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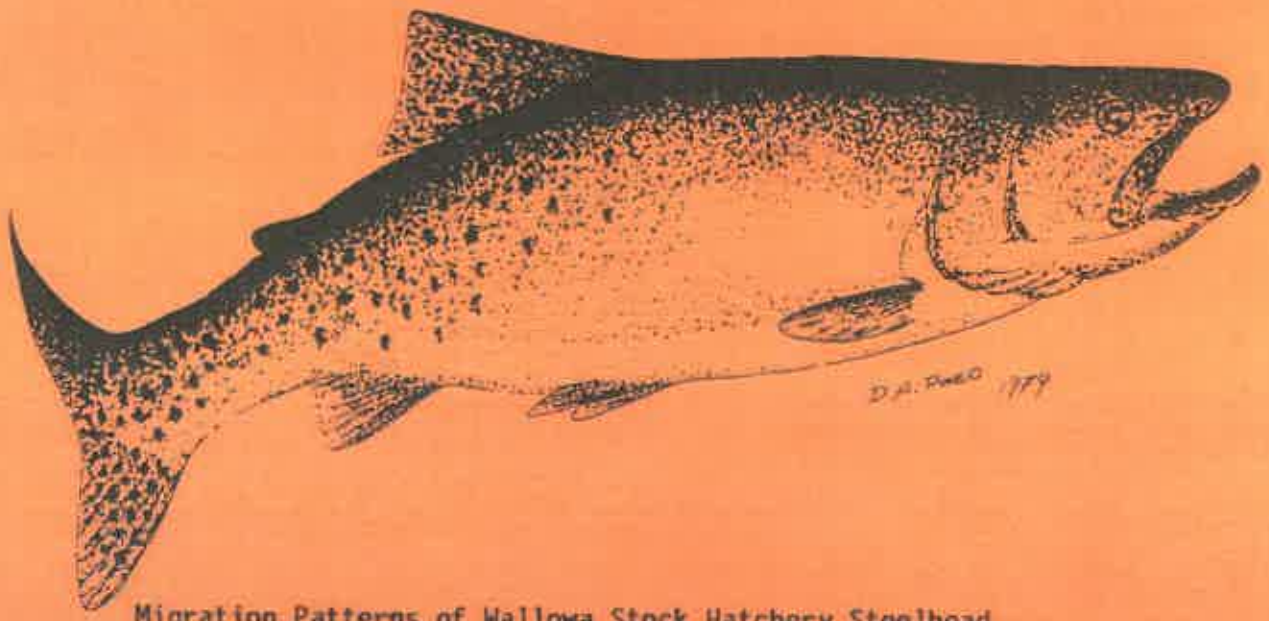

Migration Patterns of Wallowa Stock Hatchery Steelhead in the Snake and Grande Ronde rivers of Washington March 1989

By

Glen Mendel
Mark Schuck

Report No. AFF1/LSR-89-03

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Gary Lambacher of WDW spent interminable hours tracking the radio tagged steelhead and inputting the recovery information into our data base. His persistence provided many relocations of fish under adverse conditions.

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Denny Fryberger operated the Cottonwood C.P. on the Grande Ronde during the spring of 1988. Because of his endless energy and persistence, we recovered several tags that provided extremely valuable information.

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ABSTRACT

Washington Department of Wildlife personnel conducted a study on migration patterns of Wallowa stock steelhead in the Snake River during fall 1987 and spring 1988. Three separate groups of 1 and 2-ocean aged fish destined for either Lyons Ferry Hatchery (LFH), Cottonwood Conditioning Pond or Wallowa Hatchery were identified by reading freeze brands on adults trapped at Lower Granite Dam. Radio tags were implanted into the stomachs of 78 separate fish between 1 October and 5 December. A 12 mm orange disk tag was attached to the dorsal fin to identify fish containing a radio tag. Only results for fish returning to LFH or Cottonwood Conditioning pond in Washington are reported here. Results for fish destined for Wallowa Hatchery, Oregon, are reported by Carmichael et al., 1989.

Fish were tracked by car, boat, helicopter and fixed wing aircraft from 4 October to 27 April 1988. Three of the 46 fish regurgitated the tag immediately and 4 were never relocated. However, enough relocations were collected for fish from each of the groups to describe a generalized migration pattern. There were definite differences in patterns between groups released from different sites. Sport harvest on tagged fish was 9.1% and 0% for LFH 1-ocean and 2-ocean age fish, respectively; and, 23.1% and 37.5% for Cottonwood 1 and 2-ocean age fish respectively.

Steelhead destined for Lyons Ferry Hatchery appear to migrate above Lower Granite Dam and over-winter in the pool area. These fish usually did not move upstream out of the reservoir and they appeared to become disoriented in the spring after they had moved rapidly down through the reservoir to the dam. Many of these fish spawned in adjacent small streams above the dam.

Steelhead destined for Cottonwood conditioning pond moved rapidly through the reservoir and upstream to near the mouth of the Grande Ronde R. by mid December. Few fish entered the Grande Ronde R. or contributed to the fall sport fishery there, however they did over-winter in an area of the Snake River under substantial fishing pressure. Most steelhead resumed upstream migration in February. Little wandering was documented for these fish during their migration above Lower Granite Dam.

Our results place in question the desirability of the Wallowa stock of hatchery fish for continued use in the Lower Snake River Compensation Plan mitigation program. Failure to move into the terminal stream and contribute strongly to the sport fishery, coupled with their lack of general contribution to other fisheries, should be studied further. New stocks of summer steelhead that could be used in the Grande Ronde basin should be investigated.

INTRODUCTION

The desirability of using the Wallowa stock of hatchery steelhead for mitigation, under the Lower Snake River Compensation Plan (LSRCP), has become increasingly questionable (Schuck and Mendel, 1988). LSRCP goals for both the Washington Department of Wildlife (WDW) and the Oregon Department of Fish and Wildlife (ODFW) programs include "in kind" and "in place" mitigation for lost fisheries and spawning populations of steelhead, as well as protection of existing wild populations. We conducted this study to evaluate the movement and migrational characteristics of adult Wallowa stock steelhead that had been released at Lyons Ferry Hatchery (LFH) or into the Grande Ronde River basin.

A number of important and unique problems have been identified by WDW and ODFW personnel concerning releases of Wallowa stock fish from LFH and Wallowa Hatchery. Schuck and Mendel (1988) found that Wells and Wallowa stock steelhead reared at LFH in constant temperature spring water bypassed the hatchery and moved above Lower Granite Dam (LGD) during 1984 through 1986. The Wells stock fish, however, appeared to "home" to the hatchery better than the Wallowa stock fish. It was unclear whether this failure to return to the release site was an imprinting problem, a migrational characteristic, or a stock characteristic. Research done by Sutterlin and Gray (1973) indicated that returning adult Atlantic salmon actively avoided well water effluent from the hatchery in which they were reared. Therefore, lack of imprinting of smolts at LFH is a possibility, although steelhead released in the Tucannon River after being accilimated on river water for two months, demonstrate similar problems (Schuck and Mendel 1988). Several questions arise regarding fish destined for LFH or the Tucannon R. but migrating above Lower Granite Dam: 1) Are these fish "lost" (straying) or "wandering" as a normal migrational pattern? 2) Is this "wandering" behavior stock specific? 3) How many fish exihibit such behavior and does this behavior jeopardize our mitigation program? 4) Can these fish successfully return downriver through Lower Granite and Little Goose dams in the spring to spawn? and 5) What happens to steelhead that are unable to pass the dams and return downriver to their release areas?

One of the primary objectives of the LSRCP in Washington and Oregon is to re-establish productive summer steelhead fisheries in the Snake and Grande Ronde basins similar to those that existed prior to construction of the four lower Snake River dams. Sport fisheries in the Grande Ronde River traditionally occurred from August through December with the peak harvest occurring in October (Table 1). A consumptive summer steelhead sport fishery for adipose-clipped fish on the Grande Ronde R. was reopened in 1986 after being closed since 1974. Creel surveys have been conducted each year on the Grande Ronde R. to estimate catch

Table 1. Percentage harvest by month in the Grande Ronde River, Oregon and Washington, for run years 1968-69 through 1973-74, and 1986-88. Catch estimates from punch cards (ODFW 1969-1975; WDW 1969-88).

Run Year	Total Harvest	Percentage Harvest by Month											
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
OREGON													
68-69	744	1.9	4.8	17.1	25.5	12.2	3.6	0.0	2.8	32.0	-	-	-
69-70	1,596	1.8	9.1	21.2	22.5	9.4	1.3	0.9	6.5	26.3	-	-	1.1
70-71	909	1.5	11.9	16.1	35.2	8.2	4.2	0.0	6.1	16.2	-	0.6	-
71-72	605	0.0	0.8	21.3	47.3	20.5	2.3	1.8	0.0	5.9	-	-	-
72-73	832	0.0	5.9	31.5	30.0	11.1	0.7	0.5	2.0	18.3	-	-	-
73-74	133	0.0	15.8	27.8	27.8	0.0	0.0	17.3	11.3	0.0	-	-	-
$\bar{x}$	803	0.9	8.1	22.5	31.4	10.2	2.0	3.4	4.0	16.5			
SD	476	0.9	5.4	6.0	8.9	6.6	1.6	6.8	4.0	12.0			
WASHINGTON													
68-69	1,492	0.3	2.5	20.0	46.4	16.8	3.2	1.1	5.0	4.2	0.1	0.3	0.1
69-70	1,127	0.7	3.4	16.3	45.4	23.3	5.7	1.0	3.0	1.0	0.2	-	-
70-71	982	0.5	5.0	31.2	48.9	4.1	1.9	3.8	2.0	1.5	0.7	-	0.4
71-72	965	0.5	0.5	23.9	48.6	11.6	7.0	3.3	1.7	1.7	0.4	0.2	0.5
72-73	606	0.1	3.0	31.5	47.9	15.3	0.7	- [A]	-	-	-	-	-
73-74	224	0.0	1.8	19.6	74.1	1.8	1.8	- [A]	-	-	-	-	-
$\bar{x}$	899	0.4	2.7	23.7	51.9	12.1	3.4	2.3	2.9	2.1	0.4	0.1	0.3
SD	437	0.3	1.5	6.4	11.0	8.1	2.5	1.4	1.5	1.4	0.3	0.1	0.2
1986-87	200	0.0	5.0	1.5	38.5	19.5	35.5	- [A]	-	-	-	-	-
1987-88	293	0.7	0.0	0.7	3.8	6.1	1.7	0.7	1.7	46.1	38.6	0.0	0.0

[A] Season closed.

rates, effort, and harvest of hatchery fish (Carmichael et al. 1988, Mendel et al. 1988). Few hatchery fish were caught during the fall and winter period in 1986 or 1987 (Table 1) despite large smolt releases by ODFW and WDW in 1984 and 1985. Catch rates were generally good (6-28 hrs/fish) from September through December, but most of the fish caught were of wild origin. Two reasons for this might be: 1) the migration pattern of Wallowa stock may cause them to rest in or seek areas of the rivers that are not normally fished, thus they are unavailable for harvest, or, 2) Wallowa stock hatchery fish may be less catchable than wild fish. An additional concern was that the migration and holding pattern of the hatchery stock might be significantly different than that of the wild Grande Ronde stock. Both Washington and Oregon have adopted strict regulations to protect existing populations of natural/Wild steelhead. The lack of Wallowa stock fish in the fishery may cause undesirably high fishing pressure to occur on wild stocks as well as reduce recreational fishing opportunity.

