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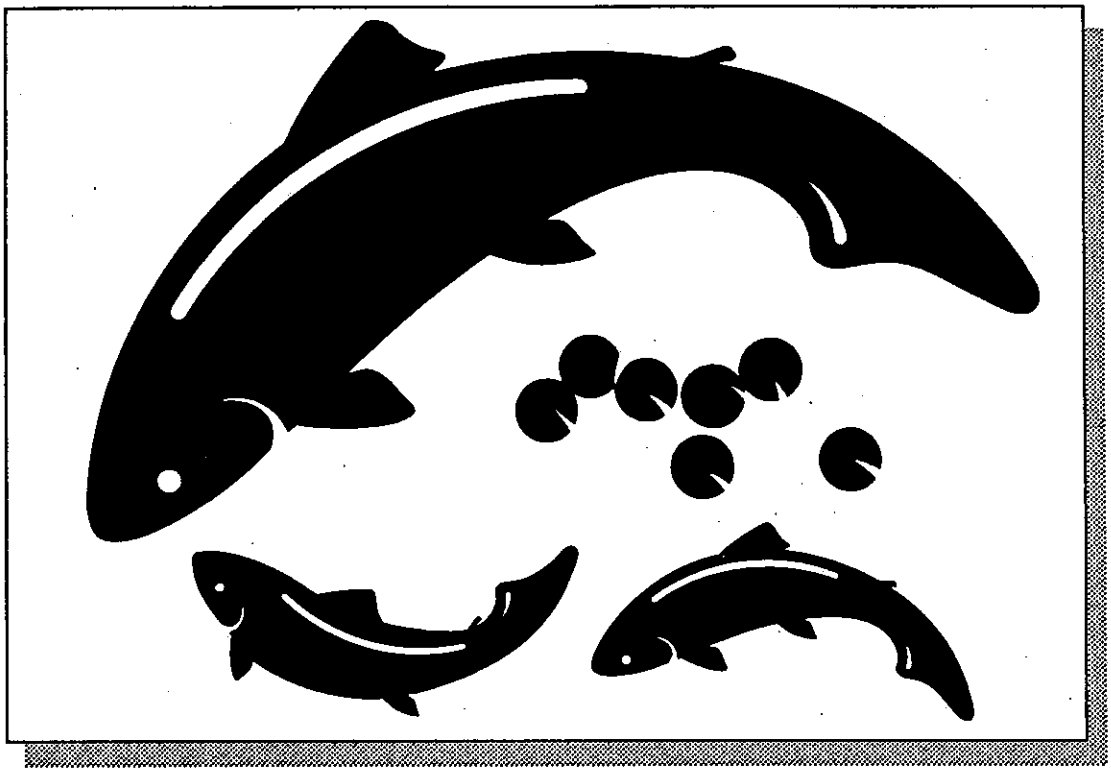

ESTIMATES OF RESIDUALISM IN SOUTHEAST WASHINGTON

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FISHERIES MANAGEMENT DIVISION

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Estimates of Residualism of Hatchery Reared Summer Steelhead and Population Size of Yearling Rainbow Trout (*Oncorhynchus mykiss*) in Southeast Washington, 1991.

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Abstract

The percent of all hatchery reared juvenile steelhead released into the Tucannon and Touchet rivers of Southeastern Washington that failed to emigrate, "residualized", during 1991 was estimated. The population size of hatchery reared yearling rainbow trout was also estimated on the Tucannon River and the North Fork of Asotin Creek. The success of emigration of: 1) different sizes of released juvenile steelhead, 2) direct stream plants of juvenile steelhead compared to release from conditioning ponds and 3) juvenile steelhead tagged with coded wire tags (CWTs) compared to un-tagged steelhead were compared. We also examined and compared the food habits of residual steelhead and yearling rainbow trout to determine if, and to what extent, they prey upon juvenile chinook salmon.

The mean percent of all steelhead released in the Tucannon River that residualized was estimated to be: 4.3% (8,559 fish) in June, 2.2% (4,460 fish) in August and 0.8% (1650) fish in October. We estimate that approximately 1000 yearling rainbow trout, 4.7 % of all rainbow trout planted in our study area, remained in the Tucannon River August through October.

The percent of residualism on the Touchet River in June was substantial, however an exact measurement of residualism was difficult due to the bias that was encountered during estimates. The mean percent of all steelhead released in the Touchet River that residualized was estimated to be within the range of 9.9% to 32.8% .

