



Bordered brown lacewing project report

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Saving the small things that run the planet

Summary

Of the 70 species of lacewing recorded in the United Kingdom, at least forty-one of them have been recorded in Scotland, with four only being recorded in Scotland. The Bordered brown lacewing (*Megalomus hirtus*) was previously known from only two sites in Scotland, at Salisbury's Crags in Holyrood Park, Edinburgh and at Doonie Point by Bridge of Muchalls in Aberdeenshire.

Scottish Natural Heritage (SNH) provided funding to Buglife for year two of 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).

With the help of volunteers, year two of the project successfully found twenty two adults of the Bordered brown lacewing. Two new areas were discovered at Holyrood Park at rocky outcrops close to St. Anthony's Chapel and a new population was discovered at Skatie Shore and Perthumie Bay by Stonehaven. A further nine adults were found by Dr Nick Littlewood at six locations from the war memorial south of Stonehaven to Portlethen Village.

A total of 264 records of 141 different species of invertebrate, including five species of lacewing, were recorded during surveys and workshops run through this project from six sites: Holyrood Park, in Edinburgh; Hermitage of Braid and Blackford Hill Local Nature Reserve in Edinburgh; Skatie Shore and Perthumie Bay by Stonehaven; Doonie Point by Bridge of Muchalls; St Cyrus National Nature Reserve near Montrose; and Drumpellier Park in North Lanarkshire. Forty three people were engaged in surveys and training workshops that raised awareness of the diversity of lacewings and their allies, and how to monitor and record these groups, with a focus on the Bordered brown lacewing.

Recommendations are provided within this report 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 (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 on flowers for 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, 41 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)	<i>Conwentzia psociformis</i>	A range of deciduous trees
	<i>Conwentzia pineticola</i>	Pines (<i>Pinus</i> species)
	<i>Coniopteryx tineiformis</i>	A range of deciduous trees
	<i>Coniopteryx borealis</i>	A range of deciduous trees
	<i>Coniopteryx pygmaea</i>	A range of deciduous trees
	<i>Semidalis aleyrodiformis</i>	A range of deciduous trees

Family	Species	Associations
	<i>Helicoconis hirtinervis</i>	Heather (<i>Calluna vulgaris</i>)
Giant lacewings (Osmylidae)	<i>Osmylus fulvicephalus</i>	Mosses in the splash zone of fast water
Spongeflies (Sisyridae)	<i>Sisyra fuscata</i>	Inquiline in freshwater sponges
Brown lacewings (Hemerobiidae)	<i>Psectra diptera</i>	Thought to have a close association with grass tussocks and root aphids
	<i>Micromus variegatus</i>	Specialist predator of root aphids
	<i>Micromus paganus</i>	Specialist predator of root aphids
	<i>Hemerobius humulinus</i>	A range of deciduous trees and bushes
	<i>Hemerobius perelegans</i>	Birch (<i>Betula</i> species) in upland habitats
	<i>Hemerobius simulans</i>	Larch (<i>Larix</i> species), Spruce (<i>Picea</i> species) and perhaps others
	<i>Hemerobius stigma</i>	Pines (<i>Pinus</i> species)
	<i>Hemerobius atrifrons</i>	European larch (<i>Larix decidua</i>)
	<i>Hemerobius pini</i>	Pines (<i>Pinus</i> species)
	<i>Hemerobius nitidulus</i>	Pines (<i>Pinus</i> species)
	<i>Hemerobius micans</i>	Deciduous trees, including oak (<i>Quercus</i> species)
	<i>Hemerobius lutescens</i>	A range of deciduous trees and bushes
	<i>Hemerobius marginatus</i>	A range of deciduous trees and bushes
	<i>Wesmaelius malladai</i>	Unknown
	<i>Wesmaelius mortoni</i>	Possibly pines (<i>Pinus</i> species)
	<i>Wesmaelius balticus</i>	Stable coastal dunes with marram (<i>Ammophila</i> species)
	<i>Wesmaelius nervosus</i>	A range of deciduous trees and bushes
	<i>Wesmaelius subnebulosus</i>	A range of deciduous trees and bushes
	<i>Wesmaelius concinnus</i>	Possibly restricted to Scots pine (<i>Pinus sylvestris</i>)
	<i>Wesmaelius quadrifasciatus</i>	European larch (<i>Larix decidua</i>)
<i>Sympherobius fuscescens</i>	Scots pine (<i>Pinus sylvestris</i>)	
<i>Megalomus hirtus</i>	Wood sage (<i>Teucrium scorodonia</i>)	
<i>Drepanopteryx phalaenoides</i>	A range of deciduous trees	
Green lacewings (Chrysopidae)	<i>Chrysopa carnea</i>	Aphid predator in range of habitats (not included as Scottish species in Neuronews)
	<i>Chrysopa perla</i>	Rough vegetation
	<i>Chrysoperla lucasina</i>	Unknown
	<i>Chrysopidia ciliata</i>	Possibly arboreal
	<i>Cunctochrysa albolineata</i>	Possibly arboreal
	<i>Dichochrysa ventralis</i>	Unknown
	<i>Nineta flava</i>	Deciduous trees, including oak (<i>Quercus</i> species)
	<i>Nineta vittata</i>	A range of deciduous trees and bushes
	<i>Nothochrysa capitata</i>	Unknown

1.1. Introduction to their allies (alderfly, scorpionfly and snake fly)

Lacewings are often grouped with three other insect orders, the alderflies (Order Megaloptera), scorpionflies (Order Mecoptera) and snake flies (Order Raphidioptera). This group make up the superorder Neuropterida.

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).

The three UK species of alderfly have all been recorded in Scotland (Table 2). The nymphs of alderflies live in a variety of freshwater habitats including streams, rivers, ponds and ditches. The adults, which are terrestrial, are often poor at flying and can be seen resting on vegetation close to water.

All four UK species of scorpionfly 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. Scorpionfly, alderfly and snakefly species recorded in Scotland (Neuronews, 2014).

Order	Common name	Species
Raphidioptera	Snake flies	<i>Atlantoraphidia maculicollis</i>
Megaloptera	Alderflies	<i>Sialis lutaria</i>
	Alderflies	<i>Sialis fuliginosa</i>
	Alderflies	<i>Sialis nigripes</i>
Mecoptera	Scorpionflies	<i>Boreus hyemalis</i>
	Scorpionflies	<i>Panorpa cognata</i>
	Scorpionflies	<i>Panorpa communis</i>
	Scorpionflies	<i>Panorpa germanica</i>



Figure 2. Far left: A male scorpionfly showing the enlarged genitals and long rostrum; image © Steven Falk. Middle: An alderfly resting on Cow parsley (*Anthriscus sylvestris*). Far right: A species of snake fly.

