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Action Plan for the Conservation of the Sand Lizard (*Lacerta agilis)* in Northwest Europe

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1. Introduction

The sand lizard, *Lacerta agilis*, is widespread in Europe but has suffered severe declines in a number of countries at the northwestern edge of its range. This Action Plan has been commissioned by the Standing Committee of the Bern Convention in order to assess the extent of the problems faced by this species in northwest Europe and to make appropriate recommendations to address these. Nine subspecies of sand lizard are currently recognised but this Plan is primarily concerned with endangered populations of the western subspecies *Lacerta agilis agilis*, specifically those occurring in the United Kingdom, northern France (Normandy), Belgium, the Netherlands, northern Germany, Denmark and Sweden. Brief mention is made, however, of the subspecies *Lacerta agilis chersonensis*, which is known to have suffered similar declines (for much the same reasons) in Estonia and, although current information is limited, presumably in other Baltic states as well. This section, Part A, summarizes the need for this Species Action Plan and highlights the most urgent priority actions required, as well as the countries to which these are relevant. Further actions and much additional information can be found in Part B, the main body of the Species Action Plan.

2. Rationale

Lacerta agilis is a small to medium sized lizard, reaching about 18cm in total length in northern Europe. Although sand lizards occur in habitats as diverse as urban gardens and alpine pastures further south in Europe, the range-edge populations in the northwest are restricted to sandy habitats, such as lowland heathland and sand dunes. These habitats are themselves limited in extent, and often under threat, and *Lacerta agilis* is further restricted within them by its specific habitat requirements at northern latitudes. These include a varied topography, but mainly with a south facing aspect, a diverse vegetation structure (such as that provided by mature and degenerate heather on dry heaths) and open, bare sand for egg laying. Populations in the United Kingdom, northern France, Belgium, the Netherlands, northern Germany, Denmark and Sweden, as well as those in Estonia and probably other Baltic states, have suffered extensive declines in recent decades. Threats include direct habitat destruction and fragmentation, habitat degradation (which is particularly severe on heathlands adjacent to urban areas), a lack of management, inappropriate habitat management and a variety of other, localised problems.

This species listed in Annexe II of the Bern Convention and Annexe IVa of the Habitats and Species Directive and receives strict protection in all of the countries covered by this Action Plan. In addition, a significant proportion of its populations in northwest Europe are now included within the Natura 2000 site series, particularly those on lowland heathland and sand dunes. Comprehensive conservation work has already been undertaken in a number of countries and, in the United Kingdom, these efforts have now been underway for 35 years. The overall goal of this Action Plan is to expand on these successes and to ensure the maintenance, and restoration where necessary, of viable range-edge populations of sand lizards in northwest Europe. A series of general objectives are outlined and specific actions are proposed that include the coordination of conservation efforts for this species, additional distribution surveys, habitat management recommendations, population and conservation status monitoring, scientific research and public awareness programmes.

3. Objectives. The main reasons for producing this Species Action Plan are to ensure that:

i. The decline of the sand lizard in northwest Europe is reversed

ii. Viable populations are re-established and enlarged, and isolated populations are re-connected, throughout its northwestern European range

iii. All populations are subsequently maintained as a viable and integral part of the habitats and landscapes they occupy

Seven general objectives are proposed to help achieve these overall aims. These cover the protection and management of both species and habitat, additional distribution surveys, population and conservation status monitoring, scientific research, the improved coordination of conservation efforts and raising public awareness.

Figure 1: Male Sand Lizard *Lacerta agilis agilis* (Photograph: Chris Gleed-Owen)

4. Recommended Actions

Conservation work is already underway for the sand lizard in most countries in northwest Europe but it is important to expand on these successes to ensure the maintenance, and restoration where necessary, of viable sand lizard populations in this region. Consequently, 49 specific actions are proposed in this Species Action Plan, 14 of which have been identified as being of the most urgent priority (see Table 1, below). These actions should therefore be implemented as soon as possible. The remaining 35 actions are of a less immediate priority, or, as in the production of national recovery plans, will take time to realise, but are nonetheless still important for the recovery of sand lizard populations. Among the most vital elements of future conservation work for sand lizards will be the effective liaison and coordination of these efforts, both within and between range countries, and, of course, adequate funding.

Table 1: Urgent Priority Actions for the Sand Lizard *Lacerta agilis* in Northwest Europe

Area of Activity	Urgent Priority Actions	Relevant Countries
Habitat Protection	**Action 4.1.1.** Ensure that all habitats supporting known sand lizard populations in the United Kingdom, northern France (especially Normandy) Belgium, the Netherlands, northern Germany, Denmark, Sweden and Estonia are protected from any threats of further habitat loss by appropriate national designations.	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia
Habitat Management	**Action 4.2.1.** Prepare management plans for all known sand lizard sites (or ensure existing plans are suitably modified) that map key sand lizard areas and fully take into account the likely movements and particular ecological requirements of this species on each site.	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia
Habitat Management	**Action 4.2.2.** Control vegetation succession on key sand lizard heathland and sand dune sites by the regular removal of trees and scrub and the control of bracken, as necessary, ensuring that sufficient cover is retained where this is important for creating a favourable microclimate in exposed areas.	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia
Habitat Management	**Action 4.2.3.** Ensure sufficient areas of bare sand, which are vital for egg laying by this species in northwest Europe, are regularly created (and are maintained as appropriate) at all known sand lizard localities. These areas of bare ground should ideally cover between 5 – 10%, of the total area of suitable sand lizard habitat on any site.	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia

Habitat Management	**Action 4.2.4.** Avoid the overstocking of grazing animals at sand lizard sites and ensure that the placement of fence lines, corrals and water troughs does not exacerbate trampling damage to key sand lizard areas.	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia
Habitat Management	**Action 4.2.5.** Prohibit excessive levels of controlled burning on heathland sand lizard sites, specifically avoiding key areas that support this species.	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia
Habitat Management	**Action 4.2.6.** To preserve the structural diversity of vegetation, avoid mechanical cutting on key sand lizard areas and ensure that no more than 5 % of the remaining area is ever cut in any one season. Limit any mechanical cutting to the autumn and winter months (November – early February).	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia
Habitat Management	**Action 4.2.7.** Avoid excessive mechanical turf cutting or turf stripping on heathland sand lizard sites, ensuring that no more than 5 % of the site is treated in any one season and that prime sand lizard areas (or "foci") are identified and avoided.	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia
Habitat Management	**Action 4.2.8.** Establish appropriate fire prevention measures on heathland sand lizard sites, including adequate firebreaks (which include an element of bare sand along the northern edges) and fire control plans.	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia
Habitat Management	**Action 4.2.9.** Where necessary, ensure that provisions are in place for adequate levels of wardening to manage public access and to prevent illegal motorbike use and other form of abuse. In particular, access to sandy areas used for egg laying by sand lizards should be carefully controlled.	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia
Distribution Surveys	**Action 4.5.1.** Continue distribution surveys and the mapping of *Lacerta agilis agilis* habitats in the United Kingdom, northern France, Belgium, the Netherlands, northern Germany, Denmark and Sweden.	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia
Distribution Surveys	**Action 4.5.2.** Collate existing information about populations and habitats of *Lacerta agilis chersonensis* in Estonia and other Baltic states with its range and initiate new surveys if necessary.	Estonia, Latvia, Lithuania, Poland, Russia
Population and Conservation Status Monitoring	**Action 4.6.1.** Determine the historical range of the sand lizard in the United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden and the Baltic states, as well as the current range of this species, to assist with the development of specific targets for habitat restoration and re-creation strategies, as well as species re-introduction programmes.	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia, Latvia, Lithuania, Poland, Russia
Improved Liaison and Coordination	**Action 4.8.1.** Ensure that the Governments and relevant conservation bodies of the United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden and Estonia adopt this Action Plan.	United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden, Estonia

