



**amphibian ark**  
2008 YEAR OF THE FROG

**Teach The Amphibian Crisis!**

**Frogs Matter.**  
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## Foreword

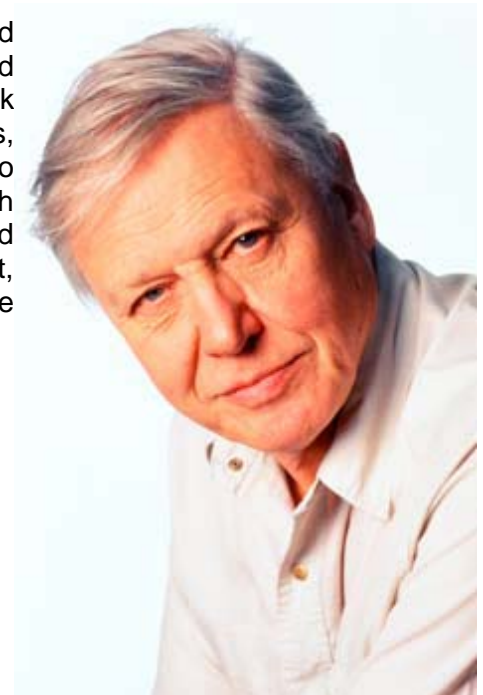
Almost everyone can recognise frogs and toads. They are those extraordinary vertebrate animals which change from egg to adult by undergoing metamorphosis. This remarkable process played a crucial part in these animals' pioneering invasion of the land. It demonstrates evolution compressed into just a few weeks and it sparks our imagination.

Today amphibians can be found in enormous variety and occupy a wide range of water and land habitats – except for the oceans and the frozen polar regions. They are so familiar to most people that they have become part of the myths, legends, and folk tales of many cultures. And there is still much more for us to learn about them for new species are being discovered even today. Yet their habitats are being destroyed at such a speed that now many species may disappear before we even discover that they exist. Infections of chytrid fungus, for which there is no known cure, are today spreading rapidly and threatening entire amphibian communities. There is thus the real possibility that much of an entire category of animals may become extinct worldwide – unless we prepare to act quickly. Captive breeding has been shown by the scientific community to be one of the most important and appropriate ways to slow down the effects of this crisis. Selected species, bred in favourable captive conditions, can multiply and prosper to such an extent that populations can be released into secure environments in the wild. The International Union for Conservation of Nature (IUCN) and the World Association of Zoos and Aquariums have therefore launched The Amphibian Ark to support such captive management projects around the world. The global zoo and aquarium community has taken on this challenge with enthusiasm and is providing appropriate facilities and breeding grounds within their institutions. But implementation calls for financial and political support from all parts of the world.

I therefore extend a warm invitation to all of you to join the efforts of the Amphibian Ark and the 2008 Year of the Frog global campaign.

The main goal of these efforts is to generate public awareness and understanding of the amphibian extinction crisis. The funds raised from this worldwide campaign will help support Amphibian Ark coordination activities and finance regional initiatives such as rescues, training workshops and cooperatively managed centres. It will also ensure the sustainability of surviving populations by creating a cash fund that will extend beyond 2008. Without an immediate and sustained conservation effort to support captive management, hundreds of species of these wonderful creatures could become extinct in our own lifetime.

**Sir David Attenborough**  
**Patron, Amphibian Ark 2008 Year of the Frog**





# Why Teach About the Amphibian Crisis?

## *The Connection Between Man and Nature*

Humans should have connections to nature. Experiences in nature literally enrich our lives and inform our choices for future generations.

- Nature renews the spirit, refreshes emotional and mental health, and provides places to live, play, recreate, explore, learn, and enjoy.
- Nature's beauty and resources are national and international treasures, defining our character and heritage.
- The variety and diversity of life on Earth is needed and inspirational for human existence.

## *Man's Effect on Nature*

All life on earth exists with interdependent relationships between living things and their environments. A healthy environment sustains life for humans and animals.

- Humans are responsible for dramatic changes to nature at a rate unprecedented in Earth's history, due to population growth, increased consumption of resources, global warming, habitat destruction, invasive species, and overuse of many species.
- People should recognize their responsibility to care for the Earth and leave a healthy environment for our families and future generations. Due to the unprecedented changes occurring on the planet, we must often intervene to save wildlife.

## *Frogs Matter*

Amphibians are a critical part of a healthy natural world. In addition to their intrinsic value as a beautiful part of nature, they offer many benefits to us:

- They play an important role in the food web as both predator and prey, maintaining the delicate balance of nature. Where they are disappearing, detrimental effects are already being documented.
- Amphibians eat pest insects, benefiting successful agriculture around the world and minimizing the spread of diseases, including malaria.



- The skin of amphibians has substances that protect them from some microbes and viruses, offering possible medical cures for a variety of human diseases, including AIDS.
- Biologists refer to amphibians as “the canary in the coal mine:” They are among the first species to be affected by environmental stressors; so when they show declines in the wild, it serves as a warning to other species, including humans.
  - Amphibians’ skin is highly permeable, allowing them to drink and breathe. Unfortunately, contaminants also readily enter the body, making amphibians an exceptional indicator of environmental quality. They are particularly sensitive to pollution, making them important sentinels to potential human threats.
- Frogs have had a special place in various human cultures for centuries, cherished as agents of life and good luck.

## *The Problem*

After thriving for over 360 million years, 1/3 to 1/2 of the world’s approximately 6,000 known amphibian species could go extinct in our lifetime.

- Earth is facing the single largest mass extinction since the disappearance of dinosaurs.

## *The Reason*

Amphibians are severely affected by habitat loss, climate change, pollution and pesticides, introduced species, and over-collection for food and pets. While habitat destruction is the major threat, the most immediate cause is a parasitic fungus called amphibian chytrid, a disease that is deadly to hundreds of amphibian species and has quickly spread from Africa across the planet over the past 30-40 years. Global climate change may have exacerbated the problem.

- Amphibian chytrid was discovered a decade ago and since then dozens of frog species have gone extinct because of it.
- Since the 1930s, African clawed frogs (likely resistant carriers of the fungus) have been shipped around the world by the thousands for human pregnancy tests and lab studies, spreading the disease worldwide. Recently, the food and pet trade may have contributed to the problem as well.
- Amphibian chytrid is currently unstoppable and untreatable in the wild, even in protected areas. In the environments where it thrives, the fungus can kill 80 percent of the native amphibians within months, leading to widespread amphibian extinctions.
- The amphibian chytrid’s spread and effects may be exacerbated by climate change.
- Warmer temperatures dry the moist areas where amphibians thrive, and cause stress that may lead to greater susceptibility to disease.



## The Solution

In response to the problem, scientists and conservationists agreed to an Amphibian Conservation Action Plan (ACAP), including research, assessment, and conservation in nature. For those species that cannot be saved in nature, the plan is to rescue them before they are gone, and to protect them in captive facilities until the threats to the wild populations can be controlled. Captive management is a vital component of ACAP's integrated conservation effort, buying valuable time to mitigate threats for species that would otherwise go extinct. The Amphibian Ark is an initiative to fulfill our responsibility for this critical component of the ACAP.

- Amphibian Ark is a program coordinated by the International Union for Conservation of Nature (IUCN)/Species Survival Commission (SSC) Conservation Breeding Specialist Group, IUCN/SSC Amphibian Specialist Group, and the World Association of Zoos and Aquariums (WAZA), and supported by a worldwide network of zoos and aquariums, to help keep threatened amphibian species afloat.
- The AArk program will rescue priority endangered species and place them in "protective custody" in dedicated biosecure facilities at zoos, aquariums, and other institutions around the world for safekeeping and breeding, helping to ensure the long-term survival of amphibians.
- These rescued amphibians will be released back into the wild when the original threats have been controlled.
- To achieve the initial goal of safeguarding just those species that cannot be saved in the wild, AArk is seeking \$50 million.

## Getting the Word Out

Organizations that support Amphibian Ark have been leading a global public awareness campaign, "2008: The Year of the Frog" to:

- Raise awareness among national governments, world media, school educators, and people generally about the vulnerability of amphibians and the extinction crisis they face.
- Raise funds through corporate sponsorship, philanthropy, public, and government involvement to support AArk's rescue efforts and ensure amphibians' long-term sustainability
- Funds are paid to AArk through the Global Conservation Network, a part of the Conservation Breeding Specialist Group. Funds cover costs such as:
  - Prioritization workshops
  - Biosecure rescue centers and operating expenses
  - Staffing and training
  - Field surveys and rescues



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## *A Further Purpose*

The Amphibian Ark project will serve as an example of how to boldly and confidently face one of our planet's biggest environmental challenges.

- The condition of our planet and its vanishing wildlife is a top concern of both adults and children, who are frustrated and unsure of how to help..
- People are invited to participate in the AArk initiative by getting engaged as volunteers where needed, spreading the word, making donations, and influencing governments. Working together, we can deal with environmental crises.



