RISK ASSESSMENT SUMMARY

Updated: September 2015

# Western green lizard (*Lacerta bilineata*)

- Large lizard native to western Europe
- One confirmed population in Bournemouth (southern England)
- Potential impacts on native species through competition, predation and disease


## History in GB

Historical reports of attempted introductions in GB from 1872 onwards. Currently only one population known to be established: on the coastal cliffs and clifftops of Bournemouth, Dorset. Unconfirmed reports of populations in Essex and Devon which cannot be ruled out.

## Native distribution

Native to parts of west and southwest Europe. GB animals may originate from Jersey, Channel Islands (where it is native).


Source: NNSIP 2014

## Distribution in GB

Area of threat: Southern England and South Wales


Source: NBN 2014

## Impacts

Environmental (moderate)

- Could outcompete native reptiles, and prey on juveniles. Some evidence it is causing a decline in common lizard at the Bournemouth site. Concerns over impacts on rare sand lizard if it spreads.
- May disrupt general ecology by putting pressure on invertebrate populations
- Could transmit novel pathogens

Economic (minor)

- None known

Social (minor)

- Potential human health concerns regarding Lyme Disease. *L. bilineta*'s sister species *L. viridis* is a host of *Ixodes ricinus* ticks; known vectors of *Borrelia*, the cause of Lyme disease.

## Introduction pathway

Deliberate (moderately likely) current wild population introduced deliberately, also risk of accidental escape.

## Spread pathways

Natural (intermediate) low dispersal rate means each colony will be slow to spread.

Human (rapid) deliberate translocation of established populations.

## Summary

| | Risk | Confidence |
|---|---|---|
| Entry | VERY LIKELY | VERY HIGH |
| Establishment | VERY LIKELY | VERY HIGH |
| Spread | SLOW | MEDIUM |
| Impacts | MINOR | HIGH |
| Conclusion | LOW | HIGH |

# RISK ASSESSMENT COVERING PAGE - ABOUT THE PROCESS

**It is important that policy decisions and action within Great Britain are underpinned by evidence. At the same time it is not always possible to have complete scientific certainty before taking action. To determine the evidence base and manage uncertainty a process of risk analysis is used.**

Risk analysis comprises three component parts: risk assessment (determining the severity and likelihood of a hazard occurring); risk management (the practicalities of reducing the risk); and risk communication (interpreting the results of the analysis and explaining them clearly). This tool relates to risk assessment only. The Non-native Species Secretariat manages the risk analysis process on behalf of the GB Programme Board for Non-native Species. During this process risk assessments are:

- Commissioned using a consistent template to ensure the full range of issues is addressed and maintain comparable quality of risk and confidence scoring supported by appropriate evidence.
- Drafted by an independent expert in the species and peer reviewed by a different expert.
- Approved by the NNRAP (an independent risk analysis panel) only when they are satisfied the assessment is fit-for-purpose.
- Approved by the GB Programme Board for Non-native Species.
- Placed on the GB Non-native Species Secretariat (NNSS) website for a three month period of public comment.
- Finalised by the risk assessor to the satisfaction of the NNRAP and GB Programme Board if necessary.

**Common misconceptions about risk assessments**

The risk assessments:

- Consider only the risks (i.e. the chance and severity of a hazard occurring) posed by a species. They do not consider the practicalities, impacts or other issues relating to the management of the species. They also only consider only the negative impacts of the species, they do not consider any positive effects. They therefore cannot on their own be used to determine what, if any, management response should be undertaken.
- Are advisory and therefore part of the suite of information on which policy decisions are based.
- Are not final and absolute. They are an assessment based on the evidence available at that time. Substantive new scientific evidence may prompt a re-evaluation of the risks and/or a change of policy.

**Period for comment**

Once placed on the NNSS website, risk assessments are open for stakeholders to provide comment on the scientific evidence which underpins them for three months. Relevant comments are collated by the NNSS and sent to the risk assessor for them to consider and, if necessary, amend the risk assessment. Where significant comments are received the NNRAP will determine whether the final risk assessment suitably takes into account the comments provided.

**To find out more:** published risk assessments and more information can be found at https://secure.fera.defra.gov.uk/nonnativespecies/index.cfm?sectionid=22

# GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

**Name of organism:** Western green lizard *Lacerta bilineata*
**Author:** Chris Gleed-Owen
**Date:** 31.01.12
**Draft:** Final (April 2016) – Rav1 - (January 2012), RAv2 (May 2012), signed off by NNRAP (February 2013), approved by GB Programme Board (March 2015), published on NNSS website (September 2015).
**Risk Assessment Area:** Great Britain (England, Scotland, Wales and their islands)

| **SECTION A – Organism Information and Screening** | | |
|---|---|---|
| **Stage 1. Organism Information** | **RESPONSE**<br>**[chose one entry, delete all others]** | **COMMENT** |
| 1. Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank? | The western green lizard *Lacerta bilineata* (Reptilia: Squamata: Sauria: Lacertidae). The Dorset animals were identified phenotypically as *L. bilineata* (probably of northeast Italian origin) by Deichsel *et al.* (2007). Animals from northeast Italy were apparently traditionally used in the pet-keeping trade in Britain. | *L. bilineata* was separated from the European green lizard *Lacerta viridis*, and raised as a new taxon, after hybridisation and phylogenetic research (Amman *et al.*, 1997; Mayer & Bischoff, 1996; Rykena, S. (1991). Despite doubt cast by subsequent research (Godinho *et al.*, 2005), the distinction between since been reinforced (Böhme *et al.*, 2007). At present, only *L. bilineata* is known from Great Britain. This does not exclude the possibility of the sister species *L. viridis* being present too. |
| 2. If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on) | N/A | |
| 3. Does a relevant earlier risk assessment exist? (give details of any previous risk assessment) | No | |
| 4. If there is an earlier risk assessment is it still entirely valid, or only partly valid? | N/A | |
| 5. Where is the organism native? | *L. bilineata* occupies a large part of western Europe: most of Italy, most of France, part of northern Spain, with isolated relicts in southern Germany. Its sister species *L.* | |

