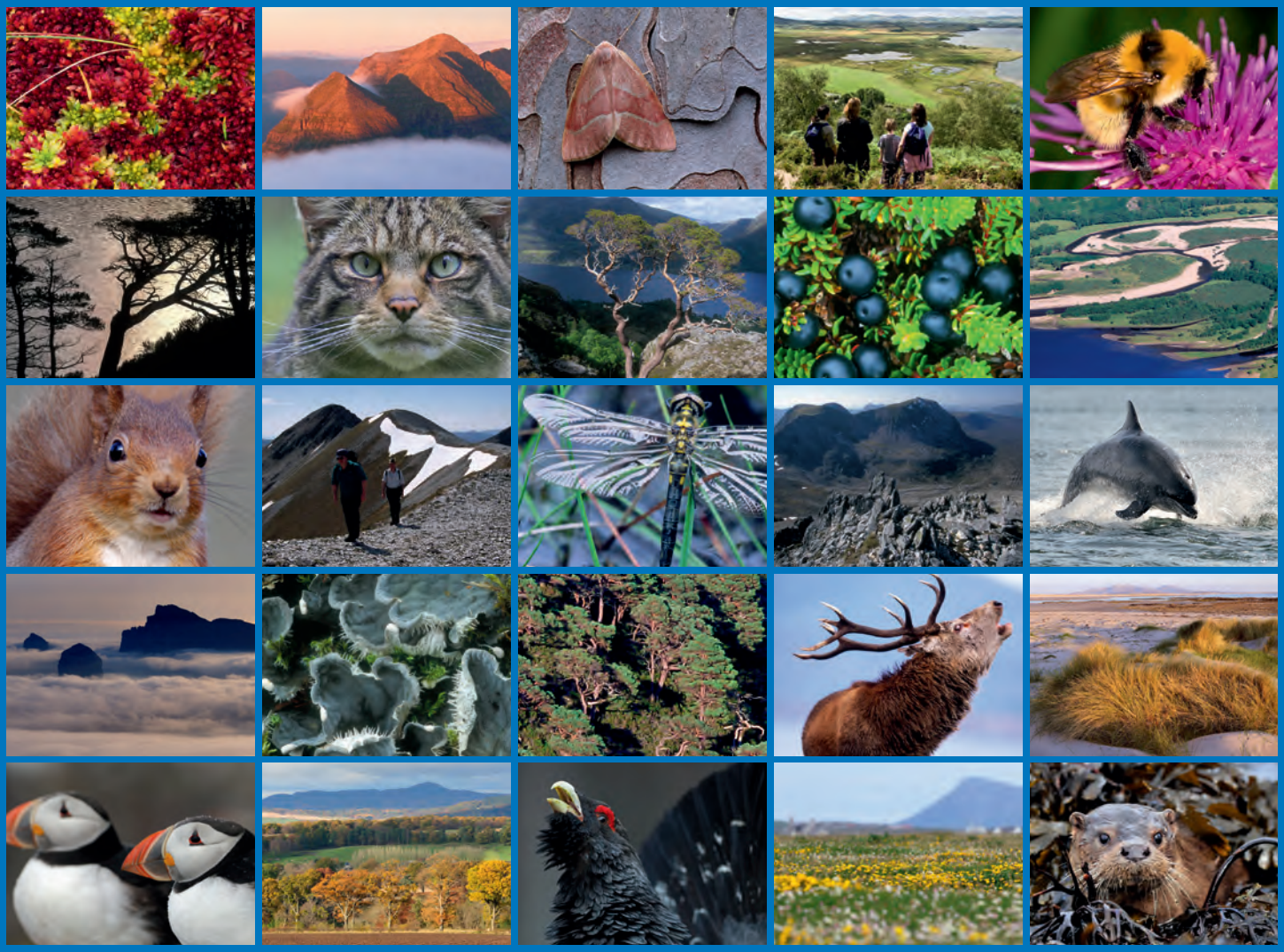
Scottish Natural Heritage
Commissioned Report No. 739

Inventory of coastal vegetated shingle in Scotland – field validation



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COMMISSIONED REPORT

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Inventory of coastal vegetated shingle in Scotland – field validation

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COMMISSIONED REPORT

Summary

Inventory of coastal vegetated shingle in Scotland – field validation

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Project No: 10539
Contractor: GeoData Institute, University of Southampton
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Keywords

Coastal vegetated shingle; aerial photographic interpretation; inventory; field validation; Annex I habitat; BAP Priority Habitat; Broad Shingle Class.

Background

Scottish Natural Heritage (SNH) has a statutory duty to report on the status of habitats listed under Annex I of the Habitats Directive. SNH previously commissioned the GeoData Institute to draw together existing information sources on coastal vegetated shingle in Scotland and to update this through aerial photographic interpretation (API) and limited field survey. This created a preliminary inventory of coastal vegetated shingle Biodiversity Action Plan (BAP) Priority Habitat in Scotland, which was published in 2011.

This initial inventory required validation and this current project undertook field validation work of the BAP Priority Habitat extents. There was also a requirement to map the habitats in greater detail, to Annex I level and specifically to a Broad Shingle Habitat classification developed by SNH.

Main findings

- This project has validated 1,083 ha (97%) of the initial Inventory dataset and it provides a uniquely detailed picture of the two Annex I coastal vegetated shingle habitats found in Scotland.

- Field validation revealed that the BAP Priority Habitat extent for coastal vegetated shingle is 1,120 ha, which is greater than previously thought. Only about 3% of polygons remain unvalidated, largely due to remoteness and / or inaccessibility. The average polygon area is 2.0 ha.

- The Annex I habitat extents are recorded as:

  H1220 perennial vegetation of stony banks 940 ha
  H1210 annual vegetation of drift lines 124 ha

Surveyors identified that the extent of annual vegetation of drift lines fluctuates throughout the year. Therefore, a second estimate is also provided which extends these parcels down to the Mean High Water Springs line:

H1210 annual vegetation of drift lines *maximum potential extent* 157 ha

- Generally the API and rule base was able to identify the coastal vegetated shingle sites well. However, field surveys did highlight some challenges for the API, with the main issues relating to the interpretation of transitional areas between habitats.

- This report also provides a detailed breakdown by 'Broad Shingle Classes'. *Festuca* grassland is identified as the dominant class. Strandline communities are recognised as an important and major component of the coastal vegetated shingle habitat resource. Woodland is rather localised but had a large area and scrub is also a major class. The class with the smallest area is stable open habitats.

- Aside from issues with grazing, the coastal vegetated shingle is generally relatively undisturbed, due to the remote nature of many of the sites. However, locally there is disturbance at the more accessible sites.

- A trial of digital field mapping during the surveys for this project showed that the systems had several advantages. However, there was still a requirement for considerable post-processing as the mapping software and data capture tools required much greater customisation than was possible within this project.

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Table of Contents **Page**

List of Figures **Page**

List of Tables **Page**

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To Duncan Blake and Gabor Barton of the SNH GIS team for their timely and efficient supply of GIS data for the project and to Sharon Mason for technical support and to Andrew Blogg, Korec Ltd. who kindly made available a Trimble tablet PC for use in the fieldwork on Orkney, Shetland and the North Coast, allowing a trial of these systems.

The collation and QA of the GIS layer was undertaken by Gemma Gubbins, Daniel Hall Ballester, Daniel Ellis, Tommy Hearne and Graeme Hornby. Julia Branson's database expertise was instrumental for the collation and reformatting of the survey data for use in GIS.

Finally, we wish to thank SNH for funding this work and the project steering group for their input and guidance - Susan Watt, Stewart Angus, Duncan Blake and Philippa Vigano.

1. INTRODUCTION

Scottish Natural Heritage (SNH) has a statutory duty under The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) to report on the status of habitats listed under Annex I of the Council directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (commonly known as the Habitats Directive). However, until recently, the information on coastal vegetated shingle habitats for Scotland was limited and had not been collated.

In 2010, SNH commissioned the GeoData Institute and their consultants (Roland Randall and Jonathan Cox) to draw together existing information sources on coastal vegetated shingle within Scotland (Murdock *et al.*, 2011). This initial (first phase) inventory drew principally on the Sneddon and Randall Surveys of the 1990s (Sneddon and Randall, 1993), but also upon more localised studies for the Solway coast and from National Vegetation Classification (NVC) and Phase 1 habitat data. In addition, the assessment of the remaining coastline was guided by SNH's shingle (substrate not vegetation) database and through Aerial Photographic Interpretation (API) alone.

This work generated an estimated coastal vegetated shingle habitat extent in Scotland of 1,120 ha, made up of 563 parcels (macropolygons). These were (bar a few exceptions) above the minimum mappable unit (MMU) size of 0.1 ha and had an average polygon size of 2.0 ha.

Although this was a best estimate of the habitat extent available, the fact that many areas were based on API alone, highlighted the need for further validation of the dataset through field survey. The aim of these surveys was to check the extent of polygons mapped.

The initial inventory report broke the identified sites down into a series of survey blocks (see Figure 1) and provided an initial estimate of the likely field survey task. SNH then issued a competitive tender for the field validation surveys which was subsequently awarded to the GeoData Institute and its consultants Roland Randall, Jonathan Cox, Ian Strachan and Central Environmental Surveys.

Some of the survey blocks were considered lower priority as they had been recently surveyed (e.g. Solway – Randall and Doody, 2000). Therefore, resources were focussed on the blocks which provided the greatest benefit from survey with the aim that subsequent surveys could be undertaken to validate remaining blocks when funding was available. A further validation stage was undertaken as an extension contract in 2012. 3 blocks remained unsurveyed due to the time and resources available for the work, 2 of which were very small island sites (see Figure 1).

The purpose of this document is to:

- Describe the field validation work and methods
- Report findings from the surveys including changes to the inventory layer and use of mobile field computing
- Provide explanations for where coastal vegetated shingle proved difficult to map from API
- Characterise the coastal vegetated shingle vegetation in Scotland
- Create an updated coastal vegetated shingle layer
- Revise area estimates for Broad Shingle Class, Annex I and BAP Priority Habitats
- Identify remaining validation required

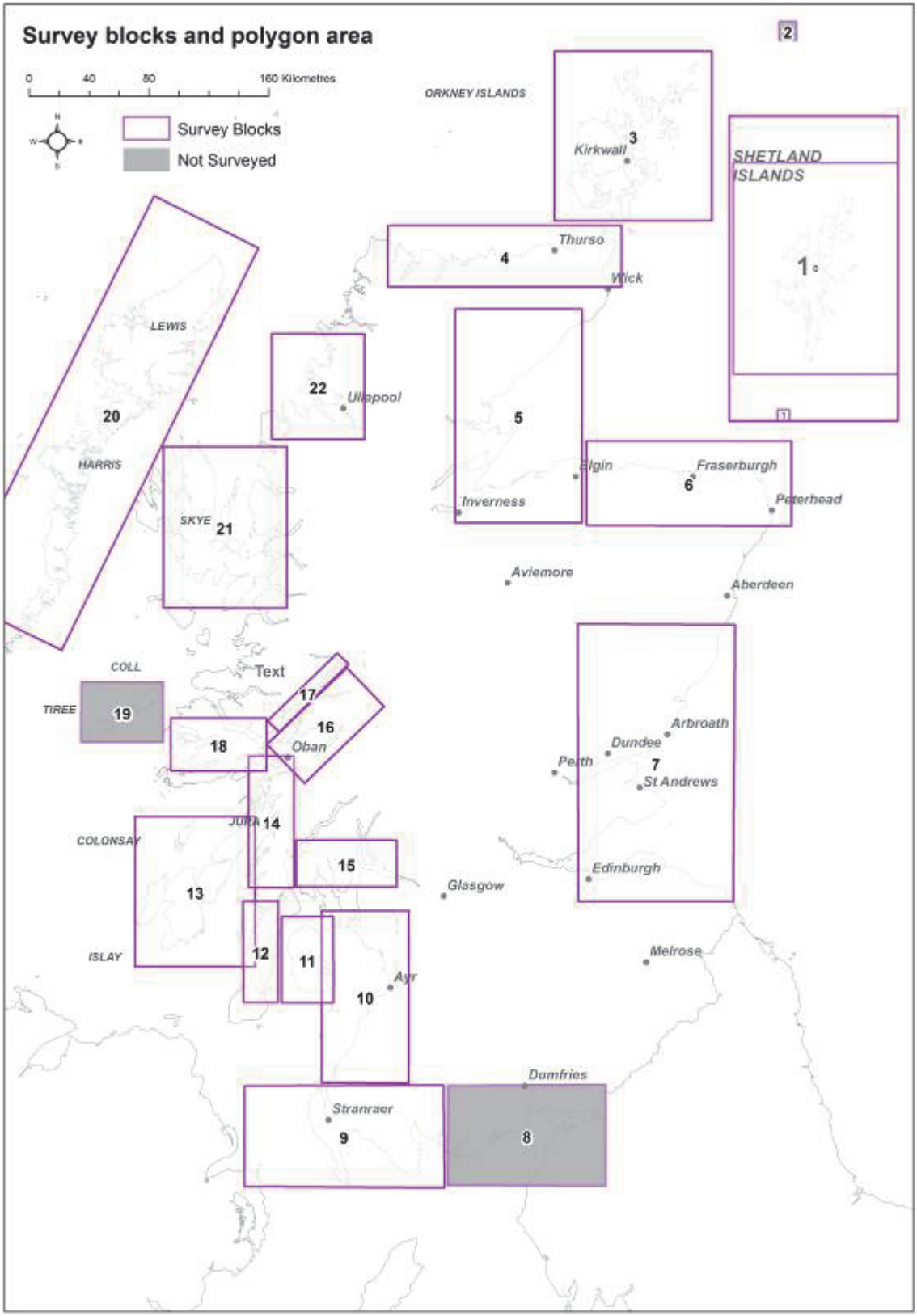

Figure 1. Field survey blocks. Contains Ordnance Survey data (© Crown copyright and database right [2014]. Ordnance Survey 100017908).

2. METHODS

2.1 Overview

The methodology for the field surveys and GIS data capture and collation is described in the following sections.

2.2 Field surveys

The field surveys were designed to be a thorough inspection of the habitat boundaries with a more rapid assessment of the habitats of the sites capturing data as described in 2.2.2.

Mapping was based on aerial imagery (and OS base mapping) and the polygons from the first phase of the inventory were modified where necessary following validation (see below) and filling in the more detailed habitat information.

Surveyors were provided with aerial photography, false colour infrared and a variety of base mapping as digital data and /or hard copy imagery. The polygons requiring validation (those captured from the first phase were also available digitally and displayed on the aerial imagery.

2.2.1 Timing and weather

Field surveys were undertaken between August and October, 2011 and 2012. While earlier surveys may have picked up additional annual species (e.g. *Aira praecox, Cerastium* spp. etc.) more easily, the timing of the surveys was favourable for the identification of the majority of species. The surveys were also undertaken early enough to avoid significant reworking of the beaches and deposition of wrack caused by winter storms. The exceptions to this were parts of Orkney (e.g. Bay of Skaill, Marwick Bay) which were subject to large storms associated with Hurricane Ophelia in the western North Atlantic in early October 2011. Similarly, in 2012, there were gale force winds around the time of survey in the Outer Hebrides.

2.2.2 Data collected during field surveys

2.2.2.1 Transects, quadrats and site photos

Surveyors recorded the start and end points of repeatable transect(s) for the site and noted vegetation transitions along the transects. The aim was to have 2 transects per macropolygon undertaken perpendicular to the shore. The exact arrangement of the transects was left up to the field surveyor, but the idea was that these ensure that there is a repeatable line that is walked that allows characterisation across the site. Where sites were too small and narrow to warrant transects, the vegetation was simply recorded for the site as a whole (e.g. narrow strips of Annex I habitat H1210 annual vegetation of drift lines).

While surveyors had GPS / mobile mapping devices, in some cases it was deemed more accurate to place the transect by tracing onto the aerial photograph. This was typically where the terrain (e.g. cliff face close by) led to large GPS errors or where sites were very narrow with the GPS derived point falling outside of the polygons.

Within these rapid surveys, it was not possible to survey multiple quadrats within homogeneous vegetation stands. The surveyors recorded species lists and DAFOR abundance ratings along the transect within the 8 Broad Shingle Classes.

Surveyors also took digital photographs along the transect at the start and end (looking back) and as geo-referenced photographs / target notes along it.

They also photographed the shingle substrate with a standard 30 cm ruler in shot – such as the one shown in Figure 2. Although this may vary across the site, the purpose was to attempt to rapidly characterise the substrate materials (size and origins). Surveyors were also asked to add additional photos if they were deemed to be helpful in broad characterisation of the site (for example where upper reaches have till cover or high sand content) or if they highlighted any other features of interest.

Figure 2. Recording shingle substrate size.

2.2.2.2 Climate change indicator species

DAFOR abundance ratings were also recorded for SNH's list of climate change indicator species (listed below).

Table 1. Climate change indicator species

Scientific name	**Common name**
Ligusticum scoticum	Scottish lovage
Mertensia maritima	Oyster plant
Polygonum boreale	Northern knotgrass
Seriphidium marítima	Sea wormwood
Carex punctata	Dotted sedge
Coincya monensis	Isle of man cabbage
Crambe marítima	Sea kale
Crithmum maritimum	Rock samphire
Erodium maritimum	Sea stork's-bill
Euphorbia paralias	Sea spurge
Euphorbia portlandica	Portland spurge
Glaucium flavum	Yellow-horned poppy
Atriplex portulacoides	Sea purslane
Hierochloe odorata	Sweet grass

Inula crithmoides	Golden samphire
Limonium humile	Lax-flowered sea-lavender
Linum perenne	Perennial flax
Medicago polymorpha	Burr medic
Puccinellia rupestris	Stiff altmarsh-grass
Raphanus maritimus	Sea radish
Trifolium ornithopodioides	Bird's-foot clover
Vicia bithynica	Bithynian vetch
Vicia lutea	Yellow vetch
Vulpia fasciculata	Dune fescue

2.2.2.3 Disturbance / coastal processes

Finally, the surveyors also recorded, where evident, occurrences of disturbance or evidence of natural processes that are affecting the site. This was done for the site as a whole but where feasible the coordinates were recorded, although this was not a specific requirement.

Issues surveyors were asked to record:

- Coastal defences
- Sand or shingle extraction
- Visitor trampling
- Vehicle damage
- Erosion
- Natural processes disrupted (linear constraints – e.g. groyne)
- Natural hydrology disrupted
- Grazing (by what)
- Heavy seaweed cover
- Other (in order to identify any other issues)

2.2.3 Mapping

2.2.3.1 Polygon layer

Based on the vegetation surveys described above, surveyors modified the boundaries of the preliminary inventory in order to:

- **Validate the macropolygon boundaries of coastal vegetated shingle BAP Priority Habitat** captured from API during the first phase of the inventory. This included the removal of polygons, editing boundaries to increase or decrease the site area or adding new polygons.
- **Map Annex I habitat boundaries** within these macropolygons for:
  H1210 Annual vegetation of drift lines
  H1220 Perennial vegetation of stony banks.
- **Map the Broad Shingle Classes** devised in the first phase of the inventory. These 3 levels are shown in the table below and surveyors mapped at the highest detail (Broad Shingle Class) in order that a nested dataset could be created later. The nested dataset allows representation at different levels, either: Broad Shingle Class, Annex I or BAP priority habitat level.

Table 2. Broad Shingle Classes and their relationship to Annex I / BAP Priority Habitats

Broad Shingle Class	Annex I	BAP Priority
Shingle grassland (*Arrhenatherum*)	H1220 Perennial vegetation of stony banks	Coastal vegetated shingle
Festuca Grassland	H1220 Perennial vegetation of stony banks	Coastal vegetated shingle
Heathland	H1220 Perennial vegetation of stony banks	Coastal vegetated shingle
Stable open habitats (lichen-rich community)	H1220 Perennial vegetation of stony banks	Coastal vegetated shingle
Scrub	H1220 Perennial vegetation of stony banks	Coastal vegetated shingle
Woodland	H1220 Perennial vegetation of stony banks	Coastal vegetated shingle
Saltmarsh	H1220 Perennial vegetation of stony banks	Coastal vegetated shingle
Strandline	H1210 Annual vegetation of drift lines	Coastal vegetated shingle
Other		Coastal vegetated shingle

Surveyors were also asked to record 'other' classes where appropriate (e.g. bare shingle or other BAP priority habitat types within the macropolygon) and then describe in the comments attribute. This allows for the potential addition of new classes if there were recurring patterns.

Outputs from the field mapping were supplied as a GIS layer (ArcGIS or MapInfo) similar to that shown in Figure 3 or in some cases, paper maps were also provided.

Figure 3. Example of Broad Shingle Classes, Phase 1 test site - Spey Bay. Aerial Photography - Data Licensed to Scottish Natural Heritage under the PGA, through Next Perspectives.

The MMU for the macropolygons was defined as 0.1 ha. However, surveyors were encouraged to use their discretion for exclusion of polygons, if a number of small patches (falling below the MMU) together made up an area greater than 0.1 ha and which functionally are effectively the same unit. The more detailed Broad Shingle Class polygons were permitted

to be mapped below the MMU, provided that they were linked to adjacent parcels which when taken together would be greater than 0.1 ha.

In addition, in some cases a 'linking polygon' was created (as a post processing step by GIS staff) which connected parcels smaller than the MMU together and which in combination would be greater than the MMU. Linking polygons were only permitted when the distance to the next polygon was less than 100 m, a rule which was adopted for the English Coastal Vegetated Shingle Inventory (Murdock *et al.*, 2010).

These linking polygons were not given a Broad Shingle Class and were not included in the estimates of Broad Shingle Class and Annex I habitat areas. However, they were reported at the BAP Priority Habitat level on the basis that most of these areas would have been bare shingle and potentially colonisable anyway. An example is shown below in Figure 4.

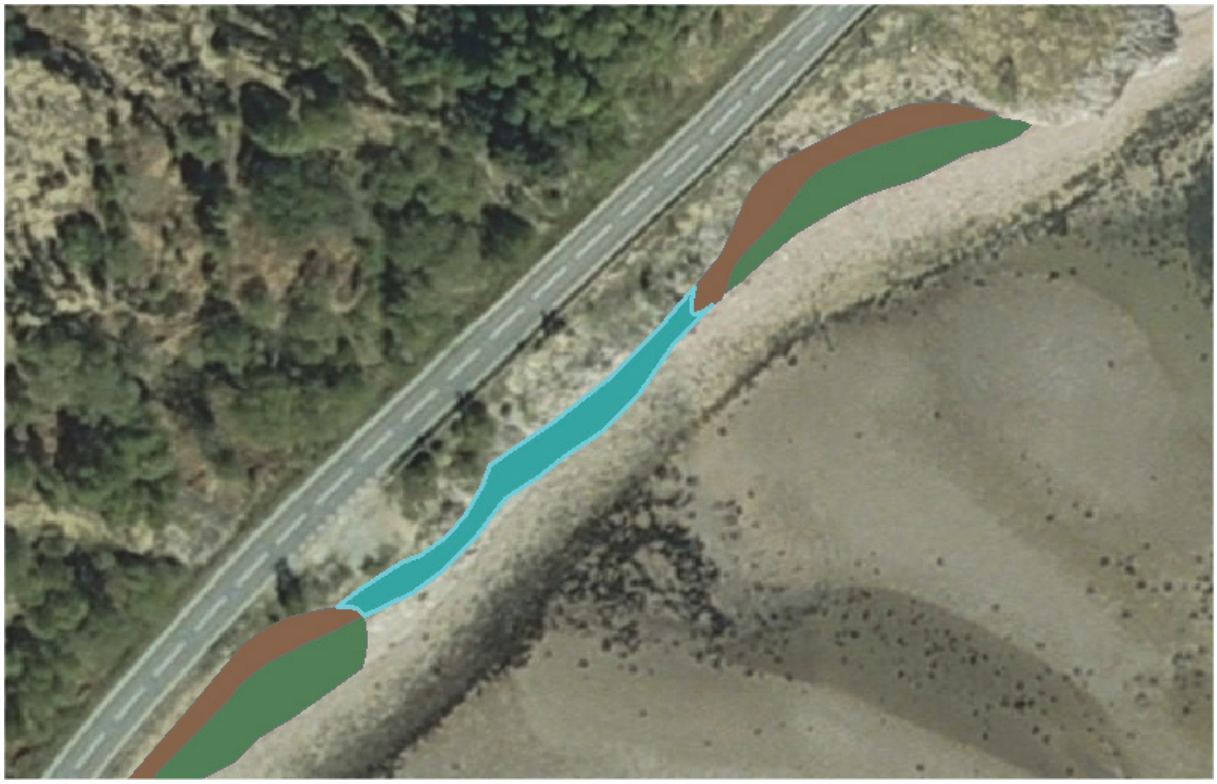

Figure 4. Example of a linking polygon connecting parcels to the right which otherwise would have failed the MMU test. Aerial Photography - Data Licensed to Scottish Natural Heritage under the PGA, through Next Perspectives.

