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), **Southerness** (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 Southerness. (Richard Mearns)

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 lactua*, 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 lactua* 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, cephalapods 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.

HONEYCOMB WORM REEFS

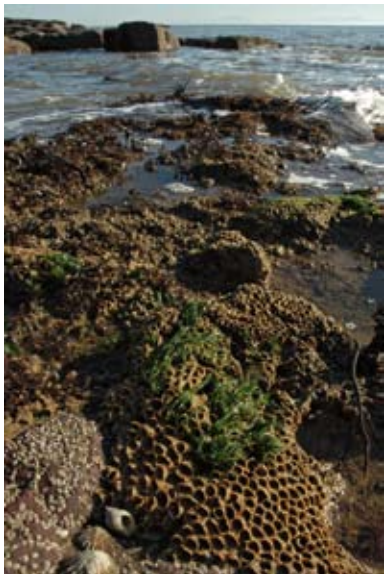
Priority Action (HWR1)

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 **Southerness** (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 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.

INTERTIDAL ROCKY SHORES

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 Southerness. 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.

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

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.

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 Southerness. 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 **Hoddom 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)

COASTAL STRANDLINES

Priority Action (CS1)

Raise awareness of the importance of coastal strandlines and the potential impacts that may result from physical damage/removal of them by including information in publications or interpretation panels.
Lead Partner: Solway Firth Partnership/Scottish Natural Heritage.

Strandline at Carrick, Fleet Bay. May 2008. (Richard Mearns)

1. Habitat Description

1.1 Physical Characteristics

Coastal strandlines occur on all low-lying coasts where space allows the accumulation of tidal debris. This includes sandy beaches, intertidal rocky shores, shingle beaches and saltmarshes. Extreme high tides mean that this zone may extend several metres landward of the normal high water mark. **Seaweed** usually forms the bulk of strandline material, but **driftwood** is also usually present.

Vegetated strandlines occur on sandy or shingle beaches and consist of various specialist plants - mostly annual species. Their seeds are washed in by the tide and protected by strandline debris from excessive evaporation and extremes of temperature (midday temperatures may be 20ºC higher in open sand) until they germinate. The development and botanical composition of strandline communities often varies considerably from one year to another.

1.2 National and International Context

Stretches of coast where seaweed, driftwood and other organic debris accumulates in sufficient quantity to support a full strandline flora and fauna are not common in the UK.

2. Dumfries & Galloway Status

2.1 Recent Trends

There has been an increasing tendency to regularly remove strandlines on beaches using mechanical methods. This has arisen as a result of increasing amounts of unsightly litter being washed up within strandlines, as well as a lack of understanding of the ecological and environmental importance of natural strandline material. Mechanical beach 'cleaning' is now carried out on several beaches in the west of the region.

2.2 Current Distribution

Strandlines occur on much of the Dumfries & Galloway coastline, being absent only where coastal cliffs and slopes directly abut the sea. They are perhaps commonest on the more exposed coasts of the west.

2.3 Associated Habitats

A number of habitats occur in close association and/or overlap with coastal strandlines, and the following action plans may also contain relevant information: Intertidal Rocky Shores, Coastal Shingle Beaches, Coastal Sandy Beaches, Coastal Saltmarshes (Merse).

3. Importance for Associated Species

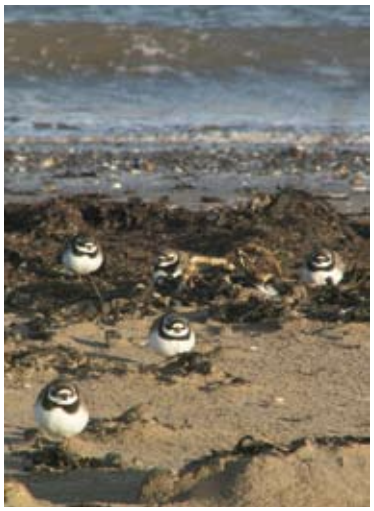
3.1 Invertebrates (very high importance)

A large number of common invertebrates frequent coastal strandlines including spiders such as *Pardosa purbeckensis;* ground beetles such as *Broscus cephalotes, Dicheirotrichus gustavi* and *Pogonus chalceus;* and several species of rove beetle and kelp fly. Of greatest abundance are sandhoppers *Talitris saltator.* The richest communities occur in thick, wet and rotting **seaweed** rather than amongst small amounts of dry weed. These invertebrates are the main prey items for birds feeding on strandlines.

Scarce and rare invertebrates also occur. The Mouse-eared Snail *Ovatella myosotis* is found in muddy sheltered places at high tide level in brackish estuaries and saltmarshes in Dumfriesshire, often under **driftwood** and other flotsam. Indeed, a number of invertebrates, especially beetles, feed preferentially or exclusively on sea-soaked wood on the strandline. The nationally scarce spider *Argenna patula* occurs in strandline litter on the estuary at Wigtown Bay, whilst the woodlouse *Armadillidium album* and the Sand Dart moth *Agrotis ripae* have been recorded on Luce Sands, one of their few Scottish locations. Amongst the species found below the strandline debris at Auchencairn Bay is the nationally scarce ground bug *Scoplostethus pictus*, which in the UK has a predominately southern distribution.

3.2 Birds (high importance)

Waders such as Oystercatchers *Haematopus ostralegus*, Turnstones *Arenaria interpres* and Curlews *Numenius arquata* feed on the strandline, along with passerine birds such as Rock Pipits *Anthus petrosus*, Linnets *Carduelis cannabina*, Twites *Carduelis flavirostris* and Choughs *Pyrrhocorax pyrrhocorax*. Other species roost on the strandline at high tide.



Ringed Plovers on seaweed strandline at Loch Ryan, January 2008. (Gavin Chambers)

Frosted Orache on the strandline at Brighouse Bay. June 2004. (Peter Norman)

3.3 Flowering Plants (medium importance)

Typical species of the strandline include Frosted Orache *Atriplex laciniata*, Sea Sandwort *Honckenya peploides*, Sea Rocket *Cakile maritima* and Prickly Saltwort *Salsola kali*, the latter experiencing drastic decline in some parts of Britain. The nationally scarce Early Orache *Atriplex praecox* occurs on vegetated strandlines of sand and shingle beaches, and Isle of Man Cabbage *Coincya monensis* subsp. *monensis* is virtually restricted to coasts between Liverpool and Glasgow, as well as the Isle of Man.

3.4 Reptiles and Amphibians (medium importance)

Slow Worms *Anguis fragilis* and Common Lizards *Zootoca vivipara* may occasionally forage on the strandline. In the areas where Natterjack Toads *Epidalea calamita* occur, these animals have been found using **driftwood** and other strandline materials as daytime refuges. Such refugia are very important for the toads.

3.5 Fungi and Lichens (low importance)

Few species of fungi occur in strandlines, although a small number of species occur on **driftwood**. Microfungi may be important in the breakdown of shells and other inorganic substances produced by animals.

4. Environmental, Economic & Social Importance of Biodiversity

- Through the decomposing action of invertebrates and bacteria, strandlines supply most of the organic material in the upper sections of sandy beaches. Without this organic material and the life it supports these beaches are more prone to be washed away during storms.
- Strandlines are very often the first stage in the formation of coastal sand dunes. Removal of strandlines may therefore weaken the natural protection against erosion and flooding afforded by dunes.
- In some locations, such as Balyett in Loch Ryan, birdwatchers are attracted to view birds that feed on the strandline.

Driftwood with nest holes of leaf-cutter bees. Claymoddie, Luce Bay, August 2007. (Peter Norman)

5. Factors affecting the Habitat

- **Mechanical beach cleaning** totally destroys this habitat. Even seasonal or occasional removal of the strandline will disrupt invertebrate breeding cycles.
- Use of driftwood for **barbecues and bonfires** can locally reduce invertebrate communities.
- **Recreational use** at high tide locally disturbs roosting birds.

6. Strategic Actions

6.1 Recent and current activity

- The **Marine Conservation Society** Beachwatch and Adopt-A-Beach campaigns encourage communities to monitor and clean beaches in an environmentally responsible way.

6.2 Other recommended actions

- **Avoid wholesale mechanical cleaning** of beaches, especially tidelines.
- Remove plastic litter from strandlines by **hand picking** to avoid ecological damage.
- Encourage **educational activities**, including community beach cleans.

COASTAL SHINGLE BEACHES

Priority Action (CSB1)

Assess the importance for invertebrates of coastal shingle in Dumfries & Galloway.
Target: Complete an invertebrate survey of selected beaches by 2015.
Lead Partner: Dumfries & Galloway Biodiversity Partnership.

Port of Counan, Luce Bay, with Sea Kale. August 2007. (Peter Norman)

1. Habitat Description

1.1 Physical Characteristics

The term shingle is applied to any sediment ranging in grain size between 2 mm (large sand grain size) and 200 mm (large stones). Shingle beaches form in high-energy environments where the sea can move and pile up shingle on the shore above the tideline. These beaches can have a relatively simple structure, or the shingle can form a more complex spit and multiple ridge system.

Unvegetated shingle is able to persist on beaches that are exposed to extreme environmental influences.

Above normal high tidelines, shingle can become a relatively stable area on which specific shingle vegetation can grow, adapted to conditions that are saline, mobile and poor in organic matter. **Vegetated shingle** will also establish on beaches where there is a matrix of finer material such as sand or silt, and hydrological conditions are also an important influence on vegetation. Much of the initial nutrient supply comes from rotting seaweed and other strandline vegetation, including **driftwood** washed in by the sea. Usually herb-rich open **pioneer vegetation** forms on the seaward side of shingle beaches, but **moss and lichen heath, grassland, and scrub** may form on more stable shingle further inland.

1.2 National and International Context

Coastal shingle is globally restricted to north-west Europe, Japan and New Zealand, with few occurrences outside these areas.

It is estimated that 30% of the UK coast is fringed by shingle beaches, which are widely distributed. However, most of this consists of simple, unvegetated beaches. Only 4000ha of semi-stable vegetated shingle occurs, and long stretches of partially vegetated raised shingle beaches of the type found on Luce Bay are scarce in the UK.

2. Dumfries & Galloway Status

2.1 Recent Trends

Some coastal shingle has been mechanically excavated, but the generally poor access to most of the region's important shingle beaches has protected them from excessive extraction and recreational disturbance.

2.2 Current Distribution

Most shingle beaches in Dumfries & Galloway are bounded on the landward side by raised beaches (with roads at some locations), cliffs and other maritime slopes, rocky protrusions and remnant sand dunes. On the sea-ward side they are fringed by various marine habitats including mud and sand, cobbles and boulders.

There are many unvegetated shingle or sparsely vegetated beaches, with those in Loch Ryan being of particular importance for nesting birds. The most important areas for vegetated coastal shingle are the bays of Kirkcudbrightshire from Balcary Point to Gypsy Point, and the eastern shore of Luce Bay from Carghidown cliffs to the Mull of Sinniness. Vegetated shingle is present along 35 km of the Solway Firth coastline, with 41 sites where shingle is greater than 100 m in length.

2.3 Site Examples

The eastern shore of **Luce Bay** (SAC) contains some of the most extensive and important vegetated shingle beaches in Britain. Smaller vegetated shingle beaches are found on the Kirkcudbrightshire coast, including **Rascarrel Bay** (SSSI) and **Abbey Burnfoot** (SSSI). **The Scar** in Loch Ryan, near Kirkcolm, is the most important shingle beach in the region for birds.

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with coastal shingle beaches, and the following action plans may also contain relevant information: Intertidal Rocky Shores, Coastal Strandlines, Coastal Sandy Beaches, Coastal Cliffs and Slopes.

3. Importance for Associated Species

3.1 Flowering Plants (very high importance)

Shingle sites on the Solway Firth are significant locations for 16 plant species at or near their northern or southern limits of distribution. For example, Yellow

Yellow Horned-poppy, one of several flowering plants restricted to coastal shingle. Port of Counan, July 1999. (Peter Norman)

Horned-poppy *Glaucium flavum* is at its northern limit and the nationally scarce Oysterplant *Mertensia maritima* close to its southern limit.

Pioneer vegetation, including species such as Sea Spurge *Euphorbia paralias* and Sea Kale *Crambe maritima,* can tolerate periodic movement. Other notable species include Portland Spurge *Euphorbia portlandica*, Early Orache *Atriplex praecox*, Isle of Man Cabbage *Coincya monensis* subsp. *monensis*, Ray's Knotgrass *Polygonum raii*, and Wood Vetch *Vicia sylvatica*.

The raised shingle beaches of the Solway are important for shingle **scrub,** comprising of Gorse *Ulex europaeus* and Bramble *Rubus fruiticosus* that thrives in acid conditions. Blackthorn *Prunus spinosa*, Hawthorn *Crataegus monogyna*, and Burnet Rose *Rosa pimpinellifolia* also occur, often in prostrate form on the lower shore. Rascarrel Bay has a locally unique shingle habitat that supports wet scrub composed of sallow *Salix cinerea* and Hazel *Corylus avellana*.

3.2 Invertebrates (high importance)

Many species of invertebrate are dependent upon shingle vegetation. The most interesting sites are those where the shingle extends above the normal high tide limit and is at least partially vegetated.

The larvae of the micro-moth *Scrobipalpa clintoni* feeds within the leaves of the common plant Curled Dock, but the moth was only discovered in 1965 and so far in Britain has only been recorded on sand and shingle beaches on the west coast of Scotland, including at Borgue and Cairnryan.

Driftwood on shingle beaches is usually exposed to full sunlight and drying winds. It therefore supports fewer invertebrate species than dead wood in other locations, but can be extremely important for a few species, especially for bees and wasps that feed on adjacent flower-rich grassland.

3.3 Birds (high importance)

Birds such as Oystercatchers *Haematopus ostralegus* and Ringed Plovers *Charadrius hiaticula* nest on shingle beaches and feed at the adjacent strandline and shore. The Scar at Wig Bay in Loch Ryan supports Dumfries & Galloway's largest tern colony with Common Terns *Sterna hirundo*, Arctic Terns *Sterna paradisaea,* Sandwich Terns *Sterna sandvicensis* and sometimes rare Little Terns *Sterna albifrons* nesting on the shingle. Other species roost on the strandline at high tide.

Sandwich Terns nest on undisturbed shingle beaches. Loch Ryan, April 2008. (Gavin Chambers)

3.4 Fungi and Lichens (medium importance)

There are interesting lichen communities on undisturbed upper shingle areas where no organic material has collected, and amongst pioneer vegetation. Species of *Cladonia* are most obvious, including *C. portentosa* and *C. furcata* subsp. *furcata.*

Cladonia portentosa lichen. Claymoddie shore, Luce Bay, August 2007. (Peter Norman)

3.5 Reptiles and Amphibians (medium importance)

All three Scottish reptile species are found on coastal **vegetated shingle**.

3.6 Non-flowering Plants (low importance)

Mosses and liverworts may be totally absent from mobile shingle, but some species occur on more stable **vegetated shingle** beaches including Broom Fork-moss *Dicranum scoparium* and Neat Feather-moss *Scleropodium purum*.

4. Environmental, Economic & Social Importance of Biodiversity

Shingle beaches are found on exposed coasts with high-energy waves. They therefore provide important protection against coastal erosion, including protection for several roads and houses.

5. Factors affecting the Habitat

- Disruption of the dynamics of shingle beach processes by coastal defence or other **construction works** that interrupts the steady supply of new shingle material.

- **Dredging** of offshore shingle/gravel ridges, stopping the natural addition of this material to the shingle beaches.
- Damage by gravel and sand **extraction** for private and commercial purposes.
- Several sites, including those containing significant plant species, have no formal conservation status and are at risk from **dumping** of building rubble, garden waste and household rubbish, unauthorised **parking** or disturbance from inappropriate **recreational use.**
- **Non-native species**, especially Japanese Knotweed, have invaded some areas of shingle.
- **Wash from high speed ferries** may cause erosion and disturbance to bird colonies in Loch Ryan.
- There is a **lack of understanding** of the value of shingle areas.
- **Climate change** may threaten a number of Dumfries & Galloway's coastal shingle beaches.

Carline Thistle, with bumblebee Bombus terrestris. Port of Counan, August 2007. (Peter Norman)

6. Strategic Actions

6.1 Recent and current activity

- SNH commissioned an **Inventory of Shingle Vegetation Survey** in the Solway in 2000.
- The first phase of the Dumfries & Galloway **Shoreline Management Plan** was published in 2005. This identifies important shingle beaches and the protection they provide against erosion.
- Some areas have been given protection through statutory **designations.**

6.2 Other recommended actions

- **Manage pedestrian and vehicle access** to coastal shingle areas to minimise disturbance.
- **Discourage tipping** of garden and household waste on shingle areas.
- Undertake a **baseline survey** of breeding birds on shingle areas.
- **Raise awareness** of the importance of coastal shingle through educational events and publications.

COASTAL SANDY BEACHES

Priority Action (CSB1)

Encourage people to visit and enjoy coastal sandy beaches and their associated habitats and learn about their biodiversity and sustainable management.
Target: Produce a guide to Dumfries & Galloway's beaches, including their biodiversity, by 2012.
Lead Partner: Solway Firth Partnership.

White Port Bay at the mouth of Rough Firth. June 2005. (Peter Norman)

1. Habitat Description

1.1 Physical Characteristics

Sand is a homogeneous habitat in comparison to rock, and sandy beaches may appear flat, featureless and empty of life. However, the majority of life remains permanently buried under the surface. The nature of the beach is largely determined by wave action, and this has an important influence on biodiversity.

Sheltered beaches are steep with **coarse sands** that drain well and dry rapidly. The sand tends to be clean and hold little organic content. In the most extreme examples, biodiversity is limited.

Wave exposed beaches are flat with low profiles and **fine sands** that take longer to be flushed by seawater, but have lower oxygen levels. They accumulate organic material that fuels teeming bacterial populations, which supports an enormous biomass of other life.

Most beaches are intermediate between coarse and fine sands, or have different conditions in different parts of the beach. Some beaches may even change from one sediment type to another and back again.

1.2 National and International Context

Sandy beaches are widespread around the coast of the UK.

2. Dumfries & Galloway Status

2.1 Recent Trends

Dumfries & Galloway's coastal sandy beaches remain largely unspoilt by major developments.

2.2 Current Distribution

Most of Dumfries & Galloway's sandy beaches are located to the west of Southerness.

2.3 Site Examples

The most extensive sandy beaches are found around **Sandhead** at the head of Luce Bay, and between **Southerness** and **Mersehead**. There are also notable beaches at **Sandyhills, Sandgreen, Port Logan** and **Broadsea Bay**, along with a number of other smaller beaches.

Sea Sandwort, a pioneer coloniser of sandy beaches. Brighouse Bay, June 2004. (Peter Norman)

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with coastal sandy beaches, and the following action plans may also contain relevant information: Intertidal Sand and Mud Flats, Coastal Strandlines, Coastal Shingle Beaches, Coastal Sand Dunes.

3. Importance for Associated Species

3.1 Invertebrates (high importance)

Though some invertebrate groups are rare or absent from sandy beaches, bristleworms *Polychaete*, bivalve molluscs and amphipod crustaceans are abundant and total biomass may be enormous. Most species are tiny, but these vastly outnumber the larger invertebrates. The upper shore of free-draining beaches of **coarse sand** is a hostile environment for marine life and only a few burrowing invertebrates such as amphipods *Bathyporeia* spp, an isopod *Eurydice pulchra* and a tube worm *Scolelepis squamata* are likely to occur to any extent.

A small number of terrestrial invertebrates also occur, such as a ground beetle *Dyschirius thoracicus* recorded on bare sandy shores in Kirkcudbrightshire. A few species are associated with vegetation, but this is of minor importance in comparison to the fauna associated with dead material on the strandline.

3.2 Flowering Plants (medium importance)

On more stable sands, usually at the top of the beach, a number of pioneer plants are able to secure a foothold. These include Frosted Orache *Atriplex laciniata,* Sea Sandwort *Honckenya peploides,* Sea Rocket *Cakile maritima* and Prickly Saltwort *Salsola kali.* The latter species has undergone a dramatic decline in some areas, possibly as a result of recreational pressure.

Sea Rocket. Ardwell Bay, September 2007. (Peter Norman)

Sanderlings are mainly seen on Solway beaches in the spring and autumn. (Gordon McCall)

3.3 Birds (low importance)

Sandy beaches are of low importance for birds compared to intertidal sand and mud flats. The main specialists are Sanderlings *Calidris alba,* though most of these birds pass through Dumfries & Galloway only during a few weeks each spring and autumn. Other waders, gulls and terns occasionally feed and roost on sandy beaches.