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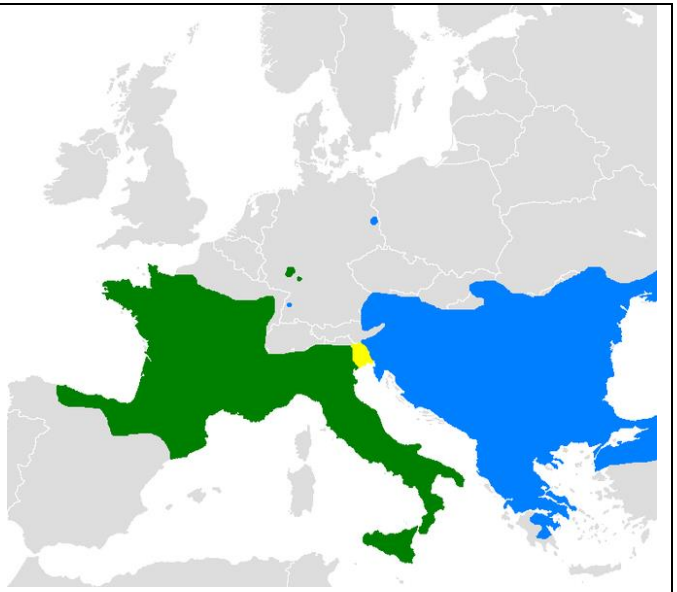
| | *viridis* occupies southeastern Europe (Balkans, Carpathians, northern Anatolia and beyond. Recent research also suggests that some western Balkan '*L. viridis*' are actually part of *L. bilineata* (Böhme *et al.*, 2007). |  Green = *L. bilineata*, blue = *L. viridis.* Map from Wikimedia Commons (Author: Christian Fischer). Note that this map does not show Böhme *et al.*'s 2007 western Balkan *L. bilineata* population. |
| 6. What is the global distribution of the organism (excluding Great Britain)? | Its global distribution is contained within western Europe (Germany, France, Spain, Italy, Jersey). | |
| 7. What is the distribution of the organism in Great Britain? | Only one population of *L. bilineata* is known to be established: on the coastal cliffs and clifftops of Bournemouth, Dorset. It occupies at least 1.5km of vegetated cliffs and scrubby clifftops, adjacent to the residential areas of Boscombe Spa, Boscombe Manor and Southbourne. The cliffs are bound to the south by the promenade and beach, and to the north by | There have been unconfirmed reports from Essex and Devon in recent years, which cannot be ruled out until investigated thoroughly. There have been many earlier historical reports of attempted introductions in southern Britain, from 1872 onwards. Lever (2003) listed these on p.105. |

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| | suburban residences. Continuous cliff habitat extends to the east and west along Poole Bay (12km in total), along which *L. bilineata* is spreading. | |
| 8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in the world? | No. | Lever (2003) only lists one other case of establishment, in the USA (Kansas). |
| **Stage 2. Screening Questions** | | |
| 9. Has this risk assessment been requested by the **GB** Programme Board? | Yes | |

## SECTION B – Detailed assessment

# PROBABILITY OF ENTRY

Important instructions:

- Entry is the introduction of an organism into GB. Not to be confused with spread, the movement of an organism within GB.
- For organisms which are already present in GB, only complete the entry section for current active pathways of entry or if relevant potential future pathways. The entry section need not be completed for organisms which have entered in the past and have no current pathways of entry.

| QUESTION | RESPONSE | CONFIDENCE | COMMENT |
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| 1.1. How many active pathways are relevant to the potential entry of this organism?<br><br>(If there are no active pathways or potential future pathways respond N/A and move to the Establishment section) | very few | high | |
| 1.2. List relevant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways.<br><br>For each pathway answer questions 1.3 to 1.10 (copy and paste additional rows at the end of this section as necessary). | | | Deliberate introduction by humans, accidental escape of pet lizards, accidental introduction via freight and transport, accidental introduction via garden centre products. |
| Pathway name: | **Accidental escape or deliberate release of pets.** | | |
| 1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)?<br><br>(If intentional, only answer questions 1.4, 1.9, 1.10, 1.11) | intentional | high | Probably very few people keep *L. bilineata* in Great Britain (fewer than ten?). Enthusiasts originally traded in stock from northeast Italy, where they would have been wild-caught. Many generations of captive-bred animals have probably been bred since then. It is legal |

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| | | | to keep and breed captive-bred animals. |
| 1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year?<br><br>Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place. | very unlikely | very high | The risk of further establishment is probably limited to the deliberate actions of one or two 'rogue' individual keepers. *L. bilineata* would be unlikely to get onto the pathway without deliberate assistance. It is unlikely that accidental escape from any of the keepers could result in establishment elsewhere. |
| 1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host? | moderately likely | medium | It is reasonable to assume that rogue individual(s) responsible for introducing *L. bilineata* to Bournemouth could do it again at any time, and indeed could already have done so. The chances of other as-yet-undiscovered *L. bilineata* populations existing are probably quite high. It would probably take at least several years to discover any newly-established population, even with a well-developed herpetological 'grapevine'. There are simply too many potential release locations, and too few suitably-experienced wildlife recorders. The Bournemouth *L. bilineata* release probably happened around 1992, but it was not formally discovered until 2002, although some local reports were later unearthed that go back to the early 1990s. Nevertheless, there are limits to how many lizards one person can breed and release. |
| 1.10. Estimate the overall likelihood of entry into GB based on this pathway? | moderately likely | medium | The pathway bringing *L. bilineata* into GB already exists. The species is kept as a pet by a few people. The question is whether all the lizards will remain in private homes and gardens, or whether some might enter the wild accidentally or deliberately. The likelihood of the latter is almost entirely down to the motivation of one or two rogue individuals; something which cannot accurately be predicted. |
| Pathway name: | **Deliberate translocation of Bournemouth animals.** | | |
| 1.3. Is entry along this pathway intentional (e.g. the | intentional | high | Since its 'discovery' in 2002, the Bournemouth |

