

INVERTEBRATE SURVEY OF COASTAL VEGETATED SHINGLE SITES IN DUMFRIES AND GALLOWAY



Craig Macadam, Suzanne Bairner and Chris Cathrine

Buglife – The Invertebrate Conservation Trust
Balallan House
24 Allan Park
STIRLING
FK8 2QG

March 2012

CONTENTS

1	INTRODUCTION.....	1
2	AIMS	1
3	METHODS	1
3.1	Site descriptions.....	2
3.1.1	Structured survey sites	2
3.1.1.1	Barlocco Bay (NX791468)	2
3.1.1.2	Abbey Burn Foot (NX745447 - NX741443)	3
3.1.1.3	Port Castle Bay (NX427358 - NX423359)	3
3.1.1.4	Claymoddie (NX419361 – NX377387)	3
3.1.1.5	Barsalloch (NX352410 - NX340430)	4
3.1.1.6	Shore Cottage (NX277492 - NX270500)	4
3.1.1.7	Balcarry (NX196555)	5
3.1.1.8	Portacree (NX116435 - NX123425).....	5
3.1.1.9	Port Mora (NW993552) and Port Kale (NW990552).....	5
3.2	Surface active invertebrates.....	6
3.2.1	Pitfall trapping.....	6
3.2.2	Hand searching	7
3.3	Specialist surveys – Hymenoptera	8
3.3.1	Active hand searches	9
3.3.2	Sweep nets.....	9
3.3.3	Direct observation.....	9
3.4	Specialist surveys – Lepidoptera.....	9
3.5	Specialist surveys – Mollusca	10
3.6	Identification of Invertebrate species.....	10
3.7	Historic record collation.....	11
3.8	Outreach activities.....	11
4	RESULTS	12
4.1	Coleoptera.....	12
4.2	Hymenoptera.....	14
4.3	Lepidoptera	14
4.4	Mollusca.....	17
4.5	NBN Gateway records	18

4.5.1	Lepidoptera.....	18
4.5.2	Diptera (True-flies).....	18
4.5.3	Myriapoda (Millipedes and Centipedes).....	18
4.5.4	Isopoda (Woodlice).....	19
4.6	Other noteworthy species recorded	19
4.6.1	Coleoptera	19
4.6.2	Araneae (Spiders)	20
4.6.3	Pseudoscorpiones (Pseudoscorpions)	22
4.6.4	Mollusca	22
4.6.5	Orthoptera	23
4.7	Site Quality Index (SQI)	24
5	DISCUSSION.....	25
6	CONCLUSIONS.....	29
7	REFERENCES.....	30
	APPENDIX 1: ADDITIONAL SPECIES RECORDS	32

SUMMARY

Buglife was commissioned by Scottish Natural Heritage to investigate the invertebrate fauna of vegetated shingle along the north Solway Firth coast. Forty sites had previously been surveyed for their vegetation by Randall and Doody (2000) however due to time constraints and resources the current study identified a subset of 9 sites; Abbey Burn Foot, Barlocco Bay, Balcarry, Barsalloch, Claymoddie, Portacree, Port Castle Bay, Port Mora / Port Kale and Shore Cottage. These sites were chosen to reflect the character of the coast and to ensure as wide coverage as possible. Access to Abbey Burn Foot was restricted due to its proximity to the Military of Defence firing range and this prevented surveying of the site.

Whilst all records of invertebrates were of interest, the survey focused particularly on three groups: Mollusca (slugs and snails), Coleoptera (beetles), and aculeate Hymenoptera (bees, wasps and ants).

The Site Quality Index (SQI) was calculated for each site to identify which sites were of most conservation interest. Using these SQI results, the sites were compared with vegetation surveys by Randall and Doody (2000).

Main Findings:

- A total of 242 invertebrate species were recorded at 8 sites surveyed. On additional sites surveyed for Mollusca and Lepidoptera a total of 132 species were recorded; this included 76 species that were not recorded at the main study sites.
- The specialist surveys recorded 59 Coleoptera species, 40 Mollusca species and 15 Hymenoptera species.
- An additional specialist Lepidoptera survey recorded 81 species at the main study sites.
- There appears to be some correlation between SQI and vegetation surveys by Randall and Doody (2000).
- Sites identified during this survey as having a high SQI were also identified by Randall and Doody (2000) as high quality habitats on the basis of their vegetation, while sites with a low SQI were previously identified as being of low quality habitat.

ACKNOWLEDGEMENTS

The authors would like to thank Scottish Natural Heritage for providing funding for this study to be undertaken. We would also like to thank Chris Miles (SNH), Peter Norman (Dumfries and Galloway Council), Mark Pollitt (DGERC), Mike Harrison, Richard Marriott, Barry Colville, Adrian Sumner, Richard Lyszkowski (NMS), Cathy Fiedler, Richard Mearns, Peter Robinson, Members of the Grey Daggers moth group, Adam Garside and Caledonian Conservation Ltd for their assistance.

1 INTRODUCTION

Shingle is a globally restricted coastal sediment type with few occurrences outside northwest Europe, Japan and New Zealand (UK Biodiversity Group, 1999). Shingle beaches are widely distributed round the coast of the UK, the largest site being over 2,000 ha in Dungeness in southern England (UK Biodiversity Group, 1999). There are only five other shingle beaches in the UK that are over 100ha in size. All major examples of shingle habitat and many minor ones have been notified for their wildlife value.

In Scotland it is estimated that nearly 3,000km of the coastline is fringed with shingle (Buglife, 2010). However most of this length consists of simple fringing beaches, so shingle structures sufficiently stable to support perennial vegetation are a comparatively rare feature. Shingle with the highest terrestrial invertebrate interest is that which extends above the normal tidal limit and is at least partly vegetated. Here, diverse invertebrate communities are found, with some species restricted to coastal shingle habitats. Some 1,100ha of vegetated shingle has been estimated to be present in Scotland, mainly located in Dumfries and Galloway, Morayshire and the North West (Murdock *et al.* 2011).

Shingle typically develops in high energy environments, where it acts as a natural form of flood defence by absorbing and dissipating wave energy (Doody and Randall, 2003). These habitats are currently threatened by a number of factors including natural mobility, exploitation through gravel extraction, disturbance, pollution, development and water abstraction (Doody and Randall, 2003; Buglife, 2010). Vegetated shingle is included on Annex I of the European Commission Habitats Directive as a habitat of international importance under 'perennial vegetation of stony banks (coastal shingle vegetation outside the reach of waves)' and is listed as a UK Biodiversity Action Plan (UKBAP) priority habitat.

Randall and Doody (2000) investigated the botanical interest at 40 sites with vegetated shingle along the north Solway Firth coast. Buglife – The Invertebrate Conservation Trust was commissioned by Scottish Natural Heritage to investigate the invertebrate fauna of these sites. Whilst all records of invertebrates were of interest, the survey focused particularly on three groups: Mollusca (slugs and snails), Coleoptera (beetles), and aculeate Hymenoptera (bees, wasps and ants). The records obtained from these surveys will help to identify the most important vegetated shingle sites on the Solway Firth coast and increase our knowledge of the species that live there.

2 AIMS

- To undertake surveys for Coleoptera (beetles); Mollusca (slugs and snails); and aculeate Hymenoptera (bees, wasps and ants) on selected sites with coastal vegetated shingle on the north Solway Firth coast.
- To compare the results of these surveys with those of the botanical survey by Randall and Doody (2000).

3 METHODS

Vegetation at 40 coastal vegetated shingle sites along the north Solway Firth coast was investigated during a Shingle Vegetation Survey (Randall and Doody, 2000). This study was designed to compare invertebrate fauna on sites with the results of this vegetation survey.

Due to constraints on time and resources the current survey identified a subset of 9 sites from the 40 studied by Randall and Doody (2000) at which the invertebrate fauna would be investigated (Table 1). Sites were chosen to reflect the character of

the coast and to ensure as wide coverage as possible. Restricted access to Abbey Burn Foot due to its proximity to a Military of Defence firing range prevented the completion of invertebrate surveys at this site.

A further 6 shingle sites (Drummore, Chapel Finian, Milton Point, Philip and Mary, Ardwell and Carsluith) were also investigated for Lepidoptera and Mollusca (Table 1). Species results and the dates of survey for these sites can be found in Appendix 1.

Table 1. Sites visited for structured Coleoptera, Hymenoptera and Mollusca surveys and sites visited for additional Lepidoptera and Mollusca surveys

Site name
Structured surveys
Abbey Burn Foot (Mollusca only)
Balcarry
Barlocco Bay
Barsalloch
Claymoddie
Portacree
Port Castle Bay
Port Mora / Port Kale
Shore Cottage
Additional surveys
Ardwell
Carsluith
Chapel Finian
Drummore
Milton Point
Philip and Mary

3.1 Site descriptions

Full descriptions of all sites surveyed including those from structured surveys and additional sites can be found in Randall and Doody (2000). A summary of this information taken from Randall and Doody (2000) report is given below.

3.1.1 Structured survey sites

3.1.1.1 Barlocco Bay (NX791468)

Barlocco Bay can only be accessed from a coastal footpath from Rascarrel Bay (NX801480). Barlocco Bay is roughly 0.6km in length and a raised shingle beach runs along it. Shingle varies in size across the site from small pebbles with a sand matrix to larger boulders over 10cm in diameter. Salt marsh has developed in the shore of Barlocco Bay between large boulders (NX794470) and the bay is backed by a cliff; crop and pasture fields also back onto the site. The area of vegetated shingle is limited at Barlocco Bay and lies to the rear of the salt marsh. Due to its isolation, there is very little recreational activity and only a few walkers pass through the site.

The area of vegetated shingle surveyed for invertebrates is small in size and is dominated by sea sandwort (*Honckenya peploides*) and silverweed (*Potentilla anserina*) (NX 7947147084-NX 7946247086). To the rear of the shingle is an area rich in wildflowers with common knapweed (*Centaurea nigra*) and sea mayweed (*Tripleurospermum maritimum*).

3.1.1.2 Abbey Burn Foot (NX745447 - NX741443)

As the name suggests, this site is at the mouth of the Abbey Burn, 3km south of Dundrennan, where a shingle beach has built up in front of a raised beach and relict cliff-line. The upper beach and backshore are composed of freshly worked pebbles 20-60 mm diameter built into steep ridges overlying a Carboniferous sandstone rock platform. These storm ridges abut a raised beach which slopes gradually up to a drift-cut relict cliff. Most of the raised beach pebbles are 10-40 mm. The Abbey Burn cuts through the raised beach making access to the west extremely difficult.

Access to this site was restricted due to its proximity to the Military of Defence firing range. Despite several attempts to gain access to the site this was not forthcoming and therefore prevented surveying of the site.

