

Measuring the pulse
of European biodiversity

European Red List of Reptiles

Philip Bowles, Igor V. Doronin, Miguel A. Carretero, Dan Cogălniceanu, Claudia Corti, Jelka Crnobrnja-Isailović, Pierre-André Crochet, Balint Halpern, Daniel Jablonski, Dušan Jelić, Ulrich Joger, Tom Kirschey, Luca Luiselli, Petros Lymberakis, Andreas Maletzky, Fernando Martínez-Freiría, Edvard Mizsei, Edoardo Razzetti, Antonio Romano, Daniele Salvi, Ulrich Schulte, Jeroen Speybroeck, Florina Stănescu, Aurore Trottet, Joanna Clay, Vittorio Bellotto, and David J. Allen



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All data produce through this project are available via the IUCN Red List Data Repository:
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Executive summary

Aim

This European Red List provides an updated summary of the conservation status of species of reptiles in Europe, evaluated according to the IUCN Red List Categories and Criteria (IUCN, 2012a) and IUCN's global (IUCN, 2022) and regional (IUCN, 2012b) guidelines. It is a completely revised second edition with the inclusion of new data and incorporation of taxonomic changes that have taken place since the first edition (Cox and Temple, 2009). It is a comprehensive, region-wide assessment of reptiles and builds on this previous work, ensuring that it remains relevant for informing contemporary conservation of this group. It identifies species threatened with extinction at the European and EU27 Member State levels, the geographic areas in most need of protection and the major threats to European reptiles, so that appropriate policy measures and conservation actions can be taken to improve their status, based on the best available evidence.

Scope

The geographic scope of this European Red List spans the entirety of the European continent. It extends from Iceland, Svalbard and Franz Josef Land (Земля Франца-Иосифа) in the north, to the Canary Islands in the south, and from the Azores in the west to the Urals in the east, including the European part of Türkiye ('Türkiye-in-Europe') and most of the European parts of the Russian Federation. Cyprus, the European Macaronesian islands (the Canaries, Madeiran and Azores archipelagos) and the Spanish North African Territories (Ceuta, Melilla, and the Plazas de soberanía) are included in the assessment region, whereas the North Caucasus parts of European Russia (e.g. Krasnodar Krai, Republic of Dagestan, Stavropol Krai and other administrative units within the Russian Northern Caucasus) fall beyond the European scope of this European Red List, as do European portions of

Kazakhstan. Red List assessments were made at two regional levels: for geographical Europe and for the 27 Member States of the European Union (hereafter, EU27). In all, 171 native or long-naturalised (introduced prior to 1500 CE) species recorded for the European region were included in this assessment. Species with a marginal occurrence in Europe (comprising less than 1% of the global range), recently introduced species (introduced after 1500 CE), and species that occur in the assessment region only in the Spanish North African Territories were considered as Not Applicable for the European Red List.

Results

This European Red List is a completely revised second edition. It is a comprehensive, region-wide assessment of reptiles and builds on the previous work done for the first *Status and Distribution of European Reptiles* (Cox and Temple, 2009) and incorporates many new data compiled from literature and contributed from the personal databases of the assessors and reviewers, reflecting 15 years of accumulated additional research and improved understanding of European reptiles and their exposure and sensitivity to different threatening processes. The substantial amount of fieldwork data and accumulated knowledge means that this assessment is based on a robust trend analysis by many experts.

Of the 171 species assessed, 12.9% (21 species) of extant species for which sufficient data are available are threatened (i.e., assessed as Critically Endangered, Endangered or Vulnerable) on the European scale, with 0.6% being Critically Endangered, 5.8% Endangered and 5.8% Vulnerable. In addition, 8.8% (15 species) were assessed as Near Threatened, with seven species (4.1%) considered Data Deficient. The situation for the 161 species occurring within

the EU is almost identical to that of Europe as a whole, though with a slightly higher proportion (6.8%) of Vulnerable species, resulting in 13.7% of species for which sufficient data are available being considered threatened. The highest number of threatened species are found in southern and southwestern Europe, including the Mediterranean and Macaronesian islands. Threats to reptiles result mainly from habitat loss, the drivers of which are discussed, while invasive species have been responsible for multiple rapid declines in native species and climate change is recognised as a threat to a greater number of species than in 2009.

Threatened European reptiles are concentrated within the European Union, which may facilitate policy interventions and management. Nevertheless, and despite several reptile-focused LIFE projects, no European reptile species were found to have undergone a genuine improvement in its Red List status since 2009, although LIFE projects ([LIFE02 NAT/E/008614](#) and [LIFE06 NAT/E/000199](#)) focused on the La Gomera Giant Lizard *Gallotia bravoana* before the 2009 assessment had successfully increased numbers of that species.

- Increase the representation of threatened species within protected areas and identify new protected areas for threatened species that are not currently well represented within protected areas networks.
- Control the spread and, where possible, mitigate the impacts of invasive species, especially regarding range-restricted island fauna.
- Reporting and protection mechanisms under European environmental legislation should reflect the latest advancements in taxonomy as a means of ensuring effective conservation, monitoring, and implementation of legislation.
- Climate change is acknowledged as a growing threat across Europe, however, the impacts on reptiles and their habitats remain uncertain. Additional research is needed to identify the full extent and nature of climate change impacts on reptiles and to identify appropriate strategies for their mitigation.
- A comprehensive Europe-wide monitoring programme is essential to understanding reptile population trends and revealing population declines, such as those resulting from the impacts of climate change, novel diseases, and invasive alien species.



1. Background

1.1. The European context

Europe is one of the seven continents on Earth, and both physically and geologically it is the westernmost peninsula of Eurasia. Europe is bound to the north by the Arctic Ocean, to the west by the Atlantic Ocean, to the south by the Mediterranean Sea, and to the southeast by the Black Sea and the Caucasus Mountains. In the east, Europe is separated from Asia by the Ural Mountains and the Caspian Sea (Figure 1). Europe is the world's second-smallest continent in terms of area, covering approximately 10,530,000 km².

The European Union (EU), comprising 27 Member States, is Europe's largest political and economic entity. It is the world's largest economy with an estimated gross domestic product (GDP) in 2022 of 14.4 trillion euros (EUROSTAT, 2022). Per capita GDP in many EU states is among the highest in the world and rates of resource consumption and waste production are correspondingly high – the EU's "ecological footprint" has been estimated to exceed the region's biological capacity (the total area of cropland, pasture, forest, and fishing grounds available to produce food, fibre and timber, and absorb waste) by 2.6 times (WWF, 2007).

The EU's Member States stretch from the Arctic Circle in the north to the Mediterranean in the south, and from the Atlantic coast and the Atlantic islands in the west to the Danube Delta and Cyprus in the east – an area containing a great diversity of landscapes and habitats, and a wealth of flora and fauna. Mediterranean Europe is particularly rich in plant and animal species and has been recognised as a global

"biodiversity hotspot" (Mittermeier et al., 2004; Cuttelod et al., 2008).

Europe has arguably the most highly fragmented landscape of all continents, and only a tiny fraction of its land and freshwater surface can be considered wilderness. For millennia most of Europe's land has been used by humans to produce food, timber and fuel and provide living space. About 80% of Europe's land surface has been shaped by human activities: covered with buildings, roads, industrial infrastructure or used for agriculture. The way the land is used constitutes one of the main drivers of environmental degradation and climate change (European Environment Agency, 2024). Consequently, European species are to a large extent dependent upon semi-natural habitats created and maintained by human activity, particularly traditional, non-intensive forms of land management. These habitats are under pressure from agricultural intensification, urban sprawl, infrastructure development, land abandonment, acidification, eutrophication and desertification. Many species are directly affected by overexploitation, persecution and impacts of alien invasive species, and climate change is set to become an increasingly serious threat in the future. Europe is a vast, diverse region and the relative importance of different threats varies widely across its biogeographic regions and countries. Although considerable efforts have been made to protect and conserve European habitats and species, biodiversity decline and the associated loss of vital ecosystem services (such as water purification, crop pollination, and carbon sequestration) continue to be a major concern in the region.



Figure 1. The European Red List terrestrial assessment boundaries. Regional assessments were made for two areas: for geographical Europe (green), and for the EU27 Member States (hatched area).

1.2. The European policy context

Biodiversity provides resources and services that are essential for sustainable development, however, the loss of biodiversity remains one of the most pressing crises facing the world. The factors driving this loss can be complex and the solutions often rely on the involvement of various groups ranging from international bodies to governments to civil society. Data on the status of biodiversity is essential to inform policies and develop frameworks which aim to reduce its loss.

In May 2011, the European Union (EU) adopted a strategy entitled '[Our life insurance, our natural capital: an EU biodiversity strategy to 2020](#)', designed to halt biodiversity loss in the region. It set out six targets and 20 actions to halt the loss of biodiversity and ecosystem services in the EU Member States by 2020. Whilst there were successes from the delivery of various actions

resulting in the recovery of some populations and habitats, the strategy did not succeed in delivering its headline target and the loss of biodiversity continues. This has prompted the EU to set out its new Biodiversity Strategy for 2030, which aims to protect nature and reverse the degradation of ecosystems by 2030 through specific actions and commitments. As a core part of the European Green Deal, the Biodiversity Strategy will also support a green recovery following the COVID-19 pandemic and it is the EU's contribution to the ongoing international negotiations on the post-2020 global biodiversity framework.

A range of EU legislation is of key relevance to reptile conservation in Europe, some directly and others indirectly. The predominant legislation for the largest number of species is the Habitats Directive ([Council Directive 92/43/EEC](#)),

which contributes to enhancing biodiversity in the European Union by conserving natural habitats and wild fauna and flora species. This Directive sets out to achieve this by establishing the Natura 2000 network of protected areas and protecting named species and habitats both within and outside Natura 2000 protected areas.

The annexes of the Directive outline the protected habitats and species:

- **Annex I** Natural habitat types of community interest whose conservation requires the designation of special areas of conservation.
- **Annex II** Animal and plant species of community interest whose conservation requires the designation of special areas of conservation.
- **Annex III** Criteria for selecting sites eligible for identification as Sites of Community Importance (SCIs) and designation as Special Areas of Conservation (SACs).
- **Annex IV** Animal and plant species of community interest in need of strict protection.
- **Annex V** Animal and plant species of community interest whose taking in the wild and exploitation may be subject to management measures.

There are at least 86 European reptile species included in Annexes II and IV of the Habitats Directive. For species in Annex II, countries must designate Special Areas of Conservation (SACs). Special conservation is required to ensure the continuing persistence of these species in the countries where they occur. The designation of Natura 2000 areas in locations where species from Annex II occur and the protection of species from Annex IV will have contributed to their conservation in Europe. Nevertheless, with a more consistent application of the existing species protection legislation during interventions, but also in agriculture and forestry, even more can be achieved.

The Council of Europe's *Convention on the Conservation of European Wildlife and Natural Habitats* (1979), known as the Bern Convention, was the first international treaty to protect both species and habitats and to bring countries together to decide how to act on nature

conservation. This convention was adopted to protect Europe's wild plants and animals and formed the backbone of later European legislation on nature conservation and protection. Eighty-one species of reptiles are listed as strictly protected in Appendix II of the Bern Convention and all reptile species (and infrataxa) not included in Appendix II are included in Appendix III. Special protected areas have been designated to protect these species and there is an obligation to protect their habitats.

In addition, 18 European reptile species are protected by the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES), an international agreement between governments that aims to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species, which entered into force in 1975. The EU is an important region of origin, destination, and transit for many of the species protected under CITES. The EU wildlife trade regulations are a set of EU laws implemented in all EU countries to enforce the provisions of CITES across EU Member States. The core regulation is the *Council Regulation (EC) No 338/97 of 9 December 1996 on the protection of species of wild fauna and flora by regulating trade therein*. In addition, there are the associated implementing regulations, the Implementing Regulation (*Commission Regulation [EC] No 865/2006*), the Permit Regulation (*Commission Implementing Regulation [EU] 792/2012*), and Suspension Regulation(s) (the most recent being *Suspension Regulation (2023/2770)*). The core Regulation (338/97) establishes the overall provisions for the import, export and re-export of species, as well as internal EU trade in specimens of species. The species are listed in its four annexes.

- **Annex A includes:**

- All CITES Appendix I species, except where an EU Member State has entered a reservation.
- Some CITES Appendix II and III species, for which the EU has adopted stricter domestic measures.
- Some non-CITES species.

- **Annex B includes:**
 - All other CITES Appendix II species, except where an EU Member State has entered a reservation.
 - Some CITES Appendix III species.
 - Some non-CITES species.
- **Annex C includes:**
 - All other CITES Appendix III species, except where an EU Member State has entered a reservation.
- **Annex D includes:**
 - Some CITES Appendix III species for which the EU holds a reservation.
 - Some non-CITES species in order to be consistent with other EU regulations on

the protection of native species, such as the Habitats Directive and the Birds Directive.

Nineteen European reptile species are included in the four annexes, and hence their trade is controlled within the EU.

An overview of the taxa mentioned in the Bern Convention, the Annexes (II or III) of the Habitats Directive, CITES and the EU wildlife trade regulations is presented in Appendix 1 of this report. A number of species names and species concepts used in the above international policy instruments now differ from those in current use and do not always reflect recent taxonomic changes.

1.3. European reptiles: diversity and endemism

Within Europe (following the borders defined in Geographic Scope below) two orders of reptiles are recognised, Squamata (lizards and snakes) and Testudines (tortoises and turtles). The great majority of terrestrial European reptiles are members of the Squamata (168 species), and this order is typically divided by taxonomists between the suborders Sauria (lizards: 118 native European species) and Serpentes (snakes: 46 native species). The presence of two species in Europe is uncertain: reports of *Parvilacerta parva* from European Türkiye require confirmation, and the inclusion in the European fauna of the turtle *Trionyx triunguis* is based on a single record from Greece that requires confirmation, and from several reports from the sea of vagrant animals that originated from Turkish populations. An additional species reported as a single individual from Greece, *Hemorrhois ravergeri*, is now believed to be a misidentification and is not included in current lists of the Greek or European fauna. The snake *Rhynchocalamus melanocephalus* was first reported from the European region (Cyprus) in 2020, but it is unclear whether this reflects a recent introduction or a long-established, and possibly native, population of a secretive species.

Over half of the assessed reptiles of Europe (100 of 171 species) are endemic to the region, but endemism is especially high in the tortoises (two of

the three native species are endemic to Europe) and the lizard families Anguidae (Slow Worms and Glass Lizards), Blanidae (Mediterranean Worm Lizards), Phyllodactylidae (Geckos) and Lacertidae (Wall Lizards and relatives) (see Table 1). Not Applicable (NA) species are excluded from Table 1, including five species (two lacer-tids, one skink, one sphaerodactylid gecko, and one Worm Lizard of the family Trogonophidae) that have been reported from the Spanish North Africa territories (treated as part of the EU) but are otherwise absent from the European region.

The most diverse reptile families in the region are the Lacertidae (typical or “true” lizards: 77 species) and the Colubridae (colubrid snakes: 24 species). Over a fifth of the world’s lacertid species occur in Europe, and nearly half of the small family Blanidae (three of 7 species). All other European species belong to families that are predominantly distributed outside Europe. Important evolutionary radiations in the region include the lizard genera *Podarcis* (27 species, all of which occur in and most of which are confined to Europe), *Iberolacerta* (eight species, all endemic to Europe), and *Gallotia* (seven extant species, entirely endemic to the Canary Islands). All the snake genera recorded from Europe are widespread and represented outside the region, except for the endemic genus *Hierophis* (Colubridae; three species). All five species of

Natrix (Natricidae) occur on the continent and one is endemic. Over half of the 11 European viper species are endemic to the continent. Although there are few native tortoise and freshwater turtle species in Europe, three of the seven species (*Emys trinacris*, *Testudo hermanni* and *T. marginata*) are regionally endemic.

