

# DISTRIBUTION AND ECOLOGY OF *VERTIGO ANGSTIOR* JEFFREYS 1830 (GASTROPODA: VERTIGINIDAE) IN AN ESTUARY IN EASTERN ENGLAND

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*Abstract* Important populations of *Vertigo angustior* have been discovered in the Blyth Estuary, Suffolk, England. The habitat for the snail has been created and maintained by the presence of man-made sea walls that spread over more than 30 km. This paper outlines the distribution of the species in the estuary, and its location and microhabitats in the context of the sea wall structures.

*Key words* *Vertigo angustior*, ecology, distribution, Habitats Directive

## INTRODUCTION

In Britain, the narrow-mouthed whorl snail *Vertigo angustior* has a wide distribution ranging from south Wales, Cumbria, Aberdeenshire and White Port on the Solway coast in Scotland. The stronghold in England is East Anglia where it is known from inland sites and maritime sites including some Norfolk and Suffolk estuaries. At its British sites the snail inhabits short vegetation with grasses, mosses and low herbs in damp, grazed meadows, coastal marshes and dunes, maritime turf, and depressions in limestone pavement.

Until 2002, *Vertigo angustior* was known to be living only at 2 sites in the county of Suffolk, at Martlesham Creek and Fritton Marshes (Killeen, 1983, 1992, 1997, 2001). Both of these populations were living in saltmarsh/maritime grassland transition. The species had also been recorded in the 1930s on the River Alde estuary, near the golf club at Aldeburgh (Killeen, 1992). Casual mollusc surveying in 2002 revealed that *Vertigo angustior* was also living in several other Suffolk sites on, and associated with the estuaries of the rivers, Deben, Alde, Blyth and Waveney. In the River Blyth estuary, the *V. angustior* population appeared to be quite extensive and preliminary indications suggested that the estuary complex was one of the most important sites for the species in the UK, or indeed, in Europe. The snail was strongly associated with man-made banks (sea walls) which were built as flood defences, in

a habitat comprising mainly of a few grass species. On the basis of the habitat present at other UK and Irish sites where the species was known, grassy sea walls had not been previously considered as habitat which might support the species, hence it had been overlooked.

There are very few studies to date which have focused on *V. angustior* and its habitat requirements. Sharland (2000) determined the gross distribution, macro-habitat and micro-habitat in which the snail occurs in Whiteford Burrows, South Wales (Sharland, 2000; Cameron, 2003), while Moorkens & Gaynor (2003) carried out a similar study at a coastal site in the West of Ireland.

The Environment Agency (UK) has undertaken a large-scale review of flood defences along the coast of East Anglia, part of which is the Blyth Estuary Strategy. Part of the review includes investigating the feasibility of barrages, reinforcement of existing defences, the flooding of selected areas and managed retreat. The Environment Agency initiated a study of *Vertigo angustior* in the Blyth Estuary area to assist with the evaluation of the flood defence review.

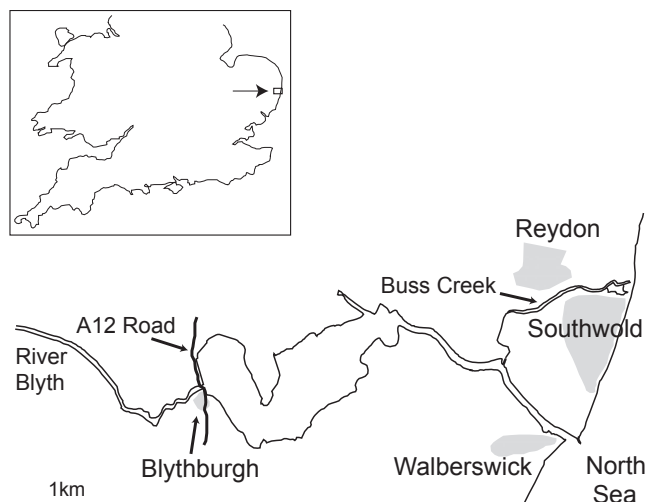
The objectives of this study were to determine the broad distribution of *Vertigo angustior* in the Blyth Estuary area and to elucidate the snail's habitat requirements on a macro and micro scale. This paper describes and discusses the results of this study.

*Vertigo angustior* is believed to be in serious decline throughout its European range (Cameron *et al.*, 2003). It is listed on Annex II of the European Community Habitats & Species Directive, and is

a priority species on the UK Biodiversity Action Plan. In 2007, EU member states reported on the conservation status of their habitats and species under Article 17 of the Habitats & Species Directive (Joint Nature Conservation Committee, 2007). The status of *Vertigo angustior* was reported from the UK as unfavourable-inadequate. This is because the assessment of the long term prospects for the species in their key estuarine habitats indicate that it is not secure, particularly as there is uncertainty over the potential impacts of sea-level rise and the effectiveness of managed coastal retreat. In order to understand the implications of future management strategies on *V. angustior*, it is necessary first to understand the habitat requirements of the snail.

