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AMERSHAM MEETING REPORT 2023 CONSERVATION, CAPTIVE BREEDING AND FIELDWORK

Simon Townson

FRONT COVER: The freshly sloughed male adder was found on the 21st of April 2024 near Frensham, Surrey. It was left undisturbed, basking in heather. Photograph supplied by Richard Callf.

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Conservation challenges and solutions for adders in Great Britain

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Introduction

The adder *Vipera berus* is one of three snakes native to Great Britain, alongside the barred grass snake *Natrix helvetica* and the smooth snake *Coronella austriaca*. It belongs to the family Viperidae, and has characters typical of vipers: it gives birth to live young, delivers venom through fangs at the front of its mouth, has elliptical pupils and keeled scales, and has a relatively stocky build. Adders have distinctive markings, notably with bold, dark zig-zag pattern along the back that contrasts with the lighter ground colour, typically grey-ish in adult males and brown-ish in females. The adder has an extensive global range, from western Europe as far east as Sakhalin Island, Russia, and to around 70° N in Scandinavia. It also has a wide range in Great Britain, being found in the far north, south, east and west, though there are large areas within this range where is it either absent or very scarce.

Concerns about adder status in Britain

The widespread nature of adders in Great Britain has, in the past, masked concerns about its conservation. Whilst it was generally accepted that, in common with many taxa, adders had suffered as a result of development and agricultural intensification in the twentieth century, serious concerns about major declines gathered pace in the early 2000s. The issue appeared particularly acute in the English midlands, where adder populations were reducing in size or disappearing to a worrying extent. A range of investigations, surveys and conservation projects has since confirmed that there are real grounds for concern. Many populations appear to be small, fragmented and declining. However, the picture is complicated as adders do also occur in large, stable or increasing populations in some regions. This mixed picture is to some extent replicated in parts of the continent, and so it may be the case that there are common factors impacting the species. An assessment of the extinction risk of adders using IUCN Red List criteria concluded that it should be considered Near Threatened in Great Britain, Scotland and Wales, and Vulnerable in England. At a European level, the species is considered Least Concern, but as in Great Britain the species is assessed as having higher extinction risk at some smaller spatial scales within Europe.

Causes of decline

A wide range of reasons for declines in adder populations has been confirmed or suggested. It is likely that each population faces a few different pressures, though the significance of some potential decline factors needs further research. Like many temperate reptiles, adders need open habitats in order to generate the right temperature conditions, and yet many sites in Britain have succumbed to a lack of active habitat management, meaning that previously open habitats are now heavily shaded. Conversely, sites are intensively managed, often meaning that there is little cover at ground level. Such conditions mean adders cannot thermoregulate as effectively, and are more vulnerable to predation. Adder sites are still being lost or fragmented by construction projects and fires. Aside from issues relating to habitat condition, adders may be threatened by human disturbance, human persecution, unnaturally high levels of predation, climate change effects, and viability or genetic issues associated with low population size. Although a generally unfavourable public perception does not directly harm adders, it can be a hindrance in taking forward conservation action. A further complicating issue is that the habitat requirements for adders do not always align well with those of other species, habitats or site uses; hence conflicts in management objectives can sometimes arise.

Recovering adders

Whilst the current situation is alarming, there are some grounds for optimism. There has been a marked increase in interest in adder conservation recently, with a range of initiatives to support

Figure 1. Female adder showing the typical dark brown markings over reddish-brown ground colour. Photo: Jim Foster/ARC.

recovery. These include research projects, monitoring projects, local conservation action, public engagement, volunteer training and national recovery planning. To name just a few:

- There has been a national adder survey in Scotland run by NatureScot, ARG UK and ARC, due to report in 2024.
- Techniques for public engagement have been investigated by ARG UK.
- Two national 'Vanishing Viper' conferences were run in 2016 and 2019.
- Regional projects working on adders have included Roots of Rockingham (part of the 'Back from the Brink' programme) and Snakes in the Heather.

The scientific research underpinning adder declines and recovery has included work on the genetics of small populations, and the potential impacts of gamebird releases. Whilst the translocation of adders is often mooted as a solution to their precarious status, it can be argued that focusing efforts on conserving existing populations is more appropriate. Translocation could be a useful tool in some particular circumstances.

Conclusions

Fundamentally, adders need more high quality, well connected habitat, increased population viability, and a reduction in threatening actions. Actions to achieve all this are, in some cases, already underway, but more effort, research and co-ordination is needed. In addition, adders could benefit from greater formal recognition in the processes that govern land management and conservation action. One example of a positive step forward here is the change in the way that protected areas known as Sites of Species Scientific Interest (SSSIs) are selected; only since late 2022 has it been possible to select land solely because of the significance of its adder population. There is work underway to generate explicit quantitative targets for adder conservation, from local to national scales, and to link those targets to the necessary actions. The upturn in interest in adder conservation is a very encouraging development, and projects in the coming years should hopefully build on that enthusiasm to create a brighter future for this beleaguered species.

Selected further reading

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Figure 2. A male adder recently emerged from hibernation, still with a thin covering of dirt as is often the case early in the season. Photo: Jim Foster/ARC.

Figure 3. Adder habitat restoration undertaken at Fineshade Wood, Northamptonshire in the Roots of Rockingham project led by Butterfly Conservation with input from ARC. Photo: Jim Foster/ARC.

