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# Translocation of the little whirlpool ramshorn snail: Scoping and detailed site surveys 2017 to identify Translocation 2018 sites

Highways England

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# Contents

# 1 Introduction

## 1.1 Background

Little whirlpool ramshorn snail *Anisus vorticulus* 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 *Anisus vorticulus* have been declining the UK since the 1960s, and in their conservation assessment for the species the Joint Nature Conservation Committee describe the future prospects for the *Anisus vorticulus* 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, *Anisus vorticulus* 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 *Anisus vorticulus*, 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 2016 and 2017 (see AECOM 2015b, and AECOM/Abrehart Ecology 2016a, 2016b, 2016c for further details), and therefore forms the initial groundwork for identifying additional sites for a third phase of translocation (hereafter referred to as Translocation 2018) for *Anisus vorticulus* within the Broads in 2018.

The translocation approach carried out to date (during the Pilot Translocation (AECOM/Abrehart Ecology, 2016a) and Translocation 2017 (AECOM/Abrehart Ecology, 2017c) has involved moving 1,800 *Anisus vorticulus* 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 the Pilot translocation and Translocation 2017, 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 donor and receptor sites used in the Pilot Translocation and Translocation 2017 and will continue for a total of at least five years in accordance with the relevant Natural England licences which were secured to conduct this work. Whilst long-term data from the Pilot Translocation 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 the receptor sites (AECOM/Abrehart Ecology 2017b).

Results from Translocation 2017(at six months post relocation) were less promising. Although twenty snails were found at [redacted], no snails were recorded during re-surveys at [redacted] were the receptor sites used in Translocation 2017.

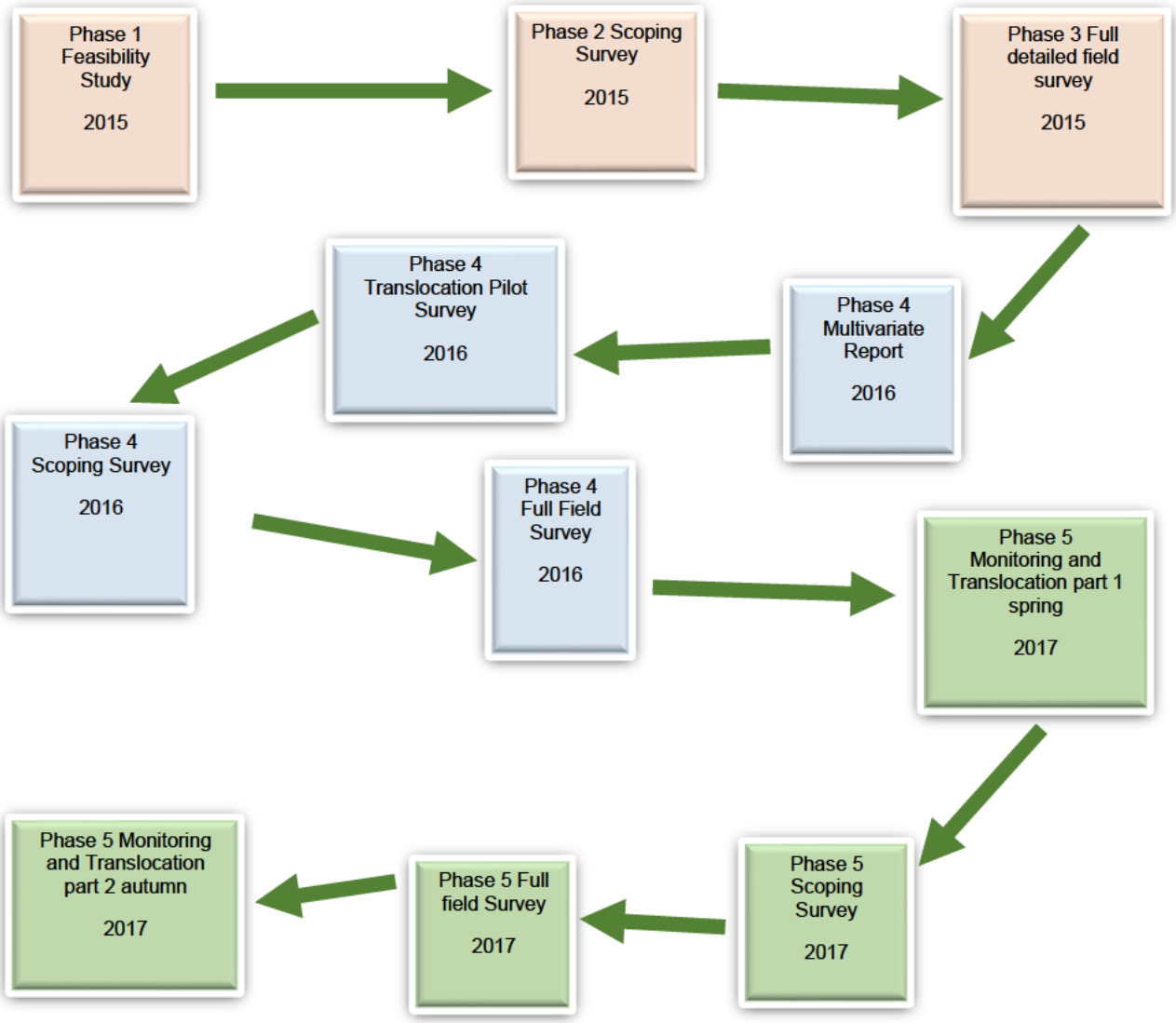
This report presents the findings of a scoping survey and subsequent detailed survey which aimed to find areas potentially suitable for Translocation 2018; a more extensive translocation of *Anisus vorticulus*.

