EVALUATION OF FACTORS AFFECTING COLLECTION EFFICIENCY ESTIMATES OF CHINOOK SALMON AND STEELHEAD SMOLTS AT McNARY DAM - 1988

by
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INTRODUCTION

Collection efficiency is the proportion of the downstream migrant population passing a dam that is collected in the fingerling bypass. An estimate of collection efficiency is valuable to researchers and managers who must assess the daily population passing a particular dam. These population assessments can be used to evaluate smolt survival between collector dams, and provide an alternative to the indirect method that uses marked releases of test and control groups to estimate survival.

Giorgi and Sims (1987) studied the relationship between collection efficiency and powerhouse discharge at McNary Dam for both steelhead and yearling chinook salmon. Freeze-branded fish were released in the forebay to generate recovery estimates at prevailing powerhouse discharge levels. The resulting calibration curves were then used to estimate daily passage. Since that research was conducted, sources of error have been identified which may affect the accuracy and account for the high variance of previous collection efficiency estimates.

Satellite photographs indicated that water from the Snake River remains as a coherent mass on the southern side of the Columbia River, even after passing through McNary Dam. Fish from the Snake River drainage may tend to remain on the south side (powerhouse side) of the river as they approach the dam whereas fish from the mid-Columbia River may approach the dam from the north (spillway side). This suggests that during spill periods there may be a bias in the recovery data depending upon the origin of the marked fish.

The majority of smolts pass the dam during the early evening hours. Fish arriving at the dam during other hours may have increased exposure to predators while waiting in the forebay for evening or may wait in preferential holding areas which may bias passage location (spill vs powerhouse).

Other sources of error which may affect collection efficiency estimates are physiological and behavioral differences among various stocks of smolting salmonids. Giorgi et al. (1988) assayed yearling chinook salmon and found significantly higher levels of gill Na^+-K^+ ATPase among fish guided than those not guided. These data suggest there is a relationship between the physiological status of smolting salmon and their susceptibility to guidance. Therefore, using test fish with previous guiding experience may bias recovery rates upward from expected rates within the total population.

During 1988, the National Marine Fisheries Service (NMFS) began a 2-year study to address possible sources of error in determining collection efficiency at McNary Dam. We addressed four objectives: 1) determine whether fish from Columbia and Snake Rivers mix as they migrate to McNary Dam (release-location tests)[1], 2) determine whether Columbia and Snake River stocks are collected at the same rates (river-of-origin tests), 3) assess whether the time of day fish are released influences their recovery rate (time-of-release tests), and 4) determine whether guided fish used in collection efficiency estimates tend to bias results (guided vs unguided tests).

DESCRIPTION OF STUDY AREA

McNary Dam is located on the Columbia River at River Mile (RM) 292. The powerhouse, near the Oregon shore, has 14 main turbines and 2 station-service turbines. The spillway, located immediately north of the powerhouse, contains 22 spill bays. The dam complex also includes a navigation lock located north of the spillway near the Washington shore. The juvenile bypass facilities at McNary Dam include screened turbine intakes, gatewells with vertical barrier screens, and a bypass channel

[1] Due to the low river flows expected in 1988, no spill was anticipated at McNary Dam; consequently, the release-location tests (Objective 1) were postponed.

to a juvenile handling/transport facility located on the tailrace deck at the north end of the powerhouse.

Daily average river discharge at McNary Dam during the spring smolt outmigration ranges from 50 to 420 kcfs. Spill generally occurs when river discharge is greater than 240 kcfs. The reservoir (Lake Wallula) receives salmonid smolts emigrating from the Walla Walla, Yakima, and Snake Rivers and from the Columbia River above Priest Rapids Dam (Fig. 1).

METHODS

The mark and recapture (observation) procedures for this study utilized the Passive Integrated Transponder (PIT) tag. Fish were marked with PIT tags using an automatic tagging instrument described by Prentice et al. (1987). Tagged fish were measured (fork length), physical condition assessed, and the tag code read. Length, condition, and code were automatically entered into a computer tagging file from a digitizing tablet and a PIT-tag data scanner. Smolts exiting the juvenile bypass facility at McNary Dam were monitored for PIT tags (Prentice et al. 1986). Individual tag codes observed at the monitor were recorded on a computer that could be accessed remotely via telephone.

A minimum of 200 tagged-fish recoveries were needed at McNary Dam, and the following factors were used to determine the appropriate sample size for releases: fish guidance efficiency, 0.70; tag detection, 0.98; post-release survival, 0.90; and proportion of the migrant populations passing through the powerhouse, from 0.60 to 1.00 (based upon spill levels ranging from 40 to 0%). We therefore estimated that 324 to 540 tagged fish would be required for each release and set a range of 324 to 600 as the number we would try to mark for each release (determined by smolt availability).

Test fish for the study were obtained from four locations (Table 1). Steelhead and yearling chinook salmon smolts for the river-of-origin test (Objective 2) were