## MATERIALS AND METHODS

*The Blyth Estuary* A feature of the coastline of the counties of Essex and Suffolk in eastern England is the large number of river estuaries with their associated complexes of creeks, salt-marsh and mudflats. Whilst the freshwater rivers themselves are often short, their tidal estuaries are large and extend over several kilometres. The estuary of the River Blyth lies on the Suffolk coast to the west of Southwold (Fig. 1). The River Blyth rises in central Suffolk and flows in a generally north-easterly direction for a distance of 15 km to Blyford. From Blyford to Blythburgh (c. 3 km) the river is canalised in places and is tidal, becoming increasingly saline towards the downstream end. The adjacent grazing marsh and arable fields are protected from flooding by high, man-made banks on either side of the river channel. At the A12 road bridge in Blythburgh the river enters an extensive shallow estuary which covers over 250 ha. A range of natural and semi-natural habitats such as saltmarsh, heathland, reedbed, and man-made banks occur all around the perimeter, and in places they extend out into the estuary. The estuary is channelled again for a further 3 km before entering the sea at Walberswick. Sea walls are present throughout on both sides of the channel. Banks and tidal creeks also protect the towns of Reydon and Southwold. Drainage of the coastal marshes and the associated defences began in earnest in the mid-eighteenth century and most of the current wall complex and associated drainage was complete by the middle of the



**Figure 1** The River Blyth Estuary.

nineteenth century. It is estimated that there is approximately 30 km of more or less continuous sea walls and transition zone habitat in the Blyth estuary complex.

The Blyth estuary complex is recognised as having high conservation value. Parts of the estuary are a Site of Special Scientific Interest (SSSI), a Special Protection Area (SPA) for birds, a candidate Special Area of Conservation (cSAC) and a national and local nature reserve.

*Methodology* This study comprised two phases of survey work. The Phase 1 survey was a very large scale presence/absence survey to determine the general distribution of *V. angustior* in the Blyth Estuary. The Phase 2 survey was carried out to provide more detailed information regarding the exact sub-habitat the snail was located in over a range of 18 selected positive stations (e.g. aspect, height, exposure), and the micro-habitat that the snail was living in on a scale pertaining to its size and day to day living requirements (thickness of thatch and presence of decaying vegetation for example was measured in mm) within the stations.

*Phase 1* The Blyth Estuary complex, including Buss Creek, was divided into sections of broadly similar habitat and these were covered on foot. In order to obtain accurate distributional data, habitat was sampled for *V. angustior* at approximately 100 m intervals. Both the landward-facing and seaward-facing sides of the sea walls were sampled at various heights. In addition, grass-

land adjacent to the walls was sampled along with zones of natural transition from saltmarsh to woodland or heathland.

At each site the following information was recorded: location using GPS; type of habitat (e.g. wall, saltmarsh transition etc); number and location of samples examined; dominant plant species and order of dominance; depth of the thatch; dampness of the thatch; notes on the location of *V. angustior* if present; abundance of *V. angustior* (usually recorded as actual numbers per sample); other mollusc species present; digital photographs.

At each location *V. angustior* was searched for by taking a large handful of litter, dead grasses and 'thatch' from the base of the grasses and shaking it over a 4 mm sieve onto a white plastic tray. The fine residue was inspected for the presence of *V. angustior* and other snails (particularly the locally uncommon *Vertigo pusilla*). If *V. angustior* was not found after 10 samples per station, it was considered to be absent. All snails and other invertebrates were returned to their habitat after examination. No attempt to quantify the *V. angustior* population or to identify the species' precise ecological niche was made during the first phase of the survey. Phase 1 of the survey was carried out between 29<sup>th</sup> August and 7<sup>th</sup> September 2003.

*Phase 2* The locations of the 18 Phase 2 stations were selected on the basis of:

- (i) geographical spread
- (ii) range of habitat type (e.g. sea wall, natural transition)
- (iii) expected vulnerability to management changes either directly or indirectly from flood relief mitigation measures
- (iv) conservation importance

At each site the following information was recorded: location using GPS; details of habitat including height and slope; number and location of samples examined; dominant plant species and order of dominance; depth of the thatch (cm); digital photographs.

The amplitude of the sub-population was determined by investigating the snail's presence in a range of niches (ranging from 5 to 14 different sub-samples). Table 1 shows a typical sampling regime for a sea wall location.