PART B. SAND LIZARD (NW EUROPE) – SPECIES ACTION PLAN

1. INTRODUCTION

The sand lizard, *Lacerta agilis*, has one of the most extensive distributions of any reptile species in the world, occurring from Spain to China, and from Sweden south to Greece. Although this species is found in a wide range of habitats, and is still abundant in many countries, it has suffered massive population declines along the northwestern edge of its world range. Here is it is largely restricted to sandy habitats, particularly lowland heathland and sand dunes, which are themselves seriously threatened in Europe. This Action Plan has been commissioned by the Standing Committee of the Bern Convention to address the problems faced by the sand lizard in northwest Europe and focuses on

the plight of this species in the United Kingdom, northern France (Normandy), Belgium, the Netherlands, northern Germany, Denmark and Sweden, with reference to other populations in Estonia and along the Baltic coast.

An attempt has been made in this Action Plan to summarise the literature that is most pertinent to sand lizard conservation in the northwestern parts of its European range. The taxonomy and ecology of this species are covered briefly, while more attention is given to its distribution and status and to the threats that it is known to face. A series of general objectives and specific conservation actions are recommended for adoption by the Bern Convention and relevant national governments. It should be noted that this Action Plan is not intended to be a static document. As additional information is obtained, and as conservation work and scientific research progress, subsequent versions should be produced that report on successes and make updated recommendations as necessary. In future years, the successful conservation of the sand lizard at the edge of its range in northwestern Europe should be seen as an important measure of, and contribution towards, international efforts to maintain the biodiversity of Europe.

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2. BACKGROUND INFORMATION

2.1. Systematics

The sand lizard was first described in 1758 by Linnaeus from a specimen found in southern Sweden. It occurs from western Europe right across to northern China and Mongolia, and from the Baltic states south to Greece and Turkey. Until recently nine subspecies were recognised from its European range (Bischoff 1988), although this has now increased to ten (Arribas 2000; Kalyabina-Hauf *et al* 2001). These are:

Lacerta agilis agilis (western, northwestern and western central Europe)
Lacerta agilis garzoni (eastern Pyrenees)
Lacerta agilis argus (eastern central Europe)
Lacerta agilis boemica (northeastern Caucasus)

Lacerta agilis bosnica (mountains of the Balkans, as far south as the Pindos in central Greece)
Lacerta agilis brevicaudata (Transcaucasia, Armenia and adjacent Turkey)
Lacerta agilis chersonensis (eastern Europe and western Russia)
Lacerta agilis exigua (Russia, east of the Dniepr river, to Mongolia and northwest China)
Lacerta agilis grusnica (eastern and southeastern coats of the Black Sea)

The sand lizard is often abundant in many parts of this huge range and, in some countries, can be the most common species of lizard. However, this Action Plan is primarily concerned with the endangered range-edge populations of *Lacerta agilis agilis* in northwest Europe, specifically the populations in the United Kingdom, northern France, Belgium, the Netherlands, northern Germany, Denmark and Sweden. Reference is also made too certain northern European populations of the subspecies *Lacerta agilis chersonensis*, particularly in Estonia.

2.2. Description

2.2.1. Morphology. *Lacerta agilis* is a short-legged, rather robust, medium sized lizard and is the smallest member of the "green lizard " group of the family Lacertidae. Sand lizards normally attain a total length of about 18 cm in the north of the range, while some continental specimens can reach 25 cm. The tail is approximately 1.5 times the snout-vent length. Male sand lizards are slightly smaller than females but have noticeably larger heads.

2.2.2. Colouration. Sand lizards exhibit distinct sexual dimorphism in coloration. Males develop bright green flanks in the breeding season, which usually fades prior to hibernation, whereas females retain the light brown or grayish ground colour all year. Males also have some dark reticulated mottling or patches of black scales along the sides, while females generally have a plain background colour. There is a dark vertebral band composed of numerous brown or black markings, which can be rectangular, circular, semicircular or irregularly shaped, along with various white spots or lines. A lighter stripe runs down either side of this band and some specimens may also have a broken white vertebral stripe. One or two rows of dark spots with white centres (ocelli) usually occur along the sides of most animals. There are many variations in the colour and pattern across the range of this species. For example, a red backed "erythronotus" form occurs in mainland Europe, and is seen more frequently in eastern populations, and males of *Lacerta agilis chersonensis* can be completely green. Adult sand lizards have distinctive markings that can be used to identify individuals (Märtens and Grosse 1996; Fearnley 2002), a recognition technique that has become popular since the advent of digital photography. Juvenile sand lizards are light brown or tan and have very distinct ocelli. Melanistic specimens of *Lacerta agilis* have been recorded but appear to be very rare.

2.3. Life History

2.3.1. Habitat Requirements. Although sand lizards can be found in a huge variety of habitats in Europe (from urban gardens to alpine pastures), the range-edge populations in the northwest are more or less restricted to sandy habitats, such as lowland heathland and sand dunes, below about 300 m (Rühmekorf 1970; Märtens *et al* 1997; Moulton and Corbett 1999). Critical elements of sand lizard habitat in the northern range countries include a predominantly south or southwest facing aspect with minimal shading, a diverse vegetation structure – providing an intimate mosaic of basking spots and shelter – and abundant exposed sand for egg laying purposes (Corbett and Tamarind 1979; House and Spellerberg 1983). On lowland heathland sites adult sand lizards are more or less confined to the later successional stages of dry heath, i.e. the mature and degenerate phases of heather growth (Glandt 1991; Moulton and Corbett 1999), although dispersing juveniles can be found in other habitats. Areas with a luxuriant ground layer of bryophytes and lichens also seem to be particularly favoured. Dwarf gorses growing amongst heather are common on many sites and may help to protect the lizards from predation.

