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Downstream Migration Timing of Two Stocks of Sockeye Salmon on the Mid-Columbia River

Abstract

Juvenile salmonids on the main-stem Columbia River must pass as many as nine dams on their seaward migration. Survival of smolts is a major concern to the various agencies that manage the salmonid resource in this area. Stocks of naturally reproducing sockeye salmon (*Oncorhynchus nerka*) migrating past Rock Island Dam originate from the Wenatchee and the Okanogan river systems. The nursery lakes for these sockeye juveniles are Lake Wenatchee and Lake Osoyoos, respectively. Data collected from Rocky Reach Dam (exclusively Osoyoos fish) confirms that fish greater than 100 mm fork length can generally be categorized as Osoyoos stock. Sockeye from the Lake Wenatchee system are predominantly smaller than 100 mm fork length. Smaller fish comprised the majority of migrants in April, whereas throughout May larger fish were more prevalent. The juvenile migration of sockeye past Rock Island Dam in 1986 was bimodal, with the first peak appearing in mid-April (primarily Wenatchee stock) and the second peak at the end of May (primarily Osoyoos stock). The difference in migration timing of these stocks at Rock Island Dam may be attributed to a greater migration distance for the Lake Osoyoos fish or possible later smoltification, or delay in down-stream movement the Osoyoos stock.

Introduction

Historically, there were eight sockeye salmon (*Oncorhynchus nerka*) nursery lakes in the Columbia River basin. Construction of Grand Coulee Dam blocked access to the upper river and sockeye spawning was limited to the Wenatchee and Okanogan river systems. A program designed to prevent the extinction of upper Columbia River salmonids was developed during the construction of Grand Coulee Dam. Returning adult salmon were trapped from the fishways at Rock Island Dam and transported to be spawned at either newly constructed federal hatcheries or in mid-Columbia tributary streams. Sockeye were transferred into the Wenatchee and Okanogan systems, where they were forced to spawn in streams above Lakes Wenatchee and Osoyoos. Others were spawned and reared at hatcheries, with juveniles released at the hatcheries or transplanted into Lakes Wenatchee and Osoyoos. The stocks of sockeye that presently inhabit these lakes are a mixture of both natural and introduced fish obtained during the Grand Coulee salvage operation more than 40 years ago (J. W. Mullan pers. comm.).

The objective of this study was to determine the relative timing of Lake Wenatchee and Lake Osoyoos stocks migrating past Rock Island Dam. Differences in the length frequency distributions of the two stocks provide a method for determining the relative frequency of each in a sample. Timing of the downstream migration of each stock was determined by plotting the daily catch rate at the Rock Island Dam juvenile bypass facility in 1986. Since sockeye smolts collected at Rocky Reach Dam can only be of Lake Osoyoos origin (the Wenatchee River confluence is downstream from Rocky Reach Dam), data collected at Rocky Reach Dam could be used to differentiate the length frequency distributions associated with the two stocks passing Rock Island Dam.

Methods

Downstream migrating salmonids were collected for identification and enumeration from the gatewell bypass trap at Rock Island Dam, riverkilometer 731.5 (rivermile 453.5), on the mid-Columbia River (Figure 1). Out-migrants, entering the gatewells from the turbine intakes passed through orifices into a bypass channel, and eventually into the trap tank. Fish in the trap passed over dewatering screens into a flume, where they were held overnight. The fish in the flume were moved via an elevator hopper to a 1.3 x 1.3 x .9 m portable fiberglass holding tank daily. The holding tank was supplied with a continuous flow of river water with a 5 hp submersible pump.

All fish collected in the trap were anesthetized with Tricaine Methane Sulfonate (MS 222). Fork length measurements taken from either the entire catch, or from a subsample of at least 100