Trapping facilities at LGD allowed returning tagged and branded steelhead to be enumerated and jaw tagged before release into the upper Snake River, the area of greatest fishing effort for the Wallowa stock fish. Jaw tagging of branded, adult steelhead passing LGD in the 1985 run year, destined for Wallowa Hatchery in Oregon, indicated an unexplained loss of fish between the two points. Only 10.4% of the fish that were jaw tagged and destined for Wallowa Hatchery returned there (Carmichael and Messmer,1986). The differences in numbers of tagged fish could not be resolved by sport harvest or recoveries at other known points. Some unexplained loss also occurred with steelhead destined to WDW facilities. In 1986, jaw tags were placed on branded, coded-wire tagged fish passing LGD and destined for the Grande Ronde River, LFH, and the Tucannon River. Substantial effort was expended to recover coded-wire tags and jaw tags from the sport fishery. Over 400 adult steelhead destined for LFH passed LGD in 1986, but only 5.6 % of those were later recaptured at the LFH fish ladder. Only 18.1 % of the 1,021 adult jaw tagged steelhead passing LGD and destined for the Cottonwood Conditioning Pond (C.P.) were harvested in the Snake R. or in Idaho sport fisheries. During this same period however, an intensive fishery was occurring on apparently wild fish in both the Snake and Grande Ronde rivers. Smolt to adult survival measured at LGD was at an acceptable level for single year class returns in 1985 and 1986 (Schuck et al. 1988). However, contributions to fisheries or terminal areas, such as hatcheries, has been disappointingly low, 10.4% for G.Ronde fish in 1985, and 24.4 % for Cottonwood fish in 1986 (Schuck and Mendel 1988; Schuck et al. 1988).

The origin of the Wallowa stock may be an important factor influencing their migration, movement, and wintering patterns. The broodstock development program was initiated in 1976 when 85 apparently wild steelhead of unknown origin were collected at Ice

Harbor Dam from 7 April to early June. In 1977, 83 wild steelhead were collected on 13 April at Little Goose Dam (LGO) and an additional 86 steelhead were collected on 25 March 1978 at LGO. An attempt was made to collect A-run steelhead, however not enough of the smaller fish typical of the A-run were available so some larger B-run type fish were utilized for broodstock. Also, in 1979 eggs from Pahsimeroi stock steelhead were obtained from Mackay Hatchery in Idaho and mixed with the Wallowa stock. All smolts from the 1976-79 broods were released at Wallowa Hatchery in Oregon where ODFW began trapping adults in 1980. The Wallowa stock now consists of progeny from broodstock collected at the hatchery.

There existed enough data to raise serious concerns about the behavior and acceptability of the Wallowa stock of fish for continued use within the LSRCP program for both ODFW and WDW. A cooperative radio telemetry study was conducted by WDW and ODFW personnel with the following objectives:

1) Document migrational patterns of adult hatchery Wallowa stock steelhead.
2) Assess availability of Wallowa stock steelhead to sport fisheries.
3) Determine the magnitude, location, and time of unexplained losses between LGD and Wallowa Hatchery.
4) Develop recommendations regarding continued use of the Wallowa stock for LSRCP mitigation programs.

METHODS

National Marine Fisheries Service (NMFS) personnel routinely capture migrating coded-wire tagged adult steelhead in their trap at LGD to monitor passage of tagged and freeze branded fish. Brands applied to smolts are readable on adults returning to LGD. Both ODFW and WDW had branded and tagged groups of steelhead returning to the upper Snake and Grande Ronde rivers in the fall of 1987. We planned to implant radio transmitters in 40 adult steelhead captured at LGD (Table 2). Tagged fish were from specific brand groups that were selected to represent returns of 1 and 2-ocean age Wallowa stock steelhead destined for LFH on the Snake R. or the Cottonwood C.P. on the Grande Ronde River. Tagging activities were spaced throughout most of the fall portion of the run.

We used Advanced Telemetry Systems (ATS) equipment because of availability, preferred transmitter and receiver size, and multiple frequency scanning ability. Frequencies ranged from 48.080 - 49.230 mHz with a minimum of 10 kHz separation, and 55 - 80 pulses/min.. Transmitters were powered by lithium batteries and had expected minimum functional lives of 130 - 170 days. The smaller transmitters (for 1-ocean fish) were 55-59 mm long, 11 mm wide and weighed 10.4-11.1 g. The larger transmitters (for 2-

ocean fish) were 61-69 mm long, 18 mm wide, and weighed 21.0-24.0 g. We modified the transmitters by attaching 2.36 mm diameter PVC heat shrink tubing to the wire antenna to keep the antenna straight and rigid in the mouth to maximize signal strength. We were concerned that the smaller transmitters required for 50-64 cm steelhead might be easily ejected from the stomach. Consequently, we attached 20 x 15 mm pieces of compressed sponge to the neck of some transmitters with 6.4 mm (1/4 in) Penrose Drain Tubing in an attempt to form a plug in the esophagus and reduce regurgitation.

Table 2. Specific Washington brand groups proposed for radio tagging at Lower Granite Dam, fall 1987.

Ocean Age	Brand	No. of Radio Tags	Destination
1	LA-IK-1,3	10	Lyons Ferry Hatchery
2	RA-H-2	10	Lyons Ferry Hatchery
1	RA-IJ-1,2,3,4	10	Cottonwood Cond. Pond
2	RA-17-1,3	10	Cottonwood Cond. Pond

In September 1987, before tracking began, two steelhead at Lyons Ferry Hatchery were implanted with transmitters to test transmitter placement, signal strength and reception distance at various depths. Lateral transmitter reception tested with a receiver in a boat was found to be very limited for fish at depths beyond 20 feet.

Captured fish were anesthesized in MS 222, measured, visually sexed and brands read. Fish with the appropriate brands were jaw tagged and disk tagged. A radio transmitter was inserted into the stomach and the antenna was cut to extend to the gum line. Fish were tracked with receivers and 40 or 48 mHz whip or directional loop antennas. Maximum signal strength was inconsistent for some frequencies, consequently, we programmed 1-3 frequencies into the scanners for each transmitter. Receivers required a minimum of 2 seconds per frequency during a scan. Thus, a full scan of 70 transmitters (which included 30 frequencies for ODFW) took a minimum of 140 seconds and often took 2.5 - 3 minutes. To expedite scans we usually used 2 receivers simultaneously scanning out of synchrony. We limited our travel speed to less than 35 mph, whenever possible, to reduce the possiblility of passing a frequency before it was detected by a receiver. The Snake River from LGD to near the Oregon State Line was usually searched twice per week, either by boat, or from an automobile in conjunction with creel survey activities. Also, the Clearwater River below Lenore, Idaho, was searched by automobile 1-4 times per month through March.

Occasional searches extended as far upstream as Orofino, Idaho. The accessible portions of the Grande Ronde below Rattlesnake Creek (RM 26.2) were searched 5-9 times per month, October through March. Portions of the Grande Ronde above Rattlesnake Ck. were checked by automobile from 1-9 times per month. (See Appendix A for a listing of search periods for each river section).

Eleven searches were conducted by air. A helicopter was used in the Grande Ronde R. canyon and along the upper Snake and lower Salmon rivers. A fixed wing aircraft was used to search the lower Clearwater River and Lower Granite and Little Goose reservoirs. All flights were conducted between 300 and 600 ft. above the water, and as slowly as possible to accomodate the slow scan rate of the receivers. Multiple passes had to be used with the fixed wing aircraft to compensate for the high mimimum flight speed (60 mph). At approximately 1 week intervals from 6 November 1987 to 10 March 1988, ODFW and WDW personnel tracked steelhead in the upper Grande Ronde R. from Rattlesnake Ck. to Wildcat Ck. (RM 53.3). Specific areas were searched more frequently. ODFW tracking methods differed slightly from those used by WDW personnel (See methods in Carmichael et al. 1989). Over 315 river miles were searched for transitter signals in Washington, Idaho, and Oregon; and most areas were searched repeatedly.

Creel survey programs were active on the Snake R. (from Little Goose Dam to the Oregon state line), the Grande Ronde (mouth to Wallowa R.), and the Wallowa River R. (from the mouth to Wallowa Hatchery). All fish observed by WDW and ODFW personnel during creel surveys were examined for tags. The creel surveys on the Snake, G. Ronde, and Wallowa rivers were conducted Sept.- March, Sept.- Dec., and Feb.- mid-April, respectively.

Notices (Appendix B) were posted in stores and at conspicuous locations along the rivers offering rewards for the return of tags and information from fish that were captured. Newspapers also carried articles describing our research project and the reward program. Tags and information concerning tagged fish could be turned in to WDW or ODFW personnel, placed in tag collection boxes, or returned by mail for rewards.

Regurgitation rates for transmitters were estimated by dividing the number of fish recovered without transmitters intact by the total number of fish recovered. All fish recoveries by anglers, hatcheries, or personnel at Lower Granite Dam were used in the calculation of regurgitation rates. Angler exploitation rates were calculated by dividing the number of tags returned by anglers by the number of disk tagged fish released.

Adult steelhead returning to Cottonwood C.P. were captured by dip netting at the pond outlet a few times each week or occasionally netting in Cottonwood Creek. Captured fish were examined for tags.

STUDY AREA

This study was conducted from LFH on the Snake R. to the Wallowa Hatchery in Oregon, and portions of the Clearwater and Salmon rivers in Idaho (Fig. 1). Landmarks and river mile locations are presented in Appendix C.