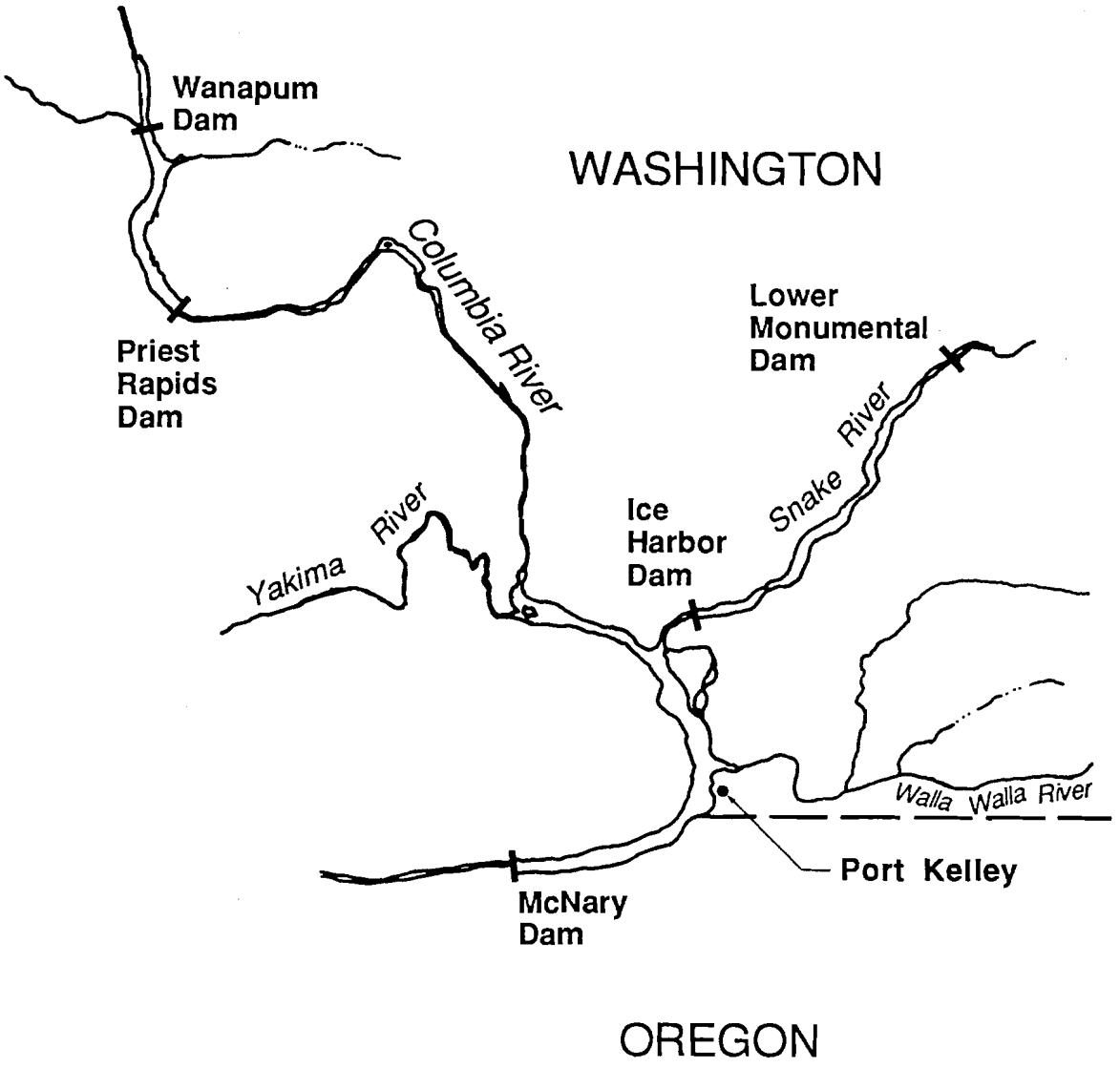

Figure 1.--Study area for the 1988 collection efficiency estimation study.

Table 1.--Schedule and procedures for the 1988 McNary Dam collection efficiency study objectives. Completion of a replicate for each of the three objectives required three days.

Objective	Capture location	Release day	Planned release time (h)	Capture method	Pre-anesthesia
1[a]	-	-	-	-	-
2	Priest Rapids	[b]	1900	Gatewell	Yes
	Ice Harbor	[b]	1900	Gatewell	No
3	Priest Rapids	[b]	0700	Gatewell	Yes
		[b]	1200	Gatewell	Yes
		[b]	1900	Gatewell	Yes
4	McNary bypass	[c]	1900	Subsample	Yes
	McNary reservoir	[c]	1900	Purse Seine	No

[a] Objective postponed due to low river flows and no spill at McNary Dam.
[b] Released the same day as tagged.
[c] Released one day after they were tagged.

obtained by dip-netting the gatewells at Ice Harbor and Priest Rapids Dams (for chinook salmon Priest Rapids time-of-release test groups were combined to form the Columbia River release group). Smolts for time-of-release tests (Objective 3) were captured by dip-netting from the gatewells at Priest Rapids Dam. Fish for testing the effect of previous guiding experience on subsequent collection rates (Objective 4) were obtained from the bypass subsample at McNary Dam and from purse seining in the McNary Dam reservoir at approximately RM 305.

Fish handling techniques were dependent upon capture location. Smolts collected at dam sites were PIT tagged at the dams and transported in 175-gal tanks to Port Kelley, approximately 20 miles upstream from McNary Dam. The tanks were loaded onto a boat for transport to the release site near the north shore at RM 308. Fish collected with the purse seine were held in a tank on the boat, tagged, and then released at RM 308.

Test fish were to be released at different times. The release time for Objectives 2 and 4 was to be 1900 h. Planned release times for Objective 3 were 0700, 1200, and 1900 h. Fish for the 0700- and 1200-h releases were captured and tagged the day before they were released. Fish for the 1900-h releases were captured, tagged, and released on the same day.

Three tests for each objective were planned for chinook salmon and for steelhead. Differences in detection rates at McNary Dam were tested by comparing rates observed from separate releases made on the same day (e.g., fish from Ice Harbor and Priest Rapids Dams for river-of-origin tests). Statistical analysis was by chi square and analysis of variance (ANOVA). Since flow and dam operational conditions were consistent throughout the study, t-tests were added to the data analysis where appropriate.

RESULTS AND DISCUSSION

Observed hourly flows at McNary Dam during the study ranged from 50 to 245 cfs. The daily average flow rate increased from 145 to 219 kcfs during the chinook salmon tests and remained steady with a slight downward trend during the steelhead tests (range 224 to 153 kcfs). All flow passed through the powerhouse.

In 1988, 8,367 chinook salmon and 8,577 steelhead were PIT tagged and released. Some planned releases of chinook salmon were not made because of 1) low catch numbers (Snake River, river-of-origin Test 1); 2) released in error at wrong time (noon release, time-of-release Test 2); 3) a broken stand-pipe on a transport tank (1900-h release, time-of-release Test 3); and 4) bad weather (1900-h release, time-of-release Test 4). The experimental design was followed for steelhead releases except that fewer fish than desired were released in the last replicate of the guided-fish test.

River-of-Origin Tests

Chinook Salmon

Of the four paired tests of chinook salmon from Columbia River and Snake River origins (4, 7, 10, and 13 May), only three were useable because the first Snake River release group contained only 21 fish and the test was excluded due to the diminutive number of Snake River fish (Table 2). Analysis of the remaining three test groups combined indicated there were no significant differences between the detection rates of the groups as they related to river of origin ($P < 0.05$). Chi square analysis of individual days revealed significant differences between the Columbia River and Snake River groups during the fourth test ($X^2 = 4.013$, $P = 0.045$). The results were confounded by the Snake River fish being released at 1900 h and the Columbia River fish being released at various times (i.e., 0700, 1200, and 1900 h).

There were no consistent differences in travel time between any of the paired chinook salmon tests for the river-of-origin tests.

Table 2.--Collection site, release date, release time, number of fish released at Port Kelley, proportion of fish detected at McNary Dam, chi square, degrees of freedom (D.F.), and level of significance (P) for tests to determine the effects of river of origin.

Collection site	Date released	Time released	Total number released	Proportion detected	Individual chi square	D.F.	P
			CHINOOK SALMON				
Ice Harbor Dam	4 May 88	1900	21	0.66	dropped due to small sample		
Priest Rapids Dam	4 May 88	0700,1200,1900	1,620	0.61			
Ice Harbor Dam	7 May 88	1900	340	0.58	0.540	1	0.463
Priest Rapids Dam	7 May 88	0700,1900	1,020	0.61			
Ice Harbor Dam	10 May 88	1900	343	0.62	0.008	1	0.977
Priest Rapids Dam	10 May 88	0700,1200	679	0.63			
Ice Harbor Dam	13 May 88	1900	295	0.61	4.013	1	0.045[a]
Priest Rapids Dam	13 May 88	0700,1200	1,198	0.67			
			STEELHEAD				
Ice Harbor Dam	16 May 88	1900	351	0.47	1.000	1	0.317
Priest Rapids Dam	16 May 88	1900	599	0.51			
Ice Harbor Dam	19 May 88	1900	602	0.51	6.818	1	0.009[a]
Priest Rapids Dam	19 May 88	1900	600	0.58			
Ice Harbor Dam	24 May 88	1900	328	0.54	0.692	1	0.406
Priest Rapids Dam	24 May 88	1900	337	0.51			

[a] Indicates significance at $P < 0.05$.