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# The Amphibian Crisis

## Introduction

The 2004 Global Amphibian Assessment of the International Union for Conservation of Nature (IUCN) revealed that one third to one half of the world's 6,000 amphibian species are threatened with extinction and that over 120 species have already disappeared in recent years. The IUCN has previously urged that "All Critically Endangered and Extinct in the Wild taxa should be subject to captive management to ensure recovery of wild populations." Scientists around the world have recognized that captive management is necessary as a temporary solution and as part of an integrated conservation effort to prevent the extinction of hundreds of additional amphibian species. Fortunately, this conservation challenge is one that the captive management community including zoos, aquariums, botanical gardens, research centers, museums, nature centers, and private breeders is uniquely capable of addressing.



During the 2005 Amphibian Conservation Summit – convened by the IUCN and Conservation International (CI) – the Amphibian Conservation Action Plan (ACAP) was developed. In that meeting the IUCN/Species Survival Commission (SSC) Conservation Breeding Specialist Group (CBSG) was commissioned with the implementation of the captive management aspects of the ACAP.

A year later, the IUCN/SSC CBSG, the IUCN/SSC Amphibian Specialist Group (ASG) and the World Association of Zoos and Aquariums (WAZA) set up a collaborative program called Amphibian Ark (AArk) to develop, promote and guide short-term captive management programs, thus making possible long-term survival of amphibians for which adequate protection in the wild is not currently feasible. The AArk coordinates captive management programs implemented by partners around the world, with emphasis on programs within the range countries of each species, and constant attention to our obligation to couple *captive* conservation measures with efforts to protect or restore species in their natural habitats.

The urgent need for the AArk was established by findings of the 2004 Global Amphibian Assessment. Since then, a considerable number of amphibians have probably been lost – perhaps 10 per year – and the survival of other species is uncertain. The spread of amphibian chytrid fungus, which is responsible for the current crisis, is relentless and does not weaken, so the imperative to act is stronger now than ever before. The preferred solution is to create "Survival Assurance Populations" in zoos, but that requires effort, engagement and investment on an unprecedented scale. AArk has been charged with helping to spearhead and coordinate programs in the U.S. and around the world, including prioritizing species for immediate rescue, coordinating placement of breeding populations in zoos and other institutions and helping provide resources for maintaining breeding populations until it is possible to reintroduce them into the wild.



## Amphibians in Danger

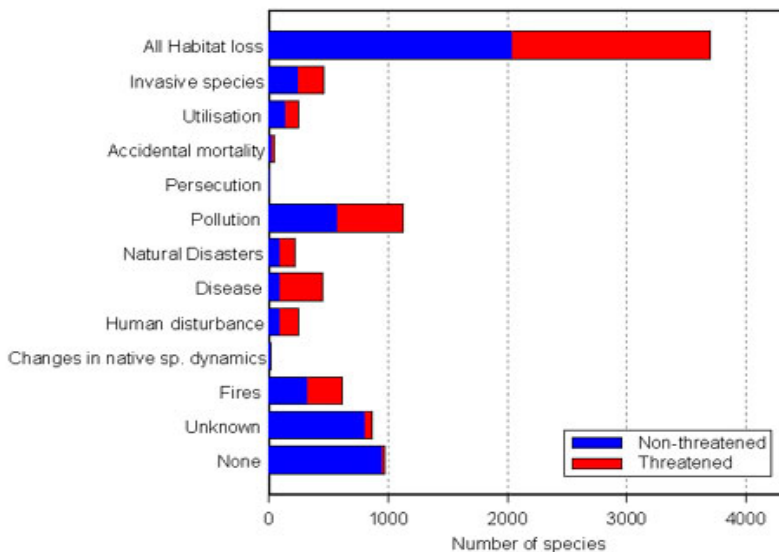
Addressing the amphibian extinction crisis represents the greatest species conservation challenge in the history of humanity. One third to one half of all amphibian species are threatened with extinction, with probably more than 120 already gone in recent years. This is significantly more than any other group of organisms: by comparison, 12 percent of bird species and 25 percent of mammal species, are threatened.

The IUCN Global Amphibian Assessment (GAA) alerted us to the fact that hundreds of species face threats that cannot be mitigated in the wild, i.e., they require zoos to save them in the short term until adequate conservation measures to secure wild populations can be developed.

**Threats** [source: 2004 Global Amphibian Assessment. [www.globalamphibians.org](http://www.globalamphibians.org)]

A variety of threats are impacting amphibian species around the world, causing the massive declines. To better understand the leading threats to amphibians, GAA researchers recorded known threats to each amphibian species using a standardized list (IUCN Major Threat Authority Files [http://www.iucnredlist.org/info/major\\_habitats.html](http://www.iucnredlist.org/info/major_habitats.html)) of major threats. A summary of the number of species affected by each threatening process is shown in Figure 1.

*Figure 1. Major Threats to Amphibians*  
[source: 2004 Global Amphibian Assessment]





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Habitat loss and degradation are the greatest threat to amphibians, affecting nearly 4,000 species. The number of species impacted by habitat loss and degradation is almost four times greater than the next most common threat, pollution. Although disease appears to be a relatively less significant threat for amphibians, for those species affected, it can cause sudden and dramatic population declines resulting in very rapid extinction. In comparison, although habitat loss and degradation affect a much greater number of species, the rate at which a species declines is usually much slower, and there are a number of strategies, such as the creation of protected areas, to counter this threat (GAA).

**Red List Status** [source: the Global Amphibian Assessment. [www.globalamphibians.org](http://www.globalamphibians.org)]

A primary goal of the GAA is to assess each known amphibian species with respect to the IUCN Red List categories and criteria [http://www.iucnredlist.org/info/categories\\_criteria.html](http://www.iucnredlist.org/info/categories_criteria.html). These categories provide an explicit framework for determining a species' conservation status, with an emphasis on identifying those at highest risk of global extinction. In this context, the term "Threatened" refers to those species classified under Red List categories of Vulnerable, Endangered, or Critically Endangered.

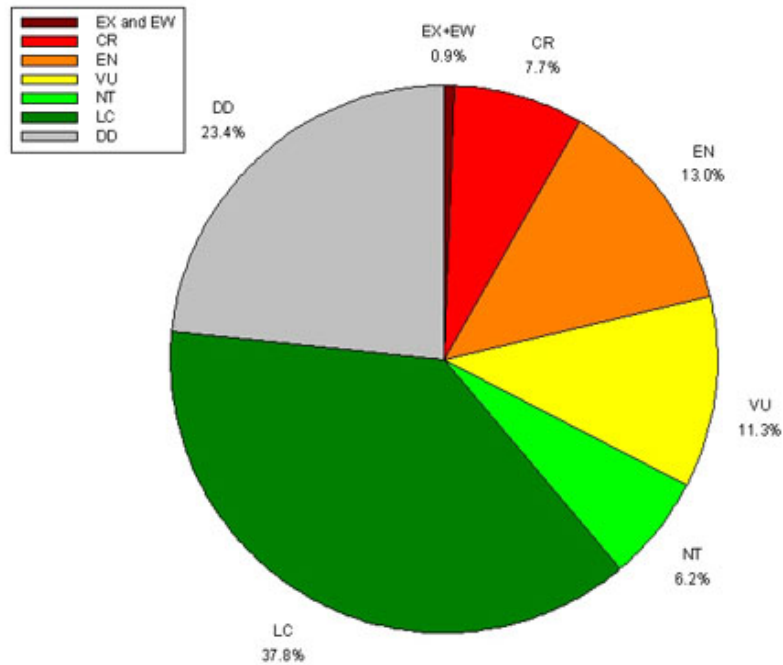
Of the 5,918 amphibian species assessed, nearly one-third of extant species (32.2%) are globally threatened, representing 1,896 species (Figure 2). This is considerably higher than the comparable figures for birds (12%) and mammals (23%), the only other animal groups for which comprehensive global assessments have been completed. Thirty-four species are considered to be Extinct (EX), and one Extinct in the Wild (EW). Another 2,604 species are not considered to be threatened at present, being classified in the IUCN Categories of Near Threatened (NT) or Least Concern (LC), while sufficient information was not available to assess the status of an additional 1,383 species.

Relative to other animal groups, a particularly high proportion of amphibians are in higher threat categories. For example, 7.7 percent of amphibians are listed as Critically Endangered (456 species) compared with 1.8 percent of birds (179 species) and 3.8 percent of mammals (184 species). Threat levels for amphibians are also undoubtedly an underestimate given that nearly a quarter (23.4%) of species are too poorly known to assess (i.e., Data Deficient), and a significant proportion of these are likely to be globally threatened. Comparable figures for birds and mammals are 0.8 percent and 5.3 percent respectively.