Behaviour of adders in captivity at Wildwood Trust monitored using trail cameras

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Concerns over declines in adder populations in the UK have recently led to the species being classified as Near Threatened in Great Britain as a whole and Vulnerable in England (Foster et al., 2021). Indeed, in recent years there have been significant declines at sites supporting small populations of adders, and it is estimated that within a couple of decades the species may be confined to just a few sites with large populations (Gardner et al., 2019). As public pressure and disturbance is one of the factors driving declines, educating the public about the plight of the adder is an important conservation action. Likewise, improving understanding of adder behaviour can inform survey design and population assessment, and ultimately the conservation of the species. Zoos can provide significant contributions to both of these goals. In addition to providing educational displays to an audience who are never likely to see an adder in the wild, well-designed adder exhibits permit the collection of scientific data that would be difficult to obtain in nature. Although individual-based studies of, for example, movements, thermoregulation and refugia use have been revealing (e.g. Hodges & Seabrook, 2016a; 2016b; 2019; Nash & Griffiths, 2018), continuous monitoring of individual wild adders on short time-scales is difficult. However, this may be possible in captive adders living in naturalistic enclosures.

Wildwood Trust has a mission to protect, conserve and rewild British wildlife. It does this through operating wildlife parks in Kent and Devon and carrying out conservation and education projects across the country. Wildwood at Kent has several outdoor reptile enclosures that provide the opportunity to carry out direct observations of species that would otherwise be difficult to achieve in the wild. This project set out to examine the activity patterns of adders in a naturalistic enclosure in relation to temperature.

Three adult female adders and up to 18 unsexed subadults were housed in an uncovered enclosure measuring approximately 10 x 5 m and containing a hibernaculum, various microhabitats, and basking spots. The enclosure was constructed from metal flashing supported on a wooden fence, with three viewing windows for the public (Figs. 1 & 2). The subadults had been born in the enclosure in 2020 and were two years old at the time of the study, measuring about 15–20 cm. Dead adult mice were offered to adults and chopped mice/mice legs offered to juveniles approximately every three days when the temperature was above 16 °C.

Five trail cameras were placed around the enclosure and were set to record an image every 15 min from 06:00 hrs until 19:45 hrs each day (Fig. 2; a pilot study showed that adders were unable to trigger the cameras automatically and hence the cameras were set to time lapse). Twenty-five dataloggers were also positioned around the enclosure to map temperature profiles of different microhabitats in the enclosure (although five dataloggers malfunctioned and one was unable to be retrieved from the enclosure). The images and temperatures were periodically downloaded for analysis and the observations obtained were analysed for the period from 19 April until 25 June 2022 (Fig. 3). Because adders were sometimes only partially visible it was not possible to reliably identify individual adders in the images. However, it was possible to estimate basking times of individuals from the sequences obtained. Other activities, such as locomotor activity, changes in the coiling position, and drinking from the pool were also captured, and the use of the different microhabitats in the enclosure extracted from the sequences.

The duration of continuous basking bouts varied considerably from day-to-day, and also within days, but on average, adult basking lasted for 44 minutes while subadults basked for around half that time (Fig. 4). These observations are consistent with those of Hodges & Seabrook (2016a) who found that immature adders were rarely encountered in the open. The duration of basking was longest between 12–17°C, and then declined with increasing temperature with very little basking observed above 25 °C. Basking was most often observed among short vegetation, and in open ground and on stumps and logs and also in the vicinity of the hibernaculum – a large woody structure in the centre of the enclosure. Hodges & Seabrook (2016b) showed that 32.9 °C was the upper thermal set point of wild adders, and

