

Ranavirus Infections in Wild North American Herpetofauna

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Table 1: Amphibian species from the USA with known ranavirus infections in wild populations

Family	Scientific Name	First Report	
Ambystomatidae	<i>Ambystoma californiense</i>	Picco et al., 2008	
	<i>Ambystoma jeffersonianum</i>	Miller et al., 2011	
	<i>Ambystoma macrodactylum</i>	Miller et al., 2011	
	<i>Ambystoma maculatum</i>	Green et al., 2002	
	<i>Ambystoma mavortium</i>	Jancovich et al., 1997	
	<i>Ambystoma opacum</i>	Todd-Thompson, 2010	
	<i>Ambystoma talpoideum</i>	O'Bryan et al., 2012	
	<i>Ambystoma tigrinum</i>	Green et al., 2002	
	Bufonidae	<i>Anaxyrus americanus</i>	Hoverman et al., 2012a
		<i>Anaxyrus boreas</i>	Patla et al., 2016
<i>Anaxyrus fowleri</i>		Monson-Collar et al., 2013	
<i>Anaxyrus terrestris</i>		Love et al., 2016	
<i>Anaxyrus woodhousii</i>		Smith et al., 2019	
Cryptobranchidae	<i>Cryptobranchus alleganiensis alleganiensis</i>	Souza et al., 2012	
Hylidae	<i>Acris blanchardi</i>	Davis et al., 2019	
	<i>Acris crepitans</i>	Hoverman et al., 2012b	
	<i>Hyla chrysoscelis</i>	Driskell et al., 2009	
	<i>Hyla chrysoscelis/Hyla versicolor Complex</i>	O'Bryan et al., 2012	
	<i>Hyla cinerea</i>	Converse and Green, 2005	
	<i>Hyla squirella</i>	Rivera et al., 2019	
	<i>Pseudacris clarkii</i>	Torrence et al., 2010	
	<i>Pseudacris crucifer</i>	Green et al., 2002	
	<i>Pseudacris feriarum</i>	Todd-Thompson, 2010	
	<i>Pseudacris fouquettei</i>	Davis et al., 2019	
	<i>Pseudacris maculata</i>	Patla et al., 2016; Kerby et al., 2016	
	<i>Pseudacris regilla</i>	Green & Ip (Unpublished) In Miller et al., 2011	
	<i>Pseudacris sierra</i>	Russell et al., 2011	
	Microhylidae	<i>Gastrophryne carolinensis</i>	Davis et al., 2019
<i>Gastrophryne olivacea</i>		Davis et al., 2019	
Plethodontidae	<i>Aneides aeneus</i>	Blackburn et al., 2015	
	<i>Desmognathus conanti</i>	Gray et al., 2009a; Gray et al., 2009b	
	<i>Desmognathus folkertsi</i>	Rothermel et al., 2013	
	<i>Desmognathus fuscus</i>	Davidson and Chambers, 2011	
	<i>Desmognathus imitator</i>	Gray et al., 2009a	
	<i>Desmognathus marmoratus</i>	Rothermel et al., 2013	
	<i>Desmognathus monticola</i>	Gray et al., 2009a,b	
	<i>Desmognathus ocoee</i>	Gray et al., 2009a	
	<i>Desmognathus orestes</i>	Hamed et al., 2013	
	<i>Desmognathus organi</i>	Hamed et al., 2013	
	<i>Desmognathus quadramaculatus</i>	Gray et al., 2009a,b	
	<i>Desmognathus santeetlah</i>	Gray et al., 2009a,b	
	<i>Desmognathus wright</i>	Gray et al., 2009a,b	
	<i>Eurycea cirrigera</i>	Davidson and Chambers, 2011	
	<i>Eurycea longicauda</i>	Davidson and Chambers, 2011	
	<i>Eurycea lucifuga</i>	Davidson and Chambers, 2011	
	<i>Eurycea wilderae</i>	Gray et al., 2009a,b	
	<i>Gynrinophilus porphyriticus</i>	Gray et al., 2009a,b	
	Ranidae	<i>Plethodon chlorobryonis</i>	Love et al., 2016
<i>Plethodon glutinosus</i>		Davidson and Chambers, 2011	
<i>Plethodon jordani</i>		Gray et al., 2009a,b	
<i>Plethodon montanus</i>		Hamed et al., 2013	
<i>Plethodon welleri</i>		Hamed et al., 2013	
<i>Lithobates blairi</i>		Green & Ip (Unpublished) In Miller et al., 2011	
<i>Lithobates capito</i>		Landsberg et al., 2013	
<i>Lithobates catesbeiana</i>		Wolf et al., 1968	
<i>Lithobates calmitans</i>		Green et al., 2002	
<i>Lithobates paulstrus</i>		Green et al., 2002	
<i>Lithobates pipiens</i>		Clark et al., 1968	
<i>Lithobates septentrionalis</i>		Green et al., 2002	
<i>Lithobates sphenoccephalus</i>		Hoverman et al., 2012b	
<i>Lithobates sylvaticus</i>	Green et al., 2002		
<i>Rana aurora</i>	Mao et al., 1999		
<i>Rana draytonii</i>	Green & Ip (Unpublished) In Miller et al., 2011		
<i>Rana heckscheri</i>	Green & Ip (Unpublished) In Miller et al., 2011		
<i>Rana chiracuenensis</i>	Isidoro-Ayza et al., 2017		
<i>Rana luteiventris</i>	Converse & Green, 2005; Green & Converse, 2005		
<i>Rana mucosa</i>	Converse and Green, 2005		
<i>Rana pretiosa</i>	Isidoro-Ayza et al., 2017		
<i>Rana sierriae</i>	Smith et al., 2017		
Salamandridae	<i>Nophthalmus viridescens</i>	Granoff et al., 1965	

