A SUMMARY OF THE 1967 OUTMIGRATION OF JUVENILE SALMONIDS IN THE COLUMBIA BASIN

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Progress Report

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TABLES

FIGURES

CONTENTS

A SUMMARY OF THE 1967 OUTMIGRATION OF JUVENILE SALMONIDS IN THE COLUMBIA BASIN

The objective of the Juvenile Migration Rate and Timing Program is to determine the effects of the changing environment in the Snake and Columbia Rivers on the migrations of juvenile salmonids. Evaluation is based on a comparison of differences in their timing and magnitude through various stretches of these rivers from year to year as the environment continue to be altered by dams and impoundments.

To accomplish this objective, a mark and recapture program was established in cooperation with the State fishery agencies of Idaho and Oregon. The State agencies collected, marked, and released juvenile salmonids in selected tributary streams of the Snake River. The Bureau of Commercial Fisheries conducted a mark and release effort in the Wenatchee and Okanogan Rivers. In addition, the Bureau carried out sampling and marking activities at Whitebird on the Salmon River, at Ice Harbor Dam on the Snake River, at Priest Rapids, McNary, The Dalles, and Bonneville dams on the Columbia River, and at selected sites in the estuary. This report summarizes results of our activities in 1967 in the tributary streams and at each of the above dams. A summary of activities in the estuary will follow.

METHODS

The general method for assessing timing and relative magnitude was basically the same as that used in 1966. Hot and cold brands were used to identify specific groups of fish from the various release sites. Separate marks identified each release group which consisted of all fish marked and released during a 1-week period at each release site.

Fish were collected from tributary streams by means of scoop traps, fyke nets, and irrigation diversion traps. They were also collected from turbine intake gatewells at Ice Harbor, Priest Rapids, McNary, The Dalles, and Bonneville dams. At each of the sampling sites, the juvenile salmonids were counted, separated by species, and examined for marks. The majority were then marked and, depending on the site, were either released back into the tributary stream or into the forebay and/or tailrace of a dam. At all dams, fish bearing a previous thermal brand were not remarked but were transported and released into the tailrace. The location of the dams and the primary sites for releasing marked fish are shown in figure 1.

