THE HERPETOLOGICAL
CONSERVATION TRUST

Initial surveillance baseline datasets for the sand lizard *Lacerta agilis*, natterjack toad *Bufo calamita* and smooth snake *Coronella austriaca* in England

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2. Summary

English Nature requires species status information for a variety of purposes. Robust surveillance data for amphibians and reptiles will be needed to assess future surveillance and status-monitoring needs for this group. This contract was awarded to create baseline datasets for three rare species: natterjack toad, sand lizard and smooth snake. The HCT has carried out or coordinated most of the monitoring for these species in recent years, and holds the national rare herpetofauna species database, although digitisation of surveillance records is not complete. GIS site inventories had been begun for sand lizards and natterjack toads, and this exercise enabled the completion of these as well as the creation of a baseline dataset for smooth snake populations. Populations have been categorised and assessments made on status, and various surveillance and monitoring issues are discussed.

The baseline datasets are attached as tabular appendices to this report, and are presented separately as MapInfo (GIS) and Excel (spreadsheet) files. Conditions of use are given in the report and, in the appendices, as a draft licence for use by EN staff.

3. Introduction

English Nature (EN) relies upon the availability of good quality information on species status for guiding many of its activities and for meeting its objectives. Access to robust surveillance data for herpetofauna (amphibians and reptiles) has been identified as an essential pre-requisite to the assessment of future surveillance and status-monitoring needs for this group (See note by Jim Foster, 4 March 2004, for further explanation). The current contract was awarded to pull together baseline datasets that would form a sound basis for identifying needs and developing future monitoring capacity. It should be stressed that these baseline datasets will be preliminary, and should not be regarded as final. As part of the same contract, an in-depth examination is under way of potential ways forward for a national herpetofauna surveillance system, including the calculation of costed options for delivery. A parallel exercise is being carried out under contract for the Countryside Council for Wales (CCW).

Much of the groundwork for creating herpetofauna baseline datasets was already in progress: the collection of field data has taken place for many years, and conversion to electronic databases and GIS began in the last few years. A large proportion of this work has been carried out by The Herpetological Conservation Trust (the HCT), and the British Herpetological Society Conservation Committee (BHSCC) before it. The availability of robust information on species status is crucial to the practical and strategic conservation of herpetofauna, and this is a key area of operational development for the Trust. The HCT has undertaken and/or coordinated species surveillance for over thirty years in the UK, focusing on the rare herpetofauna species (natterjack toad, sand lizard and smooth snake). Temporal and geographical coverage, methodologies and sampling have varied, but the datasets are the best available nationally.

Previously these datasets could not be utilised efficiently because they were not digitised. For this reason, the HCT created a national rare species database in 2002, with funding from the Esmée Fairbairn Foundation (EFF), EN and CCW. Digitisation of the backlog data is still in progress. Between 5 and 10 years of reptile data have been entered for all areas, as well as 30 years of summarised natterjack data for the UK, and various other datasets such as the Biological Record Centre's rare species holdings. The database is linked to a MapInfo GIS, which is heavily used in mapping species locations and other data. The database was supplied for upload to the NBN Gateway in 2003, and an updated version in May 2004.

EN supports the HCT's work through a Memorandum of Agreement and via contracts, and the HCT and EN have signed a Memorandum of Understanding pledging mutual support for data-related issues.

3.1. Objectives for baseline datasets

The Annex A for this contract (September 2004), and especially the note entitled *Species surveillance strategy: reptiles and amphibians* (4 March 2004), both drawn up by Jim foster, set out the types of information that EN needs and the reasons for needing them. The latter was drawn up to assist with EN Species and Surveillance Team (SST) plans to develop a sustainable surveillance and monitoring programme. It refers in turn to a note by Mike Burke and Eleanor Hill (3 November 2003). There are several broad categories for which EN needs information on species status. These can be summarised as follows:

- Condition of interest features on designated sites (SSSI, SAC, Ramsar).
- Status of BAP and other nationally important species
- Assessment of national trends in widespread species
- Legal obligations to report on status of species
- Use of species information for miscellaneous tasks

Condition of interest features on designated sites
EN is required to monitor the condition of interest features on designated sites, therefore all herpetofaunal interest features need to be monitored. This includes about 150 SSSIs with at least

one notified herpetofauna species, mostly the rare and/or European-protected species (sand lizard, smooth snake, natterjack toad, great crested newt), but sometimes widespread or 'common' species. Around 20 SACs are notified for great crested newt, and at least one natterjack has natterjack toad as an interest feature. Many other SSSIs have nationally important herpetofauna populations that are not notified as interest features and therefore hold no monitoring obligation under this category.

Status of BAP and other nationally important species

Sand lizard, natterjack toad, great crested newt, pool frog and the marine turtles (grouped) are BAP species. The HCT is the lead partner or joint lead partner for all of them.

Species	**Lead partner(s)**	**Contact point**
Great crested newt	British Herpetological Society, Froglife, The Herpetological Conservation Trust	English Nature
Natterjack toad	The Herpetological Conservation Trust	English Nature
Pool frog	English Nature, The Herpetological Conservation Trust	English Nature
Marine turtles (grouped action plan for 5 species, focus on the leatherback turtle)	Marine Conservation Society, The Herpetological Conservation Trust	Scottish Natural Heritage
Sand lizard	English Nature, The Herpetological Conservation Trust	English Nature

All of the Species Action Plans (SAPs) include action for surveillance, including addressing baseline information gaps. There is currently a 3-year cycle for reporting on BAP species status. Other non-BAP species may be considered under this category, either as key species for monitoring habitat status, or as potential additions to the BAP list. The 2005 BAP review will consider whether to give the smooth snake BAP status. There is also current concern about the possible decline of the adder nationally, which could merit this species' future consideration in a BAP review. The adder and the common lizard are strong candidates for herpetofaunal key indicator species on lowland heathland. The common toad is another possible priority for national surveillance.

