

19 January 2006

To: David Clugston (USACE) and Ron Boyce (Oregon)
From: Matt Keefer and Chris Peery

Re: Preliminary summary of adult steelhead escapement upstream from Lower Granite Dam

We used the adult radiotelemetry databases from 2000-2003 to estimate escapement of steelhead upstream from Lower Granite Dam. The estimates below are based on reported harvest (from the transmitter reward program), agency collections at hatcheries and weirs, mobile radio-tracking in tributaries, spawning ground surveys, and especially records of fish at fixed antennas. Antenna locations were in the Snake at the upstream end of Lower Granite Dam, at the mouths of the Clearwater, Grande Ronde, and Imnaha rivers, in the Salmon River at Riggins and near the NF Salmon confluence, and at four secondary tributaries (Table 1).

Table 1. Locations and numbers of fixed radiotelemetry sites upstream from Lower Granite Dam during the study years. All sites except those between Asotin and the Salmon River mouth were in operation in all years.

River basin	Fixed telemetry sites
Snake R.	Asotin (1,); Between Asotin and Salmon R. mouth (3, 2000-2001)
Clearwater R.	Mouth (1); SF Clearwater mouth (1); Lochsa mouth (1)
Grande Ronde R.	Mouth (1)
Salmon	Riggins (1); SF Salmon mouth (1); MF Salmon mouth (1); Upper salmon at NF confluence (1)
Imnaha R.	Mouth (1)

Studies used to collect these data were developed to evaluate different aspects of passage in and through the hydrosystem. This meant that the amount of effort to monitor fish upstream from the hydrosystem (upstream from Lower Granite reservoir in this instance) was not exhaustive. Consequently, escapement estimates in Tables 2-5 are not estimates of spawning success or necessarily estimates to spawning grounds. Rather, the data presented are estimates of escapement to major tributaries and possible spawning areas, as well as estimates of harvest.

A total of 1,617 steelhead were monitored in the four years. Two qualifications regarding the sampling effort are necessary. First, the radio-tagged fish were not a random sample of the fish passing Lower Granite Dam. In all years we selected at Bonneville Dam for fish with PIT tags from juvenile tagging efforts. Overall, 34% ($n = 543$) of the sample had been PIT-tagged as juveniles. Most PIT tagged fish (436, 80%) were from the mixed-stock tagging efforts at Lower Granite Dam, with the remainder (107, 20%) from a wide variety of sub-basins, hatcheries, and traps. Combined, these groups were

probably a reasonable sample of the runs, but they were not truly random. The 2000 run sample was the most random, with only 1% having juvenile PIT tags. Second, we attempted to radio tag fish at Bonneville Dam in proportion to the overall runs, but this was not always possible due to competing research objectives. In order to increase samples of Snake River steelhead in our total samples, for example, we tagged proportionately more B-group fish at Bonneville.

There were also some limitations and uncertainty regarding harvest. All transmitter returns from tribal and sport fisheries were voluntary. Despite rewards for returns, it is likely that some fish were harvested and their tags were not returned. This does not mean that unreported harvests were illegally caught fish (but it is possible). In addition, the wild (unclipped) steelhead fishery in the Snake and its tributaries has a relatively large component of catch and release. About half of the transmitters returned for wild fish (versus about 3% for fin-clipped fish) included statements that indicated fish may have been released alive. We were unable to verify catch and release. People returning tags were also encouraged to report the location and type of recapture, but some forms were incomplete and we could not verify all details. For example, we may not have been able to differentiate in some cases whether transmitters were found (i.e. in carcasses or along river corridors) or were removed during harvest. Unreported harvest would tend to reduce the escapement estimates and increase the true harvest estimates. Found transmitters returned as 'harvest' would have the opposite effect and these two factors may be partially offsetting.

The catch and release portion of steelhead harvest adds an additional layer of uncertainty to escapement estimates, both because the true status of these fish following capture is unknown, and because there are no telemetry records following the capture event and transmitter removal. For these reasons, we include estimates treating these fish as either harvest mortalities or successful migrants. The most accurate estimate should fall between these probable maximums and minimums. We note that treatment of the catch and release component had a relatively minor overall effect on escapement estimates: differences for fin-clipped fish were mostly < 3%, while differences for unclipped fish were 3-7%.

