LOWER GRANDE RONDE SMOLT TRAP MONITORING

ANNUAL REPORT 1996

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CONTENTS

Page

ABSTRACT 1

INTRODUCTION 1

METHODS 2
- Trap Site Description 2
  - 1995 2
  - 1996 2
- Trap Efficiency 3
  - 1995 3
  - 1996 3
- Trap Operational Period 3
  - 1995 3
  - 1996 4
- Fish Handling .....
  - 1995-96 4
- Migration Timing and Travel Time 7
  - 1995-96 7

RESULTS 8
- Trap Site Description 8
- Trap Efficiency 8
- Fish Handling 8
- Migration Timing and Travel Time 16
  - Wild Chinook Salmon 17
    - 1995 17
    - 1996 18
  - Hatchery Steelhead 18
    - 1995 18
  - Wild Steelhead 19
    - 1995 19
  - Hatchery/Wild Steelhead 19
    - 1996 19
  - Other Species. 30

DISCUSSION 30

REFERENCES 32

ABSTRACT

We sampled downstream migrating salmonids at Boggan's Oasis in the Grande Ronde River with a screw trap during 1995 and a scoop trap during 1996. Sampling began in March and terminated early in June. Wild spring chinook and wild/hatchery steelhead were collected and marked to assess migration patterns and timing. Fish were marked with tags in order to obtain downstream migration data with minimal fish handling. Observations were recorded when a fish swam through an interrogation monitor at hydroelectric facilities downstream.

The second year for monitoring smolts leaving the Grande Ronde River was completed in 1995. Flows during the spring were greater in 1995 than during the first year of trap operation, 1994. We deployed a dual 8 foot screw trap whenever flows were sufficient to provide a large enough area to fish two traps side by side. We were able to fish only during a narrow range of flows due to the presence of a back eddy and the maximum velocity capacity of the screw trap.

The combined total number of smolts PIT-tagged at Boggan's Oasis in 1995 - 1996 were as follows: 1.268 wild chinook, 779 wild steelhead, and 1,358 hatchery steelhead. Fifty percent of the outmigrant wild chinook and wild/hatchery steelhead left the Grande Ronde basin during late April in 1995.

River flows were above average during the 1996 trapping season. The scoop trap we fished in 1996 allowed us to continue fishing at surface velocities higher than in 1995. The number of fish captured was lower in 1996 than in 1995 due to a reduced number of outmigrants and our inability to fish the trap downstream along the thalweg. There were multiple constraints from the physical contours of the trapping site that did not make it suitable for trapping smolts.

We continued to pursue moving to a permanent location downstream for 1997 because of the limitations for trapping smolts at Boggan's Oasis. This involved reconnaissance surveys of several potential sites near the mouth of the river from 1994-1996. During February of 1996, a water velocity and bottom topography assessment was completed. Results of the assessment were used for siting the anchoring tower structure upstream approximately 1.2 miles from the mouth of the Grande Ronde river.

INTRODUCTION

This report summarizes data collected during 1995 and 1996 at the Lower Grande Ronde River trap site located at Boggan's Oasis, Washington. The objective of the project was to provide information to assess travel time and outmigrant timing of indigenous anadromous salmonids in the Grande Ronde Basin. This project is a component of the Fish Passage Center's Smolt Monitoring Program. We completed the second year of trap operation and marking of downstream migrants in 1995.

Steelhead and chinook were collected and PIT-tagged at the Lower Grande Ronde trap site during 1995 and 1996. The trap operation involved the use of either one or two 8 foot screw traps to collect the fish during 1995. During 1996, a scoop trap was fished for the entire

trapping season. We sampled all hatchery chinook and steelhead to provide information for other investigators researching life history and survival of salmonids.

In addition. the lower river potential trap sites identified during 1994 were examined at higher flows for their suitability. We selected a new permanent location for trap operation in order to acquire the ability to trap at a broader range of river discharge levels with more consistent catch levels throughout the migration period.

PIT-tag marking objectives for the report period were: 1,200 (1995) wild chinook, 1 .000 (1995) hatchery steelhead. and 1,000 (1995) wild steelhead. No hatchery chinook were to be PIT-tagged so trap operations were modified to minimize their collection. During 1996, the tagging objectives were changed (1,500 wild chinook, 1.500 hatchery steelhead, 1.500 wild steelhead) but circumstances did not allow us to achieve our objectives. Fish were only tagged during the period May 8 through June 3 and this effort was directed primarily toward steelhead.

METHODS

Trap Site Description

1995

Eight foot diameter screw traps manufactured by E.G. Solutions were used to capture smolts migrating out of the Grande Ronde River during 1995. The trap site was located at Boggan's Oasis below the Washington Highway 129 bridge. The site is situated at RM 28.8 where shoreline property is owned by the Washington Department of Transportation. This trap site is the same as used for fish collection in 1994, the first year of PIT-tag marking on the Lower Grande Ronde River. The site is physically characterized by a deep pool in the center. thalweg toward the north shore, and a shallow south shore. While river discharge is below 8 kcfs. velocities below 8.5 fps can be located at this site thus providing an area for trap operation. When discharge is higher, the only area where suitable velocity to fish the trap can be found is on the south shore. The south shore was unfishable in 1995 due to the shallow depth of a submerged sand/gravel bar which was a result of siltation. The discharge constraint is one factor that made the temporary site a poor choice for a permanent site. The other major factor was hydraulics. The flood water that moved down the Grande Ronde during February 1996 changed the shape of the shallow sand bar and removed the bench area along shore where sampling facilities had been stationed during the two previous years. The scoop trap allowed us to keep a trap fishing at velocities up to 11 fps. The shallow area along the south shore was elongated and wider after the spring flood swept the top several feet of sediment from a wide area.

Hydraulic surveys of the downstream sites identified in 1993 were performed again on three occasions during 1995. Discharge quantities at the Troy gauge (RM 45-USGS) were 7.8, 9.9. and 11.4 kcfs based on the time of the site visits.

1996

We identified the need for more precise velocity and bottom contour data. A site which had appeared favorable visually during past observations became our primary focus and a more in depth assessment was initiated. Beak Consultants worked with ODFW engineers and

smolt monitoring project biologists to define the scope of data collection that would prove useful. A summary of their field work efforts provided us with a profile of velocity and bottom contour that allowed for precise siting of the proposed tower structures. These will be built to anchor the main cable perpendicular to the river so the trap can be placed across the width of the river. The site selected (2: Table 1) has hydraulic characteristics which will provide an environment where a trapping operation can be more successful collecting downstream migrating salmonids.

Trap Efficiency

1995

On April 5, 1995 1,000 chinook from Lookingglass Hatchery were marked with acrylic paint using a Panjet marker. Two groups of 500 fish each were marked with a different paint color. The mark was a left caudal paint dot, either orange or purple. On April 10. 1995, the 499 chinook with the purple mark were released at the hatchery outlet with a flow from the Troy gauge of 7.6 kcfs. On April 16, 1995, the other marked group, the 500 chinook with an orange dot, were released at an estimated river discharge of 6.7 kcfs, also at the hatchery outlet. Recovery of these marked fish downstream at the screw trap **was** used for our 1995 trap efficiency estimate. No releases of marked steelhead were made during 1995.

1996

A similar strategy **was** employed in 1996 to estimate the efficiency of the scoop trap fishing the same location where the screw traps had been deployed in previous years. The effectiveness of this rough estimation technique was greatly reduced during 1996. We were only able to obtain hatchery steelhead due to the low numbers of hatchery chinook available within the basin. We differentially marked two groups on March 25 and 26 of 1,000 each for release. The marks were a right or left caudal peduncle orange dot. On March 31, 1996, the right mark was released from the net pen where they had been held at the stream outlet of the Cottonwood Acclimation facility (flow = 4.0 kcfs). There were 50 mortalities noted and the condition of the fish was poor. They were dark in color and displayed a tendency to head upstream into the flow after release. There were no downstream recaptures from this release. On April 8, 1996, the 1,000 fish with the left side mark were liberated in a similar fashion as the earlier release (flow = 7.5 kcfs). On the following day one fish from this release was recaptured downstream at the trap.

Trap Operational Period

1995

A single screw trap was installed on March 10 and the standard sampling interval was 24 h. The second trap was initially installed on March 28 and operated in tandem as a single unit with the other trap (Figure 1). The two trap unit was operated for two extended time intervals during 1995; 1) March 28 through April 5 and 2) April 20 through April 27. Two other single night collections were made on April 7 and June 9. During the remainder of trap operations only a single screw trap was fished. The trap operation was shut down April 7

through April 9 to reduce handling on the release of hatchery chinook from Lookingglass Hatchery. From May 1 through May 21 and again on May 29 through May 31 the traps were not fished due to the high river discharge from rain and snowmelt combined. The 1995 trap season began on March 10 and ended on June 16. Total trap operation days for the season were 66 out of 98 possible. We operated 7 days a week except for Memorial Day and one week during June. A typical sample day began at 9:00 AM and ended at that same time the following day. Fish collection numbers of both steelhead and chinook were greatly reduced in May when we resumed trap operation after the May l-22 shutdown. Presumably this **was** due to most fish leaving the river system with the runoff. The water temperature and flow at the upstream Troy gauge were recorded daily.

1996

In order to further test the site for trapping suitability, we deployed a scoop trap in March 1996 (Figure 2). This was a large structure for this particular site, but allowed us to experiment with running the new trap at higher flows and increased velocities. We did not note any reduction in fish condition associated with these different hydraulic conditions. The length of the sample season was reduced in 1996 from that undertaken in 1995. The season started on March 10 and ended June 5. The trap **was** operated on a five day/week schedule which meant that the trap began fishing on Sunday evening and finished Friday morning at 8:00 AM. We fished for 51 of the possible 63 days which were possible during this period. The scoop trap which we fished at the site this year had undergone substantial renovation during the preseason. We had down time associated with mechanical failures such as chain slippage of the wire belt, sprocket gear stripping on drive shaft, and the paddle wheel losing several blades and becoming unbalanced. These were disruptions associated with operating under the high flow conditions which were present for much of the season.

Fish Handling

1995-96

Just prior to the end of the daily sample period, the collected fish were removed from the livebox of the trap, placed in holding containers, and either processed or transported to shore. The two species remained mixed during holding and were subsequently anesthetized (MS-222) prior to data collection. All fish were counted, species noted and examined for descaling or presence of a PIT tag. Fish that were subsequently marked had their length recorded after insertion of the PIT tag. Fork lengths were recorded for 50 fish each of wild chinook. hatchery steelhead, and wild steelhead each day that total collection numbers were sufficient. Total length for nontarget species **was** also recorded when time permitted.

