



THE HERPETOLOGICAL
CONSERVATION TRUST

Initial surveillance baseline datasets for the sand lizard *Lacerta agilis* and natterjack toad *Bufo calamita* in Wales

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2. Summary

Countryside Council for Wales 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 two rare species: natterjack toad and sand lizard, and to construct costed options for a future surveillance scheme. This interim report presents baseline datasets for the two rarest species, and discusses methodological issues. 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. Digitisation of surveillance records is complete for Wales but not for England. GIS site inventories had been created for sand lizards and natterjack toads, these 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 will be discussed further in due course.

3. Introduction

The Countryside Council for Wales (CCW) 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 needs for surveillance and status monitoring for this group. The HCT is carrying out an exercise, with funding from CCW and English Nature (EN), to assess capacity for herpetofauna surveillance, investigate methodological and logistical issues, and construct costed options for a national surveillance scheme. The current contract will report in two stages: the first, this report, to present baseline datasets for rare species, and the second in January 2005 to present overall findings and recommendations for a national surveillance scheme.

Much of the groundwork for creating herpetofauna baseline datasets for England and Scotland was already in progress, and the Welsh populations had all been mapped. In a previous contract for CCW, the HCT had also mapped potential natterjack toad and sand lizard sites. Almost all British sand lizard populations are in England, and nearly all natterjack toad populations are in England and Scotland. During the last ten years, CCW and the HCT have worked together to bring both species back to Wales, and although the number of Welsh sites for these species is still small, the discussion on mapping and surveillance of English populations is of relevance to Wales, particularly as further reintroductions are planned in Wales.

The collection of surveillance data has taken place for many years in England and Scotland, and since the reintroductions, in Wales too. 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 HCT. 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), CCW and EN. Digitisation of the backlog data is still in progress for England. 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 used in mapping species locations and other data. The database was supplied for upload to the NBN Gateway in 2003, and an updated version was uploaded in May 2004.

3.1. Objectives for baseline datasets

The rationale for this project has been strongly guided by a note entitled *Species surveillance strategy: reptiles and amphibians* (4 March 2004), both drawn up by Jim Foster of EN, setting out the types of information that EN needs and the reasons for needing them. There are several broad categories for which EN needs information on species status, and it is likely that CCW will find these categories applicable too. These uses for surveillance data can be summarised as follows:

- Condition assessment 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

The Statutory Nature Conservation Organisations (SNCOs) are required to monitor the condition of interest features on designated sites, therefore all herpetofaunal interest features need to be

monitored. In England, 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. A similar assessment has not been carried out in Wales. Around 20 SACs are notified for great crested newt in England, and at least one site 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, but focus is 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 based upon suspected declines.

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 SNCO staff might require herpetofauna status information, whether for area team casework or for national projects. Jim Foster (EN) 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.

It would be useful to know whether these categories are a useful reflection of CCW business needs for herpetofauna surveillance information. In determining what requirements there are for future monitoring, there is a crucial information gap 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 constructed and made available. Coordinated effort will be required to construct and operate a sustainable national herpetofauna-monitoring programme, and the development of baseline datasets need to be addressed first. The types of information that SNCOs might require in order to make status assessments could be :

- 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. In

England, EN have recommended that the approach used in their Common Standards Monitoring (CSM) document for herpetofauna, i.e. tables listing attributes, targets and assessment methods, be used as a model.

The table below gives EN's view on the relevance of the five data need categories discussed above to each species, and identifies where the key information gaps lie. We would appreciate CCW's perspective on this.

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. 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. A similar arrangement should be sought between the HCT and CCW.

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 in 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 (in accordance with the HCT's DAP), and a similar arrangement should be set up with CCW. In the meantime, the HCT should be consulted before baseline datasets or derivatives are passed on to third parties. 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. 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. Apart from historical records (of extinct populations), the only Welsh data for rare species have come from the recent reintroductions.

The digitisation of site boundaries for the three species was carried out using MapInfo GIS, largely captured using OS raster and sites. 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%. On sand dune sites, it is very difficult to assess the distribution of all sand lizards. The population foci were mapped according to release site locations, monitoring data, and expected distribution. Nick Moulton advised on these, and on the location of coastal dune sites throughout the whole of Wales with potential for sand lizard reintroductions (pending field survey and habitat assessment). The introduced natterjack sites and all potential sites across north Wales were mapped with advice from John Buckley.

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 and sand lizard in the appendices, and electronically as Excel and MapInfo files. The remit used in the mapping of sites was determined as "habitat likely to be used by the species". The datasets should be regarded as interim, and the suggestion of a potential site does not guarantee its suitability for a future reintroduction.

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 Getmapping APs for Wales. As the remit was determined as "habitat likely to be used by the species", for actual and potential sites, 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 would 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. Little attempt has been made to exclude small-scale areas of unsuitable habitat, including some buildings and roads. The boundaries are likely to need refinement in future, perhaps using GIS habitat inventories if available, and preferably with further assessment of the likely extent of the animals on each site. All known natterjack sites since 1970 have been included in the dataset, whether extinct, extant or introduced. For Wales, there are only reintroduced sites and potential sites. It is assumed that there are no natterjack toad sites in Wales that have yet to be 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 a MapInfo file obtained from CCW. Where a natterjack site covers more than one SSSI, the names are separated by a semicolon, as are the respective site units in that field.

For this exercise as a whole (all UK sites), population status categories are as follows: increasing, stable, decreasing, extinct, new introduction, never established, potential. Only *increasing* and *potential* are used for Wales. Population status was based upon trends visible from time-series data (as presented and discussed by Buckley & Beebee, 2004). The year in which animals and/or spawn were last seen is given 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. 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 maps used for GIS data capture. '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).

