Survey, habitat and population assessments for *Vertigo geyeri*, *Vertigo moulinsiana*, *Oxyloma sarsi* and *Omphiscola glabra* at selected sites

Maria P. Long & John T. Brophy

An Roinn
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Maria P. Long[1] & John T. Brophy[2]

[1] Newtownshandrum, Charleville, Co. Cork

[2] Botanical, Environmental & Conservation Consultants Ltd, Ground Floor Offices, Loft 31, South Cumberland St., Dublin 2.

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Cover photo: *Vertigo moulinsiana* at Castletown, Co. Waterford (John Brophy)

The NPWS Project Officer for this report was: Dr Brian Nelson; brian.nelson@ahg.gov.ie

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Executive Summary

A number of surveys were carried out between September and November 2012 for four rare mollusc species, *Vertigo geyeri, Vertigo moulinsiana*, *Oxyloma sarsi* and *Omphiscola glabra*. The aims of the surveys were:

- to confirm the presence of the species at the chosen sites;

- to assess the size and range of the population at those sites;

- to document the associated molluscan species, and also the vegetation; and

- to map the habitat areas used by the species, along with categorising their suitability for the species;

Finally, at each site, the conservation status of the species was assessed.

Nine sites were visited – two for *Vertigo geyeri*, four for *Vertigo moulinsiana*, one large composite site for *Oxyloma sarsi* and two for *Omphiscola glabra*. A total of 152 molluscan samples were taken, which resulted in 5,245 individual specimens from 47 mollusc species.

Vertigo geyeri was found, albeit in low numbers, at both survey sites. The habitats recorded at both of these sites appear to be on the edge of the range of tolerance for this species, mainly in relation to the hydrological regimes. The conservation status of the species was assessed as Unfavourable – Bad at both sites.

At all four *Vertigo moulinsiana* sites the data collected during the survey expanded the known range for the species. Favourable conservation status was assigned to two sites, Lough Derg near Portumna and Castletown. The Murrough appears to have a low population size, and was assessed as Unfavourable – Inadequate. The flooding at Strancally was assessed to be impacting negatively on the *Vertigo moulinsiana* population, resulting in a conservation status of Unfavourable – Bad.

Oxyloma sarsi, a species only recently reported from Ireland, was found at seven sites along the River Shannon, between Shannonbridge and Portumna, three of which are new. This species can only be separated from *Oxyloma elegans* by dissection, making population size and range assessments challenging. This species was assessed as having a Favourable conservation status.

One of Ireland's rarest molluscs, *Omphiscola glabra*, was recently found in Co. Waterford, and a population was also reported from Co. Roscommon. This latter record required verification, and examination of the samples revealed an identification error. While detailed information was available on the location of the species in Waterford, it was not re-found during this survey. It was present in 2009 in low numbers, and is known to burrow into soft mud, making it a difficult species to survey for. It was given a conservation assessment result of Unfavourable – Bad.

Few damaging impacts were noted at the study sites, although maintenance of hydrological regime is known to be key to the survival of all of these species at all of these sites. To this end, liaison with land owners and managers, and those involved in activities which might impact on water levels, is seen as one of the key steps which needs to be taken to ensure the continued survival of these species. Monitoring for all four species should be carried out on a three-yearly cycle, and *Omphiscola glabra* should be searched for again in the Waterford site early in 2014 to re-confirm its continued presence there.

Overall, these findings add significantly to our knowledge of the populations, ranges, habitat requirements and associated flora and fauna of the four target species.

Acknowledgements

A number of people contributed their time, expertise and data to this project, and we are very grateful for this.

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Special thanks is due to Roy Anderson. While employed to work on the project for a small number of days, Roy gave generously of his time and expertise beyond this, as always.

Finally, thanks are owed to the landowers who allowed us access to their land for this work, and to NPWS (Brian Nelson in particular) for funding the project.

Introduction

The primary aim of this project was to investigate and report on the occurrence of four rare mollusc species (*Vertigo geyeri, Vertigo moulinsiana, Oxyloma sarsi* and *Omphiscola glabra*) at a list of selected sites. Additionally, population and habitat assessments, and recommendations in terms of management and future monitoring, were required.

Background and Rationale

The non-marine mollusc fauna of Ireland comprises 177 species, with 27 of these being alien species generally restricted to hothouses and aquaria, or recent introductions (Byrne *et al*., 2009).

The four species listed for survey as part of this project have the following status in the recently completed Red List for Irish non-marine molluscs (Byrne *et al.,* 2009):

- *Vertigo geyeri* - VU (Vulnerable)
- *Vertigo moulinsiana* - EN (Endangered)
- *Oxyloma sarsi* - DD (Data Deficient)
- *Omphiscola glabra* - RE (Regionally Extinct)*

*It should be noted that since the location of a population of *Omphiscola glabra* in 2009 (Anderson & McCormack, 2010), it has been recommended that its status is updated to CR (Critically Endangered).

Two of these species, *Vertigo geyeri* and *Vertigo moulinsiana*, are also listed under Annex II of the E.U. Directive on the Conservation of Habitats, Flora and Fauna (92/43/EEC), commonly known as the 'Habitats Directive'. There is an obligation to designate Special Areas of Conservation (SACs) for their conservation and a report on their conservation status must be made to the European Commission every six years under Article 17 of the Directive. *Vertigo moulinsiana* has been assessed as VU on the global (Killeen *et al.* 2012), EU27 and European red lists (Cuttelod *et al*. 2011). *Vertigo geyeri* is LC (Killeen *et al.* 2011) and *Omphiscola glabra* is NT (Prie *et al.* 2011) on the same lists.

The rationale that led to the selection of sites for survey for these four species varied. In the case of *Omphiscola glabra*, the discovery of an extant population in 2009 was a significant development, and prompted the need for a revised assessment of the species. A second site where this species was recently reported from was also included for survey (Porst & Irvine, 2009). Similarly, the recent addition of *Oxyloma sarsi* to the species list for Ireland (Holyoak & Holyoak, 2005; Holyoak, 2006), and its resultant status as 'Data Deficient' in the Red List, meant that data needed to be gathered on the occurrence and status of the species.

In the case of the two *Vertigo geyeri* sites, records existed (Holyoak, 2005) which had not been confirmed in recent surveys. In both cases, recommendations were made to re-visit the sites to

ascertain the presence of the species (Moorkens & Killeen, 2011). For two of the *Vertigo moulinsiana* sites, populations had been confirmed, but details of their range were not, thus necessitating further data gathering. The remaining two *Vertigo moulinsiana* sites were new records, and full surveys and assessments were needed.

Report Format and Conventions

Each of the four species is considered separately in their own chapter. Each chapter includes an overall introduction to the species and the methodologies used during the study, followed by the results and discussion which are presented separately for each site surveyed.

At the end of the report the overall conclusions are presented, and the appendices contain further details of the data collected (e.g. vegetation, habitats, bryophytes, grid references, etc.), along with other relevant information.

Nomenclature for molluscs follows Anderson (2005), vascular plants follows Stace (2010), and bryophytes follows Atherton, Bosanquet & Lawley (2010).

Survey Locations

The locations and dates for the surveys for each of the four target species are listed in Table 1, and cover counties Galway, Mayo, Offaly, Roscommon, Tipperary, Waterford and Wicklow (Figure 1).

Table 1: Locations surveyed for target species in 2012, along with survey dates.

Species	Site name	County(s)	Survey date(s)
Vertigo geyeri	Cooley Lough	Mayo	12 Sep
Vertigo geyeri	Carrowmoreknock	Galway	13t Sep
Vertigo moulinsiana	Lough Derg, near Portumna	Galway/Tipperary	8h, 9th Nov
Vertigo moulinsiana	Castletown	Waterford	15th Oct, 20th Nov
Vertigo moulinsiana	Strancally	Waterford	17th Oct
Vertigo moulinsiana	The Murrough	Wicklow	14th, 15th, 16th Nov
Oxyloma sarsi	Shannonbridge - Portumna	Offaly/Galway/Tipperary	5th, 6th Nov
Omphiscola glabra	Carrickavrantry Reservoir	Waterford	16th Oct
Omphiscola glabra	Brierfield turlough	Roscommon	11th Oct

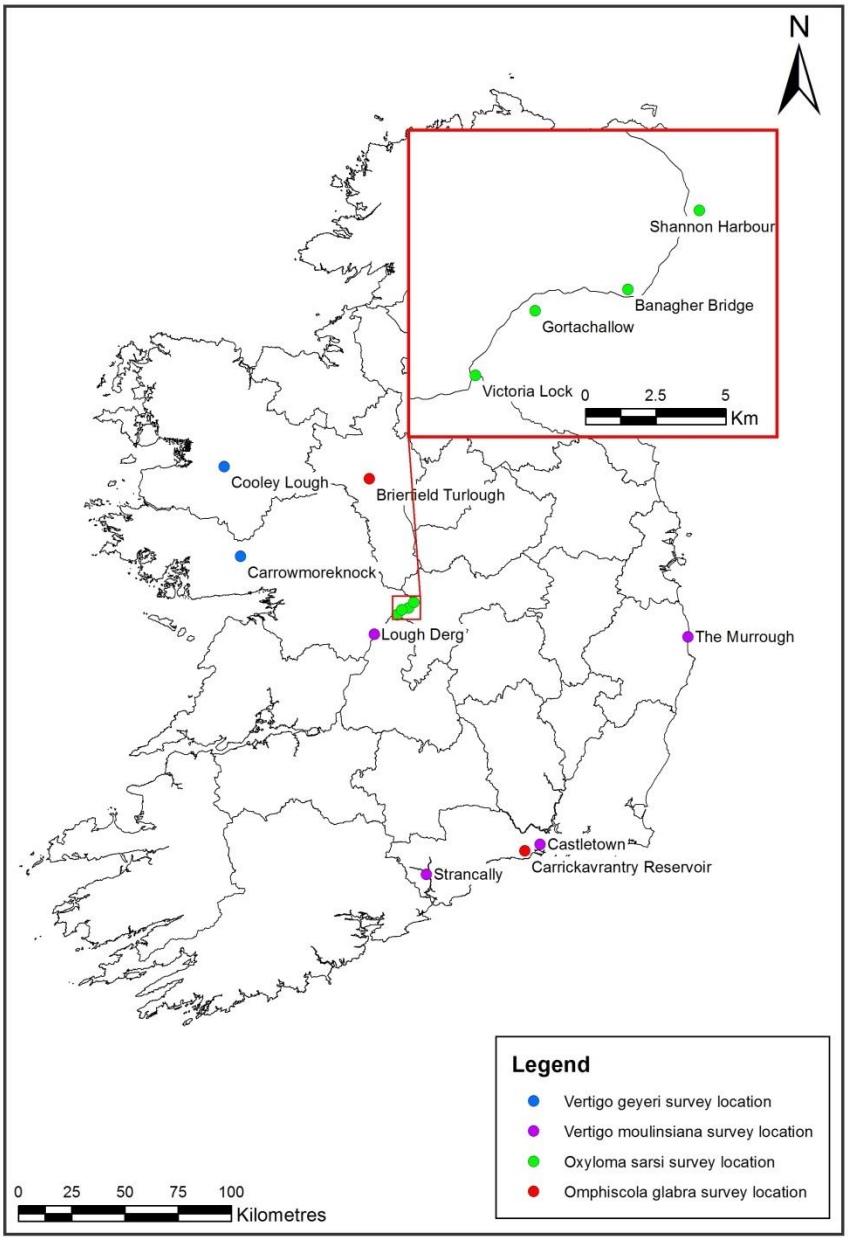

Figure 1: Locations surveyed for target species in 2012

Conservation Assessments

Assessments of the conservation status of listed species are required as part of the E.U. Habitats Directive. Four parameters are assessed – (i) range, (ii) population, (iii) habitat, and (iv) future prospects. Three outcomes are possible: Favourable, Unfavourable – Inadequate and Unfavourable – Bad. Criteria for population, habitat and future prospects can be set and assessed at the site level, range is only assessed at a national level.

Surveys were carried out for *Vertigo geyeri* (22 sites) and *Vertigo moulinsiana* (20 sites) in the period 2008-2010 with the aim of providing detailed data on monitoring and assessment (Moorkens & Killeen, 2011). Following this work, the national conservation status of *Vertigo geyeri* was assessed as

'Unfavourable – Inadequate' due to lack of information, and that of *Vertigo moulinsiana* as 'Unfavourable – Bad', due to habitat loss and the small size and vulnerability of some of its remaining populations. Moorkens & Killeen (2011) also assessed sites individually as part of this study. Sites surveyed for these species as part of the current project either have these assessments revised, or new assessments are carried out, as appropriate. Future prospects are assessed based on the activities noted, taking into account their source, effect and intensity. Reference is made to the list of impacts and guidance provided in Ssymank (2009; 2010) and Ellmauer (2010).

Vertigo geyeri

Introduction

Vertigo geyeri (Geyer's whorl snail) is very small (<2mm high), with a glossy shell with fine, regular growth-lines (Plate 1). It has four simple, peg-like teeth in the mouth or aperture. It is a member of the Family Vertiginidae and is one of three *Vertigo* species found in Ireland which are listed under Annex II of the E.U. Habitats Directive. Detailed information on identifying this species, along with its ecology, has been published (Kerney & Cameron, 1979; Cameron *et al.*, 2003; Cameron, 2003; Moorkens & Killeen 2011), and the information presented below summarises the information found in these sources.

Plate 1: *Vertigo geyeri* (© Roy Anderson)

Vertigo geyeri has very specific habitat requirements. It is found at the bases of small sedges and mosses (often in the decaying leaf matter) in calcareous flushes and fens. The area of habitat which it occupies can sometimes be very small (e.g. isolated hillside flushes, and wet flushed areas of fen by calcareous lakes). This species requires stable hydrological conditions, needing the ground to be

constantly saturated, yet it is not tolerant of flooding. It also requires quite open conditions, so light to moderate grazing levels are generally beneficial, though open conditions may also be maintained due to wetness. Plant species with which it is often associated include the sedges *Carex viridula* subsp. *brachyrrhyncha* and *Schoenus nigricans*, and the brown mosses of strongly calcareous fens and flushes (e.g. *Campylium stellatum*, *Drepanocladus/Scorpidium* spp. and *Palustriella commutata*). Tufa formation is a good indicator for the presence of this species. A degree of small-scale habitat heterogeneity greatly benefits the long-term survival prospects of *Vertigo geyeri* (e.g. small tussocks of *Schoenus nigricans*, small moss hummocks or uneven terrain), as it allows them to shelter or escape in conditions caused by very wet or very dry weather.

Methodology

Field survey

TIMING

Moorkens & Killeen (2011) state that surveying for *Vertigo geyeri* can take place between May and October, but that it is best done in late summer. Cameron *et al.* (2003) suggest surveying between August and October. Based on these recommendations, we surveyed for this species at the earliest opportunity within the timeframe of the project, i.e. early September.

SAMPLING - MOLLUSCS

Due to its tiny size, and also its usual physical location in the habitat (i.e. at the base of decaying sedges or in tufa-encrusted moss clumps), this species is exceptionally difficult to detect in the field when searching by eye. Certainly, failure to locate the snail by searching in the field does not indicate that it is not present at a site. Taking samples for consequent drying and sorting forms the most effective way of sampling a site for this species. This method also allows information on the entire molluscan community, of which *Vertigo geyeri* forms a part, to be gained. Samples (consisting mainly of mosses, sedges, other plants, and litter) were collected and removed from suitable habitat patches. The samples (approx. 3 litres) were labelled and stored in specially designed muslin bags. These were air-dried to prepare them for laboratory processing.

In the field, samples were taken from either (a) spot locations, in suitable habitat patches, or (b) locations along a transect, in sites where transects were deemed appropriate. **Spot sampling** allows confirmation of the occurrence of the species across areas of potentially suitable habitat at a site. **Transect sampling** allows accurate small-scale description of habitat change, if transects are re-

surveyed over time. They are generally established in the best examples of the habitat for *Vertigo geyeri* at the site, and ideally are easily accessible and easy to re-locate.

The locations of all sample points and transects were recorded using a hand-held GPS (Garmin GPS72H) and digital photographs were taken. The degree of wetness was recorded at each sampling location using the following definitions:

(i) too wet (inundated),
(ii) optimal wetness (saturated, water visibly rising following hand or foot pressure), and
(iii) too dry (water not visibly rising following hand or foot pressure) (from Moorkens & Killeen, 2011).

Notes on ownership, threats and management, including grazing level, were also made.

At both of the *Vertigo geyeri* sites in this project, Carrowmoreknock and Cooley Lough, all areas visited in the previous survey by Moorkens & Killeen (2011) were surveyed again.

At each site, areas containing potentially suitable habitat for *Vertigo geyeri* were mapped as **polygons**, with these being assigned to either 'optimal', 'sub-optimal' or 'unsuitable' categories. Where possible, obvious physical boundaries were chosen for the polygons (e.g. fences, paths), but often it was necessary to use boundaries between habitat types to delineate them. Moorkens and Killeen (2011) give a broad definition of the habitat suitability categories for *Vertigo geyeri* and these are reproduced in Appendix I. They also developed site-specific definitions for Cooley Lough (see Appendix I). This was not done for Carrowmoreknock due to the fact that they did not find the species, and also because the habitat was deemed largely unsuitable.

SAMPLING - VEGETATION

In addition to taking samples for molluscan analysis, full details of the vegetation (vascular plants and bryophytes) were also recorded. A species list, with percentage cover for each species, was generated for a 5x5m area around each sampling point. Other relevant ecological details recorded included:

- Percentage cover of
    - bare soil
    - bare rock
    - open water
    - litter
    - bryophytes
    - field layer
    - broadleaf herbs

- Vegetation height - average, maximum and minimum
- Slope
- Aspect
- Habitat type, following three schemes:
    - Fossitt (2000)
    - NVC category (Rodwell, 1991; 1992; 1995)
    - E.U. Habitats Directive Annex I habitat type (Anon. 2007; Anon. 2008), if applicable.

Laboratory work

Molluscan samples were air-dried by spreading them out in newspaper-lined cardboard boxes in a warm, ventilated room. The newspaper was changed and the samples turned frequently to aid drying. Once dry, the samples were transferred to labelled Ziploc bags for later sorting and analysis.

To aid the process of sorting and identification samples were passed through a series of sieves (mesh sizes: 0.5mm, 1mm and 5mm). Material that passed through the 0.5mm sieve was discarded, while the remaining fractions were processed. Samples were emptied into shallow white trays and searched for molluscs under good light. All molluscs found were transferred to labelled glass jars for later identification and enumeration. Mollusc species were identified using Cameron (2003) and Kerney & Cameron (1979) for terrestrial and wetland species, and Macan (1977) for aquatic species. All specimens were assigned as either adult (a), juvenile (j) or dead (d). Dead signifies specimens which were clearly long-dead.

Results and Discussion – Cooley Lough

Results

GENERAL

The survey for *Vertigo geyeri* at Cooley Lough, Co. Mayo was carried out on September 12 2012. The first map in Appendix II shows the locations of sampling points at the site, and Table A1 in Appendix III gives the grid references for these sampling points.

This site is a small calcareous lake located by the N84 road, approximately 8km south of Castlebar in Co. Mayo, near the village of Ballyhean. The site does not have a nature conservation designation. The lake is fringed with reedbeds and stands of tall sedges, along with areas of wet grassland, scrub and fen.

PREVIOUS RECORDS

There is a record of *Vertigo geyeri* at this site on May 27 2003 by Geraldine Holyoak (Holyoak, 2005). Three voucher specimens were retained, and are held in G. Holyoak's private collection. The record states:

> "This is a small marl lough with a calcareous flush with low vegetation (M10) rich in *Carex* sedges on its shore. A low flush grades to tall *S. nigricans* dominated fen (M13), which covers most of the shore of the lough. *Vertigo geyeri* was found at the base of low *Carex* and also at the base of *S. nigricans* tussocks forming the taller vegetation."

The site was subsequently visited (May 26 2010) as part of a larger survey on monitoring and condition assessment of populations of three *Vertigo* species (Moorkens & Killeen, 2011). The species was not re-found at the site during that survey. The conservation status of the species at the site was assessed as 'Unfavourable – Bad' due to the fact that the snail was not recorded, and also due to the lack of optimal habitat. Moorkens & Killeen (2011) report that the area of potentially suitable habitat (as outlined in Holyoak, 2005) may have contracted considerably or deteriorated in quality, or that the record may have been an error or contamination. They point to a floodline of debris being visible high on the shore of the lake as an indicator of the unsuitability of the habitat for *Vertigo geyeri*. They concluded by recommending one further survey for the species at the site.

VEGETATION AND HABITAT

The plant species recorded at the sample locations are given in Appendix IV, Table A1, and the bryophytes in Appendix V, Table A1. Appendix VI shows how the sample numbers in this survey relate to those of Moorkens & Killeen (2011). Information on habitat and vegetation type; cover of elements such as bare soil, open water, litter; and a number of other variables, including vegetation height, slope and aspect are presented in Appendix VI (Table A1). The number of vascular plant species recorded at individual sample locations ranged from 16 to 25, with a total number of 52 species across all 10 samples. There were 10 species of bryophyte recorded. Species of interest, or with restricted distributions in Ireland, include: *Chara* sp., *Cladium mariscus, Epipactis palustris, Samolus valerandi, Selaginella selaginoides* and *Utricularia intermedia*.

All samples were recorded in areas which were classified as PF1 rich fen and flush, according to Fossitt, (2000). The areas of calcareous fen were generally small, and they graded into either FS1 (reed and large sedge swamp) or grassland, or were adjacent to FL3 (limestone/marl lake). Habitats found adjacent to the study site include: hedgerows (WL1), improved grassland (GA1), neutral grassland (GS1), scrub (WS1) and semi-improved wet grassland (GSi4).

All plots corresponded to the NVC community M10 *Carex dioica-Pinguicula vulgaris* mire, and most conformed with the M10 *Briza media-Primula farinosa* sub-community. It should be noted, however, that these areas often graded into M13 *Schoenus nigricans-Juncus subnodulosus* mire, where *Schoenus* became more common and prominent. All areas of PF1 correspond with the E.U. Annex I habitat type Alkaline fen (7230).

TRANSECT

The transect set up by Moorkens and Killeen (2011) was re-surveyed. Few changes were observed in either the extent or the nature of the habitat. Some additional notes on species occurrences were added, and these can be seen in Figure A1 in Appendix VII. (For full details on original transect, refer to Moorkens & Killeen, 2011).

POLYGONS

The habitat polygons remain broadly the same as those recorded by Moorkens & Killeen (2011). One small new polygon was added at the east of the site, however, as potentially suitable habitat was found here, and this was close to the location of the Holyoak sample (Holyoak, 2005). Additionally, in a number of areas the shape of the polygons was altered a little to better indicate the extent and occurrence of PF1 (rich fen and flush). All polygons were deemed to be sub-optimal in terms of habitat suitability for *Vertigo geyeri* in this survey, whereas two areas were classed as 'sub-optimal and unsuitable' by Moorkens & Killeen (2011). Assignment to these categories was based on vegetation composition, vegetation structure and wetness, and reference was made to the definitions given in Moorkens & Killeen (2011) (Appendix I). A table listing all polygons from this survey is given in Appendix VII.

MOLLUSCS

A total of 21 mollusc species, with 782 individuals overall, were recorded from the 10 samples at Cooley Lough (Table 4). A single specimen of *Vertigo geyeri* was found, in sample 8. This specimen has been seen, and its identity verified, by mollusc experts Dr Roy Anderson and Dr Evelyn Moorkens. It has been lodged as a voucher specimen with the National Museum, Dublin.

Unsurprisingly, the suite of species recorded are strongly indicative of wetland conditions (most common species: *Galba truncatula, Oxyloma elegans* and *Zonitoides nitidus*), with fewer truly aquatic species (*Pisidium* sp., *Lymnaea palustris* and *Potamopyrgus antipodarum* were only moderately common), and relatively few terrestrial species (e.g. *Nesovitrea hammonis*).

Other species of note include three which are listed as Vulnerable (VU) in the Irish Red List for non-marine molluscs (Byrne *et al.*, 2009) (Table 3).

Table 3. Species from Cooley Lough which are listed in the Irish Red List (Byrne *et al.*, 2009).

Species	Status*	Positive samples	No. individuals
Aplexa hypnorum	VU	5, 9	3
Vallonia pulchella	VU	1-8, 10	39
Vertigo antivertigo	VU	1-5, 7, 8, 10	24

*VU = Vulnerable

Table 4: Mollusc species (including *Pisidium* sp. that was idendified to genus) recorded from Cooley Lough. (a - adult, j – juvenile, d – dead).

Sample no.: (Transect station no.:)		**S1**	**S2**	**S3 (T1)**	**S4 (T2)**	**S5 (T3)**	**S6**	**S7**	**S8**	**S9**	**S10**	**Total for site:**
Aplexa hypnorum	a									1		1
Aplexa hypnorum	j					1				1		2
Bathyomphalus contortus	j	1										1
Bathyomphalus contortus	d								1	1		2
Bithynia tentaculata	j							2				2
Bithynia tentaculata	d							5				5
Carychium minimum	a		14	8	16			1		1		40
Carychium minimum	j		2									2
Carychium minimum	d		2			2						4
Carychium tridentatum	a	1										1
Cepaea nemoralis	a	1										1
Cepaea sp.	j	2	1						1			4
Cochlicopa lubrica	a	2	1									3
Cochlicopa lubrica	d					2			1		2	5
Cochlicopa lubricella	a				1							1
Cochlicopa sp.	j	2	4		1							7
Cochlicopa sp.	d										1	1
Euconulus alderi	a	3	3			1				1	1	9
Euconulus alderi	j	7	10					1			3	21
Euconulus alderi	d	7						2	1			10
Galba truncatula	a		1						4	1	1	7
Galba truncatula	j	1	2	20	14	5		3	13	25	16	99
Galba truncatula	d	2	4	5	2	3		4	6	8	9	43
Lymnaea palustris	j			15	9	3				2	12	41
Lymnaea palustris	d			1	2	4	2			1	3	13
Nesovitrea hammonis	a	7	7		1			1	2	1		19
Nesovitrea hammonis	j	3	19		1					2	1	26
Nesovitrea hammonis	d	6	6		2			2	1	1		18
Oxyloma elegans	a				2	1	1	1	1			6
Oxyloma elegans	d	1	10	8	4	8	2	14	8	4	11	70
Oxyloma elegans	j			16	18	13	5	5	7	4	5	73
Pisidium sp.		1	6	3	1	6	1	1	19	40	4	82
Potamopyrgus antipodarum	a	1		1				2				4
Potamopyrgus antipodarum	j			1		2		1				4
Potamopyrgus antipodarum	d				2	13		2			1	18
Punctum pygmaeum	d	1				1						2
Succinea putris	j			2								2
Succinea putris	d			2	2	1						5
Vallonia pulchella	a	4	1	3	1	1			2		1	13
Vallonia pulchella	j	2	2	1	1		2	2	3		2	15
Vallonia pulchella	d	1		4		1	1		2		2	11
Vertigo antivertigo	a	2	4	4	2							12
Vertigo antivertigo	j	1		1		1						3
Vertigo antivertigo	d			2	3			1	1		2	9
Vertigo geyeri	a								1			1
Zonitoides nitidus	a	2	1		1				1			5
Zonitoides nitidus	j	3	8	1	3	2	2	6	1	4	10	40
Zonitoides nitidus	d	3			2			8	3	1	2	19
Total for sample:		67	108	98	91	71	16	64	79	99	89	**782**
Wetness*:		ii	ii	i	ii	i	ii	i-ii	i	i	ii	

*Wetness: (i) too wet, (ii) optimal wetness, (iii) too dry.

MANAGEMENT, OWNERSHIP, THREATS

There are multiple private owners (approximately seven) at this site. Management appears to consist largely of grazing. While grazing animals were not observed during the site visit, it is likely that both horses and cattle graze the area. Grazing levels were assessed as 'low' throughout most of the site, with some areas lacking evidence of any grazing activity.

A local man mentioned that the water level had been lowered in the past by the OPW, though he was not certain of when this had occurred. This is perhaps the largest potential threat in terms of the suitability of this site for *Vertigo geyeri* as any changes in water levels could quickly result in the loss of suitable habitat.

CONSERVATION ASSESSMENT

Information presented in this section utilises the conservation assessment criteria developed by Moorkens & Killeen (2011) for the site.

POPULATION ASSESSMENT

Indicator	Target	Result	Pass/Fail
Presence/absence (Transect)	• Adult or sub-adult snails are present in samples on the transect (minimum 3 samples)	*Vertigo geyeri* not found	Fail
Presence/absence (Site level)	• Adult or sub-adult snails are present in at least one other place with potential habitat (minimum 3 samples)	*Vertigo geyeri* found in one sample at site	Fail
2 passes = Favourable; 1 pass = Unfavourable - Inadequate; 0 passes = Unfavourable - Bad.			

HABITAT ASSESSMENT

Indicator	Target	Result	Pass/Fail
Habitat extent (Transect)	• At least one habitat zone on the transect is classed as optimal **And** • 30m of habitat along the transect is classed as sub-optimal or optimal	No optimal habitat 31m of sub-optimal	Fail
Habitat quality (Transect)	• Soils, at time of sampling, are saturated (optimal wetness) for 30m along the transect	Much of transect too wet	Fail
Habitat extent (Site level)	• At least 0.5ha of the most suitable habitat includes some areas classed as optimal	0ha classed as optimal	Fail
3 passes = Favourable; 2 passes = Unfavourable - Inadequate; 0-1 passes = Unfavourable - Bad.			

FUTURE PROSPECTS ASSESSMENT

Impact code	Impact	Source	Influence	Intensity	Area affected (%)
A04.02	Non-intensive grazing	Inside	Positive	Medium	100%
J02	Human induced changes in hydraulic conditions	Inside	Neutral	High	100%

Future prospects have been assessed by listing all activities/impacts noted to be occurring at the site. Their source, influence, intensity and the area likely to be affected were all considered. Grazing has a positive impact, by maintaining open vegetation. The water level control by OPW has been assessed as having a neutral influence, but this is a tentative assessment due to lack of detailed information in relation to the water management at the site. Also, any further water level changes, particularly if levels were to fluctuate, or rise, could be detrimental. Due to the uncertainty pertaining to the latter impact, the future prospects for the species at the site are assessed as Unfavourable - Inadequate.

OVERALL ASSESSMENT

The overall conservation assessment at Cooley Lough is determined by results in each of the categories: population, habitat and future prospects. The population is clearly very small at this site, with one single specimen found during this survey, and none by Moorkens & Killeen (2011). None of the habitat polygons were classed as optimal for the species, though substantial areas of habitat were classed as sub-optimal. Future prospects were assessed as Favourable, based on the activities noted at the site. Therefore the overall assessment is deemed to be Unfavourable - Bad.

Attribute	**Assessment**
Population	Unfavourable – Bad
Habitat	Unfavourable – Bad
Future Prospects	Unfavourable – Inadequate
Overall	**Unfavourable – Bad**

Discussion

The finding of *Vertigo geyeri* at this site in this survey is significant, particularly given the fact that it was not recorded from there in 2010 (Moorkens & Killeen, 2011). Given that *Vertigo geyeri* has now been recorded twice at this site, its status can be considered confirmed.

The 2010 survey (Moorkens & Killeen, 2011) took place after a long period with little rain, and so the species, if present, may have had a diminished population, and/or individuals may have been sheltering deep in vegetation, and thus been more difficult than usual to sample. Additionally, the occurrence of a floodline of debris high up on the shore in that year, indicating wide fluctuations in hydrology, may be further explanation for the failure to find the species then.

Given that Holyoak (2005) reported finding multiple specimens, and that the current survey found just one, and Moorkens & Killeen (2011) did not find it, there is a possibility that the population at the site fluctuates, or that conditions are deteriorating in terms of suitability for the species. The vegetation description given by Holyoak suggests a short, open, fen vegetation, whereas the current survey recorded high cover of *Phragmites* in many areas, albeit with fen vegetation in the understorey in places.

FUTURE MANAGEMENT AND MONITORING

Moorkens & Killeen (2011) recommended monitoring at three-yearly intervals, and thus this site should be surveyed again in 2015. The species is clearly not common at Cooley Lough, and so samples should be taken more intensively to gain a fuller understanding of the occurrence of the species across the site. To this end, it is recommended to discontinue the transect survey, in favour of additional spot samples.

The site is currently grazed in places, and this management is deemed appropriate. The main issue which may threaten the survival of this species at the site into the future is change in water level/flooding. Liaison with OPW staff to ascertain what, if any, water level management they carry out, or have planned, would be very useful.

A number of other issues may need to be monitored in the future. These include the risk of run-off of fertiliser, slurry, pesticide and any other agricultural additions. Roadworks, including storage of materials, were taking place close to the site at the time of the survey. While unlikely to directly impinge on the ecological integrity of the site at their current scale of works, the effects also need to be monitored. As these latter two issues are not currently threatening the integrity of the site, they were not included in the assessments.

Cooley Lough does not appear to hold a large population of *Vertigo geyeri*. The site does not have a nature conservation designation, in spite of holding a population of an Annex II species, as well as an Annex I habitat (Alkaline fen). There are other sites for both of these features in the geographic area, but nonetheless, this site should become a focus for future survey, monitoring, and particularly, landowner/manager liaison in terms of land and water management.

Results and Discussion – Carrowmoreknock

Results

GENERAL

The survey for *Vertigo geyeri* at Carrowmoreknock, Co. Galway was carried out on September 13 2012. The second and third maps in Appendix II shows the locations of sampling points at the site, and Table A2 in Appendix III gives the grid references for these sampling points. In an attempt to locate other possible sites for the species at Carrowmoreknock, a number of nearby areas which had potential to hold suitable habitat patches were visited. On closer inspection all failed to fulfil the needs of the species (e.g. too wet, too dry, etc.).

The site at Carrowmoreknock is located about 10km east of Oughterard in Co. Galway, close to the western shore of Lough Corrib. The area surveyed is not designated, but cSAC (001271) Gortnandarragh Limestone Pavement is nearby (<1km away).

The landscape at Carrowmoreknock is unusual, with limestone rock outcropping in an otherwise peaty terrain. The mix of acid and calcareous influences are visible in the flora – typical blanket bog vegetation (e.g. *Calluna vulgaris, Erica tetralix, Drosera rotundifolia, Sphagnum* spp., etc.) is interspersed with areas with a clear calcareous influence (with vegetation such as *Schoenus nigricans*, *Carex lepidocarpa*, *Juncus subnodulosus,* and the brown mosses of calcareous fens). The areas surveyed for *Vertigo geyeri* consisted of small calcareous patches within larger areas of acid bog (lowland blanket bog, heavily grazed). Some of the habitat patches consisted of drains or small pools, but others were in areas which may have been cut for turf in the past. Yet other areas were on the peat surface, but had a clear calcareous influence, presumably from upwelling groundwater.

PREVIOUS RECORDS

There is a record of *Vertigo geyeri* from 2004 from this site (Holyoak, 2005). The habitat is noted as a "small sedge-rich fen (M10)", and *Vertigo geyeri* are described as being "fairly common, occurring at the base of small sedges".

This site was surveyed by Moorkens & Killeen (2011), but the species was not re-found. Due to the paucity of suitable habitat at the site, and the fact that the occurrence of the species was not confirmed, the conservation status of the species at the site was deemed to be 'Unfavourable – Bad', and no targets were set (for population or habitat). One further survey at the site was recommended to attempt to confirm the species presence. Moorkens & Killeen suggest that there may have been habitat changes at the site since the species was recorded there in 2004, or perhaps that there had originally been contamination of sampling equipment. They also suggest the possibility that there may have been confusion over the identification and separation of *Vertigo geyeri* and the very similar *Vertigo pygmaea* (specifically, the fen/wetland form of this species).

VEGETATION AND HABITAT

Tables A2 in Appendices IV and V respectively, provide information on the plant and bryophyte species recorded from the samples at Carrowmoreknock, along with details such as habitat and vegetation type, and cover of elements such as bare soil, open water, litter; and a number of other variables, including vegetation height, slope and aspect. A total of 43 vascular plant species were recorded at the site, and 14 bryophyte species. Species of note include the uncommon mosses *Calliergon giganteum* and *Pseudocalliergon lycopodioides*. Table A2 in Appendix VI gives details of how the sample numbers in this survey relate to those of Moorkens & Killeen (2011).

The habitats at Carrowmoreknock were sometimes challenging to classify, as outlined in the introduction, but all samples except one were taken in areas which corresponded to PF1 (rich fen and flush) of Fossitt (2000). However, these were often small in extent and embedded in a wider acid bog habitat. One sample was classified as PF3 (transition mire and quaking bog). Adjacent habitat types included calcareous and neutral grassland (GS1), scrub (WS1), buildings and artificial surfaces (BL3), limestone/marl lakes (FL3), lowland blanket bog (PB3), dry meadows and grassy verges (GS2) and wet grassland (GS4).

All samples were taken in areas which were classified as either M10 (*Carex dioica-Pinguicula vulgaris* mire) or M13 (*Schoenus nigricans-Juncus subnodulosus* mire), both of which are closely related rich fen vegetation types, according to the Rodwell classification scheme (1991). No area was deemed to be of E.U. Habitats Directive Annex I quality.

TRANSECT

The site at Carrowmoreknock contained of small, isolated habitat/vegetation patches (in terms of suitability for *Vertigo geyeri*), and so it is not suitable for transect monitoring.

POLYGONS

A number of changes were made to the polygons originally mapped by Moorkens & Killeen (2011). This includes some minor realignment of the boundary lines to better indicate the extent and occurrence of suitable habitat patches, along with the following larger changes:

- Polygon B was decreased in size from that mapped by Moorkens & Killeen as the area which could possibly support *Vertigo geyeri* was very limited in extent, and consisted of slumps and drains in an acid bog.
- Polygon 'C' of Moorkens & Killeen was not re-surveyed due to lack of suitable habitat (vegetation types found: GS4, GS1). Another area nearby was sampled instead (consisting of PF3), and labeled polygon 'C'.
- Polygon 'D' of Moorkens & Killeen was not re-surveyed due to lack of suitable habitat (new house built adjacent). Another area nearby was surveyed, and named polygon 'D'.

All polygons were classified as sub-optimal and unsuitable in Moorkens & Killeen, whereas a number were classified as sub-optimal in this survey. Polygon C was classed as 'unsuitable' as it consisted of a very wet area (it was included for survey as it was the most suitable area located close to the previous sample of Moorkens & Killeen). Assignment to habitat suitability categories was based on vegetation composition, vegetation structure and wetness, and reference was made to the broad definitions given in Moorkens & Killeen (2011) (see Table A1, in Appendix I).

MOLLUSCS

A total of 23 mollusc species, with 696 individuals overall, were recorded from the 6 samples taken at Carrowmoreknock (Table 6). Two samples contained *Vertigo geyeri*: two specimens in sample 1, and one specimen in sample 3. These specimens have been seen and verified by mollusc experts Dr Roy Anderson and Dr Evelyn Moorkens. They have been lodged as vouchers in the National Museum, Dublin.

The samples were dominated by *Pisidium* spp. (aquatic) and *Galba truncatula* (wetland/aquatic), with a range of other wetland species being reasonably frequent (e.g. *Vertigo antivertigo* and *Zonitoides nitidus*). Samples varied considerably in their make-up, with sample 6, for example, containing a number of aquatic species not found in other samples.

Other species of note include five which are listed in the Irish Red List for non-marine molluscs (Byrne *et al.*, 2009) (Table 5).

Table 5. Species from Carrowmoreknock which are listed in the Irish Red List (Byrne *et al.*, 2009).

Species	Status*	Positive samples	No. individuals
Quickella arenaria	EN	5	1 (juvenile)
Succinea oblonga	EN	5	1 (dead)
Aplexa hypnorum	VU	2, 6	27
Vallonia pulchella	VU	6	1
Vertigo antivertigo	VU	1-3, 5, 6	29

*VU = Vulnerable, EN = Endangered

MANAGEMENT, OWNERSHIP, THREATS

There are multiple private owners at the site. Management consists largely of horse grazing, though the area where sample 6 was taken is likely to be cattle grazed. Grazing levels were assessed as high for samples 3, 4 and 5, moderate for sample 6, and absent for samples 1 and 2. Signs of supplementary feeding were noted by the road. There are large, well-maintained drains in places at the site. It is likely that these function to maintain a relatively stable hydrology.

It is likely that peat cutting has taken place in certain areas at the site in the past (in particular, sample 2 was taken in a regular-edged depression, which is probably a re-wetted area of cutover bog), but there was no evidence of recent peat removal in the vicinity. Spoil heaps (earth and gravel) were present in a number of adjacent areas, mostly by the road. Roadworks had taken place (noted also in Moorkens & Killeen, 2011) and may have had some impact on roadside habitats (e.g. drains). However, the impact is unlikely to have been far-reaching at the site.