Assessment of national trends in widespread species

The great crested newt, smooth newt, palmate newt, common toad, common frog, common lizard, slow-worm, grass snake and adder are widespread species that could be considered good indicators of 'landscape quality'. Their surveillance could be used to reflect both ecological quality and overall connectivity of the landscape.

Legal obligations to report on status of species

The EC 'Habitats Directive' 1992 aims to restore to 'favourable conservation status' (Article 2), all habitats and species of community interest (Annexes I, II, IV and V). There is an implicit requirement to monitor their status in order to fulfil the explicit need to report on status (Articles 11 and 17). The current review of the UK Conservation (Natural Habitats &c.) Regulations 1994 will probably lead to an explicit duty to undertake surveillance on the conservation status of UK herpetofauna species listed in the Habitats Directive, as follows:

- great crested newt (Annexes II, IV)
- natterjack toad (Annex IV)
- pool frog (Annex IV)

- sand lizard (Annex IV)
- smooth snake (Annex IV)
- marine turtles (Annex IV)
- common frog (Annex V)

Whilst the level of protection and proactivity required differs according to the annexes these species are on, the monitoring of conservation status is a generic requirement. In addition, there is a strong case for herpetofauna species being used as 'characteristic species' in the monitoring of Annex I habitats. The common lizard and adder would be most ubiquitous and therefore appropriate for heathlands. The common lizard ought to be considered for coastal sand dunes. The sand lizard, smooth snake and natterjack could be considered as characteristic species on heathlands and coastal dunes, but they are not ubiquitous in these habitat types. Several amphibian species might be considered as characteristic species.

Use of species information for miscellaneous tasks

This category encompasses the other types of tasks for which EN staff might require herpetofauna status information, whether for Area Team casework or for national projects. Jim Foster provided the following list of examples:

- comments on, and input to, planning matters (development control and strategic plans)
- advice on mitigation proposals for threatened sites
- advice on habitat management on designated and non-designated sites
- selection of candidate designated sites, and determination of boundaries
- selection of landscape-scale habitat creation/restoration projects (eg Area Based Delivery projects)
- decisions on land use policy
- assessment of the success of reintroductions and habitat management efforts
- scientific projects on species status
- decisions on non-native species issues (risk assessment, control options)
- assessment of optimal survey techniques and survey effort
- educational projects.

In determining what requirements there are for future monitoring, EN has identified that a crucial information gap exists in terms of baseline data for all of these categories. Although a large amount of effort has been put into herpetofauna monitoring programmes over the years, both nationally and locally, resources such as national inventories for species sites, and adequate mechanisms for assessing species status have not been available to EN. Coordinated effort will be required to construct and operate a sustainable national herpetofauna-monitoring programme, but the development of baseline datasets need to be addressed first. The types of information that EN will require in order to make status assessments are as follows:

- Geographic distribution ("natural range" according to the Directive - current, historic and potential)
- Population estimates/abundance
- Population trends
- Population viability
- Habitat condition and extent, including connectivity
- Prevalent threats and opportunities ("factors affecting conservation status").

The next part of the current contract will analyse how each of these attributes will contribute to an overall status assessment, and propose the means for monitoring against each objectives. The approach used in EN's Common Standards Monitoring (CSM) document for herpetofauna, i.e. tables listing attributes, targets and assessment methods, is the recommended model.

The table below gives the relevance of the five data need categories discussed above to each species, and identifies where the key information gaps lie in EN's view. (Recommendations from the current exercise may influence these views).

Species	**Purpose**									
	Int. features on designated sites		**BAP/ nationally important spp**		**Widespread spp trends**		**Legal obligations (Habitats Dir.)**		**Other tasks**	
	Now	Need	Now	Need	Now	Need	Now	Need	Now	Need
Common frog	●	●●			●	●●	●	●●	●	●●
Common toad	●	●●			●	●●	●	●●	●	●●
Natterjack toad	●●	●●●	●●	●●●			●●	●●●	●●	●●●
Pool frog	n/a	●●?	n/a	●●			n/a	●●	n/a	●
Smooth newt	●	●●			●	●●	●	●●	●	●●
Palmate newt	●	●●			●	●●	●	●●	●	●●
Great crested newt	●	●●●	●	●●●	●	●●●	●	●●●	●	●●●
Common lizard	●	●●			●	●●			●	●●
Slow-worm	●	●●			●	●●			●	●●
Sand lizard	●●	●●●	●●	●●●			●●	●●●	●●	●●●
Grass snake	●	●●			●	●●			●	●●
Adder	●	●●			●				●	●●
Smooth snake	●	●●●	●	●●●			●	●●●	●	●●
Marine turtles			●●	●●●	●	●●	●●	●●●	●	●●

3.2. Guidance on use of datasets

The use of biological data and associated information may be subject to data protection law, copyright and other laws. The HCT has therefore endeavoured to operate prudently when collating, managing and disseminating data, through the development of a Data Access Policy and protocols for data collection, release and exchange. The HCT's Data Access Policy (DAP) and Privacy Policy can be viewed on its website (www.herpconstrust.org.uk). It is our belief that copyright on all records in the HCT database is solely or jointly owned by the HCT, or permission has been granted to hold and disseminate the data.

The HCT and EN signed a Memorandum of Understanding in 2004, to set out a partnership approach on database and species information issues (contact Jim Foster). This forms the basis for developing a Data Exchange Agreement (DEA) between the two organisations; this is being developed under the current contract and will be in place by the end of January 2005.

