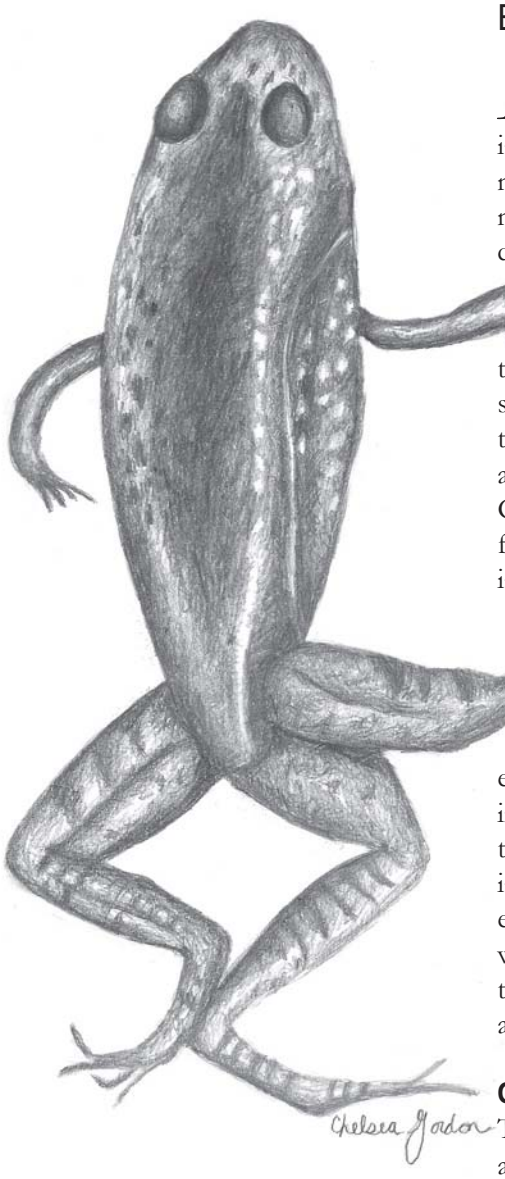
THE CANARY



"Amphibians are an important indicator species about the environment because their highly permeable skins are very sensitive toenvironmental changes in air and water quality."

By Nan Zhu

Appearing before humans, mammals, or even dinosaurs, amphibians have lived on earth for over 350 million years. Through drastic environmental changes that have led to the demise of thousands of other species, amphibians have always managed to survive. However, over the past fifty years, scientists have observed a disturbing rapid decline of these animals at a rate of four percent a year across the globe. Recently, the Global Amphibian Assessment released findings that one-third of the amphibian species on Earth are being threatened with extinction (1). These alarming trends have led scientists to believe that the dwindling numbers of amphibians raise a red flag about what impact environmental dangers, such as global warming, ozone depletion, and pollution, may have for both these creatures and for all living things on earth.

Global Trends

The global decline of amphibians is not a new problem. In 1989, international concern for these animals first surfaced during the First World Congress of Herpetology, where scientists shared anecdotal evidence about observed amphibian declines. One isolated survey at the time concerning Costa Rica's Monteverde Cloud Forest saw a stable amphibian population in 1987 crash by 40% in just 2 years (2).

However, the lack of a comprehensive picture on the decline still left many scientists skeptical. Recently, this has led to the World Conservation Union's Global Amphibian Assessment (GAA) to gather data on the population trends and threats of the 5743 species of amphibians currently known to scientists. In December of 2004, the GAA's 3-year survey found that 32% of all amphibian species face extinction, compared to 12% in bird species and 23% in mammal species (1). Most declines occur in tropical areas where biodiversity is greatest, but decreases in amphibian population have been observed everywhere, including the United States and Western Europe (3). In addition to this decline in amphibian population, there has also been an increase in genetic deformities, in which frogs with extra limbs and other visible physical problems have been found in areas with widespread use of pesticides and toxic chemicals.