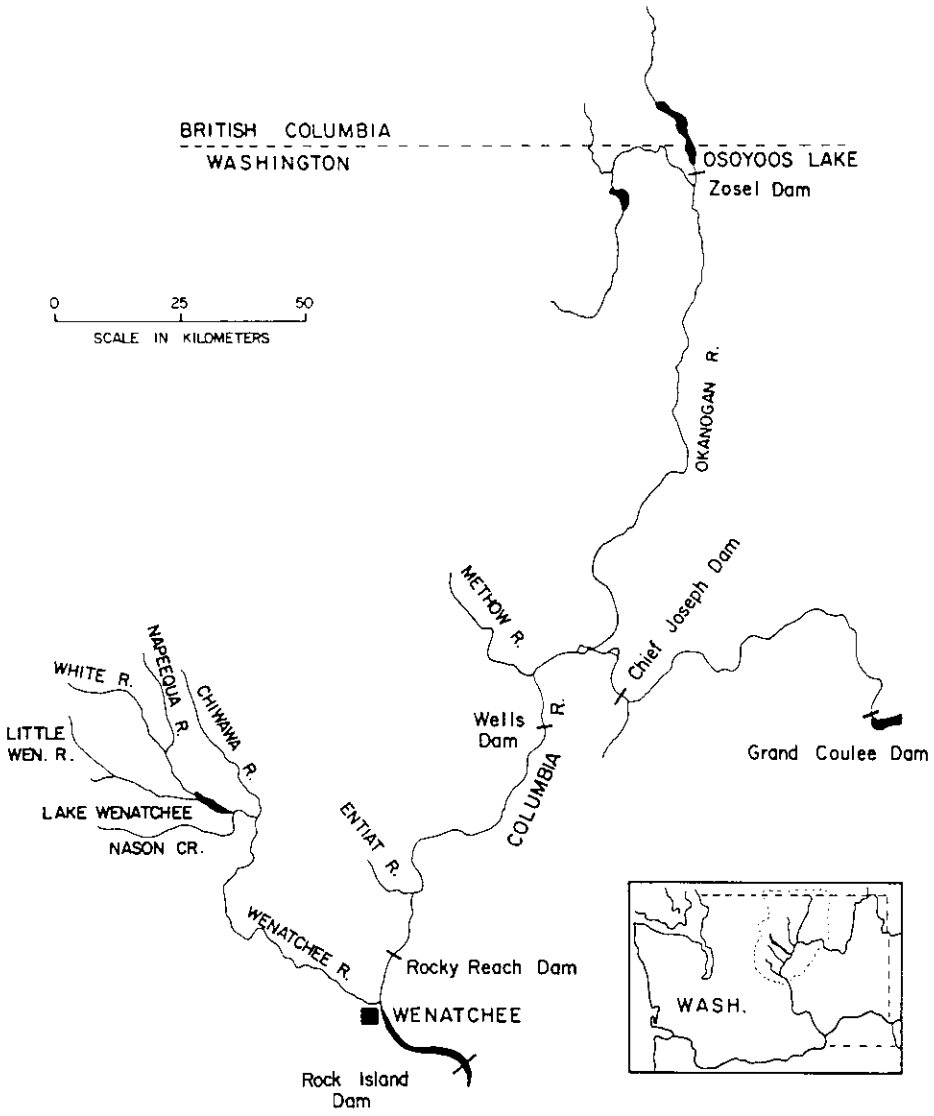

Figure 1. Columbia River and major tributaries between Grand Coulee Dam and Rock Island Dam.

when the daily catch was large. Measurements were recorded in 5 mm length classes. Examination of length frequencies indicated that 10 mm class boundaries were adequate for separation of the stocks. Sockeye lengths were sampled at Rocky Reach Dam in a similar manner where fish were collected from both fyke nets and a gatewell dipper basket.

Results

A total of 30,893 sockeye smolts was collected at the Rock Island Dam bypass trap between 8 April and 15 June, 1986. Daily collections ranged from 8-3,218 ($\bar{x}$ = 448). Nineteen percent (n = 5866) of the sockeye were sampled for length frequencies. Sample sizes ranged from 8-147 ($\bar{x}$ = 85) for the 69-day period.

