Amphibian and Reptile Groups of the United Kingdom

**Advice Note 10**

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# Reptile Survey and Mitigation Guidance for Peatland Habitats

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## 1. Summary

The guidance in this document is intended to assist in designing mitigation for impacts on reptiles during peatland restoration works. The mitigation approaches may also be suitable for the construction phase of some developments on peatland habitats. This guidance focuses on Scotland where peatland habitats are extensive, but could be applied elsewhere in the UK or Ireland where this habitat also occurs. While it deals explicitly with peatlands, many of the recommendations could be followed or adapted for other habitats which may be occupied by reptiles.

Three reptile species (adder, common lizard, and slow-worm) are known to occur in Scottish peatlands, while the grass snake is also present in England. Only common lizards occur in Northern Ireland and Ireland. All native reptile species are protected under relevant national legislation, and are also included on the national lists used to define the Biodiversity Duty of public bodies in the UK.

Built developments may be sited on peatland habitats, while restoration is often the subject of site management for nature reserves and habitat management plans associated with developments such as onshore wind farms. While restoration of peatlands will ultimately benefit biodiversity, the methods used can conflict with reptiles.

This document provides guidance to help plan peatland restoration so as to avoid negative impacts on reptiles so far as is practical.

A flow chart and summary table are provided to assist project planning.

It is essential that reptile mitigation is designed based on the best possible baseline dataset, collected through use of historic data, habitat mapping and presence surveys.

One of the greatest risks to reptiles on peatland sites is the loss of hibernaculum features, either directly or through raising the water table. Hibernacula should be mapped and it is essential to time work so as to avoid these features during the hibernation period. Recommendations are given for construction of artificial hibernacula.

## 2. Introduction

Peatland habitats are extensive throughout Scotland, and present elsewhere in the UK and Ireland. This guidance focuses on Scotland, but could be applied anywhere in the UK or Ireland (taking cognizance of relevant legislation). While it deals explicitly with peatland habitats, many of the recommendations could be followed or adapted for other habitats which may be occupied by reptiles. The guidance in this document is intended to assist in designing mitigation for impacts on reptiles during peatland restoration works. The mitigation approaches may also be suitable for the construction phase of some developments on peatland habitats (see Section 3 for detailed scope).

Three reptile species (adder, common lizard, and slow-worm) are known to occur in Scottish peatlands, while the grass snake is also present in England. Note that although the grass snake has been shown to be present in Scotland, it appears to have a limited distribution, and has not found to be associated with peatlands in this country (Cathrine, 2014; McInerny & Minting, 2016). Only common lizards occur in Northern Ireland and Ireland.

Peatland characterises much of Scotland's landscape, and supports a diversity of wildlife while also acting as a valuable carbon store which can moderate greenhouse gas emissions, combating climate change (Bain *et al.*, 2011). However, it is estimated that as much as 80% of the UK's peatlands have been damaged, largely due to historic land-use, while developments are also not infrequently sited in these habitats. Scotland holds the majority of the UK's peatlands, and it is estimated that 70% of blanket bog and 90% of raised bog habitats have been damaged to some extent (Artz *et al.*, 2014; Bain *et al.*, 2011; Lindsay & Immirzi, 1996; SNH, 2015). In order to address this, Scotland's National Peatland Plan sets out a vision for restoring peatland habitats, and the national Peatland Action project aims to deliver this (SNH, 2015). More recently, the IUCN published a UK Peatland Strategy, which sets out a collaborative approach to peatland conservation (IUCN Peatland Programme, 2018). Peatland restoration is also often the subject of large scale projects in National Parks, individual site management for nature reserves and habitat management plans which aim to provide biodiversity benefits for developments such as onshore wind farms.

Reptiles are amongst the diversity of wildlife found in peatlands, with three of Scotland's four native terrestrial species known to occur in these habitats. Common lizards (*Zootoca vivipara*) and adders (*Vipera berus*) occur regularly on Scottish peatlands, whereas slow-worms (*Anguis fragilis*) are found more rarely. Grass snakes (*Natrix helvetica*) also occur in peatland habitats in England. Common lizards are the only reptile species found in peatlands in Northern Ireland and Ireland. Without appropriate consideration, development activities can harm reptiles, and render habitat unsuitable and while restoration of peatlands will ultimately benefit biodiversity, the management methods used can have similar negative and possibly illegal impacts. All native reptiles are protected from intentional / deliberate / willful harm under relevant national legislation, and are also included on the country-specific lists used to define the Biodiversity Duty placed on public bodies in the UK. In Scotland, reptiles are also protected from reckless harm. In Northern Ireland, it is also an offence to: damage, destroy, or obstruct access to shelters used by reptiles; damage or destroy anything concealing or protecting a shelter; or to disturb reptiles while occupying a shelter. In Ireland, common lizards are also protected from harm and it is also an offence to interfere with or destroy a breeding place or resting site. There are sometimes exceptions and defences to offences, which vary between country specific-legislation. It should also be encouraged to consider impacts on existing biodiversity when planning a development or habitat management for any site. It is strongly advised that relevant country-specific legislation is consulted before undertaking any activities that may impact reptiles[1]. This document provides guidance to help to plan works in order to avoid

[1] Legislation defining protection of reptiles:
Scotland: *Wildlife and Countryside Act 1981 (as amended in Scotland)*
England and Wales: *Wildlife and Countryside Act 1981 (as amended in England and Wales)*
Northern Ireland: *Wildlife (Northern Ireland) Order 1985 (as amended)*

negative impacts on reptiles and a decision tree with mitigation suggestions is also provided in the Appendix, to assist when planning site management. However, note that the appropriate approach to mitigation will vary depending on the particular circumstances of a site, reptile populations present, and project details.

It should also be recognised that while peatland restoration may result in short-term negative impacts on reptiles (e.g. harm to individuals, or temporarily rendering small areas of habitat unsuitable), it is likely to have long-term benefits, particularly if their specific habitat requirements are incorporated into management plans (e.g. provision of suitable hibernacula). Indeed, drying out of bogs has been recognised as a decline factor for adders in the Netherlands, although work has not been undertaken to confirm if this is also the case in Scotland (Lenders, 2015). In addition, careful consideration of reptiles when designing a development can also allow incorporation of enhancements for these animals, while harm to individuals can be avoided during construction through appropriate mitigation.

This document is intended as guidance only, providing some potential survey and mitigation options which can be considered. However, the document should not be considered to be comprehensive or prescriptive. This guidance document should be used by reptile ecologists alongside their expert professional judgement and other relevant literature when designing mitigation for peatland restoration projects. Other documents already provide recommendations for survey, mitigation and habitat management, and these should be referred to for more detail. Some key sources of further information are Edgar *et al.* (2010), Froglife (1999), Gent & Gibson (2003), HGBI (1998) and Sewell *et al.* (2013).

In addition, consideration should also be given towards monitoring reptiles at development and peatland restoration sites so as to better understand their use of these habitats, impacts of activities, and efficacy of mitigation. For some projects, a robust Ecological Impact Assessment (EcIA) may be necessary, following the guidelines produced by the Chartered Institute of Ecology and Environmental Management (CIEEM) (2016a). It must also be remembered that impacts on, and appropriate mitigation for, other ecological features will also require consideration (e.g. nesting birds, protected mammals etc).

This document has been designed with reference to CIEEM principles for preparing guidance (CIEEM, 2016b).

The intended scope of this document is defined in the following section.

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Ireland: *Wildlife Act 1976 (as amended)* and *Wildlife Amendment Act 2000 (as amended)*

## 3. Scope

This document provided guidance only, and should not be considered to be comprehensive or prescriptive.

This document is intended to apply to peatland habitats only. The definition of 'peatland' used is that set out in in the Ramsar Convention 1971 and further defined in *Scotland's National Peatland Plan. Working for our future.* (SNH, 2015):

***Peatlands are ecosystems with a peat deposit that may currently support vegetation that is peat-forming, may not, or may lack vegetation entirely.***

***Peat should have an organic layer or layers that exceed 50 cm deep from the soil surface and an organic matter content of more than 60%. Shallower deposits supporting typical peatland vegetation are also included.***

Note that the above definition varies slightly from that used in IUCN Peatland Programme (2018), but is considered appropriate given the Scottish focus of this document.

The guidance in this document is intended to assist in designing mitigation for impacts on reptiles during peatland restoration works. The mitigation approaches may also be suitable for the construction phase of some developments on peatland habitats, where impacts are relatively low and/or temporary (e.g. underground pipelines or wind farms) – reference is made to such situations in the text. Detailed descriptions of some peatland restoration techniques are provided, but the same has not been included for construction methods as these will vary widely between projects and should be considered robustly in an Ecological Impact Assessment and Construction Method Statements. This guidance is not intended for high impact developments such as housing or surface mines.

The primary aim is to avoid harm to reptiles, which may constitute an offence under the Wildlife and Countryside Act 1981 (as amended). Recommendations for artificial hiberaculum construction are also provided, as natural hibernaculum features are particularly important to reptiles, and are often limited on peatland sites.

