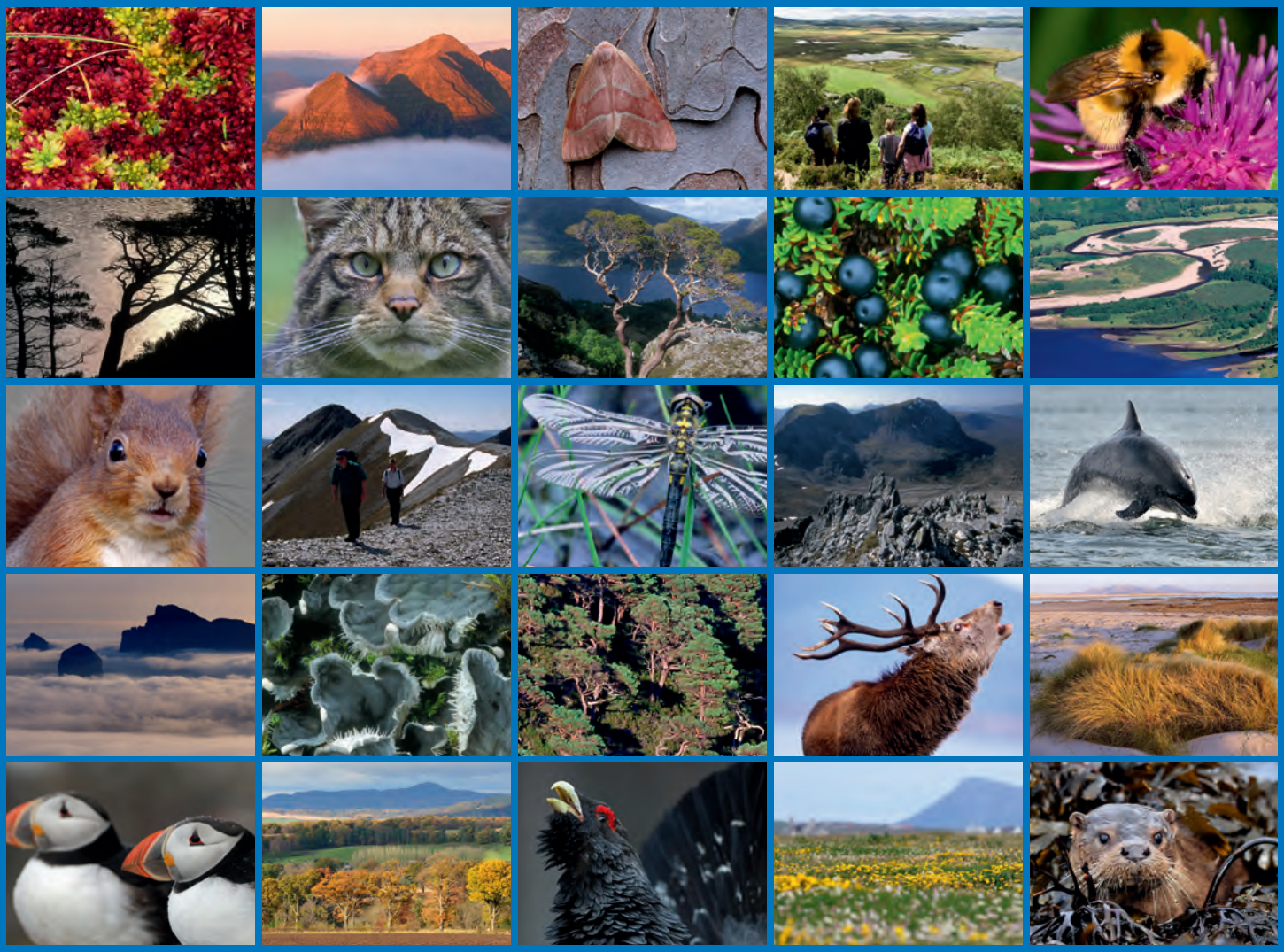
Scottish Natural Heritage
Commissioned Report No. 597

European medicinal leech *Hirudo medicinalis* L. in Scotland: surveillance 2012



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COMMISSIONED REPORT

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European medicinal leech *Hirudo medicinalis* L. in Scotland: surveillance 2012

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COMMISSIONED REPORT

Summary

European medicinal leech *Hirudo medicinalis* L. in Scotland: surveillance 2012

Commissioned Report No.: 597
Contractor: Kirkland Ecology
Year of publication: 2013

Background

There are two known extant localities for *Hirudo medicinalis* L. (European medicinal leech) in Scotland, the 'Black Lochs' near Oban, and Loch nan Digl on Islay. The last records for both sites are from 1997. The project aim was to carry out surveillance for Article 17 reporting under the EU Habitats and Species Directive.

Main findings

- The Black Lochs were visited in mid June 2012. Only one adult specimen of *H. medicinalis* was recorded, in the central loch. However, the owner reports the species to have been present in north loch in 2011. Loch nan Digl was also visited in mid June. Six *H. medicinalis* were recorded. A cocoon was found on a second visit in mid September.

- Land management around the Black Lochs has apparently changed little, except by a recent reduction in the sheep flock. At Loch nan Digl the owner also reports little management change, but the area does have large stands of *Rhododendron ponticum* (rhododendron).

- Providing a population estimate of *H. medicinalis* at the Black Lochs was not possible, as only one individual was recorded. The six *H. medicinalis* at Loch nan Digl were found by using three different methods, making comparisons with previous surveys difficult.

- *H. medicinalis* was recorded on Lismore in 1968 at Baile a' Gobhainn (Balnagowan) and Kilcheran Lochs; the two lochs have been searched unsuccessfully since, and none were located during a survey in mid September 2012.

- There is still insufficient knowledge of the species' ecology and behaviour in Scotland to allow an effective sampling programme to be implemented.

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Acknowledgements

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1. INTRODUCTION

Scottish Ministers have asked Scottish Natural Heritage (SNH) to implement a strategy for the surveillance of relevant habitats and species in Scotland. Surveillance and assessment of conservation status are obligations arising from Articles 11 and 17 of the Habitats and Species Directive, and the main results are to be reported to the European Commission every six years, in accordance with Article 17 of the Directive.

1.1 Legal protection

In Great Britain *H. medicinalis* is protected by its inclusion in Schedule 5 of the Wildlife and Countryside Act (1981) and in Appendix II of the Convention on International trade in Endangered Species of Wild Flora and Fauna (1987). It is also listed in Appendix III of the Bern Convention and Annex Va of the EC Habitats and Species Directive. It was listed as a priority species by the UK Biodiversity Steering Group in 1995 (Anon, 1995), and is on the Scottish Biodiversity List. A licence from SNH is required to disturb or take any life stage in Scotland.

1.2 Distribution of *H. medicinalis* in Scotland

In the past, *H. medicinalis* appears to have been recorded from nine localities; Sutherland (1961), Lismore (1968), Islay (1951), Oban (1968), Earn (1910), Muthill (1853), Menteith (1853), Gartincaber (1853), and Fife (1853)(Maitland, 1996).