Information on natterjack toads, sand lizards and smooth snakes is often perceived as sensitive, due to the possible threat of persecution, collection and other undesirable impacts. The sensitivity normally pertains to the whereabouts of the site. These concerns have had some basis in the past, but a review of sensitivity issues is probably needed, and would be useful to justify future access arrangements and/or restrictions. In most cases, there is probably no value in keeping the locations of these species confidential, but there are some cases where caution might be applied, e.g. an introduction in its early stages. For HCT data on the NBN Gateway, sensitivity is addressed by reducing the accuracy of grid references to 1km. (Note that some cases this would still identify the location).

EN staff will have full access to the baseline datasets through the DEA to be signed in January 2005; this use will need to be in accordance with the HCT's DAP. In the meantime, the HCT should be consulted before baseline datasets or derivatives are passed on to third parties. A draft licence permitting EN staff to use HCT data is attached in Appendix ***. In the light of the revised Environmental Information Regulations (EIR), this area may need to be revisited in due course.

4. Methods for production of datasets

Baseline datasets have been created for natterjack toad, sand lizard and smooth snake, using the HCT rare species database and a significant input from expert opinion. The bespoke MS Access database holds virtually all the known historic records for the three species from Biological Record Centre (BRC) and British Herpetological Society (BHS) sources, as well as a large proportion of the sightings data collected by the HCT over the last thirty years. Summary spawn counts for all UK natterjack toad sites monitored since 1970 are included in the database, as well as some count data and individual sightings; a total of 1,871 records). Between five and ten years' data have been entered for the smooth snake and sand lizard so far. This is more complete for some geographical areas than others. A conscious attempt was made as part of this exercise, to enter all Weald smooth snake data back to 1993, as records are fewer in this area. A total of 2,215 smooth snake records are now held on the database, the majority from the Dorset and Hampshire in the last five years. For sand lizards, the data holdings amount to 12,458 sightings records (a sighting may account for more than one animal, including for example, a release of 50 juveniles). The volumes of surveillance data for the reptiles decrease further back in time (fewer people, less monitoring capacity), therefore the data entered so far constitute a large proportion of the data available. Nevertheless, there are undoubtedly still some third-party sources of data that have not yet been discovered or fully utilised. As well as the Access database, MapInfo GIS tables were already in progress since 2001, for natterjack toad and sand lizard populations. This exercise has enabled completion of the datasets for all three species, *as far as can be achieved with current information*. Again it should be stressed that these baseline datasets are at an interim stage, not finished items.

The digitisation of site boundaries for the three species was carried out using MapInfo GIS, largely captured using ukperspectives.com (UKP) digital APs (under licence from EN in 2004) as basemaps, but also using digital OS mapping (under licence from EN) where APs were not available at the time. The status of populations at each site was assessed using a combination of expert knowledge and data held on the database. As mentioned, not all of the data held by the HCT (and others) have been digitised yet. The site boundaries for smooth snake and natterjack toad sites encompass the entire area of habitat likely to be used by these species (but see caveats below). The sand lizard site boundaries delimit the areas of greatest importance to sand lizards, often known as 'foci'. These do not therefore constitute the distribution of all sand lizards. Foci represent between approximately 50% and 95% of the sand lizards on any given site, but probably on average about 75%. Further details on the metadata, boundary capture and logic behind status assessments are given below in the sections for each species.

5. Initial surveillance baseline datasets

Baseline datasets are presented for natterjack toad, sand lizard and smooth snake in the appendices, and electronically as Excel and MapInfo files. The remit was determined as "habitat likely to be used by the species". Guidance on the dataset format required by EN was provided by Jim Foster, including suggested field names. The datasets should be regarded as interim, as there are many areas requiring further attention, not least gaps in geographical coverage. This is particularly so for smooth snakes, but also for sand lizards in some areas. This exercise has highlighted the need for further work to map species distributions and assess population statuses. It is recommended that a thorough review of the completeness and accuracy of all three baseline datasets be carried out, to assess whether they can form the basis for future monitoring.

5.1. Natterjack toad

The Natterjack Site Register (NSR) (Beebee & Buckley, 2001) and subsequent updates held by the HCT were used to construct the site list and assess population status. The boundaries of sites were captured with advice from John Buckley, using UKP APs. As the remit was determined

as “habitat likely to be used by the species”, a boundary has therefore been cast around all suitable habitat within likely reach of natterjack toads living on that site. This does not mean that animals will not be found outside that area, but that the areas within the boundaries are of primary importance. Some coastal sites are contiguous and stretch for many kilometres, particularly in Cumbria. Little attempt has been made to exclude small-scale areas of unsuitable habitat, including some buildings and roads in these cases. The boundaries are likely to need further refinement in future, perhaps using GIS habitat inventories, and preferably with further assessment of the likely extent of the animals on each site. All known English natterjack sites since 1970 have been included in the dataset, whether extinct, extant or introduced. It is assumed that all natterjack toad sites in England have been discovered.

The following fields are used in both the Excel and the MapInfo versions: *SiteKey, Site, Area_ha, Xcoord, Ycoord, SSSI, SSSI SiteUnit, Popn_status, Last_seen, Popn_class, Popn_size, Reintro, Data_capture, Source_data, Comments.* The site key is a unique identifier. The site names are those used in the NSR and subsequent updates for the recent translocations. The Cartesian area of each site boundary in hectares, and the centroid x and y coordinates were produced by MapInfo. The SSSI site names and site unit numbers were inserted by overlaying the natterjack sites onto the ‘siteunit’ MapInfo file obtained from EN. Where a natterjack site covers more than one SSSI, the names are separated by a semicolon, as are the respective site units in the ‘SSSI site unit’ field.

