Assessment of the status of southern damselfly *Coenagrion mercuriale* in the New Forest

Higher Level Stewardship Agreement: The Verderers of the New Forest AG00300016

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Front Cover: Male southern damselfly feeding whilst perched on a rush at Shobley

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Executive Summary

This project was initiated by Forestry England and funded by The Verderers of the New Forest Higher Level Stewardship Scheme (HLS). Arcadian Ecology & Consulting Ltd were initially appointed to undertake a repeat survey (originally conducted in 2004 and repeated in 2013) of southern damselfly *Coenagrion mercuriale* populations and their habitats in the New Forest Special Area of Conservation (SAC) in Hampshire, England. The findings of these surveys would be used to assess the Favourable Conservation Status of this National Site Network (formally Natura 2000) interest feature species.

Following discussions with Forestry England and Natural England, it was agreed that amendments to the assessment process were required to maximise the value of the information provided by this study. It was agreed that there would be a change in terminology used within the assessment process, to properly reflect the status of southern damselfly at each site. It was therefore agreed that the status of the southern damselfly sites should be assessed and expressed across a graded scale.

The status of southern damselfly at 22 sites in the New Forest was assessed based on four criteria; the condition or suitability of the habitats supported at the site (at 21 of the 22 sites), the site's resilience to potential future 'localised extinction' events (all sites), and the strength and density of the southern damselfly population the site currently supports (all sites). The result of the site assessments was used to determine the current condition of the southern damselfly metapopulation across the New Forest, and the potential current and future impact / implications of threats such as management practices and climate change on the condition of these sites.

Six of the 21 sites assessed were judged to provide optimal habitat conditions for southern damselfly, with two and 13 sites providing sub-optimal and poor conditions respectively. This assessment was strongly influenced by the large number of sites that failed on the water flow habitat attribute. Furthermore, three of the 22 sites assessed were considered to have a high resilience, a further three sites were judged to have moderate resilience (as they were both large and were afforded a moderate connectivity with other sites) and seven of the remaining 16 sites were considered to be vulnerable to threats or pressures that could lead to the loss of southern damselfly from those sites.

Five sites were considered to support a large or strong population of southern damselfly, including four of the six sites judged to provide optimal habitat conditions. Four and 11 sites were considered to support medium and weak strength populations respectively. Furthermore, four, three and 13 sites supported high, moderate and low density populations respectively. Finally, no southern damselfly were recorded at two of the 22 sites.

It is considered that water availability / security, site isolation and size, and (to a lesser degree) habitat management are the key issues impacting the status of southern damselfly sites in the New Forest. The former is of particular concern, as the information collected in this study cannot determine whether the water presence / flow issues are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at individual sites that could be rectified.

Based on these findings and these concerns, the authors consider that the New Forest southern damselfly metapopulation is currently of moderate status, but at risk of deterioration without the delivery of targeted management and urgent hydrological investigations.

The authors consider that improving habitat conditions and (and to a lesser degree) site resilience are the fundamental mechanisms to achieve Good or even Excellent status for the New Forest southern damselfly sites and wider metapopulation. It is therefore recommended the following action is taken:

- hydrological assessments at all sites and the delivery of associated remedial works where appropriate;
- conduct a feasibility study to determine the most suitable areas for habitat creation / restoration between southern damselfly sites to increase connectivity; and
- the delivery of a programme of short and mid-term management tasks.

Finally, a small number of recommendations are provided for further refining the methodology for future monitoring of southern damselfly sites in the New Forest.

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APPENDICES

1. INTRODUCTION

1.1 Background

This project was initiated by Forestry England and funded by The Verderers of the New Forest Higher Level Stewardship Scheme (HLS). The project objective was to undertake a repeat survey (originally conducted in 2004 and repeated in 2013) of southern damselfly *Coenagrion mercuriale* populations and their habitats in the New Forest Special Area of Conservation (SAC) in Hampshire, England. The findings of these surveys would be used to assess the Favourable Conservation Status of this National Site Network (formally Natura 2000) interest feature species.

The inclusion of the southern damselfly on Annex II of the EU Habitats and Species Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora), and transposed into UK law through The Conservation of Habitats and Species Regulations 2017, requires Natural England to identify SACs for the species and to ensure that Favourable Conservation Status applies. On individual sites, Favourable Conservation Status is a combination of the species feature being regarded as in Favourable condition while ensuring that the mechanisms that sustain the population are reliably secured for the foreseeable future. Favourable condition is defined by a series of Conservation Objectives assessed by monitoring attributes against agreed thresholds. It is intended that the assessment of Favourable Conservation Status for the National Site Network features is repeated every six years to allow on-going monitoring of the SAC.

It was the intention of this project to assess the Favourable Conservation Status of all 22 sites previously considered within the 2013 study (Rushbrook *et al*., 2014). The methodology adopted that of the previous two studies, incorporating two revisions recommended in the latter (Harvey *et al*., 2005; Rushbrook *et al*., 2014).

1.2 Revised Project Remit

A draft report (Rushbrook *et al*., 2020) was prepared following the template and assessment criteria employed in the two earlier Favourable condition assessments for the southern damselfly (Harvey *et al*., 2005; Rushbrook *et al*., 2014). On review of that document with Forestry England and Natural England, it was agreed that amendments to the assessment process were required to maximise the value of the information provided by this study.

It was agreed that there would be a change in terminology used within the assessment process, to properly reflect the status of southern damselfly at each site. It was therefore agreed that sites would no longer be defined as being in Favourable or Unfavourable condition for southern damselfly, but instead the status of the southern damselfly sites should be assessed and expressed across a graded scale.

It was agreed that a reduction in the length of habitat assessed at some sites was required to accurately reflect the availability of potentially suitable habitat present. Furthermore, several amendments to the assessment process itself were required. The detail and justification for these reductions and amendments are set out in Sections 3 and 4.

1.3 Overview of Revised Assessment Process

The suitability of the habitat present at 21 of the 22 sites was determined based on a range of habitat attributes (i.e. Howen Bottom was removed from analysis) as set out in Section 3.4. A ‘pass’ value or range of values was agreed for each attribute and applied to data collected at each site. Finally, an assessment matrix has been developed and each site was categorised as providing habitat conditions that were either optimal, sub-optimal, or poor for southern damselfly based upon the combination of habitat attributes that each site passed / failed.

Secondly, the resilience to current and potential future ‘localised extinction’ pressures was assessed for each site. This represents the long-term security of the population and / or the likelihood it will survive a wide range threats or pressures – for example natural vegetation succession, the loss of a perennial water supply due to climate change, or a localised pollution event – that could lead to the loss of southern damselfly from individual sites.

This measure was determined based on the length of potentially suitable habitat surveyed at each site, and the proximity to other known southern damselfly sites. Once again, an assessment matrix has been developed and used to categorise each site as either having high, moderate or low resilience, or as being vulnerable.

Finally, southern damselfly count data was more formally integrated into the assessment process, with the results of the adult count transect surveys used to determine the presence, strength and density of southern damselfly populations at each site (but see Section 6.10).

The results of these assessments were used in combination to determine the status of southern damselfly at each site, and the current status of the southern damselfly metapopulation across the New Forest

1.4 Scope of Report

This report assesses the current status of all 22 sites for southern damselfly based on four criteria:

- the condition or suitability of the habitats supported at the site;
- the site's resilience to potential future 'localised extinction' events;
- the strength of the southern damselfly population the site supports; and
- the density of the southern damselfly population the site supports.

The results of these four assessments were used to compare the current status of the 22 sites with Favourable condition assessments conducted in 2004 and 2013. Consideration was given to the potential effect of habitat management conducted by Forestry England (and their predecessor Forestry Commission England) based on the recommendations provided following the completion of the 2013 study (Rushbrook, *et al*. 2014). Furthermore, this report provides recommendations of future habitat management measures and technical investigations that should increase the suitability of the habitats supported and / or the long-term resilience of these sites for southern damselfly.

Finally, this report assessed both the current status of the southern damselfly metapopulation across the New Forest, and the potential current and future impact / implications of threats such as management practices and climate change on the condition of these sites.

2. SPECIES INFORMATION

The southern damselfly is one of five resident members of the *Coenagrion* genus currently found in the UK. Males of this genus are predominately blue and black in colouration and, together with the common blue damselfly *Enallagma cyathigerum* and white-legged damselfly *Platycnemis pennipes*, constitute the 'blue damselflies' (Thompson *et al*., 2003a).

Male southern damselfly (Figure 1) can be distinguished from other 'blue damselflies' by the 'mercury mark' located on the second abdominal segment (Thompson *et al*., 2003a). However, there is considerable variety in the extent of this mark both within and between populations (Rouquette, 2005), and markings along abdominal segments 3-5 and the shape of the anal appendage are more reliable identification features. Furthermore, males are typically smaller and darker than other species of 'blue damselflies' found in the UK, and have a weaker flight pattern.

Detailed accounts for this species in the UK are provided by Purse (2002), Thompson *et al*. (2003a) and Rouquette (2005), and the key habitat attributes used in this assessment process are discussed in detail in Section 5. However, the central conclusions of these studies have been summarised below to provide context for the wider criteria used within the site status assessments (see Section 6), and to provide background to the discussions points and recommendations raised in Sections 7 to 9.

2.1 Distribution and Status

The southern damselfly is one of Europe's and Britain's rarest and most threatened damselflies (Thompson *et al*., 2003a; Boudot, 2020; Daguet *et al*., 2008). In addition to its inclusion on Annex II of the EU Habitats and Species Directive 1992 (as outlined above), it is listed on Schedule 5 (full protection) of the Wildlife and Countryside Act 1981 (as amended), and is the only species of damselfly to be given priority status in the UK Biodiversity Action Plan.

Figure 1: Adult male southern damselfly with second abdominal segment enlarged, showing 'mercury mark' (main picture); additional example of 'mercury mark' shown (inset).

The distribution of southern damselfly is predominantly restricted to southern and western Europe. Though still widespread in France and parts of Spain, it is considered to be *endangered* or *critically*

endangered throughout the remainder of its European range, and is considered to have become *extinct* in Luxembourg and Sicily, and possibly extinct from Liechtenstein (Rouquette, 2005; Boudot, 2020). It should be noted that populations in Italy and northern Africa are considered to be different sub-species (*C. m. castellani* and *C. m. hermeticum* respectively) to other European populations (Askew, 1988 cited in Thompson *et al*., 2003a).

The southern damselfly is at the northern edge of its global range in the UK. This is reflected in its fragmented distribution and restriction to a small number of localities in the south and west of England and Wales (Rouquette, 2005). Major strongholds (colonies) occur in the New Forest in Hampshire, the Preseli Hills in Pembrokeshire, and in the Itchen Valley in Hampshire (Thompson *et al*., 2003a; Rouquette, 2005). All these locations have been designated as SACs, with southern damselfly listed as a key interest feature. Smaller colonies exist in Devon, Dorset, and the Gower Peninsula, and single populations are present in both Anglesey and Oxfordshire (Thompson *et al*., 2003a).

Despite this, the southern damselfly has suffered an at least 30% decline in distribution in the UK since 1960, and has an increasingly fragmented and restricted distribution (Thompson *et al*., 2003a; Rouquette, 2005). It has disappeared from Cornwall and St David's Peninsula in Pembrokeshire, and has suffered a decline in Devon and Dorset (Thompson *et al*., 2003a). Furthermore, it is considered that this species has been lost from at least three sites in the New Forest since 1998 (Rushbrook *et al*., 2014), and it is considered that its long-term future in the River Itchen valley is not guaranteed without conservation action (Rouquette, 2005; Rushbrook, 2018).

This decline of southern damselfly in the UK is believed to be due to the following main factors (adapted from Rouquette, 2005):

- **Under-management** – resulting in the loss of the habitat conditions and structure required by this species (see Section 2.3);
    - Cessation of traditional grazing practices (under-grazing) is considered to be one of the main reasons for the decline of southern damselfly in the UK, allowing scrub and invading emergent vegetation to encroach and / or enclose small streams and channels.
    - On-going management is required to maintain populations associated with artificially ditched watercourses (i.e. historic water meadow ditches).
- **Over-management** – resulting in the loss of larval habitat and / or shelter and roosting sites for adults;
    - This includes the wholesale clearance or burning of bankside or emergent vegetation and over-zealous clearance of ditches and streams to remove in-channel vegetation or accumulated silt.
- **Abstraction and water-level management** – often results in a lowering of the water table and therefore increases the likelihood of sites drying up in the summer;
- **Dredging and canalisation of streams** – destroys aquatic habitat;
- **Pollution / nutrient enrichment**; and
- **Fragmentation of suitable sites** – the southern damselfly appears to be a poor disperser and has difficulty colonising new sites (see Section 2.2).

2.2 Life History

Adult southern damselfly are characterised by their slow and erratic flight, with frequent pauses to perch on low vegetation. They are considered to have the weakest flight of the British coenagrionids, which is reflected in the limited dispersal capabilities of this species (Purse, 2002; Watts *et al*., 2004; Rouquette, 2005). A mark-release-recapture study by Rouquette (2005) found that adult damselflies rarely moved greater than 500m from their original site of capture, with only 0.1% of individuals moving over 1km, and the furthest lifetime movement less than 2km. Furthermore, the availability of suitable habitat between populations is fundamentally important in determining the dispersal capabilities of this species, and therefore the genetic diversity of populations within a wider 'colony' (Watts *et al*., 2004, 2005, 2006).

Despite their weak flight pattern, southern damselfly are able to fly earlier in the day than most species (Rouquette, 2005), and males can remain active in overcast conditions (Jenkins, personal communication). However, activity of this species peaks in the middle of the day (Purse, 2002).

Adult males spend a significantly greater portion of their lifetime at breeding sites than females do, the latter believed to visit only when they have a clutch of eggs to lay (Thompson *et al*., 2003a). Males are not territorial, but will scramble to seize females when they visit a breeding site. Following copulation, the male will typically remain in contact with the female throughout oviposition (egg-laying), a behaviour known as contact guarding, which ensures the female is not inseminated by another male prior to egg-laying (Thompson *et al*., 2003a). Copulations occur throughout the day, though there is a peak around midday.

Female southern damselfly oviposit (lay their eggs) directly into the submerged stem tissue of submerged and emergent plants. Females show a marked preference for plant species with soft stems and thin cuticles, in which it is presumably easier to make an incision with the ovipositor before laying the eggs (Thompson *et al*., 2003a; Rouquette, 2005). On heathland sites such as the New Forest, species such as bog pondweed *Potamogeton polygonifolius* and marsh St John's-wort *Hypericum elodes* are particularly favoured (Purse, 2002). However, it is evident that the selection of plants for oviposition by adult southern damselfly is based on plant type (i.e. preference for broad-leaved vegetation) and habitat structure, rather than specific plant species themselves (Purse, 2002; Rouquette, 2005).

The southern damselfly exhibits a semi-voltine development (two-year life history) in the UK. The eggs will hatch between mid-June and mid-August, with larval development usually taking two years (Thompson *et al*., 2003a; Rouquette, 2005). The larvae develop through 13 instars, with the period of larval growth restricted to between March and October (inclusive) in the UK. Knowledge of larval habitat preferences is limited, but emergent vegetation and the associated detritus and fine sediment are important components for the larval stage of this species (Purse, 2002; Rouquette, 2005).

Southern damselfly adults emerge from their final larval stage (instar) between mid-May and late July, though the exact timing of emergence varies with locality (altitude and latitude) and between years (Rouquette, 2005; Jenkins, personal communication). Adult southern damselfly usually emerge in the morning, the final instar larvae ascending emergent vegetation with rigid, upright stems (Thompson *et al*., 2003a; Rouquette, 2005). There is no consistent trend in the plant species used for emergence, but it is suggested that rigid stems that do not bend in the wind are selected to minimise the risk of damage to the damselfly's wings or abdomen during expansion and drying (Thompson *et al*., 2003a). During emergence, the adult breaks through the cuticle of the final larval instar and extracts itself from the shed larval 'cast' or exuvia, pumping fluids around its body and wings to expand to its adult size.

Following emergence, immature adults (tenerals) will remain at the emergence site whilst their new exoskeleton hardens, before leaving the immediate vicinity of the water and moving to feeding sites, where males develop their mature colouration and females develop clutches of eggs. It is believed that newly emerged adults do not fly far from their emergence site (Watts *et al*., 2004; Rouquette, 2005), and that during favourable weather conditions this stage lasts between five and eight days (Thompson *et al*., 2003a).

2.3 Habitat Requirements

The southern damselfly is at the northern edge of its range in the UK, which is reflected in its south and western distribution, and in the narrow habitat types it occurs in (Purse, 2002; Rouquette, 2005).

In the UK, the southern damselfly occurs in two distinct habitat types; base-rich lowland heathland (typically) and calcareous streams and fens (Rouquette, 2005). The former is characterised by the heathland streams and valley mires found in the New Forest and Preseli Hills, and the latter most commonly by the historic meadow systems associated with the rivers Itchen and Test in Hampshire. Although these two habitat types superficially appear different, similarities in the underlying physical and chemical habitat conditions allow both to meet the ecological requirements of this species.

Southern damselfly larvae require shallow, well oxygenated, base-rich water with a constant slow-to-moderate flow and relatively high water temperatures (Purse, 2002; Thompson *et al*., 2003a). This species is therefore often associated with spring or groundwater fed systems due to the permanence of water flow and relatively stable temperature these provide to shallow water bodies.

As outlined above, southern damselfly are at the northern edge of their range in the UK, which explains their selection of sites with relatively high water temperatures. This limits southern damselfly to sites at

the early stages of vegetation succession (Purse, 2002). They therefore do not tolerate heavy shading by dense bankside vegetation or trees, due to the significant cooling effect this would have on the shallow water habitats utilised by the larvae. However, the presence of some bankside vegetation structure is important, with adults utilising low shrubs (e.g. bog myrtle *Myrica gale*) for shelter and roosting (Purse, 2002; Rouquette, 2005).

Furthermore, the increased light levels associated with areas of unshaded streams facilitate the growth of submerged and emergent plants required for oviposition, and a study by Rouquette (2005) found that, on chalkstream sites, larvae were more abundant in areas open to grazing that supported abundant emergent soft-stemmed vegetation. This requirement for an early stage of vegetation succession requires active management (e.g. grazing, burning, cutting, etc.) to maintain suitable habitat conditions, and is reflected in the susceptibility of this species to under-management of its sites (see Section 2.1).

3. METHODOLOGY

The methodology employed to collect data to inform the assessment process was broadly consistent with protocols followed during condition assessments undertaken in 2004 and 2013, incorporating recommendations outlined within Sections 7 and 8 of the corresponding reports respectively (Harvey *et al*.; 2005; Rushbrook *et al*., 2014), as appropriate.

The southern damselfly is listed on Schedule 5 of the Wildlife and Countryside Act 1981 (as amended) and all surveys were completed under Natural England Licence 2018-35529-SCI-SCI-2 by the licence holder (Dr Ben Rushbrook) or accredited agents (i.e. Tom Selby, Carmen Green and Sarah Jackson).

3.1 Terminology

The following terms as used within this report are defined and described below:

- ***site* –** a unit of land management or ownership.
- ***transect* –** the route of samples taken through the habitat, with distinct areas of suitable habitat within a site treated as separate transects:
    - for the survey this (and transect sections) was based on the monitoring sample points assessed during the two earlier studies where feasible (see Section 6 of both Harvey *et al*., 2005 and Rushbrook *et al*., 2014), however amendments were made to transect / transect section lengths as set out in Section 3.7.2).
- ***transect section* –** several transects were divided into sections according to visual changes in habitat or other landmarks, or in keeping with the classification of the monitoring sample points assessed during one or both of the two earlier studies.
- ***sample point* –** a habitat sample point taken at approximately 10m intervals along each transect / transect section.
- ***abundance* –** this represents the total number of male southern damselfly recorded per site, transect, or transect section:
    - this is in contrast to the 2013 study and original 2019 report where abundance incorrectly referred to the number of male damselflies per 100m.
- **(linear) density –** this represents the number of male damselflies per 100m;
    - this is in contrast to the 2013 study and original 2019 report where density referred to the number of damselflies per $10m^2$ of suitable habitat; that measure of density was not included in this study as it was agreed with Forestry England that the area of potentially suitable habitat would no longer be calculated (see Section 3.3.1).

3.2 Site Selection

The contract specified that all 22 sites assessed in 2013 were to be monitored. These are considered to represent all known sites with a significant extant population of southern damselfly in the New Forest. It also includes several sites known to support small numbers of southern damselfly, a small number of sites where southern damselfly have been recorded in the relatively recent past, and two sites (i.e. Dibden Bottom / Applemore and Howen Bottom) previously identified by the Forestry Commission and Natural England to have the potential to support southern damselfly.

Kingston Great Common National Nature Reserve (NNR) was a notable exclusion from this study. This site was included within the original study (Harvey *et al*., 2005), and southern damselfly were recorded at this site during surveys conducted in 2013. However, due to complications with securing access permission and uncertainties associated with the recent and future management of the site, it was not assessed as part of the repeat study (Rushbrook, *et al*., 2014). It is understood that these considerations have not yet been resolved, and as a result Kingston Great Common NNR was not included within the sites assessed as part of this study.

The 22 sites are listed in Table 1; the central grid reference and area were calculated from Geographic Information System (GIS) mapping (see below and Section 3.3). Sites for the southern damselfly in the New Forest have been known by a variety of names, and Table 1 cross-references the names used by other recent sources of information. All site names used within this report are consistent with those used in the original study by Harvey *et al*. (2005).

Table 1: Location, size and list of historic names of New Forest sites included within the 2019 assessment study.

Site name used in current and previous condition assessments	**Central grid reference**	**Site name in Strange & Bousfield (2004)**	**Site name in Boyce (2002)**	**Site name in Stevens and Thurner (1999)**	**Site name in data supplied by Professor Thompson to Harvey *et al*. (2005)**
Acres Down	SU27000857	2 - Acres Down	Acres Down	NF28 - Acres Down	Acres Down
Bagshot Moor	SZ36909998	*site not included*	Bagshot Moor	NF17 - Bagshot Moor	Bagshot
Bull Hill	SZ33799884	21 - Bull Hill; 7 - Greenmoor	Bull Hill	NF 14 - Greenmoor Stream North; NF15 - Greenmoor Stream South	Greenmoor
Clayhill Bottom	SU23170091	10 - Holmsley Station	Clayhill Bottom	NF13 - Holmsley Station	Holmsley Station
Common Moor	SU20520440	4 - Common Moor	*site not included*	NF21 - Common Moor	Common Moor
Crockford Stream (Lower)	SZ35499895	3 - The Crockford Complex	Crockford Bridge	NF02 - Lower Crockford	Lower Crockford
Crockford Stream (Upper)	SZ34579943	3 - The Crockford Complex	Crockford Bridge	NF01 - Upper Crockford West; NF** - Upper Crockford East; NF01 - Lower Crockford	Upper Crockford; Deep Moor; Two Bridges Bottom
Dibden Bottom*	SU39430710	1 - Applemore	Dibden Bottom	NF30 - Applemore Stream	*site not included*
Duckhole Bog	SU25290215	5 - Duckhole Bog	Duckhole Bog	NF26 - Duckhole Bog	Duckhole Bog
Foulford	SU18890552	6 - Foulford	*site not included*	*site not included*	Foulford
Hatchet Stream	SU35860120	9 - Hatchet	Hatchet Pond	NF19 - Hatchet Moor; NF20 - Hatchet Pond Stream	Hatchet
Howen Bottom*	SU23111506	*site not included*	*site not included*	*site not included*	*site not included*

Site name used in current and previous condition assessments	**Central grid reference**	**Site name in Strange & Bousfield (2004)**	**Site name in Boyce (2002)**	**Site name in Stevens and Thurner (1999)**	**Site name in data supplied by Professor Thompson to Harvey *et al*. (2005)**
Latchmore	SU19111289	8 - Gypsey / Gipsey Hollies; 12 - Lay Valley Gutter	Latchmore Bottom	NF06 - Gypsey Hollies; NF27 - Lay Gutter Valley	Lay Gutter Valley; Gipsey Hollies
Mill Lawn	SU23190360	13 - The Mill Lawn Complex	Mill Lawn	NF22 - Mill Lawn; NF23 - Burley Lawn, west of Rooks Bridge; NF09 - Burley Lawn east of Rooks Bridge; NF24 - Rock Hills- Creek Bottom	Mill Lawnseque; Mill Lawn; East Rook's Bridge; Creek Bottom
Millersford Bottom	SU18561643	13.5 - Millersford East and West	Millersford Bottom	NF10 - Millersford Bottom West; NF11 - Millersford Bottom East	Millersford Bottom West; Millersford Bottom East
Round Hill	SU32970192	14 - Roundhill Stream and Mire	Round Hill	NF33 - Round Hill	Roundhill
Shipton Bottom	SZ36159931	3 - The Crockford Complex	Shipton Bottom	NF03 - Upper Peaked Hill; NF04 - Lower Peaked Hill	Shipton Bottom; Peaked Hill West; Peaked Hill East
Shobley	SU18440610	16 - Shobley	*site not included*	*site not included*	Shobley
Stag Brake	SU24620306	17 - Stag Brake Bog	Stag Brake	NF25 - Stag Brake Bog	Stag Brake Bog
Stony Moors	SZ21319969	18 - Stony Moors	Stony Moors	NF12 - Stony Moors	Stony Moors
Three Beech Bottom	SU29350022	19 - Three Beeches Bottom; 15 - Setley Plain	Three Beeches Bottom	NF08 - Three Beeches Bottom; NF05 - Setley Plain	Three Beeches Bottom; Setley Plain
Widden Bottom	SZ28949930	20 - Widden Bottom	Widden Bottom	NF07 - Widden Bottom	Widden Bottom

* site not included in Harvey *et al*. (2005)

3.3 Site / Habitat Mapping

Hampshire & Isle of Wight Wildlife Trust possessed copies of the location and sites maps, and the transect route and site boundaries as a GIS layer, from the assessments undertaken in 2004 and 2013 (Harvey *et al*., 2005; Rushbrook *et al*., 2014). Arcadian Ecology is a wholly owned subsidiary of Hampshire & Isle of Wight Wildlife Trust and, with the permission of the HLS partners, was therefore able to utilise these resources for the present study. Fieldworkers were therefore provided with site maps and aerial photographs for all sites, the latter overlain with the 2013 transect routes.

Furthermore, the location of all 22 sites was included on a separate GIS layer, and the location of the two nearest sites known to support southern damselfly was plotted for each.

3.3.1 Revisions to habitat mapping for revised report

Site boundaries, considered to show the extent of potentially suitable habitat available to southern damselfly at each site, were also annotated on all the aerial photographs provided to fieldworkers. Where appropriate, site boundaries were re-drawn during the 2019 habitat attribute surveys to define the areas of potential habitat available for southern damselfly at the time of habitat assessment, and included in the draft Favourable Condition Assessment report provided to Forestry England and Natural England (Rushbrook *et al*., 2020).

However, these were subsequently removed from this revised report and associated outputs (see Section 3.8). It is understood that the New Forest experienced high summer rainfall during 2004, when the original Favourable Condition Assessment surveys were conducted, and the authors consider it likely that the area of suitable habitat available at a several sites was over-estimated as a result (see Section 4.2.1). Furthermore, statistical analysis (conducted in the original 2019 assessment) (Rushbrook *et al*., 2020) found no significant difference in the area of potentially suitable habitat for southern damselfly when comparing 2013 and 2019 data (Paired t-test: t-value = -0.68, n = 22, p = 0.503), but a highly significant reduction in the area of potentially suitable habitat recorded when comparing these with 2004 survey data (Paired t-test: [2013] t-value = -7.40, n = 20, p < 0.001; [2019] t-value = -7.31, n = 20, p < 0.001).

It is considered highly likely that the difference in water availability observed between the 2004 and the 2013 / 2019 survey programmes is likely to be exacerbated by climate change, with the latter two years providing a more accurate reflection of current and future water availability and flow patterns at these sites. Furthermore, these assessments are highly subjective, and therefore the exact areas drawn on each occasion is likely to vary between surveyors, and even potentially between different visits by the same surveyor within a single year.

It was therefore agreed with Forestry England that the area of potentially suitable habitat would no longer be calculated due to its high variability.

3.4 Sampling of Habitat Attributes

The project brief stated that habitat attribute surveys should be conducted between the 1st July and 31st August. This survey period extends later than either of the earlier assessments (Harvey *et al*., 2005; Rushbrook *et al*., 2014) due to the later onset of this study. Furthermore, the project brief stated that all adult count surveys should be completed between mid-June and mid-July, as this represents the main flight period for southern damselfly in Hampshire (see Section 3.5). Where possible habitat attribute surveys were conducted in July (Table 2), as this represents the optimal period for this assessment and would be consistent with earlier studies (Harvey *et al*., 2005; Rushbrook *et* al., 2014). However, priority was given to completing all adult count surveys by mid-July, as it was considered that a delay in conducting these would have a relatively greater impact on the robustness of the results (compared with delaying habitat attribute surveys).

The southern damselfly is known to utilise two broad habitat types within the New Forest: linear (i.e. where there is a discernible stream or main flow) and non-linear habitats (i.e. mires and areas where no main flow is discernible). The transect routes for sampling linear habitats followed the flow of water, choosing what seemed to be the main flow where there was a choice. Conversely, the transect routes selected for non-linear habitats were chosen to zig-zag across the area of suitable habitat, selecting areas of flowing water where feasible.

Table 2: Habitat samples surveyed and analysed at each site.

Site name	No. sample points surveyed	No. sample points analysed	Date(s)	Recorder/s
Acres Down	31	31	10 July 2019	Tom Selby
			24 July 2019	Tom Selby
Bagshot Moor	36	24	16 July 2019	Carmen Green
			25 July 2019	Carmen Green
Bull Hill	42	25	01 August 2019	Tom Selby
Clayhill Bottom	18	18	11 July 2019	Tom Selby
			22 July 2019	Tom Selby
Common Moor	5	5	22 July 2019	Tom Selby
Crockford Stream (Lower)	70	70	05 August 2019	Tom Selby
			12 August 2019	Tom Selby
Crockford Stream (Upper)	187	156	08 July 2019	Tom Selby
			19 August 2019	Tom Selby
			20 August 2019	Tom Selby
			26 August 2019	Tom Selby
Dibden Bottom	18	18	25 July 2019	Tom Selby
Duckhole Bog	13	13	22 July 2019	Tom Selby
Foulford	26	26	15 July 2019	Tom Selby
			23 July 2019	Tom Selby
Hatchet Stream	59	54	31 July 2019	Tom Selby
Howen Bottom	19	0	16 July 2019	Tom Selby
Latchmore	104	104	22 August 2019	Ben Rushbrook
Mill Lawn	381	301	08 July 2019	Sarah Jackson
			10 July 2019	Sarah Jackson
			21 August 2019	Tom Selby
			22 August 2019	Tom Selby
			23 August 2019	Tom Selby
			25 August 2019	Tom Selby
Millersford Bottom	84	78	12 July 2019	Tom Selby
			24 August 2019	Tom Selby
Round Hill	84	79	15 July 2019	Ben Rushbrook
			12 August 2019	Ben Rushbrook
Shipton Bottom	166	166	13 August 2019	Tom Selby
			15 August 2019	Tom Selby
			18 August 2019	Tom Selby
Shobley	50	50	29 July 2019	Tom Selby
			06 August 2019	Tom Selby
Stag Brake	17	17	10 July 2019	Carmen Green
			25 July 2019	Carmen Green
Stony Moors	39	29	08 July 2019	Carmen Green
			25 July 2019	Carmen Green
Three Beech Bottom	67	46	09 July 2019	Carmen Green
			10 July 2019	Carmen Green
			16 July 2019	Carmen Green
Widden Bottom	34	34	25 July 2019	Carmen Green

For those transects where there was transition from linear into non-linear habitats the surveyor first followed the main flow as far as possible, treating it as a linear habitat, then added a zig-zag route to sample any remaining habitat away from the main linear flow.

The annotated aerial photographs allowed fieldworkers to replicate the 2013 transect routes / sections at the majority of the 22 sites. However, this was not always feasible for every transect section (see Section 5.1.1), with replicating the routes more difficult in mire habitats due to the absence of a defined channel or area of main flow to orientate against, or as result of differences in the hydrological conditions encountered between the three studies (see Section 3.3.1).

Where considered appropriate, areas of unsuitable habitat were retained within the 2019 transect routes surveyed, and included within the Favourable Condition Assessments set out in the draft report provided to Forestry England and Natural England (Rushbrook *et al*., 2020).

It was considered that this would allow for a more direct comparison with the two previous studies and also allow for an assessment of how a site has responded should future management actions be implemented to improve these areas of unsuitable habitat for southern damselfly. However, some sample points were subsequently removed from data analysis (as set out in Section 3.7.2).

The location of the start, end, and each of the sample points within each transect / transect section was determined using handheld Global Positioning System (GPS) devices (with an inherent error of between 3m and 7m). These locations were both manually recorded on field survey forms and stored on the handheld GPS devices, except for transect sections 1.5–1.8 at Mill Lawn where technical difficulties storing to the GPS devices arose.

Measurements of habitat attributes were recorded from a series of sample points taken at approximately 10m intervals (distance estimated by pacing) along each transect route / section. The numbering of sampling points was restarted for each individual transect section; this is consistent with the most recent study (Rushbrook *et al*., 2014), but in contrast to the original (Harvey *et al*., 2005).

The suite of habitat attributes were assessed along a 2m length of linear habitat, incorporating 1m upstream and downstream of the central sample point. In contrast, a circle 1m in radius was assessed at each sample point for non-linear habitats. This methodology was consistent with both the original and repeat study (Harvey *et al*., 2005; Rushbrook *et al.*, 2014).

The habitat attributes recorded at each sample point were (see Appendix 1 for field survey form):

- habitat type* (linear or mire);
- water flow* (dry; damp but with no open water; open water with no discernible flow; or open flowing water);
- percentage cover of emergent broad-leaved herbs (including bog pondweed *Potamogeton polygonifolius*, lesser spearwort *Ranunculus flammula*, and marsh St-John's-wort *Hypericum elodes*);
- percentage cover of submerged broad-leaved herbs^;
- percentage cover of open water^ (i.e. water surface visible)
- percentage of channel (or of sample area in non-linear habitat) in shade from overhanging bankside shrubs and trees (shrubs to include bog myrtle *Myrica gale* where this is shading the channel);
- percentage cover of bog myrtle in watercourse;
- presence / absence of bracken *Pteridium aquilinum*;
- evidence of eutrophication* (based on the presence of green filamentous, but not brown flocculent, algae);
- bankside vegetation structure within 5m radius of sample point*,† (uniformly low sward height, no shelter; uniformly high sward height, too shady; mixed sward height but too shady; or mixed sward height with good structure, sheltered but not too shady: Figure 2);
- the abundance of stiff emergent vegetation* (none; scarce; frequent; choking channel);

- percentage of channel substrate composed of each of: boulders; pebbles; gravel; sand; silt / mud / peat*,‡ (record % coverage of all types including zero values; final value should equal 100%).