Intensive surveys in Scotland 1995 and 1996 confirmed only two of the historic sites (Islay and Oban), failing to relocate *H. medicinalis* at the other seven locations, and did not discover any new populations (Maitland, 1996, 1997). Furthermore, no records from Islay or Oban (Black Lochs) have been reported since 1997 (Figure 1).

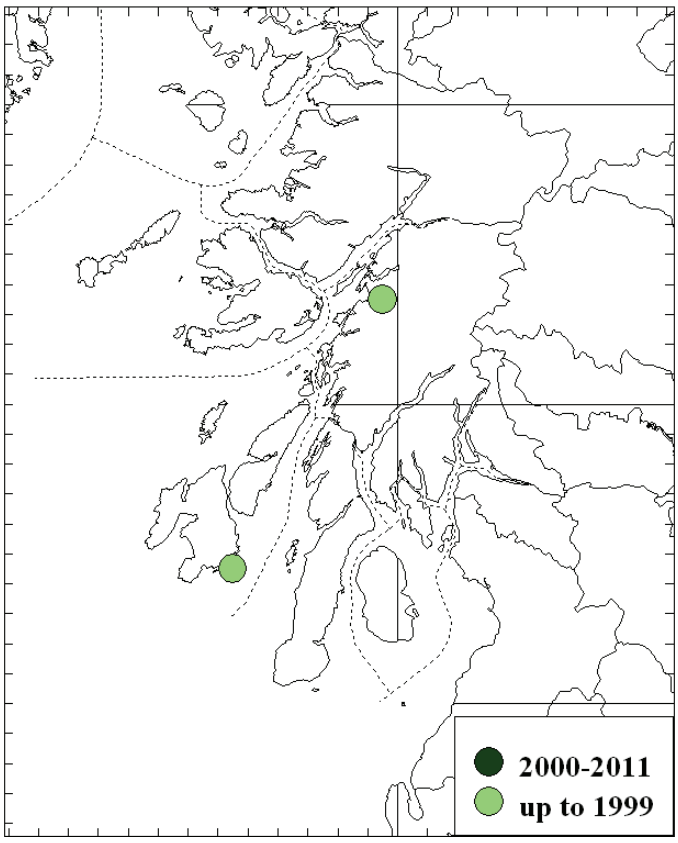

Figure 1 Location of H. medicinalis *populations (Littlewood & Stockan, 2012).*

1.3 Distribution in England and Wales

Several surveys took place in England and Wales in the late 1990s, prompted by a UK species action plan (Bass, 1996), and co-ordinated by the Medicinal Leech Steering Group (Ausden *et al.*, 2002).

In contrast to the surveys in Scotland, these located many new sites; prior to 1970, only 31 sites were known, but by 2002, *H. medicinalis* had been recorded on 135 sites.

Despite this, *H. medicinalis* is still rare and geographically restricted, occurring primarily within only five core areas (Ausden *et al*, 2002). For example, intensive surveys of over 270 tarns in south Cumbria increased the number of occupied sites from five to 33, but all of the populations lie within six 10 km^2 (Marshall, 1999).

However, many historic sites remained unconfirmed. Some only had one previous record of *H. medicinalis* and it has been suggested that these may have been due to the release of leeches used in medicine. These water bodies are unsuitable for *H. medicinalis* in the long term (Ausden *et al.*, 2002).

Maitland (1996) suggested that *H. medicinalis* was always rare in Scotland. Apart from an isolated locality in Sutherland and the sites near Oban, on Islay and Lismore, the historic records are from accessible lochs in the Central Belt, and it is possible that these originated from released specimens.

1.4 Surveillance requirements

The aim of this project was to carry out surveillance of *H. medicinalis* for Article 17 reporting on the two known sites, and two of the historical sites on Lismore:

- Black Lochs near Oban (NR 930 324)
- Loch nan Digl, Islay (NR 431 481)
- Kilcheran Loch, Lismore (NM 828 394)
- Loch Baile a' Gobhainn (Balnagowan Loch), Lismore (NM 859 426).

For the purpose of this project, surveillance was defined as the systematic collation of species data in a way that allows the assessment of trends in distribution, area of occurrence, population size, or habitat condition, for the purposes of reporting on their conservation status. Data collected were to include:

- Number of individuals in a population.
- Habitat availability.
- An evaluation of the site condition.
- Site description.
- A concise description of the methodology.
- Site management recommendations, particularly where sites are found to be unfavourable.

1.5 Survey methods

The Medicinal Leech Steering Group identified a number of survey techniques (Bass, 1996):

1.5.1 Splash Sampling

Foraging medicinal leeches are responsive to water disturbance caused by potential hosts. On detecting water disturbance, the leech swims rapidly towards the source of the

disturbance. Hence water splashing attracts medicinal leeches and facilitates their recording.

Using a standard freshwater net, the water surface is disturbed over a period of 10 min and the attracted medicinal leeches recorded. Splashing is stopped periodically to observe the water for approaching leeches and to examine boots/waders. On slowly taking the boots out of the water, the attached leeches can then be counted. Medicinal leeches that approach the recorder should be retained temporarily in a sample bottle for identification, measurement and to prevent repeat counts of the same individuals.

1.5.2 Hay Bale Search

The use of hay bales placed in water as medicinal leech refugia and cocoon deposition sites has recently been recognised as a survey option. After a period of time (more than three weeks), bales are searched.

1.5.3 Bird Nest Search

It is now known that satiated medicinal leeches use waterfowl nests as refugia and cocoon deposition sites. Nests provide easy, relatively predator-free access to bird hosts. Nest searches are particularly useful on sites where food is readily available and few medicinal leeches are foraging. There is little response to splash sampling on such sites, hence an ability to target micro-habitats used by satiated leeches is essential.

Only nests that had obviously been abandoned or where the chicks have fledged are to be approached and searched by lifting the nest material to reveal the moist vegetation just above the water table.

1.5.4 Stone Search Technique

Satiated medicinal leeches are known to use stones at or just above the water surface in warm shallow regions as refugia and cocoon deposition sites. Searching of such features may be an additional way to find medicinal leeches and their cocoons.

1.5.5 Surveys in Scotland 1995 - 1997

In the 1995 survey, Maitland (1996) searched 50-m stretches of loch shore during September and October for swimming leeches and leeches or cocoons on the undersides of submerged stones

After further surveys in early, mid and late summer 1996, Maitland (1997) reported finding that the only satisfactory survey method was searching 'deep water stones'. This consists of spending 10-15 min searching moderately large (20-50 cm) stones in deeper water (0.3-0.6 m) in late summer, targeting isolated stones lying on sand or gravel. (He also recorded *H. medicinalis* on deep-water stones at the two known sites in March 1997).

Maitland (1997) also searched ‘shore stones’ in 1996. Although he found no adult *H. medicinalis* using this method, he did find one cocoon at Loch nan Digl. During the spring visits, Maitland also found adult and young *H. medicinalis* attached to mating common toad (*Bufo bufo*) (Maitland, 1997).

Thus he recommended the following monitoring methods:

- Spring: examining mating frogs and toads for attached leeches.
- Late summer: searching the undersides of stones in deep (0.3-0.6 m) water.

Maitland (1997) also noted that the presence of *H. sanguisuga* (horse leech) could prove a useful indicator, as this was always recorded when *H. medicinalis* was present.