3.1.1.3 Port Castle Bay (NX427358 - NX423359)

Port Castle Bay to the south-east of Luce Bay is 0.4km in length. The bay is backed by a small sandstone cliff that is very steep in places. To the south of the site lie Port Castle cliffs and to the north is St. Ninian's Cave – a popular tourist destination. The bay can be accessed through Physgill Glen and a stream runs along the footpath and enters the bay (NX325358).

A shingle beach runs along the entire length of the bay and its exposure to the south-west makes this habitat very mobile. This mobility has created a raised and steep shingle beach along the bay that is roughly 5m above sea level. Shingle pebble size across the site is large and averages about 50-200mm with some finer shingle and sand near the mouth of St. Ninian's Cave.

Vegetated shingle surveyed for invertebrates lies within an isolated embayment to the west of the site entrance and stream (NX425358). This embayment is isolated and sheltered from the south-west winds and is not in the direct path of visitors to St. Ninian's cave.

Low lying plants dominate the area of vegetated shingle. There are several large individual specimens of sloe (*Prunus spinosa*) as well as ragwort (*Senecio jacobaea*), birds foot trefoil (*Lotus corniculatus*) and wild thyme (*Thymus serpyllum*) and some grasses. Surrounding the area of shingle are large areas of ivy (*Hedera helix*) and bramble (*Rubus fruticosus*).

3.1.1.4 Claymoddie (NX419361 – NX377387)

Claymoddie is to the north of Port Castle Bay and is much larger than the former at 4.6km in length. The site is exposed as it faces south-west on the eastern shore of Luce Bay. Claymoddie is part of the 'Back Bay to Carghidown' SSSI and has been notified particularly for its geology, coastal habitats as well as flowering plants and breeding birds.

The shingle beach at this site was identified during vegetation surveys by Randall and Doody (2000) as being the most important shingle site for plants on the Solway Coast. This was decided upon not only in terms of the size of the site but also because of the species composition, particularly with the number of rare and uncommon plant species.

The long shingle beach of Claymoddie varies in width along much of its length. Vegetated shingle is found across the site with varying sized pebbles. The area behind the shingle beach is flat and supports crop fields. The small strip of land between the fields and shingle beach is composed of coarse grasses and wildflowers.

Limited private access to Claymoddie prevents recreational activity and because of this there is little threat to vegetated shingle at the site. Storms in winter have been known to alter the foreshore creating a low shingle cliff but this has been seen to disappear during the summer. The greatest threat to vegetated shingle identified during vegetation surveys by Randall and Doody (2000) is the deposition of non-biodegradable waste from the marine environment. The landowner of Claymoddie usually removes this material on a regular basis.

The vegetated shingle surveyed for invertebrates is dominated by sea kale (*Crambe maritimus*) and sea radish (*Raphanus maritimus*). There are also several stands of ragwort (*Senecio jacobaea*) and sea spurge (*Euphorbia paralias*) across this area.

3.1.1.5 Barsalloch (NX352410 - NX340430)

Barsalloch Point lies on the east coast of Luce Bay, north of Monreith and south of Port William. The site is adjacent the A747 and can be accessed from several points along this main road, particularly from a layby for visitors to Barsalloch Fort, an Iron Age promontory fort (NX346411). This access allows for recreational activity across the site that may or may not influence vegetated shingle habitat. No recreational activity except people walking along the beach was observed during invertebrate surveys.

The shingle beach is narrow in width along its 2.7km length, although shingle habitat lies from before the A747 to the foreshore. Shingle pebbles vary in size from 60-120mm. Within areas of open shingle lie dense grasses and mixed herb and scrub.

A large area of shingle above the beach has previously been excavated although this appears to have stopped (NX346411). This area of open shingle is dominated by carline thistle (*Carlina acaulis*) and rosebay willowherb (*Chamerion angustifolium*).

The area of Barsalloch surveyed for invertebrates is dominated by sea kale (*Crambe maritimus*), sea raddish (*Rhapanus maritimus*) and sea mayweed (*Tripleurospermum maritimum*). There are also areas of ragwort (*Senecio jacobaea*) and sea campion (*Silene uniflora*) across the vegetated shingle.

3.1.1.6 Shore Cottage (NX277492 - NX270500)

The shingle beach at Shore Cottage is 0.7km in length and is adjacent the A747. The site is north of Port William and on the east shore of Luce Bay. Much of the beach is composed of large boulders and those above sea level have dense grasses growing between them. This area is backed with an area of vegetated shingle with a fine shingle matrix of shells and smaller pebbles.

Between the shingle beach and the A747 are pastures used for grazing cattle during the summer. Randall and Doody (2000) identified that this practice has destroyed much of the original raised beach.

Although the site lies adjacent the A747, access is limited with only a few laybys along the man road (e.g. at NX27704913). This causes little disturbance to the area of vegetated shingle.

Large boulders above the shore line are dominated by various grass species with some curled dock (*Rumex crispus*) and sea mayweed (*Tripleurospermum maritimum*). The area of shingle matrix has a varied plant assemblage of sea mayweed, yarrow (*Achillea millefolium*), sea radish (*Raphanus maritimus*) and silverweed (*Potentilla anserina*).

3.1.1.7 Balcarry (NX196555)

Balcarry is in the north east corner of Luce Bay and is north of the village Stairhaven. Most of the foreshore of Balcarry consists of a sandy intertidal area. The shingle beach lies between this sandy area and a pine plantation (*Pinus* species). During vegetation surveys of the shingle by Randall and Doody (2000), the site was barely 300m in length. Since then the quality of vegetated shingle has declined and only an area about 15-20m in length is left. This may be due to the location of the shingle habitat making it more mobile and exposed to severe winter storms.

Access to the site is limited by a path that leads off the road to Stairhaven (NX19725604).

3.1.1.8 Portacree (NX116435 - NX123425)

Portacree at New England Bay Caravan Park is south of Sandhead and is on the west of Luce bay. The intertidal beach at Portacree is wide and has a mixture of small shingle sand with some larger pebbles and a limited rocky shore. The beach is backed by a densely vegetated sand capped ridge.

During vegetation surveys by Randall and Doody (2000) only one third (0.5km) of the entire site of Portacree had shingle. Vegetated shingle was identified during invertebrate surveys as limited at the site, and reduced significantly between surveys in 2010 and 2011 through natural erosion.

Access to the site can be obtained from several points from the caravan park. Recreational activity along the entire beach is high, especially during the tourist season.

3.1.1.9 Port Mora (NW993552) and Port Kale (NW990552)

The bays of Port Mora and Port Kale lie to the north of Port Patrick and both face the Irish Sea. Both bays can be accessed from the Southern Upland Way coastal path from port Patrick. There is a heavily used path that crosses vegetated shingle at both bays.

Port Mora is in the south and is also locally known as Sandeel Bay. This bay is smaller than Port Kale and is only 50m wide. The foreshore within this bay is composed mostly of sand which is backed by a narrow width of shingle beach. The beach is backed by steeply rising ground that is dominated by grasses and scrub. A waterfall lies on the north east corner of the shingle beach and a stream from this flows down to the shore. Pebble size within the shingle is small in size, ranging between 2-50mm. Vegetation at Port Mora is dominated by sea mayweed (*Tripleurospermum maritimum*), sea campion (*Silene uniflora*) and spear leaved orache (*Atriplex prostrata*).

There are two separate areas of vegetated shingle at Port Kale divided by an extended rock outcrop (NW99075524). Together both areas of vegetated shingle in the bay are less than 100m in length and the beach rises steeply from the shore. The area of shingle south of the rocky outcrop at Port Kale is composed of small sized pebbles mixed with some sand and is limited in vegetation. There is an eroding bank behind the area of vegetated shingle. The area north of the rocky outcrop is composed of larger pebbles and has a larger area of vegetated shingle although vegetation here is sparse. Vegetation at these two sites is dominated by similar plant species as Port Mora.

3.1.2 Additional survey sites

3.1.2.1 Ardwell (NX102488 - NX110450)

This site is in the North West corner of Luce Bay and lies immediately south of the village of Sandhead. The stretch of vegetated shingle is roughly 4km in length. The narrow fringing shingle beach lies behind an extensive foreshore that has several rocky outcrops as well as areas of sand and mud. The width of the shingle beach varies along its entire length from 1m to more than 30m.

3.1.2.2 Carsluith (NX537520 - NX487544)

Carsluith is on the East side of Wigtown Bay and is between Ringdoo Point Caravan Site and Carsluith village. The beach is composed of shingle and shell with a sandy matrix and occasional large boulder. This fringing beach is backed by a steep cliff that reaches the shore at Ravenshall Point.

3.1.2.3 Chapel Finian (NX290479 - NX277492)

The stretch of raised shingle beach at Chapel Finian lies to the south of Shore Cottage (NX277492 – NX270500). The rear of the site is backed by the A747. There has been some disturbance to the site from the development of a car park and picnic tables for visitors to Chapel Finian.

3.1.2.4 Drummore (NX140369 – NX150356)

This site is immediately south of the village of Drummore. At the very north of this site there is a wide sandy bay known as Cairngarroch Bay where shingle is limited. From the southern end of the bay to Cailness Point (NX152356), a narrow exposed shingle shoreline has developed above a muddy and rocky foreshore.

3.1.2.5 Milton Point (NX315461 - NX290479)

From Milton Point to Chippermore Point (NX299473) a narrow raised shingle beach runs along this stretch of coast. The shingle beach widens at both ends where there is a large amount of vegetation. The raised shingle beach has been identified as being unusual on this stretch of coastline in that it is almost pure shingle where as elsewhere there is a sandier matrix (Randall and Doody, 2000). Sea defence works have replaced some of the vegetation on this shingle beach.

3.1.2.6 Philip and Mary (NX325458 - NX337444)

This site is just north of Port William and commences with a fringing beach and contains a series of large-scale shingle cusps. At the end of the site there is a sandy shingle spit formed on one of the end of the cusps. It is this spit that is known as Philip and Mary. The rear of the site is backed by the A747.

3.2 Surface active invertebrates

Invertebrates that are active on the surface of vegetated shingle and at different levels on the underlying stones were collected at each site in 2010 using pitfall traps and through active hand searches. This allowed for the collection of Coleoptera (beetles), Molluscs (snails) and Hymenoptera (bees, wasps and ants) and for other invertebrate species that live in this habitat.