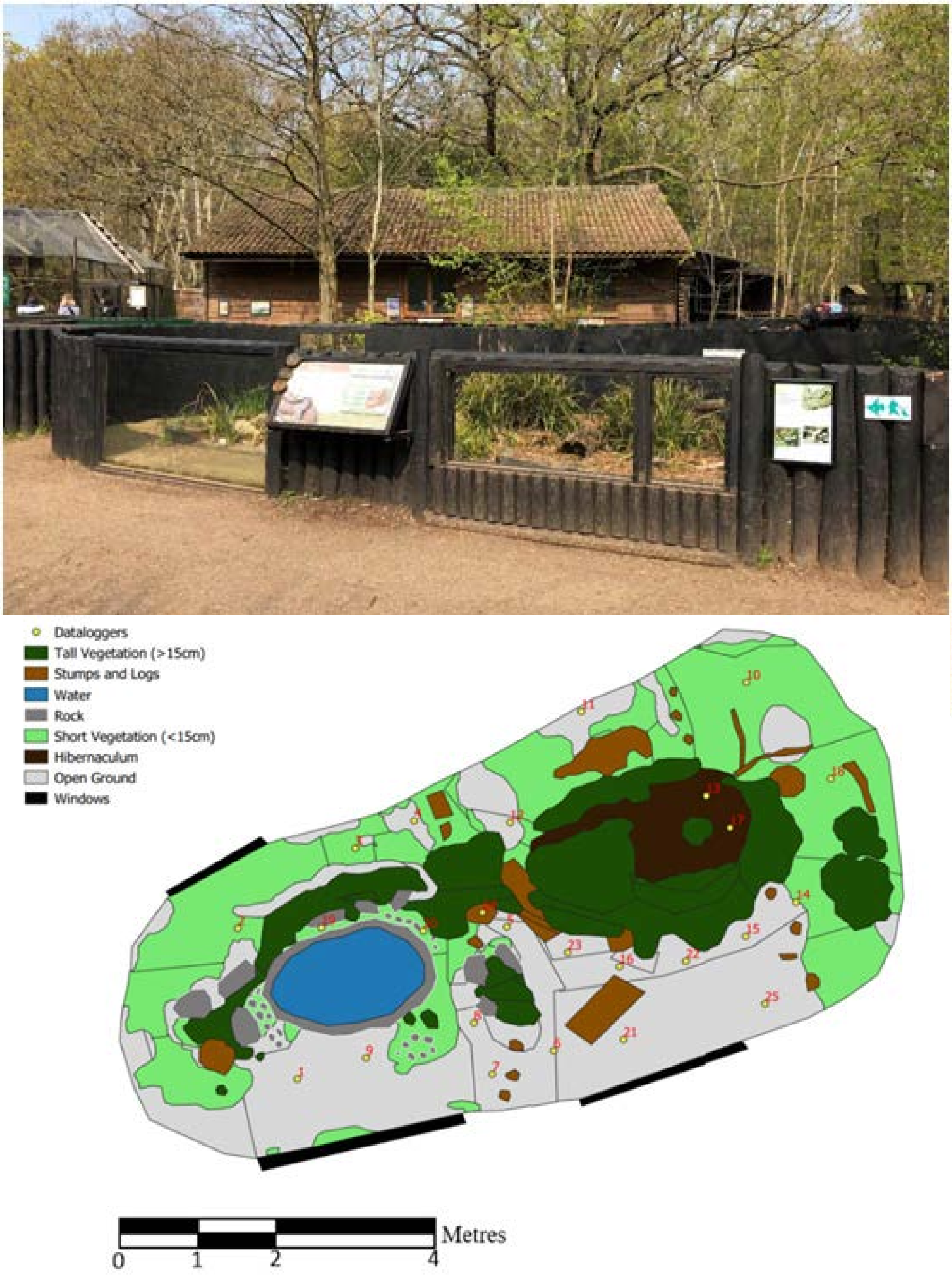

Figure 1. The adder enclosure at Wildwood showing information boards and display windows (top); map of the enclosure showing microhabitats and positions of temperature dataloggers (bottom).

that adders could maintain body temperatures 8.6 °C warmer than operative temperatures under tins. Consequently, the few adders observed basking at 25 °C at Wildwood may have had body temperatures several degrees higher than this. Activity and basking behaviour varied between the microhabitats in the enclosure and also shifted during the day and between months. Likewise, the adders adjusted their coiling patterns, and orientation and flattening of the body according to the passage of the sun. Indeed, the rear metal flashing of the enclosure absorbed and reflected solar radiation and adders were observed using this heat source as well as basking (Fig. 5).

Unlike wild adders which are usually highly sensitive to the approach of humans and will quickly disappear into cover if disturbed, the captive adders

Figure 2. Inside of the adder enclosure at Wildwood showing the positions of three trail cameras

at Wildwood were clearly habituated to the presence of human visitors and utilised favoured basking spots in the enclosure even on busy days. As an educational exhibit, the enclosure proved popular with visitors, and although adders were not always visible, trying to find one in the enclosure proved to be an engaging challenge for visitors of all ages. A sign explaining the nature of the research was also important in visitor engagement (Fig. 6).

Acknowledgements

We are grateful to the British Herpetological Society for funds to purchase the equipment for this project. Thanks to Sam Nurney for mapping the microhabitats within the enclosures and producing the map, and to Rick Hodges for comments on the article.

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Figure 3. Image obtained from a trail camera set to record every 15 min. Red circle indicates position of adder.

Figure 4. Three basking adders in the Wildwood enclosure.

Figure 5. Female adder with upper part of the body absorbing heat from the metal flashing of the enclosure and the middle and lower part of the body flattened to absorb heat from the sun.

Figure 6. Sign on the adder enclosure explaining the nature of the research.

Bermuda skinks: the long route to Trunk Island

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The Bermuda skink *Plestiodon longirostris* is the only endemic terrestrial vertebrate of Bermuda and is the only living species of an evolutionarily distinct lineage that significantly pre-dates the emergence of the Bermuda archipelago. While some reports by early settlers describe it as common, this secretive species is now Critically Endangered due to the impacts of habitat loss and various invasive species, and is now mostly restricted to small offshore islets. Chester is the only zoo worldwide currently working with this species, and first bred them successfully in 2017, and have bred them regularly since. This has enabled detailed behavioural studies that would have been unable to take place in the wild. In May 2022, along with partners in the Government of Bermuda and the Bermuda Zoological Society (BZS), we conducted the first trial release of zoo-bred Bermuda skinks back to the wild in Bermuda, on Trunk Island. Released skinks were radio-tracked to monitor their dispersal, as part of an MSc project (Turner et al., 2024). Trunk Island was chosen as a release site due to it being used as a 'living classroom' by BZS, enabling regular post-release monitoring by various groups of students and volunteers, and because a large part of the island is an actively managed nature reserve. Further releases are expected to take place in 2024.