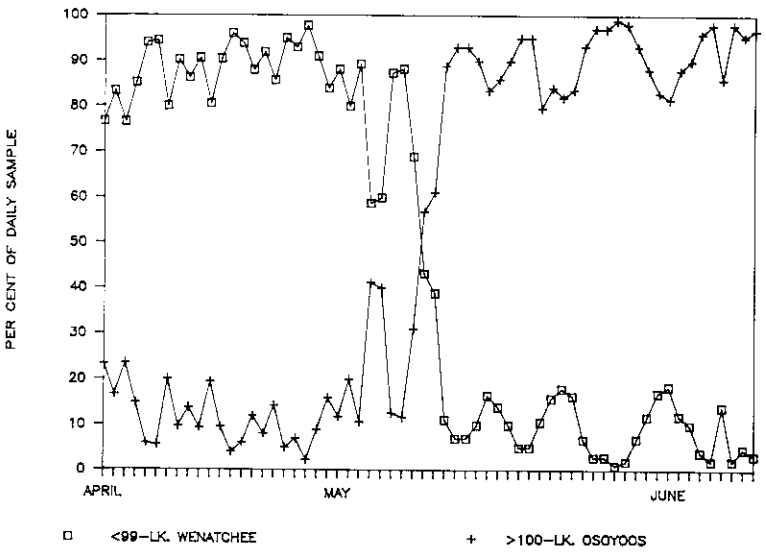

Figure 2. Estimated proportions of juvenile sockeye from Lakes Wenatchee and Osoyoos passing Rock Island Dam, 1986 (data after 8 June not included because of small sample sizes).

Sockeye length frequencies were taken from Osoyoos stock at Rocky Reach Dam (upstream from the Wenatchee River) on May 12, 13, 30, and June 2 (Figure 1). The length frequency of these samples and length data from previous studies (D. E. Weitkamp, J. A. McGee pers. comm.) show that most Osoyoos stock fish are > 100 mm fork length.

At Rocky Reach Dam, 85 percent of the Osoyoos stock sockeye were ≥ 100 mm fork length. By contrast, 88.9 percent of the sockeye sampled at Rock Island Dam in April were < 100 mm fork length. No samples limited to Lake Wenatchee sockeye were obtained for length frequency determination. However, the April catches of sockeye at Rock Island Dam appear to be of Lake Wenatchee stock, based on fork length and because sockeye comprised only 1.3 percent of 1,465 fish taken from the Rocky Reach prototype fish screen during April sampling in an earlier study (S. G. Hays pers. comm.).

A fork length of 100 mm separated the Wenatchee (≤ 99 mm) from the Osoyoos (≥ 100 mm) stocks, and provided the least degree of overlap in the length distributions. Potential misclassification of Osoyoos and Wenatchee stock using this criterion is 15 and 11 percent, respectively. Few (< 0.3%) residual sockeye (fork length > 130 mm) of the Wenatchee stock would be misclassified as Osoyoos stock.

Based on the length distribution of the daily catches, the majority of Lake Wenatchee fish had migrated past Rock Island Dam by the end of the first week in May, while Osoyoos fish began to make up more than 50 percent of the fish sampled per day by the first week in May (Figure 2). During May, 26 percent of the sockeye were < 100 mm fork length, with most of the smaller fish caught during the first week of the month. Osoyoos fish predominated catches through the remainder of May and into June (Figure 2). This finding agrees with previous studies of Osoyoos stock run timing at Wells Dam (D. E. Weitkamp, J. A. McGee, and K. B. Truscott pers. comm.).

Discussion

Based on the data collected in 1986, sockeye smolts that migrate downstream from Lake Osoyoos are larger than out-migrants from Lake Wenatchee. Lake Osoyoos has a higher production of planktonic biomass than Lake Wenatchee (J. W. Mullan pers. comm.). This results in a higher smolt production (12.4 pounds/acre) in Lake Osoyoos than Lake Wenatchee (6.3 pounds/acre) (J. W. Mullan pers. comm.). The greater availability of food may also account for the larger size of the migrating Osoyoos stock.

The downstream migration of sockeye juveniles past Rock Island Dam during both 1985

