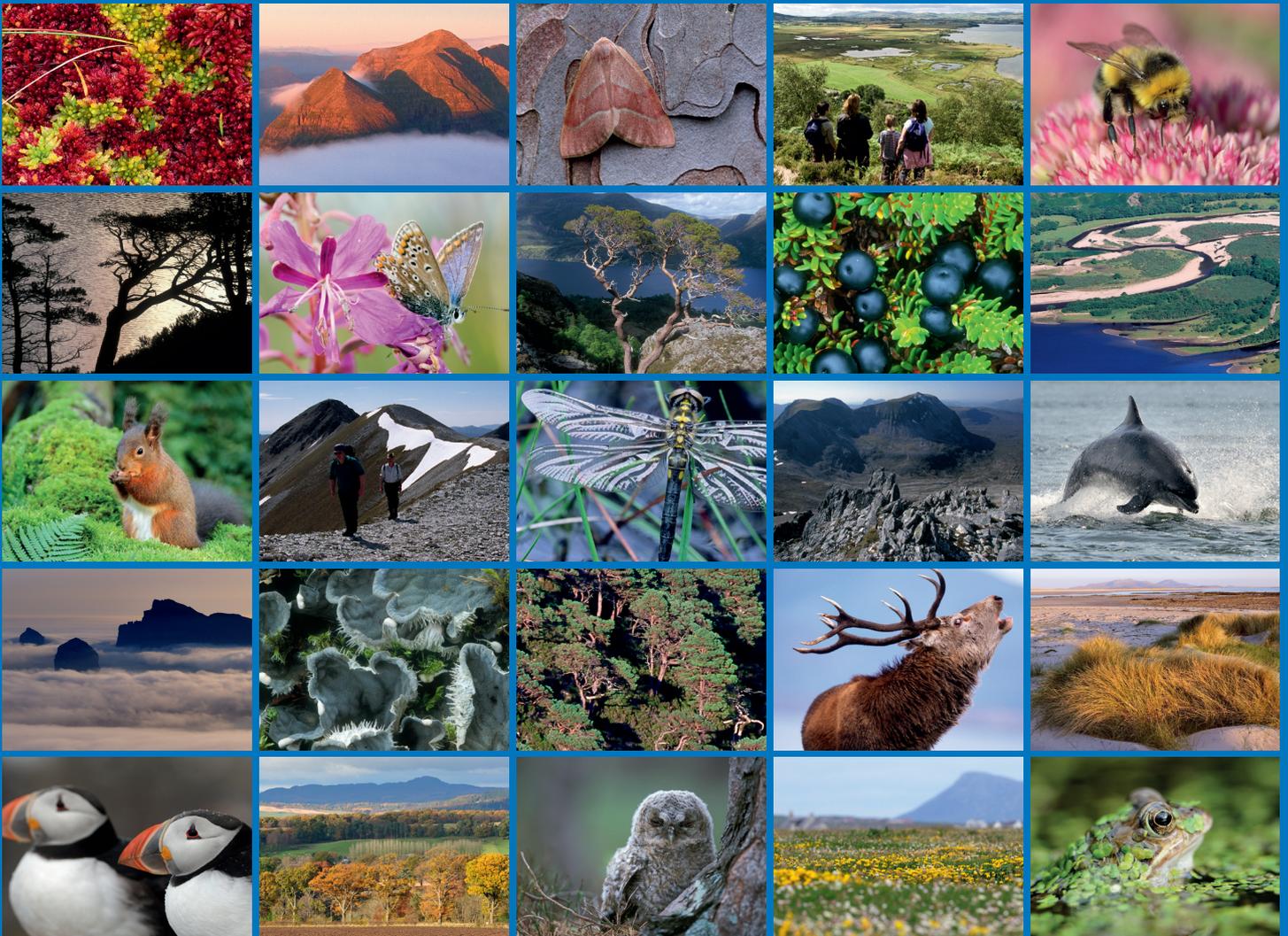


Site Condition Monitoring of *Vertigo angustior* 2017





Scottish Natural Heritage
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RESEARCH REPORT

Research Report No. 1162

Site Condition Monitoring of *Vertigo angustior* 2017

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SCM Reports

This report was commissioned by SNH as part of the Site Condition Monitoring (SCM) programme to assess the condition of special features (habitats, species populations or earth science interests) on protected areas in Scotland (Sites of Special Scientific Interest, Special Areas of Conservation, Special Protection Areas and Ramsar). Site Condition Monitoring is SNH's rolling programme to monitor the condition of special features on protected areas, their management and wider environmental factors which contribute to their condition.

The views expressed in the report are those of the contractor concerned and have been used by SNH staff to inform the condition assessment for the individual special features. Where the report recommends a particular condition for an individual feature, this is taken into account in the assessment process, but may not be the final condition assessment of the feature. Wider factors, which would not necessarily be known to the contractor at the time of the monitoring, are taken into consideration by SNH staff in making final condition assessments.



RESEARCH REPORT

Summary

Site Condition Monitoring of *Vertigo angustior* 2017

Research Report No. 1162

Project No: 113952

Contractor: Killeen, I., Willing, M. & Moorkens, E.

Year of publication: 2019

Keywords

SCM; narrow-mouthed whorl snail; *Vertigo angustior*.

Background

This report describes a Condition Assessment of the narrow-mouthed whorl snail *Vertigo angustior* in Scotland.

Vertigo angustior is listed on Annex II of the EU Habitats Directive. In Scotland the species is known only from two coastal locations at White Port on the Solway and at Garron Point SSSI and SAC, in south Aberdeenshire.

The work has been carried out to provide information for the next round of Article 17 reporting, due in 2019. A Condition Assessment has been carried out using methods designed to allow assessments of Population, Habitat and Future Prospects.

The attributes used to assess Condition were:

- Area of occupancy of *Vertigo angustior* habitat in the two individual sites at Red Man Bay and on Garron Point within the Garron Point SSSI and SAC, and at White Port
- Area of occupancy of *Vertigo angustior* in selected transects or plot areas
- Number of overall positive recordings per number of field samples
- Hydrological field assessment

Main findings

- On Garron Point *V. angustior* was widespread and locally abundant throughout the optimal habitat with densities as high as 2750/m². The extent of habitat is unchanged from the last survey in 2012. It is estimated that the area enclosing all the *Vertigo angustior* habitat considered to be Optimal is 275 m² (0.0275 ha).
- At Red Man Bay since 2012, erosion of the seaward margin of the transition zone has had a significant negative impact on the extent and quality of the *Vertigo angustior* habitat. Optimal *V. angustior* habitat in Good Condition is still present at the Red Man Bay site but the extent of habitat has been severely reduced from 2012. The area of optimal and sub-optimal habitat has reduced from an estimated 600 m² (500-700) in 2012 to 150-250 m² in 2017. *Vertigo angustior* was present in the southern half of the bay (first

80 m of the 150 m habitat transect). This is a reduction in the extent of occupancy since 2012 when the snail was recorded over the first 120 m of the 150 m habitat transect. The snail was more abundant in the optimal habitat towards the southern end of the bay where densities as high as 1500/m² were recorded.

- The White Port site is almost certainly lost as a *V. angustior* location as a result of coastal erosion. It is considered unlikely that any tiny residual pockets of *V. angustior* remain at White Port; in the unlikely event that are still present these are likely to be removed as a result of further south-easterly storms and the further advance of the scrub now shading most of the formerly unshaded habitat above the sand 'cliff' at the head of the beach.
- Having determined the attributes required to assess condition, the targets established in the previous Article 17 surveys to reflect the extent of optimal habitat and distribution were used for the current Population Assessment and Habitat for the Species Assessment. Future Prospects were assessed by examining how the impacts were affecting the other attributes and their impact if they continue unchecked. The Overall Assessment was then determined by how well the site meets these key targets for the attributes associated with this species.
- Since 2012 the overall assessment of the Garron Point site(s) has gone from Favourable Maintained to Unfavourable Bad, and White Port from Unfavourable Declining to Unfavourable Bad. Therefore, the overall assessment for *Vertigo angustior* in Scotland is Unfavourable Bad.

