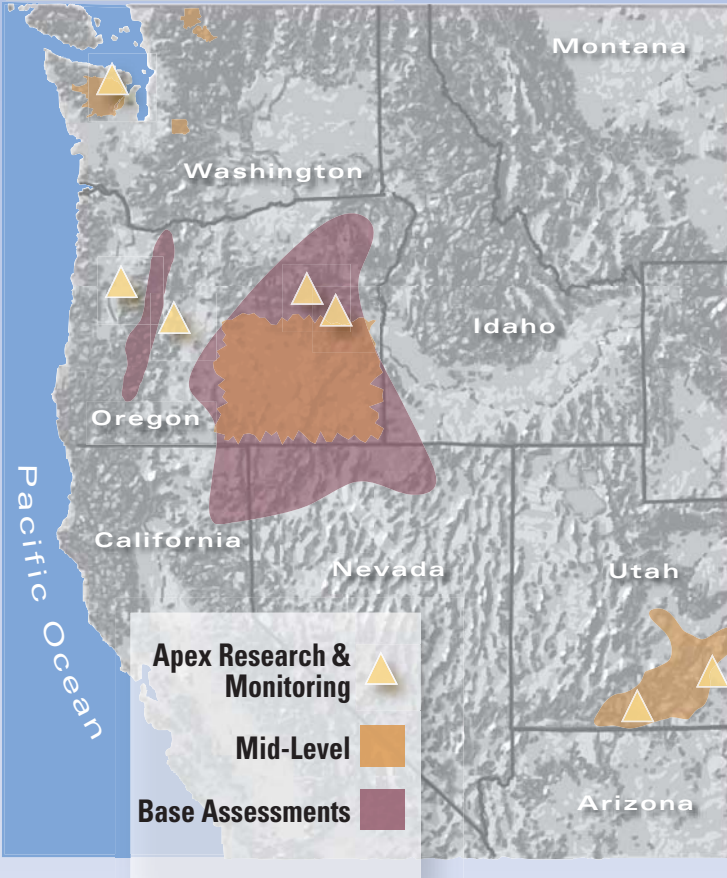


The Amphibian Research and Monitoring Initiative in the Pacific Northwest



ARMI research in the Pacific Northwest and adjacent aridlands. Combined, the Mid-Level Monitoring Areas cover 16.6 million acres (6.7 million hectares) of DOI lands. The monitoring areas will provide information on amphibian status and population trends for eight species in three western states.

Amphibian Decline

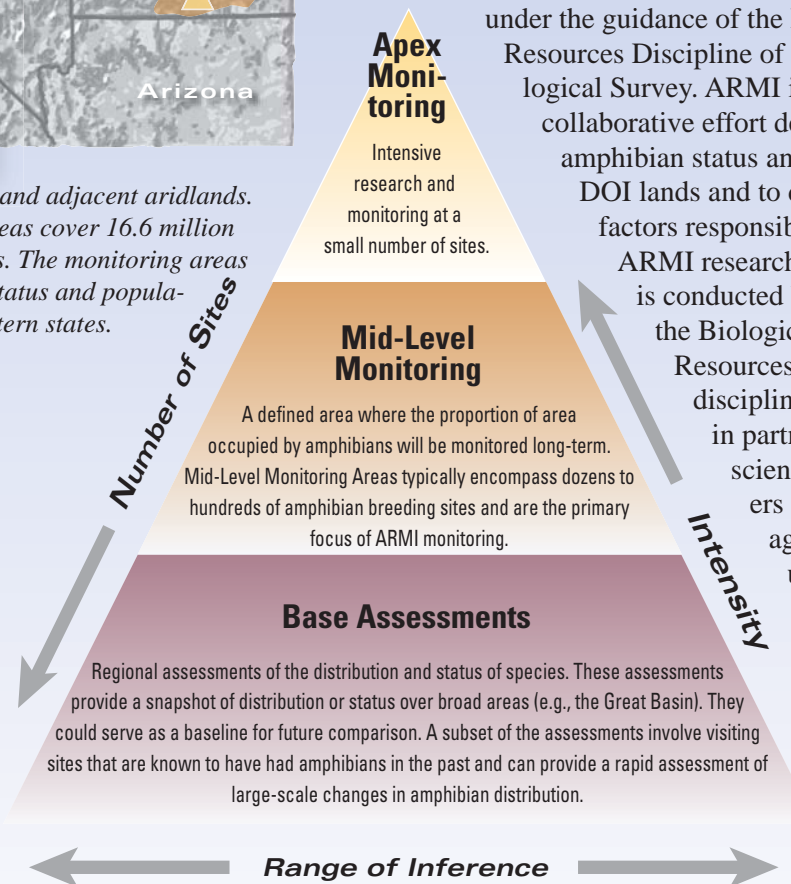
Amphibians have been disappearing from many locations around the world with reports of declines increasing in recent decades. Some of the most dramatic declines have occurred in areas that were thought to be protected from human disturbance. For example, the once-common boreal toad has virtually disappeared from Rocky Mountain National Park in Colorado. Although there has been debate on whether these declines represent a short-term fluctuation in populations or major sustained losses, there is now general scientific consensus that something really is amiss with amphibian populations.

