

EFFECT OF DAMS ON THE UPSTREAM MIGRATION RATES
AND TIMING OF COLUMBIA RIVER SALMONIDS

by

Howard L. Raymond

September 1964

FISH-PASSAGE RESEARCH PROGRAM
U. S. Bureau of Commercial Fisheries
Seattle, Washington

INTRODUCTION

For some time fishery agencies responsible for the management of stocks of anadromous fishes in the Columbia River have been concerned with the possibility that dams--particularly a sequence of dams and impoundments--may cause a serious delay in the upstream migration of salmonids. Evidence of delay was reported by Schoning and Johnson (1955). They concluded that the 2- to 3-day delay found at Bonneville Dam was insignificant, but they expressed concern over the cumulative effect of such a delay when spread over a sequence of 7 to 10 dams. With sockeye salmon (Oncorhynchus nerka), a delay of this magnitude could be very serious. Studies by the International Pacific Salmon Commission (Thompson, 1945; Andrew and Geen, 1960) revealed that a delay of 2 to 4 days is often detrimental, and that sockeye salmon delayed more than 12 days were unable to spawn effectively after reaching their spawning grounds. On the other hand, the timing of chinook salmon (O. tshawytscha) and steelhead (Salmo gairdneri) has not been found to be as critical. Spring chinook salmon often wait several months before spawning, and most steelhead migrating up the Columbia River in the summer or early fall do not spawn until the following spring. Therefore, emphasis in this paper has been placed on the effect of a sequence of dams on the timing and migration rates of the sockeye salmon runs in the Columbia River. The timing of chinook salmon runs is also considered.

APPROACH

Twenty-six years of fish counts at Bonneville (U. S. Corps of Engineers, 1938-1963) and Rock Island Dams¹ provided the basis for examining the effects of four additional dams on the migration rates and timing of Columbia River salmon. The more recent dams include Mc Nary (1954), the Dalles (1957), Priest Rapids (1959), and Wanapum (1963). Starting with Bonneville and continuing upstream to Rock Island, these dams are 145, 192, 292, 397, 413, and 450 miles, respectively, from the sea.

The evaluation consisted of comparing the arrival time of salmon runs at Bonneville and Rock Island Dams. Our analysis was simplified considerably by the availability of fish counts in standard weeks². The statistic used was the date on which the median fish passed each dam during the period 1938-1950, when only the two dams existed, and during 1951 to 1963, when more dams were being constructed or were in existence along this route of migration. In order to use this type of analysis, it was assumed that factors such as floods, changes in fishing regulations, inaccuracies in fish counts, etc., did not significantly bias the

¹Rock Island Dam salmon and steelhead counts, 1933-1963. Staff, Biological Laboratory, Bureau of Commercial Fisheries, Seattle, Washington. Processed.

²Prepared by staff, Biological Laboratory, Bureau of Commercial Fisheries, Seattle, Washington. Processed.

results.

Salmon Runs

Four species of salmonids travel up the Columbia River past Rock Island Dam. These include sockeye, chinook, steelhead, and coho (O. kisutch). This analysis is dependent upon accurate measurement of arrival time at each dam and of elapsed time between dams. To calculate elapsed time, runs of fish must be identifiable at each successive dam. This was possible only with sockeye.

Sockeye. -- This species migrates up the river in a well-defined group over a relatively short period of time. Two major races (Wenatchee and Okanogan), both spawning above Rock Island Dam, comprise the bulk of the Columbia River sockeye run. Tagging studies³ have shown no difference in the timing of these two races at Rock Island Dam. Thus, they were considered as one run for this report.

The proportion of the run reaching Rock Island Dam has varied somewhat over the years, primarily due to a fishery above Bonneville Dam. Prior to 1957, counts at Rock Island varied from 22 to 74 percent of the Bonneville tally. Following inundation of the Indian fishery at Celilo Falls in 1957 by the Dalles Dam and termination of all commercial fishing above Bonneville in the same year, this figure has increased to nearly 100 percent. The effect of the fishery, if any, on the timing of the sockeye run at Rock Island Dam was not considered in this analysis.