1.5.6 Cumbria surveys 1998 - 1999

Splash sampling was the main method employed in surveys from 30 June to 8 October 1998, and 28 April to 8 October 1999 (Marshall, 1999). Ten minutes of splash sampling were 'normally followed by at least two minutes quietly looking for leeches'. If no leeches were seen during this period, further 10-15 min were spent quietly in the water. Some leeches may take longer to swim towards the surveyor but perhaps more importantly, reducing the water disturbance makes it easier to observe approaching leeches.

Hirudo medicinalis were found between 10:15 and 19:15 h during splash sampling, and also observed swimming between 21:00 and 01:00 h during newt surveys. Sampling took place with temperatures between 7.8 and 32.0°C. Leeches were recorded at temperatures between 13.5 and 28.0°C, but most were found at above 17°C (surface water temperatures).

Marshall (1999) highlighted some of the problems with splash sampling. At one site in 1998, she recorded 56 *H. medicinalis*, but the following year, sampling at the same water temperature, produced only four. She suggested that splash sampling attracts leeches from only a small area and that it is easy to overlook them if not sampling at the right place. Another problem is that splash sampling is much less effective when the leeches are well fed (Ausden *et al*., 2002).

In March 1999 Marshall surveyed *H. medicinalis* sites for the common frog (*Rana temporaria*) and *B. bufo*, and from April to June undertook nocturnal surveys for *Triturus* spp. newts. She saw *H. medicinalis* 'frequently attached to toads', but did not record numbers, although she did note that sometimes the water temperature was as low as 7.5°C. Searching under stones and in bird nests for adults and cocoons was unsuccessful, so spent little time on these methods.

2. METHODS USED FOR THIS SURVEY

The contract commenced in early April 2012, which was too late to undertake amphibian surveys. Furthermore, the contract conditions required an interim report with results for the two extant sites by July, which meant that monitoring of the extant sites had to be undertaken in May/June 2012. Thus Maitland's specific recommended methods could not be followed.

Although Maitland (1997) recommended carrying out surveys in late summer, splash sampling is reported to have worked well in southern England, with sampling in June catching the highest proportion of leeches (Ausden *et al.*, 1992).

Thus with agreement of SNH staff, two sampling methods were to be employed, splash sampling and searching under stones in deeper water in June. Sampling was to be done at the same stations as those used in the previous survey (Maitland, 1997).

2.1 Splash sampling

Ten minutes of splash-sampling with a standard pond net was followed by five minutes or slow paddling in the same area (Marshall, 1999). Any observed leeches were to be transferred to collecting pots for identification and measurements then released. Good visibility is needed for spotting swimming leeches, thus this technique is difficult to be used in rain or windy conditions, or where the water is very turbid.

2.2 Searching under stones in deep water for leeches and cocoons

Stones from 5 to 20 cm were searched in a depth of around 0.3-0.6 m. Searching took about 10-15 minutes by wading slowly in the vicinity of the survey points. Waders and a life jacket were worn, and the owners were made aware of when the sampling was taking place.

2.3 Additional sampling method: Searching strandline/shore stones

When the sampling at Loch nan Digl had been completed in June, the undersides of some 'strandline stones' (i.e. stones that lay above the water line) were searched, and both *H. medicinalis* and *H. sanguisuga* were found.

Sampling at Lismore had to be delayed until September, and because of the positive results from the strandline searching on Islay, this was the method used on Lismore.

2.4 Measurements

2.4.1 Leech size

Assessing the age structure is one way of determining whether a population is 'healthy' in relation to regular recruitment.

Maitland (1996, 1997) estimated the size of *H. medicinalis* by measuring the volume of water displaced by leeches in a small measuring cylinder.

Marshall (1999) recorded volume, weight and the diameter of the posterior suckers (PSD) of *H. medicinalis* specimens (Figure 2). She suggested that volume could be evidence of how well fed the leeches were, but PSD would provide a better measure of age. Posterior suckers are oval, thus the maximum diameter was measured to the nearest 0.5 mm with a micrometer (0 - 25 mm x 0.01 mm Hilka external micrometer). Although no statistics were applied, there appeared to be a good correlation between weight and PSD for a sample of over 200 leeches.

Figure. 2. Posterior sucker of Haemopis sanguisuga *(horse leech)*

2.4.2 Temperature

Air temperature in the shade was measured with a standard garden thermometer. Water temperature was taken at just below the water surface, about 1 m from the edge of the loch, with a digital 'multi-thermometer' probe. Temperature measurements were taken to the nearest 0.5°C.

2.4.3 Wind, sunshine

Wind was recorded by the Beaufort scale, and sunshine by the percentage of time the sun shone during the sampling period.

2.4.4 Grid references

Ten-figure grid references were recorded using a hand-held device (GPS map 62, Garmin).

2.5 Population estimates

Maitland (1996) suggested that 'population reduction method' would be the most efficient way of assessing population size, but did not use it in his study due to the low numbers caught.

2.6 Identification

The identities of the leeches recorded were confirmed by using a low power optical microscope, a taxonomic key (Elliott & Mann, 1979), comparing photographs (Maitland 1997, 2011), and the key produced by Maitland *et al*. (2000) for identifying *H. medicinalis* adults and cocoons from those of *Haemopis sanguisuga* (Figure 3 to figure 7).

No dissections were carried out, as identification seemed straightforward. However, Elliott & Kutschera (2011) suggested that *H. verbana* has been imported from Turkey into the UK in mistake for *H. medicinalis* and is now to be found in the wild. It is not clear whether this species can be separated from *H. medicinalis* on morphological grounds

Figure 3: H. medicinalis *(centre) and two* H. sanguisuga

Figure 4: H. medicinalis *fully extended*

Figure 5: H. medicinalis *partly contracted*

Figure 6: H. medicinalis *contracted*

Figure 7: H. medicinalis *showing underside and orange side stripes*

2.7 Legal Protection

A licence from SNH was obtained for the purpose of disturbing and taking specimens (ref. No. 13648).

3. RESULTS

3.1 Black Lochs

The Black Lochs (north and central) were visited on 11 and 12 June 2012. Weather conditions were good (sunny, warm, calm).

11 June
1400-1800 h
Weather: Air temperature 15-16°C, water temperature 16.5°C, wind 1-2, sun 75% (bright but overcast).

As far as it could be ascertained, the sampling stations were the same as those used by Maitland (1997). Results are shown in Table 1.

Table 1: Survey results, 11 June 2012, Black Lochs

Maitland's (1997) Station no. & Grid Ref	2012 Grid Ref	Method	Number of *H. medicinalis*
North Loch			
Station 1 NM 931 327	NM 9301732879	15 min splash-sampling	0
Station 2 NM 932 325	NM 9306932426	15 min splash-sampling	0
Station 3 NM 928 320	NM 9289332089	15 min splash-sampling	0
Central Loch			
Station 1 NM 925 318	NM 9259231838	15 min splash-sampling	0
Station 2 NM 925 314	NM 9248831425	15 min splash-sampling	0
Station 3 NM 922 313	Not visited (heavy rain)	-	-

12 June
1030-1730 h
Weather: Air temperature15-16°C, water temperature 16.5°C, wind 1-2, sun 95%.

The method used for this second visit was to examine the undersides of 20 'deep water' stones for 10-15 min. This was done at the first two sites (Table 2). However *H. sanguisuga* adults recorded at the first sampling point were not found on the deep water stones, but were seen swimming towards the surveyor during the 10 min after sampling was finished. Similarly, the *H. medicinalis* specimen was found attached to the surveyor's waders at station 2 whilst standing at the edge of the loch for about 10 min writing notes, having spent 10 min looking under deep stones.