This document is not intended to provide guidance on assessing impacts – CIEEM Ecological Impact Assessment guidelines should be followed (CIEEM, 2016a). As well as the legal implications of harming reptiles, consideration should be given to impacts on the conservation status of species within an appropriate geographic area, habitat loss, habitat fragmentation, and disturbance, as well as cumulative impacts.

This document is not intended to provide guidance on operational phase mitigation or ongoing site management – other sources should be referred to for this aspect, such as Edgar *et al.* (2010), Gent & Gibson (2003) and HGBI (1998).

This document does not provide advice for mitigating permanent habitat loss or fragmentation, and does not include guidance on reptile translocations. A highly experienced reptile ecologist should be engaged to design and undertake translocations. Translocations should only be undertaken under appropriate licences (which vary between UK countries).

This document does not detail legal protection of reptiles in the UK or Ireland. It is strongly advised that relevant country-specific legislation is consulted before undertaking any activities that may impact reptiles.

## 4. Peatland reptile ecology

There are three widespread species of terrestrial reptile native to Scotland: the adder, common lizard and slow-worm. These species occur throughout the mainland, as well as on a number of the Inner Hebridean islands (McInerny and Minting, 2016). The grass snake (*Natrix helvetica*) is also now known to occur in Scotland, although its presence appears to be restricted to the south of the country (Dumfries & Galloway and Scottish Borders), with scattered records elsewhere in the country possibly relating to introductions (Cathrine, 2014; McInerny and Minting, 2016). There is also a single introduced population of sand lizards on the island of Coll, but no current or historic native populations are known from Scotland (Bowler and Hunter, 2007; McInerny and Minting, 2016).

As reptiles are under-recorded in Scotland, the distribution of species is currently not well understood. Details of distribution can be found by contacting local biological records centres (list at http://www.brisc.org.uk/Sources.php) and local Amphibian & Reptile Groups (list at http://www.arguk.org/local-groups). Indicative distribution maps can also be viewed on NBN Atlas (https://www.nbnatlas.org) and Record Pool (http://recordpool.org.uk/). However, note that not all records on NBN Gateway have been verified and so may not be correct, and data on Record Pool is likely to be predominantly recent. McInerny and Minting (2016) provide the most detailed description of known reptile distribution in Scotland at date of publication. Regardless of the data sources used, it is important to remember that absence of records does not indicate absence of presence, and so a precautionary approach should be adopted, considering reptiles if suitable habitat is present. A more systematic study of reptile distributions in Scotland would be invaluable.

All three widespread species are known to occur in peatland habitats, and so may come into conflict with management activities. While adders and common lizards may be found throughout peatland sites, slow-worms tend to have a more limited distribution in these habitats. Slow-worms do not seem to be common in peat soils, and some of their preferred prey items, such as earthworms and snails, are also less common or absent in peatlands (due to limited oxygen and low pH respectively) (Cameron, 2008; Riddell, 1997). As such, slow-worms are more likely to be encountered at the fringes of lowland raised bogs, as they are at Flanders Moss National Nature Reserve (NNR). Although grass snakes are unlikely to be encountered during projects on peatlands in Scotland, the mitigation set out for the widespread species will also reduce the risk of impacts to this species if present.

A review by Langton and Beckett (1995) considered available information on reptile population densities. Adders have been found to occur at densities of 4 $ha^{-1}$ (Prestt, 1971). Common lizards have been found to occur with a median population density of 40 $ha^{-1}$, although have been recorded at densities between 150 and 1,200 $ha^{-1}$ in some cases (Langton *et al.*, 1993; Massot *et al.*, 1992). Slow-worms have been found to occur with a median population density of 30 $ha^{-1}$, although have been recorded at densities as high as 1,360 $ha^{-1}$ (Langton *et al.*, 1993; Smith, 1990). McInerny has undertaken detailed studies in to the populations of reptiles at a site on the shores of Loch Lomond, including behaviour, ecology, and use of habitat ranging from replanted native woodland to upland moorland habitats (McInerny, 2014a; 2014b; 2016; 2017). All three reptile species present at this site (adder, common lizard, and slow-worm) were found at higher densities in lowland grassland habitats, compared with upland moorland. McInerny gives an estimated population density of adders as being between 62 and 236 $ha^{-1}$ depending on the year at this site at Loch Lomond, although it seems unlikely these reflect the moorland habitats onsite, where fewer reptiles were found (McInerny, 2017). While the detailed site study completed by McInerny is a helpful case study, the site is noted to be 'exceptional' (McInerny, 2014a), and so research encompassing a number of sites throughout Scotland, including a range of habitats and elevations is needed to better inform conservation and mitigation methods. It should also be noted that although McInerny finds adders to be associated with bracken at his study site (McInerny, 2014b), elsewhere this snake is found in the absence of this plant. Unfortunately, broader studies have not been completed in Scotland and

there is no robust information regarding population densities for each of the reptile species in different habitats.

Reptiles are 'poikilothermic', meaning that their internal body temperature fluctuates considerably depending on external conditions when they are inactive, unlike mammals and other 'homeothermic' animals. They maintain their body temperature above ambient levels through behavioural means, and so are 'ectothermic.' This means that their activity varies greatly throughout the year depending on air temperature and weather. As such, reptiles are particularly vulnerable to adverse weather conditions. This presents a challenge during winter, where temperatures are generally too low to permit reptiles to be active. In order to survive these conditions, reptiles enter a period of 'hibernation' or extended torpor during which time their metabolic activity is greatly reduced. Reptiles must find a suitable shelter, called a 'hibernaculum', for this period. Hibernacula must be frost-free, humid, and safe from predators and flooding (i.e. above the water table and regular winter inundation levels).

During the active season, reptiles must still adjust their behaviour throughout the day and depending on weather conditions in order to maintain their body temperatures within particular ranges. Consequently they require basking opportunities (such as south-facing slopes with some bare ground, but also vegetation for shelter) and cover (for foraging, protection from high temperatures or adverse weather and predators). Note that the three widespread species do not lay eggs, but instead give birth to young. (However, grass snakes do lay eggs and so require suitable egg laying sites.)

Figure 1 provides indicative details of active and hibernation periods for reptiles in Scotland, although it should be noted that these will vary depending on many factors including geographic location, elevation and weather conditions.

| | MONTH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| **Adder** | | | | | | | | | | | | |
| Active | | | | | | | | | | | | |
| Hibernation | | | | | | | | | | | | |
| **Common lizard** | | | | | | | | | | | | |
| Active | | | | | | | | | | | | |
| Hibernation | | | | | | | | | | | | |
| **Slow-worm** | | | | | | | | | | | | |
| Active | | | | | | | | | | | | |
| Hibernation | | | | | | | | | | | | |
| **Grass snake (unlikely to be encountered on peatland sites in Scotland)** | | | | | | | | | | | | |
| Active | | | | | | | | | | | | |
| Hibernation | | | | | | | | | | | | |

*Figure 1. Chart showing active and hibernation periods for reptiles that occur in Scotland. (Note that these vary depending on weather conditions, and differ elsewhere in the UK. Therefore, they should be considered to be indicative only.)*

Due to their ecology, all reptiles benefit greatly from a wide diversity of micro-habitats created by various vegetation types and habitat features (e.g. rocks, walls, other collapsed structures, bare ground etc), which provide essential opportunities for foraging, basking, sheltering and hibernating (Edgar *et al*., 2010). It should also be noted that a recent radio tracking study by Nigel Hand (Central Ecology/Herefordshire Amphibian & Reptile Group) found that adders may spend long periods underground in mammal burrows during the active season (Hand, 2014).

In a peatland habitat, a critical feature which may limit suitability for reptiles will be availability of hibernacula that remain above the water table and flood level during periods of winter inundation. Buried structures such as drystone dykes or old crofts, defunct hedgerows, planting ridges or other features which may be slightly raised compared to the surrounding topography and offer internal shelter that may be used as hibernacula by multiple animals. However, reptiles may also hibernate individually or in smaller numbers in small features, such as hummocks. In some cases the hibernaculum may not even be visible from the surface, making detection extremely difficult. Some examples of peatland habitats which support reptiles are provided in Figure 2.

McInerny and Minting (2016) provide detailed information on reptiles in Scotland, specifically (although much of the detailed ecological information also applies elsewhere in the UK). Further information on these and other reptiles throughout the UK can be found in more geographically comprehensive publications such as Inns (2009).

