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Warts and All: The Fate of the American Toad

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research ARTICLE

Warts and All: The Fate of the American Toad

—**Heather Moulton** (Edited by Brigid C. Casellini)

Eeew, don't they give you warts? Aren't they used in witch's stews? Often thought to be just an ugly, nasty little beast, the poor toad is quite the contrary. It is a handsome creature, rather amusing to watch when its squat little body hops around.

Toads benefit not only gardens by consuming large quantities of bugs that can be damaging to plants, but also scientists by indicating environmental disturbances that are occurring around us daily. Permeable skin and a biphasic (two-phase) life cycle make toads extremely vulnerable to diseases and pollutants. Thus, despite having been around for nearly 300 million years, many toad populations are seriously threatened. My interest in and concern for global diversity led me to study amphibians and to conduct research in New Zealand in 2005 and in Maine in 2006, both times funded by the Summer Undergraduate Research Fellowship (SURF) program. (An article about my research in New Zealand appeared in *Inquiry* '06.)

The Toadal History

Habitat alteration and fragmentation, including land use changes due to forestry, agriculture, installation of drainage systems, and road construction, greatly affect the movement patterns and breeding distributions of amphibian populations. Because many forested habitats face increased development pressure, it is imperative to understand how land use change affects these valuable populations (1).


The author with fellow researcher Jan Boyer, digging enclosures in Maine

Numerous amphibians require wetlands for certain stages of their life. Vernal pools are small, shallow ponds, identified by a lack of fish and annual/semi-annual periods of dryness. Vernal pools are crucial to the environmental health of most forested landscapes because the majority of amphibian species in the United States breed exclusively in them. An absence of predatory fish allows vernal pools to produce greater numbers of metamorphs, or juvenile, amphibians than do permanent ponds (2-4).

Vernal pools are also imperative for the survival of other vertebrate and invertebrate species. Adult and juvenile amphibians provide an important food source for snakes, mammals, and raptors; and they themselves feed on ground beetles, crickets, bugs, caterpillars, earthworms, snails, and spiders (5).

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Most amphibians in the United States are aquatic only as eggs and larvae and during short periods of adulthood for reproduction. As juveniles and adults they spend most of their time in terrestrial habitats, migrating to vernal pools only during favorable weather conditions to mate and lay eggs (6-8). These amazing little toads hop long distances from the vernal pools deeper into the forest, which provides them with food and shelter from desiccation (drying out that leads to death), predation (being eaten by other animals), and freezing (7, 9). Therefore, if suitable habitats are destroyed, or remnant patches of suitable habitat are too isolated or small to allow recolonization by dispersing individuals, amphibian populations will decline (8, 10).

The dispersal stage of a toad’s life occurs when tadpoles become juveniles and emerge from the wetland to venture into the more heavily forested upland. Although this phase is extremely important for maintaining gene flow and rescuing local populations from extinction, little is known about the factors determining the dispersal ability of juvenile amphibians in different habitats (11). It is extremely difficult to track dispersing metamorphs because their small size prevents the use of radio tracking devices.

Despite the knowledge that vernal pools are essential to maintaining high biologic productivity and biodiversity, they remain undervalued in wetland regulations (12). Amphibians require wetlands for breeding but also require adequate areas of suitable terrestrial habitat surrounding the wetlands for feeding, growth, and maturation of populations (13). The transition zone (eco-tone) between the aquatic and upland communities is often ignored, and the habitats that toads require for survival in the forests remain unclear. Therefore, it is essential that information regarding these critical habitats be obtained and shared.

The destruction or break-up of forests-usually as a result of human activities such as forestry or road construction-may result in reduced dispersal rates due to increased mortality or behavioral avoidance of unfavorable habitat. Clear-cut areas, or places where all of the trees have been harvested, may cause dispersing metamorphic toads to dry out from lack of cover and moisture (11). By examining the growth and survival of toads in different habitats, we can begin to understand the ways in which upland habitat change affects the survival and dispersal of the toads.

The objective of my study in Maine, conducted along the Penobscot River from May to August of 2006, was to determine whether there are differences between dispersing juvenile toads’ growth and survival rates in three habitat types: forest, edge, and clear-cut. (An edge is the border of forested and clear-cut land.) I chose this particular location because it has an abundance of vernal pools and adjacent forest clearings. The forest plots I studied were no less than 30 meters from a clear- cut to avoid edge effects, and the edge plots were within 10 meters of the clear-cut. I used a random stratified procedure to ensure that the plots were distributed in all cardinal directions (North, South, East, and West) and at least 20 meters from each other.

I predicted less survival and growth in the clear-cut areas than in the other two habitat types. My intention was to provide important information about how logging routines may have negative impacts on amphibian populations. Such knowledge will be crucial for future restoration, management, and conservation of amphibian habitat.