* added / modified as recommended by Harvey *et al*. (2005)

^ added / modified as recommended by Rushbrook *et al*. (2014).

† single measurement for non-linear habitats; separate measurements for left and right banks for linear habitats.

‡ following size ranges were used to categorise substrate type: *boulders* (and cobbles) – equal or larger than fist size; *pebbles* – smaller than fist size but larger than thumb nail; *gravel* – smaller than thumbnail but with individual particles visually discernible; *sand* – individual particles not easily visually discernible but grains felt when rubbed between fingers); *silt / mud / peat* – substrate feels smooth when rubbed between fingers.

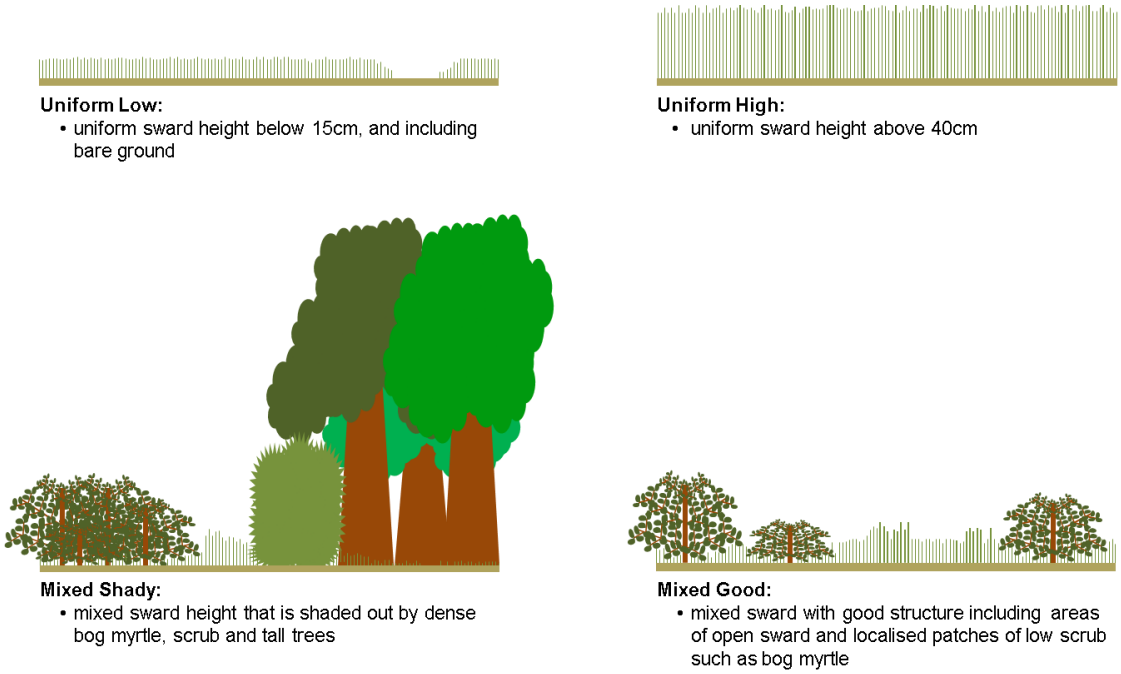


Figure 2: Diagrammatic illustration of the four categories of bankside vegetation structure.

Percentage cover was recorded at 5% interval levels in most cases, except where habitat attributes were present in very small amounts. Here a 2% level of cover was recorded following the analysis protocol used in both previous studies.

The presence and abundance of adult male southern damselfly was also recorded for each transect section during the habitat assessment. This was consistent with the methodology employed in 2013, incorporated on the recommendations of Harvey *et al*. (2005) following difficulties in assessing the size of southern damselfly populations experienced in 2004.

The field recording sheet (Appendix 1) also included a specific section for notes on the following (to potentially inform future management recommendations):

- presence / absence of evidence for recent grazing pressure at the site and its intensity (e.g. light, extensive, heavy, poaching);
- hydrology of the site;
- vegetation structure across the wider site and any evidence of succession (annotating aerial maps and / or survey forms with 'target notes' to identify locations where specific management is required, providing a grid reference or relative position to a specific sample point or points);
- the vegetation structure of the adjoining habitat and the opportunity for southern damselfly expansion from the site;
- any other additional notes or observations.

More details defining some of the habitat attributes is provided in section 4.1.1 below.

3.5 Counts of Adult Male Southern Damselfly

Transect routes for recording damselflies were, as far as possible, the same as original transect routes for habitat sampling (but see Section 3.7.2). Figures given for transect length are calculated from the GIS mapping.

Both habitat attribute and damselfly sampling were carried out by the same lead surveyor (except 13 of the 18 transects at Mill Lawn), though usually on different dates. Damselfly sampling was prioritised in order to meet the recommended survey window and suitable weather conditions (as set out below) where possible. This prioritisation was not always feasible during the original surveys performed in 2004, with the majority of adult count surveys completed during unsuitable weather conditions and / or after the peak flight period for southern damselfly (Harvey *et al*., 2005).

Flight periods for southern damselfly in Hampshire are discussed in detail by Taverner *et al*. (2004). Adult southern damselfly have been recorded in the county from early May to late September, but the main flight period is from week 24 to week 30 (from 10th June to 28th July in 2019), with a peak in week 26 (from 24th to 30th June in 2019). It was intended that all adult transect counts were undertaken within the main flight period (Taverner *et al*., 2004), and completed by the 18th July as outlined within Harvey *et al*. (2005). Within the main flight period, it was intended that transects were walked between 11am and 3pm British Summer Time (BST), with shade temperatures at least 17°C, at least 50% sunshine, and with wind speed not exceeding force 4 on the Beaufort scale.

The entire length of all transect sections were walked, with start and end points directly corresponding to those selected during habitat surveys. All male southern damselflies within an approximate 2m width across the waterway were recorded for linear habitats, and in an area approximately 1m either side of the route walked for non-linear (Harvey *et al*., 2005; Rushbrook *et al*., 2014).

Other variables recorded for each transect section were (see Appendix 2 for survey form):

- start and finish times;
- shade temperature;
- wind direction and speed (Beaufort Scale);
- % of sunshine;
- additional notes (e.g. changes in weather conditions during surveys, evidence of changes in habitat conditions since habitat attribute surveys, etc.).

3.6 Photography

Photographs were taken at the discretion of the field surveyors during the habitat assessments in order to indicate site condition. The location of each photograph was recorded using a handheld GPS device and noted on the habitat assessment recording sheet (Appendix 1). Wherever possible these locations directly correspond with one of the habitat sampling points.

For linear habitats, a photograph was typically taken both upstream and downstream of the point selected. This method was often employed at the start and end of habitat sections, to show where habitat conditions became unsuitable (e.g. showing tree cover at the end of a habitat section, in order to compare with any changes in such cover in the future).

For non-linear habitats photographs were taken at the start, end and central location where possible. Where considered appropriate, additional photographs (including from the edge of the site or another vantage point) were taken to show the adjacent habitat.

Photographs were saved as digital images using the following naming convention:

> site name transect number – sample point – viewpoint – reverse date (i.e. 20190716 for 16th July 2019).
>
> Example:
>
> Bagshot Moor 1.1 – 17 – upstream – 20190716

3.7 Data Analysis

3.7.1 Statistical analysis

All statistical analyses were performed using Microsoft™ Excel (2010), Microsoft® Excel® for Office 365 and Minitab™ (version 14.0). Where appropriate, and prior to more detailed analysis, data was tested to ensure it conformed to the assumptions associated with parametric testing. All continuous variable data was tested for normal distribution using the Anderson-Darling test. Data that deviated from normal distribution was transformed to normalise variance and subsequently tested using parametric tests. Specifically, this included:

- Log_{10}+1 transforming density of male southern damselfly at the site level to normalise and account for zero values to allow for comparison of 2013 and 2019 data;
- Square root transforming abundances of male southern damselfly at the site level to normalise and allow for comparison of 2013 and 2019 data;
- Log_{10}+1 transforming abundance of male southern damselfly in 2019 to normalise and allow for comparison between formal and informal count data at the site level;
- Log_{10}+1 transforming abundances of male southern damselfly and site pass rate to normalise and allow for comparison between the two measures in 2019 at the site level; and
- Log_{10}+1 transforming abundances of male southern damselfly and percentage of sample points supporting (passing on) flowing water to normalise and allow for comparison between the two measures in 2019 at the site, transect section, and revised transect section level.

Discrete or small sets of data that could not be normalised were tested using non-parametric equivalents, with all results from non-parametric testing adjusted for ties as appropriate.

3.7.2 Transect lengths for habitat condition assessments

In the original 2019 study assessment nearly two-thirds (15 out of 22) of the sites, and over half of the transect sections (58 out of 99) failed the 'water flow' attribute (Rushbrook *et al.*, 2020). The presence of a perennial flow is critical habitat requirement for southern damselfly, and four of the five highest abundances were recorded at one of the seven sites that passed this attribute. However, southern damselfly were recorded at 80% of the remaining sites (12/15), and it is therefore evident that these sites do support some sections or areas of habitat that provide perennial flow.

The transect lengths included within the original 2019 study assessment were predominately based on those identified during the first condition assessment conducted in 2004 (but see Section 5.1.1). As previously set out in Section 3.3.1 above, it is understood that the New Forest experienced high summer rainfall in that year (Harvey *et al*., 2005). Indeed, July 2004 was notably wetter in southern England than the corresponding months in 2013 (Centre for Ecology and Hydrology, 2020). Furthermore, although it was relatively wet in Hampshire in early June, the habitat assessments conducted in 2019 (8th July to 26th August inclusive) corresponded to an extended period of dry weather between late June and early August (Southampton Weather, 2020). Therefore, although not as dry as 2013, it is understood that the weather conditions during habitat assessments in 2019 were notably drier than in 2004.

It is therefore expected that this resulted in an overestimation of the presence (i.e. the number of transect sections in mire systems) or lengths of potentially suitable habitat at several sites. For example, the associated increase in the level of surface water experienced in 2004 is likely to have resulted in the temporary expansion of areas of non-linear habitat, resulting in the identification of a small number of transects that would not support a perennial flow of water each year, as well as extending the apparent length of transect sections of certain linear and non-linear habitats at some other sites.

Furthermore, given changes in the frequency, duration and timing of rainfall patterns due to climate change, it is expected that this situation may be further exacerbated. It was therefore agreed with Forestry England that the length of all relevant transects would be shortened to reflect the probable perennial lengths of flowing water (Table 2). This was achieved by removing sample points at one or both ends of the transect sections (Table 3), specifically any point that was recorded as 'dry' or 'damp but with no open water' prior to the first sample point that surveyors encountered 'open water with no discernible flow'.

Table 3: Detail of adjustment to transect sections with description and justification for removal of samples points

Site	Transect section	Original no. data points	Revised no. data points	Points removed	Description and reason for removal
Bagshot Moor	1.1	36	24	1-12	Points removed from northern end; points 1-6 dry and 7-12 damp
Bull Hill	1.1	15	7	1-8	Points removed from northern / upstream end. Points 1-2 flowing but 3-8 dry
	1.2	9	**0**	1-9	All points dry
Crockford Stream (Upper)	1.6	35	8	9-35	Points removed from southern / downstream end; combination of dry and damp points along this length
	1.7	28	24	1-4	Points removed from northern / upstream end; all points dry
Hatchet Stream	1.1	59	54	55-59	Points removed from western / downstream end (i.e. all points downstream of pool at western end of transect); all points dry
Howen Bottom	1.1	6	**0**	1-6	Transect entirely dry.
	1.2	6	**0**	1-6	Transect entirely dry
	1.3	7	**0**	1-7	Transect entirely dry
Mill Lawn	1.1	45	37	38-45	Points removed from western end; points 38&39 damp, points 40-45 dry
	1.7	22	13	14-22	Points removed from northern / downstream end; point 14 damp, points 15-22 dry
	1.10	19	9	1-10	Points removed from northern / downstream end. All retained points NFL.
	1.11	21	**0**	1-21	Points 1-14 dry; points 15-21 damp
	2.1	13	**0**	1-13	All points dry
	3.1	21	10	1-8 & 19-21	Points removed from both ends; points 1-7 and 19 damp, points 8 and 20-21 dry
	3.3	32	28	1-4	Points removed from northern / downstream end; all points damp
	4.1	24	20	21-24	Points removed from northern / downstream end; all points damp.
Millersford Bottom	1.4	12	6	1-6	Points removed from northern / upstream end; points 1-4 dry, points 5&6 damp
Roundhill	1.1	10	5	1-5	Points removed from northern end; all points damp
Stony Moors	1.4	10	**0**	1-10	Points 1-3 dry, 4-9 damp and 10 no flow (but removed anyway as section would comprise a single data point)
Three Beech Bottom	1.2	10	**0**	1-10	All points dry.
	1.3	7	**0**	1-7	Point 4 dry, all other points damp
	1.4	9	5	6-9	Points removed from southern end; all points damp.

The length (i.e. number of sample points) of channel originally surveyed and the adjusted lengths analysed for assessments are provided in Table 2 for ease of reference, with additional information at the transect section level provided in Table 3. It should be noted that all transect sections at Howen Bottom were removed from the analysis, and a further six sections from five transects were also completely removed.

It is strongly recommended that a hydrological assessment is conducted at several sites to determine whether the water presence / flow issues are indeed permanent changes reflecting the impact of climate change, or a result of drainage or management issues at the site that could be rectified. This is discussed in detail in Sections 6, 8 and 9.

3.7.3 Adult count transect surveys

In contrast to habitat condition assessments, analysis of the adult count transect survey data was based on the original lengths surveyed. First and foremost, it would not be possible to adjust the count data as only the total number encountered along the entire length of transect sections was recorded. Furthermore, this allowed for cautionary comparison with data collected in 2013.

Survey day was calculated from the date of the first adult transect survey (i.e. survey day 1 represents the 28th June 2019). The abundance of damselflies (i.e. damselflies per 100m surveyed) recorded per day was calculated at both the site and transect section level. At the site level, where multiple sites were visited in a single day (i.e. date), the value for each individual site has been included in the analysis. Furthermore, where a site was surveyed across multiple days (e.g. Clayhill Bottom, Mill Lawn, etc.), the abundance of damselflies across all transect sections surveyed within a single day has been calculated, with each day included in the analysis as an individual value.

3.8 Data Provision

A summary of files provided to Forestry England is provided in Appendix 3.

Forestry England has been provided with GIS layers for habitat sample points (point data) and transect routes (polyline data). The transect data are mapped in the site accounts in Sections 6.1–6.22. Due to the inherent error associated with the use of handheld GPS devices (see Section 3.4), where the sample points clearly deviate from a surveyed linear feature (i.e. stream or runnel) as shown on the aerial photograph, the plotted transect route (polyline data) was amended to correspond to the linear feature surveyed.

As explained in Section 3.3.1 above, area of potentially suitable habitat has not been calculated. Therefore, in contrast to previous studies (Harvey *et al*., 2005; Rushbrook *et al*., 2014), no polygon data has been provided to Forestry England in this instance.

All raw habitat attribute and adult transect count data was transcribed from the field recording sheets into a Microsoft® Access® 2010 database. Forestry England have been provided with copies of the sample point dataset used for the analysis (see Tables 2 and 3 / Section 3.7.2) in both spreadsheet (Microsoft® Excel® for Office 365) and database format. A second Access database that includes data from all sample points assessed during field surveys has been provided to ensure Forestry England could directly compare the three data sets (i.e. 2004, 2013 and 2019) in the future should they wish.

All photographs taken during the habitat attribute surveys (including those taken of sample points subsequently removed from analysis) have also been provided.

4. INTERPRETATION OF DATA FOR ASSESSMENTS

This report assesses the status of all sites for southern damselfly based on four broad criteria;

- the condition or suitability of the habitats supported at the site;
- the site's resilience to potential future 'localised extinction' events;
- the strength of the southern damselfly population it supports (based on a single survey); and
- the density of the southern damselfly population it supports (based on a single survey).

The results of these assessments are set out for each site in Sections 6.1–6.22.

4.1 Habitat Condition Assessment

The habitat condition assessment process was developed to allow cautionary comparisons to be made with the results of the two earlier Favourable condition assessment studies (Harvey *et al*., 2005; Rushbrook *et al*., 2020). This process has three stages:

- the objective collection of quantitative and qualitative data on attributes selected to provide information on the condition of the habitat (see Section 4.1.1);
- a subjective judgement as to the range or limits the measurements must fall within for a site to be classed as having passed each individual attribute (see Section 4.1.2); and finally
- a subjective assessment of which combination of attribute passes categorise a site as providing habitat conditions that are optimal, sub-optimal or poor for this species (see Section 4.1.3).

4.1.1 Habitat attributes used

The project brief asked for several habitat attributes to be measured, based on those assessed during the original 2004 surveys, and incorporating the recommendations included within three earlier Favourable condition assessment studies (Harvey *et al*., 2005; Daguet, 2006; Rushbrook *et al*., 2014). Table 4 summarises the habitat attributes used, and the rationale for their inclusion within this habitat condition assessment process based on Thompson *et al*. (2003b) and recommendations from the earlier studies outlined above. It is emphasised that there remains a good match between most attributes recorded in the present assessment, and those identified as 'key attributes' by these authors.

Rushbrook *et al.* (2014) questioned the inclusion of submerged vegetation within the assessment of the availability of plants for oviposition. Specifically, during surveys conducted in 2013, submerged vegetation was predominantly comprised of submerged grasses and other fine-leaved vegetation, which are rarely utilised by southern damselfly for oviposition (Rouquette, 2005). Furthermore, Daguet (2006) raised concerns regarding the relevance of this attribute at New Forest sites, and Rouquette (2005) found evidence in chalkstreams that larvae avoid areas of dense submerged vegetation. Consequently, this attribute was removed from the habitat attribute analysis conducted in that study.

Rushbrook *et al*. (2014) did observe female southern damselfly ovipositing in association with submerged broad-leaved / herbaceous vegetation at a small number of sites, and considered that disregarding this attribute entirely could result in an incorrect assessment of the ovipositing opportunities at some sites or transect sections. Specifically, for transect sections where submerged broad-leaved herbs formed a substantive component of the vegetation community (either typically or in response to elevated water levels), removing this attribute from the analysis could result in a failure based on a lack of available plants for oviposition. Therefore, the relevant attribute was amended in the current study to include an assessment of the percentage cover of submerged broad-leaved vegetation to provide a greater degree of confidence / robustness in the assessment.

Percentage cover of open water was also added to the habitat attributes assessed in the current study. Odonates locate and are attracted to water by detecting polarised ultraviolet light reflecting from the water's surface (Brooks, 2004; Paulson, 2019). Furthermore, a study in the Itchen Valley suggested that the absence of this visual cue may limit southern damselfly use of sites overgrown with emergent vegetation (Rouquette, 2005). Multiple measures of vegetation cover are included within the attributes recorded, and in combination these might obscure a channel entirely, whilst individually falling below their respective upper limits. It was therefore considered that a specific measure of open water was required.

Table 4: Notes on assessed habitat attributes (those added / amended in 2019 are shown in blue).

Attribute recorded in current study	**Field recording experience**	**Assumed relevance to condition assessment**
Water flow	Flowing water was used as an attribute for determining transect section routes through suitable habitat, and in previous studies most samples did therefore support flowing water. However, this resulted in some discrepancies between transect routes surveyed during this and the original survey work undertaken in 2004. Care was taken by all surveyors when determining between "open water, no visible flow" and barely discernible "open flowing water", following concerns raised by Daguet (2006) of possible discrepancies between surveyors in making this distinction.	Year-round flow of water is an essential attribute (matches key habitat attribute 1 in Thompson *et al*. [2003b]).
% cover of open water	This attribute appeared to complement the series of measurements of vegetation cover in determining the presence of southern damselfly along specific reaches or areas of transect / transect sections where water was present. Furthermore, it also complemented water flow to a degree, as low or zero values were recorded for dry and / or damp transects / transect sections.	Ultraviolet light reflecting off water may be an important cue in attracting southern damselfly to suitable habitat (partly matches key habitat attribute 3 in Table 8.1 of Rouquette, [2005]).
% cover of emergent broad-leaved herbs	As outlined in Harvey *et al*. (2005) and Daguet (2006), where relevant values recorded included suitable plants in damp / drier areas as presence could indicate potential suitable habitat if levels rose following habitat enhancement (e.g. drainage repairs).	Clearly important as an indication of suitable oviposition sites (matches key habitat attribute 2 in Thompson *et al*. [2003b]).
% cover of submerged broad-leaved vegetation	Females were observed ovipositing in association with submerged broad-leaved / herbaceous vegetation at a small number of sites. However, as outlined in Harvey *et al*. (2005), submerged vegetation was rarely recorded in the mires, where the water table was not deep enough for submerged vegetation. Furthermore, where observed in mires and within some narrow runnels, this feature generally comprised submerged grasses and rushes, which are considered unsuitable for oviposition (Rouquette, 2005). Therefore, this attribute was modified for the current study with only the percentage cover of broad-leaved vegetation / herbs included in this attribute.	Indicates suitable oviposition microhabitat (partly matches key habitat attribute 2 in Thompson *et al*. [2003b]).
% of channel / sample area in shade	To remain consistent with previous studies (Harvey *et al*., 2005; Rushbrook *et al*., 2014), only shade from trees or scrub directly overhanging the habitat was recorded. This reflects the potential that direct sunlight may be received within parts of the channel for at least part of the day. On linear transects, scrub and bog myrtle over-hanging from the bank top was the main cause of shade; within mire habitats, raised dry tussocks supporting heather *Calluna vulgaris,* cross-leaved heath *Erica tetralix* and bog myrtle were the main cause of shade over the 'wetted area'.	Clearly important as a negative indicator, too much shade would prevent the warm conditions required by larvae, and may inhibit development of suitable microhabitat for oviposition (partly matches key habitat attributes 2, 3 & 6 in Thompson *et al.* [2003b]).

Attribute recorded in current study	**Field recording experience**	**Assumed relevance to condition assessment**
% cover of bog myrtle	Bog myrtle within the water was present at many but not all sites. It was considered that though an assessment of structural variety and patchiness may be more informative, it would be difficult to determine an appropriate way of quantifying that would be consistently applied by different surveyors. It was therefore determined that a measure of percentage cover can provide a valuable assessment of habitat structure and remained the most appropriate measure to use.	Forms an important part of habitat structure on many (but not all) sites, though it remains unclear how this should be quantified for analysis (partly matches key habitat attribute 3 in Thompson *et al*. [2003b]).
Presence of bracken	Bracken within 2m of the habitat was rarely recorded. In most cases where it was present, it reflected drying of the habitat. Where over-hanging the sample area, bracken was also included in the value for percentage cover of shade.	It is assumed that bracken is a negative indicator, both through its potential to cast shade, and since its presence may suggest that the habitat is getting drier.
Presence of eutrophication	Only green algae was included within the assessment, though it was occasionally found associated with brown, flocculent algae. It was recorded at a small number of sites, and was often locally common and easily detected. Generally associated with areas of high livestock access and / or footfall.	A negative indicator, high levels of algal cover indicate unsuitable conditions (i.e. eutrophic rather than dystrophic or mesotrophic; matches key habitat attribute 4 in Thompson *et al*. [2003b]).
Bankside vegetation structure	The categories recommended by Harvey *et al*. (2005) and Daguet (2006) generally provided a valuable qualitative assessment of the suitability of adjacent habitat for adult damselflies at most sample points. This was particularly valuable where there was a consistency in habitat structure within the area assessed. However, difficulties arose in defining bankside vegetation structure where two distinct types were recorded within the same sample point (i.e. tightly cropped grasses interspersed with localised stands of rushes / grasses or dense scrub / bracken). This was therefore modified for the 2013 study as set out in Section 3.4.	Very high (too shady) or very low (too exposed) bankside cover would be detrimental to adult damselfly (partly matches key habitat attribute 3 in Thompson *et al*. [2003b]).
Abundance of stiff emergent vegetation	The categories recommended by Harvey *et al*. (2005) and Daguet (2006) generally provided a valuable qualitative assessment of the availability of sites for damselfly emergence. Assessment was based on distribution as well as number of stems, with a moderate number of stems, highly localised within a small number of patches, recorded as scarce rather than frequent.	Indicates suitable sites for damselfly emergence (matches key habitat attribute 2 in Thompson *et al*. [2003b]).
Substrate composition: % cover of each of boulders; pebbles; gravel; sand; silt / mud / peat	Assessment was more difficult in channels covered by dense scrub and / or bog myrtle, but it remained possible to assess the relative % cover of each of the substrate categories.	Some silt / mud / peat cover is beneficial for larvae; cover of other categories is an indicator for lack of organic substrate (matches key habitat attribute 5 in Thompson *et al*., [2003b]).

In contrast to earlier studies (Harvey *et al*., 2005, Rushbrook *et al*., 2014), notes on grazing, hydrology, and wider vegetation structure (see Section 3.4; Appendix 1) were not used in the habitat condition assessment but, where relevant, were used to identify factors that may be causing sites to fail on specific habitat attributes.

4.1.2 Habitat attribute limits

The database used allows the sampled sites to be tested against proposed limits for the recorded attributes. These analyses can be re-run for a variety of different limits to establish a set of limits that best reflects the suitability of the sites for the southern damselfly.

Harvey et *al*. (2005) assessed Favourable condition status based on habitat attribute limits as set out in Table 5 of their report. Rushbrook *et al*. (2014) initially set attribute limits to match where appropriate, incorporating recommendations included in Section 7 of that report and in Daguet (2006). These limits produced anomalies and, after experimentation with different thresholds, a revised set of limits were agreed. These, plus limits agreed for two habitat attributes added in the current study (Table 5), were used to inform habitat attributes pass / failures at the site and transect section levels (see Section 5.4.1).

Table 5: Habitat attribute limits used to inform habitat condition assessments (revised and additional attribute extents and limits highlighted in blue).

Extent for attribute (i.e. % of sample points that must fall within limits to pass attribute)	**Limits for attribute**	**Reason for change**
At least **80%** of samples within limits for **water flow**	**Flowing water**	New attribute set in 2013 with extent and limits as set out in Daguet (2006)
At least 80% of samples within limits for channel shaded	% channel shaded: 0%-40%	n/a
At least **10%** of samples within limits for **open water**	**% open water 33%-100%**	New attribute in 2019 as recommended by Rushbrook *et al*. (2014).
At least 33% of samples within limits for oviposition plants	cover of emergent broad-leaved herbs: **20%**-80%, and / or cover of submerged **broad-leaved** vegetation: **20%**-80%	Inclusion of broad-leaved herbs only for submerged vegetation cover based on observations and recommendations made in Rushbrook *et al*. (2014); lower limit raised in line for oviposition plants set by Thompson *et al*. (2003b) – see section 5.5.1 for rationale.
At least 50% of samples within limits for **bankside vegetation structure** (include both left and right banks for linear sample points)	**Bankside vegetation structure = mixed good (MG)**	Revision of attribute limit required in 2013 based on recommended changes in methodology included in Harvey *et al*. (2005) and Daguet (2006)
At least 25% of samples within limits for bog myrtle	Cover: 10-**60%**	Upper limit reduced as 80% considered to constitute too much shading over watercourse; new upper limit set in 2013 in line with Thompson *et al.* (2003b)
At least 75% within limits for bracken	Bracken not present	n/a
At least 33% of samples within limits for the **abundance of stiff emergent vegetation**	**Stiff emergent vegetation = frequent**	Revision of attribute limit required in 2019 based on recommended changes in methodology included in Harvey *et al*. (2005) and Daguet (2006)
At least 33% of samples within limits for silt/mud/peat substrate	% silt / mud/ peat: 25%-100%	n/a
At least **80%** of samples within limits for **eutrophication**	**Eutrophication not present**	Revision of attribute limit required in 2013 based on recommended changes in methodology included in Harvey *et al*. (2005) and Daguet (2006)

Recommendations are provided in Section 9.4 for proposed changes to attributes for future recording.

4.1.3 Habitat condition assessment matrix

Table 6 sets out the assessment matrix for habitat condition and was applied to 21 of the 22 sites included within the study (i.e. Howen Bottom was not included as all transect sections had been removed from analysis). If a site did not meet all criteria included within the column for optimal habitat condition, it was then tested against the subsequent columns until a match was secured (e.g. a site was of sub-optimal condition if it passed on the first three (but not five) rows, one or more of the next two rows, and at least two of final five rows).

Table 6: Habitat condition assessment matrix.

Habitat Attribute	Optimal	Sub-optimal	Poor
Flow			
Channel Shaded			
Oviposition plants			
Bankside Vegetation			
Bog Myrtle			
Stiff Emergent			
Silt / Mud / Peat			
Open Water			
Bracken			
Eutrophication			
	Must Pass	≥50% Passed	>33% Passed

The authors considered that the presence of flowing water at sufficient sample points, the amount of channel in shade, and the availability of suitable plants for oviposition to be the key habitat attributes for determining the condition or 'suitability' of individual sites for southern damselfly. Furthermore, the quality of bankside vegetation structure and coverage of bog myrtle were also considered important.

The other attributes provided useful additional information about the sites, but interrogation of whether these attributes were passed or failed against the associated damselfly abundance and density data indicated that there were no clear associations between these and status of southern damselfly at the site.

4.2 Site Resilience Assessment

Reference to the size and connectivity (or more accurately the level of isolation) of sites was included in the previous Favourable condition assessment (Rushbrook *et al*., 2014), and the draft Favourable condition assessment report produced for the 2019 study (Rushbrook *et al*., 2020). However, as the current report aims to assess the status of each site for southern damselfly, it was considered appropriate to separate resilience from the habitat assessment in this report to ensure that it capture the 'status' of each site individually.

4.2.1 Determination of site size

This would also be a largely subjective assessment based on the authors' experience and knowledge of sites visited in the New Forest and Itchen and Test valleys. It was therefore agreed that 50 or more sample points (i.e. as analysed for the habitat condition assessment; Table 2, column 3) offered an inherent degree of robustness at the site level, against potential future 'localised extinction' pressures that could lead to the loss of southern damselfly from that location.

4.2.2 Calculation of site connectivity

The maximum distance moved by an individual southern damselfly of 1060m was recorded during dispersal study within the 'Crockford complex' (Purse, 2002). Furthermore, a study in the Itchen Valley

found that less than 0.1% of individuals travelled more than 1000m away from their original point of capture, with a maximum recorded distance moved of 1790m (Rouquette, 2005).
It was therefore agreed that the following criteria would be applied to determine to the level of connectivity each site had to the wider New Forest metapopulation:

- Sites located within 1km of two sites (known to support southern damselfly) were considered to have a high level of connectivity to the wider metapopulation;
- Sites located within 1km of one site, and / or within 1.8km of two sites, were considered to have a moderate level of connectivity to the wider metapopulation;
- All other sites were considered relatively isolated.

4.2.3 Site resilience assessment matrix

Table 7 sets out the assessment matrix for site resilience and was applied to all 22 sites included within the study. If a site did not meet all criteria included within the column for high resilience, it was then tested against the subsequent columns until a match was secured (e.g. if a site only met the moderate connectivity criteria it was considered to be of low resilience). It is emphasised that any site with high connectivity will inherently pass the moderate connectivity criteria also.

Table 7: Site resilience assessment matrix.

Site Resilience	**High**	**Moderate**	**Low**	**Vulnerable**
Size (≥ 50 sample points)				
Connectivity - High				
Connectivity - Moderate				
	All true	Two of three true	One of three true	None true

4.3 Southern Damselfly Population Assessments

The remaining attribute that was formally recorded during surveys was adult male abundance on each transect section. Despite the limitations in basing a vigorous site assessment on population estimates gained from a single visit, error was minimised by imposing limits on survey time, date, and the weather conditions under which they must be carried out (see Section 3.5). All criteria were met at all sites and transect sections (see Section 5.2). This reflects a period of fine weather during early to mid-July 2019.

4.3.1 Population strength

It is considered that the adult count surveys provide an indicative abundance for comparing one site with another, with those sites that return a greater number of southern damselfly considered to support a more robust or stronger population. These values were also used to conduct a subjective appraisal of population strength for each site, and are based on the criteria used by Stevens & Thurner (1999):

- Not assessed = no individuals counted
- Weak = 1 to 29 males counted
- Medium = 30 to 99 males counted
- Strong = 100 or more males counted

This is in contrast with the previous study, where informal counts during habitat attribute assessments were used for this subjective assessment (Rushbrook *et al*., 2014). In the current study, informal counts at some key sites (e.g. Crockford Stream [Upper] and Shipton Bottom) were conducted more than five weeks after the main flight period in 2019. Therefore, despite its positive correlation with numbers recorded during adult count surveys (see Section 5.2), the data collected during the informal counts was considered unsuitable for the subjective assessment of population strength in the current study.

4.3.2 Population density

Larger sites are inherently more likely to support a greater abundance of southern damselfly. Therefore, there is a risk that directly comparing abundance alone would indicate a large site of lower habitat quality is of substantially greater value than a smaller site of high quality. It was therefore considered that calculating southern damselfly density (damselflies per 100m) would provide a valuable additional measure for comparison of southern damselfly populations between sites.

Furthermore, by correcting for site size, southern damselfly population density provides supplementary information on the recent and / or current habitat conditions. These measures can be cross-referenced against habitat condition assessments, with any discrepancies identified indicating that further investigations may be required to fully understand the habitat conditions at the site (e.g. if a site assessed to be in poor condition was found to support a high density of damselflies).

A value of 10 damselflies per 100m was cautiously proposed as a possible lower limit for favourable condition if sampling took place in optimal weather conditions (Harvey *et al*., 2005; Rushbrook *et al*., 2014), with the caveat that more transect counts were required before suitable limits can be confidently proposed (Harvey *et al*., 2005), perhaps tailored to individual sites as suggested by Thompson *et al*. (2003b). However, based on Jenkins' (1991) collection and summary of a five-year dataset from the Crockford Stream, Thompson *et al*. (2003b) calculated values of 30-100 damselflies per 100m across four sub-sections of that site. Thompson *et al*. (2003b) suggest that, due to the prolific nature of this site, “actual population targets for other sites still in favourable condition will be considerably lower than those described here”.

It was therefore considered that the following values provided a reasonable subjective assessment of population density for the current study:

- Not assessed = no individuals counted
- Low = 1 to <10 damselflies per 100m
- Moderate = 10 to <20 damselflies per 100m
- High = 20 or more damselflies per 100m

5. RESULTS

5.1 Habitat Survey

5.1.1 Sites sampled

Habitat samples were taken at all 22 sites assessed, although data collected from Howen Bottom was not included within the analysis (see Section 3.7.2). All sites were visited between the 8th July and 26th August 2019 (Table 2).

All transects surveyed within the current study followed the routes surveyed in 2013 with the following exceptions (due to different hydrological conditions and / or difficulties in locating start / end points):

- Mill Lawn: transect section 1.11 was extended with the start and end points further north and south respectively (see Section 6.14 of Rushbrook *et al*. [2014] and current report);
- Shipton Bottom: the surveyor followed a more easterly route through the mire area of transect section 1.6 (see Section 6.17 of Rushbrook *et al*. [2014] and current report);
- Stony Moors: transect sections 2.1 was shorter and followed a more southerly route (see Section 6.20 of Rushbrook *et al*. [2014] and current report).

