


Spotting Pot Beetles

Survey Report and Habitat Recommendations

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Scottish Natural Heritage
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Summary

Pot beetles (genus *Cryptocephalus*) are a fascinating group of beetles. Of the 19 species found in the UK, eleven have been recorded in Scotland and eight of these have conservation designations.

Scottish Natural Heritage (SNH) provided funding to Buglife through the 'Spotting Pot Beetles' project to run surveys and workshops to raise awareness and improve peoples identification skills of the different species of pot beetles and their leaf beetle relatives.

Two survey days with volunteers were run through this project at Kirkconnell Flow National Nature Reserve (NNR) to survey for the Six-spotted pot beetle (*Cryptocephalus sexpunctatus*) and Camghouran and Black Wood, on the south of Loch Rannoch to survey for the Ten-spotted pot beetle (*Cryptocephalus decemmaculatus*). Both surveys were successful in finding their target species of pot beetle as well as other species of pot beetles and invertebrates.

Guidance is provided within this document on managing habitat at both Kirkconnell Flow NNR and Black Wood of Rannoch for their pot beetles to ensure the long term survival of both species in Scotland.

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1. Introduction to pot beetles

Pot beetles are a fascinating and charismatic group of beetles that are in the subfamily Cryptocephalinae within the leaf beetle Chrysomelidae family. These amazing beetles get their common name from the protective shell-like cocoon or 'pot' that the larvae live in, that are created using the beetles own faeces (Figure 1) (Hubble, 2017). The pots are initially built by the female during and immediately after egg laying, with the egg being held between the rear metatarsi and covered by the female's faeces, the precise structure of the pot varies between the different pot beetle species (Hubble, 2017). Once covered, the pots are dropped to the ground amongst leaf litter and this often forms much of the larvae's diet. Another key feature of pot beetles is that the head of the adults is hidden under their bulging pronotum, which is the source of the scientific name for the genus '*Cryptocephalus*' meaning 'hidden head'.

Figure 1. A larvae of the Hazel pot beetle (*C. coryli*), image © eakringbirds.

There are 19 species of pot beetle currently known to occur in the UK, with the Violet pot beetle (*C. violaceus*) recently being described as extinct and no longer on the UK list (Table 1) (Hubble, 2014). At least eleven species are currently known to occur in Scotland (six of these have recent records from after 1980 and five have records that date pre-1979 or even before the 1900's) (Table 1). There is a record of *C. hypochaeridis* from 2008 at the Scottish Wildlife Trust reserve Jupiter Nursery in Grangemouth, this record is highly doubtful due to the habitat requirements that this species typically needs (Table 1). Many species of pot beetle have suffered declines in their distribution across the UK and are now quite rare. Six species are described as Endangered and two as Vulnerable in the recent status review (Table 1) (Hubble, 2014). Additionally, nine are described as Nationally Rare and five as Nationally Scarce within Great Britain (Table 1). In Scotland, two are on the Scottish Biodiversity List, the Six-spotted pot beetle (*C. sexpunctatus*) and the Ten-spotted pot beetle (*C. decemmaculatus*) (Table 1).

Table 1. List of *Cryptocephalus* pot beetles known to occur in the UK, with notes on when the species was described and those recorded in Scotland; records taken from NBN Atlas and Cox, 2007. Notes also include reference to rarity designations for each species as described by Natural England (Hubble, 2014) including IUCN status - Critically Endangered (Possibly Extinct): CR (PE), Endangered: EN, Vulnerable: VU and Near Threatened NT; Great Britain rarity- Nationally Rare (NR) and Nationally Scarce (NS); and whether the species is on the Scottish Biodiversity List (SBL).

Scientific Name	Common Name	Notes
Cryptocephalus aureolus (Suffrian, 1847)		Historic records and a more recent record from 2015 vin South Ayrshire.
Cryptocephalus biguttatus (Scopoli, 1763)		VU, NR
Cryptocephalus bilineatus (Linnaeus, 1767)		NS
Cryptocephalus bipunctatus (Linnaeus, 1767)	Two-spotted pot beetle	Historic records for this species in Scotland and recently found new to Kirkconnell Flow NNR. NS
Cryptocephalus coryli (Linnaeus, 1767)	Hazel pot beetle	One old record from Kincraig from 1946. No recent records. EN, NR
Cryptocephalus decemmaculatus (Linnaeus, 1767)	Ten-spotted pot beetle	Recorded in Scotland at Black Wood of Loch Rannoch. EN, NR, SBL
Cryptocephalus exiguous (Schneider, 1792)	Pashford pot beetle	CR (PE), NR
Cryptocephalus frontalis (Marsham, 1802)		NT, NR
Cryptocephalus fulvus (Goeze, 1777)		
Cryptocephalus hypochaeridis (Linnaeus, 1758)		A record for this species at one site in Scotland at SWT Jupiter reserve (on NBN Atlas); record doubtful due to habitat. LC, NS
Cryptocephalus labiatus (Linnaeus, 1761)	Black birch pot beetle	Recorded at several sites across Scotland
Cryptocephalus moraei (Linnaeus, 1758)		Old record pre-1979 for site in southern Scotland.
Cryptocephalus nitidulus (Fabricius, 1787)	Shining pot beetle	EN, NR
Cryptocephalus parvulus (Müller, 1776)		At least two old records from pre-1979 in Scotland. NS
Cryptocephalus primarius (Harold, 1872)	Rock-rose pot beetle	Old records from Scotland from pre 1900's and none show on NBN Atlas. EN, NR.
Cryptocephalus punctiger (Paykull, 1799)	Blue pepper-pot beetle	At least two old records from pre-1979 in Scotland. VU, NR
Cryptocephalus pusillus (Fabricius, 1777)		Recorded in Scotland- in Dumfriesshire and Highlands.

Cryptocephalus quercetin (Suffrian, 1848)		EN, NR
Cryptocephalus sexpunctatus (Linnaeus, 1758)	Six-spotted pot beetle	Recorded in Scotland. EN, NR, SBL

2. Spotting Pot Beetles

Scottish Natural Heritage (SNH) provided funding to Buglife to run the 'Spotting Pot Beetles' project during 2017. There is a designated page for this project on the Buglife website: www.buglife.org.uk/local/spotting-pot-beetles.