The resulting GIS layer had the following attributes:

- **Site ID**: (surveyor initials and unique number)
- **Site name**: text
- **Area_ha**: hectares
- **Broad Shingle Class**: (as above)
- **Indicator species**: storing DAFOR rating
- **Comments**: storing disturbance information and other comments from the surveyor

2.2.4 Use of digital field mapping devices

SNH also wished to evaluate the potential to use digital field computing techniques in order make field mapping more efficient. Therefore an exploratory aspect was added to the project,

in order to assess some tools and techniques for mobile data capture. This involved the digital capture of habitat boundaries, transects and photograph and target note locations.

A variety of devices were used by the surveyors including PDAs, tablet PCs and also GPS and laser range finders.

A state of the art Trimble Yuma tablet PC was also kindly supplied by Korec Ltd in order to trial, which had both integrated GPS and on-board digital camera. This was also installed with the ArcGIS ArcPad software and a specific data capture tool customisation was created in order to assist the GIS data capture and attribution, including drop-down lists of the relevant species. This is shown below in Figure 5.

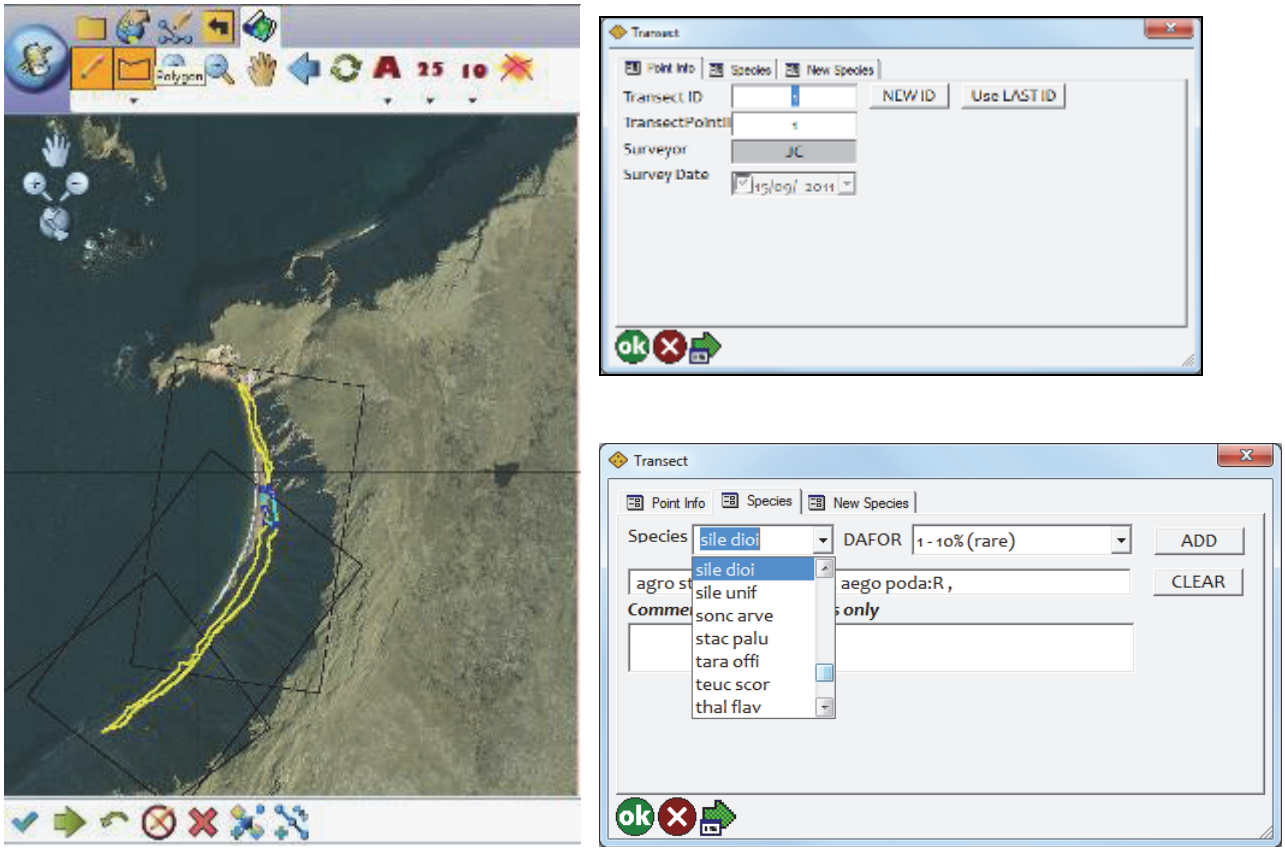

Figure 5. Tablet PC data Mapping and Data Entry Interfaces

Specifically, surveyors were asked to consider the potential and limitations of these tools and to offer suggestions as to how they might be improved in order to help SNH potentially specify hardware and software requirements of any future system procured by them.

2.3 Data collation and quality assurance

The GIS layers and vegetation data were collated into single GIS datasets. The spatial data were checked for topological issues and also for their adherence to the data capture rule base defined in the first phase of the inventory (Murdock *et al.*, 2011). Where necessary, polygons were also captured from paper maps.

This was in addition to the cleaning undertaken by surveyors themselves after their fieldwork because some of the more complex topological edits required would have been time consuming to undertake within the field.

A draft of the validated Coastal Vegetated Shingle Inventory was also sent to SNH for review and approval by their GIS team.

The following layers were available:

- Polygon layer, containing the habitat information (Broad Shingle Class, Annex I and BAP Priority Habitat and the presence of climate change indicator species)
- Point dataset showing vegetation information, photo point locations
- Transect locations

3. RESULTS - BLOCK SUMMARIES

3.1 Introduction

This section summarises the results of the field surveys and describes broadly the coastal vegetated shingle communities, climate change indicator species and the shingle structures present. Habitat polygon data can be downloaded from the SNH website through the SNHi information service. Access to all other GIS data and photographs can be obtained from SNH on request.

3.2 Summaries of coastal vegetated shingle in Scotland (by survey block)

3.2.1 Shetland (Block 1) and North Coast (Block 4)

Fieldwork dates: 19 - 30 September 2011

Strandline communities - Strandline communities dominated the vegetated shingle present in both survey blocks. In many instances, this consisted of little more than a scatter of ruderal annuals dominated by *Stellaria media* associated with the nutrient enrichment of decaying strandline debris and wrack. In places, other ruderals were also present including *Galium aparine, Urtica dioica* and *Cirsium vulgare*. It may be that heavy sheep grazing further exacerbated the nutrient enrichment and species impoverishment of these eutrophic strandlines.

More diverse strandline communities were characterised by transitions form *Atriplex glabriuscula* to increasingly perennial vegetation including *Silene uniflora, Rumex crispus, Tripleurospermum maritimum* and *Potentilla anserina*. There are clear analogues between these northern strandline communities and those defined by the NVC from more southerly locations within SD1 *Rumex crispus-Glaucium flavum* shingle community.

Sand accumulations are a common feature at the top of many of the sites visited. In most instances, the strandline of these sandy shingle sites supported a distinctive vegetation community. This was characterised by a strandline with abundant *Honckenya peploides* often with *Cakile maritima*. These more sandy strandlines also supported plants of the uncommon *Polygonum boreale* in one location. These sandy strandlines probably fall within SD2 *Honkenya peploides-Cakile maritima* strandline community. There were mostly sharp and well defined transitions from the sandy shingle vegetation to the windblown arenaceous dunes inland of this community.

It may be that there are a number of strandline communities that can be defined with further survey and analysis. An initial impression is that there are the following:

- Ruderal strandlines dominated with *Stellaria media* – no obvious NVC community analogue
- Annual vegetation of strandlines dominated by *Atriplex* species – there is no obvious NVC analogue at present although the need for a definition of *Atriplex* communities has been identified (see section 4.7.2 below)
- Perennial vegetation of strandlines dominated by either *Silene uniflora, Potentilla anserina* (often with freshwater influence over shingle), *Honckenya peploides* (sandy sites) or *Rumex crispus-Tripleurospermum maritimum* (eutrophic sites). Northern communities related to SD1 *Rumex crispus-Glaucium flavum* shingle community and SD3 *Matricaria maritima-Galium aparine* strandline community

Shingle grassland - Shingle grasslands dominated by *Festuca rubra* were common on many sites. These were generally heavily sheep grazed and tended to be rather species-poor. Other grasses present in these generally closed swards included *Holcus lanatus, Poa*

pratensis and patches of *Aira praecox* or more tussocky species such as *Dactylis glomerata* or *Arrhenatherum* where grazing was absent. Associated species typically included *Armeria maritima, Plantago coronopus, Plantago lanceolata, Trifolium pratense, Silene dioica* and *Rumex acetosa*. In places, there was abundant *Scilla verna* in these shingle *Festuca* grasslands.

Ruderal *Arrhenatherum* grasslands occur at the back of several shingle sites often associated with car parking and boat storage areas. The sward can be quite open and include some extensive areas of bare shingle – possibly created from past disturbance. A range of species can be found in these rough shingle grasslands but most are typical of MG1 *Arrhenatherum elatius* grassland communities with the addition of some coastal species as mentioned above.

Shingle saltmarsh - Transitions to shingle saltmarsh occurred at a few sites. In all instances this consisted of SM16 *Festuca rubra-Juncus gerardii* saltmarsh, sheep grazed to a fine short carpet <1 cm in height. Species composition appeared quite diverse and included frequent *Armeria maritima, Plantago maritima, Juncus gerardii* and *Plantago coronopus*. However, the diminutive height of the vegetation and the time of year meant it was virtually impossible to identify a number of species.

The transition from shingle *Festuca* grassland to saltmarsh was virtually invisible on the aerial photograph but could generally be determined by hands-and-knees searching of the turf and by a line of flotsam along the line of high water spring tides which tended to mark the transition.

Uncommon species - The northern location of Blocks 1 and 4 and the late survey date meant that few of the 'climate change' indicator species were identified. *Ligusticum scoticum*, *Mertensia maritime* (Figure 6) and *Polygonum boreale* were all recorded from a few sites with *Ligusticum* and *Mertensia* growing together at one site.

Figure 6. Mertensia maritima

Shingle structures and particle size - Shingle structures in these two survey blocks were all small or very small. Many were located at the head of small sheltered bays between rocky headlands others formed small spit features on the shores of sheltered sea lochs. On the east coast north of Wick in Block 4 there were longer stretches of shingle deposits between widely separated rock peninsulas.

Particle size of shingle was not measured although frequent photographs were taken using a 30 cm rule as a scale from which this could easily be calculated. In general shingle tended to consist of rounded cobbles of various igneous rocks some 5-10 cm in diameter (granites etc). On the east coast of Block 4 some larger flattened flagstones formed a loose pavement on the upper shore with stones 15-30 cm across, these were at the upper limit of what might be called shingle although they did support a strandline community dominated by *Galium aparine*.

There are no further sites on Shetland to validate but there are 6.6 ha (66%) of sites requiring validation on the North Coast, some of which may never be validated due to safety concerns (e.g. Dounray). While this seems a large percentage, it is because the total area in this block is small anyway.

3.2.2 Fair Isle (Block 2)

Fair Isle was not surveyed during this project because the extent of potential habitat identified from the API was small and deemed not worth the cost and effort to reach and survey it.

Further information on the vegetated shingle on Fair Isle was obtained through communication with the Fair Isle Bird Observatory (Parnaby and Riddiford), who kindly provided the following notes and comments on the API.

Main locations

Fair Isle has two main coastal vegetated shingle sites: at Muckle Uri Geo; and at Busta Geo (also known as Da Geo).

Muckle Uri Geo HZ 198 697

This is the only Fair Isle site for *Mertensia maritima*, along with small adjacent side 'geos' at Peeri Uri Geo and Små Geo. The site was colonised in 1992 (two plantlets). Slow initial then explosive population increase to approximately 2,360 plants in 2012. The population is largely protected by fencing to exclude sheep.

Other plants colonising the exclosure are *Ligusticum scoticum* – 6 plants in 2012 – and *Cakile maritima* (up to 3 per annum though none in the last two summers).

Muckle Uri Geo shingle is a long-established site for *Atriplex prostrata* (about 10 plants). Fair Isle is the northernmost UK location for this species. *Atriplex glabriuscula* is scattered but frequent on the shingle. It is also super abundant on the cliffs. It is not known whether there are hybrids, due to the difficulty of this group and September surveys may be needed to examine ripe seed capsules. Neither species is affected by sheep grazing.

One of Fair Isle's biggest storms of recent years hit the site this winter, changing the profile of the beach, re-grading the sizes of the pebbles and removing the previously firmly concrete-in enclosure posts. It is unclear how this site will develop from here but it is expected that the established plants will be well-rooted and will push up through the shingle – provided the protective fencing is replaced.

Busta Geo HZ 208 698

Busta Geo has a well-established shingle community comprising *Armeria maritima* dominant and *Ligusticum scoticum* frequent on upper shore; *Galium aparine* dominant, *Atriplex glabriuscula* frequent on lower shore.

Skadan fish-drying platform HZ 199 698

A flat quadrangle of consolidated (man-constructed) shingle above high water. Mainly unvegetated but some *Stellaria media*, *Galium aparine*, *Rumex acetosella* and *Potentilla anserina* – i.e. a commonplace community without notable constituents (apart from its diverse lichen community).

Other beaches - not classified as coastal vegetated shingle

With the exception of North Haven, other beaches (including South Haven) are mainly larger pebbles and boulders and even those qualifying as shingle are swept so vigorously and constantly by seas that vegetation rarely has time to develop or is wiped out by the instability and irregular movements of the stones.

North Haven HZ 224 724

North Haven is a sandy beach with varying amounts of large pebbles lying as a narrow strip at the base of a change to steeper slope which demarcates the forward edge of a heavily damaged grey dune – once the site of *Honckenya peploides*, this went locally extinct (i.e. lost from Fair Isle) after the area was used as a storage area for heavy machinery and other materials destined for the new North Haven pier.

The amount of stones on the upper shore is hugely influenced by the sea. After severe storms the stones are more prominent but the band gradually narrows in kinder times as they become buried by wind-blown sand.

It is suggested that the North Haven is not included as a coastal vegetated shingle site and it should be removed from the inventory.

Status of climate change indicators as they apply to Fair Isle plants.

Ligusticum scoticum: present on shingle; also widespread on and around cliffs wherever out of reach of sheep: population strong, no detectable change. Limitations: distribution restricted by sheep grazing. Long-lived, some individuals are still going strong some 30 years on (e.g. at Duttfield).

Mertensia maritima: restricted on Fair Isle to Muckle Uri Geo and its two very adjacent small geos. Population trend: explosively upwards. Limitations: expansion restricted by sheep grazing beyond current fenced area.

Polygonum boreale: a very common to abundant plant of arable rigs on the isle, limited only by decline in arable cropping over the years. However, never been found as a plant of coastal shingle on Fair Isle (Riddiford, pers comm., March 2013).

Puccinellia: Fair Isle does not have *Puccinellia rupestris* but it does have *Puccinellia distans borealis*. This can be found on shingle (possibly on Busta Geo but requires verification) but is also a very common occupant of cracks in the rocks lining the coast (e.g. around South Light) and an opportunist pioneer plant of shallow otherwise unvegetated winter-flooded pools and depressions dotted round the coast (e.g. on Vaasetter, South Green).

Other climate change species are not present with the current northerly limits of their ranges being further south.

While 0.2 ha (100%) has not been validated by the survey team, the above description captures the nature and extent of coastal vegetated shingle on Fair Isle.

3.2.3 Orkney (Block 3)

Fieldwork dates: 14 – 21 October 2011

Large storms at the end of September 2011, associated with Hurricane Ophelia in the western North Atlantic brought up large amounts of wrack – the first of this autumn, and this caused a salt-burning and browning-off of the annual vegetation of drift lines. An erosional step was also created on several beaches.

H1210 annual vegetation of drift lines is both an ephemeral community from year to year and also a dynamic community from month to month. The extent of the community increases down-beach over the period of the summer towards the High Water Mark of Ordinary Spring Tides (HWMOST) and then retreats as environmental conditions deteriorate in autumn to High Water Mark of Highest Spring Tides (HWMHST). This is particularly noticeable in more exposed locations. Therefore it may be most sensible to map the maximum POTENTIAL extent seawards rather than the ACTUAL extent on date of survey. This is discussed further in section 4.2.

The following taxonomic note is also made: *Atriplex prostrata* agg. here taken to include *A. glabriuscula* and *A. praecox*, both of which occur on Orkney as well as *A. prostrata sensu stricto*; the species of this group are all inter-fertile and many populations are made up of plants intermediate between two or more of the species (*Flora Europaea,* 1964). It seems best therefore to regard the whole complex as one very variable aggregate.

H1210 ‘ANNUAL’ vegetation of drift lines is in fact partly perennial. In some places ’annual vegetation of drift lines’ is a misnomer as this community also includes some perennials that die back to ground level over winter *e.g. Rumex crispus, Tripleurospermum maritimum* (biennial / perennial), and the rarer *Ligusticum scoticum* and *Mertensia maritima. M. maritima* was initially described as a part of this community by Scott (1963).

The ‘best’ H1210 annual vegetation of drift lines is found either in bayhead situations or on ayres, where *Ligusticum scoticum* may be present. Small islet and offshore locations, where domesticated grazing and human disturbance are limited, are the major locations for *Mertensia maritima* (Holms of Ire, Glims Holm, Copinsay).

Because of the way Orkney sandstone weathers into ‘flags’ (see Figure 7), many beaches have sediments that are c.50 mm thick but may be up to c.750 mm on the other axes. This material does not support vegetation. Exposed beaches may be very steep and not have vegetation.

Figure 7. Large flags (Bay of Tuquoy, Orkney)

There was a noticeable loss of *Mertensia maritima* from several sites on the main islands where it was seen in the 1990s (by Sneddon and Randall, 1993). Because of its disappearance from easy access and near-agricultural sites, this may be related to grazing / trampling rather than natural processes. Conversely, *Mertensia* is growing vigorously on some of its 'holm' (small islet) sites. *Ligusticum scoticum* is growing well at several sites, especially on Mainland, but also elsewhere.

Orkney also has some excellent vegetated shingle 'ayres' (as at Bay of Tuquoy or Roos Loch) and 'bayhead beaches' (as at Mar Wick and Burwick).

There is 1.4 ha (4%) of potential coastal vegetated shingle still requiring validation on Orkney.

3.2.4 Inverness (Block 5)

Fieldwork dates: 26 September - 1 October 2011

The northern sites generally comprise small coves and bays with small raised shingle beaches and ridges. Active shingle ridges with narrow, fragmentary strandlines, grade to stable, raised platforms of lichen rich shingle on which pioneer *Festuca* grass communities, sometimes rich in mosses as well, have become established. This is typically backed by species-poor *Arrhenatherum* or *Festuca* grassland with varying amounts of gorse (*Ulex europaeus*) scrub and bracken (*Pteridium aquilinum*).

Indicator species were generally sparse with only *Mertensia maritima* recorded at Dunbeath on sandy shingle and *Ligusticum scoticum* also recorded at Dunbeath and at Littleferry on Loch Fleet.

The southern Inverness polygons include the well-known larger sites of Cuthill links, Whiteness Head and Culbin Bar, along with smaller, linear sites around the Cromarty and Dornoch Firths.

Cuthill Links comprises extensive old shingle ridges and troughs with gorse scrub occupying the crest of the ridges and lichen-rich *Calluna-Erica* heath in the depressions and troughs. Sandier deposits support *Ammophila arenaria-Carex arenaria* dune grass / heath.

The Cromarty Firth sites generally support very sparse vegetated shingle apart from interesting lichen-rich communities on stable raised beach platforms. They are typically backed by species poor *Ammophila-Festuca-Arrhenatherum* grassland.

Whiteness Head and Culbin Bar support extensive areas of bare, open shingle grading through pioneer acidic *Festuca-Empetrum* grass / heath communities on shingle ridges to fixed *Festuca* grassland, acid *Calluna-Erica-Empetrum* heath and gorse, broom, bramble, birch and juniper scrub. Sandy deposits support an *Ammophila-Carex-Agrostis-Empetrum dune* heath community.

Indicator species were very sparse with only *Ligusticum scoticum* recorded at Whiteness Head and Findhorn. More indicator species would have undoubtedly been uncovered had there been more time available.

There is a further 3.9 ha (1.8%) of potential coastal vegetated shingle requiring validation.

3.2.5 Elgin to Peterhead (Block 6)

Survey dates: 19 - 24 October 2012

Block 6 consists of a series of widely spaced sites from Elgin to Peterhead along the northern Aberdeenshire coast. The large Kingston Shingles site to the east and west of the mouth of the River Spey (a Sneddon and Randall site and a pilot site for the development of field methods for this project) is an extensive raised beach with a marked storm ridge at the foreshore and a shingle spit which covers more than 100 ha. There are 10 other sites that are mainly small fringing beaches.

The single site at Peterhead and 3 of the sites around Inverallochy (south-east of Fraserborough) are adjacent to built up areas. These sites tend to be constrained to the rear by sea defences such as concrete blocks and have made-ground (artificial surface) beyond. These sites have large shingle and cobbles with a thin, broken strandline and rarer areas of *Festuca* grassland. The remaining fringing beach sites generally have steep rising land at the rear and a thin fringe of *Festuca* grassland on shingle (MC8 / MC9). Strandline vegetation is slightly less common and tends to form an occasional and interrupted line of vegetation. There are also small areas of *Arrhenatherum* grassland (MG1) and dune on shingle.

The *Festuca* grassland of the fringing beaches is quite variable and *Festuca rubra* often shares dominance with other grass species such as *Holcus lanatus* and *Arrhenatherum elatius*. Typical associates are *Plantago lanceolata*, *Armeria maritima* and *Cochlearia officinalis*. The strandline vegetation is also rather variable and two of the most common species are *Sonchus arvensis* and *Tripleurospermum maritimum.* Indicator species are rare and are found at two of the fringing beach sites (Cairnbulg and Cullen, Moray) where *Crambe maritima*, *Ligusticum scoticum* and *Raphanus raphinistrum* were recorded.

Generally the vegetation is a small proportion of the API polygons with bare shingle on the seaward side of the *Festuca* grassland and strandline vegetation. The site at Peterhead has two small areas of strandline vegetation which have a combined area below the MMU and the site to the south of Inverallochy is dune on sand with no vegetated shingle.

The main pressure and disturbance on the fringing beach sites occurs where they are close to built-up areas. Trampling pressure is light to moderate but the main disturbance is from the deposit of waste. At Inverallochy there is occasional garden waste and at Cairnbulg there is rubble, wood waste and sub-soil particularly at the east end of the site.

The slopes down to the fringing beach site Collie Head were very steep and could not be safely navigated, therefore the site was surveyed from a distance.

The Kingston Shingles to the east and west of the River Spey have a variety of vegetation types. It is characterised by a marked unvegetated storm ridge and consequently very little strandline vegetation. The most extensive area of the Kingston Shingles lies to the west of the River Spey. The flat area behind the storm ridge has mainly *Festuca* grassland (MC8 / MC9) and gorse scrub (W23) with smaller areas of dry heath (H7 / H10). There are also quite extensive damp depressions of saline influenced vegetated shingle (that have probably developed in areas where shingle has been extracted) that have some similarities to dune slack vegetation (SD15 / SD17). This vegetation is quite variable and in some areas is dominated by small sedges, *Potentilla anserin*a and *Salix repens* and other areas it is transitional to *Festuca* grassland with maritime herbs and locally dominant *Schoenus nigricans*.

To the rear of the shoreline the raised beach vegetated shingle extends back more than 500 m and is mainly scrub and woodland with some unvegetated shingle ridges. The majority of this area is pine plantation with other areas of semi-natural birch woodland (W11) and gorse scrub (W23). At the shore side of the woodland there is an area of willow carr and there is also mixed grassland across a Ministry of Defence (MOD) shooting range. Closer to the mouth of the River Spey there is a spit that runs west to Kingston and there are low lying vegetated shingle areas overlain by silt inland of the spit and extending into the estuary, some of which form small islands. The most common vegetation types are *Phalaris arundinacea* swamp (S28), *Festuca* grassland and *Arrhenatherum* grassland with lesser areas of scrub and *Bolboshoenus maritimus* swamp (S21). The areas of swamp had a variety of maritime herbs and, unusually, the non-native Michaelmas-daisy (*Aster* spp.) was common.

The area to the east of the River Spey is less extensive and partly covered by a links golf course. Close to the mouth of the River Spey the shingle becomes wide, the storm ridge is fairly low and there are closely-spaced shingle ridges with vegetation in the hollows in-between. Generally the vegetation is scattered *Fallopia japonica* (a non-native invasive scrub species) in mosaic with mixed grassland and some small areas of strandline. Further east the vegetation is mainly *Festuca* grassland and gorse scrub. There are also lesser areas of heath and, where very sandy, dune.

The golf course is not included in the survey area (presumably because it is improved grassland) but the broad raised ridges running parallel to the shoreline suggest that it is underlain by shingle. A green keeper reports that the course was artificially created more than 100 years ago by importing soil to cover the shingle. The islands of scrub within the golf course, included in the survey area, were generally found to have a sandy soil that was greater than 30 cm in depth (as evidenced by rabbit holes) and so these were not mapped as vegetated shingle.