In our opinion, the areas of greatest uncertainty for the steelhead escapement estimates are for those fish last recorded at the Clearwater River mouth, at the Riggins site on the lower Salmon River, and for fish last recorded in the mainstem Snake River upstream from Lower Granite reservoir. Most steelhead spawning sites are upstream from these locations, but we did not systematically survey all spawning sites. It is likely that many—but almost certainly not all—of the fish recorded at these antennas were successful migrants. Uncertainty is also higher for steelhead (relative to spring–summer Chinook salmon) because of overwintering behaviors and because of the high and widespread harvest effort. We have tried to capture the range of potential escapements in the equations in Tables 2-5. We have also provided the final recorded locations and fates for each fish so that the numbers can be further manipulated if necessary. (*note*: Table 7 has the catch and release numbers for each group.)

Table 2. Estimated fates and final locations of **all** radio-tagged steelhead that passed Lower Granite Dam. Equations are for a variety of potential escapement estimates, with differing criteria for success. Many additional alternatives are possible, including estimates where harvested fish are censored. ‘CR’ = portion of harvest that was reported (unverified) catch and release after transmitter removal.

	All steelhead			
	2000	2001	2002	2003
a) Snake unknown	54	64	67	31
b) Snake harvest ¹	30	19	40	23
c) Tributary harvest ¹	81	85	74	47
d) Hatchery/weir	75	43	37	29
e) Secondary tributaries	65	51	111	25
f) GRR/IMR mainstem	15	51	49	37
g) CWR: mouth to S Fork	32	60	58	14
h) CWR: above S Fork	5			
i) SAL: Riggins to N Fork	33	57	66	27
j) SAL: above N Fork	17	11	20	14
T) Total	407	441	522	247
(T-a)/T	0.867	0.855	0.872	0.874
(T-a-b-c)/T	0.595	0.619	0.653	0.591
<i>(T-a-b-c+CR)/T</i>	<i>0.602</i>	<i>0.642</i>	<i>0.693</i>	<i>0.632</i>
(T-a-b-c-g)/T	0.516	0.483	0.542	0.534
<i>(T-a-b-c-g+CR)/T</i>	<i>0.523</i>	<i>0.506</i>	<i>0.582</i>	<i>0.575</i>
(T-a-b-c-g-i)/T	0.435	0.354	0.416	0.425
<i>(T-a-b-c-g-i+CR)/T</i>	<i>0.442</i>	<i>0.376</i>	<i>0.456</i>	<i>0.466</i>

¹ Harvest numbers include reported catch and release

Table 3 provides a comparison of escapements for fin-clipped and unclipped fish. Higher percentages of fin-clipped fish were harvested, while higher percentages of unclipped fish had unknown fate in the mainstem Snake River. As a result, the first escapement estimate is higher for fin-clipped fish, but subsequent estimates are all higher for unclipped fish. It is unclear why proportionately more unclipped fish were unaccounted for in the main Snake, but possibilities include unreported harvest, differences in migration timing between clipped and unclipped fish, or more spawning by unclipped fish at unmonitored sites (i.e., in Hells Canyon or the Salmon River and its tributaries downstream from Riggins).

Table 3. Estimated fates and final locations of radio-tagged steelhead, **with and without fin clips**, that passed Lower Granite Dam.

	2000	2000	2001	2001	2002	2002	2003	2003
	clip	no clip	clip	no clip	clip	no clip	clip	no clip
a) Snake unknown	40	14	26	38	28	39	17	14
b) Snake harvest ¹	27	3	15	4	29	11	17	6
c) Tributary harvest ¹	78	3	74	11	57	17	42	5
d) Hatchery/weir	73	2	36	7	30	7	29	1
e) Secondary tributaries	43	22	21	30	24	87	25	20
f) GRR/IMR mainstem	8	7	18	33	21	28	14	23
g) CWR: mouth to SF	23	9	44	16	31	27	14	7
h) CWR: above SF	4	1						
i) SAL: Riggins to NF	19	14	33	24	20	46	13	14
j) SAL: above NF	16	1	8	3	8	12	12	2
T) Total	331	76	275	166	248	274	183	92
(T-a)/T	0.879	0.816	0.905	0.771	0.887	0.858	0.907	0.848
(T-a-b-c)/T	0.562	0.737	0.582	0.681	0.540	0.755	0.585	0.728
<i>(T-a-b-c+CR)/T</i>	<i>0.565</i>	<i>0.763</i>	<i>0.600</i>	<i>0.711</i>	<i>0.548</i>	<i>0.825</i>	<i>0.601</i>	<i>0.804</i>
(T-a-b-c-g)/T	0.492	0.618	0.422	0.584	0.415	0.657	0.508	0.652
<i>(T-a-b-c-g+CR)/T</i>	<i>0.495</i>	<i>0.645</i>	<i>0.440</i>	<i>0.614</i>	<i>0.423</i>	<i>0.726</i>	<i>0.525</i>	<i>0.728</i>
(T-a-b-c-g-i)/T	0.435	0.434	0.302	0.440	0.335	0.489	0.437	0.500
<i>(T-a-b-c-g-i+CR)/T</i>	<i>0.438</i>	<i>0.461</i>	<i>0.320</i>	<i>0.470</i>	<i>0.343</i>	<i>0.558</i>	<i>0.454</i>	<i>0.576</i>