Densities of yearling rainbow trout were so low in August in the North Fork of Asotin Cr. that we were unable to make any population estimates. This suggests that after July, very few rainbow trout remain in the North Fork.

We found no difference in percent residualism among any of the four test groups of juvenile steelhead released into the Tucannon River. However, information collected on the Touchet River suggests that smaller sized steelhead did residualize at a higher percentage than the larger fish.

An analysis of steelhead and rainbow stomach contents showed that no identifiable juvenile Chinook salmon were present.

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INTRODUCTION

This report is an effort to present and compare estimates of hatchery reared juvenile steelhead that failed to emigrate "residualized" from the Tucannon and and Touchet rivers and the North Fork of Asotin Creek during the 1991 trout fishing season (June - October).

We were concerned that residualized steelhead may be competing for food and habitat with wild salmonids. Therefore in an attempt to reduce excessive residualism we varied a number of our steelhead release strategies. We began experiments that will compare the success of emigration from: 1) differing sizes of released juvenile steelhead, 2) direct stream plants vs. release from conditioning ponds and 3) juvenile steelhead tagged with coded wire tags (CWTs) vs. un-tagged steelhead.

Originally only a spring estimate was planned for the Tucannon and Touchet rivers to investigate the effects of our varied release strategies. However during July we learned of the growing concern that these residualized hatchery reared steelhead may be negatively impacting chinook salmon, a specie whose reduced population numbers have spawned a strong movement to list these runs of salmon as threatened or endangered. At that time we were asked by the U.S. Fish and Wildlife Service to extend our efforts to estimate the numbers of residualized steelhead and the hatchery reared rainbow trout remaining in the Tucannon River and the North Fork of Asotin Creek during August and again in late October. We were also to examine the food habits of these fish to determine if, and to what extent, they prey upon juvenile chinook salmon.

METHODS

We used a Peterson mark and recapture estimate as modified by Chapmen (Ricker,1958) to calculate the number of residualized steelhead and rainbow trout. However the method of collecting the information needed to calculate an estimate changed between the June estimate and the August, October estimates. The June estimate was performed during the opening days of the trout fishing season when a considerable amount of fishing effort was occurring. We therefore took advantage of the extensive information that we could collect from anglers creels. During the August and October estimates sport fishing was minimal and we were then forced to collect the information needed by electrofishing.

Formula for population estimates using the modified Peterson method.

$$N = \frac{(M+1)\,(C+1)}{(R+1)} \qquad V(N) = \frac{N^2\,(C-R)}{(C+1)\,(R+2)}$$

$$SE = \sqrt{\frac{V(N)}{C}}$$

$$95\ \%\ CI = N \pm t,\ n-1\ (SE)$$

Where: N = Population estimate
M = number marked
C = number of recaptured fish (both marked and unmarked)
R = recaptured marked fish
V(N) = variance of the population estimate
SE = the standard error of the estimate
CI = Confidence intervals
t = value from t table
α = .05
n = sample size

June estimate

Assumptions:

1) That by the third week in May emigration of hatchery reared juvenile steelhead has ceased. Sampling conducted in previous years in the Tucannon and Touchet rivers by the U.S. Fish and Wildlife has determined that hatchery reared juvenile steelhead failing to emigrate from the river by the third week in May will not do so in the future.

2) We can plant a known number of hatchery rainbow trout in each river which would result in an artificial population within each river consisting of residualized juvenile steelhead and hatchery rainbows of equal catchability. By allowing one week for distribution and mixing of hatchery rainbows and juvenile steelhead, then sampling both rivers for the appropriate data, we will be able to calculate a population estimate consisting of the sum of hatchery rainbows and residualized hatchery reared steelhead.

We arrived at the number of steelhead that residualized in each river by subtracting the known number of planted rainbows from the population estimate or by multiplying the percentage of residualized steelhead in the sample times the total population

estimate. Dividing this number by the total juvenile steelhead released in each river produced an estimate of the percent of hatchery reared steelhead that residualized.

Creel and angling surveys were conducted from June 1 - June 4, 1991. The rainbow trout previously planted into the rivers in known numbers were considered to be the marked group of fish for the mark and recapture equation. Juvenile hatchery reared steelhead represented unmarked fish in the population. All information collected from the two methods were compared and combined to generate comprehensive results.