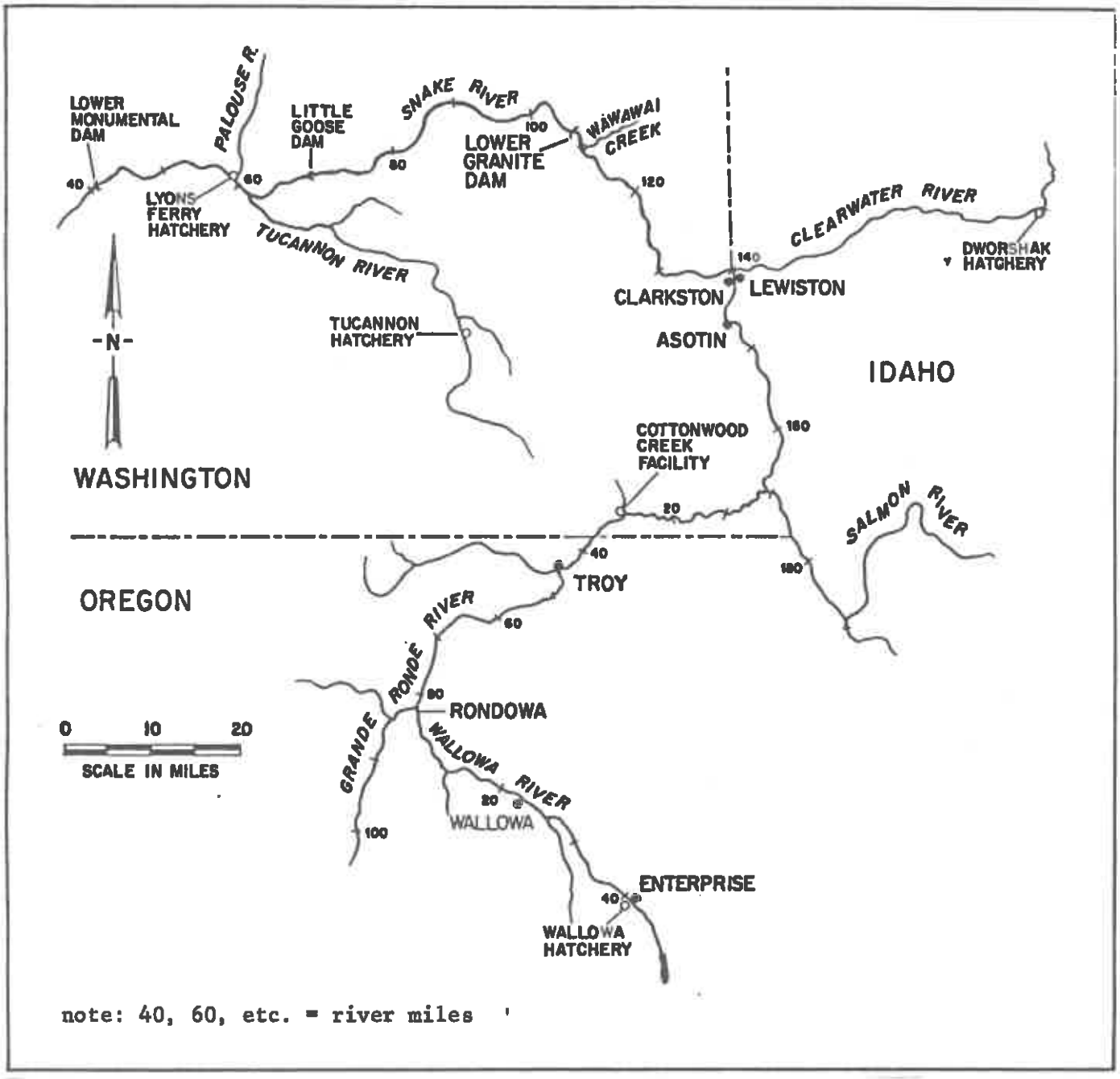


Figure 1. Study area map and relative locations of sites identified in this report.

RESULTS

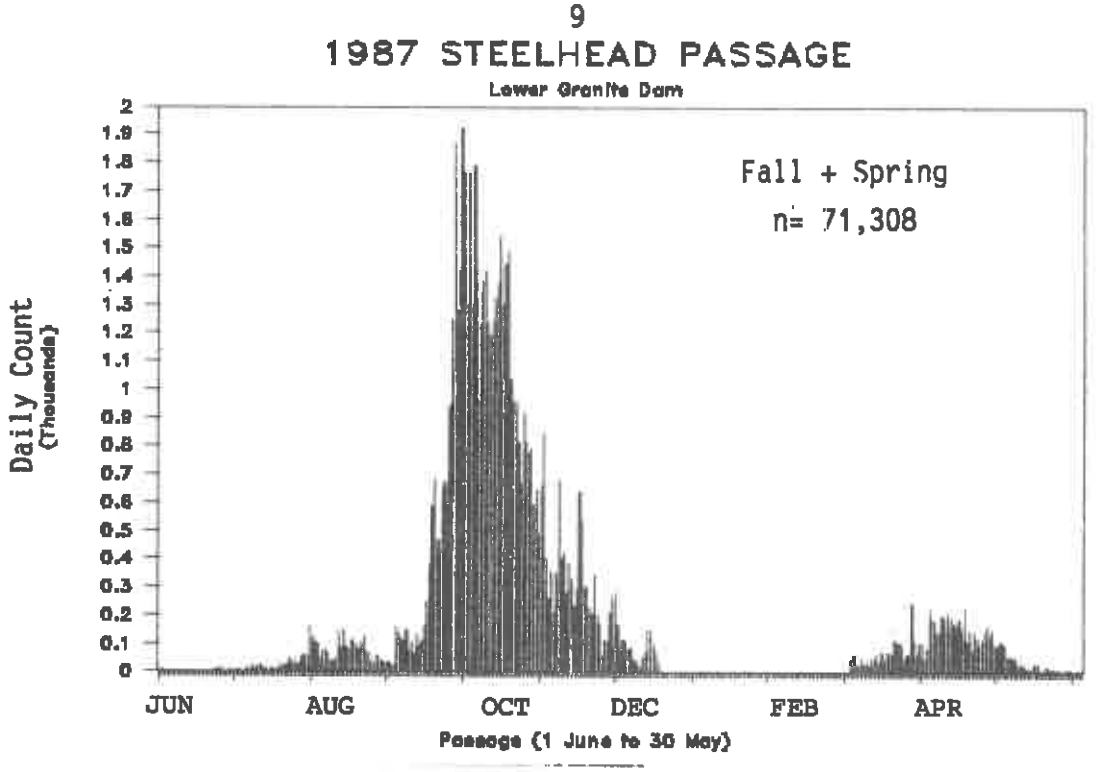
Forty-two (42) separately identifiable frequencies were initially implanted into adult steelhead at Lower Granite Dam. We attempted to tag fish in proportion to the run timing over LGD (Fig 2). However, we were unable to implant tags during the early portion of the run (Figs. 3). Four transmitters were re-implanted because 2 of them were regurgitated immediately after release in the trap, and 2 transmitters were returned by anglers shortly after release. Consequently, a total of 46 steelhead were tagged and released during the fall of 1987. We were unable to tag the desired number of 2-ocean aged steelhead (RA-H-2 brands) destined for LFH (Table 3). Specific information concerning all the steelhead tagged are presented in Appendix D. Small transmitters were regurgitated by 48.6 % of the combined recoveries of 1-ocean aged steelhead (Appendix E). A total of 10 fish were known to have been harvested in sport fisheries above LGO (Table 4). A summary of tracking and recovery data is presented in Appendix F.

Table 3. Steelhead implanted with radio transmitters at Lower Granite Dam, fall 1987 (32 fish tagged for ODFW and 5 reimplanted tags not shown).

Destination	Ocean Age	Brand	No. fish Tagged	Transmitter Losses [B]
LFH				
	1-ocean	LA-IK	10	0
		RA-IK [A]	1	
			11	0
	2-ocean	RA-H-2	6	0
G. RONDE				
	1-ocean	RA-IJ	13	1
	2-ocean	RA-17	16	1

[A] Wells stock steelhead from Lyons Ferry Hatchery; error - should have been LA-IK brand.

[B] Regurgitated in the trap at LGD.



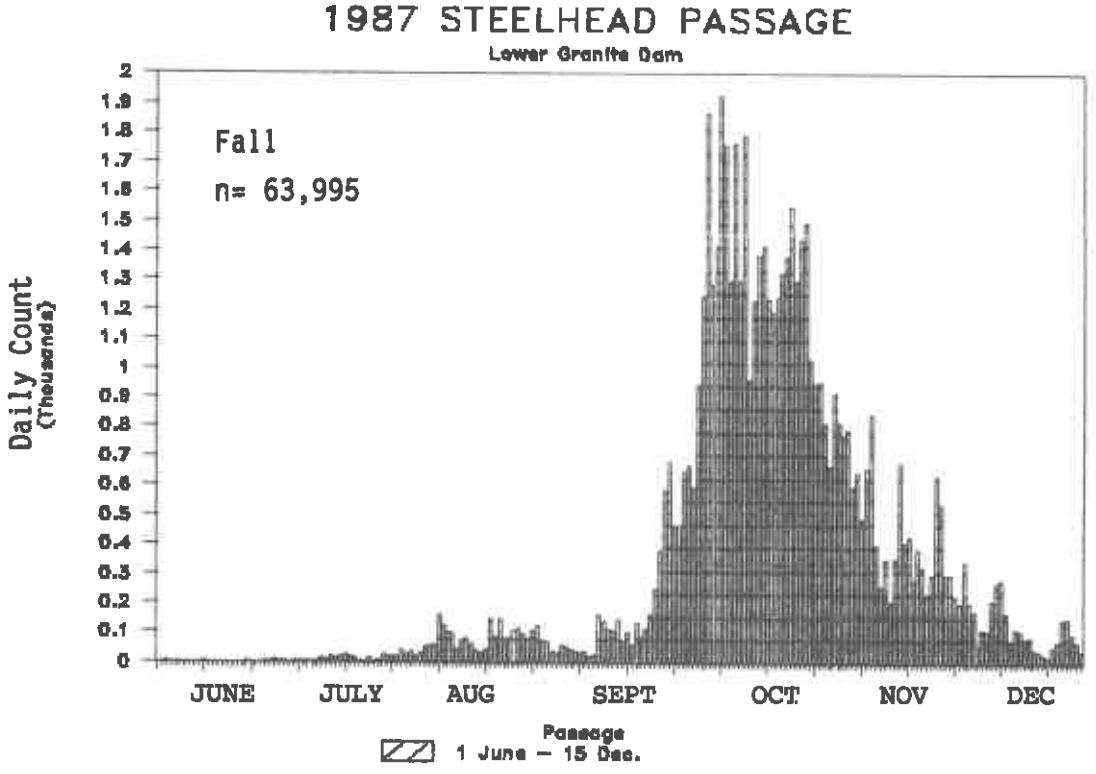


Fig. 2 Lower Granite Steelhead Passage, 1987-1988
(no passage from 15 Dec- 1 Mar)