Bermuda is a limestone archipelago in the North Atlantic, around 600 miles east of the North American continental landmass. It has a limited indigenous fauna, like many oceanic islands, and only two native reptile species are known from the modern era: the diamondback terrapin *Malaclemys terrapin*, a recent natural colonist also found in the USA (Parham et al., 2008), and the Bermuda skink *Plestiodon longirostris*, the archipelago's only endemic terrestrial vertebrate. Genetic analysis has shown the skink is the only living member of a long-distinct lineage within the genus *Plestiodon* much older than the Bermuda archipelago itself, suggesting initial divergence from the ancestors of other skink species took place somewhere else before the skinks colonised Bermuda, adding to the importance of preserving this species as a highly distinct evolutionary lineage (Brandley et al., 2010). Early reports suggest it was once widespread throughout the archipelago, probably occupying the majority of Bermuda's terrestrial habitats (Davenport et al., 2001). Initial declines in the population, reported not long after human colonisation, are probably attributable to predation by introduced cats *Felis catus* and rats *Rattus rattus* & *R. norvegicus* alongside clearance of much of the islands' natural vegetation. Subsequent further declines in the 20th Century, most notably in coastal areas and islets which were previously strongholds for the species, are attributable to a range of different invasive species; predation and competition from Jamaican anoles *Anolis grahami* and cane toads *Rhinella marina*, habitat degradation and loss of basking areas due to invasive plants including casuarina *Casuarina equisetifolia* and Brazil pepper *Schinus terebinthifolia*, and, most notably, predation by the introduced kiskadee flycatcher *Pitangus sulphuratus*, which has flown to islands inaccessible to mammalian predators (Davenport et al., 2001). Surveys in 2015–2017 suggest a total wild population of around 1500 skinks, fragmented across a number of small populations which continue to decline (Turner, 2019).

At Chester Zoo, the adult Bermuda skinks are housed in open-topped purpose-built enclosures within an off-display facility, separate from all other reptile housing. These enclosures include automated basking and UV lighting, set up to mimic day length, UVI and temperatures found in the species' native habitats in Bermuda. The skinks are fed a varied diet including livefood items such as crickets, seafood prey including defrosted crayfish, and fruit-based commercial gecko diets. These enclosures are designed to allow the mixing or separation of male-female pairs according to breeding requirements. The ability to separate the females is crucial to reduce stress and territorial

Figure 1. Bermuda skink with unsuccessful harness design around hindquarters at Chester Zoo (S. Rawlins, Chester Zoo).

aggression from the males outside the breeding season. Eggs are either incubated in vermiculite or left to be maternally incubated by the mother; both have shown success in this species. Juveniles are housed in small groups in glass exo-terra vivaria, with the keeper team carefully watching for signs of aggression and splitting the group as they grow.

Even while carrying out day-to-day spraying enclosures and feeding animals, the team at Chester very rarely see the adult skinks, as due to their shy nature they tend to run and hide under cover objects or in their burrows as soon as someone enters the room. To ensure the health of the animals can be monitored, and to carry out observations for behavioural studies, each of the enclosures is therefore fitted with a continuously-recording camera, the feed for which can be viewed by staff just outside the room. This has enabled a lot of

Figure 2. Bermuda skink with unsuccessful harness design around shoulders at Chester Zoo (G. Garcia).

Figure 3. Bermuda skink with plaster harness design on Trunk Island (G. Garcia).

observations that would not otherwise be possible, including courtship and mating behaviours and nocturnal activity. Prior to the first trial release, various methods of attaching radio-transmitters were trialled at the zoo to ensure retainability and that the skinks' behaviours weren't impacted by transmitter attachment, the observations gained from this then went on to inform the methodology used in Bermuda.

Two different locations were tested to attach the transmitters: harnesses were positioned either across the shoulders or the hind legs (Fig. 1). Placement of the harness on the hindquarters created disturbance and discomfort with the risk of autotomy of the tail, and on several occasions biting the transmitter to try to remove the attachment was observed. It was therefore decided the attachment should be at the front part of the body, but due to the semi-fossorial habitats and use of hollows and cracks of the limestone, the size of the transmitter with the harness was a concern. We tested two main methods of harness attachment; one requiring re-capture to remove the transmitter and a second that would drop off after shedding. The first was a single unit with two arms, to which the transmitter was glued on the shoulders and attached ventrally with a fishing line coated with rubber (Fig. 2). The second involved glueing the transmitter to finger plasters of different materials (Fig. 3 & 4). As Bermuda skinks are extremely cryptic, and their recapture is very difficult, it was decided to go with the option to use transmitters located between the shoulders attached using a finger plaster for the length of time the skink will take to shed.

In summer 2022 three pre-release enclosures were constructed on Trunk Island, Bermuda, prior to the arrival of 18 captive-bred Bermuda skinks from Chester Zoo (Turner et al., 2024). Nine of these animals had radio-transmitters attached, and all were kept in the enclosures for five days and closely monitored by trail cameras, before the enclosures were opened and skinks were allowed to disperse.

Radio-tracking took place twice daily following the opening of the enclosures, and the locations of each skink were precisely logged, often without visual confirmation of the animal hiding among the leaf litter and rocks. Radio-tracking data were collected for an average of two weeks and in a single individual up to one month. Transmitters were recovered before the battery drained and were clearly dropped by the skinks upon the shedding of the attached sections of their skin, as demonstrated by the plasters being located with pieces of shed skin attached (Fig. 5).

This data enabled the calculation of home range size and estimation of carrying capacity for the island (see Pichon (2022) for more details of tracking

Figure 4. Process of attaching a plaster harness to a Bermuda skink (G. Garcia).