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). Before surveys in 2019, this species was known from only two sites in the UK, both in Scotland, Holyrood Park Site of Special Scientific Interest (SSSI) in Edinburgh and most recently a coastal site at Doonie Point by Bridge of Muchalls in Aberdeenshire. The record from Doonie Point was found by Dr Nick Littlewood during a survey on 7th July 2018 and was the first record of the lacewing at this site since 1916 (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 (Figure 3) (Plant, 1997). 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; the wide costal space on the forewing is visible in this image.

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 is known to last up to four years and they typically overwinter in their cocoons (Nielsen, 2015).

In the UK, this species 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).

2. Bordered Brown Lacewing project

Scottish Natural Heritage (SNH) provided funding to Buglife to run the 'Bordered Brown Lacewing' project for a second year, from 1st April 2019 to 31st March 2020. There is a dedicated page for this project on the Buglife website (<https://www.buglife.org.uk/bordered-brown-lacewing>) where project reports can be found.

The aims of year two 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, by Bridge of Muchalls in Aberdeenshire, 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 2019

Surveys for the Bordered brown lacewing were completed from May to July 2019 and at five sites in Scotland: in Edinburgh at Holyrood Park SSSI (two survey days); Hermitage of Braid and Blackford Hill (one survey day); along the east coast at Doonie Point by Bridge of Muchalls (half a survey day); at Skatie Shore and Perthumie Bay by Stonehaven (one and a half survey days); 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 the 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
Doonie Point (by Bridge of Muchalls), Skatie Shore and Perthumie Bay (by Stonehaven)	08/05/2019	1	0
Holyrood Park	04/06/2019	4	0
St Cyrus (half day survey after workshop)	19/06/2019	7	0
Blackford Hill LNR	24/06/2019	5	0
Holyrood Park (half day survey after workshop)	25/06/2019	9	10
Skatie Shore and Perthumie Bay, Stonehaven	01/07/2019	2	10
Holyrood Park	10/07/2019	5	2
St Cyrus	18/07/2019	6	0

Twenty two adult Bordered brown lacewings were recorded during surveys in 2019 (Table 3). A total of 39 people were engaged in surveys for the Bordered brown lacewing; 23 people engaged with the full day surveys and a further 16 people in the half day survey (Table 3).

During the surveys, sweep nets were used to sweep patches of Wood sage, focusing on patches on rocky outcrops but also other patches too. Invertebrates collected in the net were put into pots to identify them. The majority of species were recorded on site and released but for those that required identification under a microscope, they were retained for further examination.

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).



Lacewing survey!

The Bordered brown lacewing is known from only two sites in the UK, at Holyrood Park in Edinburgh and Muchalls in Aberdeenshire. This visit will survey St Cyrus NNR, a possible site for this elusive and fascinating creature.

When: Thursday 11th July

Location: St Cyrus NNR, Montrose, DD10 0AQ

Time: 11am-3pm

Please wear appropriate clothes and sturdy shoes. Lunch is not provided.

For more information and to book onto the survey, please contact Suzanne Burgess at suzanne.burgess@buglife.org.uk and 01786 447504



www.buglife.org.uk Tel: 01786 447504 @BuglifeScotland

Buglife – The Invertebrate Conservation Trust is a registered charity at The Lindens, 86 Lincoln Road, Peterborough, PE1 2SN Registered charity no. 1092293, Scottish charity no. SCD0004, Company no. 4132695

Figure 4. Poster advertising a survey 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 Crags, 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.

Buglife contacted HES to survey Holyrood Park SSSI with volunteers for the Bordered brown lacewing during the summer of 2019. As Holyrood Park is a SSSI, HES helped to get permission from SNH that would allow Buglife to complete these surveys. Two survey days were organised at Holyrood Park SSSI in conjunction with the ranger service on the 4th of June and 10th of July and these events were open to the public to sign up to (Table 3). There was an additional half-day survey on site which coincided with a workshop training day on the 25th of June (Table 3). The weather for the surveys was dry and warm on all three occasions at Holyrood Park SSSI.

When planning surveys in 2019, the survey route suggested in Smith (2015) was originally looked at. This route started at Radical Road (opposite the car park for the Palace of Holyroodhouse), following this path along Salisbury Crags to Arthur’s Seat and then back to

the main road at Queen's Drive via the Dry Dam footpath. It was important to check the area by Salisbury Crags where the lacewings were recorded during surveys in 2018 as there was a large fire in this area in February 2019. However, Radical Road is currently closed due to unstable cliff edges along Salisbury Crags, which meant this area could not be surveyed. It was decided to focus efforts at suitable habitat elsewhere within Holyrood Park to determine if there were other populations of the lacewing.

On the 4th of June, the survey started opposite the car park for the Palace of Holyroodhouse at grid reference NT 270736. From here the route followed the Dry Dam surveying areas of Wood sage on either side of this (Figure 5). The route then went along the west of Arthur's Seat, finishing on Queens Drive at grid reference NT 269727. Although it was dry, we were unsuccessful in finding any Bordered brown lacewings during the day but did record other invertebrate species (Appendix 1).



Figure 5. Volunteers surveying Wood sage for the lacewing along the Dry Dam footpath.

A workshop was held in the Holyrood Park Education Centre (which looks out onto the park) on the 25th of June with 9 people. After the indoor presentation introducing lacewings and their relatives, we went out to the park to survey patches of Wood sage on rocky outcrops for the Bordered brown lacewing. It was decided to visit the rocky outcrop at NT 274737 which is very similar to where lacewings were recorded along Salisbury Crags in 2018. Within ten minutes, one of the HES rangers for the park found an adult Bordered brown lacewing at grid reference NT 2740373701 (Figure 6). A further two adults were found in this area.



Figure 6. Workshop attendees after finding the first Bordered brown lacewing in a new area of Holyrood Park.

From here we then visited the rocky cliffs by Saint Anthony's Chapel and found seven adults within this area at grid reference NT 27577370. A wide range of other invertebrates were also recorded during the half day survey including the Wood sage plume moth (*Capperia britanniodactylus*) which is currently being monitored by HES rangers across the park (Figure 7). Two HES rangers attended the workshop and due to an increase in knowledge of the lacewing and how to survey for it, they are keen to continue monitoring for the lacewing.



Figure 7. A Wood sage plume moth recorded during the workshop on the 25th of June.

The final survey day at Holyrood Park on the 10th of July was less successful in finding the lacewing and only two adults were recorded during the day, both by the chapel of St. Anthony at grid reference NT 2755073671. There were five volunteers during the day and as well as visiting the rocky outcrops by the chapel we surveyed Wood sage along Whinny Hill (at grid reference NT 2771473183 and higher up at NT 2776373433) but no lacewings were

recorded. The habitat here is very similar to elsewhere in the park and looked like it could support the Bordered brown lacewing (Figure 8). It is thought that by the 10th of July the season for the adults was nearly over and that is why only two were recorded.



Figure 8. There is plenty of Wood sage growing on Whinny Hill which has the potential to support Bordered brown lacewings.

