Northern Rocky Mountain Science Center
U.S. Department of the Interior
Geological Survey

Amphibian Research and Monitoring Initiative

Examining Causes of Amphibian Decline in the Rocky Mountain West

BACKGROUND

Populations of amphibians world wide are undergoing declines due to stressors such as habitat destruction, disease, introduced species, and pollution. Of particular concern are interactions among these factors and the future effects of climate change. Amphibians rely on both aquatic and terrestrial habitats and thus may provide insights into general ecosystem health.

In response to the phenomenon of declining amphibian populations, the U.S. Geological Survey (USGS) established the Amphibian Research and Monitoring Initiative (ARMI) under the Wildlife and Terrestrial Resources Program. The objectives of ARMI are to:

- Monitor amphibian populations to understand the severity and scope of declines and malformations.
- Determine the causes of amphibian declines.
- Develop effective management actions to halt or reverse.
- Encourage collaboration by making the information available to cooperators, land managers, the scientific community, and the public.

Figure 1. Amphibian Research and Monitoring Initiative (ARMI) study areas in the western U.S.

MONITORING

ARMI conducts long-term monitoring of amphibian occupancy, or the probability that a suitable habitat patch contains a breeding population. Study areas, often national parks or national wildlife refuges, have a defined area of inference and samples are selected using a probabilistic design.

In the Rocky Mountain Region of ARMI, monitoring at this scale is conducted in the national parks on the Continental Divide (Fig. 1). Scientists from NOROCK, the USGS Fort Collins Science Center (FORT), Idaho State University, and the Northern Rockies Conservation Cooperative have monitored occupancy on this transect since 2000. The parks differ in climate, vegetation, amounts of human influence, and amphibian occupancy, which is highest in the north and lowest in the south.

Figure 2. David Pilliod (USGS Forest and Rangeland Ecosystem Science Center) searches the margin of Black Rock Pond, Teton County, Wyoming, for boreal toads. Inset: two male toads compete to breed with a female.

More intensive population monitoring is conducted on selected species at a small number of sites. Capture-recapture methods are used to estimate variables such as population size and survival rates. These studies are often collaborations with scientists at FORT and others. A study of boreal toads (*Anaxyrus boreas*) at sites in Montana and Wyoming (Fig. 2) has yielded insights into dynamics of disease in amphibian populations. Monitoring of boreal chorus frogs (*Pseudacris maculata*) in northern Colorado by scientists at FORT and NOROCK is one of the longest continuous population studies of any amphibian species (Fig. 3), and provided data on relationships between behavior and climate and exposure to ultraviolet radiation.

Figure 3. Panoramic view of Lily Pond, Larimer County, Colorado. Inset: boreal chorus frogs have been monitored since 1986.

RESEARCH

Scientists at NOROCK conduct research into factors that may affect the distribution and abundance of amphibian populations. Current projects address the effects of disease, fire, and climate change.

Disease

The pathogenic amphibian chytrid fungus *Batrachochytrium dendrobatidis* (Bd) is a leading cause of global amphibian declines. Recent findings by NOROCK scientists and collaborators include:

- Bd is commonly found on pond-breeding amphibians and in their habitats throughout the Rocky Mountains, but the sudden and severe die-offs of amphibians seen elsewhere have not been detected.
- A seven state, nation-wide survey of stream-dwelling amphibians found Bd largely absent from these species and habitats.
- Populations of boreal toads in Montana and Wyoming with Bd had lower annual survival of adult males than a population in Colorado that was Bd free (Fig. 4).
- A Bd strain from Wyoming is as pathogenic to juvenile boreal toads as a strain from Colorado, but toads from Wyoming selected drier sites within experimental enclosures and survived longer than toads from Colorado.

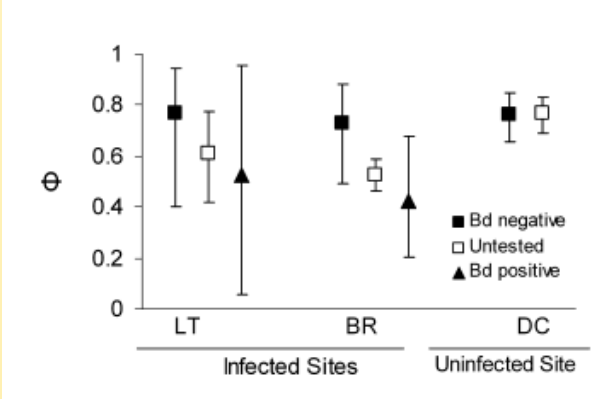


Figure 4. Average annual survival of boreal toads (Φ) relative to the disease state of individual toads and presence of the amphibian chytrid fungus (Bd) at Lost Trail National Wildlife Refuge, Montana (LT), Black Rock, Wyoming (BR), and Denny Creek, Colorado (DC) from 2003 to 2008. (from Pilliod et al. 2010).

Rocky Mountain tailed frog, Glacier National Park, Montana.

Fire

The northern Rocky Mountains have experienced large wildfires during the past decade, including Glacier National Park (GNP) where considerable data on amphibian occurrence had been recently collected. This allowed NOROCK scientists to compare populations before and after the fires. Key findings include:

- Abundance of young Rocky Mountain tailed frog (*Ascaphus montanus*) tadpoles was reduced in burned streams.
- Occupancy of breeding sites by long-toed salamanders (*Ambystoma macrodactylum*) and Columbia spotted frogs (*Rana luteiventris*) did not differ before and after fire (Fig. 5).
- Breeding sites of boreal toads increased in burned areas, and adult toads preferred to use severely burned areas in the year after fire.