Geographically, endemism in European reptiles is highest in the Iberian Peninsula, the

Mediterranean islands, and the Canary Islands. As these areas lie within the European Union, nearly three quarters of European-endemic reptiles are restricted to the EU 27. The remainder are mostly more widespread species that occur in both EU and non-EU states. Only 10 reptile species occur in Europe fully outside the borders of the European Union, of which two are endemic to European states outside the EU 27.

Table 1. Diversity and endemism in terrestrial and freshwater reptile orders and families in Europe and in the EU. This table includes species confirmed to occur in the European assessment region that are native or naturalised prior to 1500 CE. Not Applicable (NA) species (species introduced or possibly introduced after 1500 CE and species whose only occurrence in the European assessment region is in the Spanish North African territories) are not included. Four further NA species of marginal occurrence in Europe (one Chamaeleonidae, one Gekkonidae, and two Lacertidae) are also excluded.

		Pan Europe			EU 27		
		Number of species	Number of endemic species	% endemic	Number of species	Number of endemic species	% endemic
Squamata (Sauria)	Agamidae	5	1	20.0	2	1	50.0
	Anguidae	6	4	66.7	6	2	33.3
	Blaniidae	3	2	66.7	3	2	66.7
	Chamaeleonidae	0	0	0.0	0	0	0.0
	Gekkonidae	6	3	50.0	6	2	33.3
	Lacertidae	77	62	80.5	75	48	64.0
	Phyllodactylidae	5	4	80.0	5	4	80.0
	Scincidae	15	7	46.7	15	7	46.7
	Sphaerodactylidae	1	0	0.0	1	0	0.0
Squamata (Serpentes)	Erycidae	2	0	0.0	1	0	13.6
	Colubridae	25	6	24.0	23	3	0.0
	Psammophiidae	2	0	0.0	2	0	0.0
	Natricidae	5	1	20.0	5	0	0.0
	Typhlopidae	1	0	0.0	1	0	0.0
	Viperidae	11	6	54.5	10	3	30.0
Testudines	Emydidae	2	1	50.0	2	1	50.0
	Geoemydidae	2	0	0.0	2	0	0.0
	Testudinidae	3	2	66.7	3	0	0.0
Total		171	99	57.9	162	73	45.3



The Four-lined Snake, *Elaphe quatuorlineata*, is a species widespread in the Apennine and Balkan peninsulas. © Roberto Sindaco

1.3.1. Alien species

Alien species are being introduced by human activities to all regions of the world at unprecedented rates. Some become invasive (alien invasive species, IAS) and cause negative and in some cases, irreversible, impacts on biodiversity, contributing to the unparalleled degree of deterioration of the biosphere upon which humanity depends (Roy et al., 2023). Not all alien reptile species occurring in the European region are considered invasive.

At least twenty-two reptile species have been recorded as alien (introduced) to Europe since 1500 CE and have been assessed as Not Applicable (NA) for this European Red List (Table 2). This list of recent introductions is not comprehensive, with a further alien snake, *Elaphe taeniura*, recorded from Belgium (but native to South and East Asia) and the freshwater turtle *Mauremys mutica*, also native to South and East Asia but recorded in Spain (Poch et al., 2020).

Ten of the alien species that have been recorded in Europe are turtles, occurring mostly as a consequence of the commercial pet trade. One species, the Yellow-bellied Slider Turtle *Trachemys scripta*, from the Americas, is now widespread with breeding populations found widely but mainly in Mediterranean areas of Europe (although also in Central Europe). It is unclear whether other turtles have established self-sustaining breeding populations. In addition, at least 36 reptile species native to the continent have established non-native populations within Europe but outside their native ranges, most often on islands.

In some cases of apparent ancient or historical introductions of animals that naturally occur in nearby regions, it can be difficult or impossible to determine whether a species is genuinely introduced, and if it was, when that introduction took place. This is the case for example, for species known from small numbers of European records such as *Rhynchocalamus melanocephalus* and

Zamenis hohenackeri (both known from small numbers of specimens of uncertain origin collected in Cyprus). The timing of introductions can also be difficult to determine: it has previously been proposed that *Chamaeleo africanus* was introduced to Europe before 1500 CE (and hence valid for inclusion in the European Red List following the IUCN regional guidelines), likely as a result of trade between Greece and the Nile Delta and so possibly in antiquity, however, this population was only first recorded in the 1990s and its true date of introduction could therefore be considerably more recent. Another reported introduction, *Darevskia dahli*, may represent a misidentification of another species introduced to the same region, *D. armeniaca*.

At present, most alien snakes and lizards have only established populations in restricted areas in Europe. However, in several cases, these introductions are on islands where they can present a major threat to native reptiles, such as the California Kingsnake *Lampropeltis californiae* (a recognised IAS snake species) in the Canary Islands, and the Horseshoe Whip Snake *Hemorrhois hippocrepis* (a species native to other parts of Europe) on Ibiza. The majority of introduced reptiles have wide native ranges outside Europe, although the São Vicente Wall Gecko *Tarentola substituta* (introduced to the Azores) is native to only one island in the Cape Verde Archipelago, and Bogdanov's Thin-toed Gecko *Tenuidactylus bogdanovi* (introduced to Ukraine) is naturally endemic to Uzbekistan and southern Tajikistan in Central Asia. The Ibiza Wall Lizard (naturally endemic to the Balearic Islands) has been introduced to several areas of the mainland Iberian Peninsula; the Maltese Wall Lizard (naturally endemic to the Maltese Archipelago) has been introduced to the

Italian Pelagie Islands; and three species of the Canarian endemic genus *Gallotia* have established introduced populations on islands in the archipelago to which they are not native.

At the global scale, the primary introduction pathways for alien and IAS reptiles are the ornamental/aquarium/terrarium trade and aquaculture/breeding for food. Additional pathways include shipping and other vehicle stowaways, and introduction via corridors (such as transboundary rivers and canals (Nunes et al., 2015).

Preventing the unintentional introduction of reptile IAS can be challenging. First, priority introduction pathways based on the volume of past and potential future introductions of IAS associated with them need to be identified, then measures to reduce the risk of IAS introduction. Addressing introduction pathways requires strong biosecurity practices, including the implementation of inspections, disinfection protocols and appropriate facilities and training for all personnel involved. It is also essential to raise awareness through communication campaigns, to ensure that citizens are informed of the best practices to minimise potential spread (Costello et al., 2022). The EU Invasive Alien Species Regulation ([Regulation \(EU\) 1143/2014](#)) includes a set of measures to be taken across the EU in relation to invasive alien species prevention, detection and eradication, and management, and establishes a [list of Invasive Alien Species of Union concern](#). The list is updated periodically with the current summary (Brundu et al., 2022) and includes two reptile species: *Lampropeltis getula* sensu lato (i.e., including *Lampropeltis californiae*, formerly recognised as *Lampropeltis getula* ssp. *californiae*) and *Trachemys scripta*.

Table 2. Species introduced or possibly introduced to the European region since 1500 CE and listed as Not Applicable in this current assessment. This list is not comprehensive, and at least two further recently introduced species were omitted and do not have Not Applicable assessments; the introduced snake, *Elaphe taeniura*, recorded from Belgium (but native to South and East Asia), and the freshwater turtle *Mauremys mutica*, also native to South and East Asia but recorded in Spain (Poch et al., 2020).

Group	Family	Species	Native Range
Lizards	CHAMAELEONIDAE	<i>Chamaeleo africanus</i> *	North Africa
	DACTYLOIDAE	<i>Anolis carolinensis</i>	North America
	GEKKONIDAE	<i>Tenuidactylus bogdanovi</i>	Central Asia
		<i>Tenuidactylus caspius</i>	Caucasus and Central Asia
	LACERTIDAE	<i>Darevskia armeniaca</i>	Caucasus
		<i>Darevskia dahli</i>	Caucasus
		<i>Scelarcis perspicillata</i>	North Africa
	PHYLLODACTYLIDAE	<i>Tarentola substituta</i>	Cape Verde
Snakes	COLUBRIDAE	<i>Elaphe schrenckii</i>	East Asia
		<i>Hemorrhois algirus</i>	North Africa
		<i>Lampropeltis californiae</i>	North America
	TYPHLOPIDAE	<i>Indotyphlops braminus</i>	Asia
Turtles	CHELYDRIDAE	<i>Chelydra serpentina</i>	North America
		<i>Macrochelys temminckii</i>	North America
	EMYDIDAE	<i>Chrysemys picta</i>	North America
		<i>Pseudemys nelsoni</i>	North America
		<i>Trachemys scripta</i>	North America
	GEOEMYDIDAE	<i>Mauremys caspica</i>	Western Asia
		<i>Mauremys reevesii</i>	Temperate East Asia
		<i>Mauremys sinensis</i>	East Asia
	KINOSTERNIDAE	<i>Kinosternon subrubrum</i>	North America
	TRIONYCHIDAE	<i>Pelodiscus sinensis</i>	China and Vietnam

*This may be a pre-1500 introduction.

1.3.2. The changing taxonomic landscape

The results of the first regional assessment of the reptiles of Europe were published in Cox and Temple (2009). Since then, nearly 70 accepted taxonomic changes have occurred that affect

European reptile species (Appendix 2). Most of these are new species descriptions, the elevation of former subspecies to species level, and the resulting changes in species concepts for reptiles previously assessed for the European Red List. Twenty-nine previously assessed species have been subject to changes in their species

concepts since 2009, including widespread and familiar snakes and lizards such as the Adder (*Vipera berus*), Grass Snake (*Natrix natrix*), Viviparous Lizard (*Zootoca vivipara*), Slow Worm (*Anguis fragilis*), the Italian Wall Lizard (*Podarcis siculus*), and the Ocellated Lizard (*Timon lepidus*). Although most relationships have now been well-studied, in a number of cases further taxonomic work is needed to fully resolve relationships (for instance in *Vipera ammodytes*, in which a taxonomic change has been proposed since the reassessment was completed; Thanou *et al.*, 2023). These changes have sometimes had drastic effects on our understanding of species distributions. For instance, the Spanish Wall Lizard, once believed to range throughout the Iberian Peninsula and into France, is now considered to be restricted to the Spanish Levante, the eastern part of the Iberian Peninsula.

In 2019, the *Societas Europaea Herpetologica* (SEH) formed a *Taxonomic Committee* to review recent taxonomic research on European reptiles (using a definition of Europe that encompasses the European Caucasus but excludes Spanish North Africa) and to vote on whether to accept proposed taxonomic changes. The initial result of this was a list of 200 terrestrial reptile species and 6 marine turtles, which was published the following year (Speybroeck *et al.*, 2020). This work described the Committee's reasoning for accepting or rejecting proposed taxonomic changes since 2010. Four additional species have since been described or accepted, and a further species (*Rhynchocalamus melanocephalus*) reported from the European region for the first time.



Lacerta diplochondrodes was recognised as a widespread species distinct from *L. trilineata* in 2019 and assessed for the Red List for the first time in this project. © Paul Cools

The species-level taxonomy adopted in the European Red List follows that in Speybroeck et al. (2020) for species within the European Red List assessment boundaries, with the exceptions described in section 2.2 below.

In addition to these species-level changes, reptile higher taxonomy remains in a state of flux. Four families recognised in Cox and Temple (2009), Boidae, Colubridae, Gekkonidae, and Amphisbaenidae, have been split into multiple families. Boidae and Amphisbaenidae no longer

occur in the European region (their representatives belonging to Erycidae and Blanidae respectively). European colubroid snakes belong to the three families Colubridae, Natricidae, and Psammophidae; while European geckos are represented by Gekkonidae, Phyllodactylidae, and Sphaerodactylidae. The Amphisbaenia, previously regarded as a suborder of Squamata distinct from both true lizards and snakes, are now known to be a group of legless lizards related to lacertid lizards.

1.4. Assessment of extinction risk

The conservation status of plants, animals and fungi is one of the most widely used indicators for assessing the condition of ecosystems and their biodiversity. At the global scale, the primary source of information on the extinction risk of plants and animals is The IUCN Red List of Threatened Species™ (www.iucnredlist.org), which contributes to understanding the conservation status of assessed species. The IUCN Red List Categories and Criteria (IUCN, 2012a) are designed to determine the relative risk of extinction of a taxon, with the main purpose of cataloguing and highlighting those taxa that are facing a high risk of extinction. Red List assessments are policy-relevant and can be used to inform conservation planning and priority-setting processes, but they are not intended to be policy-prescriptive and are not in themselves a system for setting biodiversity conservation priorities.

The IUCN Red List Categories are based on a set of quantitative criteria linked to population trends, size and structure, threats, and geographic ranges of species. There are nine categories, with species classified as Vulnerable (VU), Endangered (EN) or Critically Endangered (CR) considered 'threatened'. When conducting regional or national assessments, the IUCN Red List Regional Guidelines (IUCN, 2012b) must be applied, and two additional categories are used: Regionally Extinct (RE) and Not Applicable (NA) (Figure 2). As the extinction risk of a species can be assessed at global, regional or national levels, a species may be classified under different Red List Categories depending on the scale of assessment, considering the population of that species at each geographical level. Logically, a species that is endemic to the EU27 region would have a single assessment, as it is not present anywhere else in the world.

1.5. Objectives of the assessment

This *European Red List of Reptiles* had five main objectives:

- To update this *European Red List of Reptiles*, taking into account new information, recent trends and threats that reptiles experienced.
- To identify prioritised geographical areas and habitats in need of urgent protection to prevent extinctions and to ensure that European reptiles reach and maintain a favourable conservation status.
- To identify the major threats to European reptiles and to propose potential mitigating measures and conservation actions to address them.
- To use the knowledge mobilised to contribute to regional reptile conservation planning.
- To strengthen the network of reptile experts in Europe, so that the knowledge can be kept current, and expertise can be recruited to address the highest conservation priorities.

The assessment produces three main outputs:

- An updated report on the status of all European reptiles (this report).
- A website (www.iucnredlist.org).
- Data portal (www.iucnredlist.org/resources/datarepository) making publicly available the assessment data and species maps for all European reptiles included in this study.

This European Red List is a completely revised second edition. It is a comprehensive,

region-wide assessment of reptiles and builds on the previous work done for the first Status and Distribution of European Reptiles (Cox and Temple, 2009), and incorporates many new data contributed from personal and institutional databases from across the European region. The substantial amount of fieldwork, data and accumulated knowledge means that this assessment is based on a robust trend analysis by many experts.