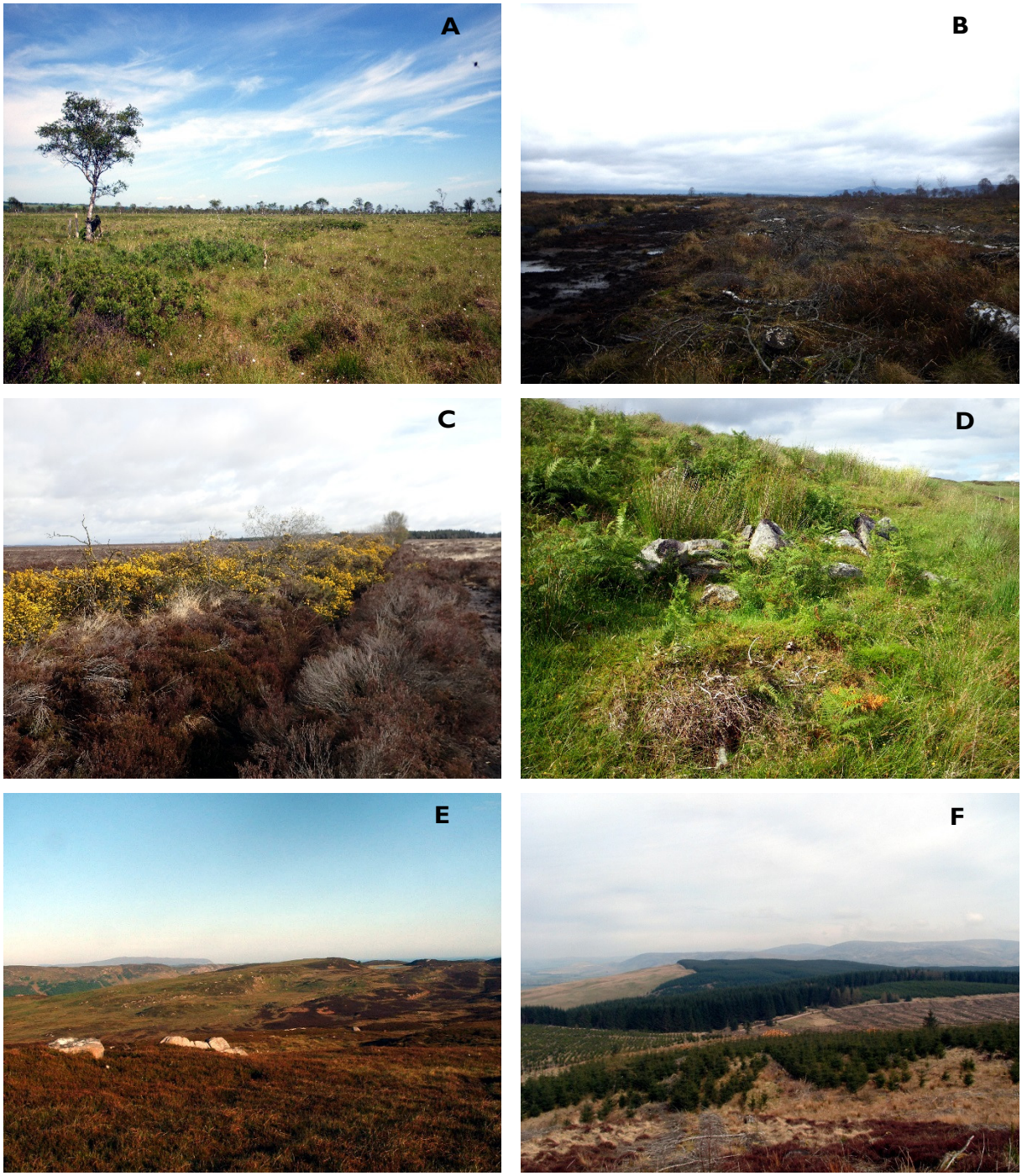



*Figure 2. Examples of peatland habitats where reptiles are found:* ***A.*** *Flanders Moss (West) (wet area where tussocks may be used by individuals or small numbers during hibernation).* ***B.*** *Flanders Moss (East) (drier area where drier ridges and brash piles may be used as communal hibernation sites).* ***C.*** *Fannyside Muir (old railway bund offers communal hibernaculum).* ***D.*** *Kintyre (degraded blanket bog where drier rocky areas and collapsed stone structures offer hibernacula).* ***E.*** *Flow country in Sutherland offers extensive reptile habitat.* ***F.*** *Commercial plantation on peatland in Dumfries & Galloway (brash piles and forest edge offer hibernacula).*

## 5. Activities and potential impacts on reptiles

The impacts of developments on reptiles should be a material considered under the planning process, given they are protected species in the UK and Ireland. Consideration should also be given to reptiles as part of public bodies' Biodiversity Duty in the UK. Any habitat loss, devegetation, excavation, pollution, or change to the water table may cause harm to reptiles, or loss of key foraging, basking, sheltering and hibernating habitat.

Note that this document does not provide advice on how to assess impacts on reptiles (e.g. permanent habitat loss), or to mitigate these during operational phase (e.g. translocation). It is recommended that an Ecological Impact Assessment is completed, to include reptiles, following CIEEM guidance (CIEEM, 2016a). A suitably qualified and experienced ecological consultant should be consulted in order to assess impacts on reptiles, and to develop operational phase mitigation.

As peatland restoration project managers may not always be familiar with reptiles, further consideration is given to potential impacts of different management techniques.

A wide range of techniques are used for peatland restoration projects, and new ones will certainly be developed as experience is gained. It is therefore not possible to provide a comprehensive list of methods which may be used in peatland restoration, and an assessment of the short-term and long-term impacts on reptiles should be undertaken for any project, following CIEEM guidance (CIEEM, 2016a). However, as the goal of peatland restoration projects is to improve the quality of peatland habitats and is likely to involve machinery, there are potential impacts for reptiles common to any method.

It is likely that an aim of most peatland restoration projects will be to raise the water table. While this will benefit the overall habitat quality, and encourage formation of different micro-habitats, there is a risk that hibernaculum features may become water-logged and so unusable by reptiles. Consideration should be given to known or likely hibernaculum features when designing peatland restoration plans to ensure some are retained. If it is not possible to retain hibernaculum features, consideration should be given to creating artificial replacements, and this is discussed in greater detail in the following section.

Ridges are often much drier than the surrounding peatland habitat and after their creation may become colonised by *Calluna vulgaris* and conifers or remain bare, exposing peat. The elevation of ridges and varied vegetation height offer excellent basking opportunities for reptiles. During the active season, reptiles may seek refuge in dykes or bog vegetation such as *Eriophorum* spp. and *Molinia caerulea*. Peatlands also provide good foraging habitat for reptiles as they can support small mammals, ground-nesting birds and invertebrates as prey items. Peatland restoration is likely to improve availability of prey in the long-term, but it is possible that reptiles may already be present within an area and should therefore be considered.

Excavation or ground-breaking of any sort also presents the common risk of injuring or killing reptiles. There is also a risk that heavy machinery may track over, and so injure or kill, reptiles while travelling across a peatland site.

Some common peatland restoration techniques that may conflict with the protection of reptiles and their associated habitat are discussed in greater detail below, in relation to potential impacts on reptiles. Further information on effective peatland restoration techniques can be found on the SNH website (www.nature.scot), and in Taylor *et al.* (2018).

## 5.1 *Ditch blocking*

### *5.1.1* Method

Blocking ditches previously used to drain peatlands is an effective way of raising the water table. For small ditches, the use of peat dams will suffice as a watertight barrier. A peat dam is created by excavating dark peat then piling and compressing this in the ditch. The darker peat is naturally watertight and will block water flow thereby raising the water table. Plastic piling can also be used for ditches that are wider, steeper or faster flowing.

### *5.1.2* Potential reptile impacts

Ditch blocking presents the inherent issues with the risk of reptile habitat loss through raising the water table and excavations. If ditch blocking is completed by hand, the risk of injury or fatality to reptiles is lower than if using machinery. If machinery is used there is increased risk to individual reptiles during excavation and piling activities, as well as the additional risk of crushing reptiles under tracks.

## 5.2 *Reprofiling and 'cross-tracking'*

### *5.2.1* Method

Hags are steep, exposed banks formed when the surrounding peat has been washed away. These steep banks are prone to erosion, which prevents vegetation from recolonising them. Creating a shallower angle and revegetating prevents the additional loss of peat. A low ground pressure excavator is used to fold back any vegetation 2 m from the hag edge. Once the vegetation has been relocated, newly exposed peat is spread down the slope creating an angle of between 33 ° and 45 °. The removed vegetation can then be replaced over the slope ensuring that no peat is exposed and then compacted so that further erosion is avoided.

Peatland that has previously been used for peat milling or commercial forestry often exhibits a 'ridge and furrow' micro-topography that has a highly contrasting hydraulic gradient, i.e. the substrate is too dry on the ridges and too wet within the furrows to allow colonisation of bog vegetation. When reprofiling the micro-topography, the ridges and furrows are levelled, hence improving the hydraulic gradient and enabling recolonisation by bog vegetation. To flatten an area of ridges and furrows, a low ground pressure machine or tracked excavator is used to 'cross-track' over a selected area in perpendicular directions.

*Sphagnum* rich mulch is often spread in order to re-vegetate areas of bare peat after reprofiling extensive areas of blanket bog. This involves using low ground pressure machines or people with rakes to spread material. The mulch itself is collected locally using a low ground pressure tractor with a device that cuts and bags the material.

Spot turfing is also sometimes used for re-vegetation after reprofiling, particularly on blanket bogs. Excavators cut turf from nearby good quality vegetation, and place this on the bare peat left after reprofiling, stretching it across the surface. The 'borrow pit' left from removing the turf is partially covered by stretching the surrounding turf over the hole.

### *5.2.2* Potential reptile impacts

Both reprofiling and cross-tracking involve the use of machinery, and risk crushing reptiles. Cross-tracking in particular can involve short-term impacts over a large area of potentially suitable reptile habitat and risks injury or mortality to reptiles without appropriate consideration.