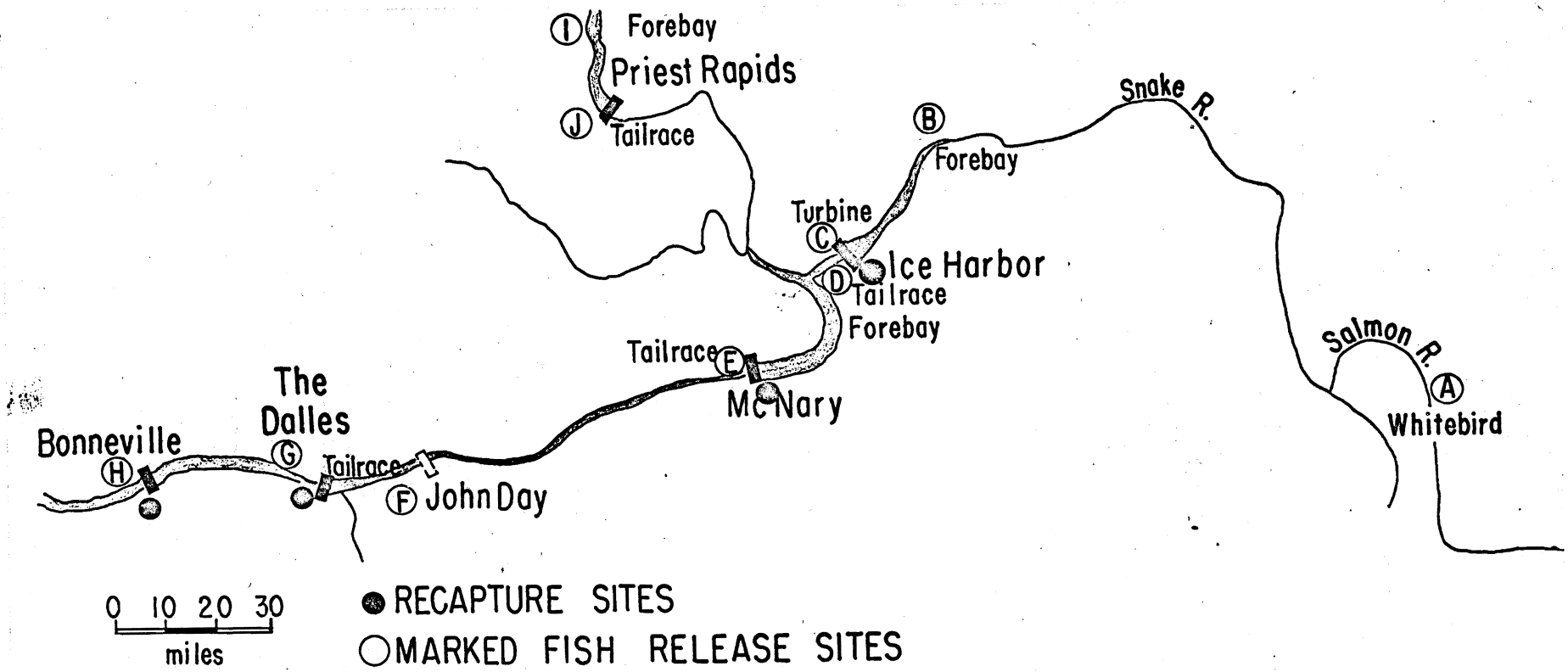

Figure 1.--Study Area- Fingerling timing and survival between dams.

Timing of migration from various tributaries of the Snake River was based on the arrival of the marked fish from each stream at Ice Harbor Dam; similarly, timing of migration from upper Columbia River tributaries was assessed at Priest Rapids Dam. The median date of recovery of the respective migrations from the various tributaries was used to compare the timing of these populations. The migration rate through free-flowing and impounded sections of river was also measured. This rate was based on the difference between the median date of release and median date of recapture for each release group.

As in previous years, timing of the total outmigration by species from the Snake and Columbia Rivers was based on an estimate of the number of downstream migrants passing Ice Harbor and Priest Rapids Dam each week. The Peterson method was employed for estimating the populations. Use of this method required marking juvenile salmonids collected from gatewells at Priest Rapids and Ice Harbor dams and releasing them upstream at some distance from the dams. The formula is $N = \frac{nt}{s}$, where N is the estimate, n = number of fish marked and released upstream in the forebay, t = the catch of unmarked fish in the gatewells, and s = the number of recaptured marks.

The river flow conditions were significantly different in 1967 from those experienced in previous years of our studies. The early spring was generally cool, thus retarding the annual runoff. No spilling occurred at Ice Harbor Dam until May 8; whereas in previous years some spilling has occurred during most of April. Spilling started on May 11 at McNary Dam vs. May 5 in 1966; and May 22 at Priest Rapids Dam vs. May 7 in 1966. The prolonged delay of high water at Priest Rapids was due in part to the high storage capacity of Grand Coulee Dam and to the initial filling of the reservoir behind Wells Dam. When high water did occur, total discharge at mainstem Columbia River dams was the highest recorded during our 4-year study (600,000 c.f.s. on June 19 at Bonneville Dam).

RESULTS

Over 1,000,000 wild juvenile salmonids were collected at our various sampling sites; we marked over 500,000 of these, about the same number as in 1966. Approximately 18,000 marked fish (3.02%) were recaptured (table 1).

Table 1.--Number of wild fingerling salmonids captured and the subsequent recovery of marked individuals from the respective release areas.

Sampling and release area	Number collected	Number marked	Number of marks recaptured	Percent recaptured
Salmon River	129,952	129,952	4,734 *	3.64
Grande Ronde River	49,998	49,998	379	.79
Ice Harbor Dam	224,222	115,278	8,196	7.10
Priest Rapids Dam	99,120	82,028	1,813	2.21
McNary Dam	288,363	110,460	1,869	1.69
The Dalles Dam	91,670	72,108	768	1.06
Bonneville Dam	219,101	18,198	--	--
Okanogan River	3,697	3,498	54	1.54
Wenatchee River	14,139	9,512	68	.71
Total	1,020,262	591,032	17,881	3.02

* Predominantly scoop trap releases, Whitebird, Idaho

Timing of Juvenile Salmonids from the Salmon River and Other Tributaries of the Middle Snake River

The timing of the juvenile salmonid outmigration from the Salmon River was generally earlier than the outmigration from the Grande Ronde River, based on the arrival time of the median fish from each stream at Ice Harbor Dam (table 2). The median for most fish from the Salmon River was in late April, whereas the majority of those from the Grande Ronde River did not arrive at Ice Harbor Dam until May or early June. Chinook migrating out of the Imnaha River in the fall of 1966 were among the earliest arrivals at Ice Harbor Dam (April 26). The latest arrivals were coho from the Wallowa River (June 6).

