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Run Reconstructions of Select Salmon and Steelhead Populations in Washington Tributaries of the Lower Columbia River

Run Reconstructions of Select Salmon and Steelhead Populations in Washington Tributaries of the Lower Columbia River

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Abstract

Run reconstructions were completed for select salmon and steelhead populations in Washington tributaries of the lower Columbia River: Coweeman tule fall chinook, East Fork Lewis tule fall chinook, North Fork Lewis bright fall chinook, Wind spring chinook, Little White Salmon spring chinook, Kalama winter steelhead, Kalama summer steelhead, Wind summer steelhead, and Grays chum. These populations were selected because they represent a mixture of species, origin (i.e. hatchery or wild), and basin-specific factors affecting each population. Accuracy of the run reconstructions reflect currently available data; improvements to the run reconstructions are welcome by other researchers if better quality data is known and available. Results of the run reconstructions confirm the general knowledge of low productivity years during the late 1980s and mid 1990s. For all populations investigated, productivity decreased as spawner abundance increased. The inverse relationship between spawner abundance and productivity suggests that, at the habitat capacity present over the duration of the run reconstructions, habitat limitations exist that affect spawning or rearing success and prevent productivity from increasing as spawner abundance increases. Spawner abundance was not an accurate predictor of ocean recruits.

Introduction

Time series of adult abundance data are a key component of many analyses of the status, limiting factors, management practices, and future prospects for salmon in the Columbia River. For example, salmon stock productivity can be estimated from run reconstructions which estimate numbers of spawners and recruits from each brood year (Ricker 1954 and 1975, Beverton and Holt 1957). Productivity of a salmon population for a specified time period is defined as the natural log of the ratio of recruits to spawners, in the absence of density dependent mortality (Neave 1953). Run reconstruction methods vary depending on the type of data available, but are considered similar to virtual population analysis (VPA) or cohort analysis models (see Megrey 1989, Hilborn and Walters 1992, and Haddon 2001 for discussion on these models). Analyses of spawner-recruit data provide one method for assessing the cumulative effects of harvest, hatchery production, habitat changes, and hydroelectric development on anadromous fish (Martin et al. 1987). Spawner-recruit data is especially useful for measuring density independent productivity in assessments of the effects of development. Time series of spawner and recruit data from stocks throughout the Columbia River Basin may provide an important inferential basis for investigations regarding the distribution of mortality throughout the life cycle (Barnthouse et al. 1994). Also, cohort replacement rates based on recruitment-stock ratios can identify ‘harvestable surpluses’ of salmon and steelhead stocks (Lindsay et al. 1986).

In this paper, we present run reconstructions for select salmon and steelhead populations in Washington tributaries of the lower Columbia River: Coweeman tule fall chinook, East Fork Lewis tule fall chinook, North Fork Lewis bright fall chinook, Wind spring chinook, Little White Salmon spring chinook, Kalama winter steelhead, Kalama summer steelhead, Wind summer steelhead, and Grays chum. These populations were selected because they represent a mixture of species, origin (i.e. hatchery or wild), and factors affecting population trends and abundance. Furthermore, continuous, long-term escapement, age composition, and harvest data are available for these populations, which is required for run reconstructions. The only species not represented in this analysis is coho salmon; at present, adequate tributary escapement, age composition, and harvest data are lacking for coho.

Methods

A wealth of escapement, age composition, and harvest data are available for populations in Washington tributaries of the lower Columbia; the challenge is determining which data most accurately estimates the true parameters for each population. When deciding on which data to use, we considered the length of the dataset, data availability, and peer evaluation of data quality. When possible, we utilized data that covered the entire time period of the run reconstructions to minimize any potential errors that could result from using data that were collected using different methods. Based on the availability of continuous data, each run reconstruction covers a different time period.

The general approach for these run reconstructions was to begin with tributary escapement data and back calculate to the number of ocean recruits. The primary milestones in the run reconstructions are the number of spawners, the run size at the mouth of the tributary, the run size at the mouth of the Columbia River, and the run size entering the ocean. At each step, known harvest rates were used to add individuals back into the population; baseline natural mortality was not included because it is expected to be minimal compared to harvest-related mortality. If age-specific harvest rates were available, then spawners were separated by age class and individuals were returned to the population in age-class specific groups, facilitating the assignment to brood year. If age-specific harvest rates were not available, then individuals were returned to the population based on known harvest rates for each fishery and age composition data was applied to the total run to complete the link to brood year.

After the number of ocean recruits by age and brood year was determined, the various population statistics were calculated. Of primary interest was the recruit to spawner ratio and the estimate of productivity obtained from the natural log of the ratio of recruits to spawners. If adequate data were available to apportion the total population into wild and hatchery components, population statistics for each component was calculated separately. If wild juvenile outmigration numbers were available (for wild populations) or hatchery juvenile release number were available (for hatchery populations), smolt to adult survival was calculated for those years of available data.

Coweeman Tule Fall Chinook

The Coweeman tule fall chinook population is considered to be sustained from natural production with very little hatchery influence. Tributary spawning data are available since 1964 so the run reconstruction covers this time period. Spawning escapement data for 1964-2001 were obtained from the Washington Department of Fish and Wildlife (WDFW) Salmon and Steelhead Stock Inventory (SASSI) 2002. An assumed 5% prespawn mortality was applied to the escapement to determine the number of spawners

(Petrosky 1995). Age composition for 1964-2001 was calculated from escapement by age data in the StreamNet database. The spawning population was first separated by age class because age-specific harvest rates are available for mainstem and tributary fisheries; individuals were then added back to the population within each respective age class. Fall chinook 'Big Sheets' are likely the best source of age-specific harvest data for the mainstem Columbia and tributaries. Although Coweeman tule fall chinook are considered a wild run, the lower river hatchery (LRH) stock was used as a surrogate for determining tributary and mainstem harvest because the LRH stock closely resembles Coweeman tule fall chinook migration timing and patterns. Therefore, the tributary harvest rate for 1980-1990 was calculated as the tributary harvest divided by the sum of the total run minus the mainstem harvest from the 'Big Sheets' using LRH stock data. Tributary harvest rate for 1964-1979 was the 5-yr average harvest calculated from 1980-1984 'Big Sheet' data. Since 1991, tributary harvest was set at zero because the Coweeman has been closed to fishing since 1991. The Columbia River mainstem harvest rate for 1980-2001 was calculated as the sum of mainstem harvest by area divided by the total run from the 'Big Sheets" using LRH stock data. The mainstem harvest rate for 1964-1979 was the 5-yr average harvest calculated from 1980-1984 'Big sheet' data. Ocean harvest rates for the time periods from 1964-1989 and 1990-2000 were based on analyses of tule fall chinook coded-wire tagging data from the available brood years within each period, respectively (Byrne et al. 2002). The ocean harvest rate for 2001 was estimated based on preliminary fishery information. Applying the age composition and respective harvest rate data to the annual spawners results in the ocean recruitment by age and year. The annual ocean recruits were assigned to a brood year based on age; for example, the 1964 brood year was assembled with 2-year old recruits from 1966, 3-year old recruits from 1967, etc.

East Fork Lewis Tule Fall Chinook

The East Fork Lewis tule fall chinook population is considered to be sustained from natural production with very little hatchery influence. Tributary spawning data are available from 1964-2001 so the run reconstruction covers this time period. Spawning escapement data for 1964-2001 were obtained from the WDFW SASSI report (2002). An assumed 5% prespawn mortality was applied to the escapement to determine the number of spawners (Petrosky 1995). Age composition for 1964-2001 was calculated from escapement by age data in the StreamNet database. The spawning population was first separated by age class because age-specific harvest rates are available for mainstem and tributary fisheries; individuals were then added back to the population within each respective age class. Fall chinook 'Big Sheets' are likely the best source of age-specific harvest data for the mainstem Columbia and tributaries. Although East Fork Lewis tule fall chinook are considered a wild run, the LRH stock was used as a surrogate for determining tributary and mainstem harvest because the LRH stock closely resembles East Fork Lewis tule fall chinook migration timing and patterns. 'Big Sheet' data is available from 1980-present; however, tributary harvest was closed beginning in 1977 and therefore was set to zero. Tributary harvest rate for years prior to 1977 (i.e. 1964-1976) was the 5-yr average of data from the 1980-1984 'Big Sheet'; annual harvest was calculated as the tributary harvest divided by the sum of the total run minus the mainstem harvest. The Columbia River mainstem harvest rate for 1980-2001 was calculated as the sum of mainstem harvest by area divided by the total run from the ‘Big Sheets” using LRH stock data. The mainstem harvest rate for 1964-1979 was the 5-yr average harvest calculated from 1980-1984 ‘Big sheet’ data. Ocean harvest rates for the time periods from 1964-1989 and 1990-2000 were based on analyses of tule fall chinook coded-wire tagging data from the available brood years within each period, respectively (Byrne et al. 2002). The ocean harvest rate for 2001 was estimated based on preliminary fishery information. Applying the age composition and respective harvest rate data to the annual spawners results in the ocean recruitment by age and year. The annual ocean recruits were assigned to a brood year based on age; for example, the 1964 brood year was assembled with 2-year old recruits from 1966, 3-year old recruits from 1967, etc.

North Fork Lewis Bright Fall Chinook

The North Fork Lewis bright fall chinook population is currently considered to be sustained primarily from natural production; historically, there was substantial influence on the population from hatchery production, which ceased in the mid 1980s. The North Fork Lewis bright fall chinook run reconstruction begins with the run year 1964. Spawning escapement data for 1964-2001 were obtained from the WDFW SASSI report (2002). Because of the hatchery influence in the North Fork Lewis, the proportion of hatchery natural spawners was applied to the total escapement to separate the escapement into wild and hatchery spawners. The run reconstruction was completed with the wild spawners only; all age composition and harvest data was applicable to wild bright fall chinook as opposed to hatchery fish. An assumed 5% prespawn mortality was applied to the escapement to determine the number of spawners (Petrosky 1995). Age composition for 1964-2001 (excluding 1979) was calculated from escapement by age data in the StreamNet database; data for 1979 was incomplete. Age composition for 1979 was derived from data presented in Myers et al. (2002) for naturally spawning bright fall chinook in the Lewis River; Myers et al. (2002) referenced Hymer et al. (1992) as the data source. The wild spawning population was first separated by age class because age-specific harvest rates are available for mainstem and tributary fisheries; individuals were then added back to the population within each respective age class. Fall chinook ‘Big Sheets’ are likely the best source of age-specific harvest data for the mainstem Columbia and tributaries. The lower river wild (LRW) stock was used as a surrogate for determining tributary and mainstem harvest because the LRW stock closely resembles North Fork Lewis bright fall chinook migration timing and patterns. Therefore, the tributary harvest rate for 1980-2001 was calculated as the tributary harvest divided by the sum of the total run minus the mainstem harvest from the ‘Big Sheets’ using LRW stock data. Tributary harvest rate for 1964-1979 was the 5-yr average harvest calculated from 1980-1984 ‘Big Sheet’ data. The Columbia River mainstem harvest rate for 1980-2001 was calculated as the sum of mainstem harvest by area divided by the total run from the ‘Big Sheets” using LRW stock data. The mainstem harvest rate for 1964-1979 was the 5-yr average harvest calculated from 1980-1984 ‘Big sheet’ data. Ocean harvest rates for the time periods from 1964-1989 and 1990-2000 were based on analyses of bright fall chinook coded-wire tagging data from the available brood years within each period, respectively (Byrne et al. 2002). The ocean harvest rate for 2001 was estimated based on preliminary fishery information. Applying the age composition and respective harvest rate data to the annual spawners results in the ocean recruitment by age and year.

Juvenile outmigration data was available for most years from 1977-1987 (Hymer et al. 1992); smolt to adult survival (SAR) was calculated for those years with outmigration data. The annual ocean recruits were assigned to a brood year based on age; for example, the 1964 brood year was assembled with 2-year old recruits from 1966, 3-year old recruits from 1967, etc.

Wind Spring Chinook

Spring chinook are not native to the Wind River. The current spring chinook population is sustained through hatchery production that began in 1955; broodstock for the hatchery program was derived from a mixture of upper Columbia and Snake River spring chinook passing Bonneville Dam. The Wind River run reconstruction began with the 1963 run year. Although total annual escapement data is available through Carson National Fish Hatchery (NFH) rack counts, rack counts are not an accurate measure of the number of fish actually spawned in the hatchery that produced subsequent juvenile releases in the basin. However, data describing the number of fish spawned annually in the hatchery are not readily available. Thus, we calculated the annual effective spawning population as the starting point for the run reconstruction and for developing accurate recruit per spawner relationships. We utilized the ratio of juvenile release goals to adult broodstock collection goals based on production goals reported in the most recent (2002) Hatchery and Genetic Management Plan (HGMP) to establish a relationship between spawning adults and resultant juvenile production. The juvenile to adult ratio was applied to known annual juvenile release numbers in year *x* to determine the effective spawning population for year *x-2*; juvenile release data was obtained from the USFWS. Age composition for 1970-2001 was calculated from WDFW data on Carson NFH spring chinook escapement by age and return year; the age composition for 1963-69 is the average based on all years of available data (i.e. 1970-2001). The effective spawning population was first separated by age class because age-specific harvest rates are available for tributary fisheries; individuals were then added back to the population within each respective age class. Tributary harvest rates for 1970-2001 were calculated from WDFW data that detailed harvest and tribal distributions by age and year; sport harvest, tribal harvest, and tribal distributions were all included as part of the tributary harvest. Tributary harvest for 1963-69 was calculated as the 5-yr average based on harvest data for 1970-74. Mainstem harvest rates were calculate from the Biological Assessment Tables for spring chinook (BA Table 1); included in the mainstem harvest was commercial, sport, and miscellaneous harvest in Zones 1-5, as well as Zone 6 commercial and ceremonial and subsistence (C&S) harvest with an assumed 35% reduction factor applied because Wind River fish are not subjected to the total fishing pressure within Zone 6. The ocean harvest rate was assumed to be 1% because spring chinook harvest in ocean fisheries is minimal. Applying the age composition and respective harvest rate data to the annual spawners results in the ocean recruitment by age and year. Hatchery releases in the basin are available since 1965; annual SAR was calculated for 1965-present based on hatchery releases and ocean recruits. The annual ocean recruits were assigned to a brood year based on age; for example, the 1963 brood year was assembled with 3-year old recruits from 1966, 4-year old recruits from 1967, etc.

Little White Salmon Spring Chinook

Spring chinook are not native to the Little White Salmon River. The current spring chinook population is sustained through hatchery production; although numerous stocks have been planted in the Little White Salmon River, the current population is considered a derivative of the Carson NFH stock. The Little White Salmon River run reconstruction began with the 1965 run year. Although total annual escapement data is available through the Little White Salmon and Willard NFH rack counts, rack counts are not an accurate measure of the number of fish actually spawned in the hatchery that produced subsequent juvenile releases in the basin. However, data describing the number of fish spawned annually in the hatchery are not readily available. Thus, we calculated the annual effective spawning population as the starting point for the run reconstruction and for developing accurate recruit per spawner relationships. We utilized the ratio of juvenile release goals to adult broodstock collection goals based on production goals reported in the most recent HGMP (2002) to establish a relationship between spawning adults and resultant juvenile production. Juvenile transfers from the Little White Salmon and Willard NFH complex to the Umatilla River were included in the ratio because the current adult broodstock goal is based on the total production goal and not just releases to the Little White Salmon basin. The juvenile to adult ratio was applied to known annual juvenile release numbers in year *x* to determine the effective spawning population for year *x-2*; juvenile release data was obtained from the USFWS. Age composition for 1970-2001 was calculated from WDFW data on Little White Salmon NFH spring chinook escapement by age and return year; the age composition for 1965-69 is the average based on all years of available data (i.e. 1970-2001). The effective spawning population was first separated by age class because age-specific harvest rates are available for tributary fisheries; individuals were then added back to the population within each respective age class. Tributary harvest rates for 1970-2001 were calculated from WDFW data that detailed harvest and tribal distributions by age and year; sport harvest, tribal harvest, and tribal distributions were all included as part of the tributary harvest. Tributary harvest for 1965-69 was calculated as the 5-yr average based on harvest data for 1970-74. Mainstem harvest rates were calculate from the Biological Assessment Tables for spring chinook (BA Table 1); included in the mainstem harvest was commercial, sport, and miscellaneous harvest in Zones 1-5, as well as Zone 6 commercial and ceremonial and subsistence (C&S) harvest with an assumed 25% reduction factor applied because Little White Salmon River fish are not subjected to the total fishing pressure within Zone 6. The ocean harvest rate was assumed to be 1% because spring chinook harvest in ocean fisheries is minimal. Applying the age composition and respective harvest rate data to the annual spawners results in the ocean recruitment by age and year. Hatchery releases in the basin are available since 1967; annual SAR was calculated for 1967-present based on hatchery releases and ocean recruits. The annual ocean recruits were assigned to a brood year based on age; for example, the 1965 brood year was assembled with 3-year old recruits from 1968, 4-year old recruits from 1969, etc.

Kalama Winter Steelhead

Historically, the Kalama winter steelhead population was a mixture of hatchery and wild production; the maximum proportion of hatchery fish in the total escapement was 64% in

1986. Since 1998, the annual escapement has been composed completely of wild winter steelhead. WDFW maintains a research station solely for research of Kalama River steelhead and trout; because WDFW has generated a substantial time series of data for both wild and hatchery fish, the run reconstruction was completed for both components of the run. WDFW has recorded wild and hatchery winter steelhead escapement to the Kalama since 1977; each component of the escapement was the starting point for the run reconstruction. An assumed 5% prespawn mortality was applied to the escapement to determine the number of spawners (Petrosky 1995). Tributary harvest of wild winter steelhead (in numbers of fish) for 1977-1996 and 1998-2002 was obtained directly from WDFW. WDFW wild tributary harvest data for 1997 were incomplete; the harvest number used for 1997 was the 5-yr average harvest from 1998-2002. Tributary harvest of hatchery winter steelhead (in numbers of fish) for 1977-1996 was obtained directly from WDFW. WDFW hatchery tributary harvest data for 1997 were incomplete; the harvest number used for 1997 was the 5-yr average harvest from 1992-1996. Hatchery harvest since 1998 was zero because no hatchery fish are present in the escapement. Historically, there were not separate wild and hatchery winter steelhead harvest regulations in the mainstem Columbia River; since 1985, retention of wild winter steelhead in the Columbia River has been prohibited. Thus, wild winter steelhead harvest rates in the Columbia River are assumed to be the same as hatchery fish up to 1984; beginning in 1985, wild fish incidental harvest mortality is assumed to be 10% of the annual hatchery harvest rate. The only exception to this rule was the 2001-02 run year; harvest rate for 2001-02 was based on the 2002 Spring Chinook Tangle Net Fishery data. WDFW estimated there was a 2% immediate mortality and a 0.5% long term mortality (i.e. after releases) for steelhead encountered in the fishery. For 1976-77 to 2000-2001 run years, hatchery winter steelhead harvest rate in the Columbia River was calculated as the lower river sport catch divided by the Columbia river index total run (WDFW and ODFW 2002). Only sport harvest was considered in the mainstem harvest rate because there has been no commercial steelhead harvest in the Columbia River since 1974. The method for deriving harvest rates for hatchery winter steelhead has some limitations: 1) the lower river sport harvest data are reported as incomplete and 2) the index total run includes fish destined for areas above Bonneville Dam. Despite these limitations, these are the best available data for estimating winter steelhead harvest in the mainstem Columbia River. Ocean harvest rate of wild and hatchery steelhead is assumed to be 0.5% based on incidental mortality. Winter steelhead harvest data in each of the respective areas was not available by age class; therefore, harvest by area was added back into the population to obtain the number of ocean recruits before the age composition data was applied. Also, because winter steelhead adult return migration and spawning period spans two calendar years, researchers generally agree that an age is assigned at the time of return and not the time of spawning. Wild winter steelhead age composition data for the run years 1976-77 to 2001-02 were obtained from WDFW. Hatchery winter steelhead age composition data was obtained from a variety of sources: 1980-1983 run year age data were from Hymer et al. (1992), 1984-1993 run year age data were from Hulett et al. (1995), 1977-1979 and 1994-2001 run year age data were from the National Marine Fisheries Service (NMFS) SimSalmon database, and 2001-02 run year age composition was the average from all years of available data. The annual ocean recruits were assigned to a brood year based on age; for example, the 1977 brood year was assembled with 2-year old recruits from 1979-80, 3-year old recruits from 1980-81, etc.