The leeches had presumably been attracted by the water disturbance and so the sampling was in fact probably more akin to splash sampling. At this point, as no leeches had been

found on the undersides of the deep-water stones, it was decided to discontinue this method, and carry on with 10 min of splash sampling, followed by 20 min of standing. However this did not produce any more *H. medicinalis*.

Table 2 Survey results, 12 June 2012, Black Lochs

Maitland's (1997) Station no. & Grid Ref	2012 Grid Ref	Method	Number of *H. medicinalis*	PSD (mm)
North Loch				
Station 1 NM 931 327	NM 9301732879	(Deep water stones)	0	n/a
Central Loch				
N/a	NM 9269731593	(Deep water stones)	0	n/a
Station 2 NM 925 314	NM 9248231424	(Deep water stones)	1	3.0
Station 3 NM 922 313	NM 9221231284	30 min splash-sampling	0	n/a

3.1.1 Summary

Haemopis sanguisuga was common in both lochs, but only one *H. medicinalis* was recorded in the central loch at NM 9248231424. However, the landowner reports receiving a *H. medicinalis* bite whilst swimming in the north loch in the summer of 2011.

3.1.2 Habitat availability and site condition

The gamekeeper stated that land management around the Black Lochs has changed little in recent years, except for the reduction in sheep flock (to around 150) in line with changes elsewhere in the Highlands.

The lochs are still used by cattle, red and roe deer and water birds. Although both lochs are large, there are extensive shallow areas with emergent macrophytes, with sections of stony shoreline.

3.1.3 Site description

The following is taken from the SSSI citation (SNH website, November 2012):

> *"Clais Dhearg Site of Special Scientific interest (SSSI) is composed of a complex mosaic of oak woods and birch woods with clearings and open ground with fen and swamp fringing the base-poor waters of the Black Lochs. The woodland habitats are interspersed by heath, grassland and bog habitat. The Black Lochs are fringed by herb-rich fen and swamp communities including reed-beds, and more limited areas of sedge-swamp. This vegetation supports great fen- sedge and tufted sedge both very local in western Scotland. The lochs themselves support populations of the medicinal leech."*

Figure 8: Black Loch (central) looking west from NM 9248 3142 (Station 2, Maitland, 1997)

Figure 9: Black Loch (central) looking north from NM 9248 3142 (Station 2, Maitland, 1997)

Figure 10: Black Loch (central) looking north from NM 9221 3128 (Station 3, Maitland, 1997)

Figure 11: H. medicinalis from the central Black Loch (NM 92482 31424)

3.2 Loch nan Digl

Loch nan Digl was visited on 14 June, during good weather conditions.

1215-1700 h.
Weather: air temperature 12.5°C, water temperature 18.5°C, wind 2-3, sun 100% overcast but bright.

No *H. medicinalis* were found by splash-sampling, but three were found on deep water stones (table 3.3). The visit coincided with a mass emergence of juvenile *B. bufo* from the southern shore of the loch, which were gathering in the shallows, along the strandline, and under strandline stones (figures 3.6, 3.7). Both *H. medicinalis* and *H. sanguisuga* were found beneath these strandline stones. PSD measurements were taken for five of the six *H. medicinalis* recorded (Table 3).

Table 3 Survey results, 14 June 2012, Loch nan Digl

Maitland's (1997) Station no. & Grid Ref	2012 Grid Ref	Method	Number of *H. medicinalis*	PSD (mm)
Station 1 NR 432 482	NR 43251 48189	30 min splash-sampling (no deep or strandline stones)	0	n/a
Stations 2 & 3 NR432 481	NR 43255 48178	30 min splash-sampling	0	n/a
		Deep water stones	1	Not recorded
		(no strandline stones)	0	n/a
Station 4 grid ref not given	NR 4328 4810	30 min splash-sampling		
		Deep water stones	2	6.5; 6.5
		Strandline stones	3	7.0; 2.5; 8.5

An attempt was made to survey the nearby Loch nan Diol, but the entire surrounds were very wet and marshy, with no outcropping rocks or a stony strandline. This not only made access difficult but may also mean that it is not suitable for *H. medicinalis*, as noted by Maitland (1997).

An opportunity arose to re-visit Loch nan Digl in September. The area where adults were recorded in June along the strandline was searched on 9 September, and one *H. medicinalis* cocoon was located at NR 43289 48123, together with several *H. sanguisuga* cocoons.

The *H. medicinalis* cocoon was 22 x 17 mm, while that of *H. sanguisuga* was 14 x 10 mm (Figure 3.8). These measurements accord well with those made by Maitland *et al*. (2000) who analysed the size differences of the cocoons of the two species.

3.2.1 Summary

A total of six *H. medicinalis* were recorded, by either lifting 'deep water' stones in 0.3-0.6 m of water or by searching under stones along the strandline.

Figure 12: H. medicinalis *attached to the underside of a stone in 'deep water', Loch nan Digl.*

Figure 13: Newly-emerged Bufo bufo *toadlets congregating along the strandline, Loch nan Digl*

Figure 14: Bufo bufo *toadlets in the shallows of Loch nan Digl, prior to emergence*