Furthermore, the small number of amendments from the original 2004 survey transect routes that were introduced / excluded in 2013 are set out in Section 4.2.1 of Rushbrook *et al*. (2014).

5.1.2 Sample data

Appendix 4 provides a summary of the revised data set used for the habitat condition assessments, giving the average (mean or mode as appropriate) value for each attribute at each site. Appendix 5 shows the percentage of sample points that fell outside the habitat attribute limits (see Section 4.1.2) for each transect section.

It was noted that substrate composition was incorrectly calculated at two sample points, with values totalling 110% and 90% recorded on sample points 27 and 34 of transect sections Shipton Bottom 1.5 and Widden Bottom 1.1 respectively. This did not impact the results of the habitat condition assessments for these sections and remains unchanged in the information provided to Forestry England (see Section 3.8 and Appendix 3).

5.2 Transect Counts of Adult Damselflies

Surveys at all 22 sites were conducted within the main flight period for southern damselfly, during the recommended time of day, with weather conditions criteria fully met (detailed weather and time data are shown in Appendix 6). The total number (i.e. abundance) and linear density (damselflies per 100m) of male southern damselflies recorded at each site are shown in Table 8.

Crockford Stream (Upper) and Shipton Bottom recorded a considerably higher number of individuals than all other sites, though relatively high numbers of individuals were also recorded at Crockford Stream (Lower), Latchmore and Mill Lawn (Table 8).

This corresponded with high densities at both of the Crockford Stream sites, Shipton Bottom, and Latchmore. Furthermore, a moderate number of individuals was recorded at Clayhill Bottom which, due to its relatively small size (Table 2), resulted in this site supporting the highest density of individuals (Table 8). Conversely, despite the relatively high numbers of individuals at Mill Lawn they were distributed at a low density relative to the length of transects surveyed (Table 8).

No southern damselfly were recorded during adult counts at Dibden Bottom, Howen Bottom or Foulford, although two individuals (males) were recorded during habitat attribute sampling at the latter site. Furthermore, several sites, including Bagshot Moor, Common Moor, Duckhole Bog and Stony Moors, returned relatively few individuals and these were also present in low densities (Table 8).

Lower densities of adult male southern damselflies were recorded later in the main flight period at both the site and transect section level (Figures 3 and 4), with the latter being statistically significant (Spearman's rank correlation: [SITE] $r_s = -0.339$, $n = 30$, $p = 0.067$; [TRANSECT] $r_s = -0.355$, $n = 99$, $p < 0.001$).

Table 8: Numbers of adult male southern damselflies recorded on transects.

Site name	Transect length (m)	Total no. of male southern damselfly	Damselflies per 100m of transect	Weather/ date/ time criteria met	Date(s)
Acres Down	336	46	13.69	yes	10 July 2019
Bagshot Moor	358	1	0.28	yes	16 July 2019
Bull Hill	431	22	5.10	yes	09 July 2019
Clayhill Bottom	183	86	46.99	yes	11 July 2019
Common Moor	67	6	8.96	yes	11 July 2019
Crockford Stream (Lower)	837	223	26.64	yes	02 July 2019
Crockford Stream (Upper)	2113	788	37.29	yes	05 July 2019
				yes	08 July 2019
				yes	09 July 2019
Dibden Bottom	225	0	0.00	yes	28 June 2019
Duckhole Bog	140	12	8.57	yes	11 July 2019
Foulford*	266	0*	0.00*	yes	15 July 2019
Hatchet Stream	735	45	6.12	yes	01 July 2019
Howen Bottom	250	0	0.00	yes	16 July 2019
Latchmore	964	176	18.26	yes	05 July 2019
				yes	07 July 2019
Mill Lawn	4139	168	4.06	yes	08 July 2019
				yes	10 July 2019
Millersford Bottom	924	26	2.81	yes	12 July 2019
				yes	16 July 2019
Round Hill	797	26	3.26	yes	15 July 2019
Shipton Bottom	1970	641	32.54	yes	03 July 2019
				yes	04 July 2019
Shobley	533	65	12.20	yes	15 July 2019
Stag Brake	169	14	8.28	yes	10 July 2019
Stony Moors	378	7	1.85	yes	08 July 2019
Three Beech Bottom	624	25	4.01	yes	09 July 2019
				yes	10 July 2019
				yes	16 July 2019
Widden Bottom	368	28	7.61	yes	10 July 2019

* Two individuals recorded on transect section 1.1 during habitat assessments

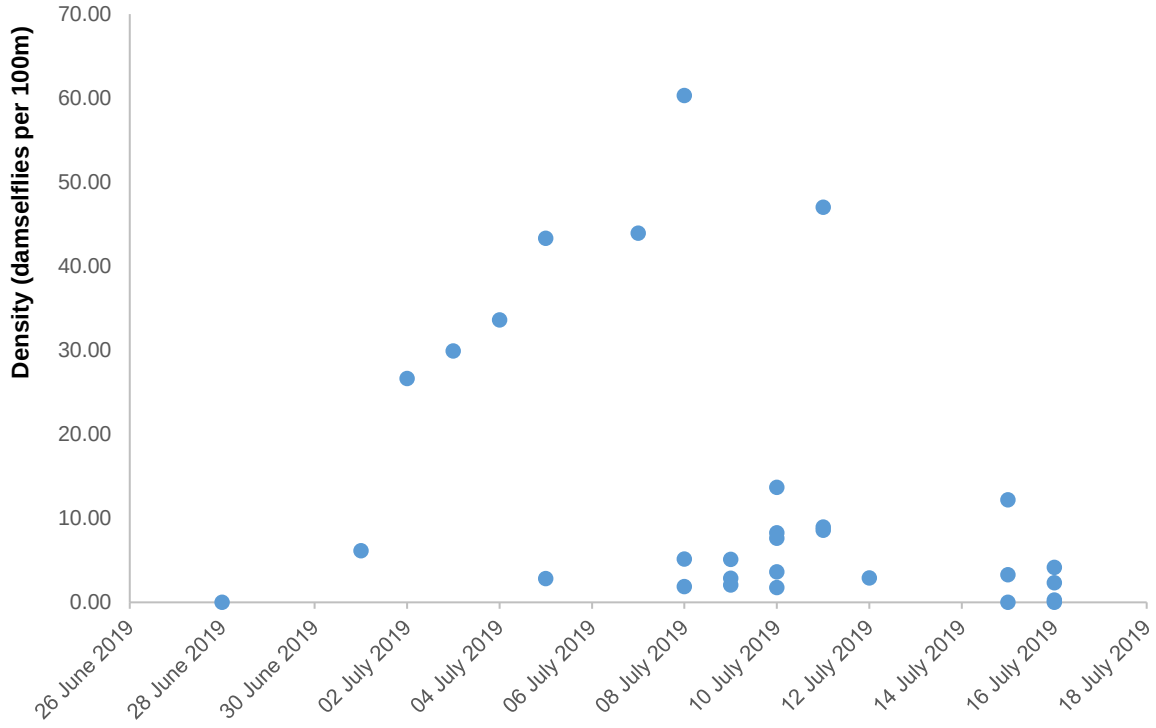


Figure 3: Relationship between linear density and date of survey at the site level.

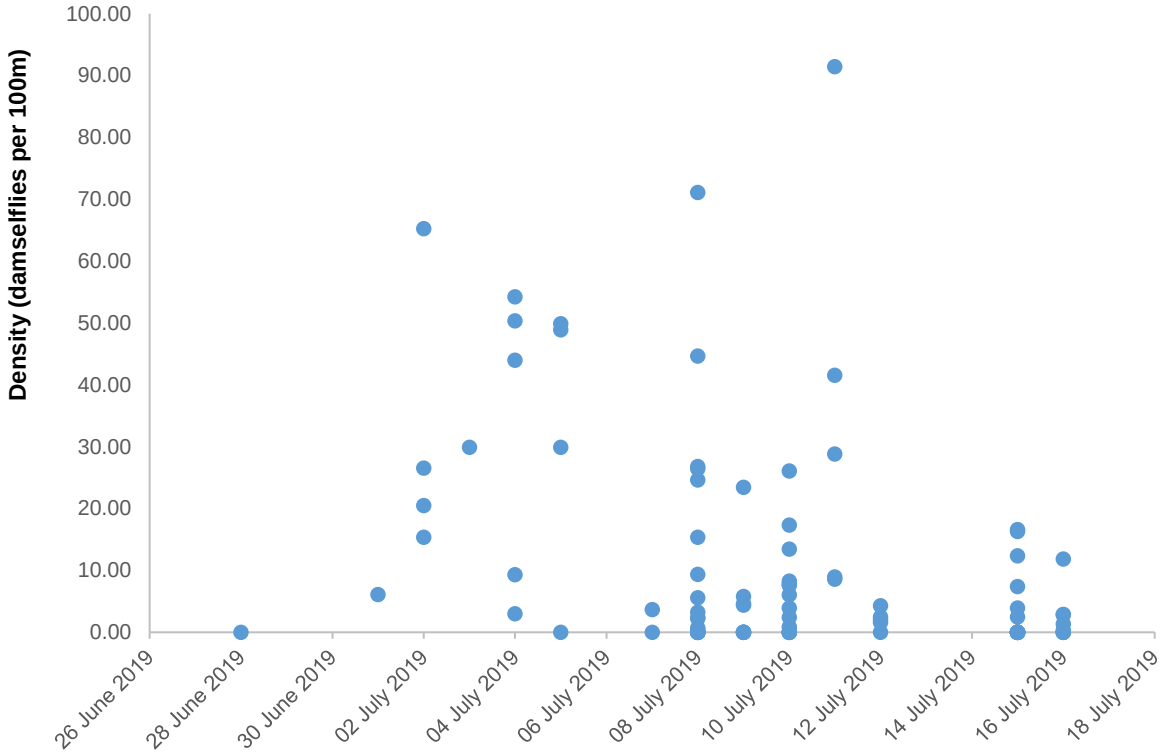


Figure 4: Relationship between linear density and date of survey at the transect section level.

However, this is considered to reflect surveyors focusing on key sites (i.e. those found to support high numbers of southern damselfly in 2013) earlier in the survey period, due to the relatively late onset of the project and uncertainty of how long the corresponding period of favourable weather would persist.

Data collected from 2004 adult count surveys was excluded from comparative analysis as it was predominately collected under poor weather conditions and / or outside the required survey window (Harvey *et* al., 2004; see Section 3.5 of this report). However, all of the 2019 and most of the 2013 adult count surveys were conducted in suitable weather conditions and during the appropriate survey window (Rushbrook *et al*., 2014; see Section 3.5. and Table 8 of this report). It is therefore considered acceptable to make rudimentary comparisons between the adult count data for the latter two studies. However, it is emphasised that the results of these comparisons must be treated with caution as they are based on a single count per site in each year, and therefore several variables could explain the differences recorded.

There was a significant reduction in the abundance and density of adult male southern damselfly recorded during the 2019 survey programme. This reduction was significant at the site level (Paired t-test: [ABUNDANCE] t-value = -2.27, n = 22, p = 0.034; [DENSITY] t-value = -2.31, n = 22, p = 0.031; Figure 5), and was highly significant at the transect section level (Wilcoxon signed rank test: [ABUNDANCE] *T*- value = 740.5, n = 99, p <0.001]; [DENSITY] *T*-value = 832.5, n =99, p <0.001]).

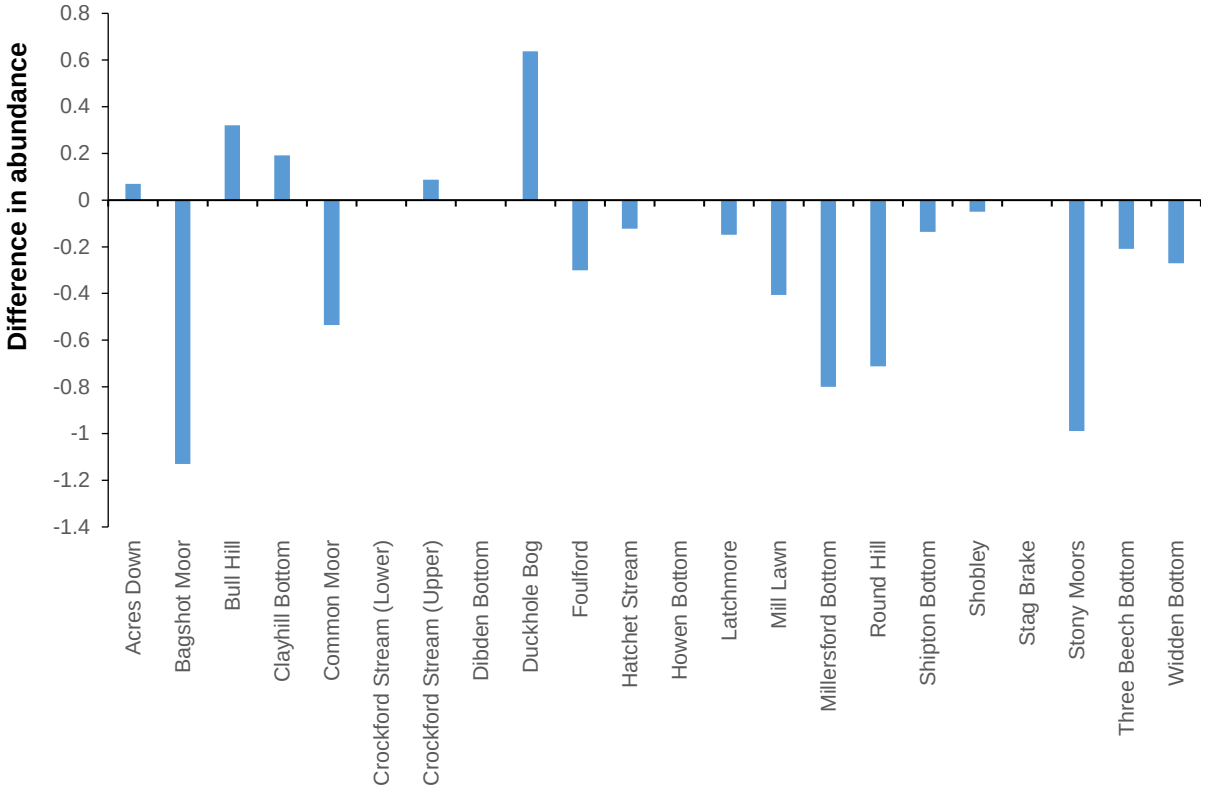


Figure 5: Differences in abundance of male southern damselfly recorded at all 22 sites between 2019 and 2013 (data Log+1 transformed).

The abundance of adult male southern damselfly observed during the habitat attribute surveys was also recorded. There were both significant and highly significant positive correlations between adult male damselfly numbers recorded during adult count and habitat attribute surveys at the site (Pearson's correlation: r = 0.492, n = 22, p = 0.020; Figure 6) and transect section levels respectively (Pearson's correlation: r = 0.450, n = 99, p < 0.001; Figure 7).

There was a substantial degree of scatter in the data at both levels (Figures 6 and 7). To increase the likelihood of gaining robust monitoring data for adult male damselflies, formal adult count surveys were given priority in the survey programme over habitat attribute assessments. Consequently, several habitat attribute surveys were conducted outside of the main flight period for this species (see Table 2 and Section 3.5), and the informal counts did not meet the required criteria for time, date and weather at the majority of transect sections. This is likely to explain the scatter in the data observed, and makes the (strongly) significant correlations recorded of particular note.

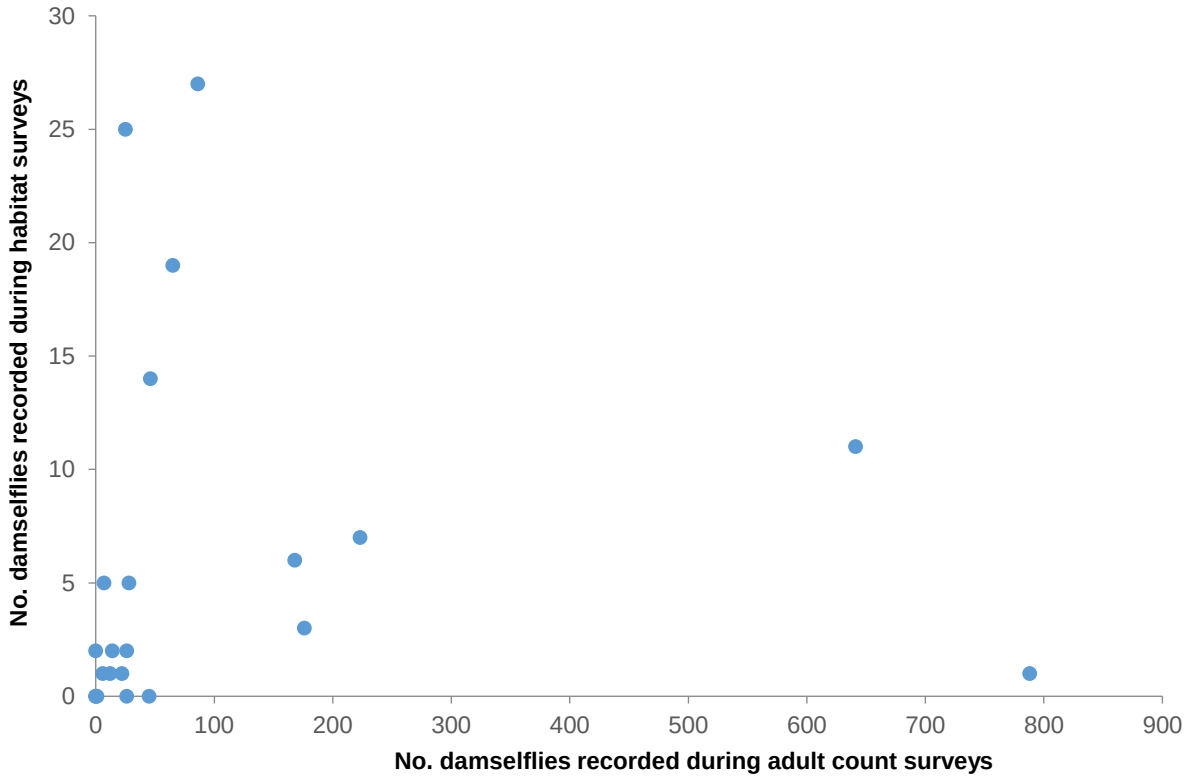


Figure 6: Relationship between abundance of adult damselflies recorded during adult count and habitat attribute surveys at the site level.

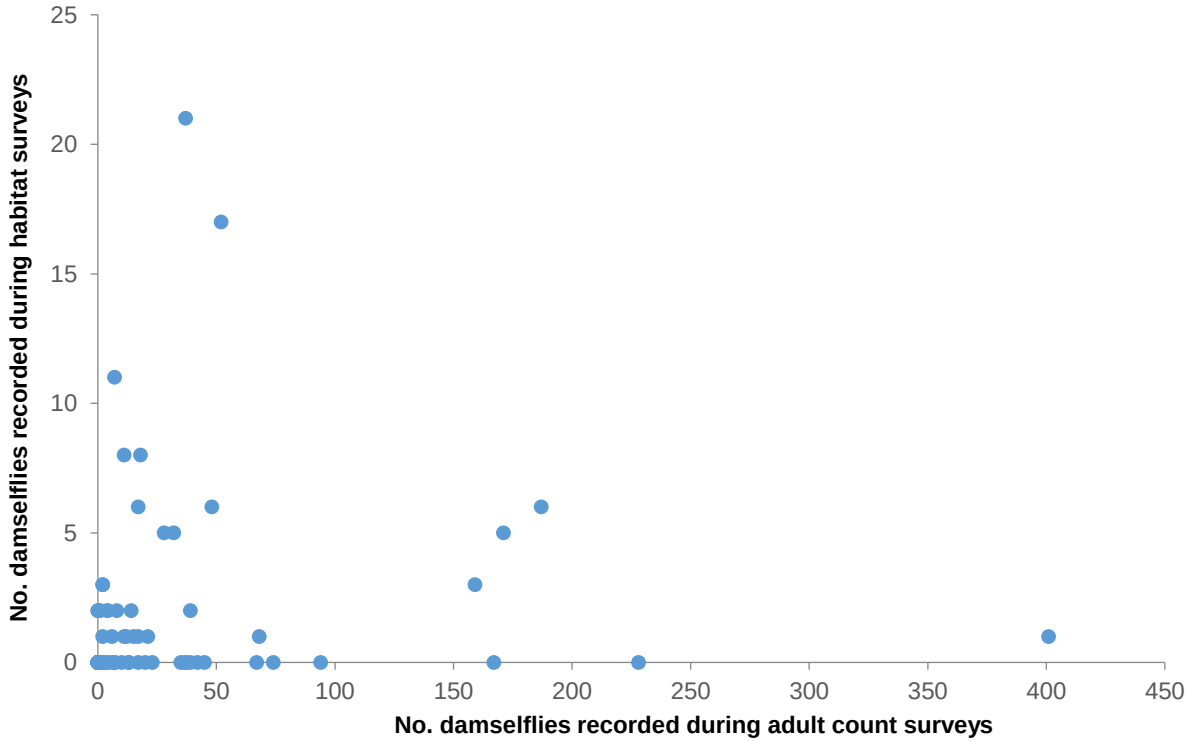


Figure 7: Relationship between abundance of adult damselflies recorded during adult count and habitat attribute surveys at the transect section level.

A cautionary subjective assessment of population strength and population density (based on the criteria set out in Section 4.3) for each site is provided in Section 5.4.3, using the abundance and density data provided in Table 8.

5.3 Habitat Attribute Testing

Using the limits set out in Section 4.1.2 a database query was set up to show which sites and transect sections pass or fail against the various attribute criteria. These data were used to inform the habitat condition assessments given in Section 5.4.1.

5.3.1 Site assessments

The percentage pass rate for each site is shown in Table 9, with the numbers of damselflies per 100m provided for comparison. The attribute columns are ordered with those considered most important for the selection of optimal condition listed first (see Section 4.1.3).

For the three key habitat attributes, 12 sites failed on the presence of flowing water at sufficient sample points, one site failed on excessive shading and three sites failed on insufficient availability of plants for oviposition. Furthermore, over half of the sites failed on suitable amounts of stiff emergent vegetation, and more than a quarter on one or both of poor bankside vegetation structure and presence of eutrophication (Table 9).

There was no significant correlation between density of damselflies and site pass rate (Pearson's correlation: $r = 0.250$, $n = 21$, $p = 0.274$). Possible explanations for the inconsistencies between damselfly abundance and habitat attribute passes could be that the attributes chosen are not clear enough indicators of habitat quality or that pass / fail limits are not set at the correct levels.

A further possible explanation is that habitat attribute passes reflect the quality of a site for the range of life stages of this species (egg, larva, and adult), whereas the counts reflect adult abundance only. Detailed studies by Purse (2002) and Rouquette (2005) identified that southern damselfly larvae prefer habitat attributes associated with a slightly later successional stage than adults. Therefore discrepancies could occur where sites that provide 'poor' habitat conditions for this species support high densities of adults but fail on features important for larvae or egg laying; if good egg laying opportunities were present two years previously, and there is sufficient stiff emergent vegetation for final instar larvae to exit the water, a high density of adults may be recorded despite a site failing across the range of attributes. Conversely, the return of low adult counts at sites that pass on all / the most important habitat attributes may reflect poor weather or site conditions two years previously, due to the semi-voltine development of this species in Britain.

It is emphasised that this analysis is based on a single adult count across 21 of the 22 sites included within this study. Therefore, the absence of correlation may reflect the limited data set, and that damselfly abundance and densities fluctuate widely across the main flight period even on sites with good habitat quality. For example, poor weather conditions during the days immediately prior to a survey conducted under suitable conditions could limit recent emergence and therefore the number of adults present.

Finally, these results are based on combining all samples into one overall site assessment, and a more detailed assessment can be made by analysing the data for the individual transect sections within each site.

5.3.2 Transect section assessments

Table 10 presents the same data as Table 9, but is separated into the individual transect sections within each site. Half of the transect sections failed on the presence of flowing water at sufficient sample points, including 10 of the 14 transect sections that had been shortened due to the absence of water at sample points at one or both ends of the transect section (Tables 3 and 10).

In total 12 and 18 of the 90 transect sections assessed failed due to excessive shading and insufficient availability of plants for oviposition respectively (Table 10). Furthermore, 35 transect sections failed on poor bankside vegetation structure, 32 failed on unsuitable amounts of bog myrtle, and 46 failed on insufficient stiff emergent vegetation.

Table 9: Pass rate for each site against habitat attribute limits, compared to adult damselfly density (males per 100m).

Site	Weather/date criteria met	Damselfly density	Site pass rate (%)	Flow	Channel shaded	Oviposition plants	Bankside vegetation structure	Bog myrtle	Stiff emergent vegetation	Silt/ mud/ peat	Open water	Bracken	Eutrophication
Acres Down	yes	13.69	**60.00**	Fail	Pass	Fail	Pass	Pass	Fail	Pass	Pass	Fail	Pass
Bagshot Moor	yes	0.28	**80.00**	Fail	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass
Bull Hill	yes	5.10	**70.00**	Fail	Pass	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Pass
Clayhill Bottom	yes	46.99	**70.00**	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Fail	Fail
Common Moor	yes	8.96	**70.00**	Fail	Pass	Fail	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Crockford Stream (Lower)	yes	26.64	**80.00**	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Fail
Crockford Stream (Upper)	yes	37.29	**80.00**	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Fail
Dibden Bottom	yes	0.00	**60.00**	Pass	Fail	Pass	Fail	Fail	Fail	Pass	Pass	Pass	Pass
Duckhole Bog	yes	8.57	**90.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Foulford	yes	0.00	**70.00**	Fail	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Fail	Pass
Hatchet Stream	yes	6.12	**80.00**	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Fail
Howen Bottom	yes	0.00	Not Assessed										
Latchmore	yes	18.26	**100.00**	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Mill Lawn	yes	4.06	**70.00**	Fail	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass
Millersford Bottom	yes	2.81	**80.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail
Round Hill	yes	3.26	**90.00**	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass
Shipton Bottom	yes	32.54	**90.00**	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail
Shobley	yes	12.20	**90.00**	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass
Stag Brake	yes	8.28	**60.00**	Fail	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Fail
Stony Moors	yes	1.85	**80.00**	Fail	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Three Beech Bottom	yes	4.01	**60.00**	Fail	Pass	Fail	Fail	Pass	Fail	Pass	Pass	Pass	Pass
Widden Bottom	yes	7.61	**60.00**	Fail	Pass	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Fail

Table 10: Pass rate for each transect section against habitat attribute limits, adult damselfly density (males per 100m).

Site	Weather/date criteria met	Damselfly density	Section pass rate (%)	Flow	Channel shaded	Oviposition plants	Bankside vegetation structure	Bog myrtle	Stiff emergent vegetation	Silt/ mud/ peat	Open water	Bracken	Eutrophication
Acres Down 1.1	yes	3.95	**70.00**	Fail	Pass	Fail	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Acres Down 1.2	yes	17.35	**50.00**	Fail	Pass	Fail	Pass	Pass	Fail	Pass	Pass	Fail	Fail
Acres Down 1.3	yes	13.46	**70.00**	Fail	Pass	Fail	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Acres Down 1.4	yes	26.09	**60.00**	Fail	Pass	Fail	Pass	Pass	Fail	Pass	Pass	Fail	Pass
Acres Down 1.5	yes	2.44	**80.00**	Fail	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Bagshot Moor 1.1	yes	0.28	**80.00**	Fail	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass
Bull Hill 1.1	yes	4.40	**80.00**	Pass	Pass	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Pass
Bull Hill 1.2	yes	0.00	Not Assessed										
Bull Hill 1.3	yes	0.00	**80.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail
Bull Hill 1.4	yes	0.00	**40.00**	Fail	Fail	Fail	Fail	Pass	Fail	Pass	Pass	Pass	Fail
Bull Hill 1.5	yes	23.44	**80.00**	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass
Clayhill Bottom 1.1	yes	28.81	**90.00**	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass
Clayhill Bottom 1.2	yes	91.43	**80.00**	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Fail	Pass
Clayhill Bottom 1.3	yes	41.57	**70.00**	Pass	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Pass	Fail
Common Moor 1.1	yes	8.96	**70.00**	Fail	Pass	Fail	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Crockford Stream (Lower) 1.1	yes	15.38	**80.00**	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Fail
Crockford Stream (Lower) 1.2	yes	65.28	**80.00**	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Fail
Crockford Stream (Lower) 1.3	yes	20.48	**90.00**	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Crockford Stream (Lower) 1.4	yes	26.53	**70.00**	Pass	Pass	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Fail
Crockford Stream (Upper) 1.1	yes	29.91	**70.00**	Pass	Pass	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Fail
Crockford Stream (Upper) 1.2	yes	49.89	**80.00**	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Fail

Site	Weather/date criteria met	Damselfly density	Section pass rate (%)	Flow	Channel shaded	Oviposition plants	Bankside vegetation structure	Bog myrtle	Stiff emergent vegetation	Silt/ mud/ peat	Open water	Bracken	Eutrophication
Crockford Stream (Upper) 1.3	yes	26.81	**70.00**	Pass	Pass	Fail	Pass	Fail	Fail	Pass	Pass	Pass	Pass
Crockford Stream (Upper) 1.4	yes	71.10	**90.00**	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Crockford Stream (Upper) 1.5	yes	44.68	**70.00**	Pass	Pass	Fail	Pass	Fail	Fail	Pass	Pass	Pass	Pass
Crockford Stream (Upper) 1.6	yes	0.00	**70.00**	Fail	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Fail
Crockford Stream (Upper) 1.7	yes	4.58	**80.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail
Dibden Bottom 1.1	yes	0.00	**60.00**	Pass	Fail	Pass	Fail	Fail	Fail	Pass	Pass	Pass	Pass
Duckhole Bog 1.1	yes	8.57	**90.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Foulford 1.1	yes	0.00	**90.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Foulford 1.2	yes	0.00	**80.00**	Fail	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Foulford 1.3	yes	0.00	**70.00**	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass
Hatchet Stream 1.1	yes	6.12	**80.00**	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Fail
Howen Bottom 1.1	yes	0.00	Not Assessed										
Howen Bottom 1.2	yes	0.00	Not Assessed										
Howen Bottom 1.3	yes	0.00	Not Assessed										
Latchmore 1.1	yes	0.00	**80.00**	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass
Latchmore 1.2	yes	3.66	**100.00**	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Latchmore 1.3	yes	48.92	**100.00**	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Latchmore 1.4	yes	0.00	**70.00**	Fail	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass
Mill Lawn 1.1	yes	0.00	**60.00**	Fail	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Fail
Mill Lawn 1.2	yes	2.24	**70.00**	Pass	Pass	Pass	Fail	Fail	Fail	Pass	Pass	Pass	Pass
Mill Lawn 1.3	yes	3.23	**70.00**	Pass	Pass	Pass	Fail	Fail	Fail	Pass	Pass	Pass	Pass

Site	Weather/date criteria met	Damselfly density	Section pass rate (%)	Flow	Channel shaded	Oviposition plants	Bankside vegetation structure	Bog myrtle	Stiff emergent vegetation	Silt/ mud/ peat	Open water	Bracken	Eutrophication
Mill Lawn 1.4	yes	26.43	**50.00**	Fail	Pass	Pass	Fail	Fail	Fail	Pass	Pass	Fail	Pass
Mill Lawn 1.5	yes	15.35	**80.00**	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass
Mill Lawn 1.6	yes	0.00	**70.00**	Fail	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Fail	Pass
Mill Lawn 1.7	yes	0.00	**30.00**	Fail	Fail	Pass	Fail	Fail	Fail	Pass	Pass	Fail	Fail
Mill Lawn 1.8	yes	9.35	**80.00**	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass
Mill Lawn 1.9	yes	0.46	**60.00**	Fail	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Fail	Pass
Mill Lawn 1.10	yes	0.00	**50.00**	Fail	Pass	Pass	Fail	Fail	Fail	Pass	Pass	Fail	Pass
Mill Lawn 1.11	yes	0.00	Not Assessed										
Mill Lawn 1.12	yes	24.65	**70.00**	Pass	Pass	Pass	Fail	Fail	Fail	Pass	Pass	Pass	Pass
Mill Lawn 2.1	yes	0.00	Not Assessed										
Mill Lawn 3.1	yes	0.00	**90.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Mill Lawn 3.2	yes	0.00	**90.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Mill Lawn 3.3	yes	6.05	**90.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Mill Lawn 4.1	yes	0.88	**50.00**	Fail	Fail	Pass	Pass	Pass	Fail	Pass	Pass	Fail	Fail
Mill Lawn 4.2	yes	0.00	**80.00**	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass
Millersford Bottom 1.1	yes	2.90	**70.00**	Fail	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Pass	Pass
Millersford Bottom 1.2	yes	2.50	**80.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail
Millersford Bottom 1.3	yes	1.61	**90.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Millersford Bottom 1.4	yes	4.27	**80.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail
Millersford Bottom 1.5	yes	2.08	**80.00**	Fail	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Millersford Bottom 1.6	yes	0.00	**40.00**	Pass	Fail	Fail	Fail	Fail	Fail	Pass	Pass	Fail	Pass
Round Hill 1.1	yes	0.00	**90.00**	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass

Site	Weather/date criteria met	Damselfly density	Section pass rate (%)	Flow	Channel shaded	Oviposition plants	Bankside vegetation structure	Bog myrtle	Stiff emergent vegetation	Silt/ mud/ peat	Open water	Bracken	Eutrophication
Round Hill 1.2	yes	2.50	**90.00**	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass
Round Hill 1.3	yes	16.31	**90.00**	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass
Round Hill 1.4	yes	0.00	**50.00**	Pass	Fail	Pass	Fail	Fail	Fail	Pass	Pass	Pass	Fail
Round Hill 2.1	yes	3.92	**90.00**	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass
Round Hill 2.2	yes	0.00	**90.00**	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass
Round Hill 2.3	yes	0.00	**50.00**	Pass	Fail	Fail	Fail	Fail	Fail	Pass	Pass	Pass	Pass
Round Hill 2.4	yes	0.00	**80.00**	Pass	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass
Round Hill 3.1	yes	0.00	**80.00**	Pass	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass
Round Hill 3.2	yes	0.00	**60.00**	Pass	Fail	Pass	Fail	Fail	Pass	Pass	Pass	Fail	Pass
Round Hill 3.3	yes	0.00	**90.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Shipton Bottom 1.1	yes	29.90	**80.00**	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Fail
Shipton Bottom 1.2	yes	9.33	**80.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail
Shipton Bottom 1.3	yes	3.00	**90.00**	Pass	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Shipton Bottom 1.4	yes	50.34	**100.00**	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Shipton Bottom 1.5	yes	44.00	**90.00**	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail
Shipton Bottom 1.6	yes	54.22	**90.00**	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Shobley 1.1	yes	16.61	**80.00**	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass
Shobley 1.2	yes	0.00	**90.00**	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass
Shobley 1.3	yes	12.36	**90.00**	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail	Pass
Shobley 1.4	yes	7.41	**80.00**	Pass	Pass	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Pass
Stag Brake 1.1	yes	8.28	**60.00**	Fail	Pass	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Fail
Stony Moors 1.1	yes	2.38	**80.00**	Fail	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass

Site	Weather/date criteria met	Damselfly density	Section pass rate (%)	Flow	Channel shaded	Oviposition plants	Bankside vegetation structure	Bog myrtle	Stiff emergent vegetation	Silt/ mud/ peat	Open water	Bracken	Eutrophication
Stony Moors 1.2	yes	0.00	**70.00**	Fail	Fail	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Stony Moors 1.3	yes	0.00	**80.00**	Fail	Pass	Pass	Pass	Pass	Fail	Pass	Pass	Pass	Pass
Stony Moors 1.4	yes	0.74	Not Assessed										
Stony Moors 2.1	yes	5.56	**60.00**	Fail	Pass	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Fail
Three Beech Bottom 1.1	yes	7.78	**60.00**	Fail	Pass	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Fail
Three Beech Bottom 1.2	yes	0.00	Not Assessed										
Three Beech Bottom 1.3	yes	0.00	Not Assessed										
Three Beech Bottom 1.4	yes	11.83	**80.00**	Pass	Pass	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Pass
Three Beech Bottom 2.1	yes	1.33	**60.00**	Fail	Pass	Fail	Fail	Pass	Fail	Pass	Pass	Pass	Pass
Three Beech Bottom 2.2	yes	0.00	**60.00**	Fail	Pass	Fail	Fail	Pass	Fail	Pass	Pass	Pass	Pass
Three Beech Bottom 2.3	yes	5.80	**50.00**	Fail	Pass	Fail	Fail	Fail	Fail	Pass	Pass	Pass	Pass
Three Beech Bottom 2.4	yes	2.82	**60.00**	Fail	Pass	Fail	Fail	Pass	Fail	Pass	Pass	Pass	Pass
Widden Bottom 1.1	yes	7.61	**60.00**	Fail	Pass	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Fail

Habitat attribute sampling and adult count surveys were conducted on the same length for 76 (84%) of the 90 transect sections where data for both was collected. It was therefore possible for the two sets of measurements to be directly linked, and considered appropriate to explore the relationship between section pass rate and damselfly density for both the entire and revised data sets.