During our creel surveys and angling we distinguished between wild steelhead, hatchery rainbow and hatchery reared juvenile steelhead; between branded and un-branded hatchery reared juvenile steelhead and between the different brand groups.

Creel Surveys

A creel survey was conducted during the first days of the fishing season (June 1-7). The Tucannon River was surveyed from Panjab Creek bridge downstream to Highway 12 (32 miles). The Touchet River was surveyed from the Bailysburg Bridge to Waitsburg (13.8 miles). Collection of information concerning the number of hatchery reared juvenile steelhead and hatchery rainbow caught was the main emphasis of the survey. We also collected information on the number and species of fish released and time spent fishing.

Angling

The difference in catchablitiy by angling, if any, of hatchery reared juvenile steelhead and hatchery rainbow trout was tested. Information from this effort allowed us to understand any bias that might affect the results from estimates based on data from creel surveys. In some cases information collected during the creel surveys was adjusted according to findings of the angling surveys. Two 1 mile sections were fished using either flys or lures. A different fishing method was used for each of the sections. The number of hatchery reared juvenile steelhead and hatchery rainbow caught in each section by the different methods were recorded.

Percent residualism

Estimates of residualism are provided for: 1) both length groups of juvenile steelhead (large vs. small groups), 2) direct stream released steelhead vs. steelhead released from the conditioning ponds and 3) coded wire tagged vs. un-tagged juvenile steelhead.

August and October methods

During August we estimated the number of residualized steelhead and hatchery trout remaining in the Tucannon River and the North Fork Asotin Creek. Since no residualized steelhead or rainbows were found in the North Fork of Asotin Creek in August, we estimated the number of residualized steelhead and hatchery trout remaining only in the Tucannon River in October. In all cases we also examined the food habits of these fish to determine if and to what extent they prey upon chinook salmon.

Site selection:

The river was divided into 3 sections: 1) Upper = Panjab Bridge downstream to Curl Lake, 2) Middle = Curl Lake downstream to the Wooten Wildlife area boundary and 3) Lower = Wooten boundary downstream to Marengo. Two sites were located in each section. In August we sampled six 300 foot sections (1.7%) of the Tucannon River and in October we sampled six different 300 foot sites (Appendix A).

Sites were chosen on the upper and middle areas by selecting a starting point at a randomly chosen distance (in miles) downstream from the top of each area. Access is limited by private land on the lower section, therefore we randomly selected bridge crossings as site locations in this section. We then randomly chose whether the upper or lower boundary of each site was located at the start of the selected distance or bridge crossing. Some subjective decisions were needed to eliminate the possibility of a site being composed of all habitat improved or unimproved area and also to eliminate very deep pools that could not be effectively sampled with our equipment.

Two 300 foot sections were sampled(2.3%) of the North Fork of Asotin creek within the area that is annually planted with hatchery trout. The area sampled was from the confluence with the South Fork upstream to the Forest Service boundary. This section of the North Fork is generally homogeneous and was therefore not separated into sections. Sample sites were located 1/3 and 2/3 of the reach length from the upper boundary of the sample section.

Sites on both rivers were set up to be 300 feet long. The upper and lower boundaries were marked with orange and yellow flagging tape and permanent tin markers were nailed to trees along the banks. Comments on percent pool, riffle, run, habitat improved and unimproved area within each site were recorded.

Population estimates

We estimated population size by a modified Petersen mark and

recapture method. We used a back-pack electro-shocker to capture residualized steelhead and hatchery trout. These fish were enumerated, marked and released back into the site. A caudal punch was used in August and a left pectoral clip in October. Four days later we returned and re-shocked the sites and enumerated the marked and unmarked fish we captured. Densities were very low. In order to have enough information to calculate population estimates, data from both sites in each section were pooled and a population estimate calculated from this pooled data. The results were then expanded to provide an overall population estimate for the entire sample areas of the Tucannon and the NF of Asotin Creek. Two electrofishing passes were needed to collect enough fish during both the marking and recapture efforts. Every effort was made to avoid shocking preferred chinook habitat to minimize any negative effects upon these fish.

Food Habits

We retained all marked and unmarked residualized steelhead and hatchery trout from the recapture efforts. Stomachs from these fish were removed and preserved in formalin. Stomach contents were identified and all species were noted. Additional stomach samples were also collected and analyzed from fish caught by angling in the lower section of the Tucannon. Analysis of stomach contents from these fish was used to determine if any predation of juvenile chinook was occurring.