Chinook. -- Chinook salmon runs are generally found in the Columbia River from mid-March to mid-October and consist of many races widely dispersed over the drainage. The species has been arbitrarily classed into three major runs: (1) "Springs", which generally spawn in upper sections of tributary streams; (2) "summers", which usually spawn in lower sections of these tributaries and in the main stem Columbia River above Rock Island Dam; and (3) "falls", which spawn primarily in the lower main stem of the Columbia River below Rock Island Dam. Most of the chinook passing Rock Island Dam are spring- and summer run fish. Unlike sockeye, however, only 5 to 8 percent of the spring run and 14 to 20 percent of the run at Bonneville, have been accounted for at Rock Island Dam. Lacking precise knowledge of the timing of Rock Island chinook at Bonneville Dam, no attempt was made to assess for delays in migrations due to dams. However, the arrival times for the spring and summer chinook at the two dams were compared.

³The influence of Rocky Reach Dam on the migration of adult sockeye salmon by Major, Richard L. And James L. Mighall, Biological Laboratory, U. S. Bureau of Commercial Fisheries, Seattle, Washington. Manuscript in preparation.

For this analysis, chinook counts at Bonneville and Rock Island Dams were separated chronologically into spring and summer runs. These dates are March 1 to May 31 and June 1 to August 1, respectively, for Bonneville Dam, and April 1 to June 25 and June 26 to September 3, respectively, for Rock Island Dam.

Steelhead. --This species is available nearly the entire year. Two major migration peaks occur at Bonneville but only one peak is evident at Rock Island. Since it is difficult to identify individual runs and since only 3 percent of the Bonneville runs pass Rock Island, this species was not considered in the computations.

Coho. --The number of coho salmon have been relatively small and counting at the dams has not continued over the entire period of migration. For these reasons, the coho data were considered insufficient for this analysis.

RESULTS

Sockeye and Chinook Time of Arrival--Bonneville and Rock Island Dams

Generally, the arrival time for both sockeye and chinook migrations at the two dams has not changed appreciably in the last 26 years (Fig. 1). This is true even in recent years when fish were required to negotiate three to four additional dams. The only exception to the trend is the summer chinook run, which is now arriving about a week earlier at Bonneville Dam. This earlier arrival could have resulted from changes in fishing regulations or adaptation of the fish to new environments created by dams.

Sockeye Migration Rate--Bonneville to Rock Island Dam

The elapsed passage time of sockeye between the two dams is shown in Figure 2. Average elapsed time between Bonneville and Rock Island in the 1938-1950 period was 17 days, whereas in the subsequent period (1951-1963), elapsed time was 19 days. Average migration rates in these two periods were 17.65 and 15.79 miles per day, respectively. The indicated average delay for the latter period is less than 3 days, which if true, would not appear to be of serious consequence.

One method of examining the effect of delays would be to compare the returning year class strength of the "slow" and "fast" migrations in relation to the respective escapements. If delays seriously affect the population, then returns from a slow-moving spawning migration would be less than those from a fast migration. Five years in which the migration was slower than average were compared with 5 years of faster than average migration (Table 1). The 1941 migration one of the fast groups (Fig. 2) was excluded from this analysis because of an

