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Diet Composition of Northern Pikeminnow in the Lower Granite Reservoir System

Abstract

Predation in Columbia River basin reservoirs by northern pikeminnow can be a major source of mortality of juvenile anadromous salmonids near dams. The purpose of this project was to estimate the diet composition of northern pikeminnow in the tailrace and forebay of Lower Granite Dam, Snake River, and compare with those from the more lotic habitat in upper Lower Granite Reservoir. Crustaceans and nonsalmonid fishes were the most abundant food items by weight in stomach samples collected from northern pikeminnow from April through August 1996 and 1997. Juvenile salmonids were not a major component of northern pikeminnow diets at any sampling locations as we found juvenile salmonid remains in 0.5% of 396 northern pikeminnow stomachs examined. Our results suggest that slamonid predation may be reduced relative to earlier years when lower flows occurred.

Introduction

Returns of wild Snake River salmon (*Oncorhynchus* spp.) and steelhead (*O. mykiss*) have declined dramatically from historic levels. Currently, all remaining species of wild Snake River salmon are listed as endangered or threatened, and wild steelhead are listed as threatened by the National Marine Fisheries Service under the Endangered Species Act of 1973 (National Marine Fisheries Service 1992). Dams have transformed the once riverine environment into a series of slackwater pools. Snake River stocks of juvenile anadromous salmonids pass as many as eight mainstem dams during their seaward migration. As a result, mortality rates of juvenile salmonids have increased because of passage through turbines, increased migration times, asynchronous smoltification, and gas bubble disease from nitrogen saturation (Raymond 1968, Bently and Raymond 1976, Ebel and Raymond 1976, Rosentreter 1977, Weitkamp and Katz 1980, Zaugg et al. 1985). Predation also has been implicated as a major source of mortality of juvenile salmonids (Rieman et al. 1991).

Fish predators annually consumed an estimated 2.7 million juvenile salmonids that entered John Day Reservoir, Columbia River, from 1983 to 1986 (Rieman et al. 1991). Northern pikeminnow (*Ptychocheilus oregonensis*) were responsible for 78% of the estimated loss. Predation rates were the highest in the McNary Dam tailrace where northern pikeminnow were estimated to be 12 to 18 times more abundant than in other parts of the reservoir (Beamesderfer and Rieman 1991). Although predation was especially intense in the McNary Dam tailrace, juvenile salmonids composed more than 60% of northern pikeminnow diets in the John Day Dam forebay (Poe et al. 1991). Reiman and Beamesderfer (1990) reported that sustained exploitation of northern pikeminnow longer than 275 mm could substantially reduce predation on juvenile salmonids. In 1991 the Sport Reward Program (SRP) was initiated to pay anglers for removal of northern pikeminnow from the Columbia and Snake rivers.

Management of piscivorous fishes in the Columbia River basin has been based largely on recent studies at John Day Reservoir, however some evidence suggests predator-prey relations may be quite different in the lower Snake River reservoirs (Ward et al. 1995). Ward et al. (1995) found that predation of juvenile salmonids by northern pikeminnow was much higher in the lower Columbia River than in middle Columbia or lower Snake rivers. The purpose of our study was to assess diet composition of northern pikeminnow in the Lower Granite Reservoir system.

Study Area

Lower Granite Reservoir is located in southeastern Washington and west central Idaho near the cities of Clarkston, Washington, and Lewiston, Idaho (Figure 1). Lower Granite Dam was completed