The project's main aim was to:

- Organise and run three training workshops to raise awareness and improve people's identification skills of the different species of pot beetles and their leaf beetle relatives in Scotland.
- Organise and run two survey days with volunteers to search for the Six-spotted pot beetle at Kirkconnell Flow NNR in Dumfriesshire and the Ten-spotted pot beetle at Loch Rannoch in Perthshire.

3. Six-spotted pot beetle

The Six-spotted pot beetle has a reddish-yellow thorax and elytra with usually three black spots (sometimes four) on each elytral wing case (Figure 2) (Douglas, 2001b; Hubble, 2012). Adult beetles are between 4.5-6.5 millimetres (mm) in size (Douglas, 2001b; Hubble, 2012). This species has been found on a number of plant species including Aspen (*Populus tremula*), Crack willow (*Salix fragilis*), Hawthorn (*Crataegus monogyna*) as well as young oak (*Quercus* species) and birch (*Betula* species) (Cox, 2007). Adults have also been seen on the flowers of Wood spurge (*Euphorbia amygdaloides*) and yellow Asteraceae species (Cox, 2007).

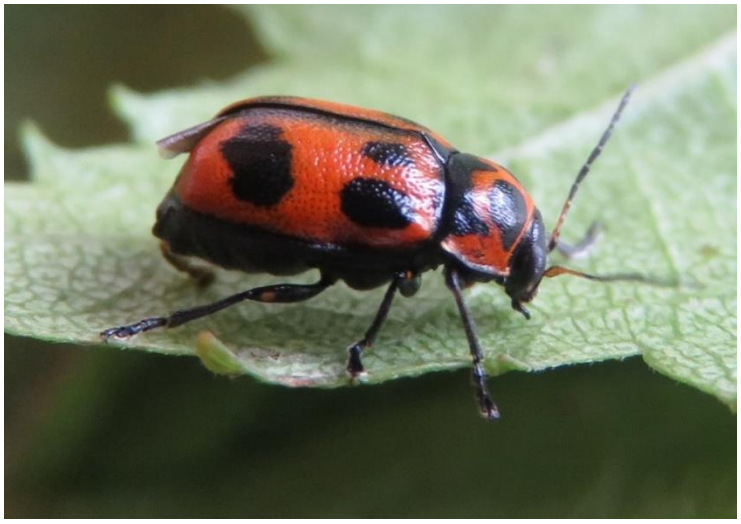

Figure 2. Six-spotted pot beetle at Kirkconnell Flow NNR.

Adults typically emerge in mid to late May and females lay their eggs in low foliage before dropping them into the leaf litter below (Douglas, 2001b). Eggs take about 3-4 weeks to hatch and the larvae take between 12-21 months to develop before anchoring themselves to a leaf, sealing the pot and pupating (Douglas, 2001b). When ready to emerge from their pot, the beetle cuts a hole at one end.

This species was once widespread in southern England with scattered records as far north as Ayrshire in Scotland (Douglas, 2001b; Piper, 2002; Anon., 2010a). The current status of the beetle is that it now has an extremely localised distribution in the UK with only one known site in Scotland at Kirkconnell Flow NNR and one known site in England at Stockbridge Down in Hampshire and another potential site at Shrawley Wood in Worcestershire (Douglas, 2001b; Piper, 2002; Anon., 2010a). At Stockbridge Down, despite repeated searches, only a few individuals have been recorded since 1990 (Piper, 2002). At Kirkconnell Flow NNR, the last beetles recorded were in the late 1990s.

Current threats to the Six-spotted pot beetle include the loss of broad-leaved woodland and inappropriate woodland management including the neglect of coppicing which has led to the development of high forest with little regeneration of young trees (Douglas, 2001b; Piper, 2002). Habitat fragmentation has led to isolation of populations of this species. There is a potential concern that this isolation is causing reproductive failure. This was noted at Stockbridge Down by Piper (2002) when collecting data for his PhD thesis where eggs that were collected failed to hatch and were deemed non-viable.

3.1. Kirkconnell Flow NNR

Located 6 kilometres (km) south of Dumfries, Kirkconnell Flow NNR is a raised bog that lies on the flood plain of the River Nith (Figure 3). Due to the dramatic decline in the area of raised bog habitat across Europe since the start of the nineteenth century, it is important that sites recognised as having ‘active’ raised bogs are protected and managed appropriately. The UK, along with Finland, Sweden and Ireland, has several large raised bogs and therefore has a particular responsibility for conserving them. In the UK, there are very few active raised bogs that remain undamaged and this includes Kirkconnell Flow NNR. Most raised bogs have been affected by activities such as peat cutting, forestry and drainage over the last two hundred years.

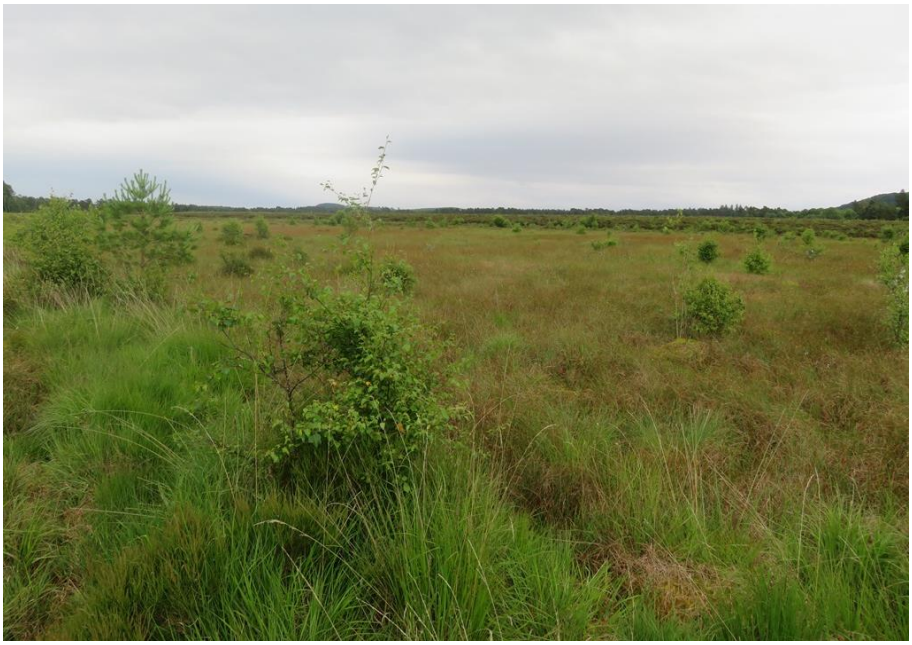

Figure 3. The open area of peat bog at Kirkconnell Flow NNR.

