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New Forest HLS Scheme Specialist Habitat and Species Surveys:

Survey and assessment of Six-spotted cranefly *Idiocera sexguttata*

Higher Level Stewardship Agreement

The Verderers of the New Forest AG00300016

November 2018

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New Forest HLS Scheme Specialist Habitat and Species Surveys:

Survey and Assessment of Six-spotted Cranefly *Idiocera sexguttata*

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EXECUTIVE SUMMARY

This report describes the re-survey of a historical site for the globally endangered Six-spotted Cranefly *Idiocera sexguttata* at Stony Moors in the New Forest, Hampshire, over two field seasons (2017 and 2018). We also report on the habitat conditions of the site surveyed, as per the specifications in the contract document. In addition, we surveyed the surrounding eight grid squares and report here on the presence/absence of *I. sexguttata*, their habitat condition and the presence of other species of note.

- Across the nine 100 x 100 m grid squares surveyed during four visits in July and early August 2017, no individuals of Six-spotted Cranefly were observed. However, during four visits in June 2018, 13 individuals were identified from four of the grid squares.
- These adult *Idiocera sexguttata* were all found in sweep samples, generally on the edge of woodland, near to seepage habitat.
- As a whole, the surveyed area was very rich in cranefly fauna and their allies, with 17 distinct recognisable taxonomic units identified from three families; Tipulidae (four species), Limoniidae (12 species) and Ptychopteridae (one species) in 2017 and 214 individuals across 24 recognisable taxonomic units from five families; Tipulidae (three species), Limoniidae (13 species), Cylindrotomidae (one species), Ptychopteridae (one species) and Dixidae (one species).
- The highest numbers of craneflies (including *I. sexguttata* in 2018) were associated with mire and wet woodland vegetation, with high numbers also located in stands of Phragmites.
- Abundance and diversity of other invertebrates were also very high, especially on the boggy areas dominated by *Myrica gale.* This included large numbers of multiple spider species, including four individuals of the raft spider *Dolomedes fimbriatus* in 2018. There were several species of Orthoptera, including frequent observations of the Nationally Rare Large marsh grasshopper *Stephophyma grossum* in 2017*,* and large numbers of leafhoppers.
- Several Odonata (potential predators of craneflies) were also observed: Keeled skimmer *Orthetrum coerulescens* (several individuals across both years), Golden-ringed dragonfly *Cordulegaster boltonii* (in 2017), Large Red damselfly *Pyrrhosoma nymphula* (several individuals in 2018) and Scarce Blue-tailed damselfly *Ischnura pumilio* (in 2017), which is listed as Near Threatened on the GB red list.
- There is very high diversity of vegetation types present within a small area at Stony Moors. The primary wet areas include acid bog, calcareous seepage and woodland streams, and these combine to form a highly diverse flora, including some rare algal stoneworts.
- All of the surveyed grid squares showed evidence of herbivory and we observed herbivory and trampling by both ponies and cattle during our visits in both years. Grazing keeps the vegetation open on the edges of the bog and seepage habitat, which may increase diversity and abundance of the invertebrates present, and the high diversity of craneflies present

along with continued presence of *Idiocera sexguttata* suggests grazing is not necessarily a threat to cranefly habitat compared to scrub encroachment

- Most records of *I. sexguttata* within the UK have been reported during the month of June (including at the site we surveyed), and in 2018 there were fewer individuals spotted in our second survey period than our first. During surveys undertaken in July and August 2017, no adult Six-spotted Craneflies were detected. We recommend that any further surveys begin in mid-May and run until July, to give a better overview of the phenology of this species.

Six-spotted Cranefly observed at the site in 2018. Picture credit Jack Potter, Natural England.

CONTENTS

1. INTRODUCTION

The Six-spotted Cranefly *Idiocera sexguttata* (Dale, 1842, synonyms *Gonomyia sexguttata* and *Limnobia sexguttata*), from the family Limoniidae, was listed as globally endangered by the IUCN prior to 1994, and has not been reviewed since. It is listed under Section 41 (S41) and Section 42 (S42) of the 2006 Natural Environment and Rural Communities (NERC) Act as of global concern. It is known from records in Dorset, Cornwall and Hampshire in England, as well as from Glamorgan and Caernarvonshire in Wales, and is thought to occupy seepage mires with sparse vegetation. Most records of this species within the UK have been reported during the month of June (NBN Gateway 2017). Internationally, there are also records from Denmark and from malaise traps in the Czech Republic (Starý 2007).

1.1 Aims and objectives

Following surveys undertaken by BUG in 2017, the aim of this project was to carry out a repeat habitat suitability assessment and survey of current known locations to identify Six-spotted Cranefly presence/absence during 2018. In addition, a habitat assessment of seepage mires, where historic populations occurred, was undertaken to assess suitability and potential presence/absence, with a view to facilitating an assessment of the New Forest population. The only previous record of this species in the New Forest is at Stony Moors (see Figure 2.1), where several adults were recorded on the 19th June 2000.

This report summarises survey effort and results over both years (2017 and 2018). The specific objectives and deliverables of this project are as follows:

- Description of methods.
- Description of habitat suitability, vegetation cover and structure within each survey site.
- Record of where the species is present and absent during the field survey.
- The location and extent of each identified site and/or meta -population mapped and presented in ARC GIS shapefile and pdf maps at the 1:10000 scale.
- Identify other suitable habitat nearby.
- Notes on competing species, if present.
- Estimation of the size of each meta-population.
- Assessment of the current status of the population within the New Forest.
- An analysis of historic trends by assessing potential change in distribution and population size within the New Forest. To include a comparison of New Forest sites recorded in the literature.
- A discussion of the threats and risks to the populations around the New Forest is to be provided in the write-up.

Note: This work is delivered under Call-Off Contract 8 (FEE0301/1/2) under Framework 304/NF/16/1326 Specialist Ecological Surveys.

2. METHODOLOGY

2.1 Field survey methods

The Environmental Change Network (ECN) standard approach for sampling craneflies involves sampling soil cores in spring and autumn for larvae (http://www.ecn.ac.uk/measurements/terrestrial/i/it). However, this approach is not suitable for this extremely rare species, as the one available historic record for the New Forest is for adults, and core sampling would cause some destruction to the habitat, which is not well characterised.

Some authors have used sticky traps placed over soil to catch emergent craneflies (Carroll *et al.* 2011) but this approach was, again, not suitable for this species as it is destructive. Peterson and Courtney (2010) used a combination of techniques to sample species from the same family, Limoniidae, including hand searching, malaise trapping and light trapping using moth traps. Light trapping resulted in the highest diversity and recorded over 70% of species, and the ECN have recently begun recording craneflies in moth traps. In addition, the British cranefly recording scheme recommends sweeping vegetation near damp areas (Stubbs 1992).

Our sampling protocol thus combined the use of a battery powered moth trap (Watkins and Doncaster 6W Heath trap) with observation and sweep netting of seepage habitats. We carried out a structured walk across the entire 100 m x 100 m square of the historic record as well as the surrounding 100 m x 100 m grid squares (nine grid squares in total, see Figure 2.1 and Figure 2.2), noting the location and extent of any seepage habitat using handheld GNSS receivers (Garmin 64s).