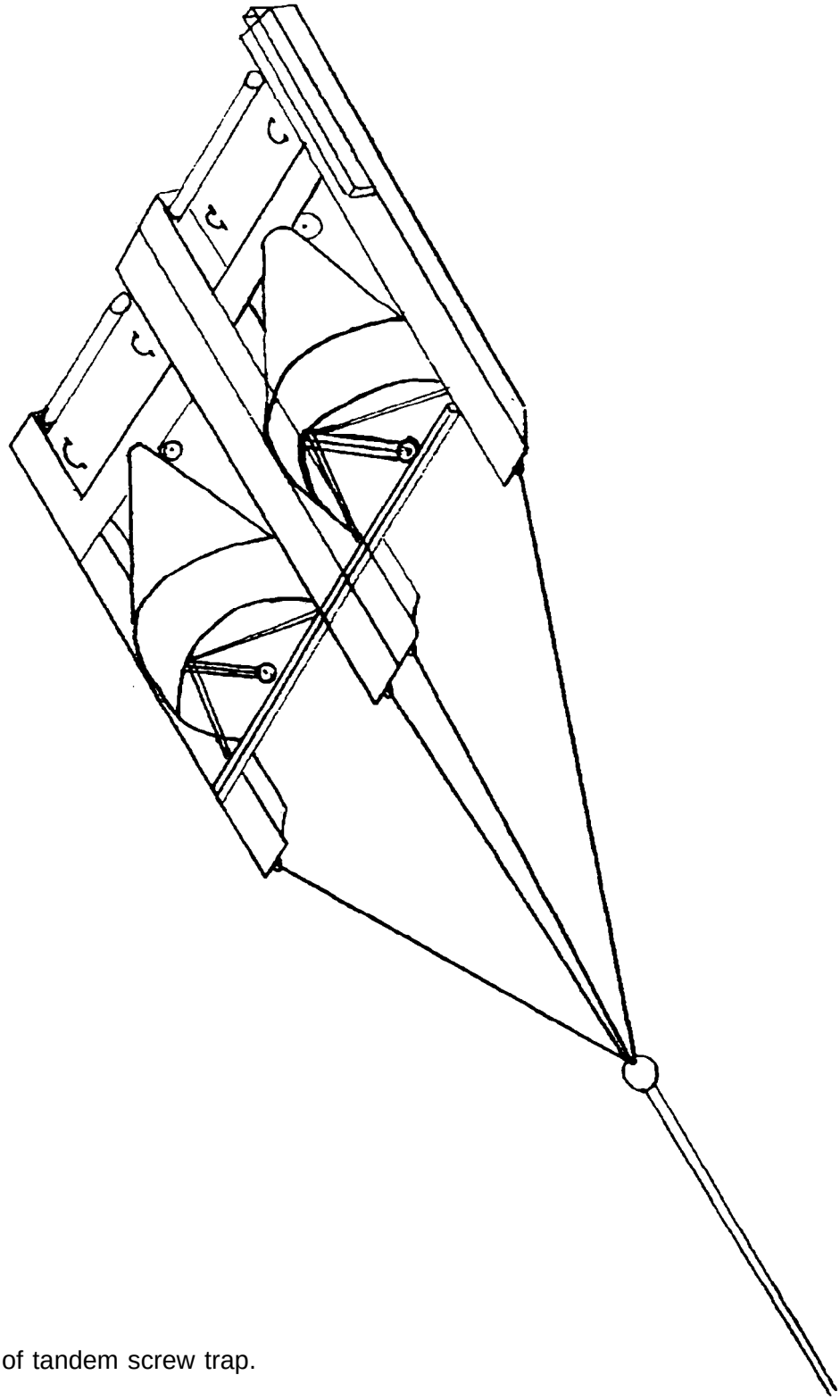

Figure 1. Drawing of tandem screw trap.

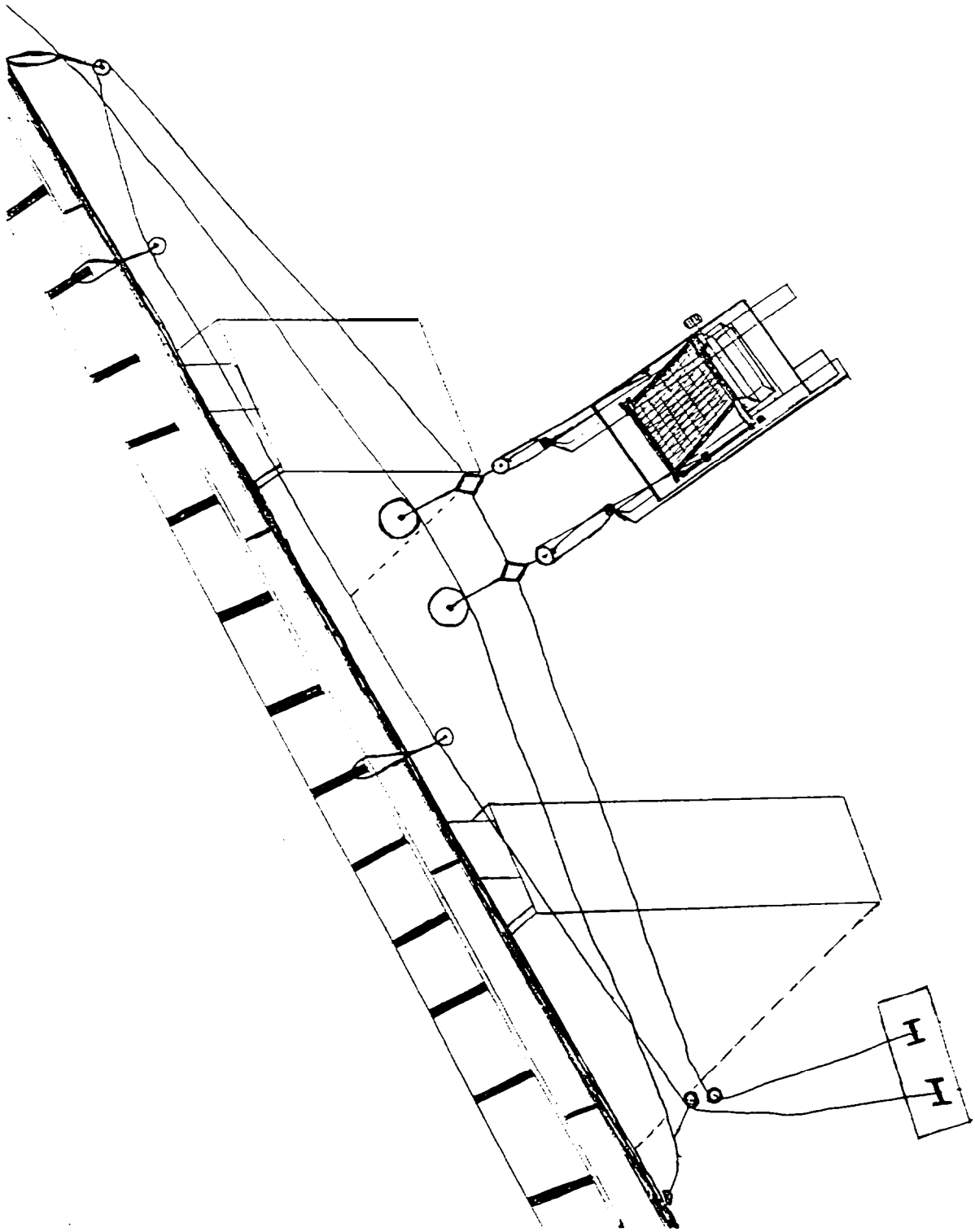

Figure 2. Sketch of cable arrangement and scoop trap mounted on the downstream side of bridge.

Migration Timing and Travel Time

1995-96

We regulated the number of each salmonid subgroup to be PIT-tagged on a daily basis to accomplish a season quota. Hatchery steelhead were an exception because we limited, on a weekly basis, the maximum number that would be tagged. Wild steelhead and wild yearling chinook were restricted from tagging if they appeared stressed or injured and we thought long-term survival was questionable. Tagging for each group **was** initiated once adequate fish were collected within a weekly interval to allow us to meet sample size needs. Hatchery steelhead releases into upper river areas begin in early April. Wild steelhead probably move downstream from April - May. Data on any recaptured PIT tagged fish and all newly tagged fish were electronically transmitted daily for incorporation into the PTAGIS database.

The marked fish provide the opportunity for determining travel time estimates to the Snake River and mainstem Columbia River dams. First observation data is used exclusively as the basis for the travel time estimate to a particular location. The migration rate was calculated (miles/day) for each release group from the Grande Ronde Trap to Lower Granite Dam (LGD). The total distance was divided by the median travel time to provide this estimate. Inflow to Lower Granite Dam was used as the discharge figure but was averaged for each individual fish prior to release group pooling. Release groups were pooled to increase sample size of observations when daily release numbers were relatively low. The wild chinook salmon releases were pooled into intervals for much of the sampling season in order to maintain an observed sample size which minimized error. For wild steelhead. half of the time periods analyzed are pooled release groups in order to keep the sample size of first observations at Lower Granite within a range that minimizes error. The first 4 and last 2 chronological groups for the season are pooled release dates. The remaining 6 intervals are single day release groups. During 1996 hatchery and wild steelhead were pooled due to the low numbers of wild steelhead that were marked. Hatchery steelhead were only pooled for the analysis late in the season when the number marked on a daily basis dropped enough to influence the number observed downstream at the dam. After May 23 - June 15, 1995, released fish were grouped in order to keep the sample size of observations above 20. Confidence intervals (95%) around the median travel time were obtained utilizing a nonparametric method to describe the normal approximation to the binomial distribution. The median travel time and reciprocal of average flow were then used to define a regression line (Berggren and Filardo, 1993).

Observations of marked fish were generally grouped by their release date to provide for a recovery rate by marking period of $n \geq 30$. Exceptions were made when this would become **a** wide interval which exceeded 7 days, and then a recovery sample of $n \leq 30$ was utilized. This recovery sample size grouping procedure allowed a median travel time estimate for the intervals with a minimum of error. For each salmonid subgroup marked each year (wild chinook. wild/hatchery steelhead) the slope of the regression lines were tested using a analysis of covariance procedure (Zar, 1964). If the slopes were equal the null hypothesis **was** accepted and the elevation of the regression lines were tested next. If the null hypotheses was rejected, identifying that the slope of the regression line between years was significantly different, testing ceased. If the slopes were found to be the same, a pooled group **was** formed and a new regression line was defined. A multiple comparison examination statistic **was** also calculated using the Tukey q statistic to test the slope pairs between years within a marked group.

RESULTS
Trap Site Description

Preliminary observations to pick out a permanent smolt trapping site with good laminar flow and a more suitable depth contour was completed. Table 1 shows the suitability measurements for trap operation based on surface velocity, depth, and roughness of the water surface. In addition, a more focused assessment of surface velocity and bottom contour **was** completed by a subcontractor for the pumphouse site.

Table 1. Assessment of suitability for a future trapping site based on three discharge levels, 1995.