**Figure 1: Location of all sites scoped in 2015-2017 within the Broads National Park**

## 1.3 Overview of Surveys to date

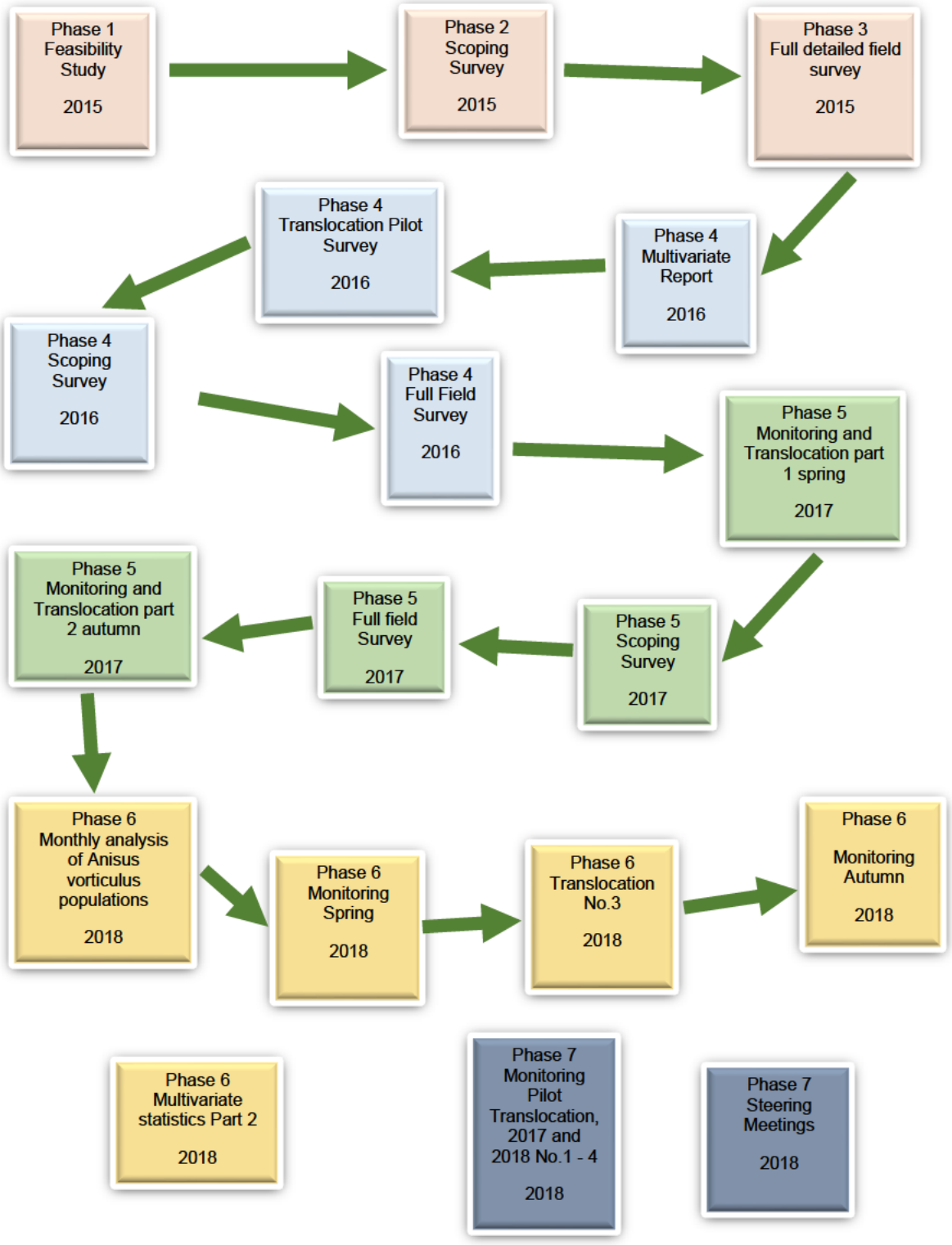
The surveys carried out so far have been carried out across four areas of the Broads National Park.

Phase 1, 2, 3, 4 & 5 – Completed.



Phase 6 – Currently at planning stage to be agreed with Highways England (HE).

