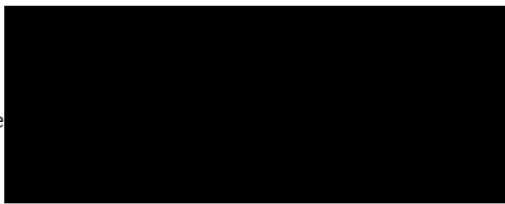


# **Translocation of the little whirlpool ramshorn snail: Scoping survey 2017**

**Highways England**

20<sup>th</sup> January 2018

Prepared by:



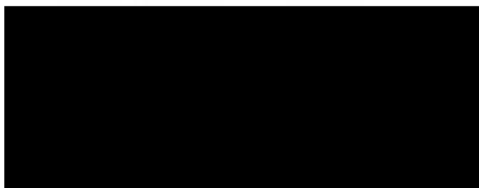
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# 1 Introduction

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## 1.1 Background

Little whirlpool ramshorn snail *Anisus vorticalus* is a small aquatic gastropod with a dorsoventrally flattened spiral shell approximately 5mm in diameter. It is a UK Biodiversity Action Plan Priority Species and the only British non-marine snail which is a European Protected Species. Since 2004, the little whirlpool ramshorn snail has been listed in the EU Habitats and Species Directive as a species of community interest, requiring special areas for conservation (Annex II) and strict protection (Annex IV), and is further listed as Red Data Book: Vulnerable.

Populations of the little whirlpool ramshorn snail have been declining in the UK since the 1960s, and in their conservation assessment for the species the Joint Nature Conservation Committee describe the future prospects for the little whirlpool ramshorn snail as 'poor'; a species likely to struggle unless conditions change (JNCC, 2007). Although the precise cause of population decline is not clear, it is thought that drainage, over frequent dredging, and eutrophication are all likely to be contributing factors (JNCC, 2007; Van Damme, 2012).

Within the UK, little whirlpool ramshorn snail can currently be found at sites in Norfolk, Suffolk, and Sussex, although most of published literature on the species has focused on the smaller Sussex populations. There is little consensus regarding the small-scale habitat preferences and ecology of little whirlpool ramshorn snail, and relatively little is known about even its basic biology (reviewed by Terrier et al. 2006). Given its precarious conservation status, the need for more research and more detailed understanding of the species is clear.

## 1.2 Project Outline

The work detailed here is a continuation from a previous pilot conservation translocation studies conducted in 2015 and 2016 (see AECOM 2015b, and AECOM/Abrehart Ecology 2016a, 2016b, 2016c for further details), and therefore forms the basis for a third phase of translocations for little whirlpool Ramshorn snail within the Broads in 2017.

The translocation approach carried out to date has involved moving 1,800 little whirlpool ramshorn snails from 'donor ditches' (which already contain healthy populations of the species) to 'receptor ditches' (where the species is absent, but the habitat is suitable to potentially support a population). Prior to translocation, ditches were assessed to ensure that they met the broad requirements of either a donor or a receptor ditch – this assessment entailed an initial non-intrusive scoping survey to identify broad, potentially suitable habitats, followed by a detailed survey of the vegetation and mollusc communities and abiotic variables (such as water quality and land management practices). This process provided data for a detailed multivariate analysis (see AECOM/Abrehart Ecology 2016b for details) which was used to select donor and receptor ditches for the pilot translocation.

Monitoring is ongoing at the pilot translocation sites, and will continue for at least three years. While long-term data from the pilot study sites will be required for a full assessment of the success of the translocation, initial results (six and 18 months post-translocation) have been promising at [REDACTED] indicating good survival of adults and reproduction at these receptor sites (AECOM/Abrehart Ecology 2017b).

Results from the second phase of translocations were less promising. Although twenty snails were found at [REDACTED], no snails were recorded during re-surveys at [REDACTED].

This report presents the findings of a scoping survey which aimed to find areas potentially suitable for a third, more extensive translocation of little whirlpool ramshorn snail.

## 1.3 Scoping Survey

The scoping survey described in this report is the first stage of a third round of conservation translocations for little whirlpool ramshorn snail (for details of the first see AECOM 2015b and AECOM/Abrehart Ecology 2015, 2016a, 2016b, 2016c, 2017a, 2017b and 2017c). The purpose of this scoping survey was to determine which sites and ditches were likely to be most suitable as receptor/donor sites, and where subsequent detailed survey efforts should be focused.

The aims of this scoping study are therefore as follows:

- to investigate whether there are adequate potential receptor and donor sites within the study area for further, more detailed survey;
- to select which are the most appropriate sites for further detailed survey; and
- to eliminate ditches with little potential to support little whirlpool ramshorn snail.

The scoping study comprises non-intrusive site walkover of the ditches, using expert knowledge of the species habitat, derived from the literature review described in the Feasibility Report (AECOM, 2015a)

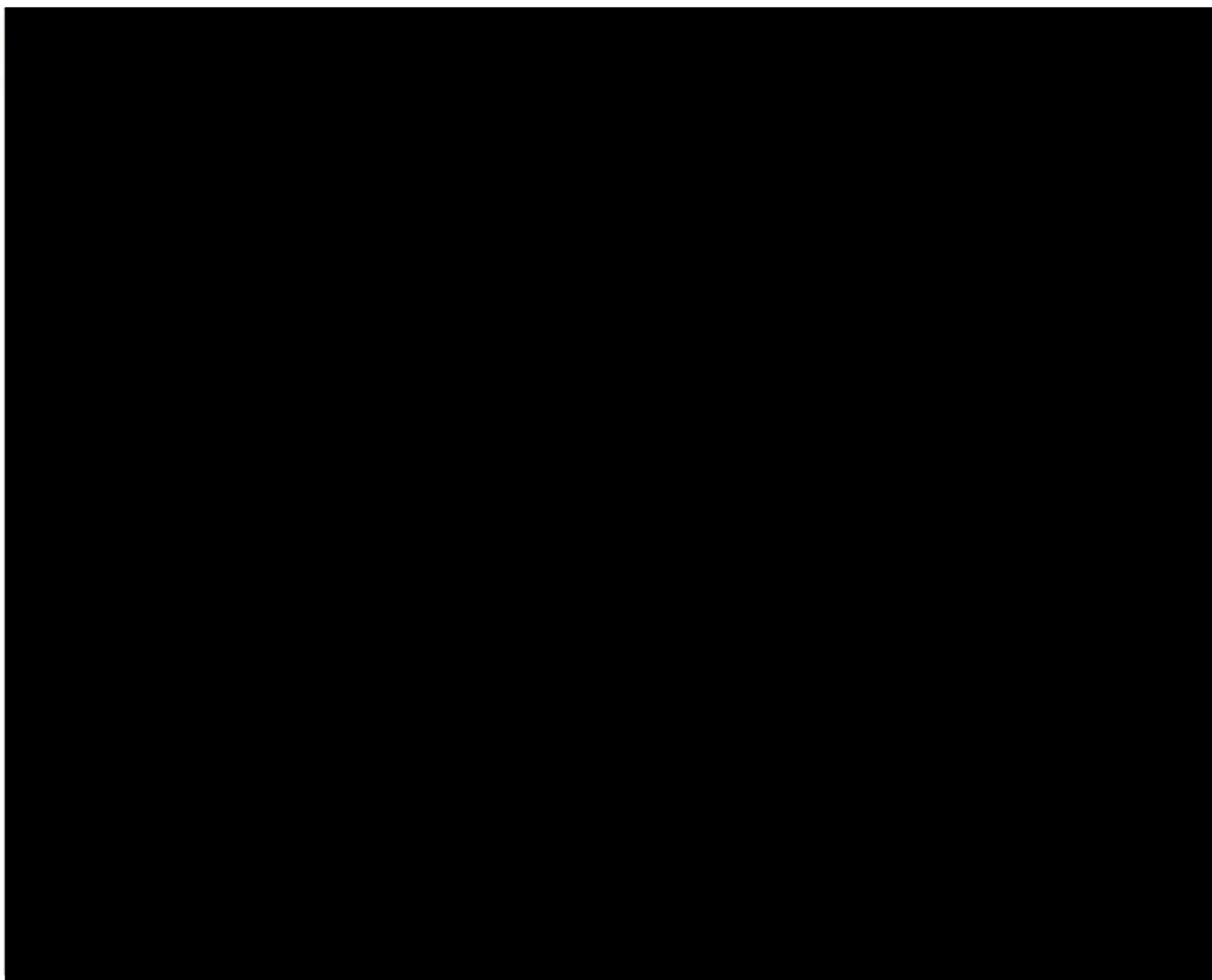


Figure 1: Location of all sites scoped in 2015-2017 within the Broads NP

## 1.4 Detailed Survey

Methods for the detailed surveys followed those from previous work (for example AECOM/Abrehart Ecology 2016a, 2017b), assessing the mollusc and vegetation communities and ditch characteristics at each sample site as well as determining the presence/likely absence of little whirlpool ramshorn snail.

Ditches selected for detailed surveying were those that were classified as between Categories 2-4 (inclusive) in the 2017 scoping survey. Based on these criteria (see Table 1), a total of 75 sample points were assessed across eight marshes (one marsh was scoped out of surveying as unsuitable for little whirlpool Ramshorn snail [REDACTED]). The survey methods were consistent with those used for initial surveys and translocation work of little whirlpool ramshorn snail (AECOM/Abrehart Ecology 2016a, 2016c). Data and sample collection was conducted by a pair of surveyors, including an experienced on-site mollusc surveyor [REDACTED] Ecologist and National Mollusc Specialist) and a second team member responsible for recording ditch features, abiotic variables, and botanical diversity [REDACTED], Ecologist at Abrehart Ecology Ltd and [REDACTED], Ecologist at Abrehart Ecology Ltd). The ditch characteristic and botanical diversity recording sheets were adapted from Buglife's manual for the survey and evaluation of grazing marsh ditch systems (Palmer et al., 2013); examples of the recording sheets used are presented in Appendix B.

At each sample location, ditch characteristics and a range of other environmental features were recorded (as in the 2015 survey; see AECOM 2015c for details). These included exposed and submerged bank profiles, channel width and depth, and levels of grazing, poaching and shelving. Abiotic parameters were recorded in the surface 10cm of water including pH and conductivity (measured using a HI98129 pH/Conductivity Tester; Hanna Instruments), dissolved oxygen and temperature (measured using a PDO-520 Dissolved Oxygen metre; Lutron). Each sample point was recorded as a 10-figure grid reference using a handheld GPS, and recorded on an Archer2 sub metre dGPS.

Mollusc community and botanical diversity were recorded at three points for each sample site, termed subsamples A, B, and C, where Subsample B formed the central point. Subsamples A and C were taken 15m on either side.

### 1.4.1 Molluscs

Mollusc community samples were collected at each of three subsampling points per sample location. The mollusc community was assessed and recorded separately for each subsample point (thus giving three sets of data for each sample location). This aimed to gauge the consistency of the mollusc community throughout the linear environment of the ditches. A copy of the recording sheet is presented in Appendix B.

Samples were collected using ten-second sweeps of a net with 0.5mm mesh. Sweeps were repeated three times for each subsample in different sections of the ditch profile, i.e. floating vegetation (where present), the benthic layer, and the submerged side of the near bank.

The material from the three sweeps was placed in a white gridded tray filled with water from the same ditch area. Molluscs were released from the collected vegetation by agitating the contents of the tray. Excess vegetation was then removed. The floating contents of the tray (chiefly vegetation and larger invertebrate species) were poured out into a 1mm mesh net, with molluscs retained in the bottom of the tray. It is accepted that a small proportion of molluscs may be lost at this stage, but previous tests of this method have shown such losses to be negligible (T. Abrehart, pers. obs.). The remaining material was then evenly distributed across the tray for assessment.

As inclement weather made identification in the field difficult, samples were removed from the sites and preserved in ethanol for later identification in the lab. All molluscs were identified to species level, and the relative abundance of each species was recorded. The abundance of notable and rare mollusc species was fully quantified, including little whirlpool ramshorn snail, shining ramshorn snail *Segmentina nitida*, slender amber snail *Oxyloma sarsi*, Desmoulin's whorl snail *Vertigo moulinsiana*, and the pea mussel species *Pisidium pseudosphaerium*.

## 1.4.2 Vegetation

The bankside, emergent, floating, and submerged flora of the ditch was recorded at each subsample point using the same methods as in previous surveys (see AECOM 2015c for full details). The relative abundance of each floral species occurring within 5m of the subsample point was quantified using a DAFOR scale (Table 3). This included vegetation on both the nearside and opposite bank and up to 1 m from the water's edge.

