

THE AMPHIBIAN DECLINE LESSON PLAN

Amphibians have existed for over 400 million years, but during the past 2 decades, nearly 170 species are believed to have gone extinct, and almost 1900 species have declining populations. These declines are happening worldwide, with higher percentages in Central America, the Caribbean, and Australia.

Amphibians are considered to be indicator species for environmental health: they have delicate skin that readily absorbs toxins from their environment; they have few defenses, and can fall prey to non-native predators; they rely on both aquatic and terrestrial habitats at various times during their life cycle. If amphibians are in decline, it is likely that the quality of the habitat in which they live is suffering. (3)

Amphibian decline first became apparent in the late 1980's when biologists began to realize that many amphibians that had previously been abundant simply weren't there anymore. (2) Amphibians were disappearing from national parks, nature reserves, and other localities where there was no habitat destruction going on, and where biodiversity is supposedly protected. Up until the past few years, since most amphibians lead mostly secretive lives, living underground, underwater, or hiding in vegetation, coming out only at night to feed, and making a brief appearance in spring to breed, were people even aware of their presence. This may account for the fact that until recently, people have not been aware of their decline. On a global scale, this decline not only raises the alarm about the deterioration of natural habitats, but also signals a growing problem for human health. Amphibians are dependent for their survival on a plentiful supply of fresh water that is free of chemical contaminants and harmful microbes; so are people. Human population and climate change are combining to create

a situation in which a large and increasing proportion of the human population is denied access to sufficient, clean water. The rapid decline of the world's amphibian population is a warning that the most precious of natural resources is under serious jeopardy.(5)

There is no single cause found for this decline in population, but multiple factors acting together to cause mortality and other sub-lethal effects. The main culprits would be habitat destruction, climate change, chemical contamination, infectious diseases, the introduction of non-native species, increased UV-B radiation, and over exploitation for the medical and biological supply markets, for food, and the pet industry.(8)

Habitat Destruction is the process in which a natural habitat is rendered functionally unable to support the species present. This process causes organisms that previously used the site to be displaced or destroyed. (7) Clearing habitats for agriculture is the principal cause of this type of destruction. It is ranked #1 as the primary cause for species

1
decline and extinction worldwide. (6) Areas with high agricultural output tend to have the highest extent of habitat destruction. Other forms of habitat destruction include mining, logging and wood extraction, urban sprawl, infrastructure or expansion development, and manmade changes to the characteristics of the land. Areas that are densely overpopulated, like China, India, Malaysia, Indonesia, and Japan, also allow little room for natural habitat.(8)

Habitat destruction can also contribute to the reduction of genetic diversity when the range of a ce

retain organism's population is decreased. This can lead to infertile youths, because these populations would have a greater chance of mating with related organisms due to their smaller population, or even with those of a different species.

Expansion and building of roads and highways can separate any remaining amphibian populations from each other, and introduce new species to the area.

These non-native amphibians can prey on, or compete with native amphibians. (17)

In the U.S. less than one fourth of native vegetation still remains in many parts of the eastern and mid-western states, and only 15% of land area remains unmodified by human activities in all of Europe. The islands suffering extreme habitat destruction include New Zealand, Madagascar, the Philippines, and Japan. Tropical rainforests have received most of the attention concerning the destruction of natural habitat. Out of approximately 16 million square kilometers of tropical rainforest that originally existed worldwide, less than 9 million remains today. The current rate of deforestation is 160,000 square kilometers per year. Less than 0.01% of dry forests in Central America's Pacific coast and less than 8% in Madagascar remain from their original extents. (8, 9, 10)

Wetlands and marine areas have also endured high levels of habitat destruction. More than 50% of wetland in the U.S. has been destroyed in the past 200 years. (9) Between 60% and 70% of European wetlands, and over 35% of the mangrove ecosystems have also been destroyed. (9, 11, 12)

In 1997, the U.S. Fish and Wildlife Service released a report that over 1 million acres of wetlands had disappeared between 1985 and 1995. (2)

The use of surviving wetlands for "fish farming" has also impacted wildlife. They have become aquac

ultural basins for the raising of both game fish and baitfish. In Wisconsin alone, in 1977, some 7,000 wetlands were made available to commercial interests for the creation of fish farms. During the conversion of a wetland to an aquacultural basin, toxic chemicals are sometimes added to kill existing fish, in order to make room for fish of commercial value. These chemicals can also kill the amphibians living there. They may also be dredged to make them deeper, and many amphibians can't survive in the deeper water. Non-native animals released in aquacultural basins, streams and other habitats can have devastating effects on the ecology of an area by preying on amphibian eggs and larvae. (2)

2

When a habitat is destroyed, the plants, animals and other organisms that occupied the habitat have a reduced carrying capacity making population decline or extinction more likely.(21) This destruction of habitat can also alter the nitrogen, phosphorus, sulfur and carbon cycle, which has increased the frequency of acid rain, algal blooms, fish kills, and contributes tremendously to global climate change.(12)