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



# 2 Methods

## 2.1 Study Area

Whilst the *Anisus vorticulus*' range extends across a number of areas in England, the scoping and subsequent detailed survey reported here concentrates on ten survey areas across East Anglia (all within Norfolk) –

- (Area 1, central grid ref: ) is managed as a nature reserve The site falls within which is one of the largest remaining areas of fen habitat in Western Europe.
- (Area 2, central grid ref: ) is immediately , near to the town of The site is managed . supports many rare plants, invertebrates, and birds.
- (Area 3, central grid ref: ) is a series of ditches and river channels immediately to the south of Area 2. This site is also .
- (Area 4, central grid ref: ) is to the north of approximately , and is .
- (Area 5, central grid ref: ) is immediately surrounded by agricultural land. The marshes at .
- (Area 6, central grid ref: ) comprises grazing marsh . .
- (Area 7, central grid ref: ) is an area of grazing marsh . . .
- (Area 8, central grid ref: ) is immediately , and . The marshes are . .
- (Area 9, central grid ref: ) is a series of ditches . The marshes are .
- (Area 10, central grid ref: ) is an area

Each of the areas were selected for scoping based upon firstly, likely suitable habitat for *Anisus vorticulus* (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.

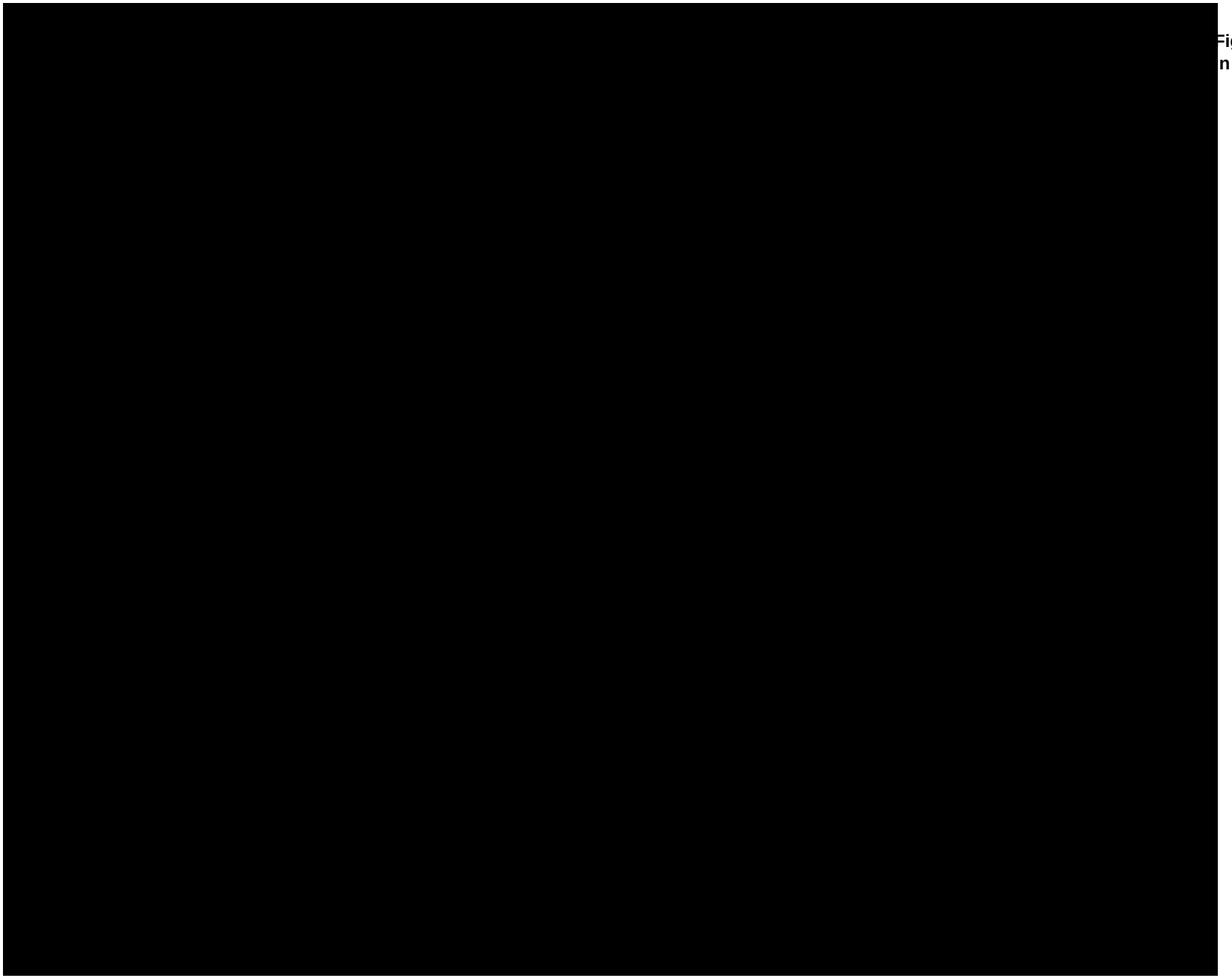


**Figure 2: Location of all sites scoped in 2017 within the Broads NP**

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 1 Summary of survey areas**