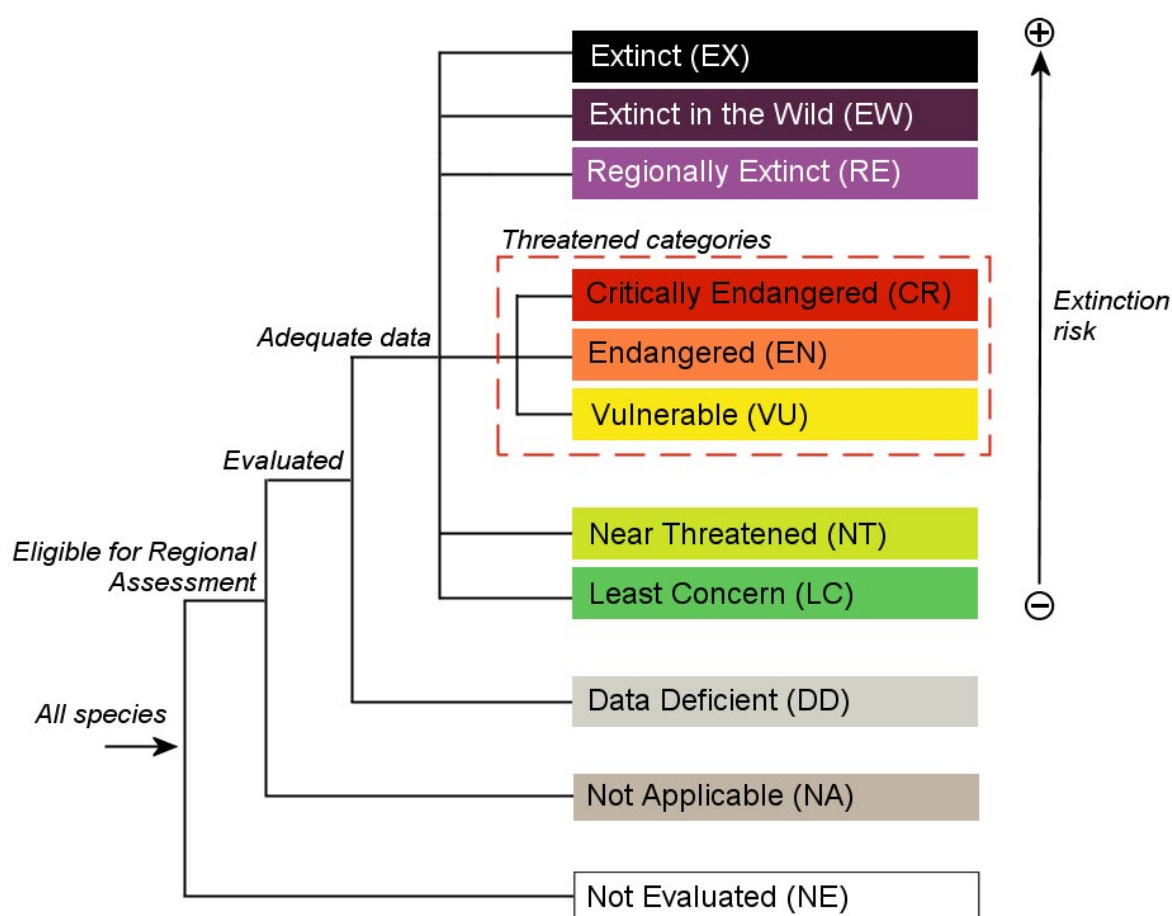


Figure 2. The IUCN Red List Categories at the regional scale (IUCN 2012b).

2. Assessment methodology

2.1. Geographic scope

The geographic scope of this European Red List spans the entirety of the European continent. It extends from Iceland, Svalbard and Franz Josef Land (Земля Франца-Иосифа) in the north to the Canary Islands in the south, and from the Azores in the west to the Urals in the east, including the European part of Türkiye ('Türkiye-in-Europe') and most of the European parts of the Russian Federation. Cyprus, the European Macaronesian islands (the Canaries, Madeiran and Azores archipelagos) and the Spanish North African Territories (Ceuta, Melilla, and the Plazas de soberanía) are included in the assessment region, whereas the North Caucasus parts of Russia (e.g. Krasnodar Krai, Republic of Dagestan, Stavropol Krai and other administrative units within the Russian Northern Caucasus) fall beyond the European scope of

this European Red List, as does Kazakhstan. The extent of the geographic scope of this European Red List is shown in Figure 1.

Red List assessments were made at two regional levels: 1) for geographical Europe (limits described above); and 2) for the area of the 27 Member States of the European Union. In comparison with the previous Status and Distribution of European Reptiles (Cox and Temple, 2009) the EU region now includes Croatia but no longer includes the United Kingdom.

In the case of species whose only European range lies in Spanish North Africa, data were collected to update the assessments, but the species were assessed as Not Applicable.

2.2. Taxonomic scope

This *European Red List of Reptiles* has assessed the status of all species of snakes, lizards, and terrestrial and freshwater turtles native to Europe or naturalised there before 1500 CE, a total of 175 species, and one species of uncertain origin (*Rhynchocalamus melanocephalus*). The initial species list was based on Speybroeck et al. (2020), excluding 16 species which occur outside the area described in 2.1 above, and updated according to the most recent taxonomic changes (see Appendix 2).

Two of the taxonomic actions proposed by Speybroeck et al. (2020) for native species have not been accepted by the relevant IUCN Specialist Groups. *Blanus vandelli* is favoured in

the IUCN taxonomy over the name *Blanus rufus* accepted by Speybroeck et al. (2020). The identity of *Emys trinacris* disputed, and it is regarded as a subspecies of *E. orbicularis* by Speybroeck et al. (2020), an approach not followed by the Red List at present on the guidance of the IUCN SSC Tortoise and Freshwater Specialist Group (TFSG). A species that is marginal in Europe, *Trapelus sanguinolentus*, is sometimes regarded as a subspecies of *Trapelus agilis* and this placement is used by Speybroeck et al. (2020) without comment. In these two cases, the taxonomic source cited is [The Reptile Database](#) for the lizard, and the most recent [Turtles of the World](#) checklist (TTWG 2021) published by the Turtle Taxonomy Working Group of the TFSG for the turtle.

Five further taxonomic changes affecting species within the assessment region have been implemented since Speybroeck et al. (2020) was published and have been accepted in the Red List:

- *Laudakia cypriaca* was elevated from a sub-species of *L. stellio* by Karameta et al. (2022).
- *Anatololacerta budaki*, split from *A. oertzeni* by Bellati et al. (2015) and accepted by Speybroeck et al. (2020), was renamed *A. finikensis* by Karakasi et al. (2021).
- Speybroeck et al. (2020) accepted evidence for a species-level split within *Podarcis peloponnesiacus* but as the new species resulting from the split had not been formally described, made no ruling. This has since been named as *Podarcis thais* (Kiourtsoglou et al., 2021).
- Speybroeck et al. (2020) accepted the recently-described *Podarcis guadarramae lusitanicus* pending the results of then-on-going research. The completed work (Caeiro-Dias et al., 2021) elevated *P. lusitanicus* to species status.
- Speybroeck et al. (2020) considered that recognising *Podarcis latastei* as a species distinct from *P. siculus* was “premature”. Subsequently, Castiglia et al. (2021) provided further arguments addressing their concerns and supporting recognition of *P. latastei*. This species is consequently recognised in the Red List pending an official ruling by the SEH but its taxonomic status remains in dispute.

The full species list used for this assessment, together with the Red List Categories and Criteria resulting from the project, is included in the [European Red List Data Repository](#).

Species introduced to Europe by humans after 1500 CE, a total of 21 species (Table 3), and two vagrant species (taxa found only occasionally in Europe) were assessed as Not Applicable (NA). The actual date of introduction of *Chamaeleo*

africanus is unclear and both that species and the vagrant *Trionyx triunguis* were treated as naturalised members of the European fauna in 2009. Both are treated here as NA in this reassessment. Six species whose occurrence is unconfirmed and/or have only a very marginal occurrence in Europe (corresponding to less than 1% of their global range) were also treated as NA. A full list of all excluded species is given in Table 3, below.



The La Gomera Giant Lizard (Gallotia bravoana) was thought to be extinct, but was rediscovered as a living animal in 1999, known only in the west of the island of La Gomera in the Canary Islands (Spain). © Miguel A. Carretero

Table 3. Reptile species found in Europe that were assessed as Not Applicable and excluded from analyses.

Group	Family	Species	Reason for exclusion
Lizards	ANOLIDAE	<i>Anolis carolinensis</i>	Recent introduction
	CHAMAELEONIDAE	<i>Chamaeleo africanus</i>	Introduced
		<i>Chamaeleo chamaeleon</i>	Marginal in Europe
	GEKKONIDAE	<i>Alsophylax pipiens</i>	Marginal in Europe
		<i>Tenuidactylus bogdanovi</i>	Recent introduction
		<i>Tenuidactylus caspius</i>	Recent introduction
	LACERTIDAE	<i>Anatololacerta finikensis</i>	Marginal in Europe
		<i>Darevskia armeniaca</i>	Introduced
		<i>Darevskia dahli</i>	Introduced or absent
		<i>Lacerta strigata</i>	Marginal in Europe
		<i>Parvilacerta parva</i>	Absent or introduced in Europe
		<i>Psammodromus blanci</i>	Only in Spanish North Africa
		<i>Scelarcis perspicillata</i>	Introduced
		<i>Timon tangitanus</i>	Absent or only in Spanish North Africa
	PHYLLODACTYLIDAE	<i>Tarentola substituta</i>	Introduced
	SCINCIDAE	<i>Chalcides parallelus</i>	Only in Spanish North Africa
	SPHAERODACTYLIDAE	<i>Saurodactylus mauritanicus</i>	Only in Spanish North Africa
	TROGONOPHIDAE	<i>Trogonophis wiegmanni</i>	Only in Spanish North Africa
Snakes	COLUBRIDAE	<i>Elaphe schrenckii</i>	Introduced
		<i>Hemorrhois algirus</i>	Introduced
		<i>Hemorrhois ravergeri</i>	Absent
		<i>Lampropeltis californiae</i>	Introduced
	TYPHLOPIDAE	<i>Indotyphlops braminus</i>	Introduced

Turtles	CHELYDRIDAE	<i>Chelydra serpentina</i>	Introduced
		<i>Macrochelys temminckii</i>	Introduced
	EMYDIDAE	<i>Pseudemys nelsoni</i>	Introduced
		<i>Chrysemys picta</i>	Introduced
		<i>Trachemys scripta</i>	Introduced
	GEOEMYDIDAE	<i>Mauremys caspica</i>	Introduced
		<i>Mauremys reevesii</i>	Introduced
		<i>Mauremys sinensis</i>	Introduced
	KINOSTERNIDAE	<i>Kinosternon subrubrum</i>	Introduced
	TRIONYCHIDAE	<i>Pelodiscus sinensis</i>	Introduced
		<i>Trionyx triunguis</i>	Vagrant

2.3. Assessment protocol

Assessments were based on the IUCN Red List Categories and Criteria Version 3.1 and the Guidelines for the application of the IUCN Red List Criteria at regional and national levels (IUCN 2012a,b, 2016), for which a correct interpretation of terms and application of criteria were ensured through training workshops.

The IUCN Species Information Service (SIS) online database was used to store relevant information for each species, based mostly on published data but also unpublished data and expert knowledge. This online database includes:

- Taxonomic classification and notes.
- Geographic range (Area of Occupancy, Extent of Occurrence).
- List of countries of occurrence.
- Population information and overall population trend.
- Habitat preferences and primary ecological requirements.
- Major threats.
- Conservation measures (in place and needed).
- Red List assessment.
- Key literature references.

For each species, a Red List Category is based on the selection of a set of standardised criteria and justified by an assessment rationale (IUCN 2012a,b). Population size reduction (Criteria A) and Geographic range (Criteria B) were the most often used criteria for assessing reptiles in Europe. Provisional assessments and the accompanying distribution maps for the lizards and snakes were compiled by the Coordinator of the IUCN SSC Snake and Lizard Red List Authority and then submitted to external scientists for an independent review and final agreement through a combination of an online workshop and email correspondence. Similar work was achieved for tortoises and freshwater turtles, their assessments being produced by Luca Luiselli with the support of experts and reviewed by the IUCN SSC Tortoise and Freshwater Turtle Specialist Group.

Consistency in the application of the IUCN Categories and Criteria was checked by the IUCN European Regional Office staff and the IUCN Red List Unit. The resulting finalised set of IUCN Red List assessments is a product of scientific consensus concerning species status supported by relevant literature and data sources.

2.4. Spatial analysis

Reptile species maps were created using distribution data available from published literature, internet sources, and several global and regional citizen science projects, and were evaluated and amended based on expert-provided feedback during the assessment process. The data available varied immensely in terms of quality; for some regions, distributional data were available as point locality data (latitude/longitude) or in grid cell format and were therefore spatially precise. Where point or grid data were available, these were projected in a Geographical Information System (GIS; ESRI ArcMap). Polygons were then drawn manually, clustering occurrence data where appropriate and selecting subcountry units (e.g. France – Corsica) or an entire country for species known to be present or extinct, but with no localised occurrence data.

The spatial analyses presented in this publication (see section 3.3) were analysed using a geodesic discrete global grid system, defined on an icosahedron, and projected to the sphere using the inverse Icosahedral Snyder Equal Area (ISEA) Projection (S39). This corresponds to a hexagonal grid composed of individual units (cells) that retain their shape and area (864 km²) throughout the globe.

These are more suitable for a range of ecological applications than the most commonly used rectangular grids (S40).

For the spatial analyses, species distributions with the following presence, origin and seasonality codes were included: presence = extant, possibly extinct; origin = native, reintroduced, assisted colonisation; and all seasonality codes (resident, breeding season, non-breeding, passage, seasonal occurrence uncertain) and converted to the hexagonal grid (see section 3.4). The occurrence information can be found [here](#). Polygons coded as 'possibly extant', 'extinct', 'presence uncertain', 'introduced', 'vagrant' and/or 'origin uncertain' were not considered in the analyses. Coastal cells were clipped to the coastline. Thus, patterns of overall species richness were mapped (Figure 4) by counting the number of species in each cell (or cell section, for species with a coastal distribution). Patterns of endemic species richness were mapped by counting the number of species in each cell (or cell section for coastal species) that were flagged as being endemic to geographic Europe as defined in this project (Figure 5). Patterns of threatened species richness (Categories CR, EN, VU at the European regional level) (Figure 6) were mapped by counting the number of threatened species in each cell or cell section.

Turtles and tortoises

Globally, turtles and tortoises are the most threatened major group of reptiles (Cox et al., 2022). In Europe disproportionately few species were found to be threatened at the European and EU levels, with only one of the seven native non-marine species (excluding the probably vagrant *Trionyx triunguis*), Hermann's Tortoise (*Testudo hermanni*) being listed Vulnerable and none in higher categories although two others are listed as nationally threatened in at least one range state.

Turtles are slow-growing, and so exhibit elevated sensitivity to sources of direct mortality compared with the majority of snakes and lizards. All three terrestrial species (the tortoises *T. hermanni*, *T. graeca* and *T. marginata*) are sensitive to impacts from fire, which can potentially deplete subpopulations within a matter of days and may be more severely affected by road mortality than other reptiles at least at local scales. In France, *T. hermanni* only remains in Corsica and in the Var and is most threatened by urbanization and increasing development of the Mediterranean coast. Population studies over the past 30 years have recorded consistent declines across subpopulations of this species in a range of habitat types, driven by a complex suite of pressures leading to both habitat loss and direct mortality. This species was uplisted from Near Threatened to Vulnerable on the basis that range-wide population declines are expected to have exceeded 30% over the past three generations and are likely to continue at a similar or increased rate (Luiselli, 2024).

Harvesting of animals for the pet trade has historically depressed subpopulations of at least some species (e.g. in the 1950s in the case of *Testudo marginata*), but all species of commercial interest are now widely captive bred. Most species are nonetheless subject to some degree of local collection for use as pets. Conversely, releases of captive Hermann's tortoise and the exotic common slider (*Trachemys scripta*) may be significant vectors of disease and promote genetic admixture between distinct evolutionary lineages for the native species.

Due to their close association with wetland habitats the four species of freshwater turtle are subject to different pressures from most European reptiles. Although habitat loss and degradation associated with agricultural and urban development are the major threats to turtles as a group, this is driven largely by water extraction and diversion. Water pollution, both eutrophication and pesticide runoff, is a potentially serious threat to the aquatic species, and *Mauremys rivulata* has been found to be most abundant in unpolluted waterbodies. Climate change-exacerbated drought is partly responsible for the loss of some *Mauremys leprosa* subpopulations in Spain, although habitat restoration and improvements in water quality have benefitted this species elsewhere in its Spanish range. Several invasive species – crayfish, crabs, and invasive fish and turtles – represent possible or active threats through either predation on young turtles or competition.



