Viability Status of Oregon Salmon and Steelhead Populations in the Willamette and Lower Columbia Basins

Appendix B: Oregon Abundance Time Series

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Mark Chilcote
Oregon Department of Fish and Wildlife

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Appendix **B**. Oregon Abundance Time Series
By Mark Chilcote

Background

The collection of data from populations of salmon and steelhead in these ESUs has been neither comprehensive nor consistent. Data is entirely missing for a substantial number of the populations. For those populations where data is available, the nature of this data and the methods to collect it were often dissimilar. For example, steelhead abundance for Sandy River populations was based on counts of fish passing Marmot Dam. In contrast, steelhead spawner abundance estimates for the Calapooia River were based on redd density estimates in short stream survey sections expanded for all of the estimated stream kilometers of spawning habitat in the basin.

The purpose of Appendix B is to describe these different methodologies and document the resulting estimates of spawners and pre-harvest abundance of wild fish for each population. Additional information on age composition, fishery catch rates, and the proportion of the spawning population that were hatchery fish are also presented. These data represent the basic information from which the viability metrics for abundance, productivity, and to a lesser extent diversity were generated.

It should be noted that it was not infrequent that the raw data sets for these populations were incomplete. Sometimes a year or more of survey data was missing. In other instances, harvest rate estimates for a particular fishery were not available. To assemble a full data set to be used in analyses and as reported here required the development a variety of methods to "fill in" these data gaps. It is recognized there is no single correct method for accomplishing this. A range of alternative estimation methods could be used to generate numbers needed to approximate the missing data.

Therefore, the methods presented here to develop a full data set for each population represent only one of these alternatives. However, it was hoped that we achieved a reasonable balance between trying to wring too much out of less than ideal data sets and throwing out useable information because it didn't conform to rigid data protocols. In the case of chum salmon, however, there were no observations in any Oregon population from which to develop data sets. We therefore, were unable to perform a quantitative evaluation of this species, other than by making inferences using data sets from the Washington side of the Columbia River where two populations are still known to exist.

Population Data Descriptions

1. Fall Chinook (Late) - Sandy

The abundance data for this population is based upon spawning survey observations conducted from 1984 to present. Both peak redd and fish counts are obtained in these surveys, however in the opinion of ODFW biologists the redd count data were more reliable. Following methodology developed by ODFW, the peak redd count was multiplied by an expansion factor of 2.5 to estimate total season spawners for the survey section. A fish per km density estimate was then determined by dividing the number of spawners by the length of the survey section, which was approximately 16 km. This spawner density was then expanded for the total 67km of linear kilometers of spawning habitat for fall Chinook in the Sandy basin to yield annual estimates of total spawner abundance for the population (Table B1). The number of stream kilometers utilized by fall Chinook within this basin was based on information provided by Maher et al. (2005).

Spawner survey data were missing for the 1981 to 1984 period and 1990. To fill in the data for these missing years, we used the observed relationship between the sport fishery catch estimates and spawner abundance estimates in years when data was available for both. It was found that for the 15-year period after 1984, 75% of the variation in spawner abundance estimates could be associated with variations in the sport fishery catch estimates. This relationship was then used, along with catch estimates for years without spawner data, to estimate what the spawner abundance might have been in 1981-84 and 1990.

Although hatchery fall Chinook are found in this basin, they belong to the Tule type of fall Chinook that spawn earlier than the late Sandy fall Chinook population. The occurrence of hatchery strays during the time when the wild population spawns has been rare. However, occasionally one of the carcass samples taken during the spawning surveys is found to contain a CWT indicating it was of hatchery origin. Therefore, a low stray of 5% (or 95% wild fraction) was assumed for the population.

Sandy late fall Chinook are caught in ocean fisheries, Columbia River mainstem fisheries and tributary sport fisheries. The impact of ocean fisheries varies depending on how many years a Chinook stays at sea before returning. For example, 3-year olds get exposed to one season of fishing, 6-year olds to three seasons of fishing. We used the estimated impact rate on 4-year old adults (the predominate age category) as an average to represent ocean fishery impacts. Most of these impact estimates came from a report that included data for wild North Lewis River fall Chinook in Washington (Daignerault et al 2003). Sandy late fall Chinook have similar timing and age composition as wild, North Fork Lewis fall Chinook. It was therefore, assumed that the ocean distribution and fishery impacts on these two populations would be similar.

Columbia River fishery impact estimates provided by Daignerault et al (2003), were also used in this data summary, except for the years after 1993 when impact rates specific to the Sandy population, as presented in the FMEP prepared by ODFW, were used. Tributary fishery impact rates were estimated from annual sport catch estimates provided by ODFW. From 2002 to the present, regulations that require the release of all unmarked Chinook have been in effect for the Sandy basin. This change effectively lowered the impact of sport fisheries as only the mortality associated with post-release mortality of fish that were caught was now a factor. We assumed this regulation change effectively reduced sport fishery impacts to 10% of their former level. The overall impact of the three fisheries was estimated as: 1 – [(1-OceanHR)*(1-ColmHR)*(1-TribHR)].

Age composition of spawning adults was based on scales collected and read from Sandy River fall Chinook by ODFW from 1998 to 2004. For the purposes of these analyses, fish observed as Age 2 were not included in the summary and the proportions for the remaining ages were adjusted so they would equal 1.00. Age 2 fish are largely jacks and comprise a small portion of the return. Inclusion of jacks in the total return estimate and can cause analytical problems because they are less susceptible to fisheries, particularly the Columbia River gillnet fishery.

Table B1. Basic data set developed for Sandy Fall Chinook

Spawn Year	Total Spawners	Wild Frac	Overal Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning			
					Age3	Age4	Age5	Age6
1981	2998	0.95	0.492	2904	0.143	0.694	0.157	0.006
1982	3472	0.95	0.498	3442	0.143	0.694	0.157	0.006
1983	2447	0.95	0.482	2278	0.143	0.694	0.157	0.006
1984	3157	0.95	0.491	3049	0.143	0.694	0.157	0.006
1985	1983	0.95	0.446	1594	0.143	0.694	0.157	0.006
1986	2703	0.95	0.630	4596	0.143	0.694	0.157	0.006
1987	8702	0.95	0.352	4735	0.143	0.694	0.157	0.006
1988	6610	0.95	0.640	11743	0.143	0.694	0.157	0.006
1989	8129	0.95	0.443	6476	0.143	0.694	0.157	0.006
1990	3340	0.95	0.364	1908	0.143	0.694	0.157	0.006
1991	2792	0.95	0.511	2915	0.143	0.694	0.157	0.006

1992	3976	0.95	0.442	3145	0.143	0.694	0.157	0.006
1993	5446	0.95	0.399	3612	0.143	0.694	0.157	0.006
1994	2299	0.95	0.397	1516	0.143	0.694	0.157	0.006
1995	4163	0.95	0.397	2745	0.143	0.694	0.157	0.006
1996	2013	0.95	0.397	1327	0.143	0.694	0.157	0.006
1997	8021	0.95	0.397	5289	0.143	0.694	0.157	0.006
1998	3088	0.95	0.397	2036	0.143	0.694	0.157	0.006
1999	1796	0.95	0.397	1184	0.143	0.694	0.157	0.006
2000	345	0.95	0.397	228	0.143	0.694	0.157	0.006
2001	3335	0.95	0.397	2199	0.143	0.694	0.157	0.006
2002	5189	0.95	0.196	1268	0.143	0.694	0.157	0.006
2003	3793	0.95	0.196	927	0.143	0.694	0.157	0.006
2004	2397	0.95	0.196	586	0.143	0.694	0.157	0.006
2005	5681	0.95	0.196	1319	0.143	0.694	0.157	0.006
2006	9934	0.95	0.196	2306	0.143	0.694	0.157	0.006

2. Fall Chinook (Tule) - Clatskanie

Peak counts of spawning fall Chinook in a 3.2 km survey section of the Clatskanie River was the source of raw data for building the data set for this population. Annual peak spawner counts were converted into an estimated season count by multiplying by a correction factor of 1.7. Using these converted numbers, a spawner density (spawners per stream km) was estimated for each year. An estimate for spawner abundance for the entire population was obtained by multiplying these annual spawner densities times the total number kilometers of fall Chinook spawning habitat (Table B2) We used the Maher et al (2005) estimate of 16 km spawning habitat for these expansions.

In recent years the proportion of stray hatchery fish into this basin appears low, as evidenced by relatively rare recoveries of CWT hatchery fish during spawning surveys. We assumed 15% of the spawners were hatchery strays from 1970 to present and 0% were hatchery strays prior to 1970. It was assumed that prior to 1970, the likelihood of stray hatchery fish was lower because sources of hatchery fish were more distant and less numerous.

The primary fishery impacts on the Clatskanie population have been the ocean fishery and the Columbia River mainstem fishery. Sport catch of fall Chinook within the Clatskanie basin is relatively minor and was not included in our calculations. Fishery impact rates from 1986 to present were estimated based on CWT recovery data for Tule Fall Chinook released from nearby Big Creek Hatchery as provide by Mark Lewis (ODFW). It was assumed that these rates were similar to those experienced by the Clatskanie population. Prior to 1986, Cowlitz Tule Fall Chinook were used as a proxy to estimate fishery impacts. Measured impact rates for ocean and Columbia fisheries Cowlitz River fall Chinook were available for 1980-83 and 1964-68. For years during this period with no data, the ocean impact rates were estimated as either the 1964-68 average or 1980-83 average depending on which dates were chronologically nearest to year for which data was missing. For the Columbia River impacts, a relationship between the number of season fishing days set for the commercial gillnet season between August 20 and September 20 and the subsequent fishery impact rate was relied upon. This relationship, first described by Cramer and Vigg (1999), was able to explain 76% of the variation in Columbia River impact rates on Cowlitz fall Chinook on the basis of the number of days the fishing season was open between August 20 and September 20. Cumulative fishery impacts were calculated as: 1- [(1-OceanHR)*(1-ColumbiaHR)].

Age composition of Clatskanie Tule fall Chinook was determined from ODFW CWT data from fall Chinook returning to nearby Big Creek hatchery. Annual estimates of age composition using these CWT data (excluding Age 2 jacks) was averaged for the time period (1986 to 2002) to yield the average age composition recorded in Table B2.