Steelhead

There were three paired tests (16, 19, and 24 May) of approximately equal numbers of steelhead which originated from the Snake and Columbia River Basins (Table 2). The mean detection rates for test fish from each basin were not statistically different ($t = -0.805$ and $P < 0.4$). Comparison of individual paired releases indicated that although in general there was no effect of river of origin, Columbia River fish were detected in significantly greater numbers ($X^2 = 6.818$, $P < 0.01$) during the second test. All steelhead in the river-of-origin studies were released in the evening (1900 h), so there were no confounding diel effects. The differences seem to be day specific and imply that other variables such as stock difference, run timing, or smolt condition influenced the result.

There were no consistent differences in travel time between any of the paired steelhead tests for the river-of-origin tests.

Time-of-Release Tests

Chinook Salmon

Analysis of variance revealed no significant differences among mean detection rates of 0.628, 0.657, and 0.605 from groups released in the morning, at midday, and in the evening, respectively ($P > 0.05$). When diel releases for individual days were examined (Fig. 2), a significant difference was found for 4 May. In this group (Table 3), there was a significant difference in detection between midday and evening releases ($X^2 = 3.917$, $P = 0.048$). No significant differences were found between morning and midday or morning and evening releases on 4 May ($X^2 = 2.26$, $P = 0.133$ and $X^2 = 0.227$, $P = 0.634$, respectively). No significant differences were found within days for any of the morning and midday replicates.

We believe that three factors could contribute to a within day difference: 1) travel time from the release site to the PIT-tag monitors in the McNary Dam bypass

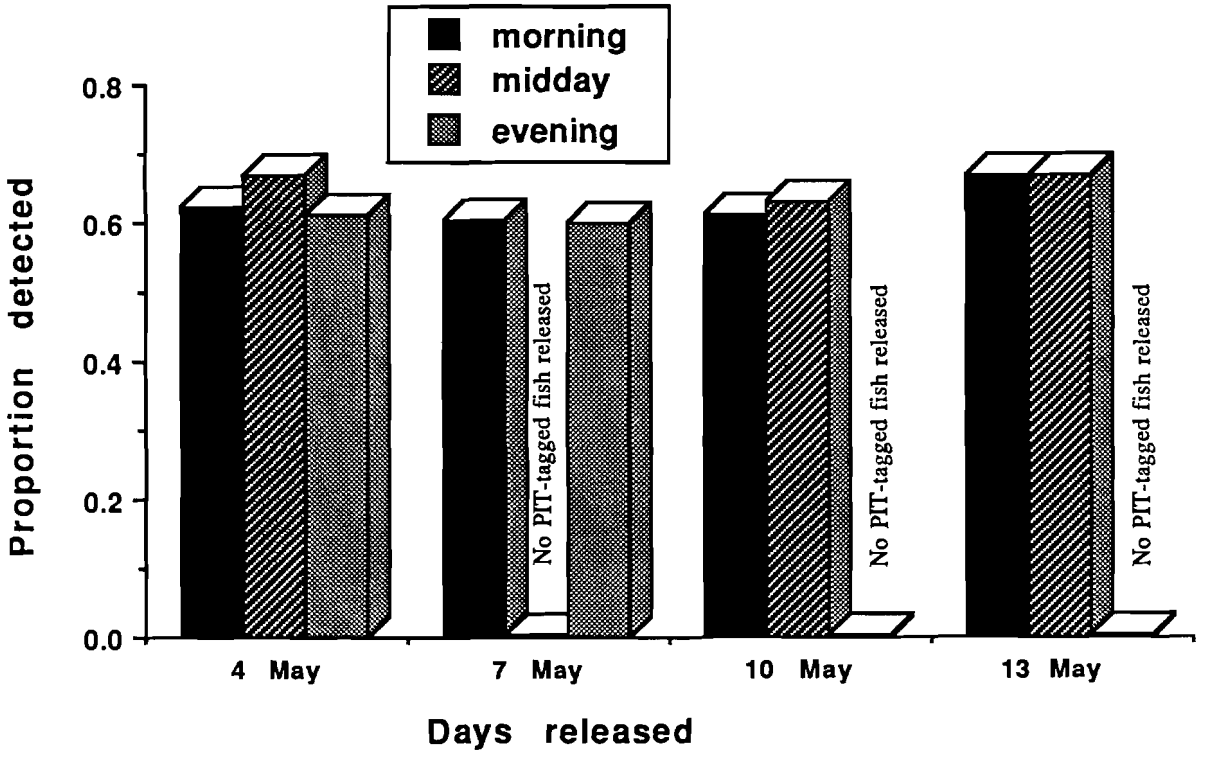

Figure 2.--Proportion of PIT-tagged chinook salmon detected at McNary Dam after release near Port Kelley, Washington, at 0700 (morning), 1200 (midday), and 1900 h (evening).

Table 3.--Collection site, release date, release time, number of fish released at Port Kelley, proportion of fish detected at McNary Dam, chi square, degrees of freedom (D.F.), and level of significance (P) for tests to determine the effects of intra-daily release time.

Collection site	Date released	Time released	Number released	Proportion detected	Individual chi square	D.F.	P
			CHINOOK SALMON				
Priest Rapids Dam	4 May 88	0700	540	0.62	vs pm = 0.227	1	0.634
Priest Rapids Dam	4 May 88	1200	539	0.67	vs am = 2.260	1	0.133
Priest Rapids Dam	4 May 88	1900	541	0.61	vs mid = 3.917	1	0.048*
					total = 4.234	2	0.120
Priest Rapids Dam	7 May 88	0700	680	0.61	0.01	1	0.928
Priest Rapids Dam	7 May 88	1900	340	0.60			
Priest Rapids Dam	10 May 88	0700	340	0.61	0.36	1	0.546
Priest Rapids Dam	10 May 88	1200	339	0.63			
Priest Rapids Dam	13 May 88	0700	598	0.67	0.01	1	0.919
Priest Rapids Dam	13 May 88	1200	600	0.67			
			STEELHEAD				
Priest Rapids Dam	16 May 88	0700	382	0.57	vs mid = 0.810	1	0.368
Priest Rapids Dam	16 May 88	1200	436	0.54	vs pm = 1.299	1	0.254
Priest Rapids Dam	16 May 88	1900	599	0.51	vs am = 4.229	1	0.040*
					total = 0.114	2	0.114
Priest Rapids Dam	19 May 88	0700	600	0.62	vs mid = 1.321	1	0.250
Priest Rapids Dam	19 May 88	1200	589	0.66	vs pm = 6.836	1	0.009*
Priest Rapids Dam	19 May 88	1900	600	0.58	vs am = 2.175	1	0.140
					total = 6.893	2	0.032*
Priest Rapids Dam	24 May 88	0700	338	0.59	vs mid = 1.088	1	0.297
Priest Rapids Dam	24 May 88	1200	337	0.55	vs pm = 1.006	1	0.316
Priest Rapids Dam	24 May 88	1900	337	0.51	vs am = 4.183	1	0.041*
					total = 4.183	2	0.124

* Indicates significance at $P < 0.05$.

system, 2) differences in handling techniques between tagging and release of the individual groups, and 3) daily changes in spill rates.