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Table of Contents		Page
1.	BACKGROUND	1
2.	OBJECTIVES AND SCOPE OF WORK	1
3.	METHODOLOGY	2
3.1	Area of habitat by site	2
3.2	Assessment using linear transects – Red Man Bay	2
3.3	Snail sampling	3
3.4	Survey methodology – White Port	3
3.5	Condition assessment	4
3.6	Timing	4
4.	RESULTS	4
5.	CONDITION ASSESSMENT FOR <i>VERTIGO ANGUSTIOR</i>	5
5.1	Population assessment	5
5.2	Habitat for the species assessment	6
5.3	Future prospects assessment <i>Vertigo angustior</i>	7
5.4	Overall assessment	9
6.	DISCUSSION	9
7.	REFERENCES	10
	APPENDIX 1: GARRON POINT SSSI AND SAC	11
	APPENDIX 2: WHITE PORT (SOLWAY COAST KIRKCUDBRIGHTSHIRE)	20

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MJW thanks SNH officer Bob Bryson for obtaining permission to visit the White Port site on the Almorness Estate. Further thanks are due to Brian MacTaggart of Dougan Hill Farm (Almorness Estate) for arranging vehicle access across private estate roads. Particular thanks are due to Richard Marriott who assisted with all aspects of field work (including some photography, botanical surveys and molluscan survey of additional sites). Richard also provided images and data from previous site visits and made valuable comments on draft White Port survey text.

1. BACKGROUND

The narrow-mouthed whorl snail *Vertigo angustior* is listed on Annex II of the EU Habitats Directive. In Scotland the species is known only from two coastal locations: at White Port on the Solway and at 2 sites in Garron Point SSSI and SAC in Aberdeenshire.

In the Second Report by the UK under Article 17 on the implementation of the Habitats Directive from January 2001 to December 2006 (JNCC 2007), the overall national assessment for *Vertigo angustior* was Unfavourable Inadequate. Although range, population, and habitat were Favourable, future prospects were Unfavourable – Inadequate. Hence, in accordance with Annex C, the overall assessment was Unfavourable – Inadequate. Paradoxically, this arose from the discovery of extensive new populations of this species on sea embankments of East Anglian estuaries which changed perceptions of future prospects from Favourable to Inadequate. This is because the bulk of the UK population is now known to occur in this habitat and there are uncertainties over the impact of predicted sea-level rise and the effectiveness of managed coastal retreat.

For the third Article 17 report (JNCC 2013), a Condition Assessment of *Vertigo angustior* in Scotland was carried out at the south Aberdeenshire sites in 2012 using methods designed to allow assessments of Population, Habitat and Future Prospects (Killeen 2013). [A condition assessment of the Solway White Port had been carried out in 2010 (Marriot & Colville 2011)]. For Garron Point the Overall Assessment was favourable Maintained and for White Port, Unfavourable Declining. Again the overall national assessment was Unfavourable – Inadequate.

2. OBJECTIVES AND SCOPE OF WORK

The principal requirements of Article 17 reporting are assessments of Range, Population, Habitat, Future Prospects and Overall. To fulfil these criteria, a programme of work which covered an adequate sub-sample of sites and using methodology specifically designed for *Vertigo* species Condition Assessments was carried out.

For the Aberdeenshire sites the 2017 Condition Assessment was based on the targets set in the 2012 study. The following work was proposed:

Assessment of the Red Man Bay transect and the Garron Point site with snail sampling, plus assessment of condition of polygons and transects. Prescription as follows:

- Describe habitat and take at least four samples from the most suitable habitat in the Garron Point site and analyse for molluscan composition
- At Red Man Bay repeat at least 6 of the short transects on the main transect between 0 and 120 m and take at least six samples from the most suitable habitat and analyse for molluscan content (see changes in Section 3)
- Re-determine boundary of the habitat polygons at Garron Point and Red Man Bay and assign habitat to either Optimal, Optimal & Sub-optimal, Sub-optimal, Sub-optimal and Unsuitable, or Unsuitable
- Assess the impacts upon the habitat for *V. angustior*

Assessment of the snail at White Port was designed to determine the extent of remaining occupied habitat as described in surveys in 2000 (Killeen & Colville 2000) and most recently in 2010 from a study by Buglife undertaken by R. Marriot and B. Colville.

3. METHODOLOGY

The principal requirements of Article 17 reporting are assessments of Range, Population, Habitat, Future Prospects and Overall. To fulfil these criteria, a programme of work using methodology specifically designed for *Vertigo* species Condition Assessments was carried out.

The methodology used for *Vertigo angustior* Condition Assessment has evolved over the last 10 years. The methods were originally designed for use at *Vertigo geyeri* sites on Anglesey by Killeen & Moorkens (2004, 2007), and developed further for application to *V. angustior* in Republic of Ireland sites (Moorkens & Killeen 2011) and for the 3rd round of reporting in Scotland in 2012 (Killen 2013). The methodology used at White Port essentially followed that used in previous surveys (Section 3.4).

The attributes used to assess Condition were:

- Area of occupancy of *Vertigo angustior* habitat in individual sites
- Area of occupancy of *Vertigo angustior* in selected transects or plot areas
- Number of overall positive recordings per number of field samples
- Hydrological field assessment

3.1 Area of habitat by site

Within each of the sites, areas of habitat were delineated for the purposes of monitoring *Vertigo angustior*. Specific habitat suitable for the snail(s) was identified, using best expert knowledge. Areas that could not possibly support the species were excluded from the study areas. The area of potential *Vertigo* habitat was delineated with a GPS. After such ground-trothing, the polygons containing all potentially suitable habitat are marked on aerial photographs to enable their transfer to a GIS system.

It was only considered practical to set up transects at Red Man Bay.

3.2 Assessment using linear transects – Red Man Bay

Transects are useful for assessing the condition of the habitat, and provide a repeatable means of future monitoring. At Red Man Bay in 2012, a series of short transects running from the High Water Mark inland at 10 m intervals along the length of the bay, were laid out using 30 m tape measures. Start points were also located with a GPS.

Starting at the 0 m end, the habitat (at the plant community and structure level) along the tape was described and the linear distance of that habitat type measured using the 30 m tapes. This was repeated every time the habitat changed, thereby delineating uniform plant community zones along the transects. Whilst there was not always a clear boundary, best expert judgement was used to delineate e.g., *Festuca* grassland, from more *Arrhenatherum* dominated grassland and so on. The habitat in each zone is then categorized into 3 classes according to its suitability for *Vertigo angustior*, an example of which is shown below:

Optimal habitat is where *Vertigo angustior* could survive in the majority (>50%) of the habitat. In Garron Point SSSI this comprises grassland dominated by *Festuca rubra* with low-growing herbs (e.g. *Plantago lanceolata*) and mosses, particularly *Rhytidiadelphus squarrosus*. This habitat is characterized by a deep layer of thatch which feels warm when one's hand is inserted. On Garron Point this habitat is found on the tops of rocky cliffs whereas at Red Man Bay, the habitat occurs as a strip in a transition zone between the shoreline and the lower slopes of the cliffs.

Sub-optimal habitat is where there are patches of vegetation and conditions that support *Vertigo angustior*, but the majority of the habitat cannot. An example would be in terrain that is generally too dry, or has a patchy distribution of sward habitat with only a thin thatch layer. At Red Man Bay sub-optimal is also defined as having some taller, transition vegetation.

Unsuitable habitat is an area of the site where the combination of vegetation and hydrological influence is outside the snail's range of tolerance. This includes both dry sparse sward with very little thatch, or tall, rank vegetation with bracken and *Arrhenatherum* dominated grassland. This habitat class may be natural unsuitable, or alternatively the snail may be restricted by excessive grazing or fertilization of flat areas of grassland, or by patches of weeds arising due to enrichment in the past.

In 2017, when it was found that much of the habitat had been lost, the methodology was revised such that at every 5 m along Red Man Bay (over a distance of 150 m) the width of the best *V. angustior* habitat (Optimal and the best of the sub-optimal) was measured.

3.3 Snail sampling

In selected delineated habitat zones on transects, and in individual habitat areas, a bag of moss/grasses and litter (c. two litres volume) was also taken. This is approximately equivalent to an area measuring 0.25 m x 0.25 m (0.125 m²). These samples were collected by plucking handfuls of moss, grass and thatch but not underlying soil.

The vegetative material was teased apart and spread on sheets of newspaper to dry. This was then shaken over a 5 mm sieve to remove the bulk of the plant material but to allow all molluscs to pass through. The residue was passed over a graded stack of sieves and examined microscopically. All mollusc species were picked out and counted.

3.4 Survey methodology – White Port

The survey methods adopted broadly replicate those used previously at White Port (Killeen & Colville 2000; Marriott & Colville 2010). At each sample location 15 minutes of field observation (examination of ground surfaces for *Vertigo angustior*) was followed by the removal of a bulk sample for later laboratory processing. Samples were obtained by the placement of a 25 cm X 25 cm quadrat frame onto the ground. Vegetation above 10cm in height was cut with a serrated knife and removed. Then all material within the frame down to a soil depth of about 3 cm (to recover any buried snails) was removed (a serrated knife used to cut around the inner frame border and cut soil/ sand to the required depth). Removed samples were air dried in muslin bags until of constant weight. The dried material was then passed through a sieve nest (2mm; 0.5 mm). Sieved residues were examined on trays beneath a low magnification binocular microscope. All specimens of *V. angustior* were recorded as live or dead as well as whether adults (with formed teeth in the shell aperture) or juveniles. Other molluscan species were recorded as presence or absence and whether living or dead.