A current study in GNP and the adjacent Flathead National Forest is examining the sub-lethal effects of fire on Rocky Mountain tailed frogs and long-toed salamanders by comparing population size, body condition, and disease state of amphibians in unburned habitats to burned sites and sites that have been salvage logged, the practice of logging trees in forest areas that have been damaged by wildfire.

Figure 5. The distribution of amphibian populations in small wetlands in Glacier National Park was not reduced by wildfire.

Climate Change

Climate change and its implications for amphibians has long been an emphasis of NOROCK scientists. Research topics have included the effects of ultraviolet (UV) radiation, long-term trends in breeding phenology (when breeding occurs each year), and responses of populations to weather conditions. Some of the results include:

- There was little relationship between UV and occurrence of amphibians at GNP or other western parks. Damaging amounts of UV do not penetrate deeply into most water used for breeding by amphibians.
- Montane amphibians breed earlier in years with low winter snow packs, exposing their eggs to lower doses of UV. Despite thinning stratospheric ozone and increasing UV radiation, annual variation in phenology results in no increase in UV for amphibian embryos.
- A long-term population study by University of Montana graduate students found that annual survival of Columbia spotted frogs was higher after winters with less snowfall, suggesting some benefits of climate change for montane amphibians.

Long-toed salamander, Ravalli County, Montana.

PARTNERSHIPS: The northern Rocky Mountain ARMI includes scientists from the USGS Northern Rocky Mountain Science Center (NOROCK). Research and monitoring is often in collaboration with other scientists, including colleagues from other USGS science centers (particularly the Fort Collins Science Center), professors and students (Idaho State University, University of Montana), resource managers at federal agencies (Park Service, Fish and Wildlife Service, Forest Service), and non-governmental organizations (Montana Heritage Program, Northern Rockies Conservation Cooperative).

Current research is investigating the consequences of climate change on the Rocky Mountain tailed frog, the dominant vertebrate in small streams in the northern Rocky Mountains. Effects of climate change predictions pose direct and indirect threats to species dependent on cold streams through increased summer temperatures, reduced summer flow and decreased length of permanent stream channels, and increased risk of wildfires. NOROCK scientists are expanding their observations of amphibian breeding phenology at several new sites in Montana and Wyoming using automated recording units (Fig. 6), which make digital recordings of the soundscape at specified intervals, allowing detection of amphibian species that produce breeding calls.

Figure 6. Automated recording unit (green box) deployed at an amphibian breeding pond in Ravalli County, Montana.

SELECTED RECENT PUBLICATIONS

Results of amphibian studies are communicated both through presentations to other scientists and land managers and publication in the primary scientific literature. Some recent papers include:

Corn PS, Muths E. 2002. Variable breeding phenology affects the exposure of amphibian embryos to ultraviolet radiation. Ecology 83:2958–2963.

Corn PS, Hossack BR, Muths E, Patla DA, Peterson CR, Gallant AL. 2005. Status of amphibians on the Continental Divide: surveys on a transect from Montana to Colorado, USA. Alytes 22:85–94.

Hossack BR, Corn PS, Fagre DB. 2006. Divergent patterns of abundance and age-class structure of headwater stream tadpoles in burned and unburned watersheds. Canadian Journal of Zoology 84:1482–1488.

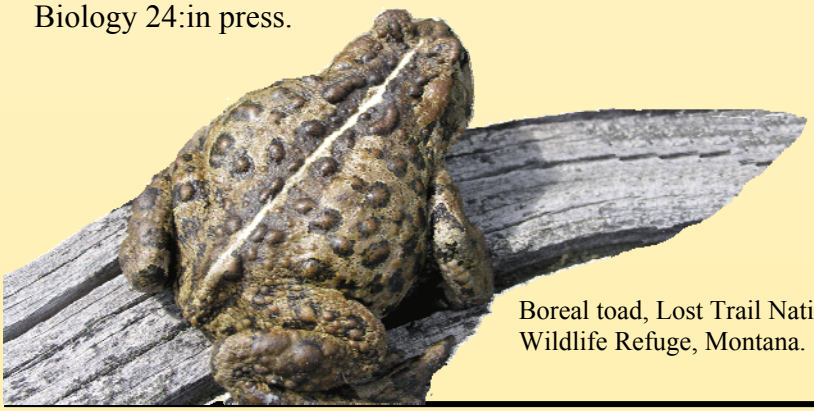
Hossack BR, Corn PS. 2007. Responses of pond-breeding amphibians to wildfire: short-term patterns in occupancy and colonization. Ecological Applications 17:1403–1410.

Murphy PJ, St-Hilaire S, Bruer S, Corn PS, Peterson CR. 2009. Distribution and pathogenicity of *Batrachochytrium dendrobatidis* in boreal toads from the Grand Teton area of western Wyoming. EcoHealth 6:109–120.

Hossack BR, Adams MJ, Grant EHC, Pearl CA, Bettaso JB, Barichivich WJ, Lowe WH, True K, Ware JL, Corn PS. 2010. Low prevalence of chytrid fungus (*Batrachochytrium dendrobatidis*) in amphibians of U.S. headwater streams. Journal of Herpetology 44:253–260.

McCaffery RM, Maxell BA. 2010. Decreased winter severity increases viability of a montane frog population. Proceedings of the National Academy of Sciences (USA). 107:8644–8649.

Pilliod DS, Muths E, Scherer RD, Bartelt PE, Corn PS, Hossack BR, Lambert BA, McCaffery R, Gaughan C. 2010. Effects of amphibian chytrid fungus on individual survival probability in wild boreal toads. Conservation Biology 24:in press.



Boreal toad, Lost Trail National Wildlife Refuge, Montana.

For more information contact:
Steve Corn, Research Zoologist
Phone: 406-542-4191
Email: scorn@usgs.gov

Blake Hossack, Zoologist
Phone: 406-542-3245
Email: blake_hossack@usgs.gov