RESULTS

June

Tucannon River

Results from our angling survey on the Tucannon River correlated well with the information that was collected during the creel survey (Table 1). Therfore the percent residualism of hatchery reared juvenile steelhead was calculated from the creel information without adjustment according to angling information. The mean residualism of steelhead on the Tucannon River was 4.3% with a range of (4.1% - 4.5%).

Touchet River

Results from our angling survey showed substantial difference when compared to the information collected during the creel survey. Two estimates of residualism, one based on unadjusted creel information and the other based on creel information adjusted according to information on angler harvest bias were calculated. Residualism on the Touchet was 9.9% based on unadjusted creel information and 32.8% based on adjusted creel data.

Table 1. Percent composition of resdualized steelhead and hatchery rainbow trout, based on data from the creel and (angling) survey on the Tucannon River June 1991.

Brand	Release site	% composition of residual SH in creel	% composition in creel
Rocking 7	Curl Lake	15.3 (11.7)[A]	
H in 2nd position	Direct stream plant near Curl Lake	14.2 (23.5)	
H in 1st position	Direct stream plant in lower river at Marengo	13.9 (14.7)	
No brand (no CWT)	Curl Lake	22.5 (29.4)	
CWT fish with unreadable brands	All locations	34.0 (11.0)	
Steelhead			51.5 (68.0)
Rainbow			48.5 (32.0)

A Percentages in parentheses are from the angling survey.

Table 2. Percent composition of resdualized steelhead and hatchery rainbow trout, based on data from the creel and (angling) survey on the Touchet River June 1991.

Brand	Size	% composition of residual SH in creel	% composition in creel
IT	Small (5.3/1b)	32.0 (56.2)[A]	
IJ	Large (3.8 1b)	36.6 (23.3)	
No brand (no CWT)	(3.7/1b)	16.3 (9.6)	
Unreadable Brands		15.0 (11.0)	
Steelhead			53.7 (89.0)
Rainbow trout			46.3 (11.0)

A Percentages in parentheses are from the angling survey.

August and October results

Table 3. Residualized steelhead population estimates on the Tucannon River, August 1991.

Section	River miles (feet)	Sample sites	Total Site length	Site estimate (95% CI)	Section estimate (95% CI)
Upper	5.5 (29,040)	R-1 R-2	600	56.7 ± 1.1	2,744 (2,691-2,798)
Middle	6.0 (31,680)	R-2.5 R-3	600	28.0 ± 8.4	1,478 (1,035-1,922)
Lower	9.0 (47,520)	R-4 R-5	600	3.0 ± 0.9	238 (168.7-306.5)
Total					4,460 (3,895-5,026)

Table 4. Hatchery reared rainbow trout population estimates on the Tucannon River, August 1991.

Section	River miles (feet)	Sample sites	Total Site length	Site estimate (95% CI)	Section estimate (95% CI)
Upper	5.5 (29,040)	R-1 R-2	600	0	0
Middle	6.0 (31,680)	R-2.5 R-3	600	7.5 ± 59.4	396 (264-2,482)[A]
Lower	9.0 (47,520)	R-4 R-5	600	5.0 ± [B]	396 (317-B)[A]
Total					792 (581-2,482)

A: The lower estimate was calculated by expanding numbers of fish actually sampled.
B: Insufficient data to calculate a confidence interval.

Table 5. Residualized steelhead population estimates on the Tucannon River, October 1991.

Section	River miles (feet)	Sample sites	Total Site length	Site estimate (95% CI)	Section estimate (95% CI)
Upper	5.5 (29,040)	R-1F R-2F	600	21.0 ± 21.7	1,016 (726-2,067)[A]
Middle	6.0 (31,680)	R-2.5F R-3F	600	6.0 ± [B]	317 (264-[B])[A]
Lower	9.0 (47,520)	R-4F R-5F	600	4.0 ± [B]	317 (238-[B])
Total					1,650 (1,228-2,067)

A: The lower estimate was calculated by expanding numbers of fish actually sampled.
B: Insufficient data to calculate a confidence interval.

Table 6. Hatchery reared rainbow trout population estimates on the Tucannon River, October 1991.