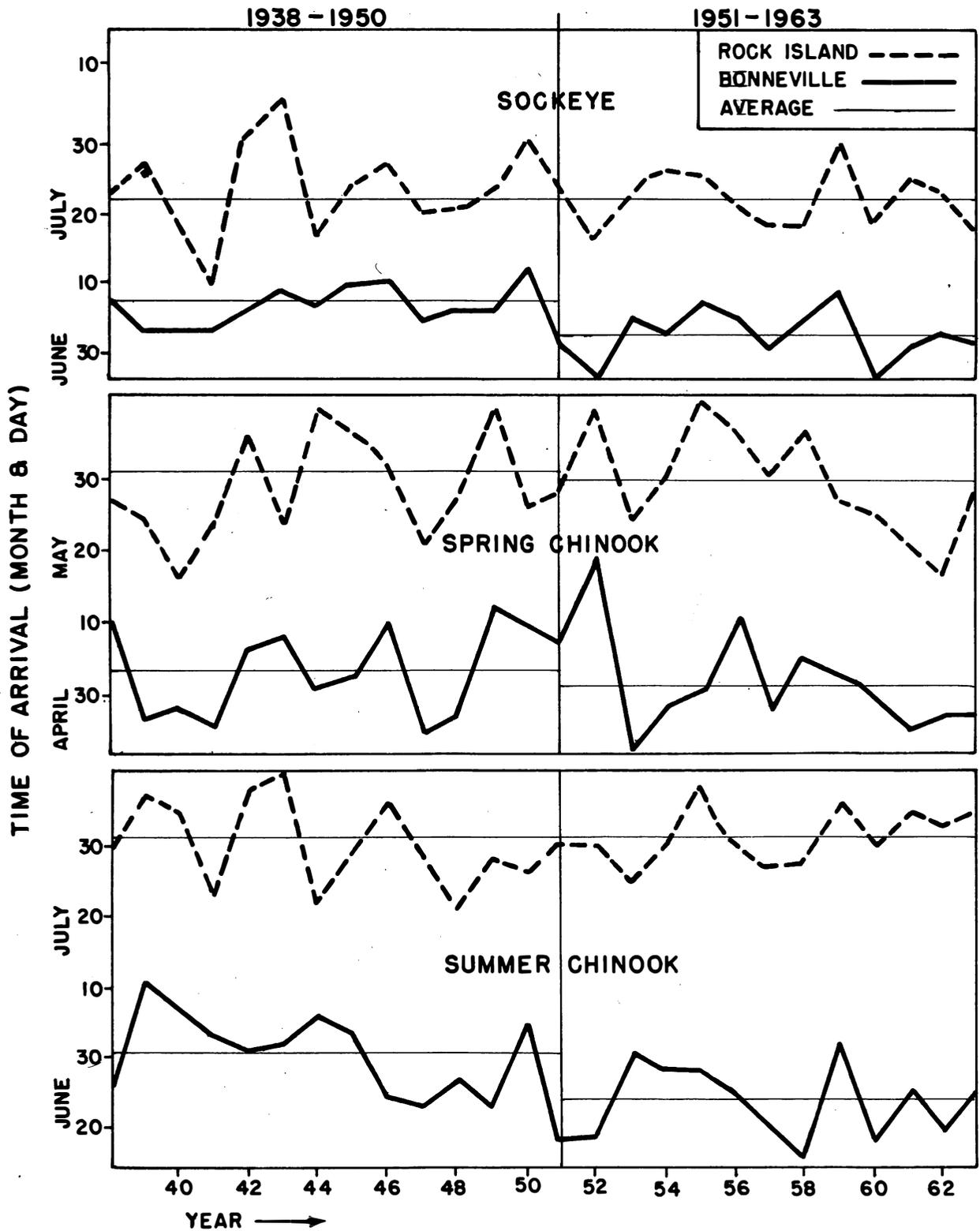


Figure 1.--Arrival times of median fish at Bonneville and Rock Island Dams for the periods 1938-50 and 1951-63.