Over the course of the two and a half survey days 12 adults of the Bordered brown lacewing were recorded (Table 3). These lacewings were collected from two new areas within the park, as previously they have been recorded along Salisbury Crag (Lemon and Burgess, 2019) and at grid reference NT 27527288 on Arthur's Seat (Smith, 2015) (Figure 9). Surveys this year have discovered that the Bordered brown lacewing can be found on Wood sage on rocky outcrops across the park.

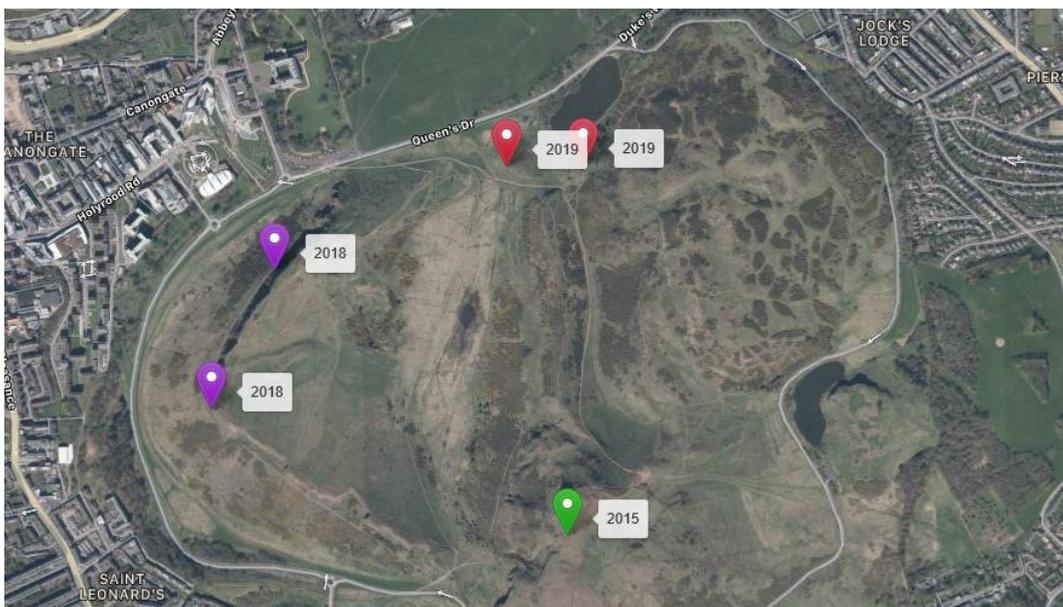


Figure 9. Map showing the location of Bordered brown lacewing recorded from across Holyrood Park during 2015 (green marker at grid reference NT 2752072880), 2018 (purple markers along Salisbury Crags from NT 26887348 to NT 26747317) and 2019 (red markers at grid reference NT274737 and NT 27577370).

During the surveys, one other species of lacewing was recorded, the green lacewing *Chrysopa perla* that is associated with rough vegetation and is widespread across Scotland (Table 1). A total of 69 other invertebrate species were recorded during the surveys at Holyrood Park SSSI including the SBL priority butterflies Grayling (*Hipparchia semele*) and Small heath (*Coenonympha pamphilus*) (Appendix 1).

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 metre 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 has previously been surveyed in 2015 and in 2018 although no lacewings were found (Smith, 2015; Lemon and Burgess, 2019). It was decided to run at least one survey day at Blackford Hill LNR during 2019 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 24th of June, which was a month earlier than the survey in 2018. Five volunteers turned up on the day to help with the survey. Unfortunately, the weather during the day was very poor with heavy rain and periods of thunder and we only lasted an hour before everyone was soaked through.

During the survey, patches of Wood sage were searched for and surveyed for the lacewing and other invertebrates. Only three species of invertebrate were recorded during the survey and this included the leafhopper *Eurypteryx* species, which was identified by the exuviae left on the underside of the leaves of Wood Sage (Appendix 2).

Wood sage was searched in the following areas, at grid reference NT 256703, NT 256704, NT 254705 and NT 255704. Habitat here was identified as being very similar to that at Holyrood Park, although in smaller patch sizes and with similar pressures of being over grown with Gorse (*Ulex europaeus*). Further surveys of the area are advised due to bad weather when running surveys here in 2018 and 2019.

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 10). Steep cliffs mark the western boundary of the NNR and the North Sea the eastern boundary (Figure 10). The reserve is owned and managed by SNH and is visited by thousands of visitors every year.



Figure 10. 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). The lacewing hasn't been recorded here for over 80 years. In 2018, surveys at the reserve were unsuccessful and this year further surveys were planned at the reserve. Permission for the surveys in 2019 was granted by SNH.

A workshop was organised at St Cyrus on the 19th of June. Seven people attended to learn about the diversity of lacewings and their allies, how to survey for them and identify the different species. This provided an excellent opportunity to raise awareness of the Bordered brown lacewing and in the afternoon we surveyed Wood sage from across the reserve. The weather during the day was very warm and dry although windy at times. During the afternoon we visited the following areas at grid reference NO 746638 and NO 746639. Although there was plenty of Wood sage in these areas, no Bordered brown lacewings were recorded. This could be due to the habitat itself, as the Wood sage was on the dune system rather than on rocky outcrops.

A further survey was organised on the 11th of July but due to a very poor weather forecast was moved to the 18th of July. A total of six volunteers attended this survey, the weather was dry and windy with a heavy rain shower at the very end of the day. SNH reserve staff had mapped areas of Wood sage from across the reserve to state if it was dense, moderate or sparse in growth. Using this map, the group visited the dense areas of Wood sage that were associated with the rocky outcrops. The first area visited was at grid reference NO 75406466 which was the furthest area of dense Wood sage from the reserves visitor centre (Figure 11). This area appeared very similar to the rocky outcrops at Holyrood Park where lacewings were found this year.



Figure 11. The rocky cliffs at grid reference NO 75406466 with plenty of Wood sage were surveyed on the 18th of July.

From here, other areas surveyed within the reserve were at grid reference NO 75036425, NO 74896406 and NO 74806394, heading back to the reserve visitor centre. The Wood sage in these areas, although plentiful was not within rocky outcrops which seem to be the preferred habitat for the Bordered brown lacewing.

No Bordered brown lacewings were recorded during either survey day at St Cyrus NNR. On the first half day survey, only Wood sage within the sand dunes was surveyed. During the second day the first area visited seemed promising but it was obvious that the Wood sage had past its best and that if there had been Bordered brown lacewings in this area they would also have finished for the season. With the week delay because of the weather this may have been enough to miss the lacewing season, if present in this area.

A wide range of other species of invertebrates were recorded during the surveys, including the brown lacewing *Psectra diptera*, which is thought to be associated with root aphids in grass tussocks. A total of 59 species of invertebrate were recorded during the two days at St Cyrus NNR and included the Black-headed leaf cutter bee (*Megachile circumcincta*) and the SBL priority species Small heath and Grayling butterfly (Appendix 3).