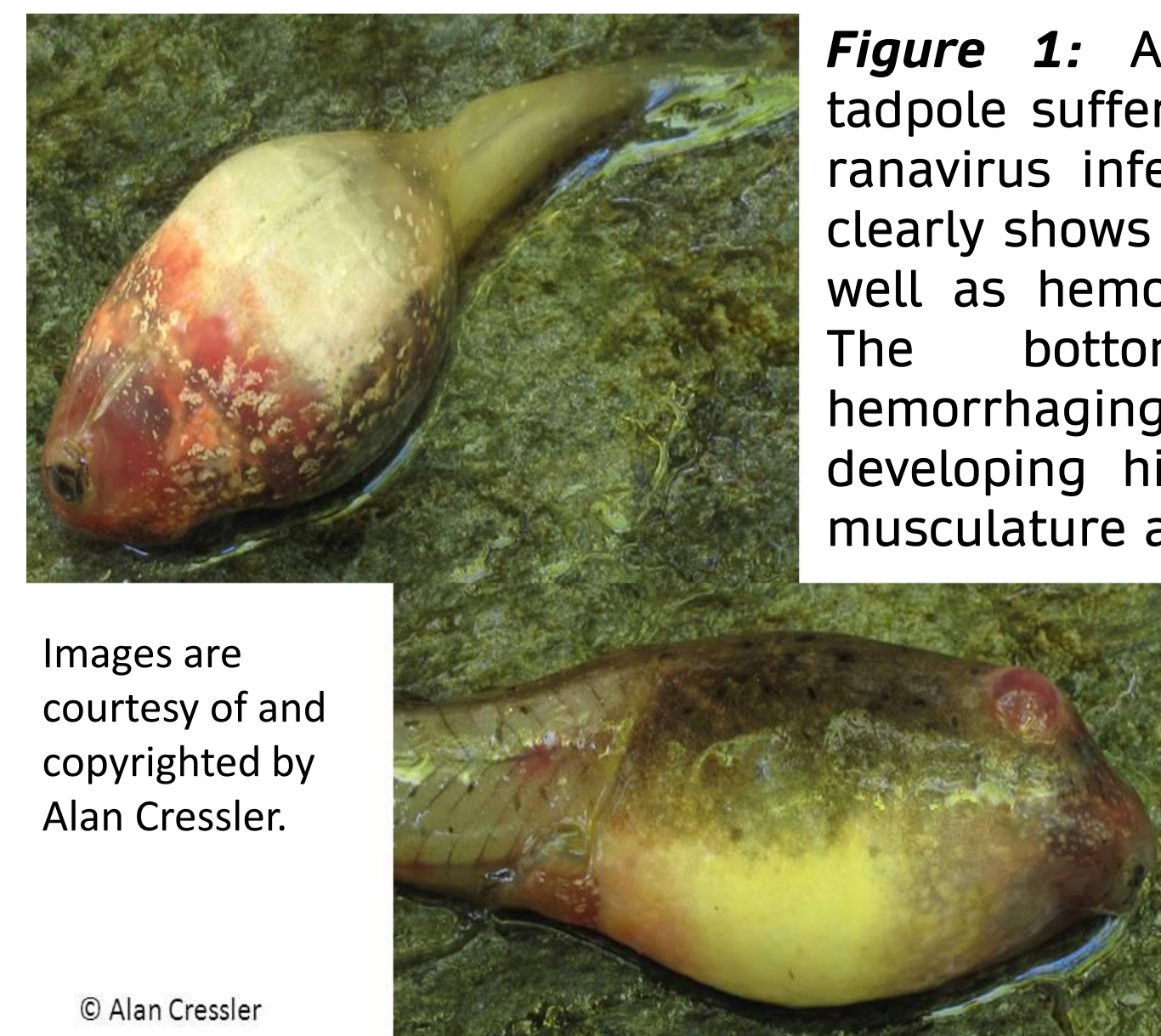


Figure 1: An American Bullfrog tadpole suffering from a suspected ranavirus infection. The top image clearly shows gular hemorrhages as well as hemorrhaging in the gills. The bottom image shows hemorrhaging of the eyes, mouth, developing hind limbs and in the musculature at the base of the tail.