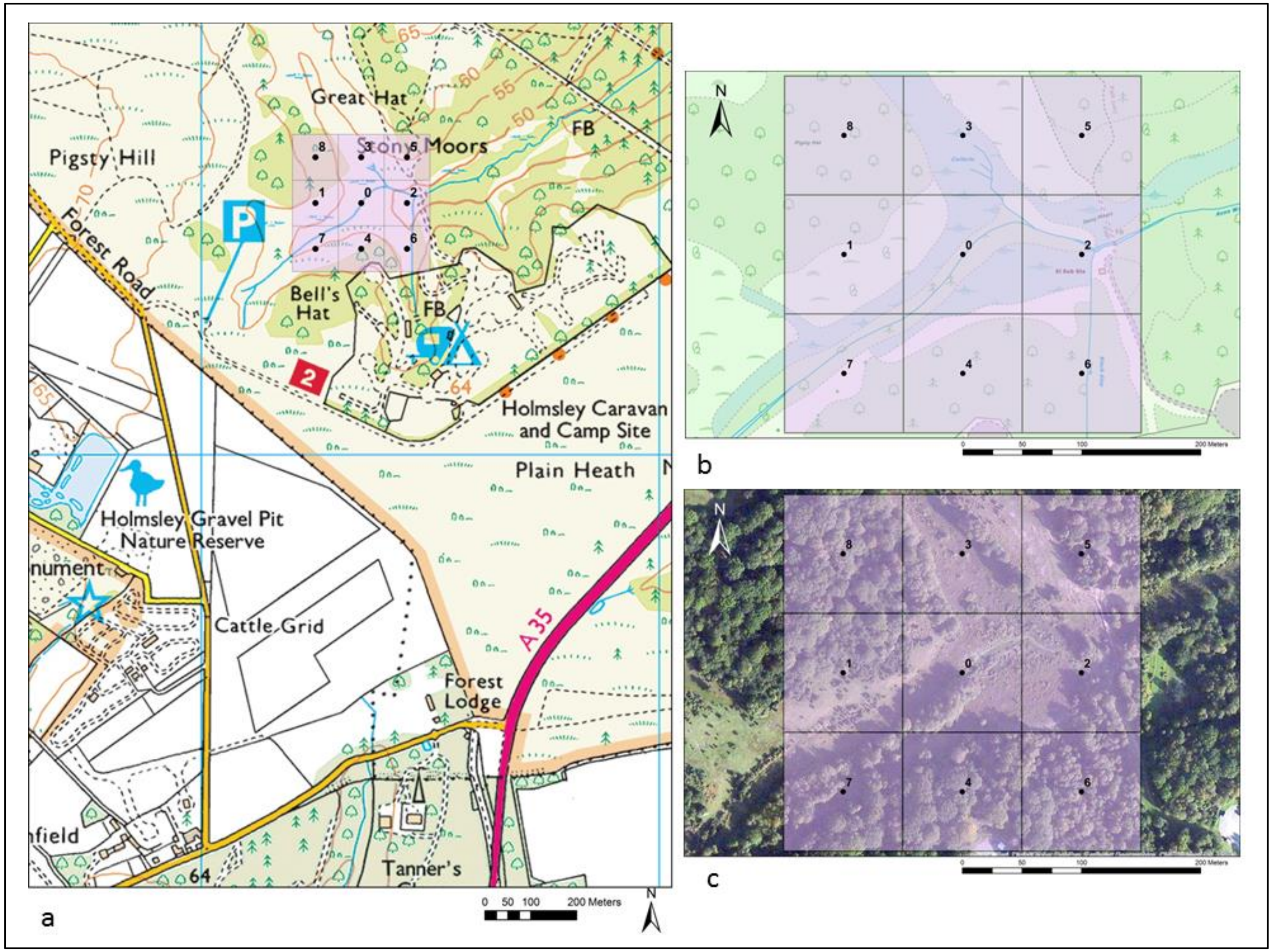

Figure 2.1. Grid locations for the sites that were surveyed for craneflies a) showing location near to Holmsley Camp Site, b) showing OS mapping at 1:1000 scale and c) over aerial imagery of the site.

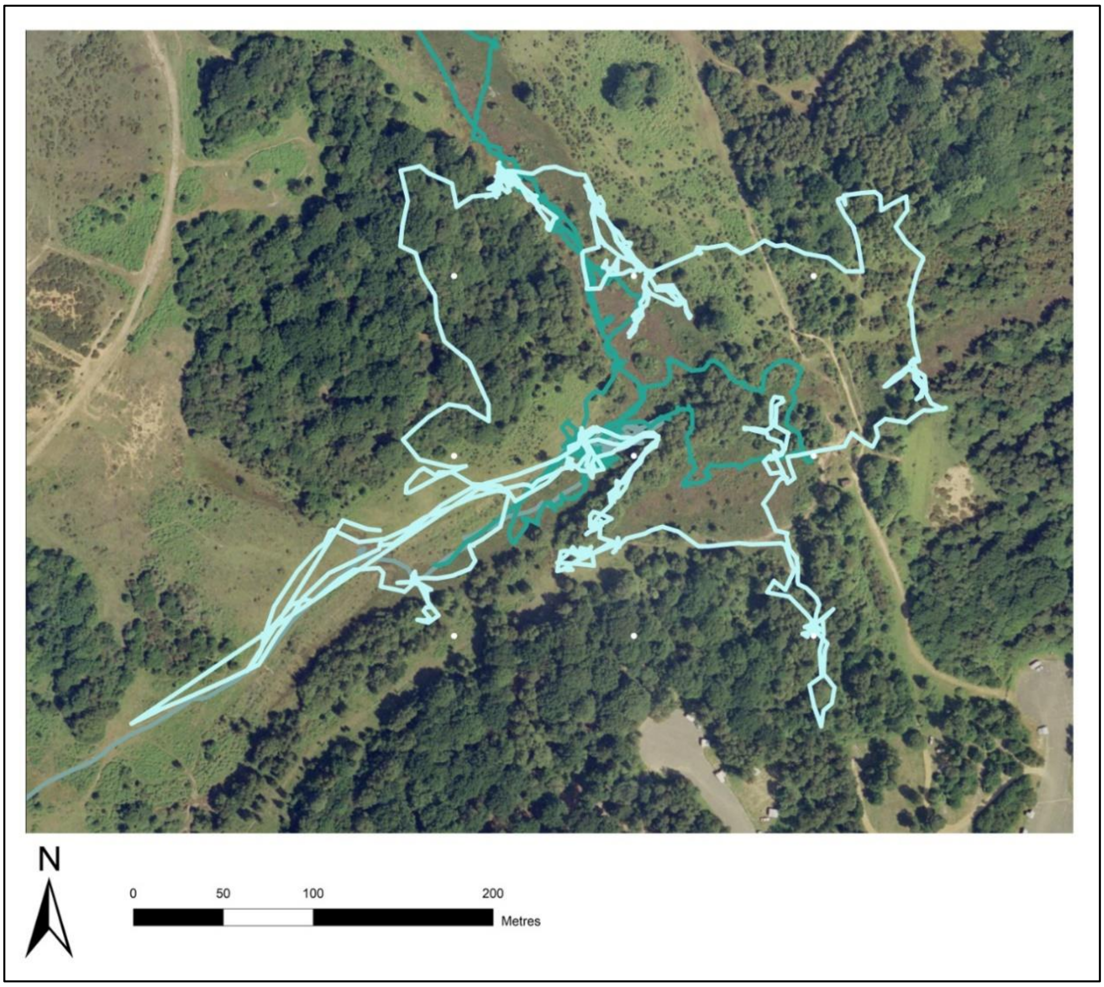

Figure 2.2. Location of sampling effort for craneflies in 2017. White points show the centre of grid. Different colour tracks show GPS tracks for the sweeping survey effort on the first (dark green; 11/10/17) and second visits (light green, 31/7/17). Surveys of the centre square on 10/7/17 and 1/8/17 are not shown.

Moth traps were left overnight next to seepage habitat within the 100 x 100m historic record grid square on the 10th and 31st July 2017 in the first field season and the 7th and 18th June 2018 in the second field season, and were emptied early the following morning. Unfortunately, a problem with the battery during the night of the 18th June 2018 meant that no invertebrates were collected in that session. The light trap uses an actinic bulb, which emits in the visible and UV spectrum; this should increase the attractiveness of the light to nocturnal invertebrates.

Sweep net sampling at identified seepage habitats took place over four sessions on the 10th, 11th and 31st July and 1st August 2017 (see Figure 2.2), when putting out and taking in the moth traps. The focal plot was sampled with 5 x 10m sweeps at each visit (20 x 10m sweeps in 2017). This was repeated on the 7th and 8th June and 18th and 19th June 2018. In 2018, 5 x 10m sweeps were carried out within each grid square surrounding the location of the focal historic record, and this was repeated twice across the field season. We directed sweeps in areas of habitat that were likely to support the presence of craneflies (i.e. wet areas), but investigated outside these areas to identify any micro-patches of habitat within forest or scrub.

2.2 Identification of six-spotted cranefly

Craneflies and their closest relatives (Tipulamorpha) are recognised by the presence of two complete anal veins in the wing and the presence of a V-shaped suture on the mesothorax (de Jong *et al.* 2008). We used these features to distinguish craneflies from diptera of similar appearance (i.e. midges and mosquitos). Captured craneflies were placed into clear plastic holding boxes and kept in the shade. They were identified to species, where possible, using a 20x hand lens and draft keys available from the crane fly recording scheme (http://www.dipteristsforum.org.uk/documents/Cranefly%20Families.pdf and http://www.dipteristsforum.org.uk/documents/Craneflies%20with%20open%20or%20no%20discal%20cell.pdf).

