



## Scenario B: Move, Adapt or Die

### Scientific and Historical Background Information for the Teacher



#### General Hellbender Information

The life expectancy of a hellbender is approximately 25 – 30 years. Hellbenders range in length from 30 – 74 cm (12 – 29 inches). They are adapted to living at the bottom of mountain streams, with flat heads, small eyes, short stocky legs and rudder-like tails. Coloration patterns range from brown to gray-brown and may occasionally be black with a yellow-brown underside.

Hellbenders are primarily a nocturnal species and hide under rocks near fast moving water riffles. They are active throughout the year and are a fully aquatic species.<sup>6,7</sup> A typical hellbender habitat includes water at a depth 16 – 56 cm with low sedimentation. Individual hellbender home ranges are 28 m<sup>2</sup> for females and 81 m<sup>2</sup> for males.<sup>6</sup> They primarily prey on crayfish, which represent roughly 90% of their food source; fish, frogs, and other invertebrates are secondary prey.

Adult hellbenders absorb oxygen from cool, fast-moving water as it flows over capillaries located within wrinkled skin flaps on the sides of their bodies. They possess lungs that are used for buoyancy purposes, not respiration. Scientists consider hellbenders a bioindicator species, since they thrive only in healthy waterways with high levels of dissolved oxygen, low sedimentation and little pollution; sometimes their decline can signal environmental changes<sup>6,7</sup>

#### Taxonomy and Range

The eastern hellbender (*Cryptobranchus alleganiensis*), is North America's largest salamander with a range which extends south from New York State to northern Georgia and west to Missouri. Hellbenders are in the class *Amphibia*, and these salamanders share many of the same characteristics of frogs including distinct life cycle stages and breathing through their skin (cutaneous breathing).<sup>6</sup>

#### Hellbender Life Cycle

By mid-September, mature males begin to create nests under rocks and lead the females that are ready for reproduction to the nesting site. Females will lay between 150 and 450 eggs which are yellow in color. Once the eggs have been laid, the males fertilize the exposed eggs, chase the females away from the nests, and guard the eggs for 68 – 75 days. The larvae have exterior gills, undeveloped legs and an attached yolk sac that sustains them for a couple of months in the stream gravel. As they mature, hellbenders turn from brown to black in color, lose their gills and begin eating small water invertebrates. Although the larval stage has the highest mortality rate, adult hellbenders may be consumed by large fish, turtles and water snakes.<sup>6,7</sup>





## Use of the Hellbender as an Indicator of Climate Change

Scientists from around the world have tracked the increase of average global temperatures with the increase in the atmospheric concentrations of greenhouse gases (carbon dioxide, nitrous oxides and methane). Hellbender habitat locations in West Virginia are situated within the Chesapeake Bay watershed, where even modest changes in climate have the potential to greatly impact indigenous wildlife and their habitats. Current climate change models project that West Virginia will experience an increase in overall yearly average temperatures varying between 4.5 – 5.0° F (11.4 – 12.7° C) in the southern areas and 5.0 – 5.6° F (12.7 – 14.2° C) in northern areas during the next 40 to 50 years. Stressors specific to West Virginia wildlife related to this level of climate change include the potential for overall drying of habitats and increase in extreme weather events. The potential for environmental impacts associated with an increase in annual average global temperatures may include changes in the distribution of species, with some populations expanding while other species may deteriorate or face extinction. “High elevation species restricted to the cool, moist summits and plateaus of the Allegheny Mountain region of the state are at increased risk because they have no possibility of migrating upward, and potential migration northward is blocked by significant low-elevation natural barriers to the north.”<sup>3</sup>