Differences in travel time for fish in individual test releases would bias collection rates if longer travel times exposed the fish to greater predation or changed passage locations at the dam. Analysis of the travel times, from release site to PIT-tag monitor for chinook salmon in the time-of-release groups, revealed about a 25-hour difference between the detection of the 80th percentile of the morning and midday releases (64 and 66 hours, respectively) and the 80th percentile of the evening release (91 hours) (Fig. 3). This difference could be related to diel migration patterns in the reservoir, to the entry time at McNary Dam, or a combination of the two. Most smolts enter the powerhouse between sunset and midnight (Brege et al. 1988). Smolts missing the first day's peak passage period at the dam would be holding in the forebay until appropriate passage conditions were again available.

A correlation value of $r = 0.12$ for the relationship between the within-group average travel time and the observed-group detection rate suggested that within the range of travel times observed in 1988, there was very little correlation between travel time and subsequent detection rates.

Mean travel times for chinook salmon groups released earlier in the study were longer than for groups tested later in the outmigration (Fig. 4). Travel times for detection of the 80th percentile from the releases were 90, 74, 55, and 43 hours, respectively, for the first through last test dates. Seasonal changes in travel time may be related to river flows, water temperature, and to increasing levels of smoltification. The correlation, $r = -0.46$, between average daily flow and the 80th percentile travel time of individual release groups indicates 46% of the variation in travel time may be associated with flow.

Chinook salmon observations at the McNary Dam PIT-tag monitors peaked at 0500 h and again between 1000 and 1200 h (Fig. 5). Eighty percent of PIT-tagged

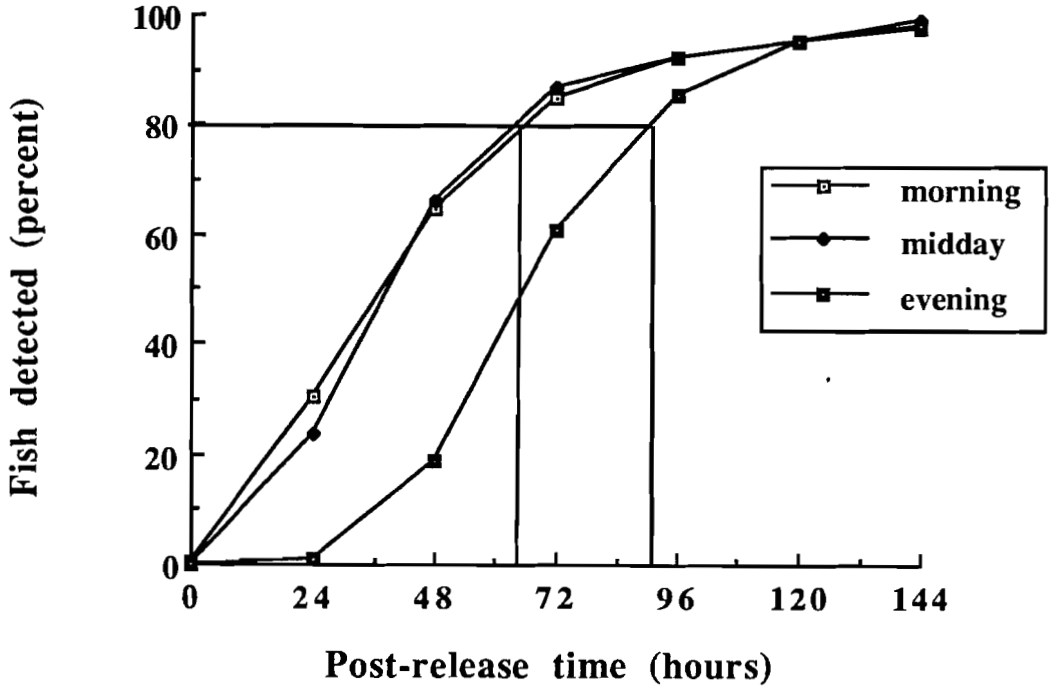

Figure 3.--Cumulative mean percent of PIT-tagged chinook salmon detected at McNary Dam after release near Port Kelley, Washington, at 0700 (morning), 1200 (midday), and 1900 h (evening).

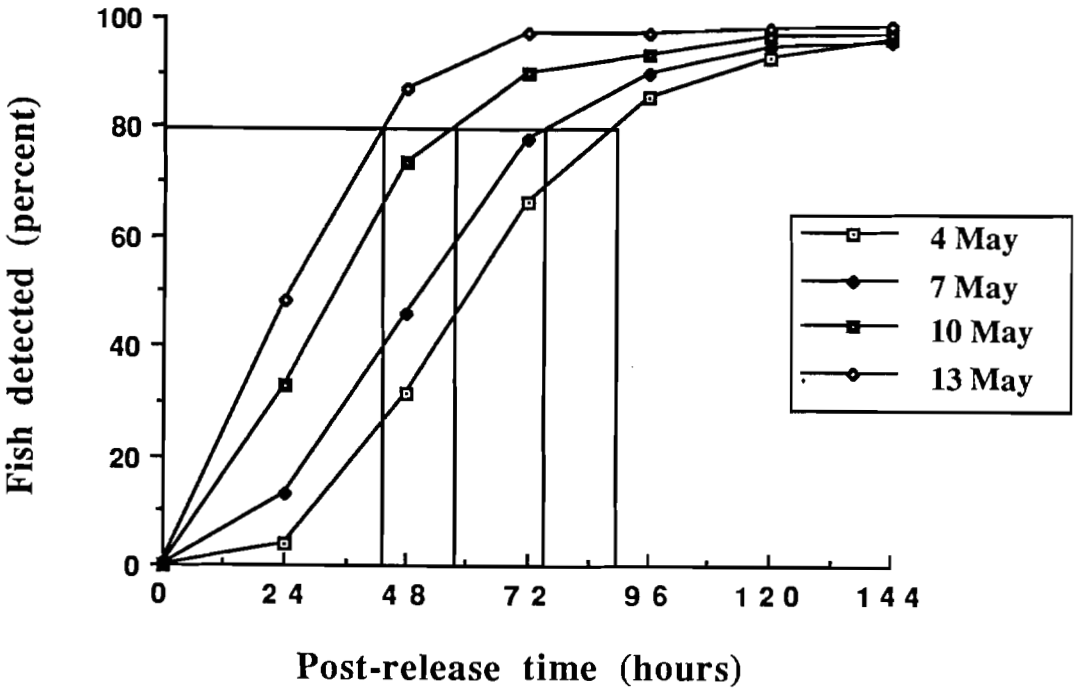

Figure 4.--Cumulative mean percent of PIT-tagged chinook salmon detected at McNary Dam after four releases near Port Kelley, Washington, on 4, 7, 10, and 13 May 1988.