	Flow (kcfs)		
Site	7.8	9.9	11.4
1[a]	N	N	N
2[b]	Y	Y	Y
3[c]	N	N	N
4[d]		Y	

[a] Site 1 on bend, below octagonal house (RM 0.5)
[b] Site 2 pumphouse (RM 0.8)
[c] Site 3 below county bridge **(RM 2.4)**
[d] Site 4 upstream of pig farm (RM 3.1). Site 4 was not examined again after the initial survey in 1995 due to the unwillingness of the property owner to even consider its use as **a** future potential trap site.

Trap Efficiency

Based on recoveries of the Panjet marked hatchery chinook at the screw trap (1995), it appears that at flows of 6.1 - 7.5 kcfs the trap efficiency ranges from 1.2 - 1.8%. The higher catch efficiency during 1995 was at the lower discharge levels which was similar to results we obtained in 1994.

Fish Handling

The 1995 season tagging totals were 1,240 wild chinook, 816 hatchery steelhead, and 656 wild steelhead. The numbers for 1996 were much reduced. The total numbers tagged during 1996 were 123 wild steelhead, 542 hatchery steelhead, and 28 wild chinook. Fifty percent outmigrant passage occurred on April 25 for wild chinook, April 23 for hatchery steelhead. and April 25 for wild steelhead at the lower Grande Ronde trap. Figures 3-5 show our daily fish collection during 1995 and figures 6 and 7 show the daily fish collection in 1996 for each group. Due to the low overall collection for the 1996 season with the different trap at the Boggan's site it was not appropriate to define passage indice landmarks for the various species on their downstream migration out of the Grande Ronde River.

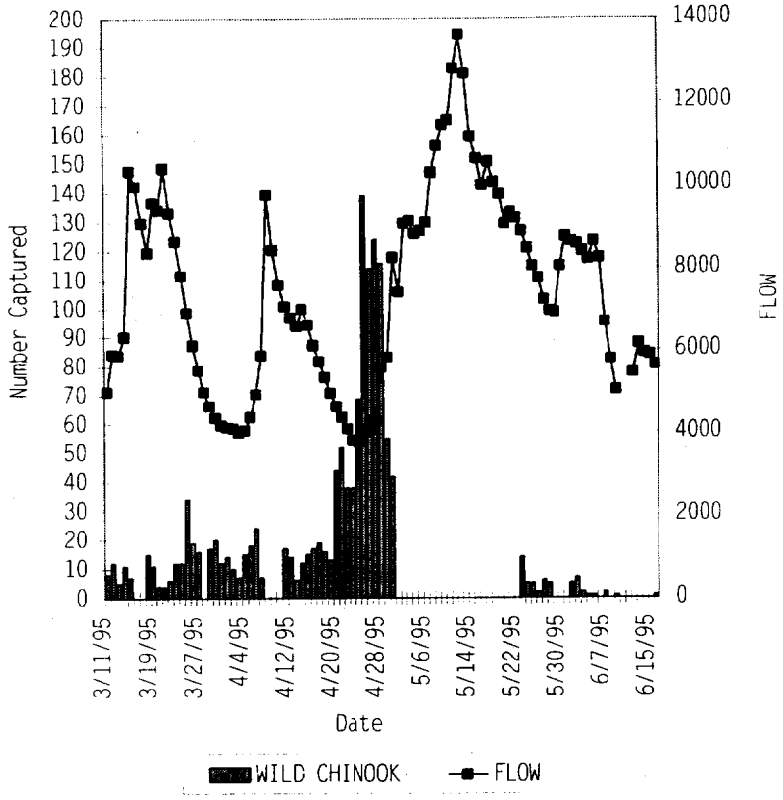

Figure 3. Daily collection of wild chinook salmon and flow on the Grande Ronde River in 1995.

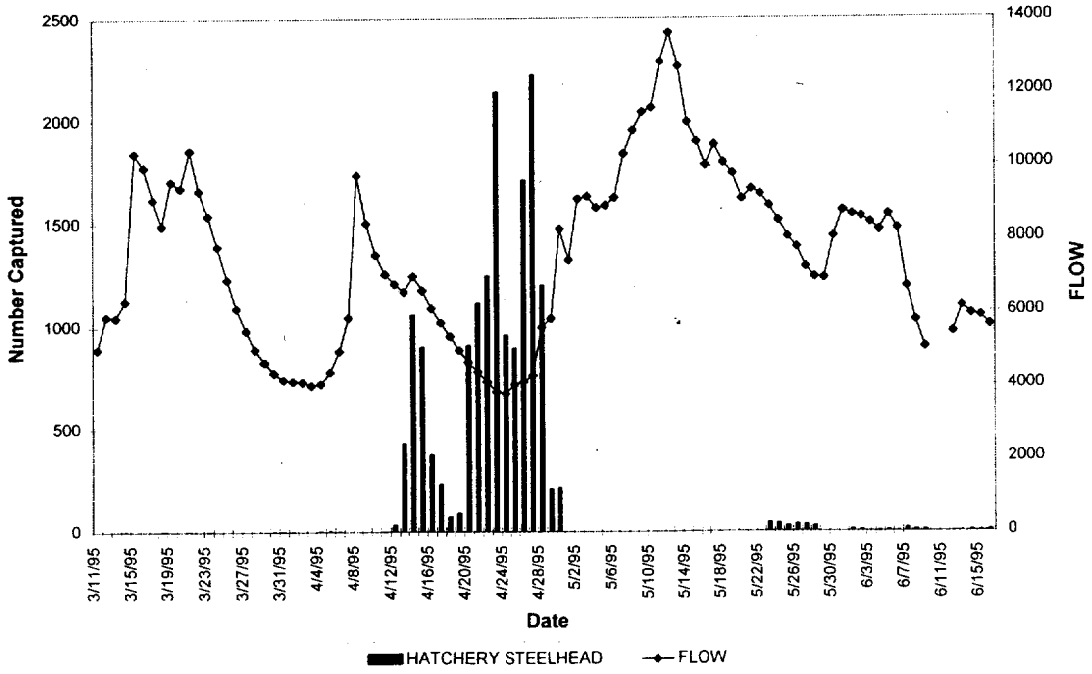

Figure 4. Daily collection of hatchery steelhead and flow on the Grande Ronde River in 1995.

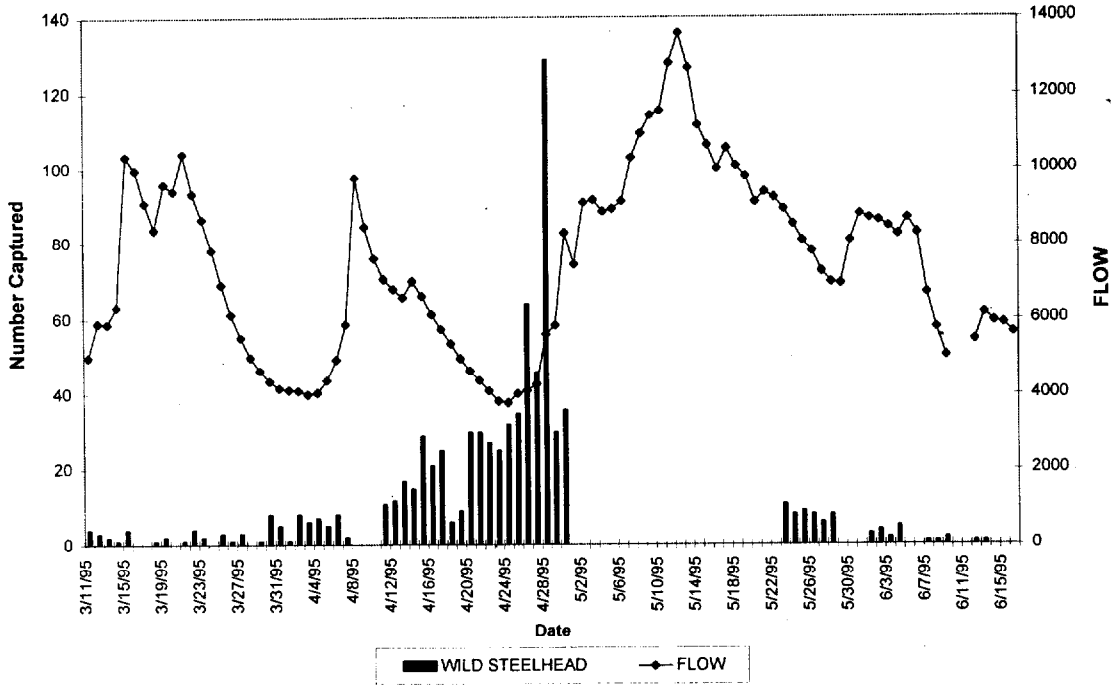

Figure 5. Daily collection of wild steelhead and flow in the Grande Ronde River in 1995.

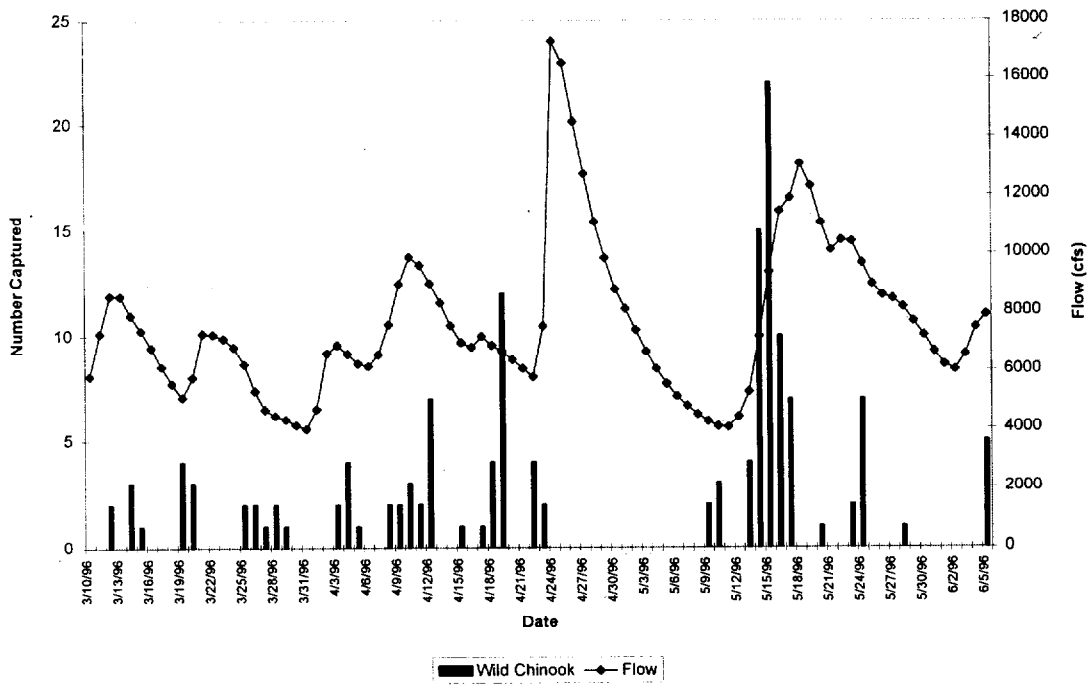

Figure 6. Daily collection of wild chinook salmon and flow in the Grande Ronde River in 1996.