Although most causes of these trends have been attributed to deforestation, pollution, habitat loss, and climate change, more than 200 amphibian species are also showing rapid and "enigmatic" declines, probably linked to weather patterns, disease, and other factors. In one case, the Chinese giant salamander, the largest amphibian in the world at six feet long, has disappeared from nearly all its range due to its use as a delicacy in China. Scientists estimate that overall, the conservation status of 435 amphibian species has worsened since 1980 (2).

Perhaps most alarming is the fact that the rapid drop being observed is the equivalent of a hundred thousand years' worth of extinctions in just a century (3). These results and other quantitative data suggest that the declines of amphibians over several decades are well beyond the natural geographic and temporal population fluctuations normally observed in such animals.

credit: Chelsea Gordon, HSR

IN THE COAL MINE

Environmental challenges from an amphibian point's of view

Why are Amphibians Important? The Canary Metaphor

So, why should people care about amphibians? Amphibians are an important indicator species about the environment because their highly permeable skins are very sensitive to environmental changes in air and water quality. While humans breathe through the lungs, which are inside us and protected from direct contact with air and waters, amphibians breathe partially through their skin, which is constantly exposed to the outside. Thus, their bodies are much more vulnerable to disease, pollution, toxic chemicals, radiation, and habitat destruction.

According to Russell Mittermeier, president of Conservation International: "Amphibians are one of nature's best indicators of overall environmental health. Their catastrophic decline serves as a warning that we are in a period of significant environmental degradation" (4). Just like canaries in coal mines whose death alerted mine workers of increasing toxicity in the mine, amphibians are serving as the "canaries" of the earth.

Causes of Amphibian Decline: Habitat Loss

Of all the causes of amphibian decline, habitat loss due to human exploitation of land is by far the most significant. Agriculture, deforestation, and wetland draining are all contributing to the overall decline.

In one study, scientists observed species diversity and abundance in salamander populations between clear-cut forest areas and mature forests. Salamander populations were five times lower in areas where forests had been cut down. In fact, it is estimated that annually, 14 million salamanders are lost due to clear-cutting of national forests in the U.S. (6).

Vast wetland drainage around the world is also a significant problem. Wetlands serve as interfaces between land and water bodies, and are extremely productive ecosystems that provide feeding and breeding grounds for reptiles, amphibians, waterfowl, mammals and invertebrates. In addition to the species diversity present in wetlands, they also serve as a water purification system that filters contaminants, and contribute to flood control by protecting shorelines from erosion. Many of the animals in wetlands are located at the bottom of the food web. Thus, the decline of amphibian populations in these areas has wide-ranging implications for the biodiversity of hundreds of other species. In the Great Lakes area alone, two-thirds of the coastal wetlands have been lost due to land development for agriculture and urban expansion (7).

Environmental Effects: Global Warming and Pollution

Global climate changes also pose threats to amphibian populations. Temperature and moisture impact amphibian biology directly. Body temperature determines amphibian heat exchange with the environment, and water availability, especially in arid regions of the world, directly determines survival of both larvae and adult amphibians (8).

In a Costa Rican cloud forest, researchers showed that extended dry periods associated with global warming were related to amphibian decline. In such forests, global warming has decreased the amount of mist precipitation in the forest, and hthis decrease in moisture has posed a stress on amphibians, making them more susceptible to pathogens. In addition, studies

