


Bordered brown lacewing project report

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Summary

Forty of the 70 UK species of lacewing are recorded in Scotland, with four only being recorded in Scotland. The Bordered brown lacewing (*Megalomus hirtus*) is currently only known from two sites in Scotland, Holyrood Park Site of Special Scientific Interest (SSSI) in Edinburgh and near Muchalls in Aberdeenshire. The record from Muchalls from 2018 is the first record of the Bordered brown lacewing at this site since 1916.

Scottish Natural Heritage (SNH) provided funding to Buglife through the Bordered Brown Lacewing project to run surveys and workshops to raise awareness and improve participant's identification skills of the different species of lacewing and their allies (alderflies, scorpionflies and snake flies).

This project successfully found the Bordered brown lacewing at Holyrood Park SSSI with the help of volunteers. Fourteen adults were recorded during two and a half survey days in June from Salisbury Crag.

A total of 80 species of invertebrate were recorded during surveys and workshops run through this project from four sites, Holyrood Park SSSI, Hermitage of Braid and Blackford Hill LNR, St Cyrus NNR and Hogganfield Park. Sixty people were engaged in surveys and training workshops that raised awareness of the diversity of lacewings and their allies, how to monitor and record these groups, with a focus on the Bordered brown lacewing.

Recommendations are provided within this report on future surveys and habitat management to ensure the long term survival of this species in Scotland.

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1. Introduction to lacewings

Lacewings are insects with soft bodies and biting mouthparts that undergo complete metamorphosis where the larvae look completely different to the adults (Figure 1). Lacewings typically have two pairs of large membranous wings with complex venation that are held over the body 'roof-like' while at rest (Plant, 1997). The majority of lacewings are predators as larvae and adults, although there are some that feed on decaying vegetation or nectar and pollen (New, 2007).

Figure 1. Larvae (left) and adult (right) of a green lacewing showing how different the life stages are from one another.

Globally, there are 6,000 species of lacewing in 18 families (New, 2007). In the UK, there are at least 70 species of lacewing recorded in six families, the brown lacewings (Family Hemerobiidae - 31 species), green lacewings (Family Chrysopidae - 21 species), wax-flies (Family Coniopterygidae - 12 species), antlions (Family Myrmeleontidae - 2 species), the giant lacewing (Family Osmylidae - 1 species) and spongeflies (Family Sisyridae - 3 species) (Neuronews, 2014). Of these, 40 species are found in Scotland, with four being only found in Scotland within the UK (Neuronews, 2014) (Table 1).

Table 1. Species of lacewing recorded in Scotland and their associated habitat; please note that there are no species of antlions in Scotland. Species in bold are only found in Scotland in the UK (Neuronews, 2014).

Family	Species	Associations
Wax-flies (Coniopterygidae)	*Conwentzia psociformis*	A range of deciduous trees
	Conwentzia pineticola	Pines (*Pinus* species)
	Coniopteryx tineiformis	A range of deciduous trees
	Coniopteryx borealis	A range of deciduous trees
	Coniopteryx pygmaea	A range of deciduous trees
	Semidalis aleyrodiformis	A range of deciduous trees

Family	Species	Associations
	Helicoconis hirtinervis	Heather (*Calluna vulgaris*)
Giant lacewing (Osmylidae)	*Osmylus fulvicephalus*	Mosses in the splash zone of fast water
Spongeflies (Sisyridae)	*Sisyra fuscata*	Inquiline in freshwater sponges
Brown lacewing (Hemerobiidae)	*Psectra diptera*	Unknown
	Micromus variegatus	Specialist predator of root aphids
	Micromus paganus	Specialist predator of root aphids
	Hemerobius humulinus	A range of deciduous trees and bushes
	Hemerobius perelegans	Birch (*Betula* species) in upland habitats
	Hemerobius simulans	Larch (*Larix* species), Spruce (*Picea* species) and perhaps others
	Hemerobius stigma	Pines (*Pinus* species)
	Hemerobius atrifrons	European larch (*Larix decidua*)
	Hemerobius pini	Pines (*Pinus* species)
	Hemerobius nitidulus	Pines (*Pinus* species)
	Hemerobius micans	Deciduous trees, including oak (*Quercus* species)
	Hemerobius lutescens	A range of deciduous trees and bushes
	Hemerobius marginatus	A range of deciduous trees and bushes
	Wesmaelius malladai	Unknown
	Wesmaelius mortoni	Possible pines (*Pinus* species)
	Wesmaelius balticus	Stable coastal dunes with marram (*Ammophila* species)
	Wesmaelius nervosus	A range of deciduous trees and bushes
	Wesmaelius subnebulosus	A range of deciduous trees and bushes
	Wesmaelius concinnus	Possibly restricted to Scots pine (*Pinus sylvestris*)
	Wesmaelius quadrifasciatus	European larch (*Larix decidua*)
	Sympherobius fuscescens	Scots pine (*Pinus sylvestris*)
	Megalomus hirtus	Wood sage (*Teucrium scorodonia*)
	Drepanepteryx phalaenoides	A range of deciduous trees
Green lacewing (Chrysopidae)	*Chrysopa perla*	Rough vegetation
	Chrysoperla lucasina	Unknown
	Chrysopidia ciliata	Possibly arboreal
	Cunctochrysa albolineata	Possibly arboreal
	Dichochrysa ventralis	Unknown
	Nineta flava	Deciduous trees, including oak (*Quercus* species)
	Nineta vittata	A range of deciduous trees and bushes
	Nothochrysa capitata	Unknown

1.1. Introduction to their allies (alderflies, scorpionflies and snake flies)

Lacewings are often grouped with three other insect orders that are represented with a handful of species each in the UK, the alderflies (Order Megaloptera), scorpionflies (Order Mecoptera) and snake flies (Order Raphidioptera). Of the four species of snakeflies recorded in the UK, only one is recorded in Scotland. *Atlantoraphidia maculicollis* is associated with the tops of pines (*Pinus* species) and European Larch (*Larix decidua*) (Table 2).