Documenting population trends is a key to assessing species status, and a special effort was made to determine which species are declining, stable, or increasing. The GAA found declines to be widespread among amphibians, with 42.5 percent of species reported to be in decline. In contrast, 26.6 percent appear to be stable and just 0.5 percent are increasing. Because trends information is not available for 30.4 percent of species, however, the percentage of species in decline may actually be considerably higher.



Figure 2. IUCN Red List Assessment for all 5,918 Known Amphibian Species  
[source: 2004 Global Amphibian Assessment]



**Extinctions** [source: the Global Amphibian Assessment. [www.globalamphibians.org](http://www.globalamphibians.org)]

Extinctions are notoriously difficult to confirm. Using the most conservative approach to documenting extinctions, just 34 amphibians are known to have become extinct since the year 1500. Of greater concern, however, are the many amphibians that are missing and can no longer be found. Until exhaustive surveys probing their disappearance can be carried out, these species cannot be classified in the Red List category of Extinct, but rather are flagged as “possibly extinct” within the Critically Endangered category. The GAA documents 130 such possibly extinct species.

Unfortunately, there is strong evidence that the pace of extinctions is increasing. Of the 34 known extinctions, nine have occurred since 1980, including such species as the golden toad (*Bufo periglenes*) of Monteverde, Costa Rica. Among those amphibians regarded as “possibly extinct,” at least 113 have disappeared and have not been seen since 1980. Fortunately, a few amphibians that previously were thought to be extinct have been rediscovered. For example, *Atelopus cruciger* was not seen in its native Venezuela after 1986, until a tiny population was found in 2003.

**Status by Taxonomic Group** [source: 2004 Global Amphibian Assessment. [www.globalamphibians.org](http://www.globalamphibians.org)]

Amphibians comprise three major groups, or taxonomic orders: Anura (frogs and toads), Caudata (salamanders and newts), and Gymnophiona (caecilians). Significant differences exist among these groups in both species numbers as well as threatened status. For instance, there is an order of magnitude – more frogs and toads than salamanders and newts, and even fewer caecilians are known. Frogs and toads, with 5,211 species, very much drive the average threat level for amphibians as a whole with 32.1 percent (1,675 species) either threatened or extinct. Salamanders and newts, however, show significantly higher threat levels, with 46.9 percent (251 species) of their species threatened or extinct. Caecilians, in contrast, appear to be relatively secure with just 2.9 percent (five species) threatened. However, two-thirds (66%) of caecilians are so poorly known that they have been assessed as Data Deficient.

Table 1. Red List Status by Taxonomic Order  
[source: 2004 Global Amphibian Assessment. [www.globalamphibians.org](http://www.globalamphibians.org)]

Order	Total	EX	EW	CR	EN	VU	NT	LC	DD	% Threatened or Extinct
Anura Frogs & Toads	5,211	32	1	401	659	582	311	2,028	1,197	32.1
Caudata Salamanders & Newts	535	2	0	54	109	86	58	155	71	46.9
Gymnophiona Caecilians	172	0	0	1	1	3	0	53	114	2.9
Total	5,918	34	1	456	769	671	369	2,236	1,382	32.9

Significant difference in threat levels is also exhibited at the level of taxonomic Family, as shown in Table 2. Very diverse families of frogs and toads that are more threatened than the global average include the Bufonidae, Leptodactylidae and Rhacophoridae. Sadly, both species of the Australian endemic family Rheobatrachidae (the gastric-brooding frogs) are now Extinct. Two other families at severe risk of disappearing altogether are Leiopelmatidae (New Zealand frogs) and Rhinodermatidae (Darwin's frogs in Chile and Argentina). Diverse families that are less threatened than the global average include Ranidae, Microhylidae, and Hyperoliidae. Among larger salamander families, Hynobiidae and Plethodontidae exhibit much higher levels of threat than Salamandridae.



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Darwin's frog (*Rhinoderma darwini*),  
Chile and Argentina / Photo by  
Michael and Patricia Fogden



Maud Island frog (*Leiopelma pakeka*), New  
Zealand / Photo by Phillip Bishop



*Nasikabatrachus sahyadrensis*  
(a frog), India / Photo by S.D. Biju



Seychelles palm frog (*Sooglossus*  
*pipilodryas*), Seychelles / Photo by Justin  
Gerlach



Southern gastric-brooding frog  
(*Rheobatrachus silus*), Australia /  
Photo by Michael J. Tyler



Table 2. Red List Assessment by Family

[source: 2004 Global Amphibian Assessment. [www.globalamphibians.org](http://www.globalamphibians.org)]

Family	TOTAL	EX	EW	CR	EN	VU	NT	LC	DD	% Threatened or Extinct
Allophrynidae	1	0	0	0	0	0	0	1	0	0
Ambystomatidae	30	0	0	9	2	2	1	13	3	43.3
Amphiumidae	3	0	0	0	0	0	1	2	0	0
Arthroleptidae	51	0	0	3	9	2	3	18	16	27.5
Ascaphidae	2	0	0	0	0	0	0	2	0	0
Astylosternidae	29	0	0	2	11	8	2	5	1	72.4
Bombinatoridae	10	0	0	0	1	4	0	5	0	50.0
Brachycephalidae	8	0	0	0	0	1	1	1	5	12.5
Bufonidae	476	5	1	85	71	52	26	171	65	45.0
Caeciliidae	113	0	0	1	1	1	0	41	69	2.7
Centrolenidae	138	0	0	6	16	29	10	28	49	37.0
Cryptobranchidae	3	0	0	1	0	0	2	0	0	33.3
Dendrobatidae	234	0	0	20	29	16	14	58	97	27.8
Dicamptodontidae	4	0	0	0	0	0	1	3	0	0
Discoglossidae	12	1	0	0	0	2	4	5	0	25.0
Heleophrynidae	6	0	0	2	0	0	0	4	0	33.3
Hemisotidae	9	0	0	0	0	1	0	4	4	11.1
Hylidae	804	1	0	71	64	47	27	431	163	22.8
Hynobiidae	46	0	0	5	10	12	2	11	6	58.7
Hyperoliidae	253	0	0	1	19	29	17	133	54	19.4
Ichthyophiidae	39	0	0	0	0	2	0	5	32	5.1
Leiopelmatidae	4	0	0	1	1	2	0	0	0	100.0
Leptodactylidae	1,238	2	0	145	247	172	61	351	260	45.7
Limnodynastidae	50	0	0	1	7	2	1	37	2	20.0
Mantellidae	158	0	0	7	12	16	12	77	34	22.2
Megophryidae	128	0	0	3	14	27	13	40	31	34.4
Microhylidae	430	0	0	6	27	39	18	177	163	16.7
Myobatrachidae	71	1	0	6	2	4	3	49	6	18.3
Nasikabatrachidae	1	0	0	0	1	0	0	0	0	100.0
Pelobatidae	4	0	0	0	1	0	1	2	0	25.0
Pelodytidae	3	0	0	0	0	0	0	3	0	0
Petropedetidae	102	0	0	3	13	8	10	39	29	23.5
Pipidae	30	0	0	1	2	0	1	21	5	10.0
Plethodontidae	365	1	0	36	82	58	37	91	60	48.5
Proteidae	6	0	0	0	1	1	1	3	0	33.3
Ranidae	666	2	0	19	61	82	60	295	147	24.6
Rhacophoridae	277	18	0	18	51	34	26	64	66	43.7
Rheobatrachidae	2	2	0	0	0	0	0	0	0	100.0
Rhinatreumatidae	9	0	0	0	0	0	0	4	5	0
Rhinodermatidae	2	0	0	1	0	1	0	0	0	100.0
Rhinophrynidae	1	0	0	0	0	0	0	1	0	0.0
Rhyacotritonidae	4	0	0	0	0	1	2	1	0	25.0



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### **Frightening Statistics!**

- 50 percent of ~6,000 described amphibian species, are threatened with extinction. 33 percent known to be threatened plus 23 percent data deficient but believed threatened mean ~3,000 species are in trouble.
- 122: minimal number of amphibian species believed to have already gone extinct.
- 500: estimated number of amphibian species whose threats currently cannot be mitigated quickly enough to stave off extinction, i.e., those who require *captive management* intervention.
- 10: number (not percentage) of amphibian species North American zoos are currently prepared to manage long term.
- 50: that same number extrapolated (extreme best-case scenario) to the global zoo community.
- 10 percent: portion of amphibian species threatened with extinction that the global zoo community is at best currently prepared to manage.

[source: AArk research and 2004 Global Amphibian Assessment. [www.globalamphibians.org](http://www.globalamphibians.org)]

### **Amphibians as indicators of environmental health and their contribution to humanity**

Amphibians profoundly enhance our lives and our world in countless ways. They provide vital biomedicines, including compounds that are being refined for analgesics, antibiotics, stimulants for heart attack victims, and treatments for diverse diseases including depression, stroke, seizures, Alzheimer's, and cancer. The Australian red-eyed treefrog (*Litoria chloris*) and relatives give us a compound capable of preventing HIV infection, the cause of AIDS.