| Site Name | Area Number | Location (National Grid Reference) | Historic records of *Anisus vorticulus* | Approximate Total area of site (Ha) | Total length of ditches (m) |
|---|---|---|---|---|---|
| [redacted] | 1 | [redacted] | None | 75.63 | [redacted] |
| [redacted] | 2 | [redacted] | None | 81.15 | [redacted] |
| [redacted] | 3 | [redacted] | None | 20.49 | [redacted] |
| [redacted] | 4 | [redacted] | Yes - [redacted] | 93.69 | [redacted] |
| [redacted] | 5 | [redacted] | Yes | 40.78 | [redacted] |
| [redacted] | 6 | [redacted] | Yes | 46.99 | [redacted] |
| [redacted] | 7 | [redacted] | Yes | 105.29 | [redacted] |
| [redacted] | 8 | [redacted] | None | 15.87 | [redacted] |
| [redacted] | 9 | [redacted] | None | 51.93 | [redacted] |
| [redacted] | 10 | [redacted] | None | 33.64 | [redacted] |

## 2.2 Scoping Survey

The scoping survey described in this report is the first stage of the proposed Translocation 2018, a third round of conservation translocations for *Anisus vorticulus* (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 scoping study comprises non-intrusive site walkover of potential areas of ditches, using expert knowledge of the species habitat, derived from the literature review described in the Feasibility Report (AECOM, 2015a).

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:

- [redacted] (Abrehart Ecology) – Principal Ecologist and Mollusc Specialist
- [redacted] (Abrehart Ecology) – Ecologist
- [redacted] (Abrehart Ecology) – Ecologist
- [redacted] (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).

### 2.2.1 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 *Anisus vorticulus* 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 *Anisus vorticulus*;
- 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 2 Description of habitat suitability classes**

| Habitat Suitability Class (HSC) | Description | Example |
|---|---|---|
| 5 – Very good potential | Ditch of very good potential for *Anisus vorticulus* | 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 *Anisus vorticulus* | 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 *Anisus vorticulus*, but with some potential limitations | Intermediate between HSC type 4 and HSC type 2 |
| 2 – Moderate potential | Ditch generally of moderate potential for *Anisus vorticulus*, 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 *Anisus vorticulus* | Ditch with few floating leaved plants, steep sided, presence of extensive algae, Enteromorpha etc. surrounding land use arable |

| Habitat Suitability Class (HSC) | Description | Example |
|---|---|---|
| 0 – Negligible potential | Ditch of very little or no potential for *Anisus vorticulus* | Heavily shaded ditch or excessively eutrophic ditch. |

## 2.3 Detailed Survey

Once potential sites have been scoped, more intrusive surveys were conducted: detailed surveys. These detailed surveys were to identify sites with appropriate invertebrate assemblages, plant communities and abiotic factors identified as being optimal conditions for supporting *Anisus vorticulus*. In summary, the fieldwork protocol involved assessment of ditches classifies as 'good' or 'moderate/good' habitat suitability for *Anisus vorticulus* within the scoped in Areas. 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 *Anisus vorticulus*. Repeating the previously used method ensured consistency in data collection, allowing each survey to contribute to a growing knowledge base on the ecology and biology of *Anisus vorticulus* in East Anglia.

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 *Anisus vorticulus* – [redacted]. The survey methods were consistent with those used for initial surveys and translocation work of *Anisus vorticulus* (AECOM/Abrehart Ecology 2016a, 2016c) and repeated in Translocation 2017. 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 PD0-520 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.

### 2.3.1 Molluscs

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 of Subsample B. 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 ([redacted], 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 *Anisus vorticulus*, shining ramshorn snail *Segmentina nitida*, slender amber snail *Oxyloma sarsi*, Desmoulin's whorl snail *Vertigo moulinsiana*, and the pea mussel species *Pisidium pseudosphaerium*.

### 2.3.2 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 3. 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% |

### 2.3.3 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.

# 3 Scoping Survey Results

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 the habitat suitability 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 *Anisus vorticulus* is likely absent. Category 5 is where *Anisus vorticulus* is known to be present.

## 3.1 [redacted] (Area 1)

[redacted], which are managed by hand cutting the sedge beds. [redacted] supports a range of ditches. The ditches range from all wet ditches [redacted]. All areas were fully accessible during the site walkover.

[redacted]

**Figure 3: Location and designated habitat potential of ditches in Area 1 [redacted]**

As shown in Figure 3, 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 *Anisus vorticulus* 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, if *Anisus vorticulus* is found to be present in detailed surveys.

