



# Alaska's Abnormal Frogs

## Why are Frogs Important?

Frogs are indicators of environmental change. In recent years, frogs have become known as the “canaries in the coal mine” of the natural world. Coal miners brought canaries to the mines to warn them when oxygen was low. Biologists think frogs can act in a similar manner, alerting humans to dangers in the natural environment that will affect frogs before they affect us.

## Why are Frogs So Sensitive?

Frogs and other amphibians are sensitive for several reasons. First, they breathe and “drink” through their skin. Frog skin is designed to let air and water flow through it. It does not keep contaminants out of the body the way human skin does. Second, much of a frog’s development, such as growing legs and lungs, occurs in the water, not within hard-shelled eggs, like birds, or protective wombs, like mammals. Third, frogs have the same hormone systems humans do. Thyroid hormone controls growth, and estrogen and testosterone regulate sexual development. Hormones act at low concentrations in the body and can be mimicked by certain environmental contaminants. Finally, frogs require diverse habitats for survival. They often breed in lakes, ponds, small wetlands, or even puddles, then live as adults in grasslands or woodlands. Therefore, loss of either aquatic or terrestrial habitat can harm frogs. These four characteristics, (1) permeable skin, (2) exposed development, (3) sensitive hormone systems, and (4) specialized habitat requirements, make frogs susceptible to damage from environmental change.

## Frogs are Disappearing

Frog populations are declining globally, a matter of concern for researchers since the early 1990s (Wake, 1991; Houlahan et al., 2000; Stuart et al., 2004). A recent study found 33% of the world’s 5,743 amphibian species are threatened with extinction, compared with 12% of birds and 22% of mammals (Stuart et al., 2004). Obvious causes, such as habitat loss, do not appear to be the only explanation for these declines. Frog populations are declining in remote areas with no physical habitat disturbance, leading to



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Figure 1. Abnormal frogs from the Kenai Refuge.

speculation that declines may have more subtle causes.

## Numbers of Abnormal Frogs are Increasing

Several researchers have evaluated whether there has been an increase in abnormal frogs recently. These studies have either re-visited historic frog study sites or examined archived museum specimens. One such study in Minnesota found “frog abnormalities [were] more frequent, more varied, more severe, and more widely distributed in 1996-97 than in 1958-93” (Hoppe, 2000). A similar study in Arkansas found the prevalence of abnormal frogs had increased from 3.3% in 1957-1979, to 6.9% in the 1990’s, to 8.5% in 2000 (McCallum and Trauth, 2003). These studies suggest there are more abnormal frogs now than there were in the past.

## Abnormalities are Indicators of Impaired Population Health

Some stressors suspected of causing

population declines (Collins and Storfer, 2003) are also known to cause physical abnormalities in frogs (Figure 1.). These stressors include chemical contaminants (Hatch and Burton, 1998), parasites (Johnson et al., 2002), UV radiation (Ankley et al., 2002), and interactions among these factors (Blaustein and Johnson, 2003). Abnormal frogs can therefore be important indicators of impaired population health.

## What is an Abnormality?

The terms abnormality, malformation, and deformity are often used interchangeably, but they are actually technical terms (Johnson et al., 2001). Abnormality is the more general term for anything visibly wrong with the animal. Malformation and deformity are more specific terms. A malformation is like a birth defect; the malformed body part either does not grow at all, or grows incorrectly

