Climate Change and Amphibians

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Green Tree Frog *(Hyla cinerea)*
(Photo: Tim Krynak)

Amphibians Matter

Amphibians are an important component of the global ecosystem. In New York State, the biomass of one diminutive salamander species alone is equal to that of all the white-tailed deer. If you think that is impressive, that same salamander species in Virginia has a biomass 7x as great, another salamander species in Japan has a biomass 50x as great, and a frog species in Puerto Rico has a biomass 150x as great. For those of us living in white-tailed deer country, try to imagine 150x as many deer running around and you will start to have some comprehension of the keystone role just one single amphibian species can have in its ecosystem. All of those amphibians can serve as food for predators in their community, and current research is documenting that in areas of the world where amphibians are disappearing, so too are their specialist predators (Karen Lips, pers. com.). Amphibians are also voracious predators themselves, with a single population of cricket frogs, for example, able to consume 5 million invertebrates in one year (Bruce and Christiansen 1976). Many of those invertebrates are pests of our crops and vectors of human disease. Clearly, amphibians play a vital role in nature.

Amphibians are also important indicators of environmental health. The same thin skin that helps them to drink and to breathe also makes them susceptible to pollutants, more so than other tetrapods. For example, consider Atrazine, the most widely used herbicide in the US and probably the world, and a potent endocrine disruptor. At low concentrations of Atrazine--lower than those the USDA says is safe in drinking water and lower than those found at the tap in millions of American homes--male clawed frogs can be chemically sterilized or even turned into females (Hayes et al. 2010). Because of their generally conspicuous presence in the environment and chemical sensitivity relative to other tetrapods, amphibians can be a considered a canary in the coalmine, valuable sentinels for human health concerns.

Small-mouthed Salamander
(*Ambystoma texanum)*
(Photo: Tim Krynak)

And amphibians are important contributors to human medicine. All amphibians have poison glands, with species-specific poisons of various potency and structure. Many of those poisons can be refined for use in human medicine. For example, a South American frog has yielded an analgesic that is 200x more potent than morphine without any of the addictive side effects (Spande et al. 1992), and an Australian treefrog produces a peptide that blocks the transmission of HIV across mucous membranes in humans (VanCompernolle 2005). Every time an amphibian species goes extinct, potential treatments to human ailments disappear as well.

Amphibians Are in Trouble

An ongoing Global Amphibian Assessment reveals that as many as 158 amphibian species are believed recently extinct, nearly one in three remaining species is currently threatened with extinction, and one in four is so poorly known that they can only be called Data Deficient (IUCN et al. 2010). Amphibians have a higher number of globally threatened species than any other group of organisms except flowering plants and a higher percentage of threatened species than any other group except gymnosperms. Moreover, the rate at which

amphibian species are going extinct is now hundreds or thousands of times higher than historic levels (McCallum, 2007; Roelants et al., 2007). This crisis represents the greatest extinction event in the history of amphibians and perhaps the greatest taxon-specific conservation challenge in the history of humanity.

Climate Change Among the Threats

Amphibians face a variety of threats, including, like every other species on the planet, climate change. Climate change is an enigmatic threat for any taxon. Although we know enough about it that we should be seriously concerned, we simply do not know exactly how, when, and to what extent it will manifest, let alone how species might respond. As such, there is inconsistency in how climate change is considered as a threat among experts, although most do now recognize that it is on track to become one of the greatest threats to all life on earth. Compare climate change to a more 'traditional' and tangible threat like habitat modification: IUCN Red List assessors consider various forms of habitat modification a threat for 3766 of 6284 amphibian species. On the other hand, only 397 species are currently considered to face the threat "climate change and extreme weather". By comparison, amphibian chytridiomycosis, for all the attention it has received, is only known to have affected 350 species to date (Fisher et al. 2009, Skerratt et al. 2007). Climate change is something of an enigma and consequently does not receive the attention it deserves, from politicians or amphibian biologists.