Amphibians' thin skins help them drink and breathe, but also make them susceptible to environmental contaminants, particularly agricultural, industrial, and pharmaceutical chemicals. For example, atrazine is the most widely used herbicide in the United States with an estimated 61 to 73 million pounds used per year during the 1990s. Scientific studies have found that atrazine may cause a variety of cancers and act as an endocrine disruptor, mimicking the feminizing hormone estrogen and harming human and animal reproductive and hormone systems. Atrazine is generally applied in spring and can accumulate in amphibian breeding pools. Laboratory studies have shown that atrazine can chemically sterilize tadpoles at levels well below the EPA maximum allowable level for drinking water. Although lawsuits brought against the EPA by the Natural Resources Defense Council date back to 1999, the EPA announced on October 31, 2003, that it had negotiated a deal with industry that would not require any new restrictions on atrazine use.

Other organochlorine pollutants (e.g., DDT, PCBs, dioxins) can also act as endocrine disruptors, inducing similar feminizing effects in amphibians. It has been demonstrated that these responses are occurring in nature, but it is yet unclear what long-term effect they will have on wild populations.



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Amphibians have been likened to canaries in the coal mine: just as miners used sensitive canaries to warn them of toxic gases in the mines, amphibians might be warning us of unsafe environmental conditions that could eventually seriously impact our health. Could we be similarly affected by these widespread endocrine disruptors, or are we already? Atrazine, for example, has been detected in more than 1 million Americans' drinking water at levels higher than the EPA's drinking water standard. Some human studies suggest that the average sperm count of adult men in certain populations is significantly decreased, as much as 50 percent of what it was two generations ago. Are we also suffering the same feminizing effects of agrochemicals, industrial waste, and other estrogen-mimics that we see affecting amphibians so drastically?

Amphibians are also vital components of their ecosystems. In the 1970s, it was discovered that the northern redback salamander (*Plethodon cinereus*) was possibly the most abundant vertebrate in eastern U.S. forests, exceeding the biomass of all the bird or mammal species combined. Amphibians feed primarily on insects and other invertebrates. It was estimated that a single population of ~1,000 cricket frogs (*Acris crepitans*) could consume almost 5 million invertebrates in one year. Clearly they serve as significant predators of small invertebrates, as abundant prey for larger predators, and as a vital link in the food web between the two. In areas of the world where amphibians have declined, there has been an increase in invertebrate pests that damage crops and that carry human diseases.

Amphibians have also played a vital role in human culture. While in some cultures frogs and toads have been despised and regarded as evil, other cultures have embraced them as life-giving keepers of the rains or agents of fertility and good luck. Some simply use them for food. Amphibians have been both cherished and persecuted by different cultures as characters in fantasy stories, ingredients in folk medicine, and as spiritual beings.

**Geographic Patterns** [source: 2004 Global Amphibian Assessment. [www.globalamphibians.org](http://www.globalamphibians.org)]

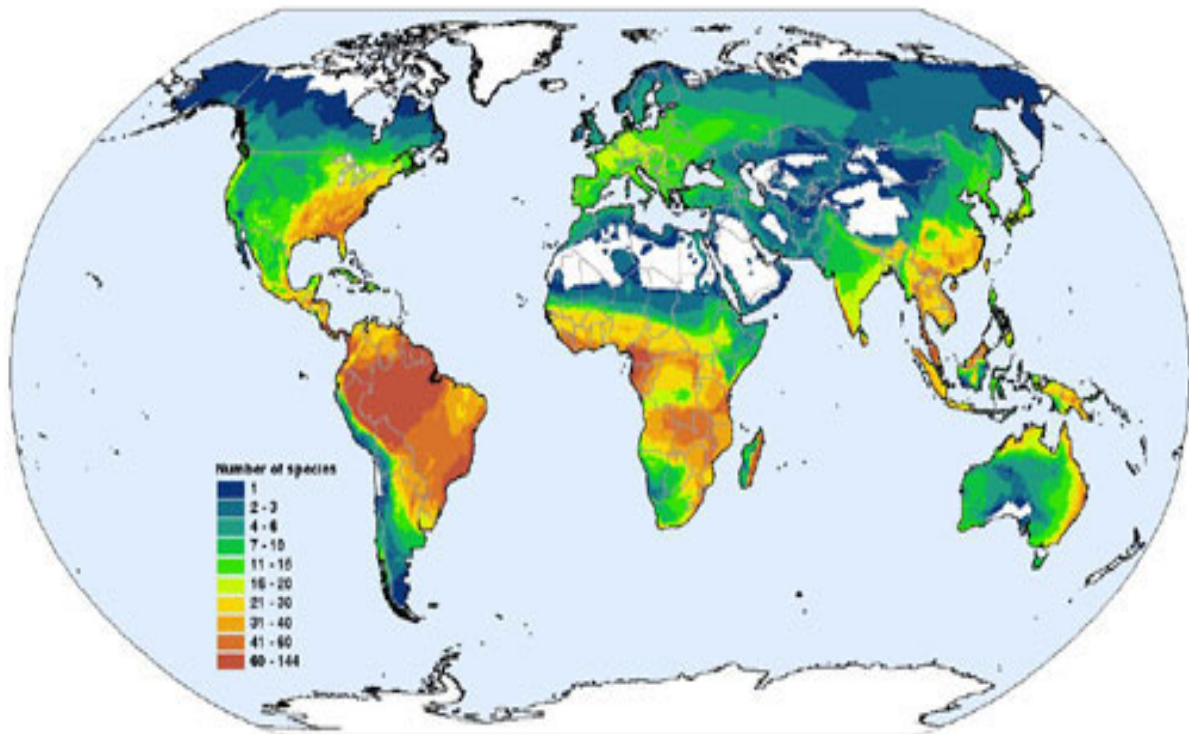
### **Diversity**

Global patterns of amphibian diversity are dramatically illustrated in Figure 3. This map clearly shows certain areas of high global diversity, including tropical South America and tropical West Africa. In contrast to the usual pattern of high species diversity occurring in the tropics, the southeastern United States is a global center for amphibian diversity, being particularly rich in salamanders. The problem of uneven survey efforts around the world, however, complicates interpretation of this map. Regions such as Indonesia, New Guinea, and the Congo Basin are especially likely to be underrepresented on this map due to lack of adequate surveys.





Figure 3. Global Diversity of Amphibian Species  
[source: 2004 Global Amphibian Assessment]



Looking at amphibian diversity from a country perspective, Brazil, with at least 751 species, has the greatest number of amphibians of any country on Earth, followed closely by Colombia. Table 3 lists the 20 most diverse countries and reveals some interesting findings. For instance, Colombia traditionally has been considered to be the richest country for amphibians, but has recently been surpassed by Brazil. Overall, though, these results must be considered in relation to the level of survey effort. Both Colombia and Brazil have received extensive survey efforts in recent decades, and although both countries can be expected to add significantly to their totals, the level of increase is likely to be less than in some of the other highly diverse countries. In South America, Peru in particular is relatively poorly sampled and is almost certain to rise very substantially in its species total, and can be predicted to pass the level of Ecuador. The diversity in Ecuador is, however, remarkable for such a small country.



Table 3. Countries with Most Amphibian Species  
[source: 2004 Global Amphibian Assessment]

Rank	Country	Total species
1	Brazil	751
2	Colombia	697
3	Ecuador	447
4	Peru	411
5	Mexico	363
6	Indonesia	347
7	China	326
8	Venezuela	298
9	United States	261
10	Papua New Guinea	244
11	India	239
12	Madagascar	226
13	Australia	214
14	Democratic Republic of the Congo	211
15	Bolivia	209
16	Malaysia	202
17	Cameroon	196
18	Panama	195
19	Costa Rica	179
20	Tanzania	162

Among the Old World countries, the level of survey effort is often much lower than in the Americas. Indonesia can be predicted to be the richest country outside the Americas, but it is doubtful if even half of its species are yet known. It may end up with a level of diversity comparable with Brazil and Colombia. The situation in India is set to change dramatically with over 100 species in the process of description. Very large increases in species totals can also be predicted for Papua New Guinea and the Democratic Republic of Congo, the latter country having received almost no amphibian survey work in the last 40 years.