Hermann's Tortoise (*Testudo hermanni*). © Ulrich Schulte



< VULNERABLE >

VU

3. Assessment results

3.1. The threatened status of European reptiles

The status of reptiles was assessed at two regional levels: geographical Europe and the EU27. At the European regional level, a best estimate indicates that 12.9% of the 163 assessed reptiles for which sufficient data are available (i.e. excluding 8 species listed Data Deficient) are threatened (species assessed as CR, EN or VU), with 0.6% Critically Endangered, 5.8% Endangered, and 5.8% Vulnerable (see Table 4 and Figure 3a). Overall, approximately one-eighth of reptiles are considered threatened in Europe. A further 8.8% are considered Near Threatened, and just 4.7% are Data Deficient.

Within the EU27, the pattern is similar, with 13.7% of reptiles for which sufficient data are available are threatened, with 0.6% Critically Endangered, 5.6% of species listed as Endangered and 6.8% Vulnerable (see Table 4 and Figure 3b).

The species assessed as threatened at the European and EU27 levels are listed in Table 6. A further 34 reptile species were considered Not Applicable (NA): this group encompasses 22 alien species that were introduced or thought to have been introduced after 1500 CE and are therefore considered to be recent introductions; one species (*Trionyx triunguis*) is of uncertain and possibly vagrant occurrence; there are five species whose only recorded occurrence in the European region is in Spanish North Africa; and a further six species are included in the native European fauna (Table 3) but excluded from the assessment due to their marginal occurrence (<1% of their global distribution) in the European assessment region. These marginal occurrence species are *Chamaeleo chamaeleon*, *Alsophylax pipiens*, *Lacerta strigata*, *Anatololacerta finikensis*, *Hemorrhois ravergieri* and *Parvilacerta parva* (the latter two of which are unconfirmed but, if present at all, are very marginal).

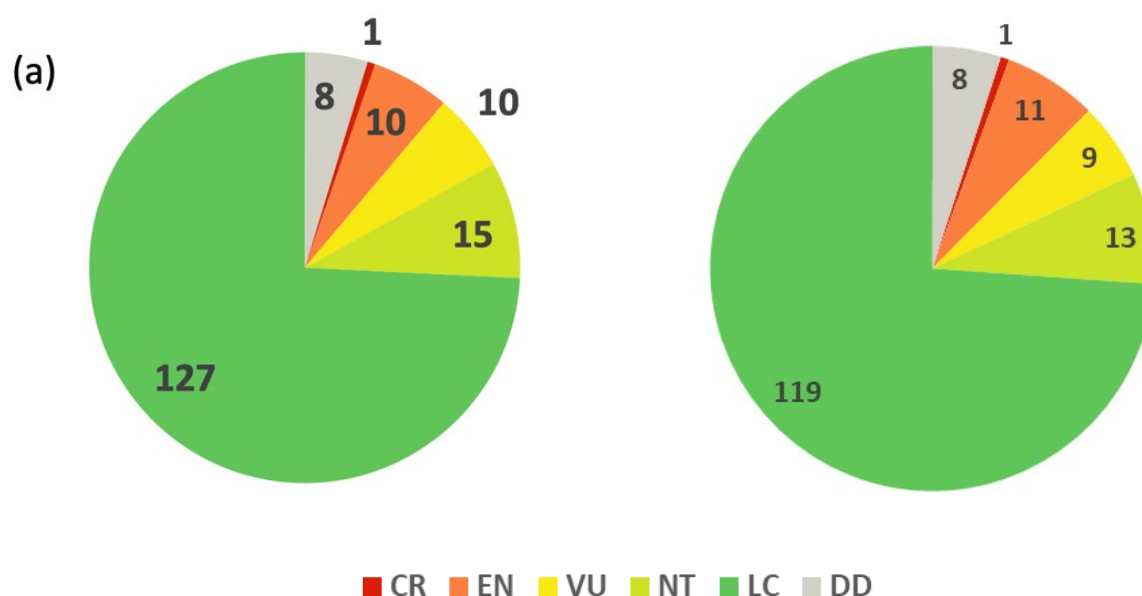


Figure 3. Red List status of reptiles in (a) Europe and (b) in the EU27 Member States, excluding NA species.

Eighteen of the 21 species threatened at the European level occur within the European Union, and all were assessed in the same category at both European and EU27 levels. Three species were assessed as Least Concern or Near

Threatened at the European level, but in threatened categories in the EU 27. All but two of the threatened species are endemic to Europe, and as a result threatened species represent a higher proportion (30%) of endemic reptiles.

Table 4. Threatened reptile species at the European and EU27 levels, with the first assessment (Cox and Temple, 2009) categories reported for comparison. Asterisks (*) mark species that are endemic to Europe.

Family	Species	Common English name	This report		First assessment (Cox and Temple, 2009)	
			Europe	EU27	Europe	EU27
Lacertidae	<i>Gallotia stehlini</i>	Gran Canaria Giant Lizard	CR*	CR*	LC	LC
Lacertidae	<i>Algyroides marchi</i>	Spanish Algyroides	EN*	EN*	EN	EN
Lacertidae	<i>Iberolacerta aurelioi</i>	Aurelio's Rock Lizard	EN*	EN	EN	EN
Lacertidae	<i>Iberolacerta martinezricai</i>	Peña de Francia Rock Lizard	EN*	EN*	CR	CR
Lacertidae	<i>Gallotia bravoana</i>	La Gomera Giant Lizard	EN*	EN*	CR	CR
Lacertidae	<i>Gallotia intermedia</i>	Tenerife Speckled Lizard	EN*	EN*	CR	CR
Lacertidae	<i>Podarcis pityusensis</i>	Ibiza Wall Lizard	EN*	EN*	NT	NT
Lacertidae	<i>Podarcis raffonei</i>	Aeolian Wall Lizard	EN*	EN*	CR	CR
Scincidae	<i>Chalcides sexlineatus</i>	Gran Canaria Skink	EN*	EN*	LC	LC
Viperidae	<i>Macrovipera schweizeri</i>	Cyclades Blunt-nosed Viper	EN*	EN*	EN	EN
Viperidae	<i>Vipera graeca</i>	Greek Meadow Viper	EN*	EN*	-	-
Agamidae	<i>Phrynocephalus helioscopus</i>	Sunwatcher	VU	-	-	-
Lacertidae	<i>Eremias velox</i>	Central Asian Racerunner	VU	-	LC	-
Lacertidae	<i>Gallotia simonyi</i>	El Hierro Giant Lizard	VU*	VU*	CR	CR
Lacertidae	<i>Podarcis carbonelli</i>	Carbonelli's Wall Lizard	VU*	VU*	EN	EN
Lacertidae	<i>Podarcis levendis</i>	Pori Wall Lizard	VU*	VU*	VU	VU
Testudinidae	<i>Testudo hermanni</i>	Hermann's Tortoise	VU*	VU	NT	NT
Viperidae	<i>Vipera aspis</i>	Asp Viper	VU*	VU	LC	LC
Viperidae	<i>Vipera latastei</i>	Lataste's Viper	VU*	VU*	VU	VU
Viperidae	<i>Vipera renardi</i>	Eastern Steppe Viper	VU	-	VU	-
Viperidae	<i>Vipera ursinii</i>	Meadow Viper	VU*	VU	VU	VU
Lacertidae	<i>Dinarolacerta mosorensis</i>	Mosor Rock Lizard	NT*	EN	VU	-
Emydidae	<i>Emys orbicularis</i>	European Pond Turtle	NT	VU	NT	VU
Lacertidae	<i>Eremias arguta</i>	Steppe-runner	LC	VU	NT	VU

Five species previously listed as either Least Concern or Near Threatened have undergone genuine population declines since the 2009 assessments sufficient to warrant listing them in more threatened categories. Except for the Central Asian Racerunner *Eremias velox*, all are endemic to Europe and are discussed in other sections of this report.

Twelve species previously assessed as threatened were reassessed in other categories; in all cases, these were nongenuine changes in status resulting from new information on the species'

distribution, population status or ecological tolerances, or determinations that the previously applied categories were incorrect (for instance, due to previous incorrect calculations of the extent of occurrence or area of occupancy).

One species, *Gallotia avaritae*, is known only from fossils and believed to have become extinct before 1500 CE and has been removed altogether from the Red List. It was included in the 2009 assessment based on a then-recent, dubious report of a photographed animal, which has since been considered a misidentification.

3.2. Status by taxonomic group

At the European regional level, threatened species belong to five of the 18 reptile families: the lizard families Agamidae and Lacertidae; the snake family Viperidae; and the turtle families Geoemydidae and Testudinidae.

All of these families are over-represented in the threatened categories compared with their representation in the European fauna as a whole. The greatest discrepancy exists in the vipers, of which 54.5% are threatened (Table 5). This family represents less than 7% of the assessed European reptiles but 26% of the threatened European reptiles. The majority of threatened

species belong to the large family Lacertidae. This group comprises 46.5% of the assessed reptiles at the European regional level, but 52.4% of threatened species including the sole Critically Endangered species and 8 of the 10 species listed as Endangered.

The remaining threatened species belong to families with small numbers of representatives in Europe. Three of the seven turtles (43%) are threatened at the regional level; another is threatened at the European Union level and only two are Least Concern.

Table 5. Red List status (excluding NA) of reptiles at the European level by taxonomic family.

Order	Family	Total	CR	EN	VU	NT	LC	DD	% of species in each family that are threatened
Squamata (Sauria)	Agamidae	5	0	0	1	0	4	0	20.0
	Anguidae	6	0	0	0	0	6	0	0.0
	Blaniidae	3	0	0	0	0	3	0	0.0
	Chamaeleonidae	0	0	0	0	0	0	0	0.0
	Gekkonidae	6	0	0	0	0	6	0	0.0
	Lacertidae	78	1	7	4	10	56	0	15.38

	Phyllodactylidae	5	0	0	0	0	5	0	0.0
	Scincidae	15	0	1	0	0	11	3	6.67
	Sphaerodactylidae	1	0	0	0	1	0	0	0.0
Squamata (Serpentes)	Erycidae	2	0	0	0	2	0	0	0.0
	Colubridae	24	0	0	0	1	20	3	0.0
	Psammophiidae	2	0	0	0	0	2	0	0.0
	Natricidae	5	0	0	0	0	5	0	0.0
	Typhlopidae	1	0	0	0	0	1	0	0.0
	Viperidae	11	0	2	4	1	4	1	54.5
Testudines	Emydidae	2	0	0	0	1	0	1	0.0
	Geoemydidae	2	0	0	0	1	1	0	0.0
	Testudinidae	3	0	0	1	1	1	0	33.3
Total		171	1	10	10	18	125	8	

3.3. Spatial distribution of species

3.3.1. Species richness

Information on the species richness of reptiles within orders and families has already been given in section 1.3 and Table 1. The geographic distribution of species richness in European reptiles is presented in Figure 4.

There is an obvious gradient of increasing species richness from north to south, with the greatest richness being found in the Balkan Peninsula. The glacial refugia of the Iberian, Italian and Balkan peninsulas are all important centres of diversity, as are a number of Mediterranean islands. Taxonomic changes since 2009 have not strongly affected this overall pattern but have resulted in a slight increase in the species richness of parts of the Iberian Peninsula.

3.3.2. Distribution of threatened species

The distribution of threatened reptiles in Europe (Figure 5) indicates little overlap between threatened reptiles, with no more than 3 species co-occurring and the pattern of threatened diversity being driven by areas in which a single species is threatened. Threatened species are found in most areas of southern and southwestern Europe. The highest concentration is found on the Italian peninsula and immediately adjacent areas, a region not identified as a hotspot of threatened reptile diversity in 2009.

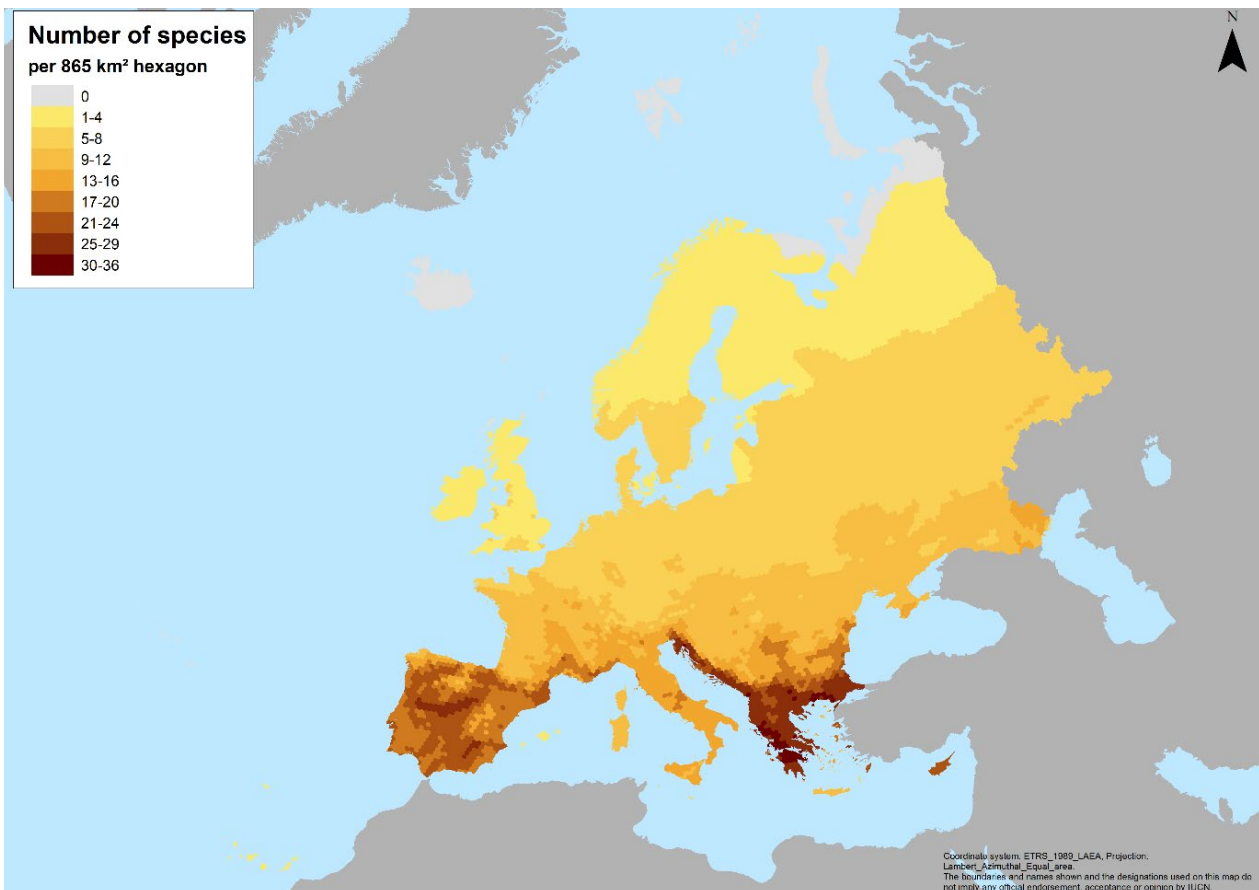


Figure 4. Overall species richness of European reptiles based on the data from the period 2009-2022. For all species richness maps (Figures 4, 5 and 6), the following presence, origin and seasonality codes were included: presence = extant, possibly extinct; origin = native, reintroduced, assisted colonisation; and all seasonality codes (resident, breeding season, non-breeding, passage, seasonal occurrence uncertain). For descriptions of these codes, see: www.iucnredlist.org/resources/mappingstandards

3.3.3. Endemic species richness

Figure 6 shows the distribution of endemic reptile species (those that are unique to Europe and are found nowhere else in the world). Reptiles show high endemic species richness throughout the Mediterranean, particularly on islands, the Peloponnese and the Balkan coast, and parts of the Iberian Peninsula. The Mediterranean islands and Macaronesian islands have many range-restricted endemic reptiles, although these regions do not show up on the endemic

species richness maps because typically each particular island will only have one or a few endemic species.