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| organism is imported for trade) or accidental (the organism is a contaminant of imported goods)?<br><br>(If intentional, only answer questions 1.4, 1.9, 1.10, 1.11) | | | population has become very well-known, even famous. It has received national press and TV coverage, and people regularly travel long distances to see them. Whereas in 2002-2003, it was difficult to see *L. bilineata* in Bournemouth, it is now easy for non-experts to find them, photograph them and even catch them. They have become much more numerous over the last ten years, and could number in thousands of individuals. The risk of deliberate translocation is therefore significant. |
| 1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year?<br><br>Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place. | unlikely | high | It is probably more likely that animals will be translocated from Bournemouth to elsewhere, than from private collections to other wild sites. The animals are so numerous in Bournemouth that they provide a ready source for deliberate translocations, and for taking into captivity. Whilst it is thought that fewer than ten serious breeders keep traditionally-traded *L. bilineata*, it is not known whether a new generation of captive-breeders is developing on the back of what is a large *L. bilineata* resource in Bournemouth. It is quite possible that keepers and possibly even traders might legitimately be capturing *L. bilineata* from Bournemouth (along with the syntopic and even-more-numerous introduced European wall lizards *Podarcis muralis* if they so wished). This is pure speculation, but it presents a real potential pathway. Children and holidaymakers might also capture *L. bilineata* and take them as pets. Large numbers are unlikely to enter this pathway in any one year. It would be possible without arousing suspicion from various regular wildlife enthusiasts who regularly visit the cliffs. Suspicions have been raised in recent years, however, that one unidentified person was allegedly capturing individual *L. bilineata* individuals, and moving them to other parts of Poole Bay's cliff-line. This is of particular concern, as it reportedly |

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| | | | included a section of cliffs from Boscombe Pier to Bournemouth Pier where native *L. agilis* are present. |
| 1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host? | moderately likely | medium | The lizards could easily be released into suitable habitat by rogue or naive persons. As discussed above, *L. bilineata* survives well in appropriate habitat, and it is simply a matter of whether a person chooses to translocate them. |
| 1.10. Estimate the overall likelihood of entry into GB based on this pathway? | likely | high | This pathway is probably more significant that the original pet-trade pathway. Now that a large population is established on Bournemouth's cliffs, *L. bilineata* could be captured and released elsewhere by any determined person(s). The established population only occupies 1.5-2km of cliff-line, but there are already reports of isolated appearances of *L. bilineata* on other parts of Poole Bay. Further deliberate translocation of the lizards could therefore be carried out in the future, either within Poole Bay or elsewhere. Indeed, such releases may already have happened. The potential for naive persons to be responsible (e.g. children bored of a pet lizard they caught on holiday) is low; whereas the risk of a determined rogue is much higher. |

# PROBABILITY OF ESTABLISHMENT

Important instructions:

- For organisms which are already well established in GB, only complete questions 1.15 and 1.21 then move onto the spread section.

| QUESTION | RESPONSE | CONFIDENCE | COMMENT |
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| 1.12. How likely is it that the organism will be able to establish in GB based on the similarity between climatic conditions in GB and the organism's current distribution? | very likely | very high | The species is already established, albeit in a very small area. The establishment of the Bournemouth population has shown that *L. bilineata* is perfectly able to live and breed on the south coast of England. In Bournemouth, *L. bilineata* has a very similar mode of existence to the native sand lizard *Lacerta agilis*: being active from mid-March to mid-October, preferring similar climatic conditions, and potentially laying two egg clutches per season (Gleed-Owen, 2004). If *L. bilineata* were released in suitable habitat in other parts of southern Britain, they could establish themselves. This is most likely to occur in areas with the warmest summer climate: low-lying areas along the south coast of England, the southwest peninsula, and coastal areas of south and west Wales. However, it could occur in other areas too; perhaps anywhere in southern Britain. Given the species' continental range limit, northern Britain is probably too cool and cloudy during its active season. It is possible that climatic change in recent decades has improved the viability of southern Britain for *L. bilineata*. The long history of apparently-failed introductions since 1872 could mean that climatic conditions were hitherto inappropriate (especially given the large founder population in some cases). In a similar species, *L. agilis*, double-clutching only began at the end of the 20$^{th}$ century, thought to be due to |

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| | | | longer/warmer summers. The same climatic changes might have allowed *L. bilineata* to breed more effectively. |
| 1.13. How likely is it that the organism will be able to establish in GB based on the similarity between other abiotic conditions in GB and the organism's current distribution? | very likely | very high | Most habitats occupied by *L. bilineata* in Europe are represented in southern Britain, although being at the northern edge of its climatic tolerance envelope, only some of these habitats are likely to be suitable under a British climate. The following habitats are likely to be suitable for *L. bilineata* to establish itself in southern Britain: rough grassland, scrub, heathland, dunes, woodland edge, hedgerows, tall herbs, brownfield land, cliffs, quarries, railway margins, roadside verges. The sandy substrate of the Bournemouth cliffs is found in many other areas, and rocky substrates would probably be equally suitable. Any well-drained substrate would be suitable, but clayey soils might be less suitable. Food sources are likely to be present in suitable habitats, in the form of invertebrates and small lizards. |
| 1.14. How likely is it that the organism will become established in protected conditions (in which the environment is artificially maintained, such as wildlife parks, glasshouses, aquaculture facilities, terraria, zoological gardens) in GB?<br><br>Subnote: gardens are not considered protected conditions | unlikely | medium | These sorts of environments are unlikely to be the locations of choice for rogue individuals releasing lizards today. However, it is possible that zoological collections containing *L. bilineata* could be the source of an escape into their own premises. |
| 1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in GB? | widespread | high | Suitable habitats are widespread but not continuous. They exist as patches connected by a network of corridors such as railway lines, road verges, and other linear features. At least some suitable habitat (rough grassland, scrub, heathland, dunes, woodland edge, hedgerows, tall herbs, brownfield land, cliffs, quarries, rail and road corridors) exists in the vast majority of monads (one-kilometre squares) in southern Britain. |
| 1.16. If the organism requires another species for critical | NA | | |