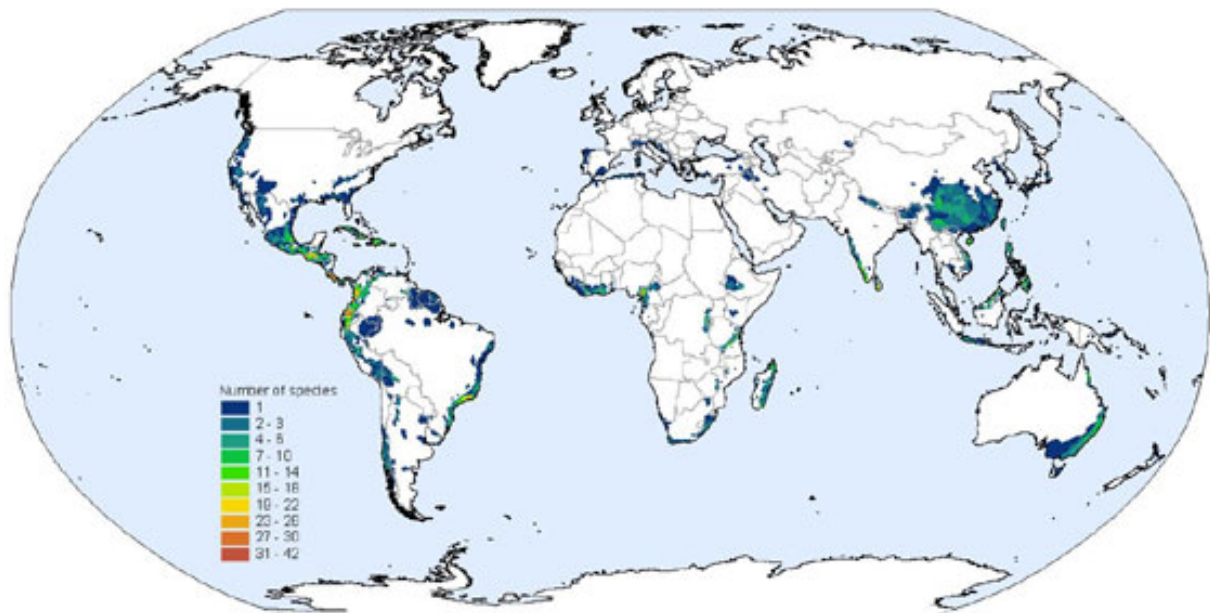
Countries that are not far behind that are set to pass the 200 species mark include Malaysia, Cameroon, Tanzania, Panama, Costa Rica, and Tanzania. The United States of America and Australia can be predicted to fall down the ranking over time, though the former will remain the most important country for salamanders, with the possible exception of Mexico.

**Geography of Threatened Species** [source: 2004 Global Amphibian Assessment.  
[www.globalamphibians.org](http://www.globalamphibians.org)]

A map showing the global distribution of threatened amphibians (Figure 4) reveals patterns very different from depictions of overall species diversity. The greatest concentration of such species—including well over half of the currently known threatened amphibians—is in a relatively limited area running from southern Mexico south to Ecuador and Venezuela, and in the Greater Antilles (details in Figure 5). This region is dominated by species with small ranges, often living in montane areas. Many of these species have been subjected to severe habitat loss, and exposure to the fungal disease chytridiomycosis.

Other important concentrations of threatened species are in the Atlantic Forests of southern Brazil (Figure 6), the Upper Guinea forests of western Africa, the forest of western Cameroon and eastern Nigeria (Figure 7), the Albertine Rift of central Africa, the Eastern Arc Mountains of Tanzania, East Africa and Madagascar (Figure 8), the Western Ghats of India, Sri Lanka (Figure 9), central and southern China, Borneo (Figure 10), the Philippines (Figure 10) and eastern Australia.

Figure 4. Global Distribution of Threatened Amphibians  
[source: 2004 Global Amphibian Assessment]





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Frogs Matter.  
*Jump In.*

Figure 5. Distribution of Threatened Amphibians in Central America, Northern South America, and the Caribbean [Source 2004 Global Amphibian Assessment]

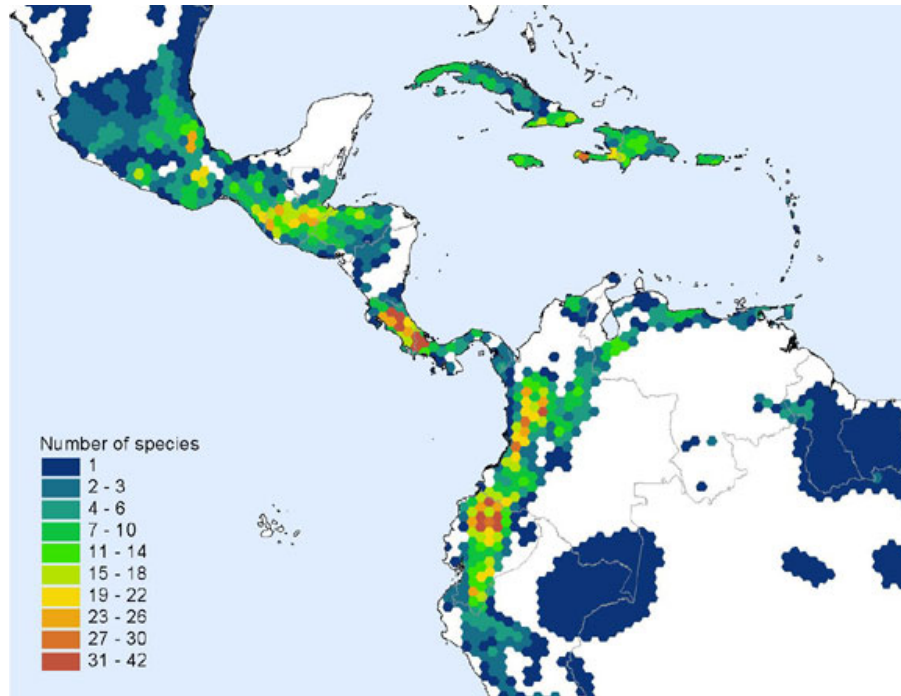


Figure 6. Distribution of Threatened Amphibians in the Atlantic Forest of Brazil. [Source 2004 Global Amphibian Assessment]

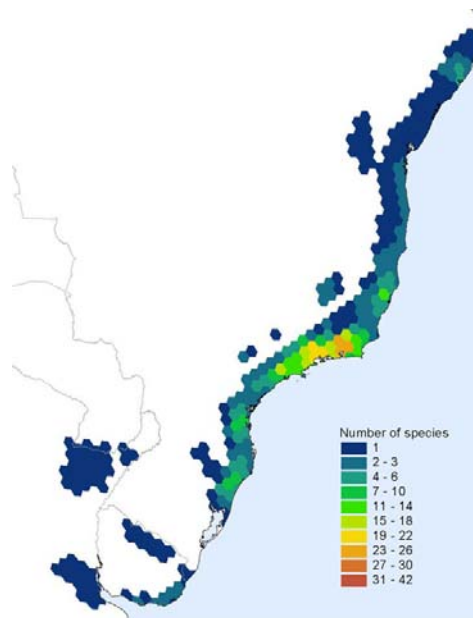




Figure 7. Distribution of Threatened Amphibians in Cameroon and West Africa.  
[Source 2004 Global Amphibian Assessment]

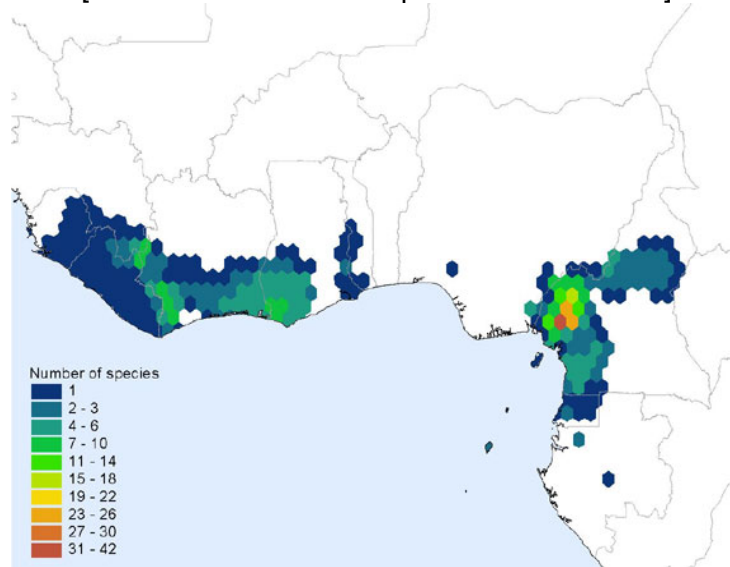


Figure 8. Distribution of Threatened Amphibians in Madagascar and Eastern Africa.  
[Source 2004 Global Amphibian Assessment]