Population status categories are as follows: increasing, stable, decreasing, extinct, new introduction, never established, potential (only a few potential sites have been mapped, usually adjoining introductions). Population status was based upon trends visible from time-series data (as discussed by Buckley & Beebee, 2004). The year in which animals and/or spawn were last seen is entered in the ‘Last seen’ field (generally 2004 for extant populations). Population size refers to the number of adults animals, based upon the assumption that each spawn string represents two adult animals. The population figures were estimated by doubling the highest available spawn count during the last 6 years, 1999-2004 (or in a few cases by animals counted). Population sizes were classified as follows: 1 = <20, 2 = 20-49, 3 = 50-99, 4 = 100-499, 5 = 500+ (and 0 = extinct). Reintroductions are recorded in the ‘Reintro’ field (true/false in MapInfo, yes/no in Excel). ‘Data capture’ refers to the GIS basemap used. ‘Source data’ is the source of data and logic behind deciding the boundary location, population size and status etc (JB = John Buckley, NSR = Natterjack Site Register).

Of the 60 natterjack toad sites mapped for England, 50 of them are extant (stable, increasing or decreasing).

5.2. Sand lizard

The sand lizard population baseline dataset has been constructed through a combination of expert knowledge and opinion, and the 12,458 sightings records held on the HCT database. The database includes all known translocations to sites that did not previously have a sand lizard population. Construction of the MapInfo table began in 2001 as a HCT exercise to map all known sand lizard population ‘foci’. This term was proposed by Keith Corbett (e.g. Corbett, 1994; Corbett & Moulton, 1998) to describe sand lizard population centres, usually associated with favourable topographic features and/or high habitat quality. Foci hold a higher density of sand lizards than the surrounding areas. Whilst the locations of foci are intrinsically linked to these factors, their size and viability are often improved by management. The purpose of defining of foci has traditionally been an attempt to draw attention, for conservation management purposes, to the most important sand lizard areas. The distribution of foci does not necessarily equate to a distribution map of all sand lizards, however. Sand lizards can live in low densities in sub-optimal habitat, and although insufficient work has been done on measuring comparative densities over a range of habitat qualities, it can be assumed that a significant proportion of animals live outside of foci. According to House & Spellerberg (1983), areas of flat heathland in the UK may support between 0.3 to 19 adult sand lizards per hectare. In contrast, prime mature well-structured

heathland habitat, with favourable topography and aspect, are the optimal conditions and can support up to 300 adults per hectare (Corbett, 1988a,b). The views gathered during this exercise (K. Corbett, H. Inns, N. Moulton, D. Tamarind, J. Webster & B. Whitaker, pers. comms.) suggest that between 5% and 50% of sand lizards live outside of foci, but that this varies greatly according to the site in question. Some sand lizard sites, particularly smaller ones, are almost completely covered by a single focus; whereas some larger sites have narrowly defined foci surrounded by large areas of sub-optimal habitat that probably support low densities of sand lizards.

The mapping of foci to date has been via the annotation of aerial photography (AP) printouts, or in some cases (before complete AP coverage was available) on printed maps. This was largely done by Keith Corbett and Nick Moulton for Dorset, the New Forest and Merseyside, and by Mike Preston and Bill Whitaker for the Weald, with advice from others in some places. Known high densities of animals are termed as 'actual foci'. A second category classed as 'potential foci' was created for areas with no sand lizard population (potential reintroduction sites), and areas that would become foci naturally if positive management were employed. A third category of 'unknown potential foci' refers to areas that appear to be suitable for sand lizards (from the APs) but that have not been surveyed. Note that these almost certainly include undiscovered sand lizard populations. The availability of APs has brought remarkable benefits in enabling the identification of potential sand lizard locations, and it was used very successfully to guide a reptile survey of Ringwood Forest in 2004.

Foci were marked by drawing a thin line around the appropriate areas on printed copies of APs. For Merseyside, most of the foci were marked on APs (dated 1989) from the Merseyside sand lizard strategy document (EAU, 1992). Re-assessment of the locations and extent showed that they are still acceptable (N. Moulton, pers. comm.), but revision might be worthwhile in due course, especially as recent data are increasing the sand lizard distribution knowledge for some parts of the Sefton Coast (J. Newton & P. Hudson, pers. comm.). Many of the Dorset foci were marked using a set of Dorset County Council APs received in 1999. Recent mapping of Dorset foci, all Weald sites, and all reintroduction sites outside the core range was carried out using UKP AP printouts.

Once marked on APs, foci were digitised visually from paper to MapInfo using UKP APs as a basemap. The shapes of foci often tend to be sinuous and irregular, generally enclosed within heath or dune habitat and rarely coinciding with sharp edges (e.g. Landline features) that could be snapped to. It seems arbitrary to define foci visually like this, but given the impossibility of measuring animal densities across all sites, it is the only viable option. Furthermore, the combined experience of the people involved suggests that it is an eminently acceptable approach.

The main caveats to attach to this dataset are that some sites are still poorly surveyed, often due to access restrictions, and that in some cases effort has clear spatial bias. The large foci polygons for Frensham and Hankley in Surrey should be treated as 'needing further assessment': they almost certainly include 'non-foci' areas but it was impossible with current data and knowledge to decide where to define the foci boundaries. Some areas of apparently good 'sand lizard habitat' (according to APs) are still absolutely unsurveyed, particularly in MoD ranges in Dorset. An attempt has been made to map some of these areas as potential foci of 'unknown' population status. There are also likely to be many small isolated populations, as yet undiscovered, in forest blocks in Dorset and Surrey. Ringwood Forest in Hampshire contains various small populations known already through intensive monitoring by one or two individuals and a survey in 2004 identified several further populations. There is no reason to believe that a similar situation might not exist in Wareham Forest (Dorset) and Wealden forest blocks. Sightings records held on the HCT database were used (with advice from Nick Moulton) to adjust foci boundaries where amendment was obviously required. This exercise also served to flag up gaps in data collection as it showed that many foci have not been monitored for at least five years. It also gave for the first time a total number of population foci and a total area figure for them: in

England, 518 actual foci have been mapped, covering a total of 1284 hectares (1025 hectares without the debatable Frensham and Hankley areas).