Table 6. Twenty-three mollusc species (including *Pisidium* sp. and *Oxychilus* sp. that were identified to genus) recorded from Carrowmoreknock. (a – adult, j – juvenile, d – dead)

Sample no.:		**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**Total for site:**
Aegopinella nitidula	a			1				**1**
Aegopinella nitidula	j			1				**1**
Aplexa hypnorum	a		1				10	**11**
Aplexa hypnorum	j						15	**15**
Aplexa hypnorum	d						1	**1**
Carychium minimum	a	2				3	4	**9**
Carychium minimum	j	1					1	**2**
Cepaea nemoralis	a		1					**1**
Cochlicopa cf *lubrica*	a			4			1	**5**
Cochlicopa cf *lubrica*	d			2				**2**
Cochlicopa sp.	j			14		1	1	**16**
Columella aspera	a					1		**1**
Columella aspera	j			2	3	2		**7**
Columella aspera	d					1		**1**
Euconulus cf *alderi*	a	1		1			1	**3**
Euconulus cf *alderi*	j			2		2	1	**5**
Galba truncatula	a			2		1	1	**4**
Galba truncatula	j	40	3	52	2	48	14	**159**
Galba truncatula	d	1		2	1	1	7	**12**
Gyraulus crista	a						2	**2**
Gyraulus crista	d						1	**1**
Lymnaea fusca	j						7	**7**
Lymnaea fusca	d						4	**4**
Nesovitrea hammonis	a			2		1		**3**
Nesovitrea hammonis	j		2	2	2	2		**8**
Nesovitrea hammonis	d		1			2		**3**
Oxychilus sp.	j				1			**1**
Oxyloma elegans	a				2			**2**
Oxyloma elegans	j	1	1		6			**8**
Pisidium sp.		66	74	54	17	41	36	**288**
Planorbis planorbis	j						1	**1**
Planorbis planorbis	d		1				1	**2**
Potamopyrgus antipodarum	a			3				**3**
Potamopyrgus antipodarum	j			21				**21**
Quickella arenaria	j					1		**1**
Succinea oblonga	d					1		**1**
Succineid	j		2	2	3		3	**10**
Vallonia pulchella	a						1	**1**
Valvata cristata	a						6	**6**
Valvata cristata	j						4	**4**
Valvata cristata	d						6	**6**
Vertigo antivertigo	a	5	1			5	9	**20**
Vertigo antivertigo	j			1		1		**2**
Vertigo antivertigo	d			1		4	2	**7**
Vertigo geyeri	a	2		1				**3**
Zonitoides nitidus	a	1	2				2	**5**
Zonitoides nitidus	j	1	4				7	**12**
Zonitoides nitidus	d		3				5	**8**
Total for sample:		121	96	170	37	118	154	**696**
Wetness*:		ii	i	i/ii	i/ii	i/ii	i	

*Wetness: (i) too wet, (ii) optimal wetness, (iii) too dry.

CONSERVATION ASSESSMENT

Conservation assessment criteria were not established for Carrowmoreknock by Moorkens & Killeen (2011) due to lack of suitable habitat and the fact that *Vertigo geyeri* was not recorded. Given that the species was found during the current survey, assessment criteria have been developed and are outlined here.

POPULATION ASSESSMENT

Indicator	Target	Result	Pass/Fail
Presence/absence (Transect)	• n/a	n/a	n/a
Presence/absence (Site level)	• Adult or sub-adult snails are present in at least two locations, separated by at least 50m	*Vertigo geyeri* found in two samples 80m apart	Pass
Presence/absence (Site level)	• Adult or sub-adult snails are present in at least 5 samples overall	*Vertigo geyeri* found in two samples only	Fail
2 passes = Favourable; 1 pass = Unfavourable - Inadequate; 0 passes = Unfavourable - Bad.			

HABITAT ASSESSMENT

Indicator	Target	Result	Pass/Fail
Habitat extent/quality (Transect)	• n/a	n/a	n/a
Habitat extent (Site level)	• At least one sampling area at the site classed as having optimal habitat	No area of habitat classed as optimal	Fail
Habitat extent (Site level)	• At least 0.25ha of optimal or sub-optimal habitat present	Only 0.05ha of sub-optimal habitat	Fail
Habitat quality (Site level)	• Soils at >50% of sampling locations have optimal wetness	Two samples too wet, and 3 classified as borderline too wet	Fail
3 passes = Favourable; 2 passes = Unfavourable - Inadequate; 0-1 passes = Unfavourable - Bad.			

FUTURE PROSPECTS ASSESSMENT

Impact code	Impact	Source	Influence	Intensity	Area affected (%)
A04.01.03	Intensive horse grazing	Inside	Negative	Low	90%
A04.02.01	Non-intensive cattle grazing	Inside	Positive	Low	10%
J02.07.01	Groundwater abstractions for agriculture [Activity = drainage]	Inside	Neutral	Low	100%

Future prospects have been assessed by listing all activities/impacts noted to be occurring at the site. Their source, influence, intensity and the area likely to be affected were all considered.

The most notable activity at the site is grazing, with horse grazing being the most common. The site was tightly grazed at the time of survey, with some evidence of overgrazing (e.g. bare patches). The northern area (sample 6) was cattle-grazed, with grazing levels appearing appropriate. There are a number of drainage ditches at the site, which, as mentioned above, probably help maintain steady water levels at the site. Therefore these were assessed as having a neutral influence.

Due to the negative impact of the horse grazing over much of the site (although it was deemed to be of low intensity), the future prospects for the site are assessed as being Unfavourable – Inadequate.

OVERALL ASSESSMENT

The overall conservation assessment at Carrowmoreknock is determined by results in each of the categories: population, habitat and future prospects. The population is clearly very small at this site, with only three individual specimens, from two samples, found during this survey. None were found by Moorkens & Killeen (2011). None of the habitat polygons were classed as optimal, though some areas were classed as sub-optimal, and many areas were categorised as too wet. Patches of suitable habitat were small and isolated. The future prospects, based on noted activities, were assessed as Unfavourable – Inadequate. Therefore the overall assessment is deemed to be Unfavourable - Bad.

Attribute	**Assessment**
Population	Unfavourable - Inadequate
Habitat	Unfavourable – Bad
Future Prospects	Unfavourable - Inadequate
Overall	**Unfavourable – Bad**

Discussion

The current survey found *Vertigo geyeri* at two locations at Carrowmoreknock. This was a significant find, but there were only three individuals in total. The species has now been recorded twice from this site, and so its status there is confirmed. The species is not common at Carrowmoreknock, however, and some of the habitat patches in which it was found are atypical in terms of what is understood to be suitable for the species.

FUTURE MANAGEMENT AND MONITORING

Moorkens & Killeen (2011) recommend monitoring for *Vertigo geyeri* at three-yearly intervals, and thus this site should be surveyed again in 2015. Due of the nature of the site, with only small pockets of habitat of potential suitability for the species, more samples should be taken from a wider geographic area to gain better information on the occurrence of the species across the area. Additionally, the surveyor should be willing to take these samples from areas which are at the edge of the range of suitability for the species.

The site is currently over-grazed in places (by horses), and there are a number of drainage ditches. Dumping of spoil, supplementary feeding of animals, peat cutting and roadworks have all occurred nearby, and may have an influence on the site again in the future. As they were not noted as current activities, they were not included in assessment.

Liaison with landowners by NPWS staff should be strongly considered, particularly in light of the importance of the site for a suite of molluscan species. The occurrence of two species listed as

'Endangered' (i.e. *Quickella arenaria* and *Succinea oblonga*), along with the presence of the Annex II species, *Vertigo geyeri,* makes this an important site from a molluscan point of view. It should be noted, however, that living adults were not found for either *Quickella arenaria* or *Succinea oblonga* (but there are previous records for both from the area).

Vertigo moulinsiana

Introduction

Vertigo moulinsiana (Desmoulin's whorl snail) is a small (up to 2.7mm high), egg-shaped, red-brown snail (Plate 2), with a glossy shell and teeth present in its aperture. It is a member of the Family Vertiginidae and is one of three *Vertigo* species found in Ireland which are listed under Annex II of the E.U. Habitats Directive. Despite its small size, it is the largest of the Vertiginidae found in Ireland. Further information on this species can be found in Kerney & Cameron (1979), Cameron *et al.* (2003), Cameron (2003), Killeen (2003a), Killeen (2003b), Killeen & Moorkens (2003), and Moorkens & Killeen (2011), and the information given below summarises it.

Plate 2: *Vertigo moulinsiana* (left: © M. Horsak, right: © John Brophy)

Vertigo moulinsiana shows a preference for calcareous wetland places, though the vegetation structure is different from that preferred by *Vertigo geyeri*. *Vertigo moulinsiana* needs tall-growing vegetation, and as such, is often associated with reed-beds and swamps, and some types of fens (e.g. *Cladium* fens) and marshes. Suitable vegetation types are additionally often found bordering waterbodies such as canals, ditches, lakes and rivers. Examples could include areas with *Glyceria maxima*, *Phragmites australis* and some tall or tussock-forming *Carex* species. This species, in contrast with *Vertigo geyeri*, can migrate

considerable distances vertically during the year, climbing high in the vegetation in autumn, and remaining low during winter.

Methodology

Field survey

SURVEY SITES

Four sites were surveyed for *Vertigo moulinsiana:*

- Lough Derg, near Portumna, Counties Galway & Tipperary
- Castletown, Co. Waterford
- Strancally, Co. Waterford
- The Murrough, Co. Wicklow

Both Lough Derg, near Portumna and The Murrough were surveyed previously by Moorkens & Killeen (2011).

TIMING

Cameron *et al.* (2003) report that peak reproduction for this species is in summer, resulting in large numbers of juveniles being present in autumn. This increases the chances of finding the species at a site. The fact that the species tends to climb high on vegetation at this time of the year also makes it a suitable time to survey. Moorkens & Killeen (2011) recommend surveying between September and November. For this project all surveys were carried out in October and November, with the sites at Portumna and The Murrough being done in early November, in order to coincide as closely as possible with their survey dates in 2010 (1st and 2nd November respectively).

SAMPLING - MOLLUSCS

Vertigo moulinsiana is the largest of the Vertiginidae in Ireland and can generally be searched for and identified in the field, although specimens may also be removed for laboratory processing and confirmation. In areas of suitable habitat, vegetation was beaten over a white tray (approx. 50x50cm). At each sample point, three adjacent areas were beaten. These were treated as single samples, with specimens pooled in the field. Molluscs collected on the tray were either identified in the field and recorded, or transferred into glass jars for return to the laboratory for later identification.

At all sites, samples were taken from spot locations in suitable habitat patches, and for two of the sites (Lough Derg, near Portumna; Castletown) samples were additionally taken at locations along a transect. The locations of all sample points and transects were recorded using a hand-held GPS

(Garmin GPS72H) and digital photographs were taken. The degree of wetness was recorded at each sampling location using the following scale:

(i) Dry – no visible moisture on ground surface
(ii) Damp – ground visibly damp, but water does not rise under pressure
(iii) Wet – water rises under light pressure
(iv) Very wet – pools of standing water, generally <5cm deep
(v) Site under water – entire sampling site in standing or flowing water >5cm deep

Notes on ownership, threats and management, including grazing level, were also made.

Spot sampling allows assessment of the occurrence of the species across areas of potentially suitable habitat at a site. **Transect sampling** allows accurate small-scale description of habitat change, if transects are re-surveyed over time. They are generally set-up in the best examples of the habitat for *Vertigo moulinsiana* at the site, and ideally are easily accessible and easy to re-locate. At both Lough Derg, near Portumna and The Murrough most of the areas visited in the previous survey (Moorkens & Killeen, 2011) were surveyed again, while Strancally and Castletown had not been previously surveyed.

At each site, areas containing potentially suitable habitat for *Vertigo moulinsiana* were mapped as **polygons**, with these being assigned to either 'optimal', 'sub-optimal' or 'unsuitable' categories. Where possible, obvious physical boundaries were chosen for the polygons (e.g. fences, paths), but often it was necessary to use boundaries between habitat types to delineate them. Moorkens and Killeen (2011) give a broad definition of the habitat suitability categories for *Vertigo moulinsiana* (Table A3, in Appendix I). They also developed site-specific habitat definitions for Lough Derg, near Portumna and The Murrough (Tables A4 and A5, Appendix I).

SAMPLING – VEGETATION

In addition to taking samples for molluscan analysis, full details of the vegetation (vascular plants and bryophytes) were also recorded. A species list, with percentage cover for each species, was generated for a 5x5m area around each sampling point. Other relevant ecological details recorded included:

- Percentage cover of
  - bare soil,
  - bare rock,
  - open water,
  - litter,
  - bryophytes,
  - field layer,
  - broadleaf herbs
- Vegetation height - average, maximum and minimum
- Slope
- Aspect
- Habitat type, following three schemes:
  - 'A Guide to Habitats in Ireland' (Fossitt, 2000)
  - NVC category (Rodwell, 1991; 1992; 1995)
  - E.U. Habitats Directive Annex I habitat type (Anon. 2007; Anon. 2008), if applicable

Laboratory work

Samples which were brought from the field were sorted, counted and identified in the laboratory. Mollusc species were identified using Cameron (2003) and Kerney & Cameron (1979) for terrestrial and wetland species, and Macan (1977) for aquatic species. All specimens were assigned as either adult (a), juvenile (j) or dead (d). Dead signifies specimens which were clearly long-dead. Examples of *Vertigo moulinsiana* from all positive sites have been lodged as voucher specimens with the National Museum, Dublin.

Results and Discussion – Lough Derg, near Portumna

Results

GENERAL

Lough Derg, near Portumna was surveyed for *Vertigo moulinsiana* on the 8th and 9th of November 2012. An overview map and six individual maps in Appendix II show the locations of sampling points at the site, and Table A3 in Appendix III shows the grid references for these sampling points. This site is extensive, and covers much of the northern end of Lough Derg. Areas were visited from Portumna Forest Park at the north-west, down to Brockagh/Kilgarvan Quay, approximately 2km south-west of Ballinderry village, on the east side of the lake. All of the areas visited fall within the 'Lough Derg, North-East Shore' cSAC (002241). The sampling locations are grouped and named geographically as follows:

- Brockagh
- Gortmore
- Lehinch
- Portumna Forest Park

In addition, *Vertigo moulinsiana* was recorded from a nearby area, Portland Park, approximately 3.5km north-east of Portumna, while surveying for *Oxyloma sarsi* (samples 9a and 9b from that survey). The data (e.g. molluscan species, vegetation, etc.) are presented in the section on *Oxyloma sarsi*.

At Brockagh (also known as Kilgarvan Quay), habitats consist of extensive areas of reedbed which grade into calcareous fen and scrub in places. At Gortmore, potential habitat was limited to small strips of *Glyceria maxima* along the shore, and pockets of reedbed associated with woodland. Lehinch consisted of areas of reedbed on the river bank.

The first cluster of sample points in Portumna Forest Park (including the transect) were taken in an area with dense stands of reeds, calcareous fen (including areas dominated by *Cladium mariscus* and *Juncus subnodulosus*) and wet grassland. Other samples taken in the Forest Park include a runnel/drain

with *C. mariscus* and tall sedges, a reedbed with *Phragmites australis* and *Schoenoplectus lacustris*, and finally, a wet woodland clearing with *C. mariscus* and *P. australis.*

Portland Park consists of a fringe of reeds along the main channel of the River Shannon.

Thus a diversity of habitat types which are potentially suitable for *Vertigo moulinsiana* are present in the area. All have in common a strong calcareous influence, tall vegetation and relatively stable hydrological regime – i.e. they generally do not dry out.

PREVIOUS RECORDS

The species was first recorded from the area in 1998 by Evelyn Moorkens, and was included in the 2010 survey of Moorkens & Killeen (2011). They noted that the amount of potentially occupied habitat for this species in the area is likely to be large, but that problems of scale and access mean that this will be difficult to assess accurately. They suggest that the species is likely to be most often associated with areas of fen habitat away from the lake shore, where a stable hydrology has developed. Our survey suggests that while these types of areas are utilised, so too are habitats right on the water's edge.

VEGETATION AND HABITAT

The plant species recorded at the sample locations are given in Appendix IV, Table A3, and the bryophytes in Appendix V, Table A3. Appendix VI shows how the sample numbers in this survey relate to those of Moorkens & Killeen (2011). Table A3 in Appendix VI also gives information on habitat and vegetation type; cover of elements such as bare soil, open water, litter; and a number of other variables, including vegetation height, slope and aspect. The number of vascular plant species recorded at individual sample locations ranged from two (*Cladium mariscus* and *Menyanthes trifoliata* in an area of *Cladium* fen) to 20 (in an area of rich fen), with a total number of 64 species across all 20 samples. There were seven species of bryophyte recorded. Species of interest, or with restricted distributions in Ireland, include: *Carex acutiformis, Chara* sp., *Sesleria caerulea, Stellaria palustris* and *Utricularia intermedia*. The uncommon *Epipactis palustris* was seen at the site, though not recorded in any of the relevés.

Samples were categorized into a number of different habitat types, with most falling into the category of 'reed and large sedge swamp' (FS1) (13 samples). Five were classed as rich fen (PF1), and one each as wet grassland (GS4) and drainage ditch (FW4). The most common corresponding NVC community was S24 (*Phragmites australis-Peucedanum palustre* tall-herb fen). Others recorded included: S2 (*Cladium mariscus* swamp and sedge-beds), S4 (*Phragmites australis* swamp and reed-beds), S5 (*Glyceria maxima* swamp) and S7 (*Carex acutiformis* swamp). One area (sample 2) was deemed to correspond to the E.U. Annex I habitat type 'Alkaline fen' (7230).

TRANSECT

Moorkens & Killeen (2011) had not previously established a transect at the site at Portumna due to the paucity of information on the species occurrence there and the expansive area of potentially suitable habitat involved. However, as more is now known about where the species occurs, a monitoring transect was established as part of this survey (refer to Lough Derg map 4 of 6, Appendix II for location, and Figure A2 and Table A1 in Appendix VII for transect details). The transect is 60m long, and runs through areas of optimal and sub-optimal habitat, which were described and their extent measured. The main vegetation types are dense beds of *Cladium*, *Juncus subnodulosus* and *Phragmites*. The transect was under water for almost its entire length at the time of surveying. Six molluscan samples were taken, and all were positive for *Vertigo moulinsiana*.

POLYGONS

A table listing all polygons from this survey is given in Appendix VIII, and they can be viewed on the aerial photographs provided in Appendix II.

New polygons indicating habitat suitability for *Vertigo moulinsiana* were drawn for Brockagh, Gortmore and Lehinch. Polygon 'A' (Moorkens & Killeen, 2011) in Portumna Forest Park was altered based on habitat assessment and further sampling, and three other small polygons were added to the west of this.

The polygons at Brockagh were classed as sub-optimal, largely due to vegetation composition and water regime. Gortmore was unsuitable, due to lack of appropriate habitat. Lehinch was deemed to be optimal, as were large areas of Portumna Forest Park. An area grading into grassland at Portumna Forest Park was called sub-optimal/unsuitable, and the three additional polygons to the west were classified as sub-optimal (one was a drain/runnel, and so limited in size; another was too wet; the final was a woodland clearing).

Following the finding of *Vertigo moulinsiana* at one of the survey sites for *Oxyloma sarsi*, a new habitat polygon was drawn. Details of this site, Portland Park, can be found in the section on *Oxyloma sarsi.* The habitat here was classed as optimal for *Vertigo moulinsiana,* and the habitat polygon coincides with the one for *Oxyloma sarsi*.

Assignment to these categories was based on vegetation composition, vegetation structure and wetness, and reference was made to the definitions given in Moorkens & Killeen (2011), and reproduced in Appendix I.

MOLLUSCS

A total of 11 mollusc species, with 382 individuals overall, were recorded from the 23 samples at Lough Derg, near Portumna (Table 7). *Vertigo moulinsiana* was found in 17 of the samples, with numbers of specimens in a sample ranging from three to 47. Note that *Vertigo moulinsiana* was also recorded at one of the *Oxyloma sarsi* survey sites, Portland Park. Data on this site is presented in the section on *Oxyloma sarsi*.

The suite of species recorded was strongly indicative of wetland conditions. The most common species by far was *Vertigo moulinsiana,* with 266 individuals. This was followed by the Succineids, a family of wetland snails (78 individuals). Species of note, apart from the target species, include *Oxyloma sarsi* (this was found at Lehinch, and is dealt with further in the section on *Oxyloma sarsi*) and *Vertigo antivertigo*, which is listed as 'Vulnerable' in the Irish Red List for non-marine molluscs (Byrne *et al.*, 2009). Perhaps also of note is the record of *Bithynia leachii*, a species which is likely to have been introduced to Ireland early in the 1900s. It has only relatively recently been recorded from the Shannon lakes (Roy Anderson, pers. comm.).

MANAGEMENT, OWNERSHIP, THREATS

There are multiple private owners at this site, and some portions are owned by the ESB (Electricity Supply Board). Some areas appear to receive little or no management, e.g. Brockagh, Lehinch and Portland Park. In these cases, the vegetation sampled was largely river- or lake-side reedbed. At Brockagh the sample which was positive for *Vertigo moulinsiana* was recorded just metres from the end of a boardwalk, and adjacent to an established angling spot. Therefore, if there were to be any future developments/additions to this, these could impact on the habitat of this species.

At Gortmore the landowner informed us that some reeds/rushes are cut for basket-making.

Sections of Portumna Forest Park are also unmanaged (e.g. the reedbeds), but other areas are grazed (horses were present at the time of survey, near sampling sites 12 and 14). Portumna Forest Park is used for recreation by local people, with the main activities likely to be walking and perhaps cycling. These are generally limited to existing pathways and are thus unlikely to have any impact on *Vertigo moulinsiana* habitats.

All habitat areas which are on the lake or river shore are susceptible to water level changes, channel/shore works, and possible marina developments.

Table 7. Eleven mollusc species recorded (including *Cepaea* sp. that was recorded to genus) from 'Lough Derg, near Portumna' (a – adult, j – juvenile, d – dead). Grey shading indicates samples with *Vertigo moulinsiana* present.

Location code*:		**B**	**B**	**B**	**G**	**L**	**L**	**L**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	
Sample/Transect station no.:		**S1**	**S2**	**S3**	**S4**	**S5a**	**S5b**	**S5c**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**	**S16**	**Total for site:**
Bithynia leachii	j				1																				**1**
Cepaea sp.	j	1		2	4																			1	**8**
Cochlicopa cf *lubrica*	d			1																					**1**
Columella aspera	a	1																						1	**2**
Columella edentula	a																							4	**4**
Euconulus cf *alderi*	a															1									**1**
Euconulus cf *alderi*	j	2								2	1					2									**7**
Galba truncatula	j							1		2									2						**5**
Oxyloma elegans	a												1	1			2						1		**5**
Oxyloma sarsi	a						2																		**2**
Oxyloma sp.	a						1																		**1**
Oxyloma sp.	j			1	6		4	10	1		2			4	7		14								**49**
Oxyloma sp.	d						1								1		3								**5**
Succineid	j	5								2						1						7		1	**16**
Vertigo antivertigo	a	5			1					1				1											**8**
Vertigo antivertigo	d										1														**1**
Vertigo moulinsiana	a			11					18		8	9	12	9	3	2	15	4	10	1	3			9	**114**
Vertigo moulinsiana	j			4			10	47	28	3	2	1	3	9		1	25			3	4			11	**151**
Vertigo moulinsiana	d										1														**1**
Total for sample:		14	0	19	12	0	18	58	47	10	15	10	16	24	11	7	59	4	12	4	7	7	1	27	**382**
Wetness:**		iv	iv	iii	v	iv	iii	iii	v	iv	v	v	v	v	v		iv			v	iv	v	v	v	
Quantitative sample*:**						**N**										**N**		**N**	**N**					**N**	

*Site name: B = Brockagh, G = Gortmore, L = Lehinch, PFP = Portumna Forest Park

**Wetness: (i) Dry – no visible moisture on ground surface, (ii) Damp – ground visibly damp, but water does not rise under pressure, (iii) Wet – water rises under light pressure, (iv) Very wet – pools of standing water, generally <5cm deep, (v) Site under water – entire sampling site in standing or flowing water >5cm deep.

***At this site, five of the samples were non-quantitative – i.e. vegetation was beaten, but not strictly following the sampling methodology.

CONSERVATION ASSESSMENT

Information presented in this section is based on the conservation assessment criteria developed by Moorkens & Killeen (2011) for the site.

POPULATION ASSESSMENT

Indicator	Target	Result	Pass/Fail
Presence/absence (Transect)	• Adult or sub-adult snails are present in samples on the transect (minimum 3 samples)	Present in all samples on transect (6 samples)	Pass
Presence/absence (Site level)	• Adult or sub-adult snails are present in at least 3 samples, other than those on the transect, near Portumna marina	Present in 5 samples	Pass
Presence/absence (Site level)	• Adult or sub-adult snails are present in at least 3 samples from at least 2 locations at the edge of the Forest Park	Present in 3 samples from 2 locations	Pass
Presence/absence (Site level)	• Adult or sub-adult snails are present in at least 2 other samples from at least 2 other locations, outside of the Forest Park area.	Present in Brockagh, Lehinch and Portland Park (5 samples, 3 locations)	Pass
3 passes = Favourable; 2 passes = Unfavourable - Inadequate; 0-1 passes = Unfavourable - Bad.			

Note: numbers of samples mentioned for this site may differ from those in Moorkens & Killeen (2011) due to the fact that samples were taken in groups of three and pooled in this survey (refer to sampling details outlined at beginning of *Vertigo moulinsiana* section).

HABITAT ASSESSMENT

Indicator	Target	Result	Pass/Fail
Habitat extent (Transect)	• At least one habitat zone on the transect is classed as optimal **And** • 30m of habitat along the transect is classed as sub-optimal or optimal	Optimal habitat present All 60m of transect classed as optimal or sub-optimal	Pass
Habitat quality (Transect)	• Soils, at time of sampling, are saturated (optimal wetness) for 30m along the transect	Much of transect too wet (i.e. soil moisture class 5)	Fail
Habitat Quality & Extent (Site level)	• Over 80% of the samples at Portumna Forest Park (not including sites near marina) are dominated by suitable vegetation (Classes I & II) **And** • Fall within soil moisture classes 3-5	80% of samples fit these criteria	Pass
Habitat extent (Site level)	• At least 6ha of habitat, across this whole site, is classed as sub-optimal or optimal.	2ha optimal, 8.5ha sub-optimal	Pass
≥3 passes = Favourable; 2 passes = Unfavourable - Inadequate; 0-1 passes = Unfavourable – Bad			

FUTURE PROSPECTS ASSESSMENT

Activity code	Activity	Location	Influence	Intensity	Area affected (%)
A04.02.03	Non-intensive horse grazing	Inside	Neutral	Low	5%
D01.01	Paths, tracks, cycling tracks	Outside	Neutral	Low	1%
F02.03	Leisure fishing	Outside	Neutral	Low	1%
F04	Taking/Removal of terrestrial plants, general	Inside	Negative	Low	1%
K04.05	Damage by herbivores (including game species) [Activity = deer grazing]	Inside	Positive	Low	60%

Future prospects have been assessed by listing all activities/impacts noted to be occurring at the site. Their source, influence, intensity and the area likely to be affected were all considered.

The horse grazing at the site appears to have little direct impact on the *Vertigo moulinsiana* habitat, being largely confined to adjacent drier, grassier areas. Therefore the impact was assessed as neutral. Signs of deer grazing were noted in places at and near Portumna Forest Park. As deer are more likely to pass through wetter areas than horses, it is possible that that have a low, but positive, influence on the habitat, helping to keep it open by both trampling and grazing. This impact has thus been assessed as positive. The removal of reeds/rushes for basket-making could have a negative impact, but it occurs at a very small scale. Activities associated with leisure fishing (e.g. marinas, boardwalks, fishing perches) were found near some areas of *Vertigo moulinsiana* habitat. They are unlikely to be currently impacting on the habitats of interest, and so have been assessed as neutral.

Assessment of future prospects balances positives and negatives to determine whether the species will survive at a site into the future. As the impacts here are low, future prospects have been assessed as Favourable.

OVERALL ASSESSMENT

The overall conservation assessment at Lough Derg, near Portumna is determined by results in each of the categories: population, habitat and future prospects. The population of *Vertigo moulinsiana* is well-distributed throughout the northern part of Lough Derg, and there are extensive areas of suitable habitat. Although many areas of habitat are difficult to access and are disjointed, substantial areas were classed as optimal. Future prospects were assessed as Favourable, based on the activities noted at the site. Therefore the overall assessment is deemed to be Favourable.

Attribute	Assessment
Population	Favourable
Habitat	Favourable
Future Prospects	Favourable
Overall	**Favourable**

Discussion

The site Lough Derg, near Portumna holds a number of locations where sizeable *Vertigo moulinsiana* populations have been recorded. It is clearly an important area for the species, and is likely to yield yet more positive sites. The inaccessibility of the habitats (often consisting of floating vegetation, and/or deep standing water, or located beyond impassable drains/channels), along with the scale of this site, means that there is potential to extend the range of the species further. This survey has extended the known range of the species far down the eastern side of Lough Derg, with the site at Brockagh being approximately 17km from Portumna. Unless water levels change in the lake, this is likely to continue to be a good site for *Vertigo moulinsiana* into the future. Overall, this site is one of high conservation importance (for habitats, plants and mollusc species), and this is reflected in its designation as a cSAC.

FUTURE MANAGEMENT AND MONITORING

This site should be surveyed again in three years time, i.e. in 2015, according to the recommendations of Moorkens & Killeen (2011). The transect should be re-surveyed, as this will allow detailed information to be gathered in terms of possible population and habitat changes. Due to the large size of this site, a second transect, located at some distance from the Portumna Forest Park area, could be beneficial. Future surveys should endeavour to further extend the range of the population around Lough Derg, and based on findings, decide on the value of another transect, and also on its location.

The site is currently grazed in places, and largely unmanaged in others, and the management regime overall seems to be appropriate. As noted above, although there is no indication that this is likely to occur, water level change in the lake is the most likely threat to the species survival at this site. Another issue to be kept in mind is any future developments such as marinas, boardwalks and fishing stands. The nature and position of any such future developments should take into account any possible impacts on *Vertigo moulinsiana* habitat.

Results and Discussion – Castletown

Results

GENERAL AND PREVIOUS RECORDS

Castletown, Co. Waterford was surveyed on the 15th of October and the 20th of November 2012. The map in Appendix II shows the locations of sampling points, and Table A4 in Appendix III shows the grid references for all sampling points.

This is a small site located just west of Waterford Airport, and approximately 3km north-east of Tramore. It consists of three parcels of wetland, mainly swamp and reedbed, and some wet grassland. It does not have a conservation designation.

Vertigo moulinsiana was first recorded at this site by Dr Stephen McCormack in 2009 as part of a wetland invertebrate survey.

VEGETATION AND HABITAT

The plant species recorded in the 21 vegetation relevés carried out at Castletown are given in Table A4 in Appendix IV, and the bryophytes from the site are in Table A4 in Appendix V. Thirty plant species were recorded, and four bryophytes. The relevés had quite low species diversity in general, a common feature of swamp habitats. Most relevés conformed to 'reed and large sedge swamp' (FS1) of Fossitt (2000), with some areas being classified as wet grassland (GS4). The most commonly recorded NVC vegetation category present was S14 (*Sparganium erectum* swamp), with 11 of the 21 relevés. Others recorded include: S4 (*Phragmites australis* swamp and reed-beds), MG10 (*Holcus lanatus-Juncus effuses* rush-pasture) and MG13 (*Agrostis stolonifera-Alopecurus geniculatus* grassland). No habitat areas were deemed to be of E.U. Habitats Directive Annex I quality.

Nearby habitats include GA1 (Improved agricultural grassland), WD4 (Conifer plantation), BL3 (Buildings and artificial surfaces) and FW4 (Drainage ditches).

TRANSECT

In order to allow a detailed measure of change in habitat/vegetation to be ascertained in the future, a transect was set up. Figure A3 and Table A2 in Appendix VII show the length, locations of samples and vegetation details, along with zones of suitability for *Vertigo moulinsiana* (refer to the Castletown map in Appendix II to see the location of the transect at the site). The transect had optimal wetness along its entire length (category '4'), and had 30m of optimal/sub-optimal habitat, 58m of sub-optimal habitat and 32m of unsuitable habitat. The main vegetation types are swamp and wet grassland. GPS

points and photos were taken at transect sampling points. Eight molluscan samples were taken, and all were positive for *Vertigo moulinsiana.*

POLYGONS

Based on the field survey three habitat polygons were drawn (details in Table A4, Appendix VIII, and Castletown map, Appendix II), all consisting of optimal/sub-optimal habitat for *Vertigo moulinsiana*. The habitat was not deemed to be optimal due to the grassy nature of the swamp/fen in places. Assignment to habitat suitability categories was based on vegetation composition, vegetation structure and wetness, and reference was made to the broad definitions given in Moorkens & Killeen for *Vertigo moulinsiana* (given in Table A3, Appendix I).

MOLLUSCS

A total of eight species of mollusc, with 688 individuals, were recorded from the 22 molluscan samples taken at Castletown (see Table 8). The samples were dominated by *Vertigo moulinsiana*, with 618 specimens from this species alone. The other species recorded were either typical wetland species (e.g. *Vertigo antivertigo* and *Euconulus* cf *alderi*) or generalist species (e.g. *Cepaea hortensis*, *Cepaea nemoralis* and *Trochulus hispidus*). The record for *Cepaea hortensis* is interesting in that this species is common only in eastern counties, and while mapped records show it as common in neighbouring Wexford, there are only two records for the species in Waterford (National Biodiversity Data Centre, 2013).

MANAGEMENT, OWNERSHIP, THREATS

The site has three owners; two private, and one section in the east owned by Coillte. It appears that most of the site is largely unmanaged (i.e. the parts that are currently swamp/fen/wet grassland), although management of neighbouring lands may have an effect on the site.

A substantial drainage ditch runs along the northern perimeter of the site. This appears to be maintained (relatively recent spoil heaps were noted alongside it). However, as the site is still quite wet, and clearly capable of supporting good populations of *Vertigo moulinsiana*, the maintenance of this drainage ditch is likely to be a positive management action.

A large (>2ha) pond was created recently adjacent to the site. Review of aerial photographs reveals that this pond was constructed between 1995 and 2000, and a house adjacent to it was built in the period 2000 to 2005 (also built on an area of reedbed). The purpose of the pond is unknown.

Table 8. Eight mollusc species recorded from Castletown (a – adult, j – juvenile, d – dead). Grey shading indicates samples with *Vertigo moulinsiana* present.

		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**	**S16**	**S17**	**S18**	**S19**	**S20**	**S21**	**S22**	**Total for site**
Cepaea hortensis	a														2			1		1				**4**
Cepaea nemoralis	a			1																				**1**
Cepaea sp.	j		1	3		1		3		2	3	1	2	1		4	2			1	2	1		**27**
Clausilia bidentata	a																		1					**1**
Euconulus cf *alderi*	a															1								**1**
Euconulus cf *alderi*	j	3											1							1				**5**
Punctum pygmaeum	a																			1				**1**
Succineid	j	3				2					1										1	1	1	**9**
Trochulus hispidus	a																				1			**1**
Trochulus hispidus	j	1																	1		1			**3**
Vertigo moulinsiana	a	12	6	2		8	1	3			25	10	29	2	5	2	3	6	10	5	9	10	11	**159**
Vertigo moulinsiana	j	60	7	1		29	3	5			59	61	79	16	36	29	20	15		3	10	11	15	**459**
Vertigo antivertigo	a	1	1	4		2	1	3			1		1							1	1			**16**
Vertigo antivertigo	j					1																		**1**
Total for sample:		80	15	11	0	43	5	14	0	2	89	72	112	19	43	36	25	22	12	13	25	23	27	**688**
Wetness*:		iv	iii	iii	iii	iii	i	iv	iv	iv	iv	iv	iv	iv	iv	iv	iv	iv	iv	iv	iv	iv	iii	

*Wetness: (i) Dry – no visible moisture on ground surface, (ii) Damp – ground visibly damp, but water does not rise under pressure, (iii) Wet – water rises under light pressure, (iv) Very wet – pools of standing water, generally <5cm deep, (v) Site under water – entire sampling site in standing or flowing water >5cm deep.

CONSERVATION ASSESSMENT

The information presented in this section reflects the conservation assessment criteria developed by Moorkens & Killeen (2011) for the various sites for *Vertigo moulinsiana*.

POPULATION ASSESSMENT

Indicator	Target	Result	Pass/Fail
Presence/absence (Transect)	• Adult or sub-adult snails are present in samples on the transect, with a minimum of 4 positive samples out of 8	All 8 samples positive	Pass
Presence/absence (Site level)	• Adult or sub-adult snails are present in all three polygons, with additional samples from polygon A being >100m from the transect	*Vertigo moulinsiana* found in all three polygons, with some samples in polygon A >100m from transect	Pass
2 passes = Favourable; 1 pass = Unfavourable - Inadequate; 0 passes = Unfavourable - Bad.			

HABITAT ASSESSMENT

Indicator	Target	Result	Pass/Fail
Habitat extent (Transect)	• At least one habitat zone on the transect is classed as optimal or optimal/sub-optimal **And** • 60m of habitat along the transect is classed as sub-optimal or better	Optimal/sub-optimal habitat present 88m of sub-optimal or better	Pass
Habitat quality (Transect)	• Soils, at time of sampling, are saturated (optimal wetness) for 60m along the transect	Entire transect at optimal wetness	Pass
Habitat extent (Site level)	• At least 10ha of the most suitable habitat includes some areas classed as optimal or optimal/sub-optimal	19.5ha classed as optimal	Pass
3 passes = Favourable; 2 passes = Unfavourable - Inadequate; 0-1 passes = Unfavourable - Bad.			

FUTURE PROSPECTS ASSESSMENT

Impact code	Impact	Source	Influence	Intensity	Area affected (%)
E01.03	Dispersed habitation [Activity = house building]	Outside	Neutral	Low	2%
G05.05	Missing or wrongly directed conservation measures [Activity = lack of knowledge of owners of conservation value of site]	Inside	Neutral	Medium	100%
J02.07.01	Groundwater abstractions for agriculture [Activity = drainage]	Outside	Positive	Low	50%
J02.13	Other human induced changes in hydraulic conditions [Activity = pond creation]	Outside	Neutral	Low	15%

Future prospects have been assessed by listing all activities/impacts noted to be occurring at the site. Their source, influence, intensity and the area likely to be affected were all considered.

This site is largely unmanaged. There are some large drains around the perimeter of the site, and the one on the northern boundary in particular is maintained. This has been deemed as a positive

management action, as water levels are appropriate for the species (i.e. it is possible that the site may become too wet/waterlogged if drains not maintained, and thus become unsuitable for *Vertigo moulinsiana*).

Adjacent areas (not included here as part of the site, but previously consisting of the same habitat) have been heavily modified in recent years, with a house having been built on an area of swamp/reedbed approximately 10 years ago, and a large pond having been created sometime in the late 1990s. The influence of these developments has been graded as 'neutral'. One of the main issues facing this site is the fact that the future land management plans of the owners are unknown, but as there is no information suggesting definite plans, this was also categorised as 'neutral'.

As all of the listed impacts are either neutral or positive in terms of their effect, the future prospects for the species at the site are assessed as Favourable.

OVERALL ASSESSMENT

The overall conservation assessment for Castletown has been determined by results in each of the categories: population, habitat and future prospects. The population is clearly large and healthy at this site (at least at the time of surveying). All habitat polygons were classed as optimal/sub-optimal for the species. Future prospects were assessed as Favourable, based on the activities noted at the site. Therefore the overall assessment is deemed to be Favourable.

Attribute	**Assessment**
Population	Favourable
Habitat	Favourable
Future Prospects	Favourable
Overall	**Favourable**

Discussion

Until Dr Stephen McCormack recorded *Vertigo moulinsiana* at this site (and at one other site in Co. Waterford) there were no records for the species in Waterford or neighbouring counties on the south coast. While relatively small and isolated, nonetheless this is clearly an important site for the species, supporting a significant population.

FUTURE MANAGEMENT AND MONITORING

This site should be monitored again in three years time, i.e. in 2015, as per the recommendations in Moorkens & Killeen (2011). The transect should be repeated, and an appropriate number of spot samples taken (refer to the conservation assessment criteria given above). In particular, additional spot samples should be taken in the southern-most polygon in order to ascertain the range of the species in that area.