Kalama Summer Steelhead

The Kalama summer steelhead population is a mixture of hatchery and wild production; the proportion of hatchery fish in the total escapement has ranged from 14% (2001) to 90% (1982). From 1977-2003, the proportion of hatchery fish in the annual escapement has average 66%. WDFW maintains a research station solely for research of Kalama River steelhead and trout; because WDFW has generated a substantial time series of data for both wild and hatchery fish, the run reconstruction was completed for both components of the run. WDFW has recorded wild and hatchery summer steelhead escapement to the Kalama since 1977; each component of the escapement was the starting point for the run reconstruction. An assumed 5% prespawn mortality was applied to the escapement to determine the number of spawners (Petrosky 1995). Tributary harvest of wild summer steelhead (in numbers of fish) for 1977-1996 and 1999-2003 was obtained directly from WDFW. WDFW wild tributary harvest data for 1997 and 1998 were incomplete; the harvest number used for 1997 and 1998 was obtained from Weinheimer et al. (2002). Tributary harvest of hatchery summer steelhead (in numbers of fish) for 1977-1996 was obtained directly from WDFW. Tributary harvest of hatchery summer steelhead for 1997-1999 was obtained from Weinheimer et al. (2002); 2000-2003 annual harvest was calculated as the most recent 5-year average harvest (1995-1999). Historically, there were not separate wild and hatchery summer steelhead harvest regulations in the mainstem Columbia River; since 1985, retention of wild summer steelhead in the Columbia River has been prohibited. Thus, wild summer steelhead harvest rates in the Columbia River are assumed to be the same as hatchery fish up to 1984; beginning in 1985, wild fish incidental harvest mortality is assumed to be 10% of the annual hatchery harvest rate. From 1977-2000, hatchery summer steelhead harvest rate in the Columbia River was calculated as the lower river sport catch divided by the lower river minimum run size (WDFW and ODFW 2002). Only sport harvest was considered in the mainstem harvest rate because there has been no commercial steelhead harvest in the Columbia River since 1974. The method for deriving harvest rates for hatchery summer steelhead has some limitations, but represents the best available data for estimating summer steelhead harvest in the mainstem Columbia River. For 2001-2003, hatchery summer steelhead harvest in the mainstem Columbia was calculated as the most recent 5-year average (1996-2000). Ocean harvest rate of wild and hatchery steelhead is assumed to be 0.5% based on incidental mortality. Summer steelhead harvest data in each of the respective areas was not available by age class; therefore, harvest by area was added back into the population to obtain the number of ocean recruits before the age composition data was applied. Wild summer steelhead age composition data for the run years 1977 to 2003 were obtained from WDFW. Hatchery summer steelhead age composition data was obtained from a variety of sources: 1984-1993 run year age data were from Hulett et al. (1995), 1977-1983 and 1994-2001 run year age data were from the NMFS SimSalmon database, and 2002-2003 run year age composition was the average from all years of available data. The annual ocean recruits were assigned to a brood year based on age; for example, the 1978 brood year was assembled with 2-year old recruits from 1980, 3-year old recruits from 1981, etc. Finally, the summer steelhead adult return migration is completed in a given year and spawning does not occur until the following year. Therefore, a one year lag was applied between the run year and brood year so accurate spawner/recruit relationships could be established.

Wind Summer Steelhead

The Wind River summer steelhead population is sustained primarily through wild production; the maximum proportion of hatchery fish in the annual escapement was 35% in 1991, however, recent escapements are almost completely wild summer steelhead. Thus, focus for the run reconstruction was wild production, but the hatchery portion of the population was reconstructed also. Spawning escapement data for run years 1985-1987 was obtained from WDF et al. (1993). For run years 1988-2002, spawning escapement numbers were obtained directly from WDFW. The total escapement was separated into wild and hatchery components based on WDFW data identifying the proportion of wild spawners annually from 1988-2002. The proportion of wild spawners from run year 1985-1987 was the 5-year average from 1988-1992. An assumed 5% prespawn mortality was applied to the escapement to determine the number of spawners (Petrosky 1995). Harvest of wild summer steelhead has been prohibited in the Wind River since 1981. The tributary harvest rate of wild summer steelhead for 1985-1987 was assumed to be 1% based on incidental mortality. The tributary harvest of wild summer steelhead (in numbers of fish) for 1988-2002 was obtained from WDFW. The tributary harvest rate of hatchery summer steelhead for 1985-1991 was based on data presented in Hymer et al. (1992); the harvest rate for 1992-2000 was the average harvest of the years of available data. Retention of wild steelhead in the mainstem Columbia River sport fisheries has been prohibited since 1985. The mainstem harvest rate of Wind wild summer steelhead from 1985-2000 was assumed to be 10% of the lower Columbia sport catch of Group A index steelhead plus the number of wild Group A index summer steelhead in the Zone 6 commercial catch (with a 35% reduction factor) divided by the total minimum Group A index summer steelhead run in the Columbia River (WDFW and ODFW 2002). Similarly, the mainstem harvest rate of hatchery summer steelhead from 1985-2000 was calculated as the lower Columbia sport catch of Group A index summer steelhead plus the number of hatchery group A index summer steelhead in the Zone 6 commercial catch (with a 35% reduction factor) divided by the total minimum run group A index summer steelhead in the Columbia River (WDFW and ODFW 2002). The mainstem harvest rate of hatchery and wild summer steelhead for 2001 and 2002 was the most recent 5-year average (1996-2000). The ocean harvest rate of wild and hatchery summer steelhead is assumed to be 0.5% based on incidental mortality. Summer steelhead harvest data in each of the respective areas was not available by age class; therefore, harvest by area was added back into the population to obtain the number of ocean recruits before the age composition data was applied. Age composition data for 1989-2001 was obtained from the NMFS SimSalmon database; the age composition for 1985-1988 and 2002 was the average based on all years of available data. The annual ocean recruits were assigned to a brood year based on age; for example, the 1986 brood year was assembled with 2-year old recruits from 1988, 3-year old recruits from 1989, etc. As previously described for summer steelhead, a one year lag was applied between the run year and brood year so accurate spawner/recruit relationships could be established.

Grays Chum

Although intermittent releases of hatchery chum salmon have occurred in the Grays River, the population is thought to be sustained through wild production. A long, continuous time series of escapement data was available for Grays River chum; the run reconstruction began with the 1959 run year. Grays River chum escapement data determined by different methods were available by major tributary from multiple sources. Escapement data for the mainstem and West Fork from 1959-2001 were based on total live fish counts; data for 1959-1985 were obtained directly from WDFW and data for 1986-2001 were presented in WDFW (2003). Tributary escapement data for Crazy Johnson, Gorley, and Fossil Creeks from 1959-1991 were expanded population estimates presented in Hymer (1993). Escapement data for Crazy Johnson, Gorley, and Fossil Creeks from 1992-2000 were peak counts of live and dead chum salmon presented in Roler et al. (2002). The proportion of hatchery and wild spawners in the annual escapement was not known, but is expected to be primarily wild spawners. Retention of chum salmon in the Grays River sport fishery has been prohibited since 1994; chum salmon retention in mainstem sport fisheries has been prohibited in Washington since 1995 and in Oregon since 1992. When retention was allowed, chum salmon were not a targeted species. Thus, tributary harvest of Grays River chum was assumed to be 1%. Mainstem harvest rate for 1959-2000 was calculated from the commercial catch in Zones 1-5 divided by the minimum Columbia River run size (WDFW and ODFW 2002). The mainstem harvest rate for 2001 was the most recent 5-year average harvest (1996-2000). Chum salmon ocean harvest was expected to be minimal and was assumed to be 1%. Chum salmon harvest data in each of the respective areas was not available by age class; therefore, harvest by area was added back into the population to obtain the number of ocean recruits before the age composition data was applied. Age composition data for 1959-1978 and 1985-2001 was obtained from the NMFS SimSalmon database. Age composition data for 1979-1984 was obtained from Hymer et al (1992). The annual ocean recruits were assigned to a brood year based on age; for example, the 1959 brood year was assembled with 3-year old recruits from 1962, 4-year old recruits from 1963, etc.

Critical Uncertainties

Accuracy of each run reconstruction is extremely sensitive to the quality of the available data. For example, inaccuracies in age composition data significantly affects the apportionment of fish throughout the run reconstruction. We attempted to utilize those data that are considered to be the best available information; there may be other unpublished or otherwise unavailable data of which we are not aware. In the absence of available data, we made professional assumptions that are expected to closely estimate the true parameters.

Results

Coweeman Tule Fall Chinook

Appendix A-1 includes the Coweeman River tule fall chinook run reconstruction table. The results cover brood years 1964-1995. Recruits per spawner were generally less than

10; average recruits per spawner was 5.748 (Figure 1). Productivity (defined as the natural log of the ratio of recruits to spawners) averaged 1.142 (consequently, this is the highest average productivity of all populations analyzed); the lowest productivity was observed in the late 1980's and mid 1990s (Figure 1). Recruits per spawner and productivity spiked in 1984. No pattern was observed in an analysis of productivity within specific decades (Figure 2). This productivity plot revealed that productivity was negative at spawner abundance greater than 500; however, the negative productivity may be an artifact of environmental conditions rather than spawner abundance. These years of negative productivity correspond with years of low ocean productivity (1988, 1989, 1994, and 1995). There is no linear relationship between spawners and recruits (r^2=0.0003, *p*=0.9297); therefore, the number of spawners is not an accurate predictor of recruits (Figure 3).

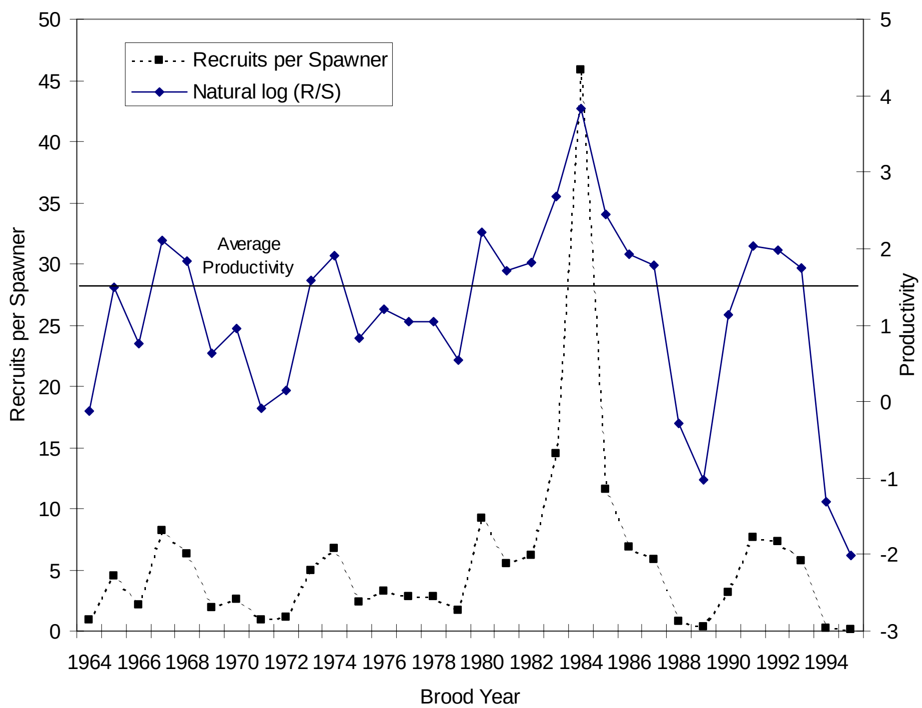

Figure 1. Coweeman tule fall chinook recruits per spawner ratio and productivity by brood year, 1964-1995.

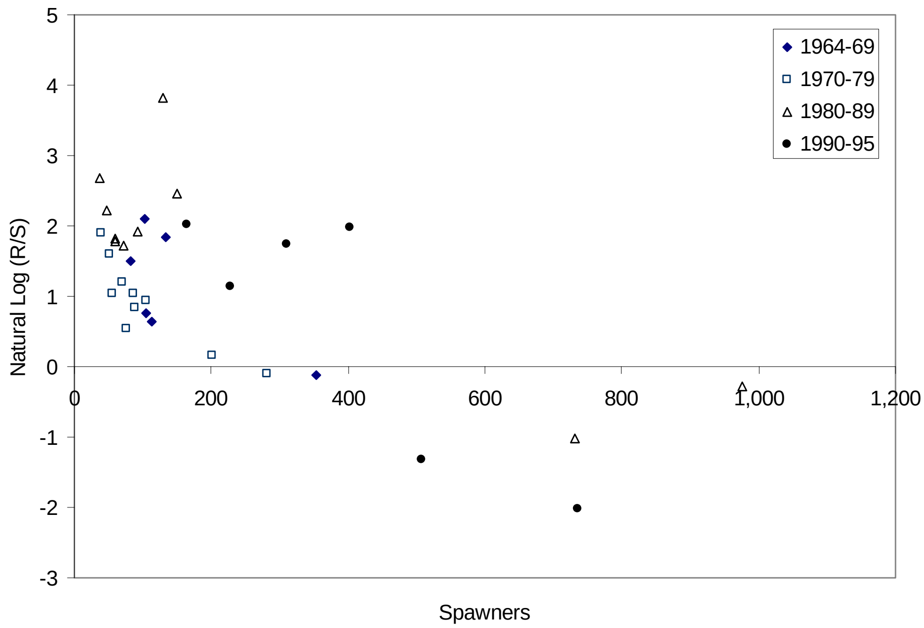

Figure 2. Scatter plot of Coweeman tule fall chinook spawners and productivity by brood year, grouped by decade.

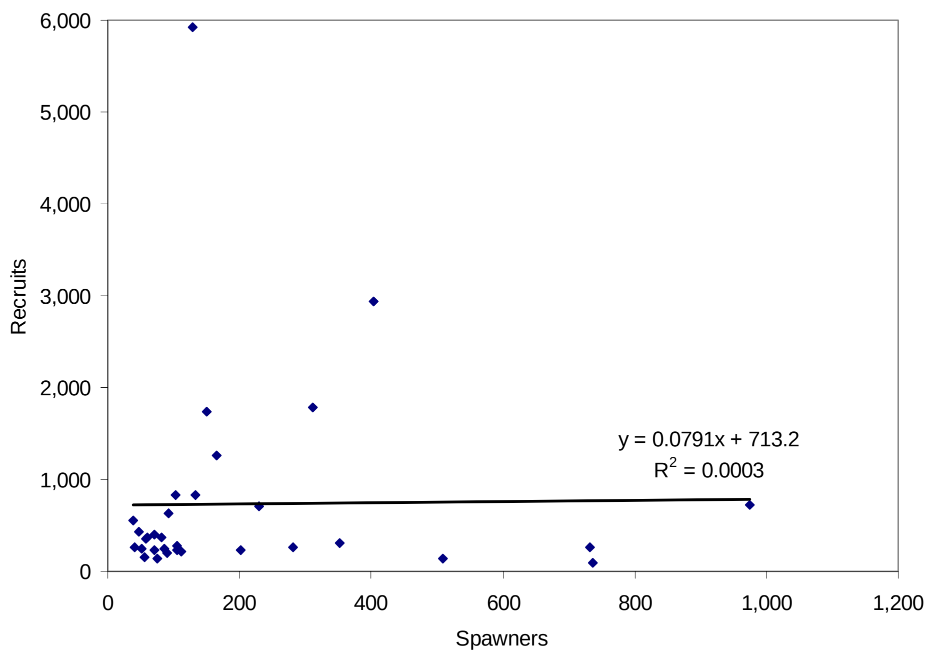

Figure 3. Scatter plot of Coweeman tule fall chinook spawners and recruits.

East Fork Lewis Tule Fall Chinook

Appendix A-2 includes the East Fork Lewis River tule fall chinook run reconstruction table. The results cover brood years 1964-1995. Recruits per spawner were generally less than 5; average recruits per spawner was 3.597 (Figure 4). A period of low recruit per spawner values was observed from 1985 to 1996; as expected, productivity was also low during this time period. Productivity averaged 0.736, with the lowest value observed in 1994 (Figure 4). Recruits per spawner and productivity spiked in the late 1960s and again in 1984. Few patterns were observed in a comparison of productivity within specific decades (Figure 5). In general, productivity in the 1990s was lower than other decades. Although the relationship appears weak, productivity may decline as spawner abundance increases. Years of negative productivity were 1988, 1989, 1991, and 1994; these years correspond with years of low ocean productivity. There is no linear relationship between spawners and recruits (r^2=0.012, p=0.5507); therefore, the number of spawners is not an accurate predictor of recruits (Figure 6).

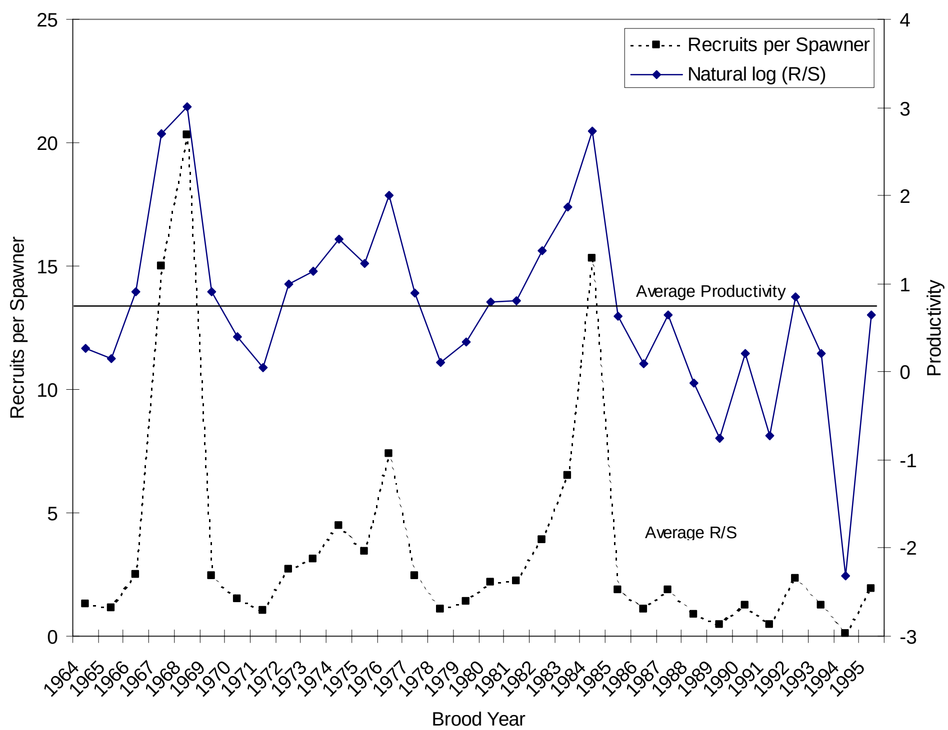

Figure 4. East Fork Lewis tule fall chinook recruits per spawner ratio and productivity by brood year, 1964-1996.