Timing and Relative Magnitude of Outmigrations from the Snake and Upper Columbia Rivers

Snake River

Peak migrations of juvenile chinook salmon have generally occurred in late April and early May, preceding the steelhead trout by about 10 days (table 3). The differences in timing between years were probably attributable to annual variability in water temperature and stream flow. For example, water temperatures which were warmer earlier in 1965 and 1966 than in 1964 or 1967 may have accounted for the earlier chinook migration in both 1965 and 1966. Stream flow did not appear to influence the timing of chinook salmon

Table 2.--Timing of juvenile salmon passing Ice Harbor Dam, 1967[1/]

River of origin	Species	Timing: Median	Timing: Range (all fish)
Salmon River System			
Upper Salmon River	Chinook	April 26	4/26-5/18
Lemhi River	"	April 21	4/11-5/18
South Fork Salmon River	"	April 25	4/25-5/5
Pahsimeroi River	"	May 5	5/4-5/9
Marsh Creek	"	--- [2/]	---
East Fork Salmon River	"	May 19	5/17-5/25
Grande Ronde River System			
Lookingglass Creek	Chinook	May 3	4/17-5/19
Minam River	"	May 15	4/13-6/6
Upper Grande Ronde River	"	May 11	4/17-5/24
Wenaha River	"	May 8	4/18-6/5
Lower Grande Ronde River (Troy)	"	May 1	4/20-5/26
Imnaha River	"	April 26	4/18-5/24
Wallowa River	Coho	June 6	5/22-6/21

1/ Sampling at Ice Harbor Dam began on March 25 and concluded on July 12.

2/ No marked fish recaptured.

Table 3.--Timing and estimated numbers of juvenile salmonids past Ice Harbor Dam, 1964-1967.

YEAR	CHINOOK			STEELHEAD		
	TIMING	ESTIMATED NUMBERS (millions of fish) BASED ON		TIMING	ESTIMATED NUMBERS (millions of fish) BASED ON	
		WATER FLOW*	MARK RECOVERY**		WATER FLOW	MARK RECOVERY
1964	EARLY MAY	2.8	2.8	MID MAY	1.6	1.6
1965	LATE APRIL	2.1	2.0	EARLY MAY	1.6	1.3
1966	LATE APRIL	4.4	4.5	EARLY MAY	1.6	1.7
1967	EARLY MAY	2.6	2.8	MID MAY	2.7	2.9

* BASED ON RELATION BETWEEN WATER FLOW & SAMPLING EFFICIENCY

** BASED ON A MARK & RECOVERY METHOD USING THE PETERSON FORMULA $\hat{N} = \frac{nt}{s}$ FOR THE ESTIMATE

as much as water temperature. Flows were low throughout most of the chinook outmigration in both 1966 and 1967, yet movement at Ice Harbor Dam in all 4 years got underway at about the time stream temperatures reached 50° F. The steelhead outmigration, on the other hand, was associated with the first significant increase in river flow in all 4 years.

The estimated population of juvenile chinook salmon was calculated to be around 2.8 million, about the same as recorded in 1964, but much lower than the 4.5 million estimated to have passed Ice Harbor Dam in 1966 (table 3). Estimated steelhead populations, by contrast, were significantly higher than in previous years. The size of the steelhead outmigration was estimated at 2.9 million in 1967; over a million higher than in previous years (table 3). Part of the increase could be attributed to a planting of 2 million hatchery-reared steelhead in the Pahsimeroi River, a tributary of the Salmon River. These fish could be distinguished by their eroded fins. In 1967, 7,700 out of 90,000 steelhead collected at Ice Harbor Dam had eroded fins, compared to less than 300 in each of the previous years. Juvenile coho and sockeye salmon again only represented a small proportion of the total Snake River outmigration.