There are three species of alderfly in the UK and all have been recorded in Scotland (Table 2). The nymphs of alderflies live in streams and rivers of varying speed and the adults are terrestrial. Adults are often poor at flying and can be seen resting on vegetation close to water.

All four of the scorpionflies recorded in the UK have been recorded in Scotland (Table 2). This includes the elusive Snow flea (*Boreus hyemalis*) which is found from October to March at ground level, including on snow. The three species of *Panorpa* can only be determined by looking at the male and female genitalia. Both sexes have a long beak like rostrum, males have enlarged genitals that look similar to the stings of scorpions (hence the name) (Figure 2).

Table 2. Scorpionflies, alderflies and snakeflies recorded in Scotland (Neuronews, 2014).

Order	**Species**
Snake flies (Raphidioptera)	*Atlantoraphidia maculicollis*
Alderflies (Megaloptera)	*Sialis luaria*
Alderflies (Megaloptera)	*Sialis fuliginosa*
Alderflies (Megaloptera)	*Sialis nigripes*
Scorpionflies (Mecoptera)	*Boreus hyemalis*
Scorpionflies (Mecoptera)	*Panorpa cognate*
Scorpionflies (Mecoptera)	*Panorpa communis*
Scorpionflies (Mecoptera)	*Panorpa germanica*

Figure 2. A male scorpionfly showing the enlarged genitals and long rostrum; image © Steven Falk.

1.2. Introduction to brown lacewings

There are 31 species of brown lacewing (in seven genera) that have been recorded in the UK (Plant, 1997). At least 23 of these have been recorded in Scotland and three are known to occur only in Scotland (Table 1) (Neuronews, 2014).

The brown lacewings are predacious as adults and larvae (Kovanci *et al.* 2014). They feed on a range of prey including aphids, whiteflies and scale insects within the sub-order Sternorrhyncha (Order Hemiptera), mites (Order Acari) and in some cases the eggs and larvae of butterflies and moths (Order Lepidoptera) (Miller *et al*. 2004; Canard, 2007). Species, such as the leaf mimic *Drepanepteryx phalaenoides* have a more omnivorous diet supplemented with honeydew and pollen (Canard, 2007).

Brown lacewings are found in a wide range of habitats, including different species of deciduous trees and bushes as well as pines (Neuronews, 2014) (Table 1). A few species have a more restricted range such as *Micromus variegatus* and *Micromus paganus* that are specialist predators of root feeding aphids, and the Bordered brown lacewing (*Megalomus hirtus*) that is associated with aphids and other insects on Wood sage (*Teucrium scorodonia*) (Neuronews, 2014) (Table 1).

1.2.1. The Bordered brown lacewing

The Bordered brown lacewing is widely distributed in northern and central Europe, becoming more locally restricted in the south of Europe (Smith and Burgess, 2015). In the UK, there are records of this species at two sites in Scotland, Holyrood Park Site of Special Scientific Interest (SSSI) in Edinburgh and most recently Muchalls in Aberdeenshire; the record from Muchalls was found by Dr Nick Littlewood during a survey on 7th July 2018 and this is the first record of the lacewing at this site since 1916 (see section 5 for more information) (Littlewood, 2018). There are historical records of Bordered brown lacewing from St Cyrus National Nature Reserve (NNR) near Montrose dating to 1935 (Littlewood and Stockan, 2013), and elsewhere within the Kincardineshire area and at Hermitage of Braid and Blackford Hill Local Nature Reserve (LNR) in Edinburgh (Plant, 1997; Smith and Burgess, 2015).

As a result of its restricted distribution, in Scotland the species is on the Scottish Biodiversity List (SBL). Given the poor knowledge of its current distribution there is a pressing need to determine its status in the UK.

The Bordered brown lacewing is about 1 cm in size and can be identified by the wide costal space on both fore wings (Plant, 1997) (Figure 3). Additionally it has at least five (sometimes six or seven) radial veins branching from the humeral vein (Plant, 1997). The patterning and hair on its wings and bodies are not diagnostic features as superficially this species looks similar to other species of brown lacewing in the Hemerobiidae family.

Figure 3. An adult Bordered brown lacewing on Wood sage.

Adults have been recorded from June to August, although they may be active earlier and later depending on the local climate (Plant, 1994; Littlewood and Stockan, 2013). Adults spend most of the day deep amongst vegetation and are unwilling to move, even when disturbed (Nielsen, 2015). Females lay eggs individually and on the underside of leaves (Nielsen, 2015). The larval stage lasts about four years and they typically overwinter in their cocoons (Nielsen, 2015).

In the UK is thought to have an association with aphids and other insects on Wood sage growing on rocky exposed slopes (Plant, 1994). In Europe it may not be confined to this plant but may also be associated with hazels (*Corylus* species) and other species of plant (Plant, 1997; Nielsen, 2015).

1.2.2. People's Trust for Endangered Species internship

In 2015, Buglife, supported by the People's Trust for Endangered Species (PTES), hosted an internship to survey Holyrood Park SSSI for the Bordered brown lacewing. The intern, Mike Smith, used a variety of survey methods including light traps, vacuum sampling (with a leaf blower on reverse) and sweep netting to target areas with Wood sage across Holyrood Park from late June 2015 to late September 2015 (Smith, 2015). A single specimen of the Bordered brown lacewing was collected by sweep-netting Wood sage in an area beside Arthurs Seat at NT27527288 on the 30th June 2015 (Smith, 2015). This was the first adult to be recorded at the site since 1982 (Plant, 1994; Littlewood and Stockan, 2013).