Photographs were taken to enable verification of records, given the rarity of this species. We used a Pentax Optio WG-II with a white background and took care to include key features (see Appendix 1). These were shared with the crane fly recording scheme (John Kramer) who verified identification of individuals recorded as Six-spotted Cranefly. Specimens were then released before departure from the site, to prevent double counting.

2.3 Vegetation survey

Different sub-categories of vegetation type were mapped while on-site, based on their outlines, using a handheld GPS to record boundaries. We classified most vegetation across the site into the following categories (shown in Figure 3.2): acid grassland, paths and path-side grassland, dry heath (principally *Calluna vulgaris* and *Agrostis* sp.), wet heath (*Calluna vulgaris, Erica tetralix* and *Trichophorum germanicum*), scrub and gorse, mire vegetation (M21 valley mire, M29 soakway, areas dominated by *Myrica gale*, *Phragmites australis*, or *Schoenus nigricans*), bracken cover (Pteridium), wet streamside woodland, salix & alder carr, and streamside vegetation and woodland. We did not investigate acid grassland, paths, dry heath, gorse scrub, bracken cover or (dry) woodland in any great detail, although these areas were searched to map vegetation and identify seepage areas.

Within each sub-category, vascular plants and bryophytes were classified according to their abundance during the 2017 field season using the DAFOR scheme (Dominant, Abundant, Frequent, Occasional and Rare; Bullock, 2006). DAFOR was chosen to reflect the relatively large area of each vegetation type in a relatively rapid manner, and the same observer was used to limit any differences in observation (Rich *et al.,* 2005; Bullock, 2006). Species were identified using Rose and O'Reilly (2006) and Atherton *et al.* (2010) where reference was required. A map was subsequently produced using ArcGIS 10.3, using a combination of GPS records and aerial photography, in order to show the different areas of vegetation and the associations with cranefly species within the habitat. At the same time, evidence of trampling and other grazing activity was recorded. The broad-scale vegetation classification was stable at the site; therefore, a repeat vegetation mapping survey was not deemed necessary during 2018.

3. RESULTS

3.1 Cranefly and invertebrate surveys

3.1.1 Records from 2017 field season

Stony Moor was very rich in Cranefly (Tipuloidea) fauna, with 17 distinct recognisable taxonomic units (Table 3.1) identified from three families; Tipulidae (4 species), Limoniidae (12 species) and *Ptychopteridae* (1 species). However, no specimens of *Idiocera sexguttata* were observed during either survey period in 2017. Whilst not all cranefly specimens could be identified to species level, *I. sexguttata* is relatively distinctive and we are confident that no craneflies we trapped belonged to this species.

Table 3.1. Taxonomic units identified during the cranefly survey in 2017. Not all species could be identified to species level; however, the following were differentiated based on identifiable features.

Species	Taxonomic Group	Trap Method	Habitat Association	Reference
Atypophthalmus inusta	Limoniidae	Light Trap	Woodland, Woody debris within streams and wet areas	Stubbs, 1992 Godfrey, 2000
Dicranomyia (Numantia) fusca	Limoniidae	Light Trap	Streams and seepages in woods	Stubbs, 1992
Dicranomyia sp. (group 2)	Limoniidae	Light Trap	Wet areas	
Limonia trivittata	Limoniidae	Sweep	Moist calcareous woods	Stubbs, 1992
Phylidorea ferrugianea	Limoniidae	Sweep	Marshes, wet woodlands	Stubbs, 1992
Phylidorea sp. 1	Limoniidae	Sweep		
Phylidorea sp. 2	Limoniidae	Sweep		
Unidentified sp. 1	Limoniidae	Sweep		
Unidentified sp. 2	Limoniidae	Sweep		
Unidentified sp. 3	Limoniidae	Sweep		
Unidentified sp. 4	Limoniidae	Sweep		
Unidentified sp. 5	Limoniidae	Sweep		
Tipula luteipennis	Tipulidae	Sweep	Valley bogs	Freeman, 1967
Tipula maxima	Tipulidae	Sweep	Marshes, bogs and wet woodlands	Stubbs, 1992 Freeman, 1967
Tipula fascipennis / Tipula sp.	Tipulidae	Sweep		
Tipula lunata	Tipulidae	Sweep	Moist soil in woodland and carr	Freeman, 1967
Ptychopteridae indeterminate	Ptychopteridae	Sweep		

Across the site, *Tipula* spp. and *Limonia trivittata,* in particular, were very frequently encountered. Most species were recorded only once, with the following exceptions: *Tipula maxima, Tipula luteipennis, Tipula fascipennis, Phylodorea ferruguinea* and *Limonia trivittata.* Table 3.2 shows the locations of cranefly captures within each 100m grid square and the number of individuals of each species.

Table 3.2. Number of individual craneflies captured within 100 m grid squares in 2017 (0 is central grid square of survey area, see Figure 2.1).

Species	Grid square									
	8	3	5	1	0	2	7	4	6	Total
Atypophthalmus inusta					1					1
Dicranomyia (Numantia) fusca					3					3
Dicranomyia sp. (group 2)					1					1
Limonia trivittata		2	1	1	4			1	1	10
Tipula luteipennis		2	1	1	2	1		1		8
Tipula maxima		2			1		1			4
Tipula fascipennis / Tipula sp.				2	2		1			5
Tipula lunata		1								1
Phylidorea ferrugianea					3		2			5
Phylidorea sp. 1					1					1
Phylidorea sp. 2			1							1
Ptychopteridae indeterminate				1						1
Unidentified sp. 1					1					1
Unidentified sp. 2					1					1
Unidentified sp. 3						1				1
Unidentified sp. 4					1					1
Unidentified sp. 5				1						1

Abundance reflected the higher diversity of *Limoniidae* craneflies, as there were fewer individuals of Tipulidae (*Tipula* spp., 18 individuals compared to 27 Limoniidae). However, individual species of Tipulidae were well represented by a high number of individuals. Craneflies were also frequently observed resting on areas of shrubby vegetation, particularly *Phragmites australis* and *Myrica gale*, most likely to take shelter during daytime rest periods. Variation in the sampling did occur over time, with *Tipula maxima* only recorded on the second sampling occasion.

Besides the Tipuloida, invertebrate abundance and diversity was very high, especially on the boggy areas dominated by *Myrica gale.* The site was rich in other diptera. Multiple spider species were captured in large numbers and were very abundant on ground vegetation. Additionally, the Nationally Rare (Sutton 2015) Large marsh grasshopper *Stephophyma grossum* was very frequently captured in sweeps and observed during the survey, and was widespread across the survey location. Several other grasshopper and cricket species were also captured. Leafhoppers were also very well represented in sweep efforts. Only one large carabid beetle was captured; however, this reflects the sweep method used, which is not a standard survey technique for this taxonomic group. Carabid beetles are often predators of cranefly larvae (Freeman, 1967).

Several dragonflies (Odonata) were encountered (and occasionally captured while sweeping) during the survey. These are potential predators of craneflies; we recorded Keeled skimmer *Orthetrum coerulescens* (several individuals), Golden-ringed dragonfly *Cordulegaster boltonii* and Scarce Blue-tailed damselfly *Ischnura pumilio.* These species are typical of acid streams, pools and wet heath and the latter is listed as Near Threatened on the GB red list for Odonata (Daguet *et al*. 2008).

3.1.2 Records from 2018 field season

A total of 214 individual craneflies from 24 recognisable taxonomic units were trapped during the 2018 field season, with 2 from moth traps and 212 from sweeping vegetation (see Table 3.3). We found 11 *Idiocera sexguttata* during the first visit (7th-8th June) and two during the second visit (18th-19th June), covering four of the nine surveyed 100 x 100 m grid squares (see Figure 3.1). Despite grid square 0 having double the sampling effort of the surrounding grid squares, in 2018 grid square 7 had both the highest richness (15 RTUs) and abundance (50 individuals recorded). Similarly, both grid square 7 and 5 had more individuals of *I. sexguttata* than grid square 0, the location of the historic record.