The Category 4 habitats were [redacted], with one section to the [redacted]. Approximately [redacted] was deemed to be of Category 3 ‘moderate/good’ potential, these supported *Stratiotes aloides*, *Hydrocharis morsus-ranae* and had narrow margins of wet fen habitat. [redacted]. These supported a low density of *Stratiotes aloides* and other submerged aquatic macrophytes but were in general considered too shaded to offer Category 4 habitat. The ditches [redacted] were of low suitability having been recently cleared and supported dense algae. These were approximately [redacted] in length, and classified as Category 2 ‘poor’. The ditches within [redacted] were highly interconnected, often with ‘good’ habitat adjoining to poorer (Categories 1 & 2) habitats to [redacted]. Within the [redacted] there were a range of habitats present with good later successional channels to the [redacted] with all other ditches of poor quality. [redacted]

## 3.2 [redacted] (Area 2)

The survey site at [redacted] covered a large area approximately [redacted]. All of the ditches in Area 2 were fully accessible during the site walkover. As shown in Figure 4, of the approximately [redacted] of ditch within this Area, [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 [redacted], through [redacted] and at the [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 [redacted]. These ranged from wide clear ditches with dense reed margins to acidic ditches forming the catch dyke from the higher land.

[redacted]

**Figure 4: Location and designated habitat potential of ditches in Area 2** [redacted]

## 3.3 [redacted] (Area 3)

All ditches in Area 3 were fully accessible during the site walkover. As shown in Figure 5, 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 [redacted]. 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 located around the edge of Area 3. These catch ditches were wide with limited flora. The only area of Category 1 ditches was the at the southern end of the site where it was dominated with *Lemna minor* and *Enteromorpha intestinalis* and as such are considered less suitable.

**Figure 5: Location and designated habitat potential of ditches in Area 3 [redacted]**

## 3.4 [redacted] (Area 4)

The ditches in Area 4 were divided into two areas, the [redacted] and those to [redacted] All the ditches in both parts of Area 4 were fully accessible during the scoping walkover. As shown in Figure 6, of the approximately [redacted] of ditch within these parcels, 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) situated throughout this Area, and approximately [redacted] of ditch were deemed to be of 'moderate' (Category 2) potential.

The Category 3 ditches on the site are the [redacted], these have good wet margins and low marginal vegetation. In the [redacted] the only section classified as Category 3 is the middle section [redacted] Category 2 ditches dominate the Area, these are wide with dense margins of *Phragmites australis* and support a low density of aquatic vegetation.

[redacted]

**Figure 6: 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 7, of the approximately [redacted] of ditch within this parcel, none are deemed to be of 'good' habitat suitability (Category 4). Approximately [redacted] of ditch, deemed to be of 'moderate/good' habitat suitability (Category 3), are located throughout this parcel, while approximately [redacted] are deemed to have moderate potential (Category 2). There was [redacted] of poor quality habitat.

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

**Figure 7: 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 8, of the approximately [redacted] of ditch surveyed, none is deemed to be of 'good' (Category 4) habitat suitability for *Anisus vorticulus*. 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 low potential (Category 1).

The Category 3 ditches are focused on the eastern side of the site and are mid successional. The rest of the site is dominated with Category 2 ditches. These were in the main, wide clear ditches with limited aquatic flora within them. [redacted] are filled with *Lemna minor* and were not considered to be of any interest.

[redacted]

**Figure 8: Location and designated habitat potential of ditches in Area 6 [redacted]**

# 3.7 [redacted] (Area 7)

Part of this Area was originally surveyed in 2016. Due to the finding of a new population of *Anisus vorticulus* in that survey it was considered that a slightly wider survey be carried out to cover more of the site to determine the extent of potentially suitable habitat in the wider Area. All the ditches in Area 7 were fully accessible during the site walkover. As shown in Figure 9, of the approximately [redacted] of ditch surveyed, approximately [redacted] were deemed to be of 'excellent' (Category 5) 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 *Anisus vorticulus*.

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

[redacted]

**Figure 9: 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 10, of the approximately [redacted] of ditch surveyed, [redacted] are Category 3, [redacted] is Category 2 and the remainder ([redacted] on the eastern side of the site is classified as Category 1.

Several of the ditches on the western side of the marshes are wide and have no suitable habitat with *Phragmites australis* frequently dominating the margins. The internal ditches in the northern section of the marshes support habitat with mid successional characters and a rich flora on the margins and within the water itself, indicating greater suitability to host *Anisus vorticulus*.

**Figure 10: Location and designated habitat potential of ditches in Area 8 [redacted]**

## 3.9 [redacted] (Area 9)

Not all the ditches in Area 9 were accessible during the scoping site walkover. As shown in Figure 11, of the approximately [redacted] of ditch surveyed, all were deemed to be of 'moderate' (Category 2) habitat suitability for *Anisus vorticulus*. This Area is not considered further.

**Figure 11: 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 12, of the approximately [redacted] of ditch surveyed, approximately [redacted] are deemed to be of 'good' (Category 4) habitat suitability, approximately [redacted] are deemed to be of 'moderate/good' (Category 3) habitat suitability, and approximately [redacted] are deemed to be of 'moderate' (Category 2) habitat suitability for *Anisus vorticulus*.