A small number of endemic species are now recognised from northern and central Europe, as a result of taxonomic changes affecting several widespread species previously thought to occur outside the continent, but now understood to be wide-ranging within but endemic to Europe such as the Slow Worm and European Grass Snake.

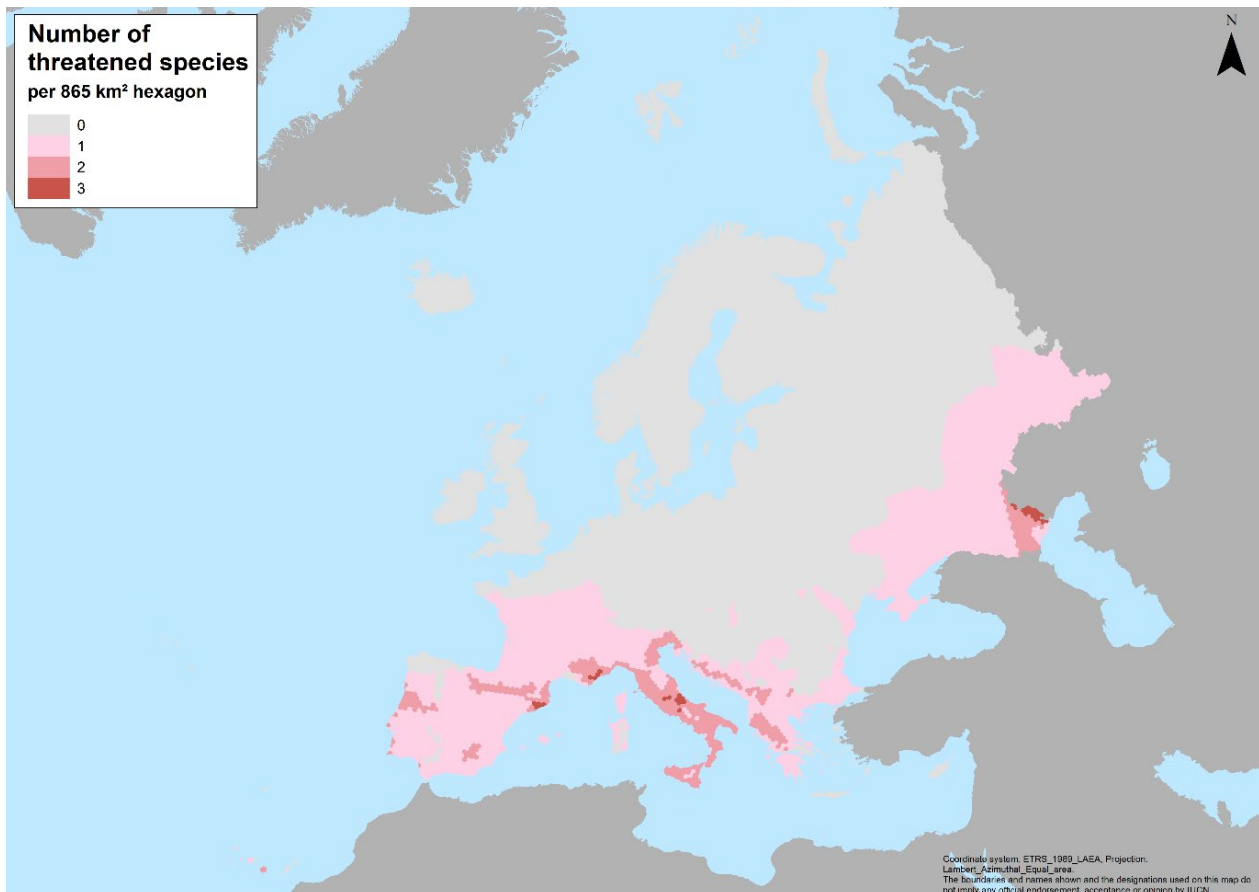
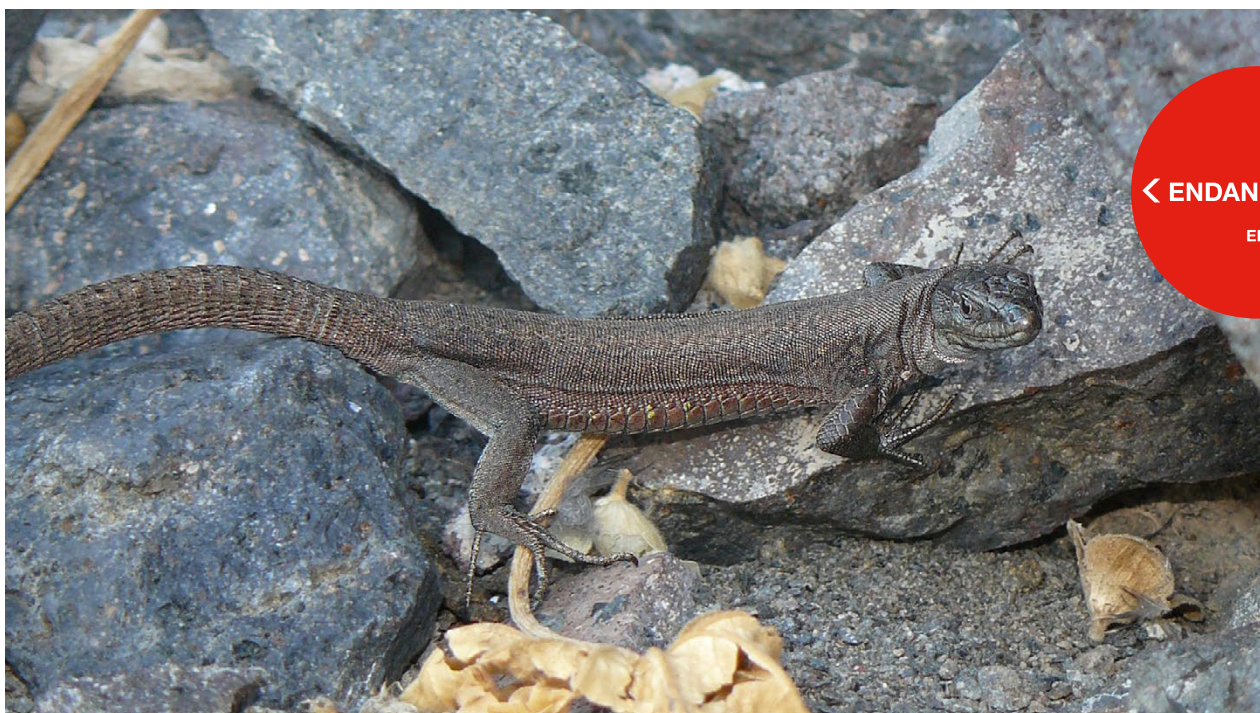


Figure 5. Threatened (CR, EN, VU) reptile species richness in Europe based on the data for the period 2009-2022.



The Aeolian Wall Lizard (*Podarcis raffonei*) is endemic to Europe, where it is restricted to the Aeolian Islands (Italy).
© Daniele Salvi

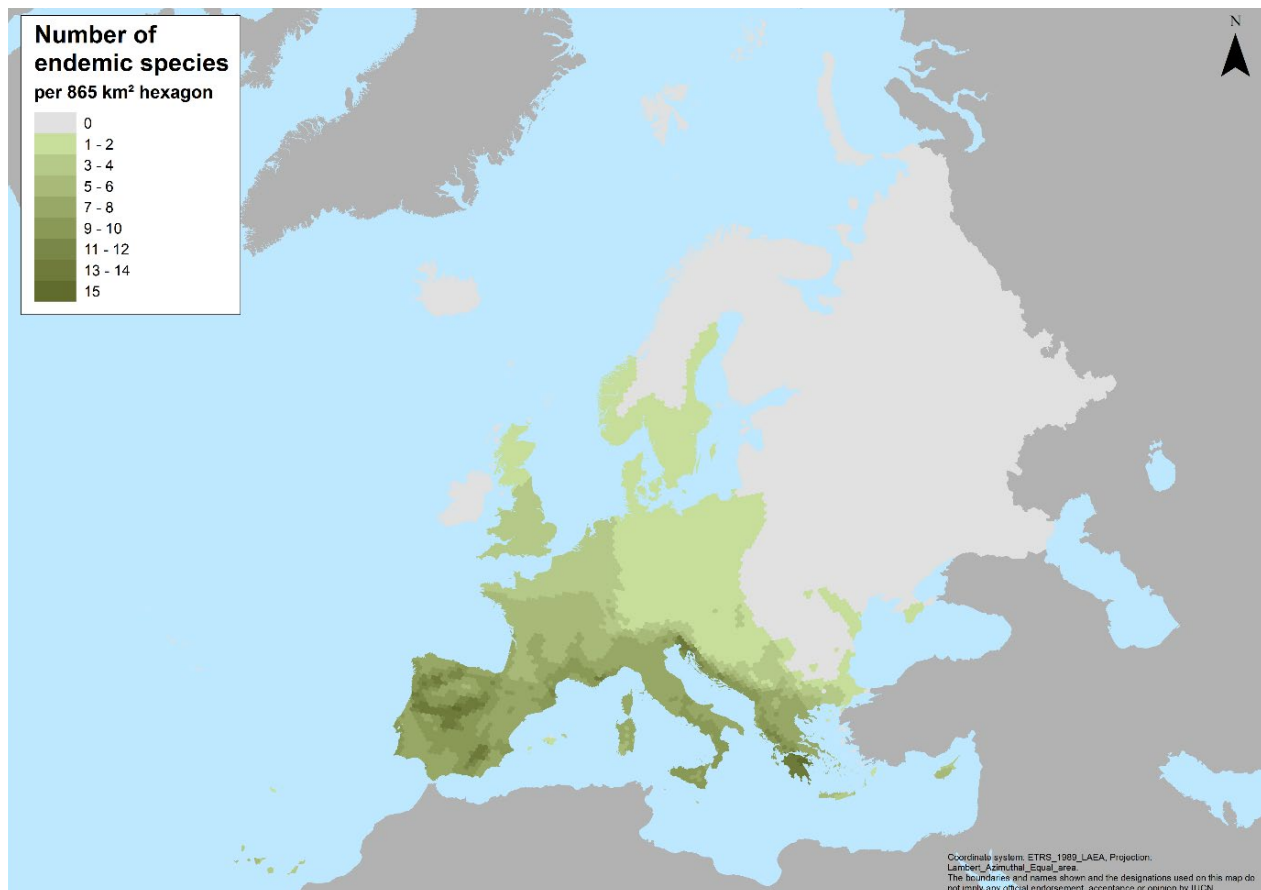


Figure 6. European endemic reptile species richness based on the data for the period 2009-2022.



Lindholm's Lizard (Darevskia lindholmi) is the only lizard species endemic to the Crimean Peninsula, where it is abundant in rocky habitats on the Crimean Peninsula. The Crimean Mountains are actively being developed by humans, but this species shows tendencies towards synanthropization. © Igor V. Doronin

3.3.4. Major threats to reptiles in Europe

Human activities resulting in habitat loss, fragmentation and degradation represent the major threats to European reptiles, as has previously been reported both in Europe (Cox and Temple, 2009) and globally (Cox et al., 2022). The primary drivers are agricultural intensification, principally for arable land and secondarily for livestock or plantations, for residential and commercial development, and for energy production (Figure 7). Although livestock grazing is a secondary driver of agricultural impacts on reptiles as a group and traditional grazing practices may benefit reptiles, when considering only threatened species, this threat affects the same number of threatened species as cropland agriculture. Development (often for tourism, including alpine ski resorts that threaten montane snakes and lizards) is a proportionately more significant threat to threatened species than to reptiles overall. Road and other transport infrastructure is often a threat associated with development activities. This is due primarily to degrading and fragmenting habitat, but direct mortality on roads can be significant. For example, roadkill (traffic-related mortality) resulted in a mean annual mortality estimated at 10% of the total population of the Endangered Cyclades Blunt-nosed Viper (*Macrovipera schweizeri*) between 1993 and 2006, before an agreement was reached to limit traffic during peak activity periods. Road mortality is also likely to have an important local impact on some subpopulations of Hermann's Tortoise *Testudo hermanni*.

Invasive species are a significant threat to European reptiles, especially impacting lizards. A total of 13 threatened species are impacted by “invasive and other problematic species”, the latter encompassing animals expanding their ranges into the assessed species' habitat with the potential for competitive displacement. The impacts of invasives — which can be especially pronounced on islands — have been more rapid and extreme than other threats. In the most extreme case, the introduction of the California Kingsnake *Lampropeltis californiae* on Gran Canaria has driven the Gran Canaria Giant Lizard (*Gallotia stehlini*) from Least Concern to Critically Endangered since the

2009 assessment (Box 1). This is a threat that has genuinely increased since the 2009 assessment, now ranking as the third most widespread threat to European reptiles overall, with several new invasions and range expansions of exotic species documented. These include those of the California Kingsnake to Gran Canaria and the Horseshoe Whipsnake *Hemorrhois hippocrepis* to Ibiza (Box 1). The latter, introduced accidentally with imported ornamental trees in or before 2003, has rapidly expanded its range on the island since 2010, leading to a decline of more than 50% in the population of the endemic Ibiza Wall Lizard *Podarcis pityusensis* and driving one subspecies to extinction.

The major invasive threats to European reptiles are snakes, which prey directly on the animals, but invasive lizards also pose a threat to island endemics through competition for habitat and resources. Predation by Wild Boar is a threat to several species in areas of western Europe where Boar populations are on the increase, and large-scale releases of Pheasants for sport have been associated with local declines in a number of snakes and lizards, including the Adder *Vipera berus*. Competition from introduced fish is a possible threat to the Sicilian Pond Turtle *Emys trinacris*, as significant differences in the turtle's abundance have been recorded in ponds with or without these exotic species.

The incidence of wildfire is increasing in Europe and is recognised as a threat to numerous reptiles, although impacts on reptiles remain largely unstudied and at least one lizard (*Psammotromus algirus*) in which the impacts of fire has been studied exhibits the ability to recolonise areas rapidly following burning. Fire is identified as a particular impact to several species restricted to Greek islands, including as an important secondary threat to the Cyclades Blunt-nosed Viper. Conversely, a number of Mediterranean reptiles may benefit from fire when it slows the regrowth of forests. Natural succession (coded in Figure 7 as ‘Natural system modifications – Other ecosystem modifications’) impacts several species, as areas formerly subject to grazing or traditional agricultural use have been abandoned. The resulting encroachment by woody vegetation is a threat, for instance, to formerly grazed prealpine wetlands

that are important for *Zootoca carniolica* and to montane meadows favoured by the Vulnerable Meadow Viper *Vipera ursinii*.

Persecution is a widespread, if generally secondary, threat to snakes in Europe as it is in much of the world, and the major activity encompassed by 'Hunting and trapping terrestrial animals' in Figure 7. Additionally, a number of reptiles are subject to wild collection for the pet trade, which is also the ultimate source of several reptile introductions to Europe including the Green Anole, the California Kingsnake, and all exotic species of turtle. Harvesting for the pet trade has exerted significant pressure on certain subpopulations of the Meadow Viper.

