



Sustaining America's Aquatic Biodiversity Frog Biodiversity and Conservation



Authored by David Bishop, Department of Fisheries and Wildlife Sciences, Virginia Tech, and Carola Haas, Department of Fisheries and Wildlife Sciences, Virginia Tech



About 8,100 species of amphibians (frogs, salamanders, and caecilians) are found world-wide. Of these, 111 species are frogs that inhabit the United States. The greatest diversity of amphibians occurs in the Southeastern United States. Frogs can be found in both aquatic and terrestrial habitats, from deep water to tall trees. They are adapted to local environments in coloration, body structure, and behavior.

Thirty-six species of amphibians including 14 species of frogs are listed as threatened or endangered under the U.S. Endangered Species Act. Many other species' populations of frogs are rapidly declining in habitats across the United States and need your help. Habitat loss and fragmentation are major threats to frog populations. Frogs are excellent indicator species because of their permeable skin, dependence on water, and complex life cycle. Since frogs have a two-part life cycle, both terrestrial and aquatic habitats must be protected and restored if we are to conserve these unique animals.

What Are Frogs and Toads?

Frogs are amphibians of the order Anura. The animals we call "toads" are frogs, but compared to other kinds of frogs, they are generally wartier in appearance, have stubby legs, and are more terrestrial. Frogs are ancient animals that have been around for about 200 million years.

Structure and appearance

All frogs are adapted for jumping. They have long hind legs relative to their body length, no neck, and a short, stiff backbone. Some species, such as the bullfrogs (ranids) have powerful hind legs and are excellent jumpers. Others species, such as the toads (bufonids) move through short hops rather than long leaps.

Despite the similarities among all frogs, they are a diverse group of animals that are adapted to their specific habitats. Aquatic species, such as the green frog and pig frog, are excellent swimmers because of their streamlined bodies and the extensive webbing between their toes. Tree-climbing species, such as the pinewoods treefrog and squirrel treefrog, have enlarged toe pads that give them an excellent ability to cling to trees and leaves. The spadefoot toad is adapted to its terrestrial lifestyle and possesses hardened "spades" on its hind feet for digging in the dirt.



Frogs and toads have large, protruding eyes located on top of their heads, giving them a wide field of view. They can move transparent eyelids, called nictitating membranes,

over their eyes for protection. Most frogs have horizontal pupils; however, the spadefoot toad has vertical ones, making it easy to distinguish it from other species.

A frog hears through a circular eardrum (the tympanum) located on each side of its head behind the eye. In some species, the size of the tympanum eardrum can be used to differentiate between the sexes. It is larger than the eye in males and smaller in females. The coloration of the eardrum differs between species.

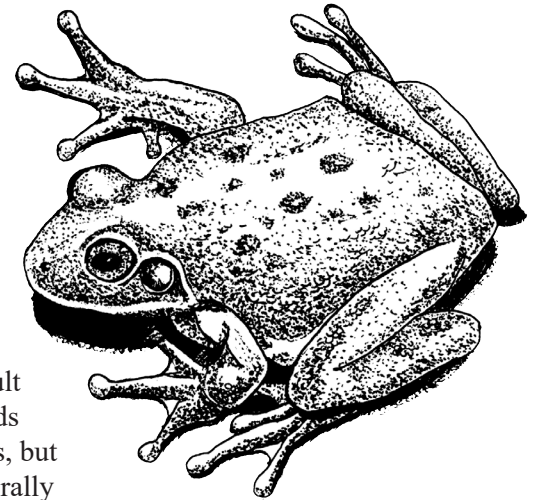
Frogs are masters of camouflage. Because of their well-adapted colors and patterns, it is not uncommon to be close to a frog without ever seeing it. The gray lichen-like coloration of the gray tree frog enables it to blend in perfectly on tree trunks, whereas the shiny green tree frog virtually disappears in wet vegetation. Some frogs display counter-shading with dark-colored backs and lighter bellies. This coloration pattern may help them hide better in water from predators searching from above or below.

In addition to camouflage and jumping away from predators, some frogs and toads inflate their bodies with air to make themselves appear larger and more difficult to swallow. If these anti-predator methods fail, toads also can produce toxic secretions from parotoid glands located behind their eyes. These glands release a poisonous secretion that is distasteful and toxic to predators. Most frogs and toads in the U.S. do not produce lethal poisons; however, some species of toads in the southern and southwestern U.S. produce a toxin that, if ingested, can kill a small dog or cat. Handling toads cannot kill people because the toxins do not pass through human skin. However, always exercise caution by washing your hands after handling amphibians.

What do they eat?

Most frogs and toads are “sit-and-wait” or “ambush” predators, watching for unsuspecting prey to approach and then snatching it with a sticky tongue that may be quickly extended to catch fast-moving prey. They eat invertebrates, including insects, spiders, and worms. Large species, such as the bullfrog, may eat fish, rodents, snakes, other frogs and amphibians, and even small birds. Large frogs and toads eat larger prey.

