PHYSIOLOGICAL STRESS INDICATORS IN FISH:

RESPONSES, ADVANTAGES AND DISADVANTAGES

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EXTENDED ABSTRACT ONLY- DO NOT CITE

Many physiological changes that occur in response to environmental disturbances are now used routinely for assessing stressed states in fish. Stress responses are mediated through neuronal and endocrine pathways, known as the primary response, following initial perception of the stressor. These, in turn, can influence secondary physiological features and tertiary or whole-animal performance characteristics in the fish, which could result in stress-induced alterations in fish populations. The initial stress response is considered adaptive, one designed to help the fish overcome the disturbance and regain its normal or homeostatic state. If the stressor is severe or long-lasting, however, the fish may no longer be able to cope with it and, as a result, enters a maladaptive or distressed state leading to decreased performance, a pathological condition or possibly death.

While many of the physiological changes documented in fish during stress still remain within the realm of experimental research and need further study, some have proven useful for quantifying stress in fish resulting from human activities, such as water pollution and habitat alteration, and in aquaculture. Typical primary responses used for evaluating stress in fish include determining circulating levels of cortisol and, to a lesser extent, catecholamines. Secondary responses include measurable changes in blood glucose, lactate, major ions (e.g., chloride, sodium) and osmolality, tissue levels of glycogen and lactate and, at the cellular level, heat-shock proteins. However, many other apparent non-stress factors influence characteristic physiological stress responses in fish that biologists need to be aware of in order to properly interpret data; these include genetic (e.g., species, strain, stock), developmental (e.g., life history stage) and

environmental (e.g., temperature, nutrition, water quality) factors, as well as the fish's prior experience to stressors.

A number of secondary physiological indicators can be measured relatively easily with portable meters (e.g., glucose, hemoglobin) or easy-to-use assay kits (e.g., lactate). Some of these devices are suitable for field use but should be calibrated with established lab methods to validate accuracy and repeatability. Other indicators, such as specific ions and, especially, circulating hormones, require more sophisticated protocols and laboratory equipment, and many need special handling in the field to maintain the integrity of the sample prior to analysis.

Physiological measurements provide a useful approach to evaluate responses of fish to acute stressors but may not necessarily be so for monitoring fish experiencing sublethal chronic stress. Unless the stressors are severe enough to challenge the fish's homeostatic mechanisms beyond their capacity to adjust, physiological mechanisms will generally adapt to compensate for the stress. In these cases, blood chemistry features, such as plasma cortisol, may appear normal and other approaches, such as evaluating the fish's response to an additional acute stressor, may be needed to determine its physiological status.

Further information may be found in the following paper from which this abstract was extracted.

Barton, B.A., J.D. Morgan, and M.M. Vijayan. 2002. Physiological and condition-related indicators of environmental stress in fish. Chapter 4 *in* S.M. Adams, editor. Biological indicators of aquatic ecosystem stress. American Fisheries Society, Bethesda, Maryland. In press.