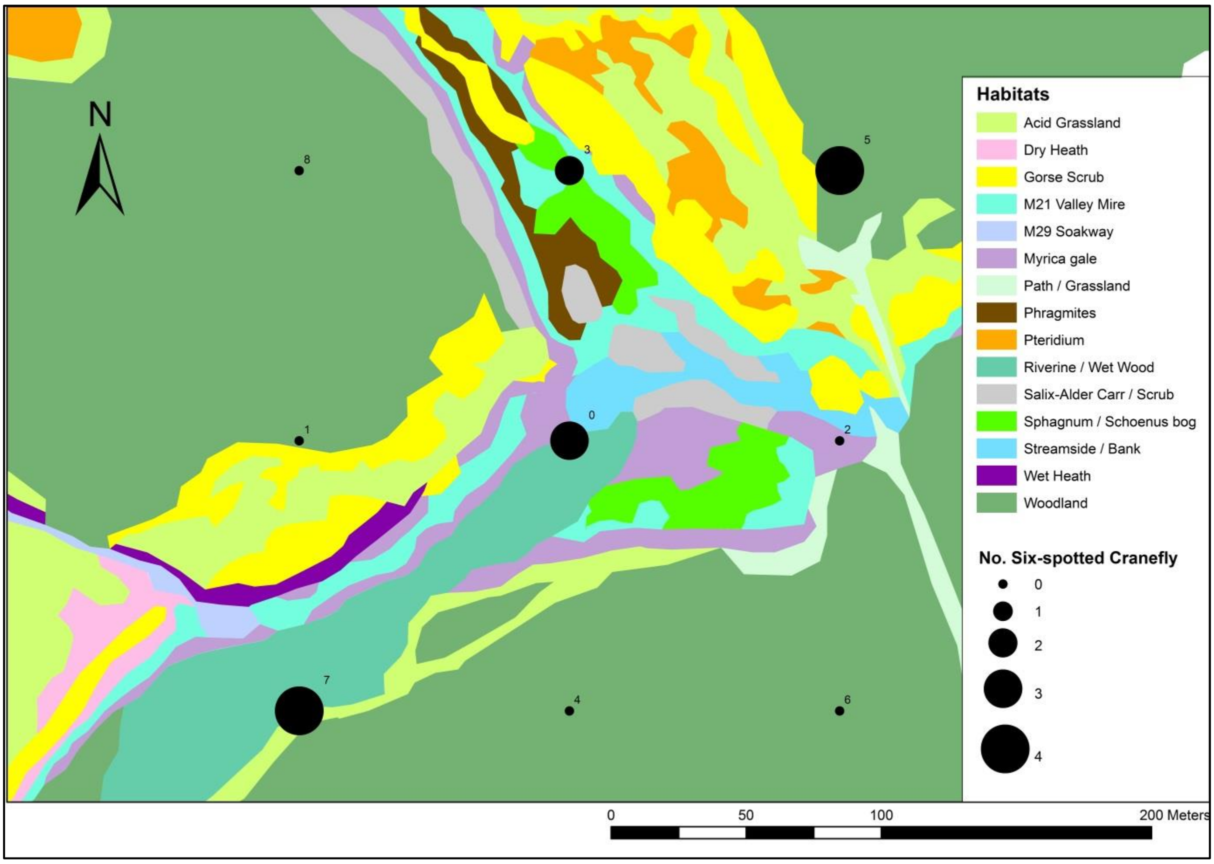

Figure 3.1. Abundance of *Idiocera sexguttata* in the nine sampled grid squares in 2018.

The site appears to have a rich invertebrate diversity in general, with one Keeled Skimmer *Orthetrum coerulescens*, one Banded Demoiselle *Calopteryx splendens,* several Variable damselflies *Coenagrion pulchellum* and numerous Large Red damselfly *Pyrrhosoma nymphula* (all Odonata, which are predators of craneflies) observed. We also saw four individuals of the raft spider *Dolomedes fimbriatus* (Nationally Scarce, Harvey *et al* 2017), a first record in the New Forest for the harvestman *Odiellus spinosus,* and 10 moth species were caught in the moth traps during the first visit. In addition, we observed common lizard *Zootoca vivipara* and common frog *Rana temporaria,* as well as one Bank Vole *Myodes glareolus* in grid square 4.

Table 3.3. Number of individual craneflies captured within 100 m grid squares in 2018 (0 is central grid square of survey area, see Figure 2.1).

Species	Grid square									
	8	3	5	1	0	2	7	4	6	Total
Idiocera sexguttata		2	4		3		4			13
Australolimnophilia ochracea							1			1
Eloeophila maculata								1		1
Erioptera flavata		5	1		17	7	2	5	2	39
Hexatoma fuscipennis							1			1
Ilisia maculata						3				3
Limonia cf. nubeculosa/flavipes							1			1
Phylidorea cf. longicornis							1			1
Phylidorea cf. squalens	10			3	2		1			16
Tipula cf. lunata		1				1				2
Tipula maxima					1					1
Cheilotrichia sp 1							1			1
Phylidorea sp 1							2			2
Cylindrotomidae indet								2	2	4
Limnophilinae indet									2	2
Limoniidae indet	4		1	1	2	2	8	17	6	41
Limoniidae sp 1					1		2	3		6
Limoniidae sp 2		4	1		7	1	2	5		20
Limoniidae sp 3		1			2					3
Limoniidae sp 4	8	9			2		3			22
Tipulidae indet					1		2			3
Dixidae indet					1					1
Ptychopteridae indet									1	1
Indet cranefly					5	2	21		1	29

3.2 Vegetation survey

The high diversity and abundance of invertebrates is likely attributable to the very high diversity of vegetation present within a small area at Stony Moors. A map of vegetation types recorded during the survey is provided in Figure 3.2. A summary of the DAFOR scheme of abundance within each grid square is provided in Appendix II. The primary wet areas include acid bog, calcareous seepage and woodland streams, and these combine to form a highly diverse flora. Around the historical record, bog vegetation forms on a gentle slope in transition from acid grassland and wet heath, with a centre carr and woodland type vegetation around and shading a central stream. As the mire slopes towards the stream, abundance of bog myrtle *Myrica gale* increases, adding structural diversity to the habitat. There are shaded banks and woody debris in the stream which may also provide habitat for *I. sexguttata* (and certainly does for other cranefly species). A separate channel flows from a valley mire to the north, and has high abundance of alder *Alnus glutinosa* and willow *Salix alba* carr in patches, and where it meets the central area it is dominated by *Phragmites australis.* Of note is the presence of all three native *Drosera* species (*D. anglica, D. intermedia* & *D. rotundifolia*), in addition to *Utricularia* sp.. This high diversity of carnivorous plants likely reflects the high abundance of invertebrates at the location.

The M29 Soakway habitat was dominated by *Hypericum elodes, Ranunculus flammul*a and *Juncus bulbosus*, with *Potomageton polygonifolius, Hydrocoytle vulgaris* and *Anagallis tenella* also present. Sphagnum was almost entirely absent from this area except on the boundaries with other bog vegetation. Patches of M21 Valley Mire community were extensive, forming the main bulk of mire vegetation, but also quite variable. In some patches of surveyed bog *Rhychosphora alba* was very abundant and in others a *Sphagnum papillosum – Narthcium ossifragum* community dominated. Towards the edges of this habitat *Myrica gale* dominated, adding significant vertical vegetation structure; although, typically not more than 50cm in height.

Carex species were also widespread on the edges of these communities, especially where *Myrica* was dominant. Where flushes were present on the bog, an influx of other species, notably *Schoenus nigricans* and *Cirsium palustre,* was observed. This often bordered areas dominated by *Phragmite*s *australis*, which was totally dominant in some areas of the side channel, grading into other habitats. This habitat was similar to the S4 Phragmites swamp and reed beds community, but with bogbean *Menyanthes trifoliata* also present. Although not officially recorded by our vegetation survey, we observed rare algae stoneworts near the uppermost centre point (SZ213996); a taxa of considerable importance to biodiversity. These were in the process of being surveyed by an unknown surveyor and were not identified to species as part of this project. The New Forest is of international importance for stonewort species (Stewart, 2004). However, at the time of publication there were no National Biodiversity Atlas records of stoneworts for this area.

Areas of carr vegetation were present near the centre of the site and were largely composed of alder *Alnus glutinosa,* with silver birch *Betula pendula* also present. Ground flora was largely dependent on the surrounding habitat. Wet and riverine woods were present alongside the stream channel at the south of the site. These transitioned from bog to wet woodland from the exterior, then to a shaded, riverine wood close to the stream. Trees were dominated by alder and birch with a sub-canopy of holly *Ilex aquifolium*. The ground flora present were sphagnums (*S. fimbriatum, S. flexuosum, S.palustre*) and graminoids (*Molinia caerulea, Juncus bulbosus*) at the bog edge, transitioning to ferns (*Blechnum spicant, Dryopteris cristata*) and woodland plants (*Hedera helix, Holcus lanatus, Oxalis acetosella*) by the stream bank, but still with some sphagnum present.