The fact that this site has no conservation designation, and that it is very unlikely that the landowner(s) are unaware of the conservation importance of their land, means that it is potentially vulnerable to destruction or change. Thus a priority at this site is to make contact with landowners. The minimal management which is occurring (i.e. some drain maintenance) should continue, but any further habitat loss such as that from the pond creation should be discouraged. Contact should also be made with Coillte in order to inform them of the importance of the site, and to discuss future plans (including management regime) for the area.

Maintaining the optimum balance in hydrology (in terms of suitability for *Vertigo moulinsiana*) will be a challenge at this site going into the future, as at other sites for this species. In order to ensure appropriate hydrological conditions, drain maintenance (or supervision of such) may need to be undertaken by landowners, NPWS or Waterford County Council.

The site could be considered for designation (e.g. pNHA), and it should be made known to the local County Council as an important area for biodiversity. In this way, possible future planning decisions can be made in an informed way.

Results and Discussion – Strancally

Results

GENERAL AND PREVIOUS RECORDS

Strancally, Co. Waterford was surveyed on the 17th of October 2012. The Strancally map in Appendix II shows the locations of sampling points, and Table A5 in Appendix III shows the grid references for all sampling points.

This is a relatively small site located at the point where the River Bride joins the River Blackwater in the west of Co. Waterford, approximately 14km north of Youghal (which is in Co. Cork). The vegetation consists of reedbeds and tall sedge swamps. It occurs within the larger designated area of 'River Blackwater (Cork/Waterford) cSAC' (002170), and also the 'Blackwater River and Estuary pNHA' (000072).

It is an unusual site, being influenced by the tides due to water in the river backing up in response to tidal incursions further downriver. Water levels rise and fall within the site according to the tides. However, the water is fresh and not brackish. There are embankments around the perimeter, with a break at the north-west corner (see northern-most point on Strancally map in Appendix II). There are also raised embankments with pathways within the site itself, and water fills and empties from the internal compartments via a series of culverts/drains set into these embankments. This means that some parts of the site are under water for longer with each tidal cycle, and some parts are under

deeper water for longer. It is worth noting that on the morning of the survey, there was an unusually high spring tide, and much of the site was flooded for a number of hours.

Vertigo moulinsiana was first recorded at this site by Dr Stephen McCormack in 2011 as part of a survey of wetland invertebrates, and confirmed by Dr Evelyn Moorkens.

VEGETATION AND HABITAT

A total of 21 plant species were recorded in 10 vegetation relevés (Table A5, Appendix IV), although half of those samples had only two species recorded. These were *Phragmites*-dominated samples, with the second species being either *Impatiens glandulifera* or *Calystegia sepium* recorded at very low cover. No bryophytes were recorded. Of note among the plant species recorded are the two invasive alien species *Impatiens glandulifera* and *Fallopia japonica*. The former was recorded in five of the 10 relevés, and the latter in just one. Table A5 in Appendix IV also gives information on habitat and vegetation type; cover of elements such as bare soil, open water, litter; and a number of other variables, including vegetation height, slope and aspect.

All samples were classed as FS1 (reed and large sedge swamps) according to the Fossitt (2000) guide to habitats in Ireland, and fell into either S4 (*Phragmites australis* swamp and reed-beds) or S26 (*Phragmites australis-Urtica dioica* tall-herb fen) of the NVC classification (Rodwell, 1995). None of the vegetation sampled conformed to an E.U. Habitats Directive Annex I habitat type.

TRANSECT

Few specimens of *Vertigo moulinsiana* were noted in the field, probably related to the flooding event on the morning of sampling at this site, and thus a good potential location for a transect was not identified.

POLYGONS

Two habitat polygons were delineated, both of which were classed as sub-optimal for *Vertigo moulinsiana*, mainly due to the tendency of the site to flood and the homogeneity of the vegetation. These can be seen on the Strancally map in Appendix II, and further details can be found in Table A5, Appendix VIII.

MOLLUSCS

A total of 153 individual molluscs were found, from eight species (Table 9). Two of the sampling locations were positive for *Vertigo moulinsiana*, with five adults and five juveniles found in total. The samples were dominated by wetland species, with 82 individuals belonging to the Succineid family.

Apart from *Vertigo moulinsiana*, the occurrence of *Vertigo antivertigo* is of note as this species is listed as 'Vulnerable' in the Red List for Irish non-marine molluscs (Byrne *et al.*, 2009).

Table 9. Eight mollusc species recorded from Strancally (a – adult, j – juvenile, d – dead). Grey shading indicates samples with *Vertigo moulinsiana* present.

		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**Total for site:**
Carychium minimum	a				3							**3**
Cepaea nemoralis	a				1		1		1		1	**4**
Cepaea sp.	j	1		3	2		2	9	4	5	5	**31**
Galba truncatula	j	1		8	1						1	**11**
Oxyloma elegans	a		1	1	1	11	1	2		1		**18**
Oxyloma elegans	d						4			1	1	**6**
Potamopyrgus antipodarum	a	1	1		1	1					1	**5**
Potamopyrgus antipodarum	j		2	1							1	**4**
Succineid	j	4	1			48		4	1			**58**
Vertigo antivertigo	a		1									**1**
Vertigo moulinsiana	a					4		1				**5**
Vertigo moulinsiana	j					5						**5**
Zonitoides nitidus	a					1						**1**
Zonitoides nitidus	d									1		**1**
Total for sample:		7	6	13	9	70	8	16	6	8	10	**153**
Wetness*:		v	v	v	v	v	v	v	v	ii	iii	

*Wetness: (i) Dry – no visible moisture on ground surface, (ii) Damp – ground visibly damp, but water does not rise under pressure, (iii) Wet – water rises under light pressure, (iv) Very wet – pools of standing water, generally <5cm deep, (v) Site under water – entire sampling site in standing or flowing water >5cm deep.

MANAGEMENT, OWNERSHIP, THREATS

The site is privately owned, and is part of a large demesne. Contact was made with the estate manager, and the owners are understood to be interested in conserving the natural habitats along the river, and as such, the site is being managed for conservation. The results of this survey were requested by the owners, along with any feedback and comments about appropriate management. Current management consists of maintaining drains and pathways.

The largest threat to the species at the site is likely to be flooding – itself a natural occurrence. Provided that drains, culverts and the breach in the main embankment are maintained, then water level fluctuations, while dramatic at spring tides, should remain at a level which allows the continued survival of the species at the site. It is worth remembering that the most abundant plant species at the site is *Phragmites australis*, a tall-growing plant. This is likely to allow at least some individuals to place themselves above the water levels during flooding events. Also, while flooding may be a relatively regular feature of this site, it is largely tidal, and thus of relatively short duration.

CONSERVATION ASSESSMENT

The information presented in this section reflects the conservation assessment criteria developed by Moorkens & Killeen (2011) for the various sites for *Vertigo moulinsiana*.

POPULATION ASSESSMENT

Indicator	Target	Result	Pass/Fail
Presence/absence (Transect)	• n/a	n/a	n/a
Presence/absence (Site level)	• Adult or sub-adult snails are present in at least two locations at the site (locations to be >100m apart)	*Vertigo moulinsiana* found in two locations, but less than 100m apart	Fail
Presence/absence (Site level)	• Adult or sub-adult snails are recorded from at least four samples at the site	*Vertigo moulinsiana* recorded in two samples only	Fail
2 passes = Favourable; 1 pass = Unfavourable - Inadequate; 0 passes = Unfavourable - Bad.			

HABITAT ASSESSMENT

Indicator	Target	Result	Pass/Fail
Habitat extent/quality (Transect)	• n/a	n/a	n/a
Habitat quality (Site level)	• At least one polygon containing optimal or sub-optimal habitat	All polygons classed as sub-optimal	Pass
Habitat extent (Site level)	• At least 2ha classed as optimal or optimal/sub-optimal	No areas classed as optimal or optimal/sub-optimal	Fail
Habitat quality (Site level)	• At least 40% of sampling locations have optimal wetness	Most sample points too wet. One too dry.	Fail
3 passes = Favourable; 2 passes = Unfavourable - Inadequate; 0-1 passes = Unfavourable - Bad.			

FUTURE PROSPECTS ASSESSMENT

Impact code	Impact	Source	Influence	Intensity	Area affected (%)
D01.01	Paths, tracks, cycling tracks	Inside	Neutral	Low	15%
J02.04.01	Flooding	Outside	Negative	Moderate	100%
J02.11.02	Dykes and flooding defence in inland water systems	Inside	Positive	High	100%

Future prospects have been assessed by listing all activities/impacts noted to be occurring at the site. Their source, influence, intensity and the area likely to be affected were all considered.

The tidally influenced flooding which occurs at this site is the main impact. It has been assessed as having a moderate negative impact, because although it is a natural cycle which occurs mostly within limits which are not likely to impinge on the snail, extreme flooding events are known to occur (e.g. on the day of survey) and are likely to have a negative impact on the population.

The site is managed mostly in terms of maintaining the embankments (which also act as pathways) and drains/culverts. Without maintenance of the embankments, and the drains and culverts which

allow water-flow during high tide, the site would regularly flood to a degree which would make it entirely unsuitable for *Vertigo moulinsiana.* This is therefore assessed as having a positive influence.

Given that flood level management is conducive to the survival of the species, and the pathways are unlikely to have any impact of the species, but that the flooding itself could be harmful, the future prospects for the species at the site are assessed as Unfavourable - Inadequate.

OVERALL ASSESSMENT

The overall conservation assessment for Strancally has been determined by results in each of the categories: population, habitat and future prospects. The population was found to be small, and the habitat deemed sub-optimal due to flooding. However, the owners manage the site sympathetically. Overall, the conservation assessment was deemed to be Unfavourable - Bad.

Attribute	**Assessment**
Population	Unfavourable – Bad
Habitat	Unfavourable – Bad
Future Prospects	Unfavourable - Inadequate
Overall	**Unfavourable - Bad**

Discussion

Until Dr Stephen McCormack recorded *Vertigo moulinsiana* at this site (and at one other site in Co. Waterford) there were no records for the species in Waterford or neighbouring counties on the south coast. While relatively small and isolated, and perhaps supporting a population with fluctuating numbers, nonetheless this is an important site for the species because of its geographic location.

This site is part of a designated area, and is also managed sympathetically. The fact that the site floods, however, is unusual. *Vertigo moulinsiana* is understood to require hydrological stability, and while it can withstand a certain degree of change in the water table, flooding on the scale seen at this site is at the edge of the normal range of tolerance of the species. It is perhaps not surprising then that the two positive samples at the site were also the most distant from the breach in the embankment – meaning that they are likely to be under water for the shortest period of time, and water levels will be lowest there also.

Interestingly, a number of rare and scarce beetles were recorded at the site by Dr Stephen McCormack in 2011, including the first Irish record for *Bembidion iricolor* (McCormack, 2011). This highlights the importance of this area for a range of wetland invertebrate species.

FUTURE MANAGEMENT AND MONITORING

Due to the concerns raised in the previous paragraph about flooding, and also to gain a fuller understanding of both the size of the population at the site, and its response to the regular flooding

events, this site should be surveyed again as soon as possible, and also monitored regularly. It should be given a high priority in terms of re-survey, should resources be limited. At the least, it should be monitored every three years, as recommended by Moorkens & Killeen (2011), with the next survey due in 2015. If a larger population of *Vertigo moulinsiana* is detected in future studies, or the extent of the species occurrence at the site is broadened, then a transect should be established for monitoring purposes.

As the owners of the land are interested in managing the area for conservation, contact should be made and maintained, with regular feedback on survey and monitoring results being provided if requested.

Continued management consisting of maintaining drains, culverts and embankments should be encouraged.

Results and Discussion – The Murrough

Results

GENERAL

The Murrough, Co. Wicklow was surveyed on the 14th, 15th and 16th of November 2012. Murrough maps 1 to 6 in Appendix II show the locations of sampling points, and Table A6 in Appendix III shows the grid references for all sampling points. Samples were taken in two main clusters – the first near Kilcoole, and the second in the vicinity of Five Mile Point.

The Murrough is an extensive strip of coastal wetland in Co. Wicklow, running from Kilcoole in the north to Wicklow town at the south (though it is not completely continuous). It runs for a length of approximately 12.5km, and varies in width from about 200m to 600m wide. It is freshwater in most areas, but there are also brackish sections. Large areas of reed- and sedge-beds exist, and it is these which make up the *Vertigo moulinsiana* habitat at the site.

PREVIOUS RECORDS

There is an old record for *Vertigo moulinsiana* from The Murrough by A.W. Stelfox from the 25th August 1954. The following notes accompany the record shown on the maps of the NBDC (National Biodiversity Data Centre, 2013):

> "100m west of the railway, half a mile south of Five Mile Point."
>
> "2 living in swamp by canal. Conchological Society record."

Because of this old record, the site was included for survey in 2010 by Moorkens & Killeen (2011). The species was found in the vicinity of Five Mile Point. A number of other spot samples were taken as

part of that survey – at Six Mile Point to the north, and at Ballybla and Clonmannon to the south. These locations were negative for *Vertigo moulinsiana.*

VEGETATION AND HABITAT

The plant species recorded at the sample locations are given in Appendix IV, Table A6, and the bryophytes in Appendix V, Table A5. Table A6 in Appendix IV also presents information on habitat and vegetation type; cover of elements such as bare soil, open water, litter; and a number of other variables, including vegetation height, slope and aspect. The number of vascular plant species recorded at individual sample locations ranged from two (*Phragmites australis* and *Carex acutiformis*/*riparia*) to 16 (in an area of reedbed with rich fen elements). There were 56 species recorded in total, from 24 vegetation relevés. There were only five bryophyte records, from four species.

Species of interest include *Carex acutiformis* and *Carex riparia,* and the moss *Oxyrrhynchium speciosum*. Both *Carex* species were present and widespread at the site, and both have relatively restricted distributions in Ireland. The species were not resolved at every individual relevé, however, and so they are scored together for this site in the vegetation table. *Oxyrrhynchium speciosum* is uncommon, and had not been seen in this area (vice-county) for some time. A voucher specimen has been submitted to the British Bryological Society, and it has been accepted as a 'de-bracketed' record (i.e. a 'new' record with >30 year gap to previous record).

Most samples (18 out of 24) were classified as FS1 – reed and large sedge swamps (Fossitt, 2000). Four samples were PF1 – rich fen. These two habitats graded into each other in places. Other habitats recorded were FW4 – drainage ditch and FS2 – tall-herb swamp. The NVC categories which occurred the most often (nine out of 23 samples) was S6/7 (S6: *Carex riparia* swamp, S7: *Carex acutiformis* swamp), and the following were also recorded at a number of relevés: S2 (*Cladium mariscus* swamp and sedge-beds), S4 (*Phragmites australis* swamp and reed-beds), S24 (*Phragmites australis-Peucedanum palustre* tall-herb fen) and M13 (*Schoenus nigricans-Juncus subnodulosus* mire). No areas were thought to conform to E.U. Habitats Directive Annex I standard.

TRANSECT

The extent of potentially suitable habitat at The Murrough is large, but somewhat disjointed. Additionally, sampling revealed only small numbers of the species, in isolated pockets. For these reasons it was decided not to set up a transect at that site (as had been decided by Moorkens & Killeen, 2011).

POLYGONS

Details of the polygons at this site can be found in Appendix VIII. Moorkens & Killeen (2011) had two polygons for this site, one north and one south of the road at Five Mile Point. The boundaries of these were altered in order to better reflect habitat boundaries and conditions based on further survey. A number of new polygons were also drawn.

MOLLUSCS

A total of 56 samples were taken for molluscs at The Murrough, and 247 individual molluscs were recorded, from 12 species (see Table 10). The species were a mix of wetland and terrestrial species, and *Vertigo moulinsiana* was recorded in seven samples from three locations. Species of note, apart from the target species, include *Vertigo pygmaea* and *Vertigo antivertigo*, both listed in the Irish Red List for non-marine molluscs ('Near threatened' status for the former, and 'Vulnerable' for the latter; Byrne *et al.*, 2009).

MANAGEMENT, OWNERSHIP, THREATS

There are multiple private owners of the lands at The Murrough, and one parcel is owned by BirdWatch Ireland (polygons C, D and E are located in the BirdWatch 'East Coast Nature Reserve'). This latter area is managed for conservation. Five small ponies (including Kerry Bog ponies) were introduced as grazers in recent years for conservation purposes, and specifically to keep control of the scrub at the site. Fences are maintained at this site, and walkways (including raised platforms) are provided for public access.

Other parts of this site appear to be unmanaged (e.g. northern-most polygon at Kilcoole), but some are grazed (e.g. some areas south of the road at Five Mile Point).

There are significant drains in all parts of the site, some being very large (presumably these are what Stelfox referred to when he mentioned a 'canal'). While evidence of active clearance/maintenance of these drains was not seen, most are functioning, and so are likely to see periodic management. At the southern of the two polygons at Kilcoole there was evidence of old spoil heaps.

No distinct threats were identified at the site, though any future changes in land management could have adverse effects (e.g. development of housing, work on adjacent railway line, etc.).

Table 10. Twelve mollusc species (including *Cepaea* sp. that was identified to genus) recorded from The Murrough (a – adult, j – juvenile, d – dead). Grey shading indicates samples with *Vertigo moulinsiana* present.

Sample no.:		**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8a**	**S8b**	**S8c**	**S9a**	**S9b**	**S9c**	**S10a**	**S10b**	**S10c**	**S11a**	**S11b**	**S11c**	**S12a**	**S12b**	**S12c**	**S13**	**S14**	**S15a**	**S15b**	**S15c**	**S16a**	**S16b**
Cepaea sp.	j		1																			1		1			1			
Clausilia bidentata	a					2																								
Clausilia bidentata	j					1																								
Columella aspera	a										4		2			1	3				2							1		
Columella aspera	j														1	3					2							3		
Discus rotundatus	a					3																								
Euconulus cf *alderi*	a																													
Euconulus cf *alderi*	j														1	2		1		1										
Oxyloma elegans	a																													
Oxyloma elegans	d																													
Punctum pygmaeum	a																													
Succineid	j					2	4		2	2	1		1	1									1							
Trochulus hispidus	a					4	1																					1		
Trochulus hispidus	j				1	8	9																							
Vertigo antivertigo	a									1																				
Vertigo moulinsiana	a																					1	2							2
Vertigo moulinsiana	j																						1						3	2
Vertigo pygmaea	a																													
Vertigo pygmaea	j																													
Zonitoides nitidus	j																			1										
Total for sample:		0	1	0	1	20	14	0	2	3	5	0	3	1	2	6	3	1	0	2	4	2	4	1	0	0	1	5	3	4
Wetness*:		iv	ii	ii	iv	ii	ii	iv	v	v	v	iv	iv	iv	iv	iv	iv	v	v	v	v	v	v	v		iii	iii	iii	v	v

*Wetness: (i) Dry – no visible moisture on ground surface, (ii) Damp – ground visibly damp, but water does not rise under pressure, (iii) Wet – water rises under light pressure, (iv) Very wet – pools of standing water, generally <5cm deep, (v) Site under water – entire sampling site in standing or flowing water >5cm deep.

Table 10 Contd. Mollusc species recorded from The Murrough (a – adult, j – juvenile, d – dead). Grey shading indicates samples with *Vertigo moulinsiana* present.

Sample no.:		**S16c**	**S16d**	**S16e**	**S17a**	**S17b**	**S17c**	**S17d**	**S18a**	**S18b**	**S18c**	**S19a**	**S19b**	**S20a**	**S20b**	**S20c**	**S21a**	**S21b**	**S21c**	**S22a**	**S22b**	**S22c**	**S23a**	**S23b**	**S23c**	**S24a**	**S24b**	**S24c**	**Total for site:**
Cepaea sp.	j													1							1		1			1			**8**
Clausilia bidentata	a																												**2**
Clausilia bidentata	j																												**1**
Columella aspera	a													26	1	4	1	10	1										**56**
Columella aspera	j													17	2	2		2											**32**
Discus rotundatus	a																												**3**
Euconulus cf *alderi*	a																					1							**1**
Euconulus cf *alderi*	j				1																					1			**7**
Oxyloma elegans	a							1		1																			**2**
Oxyloma elegans	d									1																			**1**
Punctum pygmaeum	a																1												**1**
Succineid	j	1		1	1	8	4	1		1						1	1						3	5		11	11	3	**66**
Trochulus hispidus	a																												**6**
Trochulus hispidus	j																												**18**
Vertigo antivertigo	a				1																						1	1	**4**
Vertigo moulinsiana	a																									1	4	16	**26**
Vertigo moulinsiana	j																												**6**
Vertigo pygmaea	a																							2		2		1	**5**
Vertigo pygmaea	j																							1					**1**
Zonitoides nitidus	j																												**1**
Total for sample:		1	0	1	3	8	4	2	0	3	0	0	0	44	3	7	3	12	1	0	1	1	4	8	0	16	16	21	**247**
Wetness*:		v	v	v	v	v	v	v	v	v	v	v	v	iii	iii	iii	v	v	v	iv	iv	iv	iii	iii	iii	iii	iii	iii	

*Wetness: (i) Dry – no visible moisture on ground surface, (ii) Damp – ground visibly damp, but water does not rise under pressure, (iii) Wet – water rises under light pressure, (iv) Very wet – pools of standing water, generally <5cm deep, (v) Site under water – entire sampling site in standing or flowing water >5cm deep.

CONSERVATION ASSESSMENT

Information presented in this section is based on the conservation assessment criteria developed by Moorkens & Killeen (2011) for the site. As in that report, only the polygons to the north and south of the road at Five Mile Point are included for assessment here, as these were the only ones with positive samples for *Vertigo moulinsiana* (polygons C, D, E, F and G).

POPULATION ASSESSMENT

Indicator	Target	Result	Pass/Fail
Presence/absence (Transect)	• n/a	n/a	n/a
Presence/absence (Site level)	• Adult or sub-adult snails are present in at least 5 samples (or 25% - minimum 20 samples) with a geographical spread on the north side of the road at Five Mile Point	Present in 2 out of 26 samples	Fail
Presence/absence (Site level)	• Adult or sub-adult snails are present in at least 5 samples (or 25% - minimum 20 samples) with a geographical spread on the south side of the road at Five Mile Point	Present in 5 out of 23 samples	Pass
2 passes = Favourable; 1 pass = Unfavourable - Inadequate; 0 passes = Unfavourable - Bad.			

HABITAT ASSESSMENT

Indicator	Target	Result	Pass/Fail
Habitat extent/quality (Transect)	• n/a	n/a	n/a
Habitat quality & extent (Site level)	• Over 75% of the samples (minimum 20) at sites on the north side of the road at Five Mile Point are dominated by suitable vegetation (Classes I & II) **And** • fall within soil moisture classes 3-5	100% of samples	Pass
Habitat quality & extent (Site level)	• Over 75% of the samples (minimum 20) at sites on the south side of the road at Five Mile Point are dominated by suitable vegetation (Classes I & II) **And** • fall within soil moisture classes 3-5	18 out of 23 (78%) samples dominated by suitable vegetation	Pass
Habitat extent (Site level)	• At least 10ha of the site sub-optimal, with optimal areas	>10ha with at least sub-optimal habitat	Pass
3 passes = Favourable; 2 passes = Unfavourable - Inadequate; 0-1 passes = Unfavourable - Bad.			

FUTURE PROSPECTS ASSESSMENT

Impact code	Impact	Source	Influence	Intensity	Area affected (%)
A04.02.01	Non-intensive cattle grazing	Inside	Neutral	Low	10%
A04.02.03	Non-intensive horse grazing	Inside	Positive	Medium	25%
A10.01	Removal of hedges and copses or scrub	Inside	Positive	Medium	15%
D01.01	Paths, tracks, cycling tracks	Inside	Neutral	Low	5%
G02.08	Wildlife watching	Inside	Neutral	Low	1%
G05.07	Fences, fencing	Inside	Neutral	Low	2%
J02.07.01	Groundwater abstractions for agriculture [Activity = drainage]	Inside	Positive	Medium	75%
K04.05	Damage by herbivores (including game species) [Activity = deer grazing]	Inside	Positive	Low	45%

Future prospects have been assessed by listing all activities/impacts noted to be occurring at the site. Their source, influence, intensity and the areas likely to be affected were all considered.

To the north of the road at Five Mile Point the land is managed for conservation by BirdWatch Ireland. Due to issues with scrub encroachment they introduced ponies for grazing approximately seven years ago. These grazers have helped to keep the vegetation open, and will continue to do so. There has also been targeted scrub removal, both mechanical and by hand, at the site.

It appears that both cattle and horses may have access to the area immediately to the south of the road. Grazing levels here are not high, and it is likely that what grazing does occur functions to maintain open and suitable habitats for *Vertigo moulinsiana*.

There were signs of deer grazing at both sides of the road.

Within the BirdWatch 'East Coast Nature Reserve' birdwatching occurs, and public access is facilitated through pathways and raised boardwalks. These activities are unlikely to have any impact on the occurrence of the snail at the site. In order to manage the ponies, fences are in place. Again, the effects of these are minimal on the habitat for the target species.

There are multiple drains at the site, and as noted above, although no evidence was seen of recent cleaning or maintenance, it is likely that they are maintained. They serve to regulate the hydrology of the area, and as such, are an integral part of the working of the habitats.

Given that the impacts listed above are considered to be neutral or positive, the future prospects for the species at the site are assessed as Favourable.

OVERALL ASSESSMENT

The overall conservation assessment for The Murrough has been determined by results in each of the categories: population, habitat and future prospects. The population was found to be small, but the area of potentially suitable habitat is large. The impacts on the site were deemed to be mostly neutral or positive. Overall, the conservation assessment was deemed to be Unfavourable – Inadequate.

Attribute	**Assessment**
Population	Unfavourable – Inadequate
Habitat	Favourable
Future Prospects	Favourable
Overall	**Unfavourable – Inadequate**

Discussion

This population of *Vertigo moulinsiana* is important due to its location, being the most easterly site for the species in Ireland, and in fact the only existing population on the east coast of Ireland. Its re-finding as part of Moorkens & Killeen's work in 2010 was the first confirmation of the record since the 1950s. While the species appears to occur in relatively low numbers at the site, it exists across an area which is over a kilometre long at least, though further positive sites may be discovered to the south.

FUTURE MANAGEMENT AND MONITORING

Following the recommendations made by Moorkens & Killeen (2011), this site should be surveyed again in three years time, i.e. in 2015. The area around (and south of) the southern-most sample of this survey (sample 24) should be investigated further, and should a sizeable population of *Vertigo moulinsiana* be found here, the setting up of a transect for monitoring purposes should be considered.

While BirdWatch staff are aware of the finding of the species at their reserve, liaison should be initiated with the manager of the 'East Coast Nature Reserve' immediately in order to inform the plans for managing the area. Local NPWS staff should endeavour to contact landowners/users for the area to the south of the road at Five Mile Point, both to inform them of the presence of a rare and protected species on their land, and also to discuss management, both current and future.

Liaison with Iarnród Éireann is also advised, due to the proximity of the railway to the occupied habitats, all along the site.

Direct management changes are not needed currently – light grazing in some areas where scrub is an issue is already occurring, and drains appear to be maintained, thus ensuring a relatively stable hydrological régime.

Oxyloma sarsi

Introduction

Oxyloma sarsi (slender amber snail) is a member of the Family Succineidae, and is a species of wetland habitats (Plate 3). It is very similar in appearance to the more common and widespread *Oxyloma elegans,* and the two species can only be reliably differentiated by dissection. *Oxyloma sarsi* was first confirmed from Ireland in 2004, when it was found near Banagher Bridge in Co. Galway (Holyoak & Holyoak, 2005). This species is also uncommon in the United Kingdom, being largely limited to a few locations in eastern England. Further work by Holyoak (2006) resulted in the finding of the species at three other locations nearby (from six samples), all in Co. Offaly. It is likely that this species has been overlooked by malacologists in Ireland due to its external similarity to the closely related *Oxyloma elegans*.

Plate 3: Juvenile *Oxyloma sarsi.* (© Roy Anderson)

Oxyloma sarsi was found on exposed mud and vegetation within the flood zone at Banagher Bridge (Holyoak & Holyoak, 2005), and was associated with *Glyceria maxima* or bare mud at the other Irish sites (Holyoak, 2006). Other plant species with which it was associated in Ireland include the uncommon species *Alisma lanceolatum* and *Sium latifolium*. Kerney and Cameron (1979) note the species habitat as "richly vegetated fens and marshes, characteristically on *Glyceria* and floating waterplants".

Methodology

Field survey

SURVEY SITES

All sites with previous records for *Oxyloma sarsi* were again re-visited and sampled, and an additional four sites were also surveyed in order to try to expand the known range of the species. Potentially suitable sites were chosen by using aerial photographs and other available habitat information (e.g. site notes from NPWS surveys). The sites surveyed are listed in Table 11.

Table 11. List of sites surveyed between Shannonbridge and Portumna for *Oxyloma sarsi*.

Site name	Code used	Habitat	Name of watercourse
Banagher Bridge	BB	River bank vegetation	River Shannon
Shannon Harbour	SH	Canal bank vegetation, also ditch	Grand Canal, and ditch
near Shannon Bridge	SB	Vegetated ditch in field	River Shannon
Ferbane	Fb	Canal bank vegetation	Grand Canal
Gortachallow	Gc	River bank vegetation, also ditch	Tributary of River Shannon
Victoria Lock	VL	River bank vegetation, also ditch	River Shannon, and ditch
Portland Park	PP	River bank vegetation	River Shannon
Ballymacegan	Bme	River bank vegetation	River Shannon

TIMING

Autumn is generally a good time of year to survey for molluscs. Breeding events will have taken place during the summer in many species, and weather conditions are generally suitable as it is usually not very dry at this time of year, nor is it very cold (Cook, 2001). The survey work for this species took place in early November.

SAMPLING - MOLLUSCS

Oxyloma sarsi is a large species (10-20mm), as is the similar *Oxyloma elegans*, and so individuals can readily be seen in the field. Initial searches for the *Oxyloma* morphotype were undertaken, including areas of bare mud under vegetation. Vegetation was beaten over a white tray (approx. 50x50cm) in areas of suitable habitat, and molluscs collected on the tray were either identified in the field and recorded, or transferred into glass jars for return to the laboratory. Specimens were placed in water-filled jars with tight-fitting lids in order to drown them prior to preservation in 70% IMS (industrial methylated spirits). This procedure preserves them in the relaxed state necessary to allow for their dissection, which is needed for the separation of *Oxyloma sarsi* from *Oxyloma elegans*. All Succineids encountered were removed for processing in the laboratory, and a sub-set were sent for confirmation by dissection.

Samples were taken from spot locations in suitable habitat patches, the locations of which were recorded using a hand-held GPS (Garmin GPS72H). Digital photographs were taken at each sampling location. The degree of wetness was recorded at each sampling location using the following scale:

(i) inundated,
(ii) saturated, (water visibly rising following hand or foot pressure),
(iii) dry (water not visibly rising following hand or foot pressure).

Notes on ownership, threats and management, including grazing level, were also made. Transect sampling was not carried out for this species, largely due to the narrow nature of most habitat patches, and also the fact that it is not possible to confirm the presence of the species in the field.

At each site, areas containing potentially suitable habitat for *Oxyloma sarsi* were mapped as polygons, with these being assigned to either 'optimal', 'sub-optimal' or 'unsuitable' categories. Where possible, obvious physical boundaries were chosen for the polygons (e.g. fences, paths), but often it was necessary to use boundaries between habitat types to delineate them. Defining the polygons for *Oxyloma sarsi* was somewhat easier than for the *Vertigo* species in this survey, due to the often well-defined linear strips of potentially suitable vegetation.

Definitions of habitat suitability categories for *Oxyloma sarsi* were not available, and thus provisional definitions are presented here (Table 12). As the ecology of this species in Ireland is only beginning to be understood, these definitions may be revised and updated over time. Currently they are based on expert judgement and the results of field surveys.

Table 12. Definitions of optimal and sub-optimal habitat conditions for *Oxyloma sarsi*.

Definition of optimal habitat	These habitats could support *Oxyloma sarsi* in over 50% of their area. This allows for some areas of unsuitable vegetation and/or substrate to be present. Ideal habitat conditions appear to consist of a muddy substrate, with relatively large-growing vegetation, usually found in areas with standing water. Drains, canals and banks of large rivers can all satisfy these habitat requirements. *Glyceria maxima* was the most commonly recorded dominant plant (six of our eight samples were dominated by it, one had it as a co-dominant, and only a single sample had a different dominant species – *Phalaris arundinacea*), though *Phragmites australis* and *Phalaris arundinacea* were often important vegetation components also.
Definition of sub-optimal habitat	These areas will resemble the above, but lack some element – e.g. bare mud substrate, adequate hydrological regime, or perhaps have an unsuitable suite of plant species. Generally, the target species would be unlikely to be found in the majority of the habitat, though some suitable patches may occur.

SAMPLING - VEGETATION

In addition to taking samples for molluscan analysis, full details of the vegetation (vascular plants and bryophytes) were also recorded. A species list, with percentage cover for each species, was generated for a 5x5m area around each sampling point. Other relevant ecological details recorded included:

- Percentage cover of
  - bare soil
  - bare rock
  - open water
  - litter
  - bryophytes
  - field layer
  - broadleaf herbs
- Vegetation height - average, maximum and minimum
- Slope
- Aspect
- Habitat type, following three schemes:
  - 'A Guide to Habitats in Ireland' (Fossitt, 2000)
  - NVC category (Rodwell, 1991; 1992; 1995)
  - E.U. Habitats Directive Annex I habitat type (Anon. 2007; Anon. 2008), if applicable.

Laboratory analysis

Specimens which were collected in the field were sorted, counted and identified (except those in the Succineid family – see below) in the laboratory. Mollusc species were identified using Cameron (2003) and Kerney & Cameron (1979) for terrestrial and wetland species, and Macan (1977) for aquatic species. All specimens were assigned as either adult (a), juvenile (j) or dead (d). Dead signifies specimens which were clearly long-dead.

In the case of Succineids (i.e. members of the Family Succineidae), the largest specimens from each sample location were sent to Dr Roy Anderson for dissection and consequent identification. Examples of *Oxyloma sarsi* from a selection of positive sites have been lodged as voucher specimens with the National Museum, Dublin.

Results and Discussion

Results

GENERAL AND PREVIOUS RECORDS

The surveys for *Oxyloma sarsi* were carried out on the 5th and 6th of November 2012, across a number of locations between Shannonbridge and Portumna (eight Shannonbridge – Potumna maps in Appendix II shows the locations of the sampling points, and Table 11 above summarises this information. Table A7 in Appendix III provides the grid references for the sampling locations). In addition, *Oxyloma sarsi* was recorded from a nearby area, Lehinch, approximately 1.5km east of Portumna, while surveying

for *Vertigo moulinsiana* (sample 5b from that survey). The data for this sample (e.g. molluscan species, vegetation, etc.) have been presented in the section on *Vertigo moulinsiana*.

The habitats sampled consisted mostly of bankside vegetation, of both rivers and canals (see Table 12 above for more details). At most sites, the bankside vegetation sampled was dominated by *Glyceria maxima*, with *Phalaris arundinacea* and *Phragmites australis* also common. All habitat patches sampled were linear, and most were small in extent.

Details of the previous records for this species have been given above in the introduction to this section.

VEGETATION AND HABITAT

Details on the vegetation and habitats recorded at each of the sampling locations can be found in Table A7 (Appendix IV), and bryophyte data is in Table A6 (Appendix V). Cover of elements such as bare soil, open water, litter, and a number of other variables (e.g. vegetation height, slope, aspect) are also provided in these tables. A total of 57 vascular plants were recorded from the 15 relevés, with a range of three to 16 species recorded from individual plots. Four bryophyte species were recorded. Species of note include the invasive non-native water fern, *Azolla filiculoides*, and the relatively uncommon horsetail species *Equisetum variegatum*.

The habitats recorded at the study sites were FS1 (reed and large sedge swamp), FW4 (drainage ditch), GS4 (wet grassland) and FW3 (canals) (Fossitt, 2000). The main NVC vegetation classifications recorded were S5 (*Glyceria maxima* swamp) and S28 (*Phalaris arundinacea* tall-herb fen). No areas were classified as being of E.U. Habitats Directive Annex I quality.

POLYGONS

A total of eleven habitat polygons were drawn at the eight sites visited. All polygons surveyed are listed in Table A7 (Appendix VIII). These mostly consist of strips of potentially suitable vegetation and habitat, along water features such as rivers, canals and drainage ditches. Five polygons were classed as optimal, two as optimal/sub-optimal, three as sub-optimal and one as sub-optimal/unsuitable. The latter consisted of a small area of canal bank habitat at Ferbane. Assignment to habitat suitability categories was based on vegetation composition, vegetation structure, substrate and wetness, and reference was made to the habitat suitability definitions presented above (Table 12).

As mentioned above, *Oxyloma sarsi* was also found at Lehinch while surveying for *Vertigo moulinsiana*. The habitat polygon drawn at that site for *Vertigo moulinsiana* is coincident with that for *Oxyloma sarsi*. Details of this site can be found in the section on *Vertigo moulinsiana.* The habitat was classed as optimal for *Oxyloma sarsi.*

MOLLUSCS

A total of 22 molluscan species (Table 13) were recorded from the 16 samples at eight survey locations. There were 768 individuals processed in all. Eight of these samples contained *Oxyloma sarsi*, confirmed by dissection by Dr Roy Anderson. The samples were dominated by Succineids – i.e. specimens belonging to either one of the *Oxyloma* species or one of the *Succinea* species (with *Succinea putris* being the most likely). The next most numerous species was found in only two samples, and was the rare *Vertigo moulinsiana.* The samples were thus composed principally of wetland mollusc species.

Note that *Oxyloma sarsi* was also recorded at one of the *Vertigo moulinsiana* survey sites, Lehinch. Data on this site is presented in the section on *Vertigo moulinsiana*.

Other species of note recorded include two which are listed as 'Vulnerable' in the Red List for non-marine molluscs, *Aplexa hypnorum* and *Vertigo antivertigo* (Byrne *et al.*, 2009). *Bithynia leachii* is of interest as it is probably a introduced species in Ireland (first record 1908). It has been recorded only relatively recently from the Shannon lakes (Roy Anderson, pers. comm.). *Planorbarius corneus* is also an introduced species, though it is relatively widespread in the country now. It has only recently spread widely throughout the Shannon water system (Roy Anderson, pers. comm.).

MANAGEMENT, OWNERSHIP, THREATS

There are multiple private owners of the sites visited during this survey, but it is understood that some of the land may be owned by ESB. Most areas sampled consisted of narrow fringes of vegetation between open water and land (typically grazed agricultural grassland), and as such do not appear to be managed. However, management of both the adjacent grasslands (in terms of grazing levels and application of chemicals) and the adjacent waterways (e.g. alteration of water levels) could have impacts on the molluscan habitat. If recreational use of some areas (e.g. sample site 3 is close to a path, and a canal where boats are moored) were to increase, there could be an impact on *Oxyloma sarsi* habitat. Drain clearance works, if not carried out stepwise or with other sympathetic considerations, could pose a threat to the species. However, evidence of drain dredging or clearance was not noted at the site.

At Gortachallow there is a boatyard adjacent to the sample sites, and there is evidence of some development associated with the yard in the past (perhaps a planned expansion of the yard?), though this area is now reverting to semi-natural vegetation. At Ballymacegan works had been carried out on nearby stretches of bank habitat, the purpose of which is not clear. They resulted, however, in the removal of part of the strip of vegetation inhabited by *Oxyloma sarsi*.

Table 13. Twenty-two mollusc species recorded from sites surveyed for *Oxyloma sarsi* (a – adult, j – juvenile, d – dead). Grey shading indicates samples in which *Oxyloma sarsi* or *Vertigo moulinsiana* were present.