In the baseline datasets, the following fields are used in both the Excel and the MapInfo versions: *SiteKey, Site, Focus_type, Area_ha, Xcoord, Ycoord, SSSI, SSSI SiteUnit, Popn_status, Last_seen, Popn_class, Popn_size, Reintro, Boundary_digitisation, Captured_using, Boundary_source, Comments.* The map objects are coloured yellow for actual foci, purple for potential foci, and blue for potential foci of unknown status. The large Frensham and Hankley foci requiring further attention are coloured orange. The site key is a unique identifier. The site names were suggested by the originator or taken from OS 1:10,000 raster basemaps. As there may be several foci on one site, the site names are not unique, nor do they adhere to any particular scheme, and they are not necessarily the names used by everyone. This is something that could be addressed in the future. Foci type 1 are actual foci, type 2 are potential, and 3 are unknown status. This should be used in combination with the population status field. The Cartesian area of each site boundary in hectares, and the centroid x and y coordinates were produced by MapInfo. The SSSI site names and site unit numbers were inserted by overlaying the sand lizard foci layer onto the 'siteunit' MapInfo file obtained from EN. In many cases, a focus falls across several site units. There are also many foci that only partly overlap with a site unit or units. Any assessment of sand lizard foci within and without SSSI boundaries must take this into account. Where a site covers more than one SSSI, the names are separated by a semicolon, as are the respective site units in the 'SSSI site unit' field. At a few coastal sites, the coastline according to the APs (and hence the foci) appears to have shifted since the capture of the site unit polygons. We have included all site units coincidental with foci, although presumably EN views the site unit boundaries as dynamic, at least notionally if not with respect to the GIS boundaries.

Population status categories are as follows: i = increasing, s = stable, d = decreasing, p = potential, u = unknown. Population status was rated at each of the foci by perceived or known status, largely based upon the known management regime in place. Nick Moulton provided most of the qualitative population status assessments, based upon personal experience and knowledge of the management regimes in place at the sites. With present knowledge, status assessments could only be estimated, and this underlines the need for a more scientific way of measuring and monitoring population size and density. In some cases, the status was deemed unknown.

Of the 890 sand lizard foci polygons mapped for England, 519 are actual population foci (type 1), 332 are potential foci (type 2: no sand lizards) and 39 are unsurveyed potential foci (type 3: unknown status). The actual foci cover a total area or 1,288 hectares, but Frensham and Hankley foci requiring further attention account for 259 hectares of this. The potential foci amount to 1,085 hectares, and the potential foci of unknown status cover 48 hectares. As stated earlier, this latter category probably does not account for all undetected populations, and further AP-based mapping and field survey is necessary.

Absolute population size is impossible to measure on all sand lizard populations, and even estimates cannot be objectively achieved for many population foci. At this stage, it was deemed more sensible to predict population sizes based on average densities of adult animals per hectare according to models from the literature for appropriate habitats. Corbett (1988a) suggested up to 300 adults per hectare occupied the best UK heathland habitat areas, and Corbett & Tamarind (1979) talked of 125 adults per hectare on sites which were still good but which had less exposed sand and/or less favourable topography. Corbett (in NCC, 1983) also reported densities of 210 per hectare on prime Surrey heathland habitat (Frensham) and 300 per hectare in Bournemouth. Corbett (1994) defined 'adult' as being males over three years old and females over four years old (although Corbett & Tamarind, 1979, defined it as animals after their 2nd winter. i.e. 18 months). Nicholson & Spellerberg (1989) identified densities of 48 and 52 animals per hectare on what might be termed suboptimal habitat. Home range movements detected in these studies varied greatly from about 40 to 1,400m^2 (uncorrected), but generally range between 200 and 600m^2, and always more for males than for females. On a heather dominated sand dune in the Netherlands, Strijbosch (1988) measured densities between 30 and

46 adults (4th year and older) per hectare. Density estimates do not appear to be available for marram-dominated sand dune habitats, but it presumably overlaps the range of densities found on heathland. On forest heathland patches in Sweden, Berglind (2004) found an 'equilibrium density' of 120 females per hectare, which would correspond to approximately 240 adults of both sexes. UK heathland habitats ought to be comparable to the Swedish and Dutch heathland habitats of these studies, but clearly there are too few case studies available to allow confident population predictions based upon habitat. Several German studies, some with high densities, are not readily comparable as the populations are on different habitats and/or markedly different climatic regimes. For consistency, the use of numbers of adults is suggested for estimating population sizes for UK baseline datasets. Corbett's (1994) definition of adults seems sensible and appears to be similar or identical to that used by others.

By multiplying the area of each focus by a generalised density figure an initial estimate of population size can be produced, upon which future assessments and amendments can be made. Given the variation in density estimates described above (30 to 300 on good habitat), and the current absence of a methodology for easily assessing sand lizard densities, a modest minimum figure of 30 adults per hectare is suggested for all foci, whether sand dune or heathland. As this is a modest figure, and probably a gross underestimate for many population foci, it should not be problematic to use it for proposing minimum population sizes for all UK foci. The only foci to be excluded from this (pending critical assessment of the boundary extents) are the five largest Frensham and Hankley foci. The other 514 foci comprise a total 1025 hectares in area. At a density figure as low as 30 per hectare, this still gives a surprisingly large predicted English population of sand lizards. With a higher density figure, e.g. 100 or 200 per hectare, the figures would be far greater than any previous estimates of UK sand lizard numbers. (The total area of Welsh actual foci is c.18 hectares - all reintroductions since 1995 - and sand lizards probably still number in the hundreds. The single Scottish site has not been mapped, as Scottish Natural Heritage has been unable to provide us with digital basemaps).