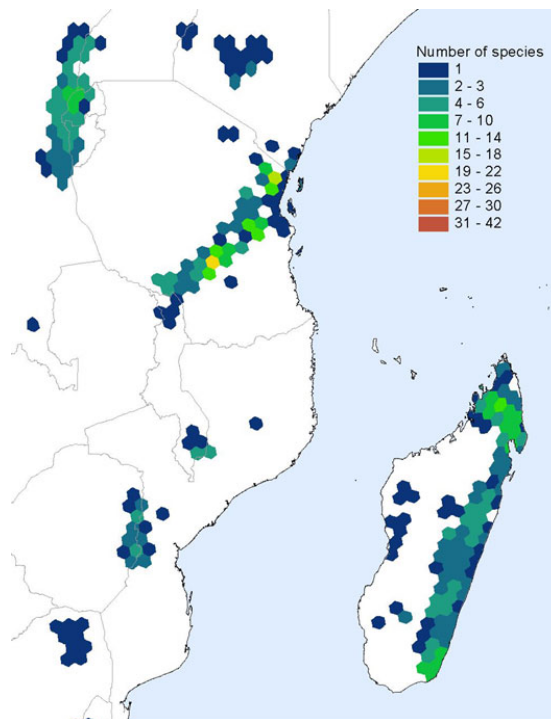




Figure 9. Distribution of Threatened Amphibians in Southern India and Sri Lanka.  
[Source 2004 Global Amphibian Assessment]

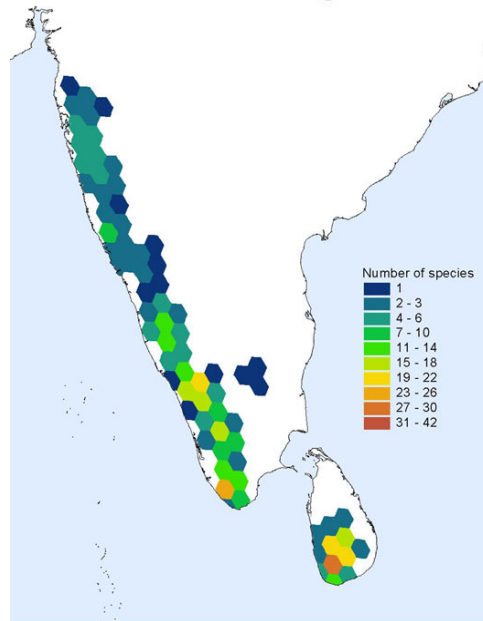


Figure 10. Distribution of Threatened Amphibians in Borneo and the Philippines.  
[Source 2004 Global Amphibian Assessment]

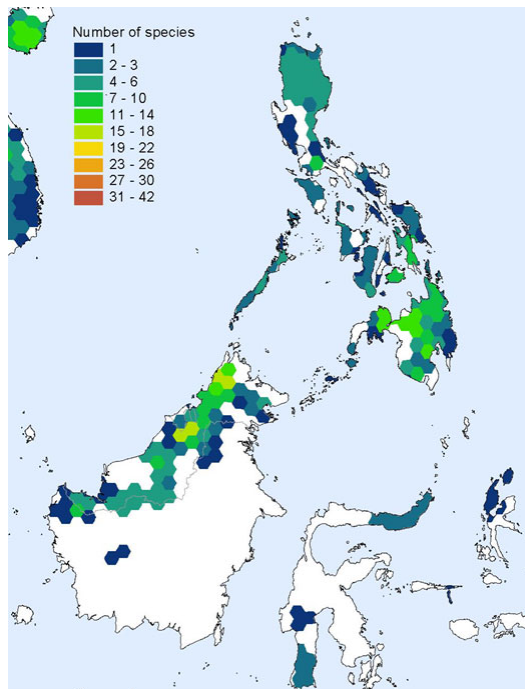


Table 4 lists the 20 countries with the highest number of threatened amphibians. These countries are in many cases different from those listed in Table 3, suggesting that either amphibians in some countries are more susceptible to threats, that threats vary between countries, or that there are other factors influencing the distribution of threatened species.

Table 4. Countries with Highest Number of Threatened Amphibians  
[Source 2004 Global Amphibian Assessment]

Rank	Country	Threatened Species
1	Colombia	209
2	Mexico	196
3	Ecuador	163
4	Brazil *	110
5	China	88
6	Peru	81
7	Guatemala	76
8	Venezuela	69
9	India	66
10	Costa Rica	61
11	Honduras	55
11	Madagascar	55
11	Panama	55
14	Cameroon	53
15	Sri Lanka	52
15	United States of America	52
17	Philippines	48
18	Australia	47
18	Cuba	47
20	Haiti	46
20	Malaysia	46

The countries listed in Table 4 have a particularly great responsibility for protecting the world's threatened amphibians. Colombia, the second-most diverse country, has the highest number of threatened species. The major threats to amphibians in Colombia are habitat loss although there have been many as yet unexplained declines also occurring, and the dramatic topography of the Andes means that many of the amphibians have very restricted ranges making them more vulnerable to threatening processes. Brazil, the most diverse country, is ranked only fourth for number of species threatened, most of which are in the Atlantic Forest region, and has a significantly lower percentage of its amphibians threatened than the global average\* (see note below.).

\* *It should be noted that for certain species endemic to Brazil, it has not yet been possible to reach agreement on the Red List Categories between the GAA Coordinating Team, and the experts on the species in Brazil. The Red List Categories displayed for individual species are those that were agreed at the GAA Brazil workshop in April 2003. However, in the subsequent consistency check conducted by the GAA Coordinating Team, many of these were found to be inconsistent with the approach adopted elsewhere in the world. Under the notes on Red Listing for each species, the likely consistent Red List Category is given for these species, and it is these consistent Red List Categories that are used in the analyses presented here.*

Considering the percentage of a country's amphibian fauna that is threatened provides a stark contrast to the previous table, which focuses on the number of threatened species. Table 5 lists the countries with the highest percentage of threatened amphibians.

Table 5. Countries with Highest Percentage of Threatened Amphibians  
[Source 2004 Global Amphibian Assessment]

Note: only countries with 10 or more species are included.

Rank	Country	% Threatened
1	Haiti	92.0%
2	Dominican Republic	86.1%
3	Jamaica	81.0%
4	Cuba	79.7%
5	Puerto Rico	72.2%
6	Sri Lanka	62.7%
7	Guatemala	55.1%
8	Mexico	54.5%
8	Seychelles	54.5%
10	Philippines	49.0%
11	Honduras	47.4%
12	Ecuador	36.5%
13	Chile	36.4%
14	Japan	35.7%
15	Turkey	34.6%
26	Costa Rica	34.1%
17	Colombia	30.0%
18	Panama	28.2%
19	El Salvador	28.1%
20	India	27.6%

The top five countries are all in the Caribbean, and at least 70 percent of all the amphibians in these countries are threatened. Compared to other regions, the Caribbean stands out as the region with by far the highest percentage of threatened species. This is mostly a result of extensive habitat loss as well as some incidents of disease, in particular in Puerto Rico. In Mexico, ranked fifth for diversity, but second for the number of threatened species, more than 50 percent of amphibians are threatened. Severe habitat loss as well as disease outbreak in some regions are the main threats. Most of the other countries in Table 5 are in Central or South America. The main causes of threat here are also disease and habitat loss.





**Patterns of Endemism** [source: the Global Amphibian Assessment. [www.globalamphibians.org](http://www.globalamphibians.org)]

The number and percentage of endemic amphibians by country shows some important patterns. Table 6 lists the 20 countries with the largest numbers of endemic species (i.e., occurring in no other countries), while Table 7 lists the twenty countries with the highest percentage of endemism.

Table 6. Countries with the Most Endemics  
[Source 2004 Global Amphibian Assessment]

Rank	Country	Country Endemics
1	Brazil	489
2	Colombia	337
3	Mexico	246
4	Madagascar	225
5	Australia	200
6	United States of America	182
7	Peru	181
8	China	171
9	Papua New Guinea	164
10	Indonesia	161
11	Ecuador	159
12	Venezuela	155
13	India	154
14	Philippines	77
15	Sri Lanka	67
16	Tanzania	65
17	Cuba	57
18	Malaysia	56
19	Cameroon	55
20	Bolivia	53
20	Democratic Republic of the Congo	53



Table 7. Countries with the Highest Percentage of Endemics  
[Source 2004 Global Amphibian Assessment]

Rank	Country	% Endemics
1	Jamaica	100%
2	Seychelles	100%
3	Sao Tome and Principe	100%
4	New Zealand	100%
5	Fiji	100%
6	Palau	100%
7	Madagascar	99.6%
8	Cuba	96.6%
9	Australia	93.5%
10	Sri Lanka	80.7%
11	Japan	80.4%
12	Philippines	78.6%
13	Puerto Rico	77.8%
14	United States of America	69.7%
15	Chile	69.1%
16	Mexico	67.8%
17	Papua New Guinea	67.2%
18	Brazil	65.1%
19	India	64.4%
20	China	52.5%

To a considerable extent, the countries with the largest number of endemic species (Table 6) match those with the largest total diversity of species (Table 3), which is not surprising. However, it is noteworthy that several island countries that do not appear in Table 3 do appear in Table 6: Sri Lanka; the Philippines; and Cuba. Brazil and Colombia have many more endemics than any other countries, with Mexico, Madagascar, and Australia each having 200 or more endemics.