As well as surveying for the Bordered brown lacewing, 123 other invertebrates were recorded from Holyrood Park SSSI. This included 62 species of moth (the majority of which were recorded in the light traps), 14 species of beetle (Order Coleoptera) and 11 species of bees, wasps and ants (Order Hymenoptera) (Smith, 2015).

The Hermitage of Braid and Blackford Hill LNR and St. Cyrus NNR were also visited during 2015 however the lacewing was not found at either site.

2. Bordered Brown Lacewing project

Scottish Natural Heritage (SNH) provided funding to Buglife to run the Bordered Brown Lacewing project from 1st April 2018 to 31st March 2019. There is a dedicated page for this project on the Buglife website: https://www.buglife.org.uk/bordered-brown-lacewing

The aims of this project were to raise awareness of the Bordered brown lacewing through surveys and training workshops. Our project targets were to:

1) Run six survey days with the help of volunteers at Holyrood Park SSSI and Hermitage of Braid and Blackford Hill LNR in Edinburgh, and St Cyrus NNR to confirm its status in the UK.
2) Run three training workshops to introduce people to lacewings and their allies that would provide information on how to identify these groups and species and how to submit records.

3. Bordered brown lacewing surveys 2018

Surveys for the Bordered brown lacewing were completed over six days between June and August 2018 and at three sites in Scotland, at Holyrood Park SSSI (four survey days) and Hermitage of Braid and Blackford Hill (one survey day) in Edinburgh, and at St Cyrus NNR (one survey day) (Table 3). Two additional half-day surveys were undertaken, one at Holyrood Park SSSI and another at St Cyrus NNR as part of the training workshops (Table 3) (see section 4 for more information about the workshops).

Table 3**:** Date of each survey at each location (including half day at Holyrood Park SSSI and St Cyrus NNR held as part of the training workshops), the number of volunteers at each survey and the number of Bordered brown lacewings that were recorded during each survey.

Location	Date	No. of volunteers	No. of Bordered brown lacewing
Holyrood Park SSSI (1/2 day at workshop)	01/06/2018	14	2
Holyrood Park SSSI	02/06/2018	3	1
Holyrood Park SSSI	12/06/2018	2	11
Holyrood Park SSSI	10/07/2018	9	0
St Cyrus NNR (1/2 day at workshop)	16/07/2018	7	0
St Cyrus NNR	17/07/2018	3	0
Hermitage of Braid and Blackford Hill LNR	20/07/2018	3	0
Holyrood Park SSSI	14/08/2018	4	0

Adult Bordered brown lacewings were recorded during two of the six full survey days and one of the two half day workshops, all from Holyrood Park SSSI (Table 3). A total of 14 adults were recorded during this project.

A total of 45 people were engaged in surveys for the Bordered brown lacewing, 24 people engaged with the full day surveys and a further 21 people in the half day surveys (Table 3).

Surveys were advertised to members of the public through social media and to various groups local to the survey area, e.g. Historic Environment Scotland (HES) helped to promote surveys at Holyrood Park SSSI and SNH helped to promote events at St Cyrus NNR (Figure 4).

Figure 4. Poster advertising a survey for the Bordered brown lacewing and a workshop to introduce lacewings and their relatives to be held at St Cyrus NNR.

3.1. Holyrood Park SSSI survey

Holyrood Park SSSI is situated in the centre of the City of Edinburgh and has a complex topography and geology. The park is comprised of three main areas, Salisbury Crag, Arthur's Seat, and Whinny Hill. It has been designated a Site of Special Scientific Interest on account of its diverse geology and flora and is managed by HES for recreational, educational and conservation purposes (Anon, 2019b). Holyrood Park Ranger Service conducts a number of wildlife surveys and practical conservation tasks within the park.

Holyrood Park SSSI has been used throughout history for religious, agriculture and recreational activities (Anon, 2019b). Habitats within this site include areas of acidic and

neutral grassland, bogs, lakes (both natural and artificial) and scrubland (Anon, 2019b). Given the diversity of habitats present it is a site that harbours a diverse range of wildlife being important for breeding birds, small mammals and invertebrates. Holyrood Park SSSI is also well used by people with a number of paths and desire lines that cross the site. Thousands of people visit Holyrood Park every year when climbing the famous Arthurs Seat.

Buglife got in touch with HES to survey Holyrood Park SSSI for the Bordered brown lacewing with volunteers from June to August 2018. We were granted permission for this survey from SNH that allowed us to collect other invertebrates during the surveys. There were four full survey days organised for Holyrood Park SSSI in conjunction with the ranger service: the 2nd June; 12th June; 10th July; and 14th August, and a half-day survey with workshop attendees on the 1st June (Table 3). The weather for the surveys undertaken on 1st, 2nd and 12th June and 10th July was bright and warm (Figure 5). For the survey on 14th August it was overcast and began to rain half way through the day.

Figure 5. Volunteers surveying for Bordered brown lacewing along Salisbury Crag, heading towards the Hawes; image © Jason Gilchrist.

During each survey at Holyrood Park SSSI we followed the same route as suggested in Smith (2015). The survey start point was at the end of Radical Road (opposite the car park for the Palace of Holyroodhouse) at NT 270736 (Figure 6). From here the route followed Radical Road around Salisbury Crag until reaching The Hawes at NT 272728 and taking the steps to the top of Arthur's Seat at NT 275729 (Figure 6). Once at the top of Arthur's Seat, the route continued through the Dry Dam or Dasses at NT 274734 and headed back to the car park for the Palace of Holyroodhouse on Queens Drive (Figure 6).

