Article

# Ongoing declines for the world's amphibians in the face of emerging threats

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Systematic assessments of species extinction risk at regular intervals are necessary for informing conservation action[1,2]. Ongoing developments in taxonomy, threatening processes and research further underscore the need for reassessment[3,4]. Here we report the findings of the second Global Amphibian Assessment, evaluating 8,011 species for the International Union for Conservation of Nature Red List of Threatened Species. We find that amphibians are the most threatened vertebrate class (40.7% of species are globally threatened). The updated Red List Index shows that the status of amphibians is deteriorating globally, particularly for salamanders and in the Neotropics. Disease and habitat loss drove 91% of status deteriorations between 1980 and 2004. Ongoing and projected climate change effects are now of increasing concern, driving 39% of status deteriorations since 2004, followed by habitat loss (37%). Although signs of species recoveries incentivize immediate conservation action, scaled-up investment is urgently needed to reverse the current trends.

The International Union for Conservation of Nature (IUCN) Red List Index (RLI) documents the extinction risk trends of species groups over time[5], generating information that is crucial for conservation prioritization and planning[6]. The landmark 2004 Global Amphibian Assessment (GAA1) was published on the IUCN Red List, demonstrating that amphibians were the most threatened class of vertebrates worldwide, and has been widely used to guide and motivate amphibian conservation efforts[7]. The 2004 baseline study identified habitat loss and degradation and over-exploitation as the main threats, contributing to the deterioration of just over half of the species that deteriorated in status between 1980–2004, while 48% were classified as enigmatic-decline species[7]. Subsequent studies support that the disease chytridiomycosis, caused by *Batrachochytrium dendrobatidis*, was most likely responsible for many enigmatic declines[8–12]. The GAA1 helped to launch a wave of research and conservation efforts directed at *B. dendrobatidis* and the other threats causing the decline in amphibians[6].

Completed in June 2022, the second Global Amphibian Assessment (GAA2) reassessed the status of the GAA1 species and added 2,286 species, bringing the number of amphibians on the IUCN Red List to 8,011 (39.9% increase from 2004; covering 92.9% of 8,615 described species). Since the GAA1, information on population trends, ecological requirements, threats and distributional boundaries of amphibians has improved considerably, and amphibian systematics have progressed. However, this new information (for example, better estimates of population size, redefining taxonomic boundaries) can sometimes result in a non-genuine change in Red List category, introducing biases in the data. We therefore used current information to estimate a backcasted Red List category for each species in 1980 and 2004 and examine only genuine category changes. With these data and the GAA2 assessments, we re-examine the global status and trends of amphibians and present new insights on threats, providing a crucial update that informs the prioritization, planning and monitoring of conservation actions.

## Threatened and extinct species

The status of amphibians worldwide continues to deteriorate: 40.7% (2,873) are globally threatened (that is, IUCN Red List categories Critically Endangered, Endangered and Vulnerable), compared with 37.9% (2,681) in 1980 and 39.4% (2,788) in 2004 (Fig. 1 and Extended Data Table 1; see the 'Percentage of threatened species' section of the Methods). The proportion of species in the Data Deficient IUCN category has decreased from 22.5% in the GAA1 to 11.3% as a result of newly available information.

The greatest concentrations of threatened species are in the Caribbean islands, Mesoamerica, the Tropical Andes, the mountains and forests of western Cameroon and eastern Nigeria, Madagascar, the Western Ghats and Sri Lanka. Other notable concentrations of threatened species occur in the Atlantic Forest biome of southern Brazil, the Eastern Arc Mountains of Tanzania, central and southern China, and the southern Annamite Mountains of Vietnam (Fig. 1). Of all of the comprehensively assessed groups on the IUCN Red List, amphibians are the second most threatened group and remain the most threatened vertebrate class (cycads, 69%; sharks and rays, 37.4%; conifers, 34.0%; reef-building corals, 33.4%; mammals, 26.5%; reptiles, 21.4%; dragonflies, 16%; birds, 12.9%; cone snails, 6.5%)[13–19].

Documented amphibian extinctions continue to increase: there were 23 by 1980, an additional 10 by 2004 and four more by 2022, for a total of 37 (Extended Data Table 1). The most recent are *Atelopus chiriquiensis* and *Taudactylus acutirostris*, after rapid declines linked to chytridiomycosis in the 1990s, while *Craugastor myllomyllon* and *Pseudoeurycea exspectata* were last seen in the 1970s and are believed to be Extinct due to agricultural expansion. Strict requirements must be met to declare a species Extinct[20]; therefore, many species missing for decades are categorized as Critically Endangered (CR) and tagged as Possibly Extinct (CR(PE)). For 1980, 24 amphibians were categorized as CR(PE), for 2004 this increased to 162, with another 23 added for 2022 (Extended Data Table 1). Thus, the number of known amphibian