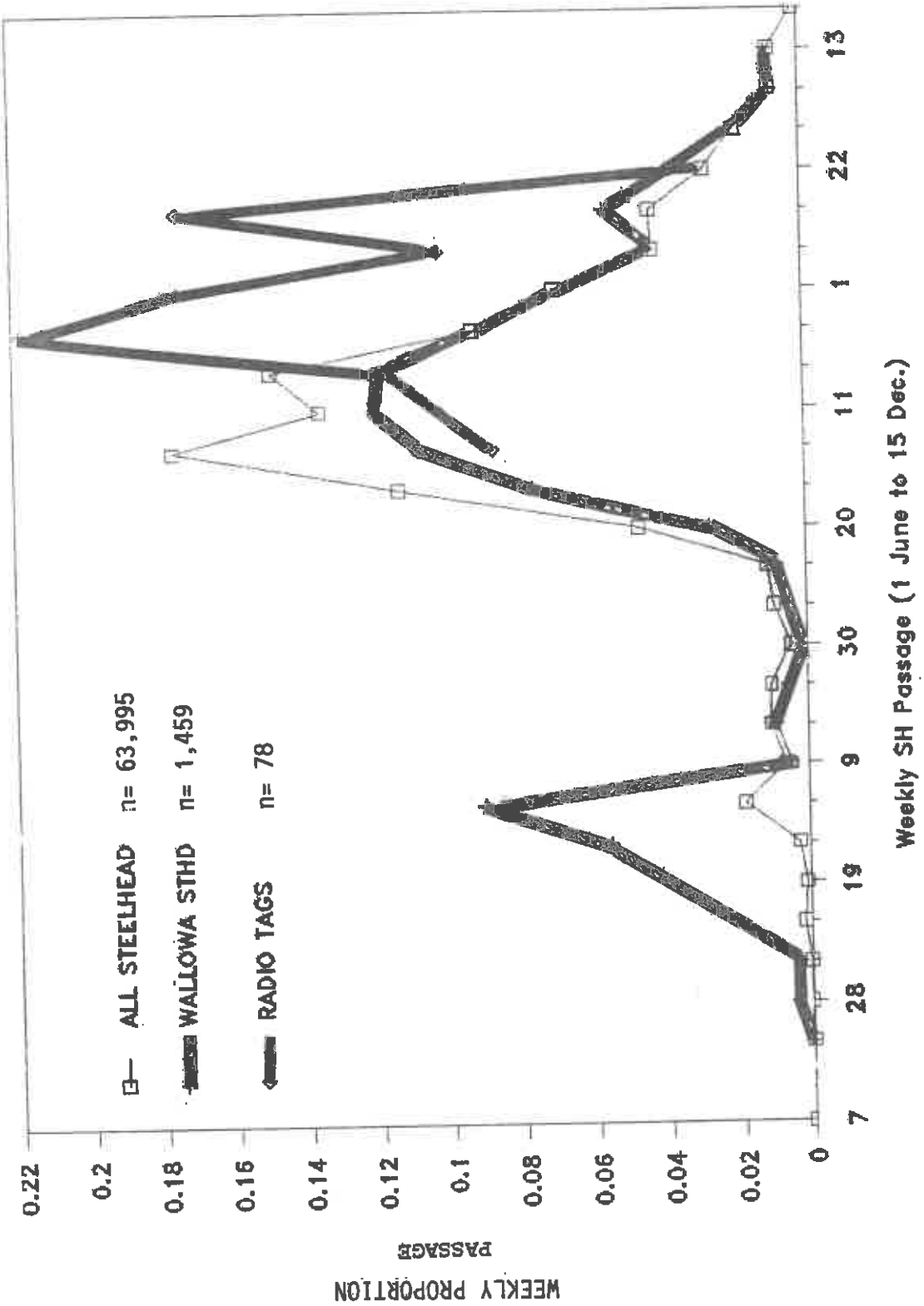


Fig. 3 Comparison of passage by Wallowa Stock steelhead with passage of all steelhead and radio tagging at LGD, fall 1987.

Table 4. Estimated exploitation rates for adult steelhead disk tagged at Lower Granite Dam, fall 1987.

Destination Ocean Age	No. Tagged fish Released	No. of fish caught			Total Exploit. rate (%)
		Snake	G. Ronde	Wallowa	
Lyons F. Hat.					
1-Ocean	11	1	--	--	9.1
2-Ocean	6	--	--	--	0.0
Cottonwood Pond					
1-Ocean	13	2	1	--	23.1 [A]
2-Ocean	16	4	2	--	37.5 [B]

[A] Snake R. exploit. rate = 15.4 %, G. Ronde = 7.7 %.
[B] Snake R. exploit. rate = 25.0 %, G. Ronde = 12.5 %.

General Migration Patterns

The maximum migration rate we documented from LGD to the free flowing Snake R. was 5 days (10.5 miles/ day). The fastest migration rates generally occurred in October. Three fish halted migration and began a holding pattern as early as October, but most fish continued to migrate until December before holding. Two of our tagged fish continued upstream movements for 8 and 17 miles in December and January, although daily movements covered relatively short distances. Several tagged steelhead in the free flowing portion of the Snake R. remained relatively stationary for 2.5 to 4 months.

Lyons Ferry Returns

We obtained relocation information from 10 of the 11 1-ocean aged, radio tagged (or disk tagged) fish destined for LFH. One fish was harvested in the sport fishery after only 1 radio relocation, thus it provided little tracking information. Only 3 of the 6 2-ocean aged tagged steelhead were relocated after release at LGD.

Although our sample size is small, the migrational pattern we documented for tagged fish destined for LFH was that of wandering in L. Granite Reservoir, or slightly farther upstream, and then returning to the dam (Fig. 4). Five of 7 fish (71 %), which were relocated numerous times during several months, are known to have remained in the reservoir for most of the winter, while 2 other fish spent a month or more in the free flowing portion of the Snake River. Only 1 of the 17 tagged LFH fish was ever relocated in the Clearwater River. Two of the 3 fish known

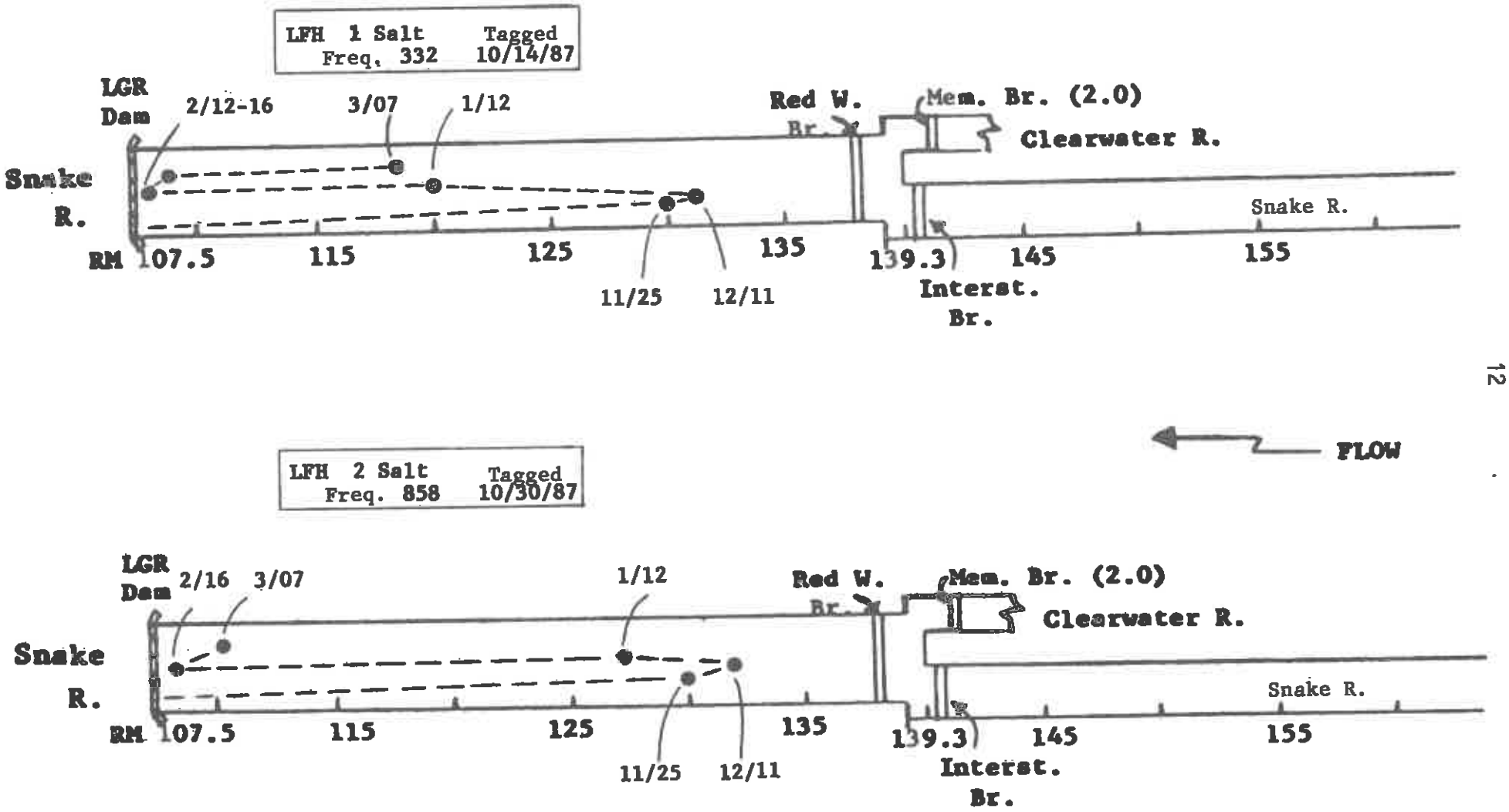


Fig. 4 Migrational patterns of tagged LFH fish in Lower Granite Reservoir. (Dates indicated for each relocation site).

to have left the reservoir returned to LGD in the spring (Fig. 5), and the other was caught by an angler. Tagged fish returned to LGD from December through April. One of our tagged fish was captured on the separator at the juvenile collection facility below LGD in April and recaptured 2 days later in the adult trap while reascending the fish ladder. Another fish was also recaptured in the adult trap in April while reascending the ladder only 6 days after it was tracked to the upstream face of the dam. We do not know the route taken by this fish to get downstream of the dam. Another tagged fish never moved more than 5 miles above the dam and in late April its transmitter was recovered from Wawawai Creek (RM 110.7) where the fish is presumed to have spawned.

Cottonwood Returns

We were able to track movements of many tagged fish in this group. Radio signals were relocated from 10 of the 13 tagged 1-ocean aged adult steelhead destined for Cottonwood C.P.. Five of these fish may have regurgitated transmitters in the Snake River as we had repeated tag relocations from the same general area and we were unable to document any further movement. One fish regurgitated its transmitter in the trap shortly after release at LGD and was later harvested in the sport fishery. No relocations were obtained from 2 other fish.

Eight 2-ocean aged steelhead destined for Cottonwood CP provided detailed radio tracking results. Radio relocations were available for another 7 fish. One of these fish may have regurgitated its transmitter in the Snake River. Only 1 steelhead regurgitated a transmitter in the trap.

Generally, movements were direct with little indication of searching or wandering. No tagged steelhead destined for Cottonwood C.P. were known to have entered the Clearwater or Salmon rivers in Idaho, nor to have passed the mouth of the Grande Ronde R. on the Snake by more than 10.5 miles. Most fish moved rapidly upstream after release and wintered in the Snake River near the mouth of the Grande Ronde River. Then in the spring they moved directly to the vicinity of Cottonwood C.P. where they remained (Fig. 6). Migration patterns for 1 and 2-ocean aged steelhead were similar.