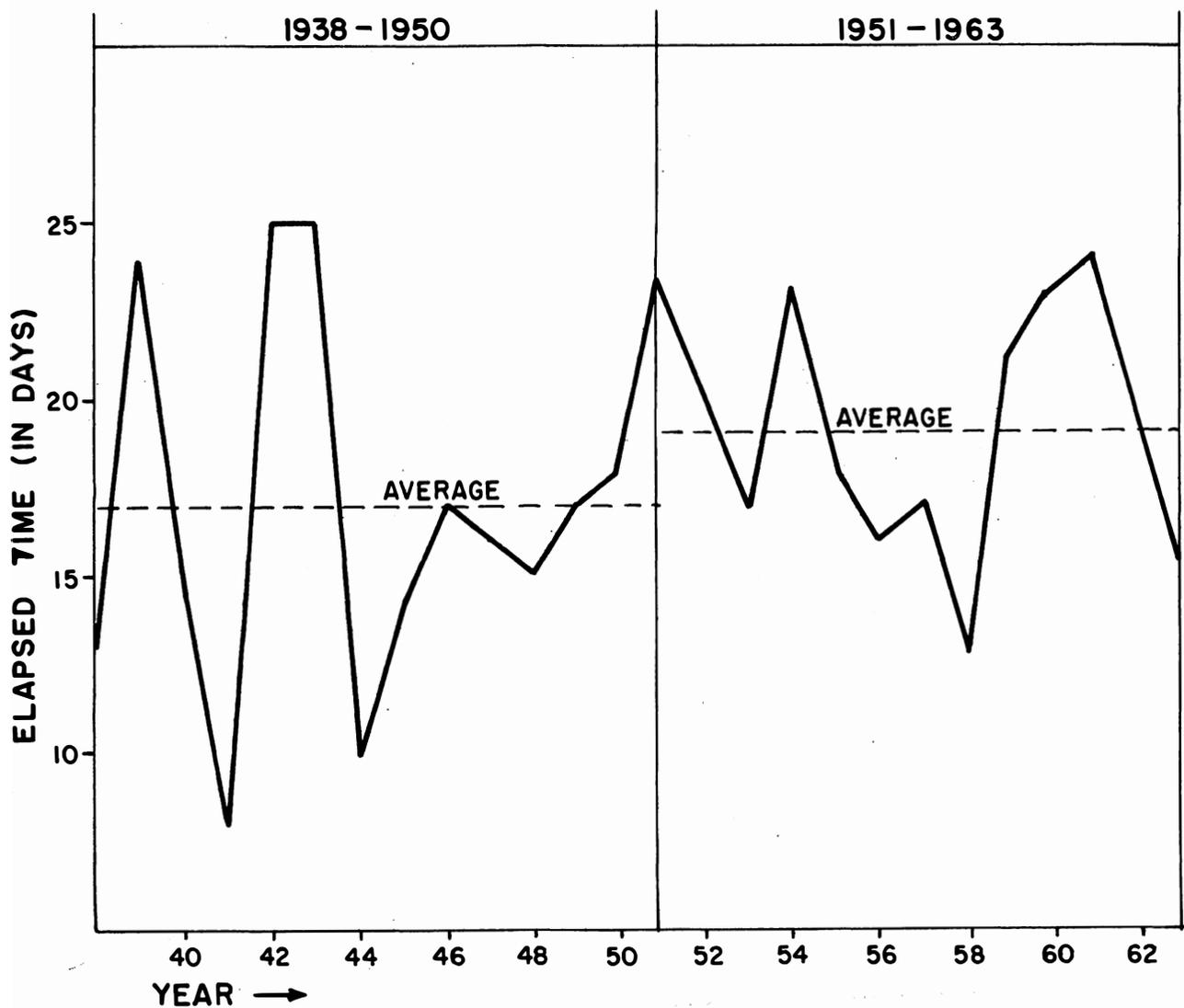


Figure 2.--Elapsed time of sockeye salmon between Bonneville and Rock Island Dams (300 miles) for the periods 1938-50 and 1951-63.

Table 1. --Parent migrations and adult returns 4 years later, showing adult returns per parent for slow and fast moving migrations of sockeye salmon past Rock Island Dam.

Slow Migration					Fast Migration				
Years	Migra- tion rate (miles/ day)	Parent fish past R. I. Dam (thousands)	Adult return ¹ (thou- sands)	Adults per parent	Year	Migra- tion rate (miles / day)	Parent fish past R. I. Dam (thousands)	Adult return ¹ (thou- sands)	Adults per parent
1942	12.2	16	101	6.2	1938	21.8	17	94	5.5
1943	12.2	18	335	19.1	1944	30.5	5	143	28.6
1951	13.3	102	245	2.4	1945	21.8	7	53	7.5
1954	13.3	91	313	3.4	1956	19.1	92	181	2.0
1959	13.9	72	160	2.2	1958	23.5	99	38	0.4
Aver- age	13	60	231	3.8	Aver- age	23	44	102	2.3

¹Catch plus escapement based on 4-year cycle, from 1963 status report of the Columbia River commercial fisheries, Oregon Fish Commission, Washington Department of Fisheries (January 1964).

abnormally low escapement (949 fish) over Rock Island Dam. These data show that the average return was actually somewhat higher for the slow moving runs. In fact, one of the better returns (1943) resulted from an escapement with the latest median arrival date (August 5) at Rock Island of all years on record.

SUMMARY

Fish counts at Bonneville and Rock Island Dams provided a means of studying the effect of dams on the timing of certain salmon runs in the Columbia River drainage. Periods compared were 1938-1950 and 1951-1963. In the early period, salmon passed only Bonneville and Rock Island Dams, but in the ensuing period, four additional dams were added within the network.

Sockeye salmon runs were distinguishable at both Bonneville and Rock Island. Hence, it was possible to assess both timing and migration rates for this species. The timing of spring and summer chinook runs was also considered in the analysis.

The comparison of fish migrations during the two periods indicated the following:

1. Additional dams have not appreciably affected the timing or migration rates of sockeye salmon. Average elapsed time between Bonneville and Rock Island Dam was only 2 days more during the 1951-1963 period than in the 1938-1950 period when no intermediate dams were present.

2. The average arrival time of spring and summer chinook at Rock Island Dam was virtually the same over the two time periods. Spring chinook salmon arrived at Bonneville Dam an average of 1 week earlier in the 1951-1963 period than they did in the 1938-1950 period.

LITERATURE CITED

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