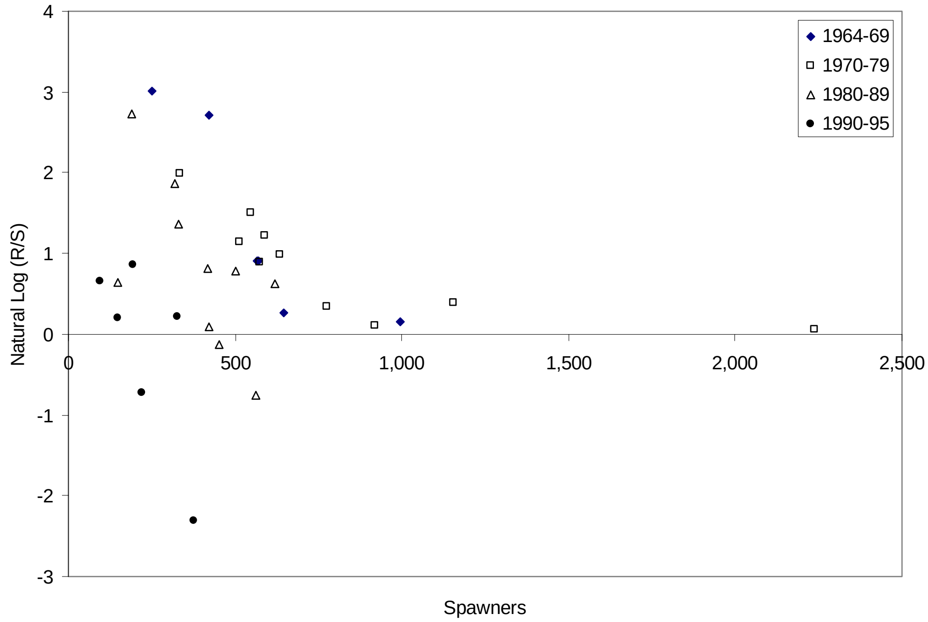

Figure 5. Scatter plot of East Fork Lewis tule fall chinook spawners and productivity by brood year, grouped by decade.

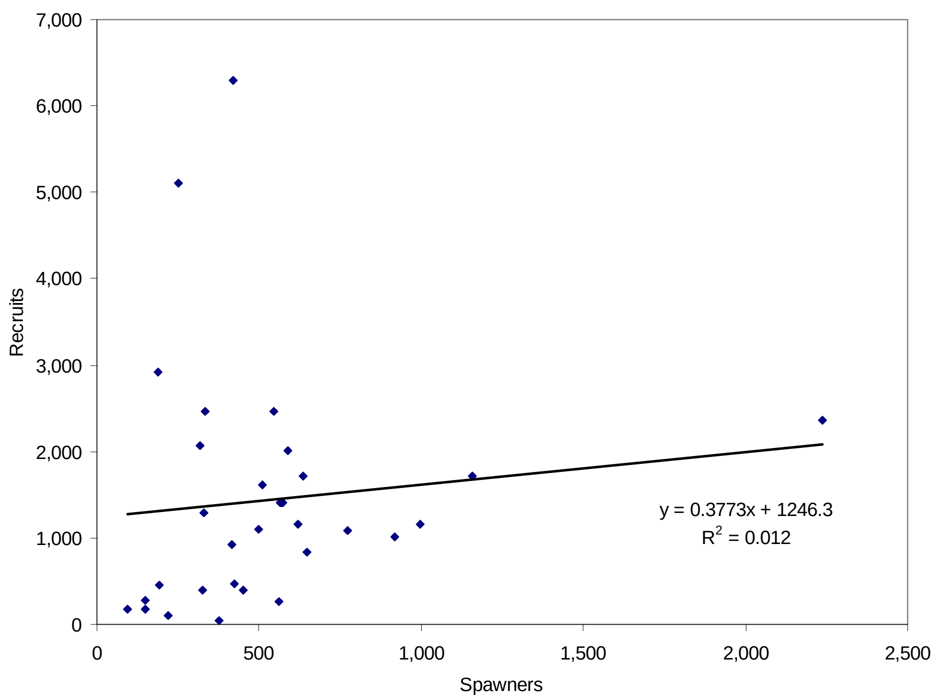

Figure 6. Scatter plot of East Fork Lewis tule fall chinook spawners and recruits.

North Fork Lewis Bright Fall Chinook

Appendix A-3 includes the North Fork Lewis River bright fall chinook run reconstruction table. The results cover brood years 1964-1995. Recruits per spawner were generally less than 4; average recruits per spawner was 2.287 (Figure 7). Productivity averaged 0.488; the lowest productivity was observed in 1994 and 1995 (Figure 7). The highest recruit per spawner and productivity values were observed in 1968, 1976, and 1984. Few patterns were observed in a comparison of productivity within specific decades (Figure 8). Productivity appears to decline as spawner abundance increases. There were nine years of negative productivity; the lowest productivity was observed in 1989, 1994, and 1995. Negative productivity was observed in at least 2 years of all decades included in the analysis. There is no linear relationship between spawners and recruits (r^2=0.0181, p=0.4631); therefore, the number of spawners is not an accurate predictor of recruits (Figure 9). Juvenile outmigration data was available from 1977-87; smolt to adult survival ranged from 0.004 in 1978 to 0.014 in 1986 (Figure 10).

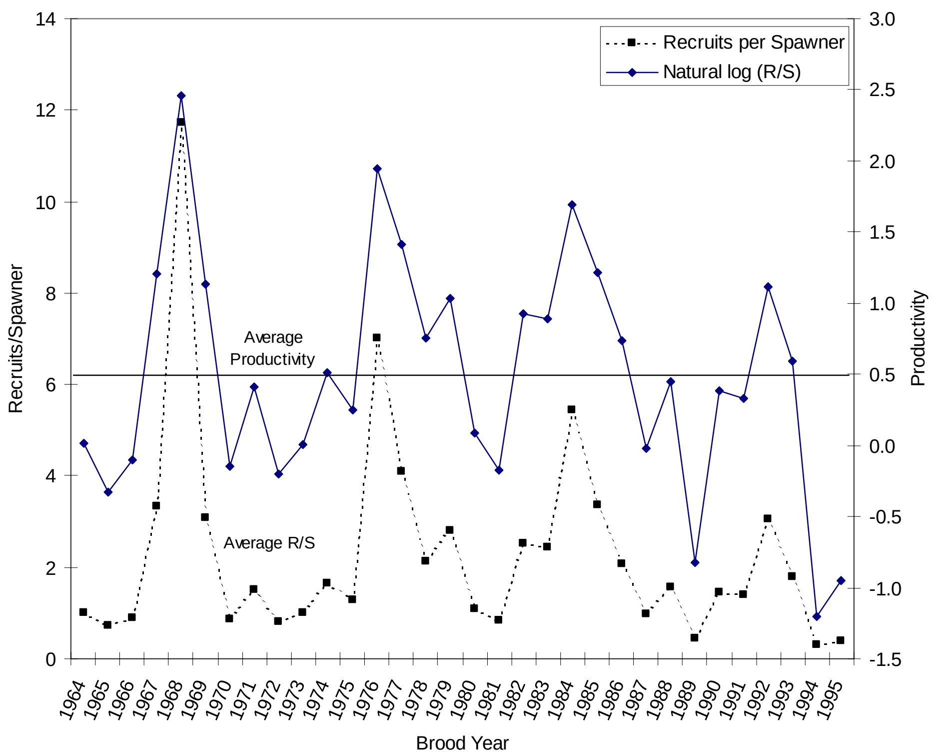

Figure 7. North Fork Lewis bright fall chinook recruits per spawner ratio and productivity by brood year, 1964-1996.

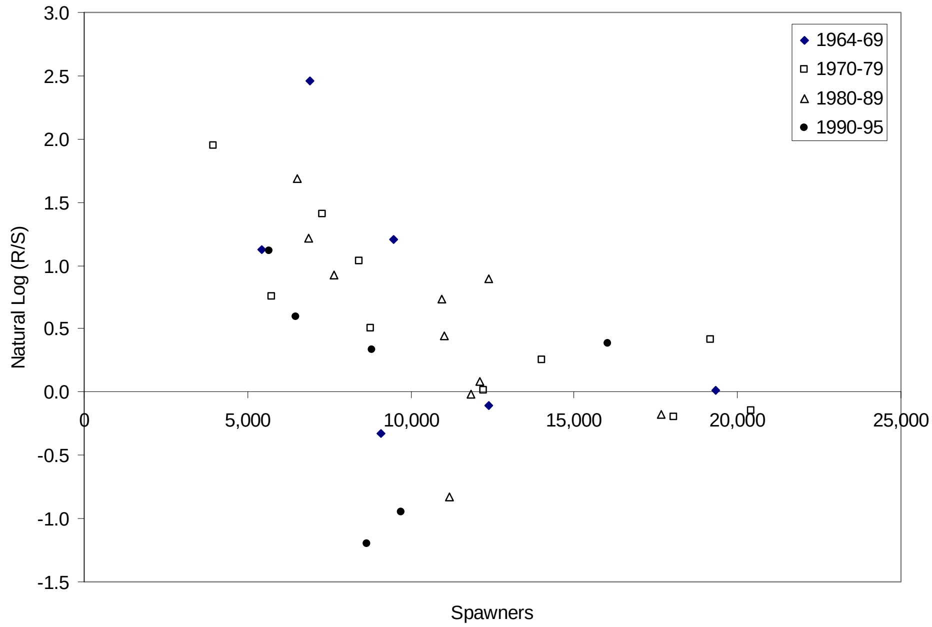

Figure 8. Scatter plot of North Fork Lewis bright fall chinook spawners and productivity by brood year, grouped by decade.

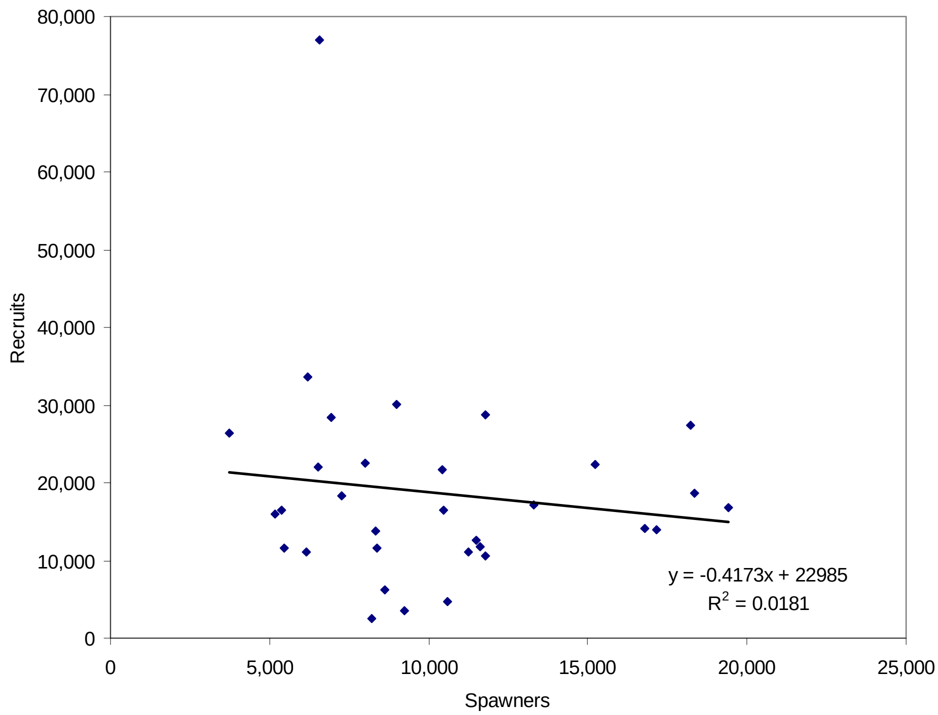

Figure 9. Scatter plot of North Fork Lewis bright fall chinook spawners and recruits.

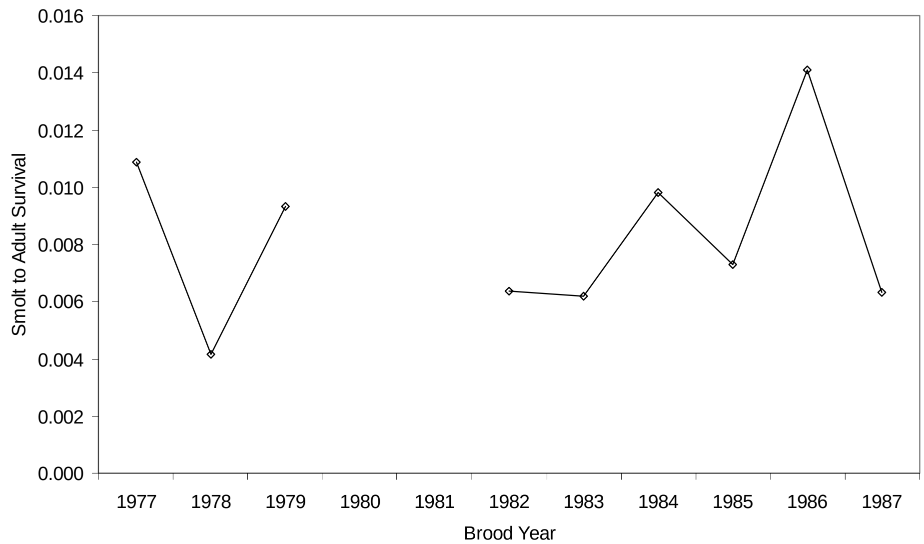

Figure 10. North Fork Lewis bright fall chinook smolt to adult survival by brood year, 1977-1987.

Wind Spring Chinook

Appendix A-4 includes the Wind River spring chinook run reconstruction table. The results cover brood years 1963-1995. Recruits per spawner were generally less than 3; average recruits per spawner was 2.275, while productivity averaged 0.432 (Figure 11). The highest recruit per spawner and productivity values were observed in 1986 and 1993. Few patterns were observed in a comparison of productivity within specific decades (Figure 12). Productivity appears to decline as spawner abundance increases. There were nine years of negative productivity; none were recorded in the 1960s. The lowest productivity was observed in 1972. Negative productivity was observed in at least 2 years of the 1970s, 1980s, and 1990s. There is weak negative linear relationship between spawners and recruits (r^2=0.048, p=0.2206); therefore, the number of spawners is not an accurate predictor of recruits (Figure 13). Hatchery release data are available from 1965 to the present; smolt to adult survival was calculated for 1965-95. Smolt to adult survival ranged from 0.0001 in 1972 to 0.007 in 1968 (Figure 14).

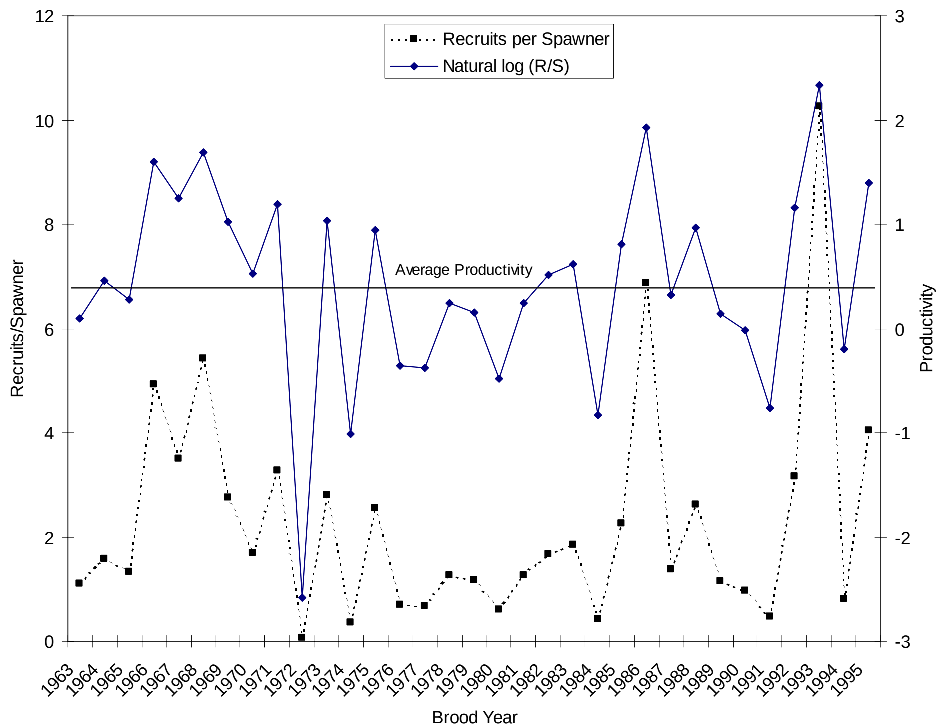

Figure 11. Wind River spring chinook recruits per spawner ratio and productivity by brood year, 1963-1995.

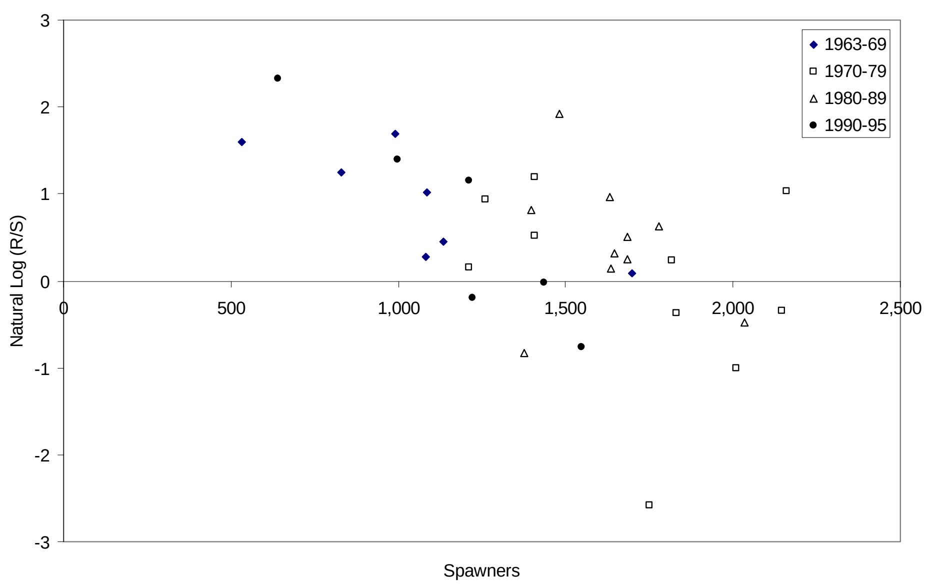

Figure 12. Scatter plot of Wind River spring chinook spawners and productivity by brood year, grouped by decade.