The use of machines when cutting turfs and *Sphagnum* rich mulch or reprofiling hags can also pose the risk of injury or killing of individual reptiles. This risk may be increased where hags are south facing, and used by reptiles for basking. Reptiles are most likely to use the interface between bare peat and vegetation when basking, which is also an area likely to be targeted by ground-breaking works.

In addition, flattening of ridges may result in loss of hibernaculum features and basking sites. This loss of favoured micro-topography could have a serious long-term negative impact on reptile populations, if used over a large area.

## 5.3 *Bunding*

### *5.3.1* Method

Bunding is used in order to prevent leakage or to raise the water table in drier areas of peatland. The main aim is to seal cracks in dried peat below the bund, while retaining a shallow layer of surface water to encourage sphagnum growth. A low ground pressure excavator is used to strip the vegetation before digging down through cracked, dried peat to wet 'putty' peat (1-2 m below), forming a trench. The putty peat at the bottom of the trench is then turned and compressed. Further peat from a borrow pit is used to seal the trench with compressed putty peat, forming a small raised bund on top. The dried peat is then deposited on the bund ensuring it is compacted so that it remains watertight. The bund is then covered with the vegetation removed previously, and compacted. Creation of bunds can help the formation of pools in dry bog areas and prevent the loss of water through leakages.

### *5.3.2* Potential reptile impacts

Bunding presents the risk of flooding suitable reptile hibernacula, while use of excavators may also cause injury or mortality to individual reptiles.

## 5.4 *Surface smoothing*

### *5.4.1* Method

Where bogs have been used for commercial forestry, surface smoothing uses leftover trees and/or stumps to fill furrows left from ploughing to raise the water table.

All trees and stumps present should be mulched before using this to backfill the furrows. The tracks of the excavator may be used to compact the mulch. If the land has been harvested leaving rows of stumps along the ridges these can be dug out by an excavator before being flipped in to the furrow and pushed down firmly in the peat. The excavator is then used to compact the furrows.

### *5.4.2* Potential reptile impacts

As stumps on dry ridges may be used as hibernacula by reptiles, this method will result in the loss of these features. The ridges themselves may also offer hibernacula and important basking sites, and at least some of these will be rendered unsuitable after compaction and raising of the water table. There is also a risk that reptiles may be injured or killed during excavation and compacting work, or while machinery is tracking over the site.

In addition, this method may result in similar long-term negative impacts to reprofiling through the loss of ridge and furrow micro-topography favoured by reptiles.

## 6. Survey

Before developing a mitigation plan for reptiles, it is important to consider whether they may be present in the first place. Historic data may be available from Local Biological Records centres or local Amphibian & Reptile Groups (ARGs) which could indicate presence (see Section 4 for details of data sources).

If historic data is not available surveys could be completed in order to determine presence, following standard methods (e.g. Froglife, 1999; Gent & Gibson, 2003; Highways Agency *et al.*, 2005; HGBI, 1998; Natural England, 2011; Sewell *et al.*, 2013). There are no strict guidelines on reptile survey, however, and attempts at achieving standardisation have been difficult, with the Natural England (2011) guidance document being withdrawn soon after publication.

The approach to survey should involve deployment of artificial refugia, left in place ideally four weeks, but at least two weeks prior to the first survey visits, combined with visual searches by experienced reptile ecologists. Seven survey visits would normally be recommended, although additional visits will improve confidence in results, particularly in peatland habitats where reptiles are likely to be present at low population densities. Survey visits should be undertaken during appropriate weather conditions (between 9 and 18 ºC air temperature, no rain, and wind less than Beaufort Force 4), using both visual search and checking artificial refugia.

Artificial refugia may consist of tiles of roofing felt, corrugated iron or onduline/coroline. A mix of materials has been shown to be the most effective, but if a site is remote, roofing felt often proves the most practical for transport on foot. Artificial refugia of 50 cm x 30 cm appear to be effective, and is the largest dimension easily fitted into rucksacks (necessary for transport to some sites), and so this is suggested here as a minimum size in the absence of robust research. Refugia should be deployed at a minimum density of one per 1,000 $m^2$ of suitable habitat (although a higher density of refugia will provide more robust results, particularly if the available time for survey is short or habitat is complex). The use of artificial refugia has been shown to improve detectability of the three reptile species which are likely to be encountered in peatland habitats in Scotland (Sewell *et al.*, 2012). In particular, the use of artificial refugia greatly improves the detectability of slow-worms (which are semi-fossorial and so burrow), and is essential for a robust presence survey for this species. Visual transects must also used as adders do not tend to use artificial refugia frequently on upland or peatland sites in particular[2], and this method can also be more effective for detecting common lizards (Sewell *et al.*, 2013). Visual transects can be completed while moving between artificial refugia or separately. As reptiles tend to bask near hibernation sites on warm days in early spring (March to April), and to a lesser extent in autumn (September to October), these are the ideal times to target reptile surveys as this maximises chance of detection and also aids in identifying hibernacula. However, presence can still be detected using the methods described above throughout the active period.

Radio telemetry studies have found that male adders and non-breeding females will spend extended periods of time below vegetation after mid-May, which is likely to reduce the likelihood of detection (Nigel Hand, pers. comm., March 2018). This behaviour, as well as the apparent reduced utilization of artificial refugia, means that adders are particularly difficult to detect when present at low densities. Therefore, if other reptile species are found it would be advisable to follow a precautionary approach assuming adders may also be present when undertaking mitigation.

Another useful approach when planning peatland restoration activities is to map habitat quality and features of particular value to reptiles, such as potential hibernacula. As with presence surveys, there is currently no formal methodology for habitat assessment, and so this should only be undertaken by a reptile ecologist with particular experience of peatland habitats. Examples of reptile habitat maps are provided in Cathrine and Norris (2015), Norris *et al.* (2015), and Cathrine and Bradley (2016). Unsuitable habitat may include expansive areas overgrown with tall dense vegetation (e.g. scrub or sedges) or closed canopy forestry, offering no basking opportunities, and/or waterlogged areas. Suitable habitat may include areas with a varied micro-topography offering shelter (e.g. heather), basking opportunities (e.g. bare ground or ridges) and hibernacula (overgrown rock or rubble piles, deadwood, woody plant roots, sheltered earth cavities, disused

[2] Adders appear to use artificial refugia more frequently in the southern part of their UK range, on lowland sites (Steve Langham, pers. comm., March 2018). This likely reflects higher population densities reducing the time taken for adders to encounter artificial refugia, rather than a behavioural difference (Čeirāns & Nikolajeva, 2017).

structures, drystone dykes etc). Note that the majority of peatland sites will offer good quality foraging habitat and basking opportunities for reptiles. However, there will occasionally be exceptions to this, such as examples where dense closed canopy mature commercial forestry without rides or clearings is present on peatland, although it is important to recognise that all UK reptile species will utilise this habitat in the earlier successional stages, up to about 20 years old, and slow-worms may persist longer than other species (see Jofré *et al.* (2016) for further information on UK reptile species and commercial forestry).

Mapping potential hibernacula is particularly critical, as these are likely to be limited on peatland sites. Many reptiles will hibernate individually or in small numbers in peat hags, tussocks or small mammal burrows which may be present throughout some peatland sites. It is impractical, and perhaps impossible, to identify or protect these during restoration works, unless a large amount of effort is expended on detailed emergence surveys. However, peatland sites will often offer a limited number of features which may be used communally, by larger numbers of reptiles. Examples of such features include raised ridges, old dykes or other structures (which may be collapsed and colonised by vegetation), old hedgerows, log and brash piles, windrows and woodland/forest edges. Prior to survey visits, aerial photography can help identify potential features, while LiDAR data can reveal small ridges that may be above the water table in an otherwise apparently featureless peatland. Completing development or restoration activities in winter while avoiding impacts on features which may offer communal hibernation sites is likely to be the optimal approach to reptile mitigation in most cases, as this will require only low input from an experienced reptile ecologist compared to if works are undertaken during the active season (see section 7.2. Hibernacula).

Due to budgetary limitations, detailed reptile surveys may not always be logistically practical, particularly for peatland restoration projects funded by grant aid. As peatland habitats do often support adders and common lizards in particular, a precautionary approach should be taken, assuming presence if surveys are beyond the scope of the project, so as to avoid risk of unlawful actions. Mapping habitat as described above will help inform plans and mitigation.

While there are often constraints (e.g. competing ecological and environmental factors, timing, man-power, funding etc), it is essential that surveys undertaken for reptiles are as thorough as possible so as to identify presence and to map areas which may be particularly important to these animals. This is vital for projects using heavy machinery, or which may result in the loss of communal hibernacula either directly or indirectly through raising of the water table.

## 7. Mitigation

Mitigation plans must be designed for the individual sites (considering baseline habitat and reptile conditions) and plans (considering activities and potential impacts), and so will be project specific. However, there are general approaches which can be considered, with appropriate methods selected for each individual project. Some of these are discussed below, however this should not be considered as a comprehensive list nor prescriptive guidelines. Ultimately, avoiding work which could impact on reptiles is the best form of mitigation, and may be possible for developments, but will rarely be compatible with peatland restoration aims, although the latter will generally offer long-term benefits for reptiles and other biodiversity.