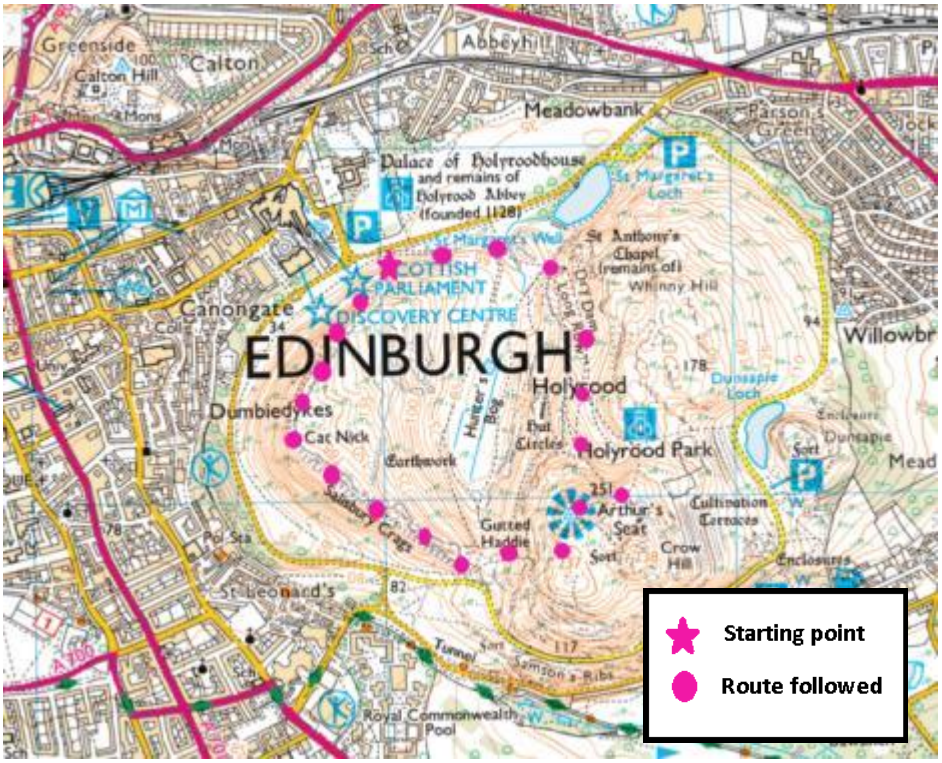

Figure 6. Map highlighting route taken during each survey day, based on previous survey by Smith (2015). Map taken from Bing maps.

Participants were provided with sweep nets and collection pots. During the survey stops were made at different points along the route which had Wood sage to use the sweep nets as well as casual observations to survey for the lacewing (Figure 7). Specimens were collected in the collection pots and anything that could not be identified in the field was retained to be identified later.


Figure 7. Images taken during the Bordered brown lacewing surveys; images © Jason Gilchrist.

A total of 32 people were involved with the surveys for the Bordered brown lacewing at Holyrood Park SSSI (Table 3). Fourteen of these were involved in the half day survey which ran after the workshop (see section 4.1 for more information).

Over the course of the four and a half survey days 14 adults of the Bordered brown lacewing were recorded (Table 3). All individuals recorded were collected along Salisbury Crag (Figure 8; Table 4). The adult recorded by Mike Smith in 2015 was swept from Wood sage in an area by Arthurs Seat at NT27527288 which is much higher than the individuals recorded during this survey. One other species of lacewing was also recorded, the brown lacewing *Micromus variegatus* that is associated with aphids that feed on plant roots (Table 1). A total of 28 other invertebrate species were recorded during the surveys at Holyrood Park SSSI including three species of ladybird and the SBL priority butterflies Grayling (*Hipparchia semele*) and Small heath (*Coenonympha pamphilus*) (Appendix 1).

Figure 8. Map showing points where adults of the Bordered brown lacewing were recorded along Salisbury Crag. Grid reference for each point is in Table 4.

Table 4. Grid reference for each point where adult Bordered brown lacewings were recorded.

Location number	Grid reference
1	NT 26886 73481
2	NT 26819 73382
3	NT 26799 73359
4	NT 26764 73305
5	NT 26757 73283
6	NT 26742 73224
7	NT 26735 73214
8	NT 26741 73175

3.2. Hermitage of Braid and Blackford Hill LNR survey

Hermitage of Braid and Blackford Hill LNR is located on the south side of the City of Edinburgh and comprises two areas, the Hermitage of Braid, which is a small woodland area through which the Braid Burn runs, and Blackford Hill, which is a 164 m high hill that has been formed by one of the oldest rocks in Edinburgh (Anon, 2019a). Habitat on Blackford Hill comprises scrub and grassland and Blackford pond that lies just to the north of the hill (Anon, 2019a). Altogether this nature reserve covers over 60 hectares and the area is owned and managed by the City of Edinburgh Council (Anon, 2019a).

There are historical records of Bordered brown lacewing from the Blackford Hill area of the LNR (Smith and Burgess, 2015). The site was surveyed during 2015 however no lacewings were found (Smith, 2015). It was decided to run at least one survey day at Blackford Hill LNR

during 2018 to determine the distribution of Wood sage at the site and if the lacewing was still present. The City of Edinburgh Council Ranger Service was contacted to provide them with information on the project and for permission to survey the site, which was granted.

The rangers helped to organise and promote the survey day held on the 20th of July. They provided Buglife with information of the distribution of Wood sage before the event which provided us with a focus for the survey. On the day volunteers were provided with sweep nets and collection pots. The survey covered the majority of the Blackford Hill LNR area but was unsuccessful in finding the Bordered brown lacewing. The brown lacewing *Hemerobius lutescens* was recorded during the day and this species is associated with deciduous woodland which is found across the LNR (Table 1).

Three volunteers attended the survey on the 20th of July. The weather on the day was overcast and it started to rain towards the end of the survey which may be why fewer species were recorded during the day. Although unsuccessful with recording Bordered brown lacewing, a total of 13 species were recorded during the survey (Appendix 1).