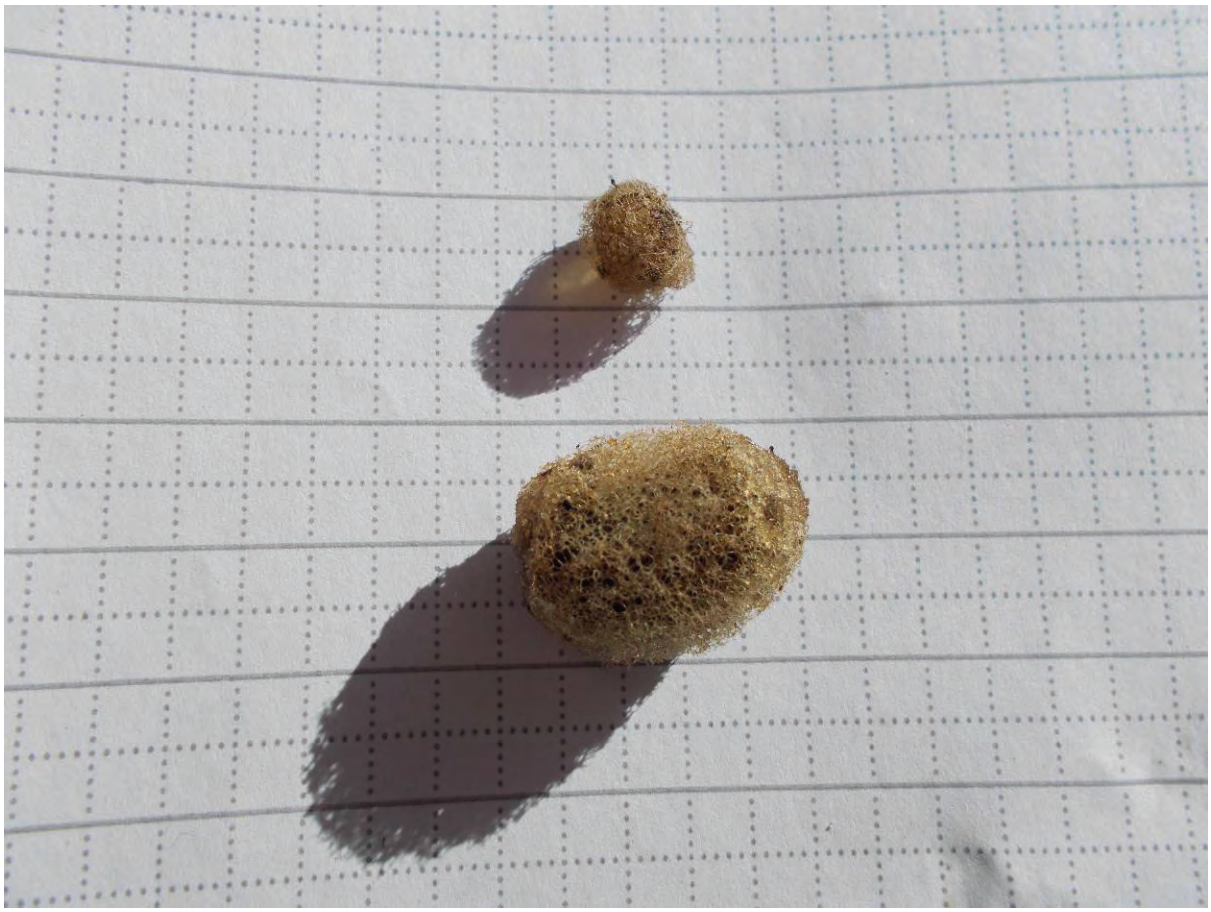

Figure 15: Egg cocoons of H. sanguisuga *(top) and* H. medicinalis *from Loch nan Digl, 9 September 2012. The small squares are 5 x 5 mm.*

3.2.2 Habitat availability and site condition

The ground leading to the loch from the east side was heavily poached by cattle, and to the north of the loch there appeared to be freshly used deer wallows. Greylag geese were seen on the loch and goose faeces were observed on the shoreline. Fish were observed, possibly pike (*Esox lucius*), which were recorded by Maitland (1997).

Although a relatively large loch, there are extensive shallow areas with emergent macrophytes, with sections of stony shoreline. Reading the description of the loch given by Reynoldson (1952), who first found *H. medicinalis* there, the appearance seems to have changed little. Discussion with the owner confirmed little change over the last 30 years. However, a significant proportion of the surrounding area is covered with rhododendron (*Rhododendron ponticum*), especially to the west of Loch nan Digl and around Loch nan Diol (Figure 16).

Figure 16: Loch nan Digl and Cnoc Rhaonastil (the 'Fairy Hill') looking north east from NR 430 480, showing some of the rhododendron.

3.2.3 Site description

The following is taken from the citation for Ardmore, Kildalton and Callumkill Woodlands SSSI (SNH website, November 2012):

> *"The SSSI represents the largest example of native woodland on Islay and is representative of the former woodland cover of the Hebrides. The majority of the woods are on the rocky ridges which run roughly parallel to the coast. Birch is the main tree species present, often with rowan in association. Sessile oak is scattered, but reasonably common and some patches have high proportions of hazel. Alder and willows are found on wetter ground. The woods are scattered, so that a range of habitats including wet heath, mire, grassland and freshwater ponds are found in between the wooded ridges."*

Figure 17: Loch nan Digl looking northeast from the southern shore (NR 4328 4810, Station 4, Maitland, 1997)

Figure 18: Loch nan Digl looking southwest from near the outfall (NR 433 382, Station 4, Maitland, 1997)

3.3 Lismore

Hirudo medicinalis was recorded in two lochs on Lismore in 1968, Loch Baile a' Gobhainn (Balnagowan Loch) and Kilcheran. They were searched unsuccessfully in 1997 but thought to be suitable for *H. medicinalis* (Maitland, 1997).

The two lochs were visited on 13 September 2012. Although the weather was wet and windy, it is not thought that this affected the sampling, which consisted of searching the strandline and deep-water stones.

3.3.1 Summary

Hirudo medicinalis adults were not located at either site, but several specimens of *H. sanguisuga* were recorded at both lochs. No cocoons of either species were seen.

3.3.2 Habitat availability

The lochs are probably used by roe deer and water birds. Although both lochs are large, there are extensive shallow areas with stony shorelines.

3.3.3 Site description

The following is taken from the SSSI citation (SNH website, November 2012):

> "*The base-rich lochs overlie metamorphic Dalradian limestone and are one of the few high-quality occurrences of this habitat type in Scotland. The component lochs have very clear water and are low in nutrients but with high alkalinity. The lochs become shallow at each end and in these areas there is a landward transition from aquatic communities to emergent vegetation, and a range of fen communities, including reed-bed, sedge swamps and brown-moss mires.*"

Figure 19: Loch Baile a' Gobhainn (Balnagowan Loch). (NM 857 422, Station 1, Maitland, 1997)

Figure 20: Loch Baile a' Gobhainn. Station 1 showing 'deep water' stones that were sampled.

Figure 21: Loch Baile a' Gobhainn. (NM 858 425, Station 2, Maitland, 1997)showing 'deep water' stones

Figure 22: Loch Baile a' Gobhainn. Station (NM 861 430, Station 3, Maitland, 1997) showing 'deep water' stones and Phragmites *debris.*

Figure 23: Loch Baile a' Gobhainn. Three H. sanguisuga *in Phragmites debris.*

Figure 24: Loch Baile a' Gobhainn showing H. sanguisuga *under a strandline stone.*

Figure 25: Loch Baile a' Gobhainn. H. sanguisuga *under a strandline stone.*

Figure 26: Kilcheran Loch (NM 830 395, Station 3, Maitland, 1997) showing 'deep water' stones, looking south east.

Figure 27: 3.20 Kilcheran Loch (NM 829 393, Station 2, Maitland, 1997) showing 'deep water' stones and remains of drystone wall, looking west.

Figure 28: Kilcheran Loch (NM 827 329, Station 1, Maitland, 1997), showing 'deep water' stones and remains of drystone wall. Looking north east.

Figure 29: Kilcheran Loch. Station 1 (Maitland, 1997) showing 'deep water' stones and Phragmites *debris, looking west.*

Figure 30: Kilcheran Loch, showing Phragmites *debris.*

4. DISCUSSION

4.1 Extant sites

Hirudo. medicinalis presence was confirmed at the Black Lochs and Loch nan Digl, the first records for these sites since 1997.

Hirudo medicinalis was not recorded at either of the two Lismore lochs, Loch Baile a' Gobhainn, and Kilcheran Loch. The records for these two lochs were both made in 1968 during fieldwork for the Nature Conservation Review, but apparently no specimens were retained in 1995. Maitland found *H. sanguisuga* to be very common, recording both adults and cocoons under ideal weather conditions (Maitland, 1996). It is possible that the records for *H. medicinalis w*ere erroneous.