Habitat destruction has many effects:

- Locally - we need trees for windbreak and shade
- Regionally - plant transpiration recycles rain water and maintains constant annual rainfall.
- Globally - plants (especially trees from tropical rainforests) from around the world counter the accumulation of greenhouse gases in the atmosphere by sequestering carbon dioxide through photosynthesis. (8)

The loss of trees from the tropical rainforests alone represents a substantial diminishing of the Earth's ability to produce oxygen and use up carbon dioxide. The increasing levels of carbon dioxide

are one of the major contributions to global climate change. (8)

Endemic organisms with limited ranges are most affected by habitat destruction, mainly because these organisms are not found anywhere else in the world; therefore they have less of a chance of recovery. Many endemic species also have very specific requirements for their survival that can only be found within a certain ecosystem, resulting in their extinction. Such a change in biodiversity creates "hotspots" that can affect over half of the world's terrestrial species. These "hotspots" are found mostly in tropical regions that feature high concentrations of endemic species. (7) High density of human population also affects these "hotspots"; in fact humans play the largest role in decreasing biodiversity. (16)

Climate Change - Amphibians are extremely sensitive to small changes in temperature and moisture. Changes in global weather patterns can alter their breeding behavior, affect reproductive success, decrease immune functions, and increase sensitivity to chemical contaminants. Since most amphibians lay their eggs in water, a drought could also have devastating effects.

Chemical Contaminants include pesticides, herbicides, synthetic chemicals, heavy metals, acidification, and nitrogen based fertilizers which can have many effects on amphibians, such as death, smaller growth rates, developmental and behavioral abnormalities, decreased reproductive success, weakened immune systems and or hermaphroditism. Pesticides can be transported by water or wind. Even though some ingredients in certain fertilizers have been banned, they may still remain in nature for a long period following its original use.

Infections and Diseases - Amphibians have extremely thin skin, which makes them sensitive to even a

slight change in temperature, humidity, and air quality. It also makes

3

them highly susceptible to fungal diseases including chytridiomycosis causing "Chytrid".

"Chytrid" has appeared in amphibians during the past 20 years; first in Australia and Central America, (14) but has now unfortunately spread worldwide.

It leads to the deaths of adults and larvae. It may cause problems immediately, or may not show up until a lethal threshold is reached. It also makes them more vulnerable to parasites and infections. Scientists are able to cure some of the frogs with "Chytrid", however they have not yet found a way to make the frogs immune to this fungus when they are released back into the wild. So far, at least 8 known species have vanished as a result of this disease, in addition, in recent years at least 113 species have not been found in the wild and may have also disappeared. This pathogen is associated with the global loss of hundreds of species of amphibians and represents a spectacular loss in biodiversity, some say the worst recorded in history. (1)

There has also been a recent and widespread increase of deformities or malformations in natural populations of amphibians. This is now perceived to be a major environmental problem.

Introduction of Nonnative Species can cause stressful competition for food, resources and habitat, and predation between the native and nonnative species. The introduced species may form hybrids with the native species, resulting in offspring that may reduce the prevalence of the native amphibian within the resulting gene pool. They may also spread disease to native inhabitants. (3) An invasive example would be the American Bullfrog introduced from the eastern U.S. to the nonnative western U.S. Th

ese frogs are amongst the largest frogs in North America, invading the natural habitat of the native frogs, and preying upon native small fish, frogs and other amphibians. They'll eat just about anything they can get into their mouth!

UV-B Radiation is the increased ultra-violet radiation resulting from the reduced o-zone layer in the Earth's atmosphere. Over the past few decades, levels of UV-B radiation in the atmosphere have risen significantly. UV-B radiation can kill amphibians directly, cause sub-lethal effects such as slow growth rates and immune dysfunctions, and work synergistically with contaminants, pathogens, and climate change.(2)

Over Exploitation for the medical and biological supply markets, for food, and the pet industry has threatened and endangered even more amphibians. Unfortunately for frogs, they make excellent specimens for scientists and biologists to study. More and more of these frogs are now being captive bred for medical and biological study. There are also virtual frog dissections available for student study. Recently, bans have been placed on the capturing and importing of wild threatened, and endangered frogs, and many species are now being captive bred for the pet industry. As far as frog legs - if we can get as many people around the world as possible, educated about the declines of our precious amphibians, maybe they will think twice about ordering them for dinner!

4

Conclusion

Even in the most pristine habitats - those that lie beyond the reach of bulldozers and crop dusters - the amphibians are disappearing at a shocking rate without explanation.