Meta-morphosis from tadpole to adult frog or toad involves not just dramatic changes in morphology, but also in ecology and behavior. Adult frogs and toads are carnivores, but tadpoles generally are herbivores, feeding primarily on algae and aquatic plants. Some tadpoles are predators and may even eat other tadpoles. Frogs and toads are important links in the aquatic food chain and are preyed upon by many wading birds (herons), mammals (otters), snakes, and other animals.



Distribution and Diversity

Frogs and toads inhabit every continent except Antarctica. Frogs are more abundant in warm, wet tropical areas, but a few species are adapted to live in dry and cool climates. Of the 111 species in the United States, the richest diversity is found in the Southeastern region, which has nearly one-half the native species (48 species). Currently, there are 14 frog and toad species considered threatened or endangered. Four species of nonnative (exotic) frogs have been found in the United States.

Where do they live?

Frogs, like all amphibians, have moist, permeable skin and must remain in wet environments to prevent drying out. Frogs are most active at night during wet periods. Toads can tolerate less moisture than frogs, but they also seek refuge from the sun during the day and dry periods by hiding under vegetation, logs or other debris, or burrowing underground.

During long periods of cold or dry weather, frogs hibernate, remain quiet, and breathe through their skin. Frogs usually overwinter buried in mud or soil or under moisture-retaining vegetation, such as sphagnum moss. When conditions are more suitable, they resume feeding and mating activities.

How do they reproduce?

North American frogs typically breed in the spring and summer. Males spend much of their time during the breeding season calling to attract females. The vocal sacs of male frogs amplify the sound. Calls also are important in establishing territories and warning other males. Each frog and toad species has a unique call that ensures mating within the species. Large frogs have deeper calls than do small ones.

Frogs are wonderful singers. The calls of the different species are pleasing to listen to, and the melodious breeding choruses mark the onset of spring and summer in many regions.

Once a male is successful in attracting a mate, he grabs her around the waist with his front legs, an embrace known as *amplexus*. The males of many species develop hard pads on their thumbs (*nuptial pads*) which help them hold onto slippery females. Female frogs are usually larger than males, and a female may carry a male on her back for some time until she decides to lay eggs or the male decides to let go. As the female releases her eggs, the male fertilizes them externally. Only a few species exhibit internal fertilization.

Eggs are laid in a jelly-like substance that quickly absorbs water, and they swell into transparent spheres. Eggs are often attached to vegetation, woody debris, or rocks. The number of eggs and egg-laying habitats differ among species. Toads deposit eggs in long strands, rather than in transparent clumps.

Tadpoles hatch quickly. Newly emerged tadpoles can barely swim and spend most of their time floating around. However, they soon begin feeding and grow quickly.

What is metamorphosis?

Metamorphosis, the process of change in form, in frogs is the transformation of a gill-breathing (usually aquatic) tadpole into an air-breathing adult. During metamorphosis, a tadpole grows legs and absorbs its tail. The complex internal changes include developing lungs and switching from a vegetarian to a carnivorous diet, a big change that requires a different digestive system and different teeth.

The length of time that a tadpole takes to metamorphose into an adult frog varies with species and location. Some species, such as the bullfrogs, can remain as tadpoles for years, while others metamorphose within a few weeks. Tadpoles hatched in temporary puddles, ponds, and ditches must grow quickly before the water dries up.

Most frogs and toads live 2 to 15 years. Some individuals have been documented to live over 30 years in captivity, but this is probably quite unusual.

Capturing and Observing Frogs and Toads

Calling frogs can be fairly easy to locate if you have the patience to sit and listen. However, they often are silent, especially when a potential predator is nearby. Some species rely on their camouflage to keep them concealed. Others quickly jump in the water and swim away to safety.

Capturing by hand is the best method, but you can also use a dipnet. When using a dipnet, you should place it slightly in front of the frog and allow the frog to jump into it to avoid accidentally injuring the animal. Large aquatic species should be gripped around the waist with your thumb and index finger to keep hold of the slippery and powerful jumpers. Your hands should be wet before capturing frogs to prevent drying of their skin and transferring oils in your hands. After observation, frogs should be kept moist and released at the same place where they were captured.

Before collecting wild animals, you should contact your state wildlife agency to make sure your activities are legal. Although collecting a few live frogs for personal use is legal in most states, some states have restrictions on the numbers, species, seasons, and locations for collecting frogs. In addition, specific lands such as parks may have restrictions on collecting, so be sure you have permission to collect in the area you are visiting. It is illegal to disturb any threatened or endangered species. Because moving animals between habitats creates a risk of disease transmission, avoid introducing frogs collected at one location to another or exotic frogs into new areas. It is also a best practice to sterilize boots and equipment used at one site before visiting another site.

What Good Are They?

Frogs have been a part of our aquatic ecosystems for millions of years. They are part of our heritage and should be part of our legacy to future generations. Frogs are valuable parts of the aquatic food web as both predators and prey. Frogs have large appetites and help keep insect pest populations reduced. The loss of frogs from an ecosystem would be a missing link that likely could not be filled by any other species.

Frog legs are gourmet food items. However, frogs grow slowly and unfortunately, wild populations of large frogs are on the decline. Because of the dramatic reduction of frogs worldwide, the harvest of wild frogs for food may not currently be justified. Attempts at frog farming, the breeding and rearing of large frog species in captivity to supply a human food market, have had mixed results. Small frogs have been successfully reared in captivity for scientific and medical research.