3.2.1 Pitfall trapping

Pitfall traps were used to capture surface active invertebrates, including nocturnal and cryptic species that are not generally susceptible to collection using standard active searching techniques. The traps were comprised of two 0.2L plastic cups that were sunk into the ground (Figure 1). Two drainage holes were made 5mm below the rim of the inner cups to prevent rain or flood water from filling the traps and washing away any of the catch. Drainage holes were made in the base of the outer cup to prevent this filling with water and causing the inner trap to float out above the

ground level. The traps contain 100ml of 70% commercial antifreeze to preserve the invertebrates, with a drop of washing-up liquid added to break the surface tension. Propylene glycol antifreeze was used as this is not as attractive and is less harmful to vertebrates than ethylene glycol. To prevent accidentally catching birds, small mammals, etc., squares of chicken wire were placed over the trap and secured to the inner cup to ensure that the cover could not be dislodged by accident (e.g. by being kicked by a person or animal as it walked by or if dug up by a dog or badger). This design ensured that the lid could not be removed without a human deliberately digging up the trap and dismantling it. The pitfall traps were set in transects of 5, with 2 metre spacing between each trap.

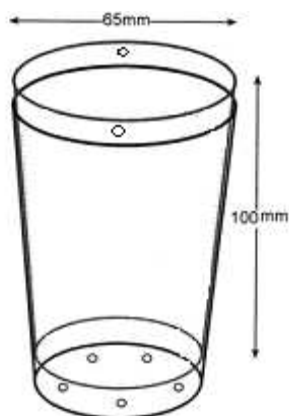


Figure 1. Pitfall trap design

When being emptied the inner trap was removed and the catch was transferred to a large sample pot, and preserved in 70% isopropanol. The contents of the traps from each transect were pooled on the collection date (Table 2). On return to the office the sample was sieved and transferred into specimen tubes with 70% isopropanol. The catch was then sorted and identified using current identification materials.

Table 2. Location and survey dates for pitfall trap transects

Site name	Transect start	Transect end	Installation	Collection
Barlocco Bay	NX7947147084	NX7946247086	20/07/2010	07/10/2010
Port Castle Bay	NX4237935933	NX4237235937	20/07/2010	11/09/2010
Claymoddie	NX4169436263	NX4166836271	21/07/2010	07/10/2010
Barsalloch	NX3462041105	NX3461641113	21/07/2010	11/09/2010
Shore Cottage	NX2755249213	NX2754749226	21/07/2010	11/09/2010
Balcarry	NX1967255460	NX1966055463	21/07/2010	30/09/2010
Portacree	NX1227542636	NX1226542640	21/07/2010	08/10/2010
Port Mora and Port Kale	NW9927355201	NW9927455196	01/06/2010 21/07/2010	21/07/2010 08/10/2010

3.2.2 Hand searching

Surface active invertebrates (Coleoptera (beetles), Hymenoptera (bees, wasps and ants), Aranea (spiders), Diplopoda (millipedes), etc.) were sampled by searching a 1m² area by hand (Table 3). A bamboo cane was thrown on to the shingle habitat to select an area for sampling. Where the cane landed a 1 x 1m quadrat was laid out using further bamboo canes. All surface stones in the sample area were removed and invertebrates collected using a pooter and preserved using 70% isopropanol (Figure 2). This process was repeated on successive layers of shingle deposits.

Table 3. Date of hand sampling for surface active invertebrates

Site name	Sampling date
Barlocco Bay	20/07/2010
Port Castle Bay	20/07/2010
Claymoddie	21/07/2010
Barsalloch	21/07/2010
Shore Cottage	02/06/2010
Balcarry	02/06/2010
Portacree	02/06/2010
Port Mora / Port Kale	01/06/2010



Figure 2. Hand-searching for surface-active invertebrates at Portacree (Photo by Mark Pollitt).

3.3 Specialist surveys – Hymenoptera

Active hand searches, sweep net collections and direct observations were used during specialist surveys of aculeate Hymenoptera (bees, wasps and ants) (Table 4).

Table 4. Date of specialist Hymenoptera surveys

Site name	Sampling date
Barlocco Bay	20/07/2011, 22/08/2011, 13/09/2011
Port Castle Bay	20/07/2011, 23/08/2011, 14/09/2011
Claymoddie	20/07/2011, 23/08/2011, 14/09/2011
Barsalloch	20/07/2011, 23/08/2011, 14/09/2011
Shore Cottage	21/07/2011, 23/08/2011, 14/09/2011
Balcarry	21/07/2011, 24/08/2011, 14/09/2011
Portacree	21/07/2011, 24/08/2011, 15/09/2011
Port Mora / Port Kale	21/07/2011, 24/08/2011, 15/09/2011

3.3.1 Active hand searches

Active searches for ants involved looking under various sized pebbles across an area of vegetated shingle. When an ant nest was found, several specimens were collected and put into a pot with 70% isopropanol to be preserved and identified later. Other invertebrate species observed during active searches were also collected and appropriately preserved to be identified later.

3.3.2 Sweep nets

Sweep nets were used to collect Hymenoptera from vegetation – particularly from flower heads. In areas of vegetated shingle with tall vegetation, the net was swept over vegetation in a figure of eight for one minute in a transect across the site. Specimens collected were put into a pot with 70% isopropanol to be preserved and identified later.

3.3.3 Direct observation

Hymenoptera (principally bumblebees) visiting flowers on vegetated shingle were identified through direct observations. Sweep nets were used to collect species for identification. If a specimen could be identified on site it was released after identification; if a specimen couldn't be identified it was collected and preserved in 70% isopropanol to be identified later. Other species identified during direct observations included Lepidoptera (butterflies and moths), Diptera (principally hoverflies) and Orthoptera (grasshoppers and crickets).

3.4 Specialist surveys – Lepidoptera

Surveys for Lepidoptera (principally moths) using light traps were undertaken by volunteers from the Grey Dagers moth group at 11 sites with vegetated shingle along the north Solway Firth coast (Table 5). Of these 11 sites, 6 were sampled for other invertebrates; results from the remaining 5 sites surveyed (Ardwell, Carsluith, Chapel Finian, Milton point and Philip and Mary) have been included in Appendix 1.

Moths were collected using light traps fitted with a 6 or 8 watt actinic bulb and powered by 12 watt car batteries. The traps were left onsite overnight and the following morning were emptied and the catch sorted and identified using current moth identification material.

Table 5. Lepidoptera sampling dates

Site name	Date surveyed
Structured survey	
Barlocco Bay	07/08/2011
Barsalloch	08/07/2011, 09/07/2011, 22/08/2011
Claymoddie	23/09/2011
Portacree	13/06/2011
Port Kale	09/09/2010
Shore Cottage	09/07/2011
Additional survey sites	
Ardwell	13/06/2011, 10/07/2011
Carsluith	22/07/2011, 31/07/2011
Chapel Finian	23/07/2010, 24/07/2010, 02/06/2011, 04/06/2011, 08/07/2011, 09/07/2011, 22/08/2011, 01/09/2011
Milton Point	02/06/2011, 04/06/2011
Philip and Mary	09/07/2011

3.5 Specialist surveys – Mollusca

Specialist surveys for Mollusca (slugs and snails) were undertaken at 10 sites (Table 6). A separate visit in 2007 to Port Castle Bay has also been included in this report. Species results for Drummore and Abbey Burn Foot are provided in Appendix 1.

Table 6. The dates Mollusca were sampled

Site name	Date surveyed
Structured survey	
Balcary	10/09/2010, 15/09/2010
Barlocco Bay	17/09/2010
Barsalloch	16/09/2010
Claymoddie	16/09/2010
Portacree	14/09/2010
Port Castle Bay	27/05/2007, 16/09/2010
Port Mora / Port Kale	09/09/2010
Shore Cottage	15/09/2010
Additional survey sites	
Abbey burn foot	17/09/2010
Drummore	11/09/2010

Sample locations were chosen after walking the full length of the shingle beach so that they represented the variations in habitat. At a smaller scale sample sites were chosen as those most likely to be good mollusc habitats, based on previous experience. All sites chosen were approximately 5-10m above the High Water Mark to reduce the possibility of collecting marine mollusc species.

Hand searches lasting 20 minutes on stones, beach litter and amongst turf were completed at each sample site. Samples of vegetation, litter and soils were also collected at intervals to be sorted and identified later. Samples of plant debris were collected as close to soil level as possible and a bulb planter was used to take up to 5 cores of soil plus surface litter. Both types of sample were then allowed to dry before sieving through 2mm and 0.5mm sieves.

The fractions saved in each sieve were hand searched using a lens for the shells they might contain. On beaches which were composed of large pebbles with little or no matrix of finer material it was impossible to collect a core sample.

Most large molluscs were seen and identified in the field. Smaller molluscs from hand searches and sieved samples were later identified using a stereo microscope.

3.6 Identification of Invertebrate species

Species that were collected during surveys through pitfall traps, hand searches and specialist surveys were identified using current identification materials. The identification of species of conservation concern was confirmed with local and/or national experts (Table 7).

Table 7. Experts consulted to confirm identifications

Invertebrate Group	Expert Consulted
Arachnida	Chris Cathrine, Suzanne Bairner
Myriapoda	Mike Davidson, Adrian Sumner, Chris Cathrine, Suzanne Bairner
Mollusca	Barry Colville, Richard Marriot, Adrian Sumner
Isopoda	Adrian Sumner, Mike Davidson, Suzanne Bairner
Coleoptera	Suzanne Bairner, Richard Lyszkowski
Hymenoptera	Murdo Macdonald, Cathy Fieldler, Suzanne Bairner
Lepidoptera	Adrian Sumner, Richard Mearns, Peter Norman, Keith Naylor, Peter Robinson, Suzanne Bairner
Odonata	Suzanne Bairner
Dermaptera	Suzanne Bairner
Orthoptera	Suzanne Bairner, Adrian Sumner
Diptera	Suzanne Bairner
Neuroptera	Suzanne Bairner
Hemiptera	Suzanne Bairner, Adrian Sumner

3.7 Historic record collation

Nearly 4,000 historic invertebrate records were sourced from Dumfries and Galloway Environmental Records Centre (DGERC). These records originated from a variety of sources and cover sites along the entire length of the north Solway coast. A species list for the whole of Dumfries and Galloway was also sourced from the NBN Gateway. These lists were compared against a list of species known to be associated with coastal vegetated shingle (Shardlow, 2001).

3.8 Outreach activities

A secondary outcome for this study was to raise awareness of the importance of shingle on the north Solway coast and to encourage others to study invertebrates in Dumfries and Galloway. During 2011 a number of events were organised or attended.

In July 2011 a 'meet the bugs' event was held at RSPB Mersehead. A local moth trapper displayed their catch from the night before and a short 'bug walk' was run by RSPB volunteers. The star of the day was however the Rhinoceros beetle (*Synodendron cylindricum*) which had been discovered on the reserve earlier in the week (see section 4.6.1). This discovery was reported in the local papers and in the RSPB's Birds Magazine.

A bug walk was held at Rascarrel Bay on the 22 August 2011. Despite poor weather this event attracted 19 participants and resulted in the discovery of a Short-winged cone-head (*Conocephalus dorsalis*) in vegetation adjacent to the shingle beach (see section 4.6.5).