Figure 5. Dropped transmitter at the release site on Trunk Island, showing shed skin stuck to the plaster (G. Garcia).

methodology and home range calculations; Figs. 6 & 7). Long term monitoring of the population will continue through the use of the island as a 'living classroom' by the Bermuda Zoological Society, meaning that the island is regularly used by students and volunteer groups for training and learning, ensuring the continued monitoring of the skinks through a form of citizen science. In spring–summer 2024 further captive-bred Bermuda skinks from 2022 and 2023 will be released onto Trunk Island following the successful eradication of rats which had recently re-colonised the island, using a different method of attaching transmitters, again trialled at Chester Zoo beforehand.

Acknowledgements

The authors would like to thank all the team at the Bermuda Zoological Society and the Department for Environment and Natural Resources involved in the restoration of Trunk Island, and all the ectotherms and science teams at Chester Zoo involved in the care of the safety-net skink population and ongoing research into this species.

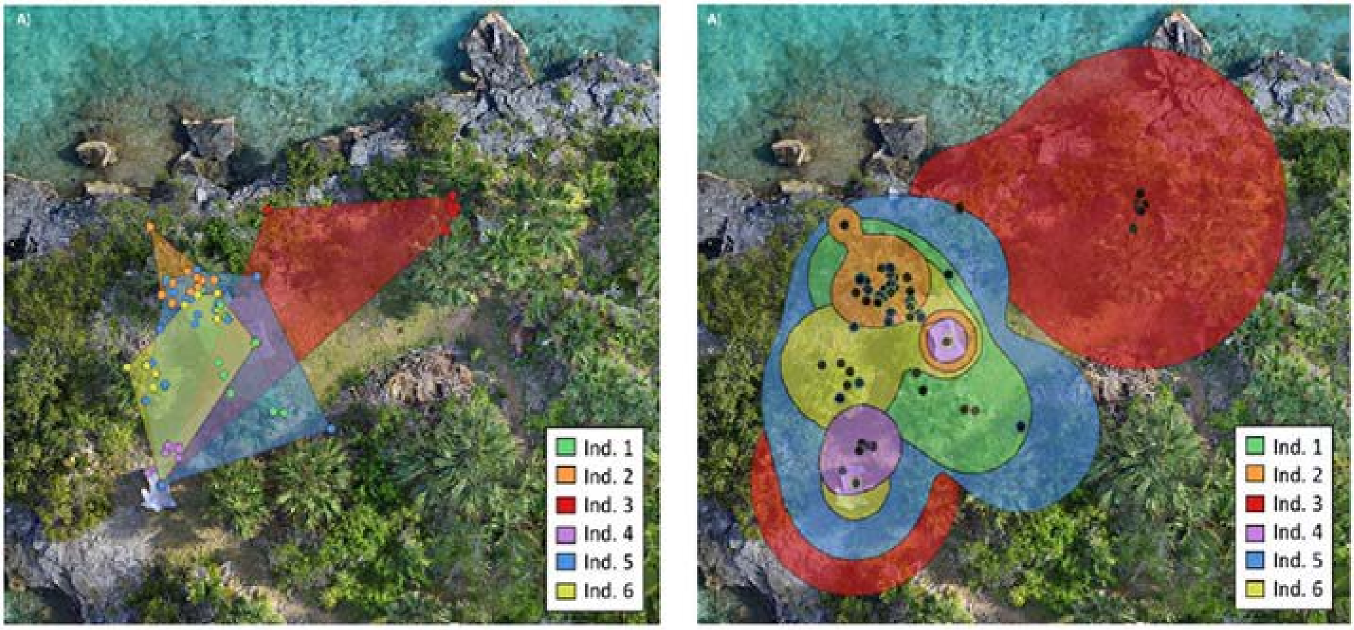

Figure 6. Minimum Convex Polygon (left) and Kernel Density Estimation (right) estimations of the home ranges of six individual Bermuda skinks on Trunk Island, from radio-tracking data (Pichon, 2022).

Figure 7. Kernel Density Estimation (KDE) for individual 3 according to the old estimate of dispersal range size (in light red) and the new estimate (in dark red) taking into account the limit of the terrestrial coastline (orange solid line) (Pichon, 2022).

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Comparison of the behaviour of Bermuda skinks in captivity and under natural conditions

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Captive breeding and reintroduction is increasingly being used as an integral component of conservation programmes for threatened reptiles. Such programmes require careful planning and long-term commitments in order to maximise the chances of success (Conde et al., 2011). Returning animals to the wild that have been bred in captivity presents many challenges, including minimising the risks of inbreeding, adaptation to captivity and release of novel pathogens. Likewise, the process of transport and release into a new habitat may result in stress-related dispersal in some animals (Nash et al., 2020). It is therefore important to try and mitigate such responses and assess how quickly animals bred in captivity can adopt natural behaviour patterns on release into the wild.

The Bermuda skink *Plestiodon longirostris* is Bermuda's only endemic terrestrial vertebrate and is Critically Endangered in the wild (Fig. 1). Facing a multitude of threats from non-native species, habitat loss and disturbance, the most viable populations are now confined to just a few small islets without permanent human settlement (Turner et al., 2021; 2023). In response to these threats the government of Bermuda has developed an action plan for the species that includes management of habitats and invasive species, as well as overseeing an ongoing monitoring programme. As an additional safety net against the risk of extinction, a population of Bermuda skinks was established in an off-show, biosecure breeding facility at Chester Zoo in 2013. The purpose of this facility was twofold: 1) to carry out research on reproductive biology and activity patterns that would be impossible to undertake in the wild; 2) to provide a source of skinks for potential reintroduction to suitable sites in the wild.