**Table 1.** DAFOR scale definitions used for quantifying botanical species abundance.

Value	Description	Percentage cover
D	Dominant	>75%
A	Abundant	51-75%
F	Frequent	26-50%
O	Occasional	11-25%
R	Rare	1-10%

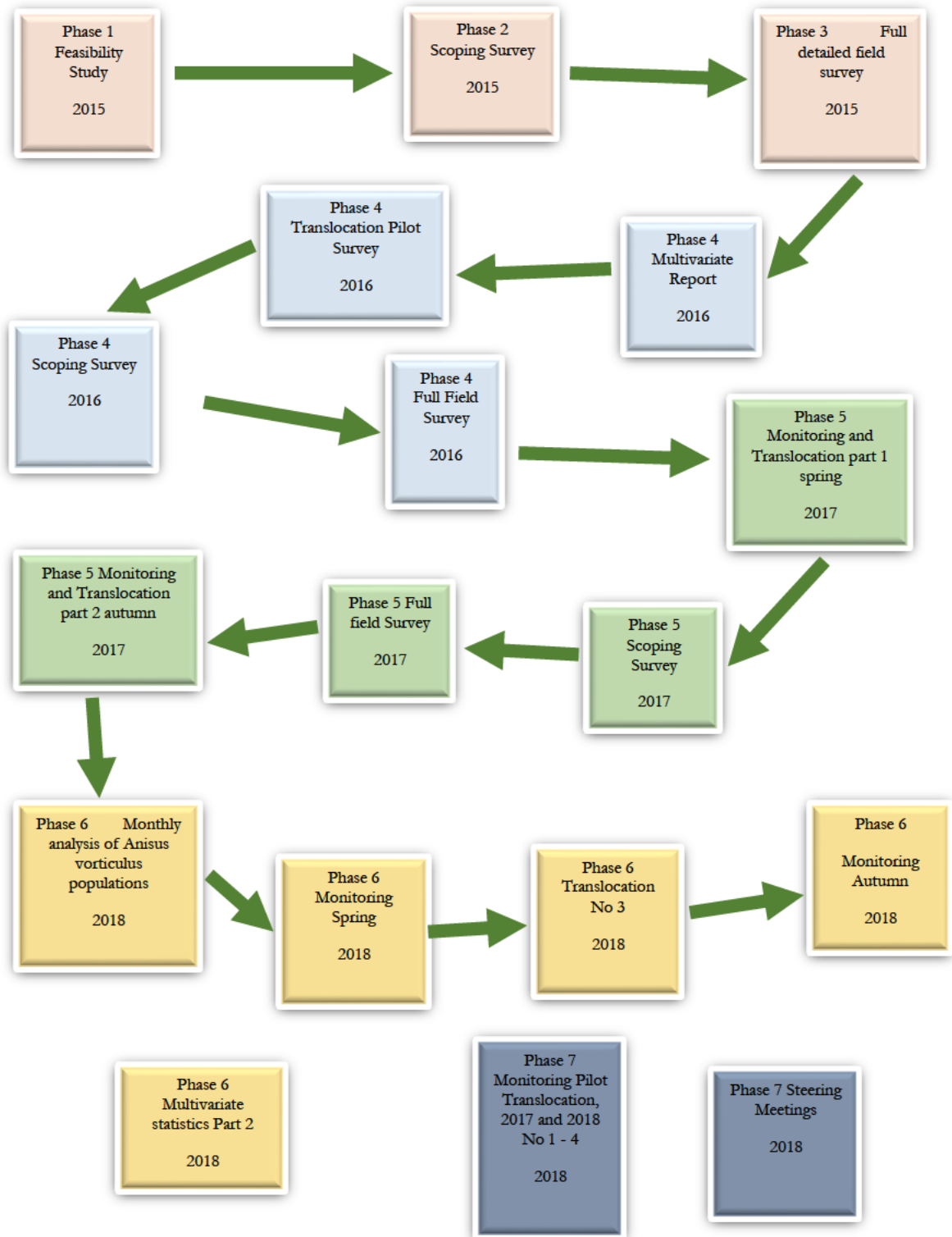
## 1.5 Overview of Surveys to date

The surveys carried out so far have been undertaken across four areas of the Broads National Park.

Phase 1, 2, 3, 4 & 5 – Completed

Phase 6 – Currently at planning stage to be agreed with HE.

Phase 7 – Continued monitoring of Pilot Translocation, Translocation 2017 and 2018 plus steering meetings to be agreed with HE





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## 2 Methods

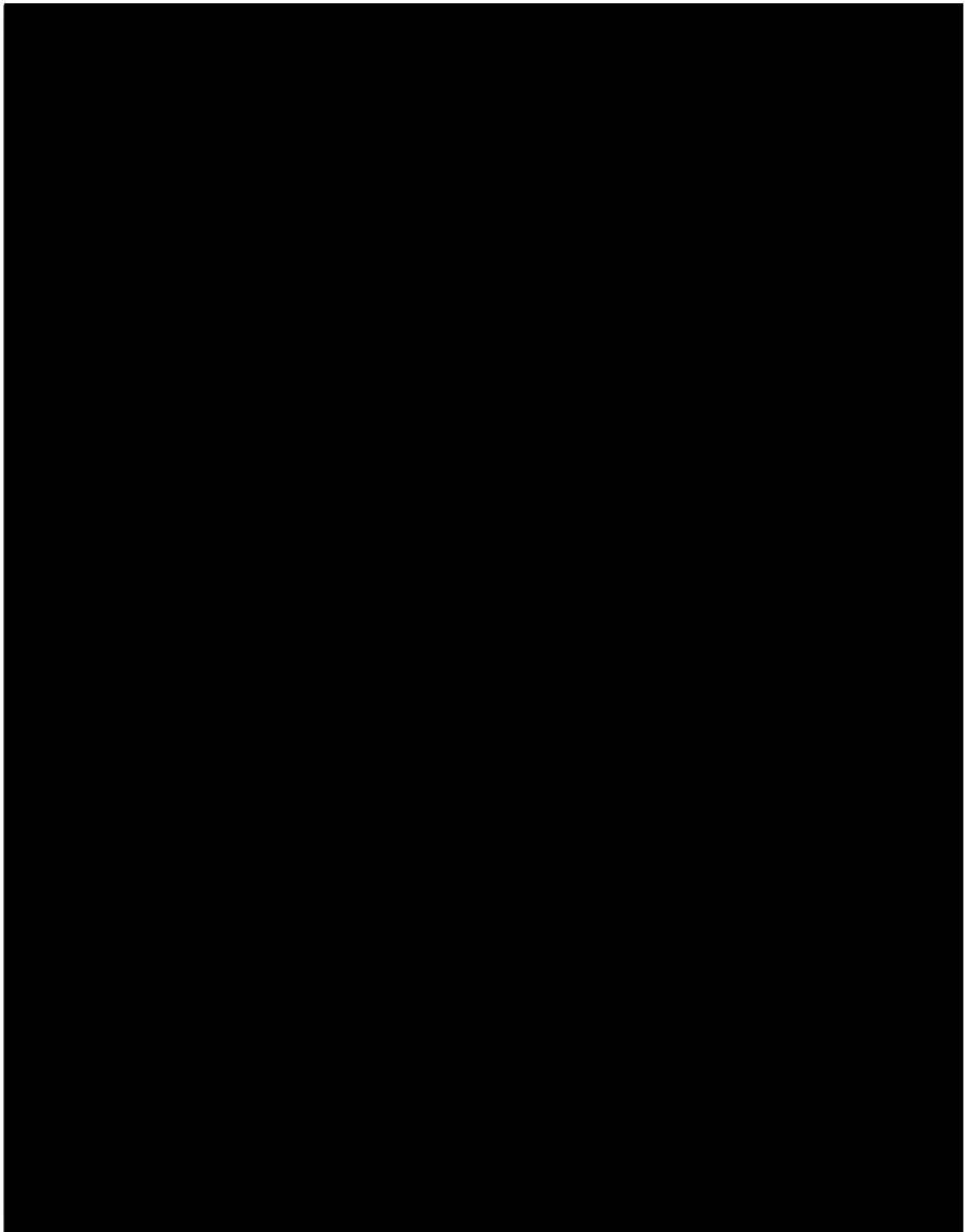
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### 2.1 Study Area

Whilst the little whirlpool ramshorn snail's range extends across a number of areas in England, the scoping survey reported here concentrates on ten survey areas across East Anglia (all within Norfolk) – [REDACTED] orth, [REDACTED], [REDACTED].

- [REDACTED] (Area 1, central grid ref: [REDACTED]) is managed as a nature reserve [REDACTED] and immediately [REDACTED]. The site falls [REDACTED].
- [REDACTED] (Area 2, central grid ref: [REDACTED]) is immediately [REDACTED], near to the town of [REDACTED]. The site is managed by the RSPB, [REDACTED]. [REDACTED] supports many rare plants, invertebrates, and birds.
- [REDACTED] (Area 3, central grid [REDACTED]) is a series of ditches and river channels immediately to the south of Area 2. [REDACTED].
- [REDACTED] (Area 4, central grid ref: [REDACTED]) is to the north of [REDACTED], [REDACTED], [REDACTED]. [REDACTED]. The [REDACTED] bisects the survey area/marshes and a number of ditches connect to the river channel.
- [REDACTED] (Area 5, central grid ref: [REDACTED]) is immediately [REDACTED] and surrounded by agricultural land. The marshes at [REDACTED].
- [REDACTED] (Area 6, central grid ref: [REDACTED]) comprises grazing marsh [REDACTED] Area 5, [REDACTED].
- [REDACTED] (Area 7, central grid ref: [REDACTED]) is an area of [REDACTED]. The [REDACTED] meanders around this area to [REDACTED].
- [REDACTED] (Area 8, central grid ref: [REDACTED]) is [REDACTED], and [REDACTED]. The marshes are approximately [REDACTED].
- [REDACTED] (Area 9, central grid ref: [REDACTED]) is a [REDACTED]. The marshes are [REDACTED].
- [REDACTED] (Area 10, central grid ref: [REDACTED]) is an area of [REDACTED]. The [REDACTED].

Each of the areas were selected for scoping based upon firstly, likely suitable habitat for little whirlpool Ramshorn snail (characterized by slow-flowing ditches within areas of grazing marsh and/or fen), and secondly by historical records of the species at some of the sites.



**Figure 1: Location of all sites scoped in 2017 within the Broads NP**

A summary of the approximate size and ditch length within the seven different areas are shown in Table 1. The ten areas contain an estimated 43.8km of ditch in total.

**Table 2 Summary of survey areas**

Site Name	Area Number	Location (National Grid Reference)	Historic records of little whirlpool ramshorn snail	Approximate Total area of site (Ha)	Total length of ditches (m)
██████████	1	██████████	None	75.63	████
██████████	2	██████████	None	81.15	████
██████████	3	██████████	None	20.49	████
██████████	4	██████████	Yes - ██████████ ██████████ ██████████	93.69	████
██████████	5	██████████	Yes	40.78	████
██████████	6	██████████	Yes	46.99	████
██████████ ██████████	7	██████████	Yes	105.29	████
██████████	8	██████████	None	15.87	████
██████████	9	██████████	None	51.93	████
██████████	10	██████████	None	33.64	████

## 2.2 Site Walkover

The site walkovers were carried out during June to August 2017 on days with suitable weather conditions (good visibility with little or no rain). The survey team comprised:

- ██████████ (Abrehart Ecology) – Principal Ecologist and Mollusc Specialist
- ██████████ (Abrehart Ecology) – Ecologist
- ██████████ (Abrehart Ecology) – Ecologist
- ██████████ (Abrehart Ecology) – Ecologist

All the ditches within each area (apart from those in Area 9) were walked and appraised. The ditches in Area 9 were scoped from a vantage point due to access constraints, and were evaluated based upon this and previous assessment of nearby sites (as reported in Abrehart Ecology, 2012).

## 2.3 Appraisal Criteria and Classification

The initial scoping study only considered parameters that could be determined by a non-intrusive walkover of the ditches within each area. The approach adopted for this scoping survey followed the method detailed in the scoping survey for the initial pilot study (AECOM 2015b). Each of the ditches within Areas 1 – 10 were appraised using criteria based on the habitat requirements of the species (as set out in the Feasibility Study report; AECOM 2015a) and other practical constraints. Factors and/or features considered favourable for little whirlpool Ramshorn snail included:

- Relatively late successional ditches (but not very late ditches that are likely to be too overgrown);
- Presence of diverse emergent and/or submerged vegetation;

- Natural high nutrient status, but not highly eutrophic - ditches that appear to be highly eutrophic (e.g. significant algal growth or choked with species indicative of eutrophication, such as common duckweed *Lemna minor*) are not likely to support little whirlpool ramshorn snail;
- No evidence of pesticide usage in adjacent terrestrial habitat (i.e. not ditches adjacent to land used for arable farming);
- Presence of shallow marginal habitats – including poached/trampled areas;
- Sympathetic management of ditches and limited mechanical digging - i.e. not ditches that appear to be area regularly or intensely determine habitat suitability classes between 1 and 5, as dredged;
- Appropriate breed and density of cattle; and
- Absence of obvious signs of pollution.

These criteria were used to assign a habitat suitability score to each ditch, using a six-tiered scoring system (described in Table 2). Sites containing a high proportion of high-scoring ditches were subsequently considered for further, detailed surveys.

**Table 3 Description of habitat suitability classes**

Habitat Suitability Class (HSC)	Description	Example
5 – Very good potential	Ditch of very good potential for little whirlpool ramshorn snail	Ditch with diverse emergent and submerged vegetation, presence of extensive shallow marginal habitat, relatively late successional, with no sign of recent management and appropriate surrounding land use
4 – Good habitat	Ditch generally of good potential for little whirlpool ramshorn snail	Ditch with relatively diverse emergent and submerged vegetation, presence of limited shallow marginal habitat, with no sign of recent management and appropriate surrounding land use
3 – Good/moderate potential	Ditch generally of good potential for little whirlpool ramshorn snail, but with some potential limitations	Intermediate between HSC type 4 and HSC type 2
2 – Moderate potential	Ditch generally of moderate potential for little whirlpool ramshorn snail, but clear potential limitations	Ditch with some floating leaved and emergent plants steep sided, but with some shallow marginal habitat due to cattle poaching. Some evidence of eutrophication and recent management/dredging.
1 – Low potential	Ditch of poor potential for little whirlpool ramshorn snail	Ditch with few floating leaved plants, steep sided, presence of extensive algae, Enteromorpha etc. surrounding land use arable
0 – Negligible potential	Ditch of very little or no potential for little whirlpool ramshorn snail	Heavily shaded ditch or excessively eutrophic ditch.

## 2.4 Limitations

The survey findings are based on conditions recorded at the time of the survey. The results presented in this report therefore describe a snapshot of the conditions of the ditches and surrounding land use.

All Areas were accessible for full and thorough assessment; therefore, there were no limitations with regards to the scoping survey.

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## 3 Scoping Survey Results

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A summary of findings of the scoping study are presented in Sections 3.1 – 3.10, and are presented on a site by site basis. For each Area, maps are presented depicting the categorization of ditches using a scale, with green representing the ditches deemed to be of good potential (Category 4 – good potential) and yellow representing those of negligible potential (Category 0), where little whirlpool ramshorn snail is likely absent.

### 3.1 [REDACTED] (Area 1)

[REDACTED] supported a range of ditches across the two ownerships [REDACTED] [REDACTED]. These ranged from all wet ditches in the areas to the north and east of the internal bund and to the west areas were late successional ditches and old later successional turf ponds. All areas were fully accessible during the site walkover.