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| stages in its life cycle then how likely is the organism to become associated with such species in GB? | | | |
| 1.17. How likely is it that establishment will occur despite competition from existing species in GB? | very likely | very high | *L. bilineata* is larger and more robust than either of the native lacertid lizards. There are unlikely to be any other lizard competitors. They may compete with birds or insectivores for invertebrate food. |
| 1.18. How likely is it that establishment will occur despite predators, parasites or pathogens already present in GB? | likely | High | *L. bilineata* is likely to suffer similar predation, parasite and pathogen risks as other British lacertids, i.e. generally not problematic. The only significant problems are therefore likely to occur near urban and suburban areas, where high densities of domestic cats and rats could pose a threat. |
| 1.19. How likely is the organism to establish despite existing management practices in GB? | likely | High | The distribution of suitable habitats is widespread, but typically patchy or linear in nature. Patches and corridors of suitable habitat are often surrounded by inappropriate habitats or ecological barriers. There is no current effort to limit the spread. No proactive management exists to contain it. |
| 1.20. How likely are management practices in GB to facilitate establishment? | unlikely | High | Unlikely to be any specific management practices that enhance *L. bilineata*'s chances of establishment. The net effect of habitat management within its known GB range is to maintain the *status quo*. The ongoing cycle of scrub management along the Bournemouth clifftops counteracts shading and seral succession in some areas; but in others, tree growth (including non-native holly oak) is gradually shading out cliff habitats, and the spread of non-native Hottentot fig along the cliffs is quickly out-competing native grass and herb habitats, as well as ousting lizards, including *L. bilineata.* No specific management efforts are currently being made to contain *L. bilineata'*s spread, or to prevent its establishment elsewhere. Public awareness is almost nonexistent outside the Bournemouth area, except among wildlife enthusiasts. |

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| 1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in GB? | very likely | very high | Even with current GB restricted to one site, eradication would be very difficult. The site comprises several kilometres of vegetated coastal cliff of high public amenity value in the town of Bournemouth. It would need to involve either complete destruction of the habitat, or capture of all *L. bilineata* individuals. Expert catchers would be needed; probably several of them. They would need extensive experience of capturing and identifying all of the reptile species that might be present: all lifestages of common lizard *Zootoca vivipara*, slow-worm *Anguis fragilis*, *L. bilineata*, and *P. muralis* (all of which are present on the site); and potentially the rare *L. agilis*, which is present nearby. Capture would need to be by hand, covering about 10ha of habitat, and perhaps 5,000 individuals. Visual search is good at detecting lizards, but the most efficient method would be a high-density deployment of artificial refugia (e.g. roofing felt mats c.30x50cm). Small felt mats ('felts') are easier and cheaper to deploy than corrugated iron or other materials. Using a dense array of felts greatly improves detectability, and gives the advantage of surprise for catching lizards by hand from underneath the refugia. Refugia must typically be placed every few metres to encounter all lizards, and possibly more closely spaced in some places; approximately c.10,000 refugia in total. At least 30 capture visits in appropriate conditions, preferably in spring (April/May). Capture would need to continue until there was reasonable confidence that no lizards remained (usually a run of five consecutive zero-captures). A zoning system would be useful, to enable removal of any areas where capture was completed sooner. A reptile exclusion fence could be installed to divide the site into such sections. Some vegetation would need to be removed to permit pedestrian access |

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| | | | to all areas of the site. Captured animals would need to be euthanased immediately, or transported to somewhere that could legitimately house them or euthanase them. Lizards can be held temporarily (e.g. during capture visits) in a cloth bag such as a pillowcase, fastened securely with a plastic clip. Drawstring and knotted bags are not secure enough to prevent juvenile lizard escape. Hand capture is the most effective method of eradication without destroying the habitat and other wildlife, but it would still require follow-up surveys over several years (and further capture if necessary) to ensure success. By comparison with similar commercial mitigation projects, the intensive capture of lizards from a 10-ha site, involving a minimum of 30 visits, would cost at least £50,000. It would also require removal of vegetation from around 2km of sand cliff and clifftop, and possibly installation of temporary exclusion fencing; both at additional cost. Destruction of the alien lizards by fire, chemicals or other dramatic methods would temporarily destroy the entire 2km of cliff habitat, in a densely-populated residential area adjacent to a busy road, promenade and pedestrian footpaths. Wholesale vegetation removal to temporarily destroy the habitat would require the rescue and re-homing of many thousands of native lizards and other wildlife protected by law, and possibly raise slope stability issues. |
| 1.22. How likely are the biological characteristics of the organism to facilitate its establishment? | likely | high | *L. bilineata* seems well-equipped to establish itself, given suitable climate and habitat. Where both are present, it can be assumed that *L. bilineata* would become established in the same way as the Bournemouth population. Although having slightly narrower climatic tolerances than *L. agilis*, it has equal or wider habitat preferences (Arnold & Ovenden, 2002; Gasc *et al.*, 1998), and could probably establish itself |