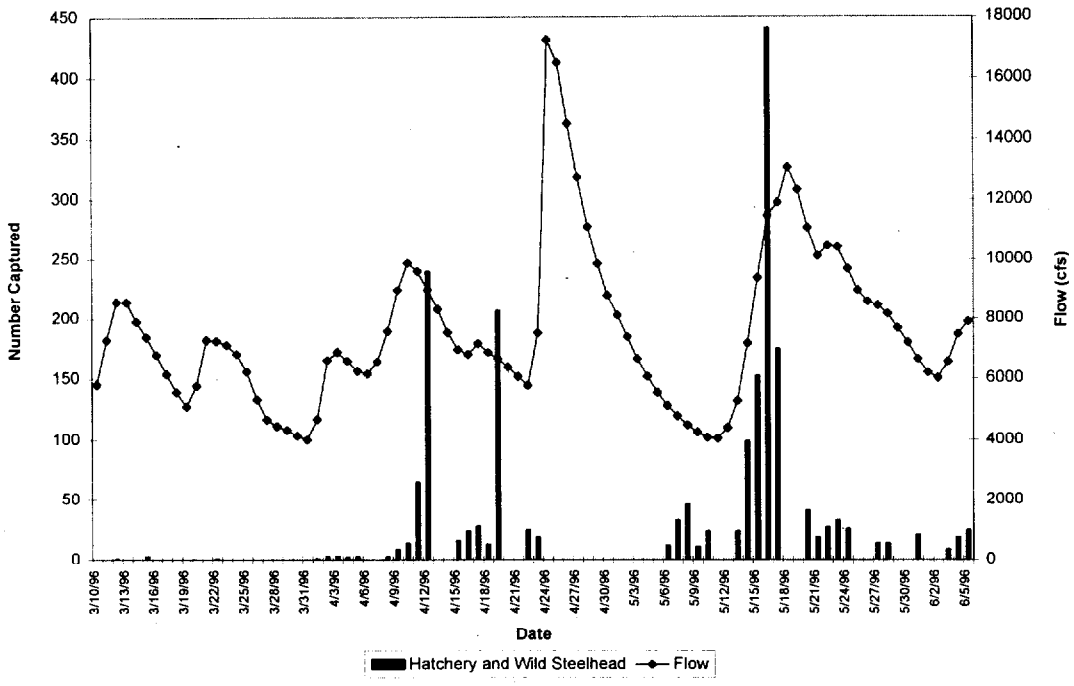

Figure 7. Daily collection of hatchery/wild steelhead and flow in the Grande Ronde River in 1996.

Total collection of salmonid smolts was 19,643 during 1995. Descaling rates in 1995 for wild chinook were 0.96%, wild steelhead were 2.0%, and hatchery steelhead were 2.6%. Mortality at trap site was 1.5% for wild chinook, 0.34% for hatchery steelhead, and 1.15% for hatchery chinook salmon. No trap mortalities of wild steelhead were recorded. Length frequency of fish marked and released from the Grande Ronde trap in 1995 are presented in Figures 8-10.

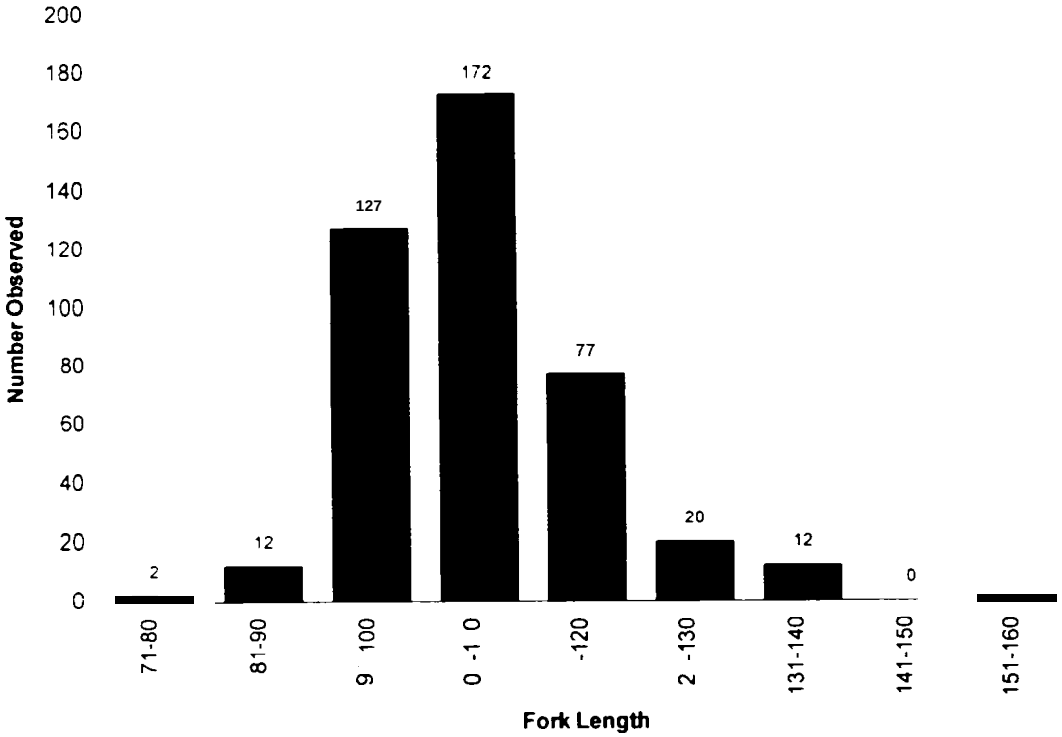

Figure 8. Length frequency distribution of wild chinook salmon captured, marked, and released on the Grande Ronde River in 1995.

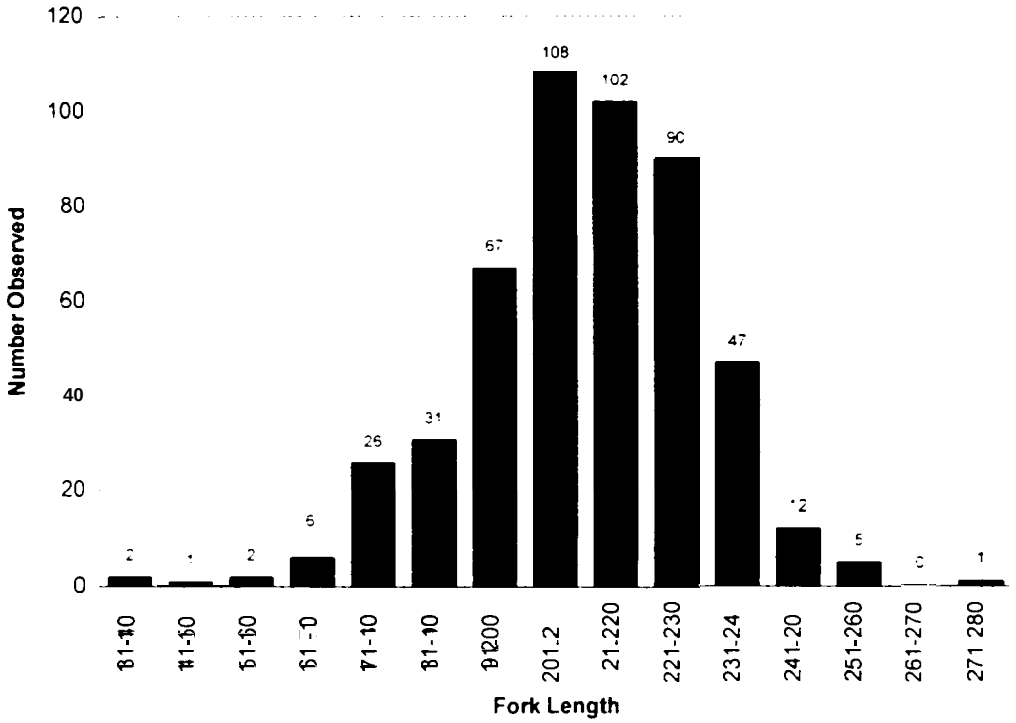

Figure 9. Length frequency distribution of hatchery steelhead captured, marked, and released on the Grande Ronde River in 1995.

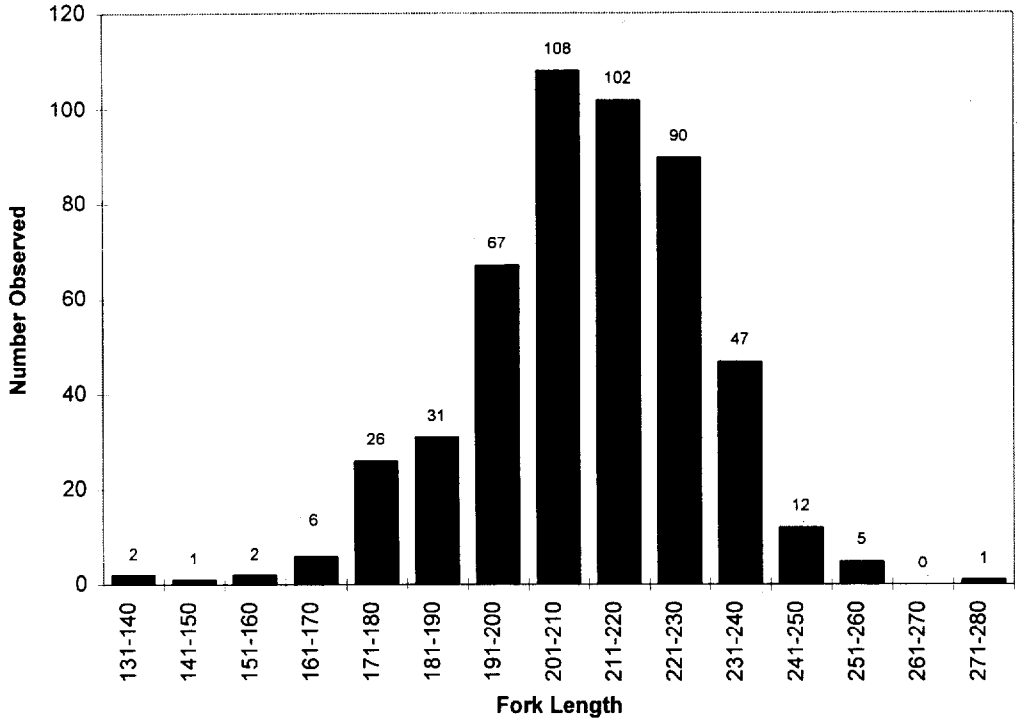

Figure 10. Length frequency distribution of wild steelhead captured, marked, and released on the Grande Ronde River in 1995.