Samples were taken along six short transects situated at positions approximately repeating the sequence used in 2010 (although being located further inland due to dune/beach erosion). The first transect was determined by measuring 13m from a 'bench mark' rock (shown in the foreground in Fig 2.2.3) and then walking inland until the erosion 'cliff' was reached. Thus transects 'A' – 'E' were approximately 19m apart with a slightly narrower 15m between transects 'E' and 'F'. On all transects one sample was taken below the sand cliff and positioned to include any remaining patches of vegetation still present (where possible avoiding bare sand); a second sample was taken on top of the sand 'cliff' (and in the case of transect 'C' two samples were taken as there was less shade in scrub at this location). Quadrats were placed, where possible, to avoid deeply scrub-shaded ground. Distances

between the samples ranged from between 2 – 3m. Plant species were recorded at each transect sample location.

In addition to sampling from the six dune transects additional samples were taken from, (1) the short turf at the north-eastern end of White Port bay and (2) short heavily grazed turf / salt marsh margins at Horse Isles Bay lying about 400 m to the north east of the White Port sites. These additional samples were taken by R. Marriott using a 5.6 cm diameter bulb planter (internal area 24.6 cm²). As with the transect samples, collected material was air dried, sieved and sorted on trays with a binocular microscope.

3.5 Condition assessment

Having obtained baseline data on the attributes required to assess condition, the baseline surveys have been used to establish thresholds to reflect the extent of optimal habitat and distribution for Population Assessment and Habitat for the Species Assessment. Future Prospects are assessed by examining how the impacts are affecting the other attributes (i.e. population and habitat for the species) and their impact if they continue unchecked. Future prospects should balance positives and negatives to determine whether the species will survive at a particular site for the foreseeable future. The Overall Assessment at a particular site is then determined by how well the site meets these key targets for the attributes associated with this species.

3.6 Timing

Fieldwork for this study was carried out at times of year considered to be most suitable for assessing extent and condition of potential whorl snail habitat (late spring/early summer) and late summer/early autumn. The site coverage, timing and team personnel were:

White Port: Martin Willing (20th June 2017)

Aberdeenshire: Ian Killeen and Evelyn Moorkens (18th – 19th September 2017)

4. RESULTS

The results from all sites are shown in appendices which contain maps, aerial photographs with outlines of habitat extent, sample location details, transect results, results of molluscan analysis and photographs.

A separate Appendix is given for each main survey site:

Appendix 1: Garron Point SAC

- Appendix 1.1: Garron Point
- Appendix 1.2: Red Man Bay

Appendix 2: White Port

Section 5 gives the national Condition Assessment for *Vertigo angustior*.

5. CONDITION ASSESSMENT FOR *VERTIGO ANGUSTIOR*

Having obtained some baseline data in 1998 on the attributes required to assess condition, the 2012 baseline survey established thresholds to reflect the extent of optimal habitat and distribution of the snail.

5.1 Population assessment

It is known that *Vertigo angustior* populations can fluctuate considerably from year to year (e.g. Sharland 2000, Moorkens & Gaynor 2003, Killeen 2011), especially as a result of poor or good weather conditions and it is for this reason that abundance of *V. angustior* has not been considered as one of the targets for Condition Assessment at any of the sites.

Table 1: Targets for population assessment

Indicator	Target	2012		2017	
		Result	Pass/Fail	Result	Pass/Fail
Presence/absence	<ul style="list-style-type: none"> Adult or sub-adult snails are present in at least 3 sites of suitable habitat with a geographical spread at Garron Point OR 75% of suitable sites surveyed (minimum 4 samples) 	Present in 6 sites	Pass	Present in 6 of 8 samples	Favourable Maintained
Presence/absence	<ul style="list-style-type: none"> Adult or sub-adult snails are present in at least 5 sites of suitable habitat with a geographical spread on the transect at Red Man Bay OR 80% of suitable sites surveyed (minimum 6 samples) 	Present in 9 sites	Pass	Present in 6 samples but geographical spread reduced	Favourable Declining
Presence/absence	<ul style="list-style-type: none"> The White Port site should support a living population of the snail (minimum 5 samples) 	Not surveyed since 2010	-	No live individuals found	Destroyed

5.2 Habitat for the species assessment

Table 2: Targets for habitats assessment

Indicator	Target	2012		2017	
		Result	Pass/Fail	Result	Pass/Fail
Habitat extent (site level)	<ul style="list-style-type: none"> Habitat at Garron Point should occur within an area of at least 275 m², of which at least 200 m² is classed as Optimal 	200 m ² classed as Optimal	Pass	At least 250 m ² classed as Optimal	Favourable Maintained
Habitat extent (site level)	<ul style="list-style-type: none"> At least 500 m² of habitat at Red Man Bay should be classed as suitable (Optimal or Sub-optimal habitat) 	600 m ² classed as Optimal	Pass	150-250 m ² classed as Optimal	Unfavourable Declining
Habitat extent (transect)	<ul style="list-style-type: none"> White Port – at least some habitat classed as Optimal or sub-optimal should be present at the site 	Not surveyed since 2010	-	No suitable habitat found	Destroyed

5.3 Future prospects assessment *Vertigo angustior*

The future prospects for *Vertigo angustior* are assessed by listing the activities that are influencing or are likely to influence the site that could result in the status of the species changing at that site. A standard list of impacts, with their standard codes has been used (see http://cdr.eionet.europa.eu/help/habitats_art17).

The locations of the pressure, its influence (positive, negative or neutral), and the intensity of the pressure (low, medium or high) are noted. The combination of the influences, both positive and negative is weighed to assess the site's future prospects as Favourable or Unfavourable.

Future Prospects have been assessed by examining how impacts are affecting the other attributes (i.e. population and habitat for the species) and their impact if they continue unchecked. Several impacts are having an effect on *Vertigo angustior* at the sites assessed most of which are assessed as negative (Table 8). Coastal erosion has destroyed the site at White Port and is having a significant impact at Red Man Bay. The greatest unknown is the future impact of climate change, Red Man Bay in particular has very low resilience to climate change and relatively small rises in sea level would inundate the habitat at Red Man Bay.

Future prospects should weigh positives and negatives to determine whether the species will survive at the Scottish sites for the foreseeable future. The status quo is not being maintained, and, therefore, even without weighting being placed upon climate change, Future prospects have been assessed as **Unfavourable Bad**.

Table 3: Impacts and Pressures (site basis)

			Influence	Intensity	Comments
All sites	M	Climate change			Climate change (M) has been included and although not assessed, its influence is likely only to be negative
	M01	Abiotic changes (climate change)			
	M01.01	temperature changes (e.g. rise of temperature & extremes)			
	M01.02	droughts and less precipitations			
	M01.06	wave exposure changes			
	M01.07	sea-level changes			
	M02	Biotic changes (climate change)			
	M02.01	habitat shifting and alteration			
Garron Point	H	Pollution	Negative	Low	Very small site, highly vulnerable
	H03.01	oil spills in the sea	Negative	Low	
	K	Natural biotic and abiotic processes (without catastrophes)	Negative	Low	
	K01.01	Erosion	Negative	Low	
	L	Geological events, natural catastrophes	Negative	Low	
	L07	Storm, cyclone	Negative	Low	
Red Man Bay	A04.02.05	non intensive mixed animal grazing	Neutral	Low	
	G05	Other human intrusions and disturbances	Negative	Low	
	H	Pollution	Negative	Low	
	H03.01	oil spills in the sea	Negative	Low	
	K	Natural biotic and abiotic processes (without catastrophes)			
	K01.01	Erosion	Negative	Severe	
	L	Geological events, natural catastrophes	Negative	Low	
	L07	Storm, cyclone	Negative	Low	
White Port	H	Pollution	Negative	Low	
	H03.01	oil spills in the sea	Negative	Low	
	L07	Storm, cyclone	Negative	Low	
	K	Natural biotic and abiotic processes (without catastrophes)			
	K01.01	Erosion	Negative	Severe	

5.4 Overall assessment

Since 2012 the assessment of the Garron Point sites has gone from Favourable Maintained to Unfavourable Bad, and White Port from Unfavourable Declining to Unfavourable Bad. Therefore, the overall assessment for *Vertigo angustior* in Scotland is Unfavourable bad.