The main forms of historical disturbance to the Kingston Shingles are shingle extraction to the rear of the storm ridge to the west of the River Spey, the villages of Kingston and Spey Bay

which have been built on shingle, the Spey Bay golf course and the pine plantation. There is also moderate level of walker pressure along the coastal area footpaths to the west of the River Spey and moderate to high visitor pressure on the area of shingle to the east of the River Spey adjacent to a wildlife visitor centre.

No indicator species were recorded at the Kingston Shingles.

There is a further 1.2 ha (0.6%) of potential coastal vegetated shingle requiring validation in the Elgin to Peterhead block.

3.2.6 Edinburgh to Aberdeen (Block 7)

Fieldwork dates: 24 - 26 October 2012

The 11 block 7 shingle polygons were visited during October 2012. All polygons were visited apart from two which could not be accessed as they are within the Barry Buddon MOD training camp where live firing was taking place. In addition, no aerial photographs were provided for these polygons.

The polygons identified for this block are generally sparsely vegetated. The typical transition is from bare shingle through a narrow band of *Festuca* grassland to *Arrhenatherum* grassland backed by varying amounts of scrub. Quite often there is no real vegetated shingle as the active shingle ridge grades abruptly into *Leymus / Ammophila* dune or *Arrhenatherum* grassland. Strandline vegetation is very sparse to absent.

The only significant vegetated shingle was found at Reed Point where there was scattered *Glaucium flavum* and *Senecio viscosus* along the strandline and Castlesea Baywhere there is base rich *Festuca* grassland, *Prunus spinosa* scrub and *Arrhenatherum* shingle grassland.

The only climate change indicator species found were *Glaucium flavum* at Reed Point and scattered *Ligusticum scoticum* at The Coves.

The majority of vegetated shingle polygons were below the MMU. Craigielaw Point was found not to be shingle but a rocky promontory. The Coves only contained small pockets of shingle along a rocky foreshore with beach-head saltmarsh.

Public pressure was the main threat identified, especially the areas of shingle at Portobello and at Stonehaven. The shingle at Portobello is particularly disturbed by dumping and public pressure but there is virtually no significant vegetated shingle to cause concern.

The Coves is quite heavily grazed by sheep and goats but again, there is very little vegetated shingle to cause concern.

There is a further 1.2 ha (29%) of potential coastal vegetated shingle requiring validation in the Edinburgh to Aberdeen block.

3.2.7 Inner Solway (Block 8)

It was not possible to survey this block during the project. However, the data from the Randall 2000 surveys have been used for validation, this included maps and species lists. The original Randall 2000 field maps and notebooks were also made available for the sites.

API identified a further 1.4 ha (5%) of potential coastal vegetated shingle which has not been validated.

3.2.8 Outer Solway (Block 9)

Fieldwork dates: 28 October – 2 November 2012
It was not possible to survey all of this block during the project. However, the data from the Randall 2000 surveys have been used to supplement the field surveys where necessary. Again, this included maps and species lists and Randall kindly made available his 2000 field maps and notebooks for the sites.

Initially, two transects were recorded across each sample site. Due to the contiguous nature of many of the sites this resulted in often repetitive recording of similar vegetation communities and given the limited time available the number of transects was reduced to reflect only significant changes in the transition of vegetated shingle communities.

Climate change indicator species were recorded on all sites. Where possible, the location of each plant or group of plants was recorded as a specific waypoint using GPS. However, for some widespread and abundant species such as *Raphanus maritimus* notes were made of their presence within a wider polygon species list.

This survey did not include the extensive vegetated shingle site at Claymoddie, as this was included in a pilot survey of the Solway coast under taken by Jonathan Cox in 2010.

This survey was undertaken at the end of the field season and some species showed evidence of die-back, in particular annual species, but this did not have a significant effect on classification of Broad Shingle Class or identification of the extent of vegetated shingle. Limited day length was an issue and on most survey days field work continued until or just after dark. Due to limited time, a reduced survey methodology was adopted after 2 days of survey with reduced numbers of transects being recorded.

3.2.8.1 Strandline community

Strandline vegetation was mostly confined to a 1-2 m wide zone along the mean high water mark. Strandline vegetation was typically dominated by *Atriplex prostrata* often showing significant levels of die-back at this time of year. Associated species included *Silene uniflora*, *Rumex crispus*, *Beta vulgaris*, *Tripleurospermum maritimum*, *Cochleria officinalis* and *Raphanus maritimus*. On more sandy strandlines, *Cakile maritima* was recorded on a few sites and at Kirkholm near Stranraer, plants of *Polygonum boreale* and *Hyoscyamus niger* were widespread on the strandline. *Crambe maritima* was also a feature of a few strandline sites on the east side of Luce Bay around Port William.

An interesting feature of the strandline vegetation in 2012 was the virtual absence of *Glaucium flavum*. Only two plants were recorded to the east of Auchenmalg Bay. Surveys undertaken by Randall (2000) found this to be quite widespread on the eastern shore of Luce Bay being recorded in relative abundance from six sites. It was also recorded as being abundant along significant sections of strandline at Claymoddie in 2010. The reasons for the apparent decline in *G. flavum* in this survey may reflect recent climatic conditions. *G. flavum* is at the northern edge of its UK range on the Solway coast.

3.2.8.2 Shingle grassland

On more stable shingle, grassland communities were dominated by either *Arrhenatherum elatius* or *Festuca rubra*.

Arrhenatherum grassland formed often rather rank and scruffy looking habitat on stable back-shore shingle. This community approaches typical MG1 *Arrhenatherum elatius* grassland of the NVC, but maritime species are normally present giving it a coastal character.

Associated species include *Raphanus maritimus, Centaurea nigra, Heracleum sphondylium, Potentilla anserina, Lathyrus pratensis* and *Achillea millefolium*.

Festuca rubra shingle grassland is also widespread in this survey unit and often forms mosaics with *Arrhenatherum* grassland. *Festuca rubra* shingle grassland occurs in more trampled locations or where there is an increase in sandy deposits overlying the shingle. In these locations, species such as *Euphorbia paralias*, *Rosa pimpinellifolia* and *Leymus arenarius* occur, such as in Monreith Bay.

3.2.8.3 Shingle saltmarsh

An important feature of the vegetated shingle within Luce Bay is the presence of well developed shingle saltmarsh communities. These form just above mean high water mark and are characterised by the presence of large cobbles and boulders set within the shingle substrate on which the saltmarsh grows. These boulders are typically encrusted by luxuriant growths of foliose lichens – mostly *Ramalina sp.* giving the vegetation a unique appearance (see Figure 8). The vegetation of these shingle saltmarshes is typically dominated by *Juncus gerardii* and hence conforms to SM16 of the NVC. Examples of this vegetation have a diverse associated flora including *Festuca rubra*, *Carex flacca*, *Glaux maritima*, *Triglochin maritima*, *Cochleria officinalis*, *Plantago maritima* and *Armeria maritima*. Sedges are also a feature of this vegetation but were not easily identified at this time of year. Both *Carex punctata* and *Carex distans* are associated with this community and were recorded from five sites along the eastern shore of Luce Bay (Randall and Doody, 2000).

Figure 8. Luce Bay illustrating Lichen communities on boulders / cobbles

3.2.8.4 Shingle scrub

Scrub communities have developed over large areas of shingle between the A747 and shoreline along much of the eastern side of Luce Bay. This strip of vegetated shingle would

presumably have been grazed in the past and maintained as open shingle grassland. However, the narrow strip between the road the shore is no longer grazed and has been allowed to succeed to scrub or has been reclaimed as domestic gardens. Scrub vegetation is dominated by blackthorn (*Prunus spinosa*) or gorse. Associated species often include abundant ivy (*Hedera helix*) with scattered plants of sea radish (*Raphanus maritimus*) and patches of bramble (*Rubus fruticosus)*, bracken and sprawling plants of honeysuckle (*Lonicera periclymenum*). At their seaward edge, the scrub vegetation shows a typical transition from *Arrhenatherum* grassland to *Festuca rubra* grassland, saltmarsh with lichen encrusted boulders at East Luce Bay.

3.2.8.5 Other shingle vegetation

Set within the stable shingle scrub and grassland are occasional open areas of almost bare shingle. These stable shingle clearings have a distinctive vegetation. The shingle is often encrusted in saxicolous lichens. In places, moss cushions occur dominated by *Dicranum scoparium* and *Pseudoscleropodium purum*. Trailing plants of *Vicia lutea* and prostrate stunted plants of *Prunus spinosa* are also a feature of these areas. Around the edges of the open stable shingle patches are species such as *Polypodium sp*., *Thymus polytrichus*, *Rosa pimpinellifolia, Teucrium scorodonia* and *Viola riviniana.*

a) b)

Figure 9. a) Stable shingle vegetation with prostrate Prunus spinosa *and* Vicia lutea *b) Stable shingle with* Polypodium *sp.,* Thymus polytrichus*,* Rosa pimpinellifolia *and* Pseudoscleropodium purum

3.2.8.6 Uncommon species

A number of the climate change indicator species were recorded as part of this survey. These are summarised in Table 3.

Table 3. Summary of climate change indicator species recorded in Block 9

Mertensia maritima Oyster plant	Found at several locations on the east side of Luce Bay including 9_37, 9_71 and 9_75
Polygonum boreale Northern Knotgrass	Found only on the sandy shore at Kirkcolm, site 9_99 north of Stranrear
Carex punctata Dotted sedge	Difficult to identify at this time of year but a feature of many of the shingle saltmarsh on the east side of Luce Bay
Crambe marítima Sea kale	Found at least four sites on the east side of Luce Bay (sites 9_24, 9_37, 9_38, 9_71).
Euphorbia paralias Sea Spurge	Present at serveral sites on the east side of Luce Bay including sites 9_24, 9_71 and 9_75
Euphorbia portlandica Portland spurge	Found only at one site on the eastern side of the Mull of Galloway at site 9_30 & 9_36
Glaucium flavum Yellow horned poppy	Restricted to a few plants at one site east of the Cock Inn, Auchenmalg Bay

4.5 ha (5%) of potential coastal vegetated shingle still require validation in the Outer Solway block.

3.2.9 Ayr (Block 10)

Fieldwork dates: 1 - 9 September 2011

- Mostly fringing beaches characterised by strandline, foredune and occasional pioneer Broad Shingle Classes
- Extensive site at Ballantrae including a shingle spit, a vegetated raised beach and pioneer communities where a number of indicator species were recorded

The majority of the Ayr sites are fringing beaches that have a mix of shingle (composed of shale rock type) and sand substrates, in some cases with sand below the mean high tide and shingle above. The main habitat types are strandline (often discontinuous) and dune to the rear (most commonly SD5 *Leymus arenarius* mobile dune community) with lesser areas of *Festuca rubra* grassland. Excluding the areas where these habitats are on pure sand, the shingle is normally admixed with sand (Figure 10) or, in the case of the dunes, sand overlays the shingle.

Figure 10. Strandline vegetation backed by dune – with shingle and sand admixed, Ayr

The indicator species *Raphanus maritimus* is a common constituent of the dune and strandline habitats, *Crambe maritima* is present at Ardrossan and *Ligusticum scoticum* is found at Pinbain Burn.

The best site is found at Ballantrae which has a typical fringing beach at the north, an extensive area of shingle (composed of shale rock type) around the mouth of the River Stinchair including a long spit, old recurved hooks and crests, and a raised beach to the south protected by a large crest at the seaward side. On these semi-stable substrates there are significant areas of pioneer herbs and open grassland. Other habitat types include saltmarsh, dune, *Festuca rubra* grassland, mixed grassland and scrub. The indicator species *Raphanus maritimus* is frequent throughout the pioneer herbs and open grassland, *Mertensia maritima* is local to the pioneer herb habitat to the north of the river mouth, and *Euphorbia portlandica* is found in the dune at the far north of the site, slightly outside the macropolygon area (probably a new record for this location).

There is no further validation required here.

3.2.10 Arran (Block 11)

Fieldwork dates: 27 – 30 October 2011

- Fringing beaches with interrupted strandlines and mixed grasslands often dominated by *Elytrigia repens*

- Some larger shingle complexes supporting a variety of habitats including open and mixed grassland, saltmarsh, bracken, heath and scrub
- The indicator species *Raphanus maritimus* is present throughout the block, and *Mertensia maritima* at a single site

The sites across Arran are a mixture of fringing beaches and larger more complex areas of vegetated shingle. The substrate is dominated by medium to large shingle, although there is often a proportion of small shingle and sand admixed. The fringing beaches tend to have an interrupted strandline with a strip of mixed grassland to the rear (Figure 11), often dominated by *Elytrigia repens.* Scattered *Rubus fruticosus* scrub is also common. The sites with more extensive areas of shingle are varied but most have bracken, scrub and occasionally heath dominated areas away from the shore. Catacol Bay is one of the most varied sites with areas of scrub and bracken, *Festuca rubra* saltmarsh, *Festuca rubra* grassland, *Elytrigia repens* grassland and smaller areas of pioneer herbs.

Figure 11. Strandline vegetation backed by mixed grassland, Arran

The indicator species *Raphanus maritimus* is recorded at most of the sites and is normally constant through the strandlines, open grassland and at the seaward edge of the permanent grasslands. *Mertensia maritima* is found at Torrylinnwater Foot only, within areas of pioneer herbs on the east and west sides of the mouth of the Kilmory Water.

There is no further validation required here.

3.2.11 Mull of Kintyre (Block 12)

Fieldwork dates: 23 – 24 September 2011 and Rhunahaorine 21 - 24 August 2012

- Mostly fringing beaches with a variety of Broad Shingle Classes including strandline, pioneer, *Festuca rubra* grassland and scrub
- A large Sneddon and Randall site covering 350+ ha. A full survey could not be completed in the time available. Therefore it was sampled and will require additional survey.

- *Raphanus maritimus* is the only indicator species recorded

The cluster of sites around Campbeltown are mainly fringing beaches that have well developed strandlines and either *Arrhenatherum elatius* or *Festuca rubra* grassland to the rear, whilst the Glenramskill site also includes saltmarsh. On Davaar Island a fairly large new site was identified that is a raised beach consisting of *Festuca rubra* grassland, heath and bracken, with a strandline along the mean high tide mark of the shingle beach. *Raphanus maritimus*, the only indicator species recorded, is present at the Campbeltown Loch sites.

The Ardpatrick Point sites by West Loch Tarbert are found along a rather rocky shore and the main vegetated shingle habitats are fragmented *Festuca rubra* grassland and fragmented saltmarsh. There is little fine shingle or sand at these sites and few maritime plant species typical of strandline and pioneer herb habitats.

Rhunahaorine

The extensive Rhunahaorine peninsula site (350 ha +) originally identified by Sneddon and Randall (1993) was sampled at three locations in the first stage of surveys in 2011 but was then surveyed in more detail during the second stage of surveys in 2012.

The site is an extensive raised beach that has two distinct levels of foreland - the lower level is found along the western and southern areas of the site and the higher level, with a 2 m to 3m step-up, is to the north and east. The area surveyed follows the boundary determined by Sneddon and Randall, however across the inland areas in the centre and north of the site the soil and peat overlaying the shingle was up to 50 cm in depth. The vegetation is very complex and includes a patchy strandline, maritime grassland and heath habitats close to the shore, and wet heath and fen habitats elsewhere. There is also a large pine plantation in the centre-south area of the site, with regenerating birch on the felled areas.

The west-facing coastline along the southern section of the site has areas dominated by shale and sand with a well developed system of *Ammophila arenaria* foredune and a rare interrupted strandline (mainly on sand). Back from the shore the habitats present are characterised by impeded drainage and there is marshy grassland (M23b), *Phragmites australis* swamp (S4) and willow carr in addition to drier areas with semi-improved pasture (MG6) and gorse scrub (W23). Immediately to the north of this area there is a pine plantation that surrounds Rhunahaorine House, although the north and east side has been felled and has regenerating birch and scrub.

The northern area of the site has well-drained habitat close to the shore where shingle is close to the surface. Here there are maritime *Festuca* and mixed grasslands (MC8 / MC9) and dry heath (H10) in mosaic with agriculturally improved grassland (MG6). Away from the shore drainage becomes more impeded with mosaics of *Molinia caerulea* mire (M25) and rush fen (M23b) grading into extensive areas of wet heath. The wet heath, underlain by up to 0.5 m of peat, is a rather rich M15 with a good *Sphagnum* species component and includes the notable species *Drosera rotundifolia* and *Rhynchospora alba*. Drainage ditches are common throughout, although in many cases they are infilling with vegetation, and some areas have been agriculturally improved and support semi-improved and improved pasture.

At the north of the site, to the east of Rhunahaorine Point, the shore is north-facing and there is a patchy strandline present along most of its length. The beach is fairly narrow and is constrained to the rear by a 3 m to 5 m high eroding face of shingle and sand (with sand martin nest holes).

Raphanus maritimus is the only indicator species recorded at the Rhunahaorine Point site. This species was found at the southern end of the site along the shore within the patchy strandline vegetation community.

The survey area follows that determined by Sneddon and Randall and appears to accurately cover the area of raised beach. At the north of the site the depth of substrate overlaying shingle, across many of the inland areas of wet heath, *Molinia caerulea* mire and semi-improved grassland, was measured to be between 20 cm and 50 cm. Under the current survey methodology a shingle depth of greater than 30 cm would not be mapped as vegetated shingle, however at Rhunahaorine Point the original Sneddon and Randall site boundary was maintained.

The survey area macropolygon included bare shingle and sand at the foreshore. Where a strandline was present the survey boundary extended onto non-vegetated sand and shingle at the seaward side. Also along the west-facing shore at the south of the site, there are areas of dune on sand that are also excluded from the survey.

The Rhunahaorine Point site has suffered a variety of damage from past developments, from woodland plantation and from agricultural land-use. The developments include an abandoned fish farm at the north of the site adjacent to the shore, Rhunahaorine House and a holiday caravan park in the south adjacent to the shore. This has led to the loss of vegetated shingle habitat and, in the case of the caravan park, replacement of semi-natural vegetation with amenity grassland. The caravan park has also caused moderate visitor trampling pressure along the shore to the north and south of the park.

A mature pine plantation covers the centre-south of the site, surrounding Rhunahaorine House. A large area of the plantation has been felled to the north and east and regeneration of birch scrub and trees is taking place.

The site has also suffered from agricultural improvement including drainage, fertilisation and reseeding – as a result there are significant areas of semi-improved grassland across the site. The drainage ditches present across the wet heath areas at the north of the site are widely spaced, infilling with vegetation and appear to be having little effect on the water table. Current levels of cattle and sheep grazing are fairly high, with the highest impact seen across the maritime grasslands and dry heath adjacent to the shore where the vegetation communities are close-cropped.

Figure 12. Stable shingle heath / acid grassland, Kintyre

There is no further validation required here.

3.2.12 Islay and Jura (Block 13)

Survey dates: 25 – 29 September 2011

- Main Broad Shingle Classes are *Festuca rubra* grassland, fragmented strandline communities and localised saltmarsh
- At most sites the majority of the macropolygon is bare shingle
- A couple of sites were raised beaches with a high proportion of 'boulders' and little vegetation
- There is possible under-recording of vegetated raised beaches across the islands
- Few indicator species (only *Ligusticum scoticum* at one site) or similar maritime strandline / pioneer species present

Figure 13. Large areas of bare cobbles associated with a raised beach, Claddach, Islay

The main Broad Shingle Classes across this block are *Festuca rubra* grassland, fragmented strandlines and localised saltmarsh. At a few locations where vegetated shingle extends back from the shore, there are also areas of mixed grassland, acid grassland and heathland. Less common habitat types include pioneer herbs, marshy grassland, bracken and scrub.

Most of the sites are fringing beaches where a majority of the original macropolygon is bare shingle with a strip of vegetated shingle to the rear (often *Festuca rubra* grassland) and only limited areas of fragmented strandline etc. Exceptions include the following two locations: Portnahaven on Islay and Corpach Bay on Jura. Here the macropolygons include areas of raised beach, comprising large shingle and boulders stretching back from the shore, which were found to support little vegetation. At Portnahaven there were some scattered plant species, particularly at the edge of the shingle, including a few perennials that had died back by the time of survey (late September). At a few sites the macropolygon was extended back from the shore to include a vegetated raised beach that supported permanent grasslands, heathland and scrub.

Across the Islay and Jura sites strandline communities are fairly scarce and fragmented, and open grassland and pioneer herb habitats are rare. Where these habitats are present there is a higher presence than normal of non-maritime species such as *Plantago media* and *Rumex acetosella*, and furthermore only one indicator species was recorded at single location (*Ligusticum scoticum* at the Portnahaven site on Islay). The reasons for this may be a combination of the exposed nature of the beaches, a lack of fine shingle and sand substrate, and a high rainfall diminishing the maritime influence of sea spray. Also many of the indicator species have restricted geographical ranges that do not extend to the survey area, which is why these surveys are recording them because this may change in future.

There is no further validation required here.

3.2.13 Oban South (Block 14)

Fieldwork dates: 4 - 12 September 2012

About 100 potential vegetated shingle sites were identified using API in Block 14. Owing to time constraints 29 sites were visited that had a high confidence level and that were accessible. The areas covered include the islands of Kerrera, Seil and Luing, north of Loch Melfort, north of Loch Craignish, around Loch Caolisport and Kilmory, and the east side of Loch Fyne (south of Lochgilphead).

The majority of sites are fringing beaches with narrow bands of strandline and grassland, with the ground rising to the rear of the beach. A few sites that are not fringing beaches include to the south of Lochgilphead which is a short shingle causeway linking the shore to Barmore Island and Eilean Orasaig at the southern end of Kerrera Island that has an area of raised beach extending back from the shoreline. There are also a couple of slightly more complex sites at the mouths of minor rivers (Bagh Taigh an Drogihinn and Kintraw) that have scrub, grassland and strandline extending further back from the shore compared to the typical fringing beach.

In general the presence of strandline vegetation is rather patchy and at some sites it is absent altogether. Where present it typically includes species such as *Tripleurospermum maritimum, Potentilla anserina* and grass species. It is within this vegetation type that the indicator species *Raphanus raphinistrum* is most commonly found. The strandline communities recorded do not conform closely with NVC strandline or shingle communities.

Grazing has a major bearing on the type of grassland present across Block 14 with grazed sites generally having *Festuca* grassland (MC8 / MC9) or semi-improved pasture (MG6) whilst ungrazed sites are more likely to have *Arrhenatherum* grassland (MG1). For example the fringing beach sites on Kerrera Island are unfenced and grazed whilst the sites along the east side of Loch Fyne are constrained by a road and are ungrazed. The two sites along the north of Loch Craignish are also ungrazed but notable for being dominated by *Festuca arundinacea* (a community not described by the NVC). Other vegetation types include occasional fragmentary saltmarsh and localised areas of scrub and marshy grassland.

An interesting feature of the Block 14 sites is the presence of slate sand and shingle across the Kererra Island and Luing Island sites (the latter is part of a group of ‘Slate Islands’). Where present, sand was a grey colour and the slate shingle was generally thin and flat. In some cases the beach shingle graded into shale-type deposits to the rear of the beach.

Mapping for the Block 14 sites involved point locations rather than polygons and most of the sites with a high a confidence level had been correctly classified as vegetated shingle. Exceptions include two adjacent sites on Luing Island which form two piers and a small harbour, and are likely to be man-made features constructed from slate spoil. Nevertheless, they support grassland, scrub and strandline vegetation. Another site on Luing Island (Port Mary) is adjacent to a disused slate quarry and the majority of the shingle was judged to be quarry spoil. Two other sites with no vegetated shingle are – Leum Mhic Mhaoilein where there are dunes and no shingle and Blackmillbay where there is dumped rubble and a former landfill site.

Secondary sites with lower levels of confidence were also visited where these were conveniently located and accessible. A single photo of the site was taken and a general description recorded. In general these ‘additional sites’ were correctly identified as vegetated

shingle but often had areas of strandline, or grassland, that were below the minimum mappable area (for example Creag a' Ghuail and Nead an Fhtitich).

Most of the sites in Block 14 were remote from areas of population and therefore damage and disturbance from visitor pressure or waste dumping was minimal or absent. Site Toberonochy is disturbed by vehicle and boat parking on the semi-improved grassland, however this is thought to be a man-made pier constructed from shingle spoil (see above). A fairly high proportion of the sites were open to livestock and, whilst some of the *Festuca* grasslands were short-cropped, the grazing intensity was generally light to moderate and no grazing damage to strandline vegetation was recorded across the survey area. A number of sites are constrained by retaining walls and made ground to the rear of the site where a coastal road is present. The main sites affected are found to the north of Loch Craignish, to the south of Loch Caolisport and along the east of Loch Fyne.

The indicator species *Raphanus raphinistrum* was recorded at nine sites mainly within the strandline or within grassland that has a maritime influence. It is often present at sites where there is a proportion of sand admixed with the shingle substrate. No other indicator species were recorded in Block 14.

Other species of note include the non-native *Crocosmia x crocosmiiflora* that has become naturalised at a number of sites including Bágh an Tailleir. The invasive non-native species *Fallopia japonica* was recorded at Clach an Easbuig and Ardrishaig and *Impatiens glandulifera* was also recorded at the latter site.