4.2 Population size

Providing a population estimate of *H. medicinalis* at the Black Lochs that could be used to compare with future estimates is not possible, given that only one was recorded. Moreover, the six *H. medicinalis* at Loch nan Digl were found by three different methods, making comparisons with previous surveys difficult.

Despite being disappointing, the low numbers recorded during this survey are similar to the numbers found by Maitland in 1995 and 1996 (Table 4).

Table 4 Comparison of results with previous surveys (Maitland 1996, 1997)

Site	Year	Date	Adult *H. medicinalis*
Black Lochs	1995	21 Sept	1
	1996	27 June	0
		31 July	4
		27 Sept	3
	2012	11-12 June	1
Loch nan Digl	1995	13 Sept	3
	1996	24 June	3
		30 July	3
		25 Sept	0
	2012	14 June	6

The records of Middleton *et al*. (1996) for Loch nan Digl obtained after the field work for this project was complete provide an interesting comparison. Their method involved two surveyors wading 25 m in shallow water along the shoreline looking for swimming leeches (Middleton *et al.*, 1996).

Table 5 Records for Loch nan Digl (Middleton et al., 1996)

Site	Year	Date	Air temp	*H. medicinalis* in 30 minutes	*H. medicinalis* in 80 minutes
Loch nan Digl	1995	1 August	25°C	10	17
	1996	17 August	21°C	7	Not recorded

Thus although several different methods have been used, the figures for Loch nan Digl seem to be broadly comparable. However, these data are probably inadequate for long-term surveillance.

4.3 Population structure

Although very little seems to be known about the population structure of *H. medicinalis*, it has been suggested that recording the range of size classes at sites may reveal information on recruitment (Marshall, 1999; Littlewood & Stockan, 2012).

The small numbers caught mean that the PSD data collected may not reflect the actual size distribution, and so must be treated with caution.

Comparing the data with those from the Cumbrian survey shows that the mean PSD for Loch nan Digl is larger, but that the minimum and maximum sizes are similar. The range in size of *H. medicinalis* PSD at Loch nan Digl indicate that there are a number of different age classes present (Table 6).

Table 6: Comparison of PSD measurements from Cumbria and Loch nan Digl.

	mean	min	max	σ-1	N
Cumbrian data (Marshall, 1999)	6.24	2.70	8.05	1.62	202
Loch nan Digl 2012	4.9	2.5	8.5	3.5	5

4.4 Site quality

Maitland (1996, 1997) provides a summary of the features of 'ideal' *H. medicinalis* sites, with the caveat that still not enough is known of the species' requirements. The recent surveys in the rest of the UK have provided additional information on the attributes commonly associated with *H. medicinalis* sites (e.g. Marshall, 1999; Ausden *et al*., 2002).

4.4.1 Physical and chemical attributes

4.4.1.1 Temperature

In the laboratory, optimal temperatures for *H. medicinalis* are 22-25°C for growth and 25.5-27.5°C for breeding, while mean temperature for 50% activity is 19°C, with only 10% activity at 11.9°C (Elliott & Tullett, 1986, 1992). Marshall did not find any leeches by splash sampling below 13.5°C, but did observe activity at 7.5°C during *B. bufo* spawning in March (Marshall, 1999).

Ausden *et al*. (1992) reported that *H. medicinalis* is most commonly seen in areas with gently sloping margins, these usually being the areas of the warmest water, especially if they are sheltered and have aquatic plant growth.

Maitland (1996) suggested that, being at the north-west edge of its European range, temperatures for breeding could be an important limiting factor. He noted that the warmest water bodies will be small, shallow, exposed to the south, at low altitude, and have a long turnover time. While both extant Scottish sites are more or less at sea level, Marshall surveyed sites from 5 to 320 m above sea level, and recorded *H. medicinalis* between 70 and 220 m (mean 144 m). Most sites (72%) were between 100 and 180 m.

4.4.1.2 Size

The two Scottish sites are at the high end of the range of sizes in which *H. medicinalis* has been found in the rest of the UK. However, both extant Scottish sites have extensive areas of shallow water (see Table 7). (Lochs Kilcheran and Loch Baile a' Gobhainn are 89,000 and 115,000 m^2 respectively, but also have large areas of shallow water.)

Table 7: Comparison of site sizes (data from Maitland, 1997 and Ausden et al., 1992).

	Minimum (m^2)	Maximum (m^2)
Cumbria	140	20,000
Dorset/Hants	100	50,000
Wales	50	60,000
Scotland	21,000	117,000

4.4.1.3 Chemistry

All of the *H. medicinalis* sites in south Cumbria fell within the pH range 5.9-7.6, while on the Dorset/Hampshire heaths, the minimum recorded for an *H. medicinalis* site was pH 5.2 (Ausden *et al*., 1992).

Maitland (1996) gives pH figures for Loch nan Digl of 6.5, and 6.5-6.8 for the Black Lochs. (The figures for Lochs Kilcheran and Loch Baile a' Gobhainn are 7.5 and 7.9 respectively).

4.4.1.4 Substrate/shoreline

Maitland (1997) suggested that a section of stony shoreline is important, although whether this benefits the leech directly in some way or provides an entry point to livestock is not clear. Marshall (1999) reported that less than 50% of her *H. medicinalis* sites had a stony margin.

It is clear from the findings at the Black Lochs and Loch nan Digl that *H. medicinalis* can lay its cocoons either on the underside of shoreline stones (this survey and Maitland, 1997), or in the roots of emergent vegetation (Maitland, 1996).

Marshall noted that most *H. medicinalis* sites had occasional stones on the bank. In England, while some sites are in gravel ponds or old marl pits presumably with stony margins, many are ditches within grazing marshes.

4.4.1.5 Water level

Maitland (1996) suggested that highly fluctuating water levels could be damaging if they affect the areas where cocoons are laid. However, in the same report he also noted that, following 24 hours of heavy rain, the water level of Loch nan Digl rose by 30 cm. Middleton *et al*. 1996 also reported that, at the same site, the water level in August 1997 was 'a foot higher' than in August 1996.

4.4.2 Biological attributes

4.4.2.1 Presence of other leeches

Maitland (1996) suggested that the presence of *H. sanguisuga* indicates potentially suitable conditions for *H. medicinalis*, and both extant Scottish sites (and the two Lismore sites) still support good populations of this species.

4.4.2.2 Amphibians

Serological studies have shown that *H. medicinalis* can feed on *Rana* spp. frogs, *Bufo* spp. and *Triturus* spp. newts (Maitland, 1996).

In south Cumbria, Marshall (1999) stated that at some *H. medicinalis* sites amphibians are the only food supply, and that two-thirds of the occupied sites had high amphibian numbers.

Maitland (1996) suggested that some *H. medicinalis* populations can survive largely on amphibians, and that amphibians may be essential hosts for juvenile *H. medicinalis*. Elliott & Kutschera (2011) went further and stated that they are crucial for the survival of juveniles.