Finally, a preliminary run reconstruction and calculation of recruits per spawner yielded unrealistically high values for the years 1953,1958-61, 1989, 1992-93, and 2000. This was most likely caused by the observation of only a single spawner, poor survey conditions resulting in an underestimate, or other unknown factors. Therefore, to make these data more compatible with the limits of fall Chinook life history and recruitment rates - the peak spawner count for each of these years was increased until the R/S value was less than 50. A value of 50 recruits per spawner was assumed to be the upper limit on the reproductive rate of naturally reproducing fall Chinook. In most cases this manipulation required increasing the observed peak count by only 1 to 2 spawners. In addition to this adjustment, there was also a minimum value of 50, placed on the spawner estimate. For example, if the spawner estimate in a particular year was 12, then a value of 50 substituted. The logic behind this change was that values less than the CRT level (which is 50 for this population) would seem unlikely if this population is continuing to persist. We assume repeated spawner levels less than CRT would likely lead to population extinction which has not occurred. We assume then that escapement estimates less than 50 are more likely an outcome of measurement error rather than true spawner abundance

Table B2. Basic data set developed for Clatskanie Tule Fall Chinook

Spawn Year	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning			
					Age3	Age4	Age5	Age6
1952	219	1.00	0.924	2673	0.211	0.540	0.250	0.000

1953	50	1.00	0.924	610	0.211	0.540	0.250	0.000
1954	50	1.00	0.924	610	0.211	0.540	0.250	0.000
1955	50	1.00	0.924	610	0.211	0.540	0.250	0.000
1956	152	1.00	0.892	1257	0.211	0.540	0.250	0.000
1957	50	1.00	0.860	308	0.211	0.540	0.250	0.000
1958	50	1.00	0.780	178	0.211	0.540	0.250	0.000
1959	50	1.00	0.796	196	0.211	0.540	0.250	0.000
1960	50	1.00	0.717	126	0.211	0.540	0.250	0.000
1961	50	1.00	0.765	162	0.211	0.540	0.250	0.000
1962	152	1.00	0.828	733	0.211	0.540	0.250	0.000
1963	379	1.00	0.828	1831	0.211	0.540	0.250	0.000
1964	260	1.00	0.804	1065	0.211	0.540	0.250	0.000
1965	50	1.00	0.850	284	0.211	0.540	0.250	0.000
1966	523	1.00	0.823	2425	0.211	0.540	0.250	0.000
1967	76	1.00	0.900	684	0.211	0.540	0.250	0.000
1968	50	1.00	0.850	283	0.211	0.540	0.250	0.000
1969	124	1.00	0.835	626	0.211	0.540	0.250	0.000
1970	67	0.85	0.881	423	0.211	0.540	0.250	0.000
1971	50	0.85	0.804	174	0.211	0.540	0.250	0.000
1972	62	0.85	0.696	120	0.211	0.540	0.250	0.000
1973	161	0.85	0.865	881	0.211	0.540	0.250	0.000
1974	87	0.85	0.711	182	0.211	0.540	0.250	0.000
1975	186	0.85	0.835	798	0.211	0.540	0.250	0.000
1976	186	0.85	0.773	538	0.211	0.540	0.250	0.000
1977	87	0.85	0.711	182	0.211	0.540	0.250	0.000
1978	50	0.85	0.727	113	0.211	0.540	0.250	0.000
1979	198	0.85	0.727	449	0.211	0.540	0.250	0.000
1980	322	0.85	0.588	392	0.211	0.540	0.250	0.000
1981	248	0.85	0.599	315	0.211	0.540	0.250	0.000
1982	459	0.85	0.638	687	0.211	0.540	0.250	0.000
1983	161	0.85	0.549	167	0.211	0.540	0.250	0.000
1984	50	0.85	0.560	54	0.211	0.540	0.250	0.000
1985	161	0.85	0.514	145	0.211	0.540	0.250	0.000
1986	161	0.85	0.683	295	0.211	0.540	0.250	0.000
1987	337	0.85	0.676	598	0.211	0.540	0.250	0.000
1988	707	0.85	0.678	1266	0.211	0.540	0.250	0.000
1989	397	0.85	0.594	494	0.211	0.540	0.250	0.000
1990	174	0.85	0.388	94	0.211	0.540	0.250	0.000
1991	50	0.85	0.601	64	0.211	0.540	0.250	0.000
1992	50	0.85	0.616	68	0.211	0.540	0.250	0.000
1993	50	0.85	0.585	60	0.211	0.540	0.250	0.000
1994	59	0.85	0.442	40	0.211	0.540	0.250	0.000
1995	84	0.85	0.327	35	0.211	0.540	0.250	0.000
1996	464	0.85	0.381	243	0.211	0.540	0.250	0.000
1997	67	0.85	0.337	29	0.211	0.540	0.250	0.000
1998	149	0.85	0.143	21	0.211	0.540	0.250	0.000
1999	124	0.85	0.241	33	0.211	0.540	0.250	0.000
2000	50	0.85	0.345	22	0.211	0.540	0.250	0.000
2001	50	0.85	0.382	26	0.211	0.540	0.250	0.000
2002	388	0.85	0.470	293	0.211	0.540	0.250	0.000

2003	472	0.85	0.457	337	0.211	0.540	0.250	0.000
2004	74	0.85	0.423	46	0.211	0.540	0.250	0.000
2005	211	0.85	0.423	131	0.211	0.540	0.250	0.000
2006	126	0.85	0.423	78	0.211	0.540	0.250	0.000

3. Spring Chinook - Sandy

The basic information used to estimate the abundance of spring Chinook in the Sandy basin were the counts of upstream migrating adults as they passed Marmot Dam on the Sandy River. These counts represented at least 90% of the entire run, as very little of spawning and rearing habitat for spring Chinook occurs downstream of Marmot Dam. Although spring Chinook have been counted at Marmot Dam since 1951, the data collected through 1960 is thought to be unreliable for a variety of reasons. Primarily the issue is that the number of fish counted is much lower than the number caught within the basin for these early years. In some cases, the unadjusted data suggest an 80% tributary fishery impact rate. It is highly unlikely a fishery could generate these levels of impact. However, this may also be an artifact of extremely high in-river mortalities associated with unfavorable water conditions for summer holding prior to migration past Marmot Dam. To avoid these complications and reduce uncertainty we choose to only use data collected from 1961 to present (Table B3).

Spring Chinook were not counted at Marmot Dam from 1971 to 1976 and only a partial count was made in 1983. In addition, the recorded count for 1964 of 660 fish was thought to be an erroneous overestimate of the return. Based on a regression between sport catch and dam counts, annual estimates of sport catch within the Sandy basin for 1964, 1971-76, and 1983 were used to estimate dam counts for these years. This regression was developed from those years with both dam count and catch data during the period 1961 to 2001. From this regression it appeared that 82% of the variation in Marmot Dam counts could be explained by the observed variations in annual sport catch estimates.

A substantial number of hatchery fish are known to return to the Sandy basin. The first hatchery spring Chinook returned in 1970. The program size was gradually increased from 50,000 fish in the mid-1970, to nearly 500,000 fish by the end of the 1990s.

However, only in recent years were direct measurements of the hatchery fraction possible via inspection of returning adults for fin clips. Prior to 2001 only a small portion or none of the hatchery release was fin clipped before they were released as smolts. Therefore, from 1961 to 2001 hatchery fish could not be visually counted separately from wild fish.

To estimate the proportion of hatchery fish for this earlier period a simple relationship was developed between the number of hatchery smolts released during the recent years when all fish were fin clipped (and could be identified as hatchery fish when they returned) and the proportion of hatchery fish observed at Marmot Dam. Based on this relationship, the average number of wild smolts produced in those years was estimated. Using this average number of wild smolts, and assuming that this was a rough estimate of wild smolt production in previous years, the ratio between wild smolts and number of hatchery smolts released for each year prior to 2002 was determined. A record of the number of hatchery smolts released is available for all years. The estimated annual ratios hatchery to wild smolts were assumed to represent the ratio of hatchery and wild adults in the corresponding return years.

It is also notable that beginning in 2002, all hatchery fish arriving at the Marmot Dam counting facility were removed from the trap and not passed upstream. Therefore, although at least 50% of the fish trapped at Marmot Dam were hatchery fish, wild fish comprised essentially 100% of the natural spawning population upstream of Marmot Dam (Table B3).

Sandy spring Chinook are caught in ocean fisheries, Columbia River mainstem fisheries, and in-river sport fisheries. The estimated ocean impact rates were assumed to be the same as those reported by Beamsederfer (…..) for Willamette River spring Chinook. The mainstem Columbia fishery impacts reported by ODFW in their FMEP for spring Chinook were used to represent the mortality caused by this fishery. Finally, annual sport catch estimates (from catch cards) for the Sandy were used to estimate impacts of the tributary fishery. However, the ODFW reported sport catch estimates were adjusted downward 32% to ensure they were not overestimates of the impact. From various locations in the Willamette basin both statistical creel programs and catch card estimates of sport catch have been made in at least four different years (ODFW, unpublished data). It is assumed that the creel estimates of catch are more accurate than the catch card estimates. Across all of the locations and years compared, the creel estimate of catch averaged 68% of the catch card estimate. This result was the basis of adjustments made to the catch card data estimates for the Sandy spring Chinook fishery.

From 2002 to present only fin clipped Chinook could be kept by sport anglers within the Sandy basin. Therefore, the only impact of the sport fishery on wild spring Chinook was catch and release mortality. It was assumed that 15% of all sport caught and released wild spring Chinook died later from stress. This rate was applied to the average sport catch impact rate in years <u>before</u> the catch and release regulations went into effect to estimate an average mortality impact of the sport fishery during the recent years.

The overall impact of the ocean, Columbia, and tributary fishery impacts fisheries was estimated as: 1 – [(1-OceanHR)*(1-ColmHR)*(1-TribHR)].

Age composition of Sandy spring Chinook was determined from scale samples obtained from fishery and carcass recovery sampling. Age 2 fish were excluded from data sets.

Table B3. Basic data set developed for Sandy Spring Chinook

Spawn Year	Hatch Fish at Dam	Hatch Fish Passed	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning			
							Age3	Age4	Age5	Age6
1961	0	0	37	1.000	0.539	43	0.00	0.60	0.39	0.01
1962	0	0	65	1.000	0.450	53	0.00	0.60	0.39	0.01
1963	0	0	124	1.000	0.462	107	0.00	0.60	0.39	0.01
1964	0	0	41	1.000	0.502	41	0.00	0.60	0.39	0.01
1965	0	0	13	1.000	0.747	38	0.00	0.60	0.39	0.01
1966	0	0	63	1.000	0.441	50	0.00	0.60	0.39	0.01
1967	0	0	51	1.000	0.497	50	0.00	0.60	0.39	0.01
1968	0	0	61	1.000	0.441	48	0.00	0.60	0.39	0.01
1969	0	0	81	1.000	0.562	104	0.00	0.60	0.39	0.01
1970	26	26	137	0.808	0.525	122	0.00	0.60	0.39	0.01
1971	13	13	85	0.850	0.502	72	0.00	0.60	0.39	0.01
1972	14	14	94	0.850	0.502	81	0.00	0.60	0.39	0.01
1973	19	19	125	0.850	0.502	108	0.00	0.60	0.39	0.01
1974	8	8	51	0.850	0.502	43	0.00	0.60	0.39	0.01
1975	58	58	386	0.850	0.502	331	0.00	0.60	0.39	0.01
1976	24	24	224	0.891	0.502	201	0.00	0.60	0.39	0.01
1977	62	62	346	0.821	0.520	308	0.00	0.60	0.39	0.01
1978	123	123	535	0.770	0.373	245	0.00	0.60	0.39	0.01
1979	102	102	233	0.561	0.729	352	0.00	0.60	0.39	0.01
1980	108	108	548	0.803	0.708	1064	0.00	0.60	0.39	0.01
1981	649	649	1089	0.404	0.643	792	0.00	0.60	0.39	0.01
1982	155	155	522	0.703	0.646	670	0.00	0.60	0.39	0.01
1983	845	845	1837	0.540	0.502	1000	0.00	0.60	0.39	0.01
1984	557	557	1211	0.540	0.551	803	0.00	0.60	0.39	0.01
1985	258	258	561	0.541	0.639	536	0.00	0.60	0.39	0.01
1986	403	403	702	0.426	0.524	329	0.00	0.60	0.39	0.01
1987	643	643	1401	0.541	0.492	734	0.00	0.60	0.39	0.01
1988	892	892	1940	0.540	0.421	762	0.00	0.60	0.39	0.01

1989	881	881	1376	0.360	0.405	336	0.00	0.60	0.39	0.01
1990	877	877	1557	0.437	0.579	934	0.00	0.60	0.39	0.01
1991	1249	1249	1888	0.339	0.532	726	0.00	0.60	0.39	0.01
1992	2947	2947	4451	0.338	0.412	1052	0.00	0.60	0.39	0.01
1993	2268	2268	3429	0.338	0.464	1007	0.00	0.60	0.39	0.01
1994	1526	1526	2309	0.339	0.362	445	0.00	0.60	0.39	0.01
1995	1002	1002	1503	0.333	0.440	393	0.00	0.60	0.39	0.01
1996	1723	1723	2561	0.327	0.386	526	0.00	0.60	0.39	0.01
1997	2185	2185	3304	0.339	0.314	513	0.00	0.60	0.39	0.01
1998	1769	1769	2612	0.323	0.326	409	0.00	0.60	0.39	0.01
1999	1360	1336	2032	0.343	0.436	538	0.00	0.60	0.39	0.01
2000	1323	1309	1986	0.341	0.411	473	0.00	0.60	0.39	0.01
2001	2312	1262	2445	0.484	0.390	756	0.00	0.60	0.39	0.01
2002	3039	0	1262	1.000	0.194	303	0.00	0.60	0.39	0.01
2003	2683	0	1197	1.000	0.194	288	0.00	0.60	0.39	0.01
2004	2587	0	2698	1.000	0.194	648	0.00	0.60	0.39	0.01
2005	2131	0	1653	1.000	0.194	397	0.00	0.60	0.39	0.01

4. Winter Steelhead – Clackamas

Winter steelhead were counted as they pass North Fork Dam on the Clackamas River. While the majority of the winter steelhead production is believed to be upstream from this counting location, a significant amount of steelhead habitat also exists in the portion of the basins downstream from North Fork Dam. Based upon estimates by ODFW, 40% of the production area occurs in this lower portion of the basin.