3.4. Doonie Point survey

An adult Bordered brown lacewing was recorded at Doonie Point, by Bridge of Muchalls at grid reference NO 90159095 on the 7th July 2018 by Dr Nick Littlewood. This was the first record of the lacewing on the east coast in over 80 years. The site was visited again by Dr Littlewood and Buglife staff on the 8th of May 2019 to determine the condition of the habitat. The Wood sage at this site is plentiful and there are several rocky outcrops which would be favourable habitat for the lacewing (Figure 12).



Figure 12. Area at Doonie Point with rocky outcrops and patches of Wood sage where the lacewing was recorded in 2018 was revisited during the survey this year.

During the morning spent at the site, only one species of invertebrate was recorded - the brown lacewing *Micromus variegatus*. It was very windy, cold and wet while we walked round the site which limited the ability to look for other species. We also decided that it was possibly too early for the lacewings to be active and to revisit the area later in the summer.

3.5. Skatie Shore and Perthumie Bay survey

Skatie Shore and Perthumie Bay are just north of the town Stonehaven and are part of Garron Point SSSI. Garron Point SSSI is a rocky promontory with adjoining coastal strips that have steep grassy cliffs, vegetated shingle and areas of species-rich grassland. The site has been designated as an SSSI to protect a combination of geological and biological features including the SBL priority species Narrow-mouthed whorl snail (*Vertigo angustior*) and Northern brown argus butterfly (*Aricia artaxerxes*).

After visiting the coastal area at Doonie Point by Bridge of Muchalls on the 8th of May 2019, Dr Littlewood suggested this stretch of coast may provide habitat for the Bordered brown lacewing. During the afternoon of the 8th of May, we spent time looking for patches of Wood sage on the rocky outcrops from Garron Point at NO 8920587611 to NO 8915388641. There were several areas that looked suitable for the lacewing and we planned a further visit that would be open to others for the 1st of July.

On the 1st of July, Skatie Shore and Perthumie Bay was visited with Dr Littlewood and Helen Young (a Ranger with Aberdeenshire Council that covers this area at Stonehaven) (Figure 13); an additional three volunteers were due to join the survey but cancelled on the day.



Figure 13. Volunteers searching Wood sage at Skatie Shore and Perthumie Bay.

Heading down to the bay, we started by sweeping Wood sage at grid reference NO 890880. An adult was found very quickly in this area at grid reference NO 89071 88007. From here we went south heading to Garron Point and found adults at grid reference NO 89049 87978, NO 89039 87948 and NO 89032 87805 (Figure 14). From here we travelled north and found an adult at grid reference NO 89047 88138.



Figure 14. Map showing the distribution of where adult Bordered brown lacewings were recorded during surveys in 2019, from the most southern search at Stonehaven War memorial, north to the surveys at Skatie Shore and Perthumie Bay, to Doonie Point and then to the furthest north record at Portlethen Village.

As well as recording the lacewing, 57 other species of invertebrate were recorded along the coast of Skatie Shore and Perthumie Bay (Appendix 4). This included the SBL priority species Northern brown argus butterfly as well as the Wood sage plume moth.

After the survey at Skatie Shore and Perthumie Bay on the 1st of July, Dr Littlewood travelled to the north of the bay to search other areas of Wood sage along the coast. He successfully found an adult at grid reference NO 89288908. He later visited the war memorial just south of Stonehaven and found an adult on Wood sage here at grid reference NO 87808481 (Figure 14).

Dr Littlewood got in touch with Buglife later that week as he recorded adults of the Bordered brown lacewing along other areas of the coast that same week. At Doonie Point (at grid reference NO 90139094) he found two adults at the same place they were recorded in 2018 (Figure 14). Another adult was recorded at Portlethen Village at grid reference NO 93349605 which only had small patches of Wood sage and was very steep to get too. Another was recorded just outside of Muchalls village at grid reference NO 90259165 (Figure 14). A further four adults all from the same clump of Wood sage were recorded at Craigeven Bay, a short way south of Garron Point from grid reference NO 88748752 (Figure 14).

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 the historic sites. The workshops involved an indoor session where a presentation 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 was given by a member of Buglife staff. A focus was given to the Bordered brown lacewing to provide information on this rare species. An outdoor session followed 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 20 people attended the three workshops and seven adult Bordered brown lacewings were recorded at the workshop run at Holyrood Park on the 25th of June (Table 4); please see section three for more information about the surveys at Holyrood Park and St Cyrus NNR.

Table 4. 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 Drumpellier Park in North Lanarkshire.

Location	Date	Number of attendees	Number of Bordered brown lacewing found
St Cyrus NNR, Angus	19/06/2019	7	0
Holyrood Park SSSI, Edinburgh	25/06/2019	9	7
Drumpellier Park, North Lanarkshire	31/07/2019	4	N/A

A wide range of other species of invertebrate was recorded during the outdoor sessions of the workshops. A complete list of species recorded during the workshops is in Appendix 1 (Holyrood Park), Appendix 3 (St Cyrus NNR) and Appendix 5 (Drumpellier Park).

5. Conclusions and key recommendations

Surveys in 2019 have successfully found adults of the Bordered brown lacewing from two new areas at Holyrood Park and from several new sites along the east coast of Scotland in Aberdeenshire.

The biggest success of the project was finding several adults at a new site on the east coast, just south of the record at Doonie Point (recorded by Dr Littlewood in 2018) at Skatie Shore and Perthumie Bay by Garron Point, near Stonehaven. During the survey on the 1st of July, 10 adults were found on different patches of Wood sage and almost all in areas of rocky outcrops.

The survey along the east coast recorded adults of the Bordered brown lacewing along a 13km stretch of coast from Stonehaven to Portlethen Village. The majority of these sites are new for this species. All adults were recorded from Wood sage.

Wood sage is a widespread flowering plant that is found in a range of habitats from woodland, dunes and in shaded dry places in calcareous soils. The flowers are important for a range of insect pollinators, in particular long-tongued bumblebees and the rest of the plant is used by a diverse range of insects from leafhoppers, beetles to moths. The caterpillars of the Wood sage plume moth only feed on Wood sage (Figure 7).

Although Wood sage is a widespread plant, there may be other factors that affect the population of Bordered brown lacewing. Adults were only found on patches of Wood sage associated with rocky cliffs and not on Wood sage in sand dunes. Only the Wood sage at the lower slopes along the east coast (including St Cyrus) were surveyed with a sweep net for safety reasons. When surveying the plants, typically only one adult was recorded and it was a surprise when Nick found four adults in the same tussock.

Adults appear to have a much shorter period of activity than previously thought in Scotland and may emerge from late May and are active until early July. This may coincide with a stage of the Wood sage plant that is preferable to the adults and the prey the lacewings feed on.

There is still a lot to learn about this rare species of lacewing in Scotland and further surveys are required, especially at St Cyrus and Blackford Hill where there are historic records for the species. Unfortunately the weather during surveys at Blackford Hill in 2018 and 2019 was very poor although the habitat appears suitable. The weather also delayed the full day survey at St Cyrus by a week. It was noticeable that with this delay the Wood sage had started to wilt in places.

