Determining thermal tolerances of freshwater mussels in Texas and the implications for environmental flows

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EXECUTIVE SUMMARY

Understanding the temperature tolerances of organisms is critical because thermal regimes of freshwater ecosystems are changing globally. Given expected changes in global climate and water needs, this may create conflicts between the needs of humans and aquatic ecosystems. Native freshwater mussels may be especially sensitive to increasing water temperatures because many species may already be living near their upper thermal limits. Detailed knowledge on lethal temperatures for mussels has been limited to less than 5% of the species known to occur in North America, and little is known about thermal tolerances of Texas mussels. This lack of information is problematic because climate change coupled with increasing human water demand is expected to increase the frequency and intensity of droughts in Texas, which may negatively impact threatened mussel populations. To determine the effects of elevated water temperature on Texas mussels, I tested the upper thermal tolerances of the larval (glochidia) life stage of freshwater mussels across 3 basins (Neches, Guadalupe, and Colorado) and adult freshwater mussels from the Guadalupe River. I tested glochidia of 5 state-threatened species (*Cyclonaias petrina*, *Fusconaia mitchelli*, *Lampsilis bracteata*, *Lampsilis satura*, and *Obovaria arkansasensis*) and 4 common species (*Amblema plicata*, *Lampsilis hydiana*, *Lampsilis teres*, and *Leptodea fragilis*). Three of these species were also tested as adults (*C. petrina*, *F. mitchelli,* and *A. plicata*). Behavioral response and survival were monitored for mussels acclimated to 3 temperatures (23, 27, or 30°C) across a range of experimental temperatures (26°C-45°C) in standard acute laboratory tests. The average median lethal temperature (LT50) among species in 24 h tests with glochidia was 32.9 °C and ranged from 27.6 to 36.0 °C. The mean LT50 in 96-h adult tests was 35.8 °C and ranged from 33.7 to 37.5 °C. Thermal tolerances differed among species for both glochidia and adults with glochidia being more sensitive than adults. For glochidia, *A. plicata*, *F. mitchelli*, and *L. teres* were the most thermally sensitive, while among adults, *F. mitchelli* and *C. petrina* were the most thermally sensitive. Acclimation temperature did not affect thermal tolerance for either life stage. Using continuous temperature data collected from the Guadalupe River, we evaluated the duration and frequency of temperatures in exceedance of thermal stress thresholds for the most sensitive species. A maximum daily water temperature of 31.2 °C lasting for more than 4 days could be sufficient to cause sublethal stress for *F. mitchelli*. The case study in the Guadalupe River indicates that freshwater mussels might already be living close to their upper thermal tolerances and to mitigate the impact, agencies responsible for managing freshwater resources should consider thermal tolerances of mussels when making and implementing environmental flow recommendations.