The total fish collected in 1996 using the different trap design in a higher flow year was substantially reduced in comparison to 1995. The total collection for 1996 of all salmonids was 2,171. The wild chinook salmon collection was 148, the hatchery steelhead was 1,745, and the wild steelhead was 200. Descaling rates in 1996 were 2.0% for wild chinook, 2.3% for hatchery steelhead and 1.5% for wild steelhead. The length frequency distribution of the steelhead marked at the Grande Ronde trap during 1996 is presented in Figures 11 and 12.

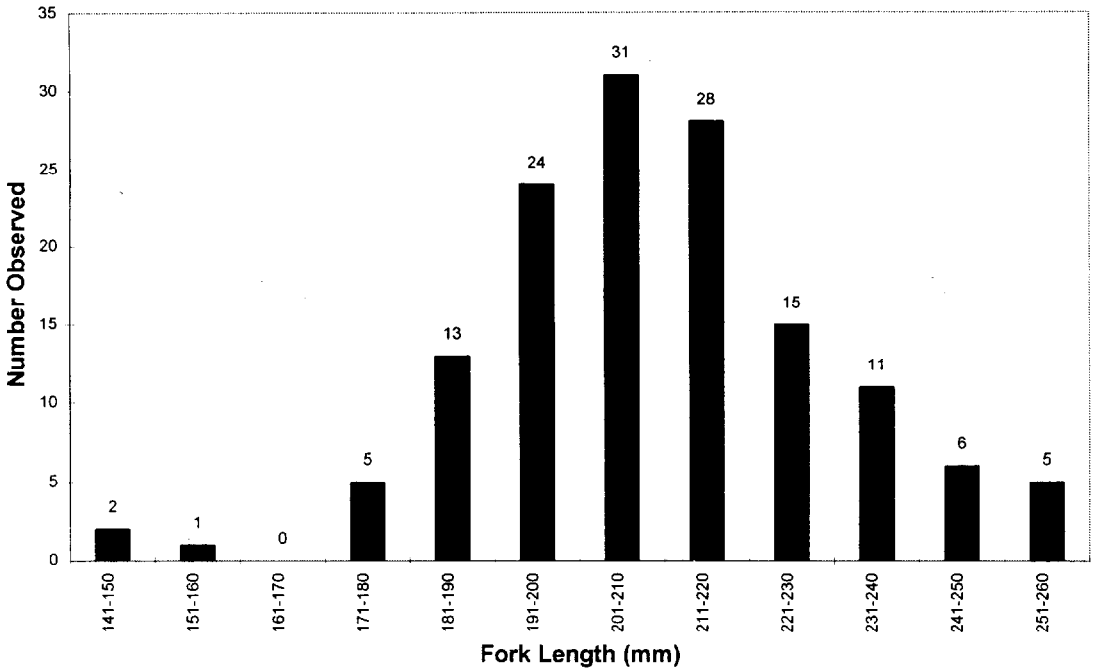

Figure 11. Length frequency distribution of hatchery steelhead captured, marked, and released on the Grande Ronde River in 1996.

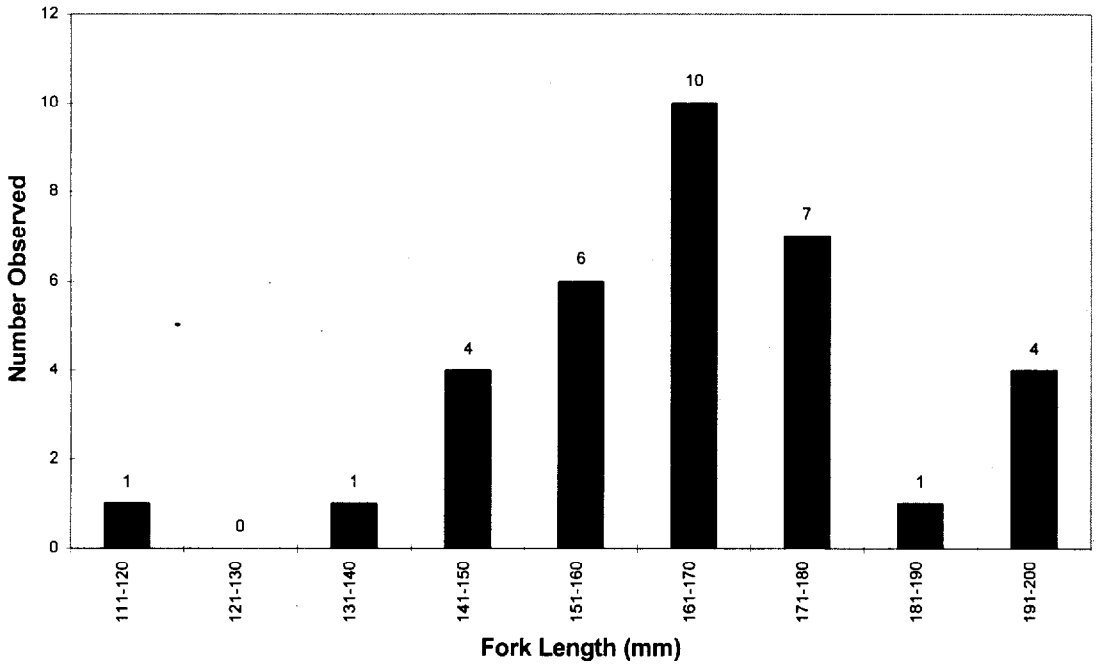

Figure 12. Length frequency distribution of wild steelhead captured, marked, and released on the Grande Ronde River in 1996.

Migration Timing and Travel Time

The total number of fish marked has varied substantially over the years of trap operation (Table 2). The percentage of PIT-tagged fish observed at Lower Granite Dam has been relatively similar for hatchery/wild steelhead for **all** years (1994-1996). However, the. percentage observed for wild chinook salmon has varied substantially between years. The rate at Lower Granite in 1995 was almost twice that observed in 1994. More hatchery steelhead have been marked during each season than their wild counterpart. The percentage recovered in 1996 was the lowest recorded for any group across all years. This low percentage of observations coincided with a high flow year where spill occurred throughout the peak of the downstream migration period. The highest percentage of first observations for all three marked groups has been at Lower Granite Dam (Table 3).

Table 2. Number of fish PIT tagged by species at Boggan's Oasis in 1994-1996 and subsequently observed downstream. Percent is presented in parenthesis.

Species	Number	Number Observed			
Year	tagged	1994	1995	1996	Total
Wild steelhead					
1994	1,140	554(48.6)	30(2.6)		584(51.7)
1995	656		456(69.5)	2(0.3)	458(69.8)
1996	123			57(46.3)	57(46.3)
Hatchery steelhead					
1994	1,602	835(52.1)	18(1.1)		853(53.2)
1995	816		605(74.1)	1(0.1)	606(74.3)
1996	542			232(42.8)	232(42.8)
Wild chinook					
1994	872	284(32.6)	6(0.7)		290(33.3)
1995	1,240		754(60.8)		754(60.8)
1996	28			2(7.1)	2(7.1)
Hatchery chinook					
1994	391	219(56.0)			219(56.0)
1995					
1996					

Table 3. Location and number of first time observations of PIT tagged chinook salmon and steelhead that were marked on the Grande Ronde River, 1994-1996.

Species Year	Number observed McNary	Lower Monumental	Little Goose	Lower Granite
Wild chinook				
1994	47	43	56	144
1995	38	105	189	422
1996	0	1	0	1
Hatchery steelhead				
1994	53	57	102	641
1995	7	40	56	502
1996	1	32	57	141
Wild steelhead				
1994	14	102	50	418
1995	8	53	37	358
1996	0	14	10	33

Wild Chinook Salmon

1995:

Migration rate, travel time, and percent observation for wild chinook salmon tagged in 1995 are presented in Table 4. Total fish collected and flow is presented in Figure 13. Tagging of wild chinook **was** initiated on March 26. The fastest travel time from the trap site to Lower Granite Dam (LGD) was 2.9 days. This fish left the trap site in the Grande Ronde River when flow was 8.3 kcfs (4.4°C) and Snake River flow at Lower Granite Dam was averaging 84.5 kcfs. The slowest migrating wild chinook salmon took 39.7 days to reach LGD. The flow out of the Grande Ronde drainage was 4.6 kcfs (5.0°C) and the Snake River was averaging 64.2 kcfs at LGD. The highest collection numbers of wild chinook salmon occurred from April 20 through April 30. River discharge began increasing following this time interval and the duration of the peak collection period may have been narrowed due to reduced trap efficiency at higher flows. We did not observe an early migration peak in mid-late March as we anticipated. Wenaha River chinook are known to be early outmigrants and it was hoped that we could distinguish their movement and recover some specific information on this stock. Walters et al. (1993) found Wenaha chinook salmon marked as parr were observed primarily between April 15 and May 15 at LGD. The dates of 10%, 25%, and 50% passage at LGD were April 17, April 29, and May 2 during 1995 for wild chinook salmon yearling smolts marked at the Lower Grande Ronde trap.

The percentage observation at Lower Granite of wild chinook salmon ranged from a low of 26.7 to a high of 50. The average was 36.5% for all groups combined. The median travel time and 95% confidence intervals are shown in Table 4. The range of median travel times was

from a low of 6 days at an average flow of 84.1 kcfs into Lower Granite Dam to **a** high of 21.9 days at an average flow of 53.5 kcfs. The mean travel time for all wild chinook over the season was 10.7 days.

The regression of median travel time (y) against the reciprocal of flow (x) had an R^2 of 0.36 and was significant at $p < .05$ level. This indicated that the relationship was not particularly strong and could not be well described using a linear relationship.

When we removed the three groups with sample sizes lower than 20 observations from the analysis an even stronger relationship ($R^2 = 0.77$) with a highly significant p value ($p < .0001$) was obtained. These three groups experienced the highest average flow through their travel period.

The relationship between the two variables was improved by eliminating the two late pooled release groups, both of which had small sample sizes. The R^2 value increased to 0.68 and the p value ($p < .001$) was highly significant. The average flows at the time these two groups were migrating were considerably higher than all other groups. In addition, there was spill occurring during these last two periods which undoubtedly changed the water movement pattern approaching the face of the dam as well **as** some distance upstream.

1996:

The number of wild chinook salmon collected and flow in 1996 is presented in Figure 14. During 1996, 28 chinook were marked during a three day interval and two of these were observed downstream passing through the Snake River dam system. Travel time was 1.8 days to Lower Granite Dam (Avg. flow 149.9 cfs) and 13.1 days to Lower Monumental (Avg. flow 155.9) based on the one observation at each site. The flow in the Grande Ronde River at release was 9.4 cfs, and the surface water temperature was 12.2°C. We believe that the operation of a scoop trap at this same site may have accentuated fish avoidance, however this may have been an unrelated effect of the high flows reducing trapping efficiency.