Samples were taken by removing vegetation to the base of the thatch from a 0.2×0.2 m quadrat. The vegetation was dried, passed over a series of

**Table 1** Example of Phase 2 sampling strategy.

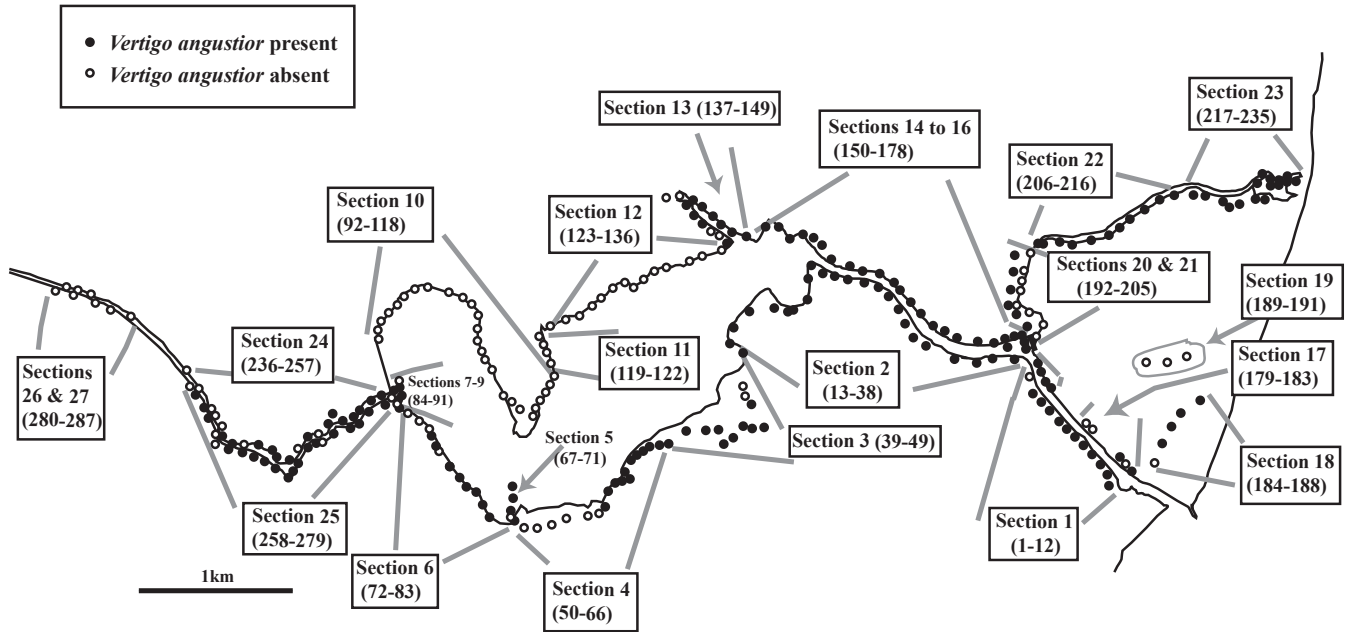
Sample site	Aspect	Sample location
1	Seaward	Saltmarsh transition with flotsam
2	Seaward	Above flotsam zone
3	Seaward	Between flotsam zone and top of wall
4	Top of wall	
5	Landward	Below top of wall
6	Landward	Mid-height of wall
7	Landward	Base of wall
8	Landward	Grassland beyond base of wall
9		+ 5 m to right of most abundant zone
10		+ 10 m to right of most abundant zone
11		+ 5 m to left of most abundant zone
12		+ 10 m to left of most abundant zone

sieves (the lowest being 0.5 mm), and the residue of each sieve was examined under a microscope. Counts were made of adult and juvenile *V. angustior*. All other mollusc species present were identified and counted. Phase 2 of the survey was carried out between and including 28<sup>th</sup> October and 5<sup>th</sup> November 2003.

## RESULTS

*Phase 1* A total of 536 individual samples were taken from 301 separate locations.

*Vertigo angustior* was found to be widespread around the Blyth estuary complex occurring at 185 of the 301 sites (Fig. 2). It was found at most of the sites on the south side of the estuary from Blythburgh to Walberswick. On the north side of the estuary, it was absent from the A12 (Bulcamp) to Wolsey Creek, where there was little suitable habitat. The snail was also found along most of the length of Buss Creek from Botany Marshes to the Southwold coastal carpark, and on the bank at the end of Reydon Marshes (west of Buss Creek). It was also found on the western flanks of Havenbeach Marshes, south of Southwold. Upstream of the A12 roadbridge, *V. angustior* occurred on both banks of the R. Blyth to a point