Although we recognized general behavior patterns from the tagged fish, there was considerable variation in wintering behavior within this group. Four (23.5%) of the 17 fish with radio telemetry relocations either regurgitated their radio tag, were lost, or were harvested near the mouth of the Grande Ronde River. Another 10 fish (58.8%) over-wintered between Rm 164 and Rm 171. Two fish (11.8%) over-wintered in L.Granite or Little Goose reservoirs. A 1-ocean aged steelhead (5.9%) entered the Grande Ronde R. in mid December (water temperatures in the Grande Ronde R. were 33-40 ° F while 40-47 ° F on the Snake R.) wintered

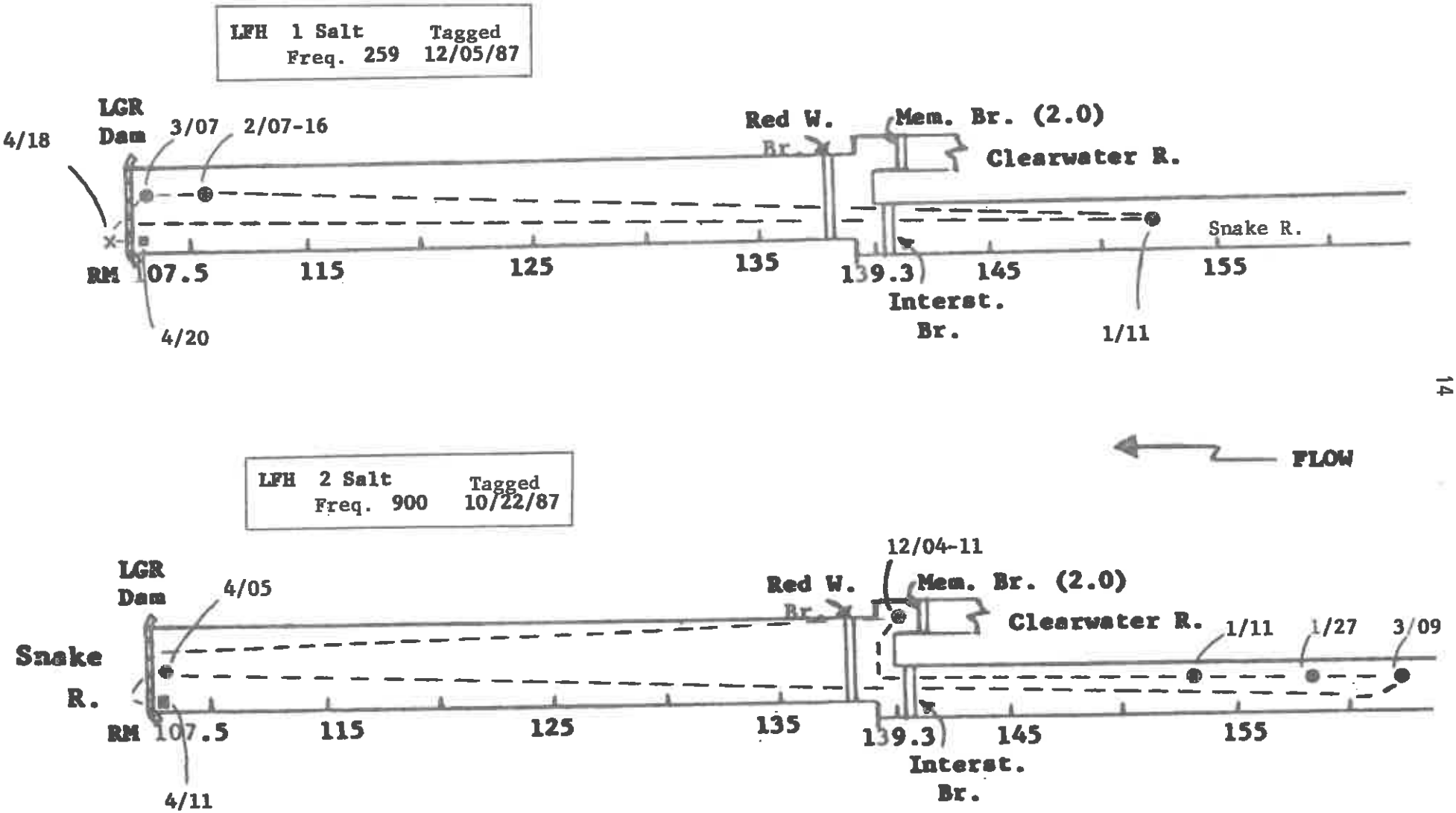


Fig. 5 Migrational patterns of tagged LFH fish above Lower Granite Dam, fall 1987 and spring 1988. (Dates indicated for each relocation site).

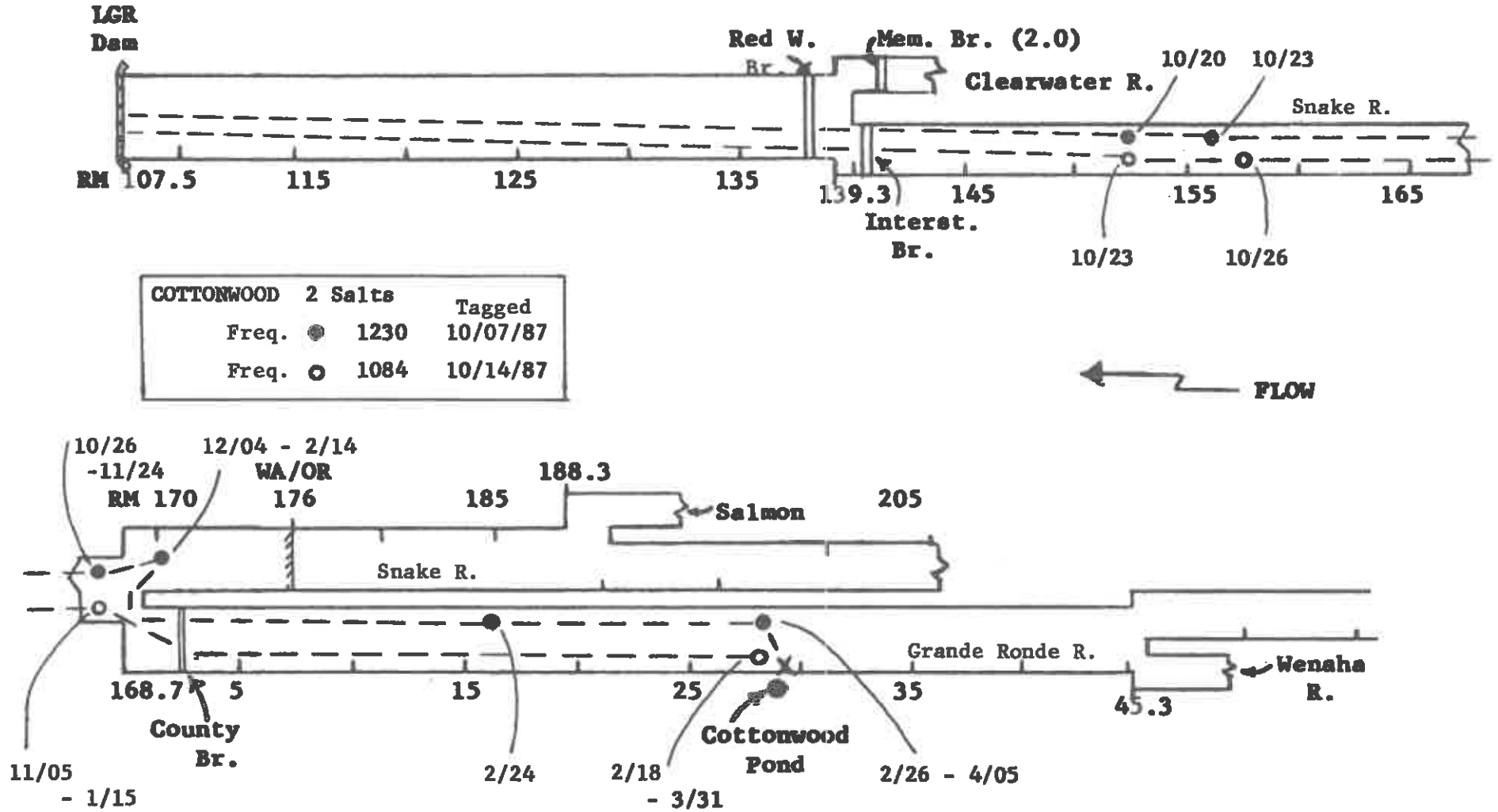


Fig. 6 Migrational patterns of tagged Wallowa stock steelhead destined for Cottonwood C.P., fall 1987 and spring 1988. (Dates indicated for each relocation site).

in the lower 2 miles of the Grande Ronde R. before moving near Cottonwood C.P. in mid February. Its signal was last relocated just above the mouth of the Wenaha River, about 17.6 miles upstream of Cottonwood C.P., however in late April its spawned out carcass and transmitter were found in Wawawai embayment, 3.2 miles above Lower Granite Dam. Eight other fish provided too few data for interpretation.

No 2-ocean aged fish entered the Grande Ronde R. before late January. Most fish we were able to track entered the Grande Ronde R. between late January and early April.

Six tagged steelhead were recovered at the outlet of Cottonwood C.P.. An additional 3 fish were caught by anglers on the Grande Ronde R. near the mouth of Cottonwood Creek, while 2 other fish known to be in the vicinity were never recovered.

DISCUSSION

The regurgitation of transmitters forced us to tag more fish than we had proposed. Yet our sample sizes for studying migration behavior were still smaller than we desired. We experienced unacceptably high regurgitation rates for the small transmitters. The addition of compressed sponge apparently had no affect in reducing the regurgitation rate. A larger piece of sponge may have been more effective in preventing regurgitation.

Tag returns from this study provided exploitation rates that exceeded our previous estimates from jaw tags or cwt returns (Schuck and Mendel 1988). Snake River exploitation rates for disk tagged fish was 15.4 % and 25 % for 1-ocean age and 2-ocean age fish respectively. Wallowa steelhead destined for Wallowa Hatchery in Oregon (n=32) confirm our exploitation estimate for 1-ocean age fish in the Snake River (Carmichael et al. 1989). The average estimated Snake River exploitation rate based solely on jaw tag returns for the fish in this study was 10.3 %, while exploitation based on combined returns of disk tags and transmitters was 20.6 %. Total sport exploitation that occurred in the Snake and Grande Ronde rivers was 31 % for the two age groups. We don't know whether the increased returns of disk and radio tags occurred because of greater public awareness, higher visibility of the disk tags, or because of higher monetary rewards for our transmitters and disk tags. We have previously stated that the jaw tag exploitation estimates should be considered <u>minimum</u> exploitation rates (Mendel et al. 1987, 1988). This study tends to confirm that assertion. No jaw tags or disk tags were lost from any tagged fish recaptured in this study.

General Migration Patterns

The migration rates we were able to document through Lower Granite Reservoir were slower than the average migration time of 4 days observed by Stabler (1981) and Ringe (unpubl. data). Falter and Ringe (1974) found that time of year and water temperature had the most effect on steelhead migration rates in the Snake River. They indicated that after October, steelhead rested with greater frequency and for longer periods, with movements generally restricted to less than 0.6 mile/day at water temperatures between 32° and 52°F.

McMaster et al. (1977) describe "over-wintering behavior" as; 1) slow movement upriver with frequent and prolonged stops, 2) limited downriver movements, and 3) concentrated in the upper 2/3 of the reservoir. They state that "over-wintering" began in late October in Lower Monumental Reservoir when movements were generally less than 0.6 miles/day. Stabler (1981) found that over-wintering behavior began on the Clearwater R. in November when water temperatures dropped to 41°F. Most of the fish we tracked through the winter held in areas of runs or glides. Stabler (1981) describes over-wintering areas as smooth laminar flow in the middle or lower end of glides.