The impact of past land use at Kirkconnell Flow has reduced the original dome of the raised bog (Anon., 2005). The cutting of peat and the building of drainage ditches have lowered the water table and this has changed the types of plants found on the bog, with mosses such as *Sphagnum* being lost to heather (*Calluna vulgaris* and *Erica* species) and sedges (Anon., 2005). As a result the central area of the bog is a mosaic with active areas that are still forming peat and degraded areas that are unable to form peat (Anon., 2005). The drier areas within the degraded patches have allowed trees such as Silver birch (*Betula pendula*) and Scot's pine (*Pinus sylvestris*) to develop (Anon., 2005).

The trees have further exacerbated the damage to this bog by further lowering the water table and shading out bog mosses. The drier the bog becomes, the more conditions favour tree growth and therefore more trees can colonise the bog surface. Due to its raised bog status, Kirkconnell Flow was designated a NNR in 1959 and was bought by SNH in 1998 (Anon., 2005). When bought by SNH a large-scale programme was developed to help restore the site to ultimately raise the water table and re-wet the bog and this would allow it to regenerate (Anon., 2005). Part of the programme involved clearing woodland from across the site and blocking drains to make the bog wetter (Anon., 2005). A fringe of woodland was left around the site to reduce visual impact on the landscape that clearing the woodland within the central area may have caused (Anon., 2005). It is this area of left mixed woodland, where young birch and oak are allowed to germinate and grow that has provided habitat for the Six-spotted pot beetle.

Due to its 'active' raised bog, the site has several conservation designations. As well as being a NNR the site is also a Site of Special Scientific Interest (SSSI), it lies within the Solway Mosses North Special Area of Conservation (SAC) which covers an area of 652 hectare and lies within the National Scenic Area (NSA) of the River Nith (Anon., 2005).

3.2. Six-spotted pot beetle volunteer survey

Six-spotted pot beetles have not been recorded at Kirkconnell Flow NNR since the late 1990s. A number of entomologists have visited the site to search for this beetle over the last decade, but without success.

Buglife organised a visit to Kirkconnell Flow NNR on the afternoon of 24 June 2017. Twelve volunteers and a member of Buglife staff surveyed the site to rediscover the Six-spotted pot beetle (Figure 4). The weather was dry and warm with a slight breeze in more open areas. In less than ten minutes an adult Six-spotted pot beetle was found by sweeping young Silver birch at the area adjacent to the bog at grid reference NX 96438 70205. Another adult was found after another 30 minutes within the same area. Due to large areas of dense woodland within the site along with a known population of Adders (*Vipera berus*), surveying effort focused on sweeping birch adjacent to the main foot path and along the woodland edge of the bog.

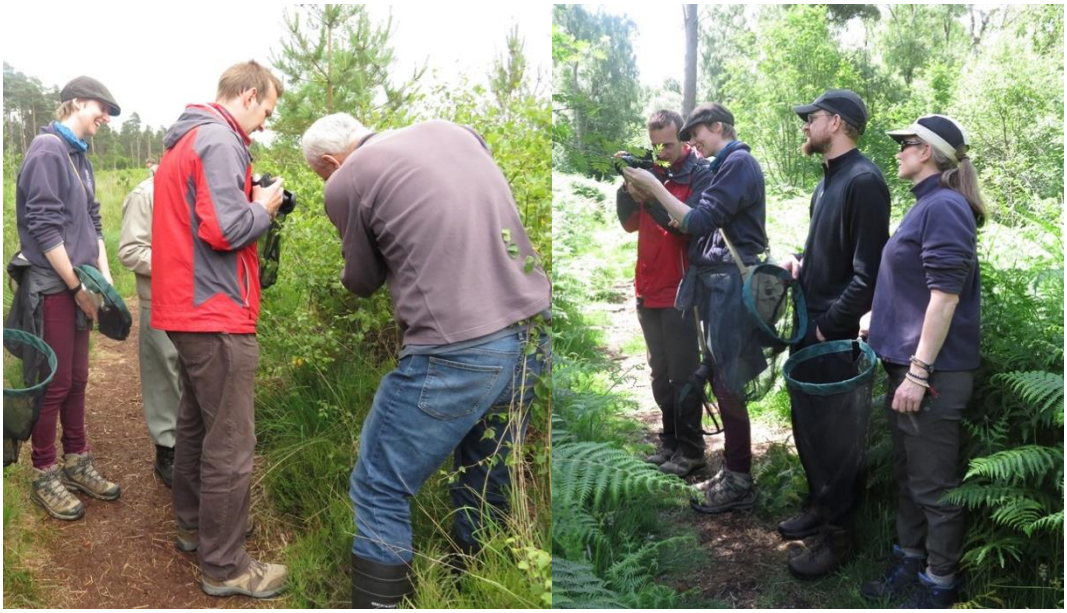

Figure 4. Volunteers surveying Kirkconnell Flow NNR for the Six-spotted pot beetle.

During the survey two individuals of a second species of pot beetle were found, the Two-spotted pot beetle (*C. bigutattus*) (Figure 5). After the survey it was discovered that this is a new species to this site. A wide range of other species of invertebrates were recorded during this survey (Table 2).