The resulting population prediction figures, based upon 30 adults per hectare, are given for all actual foci, and serve as a minimum estimate of adult population size. No entry is given for potential and unknown potential (type 2 and 3) foci, but of course the populations in these areas are not necessarily zero. The population estimates have also been converted into population size classes and entered in that column. Population size classes are as follows: 1 = <20, 2 = 20-49, 3 = 50-99, 4 = 100-499, 5 = 500+ (and 0 = not applicable). If population estimates seem unacceptably high (or low), then as well as re-examining the suggested density figure, the size and shape of each focus might also be reconsidered.

It was not possible yet to the year in which animals were last recorded for each focus. This will require further GIS development to automate the process of sifting database records. For many foci, data have either not been entered yet, or the locations are known but sightings have not been formally recorded. Reintroductions are recorded in the 'Reintro' field (true/false in MapInfo, yes/no in Excel). 'Data capture' refers to the GIS basemap used. 'Source data' refers to the named individual(s) who advised the boundary location and extent.

Brief consideration of the viability of populations, particularly the smallest and most isolated ones, is worthwhile here. The standard '50-500 rule' would suggest that any population with fewer than 50 breeding animals (potentially including subadults) might be in danger of extinction from stochastic events, even without considering the effects of genetic bottlenecking etc. Having said this, it is worth bearing in mind that many isolated UK populations might already be surviving with fewer animals than this. Their long-term viability is clearly questionable, and the need for a strategic approach for maintenance of connectivity is essential.

Critical appraisal of the sand lizard baseline dataset will be necessary to assess whether the population estimates resemble the empirical evidence where available. The appropriateness and extent of the foci boundaries will need to be examined, perhaps against a firm definition of foci based upon density of animals. Also, whether the concept of foci is appropriate for this purpose needs to be addressed. By the assumption suggested here that sand lizard densities on foci are

at least 30 adults per hectare, this in itself becomes a definition for foci, i.e. any area of habitat with this density or above. Finally, it will be necessary to target the gaps in geographical coverage, and although eminently achievable, this is likely to involve a significant amount of fieldwork.

5.3. Smooth snake

Before this exercise, there had been no attempt to map the distribution of habitat used by smooth snakes. The difficulty of detecting smooth snakes - owing to their 'cryptic heliothermy' (Beebee & Griffiths, 2000) – has meant that they are even more under-recorded than the other herpetofauna species. There is also a resource burden associated with laying refugia and surveying for smooth snakes.

This baseline dataset was created by mapping the areas of heathland habitat and adjoining areas of suitable habitat that are coincident with smooth snake records held in the HCT database. These include the known translocations. Of the total of 2,215 database records held, 579 are from the BHS database (including CAT Survey records 1984-1986), and 164 are from the BRC database. Of the other 1,453, most are from HCT-coordinated surveillance. Unsurprisingly, for the majority of smooth snake sites mapped, the most recent records are from HCT staff and others (largely volunteers) operating under the HCT's organisational survey licence. However, there are some sites for which the last record came from the BHS and BRC databases, and in some cases these are very old.

As with the natterjack and sand lizard site digitisation, the smooth snake boundaries were captured using UKP APs as basemaps. The core habitat of primary importance in the UK is mature lowland heathland, and areas of heathland are generally very clear from the APs. However, as smooth snakes also occupy (at least seasonally) bog, grassland, clear-felled forest, young pine crop and woodland edges, this range of habitats was also considered for inclusion. Non-heathland habitats tend not to have been surveyed (e.g. chalk grassland/scrub on Purbeck) and there are few data to inform an assessment of their relative value.

In the interests of efficiency, we attempted to use the EN *Lowland Heathland GIS Inventory* (version 1.2) as a basis for mapping smooth snake site boundaries, however it was not as useful as hoped. The inventory includes large areas of forest in some places, and omits significant areas of heathland in others. In some cases, polygons had to be split or reduced to remove inappropriate areas, or to separate areas that had been joined but weren't truly contiguous. Naturally the heathland inventory does not include neighbouring areas of bog and acid grassland either (relevant inventories were not used for other habitats). Therefore, where we tried to use heathland inventory polygons to capture smooth snake sites, the boundaries were often significantly amended, and the smooth snake dataset is a hybrid of heathland inventory data and new digitisation.

OS 1:10,000 raster basemaps were used to check and select site names, particularly with older records. Where the grid references of database records were of low resolution (e.g. 1km), the site boundary chosen does not always coincide with the record(s). If the exact site could not be identified (i.e. the record was too vague and/or the habitat is fragmented today), a boundary was not captured. Also, some records in the BHS database have incorrect grid references. Hence, some historic records are omitted from this dataset by default. Urbanisation, agriculture, quarrying and afforestation have destroyed some sites since the last record was made.

Areas of unsuitable but traversable habitat (e.g. closed or semi-closed forest) should not be viewed as ecological barriers to smooth snakes, therefore the GIS boundaries digitised for the baseline dataset do not purport to reflect the full extent of smooth snake populations. In some forest sites, the boundary was cut off arbitrarily at about 500m from the nearest record rather than attaching long narrow strips of ride-side habitat. The arbitrary nature of site demarcation cannot easily be overcome, and for ease of reference, some technically contiguous forest sites

have been captured as separate entities. In fact, a simple way of dealing with some of the uncertainties about smooth snake distribution would be to create a notional 500m or 1km buffer around all smooth snake sites, and to anticipate that smooth snakes may be present within this area. Nevertheless, the boundaries are probably a fairly good representation of the extent of habitat likely to be used at each site. Habitat succession and cropping cycles in forest plantations are dynamic by nature; therefore site boundaries are somewhat fluid if indeed 'boundaries' can be said t exist in forests. Also, boundaries drawn today for any site do not necessarily reflect the extent of habitat available when the records were collected.