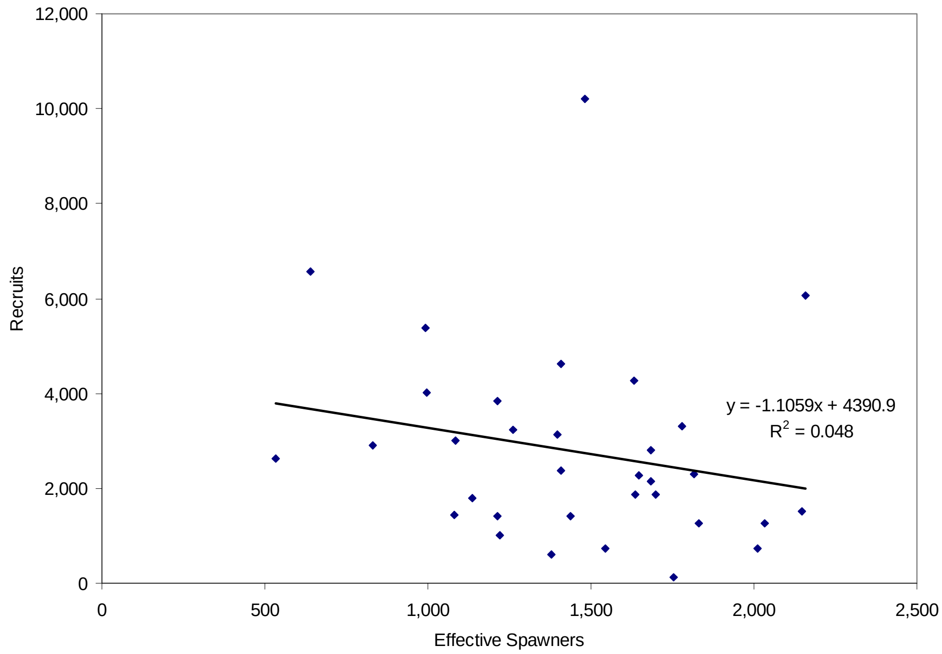

Figure 13. Scatter plot of Wind River spring chinook spawners and recruits.

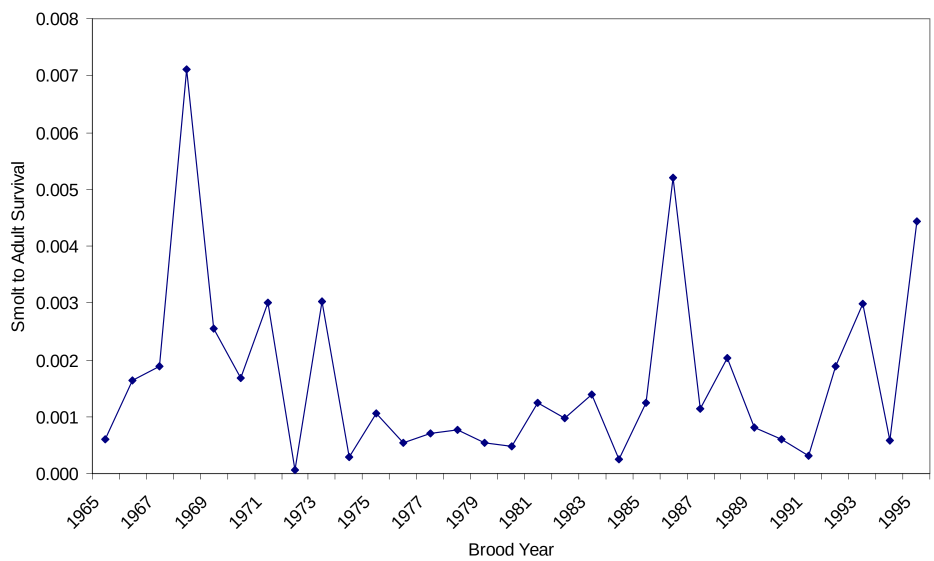

Figure 14. Wind River spring chinook smolt to adult survival by brood year, 1965-1995.

Little White Salmon Spring Chinook

Appendix A-5 includes the Little White Salmon River spring chinook run reconstruction table. The results cover brood years 1965-1995. Recruits per spawner were generally less than 5; average recruits per spawner was 3.660, while productivity averaged 0.688 (Figure 15). The highest recruit per spawner and productivity values were observed in

1965, 1981, 1982, and 1986. Few patterns were observed in a comparison of productivity within specific decades (Figure 16). There were nine years of negative productivity; six of which were recorded in the 1970s. Negative productivity occurred in all decades expect the 1960s. The lowest productivity was observed in 1976. There is weak linear relationship between spawners and recruits (r^2=0.101, *p*=0.0815; Figure 17); however, the y-intercept of –638.01 is not realistic. Therefore, the number of spawners is not an accurate predictor of recruits. Hatchery release data are available from 1967 to the present; smolt to adult survival was calculated for 1967-95. Smolt to adult survival ranged from 0.0002 in 1972 and 1976 to 0.025 in 1982 (Figure 18).

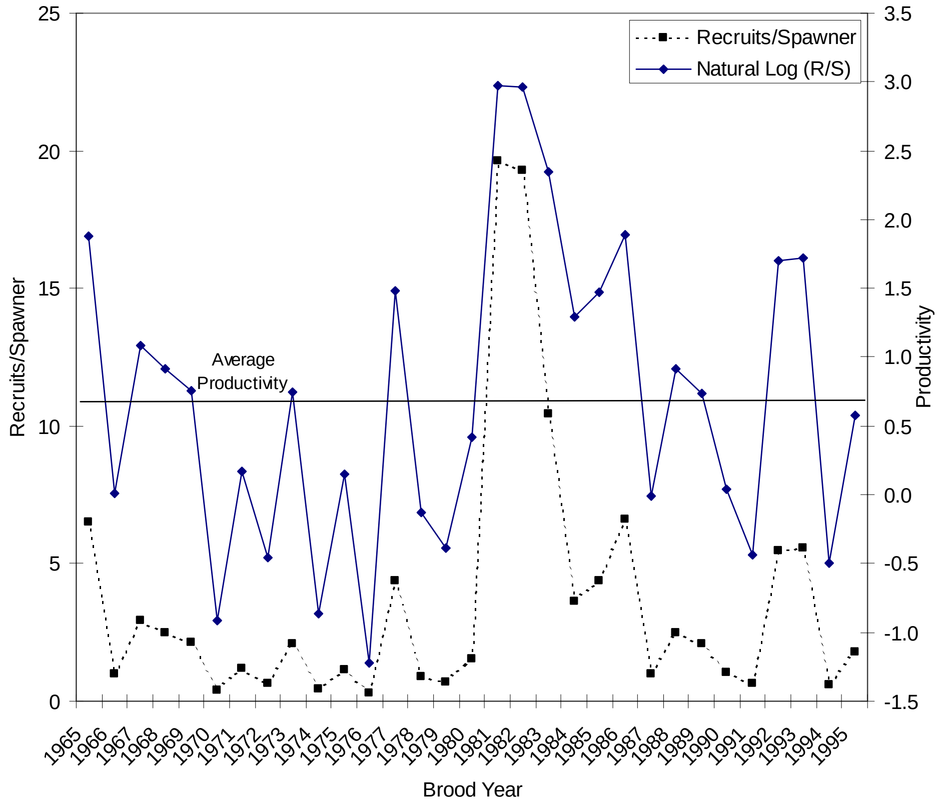

Figure 15. Little White Salmon spring chinook recruits per spawner ratio and productivity by brood year, 1963-1995.

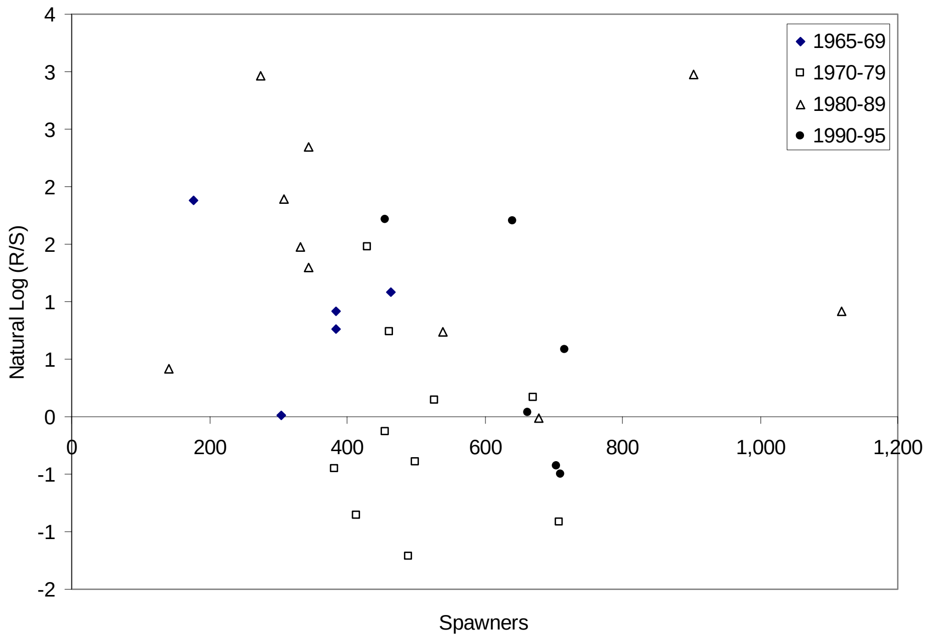

Figure 16. Scatter plot of Little White Salmon spring chinook spawners and productivity by brood year, grouped by decade.

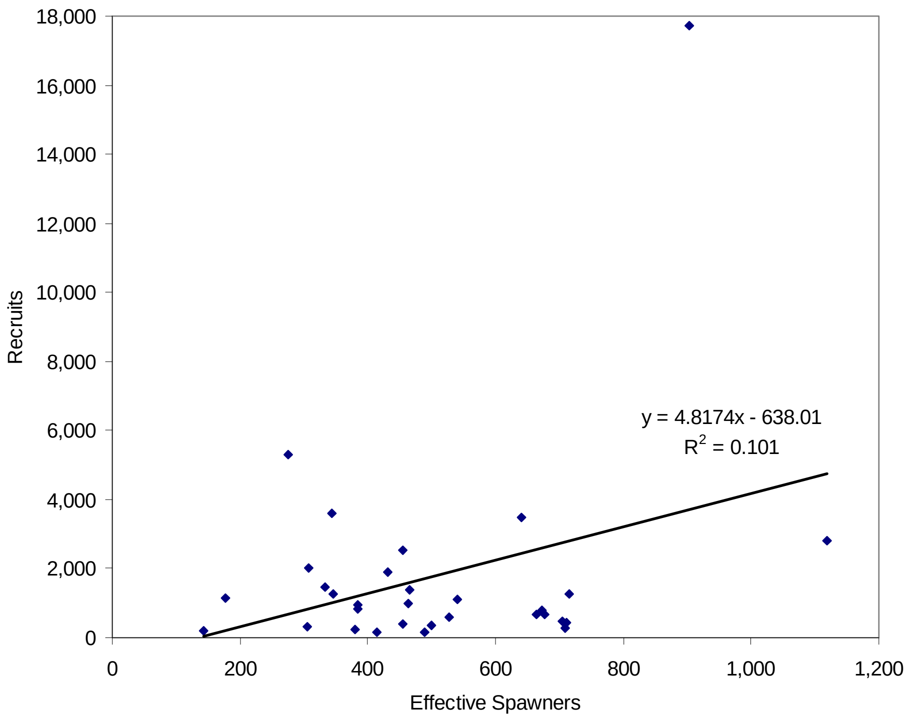

Figure 17. Scatter plot of Little White Salmon spring chinook spawners and recruits.

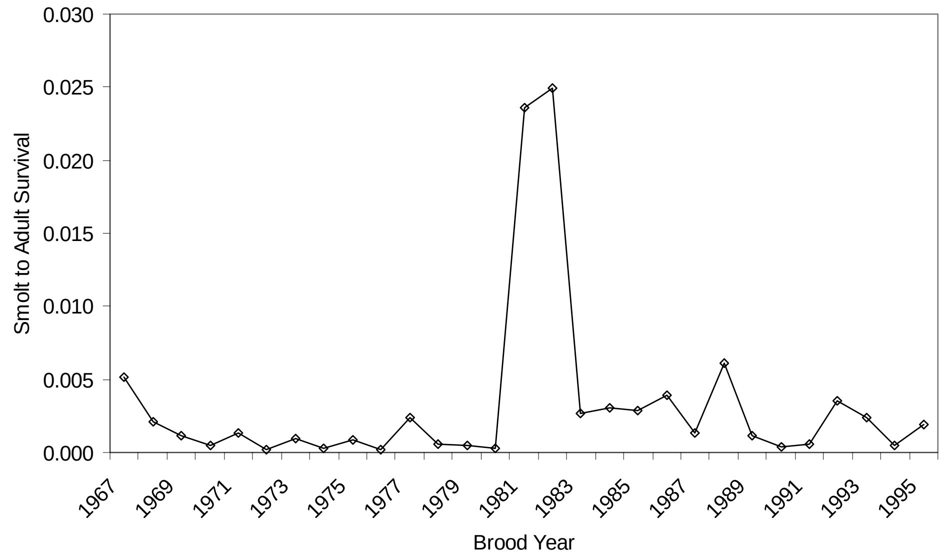

Figure 18. Little White Salmon spring chinook smolt to adult survival by brood year, 1965-1995.

Kalama Winter Steelhead

Appendix A-6 includes the Kalama River winter steelhead run reconstruction table. The results cover brood years 1977-1995. Wild and hatchery fish were analyzed separately because sufficient catch and escapement data exists that allows for the separation of these two components of the population. The total population data is also presented and generally represents an intermediary value between the wild and hatchery fish. Wild recruits per spawner were generally less than 4; average wild recruits per spawner was 1.685 (Figure 19). Generally, hatchery recruits per spawner were similar to or greater than the wild recruits per spawner for the same brood year. Average wild productivity was 0.279 (Figure 20). Generally, hatchery productivity was similar to or greater than the wild productivity for the same brood year. Maximum wild recruits per spawner and productivity occurred in 1979. Hatchery recruits per spawner and productivity spiked in 1982, 1983, and 1989; values were also high in 1979 and 1985 (Figure 20). Few patterns were observed in a comparison of productivity within specific decades (Figure 21 and Figure 22). Productivity appears to decline as spawner abundance increases (for both wild and hatchery fish). For the wild component of the population, there were seven brood years of negative productivity (two in the 1980s and five years in the 1990s; Figure 21). For the hatchery component of the population, there were two brood years of negative productivity (1977 and 1986; Figure 22); as a result of reduced hatchery operations, the hatchery component of the population began declining in the early 1990s. There is no linear relationship between wild spawners and recruits (r^2=0.0105, p=0.6763); therefore, the number of spawners is not an accurate predictor of recruits (Figure 23). There is no linear relationship between hatchery spawners and recruits (r^2=0.0016, p=0.8905); therefore, the number of spawners is not an accurate predictor of recruits (Figure 24).

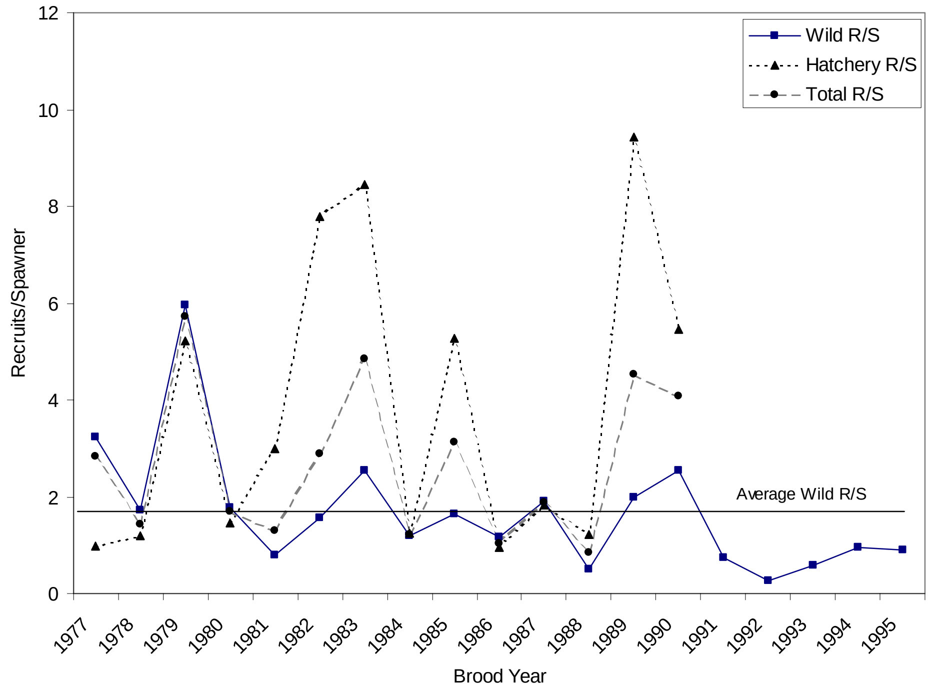

Figure 19. Kalama River winter steelhead recruits per spawner ratio by brood year for the wild and hatchery components as well as the total run, 1977-1995.

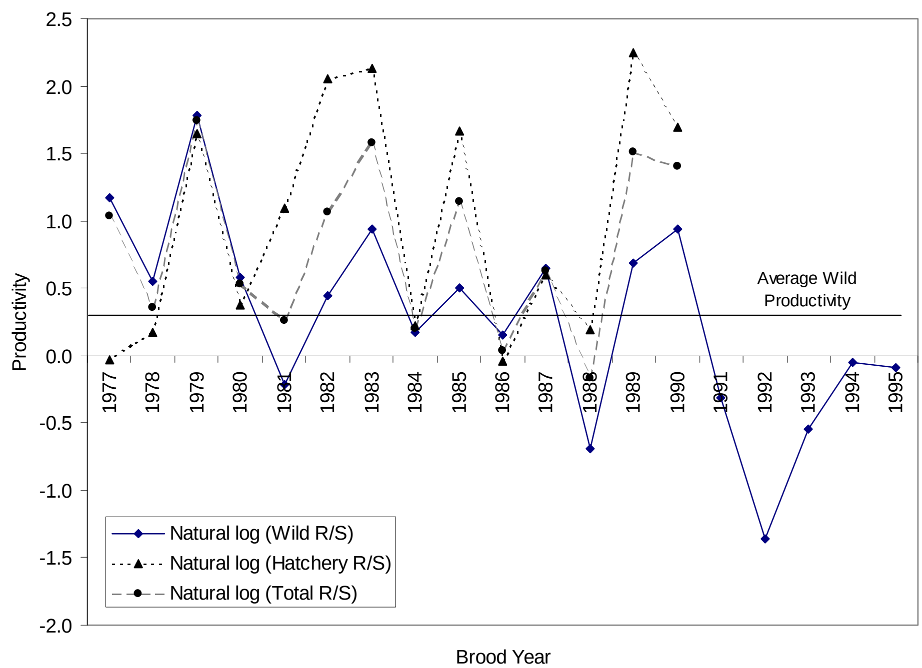

Figure 20. Kalama River winter steelhead productivity by brood year for the wild and hatchery components as well as the total run, 1977-1995.