There are only two extant (i.e. introduced) natterjack toad populations in Wales, and 23 potential sites have been identified and mapped. Of the 60 natterjack toad sites mapped for England, 50 of them are extant (stable, increasing or decreasing); the others are extinct or potential. In Scotland, there are five extant sites, including one reintroduction.

5.2. Sand lizard

The sand lizard population baseline datasets for Wales and England have been constructed through a combination of expert knowledge, introduction site records, and monitoring data. The 12,458 sightings records held on the HCT database include a small number of monitoring data for the first Welsh reintroduction sites. Together with expected dispersal and site knowledge, the extent of actual foci were mapped. In addition, the extent of apparently appropriate marram-dominated habitat on coastal dune systems has been mapped. This should not be taken to mean that a site *is* appropriate for sand lizards, nor that sand lizards are not there already (although it is increasingly unlikely that there are any sand lizard populations in Wales yet to discover). The term 'foci' 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, but do not necessarily account for all lizards in the area. Whilst the locations of foci are intrinsically linked to habitat factors, their size and viability are often improved by management. The purpose of defining foci has traditionally been an attempt to draw attention, for conservation management purposes, to the most important sand lizard areas. Sand lizards can live in low densities in sub-optimal habitat, however, although insufficient work has been done on measuring comparative densities over a range of habitat qualities. Nevertheless, at many English sites, it can be assumed that a minor but often 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. All extant and potential Welsh sites (under current thinking) are coastal sand dune systems, where a favourable balance of dune creation, mobility, and vegetation succession is critical.

The mapping of foci to date has been via the annotation of aerial photography (AP) printouts by HCT staff, or in some cases (before complete AP coverage was available) on printed maps. 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. The availability of APs has brought remarkable benefits in enabling the identification of potential sand lizard locations. The shapes of foci often tend to be sinuous and irregular, generally enclosed within 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 absolutely, it is the only viable option. Furthermore, the combined experience of the people involved suggests that it is an eminently acceptable approach.

In Wales, the two Morfa Harlech releases should now effectively form one focus, whereas the recent Presthaven Sands and Gronant releases are assumed to be restricted to core areas around the release sites until monitoring begins in 2005. The three actual foci thus mapped have a combined area of 17 hectares. The total area of potential foci for Wales (including areas contiguous with the actual foci) amounts to 1078 hectares (60 potential foci). In summary for England, 519 actual foci were mapped, 332 potential foci and 39 unknown/unsurveyed potential foci. The actual foci cover a total area of 1,288 hectares (259 hectares require further assessment); the potential foci cover 1,085 hectares, and the unknown area cover at least 48 hectares (this latter category probably does not account for all undetected populations in England).

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*, *Source_data*, *Comments*. The map objects are coloured yellow for actual foci and purple for potential foci. The site key is a unique identifier. The site names for actual foci were confirmed by Nick Moulton, and for potential foci they were taken from OS 1:10,000 raster basemaps. As there may be several foci on one site, the site names are not unique. Foci have not been given individual names yet. In the 'Focus type' field, type 1 are actual foci and type 2 are potential. 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 a MapInfo file obtained from CCW. In many cases, a focus falls across several site units. Some foci only partly overlap with a site unit or units. Any assessment of sand lizard foci within and outside 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. If the coastline has shifted since CCW's capture of SSSI boundaries, we have included all site units that are (technically) still coincidental with sand lizard foci.

Population status categories used for the UK-scale exercise are: increasing, stable, decreasing, potential, unknown. Only *increasing*, *unknown* and *potential* are used for the Welsh sites. Population status was rated at each of the foci by perceived or known status. Judging by

monitoring data from Morfa Harlech, the population is breeding and spreading, and therefore seems to be increasing in size. As monitoring has not begun yet at the most recent introductions (in 2003 and 2004), their status is unknown, but is presumably increasing. All other sites are classed as potential, i.e. potentially suitable for sand lizards, but not excluding the possibility that they are already present. Recent surveys of potential sites, and the unanswered question of why sand lizards are not more obvious if they *are* present, point towards there being no extant populations to discover.

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. As the three Welsh sites are recent reintroductions of limited extent, this exercise was mainly geared towards the English sites. Keith Corbett suggested up to 300 adults per hectare occupied the best UK heathland habitat areas (Corbett, 1988a), and reported densities of 210 per hectare on prime Surrey heathland habitat and 300 per hectare in Bournemouth (Corbett in NCC, 1983). Corbett & Tamarind (1979) talked of 125 adults per hectare on sites that were good but that had less exposed sand and/or less favourable topography than the best sites known. 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 1,400m² (uncorrected), but generally range between 200 and 600m², 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, being a habitat of similar structural diversity. On forest heathland patches in Sweden, Berglind (2004) found an 'equilibrium density' of 120 adult 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 to UK populations, as they are on different habitats and/or under markedly different climatic regimes. For consistency, the number of adults is suggested as the best measure 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 could be suggested for all actual foci as a starting point, whether on 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 (except some awaiting further assessment in England). At a density figure as low as 30 per hectare, this still gives a surprisingly large predicted UK 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 17 hectares, but only the oldest reintroduction site (Morfa Harlech) could be considered as approaching a demographically-balanced population. The two newest populations were introduced using batches of juveniles (typically 50 or more) and lesser numbers of adults. As no new animals could have reached maturity, the maximum number of adult animals at those sites can be no more than those released. The resulting population prediction figures, based upon 30 adults per hectare, are given for actual foci, and serve as an estimate of adult population size. No entry is given for potential (type 2) foci. 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) for a Morfa Harlech, then as well as re-examining the suggested density figure, the size and shape of the actual focus could be reconsidered.

The year in which animals were last recorded is given for each focus. 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 small and 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 bottlenecks 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.

6. Acknowledgements

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