3.3. St Cyrus NNR survey

St Cyrus NNR, near Montrose, is part of St Cyrus and Kinnaber SSSI which is designated for its important coastlands (including its sand dunes, shingle and saltmarsh), its lowland neutral meadows, vascular plants, breeding birds and moths and butterflies including the SBL priority species Small blue butterfly (*Cupido minimus*) (Anon, 2019c and 2019d) (Figure 9). Steep cliffs mark the western boundary of the NNR and the North Sea the eastern boundary (Figure 9). The reserve is owned and managed by SNH and is visited by thousands of visitors every year.

Figure 9. The grasslands at St Cyrus NNR with the steep cliffs marking the western boundary of the reserve.

The most recent historical record of Bordered brown lacewing outside Edinburgh was made at St Cyrus NNR in 1935 (Littlewood and Stockan, 2013). As the lacewing hasn't been recorded here for over 80 years it was decided to run a single survey day with volunteers to determine the extent of Wood sage at the reserve and if the lacewing is still present. SNH were contacted to ensure that they were happy for a survey to take place with volunteers and to gather information regarding distribution of Wood sage at the reserve.

A survey was organised in conjunction with the ranger service based at the reserve for the 16th (workshop with half day survey at the reserve, see section 4.2 for more information) and 17th July. Prior to both events, staff from the ranger service made notes of patches of Wood sage present on the reserve that was easily accessible. These areas were visited during both the half day and full day of survey. A total of 10 volunteers were involved in surveys for the lacewing at St Cyrus NNR, seven as part of the workshop on the 16th and three during the survey on the 17th of July.

During both the half day and full day survey the weather was bright and warm with a slight breeze at times. Participants were provided with a sweep net and collection pots for the survey. No Bordered brown lacewings were recorded during either of the days at the reserve. Other invertebrates were recorded and those that could not be identified on site were collected to be identified later. A total of 21 species of invertebrate were recorded during the two days at St Cyrus NNR and included the SBL priority species Small heath butterfly (Appendix 1).

4. Workshops

Three workshops were organised to raise awareness of the diversity of lacewings and their allies and to enthuse people to survey for the Bordered brown lacewing at known and historic sites. The workshops involved an indoor session where a presentation was given by a member of Buglife staff on an introduction to lacewings and their allies, their diversity in the UK, how to identify several species and how to monitor and record them. A focus was given on Bordered brown lacewing to provide information on this rare species. An outdoor session occurred in the afternoon which involved providing attendees with a sweep net and pots and showing them how to survey for lacewings and other invertebrates. A total of 36 people attended the three workshops and two adult Bordered brown lacewings were recorded at the workshop run at Holyrood Park on the 1st of June (Table 5).

Table 5. Date of workshops on an introduction to lacewings and their allies, the number of attendees at each and if any Bordered brown lacewing were recorded. Bordered brown lacewings were not surveyed at Hogganfield Park in Glasgow.

Location	Date	Number of attendees	Number of Bordered brown lacewing found
Holyrood Park SSSI, Edinburgh	01/06/2018	14	2
St Cyrus NNR, Angus	16/07/2018	7	0
Hogganfield Park, Glasgow	16/08/2018	15	N/A

4.1. Holyrood Park SSSI

The workshop on the 1st of June was organised with support from Holyrood Park HES ranger service that provided the Education Room to use for the indoor session (Table 5). Fourteen people attended from various backgrounds ranging from amateur wildlife recorders to students (Table 5). After the indoor session the afternoon was spent surveying at Holyrood Park. The same route mentioned in 3.1 was followed, although we stopped at the Hawes due to the time available (Figure 6). During the survey, volunteers discovered two species of lacewing, two adults of the Bordered brown lacewing and *Micromus variegatus*. A further five species of invertebrates were recorded during the afternoon (Appendix 1).

4.2. St Cyrus NNR

Rangers based at St Cyrus NNR gave permission and provided space for us to hold a training workshop in the visitors centre at St Cyrus NNR on the 16th of July (Table 5). The workshop followed the same format with a presentation in the morning and a survey in the afternoon. A total of seven people attended the workshop (Table 5). No Bordered brown lacewings were found during the day although 11 other species of invertebrate were recorded including the SBL priority species Small heath butterfly (Appendix 1).

4.3. Hogganfield Park

The workshop at Hogganfield Park was organised in conjunction with the Seven Lochs project for the 16th of August (Figure 10). The workshop was organised to raise awareness of lacewings and their allies, with the aim of recruiting volunteers to help with the Bordered brown lacewing survey. Information was provided during the day that would encourage volunteers to visit Holyrood Park SSSI as well as other sites for the Bordered brown lacewing and other rarely recorded species.

Figure 10. Workshop attendees surveying a wildflower meadow and shrub for lacewings during the Hogganfield Park workshop on the 16th of August.

A total of fifteen people attended the workshop. Due to forecasted bad weather for the afternoon, the outdoor session was in the morning and the presentation in the afternoon (Figure 10). During the morning we walked through the meadows along the west of Hogganfield Loch and surveyed the grassland and surrounding deciduous trees and shrubs for lacewings. Three larvae of green lacewings were collected during the two hour survey, although it was not possible to identify them to species. A total of 37 other species of invertebrate were recorded during the morning survey which included the sawfly *Ametastegia tenera* for which there are no modern records from Scotland's Central belt and appears to have not been recorded from Glasgow for about 120 years (Appendix 1).

5. North East discovery

During the project a single adult Bordered brown lacewing was discovered at a site near Muchalls at NO90159095 on the 7th July by Dr Nick Littlewood. No Bordered brown lacewing had been recorded at this site since 1916. Dr Nick Littlewood had previously surveyed the site for the Wood sage plume moth (*Capperia britanniodactylus*). The adult specimen was recorded by sweeping Wood sage on the cliffs (Littlewood, 2018).

6. Conclusion and key recommendations

This project was successful in finding the Bordered brown lacewing at Holyrood Park SSSI in Edinburgh, although not at St Cyrus NNR nor at Blackford Hill. Fourteen adult Bordered brown lacewings were recorded at Holyrood Park in June and none were recorded after this time. This may have been due to the very warm, dry spring and early summer that meant the adult population was active for a shorter period of time.