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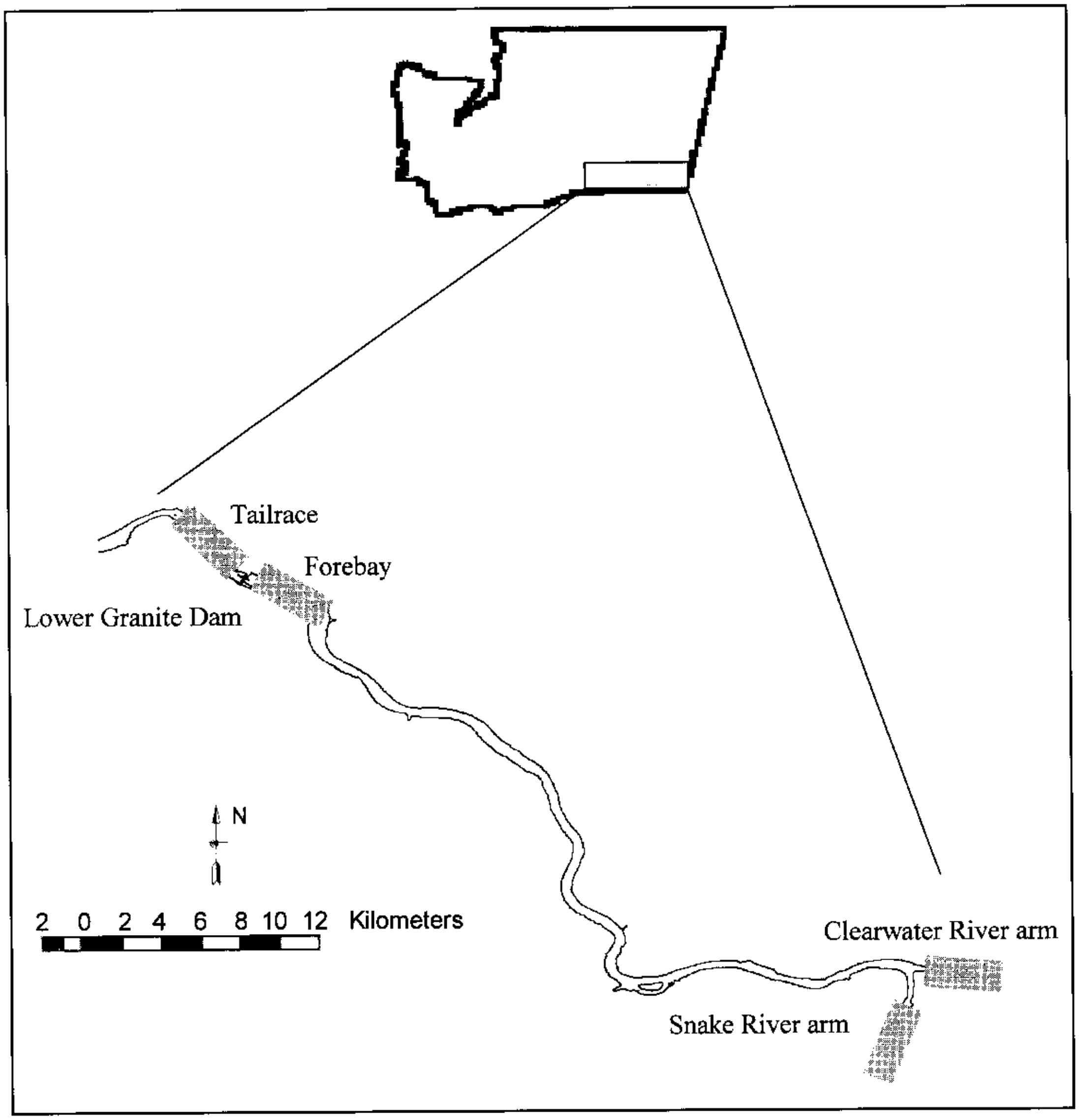

Figure 1. Sampling locations in the Lower Granite Reservoir and tailrace from April through August 1996 and 1997.

in 1975 to provide hydroelectric power, barge navigation, recreation, and flood control (Bennett et al. 1983).

Lower Granite Reservoir has a total surface area of 3,602 ha at full pool, a mean depth of 16.6 m, a maximum depth of 42.1 m (Curet 1993), and extends from Lower Granite Dam (river kilometer (rkm) 173.1) upstream beyond the confluence of the Snake and Clearwater rivers in Idaho. Surface water temperatures typically range from <7°C in March to 25°C in late summer (Funk et al. 1985). Shoreline habitat consists of rip-rap, cobble, talus, sand-silt beaches, and embayments (Bennett et al. 1983).

We selected four main locations in our study area to capture the range of physical variation in reservoir habitat: the tailrace (rkm 167-173), the forebay (rkm 173-179), the Snake River arm (rkm 225-238), and the Clearwater River arm (rkm 0-6). Locations in the forebay and tailrace included the restriction zones (RZ) immediately adjacent to Lower Granite Dam.

Three species of juvenile anadromous salmonids migrate through Lower Granite Reservoir: chinook salmon (*O. tshawytscha*), steelhead, and sockeye salmon (*O. nerka*). Spring and summer chinook salmon, steelhead, and sockeye salmon juveniles migrate seaward in April, May, and June as yearlings or older fish. Fall chinook salmon migrate seaward in June, July, and August as subyearlings (Connor et al. 1998). In 1996, nearly eight million juvenile salmonids were collected at Lower Granite Dam, whereas nearly seven million fish were collected in 1997. Juvenile salmonid migrations at Lower Granite Dam in 1996 and 1997 were made up of 9% spring or summer chinook salmon, 90% steelhead, and <1% sockeye and fall chinook salmon (Fish Passage Center 1996, 1997).