Further surveys will improve our knowledge of the distribution and requirements of this species. For example, there are patches of Wood sage at Blackford Hill that are being shaded by Gorse. It is unknown if the lacewing would be able to survive in these areas and move between patches of Wood sage with ease. By learning more about the species we will be better able to manage its habitat and ensure the long-term survival of this species in Scotland.

There may be other areas along the east coast that support this species which have not yet been visited and surveyed. It seems that where there were patches of Wood sage in rocky cliff edges that an adult Bordered brown lacewing was often present when visiting various patches by Skatie Shore and Perthumie Point. Buglife are aware of other patches of Wood sage in rocky areas that may support the lacewing, including north of Lunan Bay, between Stonehaven War Memorial and Dunnoter Castle and potentially as far south as St Abbs Head NNR.

By surveying for the lacewing it is also possible to survey for adults of the Wood sage plume moth at the same time. Looking at records for the Wood sage plume moth on the NBN Atlas there is only one record for the east coast (this record is currently placed over the ocean between Stonehaven and Aberdeen). Through surveys this year, adult Wood sage plume moth was recorded throughout Skatie Shore and Perthumie Bay.

The surveys have improved our knowledge of a range of invertebrate species. A total of 141 different species of invertebrate were recorded during this year's survey and included a diverse range of species and several SBL priority species, including Small heath, Grayling and Northern brown argus. As well as the Bordered brown lacewing a further four species of lacewing were recorded, including *Psectra diptera* which appears to be a new record for the east coast of Scotland, *Micromus paganus*, *Chrysopa perla* and *Chrysopa carnea*.

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Appendix 1. Invertebrates recorded at Holyrood Park SSSI in Edinburgh.

Common Name	Scientific Name	Grid Reference	Date
Buffish mining bee	<i>Andrena nigroaenea</i>	NT 272 734	04/06/2019
Flower bug	<i>Anthocoris nemoralis</i>	NT 272 734	04/06/2019
Click beetle	<i>Athous haemorrhoidalis</i>	NT 272 734	04/06/2019
White-tailed bumblebee	<i>Bombus lucorum</i>	NT 272 734	04/06/2019
Buff-tailed bumblebee	<i>Bombus terrestris</i>	NT 272 734	04/06/2019
Soldier beetle	<i>Cantharis nigricans</i>	NT 272 734	04/06/2019
Field grasshopper	<i>Chorthippus brunneus</i>	NT 272 734	04/06/2019
Green lacewing	<i>Chrysopa perla</i>	NT 272 734	04/06/2019
7 spot ladybird	<i>Coccinella septempunctata</i>	NT 272 734	04/06/2019
Flea beetle	<i>Derocrepis rufipes</i>	NT 272 734	04/06/2019
Bibionid fly	<i>Dilophus femoratus/humeralis</i>	NT 272 734	04/06/2019
Dance fly	<i>Empis tessellata</i>	NT 272 734	04/06/2019
Mottled Umber moth	<i>Erannis defoliaria</i>	NT 272 734	04/06/2019
Micro moths	<i>Glyphipterix</i> species	NT 272 734	04/06/2019
Small copper butterfly	<i>Lycaena phlaeas</i>	NT 272 734	04/06/2019
Trembling-wing fly	<i>Paloptera quinquemaculata</i>	NT 272 734	04/06/2019
Celery leaf beetle	<i>Phaedon tumidulus</i>	NT 272 734	04/06/2019
Meadow froghopper	<i>Philaenus spumarius</i>	NT 272 734	04/06/2019
Nettle weevil	<i>Phyllobius pomaceus</i>	NT 272 734	04/06/2019
Downlooker snipefly	<i>Rhagio scolopaceus</i>	NT 272 734	04/06/2019
Plant bug	<i>Stenodema laevigata</i>	NT 272 734	04/06/2019
Picture-winged snail killer	<i>Trypetoptera punctulata</i>	NT 272 734	04/06/2019
Cinnabar moth	<i>Tyria jacobaeae</i>	NT 272 734	04/06/2019
Silver-ground carpet moth	<i>Xanthorhoe montanata</i>	NT 272 734	04/06/2019
Click beetle	<i>Athous haemorrhoidalis</i>	NT 274 737	25/06/2019
Silver y moth	<i>Autographa gamma</i>	NT 275 737	25/06/2019

Yellow shell	<i>Camptogramma bilineata</i>	NT 274 737	25/06/2019
Wood sage plume moth	<i>Capperia britanniodactylus</i>	NT 27403 73701	25/06/2019
Wood sage plume moth	<i>Capperia britanniodactylus</i>	NT 27570 73702	25/06/2019
Brown lipped snail	<i>Cepaea nemoralis</i>	NT 274 737	25/06/2019
Field grasshopper	<i>Chorthippus brunneus</i>	NT 274 737	25/06/2019
Seven spot ladybird	<i>Coccinella septempunctata</i>	NT 274 737	25/06/2019
Candy stripe spider	<i>Enoplognatha ovata</i>	NT 274 737	25/06/2019
Marmalade hoverfly	<i>Episyrphus balteatus</i>	NT 274 737	25/06/2019
Hoverfly	<i>Eupeodes corollae</i>	NT 274 737	25/06/2019
Common earwig	<i>Forficula auricularia</i>	NT 274 737	25/06/2019
Black garden ant	<i>Lasius niger</i>	NT 274 737	25/06/2019
Plant bug	<i>Leptopterna dolabrata</i>	NT 275 737	25/06/2019
Star of thorns harvestman	<i>Megabunus diadema</i>	NT 274 737	25/06/2019
Willughby's leaf cutter bee	<i>Megachile willughbiella</i>	NT 274 737	25/06/2019
Bordered brown lacewing	<i>Megalomus hirtus</i>	NT 27403 73701	25/06/2019
Bordered brown lacewing	<i>Megalomus hirtus</i>	NT 2757 7370	25/06/2019
Red ant	<i>Myrmica species</i>	NT 274 737	25/06/2019
Chimney sweeper moth	<i>Odezia atrata</i>	NT 275 737	25/06/2019
Scorpion fly	<i>Panorpa species</i>	NT 275 737	25/06/2019
Harvestman	<i>Paroligolophus agrestis</i>	NT 275 737	25/06/2019
Common blue butterfly	<i>Polyommatus icarus</i>	NT 274 737	25/06/2019
Rough woodlouse	<i>Porcellio scaber</i>	NT 274 737	25/06/2019
Common red soldier beetle	<i>Rhagonycha fulva</i>	NT 274 737	25/06/2019
Zebra spider	<i>Salticus scenicus</i>	NT 274 737	25/06/2019
Hoverfly	<i>Scaeva pyrastris</i>	NT 274 737	25/06/2019
Picture-winged snail killer	<i>Trypetoptera punctulata</i>	NT 275 737	25/06/2019
Cinnabar moth	<i>Tyria jacobaeae</i>	NT 275 737	25/06/2019
Painted lady	<i>Vanessa cardui</i>	NT 274 737	25/06/2019
Crap spider	<i>Xysticus species</i>	NT 274 737	25/06/2019