There was a near significant positive correlation between relative abundance of damselflies and transect section pass rates when analysing data collected from all 90 transects included in the habitat attribute sampling analysis (Spearman's rank correlation: $r_s = 0.391$, n = 90, p = 0.063). This relationship was non-significant when only using data from the 76 directly comparable transects (Spearman's rank correlation: $r_s = 0.18$, n = 76, p = 0.112). However, despite the absence of a significant relationship between habitat and species data, it is still considered that the attributes chosen are indicators of habitat quality and that pass / fail limits have been set at the correct levels. Instead, this analysis could provide support for the use of an assessment matrix, in which some attributes are considered more influential than others, with a failure / poor percentage of sampling points passing for specific attributes key for the abundance and density of damselflies at a site.

The role of flow in the current and future assessments is explored in detail in the discussion and recommendations Sections of this report (see Sections 8 and 9), since several sites and transect sections that failed on flow still supported southern damselfly (Tables 9 and 10). However, it was noted that despite considerable scatter within the data (likely influenced by failures in other variables), there remained a significant positive relationship between the number of sample points supporting flow and damselfly density at the site level (Pearson's correlation: r = 0.438, n = 22, p = 0.047), which is highly significant for both transect section (Pearson's correlation: r = 0.391, n = 90, p < 0.001; Figure 8) and corrected transect section data (Pearson's correlation: r = 0.391, n = 90, p = 0.008).

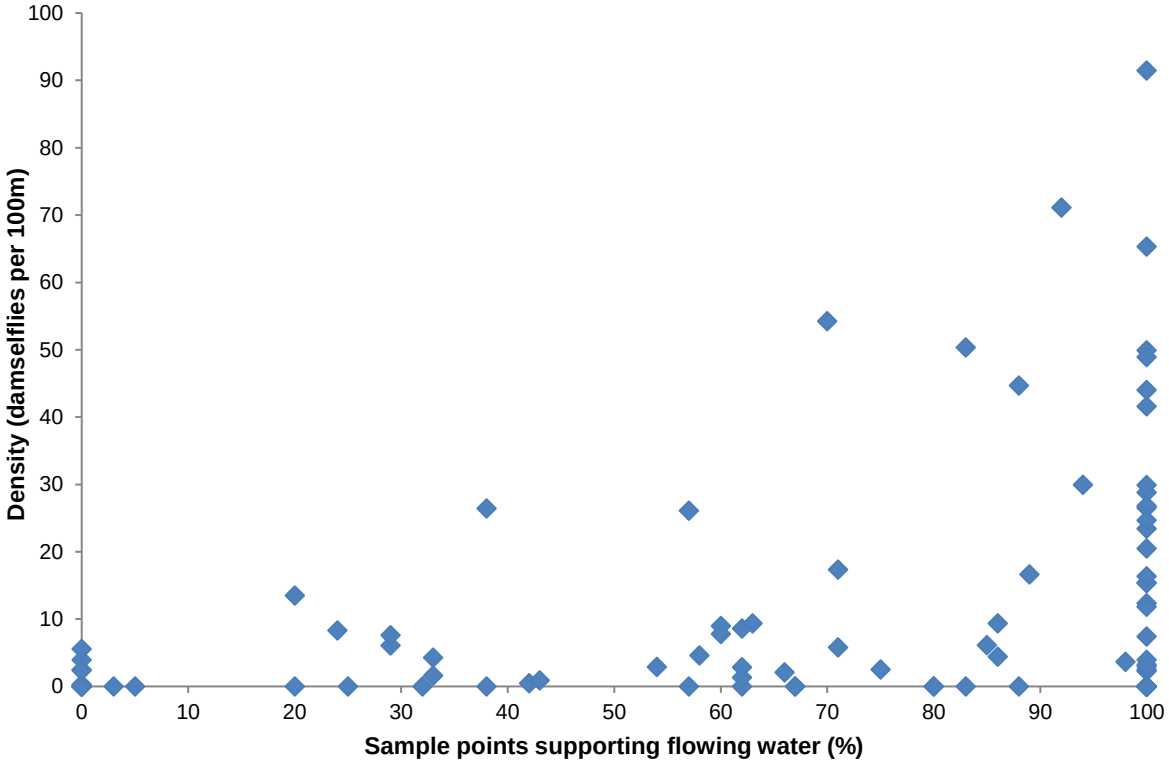


Figure 8: Relationship between linear density and the percentage of sample points supporting flowing water at the transect section level.

5.4 Assessments

The results of the four assessments used to inform site status are summarised in Table 11, with further details for each provided in Sections 5.4.1 - 5.4.3.

Table 11: Results of the four assessments used to inform site status.

Site Name	Habitat Condition Assessment	Site Resilience Assessment	Population Strength Assessment	Population Density Assessment
Acres Down	Poor	Vulnerable	Medium	Moderate
Bagshot Moor	Poor	Low	Weak	Low
Bull Hill	Poor	Low	Weak	Low
Clayhill Bottom	Sub-optimal	Vulnerable	Medium	High
Common Moor	Poor	Vulnerable	Weak	Low
Crockford Stream (Lower)	Optimal	High	Strong	High
Crockford Stream (Upper)	Optimal	High	Strong	High
Dibden Bottom	Poor	Vulnerable	Not recorded	Not recorded
Duckhole Bog	Poor	Vulnerable	Weak	Low
Foulford	Poor	Low	Weak*	Low*
Hatchet Stream	Optimal	Moderate	Medium	Low
Howen Bottom	Not assessed†	Vulnerable	Not recorded	Not recorded
Latchmore	Optimal	Low	Strong	Moderate
Mill Lawn	Poor	Moderate	Strong	Low
Millersford Bottom	Poor	Low	Weak	Low
Round Hill	Sub-optimal	Low	Weak	Low
Shipton Bottom	Optimal	High	Strong	High
Shobley	Optimal	Moderate	Medium	Moderate
Stag Brake	Poor	Low	Weak	Low
Stony Moors	Poor	Vulnerable	Weak	Low
Three Beech Bottom	Poor	Low	Weak	Low
Widden Bottom	Poor	Low	Weak	Low

* Two individuals recorded on transect section 1.1 during habitat assessments

† All transect sections entirely dry so considered unsuitable and not assessed

5.4.1 Habitat Condition Assessments

Six of the 21 sites assessed were judged to provide optimal habitat conditions for southern damselfly, with two and 13 sites providing sub-optimal and poor conditions respectively (Table 11). This assessment was strongly influenced by the large number of sites that failed on the water flow habitat attribute, with flowing water present at too few sampling points. Indeed, 12 of the 13 sites that were judged to be in poor condition failed on this habitat attribute (Tables 9 and 11). This is also evident in the transect section level data, with half of all transect sections failing on flow (Table 10; Appendix 5).

Dibden Bottom was the only site that was judged to be in poor condition but passed on the presence of flowing water at sufficient sampling points. This site was heavily shaded (Table 9; Appendix 4), with one-third of sample points falling outside of the acceptable limits for this attribute (Appendix 5). Furthermore, following its inclusion in 2013, southern damselfly have neither been recorded at this site as part of the previous (Rushbrook *et al*., 2014) nor the current study (Table 8).

5.4.2 Site Resilience Assessments

Three of the 22 sites assessed were considered to have a high resilience (Table 11). This comprised Lower Crockford, Upper Crockford and Shipton Bottom, which have historically been referred to as the 'Crockford Complex'. A further three sites were judged to have moderate resilience as they were both large and were afforded a moderate connectivity with other sites (Table 11).

Seven of the remaining 16 sites were considered to be vulnerable. These sites were all relatively small (i.e. based on the number of sample points included in the habitat condition analysis) and isolated, therefore at a greater vulnerability to threats or pressures that could lead to the loss of southern damselfly from the site, and highly unlikely to be re-populated if lost. Indeed, this included two sites where it is possible / likely that southern damselfly have already been lost (see Section 6).

5.4.3 Southern damselfly population assessments

Five sites were considered to support a large or strong population of southern damselfly (Table 11). This included four of the six sites judged to provide optimal habitat conditions. Mill Lawn also supported large numbers of southern damselfly, but this was a largely driven by the size rather than the quality of the site, with the length of transects surveyed for southern damselfly at Mill Lawn almost two times that of the next longest site (i.e. Upper Crockford), and ten-times greater than eleven of the remaining 20 sites (Table 8).

Four sites were considered to support medium strength populations including Acres Down (assessed to support poor habitat) and Clayhill Bottom (assessed to be of sub-optimal habitat quality and supporting a high density of individuals). Half of the sites were considered to support weak populations with only a single individual recorded at Bagshot Moor (Table 8), and two southern damselfly recorded during habitat attribute rather than adult count surveys at Foulford. No southern damselfly were recorded at Dibden Bottom or Howen Bottom, which is consistent with surveys conducted in 2013.

Four sites were considered to support high density populations, comprising one sub-optimal and three optimal sites based on habitat condition (Table 11). Three sites supported a moderate density of damselflies, including Acres Down which once again performed better in this measure than expected based on the habitat condition assessment. Nearly 60% of sites (i.e. 13) were considered to support low density populations, and as outlined above southern damselfly were not recorded at a further two sites. Low density populations were recorded at one site of optimal and sub-optimal habitat quality each. However, 11 of these 13 sites were also considered to be of poor habitat condition (Table 11), a further indication of a reasonably robust association between these two measures.

6. STATUS ASSESSMENTS AND SITE ACCOUNTS

Each site is given an overall subjective assessment of site status based on the results of the four assessments outlined in Section 5 above. Site status was separated into one of six categories:

- Excellent
- Good
- Moderate
- Poor
- Vulnerable
- (Potentially) Extinct

Of the 22 sites assessed (see Section 7.1), three were judged to be excellent, two good and at best four of moderate status (see Section 6.1). Furthermore, four sites were of poor status, seven vulnerable, and one considered to potentially be extinct. Finally, it is considered that the southern damselfly population previously recorded at Howen Bottom is now extinct.

An aerial photograph map is included at the beginning of each site status assessment (set out in Sections 6.1–6.22), showing the transect sections and site in the context of its surrounding habitat. Transect sections supporting male southern damselfly are coloured blue, whereas sections where none were observed are coloured yellow, and (parts of) transect sections removed from habitat condition analysis are shown in pink.

Aerial photograph maps are shown at scale of 1:4,250, so that the map shows a width of 1km. For four sites the scale has been altered to include the whole site and / or show the site in the context of its wider habitat, these are as follows: Crockford Stream (Upper) and Shipton Bottom are 1.65km wide and at scale of 1:7,000, Mill Lawn is 1.5km wide and at a scale of 1:6,350, and Millersford Bottom is 1.2km wide and at a scale of 1:5,100.

6.1 Acres Down

Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Vulnerable	Medium	Moderate

Site Status: **MODERATE TO POOR**

Explanation: Acres Down supported a medium strength southern damselfly population at a moderate density across the five transect sections. However, the site was considered to support poor habitat conditions, and is highly isolated and therefore at greater risk of extinction.

Habitat Condition: Acres Down failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed. Furthermore, it had limited cover of oviposition plants and extensive areas of bracken beginning to encroach the runnels.

Every transect section failed on water flow, with too few sample points supporting a discernible flow. Furthermore, all transect sections failed on stiff emergent vegetation, with sections 1.1–1.4 also failing due to limited opportunities for oviposition (too few); transect sections 1.2 and 1.4 failed on bracken, and 1.2 on eutrophication.

Damselflies: 46 male southern damselfly were recorded during adult transect count surveys, at a density of 13.69 damselflies per 100m, and with individuals recorded on all five transect sections.

Resilience: Acres Down is small and isolated, the nearest site (Mill Lawn) located over 6km away.

Hydrology: Primarily small runnels with limited areas of associated mire; upper slope was dominated by damp or standing water conditions, with runnels becoming more defined and supporting a slow to moderate flow on the lower sections of the slope.

Other Notes: *None.*

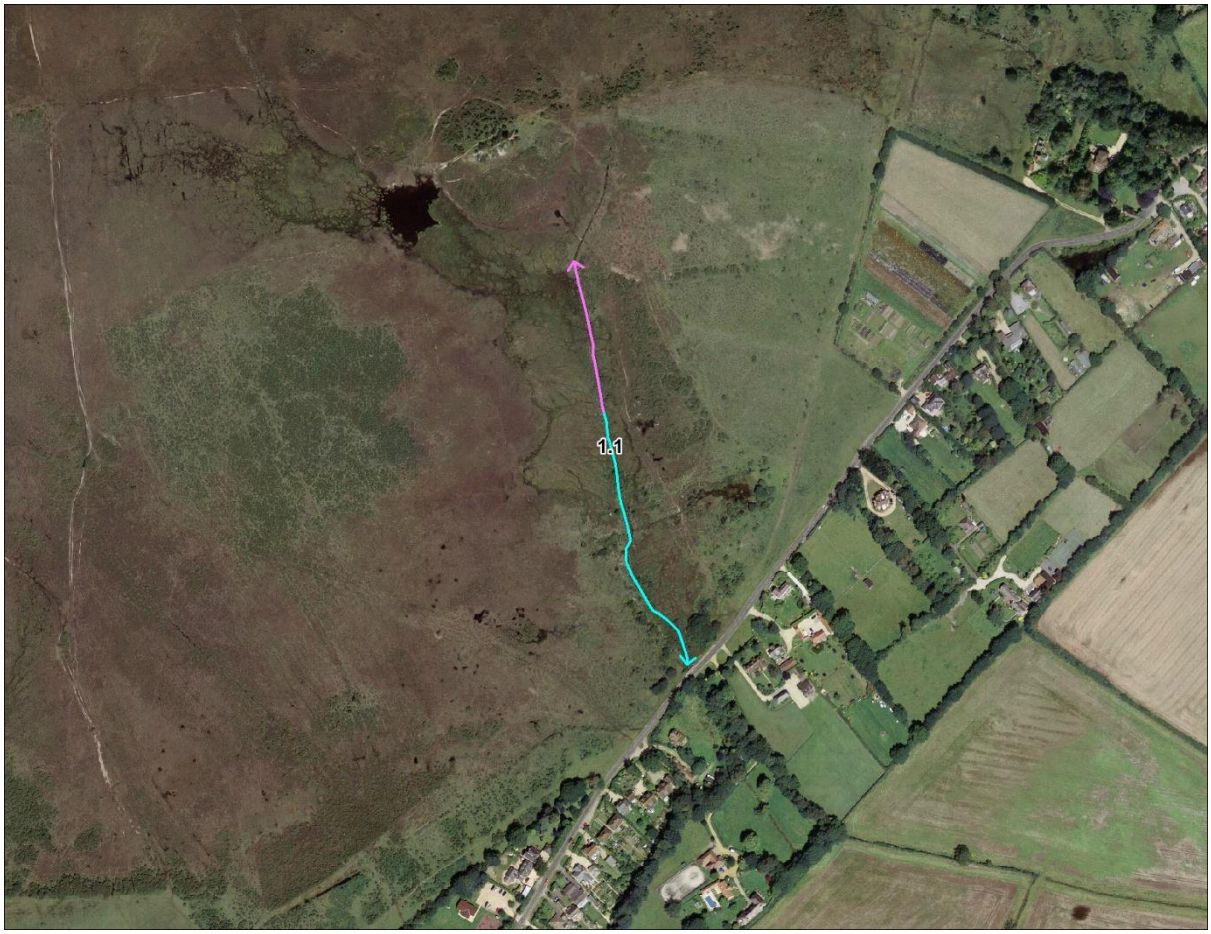
Comments: There was an increase in and similar number of transect sections that failed on flow and oviposition plants respectively compared with the 2013 study. There was a slight increase in southern damselfly abundance and density compared with the 2013 adult count survey (i.e. 39 males at 11.61 damselflies per 100m).

Acres Down was the most challenging assessment of site status, and this is reflected in the dual category assigned. The key difficulty in assessing this site was accurately assessing the condition or suitability of the habitats it supports for southern damselfly. Based on limited observations (i.e. surveys conducted in 2013 and 2019), it appears that this is a dynamic site, with the route that water flows through the site shifting between years. This may have resulted in an underestimation of the presence of flowing water (and by association amount of plants available for oviposition) across the site, with the failure of these attributes the cause for its 'poor' habitat condition assessment.

However, based on the southern damselfly population and site resilience assessments, it was considered that a 'moderate' status would be the highest category it could be assigned irrespective of any increase in its habitat condition assessment.

Finally, it is strongly recommended that a hydrological assessment is conducted at Acres Down to accurately establish the linear features and habitat areas of the site that will support a perennial supply of flowing water. This will ensure the most appropriate areas of this site are included in future monitoring, and therefore an accurate assessment of habitat condition (and by association population structure) at the site is achieved. Furthermore, this study will help to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified.

6.2 Bagshot Moor



Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Low	Weak	Low

Site Status: **VULNERABLE**

Explanation: Bagshot Moor was assessed to meet the criteria for the bottom categories for habitat condition and in both measures of population assessment, only achieving low (rather than vulnerable) site resilience due to its moderate connectivity with other southern damselfly sites.

Habitat Condition: Bagshot Moor comprised a single transect / section which failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed. Indeed, despite the removal of a third of the original sample points from the analysis, a discernible flow could not be detected at any of the remaining sample points (Appendix 5).

Furthermore, the site also failed on the quality of bankside vegetation structure present, with extensive sections supporting only uniformly low vegetation.

Damselflies: A single male southern damselfly (i.e. a density of 0.28 damselflies per 100m) was recorded during the adult count survey.

Resilience: Bagshot Moor is relatively small, though Shipton Bottom and Hatchet Stream are located within 0.7km and 1.3km respectively.

Hydrology: This site supported a distinct channel, although no discernible flow was observed along its length, and the bed of the upper (northern) reaches of the transect / section was characterised by exposed damp / dry mud and excluded from the habitat condition analysis.

Other Notes: *None*.

Comments: Bagshot Moor was assessed to be less suitable for southern damselfly in 2019 than it was in 2013. This was a result of the substantial reduction in availability of flowing water at the site, and was reflected in a reduction in both abundance and density since the previous study (i.e. 26 males at 7.26 damselflies per 100m in 2013). Indeed, the presence of only a single male damselfly during the adult transect survey indicated that this population could be at risk of being lost.

It is strongly recommended that a hydrological assessment is conducted at Bagshot Moor to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified.

6.3 Bull Hill

Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Low	Weak	Low

Site Status: **VULNERABLE**

Explanation: Bull Hill was assessed to meet the criteria for the bottom categories for habitat condition and in both measures of population assessment, only achieving low (rather than vulnerable) site resilience due to its moderate connectivity with other southern damselfly sites.

Habitat Condition: Bull Hill failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed. Indeed, transect section 1.2 was removed from the habitat condition assessment as it was entirely dry at the time of survey. Within the southern part of the site the bank tops had become dominated by a dense band of bog myrtle which was shading out the main stream, and the north of the site was also overly shaded with much of the channel flowing through dense tree and scrub cover. This therefore fragmented the potentially suitable habitat available at the site.

Transect sections 1.1 and 1.5 (present in the south of the site) were the only sections to pass on water flow, though the former only after an adjustment to the sample points analysed. Section 1.4 failed on too much shade, and transect sections 1.1 and 1.4 failed on poor bankside structure. Transect

sections 1.1, 1.4 and 1.5 all failed on too little stiff emergent vegetation, and 1.5 failed on too little bog myrtle in the watercourse. Furthermore, transect sections 1.3 and 1.4 failed on eutrophication, and 1.4 on too few plants for oviposition.

Damselflies: 22 male southern damselfly were recorded during adult transect count surveys, at a density of 5.1 damselflies per 100m, but with individuals only recorded on transect sections 1.1 and 1.5 (i.e. transect sections that passed on water flow).

Resilience: Bull Hill is relatively small, though Crockford Stream (Upper) and Crockford Stream (Lower) are located within 1km and 1.3km respectively.

Hydrology: A small stream (transect sections 1.1[lower part], 1.2 and 1.4) characterised by areas of standing water in the south, before it became completely dry through transect section 1.2. Small, slow flowing runnels fed into the southern part of the main channel (1.1 [upper section that was removed from habitat condition analysis] and 1.5) from the east, and transect section 1.3 was a small mire with no discernible flow at the time of the survey.

Other Notes: *None*.

Comments: Bull Hill was assessed to be less suitable for southern damselfly in 2019 compared with 2013. This was a result of the substantial reduction in availability of flowing water at the site. This was not reflected in the adult count data, with an increase in both the abundance and density of male southern damselfly from 10 males / 2.32 damselflies per 100m in 2013. However, male southern damselfly were recorded on four of the five transect sections in 2013, whereas only two supported southern damselfly in 2019, with over two-thirds of those recorded located on transect 1.5.

It is strongly recommended that a hydrological assessment is conducted at Bull Hill to accurately establish the linear features and habitat areas of the site that will support a perennial supply of flowing water. This will ensure the most appropriate areas of this site are included in future monitoring, and therefore an accurate assessment of habitat condition (and by association population structure) at the site is achieved. Furthermore, this study will help to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified.

6.4 Clayhill Bottom

Habitat Condition	Site Resilience	Population Strength	Population Density
Sub-optimal	Vulnerable	Medium	High

Site Status: **MODERATE**

Explanation: Clayhill Bottom supported a medium strength southern damselfly population, present at a high density across sub-optimal habitat conditions. However, it was considered that this site is vulnerable to the loss of the population due to its size and level of isolation.

Habitat Condition: Clayhill Bottom passed on key habitat attributes including water flow, level of shading, and availability of plants for oviposition. However, it failed on too little bog myrtle, plus the frequency of bracken and eutrophication (both too high).

Transect section 1.3 failed on a lack of plants for oviposition. Furthermore, transect sections 1.2 and 1.3 failed on too little bog myrtle, 1.1 and 1.2 on the frequency of bracken, and 1.3 on eutrophication.

Damselflies: 86 male southern damselfly were recorded during adult transect count surveys, at a density of 46.99 damselflies per 100m, and with individuals recorded all three transect sections.

Resilience: Clayhill Bottom is small and isolated, the nearest site (Stony Moors) located over 2km away.

Hydrology:	Linear with slow to moderate flows throughout the site; the channels were generally sunk below the adjacent habitat, increasing the impact of dense bank-top vegetation where it occurred.
Other Notes:	*None*
Comments:	This site was assessed to be in 'Unfavourable condition' in 2013. A reduction in shading and increase in the coverage of silt / mud / peat substrate are the key factors in its improved status in this assessment. This was reflected in an increase in both abundance and density of male southern damselfly recorded during adult count surveys since the previous study (i.e. 55 males at 30.05 damselflies per 100m in 2013). The site is small and relatively isolated and, given the sunken nature of this channel, susceptible to adverse impact from the development of bank top scrub. Furthermore, there was evidence of nutrient enrichment affecting the site. It was therefore considered that this site could rapidly deteriorate without continued management.

6.5 Common Moor

Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Vulnerable	Weak	Low

Site Status: **VULNERABLE**

Explanation: Common Moor was assessed to meet the criteria for the bottom categories in all four assessments.

Habitat Condition: Common Moor comprised a single transect / section which failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed. It also failed on limited opportunities for oviposition and a lack of stiff emergent vegetation.

Damselflies: 6 male southern damselfly were recorded during the adult count survey, at a density of 8.96 damselflies per 100m.

Resilience: Common Moor is extremely small (i.e. comprised of only five sample points) and isolated, the nearest site (Foulford) located nearly 2km away.

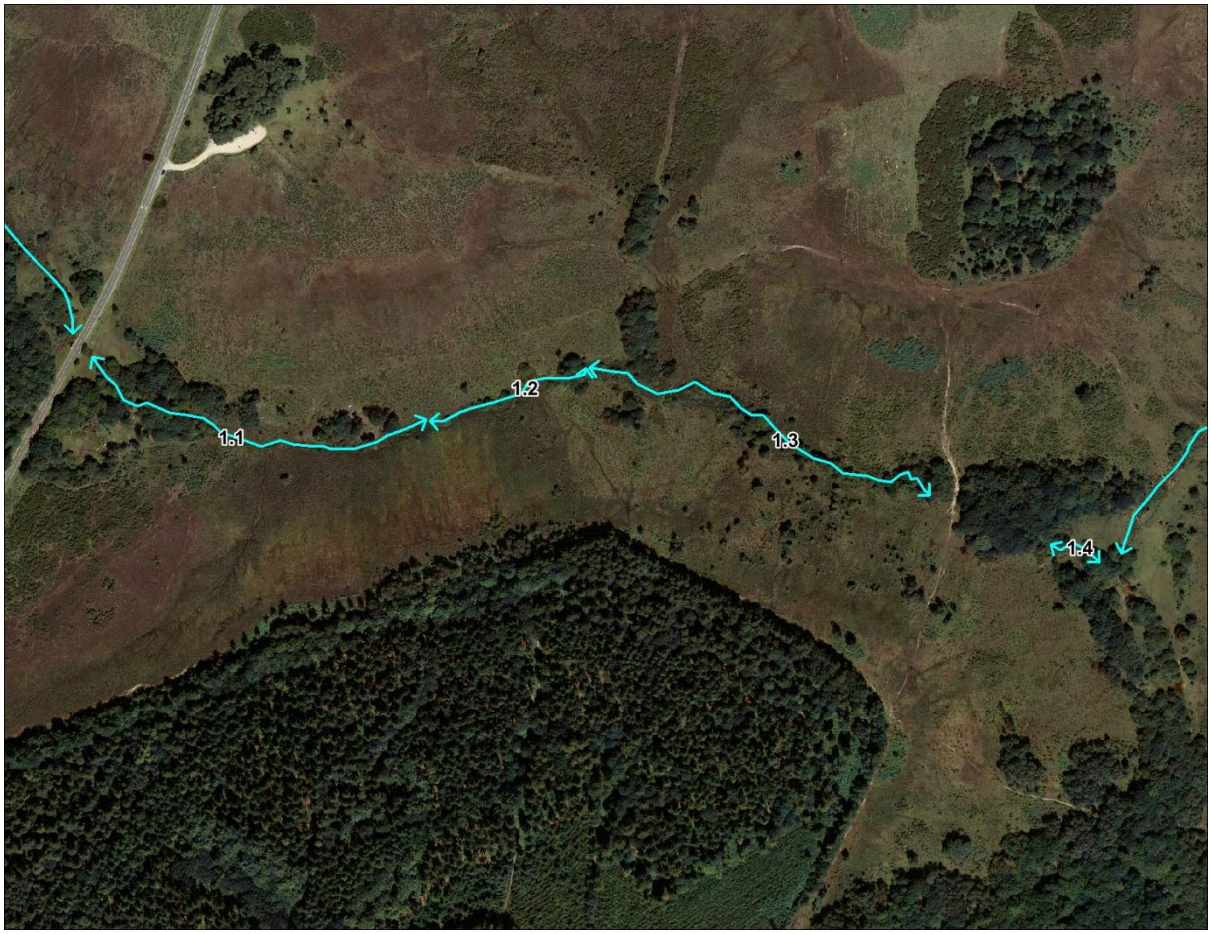
Hydrology: There was an east to west shift from a fully linear to a more mire type habitat character. However, flow was absent or barely discernible throughout the length of the transect section.

Other Notes: The hydrology of the site has varied across studies, recorded as mostly non-linear habitat in 2004, predominantly linear in 2013, to a mix of both types in 2019. There was extensive coverage of bog myrtle and purple moor grass *Molinia caerulea* across the site, and only limited evidence of grazing was recorded.

Comments: Common Moor failed on water flow and opportunities for oviposition in both 2013 and 2019. Furthermore, 2019 saw a reduction in the number of samples supporting a suitable flow, and the number of male southern damselfly recorded. Indeed, the presence of only six male damselfly during the adult transect survey indicated that this population could be at risk of being lost. Furthermore, the site was bordered by scrub, which exacerbated the isolated nature of this site by inhibiting migration into the site.

It is strongly recommended that a hydrological assessment is conducted at Common Moor to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified. Indeed, if it is a result of the latter and given the very small size of the site, it would be highly beneficial to extend the potential suitable habitat available where feasible.

6.6 Crockford Stream (Lower)



Habitat Condition	Site Resilience	Population Strength	Population Density
Optimal	High	Strong	High

Site Status: **EXCELLENT**

Explanation: Crockford Stream (Lower) was assessed to meet the criteria for the peak categories in all four assessments.

Habitat Condition: Crockford Stream (Lower) passed on all key and other important habitat attributes, but did fail on the frequency of stiff emergent vegetation (i.e. too limited) and eutrophication (i.e. too high).

Transect section 1.4 failed on poor bankside vegetation structure (uniform low providing little to no shelter for adult damselflies). Furthermore, all transect sections failed on the limited availability of stiff emergent vegetation, and sections 1.1, 1.2, and 1.4 on the frequency eutrophication was recorded.

Damselflies: 223 male southern damselfly were recorded during adult transect count surveys, at a density of 26.64 damselflies per 100m, and with individuals recorded on all four transect sections.

Resilience: Crockford Stream (Lower) is large and located within 1km of two other sites (i.e. Crockford Stream [Upper] and Shipton Bottom).

Hydrology:	Linear stream with flowing water throughout with mires and seepages running into the main channel, predominantly from the valley side to the south.
Other Notes:	Extensive areas of gorse and bracken were present on the valley side to the north of the main channel, and had the potential to encroach onto transect sections 1.1, 1.2 and 1.3 in the future; dense bands of overhanging bank top bog myrtle also shaded out reaches of transect sections 1.1 and 1.3.
Comments:	Crockford Stream (Lower) was assessed to be in 'Unfavourable' condition in 2013 due the site failing on too much shade. The site passed this attribute in 2019 and, though not directly comparable to the earlier measure, was assessed to be of 'Excellent' status in this revised study. However, transect sections 1.1, 1.2 and 1.3 were enclosed to varying degrees, within one or more reaches of dense tree and scrub cover, or were becoming encroached (from one or both banks) by trees, scrub and / or dense bands of bank top bog myrtle. It was therefore considered that this site could rapidly deteriorate without continued management.

6.7 Crockford Stream (Upper)

Habitat Condition	Site Resilience	Population Strength	Population Density
Optimal	High	Strong	High

Site Status: **EXCELLENT**

Explanation: Crockford Stream (Upper) was assessed to meet the criteria for the peak categories in all four assessments.

Habitat Condition: Crockford Stream (Upper) passed on all key and other important habitat attributes, but did fail on the frequency of stiff emergent vegetation (i.e. too limited) and eutrophication (i.e. too high).

Transect sections 1.6 and 1.7 failed on water flow, despite the removal of several and a small number of sample points respectively from the analysis of each. All sections (excluding 1.7) failed on limited availability of stiff emergent vegetation. Transect sections 1.3 and 1.5 failed on a lack of both plants for oviposition and in-channel bog myrtle, sections 1.1, 1.2, 1.6 and 1.7 failed on the presence of eutrophication, and 1.1 due to poor bankside vegetation structure (i.e. uniform low providing little to no shelter for adult damselflies).

Damselflies: 788 male southern damselfly were recorded during adult transect count surveys, at a density of 37.29 damselflies per 100m, and with individuals recorded all on all transect sections except 1.6.

Resilience: Crockford Stream (Upper) is large and located within 1km of two other sites (i.e. Crockford Stream [Lower] and Shipton Bottom).

Hydrology: Predominantly linear streams with clear flow across most of the site and some areas of associated mire. Transect section 1.6 was an equal mix of linear and mire habitats, with largely dry or damp exposed substrate at the time of the habitat assessment. Transect section 1.7 was dry in the upper reaches but became increasingly wet with a clear slow to moderate flow supported in the lower reaches.

Other Notes: Very few southern damselfly were recorded on the western arm in the upper half of the site, with zero and 13 male damselflies recorded on transect sections 1.6 and 1.7 respectively. This was similar to the adult counts conducted in 2013 (i.e. six and zero respectively). Furthermore, based on the description of the site's hydrology, 2013 survey data, and the length surveyed / analysed, it was considered likely that these transect sections were notably wetter in both 2004 and (to a lesser degree) 2013.

It was understood that water supply to transect section 1.7 was historically via a single pipe associated with the disused World War II airfield. The removal of the concrete perimeter track and the associated pipe has resulted in a more dispersed distribution of water across this area through various runnels, rather than concentrated in the main channel itself (Jenkins, personal communication).

Comments: In contrast to the general trend (see Section 5.2), there was an increase in the number of male southern damselfly recorded in comparison with the 2013 data (i.e. 644 males in total).