Location code*:		**BB**	**BB**	**SH**	**SH**	**SH**	**SB**	**SB**	**Fb**	**Gc**	**Gc**	**Gc**	**VL**	**VL**	**PP**	**PP**	**Bme**	
Sample no.:		**S1**	**S2**	**S3a**	**S3b**	**S4**	**S5a**	**S5b**	**S6**	**S7a**	**S7b**	**S7c**	**S8a**	**S8b**	**S9a**	**S9b**	**S10**	**Total for site:**
Anisus leucostoma	a		2			1		1			2							**6**
Aplexa hypnorum	a					7	2											**9**
Balea cf *heydeni*	j							1										**1**
Bithynia leachii	j								1									**1**
Bithynia tentaculata	a					1												**1**
Bithynia tentaculata	d		3			2				1								**6**
Cepaea hortensis	a									1								**1**
Cepaea sp.	j		1			2				8			1					**12**
Cornu asperum	j	1								1								**2**
Galba truncatula	j														10			**10**
Lymnaea fusca	a					1												**1**
Lymnaea fusca	j					2	1				3							**6**
Lymnaea stagnalis	a	1		1		1												**3**
Lymnaea stagnalis	d					1												**1**
Oxyloma elegans	a			3							4			2		1	1	**11**
Oxyloma sarsi	a		2	1	2						1		3	1	2		2	**14**
Oxyloma sp.	j	1	22	48	19			4	3		34	21	47	61	40	4	113	**417**
Oxyloma sp.	d							1				1	13		2	1	2	**20**
Planorbarius corneus	a					1												**1**
Planorbis cf *carinatus*	d					1												**1**
Planorbis planorbis	a													1				**1**
Radix balthica	d					1				1								**2**
Sphaerium corneum	a					2												**2**
Succineid	j					2												**2**
Trochulus hispidus	j				1													**1**
Trochulus striolatus	a					2												**2**
Trochulus striolatus	d		1															**1**
Vertigo antivertigo	a													1				**1**
Vertigo moulinsiana	a														26	1		**27**
Vertigo moulinsiana	j														200	2		**202**
Zonitoides nitidus	j												3					**3**
Total for sample:		3	31	53	22	27	3	7	4	12	44	22	67	66	280	9	118	**768**
Wetness:**		ii	ii	i	i	i	i	i	i	i	i	i	i	i	i	i	i	

*Location code: BB=Banagher Bridge, SH=Shannon Harbour, SB=near Shannon Bridge, Fb=Ferbane, Gc=Gortachallow, VL=Victoria Lock, PP=Portland Park, Bme=Ballymacegan.
**Wetness: (i) inundated, (ii) saturated, (iii) dry.

CONSERVATION ASSESSMENT

Conservation assessment criteria do not exist for *Oxyloma sarsi* both because it is not listed in the E.U. Habitats Directive and because its presence in Ireland has only been relatively recently confirmed. The species' status is discussed here, closely following the process and rationale used for the *Vertigo* species above. It should be borne in mind that any assessment of the status of this particular species will be hampered by the fact that it cannot be identified in the field, and therefore only a limited number of individuals will usually be identified with certainty. This results in poorer knowledge on

the size of the population, as well as its range, when compared to other more readily identifiable species.

POPULATION ASSESSMENT

This species was originally recorded from four locations, all within an approximately 12km stretch near Banagher. The current survey re-confirmed it's presence at all of these locations, and added a further three (this includes the site at Lehinch, recorded during survey work for *Vertigo moulinsiana*). The furthest of these is located 27km from Banagher. Thus, at present, the known range for the species is expanding, and until further surveys are carried out, population assessments can only be provisional.

If the range of the species is not much further expanded, the following could be useful as criteria for assessing the status of the population:

Indicator	Target	Result	Pass/Fail
Presence/absence (Transect)	• n/a	n/a	n/a
Presence/absence (Site level)	• The species is confirmed as present in at least five locations with a geographical spread between Shannonbridge and Portumna	Present at seven locations	Pass
Presence/absence (Site level)	• The species is confirmed as present in more than one sample from at least three locations	Present in two samples at three locations	Pass
2 passes = Favourable; 1 pass = Unfavourable - Inadequate; 0 passes = Unfavourable - Bad.			

HABITAT ASSESSMENT

Indicator	Target	Result	Pass/Fail
Habitat extent/quality (Transect)	• n/a	n/a	n/a
Habitat quality (Site level)	• Over 50% of the samples (minimum 10) are dominated by suitable vegetation and have suitable substrate and hydrology	80% of samples with suitable vegetation	Pass
Habitat extent (Site level)	• At least 4.5ha of the site sub-optimal, with optimal areas	>5ha with at least sub-optimal habitat	Pass
Habitat extent (Site level)	• At least three polygons with optimal habitat	5 polygons with optimal habitat	Pass
3 passes = Favourable; 2 passes = Unfavourable - Inadequate; 0-1 passes = Unfavourable - Bad.			

FUTURE PROSPECTS ASSESSMENT

Impact code	Impact	Source	Influence	Intensity	Area affected (%)
A10	Restructuring agricultural land holding [Activity = bankside works with unknown purpose]	Inside	Negative	High	2%
J02.07.01	Groundwater abstractions for agriculture [Activity = drainage]	Inside	Positive	Low	5%

Future prospects have been assessed by listing all activities/impacts noted to be occurring at the site. Their source, influence, intensity and the areas likely to be affected were all considered.

The sites are largely unmanaged at present, with most activities occurring in adjacent areas and unlikely to be impacting on the site (and thus they are not accessed here). The works at Ballymacegan were the only damaging activity noted. The presence of drainage ditches are likely to increase potential habitat for this species, and so this impact has been assessed as positive. Overall, the future prospects have been assessed as Favourable.

OVERALL ASSESSMENT

The overall conservation assessment for *Oxyloma sarsi* at the study sites in the Shannonbridge to Portumna area is determined by results in each of the categories: populations, habitat and future prospects. The population appears to be sizeable, with the species being confirmed (by dissection) from eight out of 16 samples (or six out of eight locations, with an additional site near Portumna town also found). Suitable habitat was found at most sample sites, and the habitat assessment was Favourable. One negative impact with a high intensity was recorded, but this was over a very small area. The future prospects were overall assessed as Favourable. Thus, the conservation assessment is deemed to be Favourable.

Attribute	**Assessment**
Population	Favourable
Habitat	Favourable
Future Prospects	Favourable
Overall	Favourable

Discussion

The finding of this species in Ireland for the first time by Holyoak & Holyoak (2005) was of great significance. Our knowledge of the species has been enhanced by the current survey, with its presence at all previous sites being re-confirmed, and an additional three new sites having been added, expanding the known range of the species to the south by a number of kilometres.

FUTURE MANAGEMENT AND MONITORING

Although this species is not listed in the E.U. Habitats Directive, it is nonetheless an uncommon species, and one only recently added to the Irish fauna. Therefore, it would be desirable to survey and monitor this species following the same guidelines as those set for the protected *Vertigo* species i.e. three-yearly intervals, with next survey due 2015. While the range of the species has been expanded as a result of this current project, it is possible that further sites for it will be discovered in the region. Consequently, surveys should endeavour to sample outside the current known range.

All survey sites consisted of narrow, linear habitat patches. Pending further survey work, a site more suited to transect survey may be found. Should this be the case, transect monitoring should be considered.

The only direct and negative impact noted on the habitat of this target species was the bankside works at Ballymacegan. NPWS should attempt to identify the landowner and seek to stop any further destruction of bankside habitat. This is important not only from the point of view of protecting the habitat of this rare species, but may also be important for the river as a whole, as bankside works can lead to erosion, instability and other issues.

A number of potential future threats have been mentioned above, but not listed during assessment, as no evidence of them occurring currently was seen. These included potential water level change and run-off from agricultural fields. The former could have very serious consequences for the snail in the future, and liaison with County Councils and other bodies associated with managing water levels in the system will be important. In terms of the latter, liaison with local landowners is crucial, and may help to ensure that agricultural run-off does not impact on the often small and vulnerable habitat patches that this species relies upon. Consultation and advice to landowners on sympathetic drain management (e.g. staggered and stepwise clearance) could also be beneficial.

Omphiscola glabra

Introduction

Omphiscola glabra (mud snail) is a freshwater snail of the Family Lymnaeidae. It is a tall-spired species, and can reach 20mm in height. It has a small aperture; only ⅓ the height of the shell (Plate 4). This species typically inhabits relatively acidic, nutrient-poor, temporary wetlands, some of which may be very small in extent. It appears to be sensitive to nutrient enrichment. Habitats include areas such as marshes, ditches and ponds (often temporary). Hurley (1981) provides a detailed description of the habitat and vegetation in the area the species was found in the Wexford site. As noted in Macadam (2006) these water-bodies are often challenging habitats in which to survey, and indeed they are often seen as inferior wildlife habitats, with low numbers of associated species (both plant and animal). The species itself can pose challenges, with population numbers fluctuating from year to year, and in situations where the habitat dries out in summer the species can burrow into the soft mud.

Omphiscola glabra was formerly more widespread in lowland Britain, where it has undergone a serious decline and is now classified as nationally scarce (Killeen, 2008). The species has always been rare in Ireland, with the last confirmed colony (before the recent re-discovery) being destroyed by drainage and land modification in 1980 (Hurley, 1981). Even considering the recent re-discovery, it is still one of

the rarest species of mollusc in Ireland (Byrne *et al.*, 2009). The species was found near Carrickavrantry Reservoir, Co. Waterford in 2009 at the base of *Menyanthes trifoliata* plants in a spring-fed acidic mire (Anderson & McCormack, 2010). It was also believed to have been found at a number of turloughs in the west of Ireland (Porst & Irvine, 2009a, b; Porst *et al.*, 2012).

Plate 4: *Omphiscola glabra* (© Roy Anderson)

Methodology

Field survey

TIMING

The surveys for this species took place in October. Autumn is generally a good time of year to survey for molluscs; breeding events will have taken place during the summer in many species, and weather conditions are generally suitable - not too dry, but not yet too cold (Cook, 2001).

SAMPLING – MOLLUSCS

Omphiscola glabra is a relatively large species, but can nonetheless be difficult to find. It is often present only in small numbers, and is known to burrow into soft substrates. Sampling was carried out using a standard pond net (25x25cm, with 1mm mesh). Suitable habitat areas were swept or dipped, with multiple repeats around each sample point. The contents of the net were emptied into write trays to scan for the presence of the target species. This material was then transferred to labelled containers, preserved with 70% IMS (industrial methylated spirits) and returned to the laboratory for processing

and identification. Samples were taken from four or five spot locations in suitable habitat patches at each site, the locations of which were recorded using a hand-held GPS (Garmin GPS72H). Photographs were taken using a digital camera at sample locations. Additional mini-spot samples were taken across the survey area at both sites in order to increase the chances of finding the target species. Details of these additional sample areas were not recorded unless the target species was found.

In order to attempt to broaden the range of the species near the Carrickavrantry site, a nearby wetland area, Fennor Bog, was also sampled. Seven mini-samples were taken at a number of locations but the species was not found.

Notes on ownership, threats and management were also made. Transect sampling was not carried out. Habitat polygons were drawn at each study site, based on habitat suitability for the species. These were assigned to either 'optimal', 'sub-optimal' or 'unsuitable' categories. Where possible, obvious physical boundaries were chosen for the polygons (e.g. fences, paths), but often it was necessary to use boundaries between habitat types to delineate them. Definitions of habitat suitability categories for *Omphiscola glabra* were not available, and thus provisional definitions are presented here (Table 14). As the ecology of this species in Ireland is not well-understood, these definitions may need to be revised or updated. Currently they are based on expert judgement and information from the published studies mentioned in the introduction.

Table 14. Definitions of optimal and sub-optimal habitat conditions for *Omphiscola glabra*.

Definition of optimal habitat	*Omphiscola glabra* is always found in acidic, base-poor areas, and typically in habitats with a degree of water fluctuation. It inhabits habitat patches which are often small and ephemeral, though it can also be associated with larger wetlands, or the fringes of these. There will often be bare mud at certain times of the year, and sometimes, though not always, associated plant and faunal species are limited in number (presumably due to the challenging nature of the habitat). Defining the habitat for this species is difficult (Killeen, 2008). In Ireland we have descriptions for two distinct habitat types which have supported the species within the past 35 years. (i) a poorly-defined, shallow, narrow, slow-flowing drain at the edge of an arable field (Hurley, 1981). The drain was overgrown by grasses, and other plant species in and near the drain included *Montia Fontana, Rumex acetosella* and starworts (*Callitriche* spp.). The substrate was muddy and littered with leaves. (ii) A small acidic spring-fed fen, with a floating scraw vegetation comprising *Juncus acutiflorus, Juncus effusus, Eriophorum angustifolium, Menyanthes trifoliata, Carex rostrata* and *Typha latifolia.* To constitute optimal habitat for the species, it should be able to survive in over 50% of the area of the habitat. This allows for some areas of unsuitable vegetation and/or substrate to be present.
Definition of sub-optimal habitat	In sub-optimal areas, the species would not be expected to survive in the majority of the habitat, though small areas which are suitable may occur.

SAMPLING – VEGETATION

In addition to taking samples for molluscan analysis, full details of the vegetation (vascular plants and bryophytes) were also recorded. A species list, with percentage cover for each species, was generated for a 5x5m area around each sampling point. Other relevant ecological details recorded included:

- Percentage cover of
  - bare soil
  - bare rock
  - open water
  - litter
  - bryophytes
  - field layer
  - broadleaf herbs
- Vegetation height - average, maximum and minimum
- Slope
- Aspect
- Habitat type, following three schemes:
  - 'A Guide to Habitats in Ireland' (Fossitt, 2000)
  - NVC category (Rodwell, 1991; 1992; 1995)
  - E.U. Habitats Directive Annex I habitat type (Anon. 2007; Anon. 2008), if applicable.

Laboratory analysis

Specimens which were collected in the field were sorted, counted and identified in the laboratory. Mollusc species were identified using Macan (1977) for aquatic species, and Cameron (2003) and Kerney & Cameron (1979) for terrestrial and wetland species. All specimens were assigned as either adult (a), juvenile (j) or dead (d). Dead signifies specimens which were clearly long-dead.

Results and Discussion - Carrickavrantry

Results

GENERAL

The survey for *Omphiscola glabra* at Carrickavrantry Reservoir, Co. Waterford was carried out on 16th October 2012. The Carrickavranty in Appendix II shows the locations of main sampling points at the site, and Table A8 in Appendix III gives the grid references for these. As noted above, a number of additional mini-spot samples were taken at locations across the site in an attempt to locate the species. As it was not found, information was not recorded at all of these points.

The site at Carrickavrantry is located approximately 3.5km west of Tramore in Co. Waterford, and it is just south of a County Council owned reservoir. It is a small acidic fen, with a large area of floating vegetation. Species such as *Juncus acutiflorus, Juncus effusus, Eriophorum angustifolium, Typha latifolia* and *Menyanthes trifoliata* are common. The habitat is well-defined, being surrounded by grassland and forestry plantations.

The nearby area of Fennor Bog was visited and a number of mini-samples taken. The target species was not found.

PREVIOUS RECORDS

Omphiscola glabra was recorded at this site for the first time in 2009 by Roy Anderson and Stephen McCormack (Anderson & McCormack, 2010). Following dedicated and prolonged searching, a total of only seven specimens were recorded at that time, and only three of these were adults. Detailed information from that survey on the vegetation and habitat, along with grid references, were made available for this survey.

VEGETATION AND HABITAT

The plant species recorded at Carrickavrantry are listed in Table A8, Appendix IV. A total of 17 vascular plants were recorded, and only a single bryophyte species – *Calliergon cordifolium*, with a cover of 1% in Sample 2. All samples were classified as PF2 (poor fen and flush) according to Fossitt (2000), and M9 (*Carex rostrata-Calliergon cuspidatum/giganteum* mire) following the NVC classification scheme.

TRANSECT AND POLYGONS

Due to the failure to locate the species, no transect was established at the site during this survey.

One habitat polygon was mapped, and assigned a category of 'optimal' due to the recent record of the species from the site indicating its suitability.

MOLLUSCS

Nine species of mollusc were recorded from Carrickavrantry (Table 15). The samples were dominated by the aquatic planorbid species *Anisus leucostoma*, with the tiny bivalve *Pisidium* also being very common. Of note is the occurrence of *Aplexa hypnorum* and *Vertigo antivertigo*, both species which are listed as 'Vulnerable' in the Irish Red List (Byrne *et al.*, 2009).

As part of the additional mini-samples taken, one old, dead, damaged shell was found which is likely to have been *Omphiscola glabra*. The area around where this shell was found was searched intensively for live shells, but none were found.

Table 15. Nine mollusc species (including *Pisidium* sp. that was indetified to genus) recorded from Carrickavrantry. (a – adult, j – juvenile, d – dead)

Sample no.:		S1*	S2	S3	S4	Total for site:
Anisus leucostoma	a	20	2	90	12	**124**
Anisus leucostoma	j	2	2	70	30	**104**
Anisus leucostoma	d	1				**1**
Aplexa hypnorum	a	3	2	1	2	**8**
Aplexa hypnorum	j			16		**16**
Aplexa hypnorum	d			1		**1**
Galba truncatula	j	6				**6**
Lymnaea fusca	a	3			1	**4**
Lymnaea fusca	j	6			12	**18**
Oxyloma elegans	j	2	1	1	2	**6**
Pisidium sp.		70	65	38	45	**218**
Radix balthica	a				4	**4**
Radix balthica	d				2	**2**
Vertigo antivertigo	a	1				**1**
Zonitoides nitidus	a			1		**1**
Total for sample:		114	72	218	110	**514**

*Due to a large volume of shells, and the lack of the target species among them, S1 was sub-sampled.

MANAGEMENT, OWNERSHIP, THREATS

The site is owned by Waterford County Council, along with the adjacent reservoir. There appears to be no management activity occurring in the habitat which was surveyed. The main threats to the site are possible scrub expansion (this is already happening in the habitat patch directly south of the surveyed area) and possible run-off from agriculture. Neither of these impacts are currently occurring on-site, and so these are not assessed.

CONSERVATION ASSESSMENT

Conservation assessment criteria do not exist for *Omphiscola glabra* both because it is not listed in the E.U. Habitats Directive and because its presence in Ireland has only been relatively recently re-confirmed. The species' status is assessed here, closely following the process and rationale used for the *Vertigo* species above.

POPULATION ASSESSMENT

This species was recorded from this site for the first time in 2009, when seven individuals were found. The site was re-surveyed as part of this project, but the species was not found.

Indicator	Target	Result	Pass/Fail
Presence/absence (Transect)	• n/a	n/a	n/a
Presence/absence (Site level)	• The species is confirmed as present at the fen in Carrickavrantry	Not confirmed	Fail
Presence/absence (Site level)	• The species is confirmed as present in more than one location at the site, with samples being >25m apart	No positive samples	Fail
2 passes = Favourable; 1 pass = Unfavourable - Inadequate; 0 passes = Unfavourable - Bad.			

HABITAT ASSESSMENT

Indicator	Target	Result	Pass/Fail
Habitat extent/quality (Transect)	• n/a	n/a	n/a
Habitat extent (Site level)	• At least some optimal habitat existing	Entire polygon is optimal	Pass
Habitat extent (Site level)	• At least 2.5ha of optimal or sub-optimal habitat exist	2.8ha of optimal habitat	Pass
Habitat quality (Site level)	• Over 25% of the samples (minimum 5) are dominated by suitable vegetation or consist of potentially suitable habitat	100% of samples	Pass
3 passes = Favourable; 2 passes = Unfavourable - Inadequate; 0-1 passes = Unfavourable - Bad.			

FUTURE PROSPECT ASSESSMENT

Impact code	Impact	Source	Influence	Intensity	Area affected (%)
K04.05	Damage by herbivores (including game species) [Activity = deer grazing]	Inside	Positive	Low	100%

Future prospects have been assessed by listing all activities/impacts noted to be occurring at the site. Their source, influence, intensity and the areas likely to be affected were all considered.

The site appears to be unmanaged, but deer tracks were noted in a number of places within the fen. Due to the lack of activities and consequent impacts, the future prospects have been assessed as Favourable.

OVERALL ASSESSMENT

The overall conservation assessment for *Omphiscola glabra* at Carrickavrantry is determined by results in each of the categories: populations, habitat and future prospects. The population would appear to be small at the site, and the failure to re-find it during this survey, in spite of dedicated and careful searching, is not encouraging. The entire habitat area surveyed was deemed to be optimal, resulting in a habitat assessment of Favourable. As there appear to be few impacts apart from deer grazing, the future prospects were assessed as Favourable. Overall, the conservation assessment is deemed to be Unfavourable – Bad.

Attribute	Assessment
Population	Unfavourable - Bad
Habitat	Favourable
Future Prospects	Favourable
Overall	Unfavourable - Bad

Discussion

The location of this species at Carrickavrantry in 2009 by Anderson and McCormack was of great significance as this species had been classed as 'Regionally Extinct' in the recent Red List (Byrne *et al.*, 2009). However, in spite of considerable effort, they recorded only three adults and four juveniles, indicating a small, or well-hidden, population. This survey failed to re-find the species living at the site (though one damaged, dead shell was found), even though detailed information had been provided on the habitat and location of the species. It is clear that this is a difficult species to survey for, not least because of its fluctuating population numbers and its tendency to burrow into soft mud. Its status at Carrickavrantry is thus uncertain, but it is hoped that the species continues to exist there, albeit in low numbers.

FUTURE MANAGEMENT AND MONITORING

It is of the utmost importance to re-survey the Carrickavrantry site again as soon as possible in order to determine if the population still exists. Thus a re-survey is recommended in the period March-May in 2014. Surveying early in the season, rather than late, as in the current survey, may help to provide a more successful outcome.

Omphiscola glabra is one of Ireland's rarest molluscs, and although it is not listed in the E.U. Habitats Directive, it is nonetheless desirable to survey and monitor this species in the medium-term following the same guidelines as those set for the protected *Vertigo* species i.e. three-yearly intervals.

In any future surveys, specimens should be identified in the field (the species is large enough to make this feasible) by an expert, and only a very low number removed to lodge as vouchers to reduce the impact on the population. Future surveys should also endeavour to sample other suitable habitat patches in the vicinity of this site, and also further afield in the south-east of the country.

Contact should be made with Waterford County Council to inform them of the presence of *Omphiscola glabra* on their land at Carrickavrantry. In particular, the importance of maintaining the water table at the site should be discussed.

Results and Discussion – Brierfield

Results

GENERAL

The survey for *Omphiscola glabra* was carried out in Brierfield Turlough, Co. Roscommon on 11th October 2012. The Brierfield map in Appendix II shows the sampling points, and Table A9 in Appendix III provides the grid references for these.

Briefriield Turlough consists of two main basins, one with a layer of peat, and it retains some water during the summer in a number of deep drains and small pools. There are a number of different vegetation types within the site. These appear to be determined largely by wetness, but in drier areas, by land management also. Some areas are grazed and some mown. A sizeable area of standing water was present at the time of survey.

PREVIOUS RECORDS

Omphiscola glabra had been recorded from Brierfield turlough by Gwendolin Porst as part of aquatic invertebrate survey work carried out for her PhD thesis (Porst & Irvine, 2009a, b). This is a very unusual habitat type for this species; it is generally found in base-poor or acidic environments. Additionally, all previous records for this species are from the south and south-east of the country. Porst additionally recorded the species from two other turloughs, Roo West on the Clare/Galway border, and Caranavoodaun in Co. Galway (Porst & Irvine, 2009b, Porst *et al.*, 2012). At the early stages of this project some doubt was expressed over the verification of the identity of these specimens. Thus part of the remit of the current project was to re-examine the original specimens collected by Porst at Brierfield (and other sites), if they were available.

VEGETATION, HABITAT, TRANSECT, POLYGONS

Five vegetation samples revealed a total of 23 plant species from Brierfield turlough (Table A9, Appendix IV). There was only a single bryophyte record – Sample 4, *Calliergonella cuspidata,* at a cover of 1%. All samples fall within the Fossitt (2000) category of turlough (FL6), a habitat type which is listed with priority status in the E.U. Habitats Directive.

Due to the unsuitability of the habitat type, and the failure to find the species, a transect was not set up at this site.

A single polygon was mapped, delineating the turlough basin, and it was classified as 'unsuitable'.

MOLLUSCS

The snail fauna from the five samples taken at the turlough are shown in Table 16. There was a very high volume of molluscs in most of the samples from Brierfield, and thus in some cases sub-sampling was employed in the laboratory. The samples were generally dominated by the common aquatic species *Radix balthica* and *Anisus leucostoma*. All eight species recorded are relatively common and widespread in Ireland.

Table 16. Eight mollusc species (including *Pisidium* sp. that was indentified to genus) recorded from Brierfield Turlough. (a – adult, j – juvenile, d – dead).

		S1	**S2***	**S3**	**S4***	**S5**	**Total for site:**
Anisus leucostoma	a	15	58	3	33		**109**
Anisus leucostoma	j	19	245	11	13		**288**
Anisus leucostoma	d			1	1		**2**
Bathyomphalus contortus	a	5		2	3	6	**16**
Bathyomphalus contortus	j	6	1	5	1	5	**18**
Gyraulus albus	a			1	1	3	**5**
Gyraulus albus	j			3		3	**6**
Gyraulus crista	a	2					**2**
Gyraulus crista	j	3					**3**
Lymnaea fusca	a			2	3		**5**
Lymnaea fusca	j	10	5	17	5		**37**
Lymnaea fusca	d	1	4	1	3		**9**
Pisidium sp.		2	3				**5**
Radix balthica	a	49	3				**52**
Radix balthica	j	100	146	120	140		**506**
Radix balthica	d	1	1	1	6		**9**
Valvata cristata	a	3		1		1	**5**
Valvata cristata	j	2	1			1	**4**
Total for sample:		203	409	165	176	19	**972**

*Due to a large volume of shells, and the lack of the target species among them, S2 and S4 were sub-sampled.

The stored samples from the Porst surveys (Porst & Irvine, 2009a, b; Porst *et al.*, 2012) were made available and examined. All specimens labelled as *Omphiscola glabra* were in fact *Cochlicopa lubrica,* a common and widespread terrestrial species. This includes the specimens from Roo West and Caranavoodaun turloughs also.

Discussion

The target species was not recorded at Brierfield turlough. Given that the original samples were viewed, and found not to be *Omphiscola glabra*, it can be taken that this record was an error and the species does not occur at this site. Consequently, no assessment has been carried out, nor any management or monitoring recommendations made.

Conclusion

This project involved surveying nine sites for four target species. Successful results were obtained for all sites and species, with the exception of *Omphiscola glabra*, which was not relocated at a known site with a recent record (Carrickavrantry). Many new locations for the other three rare species were found, for example, for *Vertigo moulinsiana* at Lough Derg and for *Oxyloma sarsi* near Portumna. Overall, the findings add significantly to our knowledge of the populations, ranges, habitat requirements and associated flora and fauna of the target species.

A total of 152 molluscan samples were collected during this project, which resulted in 5,245 individual specimens from 47 species. Seven of these are listed on the Irish Red List (Byrne *et al.*, 2009). Vegetation relevés were carried out at 115 of these sampling points, and 156 vascular plants and 29 bryophyte species were recorded. Eight of the vascular plants and three of the bryophytes were noteworthy, and three invasive alien species were noted.

Vertigo geyeri was re-confirmed at both of the survey locations. Its overall conservation status was assessed as Unfavourable – Bad at both Cooley Lough and Carrowmoreknock. In both cases the populations are small, and suitable habitat patches are limited. Few negative impacts were noted, apart from intensive horse grazing at Carrowmoreknock. It would appear that the habitats at both of these sites may be on the edge of the range of tolerance for this species, and that this may be the main factor keeping population sizes low.

Vertigo moulinsiana was assessed as being of Favourable conservation status at Lough Derg, near Portumna and at Castletown, while it had a status of Unfavourable – Bad at Strancally and Unfavourable – Inadequate at The Murrough. In the case of Strancally, the population was found to be small, and the site is known to flood regularly. Similarly, the population appears to be small at The Murrough. Negative impacts recorded for this species were few, though flooding at Strancally is likely to put pressure on the population there. In the case of The Murrough, it is an extensive site, and further investigations may lead to new finds of this species. It is known to have persisted at the site for over 50 years, so while the population is small, it appears to be able to survive in the long term.

Oxyloma sarsi was assessed as having a Favourable conservation status in the area surveyed, from Shannon Bridge to Portumna. The only negative impact recorded was the destructive works carried out at the bank at one of the sample locations.

Omphiscola glabra had an overall conservation status of Unfavourable – Bad as the species was not found during this survey. No negative impacts were recorded at the site at Carrickavrantry.

Across all species, a number of potential future threats were noted, and these included those associated with farming, such as over-grazing, supplementary feeding and agricultural run-off, as

well as some associated with lack of management, for example, under-grazing and scrub encroachment. Potential water level changes could be a threat at any of these sites, as all species are reliant to some extent on a relatively consistent hydrological regime.

Conservation management at one of the sites (The Murrough), including boardwalks for public access, scrub removal and fencing for stock control, could all potentially pose threats to the target species, *Vertigo moulinsiana*, unless carefully thought-out and planned, with appropriate advice from experts.

Other threats, though not seen to be occurring, but possible due to adjacent infrastructure, include spoil or run-off from road or railway maintenance works. Additionally, boat yards, marinas and mooring stations along waterways could all potentially have impacts unless well-managed. House building and pond creation had occurred adjacent to one site (Castletown), undoubtedly causing loss of habitat. Any further such developments, at this or other sites, would be detrimental to areas of potential habitat for any of these target species.

The occurrence of drains at many of the sites was deemed to be a positive feature, either by creating areas of suitable habitat, or by helping to maintain appropriate hydrological conditions. However, creation of new drains could be damaging, and maintenance of existing drains should be done with caution and with the advice and supervision of experts.

In conclusion, all of these sites need continued monitoring, and in many cases, further resources should be allocated to allow liaison with land owners and managers, as well as to surveying nearby areas to attempt to further document the ranges and ecological requirements of these species.

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Appendix I: Definitions of habitat suitability categories

Table A1: Broad definitions for optimal, sub-optimal and unsuitable habitat conditions for *Vertigo geyeri*. Reproduced from Moorkens & Killeen (2011).

Optimal habitat - where *Vertigo geyeri* could survive in a large area (at least 50%) of the habitat. This allows for areas that have, for example, *Schoenus nigricans* tussocks. The snail will not normally be found high in a tussock, but the structure of the tussock provides the variation that sustains the snail within the first 5-6cm of its base, depending on the hydrological conditions on the day. Thus to provide this amplitude of habitat variation to cover annual variation, the growth of unsuitable microhabitat is necessary. Another example of optimal habitat is calcareous cropped open sedge swards and moss carpets within undulating terrain. The topographical changes provide the niches for wet and dry extremes; therefore by their provision for these extremes, there will always be some habitat within them that is at least temporarily unsuitable. These habitats should not be changed to "improve" them, e.g. to make them wetter for more of the time, as the range of microtopography is important. **Sub-optimal habitat** - where there are patches of vegetation and conditions that support *Vertigo geyeri* but the majority of the habitat cannot. This can be due to terrain being generally too high, but with small suitably wet runnel flushes occurring within, or where habitat is on the margin of base tolerance for the species, where acid influence promotes mainly calcifuge species, but where occasional groundwater seepage influence provides a suitable patch that the snail can occupy. Alternatively the snail may be restricted by succession due to lack of grazing, where the snail is shaded out of most of the area, except for patches prevented from growth by being wetter than their surroundings. **Unsuitable habitat** - an area of the site where the combination of vegetation and hydrological influence is entirely outside the snail's range of tolerance.

Table A2: Definitions of optimal and sub-optimal habitat conditions for *Vertigo geyeri* specifically for Cooley Lough. Reproduced from Moorkens & Killeen (2011).

Definition of optimal habitat	Mosaic of stony ground with sedge/moss mounds 5-20cm tall, containing with species such as *Carex viridula, Briza media, Equisetum palustre, Juncus articulatus* and the mosses *Drepanocladus revolvens, Campylium stellatum*, with scattered tussocks of *Schoenus nigricans* no greater than 80cm tall. During sampling the water table should be between 0-5cm of the soil surface, but not above ground level. Bare ground should be less than 25% of the habitat area.
Definition of sub-optimal habitat	Vegetation composition as above but either vegetation height is less than 5cm or greater than 20cm, or the *Schoenus* tussocks are >1m tall, or the water table is below 5cm or ground is flooded at the time of sampling, or bare ground is > 25% of the habitat area.

Table A3: Broad definitions for optimal, sub-optimal and unsuitable habitat conditions for *Vertigo moulinsiana*. Reproduced from Moorkens & Killeen (2011).

Optimal habitat - where *V. moulinsiana* could survive in a large area (average 50%) of the habitat. It includes a good distribution of tall *Carex* species, sometimes interspersed with *Schoenus nigricans* and *Phragmites australis*. It is wet enough for water to rise and surround the surveyor's boot under light pressure.

Sub-optimal habitat - where there are patches of vegetation and conditions that support *V. moulinsiana* (average 10% of habitat), but the majority of the habitat cannot. An example would be in terrain that is generally too wet, but with small patches of tussocks arising out of open water, or an area of low growing *Schoenus* interspersed by a few taller tussocks. In these situations the snail uses the lower growing *Schoenus* to spread across relatively wide areas, so although they are not used every year, and are unsuitable for most of the time, they are essential to the function of the population. Sub-optimum wetness is either open water (too wet) or damp conditions where water does not rise under light pressure (too dry).

Unsuitable habitat - an area of the site where the combination of vegetation and hydrological influence is outside the snail's range of tolerance. This may be natural unsuitability (e.g. where bedrock is close to the surface), or alternatively the snail may be restricted by excessive cutting or burning of vegetation.

Table A4: Definitions of vegetation and soil moisture classes for *Vertigo moulinsiana* specifically for Lough Derg, near Portumna. Reproduced from Moorkens & Killeen (2011).

Vegetation Classes Class I is the most favoured, and Class IV is unsuitable	**Class I**	**Class II**	**Class III**	**Class IV**
	tall *Carex* species *Glyceria maxima* *Phragmites australis*	*Cladium mariscus* *Carex rostrata* *Equisetum fluviatile*	*Carex paniculata* *Mentha aquatica* *Schoenus nigricans* *Typha angustifolia* *Sparganium erectum*	All other species
Soil Moisture Classes Classes 3 and 4 are usually the most favourable	1 - Dry. No visible moisture on ground surface 2 - Damp. Ground visibly damp, but water does not rise under pressure 3 - Wet. Water rises under light pressure 4 - Very wet. Pools of standing water, generally less than 5cm deep 5 - Site under water. Entire sampling site in standing or flowing water over 5cm deep.			

Table A5: Definitions of vegetation and soil moisture classes for *Vertigo moulinsiana* specifically for The Murrough. Reproduced from Moorkens & Killeen (2011).

Vegetation Classes Class I is the most favoured, and Class IV is unsuitable	**Class I**	**Class II**	**Class III**	**Class IV**
	tall *Carex* species *Phragmites australis*	*Cladium mariscus* *Carex paniculata* *Schoenus nigricans* *Glyceria maxima*	*Iris pseudacorus* *Typha angustifolia* *Sparganium erectum* *Schoenoplectus*	All other species
Soil Moisture Classes Classes 3 and 4 are usually the most favourable	1 - Dry. No visible moisture on ground surface 2 - Damp. Ground visibly damp, but water does not rise under pressure 3 - Wet. Water rises under light pressure 4 - Very wet. Pools of standing water, generally less than 5cm deep 5 - Site under water. Entire sampling site in standing or flowing water over 5cm deep.			

Appendix II: Aerial photographs showing sampling points

This appendix provides 27 aerial photographs (and three overview maps) from all nine study locations. In each case, sample points, transects and polygons are illustrated, with positive and negative samples denoted, as well as habitat suitability categories for the polygons.

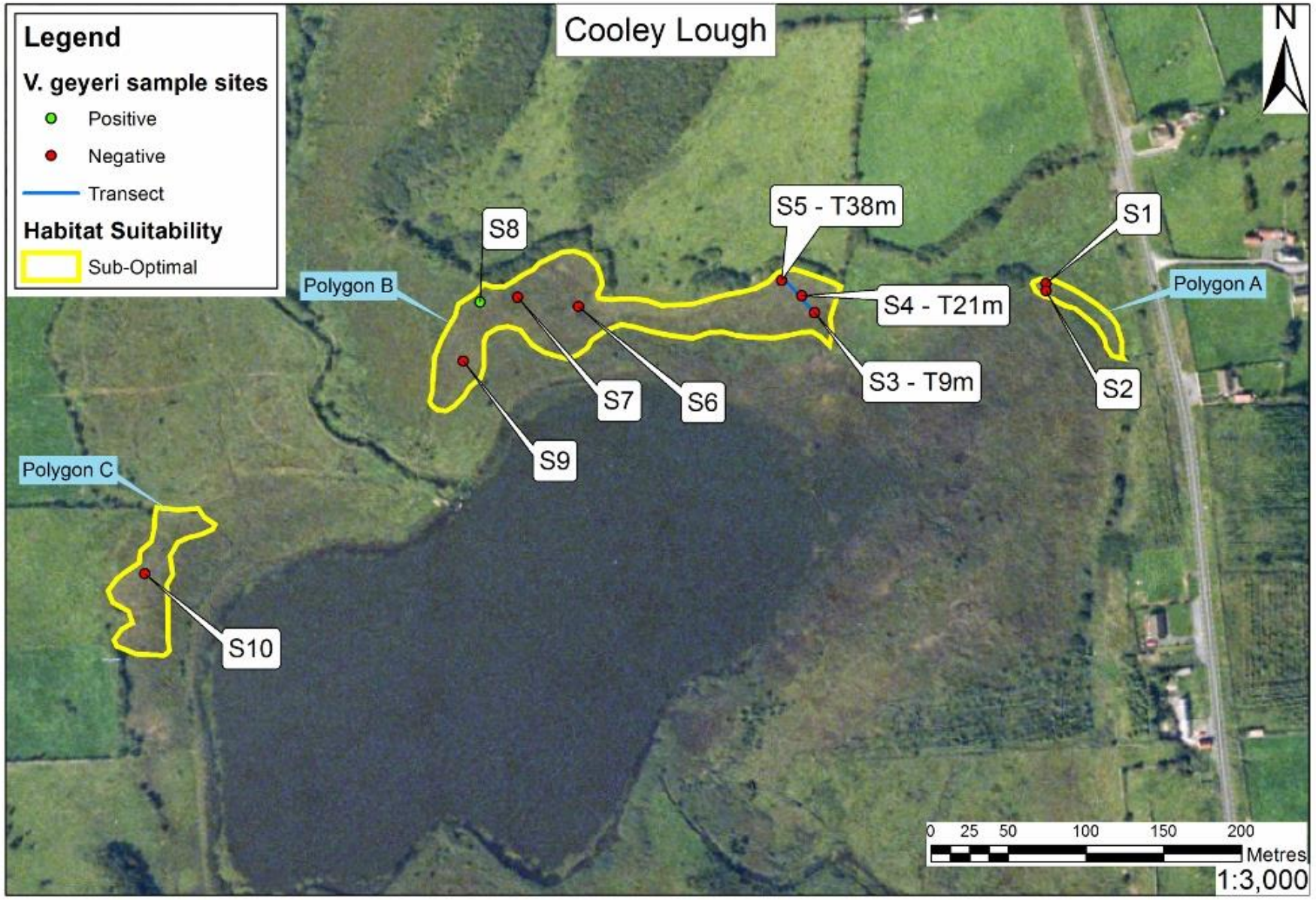
The images are of a low quality to keep this document size as small as possible, while still providing an adequate overview. Full quality images have been lodged with NPWS, along with the background GIS data.