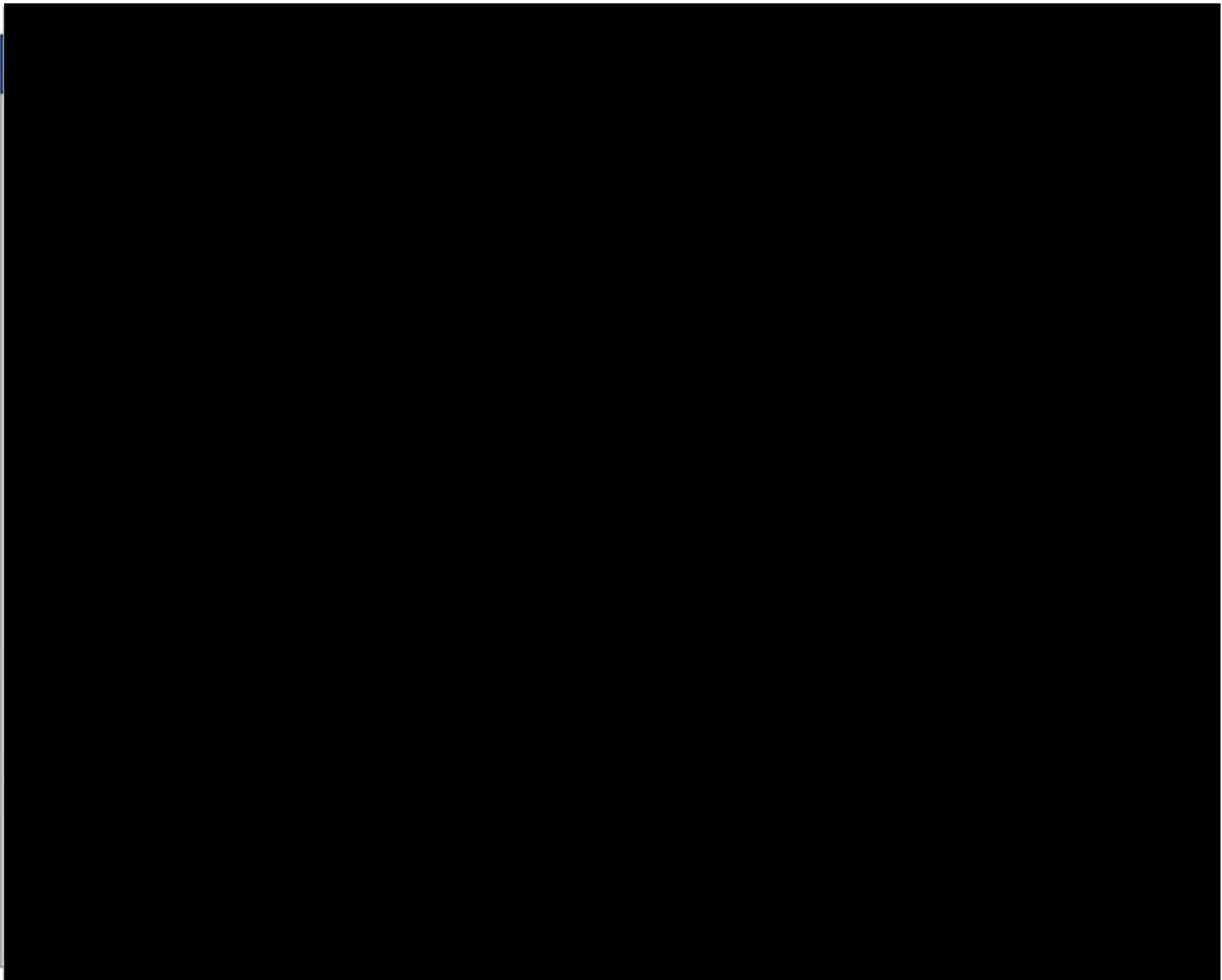


Figure 2: Location and designated habitat potential of ditches in Area 1 [REDACTED]

As shown in Figure 1, the ditches formed a mosaic of suitability across the Site, ranging from Category 2 'poor potential' (Table 2) to Category 4 'good habitat'. Of the approximately [REDACTED] of ditch within this land parcel, there was approximately [REDACTED] which was deemed to be of 'good' habitat suitability (Category 4 – Table 2) for little whirlpool ramshorn snail and thus likely

to either already support the species or be suitable to support it and therefore represent a potential donor site, or provide suitable receptor sites.

The Category 4 habitats were the internal ditches around [REDACTED], with one section to the west of the bund leading to [REDACTED]. Approximately [REDACTED] of ditch to the south and north of the bund was deemed to be of Category 3 'moderate/good' potential, these supported *Stratiotes aloides*, *Hydrocharis morsus-ranae* and had narrow margins of wet fen. On the eastern side of the site were wide ditches bordering the woodland mosaic these supported a low density of *Stratiotes aloides* and other submerged aquatic but were in general to shaded. The ditches along the bund were of low suitability being recently cleared and supported dense algae these were approximately [REDACTED] in length, Category 2 'poor'. The ditches within the RSPB/Butterfly Conservation [REDACTED] were highly interconnected, often with 'good' habitat adjoining to poorer habitats to the east (Categories 1 & 2). Within the [REDACTED] there were a range of habitats present with good later successional channels to the north and floristically rich dyke to the south with all other waterbodies of poor quality. This side of the marsh [REDACTED]

### 3.2 [REDACTED] (Area 2)

All of the ditches in Area 2 were fully accessible during the site walkover. As shown in Figure 2, of the approximately [REDACTED] of ditch within this parcel, [REDACTED] were deemed to be of 'good' habitat suitability (Category 4), and approximately [REDACTED] were deemed to be of good/moderate habitat suitability (Category 3). Approximately [REDACTED] of ditch were deemed to be of moderate potential (Category 2).

The category 4 ditches were in the central sections of the ditches through [REDACTED] and at the junction of ditches near [REDACTED]. All had a rich aquatic flora and wet margins, though they supported high vegetation creating limited shading. The category 3 ditches all lead from the Category 4 ditches in both directions. These were wider and clearer still with a good flora though with less later successional habitat along the margins. The Category 2 ditches were restricted to the east of the site. These ranged from wide clear ditches with dense reed margins to acidic ditches forming the catch dyke from the higher land.

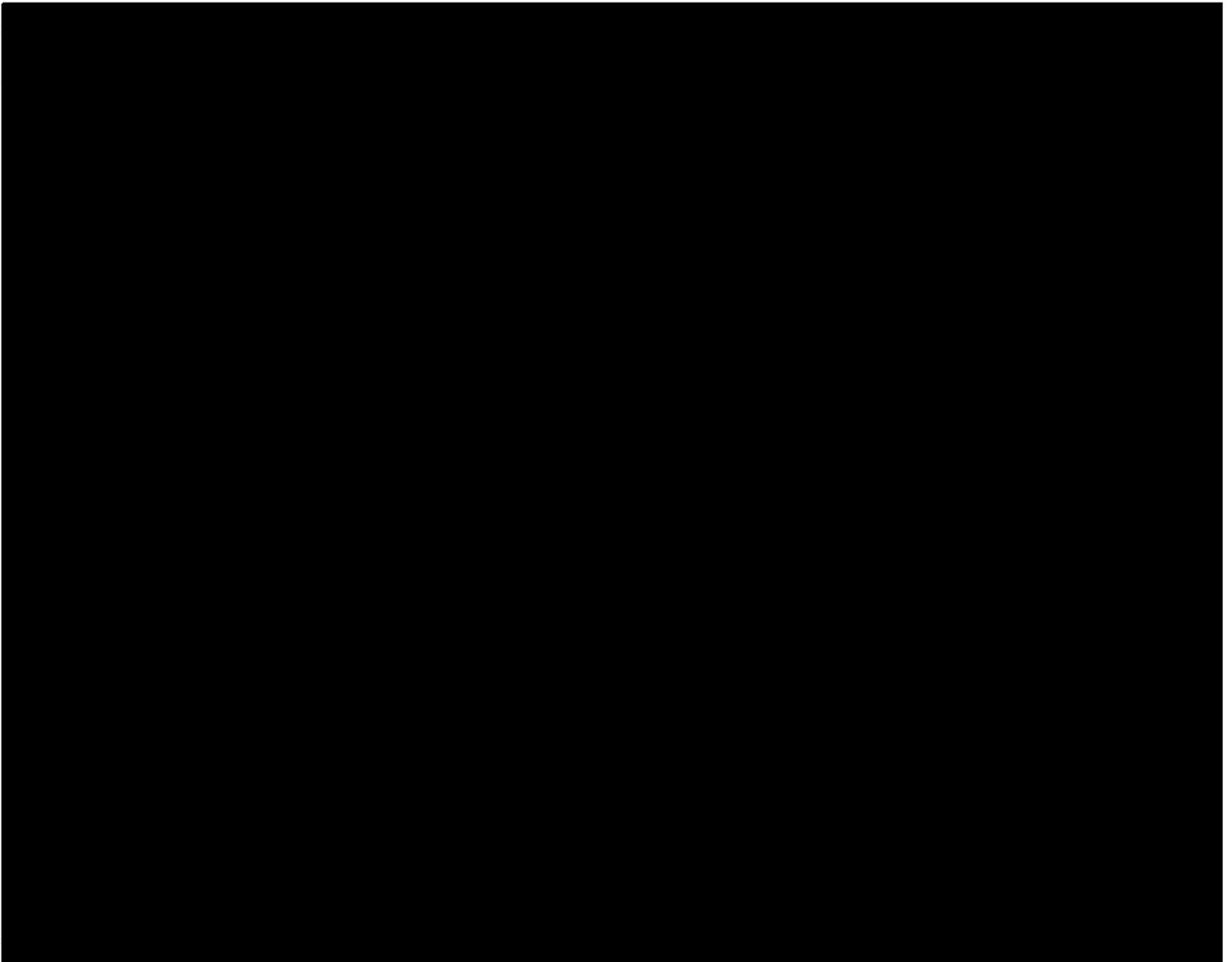


Figure 3: Location and designated habitat potential of ditches in Area 2 [REDACTED]



### 3.3 [REDACTED] (Area 3)

All ditches in Area 2 were fully accessible during the site walkover. As shown in Figure 3, of the approximately [REDACTED] of ditch within this parcel, [REDACTED] were deemed to be of 'good' habitat suitability (Category 4), and approximately [REDACTED] were deemed to be of good/moderate habitat suitability (Category 3). Approximately [REDACTED] of ditch were deemed to be of moderate potential (Category 2), while a further approximately [REDACTED] of ditch were deemed to be of 'poor' habitat suitability (Category 1).

The category 4 ditch on the site was limited to the central portion of the most northern ditch on the site. This was a mid successional ditch with a rich flora. Leading from this the habitat became less choked and clearer. The majority of the site supported Category 3 suitability ditches. These were wide and clear with limited vegetation and had dense margins of *Phragmites australis*. The water level was high but not enough to create a wet later successional margin. Category 2 ditches were around the edge of the site these catch ditches were wide with limited flora. The only area of Category 1 was the at the southern end of the site here it was dominated with *Lemna minor* and *Enteromorpha intestinalis* and as such less suitable.

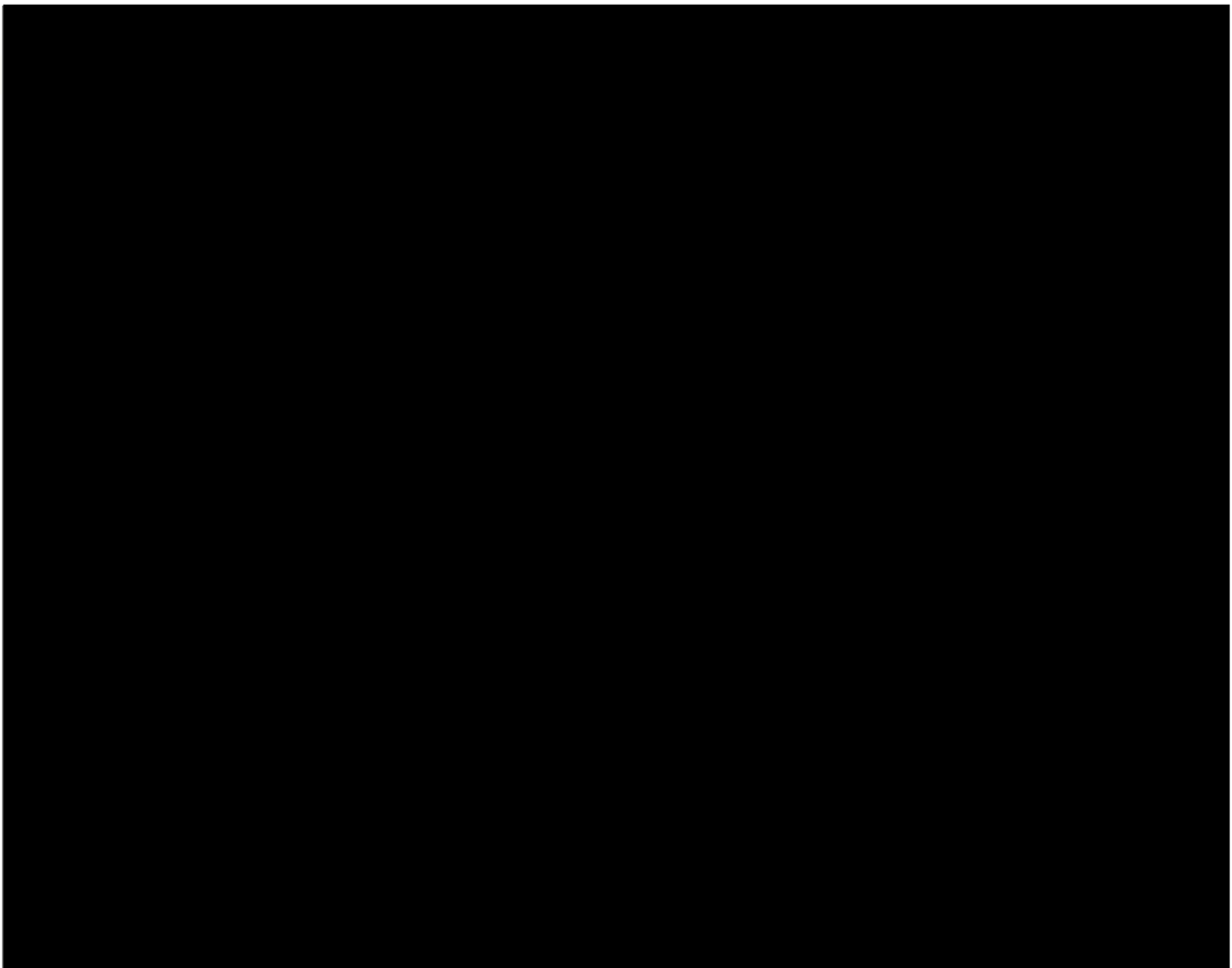


Figure 4: Location and designated habitat potential of ditches in Area 3 [REDACTED]

### 3.4 [REDACTED]

The ditches looked at here were divided into two areas, the marshes to the north of the River Bure were [REDACTED] and those to the south were [REDACTED]. All the ditches in both area were fully accessible during the site walkover. As shown in Figure 5, of the approximately [REDACTED] of ditch within these parcel, none was deemed to be of 'good' habitat suitability (Category 4). Approximately [REDACTED] of ditch deemed to be of 'moderate/good' habitat suitability (Category 3) were located throughout this parcel, and approximately [REDACTED] of ditch were deemed to be of 'moderate' (Category 2) potential.

