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Catch and Release of California Sheephead: Physiological and Behavioral Stress Effects and Post-Release Survival

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Background

A keystone predator within the kelp forests of Central and Southern California, the California sheephead (*Semicossyphus pulcher*) is a popular target species for anglers and recreational spear fishers. Within the last 15 years, it has also become highly sought after by commercial trap fishermen, who sell the fish live to Asian markets and restaurants at a substantial premium.

Because Asian markets prefer smaller, female sheephead (males can weigh more than 30 pounds) and because smaller fish are easier to keep alive in boat holds and tanks, in 1999 the California Department of Fish and Game (CDFG) imposed a 12-inch minimum size limit for all recreationally and commercially caught sheephead. The regulation is designed to improve the likelihood that female sheephead reproduce before being harvested.

Fishermen, particularly hook-and-line anglers, have criticized the regulation, arguing that the fish likely do not survive being caught and released. Hence, they argued, the regulation may be ineffective at protecting California sheephead from overfishing.

Project

Marine biology professors Chris Lowe and Kevin Kelley of California State University, Long Beach were funded to examine the physiological effects of catch-and-release practices on California sheephead. A major focus of the research was to gauge stress levels in fish by measuring hormonal changes—in particular levels of the stress hormone cortisol and insulin-like growth factor, which regulate growth, metabolism and tissue repair. They also tagged fish to study mortality rates of released fish and to monitor behavioral changes that might reduce an animal's long-term chances of survival.

Left: Sea Grant trainee Darin Topping using an underwater receiver to follow sheephead fed an acoustic transmitter. This technique allows for assessment of behavior without the trauma associated with catching. Below: Topping displaying mature sheephead. Photos: Christopher Lowe

Findings

Fish stressed by catching, handling, captivity or environmental factors exhibit a rapid but temporary elevation in adrenalin, the "fight or flight" hormone. In field and laboratory experiments, the biologists showed that this is followed by a prolonged surge in plasma cortisol levels. Elevated cortisol alters metabolic functions and increases the level of an insulin-like growth factor-binding protein (IGFBP), which inhibits the action of insulin-like growth factor. Elevated levels of IGFBP, considered a secondary response to stress, can disrupt the regulation of fish growth, impair tissue repair, and it may also adversely affect egg production and lower disease resistance. Perhaps the most intriguing aspect of the research, however, was the discovery that IGFBP remains elevated even after cortisol levels subside. This implies human-induced stress, such as from fishing, has longer-lasting effects than might be expected based on cortisol levels alone. Fish exposed to high-levels of stress may, for example, take longer to reach sexual maturity.

In field experiments at Catalina Island, the marine biologists caught sheephead by hook and line and in commercial fish traps, subjecting fish to varying levels of stress. "We fought them like an angler would for different amounts of time," Lowe explained. "Fish caught in commercial traps were allowed to soak for different lengths of time."

In all cases, plasma cortisol levels increased rapidly and dramatically proportional to the duration and intensity of handling or trapping. Plasma glucose levels also rose, as did levels of IGFBP. Angled fish, however, had higher levels of lactate in their muscles, a sign of anaerobic activity, caused by struggling against a line. In contrast, lactate levels in trapped fish were not as high, which is not too surprising since these fish were passively lured into commercial traps.

By tracking fish, the marine biologists discovered that angled fish moved around less—a sign of stress—for about 12 hours after being released. After 18 hours, many fish showed remarkable recovery, both physiologically and behaviorally. The degree of recovery, however, depended on the intensity at which they had been angled or the length of time left in a trap. It also depended on

whether fish were held in captivity or released into the wild. “The more you stress them, the more they respond,” Lowe said. “However, in the field, fish recovered very quickly. Fish held in captivity at the lab remained stressed for a month.”

Another significant result: none of the caught-and-released fish died while being tracked. The post-release survivorship rate for angled fish was 100 percent provided the fish’s swim bladder was deflated so it could swim down. “People argued a lot of fish would die,” Lowe said. “Our study confirms this is not the case.”

Implications

The research reinforces the CDFG’s minimum-size-limit for sheephead. It may also affect how the agency interprets fishing mortality rates, statistics used to estimate the effects of fishing on stock size, said Deborah Wilson-Vandenberg a research manager with the CDFG, who is coordinating the implementation of the state’s nearshore fishery management plan. Sheephead is one of 19 species covered under this plan.

The agency is in the process of finalizing its stock assessment for sheephead—the first stock assessment for a nearshore fish species since the passage of the Marine Life Management Act. The outcome of the stock assessment and peer-review of the report will determine a strategy for managing the sheephead fishery, both commercial and recreational, she said.

Next Step

Researchers do not know how long the stress-induced growth inhibitor IGFBP remains elevated in angled fish. Accordingly, the long-term implications of catch-and-release practices remain unknown. How fish respond to being repeatedly angled is also a mystery, but it is believed that in some highly fished areas, undersized sheephead may be trapped and released, or angled and released, many times before they are legal size. A better understanding of whether (or the degree to which) stress slows growth and reproduction rates may further improve the management of this economically important fishery.

Collaborations

California Department of Fish and Game
California State University, Long Beach:
Department of Biological Sciences
CSU Ocean Studies Institute

Publications

Kelley, K.M., K.E. Schmidt, L. Berg, K. Sak, M.M. Galima, C. Gillespie, L. Balogh, A. Hawayek, J.A. Reyes, and M. Jamison. 2002. Comparative endocrinology of the insulin-like growth factor-binding protein (IGFBP). *J. Endocr.* 175:3–18.

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Presentations

Galima, M.M., C.G Lowe, and K.M. Kelley. Catch-and-release stress: Impacts on the endocrine physiology of the California sheephead, *Semicossyphus pulcher*. Annual meeting, Southern California Academy of Sciences, Long Beach, California, May 14–15, 2004.

Lowe, C.G., D.T. Topping, M.M. Galima, K.J. Goldman, and K.M. Kelley. Integrating physiological and behavioral responses of California sheephead exposed to fishing-related stressors and its implications towards management. Annual meeting, Southern California Academy of Sciences, Long Beach, California, May 14–15, 2004.

Lowe, C.G., D. Topping, M. Galima, K.J. Goldman, and K.M. Kelley. Quantifying physiological and behavioral responses of California sheephead exposed to fishing-related stressors. Annual meeting American Academy of Underwater Scientists, 2004, Long Beach, California.

Topping, D.T., C.G. Lowe, D.P. Cartamil, Y.P. Papastamatiou, and J. Caselle. Movement patterns, site fidelity, and habitat use of California sheephead (Labridae) in a marine reserve. Annual meeting of the American Society of Ichthyologists and Herpetologists, June 25–July 2, 2003, Manaus, Brazil.

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Kelley, K.M. Comparative biology of the insulin-like growth factor-binding protein (IGFBP). Annual meeting of the Society for Integrative and Comparative Biology (SICB), 2003, Toronto, Canada.

Theses

Topping, D.T. Movement patterns, site fidelity, and habitat utilization of California sheephead, *Semicossyphus pulcher*, in the Catalina Marine Science Center Marine Life Refuge. Masters thesis, California State University, Long Beach, August 2003.

Galima, M.M. Catch-and-release stress: Impacts on the endocrine physiology of the California sheephead, *Semicossyphus pulcher*. Masters thesis, California State University, Long Beach, August 2004.

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