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Frogs and Toads as Indicators of Ecological Health

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Abstract

Purpose: The purpose of this review was to investigate the causes of decline in frogs and toads population in the environment using systematic literature review methodology. The specific objectives of the study were: to determine the importance of amphibians in the environment, to establish the causes of the decline of amphibians and to suggest strategies that can be put in place to control their decline.

Methodology: The systematic literature review methodology was adopted. By combining the literature overview with expert opinion, the researcher was able to crosscheck conclusions from different sources to search for general trends and regularities.

Findings: Their decline can be attributed to presence of toxic chemicals (pesticides, accaricides, termicides, fertilizers), too much heat reaching them, or destruction of their habitat, capital development projects that lower water table and environmental conditions, birds, mammals and reptiles that prey on their eggs, habitat loss, diseases like red leg syndrome, harvesting for a variety of reasons, climate change and global warming, and invasive species.

Unique Contribution to Theory, Policy and Practice: Suggested strategies for reducing decline are: .using environmentally friendly chemicals and only when very necessary otherwise, organic chemicals should be recommended, restoration of habitats, combating climate change and global warming, reducing water run-off and preventing rubbish, silt and garden waste from getting into storm water drains, constructing and maintaining sediment traps near waterways, especially when disturbing surface vegetation cover, keeping a wide belt of vegetation around water bodies as a buffer zone for contaminants and to control erosion a voiding wearing insect repellents and other lotions if you go swimming in areas where frogs live, no drainage of wetlands, no collection of bush rock, no burning of patches of bush which frogs shelter in and no reduction in the quality of wildlife corridors, which connect areas of frog habitat and proper rules and regulations on the use of wetlands, swampy areas, shorelines and river rines.

Key words: *Amphibians, Bio-indicators, Conservation, Food-webs*

INTRODUCTION:

There is an estimated 4,780 amphibian species in the world. The biodiversity of these vertebrates is phenomenal, exceeding the species richness of mammals, which is more than 4,600 species. Despite the abundance of amphibians, even in urban areas, they may be elusive and therefore not as well-known as other classes of animals. Around the world, new species of amphibians are still being discovered. In 2002, an astonishing 100 new frog species were discovered in Sri Lanka. The class name, Amphibia, originating from the Greek words for "double" and "life," reflects the life cycle of most amphibians, which includes both a water and a land stage. Frogs and toads are a class of amphibians belonging to the order Anura. (Nature Canada, 2002).

Bio-indicators are organisms, such as lichens, amphibians, birds & bacteria that are used to monitor the health of the environment. The organisms & organism associations are monitored for changes that may indicate a problem with their ecosystem. The changes can be chemical, physiological or behavioral. Bio-indicators are relevant for ecological health which can be reviewed in terms of ecosystems, where by structural and functional characteristics are maintained. Each organism with in an ecosystem has the ability to report on the health of its environment. Amphibians are believed to be sensitive to pollutants because of their highly permeable skins and their varied lives which maximize their exposure (Vitt et al, 1990). Frogs are likely to be affected by changes that occur in terrestrial and fresh water habitats and to be exposed to contaminants in air, sediment and water. This make them potential bio-indicators of environmental quality & change. "Frogs are extremely important indicators not just of climate change but also pollutants in the environment" (Katy Daigle, 2011)

During the past decades the ecology and ecotoxicology of amphibians started to get attention [Sparling et al. 2000] because of global amphibian population declines [Houlahan et al. 2000]. Based on the lists of the International Union for the Conservation of Nature (IUCN), there are 787 rare or endangered amphibian species [Frost et al. 2006] and about 1,900species known to be threatened [Stuart et al. 2008]. Frogs and toads are about 90% of all amphibians [McDiarmid and Micthell 2000] Therefore, they are an important link between human and ecosystem health [Hayes et al. 2002] and they are main components of aquatic and terrestrial ecosystems [Unrine et al. 2007]. Most adult frogs and toads feed on invertebrates, so they are important, energy-efficient trophic link between insects and other vertebrates [Sparling et al. 2000]. They are sensitive to environmental changes both in terrestrial and aquatic habitats because they have highly semi-permeable skins and different life cycle stages [Alford and Richards 1999]. Nevertheless, the information on the effects of environmental contamination on frogs and toads is little known [McDiarmid and Micthell 2000].