An 'Introduction to Invertebrates' workshop was held on the 13 September 2011 in Creetown. This workshop had 13 participants who learned about various invertebrate groups and undertook fieldwork demonstration on vegetated coastal shingle at Carsluith.

In November 2011 a talk was given in Castle Douglas to the local Scottish Wildlife Trust members' centre. The aim of this talk was to communicate the results of this study and encourage local people to study invertebrates. This talk was well received with an audience of 35. In addition, one of the SWT members present recalled

finding what he thought was a Minotaur beetle (*Typhaeus typhoeus*) at XX. This record, if confirmed, would be the second record of *Typhaeus typhoeus* in Scotland (see section 4.6.1).

4 RESULTS

A total of 242 invertebrate species were recorded during surveys at the 9 sites (access was not possible at Abbey Burn Foot due to military schedules and only specialist surveys for Mollusca occurred here; Appendix 1). At an additional 6 sites a total of 131 species of Mollusca and Lepidoptera were recorded, 76 of which were not recorded at the main study sites. The number of new 10km records is also given. In some cases new 10km records are a result of an increase in range of a species, however in the case of the majority of new 10km records from this study they indicate how grossly under-recorded the invertebrate fauna is in Dumfries and Galloway,

4.1 Coleoptera

A total of 59 species of Coleoptera were identified (Table 8). The number of species at a site ranged from 8 at Balcarry to 18 at Barlocco Bay and 19 at Claymoddie. The survey generated 106 new 10km records.

Table 8. Species of Coleoptera recorded during surveys together with their Site Quality Score showing level of rarity (Table 12) (○ symbolises a record from this survey that has previously been recorded within 10km, ● new 10km record)

Recommended name	Site Quality Score	Balcarry	Barlocco Bay	Barsalloch	Claymoddie	Portacree	Port Castle Bay	Port Mora / Port Kale	Shore Cottage
<i>Abax parallelepipedus</i>	1			●		●		●	
<i>Adalia decempunctata</i>	1								●
<i>Amara aenea</i>	1			●					
<i>Amara eurynota</i>	1			●					
<i>Amara lunicollis</i>	1								●
<i>Amara ovata</i>	1			●					
<i>Anthicus scoticus</i>	24		●	●	●				●
<i>Aphodius contaminatus</i>	1	●			●				
<i>Baeckmanniolus maritimus</i>	1	●							
<i>Bembidion lampros</i>	1			●	●	●			
<i>Bembidion tetracolum</i>	1					●		●	
<i>Broscus cephalotes</i>	1	○	●	●	●		●		
<i>Cafius xantholoma</i>	2			●		●			
<i>Calathus fuscipes</i>	1		●		●				
<i>Calathus mollis</i>	1	●			●	●			
<i>Cassida nobilis</i>	8	○	●		●				
<i>Catops nigricans</i>	1						●		
<i>Chaetocnema concinna</i>	1								●
<i>Chrysomela aenea</i>	1								●
<i>Coccinella undecimpunctata</i>	1							●	
<i>Coccinella septempunctata</i>	1		●		○			○	●
<i>Creophilus maxillosus</i>	1						●	●	

Recommended name	Site Quality Score	Balcarry	Barlocco Bay	Barsalloch	Claymoddie	Portacree	Port Castle Bay	Port Mora / Port Kale	Shore Cottage
<i>Curtonotus aulicus</i>	1		•						•
<i>Cychrus caraboides</i>	1		•						
<i>Cytilus sericeus</i>	1			•					
<i>Derocrepis rufipes</i>	1						•		
<i>Harpalus rufipes</i>	1			•	•				
<i>Harpalus affinis</i>	1				○				
<i>Helophorus brevipalpis</i>	1			○		○			
<i>Lampyris noctiluca</i>	1							•	
<i>Nebria brevicollis</i>	1				•				•
<i>Neocrepidodera ferruginea</i>	1		•				•		
<i>Nicrophorus humator</i>	1		•				•	•	
<i>Nicrophorus investigator</i>	1		•				•		
<i>Nicrophorus vespillo</i>	1		•				•		
<i>Nicrophorus vespilloides</i>	1		•						
<i>Ocypus olens</i>	1			•	•				•
<i>Oiceoptoma thoracicum</i>	1	•	•				•		
<i>Oulema melanopus</i>	1					•			
<i>Paradromius linearis</i>	1							•	
<i>Paranchus albipes</i>	1			•	○		○	•	•
<i>Philorhizus notatus</i>	1					•			•
<i>Phyllotreta nemorum</i>	1								•
<i>Psylliodes chrysocephala</i>	1			•		•	•		
<i>Pterostichus madidus</i>	1			•					
<i>Pterostichus melanarius</i>	1		•						
<i>Pterostichus niger</i>	1	•	•	•	•	○		•	
<i>Pterostichus nigrita/rhaeticus</i>	1				•	○		•	
<i>Pterostichus strenuus</i>	1							•	
<i>Rhagonycha fulva</i>	1		•	•	•		•	○	•
<i>Sciodrepoides watsoni</i>	1						•		
<i>Serica brunnea</i>	1		•		•				
<i>Silpha atrata</i>	1		•					•	
<i>Sphaeroderma testaceum</i>	1						•		
<i>Subcoccinella vigintiquattuorpunktata</i>	1	•					•		
<i>Tasgius ater</i>	1		•		•				•
<i>Thanatophilus rugosus</i>	1					•			
<i>Timarcha tenebricosa</i>	1								•
<i>Trechus quadristraitus</i>	1				•				
Total Species	-	8	18	16	19	12	15	14	15
Total New 10km records	-	6	18	15	16	9	14	12	15

4.2 Hymenoptera

A total of 15 species of Hymenoptera were identified (Table 9). The number of species at a beach ranged from 2 at Balcarry to 8 at Barsalloch, Port Castle Bay and Port Mora / Port Kale. The survey generated 33 new 10km records.

Table 9. Species of Hymenoptera recorded during surveys together with their Site Quality Score showing level of rarity (Table 12) (○ symbolises a record from this survey that has previously been recorded within 10km, ● new 10km record)

Recommended name	Site Quality Score	Balcarry	Barlocco Bay	Barsalloch	Claymoddie	Portacree	Port Castle Bay	Port Mora / Port Kale	Shore Cottage
<i>Bombus hortorum</i>	1		○				●		●
<i>Bombus lapidarius</i>	1		○		●	○	●	○	●
<i>Bombus lucorum</i>	1			●	●	○	●	○	●
<i>Bombus pascuorum</i>	1	○	○	●		○	●	○	●
<i>Bombus pratorum</i>	1		○		●				
<i>Bombus terrestris</i>	1			●	●				
<i>Ectemnius continuus</i>	4			●					
<i>Formica lemani</i>	1		○				●	●	
<i>Hylaeus hyalinatus</i>	1		●						
<i>Lasius flavus</i>	1			○			○	○	
<i>Lasius niger agg.</i>	1	●	○	●	●		●	●	●
<i>Myrmica rubra</i>	1			●					●
<i>Myrmica ruginodis</i>	1			●	●	●	●	●	●
<i>Myrmica sabuleti</i>	1				●			●	
<i>Vespula vulgaris</i>	1					●			
Total species	-	2	7	8	7	5	8	8	6
Total new 10km records	-	1	1	7	7	2	7	4	6

4.3 Lepidoptera

A total of 81 species of Lepidoptera were identified from the main study sites (Table 10). The number of species at a beach ranged from 2 at Port Castle Bay and 3 at Port Mora / Port Kale to 36 at Barsalloch and Shore Cottage. The survey generated 25 new 10km records.

Table 10. Species of Lepidoptera recorded during surveys (○ symbolises a record from this survey that has previously been recorded within 10km, ● new 10km record)

Recommended name	Balcary	Barlocco Bay	Barsalloch	Claymoddie	Portacree	Port Castle bay	Port Mora / Port Kale	Shore Cottage
<i>Abraxas grossulariata</i>								○
<i>Abrostola tripartite</i>			○					
<i>Aglais urticae</i>	○			○				
<i>Agriphila straminella</i>		●						
<i>Agriphila tristella</i>		●						
<i>Agrotis exclamationis</i>			○					●
<i>Allophyes oxyacanthae</i>				●				
<i>Amphipyra tragopoginis</i>								●
<i>Apamea monoglypha</i>			○					○
<i>Aporophyla nigra</i>								●
<i>Arctia caja</i>			○					○
<i>Autographa gamma</i>								○
<i>Bupalus piniaria</i>			●					
<i>Camptogramma bilineata</i>								○
<i>Cerapteryx graminis</i>								○
<i>Charissa obscurata</i>								●
<i>Chloroclystis v-ata</i>			○					
<i>Chortodes pygmina</i>		○						○
<i>Cosmorhoe ocellata</i>			○					
<i>Crambus pascuella</i>			●					
<i>Diachrysia chrysitis</i>			○					○
<i>Diarsia mendica mendica</i>			○	○				
<i>Diarsia rubi</i>								○
<i>Eilema complana</i>			○					○
<i>Eilema lurideola</i>			○					○
<i>Epirrhoe alternata alternata</i>		○						
<i>Eugnorisma glareosa</i>				○				○
<i>Eulithis pyraliata</i>			○					
<i>Eupithecia centaureata</i>		○	○					
<i>Euthrix potatoria</i>			○					
<i>Evergestis forficalis</i>			●					
<i>Gymnoscelis rufifasciata</i>			○					
<i>Hadena perplexa capsophila</i>								○
<i>Hipparchia semele</i>						○		
<i>Hoplodrina alsines</i>			○					
<i>Hoplodrina blanda</i>			○					○
<i>Hydraecia micacea</i>								○
<i>Idaea aversata</i>			○					
<i>Idaea dimidiata</i>			○					
<i>Inachis io</i>							○	
<i>Lacanobia oleracea</i>			○					○
<i>Lasiommata megera</i>		○						
<i>Luperina testacea</i>		●	○					○
<i>Lycaena phlaeas</i>		○						

Recommended name	Balcarray	Barlocco Bay	Barsalloch	Claymoddie	Portacree	Port Castle bay	Port Mora / Port Kale	Shore Cottage
<i>Lycophotia porphyrea</i>								○
<i>Macrothylacia rubi</i>			○					●
<i>Maniola jurtina</i>		○			○		○	
<i>Mesapamea secalis/didyma</i>								●
<i>Mesoligia literosa</i>								○
<i>Micropterix aruncella</i>					●			
<i>Micropterix calthella</i>					●			
<i>Mythimna conigera</i>			○					
<i>Mythimna farrago</i>								○
<i>Mythimna impure</i>			○					
<i>Noctua comes</i>								○
<i>Noctua interjecta caliginosa</i>								○
<i>Noctua janthe</i>		●						
<i>Noctua pronuba</i>	○	○	○			○		○
<i>Notodonta ziczac</i>			○					
<i>Nudaria mundane</i>								○
<i>Omphaloscelis lunosa</i>				○				
<i>Perizoma alchemillata</i>			○					
<i>Pieris napi</i>		○						
<i>Pieris rapae</i>	○							
<i>Plutella xylostella</i>			●					●
<i>Polyommatus icarus</i>							○	
<i>Pseudoterpna pruinata atropunctari</i>			○					○
<i>Pyrausta despicata</i>			●					
<i>Rivula sericealis</i>			○					
<i>Scotopteryx chenopodiata</i>			○					
<i>Spilosoma luteum</i>			○	○				○
<i>Stilbia anomala</i>								●
<i>Tyria jacobaeae</i>			○					
<i>Xanthia icteritia</i>								●
<i>Xanthorhoe ferrugata</i>		●						
<i>Xestia baja</i>		●						
<i>Xestia c-nigrum</i>				●				
<i>Xestia sexstrigata</i>		●						
<i>Xestia triangulum</i>				○				
<i>Xestia xanthographa</i>				○				○
<i>Zygaena filipendulae</i>			○		○			
Total species	3	15	36	9	4	2	3	36
Total new 10km square records	0	7	5	2	2	0	0	9

4.4 Mollusca

A total of 40 species of Mollusca were identified at the main study sites (Table 11). The number of species at a beach ranged from 6 at Barlocco Bay and Portacree to 23 at Port Castle Bay. The survey generated 35 new 10km records.