The percentage of endemism (Table 7) shows a very different pattern, with six island countries each having 100 percent endemism (none of these with very diverse amphibian faunas). Of the countries with high amphibian diversity (Table 3), Madagascar and Australia (both essentially very large islands) stand out with by far the highest levels of endemism.

In Figure 10, a preliminary look at Endemic Amphibian Areas is provided. This map is based on the same approach adopted by BirdLife International <http://www.birdlife.org/> in defining Endemic Bird Areas (EBAs) <http://www.birdlife.org/datazone/ebas/>. We define an Endemic Amphibian Area as any place where at least two species with ranges of less than 50,000 km<sup>2</sup> overlap. About 70 percent of amphibians have ranges of less than 50,000 km<sup>2</sup> compared with just 25 percent of bird species.

Figure 10. Endemic Amphibian Areas  
[Source 2004 Global Amphibian Assessment]

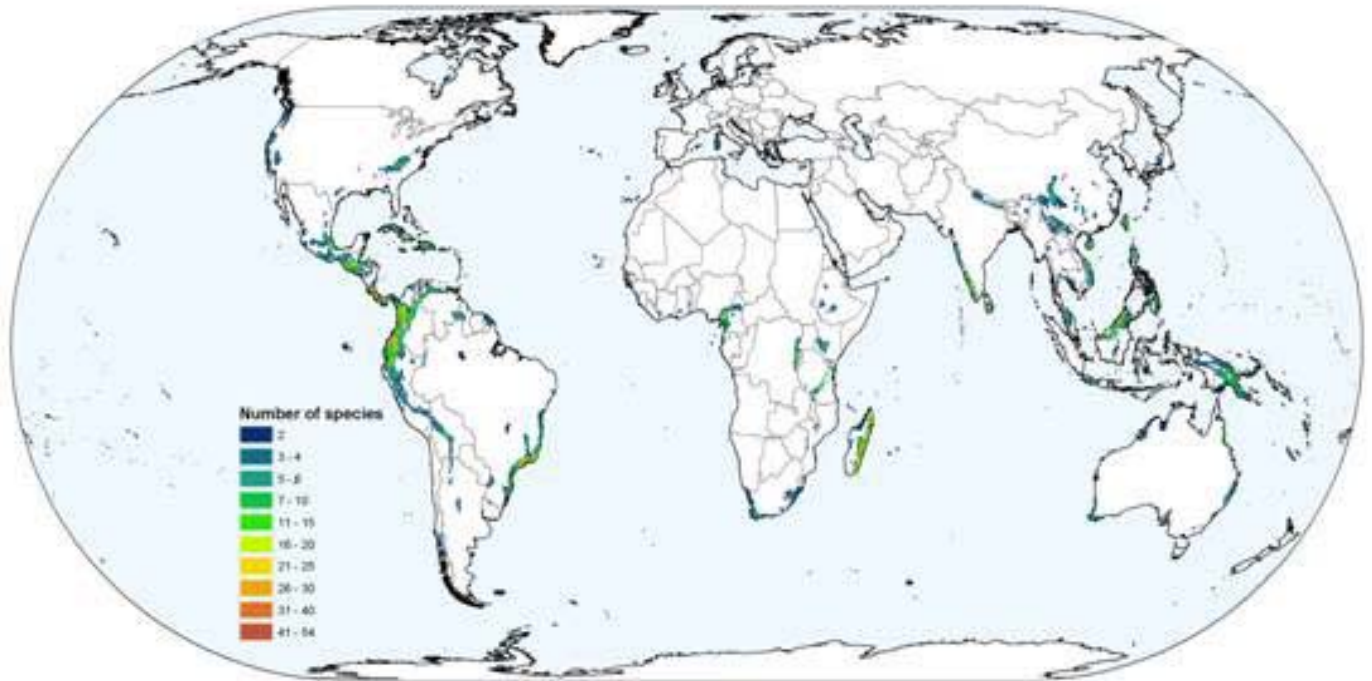


Figure 10 looks remarkably similar to the global map of Endemic Bird Areas (and also to other priority-setting mechanisms such as CI's Hotspots <http://web.conservation.org/xp/Hotspots/hotspotsScience/>). Clearly, amphibians with small ranges are concentrated in generally the same areas as birds. Preliminary results for mammals reveal a very similar pattern as well, suggesting some fundamental biogeographic patterns that tend to span diverse taxonomic groups, with different life history patterns, and different alpha-beta diversity tendencies. These fundamental patterns are clearly key to guiding the development of conservation strategies in the future. A few differences are apparent, though, the most notable being the Appalachian Mountains in the eastern United States of America, which are the world's center of salamander diversity and endemism, and are also extremely rich in other aquatic life forms, such as freshwater fishes, turtles, mussels, and crayfishes.

Our analysis of Endemic Amphibian areas includes Data Deficient species, which perhaps should have been omitted, since these include a number of species currently known only from their type localities, but which may be more widespread. We suspect that if these Data Deficient species are removed, some of the Endemic Amphibian Areas in places such as the Amazon and Congo basins would disappear, resulting in a map even more similar to that of Endemic Bird Areas.



## Chytrid Fungus

Chytrid fungi were once thought to be predominantly free-living saprophytes, with a few species capable of infecting only invertebrates and vascular plants. In 1998, a new species – *Batrachochytrium dendrobatidis* (hereafter Bd) – was described infecting amphibians. Bd has now been identified in association with amphibian die-offs on every amphibian-inhabited continent. From the site of its introduction, it generally spreads in a wave-like fashion at 28-100km/yr, often destroying entire amphibian communities as it goes. Where it thrives (generally cooler riparian habitats), 50 percent of species and 80 percent of individuals can be expected to disappear within one year. It cannot be stopped in the wild, and it persists for an unknown period of time even after the amphibians disappear. A few species seem able to live with it as adults, likely serving as reservoirs and vectors for future outbreaks. An element of hope: while many species disappear, at least one that declined appears to be coming back after 10 years. For a detailed accounting of Bd and a model regional response, see the Australian's Threat Abatement Plan <http://www.deh.gov.au/biodiversity/threatened/publications/tap/amphibians/pubs/amphibians.pdf> and Action Plan for Australian Frogs <http://www.deh.gov.au/biodiversity/threatened/action/frogs/>

The only way to avoid getting chytrid fungus in your collection is to never bring in another amphibian, from the wild (global or local) or from any other facility (zoo, commercial, lab, etc.). Obviously, this practice would make it impossible for any conservation institution to function! The realistic way to proceed is to do what most/all institutions are already doing – quarantine all incoming amphibians. Many tropical amphibians will be dead by the time a problem is visibly detected; incubation time can be 9-76 days, with most succumbing in 18-48 days. But if animals are suspected to be positive, or just as prophylaxis, an established treatment can be started as soon as they arrive. For others, and for those that die, specimens can be tested for chytrid infection. A simple skin scraping viewed under a microscope can suffice to indicate spores (see online article <http://www.jcu.edu.au/school/phtm/PHTM/frogs/papers/briggs-2003.pdf>), histology of samples from the deceased can also confirm infection (see online instruction <http://www.jcu.edu.au/school/phtm/PHTM/frogs/histo/chhisto.htm>). The surest technique is the PCR test. Swabbing techniques to collect samples for PCR and a demonstration video are included in this on line <http://www.amphibiaweb.org/aw/chytrid/index.html>.

Note: all zoos get chytrid sooner or later! While it does require a swift, thorough response, it is not the end of the world. You have probably already had it in your collection and not even known it. The key to managing chytrid is to test all suspicious sick and dead animals, and treat the survivors accordingly. Treating chytrid in captivity is easy and effective; it is the wild situation that is causing us gray hairs!



## Amphibians Role in Culture and Religion

Humans have viewed amphibians in a variety of fascinating roles. While in some cultures frogs and toads have been despised and regarded as evil, other cultures have embraced them as life-giving keepers of the rains or agents of fertility and good luck. Some simply use them for food. Amphibians have been both cherished and persecuted by different cultures as characters in fantasy stories, ingredients in folk medicine, and as spiritual beings (see section by Adler in Hutchins 2003, also Hofrichter 2000).

**Pre-biblical** Shamanism, dating back to the Stone Age, is believed to have given rise to all religions. The Shaman was the leader whose essential role was that of mediator between his people and the spirit world. Toads were important to the Shaman for their symbolic value and for creating hallucinogenic brews. In early Asiatic cultures and in the pre-Columbian civilizations of the Americas the toad was regarded as a divinity, the great Mother Earth, the source and the end of all life. The Egyptian goddess of childbirth, Heqet, is usually pictured with a frog's head. Lamps and amulets with frog shapes were placed in Egyptian tombs to repel demons from the underworld.

**The Bible.** Christian religion does not portray amphibians in such a positive light. One of the plagues of Egypt was an army of frogs sweeping over the land. Note though that the plague of the frogs' mass exodus from water preceded by plague of water pollution and succeeded by plague of insects – how prophetic!