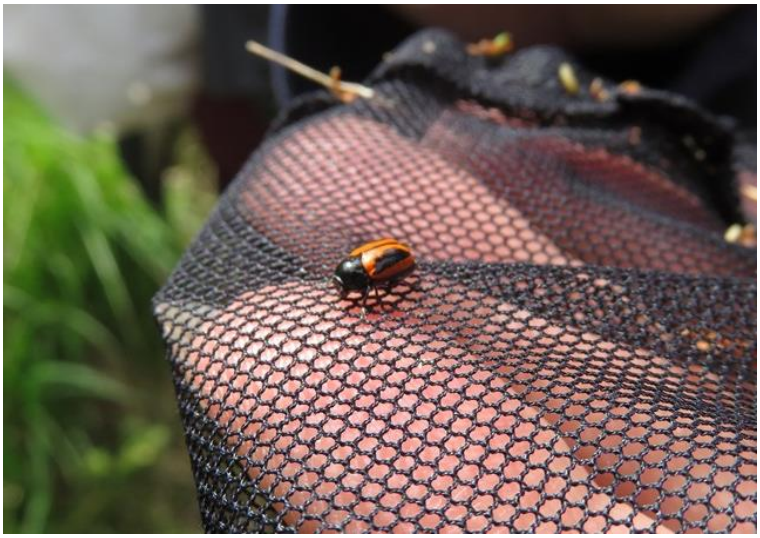

Figure 5. The Two-spotted pot beetle at Kirkconnell Flow NNR.

Table 2. List of invertebrate species recorded at Kirkconnell Flow NNR on the afternoon of 24 June 2017.

Common Name	**Scientific name**
Beetles	**Coleoptera**
Heather beetle	*Lochmaea suturalis*
Leaf beetle	*Lochmaea caprea*
Leaf beetle	*Luperus longicornis*
Reed beetle	*Plateumaris discolor*
Six-spotted pot beetle	*Cryptocephalus sexpunctatus*
Soldier beetle	*Malthodes* species
Two-spotted pot beetle	*Cryptocephalus bipunctatus*
Dragonflies and damselflies	**Odonata**
Four spot chaser	*Libellula quadrimaculata*
Large red damselfly	*Pyrrhosoma nymphula*
Bees, wasps and ants	**Hymenoptera**
Common carder bee	*Bombus pascuorum*
Butterflies and moths	**Lepidoptera**
Common heath moth	*Ematurga atomaria*
Emperor moth	*Saturnia pavonia*
Large heath butterfly	*Coenonympha tullia*
Light emerald moth	*Campaea margaritaria*
Small yellow wave moth	*Hydrelia flammeolaria*
Lacewing	**Neuroptera**
Lacewing	*Chrysopa perla*
True bug	**Hemiptera**
Bronze shield bug	*Troilus luridus*
Flower bug	*Anthocoris nemorum*
True fly	**Diptera**
Broad centurion soldier fly	*Chloromyia formosa*

Snipe fly	*Rhagio scolopaceus*

3.3. Habitat management recommendations

The following actions have been provided as advice in managing Kirkconnell Flow NNR for the Six-spotted pot beetle.

1.
Action - Ensure that a plentiful supply of young birch saplings is maintained at Kirkconnell Flow NNR.
Reason - The two adults of the Six-spotted pot beetle found during this survey were swept from saplings of Silver birch ranging in height from 1.5-3 metres (m). Silver birch is a problem on the bog itself but it is important not to remove it from across the entire site to ensure that a range of heights and ages of birch trees as well as other tree species are available.

2.
Action - Maintain good structural diversity and species within woodland along the edge of the site by creating glades and cutting areas in rotation to create sheltered micro-climates.
Reason - Adult Six-spotted pot beetles are known to feed on a range of plant species and do require open glades. Within the woodland border it is important to ensure there is a diversity of tree species and areas where new growth can occur. This will benefit not only the Six-spotted pot beetles but also other invertebrates and wildlife that require a varied structure and range of species in a woodland setting.

3.
Action - Minimise ground disturbance during the spring (April-June) when adults are seen.
Reason - Fully-grown larvae may be in the leaf litter at this time and may be more sensitive to trampling if there is very heavy disturbance. Any planting or habitat work in the area should be carried out in autumn or winter and avoid trampling and disturbance of leaf litter around existing young birch.

4. Ten-spotted pot beetle

The Ten-spotted pot beetle is characterised by five black spots on each yellow-orange elytron and a black pronotum with a distinctive yellow mark in the centre (Figure 6) (Douglas, 2001a; Cox 2007). The markings of this species are highly variable, displaying a range of spot sizes. Melanic forms with completely black elytra but retaining the yellow mark on the pronotum are known from the UK (known as species *C. decemmaculatus bothnicus*) (Piper, 2002); around 30% of both male and female individuals found at Camghouran at Loch Rannoch during the survey visit on the 1 July 2017 displayed this colour mutation.