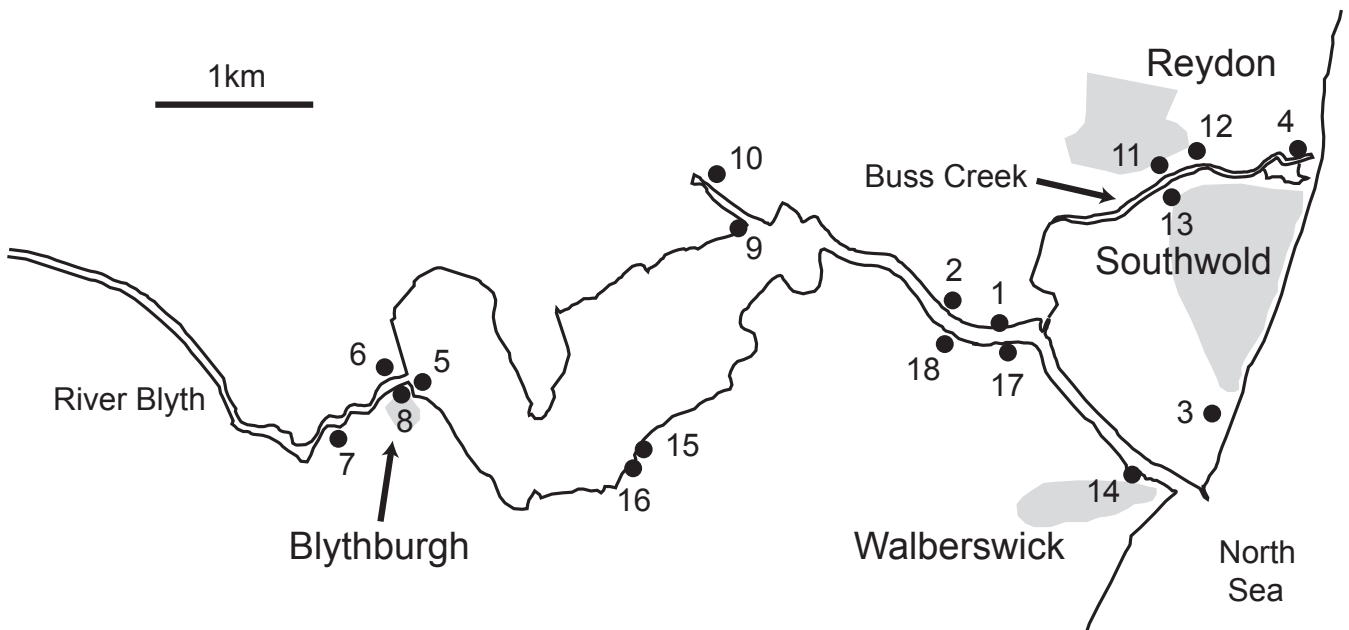
**Figure 2** Phase 1 survey – location of survey sections and *Vertigo angustior* presence/absence.

approximately halfway between the A12 and Blyford Bridge.

*Vertigo angustior* was relatively easy to locate, where present the species was usually found in the first 1 or 2 samples. In spite of the exceptionally dry conditions prior to, and during, the survey, *V. angustior* appeared to be relatively common. As many as 30 individuals were shaken from a single handful of litter at several sites.

**Phase 2** Phase 2 studies were carried out at 18 locations (Fig. 3) which are summarized in Table 2.

There were considerable differences in the location of the species with respect to aspect and altitude on the sea walls. On some walls *V. angustior* was found on both sides, whereas on others it occurred on either the seaward or landward side only. Also, *V. angustior* showed considerable



**Figure 3** Phase 2 sample locations.



**Table 2** Plants associated with *Vertigo angustior* in the Blyth Estuary.

<i>Arrhenatherum elatum</i>	<i>Glaux maritima</i>
<i>Agrostis stolonifera</i>	<i>Glyceria maxima</i>
<i>Atriplex</i> spp.	<i>Holcus lanatus</i>
<i>Beta vulgaris maritima</i>	<i>Halimione portulacoides</i>
<i>Cirsium arvense</i>	<i>Iris pseudacorus</i>
<i>Calystegia sepium</i>	<i>Phragmites australis</i>
<i>Carex riparia</i>	<i>Potentilla anserina</i>
<i>Dactylis glomerata</i>	<i>Pulicaria dysenterica</i>
<i>Elytrigia atherica</i>	<i>Sonchus arvensis</i>
<i>Eupatorium cannabinum</i>	<i>Sonchus palustris</i>
<i>Festuca rubra</i>	<i>Urtica dioica</i>
<i>Galium aparine</i>	

variation in its 'altitudinal zone'. On some walls it occurred near the base (in the tidal floodzone with sea purslane, sea beet and drifts of flotsam), on others it was found near the top, and in some cases, all up the slope. At some locations the snail was present only in grassland adjacent to the walls, and not on the walls themselves. *Vertigo angustior* was also found in the zones of natural transition between saltmarsh and woodland/heathland.