It is recommended that a hydrological assessment is conducted on transect sections 1.6 and 1.7 to determine whether they should be included in further condition assessments. It remains unclear whether the findings of the current study reflect the prevailing dry weather conditions experienced in 2019 or, given the equivalently low numbers of males recorded in 2013, that these areas no longer provide year-on-year habitat for southern damselfly.

6.8 Dibden Bottom

Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Vulnerable	Not recorded	Not recorded

Site Status: **POTENTIALLY EXTINCT?**

Explanation: Dibden Bottom was assessed to meet the criteria for the bottom categories in both habitat condition and site resilience assessments. No southern damselfly were recorded during any surveys conducted in 2019 or 2013.

Habitat Condition: Dibden Bottom comprised a single transect / section and, although it did pass on water flow, it only supported a small area of suitable habitat due to heavy shading of the channel by a continuous line of trees on the northern bank. Furthermore, it also failed due to poor bankside vegetation structure (too shady), and limited in-channel bog myrtle and stiff emergent vegetation.

Damselflies: No male southern damselfly were recorded during adult transect count surveys, and it was considered that southern damselfly was either absent or at extremely low numbers at Dibden Bottom.

Resilience: Dibden Bottom is small and highly isolated, the nearest site (Hatchet Stream) located over 6.5km away.

Hydrology: Linear channel supporting a barely discernible flow throughout much of its length.

Other Notes: *None*.

Comments: Dibden Bottom was added to the Favourable condition assessment in 2013 as southern damselfly had been recorded there in the relatively recent past. However, this species was not recorded at the site in either 2013 or 2019.

Furthermore, it failed the assessment on water flow in 2013, and on too much shade in both years. It was therefore considered highly possible that southern damselfly are no longer present at the site. If southern damselfly have been lost it is highly unlikely that the site will be re-populated due to the isolated character of this site.

6.9 Duckhole Bog

Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Vulnerable	Weak	Low

Site Status: **VULNERABLE**

Explanation: Duckhole Bog was assessed to meet the criteria for the bottom categories in all four assessments.

Habitat Condition: Duckhole Bog comprised a single transect / section which failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed. However, this site / transect section passed on all other attributes.

Damselflies: 12 male southern damselfly were recorded during the adult count survey, at a density of 8.57 damselflies per 100m.

Resilience: Duckhole Bog is small and relatively isolated, the two nearest sites (i.e. Stag Brake and Mill Lawn) located 1.1km and 1.9km away respectively.

Hydrology: Combination of linear and mire habitat with variable flow, including areas with no discernible flow.

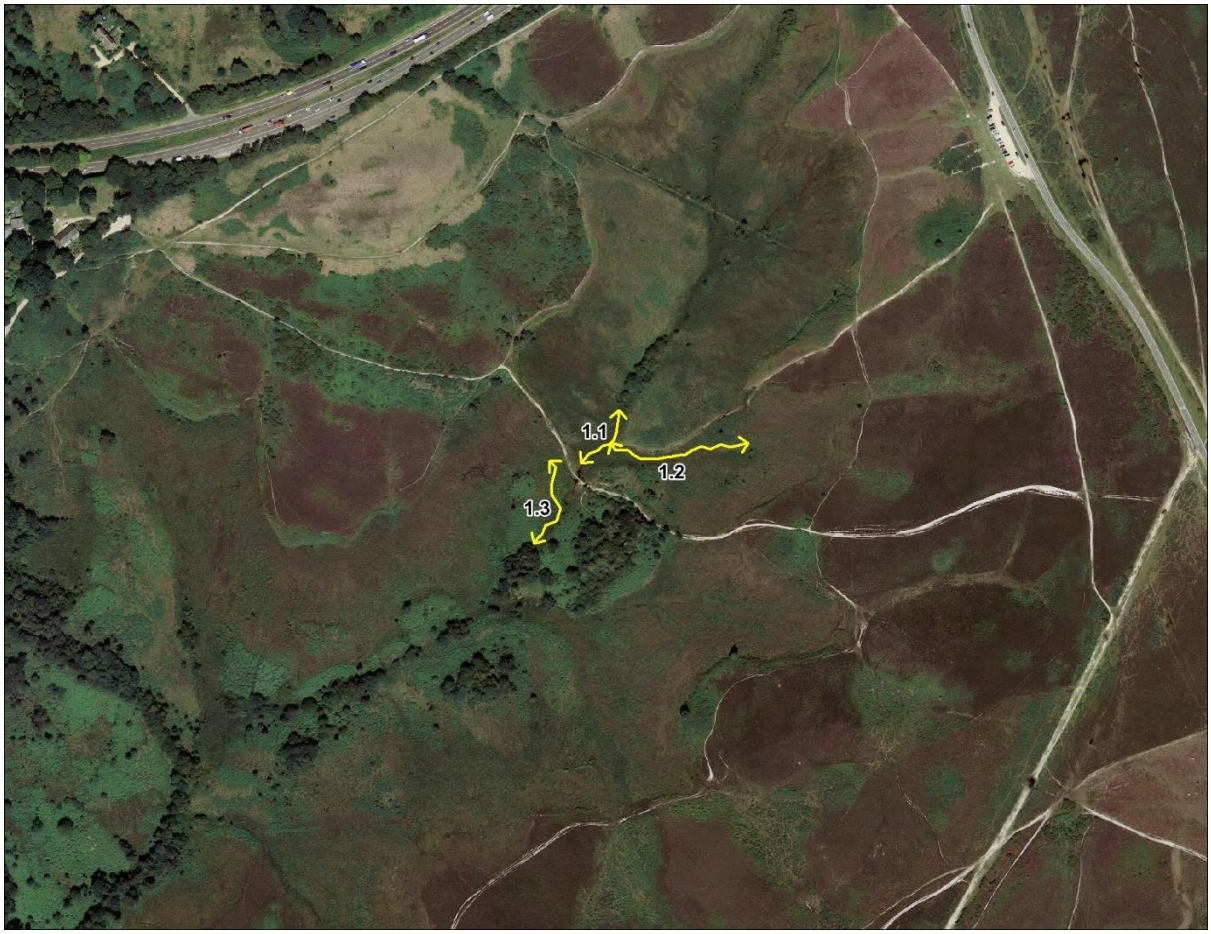
Other Notes: Within the 2013 project brief it was identified that the length of channel to be surveyed at this site may need to be extended from that assessed in the

original study, to reflect recent management at this site. However, in both 2013 and 2019 it was decided that it was more appropriate to survey the original length due to the lack of discernible flow across the site.

Comments: Duckhole Bog failed on water flow in both 2013 and 2019. There was however a slight increase in southern damselfly abundance compared with the 2013 adult count survey (i.e. 2 males in total), though this increase of 10 individuals was not considered enough to represent a corresponding increase when assessing the strength of the population.

It is strongly recommended that a hydrological assessment is conducted at Duckhole Bog to ensure that the study includes the most appropriate length of linear habitat that will support a perennial supply of flowing water. An assessment of too great length could result in an unduly negative assessment of habitat conditions at the site. Furthermore, this a hydrological study will help to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified.

6.10 Foulford



Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Low	Weak*	Low*

* Two individuals recorded on transect section 1.1 during habitat assessments

Site Status: **VULNERABLE**

Explanation: Foulford was assessed to meet the criteria for the bottom categories in three of the four assessments, and no southern damselfly recorded during the formal adult count surveys.

Habitat Condition: Foulford failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed. Furthermore, the amount of bracken present and availability of stiff emergent vegetation was of concern.

All transect sections failed on water flow, transect section 1.2 failed on the limited availability of stiff emergent vegetation and transect section 1.3 failed on too much shade and bracken.

Damselflies: No male southern damselfly were recorded during adult transect count surveys. However, two male southern damselfly were observed on transect section 1.1 during habitat attribute surveys.

Resilience:	Foulford is relatively small, but located approximately 0.6km from the nearest site (Shobley).
Hydrology:	Transect section 1.1 was linear with some reaches supporting slow water flow, but becoming subterranean for short lengths. Transect sections 1.2 and 1.3 were mires in their upstream reaches becoming linear downstream before joining or becoming the main channel respectively.
Other Notes:	The area surveyed had become encroached with scrub, bog myrtle and dense, tussock-forming grasses.
Comments:	Two male southern damselfly were recorded across both adult count and habitat attribute surveys in each of 2013 and 2019. Furthermore, concerns were raised prior to both this and the previous study regarding the level of encroachment of scrub, bog myrtle and dense, tussock-forming grasses. It was therefore considered highly likely that this site only supported a small number of southern damselfly, and the population was at risk of localised extinction. It is strongly recommended that a hydrological assessment is conducted at Foulford to accurately establish the linear features and habitat areas of the site that will support a perennial supply of flowing water. This will ensure the most appropriate areas of this site are included in future monitoring, and therefore an accurate assessment of habitat condition (and by association population structure) at the site is achieved. Furthermore, this study will help to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified.

6.11 Hatchet Stream

Habitat Condition	Site Resilience	Population Strength	Population Density
Optimal	Moderate	Medium	Low

Site Status: **MODERATE**

Explanation: Hatchet Stream was assessed to be a moderately resilient site that provided optimal habitat conditions for southern damselfly. However, it only supported a medium strength population, present at a low density.

Habitat Condition: Hatchet Stream comprised a single transect / section which passed on all key and other important habitat attributes, only failing on the frequency of stiff emergent vegetation (i.e. too limited) and eutrophication (i.e. too high). However, water flow was passed only after a small adjustment was made to the sample points analysed.

Damselflies: 45 male southern damselfly were recorded during the adult count survey, at a density of 6.12 damselflies per 100m.

Resilience: Hatchet Stream supports a reasonable length of (potentially) suitable habitat and is located within 1.3km of both Crockford Stream (Upper) and Shipton Bottom.

Hydrology: Mostly linear channel with clear flow for most of its length but became predominantly mire and eventually dry at the western (upstream) end.

Other Notes: *None*.

Comments: Fewer male southern damselflies were recorded during the 2019 adult count survey compared with 2013 (i.e. 60 males in total). However, it was considered that the difference in damselfly numbers observed could lie within the natural variation expected between single annual adult counts at this site.

The 2019 habitat attribute surveys were conducted at the end of July, following an extended period of dry weather, whereas the original length of transect / section to be surveyed was determined in 2004 following a wet July (Harvey *et al*., 2005). Therefore, since only the upper reaches of this transect section were dry in 2019, it was considered that the slightly revised transect section length included within this analysis more accurately reflected the potentially suitable habitat available, which was over-estimated in 2004 due to the high summer rainfall experienced in that year.

6.12 Howen Bottom

Habitat Condition	Site Resilience	Population Strength	Population Density
Not assessed†	Vulnerable	Not recorded	Not recorded

† All transect sections entirely dry so considered unsuitable and not assessed

Site Status: **EXTINCT**

Explanation: All three transect sections at Howen Bottom were entirely dry at the time of the 2019 surveys, and to the authors knowledge there have been no record of southern damselfly at this site since 1984. Furthermore, the site is highly isolated, and if southern damselfly have been lost it is highly unlikely that the site will be re-populated.

Habitat Condition: No habitat assessment was conducted since all three transect sections were entirely dry at the time of the 2019 surveys, and therefore considered wholly unsuitable for southern damselfly.

Damselflies: No male southern damselfly were recorded during adult transect count surveys, and it was considered extremely likely that southern damselfly have been lost from Howen Bottom.

Resilience: This site does not support any (potentially) suitable habitat and is highly isolated, the nearest site (Latchmore) located 4km away.

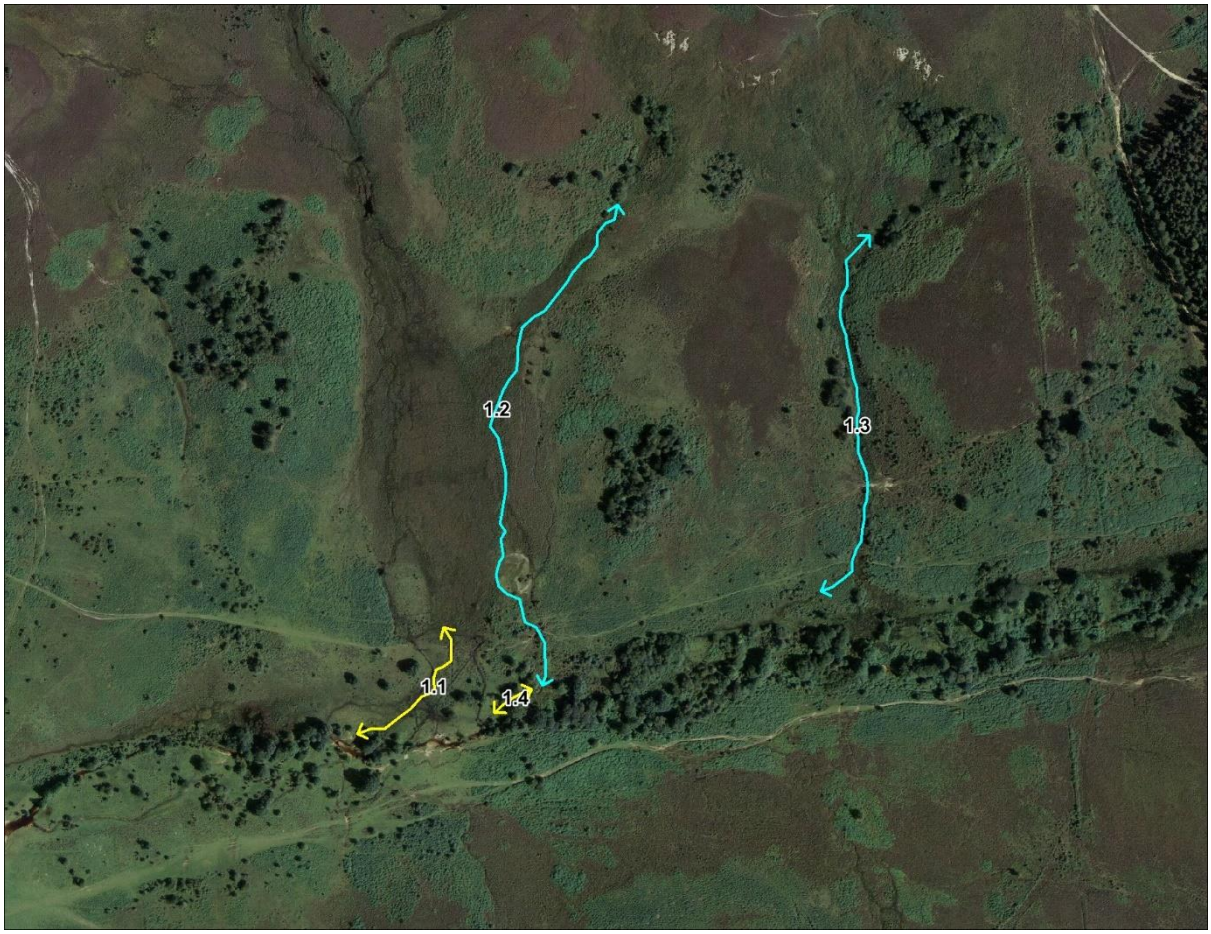
Hydrology: A linear channel that was dry at the time of survey.

Other Notes: *None.*

Comments: The results of the 2013 and 2019 condition assessments were consistent with the conclusion of Hayward's (2011) desktop and field based study that Howen Bottom was unsuitable for southern damselfly. Of specific note, the main channel was also observed to be dry during a site visit undertaken in the summer of 2010. This observation was made at a location approximately 250m 'upstream' of transect section 1.3, and 150m 'downstream' of a historic (1984) record of southern damselfly.

Furthermore, heavy grazing pressure has created a uniformly low sward height surrounding the majority of the site, which offered little shelter and roosting opportunities for adult damselfly.

6.13 Latchmore



Habitat Condition	Site Resilience	Population Strength	Population Density
Optimal	Low	Strong	Moderate

Site Status: **GOOD**

Explanation: Latchmore is a large site and provided optimal habitat conditions for southern damselfly across most of the site, which was reflected the relatively strong population it supports. However, the site is isolated, and despite its strength the population was poorly distributed across the site and present at a moderate density only.

Habitat Condition: Latchmore provided optimal habitat conditions for southern damselfly across most of the site, passing on all habitat attributes at the site level.

Transect sections 1.1 and 1.4 failed on a lack of in-channel bog myrtle and poor (uniformly low) bankside vegetation structure, with the latter also failing due to restricted water flow.

Damselflies: 176 male southern damselfly were recorded during the adult count surveys, at a density of 18.26 damselflies per 100m. However, 90% of male southern damselfly were recorded on transect section 1.3, and none recorded on either section 1.1 or 1.4.

Resilience: Latchmore is large, but also isolated, the nearest site (Millersford Bottom) located over 3km away.

Hydrology: Transect section 1.1 was predominately mire with a barely discernible to slow water flow. Transect section 1.2 was a mix of mire and linear habitat with discernible flow, whereas transect section 1.3 was linear with stronger water flow throughout. Transect 1.4 was linear but primarily without flow at the time of survey.

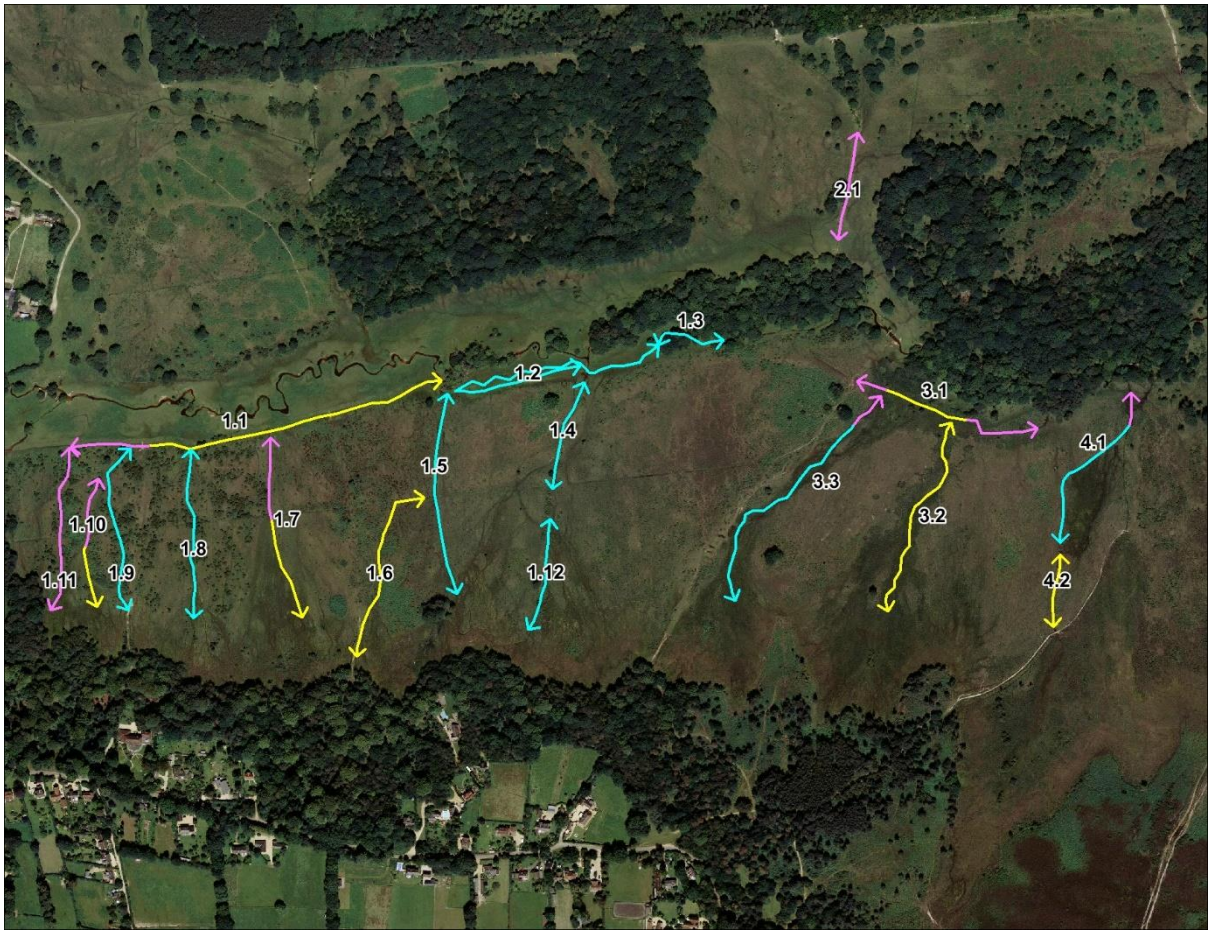
Other Notes: As a general rule linear habitats appear to be more suitable for southern damselfly (Rushbrook *et al*., 2014), and notably more individuals were associated with linear than mire habitats on transect section 1.2 at Latchmore. Bog myrtle and areas of scrub (including, but not restricted to, gorse and willow) were beginning to develop and encroach parts of transect sections 1.2 and 1.3.

Comments: Latchmore was assessed to be in 'Favourable' condition and 'Good' Status in 2013 and 2019 respectively, despite recording fewer male southern damselflies during adult count surveys in the latter (i.e. 248 males in total in 2013). This was a consequence of the habitat attribute assessments producing similar results to 2013, and because the results of the adult count surveys fell within the range of individuals recorded across a detailed survey programme conducted in 2014 (Rushbrook *et al*., 2015).

It is strongly recommended that a hydrological assessment is conducted at Latchmore to accurately establish the linear features and habitat areas of the site that will support a perennial supply of flowing water. This will ensure the most appropriate areas of this site are included in future monitoring, and therefore an accurate assessment of habitat condition (and by association population structure) at the site is achieved. Specifically, based on the authors' observations in 2013 and 2019, consideration should be given to the removal of transect section 1.4, and transect section 1.1 should either be extended or replaced to follow the runnel upstream of this section as illustrated in Rushbrook *et al*. (2015).

Furthermore, this study may identify potential additional areas that, following habitat restoration, could provide suitable habitat for southern damselfly.

6.14 Mill Lawn



Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Moderate	Strong	Low

Site Status: **MODERATE**

Explanation: Mill Lawn is an extremely large site that supported a relatively strong population of southern damselfly. However, despite the removal (i.e. transect sections 1.11 and 2.1) or adjustment of several transect sections from the analysis, the site was still assessed to provide poor habitat conditions across most of the site. Furthermore, the population was poorly distributed across the site and only present at a low density.

Habitat Condition: Mill Lawn failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed, with nearly two-thirds of the transect sections failed on this habitat attribute. Further concerns existed with regards to the poor vegetation structure associated with the majority of transect 1, where heavy grazing of the 'lawn' has resulted in areas of uniformly low bankside vegetation and little bog myrtle to provide shelter for adults.

Multiple transect sections failed on water flow (1.1, 1.4, 1.6, 1.7, 1.9, 1.10, 3.1– 3.3 and 4.1), poor bankside vegetation structure (1.1–1.5, 1.7–1.10, 1.12 and 4.2), too little bog myrtle (1.1–1.10 and 1.12), too limited stiff emergent vegetation (1.2–1.4, 1.7, 1.10, 1.12 and 4.1) and the presence of bracken (1.4,

1.6, 1.7, 1.9, 1.10 and 4.1). Furthermore, transect sections 1.7, 4.1 and 4.2 failed on too much shade, and transect sections 1.1., 1.7 and 4.1 failed on the presence of eutrophication.

Finally, transect sections 1.11 and 2.1 were almost completely and entirely dry respectively, and therefore failed due to an absence of open water (N.B these transect sections were therefore not included in the current habitat condition assessment as set out above).

Damselflies: 168 male southern damselfly were recorded during the adult count surveys, at a density of 4.06 damselflies per 100m, and with male southern damselfly recorded on only half of the transect sections surveyed.

Resilience: Mill Lawn is extremely large with the nearest site (Stag Brake) located approximately 0.8km away.

Hydrology: Transects 1 and 4 were almost exclusively linear, whereas transect 3 supported a mix of linear and mire habitat.

Other Notes: Transect section 2.1 was dry at the time of habitat surveys conducted as part of all three studies (Harvey *et al*., 2005; Rushbrook, *et al*., 2014), and the reason for its inclusion remains unclear (N.B this transect section was not included in the current habitat condition assessment as set out above).

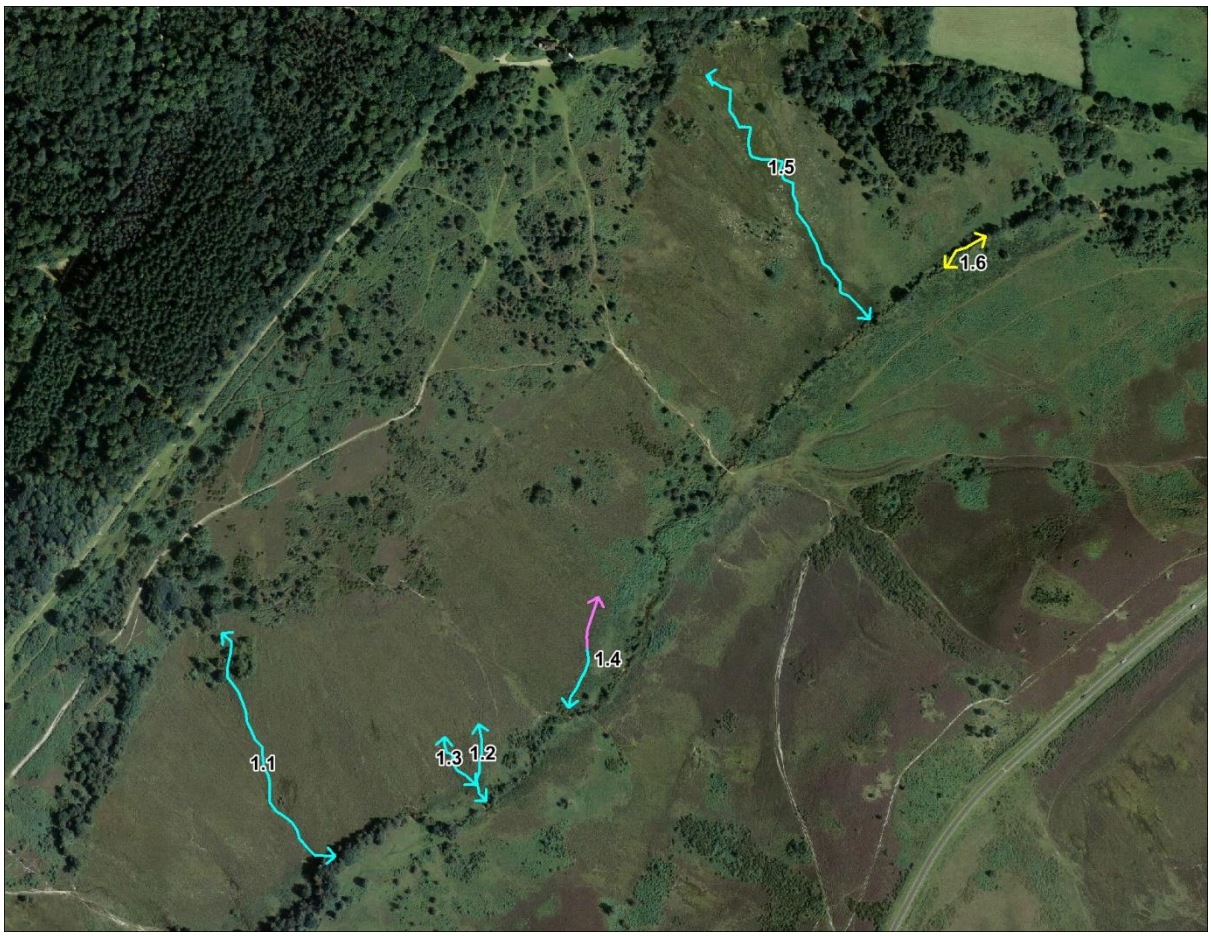
In 2013 the exact location of the original transect section 4.2 could not be determined, as the area believed to need surveying was dry with no evidence of channel or mire. The transect section 4.2 surveyed in 2013 and 2019 was therefore in a different location to that surveyed in 2004.

Heavy grazing pressure, in particular in association with transect 1, was evident at the site, and created extensive areas of uniformly low sward height surrounding the transect. Much of the site therefore offered little shelter and roosting opportunities for adult damselfly.

Comments: Mill Lawn was assessed as being in 'Unfavourable' condition in both 2004 and 2013, with water flow a concern in the 2019 and 2013 studies. Furthermore, there was a substantial reduction in the number and distribution of male southern damselfly recorded at the site, with southern damselfly recorded on all except one transect section in 2013, and a total of 428 individuals recorded across the site. This represented an almost 50% reduction in distribution at the transect section level, and an almost two-thirds reduction in total count.

It is understood that a hydrological assessment has been conducted at Mill Lawn, which was unconvinced of the value of restoration intervention here (see Section 6.23; Appendix 7). This data should be interrogated to determine which are the most appropriate linear features and habitat areas of this site to be included in future monitoring, and therefore ensure that an accurate assessment of habitat condition (and by association population structure) at the site is achieved. Further study of the data will also help to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change.

6.15 Millersford Bottom



Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Low	Weak	Low

Site Status: **VULNERABLE**

Explanation: Millersford Bottom was assessed to meet the criteria for the bottom categories in three of the four assessments. Furthermore, although it is a reasonably large site based on the number of sample points surveyed, this was offset by the poor quality of the habitat present and its isolated character.

Habitat Condition: Millersford Bottom failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed. Specifically, five of the six transect sections failed on water flow (transect sections 1.1–1.5), with transect section 1.4 adjusted due to the absence of water at the time of the survey. Furthermore, although transect section 1.6 did support suitable water flow, it failed on several key and important attributes including shade, the availability of plants for oviposition, and bankside vegetation structure (predominantly mixed shady).

Transect section 1.1 also failed on too few plants for oviposition, and transect sections 1.1 and 1.6 failed due to a lack of in-channel bog myrtle. Transect sections 1.2 and 1.4 failed on the high frequency of evidence of eutrophication, 1.5. and 1.6 on too little stiff emergent vegetation, and the 1.6 on the extent of bracken.

Damselflies: 26 male southern damselfly were recorded during the adult count surveys, at a density of 2.81 damselflies per 100m, and with a small number of male southern damselfly recorded on all transect sections except 1.6.

Resilience: Millersford Bottom is reasonably large, but is isolated with the nearest site (Latchmore) located approximately 3km away.

Hydrology: Transect section 1.5 was a mix of mire and linear habitats, whilst 1.1 was predominately mire, and forming a linear channel in its lower reaches. The remaining sections were predominately linear. Transect section 1.6 had a clear flow throughout, whereas 1.3 and 1.4 were dry in their upper reaches.

Other Notes: The best habitat was focused in the lower reaches of the site. Following discussion with local experts and based on the information provided within Strange & Bousfield (2004), it is proposed that this is a consequence of hydrological disruptions resulting from drainage works completed in the late 1990's. Despite subsequent measures undertaken to rectify this situation and return the site to its original condition, the bulk of the southern damselfly population has remained focused on the unmodified lower reaches (Jenkins, personal communication), as was observed during the current study.

The site was becoming dominated by coarse grasses and heather that was beginning to encroach the runnels in the west of the site. This was potentially due to insufficient grazing pressure (though cattle were observed on site during the surveys), which has created areas of dense thatch around the upper reaches of transect sections 1.3 and 1.4.

Within the 2013 project brief, it was identified that the length of transect section 1.6 may need to be extended following recent management undertaken at this site. However, in both 2013 and 2019 transect section 1.6 was deeply incised and subject to a high level of shading from tree cover on both bank-tops. It was therefore considered counter-intuitive to increase the length of this transect section (and by consequence it's relative contribution to the overall assessment of the site), and more appropriate to survey the original length.

It remained unclear whether the main Millersford Bottom stream (of which transect section 1.6 formed a short reach) supported southern damselfly (Hayward, 2011), or whether records of this species on the stream simply represented adult insects that had strayed from transects to the west of the channel. Measurements of pH taken approximately 25 years ago found that the stream ran at a pH of around 5.5 along its length, between Deadman Bottom and the road north of Godshill (Jenkins, unpublished data). These suggested that conditions in this stream were not suitable for this species (see section 2.3).

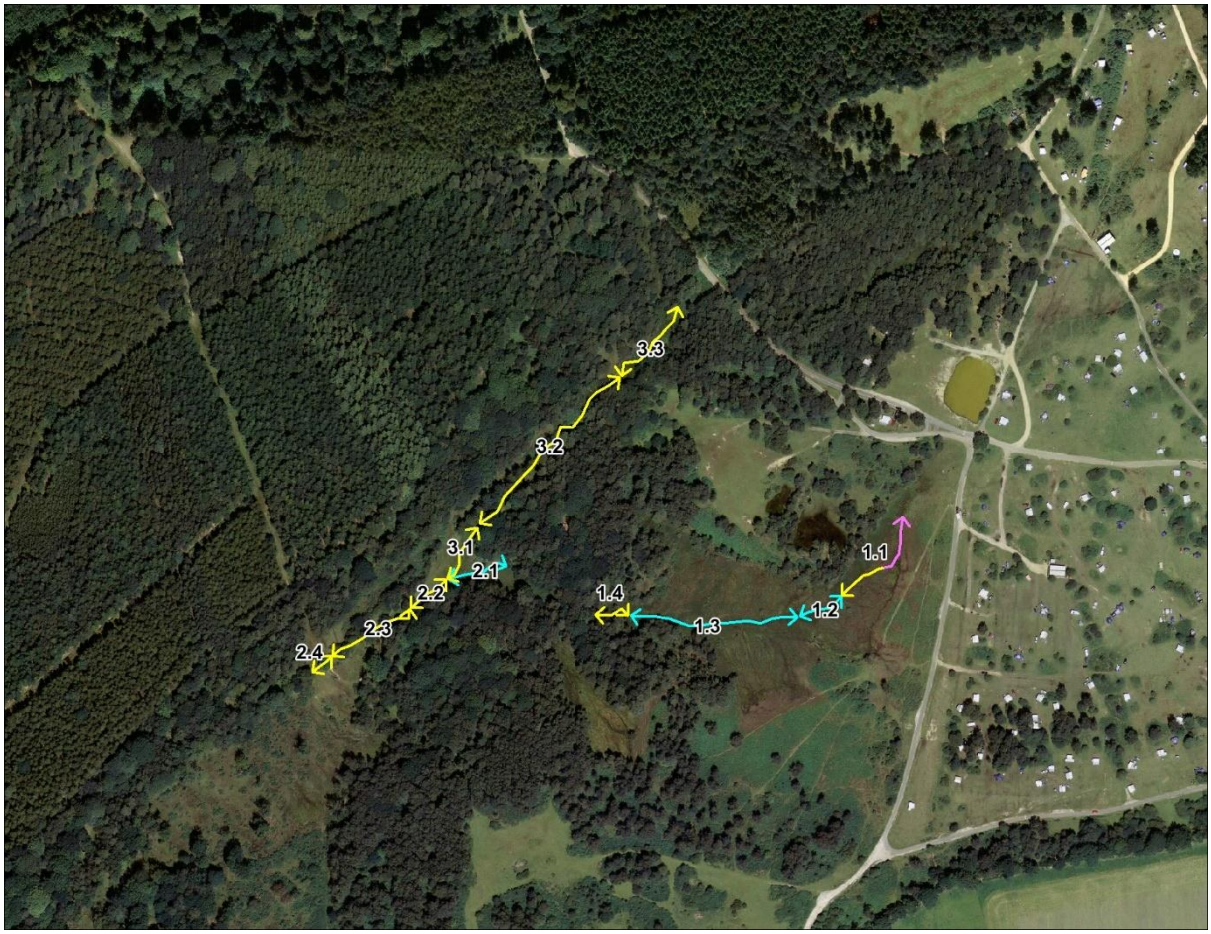
However, it is understood that pH measurements taken in 2011 and 2012 returned values of approximately pH 8 from both the main channel downstream of Millers Ford, and the lower reaches of a small side stream that entered the main channel immediately above (Jenkins, unpublished data). This level of pH was recorded along approximately half of the distance between Millers Ford and the road, and corresponded to locations where southern damselfly have been recorded (Hayward, 2011). Interestingly, Hayward (2011) reported that the water chemistry at this site was of a different ionic composition to other known southern damselfly sites. It is therefore suggested that the main channel downstream of the Millers Ford is receiving an alkaline rich pollutant, possibly derived from adjacent land use.