Leaf hopper	<i>Agallia consobrina</i>	NT 275 736	10/07/2019
Small tortoiseshell	<i>Aglais urticae</i>	NT 275 736	10/07/2019
Ringlet	<i>Aphantopus hyperantus</i>	NT 275 736	10/07/2019
Red tailed bee	<i>Bombus lapidarius</i>	NT 275 736	10/07/2019
White tailed bee	<i>Bombus lucorum</i>	NT 275 736	10/07/2019
Common carder bee	<i>Bombus pascuorum</i>	NT 275 736	10/07/2019
Yellow shell	<i>Camptogramma bilineata</i>	NT 275 736	10/07/2019
Wood sage plume moth	<i>Capperia britanniodactylus</i>	NT 275 736	10/07/2019
Field grasshopper	<i>Chorthippus brunneus</i>	NT 275 736	10/07/2019
Ladybird	<i>Coccidula rufa</i>	NT 277 731	10/07/2019
Seven spot ladybird	<i>Coccinella septempunctata</i>	NT 275 736	10/07/2019
Small heath	<i>Coenonympha pamphilus</i>	NT 275 736	10/07/2019
Plant hopper	<i>Dicranotropis hamata</i>	NT 277 731	10/07/2019
Candy stripe spider	<i>Enoplognatha ovata</i>	NT 275 736	10/07/2019
Common carpet	<i>Epirrhoe alternata</i>	NT 275 736	10/07/2019
Marmalade hoverfly	<i>Episyrphus balteatus</i>	NT 275 736	10/07/2019
Bronze furrow bee	<i>Halictus tumulorum</i>	NT 277 731	10/07/2019
Grayling butterfly	<i>Hipparchia semele</i>	NT 275 736	10/07/2019
Common black ant	<i>Lasius niger</i>	NT 275 736	10/07/2019
Meadow plant bug	<i>Leptopterna dolabrata</i>	NT 275 736	10/07/2019
Soldier beetle	<i>Malthinus flaveolus</i>	NT 275 736	10/07/2019
Meadow brown	<i>Maniola jurtina</i>	NT 275 736	10/07/2019
Bordered brown lacewing	<i>Megalomus hirtus</i>	NT 27550 73671	10/07/2019
Broad damsel bug	<i>Nabis flavomarginatus</i>	NT 275 736	10/07/2019
Common froghopper	<i>Philaenus spumarius</i>	NT 275 736	10/07/2019
Plant bug	<i>Plagiognathus chrysanthemii</i>	NT 275 736	10/07/2019
Leaf hopper	<i>Planaphrodes bifasciata</i>	NT 277 731	10/07/2019
Common blue butterfly	<i>Polyommatus icarus</i>	NT 275 736	10/07/2019
Rough woodlouse	<i>Porcellio scaber</i>	NT 275 736	10/07/2019

Click beetle	<i>Prosternon tessellatum</i>	NT 277 731	10/07/2019
Snipe fly	<i>Rhagio lineola</i>	NT 275 736	10/07/2019
Common red soldier beetle	<i>Rhagonycha fulva</i>	NT 275 736	10/07/2019
Zebra spider	<i>Salticus scenicus</i>	NT 275 736	10/07/2019
Hoverfly	<i>Scaeva selenitica</i>	NT 275 736	10/07/2019
Grass bug	<i>Stenodema laevigata</i>	NT 277 731	10/07/2019
Cinnabar moth	<i>Tyria jacobaeae</i>	NT 275 736	10/07/2019
Picture winged fly	<i>Urophora jaceana</i>	NT 275 736	10/07/2019
Painted lady	<i>Vanessa cardui</i>	NT 275 736	10/07/2019
Crab spider	<i>Xysticus species</i>	NT 275 736	10/07/2019

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

Common Name	Scientific Name	Grid Reference	Date
Field grasshopper	<i>Chorthippus brunneus</i>	NT 256 703	24/06/2019
Leaf hopper	<i>Eupteryx</i> species	NT 256 703	24/06/2019
Black slug	<i>Arion ater</i>	NT 256 703	24/06/2019

Appendix 3. Invertebrates recorded at St Cyrus NNR, Montrose.

Common Name	Scientific Name	Grid Reference	Date
Red tailed bumblebee	<i>Bombus lapidarius</i>	NO 743 635	19/06/2019
White tailed bumblebee	<i>Bombus lucorum</i>	NO 743 635	19/06/2019
Early bumblebee	<i>Bombus pratorum</i>	NO 743 635	19/06/2019
Yellow shell	<i>Camptogramma bilineata</i>	NO 743 635	19/06/2019
Plant bug	<i>Capsus ater</i>	NO 743 635	19/06/2019
Hoverfly	<i>Cheilosia illustrata</i>	NO 743 635	19/06/2019
Figwort weevil	<i>Cionus scrophulariae</i>	NO 743 635	19/06/2019
Seven spot ladybird	<i>Coccinella septempunctata</i>	NO 743 635	19/06/2019
Small heath	<i>Coenonympha pamphilus</i>	NO 743 635	19/06/2019
Fly	<i>Dilophus femoratus</i>	NO 743 635	19/06/2019
Candy stripe spider	<i>Enoplognatha ovata</i>	NO 743 635	19/06/2019
Hoverfly	<i>Eristalis intricarius</i>	NO 743 635	19/06/2019
Hoverfly	<i>Eupeodes corollae</i>	NO 743 635	19/06/2019
Black garden ant	<i>Lasius niger</i>	NO 743 635	19/06/2019
Black headed leaf cutter bee	<i>Megachile circumcincta</i>	NO 743 635	19/06/2019
Hoverfly	<i>Melanostoma scalare</i>	NO 743 635	19/06/2019
Red ant	<i>Myrmica species</i>	NO 743 635	19/06/2019
Common green grasshopper	<i>Omocestus viridulus</i>	NO 743 635	19/06/2019
Scorpionfly	<i>Panorpa germanica</i>	NO 743 635	19/06/2019
Common froghopper	<i>Philaenus spumarius</i>	NO 743 635	19/06/2019
Gorse shieldbug	<i>Piezodorus lituratus</i>	NO 743 635	19/06/2019
Big headed fly	<i>Pipunculidae</i>	NO 743 635	19/06/2019
Lacewing	<i>Psectra diptera</i>	NO 743 635	19/06/2019
Zebra spider	<i>Salticus scenicus</i>	NO 743 635	19/06/2019
Sawfly	<i>Tenthredo livida</i>	NO 743 635	19/06/2019
Sawfly	<i>Tenthredo species</i>	NO 743 635	19/06/2019