In 1965, we began testing a siphon and electronic fish counter at Ice Harbor Dam in hopes that it might be possible to automatically index the Snake River outmigration. We proved the reliability of the fish counter, but needed more data on the proportion of the population we actually sample from the gatewells. So, for the past 4 years we have been comparing the sampling efficiency for chinook and steelhead in Turbine Unit 2 for the various flow conditions which occurred. The derived curves are shown in figures 2 and 3. Although there was variability evident in both curves, the fit was reasonably good for both species. When the catch data from Unit 2 for the past 4 years was applied to the curves, the resulting estimates corresponded closely to the estimates derived from the mark and recovery method (table 3). If the 1968 estimate using the flow curve data approximates the estimate using the mark and recovery method, then we propose adapting the former for calculating future population estimates at Ice Harbor Dam.

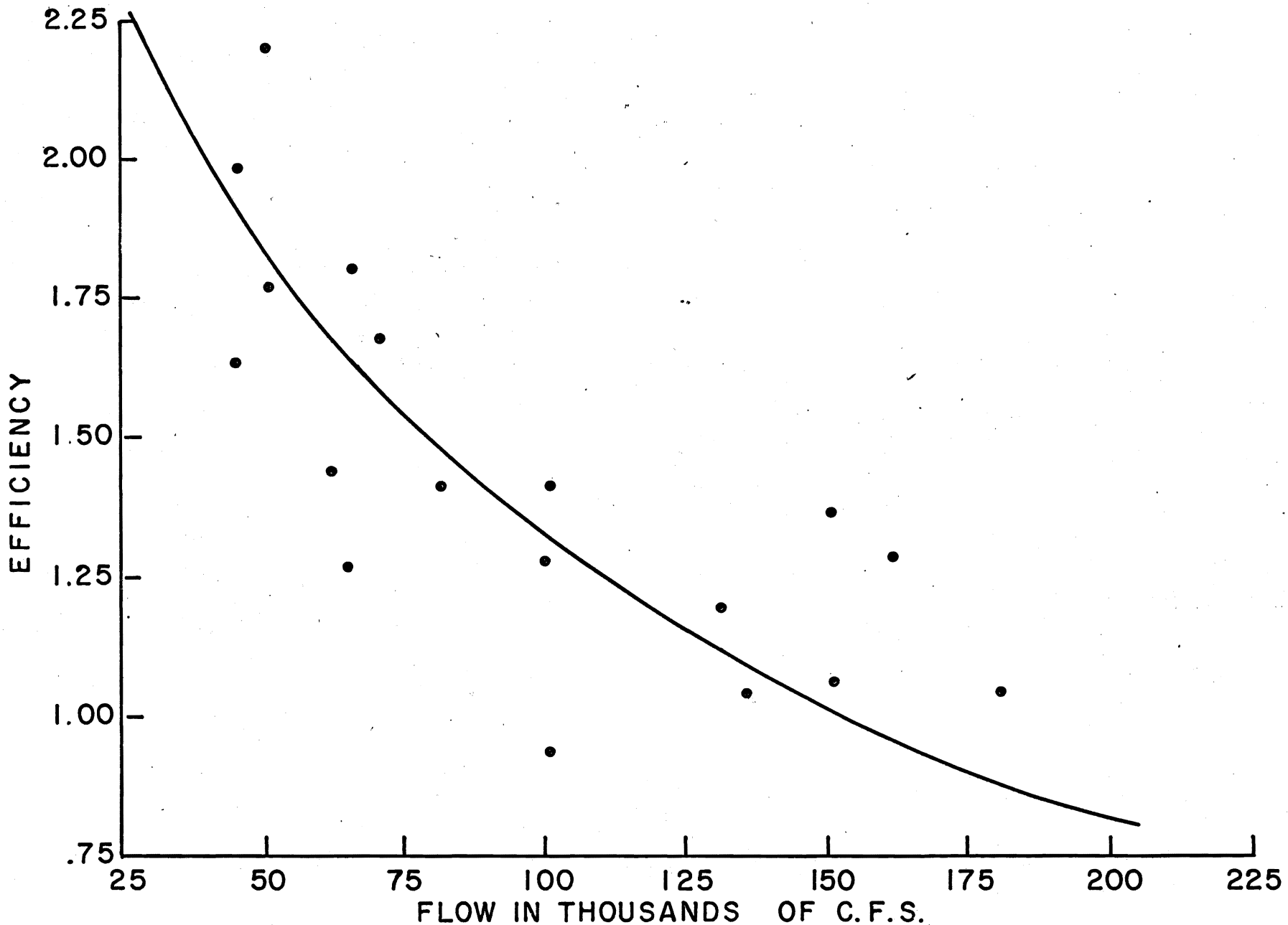

Figure 2.--Sampling efficiency of Turbine Unit No. 2 in relation to water flows at Ice Harbor Dam, 1964-1967.