The movement and home range of smooth snakes is difficult to predict, as some animals are virtually sedentary, whilst others move large distances (Gent, 1988; Gent & Spellerberg, 1993; Phelps, 1978, 2004). Proposing a buffer zone within which one could expect smooth snakes (and perhaps target survey effort) would be simpler at this stage than subjectively mapping surrounding habitat based upon conjecture. Nevertheless, there remains a significant gap in the distribution knowledge for smooth snakes, not only in non-heathland habitats such as the Purbeck chalk areas, but on heathland sites that have not been surveyed in recent decades or have never been surveyed.

There is almost certainly a significant area of unmapped occupied smooth snake habitat in southern England. A category of 'potential' smooth snake sites has therefore been added to the dataset. This comprises heathland within the presumed historic range of the smooth snake with no associated records on our database. Heathland sites above a reasonable size could at least *potentially* support undiscovered smooth snakes, but it is very unlikely that smaller sites would do so. Furthermore, outlying sites are less likely to have smooth snakes than sites within the 'core areas' of the range. As well as being targets for survey, these sites might be considered for future translocations. The sites were selected by taking polygons greater than 10 hectares from the *Lowland Heathland GIS Inventory* (after combining smaller adjacent polygons in some cases) within the presumed historic range of the smooth snake. The historic range was taken to be the shortest line that could be drawn around all smooth snake records, adjusted to include a few areas of heaths falling along its margin. The resulting heathland dataset includes outlying sites in Berkshire and Devon for example. Of course, smooth snakes are probably extinct at some of the recorded sites with 'unknown' status. Note that areas of heathland that are not in the heathland inventory have not been included in this category, nor have small heathland areas within forest blocks. There are many potential sites within forest plantations that are not mapped in the heathland inventory. There are typically many small isolated areas of heathland within conifer plantations, which by virtue of their size might not survive independently long-term. However, within a large pervious network of forest blocks, they can support smooth snakes. As a recent HCT survey in Ringwood Forest has shown, even the smallest areas of forest-enclosed heathland can support smooth snakes.

The following fields are used in both the Excel and the MapInfo versions of the dataset: *SiteKey, Site, Area_ha, Xcoord, Ycoord, SSSI, SSSI SiteUnit, Popn_status, Last_seen, Reintro, Boundary_digitisation, Captured_using, Source_data, Comments.* No attempt has been made to estimate population sizes or categorise population size classes. The site key is a unique identifier. The site names are taken from the source records, choosing the most common and/or appropriate site name where there is more than one. The Cartesian area of each site boundary in hectares, and the centroid x and y coordinates were produced by MapInfo. The SSSI site names and site unit numbers were inserted by overlaying the smooth snake sites onto the 'siteunit' MapInfo file obtained from EN. Where a smooth snake site covers more than one SSSI, the names are separated by a semicolon, as are the respective site units in the 'SSSI site unit' field. Reintroductions are recorded in the 'Reintro' field (true/false in MapInfo, yes/no in Excel). 'Data capture' refers to the GIS basemap used. 'Source data' refers to the logic behind the boundary location.

A total of 362 sites have been included in the database, but these include areas (particularly the New Forest) that require further attention to split and/or amalgamate them. There are 159 extant sites (with records from 1994 onwards), an additional 4 introduction sites, 39 sites with pre-1994

records (classed as unknown status), and 161 potential sites. The whole dataset covers 43,549 hectares, of which sites with post-1993 records (including introductions) account for 23,924 hectares. Of course, these figures do not necessarily reflect the area of occupied habitat.

Population status is difficult to assess using the available data, even for single sites, and changes in status are virtually impossible for most sites. The year of the most recent record for each site is entered in the 'Last seen' field. However, as stated earlier, surveillance is very patchy for smooth snakes, and the HCT database is incomplete. Clearly the older a record is, the more likely that the population is extinct (otherwise it should have been detected), but this is not necessarily so. It has been suggested that post-1994 records may be considered appropriate for determining whether a population should be viewed as extant or possibly extinct (based on the implementation of the Habitats Directive in the UK), but this would be inappropriate for the smooth snake because of obvious data deficiencies. Population status categories used are as follows: extant, introduced, unknown, potential. All sites with records from 1994 onwards are classed as extant. For all sites with records older than 1994, status has been recorded as unknown. Treating records older than 1970 or another arbitrary cut-off date as extinct was considered, but has not been carried out.

The estimation of population size is very difficult for smooth snakes. As well as their poor detectability, their habitat ecology is not fully explored, and the relative importance of habitat areas cannot easily be ascertained, even within mature heathland (Phelps, 1978, 2004; Reading, 1997). Smooth snakes records tend to be concentrated in 'hotspots' (Beebee & Griffiths, 2000). The current HCT survey of smooth snakes in the New Forest has identified distinct hotspots and 'blank' areas, despite all tins being laid in apparently ideal habitat. It seems that local variations in smooth snake distribution are difficult to predict from qualitative habitat assessment alone (based upon current knowledge).

Previous attempts to extrapolate local studies into national population figures (e.g. Goddard, 1984) have not fully considered these variations and are therefore not realistic. It would be spurious to expect a realistic population estimate based upon the site areas alone, whether locally or nationally, as many of the records are concentrated in small parts of sites where the tins have been laid. Population estimates could only be achieved with intensive mark-recapture exercises, and even comprehensive intra-site distribution data needs more intensive study than presently takes place at nearly all sites. Information obtained to date from mark-recapture is very thin on the ground. A few PIT tagging studies have been carried out, but the recording of individuals by drawing or photographing the dorsal head and neck pattern is more common. The latter is certainly more feasible since the advent of digital photography, and many surveyors now photograph smooth snakes. The HCT holds a large volume of such data (apparently over 400 individuals for Dorset and the New Forest), but on the whole it is not utilised. The compilation of digital images of smooth snakes with the date, sex, measurements and exact location associated with them is time consuming and only worthwhile if the images and data are to be used. Recognition of individuals could be used to track seasonal movement, home range (if relevant), the relative importance of different habitat areas, and to gauge population size and density. The data that the HCT already hold would go some way towards fulfilling these aims if carried out as part of, for example, an MSc project to assess the value of photographic identification of individuals.