There is no further validation required here.

3.2.14 Greenock (Block 15)

Fieldwork dates: 18 – 19 September 2011

- Sites near Helensburgh were fringing beaches with mixed grassland and fragmented saltmarsh vegetated shingle. Some of the sites were constrained by a road and retaining wall to the rear.
- Access permission could not be obtained for the large site at Kilfinan Bay on the Otter Estate. The site has a likely shingle spit that appears to be vegetated when viewed from a distance.
- A new site near Dunoon is identified that has saltmarsh and mixed grassland.
- *Raphanus maritimus* is the only indicator species recorded.

The two Ardmore macropolygons to the south of Helensburgh are fringing beaches characterised by *Arrhenatherum elatius* and *Elytrigia repens* grassland to the rear of the sites and very fragmented saltmarsh at the seaward side. The macropolygons on Loch Gare are constrained by a road and retaining wall leaving a thin strip of shingle at the shore. There is fragmented saltmarsh, species poor strandline and, unusually, a couple of stands of open *Festuca arundinacea* grassland on shingle.

Figure 14. Shingle, saltmarsh, Ardmore East, Greenock

It was not possible to obtain access permission from the Otter Estate for the macropolygons at Kilfinan. The site has a likely shingle spit that appears to be vegetated when viewed from a distance.

A new site was identified near Dunoon to the rear of Holy Loch which is a localised area of saltmarsh and mixed grassland on shingle.

Raphanus maritimus is occasional to frequent throughout the survey areas and is the only indicator species recorded.

A further 3.4 ha (67%) of potential coastal vegetated shingle requires validation in the Greenock block. Again the relatively large percentage here reflects the fact that the total shingle area for this block is small anyway.

3.2.15 Oban Northeast (Block 16)

Fieldwork dates: 4 – 24 October 2011

No polygons had been identified for this block in the first phase of the inventory due to lack of aerial photograph coverage. Cover subsequently made available was used to identify potential shingle sites, together with observations made during surveys for the Scottish Saltmarsh Survey (in press) and previous knowledge of the surveyor. Nine sites identified in this way were surveyed and mapped in the field. Several additional sites in Loch Creran and Loch Leven could not be surveyed due to lack of time. These include Tralee (NM 89 38), Airds Bay (NM 90 45), Dunbeg (NM 87 34), Carness (NN 06 59) and Loch Creran (various).

There are extensive shingle deposits with associated vegetation in this block, notably at the entrance to Loch Etive (Ledaig, Dunstaffnage), on the east side of Loch Linnhe (Cuil Bay, Ardsheal) and at the mouth of Loch Leven (Onich, North Ballachulish). Smaller deposits occur at Loch Laich (Ardtur) and the Lynn of Lorn (Ardentiny), also around Loch Creran and inner Loch Leven (not surveyed). Small vegetated shingle spits occur at Cuil, Ardentiny and Dunstaffnage. The shingle size is mostly medium to fine.

Strandline vegetation occurs extensively along these shingle shores, typically 5 m wide but of variable cover and often sparsely vegetated. NVC community SD3 is the usual type with *Rumex crispus, Tripleurospermum maritimum, Potentilla anserine, Atriplex glabriuscula, Rumex acetosella* and *Stellaria media* all frequent. *Silene uniflora* is very localised e.g. on the spit at Cuil Bay, with *Sedum acre*. Grasses including *Festuca rubra, Agrostis stolonifera and Poa pratensis* are also frequent, particularly where there is grazing (e.g. Ardsheal), with *Urtica dioica* and *Cirsium vulgare* also frequent in such situations. Some sites, notably Ledaig, have sections with a high proportion of sand mixed in with the shingle, and here *Honckenya peploides, Senecio viscosus* and *Ammophila arenaria* may be present in the strandline vegetation which comes closer to NVC type SD2. Where the shingle has silt / mud, saltmarsh plants may be present e.g. *Puccinellia maritima, Glaux maritima, Juncus gerardii.* Sometimes this is sparse with much exposed shingle, at other times the saltmarsh is dense with a substantial turf developed.

Above the strandline the zone of vegetated shingle is generally narrow, with *Arrhenatherum* grassland at ungrazed sites (North Ballachulish, Ledaig, Ardtur) and *Festuca* grassland at grazed sites e.g Ardsheal, Dunstaffnage Bay east. The pattern tends to be an 'open' zone with much exposed shingle and rather sparse *Arrhenatherum* or *Festuca* vegetation, often with patchy bryophytes, then a closed turf behind (MG1 or U4b). At several sites there is bare shingle with scattered 'pioneer' herbs such as *Geranium robertianum* and *Senecio jacobea* with various mosses. These more open vegetation communities are widespread on the west coast but not described in the published NVC though Rodwell *et al.* (2000) suggest an *Arrhenatherum elatius-Silene maritime* (*uniflora*) community which would cover some of the variation, though *Silene* itself is rather rare.

Enclosed pasture comes quite close to the shore in many places e.g. Ardentiny. Improved pasture (MG6 etc.) in such situations was excluded from the mapped area but unimproved pasture was included where the underlying shingle was close to the surface (less than about 7 cm soil, typically with shingle exposed in places). Soil depth and substrate type were checked with a probe and / or a trowel, but it was not feasible to do this extensively due to time limitations. The species composition is also a guide with therophytes such as *Sedum anglicum* and *Rumex acetosella* indicative of shallow soils on shingle.

Shingle spits at Cuil, Ardentiny and Dunstaffnage tend to have more interesting vegetation e.g. abundant *Daucus carota* at Ardentiny and abundant *Succisa pratensis* at Dunstaffnage. Only one location was recorded for a single climate change indicator species, *Ligusticum scoticum,* on shingle at Ledaig. This species is more typical of rocky shores in the West Highlands. Other species of note included *Solanum dulcamara* and *Sedum telephium* at Onich.

Gorse scrub is patchy but widespread, with large stands of bramble a feature at North Ballachulish. This is one of the best sites encountered, with a dense stand of *Fraxinus excelsior-Prunus spinosa* woodland / scrub on shingle, a very unusual feature in the West Highlands. It has a well-developed bryophyte layer. Behind it there are several fields running up to the road with mixed *Arrhenatherum-Festuca* grassland on a very thin soil over shingle. These fields have abundant *Hyacinthoides non-scripta* and *Conopodium majus* and present an impressive spectacle in early summer.

Apart from grazing (sheep, few cattle) and associated improvement, human impacts tend to be minor, with some vehicle damage, tipping of garden waste / spoil and use of rip-rap at Onich, gabions at Cuil Bay, and shingle extraction at Dunstaffnage Bay east. However it seems likely that substantial areas of vegetated shingle and sand at Ledaig has been lost to the airstrip and caravan site which come close to the shore along most of this site. Invasive non-natives are a concern at Cuil Bay (*Fallopia japonica)* and Ardentiny (*Spartina x townsendii)* where shingle is being colonised.

3.2.16 Fort William (Block 17)

Fieldwork dates: 19 September – 3 October 2011

Like Oban Northeast, this block has some extensive deposits of vegetated shingle, fringing Loch Linnhe. The most extensive occur around Corran and Sallachan Point and at Caol, with smaller areas at Inversanda, Camas na Croise, Coruanan and elsewhere including some new sites. Vegetated shingle spits are a feature of several sites e.g. Inversanda and Camas na Croise. Small shingle islands occur at Corpach (not surveyed). Several new sites were identified which could not be visited due to time constraints or access difficulties, including Bunree (NN 01 62), Achintore (NN 09 73), Gearadh (NM 99 60), Inverscaddle (NN 02 67), Stroncreggan (NN 07 72) and Rubha Dearg (NN 09 75). Shingle beaches with strandline vegetation also occur almost continuously around Loch Eil (the upper arm of Loch Linnhe) from NM 96 78 to NN 08 76, although this is just outside the survey area.

The vegetation is generally similar to that described above for Block 16. Strandline vegetation (NVC type SD3) is widespread as a narrow discontinuous strip, with *Potentilla anserina* locally abundant, a feature of the west coast driftlines that is not referred to in the NVC description for SD3 (Rodwell, 2000). On sites with heavy sheep grazing (e.g. Sallachan Point, Camas na Cille) the strandline is more 'weedy' with species such as stinging nettle (*Urtica dioica*) more prominent than *Tripleurospermum maritimum.* Shingle saltmarsh is present on nearly all the sites in sheltered places, with scattered to dense presence of species such as *Puccinellia maritima, Glaux maritima* or *Juncus gerardii* and transitions to saltmarsh (SM13, SM16) on deeper turf (but with underlying shingle), usually behind shingle spits e.g. Inversanda, Camas na Croise. These sites are also included in the Scottish Saltmarsh Survey (in press).

Grazed sites have *Festuca* grassland typically as a narrow upper zone, with open and closed turf as described for block 16. Closed turf often has locally abundant waxcap (*Hygrocybe* spp.) fungi e.g. at Camas na Croise. Although mostly classed as NVC type U4b it also has occasional exposed areas with U1-type vegetation, with *Rumex acetosella* and *Aira* spp. At Inversanda the grassland has calcicoles such as *Thymus praecox* (NVC type CG10). *Arrhenatherum* grassland is more typical of ungrazed sites (e.g. An Caol, Caol Beach), again with open and closed (MG1) types. A good example of the open *Arrhenatherum-Silene* type occurs in an ungrazed section west of Sallachan Point, with transition to shingle heath, and to a small stand of *Salix* woodland, features unique to this site within the block. An Caol is perhaps the most interesting and dynamic site in this block, comprising a sinuous tidal shingle bar with good examples of strandline vegetation, saltmarsh and *Arrhenatherum* grassland with scrub. Scrub with gorse (W23) is widespread on most sites.

A range of human impacts have affected these sites. Heavy grazing has modified the vegetation at some sites (as above). At Caol Beach the vegetation has been degraded by mechanical beach-cleaning, dumping of the material and regrading of the landward slope. Road embankments have affected Camas na Cille, Corran-Sallachan and Caol beach. Invasive non-natives are a concern at An Caol (*Aster novae-belgii, Lupinus nootkaensis, Fallopia japonica)*, Caol Beach (*F. japonica*) and Corran-Sallachan (*F. japonica, Impatiens glandulifera*).

A further 1.0 ha (3.5%) of potential coastal vegetated shingle requires validation within the Fort William block.

3.2.17 Mull (Block 18)

Fieldwork dates: 5 October 2011

Two contrasting sites were surveyed on Mull based on polygons identified in phase 1 of the inventory. Rubh a' Chaoil (Treshnish Farm) is an unusual site on a very exposed coast where shelter from a rocky reef has allowed vegetation to develop on a triangle of coarse basaltic shingle and boulders. The vegetation is mostly *Festuca* grassland with *Thymus praecox* and other calcicoles (CG10). Torosay at the eastern end of the island is a sheltered bay with patchy saltmarsh over shingle. Neither site is significantly affected by human impacts other than sheep grazing. Several new significant sites for vegetated shingle were noted in passing and / or from air photos, but time was not available for survey. These are Killiechronan (Loch na Keal) (NM 53 41), Salen airstrip (NM 59 43) and Craignure Golf Club (NM 70 38), but other sites, particularly for strandline vegetation, are considered likely to exist.

No further validation is required.

3.2.18 Coll and Tiree (Block 19)

Coll and Tiree were not surveyed during this project because the potential extent identified from the API was very small and deemed not worth the cost and effort to reach it. The aim is to fill in these small sites later, for example tying in with other work on these islands.

An estimated 5.7 ha (100%) of potential coastal vegetated shingle requires validation.

3.2.19 Outer Hebrides (Block 20)

Fieldwork dates: 10 - 20 September 2012

This period coincided with gale force conditions and a few days of low cloud and heavy precipitation. This precluded any visits to offshore uninhabited islands or remote sites that would have required long walks over trackless moorland, which might have been possible if the contract had been organised earlier in the summer.

Much of the Outer Hebrides coastline is composed of machair grassland, calcareous dune or low, Lewisian gneiss cliff. The areas of H1210 annual vegetation of drift lines and H1220 perennial vegetation of stony banks is therefore limited. It occurs most commonly at the top of bay-head beaches, on spits and at stream outlets and where offshore rocks and skerries protect an area of coast. The best and most extensive examples of shingle polygons occur along the north shore of Vatersay, at Eoligarry on Barra, and on South Uist at Pollachar, Ardvule Point and Stoneybridge. Further north, sites are more limited in area, though good examples occur in Lewis of lochan ayres at Lower Sandwick, Shawbost and Bragar.

The vegetation communities present in Block 20 are limited in type because of the generally small size of the sites. However, there are many good examples of H1210 annual vegetation of drift lines, some of which (e.g. Ardvule Point) are extensive. At many sites, H1210 annual vegetation of drift lines is backed by Fescue grassland on shingle. This is sometimes more extensive than is shown on aerial photographs as it often merges into sandy Fescue sward. A few sites have shingle grassland with *Arrhenatherum elatius.* There are also interesting examples of saltmarsh shingle at Holm Bay and Tolsta.

The only climate change indicator species present is *Ligusticum scoticum,* which occurs at Eoligarry (Barra), Aird Uig (Harris) and Holm Bay (Lewis).

Many of the Outer Hebridean sites are backed by dune, dune pasture or machair grassland, sometimes with a boundary that is not obvious on aerial photographs. In some cases this has resulted in the polygons being extended beyond those identified by API. There are also some interesting polygons that are backed by salt water lagoons (Tolsta) or fresh water lochans (e.g. Shawbost, Lower Sandwick). At three locations, there is tidal shingle that cannot have terrestrial vegetation but this has shown up on API as potential shingle polygons.

The major disturbance to several of the Hebridean sites was coastal erosion. Major reconstruction of the coastal shingle has recently occurred at Stoneybridge, South Uist and at Gress Lodge and Swordale Bay, Lewis. Erosion continues to be an issue around the Viking Dun at Ardvule Point, South Uist, where previous military activity has also affected the site by building concrete roads and structures.

Farm waste has been dumped at some sites including Eoligarry (Barra) and Holm Bay (Lewis). General waste dumping is found at Lower Sandwick and Vatisker (Lewis). Shingle extraction has occurred in the past at Eoligarry and Vatisker. Balranald (North Uist) and Bragar (Lewis) are Royal Society for the Protection of Birds (RSPB) sites.

An additional site was identified at Pollachar Inn and subsequently surveyed.

A further 6.0 ha of potential coastal vegetated shingle in the Outer Hebrides still requires validation.

3.2.20 Skye (Block 21)

Fieldwork dates: 28 September – 20 October 2011

Many sites for vegetated shingle occur around the Isle of Skye and the adjacent mainland (Lochalsh). The most extensive deposits occur west of Kyleakin, with smaller deposits in various lochs and bays. Several new sites or extensions of the API polygons were surveyed. Various other sites, some quite extensive, were identified from air photos or during the Scottish Saltmarsh Survey (in press) but were not surveyed for shingle vegetation due to time limitations. These include Faoilean-Rubha Cruaidhinn (NG 56 19), Barrisdale Bay (NG 86 05), Ardelve (NG 87 26), Eilean Tioram (NG 87 26), Ardintoul (NG 83 24), Glas Eilean (NG 84 25) and Glenelg-Bernera (NG 81 19).

The vegetation at quite a number of sites is similar to that described for Blocks 16 and 17. Strandline vegetation (NVC type SD3) is widespread as a narrow discontinuous strip, with *Potentilla anserina* and / or *Atriplex glabriuscula* locally abundant (e.g. Moll north and south –NG 56 30). On sites with heavy sheep grazing (e.g. Torrin, Camasunary, Strollamus) the strandline is more 'weedy' with species such as stinging nettle and goosegrass (*Galium aparine*) more prominent. Several exposed sites (e.g. Staffin Bay, Talisker Bay) have often massive, mobile ridges of shingle composed of large cobbles, with little or no vegetation, including strandline. Vegetation here is restricted to sheltered hollows behind the ridges and is often sparse. Several polygons or parts of polygons in north east Skye were consequently deleted.

Shingle saltmarsh is present at some more sheltered sites (e.g. Ord, Sligachan) with scattered to dense presence of species such as *Puccinellia maritima, Armeria maritima, Glaux maritima* or *Juncus gerardii* and transitions to saltmarsh (SM13, SM16) on deeper turf (but with underlying shingle). The largest such site is Loch Sligachan where there are extensive and dynamic areas of saltmarsh on riverine shingle. This site, and a substantial number of other loch-head saltmarshes on shingle are also included in the Scottish Saltmarsh Survey (in press).

Grazed sites have *Festuca* grassland typically as a narrow upper zone, but wider at some sites e.g. Lusa, with open and closed turf as described for Block 16. Closed turf often has locally abundant waxcap fungi e.g. at Ord, Torrin. Although mostly classed as NVC type U4b it also has occasional exposed areas with U1-type vegetation, with *Rumex acetosella, Sedum anglicum, Peltigera* spp. and *Aira praecox*. *Arrhenatherum* grassland is more typical of ungrazed sites (e.g. Aird na Meacan, Kyleakin), again with open and closed (MG1) types.

The largest sites occur between Broadford and Kyleakin where there are huge raised beach deposits (partly quarried). The most interesting site is at Lusa, where there is a large extent of dry and wet heath on shingle (a rare habitat elsewhere in West Highlands). In front of this there is stable open shingle with scattered herbs such as *Geranium robertianum* and *Sedum acre*, and bryophytes and lichens well represented including the scarce lichen *Psoroma hypnorum.* Further east at Rubha na h-Airde Glaise there is more heath with large areas of bracken on shingle. This habitat is found at other sites including Ord, Cladach a' Ghlinne and Camas na Cailinn and is often species-rich. At Aird na Meacan it is mixed with *Corylus avellana* and *Rubus fruticosus.* At Camas na Cailinn there is also heath on shingle with developing birch woodland.

At Staffin Bay and Talisker Bay there is a zone above the strandline of OV24 vegetation with abundant stinging nettle and other nitrophiles e.g. goosegrass, possibly a natural vegetation type on storm-cast drift (Rodwell, 2000). Scrub with gorse (W23) is present at a number of sites e.g. Loch Brittle. At a few sites (e.g. An Faoileann, Staffin Bay) there are transitions to vegetation on shingle in waterlogged hollows with tall *Juncus* spp. and / or *Iris pseudacorus.* Soil depth of <10 cm was used to determine areas for inclusion.

The more remote sites are relatively undisturbed but a range of human impacts have affected other sites. Heavy grazing has modified the vegetation at some sites (e.g. Rubha an Torra Mhoir) and fencing / improvement of grassland has reduced the inland extent of various sites e.g. Strollamus. Ploughing for forestry has damaged the site at Aird na Meacan. At Faolainn there is a fisherman's bothy within the site with associated disturbance. Roads and embankments have affected Camas Malag, Kilmarie and Arnisdale. The site at Lusa has an airsrtip adjacent to it which has probably covered / disturbed vegetated shingle. Invasive non-natives are a concern at Kyleakin (*Aster novae-belgii*) and at Rubha na h-Airde Glaisewhere conifers are colonising heathland.

Additional surveys:
Fieldwork dates: 30 August – 2 October 2012

The majority of Block 21 was surveyed in 2011 but various additional shingle sites were identified in Loch Torridon, Loch Carron, Loch Alsh and Glenelg Bay on the mainland and Loch Slapin on Skye. Shingle at Barrisdale Bay, which was surveyed on 20 September 2011 during the Scottish Saltmarsh Survey (in press), is also included here.

A range of vegetated shingle structures are represented. Fringing shingle beaches with strandline vegetation are widespread, generally narrow with a very long stretch present on the south side of Loch Alsh at Ardintoul. In places shingle beaches are broader with shingle saltmarsh vegetation e.g. Loch Torridon (south), Loch Carron (Attadale) and Loch Alsh (Glas Eilean). Most sites have vegetated shingle ridges and spits, with long narrow spits enclosing saltmarsh at several sites e.g. Loch Torridon, Barisdale Bay, Glenelg Bay. Two vegetated shingle islands with grassland, strandline and saltmarsh occur in Loch Alsh: Eilean Tioram at Ardelve Point and the larger Glas Eilean in the middle of the loch. Vegetated riverine shingle with maritime grassland occurs at Barrisdale.

Strandline vegetation is typically of the SD3 type with *Rumex crispus, Tripleurospermum maritimum* and *Potentilla anserina* locally abundant, often with frequent grassland and 'weed'

species e.g. *Stellaria media, Festuca rubra* and *Cerastium fontanum. Rumex acetosella* is frequent on finer sediments with sheep grazing. Strandlines with abundant or dominant *Atriplex glabriuscula* are an impressive feature of ungrazed sites in Loch Alsh, notably Kirkton and Eilean Tioram. *Silene uniflora* is also locally abundant on Eilean Tioram but scarce elsewhere. An unusual type with abundant *Oxalis acetosella* is present in Loch Alsh under overhanging birch woodland. Shingle saltmarsh is a feature of most sites, characterised by thin / open turf with much exposed shingle and species such as *Juncus gerardii, Festuca rubra, Puccinellia maritima* and *Cochlearia officinalis. Suaeda maritima* is notably abundant at several sites including Glas Eilean and Kirkton in Loch Alsh.

Shingle grassland with *Arrhenatherum elatius* dominant, usually resembling NVC type MG1, is present where grazing is absent or light, notably on Eilean Tioram and at Loch Slapin. *Festuca* grassland (usually close to NVC type U4b) is more typical on grazed sites. Glas Eilean is unusual in having much grassland which is transitional between the two, perhaps reflecting a fluctuating grazing regime. Heathy elements occur locally in *Festuca* grassland at Loch Torridon.

Scrub dominated by gorse (W23) is present in varying amounts in association with grassland at most sites, notably Glenelg Bay and Loch Carron where the abundance of *Ceratocapnos claviculata* is a significant feature. Richer scrub with species including *Rosasherardii*, *Fraxinus excelsior* and *Crataegus monogyna* occurs in mosaic with shingle grassland at Fearnaig Shore (Loch Carron).

A small but undisturbed shingle ridge at Loch Slapin (south) has a very unusual form of open vegetation with abundant *Hedera helix* and *Neckera crispa*, also with dry heath on shingle behind. Ruderal tall-herb vegetation occurs locally on Eilean Tioram with *Chamerion angustifolium* dominant, and at Fearnaig Shore with gorse dominant.

Transitions to closed-turf saltmarsh are widely represented, often around shingle spits e.g. at Loch Torridon, Loch Carron, Loch Alsh, Glenelg Bay and Barrisdale Bay. Landward transitions are typically to grassland, rush-pasture, bracken or scrub, truncated in places by roads and improved grassland. Transitions to semi-natural woodland are an unusual feature represented at Ardintoul and Loch Slapin.

No climate-change indicator species were found at any sites. Sheep grazing is widespread and locally heavy at sites in Loch Torridon, Loch Carron, Glenelg Bay and Barrisdale Bay, and at Ardintoul and Glas Eilean in Loch Alsh. In contrast Loch Slapin, as well as Kirkton and Eilean Tioram in Loch Alsh, are hardly grazed and tend to have more interesting shingle vegetation as a consequence. Agricultural improvement and enclosure has occurred at several sites and there is much evidence of past drainage / cultivation on Glas Eilean with shallow parallel ditches / hollows (lazybeds?). Forestry plantings have encroached onto shingle at Ardintoul and Loch Slapin (south).

Other human impacts are generally minor. At Loch Slapin and Ardintoul shingle vegetation has been modified locally by fish farm access and equipment storage. At Glenelg Bay a pier has been constructed near the south end for timber extraction. Also at Glenelg Bay (north end) vegetation has been modified or lost due to caravan plots. Public roads encroach onto shingle structures in a few places, at Fernaig Shore and Glenelg, as does the railway at Attadale. Rock armour in front of a house at Fearnaig Shore has buried shingle vegetation. At Loch Torridon there are localised impacts near the hotel from construction of septic tanks and dumping of shingle. The invasive non-native *Fallopia japonica* is present on shingle in several places at Glenelg Bay.

At Loch Torridon no transects were carried out for the middle ‘island’ section, as it was not accessible due to tidal conditions and rivers being in spate. However it had been visited earlier

in 2012 for the Scottish Saltmarsh Survey (in press), when shingle habitats were also mapped and photographed. The same applies to the southwest section of this site.

There is estimated to be only 0.8 ha (< 1%) of potential coastal vegetated shingle that still requires validation.

3.2.21 Ullapool (Block 22)

Fieldwork dates: 19 – 20 October 2011

Four sites were visited in this block based on polygons identified in phase 1 of the inventory.

The east side of Loch Ewe, centred on Aultbea, has several sections of vegetated shingle. These are generally narrow beaches with mostly rather sparse SD3 type strandline, and patches of shingle saltmarsh locally; and narrow strips of *Arrhenatherum* or *Festuca* grassland, varying in character from very open with much bare shingle, to closed turf MG1 or U4b. *Leymus arenarius* is an unusual feature of the strandline in one section, as is a rare patch of shingle heath. The extent of shingle vegetation has been diminished by adjacent road embankments and car parks. One area of shingle grassland was being devastated by pigs at the time of survey.