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| | | | with similar ease as the numerous legitimate introductions of *L. agilis* to many parts of Britain. |
| 1.23. How likely is the capacity to spread of the organism to facilitate its establishment? | moderately likely | medium | The species is able to spread, but not fast or in a truly invasive fashion. It could probably not spread at more than about 100m per year of its own accord. |
| 1.24. How likely is the adaptability of the organism to facilitate its establishment? | unlikely | high | Under the current climatic regime in GB, *L. bilineata* would be restricted geographically to the south, and to certain habitat types. However, if summer temperatures increase in future, *L. bilineata* could colonise a wider range of habitats. |
| 1.25. How likely is it that the organism could establish despite low genetic diversity in the founder population? | very likely | high | There are no known genetic problems affecting the Bournemouth *L. bilineata*. Problems such as bottle-necking have not previously been identified in *L. bilineata*. The northeast Italian origin of the Bournemouth *L. bilineata* (near to glacial refugia) might have equipped them with a high genetic diversity. |
| 1.26. Based on the history of invasion by this organism elsewhere in the world, how likely is to establish in GB? (If possible, specify the instances in the comments box.) | unlikely | high | This answer should be 'NA' as there is no history of invasion elsewhere. The only published successful introduction was in Kansas, USA, in the 1950s, where *L. bilineata* is now established (Lever, 2003). Kraus (2009) reported two failed introductions in New Jersey, USA, and Ireland. It is possible there are other established introductions elsewhere. |
| 1.27. If the organism does not establish, then how likely is it that transient populations will continue to occur?<br><br>Subnote: Red-eared Terrapin, a species which cannot re-produce in GB but is established because of continual release, is an example of a transient species. | unlikely | high | 'Transient' populations have been described in the past (e.g. the 1899 Isle of Wight population persisting well into the 20th century), but any introductions outside the viable climate envelope are unlikely today. |
| 1.28. Estimate the overall likelihood of establishment (mention any key issues in the comment box). | likely | high | *L. bilineata* is already established in a limited geographical area, and is likely to establish in other (equally limited) geographical areas in the future. Its establishment into the wider landscape is a less likely scenario, but still possible. If climate continues to |

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| | | | warm, this scenario becomes ever more likely. And obviously, the more locations that exist, the more potential sources for assisted dispersal. |

# PROBABILITY OF SPREAD

Important notes:

- Spread is defined as the expansion of the geographical distribution of a pest within an area.

| QUESTION | RESPONSE | CONFIDENCE | COMMENT |
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| 2.1. How important is the expected spread of this organism in GB by natural means? (Please list and comment on the mechanisms for natural spread.) | moderate | high | At the one known established location, spread will be limited to a narrow corridor of habitat, but could eventually extend into a much wider area of countryside after another five years or so. If there are other unknown locations in GB, spread could radiate naturally from those too. The rate of natural spread is never likely to exceed approximately 1km per 5-10 years. The westward spread of the Bournemouth *L. bilineata* beyond Boscombe Pier is of concern however, into habitat occupied by native *L. agilis.* These species are naturally syntopic in some parts of Europe (Gasc *et al.,* 1998; Street, 1979), but some herpetologists are concerned about competition and disease risk in Britain. |
| 2.2. How important is the expected spread of this organism in GB by human assistance? (Please list and comment on the mechanisms for human-assisted spread.) | major | medium | Whilst the number of such events is always likely to be relatively small, and to be contained within relatively small areas, the likelihood of human-assisted spread is high. |
| 2.3. Within GB, how difficult would it be to contain the organism? | with some difficulty | medium | The spread will never be fast, and is unlikely ever to be very widespread, but containment could only realistically target any future releases rather than existing population(s). Stricter legal offences might prevent further deliberate or accidental releases, but once established a population will be difficult to remove. Establishment is likely to occur before presence is identified formally, and like the |

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| | | | Bournemouth population it would not be practical to eradicate them. The spread is never likely to be truly invasive anyway, and using the term 'contain' might be over-stating the matter. |
| 2.4. Based on the answers to questions on the potential for establishment and spread in GB, define the area endangered by the organism. | Southern England, South Wales | high | It is unlikely under the current climatic regime that *L. bilineata* could establish any further north. The key factor is length and warmth of the spring, summer and autumn. *L. bilineata* tolerates colder winters than we have anywhere in GB elsewhere in its European range. |
| 2.5. What proportion (%) of the area/habitat suitable for establishment (i.e. those parts of GB were the species could establish), if any, has already been colonised by the organism? | 0-10 | very high | *L. bilineata* is only likely to colonise southern Britain, and has only colonised a tiny proportion of the available habitat so far. Southern Britain covers about 70,000 sq km or 7,000,000ha, of which perhaps 5% is suitable for *L. bilineata*. Of this 350,000ha, only about 10ha is known to be occupied, i.e. about 0.03%. |
| 2.6. What proportion (%) of the area/habitat suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)? | 0-10 | very high | It is highly unlikely that any new populations that might be discovered, together with the spread of the single known population, would amount to more than 1% of the available habitat in southern Britain in the next five years. |
| 2.7. What other timeframe (in years) would be appropriate to estimate any significant further spread of the organism in Great Britain? (Please comment on why this timeframe is chosen.) | 40 | medium | *L. bilineata* has been present in Bournemouth for about 20 years now, and spread only about 1km in each direction. It spreads faster once the initial establishment period is over, but will probably never spread more than 100-200m per year. It is unlikely to spread significantly faster than this without human assistance, or climate warming. Therefore a fairly long timescale will probably be necessary to demonstrate a significant impact from either of these effects. |
| 2.8. In this timeframe what proportion (%) of the endangered area/habitat (including any currently occupied areas/habitats) is likely to have been invaded by this organism? | 0-10 | high | Even after 40 years, it is unlikely that *L. bilineata* will have spread to more than 10% of the available habitat in southern Britain. |