The number of total spawners for this population is based on the counts of winter steelhead at NF Dam, expanded for the production area downstream of the dam by dividing the dam count by 0.60 (Table B4). As stated previously, 40% of the production of wild steelhead is thought to occur in the lower basin. This number had to be adjusted somewhat in those earlier years when a consumptive fishery was permitted on winter steelhead upstream of NF Dam. In other words, not all fish that were counted at NF Dam in those years survived to spawn.

In addition, the estimate of naturally spawning hatchery fish (which is included in the total spawner estimate) had to be adjusted to account for the hatchery fish that were removed from the counting facility at NF Dam and prevented from continuing upstream, plus the number of hatchery fish that returned to Eagle Creek Hatchery and were removed from the natural spawning population.

The identification of hatchery and wild fish in recent years was reasonably straightforward as all returning hatchery fish were identifiable by fin clip marks previously applied juvenile hatchery steelhead during hatchery rearing phase of their life history.

Estimation of hatchery and wild fish proportions prior to 1995 was more difficult because returning hatchery fish were not fin clipped. An alternate approach based on run-timing differences between wild and hatchery fish was used to make these estimates for the earlier time period.

It was found from the timing of counts of returning winter steelhead at NF Dam that prior to the first return of hatchery steelhead in 1968, less than 1% of the run passed NF Dam before March 31. However, the predominate hatchery stock used up until 1999 had a run and spawn timing that was characteristically 1 to 3 months earlier than the wild fish. It was found that from 1995 to 1999 when all returning hatchery fish were also fin clipped that the proportion of hatchery fish as estimated by the ratio of fin clips and the proportion of hatchery fish estimated by the ratio of the NF Dam fish count before March 31 and the count after March 31 was nearly the same. For these five years, 99% of the variation in the proportion of hatchery fish as determined by fin clip data, could be related to the proportion of the total run that migrated past NF Dam prior to March 31.

Based on this temporal relationship, annual winter steelhead counts at NF Dam from 1968 to 1994 were divided into an early and late portion, based on the March 31 sorting date. The early proportion was then assumed to represent the proportion of hatchery fish in that year's particular return.

Fishery impacts on this winter steelhead population occur primarily within the Clackamas basin. Catch card estimates for the Clackamas winter steelhead sport fishery, adjusted to reduce likely bias, were used to estimate the total catch. The bias adjustment consisted of multiplying all catch card estimates by 0.63. This reduction adjustment was based on data from other steelhead fisheries where catch estimates from both statistical creel surveys and catch cards were available. In these comparisons, the creel survey estimate, considered to be the more accurate of the two methods was consistently smaller. The 0.63 adjustment factor used here was based on 10 years of creel survey and catch card data collected for the winter steelhead fishery in the Alsea River. A regression of these data resulted in a significant relationship between the two (R2 = 0.87) however, with a slope of 0.63. In other words, a catch card estimate of 100, corresponded with a creel survey catch estimate of 63.

From these adjusted estimates of catch and estimates of spawner escapement, fishery impact rates were calculated. For hatchery and wild fish these rates were equal until 1992 when catch and release regulations were imposed wild fish. This regulation, in effect to the present, reduced the mortality rate on wild fish to the incidental mortality associated with the handling and stress of being caught and released. In preparing the mortality data shown in Table B4 for wild fish, we assumed that 10% of those fish caught subsequently died post-release. We estimated the proportion of the wild run that was initially caught from our estimates of harvest rate on hatchery fish (for which catch and release regulations were not in effect).

Age composition data based on the analysis of scales sampled from sport steelhead fishery in Clackamas River from 1984 to 1991.

Table B4. Basic data set developed for Clackamas Winter Steelhead

Spawn Year	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning				
					Age3	Age4	Age5	Age6	Age7
1958	2616	1.000	0.358	1459	0.005	0.510	0.398	0.083	0.004
1959	870	1.000	0.667	1745	0.005	0.510	0.398	0.083	0.004
1960	1829	1.000	0.453	1514	0.005	0.510	0.398	0.083	0.004
1961	3512	1.000	0.272	1312	0.005	0.510	0.398	0.083	0.004
1962	6949	1.000	0.283	2735	0.005	0.510	0.398	0.083	0.004
1963	3564	0.994	0.356	1955	0.005	0.510	0.398	0.083	0.004
1964	2999	0.999	0.503	3038	0.005	0.510	0.398	0.083	0.004
1965	2473	0.995	0.476	2235	0.005	0.510	0.398	0.083	0.004
1966	2056	0.998	0.618	3320	0.005	0.510	0.398	0.083	0.004
1967	1087	0.991	0.723	2809	0.005	0.510	0.398	0.083	0.004
1968	1259	0.971	0.815	5401	0.005	0.510	0.398	0.083	0.004
1969	3690	0.969	0.524	3935	0.005	0.510	0.398	0.083	0.004
1970	4476	0.952	0.463	3675	0.005	0.510	0.398	0.083	0.004
1971	6930	0.899	0.456	5212	0.005	0.510	0.398	0.083	0.004
1972	4197	0.936	0.615	6273	0.005	0.510	0.398	0.083	0.004
1973	3023	0.957	0.490	2781	0.005	0.510	0.398	0.083	0.004
1974	1069	0.955	0.625	1701	0.005	0.510	0.398	0.083	0.004
1975	2432	0.938	0.671	4647	0.005	0.510	0.398	0.083	0.004
1976	1883	0.867	0.533	1862	0.005	0.510	0.398	0.083	0.004
1977	2433	0.757	0.491	1778	0.005	0.510	0.398	0.083	0.004
1978	3166	0.537	0.582	2368	0.005	0.510	0.398	0.083	0.004
1979	2408	0.629	0.585	2132	0.005	0.510	0.398	0.083	0.004
1980	3290	0.820	0.668	5425	0.005	0.510	0.398	0.083	0.004
1981	4297	0.667	0.600	4294	0.005	0.510	0.398	0.083	0.004
1982	2304	0.797	0.686	4009	0.005	0.510	0.398	0.083	0.004
1983	1751	0.938	0.644	2974	0.005	0.510	0.398	0.083	0.004
1984	1973	0.797	0.635	2741	0.005	0.510	0.398	0.083	0.004
1985	1952	0.838	0.702	3863	0.005	0.510	0.398	0.083	0.004
1986	2282	0.834	0.664	3763	0.005	0.510	0.398	0.083	0.004

1987	2100	0.864	0.642	3254	0.005	0.510	0.398	0.083	0.004
1988	3378	0.836	0.608	4381	0.005	0.510	0.398	0.083	0.004
1989	1993	0.770	0.673	3165	0.005	0.510	0.398	0.083	0.004
1990	2369	0.641	0.673	3126	0.005	0.510	0.398	0.083	0.004
1991	1334	0.576	0.678	1620	0.005	0.510	0.398	0.083	0.004
1992	3452	0.687	0.055	139	0.005	0.510	0.398	0.083	0.004
1993	2230	0.859	0.067	139	0.005	0.510	0.398	0.083	0.004
1994	2064	0.940	0.078	165	0.005	0.510	0.398	0.083	0.004
1995	1886	0.803	0.052	82	0.005	0.510	0.398	0.083	0.004
1996	376	0.711	0.064	18	0.005	0.510	0.398	0.083	0.004
1997	896	0.539	0.049	25	0.005	0.510	0.398	0.083	0.004
1998	859	0.551	0.055	28	0.005	0.510	0.398	0.083	0.004
1999	388	0.760	0.037	11	0.005	0.510	0.398	0.083	0.004
2000	879	0.848	0.061	48	0.005	0.510	0.398	0.083	0.004
2001	2048	0.727	0.055	86	0.005	0.510	0.398	0.083	0.004
2002	3330	0.698	0.046	111	0.005	0.510	0.398	0.083	0.004
2003	2574	0.796	0.054	117	0.005	0.510	0.398	0.083	0.004
2004	6509	0.796	0.054	295	0.005	0.510	0.398	0.083	0.004
2005	1959	0.796	0.054	89	0.005	0.510	0.398	0.083	0.004

5. Winter Steelhead – Sandy

Total spawner abundance estimates for Sandy winter steelhead were derived from counts of steelhead passing Marmot Dam. Although there is some steelhead habitat in the basin downstream from Marmot Dam approximately 85% of the steelhead production area is upstream. For the purposes of this summary, population data is only meant to represent that portion of the basin upstream of Marmot Dam. No adjustment was made to add the 15% additional production believed to originate in the downstream portion of the watershed.

Complete counts of winter steelhead for the spawning years 1971 through 1977 and in 1983 were not available (Table B5). To replace these missing data, values were generated from catch card estimates of sport catch in the same years in the following manner. A regression of sport catch and Marmot Dam counts of steelhead was made for those years when both data were available. From this relationship, which was found to have an R^2 value of 0.63 (n = 25), approximate numbers of winter steelhead for those years when no data were collected were estimated.

From 1999 to present, returning hatchery fish were indefinable because they all had been fin clipped prior to their release as smolts. Therefore, the calculation of the wild fraction in the spawning populations was relatively straightforward. However, prior to 1999, estimating the fraction of wild fish in the natural spawning population (the other portion being hatchery fish) was more difficult. To estimate the proportion of hatchery fish for this earlier period, we developed a method using the annual number of smolts released into the basin and the location of these releases.

Prior to 1989, the majority of hatchery smolts were released upstream of Marmot Dam. However, starting in 1989 the release sites were all moved downstream to reduce the number of hatchery fish homing to the upper portion of the basin. From 2000 to 2003 years the proportion of the run reaching Marmot Dam of hatchery origin averaged 0.12. It should also be noted that during this time the fishing regulations permitted the keeping of only hatchery fish and any wild fish that were caught had to be released. During this period of downstream smolt releases, hatchery and wild determinations were only made after 1999. Therefore, to estimate the fraction of hatchery fish between 1999 and 1991 (1991 being the primary adult return year for the 1989 smolt release), the average of the 2000 – 03 period was used. It should also be noted that in Table B5, the fraction of wild fish is reported as being 1.000 for all years after 1998. This reflects the fact that those hatchery fish that arrived at Marmot Dam were removed during the counting procedures and prevented from continuing upstream.

Prior to 1989, hatchery smolts were released upstream of Marmot Dam and there were no differential harvest regulations on wild and hatchery fish. Scale samples obtained from Sandy steelhead caught in the sport fishery from 1984 to 1989 were analyzed and classified as either hatchery or wild fish. From these data hatchery proportions were determined. The average release of hatchery steelhead smolts for this period was related to the average proportion of hatchery fish observed during this same time frame. From these data a rough approximation of the number of wild smolts was calculated. Using this average estimate of wild smolts as a fixed number and comparing this to the number hatchery smolts released in each year prior to 1984, annual ratios of wild to hatchery smolts were generated. The proportion of adult hatchery fish was assumed to be the same as the proportion of hatchery smolts estimated two years previously (the most common ocean residence period for adults was 2 years). In this manner the proportion of hatchery fish in the spawning population (and fraction of wild fish) was estimated for the period from 1983 to 1961.