Ullapool beach has narrow strips of rather sparse driftine and *Arrhenatherum* grassland, much disturbed by a caravan site and by rubble dumping, possibly to 'reclaim' ground. There is a large area of shingle saltmarsh in the river mouth north of the API polygon, then more extensive shingle to the north of the river forming part of Ullapool golf course, which was also not identified by the initial API. Much of this has been modified as fairways, greens etc. but an intact area remains with stable open vegetation and herb-rich grassland. *Silene uniflora* is locally frequent on the driftline.

Ardmair is a large shingle headland composed of mostly coarse shingle, with locally well-developed strandline SD3. Shingle grassland is rather fragmentary and disturbed due to a caravan site, a road and housing. The fourth site near Inverpolly is small and isolated, consisting of shingle saltmarsh and *Festuca* grassland.

Several new sites were identified but could not be visited in the time available, including two large shingle beaches near Ardmair - Keanchulish (NH 12 99) and Camas Mor (NC 11 00) and also quite a number other shingle beaches around the coast of Wester Ross - these formed the basis for additional surveys described below.

Additional Surveys:
Fieldwork dates: 11 - 12 September 2012

Additional Ullapool sites were surveyed in 2012 at Loch Canaird (6 km north of Ullapool), and on the west side of Loch Ewenear Inverasdale.

At Loch Canaird there are shingle beaches to the north and south of the mouth of the River Canaird. Significant areas of vegetated shingle are restricted to Camas an Lochain and at Keanchulish House. At Midtown on Loch Ewe there is a large triangular deposit of vegetated shingle projecting into the loch with fringing beaches broken by rock outcrops to the south.

Strandlines at Loch Canaird are generally narrow and of the SD3 type but with *Potentilla anserina* and *Atriplex glabriuscula* locally abundant. The beach at Keanchulish House also has a narrow strip of shingle grassland backed by acid grassland on raised beach deposits, whereas Camas an Lochain has *Festuca* grassland on a shingle ridge which has impounded a

freshwater pool behind; transitions to heath and bracken also occur. A notable feature at Camas an Lochain is a small stand of prostrate, bryophyte-rich *Prunus spinosa* scrub.

Midtown supports an unusually extensive area of *Festuca* grassland (c. 4 ha), with bracken locally dominant and patches of bare shingle. This area is partly on raised beach deposits but these were difficult to map separately. The grassland is locally species-rich with *Lotus corniculatus* abundant, and other species including *Aira caryophyllea* and *Plantago maritima.* Strandline vegetation is intermittent, sparse, and narrow, with *Rumex crispus, Potentilla anserina* and *Agrostis stolonifera* locally abundant. Grassland to landward has been fenced and improved for grazing.

No climate-change indicator species were found at any sites. There is grazing by sheep at Midtown and Camas an Lochain. The site at Midtown has been severely modified in places by shingle extraction, probably for local use, which appears to be continuing. Otherwise disturbance at these sites is light.

There is estimated to be only 0.5 ha (4%) of potential coastal vegetates shingle that still requires validation.

4. RESULTS - HABITAT AREAS

4.1 Introduction

This section summarises the results of the field surveys in terms of the habitat area statistics.

4.2 Note on habitat areas

4.2.1 Parcels classed as Broad Shingle Class 'other'

Surveyors were asked to record parcels not fitting into the existing Broad Shingle Classes as 'other' in order to allow other habitats to be mapped where they were interspersed with vegetated shingle or to allow for the creation of potential new Broad Shingle Classes later. Polygons classed as 'other ' were screened and then either removed (if it was felt they were not coastal vegetated shingle or retained as 'other' along with the surveyor comments, when it was felt that these were part of the coastal vegetated shingle habitat. This was felt to be the most pragmatic approach because not all shingle classes fitted neatly within the SNH classification but there was also a desire to limit the number of Broad Shingle Classes.

4.2.2 Strandline communities / annual vegetation of drift lines

As described earlier in the site descriptions, several surveyors noted the dynamic nature of the strandline community from month to month. The extent of the community increases down-beach over the period of the summer towards the High Water Mark of Ordinary Spring Tides (HWMOST) and then retreats as environmental conditions deteriorate in autumn to High Water Mark of Highest Spring Tides (HWMHST). This pattern was initially described by Asprey (1947) in the Inner Hebrides for *Atriplex* spp. In most years those plants germinating later in the summer on the lower part of the beach do not set seed but are replaced in the next year by seed from more successful plants further up-beach that have completed their life-cycle earlier in the year.

In order to account for this, 2 strandline area estimates are given below: one for the mapped areas recorded by the surveyors and also one denoting the maximum POTENTIAL extent seawards based on the Mean High Water Spring (MHWS) line.

4.2.3 Additional sites – identified during the surveys

As discussed in the block descriptions above, it was not possible to validate all sites within the visited survey blocks due to access issues and the fixed survey time available within the project.

The survey timings were based on the shingle sites identified from API during phase 1 of the inventory. However, surveyors when in the field (and in particular those surveys associated with the Scottish Saltmarsh Survey (in press)) were able to identify further shingle sites but for which there was not time to fully validate. These are listed in Table 10.

85 additional sites were identified during the surveys but there was not time to visit 76 of them.

The proportion of sites not visited during the 2 stages of survey is shown below. Of the sites originally identified by API and other sources, 84% required validation. The validation was run in 2 stages: 65% of the polygons remained unvisited after stage 1 of the surveys (see Table 4 below). By the end of stage 2 only 3% of polygons remained unvisited.

Table 4. Proportion of sites not visited from each stage of survey

Survey stage	No. of polygons	No. of polygons not visited	Area not visited (ha)	Percentage (%)
Original API	454	421	927.1	84.3%
Stage 1 validation	453	169	768.7	65.2%
Stage 2 validation	563	60	38.0	3.3%

Note: Statistics above are by BAP habitat polygons (macropolygon) not by site (a site can have more than one polygon and is not always easy to define as they can extend over long stretches of coast). Stage 2 polygons not visited were identified based on the Broad Shingle Class code = NTV (not visited). This estimate does not include the polygons with Broad Shingle Class STREX (strandline maximum extent) or LNK (linking) as these were artificial extensions of the mapped polygons.

The numbers of polygons varies because some candidate polygons will have been dropped from the inventory and new sites were also found. In some instances a candidate polygon for a single 'site' may also have been broken into two or more pieces.

4.2.4 Inclusion of unvalidated phase 1 inventory area estimates to provide an updated national picture

This contract was for the validation of selected survey blocks and 3 blocks still require similar surveys to be undertaken. However, in order to provide SNH with updated national area estimates, the unvalidated polygons captured through API during the first phase of the inventory have been included in the results tables. The Fair Isle estimate is based on the correspondence with the Bird Observatory. The Inner Solway estimate is based on API and Randall and Doody (2000) maps and the figure for Coll and Tiree is based purely on API. Obviously, for some of the tables (e.g. Broad Shingle Classes) it was not possible to populate them, as the required level of detail is not yet available. Un-validated blocks and data are shown in grey text in Table 5.

4.3 BAP Priority Habitat area

Table 5. BAP Priority Habitat area by block (grey text is for un-validated blocks)

Block name	Block ID	BAP Priority Habitat area (ha)	Not visited (ha), (no. of polygons)
Shetland	1	**5.2**	
Fair Isle	2	**0.2**	
Orkney	3	**34.4**	1.4 (5)
North Coast	4	**10.0**	6.6 (1)
Inverness	5	**216.0**	3.9 (5)
Elgin to Peterhead	6	**214.3**	1.2 (3)
Edinburgh to Aberdeen	7	**4.8**	1.4 (3)
Inner Solway	8	**29.6**	1.4 (7)
Outer Solway - Stranraer	9	**91.6**	4.5 (6)
Ayr	10	**8.5**	
Arran	11	**25.8**	
Mull of Kintyre	12	**238.0**	
Islay and Jura	13	**5.6**	
Oban Southwards	14	**6.2**	
Greenock	15	**5.1**	3.4 (2)
Oban Northeast	16	**38.2**	
Fort William	17	**28.6**	1.0 (2)
Mull	18	**1.4**	
Coll and Tiree	19	**5.7**	5.7 (13)
Outer Hebrides	20	**40.6**	6.0 (9)
Skye	21	**98.1**	0.8 (2)
Ullapool	22	**12.5**	0.5 (1)
Total		**1,120.4**	**37.8 (59)**

The revised estimate for the area of BAP Priority habitat: coastal vegetated shingle in Scotland is 1,120 ha of which 1,085 ha have been validated. This leaves just c. 3% unvalidated.

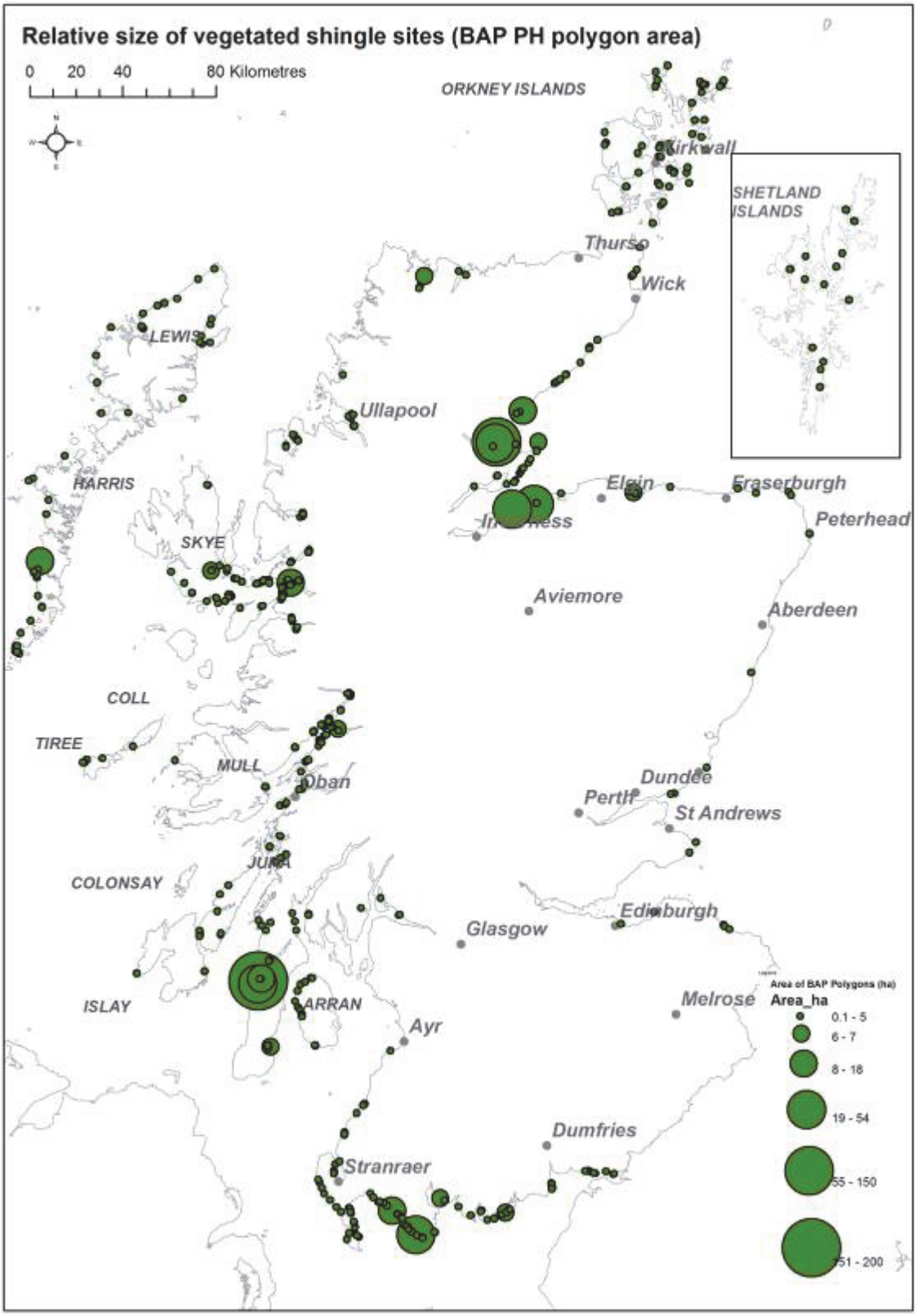

Figure 15. Size breakdown of coastal vegetated shingle BAP Priority Habitat polygons. Contains Ordnance Survey data (© Crown copyright and database right [2014]. Ordnance Survey 100017908).

4.4 Annex I habitat area

Table 6. Annex I habitat area by block

Block name	Block ID	H1210 Annual vegetation of drift lines (ha)	*H1210 Annual vegetation of drift lines (maximum extent ha)*	H1220 Perennial vegetation of stony banks (ha)	Not Visited (ha), (no. of polygons)
Shetland	1	1.7	*2.6*	2.4	
Fair Isle	2	0.2	*0.2*	0.0	
Orkney	3	14.7	*23.3*	9.5	1.4 (5)
North Coast	4	2.0	*2.5*	0.9	6.6 (1)
Inverness	5	10.4	*11.0*	199.4	3.9 (5)
Elgin to Peterhead	6	1.5	*1.5*	212.7	1.2 (3)
Edinburgh to Aberdeen	7	0.5	*0.5*	4.3	1.4 (3)
Inner Solway	8	9.2	*9.2*	20.3	1.4 (7)
Outer Solway - Stranraer	9	17.9	*17.9*	73.4	4.5 (6)
Ayr	10	2.1	*2.2*	6.0	
Arran	11	3.1	*8.5*	17.2	
Mull of Kintyre	12	1.1	*1.4*	236.6	
Islay and Jura	13	0.4	*0.7*	4.8	
Oban Southwards	14	1.3	*1.3*	4.8	
Greenock	15	0.0	*0.0*	1.7	3.4 (2)
Oban Northeast	16	9.1	*17.4*	19.9	
Fort William	17	6.5	*10.9*	16.5	1.0 (2)
Mull	18	0.0	*0.0*	1.4	
Coll and Tiree	19	0.0	*0.0*	5.7	5.7 (13)
Outer Hebrides	20	23.3	*23.3*	17.2	6.0 (9)
Skye	21	15.9	*19.1*	76.9	0.8 (2)
Ullapool	22	3.2	*3.9*	8.0	0.5 (1)
Total (validated)		**124.1**	**157.4**	**939.6**	**37.8 (59)**

Revised estimates of the Annex I habitat extents are 940.4 ha for H1220 perennial vegetation of stony banks and 124.1 ha for H1210 annual vegetation of drift lines.

By considering the maximum potential extent of H1210 annual vegetation of drift lines, the habitat area increases by 33.3 ha.

4.5 Broad Shingle Class habitat area

Table 7. Broad Shingle Class habitat area by block

Block name	Block ID	Shingle grassland (*Arrhenatherum*)	*Festuca* grassland	Heathland	Stable open habitats (lichen-rich community)	Scrub	Woodland	Strandline	*Strandline (maximum extent)*	Saltmarsh	Other	Not visited
Shetland	1	0.7	1.6		0.1			1.7	1.0	0.1		
Fair Isle	2							0.2				
Orkney	3	0.6	6.6		0.5			14.7	8.6	1.8		1.4
North Coast	4		0.8					2.0	0.5	0.1		6.6
Inverness	5	22.2	41.2	45.7	18.5	33.7		10.4	0.6		38.1	3.9
Elgin to Peterhead	6	0.9	13.1	2.8		29.2	89.5	1.5			76.0	1.2
Edinburgh to Aberdeen	7	0.2	0.7			0.0		0.5		0.1	1.9	1.4
Inner Solway	8	2.3	1.4	1.9	0.4	7.6	0.2	9.2		4.5	0.6	1.4
Outer Solway - Stranraer	9	15.6	15.7	0.3	10.3	12.3		17.9	0.0	10.2	4.6	4.5
Ayr	10		1.1			0.8		2.1	0.1	1.2	2.9	
Arran	11	0.8	2.6	0.9		4.5		3.1	5.4	0.6	7.8	
Mull of Kintyre	12	0.5	7.1	11.7		4.8	29.3	1.1	0.2	0.6	182.5	
Islay and Jura	13		1.9	0.0		0.1		0.4	0.3	0.3	2.4	
Oban Southwards	14	1.0	0.7			0.3		1.3		0.4	2.5	
Greenock	15	0.4				0.1				0.7	0.4	3.4
Oban Northeast	16	6.8	6.8			0.9	1.0	9.1	8.4	4.1	0.3	
Fort William	17	1.9	9.0			1.8	0.1	6.5	4.4	3.3	0.5	1.0
Mull	18		0.2		0.1			0.0		1.1		
Coll and Tiree	19											5.7
Outer Hebrides	20	0.6	10.0			0.0		23.3		0.4	0.3	6.0
Skye	21	9.5	24.0	4.6	0.7	5.6		15.9	3.2	27.9	4.6	0.8
Ullapool	22	0.9	4.4	0.2		0.1		3.2	0.7	1.6	0.9	0.5
Total (ha)		**64.9**	**148.9**	**68.1**	**30.6**	**101.8**	**120.1**	**124.1**	**33.4**	**59.0**	**326.3**	**37.8**

The breakdown of Broad Shingle Classes within the validated blocks shows *Festuca* grassland (149 ha), strandline (124 ha), woodland (120 ha) and scrub (102 ha) to be the main types. The woodland area is mainly confined to the large shingle sites at Spey bay and Rhunahaorine.

The next most extensive classes are heathland (68 ha), shingle grassland *Arrhenatherum* (65 ha) and saltmarsh (59 ha).

The stable open habitat class has the smallest areal coverage in the inventory with c. 31 ha. If the *maximum potential* strandline estimate is used the area of strandline vegetation would be 157 ha.

A further 326 ha are classed as 'other' (typically transitions to other habitats e.g. dune, shingle with freshwater influence (e.g. with *Iris*) etc. The surveyor's comments have been retained. These require further investigation in order to determine whether a new class is justified.

In addition, 6 ha were allocated to linking polygons (LNK).

4.6 Presence of climate change indicator species

The following summarises the presence of climate change indicator species. Changes in the presence or abundance of these species over time can be used to make inferences about potential climate change effects on these species many of which are not currently observed in the blocks surveyed.

The species observed in the most blocks were *Ligusticum scoticum* (present in 8 blocks), *Mertensia maritima* (5 blocks) and *Raphanus maritimus (5 blocks).*

Ligusticum scoticum, Mertensia marítima and *Raphanus maritimus* were observed at several sites across several blocks. *R. maritimus* had the greatest number of actual quadrat records with 36 across 5 blocks. *Crambe marítima* (8 records) was only observed within 4 blocks *and Polygonum boreale* (4 records) in 3 blocks. *L. scoticum* and *M. maritima* were widespread whereas *R. maritimus* has a south west \ west Scotland distribution. *Glaucium flavum*, had 2 records in 2 blocks. *Atriplex portulacoides* (2 records), *Carex punctata* (2 records), *Euphorbia paralias* (3 records) only occurred in a single block.

It is interesting that on the Solway there appears to be some evidence for the shifting in the geographical range of vegetation due to climate change with Cox, noting the virtual absence of *Glacium flavum* here in 2012, compared with earlier surveys of Randall and Doody (2000) where it was much more abundant. This further indicates the potential of the inventory which describes the current nature and extent and will form a valuable baseline going forward.

Table 8. Presence of climate change indicator species (number of records) - continued overleaf

Scientific name	1 Shetland	2 Fair Isle*	3 Orkney	4 North Coast	5 Inverness	6 Elgin to Peterhead	7 Edinburgh to Aberdeen	8 Inner Solway**	9 Outer Solway	10 Ayr	11 Arran	12 Mull of Kintyre
Ligusticum scoticum	1	3	6		9	1	2				1	
Mertensia maritima	4	2	2		4				2			
Polygonum boreale	1			2					1			
Seriphidium marítima												
Carex punctata									2			
Coincya monensis												
Crambe marítima						1		2	4		1	
Crithmum maritimum												
Erodium maritimum												
Euphorbia paralias									3			
Euphorbia portlandica												
Glaucium flavum							1	1				
Atriplex portulacoides									2			
Hierochloe odorata												
Inula crithmoides												
Limonium humile												
Linum perene												
Medicago polymorpha												
Puccinellia rupestres												
Raphanus maritimus								4	24	3	4	
Trifolium ornithopodioides												
Vicia bithynica												
Vicia lutea									3			
Vulpia fasciculata												

*Based on information provided by Fair Isle Bird Observatory
**Based on the Randall and Doody (2000) survey quadrats

Scientific Name	Islay and Jura 13	Oban Southwards 14	Greenock 15	Oban (Northeast) 16	Fort William 17	Mull 18	Coll and Tiree 19	Outer Hebrides 20	Skye 21	Ullapool 22
Ligusticum scoticum							-	*4*		
Mertensia maritima							-			
Polygonum boreale							-			
Seriphidium marítima							-			
Carex punctata							-			
Coincya monensis							-			
Crambe marítima							-			
Crithmum maritimum							-			
Erodium maritimum							-			
Euphorbia paralias							-			
Euphorbia portlandica							-			
Glaucium flavum							-			
Atriplex portulacoides							-			
Hierochloe odorata							-			
Inula crithmoides							-			
Limonium humile							-			
Linum perene							-			
Medicago polymorpha							-			
Puccinellia rupestres							-			
Raphanus maritimus	*1*						-			
Trifolium ornithopodioides							-			
Vicia bithynica							-			
Vicia lutea							-			
Vulpia fasciculata							-			

An example map is shown below (Figure 16) for *Mertensia maritima*. Note: this is based on all available data and some sites have not been surveyed. However, it illustrates the potential of the data.

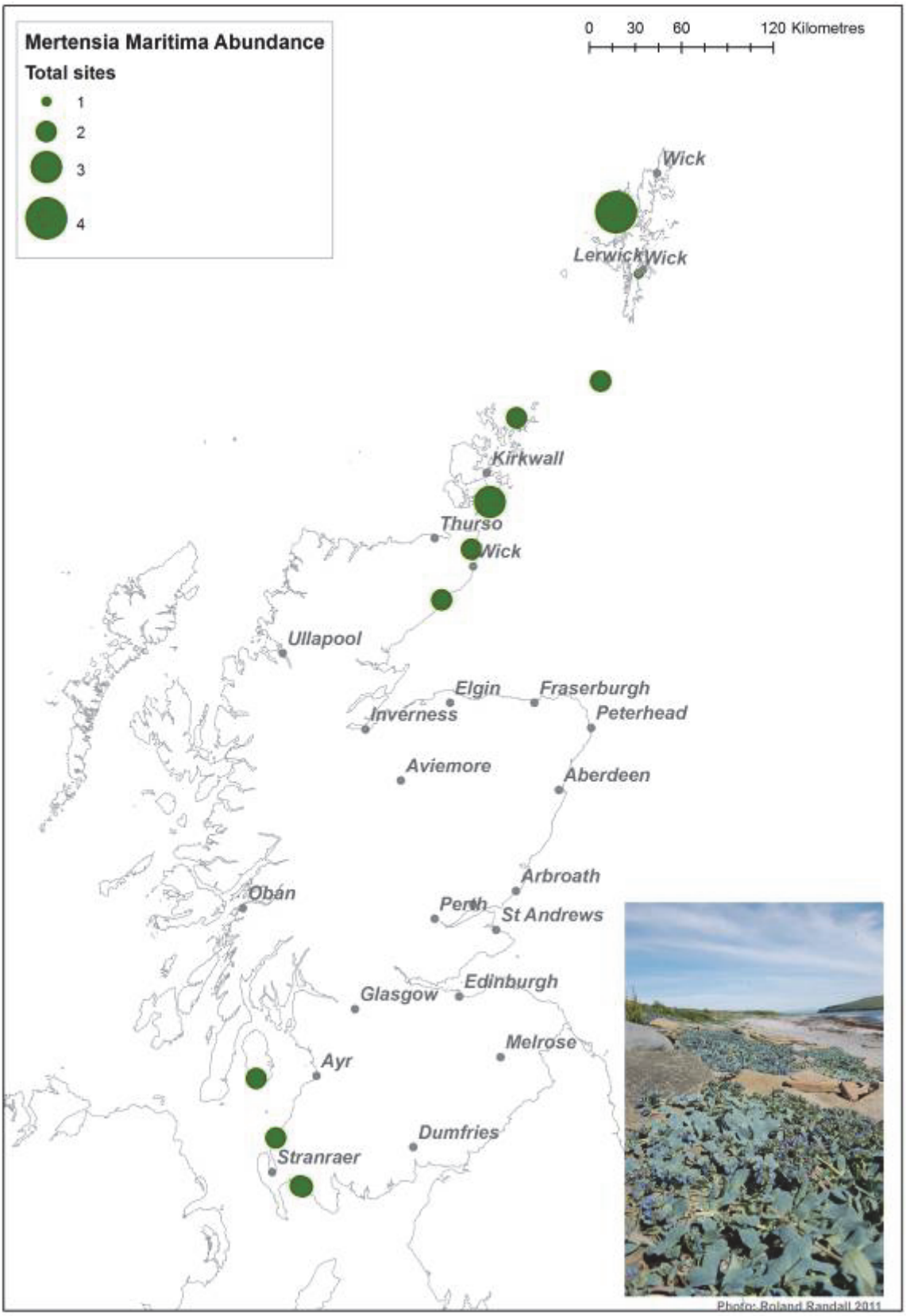

Figure 16. Abundance map – Mertensia maritima*. Note – only available for surveyed blocks. Contains Ordnance Survey data (© Crown copyright and database right [2014]. Ordnance Survey 100017908).*

4.7 Differences from phase 1 inventory extents

The table below (Table 9) summarises the differences in areas from the first phase of the inventory which was based on API and the current validated one, stating the field surveyor's views as to why the discrepancy occurred. Block ID numbers refer to the map in Figure 1. Note: not all blocks were surveyed for this project.