Section	River miles (feet)	Sample sites	Total Site length	Site estimate (95% CI)	Section estimate (95% CI)
Upper	5.5 (2,040)	R-1F R-2F	600	0	0
Middle	6.0 (31,680)	R-2.5F R-3F	600	2.0 ± [B]	106 ([B])
Lower	9.0 (47,520)	R-4F R-5F	600	12.6 ± 2.1	998 (832-1,164)
Total					1,104 (938-1,164)

A: The lower estimate was calculated by expanding numbers of fish actually sampled.
B: Insufficient data to calculate a confidence interval.

North Fork of Asotin Creek

No residualized steelhead or hatchery trout were collected within either of the two sites on the North Fork. This precluded any continued effort in population estimation or predation evaluation.

Food habits

The results of the examination of stomach contents are presented in tables 7 and 8.

Table 7. Food items found in stomachs from 36 residualized steelhead and 15 hatchery rainbows, Tucannon River, August 1991.

Food items present	Steelhead	Rainbow
Vertebates		
Salmonidae	0[A]	2 un-identified
O. tschawytscha	0	--
O. mykiss	0	--
Cottidae	6	1
Invertebates		
Coleoptera	11	5
Ephemeroptera	5	2
Diptera	6	1
Trichoperta	28	12
Lepodoptera	1	0
Hymenoptera	6	5
Plecoptera	8	6
Oligochaeta	2	1
Gastropoda	2	0
Orthoptera	1	0
Decapoda	3	1
Empty	5	0

A: Numbers indicate the number of fish stomachs containing this organism.

Table 8. Food items found in stomachs from 16 residualized steelhead and 9 hatchery rainbows, Tucannon River, October 1991.

Food items present	Steelhead	Rainbow
Vertebates		
Salmonidae	0	1 un-identified
O. tschawytscha	0	--
O. mykiss	0	--
Cottidae	1[A]	2
Invertebates		
Coleoptera	2	0
Ephemeroptera	2	0
Diptera	2	0
Trichoperta	5	8
Hymenoptera	7	2
Plecoptera	4	4
Formicoidea	1	0
Gastropoda	1	0
Oligochaeta	0	1
Decapoda	0	1
Hemiptera	4	0
Empty	4	1

A: Numbers indicate the number of fish stomachs containing this organism.

Discussion

June

Tucannon River

A mean steelhead residualism of 4.3% was found on the Tucannon in June. This level does not seem excessive, however this percentage represents 8,559 steelhead. It is unknown whether or not these fish are competing for food and space with other species.

None of the different release strategies appeared to be more successful at reducing residualism on the Tucannon. When the equal proportions of the percent of steelhead with unreadable brands are added to each brand group, no important difference in

percent composition of the total residualized steelhead can be seen (Table 1).

Touchet River

The percent of residualism on the Touchet River in June was substantial, however an exact measurement of residualism was difficult due to the bias that was encountered during the creel survey. Anglers exhibited a strong tendency to up grade the size of the fish they harvested. A comparison of creel and angling information showed that the smaller residualized steelhead were apparently released in favor of keeping the larger rainbow trout. This behavior resulted in a larger proportion of rainbows being harvested than steelhead. We believe that by the 3rd day of the season when our angling survey was done, a larger percentage of rainbow trout had been harvested than steelhead. This also biased our angling survey, resulting in a sample that was high in residualized steelhead. Therefore two estimates were made. The residualism estimate based on unadjusted creel information was 9.9% and was 32.8% based on data adjusted to remove angler bias. We believe the true estimate to lie somewhere within this range.

A comparison of percent composition among the groups of steelhead that residualized indicates that a lower percentage of unbranded steelhead residualized than branded steelhead (Table 2). Smaller steelhead (IT brands) represented approximately the the same percent composition of residualized fish as the the larger steelhead (IJ brands) based on information from the creel survey. However, smaller steelhead (IT brands) represented a higher percent composition of residualized fish than larger steelhead (IJ brands) based on information from the angling survey (Table 2). One may theorize that this was most likely due to anglers releasing small fish thus increasing the number of smaller steelhead in our angling sample. It is unlikely however, that fish released on the two days prior to our angling survey would be susceptible to fishing due to trauma of the earlier capture. Rather, we believe that the smaller steelhead did residualize at a higher rate than larger fish.