A New Research and Monitoring Initiative

In response to the growing concern about amphibian declines, the U.S. Department of the Interior (DOI) developed the Amphibian Research and Monitoring Initiative (ARMI) under the guidance of the Biological Resources Discipline of the U.S. Geological Survey. ARMI is a nationwide, collaborative effort designed to assess amphibian status and habitats on DOI lands and to determine the factors responsible for declines.

ARMI research and monitoring is conducted by scientists in the Biological, Water Resources, and Mapping disciplines of the USGS, in partnership with scientists and managers from other agencies and universities.

ARMI is a nationwide, collaborative effort designed to assess amphibian status and habitats on DOI lands and to determine the factors responsible for declines.



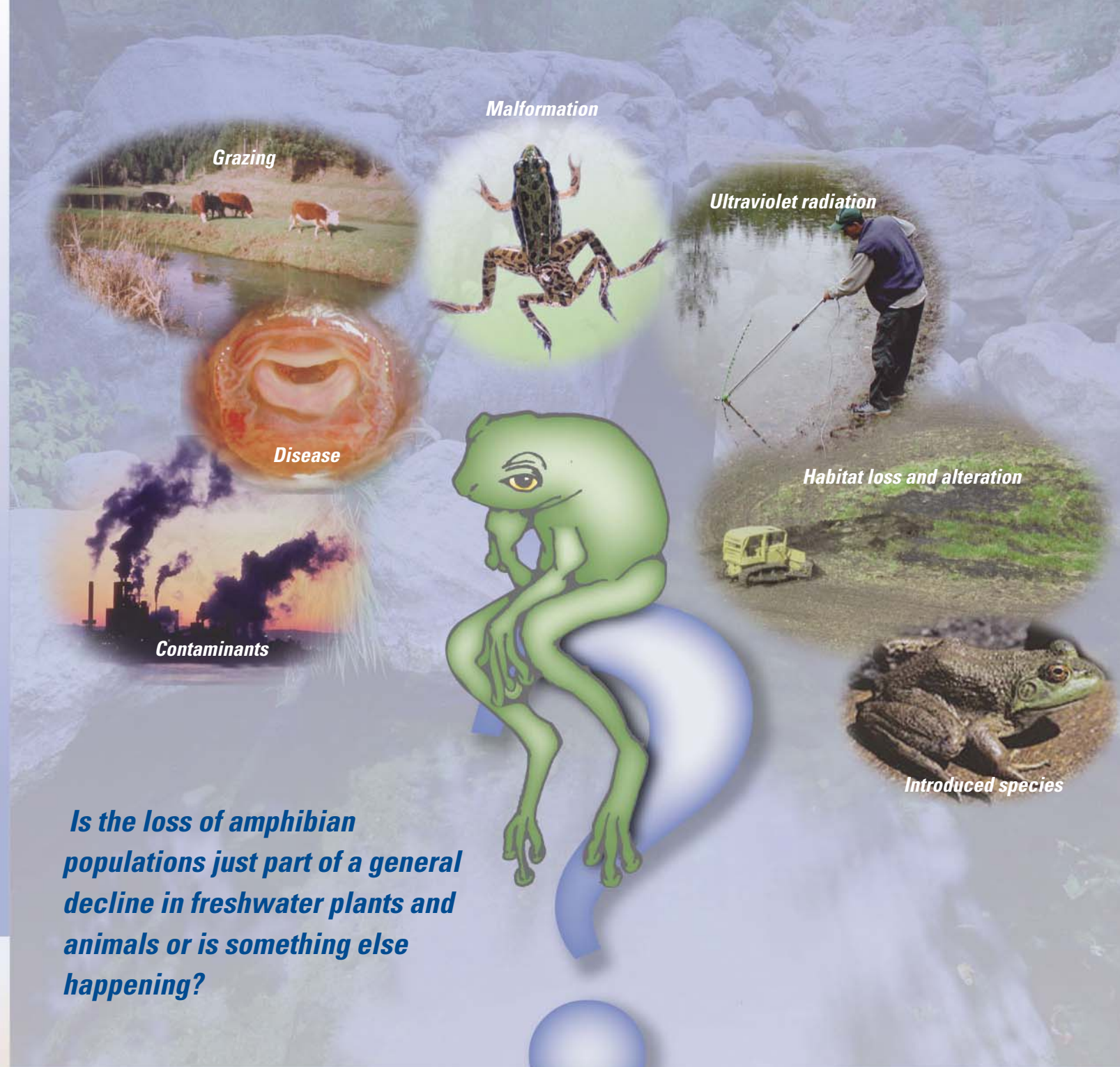
Where have all the amphibians gone?