3.4 Fishes (low importance)

Dragonets *Callionymus lyra* are found partly buried in very shallow waters on sandy beaches. Lesser Weavers *Trachinus draco* are active at night but spend the day buried in sand, except for their backs and dorsal fins, which can give a painful sting if trodden on.

3.5 Fungi and Lichens (low importance)

Some tiny fungi are adapted to live on detritus in the upper layers of sandy beaches, producing miniature fruitbodies attached to grains of sand.

4. Environmental, Economic & Social Importance of Biodiversity

Sandy beaches have a very high recreational, tourism and landscape value.

Seemingly barren beach - the biodiversity is all buried in the sand. Ardwell Bay, July 2006. (Peter Norman)

5. Factors affecting the Habitat

- The **driving of vehicles** on sandy beaches can damage fragile communities.
- **Litter** is more of an eyesore than a threat to biodiversity, but in some cases can affect wildlife.
- **Mechanical beach cleaning** can damage biodiversity and disrupt natural beach processes.

6. Strategic Actions

6.1 Recent and current activity

- A number of beaches are designated **Bathing Waters** where water quality is monitored to ensure that it meets required standards. Beaches have shown a gradual improvement since monitoring began.
- A few beaches have been adopted by community groups under the **Marine Conservation Society**'s Adopt-a-beach campaign.

6.2 Other recommended actions

- **Avoid wholesale mechanical cleaning** of beaches, especially tidelines.
- Encourage **educational activities**, including community beach cleans.
- **Promote the natural importance** and sustainable management of Dumfries & Galloway's beaches.

COASTAL SAND DUNES

Priority Action (CSD1)

Improve habitat quality of coastal sand dunes.
Lead Partner: Defence Estates/Scottish Natural Heritage.

Lyme Grass and Marram Grass on embryo dunes at Back Bay, Monreith. May 2006. (Peter Norman)

1. Habitat Description

1.1 Physical characteristics

Sand dunes develop on coasts where there is an adequate supply of sediment within the size range 0.2 to 2mm. The critical factor is the presence of a beach that dries out at low tide and where the sand grains are blown onto the land by the wind. Vegetation prevents dispersal of the sand. Some dunes occur in narrow coastal strips where geological factors limit sand availability, but others extend well inland.

Embryo dunes form a transitional zone at the top of sandy beaches. They are colonised by pioneer plants able to cope with wind, salt and drought conditions. Further inland **foredunes,** sometimes called yellow dunes, are actively building dunes. Constant sand burial and sea spray restricts the range of plants. **Fixed dunes**, or grey dunes, are more sheltered and stable environments, but still have a very shallow and fragile soil with a very low water content.

The high calcium content of **dune grasslands** results from the breakdown of shells, and results in a species-rich habitat. However, in locations without shell sand a more acidic plant community can develop, often **dune heath** dominated by Heather.

Dune slacks are areas of wetland within the dune system. They can include seasonal pools, swamps and fens. **Dune scrub** develops in both dry and wet areas of the dune system, with willows dominating in the latter.

1.2 National and International Context

Coastal sand dunes have a wide distribution throughout Europe. Around 50,000ha of dune habitat is widely distributed around the British coastline with around 31,000ha in Scotland. In Britain 43 sites exceed 50ha and are considered to be of national importance.

An estimated 689ha is currently found in Dumfries & Galloway, comprising of 2ha of embryo dune, 32ha of foredune, 253ha of acidic fixed dune grassland, 37ha of neutral-calcareous fixed dune grassland, 192ha of dune heath and bracken, 2ha of dune slack, 133ha of other dune wetland and 38ha of dune woodland and scrub.

2. Dumfries & Galloway Status

2.1 Recent Trends

The biodiversity value of sand dunes has increasingly become recognised and little deliberate loss or damage has occurred in Dumfries & Galloway in the last decade. Some dunes have, however, experienced coastal erosion.

2.2 Current Distribution

Sand dunes are restricted to the coastline from the Nith estuary westwards.

2.3 Site Examples

Torrs Warren (SAC/SPA/Ramsar/SSSI) encompasses the largest and most complex beach and dune system in southern Scotland. It is predominantly acidic dune heath with slacks and some dune grassland, and is outstanding for its geological, botanical, entomological and ornithological interest.

A narrow belt of Marram-dominated dunes occurs from **Southerness to Mersehead** (SSSI) and at **Port Logan** (LWS). At the head of **Brighouse Bay** (SSSI) there is a small area of embryo dunes and dune grassland. Narrow belts of dune habitat occur elsewhere on the Galloway coast, for example at **Sandyhills Bay**, **Almorness**, **Fleet Bay**, **Monreith**, and **Killantringan Bay.**

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with coastal sand dunes, and the following action plans may also contain relevant information: Coastal Sandy Beaches, Scrub Woods.

3. Importance for Associated Species

3.1 Invertebrates (very high importance)

Foredunes contain a small but specialised invertebrate fauna. Two species of moth are virtually restricted to this habitat. The Coast Dart *Euxoa cursoria*, which feeds on dune plants such as Sea Sandwort, Sand Couch and Early Hair Grass, has been recorded rarely in Dumfries & Galloway; the nationally scarce Belted Beauty *Lycia zonaria* has yet to be confirmed in Dumfries & Galloway but may occur on foredunes.

Coastal sand dunes are better suited to support warmth-loving invertebrates than any other habitat. A common ground beetle *Calathus mollis* is almost exclusively found in **fixed dunes,** with records from Kirkcudbrightshire and Wigtownshire. A spider-hunting wasp *Evagetes crassicornis* has been recorded at Torrs Warren, in one of only six 10km squares in Scotland, whilst Dune Robberfly *Philonicus albiceps* and Pied-winged Robberfly *Pamponerus germanicus* are near their northern limits in Galloway. Dunes are especially important for bees and wasps, with bare sand of particular value for hunting and burrowing. A mining bee *Colletes fodiens* is present at its only Scottish site at Torrs Warren, although its relative the Northern Colletes Bee *Colletes floralis* has not been refound recently. Fox and Emperor Moths *Macrothylacia rubi* and *Saturnia pavonia* occur on **dune heaths**, as well as other heathland.

Lichen-covered foredunes at Torrs Warren. June 2007. (Peter Norman)

Narrow-mouthed Whorl Snails *Vertigo angustior* are restricted to moist places with short grasses, mosses or low herbs that are quickly warmed by the sun. In Dumfries & Galloway they are found only on marshy **dune grassland** behind dunes at Almorness. The first Scottish record of a nationally scarce money spider *Mecopisthes peusi* was found at Mersehead in 2001.

3.2 Flowering Plants (very high importance)

Sand dunes, especially **foredunes,** form a very hostile environment and flowering plants require adaptations to aid survival, such as the spreading rhizomes of Sand Couch *Elytrigia juncea*, the succulent leaves of Sea Spurge *Euphorbia paralias*, and the fleshy tap root of Sea Holly *Eryngium maritimum*. Growth of Marram Grass *Ammophila arenaria* is stimulated by being covered in sand, whilst Lyme Grass *Leymus arenarius* with its ability to roll its leaves in dry weather, is one of the principal dune-builders.

Perennial Flax at its only Scottish locality on dune grassland at Brighouse Bay. June 2004. (Peter Norman)

Although **fixed dunes** have a greater range of species, many are still highly specialised. Sand Sedge *Carex arenaria* colonises and stabilises with the help of a fast-growing rhizome. The grass *Bromus hordeaceus* subsp. *thominei* has been recorded in Dumfries & Galloway only at Torrs Warren.

Coralroot Orchid *Corallorhiza trifida* has been recorded in the **dune slacks** at Torrs Warren, its only recent site in the region. Common Wintergreen *Pyrola minor* is also found here.

Perennial Flax *Linum perenne* is abundant at its only Scottish site on the **dune grassland** at Brighouse Bay, and within Dumfries & Galloway Pyramidal Orchid *Anacamptis pyramidalis* is only regularly found here and at Port Logan.

3.3 Reptiles and Amphibians (very high importance)

Natterjack Toads *Epidalea calamita*, commonly breed in dune slacks in Britain, but in Dumfries & Galloway more commonly occur in association with saltmarshes. They are found in dunes only in the Southerness to Mersehead area. Great Crested Newts *Triturus cristatus* are known to breed in the slacks at Torrs Warren.

All three Scottish reptiles, Adders *Vipera berus*, Common Lizards *Zootoca vivipara* and Slow Worms *Anguis fragilis* are regularly recorded from dune systems in Dumfries & Galloway.

3.4 Fungi and Lichens (high importance)

Few fungi are associated with mobile sand, but a number of dune specialists are found on **fixed dunes**, including Dune Brittlestem *Psathyrella ammophila*. Some species may enable pioneer dune grasses to capture essential elements such as phosphorus. A rare birds-nest fungus *Cyathus stercoreus* has been recorded on rabbit dung amongst Marram at Torrs Warren. Fixed dunes and **dune heaths** are also important for lichens, particularly species of *Cladonia* that give the dunes their grey appearance. **Slacks** are the most important dune habitat for fungal diversity, though relatively few species are restricted to this habitat.

Moor Club Clavaria argillacea. Torrs Warren, November 2007. (Peter Norman)

3.5 Non-flowering Plants (high importance)

Mosses and liverworts thrive on bare patches of calcium-rich sand, which naturally occur on **foredunes** where cycles of erosion and re-deposition provide fresh surfaces of bare damp sand. Sand-hill Screw-moss *Syntrichia ruralformis* is one of the first to colonise, forming extensive mats that bind the sand together. Once these areas become colonised by larger flowering plants the bare sand disappears and the habitat becomes less suitable. Yellow Crisp-moss

Dune heath, scrub and slack at Torrs Warren. June 2007. (Peter Norman)

Tortella flavorirens is exclusively coastal in Britain. Although it can be found below cliffs and sometimes in crevices in coastal rocks it is most abundant in calcareous sand dunes, usually on fairly stable sand. Several bryophytes are also found in **dune slacks.**

3.6 Birds (medium importance)

No birds are entirely restricted to dunes, but a number of species breed here as well as in other habitats. These include Skylarks *Alauda arvensis* and Linnets *Carduelis cannabina.* Others such as Common Kestrels *Falco tinnunculus*, Short-eared Owls *Asio flammeus,* and Barn Owls *Tyto alba* hunt over dunes.

3.7 Mammals (low importance)

The mammal fauna consists of common and widespread species, such as Field Voles *Microtus agrestis*, Rabbits *Oryctolagus cuniculus*, and Foxes *Vulpes vulpes*. In the absence of livestock, Rabbit grazing may be important in maintaining some plant and invertebrate communities.

3.8 Fishes (low importance)

Dune slacks that hold permanent water support common fish species such as Three-spined Sticklebacks *Gasterosteus aculeatus*.

4. Environmental, Economic & Social Importance of Biodiversity

- Coastal sand dunes provide natural protection against erosion and flooding. For example, Southerness golf course receives considerable protection from the adjacent dune system.
- A number of dune systems occur behind popular bathing beaches, such as Sandyhills and Brighouse Bay, though they are not frequently used by visitors other than to access the beach.

Mating Dark Green Fritillary butterflies on dune heath. Torrs Warren, June 2007 (Peter Norman)

5. Factors affecting the Habitat

- The continued **supply and movement of sand** within the site is fundamental to maintaining the diverse conditions on the site. Sand is supplied by onshore currents and moves landward over time.
- **Mechanical beach cleaning** removes vegetation behind which sand would normally accumulate.
- **Military use** and construction of military facilities at Torrs Warren has damaged some dune habitat. However, military use is likely to have protected it from greater damage from other land uses.
- **Forestry** is not widespread on dunes in the region. Only a relatively small part of Torrs Warren has been planted with conifers, and even here an interesting flora and fauna remains.
- Few of the region's dunes have any form of managed **grazing**. Light grazing with suitable livestock can maintain a diverse vegetation structure and benefit invertebrates.
- Deliberate **burning** of dune heaths has been used as a management tool in the past, but produces few benefits for the habitat. Burning of rank ungrazed heather may result in serious damage. There is also a risk from accidental fires.
- Dumfries & Galloway's dunes do not suffer badly from non-native invasive species, as in some other parts of the UK. However, **bracken and scrub invasion** has been a problem at Torrs Warren.
- Public access can be beneficial on ungrazed sites, but dunes can be damaged by heavy **recreational use.** Provision of boardwalks and the fencing of sensitive areas can control excessive trampling and erosion, though use of tanalised fences and galvanised wire can damage bryophytes. Use of trail bikes has been noted at Southerness, and is extremely damaging.
- Increasing sea levels and storm frequency resulting from **climate change** can cause foreshore steepening and increased wave attack at the base of dunes, resulting in erosion.

6. Strategic Actions

6.1 Recent and current activity

- The most important sand dunes in the region are protected from significant damage through a range of statutory and non-statutory **designations**. This does not, however, always ensure positive habitat management.
- Sands dunes are included within the **Luce Bay and Sands SAC** management scheme and process.
- The **West Freugh Conservation Group** aims to balance potentially conflicting land uses at Torrs Warren.
- **Erosion control**, through fencing and planting of Marram Grass has been carried out by Southerness Golf Course.
- **Visitor management** at Sandyhills Bay involves boardwalks on well-used access routes. At Brighouse Bay, previous parking on dune grassland has been prevented, though responsible access on foot encouraged through provision of gates and interpretation.
- Low-intensity **grazing management** at Brighouse Bay has been reinstated.

6.2 Other recommended actions

- Consider restoration of sand dunes at Torrs Warren through **removal of conifer plantations.**
- Examine the feasibility of **grazing reintroduction** at selected sites.
- Arrange guided walks and **environmental education** activities and publications.
- Conduct **invertebrate surveys**. These would be highly likely to result in the discovery of new species for the region.

COASTAL SALTMARSHES (MERSE)

Priority Action (CSM1)
Continue with current management.

Southwick Merse, August 2007. (Richard Mearns)

1. Habitat Description

1.1 Physical Characteristics

Saltmarshes are areas of specialised vegetation periodically inundated by the tide, often exposed to high daytime temperatures, and with poorly aerated soil. They develop on the middle and upper tidal levels of intertidal mud and sand areas, where fine sediments offer a substrate in a low energy stable environment conducive to the growth of salt tolerant flowering plants (halophytes). Once established, the plants slow water flow and thus increase sedimentation. Usually saltmarsh establishes in sheltered situations within estuaries and behind coastal shingle bars, but some examples are on the open seashore.

Vegetation varies with climate and the frequency and duration of tidal inundation. **Pioneer saltmarsh** vegetation colonises sand and mud flats and is an important precursor of more stable saltmarsh, where, grazing by domestic livestock is particularly significant in determining structure and species composition. **Lower saltmarsh** may be species poor, but on **mid and upper saltmarsh** there is more variation, with the upper marsh forming transitions with reed communities and freshwater grasslands.

A range of small-scale landforms is associated with saltmarshes. In various places the erosional edge of the saltmarsh forms a **saltmarsh cliff** 2-3m high. Tidal water flows in and out of the areas of saltmarsh through **creeks** and runnels that add to the structural diversity and provide a range of microhabitats. The Solway marshes provide the finest British examples of **marsh terraces** formed by the process of creek migration, storms, tidal cycles and geological uplift. Saltmarsh sediment has a very high salt content that decreases towards the upper shore, but salt may accumulate in patches to produce areas of marsh with few plants called **saltpans**.

1.2 National and International Context

Saltmarshes occur on the North Sea, English Channel and Atlantic shores of Europe. There are approximately 29,000ha of saltmarsh in the UK, with around 6,750ha in Scotland. A significant proportion of Scotland's saltmarsh, approximately 2,000ha, is found on the Solway.

2. Dumfries & Galloway Status

2.1 Recent Trends

There has been little pressure recently for improvement of marshes for agriculture.

2.2 Current Distribution

Extensive saltmarshes are found in the inner Solway and Wigtown Bay, but smaller areas occur in most of the region's estuaries, and occasionally on more exposed coasts.

2.3 Site Examples

Almost 3,000ha of saltmarsh are found on several sites in the inner Solway Firth (SAC/SPA/SSSI). On the Scottish side of the estuary this includes sites at **Browhouses, Dornock, Annan, Priestside Bank, Caerlaverock** (NNR), **Kirkconnell Merse, Carse Bay, Green Merse** and **Southwick Merse**. Several sites show a complete sequence from pioneer to upper saltmarsh and transitions to freshwater habitats. The greatest extent of saltmarsh in the outer Solway is c450ha at **Wigtown Bay** (SSSI/LNR). Smaller areas include c135ha in **Rough Firth** and **Auchencairn Bay** (SSSI), c75ha in **Kirkcudbright Bay,** c25ha in **Fleet Bay** and c35ha in **Luce Bay**.

2.4 Associated Habitats

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

3. Importance for Associated Species

3.1 Birds (very high importance)

A number of other wildfowl and wading birds rely on saltmarsh for either breeding, feeding or roosting during the course of the year.

Breeding waders include Oystercatchers *Haematopus ostralegus,* Curlews *Numenius arquata* and Redshanks *Tringa totanus*, Lapwings *Vanellus vanellus* and Snipe *Gallinago gallinago.* Redshanks are particularly important as they have declined as breeding birds in many other habitats. Historically the Solway merses used to be important for breeding Dunlins *Calidris alpina*, gulls and terns although these species now rarely breed.

The entire world population of Svalbard Barnacle Geese *Branta leucopsis* feed on the saltmarshes and surrounding pastures of the Solway during the winter, along with large numbers of Pink-footed Geese *Anser brachyrhynchus* and Greylag Geese *Anser anser*. Other wildfowl such as Pintails *Anas acuta* and Wigeons *Anas penelope* feed on and around saltmarshes. Golden Plovers *Pluvialis apricaria* and Lapwings gather in mixed flocks of up to 1,000, and Peregrines *Falco peregrinus*, Merlins *Falco columbarius* and other birds of prey frequently hunt over saltmarshes during the winter.

Twites *Carduelis flavirostris are* small finches that breed in small numbers in Dumfries & Galloway. Flocks of up to 230 have been recorded on saltmarshes during the winter, although their origins are unknown.

Drying **creeks** and **pans** are often a good hunting ground for Grey Herons *Ardea cinerea*.

3.2 Flowering Plants (high importance)

The natural zones of vegetation on a saltmarsh result from the degree of inundation by incoming tides. Plants with a higher tolerance to salt and inundation are found on the lower saltmarsh, whereas those with a more limited tolerance will be found in the upper marsh. Saltmarsh vegetation also reflects the age, type of sediment and management of the marshes.

Pioneer saltmarsh is typified by species such as Common Glasswort *Salicornia europaea,* which colonise the mud flats, Annual Seablite *Suaeda maritima* and Common Saltmarsh Grass *Puccinellia maritima*. *Salicornia* beds are uncommon on a European and UK scale. These species also occur on open **creeks** and **saltpans**. Above the pioneer zone there is a transition to grassy **lower and mid saltmarsh** dominated by Sea Milkwort *Glaux maritima,* Sea Arrow-grass *Triglochin maritimum,*

Sea Lavender at Auchencairn Bay. August 2008. (Peter Norman).

Sea Plantain *Plantago maritima* Red Fescue *Festuca rubra* Sea Aster *Aster tripolium* and Thrift *Armeria maritima.* Common Sea Lavender *Limonium vulgare* and Lax-flowered Sea Lavender *Limonium humile*, both at the northern edge of their ranges, are found on ungrazed or lightly grazed marshes.

Sea Milkwort, Ringdoo Point, Luce Bay. June 2007. (Peter Norman).

The **upper saltmarsh** is dominated by extensive grazed communities of Saltmarsh Grass *Puccinellia maritima* and Saltmarsh Rush *Juncus gerardii,* and tussocky patches of Sea Rush *Juncus maritimus.* It also includes Sea Wormwood *Seriphidium maritimum*, the uncommon Seaside Centaury *Centaurium littorale* and Lesser Centaury *Centaurium pulchellum* at northern edge of its range, as well as many plants that are not specialist salt-tolerant species, including the nationally rare Holy Grass *Hierochloe odorata.*

Saltpans and **creeks** are usually species poor, but on their fringes can be found Saltmarsh Flat Sedge *Blysmus rufus,* Brackish Water Crow-foot *Ranunculus baudotii and* Sea Purslane *Atriplex portulacoides*, the latter at the northern edge of its range.

3.3 Reptiles and Amphibians (high importance)

More than 15% of the UK population of the internationally uncommon Natterjack Toad *Epidalea calamita* is found in Dumfries & Galloway. In many parts of Britain this species is associated with sand dunes and lowland heaths, but at its northern limit in Britain the north Solway population is centred upon **upper saltmarshes** from east of Powfoot to Mersehead.