Threats

Many amphibian populations naturally cycle between high and low numbers, a feature which makes assessing the conservation status of their populations difficult in the absence of long-term monitoring. Most scientists, however, agree that there is a worldwide decline in frog numbers.

Habitat loss is a major threat to frogs. Small wetlands that are used as breeding areas by frogs are being filled, drained, and developed. Marshes and swamps are rapidly being replaced by parking lots, strip malls, and residential developments. Small wetlands (ditches, backwaters, temporary pools, and even mud puddles) are vitally important to local amphibians. Changes in seasonal rainfall amounts and temperatures due to climate change are affecting where and when breeding habitats may occur. Such changes can affect the survival of tadpoles and frogs in many regions. Many people fail to realize the importance of small aquatic habitats and when they occur for the conservation of frogs.

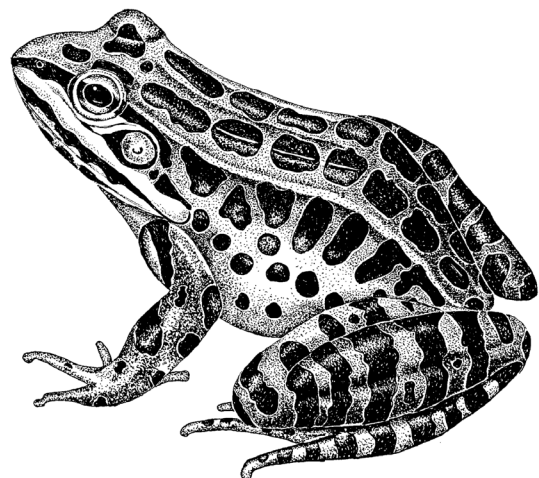
Habitat fragmentation and isolation are also major challenges to conservation. Corridors, pathways for frogs and toads to move from one pond to another, are essential. Highways built near a marsh or across

a migration route can be deathtraps for frogs. Thousands of frogs have been killed in a single night by unsympathetic or unaware motorists. The moist, permeable skin of frogs is sensitive to numerous pollutants, which is one reason why frogs are considered a good indicator species of ecosystem health. Industry, mining, agriculture, and the application of lawn and garden chemicals all release toxins into the environment. Many of these toxins can affect tadpole and adult survival. Recent reports of large numbers of developmental abnormalities in frogs, such as extra legs, may be due, in part, to an increased concentration of environmental toxins. Acid rain is suspected of reducing amphibian populations.

Exotic (nonnative) species of frogs and toads represent another threat to our native frogs and toads. Although our bullfrog is a native of eastern North America, it has been widely introduced into the western states, where it is eating and out-competing native species. Hawaii, which was historically frogless, now has foreign frogs and toads, introduced from other parts of the world. The infamous cane toad has also become established in Florida.

Along with the threat of exotics is the spread of diseases and parasites. Diseases have resulted in massive frog kills, sometimes resulting in local extinctions. Diseases in combination with water pollution, acid rain, ozone, and exotics significantly impact our frogs and toads.

Because frogs and toads have an aquatic-terrestrial life cycle, they are at risk on both water and land. In order for a conservation plan to be effective, we must preserve and restore wetlands and the nearby



terrestrial habitats that are essential for tadpoles and adults. For species such as the wood frog, preserving forested uplands around breeding ponds is critical.

Citizen scientists are providing critical information for the conservation of amphibians. You can help by monitoring local frog populations and reporting any frog deformities or abnormalities in your region. Websites and contacts for wildlife agencies that coordinate these efforts are listed below. You should immediately report any observation of pollution of waterways to your local authorities.

Useful Frog Websites

- Partners in Amphibian and Reptile Conservation: <https://parcplace.org>
- Frog Watch USA: <https://www.aza.org/frogwatch>
- Reptiles and Amphibians of Virginia and Maryland: Reptiles and Amphibians of Virginia: <https://www.virginiaherpetologicalsociety.com/>
- USGS Frog Call Quizzes: <https://www.pwrc.usgs.gov/Frogquiz/>
- Frogs and Toads of South Carolina and Georgia: <https://srelherp.uga.edu/anurans/index.htm>
- Frogs and Toads of Tennessee: <https://www.tn.gov/twra/wildlife/amphibians/frogs-and-toads.html>
- North Carolina's Amphibians and Reptiles: <https://herpsofnc.org/>
- AmphibiaWeb, worldwide database on amphibians: <https://amphibiaweb.org>

Acknowledgements

Doug Harpole and Nancy Templeman (Virginia Cooperative Extension) and Michelle Davis (Virginia Tech Department of Fish and Wildlife Conservation) provided editorial reviews of previous versions of this publication. Additional support was provided by Randy Rutan and Hilary Chapman (National Conservation Training Center, U.S. Fish and Wildlife Service.) Virginia Master Naturalist volunteers Kyle Baker and Marilyn Kupetz reviewed and edited the current version.

Art illustrations by Sally Bensusen, Mark Chorba, Karen J. Couch.