Zurucuchu Robber Frog
(Pristimantis w-nigrum)
(Photo: Tim Krynak)

Clearly though, some amphibian species are already being impacted. Reproductive activities, in particular, seem dependant on temperature and seasonal transitions. Significantly earlier breeding activity in seasonal temperate anurans and caudates has been reported from Japan (Kusano and Inoue 2008), the UK (Beebee 2002, Chadwick et al. 2006), and the US (Gibbs and Breisch 2001). Gibbs and Breisch (2001) compared first dates of seasonal calling for six anuran species near Ithaca NY at the beginning vs. the end of the 20th century and found that four species now call up to 13 days earlier, whereas two are unchanged. Beebee (2002) summarized similar observations from the UK where two species of anuran and four caudates are breeding significantly earlier while two other anurans are breeding increasingly earlier but not yet significantly so.

Changes in temperature patterns can also affect species' distributions. Seimon et al. (2007) reported an altitudinal increase in the range of 3 Peruvian anurans (and indeed a new altitudinal record for all of Amphibia) following the recent retreat of Andean glaciers. Raxworthy et al. (2008) measured a mean temperature increase of 0.34-0.40°C on one Malagasy massif over a 10-year period. Correlated with that temperature shift were 19-51m upslope range displacements in 30 species of amphibians and reptiles whose populations were moving up the mountain to stay in their preferred temperature zones. Two species, however, were already at the top of the massif and disappeared. The US Appalachian Mountains are considered one of or perhaps the greatest hotspot for salamander biodiversity, but Milanovich et al. (2010) project that climate change will cause significant decline in suitable habitat and loss of hotspot status as early as 2020.

Of course, changes in temperature drive changes in precipitation, and the availability of water is perhaps more paramount to the survival of amphibians than it is for any other tetrapod group. Whitfield et al. (2007) documented ~75% decline in both amphibian and reptile communities at La Selva Costa Rica for over 35 years and suggested climate-driven loss of leaf litter as a cause. McMenamin et al. (2008) correlated a 50% decline in amphibian populations in Yellowstone National Park (the world's oldest nature reserve) with an increase in temperature and decrease in precipitation over 60

years. Rovito et al. (2009) documented widespread and severe declines of upland salamanders in Mexico and Guatemala and presented a convincing case for causation by changes in precipitation and humidity associated with adjacent deforestation.

Foden et al. (2008) predicted that 52% of amphibian species are likely to be 'particularly susceptible' to climate change, based on biological traits like "specialized habitat requirements, limited dispersal ability and water-dependent larvae." Over one half of these species are ones that are not currently threatened, potentially pushing the number of threatened amphibians from 32% to 60% and quadrupling the number that require rescue. In other words, even though the amphibian extinction crisis is already the greatest in the history of humanity, we ain't seen nuthin' yet.

Spring Salamander
(Gyrinophilus porphyriticus)
(Photo: Tim Krynak)

It should also be noted that some authors have tried to suggest a dependent link between climate change and the disease amphibian chytridiomycosis. However, other authors have debunked that hypothesis (e.g., Lips et al. 2008), even finding that banana and beer production are better correlated to amphibian extinctions (Rohr et al. 2008). Both climate change and disease are devastating threats by themselves without the need to derive and overemphasize some synergistic conspiracy theory. If a significant synergy does indeed exist, it has yet to be clearly demonstrated.

The Amphibian Ark

With so many amphibians already threatened, and so many more quickly becoming so, the need for conservation action is profound and urgent. Fortunately, many of the threats that amphibians face can be mitigated in the wild. For example, since habitat modification is currently the top threat, protection of key habitat areas is clearly the simplest and most effective conservation action. However, threats like climate change and disease simply cannot be addressed in the wild in the foreseeable future, and species facing these threats will go extinct if they are not rescued. The Amphibian Ark (AArk) was launched in 2006 to help those species that cannot currently be safeguarded in the wild. The AArk serves as the umbrella organization globally uniting all groups that practice ex situ conservation of amphibians, e.g., zoos, aquariums, botanical gardens, natural history museums, nature centers, universities, government agencies, NGOs, and of course the private sector. Amphibian Ark staff help to raise awareness and funds, conduct assessment workshops to identify the conservation needs of each species, lead husbandry workshops to share expertise, and build partnerships to share resources where they are most needed. We are already tracking over 100 priority species in captive programs. You can read more about the Amphibian Ark, and become a member for free, at www.AmphibianArk.org. Please, do your part to help address the greatest species conservation challenge that humanity has ever known.