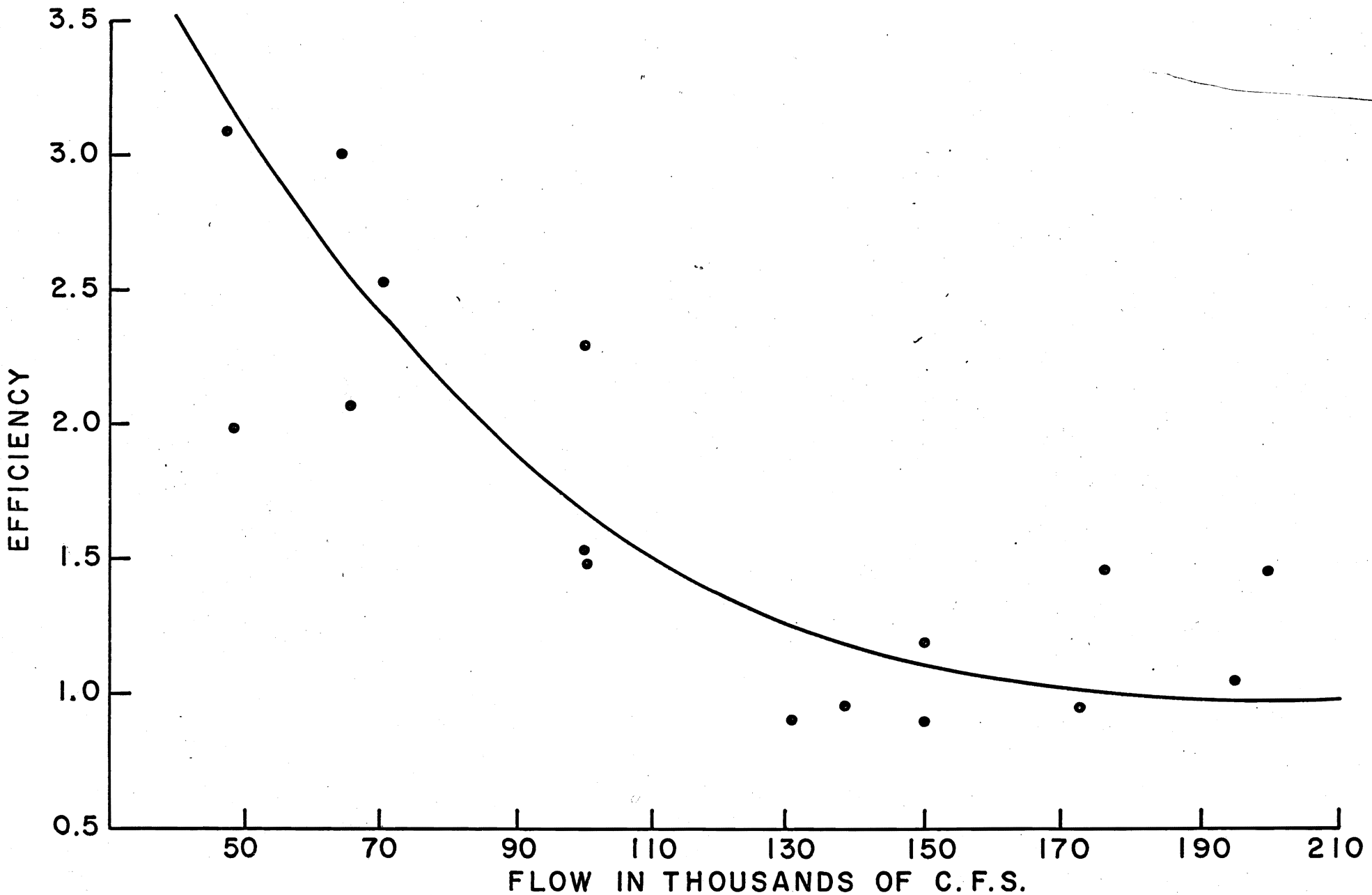

Figure 3.--Sampling efficiency of Turbine Unit No. 2 for juvenile steelhead trout in relation to water flows at Ice Harbor Dam, 1964-1967.