*Vertigo angustior* was found living principally in habitat comprising sea couch *Elytrigia atherica*. On the seaward side of the sea walls *V. angustior*

was found in flotsam with saltmarsh plants including *Halimione portulacoides* and *Beta vulgaris* ssp. *maritima*. It was also found in *Festuca rubra* dominated grassland or stands of *Phragmites australis*, particularly at the base of the slope on the landward side of the walls. In the natural transition zones *V. angustior* was also found amongst litter beneath *Quercus* and *Pteridium aquilinum*, and in patches of *Carex riparia*. A list of the plant associates is given in Table 3. In all of the habitats *V. angustior* was found most often where the thatch layer was damp and at least 5 cm deep. Photographs of a range of *V. angustior* habitats are given in Figs 4 and 5.

Results demonstrating the range that *V. angustior* displays within the estuary are shown in Figs 6 and 7, which give a pictorial representation of the profile of the walls and other habitats investigated in Phase 2 survey work. The total numbers of *V. angustior* counted in each sample are shown from the sample locations along each profile. Numbers per 0.04 m<sup>2</sup> quadrat varied from 0 to 180.

## DISCUSSION

*The Blyth population in context* In order to put the results obtained from this study in context,

**Table 3** Phase 2 survey transects.

Site	Habitat/survey type	No of samples	No of samples with <i>V. angustior</i>	Total No of <i>V. angustior</i>
2	Profile across sea wall bank	14	13	323
3	Profile across sea wall bank	11	11	714
4	Transect across marsh between 2 banks	13	1	1
5	Linear transect from bank, 30 m long	14	12	158
6	Old bank into open estuary	8	7	31
7	Profile across sea wall bank	9	9	88
8	Profile across sea wall bank	9	9	284
9	Linear transect from bank, 40 m long	11	11	463
10	Profile across sea wall bank	9	9	100
11	Profile across sea wall bank	10	6	49
12	Profile across sea wall bank	9	0	0
13	Profile across sea wall bank	6	3	9
14	Profile across sea wall bank	7	2	2
15	Profile across sea wall bank	10	8	135
16	Transect through natural transition zone	9	6	56
17	Transect through natural transition zone	8	7	118
18	Profile across sea wall bank	10	10	64
19	Profile across sea wall bank	5	5	167

(a)



(b)



(c)



**Figure 4** Transition zone habitats: a Wolsey's Creek, west side; b Phase 2, site 8; c Phase 2, site 17.

a very approximate population estimate can be made. If a rough estimate of 25,000 linear metres of habitat exists, and an equally rough estimate of 10 m width of habitat exists, and at a conservative estimate there are 25 individual *Vertigo angustior* specimens per 0.04 m<sup>2</sup> quadrat, then there are at least 156 million individuals living in

the Blyth meta-population. Although numbers of snail individuals in populations fluctuate greatly from year to year depending on weather conditions, this is still likely to be an underestimate. However, based on current evidence, and an estimate of size and value of habitat from this study, the Blyth estuary could be considered to