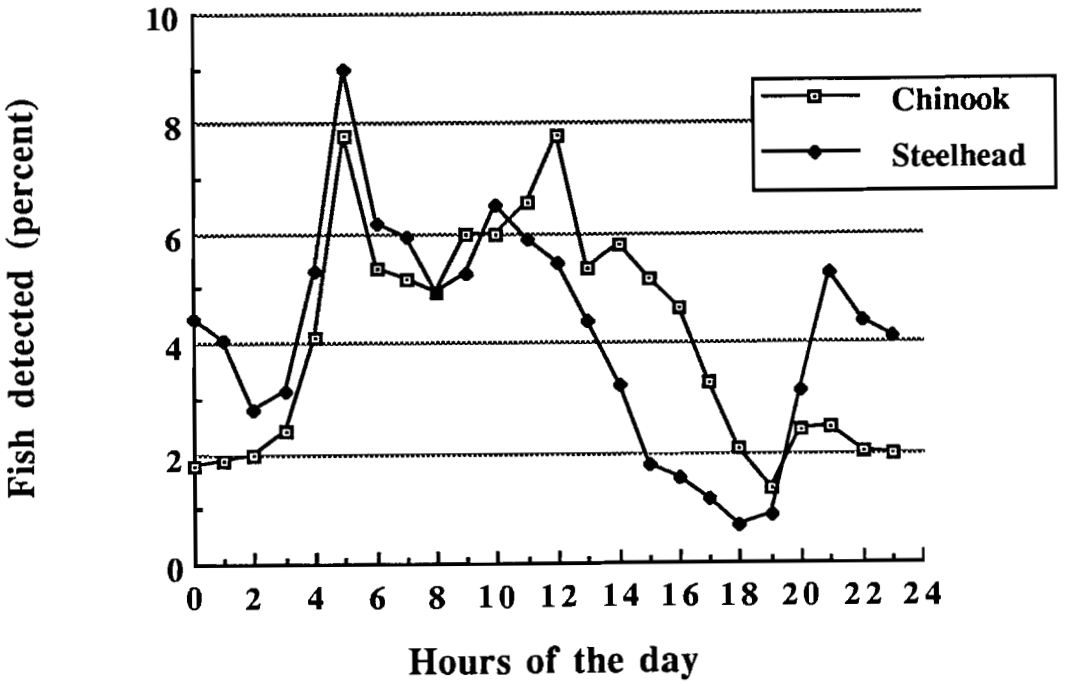

Figure 5.--Mean hourly percent of steelhead and chinook salmon detected at McNary Dam from 4 May to 30 July 1988.

chinook salmon passed the monitors during daylight (0500-2100 h). The observed pattern may be related to the turbine shutdown and associated low flow during the night and an 0500-h turbine start-up to meet daytime power demands.

Differences in handling procedures between the morning/noon groups and the evening groups could also have contributed to within day collection differences. Stress for the morning/noon groups may have been reduced by holding them overnight whereas stress for the evening group may have remained high because they were released the same day they were captured and tagged. Stress could produce lower collection rates by increasing travel time or by increasing mortality between time of release and time of detection.

Changes in spill rate could also cause within day collection differences; however, during this study, there was no spill to produce any of the variation observed.

Steelhead

Steelhead for the time-of-release tests were released at 0700, 1200, and 1900 h on 16, 19, and 24 May. The proportion of fish from morning releases detected at McNary Dam was always greater than the proportion of fish from evening releases and greater than the proportion of fish from noon releases two out of three times (Fig. 6). Analysis of the data (ANOVA) (Table 3) indicates there are significant differences between test groups based on time of release. Fisher's Protected Least Significant Difference Test (FPLSD) gives a value of 0.0451 at the 95% level of significance. Any means differing by more than the FPLSD value are significantly different. The release means were 0.5923 (morning); 0.5793 (midday), and 0.5283 (evening). Thus, the numbers of fish detected from the three evening releases were significantly less, at the 95% level, than the morning or midday releases. Analysis of individual tests revealed there were large effects within treatment groups which influenced detection rates. On the first and third days, recovery rates were statistically higher from morning releases

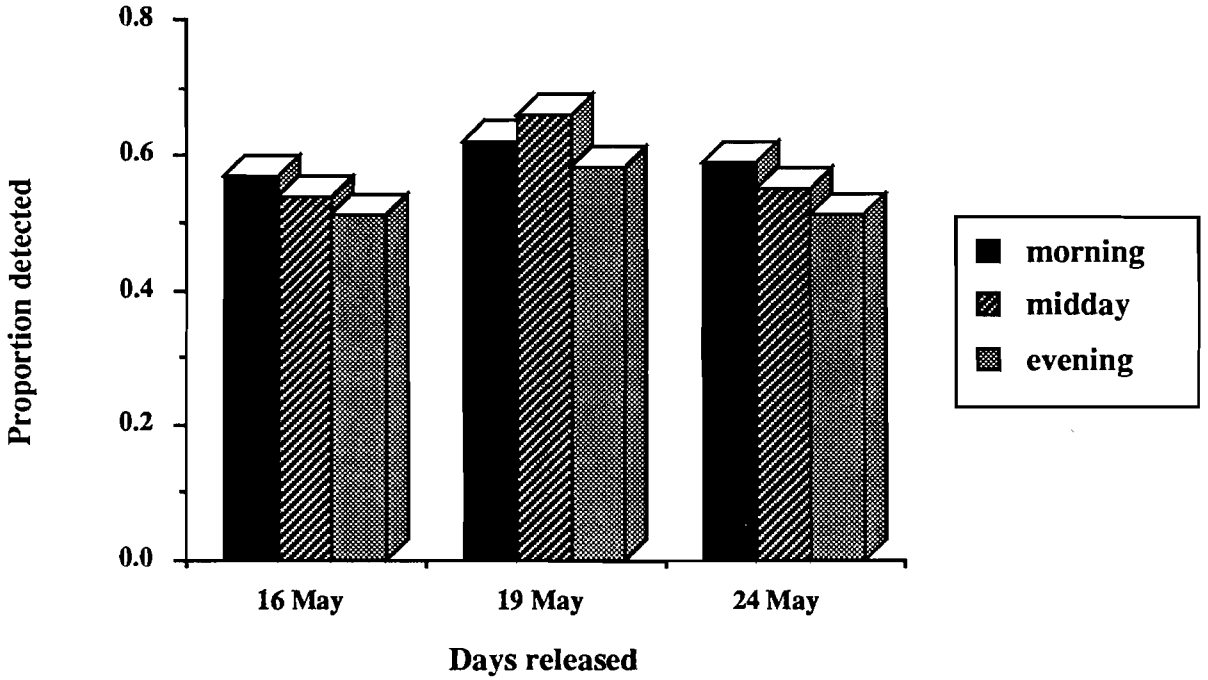

Figure 6.--Proportion of steelhead groups detected at McNary Dam after three paired releases near Port Kelley, Washington, at 0700 (morning), 1200 (midday), and 1900 h (evening).

than from the evening releases (X^2 = 4.229, P = 0.040 for Day 1, and X^2 = 4.183, P = 0.041 for Day 3). On the second test day, fish from morning releases were not detected at a significantly higher rate than fish released in the evening (X^2 = 2.175, P = 0.140). However, fish released at midday on the second test day had a significantly higher detection rate (0.66) than the other release times (X^2 = 19.39, P = 0.000).