Prime areas for this species may exist within a matrix of less suitable habitat, resulting in localised concentrations of sand lizards. Such areas of optimal habitat create “foci” that are of particular importance to sand lizard conservation. The size and quality of such foci will vary considerably, and an extensive area of good habitat with a varied topography of slopes, gullies, tumuli and banks can support a large number of lizards. Densities of 100-300 lizards per ha have been recorded (Strijbosch and Creemers 1988; Moulton and Corbett 1999). Since habitats such as lowland heathland and sand dunes are naturally limited in extent in Europe, and the distribution of the sand lizard is further

restricted within them by its specific habitat requirements at higher latitudes, populations at the northern edges of the range are far more susceptible to external threats and adverse conditions than they are elsewhere.

2.3.2. Dietary Requirements. Sand lizards are largely insectivorous, actively chasing and consuming a range of spiders and insects, especially orthopterans, bugs and beetles. This species is also known to eat its own young (Corbett and Tamarind 1979).

2.3.3. Activity and Movements. The sand lizard is a strongly diurnal species. Basking is an important activity at northern latitudes and areas selected are usually in full sunlight but sheltered from the wind. Close proximity to cover is also crucial, so basking usually takes place in small open areas amongst, or along the edges of, taller vegetation. Sand lizards are mainly ground dwelling but will also climb into low vegetation to bask. A morning air temperature of about 18°C is needed before lizards emerge from their burrows to bask (Spellerberg 1988). At temperatures above 23°C basking activity is greatly reduced and the lizards engage in foraging or other behaviour, or retreat into their burrows. Basking can be prolonged in the spring and early autumn but during the hotter summer months may only be necessary for short periods. The hibernating burrow is often used for shelter early in the season, with at least one other burrow elsewhere often used later in the year. The length of the hibernation period depends on the locality but usually starts in early September in the north of the range, although hatchlings may be active until late October. Hibernation ends in March or April (Olsson 1988) in northern Europe but in particularly sheltered places along the south coast of England these lizards can appear as early as mid-February. Males emerge from hibernation at least 10-14 days before females. Since males require sufficient time for their sperm to develop and mature, this reduces the risks of females mating with infertile partners or being predated (Olsson and Madsen 1996).

Sand lizard movements, although generally limited, appear to vary depending on their sex, the time of year and the actual sites occupied. Males have been reported as having home ranges of only a few hundred square metres (which can overlap considerably), while those of females are often even smaller (Nicholson and Spellerberg 1989). Larger areas may be occupied in suboptimal habitats but, if conditions are especially suitable, adult sand lizards can be remarkably sedentary animals and may not venture more than a few metres in their entire lives (K. Corbett, *pers. com.*). However, males can move longer distances, when searching for females, and juveniles often cover many hundreds of metres when dispersing. During the mating season, males actively defend the female they are currently courting, as well as adjacent areas, against other males. They also develop a dominance hierarchy, with the larger and most brightly green males being most able to defend particular areas and females from rivals.

2.3.4. Reproduction. Male sand lizards peacefully bask together in early spring after they have emerged from hibernation. Within a few weeks, however, they have developed their bright green breeding colours and become extremely aggressive towards each other (Olsson 1988). The intensity of the males' green colouration indicates their individual fitness to the females. Depending on the weather, prolonged mating behaviour usually occurs between late March and early May. This is a period of frenetic activity for male sand lizards, which attempt to mate with as many females as possible while also fending off any rivals. Males may guard individual females for several days after copulation (Olsson 1993), although they can also start seeking other females almost immediately. Gravid females in northern Europe require patches of open sand in which to nest (although further south they are less restricted in choice of substrate) and the most favoured egg laying sites usually have a southerly aspect. The nests are located an average of 50 cm from the nearest vegetation (House and Spellerberg 1980) and the females often dig several test burrows until a suitable site is found. Between 4-14 eggs (up to a maximum of 18), measuring up to 10 x 15 mm, are laid between late May and early July in a small chamber at the end of the burrow. The females carefully create an air space above the eggs and refill the burrow after laying. Single clutches are normal in northern Europe but two may be laid elsewhere (Arnold 2002). Hatchlings emerge in about 7-12 weeks, depending on weather conditions, and are about 55-65 mm in total length. Sand lizards can live up to 12 years in the wild (Arnold 2002).

2.3.5. Predators and Competitors. Sand lizards are consumed by a huge range of predators including mustelids, foxes, badgers (Märtens 1996), various birds of prey and corvids and many species of snake. Wood ants can be a serious threat to incubating eggs and adult sand lizards will also cannibalise their own hatchlings (Corbett and Tamarind 1979). Domestic and introduced species that

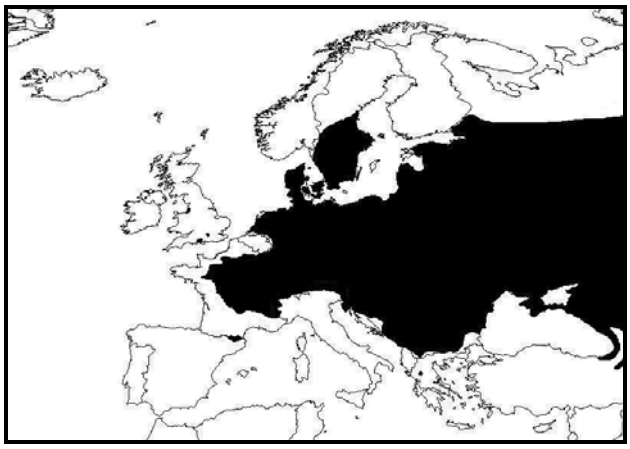
prey on sand lizards include pheasants (Bergmans and Zuiderwijk 1986), chickens and, one of the most damaging predators of all, the ordinary house cat (Henshaw 1998). Sand lizards are frequently sympatric with common lizards, *Zootica vivipara*, and slow worms, *Anguis fragilis*, in northwest Europe but do not seem to compete with either. The various green lizard and wall lizard species may be more effective competitors elsewhere.

2.4. Distribution and Conservation Status

2.4.1. Summary of the Distribution and Conservation Status of the Sand Lizard

Lacerta agilis has one of the most extensive distributions of any reptile species in the world. It occurs in 36 countries across Europe, although is largely absent from Iberia and the Mediterranean region (Figure 1: Gasc *et al* 1997), and its range extends eastwards to Mongolia and northwest China. It is distributed fairly evenly, wherever there is suitable habitat, from sea level to about 2450 m (at Col de France in the Alps).