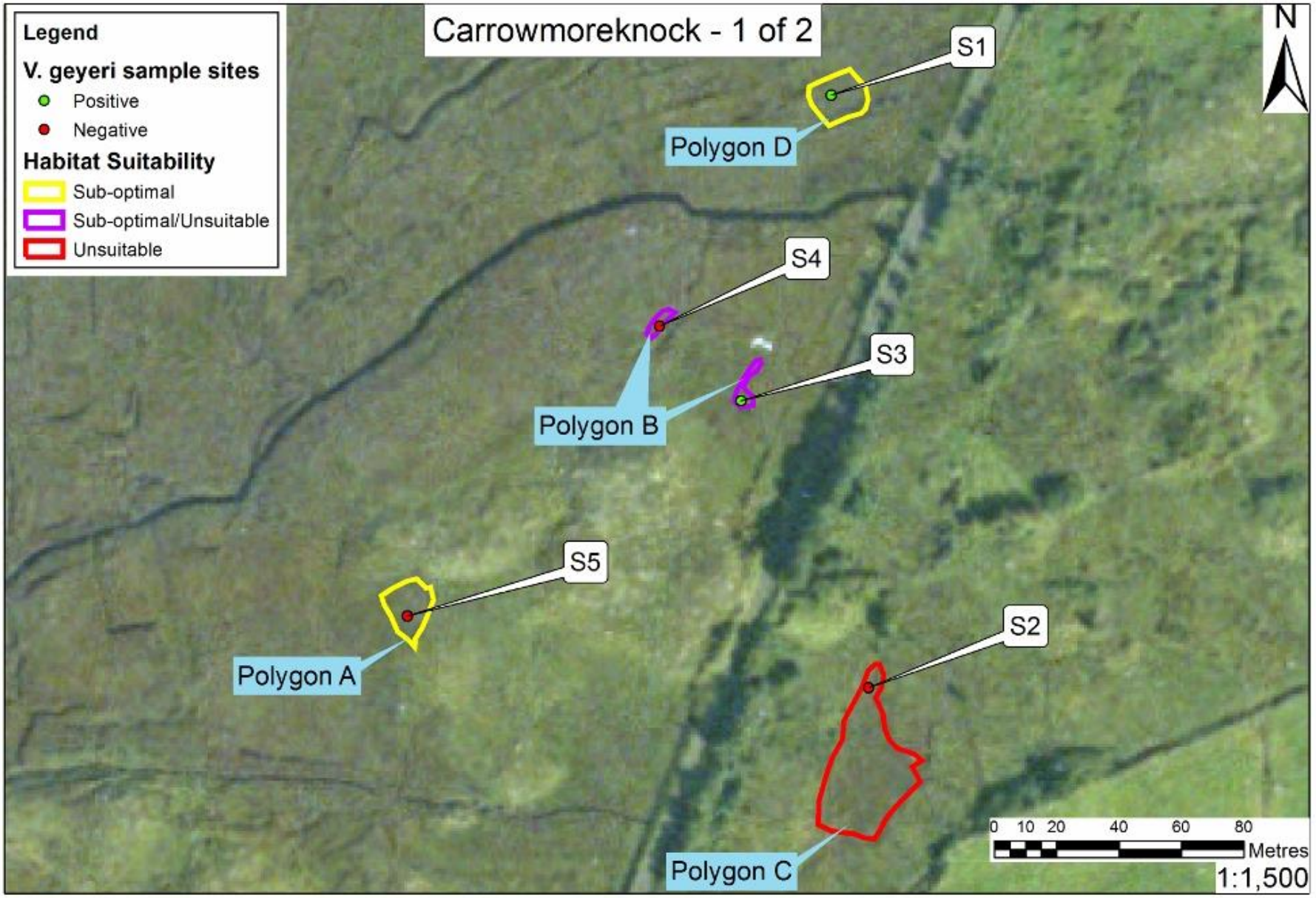
The images presented are as follows:

- Cooley Lough (x1)
- Carrowmoreknock (x2)
- Lough Derg, near Portumna (overview, x6)
- Castletown (x1)
- Strancally (x1)
- The Murrough (overview, x6)
- Shannonbridge – Portumna (overview, x8)
- Carrickavrantry (x1)
- Brierfield (x1)

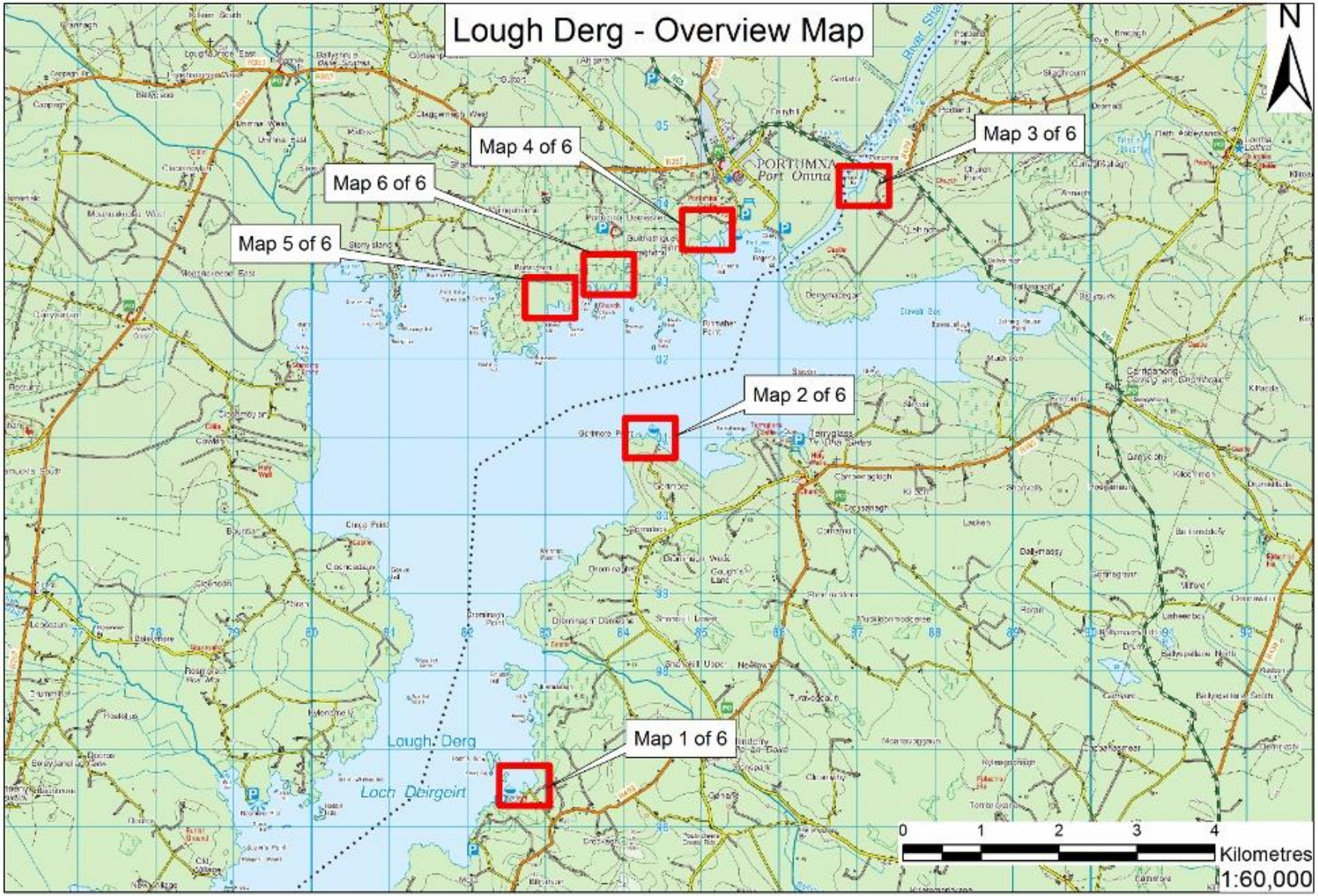
Notes have been made on the maps in the two cases where a target species was found while surveying for another - i.e. at Lehinch, *Oxyloma sarsi* was recorded while surveying for *Vertigo moulinsiana*, and at Portland Park, *Vertigo moulinsiana* was recorded while surveying for *Oxyloma sarsi*.

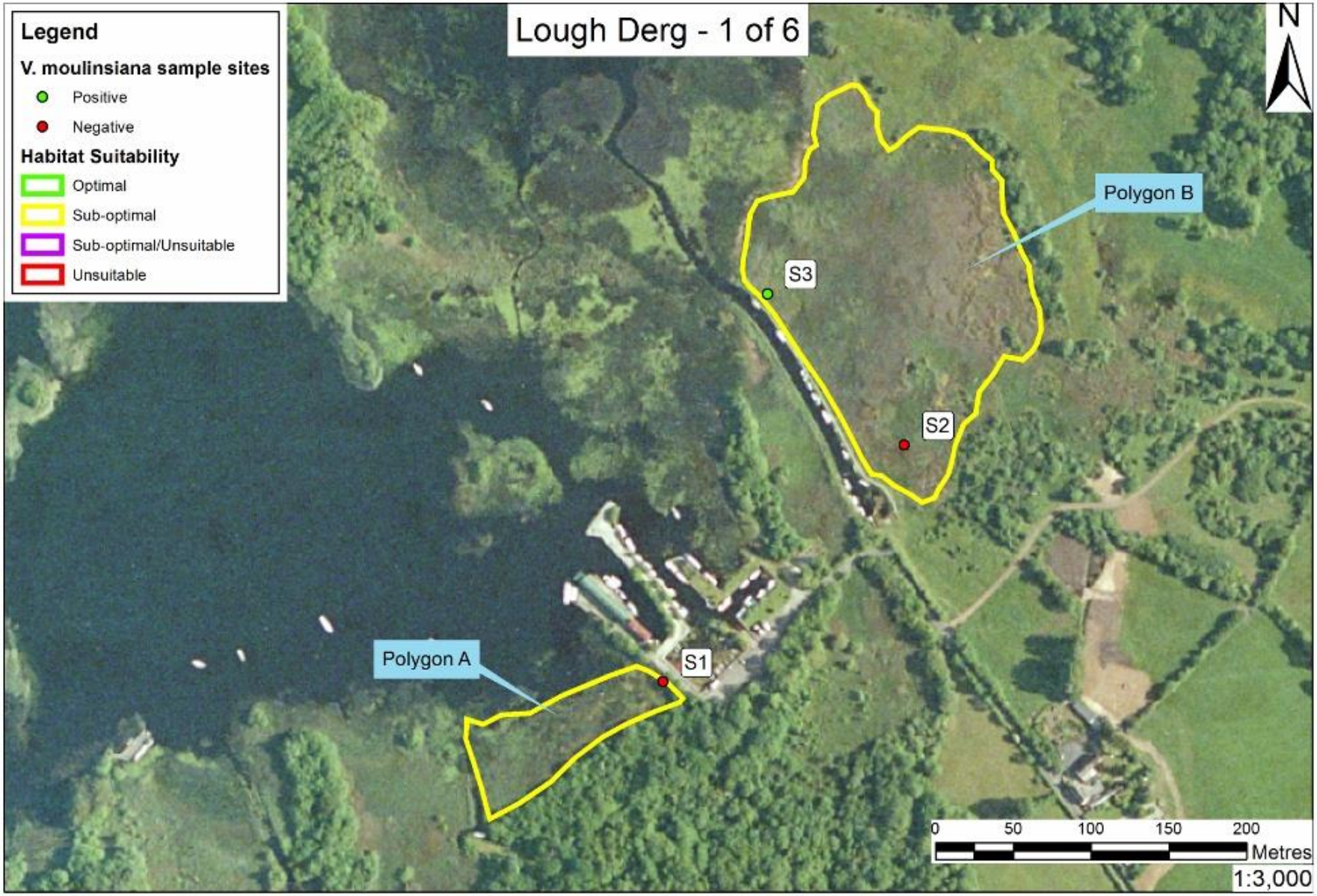
For all images:


Legend
V. geyeri sample sites
Positive
Negative
Transect
Habitat Suitability
Sub-Optimal
Cooley Lough
N
S8
S5 - T38m
S1
Polygon B
Polygon A
S4 - T21m
S3 - T9m
S7
S6
S2
S9
Polygon C
S10
0 25 50 100 150 200
Metres
1:3,000

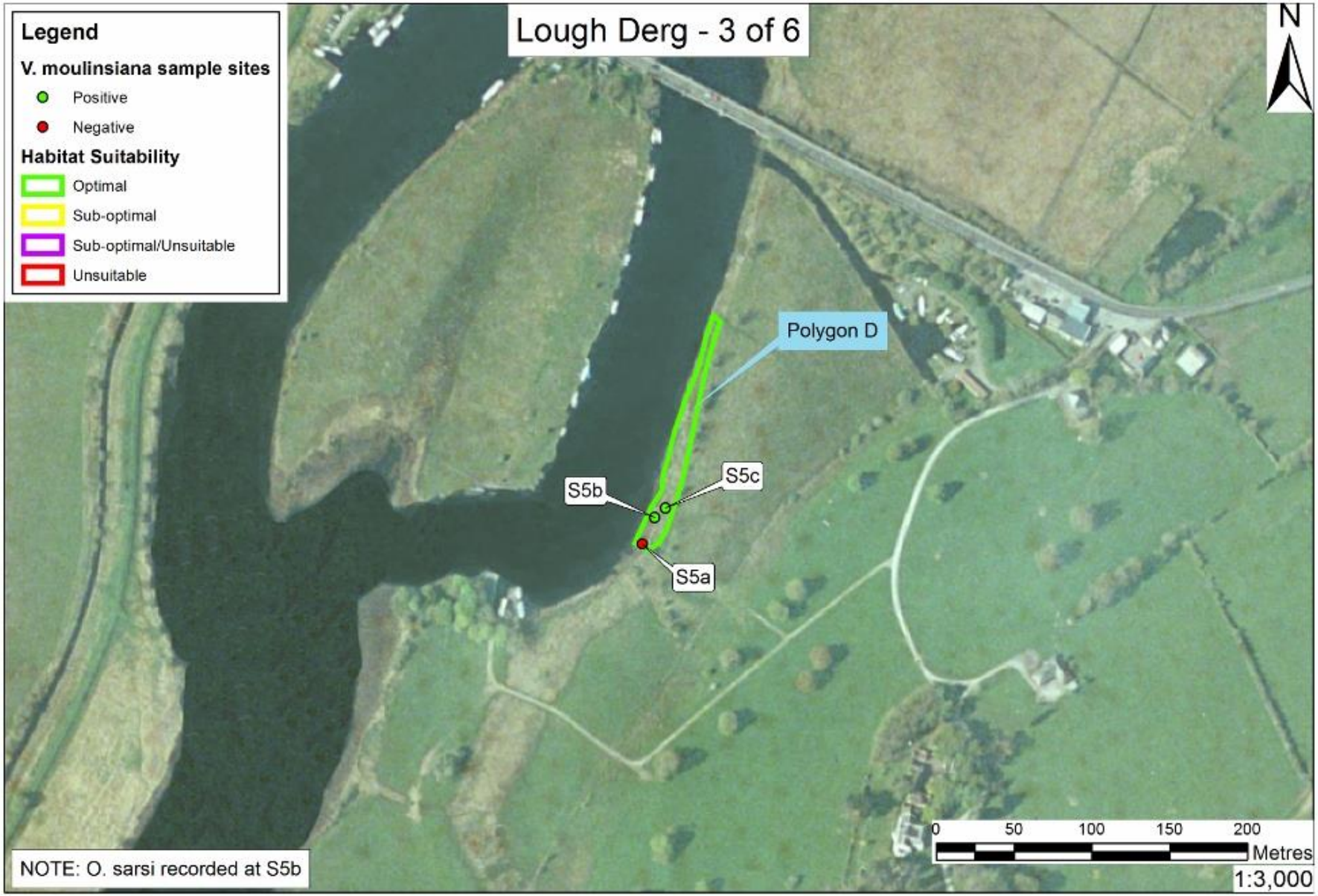

Carrowmoreknock - 1 of 2
Legend
V. geyeri sample sites
Positive
Negative
Habitat Suitability
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
N
S1
Polygon D
S4
S3
Polygon B
S5
Polygon A
S2
Polygon C
0 10 20 40 60 80
Metres
1:1,500

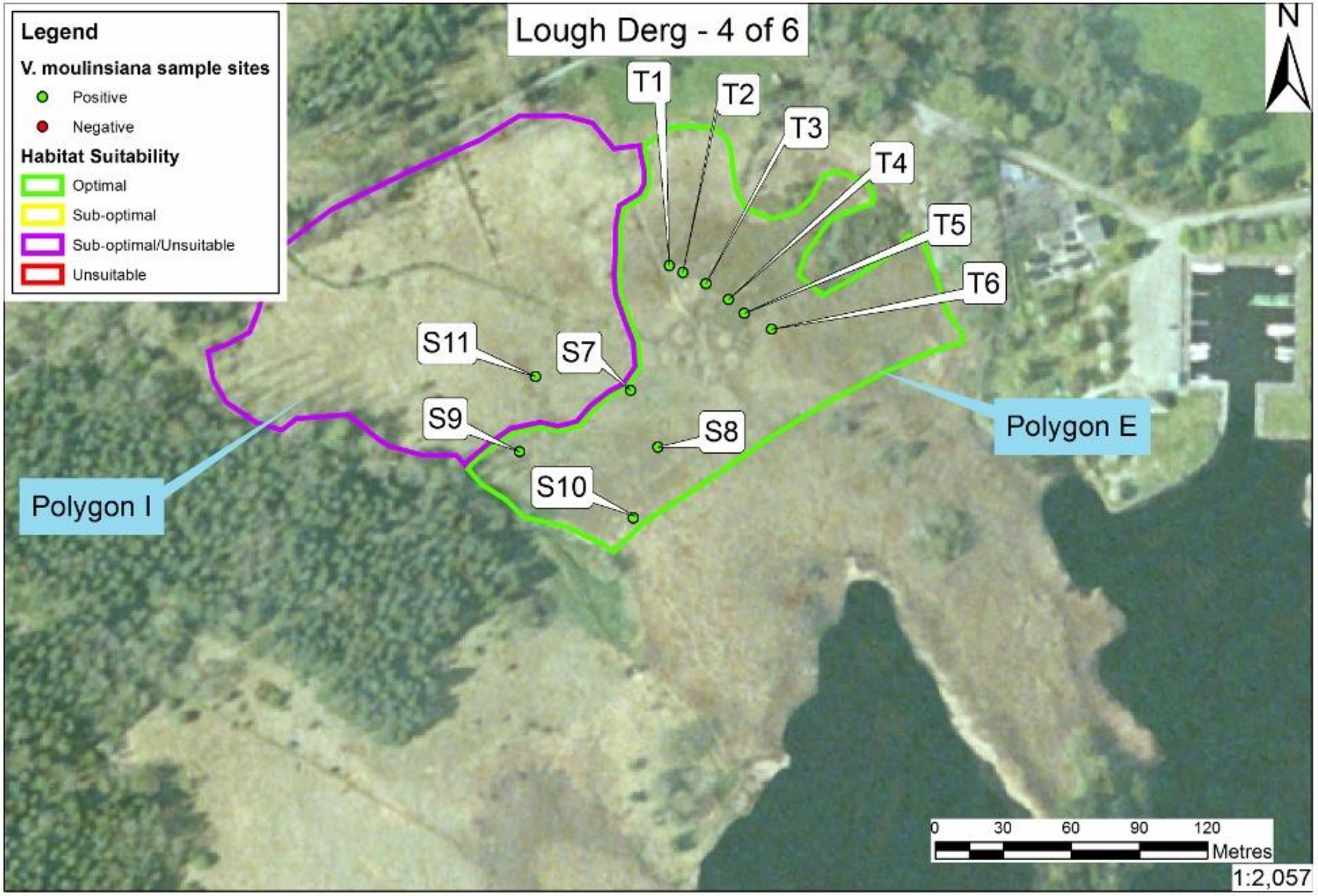

Carrowmoreknock - 2 of 2
Legend
V. geyeri sample sites
Positive
Negative
Habitat Suitability
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
S6
Polygon E
N
0 10 20 40 60 80
Metres
1:1,500

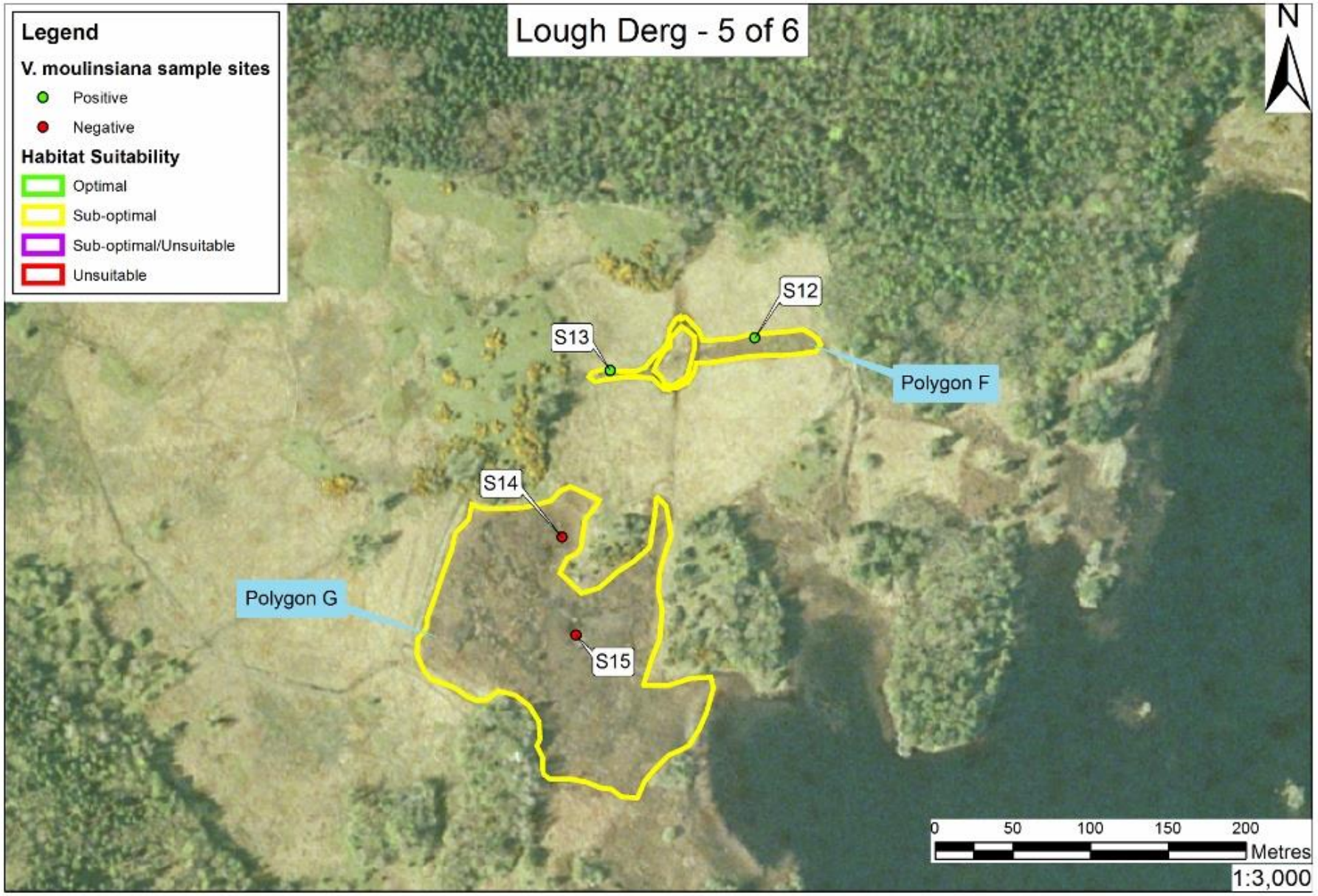

Lough Derg - Overview Map
N
Map 1 of 6
Map 2 of 6
Map 3 of 6
Map 4 of 6
Map 5 of 6
Map 6 of 6
Lough Derg
Loch Deirgeirt
PORTUMNA
Port Omna
0 1 2 3 4
Kilometres
1:60,000

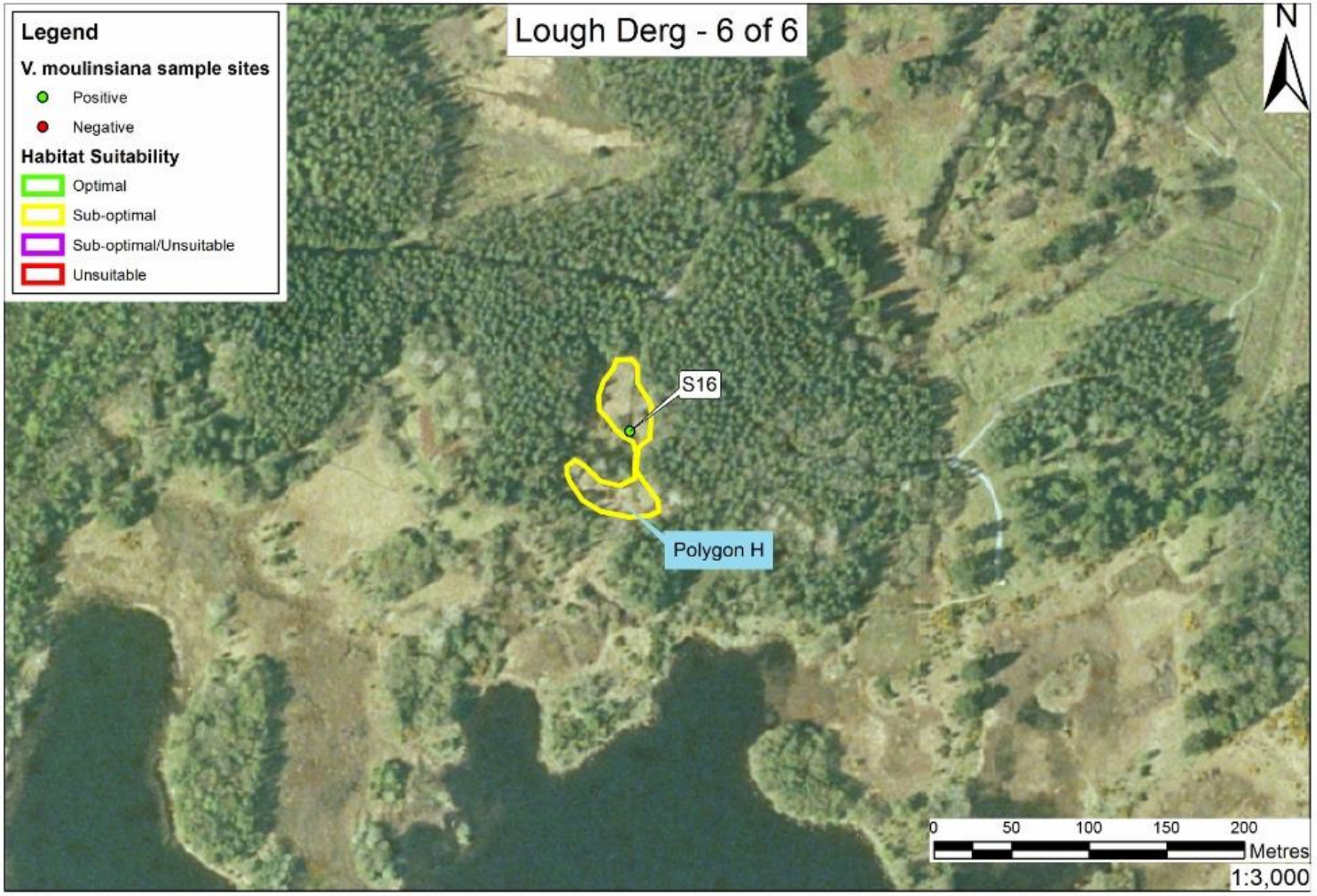

Lough Derg - 1 of 6
Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Optimal
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
N
Polygon B
S3
S2
Polygon A
S1
0
50
100
150
200
Metres
1:3,000

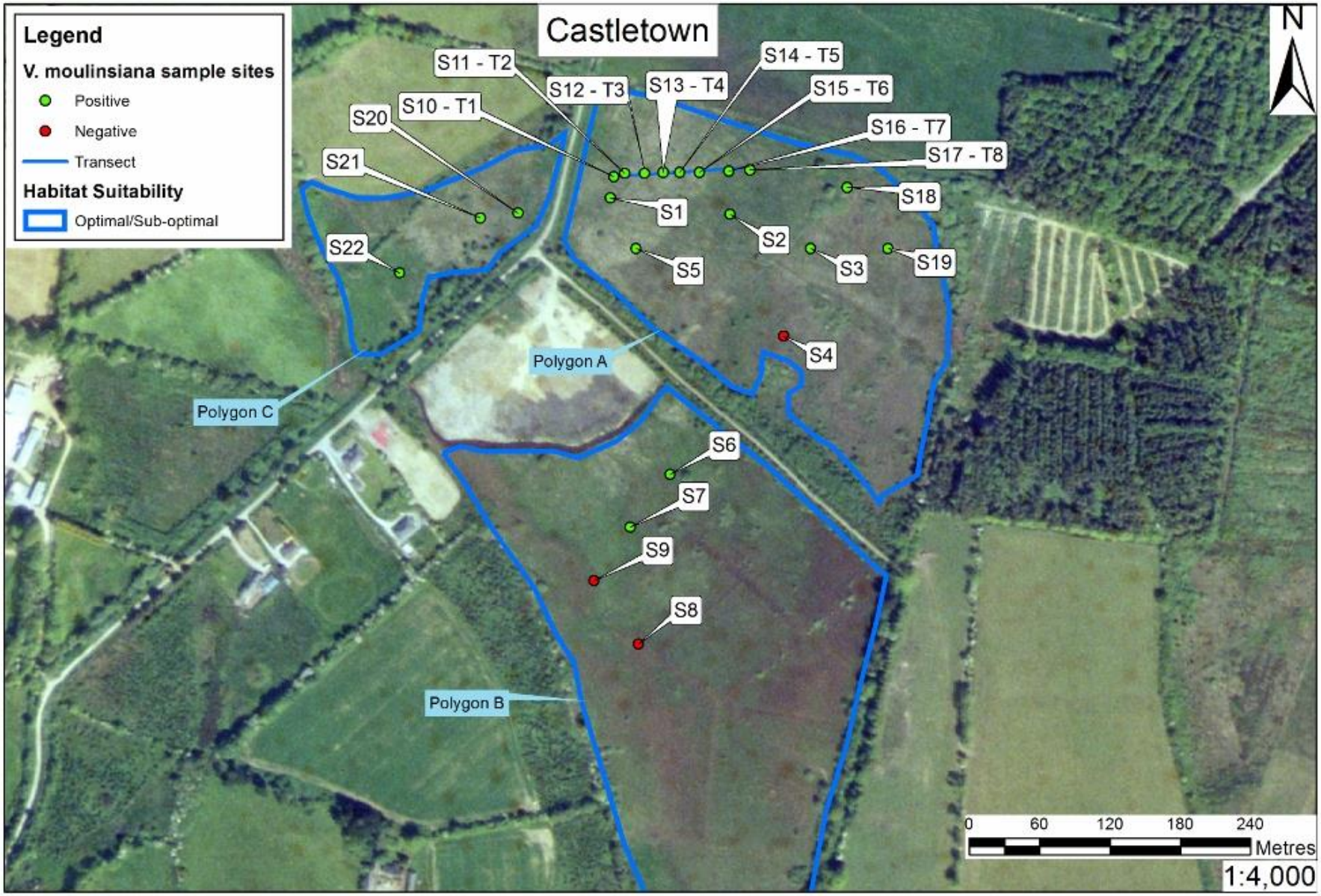

Lough Derg - 2 of 6
Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Optimal
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
N
S4
Polygon C
0
50
100
150
200
Metres
1:3,000

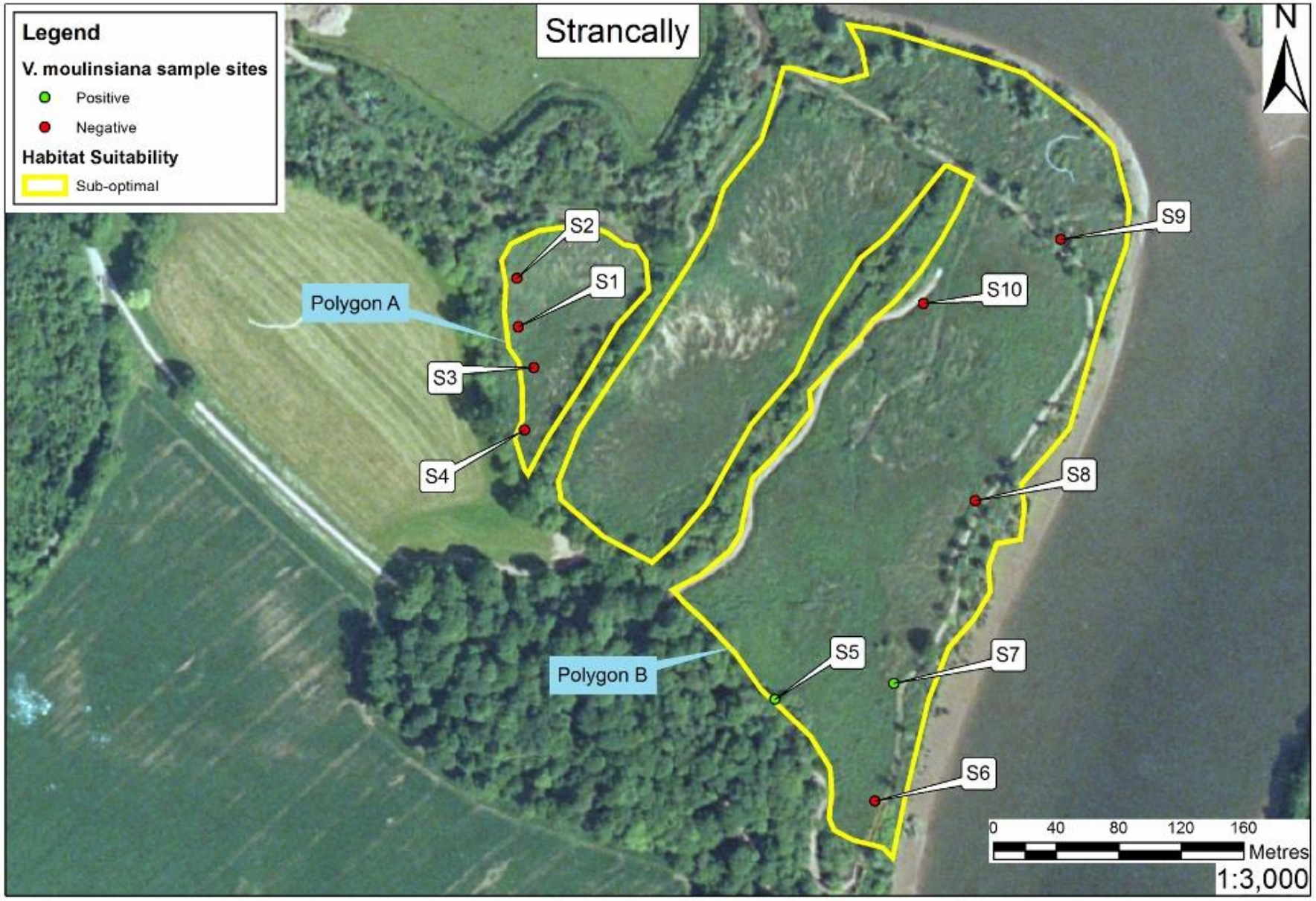

Lough Derg - 3 of 6
Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Optimal
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
Polygon D
S5b
S5c
S5a
N
0
50
100
150
200
Metres
1:3,000
NOTE: O. sarsi recorded at S5b


Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Optimal
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
Lough Derg - 4 of 6
T1
T2
T3
T4
T5
T6
S11
S7
S9
S8
S10
Polygon E
Polygon I
N
0 30 60 90 120
Metres
1:2,057


Lough Derg - 5 of 6
Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Optimal
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
N
S12
S13
S14
S15
Polygon F
Polygon G
0
50
100
150
200
Metres
1:3,000

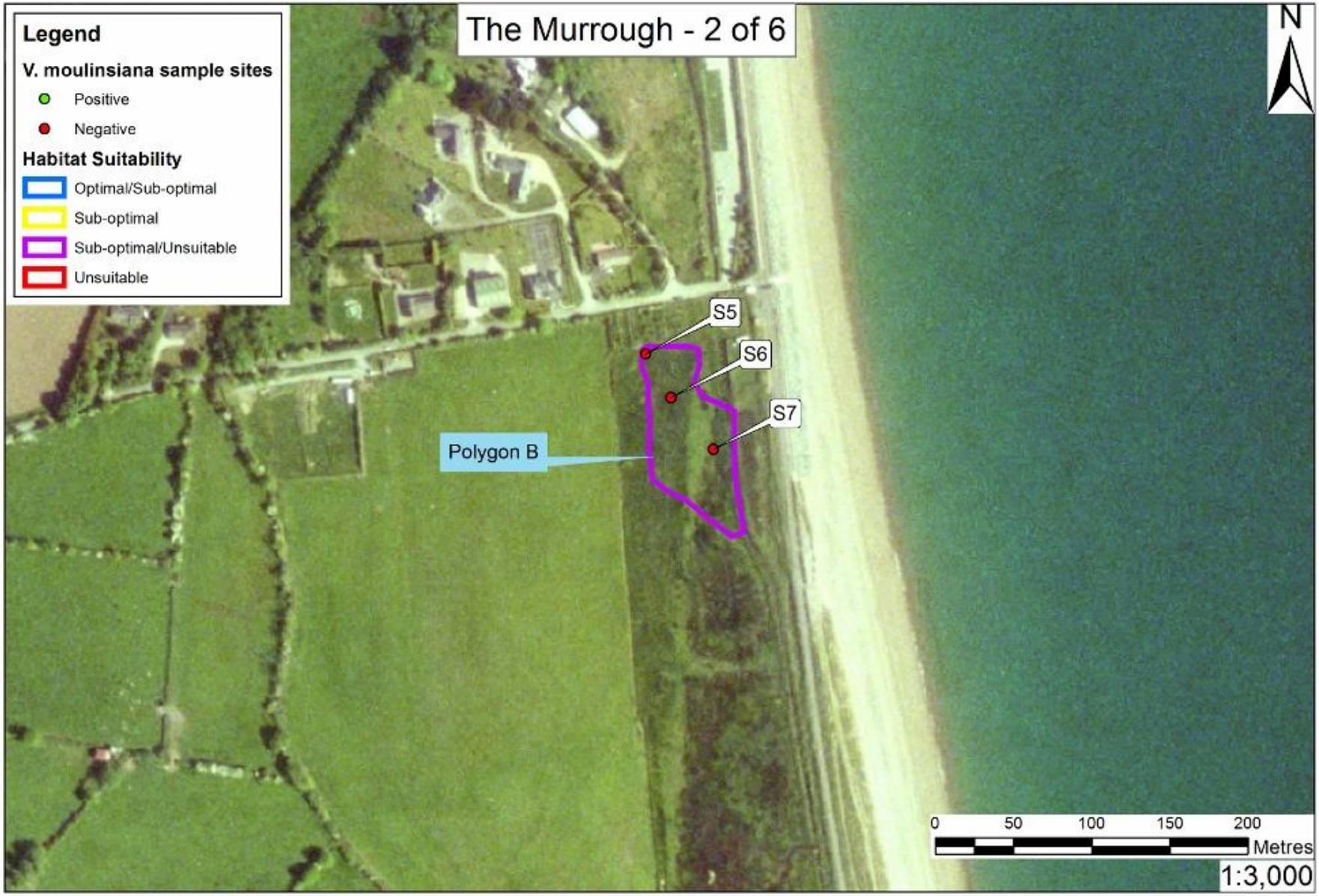

Lough Derg - 6 of 6
Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Optimal
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
S16
Polygon H
N
0
50
100
150
200
Metres
1:3,000

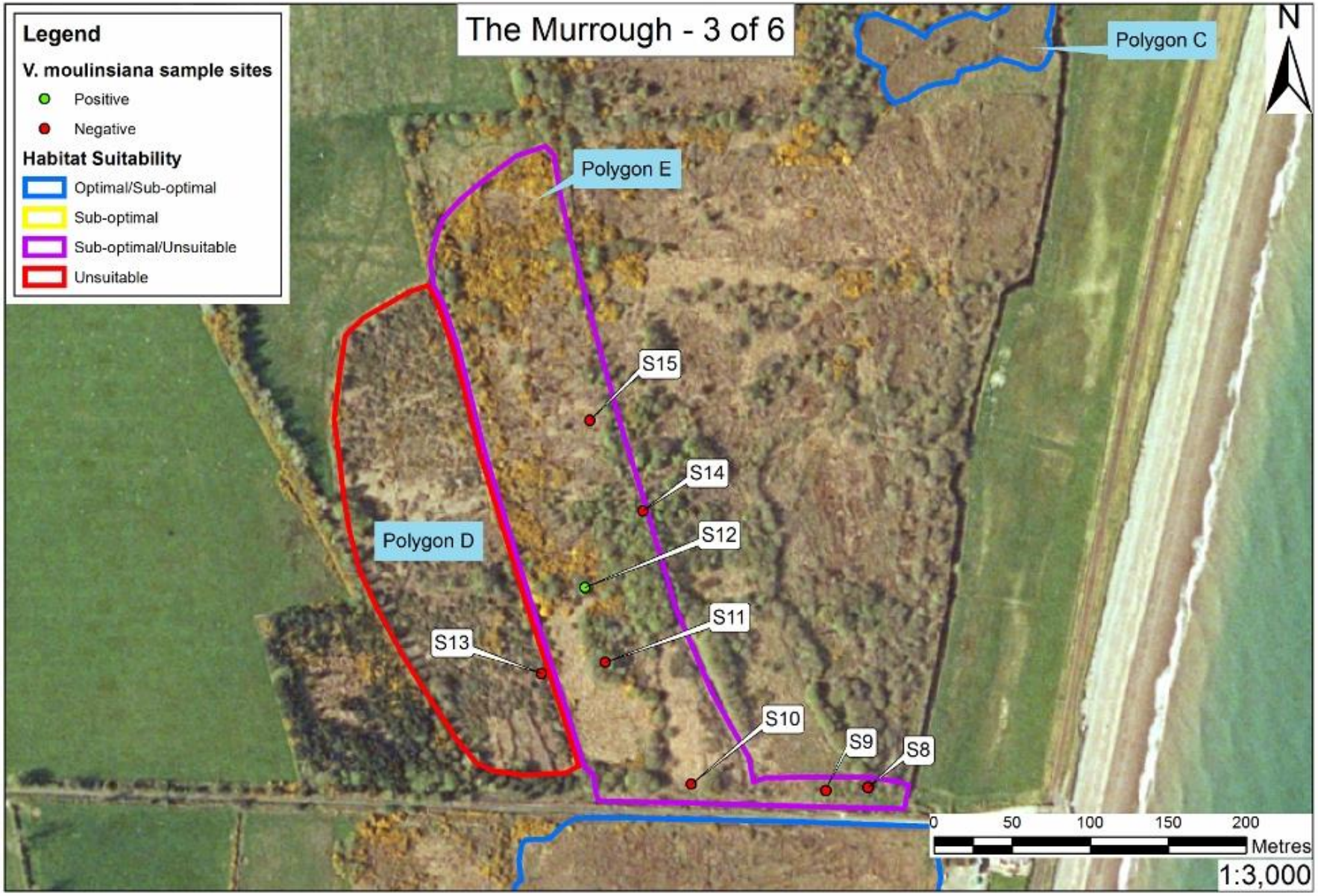

Legend
V. moulinsiana sample sites
Positive
Negative
Transect
Habitat Suitability
Optimal/Sub-optimal
Castletown
N
S11 - T2
S12 - T3
S13 - T4
S14 - T5
S15 - T6
S16 - T7
S17 - T8
S10 - T1
S20
S21
S22
S18
S19
S1
S2
S3
S5
S4
Polygon A
Polygon C
S6
S7
S9
S8
Polygon B
0
60
120
180
240
Metres
1:4,000