Climate change impacts on reptiles are believed to have been under-recorded in past Red List

assessments (Cox et al., 2022). The combined direct impacts of climate change (encompassing habitat change, drought, temperature extremes and storms) were identified as an ongoing or future threat to 44 European species (see Box 2), in addition to the contribution climate change makes to threats from fire and range expansions of competitive or predatory species.

Pollution is a recorded threat to numerous reptiles, in most cases from agricultural runoff or pesticide use. The impacts of pollution on snakes and lizards remain poorly studied (Bowles, 2023), but as currently understood the number of threatened species impacted by pollution in Europe is disproportionately low and in no case is pollution considered the major threat.

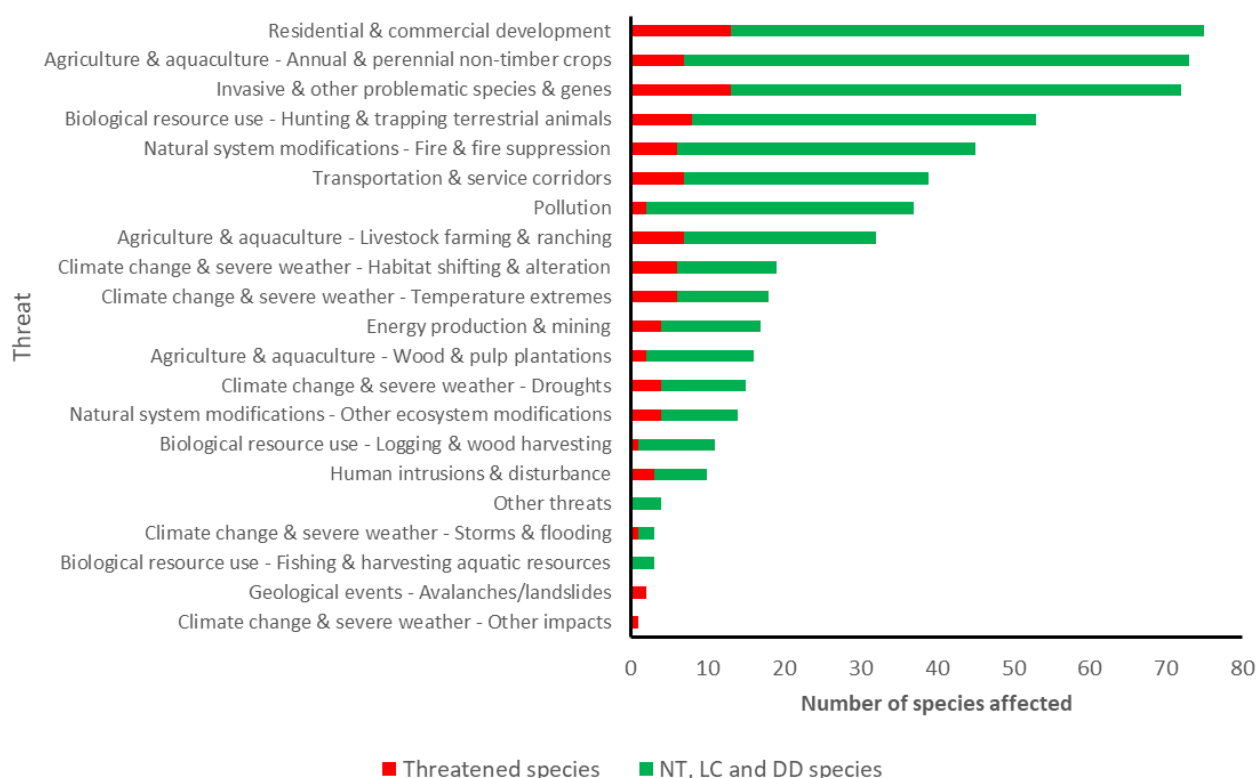


Figure 7. Major threats to reptiles in Europe based on the most recent assessments of European reptiles.

Invasive snakes on Gran Canaria



The Gran Canaria Giant Lizard (*Gallotia stehlini*), endemic to Gran Canaria. This species was formerly abundant and is still common in parts of the island where invasive snakes are absent. It has undergone a decline greater than 50% since 2007 and is projected to decline by more than 80% over the next three generations by which point the snake is likely to occur island wide. © Miguel A Carretero.

Invasive snakes represent a severe, recently-emerged threat to a number of European island lizards. The California Kingsnake, a widely-kept pet first recorded in the wild on Gran Canaria in 1998, began a rapid expansion of its range on the island in 2007 and was found in approximately 50% of the island by 2020. It is likely that it will ultimately colonise all but the most inaccessible parts of the island, with its range expansion potentially facilitated by climate change.

As a hunter, the snake naturally feeds primarily on surface-active lizards, and all three lizards native to this naturally snake-free island have undergone strong declines over a period of approximately 15 years. The most severely impacted has been the Gran Canaria Giant Lizard *Gallotia stehlini*, a slow-growing, diurnal species that reaches maturity at 4-5 years of age. Although the largest animals may be too large to be consumed, studies in areas invaded by the snake indicate that mortality of juveniles is almost complete following snake invasion, and only large individuals are now observed. This suggests that the species is functionally extinct everywhere the snake has now become established.

The Gran Canaria Skink *Chalcides sexlineatus* and Boettger's Wall Gecko *Tarentola boettgeri* both persist in areas invaded by the snake, but at less than half their density in uninvaded areas. Although the Gecko is found elsewhere in the Canary Islands, both the Skink and the Giant Lizard are endemic to Gran Canaria. All three species were listed Least Concern in 2009. The Gran Canaria Giant Lizard is now Critically Endangered, and the Skink Endangered, entirely as a result of the invasive species.

3.4. Population trends

Documenting population trends in reptiles is complicated by the lack of dedicated long-term monitoring programmes focused on this group of animals and in many cases, especially for most snake species, low detectability. Significantly, the population trend of nearly one-third (33.8%) of all species assessed is unknown (Figure 8). In common with general trends in biodiversity, it is likely that ongoing large-scale habitat destruction and degradation, amongst other threats, is resulting in hidden declines in the population of many of these species.

Almost exactly two-fifths (40.6%) of European reptiles are believed to have stable populations and only 1% are believed to be increasing (Figure 8).

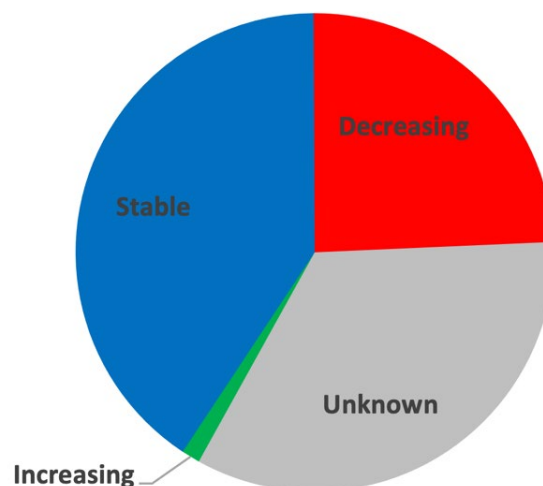


Figure 8. The population trend of reptile species in Europe over the period 2009-2023. NA species are excluded.

3.5. Gaps in knowledge

In all, eight species were assessed as Data Deficient (DD), all of which are known in Europe only from islands and most of which occur outside the continent. The most common reason for this is a lack of European material: half of these species are known from between one and nine European specimens, all from Cyprus.

One species known in Europe only from an island is the False Smooth Snake *Macropododon cucullatus* on Lampedusa (Italy). It is thought likely to be in decline as a result of human activities on the island. Nonetheless, neither the impacts of these nor whether it is genuinely native to the island are known sufficiently well to determine its risk of extinction, and it is believed that this is most likely an introduced species in the European region, native to northern Africa and the eastern Mediterranean.

In the case of the endemic Sicilian Pond Turtle *Emys trinacris*, the species itself is moderately well-known, however, data are insufficient to

determine key metrics needed to assess its risk of extinction – in particular, the extent of population decline over the past three generation length period – and so determine an appropriate Red List Category, with the result that it could conceivably be anywhere from Least Concern to Critically Endangered. Additionally, the possible impacts of climate change on this species and its habitat are in need of further study. However, the taxonomic identity of the species requires confirmation.

The rarely-observed endemic East Canarian Skink *Chalcides simonyi* was previously considered to be Endangered due to inferred association with well-formed soils to which threats exist from climate change and soil erosion. Subsequent research suggests that it may be less dependent on these habitats than previously believed and that it could be more abundant in stony areas where it is not expected to be threatened but is likely harder to detect.

Rates of decline in widespread snakes can be especially difficult to characterise due to a combination of the animals' elusive nature, the relatively low numbers of studies, and geographical differences in data availability, and this is further complicated in accurately characterising natural generation lengths in even relatively well-known species such as the Adder *Vipera berus* and Asp Viper *Vipera aspis*. It can also be unclear how long declines have been ongoing: the

Asp Viper was listed as Vulnerable on the basis of long-term studies that suggest a range-wide decline of more than 30% is likely to have taken place over the past three generations, and this is thought to have been a genuine deterioration since the 2009 assessment. It is however possible that the species would have warranted a threatened listing in the earlier assessment had comparable data been available.



The East Canary Skink (*Chalcides simonyi*) is endemic to Fuerteventura (the Canary Islands, Spain). Both its ecology and its sensitivity to possible threats are poorly understood. © Miguel A. Carretero

4. Conservation measures

4.1. Comparison with the previous *European Red List of Reptiles*

Compared to the previous assessments (Cox and Temple, 2009), more species were assessed in this reassessment as shown in Table 6. At the European level, 171 species were assessed in 2022 compared to 161 species previously, whilst for the EU region 139 species were assessed compared with 128 species in 2009. Taxonomic revision explains the majority of this increase in the number of species, with about 30 recently described or elevated species, mostly within the EU. The accession of Croatia to the EU since the first assessment likely added the remainder of the additional species found at the EU level, such as the Balkan endemic Sharp-snouted Rock Lizard *Dalmatolacerta oxycephala*. The departure of the United Kingdom did not remove any species from the EU reptile fauna. The number of Critically Endangered species has decreased from six to one, and the number of Endangered species has decreased from 11 to 10 at the European level (Table 6). All changes were

the result of ‘nongenuine’ changes in status (the result of new or better information on a species, or cases where the Criteria were found to have been applied incorrectly previously) rather than any actual improvement in these species’ conservation status.

A lower proportion of the fauna was found to be threatened at both European (13.7 in this analysis vs. 21.4% in 2009) and EU (12.9 vs. 19.7%) in the current work. This is a consequence of the larger number of Least Concern species in the current dataset, while the number of threatened species has remained similar, and does not reflect an improvement in the overall status of European reptiles.

As mentioned previously in section 3.5, 41% of European reptiles are believed to have stable populations, a proportion unchanged since 2009.

Table 6. The number of reptile species in each Red List Category in 2009 (Cox and Temple, 2009) and in this reassessment. Not Applicable species are excluded here.

IUCN Red List Categories		Number of species in Europe		Number of species in EU 27	
		2022	2009	2022	2009
Extinct (EX)		—	—	—	—
Extinct in the Wild (EW)		—	—	—	—
Regionally Extinct (RE)		—	—	—	—
Threatened categories	Critically Endangered (CR)	1	6	1	6
	Endangered (EN)	10	11	11	11
	Vulnerable (VU)	10	10	9	10

Near Threatened (NT)	15	18	13	16
Least Concern (LC)	127	92	119	83
Data Deficient (DD)	8	2	8	2
Total number of species assessed	171	139	161	128

Two species that were considered valid taxonomically but considered Not Applicable (NA) or Not Evaluated (NE) in 2009 were included and assessed in this reassessment:

- *Blanus strauchi*: Considered NA on the basis of marginal occurrence in 2009. A taxonomic change to this species has removed it from most of its former distribution outside Europe and as a result, the European range now represents more than 1% of the global range, and it is considered LC for Europe and the EU27.
- *Zamenis hohenackeri*: In 2009, this species was Not Evaluated as its presence in Europe was not confirmed at the time, with possible presence only on a small Greek island near the Turkish coast. This species was reported from Cyprus after the 2009 assessment, although from an older museum record. It remains known on the island only from one specimen and is assessed as Data Deficient, however, its occurrence on this large island suggests that its potential European range may be more than 1% of the global distribution.

4.2. Conservation management of reptiles in the EU

As listed in Appendix 1, many species (over a third of the total number of European reptile species) are included in either the Bern Convention, the Habitats Directive, or both. For the most part, the most effective action that can be taken to protect reptiles is the preservation of their habitats, and reptiles were a named focal group in, for example, the EU LIFE project **Re-creating habitat complexity for semi-aquatic fauna** (SemiAquaticLife, [LIFE14 NAT/SE/000201](#)), although wetland reptile diversity is very limited in that project's targeted areas of northern Europe.

Species-specific management for European reptiles has been targeted mainly at threatened island species, including habitat restoration, reintroduction and control of invasive species. Past EU LIFE projects have aimed to conserve the El Hierro Giant Lizard *Gallotia simonyi*, with at least one successful reintroduction ([LIFE97 NAT/E/004190](#)), and unsuccessfully to control the California Kingsnake on Gran Canaria. The Aeolian Wall Lizard *Podarcis raffonei* is the target of an ongoing project (2023-2028) that is planned to include captive breeding, habitat restoration, control of invasive rats and competing lizard species, and reintroduction ([LIFE22-NAT-IT-LIFE-EOLIZARD/101114121](#)).



*The Meadow Viper (*Vipera ursinii*) is one of the most threatened snakes in Europe and has been the subject of several EU LIFE projects, as well as ongoing conservation-focused research and management. It nevertheless remains poorly-represented in protected areas and its conservation action plan is under review. © Emanuele Santarelli*

There have also been multiple efforts aimed at the conservation of the Meadow Viper *Vipera ursinii*, which as one of the most threatened reptiles in Europe is also included in several national conservation efforts and protected area management plans. The Hungarian Meadow Viper (*Vipera ursinii rakosiensis*) was targeted by three successful LIFE projects in Hungary; *Establishing the background of saving the Hungarian meadow viper (*Vipera ursinii rakosiensis*) from extinction* (HUNVIPURS - [LIFE04 NAT/HU/000116](#)), *Conservation of Hungarian meadow viper (*Vipera ursinii rakosiensis*) in the Carpathian-basin* (CONVIPURSAK - [LIFE07 NAT/HU/000322](#)), and *Viability improvement of Hungarian meadow viper populations and habitats in the Pannonian region* (HUNVIPHAB

- [LIFE18 NAT/HU/000799](#)). The projects included large-scale habitat restoration efforts, as well as captive breeding and reintroductions in multiple locations, which are showing promising results in strengthening or restoring local populations (Halpern et al., 2024).

Efforts to control invasive species and to ensure that no new invasives become established, including improving quarantine procedures for the ornamental plant trade, are critical to the survival of several Mediterranean island lizards. Ensuring that the California Kingsnake is unable to colonise other islands in the Canary Archipelago is important to prevent declines and possible extinctions of lizards on these islands.

4.3. Red List status versus priority for conservation action

Targeted conservation management for reptiles is limited. It should primarily focus on the conservation of the specific habitats of the species and not on the species itself, in contrast to some large birds and mammals. Some species are protected under the European Union's Habitats Directive and there are efforts to protect these species in several countries, and listing under the Habitat Directive opens up access to funding schemes such as LIFE. In many cases, protected species are merely monitored. Additionally, the occurrence of rare reptile species is taken into account in the management of nature reserves in countries such as in Germany by maintaining open heath and peat land for example.