In all cases, consulting experienced reptile ecologists is invaluable. They will be able to provide expert advice specific to your site. It is recommended that the appointed consultant ecologist be a member of the CIEEM or equivalent body to ensure professional standards.

The main focus of the mitigation options discussed below is to avoid harm to reptiles, which is the strict legal requirement. This is primarily achieved through changing one or more of the following; timing, location and method.

Harm to reptiles and their places of shelter are particular risks during construction or peatland restoration works, in the short-term. However, it is best practice to give consideration to accommodating reptiles at sites in the long-term, after management works have been completed. Furthermore, ensuring positive management for reptiles could contribute towards UK public bodies' delivering their Biodiversity Duty, and could be secured by funding or planning conditions where works are completed privately. Although long-term management is outwith the scope of this document, it is discussed briefly, while directing readers to other resources which provide more detail.

### 7.1 *Timing*

As reptiles hibernate during winter, and are active between spring and autumn, their use of a site varies throughout the year. Therefore, timing of activities can be a useful mitigation tool. For example, high disturbance activities such as excavations or cross-tracking could be completed in foraging habitat while reptiles are hibernating. Conversely, if hibernation features must be affected, this could be completed during the peak reptile activity season. It should be noted, however, that there is no form of acceptable mitigation which could allow destruction of hibernation features during winter. Species specific activity and hibernation periods are provided in Figure 1. A general indication, useful for planning activities in peatlands where a variety of species may be present, is given in Figure 3. Note that Figures 1 and 3 are indicative only, and that activity will also depend on weather conditions (e.g. if the spring is particularly cold, reptiles may leave hibernation later, or if the winter is unusually warm they may remain active for longer, and emerge for periods when conditions are favourable).

| | MONTH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| **Active** | | | | | | | | | | | | |
| **Hibernation** | | | | | | | | | | | | |

*Figure 3. Chart showing general indicative active and hibernation periods for reptiles in Scotland for the purpose of planning work on peatland sites. Red indicates peak period, and amber indicates a period where this behaviour is less likely but may reasonably be expected to occur depending on weather. (Note that these do vary depending on species, weather conditions, and differ elsewhere in the UK.)*

## 7.2 *Hibernacula*

Hibernaculum features are primarily used by reptiles during hibernation periods (see Figures 1 and 3). Reptiles are also more likely to bask near their hibernation sites (usually within 100 m) on warm days in early spring, and mating also tends to occur near these features. However, reptiles may also continue to use these features for refuge throughout the year. The number of individual reptiles using a hibernaculum will be at its highest during winter and spring, and lowest mid-summer, then increasing again in autumn and winter.

The preferred approach to mitigation for hibernacula is to avoid any activities which may damage these (including tracking over with heavy plant). Where possible, a suitable buffer should also be enforced around the hibernaculum feature – this buffer should be a minimum of 30 m, although checks for basking reptiles should be completed within 100 m immediately prior to works (reptiles may emerge from hibernation sites to bask during winter). Although reasonable effort should be expended to identify and protect all hibernacula, larger features which offer communal hibernation opportunities should be a priority.

Where it is not possible to avoid works that may affect a hibernaculum, these must be scheduled to avoid the hibernation season (see Figures 1 and 3).

If hibernaculum features are to be lost, it is best practice to create artificial features as compensation. If possible, the original hibernaculum should be translocated to a receptor site nearby with similar micro-habitat and aspect. If this is not possible, material from the existing hibernaculum should be used in the creation of a new feature, as adders may locate this by scent. If both of these options are not practicable, the new hibernaculum should be created using appropriate local materials. Note that the artificial hibernaculum features must be in place before reptiles enter hibernation.

Creation of new hibernaculum features can be a low cost and effective method to enhance habitat for reptiles as the materials (e.g. brash, tree stumps etc) may become available as a by-product of works. Given the unpredictable effect raising the water table could have on hydrology of sites throughout the year and during different weather conditions, creation of hibernacula in different locations should be encouraged as a precautionary measure in peatland restoration projects.

Artificial hibernacula should be appropriate to the site being affected, and, if included to replace an existing feature, must be of at least equivalent extent. Generally, artificial hibernacula should be at least 4 m long, 2 m wide and 1 m high, but ideally larger. In general, they should be located in a sunny position, have a long southern aspect, have access points allowing reptiles to enter the structure, be located in suitable foraging habitat and not be prone to flooding (Edgar *et al.*, 2010). The latter is likely to be a critical consideration on a peatland site. It is often recommended that a pit is dug, and materials partially buried when creating a hibernaculum. However, on peatland sites where the water table is to be raised, this is unlikely to be an appropriate approach as there will be risk of flooding for at least part of the hibernaculum. Therefore, on peatland restoration sites it is generally recommended to create hibernacula on the surface of the bog, although this will depend on local hydrology.

The bulk of the hibernaculum can be created using a variety of materials, including timber, brash, tree roots, inert hardcore, bricks, rocks etc. The choice of material may be determined by what is available onsite. Materials which will decompose (e.g. plant matter) should not be placed under more enduring matter such as rocks, however, so as to avoid risk of collapse. During some projects, timber, brash and tree roots removed may offer the most convenient solution.

Turfs should be removed from the footprint of the hibernaculum before construction. These should be retained, and replaced over the completed hibernaculum. Loose topsoil or peat could be compacted into any remaining larger cavities, as reptiles will use quite small holes and this may provide some protection against predators (e.g. mustelids) while they are vulnerable during hibernation.

Further information on hibernacula design can be found in best practice documents (e.g. Baker, 2010; Edgar *et al.*, 2010; Highways Agency *et al.*, 2005; Showler *et al.*, 2005; Stebbings, 2000; Whiting & Booth 2012). Note,

however, that it is preferable to incorporate entrances using natural materials, and not to use pipes as in some of these examples as reptiles seem to prefer to use more 'natural' holes.

### 7.3 *Avoiding harm during the active season*

Where it is not possible to avoid works in suitable reptile habitat or when reptiles may be active, it is necessary to consider other methods to avoid harm to animals. These include removal, exclusion and translocation. In addition, appropriate mitigation should be applied to ground-breaking works using heavy plant so as to further minimise the risk of harm.

Note that due to the generally localised short-term nature of peatland restoration activities, the use of exclusion fencing and removal or undertaking translocations is extremely unlikely to be appropriate for most projects, and this is likely to be the case for many developments, where works take place in small area for a short period of time. This document does not include detailed guidance on these methods, although they are mentioned below. If it is deemed appropriate to use fencing or to translocate reptiles, an ecological consultant with appropriate experience of reptiles in peatland habitats should be appointed to develop a mitigation plan.

In order to prevent injury or killing to reptiles in areas of suitable habitat where ground-breaking or heavy machinery will be travelling, it is necessary to make all reasonable effort to remove them from harm's way. This can be completed when reptiles are active, but not when they are hibernating (see Figures 1 and 3). Potential activities which could harm reptiles include devegetation works, excavation or tracking heavy plant over the site, meaning it may be necessary to consider access routes as well as work areas.

As the methods generally used for peatland restoration, and many developments in these habitats (e.g. underground or overhead power lines, access tracks etc) affect small areas for only short periods of time (less than one day), full exclusion and removal is unlikely to be proportionate or necessary. In most cases, checking the area to be affected immediately ahead of works, and removing any reptiles present should mitigate the risk of injury to individuals. For an activity very much restricted in area and of relatively low impact (such as working with hand tools), visual checks and a watching brief are likely to be sufficient. Where activities affect a larger area and/or involve heavy machinery, it may be necessary to complete more thorough checks combining visual searches and a high density of artificial refugia within the works footprint. If heavy plant will need to travel across the peatland to an area of works, this route should be included in checks to avoid reptiles being crushed. A combination of hand searches and the use of a high density of artificial refugia (minimum density of one tile per 20 $m^2$) should be completed by an appropriately skilled and experienced reptile ecologist (Gent & Gibson 2003). Refugia should be placed at least one week, although ideally four weeks, prior to the first checks. Checks should be completed immediately prior to any works commencing. Note that this may not be logistically onerous on peatland restoration projects as one ecologist may be able to cover two or three work areas, each of which may have multiple machines, in a single person day, depending on activity, size and proximity. On construction sites, a single Ecological Clerk of Works (ECoW) may be able to complete reptile checks as well as other ecology surveys in the same day, if appropriately skilled. Any reptiles found should be removed and relocated to suitable habitat at least 30 m from the area scheduled for works, or in areas where management has already been completed. If they are not removed there is a risk that they will take cover and not leave the area during works, making them susceptible to injury or death during management activities. However, it is unlikely that reptiles will return to the areas while works are taking place, due to disturbance (e.g. vibrations, noise and/or visual).