During surveys for the lacewing at Holyrood Park in the summer of 2015, a single adult Bordered brown lacewing was found in an area by Arthur's Seat on the 30th of June (Smith and Burgess, 2015). Surveys during this study started on the 22nd June and finished in late September (Smith and Burgess, 2015). Typically the lacewings have been recorded from June to August but adults are known to be active earlier or later depending on the local climate. It could be that in Scotland they are active for a shorter period of time due to the climate. It is important to determine when the lacewings are active by starting surveys in May and finishing in September to aid in conservation efforts for this species.

Although 14 lacewings were recorded at Holyrood Park SSSI and one at Muchalls, it is recommended that future surveys should be conducted to determine the extent and health of the population at both sites. Thousands of people walk through Holyrood Park SSSI to access Arthurs Seat every year. Visitors don't always stick to the main paths and could be impacting on Wood sage that the lacewing is associated with. As only 14 lacewings were recorded and only from June it is important to determine how long adults are active for and to provide information to visitors using the site to prevent disturbance of important habitat, especially along Salisbury Crag where the lacewings were all recorded during this survey (Figure 8).

One adult of the Bordered brown lacewing was recorded at a site near Muchalls, and this was the first record of this species at this site since 1916 (Littlewood, 2018). It is important that this site is revisited to determine the extent of the lacewing population and Wood sage that it is associated with. This site could potentially be another stronghold for this species and vital in ensuring the long term survival of this species in Scotland.

During 2018 there was a long spell of very dry weather in May and June. Several small fires were recorded at Holyrood Park SSSI that had been started accidently. These fires can have devastating impacts on local wildlife, especially at a site that is visited by hundreds of people every week. It is important that notices are in place with information on the risks of fires to the site and how they can impact on people and the wildlife. If a large fire were to occur along Salisbury Crag affecting the Wood sage here this would seriously impact on the Bordered brown lacewing and may even cause it to become extinct at this site. If we are unable to determine the extent of the population here this is a serious threat to its survival. In addition to this any alteration to site management could make this species vulnerable to extinction in Britain.

It was noted during the survey at Blackford Hill that Wood sage is limited at this site and in some areas becoming outcompeted by Gorse (*Ulex europea*). The rangers who work at this site are aware of this and are managing the Gorse to reduce shading and allow space for other plant species to thrive on site. This will help open up areas for Wood sage that may benefit the lacewing, if it is present at the site. This management may provide habitat for any lacewings that spread into the area from Holyrood Park SSSI.

It was not possible to map the distribution of Wood sage at any of the three sites visited for surveys through this project due to limitations in time. Notes of the location of Wood sage at St Cyrus NNR and Blackford Hill LNR provided by the ranger service at both sites were useful for targeting areas for the surveys themselves. It is recommended that a more in-depth survey of Wood sage is made at all three sites to aid in the conservation efforts of the Bordered brown lacewing, in particular at Holyrood Park SSSI where the species is known to be present.

This project successfully engaged with volunteers who were interested in helping to survey for the lacewing, 24 people were involved with the six survey days. A further 21 people helped survey Holyrood Park SSSI and St Cyrus NNR during half days surveys held during the workshops at both sites. It was the first workshop at Holyrood Park SSSI on the 1st June that found two adults of the Bordered brown lacewing through this project. By engaging with people this helped raise awareness of lacewings and their allies the alderflies, snake flies and scorpionflies. Many people who booked onto the workshops didn't really know much about the group and the workshops were a fantastic way to enthuse people about these often under appreciated bugs.

After the workshop at Hogganfield Park, Buglife were contacted by an attendee who had recorded the leaf mimic *Drepanepteryx phalaenoides* by the Falls of Clyde. By attending the lacewing workshop they instantly recognised this species when out running an event at the site. This is a very under recorded species with only a handful of recent Scottish records. Another workshop attendee was able to recognise a wax-fly recorded during a bug hunt at

the Hidden Gardens in Glasgow held the following month. These workshops are providing important information to allow attendees to take the learning from the day and develop it further.

The Bordered brown lacewing is a rare and elusive species found at one of Scotland's most visited tourist attractions and appears to be thriving. Continuing the monitoring of this species at Holyrood Park SSSI and at the newly rediscovered population at Muchalls will assist with planning conservation action to ensure the long term survival of this species in Scotland and will continue to raise awareness of this very under recorded group in Scotland.

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Appendix 1. Invertebrates recorded during the surveys and training workshops.

1. Invertebrates recorded at Holyrood Park SSSI in Edinburgh

Common Name	Scientific Name	Grid Reference	Date
Honey bee	*Apis mellifera*	NT 26764 73305	01/06/2018
Pill woodlice	*Armadillidium vulgare*	NT 26764 73305	01/06/2018
White/Buff tailed bumblebee	*Bombus lucorum/terrestris*	NT 26764 73305	01/06/2018
Common carder bumblebee	*Bombus pascuorum*	NT 26764 73305	01/06/2018
Brown lacewing	*Micromus variegatus*	NT 26764 73305	01/06/2018
Neetle weevil	*Phyllobius pomaceus*	NT 26764 73305	01/06/2018
Bordered brown lacewing	*Megalomus hirtus*	NT 26735 73214	01/06/2018
Green veined white butterfly	*Pieris napi*	NT 26764 73305	02/06/2018
Honey bee	*Apis mellifera*	NT 26764 73305	02/06/2018
Pill woodlice	*Armadillidium vulgare*	NT 26764 73305	02/06/2018
St. Marks fly	*Bibio marci*	NT 26764 73305	02/06/2018
Garden bumblebee	*Bombus hortorum*	NT 26764 73305	02/06/2018
White/Buff tailed bumblebee	*Bombus lucorum/terrestris*	NT 26764 73305	02/06/2018
Common carder bumblebee	*Bombus pascuorum*	NT 26764 73305	02/06/2018
Brown lipped snail	*Cepaea nemoralis*	NT 26764 73305	02/06/2018
Garden snail	*Cornu aspersum*	NT 26764 73305	02/06/2018
Bordered brown lacewing	*Megalomus hirtus*	NT 26764 73305	02/06/2018
Rough woodlice	*Porcellio scaber*	NT 26764 73305	02/06/2018
Cinnabar moth	*Tyria jacobaeae*	NT 26764 73305	02/06/2018
Bordered brown lacewing	*Megalomus hirtus*	NT 26741 73175	12/06/2018
Bordered Brown Lacewing	*Megalomus hirtus*	NT 26742 73224	12/06/2018
Bordered Brown Lacewing	*Megalomus hirtus*	NT 26757 73283	12/06/2018
Common pill woodlouse	*Armadillidium vulgare*	NT 26764 73305	12/06/2018
Red tailed bumblebee	*Bombus lapidarius*	NT 26764 73305	12/06/2018