At the confluence between the bogs, streams and flows, a mixed vegetation was found. In the stream itself *Ranunculus omiophyllus*, *Potomageton natans* and *Mentha aquatica* are abundant; some *Salix alba* and *Alnus glutinosus* is also present. The north bank is very wet, featuring marsh lousewort *Pedicularis palustris*, rushes *Juncus* spp., selfheal *Prunella vulgaris*, *Lotus pendunculata*, *Triglochin palustre* and *Carex* spp. transitioning to bog communities with high cover of *Molinia caerulea* and *Myrica gale*. The south bank of the stream was drier, composed of acid grass with scrub and bramble, although this also transitions to bog.

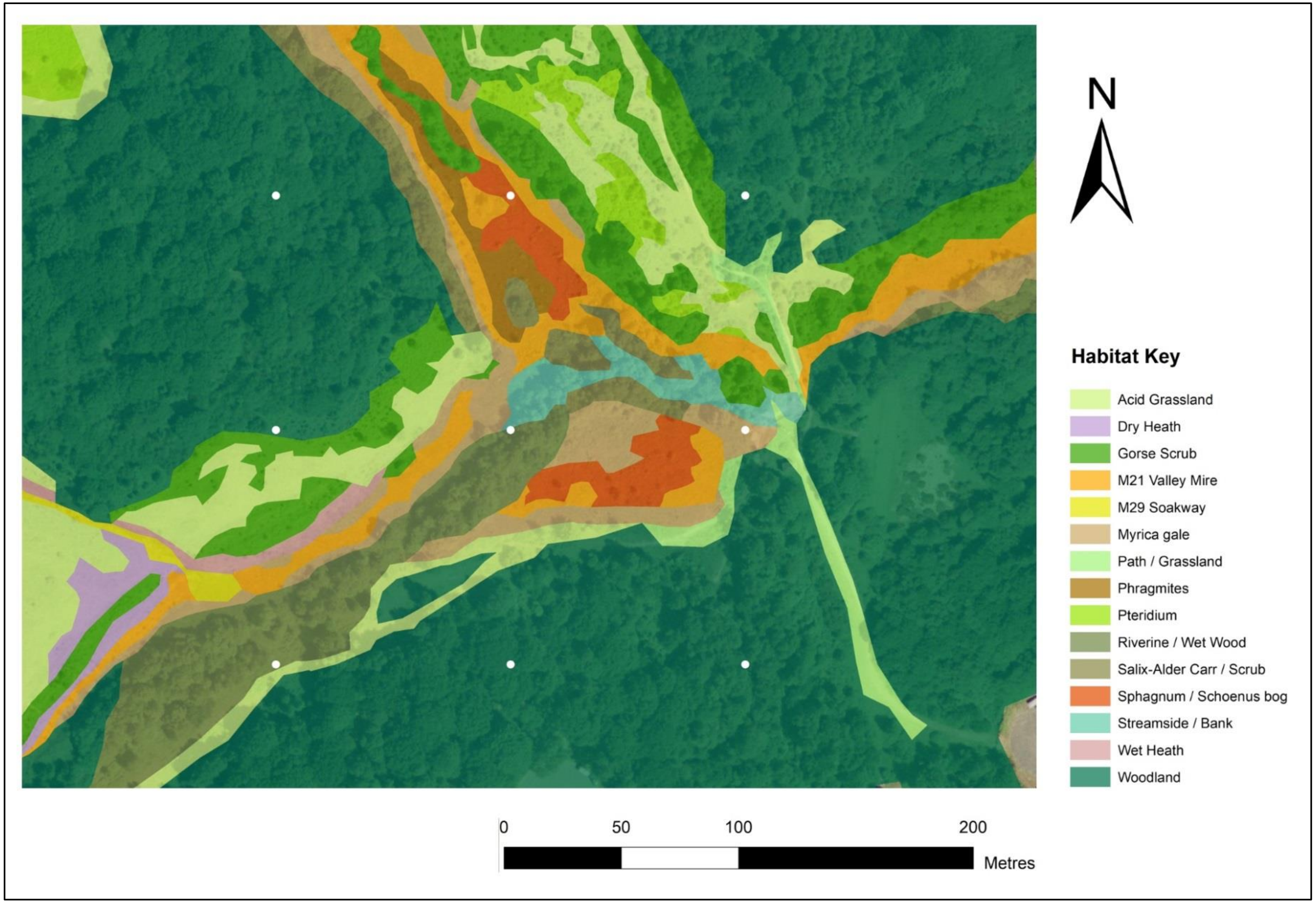

Figure 3.2. Map of vegetation recorded around the historical record and the location of seepage mire habitat.

3.3 Stream and springs

There are several areas of seepage present within the area, primarily occurring in three locations (see Figure 3.3). The patch of M29 Soakway to the west of the historic record flows south-east into the mire, where the different vegetation types mix. Sub-surface flow also appears to enter the mire communities from the gently sloping topology of this area. Two streams are present and have their sources within close proximity to the historic record; the main flowing north-east before turning east at the edge of the survey area, and the second flowing north, away from Holmsley campsite, and meets the other in the eastern part of the survey area. Water also flows into the location from the north, as a valley mire meets the stream. At this point a considerable mix in vegetation occurs, indicating the mixture of different hydrology and environmental conditions.

There are clear gradients in both acidity and nutrient concentrations in these separate seepages, as evidenced by the differences in vegetation composition. Stream flows from B and C (see Figure 3.3) both featured considerable woody debris, which increases potential habitat for craneflies, and a variety of bank types, from gentle gradients of moisture to a hard bank.

A potential impact on stream flow at point C is present, where flow exits the campsite at Holmsley. Here the stream was observed with very high turbidity, possibly owing to disturbance from the campsite, which could potentially affect habitat suitability for invertebrates in the stream. In addition, in 2018 we observed a chemical film across the valley mire from point E to A in Figure 3.3.