Map 1: Distribution of the Sand Lizard *Lacerta agilis* in Europe



Sand lizard populations in northwest Europe are largely confined to warm sandy habitats. The occurrence of this species at these higher latitudes is therefore restricted to biotopes that are already rare themselves. At the very northern edge of its European range, particularly in northern Russia and the Baltic states, sand lizard abundance is mainly limited by climatic factors. Therefore, its populations and distribution here will fluctuate naturally, regardless of the availability of suitable soils and habitats. This species is still widespread in northern countries such as Poland and Lithuania, but has suffered its most severe declines as a result of human activities, and has an unfavourable conservation status, in the following countries:

United Kingdom. Native populations of *Lacerta agilis* have been lost from the English counties of Berkshire, Cheshire, Cornwall, Devon, East Sussex, Hampshire, Kent, West Sussex and Wiltshire, and this species also became extinct in Wales (Corbett 1988a; Moulton and Corbett 1999). Sand lizards occur in significant numbers on the lowland heathlands (and one dune system) of Dorset, in southern England, which supports well over half of the UK population. Small numbers of sand lizards also survive on heathlands in Surrey, about 100 km northeast of Dorset, plus the coastal dunes of Merseyside in northwest England (Corbett 1988a). A small introduced population has also survived on the Isle of Coll, off the west coast of Scotland, for over 25 years. There were estimated to be around 6500 adult lizards surviving in the United Kingdom in 1997 (Moulton and Corbett, 1999), with all but a few hundred animals occurring on Dorset heathland, although recent estimates indicate that this number is substantially higher (C. Gleed-Owen *pers. com.*). In any event, apart from a number of urban fringe sites, which face severe public pressure, the decline of *Lacerta agilis* in the UK has been effectively halted. Most populations are now stable or increasing and sand lizards have also been re-introduced to several English counties.

Northern France (Normandy). Two subspecies of *Lacerta agilis* occur in France. *Lacerta agilis garzoni* is isolated in the eastern Pyrenees, extending slightly into Spain and Andorra, and hence occurs outside the area covered by this Action Plan (although this subspecies is of conservation

concern itself). *Lacerta agilis agilis* has a largely continental distribution in France – it does not reach the Channel and is absent from Brittany, the central west, the southwest and the Mediterranean regions of the country. While it still occurs over extensive areas of eastern and central France, many populations along the northern and western edges of this distribution are isolated and often declining. This trend is especially marked in Limousin and Normandy and is principally due to the loss of heathlands to urbanisation (P. Haffner *pers. com.*).

Belgium. The sand lizard only occurs in the extreme south of Wallonia, south of the Semois river in Luxemburg Province (Percsy *et al* 1997). This species has suffered an extremely severe decline in Belgium and is apparently now confined to just three localities. One is a heathland complex of approximately 1,500 ha, largely contained within the military training area of Arlon. The other two sites are old stone quarries, of about one ha each, where tiny numbers of lizards inhabit rough grassland with brambles. The Arlon site is regarded as the only viable sand lizard population left in Belgium, albeit with only a few hundred animals surviving, but is threatened by lack of management, especially the encroachment of conifers. This species is considered to be critically endangered in Belgium. *Lacerta agilis* is thought to have once inhabited heathland in Flanders, northeast Belgium, although is some debate as to whether it was ever found here at all (D. Bauwens *pers. com.*, J. Speybroeck *pers. com.*).

The Netherlands. The main range of the sand lizard in the Netherlands is confined to sandy heathlands, notably the Veluwe and Utrechtse Heuvelrug (Stumpel 1988), in the centre, east and south east of the country (Strijbosch 1985; Zuiderwijk *et al* 1992). It also occurs in dune systems along the coast (in the provinces of Zealand and South-Holland), on most of the Wadden islands and on the Frisian islands of Vlieland, Terschelling and Schiermonnikoog. *Lacerta agilis* is considered to be Vulnerable in the Red List for the Netherlands (Hom *et al* 1996). While the dune populations appear to be stable and are benefiting from positive conservation management (Stumpel 2004), the island populations are decreasing (RAVON 2003) and almost all of the heathland populations are under some threat, or have already been lost (Bergmans and Zuiderwijk 1986). Unfortunately, the prime sand lizard habitat of old, mature heather has been all but eradicated in the Netherlands by inappropriate conservation management, especially overgrazing and mechanised turf cutting (Strijbosch 2002; Council of Europe 2003; Stumpel 2004).

Northern Germany. Although *Lacerta agilis* is widespread and often abundant in south and west Germany, its distribution becomes more scattered under the influence of the Atlantic climate in the north of the country (Dierking-Westphal 1981; Podloucky 1988; Wollesen and Wrangel 2002). Here it is mainly confined to heathland and sand dunes in Schleswig-Holstein, Niedersachsen (Lower Saxony) and Nordrhine-Westfalen (North Rhine-Westphalia). In addition, the sand lizard occurs at lower population densities in northern Germany than it does further south. This species experienced a 25-30 % decline in Niedersachsen during the 20th Century. Over 99 % of the heathland in northern Germany has been lost and Lüneburg Heath, formerly one of the largest and most important areas for this species in northwest Europe, was devastated by British Army training exercises over many decades. Although sand lizards are still extremely rare here, this area is now being re-instated and managed more sympathetically.

Denmark. Sandy habitats are relatively abundant in Denmark so the sand lizard is widely distributed in the country - but is possibly absent from Falster, Lolland and Langeland (Pihl *et al* 2001). This species was reported in approximately 50% of the 5 km x 5 km squares investigated in Denmark by Fog (1993). Large populations are known from the Mols Bjerge (Jensen 1980) and on Røsnæs (Ravn 1997), although most others are relatively small. Moreover, the sand lizard is decreasing in Denmark and approximately 30% of known populations are thought to have become extinct between 1945 and 1980, with further losses occurring regularly since (Fog 1993). Pihl *et al* (2001) regarded this species as having an "Uncertain" conservation status in Denmark.

Sweden. The sand lizard occurs at various localities in the southern third of Sweden (Ahlén *et al* 1995). Its main area of distribution is along the southeast and south coastal areas, where it occurs more or less continuously, and quite abundantly in places, in sandy heathland, grassland or rocky habitats. In addition, there are several smaller populations further north, along the northern periphery of the distribution, which occur in pine heath forests on sandy sediments (Andrén *et al* 1988; Berglind 2005). These are isolated from each other, often by more than 100 km, so little genetic interchange seems likely, although there have been several individual sightings of *Lacerta agilis* in areas in-

between (Andrén *et al* 1988). All appear to be small remnants of a past warmer climate (Berglind 1999; 2005) and it has been estimated that populations occurring in patches of 1 ha or less in extent have >56% chance of extinction within 50 years (Berglind 2005). In the past, natural forest fires and extensive, small-scale forestry activities created and maintained a dynamic network of open patches, in the early successional stages of forest development, which allowed the species to survive a cooler climate in a number of regions. The introduction of more efficient forestry techniques and, ironically (considering the threat that fires usually pose elsewhere), the better control of forest fires have resulted in a decrease in the number and extent of these warmer, open areas and seem to be the most important factors in the decline of the species in central Sweden (Berglind 1999; 2000; 2005).