Common Name	Scientific Name	Grid Reference	Date
Seven spot ladybird	*Coccinella septempunctata*	NT 26764 73305	12/06/2018
Small heath butterfly	*Coenonympha pamphilus*	NT 26764 73305	12/06/2018
Bordered brown lacewing	*Megalomus hirtus*	NT 26799 73359	12/06/2018
Bordered brown lacewing	*Megalomus hirtus*	NT 26819 73382	12/06/2018
Bordered brown lacewing	*Megalomus hirtus*	NT 26886 73481	12/06/2018
Two spot ladybird	*Adalia bipunctata*	NT 26764 73305	10/07/2018
Ten spot ladybird	*Adalia decempunctata*	NT 26764 73305	10/07/2018
Small tortoiseshell butterfly	*Aglais urticae*	NT 26764 73305	10/07/2018
Ringlet butterfly	*Aphantopus hyperantus*	NT 26764 73305	10/07/2018
Red tailed bumblebee	*Bombus lapidarius*	NT 26764 73305	10/07/2018
White/Buff tailed bumblebee	*Bombus lucorum/terrestris*	NT 26764 73305	10/07/2018
Common carder bumblebee	*Bombus pascuorum*	NT 26764 73305	10/07/2018
Field grasshopper	*Chorthippus brunneus*	NT 26764 73305	10/07/2018
Seven spot ladybird	*Coccinella septempunctata*	NT 26764 73305	10/07/2018
Small heath butterfly	*Coenonympha pamphilus*	NT 26764 73305	10/07/2018
Grayling butterfly	*Hipparchia semele*	NT 26764 73305	10/07/2018
Meadow brown butterfly	*Maniola jurtina*	NT 26764 73305	10/07/2018
Large skipper	*Ochlodes sylvanus*	NT 26764 73305	10/07/2018
Common red soldier beetle	*Rhagonycha fulva*	NT 26764 73305	10/07/2018
Cinnabar moth (caterpillar)	*Tyria jacobaeae*	NT 26764 73305	10/07/2018
Narrow-bordered five spot burnet	*Zygaena lonicerae*	NT 26764 73305	10/07/2018
Common flower bug	*Anthocoris nemorum*	NT 26764 73305	14/08/2018
a hoverfly	*Epistrophe grossulariae*	NT 26764 73305	14/08/2018

2. Invertebrates recorded at Hermitage of Braid and Blackford Hill LNR in Edinburgh

Common Name	Scientific Name	Grid Reference	Date
Common flower bug	*Anthocoris nemorum*	NT 25266 70642	20/07/2018
Tree bumblebee	*Bombus hypnorum*	NT 25266 70642	20/07/2018
White/Buff tailed bumblebee	*Bombus lucorum/terrestris*	NT 25266 70642	20/07/2018
Common carder bee	*Bombus pascuorum*	NT 25266 70642	20/07/2018
Fork-palped harvestman	*Dicranopalpus ramosus*	NT 25266 70642	20/07/2018
Potato leafhopper	*Eupteryx aurata*	NT 25266 70642	20/07/2018
a leafhopper	*Eupteryx urticae*	NT 25266 70642	20/07/2018
a brown lacewing	*Hemerobius lutescens*	NT 25266 70642	20/07/2018
Common froghopper	*Philaenus spumarius*	NT 25266 70642	20/07/2018
Common red solider beetle	*Rhagonycha fulva*	NT 25266 70642	20/07/2018
Timothy grass bug	*Stenotus binotatus*	NT 25266 70642	20/07/2018
Cinnabar moth (caterpillar)	*Tyria jacobaeae*	NT 25266 70642	20/07/2018
Common wasp	*Vespula vulgaris*	NT 25266 70642	20/07/2018