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| 2.9. Estimate the overall potential for future spread for this organism in Great Britain (using the comment box to indicate any key issues). | slow | high | Spread is likely to occur, but will be slow. Establishment could occur in many new locations (e.g. by deliberate introductions), but the low dispersal rate means that each colony will be slow to spread, and the total occupied area in GB will remain small. A distribution map of occupied areas would probably always be patchy, with spotty, isolated locations. Only a drastic climatic warming (several degrees) would be likely to increase the rate of spread dramatically. |

# PROBABILITY OF IMPACT

Important instructions:

- When assessing potential future impacts, climate change should not be taken into account. This is done in later questions at the end of the assessment.
- Where one type of impact may affect another (e.g. disease may also cause economic impact) the assessor should try to separate the effects (e.g. in this case note the economic impact of disease in the response and comments of the disease question, but do not include them in the economic section).
- Note questions 2.10-2.14 relate to economic impact and 2.15-2.21 to environmental impact. Each set of questions starts with the impact elsewhere in the world, then considers impacts in GB separating known impacts to date (i.e. past and current impacts) from potential future impacts. Key words are in bold for emphasis.

| **QUESTION** | **RESPONSE** | **CONFIDENCE** | **COMMENTS** |
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| 2.10. How great is the economic loss caused by the organism within its existing geographic range **excluding GB**, including the cost of any current management? | Minimal | very high | No known economic costs elsewhere. |
| 2.11. How great is the economic cost of the organism **currently** in GB **excluding management** costs (include any past costs in your response)? | minimal | very high | There are probably no economic costs at present, other than the production of this risk assessment and ongoing surveillance by volunteers. |
| 2.12. How great is the economic cost of the organism likely to be **in the future** in GB **excluding management** costs? | minor | high | There are not likely to be any direct economic impacts. The only potential impacts might be in counteracting any negative impacts on native species. It is possible that syntopy with *L. agilis* might compete with that species, and undermine conservation efforts for it; but the largest threat facing all native reptile species is habitat loss and degradation, not competition with non-natives. |
| 2.13. How great are the economic costs **associated with managing** this organism **currently** in GB (include any past costs in your response)? | minimal | very high | There are no economic costs associated with managing *L. bilineata* in GB at present. No specific management is directed at it. |

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| 2.14. How great are the economic costs **associated with managing** this organism likely to be **in the future** in GB? | minor | high | This depends on what course of action is taken by Government. If a course of eradication and control is followed, this could cost a disproportionately large amount for a relatively small amount of control. If no management is carried out, there will be no management costs. |
| 2.15. How important is environmental harm caused by the organism within its existing geographic range **excluding GB**? | minimal | medium | *L. bilineata* co-exists with many other reptile species, and other wildlife, across its existing geographical range. Syntopy with many other species native to southern Britain is a natural scenario in neighbouring parts of Europe (Gasc *et al.*, 1998; Street, 1979), and without a marine barrier, *L. bilineata* would probably occur naturally in GB today. There are no reported problems caused by *L. bilineata* elsewhere in its natural range. There is only one other established population outside GB for which published data exists (city of Topeka, Kansas, USA). *L. bilineata* has been recorded since 1962, but has not spread far within the city, and not as far as Italian wall lizards (*Podarcis siculus*) also established there (Collins & Gobanyi, 2010). The limiting factors are unknown though, and may reflect a lack of suitable habitat. |
| 2.16. How important is the impact of the organism on biodiversity (e.g. decline in native species, changes in native species communities, hybridisation) **currently** in GB (include any past impact in your response)? | moderate | low | *L. bilineata* are large lizards, and could potentially out-compete other reptiles, and predate juveniles in particular. They could also put pressure on invertebrate populations, and thereby disrupt the general ecology. Reduced invertebrate availability could have deleterious effects on birds and small mammals, and in turn affect their predators. Conversely, increased lizard biomass would benefit predators such as kestrels *Falco tinnunculus* or foxes *Vulpes vulpes.* There is no evidence that *L. bilineata* causes any habitat damage. It could, however, transmit novel pathogens. A recent study by Sainsbury *et al.* (2011) examined disease risk from *P. muralis* elsewhere in Poole Bay, but not from *L. bilineata.* There is some evidence that increasing densities of *L. bilineata* at the Bournemouth site might already be causing declines in native *Z. vivipara* (Mole, 2008). Some herpetologist also fear that syntopy with *L. agilis* (expected to occur within a few years, if |

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| | | | not already) might have a similar effect. Further research would be needed to determine whether or not there are any significant effects. Note also that syntopy of *P. muralis* at the Bournemouth site could be responsible for any declines observed in native lizards. It is conceivable that there might already be impacts on invertebrate food sources, and possibly knock-on effects; but none have been identified. |
| 2.17. How important is the impact of the organism on biodiversity likely to be in the **future** in GB? | moderate | low | This depends on whether or not there are negative effects, and how extensive *L. bilineata'*s future distribution becomes. There might be locally-bad effects (e.g. declines in native lizards and invertebrates, competition with birds or mammals) wherever new populations become established. Such locations are unlikely to be very numerous and extensive in the foreseeable future, but at each location, there could be significant negative effects on local biodiversity. More research is needed in order to identify any direct or indirect effects on syntopic wildlife. |
| 2.18. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions) caused by the organism **currently** in GB (include any past impact in your response)? | minimal | high | There are currently no known impacts of these types. |
| 2.19. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions) caused by the organism likely to be in GB in the **future**? | minimal | high | No future impacts are expected. |
| 2.20. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism **currently** in GB? | minimal | high | Any impacts on site conservation status are currently insignificant, limited to the possible decline of native lizards (not including EPS). |
| 2.21. How important is decline in conservation status (e.g. sites of nature conservation value, WFD | moderate | medium | The future impact on important nature conservation sites depends on whether *L. bilineata* colonises such sites, and if |