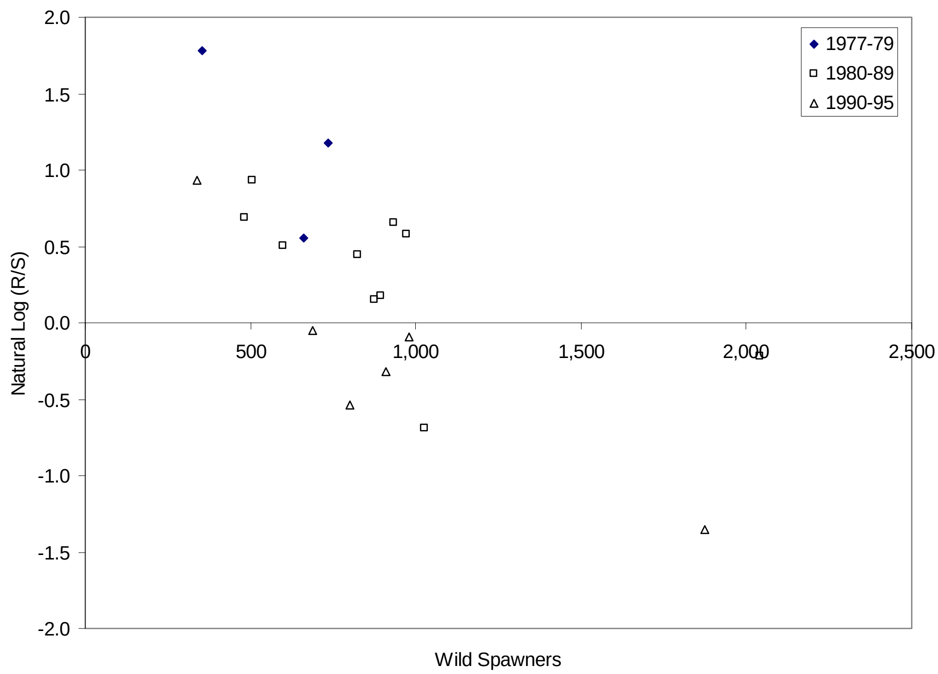

Figure 21. Scatter plot of Kalama River wild winter steelhead spawners and productivity by brood year, grouped by decade.

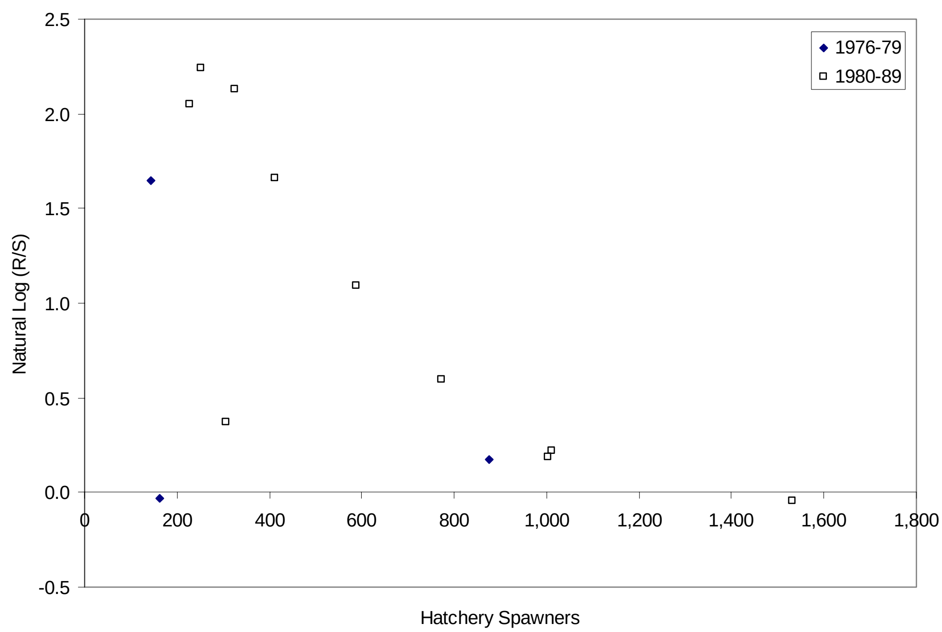

Figure 22. Scatter plot of Kalama River hatchery winter steelhead spawners and productivity by brood year, grouped by decade.

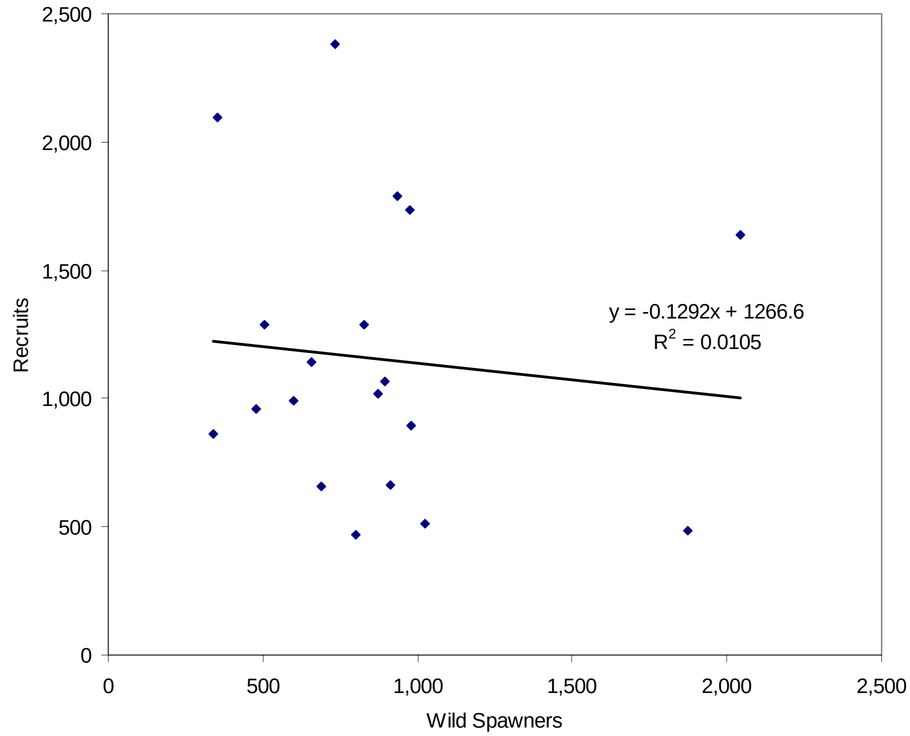

Figure 23. Scatter plot of Kalama River wild winter steelhead spawners and recruits.

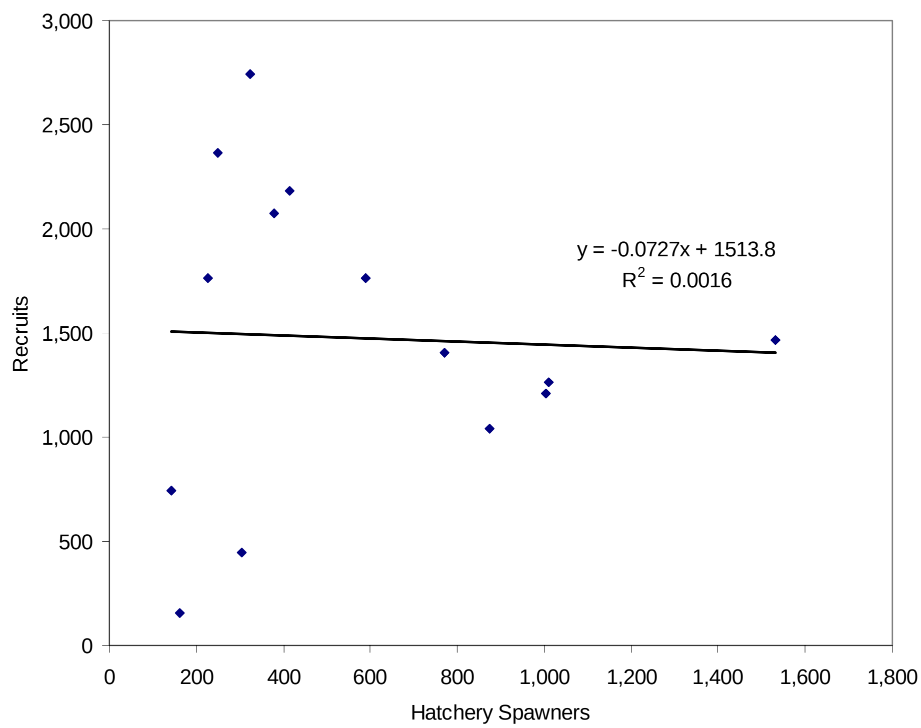

Figure 24. Scatter plot of Kalama River hatchery winter steelhead spawners and recruits.

Kalama Summer Steelhead

Appendix A-7 includes the Kalama River summer steelhead run reconstruction table. The results cover brood years 1978-1995. Wild and hatchery fish were analyzed separately because sufficient catch and escapement data exists that allows for the separation of these two components of the population. The total population data is also presented and generally represents an intermediary value between the wild and hatchery fish. Wild recruits per spawner were generally less than 3; average wild recruits per spawner was 1.863 (Figure 25). A steady decline in recruits per spawner began in 1989. Generally, hatchery recruits per spawner were similar to or greater than the wild recruits per spawner for the same brood year. Average wild productivity was 0.214 (Figure 26). Generally, hatchery productivity was similar to or greater than the wild productivity for the same brood year. The highest recruit per spawner and productivity values for both wild and hatchery fish were observed in 1978 and 1985 (Figure 25 and Figure 26). Few patterns were observed in a comparison of productivity within specific decades (Figure 27 and Figure 28). Productivity appears to decline as wild and hatchery spawner abundance increases, although the relationship for hatchery fish appears weaker than that for wild fish. For the wild component of the population, productivity in the 1990s was lower than the other decades. Of six brood years of negative productivity, four were in the 1990s and two were in the 1980s (Figure 27). For the hatchery component of the population, there were five brood years of negative productivity (three in the 1980s and two in the 1990s; Figure 28). As a result of reduced hatchery operations, the hatchery component of the population began declining in the early 1990s. There is no linear relationship between wild spawners and recruits (r^2=0.0448, p=0.3989); therefore, the number of spawners is not an accurate predictor of recruits (Figure 29). There is no linear relationship between hatchery spawners and recruits (r^2=0.0158, p=0.6081); therefore, the number of spawners is not an accurate predictor of recruits (Figure 30).

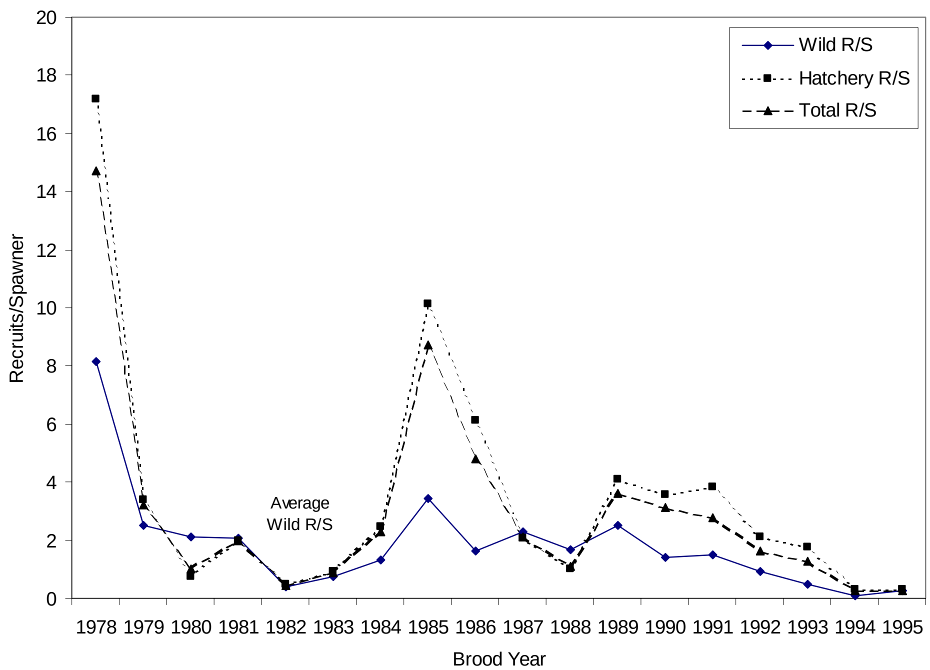

Figure 25. Kalama River summer steelhead recruits per spawner ratio by brood year for the wild and hatchery components as well as the total run, 1977-1995.

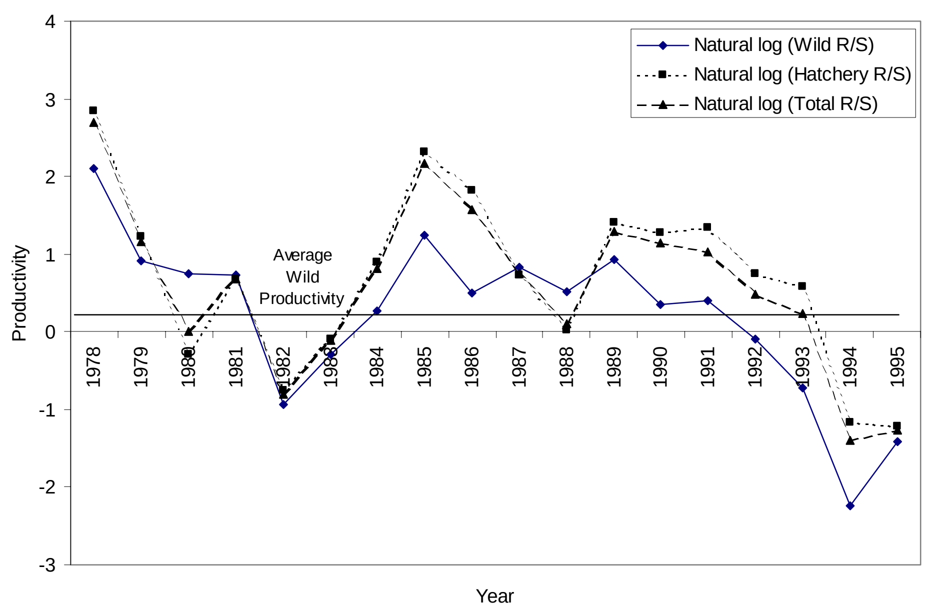

Figure 26. Kalama River summer steelhead productivity by brood year for the wild and hatchery components as well as the total run, 1977-1995.

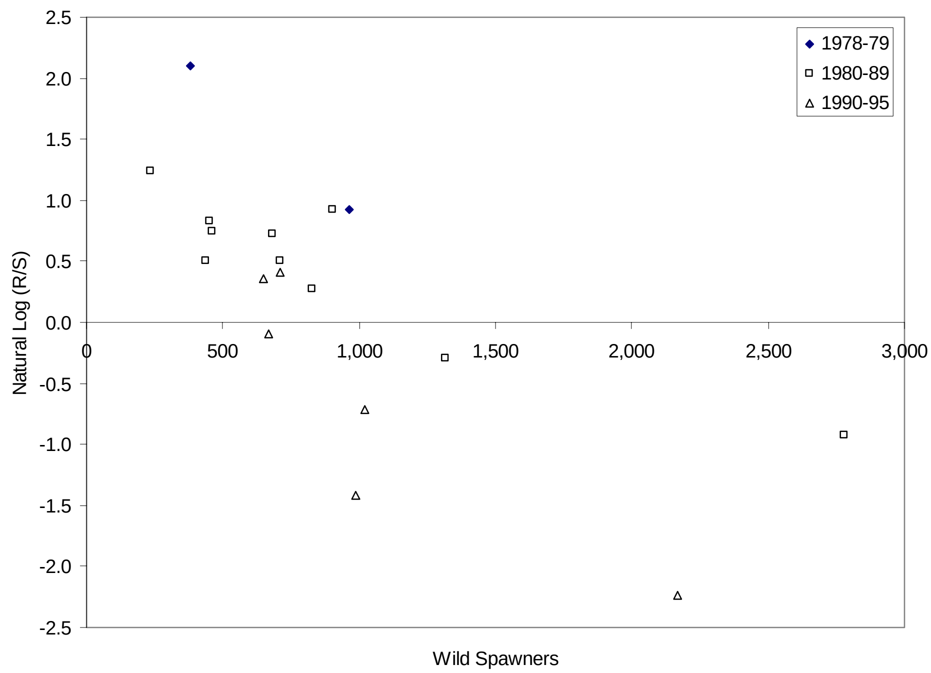

Figure 27. Scatter plot of Kalama River wild summer steelhead spawners and productivity by brood year, grouped by decade.

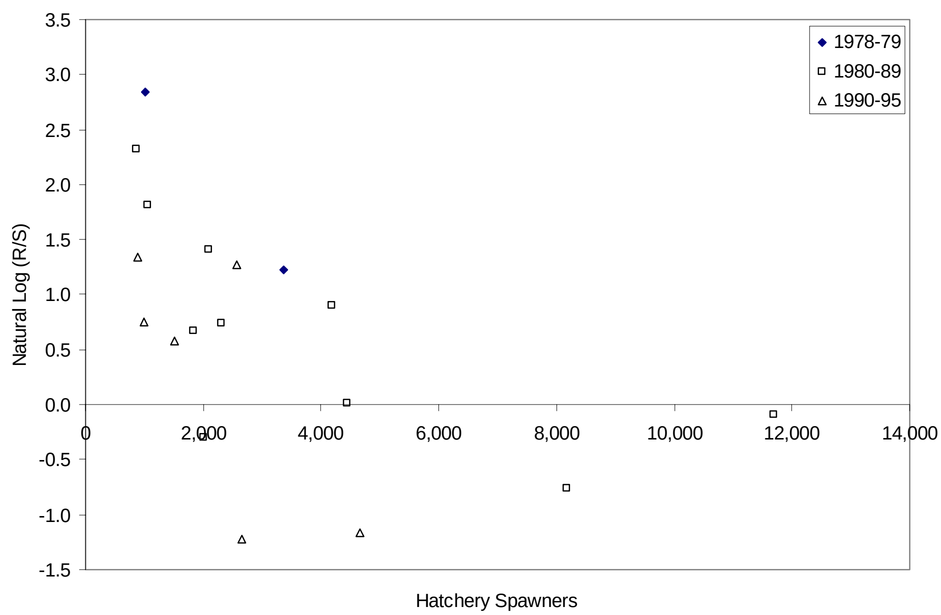

Figure 28. Scatter plot of Kalama River hatchery summer steelhead spawners and productivity by brood year, grouped by decade.

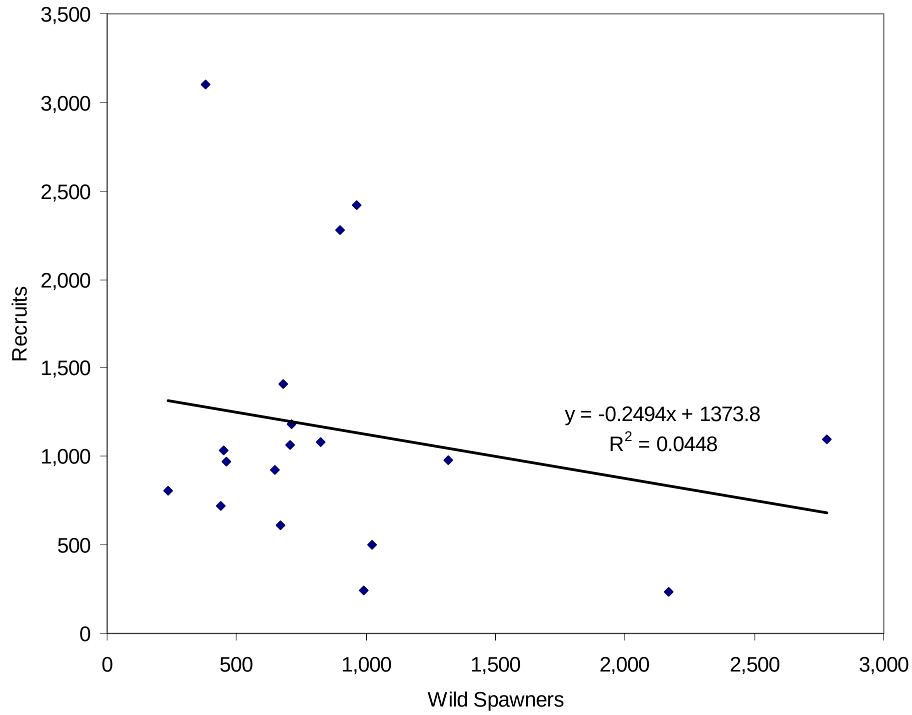

Figure 29. Scatter plot of Kalama River wild summer steelhead spawners and recruits.