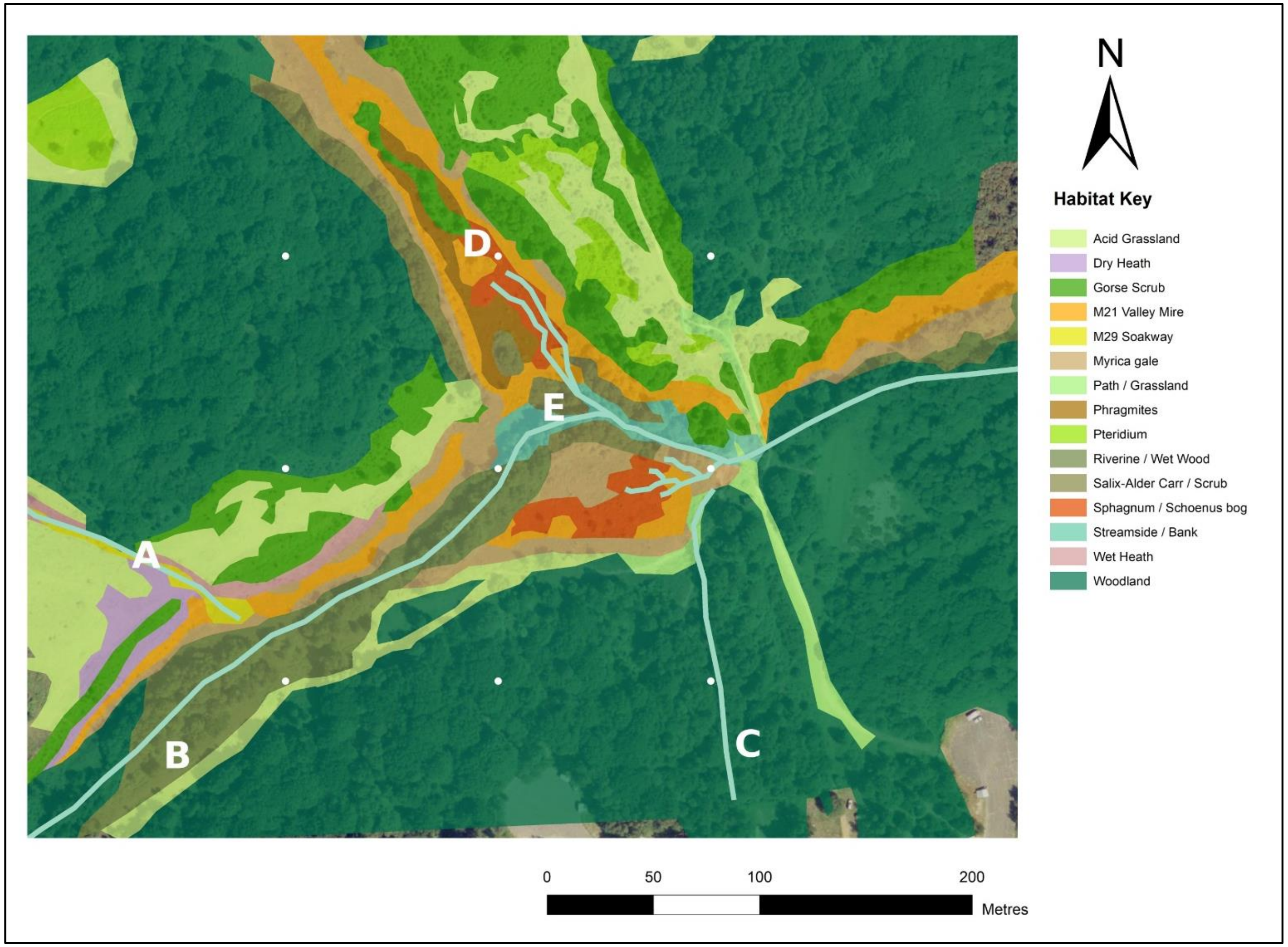

Figure 3.3. Seepage points at Stony Moors. Streams and channels indicated with blue lines, and letters indicate areas of interest. Areas of seepage primarily occur in three locations: a patch of M29 vegetation which flows into the mire channel (A), and the sources of two streams which come together to form the centre channel (B, C), the latter of which may have been modified for drainage. Water also flows into the habitat from a northern valley bog (D). At point E water from this mire valley flows into the stream, creating a very wet meadow type vegetation which is high in invertebrate and floral diversity. White dots indicate the centre point of grid cells, the centre point is the historic record of *Idiocera sexguttata.*

3.4 Trampling and grazing

All of the surveyed grid squares showed evidence of herbivory. The surrounding area is heavily grazed and trampling is particularly noticeable on bog edges and the streamside. We recorded herbivory and trampling by deer, ponies and cattle on the site (Figure 3.4 to Figure 3.6). In addition, many human footprints were visible and we observed dog walkers in 2018. Trampling was most noticeable on the edges of bog vegetation, across the entirety of soakway habitat, at the edges and crossing points of the main stream, and along the southern stream from Holmsley.

It is also likely that more central areas of bog are trampled; however, due to the rebound of substrate (particularly sphagnum) this is more difficult to identify. Trampling greatly affects the structure of the substrate in these areas, but it is difficult to quantify whether the effect is net positive or negative for craneflies. There did not seem to be any association between the number of recorded craneflies and areas of heavy trampling, and indeed high densities of craneflies were recorded in trampled areas. It, therefore, seems likely that any negative effects on craneflies, if they occur, are minimal. Indeed, we trapped more individuals from more recognisable taxonomic units in 2018 than in 2017, and trampling continued to occur between the years.

Grazing keeps the vegetation open on the edges of the bog and seepage habitat (these areas of vegetation were very noticeably subject to herbivory), which may increase diversity and abundance of the invertebrates present in this location. Aerial photographs from 2000-2011 indicate a progression of scrub cover from the surrounding woodland, despite clearance efforts. Where *Myrica gale* occurred, the height was low, suggesting a grazing influence.

Figure 3.4. Bog and shrub vegetation following one of the seepages (looking east). Woodland to the right shelters an easterly flowing stream and provides woody debris habitat. High herbivorous pressure can be seen with the low height of open vegetation.

Figure 3.5. The centre stream after it exits the wood (near point E in Error! Reference source not ound.**), featuring a high diversity of plants, *Ranunculus, Potomageton, Mentha aquatica.* To the left drains another mire channel dominated by *Phragmites* and some alder carr. Poached bare ground either side of the stream is clearly visible.**

Figure 3.6. Side channel showing bog vegetation dominated by *Phragmites australis*.

4. DISCUSSION

The historical record of *Idiocera sexgutta* occurs almost precisely at the interface between several different habitats, and all four of the grid squares where we found it in 2018 contain multiple habitats. This makes it difficult to draw direct conclusions about its precise habitat requirements within this site. In addition, we trapped adults, which only indirectly tell us about the habitat requirements of the larvae of this species.

The central 100 m grid square was where most craneflies were found overall (21 in 2017 and 42 in 2018); however, it is important to note that more effort was directed within this area. Large numbers were also found in grid cells 3, 4 and 7. This reflects the larger expanses or borders to wet vegetation in these areas. The highest numbers of craneflies were associated with mire and wet woodland vegetation; however, high numbers were also located in stands of *Phragmites.* Grid cell 4 is mostly woodland, showing that craneflies can occupy this habitat for part of their lives so long as it is close to wetter areas.

Low numbers were found in grid cells 1, 2, 5 and 6 (see Figure 4.1, and Figure 2.1 for grid cell locations). This is largely a result of the less suitable habitat (woodland or scrub) in these areas. The relatively low number in cell 2 (middle row, east) is harder to explain, as this area contains a mixture of wet habitats; however, this area could be subject to more disturbance from grazing.

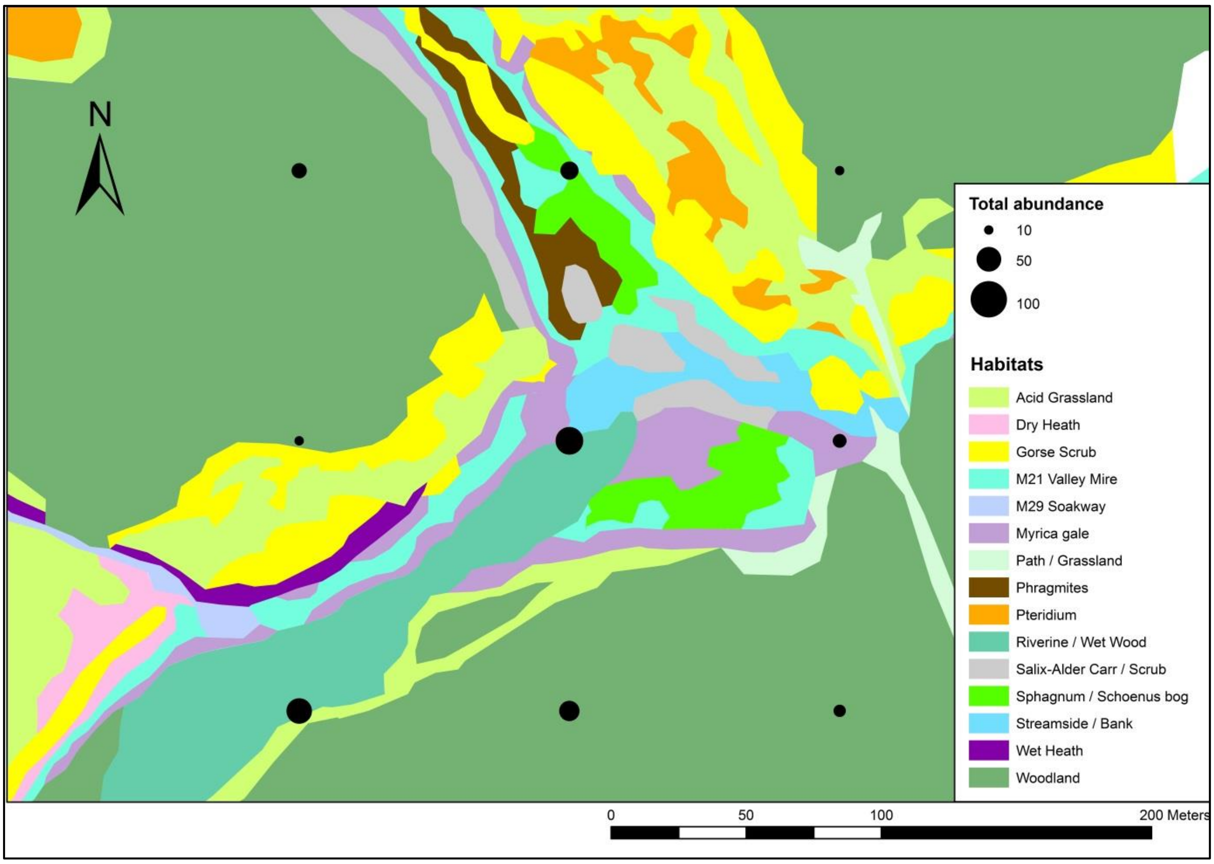

Figure 4.1. Overall abundance of craneflies across both field seasons.