The International Union for Conservation of Nature (IUCN) has listed the eastern hellbender as “near threatened” since 2007<sup>5</sup>. Because hellbenders are a cutaneous species, they are very sensitive to minor changes in their ecosystem including temperature, oxygen levels, pH, and pollutants.<sup>8</sup> Scientists are unsure of the reason, but have observed that hellbenders stop eating when temperatures rise about 73°F.<sup>1</sup> Kimberly Terrell, an aquatic biologist from the Smithsonian Institute states, “The hellbender is the ‘canary in the coal mine’ for Appalachian biodiversity. Wild populations are very sensitive to environmental change due to their unique physiology.” Due to the hellbender’s significance as a potential bioindicator, it is important to study this species so scientists can create best management practices for other salamanders and the biodiversity residing in their habitat.<sup>7</sup> Increased water temperatures due to increases in overall average yearly temperature could ultimately decrease the amount of dissolved oxygen in the hellbender’s aquatic habitat which could reduce the hellbenders metabolism and overall growth. While “species have adapted to climate change over millions of years, climate change could require adaptations on a larger or faster scales that current species have successfully achieved in the past.” Possible species adaptations may be impacted depending on the climatic change of the region’s ecosystem, but also on the species capability to adapt, move or potentially die.<sup>8</sup>



## References

- <sup>1</sup> Bellis, Jeff. *Hellbent on Conserving the Appalachians*. Fall 2011. The Mountain Institute: Appalachia Program's Spruce Knob News. Volume 10 Issue 2. Morgantown, WV [http://www.mountain.org/sites/default/files/attachments/spruce\\_knob\\_news\\_fall\\_11\\_0\\_0.pdf](http://www.mountain.org/sites/default/files/attachments/spruce_knob_news_fall_11_0_0.pdf)
- <sup>2</sup> Blunden, J., and D. S. Arndt, Eds., 2012: *State of the Climate in 2011*. Bull. Amer. Meteor. Soc., 93 (7), S1–S264. <http://www1.ncdc.noaa.gov/pub/data/cmb/bams-sotc/climate-assessment-2011-lo-rez.pdf>
- <sup>3</sup> Byers, Elizabeth and Norris, Sam. Project Report: Climate Change Vulnerability of Species in Concern. West Virginia Division of Natural Resources. February 14, 2011. Elkins, West Virginia. <http://wvdnr.gov/publications/PDFFiles/ClimateChangeVulnerability.pdf>
- <sup>4</sup> *Climate Change Indicators in the United States (PDF)* 2012. 430-R-12-004 December 2012. Washington DC: US Environmental Protection Agency.
- <sup>5</sup> *Cryptobranchus alleganiensis* - (Daudin, 1803) Hellbender. Nature Serve. Accessed March 23rd 2013. <http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Cryptobranchus+alleganiensis>
- <sup>6</sup> Grandmaison, David, Mayasich, Joseph, Phillips, Chris. Conservation Assessment for Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*) Daudin. June 2003. USDA Forest Service, Eastern Region. [http://www.fs.fed.us/r9/wildlife/tes/ca-overview/docs/amphibian\\_cryptobranchus\\_alleganiensis-EasternHellbender.pdf](http://www.fs.fed.us/r9/wildlife/tes/ca-overview/docs/amphibian_cryptobranchus_alleganiensis-EasternHellbender.pdf)
- <sup>7</sup> Johnson, Tom and Jeff Briggler, Jeff. *The Hellbender*. 2004. Purdue University. Conservation Commission of Missouri. Pg 1-8. [https://ag.purdue.edu/fnr/discover/HerpetologyLab/Documents/Johnson\\_TheHellbender.pdf](https://ag.purdue.edu/fnr/discover/HerpetologyLab/Documents/Johnson_TheHellbender.pdf)
- <sup>8</sup> Mayer, Lindsey. *Salamander Secrets*. Smithsonian Zoogoer. May-June 2012. Washington, DC. pg 10-15. [http://nationalzoo.si.edu/JoinFonz/Join/Zoogoer/Zoogoer\\_May\\_June\\_2012.pdf](http://nationalzoo.si.edu/JoinFonz/Join/Zoogoer/Zoogoer_May_June_2012.pdf)
- <sup>9</sup> Smithsonian's Conservation Biology Institute News. David H. Smith Conservation Research Fellowship. January, 2011. Smithsonian National Zoo <http://nationalzoo.si.edu/SCBI/News/2011/January/SCAFellowship.cfm>