The Category 4 ditches were on the [redacted]. These were early to mid-successional ditches with a rich flora dominated with *Stratiodes aloides* and *Hydrocharis mosus-ranae*. Filamentous algae is present, but this is limited and the ditches appeared suitable for detailed survey. This site is also where [redacted] has been introduced. The ditches to the [redacted]. The poorest looking ditches (classified as Category 2) are [redacted]

[redacted]

**Figure 12: Location and designated habitat potential of ditches in Area 10 [redacted]**

# 3.11 Discussion for Detailed Surveys

The scoping survey indicated that in nine of the ten areas there were several ditches worthy of additional detailed survey to ascertain whether they are potential receptor or donor ditches for Translocation 2018. Habitat suitability ranged from 'negligible' (Category 1) to 'good' (Category 4), but no ditches were considered of 'very good' (Category 5) suitability for *Anisus vorticulus*. Across all scoping 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 3.5km [redacted] Area 7) to none [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 *Anisus vorticulus*. 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] (Area 2/3), [redacted] (Area 7) and [redacted] (Area 10) all supported this criteria. These showed high proportions of ditches with 'good' potential habitat for *Anisus vorticulus*, and are therefore prime candidates for further, more detailed surveys. In addition to these sites it was deemed prudent to survey [redacted] marshes as these marshes are downstream from [redacted] (supporting a moderate density population of *Anisus vorticulus*) and could potentially support a population (there was a new population found to the south of the site in 2012 (Abrehart, 2012). [redacted] are also to be included in detailed surveys as they historically supported a low-density population as seen in 2012. Whilst many of the ditches have been cleared in the past two years, there is still potential to support *Anisus vorticulus* and thus worthy of a revisit to conduct detailed survey. [redacted] are also to be surveyed as they are within a rich marsh complex and may be suitable for *Anisus Vorticulus*. These marshes were used for the translocation of *Dolomedes plantarius* 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 *Anisus vorticulus* 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 [redacted] are currently tidal and have a higher potential for longevity as they are at sea level as opposed to many sites 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 7.1 km of ditch is considered to be of 'low' (Category 1) or 'negligible' (Category 0) potential to support *Anisus vorticulus* 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 or 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 *Anisus vorticulus* 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 the presence of dense, *Lemna minor*, least duckweed *Lemna minuta*, and/or thick filamentous algae. Such ditches are 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. Whilst the reasons for the decline of *Anisus vorticulus* 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 *Anisus vorticulus*.

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 could affect the long-term viability of receptor and donor sites and need to be considered further during the next phases of this study.

### 3.11.1 Recommendations for Detailed Surveys

As detailed in the 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 *Anisus vorticulus*. 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 *Anisus vorticulus* are the result of colonisation from adjacent ditches.

A decision was made on suggestions by site wardens that [redacted] would be a suitable site 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 *Anisus vorticulus* and its presence 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 currently host or have the potential to support *Anisus vorticulus* in the future. Fenland ditches are not considered to be a regularly used habitat by *Anisus vorticulus*, maybe as a result of 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 in 2017, as in the 2016 survey only the core central section had been 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 also considered important to assess. These [redacted] where there is known to be a healthy population of *Anisus vorticulus* (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.). Surveying these marshes for their suitability for further translocation could potentially locate a wider population in the Bure Valley.

Whether sufficient (or any) donor and receptor ditches are available will depend on the findings of the detailed survey. A number of potential donor sites are currently known of, thus the essential need from the current scoping and detailed surveys is to locate suitable receptor sites. For example, if some of the ditches are found to have healthy populations of *Anisus vorticulus*, other donor ditches within the region will not need to be found. Conversely, if all the ditches identified for potential receptor sites are found to contain *Anisus vorticulus*, then no potential receptor ditches will have been identified. Additionally, for the reasons described in Section 5.1, 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 Detailed Surveys Results

## 4.1 [redacted] (Area 1)

Ditches in Area 1 were surveyed using the detailed survey methodology in June and July 2017. A total of 13 sampling points were assessed in Area 1 as part of the detailed survey. Prior to surveying, there were no records of *Anisus vorticulus* 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 (627µS/S - 1229µS/S), with the highest reading from [redacted] strongly suggesting 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 on the NWT side of the marsh and more intensively managed on the RSPB side. The dykes here showed low levels of poaching and shelf/block formation along the ditch margins, which had formed infrequent swampy areas.

***Vegetation***

The main vegetation in Area 1 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* frequent within the water channels themselves, while ivy-leaved duckweed *Lemna trisulca* was present at all sample points, but not in high densities. *Hydrocharis morsus-ranae* and *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 *Anisus vorticulus* 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 decreased.

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.