The Category 3 section of habitat on the site were the mid successional sections in the central [REDACTED] and a small area to [REDACTED], these had good wet margins and low marginal vegetation. In [REDACTED] the only section was the middle section furthest from the influence of the river channel. The Category 2 ditches dominated the site, these were wide with dense margins of *Phragmites australis* and supported a low density of aquatic vegetation.

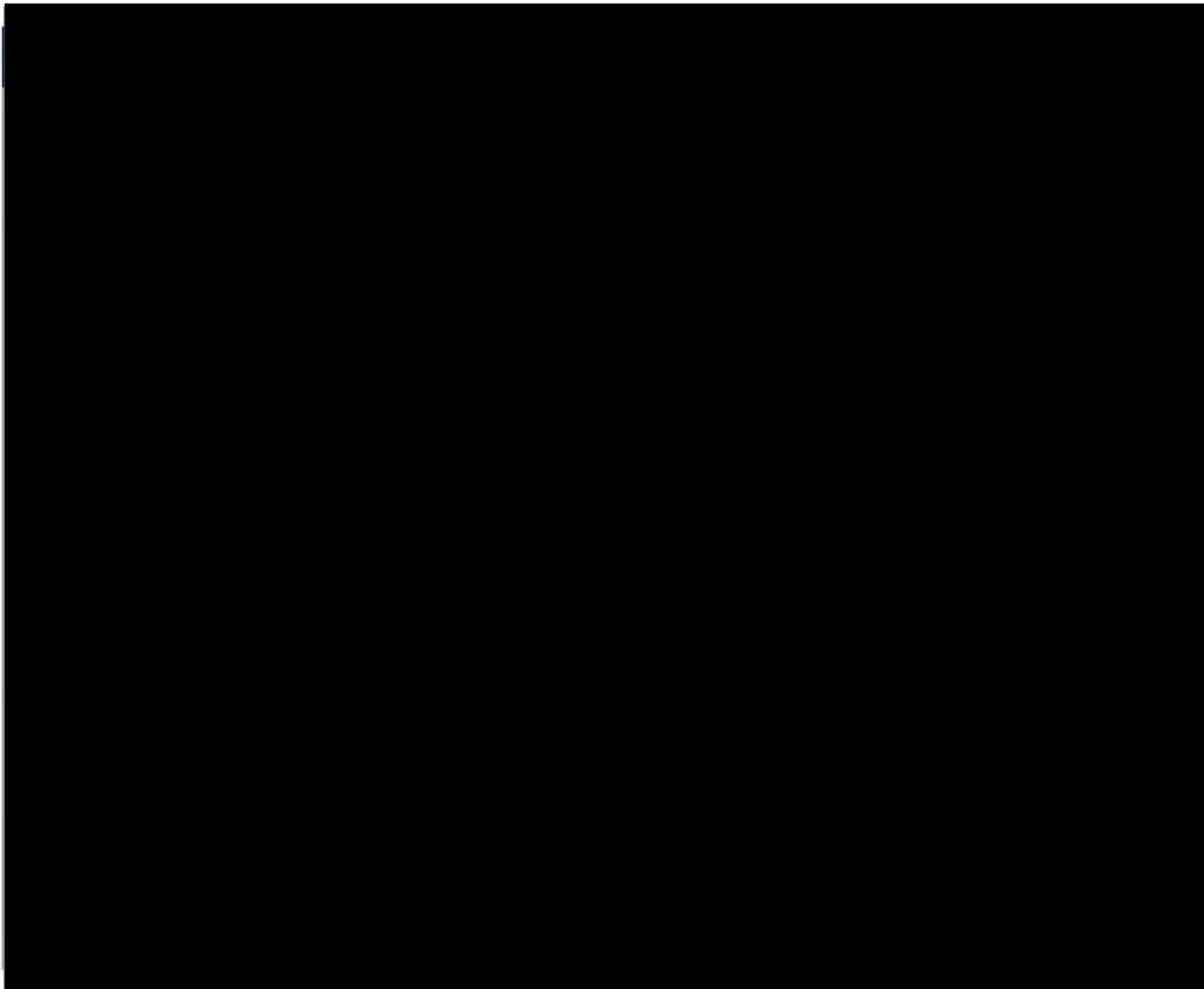


Figure 5: Location and designated habitat potential of ditches in Area 4 [REDACTED]

### 3.5 [REDACTED] (Area 5)

All the ditches in Area 5 were fully accessible during the site walkover. As shown in Figure 6, of the approximately [REDACTED] of ditch within this parcel, none were deemed to be of 'good' habitat suitability (Category 4). Approximately [REDACTED] of ditch deemed to be of 'moderate/good' habitat suitability (Category 3) were located throughout this parcel, while approximately [REDACTED] were deemed to have moderate potential (Category 2). There was [REDACTED] of poor quality habitat.

This site used to support *Anisus vorticulus* in 2013 so was assessed as part of this project. None of the ditches were deemed good potential as many had been cleared in the past two years. The majority of the ditches were recently cleared and as such were Category 2. In the remainder of the site the ditches were choked with *Phragmites australis* these were Category 1.

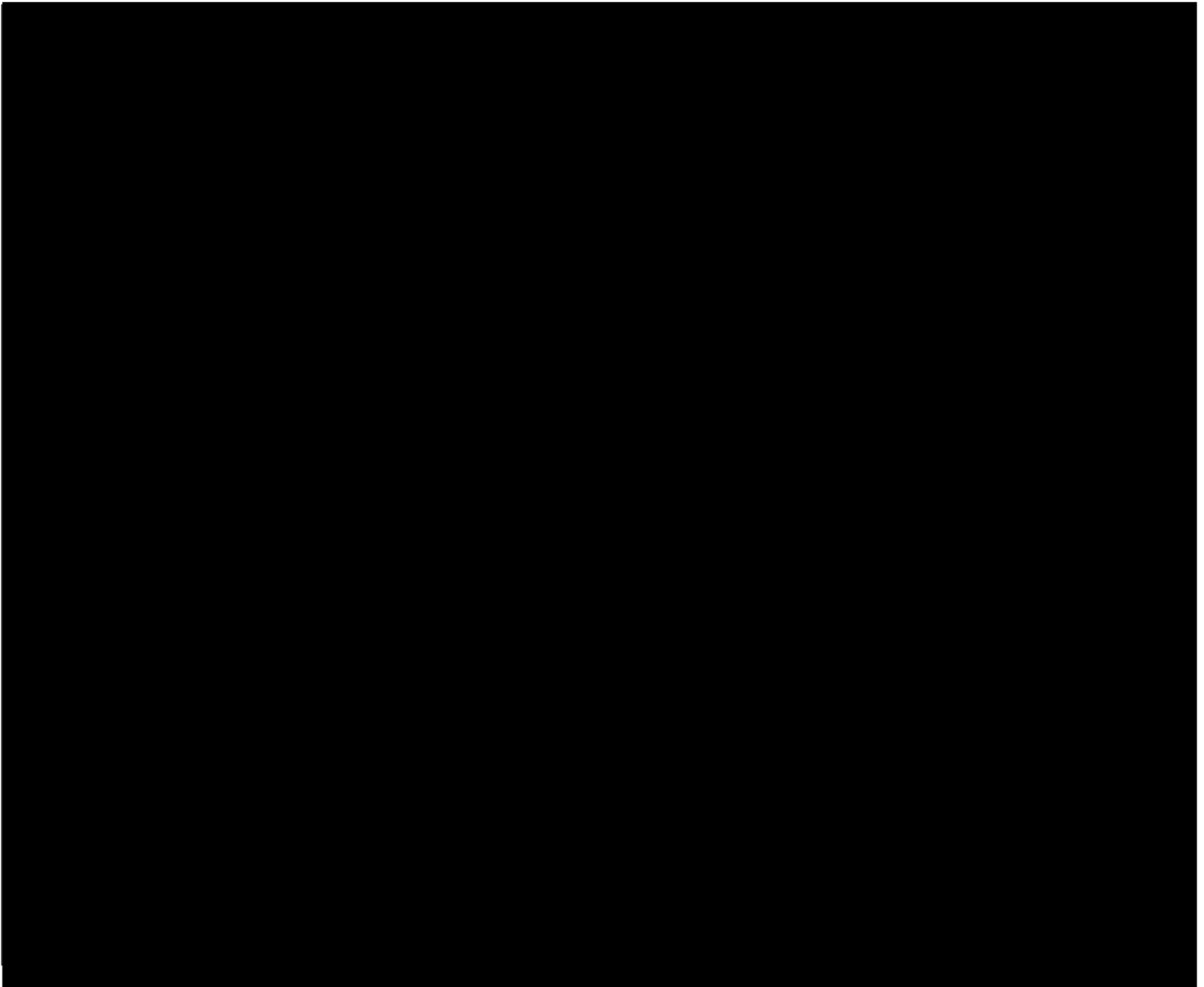


Figure 5: Location and designated habitat potential of ditches in Area 5 [REDACTED]

### 3.6 [REDACTED] (Area 6)

All the ditches in Area 6 were fully accessible during the site walkover. As shown in Figure 7, of the approximately [REDACTED] of ditch surveyed, none was deemed to be of 'good' (Category 4) habitat suitability for little whirlpool ramshorn snail. Approximately [REDACTED] were deemed to be of 'moderate/good' (Category 3) habitat suitability and a further [REDACTED] of ditch were considered of 'moderate' (Category 2) quality. One small section of ditch, approximately [REDACTED] was considered to be of low potential (Category 1) for little whirlpool ramshorn snail.

The Category 3 ditches were focused on the eastern side of the site and were mid successional. The rest of the site was dominated with Category 2 ditches. These were in the main wide clear ditches with limited aquatic flora within them. The margins were heavily poached and well grazed and had all been cleared within the past two years. The ditches close to the uplands were filled with *Lemna minor* and were not considered to be of any interest.

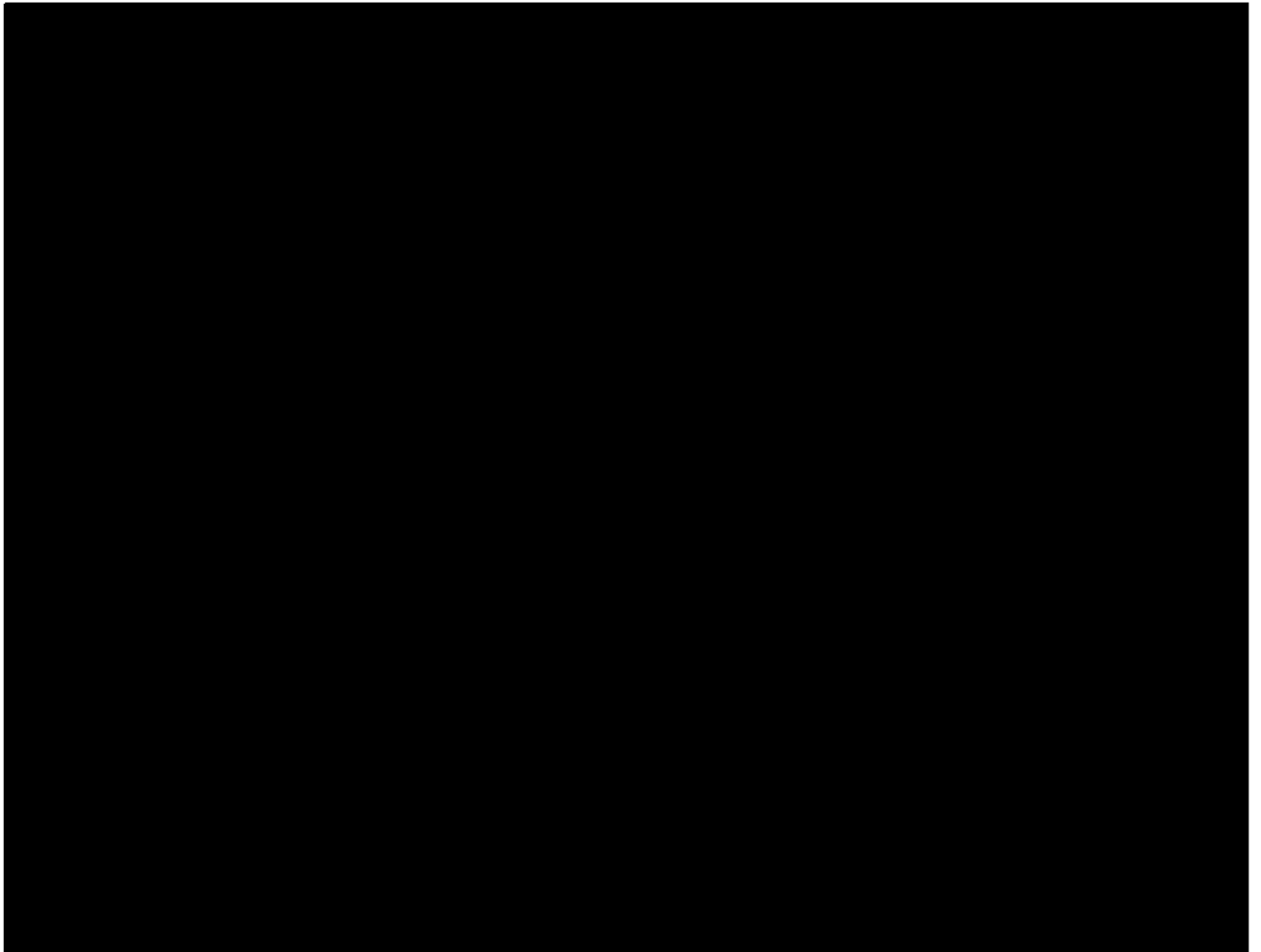


Figure 7: Location and designated habitat potential of ditches in Area 6 [REDACTED]

### 3.7 [REDACTED] (Area 7)

This site was originally surveyed in 2016 in a certain area of the site. Due to the finding of a new population in that survey it was considered that a slightly wider survey be carried out to cover more of the site to determine the extent on the site of suitable habitat. All the ditches in Area 7 were fully accessible during the site walkover. As shown in Figure 8, of the approximately [REDACTED] of ditch surveyed, approximately [REDACTED] were deemed to be of 'good' (Category 4) habitat suitability, approximately [REDACTED] were deemed to be of 'moderate/good' (Category 3) habitat suitability, and approximately [REDACTED] were deemed to be of 'moderate' (Category 2) and [REDACTED] were considered to be poor (Category 1) habitat suitability for little whirlpool ramshorn snail.