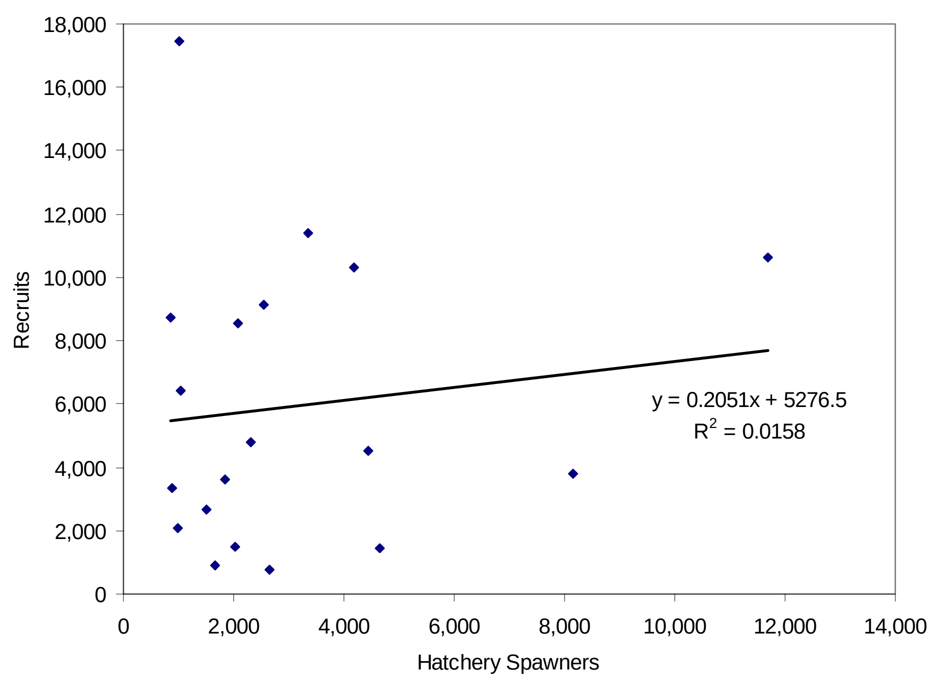

Figure 30. Scatter plot of Kalama River hatchery summer steelhead spawners and recruits.

Wind Summer Steelhead

Appendix A-8 includes the Wind River summer steelhead run reconstruction table. The results cover brood years 1986-1996; this is the shortest time period of all run reconstructions performed in this analysis. Wild and hatchery fish were analyzed separately because sufficient catch and escapement data exists that allows for the separation of these two components of the population. The total population data is also presented and generally represents an intermediary value between the wild and hatchery fish. Wild recruits per spawner were generally less than 2; average wild recruits per spawner was 1.088 (Figure 31). Generally, hatchery recruits per spawner were similar to or greater than the wild recruits per spawner for the same brood year. Average wild productivity was 0.002 (Figure 32). Generally, hatchery productivity was similar to or greater than the wild productivity for the same brood year; the only notable exception was 1995 where hatchery productivity was extremely low. The highest recruit per spawner and productivity values for hatchery fish were observed in 1986 and 1987; maximum recruit per spawner and productivity values for wild fish occurred in 1987 (Figure 31 and Figure 32). Few patterns were observed in a comparison of productivity within specific decades (Figure 33 and Figure 34). Productivity appears to decline as wild and hatchery spawner abundance increases, although the relationship for hatchery fish does not appear to be very strong. For the wild component of the population, productivity in the 1990s was lower than the other decades. Of six brood years of negative productivity, five were in the 1990s and one was in the 1980s (Figure 33). For the hatchery component of the population, there were also six brood years of negative productivity (one in the 1980s and five in the 1990s; Figure 34). As a result of reduced hatchery operations, the hatchery component of the population began declining in the late 1990s. There is no linear relationship between wild spawners and recruits (r^2=0.0151, p=0.7186); therefore, the number of spawners is not an accurate predictor of recruits (Figure 35). There is no linear relationship between hatchery spawners and recruits (r^2=0.0001, p=0.9755); therefore, the number of spawners is not an accurate predictor of recruits (Figure 36).

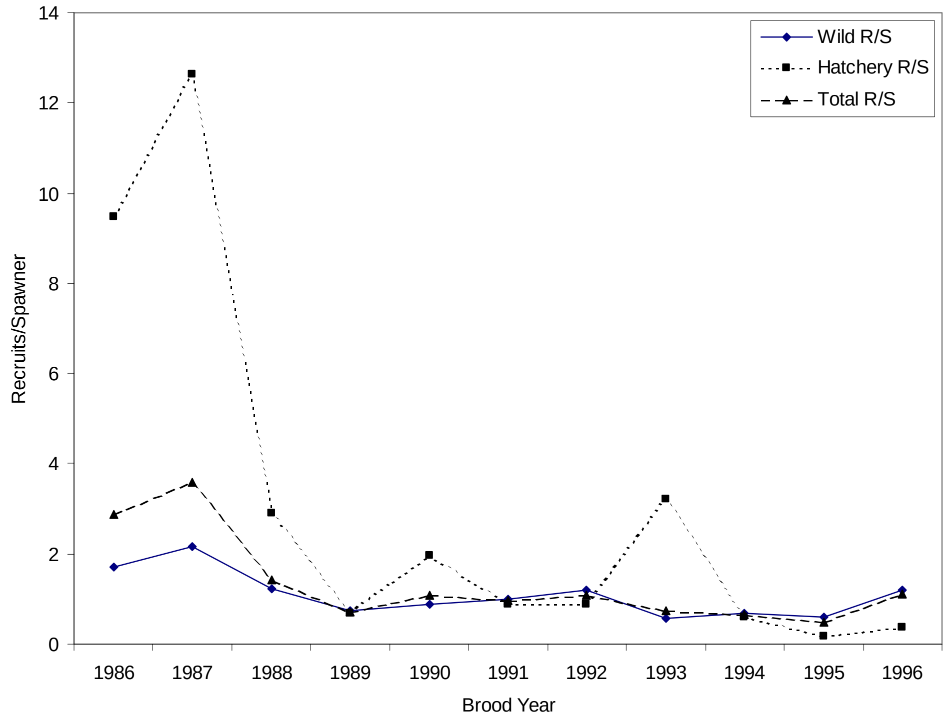

Figure 31. Wind River summer steelhead recruits per spawner ratio by brood year for the wild and hatchery components as well as the total run, 1977-1995.

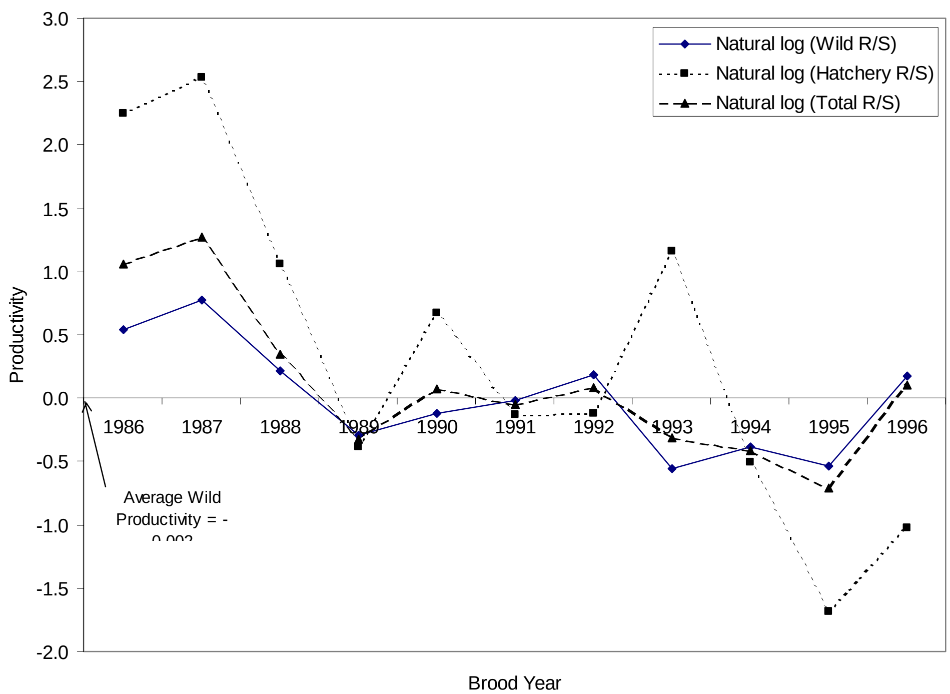

Figure 32. Wind River summer steelhead productivity by brood year for the wild and hatchery components as well as the total run, 1977-1995.

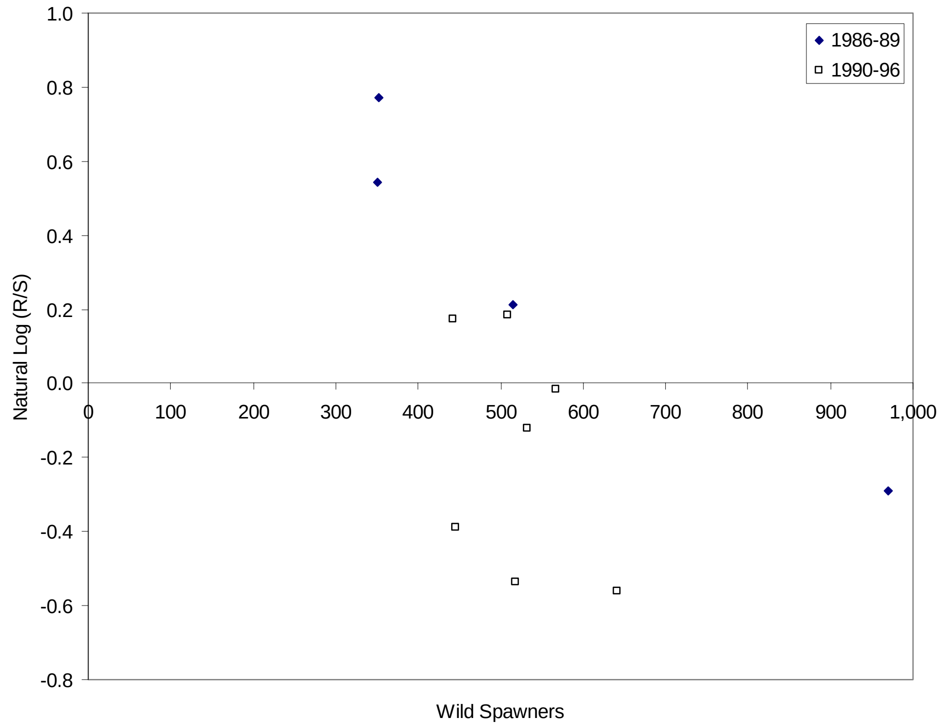

Figure 33. Scatter plot of Wind River wild summer steelhead spawners and productivity by brood year, grouped by decade.

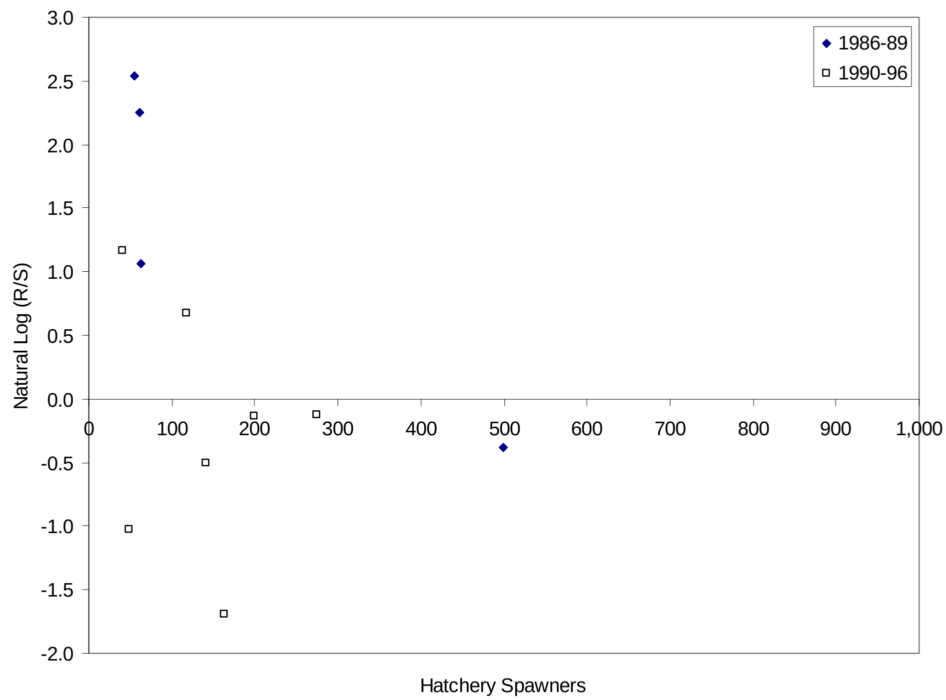

Figure 34. Scatter plot of Wind River hatchery summer steelhead spawners and productivity by brood year, grouped by decade.

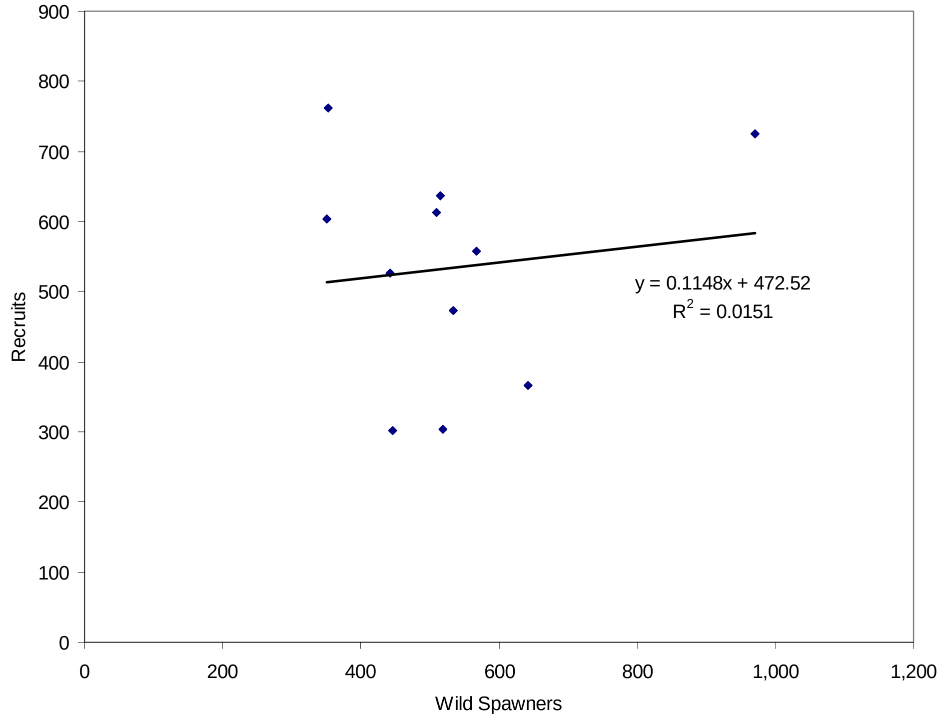

Figure 35. Scatter plot of Wind River wild summer steelhead spawners and recruits.

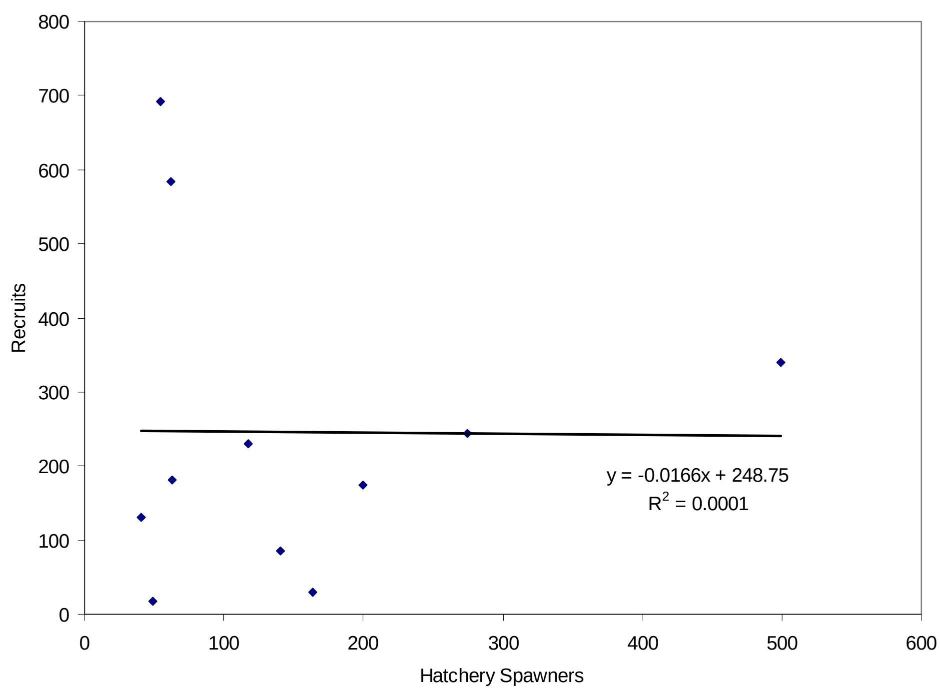

Figure 36. Scatter plot of Wind River hatchery summer steelhead spawners and recruits.

Grays Chum

Appendix A-9 includes the Grays River chum salmon run reconstruction table. The results cover brood years 1959-1996. Recruits per spawner were generally less than 10; average recruits per spawner was 6.39 (Figure 37). Productivity averaged 0.829 (Figure 37). Productivity and recruits per spawner spiked in 1981, but was also high in many other years (Figure 37). Few patterns were observed in a comparison of productivity within specific decades (Figure 38). Productivity appears to decline as spawner abundance increases. Negative productivity was observed in all decades included in the analysis; negative productivity was more prevalent in the 1960s and 1990s. There is no linear relationship between hatchery spawners and recruits (r^2=0.00004, p=0.9701); therefore, the number of spawners is not an accurate predictor of recruits (Figure 39).