3.4 Invertebrates (high importance)

The invertebrate fauna is especially rich in the **upper saltmarsh** zone. Though most species are of terrestrial rather than marine origin, many are specialists in this habitat, including a spider *Pardosa purb*eckensis, and the ground beetles *Dyschirius nitidus, D. salinus, Bembidion minimum*, and *B. normannum*, which have all been recorded in Dumfries & Galloway.

The Tadpole Shrimp *Triops cancriformis* was known in Dumfries & Galloway from Southwick in 1945, but was considered lost when this area was eroded by the sea in 1960. It was rediscovered in a small seasonal upper **saltmarsh pool** at Caerlaverock in September 2004. It is known only from one other site in Britain, a single freshwater pond in the New Forest.

The commoner saltmarsh invertebrates provide food for large numbers of waders, wildfowl and other birds.

3.5 Fungi and Lichens (medium importance)

Saltmarsh provides a specialised habitat in which fungi play an important, though not obvious, role. A number of micro species are associated with saltmarsh plants and soil, and a few larger species and lichens also occur, although few are restricted to this habitat. In some areas there is a local tradition of collecting field mushrooms *Agaricus spp.* from the merse.

Tadpole Shrimp caught at Caerlaverock. October 2004. (Wildfowl & Wetlands Trust).

3.6 Non-flowering Plants (medium importance)

British saltmarshes support relatively few mosses and liverworts. A few species can tolerate the high salinity, such as *Hennediella heimii,* which is more frequent here than in any other habitat. **Lower saltmarsh** may be totally devoid of bryophytes, though the Solway provides virtually the only UK records of *Pseudephemerum nitidum* in this habitat. Most species are found in **mid to upper saltmarshes**, especially where grazed and flushed with freshwater.

Various microscopic algal species of the genus *Vaucheria*, are found on Solway saltmarshes sometimes forming large green mats. Most occupy slightly different niches, including **creeks** and brackish waters. Although under-recorded, some of these species are rare elsewhere in Britain.

3.7 Fishes (low importance)

The widely fluctuating salinity of **saltpans** restricts their use by fish, but juvenile Flounders *Pleuronectes flesus* are more tolerant than most and can sometimes be found in these pools, along with Three-spined Sticklebacks *Gasterosteus aculeatus*.

3.8 Mammals (low importance)

Brown Hares *Lepus europaeus* and other mammals are often seen on saltmarshes, but no species are particularly dependent on this habitat.

4. Environmental, Economic & Social Importance of Biodiversity

- Saltmarshes act as a valuable natural flood-defence, dissipating wave energy and reducing scour.
- Saltmarshes provide valuable grazing for sheep and cattle. In some areas saltmarsh lamb has been specifically marketed as a very high quality product.
- Wildfowling takes place on many saltmarshes in Dumfries & Galloway, with visiting wildfowlers providing economic benefits to local businesses during the winter months.

5. Factors affecting the Habitat

- **Grazing** by domestic stock has historically been practised on Dumfries & Galloway's saltmarshes, restricting many species to creek banks that are less accessible to livestock. High grazing pressure results in a short grassy sward favoured by geese, but previously grazed saltmarshes, if abandoned, become dominated by rank grasses in the mid to upper marshes, which have limited botanical diversity. Overgrazing by sheep is highly unsatisfactory for most invertebrates and most breeding birds.
- **Destruction of the natural terrestrial transition** affects many saltmarsh species that specialise in the upper zones of saltmarsh, some of which are only tidally inundated by the highest tides.
- **Cordgrass colonisation** of open mud in Auchencairn, Orchardton Bays, Fleet Bay, Nith Estuary and Rough Firth occurred rapidly during the late 20th century producing extensive monoculture swards of reduced wildlife value. This expansion continues, albeit at a slower rate. Some colonised areas have steadily built in height and progressively been transformed into more typical saltmarsh communities, though some new clumps of cordgrass have also been detected.
- **Erosion** has been rapid on some areas of saltmarsh in the region in recent years, though for the Solway as a whole accretion may be balancing erosion. At Eastpark, Caerlaverock there has been a substantial gain in pioneer saltmarsh, with 67ha accreting between 1999 and 2006 and no significant losses.
- Saltmarsh is vulnerable from **pollution** of the estuaries it fringes, particularly oil spills and subsequent clean up operations. Waste tipping, sewage effluent and agricultural run-off also alter the flora and fauna of the saltmarsh.
- **Wildfowling** can affect numbers of birds using saltmarshes to feed and roost.
- **Sea level rise** and maintenance of sea defences may cause coastal squeeze (loss of upper and lower habitat).

6. Strategic Actions

6.1 Recent and current activity

- Most saltmarsh in the region is within **SSSI designations**, with mechanisms in place to prevent deliberate losses of marsh.
- Saltmarshes are included within the **Solway European Marine Site** management scheme.
- **Scottish Natural Heritage** ran a Merse Management Scheme that aimed to integrate the needs of saltmarsh into local agricultural units. This Scheme has now been incorporated into the Scottish Rural Development Programme.
- Careful management of wildfowling is in operation in Dumfries & Galloway.
- 'New' marsh has been allowed to establish in places where retaining walls have been broken down, such as at Annan Waterfoot. In 2000, **The Wildfowl and Wetlands Trust** at Caerlaverock allowed 8ha of improved grassland to become seasonally inundated by the tide and thus change the composition of the sward, through a conscious decision not to maintain the sea wall.
- In 2001, **RSPB** completed an assessment of all larger saltmarshes in the region and provided advice on their management for breeding and wintering birds to landowners.
- **Historic Scotland** has completed an assessment survey of the coast including erosion and geomorphology and its potential impact on archaeology and paleoenvironmental aspects of the inner Solway.

6.2. Other recommended actions

- Allow undisturbed saltmarsh to undergo the **natural processes** of erosion, deposition and plant growth without intervention. In unmanaged saltmarshes, there will be a series of successional stages with a varied structure.
- **Avoid flood defence works, development, reclamation or agricultural improvement** on saltmarshes. The upper marsh will have the highest interest, but retain a full transition of vegetation types
- **Re-creation of saltmarsh** may be possible on a limited number of sites in the Solway by the breaching of sea walls or modification to allow ingress of tidal waters and encourage saltmarsh establishment. Accretion rates may also be increased or sediments stabilised at some locations in order to promote saltmarsh formation. However, there are no payments to support this at present and any plans would need to cater for a continuity of special niches. Managed realignment could raise particular problems with seepage marsh, where the hydrology may not adjust. Gains of saltmarsh using this method may be at the expense of open intertidal areas and upset local natural sediment patterns.

Saltmarsh cliff at Powfoot. July 2006. (Peter Norman)

COASTAL CLIFFS & SLOPES

Priority Action (CCS1)

Demonstrate integrated management for farming, biodiversity, recreation, and cultural heritage on coastal slopes through establishment of a coastal heath/grassland restoration pilot project, by 2012. Lead Partner: Solway Heritage/Farming & Wildlife Advisory Group/Regional Proposal Assessment Committee.

Rhins coast near Dunskey Castle. July 2006. (Peter Norman).

1. Habitat Description

1.1 Physical Characteristics

Coastal cliffs and slopes occur at the junction between land and sea, formed by land slippage and/or erosion by the sea. The underlying geology determines the variation in landforms, with vertical **hard cliffs** created by granite and sandstone. These are resistant to weathering and erosion, but may develop a range of microhabitats, including rock face vegetation and cliff crevices, as well as bare rock exposures. A few hard cliffs also have **sea caves**, some of which are flooded by the tides. **Soft cliffs,** derived from sand and clay deposits, are less stable, being actively eroded by both the sea and by freshwater running over them. They too often develop into a complex of small, distinct microhabitats.

Coastal heath near Dunskey Castle. August 2006. (Peter Norman)

Some sections of the coast have no vertical or near vertical cliffs at all, or the cliffs are interspersed with **coastal slopes.** These slopes are colonised by a variety of different communities, including **coastal heath**, **coastal grassland**, **coastal seepages**, **bracken,** and **coastal scrub and woodland.** Some of these, such as exposed maritime grasslands, are composed of many specialised species rarely found in the equivalent habitats inland, whilst in others, such as maritime woods, the main coastal effect is to modify growth form and habitat structure.

Flora and fauna is greatly influenced by exposure to the wind and salt spray, which is greatest close to the sea and least at the cliff top, although the influence of salt may extend up to 1km inland on the most exposed coasts. Aspect can have an important bearing on exposure as well as on sunlight, with southerly facing slopes often providing warm and sheltered hollows favoured by many invertebrates.

1.2 National and International Context

Sea cliffs occur discontinuously along the west facing coasts of Europe. The UK supports a significant proportion of EU sea cliffs and slopes, with approximately 4,650km, about half of which (2,373km) is found in Scotland.

2. Dumfries & Galloway Status

2.1 Recent Trends

Almost total abandonment of grazing on coastal slopes has occurred in recent decades, combined with intensification of farming on the cliff top. However, unlike many coastal cliffs and slopes in England, there are few coastal defences at cliff bases, and relatively little coastal development, caravan sites and car parks, though there are a number of moderately used coastal footpaths.

2.2 Current Distribution

Of Dumfries & Galloway's 350km of coastline, only very small areas of low **soft cliffs** occur, mostly in the inner Solway. **Hard cliffs** with vertical exposures are more typical of the outer Solway, extending very approximately to 11km. A further 97km is composed of **coastal slopes** with grassland, scrub and woodland, not including slopes behind raised beaches. **Coastal heath** occurs only in very small pockets, particularly on the Rhins. The maximum cliff height in Dumfries & Galloway is 110m at Dunman, near Mull of Galloway.

2.3 Site Examples

The **Mull of Galloway** (SAC/SSSI) is the most important site in the region for both plants and birds. Other important sites include **Portling to Castlehill Point** (part SSSI), **Balcary to Torrs Point** (SSSI), **Borgue Coast** (SSSI), **Burrow Head,** and the west coast of the **Rhins**. Important coastal scrub and woodland occurs at **Ravenshall** (SSSI) and **Southwick** (SSSI). The Solway islands – **Rough Island**, **Hestan Island**, **Little Ross** (SSSI), the **Islands of Fleet** (SSSI) and **Scare Rocks** (SSSI) all include coastal cliffs and slopes. Sea caves include **Barlocco Heughs, Dove Cave** and **Cave of Uchtriemackean.**

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with coastal cliffs and slopes, and the following action plans may also contain relevant information: Coastal Shingle Beaches, Coastal Saltmarshes (Merse), Waterfalls, Inland Rock Outcrops.

3. Importance for Associated Species

3.1 Flowering Plants (very high importance)

Hard cliffs support a limited range of species, but many are highly specialised and of restricted local and national distribution, including Rock Sea Spurrey *Spergularia rupicola*, Roseroot *Sedum rosea*, Scot's Lovage *Ligusticum scoticum*, Rock Samphire *Crithmum maritimum*, and Ivy Broomrape *Orobanche hederae*. Golden Samphire *Inula crithmoides* is found at its only Scottish location. Remnant examples of prostrate Juniper *Juniperus communis* occur on cliffs between Sandyhills and the Rhins. Ledges occupied by breeding seabirds develop a less important plant community, more able to cope with high nutrient levels. **Soft cliffs** are relatively botanically poor.

The various habitats of **coastal slopes** are botanically rich, with perhaps **coastal grasslands** being richest of all. Typically these support Thrift *Armeria maritima*, Sea Campion *Silene uniflora,* Bloody Cranesbill *Geranium sanguineum*, and Wood Vetch *Vicia sylvatica*, with Purple Milk-vetch *Astragalus danicus* and carpets of Spring Squill *Scilla verna* at some locations. Some of the more inaccessible grassy slopes support rare species such as Sticky Catchfly *Lychnis viscaria*, Purple Oxytropis *Oxytropis halleri*, Bithynian Vetch *Vicia bithynica*, Yellow Vetch *Vicia lutea,* Small Restharrow *Ononis reclinata*, and Sea Stork's-bill *Erodium maritimum.*

Typical species of **coastal heath** include Bell Heather *Erica cinerea,* Burnet Rose *Rosa pimpinellifolia* and Western Gorse *Ulex gallii*, the latter rare in the rest of Scotland. The rare Dotted Sedge *Carex punctata* is associated with **coastal seepages.**

3.2 Invertebrates (very high importance)

Soft cliffs are of outstanding national importance for invertebrates, but no studies have been made of the few sites that occur in Dumfries & Galloway.

The invertebrate fauna of **hard cliffs** is relatively modest in comparison, but where shallow trickles or films of water run over hard surfaces algae, mosses and liverworts form the base of the food chain for a small, but exceptionally specialised invertebrate assemblage including caddisflies, beetles, and flies. For example, a slender-footed fly *Liancalus virens* has been recorded in Dumfries & Galloway, but is more usually found in Devon and Cornwall. Some invertebrates are associated with carrion and guano from seabird colonies and, remarkably, the House Martin Flea *Ceratophyllus hirundinis* is almost entirely restricted to cliff nests, with just a few records from nests in coastal buildings.

Pointed Snails *Cochlicella acuta* are found on dry, grassy **coastal slopes**, mostly on the west coast of Britain, and have rarely been recorded more than a mile inland. The locally uncommon Bloody-nosed Beetle *Timarcha tenebricosa* has been recorded at Rough Firth, whilst records of the attractive, iridescent Rose Chafer *Cetonia aurata* are concentrated on the Rhins coast.

Coastal grassland is important in a Scottish and/or local context for some butterflies and moths, including Northern Brown Argus *Aricia artaxerxes*, Wall

Lasiommata megera, Grayling *Hipparchia semele,* Thrift Clearwing *Bembecia muscaeformis*, Forester *Adscita statices*, Crescent Dart *Agrotis trux* ssp. *lunigera* and Northern Rustic *Standfussiana lucernea.* The larvae of a micro moth *Agonopterix rotundella* feeds on Wild Carrot on coastal cliffs in Wigtownshire, its only Scottish location, but the Small Blue butterfly *Cupido minimus* is probably now extinct.

The nationally scarce spider *Talavera petrensis* has been recorded from **coastal heath** at the Mull of Galloway. The only other Scottish record is from Rum.

Virtually the entire Scottish populations of Speckled and Dark Bush Crickets *Leptophyes punctatissima* and *Pholidoptera griseoaptera* are found in areas of rough grassland with **coastal scrub** in Dumfries & Galloway. Scrub also provides valuable nectar sources for many insects. **Coastal woodland** may support invertebrates that are absent inland, such as the nationally scarce bark beetle *Dryocoetinus alni,* found at Ravenshall.

The Spiders *Meta menardi* and *Porrhomma convexum* are found in **sea caves**, whilst at Ravenshall is the rare cave-dwelling woodlouse *Trichoniscoides saerocensis*. Common invertebrates, such as Herald Moths *Scoliopteryx libatrix* are also occasionally found in sea caves.

3.3 Birds (very high importance)

Hard cliffs are most important for breeding birds, supporting nationally important numbers of Gannets *Morus bassanus*, Cormorants *Phalacrocorax carbo* and Lesser Black-backed Gulls *Larus fuscus* as well as regionally important numbers of Guillemots *Uria aalga*, Razorbills *Alca torda*, Shags *Phalacrocorax aristotelis*, Fulmars *Fulmarus glacialis*, Kittiwakes

Young Peregrine Falcons at Portpatrick. (Gordon McCall)

Soft, eroding cliffs are important for some invertebrates. Inner Solway, February 2008.(Richard Mearns).

Rissa tridactyla, Herring Gulls *Larus argentatus*, Great Black-backed Gulls *L. marinus*, and small numbers of Black Guillemots *Cephus grylle* and Puffins *Fratercula arctica*. Exceptionally high densities of breeding Peregrines *Falco peregrinus,* Ravens *Corvus corax* and, rarely, Choughs *Pyrrhocorax pyrrhocorax* also breed. Several colonies of cliff-nesting House Martins *Delichon urbica* occur.

Although a few birds will visit sea caves, and the scientific name of the Wren *Troglodytes troglodytes* means cave dweller, caves generally do not form an important bird habitat. Choughs will, however, nest in caves.

Coastal scrub supports perhaps the best populations of Linnets *Carduelis cannabina*, Stonechats *Saxicola torquatus*, Lesser Whitethroats *Sylvia carruca* and Common Whitethroats *Sylvia communi* in a local context. Small numbers of Twite *Carduelis flavirostris* breed on **coastal heath**.

3.4 Fungi and Lichens (high importance)

The fungal flora of coastal cliffs and slopes is rarely of major importance, usually consisting of species common in other habitats, but a broad array of lichens occurs in this habitat. In many cases quantity is more important than the quality, with some rock faces having 100% cover of typical species such as *Verrucaria maura, Caloplaca marina* and Sea Ivory *Ramalina siliquosa*. However, rare species have also been recorded including *Cladonia peziziformis* on **coastal heath** near Portpatrick, *Degelia ligulata* on rocks in **coastal seepages** at Portpatrick, *Caloplaca britannica* on nutrient-rich bird perching sites in the Rhins and *Sticta canariensis* on moist rocks or trees at Dirk Hatteraick's Cave. The **coastal woods** at Southwick and Ravenshall are particularly lichen rich.

3.5 Non-flowering Plants (high importance)

Seaside Grimmia *Schistidium maritimum* is a moss restricted in Britain to coastal rocks on northern and western coasts, usually in shallow crevices where there is some shelter or an occasional trickle of fresh water from above. It may also colonise artificial substrates. Above the influence of salt spray, there is a high diversity of mosses and liverworts, especially on cliff faces with gullies and freshwater seepages. Sea Spleenwort fern *Asplenium marinum* also finds a home in these damp crevices.

Sea caves, especially those not regularly flooded by the sea, can also be important for bryophytes. Light intensity is the critical factor here, but a few species are able to survive in the low light levels near cave entrances.

Dark Bush Crickets are at the northern edge of their range on the Galloway coast. Ravenshall, August 2007. (Richard Mearns)

On cliff tops Soft Shield Fern *Polystichum setiferum* is sometimes found, whilst Neat Crisp-moss *Tortella nitida* has been recorded in Kirkcudbrightshire. It is frequent on dry, sunny rock outcrops set just back from the sea in south west England and Wales, even forming extensive patches on wall tops in some coastal towns, but it is rare in Scotland.

3.6 Reptiles and Amphibians (high importance)

Coastal slopes support important populations of all three native reptiles, Adders *Vipera berus*, Slow Worms *Anguis fragilis* and Common Lizards *Zootoca vivipara*. Amphibians are of lesser importance in this habitat.

3.7 Mammals (low importance)

Several common species of mammal are found on **coastal slopes**. However, part of the importance of coastal cliff and slope stems from the fact much of it is free from the effects of grazing and predatory mammals.

4. Environmental, Economic & Social Importance of Biodiversity

- Coastal and marine habitats have an extremely high landscape and amenity value. Much of this habitat falls within National Scenic Areas and Areas of Regional Scenic Significance.
- Coastal cliffs and slopes have very high recreational value, and include some of the most well-walked footpaths in the region on the Colvend coast and at Balcary, Portpatrick and Mull of Galloway. The latter site includes a cliff top café.
- Coastal areas were of great importance to early people and, due to the relatively limited disturbance of such areas in recent years, many remain rich in archaeology.

5. Factors affecting the Habitat

- **Coastal protection works** prevent natural erosion processes. Hard rock faces and soft cliffs require no management.
- Reduction or cessation of **grazing** in some areas has caused an over-dominance of scrub on maritime grasslands. Overgrazing in other areas by sheep (and perhaps feral goats in a few areas) has caused a loss of plant diversity and removal of cover for nesting birds.
- Positioning of winter **cattle feeding stations** within the coastal strip reduces plant diversity.
- **Cultivation of cliff top vegetation** has truncated the natural transition between maritime and terrestrial vegetation resulting in a loss of plant diversity and limited interchange of some animal species between the coastal strip and inland areas.
- Drift from **herbicide and pesticide** sprays.
- **Burning** of gorse and other vegetation at inappropriate places and/or inappropriate times of year.

- **Eutrophication** associated with agricultural run-off and from seabird colonies, especially at Almorness and Murray Isles.
- **Clearance of rocky outcrops** and boulders to increase grazing areas.
- **Dumping** of farm rubbish and rubble.
- Inappropriate **forestry** has affected a few sites.
- Moderate use of footpaths by walkers can be of benefit, especially in the absence of grazing, but **excessive trampling** may cause damage.
- **Rock climbing** can disturb nesting birds or damage flora.
- Adjacent **developments** in the form of caravan sites and golf courses may increase disturbance and trampling.