Ausden *et al*. (2002) reported that the gut contents of *H. medicinalis* on the Romney grazing marshes show that they feed mostly on amphibians (*T. cristatus* great crested newt, *T. vulgaris* smooth newt, and *Rana ridibunda* marsh frog), with little evidence of mammalian blood.

Elliott & Kutschera (2011) concluded that the major factor in the decline of medicinal leech populations has been the general loss of wetlands, especially eutrophic ponds and marshes throughout Europe, and that this has also led to a decline in amphibians that are an important source of blood meals for *H. medicinalis*.

Loch nan Digl certainly appears to have a very large population of *B. bufo*, and Maitland (1996) noted good numbers of *R. temporaria*, *B. bufo* and *Triturus* sp. there. He also recorded their presence at the Black Lochs.

4.4.2.3 Predators

Some species of fish are thought to predate *H. medicinalis*. Marshall (1999) found fish present in at least 24% of the occupied sites, including trout (*Salmo* spp.). Fish are present in both extant Scottish sites (Maitland, 1996).

4.4.2.4 Other vertebrates

Marshall (1999) found that cattle or horses did not visit half of the *H. medicinalis* sites, although deer probably occurred at all sites.

Hirudo medicinalis certainly use mammals as hosts; for example, one south Cumbria site was only found after adult leeches were found on a horse (Marshall, 1999). Both Scottish sites are visited by livestock (cattle, and possibly sheep) as well as deer and a variety of water birds.

4.4.3 Summary

The two extant Scottish sites still appear to have all of the key features associated with *H. medicinalis* sites that were identified by Maitland (1996, 1997), and that have been suggested since (Marshall, 1999; Ausden *et al*., 1992).

Elliott & Kutschera (2011) stated that *H. medicinalis* requires warm water ponds with a range of suitable hosts, especially amphibians, to survive and prosper. They also suggested that it can persist with a low minimum viable population size, which may be typical of rare freshwater invertebrates in isolated habitats, especially species limited by high temperature requirements and specialised food sources.

4.5 Site management and possible future threats

Both extant *H. medicinalis* sites are SSSI, and thus the site management will be informed by the SSSI citation, Site Management Statements (SMS), and the list of operations requiring consent (ORCs).

4.5.1 SSSI citations and SMS

Although the citation for Clais Dhearg SSSI does not mention *H. medicinalis*, the current SMS (SNH website, November 2012) makes a reference to maintaining water quality and level for leeches:

> *"Maintaining the current water level and quality will benefit species which rely on the open water and surrounding fen such as dragonfly, leeches and emergent and fringing aquatic vegetation".*

Neither the citation nor the SMS for Ardmore, Kildalton and Callumkill Woodlands SSSI make reference to *H. medicinalis*.

4.5.2 Possible future threats

Some factors have been identified at the extant sites (Maitland, 1996, 1997; this survey) and at other sites in the UK that may threaten *H. medicinalis* populations in the future (Ausden *et al*., 1992).

4.5.2.1 Reduction in amphibian populations

Amphibian populations are declining in many parts of the UK, due to a variety of causes. Research is needed to assess the importance of amphibians to *H. medicinalis*, and the potential impact of any decline in the amphibian populations that may occur.

4.5.2.2 Invasion of Rhododendron

Non-native *R. ponticum* is invading the surrounding land at Loch nan Digl. Surprisingly Maitland (1996, 1997) does not mention this although it is likely that the stands were present at the time of his surveys.

In time, *R. ponticum* may reduce access to the loch by livestock and deer. Amphibians may be badly affected if the *R. ponticum* becomes dense, as it could damage feeding areas and other aspects of their terrestrial habitat. Most *B. bufo* are found within 800 m of their breeding ponds, although some migrate up to 2 km (Reading *et al*., 1991).

4.5.2.3 Use of helminthicides

Following surveys in the New Forest that discovered unexplained losses of *H. medicinalis* populations, the role of helminthicides and other anti-parasitic drugs that are used to treat livestock is being investigated (Ausden *et al*., 2002).

4.5.2.4 Rarity and isolation

The occurrence of just two colonies in Scotland, isolated from each other is a cause for concern. Maitland (1996, 1997) suggested that translocations should be carried out into unoccupied but suitable sites. Further survey using better methodologies should also take place (see below).

4.5.2.5 Water levels

Although it would appear that at Loch nan Digl *H. medicinalis* can tolerate fluctuations in the water level of up to 30 cm (see above), it is thought that such changes are potentially damaging, particularly for cocoons. As noted by Maitland (1996) the outflow is in a precarious state (see figure 31).

Figure 31: The outflow of Loch nan Digl (NR 432 821).

4.6 Survey methods

There still seems to be insufficient knowledge of the species' ecology and behaviour to allow an effective sampling programme to be implemented, and further research may be needed in order to devise one.

4.6.1 Splash sampling

The main difficulty with this method is that, having eaten, *H. medicinalis* may remain inactive for many months thus rendering them undetectable. Experimental work has shown that satiated leeches may be inactive for 12-18 months, although those feeding on amphibians may need more frequent meals (Ausden *et al*., 2002).

During this period an unknown proportion of leeches will be observed by using this method and this may be the reason that there has been little consensus on the best method to use (e.g. Maitland, 1996). None the less, it is the method recommended in a recent review (Littlewood & Stockan, 2012).

Furthermore, although some sites showed a broad range in size classes of PSD with splash-sampling, Marshall (1999) thought that smaller leeches might have been under-sampled, concurring with Elliott & Tullett (1986). The method also requires good weather in which to observe the leeches.

4.6.2 Deep water stones

Hirudo medicinalis were recorded on deep-water stones by Maitland and in this survey, but the method is time-consuming and only resulted in low numbers.

4.6.3 Strandline searches for adults and cocoons

At the two extant Scottish sites, adults were found in June under shoreline stones and a cocoon found in September (at Loch nan Digl), while cocoons have been found in September in mats of vegetation at the water's edge (at north Black Loch; Maitland, 1997).

Searching strandline stones has the advantage of being less dependent on good weather. However, it is possible that the presence of adults at Loch an Digl in June under shoreline stones was related purely to the emergence of *B. bufo* juveniles, thus it might not be a useful method at a different time of the year.

Searching for cocoons may provide a measure of relative population size, as well as confirming breeding. At Dungeness in Kent, (presumably captive) leeches laid two cocoons each, producing on average eight hatchlings (Ausden *et al*., 2002).

Cocoons were found predominantly 65-90 cm from the water edge amongst the roots of greater willowherb (*Epilobium hirsutum*), while at the Walland Marshes, also in Kent, they were mostly found in crevices made by sheep 35-40 cm from the waterline (Ausden *et al*., 2002).

It may be possible to place clearly identifiable stones along the water's edge at the start of the season in March/April, and revisit these two or more times until September/October. The cocoons seem to persist for a while after the juveniles have emerged (pers. obs). Studies will be needed to see if stones in these situations are indeed used, or whether *H. medicinalis* prefers to lay its cocoons in the roots of vegetation. The latter would be much harder and more time-consuming to sample, and the benefit of using stones is that a degree of standardisation should be possible.

Cocoons are thought to take between four and ten weeks to be produced, depending on factors such as water temperature (Ausden *et al*., 2002). If frogs and/or toads are important hosts at a site, cocoons should be present between late April and early June.