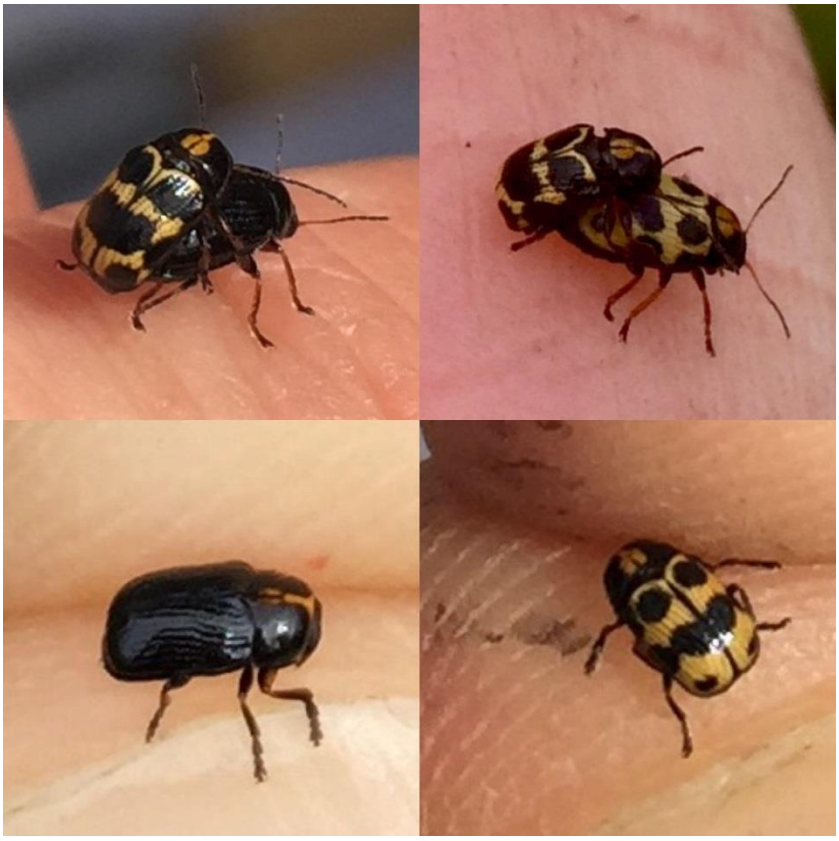

Figure 6. Ten-spotted pot beetle at Camghouran in Loch Rannoch. Clockwise from top right: Mating pair (with melanic *bothnicus* female); mating pair (showing range of spotted forms); Ten-spotted pot beetle male; melanic *bothnicus* male.

Clear sexual dimorphism is non-apparent, although female beetles are often slightly bulkier reaching 4 mm in length, whereas males can reach 3 mm, females have relatively shorter prothoracic limbs and antennae (Hubble, 2012). Adults of both sexes have wings, and will readily fly if disturbed, but studies of dispersal indicate they generally don't fly great distances.

The larvae of this species are brownish white with a black sclerotised head capsule and prothorax (Piper, 2002).

The Ten-spotted pot beetle is associated with willow (*Salix* species) growing in sheltered *Sphagnum* covered heathland habitat on hillsides on or the edges of quaking bogs. Favoured host plants in Scotland appear to be specimens under 1 m tall of Eared willow (*Salix aurita*), Grey willow (*Salix cinerea*) and Goat willow (*Salix caprea*) and occasionally Downy birch (*Betula pubescens*) have been recorded as being used in England (Douglas, 2001a; Cox, 2007).

Adults of this species are usually found in May and June, although individuals have been found through to the end of August e.g. at the well-studied site Wybunbury Moss NNR (Piper, 2002). Observations of wild larvae show that the immature stages of this species can be found beneath the adult host plants feeding on leaf litter of the adult host plant. In captivity larvae seem to prefer the leaves of Grey willow (Piper, 2002). Larval development generally takes two years in the wild, with some years very few adults emerging.

Only two sites are currently known to support Ten-spotted pot beetles in the UK, Wybunbury Moss NNR in Cheshire, and Camghouran on the southside of Loch Rannoch in Perthshire (Piper and Compton, 2013; Piper, 2013; Piper, 2015). Single specimens have previously been recorded from two other sites in Scotland: at Muir of Dinnet in Aberdeenshire in 1986, and within 'the Braemer area' in Aberdeenshire in 1959, however the exact locations of both sites are unknown (Douglas, 2001a).

4.1. Camghouran and the Black Wood of Rannoch, Loch Rannoch

The Black Wood of Rannoch is an area of ancient woodland growing along the south shore of Loch Rannoch between Dall and Camghouran in Perthshire. This ancient forest holds some of the oldest pines in Scotland, with some estimated at over 400 years old (Anon., 2017a; Anon., 2017b). It is thought that woodland has been growing on this site virtually undisturbed since the end of the last Ice Age 10,000 years ago.

The various habitats within Black Wood of Rannoch support a diverse array of species. It is due to these diverse habitats that the site has been designated as a SSSI and a SAC, protecting the many special plants and animals that live among the pine trees and wetland areas (Anon., 2017a; Anon., 2017b). The site is particularly rich in lichens, fungi and rare vascular plants, and has been designated as an internationally Important Plant Area (IPA) (Anon., 2017b). In addition to Caledonian woodland, the area holds a mix of other habitats including bogs, fens, marsh, heath, scrub and dry grassland and riparian habitats, supporting a plethora of rare invertebrates (Anon., 2017a).

Within Black Wood of Rannoch, the Ten-spotted pot beetle was last recorded by Piper in 2002 within an area of mixed broadleaved and coniferous woodland at grid reference NN5455 (Figure 7) (Piper, 2002); only larvae were recorded during this previous survey. This area lies to the west of the Allt Camghouran burn which cascades down the north-facing slope towards Loch Rannoch, passing the open area of hillside known as Camghouran. Piper (2002) described this area of suitable habitat for the beetle at this site as being around 60m^2 in size with parts being dominated by birch with very few willows present; it was this area within Black Wood of Rannoch where the volunteer survey on the 1 July 2017 focused its attention, see 4.2 below for more information.

In the area of suitable habitat, despite being on a north-facing slope, some areas are fairly flat, and the ground layer is saturated, with some standing surface water. Carpets of *Sphagnum* mosses (mainly *Sphagnum fallax* and *Spahgnum palustre*) are widespread, between tussocks of Purple moor grass (*Molinia caerulea*) and in drier areas there are large patches of Bracken (*Pteridium aquilinum*). There are several species of orchid (*Dactylorhiza* species) alongside Bog Asphodel (*Narthecium ossifragum*) present in the clearings.

