Taking the Heat: Climate Change Effects on Muscle Physiology of Fish in the Narragansett Bay

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An organism's ability to alter its physiology in response to external pressures reveals their adaptability and tolerance of future environmental conditions, especially in the case of climate change. We expect fish species including, black sea bass, scup, winter and summer flounder will recruit more red muscle when exposed to higher temperature waters in order to complete simple movements. Sedentary species like the flounder will likely demonstrate less of a physiological adjustment than the more active pelagic species. Red and white muscles at half the body length and at the caudal end were all monitored via electrodes hooked up to an electromyography data acquisition system in order to analyze their recruitment during different movements. Fish then swam at each of the experimental temperatures (18 and 22°C) to determine muscle mechanics. Respirometry experiments were also conducted within isolated tanks measuring the dissolved oxygen in the water, quantifying mass corrected oxygen consumption for each species at the two temperatures. Winter flounder exhibited a significant (p-value < 0.05) decrease in burst duration in both caudal muscle fibers and mid white muscles, revealing that muscle contractions occur quicker under higher temperature conditions. Furthermore, caudal red muscles saw stronger recruitment at 22°C conditions, as seen in greater intensity bursts. Mid red muscle had a significantly (p-value < 0.01) lower duty factor at higher temperatures, meaning that the muscles were more active for a shorter portion of the cycle than under 18°C conditions. These results confirm that red muscles were recruited more at 22°C than at 18°C. Aerobic red muscles operate more efficiently under warmer temperatures, explaining why the red muscle of the studied fish contracted faster and more often in the 22°C experiments. Further studies will be needed to understand the energetic costs associated with these physiological changes, as well as how other physical and chemical changes accompanying climate change will impact fish muscle recruitment. In Narragansett Bay, studying the muscle function and oxygen consumption of various fish species will indicate their fitness in the coming years and how local stakeholders must also adapt in order to achieve long-term fishery sustainability.

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