Hatchery Steelhead

1995:

The number of hatchery steelhead collected in 1995 and flow is presented in Figure 15. Migration rate, travel time, and percent observation is presented in Table 5. Similar to chinook, the analyses was based on first observation of PIT-tagged fish at Lower Granite Dam. Hatchery steelhead were first PIT-tagged on April 13. The fastest travel time to Lower Granite Dam for a fish released June 4, 1995 **was** 1.6 days. Average Snake River flow at the dam was 146 kcfs and the discharge from the Grande Ronde River was around 8.2 kcfs with a water temperature of 12.8°C. The slowest hatchery steelhead had a travel time of 34.4 days and **was** marked at the trap on May 23. Average flow at LGD was 110 kcfs and in the Grande Ronde River was 8.9 kcfs at 11°C. Peak collection of hatchery steelhead at the screw traps followed numerous releases into the Upper Grande Ronde River basin from Wallowa, Big Canyon, and Irrigon hatcheries and volitional releases from the Cottonwood Acclimation Facility. During the period April 13 through April 30 hatchery steelhead dominated collections each day. The median passage dates at LGD based on 10%. 25% and 50% passage were April 22, April 26, and May 2. respectively.

The lowest percent observed for a release period was 50.7% and the highest was 76%. The highest percentage of observations occurred twice during the season at two very different average flows. The 95% confidence intervals around the median travel time are shown in Table 2. The average travel time for hatchery steelhead throughout the season was 8.5 days.

The regression line fitted as described for wild chinook using all data points, had an R^2 of 0.45 and was significant at $p<.01$. When the four pooled groups released during high flows were removed the R^2 dropped to 0.27 and $p < 0.1$, suggesting a non-significant relationship. This was contrary to what was observed for wild chinook.

Wild Steelhead

1995:

The number of wild steelhead collected and flow is presented in Figure 16. Migration rate, travel time, and percent observation for wild steelhead are presented in Table 6. The PIT tag marking of wild steelhead was initiated on April 15. The peak collection period was April 11 through April 30. The date of highest daily collection was April 28. Two fish shared the fastest travel time of 2.6 days. Flow to Lower Granite was roughly the same but the discharge out of the Grande Ronde River was markedly different for these two fish. The fish marked on April 28 left on 5.5 kcfs at 10.6°C while the fish marked and released on April 30 left with 8.3 kcfs at 7.8°C out of the Grande Ronde River. The slowest travel time was 38.7 days and flow out of the Grande Ronde River on April 20 was 4.6 kcfs and 6.7°C while flow to the dam averaged 96.7 kcfs. It would be interesting to know where this fish spent so much time prior to being interrogated at LGD. This could only be resolved if the fish had also been fitted with a radio tag. The 10%, 25% and 50% passage dates for this group through Lower Granite Dam in 1995 were April 26. April 29, and May 1. respectively.

The median travel time varied between 4 days and 7.9 days. The mean travel time for all wild steelhead during the 1995 season was 7.0 days. The average percent of observations varied from 33.3 to 75 with **a** mean of 58.8. The linear regression line calculated using travel time versus reciprocal of flow had an R^2 value of 0.49 and a p value of 0.01. The regression line was significant. The flows into Lower Granite were below spill volume except for the last two groups included in the analyses. Elimination of these two groups reduced both the R^2 and significance level, again contrary to what occurred with the wild chinook. The sample size for' the last group was very small ($n=6$) and when it was dropped from the analysis both the R^2 and its significance level were only reduced slightly.

Hatchery/Wild Steelhead

1996:

The number of hatchery and wild steelhead collected in 1996 and flow is presented in figures 17 and 18, respectively. Migration rate, travel time, and percent observation for hatchery and wild fish combined is presented in Table 7. As reported earlier, this summarization focused only on observations to Lower Granite Dam and was pooled due to the small number of wild steelhead collected. The fastest travel time observed (1.5 days) was from fish released on May 16 when the average flow in the Snake River at Lower Granite Dam was 160.4 cfs. The water temperature at the trap site was 11 .1°C and the Grande Ronde River flow

was 11.2 cfs. The slowest fish observed from the 1996 release was marked on May 20 and spent 21.3 days traveling to Lower Granite Dam (Avg. Snake River flow = 158.3). The Grande Ronde was discharging 12.1 cfs with a surface water temperature of 10.0°C. The passage date for 10%. 25%, and 50% of hatchery steelhead at Lower Granite was May 15, May 17, and May 18, respectively.

Hatchery and wild steelhead were tagged as a combined group in 1996 due to the low numbers of wild steelhead collected daily. Six pooled tagging intervals were identified with only the last having a sample size of less than 25 fish (Table 5). The percentage observed at Lower Granite was reduced in 1996 in comparison to 1995. Spill at Lower Granite occurred for the entire period of outmigration in 1996. The percentage observed for all pooled release intervals were generally close and ranged between 21.7% and 36% Interestingly, these upper and lower percentages were inversely related to average Snake River flow to Lower Granite Dam (Table 5). Table 5 shows the 95% confidence intervals around the median travel time. For the year 1996. the average travel time for a marked steelhead from the Grande Ronde trap to arrive at Lower Granite Dam was 4.1 days.

Table 4. Summary of information related to wild chinook smolts tagged in 1995 on the Grande Ronde River

Date	Mean fork length	Percent observed at LGD	Number observed	Number released	Travel time (days)			95% C.I.		Flow (kcfs)
					Min	Med	Max	Lower	Upper	
03/26-03/29	97.3	0.33	20	61	12.3	21.9	39.7	20.2	26.8	53.5
03/30-04/02	102.1	0.27	24	90	11.2	17.7	37.3	12.8	19.5	55.1
04/03-04/06	107.4	0.32	30	94	5.5	11.4	31.8	9.8	15.4	60.9
04/11-04/14	101.4	0.5	24	48	6.5	14.8	39.5	11.7	17.2	67.4
04/15-04/18	100.9	0.38	25	65	6.1	13.9	36.7	10.4	16.3	68.3
04/19-04/20	111.3	0.42	23	55	5.4	10.3	18.8	8.7	11.5	65.5
04/21	109.2	0.39	20	51	6	10.3	20.7	8.8	11.4	68.5
04/22-04/23	106.4	0.32	24	74	5.6	9.2	15.3	7.5	10.7	71.7
04/24	106.7	0.42	29	69	4.5	7.4	13.8	6.6	7.8	69.9
04/25	105.9	0.37	50	137	4.7	6.8	21.3	6.4	7.6	76
04/26	105.2	0.33	35	107	4.2	6.1	13.1	5.4	6.9	78.3
04/27	111.9	0.29	31	108	3.6	6.6	15.2	4.9	7.8	82.6
04/28	107.5	0.43	53	124	3.8	6	12.3	5.1	6.8	84.1
04/30	101.8	0.33	13	39	2.9	6.7	19.8	5.4	11	94.5
05/23-05/28	111.8	0.36	13	36	5.7	9	19.9	7.1	11.6	121.3
06/01-06/09	103.7	'0.39	7	18	4.7	12.4	15.8	4.7	15.8	130.8

Table 5. Summary of information related to hatchery steelhead smolts tagged in 1995 on the Grande Ronde River

Date	Mean fork length	Percent observed at LGD	Number observed	Number released	Travel time (days) Min	Med	Max	95% C.I. Lower	Upper	Flow
04/13	213.4	0.52	26	50	3.4	7.5	25.5	4.9	12.8	68.9
04/14	209.4	0.64	32	50	3.5	9.0	30.9	7.1	17.5	70.0
04/15	219.0	0.64	32	50	3.5	10.2	21.1	6.7	15.1	67.8
04/16	214.2	0.7	35	50	3.7	9.8	22.8	5.9	13.4	66.7
04/18	211.3	0.76	38	50	3.5	11.9	21.4	6.3	13.8	65.3
04/19	211.8	0.68	34	50	2.6	7.2	20.2	5.9	10.2	63.9
04/20	210.4	0.7	35	50	2.6	5.5	26.7	4.7	6.8	65.3
04/21	210.1	0.54	27	50	3.5	6.6	25.0	4.7	10.3	64.5
04/25	207.2	0.74	37	50	4.0	6.8	24.3	5.8	7.6	76.9
04/26	210.0	0.68	34	50	4.2	6.4	17.2	5.2	7.2	79.0
04/27	202.2	0.72	36	50	3.4	5.3	28.3	4.5	6.6	82.2
04/28	189.3	0.52	26	50	2.9	5.1	17.0	4.2	5.6	82.8
05/23-05/24	209.2	0.6	28	47	2.6	5.9	34.4	3.9	9.9	116.5
05/25-05/27	208.7	0.51	35	69	2.6	4.4	23.8	3.7	5.9	111.0
05/28-06/07	200.3	0.64	25	39	1.6	4.8	22.6	3.7	6.8	125.5
06/08-06/15	220.5	0.76	19	25	1.8	4.6	12.3	3.2	6.2	116.8

Table 6. Summary of information related to wild steelhead smolts tagged in 1995 on the Grande Ronde River

Date	Mean fork length	Percent observed at LGD	Number observed	Number released	Travel Time (days) Min	Med	Max	95% C I Lower	Upper	Flow (Kcfs)
04/15-04/16	173.0	0.65	33	51	3.5	7.6	21.4	7.6	13.1	66.7
04/17-04/19	172.4	0.53	21	40	3.7	7.9	16.0	5.5	13.7	64.5
04/20-04/21	175.2	0.62	37	60	3.6	7.9	38.7	5.6	8.5	63.3
04/22-04/23	171.2	0.64	33	52	3.7	6.9	15.2	5.4	7.7	64.5
04/24	175.7	0.75	24	32	3.8	5.3	11.7	4.4	7.5	67.1
04/25	173.4	0.74	25	34	4.3	6.6	9.4	5.3	6.4	73.2
04/26	173.2	0.49	31	63	3.5	5.2	7.4	4.6	5.6	76.1
04/27	167.5	0.63	29	46	3.5	7.8	20.3	4.5	5.6	80.1
04/28	145.0	0.63	72	115	2.6	5.4	11.2	4.0	4.7	90.0
04/30	169.6	0.47	17	36	2.6	4.0	7.5	2.9	4.9	86.8
05/23-05/28	164.0	0.59	29	49	2.7	4.7	11.2	3.6	6.6	114.5
06/01-06/12	165.4	0.33	6	18	3.0	4.7	10.9	3.5	10.9	129.6