Methods

Northern Pikeminnow Collections

We collected northern pikeminnow near and parallel to the shoreline in the four sampling locations by using nighttime electrofishing with an output of 400 volts at 3-5 amps. Sampling was conducted to coincide with peak feeding activity of northern pikeminnow that occurs at dawn and dusk (Steinberger and Larkin 1974, Vigg et al. 1991). We used proportional allocation methods (Scheaffer et al. 1990) to determine the number of sites of each habitat to sample within each reservoir location. Each week, we sampled at least eight, 400-m sites in the tailrace and forebay from April-August 1996 and 1997, 16 sites from May-August in the Snake River Arm in 1996 (eight sites from April-August in 1997), and eight sites from May-August in the Clearwater River Arm in both years.

All northern pikeminnow collected were immediately placed in a live well and measured for total length (mm). Weights of captured fish were estimated using weight-length regressions developed by Bennett et al. (1983). Northern pikeminnow ≥200 mm, the approximate minimum size of salmonid predators (Poe et al. 1991, Chandler 1993), were killed for stomach analysis.

Prey Collections and Dietary Analysis

We removed the entire digestive tract because northern pikeminnow lack a true stomach (Hofer 1991). Stomach contents were collected by cutting open the body cavity, pinching shut the anterior end of the esophagus behind the pharyngeal teeth, and stripping the contents into a plastic cup. Within each site in the field, all collections were preserved in a 10% buffered formalin solution.

In the laboratory, prey items were identified with the aid of a dissecting microscope and divided into the following prey groups: macroinvertebrates, crustaceans, nonsalmonids and salmonids. Each prey group was blotted dry and weighed to the nearest 0.0001 g. Partially digested, unidentifiable macroinvertebrates were weighed as a group. When prey fish were too digested to measure fork or total length, diagnostic bone lengths (Hansel et al. 1988) and nape to tail lengths (Vigg et al. 1991) were used to estimate the fork length using regression equations. Diagnostic bone lengths were taken from cleithra, opercles, pharyngeal teeth, and dentaries found in stomachs of northern pikeminnow. Vertebrae shape was used to distinguish between salmonid and nonsalmonid prey fish when other diagnostic bones were absent. We pooled salmonid prey into a general category of salmonids because stock identification was not possible.

Results

We examined the stomach contents of 396 of 648 northern pikeminnow collected in 1996 and 1997. The remaining fish were released with tags in an attempt to estimate their abundance or implanted with radio-transmitters (Piaskowski 1998). In 1996, 106 (81%) of the northern pikeminnow stomachs examined were from fish <349 mm in length, whereas 25 were from northern pikeminnow >349 mm in length. We sampled 265 northern pikeminnow stomachs from April through August 1997; 249 (94%) were from northern pikeminnow 200-349 mm in length. The abundance of prey items in diets of northern pikeminnow differed among sampling locations in 1996 (Figure 2). Crustaceans were the most abundant prey item by weight from northern pikeminnow stomachs collected in the tailrace (71.3%), Clearwater River Arm (84.9%), and Snake River Arm (90.6%). We found one juvenile salmonid in one northern pikeminnow collected from the tailrace-RZ. Juvenile salmonids were absent from stomachs of northern pikeminnow collected at the other locations in 1996.