Since most records of *Idiocera sexguttata* within the UK have been reported during the month of June, our initial surveys (during 2017) may have taken place too late in the year to detect adult Six-spotted craneflies; although some records have been reported in July in other parts of the UK. Following our recommendations from the January 2017 survey report, sampling for our second field season occurred in June and did successfully locate a number of individuals of *Idiocera sexguttata*. Even within the short period of our surveys, there appeared to be a large turnover within the cranefly community at the site, and there was a higher abundance of *Idiocera sexguttata* at the earlier visit. With the commonly observed phenomenon of advancing phenology in response to climate change (e.g. Thackeray *et al*. 2016), we recommend that any future surveys begin in mid-May and run until July, to give a better chance of quantifying the seasonal activity of this species.

In some of the live specimens and photographs, identification to species proved very difficult, largely down to the rapid and erratic movements of the live animals. This rendered identification to species level impossible in some cases; however, clear distinctions between taxa could be observed. Generally, identification using hand-lenses was more effective than photography. This did not, however, affect our search for *Idiocera sexguttata,* which features (along with some close relatives) distinctive wing spots. For future surveys of the cranefly community, selective destructive sampling, involving the capturing and preservation of unidentifiable specimens of low conservation importance, is recommended to verify the identity of non-target species.

Sweep netting was the most productive method for capturing craneflies. Only three species and seven individual craneflies were captured using the moth-traps. A number of moths were also captured, which were predominantly woodland species. Despite the low number of captures, the species caught with this method were not found during the sweep-netting survey; therefore the technique could still be valuable in future surveys of the cranefly community. However, direct searching with a net could also prove a useful addition to this and sweep surveys.

4.1 Habitat requirements

Because all of the grid squares with *I. sexguttata* include a close proximity of different vegetation types, it is difficult to ascertain the precise habitat requirements. However, the fact that all four grid squares where we found adults have or are near seepage habitat but with other vegetation present agrees with the hypothesis that they prefer seepage habitat with sparse vegetation. It is likely that the ecotones and boundaries of habitats in this location greatly enhance diversity of the invertebrate fauna and similar habitats with such diversity are likely to be good locations to investigate in other areas. Indeed, adult *I. sexguttata* were mostly sampled from the boundaries between wetland and woodland habitats, indicating that both may be important at least during the dispersive part of the life cycle. The substrate across the area is likely to be a good feeding area for craneflies due to the mixture of vegetation types and gradient from aquatic to terrestrial environment.

Most species of Tipuloidea are aquatic or semi-aquatic as larvae (de Jong, 2008), and adults usually occur in moist environments within the damp vegetation along the borders of lakes and streams (de Jong, 2008). They are often extremely abundant and play key roles in many ecosystems, including aquatic systems; either as consumers or as prey for a wide variety of predators, including fish, amphibians, birds, mammals, and other invertebrates (de Jong *et al.,* 2008). In peatland areas, they are a major component of the diet of breeding birds (Pearce-Higgins, 2010; Buchanan *et al.,* 2006).

Our observed tipulioidea records indicate the presence of multiple habitats being important (Figure 4.1) for the diversity of craneflies at Stony Moors; species are associated with several different microhabitats. *Tipula maxima* is often associated with alder carr (Freeman, 1967), and was found in abundance in the area. *T. luteipennis* is often found in sphagnum at the edges of carr, and has been frequently found in valley mires (Freeman, 1967), as in this study. *T. lunata* is most characteristic of moist woodland soils (Freeman, 1967). Cranefly larvae are known to predominantly consume dead or decaying plant material (Freeman, 1967); however, Limonidae, which *I. sexguttata* belongs to, are often predaceous (de Jong *et al.,* 2008).

4.2 Threats

4.2.1 Grazing impacts

Tipulidae are considered to be susceptible to high grazing pressure, because of the associated impacts from soil compaction, drying, and loss of vegetative cover (Yadamsuren *et al.,* 2015). This is because the larvae generally consume dead organic matter (usually decaying plant material), and adults have weak flight capabilities (Service 1973), nearly always remaining near natal habitats (Freeman 1968). In an extensive study, Yadamsuren *et al*. (2015) found significant negative effects on Tipuloid diversity from moderate to intensively grazed valleys in Mongolia, compared with lightly grazed areas, and it is conceivable that similar impacts are possible here.

However, evidence more locally is somewhat equivocal. Dennis *et al.* (2008) found no impact on craneflies from changes in grazing intensity (although impacts were found on other taxa). In the present study, cranefly diversity and abundance appeared to be high despite widespread presence of grazing and heavy impacts from trampling. These impacts were, however, localised, and may also play a role in preventing a change in habitat that would negatively impact habitat suitability for Tipuloids. Because of the lack of study of craneflies compared to other invertebrate groups, it may be that direct and detailed scientific investigation is required to determine whether impacts in the New Forest have a negative or positive effect on diversity or abundance of these invertebrates. Currently, it does not appear that there are any indications of negative impacts occurring, despite the potential from, for example, soil compaction.

4.2.2 Drainage

Impacts from drainage are likely to be serious, in as much as they will affect the habitat availability for craneflies. Cranefly eggs and larvae are vulnerable to desiccation (Coulsen, 1962; Freeman, 1967); therefore, any loss of soil moisture or lowering of the water table is likely to have a negative impact on populations of Tipuloidea. In upland communities, lowered water-table depth in peatland environments, results in lower abundances of craneflies; suggesting particular vulnerability (Carroll *et al.,* 2015). In a study examining drainage in these areas, upland Tipulids were strongly associated with high soil moisture and decreased in abundance in drained areas (Carroll *et al.,* 2011). Areas where the water table was restored with drain blocking were more likely to support cranefly populations in dry years, with all areas supporting populations in wetter years (Carroll *et al.,* 2011).

We observed some erosion and stream modification at Stony Moors; however, expanses of seepage habitat still remain and appear to support a high diversity and abundance of craneflies, in addition to other invertebrates. Therefore we suggest that effects of drainage at this location may be subtle;

impacts through disturbance such as trampling may be similar. Of some cause for concern, however, was the observation of a chemical sheen to the surface of standing water in 2018, and this would ideally be monitored in subsequent years to determine if this is an ongoing impact.

4.3 Recommendations for future surveys

Much remains to be investigated at this site. Given that we found individuals of *I. sexguttata* in the grid squares surrounding the historical record, there would be considerable value in investigating the full patch of seepage habitat and riverine wet wood, to discover the full spatial extent of this population. It would also be useful to begin surveys in mid-late May to discover more about the phenology of this species. In terms of habitat requirements and threats to this, it would be useful to monitor e.g. the pH, dissolved oxygen and temperature of the seepage areas. Observational studies of human and herbivore presence at the site could also help quantify whether the level of trampling is an issue for this species.