Hopping from Day to Day

Each day of my research brought new questions, excitements, and trials. In the spring prior to the start of my study, I collected American toad egg masses from vernal pools where the females had deposited them. I used 20 liter aquaria filled with aerated well water to hold the egg masses until hatched. I then transferred and reared the tadpoles in 1000-cubic meter mesocosms (cattle watering tanks) that were designed to simulate the environment of a vernal pool. I added leaf litter, phytoplankton (microscopic plants such as algae), and zooplankton (microscopic animals such as daphnia) to produce a simplified food web that is absent of predators.

Once the larvae became metamorphs, or little juvenile toads, it was time to put them in their homes! Before releasing the toads I recorded the date and the mass (weight) of all individuals. A subset was released into each of ten 2m x 2m silt screen enclosures, which were randomly located in each of the three habitats (forest, edge, and clear-cut). Despite the bugs, we certainly had fun digging the enclosures.

Each of the 30 enclosures (10 in each habitat) was stocked with two metamorphs, one of which was marked with a single toe clip to enable measuring of individual growth rates and survival. At the time of release into the enclosures and once a week thereafter, I measured toad snout urostyle length (SUL) with calipers and measured mass with a portable digital scale. (The toads were usually quite good and sat still). To measure survival, I got on my hands and knees to systematically search for toads in the enclosures, thereby decreasing the chance of false mortality in my results. All enclosures in which both toads were not found were searched again in the same week. If I did not find toads in an enclosure after three searches, I did not search that enclosure again, assuming the toads had been eaten or otherwise escaped. As I discovered during the course of my research, I am definitely the "toad whisperer."

I also measured several environmental variables in three random locations within each enclosure. Weekly measured variables were soil temperature, air temperature, and rainfall amounts. The monthly variables were soil moisture (measured by weighing, drying, and reweighing a 20g soil sample); soil pH; canopy cover (measured with a densitometer); and depth of leaf litter.

To sample the bugs that American toads may eat, I randomly positioned two pitfall traps within one meter of each enclosure. This is a simple, effective, and relatively inexpensive way to survey large areas for comparison of different species and numbers of invertebrates (14). All traps were set even with the ground, and plastic lids were staked a few inches above the trap to minimize the presence of falling debris. Each trap, about the size of a Cool Whip container, was filled with a little water, a preservative, and detergent which served as a surfactant to break the water tension and allow bugs to sink into the traps. Pitfalls were checked weekly, and the contents were transported to the lab.

After returning to the lab I observed how interesting the invertebrates looked under a microscope and identified them to the lowest taxonomic level. I wanted to look at the differences in invertebrate assemblages among the three habitats because the results could indicate additional reasons why toads prefer certain habitats. This aspect of my study is still in progress.

Leaps and Bounds: Results and Discussion

My results showed that survival of the toads steadily decreased over the research period and mortality was unexpectedly high in all three habitats (see figure 1). Although no treatment resulted in zero survival by week five, only 20% of toads remained in any treatment, and toad populations remained highest in the edge habitat. Surprisingly, toad populations at the end of the study were the same in forested and clear-cut habitats.

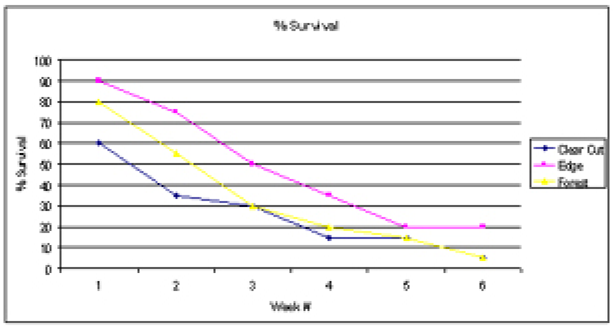

Figure 1: Toad survival steadily decreased with time, and the edge habitat showed the greatest percent survival.

Both the masses and the SULs of the surviving toads in all habitat types increased during some weeks and hardly at all during others (see figures 2 and 3). Mass and SUL % increases were the highest for toads in the forest habitat and lowest for those in clear-cut areas. Among all habitats, the spike at the end is caused by just a few surviving individuals who were perhaps healthier or larger when initially released into the enclosures.

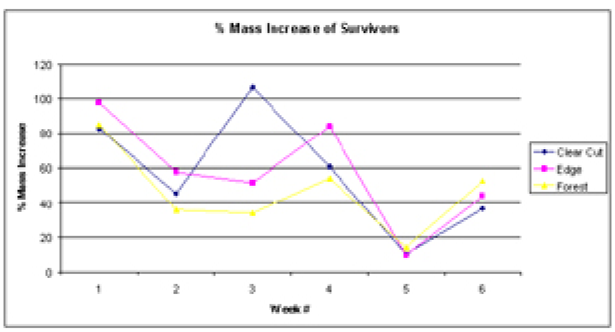

Figure 2: The mass increases of surviving toads displayed fluctuations in all three habitat types.