It is likely that most peatland restoration projects, and many developments in these habitats, will involve activities that will be extremely localised, and completed quickly (less than a day). In these cases, the use of exclusion fencing would be impractical, disproportionate and may result in greater impacts on reptile populations than the activity it is designed to mitigate. Instead, the use of a high density of refugia and hand checks immediately prior to works using heavy machinery may be more appropriate (following the same approach as for access routes described above). Any reptiles found can be removed from the area of works, and activities will have ended by the time they are able to return.

Where heavy plant is used in ground-breaking activities, it is recommended that vegetation turfs are removed first using hand tools if possible, and replaced after works. A toothed bucket should be used in order to

minimise risk to reptiles. A watching brief should be maintained during works, and an appointed ecologist should inspect works if appropriate.

If a reptile is found during works, activities must stop immediately (or as soon as it is safe to do so) within 30 m, until a suitably experienced ecologist removes this from the area (see 7.4 Note on reptile handling).

Where habitat will be destroyed and lost to development, or a discrete area will be subject to a high level of disturbance over a longer period, it may be appropriate to consider the use of one-way reptile exclusion fencing, as well as removing individuals from the area. A proprietary reptile fencing product may be installed, or an appropriate barrier fence constructed onsite prior to works commencing, under supervision by an ecologist. If constructing a fence, this should consist of thick UV resistant polythene sheet (or equivalents such as polypropylene) at least 40 to 50 cm high above ground, and held in place by stakes. The polythene should be buried by 20 cm so as to prevent reptiles from moving into the area underneath the fence. Curl joins should be used to continue fencing between two sheets, and this join must continue below ground. The fence should be sloped at an angle of between 45 ° and 40 ° (facing out from the area of works) to allow reptiles to scale this and leave the site. This angle should also make it more difficult for reptiles to climb the fence in the opposite direction. Nails or staples should be used to attach the polythene sheet to stakes, as these will be flush, whereas the use of battens should be avoided as these may assist reptiles to climb the fence. An example specification for one-way reptile exclusion fencing is provided in Figure 4.

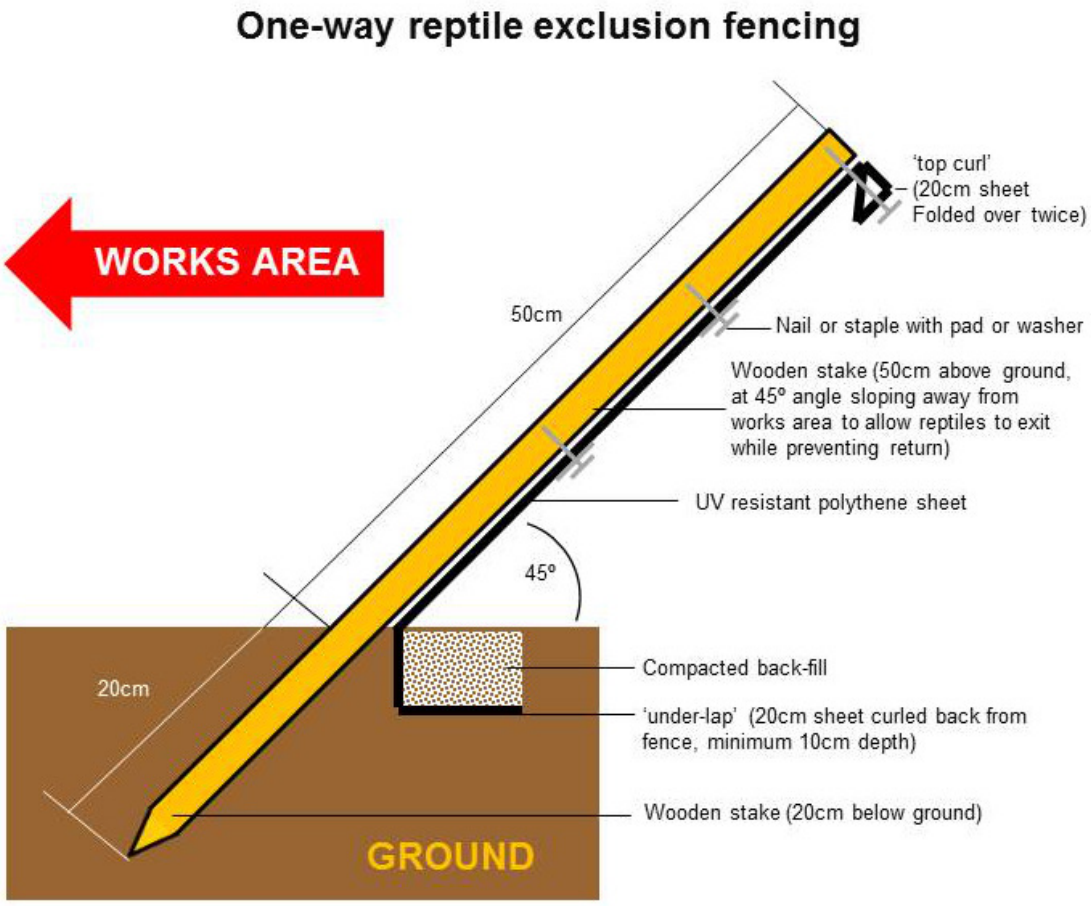



*Figure 4. Example specification for one-way reptile fencing.*

Vegetation may need to be cleared within 50 cm of the fence to prevent reptiles from climbing this to access the area of works. Reptile fencing requires regular inspection to ensure any maintenance requirements are identified and addressed quickly. Careful thought must be given to vehicular access, if required. The installation of plastic fencing which can deform and spring back into place after a vehicle transits over may be a potential option.

After installation of exclusion fencing, reptiles should then be removed from the area enclosed before works commence. This would involve the deployment of artificial refugia (density between one per 10 $m^2$ and one per 20 $m^2$ of suitable habitat), and, potentially, destructive searches. Vegetation and refugia must be thoroughly searched as part of a capture programme designed to remove reptiles from the area enclosed by fencing. This is likely to require a large amount of effort, with many visits. Exclusion and removal can be very complex, and is dependent on many factors, such as species present, habitat type, site size, time of year etc. The subject is covered in greater detail elsewhere (e.g. Highways Agency *et al.*, 2005; HGBI, 1998; Gent & Gibson, 2003; Natural England, 2011). As such, an appropriately experienced reptile ecologist must be engaged to lead this, including the selection of an appropriate minimum number of visits which must be made prior to works commencing (note that no works should begin until after at least five consecutive visits have been made where no reptiles have been found in the area – this may result in an increase in the number of visits necessary, but should not reduce this below the minimum effort planned).

An alternative approach to traditional capture, removal and exclusion methods described above may be to render habitat scheduled for works unsuitable for reptiles by reducing vegetation height and removing refuges ('passive exclusion'). However, this approach is unlikely to be compatible with most peatland restoration projects, and shouldn't be used where large areas of habitat will be lost to development.

As noted previously, some adders may spend long periods of time underground in small mammal burrows (Hand, 2014). A practical method to avoid harm to adders while underground has not been developed at time of writing.

Where habitat will be rendered unsuitable for reptiles after works, translocation may be necessary (subject to appropriate licences if moving outside their native range as defined in National Species Reintroduction Forum (2014a, 2014b)). In this case 'translocation' refers to a situation where reptiles are moved to a new site as habitat on the original site will no longer be suitable after works (i.e. rehoming). A situation where animals are simply moved out of the way of temporary works but are able to return to the original area later (i.e. relocation) is not considered to be translocation. Translocations are all site specific and very complex, requiring much preparatory work and so an appropriately experienced reptile ecologist must be engaged to lead this. Further information on reptile translocations can be found in Gent & Gibson 2003. In Scotland, conservation translocations must also adhere to *The Scottish Code for Conservation Translocations*, and this is likely to apply to projects where habitat is lost and reptiles are moved to a receptor site where these species are thought to be absent (National Species Reintroduction Forum, 2014a; National Species Reintroduction Forum, 2014b). As such, a licence may be required for translocations in Scotland. As peatlands will generally continue to offer suitable habitat for reptiles after restoration works have been completed it is unlikely that translocations will be necessary for such conservation projects. For particularly high impact peatland restoration projects, a staged approach may be used which could avoid the need for translocations, instead relying on exclusion and removal methods.

### 7.4 *Note on reptile handling*

All reptiles are fragile animals, and incorrect handling can cause injury or fatalities. In addition, both common lizards and slow-worms will shed their tails when stressed, and so care must be taken to avoid this. It is therefore essential that any reptiles found are only handled by suitably experienced ecologists. Furthermore, adders are venomous and so must only be handled by skilled and experienced snake ecologists, using appropriate personal protective equipment.

If a reptile is found by other project team members, they must bring this to the attention of the ecologist as soon as it is safe to do so, so that they can deal with the animal appropriately.

### 7.5 *Long-term habitat management and monitoring*

While this document focuses on mitigation techniques which aim to avoid harm to reptiles during works, consideration should also be given to the potential long-term impacts on these animals. Reptile populations onsite should be included within site management or enhancement plans, and it may be appropriate to set specific conservation objectives for these. Efforts to preserve the specific habitat requirements of reptiles onsite (e.g. varied micro-topography, basking sites, hibernaculum features etc) should be incorporated in to site management or enhancement plans. Where opportunities arise, habitat enhancement (e.g. creating new hibernacula) should be undertaken. A summary of artificial hibernacula construction and further reading has been provided in Section 7.2, and the *Reptile Habitat Management Handbook* (Edgar *et al.*, 2010) is an excellent resource which should be referred to when preparing site management plans. This document also includes advice to help resolve perceived conflicts between wider habitat management objectives and reptiles.