Details of the husbandry of the skinks are provided by Williams et al. (2022) and are summarised here. The 'skink pod' housed four enclosures each divided into two 86 x 78 x 60 cm modules. Each enclosure housed a pair of skinks, and the two halves of each enclosure were connected by gates to control the mixing of skinks for breeding. The enclosures were furnished with a gravel substrate deep enough to allow burrowing, rocks to provide

Figure 1. Adult (top), subadult (middle) and juvenile Bermuda skinks

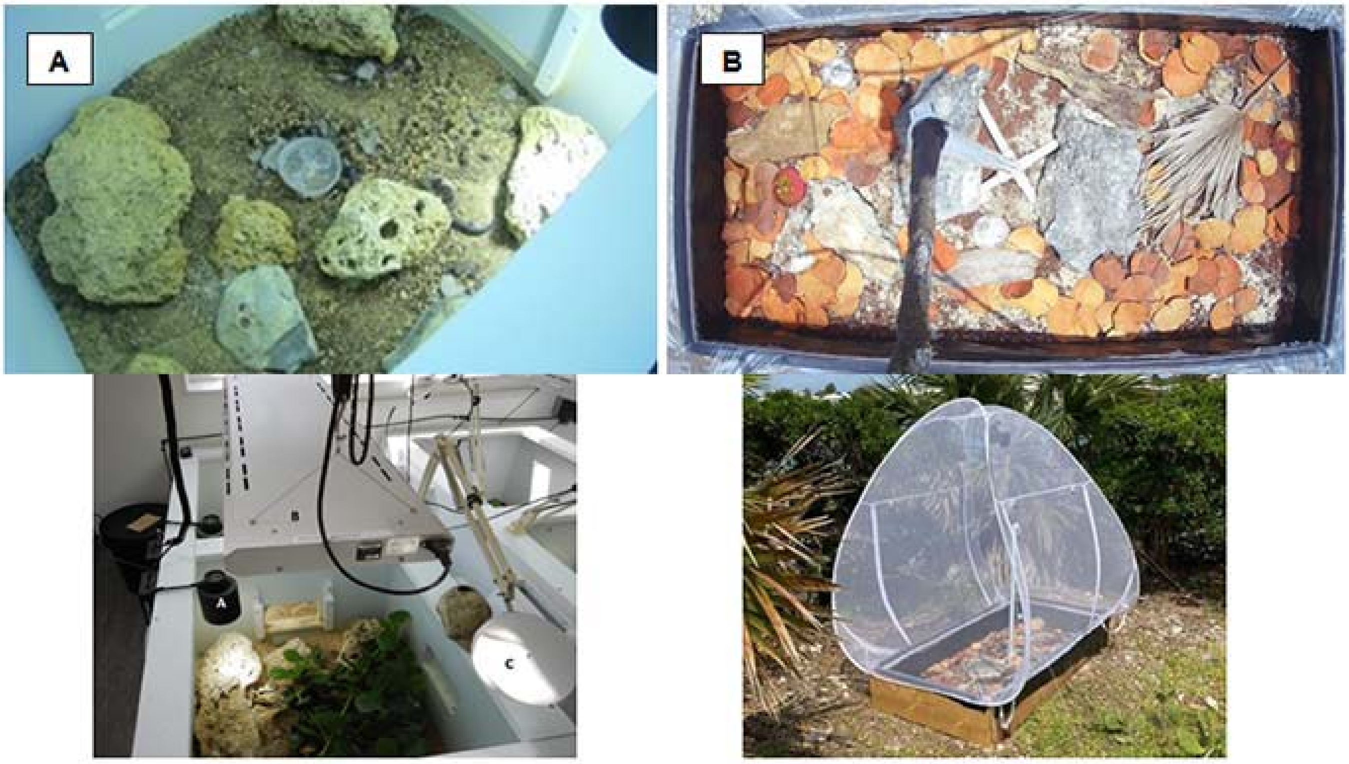

Figure 2. A. skink breeding enclosure at Chester Zoo; **B.** the pre-release enclosure on Trunk Island.

hiding places, leaf litter and plants. Lighting was provided by an Arcadia T5 UVB tube and a 70W Exoterra Sunray basking lamp. The basking area provided a temperature of 36–40 °C with the rest of the enclosure at 25–30 °C during the day. The lighting system switched on at 07:00 hrs and off at 18:00 hrs and was complemented by natural light through skylights. Each enclosure was equipped with a CCTV camera to continually monitor behaviour over 24 hrs. Skinks were fed a varied diet of fruit and insects supplemented by Repashy Calcium Plus and Repashy Superfoods (Fig. 2A).

In June 2022, 18 captive-bred Bermuda skinks (7 adults, 6 subadults, 5 juveniles) from Chester Zoo were transferred to Trunk Island, Bermuda, for release into the wild (Fig. 3). Rather than release them immediately into the wild, the skinks were housed in three pre-release (or 'soft release') enclosures (one enclosure for each life stage) for two weeks to allow them to settle and acclimatise to local conditions. The adult and subadult enclosures consisted of a sealed wooden base measuring 2.1 x 1.2 m (adults and subadults) or 1.2 x 1.2 m (juveniles) and were covered by an insect-rearing tent-like roof (Fig. 2B). The enclosures were furnished in the same way as the enclosures at Chester Zoo and, the skinks were fed locally obtained fruits and Bermuda crickets, supplemented by Repashy gecko diet. During the period of observation the skinks were subject to an average daily photoperiod of 14 hrs of natural sunlight. As in the zoo enclosures, a CCTV camera was fitted to the roof of the enclosure and recorded behaviour continuously for ten days before the enclosures were opened and the skinks allowed to disperse.