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Figure 2: Gross clinical signs of ranavirus in chelonians. Note the swollen eyes and oral plaques. Photo Credit: Clinic for the Rehabilitation of Wildlife (CROW): <http://crowclinic.org/articles/warning-signs>

Figure 3: *Ambystoma* spp. larva that is close to the completion of metamorphosis showing signs associated with ranaviral disease. A) Note the hemorrhages that are seen on the chin, the body and the venter. B) Note the ulcerations and hemorrhages present at the mouth, behind the limbs, and on the side of the animal. C) Note the large area of hemorrhage (without obvious ulceration) on the side of the animal.



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What are Ranaviruses?

- Globally emerging infections of herpetofauna and fish
- Double stranded DNA viruses from the family *Iridoviridae*
- Multi-host pathogens affecting herpetofaunal communities
- Affect species of special concern in some areas
 - e.g. Hellbenders, Sonoran Tiger Salamanders, Eastern Box Turtles
 - See Tables 1 – 4
- Also known to affect invasive species
 - e.g. American Bullfrogs
- Found in ranaculture facilities in the USA and Mexico
- Gross clinical signs of disease are consistent across species and life history stages in amphibians (see Figures 1 and 3)
- In chelonians, gross clinical signs include, but are not limited to, swollen eyes, nasal discharge, aural abscesses and oral plaques (see Figure 2)
- In amphibians, ranaviruses are considered to be a reportable disease by the OIE (World Health Organization for Animals) and if a disease/die-off event is suspected to be caused by a ranavirus, it should be reported to the appropriate state authorities
- Additionally, any suspected herp diseases should be reported to the Partners in Amphibian and Reptile Conservation (PARC) Herp Disease Alert System (HDAS) at herp_disease_alert@parcplace.org
- See PARC's Disease Task Team for more information at <https://parcplace.org/resources/parc-disease-task-team/>