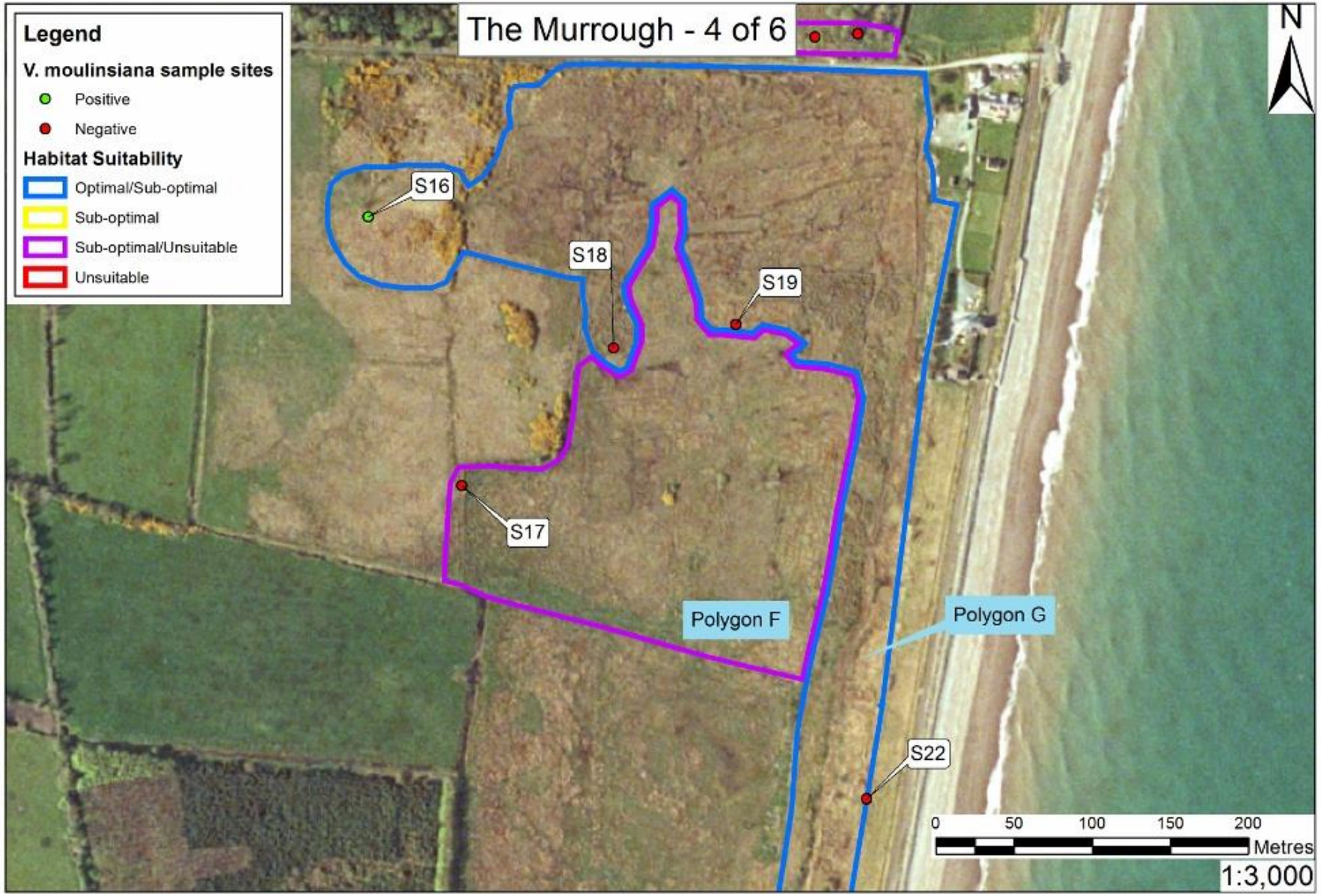

Strancally
Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Sub-optimal
N
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
Polygon A
Polygon B
0
40
80
120
160
Metres
1:3,000

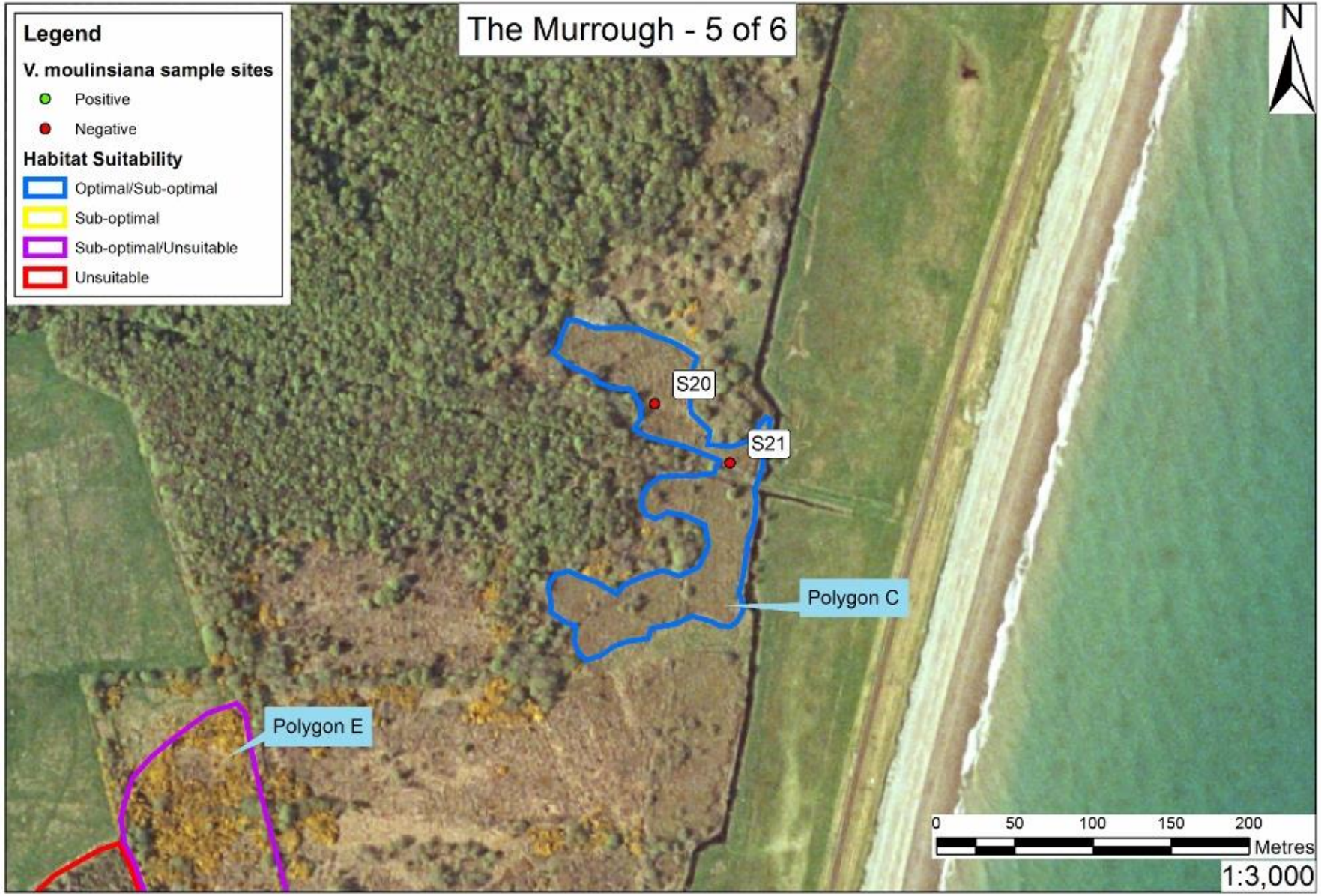

The Murrough - Overview Map
Map 1 of 6
Map 2 of 6
Map 3 of 6
Map 4 of 6
Map 5 of 6
Map 6 of 6
N
Vartry Reservoir
ST. GEORGE'S CHANN
Muir Bhreatan
0 1 2 3 4
Kilometres
1:70,000

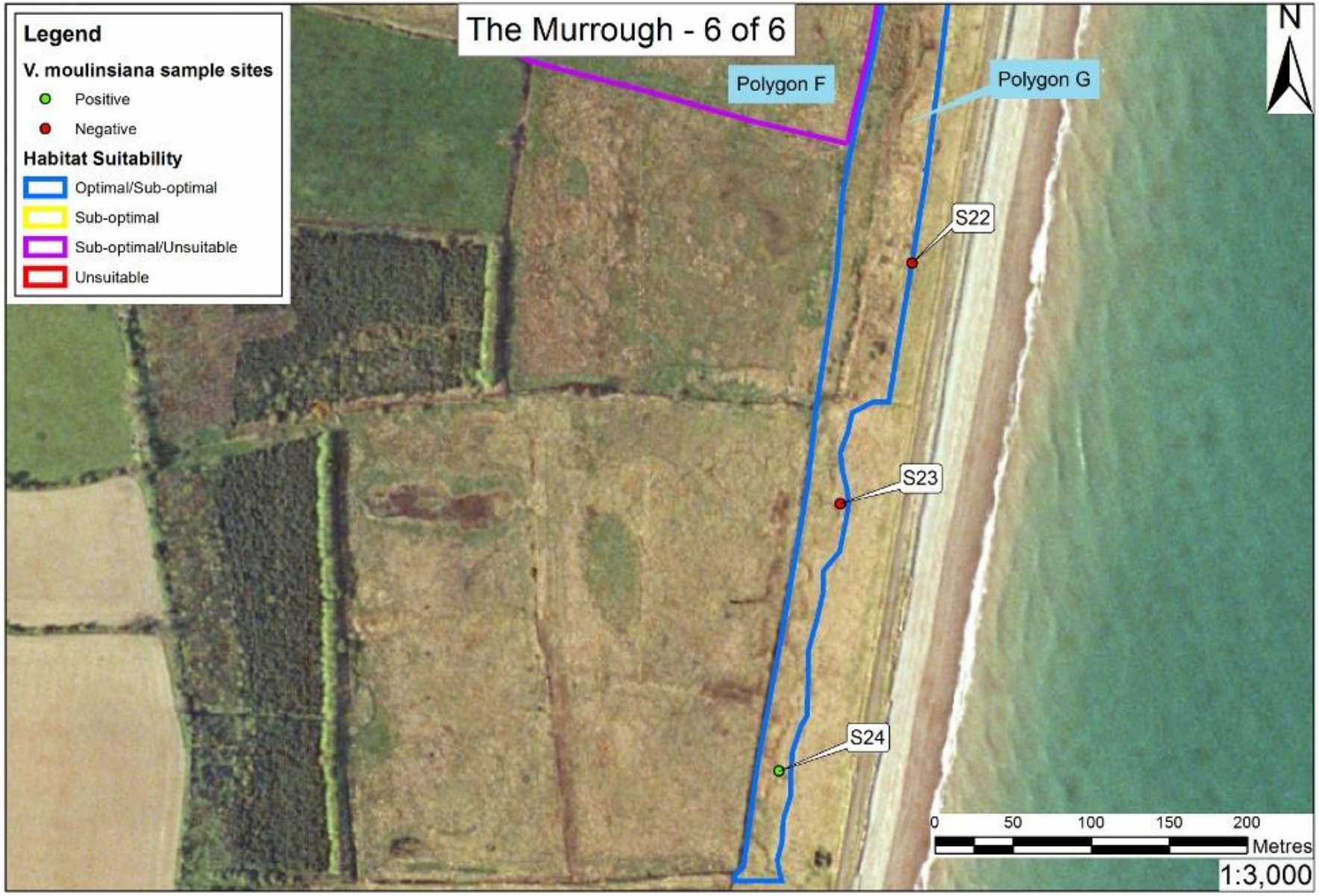

The Murrough - 1 of 6
Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
Polygon A
S1
S2
S3
S4
N
0
50
100
150
200
Metres
1:3,000

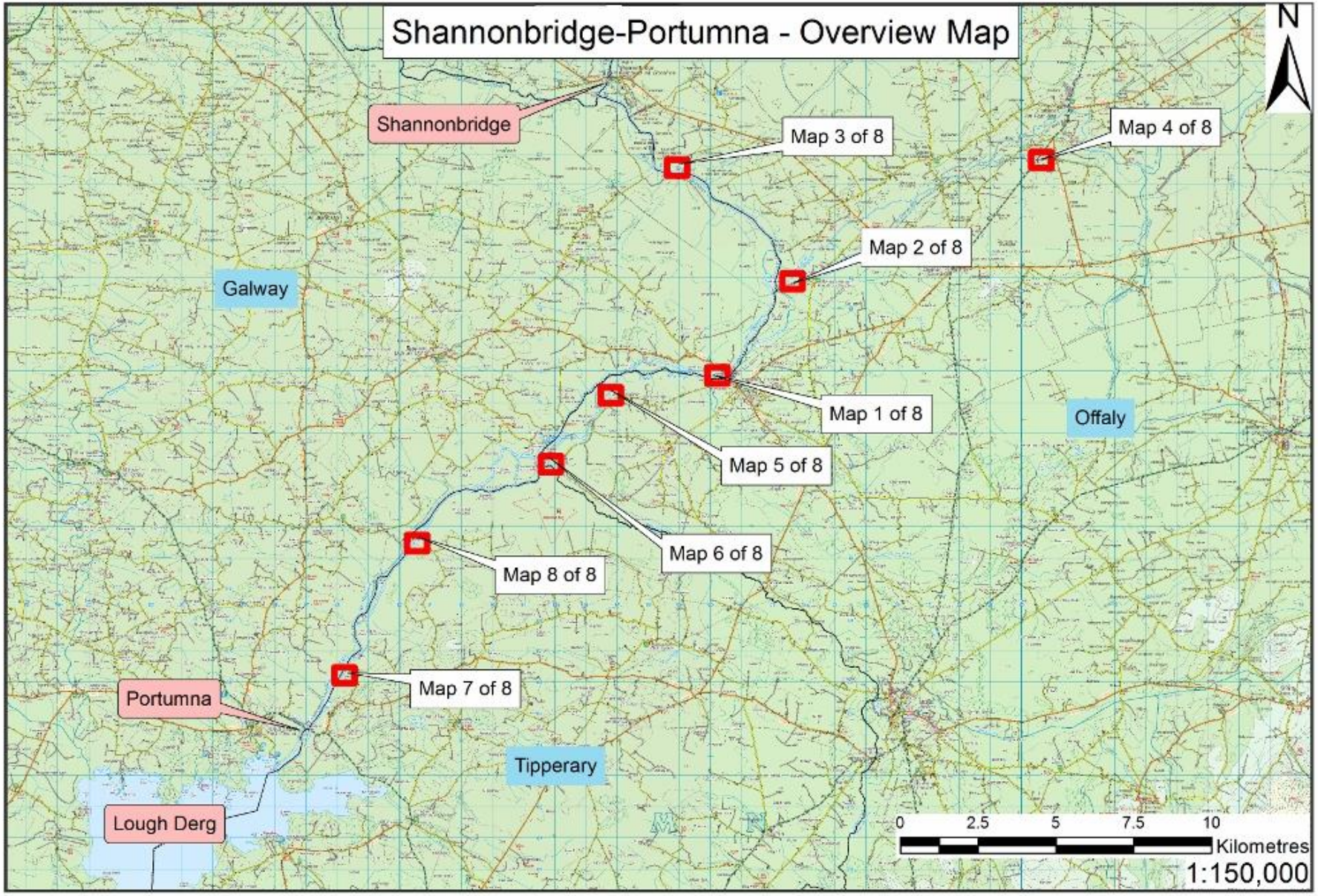

The Murrough - 2 of 6
Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
S5
S6
S7
Polygon B
N
0
50
100
150
200
Metres
1:3,000

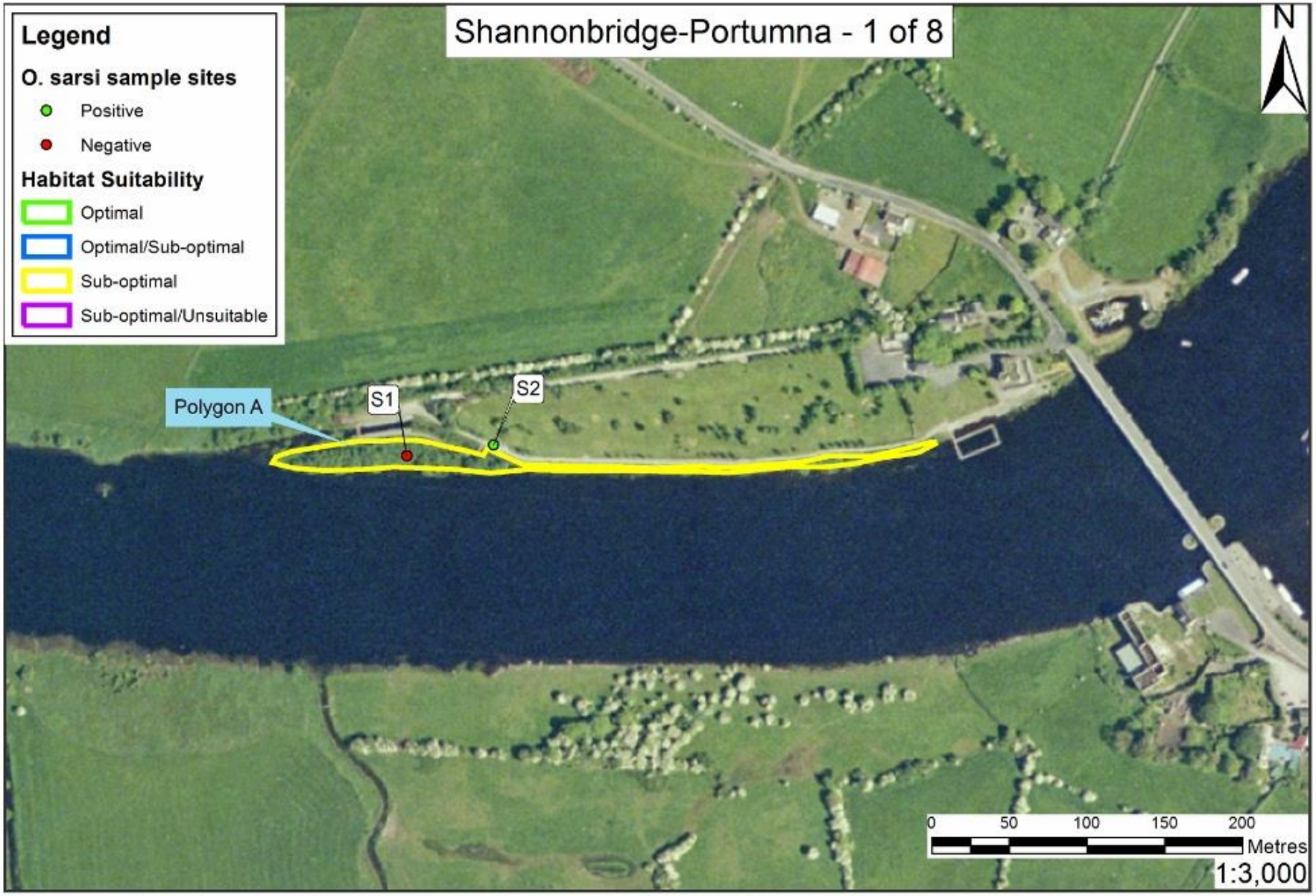

The Murrough - 3 of 6
Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
Polygon C
Polygon E
Polygon D
S15
S14
S12
S11
S13
S10
S9
S8
N
0
50
100
150
200
Metres
1:3,000

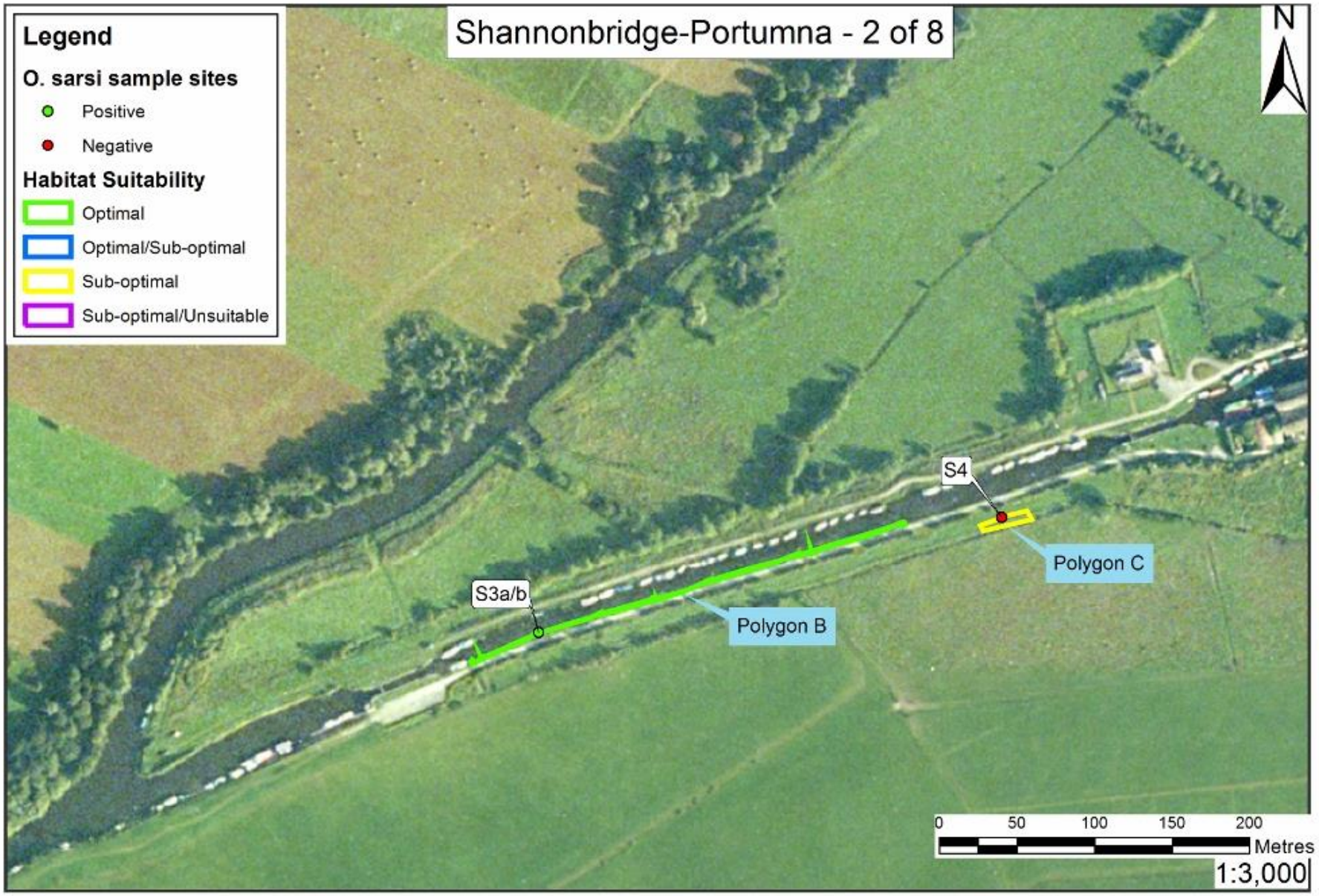

Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
The Murrough - 4 of 6
N
S16
S18
S19
S17
Polygon F
Polygon G
S22
0
50
100
150
200
Metres
1:3,000

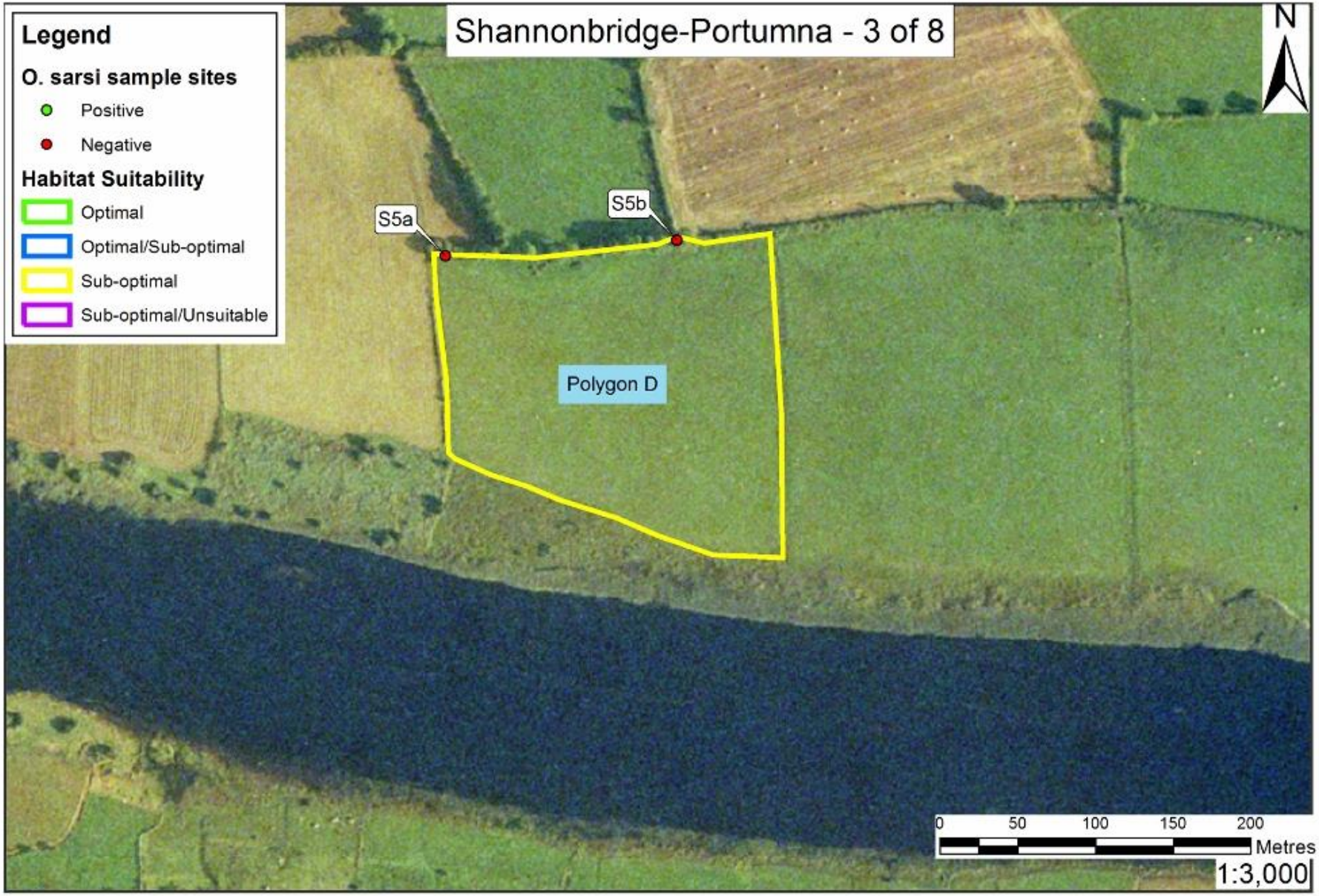

Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
The Murrough - 5 of 6
N
S20
S21
Polygon C
Polygon E
0
50
100
150
200
Metres
1:3,000

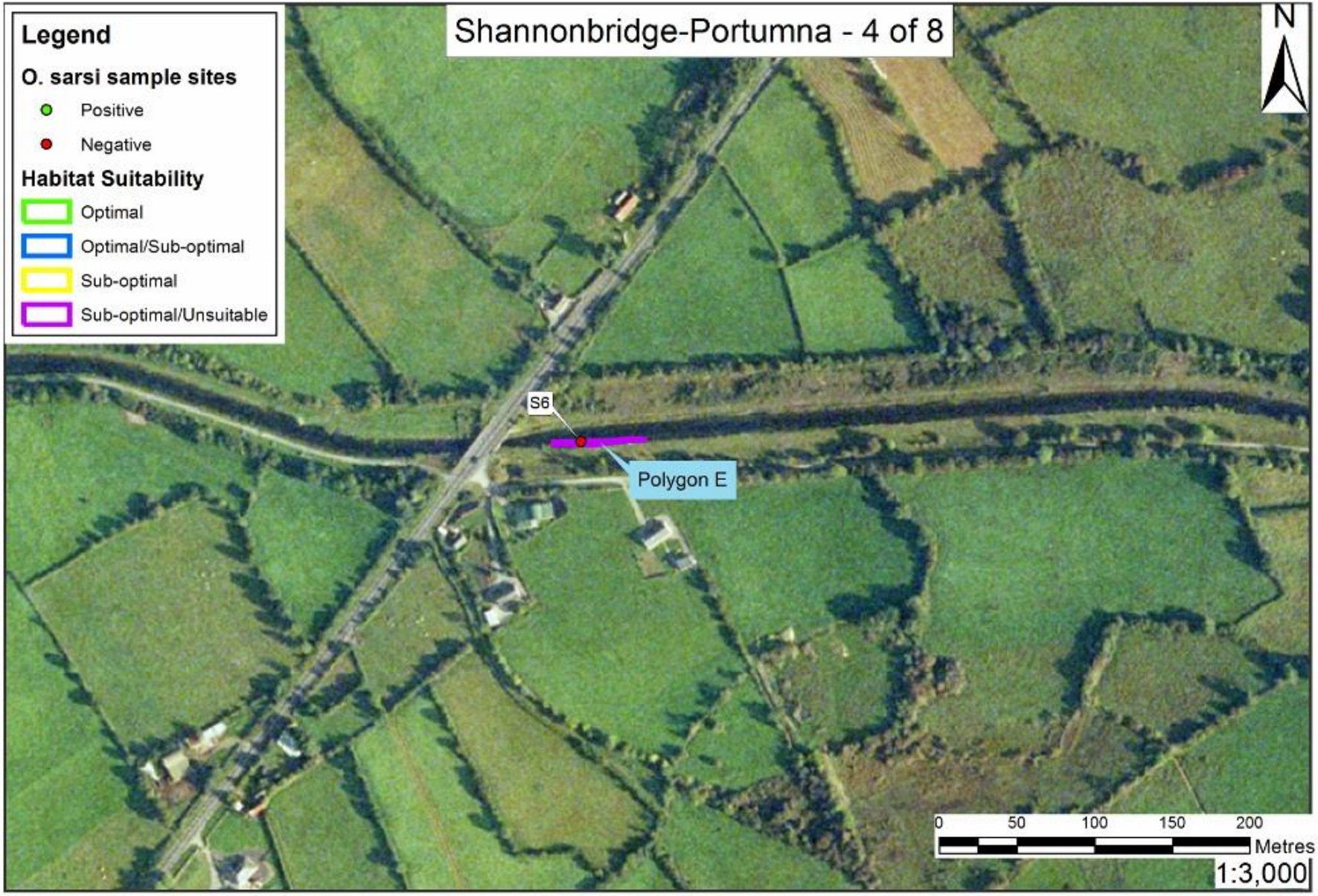

The Murrough - 6 of 6
Legend
V. moulinsiana sample sites
Positive
Negative
Habitat Suitability
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
Unsuitable
Polygon F
Polygon G
S22
S23
S24
N
0
50
100
150
200
Metres
1:3,000

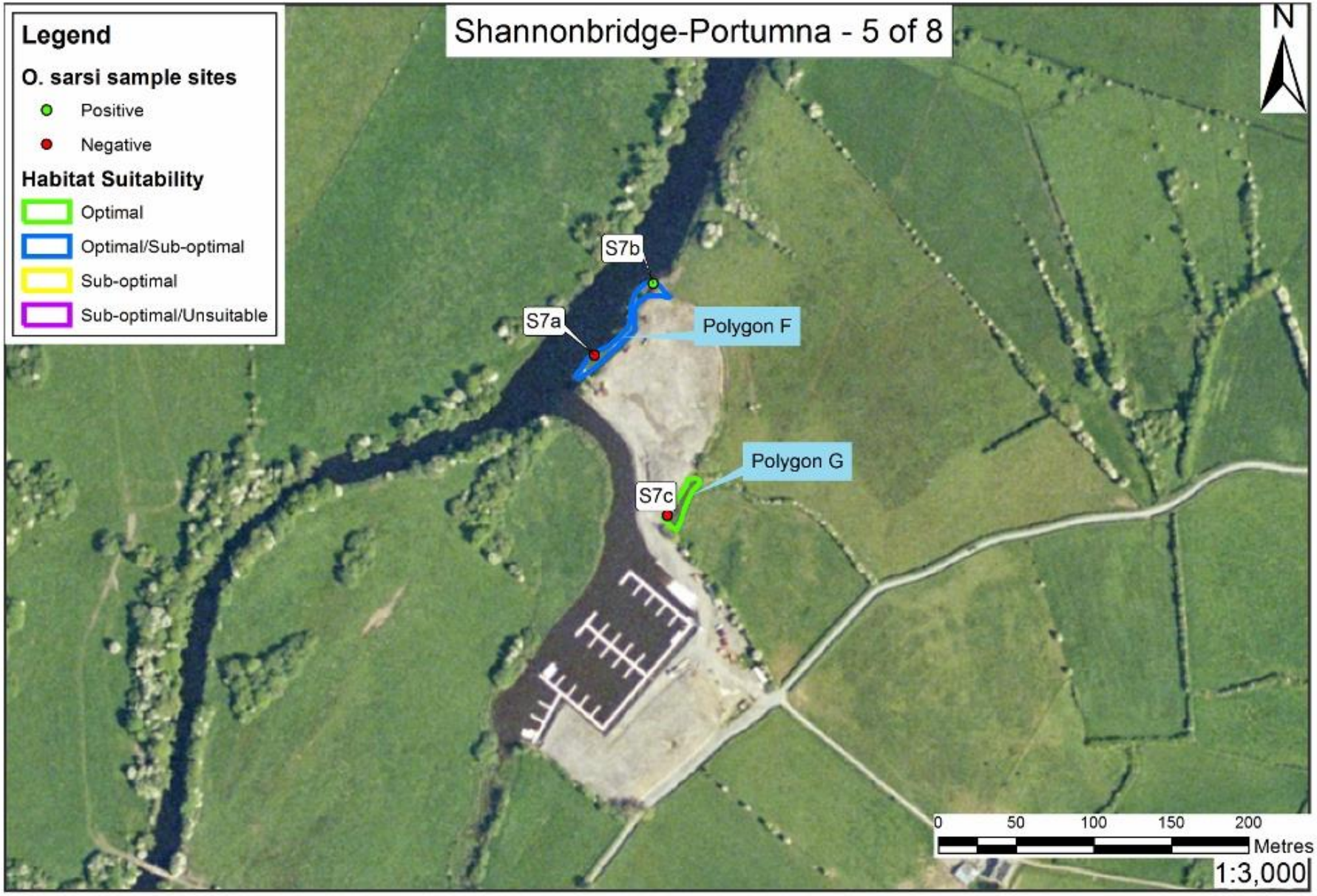

Shannonbridge-Portumna - Overview Map
N
Shannonbridge
Map 3 of 8
Map 4 of 8
Map 2 of 8
Galway
Map 1 of 8
Offaly
Map 5 of 8
Map 6 of 8
Map 8 of 8
Map 7 of 8
Portumna
Tipperary
Lough Derg
0
2.5
5
7.5
10
Kilometres
1:150,000

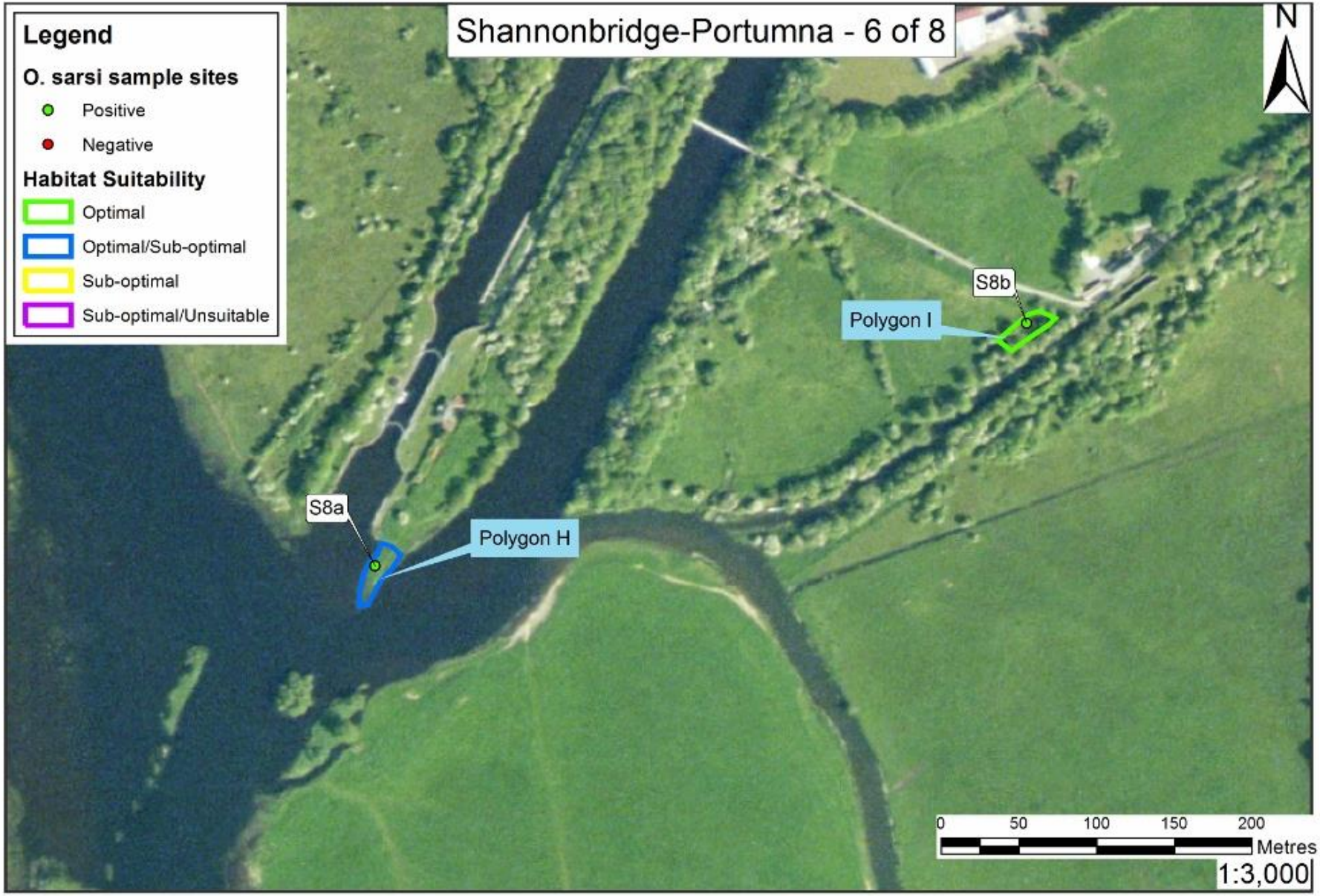

Shannonbridge-Portumna - 1 of 8
Legend
O. sarsi sample sites
Positive
Negative
Habitat Suitability
Optimal
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
Polygon A
S1
S2
N
0
50
100
150
200
Metres
1:3,000