Skinks in the enclosures at the zoo and skinks in the pre-release enclosures on Trunk Island showed similar, bimodal daily cycles of activity. This comprised a morning peak of activity, a trough around the middle of the day, and then a second peak later in the afternoon. Very low levels of activity were observed during the hours of darkness. Although the photoperiod in Bermuda was longer than that used in the enclosures at Chester Zoo, the two activity peaks started a little later and finished earlier than in the zoo. These peaks in activity corresponded with peaks in basking behaviour in both captivity and in the wild. In the pre-release enclosures, juvenile skinks appeared to be more active and to bask for longer than subadults or adults. Other activities comprised exploratory behaviour, burrowing in the substrate, feeding, tongue-flicking, occasional agonistic behaviour, and climbing on enclosure furnishings or – in Bermuda – on the tent covering the enclosure. Skinks in the zoo and skinks in the pre-release enclosures displayed an omnivorous diet, consuming both fruit-based and invertebrate food, but tended to avoid eating crickets.

Although the relationships with the ambient temperature and light cycles in both situations await further analyses, it is reassuring that the skinks in the pre-release enclosures in Bermuda displayed similar activity patterns to those observed in the skink-pod at Chester Zoo. Although neither situation was entirely natural, the monitoring of wild skinks using pitfall trapping suggests that low-levels of activity – and consequently trapping – occurs during the middle of the day (Davenport et al., 2001). Consequently, skinks may avoid the hottest parts of the day.

After two weeks in the pre-release enclosures, the enclosures were opened and the skinks allowed to disperse naturally. The dispersal is being monitored by direct observations, pitfall trapping and radiotelemetry of adults. The discovery of a juvenile skink on Trunk Island one year after the releases indicates that breeding may have already occurred there.

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Figure 3. Trunk Island showing the location of the three pre-release enclosures (circled).

Investigating the effects of habitat fragmentation on amphibians in Madagascar's Central Highlands

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Madagascar's forests are threatened by human activities and are becoming increasingly fragmented. The island's unique anuran fauna - over 500 endemic frog species are thought to be extant – are inevitably threatened by this habitat loss. Our research (Katherine's PhD) was focussed in the Central Highlands region where little forest remains.

We aimed to gain an insight into the effects of forest fragmentation on amphibian diversity and communities using mitochondrial DNA barcoding for phylogenetic diversity (phylodiversity) analysis. Given the financial, logistical and capacity challenges of conservation in many countries, conservation triage may be necessary. Species richness is often used as a metric to conduct this; however, using this metric alone does not consider the evolutionary distinctiveness of species present. Instead, phylodiversity is a key metric for ensuring a represented tree of life is protected. While it is known that species richness declines in forest fragments, the impact on phylogenetic diversity has not been studied for amphibians. Buccal swabbing of over 500 individual frogs was conducted across nine

Figure 1. The landscape of our study area in the Central Highlands showing an example of the forest fragments that remain in some gullies.

Figure 2. Measuring *Anodonthyla vallani*

forest fragments and over 1,000 frogs were included in the analysis. Three mitochondrial genes were barcoded and concatenated for these individuals, and a phylogeny constructed for analysis.

Our results showed that phylodiversity was significantly different in fragments compared to control forests, and decreased with decreasing fragment size and increasing fragment isolation. Community composition was also influenced. Communities in smaller more isolated fragments were subsets of those in large forests and observed the same phylogenetic clustering as one another, with smaller more isolated fragments being more evolutionarily similar. Extinction debt was observed in the smallest fragments close to the core forest block and future loss is considered likely in the smaller fragments. Our results highlight the importance of maintaining fragments over 50 hectares in size for amphibian diversity and support the use of phylodiversity as a conservation triage metric instead of, or alongside, species richness. Our DNA barcoding results highlight the unique diversity that remains in the Central Highlands and the importance of conserving the remaining fragments, for example, we described a new species of *Stumpffia* (Mullin et al., 2022; ZooKeys) and extended the range of *Anilany helenae* and other species (Mullin et al., 2021; Herp Notes).

This project also used ddRAD-seq to develop Single Nucleotide Polymorphism (SNP) libraries for three species: two Critically Endangered microendemic species, *Anilany helenae* and *Anodonthyla vallani,* and one widespread species, *Mantidactylus betsileanus*. The SNP library was used to conduct population genetic studies to gain an insight into the historic habitat connectivity across the region, between the sites Ankafobe, Ambohitantely, Anjozorobe and Andasibe to guide future conservation and restoration strategies. We also aimed to determine the impacts of habitat fragmentation on species with different life histories and conservation status. Our results did indicate that the genetic impacts of habitat fragmentation vary between species, and population genetics suggest very recent fragmentation at the local scale, but historical forest contraction during the last glacial maximum.

This wider study has produced valuable insight into amphibian diversity in the Central Highlands and we look forward to publishing the results in 2024.

Figure 3. Close up of *Anilany helenae* – one of the smallest frogs in the world.

