

## INSIDE JEB

## Warmer waters make sturgeon think they're sick



Young lake sturgeon. Photo credit: Luke Belding and Mike Latschislaw.

In the lakes and rivers of Manitoba lives the lake sturgeon (*Acipenser fulvescens*), a large truly prehistoric fish. In years past, this bottom-dwelling fish has been overfished for its meat and eggs, but recent efforts have helped to restore their populations. However, the warming of their waters due to global climate change is causing these sturgeon to face new challenges. Once reaching adulthood, lake sturgeon are hardy and incredibly long lived (the oldest fish caught was estimated to be 125 years old!), but the hatchlings aren't so robust. William Bugg and colleagues from the University of Manitoba, Canada, are trying to determine what happens to the little developing fish when their waters get warmer. Are they in a constant state of stress? And will the warmer waters affect other aspects of their well-being?

After obtaining fertilized eggs, the researchers hatched the sturgeon and began the process of getting some of them used to 20°C water. This temperature is within the range that the sturgeon experience in the lakes and rivers early in their development, but

these higher temperatures are expected to last longer and get even hotter as the climate changes. The team then measured the expression levels of genes related to stress, including those that are important in fighting off infections. When the fish were raised at 20°C, they had higher levels of mRNA for genes involved in detecting pathogens (bacteria and viruses), the immune system response (to attack the bacteria and viruses) and the stress response. This suggests that being raised in warmer water causes the fish to be stressed and their immune system to respond similarly to the way it does when the fish are sick.

So, if the sturgeon were already responding as if they were stressed and sick, what would happen if they really were under attack by bacteria? To answer this, Bugg and colleagues measured the mRNA levels of these same genes after the sturgeon were given doses of bacteria. The sturgeon raised at 20°C couldn't generate as big of a response to these bacterial invaders as sturgeon that were raised at 16°C. This means that sturgeon from warmer waters couldn't fight off bacterial infections as well as those raised

in cooler waters. In fact, when given the higher dose of bacteria, 100% of the sturgeon raised in 20°C succumbed to the infection, while only 1.3% of the fish raised at 16°C were unable to fight off the same dose of bacteria.

This surprising result led the team to question whether there were other aspects of the sturgeon's stress response or development that were affected by being raised at 20°C. The increased temperature also caused an increase in the levels of the stress hormone cortisol, and a decrease in liver size, which is an indication of the amount of energy stores the fish have. Interestingly, the fish raised at 20°C were bigger, suggesting the sturgeon were putting most of their energy towards growth without reserving as much for energy stores. In this case, having additional energy stores may have helped fish fight off bacterial infections.

However, being raised at 20°C did have one potential benefit; it increased the temperature at which fish could function. As the researchers slowly increased the water temperature, they tested the ability of the sturgeon to withstand rising temperatures in the future. Sturgeon raised in warmer waters were able to tolerate hotter water temperatures than those raised at 16°C. So, while our efforts at conserving this important fish species have shown some success, global climate change will present a new and unexpected challenge to these potentially long-lived fish.

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**Bugg, W. S., Yoon, G. R., Schoen, A. N., Weinrauch, A. M., Jeffries, K. M. and Anderson, W. G. (2023).** Elevated temperatures dampen the innate immune capacity of developing lake sturgeon (*Acipenser fulvescens*). *J. Exp. Biol.* **226**, jeb245335. doi:10.1242/jeb.245335

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