Estonia. The country accounts above all refer to the western subspecies of the sand lizard *Lacerta agilis agilis*. The subspecies *Lacerta agilis chersonensis*, is still fairly abundant in Eastern Europe and Russia and is mainly limited by natural climatic factors along the northern edge of its distribution. In Estonia, however, it is known to have suffered very similar human-induced declines to *Lacerta agilis agilis* in northwest Europe and, at the request of the Estonian Ministry of Environment, is therefore also included in this Action Plan (R. Rannap *pers. com.*). Sand lizards have a scattered distribution all over the mainland of Estonia and on Kihnu Island, although many populations are now isolated. *Lacerta agilis chersonensis* prefers dry sandy habitats such as sand dunes, heaths and managed wooded meadows with sandy soils. The main threats include the succession of scrub on sand dunes and heaths, the planting of introduced conifers on sand dunes and the mismanagement of wooded meadows, which also leads to over-shading by scrub. The increasing scale of these problems means that sand lizards are now mainly confined to sand quarries in Estonia (Rannap 2005).

2.5. Threats

2.5.1. Habitat Destruction. Reasons for the decline of the sand lizard in northern Europe have been well established and centre almost exclusively on habitat destruction, plus the associated effects of habitat degradation and fragmentation in the remaining areas (Corbett 1988a; 1989; Corbett and Tamarind 1979; Nature Conservancy Council 1983; Council of Europe 2003; Stumpel 2004). Lowland heathland has been widely reclaimed for agriculture, mineral extraction, landfill and conifer plantations, and developed for housing, industrial areas, roads and golf courses. Many coastal populations on sand dunes have also been lost to holiday developments, campsites and car parks, as well as to the commercial planting of conifers.

2.5.2. Habitat Degradation. Urban development adjacent to sand lizard habitats has caused many problems due to the associated increase in recreational pressures and deliberate abuse. Due to an unfortunate geographical accident, for example, the last stronghold of the sand lizard in the United Kingdom is situated at the edge of one of the fastest growing urban areas in Europe (Bournemouth/Poole). The huge pressures that have resulted have caused local extinctions of sand lizards and still threaten many populations (de Molenaar, 1998; Council of Europe 1998; Moulton and Corbett 1999; Haskins 2000; Edgar 2002), especially on the smaller fragments of habitat that still survive. Problems such as arson and post-fire habitat changes, the use of mountain bikes, motorbikes and 4-WD vehicles, uncontrolled horse riding, erosion, vegetation trampling, the dumping of litter and garden waste, pollution, collection by children and the effects of dogs and cats are all much more severe on urban fringe sites. The sand lizard is known to be more sensitive to these factors than other reptile species (Strijbosch 1988; Edgar 2002). In addition, the costs of wardening urban fringe sites are many times those of rural areas (Haskins 2000).

2.5.3. Habitat Fragmentation. Habitat destruction has severely fragmented sand lizard habitats in northern Europe, especially in intensively developed areas such as southern England and the Netherlands. Roads, urban development and agriculture all form effective barriers to natural dispersal and gene flow between sand lizard populations. In the United Kingdom, sand lizards from the small, isolated populations in Surrey and Merseyside now show low genetic diversity (Beebee and Rowe 2001), as do populations from central Sweden (Gullberg 1996; Gullberg et al 1998). However, this does not yet appear to a major factor in the decline of sand lizards in Sweden (Madsen *et al* 2000) or the Netherlands (Nijman 1996).

2.5.4. Lack of Habitat Management. Heathlands and dune systems are dynamic, successional habitats. Without some kind of external influences periodically reversing succession, or deliberate management by humans, sand lizard habitats may gradually disappear as the woodland climax

vegetation develops. However, sand dunes often form the actual climax vegetation in many coastal areas, as do dry heaths on some particularly poor sandy soils. In any event, reptiles are well adapted to succession in natural landscapes and form metapopulations that shift in space and time in response to changing conditions. In modern Europe, however, habitat destruction and fragmentation has often trapped species such as sand lizards on "islands" of semi-natural habitat, surrounded by highly modified landscapes, so natural metapopulation dynamics no longer occur. The small size of most sites, plus recreational pressures, self-sown conifers, invasive introduced species, pollution and many other factors have all exacerbated this problem. In order to maintain sand lizard populations in such circumstances, therefore, habitat management is essential (Corbett 1988; Stumpel 2004). To make matters worse, several species of invasive plant introduced into Europe are an increasingly severe threat to sand lizard habitats in many areas. The worst offenders include rhododendron, *Rhododendron ponticum*, and pheasant berry, *Gaultheria shallon*, on lowland heathland. Urban fringe heathland sites are also at risk from the introduction of alien plants through the dumping of garden waste. Sea buckthorn, *Hippophae rhamnoides*, although native to parts of Europe, has been widely introduced to sand dune sites elsewhere and is also a serious problem for sand lizards when not controlled.

2.5.5. Inappropriate Habitat Management. The need to manage habitats such as lowland heathland has long been recognised in Europe and significant amounts of funding have been allocated for this in recent years. While the long-term conservation of habitats is of paramount importance, certain forms of management have proved to be detrimental to sand lizards when the particular habitat requirements and ecology of this species have not been adequately considered (Stumpel 1992; 2004; Moulton and Corbett 1999). Grazing is an important conservation management tool in Europe and, ideally, an appropriate grazing regime would have positive, or at worst neutral, effects on sand lizards. However, the overgrazing of heathland has destroyed the habitat microdiversity required by this species in a number of cases (Strijbosch 2002; Stumpel 2004) and populations on small sites are particularly vulnerable (Offer *et al* 2003). Grazing can also have negative effects for sand lizards on sand dune habitats (Overleg Duinhagedis 1999), although appears to benefit this species on Dutch dunes (Stumpel 2004).

Similarly, the cutting or forage harvesting of heathland vegetation to maintain this habitat can be extremely damaging to sand lizard habitats when the areas treated are too large, or badly sited, and too much is cut in any one season. The removal of heathland turfs is often essential to create suitable areas for sand lizard nesting but the large-scale mechanised turf-stripping ("plaagen") carried out in the Netherlands in recent years has been disastrous for many populations of this species (Stumpel 1992; 2000; 2004). Controlled burning has also been used to manage some lowland heathland sites and, again, when this technique is used too extensively or is carried out in inappropriate areas, sand lizard habitat has been destroyed. For example, the loss of the sand lizard from the New Forest, in southern England, is thought to have been the result of over-enthusiastic controlled burning (Tubbs, 1976).

