Assessment of Smolt Condition: Biological and Environmental Interactions

Executive Summary

The Bonneville Power Administration (BPA) has funded the Assessment of Smolt Condition project since 1987. During that time the project changed frequently to meet the information needs of fish managers by conducting studies throughout the Columbia River basin. Past research has examined the influence of smolt physiological development and health on migration rate; differences in development and migration rates of smolts of hatchery or wild origins; and the impacts of hatchery practices on smolt development. The Smolt Assessment Project will not continue beyond 2004, and here we report on the final study of the project in which we used bioenergetics modeling to investigate predation on juvenile salmonids by northern pikeminnow, smallmouth bass, and walleye in the lower Columbia River reservoirs.

The first portion of the work reported here investigated the role of anadromous preyfish and water temperature in the growth and salmonid consumption of northern pikeminnow. This modeling will be combined with similar work completed as part of another BPA-funded project to identify large-scale northern pikeminnow predation patterns in the lower Snake and Columbia rivers. In attempting to understand the interactions driving smolt predation, our research identified three spatially separate northern pikeminnow predation patterns in the lower Columbia River basin. The biotic and abiotic factors contributing to these spatially distinct northern pikeminnow growth and predation patterns are: (1) release of large numbers of hatchery salmonids into the free-flowing Columbia River below Bonneville Dam, (2) rearing and emigration of large numbers of invasive American shad in the lower Columbia River reservoirs, and (3) low numbers of anadromous preyfish and warmer water temperatures in the lower Snake River reservoirs. Identification of these predation patterns provides management agencies with large-scale spatial information on the factors driving northern pikeminnow predation on juvenile salmonids in different areas of the lower Columbia River basin, and opportunities for development of innovative predation control measures.

The second portion of this study focused on the potential impact of larval and juvenile American shad, an invasive preyfish, on the growth and salmonid consumption of invasive predators in the lower Columbia River reservoirs. We estimated the late summer and fall diet of smallmouth bass and walleye, and used size-at-age data on smallmouth bass (Beamesderfer and Ward 1994) and walleye (Tinus and Beamesderfer 1994) collected in John Day Reservoir to run bioenergetics simulations under various prey and water temperature scenarios. Most significantly, our modeling on invasive aquatic predators suggests that a relatively small increase in the growth of smallmouth bass due to American shad preyfish in the late summer and fall diet could potentially result in a large increase in the proportion of juvenile salmonids consumed by this predator. Our results support earlier research and reinforces concern expressed by numerous authors that smallmouth bass predation may result in heavy losses of subyearling fall Chinook (Gray and Rondorf 1986; Curet 1993; Tabor et al. 1993; Poe et al. 1994; Zimmerman 1999; Duran et al. 2003; Petersen et al. 2003). Because of their smaller size and later migration period, wild fall Chinook from the Hanford Reach and Snake River may be more vulnerable to smallmouth bass predation than hatchery fish. Juvenile salmonids may also be vulnerable to smallmouth bass predation whenever foraging or flow patterns bring migrants near shorelines, or migrants are delayed in dam forebays, particularly later in the spring once water temperatures have warmed.

Bioenergetics modeling also suggests that the growth of walleye is enhanced by a late summer and fall diet of American shad. Unlike smallmouth bass, the increased walleye growth predicted with a fall diet that includes American shad produced only a modest rise in salmonid consumption. Bioenergetics simulations also suggest that warmer summer and fall water temperatures in the impounded lower Columbia River contribute substantially to the growth rates of smallmouth bass and walleye. The increased feeding rate of these introduced aquatic predators in response to warmer water temperatures during the summer months suggests these species may primarily impact subyearling fall chinook in the lower Columbia River.