We believe that the same factors that could produce the within day differences in collection rates for chinook salmon could also apply to steelhead.

Mean travel time was least for the three groups of steelhead released at midday. The 80th percentile passage of fish released at midday (68 hours) was about a day before either the morning (86 hours) or evening (107 hours) release groups (Fig. 7). Within day effects from the second noon replicate significantly affected the means. In two out of three test days, there were no differences in travel time between morning and midday release groups (Figs. 8, 9, and 10). Changes in travel time for the 80th percentile of steelhead detection ranged from 64 to 72 hours during the study. As with chinook salmon, the average steelhead travel times for the individual release groups did not correlate (r = 0.09) with the average daily river flows.

Guided vs Unguided Tests

Chinook Salmon

Fish collected at the fingerling facility at McNary Dam (guided) were recovered at consistently higher rates than fish that were collected from the McNary Dam reservoir (non-guided)(Table 4). Chi square analysis of the collection rates of fish released on 5, 9, and 11 May (guided and unguided tests) (Fig. 11) indicated significant differences in recovery rate for all intergroup comparisons ($P < 0.05$). These data support the hypothetical relationship between the physiological status of smolting salmon and their susceptibility to guidance (Giorgi et al. 1988). However, Smith (1974)

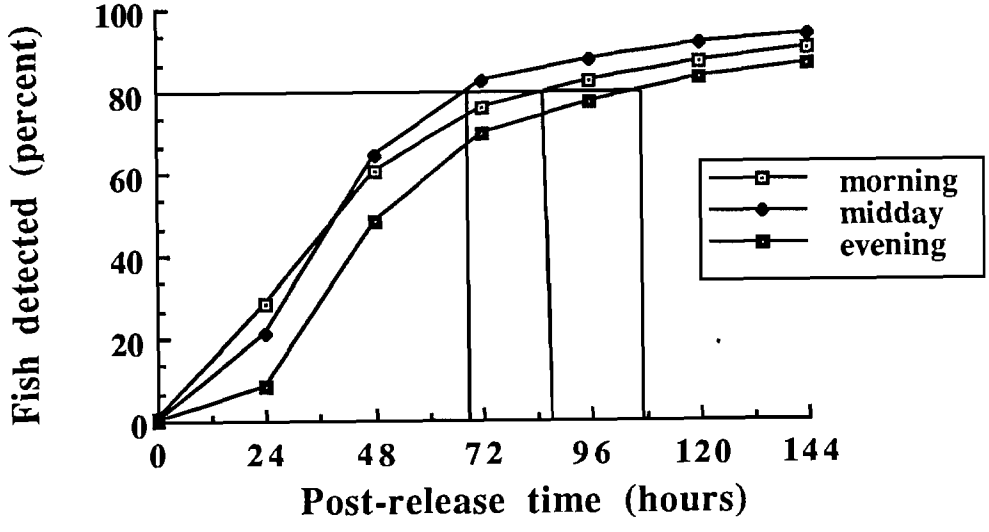

Figure 7.--Cumulative mean percent of PIT-tagged steelhead detected at McNary Dam after release near Port Kelley, Washington, at 0700 (morning), 1200 (midday), and 1900 h (evening).

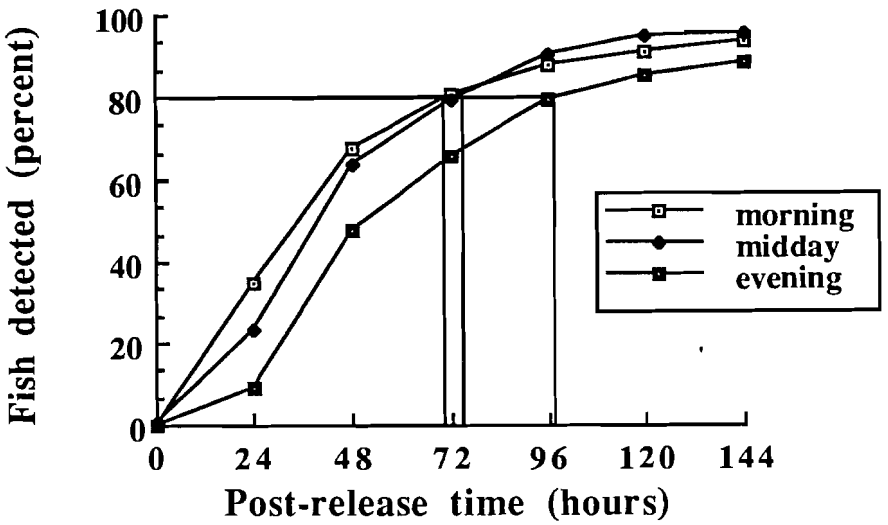

Figure 8.--Cumulative mean percent of PIT-tagged steelhead detected at McNary Dam after release near Port Kelley, Washington, at 0700 (morning), 1200 (midday), and 1900 h (evening) on 16 May 1988.

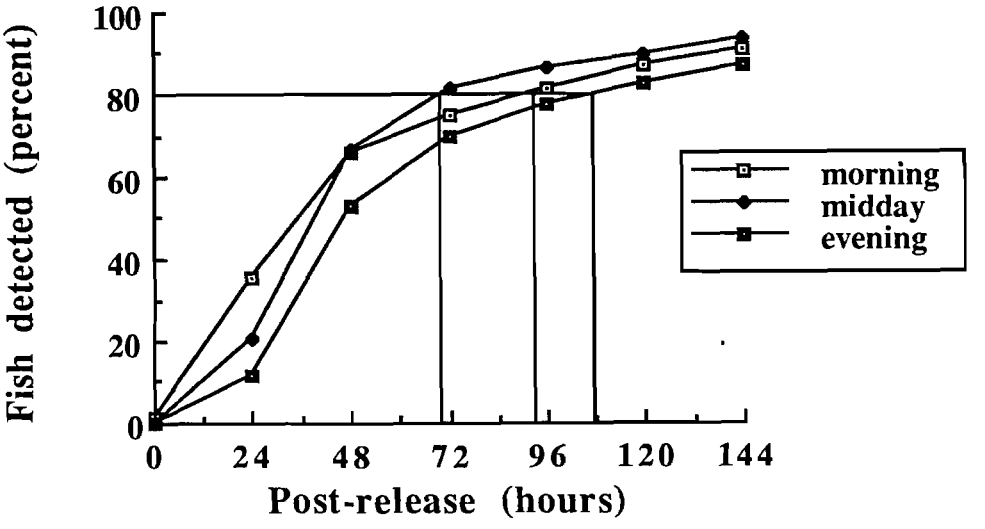

Figure 9.--Cumulative mean percent of PIT-tagged steelhead detected at McNary Dam after release near Port Kelley, Washington, at 0700 (morning), 1200 (midday), and 1900 h (evening) on 19 May 1988.