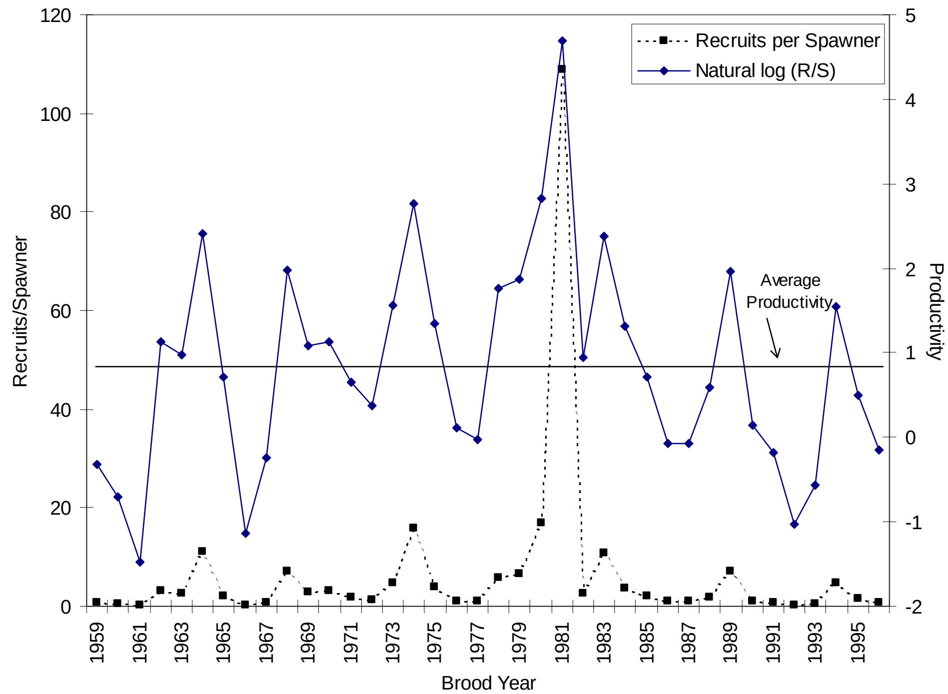

Figure 37. Grays River chum salmon recruits per spawner ratio and productivity by brood year, 1959-1996.

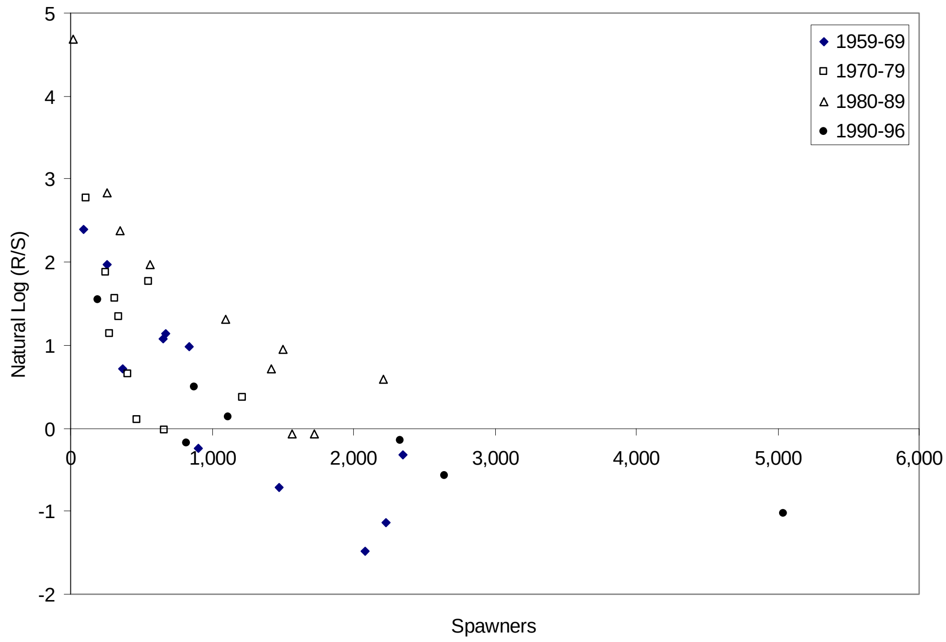

Figure 38. Scatter plot of Grays River chum salmon spawners and productivity by brood year, grouped by decade.

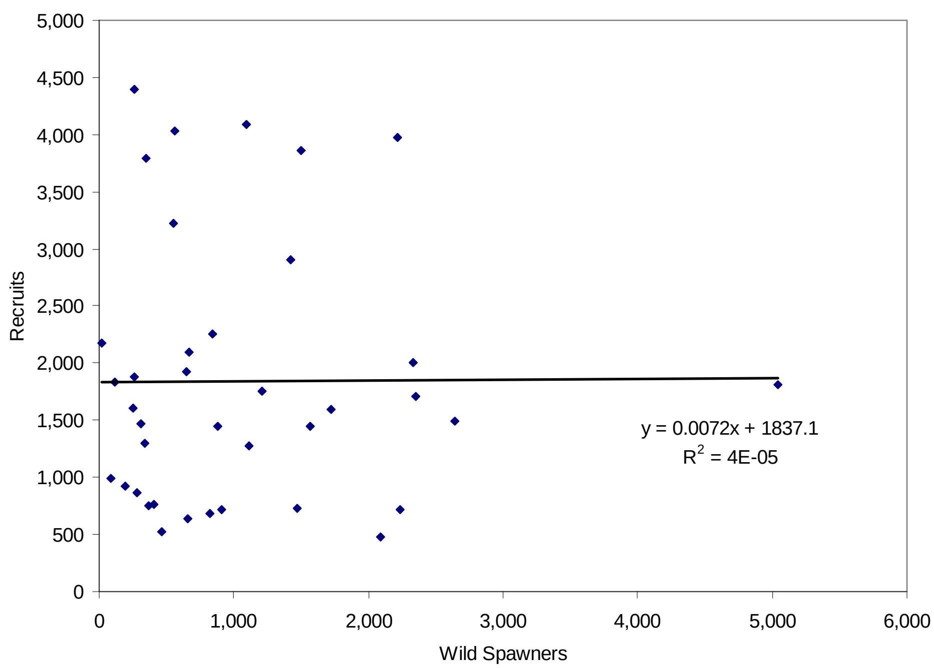

Figure 39. Scatter plot of Grays River chum salmon spawners and recruits.

Discussion

The populations chosen for these run reconstructions represent a mixture of species, origin (i.e. hatchery or wild), and basin-specific factors affecting each population, such as habitat quality and passage barriers. The results of these run reconstructions reflect the quality of data used to create them; the run reconstructions are intended to serve as a starting point for additional investigation. Improvements in methods and data quality are welcome. As unpublished data become available, new and improved data can easily be incorporated into the run reconstructions. Also, as information becomes available annually, each run reconstruction can be updated so that more recent brood year evaluations can be completed. A summary of the primary population statistics from the run reconstructions is presented in Table 1 for comparison purposes.

Table 1. Comparison of recruit to spawner ratio and productivity for each population.

Population	Average Recruits per Spawner	Average Productivity
Coweeman Tule Fall Chinook	5.748	1.142
East Fork Lewis Tule Fall Chinook	3.597	0.736
North Fork Lewis Bright Fall Chinook	2.287	0.488
Wind Spring Chinook	2.275	0.432
Little White Salmon Spring Chinook	3.660	0.688
Kalama Winter Steelhead		
Wild	1.685	0.279
Hatchery	3.816	1.001
Total	2.676	0.809
Kalama Summer Steelhead		
Wild	1.863	0.214
Hatchery	3.471	0.685
Total	3.013	0.585
Wind Summer Steelhead		
Wild	1.088	0.002
Hatchery	3.071	0.349
Total	1.337	0.103
Grays Chum	6.390	0.829

A few general patterns have developed from the run reconstruction results. Most run reconstructions indicate that productivity and the recruit to spawner ratio was low for the late 1980s and the mid 1990s (particularly, brood years 1988, 1989, 1994, and 1995). This pattern is consistent with existing knowledge of the extremely poor environmental conditions during those years; this consistency lends credibility to the results. Notable exceptions to this pattern include the Wind spring chinook 1988 and 1995 broods (Figure 11), the Kalama hatchery winter steelhead 1989 brood (Figure 19 and Figure 20), and the Grays chum 1989 and 1994 broods (Figure 37), which had better than average productivity and recruit to spawner ratio.

For all populations investigated, productivity decreased as spawner abundance increased. Although the relationship was weak for some populations, the general pattern was still evident. This observation needs to be interpreted cautiously; the observed inverse relationship between spawner abundance and productivity is not justification for maintaining low spawner numbers. The relationship simply indicates that, as spawner abundance increases, the population as a whole performs poorly; thus, each individual contributes less to the population's production. Poor population performance at high spawner abundance seems logical if some part of the life cycle is limited, but poor population performance does not make sense in a population that has unrestricted access to quality spawning and rearing habitat. Therefore, the inverse relationship between spawner abundance and productivity suggests that, at the habitat capacity present over the duration of the run reconstructions, habitat limitations exist that affect spawning or rearing success and prevent productivity from increasing as spawner abundance increases.

The number of spawners is a poor predictor of recruits. In most populations analyzed, there was no linear relationship between spawners and recruits. In one population, spring chinook in the Little White Salmon River, a weak linear relationship existed between spawners and recruits (Figure 17). However, the regression equation defining this relationship does not make sense. In particular, the y-intercept of this equation was -638.01; in reality, it is not possible to have a negative number of recruits. If the y-intercept of the regression equation is set at zero, the resulting r^2 is negative, which violates the underlying assumptions of the regression relationship; this result is true of all populations analyzed.

Each fall chinook population realized a spike in productivity and recruit to spawner ratio in the 1984 brood year (Figure 1, Figure 4, and Figure 7). The spike was more pronounced for the Coweeman and East Fork Lewis tule fall chinook populations, but was still prominent for the North Fork Lewis bright fall chinook. This increased productivity did not occur with other species; in actuality, the 1984 brood was a poor performer for many of the other populations investigated. Thus, conditions specific to these fall chinook populations are responsible for this success of the 1984 brood, although causation would be difficult to determine. Multiple factors may have had an effect, such as migration timing or pattern that exposed this brood to excellent ocean productivity, possible harvest changes that allowed for better survival, or productive rearing conditions in the Cowlitz and Lewis River basins.

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APPENDIX A. Run Reconstruction Tables

APPENDIX A-1. Coweeman River Tule Fall Chinook Run Reconstruction Table

Run Year	Escapement			Age Composition					Spawners by Age					Tributary Harvest Rate by Age				
	Total Escapement (wild)	Pre-spawn Mortality	Total Spawners (wild)	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6
1964	371	0.05	352	0.019	0.561	0.334	0.086	0.000	7	198	118	30	0	0.133	0.017	0.047	0.080	0.014
1965	86	0.05	82	0.128	0.163	0.674	0.035	0.000	10	13	55	3	0	0.133	0.017	0.047	0.080	0.014
1966	110	0.05	105	0.018	0.527	0.373	0.082	0.000	2	55	39	9	0	0.133	0.017	0.047	0.080	0.014
1967	108	0.05	103	0.074	0.250	0.630	0.046	0.000	8	26	65	5	0	0.133	0.017	0.047	0.080	0.014
1968	140	0.05	133	0.057	0.371	0.436	0.136	0.000	8	49	58	18	0	0.133	0.017	0.047	0.080	0.014
1969	118	0.05	112	0.271	0.220	0.449	0.059	0.000	30	25	50	7	0	0.133	0.017	0.047	0.080	0.014
1970	111	0.05	105	0.351	0.369	0.243	0.036	0.000	37	39	26	4	0	0.133	0.017	0.047	0.080	0.014
1971	296	0.05	281	0.020	0.348	0.598	0.034	0.000	6	98	168	10	0	0.133	0.017	0.047	0.080	0.014
1972	212	0.05	201	0.179	0.179	0.580	0.061	0.000	36	36	117	12	0	0.133	0.017	0.047	0.080	0.014
1973	54	0.05	51	0.222	0.278	0.389	0.111	0.000	11	14	20	6	0	0.133	0.017	0.047	0.080	0.014
1974	42	0.05	40	0.024	0.286	0.595	0.095	0.000	1	11	24	4	0	0.133	0.017	0.047	0.080	0.014
1975	94	0.05	89	0.032	0.330	0.511	0.128	0.000	3	29	46	11	0	0.133	0.017	0.047	0.080	0.014
1976	74	0.05	70	0.081	0.365	0.446	0.108	0.000	6	26	31	8	0	0.133	0.017	0.047	0.080	0.014
1977	91	0.05	86	0.058	0.372	0.477	0.093	0.000	5	32	41	8	0	0.133	0.017	0.047	0.080	0.014
1978	58	0.05	55	0.065	0.258	0.581	0.097	0.000	4	14	32	5	0	0.133	0.017	0.047	0.080	0.014
1979	80	0.05	76	0.091	0.307	0.466	0.136	0.000	7	23	35	10	0	0.133	0.017	0.047	0.080	0.014
1980	50	0.05	48	0.107	0.321	0.500	0.071	0.000	5	15	24	3	0	0.005	0.017	0.070	0.073	0.000
1981	75	0.05	71	0.079	0.211	0.605	0.105	0.000	6	15	43	8	0	0.239	0.011	0.060	0.097	0.071
1982	63	0.05	60	0.171	0.197	0.553	0.079	0.000	10	12	33	5	0	0.166	0.031	0.048	0.116	0.000
1983	40	0.05	38	0.000	0.500	0.500	0.000	0.000	0	19	19	0	0	0.052	0.007	0.012	0.022	0.000
1984	136	0.05	129	0.171	0.104	0.659	0.067	0.000	22	13	85	9	0	0.097	0.013	0.050	0.057	0.000
1985	158	0.05	150	0.060	0.179	0.673	0.089	0.000	9	27	101	13	0	0.235	0.030	0.044	0.057	0.000
1986	97	0.05	92	0.218	0.145	0.355	0.210	0.073	20	13	33	19	7	0.087	0.070	0.024	0.051	0.000
1987	62	0.05	59	0.279	0.186	0.360	0.174	0.000	16	11	21	10	0	0.173	0.020	0.100	0.115	0.000
1988	1,027	0.05	976	0.073	0.153	0.734	0.040	0.000	71	150	716	39	0	0.113	0.041	0.036	0.048	0.080
1989	770	0.05	732	0.030	0.084	0.330	0.555	0.000	22	62	241	406	0	0.129	0.049	0.077	0.107	0.029
1990	241	0.05	229	0.101	0.257	0.373	0.228	0.041	23	59	85	52	9	0.097	0.060	0.068	0.098	0.083
1991	174	0.05	165	0.000	0.316	0.379	0.305	0.000	0	52	63	50	0	0.000	0.000	0.000	0.000	0.000
1992	424	0.05	403	0.023	0.074	0.735	0.157	0.012	9	30	296	63	5	0.000	0.000	0.000	0.000	0.000
1993	327	0.05	311	0.066	0.309	0.354	0.271	0.000	20	96	110	84	0	0.000	0.000	0.000	0.000	0.000
1994	535	0.05	508	0.056	0.315	0.556	0.074	0.000	28	160	282	37	0	0.000	0.000	0.000	0.000	0.000
1995	774	0.05	735	0.025	0.300	0.519	0.156	0.000	19	220	382	115	0	0.000	0.000	0.000	0.000	0.000
1996	2,148	0.05	2041	0.002	0.154	0.663	0.181	0.000	4	315	1,353	369	0	0.000	0.000	0.000	0.000	0.000
1997	1,328	0.05	1262	0.000	0.007	0.619	0.374	0.000	0	9	781	472	0	0.000	0.000	0.000	0.000	0.000
1998	144	0.05	137	0.014	0.082	0.493	0.411	0.000	2	11	67	56	0	0.000	0.000	0.000	0.000	0.000
1999	93	0.05	88	0.031	0.354	0.458	0.156	0.000	3	31	40	14	0	0.000	0.000	0.000	0.000	0.000
2000	126	0.05	120	0.016	0.172	0.742	0.070	0.000	2	21	89	8	0	0.000	0.000	0.000	0.000	0.000
2001	646	0.05	614	0.022	0.203	0.681	0.094	0.000	13	124	418	58	0	0.000	0.000	0.000	0.000	0.000

Run Year	Coweeman River Run Size by Age					Mainstem Harvest Rate by Age					Columbia River Run Size by Age					Ocean Harvest Rate by Age					Ocean Escapement by Age				
	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6
1964	8	201	124	33	0	0.117	0.304	0.358	0.409	0.749	9	289	192	56	0	0.530	0.530	0.530	0.530	0.530	18	615	409	119	0
1965	12	14	58	3	0	0.117	0.304	0.358	0.409	0.749	14	19	90	5	0	0.530	0.530	0.530	0.530	0.530	29	41	191	11	0
1966	2	56	41	9	0	0.117	0.304	0.358	0.409	0.749	2	81	64	16	0	0.530	0.530	0.530	0.530	0.530	5	171	135	33	0
1967	9	26	68	5	0	0.117	0.304	0.358	0.409	0.749	10	37	105	9	0	0.530	0.530	0.530	0.530	0.530	21	80	224	19	0
1968	9	50	61	20	0	0.117	0.304	0.358	0.409	0.749	10	72	95	33	0	0.530	0.530	0.530	0.530	0.530	21	154	201	71	0
1969	35	25	53	7	0	0.117	0.304	0.358	0.409	0.749	40	36	82	12	0	0.530	0.530	0.530	0.530	0.530	84	77	175	26	0
1970	43	40	27	4	0	0.117	0.304	0.358	0.409	0.749	48	57	42	7	0	0.530	0.530	0.530	0.530	0.530	103	121	89	15	0
1971	7	100	176	10	0	0.117	0.304	0.358	0.409	0.749	7	143	275	17	0	0.530	0.530	0.530	0.530	0.530	16	304	584	37	0
1972	42	37	123	13	0	0.117	0.304	0.358	0.409	0.749	47	53	191	23	0	0.530	0.530	0.530	0.530	0.530	100	112	406	48	0
1973	13	14	21	6	0	0.117	0.304	0.358	0.409	0.749	15	21	33	10	0	0.530	0.530	0.530	0.530	0.530	32	44	69	22	0
1974	1	12	25	4	0	0.117	0.304	0.358	0.409	0.749	1	17	39	7	0	0.530	0.530	0.530	0.530	0.530	3	35	83	15	0
1975	3	30	48	12	0	0.117	0.304	0.358	0.409	0.749	4	43	74	21	0	0.530	0.530	0.530	0.530	0.530	8	92	158	45	0
1976	7	26	33	8	0	0.117	0.304	0.358	0.409	0.749	7	37	51	14	0	0.530	0.530	0.530	0.530	0.530	16	80	109	30	0
1977	6	33	43	9	0	0.117	0.304	0.358	0.409	0.749	7	47	67	15	0	0.530	0.530	0.530	0.530	0.530	14	100	143	31	0
1978	4	14	34	6	0	0.117	0.304	0.358	0.409	0.749	5	21	52	10	0	0.530	0.530	0.530	0.530	0.530	10	44	111	21	0
1979	8	24	37	11	0	0.117	0.304	0.358	0.409	0.749	9	34	58	19	0	0.530	0.530	0.530	0.530	0.530	19	73	123	41	0
1980	5	16	26	4	0	0.102	0.496	0.557	0.688	1.000	6	31	58	12	0	0.530	0.530	0.530	0.530	0.530	12	66	123	25	0
1981	7	15	46	8	0	0.118	0.139	0.319	0.365	0.000	8	18	67	13	0	0.530	0.530	0.530	0.530	0.530	18	37	143	28	0
1982	12	12	35	5	0	0.161	0.359	0.314	0.309	0.000	15	19	51	8	0	0.530	0.530	0.530	0.530	0.530	31	40	108	16	0
1983	0	19	19	0	0	0.045	0.196	0.166	0.121	0.000	0	24	23	0	0	0.530	0.530	0.530	0.530	0.530	0	51	49	0	0
1984	24	14	90	9	0	0.095	0.321	0.336	0.180	1.000	27	20	135	11	0	0.530	0.530	0.530	0.530	0.530	57	43	287	24	0
1985	12	28	106	14	0	0.046	0.171	0.177	0.266	0.000	12	33	128	19	0	0.530	0.530	0.530	0.530	0.530	26	71	273	41	0
1986	22	14	33	20	7	0.189	0.571	0.470	0.448	0.440	27	34	63	37	12	0.530	0.530	0.530	0.530	0.530	58	71	135	79	25
1987	20	11	24	12	0	0.314	0.566	0.675	0.771	0.940	29	26	73	51	0	0.530	0.530	0.530	0.530	0.530	62	55	154	108	0
1988	80	156	742	41	0	0.216	0.598	0.634	0.709	0.627	103	388	2,031	140	0	0.530	0.530	0.530	0.530	0.530	218	826	4,320	298	0
1989	25	65	262	455	0	0.005	0.262	0.274	0.344	0.600	26	88	360	693	0	0.530	0.530	0.530	0.530	0.530	54	187	767	1,475	0
1990	26	63	92	58	10	0.248	0.129	0.110	0.111	0.243	34	72	103	65	14	0.250	0.250	0.250	0.250	0.250	45	96	137	87	18
1991	0	52	63	50	0	0.157	0.212	0.219	0.122	0.164	0	66	80	57	0	0.250	0.250	0.250	0.250	0.250	0	88	107	76	0
1992	9	30	296	63	5	0.174	0.143	0.141	0.064	0.450	11	35	344	67	8	0.250	0.250	0.250	0.250	0.250	15	46	459	90	11
1993	20	96	110	84	0	0.112	0.177	0.127	0.183	0.000	23	116	126	103	0	0.250	0.250	0.250	0.250	0.250	31	155	168	138	0
1994	28	160	282	37	0	0.000	0.000	0.000	0.000	0.000	28	160	282	37	0	0.250	0.250	0.250	0.250	0.250	38	213	377	50	0
1995	19	220	382	115	0	0.088	0.040	0.012	0.059	0.000	20	230	386	122	0	0.250	0.250	0.250	0.250	0.250	27	306	515	163	0
1996	4	315	1,353	369	0	0.050	0.140	0.052	0.009	0.020	4	366	1,428	372	0	0.250	0.250	0.250	0.250	0.250	5	488	1,904	496	0
1997	0	9	781	472	0	0.004	0.201	0.119	0.087	1.000	0	11	886	517	0	0.250	0.250	0.250	0.250	0.250	0	14	1,182	690	0
1998	2	11	67	56	0	0.100	0.109	0.074	0.108	0.000	2	13	73	63	0	0.250	0.250	0.250	0.250	0.250	3	17	97	84	0
1999	3	31	40	14	0	0.000	0.094	0.201	0.065	0.000	3	35	51	15	0	0.250	0.250	0.250	0.250	0.250	4	46	68	20	0
2000	2	21	89	8	0	0.120	0.176	0.121	0.166	0.000	2	25	101	10	0	0.250	0.250	0.250	0.250	0.250	3	33	135	13	0
2001	13	124	418	58	0	0.067	0.114	0.061	0.195	0.000	14	141	445	72	0	0.325	0.325	0.325	0.325	0.325	21	208	659	107	0