6. Strategic Actions

6.1 Recent and current activity

- Monitoring of larger seabird colonies by **RSPB** and volunteers.
- Seabird ringing by **North Solway Ringing Group**.
- Monitoring of Peregrine and Raven breeding success by **Dumfries & Galloway Raptor Study Group**.
- Sticky Catchfly population enhancement by **SWT, SNH** and **Royal Botanic Garden Edinburgh**.
- SSSI notifications have given a degree of protection.
- Reserve status or similar provides protection, and in some cases management, at Southwick (**SWT**), Rockcliffe and Murray Isles (**NTS**).
- The **Mountaineering Council of Scotland** has produced an information sheet about birds and climbing, which contains guidance on responsible climbing.

6.2 Other recommended actions

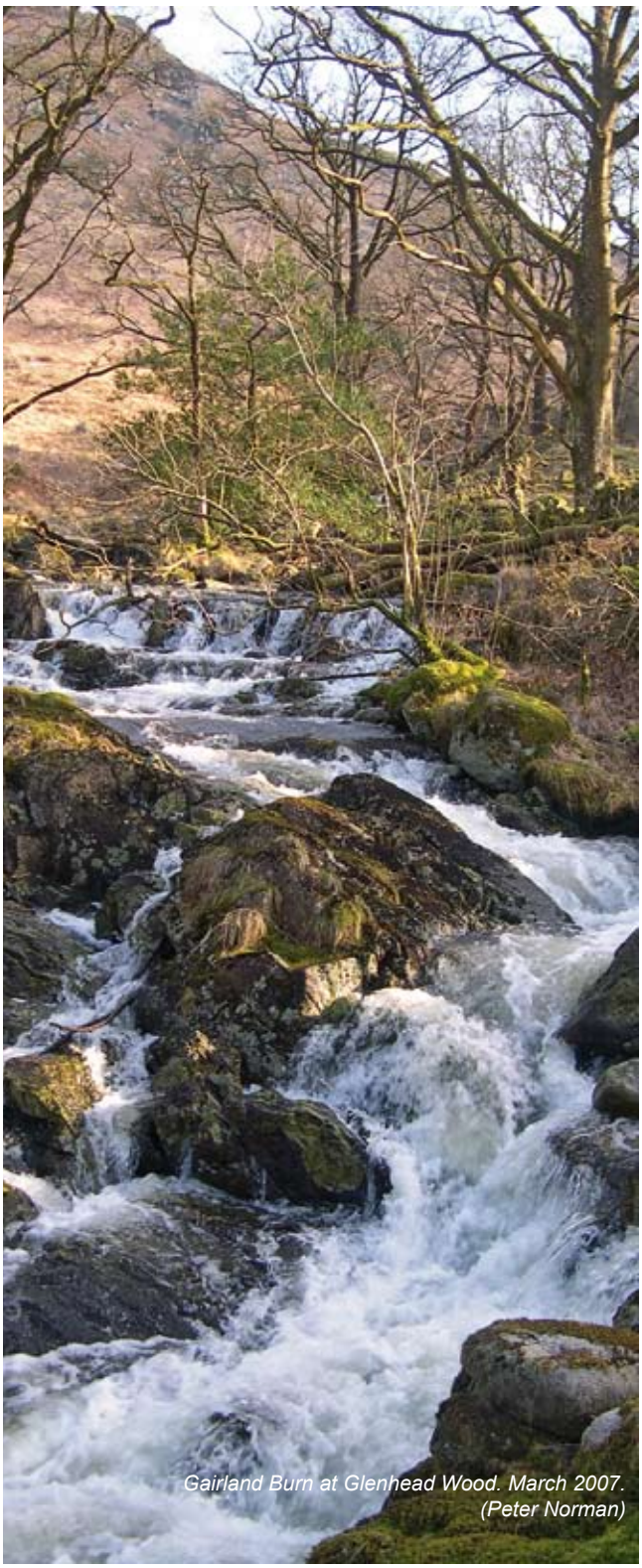
- Implement **Coastal Zone Management** strategies at local, regional and national levels.
- Encourage further **survey work and research** into the ecology of this habitat.

Sea Caves and cliffs. Barlocco, April 2007. (Richard Mearns)

RIVER HEADWATERS

Priority Action (RH1)

Encourage semi-natural habitats on the banks of river headwaters by fencing (and planting if necessary) to encourage regeneration of semi-natural habitats.
Target: 30km of river bank by 2015.
Lead Partner: Galloway Fisheries Trust/District Salmon Fisheries Boards/Regional Proposal Assessment Committee.



Gairland Burn at Glenhead Wood. March 2007. (Peter Norman)

1. Habitat Description

1.1 Physical Characteristics

Most British rivers rise in the uplands. Their headwaters are high-energy environments that flow, with irregular velocity, over steep gradients. They are characterised by narrow **river channels** with rocky bottoms strewn with boulders and other coarse channel sediments. The water is colder than in lower reaches, low in nutrients but containing higher levels of dissolved oxygen and carbon dioxide.

River banks of headwaters tend to be steep and sparsely vegetated, resulting in a high input of sediments. Although historically the banks of river headwaters may have been well wooded, this is rarely the case today. **Coarse woody debris** consists of tree trunks, root boles, logs, branches and other pieces of partially submerged wood larger than 10cm in diameter and 1m in length. It supports a range of wildlife and though it naturally occurs throughout the course of rivers, because of the narrowness of the channels, it is most common in headwaters.

1.2 National and International Context

Headwaters are common throughout Europe. Upland headwaters in Britain are mostly found in the north and west.

2. Dumfries & Galloway Status

2.1 Recent Trends

Over the last 20 years a number of projects have begun to address historical impacts on river headwaters. These include the discouragement of overgrazing, overburning and moorland drainage through agricultural grant schemes; improved forestry techniques through the Forests and Water Guidelines; and the fencing of sections of headwaters, planting of native trees and stabilisation of eroding river banks, led by fish and angling interests.

2.2 Current Distribution

Most of the region's rivers have a north to south flow. River headwaters are therefore mostly located the Southern Uplands, in the north of the region.

2.3 Site Examples

All of the region's main rivers rise in the uplands and have important associated headwaters. Examples include **Tarf Water** (SAC/SSSI) for the River Bladnoch, **Water of Trool** and **Water of Minnoch** for the River Cree**, Big Water** and **Little Water of Fleet** for the River Fleet, **Water of Ken** and **Blackwater of Dee** for the River Dee, **Scaur Water** and **Carron Water** for the River Nith, and **Moffat Water** and **Water of Ae** for the River Annan.

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with river headwaters, and the following action plans may also contain relevant information: Exposed River Shingle, Waterfalls, Upland Springs and Flushes, Blanket Bogs, Acid Grasslands, Inland Rock Outcrops, Upland Heaths, Native Wet Woods.

3. Importance for Associated Species

3.1 Fishes (very high importance)

The characteristic fish of river headwaters is the Brown Trout *Salmo trutta*. It thrives in the cold, well-oxygenated **river channels**. They, and their close

Salmon migrate upstream to spawn in the clean gravel beds of headwaters. (Laurie Campbell)

relative the Salmon *S. salar* require clean, silt free gravel beds in which to spawn. These beds, known as redds, are found upland headwaters as well as some lowland tributaries. Eels *Anguilla anguilla* are also typical of headwaters.

3.2 Non-flowering Plants (very high importance)

Due to the physical and chemical composition of river headwaters, algae, mosses and liverworts are often the dominant vegetation. Alpine Water-moss *Fontinalis squamosa* is one of the few mosses that actually grows in the water, usually in **river channels** with fast flowing water. It is recorded from several sites in Dumfries & Galloway including the River Cree, Water of Luce and Water of Ae.

On **river banks** there are many species and much variation between different watercourses, but typical bryophytes include: Yellow Fringe-moss *Racomitrium aciculare* in profusion on top of rocks in fast-flowing, base-poor headwaters; Fountain Apple-moss *Philonotis fontana* and Drab Brook-moss *Hygrohypnum luridum* by fast-flowing burns in the uplands; Water Earwort *Scapania undulata* often prominent by acid burns; and Transparent Flapwort *Jungermannia hyalina* commonly found on gritty rock ledges near water-level in stream gullies or on boulder tops in rocky rivers. On shaded damp rocks and trees, including in deep headwater valleys, is found the locally rare Wilson's Filmy-fern *Hymenophyllum wilsonii*. Tunbridge Filmy-fern *Hymenophyllum tunbrigense* occurs in similar habitats, but is very rare, possibly extinct in the region.

3.3 Invertebrates (very high importance)

Invertebrates of shallow fast-flowing waters include water bears, mayflies, caddisflies, blackflies and molluscs. The region's largest common dragonfly, the Golden-ringed *Cordulegaster boltonii* is even able to breed in such habitats. Most of these creatures live under stones and/or have flat bodies to reduce resistance to the current.

A number of notable aquatic invertebrates have been recorded in headwater **river channels** Dumfries & Galloway, including a water beetle *Hydraena pygmaea* under mossy boulders in steep streams in Galloway, with recent records from only three 10km squares

Golden-ringed Dragonflies breed in the flowing waters of headwater burns. Garroch Glen, July 1999. (Peter Norman)

Coarse woody debris in Water of Trool. Caldons, May 2006. (Peter Norman)

in Scotland. All Scottish records for River Skaters *Aquarius najas* relate to Galloway, including Water of Trool and Blackwater of Dee. The next nearest populations are in North Wales. Freshwater Pearl Mussels *Margaritifera margaritifera* once occurred in most of the region's headwaters, but now only small and vulnerable populations of this rare mollusc survive. Their larvae grow for almost a year attached to the gills of salmonid fish.

Although little research has been carried out in the UK, extensive studies in North America suggest **coarse woody debris** is of high importance for a range of specialist invertebrates. These feed directly on wood, or on the algae, bacteria and other materials on the surface of wood, or indirectly benefit from the changes coarse woody debris has to the river and stream structure. Coarse woody debris is particularly important for craneflies, with *Lipsothrix errans* particularly notable in Dumfries & Galloway. Deep pools immediately downstream of coarse woody debris dams also support mayflies *Ephemeroptera*.

A number of invertebrates, such as a ground beetle *Bembidion atrocoeruleum*, are associated with **river banks** of upland streams across the region. Overhanging vegetation on the river banks also provides an important source of invertebrate food for fish.

3.4 Birds (medium importance)

The characteristic bird of river headwaters is the Dipper *Cinclus cinclus*, which feeds underwater on mayfly and caddisfly larvae. Goosanders *Mergus merganser*, Common Sandpipers *Actitis hypoleucos* and Grey Wagtails *Motacilla cinerea* also occur.

3.5 Fungi and Lichens (medium importance)

A number of fungi, mostly micro species, are specifically adapted to river habitats. Some are specialist wood-rotters that create suitable conditions in **coarse woody debris** for invertebrates to colonise. The largest and most obvious species is the uncommon *Vibrissea truncorum*, recorded from the River Cree.

A greater range of lichens occurs on headwaters than on lower stretches of rivers, though few are restricted to this habitat. The most important areas are bouldery stretches or waterfalls, where there is much exposed rock.

3.6 Mammals (medium importance)

Water Voles *Arvicola terrestris* have declined substantially in Britain, especially in lowland areas. Although fast flowing rocky headwaters with little vegetation is a poor habitat for Water Voles, slower flowing stretches with bankside cover may provide the best remaining Water Vole habitat in the region.

3.7 Flowering Plants (low importance)

Most flowering plants are unable to gain a foothold in the **river channel** of headwaters. **River banks** are also generally species poor, though in some marshy areas with low grazing pressure species such as Grass of Parnassus *Parnassia palustris*, Heath Spotted Orchid *Dactylorhiza maculata* and Bog Asphodel *Narthecium ossifragum* occur, along with thickets of willow, including the locally scarce Dark-leaved Willow *Salix myrsinifolia*. Serrated Wintergreen *Orthilia secunda* is an evergreen herb of pine and birch woods, open moorland and on ledges in rocky gullies and stream banks, mainly in the Highlands. It was recorded at Grey Mare's Tail (Moffat) in the 1950s and next to Caldons Burn in 1962, but has not been relocated at either location.

4. Environmental, Economic & Social Importance of Biodiversity

Headwaters exert a major influence on the hydrology and quality of rivers downstream, affecting issues such as drinking water, flooding, soil erosion and fishing.

5. Factors affecting the habitat

- **Acidification**, caused by atmospheric emissions from industry and transport in other parts of the country/world. Those in the west of the region such as the Luce, Cree, Bladnoch, Fleet and Dee, have been most severely affected due to heavy rainfall levels, poor buffering capacity of the bedrock and the capacity of extensive conifer plantation to capture atmospheric pollutants.
- Prior to the implementation of recent guidelines, **conifer planting** often occurred right up to the edge of watercourses, and some of these trees still remain. They cast a heavy shade, limit vegetation growth, and expose the banks to erosion.

An aquatic lichen Dermatocarpon luridum, found on rocks in upland burns. Tarff Water, May 2008. (Peter Norman)

- Many of the upland **drainage** systems installed in the last century still operate, affecting the capacity of upland areas to mitigate peak headwater flows.
- High turbidity levels due to **inputs of fine sediments** such as clay, silt and fine sands resulting from poor management of cultivation, drainage, road building and timber harvesting. This reduces aquatic light levels, biomass productivity, fish feeding and migration, and when it settles it damages fish spawning areas.
- **Nutrient enrichment** following large scale forestry felling or application of fertiliser.
- Pollution through **agricultural and forestry chemicals or oil**, though generally not significant in the region, has the potential to pose a localised threat to headwater biodiversity.
- **Removal of coarse wood debris**, as this is often seen as potentially hazardous. Watercourses containing high amounts of coarse woody debris are therefore uncommon.

6. Strategic Actions

6.1 Recent and current activity

- Many of the factors affecting the habitat resulting from forestry practices are addressed through the Forest and Water Guidelines. In particular, forest restructuring is minimising the impact of acidification.
- River catchment plans have been completed for the Bladnoch, Nith, Annan and Dee-Ken catchments.
- As part of the Water Framework Directive, a River Basin Plan for the Solway-Tweed is in preparation and will be published by December 2009.

6.2 Other recommended actions

- Establish **more native broadleaves** along the banks of headwaters.
- **Archaeological sites** and other important features of the historic landscape may be more frequent in the uplands. Identify all such sites and ensure habitat works protect and, where possible, enhance them.
- **Carefully plan and execute all road building** in forests and other areas in the vicinity of headwaters, including choice of materials, timing of work and ongoing operational requirements. Consultation with all relevant organisations is essential.
- **Do not culvert** headwaters wherever possible.

LOWLAND RIVERS & BACKWATERS

Priority Action (LRB1)

Assess the feasibility of restoring or reinstating a river backwater system, and encourage this where appropriate.

Target: Identify potential sites for backwater restoration on one of the region's major rivers by 2012, avoiding sites currently of high biodiversity or historical importance.

Lead Partner: Scottish Environment Protection Agency/Regional Proposal Assessment Committee.

Seasonal backwater on Water of Ae, August 2004. (Peter Norman)

1. Habitat Description

1.1 Physical Characteristics

The nature of lowland river channels is dependent on the properties of the bedrock over which it flows, the nature of the flow itself, and the type and quantity of sediments it carries. Lowland rivers are highly dynamic systems: As water works its way downstream, materials are constantly transported and rearranged, meanders migrate, banks erode, new channels form and old ones are cut off. Instream and riparian wildlife has adapted to the natural flow regimes associated with individual rivers, and most rivers encompass a wide variety of habitats. The highest biodiversity occurs on unmanaged lowland rivers, particularly those associated with extensive backwater systems.

The **channel bed** in lowland rivers may be composed of a wide variety of sediment sizes from cobbles and gravels, through to silt, clay and alluvium. **Riffles**, where shallow water flows rapidly over coarse gravels, stones or boulders, are natural in-channel formations. They are constantly being reprofiled by floods so a constant supply of material is needed to maintain them. Riffles often occur in association with **pools**, areas of deeper slow-flowing water, and **runs**, where deep water flows swiftly. They are important for a range of aquatic biodiversity.

In-stream and riparian vegetation is vital for a healthy and sustainable ecosystem, especially where a watercourse has little variation in physical structure. It fulfils many functions, including water purification, nutrient re-cycling, riverbank stability and erosion protection, modification of flows, and provision of shelter, shade and food for many species.

Backwaters may be connected to the main channel at both ends and therefore have a continuous, if reduced flow; connected only at the downstream end; or lack any permanent connection to the main channel at all, such as in oxbows. The latter are usually influenced by floods to some extent. Backwaters act as refuge areas during periods of pollution.

Eroding **bankside cliffs** often occur on the outside of meanders. Though excessive erosion is damaging, the presence of some erosion features is a necessary part of river systems. Banks of exposed sand, silt and mud are also important for specialised biodiversity.

Gravel bars are included in a separate action plan for Exposed River Shingle

1.2 National and International Context

Lowland rivers are widespread throughout Britain and Europe. Similar river habitats to those found in Dumfries & Galloway are found on hard rocks in south-west England, Wales, northern England and many parts of Scotland.

2. Dumfries & Galloway Status

2.1 Recent Trends

There has been a recent trend towards more natural techniques of river engineering, though the majority of hard engineering river defences installed in the past are still operational across the region.

2.2 Current Distribution

As most of Dumfries & Galloway's rivers flow from north to south, most stretches of lowland river habitat is located in the south of the region.

2.3 Site Examples

The main rivers in Dumfries & Galloway are, from west to east, the **Water of Luce**, **River Bladnoch, River Cree, Water of Fleet, River Dee, River Urr, River Nith, River Annan, Kirtle Water, River Sark** and **Border Esk**. All have high biodiversity value, though also have some areas of degraded habitat along their course.

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with lowland rivers and backwaters, and the following action plans may also contain relevant information: Exposed River Shingle, Lowland Burns and Ditches, Waterfalls, Reedbeds, Swamps, Native Wet Woods.

3. Importance for Associated Species

3.1 Fishes (very high importance)

Under the Fresh Water Fisheries Directive, 75% of Dumfries & Galloway's watercourses are designated salmonid waters, capable of supporting Atlantic Salmon *Salmo salar* Salmon and/or Sea/Brown Trout *S. trutta*. The other 25% of watercourses are designated as ciprinid waters. This designation includes whole catchments and not just the main rivers. Indeed, many of the minor tributaries provide the redds where salmonids spawn and are an integral part of the overall catchment.

Most freshwater fish are opportunist feeders, but salmon are especially dependent on aquatic insects and crustaceans, whilst trout and other species rely on invertebrates associated with **in-stream vegetation** or that have fallen in the water from **riparian vegetation**. Eels *Anguilla anguilla* are found in a wide range of freshwaters, but seem to prefer slow moving lowland rivers with muddy bottoms and plenty of bank side vegetation. **Backwaters** are important refuges for young fish from the current of the main flow.

Most coarse fish such as Pike *Esox lucius* and Perch *Perca fluviatilis* lay their eggs on **in-stream vegetation**. Others such as Minnows *Phoxinus phoxinus* use gravely areas, such as the tail-end of **riffles**.

Sparling (otherwise known as Smelt) *Osmerus eperlanus* spend most of their life in the sea, but require unpolluted water and a sandy or gravely channel bed for spawning, around the upper limit of the tidal influence. They have declined enormously in Britain, the River Cree being one of the few remaining spawning rivers. Important populations of Allis Shad *Alosa alosa*, Twaite Shad *Alosa fallax* and lampreys are also found in the region's rivers.

3.2 Invertebrates (very high importance)

Lowland rivers support very high numbers of invertebrates – 10-15,000 per square metre of **channel bed**. Each species is well adapted to its environment. For example on rocky beds mayflies of the genus *Ecdyonurus* have strong limbs to enable them to cling onto the undersides of rocks, whilst stonefly nymphs search out crevices where turbulence is reduced. Gravel, sand and silt beds support fewer species, but burrowing invertebrates such as non-biting midge larvae occur in high density.

A large number of water beetles are associated with lowland rivers, particularly exposed **mud and silt banks** in slow flowing stretches and backwaters: *Hygrotus versicolor* was found in the River Dee in 1996, its only Scottish location; *Bidessus minutissimus,* a nationally rare species has been found in fine silt, often among plant roots, at the edge of the River Nith at Lochside; *Hydraena pulchella* occurs in clean silt on the river edge, currently known from only four rivers in Scotland; and *Heterocerus marginatus* on mud banks beside the River Urr, known from only three rivers in Scotland. Other important invertebrates of river sediments include a cranefly *Nephrotoma guestfalica* of shaded sandy banks at two sites in Dumfriesshire, out of only four in Scotland.