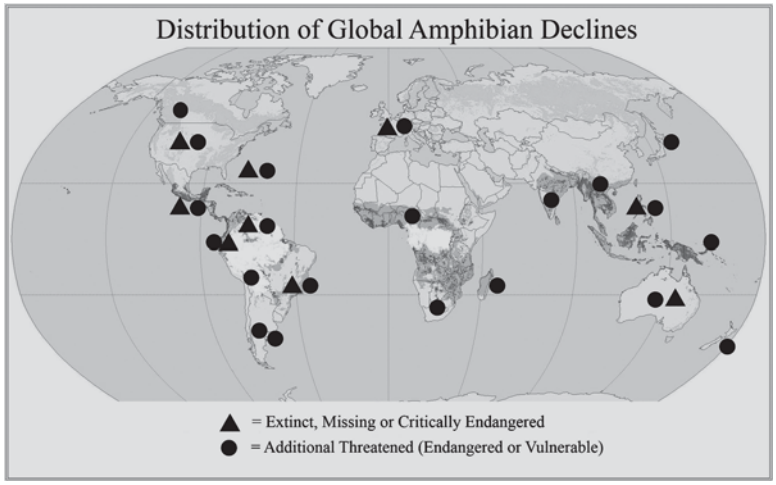


Figure 1. Distribution of Global Amphibian Decline. Of all the causes of amphibian decline, habitat loss due to human exploitation of land is by far the most significant. Agriculture, deforestation, and wetland draining are all contributing to the overall decline.

credit: Pimkwan Jaru-ampornpan, HSR

have shown that amphibians are responding to climate change by breeding earlier, which disrupts their lifecycle and their ability to produce a sustainable population (4).

Increases in ultraviolet-B (UV-B) radiation from ozone depletion may also be contributing to amphibian declines. The disruptions in DNA caused by UV-B often lead to cell suicide and to a host of subsequent developmental problems. It has been shown that hatching success rates of amphibians is lower when they are exposed to UV-B than those that are shielded from it. In addition, UV-B is also contributing to the increase in physical deformities in amphibians that have been observed worldwide (4).

Toxic chemicals such as pesticides, fertilizers, and other pollutants are also the cause of deformities and deaths. Chemicals act as immunosuppressors and endocrine disrupters, causing greater amphibian susceptibility to illness and changes in development and behaviors. Nitrogenous fertilization, combined with acid pollution, has caused mortality rates to increase in amphibians through their decrease of water pH alone. In many cases, multiple environmental factors act in synergism to increase the stress imposed on amphibians. Chemical contaminants that absorb a strong portion of the UV spectrum can become phototoxic, and the negative effects on amphibians are greatly increased (4).

Invasive Species and Fungal Diseases

The effect of invasive, nonnative species also contributes to the decline in amphibian populations. Invasive species prey upon amphibians, compete with them for resources, and introduce new diseases. In western North America, bullfrogs have contributed to the loss of many native amphibians. In California, mosquitofish and crayfish have become predators of larval newts. Many of these species can also infect amphibians with pathogens (4).

One of the most deadly pathogens for amphibians is the fungal disease chytridiomycosis. First appearing 20 years ago in Australia and Central America, it has now spread to amphibians around the world. Eight species have become extinct, and 113 species have disappeared from the wild. Scientists believe that once again, the culprit is the warming of the global climate, which has allowed for the fungus to persist and spread (9).

Solutions and Controversies

Scientists and conservationists worry that by focusing attention on amphibians, many people in the global community may believe that the problems causing their decline is unique only to those animals. In truth, factors such as climate change, pollution, loss of habitat, and UV-B radiation are harmful to many other animals as well. Even the prevalence of chytridiomycosis, which is specific to amphibians only, reflects similar increases in disease among other wildlife populations. Thus, efforts to reduce declines in amphibians could also have wide-ranging effects on other animals.

Captive Breeding and Habitat Conservation

The Global Amphibian Assessment, with support from the United Nations' biodiversity agency IUCN, in its September 2005 meeting, has developed a plan to breed amphibians in captivity. In their $400 million dollar plan to increase amphibian populations, they have proposed that approximately 1000 species be bred at special facilities on every continent. But, while success stories such as the reintroduction of the Mallorcan midwife toad have been possible, many captive breeding programs have failed (10).

According to Cynthia Carey of the University of Colorado, "Many species can't be bred in captivity, and with 99% of the species they're looking at, we just don't know how to do it" (10). In fact, a captive breeding program of the boreal toad by Professor Carey's researchers has failed to re-introduce the animals to the wild eight times. Therefore, it is important to address the environmental factors that are affecting the amphibians rather than breeding the amphibians without changing their increasingly toxic habitats (10).