The extra ditches added to this year's survey were on the north, south and west of the site.

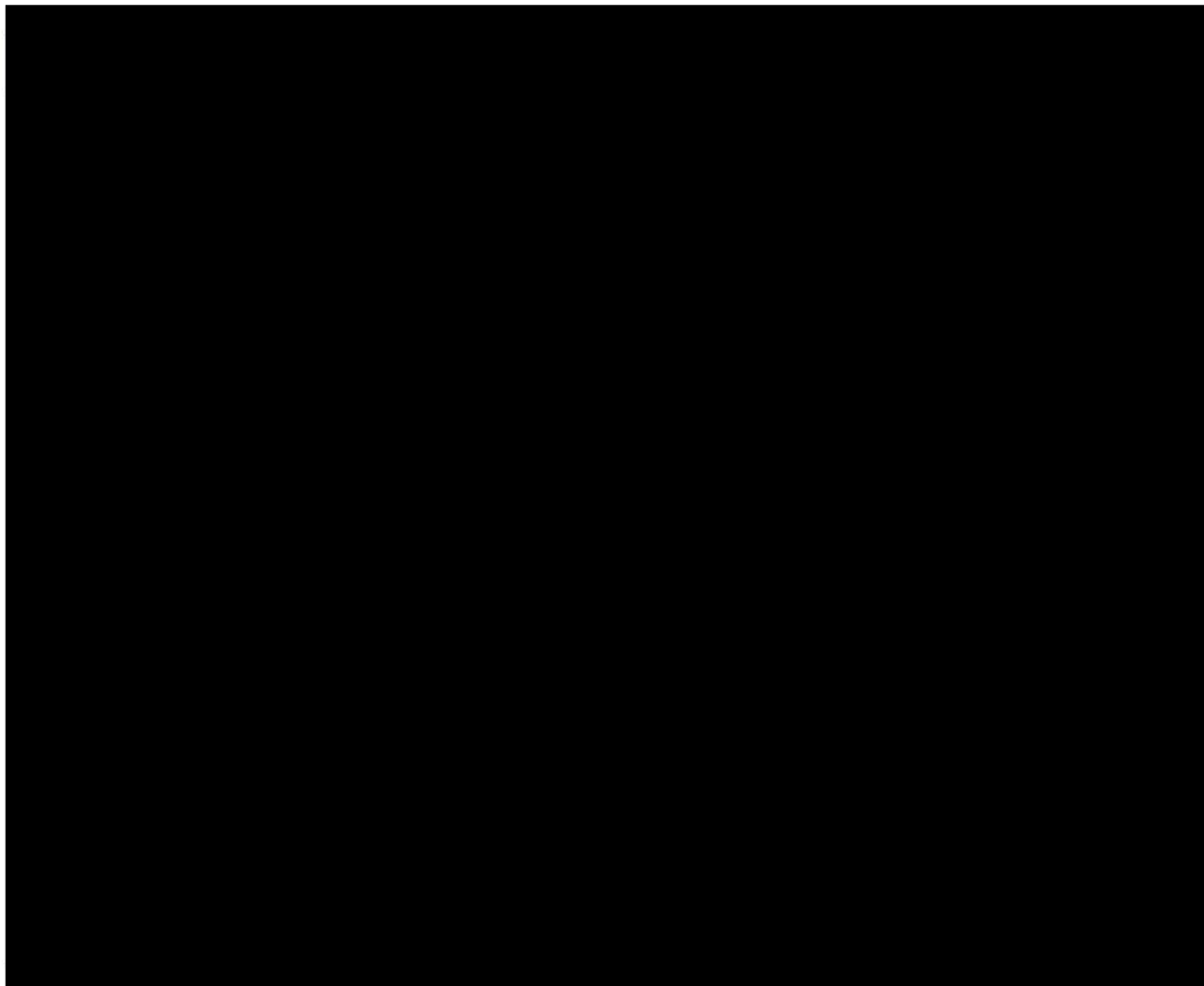


Figure 8: Location and designated habitat potential of ditches in Area 7 [REDACTED]

### 3.8 [REDACTED] (Area 8)

All the ditches in Area 8 were fully accessible during the site walkover. As shown in Figure 9, of the approximately [REDACTED] of ditch surveyed, of which [REDACTED] were Category 3, [REDACTED] was Category 2 and the remainder was on the eastern side of the site at [REDACTED] of Category 1 habitat suitability for little whirlpool ramshorn snail.

Several of the ditches on the western side of the marshes were wide and had no suitable habitat with *Phragmites australis* frequently dominating the margins. The internal ditches in the northern section of the marshes supported the better-looking habitat with mid successional characters and a rich flora on the margins and within the water itself.

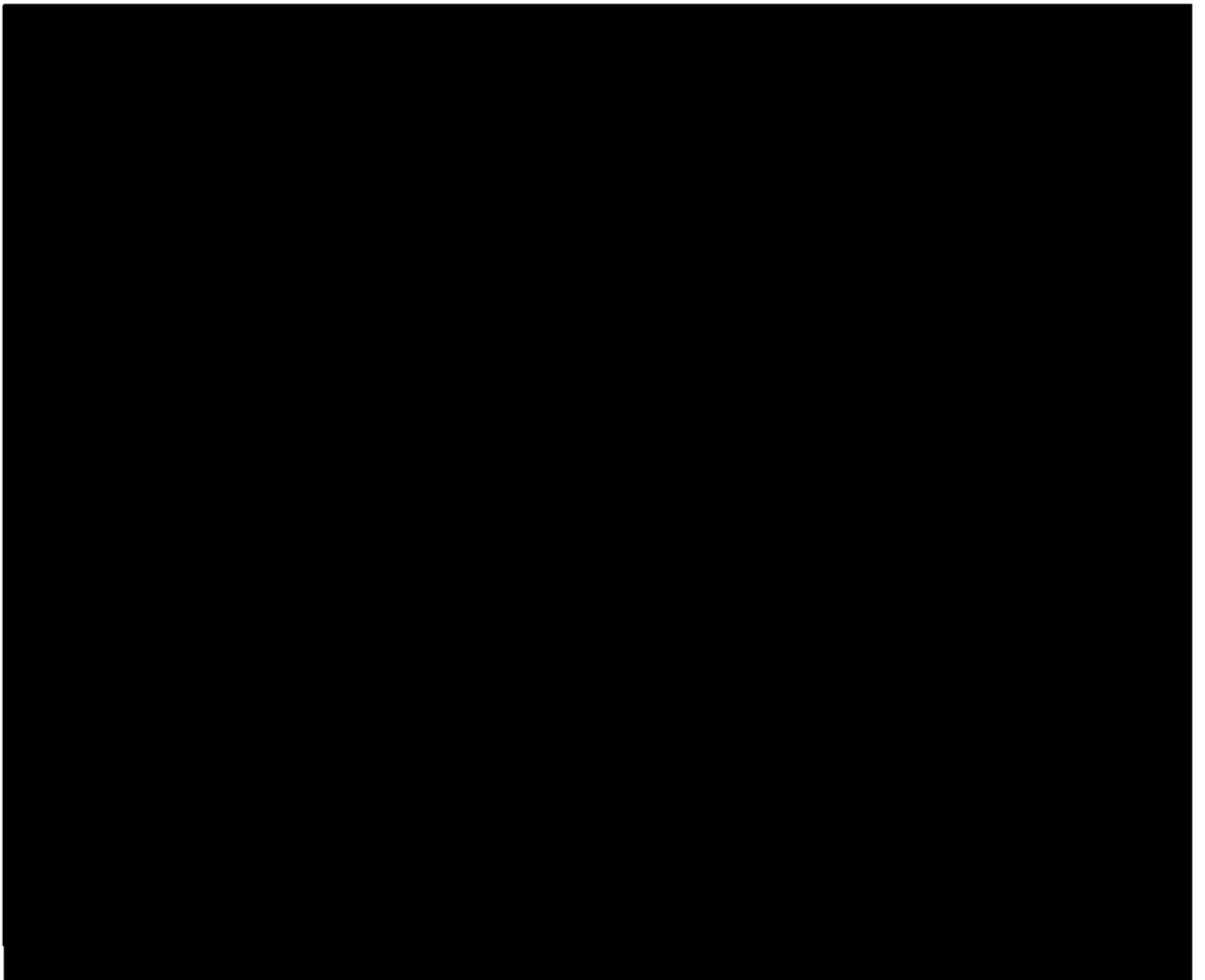


Figure 9: Location and designated habitat potential of ditches in Area 8 [REDACTED]

### 3.9 [REDACTED] (Area 9)

All the ditches in Area 9 were not fully accessible during the site walkover. As shown in Figure 10, of the approximately [REDACTED] of ditch surveyed, all were deemed to be of 'moderate' (Category 2) habitat suitability for little whirlpool ramshorn snail.

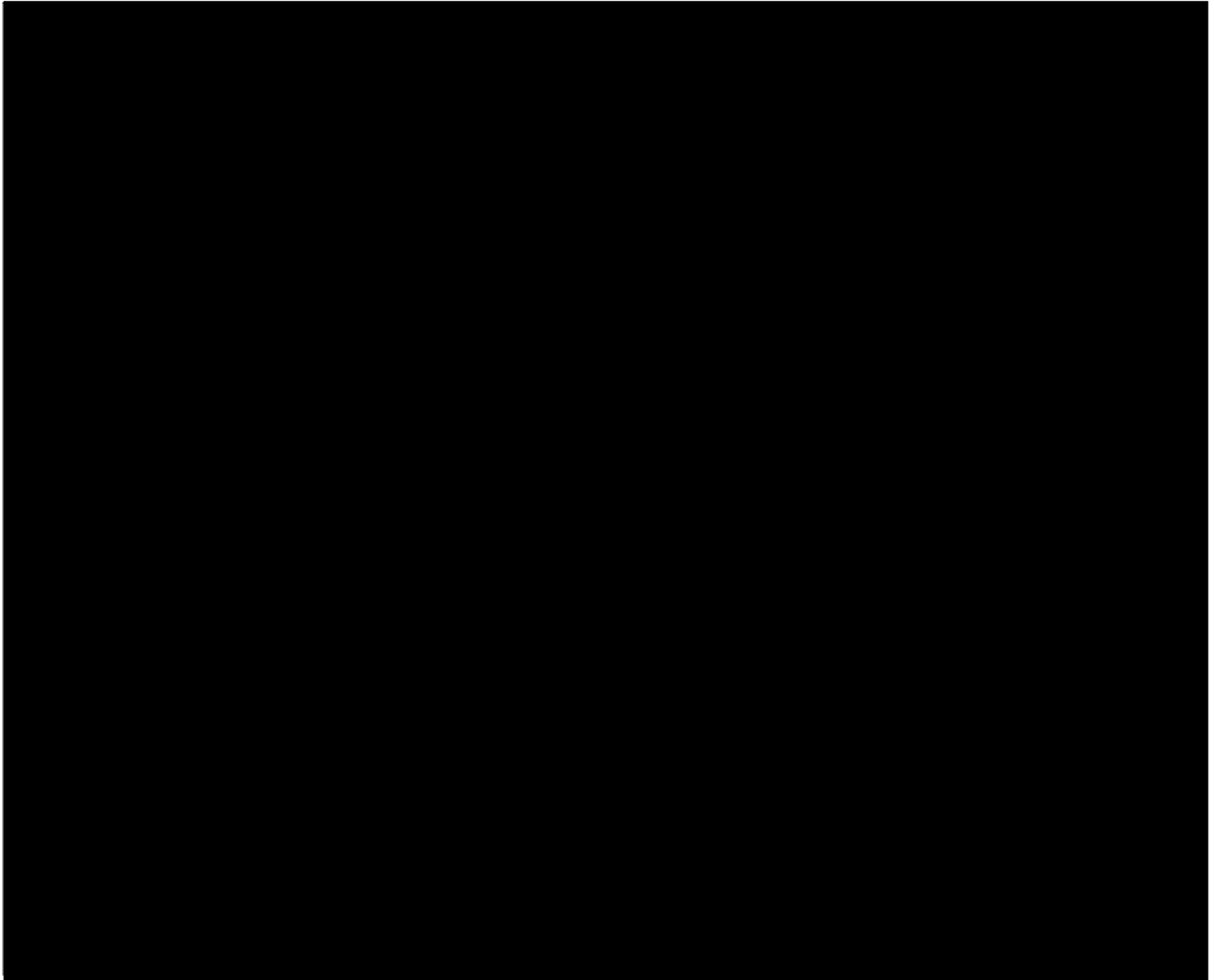


Figure 10: Location and designated habitat potential of ditches in Area 9 [REDACTED]

### 3.10 [REDACTED] (Area 10)

All the ditches in Area 10 were fully accessible during the site walkover. As shown in Figure 11, of the approximately [REDACTED] of ditch surveyed, approximately [REDACTED] were deemed to be of 'good' (Category 4) habitat suitability, approximately [REDACTED] were deemed to be of 'moderate/good' (Category 3) habitat suitability, and approximately [REDACTED] were deemed to be of 'moderate' (Category 2) habitat suitability for little whirlpool ramshorn snail.

The Category 4 ditches were on the north east of the site. These were early to mid-successional ditches with a rich flora dominated with *Stratiodes aloides* and *Hydrocharis mosus-ranae*. These was filamentous algae, but this was limited and the ditches looked good. This site is also where there has been the introduction of the Fen raft spider. The ditches tot eh south west looked very healthy and had been cleared in the past three years. The poorest looking ditches were on the north of the site and along the catch dyke section of the site.