4.7.1 Summary

The comparison aims to identify challenges faced when generating inventory polygons from API rather than provide a precise accuracy assessment of the initial validation. This would be misleading since some large areas were included for validation which may have been assigned as 'low confidence' by the capture staff and which they might expect to be completely excluded following field survey (e.g. if the substrate was unclear).

Generally the API and rule base was able to identify the coastal vegetated shingle sites well. That is, there were relatively few sites identified which were not shingle in some way. Some additional sites were added, for example where due to coordination with Scottish Saltmarsh Survey (in press) this meant that surveyors were present on the ground in other locations.

Some areas of coastal vegetated shingle just could not have been spotted from aerial photographs alone and some examples of challenges for the API are discussed below.

Table 9. Differences in BAP Priority Habitat area from API derived extents by block

Block Name	Block ID	Total area (ha)	Difference in area (ha)	Comments
Shetland	1	**4.3**	**-13.8**	Ephemeral nature of the strandline over the season migration up and down the beach, transitions to grassland inland.
Fair Isle	2	**0.22**	**-0.1**	Discussions with the Fair Isle Bird Observatory (FIBO) indicates that the API misidentified a potential site (North Haven and South Haven) and additional small sites were also identified elsewhere and subsequently confirmed by FIBO - these were removed by our methodology as they were below the MMU. Given that no other data exists for Fair Isle we relaxed the MMU in this case to retain the polygons - but the exact extents have not been verified.
Orkney	3	**25.9**	**-13.8**	The vast majority of shingle sites had been correctly identified from aerial photographs. Most were narrow 'fringing beach' sites, some with either shingle grassland or fescue grassland to the rear. A few annual vegetation of drift lines sites were extended further along beach on inspection and a few others were reduced. This is to be expected with an ephemeral vegetation type in a mobile habitat. Other coastal types were shown as shingle on initial API but were not vegetated. These were sandy beaches with steep shingle backshores backed by dune. These were too mobile for annual vegetation of drift lines. A typical suite of these occurred at Whitemill Bay, Sanday. The other, typified by Melberry Dunes, Hoy, occurred where shore

				material was large Orkney Flag cobbles (up to 600 750 mm), lacking in interstitial material and therefore vegetation. The dunes at Rothiesholm, Stronsay, had suffered severe recent blowout down to a bare shingle pavement. This had shown up as potential annual vegetation of drift lines shingle on air photos but was too exposed / disturbed for current vegetation.
North Coast	4	**9.5**	**-1.7**	Ephemeral nature of the strandline over the season migration up and down the beach, transitions to grassland inland
Inverness	5	**215.4**	**+12.9**	Shingle deposits in front of Dunrobin Castle were very sparse with sea defences possibly to blame. However, shingle appears to be more extensive to the west where it runs along the coast to Golspie. This could not be investigated further due to time constraints. A new polygon was added to the Golspie site incorporating shingle dominated by *Atriplex* spp. and backed by *Hippophae* scrub. Sites along the southern edge of the Dornoch Firth contained very little shingle so should be removed from the inventory. Coastal erosion seems quite active here. The sites south of Balintore contain very little vegetated shingle of value and should probably be removed from the inventory. Similarly, around Nigg Bay and Alness Bay are also very sparsely vegetated containing only fragmentary strandlines backed by species poor *Arrhenatherum* grassland. The polygons for Whiteness Head and Culbin Bar generally remained the same apart from an extension to Whiteness Head incorporating more of a shingle bar that extends to the east. A small area of saltmarsh was removed from the east of Culbin bar. The Findhorn site was extended to include more of the sandy shingle spit and shingle ridge that extends along the coast to the east.
Elgin to Peterhead	6	**214.3**	**-64.5**	This is a difficult site as it is extensive and the shingle substrate extends a long way in land. Issues with API were previously reported for here in the pilot.
Edinburgh to Aberdeen	7	**4.8**	**+1.0**	Small sites (av. 0.1 ha). Generally the vegetation is a small proportion of the API polygons with bare shingle on the seaward side of the *Festuca* grassland and strandline vegetation.
Inner Solway	8			Not surveyed - the difference value here is that between API polygons and those captured from Randall and Doody (2000) maps.
Outer Solway	9			Not fully surveyed here. The difference reported is

				that between API and a combination of Field Surveys and polygons captured from Randall and Doody (2000).
Ayr	10	**8.5**	**-8.7**	There is a fairly good relationship between the vegetated shingle and the mapped macropolygons, although significant areas of sand have been included within the macropolygons at most sites. The complex Ballantrae site was difficult to map because the morphology of the shingle (shale) structures has changed since the aerial photographs were taken. In particular the river has breached the spit at a new location and there are new brackish pools in the centre-north area of the site.
Arran	11	**20.5**	**-6.5**	There is a good relationship between the mapped polygons and vegetated shingle, although the fringing beach macropolygons do contain significant areas of bare shingle at the seaward side. The only site that was significantly extended was Lochranza Castle. The castle was built on a stable, natural shingle (shale) spit which supports mixed grassland and *Festuca rubra* saltmarsh to the south. The macropolygon only covered a small area of open grassland at the east end of the spit, whilst the actual vegetated shingle habitat extends further west and south.
Mull of Kintyre	12	**238**	**-35.5**	The macropolygon at the north of Davaar Island (on Campbeltown Loch) delineated an area of boulders with scattered bracken, rather than shingle. A new site was identified at the western tip of the island that is a raised beach with permanent grassland, bracken and heath (difficult to identify as vegetated shingle from the aerial photograph). The Lochranza Castle macropolygon was also extended. The biggest difference here is the more detailed mapping of Rhunahaorine where a very large initial polygon was captured during API and was mapped in detail in 2012.
Islay and Jura	13	**5.3**	**-4.0**	Large areas of bare shingle mapped within the macropolygon yet there is only small finging vegetation at the rear. Extension inland to include permanent grassland and heath and also to include saltmarsh shingle vegetation. Possibly further sites related to vegetated raised beaches (grassland / heath) difficult to identify from API due to closed sward.
Oban Southwards	14	**6.2**	**N/A**	No aerial photography available for Phase 1 inventory - so an API derived extent was not created
Greenock	15	**5.1**	**0.1**	Closely matched the vegetated shingle seen on the ground, with only minor extensions
Oban Northeast	16	**38.2**	**N/A**	No aerial photography available for Phase 1 inventory - so an API derived extent was not created
Fort William	17	**24.2**	**10.4**	Polygons extended considerably and new sections identified, especially north and south of Sallachan point. Closed grassland vegetation typically missed from API. Driftline vegetation and shingle saltmarsh occur semi-continuously round much of Loch Linnhe and Loch Eil but difficult to map from API without ground-truthing. Some areas deleted e.g. tidal shingle spits at Inversanda and Camas na Croise with no vegetation.

Mull	18	**1.4**	**-1.4**	Bare shingle at Treshnish included by API but is not vegetated due to exposure and / or is above max. size for shingle
Coll and Tiree	19	**N/A**	**N/A**	Not surveyed.
Outer Hebrides	20	**40.6**	**-3.4**	The nature of the sites here, mainly small narrow strandlines and grassland (macropolygon av. 0.4 ha) presents a challenge for API. Additional sites were identified by the surveyor while in the field.
Skye	21	**48.0**	**+36.1**	Generally reasonable match but often considerable extension inland, as not feasible to judge where shingle ends without fieldwork e.g. for closed *Festuca* turf. Strandline vegetation often extends further along shore than predicted. A few identified sites proved to be too exposed to support driftline vegetation (e.g. Trotternish).
Ullapool	22	**6.2**	**+2.5**	API polygons mostly confirmed as driftline vegetation but often extended landward as not feasible to judge where shingle ends without fieldwork. Quite large area missed at Ullapool north of river (golf course). Polygons extended and added to at Loch Ewe, especially driftline which does not show clearly.

The following sections describe factors affecting the ability to determine the vegetated shingle extent through API with site references in brackets.

4.7.2 Ephemeral nature of the strandline

Atriplex spp. and *Galium aparine* are the main annuals of the shoreline around the Scottish shingle coasts. The distribution of these species extends down the beach as the summer progresses, establishing in successively lower driftlines. As autumn storms cause increasing shore mobility and deposition of wrack, these species are uprooted / destroyed in the lower part of their range but continue to flower and seed on the upper beach until the end of the growing season in late September / early October.

There is, therefore, a maximum and minimum extent of the annual vegetation of drift lines vegetation that will vary from year to year, according to climatic conditions. It is important to be aware of this when mapping the areal extent of H1210 annual vegetation of drift lines. This report quotes the observed and potential maximum extent. However, it is not always possible to identify this lower extent from the available aerial photography and when OS MasterMap surveys are several years old.

Where *only* strandline vegetation exists, it may be preferable to record the length of vegetated shingle habitat rather than the area due to the difficulty in estimating the width of this strandline zone (Cox, Shetland and North Coast). In most instances, an attempt was made to map the width as well as length of strandline vegetation present on each site but it is worth being aware that this represents the minimum representation of the habitat which may occupy a greater width of the beach. Also, the strandline often extends for long distances which are time-consuming to map accurately, and a more pragmatic solution is to map length and estimate width at sample locations.

4.7.3 Transitions to grassland landward

Transitions to landward were often difficult to define from API, especially where these were transitions to other semi-natural vegetation types. The distinction between vegetated shingle and other vegetation was generally quite easy to identify in the field although some difficulty

can arise where there are transitions to terrestrial *Arrhenatherum elatius* dominated grasslands (MG1). However, the presence of some coastal species such as *Tripleurspermum maritimum* or *Silene uniflora* and presence of patches of open unvegetated shingle usually helped identify the transition (Cox, Shetland and North Coast).

At several sites where shingle grassland is present, this grades almost imperceptibly into unimproved agricultural grassland. It is not possible easily to distinguish this boundary from aerial photography but is usually recognisable in the field by micro-topographic variation. (Randall, Orkney). In some instances soil depth and substrate type were checked with a probe and / or a trowel, but it was not feasible to do this extensively due to time limitations. The species composition is also a guide with therophytes such as *Sedum anglicum* and *Rumex acetosella* indicative of shallow soils on shingle (Strachan, Oban, Mull, Fort William, Skye, Ullapool).

In general, polygons were extended inland to include raised beach features where improved, grazed pasture overlays old shingle deposits. The extent of shingle polygons at Tarbat Ness were extended farther inland to incorporate more heavily grazed shingle grassland (Central Environmental Surveys - Block 5 Inverness, South).

4.7.4 Transitions to sand dune landward

A number of the beaches on Sanday are dune locations with a steep backshore composed of flag plates (Whitemill Bay, The Dees [HY 699 392]). These may look like potential H1210 annual vegetation of drift line sites on aerial photographs but are too exposed and suffer frequent sandblow, so are not vegetated. (Randall, Orkney).

Transitions to sand dunes did not prove hard to define in the field as sandy vegetated shingle forms a characteristic community that appeared quite distinct from the *Ammophila arenaria* and *Elytrigia juncea* dominated arenaceous dunes that backed these beaches (Cox, Shetland and North coast).

Dunes over old shingle deposits are more extensive at Littleferry (Loch Fleet). Photos taken inland show the links are underlain by old shingle originally noted by Ogilvie (1923) (Block 5 Inverness, North).

4.7.5 Transitions to saltmarsh / freshwater marsh

Bayhead and ayres - In some bayhead locations, shingle is deposited as an ayre, with a fresh or brackish loch behind. In other locations, such as Braewick, the lagoon has infilled to give freshwater marsh (Randall, Orkney).

At many West Highland sites (Oban to Ullapool, including Skye) and elsewhere, there are frequent occurrences of saltmarsh on shingle, especially in sealochs (Burnett, 1964). These range from scattered saltmarsh plants with much bare shingle to a closed turf of varying thickness overlying shingle. The main NVC types are SM13 and SM16 with localised occurrences of SM8 (with *Salicornia* spp.), SM9 (with *Suaeda maritima*) and SM28 (with *Elytrigia repens*). A recurring type has dense *Juncus gerardii* amongst shingle. Inclusion of saltmarsh in shingle polygons is based as far as possible on whether the vegetation appears to be influenced by the shingle substrate (excluding areas with deep turf), although it was not always straightforward.

Many of the larger saltmarsh sites on the west coast and islands are underlain predominantly by shingle. It is recommended that comparison with the Scottish Saltmarsh Survey (in press) is made at some point to ensure consistency and to identify additional shingle saltmarsh sites if appropriate.

At a few sites on Skye there are transitions to vegetation on shingle in waterlogged hollows with tall *Juncus* spp. and / or *Iris pseudacorus* where soil depth of <10 cm was used to determine areas for inclusion.

4.8 Disturbance and pressures

Disturbance of vegetated shingle tended to be localised and related to the more accessible sites or those with residences or activities on or adjacent to the beach. Other sites had very little disturbance (Islay and Jura, Greenock, parts of Skye and Mull).

The following types of disturbances and pressures were noted from the sites with examples.

4.8.1 Construction of roads, buildings, car and boat parking

The physical presence of man-made structures on the shingle such as roads, buildings and car and boating parking is the main disturbance across the sites where it replaces or disturbs the shingle. For example at Ballantrae (Ayr), there is some evidence of damage from car parking. A small car park has recently been constructed on a shingle spit at Dunstaffnage Bay (Oban NE). Elsewhere in many cases the presence of a metalled coast road tight to the coast with its retaining wall constrains the shingle features (e.g. the Loch Gare sites, Greenock, Aultbea (Ullapool) and Kilmarie (Skye)).

At the Rhunahaorine peninsula site (Mull of Kyntire) there is a fairly large static and mobile caravan development adjacent to the coast that has caused disturbance through the establishment of buildings, caravan pitches and landscaping. Caravan sites at Ledaig (Oban NE), Ullapool and Ardmair (Ullapool) have caused similar disturbance. And similar issues are associated with residential properties at Pirnmill (Arran) where the area of vegetated shingle has been affected both by the construction of the road and by the creation of car parking spaces.

Construction of airstrips at Ledaig (Oban NE) and Kyleakin (Skye) appears to have resulted in losses and disturbance of vegetated shingle.

4.8.2 Trampling / visitor pressure

At many sites where there is a coast road, car parking or access adjacent to the site, there is often trampling from visitors (including dog walkers). For example, the Ballantrae (Ayr) site is easily accessible from the town and suffers somewhat from visitor pressure such as dog walking.

At the Rhunahaorine peninsula site and Davaar Island site (Mull of Kintyre) there is also disturbance through trampling pressure from visitors.

By contrast the Findhorn site (Inverness) is popular with the public and easily accessible with car parks just behind the dunes. There are many well trampled paths leading down to the shingle ridges but actual disturbance seems minimal.

4.8.3 Dumping of rubbish and rubble

Dumping of garden waste and building rubble was evident at several sites, such as Nigg Bay (Inverness), Onich (Oban NE), and at Pirnmill (Arran) where households appear to be using the edge of the beach to dispose of household waste, and occasionally rubble. At Ullapool large quantities of rubble have been dumped on shingle (for land claim?) and at Caol (Fort William) shingle beach material from a beach cleaning project has been piled above the shore.

At several Orkney sites, e.g. Bay of Bomasty, Stronsay, Bay of Sandgarth, Shapinsay, dumping of agricultural waste has partially covered vegetated shingle.

There was also evidence of dumping of rubble at the Campeltown Loch (Mull of Kintyre).

4.8.4 Scrub encroachment

Scrub encroachment (e.g. including particularly birch, gorse and broom) was identified as being potentially problematic on the larger sites at Cuthill, Whiteness Head and Culbin where it is felt that it will eventually suppress the heathland communities. Some burning of gorse scrub has taken place at Whiteness Head to combat this. A similar issue was identified for non-native conifers colonising shingle heathland at Rubha na h-Airde Glaise (Skye).

Invasive non-native plants are a problem at some locations e.g. Caol Spit (Fort William) where *Fallopia japonica, Aster novae-belgii* agg. and *Lupinus nootkaensis* are all expanding. *F. japonica* is a problem at other sites e.g. Cuil Bay (Oban NE).

4.8.5 Small scale shingle extraction

Small scale extraction of shingle was identified at some sites e.g. Tarbet Ness (Inverness), Dunstaffnage Bay (Oban NE), Ballantrae (Ayr) and at various locations on Arran.

4.8.6 Grazing / agricultural improvement

Agricultural improvement and grazing pressures were identified at several sites. For example, Ballantrae (Ayr) where there was cattle poaching of the grassland and saltmarsh on the raised beach in the south. Imachar Point (Arran) also showed significant damage from sheep grazing; the strandline and pioneer herb habitats were accessible from the adjacent mixed grassland and species such as *Raphanus maritimus* and *Tripleurospermum maritimum* were heavily grazed. In addition, the Rhunahaorine peninsula (Mull of Kintyre), has suffered disturbance including the agricultural improvement of grasslands and the presence of a conifer plantation in the centre-south of the site.

4.8.7 Erosion

Erosion was not identified as a major issue generally but there was some erosion on the eastern edge of Culbin Bar (Inverness) where heathy dune communities are being cut back by wave action. In addition, on Islay and Jura, a few fringe beaches have eroding soil / shingle profiles at the seaward edge of the *Festuca rubra* or mixed grassland swards.

4.9 Sites not possible to visit during the surveys

While the aim was to validate 100% of the polygons identified by the initial inventory within the target blocks, it was not possible to achieve this, either for safety reasons, or due to the time limitations and remoteness of some of these sites. This was particularly where the additional contribution of area was not deemed to be worth the amount of effort required in order to get to these sites.

A table is provided below of the sites which were missed with some justification and also an indication of the size of the sites. This includes additional sites identified just from the surveyors being in the field. In addition the GIS polygon layer records the locations of sites still requiring validation from the phase 1 inventory API (this is stored as “NTV” – in the Broad Shingle Class).

Table 10. Sites not possible to visit during the surveys

Block Name	**Block ID**	**Sites** (unvisited and additional)	**Area (ha)**	**%**	**No. sites**
Shetland	1	None	0	0	0
Fair Isle	2	It was decided not to visit Fair Isle due to the small amounts of potential habitat identified from API. However, as discussed above, some information was provided by Fair Isle Bird Observatory.		100	
Orkney	3	A small number of sites were on islands to which there were no ferry services, and with the additional expense and limited time available were not visited. However, other off-islets were visited in 2008 and data from those visits were included. Sites not visited: Northwick, Papa Westray, Cava Island, Papa Stronsay, Auskerry Stronsay. As a result of previous visits and checks this time, additional sites were added at Glims Holm, South Ronaldsay and Sands of the Crook, Stronsay. There could be more. Given time, it might be good to request comments/information from local rangers, RSPB etc for completeness.	1.4	4.1	5
North Coast	4	3 sites: Dounray / Portnancon, one in nuclear power station, one with a bull and one at bottom of 60m high shear cliff.	6.6	66.6	1
Inverness	5	Ord of Caithness - the site is at the foot of gorse/bracken covered cliffs with no obvious/safe access route from the road. Whiteness sands - Within the Tain bombing range so will need RAF clearance. South of Balintore - along the foot of precipitous 400ft cliffs with no access from land - only accessible by boat.	3.9	1.8	5
Elgin to Peterhead	6	2 small sites < 1ha require visiting - Locations inherent in the GIS table	1.2	0.5	3
Edinburgh to Aberdeen	7	3 small sites - captured on the basis of shingle NVC classes recorded at that location up to c 1.5ha in total. - Locations inherent in the GIS table	1.4	29.2	3
Inner Solway	8	No sites visited. The surveys of Randall and Doody were used to supplement the inventory. Carsethorn, Torduff Point x 2, Dornock, Arbigland x 2, Rascarrel Bay	1.4	4.7	7
Outer Solway	9	The surveys of Randall and Doody	4.5	4.9	6

		were used to supplement the inventory for sites not visited. Claymoddie was surveyed as part of the pilot work but does not have detailed species lists here - except for those of Randall and Doody - and Cox observed that at least some species (e.g. *Glaucium flavum,* appeared to have shifted extent since 2000). Isle of Whithorn, Drummore x 2, West of Stranraer, Knockbrex, South of Port William, North of Lochryan House			
Ayr	10	None	0	0	0
Arran	11	None	0	0	0
Mull of Kintyre	12	While the large Rhunahaorine site was only surveyed briefly in 2011 it was revisited and thoroughly surveyed in 2012	0	0	0
Islay and Jura	13	It is likely that vegetated raised beaches were under-recorded across Islay and Jura. Unfortunately these areas are difficult to identify where they support a closed heath or grassland sward and there was insufficient time to attempt to survey these areas.	0	0	0
Oban South	14	71 mid to low confidence polygons, (flagged by API aloine mid to low confidence) which were prioritised down due to time constraints	0	0	0
Greenock	15	No access was granted for the large site at Kilfinan Bay on the Otter Estate.	3.5	66.7	2
Oban Northeast	16	Several additional sites in Loch Creran and Loch Leven could not be surveyed due to lack of time. These include Tralee (NM8938), Airds Bay (NM9045), Dunbeg (NM8734), Carness (NN0659) and Loch Creran (various).			
Fort William	17	Corpach islands: boat access not feasible due to weather conditions. ca 1.5 ha, definitely veg shingle	1.0	3.5	2
Mull	18	Several new significant sites for vegetated shingle were noted in passing and/or from air photos, but time was not available for survey. These are Killiechronan (Loch na Keal) (NM5341), Salen airstrip (NM5943) and Craignure Golf Club (NM7038), but other sites, particularly for strandline vegetation, are considered likely to exist.			
Coll and Tiree	19	All sites on Coll and Tiree remain unvisited during this survey	5.7	100	13
Outer Hebrides	20	The following locations were not visited: Berneray. 8km walk from nearest access in bad weather	6	14.8	9

		Taransay. Offshore island. No access in bad weather Stioclett Bay, Tarbert. 4km walk from nearest access in bad weather Mulhagery, Harris. Only accessible by boat. Scarp. Offshore island. No access in bad weather.			
Skye	21	Sites not possible to cover in the first stage of survey (2011) were captured in second stage (2012) except for sites South of Kyleakin, South of Gars - bheinn	0.8	0.8	2
Ullapool	22	Sites not possible to cover in the first stage of survey (2011) were captured in second stage (2012) except Isle Martin	0.5	4	1

Note: The sites not visited include those viewed by binoculars or from a distance as shingle as well as those unvisited that have been digitised in-house by GeoData using API and Ordnance Survey MasterMap data. Names taken from nearest placename in Open Street Map. Further details are provided in Appendix C.

4.10 Outputs

The following outputs have been created by this project. All have detailed metadata collected to UK Gemini II standard (see Appendix B). This is the most detailed and up to date dataset available for the UK on coastal vegetated shingle.

4.10.1 GIS inventory polygon layer

A nested GIS based polygon dataset depicting the areas of shingle habitats which are classified in a nested structure from the more detailed Broad Shingle Classes, to Annex I and BAP Priority Habitats. These are given as attributes of the layer. The principle is illustrated in Figure 17.