Comments: Millersford Bottom was assessed as being in 'Unfavourable' condition in both 2004 and 2013, with water flow a concern in the 2019 and 2013 studies, but a reason of site failure in 2019 only. Furthermore, there was a very concerning

substantial reduction in the number of southern damselfly recorded at the site (i.e. 169 males seen in 2013).

It is strongly recommended that a hydrological assessment is conducted at Millersford Bottom to accurately establish the linear features and habitat areas of the site that will support a perennial supply of flowing water. This will ensure the most appropriate areas of this site are included in future monitoring, and therefore an accurate assessment of habitat condition (and by association population structure) at the site is achieved. Furthermore, this study will help to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified.

6.16 Round Hill



Habitat Condition	Site Resilience	Population Strength	Population Density
Sub-optimal	Low	Weak	Low

Site Status: **POOR**

Explanation: Round Hill was considered to provide sub-optimal habitat conditions for southern damselfly, but only supported a weak southern damselfly population at a low density. Furthermore, although it is a reasonably large site based on the number of sample points surveyed, it was still considered to have low site resilience due to its isolated character.

Habitat Condition: Round Hill passed on all bar one habitat attribute overall (i.e. in-channel bog myrtle). However, the majority of transect sections failed on one or more of the key or important habitat attributes including water flow, level of shading, availability of plants for oviposition, and bankside vegetation structure.

Specifically, transect section 3.3 failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed, with section 1.1 only passing on this attribute following the adjustment to the sample points analysed. Sections 1.1 and 2.3 failed on the limited availability of plants for oviposition, 1.4, 2.3 and 3.2 on too much shading and on poor bankside vegetation structure which was also failed by transect section 3.1. Furthermore, other than 1.1 and 3.3, all transect sections failed on a lack of bog myrtle coverage. Finally, transect sections 1.4,

2.3 and 2.4 failed on too little stiff emergent vegetation, 3.2 on the presence of bracken, and 1.4 on evidence of eutrophication.

Damselflies: 26 male southern damselfly were recorded during the adult count surveys, at a density of 3.26 damselflies per 100m, and with male southern damselfly recorded on only three of the 11 transect sections surveyed.

Resilience: Round Hill supported a reasonable length of (potentially) suitable habitat but is isolated, located approximately 2.5km form the nearest site (Crockford Stream [Upper]).

Hydrology: Transect sections 1.1 and 1.2 were predominantly mire habitat, with sections 1.3, 3.1 and 3.3 a mix of mire and linear habitats. In addition to those transect sections that formally failed on water flow, limited or no flow was recorded at several sample points on both sections 3.1 and 3.2.

Other Notes: The area of suitable non-linear habitat recorded in association with transect 1 was substantially reduced in both 2013 and 2019, when compared with the area mapped during the original survey in 2004 (see section 6.15 of Harvey *et al*., 2005).

It is approximately 2.5km from the nearest site, but there exists potential for habitat restoration / expansion within the site.

Comments: There was a substantial reduction in the number and distribution of male southern damselfly recorded at the site, with 138 male southern damselfly recorded in 2013, and individuals present on eight of the 11 transect sections. Furthermore, there was a substantial reduction in water flow and / or availability across the site, particularly notable on all of transect 3.

It is strongly recommended that a hydrological assessment is conducted at Round Hill to accurately establish the linear features and habitat areas of the site that will support a perennial supply of flowing water. This will ensure the most appropriate areas of this site are included in future monitoring, and therefore an accurate assessment of habitat condition (and by association population structure) at the site is achieved. Furthermore, this study will help to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified.

6.17 Shipton Bottom

Habitat Condition	Site Resilience	Population Strength	Population Density
Optimal	High	Strong	High

Site Status: **EXCELLENT**

Explanation: Shipton Bottom was assessed to meet the criteria for the peak categories in all four assessments, is a large site that supported strong numbers of southern damselfly and, at the site level, passed on all key habitat attributes.

Habitat Condition: Shipton Bottom passed on all key and other important habitat attributes, failing only on the frequency of eutrophication (i.e. too high).

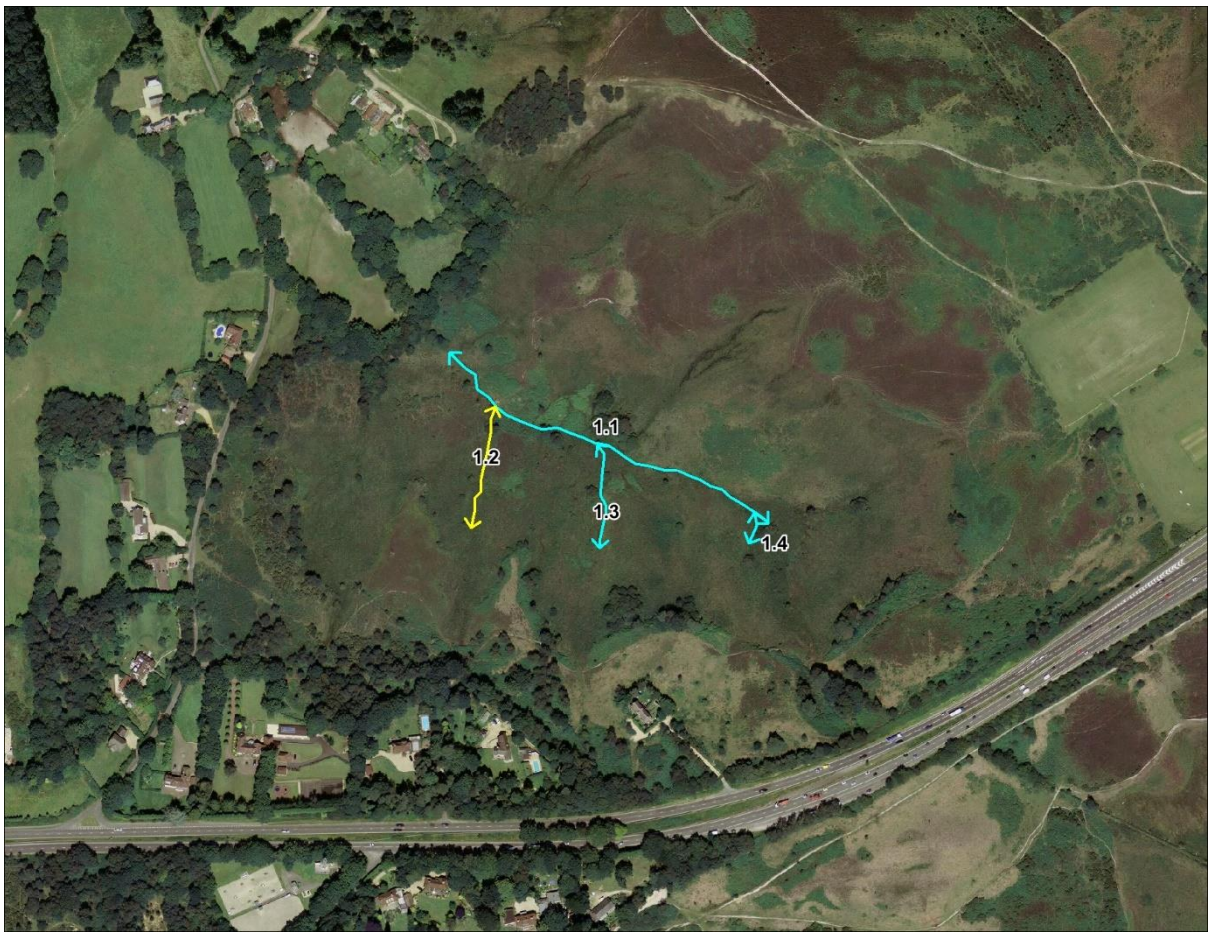
Transect sections 1.2 and 1.6 failed on water flow. Furthermore, transects 1.1, 1.2 and 1.5 failed on the presence of eutrophication, with 1.1 also failing on poor bankside vegetation structure, and 1.3 on limited stiff emergent vegetation.

Damselflies: 641 male southern damselfly were recorded during adult transect count surveys, at a density of 32.54 damselflies per 100m, and with individuals recorded on all transect sections.

Resilience: Shipton Bottom is large and located within 1km of three other sites (i.e. Crockford Stream [Lower], Crockford Stream [Upper] and Bagshot Moor).

Hydrology:	Transect sections 1.1, 1.3 and 1.5 were either entirely or predominately linear habitats. 1.2, 1.4 and 1.6 were a mixture of linear and mire.
Other Notes:	Transect section 1.4 was a relatively incised, narrow channel where linear, becoming encroached by a reed bed (*Phragmites australis*) in the upstream (north) mire section.
Comments:	Shipton Bottom was considered to be in 'Favourable' condition in 2004 and 2013, and 'Excellent' status in the current study. Furthermore, despite a reduction in the total number of individuals recorded (876 males in total in 2013), the site continued to a support strong, high-density population, well-distributed across the site.

6.18 Shobley



Habitat Condition	Site Resilience	Population Strength	Population Density
Optimal	Moderate	Medium	Moderate

Site Status: **GOOD**

Explanation: Shobley was assessed to be a moderately resilient site that provided optimal habitat conditions and supported a medium strength southern damselfly population present at a moderate density.

Habitat Condition: Shobley passed on all key and other important habitat attributes, failing only on the extent of bracken present (i.e. too high). However, the runnels had become narrow and encroached by tall bankside scrub and / or trees in multiple locations, though it was noted that there had been a positive reduction in bank top bog myrtle since 2013. Furthermore, there were concerns regarding water flow across Shobley, with all transect sections supporting barely discernible flow for the majority or extensive reaches of their length.

Specifically, transect section 1.1 failed due to over-shading, 1.1-1.3 on the presence of bracken, and transect section 1.4 failed due to encroaching / tall bankside vegetation, and the limited presence of stiff emergent vegetation.

Damselflies: 65 male southern damselfly were recorded during adult transect count surveys, at a density of 12.20 damselflies per 100m, and with individuals recorded on all transect sections except 1.2.

Resilience:	Shobley supported a reasonable length of (potentially) suitable habitat and is located approximately 0.6km from Foulford.
Hydrology:	All transects were either exclusively or predominately linear, with short sections of mire habitat present on transect sections 1.2 and 1.3. Water flow appeared to either become subterranean (i.e. pass through areas of loose soil), or the bank top had collapsed over the channel to form a 'land bridge', on a number of short reaches on transect section 1.1.
Other Notes:	Dense areas of tall bog myrtle had developed along extensive reaches of the main channel that flowed through the valley bottom (i.e. transect section 1.1), and on the mire on the south and west valley sides. The valley sides to the north and east of the main channel was generally drier and dominated by dense bracken and scrub. The area of wet mire habitat observed during the 2019 and (to a lesser degree) the 2013 habitat assessment surveys, was notably smaller than that recorded in 2004.
Comments:	Southern damselfly numbers and distribution were consistent with the findings of the 2013 adult count surveys, with 73 males recorded across transect sections 1.1, 1.2 and 1.4. There was a substantial reduction in water flow across the site however, particularly notable on transect section 1.1. It is strongly recommended that a hydrological assessment is conducted at Shobley to accurately establish the linear features and habitat areas of the site that will support a perennial supply of flowing water. This will ensure the most appropriate areas of this site are included in future monitoring, and therefore an accurate assessment of habitat condition (and by association population structure) at the site is achieved. Furthermore, this study will help to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified.

6.19 Stag Brake

Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Low	Weak	Low

Site Status: **POOR**

Explanation: Stag Brake was assessed to meet the criteria for the bottom categories in three of the four assessments.

Habitat Condition: Stag Brake comprised a single transect / section which failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed. Furthermore, this site failed on poor bankside vegetation structure (extensive reaches dominated by uniformly low vegetation), too little in-channel bog myrtle, and prevalence of evidence of eutrophication.

Damselflies: 14 male southern damselfly were recorded during the adult count survey, at a density of 8.28 damselflies per 100m.

Resilience: Stag Brake is small but located approximately 0.8km and 1.1km from Mill Lawn and Duckhole Bog respectively.

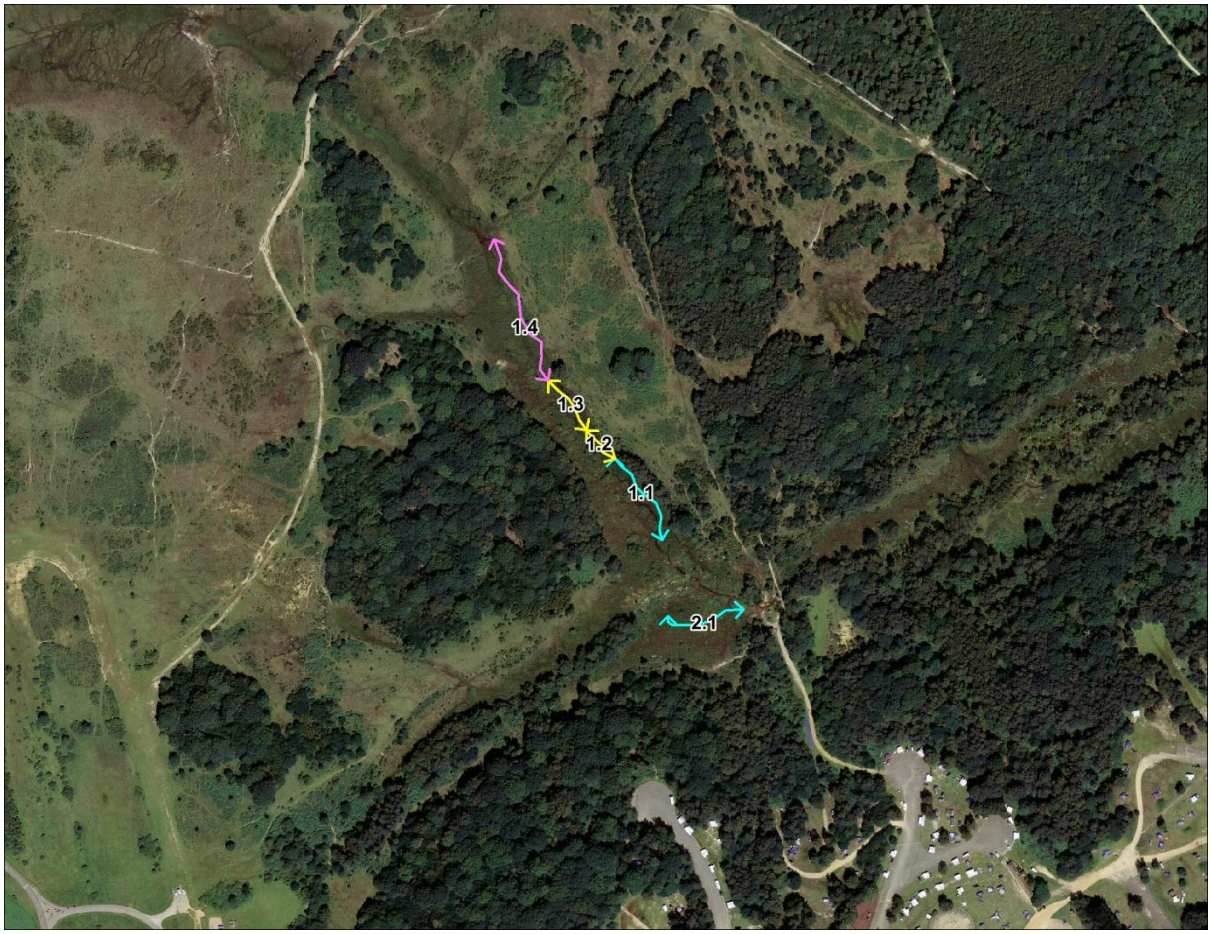
Hydrology: Predominately linear in the south of the site, becoming a mire in the north, with a discernible flow only evident in a short reach of the southern part.

Other Notes: It appeared that oil from the road had leaked into the watercourse in places.

Comments: Stag Brake was assessed to be in 'Favourable' condition in 2013. However, despite no corresponding change in southern damselfly numbers (i.e. 14 males in total in 2013), there was a substantial reduction in water flow during this study's habitat condition surveys.

It is strongly recommended that a hydrological assessment is conducted at Stag Brake to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified. Indeed, if it is a result of the latter, and given the very small size of the site, it would be highly beneficial to extend the potential suitable habitat available where feasible.

6.20 Stony Moors



Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Vulnerable	Weak	Low

Site Status: **VULNERABLE**

Explanation: Stony Moors was assessed to meet the criteria for the bottom categories in all four assessments.

Habitat Condition: Stony Moors failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed. This is the despite the removal of transect section 1.4 from the habitat condition assessments.

Indeed, all four remaining transect sections failed on water flow. Furthermore, transect section 1.2 failed on over-shading, and section 2.1 on a lack of plants for oviposition, poor bankside vegetation structure (i.e. uniformly low), and evidence of eutrophication (i.e. too high). Finally, transect sections 1.1–1.3 failed on limited stiff emergent vegetation.

Damselflies: 7 male southern damselfly were recorded during the adult count survey, at a density of 1.85 damselflies per 100m, with a low number of male southern damselfly recorded on transect sections 1.1 and 2.1, and a single individual recorded on section 1.4.

Resilience:	Stony Moors is small and isolated, the nearest site (Clayhill Bottom) located over 2km away.
Hydrology:	Transect sections 1.1–1.3 were linear or a mix of linear and mire habitats, whereas transect sections 1.4 and 2.1 were entirely comprised of mire habitat. Sample points on transect sections 1.1–1.3 and 2.1 predominately or entirely supported standing water without flow, whereas 90% of the sample points on transect 1.4 were either damp or dry.
Other Notes:	*None*.
Comments:	There was a substantial reduction in the number and distribution of male southern damselfly recorded at this site, with 77 males recorded across all transects sections in 2013. Furthermore, there was a substantial reduction in water flow and / or availability across the site, with three of five sections (i.e. 1.1–1.3) passing this attribute in the previous study. It is strongly recommended that a hydrological assessment is conducted at Stony Moors to accurately establish the linear features and habitat areas of the site that will support a perennial supply of flowing water. This will ensure the most appropriate areas of this site are included in future monitoring, and therefore an accurate assessment of habitat condition (and by association population structure) at the site is achieved. Furthermore, this study will help to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified.

6.21 Three Beech Bottom

Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Low	Weak	Low

Site Status: **POOR**

Explanation: Three Beech Bottom was assessed to meet the criteria for the bottom categories in three of the four assessments.

Habitat Condition: Three Beech Bottom failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed. This is the despite the removal of transect sections 1.2 and 1.3 from the habitat condition assessments (i.e. all sample points surveyed on sections 1.2 and 1.3 were either only damp or completely dry), as well as an adjustment of the sample points analysed on transect section 1.4.

Indeed, transect section 1.4 was the only section to pass on water flow, with too few sample points supporting a discernible flow on all remaining transect sections. Furthermore, all transect sections failed on poor bankside vegetation structure (i.e. too many sample points uniformly low) and limited stiff emergent vegetation. Transect sections 2.1–2.4 failed on limited opportunities for oviposition, whilst transect section 2.3 supported too little in-channel bog myrtle and 1.1 returned too frequent evidence of eutrophication.

Damselflies:	25 male southern damselfly were recorded during the adult count surveys, at a density of 4.01 damselflies per 100m, with a low number of male southern damselfly recorded on transect sections 1.1, 1.4, 2.3 and 2.4, and a single individual recorded on section 2.1.
Resilience:	Three Beech Bottom is relatively small (based on the sample points included in the habitat condition assessment) but is located approximately 0.8km from the nearest site (Widden Bottom).
Hydrology:	Transect sections 1.1, 1.4 and all sections on transect 2 were linear, with flowing water present to a greater or lesser degree. Transect sections 1.2 and 1.3 were classified as mire, although the former was entirely dry at the time of survey (and therefore not included in the current habitat condition assessment as set out above), and the latter a mix of dry and damp ground.
Other Notes:	A number of other small runnels / areas of mire habitat were recorded in close proximity to transect 2.
Comments:	There was a reduction in the number of male southern damselfly recorded at Three Beech Bottom (i.e. 41 males in total recorded in 2013). However, the difference in numbers observed could lie within the natural variation expected between single annual adult counts at this site. However, there was a substantial reduction in the availability of flowing water across the site, with four of the seven transect sections having passed this habitat attribute in 2013. Furthermore, in 2013 the same hydrological assessment was made of transect sections 1.2 and 1.3 (i.e. all sample points surveyed were either damp or dry), and the reason for their continued inclusion remains unclear. It is strongly recommended that a hydrological assessment is conducted at Three Beech Bottom to accurately establish the linear features and habitat areas of the site that will support a perennial supply of flowing water. This will ensure the most appropriate areas of this site are included in future monitoring, and therefore an accurate assessment of habitat condition (and by association population structure) at the site is achieved. Furthermore, this study will help to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified.

6.22 Widden Bottom

Habitat Condition	Site Resilience	Population Strength	Population Density
Poor	Low	Weak	Low

Site Status: **POOR**

Explanation: Widden Bottom was assessed to meet the criteria for the bottom categories in three of the four assessments.

Habitat Condition: Widden Bottom comprised a single transect / section which failed on water flow (i.e. too few sample points supporting a discernible flow), considered to be the most important habitat attribute of the suite assessed. Indeed, flowing water was only recorded in approximately one quarter of all sample points.

Furthermore, the transect / section failed on poor bankside vegetation structure (i.e. uniformly low), limited stiff emergent vegetation and too frequent evidence of eutrophication.

Damselflies: 28 male southern damselfly were recorded during the adult count surveys, at a density of 7.61 damselflies per 100m.

Resilience: Widden Bottom is relatively small but is located approximately 0.8km from the nearest site (Three Beech Bottom).

Hydrology: Predominately linear, interspersed with short sections of mire, and the presence of flowing water was only evident at its western end.

Other Notes: *None*.

Comments: There was a reduction in the number of male southern damselfly recorded at Widden Bottom (i.e. 53 males in total recorded in 2013). However, the difference in numbers observed could lie within the natural variation expected between single annual adult counts at this site.

There was also a reduction in the distribution of flowing water across the site compared with previous studies. However, it should be noted that standing water or damp substrate was also recorded at 53% of sample points in 2013.

It is strongly recommended that a hydrological assessment is conducted at Widden Bottom to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change, or as a result of drainage or management issues at the site that could be rectified.

6.23 Impact of Recent Management at Study Sites

A summary of recent works conducted by Forestry England and their predecessors is set out in Appendix 7. Based on the field observations and the assessments conducted under this study, these works have:

- Ensured that a suitable bankside vegetation structure has been retained at Acres Down;
- Ensured that suitable levels of bog myrtle have been retained at Bagshot Moor;
- Ensured that a mixed shady vegetation bankside structure has not developed at Bagshot Moor;
- Ensured that tall scrub (that could create a high level of shade) has not encroached the channel at Clayhill Bottom;
- Ensured that a suitable bankside vegetation structure and levels of bog myrtle have been retained at Common Moor;
- Reduced shading and ensured that suitable bankside vegetation structure and levels of bog myrtle have been retained at Crockford Stream (Upper);
- Ensured that a suitable bankside vegetation structure and levels of bog myrtle have been retained at Duckhole Bog;
- Ensured that trees and tall scrub (that could create a high level of shade) have not encroached the channel at Foulford;
- Ensured that a suitable bankside vegetation structure has been retained at Foulford;
- Ensured that a suitable bankside vegetation structure has been retained at Latchmore;
- Ensured that a mixed shady vegetation bankside structure has not developed (where relevant) at Mill Lawn;
- Reduced the risk of encroachment of scrub and heather / coarse grasses from adjacent land at Millersford Bottom;
- Ensured that a suitable bankside vegetation structure and levels of bog myrtle have been retained at Shipton Bottom;
- Reduced shading and ensured that a suitable bankside vegetation structure and levels of bog myrtle have been retained at Shobley; and
- Reduced the risk of encroachment of scrub and heather / coarse grasses from adjacent land at Stag Brake;

It is understood that work was undertaken at Widden Bottom to stabilise an eroding knick point and thereby protect southern damselfly habitat at the site. Furthermore, it appears that work had been undertaken to reduce shading at Crockford Stream (Lower), and this site now passes at the site and all transect section levels for this attribute. However, no reference to recent works was included in the information provided by Forestry England.

Finally, it is understood that a hydrological assessment has been undertaken at Mill Lawn, which was unconvinced of the value of restoration intervention here. However, this data should be interrogated to determine which are the most appropriate linear features (runnels) / areas of this site to be included in any future assessments, and therefore ensure that an accurate assessment of the habitat condition and southern damselfly population at the site is being achieved. Furthermore, if the current transect sections do reflect the most appropriate features / areas to be included, further study of the data will help to determine whether the water presence / flow issues identified at this site are indeed permanent changes reflecting the impact of climate change.

7. COMPARISON OF CURRENT AND HISTORIC ASSESSMENTS

Tables 12 and 13 summarise the assessments set out in sections 6.1–6.22 and compares them with assessments from other sources. These comparisons must be considered with care, as the various assessments will have been made at different times, from different perspectives, and using different criteria from the current study (with exceptions) as outlined below:

- The current study has assessed site status based on habitat condition, site resilience and the southern damselfly population structure.
- Rushbrook *et al*. (2014) and Harvey *et al*. (2005): site condition assessments were primarily based on habitat attribute data as collected in the current study (with the exception of modifications outlined in Section 4), along with reference to site size and isolation.
- Stevens & Thurner (1999): sites surveyed, damselfly populations categorised as:
    - Nil – no individuals counted on any of 3-4 visits;
    - Weak – 1-29 individuals counted on “best” visit;
    - Medium – 30-99 individuals counted on “best” visit;
    - Strong – 100 or more damselflies counted on “best” visit;
    - Some sites that could not be thoroughly surveyed were given assessments of “believed” strong or weak etc.
- Boyce (2002): sites assessed on basis of extent of suitable habitat, this being defined as “an area of shallow, relatively slow-flowing water, without excessive encroachment of rank vegetation or scrub, with frequent soft emergent herbs and located within an area in which southern damselfly adults have been recorded since 1990”; where suitable habitat was found it was assessed as favourable if there was more than 200m of watercourse, and unfavourable if less than 200m, with a judgement as to whether the area was stable, increasing or declining.
- Strange & Bousfield (2004): assessment of site management requirements over a subsequent 5-10 year period.

7.1 Site status and ‘condition’

Direct comparisons cannot be made between the current and the two previous Favourable condition assessments (Harvey *et al*., 2005; Rushbrook *et al*., 2014). However, the authors are confident that excellent and good site status would represent an equivalent measure to 'Favourable’ condition, whereas sites of poor or vulnerable status would be considered to be in an ‘Unfavourable’ condition. Assigning sites of moderate status is more challenging, and requires consideration of each of the separate four assessments. Based on this a cautionary comparison of site ‘condition’ between the current and these earlier studies can be made.

Seventeen of the twenty-two sites re-assessed within the current study were of directly comparable status category when compared to the earlier two Favourable condition assessment studies (Harvey *et al*., 2005; Rushbrook *et al*., 2014). However, of these only three sites had been assigned excellent or good site status (i.e. Crockford Stream [Upper], Latchmore and Shipton Bottom), with twelve sites previously assessed to be in Unfavourable condition assigned poor or worse status in the current study (Table 12). Furthermore, Hatchet Stream and Mill Lawn, currently assessed to be of moderate status but previously to be in 'Favourable' and 'Unfavourable’ condition respectively, were considered to be of comparable ‘condition’ in the current study based on the results of the four individual assessments.

It is considered that the status of three sites had increased since the previous Favourable condition study. Crockford Stream (Lower) and Shobley were previously considered in 'Unfavourable’ condition, but were assessed to be excellent and good respectively (Table 12). Furthermore, although assessed to be of moderate status in the current study, it considered that the ‘condition’ of Clayhill Bottom has increased since 2013 based on the results of the four individual assessments.

In contrast, it is considered that the condition of two sites, Bagshot Moor and Stag Brake, had declined when compared to the earlier two Favourable condition assessment studies. This decline appeared to be particularly dramatic at Bagshot Moor, which is currently considered to be vulnerable with no discernible flow observed along its length and only a single male southern damselfly recorded during the adult count surveys (see Section 6.2).

Table 12: Current site status assessments compared to other site assessments.

Site name	**Site status assessment**	**Site condition assessment in Rushbrook *et al*., 2014**	**Site condition assessment in Harvey *et al*., 2005**	**Site assessment in Boyce, 2002**	**Summarised management recommendations from Strange & Bousfield, 2004**
Acres Down	Moderate to Poor	Unfavourable	Unfavourable	Unfavourable, no change	requires clearance of scrub, bracken, and some bog myrtle
Bagshot Moor	Vulnerable	Favourable	Favourable	Unfavourable, no change	*not assessed*
Bull Hill	Vulnerable	Unfavourable	Unfavourable	Unfavourable, no change	remove trees and scrub
Clayhill Bottom	Moderate	Unfavourable	Unfavourable	Unfavourable, no change	light burn in 3-4 years
Common Moor	Vulnerable	Unfavourable	Unfavourable	*not assessed*	requires increased grazing and/or burn to remove *Molinia* and some scrub clearance
Crockford Stream (Lower)	Excellent	Unfavourable	Unfavourable	Favourable	remove scrub, partial removal of bog myrtle
Crockford Stream (Upper)	Excellent	Favourable	Favourable	Favourable	some removal of scrub and bog myrtle
Dibden Bottom	Potentially Extinct?	Unfavourable / Extinct?	*not assessed*	Unfavourable, no change	*not assessed*
Duckhole Bog	Vulnerable	Unfavourable	Unfavourable	Favourable	remove scrub and *Molinia*
Foulford	Vulnerable	Unfavourable	Unfavourable	*not assessed*	extensive removal of trees/scrub
Hatchet Stream	Moderate	Favourable	Favourable	Favourable	light burn in 4-5 years
Howen Bottom	Extinct?	Unfavourable/ Extinct?	*not assessed*	*not assessed*	*not assessed*
Latchmore	Good	Favourable	Favourable	Favourable	partial removal of bog myrtle
Mill Lawn	Moderate	Unfavourable	Unfavourable	Favourable	light burn and slightly reduced grazing on lawns, mire restoration to the east
Millersford Bottom	Vulnerable	Unfavourable	Unfavourable	Unfavourable, no change	extensive mire restoration
Round Hill	Poor	Unfavourable	Unfavourable	Unfavourable, no change	remove trees and scrub
Shipton Bottom	Excellent	Favourable	Favourable	Favourable	requires burn in 3-4 years
Shobley	Good	Unfavourable	Unfavourable	*not assessed*	burn in 5-6 years
Stag Brake	Poor	Favourable	Favourable	Favourable	remove scrub
Stony Moors	Vulnerable	Unfavourable	Unfavourable	Favourable	remove trees and scrub
Three Beech Bottom	Poor	Unfavourable	Unfavourable	Favourable	burn in 6-7 years (Setley Plain burn in 3-4 years)
Widden Bottom	Poor	Unfavourable	Unfavourable	Unfavourable, no change	burn in 3-4 years

7.2 Population strength

It is also valuable to conduct a cautionary comparison of the strength of the southern damselfly populations recorded across surveys conducted in 1999, 2013 and in 2019 for the current study. These are comparable as they used the same criteria for categorising population strength (see above and Section 4.3.1), though it is noted that in the 1999 study multiple survey visits were conducted at many sites and all individuals were included, whereas assessments of the 2013 and 2019 data is based on the number of males encountered on a single visit only.

Table 13: Comparison of current and historic southern damselfly population strength assessments.

Site name	**Population strength in 2019**	**Population strength in Rushbrook *et al*., 2014***	**Population strength in Stevens and Thurner, 1999**
Acres Down	Medium	Medium	Weak
Bagshot Moor	Weak	Weak	Weak
Bull Hill	Weak	Weak	Weak
Clayhill Bottom	Medium	Medium	Medium
Common Moor	Weak	Weak	Weak
Crockford Stream (Lower)	Strong	Strong	Believed strong
Crockford Stream (Upper)	Strong	Strong	Strong / believed strong
Dibden Bottom	Not recorded	Not recorded	Weak
Duckhole Bog	Weak	Weak	Weak
Foulford	Weak	Weak	*Not assessed*
Hatchet Stream	Medium	Medium	Medium
Howen Bottom	Not recorded	Not recorded	*Not assessed*
Latchmore	Strong	Strong	Strong / believed strong
Mill Lawn	Strong	Strong	Medium / strong
Millersford Bottom	Weak	Strong	Medium
Round Hill	Weak	Strong	Strong
Shipton Bottom	Strong	Strong	Believed strong
Shobley	Medium	Medium	*Not assessed*
Stag Brake	Weak	Weak	Weak
Stony Moors	Weak	Medium	Medium
Three Beech Bottom	Weak	Medium	Weak / believed strong
Widden Bottom	Weak	Medium	Weak

*Based solely on the results of adult count surveys

Of the 19 sites visited in both 1999 and 2013, 14 supported a similar strength population, there was an increase in strength at three sites, an unclear trend at one site (i.e. Three Beech Bottom), and southern damselfly appeared to have been lost from Dibden Bottom. Therefore, particularly when accounting for the greater number of survey visits and inclusion of all individuals identified in the earlier study, the data indicates a slight overall increase in the strength of the New Forest southern damselfly metapopulation over this time period, though caution must be applied when drawing conclusions from these single datasets.

In contrast, across the 22 sites visited in both 2013 and 2019, 17 sites recorded a similar strength population (including no evidence of southern damselfly at Howen Bottom and Dibden Bottom), and

five sites had declined, including substantial reductions in abundance at Millersford Bottom and Round Hill. Indeed, of the sites included within the two studies, seven were considered to be strong in 2013 and only five in 2019, whereas six sites supported a weak population in 2013 compared with 11 sites in 2019. Furthermore, a more detailed interrogation of the data identified a substantial reduction in the number of males recorded at several sites (see Section 5.2; Figure 5; Table 8), and six sites where either no or fewer than 10 males were recorded.