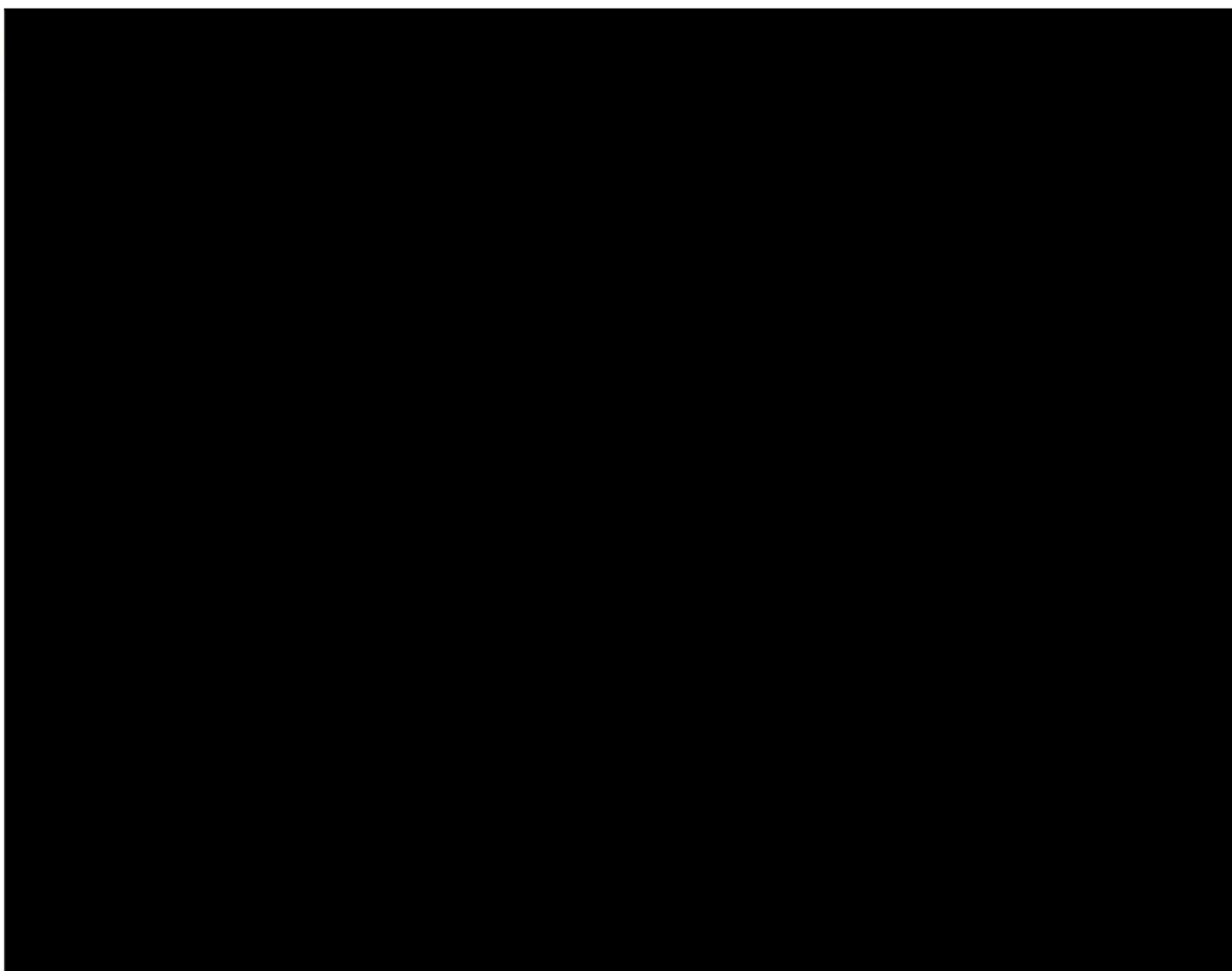


Figure 11: Location and designated habitat potential of ditches in Area 10 [REDACTED]



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## 4 Discussion for Full Surveys

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### 4.1 General

The scoping survey indicated that in nine of the ten areas there are several ditches worthy of additional detailed survey to ascertain whether they are potential receptor or donor ditches for translocation. Habitat suitability ranged from 'negligible' (Category 1) to 'good' (Category 4), but no ditches were considered of 'very good' (Category 5) suitability for little whirlpool ramshorn snail. Across all surveyed areas, a total of approximately 17.9km of ditch was considered to have 'good' (4) or 'moderate/good' (3) potential to support the target species.

The total lengths of ditches with 'good' (Category 4) or 'moderate/good' (Category 3) potential varied considerably between sites, from [REDACTED] [REDACTED], Area 7) to [REDACTED] at [REDACTED] [REDACTED] [REDACTED] and [REDACTED] [REDACTED] and [REDACTED] [REDACTED]. However, as total ditch length is a product of survey area size, areas have been considered for further, detailed survey based on the proportion of ditches with 'good' (Category 4) potential for little whirlpool ramshorn snail. Future detailed surveys should be focused on sites which contain a high proportion of ditches with good potential, rather than on sites with one or two suitable ditches surrounded by habitat with no or negligible potential. [REDACTED] (Area 1), [REDACTED] [REDACTED] (Area 2/3), [REDACTED] (Area 7) and [REDACTED] (Area 10). These showed high proportions of ditches with 'good' potential habitat for little whirlpool ramshorn snail, and are therefore prime candidates for further, more detailed surveys. In addition to these sites it was deemed prudent to survey [REDACTED] [REDACTED] as these marshes are downstream from [REDACTED] (supporting a moderate density population) and could support a population (there was a new population found to the south of the site in 2012 (Abrehart)). [REDACTED] were also to be included as they used to support a low-density population as seen in 2012, many of the ditches had been cleared in the past two years but there was still potential to support *Anisus vorticulus* and worthy of a revisit. [REDACTED] where to be surveyed as they are within a rich marsh complex and may be suitable for *A. vorticulus*, these marshes were used for the translocation of Fen Raft Spider in 2016 and there is a strong association between these two species in Suffolk. By adopting this approach, it should be possible to ensure that little whirlpool ramshorn snail can be moved to suitable habitat at receptor sites and have chance to expand its range at those sites in the future – by avoiding isolation in small 'islands' of habitat, the persistence of translocated populations is more likely. The marshes in the [REDACTED] [REDACTED] are currently tidal and have a higher potential for longevity as they are at sea level as opposed to many site which are up to 2m below sea level. Additionally, [REDACTED] is prone to annual flooding which may aid the dispersal and recruitment of molluscs if the site is subsequently assessed as a receptor area through detailed surveys.

Across the ten survey areas, approximately [REDACTED] [REDACTED] of ditch is considered to be of 'low' (Category 1) or 'negligible' (Category 0) potential to support little whirlpool ramshorn snail and would be suitable as neither receptor nor donor sites. Consequently, it is recommended that these ditches are 'scoped out' of the detailed surveys. Ditches were scored as having 'low' or 'negligible' potential for a number of reasons. Some were heavily shaded, for example by adjacent woodland very tall, dense reeds, and were therefore bereft of aquatic flora. Aquatic vegetation is an absolute requirement for colonisation by many mollusc and invertebrate taxa, and little whirlpool ramshorn snail in particular has been associated with dense and varied macrophyte communities (Willing 2006; Terrier et al. 2006). Other ditches with 'low' or 'negligible' potential was scoped out as they were highly eutrophic, indicated by with dense common duck weed, least duckweed *Lemna minuta*, and/or thick filamentous algae growing in them. These were often catch dykes intercepting runoff from the higher surrounding land and feeding into IDB drains. IDB drains, in addition to frequently being eutrophic, are also dredged more regularly than surrounding ditches. While the reasons for the decline of little whirlpool ramshorn snail are not fully understood (JNCC, 2015), eutrophication and dredging are likely to be important factors (English Nature 2000, Van Damme 2012) – ditches where these factors are known to be common (such as IDB drains) should not therefore be considered as appropriate for any conservation translocation of little whirlpool ramshorn snail.

The survey findings reported here present a 'snapshot' of current conditions, and ditches that are currently 'good' habitat suitability may deteriorate (for example become eutrophic and/or dredged) if there are changes in land use or drainage. Likewise, as full details of the management regimes are not known at all the survey areas, there may be threats to ditch quality from the management that have not been identified by this investigation. This would affect the long-term viability

of receptor ditches. Both of these issues will could affect the long-term viability of receptor and donor sites, and need to be considered further during the next phases of this study.

## 4.2 Recommendations for Detailed Surveys

### 4.2.1 Site Selection

As detailed in the initial pilot translocation scoping report (AECOM 2015b) and detailed survey report (AECOM/Abrehart Ecology 2017a) the highest scoring ditches from this scoping survey should be given priority for detailed surveying, progressing to lower-scoring ditches as required until sufficient potential receptor and donor sites have been identified. No ditches were classified as having 'very good potential' (Category 5) during this scoping survey, so it is recommended that the 17.9km of ditch classified as 'good' (Category 4) or 'moderate/good' (Category 3) are surveyed first. Additional sampling should be carried out on ditches adjacent to potential receptor ditches (even if they are of lower habitat suitability) in order to ensure that the immediate network of ditches does not support populations of little whirlpool ramshorn snail. This is considered as being important, as existing nearby populations may subsequently colonise receptor ditches and give a 'false positive' result, i.e. indicate that the translocation trial was successful when in fact receptor ditches with newly established populations of little ramshorn snail are the result of colonisation from adjacent ditches.

A decision was made on suggestions by site wardens that the [REDACTED] would be good to assess. This is a botanically and invertebrate rich set of marshes. Although no records of *Anisus vorticulus* were known. *Segmentina nitida* was known from [REDACTED] indicating that it may support some mid to late successional habitat, this species has a strong association with *A. vorticulus* and it's present may indicate suitability as a receptor site. Due to the presence of *Anisus vorticulus* in the fenland ditches at [REDACTED] in 2016 it was considered that these marshes may well either hold or have the potential to support it in the future. Fenland ditches are not considered to be a regularly used habitat by *Anisus vorticulus*, maybe through regular clearance in order to allow vessels into the marshes for the removal of sedge and reeds for roofing materials. This regular clearance would reduce the area of ditch suitable to support the mid to late successional habitat required for *Anisus vorticulus*.

[REDACTED] was re-assessed as in the 2016 survey only the core central section was assessed. Following on from this discovery of a new population it was considered important to see if there was a wider area of good habitat suitable to support a larger population. This population within a fenland ditch system is the only one known in the Broads and opens up potential for more populations to be discovered in this habitat or for this habitat to support a population should it be moved into suitable ditches as part of a translocation.

Along a similar line the [REDACTED] were considered important to assess. These marshes are located downstream [REDACTED] where there is known to be a healthy population (AECOM/Abrehart Ecology 2016b). In addition to this population there was a population found to the south-east of the site in an Article 17 survey for Natural England in 2012 [REDACTED]. (2012) *Article 17 assessment on Anisus vorticulus in Norfolk, March 2012*. Lot 5.) as part of an article 17 survey for Natural England. Surveying these marshes for their suitability for further surveys could potentially locate a wider population in [REDACTED].

Whether sufficient (or any) donor and receptor ditches are available will depend on the findings of the detailed survey. We currently have a number of potential donor sites, so this is not an essential need from this year's project. For example, if none of the ditches are found to have healthy populations of little whirlpool ramshorn snail, other donor ditches within the region will need to be found. Conversely, if all the ditches identified are found to contain little whirlpool ramshorn snail, then no potential receptor ditches will have been identified. Additionally, for the reasons described in section 4.1, identifying ditches with suitable management (notably dredging frequency and method) is key - if suitably managed ditches are not found within the current survey areas, alternative receptor sites will need to be considered.

### 4.2.2 Fieldwork Protocol

Methods for the detailed surveys will follow those described for the initial pilot translocation conducted in 2016 (see AECOM/Abrehart Ecology 2015 and AECOM/Abrehart Ecology 2016a). This will ensure consistency in data collection, allowing each survey to contribute to a growing knowledge base on the ecology and biology of little whirlpool ramshorn snail in East Anglia.

In summary, the fieldwork protocol will involve assessment of ditches classified as 'good' or 'moderate/good' habitat suitability for little whirlpool ramshorn snail. Surveys will be conducted by a pair of surveyors, including an experienced on-site mollusc surveyor (██████████, national mollusc specialist) and a second team member responsible for recording ditch features, abiotic variables, and botanical diversity. The ditch characteristic and botanical diversity recording sheets are adapted from Buglife's manual for the survey and evaluation of grazing marsh ditch systems (██████████ et al., 2013).

At each sample location, ditch characteristics and a range of other environmental features will be recorded, including exposed and submerged bank profiles, channel width and depth, and levels of grazing, poaching and shelving. Abiotic parameters in the surface 10cm of water will be measured, including pH and conductivity (measured using a HI98129 pH/Conductivity Tester; Hanna Instruments), dissolved oxygen and temperature (measured using a PDO-520 Dissolved Oxygen metre; Lutron). Each sample point will be recorded as a 10-figure grid reference using a handheld GPS.

Mollusc community samples will be collected at each of three subsampling points spaced approximately 15m apart per sample location, giving three sets of data for each sample location. Samples will be collected using ten-second sweeps of a net with 0.5mm mesh, repeated three times in different sections of the ditch profile for each subsample i.e. floating vegetation (where present), the benthic layer, and the submerged side of the near bank. Samples will be removed from the sites and preserved in ethanol for later identification in the lab (appropriate licences will be obtained from Natural England for this purpose). All molluscs will be identified to species level, with the exception of pea mussels which will be identified to genus level only. The relative abundance of each species will be recorded using a DAFOR scale<sup>1</sup>. The abundance of notable and rare mollusc species will be fully quantified, including little whirlpool ramshorn snail, shining ramshorn snail *Segmentina nitida*, slender amber snail *Oxyloma sarsi*, Desmoulin's whorl snail *Vertigo moulinsiana*, and the pea mussel species *Pisidium pseudosphaerium*.

The bankside, emergent, floating, and submerged flora of the ditch will be recorded at each subsample point. The relative abundance of each floral species occurring within 5m of the subsample point will be quantified using a DAFOR scale<sup>2</sup> - this will include vegetation on both the nearside and opposite bank and up to 1 m from the water's edge.

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<sup>1</sup>, DAFOR. D = dominant (> 100 specimens recovered), A = abundant (31 -100 specimens recovered), F = frequent (10 - 30 specimens recovered), O=occasional (3 - 9 specimens recovered), R = rare (1 - 2 specimens recovered).

<sup>2</sup> DAFOR. D = dominant (>75% cover), A = abundant (51-75% cover), F = frequent (26-50% cover), O = occasional (11-25% cover), R = rare (<10% cover)

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## 5 Detailed Surveys

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### 5.1 Site Descriptions

Appendix C presents maps showing sampling locations at each site, and the distribution of little whirlpool ramshorn snail at each site.

### 5.2 [REDACTED] (Area 1 – surveyed June and July 2017)

[REDACTED] is managed [REDACTED] by the RSPB and Butterfly Conservation [REDACTED], and by [REDACTED] of the site. It is located approximately [REDACTED]. The site falls [REDACTED] and is noted for its floristically diverse fen habitats, which are managed by hand cutting the sedge beds. A total of 13 sampling points were assessed at the site as part of this survey. Prior to surveying, there were no records of little whirlpool ramshorn snail in the surrounding area, or on the site itself.