June, August and October

Tucannon

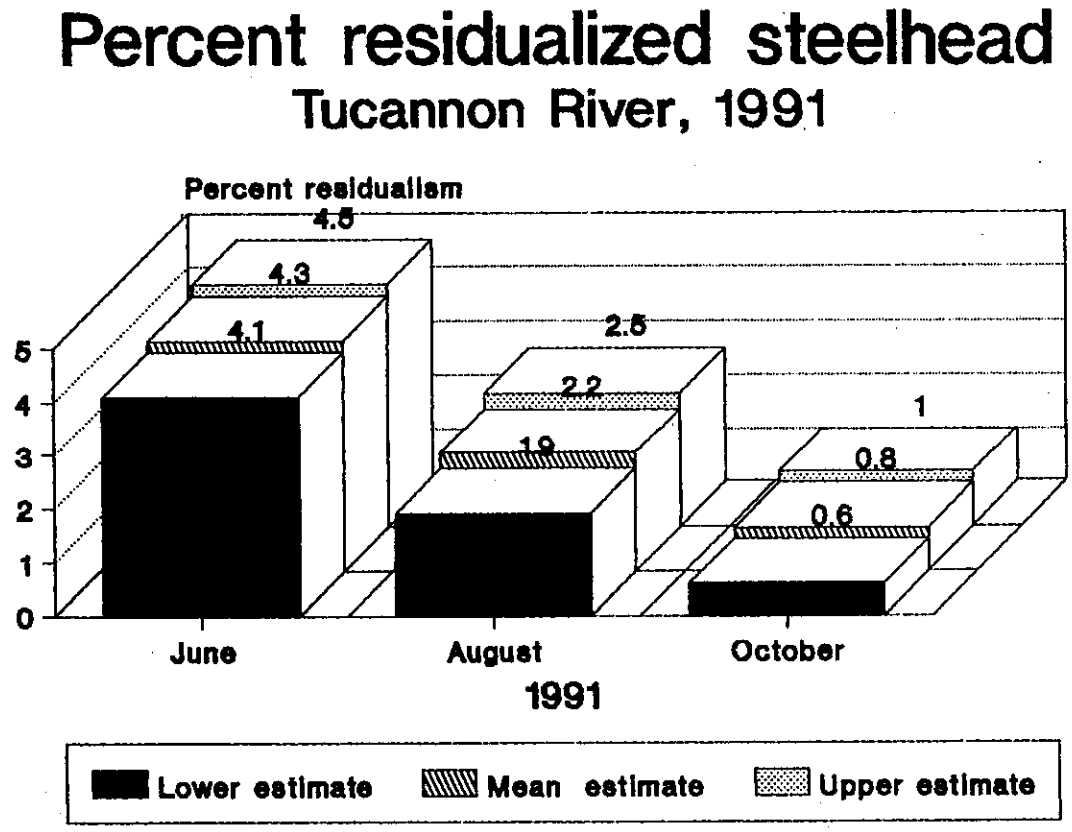
The mean percent residualized steelhead decreased from 4.3% (8,559 fish) in June to 2.2% (4,460 fish) in August and then to 0.8% (1650) fish in October (figure 1). This steady decline in residual fish was what we expected to see due to natural and fishing mortalitys that occur throughout the summer.

We estimate that approximately 1000 hatchery trout remained in the Tucannon River, August through October which represents

4.7 % of the fish planted in our study area (Tables 4 and 6). We were unable to detect a decrease in the density of catchable trout between August and October as we did with steelhead. We believe this lack of sensitivity to be the result of small sample sites. No rainbow were found during our sampling efforts on the upper section. This was expected as only a small portion of this section receives catchable rainbow plants.

Stomach analysis of steelhead showed that no identifiable salmonids were present. However we did find 3 partially digested, unidentifiable salmonids in the stomachs of rainbow trout. Both steelhead and rainbows are selecting a wide diversity of aquatic and terrestrial insects to feed on. Insects made up the largest percent of stomach contents. Our sample suggests very little predation upon juvenile chinook. However our sample was small and we were not able to identify the 3 salmonids found from rainbow stomach contents. The collection of more samples would be needed to adequately answer the question of predation.

Densities were so low on the North Fork of Asotin Creek we were unable to make any population estimates. This suggests that very few rainbows remain on the North Fork. When densities are this low, extremely long sites are needed to make an estimate.



Percent residualized steelhead
Tucannon River, 1991

Figure 1.