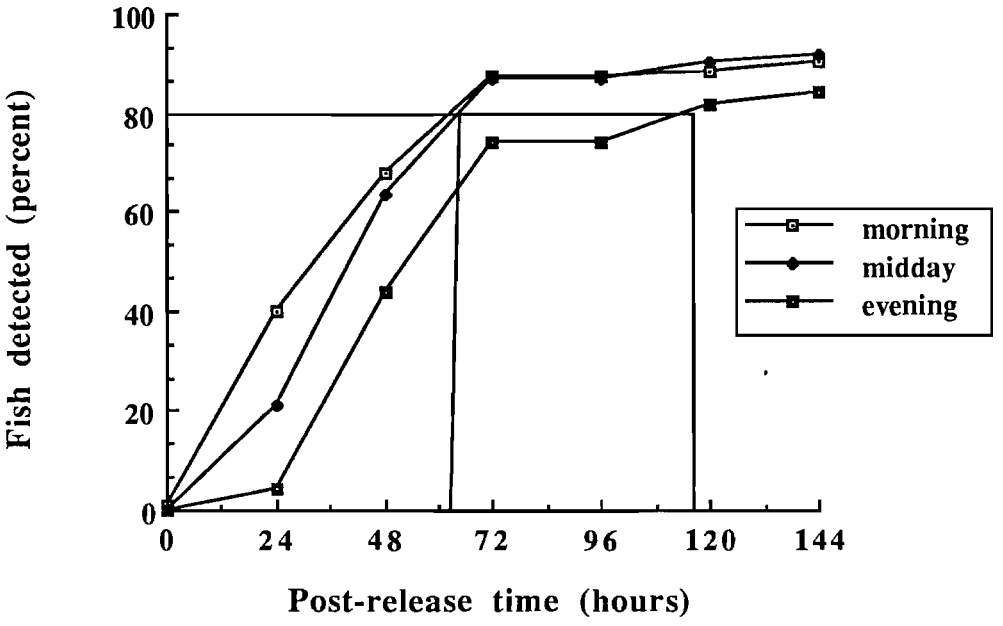

Figure 10.--Cumulative mean percent of PIT-tagged steelhead detected at McNary Dam after release near Port Kelley, Washington, at 0700 (morning), 1200 (midday), and 1900 h (evening) on 24 May 1988.

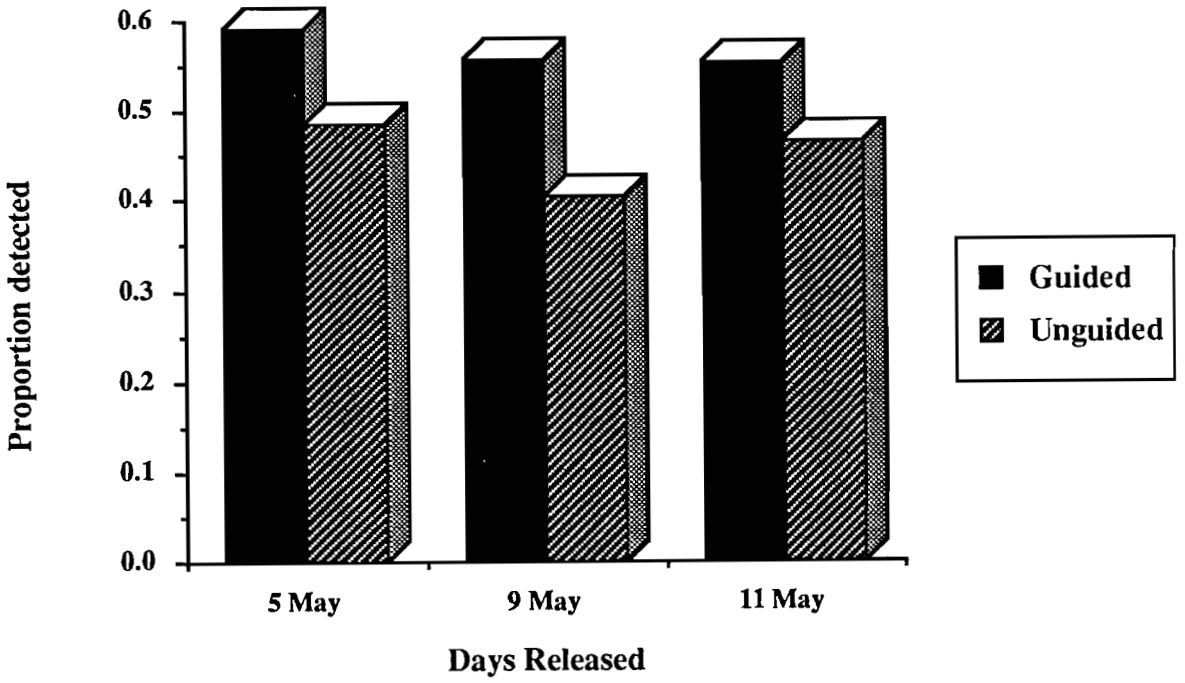

Figure 11.--Proportion of PIT-tagged chinook salmon detected at McNary Dam from three paired releases of fish collected from the dam bypass system (guided) and fish collected from the forebay (unguided).

Table 4.--Collection site, release date, release time, number of fish released at Port Kelley, proportion of fish detected at McNary Dam, chi square, degrees of freedom (D.F.), and level of significance (P) for tests to determine the effects of previous fish passage guidance.

Collection site	Date released	Time released	Number released	Proportion detected	Individual chi square	D.F.	P
			CHINOOK SALMON				
Bypass system	5 May 88	1900	538	0.59	6.895	1	0.009*
Forebay	5 May 88	1900	216	0.48			
Bypass system	9 May 88	1900	600	0.56	26.904	1	0.001*
Forebay	9 May 88	1900	568	0.41			
Bypass system	11 May 88	1900	582	0.55	6.678	1	0.010*
Forebay	11 May 88	1900	347	0.46			
			STEELHEAD				
Bypass system	17 May 88	1900	596	0.57	32.180	1	0.000*
Forebay	17 May 88	1900	420	0.39			
Bypass system	20 May 88	1900	602	0.53	37.650	1	0.000*
Forebay	20 May 88	1900	601	0.35			
Bypass system	25 May 88	1900	605	0.49	0.090	1	0.764
Forebay	25 May 88	1900	254	0.48			

* Indicates significance at $P < 0.05$.

observed that 58% of spring chinook salmon were in the upper 12 ft of the Lower Monumental Dam reservoir--the depth range likely intercepted by our purse seine. Thus, if smolt development similarly influences depth distribution in the reservoir and at the fish guiding screens, fish collected by seine were probably biased toward smolts as were the fish collected at the dam.

Reduced detection of unguided fish may also be related to the handling methods. Guided fish were collected from the McNary Dam bypass subsample tank. They were anesthetized in the subsample tank before handling. Unguided fish were collected by purse seine from the McNary Dam reservoir, dip-netted into a holding tank, and dip-netted again into anesthetic for tagging. At Lower Granite Dam, significant differences in survival have been found between one group of fish anesthetized before netting and another anesthetized after netting (Matthews et al. 1986).