The declines of amphibian populations are caused by a number of factors, including habitat loss and fragmentation [Icochea et al. 2002, Beebee and Griffiths 2005], ultraviolet radiation and chemical pollution [Blaustein et al. 2003], climate change [Pounds 2001] and epidemic disease

like chytric fungus [Pounds et al. 2006]. Some of these factors may also cause deformities and abnormalities in their development [Blaustein and Johnson 2003] lowering further the viability of populations. Effects of contamination may result in shorter body length, lower body mass, malformations of limbs or other organs [Sparling et al. 2000]. Thus, the risk of mortality and exposure to predation is increased by slowed down development, late metamorphosis, and small metamorph size [Rowe et al. 2001, Pahkala et al. 2002, 2003]. As a result, the use of anurans as bioindicators of accumulation of contaminants in pollution studies is increasing [Welsh and Ollivier 1998, Johansson et al. 2001, Loumbourdis et al. 2007].

Habitats of many frog and toad populations are small, temporary ponds and the surrounding forested area, which are usually suffered by many stressors such as UV-radiation [Cummins 2003, Hatch and Blaustein 2003], the use of pesticides [Gendron et al. 2006, Fellers et al. 2004] and industrial chemicals [Bishop and Gendron 1998, Sower et al. 2000], urbanization [Barrett et al. 2010], climate change [Corn 2005]. Since frogs and toads are sensitive to the alterations of their environment, they could be used as bioindicator organisms to follow changes in their habitats and in ecotoxicological studies [Henry 2000]. As their populations usually contains high numbers of individuals and they are good representatives of freshwater environments, they are good model organisms for pollution studies [Burger and Snodgrass 1998]. What is more, adult anurans play an important, usually intermediate role in food-webs because they are preys and predators as well but their position changes with their development, i.e. tadpoles also feed on algae [Murphy et al. 2000] making them even more sensitive to different stressors. Thus, frogs and toads may be used as biological indicators to assess the effects of environmental factors that may cause the declines of amphibian population.

In several earlier studies these animals were used to assess the effects of UV radiation [Cummins 2003, Hatch and Blaustein 2003]. Its direct effects was demonstrated to cause embryonic mortality [Pahkala et al. 2002], abnormal larval development [Belden and Blaustein 2002], limb and muscular deformities [Weyrauch and Grubb 2006]. Similarly, different pesticides were also tested and deformities were detected [Pickrell 2002] but these studies were based on laboratory toxicity test [Cowman and Mazanti 2000]. Although most pesticides do not accumulate their toxicity is relative high [Kamrin 1997] which may cause paralysis [Fellers et al. 2004], decreased size of metamorphosis [Relyea and Diecks, 2008] and negative effects of liver and kidney [Khan et al. 2003]. The use of frogs and toads, as biological indicators of metal pollution is becoming more common [Burger and Snodgrass 1998]. The effects of metal accumulations were studied both under laboratory [Perez-Coll and Herkovits 1996, Herkovits and Helguero 1998, James and Little 2003] and field conditions [Puky and Oertel 1997, Demichellis et al. 2001, Flyaks and Borkin 2004, Fenoglio et al. 2006] but the number of field studies is low. In an earlier study the whole body of *Rana catesbeiana* tadpoles were analyzed for different heavy metals (cadmium, chrome, manganese, arsenic, mercury) and the highest concentration of metals were found in the digestive tracts of tadpoles [Burger and Snodgrass 1998].

In another study, the elemental concentration of *Rana dalmatina, Bufo bufo* and *Rana ridibunda* tadpoles were compared and significant differences were found between the studied species. The heavy metal concentration of *R. dalmatina* in the whole body was significantly lower than in the other species which is caused by sediment contamination in the *R. dalmatina* habitat [Grillitsch and Chovanec 1995]. In the case of tadpoles Zhang et al [2007] reported that the ATPase activity increased with increasing of Cd and Pb concentrations in *Bufo raddei* tadpoles. This means that the ATPase activity may be a warning signal of pollutant-induced damages in the ionic and osmoregulatory system [Zhang et al. 2007]. In other studies differences were demonstrated between the different development stages [Baudo 1976, Puky and Oertel 1997]. Higher heavy metal concentration in tadpoles than adults may be caused by changes in feeding during development, tadpoles are detritivorus unlike adults, which are carnivorous and the detritivorous diet may be richer in metals [Baudo 1976]. Pavel and Kucera [1986] studied the accumulation of manganese, iron, copper and zinc in the whole body of *Rana esculenta* adults from three different localities. Their study demonstrated that in the case of manganese, iron and copper significantly different concentrations were found at the selected localities. However, studies including all development stages is needed because of the changing of susceptibility of frogs to heavy metals may depend on different stages of development [Perez-Coll and Herkovits 1996]. Puky and Oertel (1997) demonstrated e.g. that eggs contain a relatively low concentration of different heavy metals in comparison with a range of adult tissues such as muscle and parts of the body (e.g. kidney, liver).