Is the loss of amphibian populations just part of a general decline in freshwater plants and animals or is something else happening? Some scientists have suggested that amphibians might be analogous to canaries in coal mines—their welfare capable of forecasting a catastrophic deterioration in the environment.

Amphibians are thought to be particularly susceptible to toxins, both because of their permeable skin and eggs, and because they could be negatively affected by disturbance to both aquatic and terrestrial habitats. The high rate of malformations in some populations and the decline of amphibians in some of our most protected environments may indicate that there are urgent problems to be addressed in the world's ecosystems.

We know that the massive loss of freshwater habitats (greater than 50% during the past 100 years in North America) has contributed to many declines of native biota. However, this habitat loss cannot explain the large-scale declines in protected areas. A number of other factors are also suspected, including invasive species, disease, contaminants, ultraviolet radiation, and climate change.

The challenge for us now is to investigate the status of amphibians on DOI lands and to determine the factors responsible for population declines.



Is the loss of amphibian populations just part of a general decline in freshwater plants and animals or is something else happening?

PAO—Proportion of Area Occupied

Proportion of Area Occupied (PAO) is the primary response variable for ARMI Mid-Level Monitoring Areas. PAO is an unbiased estimate of site occupancy rate that incorporates species detectability. Surveys for amphibians are rarely 100% effective and may result in species being overlooked at a site. This biases estimates unless the probability of detection is estimated. Multiple visits to sites and USGS software (called Presence) are used to estimate PAO and to estimate change over time [<http://www.mbr-pwrc.usgs.gov/software>]. The software allows the testing and incorporation of factors that may affect species presence, such as pond depth, and factors that may affect detectability, such as air temperature.

Why are amphibians vulnerable?



Permeable skin and eggs
The permeable skin and eggs of amphibians can easily absorb pollutants. Pollutants can adversely affect all stages of development.



Complex life cycles
Living in both terrestrial and aquatic habitats increases an amphibian's exposure to environmental stressors. This dual exposure makes amphibians potentially broad indicators of ecosystem health.



Malformations
Although malformations may exist in every population to a small degree, the higher than typical malformation rates in some amphibian populations could signal environmental degradation.

Contaminants

Amphibians can be sensitive to a variety of pollutants. The USGS Water Resources and Biological Resources Disciplines are working together to understand the role of contaminants in amphibian declines.

Disease

Diseases, such as a skin fungus called chytridiomycosis, have been associated with amphibian declines in Australia, Central America, and North America. In cooperation with the USGS National Wildlife Health Center, we are monitoring this and other pathogens, and are studying the role of pathogens in declines.

Grazing

Cattle grazing can be both an effective management tool and a potential degrading force in the environment. Grazing occurs over large portions of the western United States, including much of the range of the Columbia spotted frog, which is a candidate for federal endangered status. We do not know if the effects of grazing on spotted frogs are positive, negative, or nonexistent.

Malformation

Parasites, pollutants, and other agents can cause malformations by affecting tadpoles during early development. In cooperation with the USGS National Wildlife Health Center, Madison, WI, we are addressing the range, frequency, characteristics, and causes of malformations in amphibian populations.

Ultraviolet radiation

Some studies have shown that ambient ultraviolet-b radiation can increase mortality of amphibian embryos and larvae compared to filtered sunlight. However, it is not known if this difference in mortality translates into population losses. Other recent studies suggest that most amphibians are naturally protected from ultraviolet-b radiation by dissolved organic matter that is present in water.