Long-term monitoring of reptiles at peatland sites should also be considered. If habitat management is undertaken at a site, monitoring will help determine whether reptile mitigation has been successful, and can inform future projects. Monitoring can also help to identify negative population changes at an early stage, allowing them to be addressed. Reports detailing the results of mitigation and monitoring should be made available to decision makers, site managers and professional ecologists so that they can use this information. These reports should be written with reference to CIEEM guidance (CIEEM, 2015). Fuller *et al.* (2016) provide excellent recommendations to help design and focus monitoring plans for particular sites, and with consideration to varying budgets.

If it is not possible to accommodate reptile populations during a project, then enhancing a neighbouring site (which need not be a peatland) as compensation may be appropriate. However, this is unlikely to be a common problem for projects in peatland habitats, as, if considered appropriately, these sites will not only continue to support reptiles, but habitat may also be improved for these animals after management has been completed.

## 8. References


Artz, R.R.E., Donnelly, D., Andersen, R., Mitchell, R., Chapman, S.J., Smith, J., Smith, P., Cummins, R., Balana, B. & Cuthbert, A. 2014. *Managing and restoring blanket bog to benefit biodiversity and carbon balance – a scoping study. Scottish Natural Heritage Commissioned Report No. 562*. SNH, Inverness.

Bain, C.G., Bonn, A., Stoneman, R., Chapman, S., Coupar, A., Evans, M., Gearey, B., Howat, M., Joosten, H., Keenleyside, C., Labadz, J., Lindsay, R., Littlewood, N., Lunt, P., Miller, C.J., Moxey, A., Orr, H., Reed, M., Smith, P., Swales, V., Thompson, D.B.A., Thompson, P.S., Van de Noort, R., Wilson, J.D. & Worrall, F. 2011. *IUCN UK Commission of Inquiry on Peatlands.* IUCN UK Peatland Programme, Edinburgh.

Baker, J. 2010. *Dunwich Forest Habitat Management Proposals for Reptiles.* Amphibian and Reptile Conservation, Bournemouth.

Bowler, J. & Hunter, J. 2007. *The Birds of Tiree and Coll.* Paircwood Publishing, Balephuil.

Cameron, R. 2008. *Land Snails in the British Isles. Second edition. AIDGAP.* FSC Publications, Telford.

Cathrine, C. 2014. Grass Snakes (*Natrix natrix*) in Scotland. *The Glasgow Naturalist*, **26**, 36-40.

Cathrine, C. & Bradley, I. 2016. Freasdail Wind Farm Grid Connection: Reptile Mitigation. *The Vanishing Viper: Priorities for adder conservation.* Cheddar, 9 October 2016. Available at: http://www.caledonianconservation.co.uk/cms/resources/Publications/vanishingviperfreasdailpresccibwebl.pdf

Cathrine, C. & Norris, G. 2015. *Buglife – The Invertebrate Conservation Trust: LIFE13 BIO / UK / 000428 Fannyside Muir Construction Method Statement: Reptile Mitigation. CC0300/CMS1*. Caledonian Conservation Ltd, Bridge of Allan. Available at: http://caledonianconservation.co.uk/Fannyside_Muir_Method_Statement_CMS1_Reptile_Mitigation_20150730.pdf

Čeirāns, A. & Nikolajeva, L. 2017. Habitat ecology of the smooth snake *Coronella austriaca* and its reptilian prey in the degraded bog with implications for artificial refuge surveys. *Zoology and Ecology*, **27**, 19-29.

Chartered Institute of Ecology and Environmental Management (CIEEM). 2015. *Guidelines on Ecological Report Writing.* Chartered Institute of Ecology and Environmental Management.

CIEEM. 2016a. *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal. 2nd ed.* Winchester: Chartered Institute of Ecology and Environmental Management.

CIEEM. 2016b. *Principles of Preparing Good Guidance for Ecologists and Environmental Managers.* CIEEM, Winchester.

Edgar, P., Foster, J. & Baker, J. 2010. *Reptile Habitat Management Handbook.* Amphibian and Reptile Conservation, Bournemouth.

Froglife. 1999. *Advice Sheet 10. Reptile survey: an introduction to planning, conducting and interpreting surveys for snake and lizard conservation.* Froglife, Peterborough.

Fuller, R., Marshall, M., Eversham, B., Wilkinson, P. & Wright, K. 2016. The Increasing Importance of Monitoring Wildlife Responses to Habitat Management. *British Wildlife*, **27**(3), 175-186.

Gent, T. & Gibson, S. 2003. *Herpetofauna Workers Manual*. Joint Nature Conservation Committee, Peterborough.

Hand, N. 2014. Adder antics in the Malvern Hills: What does radio-telemetry reveal? *Herpetofauna Workers' Meeting 2014*. Bristol, 1 February 2014.

Herpetofauna Groups of Britain and Ireland (HGBI). 1998. *Evaluating local mitigation/translocation programmes: maintaining best practice and lawful standards. HGBI advisory notes for amphibian and reptile groups.* HGBI c/o Froglife, Halesworth. (Unpublished).

Highways Agency, Scottish Executive, Welsh Assembly Government & The Department for Regional Development Northern Ireland. 2005. *DMRB Volume 10 (Environmental Design and Management). Section 4, Part 7 (HA116/05): Nature Conservation –Advice in relation to reptiles and roads.* Highways Agency, Scottish Executive, Welsh Assembly Government & The Department for Regional Development Northern Ireland.

Inns, H. 2009. *Britain's Reptiles and Amphibians. A guide to the reptiles and amphibians of Great Britain, Ireland and the Channel Islands.* WILDGuides Ltd, Old Basing.

IUCN Peatland Programme. 2018. *UK Peatland Strategy.* IUCN.

Jofré, G.M., Warn, M.R. & Reading, C.J. 2016. The role of managed coniferous forest in the conservation of reptiles. *Forest Ecology and Management*, **362**, 69-78.

Langton, T.E.S. & Beckett, C.L. 1995. *Home range size of Scottish amphibians and reptiles. Scottish Natural Heritage Review No. 53.* SNH, Battleby.

Langton, T.E.S., Beckett, C.L. & Dunmore, I. 1993. *UK Herpetofauna. A Review of British Herpetofauna Populations in a Wider Context, April 1993. A Report to JNCC by Herpetofauna Consultants International.* JNCC.

Lenders, T. 2015. Het effect van dynamisch terreinbeheer op een slinkende adderpopulatie. *RAVON*, **57**, 31-35.

Lindsay, R.A. & Immirzi, C.P. 1996. *An inventory of lowland raised bogs in Great Britain. Scottish Natural Heritage Research, Study and Monitoring Report. No. 78.* SNH, Battleby.

Massot, M., Clobert, J., Pilorge, T., Lecomte, J. & Barbault, R. 1992. Density dependence in the common lizard: demographic consequences on density manipulation. *Ecology*, **73**, 1742-1756.

McInerny, C.J. 2014a. Observations on a population of adders, slow-worms and common lizards on Loch Lomondside, Scotland. *The Glasgow Naturalist*, **26**, 63-68.

McInerny, C.J. 2014b. Habitat preferences of European adders at Loch Lomond, Scotland. *The Glasgow Naturalist*, **26**, 69-74.

McInerny, C.J. 2016. Reptile populations persist following the installation of a hydroelectric scheme at Loch Lomond, Scotland. *The Herpetological Bulletin*, **135**, 11-14.

McInerny, C.J. 2017. Observations on co-existing populations of adders, slow-worms and common lizards at Loch Lomond, Scotland: implications for conservation. *The Glasgow Naturalist*, **26**, 15-24.

McInerny, C.I. & Minting, P. 2016. *The Amphibians and Reptiles of Scotland.* The Glasgow Natural History Society, Glasgow.

National Species Reintroduction Forum. 2014a. *The Scottish Code for Conservation Translocations*. Scottish Natural Heritage.

National Species Reintroduction Forum. 2014b. *Best Practice Guidelines for Conservation Translocations in Scotland Version 1.1*. Scottish Natural Heritage.

Natural England. 2011. *Reptile Mitigation Guidelines.* Natural England, Peterborough. (Withdrawn)

Norris, G., Cathrine, C., Gillen, G. & Johnston, S. 2015. *Buglife – The Invertebrate Conservation Trust: LIFE13 BIO / UK / 000428 Fannyside Muir: Baseline Ecology Report.* Caledonian Conservation Ltd, Bridge of Allan. Available at: http://caledonianconservation.co.uk/Buglife_Fannyside_Muir_Baseline_Report_20150730.pdf

Prestt, I. 1971. An ecological study of the viper (*Vipera berus*) in southern Britain. *Journal of Zoology*, **164**, 373-418.

Riddell, A. (ed) 1997. *The Slow-worm.* Kent Amphibian and Reptile Group (KRAG), Canterbury.