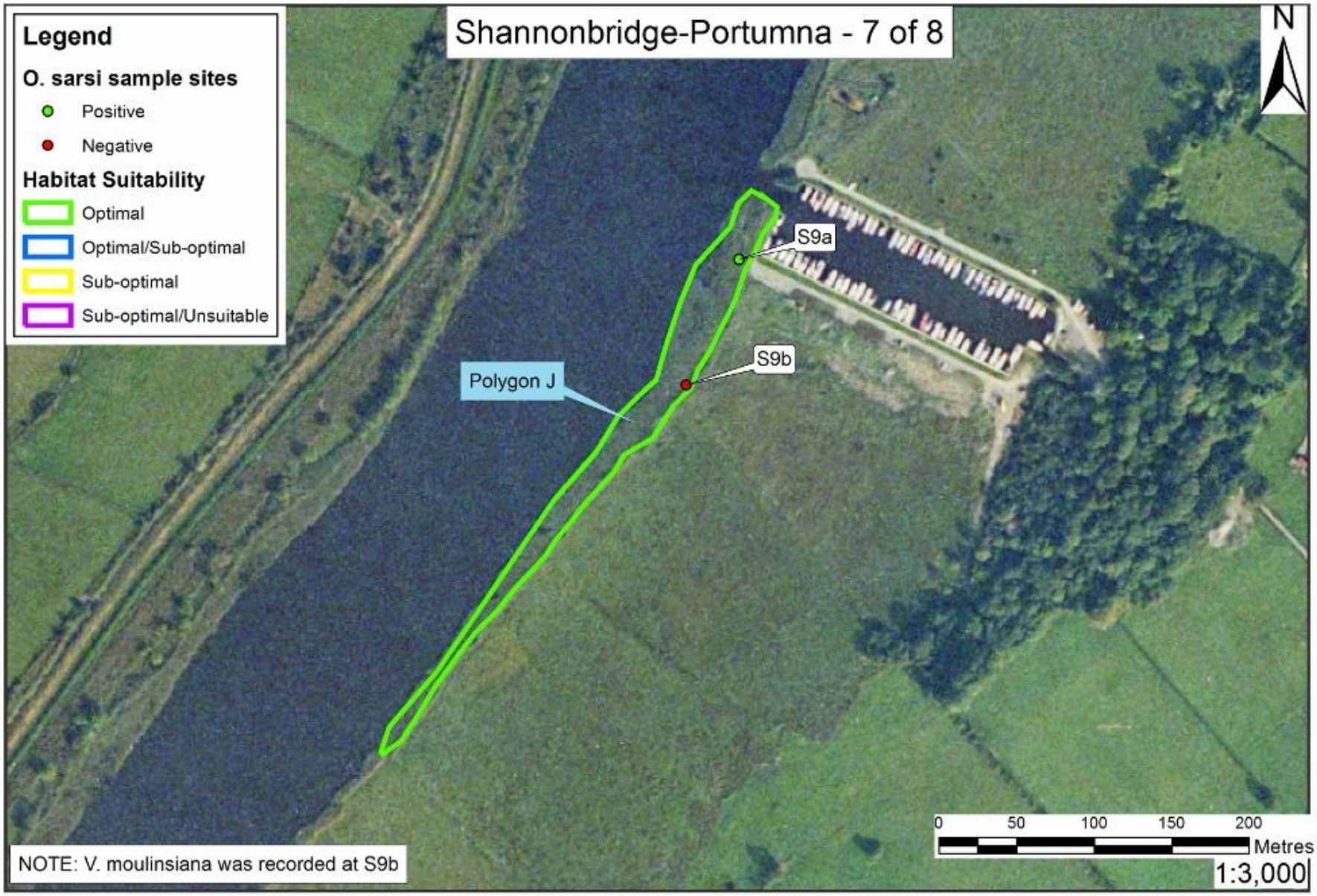

Shannonbridge-Portumna - 2 of 8
Legend
O. sarsi sample sites
Positive
Negative
Habitat Suitability
Optimal
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
N
S4
Polygon C
S3a/b
Polygon B
0
50
100
150
200
Metres
1:3,000

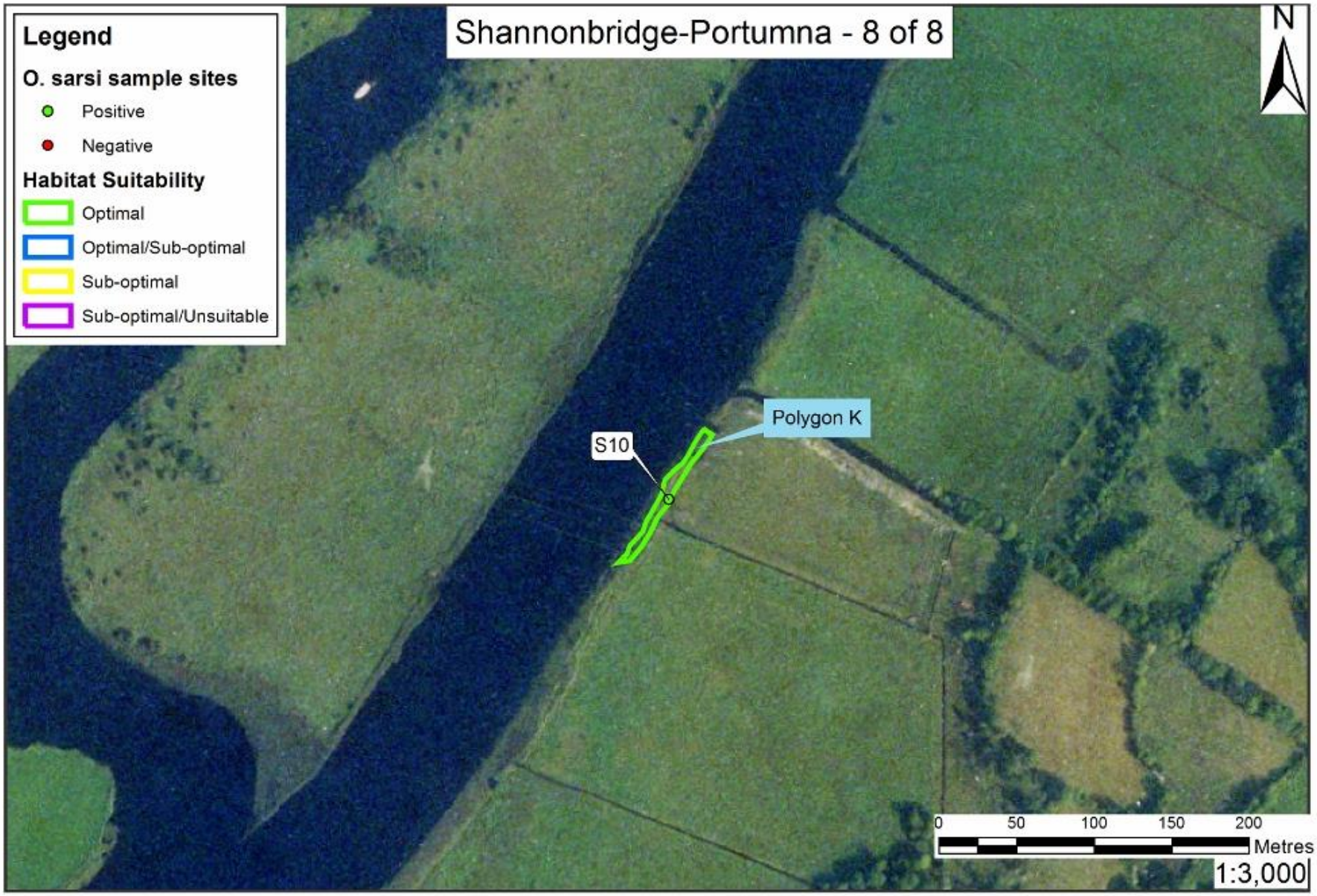

Legend
O. sarsi sample sites
Positive
Negative
Habitat Suitability
Optimal
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
Shannonbridge-Portumna - 3 of 8
N
S5a
S5b
Polygon D
0
50
100
150
200
Metres
1:3,000

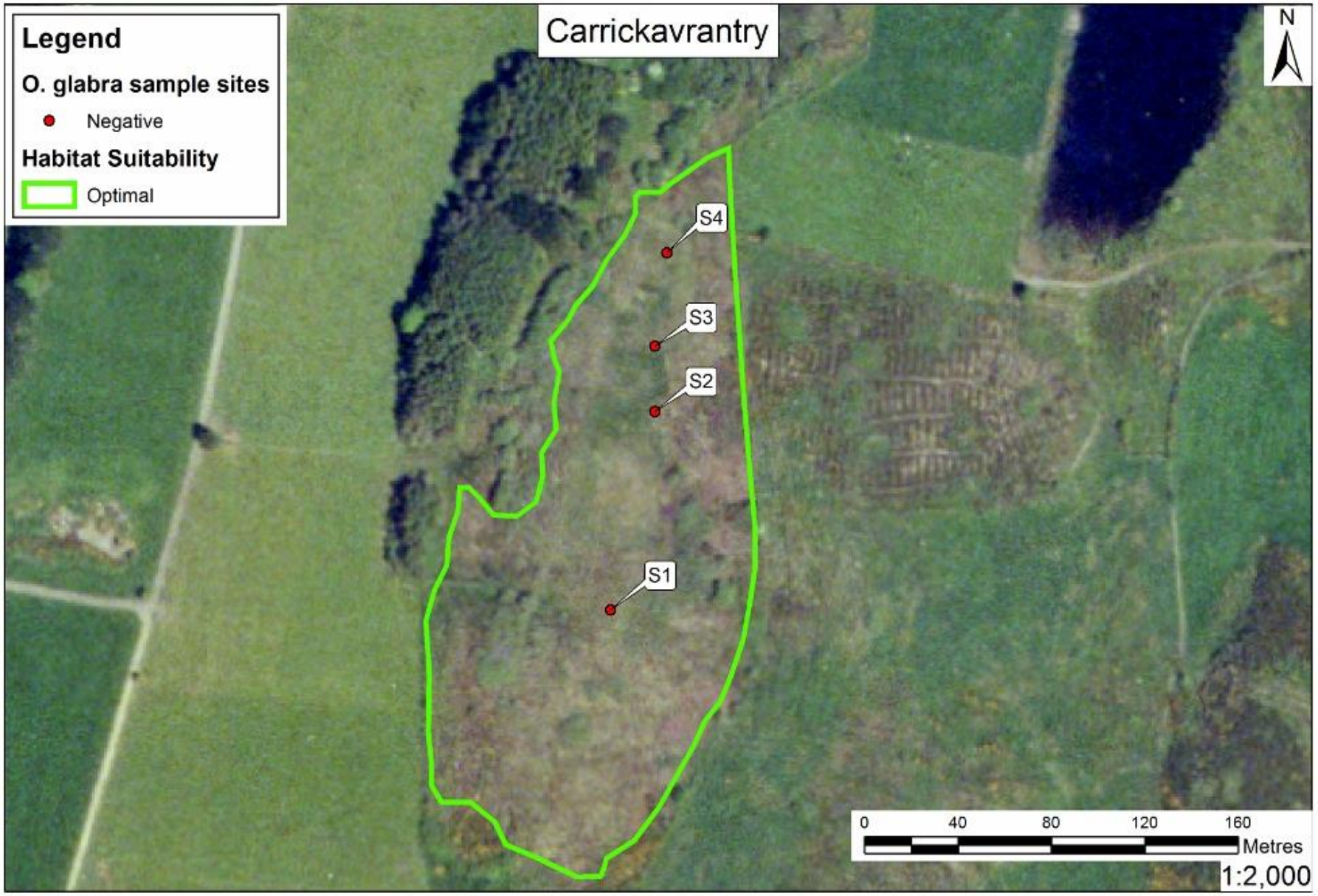

Shannonbridge-Portumna - 4 of 8
Legend
O. sarsi sample sites
Positive
Negative
Habitat Suitability
Optimal
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
S6
Polygon E
N
0
50
100
150
200
Metres
1:3,000

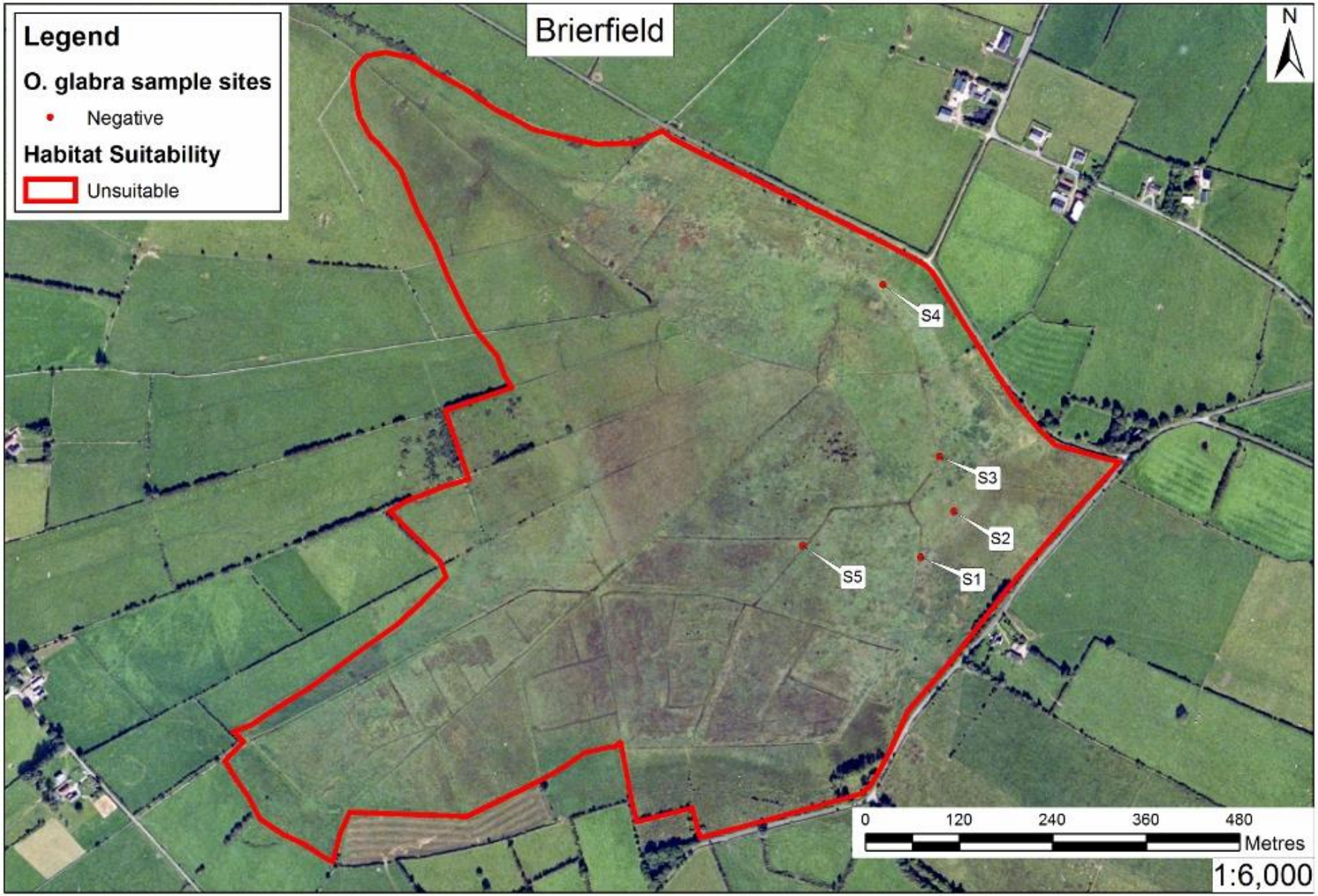

Shannonbridge-Portumna - 5 of 8
Legend
O. sarsi sample sites
Positive
Negative
Habitat Suitability
Optimal
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
S7b
S7a
S7c
Polygon F
Polygon G
N
0
50
100
150
200
Metres
1:3,000


Shannonbridge-Portumna - 6 of 8
Legend
O. sarsi sample sites
Positive
Negative
Habitat Suitability
Optimal
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
S8b
Polygon I
S8a
Polygon H
N
0
50
100
150
200
Metres
1:3,000


Shannonbridge-Portumna - 7 of 8
Legend
O. sarsi sample sites
Positive
Negative
Habitat Suitability
Optimal
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
S9a
S9b
Polygon J
N
0
50
100
150
200
Metres
1:3,000
NOTE: V. moulinsiana was recorded at S9b


Shannonbridge-Portumna - 8 of 8
Legend
O. sarsi sample sites
Positive
Negative
Habitat Suitability
Optimal
Optimal/Sub-optimal
Sub-optimal
Sub-optimal/Unsuitable
S10
Polygon K
N
0
50
100
150
200
Metres
1:3,000


Legend
O. glabra sample sites
Negative
Habitat Suitability
Optimal
Carrickavrantry
N
S4
S3
S2
S1
0
40
80
120
160
Metres
1:2,000


Brierfield
Legend
O. glabra sample sites
Negative
Habitat Suitability
Unsuitable
N
S4
S3
S2
S5
S1
0
120
240
360
480
Metres
1:6,000

Appendix III: Grid references for sampling points

Table A1: Grid references for sampling points at Cooley Lough, Co. Mayo.

Site number	Irish Grid
Site 1	M 13647 82580
Site 2	M 13647 82575
Site 3 – T9m	M 13498 82561
Site 4 – T21m	M 13490 82572
Site 5 – T38m	M 13477 82582
Site 6	M 13346 82565
Site 7	M 13307 82571
Site 8	M 13283 82568
Site 9	M 13272 82530
Site 10	M 13067 82393

Table A2: Grid references for sampling points at Carrowmoreknock, Co. Galway.

Site number	Irish Grid
Site 1	M 21191 40199
Site 2	M 21203 40009
Site 3	M 21162 40101
Site 4	M 21136 40125
Site 5	M 21055 40032
Site 6	M 21396 40595

Table A3: Grid references for sampling points at Lough Derg, near Portumna, Counties Tipperary and Galway.

Site number	**Irish Grid**
Site 1	R 82670 96373
Site 2	R 82825 96525
Site 3	R 82737 96622
Site 4	M 84268 00980
Site 5a	M 87079 04169
Site 5b	M 87087 04186
Site 5c	M 87094 04192
Transect 1	M 85080 03729
Transect 2	M 85086 03726
Transect 3	M 85096 03721
Transect 4	M 85106 03714
Transect 5	M 85113 03708
Transect 6	M 85125 03701
Site 7	M 85063 03674
Site 8	M 85075 03649
Site 9	M 85014 03647
Site 10	M 85064 03618
Site 11	M 85021 03680
Site 12	M 83153 02882
Site 13	M 83060 02861
Site 14	M 83029 02754
Site 15	M 83038 02691
Site 16	M 83811 03089

Table A4: Grid references for sampling points at Castletown, Co. Waterford.

Site number	Irish Grid
Site 1	S 61904 05104
Site 2	S 62006 05090
Site 3	S 62075 05061
Site 4	S 62052 04986
Site 5	S 61926 05061
Site 6	S 61955 04868
Site 7	S 61921 04823
Site 8	S 61928 04723
Site 9	S 61890 04777
Site 10 – T1	S 61907 05122
Site 11 – T2	S 61916 05125
Site 12 – T3	S 61933 05125
Site 13 – T4	S 61949 05126
Site 14 – T5	S 61963 05126
Site 15 – T6	S 61980 05126
Site 16 – T7	S 62005 05127
Site 17 – T8	S 62005 05127
Site 18	S 62106 05113
Site 19	S 62141 05061
Site 20	S 61825 05091
Site 21	S 61793 05087
Site 22	S 61724 05040

Table A5: Grid references for sampling points at Strancally, Co. Waterford.

Site number	Irish Grid
Site 1	W 08477 91009
Site 2	W 08476 91040
Site 3	W 08487 90983
Site 4	W 08481 90943
Site 5	W 08641 90771
Site 6	W 08705 90706
Site 7	W 08717 90781
Site 8	W 08769 90898
Site 9	W 08824 91065
Site 10	W 08736 91024

Table A6: Grid references for sampling points at The Murrough, Co. Wicklow.

Site number	**Irish Grid**
Site 1	O 31061 08182
Site 2	O 31175 08287
Site 3	O 31160 08303
Site 4	O 31141 08577
Site 5	O 31174 07900
Site 6	O 31190 07872
Site 7	O 31217 07839
Site 8	O 31337 02588
Site 9	O 31310 02586
Site 10	O 31224 02590
Site 11	O 31169 02668
Site 12	O 31126 02716
Site 13	O 31128 02661
Site 14	O 31113 02765
Site 15	O 31159 02823
Site 16	O 31024 02471
Site 17	O 31084 02299
Site 18	O 31181 02387
Site 19	O 31259 02402
Site 20	O 31398 03190
Site 21	O 31446 03152
Site 22	O 31343 02099
Site 23	O 31297 01945
Site 24	O 31258 01774

Table A7: Grid references for sampling points at Shannonbridge to Portumna, Counties Tipperary, Galway and Offaly.

Site number	Irish Grid
Site 1	N 00061 15861
Site 2	N 00117 15868
Site 3	N 02549 18794
Site 4	N 02847 18868
Site 5a	M 98774 22659
Site 5b	M 98923 22669
Site 6	N 10580 22827
Site 7a	M 96755 15289
Site 7b	M 96793 15335
Site 7c	M 96802 15186
Site 8a	M 94647 12957
Site 8b	M 95066 13113
Site 9a	M 88276 06333
Site 9b	M 88242 06252
Site 10	M 90553 10457

Table A8: Grid references for sampling points at Carrickavrantry, Co. Waterford.

Site number	Irish Grid
Site 1	S 54618 01804
Site 2	S 54637 01889
Site 3	S 54637 01917
Site 4	S 54642 01957

Table A9: Grid references for sampling points at Brierfield, Co. Roscommon.

Site number	Irish Grid
Site 1	M 81930 76775
Site 2	M 81972 76834
Site 3	M 81954 76904
Site 4	M 81881 77125
Site 5	M 81778 76790

Appendix IV: Vascular plant, habitat, and other related data

Table A1: Vascular plant species recorded at each sampling point at Cooley Lough, along with habitat categories and other ecological variables. Plant species are ordered with most frequent first, and then alphabetically. Refer to text for explanation of habitat codes. [Note: *Chara* sp. also included, and figures are percentage cover.]

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Freq
Hydrocotyle vulgaris	2	1	1	1	1	1	1	1	1	1	**10**
Mentha aquatica	5	1	1	1	1	1	2	1	5	2	**10**
Molinia caerulea	2	3	1	2	10	25	4	5	30	5	**10**
Parnassia palustris	5	5	1	5	1	5	2	2	5	1	**10**
Phragmites australis	15	30	1	2	1	1	10	5	3	15	**10**
Succisa pratensis	15	10	0.5	5	1	15	3	1	5	1	**10**
Angelica sylvestris	2	3	1	1		1	2	3	15	1	**9**
Carex lepidocarpa	25	25	15	35	30	50	60	25	30		**9**
Filipendula ulmaria	0.5	1	1	1		1	1	1	3	2	**9**
Carex rostrata	5	1	15	15		3	4	40		35	**8**
Juncus articulatus			1	3	1	1	1	2	15	1	**8**
Pedicularis sylvatica		2		1	1	1	1	2	3	1	**8**
Carex flacca		1			1	10	1	1	2	1	**7**
Carex panicea				10	20	5	2	3	3	35	**7**
Salix cinerea	5	2	1		1		2	1	2		**7**
Schoenus nigricans	3	30	50	20	3	2				4	**7**
Ranunculus flammula			1	1	1		1	1		1	**6**
Triglochin palustris			1		1	1		1	1	1	**6**
Chara sp.		2	2		1	1	5				**5**
Equisetum fluviatile		1				1	1			1	**4**
Equisetum palustre	3	1	1						1		**4**
Eleocharis quinqueflora							10	2		15	**3**
Eriophorum angustifolium			1		5				2		**3**
Linum catharticum	0.5						1			1	**3**
Lythrum salicaria						1		1	1		**3**
Agrostis stolonifera		0.5		1							**2**
Briza media	2								1		**2**
Epipactis palustris	2	3									**2**
Juncus acutiflorus	5	1									**2**
Orchid sp.									1	1	**2**
Sagina procumbens		1								1	**2**
Alnus glutinosa								1			**1**
Anagallis tenella										1	**1**
Anthoxanthum odoratum							1				**1**
Caltha palustris							1				**1**
Cardamine pratensis									1		**1**
Carex nigra										1	**1**
Cladium mariscus								30			**1**
Epilobium palustre		1									**1**

Equisetum arvense							1				**1**
Galium palustre		1									**1**
Holcus lanatus									1		**1**
Hypericum tetrapterum								1			**1**
Juncus inflexus									1		**1**
Prunella vulgaris									1		**1**
Rhinanthus minor		1									**1**
Salix aurita										5	**1**
Samolus valerandi			1								**1**
Scorzoneroides autumnalis										1	**1**
Selaginella selaginoides	1										**1**
Typha latifolia						5					**1**
Utricularia intermedia						1					**1**
Total no. species	**18**	**24**	**19**	**16**	**17**	**21**	**23**	**22**	**24**	**25**	**52**
Ecological variables (% cover):											
Bare soil	2	2	5	5	10	1	1	1	0	2	
Bare rock	0	1	1	10	10	0	0	0	0	1	
Open water	5	3	40	20	45	5	10	10	1	5	
Litter	5	3	2	15	15	15	20	40	4	20	
Bryophytes	60	75	40	60	65	80	75	25	45	55	
Field layer	70	65	65	80	75	90	80	95	95	95	
Broadleaved herbs	40	35	1	10	15	15	5	5	30	5	
Vegetation height (cm):											
Average	33	64	80	28	23	28	28	40	31	28	
Max.	170	158	80	85	67	140	108	112	128	140	
Min.	5	5	5	4	3	3	1	1	3	1	
Other:											
Slope	0	0	0	0	0	0	0	0	0	0	
Aspect	-	-	-	-	-	-	-	-	-	-	
Habitat type:											
Habitat code (Fossitt, 2000)	PF1	PF1	PF1	PF1	PF1	PF1	PF1	PF1	PF1	PF1	
Veg. Community (NVC)	M10	M10	M10	M10	M10	M10	M10	M10	M10	M10	
E.U. Annex Habitat	7230	7230	7230	7230	7230	7230	7230	7230	7230	7230	

Table A2: Vascular plant species recorded at each sampling point at Carrowmoreknock, along with habitat categories and other ecological variables. Plant species are ordered with most frequent first, and then alphabetically. Refer to text for explanation of habitat codes. [Note: figures are percentage cover.]

	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**Freq**
Carex panicea	5	5	25	10	5	10	**6**
Molinia caerulea	15	30	15	15	15	1	**6**
Calluna vulgaris	1	1	1	1	5		**5**
Carex lepidocarpa	15	10	20	15	5		**5**
Erica tetralix	3	2	3	5	8		**5**
Schoenus nigricans	60	35	20	25	45		**5**
Succisa pratensis	5	1	1	1	5		**5**
Anagallis tenella			1		1	2	**3**
Drosera rotundifolia			1	1	1		**3**
Eriophorum angustifolium	1	10		2			**3**
Hydrocotyle vulgaris				1	1	2	**3**
Narthecium ossifragum		1	1		2		**3**
Osmunda regalis		1	1	1			**3**
Parnassia palustris	1		1		1		**3**
Pinguicula sp.		1	1		1		**3**
Ranunculus flammula		1	1			1	**3**
Selaginella selaginoides	1		1		1		**3**
Carex nigra				1		55	**2**
Lythrum salicaria				1		1	**2**
Mentha aquatica					1	5	**2**
Menyanthes trifoliata	10	3					**2**
Potentilla erecta			1		1		**2**
Alnus glutinosa		3					**1**
Cardamine pratensis						1	**1**
Carex echinata		10					**1**
Comarum palustre		1					**1**
Eleocharis multicaulis				5			**1**
Equisetum fluviatile		1					**1**
Galium palustre						1	**1**
Juncus acutiflorus						5	**1**
Juncus articulatus		1					**1**
Juncus bulbosus			3				**1**
Juncus subnodulosus					20		**1**
Leontodon saxatilis						1	**1**
Pedicularis sylvatica		1					**1**
Potamogeton polygonifolius		2					**1**
Potamogeton sp.				2			**1**
Pteridium aquilinum				1			**1**
Scorzoneroides autumnalis						1	**1**
Trifolium pratense						1	**1**
Trifolium repens						1	**1**
Triglochin palustris		1					**1**
Typha latifolia	1						**1**

Total no. species	**12**	**21**	**17**	**16**	**17**	**15**	**43**
Ecological variables (% cover):							
Bare soil	3	1	25	10	15	0	
Bare rock	0	0	0	0	0	10	
Open water	15	20	55	30	20	20	
Litter	15	5	2	5	5	2	
Bryophytes	40	60	70	40	20	70	
Field layer	80	75	55	50	50	75	
Broadleaved herbs	15	5	5	3	10	10	
Vegetation height (cm):							
Average	73	33	10	25	10	21	
Max.	82	104	48	48	70	46	
Min.	3	0.5	0.5	0.5	0.5	0.5	
Other:							
Slope	0	0	0	0	0	0	
Aspect	-	-	-	-	-	-	
Habitat type:							
Habitat code (Fossitt, 2000)	PF1	PF3	PF1	PF1	PF1	PF1	
Veg. Community (NVC)	M13	M13	M10	M13	M13	M10	
E.U. Annex Habitat	n/a	n/a	n/a	n/a	n/a	n/a	

Table A3: Vascular plant species recorded at each sampling point at 'Lough Derg, near Portumna', along with habitat categories and other ecological variables. Plant species are ordered with most frequent first, and then alphabetically. Refer to text for explanation of habitat codes. [Note: *Chara* sp. also included, and figures are percentage cover.]

Site name*:	**B**	**B**	**B**	**G**	**L**	**L**	**L**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	
	S1	**S2**	**S3**	**S4**	**S5a**	**S5b**	**S5c**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**S7**	**S9**	**S12**	**S13**	**S14**	**S15**	**S16**	**Freq**
Mentha aquatica			15	5	2	1		3	1	2		1	2	2			1			5	**12**
Phragmites australis	75	10	65		60	15	15					20	100	100				55	20	25	**12**
Cladium mariscus		10						50	20	75	100	65				90		45	15	85	**10**
Agrostis stolonifera	1		1		1		25		2				5	2	30		5				**9**
Filipendula ulmaria			2	1	1		1		5	3					20					1	**8**
Angelica sylvestris							1	1	2	1			1	1			1				**7**
Equisetum fluviatile		1	5		3		3		1						2		1				**7**
Equisetum palustre								1	1	1			1	5	1						**6**
Eriophorum angustifolium								35	20	10						3	15	30			**6**
Iris pseudacorus	3		25				5							1	20				1		**6**
Juncus subnodulosus		80						1	30	10		15		1							**6**
Menyanthes trifoliata					1					1	5	5						3	5		**6**
Molinia caerulea								5	20	5						2	5				**5**
Schoenus nigricans								2	3	3						1		3			**5**
Glyceria maxima	30			60	40	65															**4**
Lycopus europaeus			1										1				2		2		**4**
Rumex hydrolapathum		1	5				1												1		**4**
Schoenoplectus lacustris										1		3					5		60		**4**
Typha latifolia		5			1	5	5														**4**
Festuca rubra									10	3							5				**3**
Phalaris arundinacea						10	60								35						**3**
Pulicaria dysenterica								3	1	3											**3**
Schedonorus arundinaceus									1								5			2	**3**
Succisa pratensis								1	1							1					**3**
Valeriana officinalis							2		1			1									**3**
Berula erecta			3		2																**2**
Briza media									4	1											**2**
Calystegia sepium	1						1														**2**
Carex cf *acutiformis*																	65		10		**2**

Carex disticha							15							1							**2**
Deschampsia cespitosa								1							5						**2**
Epilobium hirsutum					1	4															**2**
Fraxinus excelsior																	1			10	**2**
Galium palustre					1												1				**2**
Juncus inflexus								5							2						**2**
Lythrum salicaria															1					2	**2**
Nasturtium officinale										1							1				**2**
Potentilla erecta									1	1											**2**
Ranunculus lingua										1									1		**2**
Betula pubescens																				5	**1**
Carex flacca								10													**1**
Carex lepidocarpa								3													**1**
Carex rostrata		3																			**1**
Carex sp.						5															**1**
Chara sp.																			1		**1**
Cirsium dissectum								1													**1**
Elytrigia repens														1							**1**
Epilobium obscurum							1														**1**
Epilobium parviflorum			10																		**1**
Hippuris vulgaris		1																			**1**
Holcus lanatus														1							**1**
Hydrocotyle vulgaris			1																		**1**
Juncus acutiflorus								2													**1**
Juncus conglomeratus									2												**1**
Lemna minor	3																				**1**
Linum catharticum									1												**1**
Ranunculus repens																	1				**1**
Salix cinerea																				15	**1**
Sesleria caerulea								1													**1**
Sparganium erectum					1																**1**
Stachys palustris			2																		**1**
Stellaria palustris																	1				**1**
Urtica dioica														5							**1**

Utricularia intermedia																1				**1**
Total no. species	**6**	**8**	**12**	**3**	**12**	**7**	**13**	**17**	**20**	**17**	**2**	**7**	**6**	**11**	**9**	**6**	**16**	**5**	**10**	**9**	**64**
Ecological variables (% cover):																					
Bare soil	2	5	3	3	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	
Bare rock	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Open water	15	5	3	85	0	2	0	70	5	75	90	100	95	85	10	100	25	85	100	80	
Litter	80	95	65	20	100	90	85	60	75	90	30	35	50	70	75	50	40	65	60	35	
Bryophytes	0	0	65	0	0	0	0	1	15	0	0	0	2	0	0	5	10	0	0	0	
Field layer	95	100	100	60	100	100	100	95	100	95	100	95	100	100	100	90	90	80	100	100	
Broadleaved herbs	6	2	65	5	4	5	8	6	10	10	5	5	3	8	35	1	3	3	7	7	
Vegetation height (cm):																					
Average	78	75	190	74	70	134	86	132	58	138	138	154	178	169	105	142	80	95	120	125	
Max.	206	187	250	104	260	200	150	148	128	160	190	240	210	210	132	162	141	210	210	215	
Min.	41	38	27	22	18	45	19	68	18	18	64	66	25	31	32	54	12	23	48	28	
Other:																					
Slope	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Aspect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Habitat:																					
Habitat code (Fossitt, 2000)	FS1	PF1	FS1	FS1	FS1	FS1	FS1	PF1	PF1	PF1	FS1	FS1	FS1	FS1	GS4	PF1	FW4	FS1	FS1	FS1	
Veg. Community (NVC)	S24	S24	S24	S5	S24	S24	S24	S24	S24	S24	S2	S2	S4	S4		S2	S7			S2	
E.U. Annex Habitat	n/a	7230	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	

*Site name: B = Brockagh, G = Gortmore, L = Lehinch, PFP = Portumna Forest Park

Table A4: Vascular plant species recorded at each sampling point at Castletown, along with habitat categories and other ecological variables. Plant species are ordered with most frequent first, and then alphabetically. Refer to text for explanation of habitat codes. [Note: figures are percentage cover, and no vegetation relevé was carried out for S18.]

	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**	**S16**	**S17**	**S19**	**S20**	**S21**	**S22**	**Freq**
Equisetum fluviatile	35	25	5	2	35	2	15	3	15	5	5	10	5	5	10	3	5	10	15	20	5	**21**
Agrostis stolonifera	35	25	3	10	10	45	5		20	15	5	3	15	15	15	20	5	30	30	15	75	**20**
Holcus lanatus	2	10	35		4		2			50	60	75	50	70	45	70	80	15	15	5	10	**17**
Filipendula ulmaria		15	30	5	3	25	50		25	1	3		15	20	10	20	10			1		**15**
Sparganium erectum	30	25	5	5	80			5		20	30	40	30	35	50				40	1	10	**15**
Juncus effusus		20	60	10		1	3					5	5	1		2	10	15				**11**
Lythrum salicaria		4	5	5		10	25		10						1	2	3	1	1			**11**
Epilobium palustre			1		1		1	1					1	1		1		1	1	30		**10**
Galium palustre			1	2	3	2	1	1									2	1		1	1	**10**
Carex rostrata		5	15						1							15	10	1		5		**7**
Comarum palustre			20	55		25		3	5								15	1				**7**
Typha latifolia	15									30	15	5							35	15		**6**
Lotus pedunculatus		5					1		1						3				5			**5**
Lycopus europaeus						1	2	3							1							**4**
Phragmites australis						55	45	95	85													**4**
Rumex acetosa															1	1	1	1				**4**
Epilobium hirsutum										2		2									40	**3**
Juncus acutiflorus			1															60		3		**3**
Mentha aquatica													1	1	1							**3**
Agrostis canina																				2		**1**
Angelica sylvestris								1														**1**
Betula pubescens																				2		**1**
Cardamine pratensis																				2		**1**
Carex nigra																				30		**1**
Eriophorum angustifolium				45																		**1**
Festuca rubra							2															**1**
Poa humilis						1																**1**
Ranunculus repens		2																				**1**
Rubus fruticosus agg.						5																**1**
Vicia cracca						1																**1**

Total no. species:	**5**	**10**	**12**	**9**	**7**	**12**	**12**	**8**	**8**	**7**	**6**	**7**	**8**	**8**	**10**	**9**	**10**	**11**	**8**	**14**	**6**	**30**
Ecological variables (% cover):																						
Bare soil	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bare rock	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Open water	0	0	0	0	0	0	0	70	20	10	2	2	3	3	3	1	5	15	25	45	5	
Litter	30	25	65	60	40	80	80	35	35	80	75	85	90	85	85	80	85	90	90	95	85	
Bryophytes	0	0	2	2	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	5	0	
Field layer	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	95	100	
Broadleaved herbs	0	20	45	65	5	50	60	4	35	3	3	2	15	20	15	23	30	3	6	30	40	
Vegetation height (cm):																						
Average	109	96	69	58	147	126	108	142	134	48	53	39	94	55		42	40	39	80	53	43	
Max.	183	124	142	110	186	149	144	198	180	100	170	125	145	149		134	126	105	162	101	91	
Min.	17	28	40	26	36	19	24	28	34	12	22	35	27	27		24	26	17	12	4	11	
Other:																						
Slope	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Aspect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Habitat code (Fossitt, 2000)	FS1	FS1	GS4	GS4	FS1	FS1	FS1	FS1	FS1	FS1	FS1	FS1	FS1	FS1	FS1	GS4	GS4	GS4	FS1	FS1	GS4	
Veg. Community (NVC)	**S14**	**S14**	**MG10**		**S14**	**S4**	**S4**	**S4**	**S4**	**S14**	**S14**	**S14**	**S14**	**S14**	**S14**	**MG10**	**MG10**	**MG13**	**S14**	**S14**		
E.U. Annex Habitat	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	

Table A5: Vascular plant species recorded at each sampling point at Strancally, along with habitat categories and other ecological variables. Plant species are ordered with most frequent first, and then alphabetically. Refer to text for explanation of habitat codes. [Note: figures are percentage cover.]