A brief mention of population density is appropriate, although there is little data available. Beebee & Griffiths (2000) suggested densities of up to 20 smooth snakes per hectare. An examination of a heavily-tinned heathland and acid grassland HCT reserve (3 hectares) in Dorset recorded at least 25 adults and subadult individuals (mostly adult) over two years (unpublished HCT data). This would approximate to about 8 animals per hectare. The site is bounded by closed conifer plantation, acid grassland, housing and clear-felled forestry. It may serve as a focus for 'local' smooth snakes, however, because of its high population of slow-worms.

Given the large uncertainties within this baseline dataset, we have not attempted to produce population estimates based on densities. This baseline dataset should be regarded as the first

stage in assessing the full distribution of smooth snakes in England. A great deal of further survey is needed before a true baseline can be produced. This is certainly achievable, and although tins are most effective after 4 or 5 years (N. Moulton, pers. comm.), many of the gaps could easily be filled within two years. Recent HCT survey has produced smooth snake records within weeks and months. If resources were targeted at tinning and surveying potential sites early in 2005, it would produce results by the end of the summer. It is recommended that core area heathland sites with no records should be surveyed as a matter of priority. This includes sites with pre-1994 records and sites with no records that have apparently never been surveyed. Furthermore, effort should be targeted in Forestry Commission (FC) land, in collaboration with FC staff, to identify smooth snake populations (and sand lizards) as yet undiscovered within forest blocks. Some smooth snake data collected by FC staff in Dorset have yet to be entered onto the HCT database (pending location details), but there are other areas that remain unsurveyed.

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7. References

Beebee, T.J.C. & Buckley, J. 2001*. Natterjack toad (*Bufo calamita*) site register for the UK 1970-1999 inclusive.* Unpublished report by the University of Sussex and The Herpetological Conservation Trust.

Beebee, T.J.C. & Griffiths, R.A. 2000. *Amphibians and reptiles. A natural history of the British herpetofauna.* HarperCollins, London.

Berglind, S.-A. 2004. Sand Lizard (*Lacerta* agilis) in Central Sweden. Modelling Juvenile Reintroduction and Spatial Management Strategies for Metapopulation Establishment. *In*: Akçakaya, H.R. *et al* (ed.). *Species Conservation and Management: Case Studies.* Oxford University Press, Oxford.

Buckley, J. & Beebee, T.J.C. 2004. Monitoring the conservation status of an endangered amphibian: the natterjack toad *Bufo calamita* in Britain. *Animal Conservation*, 7, 221-228.

Corbett, K.F. 1988a. Distribution and status of the sand lizard, *Lacerta agilis agilis*, in Britain. *Mertensiella*, 1, 92-99.

Corbett, K.F. 1988b. Conservation strategy for the sand lizard (*Lacerta agilis agilis*) in Britain. *Mertensiella*, 1, 101-109.

Corbett, K. 1994. *Pilot study for Sand Lizard UK Recovery Programme.* English Nature Research Report 102, Peterborough.

Corbett, K.F. & Moulton, N.R. 1998. *Sand lizard Species Recovery Programme project (1994-1997). Final report.* English Nature Research Report 288, Peterborough.

Corbett, K.F. & Tamarind, D.L. 1979.Conservation of the sand lizard, *Lacerta agilis*, by habitat management. *British Journal of Herpetology*, 5, 799-823.

EAU (Environmental Advisory Unit Ltd). 1992. *Sand lizard conservation strategy for the Merseyside coast.* Unpublished report for English Nature, Peterborough.

House, S.M. & Spellerberg, I.F. 1983. Ecology and conservation of the sand lizard (*Lacerta agilis* L.) habitat in southern England. *Journal of Applied Ecology*, 20, 417-437.
Gent, A.H. 1988. *Movement and dispersion of the smooth snake (*Coronella austriaca *Laurenti) in relation to habitat.* PhD thesis, University of Southampton.
Gent, A.H. & Spellerberg, I.F. 1993. Movement rates of the smooth snake *Coronella austriaca* (Colubridae): a radio-telemetric study. *Herpetological Journal,* 3, 140-146.
Goddard, P. 1984. Morphology, growth, food habits and population characteristics of the smooth snake *Coronella austriaca* in southern Britain. *Journal of Zoology (London)*, 204, 241-257.
NCC (Nature Conservancy Council). 1983. *The ecology and conservation of amphibian and reptile species endangered in Britain.* Wildlife Advisory Branch, NCC, London.
Nicholson, A.M. & Spellerberg, I.F. 1989. Activity and home range of the lizard *Lacerta agilis* L. *Herpetological Journal*, 1, 362-365.
Phelps, T.E. 1978. Seasonal movement of the snakes *Coronella austriaca, Vipera berus* and *Natrix natrix* in southern England. *British Journal of Herpetology,* 5, 755-761.
Phelps, T.E. 2004. Beyond hypothesis – a long-term study of British snakes. *British Wildlife*, 15 (5), 319- 327.
Reading, C.J. 1997. A proposed standard method for surveying reptiles on dry lowland heath. *Journal of Applied Ecology*, 34, 1057-1069.
Strijbosch, H. 1988. Reproductive biology and conservation of the sand lizard. *Mertensiella*, 132-145.