Table 11. Species of Mollusca recorded during surveys together with their Site Quality Score showing level of rarity (Table 12) (○ symbolises a record from this survey that has previously been recorded within 10km, ● new 10km record)

Recommended name	Site Quality Score	Balcarry	Barlocco Bay	Barsalloch	Claymoddie	Portacree	Port Castle Bay	Port Mora / Port Kale	Shore Cottage
<i>Aegopinella nitidula</i>	1	○					○		●
<i>Arianta arbustorum</i>	1	○	○				○		
<i>Arion subfuscus</i>	1						○		
<i>Arion ater</i>	1	○							
<i>Arion ater agg.</i>	1	○					○	●	
<i>Arion distinctus</i>	1	○			●				
<i>Ashfordia granulata</i>	1			●					
<i>Candidula intersecta</i>	1	○		●	○	○			●
<i>Cecilioides acicula</i>	4			●					
<i>Cepaea hortensis</i>	1							○	
<i>Cepaea nemoralis</i>	1	○	○	○	○	○	○	●	○
<i>Clausilia bidentata</i>	1	○	○	○	○	○	○	○	●
<i>Cochlicella barbara</i>	1				○				
<i>Cochlicella acuta</i>	1			●					
<i>Cochlicopa lubrica</i>	1			○			○	●	●
<i>Cochlicopa lubricella</i>	1			●	●		●		○
<i>Cornu aspersum</i>	1	○		○	○	○	○	○	○
<i>Deroceras panormitanum</i>	1			●					
<i>Deroceras reticulatum</i>	1	○			●		○		●
<i>Discus rotundatus</i>	1	○	○	○			○	○	
<i>Euconulus fulvus</i>	1	○							
<i>Lauria cylindracea</i>	1	○		○	○		○		○
<i>Limax maximus</i>	1						○		
<i>Myosotella myosotis</i>	1	●							
<i>Nesovitrea hammonis</i>	1			○				○	
<i>Oxychilus alliarius</i>	1	○		○			○	○	●
<i>Oxychilus cellarius</i>	1			○			○	●	●
<i>Oxychilus draparnaudi</i>	1						○		
<i>Oxychilus navarricus subsp. helveticus</i>	1						○		
<i>Potamopyrgus antipodarum</i>	1	○							
<i>Punctum pygmaeum</i>	1						○		
<i>Pupilla muscorum</i>	1								●
<i>Trochulus hispidus</i>	1	○	○	○					○
<i>Vallonia excentrica</i>	1	●	●	●	●		○	●	○
<i>Vertigo pygmaea</i>	1			●	●		○	●	

Recommended name	Site Quality Score	Balcarray	Barlocco Bay	Barsalloch	Claymoddie	Portacree	Port Castle Bay	Port Mora / Port Kale	Shore Cottage
<i>Vitrea contracta</i>	1				○				
<i>Vitrea crystallina</i>	1				●		●		
<i>Vitrina pellucida</i>	1	○		○		○	○		○
Total species	-	19	6	19	14	6	23	12	16
Total new 10km records	-	2	1	8	6	0	2	6	8

4.5 NBN Gateway records

The NBN Gateway was interrogated and a species list extracted for the Dumfries and Galloway region. This list was combined with records sourced from Dumfries and Galloway Environmental Resources Centre (DGERC) and compared against a list of species associated with coastal vegetated shingle (Shardlow, 2001). Six species were identified that had an affinity with the habitat and were found on, or close to the coast. Details of the species are given below. None of these species were found during the current study.

4.5.1 Lepidoptera

Noctuidae: Sand dart (*Agrotis ripae*)

This is a maritime moth species which is associated with sand dunes and other coastal habitats. The larvae feed on several sand dune plants and burrow into the sand during the day. There is one previous record from Dumfries and Galloway which was taken from the eastern shore of Lucy Bay, approximately 1km from the Shore Cottage site.

Crambidae: White-line grey (*Eudonia lineola*)

This relatively uncommon moth is generally associated with coastal habitats. The larvae feed on various lichens. The record held by DGERC is from the Monreith area. Further trapping by local lepidopterists has now located this species at other sites, covering 5 different 10km squares in Dumfries and Galloway.

Pterophoridae: Tansy plume moth (*Platyptilia ochrodactyla*)

A plume moth associated with Tansy (*Tanacetum vulgare*). This species is widely distributed over England and Wales but the record held by DGERC is only the second for Scotland.

4.5.2 Diptera (True-flies)

Bombyliidae: Flea bee fly (*Phthiria pulicaria*)

This species of bee fly is associated with coastal dunes where it is thought to be a parasitoid of moth caterpillars. The NBN Gateway lists one record for Dumfries and Galloway from Torrs Warren.

4.5.3 Myriapoda (Millipedes and Centipedes)

Julida: *Thalassiosobates littoralis*

This small grey millipede is found among shingle and coarse sand on the coast. Most records are from the south of England however there is a single record for Scotland from Mullock Bay on the Solway coast.

4.5.4 Isopoda (Woodlice)

Trichoniscidae: *Trichoniscoides saeroeensis*

This woodlouse is only found at the coast where it lives in soil or deep litter deposits under shingle and stones. It has a wide distribution with five records from the Solway Firth coast.

4.6 Other noteworthy species recorded

During the course of these surveys a number of other noteworthy species were recorded. Details of these species are given below.

4.6.1 Coleoptera

Carabidae: *Calathus mollis*

This small ground beetle lives under driftwood and plants on the coast. It is widely distributed around the coast of Scotland however it has only been found on one occasion on the north Solway coast, at Port Logan Bay in 1980. The current surveys recorded this species from Portacree, Balcarry and Claymoddie.

Carabidae: *Philorhizus notatus*

Philorhizus notatus is a small (3-4mm long) ground beetle found among vegetation in sandy and gravelly conditions. The records from Portacree and Shore Cottage are the first from Dumfries and Galloway. Whilst this species has been found on the east coast of Scotland as far north as the Black Isle, these records are only the second time that this species has been recorded from the west of the country.

Staphylinidae: *Tasgius ater*

This rove beetle is rare in Scotland with only three previous records on the NBN Gateway, including one from the Islands of Fleet area. It is found in open habitats near the shore where the adults search for prey in the inter-tidal zone. The current surveys recorded this species at Shore Cottage, Claymoddie and Barlocco Bay.

Staphylinidae: *Cafius xantholoma*

This species of rove beetle is found strictly in coastal habitats in England, Wales and the southern coasts of Scotland. Previously recorded from along the Solway at Carrick in 1987 (NX5749). Current surveys recorded the species at Portacree and Barsalloch.

Chrysomelidae: *Timarcha tenebricosa*

The NBN Gateway lists only one previous record of this bloody-nosed beetle from Scotland from Potterland Hill, Kirkcudbrightshire. Peter Norman found it again on 18/05/2009 at Cairnmon Fell/Money Head (NX047483). This species is typically found on calcareous or sandy grassland, often in coastal areas. The current study recorded this species from Shore Cottage.



Figure 3. Bloody-nosed beetle (*Timarchia tenebricosa*). Photo: Suzanne Bairner

Lucanidae: Rhinoceros beetle (*Sinodendron cylindricum*)

The Rhinoceros beetle is one of the largest beetles in Britain and is typically found in deciduous or mixed woodland. At RSPB Mersehead nature reserve in July 2011, 3 adult males were seen patrolling a fallen piece of beech wood. Although widespread in England, previous records of this species in Scotland are from the Highlands, although there are also records from the Lothians.

Scarabaeidae: Minotaur beetle (*Typhaeus typhoeus*)

This large, round dung beetle feeds on rabbit droppings and other dung in sandy grassland and heathland. There is a single record of this species in Scotland from the NBN Gateway from Shewalton Sandpits SWT reserve by Garth Foster. During a talk to SWT members by Buglife in November 2011, one of the SWT members, Brian Smith, recalled finding what he thought was a Minotaur beetle (*Typhaeus typhoeus*). If this record were to be confirmed it would be the first record of this species in Dumfries and Galloway.

4.6.2 Araneae (Spiders)

Salticidae: Copper sun-jumper (*Heliophanus cupreus*)

Heliophanus cupreus is an attractive small jumping spider with a local distribution, and, although it is found in a variety of habitats elsewhere in the UK, the vast majority of Scottish records for this species are from shingle beaches on the Solway coast.



Figure 4. Copper sun-jumper spider (*Heliophanus cupreus*). Photo: Chris Cathrine

Gnaphosidae: Black zipper (*Zelotes apricorum*)

Zelotes apricorum is an impressive fast moving black spider. This species has a patchy western distribution in the UK, and prefers stony habitats, including coastal shingle. There have been relatively few records in Scotland, with the majority of these being from shingle beaches on the Solway coast.



Figure 5. Black zipper spider (*Zelotes apricorum*). Photo: Chris Cathrine

Lycosidae: Sand bear spider (*Arctosa perita*)

This species of wolf spider is widespread in coastal habitats around Britain. In Scotland, the Sand bear spider is a truly coastal species whereas in England and Wales there are scattered inland records on dry heath. It is thought that this species may be increasing its range inland.