Attribute	Assessment			
	Garron Point	Red Man Bay	White Port	Scotland
Population	Favourable maintained	Favourable Declining	Destroyed	Unfavourable Bad
Habitat for the species	Favourable Maintained	Unfavourable Declining	Destroyed	Unfavourable Bad
Future Prospects	Unfavourable Inadequate	Unfavourable Declining	Unfavourable Bad	Unfavourable Bad
Overall	Unfavourable Inadequate	Unfavourable Bad	Unfavourable Bad	Unfavourable Bad

6. DISCUSSION

The results and observations from the 2017 surveys give a high degree of confidence that the approach and methodology devised along with the targets and thresholds set are appropriate for the Assessment of Condition of *Vertigo angustior* in Scotland. We recommend that this regime is implemented for future monitoring – at least at the Garron Point SSSI and SAC.

The remaining habitat at Red Man Bay is maintained by (some) rabbit and deer grazing, and by the natural marine processes and hydrological regime. It is unlikely that any practical or feasible mitigation measures could be implemented to prevent the rate of erosion to the habitat, and it is probable that the site will disappear in the next 25 years. However, it is recommended that monitoring should continue (ideally at three yearly intervals, but 2 yearly if possible), particularly through the use of photography (aerial and terrestrial) and the series of habitat transects, as this will provide information on rate of change and maybe correlated with weather, storm and tidal events.

Marriot carried out a general, more widespread search for *Vertigo angustior* in Garron Point SSSI and SAC in 2004, and found the species to be quite restricted. The distribution may be to some extent controlled by aspect, being present in habitat associated with warmer slopes. However, it is possible that the snail is not restricted to 2 such small, isolated sites, especially as *Festuca rubra* dominated grassland is such a common maritime feature of the area. Given the importance of the location in a wider Scottish context and the 13 year interval since the last more widespread search, and given the present threat and future vulnerability of the 2 known sites, it is strongly recommended that a new survey is undertaken in other potential sites: firstly through the identification of potential sub-sites (initially through aerial imagery) and then through ground survey, to determine if the species is present and can be safeguarded elsewhere in eastern Scotland.

The White Port site is almost certainly lost as a *V. angustior* location. It is considered unlikely that any tiny residual pockets of *V. angustior* remain at White Port; in the unlikely event that are still present these are likely to be removed as a result of further south-easterly storms and the further advance of the hawthorn-dominated scrub now shading most of the formerly unshaded habitat above the sand 'cliff' at the head of the beach. It is doubtful whether future monitoring is merited.

7. REFERENCES

JNCC, 2007. European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC). Second Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2001 to December 2006. Conservation status assessment for Species S1014 Narrow-mouthed whorl snail (*Vertigo angustior*).

JNCC, 2013. European Community Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC). Third Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2007 to December 2012. Conservation status assessment for Species S1014 Narrow-mouthed whorl snail (*Vertigo angustior*).

Killeen, I.J., 2010. A Condition Assessment of *Vertigo angustior* at Gait Barrows, Cumbria. Unpublished report, Natural England.

Killeen, I.J. 2013. Whorl snails (*Vertigo* spp.) surveillance in Scotland: A condition assessment of the narrow-mouthed whorl snail *Vertigo angustior* in Aberdeenshire. *Scottish Natural Heritage Commissioned Report No. 615*.

Killeen, I.J & Colville, B. 2000. Survey for the whorl snail *Vertigo angustior* on the Solway coast. *Scottish Natural Heritage Commissioned Report F99AC317*. (Unpublished report)

Marriott, R.W. 2004. Site condition monitoring of molluscs on SSSIs; *Vertigo angustior* at Garron Point, Stonehaven, Grampian. *Unpublished report to SNH*.

Marriott, R.W. & Colville, B. 2011. Survey for the Narrow mouthed whorl snail (*Vertigo angustior*) at White Port SSSI, Kircudbrightshire. *Report to Buglife – The Invertebrate Conservation Trust*. (Unpublished report)

Mookens, E.A. & Gaynor, K., 2003. Studies on *Vertigo angustior* at a coastal site in western Ireland (Gastropoda, Pulmonata: Vertiginidae). *Heldia*, 5(7), 125-134.

Phillips, D. 2002. Notes on visit to the Stonehaven *Vertigo angustior* site with Richard Marriott on 2 August 2002. Report to Scottish Natural Heritage. September 2002.

Sharland, E., 2000. Autecology of *Vertigo angustior* and *Vertigo geyeri* in Wales. *CCW Contract Science Report 392*. Countryside Council for Wales.

APPENDIX 1: GARRON POINT SSSI AND SAC

Garron Point SAC (Code UK0030356) comprises 15.6 ha of coastal area with the following habitats (source JNCC):

Coastal sand dunes. Sand beaches. Machair (4.5%)
Shingle. Sea cliffs. Islets (11%)
Bogs. Marshes. Water fringed vegetation. Fens (5.8%)
Heath. Scrub. Maquis and garrigue. Phygrana (18.7%)
Humid grassland. Mesophile grassland (60%)

The narrow-mouthed whorl snail *Vertigo angustior* is the sole reason for SAC designation. It is known from 2 locations: at Garron Point, in *Festuca rubra* grassland on top of a rocky peninsula, and at Red Man Bay in a narrow strip of mossy grassland immediately above the High Water Mark. The locations of the two sites are shown in Figure 1.

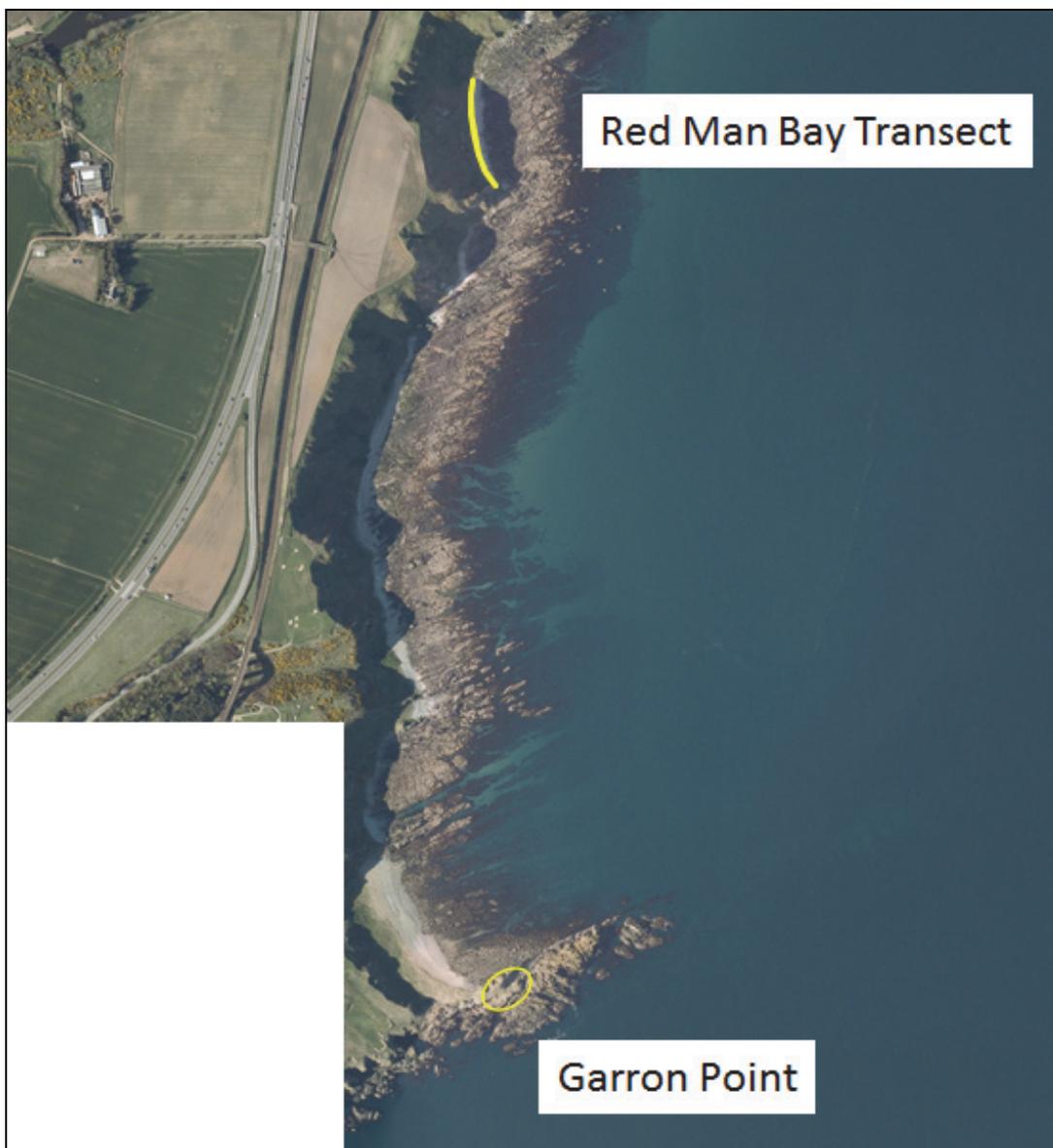


Figure 1: Garron Point showing locations of *Vertigo angustior* sites

Appendix 1.1 Garron Point

The area of suitable habitat is similar to that recorded by Marriot (2004) and Killeen (2012) and is restricted to a gentle sloping hollow of grassland on a rocky peninsula (Figure 1.1.2). The habitat comprises *Festuca rubra* dominated grassland with a deep, springy thatch layer, and with *Armeria maritima*, *Plantago lanceolata*, *Lotus corniculatus*, *Trifolium repens*, and occasional *Plantago maritima*, *Potentilla anserina* and *Anthyllis vulneraria*. The habitat is grazed by rabbits.