Upper Columbia River

Juvenile salmon were marked in the Wenatchee and Okanogan Rivers in the spring of 1967, to obtain a measure of timing from these tributaries, especially for sockeye salmon (table 4). Sockeye salmon from the Okanogan River migrated past Priest Rapids Dam 10 days earlier than those from the Wenatchee River. The significance of this 10-day difference in timing is not readily discerned; however, it is probably a result of the Okanogan River warming earlier.

Timing of chinook, coho, and sockeye salmon, and steelhead trout at Priest Rapids Dam was approximately the same over the last three years (table 5). Sockeye and yearling chinook salmon peaked in early May; coho salmon and steelhead trout in mid-May; and, 0-age-group chinook salmon in early August. In 1967, yearling chinook salmon represented only slightly more than 10% of the total chinook outmigration as compared to 15% in 1966. Approximately 55% of the chinook salmon migrated past Priest Rapids Dam in August in 1967 compared to 40% in 1966 and 60% in 1965. As in 1966, based upon our summer and fall sampling at McNary Dam, very few of the late chinook salmon migrants migrated past McNary in their first year.

Table 4.--Timing of juvenile salmon passing Priest Rapids Dam, 1967[1/]

River of origin	Species	Timing	
		Median	Range (all fish)
Okanogan	Sockeye	May 1	[2/] 4/25 to 5/19
Wenatchee	Sockeye	May 11	[2/] 5/ 9 to 5/25
Wenatchee R. (Leavenworth)	Coho	May 16	[2/] 4/18 to 6/23
Columbia R. Tributaries	Chinook (I-age-group)	May 5	[3/] 4/17 to 7/17
Columbia R. Tributaries	Chinook	August 4	[3/] 4/17 to 9/19

1/ Sampling at Priest Rapids Dam began on April 17 and concluded September 19.

2/ Based on mark returns.

3/ Based on daily catch.

Table 5.--Timing and estimated numbers of juvenile salmonids past Priest Rapids Dam, 1965-1967.

YEAR	SOCKEYE		CHINOOK	
	TIMING	EST. NUMBERS (millions of fish)	TIMING	EST. NUMBERS (millions of fish)
1965	EARLY MAY	2.63	EARLY AUG.	1.62
1966	"	4.10	"	1.35
1967	"	0.95	"	2.07

YEAR	COHO		STEELHEAD	
	TIMING	EST. NUMBERS (millions of fish)	TIMING	EST. NUMBERS (millions of fish)
1965	MID MAY	0.22	MID MAY	0.27
1966	"	1.17	"	0.24
1967	"	1.17	"	0.26

The relative magnitude of migration by species for each year of study is indicated in table 5. The sockeye outmigration was less than 1.0 million fish in 1967; this represents only 25% of the outmigration measured in 1966 and 33% of the numbers estimated for 1965. The decline could have resulted from several factors: (1) the adult year class, which produced the 1966-67 seaward migrants, was down in 1965 compared to 1964; (2) there was no contribution from hatcheries to the seaward migration as there was in previous years; or (3) unexplained factors in the natural environment, which caused a lower than usual survival to smolt size. The increase of coho salmon in 1966 which also held through 1967 was, at least in part, due to increased hatchery production. Steelhead populations, which are strongly supported by hatcheries, were approximately the same as previous years. By contrast, juvenile chinook populations were higher in 1967 than in 1966 or 1965.

Survival Measurements

In 1966 we measured a 50 percent loss of yearling chinook between the Salmon River and The Dalles Dam during April, with most of the loss occurring in the vicinity of Ice Harbor Dam. In 1967 we showed only a 10-20 percent loss.

Possibly higher losses occurred but were masked by the variabilities in the recovery effort. However, since river flows and handling techniques were similar for the two years compared, it would appear more logical that losses were actually less in 1967. This hypothesis is substantiated by the fact that 40 percent fewer chinook migrated past Ice Harbor Dam in 1967; yet the number estimated at The Dalles was approximately the same in both years. The addition of the 10-20 percent loss measured in 1967 to the 40 percent figure above adds up to the 50 percent loss estimated in 1966. The Dalles estimates were based on both recoveries of marked fish and catch-per-unit-effort. Studies in 1968 may clarify these differences.