Scottish Natural Heritage (SNH). 2015. *Scotland's National Peatland Plan. Working for our future.* SNH, Inverness.

Sewell, D., Griffiths, R.A., Beebee, T.J.C., Foster, J. & Wilkinson, J.W. 2013. *Survey Protocols for the British Herpetofauna. Version 1.0.* Amphibian and Reptile Conservation Trust, Durrel Institute of Conservation and Ecology & University of Sussex.

Sewell, D., Guillera-Arroita, G., Griffiths, R.A. & Beebee, T.J.C. 2012. When is a species declining? Optimizing survey effort to detect population changes in reptiles. *PLoS ONE*, **7**(8): e43387. doi:10.1371/journal.pone.0043387

Showler, D.A., Aldus, N. & Parmenter, J. 2005. Creating hibernacula for common lizards Lacerta vivipara, The Ham, Lowestoft, Suffolk, England. *Conservation Evidence*, **2**, 96-98.

Smith, N.D. 1990. *The Ecology of the Slow-worm (*Anguis fragilis *L.) in southern England. A Thesis for the Degree of Master of Philosophy.* Department of Biology, University of Southampton.

Stebbings, R. 2000. Reptile hibernacula – providing a winter refuge. *Enact, English Nature*, **8**, 2, 4-7.

Taylor, N.G., Grillas, P. & Sutherland, W.J. 2018. *Peatland Conservation: Global Evidence for the Effects of Interventions to Conserve Peatland Vegetation.* Synopses of Conservation Evidence Series. University of Cambridge, Cambridge.

Whiting, C. & Booth, H.J. 2012. Adder Vipera berus hibernacula construction as part of a mitigation scheme, Norfolk, England. *Conservation Evidence*, **9**, 9-16.

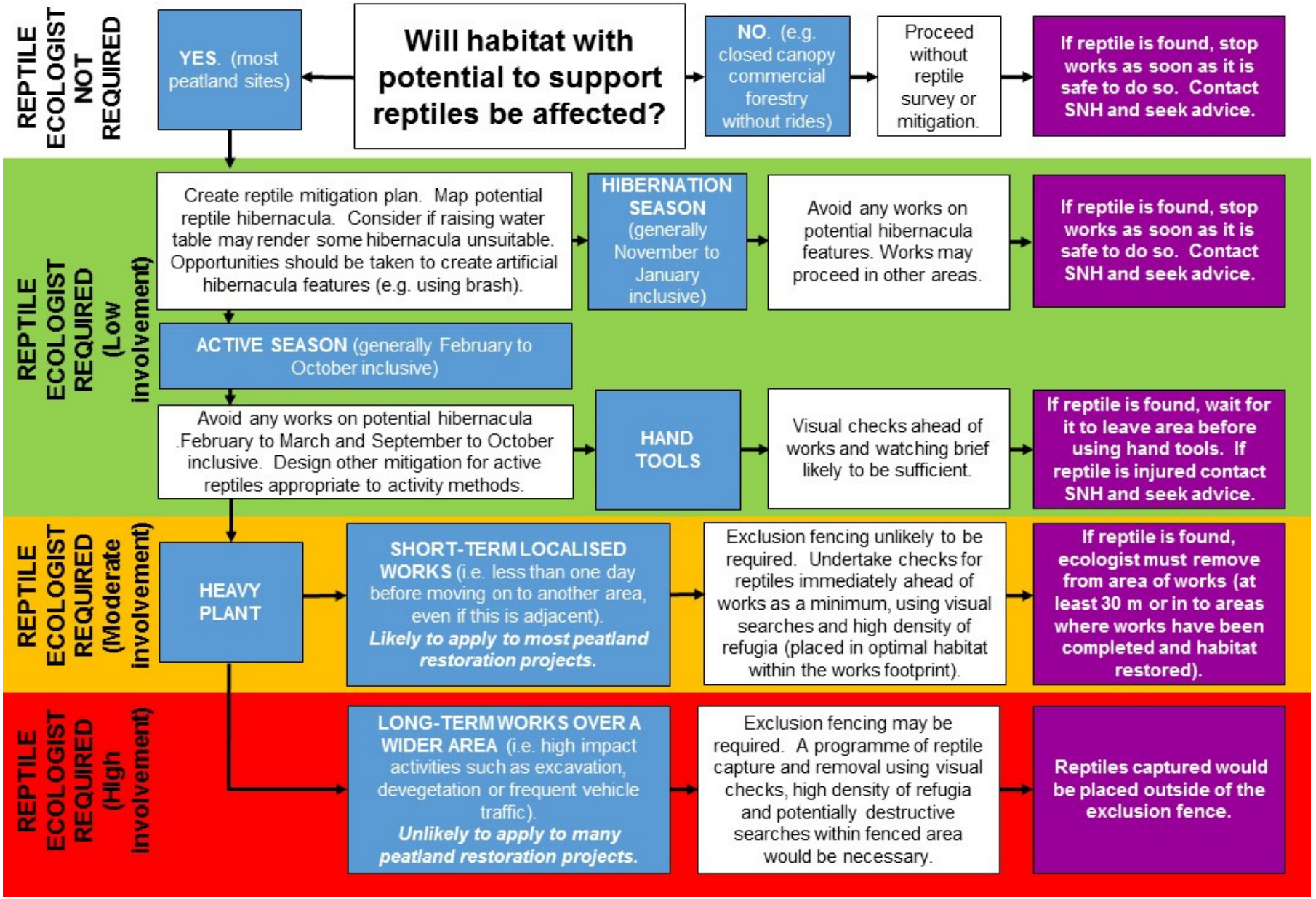
## APPENDIX: Flow chart and mitigation summary for reptiles on peatland sites

This Appendix provides a flow chart to help decide on the appropriate approach to planning work on peatland sites while giving consideration to reptiles. It also indicates when it is advisable to seek advice from reptile ecologists, and the likely level of involvement from these experts that will be necessary for different approaches to aid with project planning.

A table summarising general activities with suggestions for appropriate mitigation is also provided. However, note that the appropriate mitigation approaches will vary depending on the particular circumstances of a site, reptile populations present, and project details.

The flow chart and summary table could be printed on both sides of an A4 sheet and taken on site to aid with project planning.

***Peatland Restoration Site Management Decision Flow Chart***



## *Peatland Reptile Mitigation Summary Table*

| **Works Activity** | **Season*** | **Action / Mitigation** | **Further Information** |
|---|---|---|---|
| Site Design or Preparation of Site Management Plan. | General | Incorporate reptile ecology requirements in to site management plan, including maintaining or enhancing habitat such as hibernaculum features. Set reptile objectives. | Section 5<br>Section 7.5 |
| Gathering baseline information for preparation of Mitigation Plan. | General | Data search for existing historic reptile records. | Section 5<br>Section 6 |
| | Hibernation | Map potential hibernaculum features. | Section 5<br>Section 6 |
| | Active | Map suitable habitat. Undertake presence survey if required using artificial refugia and visual transects. | Section 5<br>Section 6 |
| Activities using hand tools. | Hibernation | Do not undertake works which could damage hibernacula. | Section 7.2 |
| | Active | Visual check of work area immediately prior to activity. If reptiles present, do not complete works until they have left area. | Section 7.3 |
| Activities using heavy plant – localised, short-term (including infrequent movements of heavy plant across suitable reptile habitat).<br>***Likely to apply to most peatland restoration projects.*** | Hibernation | Do not undertake works which could damage hibernacula. Heavy plant must not move over hibernacula. | Section 7.2 |
| | Active | Ecologist check for reptiles immediately before works using high density of artificial refugia (minimum density of one tile per 20 $m^2$ placed at least one week prior to works) and visual searches within works footprint (including access routes for heavy plant). Any reptiles found should be removed by the ecologist and relocated to suitable habitat at least 30 m from the area scheduled for works, or in areas where works have already been completed and habitat restored. | Section 7.3<br>Section 7.4 |
| Activities using heavy plant – larger areas, long-term (including frequent movements of heavy plant using across suitable reptile habitat).<br>***Unlikely to apply to many peatland restoration projects.*** | Hibernation | Do not undertake works which could damage hibernacula. Heavy plant must not move over hibernacula. | Section 7.2 |
| | Active | May require use of barrier fencing to exclude reptiles from an area which will be subject to intensive destructive work or where a particular route will be used for frequent heavy plant movements over an extended period. Fence installation should be supervised by an ecologist. All reasonable effort should be made by an ecologist to remove reptiles from the fenced area, and to place these outside the fence. Destructive searches may be required. If the area will not be restored for reptile use after works are complete, translocation (under licence if appropriate) and/or creation of new areas of reptile habitat as compensation may be necessary. | Section 7.3<br>Section 7.4 |
| Monitoring | General | Long-term monitoring of reptiles at peatland sites should also be considered. If habitat management is undertaken at a site, monitoring will help determine whether reptile mitigation has been successful, and can inform future projects. Monitoring can also help to identify negative population changes at an early stage, allowing them to be addressed. | Section 7.5 |

**Hibernation season = September to March inclusive; Active season = February to October inclusive. See Section 2 and Figures 1 and 3 for more information.*

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