Vertigo angustior was found in both samples collected and was also found at a further four locations within the core area in the field (Table 4). *V. angustior* was widespread and locally abundant throughout the optimal habitat. Numbers of individuals in the 2 samples were 321 and 368 respectively (mean 344) giving an approximate density of 2750/m². The density in 2017 is over 4 times that recorded in 2012. However, this is likely to be an artefact of the difference in seasons between the 2 years (most *Vertigo* species are at their most abundant in late summer/early autumn following their main breeding events). Based upon these results the Population Assessment for Garron Point is Favourable Maintained.

The extent of habitat is unchanged from 2012. The boundaries of the site were re-determined (Figure 1.1.1) and are within error that might be expected from a hand-held GPS. The difference in 2017 is that the area of sub-optimal habitat on the northern part of the site has been included. It is estimated that the area enclosing all the *Vertigo angustior* habitat considered to be Optimal is 275 m² (0.0275 ha) (Figure 1.1.1). Allowing for rocks and more marginal habitat (? 20%), it is estimated that at least 250 m² are Optimal habitat. The sub-optimal habitat on the northern slopes does not seem to support *V. angustior* – it was not seen in the field on this or previous occasions. The Habitat Assessment is Favourable Maintained.

The habitat at Garron Point is maintained by (some) rabbit grazing, and by the natural marine processes and hydrological regime. No other management is recommended (or possible). On the basis of the status quo being maintained, Future prospects have been assessed as Favourable, but given the vulnerability of the site, and if greater weighting was placed upon climate change, then as with the 2007 and 2013 national assessments, the prospects would be Unfavourable Inadequate.

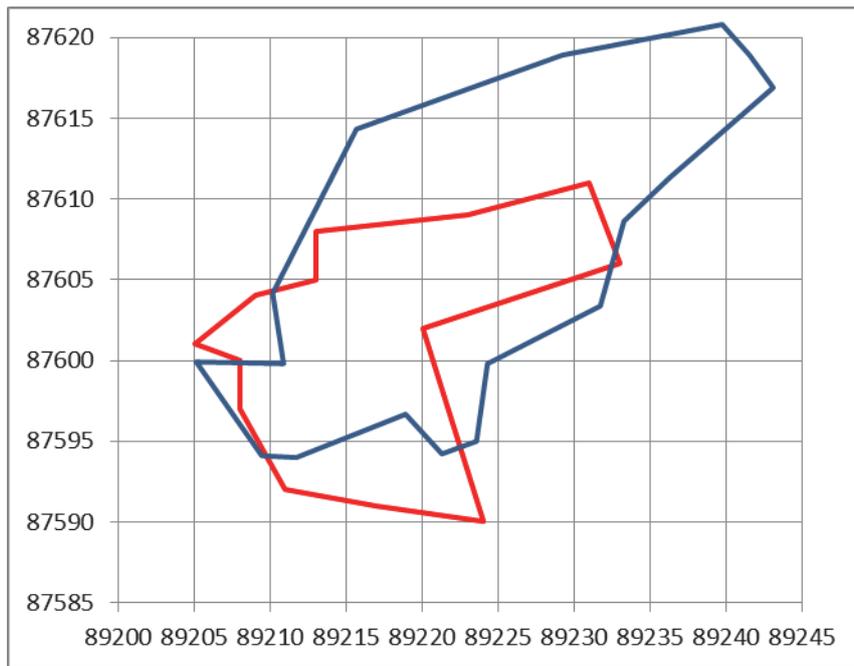


Figure 1.1.1 Garron Point polygon showing limit of suitable habitat (Red outline = 2012, Blue = 2017)

Table 4 Garron Point Sample sites and Results of molluscan analysis (*P* = present)

Sample	1	2	3	4	5	6	7	8
Grid Ref.	NO89219 87603	NO89220 87599	NO89217 87602	NO89224 87604	NO89232 87604	NO89227 87609	NO89229 87621	NO89216 87608
<i>Vertigo angustior</i> (Adult)	172	220	P	P	P	P	No	No
<i>Vertigo angustior</i> (Juvenile)	149	148						
<i>Clausilia bidentata</i>	4	15						
<i>Cochlicopa lubricella</i>	19	16						
<i>Lauria cylindracea</i>	7	15						
<i>Nesovitrea hammonis</i>	1							
<i>Punctum pygmaeum</i>	55	43						
<i>Vertigo pygmaea</i>	4	3						
<i>Vertigo substriata</i>	6	31						
Total No. of species	8	7						
Total No. of snails	425	498						



Figure 1.1.2 Photographs – Garron Point

Appendix 1.2 Red Man Bay

In 2012, the Red Man Bay site was described thus:

“The *Vertigo angustior* habitat comprises a narrow strip of transition grassland between the High Water Mark and the slopes at the base of the cliffs. The habitat is mostly *Festuca rubra* sward with the moss *Rhytidiadelphus squarrosus* lying approximately 1-5 m from the HWM. The zone nearest the HWM tends to be rather dry and fragmented with sparse vegetation over gravel and limpet shells, whereas on the lower cliff slopes the vegetation is dominated more by taller grasses such as *Arrhenatherum elatius* and bracken *Pteridium aquilinum*. The suitable habitat extends for approximately 150 m from south to north but is rarely more than 6 m in width from the HWM”.

Optimal *Vertigo angustior* habitat in Good Condition is still present at the Red Man Bay site but the extent of habitat has been severely reduced from 2012. Comparison of photographs (Figures 1.2.1 and 1.2.2) and measurements from a series of transects throughout the extent of the transition zone habitat (Table 5) shows that the area of optimal and sub-optimal habitat has reduced from an estimated 600 m² (500-700) in 2012 to 150-250 m² in 2017. This is principally a result of erosion on the seaward side of the habitat zone, but also there has been some encroachment of rank grassland from the landward side (see photographs in Figure 1.2.3). The area of *Phragmites* wetland at the northern end of the bay also seems to have expanded in area. The Habitat Assessment is therefore Unfavourable Declining.

Vertigo angustior was present in the southern half of the bay (first 80 m of the 150 m habitat transect). It was more abundant in the optimal habitat towards the southern end. This is a reduction in the extent of occupancy since 2012 when the snail was recorded over the first 120 m of the 150 m habitat transect. Although the density extrapolated from 5 quantitative samples in 2017 is 50% higher than that recorded in 2012, this is likely to be an artefact of the difference in seasons between the 2 years (most *Vertigo* species are at their most abundant in late summer/early autumn following their main breeding events). The Population Assessment is Favourable Declining.

Since 2012, erosion of the seaward margin of the transition zone has had a significant negative impact on the extent and quality of the *Vertigo angustior* habitat.

Other impacts having a minor effect at Red Man Bay include deer browsing and rabbit grazing but neither are having a negative impact on the quality of the habitat. Use of disposable barbeques and building fires using driftwood was again evident at Red Man Bay and this combined with trampling would adversely affect the transition margin habitat.

As the status quo is not being maintained at Red Man Bay, and, even without weighting being placed upon climate change, Future prospects have been assessed as Unfavourable Declining.

The remaining habitat at Red Man Bay is maintained by (some) rabbit and deer grazing, and by the natural marine processes and hydrological regime. It is unlikely that any practical or feasible mitigation measures could be implemented to prevent the rate of erosion to the habitat, and it is probable that the site will disappear in the next 25 years. However, it is recommended that monitoring should continue (ideally at three yearly intervals, but 2 yearly if possible), particularly through the use of photography (aerial and terrestrial) and the series of habitat transects, as this will provide information on rate of change and maybe correlated with weather, storm and tidal events.