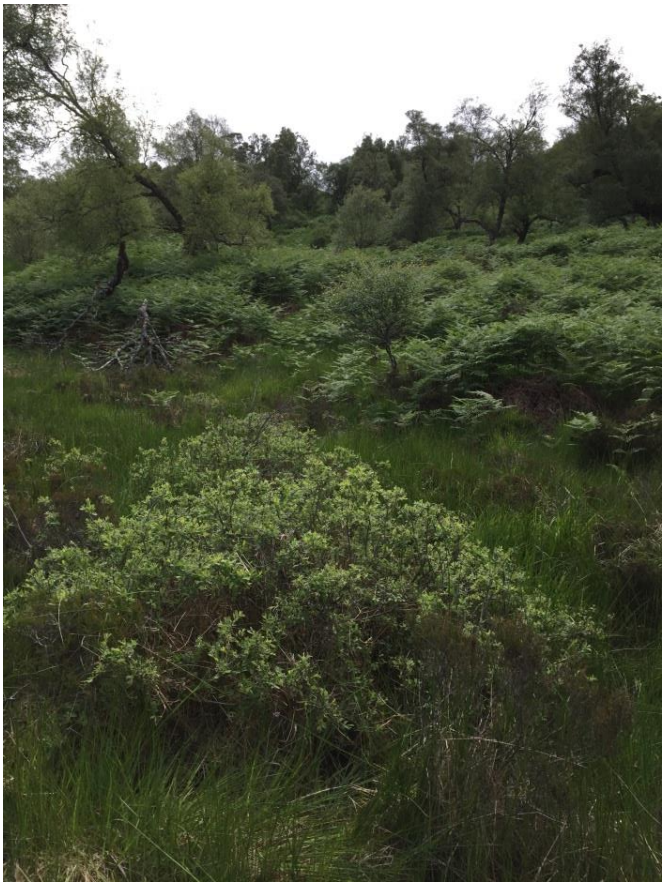

Figure 7. Clearing at Camghouran with dwarf species of willow where Ten-spotted pot beetles were discovered.

4.2. Ten-spotted pot beetle volunteer survey

On the 1 July 2017, three volunteers and a member of Buglife Scotland staff visited Camghouran to attempt to rediscover the colony found by Piper in 2002 and find other populations in the surrounding area. Equipment consisted of sweep nets, a beating tray and pots as well as white trays and a sieve for checking leaf litter for larvae.

Initial searches for suitable habitat and the beetle were carried out on the east side of the Allt Camghouran River. After approximately 90 minutes of searching in unpromising riparian, birch-dominated habitat and neighbouring open heathland and bog, the focus moved to the west side of the Alt Camghouran.

Following a path up the side of the river until the 1 km OS grid reference square NN5444 was reached, a fairly dense area of birch dominated woodland was entered. Within this area we spent time looking for willows and sweeping small birches and other vegetation growing through the tussocks of Purple moor grass (*Molinia caerulea*), Bog myrtle (*Myrica gale*) and Bracken (Figure 8). Willows were found to be very infrequent, and those that were found were mainly 'leggy' and surrounded by birch scrub that was dense in places. Despite the presence of deer fencing, many of the willows showed signs of deer grazing in the past, with stripped lower vegetation and heavier canopies.

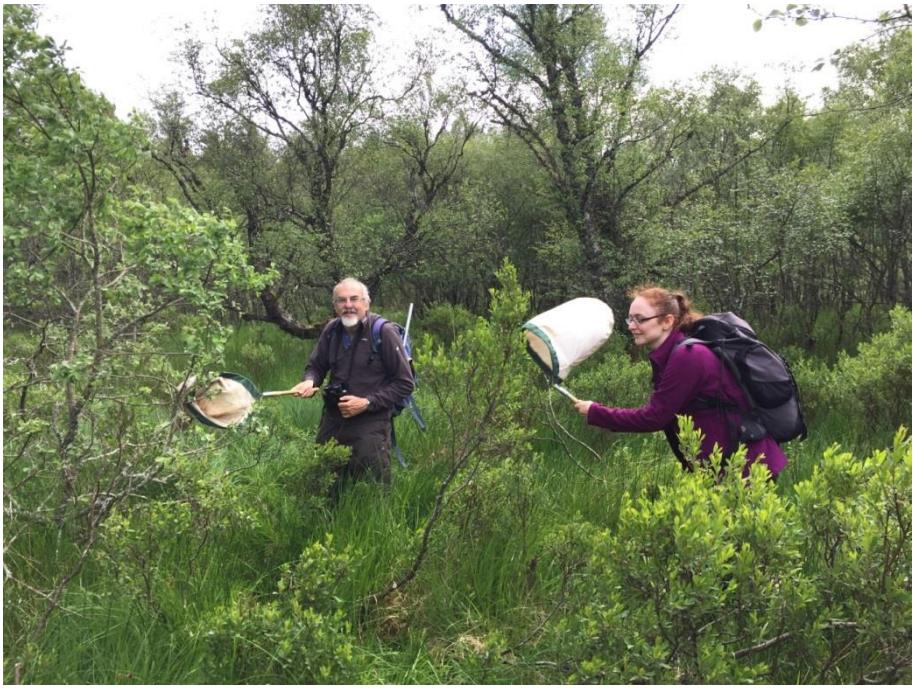

Figure 8. Volunteers sweeping scrub vegetation for pot beetles at Camghouran. Note the tall willow on the left has little vegetation lower down and ground vegetation is dominated by tussocks of Purple moor grass and Bog myrtle.

Individuals of the Ten-spotted pot beetle were eventually found after searching for a further two hours within an open clearing at grid reference NN544557. During this time the weather had become more overcast. An initial sweep of three small Eared willow bushes covering a total area less than 6m^2, produced a single melanic *(bothnicus*) male. Returning to this cluster of Eared willow bushes after the sun reappeared produced a further six adults (two females, one of which was melanic and four males). Females and males in the same nets almost immediately began copulation (Figure 6). Fallen leaves were present under the small willows, but no larvae were found using the sieve and random hand searching. Few other willows were recorded nearby in this area. A single 'tall' Eared willow shrub about 20m away showed signs of deer grazing (Figure 9).

A number of other species of invertebrate were found by volunteers during this survey (Table 3).