2.5.6. Other Threats. Sand lizard populations in northwest Europe face a number of other, usually localised threats. Eutrophication (nutrient enrichment) of poor soils can dramatically alter heathland vegetation and this can occur adjacent to busy roads, where livestock are given supplementary feed, along paths and tracks heavily used by dog walkers and as a result of agricultural run-off. The atmospheric deposition of nitrates from intensive pig farming has had profound impacts on many heaths in the Netherlands, and not only has this changed heather dominated areas to grassland but has also resulted in the requirement to carry out mechanised turf-stripping (see Section 2.5.5). In military training areas, heavy vehicles can devastate vegetation and cause severe soil compaction and night exercises are frequently accompanied by heathland fires started by flares. Introduced pheasants are thought to be causing problems for sand lizards in the United Kingdom (K. Corbett *pers. com.*) and the Netherlands (Bergmans and Zuiderwijk 1986). Wall lizards (*Podarcis muralis*) have also been widely introduced in the United Kingdom and appear to have replaced sand lizards at one site on sandy coastal cliffs. Wood ants, which often destroy sand lizard nests, have increased in areas of commercial forestry and self-sown conifers on, and adjacent to, many heathland sites in northern Europe. The winter gassing of burrows, which may be used for hibernation by sand lizards, to control rabbits is considered to be a problem in the United Kingdom.

One threat that is far wider reaching is climate change, although its potential effects on species such as the sand lizard are hard to predict, especially for the many isolated populations that cannot move to adapt. It was once postulated that lower than average May sunshine levels were a factor in the decline of the sand lizard on Merseyside in northwest England (Jackson 1978; 1979). However, this deteriorating climate theory has since been disproved (Langton 1988) and human impacts are now seen as wholly responsible. In the future, however, heavier rainfall would destroy more sand lizard nests and reduce juvenile survival rates, whereas drier summers would cause more heathland fires, drought damage to habitats and desiccation of nests. On the other hand, warmer weather could see more double clutches of eggs, as well as improved juvenile survival rates. Moreover, Thomas *et al* (1999) theorise that even a small rise in average temperatures could result in a large increase in the area of habitat available in Britain for species like the sand lizard that are living on the edge of their European range. This would therefore mean that sand lizards would be less restricted to heathland and sand dunes in northern Europe.

2.6. Current Protection

2.6.1. Species Protection

International Protection. The sand lizard is listed in Annexe II of the Council of Europe's 'Convention on the Conservation of European Wildlife and Natural Habitats' (the Bern Convention) as well as in Annexe IVa of the European Community's 'Directive on the Conservation of Natural and Semi-natural Habitats and of Wild Fauna and Flora, Directive 92/43/EEC' (the Habitats and Species Directive).

National Protection. European Union member states have drafted laws that transpose the EU Habitats Directive into national legislation so the sand lizard is therefore strictly protected in the United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden and Estonia at all stages of its life cycle.

2.6.2. Habitat Protection. While European Union member states are not specifically required to declare Special areas of Conservation for Annex IV species, the sand lizard is still found within a large number of such sites in northern Europe due its dependence on Annex I habitats such as heathland and sand dunes. Similarly, this species occurs in many Special Protection Areas, particularly where these have been designated for heathland birds. *Lacerta agilis* is thus well represented in the Natura 2000 site series and the majority of its populations in the United Kingdom, northern France, Belgium, the Netherlands, northern Germany, Denmark and Sweden (although less so in Estonia) now occur on habitats protected for other reasons.

2.7. Recent Conservation Actions

Recommendation 26 of the Standing Committee of the Bern Convention (Council of Europe 1991) urged the governments of the United Kingdom, Belgium, the Netherlands, Germany, Denmark and Sweden to take appropriate steps to ensure the conservation of sand lizard populations and habitats. Surveys and local conservation activities have since been undertaken in all these countries. In the Belgian region of Wallonia, an agreement has been reached between the National Defence and the Nature and Forest Departments over the future management of the Arlon military training area, and other heaths in the area have been managed with LIFE funding (LIFE96 NAT/B/003034). Comprehensive surveys and management planning have been carried out on sand dune habitats at many sites in the Netherlands (Overleg Duinhagedis 1999), annual monitoring programmes instigated for reptiles (Zuiderwijk *et al* 1998) and detailed ecological and population studies (e.g. van Dijk 1996) undertaken on sand lizards at Amsterdam, Nijmegen and Wageningen Universities. Conservation programmes have been drawn up for the heaths of northern Germany (Council of Europe 1991) and, in particular, restoration and re-creation management is underway at Lüneburg Heath. Detailed surveys have also been recently carried out in Germany (e.g. Wollesen & Wrangel 2002). In Sweden, the universities at Uppsala and Goteburg have been particularly active in conducting wide-ranging research on sand lizards and much conservation management has also been carried out.

Perhaps the most significant conservation efforts for the sand lizard in northwest Europe have involved the intensive work over the past 35 years in the United Kingdom (Corbett 1969; Webster 1985; Corbett 1988b; Moulton and Corbett 1999). *Lacerta agilis* is listed as a priority species for conservation action in the United Kingdom (UK Steering Group on Biodiversity 1995) and, from 1994

to 1997, was the subject of an English Nature funded Species Recovery Programme (Corbett, 1994; Corbett and Moulton 1998). A captive breeding and release programme for sand lizards (Langford 1985; Edgar 1990; Corbett and Moulton 1998) has resulted in the re-introduction of this species to six English counties, as well as to north Wales, plus health screening and disease management protocols. Over 80 lowland heathland reserves supporting *Lacerta agilis* are now owned or leased by the Herpetological Conservation Trust, with another three owned by British Herpetological Society. A multi-million pound project, Tomorrow's Heathland Heritage (1999-2005), has also restored and re-created lowland heathland throughout the United Kingdom, and has included work on many sand lizard sites. The extensive management of sand dunes has also been carried out in many coastal areas. English Nature and the Countryside Council for Wales currently fund Biodiversity Action Plan work on sand lizards and management, population monitoring and publicity programmes are undertaken for this species on an annual basis. The former organisation has also commissioned a report to define "Favourable Conservation Status" for *Lacerta agilis* in the UK. Many research projects have been carried out by universities, such as Southampton and Sussex, and include current PhD. work on this species. As a result of all these efforts the conservation status of the sand lizard in the United Kingdom has improved enormously in recent years.

In addition, Recommendation 67 of the Standing Committee of the Bern Convention was adopted in 1998 following an appraisal of the continuing threats to the Dorset heathlands (de Molenaar 1998). Among other actions, the UK Government was recommended to take every effort to prevent further loss and degradation of Dorset heathland, such as ensuring appropriate planning controls are applied, adequately controlling recreational use on the urban and urban fringe sites and taking decisive action to prevent uncontrolled and deliberate fires. This led directly to the establishment of a LIFE funded project in Dorset (LIFE 00 NAT/UK/007079) aimed at tackling urban fringe problems between 2000-2005.