Most of the tagged fish destined for the Grande Ronde R. in Washington or Oregon over-wintered near the confluence of the Snake and Grande Ronde rivers (see also, Carmichael et al, 1989). The longest duration of holding, or over-wintering behavior, that we documented for all tagged fish destined for the Grande Ronde R. (Cottonwood C.P. or Wallowa Hatchery) was from 20 October to 24 February (n = 26 fish with over-wintering data available). We were unable to correlate the cessation of migration with water temperatures in the upper river, or identify over-wintering behavior for fish in the reservoirs because of the sporadic relocations for each fish. Migration generally resumed in late January or February for both groups of fish.

We documented an unexpected movement of 5 1-ocean aged steelhead (4 of which were destined for Wallowa H.) into the Grande Ronde River between 4 and 23 December (Carmichael et al, 1989). Water temperatures were generally 7°F colder in the Grande Ronde than in the Snake River during the period of fish movement. These 5 fish had previously been relocated in the Snake R. within 4 miles either upstream or downstream of the confluence of the Grande Ronde R. on 4 or 8 December. They were relocated within the lower 9.4 miles of the Grande Ronde R. by 23 December (4 of the 5 fish were at RM 2.3 or below). By 20 December, water temperatures on the Grande Ronde R. were consistently below 34°F and the river had turned to slush. These fish remained stationary until 21 January, at which time stream flows increased, water temperatures warmed to 34°F and all fish moved upstream 1-2 miles. Stabler (1981) indicated that "over-wintering is not caused by physiological inability of steelhead

to swim quickly in cold water". The activity of these 5 fish on the Grande Ronde R. suggest that steelhead can move in cold water and they may even select cold waters.

Lyons Ferry Returns

Relocating radio instrumented fish was difficult in the deep, wide, reservoirs because we had limited signal range from our transmitters over 20 ft deep. We were relatively ineffective in relocating tagged fish in the reservoirs by using boat or automobile. This was in contrast to the tracking results of other studies within L. Granite Reservoir where tracking by boat or vehicle was successful (Bjornn and Ringe 1982, Falter and Ringe 1974, Stabler 1981). Use of a lower frequency range (30 mhz) transmitter could have improved our reception in deep water and provided results similar to those of other studies. Monthly flights with multiple passes provided us the only consistently reliable means of relocating transmitters within the reservoir.

The fact that most of the tagged fish remained in, or near, the reservoir, and that they returned to the dam (particularly during the spring), would suggest that they were not "lost" but that they were attempting to return downriver to their original release locations. It is not uncommon for steelhead to winter upstream of their place of release and then return downstream to spawn. Pettit (1977) and Pettit and Lindland (1979) documented such behavior for Clearwater R. B-run steelhead wintering in the upper Clearwater R., or in the Snake River above the mouth of the Clearwater River. They found most of these fish returned successfully to Dworshak National Fish Hatchery (NFH) in the spring. Stabler (1981) indicated that steelhead historically wintered in the reservoir area before LGD was built, and that after the dam's closure most steelhead preferred to remain in the upper portions of the reservoir or in the free flowing Snake River. McMaster et al. (1977) also noted that steelhead preferred to winter in the upper 2/3 of Lower Monumental Reservoir on the lower Snake River. Thus, it appears that L. Granite and other lower Snake River reservoirs encompass portions of the river that were historical wintering areas for steelhead, and that the reservoirs can influence where steelhead will hold.

Radio telemetry techniques are insufficient to address all the questions that arise concerning steelhead destined for LFH but that pass above LGD. Therefore, jaw tagging, enumeration of branded steelhead crossing LGD, and stream surveys for spawning adults were used to supplement the data obtained by this radio telemetry study.

Steelhead of both Wells and Wallowa stocks that were released into the Tucannon River, and at LFH, have migrated upstream of LGD over the past several years (Schuck and Mendel 1987, Schuck et al, 1988). Additionally, returning Lyons Ferry

stock steelhead released at both locations have been recently captured at LGD (unpubl. data from Jerry Harmon, NMFS). Consequently the migration pattern of returning steelhead, destined for the lower Snake River, but passing above LGD, does not appear to be stock specific. Nor does it appear related to the specific release location of smolts in the lower Snake River drainage.

As much as 1% of steelhead released as smolts at LFH, or the Tucannon River, returned to above LGD during 1982-1984 (Schuck et al, 1988). However, returns of steelhead destined for the Grande Ronde R. are of a similar magnitude at LGD. This leads us to believe that most of the steelhead in these lower river groups are passing Lower Granite Dam. This could be a problem for the LFH hatchery program if steelhead are unable to return downriver. Until we have some way to recapture greater numbers of returning steelhead at LFH and/or the Tucannon River during the spring it is impossible to definitely ascertain the magnitude of this behavior or the severity of this potential problem.

Data from our jaw tag returns suggest that a few steelhead are able to negotiate the dams and reservoirs and return downriver to either the Tucannon River and/or LFH (Table 5). However, we do not know the percentage or the actual numbers of fish that are able to return to their point of release.

Table 5. Recaptures of steelhead destined for LFH or the Tucannon River that were jaw tagged at LGD.

Recapture Location	Recapture Year	# of steelhead
LFH	1986	3
	1987	10
	1988	0 *
Tucannon R.	1988	3

* No recaptures because the ladder at LFH was not operated in the spring of 1988.

Both steelhead with radio transmitters that are known to have passed downriver of LGD re-ascended the ladder a few days later and were recaptured in the adult trap. Thus, steelhead decending through the dam may become disoriented and reascend the ladder. This disorientation could increase straying during the spring as steelhead ripen and are unable to freely move downriver because of the dam. Dworshak NFH, the nearest hatchery above LGD (approx. 75 mi.), received 9 steelhead with LFH or Tucannon R. brands in 1987, and 6 in 1988 (Ralph Roseburg, USFWS, Dworshak NFH, pers. comm.). Also, many hatchery fish were found spawning

in Wawawai and Offield creeks, small tributaries of the Snake River above LGD (Table 6). Offield Creek (approx. RM 109) was only accessable to steelhead for about 0.2 miles, as was Wawawai Creek (RM 110.7). These two streams were shallow, turbid creeks with mud or severely embedded gravel substrates. Adult steelhead were so abundant that carcasses littered the streams and eggs were exposed on the surface of the substrate. None of the other streams we examined above or below LGD contained any evidence of steelhead spawning. Also, 2 carcasses (both wild females) and a live, adipose-clipped steelhead were observed along the shoreline in Offield embayment. These fish may have spawned in the vicinity or they may have been in the area as migrating kelts. Thus, steelhead that may be blocked by the dam apparently will spawn wherever possible when ripe, even in unsuitable habitat. Interestingly, we did observe 10 wild (or naturally produced) steelhead and 3 Wells stock hatchery fish of the 80 total adults sampled. This may suggest that wild fish, and two hatchery stocks released at LFH or the Tucannon R., are displaying similar migration and spawning behavior.

Table 6. Results of searches for tagged steelhead in tributary streams near LGD, spring 1988.

Creek	Approx. Length of stream sampled (mi)	No. adult steelhead recovered	No. fish with marks*	Origin of Marks (No. of fish) LFH	Tuc. R.	Other
Steptoe	0.2	0	0			
Wawawai	0.2	52	11 [A]	5	2	1 [B]
Offield	0.15	28	9 [C]	6 [D]	1	0
Almota	0.3	0	0			
Casey	0.1	0	0			
		80	20	11	3	1

* Tags or LV clips.

A Includes 3 LV fin clipped fish with snouts not taken or no cwt found - unknown origin.

B 1 carcass with disk tag, jaw tag, and radio transmitter that were put in a fish destined for the Grande Ronde (RA-IJ brand).

C Includes 1 LV fin clipped fish with no snout collected - unknown origin.

D Includes 3 fish of Wells stock.

Cottonwood Returns

Tagged steelhead destined for Cottonwood C.P. generally did not wander into non-parent waters. No tagged fish were relocated in the Clearwater River. This was unexpected based on the results of previous radio telemetry studies in the Snake River (Falter and Ringe 1974, Bjornn and Ringe, 1982; Stabler 1981). It is possible that because we did not implant any transmitters prior to early October we did not observe any entry of Wallowa stock fish into the Clearwater River. Pettit and Lindland (1979) and Stabler (1981) indicated that many of their tagged steelhead destined for tributaries of the upper Snake R. left the Clearwater R. and resumed migration in the Snake R. in October when flows decreased in the Clearwater.

We documented only a slight amount of wandering by several fish that migrated a short distance (maximum of 10 miles) upstream on the Snake R. above the mouth of the Grande Ronde R., and 1 fish passed Cottonwood Creek by more than 7 miles. The recovery of this fish (freq. 48.161) at Wawawai embayment is puzzling. We do not know if this fish spawned near Cottonwood Creek, or upstream in the G. Ronde drainage, or near Wawawai Creek. The fish could have spawned in the Grande Ronde drainage and died near Wawawai as a downstream migrating kelt.

All known tagged steelhead over-wintered in areas where substantial winter fisheries occur. Many tagged fish wintering in the Snake R. near the mouth of the Grande Ronde were under constant fishing pressure for 3-6 months, and yet they were not caught. Other fish remained in Little Goose or L. Granite reservoirs where the fisheries are less intense. There is no evidence from this study that these hatchery fish enter the Grande Ronde in the fall or provide any fishing opportunity there prior to mid February. Harvest estimates based on punchcard returns (200 fish in 1986-87 and 293 in 1987-88) for the only recent consumptive fishing seasons confirms that the large numbers of hatchery fish returning to the Grande Ronde are not being harvested there. Some spring fishing currently occurs at the mouth of Cottonwood Creek.

Tagged Wallowa stock steelhead destined for Oregon demonstrated very similar results to our fish destined for Cottonwood C.P. (Carmichael et al. 1989). Wallowa stock steelhead returning to Wallowa Hatchery wintered in the same areas (with two exceptions) of the Snake River as our Cottonwood returning steelhead and were likewise unavailable for a fall fishery on the Grande Ronde R.. Exploitation on the Snake River, based on disk tag returns, while higher than was low for both groups of fish.

CONCLUSIONS

Our primary objectives for the radio telemetry study were to document migration patterns for Wallowa stock steelhead released at LFH and in the Grande Ronde basin, determine their availability to sport fisheries, and account for unexplained losses or the failure of adult fish to return to their point of release.

We currently have no reason to believe that the migration behavior of fish released in the lower Snake River and crossing LGD to over-winter is stock specific. Nor does it appear from our small sample size that LFH fish above LGD are lost, but may only be seeking favored or traditional wintering areas. These fish are in an area subjected to substantial fishing pressure during winter months. Many fish may be unable to return downstream through the dams to their release sites. Those fish that are unable to pass downstream of the dams then appear to stray. Straying of fish to Dworshak NFH and small tributary streams above LGD seem to be restricted primarily to steelhead released in the Tucannon R. or at LFH. Few or no other brands or tags are recovered at Dworshak NFH or the tributary streams. The limited data we have to date suggest that wild fish destined for spawning areas in the lower Snake R. may also be crossing LGD and then straying into poor habitat tributaries to spawn. Straying fish may account for some of our previously unexplained losses. We must be able to sample a greater number of fish at LFH and the Tucannon River in the future to: 1) determine the magnitude of wandering by lower river release groups, and 2) the proportion of those fish crossing LGD that are able to return to their point of release.