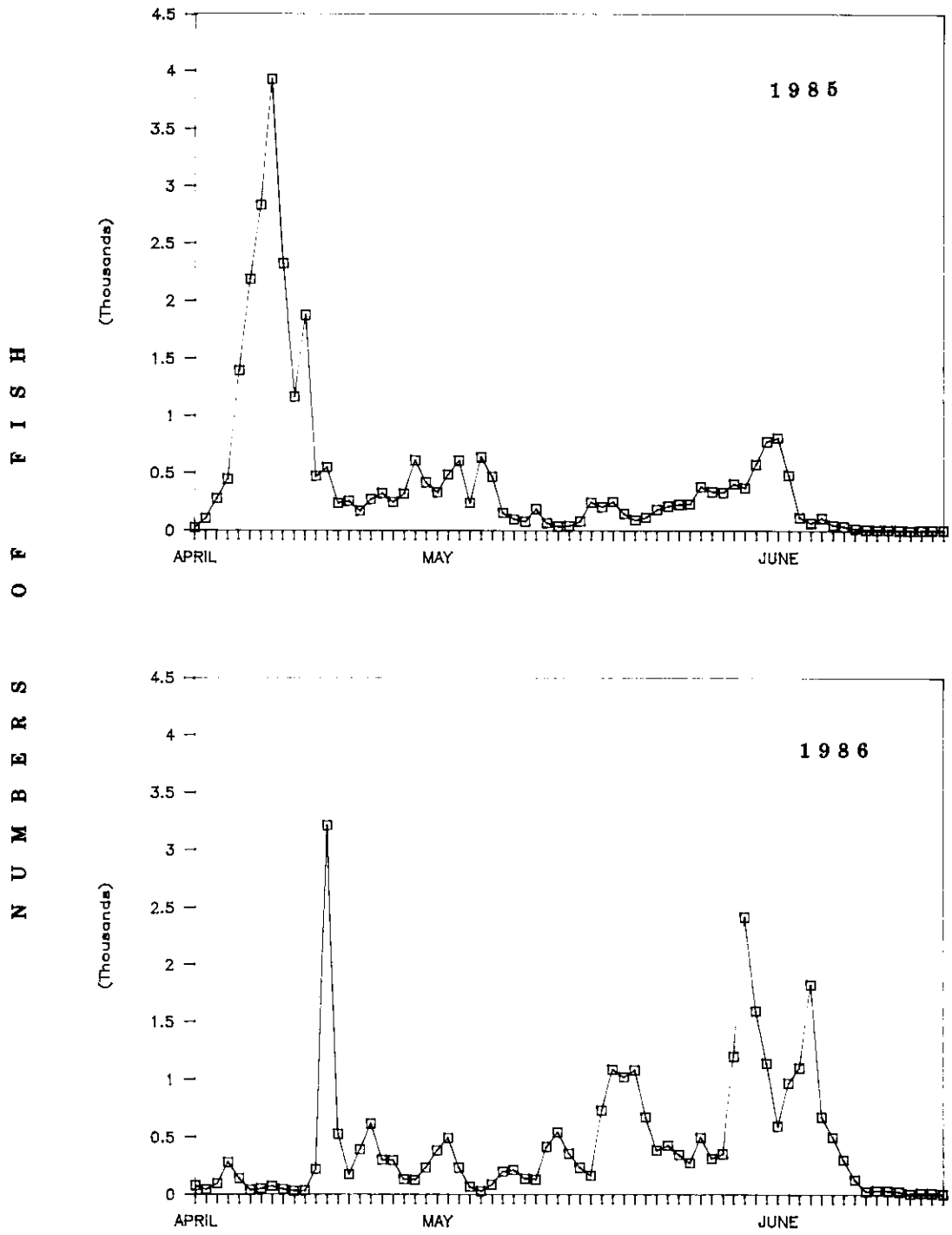

Figure 3. Daily catch numbers of sockeye salmon juveniles from the Rock Island Dam bypass trap for 1985 and 1986.

and 1986 was bimodal (Figure 3) with the peaks representing the two stocks of sockeye passing the dam. The length-frequency data indicate that the 1986 contribution of Osoyoos fish to the total run was larger than the 1985 contribution. Most of the out-migrants observed at Rock Island Dam in 1986 were from the 1984 brood year (S. G. Hays pers. comm.). In 1983, 30 percent of the returning sockeye adults were Osoyoos-bound fish, while in 1984, 67.2 percent of the returning adults were migrating to Lake Osoyoos. This supports the conclusion that the downstream migration of Osoyoos-reared sockeye smolts made up a larger portion of the 1986 run observed at Rock Island Dam than that in 1985 (Figure 3).

The difference in migration timing between the two stocks of sockeye may be attributed to a greater migration distance for the Lake Osoyoos stock, although previous studies (D. E. Weitkamp, J. A. McGee pers. comm.) have shown that Osoyoos fish do not start their annual migration until late April.

Later smoltification may also contribute to the difference in timing of the Osoyoos stock. Smoltification is initiated by a variety of factors, some of which include changes in temperature, photoperiod, stream flow, and lunar cycles (E. L. Brannon pers. comm.). Of these factors, stream flow and temperature regimes would influence the two stocks differently.

Only the relative proportion of each stock migrating past Rock Island Dam can be estimated from the numbers of fish caught at the bypass trap because there is no estimate of trap efficiency. Variables such as spill and power generation influence the numbers of juveniles caught in the bypass trap. Behavioral differences in the two stocks may also affect the efficiency of the daily catch.

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