Cinnabar moth	<i>Tyria jacobaeae</i>	NO 743 635	19/06/2019
Hoverfly	<i>Volucella bombylans</i>	NO 743 635	19/06/2019
Six spot burnet moth	<i>Zygaena filipendulae</i>	NO 743 635	19/06/2019
Shiny margined mini miner	<i>Andrena semilaevis</i>	NO 750 642	18/07/2019
Ringlet	<i>Aphantopus hyperantus</i>	NO 750 642	18/07/2019
Gold spangle	<i>Autographa bractea</i>	NO 750 642	18/07/2019
Tree bumblebee	<i>Bombus hypnorum</i>	NO 750 642	18/07/2019
Red tailed bee	<i>Bombus lapidarius</i>	NO 750 642	18/07/2019
White tailed bee	<i>Bombus lucorum</i>	NO 750 642	18/07/2019
Common carder bee	<i>Bombus pascuorum</i>	NO 750 642	18/07/2019
Plant bug	<i>Calocoris roseomaculatus</i>	NO 750 642	18/07/2019
White lipped snail	<i>Cepaea hortensis</i>	NO 750 642	18/07/2019
Hoverfly	<i>Cheilosia illustrata</i>	NO 750 642	18/07/2019
Field grasshopper	<i>Chorthippus brunneus</i>	NO 750 642	18/07/2019
Green lacewing	<i>Chrysopa carnea</i>	NO 750 642	18/07/2019
Small heath	<i>Coenonympha pamphilus</i>	NO 750 642	18/07/2019
Hairy shieldbug	<i>Dolycoris baccarum</i>	NO 750 642	18/07/2019
Candy stripe spider	<i>Enoplognatha ovata</i>	NO 750 642	18/07/2019
Common footman	<i>Eilema lurideola</i>	NO 750 642	18/07/2019
Pine ladybird	<i>Exochomus quadripustulatus</i>	NO 750 642	18/07/2019
Common earwig	<i>Forficula auricularia</i>	NO 750 642	18/07/2019
Leaf beetle	<i>Galeruca tanaceti</i>	NO 750 642	18/07/2019
Grayling butterfly	<i>Hipparchia semele</i>	NO 750 642	18/07/2019
Plant bug	<i>Leptopterna dolabrata</i>	NO 750 642	18/07/2019
Meadow brown	<i>Maniola jurtina</i>	NO 750 642	18/07/2019
Smoky Wainscot	<i>Mythimna impura</i>	NO 750 642	18/07/2019
Celery leaf beetle	<i>Phaedon tumidulus</i>	NO 750 642	18/07/2019
Horned harvestman	<i>Phalangium opilio</i>	NO 750 642	18/07/2019
Common froghopper	<i>Philaenus spumarius</i>	NO 750 642	18/07/2019

Plant bug	<i>Phytocoris varipes</i>	NO 750 642	18/07/2019
Plant bug	<i>Plagiognathus chrysanthemi</i>	NO 750 642	18/07/2019
Common blue butterfly	<i>Polyommatus icarus</i>	NO 750 642	18/07/2019
Common red soldier beetle	<i>Rhagonycha fulva</i>	NO 750 642	18/07/2019
Conopid fly	<i>Sicus ferrugineus</i>	NO 750 642	18/07/2019
Hoverfly	<i>Sphaerophoria scripta</i>	NO 750 642	18/07/2019
Plant bug	<i>Stenodema laevigata</i>	NO 750 642	18/07/2019
Tachinid fly	<i>Tachina grossa</i>	NO 750 642	18/07/2019
Stillete fly	<i>Thereva nobilitata</i>	NO 750 642	18/07/2019
Picture-winged snail killer	<i>Trypetoptera punctulata</i>	NO 750 642	18/07/2019
Cinnabar moth	<i>Tyria jacobaeae</i>	NO 750 642	18/07/2019
Silver ground carpet	<i>Xanthorhoe montanata</i>	NO 750 642	18/07/2019

Appendix 4. Invertebrates recorded at Skatie Shore and Perthumie Bay, by Stonehaven.

Common Name	Scientific Name	Grid Reference	Date
Black slug	<i>Arion ater</i>	NO 89065 88122	08/05/2019
White lipped snail	<i>Cepaea hortensis</i>	NO 89065 88122	08/05/2019
Brown lipped snail	<i>Cepaea nemoralis</i>	NO 89065 88122	08/05/2019
Black garden ant	<i>Lasius niger</i>	NO 89065 88122	08/05/2019
Red ants	<i>Myrmica</i> species	NO 89065 88122	08/05/2019
Orange striped millipede	<i>Ommatoiulus sabulosus</i>	NO 89065 88122	08/05/2019
Solitary wasp	<i>Ancistrocerus gazella</i>	NO 89053 88121	01/07/2019
Nettle tap moth	<i>Anthophila fabriciana</i>	NO 89102 88535	01/07/2019
Ringlet	<i>Aphantopus hyperantus</i>	NO 89044 88124	01/07/2019
Dark green fritillary	<i>Argynnis aglaja</i>	NO 89102 88535	01/07/2019
Northern brown argus	<i>Aricia artaxerxes</i>	NO 89044 88124	01/07/2019
Silver y moth	<i>Autographa gamma</i>	NO 89044 88124	01/07/2019
Red tailed bee	<i>Bombus lapidarius</i>	NO 89044 88124	01/07/2019
White tailed bee	<i>Bombus lucorum</i>	NO 89044 88124	01/07/2019
Common carder bee	<i>Bombus pascuorum</i>	NO 89044 88124	01/07/2019
Buff tailed bee	<i>Bombus terrestris</i>	NO 89044 88124	01/07/2019
Yellow shell	<i>Camptogramma bilineata</i>	NO 89102 88535	01/07/2019
Wood sage plume moth	<i>Capperia britanniodactylus</i>	NO 89047 88139	01/07/2019
Wood sage plume moth	<i>Capperia britanniodactylus</i>	NO 89048 87976	01/07/2019
Wood sage plume moth	<i>Capperia britanniodactylus</i>	NO 89030 87930	01/07/2019
Wood sage plume moth	<i>Capperia britanniodactylus</i>	NO 8928689086	01/07/2019
Common marble	<i>Celypha lacunana</i>	NO 89102 88535	01/07/2019
Hoverfly	<i>Cheilosia illustrata</i>	NO 89044 88124	01/07/2019
Latticed heath moth	<i>Chiasmia clathrata</i>	NO 89044 88124	01/07/2019
Black snipefy	<i>Chrysopilus cristatus</i>	NO 89044 88124	01/07/2019
Garden grass veneer	<i>Chrysoteuchia culmella</i>	NO 89102 88535	01/07/2019