Methodology

Various literature work was reviewed concerning toads and frogs' in-order to get a balanced conceptual judgment concerning them and the environment. The areas of concerned were: To determine the importance of amphibians in the environment, to establish the causes of the decline of amphibians in the environment, and to suggest strategies that should be put in place to control their decline from the environment**.** The systematic literature review methodology was adopted. By combining the literature overview with expert opinion, I was able to crosscheck conclusions. from different sources to search for general trends and regularities.

To determine the importance of amphibians in the environment

From the ecological perspective amphibians are regarded as good ecological indicator. Since frogs and toads are sensitive to be alterations of their environment, they could be used as bio-indicator organisms to follow changes in their habitats and in ecotoxicological studies (Henry 2000). A frog's role in the food web is unique. Instead of occupying a single level of the food web either herbivore, predator or prey it occupies all their levels through its life. For example, tadpoles keep underway clean by feeding on algae and helping to control its health. As the tadpoles, change into a frog, it switcher from being a plant eater (herbivore) to being a predator that eats other aquatic and land insects, thus helping to control insects that can transmit diseases to humans such as

mosquitoes. Raghavendra et al (2008) have encouraged biological control using frogs to fight mosquito borne diseases.

Frogs and toads—like the canaries in the coal mines of yesteryear—respond quickly to changes in their environment. This is important because we rely on the wetland ecosystems where they live for our clean water. Frogs are also predators of invertebrates, including many insects considered pests by farmers and gardeners (Nature Canada, 2002). A frog's role in the food web is unique. Instead of occupying a single level of the food web either herbivore, predator or prey it occupies all their levels throughout its life. For example, tadpoles keep underway clean by feeding on algae and helping to control its health. As the tadpoles, change into a frog, its switcher from being a plant eater (herbivore) to being. Raghavendra et al (2008) have encouraged biological control using frogs to fight mosquito borne diseases.

Frogs can tell us a lot about the weather due to their permeable skin, they respond to even small

changes in atmospheric moisture and temperature. The scientists reassured that an analysis of sound recording could help to improve our understanding of the impact of climate change. (www/frogs are green.org) Frogs are also part of our cultural heritage, air folktales, fairy tales, myths, children's stories & legends. In many cultures, they are symbol of good luck, fertility, healing, and prosperity and are associated with rain & good harvests. According to Nature Canada (2002), frogs and toads make exceptionally good indicator species because a variety of factors makes them more susceptible to environmental changes than many other groups of organisms. These factors include: **Amphibious life history:** Since most frogs and toads spend part of their life in the water and part on land, changes to either habitat may affect them. In addition, their transformation from tailed, gill-breathing creatures into four-legged air breathers is a complex process. Some chemical pollutants can act as hormones, interfering with this metamorphosis and possibly causing deformities. **Permeable skin** Frogs and toads drink by absorbing water through their skin. This makes them prone to absorbing toxic chemicals or microorganisms through their skins as well. Like conveyor belts, frogs—by their amphibious nature—move nutrients from water to land as part of both terrestrial and aquatic food chains. A single frog can lay thousands of eggs. If the eggs hatch, most will end up as critical prey for species of birds, mammals and reptiles. Frogs are also predators of invertebrates, including many insects considered pests by farmers and gardeners lots, malls and residential development (Nature Canada, 2002).

To establish the causes of the decline of amphibians in the environment

Global Threats

Declines in frog populations may indicate ecological problems in an ecosystem that should be investigated for wider impacts on other species including humans. A single frog can lay thousands of eggs. If the eggs hatch, most will end up as critical prey for species of birds, mammals and reptiles (Nature Canada, 2002). In the past three decades, declines in population of amphibians

have occurred worldwide. In 2004 according to the Global assessment, 32 percent of species were globally threatened, at least 43 percent were experiencing some form of population decrease and that between 9 and 122 species have become extinct since 1980. As of the IUCN Red List (2010), this incorporates the global Amphibian Assessment and subsequent updates, lists 486 species as critically endangered. According to recent findings of Zoological survey of India, more than 20 percent of frogs& toad-78 of 340 species found in India are under threat (www. the hindu.com/frogs./2014). Habitat loss is the biggest threat to frogs. Small wetlands that are used as breeding areas by frogs are being filled, drained and developed. Marshes & swamps are rapidly being replaced by parking lots, malls and residential development. Small wetlands are vitally important to local amphibians. In recent years, scientist & conversationalists have been working to raise public awareness of threats in amphibian populations. We can do so thing about possibly in our own backyard or neighborhood. We can lend our voice to land conservation that protects vernal pools. Dr. KerryKriger, Founder& executive director of Save the Frog says, "When we save the frog we are protecting all our wild life, all our ecosystem & all humans." Frogs after all, are the earth's most ancient singers. We want to continue hear their songs for long, long time.