	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**Freq**
Phragmites australis	90	100	100	100		30	20	100	20	100	**9**
Calystegia sepium				1		2		1	5	1	**5**
Carex riparia					80	75	80	2	85		**5**
Impatiens glandulifera	1	1	1		1		1				**5**
Agrostis stolonifera					10	1		1			**3**
Filipendula ulmaria						1		1			**2**
Iris pseudacorus					1	5					**2**
Lycopus europaeus					1		1				**2**
Mentha aquatic					10	2					**2**
Phalaris arundinacea						1			5		**2**
Solanum dulcamara							1		2		**2**
Urtica dioica					2	1					**2**
Berula erecta					10						**1**
Cirsium arvense						1					**1**
Fallopia japonica						1					**1**
Galium palustre						2					**1**
Holcus lanatus					1						**1**
Juncus effuses						1					**1**
Rumex hydrolapathum						3					**1**
Salix cinerea						1					**1**
Salix sp.									1		**1**
Total no. species:	**2**	**2**	**2**	**2**	**9**	**15**	**5**	**5**	**6**	**2**	**21**
Ecological variables (% cover):											
Bare soil	0	0	0	0	0	0	0	0	0	0	
Bare rock	0	0	0	0	0	0	0	0	0	0	
Open water	100	100	100	100	90	95	100	100	5	5	
Litter	75	75	75	85	40	75	60	80	80	95	
Bryophytes	0	0	0	0	0	0	0	0	0	0	
Field layer	90	100	100	100	95	100	95	100	100	100	
Broadleaved herbs	1	1	1	1	20	10	3	2	7	1	
Vegetation height (cm):											
Average	190	153	180	191	113	110	124	290	101	108	
Max.	250	196	230	260	118	150	250	290	175	183	
Min.	83	66	123	83	30	30	35	40	52	40	
Other:											
Slope	0	0	0	0	0	0	0	0	0	0	
Aspect	-	-	-	-	-	-	-	-	-	-	
Habitat code (Fossitt, 2000)	FS1	FS1	FS1	FS1	FS1	FS1	FS1	FS1	FS1	FS1	
Veg. Community (NVC)	S4	S4	S4	S4	S6	S26	S26	S26	S26	S4	
E.U. Annex Habitat	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	

Table A6: Vascular plant species recorded at each sampling point at The Murrough, along with habitat categories and other ecological variables. Plant species are ordered with most frequent first, and then alphabetically. Refer to text for explanation of habitat codes. [Note: figures are percentage cover.]

	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**	**S16**	**S17**	**S18**	**S19**	**S20**	**S21**	**S22**	**S23**	**S24**	**Freq**
Phragmites australis	100	20	100	75			95	40	70	20	15	80	25	10	10	2		3	5	2	75	65	10	45	**21**
Carex acutiformis/riparia	5	65	2	30	100		5	70	30	90	25	3	45			15	95		60			40	85	85	**18**
Agrostis stolonifera	2				1	2	2		5		5	2							3		1		3		**10**
Carex disticha	5	5			5	3			10	2		3								2			20		**9**
Juncus subnodulosus									3	1	10	20	1	10	10	10	3								**9**
Molinia caerulea										1	5	15	10	35	20	55									**7**
Rubus fruticosus agg.		2						1	5			1				3				5	5				**7**
Cladium mariscus								2										95	25	100	60				**5**
Filipendula ulmaria						1				2	1								1			5			**5**
Iris pseudacorus		15			3	85	1														5				**5**
Juncus effusus															1	2	3	1	3						**5**
Lythrum salicaria		1							1	1										5				1	**5**
Schoenus nigricans												2	2	5	65	30									**5**
Galium palustre					1			1	2		1														**4**
Urtica dioica		2		3			3															1			**4**
Calluna vulgaris												1			3	2									**3**
Carex paniculata											10	5		55											**3**
Mentha aquatica								1						1				1							**3**
Potentilla erecta												1			1	1									**3**
Angelica sylvestris													1			1									**2**
Anthoxanthum odoratum											1					1									**2**
Betula pubescens												3		5											**2**
Cardamine pratensis											1					1									**2**
Carex flacca														1	1										**2**
Elytrigia repens						2														1					**2**
Juncus articulatus													1						1						**2**
Lemna minor											1						1								**2**
Ranunculus flammula												1						1							**2**
Ranunculus repens						1													1						**2**

Salix cinerea									1		10														**2**
Ulex europaeus												1	1												**2**
Vicia cracca										1		1													**2**
Calystegia sepium				1																					**1**
Carex lepidocarpa															1										**1**
Carex pulicaris															1										**1**
Cirsium palustre																1									**1**
Dactylis glomerata																						1			**1**
Epilobium hirsutum		2																							**1**
Epilobium sp.																								3	**1**
Equisetum fluviatile																	1								**1**
Erica tetralix															1										**1**
Eupatorium cannabinum																					1				**1**
Galium aparine												1													**1**
Hydrocotyle vulgaris																		1							**1**
Juncus acutiflorus					1																				**1**
Juncus inflexus																	1								**1**
Lycopus europaeus								2																	**1**
Phleum pratense					1																				**1**
Poa humilis						2																			**1**
Potamogeton polygonifolius													5												**1**
Potamogeton sp.											1														**1**
Schedonorus arundinaceus									3																**1**
Schoenoplectus lacustris																			5						**1**
Succisa pratensis																3									**1**
Trifolium repens																1									**1**
Typha latifolia											10														**1**
Total no. species:	**4**	**8**	**2**	**4**	**7**	**7**	**5**	**7**	**10**	**8**	**14**	**16**	**9**	**8**	**11**	**15**	**6**	**6**	**9**	**6**	**6**	**5**	**4**	**4**	**56**
Ecological variables (% cover):																									
Bare soil	35	0	0	0	0	1	2	1	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	1	
Bare rock	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Open water	15	0	5	40	5	0	15	50	65	40	60	65	90	35	1	45	70	90	100	5	80	40	5	0	

Litter	95	85	100	90	80	70	90	85	95	85	65	85	60	45	80	55	50	25	65	100	45	70	95	65	
Bryophytes	0	0	0	1	0	0	0	1	0	0	10	0	0	0	0	4	0	0	0	0	0	0	0	0	
Field layer	100	100	100	100	100	100	100	90	100	100	85	100	65	95	100	90	95	100	85	100	100	100	100	100	
Broadleaved herbs	0	15	0	3	0	85	3	3	1	3	3	2	5	1	1	3	1	1	1	5	5	5	0	1	
Vegetation height (cm):																									
Average	190	130	240	240	95	95	185	105	190	92	72	190	110		75	101	110	107	110	125	125	210	102		
Max.	197	200	250	250	100	124	210	197	200	196	184	195	200		175	147	120	174	181	155	240	220	190		
Min.	45	55	90	51	54	21	56	24	55	48	12	47	28		22	26	65	42	35	45	35	42	52		
Other:																									
Slope	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Aspect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Habitat code (Fossitt, 2000)	FS1	FS1	FS1	FS1	FS1	FS2	FS1	FS1	FS1	FS1	PF1	FS1	FW4	PF1	PF1	PF1	FS1	FS1	FS1	FS1	FS1	FS1	FS1	FS1	
Veg. Community (NVC)	S4	S6/7	S4	S4	S6/7		S4	S6/7	S24	S6/7	M13	S24	S6/7	M13	M13	M13	S6/7	S2	S6/7	S2	S24	S4	S6/7	S6/7	
E.U. Annex Habitat	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	

Table A7: Vascular plant species recorded at each sampling point at 'Shannonbridge - Portumna', along with habitat categories and other ecological variables. Plant species are ordered with most frequent first, and then alphabetically. Refer to text for explanation of habitat codes. [Note: figures are percentage cover.]

Location code*:	**BB**	**BB**	**SH**	**SH**	**SB**	**SB**	**Fb**	**Gc**	**Gc**	**Gc**	**VL**	**VL**	**PP**	**PP**	**Bme**	
	S1	**S2**	**S3**	**S4**	**S5a**	**S5b**	**S6**	**S7a**	**S7b**	**S7c**	**S8a**	**S8b**	**S9a**	**S9b**	**S10**	**Freq**
Phalaris arundinacea	90	90		10		5		80	5	40	20		10	5	5	**11**
Glyceria maxima			80	60		80			75	45	60	95	50	15	80	**10**
Agrostis stolonifera		2	2	1	5	3			2	15		1			1	**9**
Filipendula ulmaria	1		1	2			5		1	1					1	**7**
Iris pseudacorus					2		1		1	1	5	5			2	**7**
Mentha aquatica		3	2						15		5		1	4	2	**7**
Salix cinerea		1	1				10		10	2	1					**6**
Galium palustre			1		2					1	1				1	**5**
Phragmites australis	3										10		45	80	20	**5**
Ranunculus repens		1	1		10	3					1					**5**
Urtica dioica		3				2		20	1	3						**5**
Apium nodiflorum				3	20	5									1	**4**
Equisetum fluviatile										1			3	2	1	**4**
Juncus inflexus			4				3			2			1			**4**
Sparganium erectum					5		1				1	3				**4**
Angelica sylvestris			2				1								1	**3**
Azolla filiculoides											1		1	1		**3**
Epilobium hirsutum	2	2													1	**3**
Equisetum palustre	1	1					1									**3**
Festuca rubra		1	2				10									**3**
Lythrum salicaria	1		1							2						**3**
Ranunculus lingua											2			2	1	**3**
Rubus fruticosus agg.	3					5	5									**3**
Vicia cracca	1		1			1										**3**
Arrhenatherum elatius			1				1									**2**
Carex hirta										1			1			**2**
Carex sp.					15									5		**2**
Juncus effusus								3		2						**2**
Lemna minor				5								1				**2**
Lysimachia vulgaris	1									1						**2**
Menyanthes trifoliata										1				1		**2**
Myosotis sp.					5										1	**2**
Persicaria amphibia	2										2					**2**
Schoenoplectus lacustris			4				20									**2**
Typha latifolia													3	1		**2**
Carex rostrata				1												**1**
Comarum palustre		1														**1**
Crataegus monogyna						1										**1**
Dactylis glomerata							1									**1**
Equisetum variegatum							25									**1**
Fraxinus excelsior						90										**1**
Galium aparine						1										**1**
Glyceria notata					10											**1**
Lathyrus pratensis							1									**1**
Lotus corniculatus							1									**1**
Lycopus europaeus						1										**1**

Plantago major						1										**1**
Rosa canina						1										**1**
Rumex conglomeratus					15											**1**
Rumex hydrolapathum														1		**1**
Rumex obtusifolius						1										**1**
Schedonorus arundinaceus			2													**1**
Scrophularia auriculata			1													**1**
Scrophularia nodosa											1					**1**
Senecio aquaticus					1											**1**
Valeriana officinalis							1									**1**
Veronica beccabunga									2							**1**
Total no. species:	**10**	**10**	**16**	**7**	**11**	**15**	**16**	**3**	**9**	**15**	**13**	**5**	**9**	**11**	**14**	**57**
Ecological variables (% cover):																
Bare soil	0	0	0	1	1	3	0	5	0	0	5	0	0	3	0	
Bare rock	10	0	0	0	5	0	3	0	0	0	0	0	0	0	0	
Open water	5	10	60	50	65	5	60	3	70	40	85	65	10	15	55	
Litter	40	50	35	35	10	20	30	70	30	65	25	80	85	90	90	
Bryophytes	5	0	0	1	0	0	0	0	0	1	0	0	0	1	0	
Field layer	80	95	90	70	80	100	65	90	85	90	85	100	100	100	100	
Broadleaved herbs	5	8	5	5	50	10	8	20	15	5	10	5	1	6	5	
Vegetation hgt (cm):																
Average	102	69	79	66	25		90	49	63	44	70	73	152	180	67	
Max.	120	134	150	96	72		145	157	172	190	144	172	250	250	196	
Min.	20	22	29	0	11		90	25	33	20	12	35	19	25	32	
Other:																
Slope	4	4	4	4	2	0	4	0	0	0	0	0	0	0	0	
Aspect	S	SW	N	S	S	-	N	-	-	-	-	-	-	-	-	
Habitat code (Fossitt, 2000)	FS1	FS1	FS1	FW4	GS4	FW4	FW3	FS1	FS1	FW4	FS1	FS1	FS1	FS1	FS1	
Veg. Community (NVC)	**S28**	**S28**	**S5**	**S5**		**S5**	**S8**	**S28**	**S5**	**S28**	**S5**	**S5**	**S4**	**S4**	**S5**	
E.U. Annex Habitat	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	

*Location code: BB=Banagher Bridge, SH=Shannon Harbour, SB=near Shannon Bridge, Fb=Ferbane, Gc=Gortachallow, VL=Victoria Lock, PP=Portland Park, Bme=Ballymacegan.

Table A8: Vascular plant species recorded at each sampling point at Carrickavrantry, along with habitat categories and other ecological variables. Plant species are ordered with most frequent first, and then alphabetically. Refer to text for explanation of habitat codes. [Note: figures are percentage cover.]

	S1	**S2**	**S3**	**S4**	**Freq**
Agrostis stolonifera	3	1	25	10	**4**
Carex rostrata	10	10	15	10	**4**
Eriophorum angustifolium	20	45	10	5	**4**
Galium palustre	3	10	2	5	**4**
Juncus acutiflorus	35	35	40	40	**4**
Juncus effusus	40	15	2	3	**4**
Typha latifolia	1	1	10	25	**4**
Comarum palustre	1	1		1	**3**
Epilobium obscurum	2		1	1	**3**
Lemna minor		1	1	5	**3**
Menyanthes trifoliata		3	25	20	**3**
Nasturtium officinale	1	1			**2**
Ranunculus flammula	1			1	**2**
Agrostis canina				2	**1**
Equisetum fluviatile	5				**1**
Glyceria fluitans	2				**1**
Hydrocotyle vulgaris	1				**1**
Total no. species:	**14**	**11**	**10**	**13**	**17**
Ecological variables (% cover):					
Bare soil	0	0	0	0	
Bare rock	0	0	0	0	
Open water	40	30	25	60	
Litter	35	50	25	50	
Bryophytes	0	1	0	0	
Field layer	90	85	95	75	
Broadleaved herbs	5	10	40	25	
Vegetation height (cm):					
Average	98	52	67	48	
Max.	125	140	155	141	
Min.	5	18	15	17	
Other:					
Slope	0	0	0	0	
Aspect	-	-	-	-	
Habitat code (Fossitt, 2000)	PF2	PF2	PF2	PF2	
Veg. Community (NVC)	M9	M9	M9	M9	
E.U. Annex Habitat	n/a	n/a	n/a	n/a	

Table A9: Vascular plant species recorded at each sampling point at Brierfield turlough, along with habitat categories and other ecological variables. Plant species are ordered with most frequent first, and then alphabetically. Refer to text for explanation of habitat codes. [Note: figures are percentage cover.]

	S1	**S2**	**S3**	**S4**	**S5**	**Freq**
Carex nigra	25	10	25	10	10	**5**
Eleocharis palustris	2	70	10	5	3	**5**
Galium palustre	2	45	10	1	25	**5**
Phalaris arundinacea	4	5		45	1	**4**
Ranunculus repens	4	2	2		1	**4**
Persicaria amphibia	1		10	3		**3**
Potentilla anserina	5			20	5	**3**
Equisetum fluviatile			1		1	**2**
Glyceria fluitans	10		3			**2**
Mentha aquatica	1		1			**2**
Veronica anagallis-aquatica	1		3			**2**
Veronica scutellata	1				1	**2**
Agrostis stolonifera	15					**1**
Cardamine pratensis	1					**1**
Comarum palustre				30		**1**
Hippuris vulgaris					1	**1**
Menyanthes trifoliata					60	**1**
Nasturtium officinale			1			**1**
Oenanthe aquatica			4			**1**
Ranunculus flammula					1	**1**
Ranunculus lingua			35			**1**
Rorippa amphibia		20				**1**
Utricularia sp.			1			**1**
Total no. species:	**13**	**6**	**13**	**7**	**11**	**23**
Ecological variables (% cover):						
Bare soil	25	0	1	0	0	
Bare rock	0	0	0	0	0	
Open water	25	95	75	60	45	
Litter	5	80	15	60	10	
Bryophytes	0	0	0	1	0	
Field layer	45	95	90	75	90	
Broadleaved herbs	10	55	55	50	75	
Vegetation height (cm):						
Average	8	30	26	13	31	
Max.	26	45	42	26	60	
Min.	1	10	6	4	10	
Other:						
Slope	2	0	0	3	0	
Aspect	W	-	-	SW	-	
Habitat code (Fossitt, 2000)	FL6	FL6	FL6	FL6	FL6	
E.U. Annex Habitat	*3180 Turloughs	*3180 Turloughs	*3180 Turloughs	*3180 Turloughs	*3180 Turloughs	

Appendix V: Bryophyte data

Table A1: Bryophyte species recorded at each sampling point at Cooley Lough, along with total bryophyte cover. Species are ordered with most frequent first, and then alphabetically. 'P' denotes 'present' (percentage cover values are not available for individual bryophyte species at this site).

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Freq
Campylium stellatum (s.l.)	P	P	P	P	P	P	P		P	P	**9**
Scorpidium scorpioides	P	P	P	P	P	P	P	P		P	**9**
Calliergonella cuspidata	P	P	P	P			P	P	P	P	**8**
Scorpidium revolvens			P			P	P				**3**
Cratoneuron filicinum			P	P							**2**
Palustriella falcata						P				P	**2**
Fissidens sp.										P	**1**
Palustriella cf *commutata*								P			**1**
Philonotis calcarea					P						**1**
Scorpidium cossonii									P		**1**
Total no. species:	**3**	**3**	**5**	**4**	**3**	**4**	**4**	**3**	**3**	**5**	
Total bryophyte cover:	**60**	**75**	**40**	**60**	**65**	**80**	**75**	**25**	**45**	**55**	
TOTAL AT SITE = 10 spp.											

Table A2: Bryophyte species recorded at each sampling point at Carrowmoreknock, along with total bryophyte cover. Species are ordered with most frequent first, and then alphabetically.

	S1	S2	S3	S4	S5	S6	Freq
Campylium stellatum (s.l.)	40	40	40	15	20	5	**6**
Scorpidium scorpioides	1	3	15	20	2	40	**6**
Scorpidium revolvens		1	10	5		10	**4**
Bryum cf *pseudotriquetrum*		0.5				0.5	**2**
Calliergonella cuspidata		1				15	**2**
Calliergon giganteum		1				2	**2**
Fissidens sp.	1	0.5					**2**
Sphagnum spp.		10	5				**2**
Aulacomnium palustre			1				**1**
Breutelia chrysocoma			1				**1**
Ctenidium molluscum			1				**1**
Pseudocalliergon lycopodioides						1	**1**
Sphagnum capillifolium		5					**1**
Thuidium tamariscinum		1					**1**
Total no. species:	**3**	**10**	**7**	**3**	**2**	**7**	
Total bryophyte cover:	**40**	**60**	**70**	**40**	**20**	**70**	
TOTAL AT SITE = 14 spp.							

Table A3: Bryophyte species recorded at each sampling point at 'Lough Derg, near Portumna', along with total bryophyte cover. Species are ordered with most frequent first, and then alphabetically.

Site name*:	**B**	**B**	**B**	**G**	**L**	**L**	**L**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	**PFP**	
	S1	**S2**	**S3**	**S4**	**S5a**	**S5b**	**S5c**	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**S7**	**S9**	**S12**	**S13**	**S14**	**S15**	**S16**	**Freq**
Calliergonella cuspidata			65						15							3	5				**4**
Ctenidium molluscum								0.5								2					**2**
Brachythecium rivulare													2								**1**
Campylium stellatum (s.l.)								1													**1**
Kindbergia praelonga																	1				**1**
Plagiomnium cf *elatum*																	3				**1**
Pseudoscleropodium purum																	2				**1**
Total no. species:	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**2**	**4**	**0**	**0**	**0**	
Total bryophyte cover:	**0**	**0**	**65**	**0**	**0**	**0**	**0**	**1**	**15**	**0**	**0**	**0**	**2**	**0**	**0**	**5**	**10**	**0**	**0**	**0**	
TOTAL AT SITE = 7 spp.																					

*Site name: B = Brockagh, G = Gortmore, L = Lehinch, PFP = Portumna Forest Park

Table A4: Bryophyte species recorded at each sampling point at Castletown, along with total bryophyte cover. Species are ordered with most frequent first, and then alphabetically.

	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**	**S16**	**S17**	**S19**	**S20**	**S21**	**S22**	**Freq**
Brachythecium rutabulum			2						1													**2**
Brachythecium rivulare																				5		**1**
Calliergon cordifolium				2																		**1**
Calliergonella cuspidata								3														**1**
Total no. species:	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	
Total bryophyte cover:	**0**	**0**	**2**	**2**	**0**	**0**	**0**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	
TOTAL AT SITE = 4 spp.																						

[Note that no bryophytes were recorded at Strancally.]

Table A5: Bryophyte species recorded at each sampling point at The Murrough, along with total bryophyte cover. Species are ordered with most frequent first, and then alphabetically.

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	Freq
Calliergonella cuspidata											10					4									**2**
Drepanocladus aduncus											1														**1**
Kindbergia praelonga								1																	**1**
Oxyrrhynchium speciosum				1																					**1**
Total no. species:	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Total bryophyte cover:	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**10**	**0**	**0**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
TOTAL AT SITE = 4 spp.																									

Table A6: Bryophyte species recorded at each sampling point at the *Oxyloma sarsi* sample sites between Shannonbridge and Portumna, along with total bryophyte cover.

	S1	S2	S3	S4	S5a	S5b	S6	S7a	S7b	S7c	S8a	S8b	S9a	S9b	S10	Freq
Brachythecium rutabulum	1															**1**
Calliergonella cuspidata										1						**1**
Cinclidotus fontinaloides	3															**1**
Oxyrrhynchium hians														1		**1**
Total no. species:	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	
Total bryophyte cover:	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	
TOTAL AT SITE = 4 spp.																

Appendix VI: Concordance of sample numbers

Table A1. Sample numbers from the current survey for *Vertigo geyeri* at Cooley Lough, compared with those of Moorkens & Killeen (2011).

Sample number in current survey*	Sample number in Moorkens & Killeen (2011)*
1	-
2	-
3 (T)	T1
4 (T)	T2
5 (T)	T3
6	4
7	3
8	2
9	1
10	5

*T = transect

Table A2. Sample numbers from the current survey for *Vertigo geyeri* at Carrowmoreknock, compared with those of Moorkens & Killeen (2011).

Sample number in current survey	Sample number in Moorkens & Killeen (2011)
1	-
2	n/a
3, 4	3, 2
5	1
6	6

Table A3. Sample numbers from the current survey for *Vertigo moulinsiana* at 'Lough Derg, near Portumna', compared with those of Moorkens & Killeen (2011).

Sample number in current survey*	Sample number in Moorkens & Killeen (2011)
1-3	-
4	-
5	-
T1 – T6, 7 – 11	2-10
12, 13	14, 15
14, 15	-
16	-

*T = transect

Table A4. Sample numbers from the current survey for *Vertigo moulinsiana* at The Murrough, compared with those of Moorkens & Killeen (2011).

Sample number in current survey	Sample number in Moorkens & Killeen (2011)
1-4	-
5-7	-
8	1
9	2
10	4
11	9
12	7
13	-
14	-
15	-
16	11
17-24	-

Appendix VII: Transect diagrams

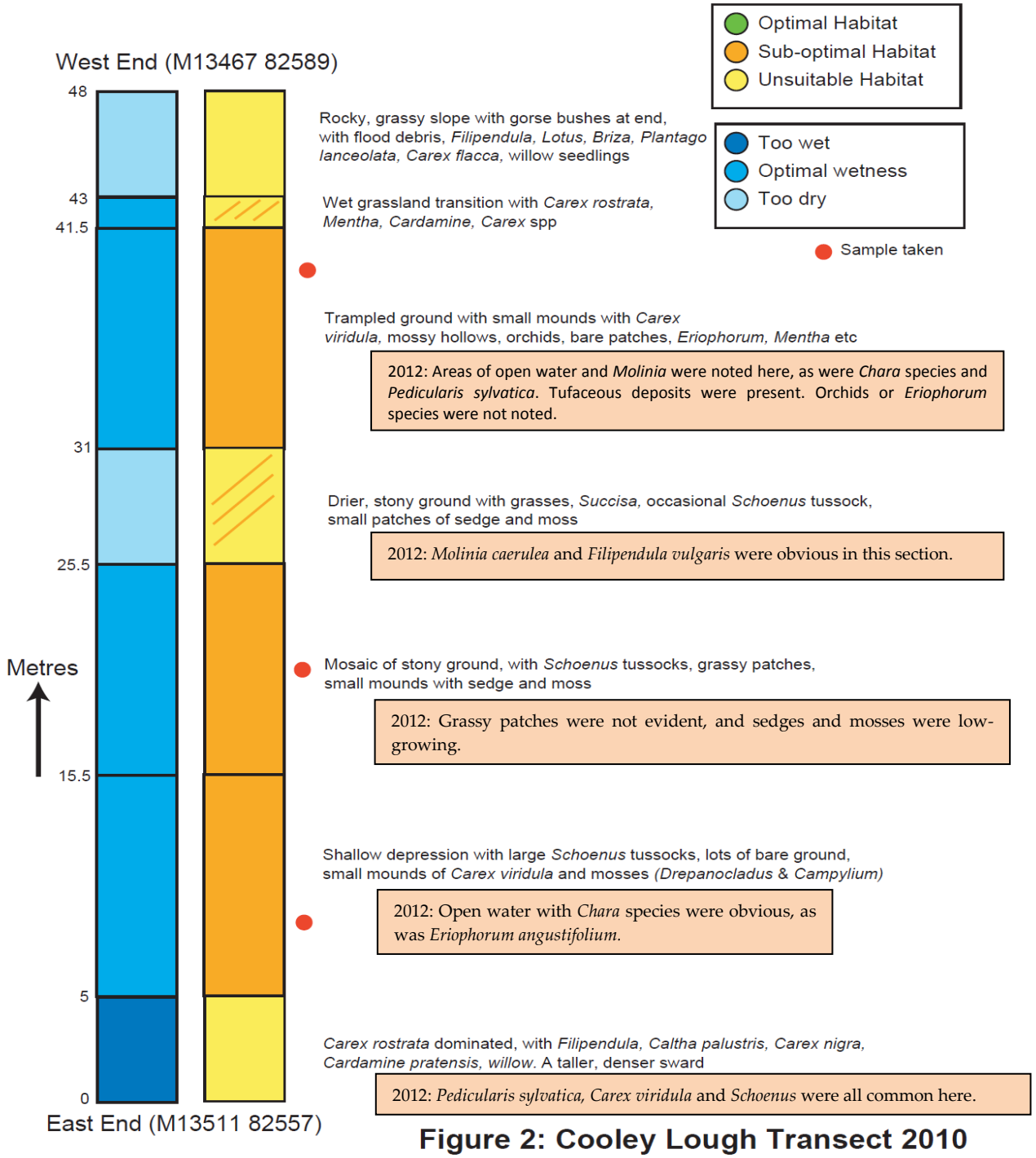


Figure A1. Transect at Cooley Lough (diagram taken from Moorkens & Killeen, 2011), with annotations from the present survey shown in pink.

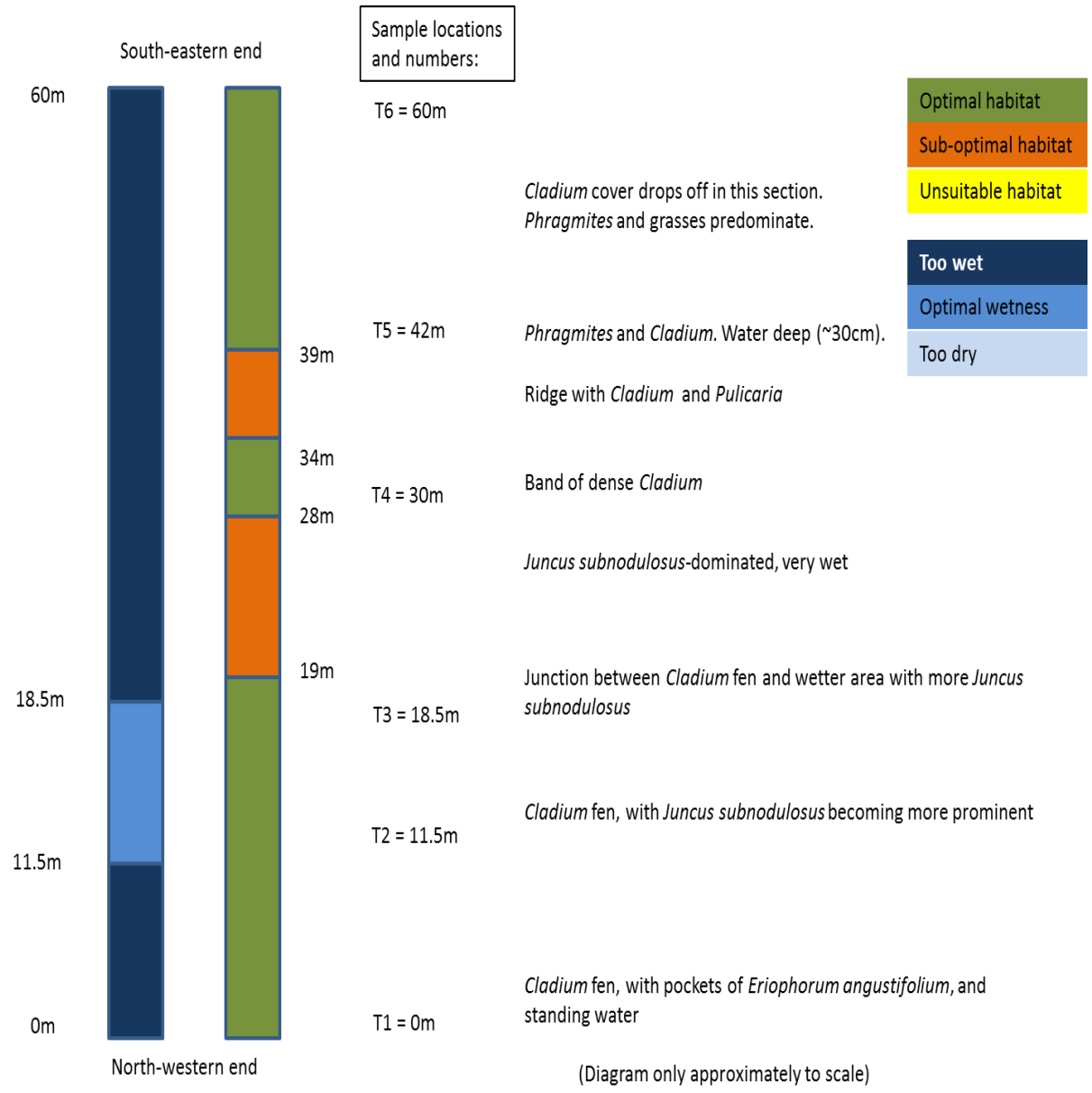


Figure A2. Transect at Portumna Forest Park (within 'Lough Derg, near Portumna' site), showing habitat suitability, wetness and vegetation type.

Table A1. Transect details, Portumna Forest Park ('Lough Derg, near Portumna' site).

Start Point:	M 85080 03729 adjacent to N-S embankment
End point:	M 85125 03701
Transect Length:	60m
Description:	The habitat comprises mainly *Cladium* fen, with pockets of *Juncus subnodulosus*. It changes to *Phragmites*-dominated vegetation at the south-eastern end. It is very wet throughout, with standing water.
Direction:	North-west to south-east
Sampling frequency:	Samples were taken for *Vertigo moulinsiana* at approximately 10m intervals, but exact sampling locations were chosen based on the vegetation. The vegetation along the length of the transect was described and the linear extent along the transect measured. This was repeated every time the habitat changed, thereby delineating uniform plant community zones along the transect.

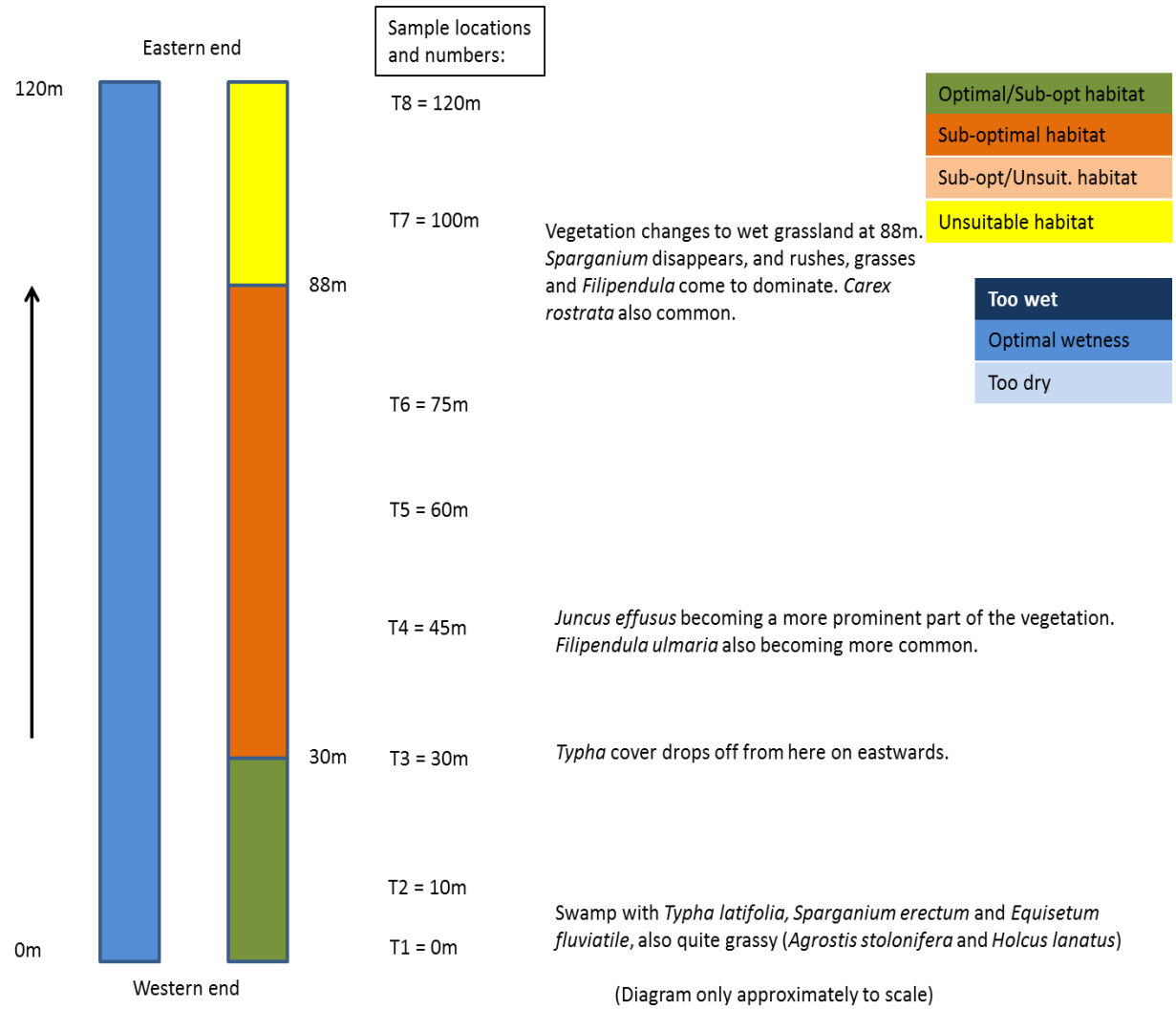


Figure A3. Transect at Castletown, showing habitat suitability, wetness and vegetation type.

Table A2. Transect details for Castletown site.

Start Point:	S 61907 05122
End point:	S 62023 05128
Transect Length:	120m
Description:	The habitat at the location of the transect at Castletown consists of mainly of a mixed swamp vegetation, which grades into rushy wet grassland at the eastern end. The ground was wet, but in most cases there was not standing water.
Direction:	West to East
Sampling frequency:	Samples were taken for *Vertigo moulinsiana* at intervals or between 10 and 25m, with exact sampling locations being chosen based on the vegetation. The vegetation along the length of the transect was described and the linear extent along the transect measured. This was repeated every time the habitat changed, thereby delineating uniform plant community zones along the transect.

Appendix VIII: Polygon details

Details of polygons mapped during survey, including area.

Species	County	Survey location	Polygon	Habitat suitability	Area (ha)
Vertigo geyeri	Mayo	Cooley Lough	A	Sub-optimal	0.0790
Vertigo geyeri	Mayo	Cooley Lough	B	Sub-optimal	0.9484
Vertigo geyeri	Mayo	Cooley Lough	C	Sub-optimal	0.2739
				TOTAL FOR SITE:	**1.3013**
Vertigo geyeri	Galway	Carrowmoreknock	A	Sub-optimal	0.0261
Vertigo geyeri	Galway	Carrowmoreknock	B	Sub-optimal/unsuitable	0.0138
Vertigo geyeri	Galway	Carrowmoreknock	C	Unsuitable	0.1077
Vertigo geyeri	Galway	Carrowmoreknock	D	Sub-optimal	0.0274
Vertigo geyeri	Galway	Carrowmoreknock	E	Sub-optimal	0.0229
				TOTAL FOR SITE:	**0.1979**
				TOTAL FOR SPECIES:	**1.4992**
Vertigo moulinsiana	Tipperary	Lough Derg, near Portumna	A	Sub-optimal	0.6191
Vertigo moulinsiana	Tipperary	Lough Derg, near Portumna	B	Sub-optimal	3.1296
Vertigo moulinsiana	Tipperary	Lough Derg, near Portumna	C	Unsuitable	0.7385
Vertigo moulinsiana	Tipperary	Lough Derg, near Portumna	D	Optimal	0.2066
Vertigo moulinsiana	Galway	Lough Derg, near Portumna	E	Optimal	1.7733
Vertigo moulinsiana	Galway	Lough Derg, near Portumna	F	Sub-optimal	0.2400
Vertigo moulinsiana	Galway	Lough Derg, near Portumna	G	Sub-optimal	2.2462
Vertigo moulinsiana	Galway	Lough Derg, near Portumna	H	Sub-optimal	0.2986
Vertigo moulinsiana	Galway	Lough Derg, near Portumna	I	Sub-optimal/unsuitable	1.9880
				TOTAL FOR SITE:	**11.2399**
Additional site:					
Vertigo moulinsiana	Tipperary	Shannonbridge - Portumna	J	Optimal	0.8992
				TOTAL INCL. EXTRA:	**12.1391**
Vertigo moulinsiana	Waterford	Castletown	A	Optimal/sub-optimal	6.8919
Vertigo moulinsiana	Waterford	Castletown	B	Optimal/sub-optimal	10.6102
Vertigo moulinsiana	Waterford	Castletown	C	Optimal/sub-optimal	2.0343
				TOTAL FOR SITE:	**19.5364**
Vertigo moulinsiana	Waterford	Strancally	A	Sub-optimal	0.8970
Vertigo moulinsiana	Waterford	Strancally	B	Sub-optimal	9.9958
				TOTAL FOR SITE:	**10.8928**
Vertigo moulinsiana	Wicklow	The Murrough	A	Sub-optimal	10.6164
Vertigo moulinsiana	Wicklow	The Murrough	B	Sub-optimal/unsuitable	0.5465
Vertigo moulinsiana	Wicklow	The Murrough	C	Optimal/sub-optimal	1.3540
Vertigo moulinsiana	Wicklow	The Murrough	D	Unsuitable	2.6778
Vertigo moulinsiana	Wicklow	The Murrough	E	Sub-optimal/unsuitable	4.1047
Vertigo moulinsiana	Wicklow	The Murrough	F	Sub-optimal/unsuitable	4.3539
Vertigo moulinsiana	Wicklow	The Murrough	G	Optimal/sub-optimal	7.8900
				TOTAL FOR SITE:	**31.5433**
				TOTAL FOR SPECIES:	**74.1116**

Species	County	Survey location	Polygon	Habitat suitability	Area (ha)
Oxyloma sarsi	Galway	Shannonbridge - Portumna	A	Sub-optimal	0.4524
Oxyloma sarsi	Offaly	Shannonbridge - Portumna	B	Optimal	0.0715
Oxyloma sarsi	Offaly	Shannonbridge - Portumna	C	Sub-optimal	0.0301
Oxyloma sarsi	Offaly	Shannonbridge - Portumna	D	Sub-optimal	3.8376
Oxyloma sarsi	Offaly	Shannonbridge - Portumna	E	Sub-optimal/unsuitable	0.0301
Oxyloma sarsi	Offaly	Shannonbridge - Portumna	F	Optimal/sub-optimal	0.0757
Oxyloma sarsi	Offaly	Shannonbridge - Portumna	G	Optimal	0.0411
Oxyloma sarsi	Offaly	Shannonbridge - Portumna	H	Optimal/sub-optimal	0.0648
Oxyloma sarsi	Offaly	Shannonbridge - Portumna	I	Optimal	0.0550
Oxyloma sarsi	Tipperary	Shannonbridge - Portumna	J	Optimal	0.8992
Oxyloma sarsi	Tipperary	Shannonbridge - Portumna	K	Optimal	0.0946
				TOTAL FOR SITE:	5.6521
Additional site:					
Oxyloma sarsi	Tipperary	Lough Derg, near Portumna	D	Optimal	0.2066
				TOTAL INCL. EXTRA:	**5.8587**
				TOTAL FOR SPECIES:	**5.8587**
Omphiscola glabra	Waterford	Carrickavrantry	-	Optimal	2.8203
Omphiscola glabra	Roscommon	Brierfield	-	Unsuitable	63.5656
				TOTAL FOR SPECIES:	**66.3859**