THE EFFECTS OF CHRONIC STRESS ON SWIMMING PERFORMANCE, STANDARD METABOLIC RATE AND METABOLIC SCOPE FOR ACTIVITY IN GREEN STURGEON, *ACIPENSER MEDIROSTRIS.*

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EXTENDED ABSTRACT ONLY- DO NOT CITE

Introduction

Identifying accurate and inclusive indices of fish stress and health that are reliably and practically measured has interested fish biologists for decades. Investigators have examined alterations in multiple physiological parameters from the molecular to the organismal levels. There are several physiological parameters that can serve as indicators of stress or poor health in fish including hematocrit, and circulating lymphocyte, hemoglobin, and red blood cell concentrations (Schreck, 1996). Attenuation of the reproductive system during times of stress or declining health has also been reported (Haddy and Pankhurst, 1999). In addition, acid-base and osmoregulatory perturbations are very common measures of fish health and stress. Although these physiologically based measures inform the investigator that specific systems are impacted during times of poor health, most of these reveal little information about the energetic status or potential long-term survivability of fishes, when considered alone.

Investigations into organismal indices of fish health and stress circumvent the specific nature of physiological or molecular measures, due to their inherent level of integration. Examples include growth rate and body composition measures, which provide estimates of how an organism is utilizing available resources. More short-term measures of an animal's energetic expenditures and available metabolic resources would be the standard metabolic rate (SMR) and metabolic scope for activity (MSA), respectively. Swimming performance (e.g., as critical swimming velocity, U_{crit}) could also be utilized to estimate aerobic capacity and general health in fish. However, significant variation among individual fish regarding acclimation to experimental devices and willingness to swim in laboratory settings can present drawbacks to using organismal measures of fish health and stress.

Approach and Methods

We investigated the impacts of chronic stress on the SMR, MSA, and U_{crit} in green sturgeon, *Acipenser medirostris*. The research model theorized that repeated acute stressors sum to result in "chronic stress." Our approach was based upon a bioenergetic relationship, which hypothesizes that chronic stress will increase maintenance requirements for the fish to maintain homeostasis. The increased energy requirements would result in a significantly increased SMR, decreased MSA, and decreased energy resources for the immune system, reproductive system, growth and general health. If the stressors are severe enough or prolonged, the animal is thought to enter a pre-pathological state, leaving the animal more susceptible to pathogens (Moberg, 1985; Fig. 1).

To simulate chronic stress, groups of three young-of-the-year green sturgeon were place into one of five identical, flow-through, in-door tanks and maintained on a natural photoperiod. Fish were stressed twice a day (1000 and 1600 h) for 28 consecutive days by exposure to two of three randomized stressors: a 5-min confinement stressor, a 5-min chasing stressor, or a 10-min water depth reduction stressor (to the dorsal surface of the fish), prior to metabolic and swimming experiments. Control animals were undisturbed prior to their experiments.

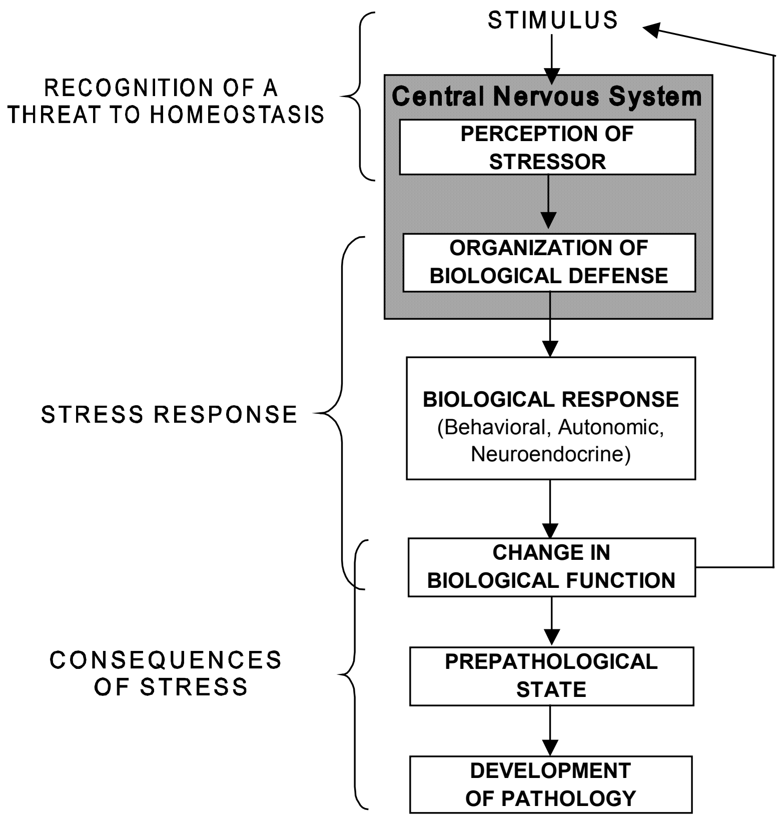

Figure 1: Model for the response of an animal to a stressor and the development of the prepathological state as described by Moberg (1985).

Measurements of SMR, MSA, and U_{crit} were conducted using a closed, variable speed, Brett-type respirometer (Brett, 1964). The SMR was measured at approximately 0800-1000 h with the velocity in the respirometer at 10 cm s^{-1}. This velocity adequately circulated the respirometer water without inducing the fish to swim. The velocity was then increased to 35 cm s^{-1} for 45 min, the respirometer water PO_2 was measured at the beginning and end of the 45-min period, and the O_2 consumption rate was calculated following Cech (1990). The respirometer water velocity was then increased 5 cm s^{-1} in a step-wise manner at 1-h intervals, with corresponding O_2 consumption rates measured, until the fish fatigued. The MSA was calculated by subtracting the SMR from the highest ("active") metabolic rate measured, and the U_{crit} was calculated following Brett (1964).

Results and Conclusions

Exposure to the chronic stress regime resulted in an increased SMR and a trend suggesting a reduced MSA, consistent with the hypotheses that acute stressors sum to simulate chronic stress and that chronic stress affects the SMR and MSA. Interestingly, there was no difference in U_{crit} between the stressed and control fish, and the stressed fish displayed positive growth throughout the 28-day regime. We conclude that our chronic stress regime resulted in a significant metabolic cost to green sturgeon, as indicated by the SMR and MSA measurements, but may not have jeopardized that the overall health of these fish, as indicated from the U_{crit} and growth measurements.

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