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| classification) caused by the organism likely to be in the **future** in GB? | | | so, whether it outcompetes indigenous lizards such as *L. agilis*, which is present on SSSI cliffs within 1km of the current extent. *L. bilineata* may or may not have negative impacts on *L. agilis*, and may or may not become established in many important sites. The rare smooth snake *Coronella austriaca* and the declining adder *Vipera berus* could conceivably benefit from increased lizard biomass (food source) if *L. bilineata* colonised heathlands and other habitats; but this very much depends on whether *L. bilineata* competitively disadvantages any other lizards. |
| 2.22. How important is it that genetic traits of the organism could be carried to other species, modifying their genetic nature and making their economic, environmental or social effects more serious? | minimal | very high | There are no native populations of *L. bilineata* in GB, and this species is not known to hybridise with *L. agilis* or *Z. vivipara.* Interspecific hybridisation is possible among true lacertids (e.g. Rykena, 1991), but very unlikely between these species. |
| 2.23. How important is social, human health or other harm (not directly included in economic and environmental categories) caused by the organism within its existing geographic range? | minor | high | There are potential social or human health concerns regarding Lyme Disease. *L. bilineata'*s sister species *L. viridis* is a host of *Ixodes ricinus* ticks, which are known vectors of *Borrelia*, the cause of Lyme Disease (Majláthová *et al.*, 2006). Increased *L. bilineata* populations could conceivably increase the Lyme borreliosis risk to humans, particularly if net lizard numbers and biomass increase. The Lyme Disease risk carried by *Borrelia* is already widespread and significant in the Bournemouth area, particularly in heathland and forest-edge habitats, and humans are much more likely to pick up ticks when walking in such habitats than on the paved footpaths of Poole Bay cliffs. However, if *L. bilineata* spreads to a wider suite of habitats in the future, the risk to humans could increase, at least notionally. |
| 2.24. How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)? | minor | high | *Ixodes* ticks are very widespread and common in heathland, grassland, bracken and forest-edge habitats around Bournemouth and southeast Dorset where reptiles are present. They have many hosts, including several deer species, humans, domestic pets, wild birds, mammals and reptiles. |

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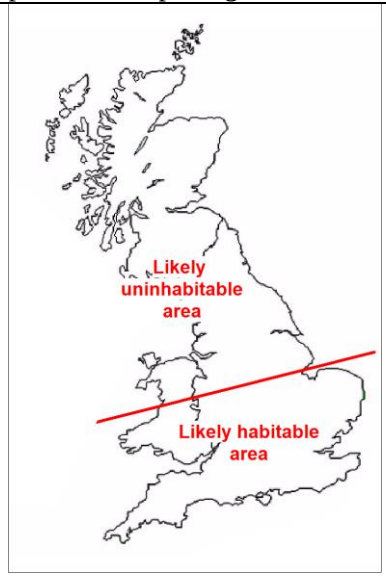
| | | | There is a possibility that increased *L. bilineata* populations might increase tick numbers and Lyme Disease spread, but any effects are likely to be minor. It is conceivable that there might be other as-yet-unknown effects (e.g. regarding novel pathogens), but this is hypothetical at present. |
| 2.25. How important might other impacts not already covered by previous questions be resulting from introduction of the organism? (specify in the comment box) | NA | high | No other impacts known or predicted at present. |
| 2.26. How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in GB? | minor | high | *L. bilineata* has native predators (e.g. kestrels and foxes) at the Bournemouth site, but this does not appear to restrict the population. The expected low impacts of *L.* bilineata's establishment here will probably not be restricted further by predation or pathogens. |
| 2.27. Indicate any parts of GB where economic, environmental and social impacts are particularly likely to occur (provide as much detail as possible). | | High |  If *L. bilineata* spreads any further at all, it is only likely (under the current climatic regime) to stay within southern Britain, roughly the area marked on the map above. It is conceivable |

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| | | | that isolated populations could establish in western coastal areas (e.g. North Wales), given the establishment of thermophilic reptiles (Aesculapian snake *Zamenis longissimus*) there (hence the map below might be better?), but the most tolerable climate would be further south. Any impacts, such as declines in native lizards, should therefore be limited to this area.<br>  <br> |

# RISK SUMMARIES

| | RESPONSE | CONFIDENCE | COMMENT |
|---|---|---|---|
| **Summarise Entry** | very likely | very high | It is already here. |
| **Summarise Establishment** | very likely | very high | It is already established, likely to establish in more places, and would be difficult to eradicate. |
| **Summarise Spread** | slow | medium | It will probably spread slowly at each established site, and the rate of establishment of new populations will probably remain low. However, without knowing the source and frequency of human assistance, it is difficult to predict with confidence what the future pattern will be. |
| **Summarise Impact** | minor | high | It is difficult to say whether there will be significant impacts. Several potential risks exist, but further research is needed. Declines in syntopic native lizards have already been reported, and if true, this effect is likely to be exacerbated by future dispersal or new colonisations. Impacts on invertebrate populations and other wildlife are conceivable, but remain unproven. Disease risk from novel pathogens and tick-hosting could potentially affect humans and other wildlife. Whatever the actual situation is, the slow rate of spread is unlikely to make these threats major or urgent. |
| **Conclusion of the risk assessment** | low | high | The overall risk on a national scale is low. The impact at a local scale could be significant, but it would take decades to have any wider significance. (But see below...). |

Additional questions are on the following page ...