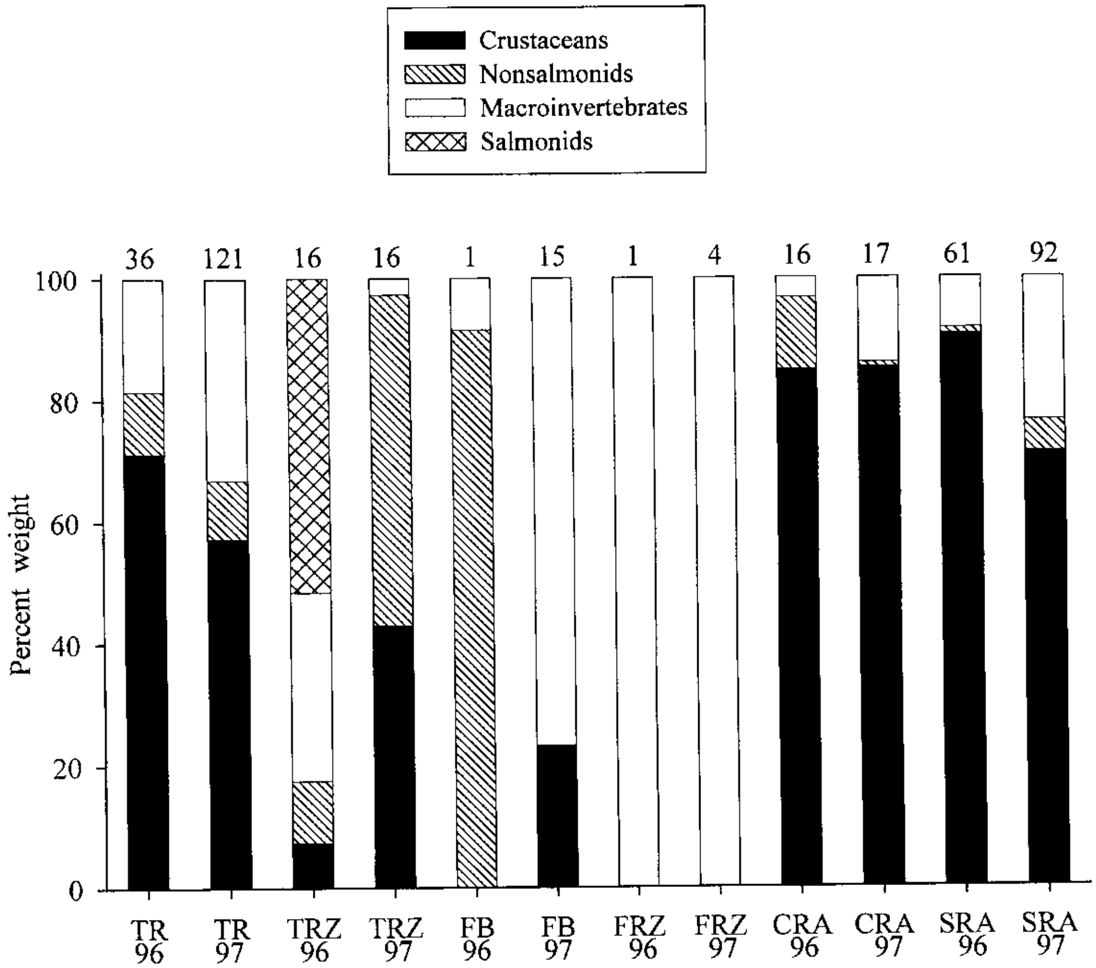

Figure 2. Spatial variation in diet composition by location of northern pikeminnow (n=396) collected in Lower Granite Reservoir and tailrace in 1996 and 1997. Locations are Lower Granite Dam tailrace (TR), tailrace restricted zone (TRZ), forebay (FB), forebay restricted zone (FRZ), Clearwater River arm (CRA), and Snake River arm (SRA). Numbers above bars indicate number of stomachs sampled at each location.

Diets of northern pikeminnow also differed among reservoir locations in 1997 (Figure 2). As in 1996, crustaceans were the dominant prey items by weight in northern pikeminnow stomachs collected from the tailrace (57.2%), Clearwater River Arm (85.2%), and the Snake River Arm (71.2%). Nonsalmonid fishes were the most abundant prey items by weight in the tailrace-RZ (54.3%), whereas macroinvertebrates accounted for 100% of the diet weight of four northern pikeminnow collected from the forebay-RZ. Juvenile salmonids accounted for 0.1% of the diet weight of 123 northern pikeminnow collected from the tailrace but were absent in stomach samples from all other locations.

Discussion

Of the 648 northern pikeminnow captured 17% were large (>349 mm in length), the size range considered highly predatory on juvenile salmonids (Poe et al. 1991). We found the highest concentration of these large northern pikeminnow the tailrace-RZ, similar to findings at other Columbia (Beamesderfer and Rieman 1991) and Snake river dams (Ward et al. 1995).

Based on diet composition and their low abundance, we did not find that the northern pikeminnow was a major predator of juvenile salmonids in the tailrace and forebay of Lower Granite Dam in 1996 and 1997 (Figure 2). Our estimates of predation of juvenile salmonids by northern pikeminnow are substantially less than those reported for the McNary Dam tailrace (Rieman et. al 1991). We suspected lower salmonid consumption than at the Lower Columbia River dams based on results from Ward et al. (1995) who reported the index of salmonid consumption decreased from downstream to upstream in the Columbia River basin. Although direct comparison is not possible, salmonid consumption in the Lower Granite tailrace was less in 1996 and 1997 than in 1991 (Ward et al. 1995). One apparent difference in habitat conditions between 1991 and 1996 and 1997 was that flows in the lower Snake River in the spring of 1996 and 1997 were considerably higher than those in 1991. In our study, the two salmonids found in northern pikeminnow stomach samples were collected from fish captured within 1 km of Lower Granite Dam. We hypothesize that the lower incidence of salmonids in northern pikeminnow stomachs was related to higher flows that resulted in northern pikeminnow displacement (Piaskowski 1998) or reduced sightability (Vinyard and O'Brien 1976).

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