Emergent vegetation in **backwaters** perhaps supports the most diverse range of invertebrates, with large numbers of water fleas, caddisfly larvae,

water beetles, damselflies and water snails. The latter group includes the Flat Valve Snail *Valvata cristata,* uncommon in Scotland and restricted to well oxygenated, slowly flowing or still water with rich vegetation, especially in quiet clean backwaters.

3.3 Non-flowering Plants (high importance)

The long fronds of Greater Water-moss *Fontinalis antipyretica* are a familiar sight in **pools** and **runs** on most of the region's rivers. It is the world's largest moss. Other typical bryophytes of riverside rock or gravel include Yellow Fringe-moss *Racomitrium aciculare,* Long-beaked Water Feather-moss *Rhynchostegium riparioides*, Brook-side Feather-moss *Amblystegium fluviatile* and Water Earwort *Scapania undulata.*

Riparian vegetation supports fewer specialist species than riverside rock, but several species have been recorded in association with the silt that accumulates on tree trunks in the flood zone. These include Many-fruited Leskea *Leskea polycarpa* and River Bristle-moss *Orthotrichum rivulare.* The nationally scarce Spruce's Bristle-moss *Orthotrichum sprucei*, a riverside epiphyte of Alder, Ash, and willow where occasionally inundated, has been recorded beside Cargen Water, near Dumfries.

3.4 Flowering Plants (high importance)

Rivers with floating mats of water crowfoots, including Stream Water Crowfoot *Ranunculus penicillatus* ssp. *pseudofluitans and* Pond Water Crowfoot *R. peltatus,* are considered particularly valuable, both in their own right and in terms of the shelter and food they provide for fish and invertebrates. Other mid stream species include Yellow Water-lily *Nuphar lutea,* Intermediate Water-starwort *Callitriche hamulata* and various pondweeds and water-milfoils.

Purple Loosestrife, a typical plant of lowland river banks. River Dee at Threave, July 1994. (Peter Norman)

Otters are found on all of Dumfries & Galloway's rivers. (Laurie Campbell)

3.5 Mammals (high importance)

Otters *Lutra lutra* occur on all watercourses in Dumfries & Galloway, but those with abundant **in-stream and riparian vegetation** support highest population densities. Bankside tree roots, especially oaks, Ash and Sycamore are of great importance as holt sites. Water Voles *Arvicola terrestris* are now rare on lowland rivers in Dumfries & Galloway, probably due to predation by American Mink *Mustela vison*. They also prefer tall and luxuriant bankside vegetation, but it must not be excessively shaded by trees and shrubs. Water Shrew *Neomys fodiens* distribution is poorly known, but vegetation cover is essential. All bat species hunt over waterbodies, but Daubenton's Bats *Myotis daubentonii* are specialist hunters low over slow flowing open water, preferring watercourses more than 9m wide and sheltered by overhanging trees.

3.6 Birds (high importance)

For many of the birds that use rivers as breeding and feeding grounds, **in-stream and riparian vegetation** in the form of emergent plants, terrestrial herbs, scrub and trees is a fundamental component, providing cover, food and nesting sites. Mallards *Anser platyrhynchos* and Moorhens *Gallinula chloropus* are able to nest on most rivers, but Little Grebes *Tachybaptus ruficollis* rely on an abundance of vegetation and are often restricted to backwaters, whilst Goosanders *Mergus merganser* need hollow trees. Kingfishers *Alcedo atthis* and Sand Martins *Riparia riparia* dig nest burrows in steep or vertical sandy **bankside cliffs** over water. Many stretches of lowland rivers are also important for wintering wildfowl, especially species such as Teals *Anas crecca* and Goldeneyes *Bucephala clangula*.

3.7 Reptiles and Amphibians (medium importance)

Common Frogs *Rana temporaria* and Palmate Newts *Lissotriton helvetica* have been known to breed in quiet **backwaters**, but the commonest amphibian in river habitats is the Common Toad *Bufo bufo*, which wraps it strings of spawn around plants in still or slow flowing water up to 30cm deep.

3.8 Fungi and Lichens (medium importance)

A number of fungi, mostly micro species, are specifically adapted to river habitats, and play an important role in the decay of submerged leaves. Their spores are abundantly found in river foam, and a few species are known only from this source.

4. Environmental, Economic & Social Importance of Biodiversity

- Angling for salmon and other freshwater fish in Dumfries & Galloway provides a major source of income to local economies and is a highly significant component of local employment patterns, both directly and in related tourist industries.
- Rivers and streams provide a wildlife corridor link between fragmented habitats in intensively farmed areas. This is particularly the case in the lower reaches of the rivers Dee and Urr.

5. Factors affecting the Habitat

- In the west of the region **acidification** of watercourses such as the Luce, Cree, Bladnoch, Fleet and Dee has led to loss of Salmon and/or Trout populations.
- **Changes in flow patterns** by forestry and other land uses in river catchments has affected fish stocks in areas of Galloway.
- **Land drainage and flood defence works**, if not sensitively carried out, can reduce riverine habitats, isolate streams from their floodplains and reduce river productivity. Dredging the channel bed with a mechanical digger increases suspended sediment load and turbidity for some distance downstream. In the long term it can destroy or disrupt features such as pools, riffles, point bars, floodplains and bankside vegetation. Settling out of the material in suspension will alter composition of the substrate. Disposal of soil from dredging on land may also be damaging.
- Agriculture and other **point source and diffuse discharges** have adversely affected rivers.
- **Sewage treatment works** are unable to treat some chemicals which are detrimental to fish and invertebrate species.
- **Accidental pollution spills** from various sources including agricultural slurry, silage effluent, sheep dip, and industrial products such as oil, can have a drastic impact.
- **Construction/engineering** projects, such as roads, urban development and mineral extraction, have led to modification of natural river systems.
- **Urban development**, including industry and housing, has the potential to affect run-off quantity and quality into rivers.
- The construction and operation of **dams and reservoirs**, such as those in the Ken-Dee Hydro Scheme, affects rivers and their biodiversity.
- Although limited livestock access along certain reaches can produce muddy margins beneficial for birds and invertebrates, **removal of woodland, bankside scrub and overwintered vegetation** through grazing or agricultural cultivation dramatically reduces the suitability of a river stretch for many species. Vegetation removal to provide better access for anglers is also carried out, but this is rarely beneficial for the conservation of biodiversity.
- Introduction of **North American Signal Crayfish** *Pacifastacus leniusculus* undermines riverbanks and consumes large amounts of aquatic vegetation, disrupting the ecological balance of rivers. Introduction and spread of other invasive plant and animal species, including non-native fish via live bait, also affects the habitat.
- Excessive **ground water and surface water abstraction** has the potential to cause damage.
- **Recreational disturbance**, such as canoeing and angling may have localised impacts.
- **Lack of education** about catchments and their use, problems and current action has led to unnecessary damage.

Backwater pools and willows on River Nith at Dalscone, January 2007. (Peter Norman)

6. Strategic Actions

6.1 Recent and current activity

- The EU Water Framework Directive requires integrated catchment management across the European Union.
- Catchment management plans have been produced for the Annan, Nith and Dee-Ken systems, co-ordinated by **SEPA**.
- River habitat enhancement schemes have been undertaken by bodies such as the **Nith District Salmon Fishery Board, The River Annan District Salmon Fishery Board** and **Galloway Fisheries Trust.** These schemes have included exclusion of livestock through fencing, planting of stabilising deciduous trees, sensitive bankside protection methods, and sensitive instream works to diversify substrate and flow types.
- Monitoring of the hatchery release programme on rivers Luce, Bladnoch, Cree, Fleet, Dee, Nith and Piltanton Burn by **Galloway Fisheries Trust** or **District Salmon Fisheries Boards**.
- Education of public value and sensitivity of rivers and the species they support, through for example 'Salmon in the Classroom' primary school projects.
- The ecology of rare fish, particularly Sparling, Allis Shad, Twaite Shad and lampreys has been studied on the Cree by **Galloway Fisheries Trust, SNH**, consultants and universities.
- Water quality, hydrology and salmonid production are monitored by organisations such as **SEPA, Galloway Fisheries Trust** and **District Salmon Fisheries Boards**.

6.2 Other recommended actions

- Meet and maintain the **Good Ecological Status** (according to Scottish Environment Protection Agency River Classification System) in all of the region's rivers.
- **Reduce pollution** in watercourses through more effective treatment of effluent and alternative disposal methods. Encourage the creation of buffer habitats adjacent to watercourses.
- Where bank stabilisation is necessary, use environmentally sensitive materials and **soft engineering techniques** wherever possible.
- Ensure that adequate **consultation** takes place when developments are proposed in river catchment systems.
- Take care to avoid any actions that may result in the spread **non-native invasive species**. Eradicate existing non-native invasive species where this is feasible and resources allow.

LOWLAND BURNS & DITCHES

Priority Action (LBD1)

Raise awareness of the importance of small burns and ditches through publications, demonstration days and farm visits.
Target: Make direct contact with 500 farmers by 2012.
Lead Partner: Scottish Environment Protection Agency/Farming & Wildlife Advisory Group.

Varied riparian habitats including Alders, shingle, pools and riffles on the Crichope Burn. June 2007. (Peter Norman).

1. Habitat Description

1.1 Physical Characteristics

Lowland burns and ditches usually contain slow-flowing water that is high in nutrients and relatively warm for much of the year. They have a relatively narrow channel width and often have muddy bottoms with dead leaves and other decaying plant material, and dense aquatic, emergent and marginal vegetation.

Ditches that are obviously man-made are included in the action plans for other habitats. However, many lowland burns have been modified by straightening and deepening to such an extent that they are indistinguishable from ditches. Many of these are managed for land drainage purposes and much of the information in this plan is relevant. **Canals** share many of the same characteristics as ditches and small lowland watercourses.

1.2 National and International Context

Small watercourses and ditches are common throughout lowland Britain.

2. Dumfries & Galloway Status

2.1 Recent Trends

Few new open ditches are being created today – recent drainage systems tend to use piped drains.

2.2 Current Distribution

Small burns and ditches are common in lowland areas of Dumfries & Galloway. Most are linked to larger rivers, but a number of lowland burns flow directly into the sea, without entering a major river.

2.3 Associated Habitats

A number of habitats occur in close association and/or overlap with lowland burns and ditches, and the following action plans may also contain relevant information: Lowland Rivers and Backwaters, Fens, Marshes, Native Wet Woods, Conifer Plantations.

3. Importance for Associated Species

3.1 Invertebrates (high importance)

Ditches and pools in the shade support a different fauna from that in open situations. Some species have aquatic larvae in ditches full of saturated organic mud. The Moss Bladder Snail *Aplexa hypnorum* is rare in Scotland and declining in the UK, but has been recorded in Kirkcudbrightshire. It occurs in weed-choked ditches, but rarely in 'higher quality' freshwaters. A number of dragonflies breed in burns and ditches, including Emerald damselfly *Lestes sponsa* and Banded Demoiselle *Calopteryx splendens*. The latter species, which prefers slow-flowing, muddy-bottomed watercourses, was discovered for the first time in Scotland in Kirkgunzeon Lane in 2004. It has since been found in another small burn close-by.

3.2 Mammals (high importance)

Although detailed survey information is lacking, lowland burns and ditches are probably the most important habitat in the region for Water Voles *Arvicola terrestris* and Water Shrews *Neomys fodiens.* Otters *Lutra lutra* also use surprisingly small

watercourses for feeding and movement, sometimes with just a few centimetres of water.

3.3 Fishes (high importance)

Typical fishes of small slow flowing watercourses include Three-spined Sticklebacks *Gasterosteus aculeatus,* Eels *Anguilla anguilla* and Brook Lampreys *Lampetra planeri.* Lowland burns and ditches may also be important for spawning and juvenile fish, even if there are few adult fish. They can be particularly important for Trout *Salmo trutta.*

3.4 Flowering Plants (high importance)

A high diversity of plants occurs in lowland burns and ditches, and all available microhabitats are usually colonised. For example, there are submerged species such as Spiked Water-milfoil *Myriophyllum spicatum* and Various-leaved Water Starwort *Callitriche platycarpa*; plants with leaves that float on the water surface such as Common Duckweed *Lemna minor* and Pondweeds *Potamogeton* spp.; plants in shallow water such as Brooklime *Veronica beccabunga* and Watercress *Rorippa nasturtium-aquaticum*; and emergent plants such as Reed Canary Grass *Phalaris arundinace* and bur-reeds *Sparganium* spp. Few rare species occur, but Round-leaved Water Crowfoot *Ranunculus omiophyllus* is not common in Scotland outside of the south west.

Ditch with range of aquatic vegetation, Cree Valley. June 2006. (Peter Norman)

3.5 Reptiles and Amphibians (medium importance)

Common Toads *Bufo bufo*, Common Frogs *Rana temporaria*, Smooth Newts *Lissotriton helvetica* and Palmate Newts *Lissotriton helvetica* commonly breed in slow flowing burns and ditches.

3.6 Non-flowering Plants (medium importance)

Algae play an important role in the ecosystem of lowland burns and ditches. Most are single-celled species, but filamentous green algae, such as *Spirogyra*, are also common.

Bog Beacon Mitrula paludosa, found on rotting leaves in ditches in Spring. Slogarie, April 2008. (Peter Norman)

3.7 Fungi and Lichens (medium importance)

A number of fungi grow on submerged leaves in stagnant conditions in ditches. They play an important role in the decay process. The most obvious of them is Bog Beacon *Mitrula paludosa*, which produces orange fruit bodies in late spring.

3.8 Birds (low importance)

Moorhens *Gallinula chloropus* and Sedge Warblers *Acrocephalus schoenobaenus* are among the common breeding birds in marginal vegetation beside lowland burns and ditches. Herons *Ardea cinerea*, Snipe *Gallinago gallinago* and Green Sandpipers *Tringa ochropus* visit to feed; the first two throughout the year, the latter mostly on its migration through the region in the autumn.

4. Environmental, Economic & Social Importance of Biodiversity

- Most agricultural and urban drains feed into minor watercourses rather than larger rivers. Without them, land drainage would cease to operate. Some also provide drinking water for livestock.
- The network of burns and ditches enhances the landscape.

5. Factors affecting the Habitat

- A **perception** that minor watercourses and ditches are no more than drainage channels hinders their conservation.

- **Culverting** ditches and small watercourses virtually eliminates their biodiversity interest.
- **Mechanised dredging** or 'cleaning' of small watercourses is frequently carried out. There has been little assessment of the long-term biodiversity impact of such works.
- Though they are naturally rich in nutrients, additional **nutrient enrichment** through agricultural operations causes loss of biodiversity.
- Due to their widespread distribution, **pollution** often enters larger watercourses via small burns and ditches. Pollution sources include slurry, pesticides, road run-off and sewage discharges.
- North American **Mink** are widespread and may exert a serious impact on fish, bird and especially Water Vole populations.

Steep, but well-vegetated banks on Abbey Burn, near Dundrennan. June 2006. (Peter Norman)

6. Strategic Actions

6.1 Recent and current activity

- **Galloway Fisheries Trust** and **Solway Heritage** carried out an ecological assessment of selected small watercourses that run directly into the sea.
- Training days have been organised by **SEPA** and the **Farming & Wildlife Advisory Group**, as part of the Dee-Ken Catchment Management Plan, to demonstrate good practice.

6.2 Other recommended actions

- Highlight the importance of even the smallest burn or ditch in terms of the biodiversity it supports and its linkages it has with other wetlands.

WATERFALLS

Priority Action (WF1)

Raise awareness of the biodiversity importance of waterfalls, by producing a guide to the waterfalls of Dumfries and Galloway.
Lead Partner: Dumfries & Galloway Biodiversity Partnership

1. Habitat Description

1.1 Physical Characteristics

Spout of Achentallach, near Twynholm. May 2008. (Peter Norman)

Waterfalls usually form due to differential erosion of the bedrock, either due to faults and other weaknesses, or to different rock types, but some were also formed when glaciers gouged out wide U-shaped valleys, leaving the feeder streams hanging above them. Although the public perception of waterfalls is of high, spectacular landscape features, low waterfalls have similar environmental conditions and support similar biodiversity.

The water flowing over waterfalls can vary from a trickle to a torrent, depending on weather conditions. The rock over which the water flows is usually polished smooth by the erosive force of the water. In the **spray zone** a cloud of fine spray results in damp conditions immediately adjacent to the falls, but overhangs and crevices behind and beside the falls are cushioned from environmental extremes and receive constantly low light levels, high humidity and frost free conditions. At the base of the falls, the **plunge pool** is usually one of the deepest parts of the river.

1.2 National and International Context

Waterfalls tend to be concentrated in the uplands, and therefore occur more frequently in the west and north of Britain.

2. Dumfries & Galloway Status

2.1 Recent Trends

There is no evidence of significant recent changes to Dumfries & Galloway's waterfalls.

2.2 Current Distribution

Waterfalls occur along all parts of most of the region's watercourses. They are most frequent in the headwaters and on the Galloway coast, where watercourses often flow over raised beach slopes immediately before entering the sea.

2.3 Site Examples

The highest and best known of the region's waterfalls is **Grey Mare's Tail** in Moffatdale (SAC/SSSI). Others include **Grey Mare's Tail** on a tributary of the Palnure Burn and **Holy Linn** on the Garple Burn near Dalry. On the coast are the **Black Burn Waterfall** near Lot's Wife at Southwick, and various falls around the Rhins peninsula.

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with waterfalls, and the following action plans may also contain relevant information: Coastal Cliffs and Slopes, Headwaters, Lowland Rivers and Backwaters, Lowland Burns and Ditches, Inland Rock Outcrops, Upland Springs and Flushes.

3. Importance for Associated Species

3.1 Non-flowering Plants (very high importance)

Both felt-forming and filamentous blue-green algae thrive in the conditions created by waterfalls. Genera such as *Chamaesiphon* and *Homoeothrix* form flat crusts on rock surfaces; slimy brown and green filaments of *Phormidium* frequent the lips of the falls; tough, leathery tufts of *Tolypothrix* have the ability to fix nitrogen in nutrient-poor upland areas; and red *Lemanea* is common on many waterfalls in the spring.

Waterfalls in rocky ravines in the uplands have an extremely rich liverwort flora, though the species tend to be very small in stature. Several species of *Nardia, Marsupella* and *Scapania* grow tightly pressed to the rock surface to avoid being dislodged. Less common species include Pale Scalewort *Radula voluta* recorded by a waterfall in Garlies Wood, and Shining Flapwort *Jungermannia paroica* at several

locations, often on very wet rock ledges or on rocks in the water. The latter species is largely restricted to Wales, Northern England and Scotland. Mosses are more common on lowland waterfalls. Holt's Mouse-tail Moss *Isothecium holtii,* a distinctive moss restricted to western Britain, requires high humidity and is frequently found by waterfalls.

On shaded rocks in the **spray zone** there are several ferns that benefit from the high humidity. These include the locally rare Wilson's Filmy-fern *Hymenophyllum wilsonii*. Tunbridge Filmy-fern *Hymenophyllum tunbrigense* occurs in similar habitats, but is very rare, possibly extinct, in the region.

3.2 Invertebrates (medium importance)

Few invertebrates are waterfall specialists, but saturated moss and surfaces constantly kept wet by waterfalls or fast-flowing streams may support populations of rove beetles, including *Dianous coerulescens* and *Lesteva pubescens* at their northern distribution limit on the Urr Water. Mayflies, stoneflies and caddisflies also occur. Aquatic invertebrates above waterfalls benefit from reduced fish numbers.

3.3 Flowering Plants (medium importance)

Virtually no flowering plants are able to withstand the harsh environment of waterfalls, but in the **spray zone** a number of species, such as Bog Pimpernel *Anagallis tenella* take advantage of the humid conditions. Purple Saxifrage *Saxifrago oppositifolia* occurs on only two sites in Dumfries & Galloway, one of which is beside the Grey Mare's Tail in Moffatdale.

Purple Saxifrage. (Laurie Campbell)

3.4 Reptiles and Amphibians (medium importance)

No amphibians are strongly associated with waterfalls, but the barrier that high falls present to the upstream movement of fish reduces predation on Common Toads *Bufo bufo*, Common Frogs *Rana temporaria* and Palmate Newts *Lissotriton helvetica*, enabling them to breed in parts of the river system which otherwise may not be suitable.

3.5 Fungi and Lichens (medium importance)

Although not confined to waterfalls, a number of lichens occur on damp rocks in the **splash zone** including *Collema flaccidum.* The spores of some fungi are abundantly found in river foam, and a few species are known only from this source.