| **ADDITIONAL QUESTIONS - CLIMATE CHANGE** | | | |
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| 3.1. What aspects of climate change, if any, are most likely to affect the risk assessment for this organism? | Summer warming | | If mean summer temperatures continue to increase, it will probably result in *L. bilineata*: colonising a wider range of habitats, lengthening its breeding season (e.g. two egg clutches every year), greater hatching and survival rates of young, and a facilitated expansion into a wider geographical area. The most useful comparison is with native species that are rare and restricted to one or two habitat types (e.g. sand lizard and smooth snake only found on sandy habitats with high insolation, but much less fussy on the continent). Sand lizards are already spreading into non-heathland habitats, and double-clutching regularly in Dorset, putatively due to climate change. If climate warms further, it is anticipated that they will extend their range to other habitat types. Western green lizards would be expected to follow the same pattern. Thus if summer warming occurred, their theoretically-tolerable climate envelope would extend correspondingly further north. |
| 3.2. What is the likely timeframe for such changes? | 20 years | medium | Unless anyone can predict the future climate trend with accuracy and confidence, this number is a subjective guess. |
| 3.3. What aspects of the risk assessment are most likely to change as a result of climate change? | Geographical range and rate of spread | high | *L. bilineata* was naturally absent from GB because of its thermophilic climatic preferences, and its failure to colonise before sea level rose isolated it. Its artificial establishment today is similarly restricted by climatic tolerances which dictate its geographical potential. |

| **ADDITIONAL QUESTIONS – RESEARCH** | | | |
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| 4.1. If there is any research that would significantly strengthen confidence in the risk assessment please summarise this here. | Continued surveillance of Bournemouth site, survey of historical sites, research into possible impacts on native reptiles. | very high | Without doubt, the continued monitoring of the Bournemouth population will inform our knowledge of rates of spread, and will be key to understanding whether there are any impacts on native reptiles. A specific research project to monitor native and alien reptiles in a zone of contact would be necessary. Containment within the Poole Bay cliffs would be an ideal goal; but it is not possible at present to say whether there are any other populations, or whether human-assisted dispersal is still occurring. It most likely *is* occurring, and it is probably inevitable that further populations will establish in due course. Surveys of historical introduction sites would be simple to achieve, and would be useful to rule these out of the equation (or otherwise). |

Please provide a reference list on the following page ...

# REFERENCES:


Amann, T., Rykena, S., Joger, U., Nettmann, H. K. & Veith, M. (1997). Zur artlichen Trennung von *Lacerta bilineata* Daudin, 1802 und *L. viridis* (Laurenti, 1768). *Salamandra*, 33, 255-268.

Arnold, E.N & Ovenden, D. (2002). *A Field Guide to the Reptiles and Amphibians of Britain and Europe*. HarperCollins, London.

Böhme, M. U., Fritz, U., Kotenko, T., Dzukic, G., Ljubisavljevid, K., Tzankov, N. & Berendonk, T. U. (2007). Phylogeography and cryptic variation within the *Lacerta viridis* complex (Lacertidae, Reptilia). *Zoologica Scripta*, 36, 119–131.).

Collins, J.T. & Gubanyi, J.E. (2010). History and distribution of the western green lacertam *Lacerta bilineata* (Reptilia: Squamata: Lacertidae), in Topeka, Kansas. *Journal of Kansas Herpetology*, 34 , 8-9.

Deichsel, G., Gleed-Owen, C. P. & Mayer, W. (2007). *Lacerta bilineata bilineata* (Western Green Lizard) and *Podarcis muralis maculiventris* (Common Wall Lizard) United Kingdom, Dorset. *Herpetological Review* 38 (1), 100-101).

Gasc, J.-P., Cabela, A., Crnobrnja-Isailovic, J. et al. (eds.) (1997). Atlas of Amphibians and Reptiles in Europe. Societas Europaea Herpetologica, and Museum National d'Histoire Naturelle, Paris.

Gleed-Owen, C. P. (2004). Green lizards and Wall lizards on Bournemouth Cliffs. *Herpetological Bulletin*, 88, 3-7.

Godinho, R., Crespo, E. G., Ferrand, N. & Harris, D. J. (2005). Phylogeny and evolution of the green lizards, *Lacerta* spp. (Squamata: Lacertidae) based on mitochondrial and nuclear DNA sequences. *Amphibia-Reptilia*, *26*, 271–430.

Kraus, F. (2009). *Alien Reptiles and Amphibians, a Scientific Compendium and Analysis. Invading nature: springer series in invasion ecology*, 4. Springer Science, New York.

Lever, C. (2003). *Naturalized Reptiles and Amphibians of the World*. Oxford University Press, Oxford.

Majláthová, V., Majláth,I., Derdáková, M., Víchová,B, & Peťko, B. 2006. *Borrelia lusitaniae* and Green Lizards (*Lacerta viridis*), Karst Region, Slovakia. *Emerging Infectious Diseases*, 12(12), 1895–1901.

Mayer, W. & Bischoff, W. (1996). Beitrafe zur taxonomischen Revision der Gattung *Lacerta* (Reptilia: Lacertidae). 1. *Zootoca, Omanasaura, Timon* und *Teira* als eigenstandige Gattungen. *Salamandra* 32, 163-170.

Mole, S. (2008). *An Investigation into the Effects of the Western Green Lizard (*Lacerta bilineata*) and the Common Wall Lizard (*Podarcis muralis*) Introduced onto Boscombe Cliffs, Dorset, U.K.* BSc dissertation, Sparsholt College, Winchester.

Rykena, S. (1991). Kreuzungsexperimente zur Prüfung der Artgrenzen im Genus Lacerta sensu stricto. Mitteilungen des Zoologischen Museum Berlin, 67, 55–68.).

Sainsbury, A.W., Foster, J., Bird, D., Moulton, N., Molenaar, F., Vaughan, R., Peniche, G. & Marschang, R. (2011). *Evaluating the Threat to the Conservation of the Sand Lizard,* Lacerta agilis*, from Parasites Harboured by the Introduced Wall Lizard,* Podarcis muralis. Unpublished Report. Institute of Zoology, London.

Street, D. (1979). *The Reptiles of Northern and Central Europe.* B.T. Batsford Ltd, London.