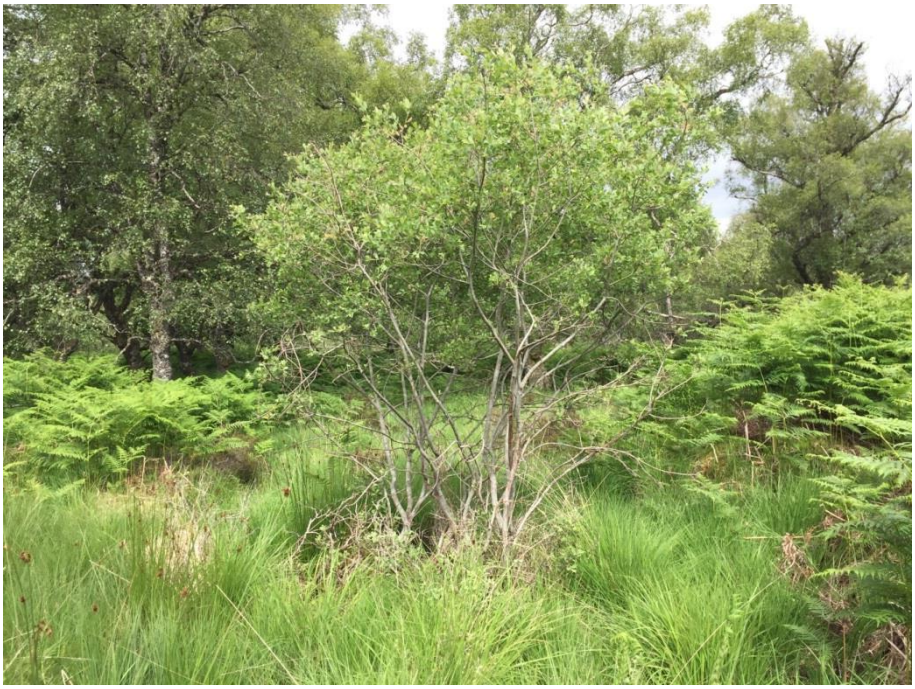

Figure 9. 'Leggy' eight foot tall Eared willow showing signs of deer grazing. This shrub, which was less than 20m from the shrubs with beetles, was sampled with nets and a beating tray, but no Ten-spotted pot beetles were recovered from it.

Table 3. A list of invertebrate species recorded at Black Wood of Rannock on the 1 July 2017.

Common Name	**Scientific name**
Beetles	**Coleoptera**
Black birch pot beetle	*Cryptocephalus labiatus*
Cream-spot ladybird	*Calvia quattuordecimguttata*
Dung beetle	*Aphodius ater*
Four-striped longhorn	*Leptura quadrifaciata*
Ground beetle	*Carabus problematicus*
Leaf beetle	*Lochmaea caprea*
Leaf beetle	*Luperus longicornis*
Leaf beetle	*Phratora vulgatissima*
Reed beetle	*Plateumaris discolor*
Seven-spot ladybird	*Coccinella septempunctata*
Soldier beetle	*Cantharis decepiens*
Ten-spotted pot beetle	*Cryptocephalus decemmaculatus*
Weevil	*Otiorhynchus singularis*
Weevil	*Deporaus betulae*
Weevil	*Strophosoma melanogrammum*
Dragonflies and damselflies	**Odonata**
Four spot chaser	*Libellula quadrimaculata*
Large red damselfly	*Pyrrhosoma nymphula*
Bees, wasps and ants	**Hymenoptera**

Common carder bee	*Bombus pascuorum*
Hairy wood ant	*Formica lugubris*
Heath bumblebee	*Bombus jonellus*
Butterflies and moths	**Lepidoptera**
Common heath moth	*Ematurga atomaria*
Emperor moth	*Saturnia pavonia*
Garden grass-veneer	*Chrysoteuchia culmella*
Green-veined white butterfly	*Pieris napi*
Hook-streak grass-veneer moth	*Crambus lathoniellus*
Northern eggar moth	*Lasiocampa quercus* subsp*. callunae*
Ringlet butterfly	*Aphantopus hyperantus*
Silver-ground carpet moth	*Xanthorhoe montanata*
Small argent & sable moth	*Epirrhoe tristata*
Small heath butterfly	*Coenonympha pamphilus*
Yellow shell moth	*Camptogramma bilineata*
Scorpionflies	**Mecoptera**
Scorpionfly	*Panorpa germanica*
Lacewing	**Neuroptera**
Lacewing	*Chrysotropia ciliata*
True bug	**Hemiptera**
Hawthorn shield bug	*Acanthosoma haemorrhoidale*
Lacehopper	*Cixius nervosus*
Meadow plant bug	*Leptopterna dolabrata*
Spiders	**Araneae**
Crab spider	*Xysticus* species
Four-spotted orb weaver	*Araneus quadratus*
Long-jawed spider	*Tetragnatha extensa*
True fly	**Diptera**
Down-looker snipe fly	*Rhagio scolopaceus*
Hoverfly	*Chloromyia formosa*
Hoverfly	*Sericomyia silentis*
Hoverfly	*Syrphus vitripennis*
Hoverfly	*Sphaerophoria philanthus*
Hoverfly	*Eristalis intricarius*
Hoverfly	*Eristalis nemorum*
Hoverfly	*Melanostoma scalare*
Hoverfly	*Melangyna labiatarum*
Hoverfly	*Platycheirus angustatus*
Hoverfly	*Xylota segnis*

4.3. Habitat management recommendations

During the survey visit on the 1 July 2017, adult beetles were found in a very small area of open sunny habitat on three small bushes of dwarf Eared willow that were all less than 1 m in height and within a total area of between 6-7 m^2. This is a small area of apparently remaining habitat. The closest willow to these bushes was about 20m away, but showed signs of deer grazing and no adults beetles were recorded from this shrub.

Mark and recapture studies of Ten-spotted pot beetles by Piper and Compton (2013) have indicated that the majority of adults move very short distances during their short lives, average of 17 days for males and 27 days for females. Around 60% of both males and females from that study had moved only 1-4 m over 4 days. The furthest any beetle was recorded as moving in this time was less than 50 m.

The apparent low density of suitable willows in sheltered, sunny locations that weren't shaded by birch suggests this one small patch of dwarf Eared willow was all that remained of suitable habitat in the area.

A considerable amount of habitat management has been carried out at Wybunbury Moss that appears to have benefited the Ten-spotted pot beetles there, and has lead to large increases in the population at that site (Piper, 2013; Piper 2015). The following recommendations are therefore based on proven management techniques.