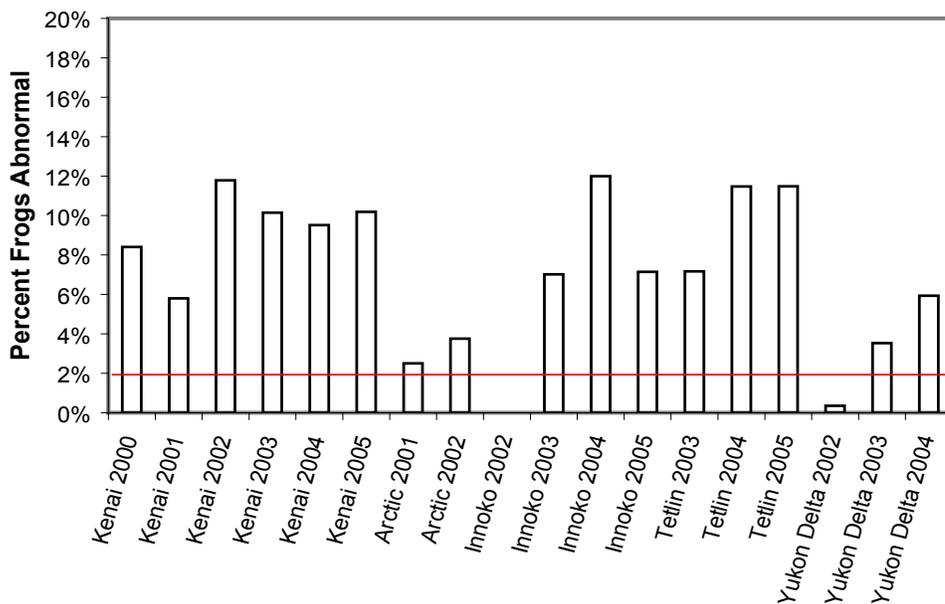


Figure 2. Percent frogs abnormal out of those examined at each Refuge, each year. Line at 2% shows expected abnormality prevalence in wild populations. More frogs and more sites have been assessed at Kenai than other Refuges. Sample numbers at Kenai are in the thousands, whereas numbers at other Refuges are in the hundreds.

in the embryo. A deformity is a change in an otherwise normal body part, like an amputation. Because it is difficult or impossible to determine the difference between malformations and deformities when we look at frogs in the field, and because both are important, we document all abnormalities we encounter:

#### USFWS has Studied Abnormal Amphibians since 2000

In response to the increasing number and range of reported frog abnormalities, in 2000, the U.S. Fish and Wildlife Service (USFWS) launched an investigation of abnormal frogs on National Wildlife Refuges (Refuges) across the country. The goals of this effort are to identify Refuges with significant numbers of abnormal frogs, and to investigate what role environmental stressors play in causing the abnormalities. As of January 2006, 131 Refuges in 47 states have been monitored at least once for abnormal frogs, and many Refuges have been assessed more than once.

#### Are there Abnormal Amphibians in Alaska?

People are often surprised to learn there are frogs in Alaska, much less abnormal ones. Since 2000, USFWS biologists in Alaska have examined 6,723 young wood frogs (*Rana sylvatica*) from 67 breeding sites on 5 National Wildlife Refuges. We

examine only metamorphic individuals that are changing from tadpoles to mature frogs. At this stage, they have all four legs and are reabsorbing their tails. We have found abnormal frogs in both remote and developed sites, and within the boundaries of all Alaskan Refuges studied (Figure 2). Common abnormalities include missing or shrunken limbs and parts of limbs, as well as missing or abnormal eyes. Some of these abnormalities (about 20-30%) are injuries or deformities related to trauma, but a larger proportion of the abnormalities appear to be developmental malformations, based on x-rays of the abnormal animals.

#### How does Alaska Compare to Other Places in North America?

Based on reviews of historic literature, we expect fewer than 2% of wild frogs to be abnormal (Ouellet, 2000). Based on this benchmark, Alaskan Refuges have more abnormal frogs than expected. At the Kenai Refuge, and road-accessible sites within the Tetlin Refuge, 6-11% of the frogs we examine are abnormal. This is higher than recently published field studies in Canada (<2%, Eaton et al., 2004), Vermont (1.6%, Taylor et al., 2005), Minnesota (2.5%, Hoppe, 2000), and the north-central United States (1.4-2.3%, Schoff et al., 2003), but is comparable to

regional studies in the Lake Champlain Basin of Vermont (6.0% Levey, 2003) and in Arkansas (8.5%, McCallum and Trauth, 2003). At specific ponds, like those infested with a parasite known to cause limb malformations in amphibians, up to 90% of the frogs examined can be abnormal (Johnson et al., 2002), however these high, site-specific percentages are rarely observed at the regional, multiple-pond scale. In Alaska, the regional prevalence of abnormal frogs in some Refuges is as high or higher than published reports elsewhere in North America.

#### The Kenai Refuge Helps Us Understand Causes of Abnormal Frogs

In 2004, the USFWS increased the scope of the abnormal frog study on the Kenai National Wildlife Refuge to explore potential causes. The goals of this ongoing study are to expand the original study area to include remote wilderness, and to identify stressors that could be contributing to the frog abnormalities. The stressors we are investigating include parasites, contaminants, temperature, predators, ultraviolet radiation, and disease. We are also taking x-rays of the abnormal frogs, looking for genetic damage, and seeing whether their reproductive organs are normal. We have just finished our second of three field seasons on this project, and results of the study are pending.

#### USFWS Fosters Partnerships in Amphibian Conservation

The USFWS has developed partnerships through this project. We are currently working with the following partners in Alaska and the rest of the United States to understand frog abnormalities and population declines. We thank the Alaska Department of Fish and Game, Alaska Natural Heritage Program, Alaska Pacific University, Unocal Corporation, National Park Service, U.S. Geological Survey (USGS) Alaska Science Center, USGS Columbia Environmental Research Center, USGS National Wetlands Research Center, USGS Amphibian Research and Monitoring Initiative, USGS National Wildlife Health Center, McNeese State University, University of Wisconsin at Lacrosse, Ball State University, and University of California at Riverside. This study would not be possible without their support.