3.6 Birds (low importance)

Waterfalls often feature in the breeding territories of both Dippers *Cinclus cinclus* and Grey Wagtails *Motacilla cinerea,* and the nest may actually be located behind the falls. However, neither species are dependent on waterfalls.

3.7 Fishes (low importance)

Waterfalls usually present a barrier in the movement of fish. Some species, such as Salmon *Salmo salar* are able to leap low falls and Eels *Anguilla anguilla* may be able to go round them overland in certain conditions, but most species are constrained by them.

4. Environmental, Economic & Social Importance of Biodiversity

Waterfalls are significant features in the landscape, and the larger ones usually have individual names. Several are tourist attractions.

5. Factors affecting the Habitat

- **Pollution** of watercourses has the potential to adversely affect waterfall wildlife.
- **Pressure for removal of natural waterfalls** to allow fish access to a greater part of the river has come from some anglers.
- **Inappropriate abstraction** may reduce waterfall flow.
- There is the potential for disturbance from recreational disturbance.

EXPOSED RIVER SHINGLE

Priority Action (ERS1)

Identify areas of exposed river shingle with important invertebrate interest.
Target: Assess of 20 potential sites by 2015.
Lead Partner: Scottish Natural Heritage/Scottish Environment Protection Agency.

1. Habitat Description

1.1 Physical Characteristics

Exposed river shingle takes the form of banks, bars and islands. These features are generally transient, dependent on the natural processes of erosion, sediment transport and deposition. In the upper reaches of rivers narrow steep-sided channels prevent the formation of shingle features, but in more open channels, such as in U-shaped valleys, extremely **unstable shingle** banks often form, composed of small boulders and pebbles. In the lower reaches more **stable shingle**, composed of finer gravels, sometimes mixed with areas of sand and silt, is closely associated with rivers meandering across flood plains.

Upland shingle on Firthhope Burn, Carrifran. July 2006. (Peter Norman)

1.2 National and International Context

Exposed river shingle is widespread throughout Europe. It is most common in Britain in the north and west where the bedrock is hard, although there are significant lowland river shingles associated with younger rocks that are resistant to weathering, or glacial deposits. Studies indicate significant losses of exposed shingle habitat on several river systems in the UK.

2. Dumfries & Galloway Status

2.1 Recent Trends

Despite an increasing awareness of the biodiversity importance of exposed river shingle, these habitats remain at risk of removal through engineering works.

2.2 Current Distribution

Exposed river shingle occurs on all the main rivers in Dumfries & Galloway.

2.3 Site Examples

On the River Nith there are important areas of exposed river shingle at **Carnsalloch Shingle Bank** (LWS) and **Auldgirth**. Perhaps the best site in the region for invertebrates is the extensive shingle at **Ae Bridgend** on the Water of Ae. On headwaters, the **Moffat Water** has extensive areas of shingle.

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with exposed river shingle, and the following action plans may also contain relevant information: River Headwaters, Lowland Rivers and Backwaters.

3. Importance for Associated Species

3.1 Invertebrates (very high importance)

A number of scarce and rare invertebrates are associated with exposed river shingle. There are recent (1990s) records from the Nith of *Perileptus areolatus,* a scarce ground beetle exclusively associated with exposed riverine shingle or sand, mostly near to the water's edge; a water beetle *Bidessus minutissimus* found in fine silt on a shingle bank near Dumfries; and Northern Stiletto-fly *Spiriverpa lunulata* on exposed sandy riverine sediments in the upper Cree/Minnoch.

There are old records from southern Scotland of other rare invertebrates associated with this habitat, and it is likely that new surveys would find some of these in Dumfries & Galloway. They include the nationally scarce ground beetles *Perileptus areolatus*, *Thalassophilus longicornis*, *Bembidion bipunctatum, B. litorale*, *B. testaceum* and *B. monticola* and a click beetle *Negastrius sabulicola*. A tiny and probably much overlooked rove beetle *Meotica anglica* is associated with riparian gravel and sand, but appears to be largely subterranean and rarely seen on the surface. It is currently known only from four sites in the world, all in the UK, including one in southern Scotland close to the Dumfriesshire border. It may therefore also be present in the region.

Though common in many habitats in Europe, in Britain the Five-spot Ladybird *Coccinella 5-punctata* is rarely found more than a few metres from unstable river shingle. Here, it is very rare and endangered, being rediscovered in 1987 following an absence of around 30 years. There are no records from Dumfries & Galloway, but one from near Carlisle suggests that its occurrence is not totally out of the question.

3.2 Birds (high importance)

Relatively few birds use exposed river shingle, but some species more typically found on the coast regularly nest on river shingle. These include Oystercatchers *Haematopus ostralegus* and Ringed Plovers *Charadrius hiaticula*. Little Ringed Plovers *Charadrius dubius* have also nested on river shingle at a few locations in Dumfries & Galloway, virtually their only Scottish breeding sites. Common Sandpipers *Actitis hypoleucos,* Grey Wagtails *Motacilla cinerea* and Pied Wagtails *Motacilla alba* regularly feed on river shingle.

3.3 Non-flowering Plants (medium importance)

Common mosses, such as River Feather-moss *Brachythecium rivulare* and Fountain Apple-moss *Philonotis fontana,* are the prime colonisers of upland **unstable shingle**. As the shingle becomes more stable they are replaced by flowering plants.

3.4 Fishes (medium importance)

The removal of exposed shingle denudes the river of substrates that are an essential part of the river system. This removes the possibility of such substrates forming important fish spawning habitats in other parts of the river.

Field Pansy on Water of Ae shingle. May 2008. (Peter Norman)

3.5 Flowering Plants (low importance)

Unstable shingle may support no flowering plants at all. Any that are able to colonise need to be fast growing prostrate plants that can withstand both drought and flood conditions. On more **stable shingle** the main colonisers are mainly opportunistic 'weed' species.

4. Environmental, Economic & Social Importance of Biodiversity

- River shingle forms an important habitat for several fish that are of economic importance.
- Shingle is one of several riverine features that add variety to watercourses, contributing to their visual appeal in the landscape.

5. Factors affecting the Habitat

- **River engineering**, such as straightening, dredging, or grading of river banks is likely to remove this habitat totally unless special care is taken.
- **Extraction of gravel** results in local destruction of the habitat. Even if adjacent areas of shingle are not removed, they may be loosened and become more susceptible to being washed away.

- **Livestock encroachment** on riverside shingle and other river bank features.
- **Agricultural pollution** (especially the use of pyrethroid sheep dips), nutrient enrichment, and acidification.
- Water level regulation and control of flow by **damming and flood alleviation** schemes.
- Colonisation of river banks by Himalayan balsam *Impatiens glandulifera* and other **invasive plant species**.

6. Strategic Actions

6.1 Recent and current activity

- **SNH** funded a survey of exposed river sediments in the Nith catchment in 1996 and 1997. The aim was to survey the habitat resource and to characterise the sediment types favoured by the specialist invertebrate fauna.
- Entomologists from the **Scottish Entomologists Meeting** in 2005 carried out brief surveys of a selected number of sites, and discovered a number of important invertebrates.

6.2 Other recommended actions

- **Consider designating as Local Wildlife Sites** those sites supporting viable populations of important invertebrates, where this is necessary to secure their long-term protection and appropriate management.
- **Advise landowners, managers and advisors** of the presence of this habitat and the importance of beneficial management for their conservation.
- Carry out comprehensive **invertebrate surveys** of potentially important sites.
- **Raise awareness** of the importance of exposed riverine sediment species and of the conservation issues associated with them. This may be achieved by articles in wildlife, environmental, and user-group (e.g. anglers, engineers) journals.

Partially vegetated river shingle on the Water of Ae. May 2008. (Peter Norman)

EUTROPHIC LOCHS

Priority Action (EL1)

Maintain good ecological status of eutrophic lochs by implementing measures included in River Basin Management Plan as part of EU Water Framework Directive.
Lead Partner: Scottish Environment Protection Agency.

Carlingwark Loch with fringing reedswamp. June 2008. (Peter Norman)

1. Habitat Description

1.1 Physical Characteristics

Eutrophic lochs have naturally high nutrient level, which makes them very productive. They have been classified as having more than 30 milligrams of calcium carbonate per litre, and a pH of more than 7. Anaerobic mud rich in organic matter supports abundant invertebrates, and dense populations of algae in mid summer often makes the water green. Their beds are covered by dark mud, rich in organic matter.

1.2 National and International Context

Eutrophic waters are most typical of hard water areas of southern and eastern Britain, but they also occur in the north and west, especially near the coast. Their total extent is not accurately known, the best estimate being around 1785km^2 in the UK with around 240km^2 in Scotland (around 15% of all Scottish standing waters).

2. Dumfries & Galloway Status

2.1 Recent Trends

Intensive agriculture in the catchments of lochs continues to increase levels of eutrophication and several lochs are now suffering from hyper-eutrophication, leading to algal blooms and fish/ invertebrate deaths.

2.2 Current Distribution

Eutrophic lochs are concentrated in the lowlands in the south of Dumfries & Galloway.

2.3 Site Examples

There are many eutrophic lochs in the region. Some of the best known are **Castle Loch** (SPA/SSSI), **Carlingwark Loch** (SSSI) and **Soulseat Loch.**

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with eutrophic lochs, and the following action plans may also contain relevant information: Swamps, Reedbeds, Fens, Marshes, Native Wet Woods, Mesotrophic Lochs, Reservoirs.

3. Importance for Associated Species

3.1 Birds (high importance)

Typical breeding waterfowl of eutrophic lochs include Great Crested Grebes *Podiceps cristatus,* Little Grebes *Tachybaptus ruficollis*, Mallards *Anser platyrhynchos*, Coots *Fulica atra* and Moorhens *Gallinula chloropus*. Rarer breeding species include Gadwalls *Anas strepera,* Garganeys *Anas*

Coots are common nesting birds on eutrophic lochs. (Gordon McCall)

querquedula, Pintails *Anas acuta,* Shovelers *Anas clypeata* and Tufted Ducks *Aythya fuligula,* whilst the very rare Black-necked Grebe *Podiceps nigricollis* has attempted to breed recently. In winter, wildfowl numbers are swelled by large numbers of Teals *Anas crecca,* Wigeons *Anas penelope,* Pochards *Aythya farina,* Goldeneyes *Bucephala clangula* and Coots.

Although grassland feeders, a number of wintering geese and swans use eutrophic lochs for roosting. Most important are Whooper Swans *Cygnus cygnus,* Pink-footed Geese *Anser brachyrhynchus,* Greylag Geese *Anser anser* and White-fronted Geese *Anser albifrons.*

3.2 Mammals (high importance)

The dense emergent and marginal vegetation of eutrophic lochs provide ideal habitat for Otters *Lutra lutra.* An abundance of insect life also makes these lochs valuable for all species of bat, with Daubenton's Bats *Myotis daubentonii* being specialist feeders over water.

3.3 Invertebrates (high importance)

Zooplankton is abundant in the water column of eutrophic lochs, and there may be abundant bottom-dwelling invertebrates. Many lochs have a diverse invertebrate fauna, including snails, crustaceans, water beetles and dragonflies. Blue-tailed damselflies *Ishnura elgans* and Common Blue damselflies *Enallagma cyathigerum* can be abundant. Duck Mussels *Anodonta anatina* are known in the region only from Castle Loch (Lochmaben).

3.4 Fishes (medium importance)

Eutrophic lochs are important for their high populations of coarse fish, including Pike *Esox lucius,* Roach *Rutilus rutilus* and Tench *Tinca tinca*, which is uncommon in Scotland.

3.5 Flowering Plants (medium importance)

Pondweed communities of eutrophic lochs include less common species such as Flat-stalked Pondweed *Potamogeton friesii*, Lesser Pondweed *P. pusillus*, Blunt-leaved Pondweed *P. obtusifolius* and Fennel Pondweed *P. pectinatus*, all recorded from Carlingwark Loch. There is often a marginal fringe of reedswamp that can include scarce species such as Cowbane *Cicuta virosa,* Sawwort *Serratula tinctoria* and Lesser Tussock-sedge *Carex diandra*.

3.6 Non-flowering Plants (medium importance)

Planktonic algae are usually abundant in the water column, where they are responsible for production of most of the nutrients that support other biodiversity. The rare aquatic fern Pillwort *Pilularia globulifera* grows in eutrophic lochs where competition is reduced by fluctuating water levels or disturbance, such as in Loch Ken. It is however, susceptible to over-eutrophication.

3.7 Reptiles and Amphibians (low importance)

Most eutrophic lochs contain too many predators to be suitable for breeding amphibians, though some may be able to find suitable sites on quiet lochsides. Common Toads *Bufo bufo* are more able to withstand predation than other amphibians.

4. Environmental, Economic & Social Importance of Biodiversity

- Many eutrophic lochs are located close to towns and villages and are significant landscape and recreational assets for these communities.

5. Factors affecting the Habitat

- **Nutrient enrichment** caused by organic and inorganic fertilisers damages plant and animal communities and results in a loss of biodiversity.
- **Algal blooms and excessive weed growth** are a problem in many lochs, compounded by high nutrient inputs through diffuse pollution.
- Changes in land-cover can result in increased siltation and release of nutrients into the water body, causing increased eutrophication. **Removal of waterside vegetation** and reedswamp is damaging, as they act as barriers to particulate matter and absorb nutrients.
- The **introduction of fish or removal of predators** leads to the loss of natural fish populations and may affect plant and invertebrate communities. Heavy stocking of bottom-feeding fish such as Carp *Cyprinus carpio* can cause turbidity and accelerate the release of nutrients from sediments.

- **Recreational and sporting use** may create disturbance. Marginal vegetation may suffer from trampling and wave erosion; the action of boat hulls and propellers destroys aquatic plants and stirs up sediments, contributing to enrichment. The construction of marinas and other leisure facilities may also destroy valuable habitat and can lead to increased pollution. However, recreational use can often be sustained with minimal damage to biodiversity, through adequate management programmes

6. Strategic Actions

6.1 Recent and current activity

- The **EU Water Framework Directive** requires preparation and implementation of River Basin Management Plans. These will include a series of measures to maintain good ecological status of all waterbodies.
- Loch Ken, Castle Loch and Carlingwark Loch have **management plans and advisory management committees.**
- Nutrient levels are monitored by **SEPA** at some lochs, such as Castle Loch and Carlingwark Loch.
- **Dumfries & Galloway Council** carry out control of algal blooms in Carlingwark Loch by the annual installation of specially designed straw booms that chemically counteract the algae.

Flood debris supports a varied, if inconspicuous, biodiversity. Woodhall Loch, March 2007. (Peter Norman)

6.2 Other recommended actions

- Conduct **research** to determine the level of agricultural run-off reaching lochs and the impact in terms of eutrophication.
- Investigate the causes of **algal blooms** and possible solutions.

MESOTROPHIC LOCHS

Priority Action (EL1)

Maintain good ecological status of mesotrophic lochs by implementing measures included in River Basin Management Plan as part of EU Water Framework Directive.
Lead Partner: Scottish Environment Protection Agency.

Loch Kindar, April 2007. (Richard Mearns)

1. Habitat Description

1.1 Physical Characteristics

Mesotrophic lochs are characterised by having a narrow range of nutrients, particularly organic nitrogen and total phosphorous. They have been classified as having 10-30 milligrams of calcium carbonate per litre, and a pH of around 7. They also usually have a hard substratum, often clear water, but plenty of submerged and emergent plants.

1.2 National and International Context

Mesotrophic lakes and lochs are largely confined to the margins of upland areas in the north and west of Britain. Bassenthwaite and Derwentwater in the Lake District are two of the best examples in England. Due to their sensitivity to artificially increased levels of nitrogen and phosphorous, they are an increasingly rare type of waterbody, but there is an estimated 1,750 mesotrophic standing waters in Scotland.

2. Dumfries & Galloway Status

2.1 Recent Trends

Intensive agriculture in the catchments of lochs continues to increase levels of eutrophication. Mesotrophic lochs are an increasingly rare and threatened habitat.

2.2 Current Distribution

There is no comprehensive inventory of mesotrophic lochs in the region.

2.3 Site Examples

A number of lochs have been assessed from vegetation surveys and chemical samples as being mesotrophic. They include **Milton Loch** (SSSI) and **Loch Kindar** (LWS). **Mill Loch** (SSSI) at Lochmaben was formerly mesotrophic but now appears to be eutrophic.

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with mesotrophic lochs, and the following action plans may also contain relevant information: Swamps, Reedbeds, Fens, Marshes, Native Wet Woods, Eutrophic Lochs, Reservoirs.

3. Importance for Associated Species

3.1 Flowering Plants (very high importance)

Mesotrophic lochs potentially have the highest diversity of large plants and contain a higher proportion of nationally scarce and rare aquatic plants than any other loch type. Typical species include Yellow Water-lily *Nuphar lutea* and Amphibious Bistort *Persicaria amphibia.* Slender Naiad *Najas flexilis* is a rare aquatic plant usually found in deep, clear, mesotrophic lochs. It occurs predominantly in western Ireland and the Scottish Highlands and Islands, but has been recorded from Loch Kindar.

3.2 Birds (very high importance)

Mesotrophic lochs support the greatest number and diversity of waterbirds of any waterbody type. Typical breeding species include Great Crested Grebes *Podiceps cristatus* Mallards *Anser platyrhynchos* and Tufted Ducks *Aythya fuligula.* Less common nesting wildfowl include Gadwalls *Anas strepera,* Pintails *Anas acuta,* Shovelers *Anas clypeata,* and Teals *Anas crecca.*

In winter, mesotrophic lochs may be used by large numbers of feeding and roosting Whooper Swans *Cygnus cygnus,* Pink-footed Geese *Anser brachyrhynchus,* Greylag Geese *Anser anser,* White-fronted Geese *Anser albifrons,* Pochards *Aythya farina* and Goldeneyes *Bucephala clangula.*

3.3 Fishes (very high importance)

The mesotrophic Mill Loch at Lochmaben once supported Vendace *Coregonus albula* at one of its few British sites. This species now appears to have become extinct due to eutrophication, but has been introduced to Loch Skene, an oligotrophic loch in the Moffat Hills. A wide range of coarse and salmonid fish is also found in mesotrophic lochs.

Four-spotted Chaser dragonfly, Lochmaben 2008. (Paul McLaughlin)

3.4 Invertebrates (very high importance)

Mesotrophic lochs are among the richest of all caddisfly habitats. Other macroinvertebrates are well represented, with particularly important groups being dragonflies, water beetles, stoneflies and mayflies. Aquatic marginal and terrestrial transition zones can be rich in terrestrial groups such as flies and beetles. Hairy Dragonflies *Brachytron pratense* are typical of well-vegetated mesotrophic lochs in England, but are restricted to a few sites in Scotland, including Colvend Lochs in Dumfries & Galloway.

3.5 Mammals (high importance)

Emergent and marginal vegetation of mesotrophic lochs provide ideal habitat for Otters *Lutra lutra.* An abundance of insect life also makes these lochs valuable for all species of bat, with Daubenton's Bats *Myotis daubentonii* being specialist feeders over water.

3.6 Non-flowering Plants (medium importance)

Planktonic algae are usually abundant in the water column, where they are responsible for production of most of the nutrients that support other biodiversity. Stoneworts are more complex types of algae, often pioneers on the open beds of newly created water bodies, forming dense underwater meadows. They are not confined to mesotrophic lochs, but are often swamped by the vigorous growth of flowering plants in more nutrient-rich waterbodies. Just a few stoneworts have been recorded in Dumfries & Galloway, including Translucent Stonewort *Nitella translucens* in Morton Loch.

3.7 Reptiles and Amphibians (low importance)

Most mesotrophic lochs contain too many predators to be suitable for breeding amphibians, though some may be able to find suitable sites on quiet lochsides. Common Toads *Bufo bufo* are more able to withstand predation than other amphibians.

4. Environmental, Economic & Social Importance of Biodiversity

Mesotrophic lochs are significant landscape and recreational assets for local communities and visitors.