4.6.3 Pseudoscorpiones (Pseudoscorpions)

Cheliferidae: *Chthonius tetrachelatus*

This tiny pseudoscorpion species can be found under stones and rocks at the coast where it lives amongst leaf litter and decaying vegetation. It is widely distributed although the record from Claymoddie during this survey represents only the second record for the Solway coast.

4.6.4 Mollusca

Pupillidae: *Pupilla muscorum*

This small snail can be found in dry meadows, sand dunes and other calcareous habitats. In Scotland it is restricted to the coast (predominately the east coast), however in parts of England it can be found inland. The record of *Pupilla muscorum* from Shore Cottage during these surveys is only the second record for Wigtownshire.

Ferussaciidae: Blind agate snail (*Ceciliodes acicula*)

This small snail (5.5mm tall x 1.2mm wide) lives underground, up to 2m below the surface, in unwooded calcareous places. Because of its subterranean habitat, this species is often found only as an empty shell, and in this survey several shells were found in an ant-hill of *Lasius flavus* at Barsalloch. This record represents only the second extant colony of this species in Scotland.

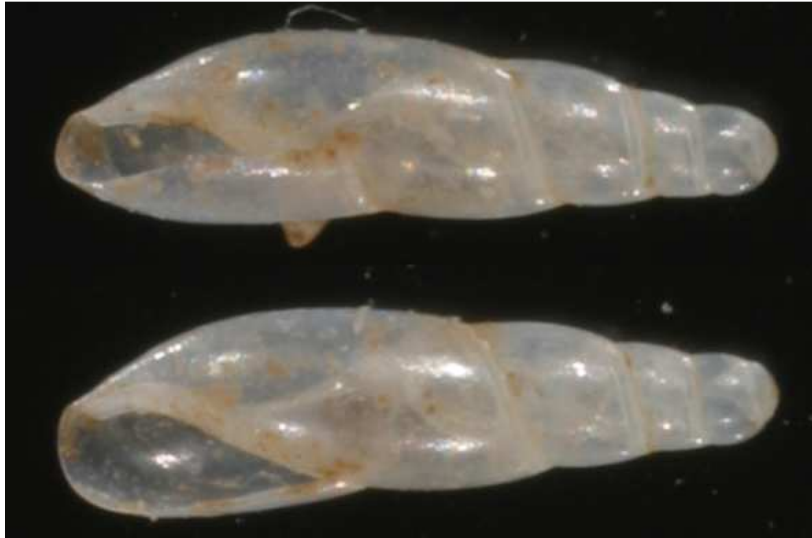


Figure 6. Blind agate snail (*Cecilioides acicula*). Photo: Francisco Schultes

Hygromiidae: *Ashfordia granulata*

This snail is typically found in damp herbage alongside semi-aquatic snails. Towards the north and west of its range in the British Isles it is found away from freshwater on road verges, brownfield sites and along the coast from sandhills and sea cliffs. The record from Barsalloch during these surveys is only the fourth recent record of this species from the north Solway coast.

Ellobiidae: Mouse-eared snail (*Myosotella myosotis*)

This species is typically found under driftwood at the high water mark or in saltmarshes. It is occasionally found in shingle or in crevices of exposed rocks. It has a widespread though localised distribution and the record from Balcarry made during these surveys is the first for Wigtownshire and one of only a few on the west coast of Scotland.

4.6.5 Orthoptera

Tettigoniidae: Short-winged conehead (*Conocephalus dorsalis*)

The Short winged conehead is found in two distinct habitats; coastally on saltmarsh and sand dunes, and inland on lowland bogs, reedbeds, river floodplains and lakes. Several adults were recorded during a bugwalk held by Buglife at Rascarrel bay on the 22nd of August 2011. This is the second record of this species from Scotland. It was previously recorded from Tenstmuir Forest in Fife in August 2010 by Gordon Maxwell.

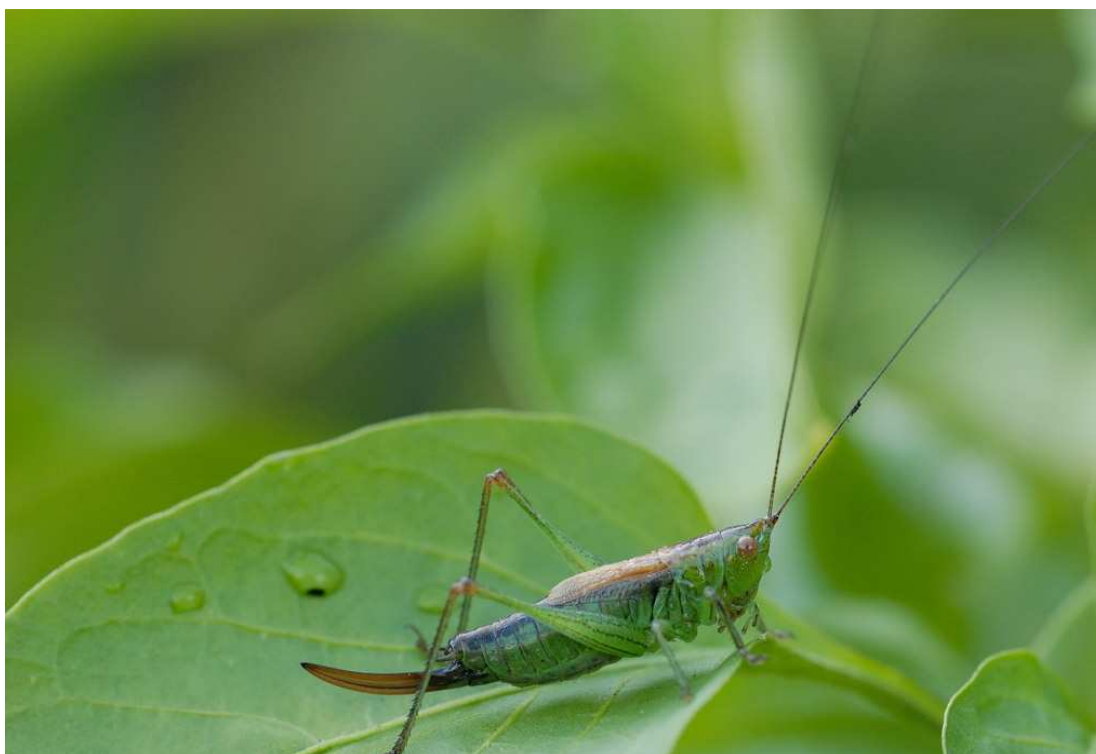


Figure 7. Short-winged conehead (*Conocephalus dorsalis*). Photo: Keith Kirk

4.7 Site Quality Index (SQI)

Once a species list has been compiled for a site the list can be compared with those from other locations to identify which is of greater conservation value in terms of the rare species that the site supports (Williams, 2000; Drake *et al.* 2007). In order to objectively compare species lists between sites, an average score index known as the Site Quality Index (SQI) is often used. These scores are becoming an increasingly common way to assess and compare the quality of a site although the scores are only valid when calculated using lists with at least 15 species (Drake *et al.* 2007). A SQI score of 2.0 or above is considered to indicate a site with good quality habitat (Williams, 2000). This objective method was employed to compare the 8 main sites surveyed during structured surveys in this study.

When calculating an SQI, scores are initially given to each species recorded depending on the level of its rarity (Table 12).

Table 12. Score given to species depending on their level of conservation concern

Conservation Designation	Rarity Score
Common	1
Local (Scarce)	2
Regionally Notable (UKBAP, Scottish Biodiversity Species etc)	4
Nationally Scarce categories Nb and unclassified Notable	8
Nationally Scarce categories Na	16
Red Data Book (RDB1 and RDB3)	24
Red Data Book (RDB2 and RDB1)	32

For each site, the rarity scores are then summed to give the Site Quality Score (SQS). The SQS is then divided by the total number of species recorded at that site to get the SQI (Drake *et al.* 2007): Difference in recording effort between sites are corrected for by dividing the SQS by the total number of species recorded at that sites (Williams, 2000; Drake, *et al.*, 2007).

$$\text{SQI} = \text{SQS} \div \text{the total number of species}$$

The SQI was compared between sites using species collected during specialist Coleoptera, Mollusca and Hymenoptera surveys only as the methods and effort for sampling each of these groups was replicated between each site (Table 13). Results from specialist surveys and other species groups were not included when calculating the SQI as these were not part of the structured surveys, and so effort was not comparable between sites. Inclusion of other species groups or results from specialist surveys in SQI calculations would therefore not be valid.

Table 13. Total number of invertebrate species recorded at each site and the total number of Coleoptera, Mollusca and Hymenoptera recorded during specialist surveys. SQI depicting total species richness and specialist survey species richness

Site Name	Total Species*	Specialist Survey Total Species	Specialist Survey (SQI)
Balcarray	50	31	1.23
Barlocco Bay	58	32	1.94
Barsalloch	95	44	1.70
Claymoddie	60	39	1.77
Port Castle Bay	53	41	1
Port Mora / Port Kale	59	32	1
Portacree	33	24	1.04
Shore Cottage	90	37	1.62

*Includes all species recorded during main structured surveys and additional surveys.

5 DISCUSSION

A total of 242 species of invertebrate were recorded on vegetated shingle at 8 sites along the north Solway Firth coast. A further 7 sites were sampled for Mollusca and Lepidoptera where a total of 132 species were recorded (Appendix 1); 76 of these species were recorded only at the additional sites surveyed during specialist surveys.

Specialist invertebrate surveys using the methods described above concentrated on Coleoptera (59 species recorded), Mollusca (40 species recorded) and aculeate Hymenoptera (15 species recorded). The greatest numbers of Coleoptera were recorded from Claymoddie which had a total of 19 species from 7 families. Port Castle Bay had the greatest number of Mollusca species recorded with a total of 23 species from 13 families. The greatest number of Hymenoptera was recorded from Barsalloch, Port Castle Bay and Port Mora / Port Kale which each had 8 species from a total of 3 families.

An additional specialist invertebrate survey for Lepidoptera was undertaken using light traps at 11 sites including 6 main structured sites (Barlocco Bat, Barsalloch, Claymoddie, Portacree, Port Mora / Port Kale, Shore Cottage) and 5 additional sites (Ardwell, Carsluith, Chapel Finian, Milton Point and Philip and Mary). This survey recorded 153 species altogether, 81 of which were recorded at the 8 main study sites. Chapel Finian (NX279486) to the south of Shore Cottage had the greatest number of Lepidoptera recorded with a total of 90 species (Appendix 1). This site was only surveyed for Lepidoptera and sampling here occurred on several days. Of

the 8 main study sites, 5 were also sampled for Lepidoptera, namely; Barsalloch, Barlocco Bay, Claymoddie, Portacree and Shore Cottage. Of these 5 sites, Barsalloch had the greatest number of Lepidoptera species (37).