Table 5: Red Man Bay Transect, width of good habitat at 5 m intervals (10 m in 2012)

(m) S to N	Width of good habitat (m)		Comments
	June 2012	September 2017	
0	2.5	2.3	Start point boulder has fallen on to beach
5		1.1	Mostly rank in 2017
10	2.5	2.5	Very good habitat remaining
15		0.6	
20	2.7	0.9	Erosion at seaward edge and spread of rank vegetation
25		3.1	
30	4.1	1.7	Erosion at seaward edge and spread of rank vegetation
35		0.8	
40	2.1	0	Erosion at seaward edge and spread of rank vegetation
45		0	Erosion at seaward edge and spread of rank vegetation
50	1.2	0	Erosion at seaward edge and spread of rank vegetation
55		0.7	Erosion at seaward edge and spread of rank vegetation
60	6.3	0	Severe erosion at seaward edge
65		0	
70	0.7	0	
75		0	
80	5.9	1.8	
85		0.6	
90	4	2.5	Some good habitat remaining
95		4.3	Some good habitat remaining
100	4	2.8	Some good habitat remaining
105		2.5	Some good habitat remaining
110	5.8	2.3	Some good habitat remaining
115		1.05	
120	2.6	0.7	
125		0.4	
130	3.2	0	All good habitat gone – merge from shore to rang vegetation
135		0	As above
140	3.2	0	As above
145		0	As above
150	1.5	0	As above

Table 6: Red Man Bay sample sites and numbers of *Vertigo angustior* (*P* = present)

Sample site	Grid reference	No. adult <i>V. angustior</i>	No. juvenile <i>V. angustior</i>	Total No. <i>V. angustior</i>	Density <i>V. angustior</i> m ⁻²
1	NO89200 88749	Present			
2	NO89198 88755	120	67	187	1496
3	NO89191 88766	16	11	27	216
4	NO89192 88768	Present			
5	NO89176 88817	17	10	27	216
6	NO89172 88835	11	4	15	120
7	NO89173 88847	0	0	0	0

Table 7: Red Man Bay Results of molluscan analysis (P = present)

Sample	1	2	3	4	5	6	7
<i>Vertigo angustior</i> (Adult)	P	120	16	P	17	11	0
<i>Vertigo angustior</i> (Juvenile)		67	11		10	4	0
<i>Carychium tridentatum</i>		59	10		9	26	30
<i>Cepaea nemoralis</i>					1	1	
<i>Clausilia bidentata</i>							1
<i>Cochlicopa lubricella</i>		10			2	5	2
<i>Discus rotundatus</i>			6		2	6	2
<i>Euconulus fulvus</i>		7				2	2
<i>Nesovitrea hammonis</i>		9	9		19	23	9
<i>Pupilla muscorum</i>					1		
<i>Punctum pygmaeum</i>		15	46		35	21	44
<i>Vertigo substriata</i>						3	
Total No. of species		6	5		8	9	7
Total No. of snails		287	98		96	102	80



Figure 1.2.2: Red Man Bay site in June 2012 (inset showing main habitat area)



Figure 1.2.2: Red Man Bay site in September 2017

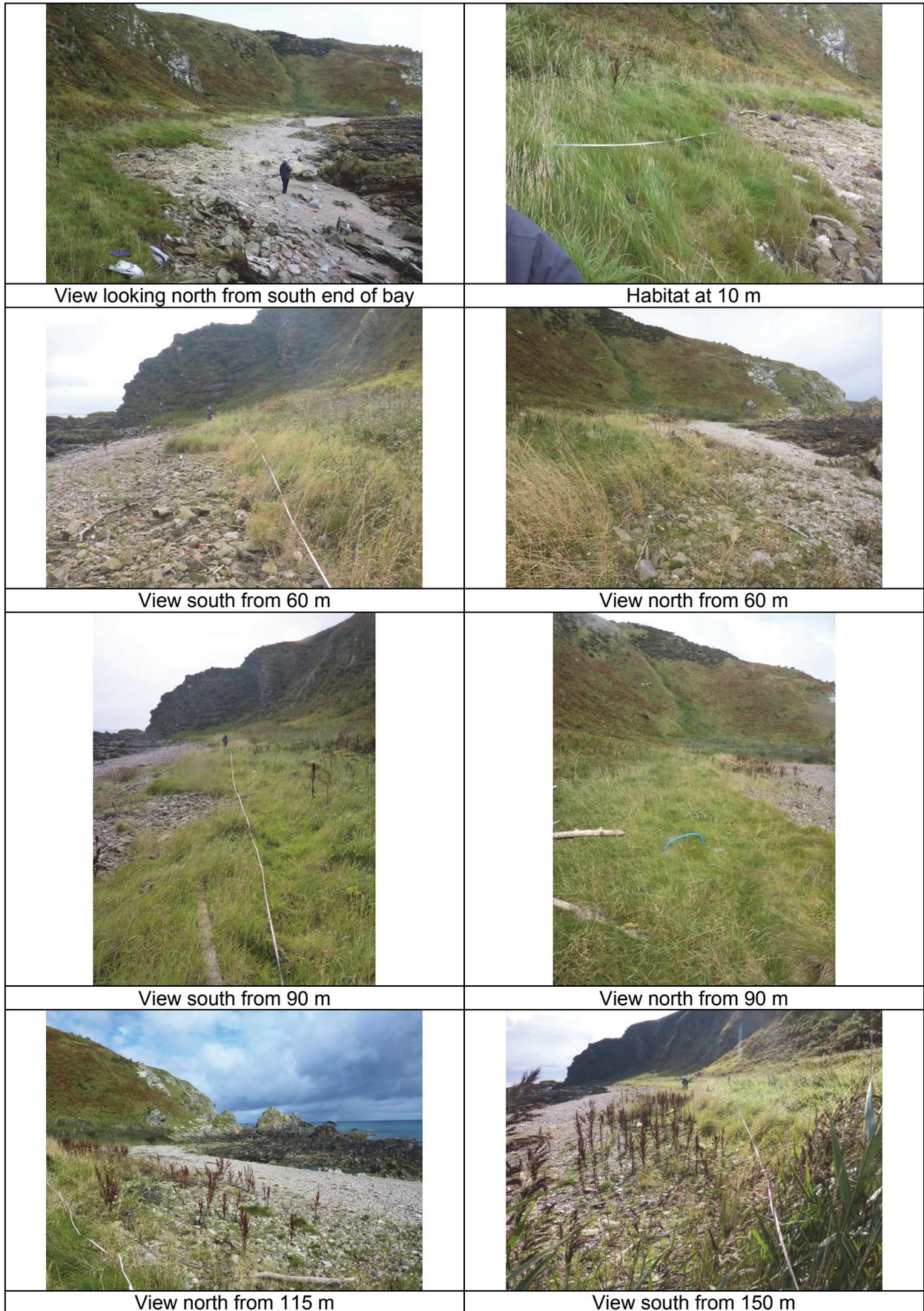


Figure 1.2.3: Photographs Red Man Bay in September 2017

APPENDIX 2: WHITE PORT (SOLWAY COAST KIRKCUDBRIGHTSHIRE)

Vertigo angustior was first confirmed living in Scotland in 1992 by Barry Colville (Colville 1994) at a coastal dune site at White Port on the southern end of Rough Firth on the Solway Firth coast south of Dalbeattie. Dead shells had been reported previously at the site in 1974 by Chris Paul who considered them to be sub-fossil. A further survey of the area by Colville in 1998 (observations cited in Killeen & Colville 2000) re-confirmed *V. angustior* presence but noted that there had been serious erosion of the dune margins resulting in noticeable habitat loss. The first systematic site survey was undertaken in 1999 (Killeen & Colville 2000). 54 samples were taken mostly along a series of transects running inland from the foredunes. Results showed *V. angustior* in 83% of the samples with a mean density of 344 of the snails m⁻². The report noted that, “As a result of erosion of the dune margin and encroachment by scrub, particularly at the southern end of the site, there is little suitable habitat remaining. If erosion continues at its present rate, it is likely that most of the suitable habitat and *V. angustior* population will completely disappear within the next 5 – 10 years”. The report recommended urgent site management action including control of advancing scrub vegetation and the installation of sea defences to prevent further erosion. As well as surveying the White Port site, Killeen and Colville surveyed a further 14 sites along the Solway coast (from Tors Warren running eastwards to Stanhope to Newbie Mains lying east of White Port), but did not locate further populations of the snail.

In 2003 Colville revisited White Port and further confirmed the presence of *V. angustior* across the site (taking 14 samples from 8 evenly spaced transects - unpublished notes taken by B. Colville; R. Marriott personal communication).