Fishery impacts on this winter steelhead population occur primarily within the Sandy basin. Catch card estimates for the Sandy winter steelhead sport fishery, adjusted to reduce likely bias, were used to estimate the total catch. The bias adjustment consisted of multiplying all catch card estimates by 0.63. This reduction adjustment was based on data from other steelhead fisheries where catch estimates from both statistical creel surveys and catch cards were available (see discussion on this topic in the previous Clackamas winter steelhead section).

From these adjusted estimates of catch and estimates of spawner escapement, fishery impact rates were calculated. For hatchery and wild fish these rates were equal until 1990 when catch and release regulations were imposed wild fish. This regulation, in effect to the present, reduced the mortality rate on wild fish to the incidental mortality associated with the handling and stress of being caught and released. In preparing the mortality data shown in Table B5 for wild fish, we assumed that 10% of those fish caught subsequently died post-release. We estimated the proportion of the wild run that was initially caught from our estimates of harvest rate on hatchery fish (for which catch and release regulations were not in effect).

Age composition data based on the analysis of scales sampled from sport steelhead fishery in Sandy River from 1984 to 1991.

Table B5. Basic data set developed for Sandy Winter Steelhead

Spawn Year	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning				
					Age3	Age4	Age5	Age6	Age7
1961	3124	0.402	0.277	482	0.002	0.495	0.406	0.091	0.005
1962	4045	0.422	0.287	686	0.002	0.495	0.406	0.091	0.005
1963	3325	0.256	0.319	399	0.002	0.495	0.406	0.091	0.005
1964	3880	0.241	0.408	644	0.002	0.495	0.406	0.091	0.005
1965	5529	0.213	0.386	740	0.002	0.495	0.406	0.091	0.005
1966	3584	0.219	0.582	1093	0.002	0.495	0.406	0.091	0.005
1967	4076	0.220	0.541	1058	0.002	0.495	0.406	0.091	0.005
1968	2938	0.261	0.561	978	0.002	0.495	0.406	0.091	0.005
1969	3176	0.256	0.547	983	0.002	0.495	0.406	0.091	0.005
1970	2390	0.265	0.625	1057	0.002	0.495	0.406	0.091	0.005
1971	3100	0.269	0.656	1589	0.002	0.495	0.406	0.091	0.005
1972	3312	0.246	0.662	1601	0.002	0.495	0.406	0.091	0.005
1973	2243	0.263	0.613	934	0.002	0.495	0.406	0.091	0.005
1974	2311	0.260	0.618	973	0.002	0.495	0.406	0.091	0.005
1975	2951	0.261	0.651	1439	0.002	0.495	0.406	0.091	0.005
1976	2683	0.238	0.640	1136	0.002	0.495	0.406	0.091	0.005
1977	1705	0.260	0.548	537	0.002	0.495	0.406	0.091	0.005
1978	4071	0.228	0.638	1636	0.002	0.495	0.406	0.091	0.005
1979	2000	0.242	0.684	1047	0.002	0.495	0.406	0.091	0.005
1980	3015	0.207	0.730	1682	0.002	0.495	0.406	0.091	0.005
1981	4078	0.314	0.536	1477	0.002	0.495	0.406	0.091	0.005
1982	2600	0.235	0.714	1525	0.002	0.495	0.406	0.091	0.005
1983	2449	0.221	0.600	811	0.002	0.495	0.406	0.091	0.005
1984	2232	0.320	0.677	1496	0.002	0.495	0.406	0.091	0.005
1985	2787	0.211	0.699	1365	0.002	0.495	0.406	0.091	0.005
1986	2752	0.227	0.557	783	0.002	0.495	0.406	0.091	0.005

1987	3675	0.225	0.485	780	0.002	0.495	0.406	0.091	0.005
1988	3440	0.206	0.638	1250	0.002	0.495	0.406	0.091	0.005
1989	2993	0.208	0.617	1001	0.002	0.495	0.406	0.091	0.005
1990	3065	0.205	0.063	42	0.002	0.495	0.406	0.091	0.005
1991	1995	0.879	0.063	117	0.002	0.495	0.406	0.091	0.005
1992	2916	0.879	0.053	144	0.002	0.495	0.406	0.091	0.005
1993	1636	0.879	0.065	100	0.002	0.495	0.406	0.091	0.005
1994	1567	0.879	0.041	59	0.002	0.495	0.406	0.091	0.005
1995	1680	0.879	0.042	65	0.002	0.495	0.406	0.091	0.005
1996	1287	0.879	0.042	49	0.002	0.495	0.406	0.091	0.005
1997	1426	0.879	0.036	47	0.002	0.495	0.406	0.091	0.005
1998	883	0.879	0.029	23	0.002	0.495	0.406	0.091	0.005
1999	816	1.000	0.046	39	0.002	0.495	0.406	0.091	0.005
2000	741	1.000	0.043	33	0.002	0.495	0.406	0.091	0.005
2001	902	1.000	0.053	50	0.002	0.495	0.406	0.091	0.005
2002	1031	1.000	0.069	76	0.002	0.495	0.406	0.091	0.005
2003	671	1.000	0.067	48	0.002	0.495	0.406	0.091	0.005
2004	871	1.000	0.055	51	0.002	0.495	0.406	0.091	0.005
2005	626	1.000	0.055	37	0.002	0.495	0.406	0.091	0.005

6. Winter Steelhead – Hood River

The primary source of data for Hood River steelhead is obtained at the fish handling facility at Powerdale Dam, near the mouth of the basin. At this facility all steelhead are counted, hatchery and wild determinations made, and scales taken from each fish for subsequent age determination. The results of this data collection effort are summarized in Table B6.

Hood River steelhead are caught in both mainstem gillnet fisheries and sport fisheries in the Hood River downstream of Powerdale Dam. From 1997 to 2003, the sport catch was estimated from statistical creel surveys. The primary target of these fisheries is hatchery fish. From these creel surveys the number of hatchery fish caught was estimated. Using this number and the count of hatchery fish upstream at Powerdale Dam it was possible to estimate a harvest rate for hatchery steelhead. However, for wild steelhead the impact rate is much lower because the angling regulations required that all wild steelhead that are caught be released and not kept. It was assumed that there was a 10% mortality rate for caught and released wild steelhead. Therefore, the mortality impact rate of this sport fishery on wild fish was 0.10 times the rate estimated for hatchery fish.

Prior to 1997 there were no statistical creel surveys to estimate catch in the Hood River. For this earlier period, we used the catch card estimates for the Hood River winter steelhead fishery, adjusted downward to account for the overestimation bias of these data. The 0.47 adjustment factor applied to the catch card data for this purpose was derived from observations between 1997 and 2003. In these years, the statistical creel estimate of catch averaged 0.47 of the catch card estimate for the same period.

A portion of the Hood River winter steelhead return is also caught in mainstem Columbia gillnet fishery. Although the impact rate of this fishery is thought to be low, there is some uncertainty as what this level actually is. For the purposes of this exercise we assumed the average fishery related mortality rate on wild fish 0.05.

The overall impact rate of both the mainstem and Hood River fisheries on returning adults was calculated as: 1-[(1 – ColumbiaHR) * (1 – HoodHR)].

Table B6. Basic data set for Hood River Winter Steelhead

Spawn Year	Wild Fish at Dam	Wild Fish Passed[a]	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning				
							Age3	Age4	Age5	Age6	Age7
1992	688	618	902	0.685	0.082	62	0.020	0.662	0.290	0.028	0.000
1993	402	345	355	0.972	0.096	43	0.103	0.478	0.375	0.045	0.000
1994	378	300	305	0.984	0.096	40	0.028	0.724	0.243	0.005	0.000
1995	203	161	166	0.970	0.102	23	0.156	0.585	0.231	0.023	0.005
1996	275	210	371	0.566	0.094	29	0.107	0.682	0.188	0.023	0.000
1997	284	238	490	0.486	0.064	20	0.045	0.722	0.202	0.031	0.000
1998	221	182	344	0.529	0.075	18	0.066	0.644	0.279	0.011	0.000
1999	297	256	443	0.578	0.065	21	0.214	0.543	0.207	0.036	0.000
2000	912	865	1089	0.794	0.087	87	0.010	0.896	0.091	0.003	0.000
2001	1008	878	1534	0.572	0.073	79	0.028	0.681	0.274	0.017	0.000
2002	1024	950	1633	0.582	0.085	95	0.035	0.609	0.333	0.023	0.000
2003	719	654	1066	0.614	0.080	63	0.025	0.604	0.329	0.041	0.000
2004	582	507	1077	0.471	0.068	42	0.046	0.646	0.272	0.036	0.000

[a] In each year a portion of the wild return was removed to be used for hatchery program broodstock. Therefore, the number of wild fish passed upstream was less than the number that arrived at the dam.

7. Summer Steelhead – Hood River

The methods used to obtain and summarize data for Hood River summer steelhead were essentially the same as for Hood River winter steelhead described in the previous section. At the Powerdale Dam fish handling facility, all summer steelhead were counted, hatchery and wild determinations made, and scales taken from each fish for subsequent age determination. The results of this data collection effort are summarized in Table B7.

Hood River steelhead are caught in both mainstem Columbia gillnet fishery and the sport fishery in the Hood River downstream of Powerdale Dam. From 1997 to 2003, the sport catch was estimated from statistical creel surveys. The primary target of this fishery is hatchery fish. From these creel surveys the number of hatchery fish caught was estimated. Using this number and the count of hatchery fish upstream at Powerdale Dam it was possible to estimate a harvest rate for hatchery steelhead. However, for wild steelhead the impact rate is much lower because the angling regulations required that all wild steelhead that are caught be released and not kept. It was assumed that there was a 10% mortality rate for caught and released wild steelhead. Therefore, the mortality impact rate of this sport fishery on wild fish was 0.10 times the rate estimated for hatchery fish.

Prior to 1997 there were no statistical creel surveys to estimate catch in the Hood River. For this earlier we used the catch card estimates for the Hood River winter steelhead fishery, adjusted downward to account for the overestimation bias of these data. The 0.46 adjustment factor applied to the catch card data for this purpose was derived from observations between 1997 and 2003. In these years, the statistical creel estimate of catch averaged 0.46 of the catch card estimate for the same period.

A substantial portion of the overall fishery impact on Hood River summer is due to mainstem Columbia River gillnet fisheries, especially prior to 2001. The estimated impact rates of these fisheries on wild summer steelhead were based primarily on analyses provided by ODFW and WDFW (2000).

The overall impact rate of both the mainstem and Hood River fisheries on returning adults was calculated as: 1-[(1 – ColumbiaHR) * (1 – HoodHR)].