¹ Harvest numbers included reported catch and release

Tables 4 and 5 are summaries of unclipped and fin-clipped fish that either did or did not fall back at Columbia or Snake River dams during migration. We included these comparisons because of the reasonably well established link between fallback and reduced Hydrosystem escapement and the concern that some effects of Hydrosystem passage carry over to the migrations upstream from Lower Granite Dam. In general, fin-clipped steelhead that fell back during migration had lower escapement estimates upstream from Lower Granite Dam than their counterparts that did not fall back (Table 5). The relationship was less consistent for unclipped fish (Table 4). Note that sample sizes for fallback fish were small ($n = 13-36$) for the unclipped groups, and that conclusions should be tempered by this restriction. We also note that fallback likely occurs for a variety of reasons, including operations at dams, poor individual fish fitness, juvenile experiences (i.e. we have seen much higher fallback by transported fish), and other factors. To better understand the escapement patterns presented here, we recommend that follow up analyses consider migration timing, passage times in the Hydrosystem, and both temperature and flow exposure histories.

Table 4. Estimated fates and final locations of **unclipped** radio-tagged steelhead that passed Lower Granite Dam and **did or did not fall back (FB)** during migration through the hydrosystem.

	Unclipped steelhead							
	2000	2000	2001	2001	2002	2002	2003	2003
	FB	no FB	FB	no FB	FB	no FB	FB	no FB
a) Snake unknown	2	12	9	29	11	28	1	13
b) Snake harvest ¹	1	2		4	4	7	3	3
c) Tributary harvest ¹		3	3	8	4	13	1	4
d) Hatchery/weir		2		7	1	6		1
e) Secondary tributaries	3	19	4	26	8	79	5	15
f) GRR/IMR mainstem	1	6	5	28	3	25	1	22
g) CWR: mouth to SF	2	7	8	8		27	1	6
h) CWR: above SF	1							
i) SAL: Riggins to NF	3	11	1	23	4	42	1	13
j) SAL: above NF		1	1	2	1	11	1	1
T) Total	13	63	31	135	36	238	14	78
(T-a)/T	0.846	0.810	0.710	0.785	0.694	0.882	0.929	0.833
(T-a-b-c)/T	0.769	0.730	0.613	0.696	0.472	0.798	0.643	0.744
<i>(T-a-b-c+CR)/T</i>	<i>0.769</i>	<i>0.762</i>	<i>0.677</i>	<i>0.719</i>	<i>0.667</i>	<i>0.849</i>	<i>0.643</i>	<i>0.833</i>
(T-a-b-c-g)/T	0.615	0.619	0.355	0.637	0.472	0.685	0.571	0.667
<i>(T-a-b-c-g+CR)/T</i>	<i>0.615</i>	<i>0.651</i>	<i>0.419</i>	<i>0.659</i>	<i>0.667</i>	<i>0.735</i>	<i>0.571</i>	<i>0.756</i>
(T-a-b-c-g-i)/T	0.385	0.444	0.323	0.467	0.361	0.508	0.500	0.500
<i>(T-a-b-c-g-i+CR)/T</i>	<i>0.385</i>	<i>0.476</i>	<i>0.387</i>	<i>0.489</i>	<i>0.556</i>	<i>0.559</i>	<i>0.500</i>	<i>0.590</i>

¹ Harvest numbers included reported catch and release

Table 5. Estimated fates and final locations of **fin-clipped** radio-tagged steelhead that passed Lower Granite Dam and **did or did not fall back (FB)** during migration through the hydrosystem.