An invertebrate species list was extracted from the NBN Gateway for Dumfries and Galloway and was combined with records from the Dumfries and Galloway Environmental Records Centre (DGERC). This list was compared against a list of species associated with coastal vegetated shingle (Shardlow, 2001). There were several species that are typical of coastal and shingle habitat such as sand dart moth (*Agrotis ripae*), the flea bee fly (*Phthiria pulicaria*) and the millipede *Thalassiosobates littoralis*. None of these species were recorded during the present study.

During this study several species of conservation concern were recorded including the Red Data Book ant-like beetle *Anthicus scoticus* (RDB3) and Nationally Scarce leaf beetle *Cassida nobilis* (Nb). Specialist moth surveys recorded 18 UKBAP species (listed for research only). An additional 15 moth species with Local distribution (including scarce footman (*Eilema complana*) and common emerald (*Hemitea aestivaria*)) and 8 moth species with Scarce distribution (including lime-speck pug (*Eupithecia centaureata*) and black rustic (*Aporophyla nigra*)) were also recorded. The UKBAP butterflies grayling (*Hipparchia semele*) and wall brown (*Lasiommata megera*, research only) were also recorded through direct observations.

Other species of interest include the Locally distributed rove beetle *Cafius xantholoma* which is strictly coastal in its distribution and the solitary wasp *Ectemnius continuus* which is listed on the Scottish Biodiversity List.

Despite the small number of sites surveyed there appears to be some correlation between the invertebrate fauna and vegetation surveyed by Randall and Doody (2000).

Species lists for each site were compared using a Site Quality Index (SQI) score to identify which sites had the greater number of rare species (Williams, 2000) (see section 4.7 and table 13). Although, no sites in this study had a SQI score over 2.0, Barlocco Bay (SQI: 1.94) and Claymoddie (SQI: 1.77) both had scores that were close to this (Table 13). *Anthicus scoticus* (RDB3) and *Cassida nobilis* (Nb) were both recorded at Barlocco Bay and Claymoddie. *A. scoticus* was also collected from Barsalloch (SQI: 1.70) and Shore Cottage (SQI: 1.62) and *C. nobilis* was also collected from Balcarry (SQI: 1.23). Vegetated shingle habitat at all these sites is relatively isolated from disturbance due to access difficulties, although these sites may still be affected with natural mobility of the shingle through the action of the tide and weather.

Barlocco Bay can only be accessed by a coastal path from Rascarrel Bay and is therefore isolated from disturbance. A total of 32 species of invertebrate were identified during specialist surveys, with a further 28 recorded during other surveys. The high SQI indicates how important this site is for the target invertebrate groups. The rear of the vegetated shingle at this site is rich in wildflowers which provides additional habitat for many invertebrate species, particularly pollinators.

Claymoddie is a long vegetated shingle beach along the south west shore of Luce Bay. Access is limited at this site due to private ownership and because of this the site is isolated and protected from recreational activities. A total of 39 invertebrate species were collected during specialist surveys with a further 21 recorded during other surveys. Claymoddie has previously been identified as being the most important shingle site for its vegetation on the Solway coast and one of the largest

sites with vegetated shingle in Scotland (Randall and Doody, 2000; Murdock *et al.* 2011). This site was also identified as providing particularly good habitat for invertebrates due to the plant diversity and extent of the site. In addition, this site may also be important for reptiles, particularly slow worms (*Anguis fragilis*) which were recorded here during surveys for aculeate Hymenoptera in August 2011. Slow worms are predators of snails and slugs and 14 species of Mollusca were recorded at this site, with particularly high numbers of garden snail (*Cornu aspersum*) present. The highest number of beetles was recorded at this site with 19 species, 16 of which were new 10km records for the area. This site also had the highest number of new 10km records for Hymenoptera with 7 new records for the site.

The sites at Port Mora / Port Kale and Port Castle Bay had the lowest SQI score (1). A total of 32 (Port Mora / Port Kale) and 41 (Port Castle Bay) invertebrate species were recorded during specialist surveys at these sites. Vegetated shingle at these sites was identified by Randall and Doody (2000) as being small in size and of low quality.

The 3 separate areas of vegetated shingle at Port Mora / Port Kale are all small in size; there are two small areas of vegetated shingle at Port Kale and one slightly larger one in Port Mora. The Southern Upland Way coastal path from Port Patrick goes through both bays and this may impact on vegetated shingle habitat as the path lies close to vegetated shingle and crosses it in areas.

Port Castle Bay is just south of Claymoddie and vegetated shingle is restricted to a small embayment (NX425358). High numbers of tourists visit St. Ninians Cave which lies to the north of Port Castle Bay. The path used by tourists passes the area of vegetated shingle although it appears that there is little disturbance by people. Vegetation is low lying and there are several individual plants of sloe (*Prunus spinosa*) and a small area with ragwort (*Senecio jacobaea*), wild Thyme (*Tymus serpyllum*) and birds foot trefoil (*Lotus corniculatus*). The highest number of Mollusc species was recorded at this site with a total of 22 species, although only 2 of these were new 10km records.

Barlocco Bay and Claymoddie had the highest SQI score and were recognised by Randall and Doody (2000) as being good quality habitat. This may be due to their isolation from disturbance and the large areas of vegetated shingle present at these sites. In contrast, the sites at Portacree and Port Mora / Port Kale had the lowest SQI score and were recognised by Randall and Doody (2000) as being low quality habitat due to their small size and limited floral diversity. Due to the location of these areas of vegetated shingle, these sites are well used for recreational activity such as walking and this disturbance may influence the habitat at these sites.

A relatively low number (15) of aculeate Hymenoptera species were recorded from the Solway, especially during the specialist surveys in July, August and September 2011. In total 15 species were recorded during the specialist survey. The highest number of species was recorded at Port Mora / Port Kale; Port Castle Bay; and Barsalloch with a total of 8. This is a relatively low number of species to be recorded within this order and mostly includes species of bumblebee and ant. This low number is unlikely to be indicative of the true Hymenoptera diversity at the site but is more likely to be due to the timing of the surveys and adverse weather conditions experienced during the visits. Surveys for Hymenoptera are best done early in the year as many solitary bees such as *Andrena* spp. and *Halictus* spp. are typically found in April and May. The commencement of this contract was such that the optimum period for Hymenoptera surveys was missed.

Portacree recorded the lowest number of invertebrate species from specialist surveys with 24 species and a SQI score of 1.04. Randall and Doody (2000) identified that only one third (0.5km) of the entire site at Portacree had shingle during vegetation surveys. This site is adjacent to a caravan park and during the summer there are a high number of tourists within the area. Very little vegetated shingle was identified during the current study and a majority of the shingle beach was covered by wrack, leaves and other debris from recent storms. Indeed, the area of vegetated shingle decreased significantly due to natural erosion between surveys in 2010 and 2011.

The poor quality of vegetated shingle habitat was also evident at Balcarry, which had a total of 31 invertebrate species identified from specialist surveys and a SQI score of 1.23. Randall and Doody (2000) documented that there was less than 300m of vegetated shingle at Balcarry. In September 2011, this was reduced to an area of about 15-20m and was mostly covered by debris from recent storms. The reduction in habitat extent may be due to the exposed location of the site and the natural mobility of the shingle, illustrating just how fragile these habitats are.

The highest total number of invertebrate species recorded (including those identified during specialist surveys and other surveys) was from Barsalloch (95 species), followed by Shore Cottage (90 species). Vegetated shingle at both of these sites was identified as being particularly good for invertebrates, due to the diversity of wildflowers along with the size of both sites and the lack of disturbance within these areas.

Shore Cottage, with a SQI of 1.62, was the only site on the Solway to have the bloody nosed beetle (*Timarcha tenebricosa*), the flea beetle *Phyllotreta nemorum*, the ant-like beetle *Anthicus scoticus* and also the snail *Pupilla muscorum*. Shore Cottage is to the north of Port William and lies adjacent the A747. There is only limited access to this site which restricts recreational activity and limits disturbance to the area.

Although there have been many *ad hoc* surveys of saline shingle beaches around Britain, there have been few large scale and co-ordinated surveys, the exception being at Snettisham RSPB reserve in Norfolk where invertebrate surveys occurred on shingle from 1993-97 (Shardlow, 2001). Short-term professional invertebrate surveys have occurred at several shingle beaches along the south and south-east coast of Britain: Dungeness (Kent), Rye Harbour (East Sussex), Orford Ness (Suffolk), Havergate Island (Suffolk) and Chesil Beach (Dorset).

In Britain, there are at least 390 invertebrate species of conservation importance on coastal shingle, including 15 Priority species, 18 species of Conservation Concern and 114 RDB species (Shardlow, 2001). Previous surveys on shingle have shown that many invertebrate species recorded in this habitat are also associated with non-shingle habitat, highlighting the importance of this habitat to all invertebrates. This was certainly the case in the current study. The lack of detailed invertebrate surveys on Scottish coastal vegetated shingle means that it is difficult to draw comparisons with what has been recorded during these surveys. Whilst the surveys have recorded many invertebrate species that have otherwise not been recorded or recorded infrequently in south west Scotland, the lack of shingle 'specialists' is slightly disappointing. It is possible however that this is an artefact of the paucity of studies on Scottish shingle. It is clear though that the north Solway Coast is of considerable importance for invertebrates.

Shingle beaches sufficiently stable enough to support perennial vegetation are a comparatively rare feature globally. The quality of vegetated shingle habitat can

deteriorate quickly due to the mobile nature of shingle through tide action and weather along with various man made influences such as disturbance through recreational activities and pollution.

The natural mobility of shingle particles in high energy environments is a natural threat to the long-term maintenance of vegetated shingle habitats. Many of the plant and invertebrate species that live in this habitat are however well adapted for changes in salinity. The mobility of shingle may be accelerated through climate change by for example, rising sea levels and an increased frequency of storms (Doody and Randall, 2003). This may affect the ability of shingle to support plants and those specialised species that are tolerant of salinity, drought and low nutrients, and the many invertebrate species associated with them may become threatened as their local range contracts further.

There are several man-made threats to vegetated shingle. Disturbance is common and may be caused by recreational activities such as walking or cycling, or through development or exploitation of these sites for aggregate extraction. In the future with the further intensification of coastal agriculture more areas of shingle habitat may experience 'Coastal squeeze' as they are trapped between farmland on the landward side and rising sea levels on the seaward side .

Pollution is also another problem that is experienced by areas of vegetated shingle. This pollution may come from the land or from the sea and also through the dumping of waste as the value of this habitat isn't always recognised, and fly-tipping is not uncommon on vegetated shingle (Doody and Randall, 2003). There can also be evidence of drought stress on vegetated shingle in areas of water abstraction for groundwater nearby (Buglife, 2010).

This study has highlighted the importance of vegetated shingle along the north Solway Firth coast for invertebrates. As the formation of new areas of vegetated shingle is relatively rare, every effort should be made to protect and manage these sites appropriately.

