National Wildlife Health Center
Wildlife Health Bulletin 2012-02

Update on Ranavirus in Amphibians and Reptiles

To: Natural Resource/Conservation Managers
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A recent study of free-ranging box turtles in Maryland by scientists from Towson University (Richard Siegel and Scott Farnsworth) brought to light that turtles, as well as young salamanders and tadpoles, were dying from ranavirus infections at the study site. Some of the turtle carcasses were sent to the USGS National Wildlife Health Center (NWHC) for diagnosis where ranavirus infection was identified. This bulletin provides an update about ranavirus in amphibians and turtles, and expresses our interest in receiving reports of unusual die-offs of turtles.

Large die-offs of amphibians are often caused by ranaviruses. USGS scientists have isolated ranaviruses associated with die-offs in over 25 states involving more than 20 species amphibians and two species of turtles in mortality events ranging from one to thousands of individuals. Some events may involve a single species, others may involve multiple species. Frogs and salamanders in the same pond, for example, may die from ranaviral infections at the same time.

Ranavirus-caused die-offs in amphibians have occurred on private, state, and federal lands, including several National Parks and Wildlife Refuges. Many of the amphibian species involved in die-offs are fairly common and widespread in the United States, but some are either declining in number or are already threatened or endangered.

Host species: The NWHC has isolated amphibian ranaviruses from 16 species of frogs, one species of toad and six species of salamanders. Mortality events due to ranaviruses occur most commonly in larval amphibians such as mole salamanders (*Ambystoma* spp.), true frogs (*Lithobates* spp. and *Rana* spp.) and chorus frogs (*Pseudacris* spp.). Infrequent isolates have been obtained from adult newts (*Notophthalmus viridescens*), adult tree frogs (*Hyla* spp.) and post-metamorphic Columbia spotted frogs (*Lithobates luteiventris*). In states east of the Mississippi River, especially Atlantic coastal states, mortality events tend to involve all species within the wetland (frogs, toads and salamanders) while those in western states, with less amphibian species diversity, tend to involve only one species.

Ranavirus infections in turtles have occurred mostly in captive colonies of eastern box turtles (*Terrapene carolina carolina*) and true tortoises, but die-offs of free-ranging box turtles also have been observed (Johnson and others, 2008). Because box turtles in the wild usually are solitary animals, it has been difficult to document die-offs of multiple box turtles from an area. Ranavirus also was associated with a die-off of snapping turtles in central Pennsylvania (NWHC unpublished data).

Distribution: Amphibian ranaviruses probably are present in every state with the possible exception of Hawai'i. Globally, ranavirus diseases in amphibians have been diagnosed in North and South America, Europe, Asia, and Australia.

All confirmed cases of ranaviral infection in wild eastern box turtles on file at the USGS NWHC are from Maryland. Additional ranaviral disease outbreaks in box turtles have been reported by others in New York, Pennsylvania, Georgia, and Florida. Unexplained die-offs of wild box turtles with signs resembling ranaviral infection have been reported in other eastern states.

Seasonality: Because mortality events due to ranaviruses mostly affect larval amphibians, there is a strong correlation between the presence of amphibian larvae in the spring and summer and ranaviral die-offs. Mortality events often are first detected in April when large populations of wood frogs (*Lithobates sylvaticus*, formerly *Rana sylvatica*) are present in eastern and northern wetlands. Early and mid-summer die-offs due to ranaviruses tend to involve a variety of amphibian species nationwide. Late summer and autumn mortality events involve mostly larval bullfrogs (*Lithobates catesbeianus*) and tiger salamanders (*Ambystoma tigrinum*).

Cause/Etiology: Ranaviruses are DNA-based viruses of the genus Ranavirus, in the family Iridoviridae. Occasionally, amphibian ranaviruses are called iridoviruses; however, this can be confusing because there is a genus of insect viruses called Iridovirus. Some isolates of amphibian ranaviruses have been named; most noteworthy are Frog Virus-3 (FV-3), first isolated in the 1960s, and *Ambystoma tigrinum* (tiger salamander) Ranavirus. Other strains or isolates of ranaviruses have informal names (e.g., Bohle virus in Australia, Redwood Creek virus in northern California, Southern High Plains virus, etc.), but the status of most isolates as species or strains of ranavirus has yet to be clarified.