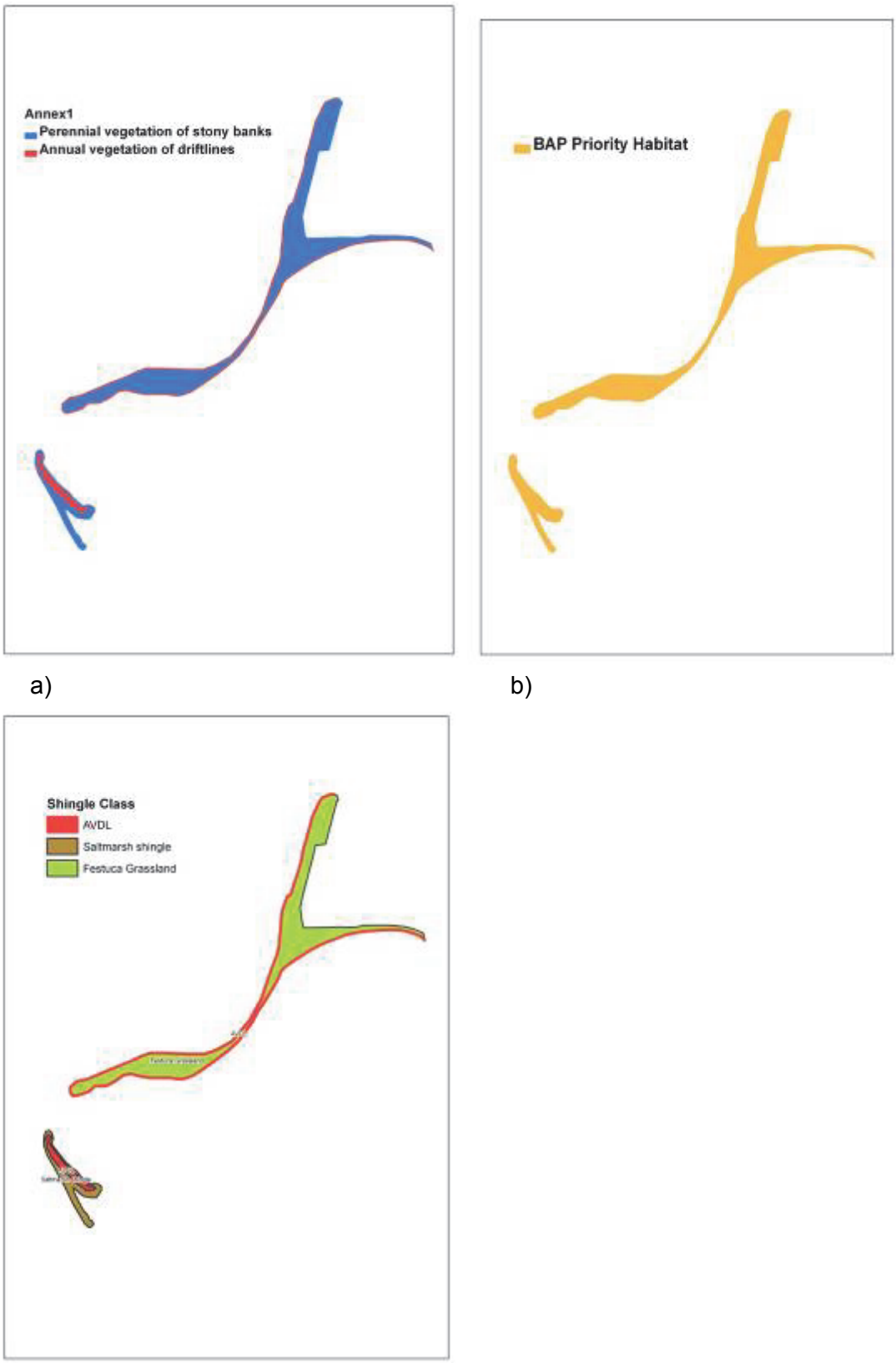

Figure 17. Aggregation of more detailed shingle class polygons into a) Annex I and b) BAP Priority Habitats. (Note: AVDL refers to annual vegetation of drift lines).

4.10.2 GIS transect layer / GIS point dataset of species data

These transects were used to show the location of the transect survey and the associated points contain species that were observed. These species were stored with the DAFOR rating of abundance.

All species that were observed were recorded including any of the climate change indicator species. These indicator species were then linked to the associated polygon.

The point and transect layers link together spatially but also with a unique TransectID. Within the GIS a relationship (ArcGIS relationships) has been established to allow quick access to species abundance values for each of the points in the database (Figure 18). The user clicks on a point and is presented with the list of species; they can then select each in turn to view the details.

2 points dataset are available for species, one for the first stage and another for the second. This includes links to the Randall and Doody (2000) Solway Quadrat data.

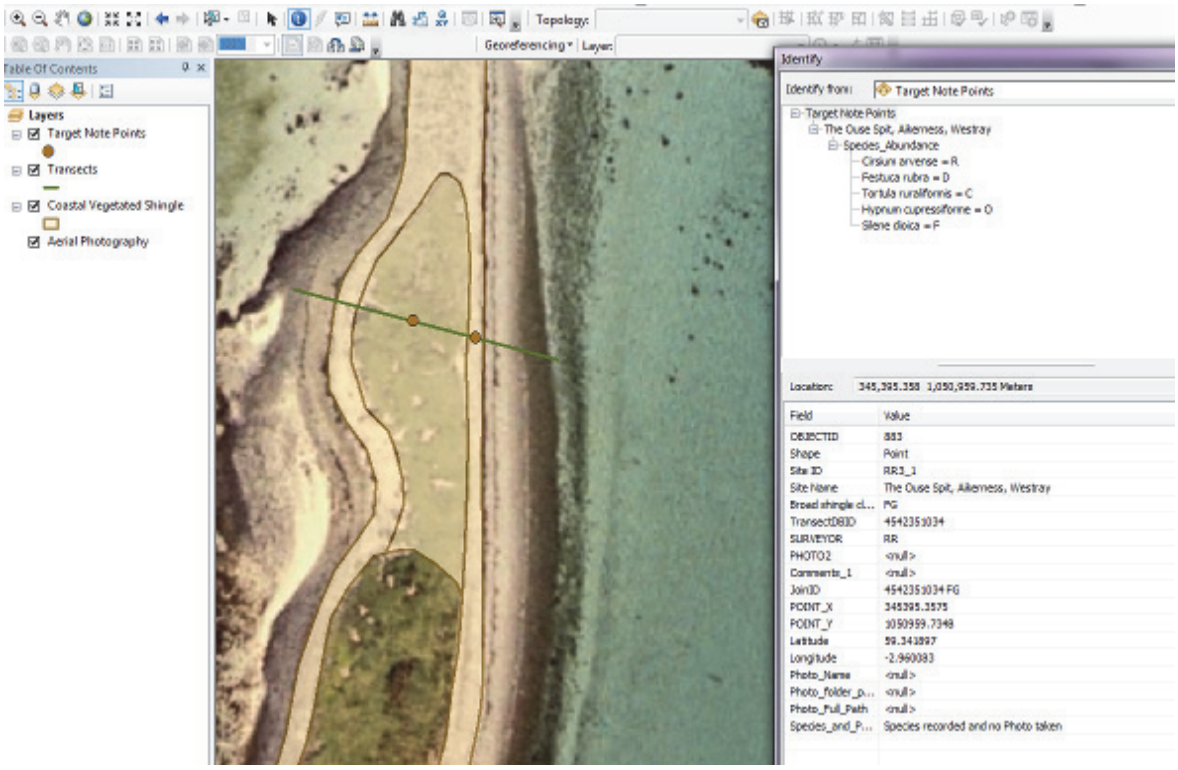

Figure 18. Transect example with quadrat locations and species lists.

5. DISCUSSION

5.1 The context of Annex I habitats within Scotland

5.1.1 Introduction

Existing definitions of the Annex I from JNCC (2007) and SNH (unpublished) do not effectively represent the variety and species assemblages found within Scottish situations. This section examines the context of the two Annex I habitats of shingle within Scotland.

5.1.2 Classifications

It is difficult to identify Annex I habitats from API. However, existing work and the experience from the field surveys enables a summary of Annex I habitats to be given.

Gimingham (1964) divided Scottish shingle vegetation into three types: Foreshore, Apposition Banks and Shingle Salt-marsh communities. The first of these approximates to Annex I H1210 annual vegetation of drift lines, the second approximates to the H1220 *perennial vegetation of stony banks*, while the third is a relatively common shingle habitat in north and west Scotland that rarely occurs elsewhere in the UK, outside the Solway Firth. Although primarily composed of perennial saltmarsh species, this habitat is effectively a part of the vegetation of driftlines. The presence of saltmarsh communities on shingle is associated with shingle beaches which are not raised sufficiently above sea-level to prevent inundation and / or which are sufficiently sheltered, low energy beaches to encourage development of saltmarsh communities.

Early records of this shingle-saltmarsh community were from Canna (Asprey, 1947) and Mull (Gillham, 1957) but Randall (for this project) has reported it from Spey Bay, and Mill Sand and Isbister (Orkney), whilst Cox (also for this project) found examples of shingle saltmarsh at Claymoddie (Dumfries and Galloway) and on the shores of Loch Linnhe near Fort William. Other locations known are Haroldswick (Shetland) and the leeward part of Culbin Bar (Stewart & Patton, 1927). All these locations have low-lying shingle with very fine clay or organic interstitial material and are usually protected from extreme physical disturbance. Shingle saltmarsh communities have some similarity with *Puccinellia* marsh SM13, *Juncus gerardii* marsh SM16, *Atriplex-Beta* cliff MC6 or *Festuca-Holcus* cliff MC9. However, the presence of driftline annuals or *Tripleurospermum maritimum* among the marsh vegetation makes for a poor fit. It is also much more open and fragmentary vegetation than normal saltmarsh.

Fuller (1975) classified and mapped the vegetation of Culbin Bar. In this he highlighted the importance of the fine fraction matrix within the shingle substrate, emphasising its role in moisture retention. The pattern of vegetation was found to be related to the distribution of wind-blown sand within the shingle and the mulching effect of a shingle layer on top of sand or damp shingle. However, because of its exposed nature little driftline vegetation is present at Culbin.

The autecology of several species which are found primarily on Scottish shingle has enabled a somewhat greater understanding of communities within this habitat. These include the works of Scott (1963) and Randall (1988, 1992) on *Mertensia maritima.* An important factor present at many shingle locations is human disturbance. This is particularly relevant to the H1220 perennial vegetation of stony banks and has been reviewed by Randall (1981, 1989), Ranwell (1981), and Fuller and Randall (1988).

Recent reviews of the Annex I habitats by Averis and Averis (2010) have sought to provide a Scottish context to the definitions based on the NVC community types.

5.1.3 H1210 Annual vegetation of drift lines

This is the very sparse, open and fragmentary vegetation found on the strandline just above the high tide line. This community makes use of the nutrients present in the drift and much of the vegetation is distributed by sea within the drift material. Hence, this ephemeral vegetation may advance down-beach in summer and then retreat to just above the highest spring-tide line as storminess increases later in the year. Because it is annual, sparse and low-growing, it may be completely buried or be destroyed by drift after the first major storms of the autumn. However, this is part of the natural dynamics of the system.

The species composition of this vegetation is dependent upon the type of interstitial material present within the substrate. It should be noted that in Scotland, H1210 annual vegetation of drift lines will also be home to some perennial species. Where the fine fraction is sand, the flora is often similar to that of Rodwell's SD2 *Honckenya peploides-Cakile maritima* strandline. With less sand but with some interstitial organic matter the flora moves toward SD3 *Tripleurospermum maritimum-Galium aparine* strandline. However, in most cases the shingle driftlines will also have *Atriplex* spp*., Rumex crispus* or, where there is enough moisture, as at Barlocco Bay, *Glaux maritima.* With sufficient organic enrichment sandy shingle driftlines may also have *Leymus arenarius* as at some Orkney sites. Where grazing occurs on the beach, nitrophilous annuals such as *Stellaria media* may be present.

A typical example from the Solway coast is at Powfoot. The community is present on the raised fringing shingle beach to the west of the spit, parallel to the high water mark. The drift line vegetation is SH31b *Honckenya peploides – Potentilla anserina* dominated community with *Tripleurospermum maritimum*. Many other species are also present including *Polygonum raii, Atriplex* spp, *Silene uniflora, Galium aparine, Euphorbia paralias* and *Crambe maritima*. The combination of species reflects both sand and saltmarsh influences at this site. This community is very open with some quadrats containing over 40% bare shingle. This vegetation keys out as similar to the SD2 NVC community, but *Cakile maritima* is not present. Further east, near Barnkirk Point, the pioneer community that occupies the steep shingle foreshore is SH27c*Tripleurospermum maritimum – Atriplex prostrata – Rumex crispus* pioneer community (*Potentilla anserina* subcommunity) which keys out as SD1. This area also contains a few plants of *Crambe maritima*.

Where a stream crosses the shingle, a different driftline community may be present almost totally lacking in annuals. For instance, at Rascarrel Bay, the seaward edge of the foreshore and around the river mouth at the western end of the site, there is a shingle saltmarsh community SH77, dominated by *Glaux maritima, Festuca rubra* and *Juncus maritimus*.This community includes *Agrostis stolonifera, Cochlearia officinalis* and *Triglochin maritimum*. It is related to NVC SM18 but is also subject to riverine influences. *Phragmites australis* may occur where a stream enters a shingle beach as at Spey mouth and the smaller streams to the east within Spey Bay.

Mullock Bay, within the MOD land of the Kirkudbright Range, is an extremely good example of shingle driftline vegetation because of its undisturbed nature and the low-energy, naturally protected nature of the foreshore, resulting in both saltmarsh shingle and extensive pioneer vegetation. The shingle saltmarsh at the seaward edge of the foreshore is the SH77 community dominated by *Glauxmaritima – Festuca rubra – Juncus maritimus*. Here *Juncus gerardii, Plantago lanceolata, Triglochin maritimum* and *Armeria maritima* are all constants and *Aster tripolium* a major associate. At the western end of the drift line vegetation is open SH24 *Tripleurospermum maritimum – Rumex crispus –Glaucium flavum* pioneer community with unusual associates such as *Fumaria muralis* and *Verbascumthapsus* which can grow in a sheltered location. Further east the pioneer vegetation is SH31b *Honckenyapeploides – Potentilla anserina* community, where the sandy matrix is greater and SH27a

Tripleurospermummaritimum – Atriplex prostrata – Rumex crispus assemblage with *Potentilla anserina* and *Crambe maritima* where drift debris accumulates.

To the south west of Scotland, the vegetated shingle communities at Clamoddie provide another fine example of driftline vegetation. Here, there are examples of SD2 *Honkenya peploides-Cakile maritima* vegetation although perennial species such as *Beta vulgaris*, *Crambe maritima* and *Glaucium flavum* may extend down shore into this driftline zone.

This is not a type of vegetation subject to active management: the only management possibilities are to avoid damage such as extracting shingle from beaches and the use of off-road vehicles across the foreshore. The custom of removing seaweed and other debris from popular and accessible tourist beaches can be damaging to this type of vegetation.

5.1.4 Transitions

As one goes further north, particularly on sites with organic interstitial material, the two Annex I habitats become blurred and more perennial species mix into the H1210 annual vegetation of drift lines - especially *Tripleurospermum maritimum* and in some locations, *Mertensia maritima*. At some exposed Arran sites, *Mertensia* is the sole representative down beach of the main vegetation of stony banks. A large-seeded ecotype of *Galium aparine* may often be a significant or sole representative of H1210 annual vegetation of drift lines in north and west of Scotland. A good example is on the shingle beach of Ceann Ear opposite Scrot Mor, Heisgeir, Outer Hebrides. In most sites, however, the dominant vegetation of driftlines is species of *Atriplex*. Hulme (1957) recorded *Atriplex hastata s.l., A. laciniata and A. littoralis* at Gosford Bay, Longniddry, East Lothian on sandy and muddy shingle.

5.1.5 H1220 Perennial vegetation of stony banks

Stony banks are shingle, thrown up into a bank by the sea, just beyond the reach of all but the highest tides. In places such as Kingston and Rhunahaorine they may extend as apposition banks to include heath, scrub and woodland. The size of the particles ranges from gravel a centimetre or so across to larger stones up to about 10 cm. The most continuous swards tend to be on the finer substrates. The habitat is enriched by deposits of dead seaweed, which form a mulch, keeping the substrate cool and moist and also act as a seed bed for regenerating plants. The community is subject to salt spray and wind-blown sand as well as occasional inundation by exceptionally high tides or storm surges. The pH tends to be neutral to base-rich. Once well-established, the plants that make up this community can withstand a considerable amount of rearrangement of the shingle in winter storms, but these assemblages can come and go along beaches as the habitat is periodically created or destroyed. However, where the spreads of shingle are larger, the more terrestrial areas are frequently acid and nutrient poor but are much damper than equivalent habitats further south.

Within the H1220 perennial vegetation of stony banks, five of the communities recognised by Sneddon & Randall (1994) (SH42, SH55, SH83, SH85 and SH91) are restricted to the north-east of Scotland. They are all indicative of the higher / drier and undisturbed nature of parts of some shingle sites in this region. The major presence of mosses and lichens (*e.g. Dicranum scoparium* and *Cladonia impexa*) within these communities illustrates the less disturbed nature of these sites. These communities appear to be confined to shingle sites with no clear NVC equivalent, which highlights the importance of the north eastern suite of shingle sites for conservation purposes. The Kingston Shingles within Spey Bay and the Culbin Bar are the classic sites for these lichen / moss-rich communities.

Seven of Sneddon & Randall's communities fall into a 'northern' category, rarely found south of the Scottish border (SH57, SH81, SH84, SH92, SH93, SH99 and SH100). Two of these comprise *Salix cinerea* woodland communities (SH81 and SH99) associated with damp

shingle where the water table is near the surface as at Rascarrel Bay. The SH100 *Juncus effuses / Holcus lanatus* community also occurs on damp shingle with a water table close to the surface. Some other of these northern communities (e.g. SH92) are types of H11 lowland heath; an increasingly rare resource due to disturbance of sites. These more northerly latitudes favour the growth of heath on shingle with wetter conditions leading to the development of acid conditions conducive to heath development. Lower levels of recreational use due to isolation may also be significant.

A third significant sub-set of communities are those found predominantly in south west Scotland, especially on the Solway Firth, Arran and Rhunahaorine. These are designated as SH12, SH13, SH31a,b, SH73, SH75, SH90, SH94, SH110 and SH117 by Sneddon & Randall (1993). In exposed locations within this area, where the matrix is arenicolous (SH31a, b), conditions are not suitable for annuals and the annual vegetation of drift lines may include or even be replaced by the perennial succulent *Honckenya peploides*. This species has a competitive advantage under conditions of temporary saline inundation.

Several communities are united by the presence of *Rhaphanus maritimus* (SH12, SH13, SH73 and SH117). This species may occur within the annual vegetation of drift lines along with *Atriplex prostrata* in sheltered sites (SH13) but more frequently occurs in the more mature perennial vegetation of stony banks (SH12, SH73). The scrub assemblage SH117, which includes *Raphanus,* exists where higher levels of precipitation allow the occurrence of a freshwater environment sufficiently close to the sea that there is still a strong saline influence in the form of salt-spray, thus allowing the maintenance of maritime herbs within the scrub. This is also seen to operate on maritime cliffs (Rodwell, 2000).

At Claymoddie and Rascarrel there are particularly sheltered and ungrazed shingle areas where species-rich scrubby grassland is present (SH110). The species that occur in this community are individually more widespread but the lack of disturbance and high rainfall at these locations may explain the high herb content.

In the west Arran sites and at Rhunahaorine a *Festuca ovina* (SH75) dominated community is found. This is somewhat similar to that occurring on acid, upland pastures. The moist, acid conditions of the south-western shingle where organic, peaty interstitial material is present may explain this distribution.

SH90 is a species-poor heathland community limited to the south-western Scottish shingle. It appears to be associated with the wetter conditions of this region as illustrated by the lack of lichen species commonly found elsewhere in Scottish shingle heathland.

Molinia caerulea heath (SH94) is also only found on shingle in the south-west. The combination of high rainfall and a well-drained substrate has led to the presence of *Molinia* in association with dry heathland elements. Conversely in the north-east it is too dry to allow the establishment and effective competition of this species.

For more detail on these communities see Randall and Doody (2000). As with the north-eastern communities, these are unique to Scottish shingle and, as such, warrant high conservation value.

Perennial stony bank communities are subject to disturbance by coastal defence works and by the construction of paths, promenades and other works at the upper limit of shingle beaches. Trampling can also be a problem on popular tourist beaches.

5.2 Nature of coastal vegetated shingle in Scotland

This project has shown that the extent of coastal vegetated shingle in Scotland is greater than previously thought. Earlier estimates were largely based on the surveys in the 1990s of Sneddon and Randall which focussed on the larger established sites and in addition were not intended to capture the H1210 annual vegetation of drift lines component.

The surveys undertaken for the current project highlight the importance of strandline communities as a major component of the coastal vegetated shingle habitat resource, making 124.1ha (11%) of the extent (and 157.4ha 14%) if the maximum potential extent is used. These are often very narrow and extend considerable distances along the coastline, especially when associated with sea-lochs. Elsewhere the extent and particularly the width of the strandline will vary throughout the season (extending down the beach earlier in the season). Therefore, it seems sensible to map the maximum *potential* extent of this community. In the GIS layer we have extended this habitat down to Mean High Water Springs (MHWS) as separate polygons (to allow both figures to be explored). However, it would be helpful to undertake repeat surveys of strandlines at selected sites in order to look at this more closely. The surveys also noted the presence of *perennial* vegetation within the annual vegetation of drift lines.

Small shingle spits are another characteristic Scottish coastal vegetated shingle feature, occurring at the mouths of small rivers and often associated with saltmarsh at the heads of sea lochs.

There are fewer large apposition beach type sites but where these do occur they can be extensive and are better known sites from the Sneddon and Randall Surveys (e.g. Rhunahaorine etc.)

The size of shingle material varies from very small pebbles to cobbles (e.g. Islay) and sites with large flags (Orkney) with sea weed deposits also hold vegetated shingle species. There are also some interesting examples of thin flat slate shingle on the Kererra Island and Luing Island sites.

Some of the shingle sites are very dynamic and although large areas of bare shingle exist, they have very little vegetation or are unvegetated (e.g. Staffin Bay, Skye). Similarly, in some locations (e.g. Orkney) the beach material is made up of large flags which are beyond the size limit for coastal vegetated shingle and mostly unvegetated. Although, as noted previously (Murdock *et al*., 2011), the presence of wrack and other interstitial material may support localised coastal vegetated shingle species.

In terms of condition, grazing by livestock (particularly sheep) is the most common factor in terms of the degradation of sites. This is probably due to a combination of the grazing out of the characteristic species and also increased nutrient inputs which favour other species such as ruderal vegetation (e.g. stinging nettle). This ruderal strandline community is probably worthy of further investigation through detailed quadrat surveys. Aside from grazing the coastal vegetated shingle sites are relatively undisturbed in terms of shingle extraction etc. This reflects the relative isolation of many of these sites. Several ungrazed sites are of high interest such as North Ballachulish (which is developing to woodland on shingle).

Sites close to properties, roads and other access points tend to have localised damage due to retaining walls, dumping, rubbish, trampling etc. The survey photographs also often show large amounts of rubbish washed up on the shore (fishing nets, plastic bags and bottles and other litter).

The sites often coincide with other BAP priority habitats (e.g. saltmarsh and sand dune) and have transitions / overlaps between them. In addition, these overlapping regions form interesting communities such as acid grassland on shingle (in some cases which were rich in waxcap fungi species). Freshwater flushes onto the shingle were also interesting and associated with *Iris* and wet *Agrostis stolonifera* grassland (e.g. Rascarrel) and are similar to MG11. Bracken-dominated vegetation on shingle and shingle dunes were also identified as being of interest. Where these habitats did not fit well within the SNH Broad Shingle Classification, they have been initially assigned 'other'. This is to allow them to be reclassified into new classes if desired for the final version of the inventory (i.e. when all blocks have been surveyed).

The surveys undertaken for this project have the potential to be useful when looking at other related BAP Priority Habitats. It also suggests that there is value in surveying the coastal vegetation as whole, rather than just single BAP priority habitats.
Finally, observations of the climate change indicator species were relatively few. However, these species were selected because they are at the northern limit of their European ranges.

Ligusticum scoticum, Mertensia marítima and *Raphanus maritimus* were observed at several sites across several blocks. With 8, 5 and 5 blocks respectively.

Raphanus maritimus had the greatest number of actual quadrat records with 36 across 5 blocks. *Crambe marítima* (8 records) was only observed within 4 blocks *and Polygonum boreale* (4 records) in 3 blocks.

Glaucium flavum, had 2 records in 2 blocks.

Atriplex portulacoides (2 records), *Carex punctata* (2 records), *Euphorbia paralias* (3 records) only occurred in a single block.

Monitoring of the presence / absence of these species in future will help assess climate change effects on these species.

5.3 Lessons learnt for API of coastal vegetated shingle

Generally the API and rule base was able to identify the coastal vegetated shingle sites well. That is, there were relatively few sites identified which were not shingle. Some of the larger discrepancies can be accounted for by the inclusion of large areas which were included at low confidence over the total extent but which the API staff felt was at least in part coastal vegetated shingle.

However, the surveys also highlighted challenges for the API. The actual extents were overestimated for perennial vegetation of stony banks, with confusion occurring where there were:

- transitions landwards to other grassland habitats
- transitions to grassland and sand dune landward
- transitions to freshwater marsh
- extensive bare shingle areas

For the annual vegetation of drift lines the following led to an underestimation with surveyors able to identify significantly more in the field:

- narrowness and ephemeral nature of the strandline made it difficult to identify from aerial photography
- transitions with saltmarsh communities

Therefore, when attempting to capture these habitats from API in future, it is worth noting these issues and seeking the best available resolution and existing habitat data available.

5.4 Potential for SNH to make wider use of mobile mapping and field recording devices

As an addition to the programme, the potential to use mobile mapping devices in the field was explored for inventory work versus traditional paper based methods. As described in section 2.2.4, this was in order to assess some tools and techniques for mobile data capture.

This was based on a variety of tools PDAs and Trimble Yuma Tablet PC.