Table B7. Basic data set for Hood River Summer Steelhead

Spawn Year	Wild Fish at Dam	Wild Fish Passed[a]	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning[b]				
							Age3	Age4	Age5	Age6	Age7
1993	489	489	2211	0.221	0.179	106	0.000	0.065	0.668	0.265	0.002
1994	243	243	1348	0.180	0.175	52	0.000	0.052	0.495	0.406	0.048
1995	218	218	1845	0.118	0.122	30	0.000	0.025	0.441	0.478	0.055
1996	131	131	650	0.202	0.135	20	0.000	0.118	0.656	0.218	0.008
1997	178	178	1491	0.119	0.116	23	0.000	0.049	0.744	0.195	0.012
1998	78	65	513	0.127	0.120	11	0.000	0.118	0.628	0.254	0.000
1999	129	98	102	0.961	0.111	16	0.000	0.139	0.620	0.241	0.000
2000	180	147	149	0.987	0.096	19	0.000	0.166	0.647	0.180	0.006
2001	207	180	181	0.994	0.059	13	0.000	0.128	0.545	0.310	0.016
2002	476	415	539	0.770	0.058	30	0.000	0.166	0.740	0.086	0.008

2003	620	542	1042	0.520	0.064	42	0.000	0.121	0.517	0.337	0.026
2004	219	183	388	0.472	0.063	15	0.000	0.186	0.503	0.299	0.013
2005	180	143	311	0.460	0.062	12	0.000	0.111	0.600	0.272	0.016

[a] Starting with the 1997-98 return In each year a portion of the wild return was removed to be used for hatchery program broodstock. Therefore, the number of wild fish passed upstream was less than the number that arrived at the dam.
[b] Note that for summer steelhead scales are collected in the summer/fall time period, 6 to 12 months before spawning takes place and therefore ages determined from reading these scales were advanced one year to be standardized to the year of spawning not the year of return. For example, a summer steelhead that is determined from scales taken in July to be 4 years old, is closer to being 5-years old when it spawns the following April.

8. Coho – Clackamas

Coho are counted as they pass North Fork Dam on the Clackamas River. While the majority of the coho production is believed to be upstream from this counting location, a significant amount of coho habitat also exists in the portion of the basins downstream from North Fork Dam. Based upon estimates by ODFW, 40% of the production area occurs in this lower portion of the basin.

The number of total wild spawners for this population is based on the counts of wild coho at NF Dam, expanded for the production area downstream of the dam by dividing the dam count by 0.60 (Table B8). Estimating hatchery spawner abundance was more complicated. Upstream of NF Dam, the incidence of hatchery coho in most years was thought to be very low. This conclusion was based on the very low number of fin-clipped hatchery fish observed at NF Dam counting facility (<2% of the run) in recent years. Since all hatchery coho in the lower Columbia basin had been fin-clipped prior to their release as smolts during this period, we are reasonably confident that the proportion of hatchery strays upstream of NF Dam has been low.

However, there were three times since 1957 when this has not been the case. From 1967 to 1971 a substantial number of excess hatchery fish returning to various lower Columbia hatchery facilities were transported to the basin upstream of NF Dam and released. For most of these years the number of transported hatchery fish outnumbered the count of wild fish passing NF Dam.

In 1988 -90 and again in 2000 – 02, hatchery fish from an experimental program using Clackamas wild fish as parental broodstock returned to the upper basin. In most years these hatchery fish represented less than 15% of the total spawners upstream of NF Dam.

The proportion of hatchery fish downstream of NF Dam was not been measured until recent years when extensive spawning surveys have been conducted. The results from these recent surveys document an average of proportion of hatchery fish of 0.52. These hatchery fish are most likely from the large hatchery program at Eagle Creek Hatchery in the lower basin, which has been producing coho for a long period of time. Therefore, we assumed the proportion of hatchery fish observed in recent years approximated the proportion of hatchery fish in most years since 1957. Using this assumption we were able to estimate the number of hatchery spawners from the estimated number of wild fish in the lower basin each year and the assumption that they represented 1 – 52% = 48% of the natural spawning population each year.

Wild Clackamas coho are caught primarily in ocean and Columbia River fisheries. The estimation of the impact rates for the Columbia River fisheries are complicated by the variable nature of both the run timing of natural produced coho returning to the Clackamas basin and the variable timing of the fisheries themselves. Shifts in both have occurred over the period these data. The estimates of overall fishery impacts (ocean and Columbia River) provided here are preliminary estimates prepared by ODFW and will likely change with future data and analyses.

Table B8. Basic data set for Clackamas River Coho

Spawn Year	Total Wild Fish Count[a]	Wild Fish Spawners	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Age Proportion	
							Age2	Age3
1957	678	678	887	0.764	0.942	11065	0.000 [b]	1.000
1958	433	433	567	0.764	0.940	6738	0.000	1.000
1959	1464	1464	1918	0.764	0.882	10900	0.000	1.000
1960	938	938	1228	0.764	0.751	2829	0.000	1.000
1961	2029	2029	2657	0.764	0.749	6056	0.000	1.000
1962	3731	3731	4886	0.764	0.740	10642	0.000	1.000
1963	718	718	941	0.764	0.852	4146	0.000	1.000
1964	2631	2631	3445	0.764	0.840	13817	0.000	1.000
1965	4640	4640	6076	0.764	0.824	21705	0.000	1.000
1966	739	739	968	0.764	0.833	3679	0.000	1.000
1967	1534	1534	3358	0.457	0.876	10851	0.000	1.000
1968	5816	5816	9646	0.603	0.829	28217	0.000	1.000
1969	1988	1988	3305	0.601	0.824	9324	0.000	1.000
1970	3104	3104	4065	0.764	0.858	18781	0.000	1.000
1971	5477	5477	9557	0.573	0.910	55114	0.000	1.000
1972	1372	1372	4570	0.300	0.918	15441	0.000	1.000
1973	900	900	1179	0.764	0.911	9192	0.000	1.000
1974	1261	1261	1652	0.764	0.929	16588	0.000	1.000
1975	1586	1586	2077	0.764	0.897	13858	0.000	1.000
1976	1694	1694	2218	0.764	0.954	35096	0.000	1.000

1977	1254	1254	1643	0.764	0.933	17433	0.000	1.000
1978	1096	1096	1436	0.764	0.899	9804	0.000	1.000
1979	1602	1602	2097	0.764	0.884	12229	0.000	1.000
1980	4469	4469	5852	0.764	0.874	30888	0.000	1.000
1981	1638	1638	2145	0.764	0.885	12667	0.000	1.000
1982	3574	3574	4681	0.764	0.802	14479	0.000	1.000
1983	2239	2239	2932	0.764	0.825	10572	0.000	1.000
1984	956	956	1252	0.764	0.782	3440	0.000	1.000
1985	4583	4438	5812	0.764	0.745	13354	0.000	1.000
1986	6086	5986	7839	0.764	0.829	29533	0.000	1.000
1987	1941	1886	2470	0.764	0.843	10436	0.000	1.000
1988	2267	2267	3060	0.741	0.884	17214	0.000	1.000
1989	3006	3006	4056	0.741	0.859	18248	0.000	1.000
1990	979	979	1300	0.753	0.836	4997	0.000	1.000
1991	4372	4372	5726	0.764	0.859	26545	0.000	1.000
1992	4866	4866	6373	0.764	0.764	15785	0.000	1.000
1993	235	235	308	0.764	0.747	695	0.000	1.000
1994	4036	4036	5286	0.764	0.433	3080	0.000	1.000
1995	2852	2852	3735	0.764	0.428	2137	0.000	1.000
1996	122	120	158	0.764	0.347	65	0.000	1.000
1997	1977	1896	2482	0.764	0.422	1444	0.000	1.000
1998	461	321	420	0.764	0.246	150	0.000	1.000
1999	283	153	200	0.764	0.410	197	0.000	1.000
2000	3406	3406	4855	0.702	0.215	934	0.000	1.000
2001	4392	4392	6909	0.636	0.200	1095	0.000	1.000
2002	1184	1184	1673	0.708	0.303	515	0.000	1.000
2003	2947	2947	3859	0.764	0.300	1263	0.000	1.000
2004	2681	2681	3511	0.764	0.308	1196	0.000	1.000
2005	1694	1694	2218	0.764	0.300	726	0.000	1.000

[a] In certain years a portion of the wild return was removed at the dam to be used for hatchery program broodstock. Therefore, the number of wild fish that spawned naturally was less than returned to the basin in these years.

[b] Although a variable number of age 2 jacks were observed in most years – they were not consistently counted. Since 2 year old coho are thought to be a minor contribution to the reproductive characteristics of coho populations, no attempt was made to quantify their abundance or their pre-harvest abundance.

9. Coho – Sandy River

Total spawner abundance estimates for Sandy coho were derived from counts of fish passing Marmot Dam. Although there is coho habitat in the basin downstream from Marmot Dam, most is upstream. For the purposes of this summary, population data is only meant to represent that portion of the basin upstream of Marmot Dam. No adjustment was made to add the 15% additional production believed to originate in the downstream portion of the watershed.

Complete counts of coho for the spawning years 1970 through 1977 and in 1983 were not available (Table B9). To replace these missing data, values were generated from counts of wild coho observed at NF Dam on the Clackamas. A regression of Marmot and NF dam counts of coho for those years when both data were collected generated a $R^2 = 0.53$. Using this relationship, annual counts of wild fish counted at NF dam were used to predict the return of wild coho to the Sandy for those years where Marmot counts were not available.

The incidence of hatchery coho upstream of Marmot Dam in the majority of years was thought to be very low. This conclusion was based on the very low number of fin-clipped hatchery fish observed at Marmot Dam counting facility (<2% of the run) in recent years. Since all hatchery coho in the lower Columbia basin, and in particular those released into the lower Sandy basin from Cedar Creek Hatchery, had been fin-clipped prior to their release as smolts during this period, we are reasonably confident that the proportion of natural hatchery strays upstream of Marmot Dam has been low.

However, from 1964 to 1972 and again from 1980 to 1986 a substantial number of excess hatchery fish returning to Cedar Creek Hatchery and other lower Columbia hatchery facilities were transported to the basin upstream of Marmot Dam and released. When compared to the number of wild fish passing Marmot dam in these years, it was evident more than 50% of the natural spawning population were hatchery fish (Table B9).

Wild Sandy coho are caught primarily in ocean and Columbia River fisheries. The estimation of the impact rates for the Columbia River fisheries are complicated by the variable nature of the fishery timing over the years since the early 1960s. The estimates of overall fishery impacts (ocean and Columbia River) provided here are preliminary estimates prepared by ODFW and will likely change with future data and analyses.

Table B9. Basic data set for Sandy River Coho

Spawn Year	Wild Fish Spawners	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Age Proportion	
						Age2	Age3
1960	1102	1102	1.000	0.751	3323	0.000[a]	1.000
1961	1525	1525	1.000	0.749	4553	0.000	1.000
1962	1006	1006	1.000	0.740	2869	0.000	1.000
1963	1056	1056	1.000	0.852	6095	0.000	1.000
1964	749	7674	0.098	0.840	3934	0.000	1.000
1965	677	2053	0.330	0.824	3167	0.000	1.000

1966	162	947	0.171	0.833	806	0.000	1.000
1967	386	1636	0.236	0.876	2730	0.000	1.000
1968	841	1713	0.491	0.829	4081	0.000	1.000
1969	411	649	0.633	0.824	1928	0.000	1.000
1970	888	1368	0.649	0.858	5374	0.000	1.000
1971	1205	1591	0.757	0.910	12123	0.000	1.000
1972	573	900	0.637	0.918	6450	0.000	1.000
1973	457	457	1.000	0.911	4667	0.000	1.000
1974	548	548	1.000	0.929	7204	0.000	1.000
1975	619	619	1.000	0.897	5412	0.000	1.000
1976	642	642	1.000	0.954	13295	0.000	1.000
1977	546	546	1.000	0.933	7590	0.000	1.000
1978	397	397	1.000	0.899	3552	0.000	1.000
1979	652	652	1.000	0.884	4979	0.000	1.000
1980	606	1806	0.336	0.874	4189	0.000	1.000
1981	591	939	0.629	0.885	4569	0.000	1.000
1982	722	1648	0.438	0.802	2925	0.000	1.000
1983	745	745	1.000	0.825	3520	0.000	1.000
1984	798	1598	0.499	0.782	2871	0.000	1.000
1985	1445	2045	0.707	0.745	4211	0.000	1.000
1986	1546	2546	0.607	0.829	7502	0.000	1.000
1987	1205	1205	1.000	0.843	6479	0.000	1.000
1988	1506	1506	1.000	0.884	11438	0.000	1.000
1989	2182	2182	1.000	0.859	13246	0.000	1.000
1990	376	376	1.000	0.836	1920	0.000	1.000
1991	1491	1491	1.000	0.859	9052	0.000	1.000
1992	790	790	1.000	0.764	2562	0.000	1.000
1993	193	193	1.000	0.747	570	0.000	1.000
1994	601	601	1.000	0.433	459	0.000	1.000
1995	697	697	1.000	0.428	522	0.000	1.000
1996	181	181	1.000	0.347	96	0.000	1.000
1997	116	116	1.000	0.422	85	0.000	1.000
1998	261	261	1.000	0.246	85	0.000	1.000
1999	162	162	1.000	0.410	113	0.000	1.000
2000	730	730	1.000	0.215	200	0.000	1.000
2001	1388	1388	1.000	0.200	346	0.000	1.000
2002	310	310	1.000	0.303	135	0.000	1.000
2003	1173	1173	1.000	0.300	503	0.000	1.000
2004	1025	1025	1.000	0.308	457	0.000	1.000
2005	717	717	1.000	0.300	307	0.000	1.000

[a] Although a variable number of age 2 jacks were observed in most years – they were not consistently counted. Since 2 year old coho are thought to be a minor contribution to the reproductive characteristics of coho populations, no attempt was made to quantify their abundance or their pre-harvest abundance.