Signs and Lesions: Field signs of a ranaviral epizootic include sudden or explosive onset of illness in amphibians in a wetland, often with hundreds or thousands of sick and dead amphibians found in a 1–5 day period. Overall mortality rates in juvenile frogs and salamanders in a wetland can exceed 90%. Affected individuals usually present with subtle to severe hemorrhages in the ventral skin, especially at the base of the hind limbs and around the vent opening. Hemorrhages may be present from tip of chin to tip of tail ventrally and may be pinpoint or irregular patches.

Other clinical signs include lethargy, swimming erratically, weakly, or on their sides, and mild to severe fluid accumulation under the skin (in lymphatic sacs) of the abdomen and proximal hind limbs. Internally, there may be fluid accumulation (clear or red-tinged) in the body cavity (called hydrocoelom), and hemorrhages on the serosal surfaces of viscera, especially heart, stomach and liver. Occasionally, white minute foci of necrosis are evident in the liver or spleen. Ulcers of the skin and palate tend to be randomly scattered, but are detected in a low percentage of casualties.

Box turtles with ranavirus infection show weakness, swollen eyelids, discharge from the nose and mouth, and the tongue and palate may show dull, white or thick, yellow plaques. At dissection, these plaques also may be found in the pharynx and esophagus. Occasionally, turtles may show ulcers on the bottom of their feet. Like ranaviral infections in tadpoles and salamanders, infection in box turtles spreads throughout the body affecting many organs including blood vessels. Additional research is needed to determine whether ranaviruses from box turtles and amphibians are identical and may be transmitted between the different genera and species.

Significance/Zoonotic Risk: At present, ranaviral infections appear to be limited to ectothermic vertebrates (i.e., fish, amphibians and reptiles). The virus generally cannot be cultured at temperatures above 30^{o}C, so it probably is not infectious to domestic mammals and humans. At present, it is unclear how many strains or species of ranavirus are infecting and killing amphibians and turtles. Ranaviral outbreaks involving more than one class of vertebrates (i.e., fish and amphibians, or amphibians and reptiles) at a site are rarely reported in the wild, but such mortality events are of great interest ecologically. Ongoing research by USGS scientists and others will help to determine whether die-offs due to ranavirus are causing or contributing to population declines in turtles and amphibians. We are very interested in receiving reports of amphibian and turtle die-offs, and potentially receiving specimens for diagnostic evaluation so we can get a more complete picture of ranavirus infection in these species.

To report or request assistance for wildlife mortality events or health issues, visit
http://www.nwhc.usgs.gov/mortality_events/reporting.jsp or contact Dr. Anne Ballmann, 608-270-2445, aballmann@usgs.gov; Dr. LeAnn White, 608-270-2491, clwhite@usgs.gov; Barb Bodenstein, 608-270-2447, bbodenstein@usgs.gov; Dr. Thierry Work, 808-792-9520, thierry_work@usgs.gov (Hawaii and Pacific Islands); or Jennifer Bradsby, 608-270-2443, jbradsby@usgs.gov (single mortality events nationwide).

To see past Wildlife Health Bulletins, click here. More information about ranavirus can be found at http://www.nwhc.usgs.gov/disease_information/other_diseases/index.jsp

Citation: Johnson, A.J., Pessier, A.P., Wellehan, J.F., Childress, A., Norton, T.M., Stedman, N.L. Bloom, D.C., Belzer, W., Titus, V.R., Wagner, R., Brooks, J.W., Spratt, J., and Jacobson, E., 2008, Ranavirus infection of free-ranging and captive box turtles and tortoises in the United States. Journal of Wildlife Diseases, v. 44 no. 4, p. 851-863.

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