A further survey in 2010 (Marriott & Colville 2011) broadly replicated the 1999 and 2003 surveys. This took 18 samples along 6 transects spread out across the site and recovered *V. angustior* in 78% of the samples with mean snail numbers of 582 m⁻² (higher than from the 1999 survey). The report noted that, compared to earlier surveys, the area of habitat occupied by *V. angustior* had considerably reduced due to a combination of seaward advance of scrub vegetation and dune erosion. They state, “BC’s impression was that the erosion had continued inland between that survey (the 2003 visit) and the present one, leading to the conclusion that although the densities of *Vertigo angustior* found in the present survey are higher, the total area occupied by the species is distinctly less”. They also state, “However, if there was a very high tide with a wind from the south east all *Vertigo angustior* below the ‘cliff’ would be lost and there could be further losses from above the ‘cliff’ if it erodes further”.

The White Port *Vertigo angustior* site has no protective designations. Coastal sand dunes. Sand beaches. Machair (formerly ca 100%).



Figure 2.1.1: White Port Bay showing locations of transect survey points (A – F) and one site of additional sampling

Appendix 2.1: The 2017 White Port survey

No live *Vertigo angustior* were found at any of the 6 dune transect sites; only a few dead shells (age unknown) were recovered. The species was also not located from the additional samples taken from (1) the short turf habitat found amongst the rocks at the north-east end of the White Port bay or (2) from short close-grazed turf/upper salt marsh transition zone habitat at Horse Isles Bay.

The cause of *V. angustior* disappearance at White Port is habitat loss; it is estimated that between 8 – 10m of dune habitat beneath the low sand ‘cliff’ has been removed, presumably by one or more south-easterly storm events occurring at some time or times since the last site survey in 2010 (Figure 2.2.2). Observations and predictions of habitat loss by tidal / storm erosion have been a feature in all previous White Port survey reports (see earlier background discussion). Thus in 1999 Killeen and Colville predicted that suitable *V. angustior* would have been lost within 5 – 10 years due to a combination of fore dune erosion combined with the seaward advance of shading scrub on top of the low sand ‘cliff’ at the head of the beach. Marriott and Colville (2010) also noted the loss of habitat at the site and warned that just a single bad storm could cause the total loss of *V. angustior* there.

Killeen and Colville (2000) suggested that sea defences might be considered to protect the dunes from erosion and that grazing be used on the land immediately behind the dunes to prevent scrub advance. No conservation management action appears to have been taken however, to secure the site, which is almost certainly lost as a *V. angustior* location. It is considered unlikely that any tiny residual pockets of *V. angustior* remain at White Port; in the unlikely event that any are still present then these are likely to be removed as a result of further south-easterly storms and the further advance of the hawthorn-dominated scrub now

shading most of the formerly unshaded habitat above the sand 'cliff' at the head of the beach.

An unusual feature of both the transect samples and the addition samples was the virtual absence of any other live Mollusca. Only 5 individuals from 4 species were found in the transect samples and no live snails were found at the additional sites. It is not known why live molluscs are now so rare at the site; has a 'mass-mortality' event been caused by salt-laden sea spray?

Table 8: Summary of White Point transect sampling for the presence of Vertigo angustior (Quantitative quadrat samples from areas of 0.25 m x 0.25 m [0.125m²])*

Sample Site & no. of quadrat samples* taken	Grid reference	No. live adult <i>V. angustior</i>	No. juvenile <i>V. angustior</i>	Total No. <i>V. angustior</i>	Density live <i>V. angustior</i> m⁻²	Dead <i>V. angustior</i> in total quadrat samples
A (x2)	NX 84027 51941	0	0	0	0	1
B (x2)	NX 84010 51929	0	0	0	0	1
C (x3)	NX 84000 51915	0	0	0	0	0
D (x2)	NX 83988 51898	0	0	0	0	4
E (x2)	NX 83979 51884	0	0	0	0	7
F (x2)	NX 83973 518 70	0	0	0	0	3

Table 9: Summary of White Point transect sampling: full molluscan results

Transects:	A		B		C			D		E		F	
Samples:	1	2	1	2	1	2	3	1	2	1	2	1	2
Grid. ref.	NX 84027 51941		NX 84010 51929		NX 84000 51915			NX 83988 51898		NX 83979 51884		NX 83973 51870	
<i>Vertigo angustior</i> (all dead)		x (1)	x (1)					x (4)		x (6)	x (1)	x (1)	x (2)
<i>Acicula fusca</i>									✓		x	x	
<i>Acanthinula aculeata</i>		x	x	x				x		x	x	x	
<i>Aegopinella nitidula</i>		x		x				x				x	
<i>Aegopinella pura</i>		x		x		x		x	✓	x	x	x	
<i>Cepaea hortensis</i>		x											
<i>Cepaea nemoralis</i>	x										x		
<i>Cepaea</i> sp					x								
<i>Carychium minimum</i>		x											
<i>Carychium tridentatum</i>		x	x	x		x		x		x			x
<i>Cochlicopa lubrica</i>							✓		✓	x	x		
<i>Cochlicopa lubricella</i>	x	✓						x				x	
<i>Cochlicopa</i> sp			x	x		x	x	x		x	x		x
<i>Columella aspera</i>					x			x		x			
<i>Clausilia bidentata</i>		x								x	x		
<i>Euconulus fulvus</i>													x
<i>Lauria cylindracea</i>											x	x	
<i>Oxychilus</i> sp										x	x		
<i>Punctum pygmaeum</i>				x			x						
<i>Vallonia costata</i>	x	x	x	x	x		x	x		x	x	x	x
<i>Vertigo pusilla</i>		x											x
<i>Vertigo pygmaea</i>						x							x
<i>Vertigo substriata</i>						x				x	x	x	
<i>Vitrea contracta</i>		x	x	x	x					x	x	x	
<i>Vitrea crystallina</i>				x									
<i>Vitrina pellucida</i>				x									

KEY: x = dead shell; ✓ = live animal

Table 10: Summary of White Point transect sampling: botanical results

Transect: Site:	A		B		C			D		E		F	
	1	2	1	2	1	2	3	1	2	1	2	1	2
Species													
<i>Achillea millefolium</i>				*			*						
<i>Allium scorodoprasum</i>					*	*							
<i>Ammophila arenaria</i>	*		*		*					*			
<i>Arrenatherum elatius</i>										*			
<i>Brachypodium sylvaticum</i>		*		*		*	*	*		*	*		
<i>Carex arenaria</i>				*									
<i>Clinopodium vulgare</i>									*				
<i>Crataegus monogyna</i>							*						*
<i>Cruciata laevipes</i>		*				*			*		*		*
<i>Festuca arenaria</i>												*	
<i>Festuca rubra</i>		*				*	*	*	*				
<i>Fragaria vesca</i>											*		*
<i>Geranium robertianum</i>										*			*
<i>Geranium sanguineum</i>				*									
<i>Leymus arenarius</i>	*												
<i>Linum catharticum</i>							*						
<i>Lotus corniculatus</i>											*		
<i>Mercurialis perennis</i>		*							*				*
<i>Ononis repens</i>	*	*	*	*	*	*			*				
<i>Pimpinella saxifraga</i>						*	*						
<i>Primula vulgaris</i>													*
<i>Prunella vulgaris</i>											*		
<i>Prunus spinosa</i>		*											
<i>Pteridium aquilinum</i>		*	*	*		*	*		*		*		*
<i>Rubus sp</i>									*	*			*
<i>Teucrium scordium</i>										*			
<i>Veronic chamaedrys</i>									*		*		
<i>Viola sp</i>									*				
<i>Rhaphanus raphanistrum</i>								*				*	
<i>Rhytidadelphus squarrosus</i>				*		*							
<i>Moss sp</i>									*				

Table 11: Summary of White Point additional sampling: molluscan results

Samples	1	2	3	4	5	6
Grid reference of sample	NX 84066 51948	NX 84062 51943	NX 84065 51944	NX 84058 51937	NX 84058 51935	NX 84056 51940
Species						
<i>Aegopinella pura</i>			X (2)			
<i>Clausilia bidentata</i>			X (1)	X (2)	X (1)	
<i>Cochlicopa sp</i>			X (1)	X (1)		
<i>Pupilla muscorum</i>				X (12)	X (1)	X (1)
<i>Vallonia costata</i>	X (2)			X (1)	X (1)	
<i>Vallonia excentrica</i>			X (3)	X (3)	X (1)	
<i>Vertigo pygmaea</i>	X (1)			X (1)		X (1)
<i>Vitrea crystallina</i>			X (6)			
<i>Vitrea sp</i>	X (1)					

KEY: X = dead shells (no live snails recorded)