3. ACTION PLAN OBJECTIVES

3.1. Overall Goal

The overall goal of this action plan is to ensure that the decline of range edge populations of sand lizard in northwest Europe is reversed and that these populations are subsequently maintained as a viable and integral part of the habitats and landscapes they occupy.

3.2. Objectives

In order to achieve this goal, it is necessary to identify and then remove (or mitigate for) any threats to sand lizard populations and their habitats. The following objectives are integral to this process:

Objective 1. To plan and carry out field surveys to fill all gaps in current knowledge about the distribution and status of the sand lizard in northwest Europe, specifically the United Kingdom, northern France, Belgium, the Netherlands, northern Germany, Denmark and Sweden, plus Estonia and other Baltic states.

Objective 2. To ensure that any significant, unprotected populations of sand lizard in the countries listed in Objective 1 are safeguarded by suitable national designations.

Objective 3. To define and quantify "Favourable Conservation Status" targets for the sand lizard in the countries listed in Objective 1 in order to plan monitoring programmes and provide an accurate measure of the success of future actions.

Objective 4. To produce management plans (or assist with the amendment of existing plans if necessary) for protected areas that support significant sand lizard populations in the countries listed in Objective 1, taking into account the particular ecological requirements of this species and thereby ensuring that appropriate management regimes are established.

Objective 5. To encourage and support scientific research relevant to sand lizard conservation.

Objective 6. To promote a positive public attitude towards sand lizards in Europe and secure the support of all relevant governments, policy makers, organisations, institutions, landowners and individuals.

Objective 7. To improve international liaison and coordination between all those engaged in surveys, monitoring, habitat management and scientific research (to more effectively achieve Objectives 1-8).

4. ACTIONS REQUIRED

4.1. Habitat Protection

The endangered status of many sand lizard populations at the edge of the species' range in northwestern Europe indicates that all occupied habitat should be as fully protected as possible.

A. Urgent Priority Actions

Action 4.1.1. Ensure that all habitats supporting known sand lizard populations in the United Kingdom, northern France (especially Normandy), Belgium, the Netherlands, northern Germany, Denmark, Sweden and Estonia are protected from any threats of further habitat loss by appropriate national designations.

B. Medium Priority Actions

Action 4.1.2. Establish adequate buffer zones around sand lizard sites where development, or any other activities that are known to have an adverse impact on the species' habitat, are strictly controlled.

Action 4.1.3. If any new sand lizard populations are discovered through future distribution surveys, ensure that these are brought to the attention of the relevant governments and conservation bodies and that they receive full protection at the earliest opportunity.

Action 4.1.4. Control development on, or the destruction of, areas that include potential sand lizard habitats, particularly where these form important future corridors for the dispersal of key populations.

4.2. Habitat Management

In addition to the legal protection of sites, the specific habitats required by sand lizards must be managed appropriately. The physical structure of habitats is generally a much more important factor, as far as survival of sand lizards is concerned, than the actual plant species composition. Nonetheless, particular plant species may be more heavily utilised by sand lizards than others, and may also be vital for certain prey species. In addition, sand lizard populations are seldom distributed uniformly, even within apparently suitable habitat, and the often highly localised nature of lizard concentrations may have implications for conservation management plans. Although species-specific management should obviously not dominate across an entire site, a balance must be achieved with general ecosystem management in certain key areas to ensure the long-term viability of sand lizard populations. In some areas, but especially on the heathlands of southeast Dorset in the United Kingdom, public access must be properly managed and controlled to prevent habitat deterioration through misuse and deliberate abuse. Habitat re-creation will also be essential in many areas to allow dispersal and to prevent the ultimate loss of small sand lizard populations.

A. Urgent Priority Actions

Action 4.2.1. Prepare management plans for all known sand lizard sites (or ensure existing plans are suitably modified) that map key sand lizard areas and fully take into account the likely movements and particular ecological requirements of this species on each site.

Action 4.2.2. Control vegetation succession on key sand lizard heathland and sand dune sites by the regular removal of trees and scrub and the control of bracken, as necessary, ensuring that sufficient cover is retained where this is important for creating a favourable microclimate in exposed areas.

Action 4.2.3. Ensure sufficient areas of bare sand, which are vital for egg laying by this species in northwest Europe, are regularly created (and are maintained as appropriate) at all known sand lizard localities. These areas of bare ground should ideally cover between 5 – 10%, of the total area of suitable sand lizard habitat on any site.

Action 4.2.4. Avoid the overstocking of grazing animals at sand lizard sites and ensure that the placement of fence lines, corrals and water troughs does not exacerbate trampling damage to key sand lizard areas.

Action 4.2.5. Prohibit excessive levels of controlled burning on heathland sand lizard sites, specifically avoiding key areas that support this species.

Action 4.2.6. To preserve the structural diversity of vegetation, avoid mechanical cutting on key sand lizard areas and ensure that no more than 5 % of the remaining area is ever cut in any one season. Limit any mechanical cutting to the autumn and winter months (November – early February).

Action 4.2.7. Avoid excessive mechanical turf cutting or turf stripping on heathland sand lizard sites, ensuring that no more than 5 % of the site is treated in any one season and that prime sand lizard areas (or "foci") are identified and avoided.

Action 4.2.8. Establish appropriate fire prevention measures on heathland sand lizard sites, including adequate firebreaks (which include an element of bare sand along the northern edges) and fire control plans.

Action 4.2.9. Where necessary, ensure that provisions are in place for adequate levels of wardening to manage public access and to prevent illegal motorbike use and other form of abuse. In particular, access to sandy areas used for egg laying by sand lizards should be carefully controlled.

B. Medium Priority Actions

Action 4.2.10. Reduce and control the numbers of species such as pheasants where these are known or are thought to be causing problems for any sand lizard population.

Action 4.2.11. Where applicable on land under military control, negotiate agreements with the relevant authorities to alter or limit any damaging training activities on key sand lizard habitats.

Action 4.2.12. Produce and implement habitat re-creation and restoration plans in all relevant countries where this is possible and appropriate, particularly where this work would reverse the effects of agricultural reclamation, forestry, mineral extraction or other past activities, thereby re-connecting presently fragmented sand lizard populations and re-establishing a permanent gene flow. Ensure that mineral extraction and landfill sites in former sand lizard areas are restored back to heathland and not to artificial lakes for recreational use or to other habitat types.

4.3. Species Protection

The sand lizard already receives a high degree of protection across northwest Europe, although this has often failed to reduce illegal activities such as damage to habitats. In many cases, only the adequate wardening of the most vulnerable populations will provide adequate protection.

B. Medium Priority Actions

Action 4.3.1. Carry out a review of the effectiveness of current legal protection for the sand lizard and its enforcement throughout the range of this species. Provide recommendations for improving the situation where necessary, for example through the imposition of higher penalties for infringements.