Turtle Tally UK: 5 years of citizen science research

Suzie Simpson

The issue of released terrapins has been a global problem for numerous decades. Due to their aesthetics and size when they are juveniles, they are often bought by the public, and the size and difficulties involved in keeping are often not considered at that time. During the work carried out by the Turtle Tally UK project, issues related to released specimens have been uncovered and a clear link to socio-economic factors can be seen. Many pet owners have struggled with the financial crisis and loss of jobs, divorce, moving house, domestic violence and loss of interest have all been highlighted as issues resulting in relinquishments. In addition, the lack of rehoming resources is assumed to have resulted in further releases. Further to this, pet sales continue to adapt to accommodate public demand and if a species is banned, another takes its place. The prohibition of *Trachemys scripta* spp. in 1997 and 2016 (EU Invasive Non-Native Alien Species Regulation (1143/2014)) has been linked to sales meeting customer demand with similarly problematic species such as river cooters (*Pseudemys* spp.).

Here are a few of the findings uncovered:

- Over 658 sightings submitted (2019–2022).
- Majority are individual terrapins sighted.
- Plastic, seeds, gravel, plant matter and invertebrates found in faecal samples.
- Spring 2022, an adult female common snapping turtle *Chelydra serpentina*, weighing 10kg, removed (Fig. 1). Observed living there for 6 years, faecal sample (within 24 hours) containing a bird leg bone.
- Fishing hooks found in digestive tract of released dead individuals.
- One report of behaviour changes in nesting Grebes due to terrapins basking on nests.
- Between late 2018 and Summer 2023, 2148 terrapins relinquished at the National Centre for Reptile Welfare (captive and released) for rehoming. Lack of resources to support rehoming numbers.
- Public surveyed want to rehome if legislation allowed.

Figure 1. Common snapping turtle removed from an inlet behind a house. She had been there for six years and named ‘Claudia’.

The main species seen in UK waterbodies are *Trachemys scripta* spp. Although other species are seen, these are sliders and they are primarily herbivorous. More concern regarding *C. serpentina* (Common snapping turtles) and *Pelodiscus sinensis* (Chinese softshell turtles) due to their carnivorous nature. Although, these are fewer in numbers, we recommend removal.

Pet terrapins kept in tanks with shallow water have not developed skills or muscle mass to swim to the surface, if released in deep bodies of water. The potential for initial release mortality by drowning is a factor owners may not realise. Although individuals are producing potentially fertile eggs, the current climate is sub-optimal for eggs to hatch successfully. They are believed to be causing little impact in smaller numbers due to being primarily herbivorous species. Disease investigation is being carried out.

Legislative changes allowing easier rehoming practices to be carried out regarding listed species, alongside prohibited imports, and further support to licenced sanctuaries is recommended. Public education is ongoing to encourage responsible rehoming where possible (Fig. 2).

Figure 2. Public engagement at Swanley Park where active removals had been agreed with park staff due to planned winter lake management.

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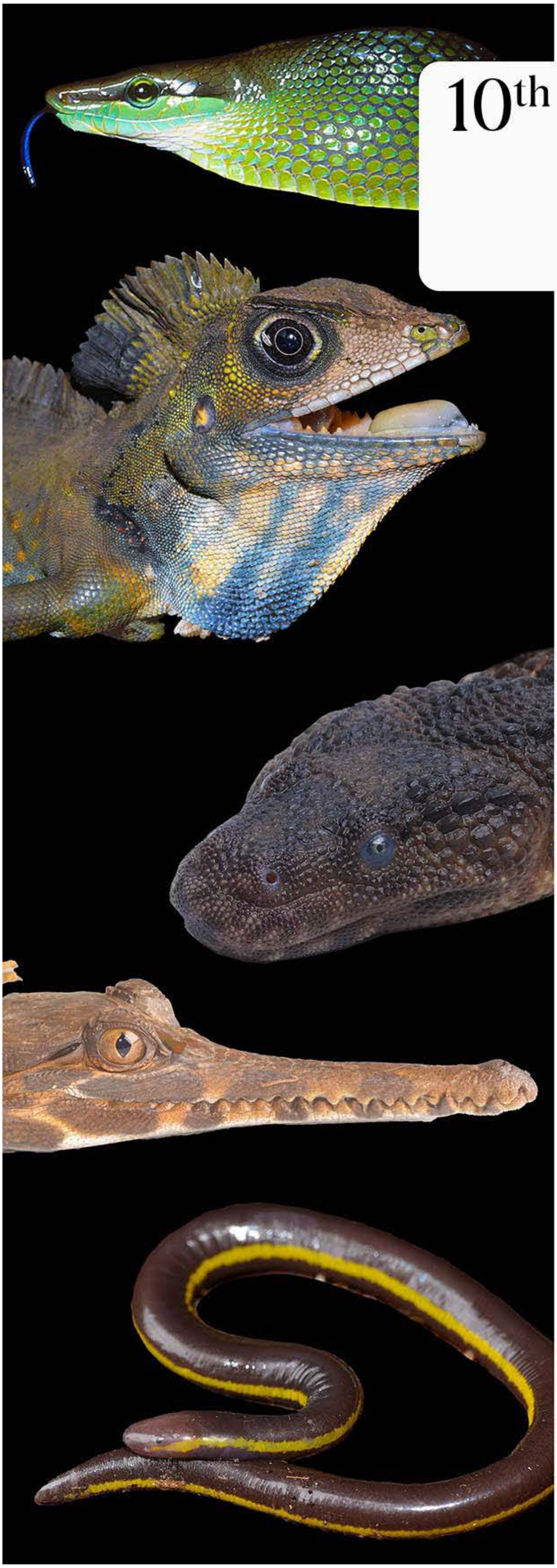

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