Table 12: White Port additional molluscan sampling: associated plants

<i>Achillea millefolium</i>	<i>Bellis perennis</i>
<i>Carex distans</i>	<i>Carex flacca</i>
<i>Festuca ovina</i>	<i>Festuca rubra</i>
<i>Galium verum</i>	<i>Helianthemum nummularium</i>
<i>Linum catharticum</i>	<i>Lotus corniculatus</i>
<i>Ononis repens</i>	<i>Plantago lanceolata</i>
<i>Plantago maritimum</i>	<i>Thymus polytrichus</i>
<i>Trifolium repens</i>	

Horse Isles Bay additional sampling: molluscan results

1. 5 samples taken at NX 8377 5232: 2 dead *Pupilla muscorum*
2. 5 samples taken at NX 8379 5230 : no molluscs recovered



View 17.09.2010 (dotted line shows approximate position at top of sand 'cliff')

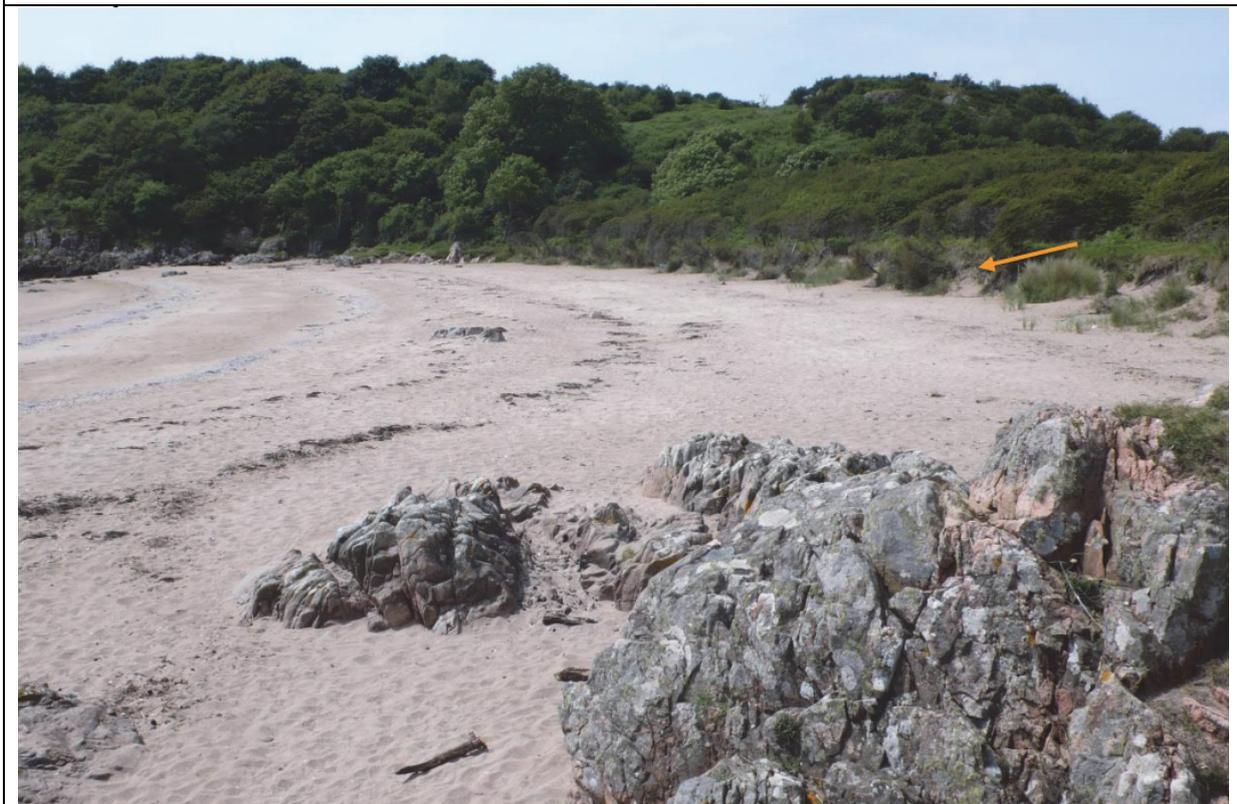


View 20.06.2017 showing loss of between 8 – 10m of dune habitat (dotted line shows approximate position at top of sand 'cliff')

Figure 2.2.2 White Port Bay displaying habitat changes as displayed from fixed point images taken September 2010 & June 2017



View 17.09.2010



View 20.06.2017 showing loss of between 8 – 10m of dune habitat

Figure 2.2.3 White Port Bay White Port Bay displaying habitat changes as displayed from fixed point images taken September 2010 & June 2017

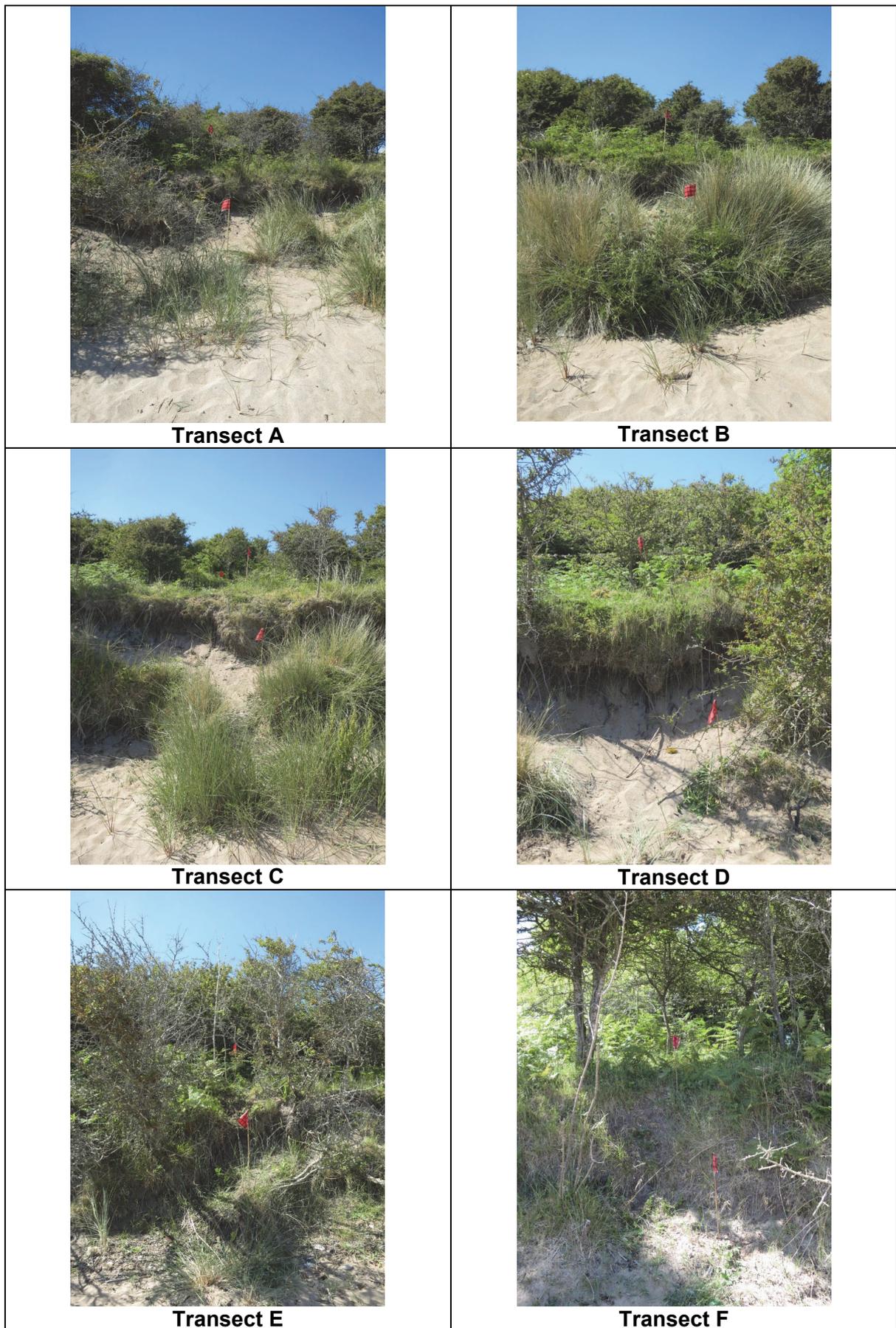


Figure 2.2.4 Images of White Port transect lines taken from shore and looking inland)



Figure 2.2.5 Image of White Port additional sample habitat (amongst rocks at north-east of bay)



Figure 2.2.6 Image of additional sampling at Horse Isles Bay (using 'bulb planter' to remove turf samples)

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