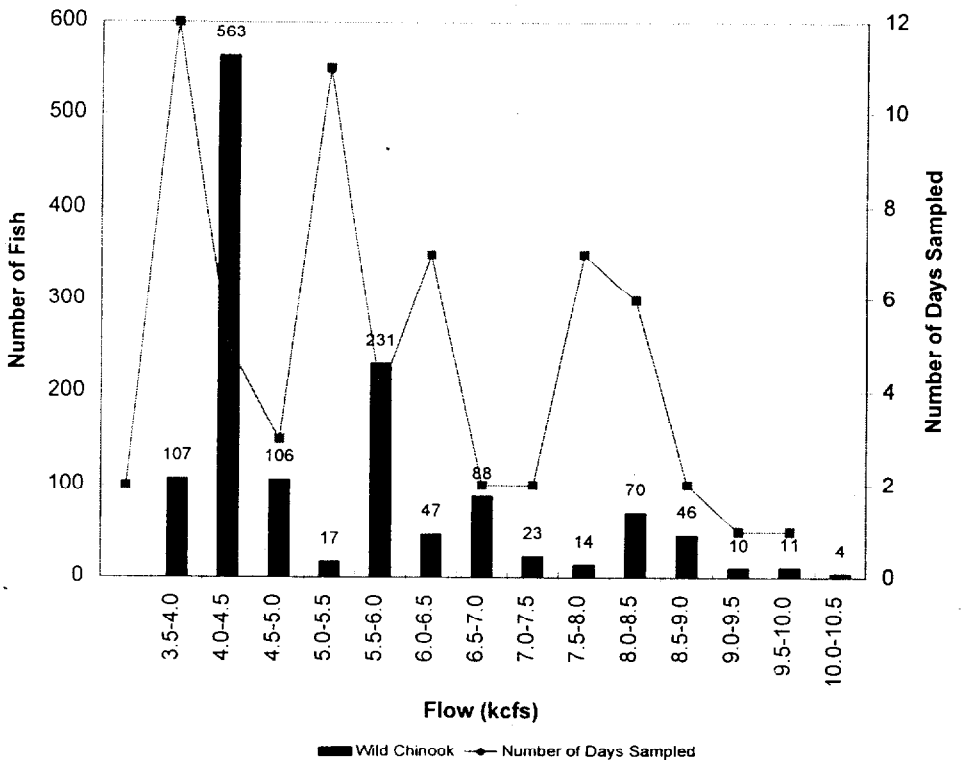

Figure 13. Total collection of wild chinook salmon and flow at the Lower Grande Ronde River trap during 1995.

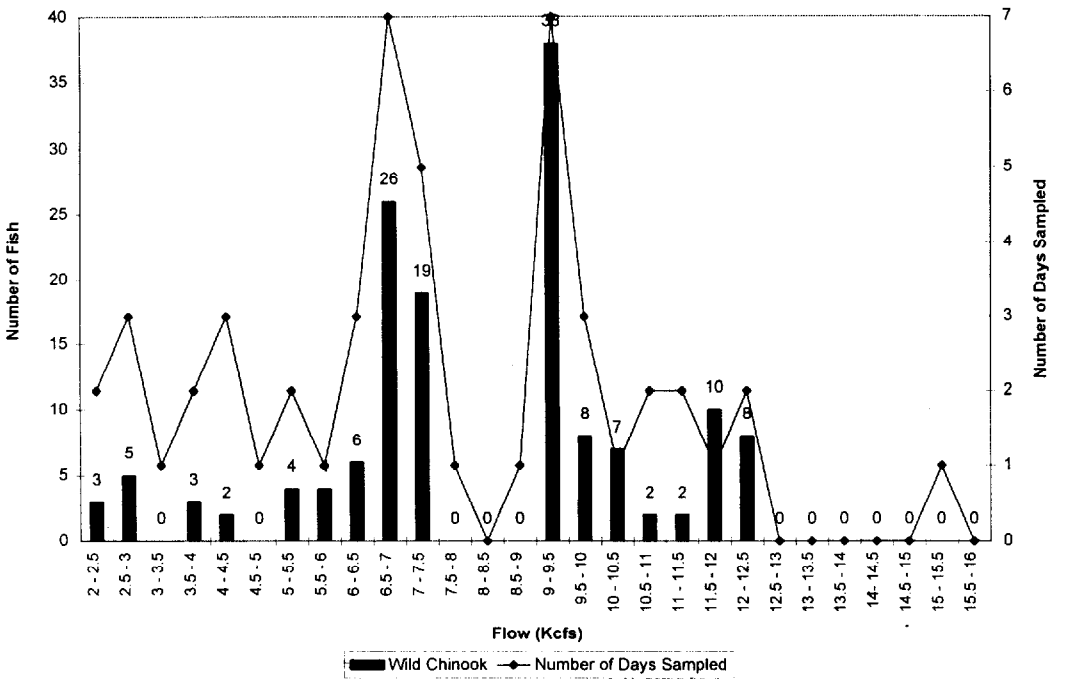

Figure 14. Total collection of wild chinook and flow at the Grande Ronde River trap during 1996.

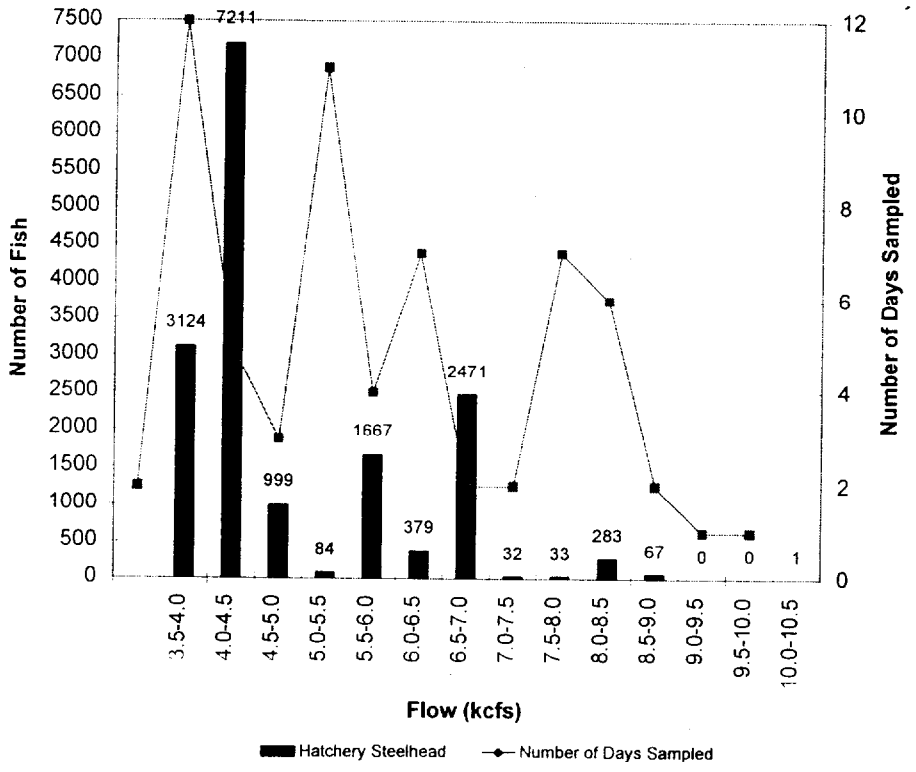

Figure 15. Total collection of hatchery steelhead and flow at the Lower Grande Ronde River trap during 1995.

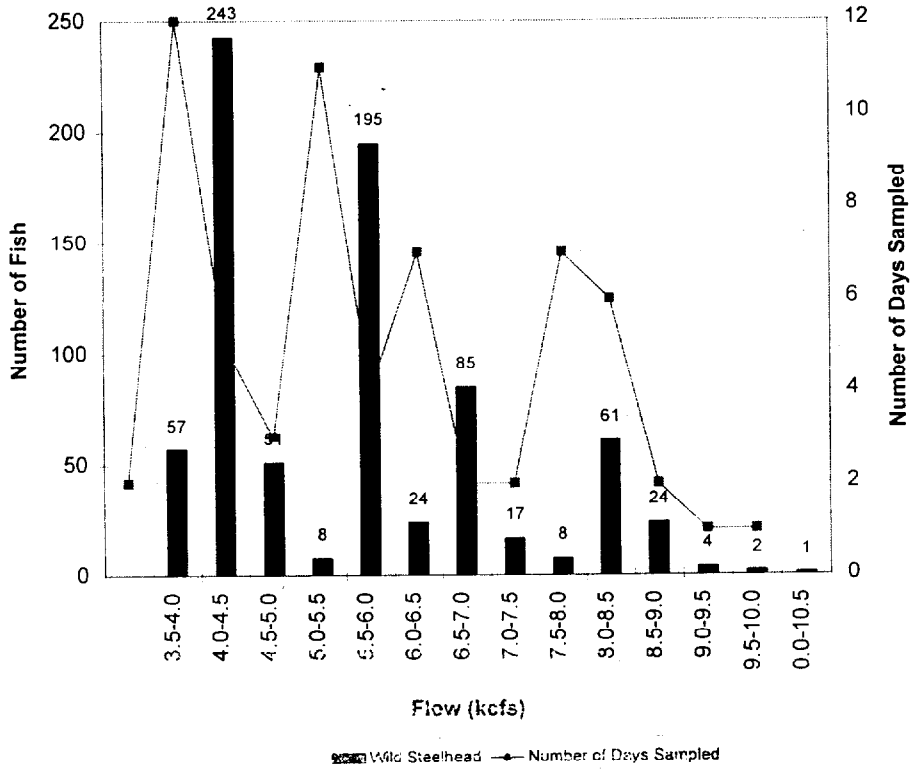

Figure 16. Total collection of wild steelhead and flow at the Lower Grande Ronde River trap during 1995.

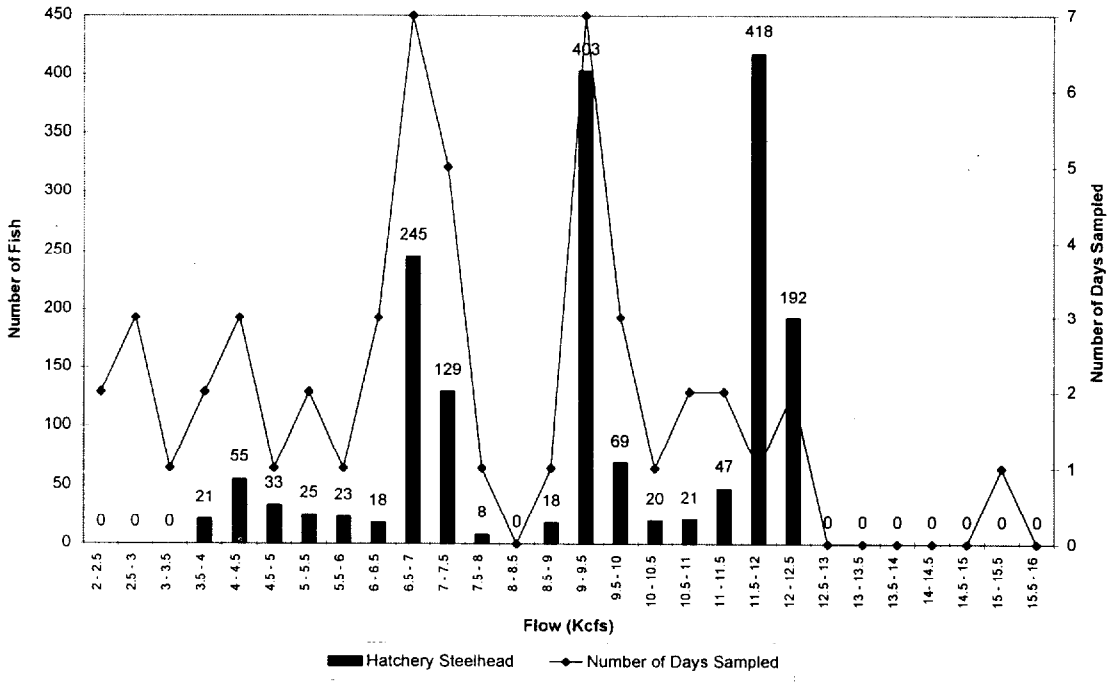

Figure 17. Total collection of hatchery steelhead and flow at the Lower Grande Ronde River trap during 1996.