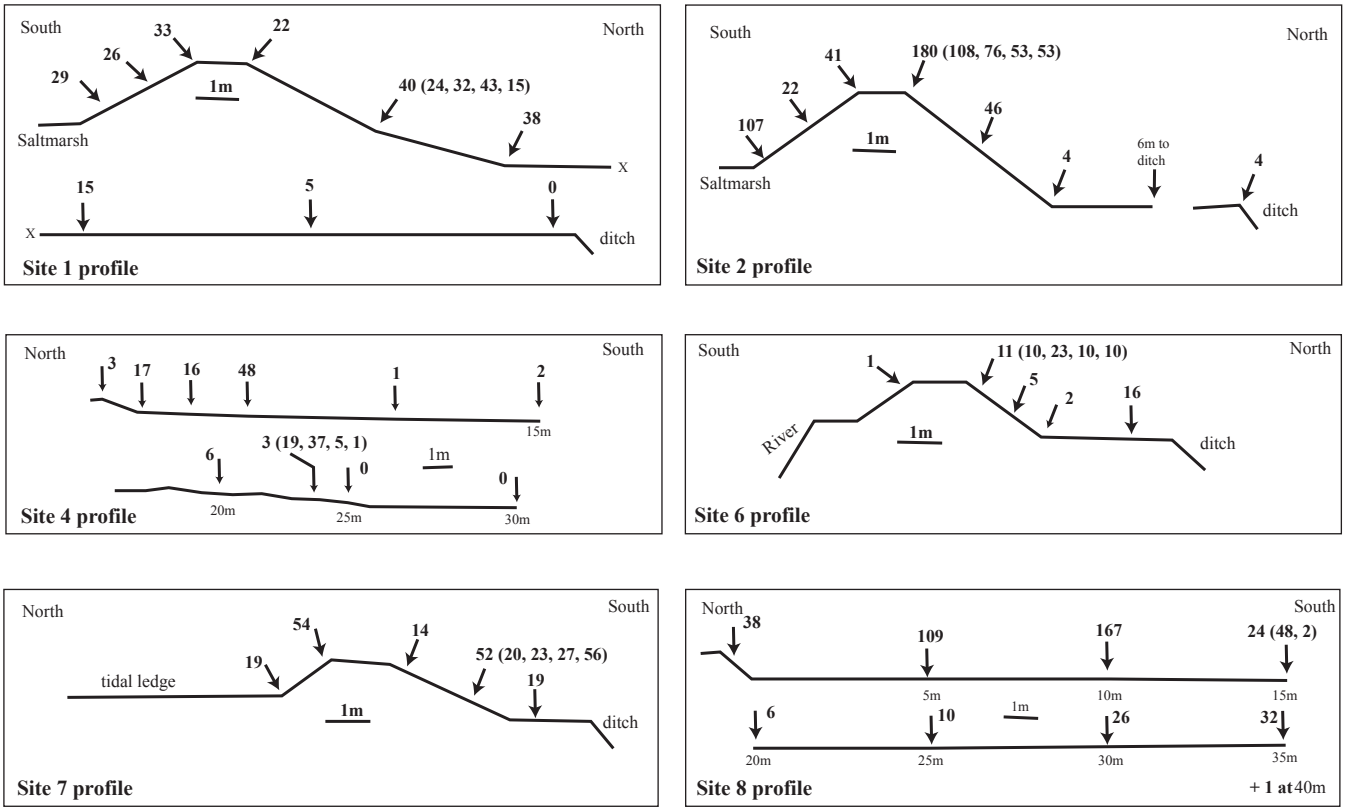
**Figure 5** Sea wall habitats: a Phase 2, site 1; b Phase 2, site 5; c Buss Creek.

be one of the most important single sites in the world for *V. angustior*.

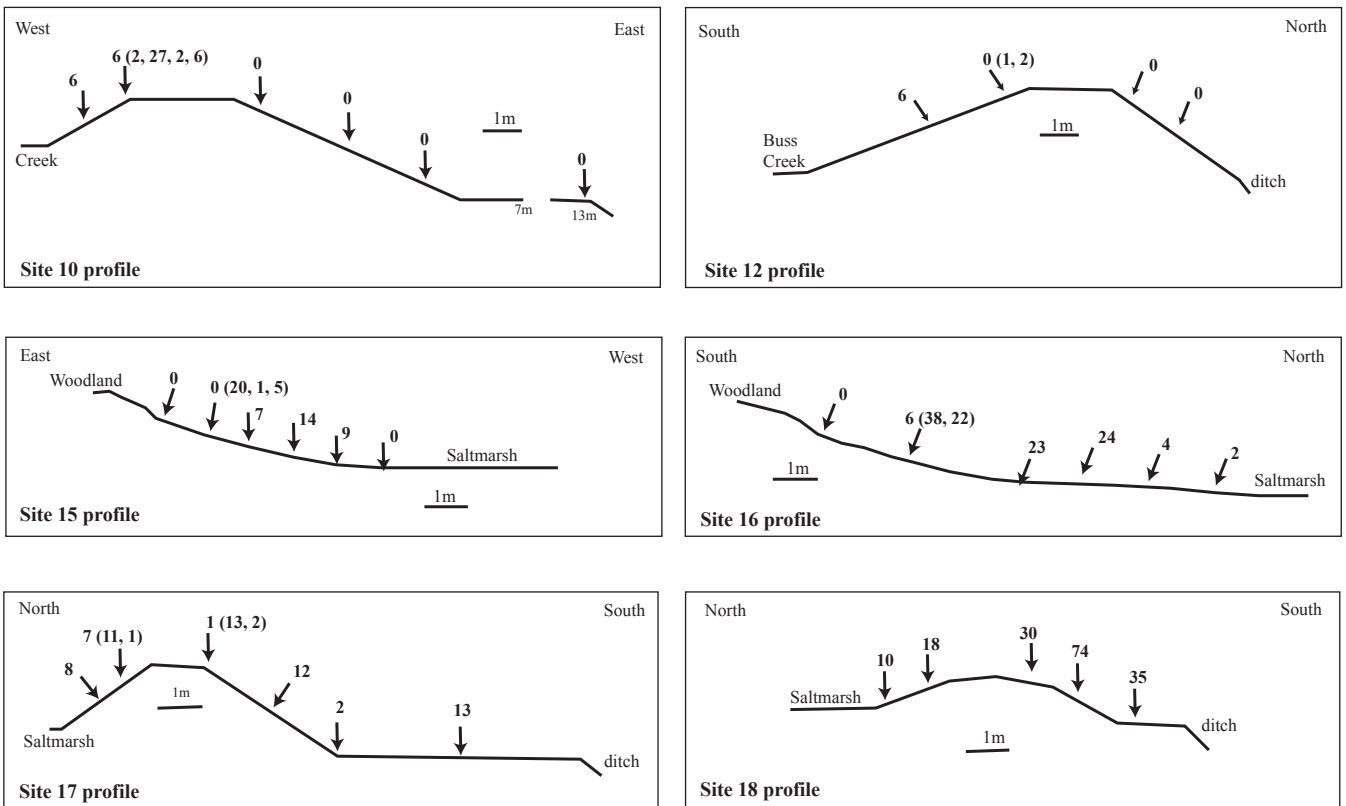
The current study is the largest that has been undertaken for this species. The results confirm the known micro-habitat preference of *V. angustior*: the snail is most abundant in dense narrow-grass habitat with a deep thatch overlying well drained soil within an area with a high water table. While the micro-habitat within which the snail exists is not a surprise, the larger area of sea wall associated with this habitat is surprising, as there is no historical documentation of sea walls as a habitat for this species.