This indicates that there may have been a reduction in the strength of the New Forest southern damselfly metapopulation over this time period, though caution must be applied when drawing conclusions from these single datasets.

8. DISCUSSION

8.1 Status of New Forest southern damselfly sites

A position where the status of most southern damselfly sites is Excellent or Good should be the overarching aim of southern damselfly conservation in the New Forest. However, the status calculated for over half of the 22 southern damselfly sites in this study was poor or worse, with four sites considered to be of poor status, seven vulnerable, and two sites either extinct or potentially extinct (see Section 6), Indeed, only three, two, and (at best) four sites were assessed to be of Excellent, Good or Moderate status respectively.

It should be emphasised that the absence of a discernible water flow across a sufficient length / area of habitat sampled was one of the, if not the key, fundamental reasons for this finding across the 22 sites. Indeed, 12 of the 13 sites that were judged to provide poor habitat conditions also failed on this habitat attribute. However, although at some sites the observed lack of water availability could potentially be addressed through remedial action, it is considered likely that at other sites this finding is a result of an over-estimation of the suitable habitat / transect lengths supported at these sites during the 2004 Favourable condition assessment. This is discussed in more detail in Sections 3.7.2 and 9.1.

This section outlines this and other key reasons for the generally poor status of southern damselfly sites in the New Forest, with recommendations to address these provided in Sections 8.3 and 9.1–9.3.

8.1.1 Water security, climate change and habitat restoration

The availability and distribution of flowing water was the fundamental concern at 12 of the 21 sites where habitat condition assessments were conducted (i.e. excluding Howen Bottom). A perennial flow is an essential requirement for southern damselfly (see Section 2.3), and the dramatic reduction in flow identified at several sites (i.e. compared with the 2013 study) is of significant concern. Indeed, significant and highly significant correlations between the number of sample points supporting flow and damselfly density was identified at the site and transect section levels (see Section 5.3.2). Furthermore, mean damselfly density was nearly four times higher across the 45 transects that passed on the extent of flowing water, when compared with the 45 transects that failed (Table 10).

It is understood that no significant new abstractions from the aquifers supplying southern damselfly sites were approved between 2013 and 2019, and it is considered likely that the differences observed in water availability / distribution will, at least in part, be a consequence of shifts in prevailing climatic conditions (Environment Agency, personal communication).

It is therefore important that the size of the perennially suitable habitat is accurately known to determine the robustness of a site, as an over-estimate of the size of available habitat could affect its habitat condition assessment, and by association its perceived status. Furthermore, it is important that the distribution of water across the sites is understood and monitored, to determine where changes in their hydrology are a direct consequence of changes in climatic / rainfall patterns, or where a lack of management (i.e. increased levels of scrub and tree cover resulting in drier conditions) or removal of infrastructure (i.e. as in Crockford Stream [Upper]) has substantially altered the length / area of suitable habitat available.

8.1.2 Shading and bankside vegetation structure

In addition to a lack of water / poor flows, the main habitat attributes contributing to the 'Unfavourable' condition assessment of sites in 2013 were over-shading and scrub encroachment, limited opportunities for oviposition, and poor bankside vegetation structure (Rushbrook *et* al., 2014). These were typically a consequence of insufficient management pressure, and management and habitat works conducted by Forestry England since 2013 have addressed these at a several sites (see Section 6.23). However, due to the on-going nature of the management required, these attributes require continued consideration at several sites for the reasons set out below.

Insufficient management (i.e. under-management) of vegetation to suppress successional change was identified as the key / one of the key reasons for the 'Unfavourable' condition assessment of several sites in 2013 (Rushbrook *et al*., 2014). It is emphasised that the term 'under-management' within this document specifically refers to the level of management pressure that fails to suppress successional

change and maintain a bank top vegetation structure that is suitable for southern damselfly. This under-management, and the associated development of unsuitable habitat conditions at a later stage of succession, results in the deterioration / loss of suitable in-channel and bankside habitat, prevents the expansion of populations to adjacent (potentially suitable) areas, and results in the fragmentation of suitable habitat within a site.

The management of vegetation in the New Forest is implemented passively through extensive grazing by (predominantly) ponies and cattle, and more actively through cutting and / or burning areas of dense woody vegetation. Though it is accepted that there has been a substantial increase in grazing pressure across the wider New Forest in the last 60 years (Cox, 2013), the authors considered that the grazing pressure associated with most southern damselfly sites is insufficient to suppress successional change, in particular the encroachment of linear features by scrub. However, it is important to note that this is not uniformly true, as a small number of sites, including Mill Lawn, suffer from excessive cattle grazing pressure.

The mechanism(s) driving this are not fully understood, but it is suggested that grazing animals will preferentially select areas or vegetation types other than those associated with southern damselfly sites. As a consequence, to maintain vegetation conditions suitable for southern damselfly, more active management is required to manage the dense and woody vegetation that develops at several southern damselfly sites (see Sections 6.23 and 9.3; Appendix 7).

8.1.3 Site resilience

Isolation is considered to be another key reason for the poor status of several sites in the current study, and the 'Unfavourable' condition assessment of these sites in previous studies (Harvey *et al*., 2005; Rushbrook *et al*., 2014),

This may be exacerbated by under-management of potential suitable habitat between existing sites. Sites present within a wider 'complex' (i.e. within the dispersal range of <1km for this species) are considered more robust due to immigration / emigration between sites, which will both increase genetic diversity within the individual populations, but also allow for the re-colonisation of under-managed areas / sites once habitat suitability has been improved or returned. It is particularly crucial to maintain the integrity of smaller sites, but all isolated sites (see Section 4.2.2) will be at risk from extinction due to chance 'events' such as pollution, inappropriate management, or unintentional heathland fire.

The impacts of under-management (see Section 8.1.2) are exacerbated by the small size of a number of these sites. Large sites are considerably more robust and able to withstand localised deterioration or temporary loss of habitat, retaining areas of suitable habitat within the site from which re-colonisation of under-managed areas can occur once habitat suitability has been improved or returned. Smaller sites are inherently less robust to the deterioration or loss of habitat, with a lower capacity to sustain viable numbers of southern damselfly, and therefore at greater risk of their populations being lost.

8.2 Status of the New Forest Southern Damselfly Metapopulation

The New Forest southern damselfly metapopulation supports several large, strong and nationally important populations, the three sites within the 'Crockford Complex' of particular importance. However, the current study found most of its sites provide poor habitat conditions, primarily due to a lack of perennial water flow across a sufficient quantity of habitat sampling points.

Without the required detailed understanding of the hydrology of these sites, it is unclear to the authors whether the concerns identified regarding lack of water and poor flows simply represent an over-estimation of suitable habitat in the original study (Harvey *et al*., 2005), or reflect an issue in long-term water security at the sites. This is of particular concern considering widely accepted future climate change trends, for example in terms of the frequency and duration of rainfall in winter and summer. The wider and site-specific 'cause' for the lack of water and poor flows cannot be determined from the data collected, and emphasises the need for a thorough hydrological assessment as set out in Section 9.1.

Metapopulation theory (e.g. Hanski, 1999 cited in Rouquette, 2005) has shown that the presence of several interconnected populations in a fragmented landscape increases the probability of the long-term persistence of insect populations, and several of the sites in this study are small and / or isolated. Furthermore, it is considered likely that several sites have been lost in the New Forest since the

systematic survey of Hampshire undertaken in 1998 (Stevens & Thurner, 1999). No southern damselfly were recorded at Dibden Bottom and Howen Bottom during either 2013 or 2019 studies (Table 8; Rushbrook *et al*., 2014) and the authors consider that southern damselfly populations have potentially been lost and have been lost from these sites respectively. Furthermore, only a very small number of individuals were recorded at Foulford in both studies (Table 8; Rushbrook *et al*., 2014), indicating that there is a real possibility this population could be lost in the near future. Finally, short walk-over survey visits conducted in 2013 identified that only one (Frogmoor) of four other former sites (i.e. Nomansland, Blackwell Common and Rowbarrow Pond Inlets) provided a suitable water flow regime to support this species.

With sites both being lost or declining in suitability, it is essential that new sites are created and existing / historic sites restored to allow the New Forest populations to function as a stable metapopulation(s). To the authors' knowledge, no new sites have been intentionally created for southern damselfly within the New Forest since 1998, though it is recognised that sites may have emerged from river restoration and Inclosure clearances undertaken in the past decade. Furthermore, given that under-management has been, and to a lesser degree still is, a key cause of poor habitat condition at the site level, it is considered unlikely that sites will have been created / restored naturally through the existing management regime prevailing in the New Forest.

For the reasons outlined above, there is evidence to support the assumption that there has been a net decline in the condition and overall number of southern damselfly sites in the New Forest. However, given the limited frequency (i.e. studies conducted in 2004, 2013 and 2019) and quantity of formal data collected for re-assessment, and the associated difficulties / limitations in comparative analysis as outlined in Section 5, it is not considered appropriate to assess whether the status of southern damselfly is in decline or recovery.

It is therefore the conclusion of these authors that the metapopulation is currently of moderate status, but at risk of deterioration without the delivery of targeted management and urgent hydrological investigations.

8.3 Enhancing the Status of Southern Damselfly Sites and Metapopulation

The authors consider that improving habitat conditions and (to a lesser degree) site resilience are the fundamental mechanisms to achieve Good or even Excellent status for the New Forest southern damselfly sites and wider metapopulation. The former should increase the population strength and density, making them more robust to threats or pressures that could lead to the loss of southern damselfly from those sites

As outlined in Sections 8.1 and 8.2 above, addressing concerns regarding water availability and security cannot be determined from the data collected in this and previous studies, and further investigations are required (see Section 9.1). In contrast, the potential mechanisms to rectify the under-management of existing southern damselfly sites can be tackled, and mechanisms to achieve this are summarised in Section 9.3. However, addressing the highly fragmented distribution of this species in the New Forest is more complex.

For southern damselfly sites to function as a metapopulation, new sites within the dispersal range of this species must be (re)discovered, re-established (i.e. at historic sites now lost) or created between existing populations. Movements of up to 500m by southern damselflies have been readily observed, and longer distances have been achieved along continuous lines of habitat, but rarely over 1km (Purse, 2002; Rouquette, 2005). It is therefore recommended that, where appropriate, areas of suitable habitat are 'created' (either through the application of appropriate management or capital works) within 500m to 1km of existing sites to act as 'stepping stones' that would re-connect these populations.

Due to the specific requirements of this species (as set out in Section 2.3), the selection of any new sites needs to be undertaken with careful consideration. The geology of the New Forest is varied and complex, and it is fully accepted there will be areas of the New Forest that are entirely unsuitable for southern damselfly, and that the creation of a single metapopulation connecting all sites throughout the New Forest is likely to be unfeasible. The objective should be to ensure that all sites are within the dispersal range of its nearest adjacent site. This will create a series of localised metapopulations similar to the 'Crockford Complex'.

The process of identifying opportunities for habitat creation / restoration should initially focus on sites known to have historically supported this species (Figure 9), with those sites where the loss of suitable habitat was a result of under-management offering the greatest likelihood of success. However, certainty of year-round flowing water must be secured before measures are implemented to try and create / restore the other required habitat conditions for this species. Furthermore, where former sites are now located beyond the natural dispersal range of this species, additional sites between them and the appropriate extant population would need to be first created for sites to be re-colonised naturally.

Figure 9: Sites where a population of southern damselfly have been recorded since January 1998 (sites included within the past three Favourable condition / site status assessments shown in blue, all other sites in orange, and National Park shown in pale green).

9. RECOMMENDATIONS

9.1 Hydrological Assessments

The absence of a discernible water flow across a sufficient length / area of habitat sampled is the key attribute resulting in the 'poor' habitat condition assessment of several sites for southern damselfly. It is therefore strongly recommended that a hydrological assessment is conducted at all study sites that support an extant population of southern damselfly, with vulnerable, poor and moderate status sites prioritised when planning these assessments.

These studies should have two aims:

- to accurately establish the appropriate linear features (runnels) and habitat areas (mires) of the site that will support a perennial supply of flowing water and should therefore be included in future monitoring; and
- identify opportunities to increase the distribution and retention of flowing water at these sites.

The parameters for this study would need to be established by an experienced hydrologist with a thorough understanding of the habitats that support this species in the New Forest. It should aim to identify the minimum length / area of potentially perennially suitable habitat that the site would support, thereby excluding the impact of extreme low rainfall conditions. Furthermore, it is important that the history of any previous engineering of watercourses (i.e. linear features) or mire habitat (i.e. non-linear habitats) is considered within these studies, as these can have significant impacts on the movement and retention of water at and across a site.

This study should aim to have three key outputs. Firstly, by determining the current length / area of potentially suitable habitat based on water supply, this will ensure that only appropriate sample points are included in future studies, which will ensure that accurate assessments of habitat condition, site resilience, and population structure are conducted at each site. For example, prior to the revisions set out in Section 3.7.2, Hatchet Stream failed the 'water flow' habitat attribute (Rushbrook *et al*., 2020). However, following the removal of five dry / damp sample points at the western end of the transect section, this site passed the water flow attribute. Therefore, it is considered that the 'failure' in the original report (Rushbrook, *et al*., 2020) was due to an over-estimation of available habitat based on the high summer rainfall experienced in 2004, rather than an inherent issue with water flow at the site.

Secondly, if possible, the study should attempt to determine whether the observed reduction in the presence and distribution of suitable water flow conditions across the three studies simply represents natural annual variation, or a long-term trend in water security. This assessment must endeavour to determine the current and potential future impacts of climate change, which is critical for understanding the long-term security of individual sites.

Thirdly, the study should identify opportunities to increase the distribution and retention of flowing water at these sites where appropriate. This could be through the modification or adoption of different management techniques, or targeted habitat enhancement and restoration measures such as the repair of knick points and drain infill within mires.

9.2 Metapopulation Development Studies

As set out in Section 8.3, increasing site resilience by increasing metapopulation connectivity is the second fundamental mechanism to achieve Good or even Excellent status across the New Forest. It is therefore recommended that a feasibility study be undertaken to determine the most suitable areas for habitat creation / restoration for this species.

This study should develop the work undertaken by Hayward (2011), and would need to focus on three key elements; the hydrology and geology of the sites, the value of its geographical location in creating functioning metapopulations, and whether the mechanisms can be implemented to ensure it is appropriately managed for the foreseeable future. Of these elements, the hydrological assessment is likely to be most complex, and it is recommended that an assessment of all potential future sites be prioritised after the extant vulnerable, poor and moderate status sites.

9.3 Short and Mid-Term Management Tasks

Table 14 provides a summary of management actions recommended for each site and the potential timescale for their implementation based on the information currently available. It is important to emphasise that these recommendations relate to actions that would enhance the habitat at the site specifically for southern damselfly. It is essential that other interest features of the New Forest SAC, associated SSSIs, protected species, and protected habitats are considered when selecting and delivering works. These can be addressed through the application of due process.

There has been only limited assessment of the success of previous habitat enhancements implemented to benefit southern damselfly (but see Section 6.23), and concerns regarding the extent and severity of some works have previously been raised by local, independent specialists (Rushbrook *et al*., 2014). Therefore, the following recommendations are provided in association with the actions proposed in Table 14:

- all burning must be managed to avoid pollution of the watercourse (Purse, 2002) and be undertaken in the phased approach specified below where appropriate;
- the removal of bog myrtle and other bankside herbs should be undertaken using hand-tools (including powered-tools) only, and mechanical clearance of any kind should be avoided;
- when clearing bankside vegetation such as bog myrtle, it is strongly advised that intermittent smaller plants or tussocks are retained to provide sheltering and roosting opportunities for adults – e.g. Strange and Bousfield (2004) recommended that the partial removal of bog myrtle should include retaining approximately two smaller plants per $2m^2$ of area cleared;
- a phased or rotational approach to bankside clearance must be adhered to where specified, to ensure adequate adult habitat is retained within the wider site;
- during (a minimum of) the first three years works should be undertaken in a conservative manner, and any concerns regarding their potential negative effects recorded;
- an annual review meeting should be held at the end of each summer (i.e. August / September) to discuss the success of the previous years' work, incorporating the results of the annual species monitoring work (see Section 9.4) and any concerns raised during delivery; the outcomes of these discussions should be used to inform the implementation of the following autumn / winter's work.

9.4 Future Monitoring

9.4.1 Site selection and future assessment of the status of southern damselfly sites

Solely assessing the status of extant southern damselfly sites on a six year basis fails to properly assess the status of the New Forest metapopulation, and could entail assessing a diminishing number of sites. As recommended in both recent Favourable condition studies (Harvey *et al*., 2005; Rushbrook *et al*., 2014), additional sites should be introduced to the next round of monitoring, including sites in the New Forest that this species was recorded at (i.e. did not record a 'nil' result) during the systematic survey of Hampshire undertaken in 1998 (Stevens & Thurner, 1999), any potential sites identified through desktop studies (see Section 9.2), and any sites where habitat has been specifically restored / created for this species.

It is noted that these criteria would require both the removal of Howen Bottom from, and the inclusion of Kingston Great Common in, future site monitoring. This is supported by the authors since southern damselfly have not been recorded at Howen Bottom since 1984, and the site was assessed as unsuitable for this species by Hayward (2011), whereas, Kingston Great Common has only been excluded since the 2013 study due to difficulties in securing access permission. Furthermore, it is recommended that Duckhole Bog is retained to determine the success of the proposed works (Table 14).

GIS maps created during this study should be used as the basis for future site monitoring, ideally using an updated set of aerial photographs if available. Where new information is available (i.e. sites where hydrological assessments have identified the appropriate linear features and habitat areas of the site to be included), it is recommended that transects / sections are adjusted and / or created to ensure that accurate assessments are completed.

Table 14: Management action plan.

Priority 1 – Immediate / Urgent Action	Priority 2 - Management Action Required		Priority 3 - On-going / Future Management	No Management Action Recommended
Acres Down Clearance of bracken and bog myrtle on transect sections 1.2 and 1.4.	**Bull Hill** Removal of tree and scrub cover between transect sections 1.2-1.4 (inclusive), and partial clearance of bog myrtle from main channel at site as appropriate.	**Acres Down** Rotational clearance of bracken and bog myrtle.	**Acres Down** Rotational clearance of bracken and bog myrtle.	**Dibden Bottom** The presence of southern damselfly at the site should be confirmed before any management action is implemented for this species.
Clayhill Bottom Removal of tree and scrub cover from transect section 1.1, and associated light burn of bank top vegetation where appropriate.	**Lower Crockford** Widespread clearance and removal of trees and scrub and partial removal of bog myrtle where appropriate.	**Clayhill Bottom** Light burn of habitat adjacent to transect sections 1.2 and 1.3.	**Bagshot Moor** Continue removal of woody plant species from channel and partial removal of bog myrtle as necessary.	**Howen Bottom** The presence of southern damselfly at the site should be confirmed before any management action is implemented for this species.
Common Moor Partial clearance and removal of bog myrtle and purple moor grass through cutting (preferred) or burning (if necessary).	**Upper Crockford** Expand on previous removal of tree and scrub associated with transect sections 1.1 and 1.2. Removal of bog myrtle where encroaching and enclosing the channel.	**Latchmore** Clearance of scrub from bank tops along transect section 1.2 and 1.3 as appropriate, and cutting back or burning of bog myrtle and grasses from transect section 1.2 as necessary.	**Upper Crockford** Light burn across the length of transect sections 1.4, 1.6–1.7. Maintain management of tree and scrub (transect sections 1.1 and 1.2) and thin bog myrtle as required.	
Foulford Burn the length of transect sections 1.1 and 1.2, and clear willow immediately upstream of transect section 1.1. Partial removal of bog myrtle where necessary.	**Duckhole Bog** Continue removal of scrub along the length of the transect, extending below the southern limit of the transect to potentially increase suitable habitat.	**Mill Lawn** Light burn across those areas at a later stage of succession.	**Duckhole Bog** Light burn across the site.	
Latchmore Localised cutting back (by hand) or burning of bog myrtle and grasses from middle to upper reaches of transect section 1.3 where necessary.	**Hatchet Stream** Burn half the length of the transect on one bank only; removal of scrub prior to burning as appropriate.	**Round Hill** Extensive tree, scrub and bracken removal associated with transect 3, with partial removal (by hand) of bog myrtle associated with transects 2 and 3 as necessary.	**Foulford** Assess current intrinsic value and, if considered appropriate, selective removal of trees and scrub and partial clearance of bog myrtle downstream of transect section 1.3.	

Priority 1 – Immediate / Urgent Action	Priority 2 - Management Action Required		Priority 3 - On-going / Future Management	No Management Action Recommended
Mill Lawn Clearance of gorse scrub that separates transect sections 1.4 and 1.12, and small tree growing in the centre of transect section 1.1.	**Millersford Bottom** Light burn across the western part of the site (i.e. west of Millers Ford).	**Shipton Bottom** Removal of trees and scrub along transect 1.3 where appropriate. Burn of eastern arm of upper part of site.	**Hatchet Stream** Rotational burn / clearance of half of the length of the transect on one bank only; removal of scrub prior to burning as appropriate.	
Round Hill Removal of trees and scrub between transect sections 1.4 and 2.1, and associated with transect 2 as appropriate. Clearance of bracken at junction of transect sections 2.1 and 2.2.	**Three Beech Bottom** Light burn across all sections in transect 1. Light burn across all sections in transect 2 approximately two years later.	**Shobley** Burn habitat to the south and west of main channel (transect section 1.1).	**Millersford Bottom** Light burn across the eastern part of the site (i.e. east of Millers Ford).	
Shipton Bottom Removal of trees and scrub along transect section 1.1 where appropriate. Burn western arm of upper part of site.			**Round Hill** Monitor potential encroachment of transect 1.3 and manage as required.	
Shobley Removal of tree and scrub across site where appropriate. Burn habitat to the north and east of main channel (transect section 1.1).			**Stag Brake** Light burn across the site.	
Stony Moors Remove tree and scrub from bank-tops of transect section 1.1 and 1.2. Clearance of tall bog myrtle from transect sections 1.1-1.3.			**Widden Bottom** Light burn across the site.	

However, where this is not relevant, the transect / section routes and number of samples for the habitat condition assessment used within the current analysis should be used for both habitat and adult count surveys. This would result in the shortening and / or removal of several transects as set out in Table 3.

9.4.2 Habitat monitoring

It is strongly recommended that similar habitat monitoring is carried out again for any future assessment of the status of New Forest southern damselfly sites and metapopulation for the following reasons:

- it provides good data to monitor changes in the sites, even if not all data is directly comparable, and their overall 'condition' remains unaltered;
- it will allow for the identification of specific locations where future management works should be focused; and
- it will allow for the identification of any specific changes in habitat conditions that are a result of future management works, which is considered essential so that management actions and programmes can be reviewed and developed as appropriate (to ensure that future works are successful in maintaining / restoring / creating suitable habitat for southern damselfly).

It is recommended that the following habitat attributes are recorded as they were in 2019 (see Section 3.4 for details):

- habitat type;
- water flow;
- percentage cover of emergent broad-leaved herbs;
- percentage cover of submerged broad-leaved herbs;
- percentage cover of open water (i.e. water surface visible);
- percentage of channel / sample area in shade from overhanging bankside shrubs and trees;
- percentage cover of bog myrtle in watercourse;
- bankside vegetation structure;
- abundance of stiff emergent vegetation;
- percentage of channel substrate types.

It is recommended that the additional notes recorded for each 100m length of transect are retained (see Section 3.4 for details), as this information can be valuable in understanding some of the trends in the habitat attribute data recorded at some sites (e.g. a lack of / too high grazing pressure could explain why several transects / sections fail on bankside vegetation structure). Specifically this includes:

- evidence of grazing;
- hydrology of the site;
- vegetation structure across the wider site and any evidence of succession;
- vegetation structure of the adjoining habitat and the opportunity for southern damselfly expansion from the site.

In contrast, it is recommended that the presence / absence of bracken and evidence of eutrophication are removed from the list of habitat attributes recorded at each sample point, since a failure in one or both these attributes does not accurately reflect the status of a site or the southern damselfly population it supports (e.g. Clayhill Bottom, the Crockford Stream sites, and Shipton Bottom). Instead they should be included within the additional notes, since their presence may form part of a suite of indicators that can inform site management. This could be indications of early-stage development of a uniformly high or mixed sward / too shady bankside vegetation structure, or the need to further investigate potential sources of eutrophication and the actual risk posed.

9.4.3 Species monitoring

As discussed in Rushbrook *et al* (2014), gaining robust monitoring data for adult damselflies is not easy; the ability to determine the presence and size of populations is strongly influenced by the weather conditions at the time of recording, and the timing of the main flight period can vary substantially from year to year. To overcome this difficulty, two different approaches to species monitoring are recommended, and one should be selected according to the level of monitoring effort available.

As a minimum requirement for any future assessment of the status of the New Forest southern damselfly sites and metapopulation, it is recommended that formal adult counts following the criteria outlined in Section 3.5 are conducted at all sites included within the next round of monitoring (see Section 9.4.1). Future rounds of monitoring should be undertaken every five years, or every five and then seven years (to keep broadly to Natural England's six year condition assessment cycle), to take into account the semi-voltine development of this species and ensure that both cohorts are being monitored.

In addition to the collection of abundance data, it is recommended that surveyors are provided with a hand-held GPS and maps of all transect sections overlain with the relevant 10m by 10m grid squares (Figure 10). Using the hand-held GPS, the map should be annotated to show all the grid squares where adult male southern damselfly are recorded. This will potentially allow for changes in distribution within the site to be monitored, and would be particularly useful for identifying responses to management action implemented between monitoring rounds.

It is recommended that formal adult counts are supplemented, but not replaced by, informal counts during the habitat attribute surveys. Informal counts can be important in confirming presence of southern damselfly when only present in very low numbers (i.e. Foulford), and have been shown to significantly correlate with formal adult counts at the site and transect section level (see Section 5.2; Rushbrook *et al*., 2014). However, as a rule informal counts typically produce substantially lower values than formal counts (Figures 6 and 7), as the surveyors focus on the habitat itself, and it is considered highly unlikely that all habitat attribute surveys could be completed if the same restrictions on dates, time and weather were applied.

In order to assess southern damselfly population status at the site and transect section level more accurately, transect routes will need to be sampled more frequently. Harvey *et al*. (2005) suggested that population estimates could be derived from *ad hoc* records collated by the British Dragonfly Society (BDS). However, it is considered that this would be of only limited value, simply providing evidence of presence (and maybe distribution) at a site, but could not be used for comparative analysis as neither the survey effort nor the data resolution (e.g. males only, both sexes, actual counts, estimated counts, etc.) could be standardised.

Harvey *et al*. (2005) also recommended it should be possible to encourage local BDS and Wildlife Trust volunteers to help carry out a more rigorous, formal survey programme. Support for such volunteers could be provided by BDS, Forestry England and / or the Trust, so that volunteers were equipped with clear site maps and instructions, and provided with training and expenses as required. Health and Safety issues would also have to be addressed, as these sites are potentially hazardous, and lone working is not recommended.

If volunteers were to be engaged to carry out surveys, it is strongly recommended that the current methodology is strictly followed for all surveys to allow for direct comparison with the results of the status assessments. It is considered that the level of survey effort should be tailored to the level of interest from volunteer surveyors and the resources available from the co-ordinating organisation(s). If volunteers and / or resources are limited, then it is recommended that a minimum of six sites are selected for detailed assessment, and that the remaining sites are surveyed once every three-years on a rolling programme.

The sites selected for detailed assessment should cover the range of perceived population strengths and must include sites subject to management action in the immediate future, so that the success and / or impacts of these works can be assessed and used to develop future management actions / programmes. These sites should be visited fortnightly through the main flight period if possible, or on a minimum of four occasions with at least two visits (separated by at least one week) between the 20th June and 5th July. The counts collected during these surveys should then be analysed prior to the next round of monitoring to determine whether the value ranges used to categorise population strength and density (see Section 4.3) in the current study are appropriate.

If volunteers and / or resources are more readily available, then it is recommended that the number of sites selected for detailed assessment is increased.

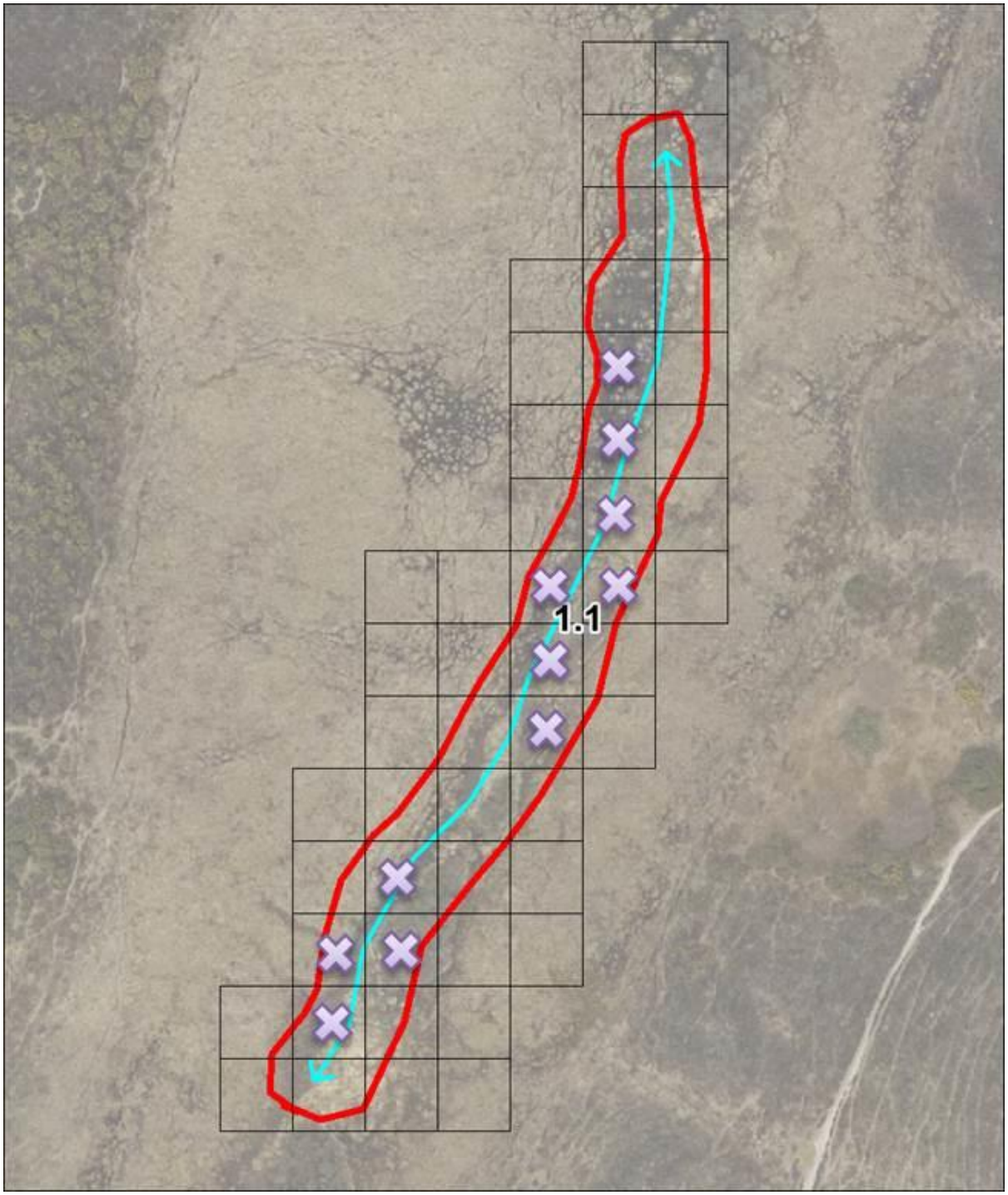


Figure 10: Example of a transect section overlain with 10m by 10m grid squares with the presence of adult male southern damselflies represented by a cross within each relevant square.

9.4.4 Assessment processes

It is strongly recommended that the four assessment criteria (i.e. habitat condition, site resilience, population strength and population density) set out in Section 4 are used for future investigations into the status of New Forest southern damselfly sites and the wider metapopulation. It is recommended that the same assessment processes and categories are utilised with a minor modification to the habitat condition assessment matrix. Specifically, it is recommended that both bracken and eutrophication are removed, since these attributes are not considered to provide sufficient indication of habitat condition, and details for these will be collected for 100m transect / section lengths (based on recommendations in Section 9.3.2), rather than at each sampling point.

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APPENDICES

Appendix 1:

Recording sheet used for habitat attribute sampling in 2019

Appendix 1: Recording sheet used for habitat attribute sampling in 2019.

Site:_____ Transect:_____

Recorder(s):_____

Section start gridref:
Section finish gridref:

Transect Sample No.										
Waymark No. / NGR										
Habitat type: (Linear / Mire)										
Water flow: (Dr, Da, NFl, Fl1-4)										

% cover emergent broad-leaved herbs (Incl. *Potamogeton polygonifolius*, and/or *Ranunculus flammula*, and / or *Hypericum elodes)*										
% cover submerged vegetation										
% of channel in shade from overhanging bankside shrubs and trees										
% cover of Bog Myrtle in watercourse										

Is bracken present? (Y/N)										
Evidence of eutrophication (Y/N)										

Bankside vegetation structure: (UL / UH / MS / MG)										

Stiff emergent vegetation for emergence: (N / S / F / C)										

% Channel substrate: (record % of all types)	Boulders										
	Pebbles										
	Gravel										
	Sand										
	Silt / mud / peat										

No. southern damselfly:		

Photo point / gridref	up- / downstream, or panorama?	photo number on camera

General Comments:

Grazing:

Hydrology:

Vegetation Structure and succession:

Adjoining habitat / expansion potential:

Additional Notes / Comments:

Appendix 2:
Recording sheet used for adult count surveys in 2019

Appendix 2: Recording sheet used for adult count surveys in 2019.

Site:_____ Date:_____

Recorder(s):_____

Start time:	**Finish time:**	**Transect No.:**
Shade temperature (ºC):	**Wind direction and speed:**	**% Sunshine:**

Transect section	**Tally of male southern damselfly seen**	**Ta**	**Co**	**Ov**	**Total**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Comments:

Notes for transect walkers:

1) Transects should be walked between 10th June and 18th July (depending on sites).
2) Counts should take place between 11:00 and 15:00 BST
3) Weather conditions should meet the following minimum requirements:
   - The air temperature in the shade should be above 17°C
   - There should be at least 50% sunshine
   - Wind should not exceed force 4 on the Beaufort scale (i.e. no more than leaves and branches moving)

Appendix 3:
Files supplied to the Forestry Commission

Appendix 3: Files supplied to the Forestry Commission.

The following electronic files will be supplied to Leanne Sargent at the Forestry England

- Database: “Southern Damselfly monitoring 2019 v1 – 1.mdb”
    - This is the database used to analyse the habitat sample and damselfly transect data resulting from the fieldwork. It also stores details of the photo-monitoring points, and of the criteria used for condition assessment. The database is in a Microsoft™ Access 2010 format. The queries are set up to analyse the full dataset within the database, and will require some editing if they are required for use in future years.