If amphibians are unimportant at a particular site, then it is possible that cocoons will be produced over a longer period of time, depending of course on the timing of use of the loch waters by birds and mammals. Thus this method could also help to identify whether frogs and/or toads are important to a particular population.

4.6.4 Monitoring using amphibians

In spring 1997 Maitland examined *B. bufo* adults at six lochs in the two known localities. At Loch nan Digl on 11 March, migration had just commenced, the *B. bufo* seen being mostly unpaired males, while at the Black Lochs on 12 March *B. bufo* migration was at its peak, with many paired males and females. Adult and juvenile *H. medicinalis* were found attached to the toads in both sites. Several corpses were observed, some of these being fed upon by *H. sanguisuga* (Maitland, 1997). The results are shown in Table 8.

Table 8: Number of H. medicinalis found on B. bufo, data from Maitland (1997)

Site	No. of toads examined	No. with *H. medicinalis*	% of toads with *H. medicinalis*
Loch nan Digl	39	2	5
Black Loch (north)	101	4	4
Black Loch (central)	5	0	-
Black Loch (south)	36	0	-

This could provide a useful method of confirming presence of *H. medicinalis*. If sufficient individuals were collected and some scale (e.g. PSD) measured, this may give some idea of population structure. To be reliable this would depend on an equal probability of all size classes being located.

This method may also give an idea of relative population size, particularly if the sampling can be done over several days, using the population reduction method (Maitland, 1997). Attacked toads could be removed from the loch and held - with their leeches still attached - until the sampling had finished. Some regular assessment of the *B. bufo* population would also be useful.

4.7 Future survey

Several former sites identified by Maitland (1996) seem to have only been visited once. Some sites were identified as potential *H. medicinalis* sites, but were visited rather late in the year (such as Loch Macanrie, Mentieth, visited on 29 Oct 1995), and would be worth visiting again, particularly in the spring when *B. bufo* is breeding.

4.8 Research into the origins of the Scottish populations

The presence of two isolated populations on the Argyll coast suggests that they are of human origin and linked to the presence of monks. However, even if the original populations of *H. medicinalis* were introduced to these sites, they have evidently survived many decades and thus could be considered 'naturalised' and still worthy of conservation, particularly given the apparent declines across Europe (Maitland, 1997).

A reference was found in the Museum of Islay Life (Adam Standring, pers. comm.) to the leeches at Loch nan Digl:

> *"Near Kildalton is the Lily Loch, also called the Leech Loch as it abounded in water lilies and leeches. The local doctor got his leeches from this loch and kept a supply in his surgery for use as required. Local inhabitants used them as well".*

Such 'cultural clues' could be used to look for other sites in Scotland. As Maitland (1997) notes, Loch nan Digl can mean 'loch of the leech', and a well-known tarn in Cumbria has for many years been know as 'leech tarn' or the 'healing tarn' (Marshall, 1999).

Genetic research on the two Scottish populations may reveal affinities with populations from other parts of the UK and mainland Europe. If there has been work carried out on the genetics of *H. medicinalis* elsewhere, it would be of interest to carry out similar work on the Scottish populations, which may shed light on their origins.

5. RECOMMENDATIONS

5.1 The extant sites

Both sites still support *H. medicinalis*. Land management appears to have changed little, and both landowners are very interested in, and supportive of the conservation of the species.

Recommendations

- The owners are congratulated on the continued presence of *H. medicinalis* on their land, and informed of the results of the survey and provided with copies of the report.

5.2 Black Lochs

Hirudo medicinalis was only recorded in the central loch in 2012, but it was present in north loch in 2011. The land and loch management recommendations provided by Maitland (1997) are still applicable.

Recommendations

- There should be no attempts to increase the fish population in the lochs.
- Land management of the surrounds should remain the same as far as is possible, with no major increase or decrease in livestock levels.
- There should be no alteration in the management of aquatic and emergent plants.
- Any use of herbicides, pesticides (particularly the use of helminthicides), or inorganic fertilisers in the immediate catchment should be controlled.

5.3 Loch nan Digl

The recommendations provided by Maitland (1997) still apply.

Recommendations

- The outflow should be rebuilt in order to maintain the current water level.
- Land management of the surrounds should remain the same as far as is possible, with no major increase or decrease in livestock levels.
- There should be no alteration in the management of aquatic and emergent plants.
- All *R. ponticum* within at least 250 m of the loch shores should be carefully removed.
- Any use of herbicides, pesticides (particularly the use of helminthicides), or inorganic fertilisers in the immediate catchment should be controlled.

5.4 Survey methods: adults and cocoons

The recommendations to carry out further work into an effective sampling methodology given in earlier reports still apply (Maitland 1997).

Recommendations

- Investigate the potential for the use of amphibians in *H. medicinalis* surveillance.
- Include assessment of the *B. bufo* populations as part of *H. medicinalis* surveillance or site condition monitoring.
- Carry out an experiment to see if *H. medicinalis* will lay cocoons on stones placed along the shoreline, as a way of monitoring them. Landowners' support and co-operation will obviously be needed.

5.5 Further survey work

Although Maitland carried out intensive surveys (1996, 1997), still more could be done to see if the species does now only occur at two sites.

Recommendations

- Sites thought to be suitable by Maitland (1996) should be re-surveyed in March to coincide with the presence of breeding frogs and/or toads.

5.6 Research

Not enough is known about the ecology, behaviour or importance of *H. medicinalis* in Scotland, but it is undoubtedly one of our rarest invertebrates.

Recommendations

- Assess the importance of amphibians to *H. medicinalis.*
- Investigate the effect of *R. ponticum* on *B. bufo* at other sites.
- Investigate the origins of the Scottish *H. medicinalis* populations.

5.7 Translocation

The recommendations regarding translocations in Maitland (1997) still apply, although should perhaps be considered only after further survey has taken place using a more efficient methodology at the appropriate time.

Recommendations

- Assess the amphibian populations at the former and potential sites surveyed by Maitland (1996), which were thought to be still suitable.

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ANNEX 1: RECORDS IN 2012 FOR *HIRUDO MEDICINALIS* L. EUROPEAN MEDICINAL LEECH

Site	Grid ref	Date	Life Stage	Sampling method	PSD (mm)[2]
Black Loch central	NM 92482 31424	12/6/12	Adult	Splash sampling[1]	3.0
Loch nan Digl	NR 43255 48178	14/6/12	Adult	Splash sampling	Not recorded
Loch nan Digl	NR 4328 4810	14/6/12	Adult	Deep water stones	6.5
Loch nan Digl	NR 4328 4810	14/6/12	Adult	Deep water stones	6.5
Loch nan Digl	NR 4328 4810	14/6/12	Adult	Strandline search	7.0
Loch nan Digl	NR 4328 4810	14/6/12	Adult	Strandline search	2.5
Loch nan Digl	NR 4328 4810	14/6/12	Adult	Strandline search	8.5
Loch nan Digl	NR 4328 4810	14/6/12	Cocoon	Strandline search	N/a

Notes

1 As explained in the text, this leech was in effect found by splash sampling, but while looking under deep water stones.
2 PSD posterior sucker diameter, measured to the nearest 0.5 mm (Marshall, 1999).

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