5. Factors affecting the Habitat

- **Nutrient enrichment** (eutrophication) has a major impact on mesotrophic lochs, causing increased growth of aquatic algae and larger plants. If eutrophication reaches a threshold, the submerged aquatic flora will deteriorate and may disappear. Many aquatic invertebrates are very sensitive to pollution. Pollution may have many sources, including discharge of sewage effluent, forestry and agricultural run-off, and accidental spillages of, for example, slurry. Airborne water acidification is also a factor in some upland catchments.
- Activities such as **ploughing, afforestation and peat cutting** can increase soil erosion with a consequent increase in water-borne sediments. In suspension, these cause turbidity and reduction in light levels, inhibiting the growth of rooted aquatic plants and increasing the likelihood of algal blooms. Settled sediments may continue to introduce nutrients into the water column and may change the lake bed substrate.
- **Introduced fish** for angling can have an adverse effect on loch ecosystems by eating the invertebrates that graze algae and keep it in check. The introduction of bottom-feeding fish such as carp will disturb the sediments, leading to turbidity and the release of nutrients, which will encourage algal blooms. If not properly managed, angling can also result in disturbance of wildlife, including nesting birds.
- Water-borne **recreation traffic** can damage aquatic plants at the point of launch, or through bankside wave erosion, passage through strands of vegetation, or the cutting action of propellers. Increased turbidity from boat-wash may also compound plant loss. This again may promote unwanted algal growth.

6. Strategic Actions

6.1 Recent and current activity

- The **EU Water Framework Directive** requires preparation and implementation of River Basin Management Plans. These will include a series of measures to maintain good ecological status of all waterbodies.
- **SEPA** has prepared a provisional inventory of Scottish mesotrophic lochs, based on existing survey information. The inventory is not likely to be comprehensive.

6.2 Other recommended actions

- Carry out a survey to **identify current mesotrophic lochs** in Dumfries & Galloway, and those that were naturally mesotrophic but which have been changed as the result of man's activities.
- **Control discharges** of effluent from wastewater treatment works and other point sources of pollution to ensure that the quality and quantity of they do not pose a threat to mesotrophic lochs.
- **Investigate the causes of algal blooms** in mesotrophic lochs of Dumfries & Galloway.

OLIGOTROPHIC LOCHS

Priority Action (EL1)

Maintain good ecological status of oligotrophic lochs by implementing measures included in River Basin Management Plan as part of EU Water Framework Directive.
Lead Partner: Scottish Environment Protection Agency.

Loch Dee with Water Lobelia in the foreground. July 2007. (Richard Mearns)

1. Habitat Description

1.1 Physical Characteristics

Oligotrophic, or nutrient poor, lochs typically occur in acidic upland areas and are characterised by cold, well oxygenated clear waters with only a small aquatic plant and invertebrate community. They have been classified as having 0-10 milligrams of calcium carbonate per litre, and a pH of 6-7.

Dystrophic lochs are the most extreme of nutrient poor waterbodies, highly acidic and confined to peaty areas. They have been classified as having 0-2 milligrams of calcium carbonate per litre, and a pH of less than 6.

1.2 National and International Context

Oligotrophic waters are widespread throughout Europe. They are also widespread in Britain, but frequent only in the uplands of the north and west.

2. Dumfries & Galloway Status

2.1 Recent Trends

There has been little new afforestation in recent decades, and considerable improvements in forest management to reduce effects on upland lochs.

2.2 Current Distribution

Oligotrophic lochs are predominantly located in the Southern uplands in the north of the region.

2.3 Site Examples

The lochs of the Galloway Hills are mostly oligotrophic: **Loch Enoch** (SSSI), **Loch Neldricken** (SSSI), **Loch Valley** (SSSI), **Long Loch of Glenhead** (SSSI), **Round Loch of Glenhead** (SSSI), **Long Loch of The Dungeon** (SSSI), **Round Loch of The Dungeon** (SSSI), **Loch Grannoch, Loch Fleet, Loch Dee, Loch Skerrow, Stroan Loch** (SSSI) and **Lochenbreck Loch**. Away from this area, in Wigtownshire **Mochrum Lochs** (SSSI) includes several oligotrophic lochs and in Dumfriesshire **Loch Skene** (SSSI) is probably the most important site in the region, with relatively little human modification and supporting several rare species.

Dystrophic lochs are rare in Dumfries & Galloway, but **Dernaglar Loch** (SSSI) in Wigtownshire and **Ironhirst Loch** in Dumfriesshire may fall into this category. The latter site is entirely man-made through nineteenth and early 20th century peat extraction on Lochar Moss.

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with oligotrophic lochs, and the following action plans may also contain relevant information: Blanket Bogs, Upland Heaths, Acid Grasslands, Conifer Plantations, Reservoirs.

3. Importance for Associated Species

3.1 Non-flowering Plants (high importance)

Quillwort *Isoetes lacustris* is a submerged aquatic perennial related to ferns, found in oligotrophic lochs with a rocky substrate. It is frequent in such habitats in Dumfries & Galloway, but otherwise mainly restricted to the Highlands, Lake District and Wales. Spring Quillwort *Isoetes echinospora* has a similar distribution but is less common throughout its range, despite occurring on a wider range of substrates.

Though poor in aquatic mosses and liverworts, oligotrophic lochs are reasonably rich in riparian bryophytes. Typical species of loch side boulders include Pendulous Wing-moss *Antitrichia curtipendula* and Spreading-leaved Grimmia *Grimmia curvata.*

3.2 Flowering Plants (high importance)

Though oligotrophic lochs do not support a great diversity of flowering plants, a number of species of high conservation value are found. These include: Awlwort *Subularia aquatica,* an annual aquatic that grows on silt, gravel or stony substrates in shallow water; Water Lobelia *Lobelia dortmanna,* a slow-growing attractive herb with little ability to withstand shade or competition; Intermediate Bladderwort *Utricularia intermedia*, a semi-carnivorous, rare-flowering species of shallow water; and Esthwaite Waterweed *Hydrilla verticillata* at its only extant UK site. More typical species include Alternate Water-milfoil *Myriophyllum alterniflorum* and Bog Pondweed *Potamogeton polygonifolius.*

3.3 Invertebrates (high importance)

The invertebrate fauna of oligotrophic lochs is dominated by mayflies and caddisflies in shore zones, though a few common species from the lowlands, such as a diving beetle *Hydroporus erythrocephalus,* are equally at home in such habitats. The only known world site of a pond snail *Lymnaea burnetti* is Loch Skene, although it is probably not a distinct species, but a form of very common *Lymnaea peregra* that has resulted from the harsh environment and genetic isolation.

Goldeneye, one of the few ducks to frequent oligotrophic lochs in winter. (Gordon McCall)

3.4 Birds (high importance)

The Black-throated Diver *Gavia arctica* is a nationally rare breeder and has attempted breeding on lochs in the Southern Uplands, the most southerly location in Britain. Common Scoter *Melanitta nigra* may also occasionally attempt to breed. More common, though still scarce, breeding wildfowl include Teals *Anas crecca* and Wigeons *Anas Penelope.* A number of scarce upland breeding waders, such as Dunlins *Calidris alpina* feed on the edges of oligotrophic lochs. In winter, these lochs support few birds with only Goldeneyes *Bucephala clangula* regularly recorded in small numbers.

3.5 Fishes (medium importance)

Brown Trout *Salmo trutta* are often the commonest fish species in oligotrophic lochs, though conditions rarely ideal for optimum growth. Arctic Charr *Salvelinus alpinus* are scarce in Britain, occurring mainly in the Scottish Highlands. In Dumfries & Galloway they used to be found in Loch Grannoch and Loch Dungeon, but now probably only occur just over the border of the region in Loch Doon. Vendace *Coregonus albula* have been introduced to Loch Skene and appear to be prospering.

3.6 Mammals (low importance)

Remote, undisturbed oligotrophic lochs appear to fulfil the public perception of ideal Otter *Lutra lutra* habitat. In reality the low productivity and lack of dense riparian vegetation mean that they are infrequently visited by Otters and other mammals.

3.7 Fungi and Lichens (low importance)

Oligotrophic lochs are generally the richest lochs for lichens, though the degree of shade and type of rock has an important bearing on species composition.

An aquatic lichen Porpidia hydrophila on submerged rocks in Loch Trool. March 2007. (Peter Norman)

3.8 Reptiles and Amphibians (low importance)

In some circumstances Common Frogs *Rana temporaria,* Common Toads *Bufo bufo* and Palmate Newts *Lissotriton helvetica* may be found in oligotrophic lochs, but the habitat is generally poor for amphibians.

4. Environmental, Economic & Social Importance of Biodiversity

Often located in remote areas, oligotrophic lochs are an important component of wild-land environments.

5. Factors affecting the Habitat

- **Acidification** as a result of atmospheric deposition of pollution, exacerbated by local geology, soils and land use, especially forestry. Despite recent improvements in forest design and management, acidification remains an issue.
- **Eutrophication** caused primarily by nitrates or phosphates in run-off from surrounding agricultural or forestry operations, though most land surrounding oligotrophic lochs in Dumfries & Galloway is not subject to intensive management.

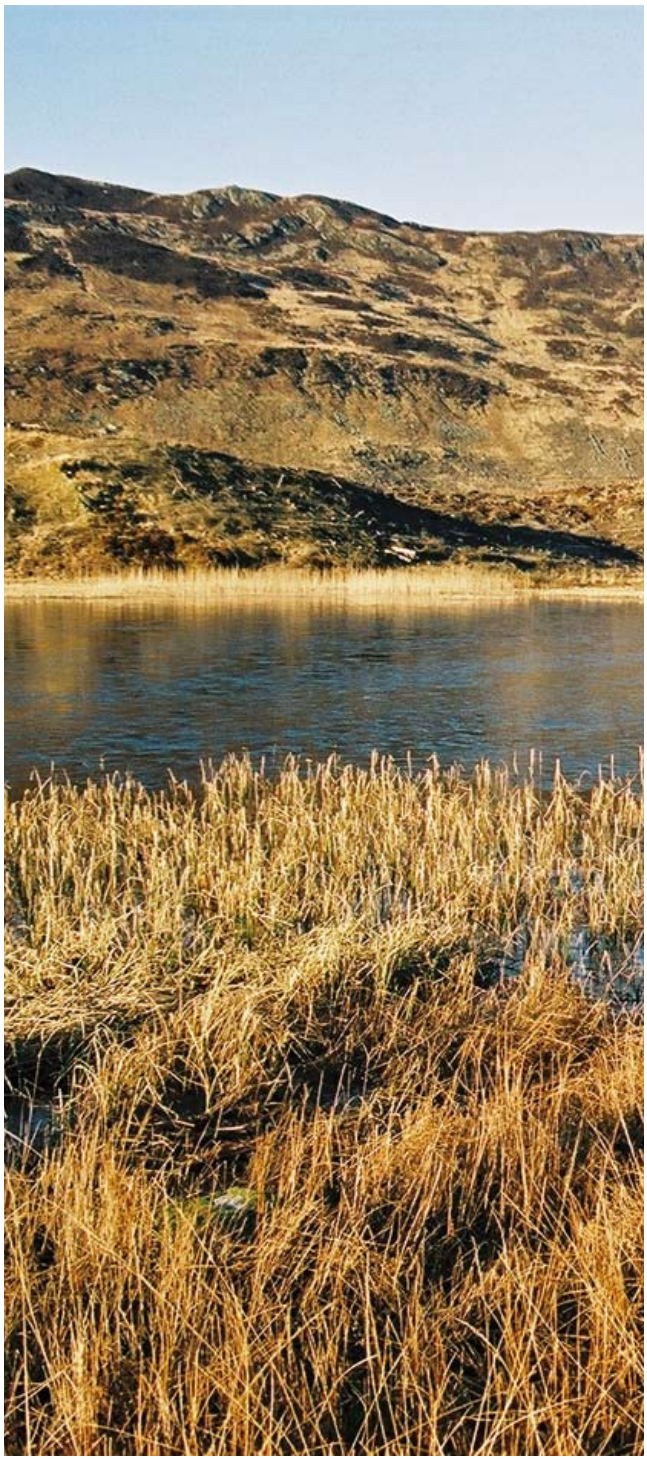
6. Strategic Actions

6.1 Recent and current activity

- The **EU Water Framework Directive** requires preparation and implementation of River Basin Management Plans. These will include a series of measures to maintain good ecological status of all waterbodies.
- The **Loch Dee Project** and subsequent research has looked into the causes and possible solutions of acidification.
- **SEPA** monitor freshwater acidification at several sites.
- Fish populations are monitored by **Galloway Fisheries Trust.**
- **Forestry Commission Scotland** has made changes to the structure of forests in line with agreed Forest and Water Guidelines.

6.2 Other recommended actions

- Continue research and action to reduce the impacts of acidification of oligotrophic lochs.
- Consider **reintroduction of Arctic Charr** to Loch Grannoch, if conditions are considered suitable.



A completely frozen Lillie's Loch, near Clatteringshaws. January 2003. (Peter Norman)

SWAMPS

Priority Action (S1)
Continue with current management.

Fringing swamp at Hightae Mill Loch, Lochmaben 2008. (Paul McLaughlin)

1. Habitat Description

1.1 Physical Characteristics

Swamps are vegetated habitats where the water table is above the ground level for much, if not all, of the year. They usually have tall vegetation dominated by one or two species. Fen and swamp habitats often occur together and may integrate, but can also be found separately. Both often grade into open water at one end and carr at the other and some times occur in association with reedbeds.

1.2 National and International Context

Swamps are widespread across Europe, though probably have declined in the last 50 years. Due to the fact that this habitat usually occurs in close association with other wetland types, it is not possible to make an accurate assessment of the extent of swamps in Scotland, but in 1998 there was approximately 3370km^2 of fen, marsh and swamp (the majority likely to be marsh). The extent in Dumfries & Galloway is not known.

2. Dumfries & Galloway Status

2.1 Recent Trends

In Scotland, there has been an increase in swamps since the 1990s, but the trend in Dumfries & Galloway is not known.

2.2 Current Distribution

In Dumfries & Galloway swamp is widespread but fragmented. It is usually integrated with fens, carrs, reedbeds and open water habitats.

2.3 Site Examples

A large number of small sites are present across the region, but larger areas of this habitat is found on a number of designated sites, including **Ken-Dee Marshes** (SPA/SSSI), **Kenmure Holms** (SPA/SSSI), **Blackpark Marsh**, Threave (SPA/SSSI), **Carlingwark Loch** (SSSI), **Auchrochar Wetlands** (SSSI), **Dowalton Loch** (SSSI), **Hightae Mill Loch** (LNR), **Cumrue Loch** (LWS) and **Colvend Lochs** (LWS).

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with swamps, and the following action plans may also contain relevant information: Eutrophic Lochs, Mesotrophic Lochs, Oligotrophic Lochs, Reedbeds, Fens, Native Wet Woods.

3. Importance for Associated Species

3.1 Flowering Plants (high importance)

Bogbean, Lochmaben, May 2007. (Paul McLaughlin)

Swamps have species poor vegetation in comparison to fens, often dominated by beds of Bottle Sedges *Carex rostrata* or Bladder Sedges *C. vesicaria*. However, less common plants occur, including Cowbane *Cicuta virosa*, Greater Spearwort *Ranunculus lingua*, Water Sedge *Carex aquatilis* and Great Fen Sedge *Cladium mariscus*.

3.2 Birds (medium importance)

A number of birds nest and feed within swamps, and swamp vegetation may be particularly important in providing cover for their young. Species include Little Grebes *Tachybaptus ruficollis,* Water Rails *Rallus aquaticus,* Shovelers *Anas clypeata*, Teals *Anas crecca*, and Pintails *Anas acuta.* During the autumn and winter, swamps form an important roosting habitat for harriers.

3.3 Invertebrates (medium importance)

Swamps are an important habitat for several species of snail, including the nationally rare Lilljeborg's Whorl Snail *Vertigo lilljeborgi,* which is restricted to decaying vegetation in sedge and rush swamps, sometimes shaded by Alders. It has recently been recorded at a few sites in Wigtownshire, but may have been lost form Kirkcudbrightshire and Dumfriesshire.

3.4 Reptiles and Amphibians (low importance)

Amphibians such as Common Frogs *Rana temporaria* are found in swamps

Common Frog, Lochmaben, March 2007. (Paul McLaughlin)

3.5 Mammals (low importance)

A number of mammals hunt for food in swamps, though a mosaic of wetland habitats is probably more important to them than swamps alone. Typical species include Otters *Lutra lutra,* Water Shrews *Neomys fodiens* and all species of bats.

3.6 Non-flowering Plants (low importance)

A number of bryophytes are adapted to the semi-aquatic conditions of swamps, including the Lesser Cow-horn Bog-moss *Sphagnum inundatum.*

3.7 Fishes (low importance)

Though a number of fish species can be found in swamps, the habitat is not of critical importance to them.

4. Environmental, Economic & Social Importance of Biodiversity

Swamps provide protection from bankside erosion in lochs and rivers.

5. Factors affecting the Habitat

- Dumfries & Galloway's swamps are mostly **small in extent and highly fragmented**.
- As with other wetland habitats, swamps are dependent on good water quality and can be damaged by **pollution and excessive nutrient inputs** from surrounding land-uses leading to eutrophication.
- Though drainage of swamps is rarely successful, **changing water levels** in adjacent rivers and lochs will lead to the loss or displacement of swamps.

Water Horsetail swamp. Carrick Ponds, June 2007. (Peter Norman)

- Grazing with cattle can maintain plant diversity, but there is an increasing **reluctance to graze** stock in such habitats. Ungrazed swamps can quickly become dominated by a single species, such as Reed Sweet Grass.
- **Invasive plants** such as American Skunk Cabbage may pose a threat in some locations.

6. Strategic Actions

6.1 Recent and current activity

- In other parts of the UK, loss of cattle grazing has been replaced by **grazing with water buffalo.**

6.2 Other recommended actions

- Identify the **current extent and distribution** of swamps in Dumfries & Galloway.

REEDBEDS

Priority Action (RB1)

Create new reedbeds in Dumfries and Galloway.
Target: 20ha of new reedbed by 2015.
Lead Partner: Dumfries & Galloway Biodiversity Partnership.

1. Habitat Description

1.1 Physical Characteristics

Reedbeds are dominated by stands of one plant, the Common Reed. Most are freshwater habitats, but reedbeds are also found in brackish and tidal waters. Where they have 20cm or more of surface water in the summer they are often referred to as reedswamps. Reedbeds with water at or below the surface are often referred to as reedfens. In practice there is no clear distinction between the two, and Common Reed may be a component of many types of swamp, fen and other wetland habitats.

Common Reed is an active coloniser of wet ground or open water and reedbeds form a transition stage in the eventual succession to woodland. In tidal areas or sites that are subject to regular freshwater flooding, a reedbed may persist in a relatively stable state unless there is heavy siltation. Elsewhere, the accumulation of dead vegetation and **reed litter** will result in the gradual drying of the bed, allowing growth of scrub or woodland species.

1.2 National and International Context

British reedbeds are geographically important in a global context, being some of the farthest west in Europe. In 1994 there were approximately 1000 reedbed sites in the UK totalling around 6,530ha, mostly in small blocks of less than 1ha, making it a nationally scarce habitat. There are probably less than 100ha of reedbeds in Dumfries & Galloway.

2. Dumfries & Galloway Status

2.1 Recent Trends

There has been little deliberate drainage or removal of reedbeds in recent years, but the natural succession of reedbeds to scrub and drier habitats is likely to have resulted in their continual decline. Since the late 1990s, interest in reedbeds from a conservation and water treatment perspective has grown, but this has not so far resulted in the creation of any extensive new reedbeds.

Reedbeds fringe many lochs and ponds. Collochan Loch, Terregles, April 2006. (Peter Norman)

2.2 Current Distribution

Reedbeds in Dumfries & Galloway are widely scattered but highly fragmented. Most of the estuaries have some reedbeds; there many small reedbeds scattered throughout lowland farmland and on slow flowing stretches of some rivers. However, reedbeds are perhaps most frequent as a narrow fringe around many lowland lochs.

2.3 Site Examples

Some of the larger brackish reedbeds are found around the edge of **Wigtown Bay**, at the confluence of Rivers Tarff and Dee in the upper reaches of **Kirkcudbright Bay** and in the **Nith Estuary.** Narrow freshwater reedbeds fringe many lochs in the region, with more extensive areas at a few sites, such as at **Glentoo Loch** and **Lochrutton Loch** (LWS).

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with reedbeds, and the following action plans may also contain relevant information: Coastal Saltmarshes (Merse), Lowland Burns and Ditches, Fens, Swamps, Marshes.

3. Importance for Associated Species

3.1 Invertebrates (high importance)

All stages in the development of reedbeds are important habitats for invertebrates; the areas of lowest invertebrate interest being those of open water.

Forty species of bugs, moths, beetles and flies are known to feed only on reed, with a further 24 insects feeding partly on reed during their life cycle. A wide range of invertebrates is also associated with reed even if they do not feed directly on it. These include predators (mainly beetles and spiders) and parasites of the reed-feeding invertebrates which live in the stems, including gall-forming flies and solitary wasps.