In the United States, habitat destruction poses the biggest challenge to the amphibian population. In California, for example, developers and conservationists have been fighting over the fate of the California tiger salamander, which has lost 75% of its habitat due to urbanization and agricultural development (2). In many similar cases, the developers are winning out due to their economic advantage over environmentalists. Paul Ehrlich, a Stanford University ecologist, says that government officials are "destroying the working supports of our life system" by exploiting rather than conserving habitat. According to Ehrlich, "They're [the government] sawing off the limb that humanity is sitting on. Without biodiversity, we'd be dead" (2).

Global Warming and the Kyoto Debacle

In the global warming spectrum, politics isn't helping either. The U.S., a major contributor of greenhouse gases, has been highly reluctant in joining the rest of the developed world in efforts to reduce global warming. Whereas European nations are planning to cut emissions (by 50% in Germany and 80% in Holland) in the next half-century, the U.S. has rejected the Kyoto Protocol, which aims to reduce global warming (11).

During environmental talks at the G8 meeting in the summer of 2005, President Bush stated: "If this looks like Kyoto, the answer is 'no.' The Kyoto treaty would have wrecked our economy" (12). In fact, however, many environmentalists argue that cutting emissions and developing low-carbon, renewable technologies could dramati-

Figure 2. Fauna: amphibian habitat. Wetlands serve as interfaces between land and water bodies, and are extremely productive ecosystems that provide feeding and breeding grounds for reptiles, amphibians, waterfowl, mammals and invertebrates.

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cally expand the amount of wealth in the world. U.S. inaction in the global warming front, then, has created a huge setback in global efforts to thwart increasing temperature trends caused by humans. As a result, amphibian population declines continue to reflect the environmental consequences of global warming.

Governmental Action?

In addition to its reluctance to do its part in curbing global warming, in recent years, the U.S. government has also curbed many of its existing laws aimed at protecting the environment and endangered species.

The Endangered Species Act of 1973, which is enforced by the U.S. Fish and Wildlife Service, has been greatly compromised by farming corporations, forest trade companies, and electric utilities companies who oppose the act's banning of development of lands inhabited by endangered species. Many endangered animals are put on a "warranted but precluded" list, where they receive no legal protection. Usually, a species stays on the list for an average of 17 years before its inclusion into the endangered species list. (13)

In 2003, conservation groups in California filed a lawsuit in the United States District Court challenging the delay of Endangered Species Act protection for the Sierra Nevada population of the mountain yellow-legged frog, an extremely imperiled amphibian inhabiting high elevation lakes, ponds, and streams in the Sierra Nevada. Jeff Miller, the spokesperson for the Center for Biological Diversity stated, "Considering [the government's] terrible track record on Endangered Species Act enforcement, not a single species listed…wasn't a result of environmental lawsuits or petitions" (13).

In 2001, a Supreme Court also greatly limited the federal Clean Water Act by essentially eliminating wetland protection (14). In 2003, the Bush administration set out to further re-write the act, ordering the Environmental Protection Agency and the Army Corps of Engineers to immediately stop enforcing the law for as many as 20 million acres of wetlands in the lower 48 states – even before it finished writing the new rules (15). This, conservationists say, has been a giant blow to efforts at reducing amphibian declines in the U.S.

Perhaps one of the few positive actions by the government has been the establishment of the Task Force on Amphibian Declines and Deformities (TADD) in 1999, which spends approximately $4 million a year to monitor amphibians. The survey from TADD has found that the U.S. is losing amphibians in the largest national parks and wilderness areas of the country. TADD has set up a database for amphibian researchers, who can share information with each other and the federal agencies about amphibian monitoring. However, researchers involved with the task force have stated that federal response is limited because most amphibians live on private properties. Thus, more public awareness is required if large improvements are to be observed (16).

Today, there is no doubt that amphibian populations are declining, and that their dwindling numbers reflect the many global environmental problems humans must face in order to avoid further, more dire consequences. Clearly, more must be done by the global community to curb human impact on the ecosystem. If not, the unique diversity of amphibians that has persisted on earth for millions of years and forms an essential place in biological infrastructure may disappear forever. H

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