*Vertigo angustior* is a common Holocene fossil throughout Britain. The species thrived after the last glaciation when open, damp grassland habitats were widespread (Kerney, 1999). Its decline is generally associated with the succession of

open habitats to woodland, where the shade favoured a new suite of snail species at the expense of *V. angustior*, which became restricted to the few open habitats, mostly maritime, that remained unforested (Kerney, 1999). The optimum habitat for the snail, as evidenced e.g. at Whiteford Burrows, south Wales (Sharland, 2000) and at Fritton, Suffolk (Killeen, 2001), is a natural, damp transition zone between a lower zone salt marsh, and an upper zone of drier grassland which is unsuitable for *V. angustior*. The few remaining natural transition habitats for this species are now isolated geographically from one another by habitat that is unsuitable for the snail, and therefore there is no longer a possibility of natural local recolonisation of fresh or new habitats. The conclusion can be drawn that either *V. angustior* can colonise new sites from a con-



**Figure 6** Profiles of selected Phase 2 sites showing locations and numbers of *Vertigo angustior*.



**Figure 7** Profiles of selected Phase 2 sites showing locations and numbers of *Vertigo angustior*.



siderable distance, or it has existed in the Blyth area since the early to middle Holocene, and spent many centuries living in a natural transition habitat. When the sea walls were built, they provided, over time, an artificial analogue of this natural habitat, and the snail has thus thrived. *V. angustior* populations have been recorded on other similar sea wall habitats in other estuaries (e.g. in Suffolk personal observations; and in Norfolk, Baker *et al.* 2007). However, the sea walls themselves are not enough to presume the presence of the snail. They have to be of an age and quality to provide the correct micro-habitat, and in addition they must be in the vicinity of a natural transition zone that already hosts the species in order to seed the population. It is unlikely that this is a commonplace occurrence.

*The distribution of Vertigo angustior in the Blyth estuary* The results of Phase 1 indicated that the snail has a widespread distribution in terms of area, although it is often restricted at the local level. Where *V. angustior* was absent from Phase 1 sites, it was generally absent for a considerable distance around. The reasons for its absence from large stretches of the estuary are considered to be five-fold: significant saline influence; over-grazing; woodland encroachment; deep drainage; and flooding from sluice-backup.

The Phase 1 results provide evidence of the importance of the transition zone, and a warning that management practices can eliminate the snail from large tracts of habitat. In the light of these results the Phase 2 survey was designed, with the aim of elucidating the causes of local limitations to snail survival in areas of suitable macro-habitat.

*The factors restricting local distribution of Vertigo angustior in the Blyth estuary* The Phase 2 survey for *Vertigo angustior* in the Blyth Estuary highlighted the importance of this population in world terms, and also the range of habitat characteristics that the snail can tolerate. The Phase 2 results underlined the importance of micro-habitat requirements; anything that interfered with the micro-habitat characteristics already described, i.e. climax maritime narrow-leaved damp grassland with deep thatch, would be detrimental.