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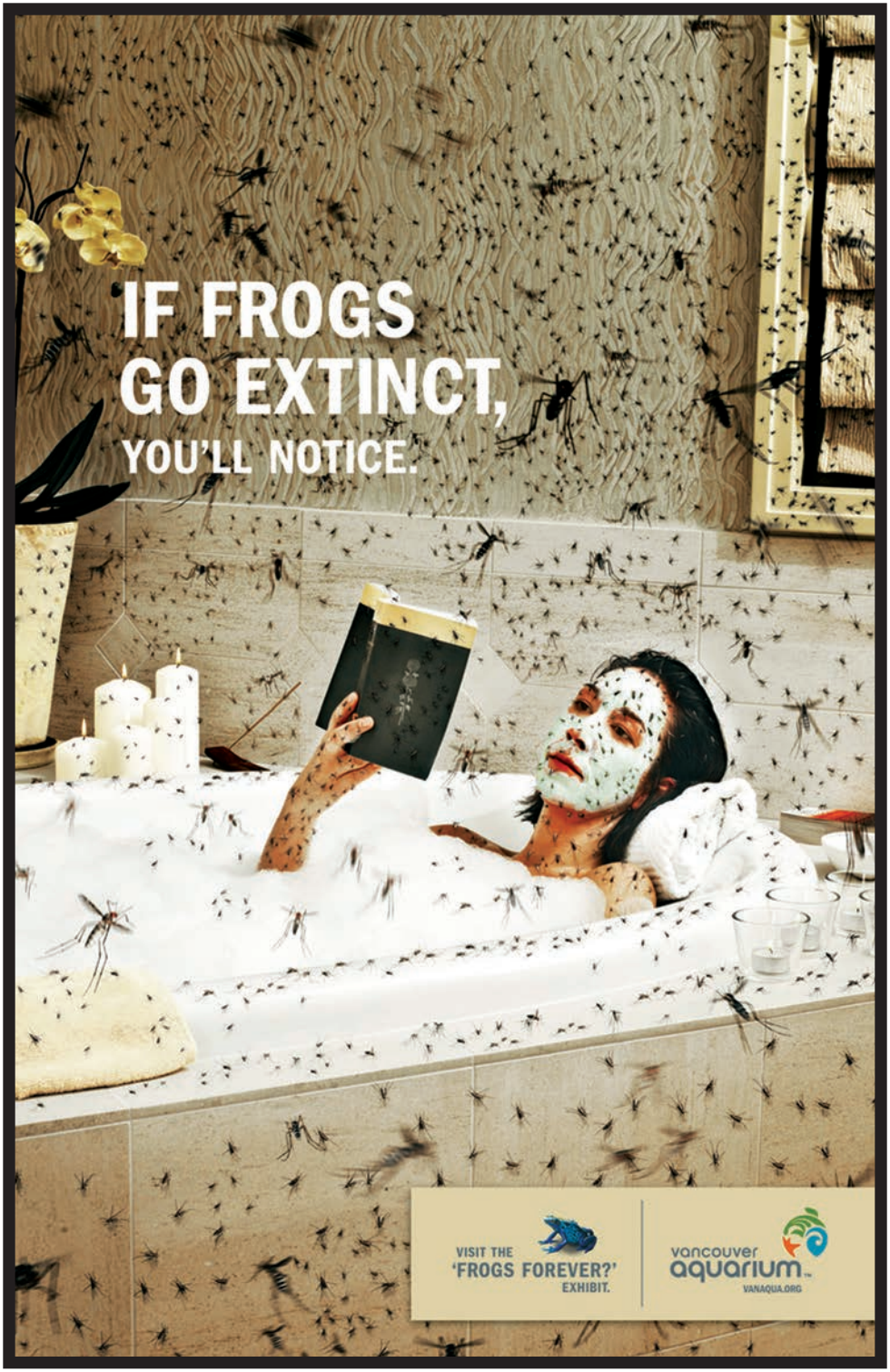

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