3.2 Birds (high importance)

The Reed Warbler *Acrocephalus scirpaceus* is a reedbed specialist, rarely nesting in other habitats. Although common in England, it was not known in Scotland until breeding was recorded in Dumfries & Galloway in the 1990s. It continues to expand its range. Water Rails *Rallus aquaticus,* Sedge Warblers *Acrocephalus schoenobaenus* and Reed Buntings *Emberiza schoeniclus* also breed in reedbeds, though are less dependent on this habitat. Marsh Harriers *Circus aeruginosus* are occasional breeders in Dumfries & Galloway, favouring reedbeds for nesting, but also using other habitats. Bitterns also probably once bred in Dumfries & Galloway and are still occasionally recorded as visitors. They require large reedbeds, but if such conditions could be created it is highly likely that they would return as a breeding species.

Reedbeds provide roosting sites for a few of other species, particularly Swallows *Hirundo rustica*, House Martins *Delichon urbica* and Starlings *Sturnus vulgaris*, and occasionally Hen Harriers *Circus cyaneus.* Wintering wildfowl also use them.

3.3 Mammals (high importance)

Although by no means confined to this habitat, it has been suggested that Water Voles *Arvicola terrestris* that inhabit extensive reedbeds are better able to withstand predation by Mink *Mustela vison*. Water Shrews *Neomys fodiens* and Harvest Mice *Micromys minutus* also breed in reedbeds, the latter at its northern limit in Britain. Otters *Lutra lutra* frequently lie-up in the dense cover of reedbeds during the day, and hunt for Eels and other fish during the night.

3.4 Fishes (medium importance)

The fish species of reedbeds are similar to those of lowland rivers. They include Pike *Esox lucius* and Eels *Anguilla anguilla* in ditches and Minnows *Phoxinus phoxinus* and Three-spined Sticklebacks *Gasterosteus aculeatus* amongst the reedstems of flooded reedbeds.

3.5 Flowering Plants (low importance)

The wettest reedbeds may contain Common Reed *Phragmites australis* and little else, but most reedbeds include some other species, including Yellow Flag Iris *Iris pseudacorus* and Reedmace *Typha latifolia*. Less common associates include Cowbane *Cicuta virosa* and stands of Greater Tussock Sedge *Carex paniculata*.

4. Environmental, Economic & Social Importance of Biodiversity

Common Reed is known to be an efficient natural water purifier, and is increasingly being used specifically for this purpose in constructed reedbeds.

5. Factors affecting the Habitat

- Loss of reedbeds through **land drainage and conversion** to intensive agriculture.
- **Lack of management** leading to drying, scrub encroachment and succession to woodland
- **Pollution and siltation** of water sources feeding reedbed systems causing eutrophication and death of reed and associated organisms.

6. Strategic Actions

6.1 Recent and current activity

- Reedbeds have been constructed by **Scottish Water** for water treatment purposes at various locations (e.g. Beeswing treatment works).
- In 1997 **RSPB** began creating new reedbeds on land of low conservation interest at Mersehead.

6.2 Other recommended actions

- **Assess the current extend and distribution** of reedbeds in Dumfries & Galloway.
- **Increase the size** of reedbeds in Dumfries & Galloway. A few large reedbeds are preferable to many smaller ones.
- Encourage the continued use of reedbeds for **water treatment** purposes.

MARSHES

Priority Action (MA1)

Identify areas where new floodplain grazing marsh could be created that will contribute to biodiversity enhancement and flood alleviation, taking into account of current land-uses, landscapes and cultural heritage.
Target: Carry out a feasibility study by 2015.
Lead Partner: Dumfries & Galloway Flood Liaison and Advisory Group

1. Habitat Description

1.1 Physical Characteristics

Marsh is a rather ill defined term but usually refers to vegetation occurring on mineral soils that has the water table close to the surface for most of the year. They are usually found in lowland areas. Some have formed under relatively natural circumstances, for example around the margins of lochs and ponds, and many of these have existed at the same location for many years with little human modification. Many others occur on agricultural land with poor drainage.

Extensive marshes, along with swamp and wet woodland at Kenmure Holms, New Galloway, June 2007. (Peter Norman)

Though grazing takes place on many marshes, some have a long history of management that involves deliberate periodic flooding and livestock grazing. **Coastal grazing marshes** are periodically inundated pastures found behind the sea wall, whilst **floodplain grazing marshes** are areas of flat ground that are regularly flooded by adjacent watercourses. Both habitats usually contain **ditches**, which assist in maintaining high ground water levels and are sometimes used as stock barriers, and brackish or freshwater **pools** that can be seasonal or permanent. Seasonal flooding is an integral part of land management, so ditches tend to have high water levels throughout much of the year, and support a high biodiversity. Other management sometimes includes cutting for hay or silage.

1.2 National and International Context

There are an estimated total of 300,000ha of **grazing marsh** in the UK. 100,000ha of this are found in Scotland, Wales and Northern Ireland collectively. Only a small proportion of this figure is semi-natural, supporting a high diversity of native plant species (5,000ha in the UK, half of which is found outside England). Other types of marshes are more widespread and abundant - in 1998 there was approximately 3,370km^2 of fen, marsh and swamp in Scotland, the majority likely to be marsh.

2. Dumfries & Galloway Status

2.1 Recent Trends

In Scotland, there has been an increase in marshes since 1990s, but the trend in Dumfries & Galloway is not known. For **floodplain grazing marshes,** there have been no recent losses but the traditional management of this habitat continues to decline. Changes to flooding patterns, perhaps as a result of climate change, can make grazing and mowing difficult, leading to abandonment of these practices. A few new **coastal grazing marshes** have been created by conservation organisations.

2.2 Current Distribution

In Dumfries & Galloway marsh habitat is widespread but fragmented. Most **floodplain grazing marsh** in Dumfries & Galloway is found on the rivers Bladnoch, Dee, Ken, Nith and Annan, but it is estimated to be less than 500ha in area. **Coastal grazing marsh** is extremely limited extent and it is possible that there are no sites that have the full range of features found in areas such as Broadland or the Somerset Levels.

2.3 Site Examples

Extensive marshes are found around the fringes of **Loch Ken** (SPA/SSSI). There are excellent grazing marshes, as part of a mosaic of wetland habitats, between Torhouse Mill and Mochrum Park on the **Bladnoch floodplain** (LWS) and at **Threave** (SPA/SSSI) on the River Dee. Coastal grazing marsh has been recreated at **Caerlaverock**, **Mersehead**, and **Wigtown Harbour**.

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with marshes, and the following action plans may also contain relevant information: Lowland Burns and Ditches, Eutrophic Lochs, Mesotrophic Lochs, Fens, Swamps, Reedbeds, Neutral Grasslands, Native Wet Woods, Agriculturally Improved Grasslands, Urban Watercourses and Wetlands.

3. Importance for Associated Species

3.1 Flowering Plants (high importance)

Often the dominant plants of marshes are rushes, but many other species are also found. Typical wildflowers include Meadowsweet *Filipendula ulmaria* and Ragged Robin *Lychnis flos-cuculi,* whilst Small Water Pepper *Persicaria minor*, an annual of wet marshy places trampled by stock, is mostly confined to the southwest in Scotland. Orchids include Northern Marsh *Dactylorhiza purpurella* and Early Marsh *Dactylorhiza incarnata.*

Globeflower, a local speciality of marshes and wet meadows, Dundrennan, June 2006. (Peter Norman)

Typical plants of **grazing marshes** include Cuckoo Flower *Cardamine pratensis*, Marsh Cinquefoil *Potentilla palustris* and various sedges and rushes including Carnation Sedge *Carex panacea* and tussocks of Soft Rush *Juncus effuses.* Less common species include Marsh Stitchwort *Stellaria palustris*. Purple Loosestrife *Lythrum salicaria* and Common Reed *Phragmites australis* are typical **ditch** species.

3.2 Birds (high importance)

Snipe *Gallinago gallinago,* Curlews *Numenius arquata* and Redshanks *Tringa totanus* are typical breeding birds of marshes in Dumfries & Galloway, though have declined in recent years. Lapwings *Vanellus vanellus* require less dense vegetation and are therefore more common on grazing marshes. Winter flooding attracts wildfowl, particularly Barnacle Geese *Branta leucopsis,* Greylag Geese *Anser anser* and Pink-footed Geese *Anser brachyrhynchus.* Smaller birds such as Grasshopper Warblers *Locustella naevia* also nest in this habitat, whilst Spotted Crakes *Porzana porzana* are very rare breeders in dense ungrazed marshes. Marshes may also be used by hunting birds of prey, including Hen Harriers *Circus cyaneus,* Marsh Harriers *Circus aeruginosus* and Barn Owls *Tyto alba*.

Snipe often nest in tussocky marshes. (Steven Round)

3.3 Invertebrates (high importance)

A wide range of invertebrates is associated with marshes, such as a ground beetle *Pterostichus minor*, a common marsh species recorded at various locations in the region. The Silver Hook *Deltote uncula,* a day-flying moth that is locally distributed in Scotland, frequents marshes and other wet habitats. The caterpillars of Small Pearl-bordered Fritillary *Boloria selene* feed on Marsh Violet, and this butterfly is possibly more common on fens and marshes than in other habitats in Dumfries & Galloway.

The caterpillars of Small Pearl-bordered Fritillary butterflies often feed on Marsh Violets. (Richard Mearns)

The greatest diversity of invertebrates on **coastal and floodplain grazing marshes** is usually found in the **ditches** or other permanently saturated ground. Dragonflies, ground beetles, water beetles and some groups of flies are of most importance, though few surveys have been completed in Dumfries &

Galloway. Non-biting midges *Chironomidae* are the most abundant group of insect. Larvae, pupae and adults form a critical part of the food chain for ducklings and many other birds. They depend on organic material in the damp surface layer of the soil.

3.4 Reptiles and Amphibians (medium importance)

No amphibians have a marked association with marshes, but all 6 species have been found in this habitat, including Natterjack Toads *Epidalea calamita.* Few reptiles are found, though there have been unconfirmed reports of Grass Snakes *Natrix natrix*.

3.5 Mammals (medium importance)

Otters *Lutra lutra*, Water Shrews *Neomys fodiens,* and Water Voles *Arvicola terrestris* all use marshes, though the latter tend to avoid sites with brackish water. Bats also take advantage of high invertebrate levels for feeding.

3.6 Non-flowering Plants (medium importance)

A range of mosses, liverworts and algae is found in grazing marshes.

3.7 Fungi and Lichens (low importance)

A range of grassland fungi occurs on marshes, especially those that have not been heavily improved. Some such as field mushrooms *Agaricus* spp. and mottlegills *Panaeolus* spp. are also able to withstand some fertilisation.

4. Environmental, Economic & Social Importance of Biodiversity

- Floodplain grazing marshes act as a natural form of flood alleviation, absorbing high river flows and reducing the speed that rainwater reaches watercourses. In doing so they also filter water, thereby improving water quality.
- Coastal grazing marshes give protection from coastal flooding and erosion.

5. Factors affecting the Habitat

- **Drainage** of land for agriculture has reduced the extent of marshes.
- Changes to flooding regimes and water levels has occurred as a result of engineering works such as **hydro-electric schemes and flood defences**, as well as climate change.
- Loss of traditional management regimes, including the **frequency and timing of grazing and cutting**, affects habitat composition.
- **Eutrophication** (nutrient loading) or other pollution of groundwater or surface water results in changes to plant diversity.
- Increased **salt water flooding** due to sea level rise threatens coastal sites.
- Floodplains, though part of a single ecological unit, are **rarely under single ownership** or management. It is therefore difficult to allow a more natural flood regime without affecting adjoining sites.

Northern Marsh Orchid. Carrick, Gatehouse of Fleet, June 2007. (Peter Norman)

6. Strategic Actions

6.1 Recent and current activity

Most coastal grazing marsh is managed for conservation by organisations such as the **Wildfowl and Wetlands Trust**, **RSPB** and **Dumfries & Galloway Council/Wigtown Bay Wildfowlers Club.**

6.2 Other recommended actions

- **Establish the location and extent** of marshes, especially coastal and floodplain grazing marshes, in Dumfries & Galloway.
- **Survey coastal and flood plain grazing marshes** in the region and use the data obtained to identify areas where restoration is possible and to act as a baseline for a monitoring programme.
- **Consider the feasibility of creating new areas** of marsh on land of low conservation and farm value, by raising water levels or allowing a watercourse to overflow onto its natural floodplain.
- Conduct **farm walks** on sites with marshes.

UPLAND SPRINGS & FLUSHES

Priority Action (USF1)

Monitor the quality of springs and flushes in the uplands of Dumfries & Galloway.
Target: Monitor springs and flushes at Carrifran until 2012.
Lead Partner: Borders Forest Trust

1. Habitat Description

1.1 Physical Characteristics

Upland springs are the source of many watercourses, where water bubbles or flows out of the ground, either strongly, or more usually as a slow seep. Flushes form where water, either from springs or other sources, flows diffusely over soil, gravel, stones or sparse vegetation.

Butterwort, a typical plant of unshaded flushes. Laghead, Gatehouse of Fleet, June 2007. (Peter Norman)

Despite the low volume of flow, spring-fed seepages are generally derived from very extensive underground aquifers, and are therefore not greatly affected by short-term fluctuations in rainfall. The water is usually cold, but temperature and acidity (pH) tends to be fairly constant throughout the year.

The mineral content of the water is determined by the chemical composition of the rocks from which it emerges. Where the rocks are alkaline or rich in lime, the plants that grow in the springs and flushes are very different from those that grow where the water is acid and deficient in lime. **Acid springs and flushes** tend to be commonest in the uplands, but even these tend to be relatively nutrient rich in comparison to the surrounding land because they have accumulated nutrients washed down through the bedrock, whilst the surrounding soils have often been extensively leached by very high rainfall. More **base-rich springs and flushes** are rarer, but are of exceptional biodiversity value.

The low flow volume of most springs and flushes allows the development of a thick muddy substrate on all but the steepest gradients. Rich organic material combined with well-oxygenated water provides a highly productive resource for a surprisingly diverse community of plants and animals. In practice this means that diversity in spring fed flushes tends to be very much greater than it is in those derived from surface water run-off.

1.2 National and International Context

Springs and flushes are small-scale localised habitats, but are widespread throughout the uplands of Britain.

2. Dumfries & Galloway Status

2.1 Recent Trends

As far as is known, there have been no significant recent changes to upland springs and flushes.

2.2 Current Distribution

Spring-fed flushes in upland areas are widespread and not uncommon in Dumfries & Galloway.

2.3 Site Examples

Important flush communities are found in the **Moffat Hills** (SAC/SSSI).

2.4 Associated Habitats

A number of habitats occur in close association and/or overlap with upland springs and flushes, and the following action plans may also contain relevant information: Fens, Acid Grasslands, Inland Rock Outcrops, Upland Heaths.

3. Importance for Associated Species

3.1 Non-flowering Plants (very high importance)

Upland springs and flushes are often dominated by mosses and liverworts. Typical species of **acid flushes** include the bright green Fountain Apple-moss *Philonotis fontana* and the brilliant yellow-green Marsh Forklet-moss *Dicranella palustris.* Cow-horn Bog-moss *Sphagnum denticulatum*, with its stout curved red-gold shoots, is a common plant in springs which emerge through peaty soils.

The most common liverwort in springs and flushes is Water Earwort *Scapania undulata*, but Cordate Flapwort *Jungermannia exsertifolia* is characteristic of stony upland flushes, where it often forms extensive turfs. It also grows in springs as rather spongy mounds.

The greatest diversity of species occurs in **base-rich upland flushes**, with species such as Lesser Clubmoss *Selaginella selaginoides* and Flat-leaved Bog-moss *Sphagnum platyphyllum,* the most base-demanding *Sphagnum* that occurs uncommonly in Dumfries & Galloway at the edges of open stony calcareous flushes. There are also a few regional records for Rigid Bog-moss *Sphagnum teres* in moderately base-rich flushes, often in a narrow band alongside the flush. Warnstorf's Bog-moss *Sphagnum warnstorfii* grows in a similar habitat.

A number of rare species also occur in this habitat: Varnished Hook-moss *Hamatocaulis vernicosus* is a plant of neutral flushes, especially springheads where alkaline water breaks through an acid peatland, or areas where alkaline flushes spread on to acid flushed ground. In Dumfries & Galloway it was recently refound at its former site in the Dalveen Pass. Water Grimmia *Schistidium agassizii*, a moss with few British records, has been recorded from flushed igneous outcrops in a valley in the Galloway Hills. *Splachnum vasculosum* was found on dung in springs and flushes at high altitude in the Moffat Hills in 1957 and 1985. Duval's Thread-moss *Bryum weigelii* is also recorded from flushes in the Moffat Hills.

3.2 Flowering Plants (very high importance)

Though springs and flushes may represent only a very small part of the total area of an upland site, they are distinct vegetation communities in their own right. A number of rare or uncommon flowering

Starry Saxifrage is found in higher altitude open flushes. White Coomb, July 2007. (Peter Norman)

plants are associated with them in Dumfries & Galloway: Hairy Stonecrop *Sedum villosum,* Starry Saxifrage *Saxifraga stellaris,* Mossy Saxifrage *Saxifraga hypnoides,* Pale Forget-me-not *Myosotis stolonifera*, Alpine Sawwort *Saussurea alpina,* Alpine Rush *Juncus alpinoarticulatus*, Hair Sedge *Carex capillari,* Sheathed Sedge *Carex vaginata,* Bog Orchid *Hammarbya paludosa* and Alpine Foxtail *Alopecurus borealis.* More typical species include Butterwort *Pinguicula vulgaris,* Carnation Sedge *Carex panicea* and Star Sedge *Carex echinata*.

Taller and more continuously vegetated flushes, merging into fens and marshes, occur wherever the lie of the land concentrates the flow of surface water into hollows, gullies and valley bottoms. Sedges and rushes are more common here than bryophytes.

3.3 Invertebrates (high importance)

Springs and flushes on wet muds tend to be the most densely-vegetated and to have the richest invertebrate fauna, those on peat are often very acid and sustain fewer species. Some spring and flush invertebrates are at least partially subterranean and a number are aquatic, frequently occurring in the upper sections of seepages. Microscopic aquatic animals occur in enormous numbers, up to 16 million protozoans per square metre of *Sphagnum* moss. Examples of larger aquatic species include the water beetles *Hydroporus longulus* and *Hydraena britteni*. Other invertebrate groups frequently encountered in springs and flushes include spiders, flies, and aphids. A number of very rare snails and craneflies have also been recorded from springs and flushes in northern England, but little survey work has been completed in Dumfries & Galloway.

3.4 Birds (high importance)

A number of upland waders and other birds feed on the invertebrates associated with springs and flushes. Such invertebrates are crucial for the survival of Red Grouse *Lagopus lagopus* and Black Grouse *Tetrao tetrix* chicks. In winter, springs and flushes become even more important for feeding birds when other ground is frozen and invertebrates are otherwise unobtainable. Similarly, they assume greater importance in dry periods during the breeding season, an increasingly common occurrence in recent years.

3.5 Fungi and Lichens (medium importance)

A few lichens are specialists of springs and flushes, including *Polyblastia cruenta*, which forms an inconspicuous dark brownish-green layer over submerged stones in acid springs, and the distinctive bright orange *Lonaspis lacustris*, which is also common on stones.

3.6 Reptiles and Amphibians (medium importance)

Common Frogs *Rana temporaria* abound in upland springs and flushes, and Common Toads *Bufo bufo*, Common Lizards *Zootoca vivipara* and Adders *Vipera berus* also hunt in this habitat.

Adder (Laurie Campbell)

4. Environmental, Economic & Social Importance of Biodiversity

- Water from upland springs has long been associated with many religions and is believed to have therapeutic qualities. The town of Moffat is founded on such associations.
- Around 30 brands of natural spring water, which by law must come from an unpolluted underground source, be free from microbial contamination and have received no treatment apart from filtration, are currently sold in the UK. None is collected from upland springs in Dumfries & Galloway, which is maybe just as well as the plant life of the original spring rarely survives the process. However, upland springs do supply a number of private water supplies.
- Scottish spring water is the basic liquid from which whisky is made.

5. Factors affecting the Habitat

- Sheep, cattle, deer goats, hares and rabbits graze in springs and flushes and their **trampling and poaching** may help to keep the cover of vegetation open and prevent encroachment of trees and shrubs. However, in some places deer can badly damage springs. They wallow in springs and flushes in summer, coating themselves with peat in order to discourage flies and to protect themselves from the heat of the sun.
- Large scale **developments** such as open-cast mining can destroy natural springs and flushes, and such features are almost impossible to reinstate following restoration.
- Springs and flushes are susceptible to damage by **quad-bikes and recreational activities.**