10. Spring Chinook - Clackamas

Spring Chinook are counted as they pass North Fork Dam on the Clackamas River. While the majority of the spring Chinook production occurs upstream from this counting location, 22% of the spring Chinook habitat is population is thought to utilize the basin downstream of NF Dam based on data provided by Maher et al (2005). Therefore, the number of spring Chinook for the entire population was estimated by dividing the count at NF Dam by 0.78.

Only since 2002 has it been possible to visually discriminate between hatchery and wild fish as they passed NF Dam. During this period all fin clipped fish (hatchery fish) were removed from the ladder and prevented from passing upstream. Therefore, only unmarked spring Chinook were present in the upper basin. However, otoliths obtained from spring Chinook carcasses sampled upstream of NF Dam in 2002 and 2003 were analyzed by ODFW. Twenty six percent of the fish sampled in these years were found to have growth patterns that indicated they were hatchery fish. Therefore, the count of hatchery and wild fish at NF Dam (which used fin marks to distinguish hatchery from wild fish) was adjusted to account for this significant portion of unmarked hatchery fish.

From 1980 to 2001, the separate counts of hatchery and wild fish were not available. For the purposes of this data summary the fraction of wild fish was assumed to be equal to the proportion of wild fish estimated from 2002 to 2003 as they were counted arriving at the NF Dam (not after hatchery fish were sorted out and only unmarked fish passed upstream).

Clackamas spring Chinook are caught in ocean, Columbia River, lower Willamette, and lower Clackamas fisheries. The overall fishery impact rate associated with these fisheries shown in Table B10 was provided by ODFW. The age data reported here (Table B10) is an average of annual data collected from Willamette basin spring Chinook sampled by ODFW.

Table B10. Basic data set for Clackamas spring Chinook

Spawn Year	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning				
					Age3	Age4	Age5	Age6	Age7
1958	495	1.000	0.661	964	0.00	0.60	0.39	0.01	0.00
1959	372	1.000	0.661	725	0.00	0.60	0.39	0.01	0.00
1960	232	1.000	0.661	451	0.00	0.60	0.39	0.01	0.00
1961	285	1.000	0.661	556	0.00	0.60	0.39	0.01	0.00
1962	730	1.000	0.661	1420	0.00	0.60	0.39	0.01	0.00
1963	685	1.000	0.661	1333	0.00	0.60	0.39	0.01	0.00
1964	443	1.000	0.661	862	0.00	0.60	0.39	0.01	0.00
1965	393	1.000	0.661	765	0.00	0.60	0.39	0.01	0.00
1966	283	1.000	0.661	551	0.00	0.60	0.39	0.01	0.00
1967	168	1.000	0.661	326	0.00	0.60	0.39	0.01	0.00

1968	522	1.000	0.661	1018	0.00	0.60	0.39	0.01	0.00
1969	1164	1.000	0.660	2262	0.00	0.60	0.39	0.01	0.00
1970	737	1.000	0.672	1508	0.00	0.60	0.39	0.01	0.00
1971	426	1.000	0.648	785	0.00	0.60	0.39	0.01	0.00
1972	243	1.000	0.706	585	0.00	0.60	0.39	0.01	0.00
1973	584	1.000	0.624	968	0.00	0.60	0.39	0.01	0.00
1974	576	1.000	0.656	1098	0.00	0.60	0.39	0.01	0.00
1975	463	1.000	0.702	1092	0.00	0.60	0.39	0.01	0.00
1976	554	1.000	0.674	1146	0.00	0.60	0.39	0.01	0.00
1977	557	1.000	0.590	802	0.00	0.60	0.39	0.01	0.00
1978	532	1.000	0.637	935	0.00	0.60	0.39	0.01	0.00
1979	758	1.000	0.584	1062	0.00	0.60	0.39	0.01	0.00
1980	2716	0.471	0.541	1505	0.00	0.60	0.39	0.01	0.00
1981	3823	0.471	0.541	2118	0.00	0.60	0.39	0.01	0.00
1982	3725	0.471	0.557	2207	0.00	0.60	0.39	0.01	0.00
1983	3325	0.471	0.619	2547	0.00	0.60	0.39	0.01	0.00
1984	3498	0.471	0.598	2447	0.00	0.60	0.39	0.01	0.00
1985	2168	0.471	0.622	1682	0.00	0.60	0.39	0.01	0.00
1986	2300	0.471	0.660	2106	0.00	0.60	0.39	0.01	0.00
1987	2764	0.471	0.570	1723	0.00	0.60	0.39	0.01	0.00
1988	3954	0.471	0.555	2317	0.00	0.60	0.39	0.01	0.00
1989	3652	0.471	0.565	2235	0.00	0.60	0.39	0.01	0.00
1990	4337	0.471	0.600	3068	0.00	0.60	0.39	0.01	0.00
1991	5866	0.471	0.591	3985	0.00	0.60	0.39	0.01	0.00
1992	4495	0.471	0.448	1720	0.00	0.60	0.39	0.01	0.00
1993	3916	0.471	0.520	2000	0.00	0.60	0.39	0.01	0.00
1994	2766	0.471	0.445	1043	0.00	0.60	0.39	0.01	0.00
1995	2098	0.471	0.519	1065	0.00	0.60	0.39	0.01	0.00
1996	1137	0.471	0.431	406	0.00	0.60	0.39	0.01	0.00
1997	1622	0.471	0.338	389	0.00	0.60	0.39	0.01	0.00
1998	1786	0.471	0.263	300	0.00	0.60	0.39	0.01	0.00
1999	1101	0.471	0.342	269	0.00	0.60	0.39	0.01	0.00
2000	2724	0.471	0.331	635	0.00	0.60	0.39	0.01	0.00
2001	4694	0.410	0.298	817	0.00	0.60	0.39	0.01	0.00
2002	4572	0.693	0.155	580	0.00	0.60	0.39	0.01	0.00
2003	7828	0.784	0.145	1038	0.00	0.60	0.39	0.01	0.00
2004	6516	0.739	0.205	1244	0.00	0.60	0.39	0.01	0.00
2005	3689	0.739	0.201	685	0.00	0.60	0.39	0.01	0.00

[a] Although a minor number of age 3 jacks were observed in most years – they were not consistently counted. Since 3 year old Chinook are thought to be a minor contribution to the reproductive characteristics of Chinook populations, no attempt was made to quantify their abundance or their pre-harvest abundance.

11. Spring Chinook - McKenzie

The source of data used to estimate abundance of McKenzie spring Chinook were counts of migrating adults passing Leaburg Dam as reported by Firman et al (2005). Counts of jacks (age 3, precocious males) are not included in these data. Most of the spawning and rearing habitat for this population is located upstream from this counting location.

Wild and hatchery fish have both been substantial portions of the natural spawning population upstream of Leaburg Dam since 1976. Estimates of the wild fraction from 1994 to present were taken from the 2001 FMEP prepared by ODFW or Firman et al (2005). Prior to 1994, specific wild fraction estimates were not available. For the purposes of generating data for this recovery planning effort, the wild fraction for this earlier time period was estimated from a regression between the number of hatchery fish recovered at the McKenzie Hatchery trap and the estimate of hatchery fish passing Leaburg Dam from 1994 to 2005. It was found that 77% of the variation in the estimated number of hatchery Chinook passing Leaburg Dam between 1994 and 2005 could be associated with the number of fish trapped at McKenzie Hatchery. Since the number of fish trapped at McKenzie hatchery has been recorded since 1970, it was then possible to use these numbers to approximate the likely number of hatchery fish that passed Leaburg Dam from 1970 to 1993 and thereby obtain wild fraction estimates.

McKenzie spring Chinook are caught in ocean, Columbia River, lower Willamette, and McKenzie River fisheries. The overall fishery impact rate associated with these fisheries shown in Table B11 was calculated from the following: HRoverall = 1 – [(1-OceanHR)*(1-ColumbiaHR)*(1-WillamHR)*(1-McKenzieHR)]. The 2001 FMEP prepared by ODFW was the primary source of the fishery impact data for all fisheries except the McKenzie River fishery. In this case, the impact rate was determined by dividing the combined count of all Chinook at Leaburg Dam and the McKenzie Hatchery trap for each year into an adjusted sport catch estimated based on ODFW punch-card data records. The ODFW reported sport catch estimates were adjusted downward 32% to ensure they were not overestimates of impact. From various locations in the Willamette basin both statistical creel programs and catch card estimates of sport catch have been made in at least four different years (ODFW, unpublished data). It is assumed that the creel estimates of catch are more accurate than the catch card estimates. Across all of the locations and years compared, the creel estimate of catch averaged 68% of the catch card estimate.

Finally, from 1995 onward angling regulations required the release of any fish caught without a fin clip mark. This regulation was intended to focus the fishing mortality on hatchery fish and significantly reduce the impact on wild fish. The estimated impact of these catch and release impacts on wild fish was assumed to be 10% of the average catch rate for the period in the McKenzie prior to 1995. This was based on the assumption that the interception rate on wild fish was relatively unchanged from previous years and that the delayed mortality of caught and released fish was 10%.

The age data reported here for McKenzie spring Chinook were based on annual scale samples collected by ODFW from returning adult spring Chinook and subsequent age analyses (Table B11).