In a study recently published in the New York Academy of Science, the scientists concluded that no one cause can explain all of the population declines that are occurring at an unprecedented rate, and much faster with amphibians, than any other animals. (4)

The amphibian declines are linked to natural forces such as competition, predation, reproduction and disease, as well as human induced stresses such as habitat destruction, environmental contamination, invasive species, and climate change.(4)

"An enormous amount of change has occurred in the past 100 years, and amphibians are not evolving fast enough to keep up with it," said Andrew Blaustein, a Professor of Biology at Oregon State University, and a universal leader in the study of amphibian declines. "We're now realizing that it's not just on thing, it's a whole range of things." "With permeable skin and exposure to both aquatic and terrestrial problems, amphibians face a double whammy. Because of this, mammals, fish, and birds have not experienced population impacts as severely as amphibians - at least, not yet."(4)

The totality of these changes leads these researchers to believe that the Earth is now in a major extinction episode similar to five other mass destruction events in the planet's history. And amphibians are leading the field. One estimate indicates they are disappearing at more than 200 times that of the average extinction rate. (4)

This decline has many often over-lapping causes. "We suggest that single-factor explanations for amphibian declines are likely the exception rather than the rule," the researchers wrote in their report.(4)

The problems facing amphibians are a particular concern, scientists say, because they have been one

of Earth's great survivors - evolving about 300 million years before the dinosaur, persisting through the ice ages, asteroid impacts, and a myriad other ecological and climatic changes. These pressures and adversaries may be too severe, and may have arisen too rapidly for amphibians to evolve adaptations to overcome them.(4)

Outlook

The ever-increasing human population of the world will require farmers to grow even more crops, causing a major source of further worldwide habitat destruction. Species will be pushed out of their habitats either directly by habitat destruction or indirectly by fragmentation, degradation, or pollution. Any efforts to protect the world's remaining natural habitats and biodiversity will compete directly with humans' growing demand for natural resources, especially new agricultural land.(18)

5

Solutions - What Can/is Being Done?

- Educate the public about the importance of natural habitat and biodiversity.
- Preserve life in wetland communities and emphasize the importance of protecting these vulnerable species.
- Programs are currently underway to rescue frogs from declining wild populations and breed them in captivity to ensure that species are not lost to extinction. This study also suggests that selective breeding of individuals with known disease resistant genes might produce offspring that can survive infections by pathogens even after the frogs are introduced back into the wild. (20) Captive breeding programs for endangered species are being carried out in zoos and other places in controlled, "Chytrid-free" environments.
- Reintroduction places amphibians back into wild

d habitats in hope that new populations can be established.

- Reduction of chemical pollution into the atmosphere.

- Removal of non-native species when they threaten native species. (Better yet, don't introduce them to a nonnative area in the first place.) The Cuban treefrog now found in Florida, will eat native frogs and compete with them for food. For additional information on invasive species in your state visit www.invasivespeciesinfo.gov/unitedstates/state.shtml

- Government leaders must acquire a detailed understanding of the complex combination of proximate causes and underlying driving forces of deforestation in a given area or country, prior to any local, national, or international deforestation policies can be written and enforced. (19)

- Finding ways to safely increase agriculture output on existing farmland, instead of increasing the land used in production.

- Making virtual frog dissections available for student study, instead of each student personally dissecting a frog.

- Stop serving frog legs at restaurants and selling them in fish markets.

- People can create artificial ponds in their backyards to attract amphibians (frogs eat tons of mosquitoes), or even something as simple as setting up several PVC pipes to attract tree frogs. For tips on how to build a backyard pond, visit www.nwf.org/backyardpond

- Create or buy a toad abode and place it in a shady spot near a water source, such as a small pond or even a large saucer of water. For more information on toad abodes visit www.nwf.org/doteontoads

- Support nonprofit groups such as onefrogatatime.org or savethefrogs.org

- Amphibian pets should be captive bred, not wild caught.

- Landscape naturally, keep local streams and wetlands healthy.

- Become part of the solution to frog decline by participating in scientific monitoring projects like the National Wildlife Federation's Nature Quest™ FrogwatchUSA program at www.nwf.org/frogwatchUSA.

6

I can remember as a child, my mom and dad driving into the parking area at my aunt's cottage in the evening, and having our car's headlights catch 20 or so toads hopping around in the grass looking for their dinner; then walking down to the lake, having numerous frogs splash into the water as they saw us coming and "serenading" us as we were getting ready to go to bed. This gave me a love for these wonderful, mysterious creatures that I still have today. Things have surely changed; during the last ten years, maybe we have seen one toad every so often, and haven't seen any frogs, either on the shore or in the lake in years. I truly miss those days of wonder, and am very disappointed that my young grandchildren won't have the same awesome opportunity to study these beautiful creatures in nature, as I had growing up.

Educating the public in all of these areas would have the best long lasting effect on the survival of our precious amphibians. Giving them a chance to repopulate and thrive, so that maybe someday our children and grandchildren to come will be able to observe and enjoy them as we did.

Notes

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7

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