The structure of the surveyed ditches diverse - all were between 1-4m in width with shallow banks and a steep underwater profile, containing water between 0.75-1m deep. The sediment layer within the ditches was generally <0.5m across the site. Water quality was good with low turbidity overall, although turbidity at two sample points was slightly higher (potentially due to feeding activity of swans at those points). However, conductivity readings across the site ranged from (627 $\mu$ S/S - 1229 $\mu$ S/S), with the highest reading from dykes directly linked to the Broad strongly suggesting a saline influences in the south-west of the site. This was confirmed through communications with the site warden (see Section 5.3 for more details).

The land adjacent to the sampled ditches was fen/swamp habitat, lightly managed [REDACTED] and more intensively [REDACTED]. The dykes There were low levels of poaching and shelf/block formation along the ditch margins, which had formed infrequent swampy areas.

#### Vegetation

The main vegetation here was classic high quality Norfolk Broads Fen with the land around the ditches species rich supporting one of the largest population of fen orchid in the UK. The majority of the land habitat was covered in *Cladium mariscus*, *Myrica gale* and *Phragmites australis* with *Juncus subnodulosus* common throughout. These species were all present on the margins of most of the ditches across this diverse site. *Carex* species were less common with small areas along each of the ditch mainly *Carex paniculata*, *Calamagrostis canescens* was a common component in the ditch side sward. There was no grazing on the site with only low level habitat management for the benefit of the invertebrates and rare flora present on site. The ditch flora was in general diverse with Whorl-leaf water milfoil *Myriophyllum verticillatum* was frequent within the water channels themselves, while ivy-leaved duckweed *Lemna trisulca* was present at all sample points, but not in high densities. Frogbit *Hydrocharis morsus-ranae* and water soldier *Stratiotes aloides* were present at the majority of sample points, but again not in high densities. There were large areas of open water in all ditches sampled.

#### Molluscs

No little whirlpool ramshorn snail was found at [REDACTED], and the mollusc communities in general were good with a good diversity of species several of the samples holding 20 species of aquatic mollusc. The highest density of molluscs were present in the margins of the ditches with the greatest areas of vegetation within the ditch and with the latest successional habitat. There was an increase in salinity on the southern section of the site and the corresponding mollusc diversity decrease.

The only species consistently found throughout the site was common Bithynia *Bithynia tentaculata* (a common species). A few shining ramshorn snail *Segmentina nitida* were found in ditches in the north and west of the survey area.

### 5.3 [REDACTED] (Area 2 – surveyed August 2017)

The survey site at [REDACTED] covered a large area [REDACTED]. A total of 8 sample points were surveyed across the area. [REDACTED] and is extremely well managed due to the high quality of the habitat for [REDACTED]. Prior to surveying, there were no historic records of little whirlpool ramshorn snail in the surrounding area or on the site itself.

The width of the surveyed ditches was mainly 2-3m, but this varied from <1m to >4m. Water depth was similarly varied, between 0.25m – 1m (although generally between 0.5m - 0.75m). Water quality appeared good, with little to no turbidity at the majority of sites however, there was moderate turbidity in two ditches, and occasional filamentous algae in places. pH was slightly below neutral on average (7.23), while conductivity ranged from 461-845µS/S. The adjacent land at all sampling points was fenland marginal habitat with either sedges or *Phragmites australis* along the edge of the dykes. There was very limited mid successional habitat along the margins of the dykes across the site. They were deep (>1m) with steep sides and moderate silt depth. All adjacent land use was un-improved fenland marshes with high botanical diversity. The water level was high in the dykes creating a wet margin to the dykes This created swampy areas of submerged vegetation, and potentially micro-habitats suitable for little whirlpool ramshorn snail - at other sites the species has been observed to be more abundant in swampy marginal areas at the edges of ditches than in the open water (T. Abrehart, pers. obs).

#### **Vegetation**

Bankside vegetation across the site was dominated by sedges (largely greater pond sedge with more occasional, narrow areas of lesser pond-sedge) with frequent *Phragmites australis* and occasional grasses. Additional margin vegetation included *Sium latifolium* and *Typha angustifolia* with *Juncus subnodulosus* across the site.

[REDACTED] contained ditches at a very similar age range with limited levels of succession, these generally supported a diverse flora. The marginal vegetation was consistent across the site with a similar uniform flora. Along the margins ditches the vegetation was

The aquatic macrophyte cover within the dykes was rich with abundant *Hydrocharis morsus-ranae* across most of the dykes and in the deeper dykes *Nyphar lutea* was present. *Utricularia vulgaris* was common across the site with occasional *Elodea canadensis*. Duckweeds were limited to *Lemna trisulca*, *Lemna minor* and *Spirodelia*. *Myriophyllum verticillatum* was frequent within the water channels themselves, while ivy-leaved duckweed *Lemna trisulca* was present at all sample points, but not in high densities. Frogbit *Hydrocharis morsus-ranae* was scattered across the site with some of the ditches supporting a high density of plants. Filamentous algae was observed in some areas, but was not common or abundant.

#### **Molluscs**

No little whirlpool ramshorn snail was found at any of the sample points visited. Mollusc communities were otherwise species-rich across the survey area, averaging 20 species per sample point (maximum 22, minimum 13 species). Shining ramshorn snail was occasionally observed in low numbers, and flat valve snail *Valvata cristata* was scattered– both these species are associated with diverse mollusc communities, and have been suggested as indicator species for suitable little whirlpool ramshorn snail habitat (AECOM/Abrehart Ecology 2016b). Additional species of interest found at Sutton Fen were the bivalve *Pisidium pseudosphaerium*, which was found at several sample points but generally in low numbers. Other species frequently observed at the site included wandering pond snail *Radix balthica*, common bladder snail *Physa fontinalis*, Leach's Bithynia *Bithynia leachii*, common Bithynia, margined ramshorn snail *Planorbis planorbis*, and twisted ram's horn *Bathyomphalus contortus*.

The diverse mollusc communities the presence of indicator species (shining ramshorn snail and flat valve snail), combined with the diverse vegetation communities observed at the site and the management of the area, make [REDACTED] a good potential receptor site for a future translocation of little whirlpool ramshorn snail.

## 5.4 [REDACTED] (Area 3 – surveyed August 2017)

The survey site at [REDACTED] covered a large area approximately [REDACTED]. A total of six sample points were surveyed across the area. The site is [REDACTED] and is well managed due to the high quality of the habitat for [REDACTED]. Prior to surveying, there were no historic records of little whirlpool ramshorn snail in the surrounding area or on the site itself.

The width of the surveyed ditches was mainly 4-6m, but this varied from <4m to >6m. Water depth was similarly varied, between 0.25m – >1m (although generally between 0.5m - 0.75m). Water quality appeared good, with little to no turbidity at the majority of sites however, there was moderate turbidity in two ditches, and occasional filamentous algae in places. pH was slightly below neutral on average (7.33), while conductivity ranged from 461-845µS/S. The adjacent land at all sampling points was reed dominated fenland marginal habitat with either sedges or *Phragmites australis* along the edge of the dykes. As with the area to the north there was very limited mid successional habitat along the margins of the dykes across the site. They were deep (>1m) with steep sides and moderate silt depth. The water level was 60cm from the top of the bank this created limited areas of swampy margins and little potentially micro-habitats suitable for little whirlpool ramshorn snail.

### **Vegetation**

Bankside vegetation across the site was dominated by *Phragmites australis* and sedges (largely greater pond sedge with more occasional, narrow areas of lesser pond-sedge) and occasional grasses, commonly *Calamagrostis canescens*. Occasional species included *Thelypteris palustris*, *Rumex hydroplantum*, *Myrica gale* and *Sium latifolium*.

[REDACTED] contained ditches at a very similar age range with limited levels of succession, these generally supported a moderately diverse flora. The marginal vegetation was consistent across the site with a similar uniform flora.

The aquatic macrophyte cover within the dykes was rich with abundant *Hydrocharis morsus-ranae* across most of the dykes and in the deeper dykes *Nyphar lutea* was present. *Utricularia vulgaris* was common across the site with dense *Elodea canadensis*. Duckweeds were limited to *Lemna trisulca*, *Myriophyllum verticillatum* was frequent within the water channels themselves, while ivy-leaved duckweed *Lemna trisulca* was present at all sample points, though not in high densities. Filamentous algae was observed in some areas particularly in the southern end of the site, but was not common or abundant across the whole site.

### **Molluscs**

No little whirlpool ramshorn snail was found at any of the sample points visited. Mollusc communities were otherwise species-moderately rich across the survey area with 22 species recorded, averaging 13 species per sample point (maximum 16, minimum 10 species). Shining ramshorn snail was found in the northern ditches only in low numbers, and flat valve snail *Valvata cristata* was at a low density in two ditches– both these species are associated with diverse mollusc communities, and have been suggested as indicator species for suitable little whirlpool ramshorn snail habitat (AECOM/Abrehart Ecology 2016b). Additional species of interest found at [REDACTED] were the bivalve *Pisidium pseudosphaerium*, which was found at several sample points but generally in low numbers. Other species frequently observed at the site included common Bithynia, wandering pond snail *Radix balthica*, common bladder snail *Physa fontinalis*, Leach's Bithynia *Bithynia leachii*, margined ramshorn snail *Planorbis planorbis*, and twisted ram's horn *Bathymphalus contortus*.

The diverse mollusc communities, presence of indicator species (shining ramshorn snail and flat valve snail), combined with the diverse vegetation communities observed at the site and the management of the area, make Sutton Fen south a potential receptor site for a future translocation of little whirlpool ramshorn snail, though the general species richness and marginal habitat make it a possible site for translocation. .

## 5.5 [REDACTED] (Area 4 – surveyed October 2017)

The survey site at [REDACTED] covered a large area of land approximately 14.5km [REDACTED]. A total of 13 sample points were surveyed across the area. The site is [REDACTED]. Prior to surveying, there were no historic records of little whirlpool ramshorn snail in the sites surveyed, though there was a new site found to the south east in 2012 [REDACTED] (2012 Article 17 assessment on *Anisus vorticulus* in Norfolk, March 2012. Lot 5.) as part of an article 17 survey for Natural England.

The width of the surveyed ditches was mainly 4-6m, but this varied from <4m to >6m. Water depth was similarly varied, between 0.25m – 0.75m (although generally between 0.26m - 0.75m). Water quality appeared moderate, with some turbidity at the majority of sites with filamentous algae in most sites. pH was slightly below neutral on average (6.98), while conductivity was generally high ranging from 1186->4000µS/S. The adjacent land at all sampling points was reed dominated fenland marginal habitat with either sedges or *Phragmites australis* along the edge of the dykes. In [REDACTED] there was a range of successional ditches with two supporting margins of floating vegetation. The remainder were wide and steep sided. In the [REDACTED] the ditches were in general wide with margins of *Phragmites australis* which had been lightly poached into the ditches. These ditches had a very high conductivity starting at 2634 and exceeding the meter at over 4000 for two of the sample points. As with [REDACTED] there was very limited mid successional habitat within the ditches.

### Vegetation

Bankside vegetation across the site was dominated by *Phragmites australis* and sedges (largely greater pond sedge with more occasional, narrow areas of lesser pond-sedge) and occasional grasses, commonly *Calamagrostis canescens*. Occasional species included *Thelypteris palustris*, *Rumex hydroplantum*, *Myrica gale* and *Sium latifolium*.

[REDACTED] contained ditches at a very similar age range with limited levels of succession, these generally supported a moderately diverse flora. The marginal vegetation was consistent across the site with a similar uniform flora. [REDACTED] were grazed by cattle and there were well grazed margins close to the river.

The aquatic macrophyte cover within the dykes was rich with abundant *Hydrocharis morsus-ranae* across most of the dykes and in the deeper dykes *Nyphar lutea* was present. *Utricularia vulgaris* was common across the site with dense *Elodea canadensis*. 4 species of duckweeds were found including *Lemna turionifera* and *Lemna trisulca*, *Myriophyllum verticillatum* was frequent within the water channels themselves, while *Ceratophyllum demersum* was present at high density in half the ditches. Filamentous algae was observed in some areas and often coated the vegetation.

### Molluscs

No little whirlpool ramshorn snail was found at any of the sample points visited. Mollusc communities were otherwise species-moderately rich across the survey area with 23 species recorded, averaging 12 species per sample point (maximum 17, minimum 8 species). Shining ramshorn snail was found in both marsh systems with a higher density in the [REDACTED] with up to 1800 in a sample. The flat valve snail *Valvata cristata* was at a high density in a number of the sample sites and *Valvata macrostoma* was found in six samples. Both these species are associated with diverse mollusc communities, and have been suggested as indicator species for suitable little whirlpool ramshorn snail habitat (AECOM/Abrehart Ecology 2016b). It is of note that bivalves were only recorded at a low density across the site and often were not present at all in many of the samples. There was a correlation with increased conductivity and lack of this group. Additional species of interest found at [REDACTED] was *Gyraulus albus* which was found in only one sample indicating an increase in the water body size. Other species frequently observed at the site included common Bithynia, wandering pond snail *Radix balthica*, Leach's Bithynia *Bithynia leachii* and twisted ram's horn *Bathyomphalus contortus*.

The moderately diverse mollusc communities, presence of indicator species (shining ramshorn snail and flat valve snail), combined with the diverse vegetation communities observed at the site and the management of the area, make [REDACTED] a potential receptor site for a future translocation of little whirlpool ramshorn snail, though the general species richness and marginal habitat and very high conductivity exclude this from being a viable option.

## 5.6 [REDACTED] (Area 4 and 5 – surveyed October 2017)

The survey site at [REDACTED] covered an area of land approximately 20km [REDACTED]. A total of six sample points were surveyed across the area. [REDACTED]. Prior to surveying, there were historic records of little whirlpool ramshorn snail in the sites surveyed, these were confirmed in 2012 [REDACTED] (2012) Article 17 assessment on *Anisus vorticulus* in Norfolk, March 2012. Lot 5.) as part of an article 17 survey for Natural England.

The width of the surveyed ditches was mainly 4-6m, but this varied from 2m to >6m. Water depth was similarly varied, between 0.25m – 0.75m (although generally between 0.51m - 0.75m). Water quality had slight colouration, with some turbidity at the majority of sites with filamentous algae in most sites. pH was slightly above neutral on average (7.39), while conductivity was generally low ranging from 853-922 $\mu$ S/S. The adjacent land at all sampling points was improved marshes dominated with *Lolium perenne* in the whole with reed dominated ditch margins. All the ditches had recently been heavily cleared from one side but the clearance had heavily affected both side of each ditch. The water level across the site was low in most of the ditches with up to 1m of freeboard.