According to Gone Froggin, (2024), diseases like red leg syndrome is caused by the capillaries stretching and even bleeding out under the frog's skin. Untreated, this can lead to the frog's death. *Ranavirus* is responsible for large die offs of frogs, other amphibians, and turtles. *Ranavirus* is a genus of viruses from the family Iridoviridae, One of the driving forces behind the frog extinction crisis is the over-harvesting of frogs. Frogs are harvested for a variety of reason: pet trade, food, etc. but these can harm the native frog populations. Some frog populations are already too small and removing even a few species could be detrimental to the group. As the climate around the world changes and warm up, the animals of the world have to deal with the changes around them. The warmer climate is bad news for frogs. Droughts will be more common and frogs need rain and water. Ponds and lakes that frogs use to breed are drying up, leaving the eggs in a bad spot, when people think of pollution, they usually think about trash in parks or the ocean, but that's just the tip of the pollution problem. While this type of pollution is a serious problem, it doesn't affect frogs as much as other types. It is still bad and the plastic can break down and harm frogs.

Frogs have thin skin that allows chemicals and minerals to easily pass into their body. Their eggs don't have thick, hard shell either and are susceptible as well. Habitat loss is the biggest threat to frogs, toads, and wildlife in general around the world. Without a suitable habitat for frogs, they will die out. There are 3 different types of Habitat loss: habitat destruction, habitat fragmentation, and habitat degradation. Habitat destruction is where the habitat is completely destroyed, such as plowing down trees for a palm oil plantation. The main reason for habitat destruction is actually agriculture to make room for more crops. Other reasons include mining, urban development, and logging and invasive species are a threat to frog populations worldwide but what is an invasive species? An invasive species is a non-native species that has a negative impact of the environment. They can be both plants and animals. These introduced species thrive in their new areas since they

lack their natural predators and don't have to compete against organisms that limited their growth in their native environment. These organisms can be purposely released in the new environment or by accident. Often, these organisms are released into an area to stop a problem, but actually cause even more problems. The Cane Toad was introduced to Australia to reduce insects harming sugar cane crops but the Cane Toad spread and caused harmed to other native species. Typically, frog and toad eggs float in a jelly-like mass at or near the surface of the water. As ultraviolet levels increase around the world due to the thinning of the ozone layer, eggs are exposed to more harmful, and possibly lethal, radiation. Frog eggs can't move out of the sun or apply sunblock. Many frogs and toads depend upon temporary wetlands, such as seasonal spring ponds or puddles. They must breed, the eggs must hatch and the tadpoles must grow and transform before these ponds dry up. In drought years, many populations will not breed successfully. Although amphibians are adapted to occasional dry spells, populations can be eliminated if droughts occur more frequently (Nature Canada, 2002)

To suggest strategies that should be put in place to control their decline from the environment

According to https://dorrbughby-e-schools.nsw.gov.au, the following measures can reduce the decline of frogs and toads from the decline:

1. For the loss of habitats, the following solutions can work:

    (a) Restore stream-bank vegetation (b) Build fish and frog friendly crossings and cattle water stations (c) Make your garden frog friendly! Install a frog pond (d) Plant plenty of low-growing plants (d)Be careful with disposal of chemicals

2. In addressing climate change challenges, the following can be put in place:

    (a) Protect, restore and rebuild frog habitat (b) Combat Climate change by: (i) Switch to Clean Energy (ii) Use Less Energy (iii) Travel Green (iv) Watch Your Water Use (v)Reduce Waste

3. In addressing the issue of pollution, the following should be adopted:

(a) Dispose of household chemicals and rubbish responsibly (b) Plant buffer strips of log-growing vegetation along streams to stop sediments and pollutants (c) Install sediment traps near waterways (d) When you go swimming in frog habitat, wash off personal products away from the waterway €Don't touch frogs with your bare hands- use a clean, wet cloth or glove

4. For control of fungus, do the following**:**

If you are going into frog habitats, you can take the following precautions to stop the spread of Chytrid Fungus:

(a) Only touch frogs when absolutely necessary. Remember to use disposable gloves if you have to.