1.
Action - Ensure areas currently supporting the beetle are open to the maximum amount of sunlight, without exposure to excessive winds. Create open clearings around existing willows by removing tall birch scrub shading them, but don't completely remove scrub as this offers shelter.
Reason - Adult beetles are often found basking on willow trees in open, sunny, but sheltered locations. Larvae develop in the fallen leaves beneath the food plant. In the wet boggy habitats where this beetle is found, basking locations are likely to be important to increase body temperature above a threshold required for various activities such as mating, egg development, escape from predators, and for larval development.

2.
Action - Attempt to expand the area of suitable habitat by planting preferred host plants including Eared willow and/or Grey willow and remove potential barriers to dispersal, such as tall birch scrub. A detailed map showing how many willows are in this area would be of benefit.
Reason - The number of suitable willows in this 1 km square appeared to be very low, and is likely a major population-limiting factor. No Ten-spot pot beetles were recorded on birches, which were abundant in the area. Increasing the density and choice of food plants for the adults and larvae is a good strategy for increasing the beetle population.

3.
Action - Minimise ground disturbance during the spring when adults are seen.

Reason - Fully-grown larvae may be in the leaf litter at this time and may be more sensitive to trampling if there is very heavy disturbance. Any planting or habitat work in the area should be carried out in autumn or winter, and avoid trampling and disturbance of sphagnum and leaf litter around existing willows.

4.
Action - Scallop woodland edges to create sheltered micro-climates.
Reason - Cutting back birch and other trees and shrubs (including non-willows, Bog myrtle and Bracken) to create sunny scallops or small clearings around favoured food plants would open them up to sunshine, while protecting them from too much wind.

5. Further recommendations

As well as the suggested habitat management recommendations described above for both the Six-spotted pot beetle and Ten-spotted pot beetle, there are a number of other considerations for both species.

1.
Action - Monitor beetles at Black Wood of Rannoch (Ten-spotted pot beetle) and Kirkconnell Flow NNR (Six-spotted pot beetle) to establish population size and health.
Reason - This is the first year the Six-spotted pot beetles have been recorded at Kirkconnell Flow NNR since the late 1990's and the Ten-spotted pot beetles have been recorded at Black Wood of Rannoch since 2002. Due to the limited numbers of adults seen of both species and the fact that no larvae were recorded it is important to continue to survey and monitor for both species at both sites. Due to the likelihood of a two year lifespan it is strongly recommended that there are further surveys at both sites in 2018 and onward that aim to establish the size and health of the population. Continued surveys to monitor population size and health is also recommended by Anon. (2010a; 2010b).

2.
Action - Expand searches for suitable habitat to surrounding 1 km squares and attempt to find further sub-populations in the local area of Dumfriesshire for the Six-spotted pot beetle and Loch Rannoch for the Ten-spotted pot beetle.
Reason - Checking for suitable habitat in surrounding areas should be attempted to assess how localised the population is within Kirkconnell Flow NNR (Six-spotted pot beetle) and Camghouran and Loch Rannoch (Ten-spotted pot beetle) and the surrounding areas.

3.
Action - Carry out searches for suitable habitat and the species at known historic locations across Scotland.
Reason - Checking for suitable habitat at locations where the species has been recorded in the past may enable remnant populations to be rediscovered. For example there is a record on the NBN Atlas for a single individual of Six-spotted pot beetle recorded by the Royal Horticultural Society within their insect reference collection from 2008 at Grantown-on-Spey at grid reference NJ0326. The Ten-spotted pot beetle has previously been recorded near Braemar and Muir of Dinnet in the Cairngorms. Visits in June and early July would be

recommended for both species, and as well as searching for the beetles themselves the surveys could also focus on searching for preferred host plants and the condition of habitat. Searching an area with trained volunteers has proven to be very successful in the current survey.

4.
Action - Potential captive breeding of both species for re-introduction to known sites and potential historically known sites.
Reason - Captive rearing of the Ten-spotted pot beetle was undertaken in the past by Piper (2002). A captive breeding programme could help to boost numbers of both the Six-spotted pot beetle and Ten-spotted pot beetle from the incredibly low population size at present, while habitat management work is taking place. The Royal Zoological Society of Scotland's Native Species Conservation Programme has expressed interest in working with this species. If successful, adults or mature larvae could be returned to the site to help strengthen the local population, and potentially help recolonise suitable habitat near by.

6. Conclusions

Over centuries our landscape has been shaped and tamed by human hands and livestock, so that very few ancient habitats now remain. Lowland raised bogs and associated damp boggy habitats have escaped relatively untouched for thousands of years, until recently (last 200 years), when technology has facilitated the exploitation of these wet peatlands through drainage for agriculture, forestry and/ or peat extraction. This has lead to the loss of over 80% of our lowland raised bogs in Scotland. It has also meant that species associated with boggy habitats such as the Ten-spotted pot beetle and Six-spotted pot beetle have found their refuges under threat.

Pot beetles in general exhibit low dispersal ability and often high genetic diversity between nearby populations, indicating a lack of gene-flow between close populations. This has lead to many species existing in small, isolated populations, which greatly increases their risk of local extinction (Piper and Compton, 2013). The small population size and poor dispersal ability may be an adaption to living in specialised niches, where it doesn't pay to disperse too far from the original colony. It also suggests that some colonies may be dependent on particular individual host plants for successive generations.

Small changes in the management of bogs and woodland hosting these species, such as indiscriminate scrub clearance, a local increase in livestock grazing density or change in deer management may be responsible for loss of these species from their only known sites. Without some protection and positive management to increase local populations and to help the species recolonise/expand their range to new areas and hopefully reconnect with other isolated populations, both of these species are at high risk of local extinction in Scotland.

With the help of volunteers, surveys for both the Six-spotted pot beetle and Ten-spotted pot beetle through this project have been a great success. Due to the low numbers of adults seen at both Kirkconnell Flow NNR and Black Wood of Rannoch it is important to continue

these surveys in future years to identify population size and health. Additionally it is important to manage both sites appropriately to ensure the long term survival of both these species of pot beetles in Scotland.

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