Habitat loss and alteration

Regional trends in land use and wetland management are extensively altering the physical and biotic characteristics of wetland habitats. Understanding how the hydrological diversity, spatial arrangement, and landscape context of wetlands influence the health of native amphibian populations is critical for effectively developing techniques for managing wetland resources.

Introduced species

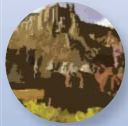
Non-native species, such as the bullfrog and a variety of fishes, have been suggested to cause amphibian declines in the western U.S. Recent findings suggest that non-native fishes have a stronger negative effect on native amphibians than bullfrogs, but the interactions are complex and understanding their effects will require more research.

ARMI's Pacific Northwest and Adjacent Aridlands Project

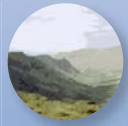
In the Pacific Northwest, the USGS, the National Park Service, and the Bureau of Land Management (BLM) are working to establish three Mid-Level Monitoring Areas. These areas are:



North Coast and Cascades
Network, Washington



National Park and BLM lands on
the Colorado Plateau, Utah



BLM lands in the northern
Great Basin, Oregon

We have obtained preliminary data on amphibian occurrence and water quality and are currently evaluating the suitability and feasibility of continued monitoring of these areas over the long-term. We also have Apex Monitoring Sites scattered around our region. Focal research projects include interactions among non-native species that affect amphibians, the effects of cattle grazing on the Columbia spotted frog, and the effects of ultraviolet-b radiation on amphibians.

Additional Reading

Adams MJ, Pearl CA, Bury RB. 2003. Indirect facilitation of an anuran invasion by non-native fishes. *Ecology Letters* 6:344-352.

Adams MJ, Bury RB. 2002. The endemic headwater stream amphibians of the American Northwest: associations with environmental gradients in a large forested preserve. *Global Ecology and Biogeography* 11:169-178.

Adams MJ, Schindler DE, Bury RB. 2001. Association of amphibians with attenuation of ultraviolet-b radiation in montane ponds. *Oecologia* 123:519-525.

Adams MJ. 2000. Pond permanence and the effects of exotic vertebrates on anurans. *Ecological Applications* 10:559-568.

Adams MJ, Bury RB. 2000. Amphibians of Olympic National Park. USGS Fact Sheet. FS-098-00. <http://fresc.usgs.gov/products/factsheets.asp>

Adams MJ. 1999. Correlated factor in amphibian decline: exotic species and habitat change in western Washington. *Journal of Wildlife Management* 63:1162-1171.

Bury RB. 1999. A historical perspective and critique of the declining amphibian crisis. *Wildlife Society Bulletin* 27:1064-1068.

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

Corn PS. 1994. What we know and don't know about amphibian declines in the West. Pages 59-67 in W. Covington and

L. DeBano, editors. Sustainable ecological systems: implementing an ecological approach to land management. USDA Forest Service. General Technical Report RM-247, Fort Collins, Colorado, USA.

MacKenzie DI, Nichols JD, Lachman GB, et al. 2002. Estimating site occupancy rates when detection probabilities are less than one. *Ecology* 83:2248-2255.

Meteyer CU. 2000. Field guide to malformations of frogs and toads with radiographic interpretations. Biological Science Report USGS/BRD/BSR-2000-0005.

Palen WJ, Schindler DE, Adams MJ, et al. 2002. Optical characteristics of natural waters can protect amphibian populations from UV-B in the US Pacific Northwest. *Ecology* 83:2951-2957.

For more information, contact:

Michael J. Adams
USGS Forest and Rangeland Ecosystem
Science Center
3200 SW Jefferson Way
Corvallis, OR 97331

Tel: (541) 758-8857

Fax: (541) 758-8806

Email: michael_adams@usgs.gov

ARMI website: <http://edc2.usgs.gov/armi>

Edited by: Danielle Jarkowsky

Graphic design: Gretchen Bracher

Photo credits: Disease: Gary Fellers, Grazing: Bill Rogers, Malformation: USGS National Wildlife Health Center, Ultraviolet radiation: USGS, courtesy of Stephen Corn, Introduced species: Alan Resetar, Tree frog: Glenn McCrea. All others: stock photos or public domain.



Bureau of Land
Management



National Park
Service



U.S. Fish &
Wildlife Service