**Figure 13: Location of sample points across [redacted]**

## 4.2 [redacted] (Area 2)

Ditches in Area 2 were surveyed using the detailed survey methodology in August 2017.A total of 8 sample points were surveyed across the area. The site is [redacted] is extremely well managed due to the high quality of the habitat for invertebrates it [redacted] Prior to surveying, there were no historic records of *Anisus vorticulus* 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 above 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 semi-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 *Anisus vorticulus.* 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 ([redacted], pers. obvs).

***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 ditch margins the vegetation was dominated with tall Phragmites australis and Carex species. Management in some of the ditch margins had been to cut the vegetation lower of the vegetation communities were of a lower stature, i.e. dominated with *Dryopteris cristata* communities

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 with occasional *Elodea canadensis*. Duckweeds were limited to *Lemna trisulca, Lemna minor and Spirodelia polyrhiza. Myriophyllum verticillatum* was frequent within the water channels themselves, while ivy-leaved duckweed *Lemna trisulca* 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 *Anisus vorticulus* 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 *Anisus vorticulus* habitat (AECOM/Abrehart Ecology 2016b). Additional species of interest found at [redacted] 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 Sutton Fen a good potential receptor site for a future translocation of *Anisus vorticulus.*

**Figure 14: Location of sample points across [redacted]**

# 4.3 [redacted] (Area 3)

Ditches in Area 3 were surveyed using the detailed survey methodology in August 2017. A total of six sample points were surveyed across the area. [redacted] is well managed due to the high quality of the habitat for invertebrates, [redacted]. Prior to surveying, there were no historic records of *Anisus vorticulus* 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 *Anisus vorticulus*.

***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 *Anisus vorticulus* 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 *Anisus vorticulus* 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 ramshorn *Bathyomphalus 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 *Anisus vorticulus*, though the general species richness and marginal habitat make it a possible site for translocation.

**Figure 15: Location of sample points across [redacted]**

# 4.4 [redacted] (Area 4)

Ditches in Area 1 were surveyed using the detailed survey methodology in October 2017. A total of 13 sample points were surveyed across the area. The site is [redacted]. Prior to surveying, there were no historic records of *Anisus vorticulus* in the sites surveyed, though there was a new site found to the south east in 2012 (*Abrehart, T.R. (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), whilst 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 [redacted] to the north east 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 4,000 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 *Nuphar 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 *Anisus vorticulus* 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 1,800 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 *Anisus vorticulus* 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 ramshorn *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 *Anisus vorticulus*. Despite the general species richness and marginal habitat, the very high conductivity excludes this site from being a viable option as a translocation site for Translocation 2018.

**Figure 16: Location of sample points across [redacted]**

# 4.5 [redacted] (Area 5 and 6)

Ditches in this area were surveyed using the detailed survey methodology in October 2017. The survey site at [redacted] north covered an area of land approximately 20km east of Norwich. A total of six sample points were surveyed across the area. [redacted]. Prior to surveying, there were historic records of *Anisus vorticulus* in the sites surveyed, these were confirmed in 2012 (*Abrehart, T.R. (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 generally 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 853-922µS/S. The adjacent land at all sampling points was improved marshes dominated with *Lolium perenne* with reed dominated ditch margins. All the ditches had recently been heavily cleared from one side, but the clearance had 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 *Arrhenatherium elatius* were common on the dredged material piles.

[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 latifolia* frequently recordd 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*, and two species of duckweed were found including *Lemna trisulca*. Filamentous algae was observed in some areas and often coated the vegetation.

***Molluscs***

No *Anisus vorticulus* were found at any of the sample points visited. Mollusc communities were otherwise moderately species-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 [redacted] 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 *Anisus vorticulus* 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, this indicated that they maybe saline influence within the water column, as these species are most frequently found in the base sediments higher salinity will effect these species first. The pill clam *Pisidium pseudosphaerium* was 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 ramshorn *Bathyomphalus contortus.*

The moderately diverse mollusc communities, including the presence of indicator species (shining ramshorn snail and flat valve snail), are good to see, it is of concern that *Anisus vorticulus* is currently not found on the site. The over clearance of the ditches will potentially have contributed to this status. The management of the ditches needs to be addressed. If management practices improve, increasing the habitat suitability for *Anisus vorticulus*, the site may be a good candidate as a receptor for *Anisus vorticulus* in years to come.

**Figure 17: Location of sample points across [redacted]**

**Figure 18: Location of sample points across [redacted]**

# 4.6 [redacted] (Area 7)

Ditches in this area were surveyed using the detailed survey methodology in October 2017. A total of 14 sample points were taken across the area (10 in the autumn of 2016 (AECOM/Abrehart Ecology 2016c)) of which four were taken in the autumn of 2017. The site is [redacted] Prior to the 2017surveying, there were no historic records of *Anisus vorticulus* in the sites surveyed, the nearest was the new site at [redacted] in 2012 (*Abrehart, T.R. (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 cowbane *Cicuta virosa*. Within the main channel there were large *Nuphar lutea* plants 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 purple small reed *Calamagrostis canescens*. Occasional species included marsh fern *Thelypteris palustris, Rumex hydrolaplantum,* bog myrtle *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***

*Anisus vorticulus* 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 *Anisus vorticulus* 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 ramshorn *Bathyomphalus contortus.*

The high diversity of the mollusc communities, the 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.