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Figure A.1. ***Tipula maxima*****.**

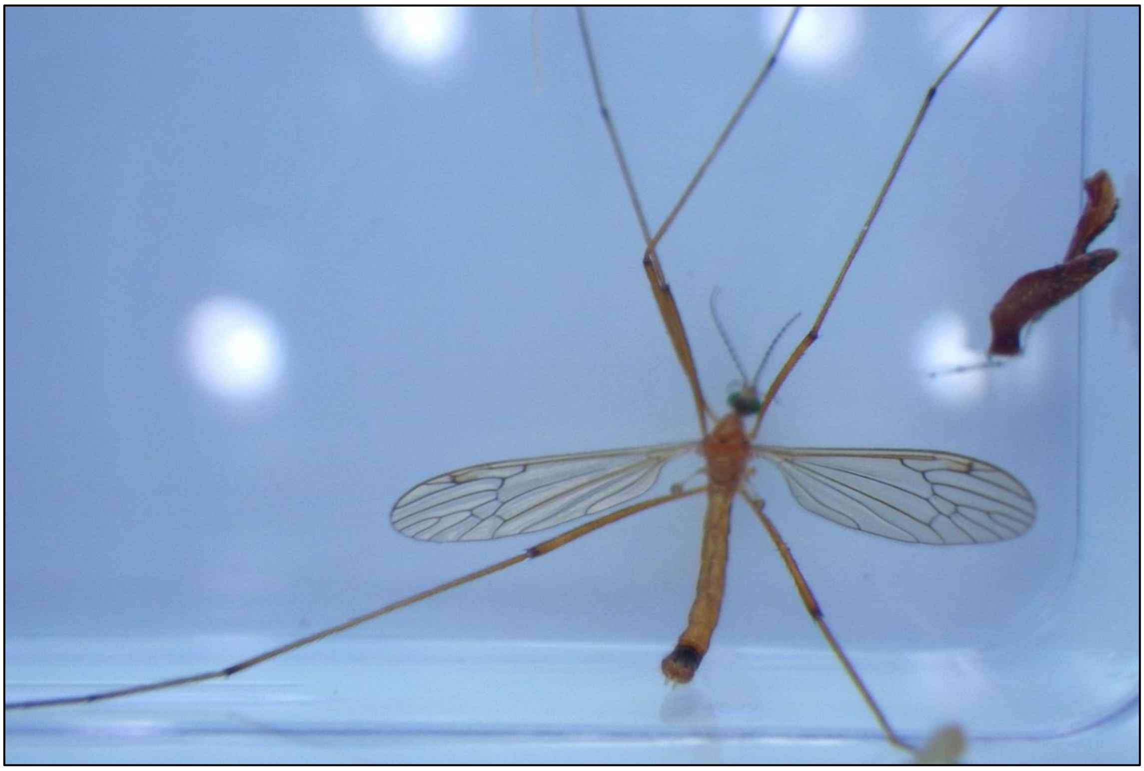

Figure A.2. ***Phylidorea ferruginea*.**

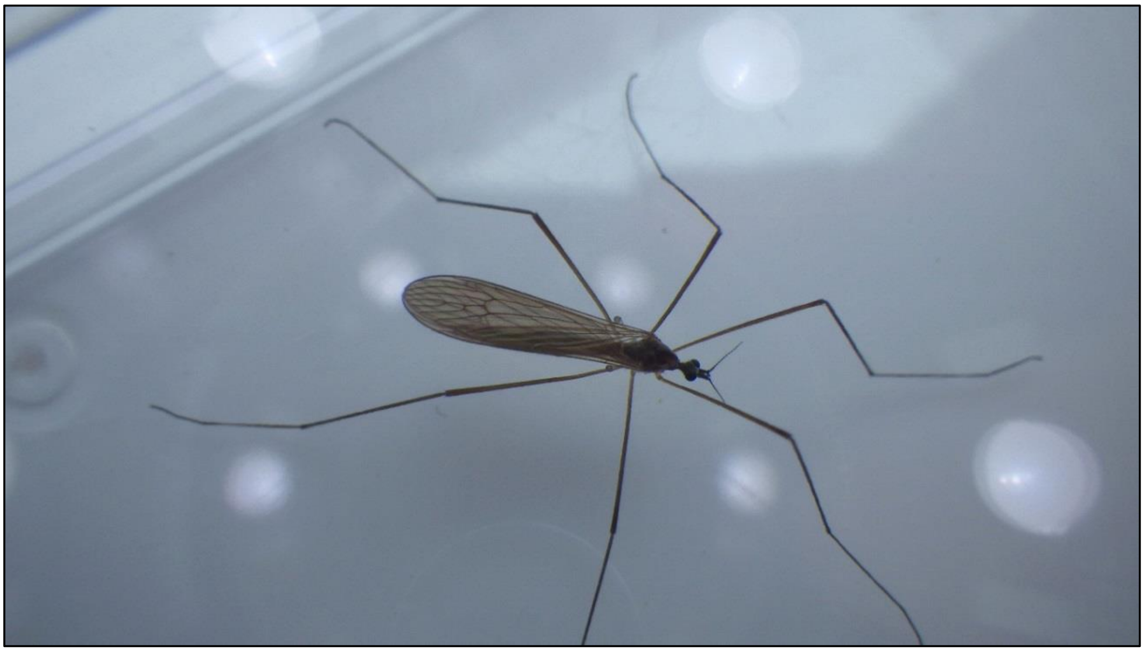

Figure A.3. ***Limonia trivittata*.**

Figure A.4. ***Tipula sp..***

Figure A.5. ***Atypophthalmus inust*** **(specimen found dead in light trap).**

Figure A.6. ***Idiocera sexguttata*** **under a light microscope. Picture sent to John Kramer for verification**

Figure A.7. Idiocera sexguttata – live specimen photographed at Stony Moors. Picture sent to John Kramer for verification

APPENDIX II – DAFOR scheme of vegetation abundance within each grid square

Species	Grid square										
	1	Wood-Stream	2	3	4	5	6	7	8	Stream	9
Agrostis stolonifera		F									
Alnus glutinosa		D	O								A
Anagallis tenella					O	O	O	O	O		A
Betula pendula		O	O			O		O	O		O
Betula pubescens		A	O								
Blechnum spicant		F									
Calluna vulgaris				F		R			O		
Carex echinata						O					
Carex lepidocarpa						O					
Carex panicea				O		R	O	O	A		
Carex remota		F									
Carex viridula							O	O			
Cirsium dissectum									O		F
Cirsium palustre										R	
Drosera anglica								F			
Drosera intermedia	R										
Drosera rotundifolia	R		A			O	O	O			
Dryopteris cristata		R									
Eleocharis quinquefolia	R		O				A		F		A
Epilobium hirsutum									F		
Equisetum palustre											O
Erica tetralix	R		F	F		F	F	F	F		O
Eriophorum angustifolium	R							O			
Galium saxatile											R
Hedera helix		O									
Holcus lanatus		O								R	
Hydrocotyle vulgaris					O						
Hypericum elodes					D						
Ilex aquifolium		A	O								
Juncus acutiflorus			F			O		A			F
Juncus articulartus							O		F		
Juncus bulbosus	F	F			A	O	O				
Juncus conglomeratus											
Lotus pedunculatus										O	
Mentha aquatica									F	A	
Menyanthes trifoliata						O			O		
Molinia caerulea	A	O	F	A		F	F	F	A		O
Myrica gale			F			D	D	A	A		A
Narthecium ossifragum	A		A			F	F				

Species	Grid square										
	1	Wood-Stream	2	3	4	5	6	7	8	Stream	9
Oxalis acetosella		F									
Pedicularis palustris								O	A		
Phragmites australis									O		D
Pinus sylvestris			O								
Plantago lanceolata									O		
Polytrichum commune		F									
Potentilla erecta	O		F			O	O	O	O		
Potomageton coloratus					O						
Potomageton natans										O	
Potomageton polygonofolius			A		F	O	O				O
Prunella vulgaris									O	O	
Pseudoscelropodium purum								A			
Quercus robur		O									
Ranunculus omiophyllus										O	
Ranunculus flammula					A						
Rhynchospora alba			D			A	A	A	F		A
Rubus fruticosus							R				
Rumex acetosella									O		
Sagina apetala									O		
Salix alba										R	R
Schoenus nigricans											F
Senecio aquaticus									R		
Sphagnum cuspidatum	O										
Sphagnum fimbriatum		F									O
Sphagnum flexuosum		F									
Sphagnum inundatum	F		A								
Sphagnum palustre	O	F							F		O
Sphagnum papillosum	O		F			F		F			R
Sphagnum subnitens						O			F		
Sphagnum denticulatum	F					O					
Taxus baccata											R
Trichophorum germanicum	A			F		O					
Trifolium repens										O	
Triglochin palustre								R	F	O	
Ulex europaeus				F							
Unknown Moss 1											O
Utricularia intermedia								O			

Key: D = Dominant, A = Abundant, F = Frequent, O = Occasional, R = Rare

APPENDIX III – GIS Shapefiles

List of shapefiles provided:

- cf_track.shp

  GPS tracks of the cranefly sampling visits, showing the routes taken across the survey location.

- habitats.shp

  Broad vegetation types across the survey location, based on ground survey and aerial photography.

- Midpoints.shp

  Centre points of 100 m grid squares around the site record.

- ninesquarespoly.shp

  100 m grid squares around the site record.