There were no statistical differences in travel time between any of the paired chinook salmon guidance tests.

Steelhead

Due to high variation in the detection rates of the paired test groups (Fig. 12), the mean detection rates for guided vs unguided steelhead (17, 20, and 25 May) were not significantly different ($t = 2.215$, $P > 0.1$). Individual analysis of each test day (Table 4) revealed significant differences between the paired groups on the first two tests ($X^2 = 32.180$, $P < 0.000$; $X^2 = 37.650$, $P < 0.000$) but not for the third test ($X^2 = 0.090$, $P = 0.764$).

We believe that the same factors that led to the guided vs unguided collection rate differences for chinook salmon would also apply to steelhead.

There were no statistical differences in travel time between any of the paired steelhead tests.

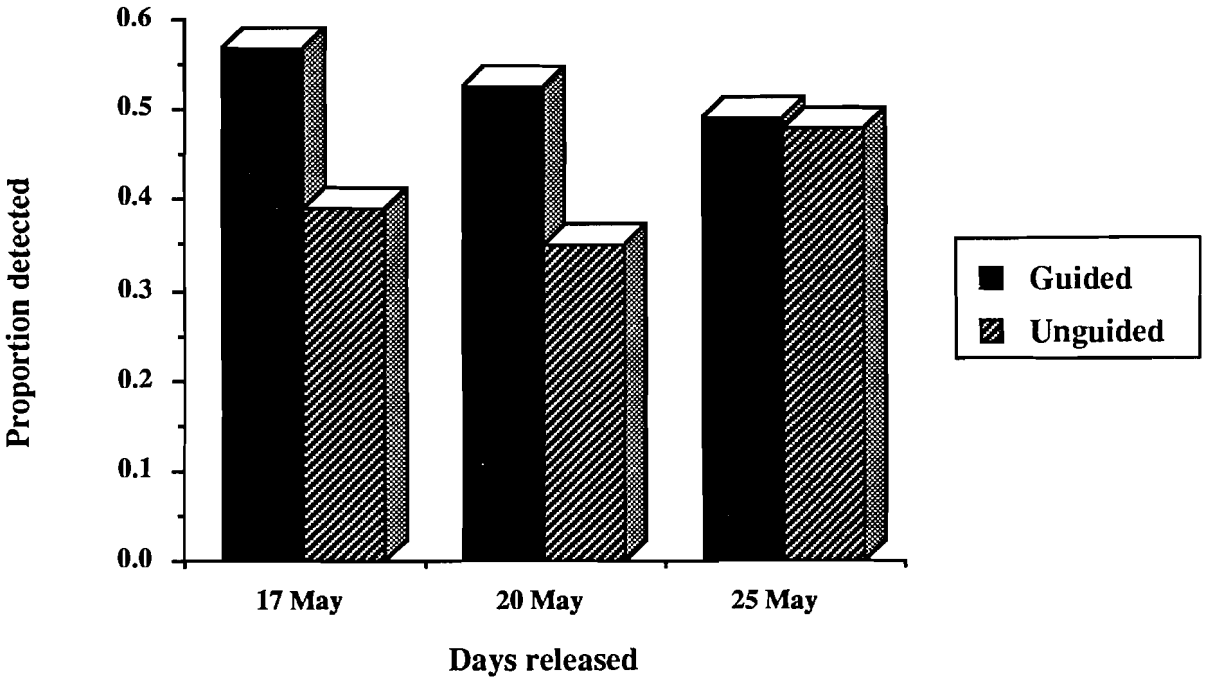

Figure 12.--Proportion of PIT-tagged steelhead detected at McNary Dam from three paired releases of fish collected from the dam bypass system (guided) and fish collected from the forebay (unguided).

SUMMARY AND CONCLUSIONS

In this study, the relationship between travel time and detection rate of tagged fish identified at the McNary PIT-tag monitors was not consistent. Several of the release groups that produced significantly different detection rates had significantly longer travel times (release time objectives). Other release groups (guided vs unguided) that had significantly different detection rates had travel times that were not different. In addition, changes in travel time observed as the migration progressed (chinook salmon) did not significantly change detection rates.

The affects of handling stress appeared to be more consistent. Fish captured, tagged, and released on the same day had lower recovery rates than those that were held overnight and then released. Smolts from the purse seine had the lowest recovery rates and likely the most severe handling (purse seined, no pre-anesthesia, tagged, and released the same day). To determine if differences in mortality rates between release and monitor arrival are biasing recovery at the dam, tests in 1989 will include delayed mortality estimates. To reduce the handling stress, all smolts will be held overnight before release.

The following conclusions should be considered preliminary as this report represents only the first year of a 2-year study.

1) Although there may be some impact on collection efficiency due to river-of-origin, factors such as stock differences, run timing, and smolt development most likely will conceal it.
2) The differences in detection rate of PIT-tagged yearling chinook salmon and steelhead smolts in the time-of-release tests are significant and appear to be related to travel time and to stress associated with the handling of the evening release groups.

3) The significant differences in detection rates between guided vs unguided fish may be associated with differences in capture methods. (In 1989 consistent handling of fish will be emphasized.)

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LITERATURE CITED

Brege, D. A., W. T. Norman, G. A. Swan, and J. G. Williams.
1988. Research at McNary Dam to improve fish guiding efficiency of yearling and subyearling chinook salmon, 1987. Report to U. S. Army Corps of Engineers, Contract DACW68-84-h-0034, 34 p. (Available from Northwest Fisheries Center, 2725 Montlake Blvd. E., Seattle, WA 98112.)

Giorgi, A. E., and C. W. Sims
1987. Estimating the daily passage of juvenile salmonids at McNary Dam on the Columbia River. N. Amer. J. Fish. Mgmt. 7:215-222.

Giorgi, A. E., G. A. Swan, W. S. Zaugg, T. Coley, and T. Y. Barila.
1988. Susceptibility of chinook salmon smolts to bypass systems at hydroelectric dams. N. Amer. J. Fish. Mgmt. 8:25-29.

Matthews, G. M., D. L. Park, S. Achord, and T. E. Ruehle.
1986. Static seawater challenge test to measure relative stress levels in spring chinook salmon smolts. Trans. Amer. Fish. Soc. 115:236-244.

Prentice, E. F., T. A. Flagg, and S. McCutcheon.
1987. A study to determine the biological feasibility of a new fish tagging system, 1986-1987. Annual report to Bonneville Power Administration, Contract DE-A179-84BP11982. 113 p. (Available from Northwest Fisheries Center, 2725 Montlake Blvd. E., Seattle, WA 98112.)

Prentice, E. F., D. L. Park, T. A. Flagg, and S. McCutcheon.
1986. A study to determine the biological feasibility of a new fish tagging system, 1985-1986. Annual report to Bonneville Power Administration, Contract DE-A179-84BP11982. 91 p. (Available from Northwest Fisheries Center, 2725 Montlake Blvd. E., Seattle, WA 98112.)

Smith, J. R.
1974. Distribution of seaward-migrating chinook salmon and steelhead trout in the Snake River above Lower Monumental Dam. Mar. Fish. Rev. 36(8):42-45.