	Fin-clipped steelhead							
	2000	2000	2001	2001	2002	2002	2003	2003
	FB	no FB	FB	no FB	FB	no FB	FB	no FB
a) Snake unknown	12	28	8	18	6	22	6	11
b) Snake harvest ¹	13	14	4	11	6	23	2	15
c) Tributary harvest ¹	12	66	14	60	13	44	7	35
d) Hatchery/weir	9	64	11	25	4	26	3	26
e) Secondary tributaries	9	34	2	19	4	20	1	24
f) GRR/IMR mainstem	1	7	3	15	2	19	3	11
g) CWR: mouth to SF	5	18	11	33	11	20	2	12
h) CWR: above SF		4						
i) SAL: Riggins to NF	2	17	9	24	3	17	3	10
j) SAL: above NF	2	14	3	5	3	5	1	11
T) Total	65	266	65	210	52	196	28	155
(T-a)/T	0.815	0.895	0.877	0.914	0.885	0.888	0.786	0.929
(T-a-b-c)/T	0.431	0.594	0.600	0.576	0.519	0.546	0.464	0.606
<i>(T-a-b-c+CR)/T</i>	<i>0.431</i>	<i>0.598</i>	<i>0.615</i>	<i>0.595</i>	<i>0.519</i>	<i>0.556</i>	<i>0.500</i>	<i>0.619</i>
(T-a-b-c-g)/T	0.354	0.526	0.431	0.419	0.308	0.444	0.393	0.529
<i>(T-a-b-c-g+CR)/T</i>	<i>0.354</i>	<i>0.530</i>	<i>0.446</i>	<i>0.438</i>	<i>0.308</i>	<i>0.454</i>	<i>0.429</i>	<i>0.542</i>
(T-a-b-c-g-i)/T	0.323	0.462	0.292	0.305	0.250	0.357	0.286	0.465
<i>(T-a-b-c-g-i+CR)/T</i>	<i>0.323</i>	<i>0.466</i>	<i>0.308</i>	<i>0.324</i>	<i>0.250</i>	<i>0.367</i>	<i>0.321</i>	<i>0.477</i>

¹ Harvest numbers included reported catch and release

Particular interest has been raised regarding harvest of unclipped steelhead, as these are the focus fish for the Snake River ESUs. Table 6 summarizes the numbers and percentages of unclipped fish that were reported harvested (includes catch and release) as well as the distribution of harvest among sites. We wish to reiterate that the samples were not completely random and some tagging bias may have occurred. However, 43% ($n = 26$ of 34) of the harvested unclipped fish were randomly-collected (no juvenile PIT tag) and another 53% (32) were from mixed stock juvenile tagging at Lower Granite Dam, suggesting limited bias due to fish selection; only 2 harvested fish were PIT tagged as juveniles in upper basin tributaries (both in the Clearwater).

As mentioned previously, transmitters for many unclipped steelhead were returned from fisheries with claims of catch and release. Because fish status was unverifiable, we have included both harvest estimates where caught and released fish were considered mortalities and estimates where they were treated as non-harvest (Table 6). Differences between these estimates ranged from 2.6% to 6.9% and averaged 4.2%. We have no estimates of unreported harvest for unclipped steelhead, but believe that this harvest component is > 0 .

Table 6. Harvest summary for **unclipped** radio-tagged steelhead that passed Lower Granite Dam. 'CR' = portion of harvest that was reported (unverified) catch and release after transmitter removal.

	2000	2001	2002	2003	Total
Total <i>n</i>	76	166	274	92	608
Sport	6 (7.9%)	13 (7.8%)	27 (9.9%)	11 (12.0%)	
Tribal		1 (0.6%)	1 (0.4%)		
Unknown harvest type		1 (0.6%)			
Total¹	6 (7.9%)	15 (9.0%)	28 (10.2%)	11 (12.0%)	60 (9.9%)
Total minus CR²	4 (5.3%)	10 (6.0%)	9 (3.3%)	4 (7.6%)	27 (4.4%)
Snake	3 (3.9%)	4 (2.4%)	11 (4.0%)	6 (6.5%)	24 (3.9%)
Clearwater	1 (1.3%)	5 (3.0%)	7 (2.6%)	4 (4.3%)	17 (2.8%)
Salmon	1 (1.3%)	5 (3.0%)	10 (3.6%)	1 (1.1%)	17 (2.8%)
Grande Ronde	1 (1.3%)	1 (0.6%)			2 (0.3%)

¹ A possible maximum

² A possible minimum

Table 7. Numbers of transmitters returned from fisheries for which 'catch and release' was indicated.

	2000	2001	2002	2003
All steelhead	3	10	21	10
Unclipped	2	5	19	7
Fin-clipped	1	5	2	3
Unclipped, fallback	0	2	7	0
Unclipped, no fallback	2	3	12	7
Fin-clipped, fallback	0	1	0	1
Fin-clipped, no fallback	1	4	2	2