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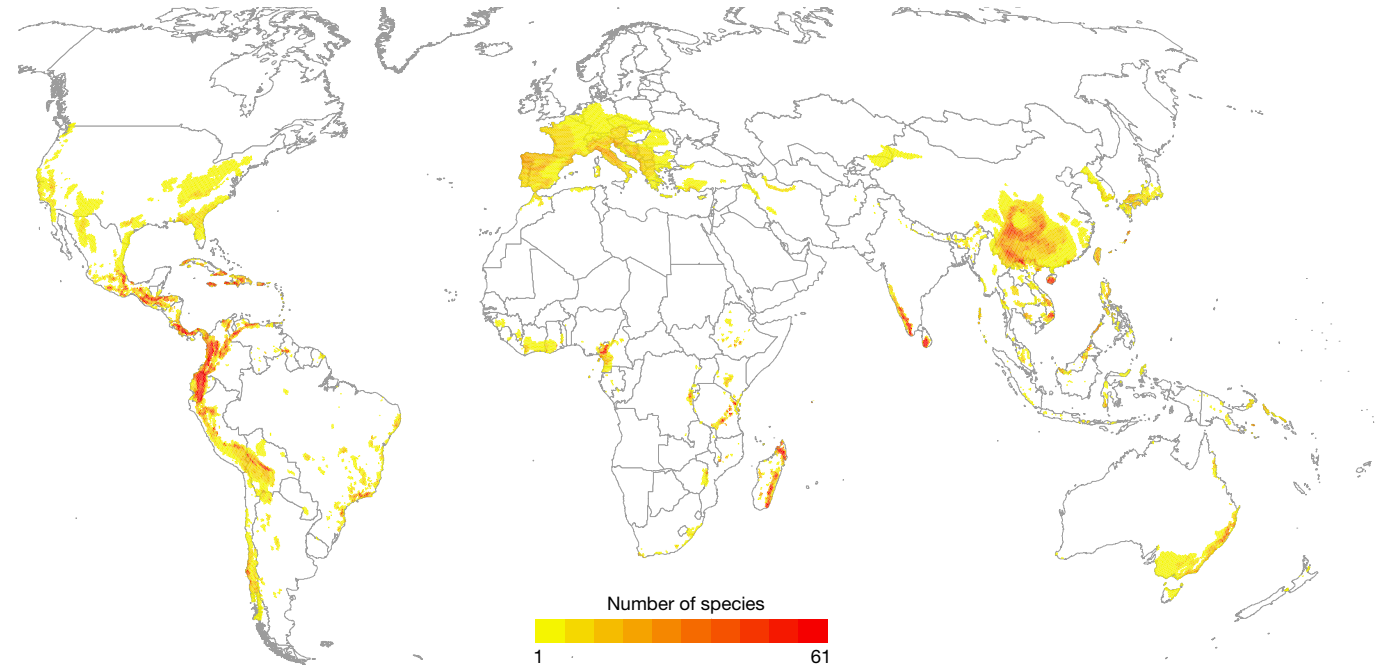


**Fig. 1 | The distribution of 2,873 globally threatened amphibian species.** The darker colours correspond to higher species richness. The colour scale is based on 10 quantile classes. Maximum richness equals 61 species. The cell area is 865 km$^2$. One species was excluded because no spatial data were available.

extinctions could be as many as 222 over the last 150 years if all CR(PE) species are indeed extinct.

When considering all threatened amphibians, the most commonly documented threats are types of habitat loss and degradation, with the top three being agriculture (77% of species impacted), timber and plant harvesting (53%), and infrastructure development (40%) (Fig. 2). Climate change effects (29%) and disease (29%) are other common threat types. Although these are important findings, they do not account for the severity and scope of these threats.

## The RLI

The RLI is an indicator calculated from Red List categories to measure trends in extinction risk over time[5]. RLI values range from 1 (all species

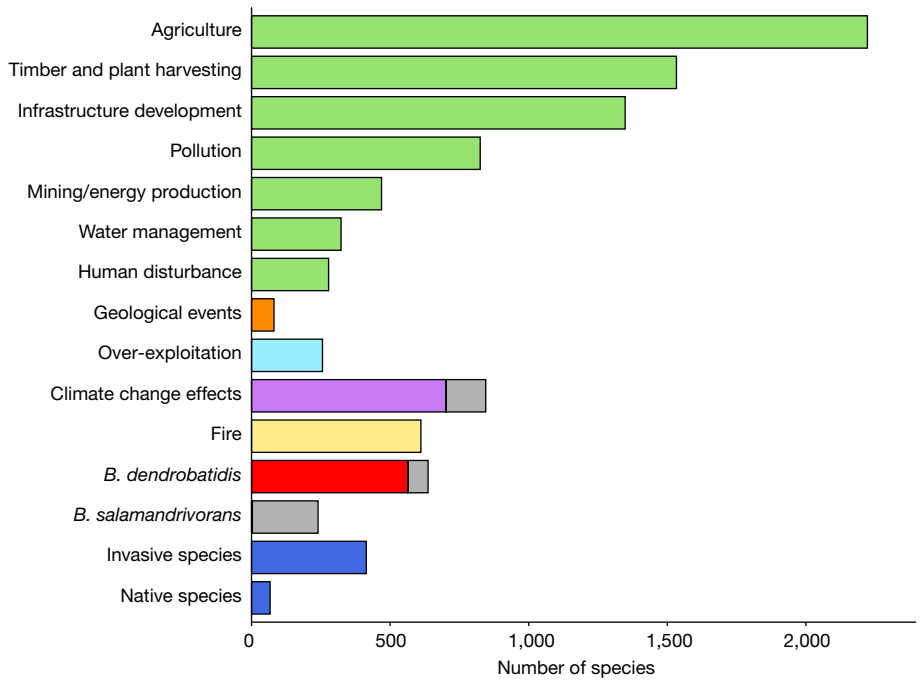


**Fig. 2 | The types of threats affecting amphibian species in threatened categories.** The threats to a species were coded using the threat-classification scheme and grouped for ease of comparison (see the 'Classification schemes' and 'Threats to threatened species' sections of the Methods). All threats shaded in green are causing habitat loss and degradation. The grey sections denote the number of species for which the threat timing is in the future rather than ongoing. Note that most species are experiencing multiple threats.