Several habitat types that harbour reptiles that need protection are listed in the Habitats Directive and therefore are managed to maintain or improve this habitat. These include several types of management measures, such as removing trees to maintain open habitats and increasing structural diversity within habitats.

- Conservation, development, maintenance and connection of habitats and habitat complexes in open landscapes (e.g. meadows, grasslands, edges, heaths, peats) as well as structurally rich clearings, outer and inner edges of forests.
- Re-establishment of river dynamics with sediment erosion and aggradation as well as landscape dynamics in forests and on rocky slopes.
- Conservation and restoration of structurally rich wetlands.
- Conservation and reptile-friendly maintenance of linear landscape structures (railway embankments, road and path edges, power lines and cable routes, fire protection strips in forests) as habitats and as connectivity and dispersal axes.
- Conservation of specific structures, e.g. stone walls, stone piles and dead wood in open land biotopes.

Climate change and montane lizards: case study of the European endemic genus *Iberolacerta*

This group of cold-adapted lizards is likely to have been undergoing gradual decline and range contraction resulting from climatic changes since the last Ice Age. Seven of the eight species are considered to be threatened by human-induced climate change, through the combined effects of direct temperature increases and habitat shifts characterised by an increase in vegetation cover that will reduce the availability of basking sites and result in overgrowth of the open rocky and gravelly habitats on which the species depend.

Experimental translocation of the central Pyrenean *I. bonnali*, one of the species with the widest thermal ranges, to lower elevations indicated that it exhibits reduced performance at least in conditions currently prevailing below 500 m asl. Even limited exposure to temperatures in excess of 40 °C have been found to be lethal to members of this genus and temperatures close to this have recently been recorded on Peña de Francia, to which *I. martinezricai* is almost endemic, and this species may already be confined to a habitat at the limit of its thermal range. Similarly, mountain summit subpopulations of *I. aranica* and *I. aurelioi* may be on the verge of imminent extinction.

An indirect consequence of these ecological changes may be the range expansion of the adaptable Common Wall Lizard *Podarcis muralis*, which has a projected elevational range expansion of as much as 500 m upslope based on expected average temperature increases in France and has established numerous expanding populations (Schulte et al., 2012; While et al., 2015). Italian *P. muralis* introduced to England responded to lower soil temperatures by delaying egg laying, leading to significant survival advantages for the offspring. This enables the species to spread into regions that would not be colonizable with the incubation period of the native range. As a potential competitor this species may contribute to increased mortality in species such as *Iberolacerta aranica* and *I. aurelioi* and the life history of this genus – characterised by low fecundity and so reliance on high juvenile survivorship – is likely to make *Iberolacerta* highly sensitive to any pressures that increase mortality. Several other species that do not presently represent major competitors may become so as a result of climate change-induced habitat shifts, such as *Podarcis guadarramae*. Although most species of *Iberolacerta* are presently widespread and abundant where temperature regimes remain suitable, two are now listed as Endangered and three as Near Threatened.



Aurelio's Rock Lizard (Iberolacerta aurelioi) is known from a restricted area of the Pyrenees in the France-Andorra-Spain border region between 1,960 and around 3,000 m asl. It is subject to a primary ongoing threat from climate change, exacerbated by development of ski resorts and hydroelectric power. © Benny Trapp



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5. Recommendations

5.1. Recommended actions

No species was found to have experienced a genuine improvement in its Red List status in the years between the 2009 assessment and the current work, and it is consequently clear that conservation efforts over this period have not been sufficient to protect this group of animals.

The Red List assessments resulting from this project include species-specific recommendations for conservation and research where relevant for both threatened and non-threatened species. For the conservation of threatened reptiles in Europe, as in other parts of the world, the most effective measures are ensuring appropriate land management and the control of invasive species and preventing further introductions, especially on islands.

The European region, and especially the European Union, has a strong legislative framework for the protection of wildlife, which

potentially provides for effective measures to conserve a number of the continent's reptiles, however, it needs to be applied with greater consistency. The effectiveness of interventions and protections needs to be monitored, and both successes and failures accurately reported. Reporting under the Habitats Directive should reflect the latest understanding of reptile taxonomy as a means of ensuring effective conservation and monitoring.

For species assessed as Near Threatened and Data Deficient in particular, targeted research and conservation are needed to ensure that these species do not warrant listing in a threatened category in future. As shown most drastically in the case of the Gran Canaria Giant Lizard, however, species assessed as Least Concern may also be susceptible to rapid changes in status if appropriate actions are not taken to prevent this outcome.

5.2. Application of project outputs

Red Lists are a dynamic tool that will evolve over time as species are reassessed according to new information, situations, or changed taxonomic arrangements. By making this report and the underlying data widely and freely available, we hope to stimulate and support research, monitoring, and conservation action at local, regional

and international levels. All assessments and distribution data species included in this project will be included in the IUCN Red List (www.iucnredlist.org) and the data made available in the IUCN Red List Data Repository (www.iucn-redlist.org/resources/data-repository).

5.3. Future work

The taxonomy of many of Europe's reptiles is now believed to be well-resolved, but further taxonomic changes are inevitable. Research is needed to ensure that the entities assessed for the Red List accurately reflect evolutionary history and to ensure that conservation needs are

accurately identified to maximise the preservation of biodiversity.

Climate change is recognised as a threat to more species than was the case in 2009, however, in many cases, impacts remain unclear or are projected into the future. Research is needed

to corroborate these predictions and to identify the full extent and nature of climate change impacts on reptiles as well as to identify appropriate strategies for mitigation.

A robust Europe-wide monitoring programme is required for reptiles in order to understand population trends and reveal population declines, for example resulting from the impacts of novel diseases and invasive alien species.



The European Pond Turtle (Emys orbicularis) is considered to be in significant decline. This species is quite tolerant of habitat modifications, and can be observed also in suburban and relatively polluted sites. Despite this, habitat loss (e.g. linked to wetland drainage) remains a great threat to its survival.

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Appendices

Appendix 1.

Overview of European reptile species mentioned in EU and international policy instruments; the Bern Convention, the EU Habitats Directive, and the EU wildlife trade regulations. All reptile species and infrataxa not included in Appendix II of the Bern Convention are considered to be included in Appendix III.

Species	Habitat Directive	Bern Convention	CITES	EU Wildlife Trade regulations	Endemic to Europe	Assumed to have inherited listing from parent taxon
<i>Ablepharus budaki</i>		III				
<i>Ablepharus kitaibelii</i>	II, IV	II				
<i>Acanthodactylus erythrurus</i>		III				
<i>Acanthodactylus schreiberi</i>		III			Yes	
<i>Algyroides fitzingeri</i>	II, IV	II			Yes	
<i>Algyroides marchi</i>	II, IV	II			Yes	
<i>Algyroides moreoticus</i>	II, IV	II			Yes	
<i>Algyroides nigropunctatus</i>	IV	II			Yes	
<i>Alsophylax pipiens</i>		III				
<i>Anatololacerta anatolica</i>		III				
<i>Anguis cephallonica</i>		III [as <i>Anguis cephallonicus</i>]			Yes	
<i>Anguis colchica</i>		Bern III [component of <i>Anguis fragilis</i>]				
<i>Anguis fragilis</i>		III			Yes	
<i>Anguis veronensis</i>		III			Yes	

Species	Habitat Directive	Bern Convention	CITES	EU Wildlife Trade regulations	Endemic to Europe	Assumed to have inherited listing from parent taxon
<i>Archaeolacerta bedriagae</i>	IV [as <i>Lacerta bedriagae</i>]	II, III [as <i>Lacerta bedriagae</i>]			Yes	
<i>Blanus cinereus</i>		III			Yes	
<i>Blanus strauchi</i>		III				
<i>Chalcides bedriagai</i>	IV	II			Yes	
<i>Chalcides chalcides</i>		III				
<i>Chalcides coeruleopunctatus</i>		III			Yes	
<i>Chalcides ocellatus</i>	II, IV	II				
<i>Chalcides parallelus</i>		III				
<i>Chalcides sexlineatus</i>	IV	II			Yes	
<i>Chalcides simonyi</i>	II, IV [as <i>Chalcides occidentalis</i>]	II, III, Revised I [as <i>Chalcides occidentalis</i>]			Yes	
<i>Chalcides striatus</i>		III			Yes	
<i>Chalcides viridanus</i>	II, IV	II			Yes	
<i>Chamaeleo africanus</i>		II	II	B		
<i>Chamaeleo chamaeleon</i>	II, IV	II	II	A		
<i>Chelydra serpentina</i>			II	B		
<i>Chrysemys picta</i>				B		
<i>Coronella austriaca</i>	II, IV	II				
<i>Coronella girondica</i>		III				
<i>Dalmatolacerta oxycephala</i>	II, IV	III			Yes	
<i>Darevskia armeniaca</i>		III [as <i>Lacerta armeniaca</i>]				
<i>Darevskia lindholmi</i>		III			Yes	
<i>Darevskia praticola</i>		III [as <i>Lacerta praticola</i>]				
<i>Dinarolacerta mosorensis</i>	II, IV	III			Yes	
<i>Dinarolacerta montenegrina</i>	II, IV [as <i>Dinarolacerta mosorensis</i>]	III [as <i>Dinarolacerta mosorensis</i>]			Yes	

Species	Habitat Directive	Bern Convention	CITES	EU Wildlife Trade regulations	Endemic to Europe	Assumed to have inherited listing from parent taxon
<i>Dolichophis caspius</i>	IV	II [as <i>Coluber caspius</i>]				
<i>Dolichophis jugularis</i>	IV [as <i>Coluber jugularis</i>]	II [as <i>Coluber jugularis</i>]				
<i>Eirenis modestus</i>	IV [as <i>Eirenis modesta</i>]	III				
<i>Elaphe dione</i>		III				
<i>Elaphe quatuorlineata</i>	II, IV	II			Yes	
<i>Elaphe sauromates</i>	II, IV	II				
<i>Emys orbicularis</i>	II, IV	II, Revised I	III	C		
<i>Emys trinacris</i>	IV	II, Revised I			Yes	
<i>Eremias arguta</i>		III				
<i>Eremias velox</i>		III				
<i>Eryx jaculus</i>	II, IV	II	II	A		
<i>Eryx miliaris</i>		III	II [as Boidae spp.]	B [as Boidae spp.]		
<i>Euleptes europaea</i>	II, IV [as <i>Phyllodactylus europaeus</i>]	II, Revised I [as <i>Phyllodactylus europaeus</i>]				
<i>Eumeces schneiderii</i>		III				
<i>Gallotia atlantica</i>	II, IV	III			Yes	
<i>Gallotia bravoana</i>		III			Yes	
<i>Gallotia caesaris</i>		III			Yes	
<i>Gallotia galloti</i>	II, IV	II			Yes	
<i>Gallotia intermedia</i>		III			Yes	
<i>Gallotia simonyi</i>	II, IV	II, Revised I	I	A	Yes	
<i>Gallotia stehlini</i>	II, IV	II			Yes	
<i>Hellenolacerta graeca</i>	IV [as <i>Lacerta graeca</i>]	II [as <i>Lacerta graeca</i>]			Yes	
<i>Hemidactylus turcicus</i>		III				

Species	Habitat Directive	Bern Convention	CITES	EU Wildlife Trade regulations	Endemic to Europe	Assumed to have inherited listing from parent taxon
<i>Hemorrhois hippocrepis</i>	IV [as <i>Coluber hippocrepis</i>]	II, III [as <i>Coluber hippocrepis</i>]				
<i>Hemorrhois nummifer</i>	IV [as <i>Coluber nummifer</i>]	III [as <i>Coluber nummifer</i>]				
<i>Hemorrhois ravergieri</i>		III				
<i>Heremites auratus</i>		III [as <i>Mabuya aurata</i>]				
<i>Heremites vittatus</i>		III [as <i>Mabuya vittata</i>]				
<i>Hierophis cypriensis</i>	II, IV [as <i>Coluber cypriensis</i>]	II, III, Revised I [as <i>Coluber cypriensis</i>]			Yes	
<i>Hierophis gemonensis</i>	IV	III			Yes	
<i>Hierophis viridiflavus</i>		III [as <i>Coluber gyarusensis</i>]			Yes	
<i>Iberolacerta aranica</i>	II, IV	III			Yes	
<i>Iberolacerta aurelio</i>	II, IV	III [as <i>Lacerta aurelio</i>]			Yes	
<i>Iberolacerta bonnali</i>	II, IV [as <i>Lacerta bonnali</i>]	III, Revised I [as <i>Lacerta bonnali</i>]			Yes	
<i>Iberolacerta cyreni</i>		III			Yes	
<i>Iberolacerta galani</i>		III			Yes	
<i>Iberolacerta horvathi</i>	IV [as <i>Lacerta horvathi</i>]	II [as <i>Lacerta horvathi</i>]			Yes	
<i>Iberolacerta martinezricai</i>		III			Yes	
<i>Iberolacerta monticola</i>	II, IV [as <i>Lacerta monticola</i>]	II [as <i>Archaeolacerta monticola</i>] III, Revised I [as <i>Lacerta monticola</i>]			Yes	
<i>Kinosternon subrubrum</i>			II	B		
<i>Lacerta agilis</i>	II, IV	II				
<i>Lacerta bilineata</i>	IV	III			Yes	
<i>Lacerta diplochondrodes</i>	IV [as <i>Lacerta trilineata</i>]	II [as <i>Lacerta trilineata</i>]				
<i>Lacerta schreiberi</i>	II, IV	II, Revised I			Yes	
<i>Lacerta strigata</i>		III				

Species	Habitat Directive	Bern Convention	CITES	EU Wildlife Trade regulations	Endemic to Europe	Assumed to have inherited listing from parent taxon
<i>Lacerta trilineata</i>	II, IV	II			Yes	
<i>Lacerta viridis</i>	IV	II, III				
<i>Laudakia stellio</i>	IV [as <i>Stellio stellio</i>]	II [as <i>Stellio stellio</i>]				
<i>Macrochelys temminckii</i>			II	B		
<i>Macroprotodon brevis</i>		III				
<i>Macroprotodon cucullatus</i>		III				
<i>Macrovipera lebetinus</i>	IV [as <i>Vipera xanthina</i>]	II [as <i>Vipera xanthina</i>]				
<i>Macrovipera schweizeri</i>	II, IV [as <i>Vipera lebetina schweizeri</i>]	II [as <i>Vipera schweizeri</i>] Revised I [as <i>Vipera lebetina schweizeri</i>]			Yes	
<i>Malpolon insignitus</i>		III				
<i>Malpolon monspessulanus</i>		III				
<i>Mauremys caspica</i>	II, IV	II				
<i>Mauremys leprosa</i>	II, IV	II [as <i>Mauremys caspica leprosa</i>] Revised I				
<i>Mauremys reevesii</i>			III	C		
<i>Mauremys rivulata</i>		III				
<i>Mauremys sinensis</i>			III	C		
<i>Mediodactylus bartoni</i>	IV [as <i>Cyrtopodion kotschy</i>]	II [as <i>Cyrtodactylus kotschy</i>]				
<i>Mediodactylus danilewskii</i>	IV [as <i>Cyrtopodion kotschy</i>]	II [as <i>Cyrtodactylus kotschy</i>]				Elevated to species level from <i>Mediodactylus kotschy danilewskii</i> ; HD IV [as <i>Cyrtopodion kotschy</i>], Bern II [as <i>Cyrtodactylus kotschy</i>]
<i>Mediodactylus kotschy</i>	IV [as <i>Cyrtopodion kotschy</i>]	II [as <i>Cyrtodactylus kotschy</i>]			Yes	