The short sites that we elected to use in order to minimize any negative effects upon chinook do have some drawbacks. The most notable are the small sample size of fish and the opportunity of marked fish to move out of the sample area both before and during the recapture effort. We planned to add a block net at the lower end of our sample sites during our fall estimates. This would have prevented any fish form escaping downstream during our recapture efforts but would not have prevented marked fish from leaving prior to when we put the net in. We were however unable to use a net in October due to a large amount of drifting leaves. A combination of slightly larger sites and the use of a block net during recapture efforts may improve accuracy. To reduce impacts on chinook a person could be stationed at the net to instantly remove any chinook trapped against the net.

These surveys were preliminary and more work is needed. A repetition of these efforts plus an in-depth survey designed to determine if there exits any substantial competition for food and/or space between residual hatchery fish, and wild chinook salmon and steelhead is needed. Additional work is also needed to determine how much, if any, predation is occuring by hatchery origin fish upon wild salmon and steelhead.

REFERENCES

Ricker, W. E. 1958 Handbook of computations for biological statistics of fish populations. Fisheries Research Board of Canada, Bulletin 119. 300p.

Appendix

August Tucannon Sites

Site R1 (R is for residual)
Located 1 mile below Panjab Bridge adjacent to the camp ground. Comments: 75% riffle/run 25% pool, no habitat improvement.

Site R2
Located 1 mile below Curl Lake adjacent to campground 9. Comments: 50% riffle/run with habitat improvement (boulder placements), 50% cascading riffle with no habitat improvement. Located adjacent to a camping area, receives considerable fishing pressure.

Site R2.5
Located 2 miles below Curl Lake.
Comments: This site is located away from camp sites and was added to include an area that received less fishing pressure than R1 and R2.

Site R3
Located 3 miles below Curl Lake at the lower end of campground 7.
Comments: 33.3% riffle/run with habitat improvement (boulder placements), 66.6% unimproved riffles pools and cascade. Located adjacent to a camping area, receives considerable fishing pressure.

Site R4
Located downstream from the second bridge below the Wooten Wildlife area boundary. The downstream side of the bridge is the upper boundary of the site.
Comments: 75% wide run, 25% pool no habitat improvements.

Site R5
Located upstream from bridge number 11. The lower boundary of the site is 44 ft upstream from the bridge.
Comments: Good natural instream habitat Pools run and riffles, no habitat improvement. Chest waders will help in one pool.

NF Asotin sites

Site NF-R1
Located 1.2 miles downstream from the Forest Service boundary.
Comments: Good natural instream habitat; pools, run and riffles, no habitat improvement.

Site NF-R2
Located 1.35 miles upstream form the confluence with the South fork. Three log weirs and some boulder placements, includes NA2c-83. Chosen to represent a sample of a habitat improved area.

October Tucannon sites

Site R1F
Top is located 100 feet below the lower end of R1.
Comments: pools, riffles and run, no habitat improvements.

Site R2F
Top is located 100 feet below the lower end of R2.
Comments: Pools, riffles and run, no habitat improvements.

Site R2.5F
Top is located 100 feet below the lower end of R2.5.
Comments: Wide flat run, some riffle, 2 deep holes.

Site R3F
Top is located 700 feet below the lower end of R3.
Comments: 25% boulder placement, 50% run, 25% riffle.
Follow the trail on the west side of the river to site.

Site R4F
Top is located 100 feet below the lower end of R4.
Comments: considerable amount of instream brushy cover. 75% run, 25% riffle.

Site R4F
The bottom is located 100 feet above the upper end of R5.
Comments: Wide riffle. There is also a small side channel located on the west side of the river. Walk through pasture to the top of site

Data used to calculate population estimates on the Tucannon River, August 1991.

Site	Steelhead Marked	Rainbow Marked	Steelhead Recaptured		Rainbow Recaptured	
			Marked	Unmarked	Marked	Unmarked
R-1	7	0	1	6	0	0
R-2	12	0	4	5	0	0
R-2.5	11	0	2	4	0	0
R-3	0	4	0	0	1	1
R-4	1	0	0	0	0	0
R-5	2	4	1	1	1	0

Data used to calculate population estimates on the Tucannon River, October 1991.

Site	Steelhead Marked	Rainbow Marked	Steelhead Recaptured		Rainbow Recaptured	
			Marked	Unmarked	Marked	Unmarked
R-1F	4	0	1	0	0	0
R-2F	8	1	2	2	0	0
R-2.5F	5	0	4	0	0	0
R-3F	0	2	0	0	0	0
R-4F	1	6	1	0	3	2
R-5F	2	2	2	1	1	0

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