### Vegetation

Bankside vegetation across the southern end of the site was dominated by *Phragmites australis* where it had not already been cleared, with bare soils on the opposite banks. In the northern section the margins of the ditches were heavily grazed marshes with heavily poached banks. *Urtica dioica*, *Dactylis glomerata*, *Holcus lanatus* and *Arrhenatherum elatius* were common on the dredged material.

[REDACTED] contained ditches at a very similar age range with almost no succession, these generally supported a low diversity flora. With *Phragmites australis*, *Sparganium erectum* and *Typha latifolium* most frequently found within the ditches.

The aquatic macrophyte cover within the dykes was poor with *Hydrocharis morsus-ranae* across most of the dykes and in the most recently cleared ditches *Potamogeton natans* was present. *Sagittaria sagittifolia*, *Hottonia palustris* and *Myriophyllum verticillatum* were scattered across the site. All indicating a more recently cleared ditch. *Elodea canadensis*. two species of duckweeds were found including *Lemna trisulca*. Filamentous algae was observed in some areas and often coated the vegetation.

### Molluscs

No little whirlpool ramshorn snail was found at any of the sample points visited. Mollusc communities were otherwise species-moderately rich across the survey area with 22 species recorded, averaging 14 species per sample point (maximum 16, minimum 12 species). Shining ramshorn snail was found in three samples both marsh systems with a low density at each site. The flat valve snail *Valvata cristata* was at a low density in a number of the sample sites. Both these species are associated with diverse mollusc communities, and have been suggested as indicator species for suitable little whirlpool ramshorn snail habitat (AECOM/Abrehart Ecology 2016b). The fact that *Anisus vorticulus* was no found during this survey is worrying. It is of note that bivalves were only recorded at a low density across the site and often were not present at all in many of the samples. *Pisidium pseudosphaerium* was only present in one sample only. Other species frequently observed at the site included common Bithynia, wandering pond snail *Radix balthica*, Leach's Bithynia *Bithynia leachii* and twisted ram's horn *Bathyomphalus contortus*.

The moderately diverse mollusc communities, presence of indicator species (shining ramshorn snail and flat valve snail), are good to see, it is worrying that *Anisus vorticulus* is currently not found on the site. The over clearance of the ditches will have greatly contributed to this. The management of the ditches needs to be addressed, if so the site may be a good candidate for re-introduction of *Anisus vorticulus* in years to come.



## 5.7 [REDACTED] (Area 7 – surveyed October 2017)

The survey site at [REDACTED] covered a large area of land approximately [REDACTED], [REDACTED]. A total of 14 sample points were surveyed across the area of which four were taken in the autumn of 2017. The site is managed by [REDACTED]. Prior to the 2016 surveying, there were no historic records of little whirlpool ramshorn snail in the sites surveyed, the nearest was the new site at [REDACTED] in 2012 ([REDACTED] (2012) *Article 17 assessment on Anisus vorticulus in Norfolk, March 2012*. Lot 5.) as part of an article 17 survey for Natural England.

The width of the surveyed ditches was mainly 4-8m, but this varied from <3m to >10m. Water depth was similarly varied, between 0.25m – 0.75m (although generally between 0.26m - 0.75m). Water quality appeared moderate, with some turbidity at the majority of sites with filamentous algae in most sites. pH was slightly above neutral on average (7.13), while conductivity was generally low ranging from 520-662µS/S. The adjacent land at all sampling points was fenland with botanically rich marshes and marginal habitat with mainly sedges along the edge of the dykes. The four samples taken were scattered across the site and ranged from wide clear ditches (three of the sites) to the wide tidal channel running through the centre of the site. Floating vegetation was limited to small stands of vegetation often associated with *Cicuta virosa*. Within the main channel there were large *Nuphar lutea* and otherwise only a few aquatic macrophytes, the margins of the dyke were steep sided with deep sediment.

### **Vegetation**

Bankside vegetation across the site was dominated by sedges (largely *Carex acutiformis* with more occasional, *Carex paniculata*) and occasional grasses, commonly *Calamagrostis canescens*. Occasional species included *Thelypteris palustris*, *Rumex hydroplantum*, *Myrica gale* and *Cicuta virosa*.

[REDACTED] contained ditches of a very similar age range with limited levels of succession, these generally supported a moderately diverse flora. The marginal vegetation varied across the site with low levels of grazing in some of the marshes, the flora was similar across the site with subtle variations.

The aquatic macrophyte cover within the dykes was rich with abundant *Hydrocharis morsus-ranae* across most of the dykes and in the deeper dykes *Nuphar lutea* was present. *Utricularia vulgaris* was common across the site. 4 species of duckweeds were found including *Lemna turionifera* and *Lemna trisulca*, *Myriophyllum verticillatum* was frequent within the water channels themselves, while *Ceratophyllum demersum* was present in the ditches. Filamentous algae was observed in some areas though was rare.

### **Molluscs**

little whirlpool ramshorn snail was found in all of the sample points visited. Mollusc communities were species-rich across the survey area with 23 species recorded, averaging 19 species per sample point (maximum 21, minimum 19 species). Shining ramshorn snail was found across the site at a low density with a high density of flat valve snail *Valvata cristata*. Both these species are associated with diverse mollusc communities, and have been suggested as indicator species for suitable little whirlpool ramshorn snail habitat (AECOM/Abrehart Ecology 2016b). Other species frequently observed at the site included *Hippeutis complanata*, *Acroluxus lacustris* and *Planorbis carinatus* along with the more common common Bithynia, wandering pond snail *Radix balthica*, Leach's Bithynia *Bithynia leachii* and twisted ram's horn *Bathyomphalus contortus*.

The high diversity of the mollusc communities, presence of *Anisus vorticulus* precludes this site from being a receptor site though it may be used in the future as a donor should the need be required.

## 5.8 [REDACTED] (Area 8 – surveyed October 2017)

The survey site at [REDACTED] covered a small parcel of land approximately [REDACTED]. A total of three sample points were surveyed across the area which were taken in the autumn of 2017. The site is managed by [REDACTED] it is well managed, [REDACTED]. Prior to the 2016 surveying, there were no historic records of little whirlpool ramshorn snail in the sites surveyed, the nearest was the new site at [REDACTED] as part of this project.

The width of the surveyed ditches was mainly 4-6m, but this varied from <3m to 8m. Water depth was similarly varied, between 0.25m – 0.75m (although generally between 0.75m - 1m). Water quality appeared moderate, with some turbidity at the majority of sites with filamentous algae in most sites. pH was slightly below neutral on average (6.93), while conductivity was generally low ranging from 538-1281µS/S. The adjacent land at all sampling points was restored fenland with the surface material being scraped to try to re-invigorate the marshes and marginal habitat with mainly sedges along the edge of the dykes. The three samples taken were scattered across the site and ranged from wide clear ditches (one site) to the narrow mid successional ditches across the middle of the site.

### **Vegetation**

Bankside vegetation across the site was dominated by sedges and rushes (largely *Carex pseudocyperus* with more *Juncus subnodulosus*) and occasional grasses, commonly. Occasional species included *Ranunculus flammula*, *Mentha aquatica* and *Cicuta virosa*.

[REDACTED] contained ditches of a variety of age ranges with limited levels of succession, these generally supported a moderately diverse flora. The marginal vegetation varied across the site with low levels of grazing across them, the flora was similar across the site with subtle variations.

The aquatic macrophyte cover within the dykes was rich with *Stratiotes aloides* and abundant *Hydrocharis morsus-ranae* across most of the dykes. *Hottonia palustris* was scattered across the site with *Cicuta virosa*, *Myriophyllum verticillatum* was frequent within the water channels themselves, while *Potamogeton obtusifolius* was rare in sample site 3. Filamentous algae was observed in some areas though was rare.

### **Molluscs**

Little whirlpool ramshorn snail was found in all of the sample points visited. Mollusc communities were species-rich across the survey area with 17 species recorded, averaging 14 species per sample point (maximum 15, minimum 14 species). Few species of interest were found in the samples with the flat valve snail *Valvata cristata* found in abundance in all the samples. Other species frequently observed at the site included *Hippeutis complanata* at >400 per sample. All other species were found at a range of densities with *Physa fontinalis*, *Acroluxus lacustris* and *Planorbis carinatus* most frequent. Uncommon was common Bithynia, wandering pond snail *Radix balthica*.

The moderate/low diversity of the mollusc communities, precludes this site from being a receptor site.

## 5.9 [REDACTED] (Area 9 – surveyed October 2017)

The survey site at [REDACTED] covered a large area of land approximately [REDACTED]. A total of 10 sample points were surveyed across the area and all were taken in the autumn of 2017. The site is [REDACTED]. Prior to the 2016 surveying, there were no historic records of little whirlpool ramshorn snail in the sites surveyed, the nearest site at [REDACTED] to the south in 2012 [REDACTED], [REDACTED] (2012) Article 17 assessment on *Anisus vorticulus* in Norfolk, March 2012. Lot 5.) as part of an article 17 survey for Natural England.

The width of the surveyed ditches was mainly 4-8m, but this varied from 2m to 6m. Water depth was similarly varied, between 0.25m – 1m (although generally between 0.51m - 0.75m). Water quality appeared good, with no noticeable turbidity at the majority of sites with filamentous algae in most sites. pH was slightly above neutral on average (7.53), while conductivity was generally low ranging from 713-952 $\mu$ S. The adjacent land at all sampling points was improved grazing marsh that were botanically poor and marginal habitat with mainly sedges along the edge of the dykes. The ten samples taken were scattered across the northern side of the site and was dominated with clear ditches with well poached margins. There was no floating vegetation within the ditches though there were areas of vegetation lying on the waters surface, this was mainly *Juncus subnodulosus* Otherwise the ditches were full of submerged and floating macrophytes.

### **Vegetation**

Bankside vegetation across the site was dominated with largely *Carex riparia* with more occasional, *Juncus subnodulosus* and occasional grasses, commonly *Agrostis stolonifera*. Herbs were commonly found along the ditch margins, with *Mentha aquatica*, *Myosotis scorpioides*, *Galium palustris* and *Lotus pedunculata*.

[REDACTED] contained ditches of a very similar age range with limited levels of succession, these generally supported a moderately diverse flora. The marginal vegetation varied across the site with moderate levels of grazing in all of the marshes, the flora was similar across the site with subtle variations.

The aquatic macrophyte cover within the dykes was rich with abundant *Hydrocharis morsus-ranae* across most of the dykes and *Stratiodes aloides*, choking many of the sites. *Lemna trisulca*, *Myriophyllum verticillatum* were frequent within the ditches with some of the deeper more recently cleared ditches supporting a high density of *Utricularia vulgaris*. Filamentous algae was observed in some areas though was uncommon.

### **Molluscs**

little whirlpool ramshorn snail was not found in any of the sample points visited. Mollusc communities ranged from species-rich to species poor with 24 species recorded, averaging 14 species per sample point (maximum 19, minimum 8 species). Most of the mollusc species found in the ditches were common species for the Broads, with only one rare species, *Pisidium pseudosphaerium*, which was found in seven of the sample points. There was a low density of flat valve snail *Valvata cristata* at only four sample sites. Three species were found in all locations, *Planorbarius corneus*, *Bithynia leachi* and *Bithynia tentaculata*.

The range of species and abundance within the site indicates that there are a number of factors across the site that may affect molluscs. Only four sites supported moderately high mollusc diversity all the others support a low diversity. With the current ditch clearance regime under HLS it is considered that the is unlikely to be able to support *Anisus vorticulus* in the long term.

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## 6 Discussion & Recommended Future Work

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### 6.1 Scoping

The survey involved a walkover of 49.1km of potential receptor and donor ditches within ten distinct land parcels (Areas 1 – 10). The habitat potential for little whirlpool ramshorn snail of ditches within each area was appraised against set criteria, based on species requirements and practical constraints determined during the pilot study conducted in 2016 (AECOM 2015b; AECOM/Abrehart Ecology 2016a, 2016b, 2016c, 2017a, 2017b and 2017c).

The findings of the survey were that, 17,921km of ditch were deemed of 'good' (Category 4) or 'moderate/good' (Category 3) these had the potential to support little whirlpool ramshorn snails and were recommended to be carried into the next stage of detailed surveys. This was in line with the methods applied during the 2015 and 2016 scoping survey (AECOM 2015b and AECOM/Abrehart Ecology 2017a).

This is a confirmed appropriate approach during detailed surveys of the pilot study area in 2016 (AECOM/Abrehart Ecology 2016a, 2016b, 2016c, 2017a, 2017b and 2017c). It is recommended that ditches of 'low' (Category 1) or 'negligible' (Category 0) potential are scoped out of the detailed surveys. Ditches were considered as being of 'low' or 'negligible' potential for several reasons. These included high salinity, eutrophication, over excessive ditch clearance and poor management.

### 6.2 Full surveys

These surveys of nine sites was carried out in the summer and autumn of 2017. They showed that *Anisus vorticulus* was only found in one of the sites [REDACTED] though in a larger number of ditches than found in 2016. There was another site [REDACTED] where it was previously found and was not located during this year's session of surveys. The fact that it was not found at [REDACTED] was worrying and these ditches had been heavily cleared in the past year and the remaining ditches were dry and choked with *Phragmites australis*. The clearance of all the southern [REDACTED] [REDACTED] where *Anisus vorticulus* was present in one go was inappropriate maintenance under the HLS agreement. It may be that some *Anisus vorticulus* have survived in one of these ditches and may repopulate in time. This site will need re-monitoring as part of a Natural England survey and may be a site that can be used in future translocations once agreements on management have been put in place.

*Segmentina nitida* was found in [REDACTED]. This species is strongly associated with *Anisus vorticulus* and it's presence can indicate that the ditches are within the later succession required to support *Anisus vorticulus*.

There were no new donor sites selected during this survey season though there were two sites where translocation could be undertaken if permissions were granted. These are [REDACTED] in [REDACTED] and under ownership of RSPB.

If agreements can be set up then a translocation in late April or early May would be the time to set up the first round of moving the *Anisus vorticulus*.

### 6.3 Future work summary

- As per the translocation licence, continued monitoring of the pilot donor and receptor sites at [REDACTED]
- Continued monitoring of the translocation sites for 2017, the donor sites at [REDACTED] and the receptor sites at [REDACTED]. Here 1500 *Anisus vorticulus* were moved over two seasons of 2017 to each

site. The bi-annual monitoring is important to determine the success of this translocation of two different populations across a large distance. One from a different river system and one from within the same river system.

- Monthly monitoring of six sites across the Broads National Park area – this will indicate the seasonal variability across the population with the study area. This work has not been completed before and is considered very important for future understanding of this species and its optimal survey and translocation timings.

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## 7 Acknowledgements

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## 8 References

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