The Phase 2 results also showed that there was no requirement for any particular aspect or

exposure level, on both seaward and landward slopes. However, the steepness of the bank and the levels of the bank with regard to potential inundation with salt water, the material used in the sea walls and the ongoing management of the walls were all important for the snail's survival. Age of most recent works was also relevant, but it was clear that the recovery of sub-populations after sea wall works was fast if the material used was suitable for habitat recovery.

*Age of works* The highest numbers of *Vertigo angustior* were associated with sites that had not had recent coastal protection works carried out, i.e. Site 1, at the Southwold windmill, Sites 7 and 8 on the south bank of the River Blyth, Site 18 at Tinker's Marshes, and the natural transition of Sites 15 and 16. However, parts of Site 2 west of the windmill at Reydon Marshes had very good numbers of the snail, in spite of works taking place approximately 5 years before. In Hungary, *V. angustior* colonised relatively new fish pond banks (Hornung *et al.*, 2003), while in Ireland, the species colonised an artificial sand dune after only one year, where the habitat was suitable (Moorkens & Gaynor, 2003). In the Blyth Estuary, apart from specific areas where disturbance continues (such as where a vehicle track has produced a pair of muddy rills through the base of the slope), the maritime vegetation has also recovered well.

*Angle of slope* *Vertigo angustior* has recovered after works where the sea wall slopes have remained gentle, such as at Site 14, Walberswick. However, most of the gently sloping habitat remains in areas that have not been changed substantially over long periods, such as Sites 1, 7, 8 and 18. The snail population is poor where the slopes are steep, which is particularly evident at Site 6 on the north bank of the River Blyth, Site 11 on the north side of Buss Creek, and at Site 13 on the south side of Buss Creek. Gentle slopes leave the most amplitude for optimum *Vertigo angustior* habitat. Steep slopes leave a very narrow transition band and leave a ribbon of *Vertigo* habitat that is vulnerable to weather extremes, particularly desiccation in dry weather.

*Naturalness of Material* It seems reasonable to assume that the early coastal defences in the Blyth Estuary were built up from material

derived locally. The result of these older works is evidenced in a naturalised transition habitat that readily mimics maritime slopes with climax narrow-grass vegetation. Excellent habitat of this kind is found at Sites 1, 2, 7, 8, 15, 16 and 18. Inappropriate material from non-local sources is evidenced at Site 6, where the north bank of the Blyth River has lush weed growth, at Site 11 on the north side of Buss Creek, which is dominated by thistles in places, and at Site 13 on the south side of Buss Creek where the still-evident spoil has a dense weed growth, with *Cirsium arvense*, *Urtica dioica* and *Galium aparine* succeeding to brambles in the margins.

*Management of Sites* Ongoing management also divided the good *V. angustior* sub-sites from the remainder. The best of the sites, and the best areas within each site, were areas where the habitat was well established and of a climax community that was not subject to continuous management. The snail was absent from well worn paths that have been overlain with any reinforcement material from tarmacadam to gravel, or from wear and tear of constant trampling of vegetation, such as in Sites 10 and 14. Where paths are managed for walkers by strimming, *V. angustior* was absent from areas which were strimmed, and also where the cut grass lay. The snail was also absent from rutted vehicular tracks at the base of slopes.

Grazing management also reduces the amount of available *Vertigo* habitat in places, such as Site 10 at Wolsey's Creek, where the short turf creates conditions that are too dry to support a population of the snail. However, naturalised banks on the creek side of Site 10 provides useful habitat that is self-maintaining. Arable and other agricultural practices close to the sea walls can also reduce the amplitude of the snail population, for example at Site 9.

On both sides of the River Blyth upstream of the A12 roadbridge, the tops and upper slopes of the banks are dominated by a tall vigorous form of *Atriplex* which may be a hybrid. This plant appears to have the effect of smothering the grassland habitat which then becomes unsuitable for *V. angustior*.

*Potential for inundation* The results of Phase 1 showed that *Vertigo angustior* was limited, and eventually disappears towards the inland extremes of the estuary, when the maritime influ-

ence promoting climax maritime grassland no longer exists. While the presence of maritime grassland requires a contribution of salt spray and perhaps occasional short-term inundation, it becomes quite clear from the Phase 2 results that *V. angustior* cannot be maintained in low lying slopes and hollows that are inundated by salt water for prolonged periods. Stretches of the transects from Sites 1, 2, 3, 4, 9 and 17 on the landward side of the seawalls are lower than creek level, and in places support vegetation that is best described as salt-marsh rather than maritime grassland. Where the slopes are gentle and the sides are long, there is plenty of alternative habitat for the snail. Loss of habitat would occur if the low lying slopes backed up against steep walls and there was no transition zone to enable a population to be maintained.

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