Study on Abnormal Amphibian Distributions on National Wildlife Refuges Questions and Answers

Q: Why was the study undertaken?
A: Reports of abnormal amphibians have increased during the last 30 years, raising concerns among scientists and the public. Many amphibian species live on national wildlife refuges, and the U.S. Fish and Wildlife Service wanted to know whether abnormal amphibians (primarily frogs and toads) are commonly found on refuges, and, if so, whether there were any patterns in the data.

Q: What is in this paper published in PLOS ONE?
A: This research paper describes the findings of 10 years of systematic sampling of amphibians for abnormalities on national wildlife refuges and to introduce the dataset, which we are sharing publically on DataDryad.org with the larger research community. Results will help guide future research on what may cause these abnormalities.

Q: Why is this research important?
A: Amphibians are declining globally at precipitous rates. The Service is concerned about this from a conservation perspective and also because amphibians are believed to be indicators of environmental quality. By systematically examining, for all types of abnormalities, more than 68,000 frogs and toads at 152 national wildlife refuges, Service biologists have greatly advanced the body of science on amphibian abnormalities. In a sense, the Service's National Wildlife Refuge System is a natural laboratory for studying the health of amphibians across the whole country in a coordinated effort.

Q: What are the findings of your research?
A: The good news is that refuges across large areas of the country were within expected background levels for amphibian abnormalities and the severe, extra-legged abnormalities (that raised concern in the mid-1990s) were extremely rare on refuges. Using a core dataset of 48,081 frogs and toads from 132 refuges, only 12 individuals had this type of abnormality (0.025 percent).

On average, only 2 percent of the frogs and toads were classified as having skeletal or eye abnormalities, the types of abnormalities most commonly studied. The expected background range of zero to 2 percent skeletal or eye abnormalities was found at many refuges. These types of abnormalities are likely to affect the survival of individual frogs and toads. For example, the frogs and toads that we found with missing or shortened limbs are likely to be less successful at capturing prey and avoiding predators. But overall the percentages of frogs and toads with severe abnormalities were low at most of our sampling sites.

Nonetheless, we also found some areas where percentages of abnormal frogs were higher than expected in California, the Mississippi River Valley and Alaska. We found that locations with high numbers of abnormal frogs clustered together in these places (in areas tens to hundreds of kilometers across). Additional research is needed to find out the causes of the high abnormality rates in these areas.

For more information on this study, visit: www.fws.gov/contaminants/Issues/Amphibians.cfm.

Q: How does your percentage of abnormal frogs compare to what was found in other studies?

A: There are no comparable large scale nationwide studies. The abnormality frequencies we found seem to be either lower on most national wildlife refuges or comparable to other studies. In the few places where we documented significant clusters of abnormal frogs, our observations agree with smaller-scale studies done in these areas. For example, our study documented high frequencies of abnormal frogs on refuge lands in California consistent with a separate, recent study off of refuge lands that found abnormal frogs and similarly elevated, or sometimes much higher rates. We documented a significant hotspot cluster in the Lower Mississippi River Valley that had not been identified prior to our study, except for one paper published in 2003 that showed abnormality frequencies in this area appeared to have increased since the late 1950s.

Other studies show hotspot locations for abnormal frogs in Minnesota and Vermont. These places were not shown to be statistically significant hotspot clusters in our study (a finding we discuss further in our paper). We did find individual sites with high levels of abnormal frogs in both Minnesota and Vermont, but these sites were not found to be in significant hotspot clusters because they had high numbers of abnormalities in some years but not others and because nearby sites had low levels of abnormalities.

Q: What kinds of abnormalities did you find?

A: The most common abnormalities were missing or partial limbs, missing or partial digits, and surficial abnormalities (like swelling, wounds, pigment anomalies, and dermal cysts, which do not affect the skeleton of the animal). We only present the results of the skeletal and eye abnormality analyses in this paper, and the patterns in the surficial abnormalities (which may be important, particularly from a disease perspective) have not yet been analyzed. However, we are sharing the data and our collection methods on all abnormality types online through DataDryad.org. Using this web site, scientists and the public can download and review the data on all abnormality types.

Q: What might cause the abnormalities?