- Spreadsheet file: “database export – damselfly transect raw data.xls”
    - Exports of raw data from the database
- Spreadsheet file: “database export – habitat sampling raw data.xls”
    - Exports of raw data from the database
- Spreadsheet file: “database export – site photo list.xls”
    - Exports of raw data from the database

- New Forest Southern Damselfly site assessment GIS data.zip - this compressed file will contain four ArcGIS tables:
    - 2019 damselfly transect routes.SHP (line data showing transect routes)
    - 2019 habitat sample points with photos.SHP (i.e. those sample points from which photos were taken)
    - 2019 habitat sample points.SHP (point data showing sample points)
    - 2019 potential habitat area.SHP (polygon data showing areas assessed as being habitat for southern damselfly)

- This document saved as a Word document, as a high-resolution .pdf files, and also as a low-resolution .pdf (suitable for emailing)

- Digital photos (.jpg files) for all photo monitoring
- Aerial photo images (.jpg files) showing location of photo monitoring points
- Any necessary software for viewing photos
    - The original .jpg files will be placed on (in the “images” folder), along with the photo viewing software that will provide an additional resource for viewing the photos for each site

Appendix 4:

Summary of habitat sample data, showing the average (mean or mode as appropriate) value of each recorded attribute

Appendix 4: Summary of habitat sample data, showing the average (mean or mode as appropriate) value of each recorded attribute.

Site name	Mode of water flow	Mean % channel shaded from overhanging trees/shrubs	Mean % cover emergent broad-leaved herbs	Mean % cover submerged broad-leaved herbs	Mode of left bankside vegetation	Mode of right bankside vegetation	Mean % cover bog myrtle	Mode of stiff emergent vegetation	Mean % substrate boulder	Mean % substrate pebbles	Mean % substrate gravel	Mean % substrate sand	Mean % substrate silt/mud/peat	Mean % cover open water	Mode of bracken present	Mode of eutrophication present?
Acres Down	NFl	8.55	8.23	0.52	MG	MG	19.03	S	0.00	0.65	0.00	0.00	99.35	49.52	Absent	Absent
Bagshot Moor	NFl	8.42	50.67	6.21	UL	UL	21.13	F	0.21	0.00	2.71	0.00	97.08	27.08	Absent	Absent
Bull Hill	Fl	16.00	27.80	4.92	MG	UL	7.20	S	1.20	4.48	1.80	2.00	90.52	65.80	Absent	Absent
Clayhill Bottom	Fl	10.28	12.06	7.67	MG	MG	3.00	F	1.11	16.11	6.72	4.44	71.61	76.11	Absent	Absent
Common Moor	Fl	0.00	6.00	0.40	MG	MG	24.20	S	0.00	0.00	0.00	0.00	100.00	64.00	Absent	Absent
Crockford Stream (Lower)	Fl	11.64	23.41	15.26	UL	MG	15.21	S	1.60	6.70	3.57	2.66	85.47	72.16	Absent	Absent
Crockford Stream (Upper)	Fl	2.71	19.33	7.36	MG	MG	9.92	S	0.57	8.12	3.44	3.04	84.83	74.10	Absent	Absent
Dibden Bottom	Fl	31.39	31.11	11.50	MS	MS	2.78	S	0.00	1.11	1.11	0.56	97.22	63.89	Absent	Absent
Duckhole Bog	Fl	0.38	27.69	15.38	MG	MG	11.15	F	0.00	0.00	0.00	0.00	100.00	63.08	Absent	Absent
Foulford	Fl	9.81	18.65	7.92	MG	MG	12.12	S	0.08	0.77	0.19	0.00	98.96	50.58	Absent	Absent
Hatchet Stream	Fl	1.94	24.74	4.59	MG	MG	7.78	S	1.59	10.31	5.81	1.56	80.72	70.76	Absent	Absent
Howen Bottom	Not Assessed															
Latchmore	Fl	6.01	32.64	4.32	MG	MG	5.53	F	0.05	0.14	0.53	0.96	98.32	37.93	Absent	Absent
Mill Lawn	NFl	6.73	43.19	5.44	UL	UL	4.84	F	0.00	0.84	2.32	0.07	96.78	35.91	Absent	Absent
Millersford Bottom	Fl	8.14	24.00	3.41	MG	MG	6.73	F	0.38	2.18	0.71	0.00	96.73	38.85	Absent	Absent
Round Hill	Fl	18.51	27.80	5.92	MG	MG	2.78	F	0.00	1.27	3.35	3.61	91.77	47.84	Absent	Absent
Shipton Bottom	Fl	6.60	26.73	11.34	MG	MG	15.42	S	0.46	5.70	2.20	0.86	90.83	62.14	Absent	Absent
Shobley	Fl	11.70	29.40	7.70	MG	MG	14.50	F	0.04	0.60	0.60	0.00	98.76	47.00	Present	Absent
Stag Brake	NFl	2.65	31.71	4.76	UL	UL	0.00	S	0.00	0.00	0.00	0.00	100.00	27.41	Absent	Present
Stony Moors	NFl	10.34	23.00	7.21	MG	MG	20.62	S	0.00	0.00	0.00	0.00	100.00	37.80	Absent	Absent
Three Beech Bottom	Fl	5.26	19.76	4.46	UL	UL	15.39	S	0.00	0.00	1.20	0.43	98.37	47.70	Absent	Absent
Widden Bottom	NFl	1.24	32.76	7.41	UL	UL	10.91	S	0.00	0.00	1.68	2.21	95.82	57.65	Absent	Present

Appendix 5:

Percentage of sample points falling outside the habitat attribute limits for each transect section

Appendix 5: Percentage of sample points falling outside the habitat attribute limits for each transect section.

Site and transect section	% no flow	% too much shade	% too few emergent	% too many emergent	% too few submerged	% too many submerged	% vegetation structure not MG on either bank	% too much bog myrtle	% not enough bog myrtle	% non frequent stiff emergent	% not enough silt/ mud/ peat	% not enough open water	% bracken present	% eutrophication present	% samples mire	% samples linear
Acres Down 1.1	100	13	75	0	100	0	25	0	25	88	0	0	25	0	75	25
Acres Down 1.2	29	0	86	0	100	0	29	14	29	71	0	0	71	29	14	86
Acres Down 1.3	80	0	100	0	100	0	0	0	20	100	0	0	20	20	0	100
Acres Down 1.4	43	0	100	0	100	0	29	0	14	86	0	0	71	0	0	100
Acres Down 1.5	100	0	50	0	100	0	25	0	25	75	0	25	25	0	25	75
Bagshot Moor 1.1	100	0	17	13	100	0	58	0	21	46	0	13	0	13	0	100
Bull Hill 1.1	14	0	29	0	100	0	86	0	43	100	0	0	0	0	0	100
Bull Hill 1.2	Not Assessed															
Bull Hill 1.3	100	0	25	0	100	0	0	0	50	50	0	0	0	25	100	0
Bull Hill 1.4	43	43	71	0	100	0	93	0	57	71	0	0	0	43	0	100
Bull Hill 1.5	0	0	29	0	100	0	43	0	100	100	0	0	0	0	0	100
Clayhill Bottom 1.1	0	17	33	0	67	0	33	0	67	50	0	0	33	0	0	100
Clayhill Bottom 1.2	0	0	50	0	75	0	63	0	100	25	0	0	75	0	0	100
Clayhill Bottom 1.3	0	0	100	0	100	0	25	0	100	63	13	0	0	50	0	100
Common Moor 1.1	40	0	100	0	100	0	0	0	20	80	0	0	0	0	60	40
Crockford Stream (Lower) 1.1	0	8	27	0	65	0	60	0	62	73	12	0	0	62	4	96
Crockford Stream (Lower) 1.2	0	0	33	0	58	0	33	0	58	75	0	0	0	67	0	100
Crockford Stream (Lower) 1.3	0	11	37	0	59	0	72	4	26	96	4	0	7	4	0	100
Crockford Stream (Lower) 1.4	0	0	40	0	100	0	80	0	40	100	0	0	0	80	0	100
Crockford Stream (Upper) 1.1	6	0	65	0	82	0	74	0	47	94	0	0	0	35	0	100
Crockford Stream (Upper) 1.2	0	0	46	0	78	0	7	0	30	81	3	0	0	46	14	86

Site and transect section	% no flow	% too much shade	% too few emergent	% too many emergent	% too few submerged	% too many submerged	% vegetation structure not MG on either bank	% too much bog myrtle	% not enough bog myrtle	% non frequent stiff emergent	% not enough silt/ mud/ peat	% not enough open water	% bracken present	% eutrophication present	% samples mire	% samples linear
Crockford Stream (Upper) 1.3	0	0	77	0	85	0	15	0	100	100	8	0	0	8	0	100
Crockford Stream (Upper) 1.4	8	4	53	0	94	0	20	0	59	78	0	0	2	18	18	82
Crockford Stream (Upper) 1.5	13	0	75	0	88	0	63	0	100	100	0	0	0	13	0	100
Crockford Stream (Upper) 1.6	100	0	25	0	100	0	13	0	38	75	0	0	0	25	50	50
Crockford Stream (Upper) 1.7	42	0	33	0	92	0	0	0	46	46	0	0	0	42	50	50
Dibden Bottom 1.1	17	33	44	6	78	0	92	0	83	100	0	0	6	0	0	100
Duckhole Bog 1.1	38	0	15	0	69	0	27	0	46	31	0	0	0	0	46	54
Foulford 1.1	33	17	67	0	67	0	17	0	50	67	0	33	0	0	17	83
Foulford 1.2	33	0	25	0	100	0	17	0	50	75	0	8	17	0	42	58
Foulford 1.3	38	25	38	0	88	0	13	13	25	63	0	25	75	0	50	50
Hatchet Stream 1.1	15	0	54	7	96	0	35	2	67	85	2	6	0	22	4	96
Howen Bottom 1.1	Not Assessed															
Howen Bottom 1.2	Not Assessed															
Howen Bottom 1.3	Not Assessed															
Latchmore 1.1	0	0	27	0	100	0	77	0	87	0	0	0	0	0	47	53
Latchmore 1.2	2	0	18	2	100	0	20	0	73	29	0	0	6	8	84	16
Latchmore 1.3	0	11	31	0	97	0	26	0	54	20	0	6	23	0	29	71
Latchmore 1.4	80	0	0	0	100	0	100	0	100	0	0	20	20	0	0	100
Mill Lawn 1.1	97	0	3	41	97	0	100	0	100	65	0	27	11	35	0	100
Mill Lawn 1.2	0	0	28	4	64	4	100	0	100	84	24	0	0	0	0	100
Mill Lawn 1.3	0	20	50	0	70	0	100	0	100	100	0	0	10	10	0	100
Mill Lawn 1.4	62	0	15	8	92	0	77	0	100	85	0	15	38	8	46	54
Mill Lawn 1.5	0	8	44	4	92	0	84	0	100	60	0	4	4	4	32	68

Site and transect section	% no flow	% too much shade	% too few emergent	% too many emergent	% too few submerged	% too many submerged	% vegetation structure not MG on either bank	% too much bog myrtle	% not enough bog myrtle	% non frequent stiff emergent	% not enough silt/ mud/ peat	% not enough open water	% bracken present	% eutrophication present	% samples mire	% samples linear
Mill Lawn 1.6	100	4	13	0	100	0	71	0	100	38	0	13	71	13	0	100
Mill Lawn 1.7	92	0	8	0	100	0	69	0	100	69	0	0	0	31	23	77
Mill Lawn 1.8	14	0	5	0	95	0	95	0	100	48	0	0	19	14	52	48
Mill Lawn 1.9	58	5	0	0	100	0	84	0	100	63	0	16	63	16	0	100
Mill Lawn 1.10	100	0	44	0	100	0	67	0	100	100	0	22	33	0	44	56
Mill Lawn 1.11	Not Assessed															
Mill Lawn 1.12	0	20	40	0	100	0	80	0	100	80	0	20	7	0	0	100
Mill Lawn 2.1	Not Assessed															
Mill Lawn 3.1	100	0	0	40	100	0	5	0	20	40	0	20	0	10	0	100
Mill Lawn 3.2	68	0	5	0	100	0	5	0	55	41	0	14	0	0	27	73
Mill Lawn 3.3	71	0	21	7	100	0	0	0	25	57	0	4	18	7	39	61
Mill Lawn 4.1	40	25	15	5	100	0	48	5	55	65	0	15	0	0	0	100
Mill Lawn 4.2	0	70	60	0	100	0	90	0	30	60	0	50	0	0	0	100
Millersford Bottom 1.1	46	4	71	0	96	0	13	0	92	58	0	4	8	17	63	38
Millersford Bottom 1.2	25	0	38	0	100	0	38	0	75	38	0	13	0	50	0	100
Millersford Bottom 1.3	67	0	67	0	100	0	8	0	33	50	0	67	0	17	17	83
Millersford Bottom 1.4	67	17	0	17	83	0	33	0	17	33	0	17	0	83	33	67
Millersford Bottom 1.5	34	3	28	0	97	0	38	0	72	79	0	0	21	3	41	59
Millersford Bottom 1.6	0	60	100	0	100	0	100	0	100	100	20	0	40	20	0	100
Round Hill 1.1	0	0	100	0	100	0	0	0	60	40	0	0	0	0	100	0
Round Hill 1.2	0	0	40	0	100	0	0	0	80	0	0	0	0	0	100	0
Round Hill 1.3	0	6	25	0	94	0	13	0	88	38	0	0	0	0	44	56
Round Hill 1.4	0	33	67	0	100	0	83	0	100	100	67	0	0	33	0	100
Round Hill 2.1	0	0	60	0	100	0	10	0	80	40	0	0	20	0	20	80
Round Hill 2.2	0	0	75	0	0	0	75	0	100	25	0	0	0	0	0	100

Site and transect section	% no flow	% too much shade	% too few emergent	% too many emergent	% too few submerged	% too many submerged	% vegetation structure not MG on either bank	% too much bog myrtle	% not enough bog myrtle	% non frequent stiff emergent	% not enough silt/ mud/ peat	% not enough open water	% bracken present	% eutrophication present	% samples mire	% samples linear
Round Hill 2.3	0	75	100	0	88	0	100	0	100	88	13	0	25	0	0	100
Round Hill 2.4	0	0	67	0	100	0	67	0	100	100	33	0	0	0	0	100
Round Hill 3.1	20	0	0	0	100	0	80	0	100	20	0	20	0	0	80	20
Round Hill 3.2	12	29	47	0	100	0	100	0	88	47	0	18	41	0	0	100
Round Hill 3.3	63	0	0	13	100	0	38	0	63	25	0	25	13	0	63	38
Shipton Bottom 1.1	0	13	33	0	50	0	70	2	35	67	0	0	0	58	0	100
Shipton Bottom 1.2	37	0	3	9	94	0	6	0	34	46	0	3	0	34	83	17
Shipton Bottom 1.3	0	10	20	0	70	0	65	0	60	80	0	0	0	20	0	100
Shipton Bottom 1.4	17	0	58	0	67	0	38	0	33	17	0	0	0	8	42	58
Shipton Bottom 1.5	0	6	44	0	74	0	37	6	32	62	0	0	0	32	9	91
Shipton Bottom 1.6	30	0	59	0	100	0	6	0	59	56	0	0	0	15	44	56
Shobley 1.1	11	21	36	4	82	0	43	0	36	50	0	14	54	0	0	100
Shobley 1.2	20	10	30	0	100	0	25	0	30	60	0	0	50	0	20	80
Shobley 1.3	0	0	0	0	100	0	38	0	13	13	0	0	63	0	38	63
Shobley 1.4	0	0	25	0	100	0	75	0	0	75	0	0	25	0	0	100
Stag Brake 1.1	76	0	35	0	100	0	71	0	100	59	0	24	0	71	41	59
Stony Moors 1.1	100	0	33	11	56	0	33	0	33	89	0	0	0	0	11	89
Stony Moors 1.2	100	25	0	0	100	0	0	0	25	100	0	50	0	0	50	50
Stony Moors 1.3	100	0	17	0	83	0	0	0	17	100	0	17	0	0	33	67
Stony Moors 1.4	Not Assessed															
Stony Moors 2.1	100	0	80	0	100	0	80	0	0	60	0	20	0	40	100	0
Three Beech Bottom 1.1	40	0	10	10	100	0	100	20	10	100	0	10	0	40	0	100
Three Beech Bottom 1.2	Not Assessed															
Three Beech Bottom 1.3	Not Assessed															
Three Beech Bottom 1.4	0	0	40	0	100	0	60	0	20	100	0	0	0	0	0	100

Site and transect section	% no flow	% too much shade	% too few emergent	% too many emergent	% too few submerged	% too many submerged	% vegetation structure not MG on either bank	% too much bog myrtle	% not enough bog myrtle	% non frequent stiff emergent	% not enough silt/ mud/ peat	% not enough open water	% bracken present	% eutrophication present	% samples mire	% samples linear
Three Beech Bottom 2.1	38	0	88	0	100	0	88	0	25	100	0	0	0	0	0	100
Three Beech Bottom 2.2	75	0	100	0	100	0	100	0	75	88	0	0	0	13	13	88
Three Beech Bottom 2.3	29	0	86	0	100	0	100	0	86	100	0	0	0	0	14	86
Three Beech Bottom 2.4	38	0	88	0	100	0	88	0	38	100	0	0	0	0	13	88
Widden Bottom 1.1	71	0	35	0	88	0	82	0	56	97	0	0	0	62	12	88

Appendix 6:

Weather and time data for adult transect counts

Appendix 6: Weather and time data for adult transect counts.

Site name and transect section	Date	Start (BST)	Finish (BST)	Shade Temperature (°C)	Wind direction	Beaufort number	Sunshine (%)	Notes	Recorder/s
Acres Down 1.1	10 July 2019	11:00	14:00	23	south-west	2	70		Tom Selby
Acres Down 1.2	10 July 2019	11:00	14:00	23	south-west	2	70		Tom Selby
Acres Down 1.3	10 July 2019	11:00	14:00	23	south-west	2	70		Tom Selby
Acres Down 1.4	10 July 2019	11:00	14:00	23	south-west	2	70		Tom Selby
Acres Down 1.5	10 July 2019	11:00	14:00	23	south-west	2	70		Tom Selby
Bagshot Moor 1.1	16 July 2019	14:25	15:00	20	north	2	100	Watercourse dry/damp in places + scrubbed over in the middle	Carmen Green
Bull Hill 1.1	09 July 2019	13:25	14:55	21	south-west	3	60		Tom Selby
Bull Hill 1.2	09 July 2019	13:25	14:55	21	south-west	3	60		Tom Selby
Bull Hill 1.3	09 July 2019	13:25	14:55	21	south-west	3	60		Tom Selby
Bull Hill 1.4	09 July 2019	13:25	14:55	21	south-west	3	60		Tom Selby
Bull Hill 1.5	09 July 2019	13:25	14:55	21	south-west	3	60		Tom Selby
Clayhill Bottom 1.1	11 July 2019	13:00	13:51	22	south-west	3	50		Tom Selby
Clayhill Bottom 1.2	11 July 2019	13:00	13:51	22	south-west	3	50		Tom Selby
Clayhill Bottom 1.3	11 July 2019	13:00	13:51	22	south-west	3	50		Tom Selby
Common Moor 1.1	11 July 2019	14:29	14:50	22	north-east	3	50		Tom Selby
Crockford Stream (Lower) 1.1	02 July 2019	11:25	15:00	20	north-west	3	60		Tom Selby
Crockford Stream (Lower) 1.2	02 July 2019	11:25	15:00	20	north-west	3	60		Tom Selby
Crockford Stream (Lower) 1.3	02 July 2019	11:25	15:00	20	north-west	3	60		Tom Selby
Crockford Stream (Lower) 1.4	02 July 2019	11:25	15:00	20	north-west	3	60		Tom Selby
Crockford Stream (Upper) 1.1	05 July 2019	11:07	13:58	18	west	3	50		Tom Selby
Crockford Stream (Upper) 1.2	05 July 2019	11:07	13:58	18	west	3	50		Tom Selby
Crockford Stream (Upper) 1.3	08 July 2019	11:10	14:15	21	south	3	80		Tom Selby
Crockford Stream (Upper) 1.4	08 July 2019	11:10	14:15	21	south	3	80		Tom Selby

Site name and transect section	Date	Start (BST)	Finish (BST)	Shade Temperature (°C)	Wind direction	Beaufort number	Sunshine (%)	Notes	Recorder/s
Crockford Stream (Upper) 1.5	08 July 2019	11:10	14:15	21	south	3	80		Tom Selby
Crockford Stream (Upper) 1.6	09 July 2019	11:00	12:30	21	south-west	4	60		Tom Selby
Crockford Stream (Upper) 1.7	09 July 2019	11:00	12:30	21	south-west	4	60	Source of 1.7 moved? WM 145 - SU 34282 00037. Possibly 2-3 runnels through wide mire converging,	Tom Selby
Dibden Bottom 1.1	28 June 2019	13:34	14:15	24	south-east	3	70		Tom Selby
Duckhole Bog 1.1	11 July 2019	11:10	11:59	22	north-west	3	60		Tom Selby
Foulford 1.1	15 July 2019	13:30	14:35	22	north-east	3	60		Tom Selby
Foulford 1.2	16 July 2019	13:30	14:35	23	north-east	3	60		Tom Selby
Foulford 1.3	17 July 2019	13:30	14:35	24	north-east	3	60	1.3 Heavy bog myrtle growth. Transect difficult to follow.	Tom Selby
Hatchet Stream 1.1	01 July 2019	12:10	14:57	21	north-west	3	50		Tom Selby
Howen Bottom 1.1	16 July 2019	13:20	13:40	22	south-west	2	80	All sections dry. No odonata.	Tom Selby
Howen Bottom 1.2	16 July 2019	13:20	13:40	22	south-west	2	80	All sections dry. Muddy pool beneath trees between 1.2 and 1.3. No odonata.	Tom Selby
Howen Bottom 1.3	16 July 2019	13:20	13:40	22	south-west	2	80	All sections dry. No odonata.	Tom Selby
Latchmore 1.1	07 July 2019	14:27	14:34	23	south	2	85		Ben Rushbrook
Latchmore 1.2	07 July 2019	13:52	14:17	23	south	1	70		Ben Rushbrook
Latchmore 1.3	05 July 2019	11:47	12:08	24	south-west	2	65		Ben Rushbrook
Latchmore 1.4	05 July 2019	13:37	13:38	24	south-west	2	100		Ben Rushbrook
Mill Lawn 1.1	08 July 2019	14:45	14:56	22	south-east	3	100		Sarah Jackson
Mill Lawn 1.2	08 July 2019	14:28	14:43	22	south-east	2	100		Sarah Jackson
Mill Lawn 1.3	10 July 2019	11:02	11:24	21	south-east	3	100		Sarah Jackson
Mill Lawn 1.4	08 July 2019	14:00	14:17	21	south-east	2	100	Common Lizard	Sarah Jackson
Mill Lawn 1.5	08 July 2019	13:40	13:52	20	south-east	2	100		Sarah Jackson

Site name and transect section	Date	Start (BST)	Finish (BST)	Shade Temperature (°C)	Wind direction	Beaufort number	Sunshine (%)	Notes	Recorder/s
Mill Lawn 1.6	08 July 2019	12:07	13:05	21	south-east	2	100		Sarah Jackson
Mill Lawn 1.7	08 July 2019	12:44	12:52	21	south-east	3	100		Sarah Jackson
Mill Lawn 1.8	08 July 2019	12:15	12:30	21	south-east	3	100		Sarah Jackson
Mill Lawn 1.9	08 July 2019	11:44	11:56	22	south-east	3	90		Sarah Jackson
Mill Lawn 1.10	08 July 2019	12:00	12:08	21	south-east	3	100		Sarah Jackson
Mill Lawn 1.11	08 July 2019	11:20	11:36	20	south-east	3	100		Sarah Jackson
Mill Lawn 1.12	08 July 2019	14:00	14:17	21	south-east	2	100	Common Lizard	Sarah Jackson
Mill Lawn 2.1	10 July 2019	11:32	11:35	22	south-east	3	100	Looks as though it's been dry for a long time.	Sarah Jackson
Mill Lawn 3.1	10 July 2019	11:46	11:50	23	south-east	2	100		Sarah Jackson
Mill Lawn 3.2	10 July 2019	13:39	13:48	24	south-east	1	100		Sarah Jackson
Mill Lawn 3.3	10 July 2019	13:58	14:21	24	south-east	3	80	Juvenile frog. Woodcock.	Sarah Jackson
Mill Lawn 4.1	10 July 2019	11:59	12:23	22	south-east	3	100	Common Lizard	Sarah Jackson
Mill Lawn 4.2	10 July 2019	11:59	12:23	22	south-east	3	100	Common Lizard	Sarah Jackson
Millersford Bottom 1.1	16 July 2019	11:00	11:45	20	north-west	2	80		Tom Selby
Millersford Bottom 1.2	12 July 2019	11:10	14:30	21	south-east	3	50		Tom Selby
Millersford Bottom 1.3	12 July 2019	11:10	14:30	21	south-east	3	50		Tom Selby
Millersford Bottom 1.4	12 July 2019	11:10	14:30	21	south-east	3	50		Tom Selby
Millersford Bottom 1.5	12 July 2019	11:10	14:30	21	south-east	3	50		Tom Selby
Millersford Bottom 1.6	12 July 2019	11:10	14:30	21	south-east	3	50		Tom Selby
Round Hill 1.1	15 July 2019	11:28	11:34	18	south	4	100		Ben Rushbrook
Round Hill 1.2	15 July 2019	11:37	11:40	18	south	4	100		Ben Rushbrook
Round Hill 1.3	15 July 2019	12:03	12:11	18	south	3	100		Ben Rushbrook
Round Hill 1.4	15 July 2019	12:40	12:42	18	south	2	100		Ben Rushbrook
Round Hill 2.1	15 July 2019	13:36	13:40	20	south	3	80	Juvenile frog.	Ben Rushbrook
Round Hill 2.2	15 July 2019	14:01	14:05	21	south	2	100		Ben Rushbrook

Site name and transect section	Date	Start (BST)	Finish (BST)	Shade Temperature (°C)	Wind direction	Beaufort number	Sunshine (%)	Notes	Recorder/s
Round Hill 2.3	15 July 2019	13:54	13:58	21	south	3	90		Ben Rushbrook
Round Hill 2.4	15 July 2019	13:46	13:48	21	south	2	100		Ben Rushbrook
Round Hill 3.1	15 July 2019	12:58	13:00	20	south	2	90	Only damp with 1 or 2 puddles.	Ben Rushbrook
Round Hill 3.2	15 July 2019	13:02	13:10	20	south	2	90	Limited wetted area and limited evidence of flow.	Ben Rushbrook
Round Hill 3.3	15 July 2019	13:17	13:23	20	south	2	100	Largely just very soft and damp but not much visible surface water.	Ben Rushbrook
Shipton Bottom 1.1	03 July 2019	11:10	13:07	19	east	3	50		Tom Selby
Shipton Bottom 1.2	04 July 2019	11:00	15:00	18	south	2	100		Tom Selby
Shipton Bottom 1.3	04 July 2019	11:00	15:00	18	south	2	100		Tom Selby
Shipton Bottom 1.4	04 July 2019	11:00	15:00	18	south	2	100		Tom Selby
Shipton Bottom 1.5	04 July 2019	11:00	15:00	18	south	2	100		Tom Selby
Shipton Bottom 1.6	04 July 2019	11:00	15:00	18	south	2	100		Tom Selby
Shobley 1.1	15 July 2019	11:00	12:53	17	south-east	3	65		Tom Selby
Shobley 1.2	15 July 2019	11:00	12:53	17	south-east	3	65		Tom Selby
Shobley 1.3	15 July 2019	11:00	12:53	17	south-east	3	65		Tom Selby
Shobley 1.4	15 July 2019	11:00	12:53	17	south-east	3	65		Tom Selby
Stag Brake 1.1	10 July 2019	11:09	11:40	21	north-east	2	90	Common Lizard. Silver-washed fritillary.	Carmen Green
Stony Moors 1.1	08 July 2019	12:25	12:43	20	north-west	3	100		Carmen Green
Stony Moors 1.2	08 July 2019	12:53	12:55	20	north-west	2	100		Carmen Green
Stony Moors 1.3	08 July 2019	13:00	13:08	20	north-west	2	100		Carmen Green
Stony Moors 1.4	08 July 2019	13:12	13:25	20	north-west	2	100		Carmen Green
Stony Moors 2.1	08 July 2019	11:27	11:55	20	no wind	0	100		Carmen Green
Three Beech Bottom 1.1	10 July 2019	14:11	14:40	24	north-east	4	80		Carmen Green

Site name and transect section	Date	Start (BST)	Finish (BST)	Shade Temperature (°C)	Wind direction	Beaufort number	Sunshine (%)	Notes	Recorder/s
Three Beech Bottom 1.2	10 July 2019	14:45	14:53	23	north-east	4	90	Grass Snake. Woodcock.	Carmen Green
Three Beech Bottom 1.3	16 July 2019	11:45	11:48	20	north	2	70	Dry.	Carmen Green
Three Beech Bottom 1.4	16 July 2019	11:17	11:40	21	north	2	70	Dry at southern end.	Carmen Green
Three Beech Bottom 2.1	16 July 2019	13:20	13:28	22	north	2	100	Common Lizard.	Carmen Green
Three Beech Bottom 2.2	09 July 2019	14:03	14:13	25	north-east	3	80		Carmen Green
Three Beech Bottom 2.3	09 July 2019	13:07	13:17	21	north-east	3	60		Carmen Green
Three Beech Bottom 2.4	16 July 2019	13:35	13:43	21	north	3	100	Woodcock.	Carmen Green
Widden Bottom 1.1	10 July 2019	12:31	13:28	24	north-east	3	90	Large marsh grasshopper. Common lizard. Woodcock.	Carmen Green

Appendix 7:

Summary of management works conducted at known southern damselfly sites in the New Forest since 2013

Appendix 7: Summary of management works conducted at known southern damselfly sites in the New Forest since 2013.

Site Name	Site condition assessment in Rushbrook *et al*., 2014	Priority level	location (Grid ref)	Summary of threats	Summary of management recommendations	Report ref	Action by	Year work undertaken
Acres Down	Unfavourable	Priority level 1	SU2698308545	Successional vegetation	Rotational cutting of bracken stands focussing on runnels undertaken biannually.	6.1 Ref page 38	Open Forest	2016
Bagshot Moor	Favourable	Priority level 2	SZ3696499840	Successional vegetation	Woody plant species (willow, gorse etc) cut back from 5m of stream.	6.2 Ref page 40	Open Forest HLS Wetland (NW)	2015 for burn 2015/16 for scrub
Clayhill Bottom	Unfavourable	Priority level 2	SU2311900852	Successional vegetation	Tall scrub (including but not exclusively alder, willow, silver birch) cut back from within 5m of stream on section 1.1	6.4 Page 44	Open Forest	2016
Common Moor	Unfavourable	Priority level 2	SU2055204410	Succession vegetation bog myrtle and *Molinia*	partial clearance of *Molinia* and bog myrtle by hand or consider burning.	6.5 Page 46	Open Forest	2016
Crockford Stream (Upper)	Favourable	Priority level 2	SZ3506898986	shading	Tall scrub (including but not exclusively alder, willow, birch, hawthorn, blackthorn, guilder rose, bramble) cut back from within 5m of stream.	6.7 page 51	HLS Terrestrial HLS wetland team (NW)	2014 2016
Crockford Stream (Upper)	Favourable	Priority level 2	SZ3506898986	Successional vegetation	Light burn to keep scrub and bog myrtle in check	6.7 page 51	Open Forest	2016
Duckhole bog	Unfavourable	Priority level 1	SU2525902098	Successional vegetation	Scrub removal – immediately	6.9 page 56	HLS Terrestrial Programme	Jan/Feb 2019

Site Name	Site condition assessment in Rushbrook *et al*., 2014	Priority level	location (Grid ref)	Summary of threats	Summary of management recommendations	Report ref	Action by	Year work undertaken
Foulford	Unfavourable	Priority level 1	SU1886405535	Successional vegetation	Completely clear willow up stream.	6.10 page 58	HLS Terrestrial Programme	2016
Foulford	Unfavourable	Priority level 1	SU1886405535	Successional vegetation	Removal of gorse and bracken partial removal of myrtle – by hand in mire section 1.3	6.10 page 58	HLS Terrestrial Programme	2016
Foulford	Unfavourable	Priority level 1	SU1886405535	Successional vegetation	Down stream selective (50%) removal of trees and scrub within 10m – check value of woodland first.	6.10 page 58	HLS Terrestrial Programme HLS Wetland (SO)	2016 2018
Hatchet stream	Favourable	Priority level 3	SU3621301221	Too few plants for oviposition	2018 light burn to keep scrub, bog myrtle and other vegetation in check	6.11 page 60	Open Forest	2016
Latchmore	Favourable	Priority level 2	SU1900812867	Successional vegetation	Scrub removal within 5m of banks sections 1.2 &1.3	6.13 page 64	Open Forest	2018
Mill Lawn	Unfavourable	Priority level 3	SU2258803523	Successional vegetation	gorse clearance by burning / cutting and removal.	6.14 page 66	Open Forest	2017
Mill Lawn	Unfavourable	Priority level 3	SU2258803523	Poor vegetation structure – heavy grazing /low lawns	2018 light burn to control vegetation in ‘non lawn’ areas	6.14 page 66	Open Forest	2013
Mill Lawn	Unfavourable	Priority level 3	SU2258803523	Hydrology – water flow.	Hydrological assessment of site to determine availability of water to the site.	6.14 page 66		2017 assessed

Site Name	Site condition assessment in Rushbrook *et al*., 2014	Priority level	location (Grid ref)	Summary of threats	Summary of management recommendations	Report ref	Action by	Year work undertaken
Millersford Bottom	Unfavourable	Priority level 2	SU1830316208	Course vegetation /insufficient grazing pressure	2016 light burn to control vegetation western/ eastern areas to reduce vegetation.	6.15 page 68	Open Forest	2018
Shipton Bottom	Favourable	Priority level 2	SZ3593898802	Scrub / vegetation structure	Phased light burning	6.17 page 73	Open Forest	2014
Shobley	Unfavourable	Priority level 1	SU1830906185	Scrub / vegetation structure	localised clearance of tree cover/ dense scrub/ tall bog myrtle	6.18 page 75	HLS wetland team	2018
Shobley	Unfavourable	Priority level 1	SU1830906185	Scrub / vegetation structure	Phased light burning	6.18 page 75	Open Forest	2016
Stag Brake	Favourable	Priority level 3	SU2462802990	On going management needed	Phased light burning	6.19 page 77	Open Forest	2013 & 2018
Widden Bottom	Unfavourable	Priority level 3	SZ2904799421	Vegetation structure	light burning to check purple moor grass	6.22 page 83	Open Forest HLS Wetland (SO)	HLS wetland work 2018