Species	Habitat Directive	Bern Convention	CITES	EU Wildlife Trade regulations	Endemic to Europe	Assumed to have inherited listing from parent taxon
<i>Mediodactylus oertzeni</i>	IV [as <i>Cyrtopodion kotschy</i>]	II [as <i>Cyrtodactylus kotschy</i>]			Yes	
<i>Mediodactylus orientalis</i>	IV [as <i>Cyrtopodion kotschy</i>]	II [as <i>Cyrtodactylus kotschy</i>]				Elevated to species level from <i>Mediodactylus kotschy orientalis</i> , HD IV [as <i>Cyrtopodion kotschy</i>], Bern II [as <i>Cyrtodactylus kotschy</i>]
<i>Montivipera xanthina</i>	IV [as <i>Vipera xanthina</i>]					
<i>Natrix astreptophora</i>		II,III				Bern II [<i>Natrix natrix</i> as <i>Natrix megaloccephala</i>], Bern III
<i>Natrix helvetica</i>		II,III			Yes	Bern II [<i>Natrix natrix</i> as <i>Natrix megaloccephala</i>], Bern III
<i>Natrix maura</i>		III				
<i>Natrix natrix</i>		II [as <i>Natrix megaloccephala</i>], III				
<i>Natrix tessellata</i>	II, IV	II				
<i>Ophiomorus kardesi</i>	IV	II				HD IV, Bern II [as <i>Ophiomorus punctatissimus</i>]
<i>Ophiomorus punctatissimus</i>	II, IV	II			Yes	
<i>Ophisops elegans</i>	II, IV	II				
<i>Parvilacerta parva</i>		II [as <i>Lacerta parva</i>]				
<i>Phoenicolacerta troodica</i>		III			Yes	
<i>Phrynocephalus guttatus</i>		III				
<i>Phrynocephalus helioscopus</i>		III				
<i>Phrynocephalus mystaceus</i>		III				
<i>Platyceps collaris</i>		II [as <i>Coluber rubriceps</i>]				
<i>Platyceps najadum</i>	IV [as <i>Coluber najadum</i>]	II, III [as <i>Coluber najadum</i>]				
<i>Podarcis bocagei</i>		III			Yes	
<i>Podarcis carbonelli</i>		III			Yes	

Species	Habitat Directive	Bern Convention	CITES	EU Wildlife Trade regulations	Endemic to Europe	Assumed to have inherited listing from parent taxon
<i>Podarcis cretensis</i>	IV	II			Yes	
<i>Podarcis erhardii</i>	IV	II			Yes	
<i>Podarcis filfolensis</i>	II, IV	II			Yes	
<i>Podarcis gaigeae</i>		III			Yes	
<i>Podarcis hispanicus</i>		III			Yes	
<i>Podarcis levendis</i>	IV	II			Yes	
<i>Podarcis lilfordi</i>	II, IV	II, Revised I	II	A	Yes	
<i>Podarcis liolepis</i>	IV	III			Yes	
<i>Podarcis melisellensis</i>	II, IV	II			Yes	
<i>Podarcis milensis</i>	IV	II			Yes	
<i>Podarcis muralis</i>	II, IV	II				
<i>Podarcis peloponnesiacus</i>	IV [as <i>Podarcis peloponnesiaca</i>]	II [as <i>Podarcis peloponnesiaca</i>]			Yes	
<i>Podarcis pityusensis</i>	II, IV	II, Revised I	II	A	Yes	
<i>Podarcis raffonei</i>		III [as <i>Podarcis raffoneae</i>]			Yes	
<i>Podarcis siculus</i>	IV	II			Yes	
<i>Podarcis tauricus</i>	IV	II				
<i>Podarcis tiliguerta</i>	II, IV	II			Yes	
<i>Podarcis vaucheri</i>		III				
<i>Podarcis waglerianus</i>	IV	II			Yes	
<i>Psammodromus algirus</i>		III				
<i>Psammodromus blanci</i>		III				
<i>Psammodromus hispanicus</i>		II			Yes	
<i>Psammodromus occidentalis</i>		III			Yes	

Species	Habitat Directive	Bern Convention	CITES	EU Wildlife Trade regulations	Endemic to Europe	Assumed to have inherited listing from parent taxon
<i>Pseudopus apodus</i>	IV [as <i>Ophisaurus apodus</i>]	II [as <i>Ophisaurus apodus</i>]				
<i>Saurodactylus mauritanicus</i>		III				
<i>Scelarcis perspicillata</i>		III				
<i>Tarentola angustimentalis</i>	II, IV	II			Yes	
<i>Tarentola boettgeri</i>	II, IV	II			Yes	
<i>Tarentola delalandii</i>	II, IV	II			Yes	
<i>Tarentola gomerensis</i>	II, IV	II			Yes	
<i>Tarentola mauritanica</i>		III				
<i>Teira dugesii</i>	IV [as <i>Lacerta dugesi</i>]	II [as <i>Lacerta dugesii</i>]			Yes	
<i>Telescopus fallax</i>	IV	II				
<i>Tenuidactylus caspius</i>		[III as <i>Cyrtodactylus caspius</i>]				
<i>Testudo graeca</i>	II, IV	II, Revised I	II [as Testudinidae spp.]	A		
<i>Testudo hermanni</i>	II, IV	II, Revised I	II	A	Yes	
<i>Testudo marginata</i>	II, IV	II, III [as <i>Testudo weissingeri</i>] Revised I	II [as Testudinidae spp.]	A	Yes	
<i>Timon lepidus</i>		II [as <i>Lacerta lepida</i>]			Yes	
<i>Timon nevadensis</i>		II [as <i>Timon lepidus nevadensis</i>]			Yes	
<i>Timon tangitanus</i>		III				
<i>Trachemys scripta</i>		III				
<i>Trionyx triunguis</i>		II, Revised I	II	B		
<i>Trogonophis wiegmanni</i>		III				
<i>Vipera ammodytes</i>	II, IV	II				
<i>Vipera aspis</i>		III			Yes	

Species	Habitat Directive	Bern Convention	CITES	EU Wildlife Trade regulations	Endemic to Europe	Assumed to have inherited listing from parent taxon
<i>Vipera berus</i>		III				
<i>Vipera graeca</i>	II, IV [as <i>Vipera ursinii</i>]	II, Revised I [as <i>Vipera ursinii</i>]			Yes	
<i>Vipera latastei</i>		II			Yes	
<i>Vipera renardi</i>		III				
<i>Vipera seoanei</i>	IV [as <i>Vipera seoanni</i>]	III			Yes	
<i>Vipera ursinii</i>	II, IV	II, Revised I	I	A	Yes	
<i>Xerotyphlops vermicularis</i>		III				
<i>Zamenis hohenackeri</i>		III				
<i>Zamenis lineatus</i>	IV [as <i>Elaphe lineata</i>]	II [as <i>Elaphe lineata</i>]			Yes	
<i>Zamenis longissimus</i>	IV [as <i>Elaphe longissima</i>]	II [as <i>Elaphe longissima</i>]				
<i>Zamenis scalaris</i>		III [as <i>Elaphe scalaris</i>]			Yes	
<i>Zamenis situla</i>	II, IV [as <i>Elaphe situla</i>]	II, Revised I [as <i>Elaphe situla</i>]				
<i>Zootoca carniolica</i>	IV [as <i>Lacerta vivipara pannonica</i>]	III [as <i>Lacerta vivipara</i>]			Yes	
<i>Zootoca vivipara</i>	IV [as <i>Lacerta vivipara pannonica</i>]	III [as <i>Lacerta vivipara</i>]				

Appendix 2.

Taxonomic changes affecting the European reptile fauna accepted since Cox and Temple (2009).

Family	Species	Taxonomic Action	Source
Agamidae	<i>Laudakia cypriaca</i>	Elevated from subspecies of <i>Laudakia stellio</i>	Karameta et al., 2022
	<i>Laudakia stellio</i>	Taxonomic split	Karameta et al., 2022
Anguidae	<i>Anguis colchica</i>	Elevated from subspecies of <i>Anguis fragilis</i>	Gvoždík et al., 2010
	<i>Anguis fragilis</i>	Taxonomic split	Gvoždík et al., 2010
	<i>Anguis graeca</i>	Removed from synonymy with <i>Anguis fragilis</i>	Gvoždík et al., 2010
	<i>Anguis veronensis</i>	New description	Gvoždík et al., 2013
	<i>Blanus alexandri</i>	New description	Sindaco et al., 2014
Blanidae	<i>Blanus aporus</i>	Elevated from subspecies of <i>Blanus strauchi</i>	Sindaco et al., 2014
	<i>Blanus cinereus</i>	Change in species concept	Cerriaco and Bauer, 2018
	<i>Blanus strauchi</i>	Taxonomic split	Sindaco et al., 2014
	<i>Blanus vandelli</i>	New description	Cerriaco and Bauer, 2018
	<i>Elaphe sauromates</i>	Taxonomic split (other species not in Europe)	Jablonski et al., 2019
Colubridae	<i>Rhynchocalamus melanocephalus</i>	Taxonomic split (other species not in Europe)	Šmíd et al., 2015
	<i>Zamenis scalaris</i>	Generic change from <i>Rhinechis</i>	Salvi et al., 2018
Erycidae	<i>Eryx miliaris</i>	Change in species concept	Eskandarzadeh et al., 2020
Gekkonidae	<i>Hemidactylus turcicus</i>	Taxonomic split (other species do not occur in Europe)	Moravec et al., 2011
	<i>Mediodactylus bartoni</i>	Elevation from subspecies of <i>Mediodactylus kotschy</i>	Kotsakiozi et al., 2018
	<i>Mediodactylus danilewskii</i>	Elevation from subspecies of <i>Mediodactylus kotschy</i>	Kotsakiozi et al., 2018
	<i>Mediodactylus kotschy</i>	Taxonomic split	Kotsakiozi et al., 2018
	<i>Mediodactylus oertzeni</i>	Elevation from subspecies of <i>Mediodactylus kotschy</i>	Kotsakiozi et al., 2018
	<i>Mediodactylus orientalis</i>	Elevation from subspecies of <i>Mediodactylus kotschy</i>	Kotsakiozi et al., 2018

Lacertidae	<i>Acanthodactylus erythrurus</i>	Taxonomic split (other species not in Europe)	Miralles et al., 2020
	<i>Acanthodactylus schreiberi</i>	Taxonomic split (other species not in Europe)	Tamar et al., 2014
	<i>Anatolacerta oertzeni</i>	Removed from Europe following taxonomic change	Speybroeck et al., 2020
	<i>Anatololacerta pelasgiana</i>	Elevated from subspecies of <i>Anatololacerta anatolica</i>	Bellati et al., 2015
	<i>Anatololacerta anatolica</i>	Generic change from <i>Lacerta</i> . Taxonomic split	Speybroeck and Crochet, 2007
	<i>Anatololacerta finikensis</i>	Elevation to species rank from within <i>A. oertzeni</i>	Bellati et al., 2015; Karakasi et al., 2021
	<i>Anatololacerta pelasgiana</i>	Generic change from <i>Lacerta</i>	Speybroeck and Crochet, 2007
	<i>Dinarolacerta montenegrina</i>	New description	Ljubisavljević et al., 2007
	<i>Dinarolacerta mosorensis</i>	Taxonomic split	Ljubisavljević et al., 2007
	<i>Lacerta citrovittata</i>	Elevation from subspecies of <i>Lacerta trilineata</i>	Kornilios et al., 2019, 2020
	<i>Lacerta diplochondrodes</i>	Elevation from subspecies of <i>Lacerta trilineata</i>	Kornilios et al., 2019, 2020
	<i>Lacerta trilineata</i>	Taxonomic split	Kornilios et al., 2019, 2020
	<i>Podarcis erhardii</i>	Change in species concept	Lymberakis et al., 2008
	<i>Podarcis guadarramae</i>	New description	Geniez et al., 2014
	<i>Podarcis hispanicus</i>	Taxonomic split	Geniez et al., 2007, Geniez et al., 2014
	<i>Podarcis ionicus</i>	Elevated from subspecies of <i>Podarcis tauricus</i>	Psonis et al., 2016
	<i>Podarcis latastei</i>	Elevated from subspecies of <i>Podarcis siculus</i>	Senczuk et al., 2019; Castiglia et al., 2021
	<i>Podarcis lusitanicus</i>	New description	Caeiro-Dias et al., 2021
	<i>Podarcis peloponnesiacus</i>	Taxonomic split	Kiourtsoglou et al., 2021
	<i>Podarcis siculus</i>	Taxonomic split	Senczuk et al., 2019
	<i>Podarcis tauricus</i>	Taxonomic split	Psonis et al., 2016
	<i>Podarcis thais</i>	Elevated from subspecies of <i>Podarcis peloponnesiacus</i>	Kiourtsoglou et al., 2021
	<i>Podarcis virescens</i>	New description	Geniez et al., 2014
	<i>Psammodromus algirus</i>	Change in species concept	Verdú-Ricoy et al., 2010
	<i>Psammodromus edwardsianus</i>	Elevation from subspecies of <i>P. hispanicus</i>	Fitze et al., 2011
	<i>Psammodromus hispanicus</i>	Taxonomic split	Fitze et al., 2011
	<i>Psammodromus occidentalis</i>	New description	Fitze et al., 2011
	<i>Timon lepidus</i>	Taxonomic split	Miraldo et al., 2013
	<i>Timon nevadensis</i>	Elevation from subspecies of <i>Timon lepidus</i>	Miraldo et al., 2013
	<i>Zootoca carniolica</i>	Elevation from subspecies of <i>Zootoca vivipara</i>	Speybroeck et al., 2020
	<i>Zootoca vivipara</i>	Taxonomic split	Speybroeck et al., 2020

Natricidae	<i>Natrix astreptophora</i>	Elevated from subspecies of <i>Natrix natrix</i>	Pokrant et al. 2016
	<i>Natrix helvetica</i>	Elevated from subspecies of <i>Natrix natrix</i>	Kindler et al., 2017
	<i>Natrix natrix</i>	Taxonomic split	Kindler et al., 2017
Scincidae	<i>Chalcides coeruleopunctatus</i>	Elevated from subspecies of <i>Chalcides viridanus</i>	Carranza et al., 2008
	<i>Chalcides viridanus</i>	Taxonomic split	Carranza et al., 2008
	<i>Eumeces schneideri</i>	Emendation of name to <i>Eumeces schneiderii</i>	Speybroeck et al., 2020
	<i>Ophiomorus kardesi</i>	New description	Kornilios et al., 2018
	<i>Ophiomorus punctatissimus</i>	Taxonomic split	Kornilios et al., 2018
Typhlopidae	<i>Xerotyphlops vermicularis</i>	Taxonomic split (other species not in Europe)	Kornilios et al., 2020
Viperidae	<i>Macrovipera lebetina</i>	Emendation of name to <i>Macrovipera lebetinus</i>	Fretey, 2019
	<i>Vipera berus</i>	Synonymisation of <i>Vipera nikolskii</i>	Ghielmi et al., 2016
	<i>Vipera graeca</i>	Elevation from subspecies of <i>Vipera ursinii</i>	Ferchaud et al., 2012; Mizsei et al., 2017
	<i>Vipera latastei</i>	Taxonomic split (other species not in Europe)	Martínez-Freiría et al., 2021
	<i>Vipera renardi</i>	Change in species concept being assessed	Freitas et al., 2020
	<i>Vipera ursinii</i>	Taxonomic split	Ferchaud et al., 2012; Mizsei et al., 2017



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