5.4.1 Feedback from the surveyors on use of mobile field technology

Advantages

The perceived advantages of digital field mapping equipment are as follows:

- potential for a single device with on board GPS and camera
- new technology allows for a whole day's work on a single battery charge
- ability to see one's location against mapping and an aerial photo backdrop
- removes the requirement for post field transcription
- potential to email results back to office after the field session
- ability to have a wide range of mapping and other information available at one's fingertips while in the field

In reality, surveyors typically still relied (in some cases) on traditional techniques and felt that on some occasions it was more accurate to place transects by tracing them onto the aerial photos (digital or printed versions) maps, rather than relying solely on the GPS. On short, simple strandline annual vegetation of drift line type sites with few species, it was felt to be far quicker and easier to record on paper, and locate transects with GPS, then type up later in more amenable surroundings. It was also felt that this technology is likely to be more valuable on larger more complex sites.

In addition, it is currently not practical to make detailed GIS edits within the field (e.g. topological editing that snaps to other features (e.g. OS MasterMap boundaries). Surveyors captured rudimentary polygons against the aerial photos which were subsequently edited. Therefore there was still a requirement for considerable post processing in order to meet the expected mapping quality.

Disadvantages

Some of the issues reported by surveyors related to the hardware itself such as:

- the Trimble Yuma tablet PC used was rather heavy to carry on long hikes across shingle (not the case for PDAs)
- it was not always easy to see the screen in bright light or very poor weather
- the screen was not really large enough to work with aerial photographs at the scale needed to cover whole site (this is especially true of PDAs)

However, most of the issues related to usability of the software (in this case, ESRI ArcPad). The fact that this was an exploratory aspect of the project, there was limited time available to develop data capture software that was bespoke to these requirements and while a tool was developed to make data entry easier, it would a have been beneficial to allow a longer period for testing and refinement of the system, as well as for training. For example, while drop down lists were useful for small numbers of categories in the data attribution, it was lest practical for lengthy species lists, when auto-recognition of species names was preferred.

5.4.2 Implications for potential future use

Based on the surveyor feedback it is clear that there is good potential for SNH to make use of mobile mapping technology in future. However, this should take into account the following considerations.

The design of the software is most important to make data entry efficient and easy for users. It also depends on the experience of the user, with some well used to traditional field techniques and finding it less efficient to capture digitally.

As hardware improves, systems will get lighter and further integrated. The pervasiveness of smart phones offers potential for a simple device for say, target note capture but the screens are too small for anything other than rudimentary mapping. There are a number of existing Smartphone Apps for data capture (e.g. FieldAssets for the Apple iPhone). However, although customisable, these are designed for generic use and, to create an efficient system, it would be necessary to undertake some bespoke development. This could be developed as part of collaborative research project in conjunction with other agencies.

There is the potential that use of digital field equipment would also make survey vulnerable to disruption through IT issues and effectively having overreliance on a single piece of equipment. Therefore, there is still a requirement for some sort of backup, in case of technical issues during the survey. This may include carrying paper maps as was done during this survey.

In remote or mountainous locations, it may not be possible to send data without WIFI or internet connections. However, most applications will not require such immediacy anyway.

The data packets created are relatively small though and data transfer tools could be programmed into the software.

6. CONCLUSIONS

This project has created for the first time a national inventory of coastal vegetated shingle habitats for Scotland which has been subject to considerable field validation. Some further validation (3% of the total area) is required in order to do to make this a 'complete' inventory and ideally this should be undertaken as soon as possible, in order to ensure that the inventory remains consistent in date.

Unlike most other national habitat inventories, the Coastal Vegetated Shingle Inventory for Scotland is far more detailed and allows reporting to Annex I habitat level and to a more detailed SNH Broad Shingle Classification. This hierarchical structure is flexible and allows for habitat reporting at a variety of levels. There is the potential to extend this classification to include some new classes and the surveys also highlighted some areas for further research such as the seasonal extent of strandline communities and also perennial strandline vegetation.

The results of this work show that the areal of extent of coastal vegetated shingle habitats in Scotland is greater than was previously thought.

We have also identified interesting regional variations in coastal vegetated shingle in Scotland which characterise and distinguish it to that previously described. This includes the description of 'northern communities' and for example the influence of the water table / precipitation. The surveys also highlight the importance of the strandline as a major component of the resource and its change in extent through the season.

The inventory forms a baseline for ongoing monitoring, including monitoring the potential effects of climate change on selected species and the data gathered are already enabling general comparisons to be made with earlier mapping of the extents for some species.

Aside from issues with grazing, the coastal vegetated shingle is generally relatively undisturbed, due to the remote nature of many of the sites. However, locally there is disturbance where sites are more accessible, typically associated with residences, roads and other access points.

Field mapping systems were trialled as part of this project and highlight the potential of the equipment. However, surveyors noted that this equipment should be light and have a screen which is clear in different weather conditions. Improvements in smartphone technology have been dramatic over the last decade and as they are now widely used may offer another option for some aspects of field recording.

However, most importantly the mapping / data capture software needs to be carefully designed and tailored to the specific survey tasks and that sufficient training be provided to survey staff who may be more used to (or prefer) traditional paper based techniques.

It has only been possible to explore digital field equipment briefly here and a more detailed study is required, focussing on the spectrum of SNH's field survey requirements.

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APPENDIX A – ATTRIBUTES OF THE GIS LAYER

Field	Description	Comment	Example
OBJECTID	This is an ArcGIS ID and provides a unique identifier for each habitat inventory polygon		*554*
SOURCE1TXT	Title of primary source data set	If the site was surveyed the surveyor name and date will be the source (please note surveyors used aerial imagery as well as ground truthing to capture the shingle extents). If the source is aerial photography or OSMM with a date this shows the data was captured by GeoData staff and did not include field survey. All data sources are listed in chronological order.	*Jon Cox Field Survey 2010*
SOURCE2TXT	Title of secondary source data set	If this is completed when the Source1TXT is a field surveyor, this shows the data sources used to digitise the polygon by the data capture staff at GeoData in chronological order. Please note surveyors used aerial imagery as well as ground truthing to capture the shingle extents.	*Aerial Photography 2008*
SOURCE3TXT	Title of tertiary source data set	If this is completed when the Source1TXT is a field surveyor, this shows the data sources used to digitise the polygon by the data capture staff at GeoData in chronological order. Please note surveyors used aerial imagery as well as ground truthing to capture the shingle extents.	*OSMM 2006*
SITEREF	Any site reference(s) or local place names that may be available to define the general location of the polygon.	In practice only about 35% of polygons were flagged in this way. Some are very rural making identifying site refs difficult.	*Bay of Brough*
CREATEDATE	Date inventory polygon captured	Note this may be later than the field survey date	*22/03/2013*
CREATEDBY	Name of individual capturing data	Used for QA purposes	*DPHB*
GENERALCOM	Any additional comments about the polygon, habitat etc. NOT included elsewhere, and which are necessary to give a proper understanding of the site.	Typically this was to capture the surveyors comments (e.g. species or features of interest related to that polygon) which they had annotated onto the map or to allow data capture staff to highlight any issues.	*Rough grass on back slope of shingle bank*
CONFIDENCE	Confidence that the captured polygon is coastal vegetated shingle	This was mainly used in the first phase of work prior to validation when the definition of (BAP) habitat polygons was based on API mostly. Presence of shingle as identified by secondary data sources improved the confidence	*MED*
MODDATE	Date polygon was last modified – *for use in the next phase to track changes from the validation work*	For use in ongoing monitoring to track changes to the polygons	

MODBY	Name of individual last modifying polygon – *for use in the next phase to track changes from the validation work*	For use in ongoing monitoring to track changes to the polygons	*DPHB*
MODSMADE	Modification made e.g. Boundary - *for use in the next phase to track changes from the validation work*	For use in ongoing monitoring to track changes to the polygons	*Realignment of the rear of the parcel to follow OS Mastermap*
MODSREASON	Reason for modification e.g. Change in habitat distribution - *for use in the next phase to track changes from the validation work*	For use in ongoing monitoring to track changes to the polygons	*Better definition of the extents*
MODSCOMMEN	Update comment – *for use in the next phase to track changes from the validation work*	For use in ongoing monitoring to track changes to the polygons	*Approved*
AREA	Area of the polygon in square metres		*2117*
AREA_HA	Area of the polygon in hectares		*0.22*
S1HabType	Habitat type for the source dataset from which the BAP Priority Habitat determination was made	This was typically only included where secondary data were defining the presence of coastal vegetated shingle - e.g if it was derived from NVC records, the NVC classes (SD1, SD2) were retained	*S1*
PERIMETER	Perimeter of the polygon in metres		*604.78*
AVDL_lengt	Estimated length of annual vegetation of drift lines for the polygon	This is based on a notional width of AVDL 2 m multiplied by the length of ½ the perimeter in metres	*604.78*
Broad_Shingle_Class	Broad Shingle Class ID. Shorthand of each Broad Shingle Class	Key: **FG** Festuca Grassland **HE** Heathland **LNK** Linking polygon **NTV** Not visited **OT** Other **S** Scrub **SG** Shingle Grassland **SM** Saltmarsh **SOH** Stable Open Habitats (lichen rich community) **ST** Strandline **STREX** Strandline (Maximum Potential Extent) **W** Woodland	
Ligusticum_scoticum	Climate Change Indicator species	Relative abundance recorded using the DAFOR score: **D** Dominant **A** Abundant **F** Frequent **O** Occasional **R** Rare	

Mertensia_maritima	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Polygonum_boreale	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Seriphidium_marítima	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Carex_punctata	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Coincya_monensis	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Crambe_marítima	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Crithmum_maritimum	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Erodium_maritimum	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Euphorbia_paralias	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Euphorbia_portlandica	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Glaucium_flavum	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Atriplex_portulacoides	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Hierochloe_odorata	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Inula_crithmoides	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Limonium_humile	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Linum_perene	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Medicago_polymorpha	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Puccinellia_rupestres	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Raphanus_maritimus	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Trifolium_ornithopodioides	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Vicia_bithynica	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Vicia_lutea	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	

Vulpia_fasciculata	Climate Change Indicator Species	Relative abundance recorded using the DAFOR score (refer to *Ligusticum_scoticum* comments for key)	
Comments	General comments about the polygon including surveyor notes		
Capture Staff	Person responsible for the capture of the polygon	This could be a GeoData staff member or a surveyor. See key below: Initials – Staff APM – Andrew Murdock – GeoData Institute CES – Central Environmental Surveys staff – Surveyor DPHB – Daniel Hall Ballester – GeoData Institute GBD – Gemma Doneghan – GeoData Institute GG – Gemma Gubbins – GeoData Institute GMH – Graeme Hornby – GeoData Institute IS – Ian Strachan – Surveyor JC – Jon Cox – Surveyor RR – Roland Randall – Surveyor TH – Tommy Hearne – GeoData Institute	
QA Staff	Person responsible for the Quality Assurance of the polygon.	Refer to the key above for the Staff Name. Topod refers to an automated quality assurance check carried out by the ArcGIS software used.	
QA Date	Date of Quality Assurance		
Annex1	The Annex 1 habitat assigned to the polygon	H1220 Perennial vegetation of stony banks (PVSB) H1210 Annual vegetation of drift lines (AVDL) (Note there are blank records here where the polygon captured has not been visited by a surveyor or is a linking polygon to generate a macro polygon by joining groups of polygons together that are close)	
BAP	The BAP Priority Habitat assigned to the polygon	**CVS** – Coastal vegetated shingle, all polygons in the inventory would be assigned this class	
BlockID	Survey block ID within which the polygon is located		
Shape_Length	GIS automated column providing the perimeter or the polygon in metres		
Shape_Area	GIS automated column providing the area of the polygon in metres squared		

APPENDIX B – METADATA

Habitat polygons

Metadata Element	Obligation	No	Content
1 Title	M	1	Scottish Coastal Vegetated Shingle Polygon Layer
2 Alternative title	O	N	
3 Dataset language	M	N	English
4 Abstract	M	1	GIS based habitat polygons representing coastal vegetated shingle for Scotland. The datasets is derived from existing sources, modified through aerial photographic interpretation and field survey. This layer is intended to be the final pass since subsequent work was undertaken to further validate the original CVS GIS layer produced by the GeoData Institute to improve accuracy where no secondary data were available. Field validation was carried out in Scotland in September and October 2011 and August to November 2012 by Roland Randall, Ian Strachan, Jonathan Cox, Alan Booth, Frazer Milne and S. Smith (CES) and Clive Bealey.
5 Topic category	M	N	Biota, environment
6 Subject	M	N	Biodiversity, Plants and animals
7 Date	M	1	01.09.2011 - 31.10.2012
8 Dataset reference date	M	1	20120327
9 Originator	O	N	Andy Murdock GIS Manager GeoData Institute, University of Southampton Southampton S017 1BJ 023 8059 2719 gis-support@geodata.soton.ac.uk
10 Lineage	O	1	Derived from existing data sources (Sneddon and Randall (1993), Randall and Doody (2000) and Phase 1 \ NVC survey where available). Additional sites were identified from the SNH shingle database (Angus, 2010). These sources were used to locate the sites. The extents of coastal vegetated shingle were then interpreted from Aerial Photographic Interpretation, in many cases updating the extents from the original surveys. This data was then used as a base for field validation surveys. All of the sites that were surveyed were subsequently updated in the GIS with the most up to date boundary, Broad shingle class and Climate Change indicator species. For full details of the survey specifications and methodologies please see the final project report. A detailed GIS rule base for capture is provided within the project report. Attributes include reference to sources, comments from the digitisers and underlying habitat communities where available.
11 West bounding coordinate	M	1	-3.3305

12 East bounding coordinate	M	1	-3.2588
13 North bounding coordinate	M	1	53.9704
14 South bounding coordinate	M	1	54.012
15 Extent	M	N	GB-SCT
16 Vertical extent information	O	N	
17 Spatial reference system	M	1	British National Grid
18 Spatial resolution	O	1	0.625 – 5m (sources range from OS MasterMap to 1:10k field mapping)
19 Spatial representation type	O	N	Vector
20 Presentation type	O	N	mapDigital
21 Data format	M	N	Shapefile
22 Supply media	O	N	Cdrom\ email
23 Distributor			
24 Frequency of update	M	1	Irregular
25 Access constraint	O	N	Copyright and Licence
26 Use constraints	O	N	None
27 Additional information source	O	1	Murdock *et al.* (2011)
28 Online resource	O	N	
29 Browse graphic	O	N	
30 Date of update of metadata	M	1	20120425
31 Metadata Standard Name	O	1	ISO 19115 Geographic Information - Metadata
32 Metadata Standard Version	O	1	DIS_ESRI1.0
1 Title	M	1	Scottish Coastal Vegetated Shingle Polygon Layer

Species / Photo Point data

Metadata Element	Obligation	No	Content
1 Title	M	1	Scottish Coastal Vegetated Shingle Point Layer
2 Alternative title	O	N	
3 Dataset language	M	N	English
4 Abstract	M	1	GIS based species point representing target notes along transects and / or photo locations from field validation survey of Coastal Vegetated Shingle in Scotland. This layer is intended to accompany the Coastal Vegetated Shingle Polygon and Transect layers. Field validation was carried out in Scotland in September and October 2011 and August to November 2012 by Roland Randall, Ian Strachan, Jonathan Cox, Alan Booth, Frazer Milne and S. Smith (CES) and Clive Bealey.
5 Topic category	M	N	Biota, environment
6 Subject	M	N	Biodiversity, Plants and animals
7 Date	M	1	01.09.2011 - 31.10.2012
8 Dataset reference date	M	1	20120327
9 Originator	O	N	Andy Murdock GIS Manager GeoData Institute, University of Southampton Southampton S017 1BJ 023 8059 2719 gis-support@geodata.soton.ac.uk
10 Lineage	O	1	Derived from existing data sources (Sneddon and Randall (1993), Randall and Doody (2000) and Phase 1 \ NVC survey where available). Additional sites were identified from the SNH shingle database (Angus, 2010). These sources were used to locate the sites. The extents of coastal vegetated shingle were then interpreted from Aerial Photographic Interpretation, in many cases updating the extents from and #13; the original surveys. This data was then used as a base for field validation surveys. All of the sites that were surveyed were subsequently updated in the GIS with the most up to date boundary, Broad shingle class and Climate Change indicator species. For full details of the survey specifications and methodologies please see the final project report. A detailed GIS rule base for capture is provided within the project report. Attributes include reference to sources, comments from the digitisers and underlying habitat communities where available.
11 West bounding coordinate	M	1	-3.3305
12 East bounding coordinate	M	1	-3.2588

13 North bounding coordinate	M	1	53.9704
14 South bounding coordinate	M	1	54.0122
15 Extent	M	N	GB-SCT
16 Vertical extent information	O	N	
17 Spatial reference system	M	1	British National Grid
18 Spatial resolution	O	1	0.625 – 5m (sources range from OS MasterMap to 1:10k field mapping)
19 Spatial representation type	O	N	Vector
20 Presentation type	O	N	mapDigital
21 Data format	M	N	Shapefile
22 Supply media	O	N	Cdrom\ email
23 Distributor			
24 Frequency of update	M	1	Irregular
25 Access constraint	O	N	Copyright and Licence
26 Use constraints	O	N	None
27 Additional information source	O	1	SNH Commissioned Report No. 423 project
28 Online resource	O	N	
29 Browse graphic	O	N	
30 Date of update of metadata	M	1	20120425
31 Metadata Standard Name	O	1	ISO 19115 Geographic Information - Metadata
32 Metadata Standard Version	O	1	DIS_ESRI1.0
1 Title	M	1	Scottish Coastal Vegetated Shingle Point Layer

Transect data

Metadata Element	Obligation	No	Content
1 Title	M	1	Coastal vegetated shingle transect layer
2 Alternative title	O	N	
3 Dataset language	M	N	English
4 Abstract	M	1	GIS polyline layer representing transects across shingle polygons at locations of detailed survey of coastal vegetated shingle in Scotland. This layer is intended to accompany the Coastal Vegetated shingle polygon layer for Scotland. Field validation was carried out in Scotland in September and October 2011 and August to November 2012 by Roland Randall, Ian Strachan, Jonathan Cox, Alan Booth, Frazer Milne and S. Smith (CES) and Clive Bealey.
5 Topic category	M	N	Biota, environment
6 Subject	M	N	Biodiversity, Plants and animals
7 Date	M	1	01.09.2011 - 31.10.2012
8 Dataset reference date	M	1	20120327
9 Originator	O	N	Andy Murdock GIS Manager GeoData Institute, University of Southampton Southampton S017 1BJ 023 8059 2719 gis-support@geodata.soton.ac.uk
10 Lineage	O	1	Derived from existing data sources (Sneddon and Randall (1993), Randall and Doody (2000) and Phase 1 \ NVC survey where available). Additional sites were identified from the SNH shingle database (Angus, 2010). These sources were used to locate the sites. The extents of coastal vegetated shingle were then interpreted from Aerial Photographic Interpretation, in many cases updating the extents from and #13; the original surveys. This data was then used as a base for field validation surveys. All of the sites that were surveyed were subsequently updated in the GIS with the most up to date boundary, Broad shingle class and Climate Change indicator species. For full details of the survey specifications and methodologies please see the final project report. A detailed GIS rule base for capture is provided within the project report. Attributes include reference to sources, comments from the digitisers and underlying habitat communities where available
11 West bounding coordinate	M	1	-3.3305
12 East bounding coordinate	M	1	-3.2588

13 North bounding coordinate	M	1	53.9704
14 South bounding coordinate	M	1	54.0122
15 Extent	M	N	GB-SCT
16 Vertical extent information	O	N	
17 Spatial reference system	M	1	British National Grid
18 Spatial resolution	O	1	0.625 – 5m (sources range from OS MasterMap to 1:10k field mapping)
19 Spatial representation type	O	N	Vector
20 Presentation type	O	N	mapDigital
21 Data format	M	N	Shapefile
22 Supply media	O	N	Cdrom\ email
23 Distributor			
24 Frequency of update	M	1	Irregular
25 Access constraint	O	N	Copyright and Licence
26 Use constraints	O	N	None
27 Additional information source	O	1	SNH Commissioned Report No. 423 project
28 Online resource	O	N	
29 Browse graphic	O	N	
30 Date of update of metadata	M	1	20120425
31 Metadata Standard Name	O	1	ISO 19115 Geographic Information - Metadata
32 Metadata Standard Version	O	1	DIS_ESRI1.0
1 Title	M	1	Coastal vegetated shingle transect layer

APPENDIX C – ADDITIONAL SITES IDENTIFIED DURING SURVEYS

SiteName	X	Y	Subsequently Visited	Area Ha	No. Polygons
Buree	260000	720000	No	0.0	0
Achinore	270000	730000	No	0.0	0
Gearadh	160000	700000	No	0.0	0
Inverscaddle	260000	770000	No	0.0	0
Stoncreggan	270000	720000	No	0.0	0
Rubha Dearg	270000	750000	No	0.0	0
Loch Eil	170000	780000	No	0.0	0
Barnsdale Bay	100000	850000	No	0.0	0
Ardelve	120000	860000	Yes	0.6	2
Eilean Tioram	120000	860000	Yes	2.3	10
Ardintoul	120000	840000	Yes	3.3	16
Glas Eilean	120000	850000	Yes	10.7	12
Glenelg-Bernera	110000	890000	Yes	0.1	1
Ardmair - Keanchulish	290000	890000	Yes	0.3	2
Camas Mor	200000	900000	Yes	0.9	6
Tralee	189000	738000	No	0.0	0
Airds Bay	190000	745000	No	0.0	0
Dunbeg	187000	734000	No	0.0	0
Carness	206000	759000	No	0.0	0
Loch na Keal	153000	741000	No	0.0	0
Salen airstrip	159000	743000	No	0.0	0
Craignure Golf club	170000	738000	No	0.0	0
Faoilean-Rubha Cruaidhinn	156000	819000	Yes	0.94	9
Barrisdale Bay	186000	805000	Yes	2.44	9
North Wick, Papa Westray	350552	1053804	Yes	0.38	1
Cava Island	332318	1000272	Yes	0.15	1
Cava Island	332363	1000282	Yes	0.19	1
Papa Stronsay	366827	1029662	Yes	0.29	1
Auskerry, Stronsay	367419	1016607	Yes	0.42	1
Unspecified	243188	960850	Yes	6.60	1
Unspecified	283455	870423	Yes	1.98	1
Unspecified	282908	869697	Yes	0.21	1
Unspecified	283573	886510	Yes	1.18	1
Unspecified	305933	917364	Yes	0.32	1
Unspecified	305527	917173	Yes	0.26	1
Kilfinan Bay North	192139	678998	Yes	2.81	1
Kilfinan Bay South	192245	678427	Yes	0.55	1
Caol Spit	209558	776243	Yes	0.16	1
Caol Spit	209317	776193	Yes	0.79	1
Unspecified	174934	825191	Yes	0.23	1
Unspecified	147418	817007	Yes	0.53	1
Isle Martin	209890	898845	Yes	0.48	1

Unspecified	413036	847039	Yes	0.27	1
Unspecified	405168	863985	Yes	0.12	1
Spey Bay	336348	864605	Yes	0.85	1
Unspecified	344464	679815	Yes	0.12	1
Unspecified	353510	732187	Yes	1.07	1
Unspecified	351977	731915	Yes	0.19	1
Unspecified	101296	747636	Yes	0.67	1
Unspecified	114867	752978	Yes	0.15	1
Unspecified	93027	745905	Yes	0.46	1
Unspecified	93297	745803	Yes	0.26	1
Unspecified	92736	745776	Yes	1.23	1
Unspecified	92580	745705	Yes	0.19	1
Unspecified	92618	745846	Yes	0.10	1
Unspecified	92713	745948	Yes	0.37	1
Unspecified	92741	746050	Yes	0.10	1
Unspecified	92977	746049	Yes	0.21	1
Unspecified	93232	745989	Yes	0.14	1
Unspecified	93708	746333	Yes	1.55	1
Carrastaoinm, Hough, Tiree	94314	747182	Yes	0.29	1
Unspecified	136678	906616	Yes	0.15	1
Unspecified	144833	934343	Yes	0.14	1
Unspecified	100750	900261	Yes	0.36	1
Unspecified	84642	881240	Yes	1.95	1
Unspecified	112760	900424	Yes	0.62	1
Unspecified	98888	913608	Yes	0.94	1
Unspecified	128758	948896	Yes	0.11	1
Unspecified	62880	794949	Yes	1.19	1
Unspecified	72880	819436	Yes	0.50	1
Unspecified	247837	538539	Yes	0.29	1
Drummore Cailness	213330	537111	Yes	0.88	1
Drummore Cailness	213673	536866	Yes	0.29	1
Salt Pans Bay	197044	560583	Yes	0.87	1
Unspecified	258300	549572	Yes	0.12	1
Unspecified	237706	538528	Yes	1.28	1
Unspecified	205918	569673	Yes	1.02	1
Carsthorne	299304	559903	Yes	0.16	1
Unspecified	327130	564216	Yes	0.11	1
Unspecified	326760	563971	Yes	0.51	1
Unspecified	323345	565182	Yes	0.13	1
Unspecified	299820	557893	Yes	0.15	1
Unspecified	299466	557504	Yes	0.10	1
Unspecified	281191	548351	Yes	0.23	1

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