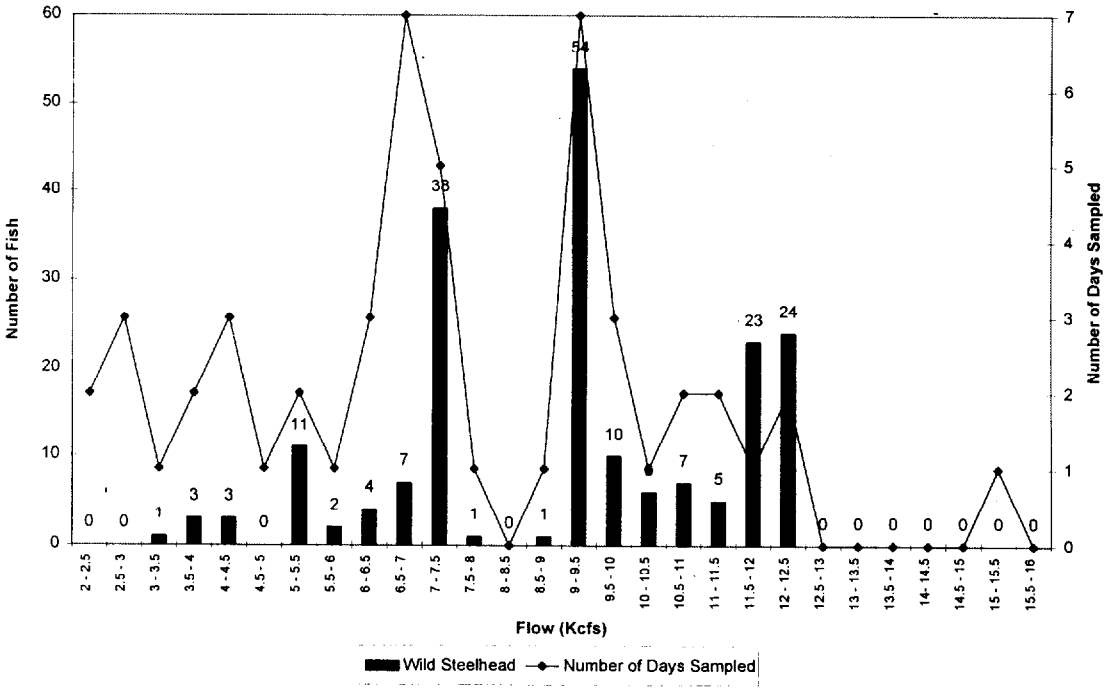

Figure 18. Total collection of wild steelhead and flow at the Lower Grande Ronde River trap during 1996.

Table 7. Summary of information on wild/hatchery steelhead tagged in 1996 at the Grande Ronde River trap.

Date	Mean fork length	Percent observed at LGD	Number observed	Number released	Travel time (days) Min.	Med.	Max.	95% C I Lower	Upper	Flow (cfs)
05/08-05/10	205.2	35.0	27	77	4.76	5.81	8.5	5.33	7.61	99.9
05/13-05/14	200.2	28.7	27	94	2.07	2.32	2.67	2.90	2.24	133.4
05/15	195.8	24.0	30	125	1.95	2.09	2.41	1.98	2.84	151.9
05/16-05/17	203.9	19.2	33	172	1.91	2.28	2.85	2.22	4.04	170.7
05/20-05/24	195.8	27.5	41	149	2.55	2.86	3.52	3.3	6.28	146.9
05/27-06/03	213.4	29.1	16	55	2.53	4.98	7.9	3.6	7.66	148.7

Other Species

A variety of other species have been collected over the past two years of trap operation at Boggan's Oasis. This broad classification covers all fish other than chinook salmon and steelhead/rainbow trout. The overall diversity was broader as indicated by a greater number of species and the higher collection in 1995 (n=1756) compared to 1996 (n= 38). Since this data is collected ancillary to that of downstream migrant salmonids. it is included here primarily as additional information to illustrate the diversity of species being collected (Figure 19).

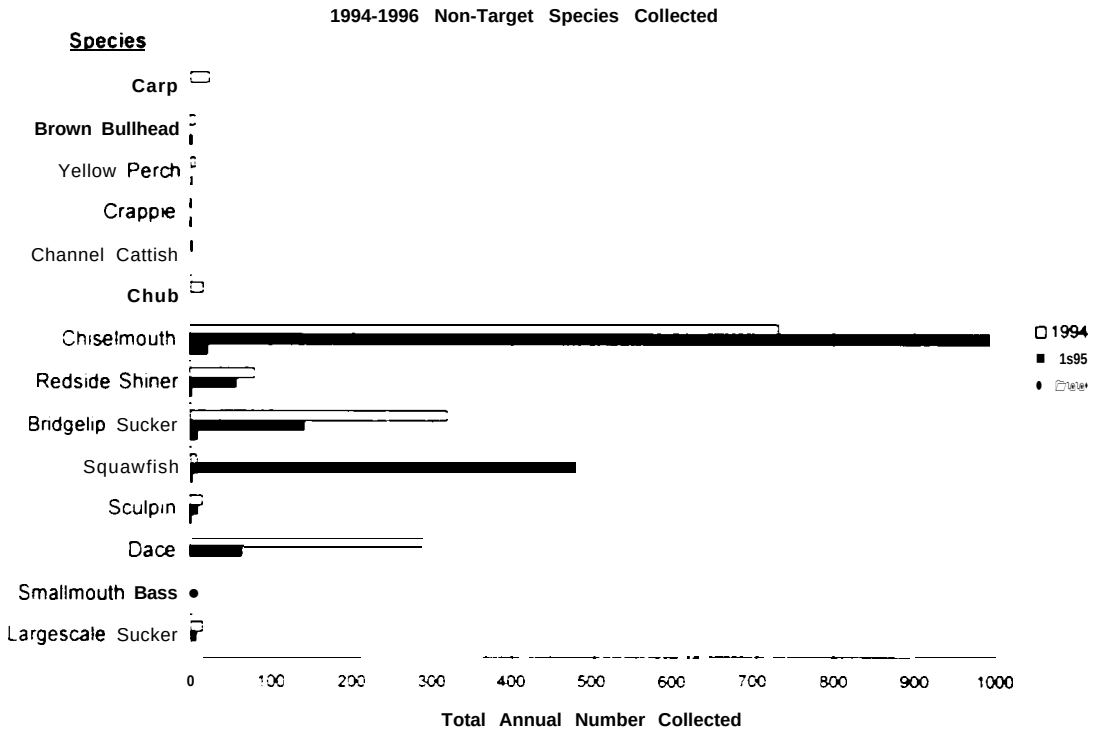

Figure 19. Summary of other species collected in 1994-1996 at the Grande Ronde River Trap.

DISCUSSION

Analyses of first observations for both salmonid species indicates that steelhead are consistently observed at a higher rate than chinook salmon. As we are able to document observation rates in years of high flow and spill versus those with low flow and spill, we may better understand the effectiveness of spill for passing downstream migrants. The median travel time between Boggan's Oasis and Lower Granite Dam is influenced by the Grande Ronde and, subsequently, the Clearwater and Snake rivers. Flow control, manipulated by dams upstream of the main migration corridor. play a role in influencing travel time. Several factors other than flow have also been shown to influence migratory timing of smolts moving downstream. Water temperature is a variable of importance influencing migration (Wedemeyer et al., 1980). Higher water temperatures can stall fish, initiate reversion from smolt or provide impetus to move quickly (Folmar and Dickoff. 1980). Colder water temperatures can delay both outmigration and the physiological changes that allow **a** smolt to prepare for saltwater transition

The temperature experienced after leaving the Grande Ronde River often is a result of water management manipulations upstream from the variety of storage reservoirs.

Our inability to collect data from May 1 - May 22 in 1995 compromised our ability to assess travel time and migration patterns. At the beginning of this downtime period we were in the middle of our peak collection for both wild chinook salmon and wild steelhead. The velocity into the screw traps was too swift when flows were above 9.200 cfs to allow fish collection without trap damage and high descaling rates on fish. The time interval when fish were marked was narrower in 1995 than 1994 as a result of the low flow regime in 1994. As mentioned above. inadequate numbers of chinook salmon were marked in 1996 to merit discussion.

The results of fishing the tandem screw trap operation were relatively unsuccessful. We could not consistently double our catch with the dual trap operation. Total flow, the width of the area with appropriate velocity for trap operation, and screw trap design limited successful fish collection. During the second interval that we fished two traps we did increase our fish collection two-fold, but the discharge within the Grande Ronde was lower so the trap efficiency was likely higher. This appears to be the best explanation for the increased fish collection.

Travel time differed between the three anadromous salmonids during 1995 with wild steelhead migrating the fastest (Avg. = 7.0 days), hatchery steelhead at an intermediate rate (Avg. 8.5 days), and wild chinook the slowest (Avg. = 10.7 days). Between years, the average travel time varied based on the Snake River discharge. In 1996, wild steelhead were still the fastest (Avg. = 3.6 days) of the two marked groups that could be examined. Hatchery steelhead spent an average of 4.2 days traveling enroute to Lower Granite Dam. Fork length as a descriptor of fish size does not help explain this result because the longest fish at capture were hatchery steelhead (210.1 mm), with wild steelhead intermediate (174.0 mm), and wild chinook the shortest (106.0 mm). The fact that hatchery steelhead on average are traveling slower suggests that they may not be fully smolted at the time of release.

Spill at Lower Granite Dam was the only significant factor in the analysis of travel time of wild chinook salmon. The regression analysis of steelhead did not reflect the relationship between flow and travel time. Spill was present throughout the migration period in 1996 so there was no comparison to assess. However, the lower observation rates noted in 1996 compared to 1995 for the tagged groups suggests that spill may have decreased the likelihood of interrogation. It is important for us to change methodology to allow for fish collection during high flow conditions to provide data to estimate travel time at all flow levels. The low numbers of chinook outmigrating in 1996, spring flood conditions during late February, and higher than average flows throughout the migration season did not provide good quantitative data for comparison with prior years.

Recoveries of PIT-tagged fish at Lower Granite were better during 1995 for both species based on percentage of marked fish interrogated. The drawback, however, was that more marked fish were needed to cover the entire migration period and estimate travel time. These two years (1995-96) were both good flow years and adequate water was available during outmigration to facilitate migratory behavior.

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