A: Our study was not designed to investigate causes of abnormalities in amphibians. However, other research has identified the following possible causes of predators: parasites, pollution, and

ultraviolet (UV) -B radiation, acting singly or in combination. Statistical analyses of our data strongly indicated that the causes for the abnormalities were local to regional in nature rather than large-scale factors such as climate or weather. We had virtually no evidence to suggest certain species were more vulnerable to abnormalities than others, or that abnormalities were particularly high in some years. What we found is that where a frog lives is the best predictor of whether or not it will be abnormal, suggesting that something about these places where abnormal frogs are found is making the frogs abnormal. More research is needed to definitively identify causes of frog abnormalities.

Q: Which areas of the country had the highest percentage of abnormalities?
A: The geographic patterns varied across the country, but we detected clusters of high-abnormality sites in the Mississippi River Valley (northeast Missouri, Arkansas and northern Louisiana), throughout California and in south-central and eastern Alaska. Within these hotspot clusters, abnormality frequency reached up to 40 percent of emerging amphibians.

Q: What percentage of abnormalities would be normal?
A: There is no strict threshold. Many researchers believe that the "normal" prevalence of abnormal frogs in wild populations is between 0 and 2 percent, but other research suggests that a normal frequency might be as high as 5 percent of a surveyed population. By surveying tens of thousands of frogs in a nationwide, 10-year effort, our study provides a key piece of information to answer this question. Our research agrees with prior studies suggesting background levels of abnormal frogs should be within 0 and 2 percent of any population surveyed. The average frequency in our study was 2 percent, and in more than half of our collections fewer than 2 percent of the frogs were abnormal. Moreover, our study suggests that a 5-percent abnormality frequency is unusually high in places managed for wildlife conservation.

Q: Why did the research in this study focus on U.S. Fish and Wildlife Service national wildlife refuges? Is there similar research conducted on non-public lands?
A: National wildlife refuges are owned and managed by the Service and, as such, they are one of the agency's priorities for research and management of wildlife issues. Having access to the national wildlife refuge system allows our biologists to conduct large-scale studies and monitoring. There is no equivalent large-scale effort on private lands – or anywhere in the world – in terms of numbers of amphibians sampled systematically during a long time period. Most other studies in the United States have examined frog and toad abnormalities within one state or across several states.

Q: What does the study tell us about the status of amphibian populations?
A: The study was not designed to determine the population status of frogs. This subject of

population status in amphibians was examined by the U.S. Geological Survey's Amphibian Research and Monitoring Initiative (ARMI) during the same 10-year period as our study. ARMI's goals were to assess the distribution and status of amphibian populations, the scope and severity of declines, and gain an understanding of causes of amphibian loss. A recent ARMI study concluded that "U.S. amphibian declines may be more widespread and severe than previously realized, and that significant declines are notably occurring even in protected national parks and wildlife refuges." Although we know that severe abnormalities can affect the survival of individual frogs, researchers have only just recently begun to link amphibian abnormalities with population declines, in part because this type of study is difficult and costly to execute.

Q: What do we know now about frog abnormalities that we didn't know before this study was done?

A: We now know that abnormal frogs occur infrequently or not at all in many refuges of the United States, but there are some places that deserve more research attention due to higher than expected numbers of abnormal frogs. This information from a broad-scale, systematic survey of national wildlife refuges across the United States is a critical piece of the science puzzle of what is causing abnormal frogs. This research gives context to smaller-scale studies that focused solely on abnormality hotspots. It shows that having high frequencies of abnormal frogs is not the norm on refuges. It highlights areas where abnormal frogs occur at higher than expected frequencies and suggests that more work is needed to determine the causes of the abnormalities in these places. If we can understand the causes of the abnormalities, we can manage our landscapes and waters to limit them and conserve amphibian populations.

Q: What is the Service doing to conserve frogs and other amphibians?

A: The Service has funded extensive research into the abnormality hotspot clusters we have documented in Alaska, and this research has advanced the science of amphibian abnormalities in general and helped us understand the causes of the abnormalities in Alaska and how we might better manage refuges to prevent them. The Service also administers Amphibians in Decline, the only federal government program dedicated to funding research and conservation of amphibians around the world. Through this fund and other programs, the Service is actively involved in a number of projects specifically targeting amphibians. This includes research in the United States and overseas into the chytrid fungus, widely recognized as one of the most serious and widespread threats to frogs globally; protection of key habitat for threatened frog species such as the golden matilla in Madagascar; invasive species control for species such as the rough moss frog in South Africa; and community education programs. In 2012, the fund distributed $121,000 in grants, leveraging an additional $263,000 in matching partner contributions.