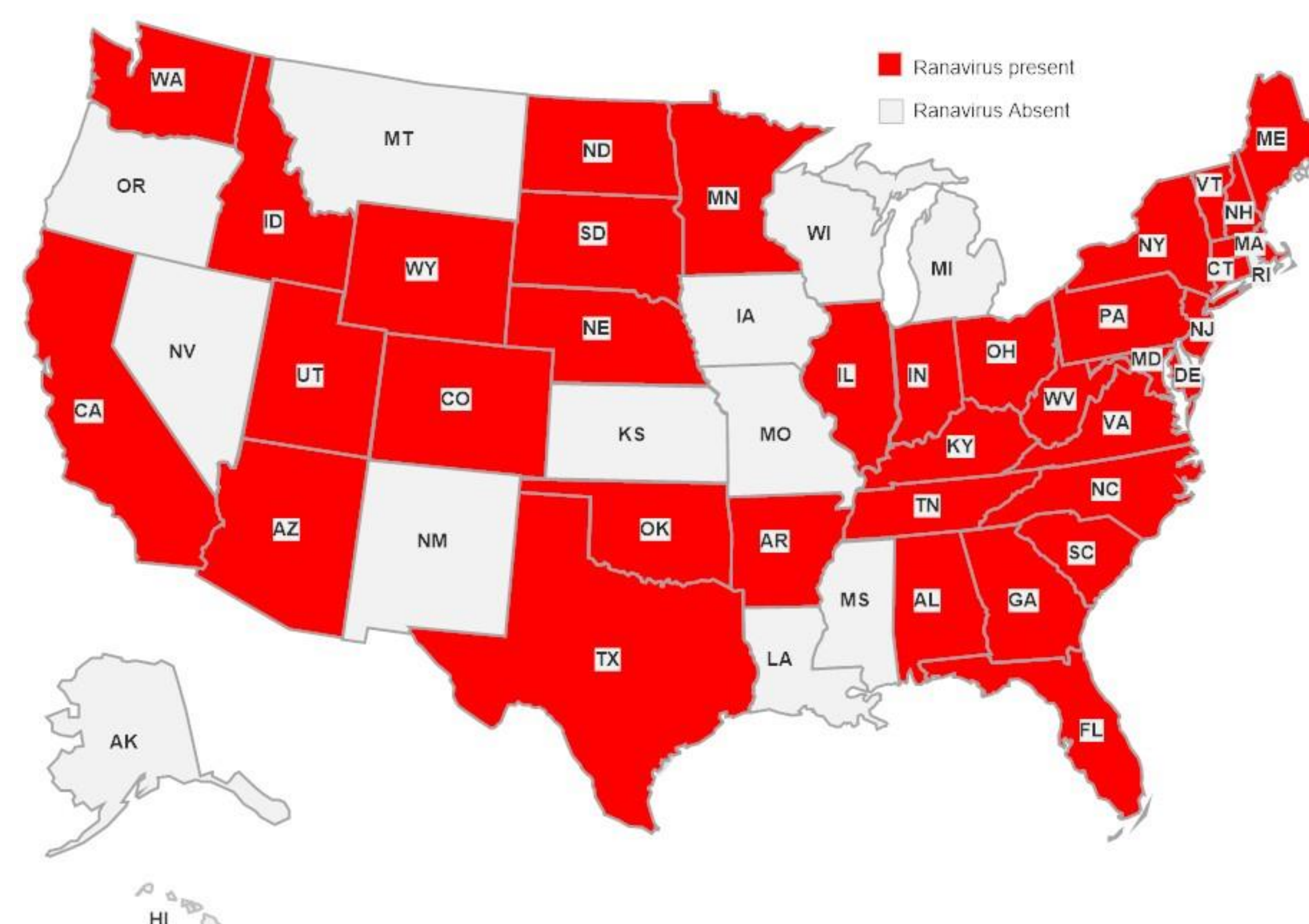


Figure 4: Known distribution of ranaviruses in wild populations of herpetofauna in the USA.



Figure 5: Known distribution of ranaviruses in wild populations of herpetofauna in Canada

Table 3: Amphibian species from Canada with known ranavirus infections in wild populations

Family	Scientific Name	First Report
Ambystomatidae	<i>Ambystoma mavortium</i>	Bollinger et al., 1999
Bufonidae	<i>Anaxyrus hemiophrys</i>	Grant et al., 2019
	<i>Hyla versicolor</i>	Duffus et al., 2008
Hylidae	<i>Pseudacris maculata</i>	Forzan et al., 2019
	<i>Pseudacris spp.</i>	Duffus et al., 2008
	<i>Pseudacris spp.</i>	Duffus et al., 2008
Ranidae	<i>Lithobates clamitans</i>	St. Amour and Lesbarreres, 2007
	<i>Lithobates pipiens</i>	Greer et al., 2005
	<i>Lithobates sylvaticus</i>	Greer et al., 2005
Salamandridae	<i>Notophthalmus viridescens</i>	Duffus et al., 2008

Table 4: Reptile species from Canada with known ranavirus infections in wild populations

Family	Latin Name	First Report
Testudinidae	<i>Chelydra serpentina</i>	McKenzie et al., 2018
	<i>Chrysemys picta</i>	Carstairs et al., 2020

Table 2: Reptile species from the USA with known ranavirus infections in wild populations

Family	Latin Name	First Report
Emydidae	<i>Chrysemys picta</i>	Goodman et al., 2013
	<i>Graptemys pseudogeographica</i>	Butterfield, 2019
	<i>Terrapene carolina bauri</i>	Johnson et al., 2008
	<i>Terrapene carolina carolina</i>	Mao et al., 1997
	<i>Trachemys scripta elegans</i>	Moore et al., 2018
Kinosternidae	<i>Kinosternon subrubrum</i>	Winzeler et al., 2015
Phrynosomatidae	<i>Sceloporus undulatus</i>	Goodman et al., 2018
Serpentes	<i>Thamnophis sauritus sackenii</i>	Wellehan et al., 2008
Testudinidae	<i>Gopherus polyphemus</i>	Westhouse et al., 1996

Selected References:

Chinchar et al. (2017) <https://doi.org/10.1016/j.virol.2017.06.007>; Chinchar et al. (In Press) Ecology of Viruses Infecting Ectothermic Vertebrates: The Impact of *Ranavirus* Infections on Amphibians. In: C. Hurst Ed, Studies in Viral Ecology, 2nd Edition. Wiley and Sons. Duffus et al. (2015) https://link.springer.com/chapter/10.1007/978-3-319-13755-1_2; Johnson et al. (2008) *Journal of Wildlife Diseases* 44: 851-863; Miller et al. (2015) https://link.springer.com/chapter/10.1007/978-3-319-13755-1_7;

Acknowledgements:

Allan Cressler for the use of his images.