Table B11. Basic data set for McKenzie spring Chinook

Spawn Year	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning				
					Age3[a]	Age4	Age5	Age6	Age7
1970	2857	0.997	0.623	4705	0.00	0.51	0.48	0.01	0.00
1971	3451	0.893	0.588	4400	0.00	0.61	0.38	0.01	0.00
1972	1478	0.855	0.726	3353	0.00	0.35	0.65	0.00	0.00
1973	3742	0.859	0.597	4755	0.00	0.45	0.53	0.02	0.00
1974	3657	1.000	0.629	6193	0.00	0.42	0.55	0.03	0.00
1975	1300	1.000	0.687	2857	0.00	0.50	0.47	0.03	0.00
1976	1833	0.402	0.592	1069	0.00	0.64	0.35	0.01	0.00
1977	2650	0.634	0.518	1807	0.00	0.49	0.49	0.01	0.00
1978	3020	0.331	0.560	1272	0.00	0.49	0.50	0.01	0.00
1979	1107	0.634	0.527	781	0.00	0.40	0.59	0.01	0.00
1980	1972	0.671	0.417	947	0.00	0.50	0.47	0.03	0.00
1981	1087	0.584	0.506	650	0.00	0.48	0.50	0.01	0.00
1982	1706	0.432	0.475	666	0.00	0.59	0.40	0.01	0.00
1983	1405	0.729	0.471	913	0.00	0.60	0.40	0.01	0.00
1984	921	0.634	0.509	606	0.00	0.56	0.43	0.01	0.00
1985	808	0.634	0.522	560	0.00	0.60	0.39	0.01	0.00
1986	1736	0.432	0.484	702	0.00	0.71	0.29	0.01	0.00
1987	2933	0.714	0.512	2199	0.00	0.68	0.32	0.01	0.00
1988	6613	0.779	0.474	4647	0.00	0.63	0.36	0.01	0.00
1989	3852	0.590	0.511	2372	0.00	0.41	0.58	0.01	0.00
1990	6988	0.772	0.486	5100	0.00	0.56	0.43	0.01	0.00
1991	4287	0.473	0.541	2395	0.00	0.40	0.57	0.02	0.00
1992	3679	0.539	0.417	1421	0.00	0.32	0.67	0.02	0.00
1993	3554	0.709	0.518	2710	0.00	0.39	0.59	0.02	0.00
1994	1507	0.540	0.442	645	0.00	0.48	0.50	0.01	0.00
1995	1577	0.580	0.433	697	0.00	0.39	0.59	0.02	0.00
1996	1432	0.760	0.319	511	0.00	0.40	0.59	0.01	0.00
1997	1110	0.840	0.179	204	0.00	0.56	0.43	0.01	0.00
1998	1848	0.760	0.190	329	0.00	0.43	0.56	0.01	0.00
1999	1862	0.720	0.228	397	0.00	0.50	0.49	0.01	0.00
2000	2533	0.749	0.284	751	0.00	0.55	0.44	0.01	0.00
2001	4428	0.760	0.301	1446	0.00	0.53	0.47	0.00	0.00
2002	6774	0.623	0.152	759	0.00	0.76	0.24	0.01	0.00
2003	10524	0.550	0.142	960	0.00	0.35	0.64	0.00	0.00
2004	9043	0.529	0.203	1220	0.00	0.56	0.42	0.01	0.00
2005	3061	0.832	0.203	649	0.00	0.56	0.42	0.01	0.00

[a] Although a minor number of age 3 jacks were observed in most years (1% to 3% of the total return) – they were not consistently counted. Since 3 year old Chinook are thought to be a minor contribution to the reproductive characteristics of Chinook populations, no attempt was made to quantify their abundance or their pre-harvest abundance

12. Winter Steelhead – Molalla

The abundance of winter steelhead in the Molalla basin (Table B12) was based on spawning survey data, adjusted so that the combined count of all steelhead populations in the Willamette steelhead ESU did not exceed the count of wild winter steelhead estimated to have passed Willamette falls. The methodology will be described in some detail for the Molalla population. For other populations, since the approach is basically the same, the reader will be referred back to the Molalla population methodology described in the following paragraphs.
Spawning surveys were conducted in the Molalla basin in most years from 1980 to 2001. The peak count of steelhead redds observed in these surveys was converted to fish per stream kilometer by multiplying the redd count by 1.35 to convert the data so that it was expressed as the number of spawners. This number was then divided by the length of survey to obtain a fish per kilometer spawner density estimate. These annual density estimates were then expanded by the 240 stream kilometers of total steelhead habitat reported by Maher (2005) for the Molalla basin.

Spawning survey data were missing for 1986 and 1987 as well as from 2002 to 2005. To fill-in these missing years of data, a regression between redds per kilometer and the count of wild winter steelhead at Willamette Falls was developed. From this relationship, the Willamette Falls count could be used to approximate Molalla steelhead redd densities for 1986-87 and 2002-05. These densities were then converted to total spawner estimates as described for the other years.

With the exception of the upper South Santiam, similar spawning survey data sets and expansion to total spawner population estimate was the case for all other populations in the ESU (i.e., North Santiam, South Santiam, and Calapooia). However, it was noted that when all of these individual population estimates were added together, there were a number of years when this combined estimate was substantially greater or sometimes less than the count of wild winter steelhead at Willamette Falls.

To clear up this data inconsistency, a simple adjustment procedure was used, based upon the assumption that the Willamette Falls count was more accurate for the ESU, than the combined count of estimates for individual populations based on spawning surveys. The adjustment procedure involved selecting a multiplication factor that would bring the combined annual spawner estimate based on the spawning survey data into line with the total count of wild winter steelhead at Willamette Falls for each corresponding year. This correction factor was then applied to all individual population data sets, essentially standardized the population estimates such that their new combined value would match the count at Willamette Falls for each year.

Although hatchery winter steelhead have been released into the Molalla basin in past years, this program was terminated in the late 1990s. Because the particular stock of fish used in this basin had a spawn timing that was 2 months earlier than that of the wild population and the spawning surveys focused on the time period when the wild fish spawned, it is unlikely any of the redds counted during these surveys were produced by hatchery fish. We have therefore have assigned a wild fraction for this population of 1.00 in all years. However, it should be acknowledged that is not entirely accurate because an unrecorded number of hatchery fish most likely spawned naturally within the basin during part of the years covered by these data.

Steelhead from this population were caught in fisheries conducted in three the locations: the Columbia, Willamette, and Molalla Rivers. The impact rates presented in this data summary are from ODFW's FMEP on Willamette steelhead. The major reduction in fishery related mortality that occurred in 1993 was caused by the switch to angling regulations that permit the retention of only fin-clipped, hatchery fish. Unclipped steelhead were assumed to wild and if caught were required to be released. A 10% percent post-release mortality was assumed for caught and released steelhead. It was assumed that the catch rate (not kill rate) of wild fish from 1993 to present was the same as for the period prior to 1993, when the catch and release regulations on wild fish were not in place.

The age composition data presented in Table B12 is from the scale reading analyses of scales that were sampled from wild North Santiam steelhead in the 1980s. There were insufficient scales obtained from the Molalla population during this period to make similar analysis. However, it was assumed that since both of these populations were from the same ESU and adjacent to each other within the Willamette basin that the age structure of the Molalla population was probably quite similar to that of the North Santiam.

Table B12. Basic data set for Molalla winter steelhead.

Spawn Year	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning				
					Age3	Age4	Age5	Age6	Age7
1980	4435	1.00	0.23	1294	0.000	0.481	0.412	0.101	0.006

1981	2583	1.00	0.23	753	0.000	0.481	0.412	0.101	0.006
1982	1322	1.00	0.23	385	0.000	0.481	0.412	0.101	0.006
1983	924	1.00	0.23	269	0.000	0.481	0.412	0.101	0.006
1984	2013	1.00	0.23	587	0.000	0.481	0.412	0.101	0.006
1985	2983	1.00	0.23	870	0.000	0.481	0.412	0.101	0.006
1986	2539	1.00	0.23	741	0.000	0.481	0.412	0.101	0.006
1987	1755	1.00	0.23	512	0.000	0.481	0.412	0.101	0.006
1988	4566	1.00	0.23	1332	0.000	0.481	0.412	0.101	0.006
1989	1334	1.00	0.23	389	0.000	0.481	0.412	0.101	0.006
1990	1654	1.00	0.23	482	0.000	0.481	0.412	0.101	0.006
1991	460	1.00	0.23	134	0.000	0.481	0.412	0.101	0.006
1992	1119	1.00	0.23	326	0.000	0.481	0.412	0.101	0.006
1993	359	1.00	0.07	27	0.000	0.481	0.412	0.101	0.006
1994	1366	1.00	0.07	101	0.000	0.481	0.412	0.101	0.006
1995	501	1.00	0.07	37	0.000	0.481	0.412	0.101	0.006
1996	355	1.00	0.07	26	0.000	0.481	0.412	0.101	0.006
1997	528	1.00	0.07	39	0.000	0.481	0.412	0.101	0.006
1998	792	1.00	0.07	59	0.000	0.481	0.412	0.101	0.006
1999	718	1.00	0.07	53	0.000	0.481	0.412	0.101	0.006
2000	800	1.00	0.07	59	0.000	0.481	0.412	0.101	0.006
2001	1752	1.00	0.07	130	0.000	0.481	0.412	0.101	0.006
2002	2865	1.00	0.07	212	0.000	0.481	0.412	0.101	0.006
2003	1532	1.00	0.07	114	0.000	0.481	0.412	0.101	0.006
2004	1570	1.00	0.07	116	0.000	0.481	0.412	0.101	0.006
2005	1093	1.00	0.07	81	0.000	0.481	0.412	0.101	0.006

13. Winter Steelhead – North Santiam

The abundance of winter steelhead in the North Santiam basin (Table B13) was based on spawning survey data, adjusted so that the combined count of all steelhead populations in the Willamette steelhead ESU did not exceed the count of wild winter steelhead estimated to have passed Willamette Falls. See the Molalla winter steelhead population section for a more detailed description of this methodology.

Spawning survey data for this basin was missing for quite few of the years. When the missing data was represented by a single year, 1984, 1986, 1990, and 1996 an approximate value was filled in by taking the average of the year before and after the missing data point. When the missing data was for a string of two or more years, in this case 1980-82 and 1999-00, the fill-in values were obtained from a regression of known data point with a paired data set for the Calapooia population. From this relationship and the redd densities observed in the

Calapooia, redd density values for the North Santiam were generated for the missing data years.

Until the 2001 return, hatchery winter steelhead were present within the North Santiam basin. Because this particular hatchery stock was derived from the later spawning wild fish, the spawn timing was similar. This meant that the redd counts made during spawning surveys likely included some that were produced by hatchery fish. Therefore, the estimate of total spawner abundance had to be split between hatchery and wild fish to accommodate this situation. This was done using data obtained from 1993 to 2000 when it was possible to identify hatchery and wild fish in fishery recoveries and counting locations on the basis of the presence or absence of a fin clip. The average fraction of wild fish observed for this time period was applied to previous years as a means to estimate the wild fraction for this earlier time period.

Steelhead from this population were caught in fisheries conducted in three the locations: the Columbia, Willamette, and North Santiam Rivers. The impact rates presented in this data summary are from ODFW's FMEP on Willamette steelhead. The major reduction in fishery associated mortality that occurred in 1993 was caused by the switch to angling regulations that permit the retention of only fin-clipped, hatchery fish. Unclipped steelhead were assumed to wild and if caught were required to be released. A 10% percent post-release mortality was assumed for caught and released steelhead. It was assumed that the catch rate (not kill rate) of wild fish from 1993 to present was the same as for the period prior to 1993, when the catch and release regulations on wild fish were not in place.

The age composition data presented in Table B13 is from the scale reading analyses of scales that were sampled from wild North Santiam steelhead in the 1980s.

Table B13. Basic data set for North Santiam winter steelhead.