Other Findings

(1) Migration rates through free-flowing and impounded sections of river were generally comparable to those rates measured in 1966. Differences in river flows for the two years precluded any attempt to duplicate the measurements exactly. The significant slowdown through McNary Reservoir was demonstrated again in 1967.

(2) Recoveries of juvenile spring chinook salmon released from the Rapid River Hatchery (lower Salmon River drainage) indicated that: (a) a pectoral finclip may have adversely affected the timing and perhaps the survival of juvenile salmon in their movement to sea, and (b) survival of spring-released fish was much higher than fall-released fish.

(3) At Priest Rapids Dam 0-age-group chinook salmon were marked during July and August in 1966-67. From marked returns at McNary Dam in 1967, over 60 percent were from fish that were marked in July--even though nearly 2½ times as many fish were marked in August. In 1966 our findings were essentially the same except that a few July marked fish were recovered as far downriver as Bonneville Dam. Although the data are not conclusive, they suggest that the chinook salmon passing Priest Rapids in August are not migrating to sea in the same year.

(4) Marked fish released back into the gatewells at McNary Dam generally took 6 to 12 days longer to travel to The Dalles Dam than fish marked and released into the tailrace of McNary Dam.

(5) Growth of 0-age chinook migrating from Priest Rapids in July and August into the McNary Reservoir was approximately 1 mm. per day.

(6) Branded wild salmonid fingerlings were recovered at a rate in excess of 2 percent, whereas fin-clipped chinook, steelhead, and coho originating from hatcheries were recovered at a rate of only 0.4 percent. This recovery suggests that either hatchery fish do not survive their seaward journey to the same extent as wild fish or that the fin-clip is causing excessive mortalities.

(7) Several 0-age chinook marked and released at Priest Rapids Dam and the spawning channel below the dam in 1966 were recovered in the spring of 1967.

(8) Of 110,000 fin-clipped coho released at Leavenworth Hatchery, 1,075 were recovered at Priest Rapids Dam. Based on the sampling efficiency of the gatewells during their migration, we estimated that 50 percent of the release from Leavenworth traveled as far as Priest Rapids Dam. By contrast, only 39 were recovered at McNary Dam, and 5 each at The Dalles Dam, Bonneville Dam, and the estuary. The apparent loss below Priest Rapids cannot be explained.

SUMMARY

Based on the returns of marked juvenile salmonids in the gatewell catches at Ice Harbor, Priest Rapids, McNary, The Dalles, and Bonneville dams, we were able to determine the following in 1967:

(1) Timing of the migration of juvenile salmonids from the Salmon River at Ice Harbor Dam as in 1966 was approximately one month earlier than the migration from the Grande Ronde River.

(2) General timing of chinook salmon and steelhead trout at Ice Harbor Dam was about 10 days later than in 1966 or 1965; reflecting the cooler spring of 1967.

(3) The magnitude of the chinook outmigration passing Ice Harbor Dam in 1967 was down 40 percent from 1966. By contrast, 40 percent more steelhead were estimated to have passed Ice Harbor in 1967 than in any previous year.

(4) Population estimates of both chinook salmon and steelhead trout based on mark recaptures corresponded closely with estimates based on a derived flow-efficiency curve. Automatic indexing at Ice Harbor Dam in future years may be possible by passing fish from the gatewells of Turbine Unit 2 through the proven fish counter and into a bypass.

(5) Timing of all species passing Priest Rapids Dam has been essentially the same from 1965 to 1967. Sockeye from the Okanogan migrated about 10 days earlier than those from the Wenatchee River in 1967.

(6) The size of the sockeye salmon outmigration passing Priest Rapids Dam was only 25 percent of the number passing in 1966, and 33 percent of the numbers estimated for 1965. By contrast, the relative magnitude of chinook was 35 percent higher than in 1966 and 21 percent higher than in 1965. Coho salmon and steelhead trout populations were about the same as 1966.

(7) Survival of juvenile chinook between Ice Harbor Dam and The Dalles Dam in 1967 was approximately 40 percent higher than in 1966.