**Figure 19: Location of sample points across [redacted]**

# 4.7 [redacted] (Area 8)

Ditches in this area were surveyed using the detailed survey methodology in October 2017. The survey site at [redacted] covered a small parcel of land [redacted]. A total of three sample points were surveyed across the area which were taken in the autumn of 2017. [redacted], [redacted]. Prior to the 2017surveying, there were no historic records of *Anisus vorticulus* in the sites surveyed, the nearest was the new site at [redacted] found in 2016 as part of this project (AECOM/Abrehart Ecology 2016c).

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 hop sedge *Carex pseudocyperus* with more *Juncus subnodulosus*) and occasional grasses. Occasional forb species included lesser spearwort *Ranunculus flammula*, water mint *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. Water violet *Hottonia palustris* was scattered across the site with *Cicuta virosa*, whorl-leaf watermilfoil *Myriophyllum verticillatum* frequent within the water channels themselves. Blunt-leaved pondweed, *Potamogeton obtusifolius* was rare in sample site 3. Filamentous algae was observed in some areas though was rare.

***Molluscs***

*Anisus vorticulus* was found in none of the sample points visited. Mollusc communities were of moderate /low 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 and wandering pond snail *Radix balthica*.

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

**Figure 20: Location of sample points across [redacted]**

# 4.8 [redacted] (Area 9)

Ditches in this area were surveyed using the detailed survey methodology in October 2017. The survey site at [redacted] covered a large area of land [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 20167surveying, there were no historic records of *Anisus vorticulus* in the sites surveyed, the nearest site was at Muckfleet to the south in 2012 (*Abrehart, T.R. (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 713-952µS/S. The adjacent land at all sampling points was improved gazing 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 floating vegetation within the ditches with areas of vegetation lying on the water's surface, 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 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 pedunculus*.

[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*, chocking 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***

*Anisus vorticulus* 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* found 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 supported a low diversity. With the current ditch clearance regime under HLS it is considered that the site is unlikely to be able to support *Anisus vorticulus* in the long term.

**Figure 21: Location of sample points across [redacted]**

# 5 Discussion & Recommended Future Work

## 5.1 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 *Anisus vorticulus* 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 *Anisus vorticulus* s 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. All sites were scoped in with the exception of Irstead Marshes, these were too deep and too shaded.

## 5.2 Detailed surveys

These surveys of nine sites were 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 (*Abrehart, T.R. (2012) Article 17 assessment on* Anisus vorticulus *in Norfolk, March 2012.* Lot 5.) and was not located during this year's session of surveys. The fact that it was not found at [redacted] was concerning and considered due to the fact that these ditches had been heavily cleared in the past year and the remaining ditches were dry and choked with *Phragmites australis*. The clearance, in one go, of all the southern [redacted] marsh where *Anisus vorticulus* was previously present was indicative of the effects of inappropriate management regime [redacted]. It may be that some *Anisus vorticulus* have survived in one of these ditches and may repopulate in time. However, 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 its presence can indicate that the ditches are within the later succession required to support *Anisus vorticulus*. Supporting this is the fact that at [redacted] *Anisus vorticulus* was present, at [redacted] *Anisus vorticulus* used to be present. At [redacted] *Anisus vorticulus* is found 1km to the south east. This leaves [redacted] as potential receptor sites.

There were no new donor sites selected during this survey season though there were two sites which could act as potential receptor sites for the translocation if permissions were granted. These are [redacted]. [redacted] though supporting a population of Anisus vorticulus the populations were deemed too low to remove for a translocation. The donor sites at [redacted] were still very strong and robust for donor sites still.

If agreements can be set up then a translocation in September to October would be the time to set up the first round of moving the *Anisus vorticulus* as part of Translocation 2018.

# 5.3 Future work summary

- Following on from this years survey we have been able to find two sites for possible translocation in 2018. These are [redacted].

- [redacted] is the most suitable following discussions with site managers as [redacted] has ongoing issues with the site becoming more acid with nearby water abstractions. [redacted] is the more stable and more extensive site for use as a receptor site.

- In order to use [redacted] we will need to resurvey the site again in the summer of 2018 to ensure that there are still no Anisus vorticulus on the site and that the other mollusk species present still indicate that the site is suitable. Then a process of applying to [redacted] for permission from the translocation group and to allow [redacted] to be put in place before the translocation is carried out in the autumn of 2018.

- As per the translocation licence, continued monitoring of the pilot donor and receptor sites at [redacted] in May/June and October/November.

- Continued monitoring of the Translocation 2017 sites, the donor sites at [redacted] and the receptor sites at [redacted]. Here 1,500 *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 and a requirement of the licence. 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.

# 6 Acknowledgements

Thank you to [redacted] for granting access to the survey sites, and for their support and interest in the project.

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