3. Invertebrates recorded at St Cyrus NNR, Montrose

Common Name	Scientific Name	Grid Reference	Date
Lucerne bug	*Adelphocoris lineolatus*	NO 74453 63513	16/07/2018
Red tailed bumblebee	*Bombus lapidarius*	NO 74453 63513	16/07/2018
White/Buff tailed bumblebee	*Bombus lucorum/terrestris*	NO 74453 63513	16/07/2018
Common carder bumblebee	*Bombus pascuorum*	NO 74453 63513	16/07/2018
Brown lipped snail	*Cepaea nemoralis*	NO 74453 63513	16/07/2018
Small heath butterfly	*Coenonympha pamphilus*	NO 74453 63513	16/07/2018
Heath assassin bug	*Coranus subapterus*	NO 74453 63513	16/07/2018
Common green grasshopper	*Omocestus viridulus*	NO 74453 63513	16/07/2018
Common frog hopper	*Philaenus spumarius*	NO 74453 63513	16/07/2018
Common blue butterfly	*Polyommatus icarus*	NO 74453 63513	16/07/2018
Cinnabar moth (caterpillar)	*Tyria jacobaeae*	NO 74453 63513	16/07/2018
Lucerne bug	*Adelphocoris lineolatus*	NO 74453 63513	17/07/2018
Small tortoiseshell butterfly	*Aglais urticae*	NO 74453 63513	17/07/2018
Common flower bug	*Anthocoris nemorum*	NO 74453 63513	17/07/2018
Dark green fritillary	*Argynnis aglaja*	NO 74453 63513	17/07/2018
Red tailed bumblebee	*Bombus lapidarius*	NO 74453 63513	17/07/2018
White/Buff tailed bumblebee	*Bombus lucorum/terrestris*	NO 74453 63513	17/07/2018
Common carder bumblebee	*Bombus pascuorum*	NO 74453 63513	17/07/2018
Common field grasshopper	*Chorthippus brunneus*	NO 74453 63513	17/07/2018
Small heath butterfly	*Coenonympha pamphilus*	NO 74453 63513	17/07/2018
Small copper butterfly	*Lycaena phlaeas*	NO 74453 63513	17/07/2018
Meadow brown butterfly	*Maniola jurtina*	NO 74453 63513	17/07/2018
Common green grasshopper	*Omocestus viridulus*	NO 74453 63513	17/07/2018
Green veined white butterfly	*Pieris napi*	NO 74453 63513	17/07/2018
Small white butterfly	*Pieris rapae*	NO 74453 63513	17/07/2018
Common blue butterfly	*Polyommatus icarus*	NO 74453 63513	17/07/2018

Common red solider beetle	*Rhagonycha fulva*	NO 74453 63513	17/07/2018
Cinnabar moth (caterpillar)	*Tyria jacobaeae*	NO 74453 63513	17/07/2018
Red admiral butterfly	*Vanessa atalanta*	NO 74453 63513	17/07/2018

4. Hogganfield Park, Glasgow

Common Name	**Scientific Name**	**Grid Reference**	**Date**
Hawthorn shieldbug	*Acanthosoma haemorrhoidale*	NS 64319 66944	16/08/2018
Straw grass-veneer moth	*Agriphila straminella*	NS 64319 66944	16/08/2018
a sawfly	*Ametastegia tenera*	NS 64319 66944	16/08/2018
Alder spittlebug	*Aphrophora alni*	NS 64319 66944	16/08/2018
Honey bee	*Apis mellifera*	NS 64319 66944	16/08/2018
Garden cross spider	*Araneus diadematus*	NS 64319 66944	16/08/2018
Four-spotted orb-weaver	*Araneus quadratus*	NS 64319 66944	16/08/2018
Silver Y moth	*Autographa gamma*	NS 64319 66944	16/08/2018
Red tailed bumblebee	*Bombus lapidarius*	NS 64319 66944	16/08/2018
White tailed bumblebee	*Bombus lucorum*	NS 64319 66944	16/08/2018
Common carder bee	*Bombus pascuorum*	NS 64319 66944	16/08/2018
Buff tailed bumblebee	*Bombus terrestris*	NS 64319 66944	16/08/2018
Potato capsid	*Closterotomus norwegicus*	NS 64319 66944	16/08/2018
Fever fly	*Dilophus febrilis*	NS 64319 66944	16/08/2018
Nut-bud moth	*Epinotia tenerana*	NS 64319 66944	16/08/2018
Marmalade hoverfly	*Episyrphus balteatus*	NS 64319 66944	16/08/2018
Small grey	*Eudonia mercurella*	NS 64319 66944	16/08/2018
a hoverfly	*Eupeodes latifasciatus*	NS 64319 66944	16/08/2018
Common earwig	*Forficula auricularia*	NS 64319 66944	16/08/2018
Tiger hoverfly	*Helophilus pendulus*	NS 64319 66944	16/08/2018
Tarnished plant bug	*Lygus* species	NS 64319 66944	16/08/2018
Harvestman	*Mitopus morio*	NS 64319 66944	16/08/2018

Common Name	Scientific Name	Grid Reference	Date
Batman hoverfly	*Myathropa florea*	NS 64319 66944	16/08/2018
Large yellow underwing	*Noctua pronuba*	NS 64319 66944	16/08/2018
Harvestman	*Paroligolophus agrestis*	NS 64319 66944	16/08/2018
Red legged shieldbug	*Pentatoma rufipes*	NS 64319 66944	16/08/2018
Common froghopper	*Philaenus spumarius*	NS 64319 66944	16/08/2018
a plant bug	*Plagiognathus arbustorum*	NS 64319 66944	16/08/2018
a soldier fly	*Sargus bipunctatus*	NS 64319 66944	16/08/2018
a hoverfly	*Scaeva pyrastri*	NS 64319 66944	16/08/2018
a grass bug	*Stenodema holsata*	NS 64319 66944	16/08/2018
a grass bug	*Stenodema laevigata*	NS 64319 66944	16/08/2018
a barkfly	*Stenopsocus immaculatus*	NS 64319 66944	16/08/2018
a hoverfly	*Syrphus vitripennis*	NS 64319 66944	16/08/2018
a sawfly	*Tenthredo arcuata/notha*	NS 64319 66944	16/08/2018
a long jawed spider	*Tetragnatha extensa*	NS 64319 66944	16/08/2018
a leafhopper	*Typhlocybinae*	NS 64319 66944	16/08/2018
Pale straw pearl	*Udea lutealis*	NS 64319 66944	16/08/2018
Red admiral butterfly	*Vanessa atalanta*	NS 64319 66944	16/08/2018
Flame carpet	*Xanthorhoe designata*	NS 64319 66944	16/08/2018
Bird cherry ermine moth	*Yponomeuta evonymella*	NS 64319 66944	16/08/2018

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