Spawn Year	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning				
					Age3	Age4	Age5	Age6	Age7
1980	5700	0.852	0.23	1416	0.000	0.481	0.412	0.101	0.006
1981	3491	0.852	0.23	868	0.000	0.481	0.412	0.101	0.006
1982	3081	0.852	0.23	766	0.000	0.481	0.412	0.101	0.006
1983	3066	0.852	0.23	762	0.000	0.481	0.412	0.101	0.006
1984	6307	0.852	0.23	1567	0.000	0.481	0.412	0.101	0.006
1985	8375	0.852	0.23	2081	0.000	0.481	0.412	0.101	0.006
1986	7368	0.852	0.23	1831	0.000	0.481	0.412	0.101	0.006
1987	4876	0.852	0.23	1212	0.000	0.481	0.412	0.101	0.006
1988	5104	0.852	0.23	1268	0.000	0.481	0.412	0.101	0.006
1989	3604	0.852	0.23	896	0.000	0.481	0.412	0.101	0.006

1990	4534	0.852	0.23	1127	0.000	0.481	0.412	0.101	0.006
1991	1428	0.852	0.23	355	0.000	0.481	0.412	0.101	0.006
1992	1847	0.852	0.23	459	0.000	0.481	0.412	0.101	0.006
1993	2160	0.837	0.07	134	0.000	0.481	0.412	0.101	0.006
1994	1944	0.868	0.07	125	0.000	0.481	0.412	0.101	0.006
1995	1236	0.889	0.07	81	0.000	0.481	0.412	0.101	0.006
1996	618	0.889	0.07	41	0.000	0.481	0.412	0.101	0.006
1997	2379	0.911	0.07	161	0.000	0.481	0.412	0.101	0.006
1998	2006	0.695	0.07	103	0.000	0.481	0.412	0.101	0.006
1999	2781	0.732	0.07	151	0.000	0.481	0.412	0.101	0.006
2000	1593	0.876	0.07	103	0.000	0.481	0.412	0.101	0.006
2001	4507	1.000	0.07	334	0.000	0.481	0.412	0.101	0.006
2002	7368	1.000	0.07	546	0.000	0.481	0.412	0.101	0.006
2003	4151	1.000	0.07	308	0.000	0.481	0.412	0.101	0.006
2004	4217	1.000	0.07	313	0.000	0.481	0.412	0.101	0.006
2005	2251	1.000	0.07	167	0.000	0.481	0.412	0.101	0.006

14. Winter Steelhead – South Santiam

The abundance of winter steelhead in the South Santiam basin was based on two methods. For the area downstream of Foster Dam (approximately ½ of the basin's steelhead habitat) spawning survey data was used, adjusted so that the combined count of all steelhead populations in the Willamette steelhead ESU did not exceed the count of wild winter steelhead estimated to have passed Willamette falls. See the Molalla winter steelhead population section for a more detailed description of this methodology.

Counts of winter steelhead at Foster Dam were used to estimate spawner abundance for the upper portion of the basin. Numbers from both areas (and methods) were combined to obtain the total spawner data presented in Table B14.

The data set of winter steelhead counts at Foster Dam start in 1968, however the spawner survey data for the lower portion of the basin (downstream of Foster Dam) do not start until 1980. To approximate the number of spawners in the lower basin between 1968 and 1980, a relationship was developed between the Foster Dam counts and spawner abundance estimates for the basin downstream of Foster Dam derived from the spawning survey methodology.

Using this relationship, the Foster Dam counts were used to approximate the lower basin spawner escapement. It should be noted that Green Peter Dam (upstream of Foster Dam) was still passing wild steelhead during this earlier period. However, the steelhead return above Green Peter went extinct in the late 1970s. Therefore, to make the Foster Dam counts used for the prediction regression (post-1980) comparable to the Foster Dam counts in the 1970s, it was necessary to subtract out the number of steelhead counted passing Green Peter Dam.

Finally, it should be noted that spawning surveys in the lower section of the South Santiam were not conducted every year. The years with missing data were the same as the case for the North Santiam. These missing data points were filled in following the same procedure as described for the North Santiam.

With the exception of a period during the 1980s, there has been no hatchery winter steelhead program in the South Santiam. The wild fraction among the spawning population was essentially 1.00 in all years except during this period in the 1980s. During this period the wild fraction was computed as the total spawner estimate minus the hatchery fish counted at Foster Dam, divided by the total spawner estimate.

Steelhead from this population are caught in fisheries conducted in three the locations: the Columbia, Willamette, and South Santiam Rivers. The impact rates presented in this data summary are from ODFW's FMEP on Willamette steelhead. The major reduction in fishery associated mortality that occurred in 1993 was caused by the switch to angling regulations that permit the retention of only fin-clipped, hatchery fish. Unclipped steelhead were assumed to wild and if caught were required to be released. A 10% percent post-release mortality was assumed for caught and released steelhead. It was assumed that the catch rate (not kill rate) of wild fish from 1993 to present was the same as for the period prior to 1993, when the catch and release regulations on wild fish were not in place.

The age composition data presented in Table B14 is from the scale reading analyses of scales that were sampled from wild North Santiam steelhead in the 1980s. There were insufficient scales obtained from the South Santiam population during this period to make similar analysis. However, it was assumed that since both of these populations were from the same ESU and adjacent to each other within the Willamette basin that the age structure of the South Santiam population was probably quite similar to that of the North Santiam.

Table B14. Basic data set for North Santiam winter steelhead.

Spawn Year	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning				
					Age3	Age4	Age5	Age6	Age7
1968	3674	1.00	0.23	1072	0.000	0.481	0.412	0.101	0.006

1969	5367	1.00	0.23	1565	0.000	0.481	0.412	0.101	0.006
1970	4777	1.00	0.23	1393	0.000	0.481	0.412	0.101	0.006
1971	12667	1.00	0.23	3694	0.000	0.481	0.412	0.101	0.006
1972	7191	1.00	0.23	2097	0.000	0.481	0.412	0.101	0.006
1973	3172	1.00	0.23	925	0.000	0.481	0.412	0.101	0.006
1974	2966	1.00	0.23	865	0.000	0.481	0.412	0.101	0.006
1975	2032	1.00	0.23	593	0.000	0.481	0.412	0.101	0.006
1976	1840	1.00	0.23	537	0.000	0.481	0.412	0.101	0.006
1977	2291	1.00	0.23	668	0.000	0.481	0.412	0.101	0.006
1978	2227	1.00	0.23	650	0.000	0.481	0.412	0.101	0.006
1979	1408	1.00	0.23	411	0.000	0.481	0.412	0.101	0.006
1980	7213	1.00	0.23	2104	0.000	0.481	0.412	0.101	0.006
1981	4600	1.00	0.23	1342	0.000	0.481	0.412	0.101	0.006
1982	3772	0.96	0.23	1052	0.000	0.481	0.412	0.101	0.006
1983	1686	0.96	0.23	473	0.000	0.481	0.412	0.101	0.006
1984	4756	0.79	0.23	1097	0.000	0.481	0.412	0.101	0.006
1985	5600	0.89	0.23	1450	0.000	0.481	0.412	0.101	0.006
1986	5005	0.90	0.23	1318	0.000	0.481	0.412	0.101	0.006
1987	3408	0.93	0.23	920	0.000	0.481	0.412	0.101	0.006
1988	6604	0.94	0.23	1803	0.000	0.481	0.412	0.101	0.006
1989	1636	0.96	0.23	459	0.000	0.481	0.412	0.101	0.006
1990	2786	1.00	0.23	810	0.000	0.481	0.412	0.101	0.006
1991	1275	1.00	0.23	372	0.000	0.481	0.412	0.101	0.006
1992	2144	1.00	0.23	625	0.000	0.481	0.412	0.101	0.006
1993	1275	1.00	0.07	94	0.000	0.481	0.412	0.101	0.006
1994	1923	1.00	0.07	143	0.000	0.481	0.412	0.101	0.006
1995	2118	1.00	0.07	157	0.000	0.481	0.412	0.101	0.006
1996	1006	1.00	0.07	75	0.000	0.481	0.412	0.101	0.006
1997	1248	1.00	0.07	92	0.000	0.481	0.412	0.101	0.006
1998	967	1.00	0.07	72	0.000	0.481	0.412	0.101	0.006
1999	3580	1.00	0.07	265	0.000	0.481	0.412	0.101	0.006
2000	2256	1.00	0.07	167	0.000	0.481	0.412	0.101	0.006
2001	4951	1.00	0.07	367	0.000	0.481	0.412	0.101	0.006
2002	4663	1.00	0.07	345	0.000	0.481	0.412	0.101	0.006
2003	2384	1.00	0.07	176	0.000	0.481	0.412	0.101	0.006
2004	4487	1.00	0.07	333	0.000	0.481	0.412	0.101	0.006
2005	2155	1.00	0.07	160	0.000	0.481	0.412	0.101	0.006

15. Winter Steelhead – Calapooia

The abundance of winter steelhead in the Calapooia basin (Table B15) was based on spawning survey data, adjusted so that the combined count of all steelhead populations in the Willamette steelhead ESU did not exceed the count of wild winter steelhead estimated to have passed Willamette falls. See the Molalla winter steelhead population section for a more detailed description of this methodology.

Spawning survey data for this basin was missing for 1984, 1986, 1990, 1996, and 1999. An approximate value for these single data points was filled in by averaging the redds per kilometer values for year before and after the year for which there were no data.

Hatchery steelhead have never been released in the Calapooia basin and the strays from other hatchery programs have never been observed. Therefore, the fraction of wild fish for this population was assumed to 1.00 in all years.

Steelhead from this population are caught in fisheries conducted in three the locations: the Columbia, Willamette, and Calapooia Rivers. The impact rates presented in this data summary are from ODFW's FMEP on Willamette steelhead. The major reduction in fishery associated mortality that occurred in 1993 was caused by the switch to angling regulations that permit the retention of only fin-clipped, hatchery fish. Unclipped steelhead were assumed to wild and if caught were required to be released. A 10% percent post-release mortality was assumed for caught and released steelhead. It was assumed that the catch rate (not kill rate) of wild fish from 1993 to present was the same as for the period prior to 1993, when the catch and release regulations on wild fish were not in place.

The age composition data presented in Table B15 is from the scale reading analyses of scales that were sampled from wild North Santiam steelhead in the 1980s. There were insufficient scales obtained from the Calapooia population during this period to make a similar analysis. However, it was assumed that since both of these populations were from the same ESU, the age structure of the Calapooia population was similar to that of the North Santiam.

Table B15. Basic data set for Calapooia winter steelhead.

Spawn Year	Total Spawners	Wild Frac	Overall Fishery Mortality	Total Wild Catch	Proportion by Age at Spawning				
					Age3	Age4	Age5	Age6	Age7
1980	859	1.00	0.23	251	0.000	0.481	0.412	0.101	0.006
1981	421	1.00	0.23	123	0.000	0.481	0.412	0.101	0.006
1982	597	1.00	0.23	174	0.000	0.481	0.412	0.101	0.006
1983	491	1.00	0.23	143	0.000	0.481	0.412	0.101	0.006
1984	933	1.00	0.23	272	0.000	0.481	0.412	0.101	0.006
1985	1179	1.00	0.23	344	0.000	0.481	0.412	0.101	0.006
1986	1174	1.00	0.23	342	0.000	0.481	0.412	0.101	0.006
1987	916	1.00	0.23	267	0.000	0.481	0.412	0.101	0.006
1988	1620	1.00	0.23	472	0.000	0.481	0.412	0.101	0.006
1989	246	1.00	0.23	72	0.000	0.481	0.412	0.101	0.006
1990	482	1.00	0.23	141	0.000	0.481	0.412	0.101	0.006
1991	227	1.00	0.23	66	0.000	0.481	0.412	0.101	0.006
1992	157	1.00	0.23	46	0.000	0.481	0.412	0.101	0.006

1993	54	1.00	0.07	4	0.000	0.481	0.412	0.101	0.006
1994	212	1.00	0.07	16	0.000	0.481	0.412	0.101	0.006
1995	135	1.00	0.07	10	0.000	0.481	0.412	0.101	0.006
1996	102	1.00	0.07	8	0.000	0.481	0.412	0.101	0.006
1997	505	1.00	0.07	37	0.000	0.481	0.412	0.101	0.006
1998	448	1.00	0.07	33	0.000	0.481	0.412	0.101	0.006
1999	428	1.00	0.07	32	0.000	0.481	0.412	0.101	0.006
2000	211	1.00	0.07	16	0.000	0.481	0.412	0.101	0.006
2001	1052	1.00	0.07	78	0.000	0.481	0.412	0.101	0.006
2002	1417	1.00	0.07	105	0.000	0.481	0.412	0.101	0.006
2003	838	1.00	0.07	62	0.000	0.481	0.412	0.101	0.006
2004	1319	1.00	0.07	98	0.000	0.481	0.412	0.101	0.006
2005	339	1.00	0.07	25	0.000	0.481	0.412	0.101	0.006

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