Mortality could have been caused by a number of factors, including lack of food or desiccation. (It is important to note that toads do not drink water; they absorb moisture through their skin.) The weather was not particularly dry during my study, but because the toads could not move to areas of greater moisture, desiccation is a possibility. There did seem to be, however, ample amounts of moist leaf litter in most of the enclosures, making death due to desiccation less likely.

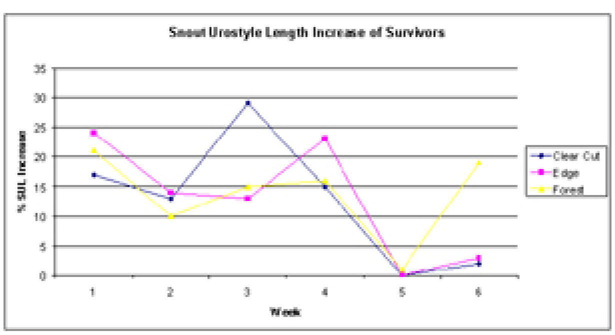

Figure 3: The SUL increases of surviving toads coincide with mass increases.

Escape was not likely due to the depth and height of the enclosures. And although toads do tend to hide under rocks, logs, dead leaves, and soil, my thorough search methods decreased the likelihood that I simply did not find them. Therefore, predation (for example, by shrews that can burrow or snakes that can climb into the enclosures) seems to be the most likely cause of mortality among the toads observed in my study.

On average, the clear-cut had the least amount and depth of leaf litter cover, while the forest had the greatest. The soil in the clear-cut was the hottest and driest, whereas the soil in the forest was the coolest and moistest. Thus, the abiotic (non-living) factor differences in habitats coincide with my previous knowledge of recognized suitable toad habitats.

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Looking Ahead

Should this research be conducted again, I suggest placing mammal traps in and around the enclosures before the start of the experiment and digging the enclosures deeper into the ground to help avoid predation. I expect that doing so would lead to more pronounced impacts, that is, higher mortality, in the clear-cut areas due to desiccation and lack of resources, such as appropriate shelter and food.

Although the results were not as conclusive as I had hoped, I am so fortunate to have conducted this project in addition to last year’s SURF project in the Hunua Ranges of New Zealand, for the experiences provided me with a glimpse into the value of scientific exploration and presentation. Both studies directly relate to my current and upcoming courses and research, and will greatly benefit my future career and participation in the conservation of threatened species.

I would like to thank my mentor, Dr. Kimberly Babbitt, for her organization, assistance, and friendship. Thanks also to Emma Carcagno, Joanne Theriault, Nicole DiManno, and Jan Boyer for their dedication and camaraderie. This study was funded by a Summer Undergraduate Research Fellowship awarded by the University of New Hampshire’s Undergraduate Research Opportunities Program.

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Author Bio

***Heather Lee Moulton**, a senior from Barrington, Rhode Island, will graduate with a Bachelor of Science in wildlife ecology in May 2007. A passionate researcher with a strong interest in amphibians, this is her second publication in Inquiry. (See Heather's research on rare frogs in New Zealand in Inquiry '06.) "I enjoyed the first experience so much that I did not hesitate to submit my current research when asked again," she said. Learning about the worldwide importance of amphibians from Dr. Kimberly Babbitt of the University of New Hampshire's Department of Natural Resources and from Dr. Matthew Baber of the EcoQuest Program in New Zealand, she was inspired "to pursue projects that would benefit the animals and the scientific community as a whole." Through her research, Heather "discovered the importance of scientific research and how it benefits our physical and mental wellbeing, the earth around us, and hopefully our children." She describes her research in Maine as "a great bonding experience with other researchers and peers, from whom I learned an immense amount ... It taught me to ask more specific questions before carrying out a research endeavor, such as how much will we disturb and/or interfere with the animal?" In the future, Heather hopes to continue researching species in danger and traveling to exotic places. She would like to eventually teach at the university level, "to give back to a community that I have benefited so much from." She also has some very specific goals: "I hope to have two dogs, two horses, a motorcycle, and a house with a mountain view. Every project I do, no matter how seemingly trivial, gets me one step closer to these goals."*

Mentor Bio

*Dr. **Kimberly Babbitt** is an associate professor of wildlife ecology in the natural resources department at the University of New Hampshire. She is the academic program coordinator of EcoQuest and has been a mentor for over twenty Summer Undergraduate Research Fellowship (SURF) projects, including several conducted in New Zealand. Dr. Babbitt specializes in amphibian and wetland ecology and is the co-editor of Amphibians and Reptiles: Status and Conservation in Florida. In May 2006 Dr. Babbitt received the Class of 1938 Professorship, an award that recognizes excellence in teaching. She has been at UNH for ten years.*