(b) Clean and dry all equipment and wet or muddy footwear before and between visiting frog sites. This may include cleaning the tyres of your vehicle before visiting known high-risk sites where threatened frog species may live.

(c) Never move a frog from one area to another.

According to info@environment.nsw,gov.au, 2024.

Frogs generally spend part of their lifecycle in water, and their moist skins are especially sensitive to pollution. Ways of reducing the impact of pollution on frogs include:

(i)preventing chemicals such as petrol, insecticides, detergents and fertilizers from entering waterways

2. reducing water run-off and preventing rubbish, silt and garden waste from getting into storm water drains
3. constructing and maintaining sediment traps near waterways, especially when disturbing surface vegetation cover
4. keeping a wide belt of vegetation around water bodies as a buffer zone for contaminants and to control erosion
5. a voiding wearing insect repellents and other lotions if you go swimming in areas where frogs live.
6. Plague minnows

   The plague minnow (*Gambusia holbrookii*) is a small fish sometimes called the mosquito fish. It was originally introduced to control mosquitoes but was not successful in doing this. It is now common and widespread, and known to eat native frog eggs and tadpoles. Never introduce this fish into the wild or into a pond in your garden. In some cases, you can remove the plague minnow from a garden pond by draining it and then refilling it once the mud on the bottom has dried.
7. Other introduced fish species

   Other exotic fish - such as trout, carp and goldfish - also eat native frog eggs and tadpoles. These species should not be used to stock garden ponds or dams that are prone to flooding. They should never be released into the wild (although trout can be released into some streams with the approval of relevant authorities).
8. A frog's habitat is the environment in which it feeds, shelters and breeds. If it cannot find suitable habitat, it will die. So it's hardly surprising that habitat loss is probably the greatest threat to frogs. Humans can damage frog habitat in many ways. For example, people:

(a) clear large areas of native vegetation for housing and agriculture.

(b) drain wetlands or allow cattle to graze in them

(c) collect bush rock, which is used for shelter by some frogs such as the red-crowned toadlet

(d) frequently burn patches of bush which frogs shelter in

(e) reduce the quality of wildlife corridors, which connect areas of frog habitat. This makes it difficult for frogs to move from one area to another.

Conclusion

Importance of toads and frogs include sensitivity to some chemical pollutants, lethal, radiation, sensitive to droughts, to climate change, a predator that eats other aquatic and land insects, thus helping to control insects that can transmit diseases to humans such as mosquitoes, good representatives of fresh water environments, indicator of metal pollution and can guide by their behavior the closeness of rainfall, move nutrients from water to land as part of both terrestrial and aquatic food chains, used biologically to control mosquitos, are also part of our cultural heritage, air folktales, fairy tales, myths, children's stories & legends. In many cultures, they are symbol of good luck, fertility, healing, and prosperity and are associated with rain & good harvests. Their decline can be attributed to presence of toxic chemicals (pesticides, accaricides, termicides, fertilizers), too much heat reaching them, or destruction of their habitat, capital development projects that lower water table and environmental conditions, birds, mammals and reptiles that prey on their eggs, habitat loss, diseases like red leg syndrome, harvesting for a variety of reasons, climate change and global warming, and invasive species. Suggested strategies for reducing decline are: .using environmentally friendly chemicals and only when very necessary otherwise, organic chemicals should be recommended, restoration of habitats, combating climate change and global warming, reducing water run-off and preventing rubbish, silt and garden waste from getting into storm water drains, constructing and maintaining sediment traps near waterways, especially when disturbing surface vegetation cover, keeping a wide belt of vegetation around water bodies as a buffer zone for contaminants and to control erosion a voiding wearing insect repellents and other lotions if you go swimming in areas where frogs live, no drainage of wetlands, no collection of bush rock, no burning of patches of bush which frogs shelter in and no reduction in the quality of wildlife corridors, which connect areas of frog habitat and proper rules and regulations on the use of wetlands, swampy areas, shorelines and river rines.

Recommendation

As human population increases, there is the tendency to modify the environment partly for food production and other development undertakings. Any chemical used should be environmentally friendly to other organisms, socially acceptable and proper disposal should be adhered to. Empty containers or packets should not be thrown in water bodies where amphibians are found.

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