Tagged fish destined for the Grande Ronde drainage demonstrated little wandering. Most fish over-wintered in a small portion of the Snake River near the mouth of the Grande Ronde. Tagged steelhead unexpectedly entered the Grande Ronde River from warmer water in the Snake River. We were unable to identify any "trigger" that initiated this relatively simultaneous movement by 5 fish. These 5 tagged steelhead destined for Cottonwood C.P. or Wallowa Hatchery were the only fish known to have entered the Grande Ronde R. prior to January. Most other fish wintered in an area of intense fishing on the Snake River for as much as 4 months, although few were harvested. As a result of over-wintering on the Snake R. these hatchery fish were not available to provide the fall steelhead fishery on the Grande Ronde as was intended.

Our use of ATS equipment is not an endorsement or a recommendation for this equipment. ATS provided several features that we desired, but the receivers proved difficult to use for tracking large numbers of frequencies over large areas. The lack of "noise" filtration and the slow scan rate made it difficult to rapidly and accurately search for 60-70 frequencies over many

river miles. A receiver that includes lights for visual detection of a frequency as well as simultaneously searching all frequencies would substantially improve the speed and ease of detecting signals. Man-hours and costs of tracking activities could be reduced considerably.

The small transmitters must be modified in the future to reduce regurgitation rates and provide reliable tracking data for reasonable sample sizes of fish. One additional month of battery life in the transmitters would have helped us interpret data for some tags. We were unable to determine whether some tag relocations represented wintering fish or were tags regurgitated prior to loss of radio signal.

We cannot be positive that our results are representative of a "typical year" due to drought conditions during the study. Also, we did not tag early returning Wallowa stock steelhead in July - September, thus we were unable to describe their migration behavior above Lower Granite Dam.

Changing stocks may have little effect upon the migration behavior of fish released at LFH or the Tucannon River. However, it may be justified and desirable to change stocks for release in the Grande Ronde drainage to improve the fall steelhead fishery in the Grande Ronde River. However, we do not intend to base our evaluations of the Wallowa stock of hatchery steelhead solely on the results from our radio telemetry study. Returning Wallowa stock steelhead have been tagged at Lower Granite Dam for several years and have provided valuable data. We will continue to tag large numbers of returning adults destined for Cottonwood C.P. in order to further evaluate their magnitude and timing of entry into the Grande Ronde River fishery. This tagging will supplement our telemetry study and provide a larger sample size of fish, as well as provide results over several years. We also plan to tag returning steelhead from other stocks destined for lower Snake River release sites as they cross LGD. Sampling at LFH and the Tucannon R. will be intensified, if possible, to recapture returning jaw tagged steelhead and to determine the magnitude of upriver wandering.

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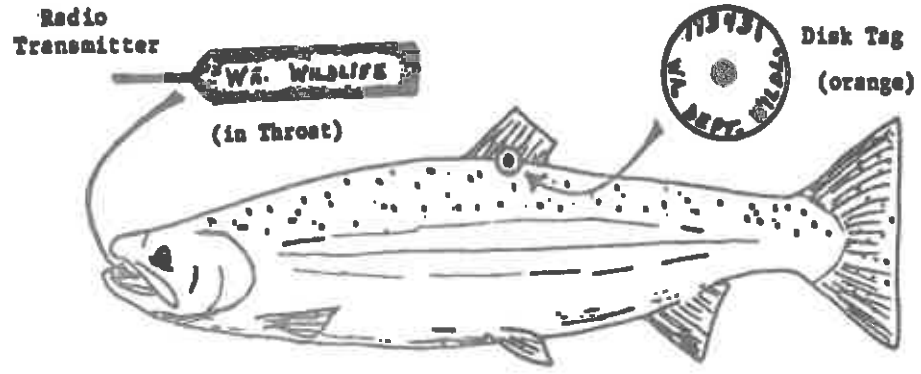
Appendix A. KEY RADIO TELEMETRY SEARCHES
by WDW personnel

River	Date of Search	Comments
Snake	10/4	1st boat search of reservoir to Asotin
LGR	10/9	1st vehicle search of LGR
	11/25	1st fixed wing flight of LGR to Central Ferry
	12/11	fixed wing
	1/12	fixed wing
	2/16	fixed wing
	3/7	fixed wing of LGR and LGO
	3/27	last boat check of LGR
	4/29	last vehicle search of LGR
Snake	10/10	1st vehicle search
upper	10/15	1st helicopter flight - bad antenna - no data
	10/20	1st boat search
	10/27	1st successful helicopter flight
	11/13	helicopter flight - includes lower 10 miles of Salmon R. and to Dug Bar
	11/24	helicopter flight
	12/23	helicopter flight to Pittsburg Landing
	3/5	last helicopter flight
	3/12	last boat search
	3/27	last vehicle search
G. Ronde	10/10	1st vehicle search
	10/15	1st helicopter flight - bad antenna
	10/27	1st successful helicopter flight
	11/24	helicopter - mouth to Cottonwood.
	12/23	helicopter to Shumaker Ck.
	2/24	vehicle search of upper G. Ronde above Bogans
	3/2	vehicle search of upper G. Ronde above Bogans
	3/5	last helicopter flight to Cottonwood
	3/9	vehicle search of upper G. Ronde above Bogans
	3/14	vehicle search of above Bogans to wildcat
	3/19	vehicle search of above Bogans to OR state line
	3/22	vehicle search to abv. Cottonwood
	3/27	vehicle search to abv. Cottonwood
	3/31	vehicle search of above Bogans to 4 miles abv Troy
	4/19	vehicle search to above Cottonwood
	4/27	last vehicle search to abv. Cottonwood
Clearwater		
	10/16	first vehicle search to Potlatch Creek
	11/25	1st fixed wing flight to Lenore
	12/11	fixed wing flight to Spaulding
	1/12	fixed wing flight to Lenore
	2/16	last fixed wing flight to Potlatch Mill
	3/6	vehicle search to Orofino - last

Appendix B. Reward poster for transmitter and tag recovery program, 1987-1988.

REWARD!!

$15.00 for the return of a radio transmitter and $2.00 for the attached disk tag. The date, and specific location of capture must be included. (Only steelhead with disk tags have radio transmitters).



The Washington Dept. of Wildlife and the Oregon Dept. of Fish and Wildlife are conducting a research project to study migration behavior of hatchery steelhead. Radio transmitters have been implanted this fall at L.Gr. Dam.

You can help by returning all tags, transmitters and related information to a Tag Return Box located at the Asotin Check Station, Wenaha Wildlife HQ (Grande Ronde R.), or a Dept of Wildlife employee. Or protect the tags in a small box and mail to:

Washington Dept. of Wildlife
N. 8702 Division, Spokane, WA 99218

Serving Washington's wildlife and people now and in the future

Tel. (509) 456-4082

THANK YOU !

OREGON
Fish & Wildlife

Appendix C. River mile locations (adapted from Corps of Engineers River mile index and navigation charts for the Snake River and its' tributaries).

River Mile	Location Description
58.0	Lyons Ferry Hatchery
70.3	Little Goose Dam
82.5	Central Ferry
107.5	L. Granite Dam
108.5	Offield
110.7	Wawawai
113.7	Granite Point
119.6	Blyton
128.2	Steptoe Ck.
130.6	Alpowa Ck.
134.3	Port of Wilma
139.1	Idaho State Line
139.3	Mouth of Clearwater R.
0.6	RR bridge
2.0	Memorial Br.
4.2	Gage Station
7.0	Hatwai Ck.
9.5	Hog Island
139.6	Interstate Br.
143.7	Hellsgate Ck.
145.3	Asotin Creek
146.0	Hen and Chicks
149.4	10 mile rapids
150.3	10 mile Creek
155.5	Red Bird Ck.
157.6	Couse Ck.
159.7	Buffalo Rapids (Buffalo Eddy 160.6)
162.5	Captain John Ck.
163.5	Captain John Rapids
164.9	Billy Ck.
166.5	Lewis Rapids
167.3	Anatone gage
168.7	Mouth of Grande Ronde R.
1.5	Shadow hole
2.5	County Bridge
4.3	Joseph Ck.
4.4	Narrows
15.7	Shumaker Ck. (4.4 miles of access)
18.6	upper Shumaker
26.2	Rattlesnake Ck.
28.7	Cottonwood Ck.
30.7	Cougar Ck.
35.9	Wenatchee Ck.
37.0	Oregon State Line
40.0	Grouse Ck.
45.2	Gage at Troy
45.3	Mouth of Wenaha R.

53.3	Wildcat Ck.
81.4	Mouth of Wallowa R. (Rondowa)

Appendix C. (cont')

River Mile	Location Description
81.4	Mouth of Wallowa R. (Rondowa)
9.8	Minam
10.1	Mouth of Minam R.
40.5	Mouth of Spring Ck.
0.5?	Wallowa Hatchery
164.3	LaGrande
169.0	Rogersburg
169.5	Lime Rapids
169.6	Lime Point
172.5	Deer Head Rapids
173	Wild Goose Rapids
174.4	Shovel Creek Rapids
176	China Gardens Rapids - Oregon State line.
176.4	Cougar Rapids
178.5	Cochran Island Rapids - Cougar Bar
188.3	Salmon River
9.8	Eagle Creek

Appendix D. Fish implanted with transmitters, at L. Granite Dam, fall 1987.