Lacehopper	<i>Cixius nervosus</i>	NO 89102 88535	01/07/2019
Seven spot ladybird	<i>Coccinella septempunctata</i>	NO 89044 88124	01/07/2019
Small heath	<i>Coenonympha pamphilus</i>	NO 89044 88124	01/07/2019
Hook streaked grass veneer	<i>Crambus lathoniellus</i>	NO 89102 88535	01/07/2019
Chamomile shark	<i>Cucullia chamomillae</i>	NO 89102 88535	01/07/2019
Flea beetle	<i>Derocrepis rufipes</i>	NO 89044 88124	01/07/2019
Candy stripe spider	<i>Enoplognatha ovata</i>	NO 89044 88124	01/07/2019
Marmalade hoverfly	<i>Episyrphus balteatus</i>	NO 89044 88124	01/07/2019
Hoverfly	<i>Eupeodes corollae</i>	NO 89044 88124	01/07/2019
Leafhopper	<i>Eupteryx stachydearum</i>	NO 89102 88535	01/07/2019
Leafhopper	<i>Evacanthus interruptus</i>	NO 89102 88535	01/07/2019
Cocksfoot moth	<i>Glyphipterix simplicella</i>	NO 89102 88535	01/07/2019
Jumping spider	<i>Heliophanus cupreus</i>	NO 89044 88124	01/07/2019
Black garden ant	<i>Lasius niger</i>	NO 89044 88124	01/07/2019
Plant bug	<i>Leptopterna dolabrata</i>	NO 89044 88124	01/07/2019
Meadow brown	<i>Maniola jurtina</i>	NO 89044 88124	01/07/2019
Bordered brown lacewing	<i>Megalomus hirtus</i>	NO 89047 88138	01/07/2019
Bordered brown lacewing	<i>Megalomus hirtus</i>	NO 89071 88007	01/07/2019
Bordered brown lacewing	<i>Megalomus hirtus</i>	NO 89049 87978	01/07/2019
Bordered brown lacewing	<i>Megalomus hirtus</i>	NO 89039 87948	01/07/2019
Bordered brown lacewing	<i>Megalomus hirtus</i>	NO 89032 87805	01/07/2019
Bordered brown lacewing	<i>Megalomus hirtus</i>	NO 89286 89086	01/07/2019
Lacewing	<i>Micromus paganus</i>	NO 89286 89086	01/07/2019
Red ant	<i>Myrmica scabrinodis</i>	NO 89102 88535	01/07/2019
Common green grasshopper	<i>Omocestus viridulus</i>	NO 89044 88124	01/07/2019
Common froghopper	<i>Philaenus spumarius</i>	NO 89044 88124	01/07/2019
Green veined white	<i>Pieris napi</i>	NO 89044 88124	01/07/2019
Hoverfly	<i>Pipizella viduata</i>	NO 89102 88535	01/07/2019
Diamond back moth	<i>Plutella xylostella</i>	NO 89102 88535	01/07/2019

Common blue butterfly	<i>Polyommatus icarus</i>	NO 89102 88535	01/07/2019
Ground bug	<i>Scolopostethus decoratus</i>	NO 89102 88535	01/07/2019
Common grey	<i>Scoparia ambigualis</i>	NO 89102 88535	01/07/2019
Meadow grey	<i>Scoparia pyraella</i>	NO 89102 88535	01/07/2019
Conopid fly	<i>Sicus ferrugineus</i>	NO 89044 88124	01/07/2019
Picture-winged snail killer	<i>Trypetoptera punctulata</i>	NO 89102 88535	01/07/2019
Cinnabar moth	<i>Tyria jacobaeae</i>	NO 89102 88535	01/07/2019
Red admiral	<i>Vanessa atalanta</i>	NO 89044 88124	01/07/2019
Painted lady	<i>Vanessa cardui</i>	NO 89044 88124	01/07/2019
Silver ground carpet	<i>Xanthorhoe montanata</i>	NO 89102 88535	01/07/2019
Crap spider	<i>Xysticus species</i>	NO 89044 88124	01/07/2019
Six spot burnet moth	<i>Zygaena filipendulae</i>	NO 89044 88124	01/07/2019

Appendix 5. Invertebrates recorded at Drumpellier Park, North Lanarkshire.

Common Name	Scientific Name	Grid Reference	Date
Ten spot ladybird	<i>Adalia decempunctata</i>	NS 639 673	31/07/2019
Leaf beetle	<i>Altica palustis</i>	NS 639 691	31/07/2019
Leaf hopper	<i>Aphrodes makarovi</i>	NS 639 700	31/07/2019
Alder spittle bug	<i>Aphrophora alni</i>	NS 639 687	31/07/2019
Garden cross spider	<i>Araneus diadematus</i>	NS 639 689	31/07/2019
Garden bee	<i>Bombus hortorum</i>	NS 639 676	31/07/2019
White tailed bee	<i>Bombus lucorum</i>	NS 639 677	31/07/2019
Common carder bee	<i>Bombus pascuorum</i>	NS 639 678	31/07/2019
Early bumblebee	<i>Bombus pratorum</i>	NS 639 679	31/07/2019
Buff tailed bee	<i>Bombus terrestris</i>	NS 639 680	31/07/2019
Leaf beetle	<i>Chrysolina polita</i>	NS 639 690	31/07/2019
Green lacewing	<i>Chrysopidae species</i>	NS 639 692	31/07/2019
Leaf hopper	<i>Cicadella viridis</i>	NS 639 695	31/07/2019
Ladybird	<i>Coccidula rufa</i>	NS 639 674	31/07/2019
Davies Colletes	<i>Colletes daviesanus</i>	NS 639 675	31/07/2019
Marmalade hoverfly	<i>Episyrphus balteatus</i>	NS 639 682	31/07/2019
Drone fly	<i>Eristalis pertinax</i>	NS 639 683	31/07/2019
Hoverfly	<i>Eupeodes corollae</i>	NS 639 699	31/07/2019
Common earwig	<i>Forficula auricularia</i>	NS 639 681	31/07/2019
Solitary bee	<i>Lasioglossum calceatum/albipes</i>	NS 639 697	31/07/2019
Plant bug	<i>Leptopterna dolabrata</i>	NS 639 694	31/07/2019
Green bottle	<i>Lucillia species</i>	NS 639 698	31/07/2019
Marsh damsel bug	<i>Nabis flavomarginatus</i>	NS 639 688	31/07/2019
Common froghopper	<i>Philaenus spumarius</i>	NS 639 686	31/07/2019
Plant bug	<i>Plagiognathus arbustorum</i>	NS 639 701	31/07/2019
Hoverfly	<i>Platycheirus albimanus</i>	NS 639 684	31/07/2019

Hoverfly	<i>Scaeva pyrastris</i>	NS 639 693	31/07/2019
Grass bug	<i>Stenodema</i> species	NS 639 685	31/07/2019
Pale Straw pearl	<i>Udea lutealis</i>	NS 639 704	31/07/2019
Picture winged fly	<i>Urophora jaceana</i>	NS 639 702	31/07/2019
Common wasp	<i>Vespula vulgaris</i>	NS 639 703	31/07/2019
Crab spider	<i>Xysticus cristatus</i>	NS 639 696	31/07/2019

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