6 CONCLUSIONS

Overall the results of this study have highlighted the importance of vegetated shingle for invertebrates along the north Solway Firth coast. The survey recorded a total of 242 invertebrate species (111 of which are from specialist Coleoptera, Hymenoptera and Mollusca surveys) and produced 199 new 10km square records in an under-recorded area of Scotland.

It is disappointing that invertebrate species strictly associated with shingle habitat were not recorded during this survey. Several species that are typically only found in coastal situations were however recorded including the beetles *Calathus mollis*, *Tasgius ater* and *Cafius xantholoma* as well as the spider *Erigone arctica* and the mollusc *Cochlicella acuta*. Invertebrates of conservation importance recorded on shingle beaches during this study include the ant-like beetle *Anthicus scoticus* (RDB 3), the leaf beetle *Cassida nobilis* (Notable B), the UKBAP species Grayling (*Hipparchia semele*), solitary wasp *Ectemnius continuus* and mollusc *Ceciliodes acicula* as well as 18 Local, 7 Scarce and 18 UKBAP (research only) species.

Most of the shingle beaches surveyed in this study were identified as having good habitat for invertebrates. Shingle beaches at Claymoddie were recognized as being of particular importance with a total of 60 invertebrate species recorded. This site has previously been identified by Randall and Doody (2000) of being important for the plant communities present.

It is recommended that further invertebrate surveys on vegetated shingle along the north Solway Firth coast are undertaken. Surveys should be carried out at a greater number of sites as the fragile nature of shingle can quickly alter the quality of the habitat such as was seen at Portacree and Balcarry during this study. Surveys should concentrate on aculeate Hymenoptera as well as completing further surveys of Coleoptera, Mollusca and Lepidoptera and other species of invertebrates that may be found in this habitat. It may also be useful to look at the invertebrate fauna which overwinters in vegetation tussocks on the shingle.

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APPENDIX 1: ADDITIONAL SPECIES RECORDS

Lepidoptera

Moth traps were set at an additional five sites along the north coast of the Solway. These traps generated 125 species of moth. The number of species at a beach ranged from 90 at Chapel Finian to 13 at Philip and Mary. These results contributed 49 new 10km records.

Table 14. Dates Lepidoptera were sampled during specialist surveys at the additional 5 sites surveyed by volunteers using light traps

Site name	Date surveyed
Ardwell	13/06/2011, 10/07/2011
Carsluith	22/07/2011, 31/07/2011
Chapel Finian	23/07/2010, 24/07/2010, 02/06/2011, 04/06/2011, 08/07/2011, 09/07/2011, 22/08/2011, 01/09/2011
Milton Point	02/06/2011, 04/06/2011
Philip and Mary	09/07/2011

Table 15. Species of Lepidoptera recorded during surveys in 2010 and 2011 at the 5 additional sites surveyed by volunteers using light traps (○ symbolises a record from this survey that has previously been recorded within 10km, ● new 10km record)

Recommended name	Ardwell	Carsluith	Chapel Finian	Milton point	Philip and Mary
<i>Abraxas grossulariata</i>			○	○	
<i>Abrostola tripartita</i>			○		
<i>Acronicta rumicis</i>				○	
<i>Agrotis exclamationis</i>	○		○		
<i>Agrotis ipsilon</i>			○		
<i>Alcis repandata repandata</i>				●	
<i>Amphipyra tragopoginis</i>			○		
<i>Apamea crenata</i>	●				
<i>Apamea lithoxyloae</i>	●		○		
<i>Apamea monoglypha</i>	○	○	○		○
<i>Apamea remissa</i>	○				
<i>Aphelia paleana</i>	●				
<i>Aphomia sociella</i>			●		
<i>Arctia caja</i>	○	○	○		○
<i>Autographa gamma</i>	○		○	○	
<i>Autographa jota</i>			○		
<i>Autographa pulchrina</i>			●	●	
<i>Axylia putris</i>	○		○		
<i>Cabera exanthemata</i>		○			
<i>Camptogramma bilineata</i>	○				
<i>Caradrina morpheus</i>	●				
<i>Cerapteryx graminis</i>	○		○		
<i>Chloroclysta truncata</i>				○	
<i>Chloroclystis v-ata</i>			○		
<i>Cidaria fulvata</i>			○		
<i>Cilix glaucata</i>			○	○	

Recommended name	Ardwell	Carsluth	Chapel Finian	Milton point	Philip and Mary
<i>Coenobia rufa</i>			●		
<i>Colocasia coryli</i>		○			
<i>Colostygia pectinataria</i>					○
<i>Crocallis elinguaris</i>			○		
<i>Cybosia mesomella</i>				○	
<i>Deilephila elpenor</i>				○	
<i>Deilephila porcellus</i>			○		
<i>Diachrysis chrysitis</i>	○	○	○		
<i>Diarsia mendica mendica</i>	●		○		○
<i>Diarsia rubi</i>			○		
<i>Dicallomera fascelina</i>				○	
<i>Dipleurina lacustrata</i>		●			
<i>Ecliptopera silaceata</i>				○	
<i>Eilema complana</i>			○		○
<i>Eilema lurideola</i>	○	○	○		○
<i>Ennomos alniaria</i>			○		
<i>Epirrhoe alternata alternata</i>			●		●
<i>Eugnorisma glareosa</i>			○		
<i>Eulithis pyraliata</i>	●				○
<i>Eupithecia absinthiata</i>			○		
<i>Eupithecia centaureata</i>	○		○	○	
<i>Eupithecia icterata subfulvata</i>			●		
<i>Eupithecia nanata</i>		○	○		
<i>Euproctis similis</i>			○	○	
<i>Euthrix potatoria</i>			○		
<i>Euxoa tritici</i>			○		
<i>Evergestis forficalis</i>	●		●		●
<i>Evergestis pallidata</i>			●		
<i>Gymnoscelis rufifasciata</i>	○		○		
<i>Hada plebeja</i>				○	
<i>Hadena bicruris</i>	○				●
<i>Hadena confusa</i>	○			○	
<i>Hadena perplexa capsophila</i>			○	○	
<i>Hemithea aestivaria</i>			●		
<i>Hepialus fusconebulosa</i>	○		●	●	
<i>Hoplodrina alsines</i>	○		○		
<i>Hoplodrina blanda</i>	○		○		
<i>Hydraecia micacea</i>			○		
<i>Hydriomena furcata</i>		○	○		
<i>Idaea aversata</i>	○		○		
<i>Idaea biselata</i>			○		
<i>Idaea dimidiata</i>	○		○		
<i>Lacanobia oleracea</i>			○		
<i>Laothoe populi</i>			○		
<i>Lomaspilis marginata</i>	●				
<i>Luperina testacea</i>			○		

Recommended name	Ardwell	Carsluth	Chapel Finian	Milton point	Philip and Mary
<i>Lycophotia porphyrea</i>			○		
<i>Macrothylacia rubi</i>			○	○	
<i>Melanchra pisi</i>			●		
<i>Mesapamea secalis/didyma</i>			○		
<i>Mesoligia furuncula</i>			○		
<i>Mesoligia literosa</i>			○		
<i>Myelois circumvoluta</i>			●		
<i>Mythimna comma</i>			●	●	●
<i>Mythimna ferrago</i>			○		
<i>Mythimna impura</i>	○		○		
<i>Noctua comes</i>			○		
<i>Noctua interjecta caliginosa</i>			○		
<i>Noctua janthe</i>			○		
<i>Noctua pronuba</i>	○	○	○		
<i>Nudaria mundana</i>	○		○		
<i>Ochropleura plecta</i>	○				
<i>Opisthograptis luteolata</i>			○	○	
<i>Orthonama vittata</i>			○		
<i>Pasiphila rectangulata</i>			●		
<i>Pelurga comitata</i>					○
<i>Peribatodes rhomboidaria</i>		○			
<i>Perizoma alchemillata</i>			○		
<i>Perizoma didymata didymata</i>			●		
<i>Perizoma flavofasciata</i>	○				
<i>Petrophora chlorosata</i>				○	
<i>Phalera bucephala</i>			●	●	
<i>Plusia putnami gracilis</i>	●				
<i>Plutella xylostella</i>			●	●	●
<i>Pseudoterpna pruinata</i>					
<i>atropunctari</i>			○		
<i>Pterophorus pentadactyla</i>			●		
<i>Rivula sericealis</i>			○		
<i>Schrankia costaestrigalis</i>	○				
<i>Scoliopteryx libatrix</i>				●	
<i>Scotopteryx luridata</i>					
<i>plumbaria</i>	○				
<i>Selenia dentaria</i>	○	○	○		
<i>Spilosoma lubricipeda</i>	○		○	○	
<i>Spilosoma luteum</i>	○		○	○	
<i>Spodoptera exigua</i>	●				
<i>Thera britannica</i>				○	
<i>Thyatira batis</i>			●		
<i>Tyria jacobaeae</i>	○		○		
<i>Udea ferrugalis</i>	●				
<i>Udea prunalis</i>		●			
<i>Xanthorhoe designata</i>			○		

Recommended name	Ardwell	Carsluith	Chapel Finian	Milton point	Philip and Mary
<i>Xanthorhoe ferrugata</i>	●		○		
<i>Xanthorhoe fluctuata fluctuata</i>	●		●	●	
<i>Xanthorhoe montanata</i>	○			○	
<i>Xestia baja</i>			○		
<i>Xestia ditrapezium</i>		○	○		
<i>Xestia sexstrigata</i>			○		
<i>Xestia triangulum</i>	○	●	●		
<i>Xestia xanthographa</i>			○		
<i>Zygaena filipendulae</i>			○		
Total species	45	15	90	29	13
Total new 10km square records	13	3	20	8	5

Mollusca

Additional records of Mollusca during the period of this study are available for two sites. The results from Abbey Burn Foot have been included here as restricted access to this site prevented systematic surveys. At both Abbey Burn Foot and Drummore, 4 species of Mollusca were recorded. One of these was a new 10km record.

Table 16. The dates Mollusca were sampled during specialist surveys

Site name	Date surveyed
Abbey burn foot	17/09/2010
Drummore	11/09/2010

Table 17. Species of Mollusca recorded during surveys in 2007 and 2010 (○ symbolises a record from this survey that has previously been recorded within 10km, ● new 10km record)

Recommended Name	Abbey Burn Foot	Drummore
<i>Cepaea nemoralis</i>	○	○
<i>Cernuella virgata</i>		●
<i>Clausilia bidentata</i>	○	
<i>Cornu aspersum</i>		○
<i>Trichia striolatus</i>	○	
<i>Trochulus hispidus</i>		○
<i>Vallonia excentrica</i>	○	
Total species	4	4
Total new 10km square records	0	1