FREQ.	DISK TAG No.	DATE TAGGED	FISH LEN (cm)[B]	FISH SEX	BRAND [A]	JAW TAG #	
48.080	14	10/07	60	M	RA-IJ-3	GR396	
48.080	65	11/12	62	M	LA-IK-1	GR652	
48.090	74	11/12	62	M	LA-IK-3	G18858	
48.101	60	10/02	59	M	LA-IK-3	GR360	
48.111	42	10/07	60	M	LA-IK-3	G18855	
48.150	59	10/07	58	M	RA-IJ-3	GR400	
48.161	48	10/02	60	F	RA-IJ-1	GR353	
48.171	67	10/07	64	F	RA-17-1	GR397	
48.180	75	10/02	60	F	RA-IJ-3	GR352	
48.191	11	10/02	62	F	RA-IJ-3	GR354	
48.211	18	12/05	60	M	RA-IJ-3	G19069	
48.259	22	12/05	64	M	LA-IK-3	GR680	
48.270	81	12/13	60	M	RA-IJ-1	GR684	
48.279	85	10/22	60	M	RA-IJ-1	GR554	*
48.312	32	11/12	65	F	RA-17-3	GR651	
48.322	30	10/23	58	M	LA-IK-3	GR561	*
48.332	21	10/14	59	F	LA-IK-1	GR474	
48.340	77	12/13	62	M	LA-IK-1	G9074	*
48.361	98	11/03	56	F	RA-IJ-1	GR621	*
48.370	10	10/22	64	M	RA-IK-1	G18718	*
48.381	16	10/22	59	M	RA-IJ-4	GR555	*
48.421	80	10/23	58	M	RA-IJ-3	GR565	*
48.430	93	11/12	64	M	RA-IJ-1	G19030	
48.441	8	10/29	59	F	RA-H-2	GR604	
48.500	66	10/22	60	M	LA-IK-3	GR556	*
48.541	40	10/14	60	F	LA-IK-3	GR471	
48.731	97	10/14	62	M	RA-IJ-1	G18912	
48.748	82	11/12	71	M	RA-17-1	G21510	
48.840	28	11/21	71	F	RA-17-3	G19055	
48.840	36	12/13	66	F	RA-H-2	G19073	
48.858	1	10/30	67	F	RA-H-2	G18999	
48.900	15	10/22	73	F	RA-H-2	G18958	*
48.931	7	11/17	69	F	RA-17-1	G19047	
48.952	37	10/07	77	M	RA-17-3	G21475	
48.969	20	11/10	70	F	RA-H-2	G19027	
48.990	100	10/23	72	F	RA-17-3	G18908	*
49.030	68	10/14	68	F	RA-17-3	G18905	
49.072	72	10/14	77	M	RA-17-1	G21486	
49.084	69	10/14	70	F	RA-17-3	G18907	
49.100	17	10/02	71	F	RA-17-3	G18812	
49.100	57	11/21	69	F	RA-17-3	G19054	
49.129	50	10/22	70	F	RA-17-1	G18957	*
49.150	90	11/21	74	F	RA-17-1	G19052	
49.170	31	10/22	68	F	RA-17-1	G18956	*
49.170	45	12/05	68	F	RA-H-2	G19068	
49.230	6	10/07	73	F	RA-17-3	G18853	

Total fish tagged = 46 [C]

[A] RA-17; RA-IJ ; = COTTONWOOD POND on the GRANDE RONDE R. 1985 and 1986 release, respectively: RA-H-2, LA-IK = LYONS FERRY HATCHERY release for 1985 and 1986.

* Sponge added to outside of transmitter.

[B] Large transmitters for all fish > 65 cm.

[C] An additional 32 fish were tagged for ODFW, see Carmichael et al, 1989.

Appendix E. Estimated regurgitation rates of radio transmitters implanted at LGD, fall 1987. ^

Recovery Type	# Recoveries with transm.	# Recoveries without transm.	Total # of Recoveries	Regurgitaion rate (%)
Big Transmitters				
Sport	4	1	5	20.0
Rack	4	0	4	0.0
LGD Recapture	1	0	1	0.0
Total	9	1	10	10.0
Small Transmitters				
Sport	9	12	21	57.1
Rack	4	4	8	50.0
Spawning Survey	2	0	2	0.0
LGD Recapture	3	1	4	25.0
Total	18	17	35	48.6
Immediate Regurgitation				
Big Transmitters	0			
Small Transmitters	7			

^ Includes fish tagged for ODFW.

Appendix F. Summary of observations of disk and radio tagged Wallowa stock summer steelhead in the Snake and Grande Ronde river basins.

ocean-age tag frequency	Date Tagged	Snake River No. obs.	Snake River Time period	Snake River River miles	Grande Ronde River No. obs.	Grande Ronde River Time period	Grande Ronde River River miles	Recovery Type	Recovery Location	Recovery Date
Lyons Ferry Hatchery										
1-ocean										
48.080	11-12-87	2	11-29-87	108.5-114.0						
48.332	10-14-87	7	11-25-87 to 03-07-88	108.5-131.0						
48.340	12-13-87	2	02-14-88 to 03-07-88	108.5-143.7						
48.090	10-07-87	3	10-11-87 to 11-25-87	107.5-134.0						
48.101	10-02-87	2	11-25-87 to 12-13-87	108.0-130.0						
48.111	10-07-87	11	10-09-87 to 01-30-88	107.5-110.7				spawning ground survey	Wawawai Creek(Rm 110.7)	04-29-88
48.259	12-05-87	4	01-11-88 to 03-07-88	107.5-152.0				smolt separator (recapture)	Lower Granite Dam	04-18-88
48.322	10-23-87	1	10-24-87	107.5						
48.500	10-22-87	1	11-19-87	150.0				sport catch	Snake River(Rm 150.0)	11-27-88
48.541	10-14-87	4	12-11-87 to 03-07-88	107.5-119.0						
48.370[a]	10-22-87	1	11-07-87	127.0						
2-ocean										
48.441	10-29-87	6	11-07-87 to 01-12-88	107.5-119.0						
48.840	12-13-87	0								
48.858	10-30-87	5	11-25-87 to 03-07-88	108.5-132.0						
48.900	10-22-87	3	12-04-87 to 12-11-87	0.5[b]						
		4	01-11-88 to 04-05-88	153.0-162.0				adult trap(recapture)	Lower Granite Dam	04-11-88
48.969	11-10-87	0								
48.170	12-05-87	0								
Cottonwood Creek										
1-ocean										
48.161	10-02-87	11	10-18-87 to 12-08-87	166.0-173.0	12	12-20-87 to 02-26-88	2.3-46.3	spawning ground survey	Wawawai Creek(Rm 110.7)	04-29-88
48.270	12-13-87	0[c]						sport catch	Wallowa River	03-13-88
48.279	10-22-87	4	10-26-87 to 11-24-87	157.0-170.0				sport catch	Snake River(Rm 170.0)	11-29-88
48.361	11-03-87	2	12-20-87 to 02-14-88	164.5-170.0	5	02-28-88 to 03-13-88	17.5-28.5	sport catch	Grande Ronde R.(Rm 28.7)	04-02-88
48.430	11-12-87	5	11-19-87 to 01-22-88	147.0-171.0						
48.731	10-14-87	7	10-14-87 to 12-04-87	108.5-169.0						
		17	12-06-87 to 02-14-88	169.0[d]				rack return	Cottonwood Cr.(Rm 28.7)	03-06-88
48.080	10-07-87	0[c]						sport catch	Snake River(Rm 168.0)	11-21-87
48.150	10-07-87	4	10-26-87 to 11-19-87	168.0-170.0						
		15	11-24-87 to 03-12-88	169.5[d]						
48.180	10-02-87	5	10-04-87 to 11-20-87	126.5-159.0						
48.191	10-02-87	9	10-27-87 to 02-14-88	165.0-179.0						
48.211	12-05-87	2	01-12-88 to 01-27-88	110.5-145.0						
		4	02-14-88 to 03-12-88	145.0[d]						
48.421	10-23-87	0								
48.381	10-22-87	3	10-26-87 to 12-04-87	149.0-154.0						
		4	01-11-88 to 03-01-88	153.0[d]				rack return	Cottonwood Cr.(Rm 28.7)	03-18-88

Appendix F. (cont')

Release location Ocean-age tag frequency	Date Tagged	Snake River No. obs.	Snake River Time period	Snake River River miles	Grande Ronde River No. obs.	Grande Ronde River Time period	Grande Ronde River River miles	Recovery Type	Recovery Location	Recovery Date
2-ocean										
48.171	10-07-87	2	10-20-87 to 11-13-87	170.0-176.5						
		3	11-24-87 to 02-21-88	176.5[d]				sport catch	Grande Ronde R.(Rm 28.7)	03-12-88
								rack return	Cottonwood Cr.(Rm 28.7)	04-04-88
48.748	11-12-87	6	12-04-87 to 01-27-88	167.0-168.0						
48.931	11-17-87	4	11-24-87 to 12-13-87	128.0-149.0						
49.072	10-14-87	15	11-24-87 to 02-14-88	160.5-166.0	7	03-02-88 to 03-27-88	28.5-29.0	sport catch	Grande Ronde R.(Rm 28.7)	04-03-88
49.129	10-22-87	18	10-27-87 to 02-06-88	150.0-169.0				sport catch	Snake River(Rm 169.0)	02-09-88
49.150	11-21-87	5	11-25-87 to 03-19-88	111.0-165.0				rack return	Cottonwood Cr.(Rm 28.7)	04-16-88
49.170	10-22-87	2	10-24-87 to 11-05-88	107.5-139.3				sport catch	Snake River(Rm 148.0)	11-20-87
48.312	11-12-87	1	11-17-87	107.5				sport catch	Snake River(Rm 70.5)	02-23-88
48.840	11-21-87	0[c]								
48.952	10-07-87	6	10-25-87 to 01-15-88	168.0-170.5	8	02-18-88 to 03-13-88	26.2-41.6	rack return	Cottonwood Cr.(Rm 28.7)	03-19-88
48.990	10-23-87	1	10-26-87	118.0						
49.030	10-14-87	28	10-20-87 to 02-24-88	166.0-168.5	8	03-02-88 to 03-31-88	28.7			
49.084	10-14-87	9	10-23-87 to 01-15-88	153.0-169.0	10	02-18-88 to 03-31-88	27.5-28.7			
49.100[e]	10-02-87	2	10-04-87 to 10-20-87	127.0-146.5				sport catch	Snake River(Rm 145.0)	11-11-87
49.100[e]	11-21-87	5	11-25-87 to 01-22-88	110.0-170.5						
49.230	10-07-87	24	10-07-87 to 02-14-88	108.0-170.5	11	02-24-88 to 03-31-88	16.3-28.7	rack return	Cottonwood Cr.(Rm 28.7)	04-05-88

a Wells stock steelhead (RA-IK-1 brand) radio tagged in error.
b Observations in Clearwater River, river mile 0.5.
c Transmitter regurgitated at Lower Granite trap site.
d Transmitter did not move, possibly regurgitated at river mile noted.
e Transmitter recovered from sport catch on 11-11-87 and implanted in another fish of same stock and age on 11-21-87.
f Transmitter regurgitated at Lower Granite trap site and recovered from trap on 12-08-88. Fish was recaptured at Lower Granite on 11-15-87, released, then recaptured at trap site on 03-07-88.
g Fish was recaptured at Lower Granite trap site on 11-15-87 and released. Transmitter was intact.
h Fish was recaptured at Lower Granite trap site on 3-24-88 and released. Transmitter was intact.
i Transmitter regurgitated at trap site on day of tagging and recovered from trap the following day. Transmitter was reimplanted in another fish of same stock on 11-10-87.
j Frequency was also recorded on Wallowa River (Rm 9.3) on 03-10-88.

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Appendix G. Fish collected during spawning ground surveys of streams immediately above LGD.

Sex	Origin: Hatchery Ad	Hatchery Lv	Wild	Unk.	Total
Wawawai Cr.					
Male	12	2	2	0	16
Female	18	8	3	4 [A]	33
Unknown			1	1	2
	30	10	6	5	51 [B]
Offield Cr.					
Male	7	4			11
Female	10	4	2	1	17
Unknown					
					28

[A] includes 1 unclipped fish with stubbed dorsal fin which may have been hatchery origin.

[B] 1 additional radio frequency was detected for which no live fish or carcass could be found.

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