Action 4.3.2. Whenever possible, ensure that key sand lizard sites under particular pressure from public access, and illegal activities such as motorbike use and arson, are adequately wardened.

4.4. Species Management

Appropriate management, habitat re-creation schemes and adequate wardening where required will be sufficient for most sand lizard populations to recover naturally, thus negating the need for species management. However, opportunities for natural recolonisation no longer exist in many areas, especially where development or road construction has isolated habitats. In such cases, direct intervention, mainly through captive breeding and release programmes, will be required to re-establish this species or to ensure that existing populations remain viable.

B. Medium Priority Actions

Action 4.4.1. Review current species management efforts currently being undertaken for sand lizards in the United Kingdom, northern France, France, Belgium, the Netherlands, northern Germany, Denmark and Sweden, plus Estonia and other Baltic states, and assess the requirement for new initiatives.

Action 4.4.2. Where necessary, develop new plans and strategies for the potential re-introduction of sand lizards into parts of the historical range of this species where this is considered feasible and where previous known threats have been removed.

Action 4.4.3. Investigate pathogens likely to affect sand lizards in any captive breeding and release programme. Ensure that, prior to release, all animals receive adequate health screening for any diseases or parasites that may compromise the survival of both the released lizards and any other wildlife species.

4.5. Distribution Surveys

The extent and status of all sand lizard populations at the northwestern and northern edges of the species' range must be established before the success of conservation efforts can be properly planned and implemented, let alone measured. However, distribution data for sand lizards are still incomplete for some areas, especially for *Lacerta agilis chersonensis* along parts of the Baltic coast. Standardised survey methods and mapping techniques, particularly the use of Geographic Information Systems (GIS), will be useful tools to help fill such gaps in current knowledge.

A. Urgent Priority Actions

Action 4.5.1. Continue distribution surveys and the mapping of *Lacerta agilis agilis* habitats in the United Kingdom, northern France, Belgium, the Netherlands, northern Germany, Denmark and Sweden.

Action 4.5.2. Collate existing information about populations and habitats of *Lacerta agilis chersonensis* in Estonia and other Baltic states with its range and initiate new surveys if necessary.

4.6. Population and Conservation Status Monitoring

It is important to regularly monitor sand lizard populations at the edge of the range to detect changes in status and to assess the effectiveness of any conservation actions taken. This should also enable any effects attributable to climate change to be detected. The results can be used to refine and adjust conservation and habitat management techniques and to prioritise the allocation of available resources. Defining and quantifying "Favourable Conservation Status" for the sand lizard in northwest Europe should be central to this process and will enable a clear set of goals, targets and funding requirements for conservation actions to be produced.

A. Urgent Priority Actions

Action 4.6.1. Determine the historical range of the sand lizard in the United Kingdom, northern France, Belgium, the Netherlands, northern Germany, Denmark, Sweden and Estonia, as well as the current range of this species, to assist with the development of specific targets for habitat restoration and re-creation strategies, as well as species re-introduction programmes.

B. Medium Priority Actions

Action 4.6.2. Develop standardised GIS-based methods for the mapping and measuring of prime habitats specifically used by sand lizards (as opposed to broader habitat categories) to enable the future assessment of changes in the extent and quality of these habitats at all sites.

Action 4.6.3. Produce a standardised methodology for monitoring and calculating the condition of individual, range-edge sand lizard populations and any future changes to their status. Monitoring should also take place adjacent to, and between key areas, as adult sand lizards can survive for many years in sub-optimal habitats (e.g. railway embankments, road verges, overgrown gardens or old mineral workings).

Action 4.6.4. Inform national governments, the Standing Committee of the Bern Convention and other relevant parties of the results.

4.7. Scientific Research

Appropriate scientific research can be used to inform and refine conservation management. Significant bodies of work on various aspects of sand lizard ecology have already been published but there is still a lot to learn about this species. As much support as possible should be given to academic institutions planning to conduct any sand lizard research that is relevant to the objectives of this Action Plan.

B. Medium Priority Actions

Action 4.7.1. Encourage and support scientific research investigating the general ecology, behaviour and habitat use of the sand lizard.

Action 4.7.2. With experienced scientists, develop a series of applied research goals that are relevant to the conservation of sand lizards, especially empirical work investigating the response of lizards to various forms of habitat management, such as grazing, controlled burning, vegetation cutting and the provision of egg-laying substrate, as well as to public access pressures.

Action 4.7.3. Expand on previous studies into the genetic variation of declining and isolated sand lizard populations.

Action 4.7.4. Investigate the potential for research projects looking into the effects of climate change on range-edge populations of sand lizards to help inform any resulting changes to habitat management that may be necessary, as well as the planning of dispersal corridors if required.

4.8. Improved Liaison and Coordination

Conservation efforts to halt the decline of sand lizard populations in northwestern and northern Europe have progressed enormously in recent years. However, there is still much to be done to ensure the long-term viability of this species at the edge of its range. Although conservation is always more effective when carried out by local workers, within their own country, international liaison has clearly been highly beneficial in the past and there is still a need to further improve cooperation in order to facilitate the exchange of information and ideas and to provide mutual support.

A. Urgent Priority Actions

Action 4.8.1. Ensure that the Governments and relevant conservation bodies of the United Kingdom, France, Belgium, the Netherlands, Germany, Denmark, Sweden and Estonia implement this Action Plan.

B. Medium Priority Actions

Action 4.8.2. Develop a common, agreed protocol to standardise further distribution surveys and habitat mapping, as well as the effective population and conservation status monitoring of sand lizards.

Action 4.8.3. Where these do not already exist, encourage the production and implementation of national Sand Lizard Recovery Plans (in a standard format) for the United Kingdom, northern France, Belgium, the Netherlands, northern Germany, Denmark, Sweden and Estonia. Ensure that these recovery Plans are formally adopted by the relevant Governments and are thus binding on all key players.

4.9. Public Awareness

Conservation of sand lizards is often inhibited more by the lack of public support for management than it is by problems such as illegal collection. Tree clearance on heathland is particularly contentious and the fact that this work is necessary to preserve a habitat of international importance, which supports a range of other rare flora and fauna, is not always appreciated. It can also be a challenge to convince people that certain damaging activities should be controlled or even prohibited.

B. Medium Priority Actions

Action 4.9.1. Produce appropriate educational and public awareness material that is aimed at local people and stresses the conservation significance of the sand lizard and its habitats.

Action 4.9.2. Ensure that local communities are informed about the necessity and importance of managing lowland heathland, sand dunes and other key sand lizard habitats in northwest Europe.

Action 4.9.3. Develop educational material aimed at informing the public about problems caused by arson and other forms of abuse of sand lizard habitats.

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