I will smite with the rod that is in my hand upon the waters which are in the river, and they shall be turned to blood. And the fish that are in the river shall die, and the **river shall become foul**, and the Egyptians shall loathe to drink water from the river. (Exodus, 7:15-22)

And if thou refuse to let them go, behold, I will smite all thy borders with **frogs**. And the river shall swarm with **frogs**, which shall go up and come into thy house, and into thy bed-chamber, and upon thy bed, and into the house of thy servants, and upon thy people, and into shine ovens, and into thy kneading-troughs. And the **frogs** shall come up both upon thee, and upon thy people, and upon all thy servants. (Exodus, 7:28-29) And Aaron stretched out his hand over the waters of Egypt; and the **frogs** came up, and covered the land of Egypt. (Exodus, 8:2)

And the LORD said unto Moses: 'Say unto Aaron: Stretch out thy rod, and smite the dust of the earth, that it may become **gnats** throughout all the land of Egypt.' And they did so and Aaron stretched out his hand with his rod, and smote the dust of the earth, and there were gnats upon man, and upon beast; all the dust of the earth became gnats throughout all the land of Egypt . (Exodus, 8:12-13)



**Middle ages.** Since the Middle Ages, witches and toads have been closely connected. By some accounts, witches cohabited with and even dressed their amphibian associates. Chemicals in the toads' skin made them popular ingredients in magical concoctions. In Shakespeare's *Macbeth*, the witches chant:

*Round about the cauldron go;  
In the poison'd entrails throw.  
**Toad**, that under cold stone  
Days and nights has thirty-one  
Sweltered venom sleeping got*

*Boil thou first i' the charmed pot.  
Double, double toil and trouble;  
Fire burn and cauldron bubble.  
Fillet of a fenny snake,  
In the cauldron boil and bake;  
Eye of **newt** and toe of **frog**,  
Wool of bat and tongue of dog,  
Adder's fork and blind-worm's sting,  
Lizard's leg and owlet's wing,  
For a charm of powerful trouble,  
Like a hell-broth boil and bubble.*

**Modern indigenous cultures.** The hunters in some indigenous tribes of the Amazon rub the skin secretions of the giant monkey frog (*Phyllomedusa bicolor*) into self-inflicted burns. The toxins in the skin secretions induced nausea and hallucinations in the hunters, who claim to then have heightened awareness and increased hunting success (Daly et al. 1992). Aborigines use waterholding frogs (genus *Cyclorana*) as a water source during drought; they dig in dried-up ponds until they find the cocooned amphibians, then squeeze the bladder-stored water out into their mouths. The Amerindians of Columbia rub their hunting darts across the backs of golden dart frogs (*Phylllobates terribilis*), or sometimes stab the frogs with the darts, to poison the dart and create a deadly projectile with which to shoot monkeys from the canopy (Myers et al. 1978).

**Popular culture.** Kermit the frog, one of the original Jim Henson Muppets, made his television debut in 1955. He continues to charm children of all ages with his talent, warmth, and sincerity.

Some notable Kermit quotes:

*"I'm a very lucky frog. I've gone everywhere, done a lot of fun things, and I've met a lot of really nice people. It doesn't get any better than that."*

*"It's not easy being green."*

*"It seems to me that if you wait until the frogs and toads have croaked their last to take some action, you've missed the point."*



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Frogs Matter.  
*Jump In.*

Other pop culture amphibians include the Michigan J. Frog and the Budweiser Frogs. Frogs also show up in stories like the Frog Prince, the Adventures of Frog and Toad, and the Celebrated Jumping Frog of Calaveras County.

**Cultural abuses.** Biology classes in high schools and colleges generally require a frog dissection laboratory. Some involve using preserved animals; others require the students to kill the frogs with an overdose of ether, by decapitation, or by pithing (scrambling the animal's brain with a sharp wire). None of these options is humane. In any case, the animals have almost certainly been collected from the wild by biological supply companies, usually by the thousands from one small area of habitat. Such overcollecting is likely not sustainable. Most students do not need to dissect frogs or other animals. The career paths they will follow will have nothing to do with animal anatomy. They can learn everything they need to know from detailed textbooks and videos. For those students planning a career in zoology or medicine who need that information, there are alternatives. Video recordings of dissections and virtual dissections are viable options that are readily available. A Yahoo search for 'virtual frog dissection' yielded over 10,000 results, including:

[curry.edschool.virginia.edu/go/frog/](http://curry.edschool.virginia.edu/go/frog/)  
[www-itg.lbl.gov/ITG.hm.pg.docs/dissect/info.html](http://www-itg.lbl.gov/ITG.hm.pg.docs/dissect/info.html)  
[www.froguts.com/flash\\_content/index.html](http://www.froguts.com/flash_content/index.html)  
[step.sdsc.edu/projects95/Frog.Dissection/](http://step.sdsc.edu/projects95/Frog.Dissection/)

In those cases where it is absolutely necessary for the student to use animals, for example, a medical student studying the effect of a new drug on the physiological interactions between nerves and muscles, farm-raised frogs are readily available ([www.ranaranch.com](http://www.ranaranch.com), [www.researchamphibians.com](http://www.researchamphibians.com)) and can be euthanized humanely with an appropriate anesthetic (see monograph on diseases).

Another cultural abuse is the consumption of frog legs as human food. The United States consumes over 1.25 million pounds of frog legs annually, primarily from the American bullfrog. Some bullfrog ranches exist, and frog-farming is far better for the environment (in terms of pollution) than raising beef or chicken. However, most of the frogs for restaurants are wild-caught. The method of collection is quite inhumane – a practice called 'gigging' in which the animal is skewered alive on a barbed, metal stick before its legs are cut off and it is tossed back to the water to die. If you choose to order frog legs in a restaurant, ask and make sure they were farm-raised. Unfortunately, bullfrogs have been introduced for human food into places outside their natural range, including Hawaii, many Caribbean islands, Mexico, Venezuela, the Netherlands, Italy, Java, Japan, Thailand, China, and throughout the western United States. Introduced bullfrogs compete with or eat the native animals, and often bring in new diseases. There is a great *discussion* of frog leg consumption at *AmphibiaWeb*:



*“In the 1990’s, Europe imported 6,000 metric tons of frog legs each year (Jensen and Camp 2003). Between 1981 and 1984, the United States imported more than 6.5 million pounds (3 million kg) of frog meat per year. That is the equivalent of approximately 26 million frogs (Jensen and Camp 2003). Asia is the second largest market for frog leg consumption, where the most common species consumed is the Chinese Edible Frog, *Hoplobatrachus rugulosus* (Jensen and Camp 2003). In just one year, over 6 million Chinese Edible Frogs were imported to Hong Kong from Thailand (Wai-Neng Lau et al. 1999). It is presumed that all these frogs are being collected from the wild since most of the frog farms in Thailand only raise American bullfrogs (Wai-Neng Lau et al. 1999). Given the sheer number of frogs collected, this species is likely being overharvested and if this practice continues could wipe out remaining wild populations.*

*Overharvesting has had devastating effects on amphibians in the United States. In the West, the California red-legged frog, *Rana draytonii*, began to be exploited for food during the gold rush of 1849 and heavy harvesting continued until the early 1900s (Jennings and Hayes 1985). By the mid-1870s, their numbers had been significantly depleted in the vicinity of San Francisco (Lockington 1879). The overharvesting of this species was driven by a significant commercial demand. Frog legs from California were selling for \$4.09/lb in France at the turn of the century. California red-legged frogs are currently listed as federally threatened and are no longer being harvested, but their populations are still in trouble. To compensate for diminishing wild populations, people began to farm and also release into the wild American bullfrogs, *Rana catesbeiana* (Jennings and Hayes 1985). Today, American bullfrogs pose a serious threat to red legged frog populations (see introduced species page).” See also the chapter in Hofrichter (2000).*

## Literature Cited

- Daly, J.W., J. Caceres, R.W. Moni, F. Gusovsky, M. Moos Jr, K.B. Seamon, K. Milton, C.W. Myers. 1992. Frog secretions and hunting magic in the Upper Amazon: identification of a peptide that interacts with an adenosine receptor. *Proceedings of the National Academy of Sciences* 89:1096-3.
- Hofrichter, R (ed.). 2000. *Amphibians: The World of Frogs, Toads, Salamanders and Newts*. Buffalo: Firefly Books.
- Hutchins, M., W.E. Duellman, N. Schlager (eds.). 2003. *Grzimeck’s Animal Life Encyclopedia*, 2<sup>nd</sup> Ed. Vol.6, Amphibians. Farmington Hills, MI: Gale Group.
- Myers, C.W., J. Daly, B. Malkin. 1978. A dangerously toxic new frog (*Phyllobates*) used by Emberá Indians of western Colombia, with discussion of blowgun fabrication and dart poisoning. *Bulletin of the American Museum of Natural History* 161:307-66.