Results								
Brood Year	2	3	4	5	6	Total Recruits	Recruits per Spawner	Natural log (R/S)
1964	5	80	201	26	0	312	0.886	-0.120
1965	21	154	175	15	0	365	4.462	1.496
1966	21	77	89	37	0	224	2.146	0.764
1967	84	121	584	48	0	838	8.170	2.100
1968	103	304	406	22	0	836	6.283	1.838
1969	16	112	69	15	0	212	1.894	0.639
1970	100	44	83	45	0	272	2.577	0.947
1971	32	35	158	30	0	255	0.908	-0.096
1972	3	92	109	31	0	235	1.165	0.153
1973	8	80	143	21	0	252	4.908	1.591
1974	16	100	111	41	0	268	6.708	1.903
1975	14	44	123	25	0	206	2.309	0.837
1976	10	73	123	28	0	233	3.313	1.198
1977	19	66	143	16	0	245	2.829	1.040
1978	12	37	108	0	0	157	2.855	1.049
1979	18	40	49	24	0	131	1.727	0.546
1980	31	51	287	41	25	435	9.164	2.215
1981	0	43	273	79	0	394	5.532	1.711
1982	57	71	135	108	0	371	6.196	1.824
1983	26	71	154	298	0	550	14.471	2.672
1984	58	55	4,320	1,475	18	5,926	45.867	3.826
1985	62	826	767	87	0	1,741	11.600	2.451
1986	218	187	137	76	11	630	6.841	1.923
1987	54	96	107	90	0	347	5.895	1.774
1988	45	88	459	138	0	731	0.749	-0.289
1989	0	46	168	50	0	264	0.361	-1.018
1990	15	155	377	163	0	710	3.099	1.131
1991	31	213	515	496	0	1,255	7.592	2.027
1992	38	306	1,904	690	0	2,938	7.293	1.987
1993	27	488	1,182	84	0	1,781	5.734	1.746
1994	5	14	97	20	0	136	0.268	-1.315
1995	0	17	68	13	0	98	0.133	-2.017
1996	3	46	135	107				
1997	4	33	659					
1998	3	208						
1999	21							
2000								
2001								

Notes:
Spawning escapement data for 1964-2001 were obtained from the Washington State salmon and steelhead stock inventory (WDF et al. 1993 and WDFW 2003).
Prespawn mortality is assumed to be 5%.
Age composition data for 1964-2001 were calculated from escapement data available in the StreamNet database.
Tributary harvest rate for 1964-1979 was the 5-yr average harvest calculated from the 1980-1984 “big sheets” using the lower river hatchery (LRH) stock: tributary harvest divided by the total run minus the mainstem harvest.
Tributary harvest rate for 1980-1990 was calculated from the “big sheets” using LRH stock: tributary harvest divided by the total run minus the mainstem harvest.
Tributary harvest has been closed since 1991.
Mainstem harvest rate for 1980-2001 was calculated from the “big sheets” using the LRH stock: sum of mainstem harvest divided by the total run.
Mainstem harvest rate for 1964-1979 was the 5-yr average calculated from the 1980-1984 “big sheets” using the LRH stock: sum of mainstem harvest divided by the total run.
Ocean harvest rate for 1964-1989 obtained from the Lewis River Subbasin Plan that summarized CWT recoveries for all available brood years.
Ocean harvest rate for 1990-2000 obtained from the Lewis River Subbasin Plan that summarized CWT recoveries for all available brood years.
Ocean harvest rate for 2001 was estimated (Guy Norman, personal communication).

APPENDIX A-2. East Fork Lewis River Tule Fall Chinook Run Reconstruction Table

	Escapement			Age Composition					Spawners by Age					Tributary Harvest Rate by Age					Lewis River Run Size by Age				
Run Year	Total Escapement (wild)	Pre-spawn Mortality	Spawning Escapement (wild)	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6
1964	680	0.05	646	0.071	0.531	0.318	0.081	0.000	46	343	205	52	0	0.133	0.017	0.047	0.080	0.014	53	349	215	57	0
1965	1,048	0.05	996	0.150	0.157	0.654	0.039	0.000	149	157	651	39	0	0.133	0.017	0.047	0.080	0.014	172	159	683	42	0
1966	595	0.05	565	0.020	0.521	0.378	0.081	0.000	11	295	214	46	0	0.133	0.017	0.047	0.080	0.014	13	300	224	50	0
1967	442	0.05	420	0.070	0.251	0.631	0.048	0.000	29	105	265	20	0	0.133	0.017	0.047	0.080	0.014	34	107	278	22	0
1968	265	0.05	252	0.060	0.370	0.438	0.132	0.000	15	93	110	33	0	0.133	0.017	0.047	0.080	0.014	18	95	116	36	0
1969	599	0.05	569	0.451	0.169	0.337	0.043	0.000	257	96	192	25	0	0.133	0.017	0.047	0.080	0.014	296	98	201	27	0
1970	1,217	0.05	1,156	0.460	0.311	0.200	0.028	0.000	532	360	232	32	0	0.133	0.017	0.047	0.080	0.014	613	366	243	35	0
1971	2,354	0.05	2,236	0.090	0.324	0.556	0.030	0.000	201	725	1,244	67	0	0.133	0.017	0.047	0.080	0.014	232	738	1,304	72	0
1972	668	0.05	635	0.201	0.177	0.564	0.058	0.000	127	112	358	37	0	0.133	0.017	0.047	0.080	0.014	147	114	376	40	0
1973	538	0.05	511	0.610	0.136	0.188	0.067	0.000	312	69	96	34	0	0.133	0.017	0.047	0.080	0.014	359	71	101	37	0
1974	576	0.05	547	0.271	0.203	0.451	0.075	0.000	148	111	247	41	0	0.133	0.017	0.047	0.080	0.014	171	113	259	44	0
1975	618	0.05	587	0.060	0.320	0.494	0.126	0.000	35	188	290	74	0	0.133	0.017	0.047	0.080	0.014	41	191	304	81	0
1976	353	0.05	335	0.079	0.360	0.453	0.108	0.000	27	121	152	36	0	0.133	0.017	0.047	0.080	0.014	31	123	159	39	0
1977	604	0.05	574	0.060	0.376	0.474	0.091	0.000	34	216	272	52	0	0.000	0.000	0.000	0.000	0.000	34	216	272	52	0
1978	968	0.05	920	0.290	0.191	0.447	0.071	0.000	267	176	411	66	0	0.000	0.000	0.000	0.000	0.000	267	176	411	66	0
1979	814	0.05	773	0.120	0.297	0.450	0.133	0.000	93	230	348	103	0	0.000	0.000	0.000	0.000	0.000	93	230	348	103	0
1980	526	0.05	500	0.409	0.129	0.394	0.068	0.000	204	65	197	34	0	0.000	0.000	0.000	0.000	0.000	204	65	197	34	0
1981	438	0.05	416	0.094	0.089	0.687	0.130	0.000	39	37	286	54	0	0.000	0.000	0.000	0.000	0.000	39	37	286	54	0
1982	346	0.05	329	0.306	0.324	0.355	0.014	0.000	101	106	117	5	0	0.000	0.000	0.000	0.000	0.000	101	106	117	5	0
1983	334	0.05	317	0.087	0.105	0.704	0.105	0.000	28	33	223	33	0	0.000	0.000	0.000	0.000	0.000	28	33	223	33	0
1984	200	0.05	190	0.040	0.025	0.790	0.145	0.000	8	5	150	28	0	0.000	0.000	0.000	0.000	0.000	8	5	150	28	0
1985	653	0.05	620	0.173	0.211	0.462	0.153	0.000	107	131	287	95	0	0.000	0.000	0.000	0.000	0.000	107	131	287	95	0
1986	445	0.05	423	0.126	0.393	0.411	0.070	0.000	53	166	174	29	0	0.000	0.000	0.000	0.000	0.000	53	166	174	29	0
1987	157	0.05	149	0.140	0.242	0.446	0.172	0.000	21	36	67	26	0	0.000	0.000	0.000	0.000	0.000	21	36	67	26	0
1988	476	0.05	452	0.103	0.145	0.582	0.170	0.000	47	66	263	77	0	0.000	0.000	0.000	0.000	0.000	47	66	263	77	0
1989	591	0.05	561	0.050	0.079	0.386	0.486	0.000	28	44	217	273	0	0.000	0.000	0.000	0.000	0.000	28	44	217	273	0
1990	342	0.05	325	0.042	0.160	0.266	0.213	0.319	14	52	86	69	104	0.000	0.000	0.000	0.000	0.000	14	52	86	69	104
1991	230	0.05	219	0.080	0.320	0.320	0.240	0.040	17	70	70	52	9	0.000	0.000	0.000	0.000	0.000	17	70	70	52	9
1992	202	0.05	192	0.060	0.153	0.698	0.088	0.000	12	29	134	17	0	0.000	0.000	0.000	0.000	0.000	12	29	134	17	0
1993	156	0.05	148	0.077	0.243	0.479	0.201	0.000	11	36	71	30	0	0.000	0.000	0.000	0.000	0.000	11	36	71	30	0
1994	395	0.05	375	0.249	0.063	0.521	0.167	0.000	93	24	195	63	0	0.000	0.000	0.000	0.000	0.000	93	24	195	63	0
1995	100	0.05	95	0.103	0.161	0.265	0.471	0.000	10	15	25	45	0	0.000	0.000	0.000	0.000	0.000	10	15	25	45	0
1996	167	0.05	159	0.012	0.189	0.692	0.107	0.000	2	30	110	17	0	0.000	0.000	0.000	0.000	0.000	2	30	110	17	0
1997	184	0.05	175	0.000	0.013	0.397	0.590	0.000	0	2	69	103	0	0.000	0.000	0.000	0.000	0.000	0	2	69	103	0
1998	52	0.05	49	0.063	0.486	0.225	0.225	0.000	3	24	11	11	0	0.000	0.000	0.000	0.000	0.000	3	24	11	11	0
1999	109	0.05	104	0.027	0.448	0.426	0.099	0.000	3	46	44	10	0	0.000	0.000	0.000	0.000	0.000	3	46	44	10	0
2000	323	0.05	307	0.059	0.149	0.644	0.149	0.000	18	46	198	46	0	0.000	0.000	0.000	0.000	0.000	18	46	198	46	0
2001	530	0.05	504	0.008	0.468	0.491	0.034	0.000	4	236	247	17	0	0.000	0.000	0.000	0.000	0.000	4	236	247	17	0

	Mainstem Harvest Rate by Age					Columbia River Run Size by Age					Ocean Harvest Rate by Age					Ocean Escapement by Age				
Run Year	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6
1964	0.117	0.304	0.358	0.409	0.749	60	501	335	96	0	0.530	0.530	0.530	0.530	0.530	127	1,067	713	205	0
1965	0.117	0.304	0.358	0.409	0.749	195	229	1,063	72	0	0.530	0.530	0.530	0.530	0.530	414	487	2,261	153	0
1966	0.117	0.304	0.358	0.409	0.749	15	430	349	84	0	0.530	0.530	0.530	0.530	0.530	32	916	743	179	0
1967	0.117	0.304	0.358	0.409	0.749	38	154	433	37	0	0.530	0.530	0.530	0.530	0.530	82	328	921	78	0
1968	0.117	0.304	0.358	0.409	0.749	20	136	180	61	0	0.530	0.530	0.530	0.530	0.530	42	290	383	130	0
1969	0.117	0.304	0.358	0.409	0.749	335	140	313	45	0	0.530	0.530	0.530	0.530	0.530	713	298	667	97	0
1970	0.117	0.304	0.358	0.409	0.749	695	526	379	59	0	0.530	0.530	0.530	0.530	0.530	1,478	1,120	805	127	0
1971	0.117	0.304	0.358	0.409	0.749	263	1,060	2,031	122	0	0.530	0.530	0.530	0.530	0.530	560	2,254	4,321	260	0
1972	0.117	0.304	0.358	0.409	0.749	166	164	585	68	0	0.530	0.530	0.530	0.530	0.530	354	349	1,244	145	0
1973	0.117	0.304	0.358	0.409	0.749	407	101	157	63	0	0.530	0.530	0.530	0.530	0.530	866	216	333	134	0
1974	0.117	0.304	0.358	0.409	0.749	194	162	403	75	0	0.530	0.530	0.530	0.530	0.530	412	346	858	160	0
1975	0.117	0.304	0.358	0.409	0.749	46	275	473	136	0	0.530	0.530	0.530	0.530	0.530	98	585	1,007	290	0
1976	0.117	0.304	0.358	0.409	0.749	35	176	248	66	0	0.530	0.530	0.530	0.530	0.530	74	375	528	141	0
1977	0.117	0.304	0.358	0.409	0.749	39	310	423	88	0	0.530	0.530	0.530	0.530	0.530	82	659	900	188	0
1978	0.117	0.304	0.358	0.409	0.749	302	252	640	111	0	0.530	0.530	0.530	0.530	0.530	643	537	1,363	236	0
1979	0.117	0.304	0.358	0.409	0.749	105	330	541	174	0	0.530	0.530	0.530	0.530	0.530	224	703	1,152	370	0
1980	0.102	0.496	0.557	0.688	1.000	228	128	444	110	0	0.530	0.530	0.530	0.530	0.530	484	273	945	234	0
1981	0.118	0.139	0.319	0.365	0.000	44	43	420	85	0	0.530	0.530	0.530	0.530	0.530	94	92	894	181	0
1982	0.161	0.359	0.314	0.309	0.000	120	166	170	7	0	0.530	0.530	0.530	0.530	0.530	255	353	362	15	0
1983	0.045	0.196	0.166	0.121	0.000	29	41	268	38	0	0.530	0.530	0.530	0.530	0.530	61	88	570	81	0
1984	0.095	0.321	0.336	0.180	1.000	8	7	226	34	0	0.530	0.530	0.530	0.530	0.530	18	15	481	72	0
1985	0.046	0.171	0.177	0.266	0.000	113	158	349	129	0	0.530	0.530	0.530	0.530	0.530	240	337	742	275	0
1986	0.189	0.571	0.470	0.448	0.440	66	388	328	53	0	0.530	0.530	0.530	0.530	0.530	140	825	698	114	0
1987	0.314	0.566	0.675	0.771	0.940	30	83	205	112	0	0.530	0.530	0.530	0.530	0.530	65	177	435	239	0
1988	0.216	0.598	0.634	0.709	0.627	59	163	720	265	0	0.530	0.530	0.530	0.530	0.530	126	347	1,531	563	0
1989	0.005	0.262	0.274	0.344	0.600	28	60	298	415	0	0.530	0.530	0.530	0.530	0.530	60	128	635	884	0
1990	0.248	0.129	0.110	0.111	0.243	18	60	97	78	137	0.250	0.250	0.250	0.250	0.250	24	79	129	104	183
1991	0.157	0.212	0.219	0.122	0.164	21	89	90	60	10	0.250	0.250	0.250	0.250	0.250	28	118	119	80	14
1992	0.174	0.143	0.141	0.064	0.450	14	34	156	18	0	0.250	0.250	0.250	0.250	0.250	19	46	208	24	0
1993	0.112	0.177	0.127	0.183	0.000	13	44	81	36	0	0.250	0.250	0.250	0.250	0.250	17	58	108	49	0
1994	0.000	0.000	0.000	0.000	0.000	93	24	195	63	0	0.250	0.250	0.250	0.250	0.250	125	31	261	84	0
1995	0.088	0.040	0.012	0.059	0.000	11	16	25	48	0	0.250	0.250	0.250	0.250	0.250	14	21	34	63	0
1996	0.050	0.140	0.052	0.009	0.020	2	35	116	17	0	0.250	0.250	0.250	0.250	0.250	3	47	155	23	0
1997	0.004	0.201	0.119	0.087	1.000	0	3	79	113	0	0.250	0.250	0.250	0.250	0.250	0	4	105	151	0
1998	0.100	0.109	0.074	0.108	0.000	3	27	12	12	0	0.250	0.250	0.250	0.250	0.250	5	36	16	17	0
1999	0.000	0.094	0.201	0.065	0.000	3	51	55	11	0	0.250	0.250	0.250	0.250	0.250	4	68	74	15	0
2000	0.120	0.176	0.121	0.166	0.000	21	55	225	55	0	0.250	0.250	0.250	0.250	0.250	27	74	300	73	0
2001	0.067	0.114	0.061	0.195	0.000	4	266	263	21	0	0.325	0.325	0.325	0.325	0.325	6	394	390	31	0

Results								
Brood Year	2	3	4	5	6	Total Recruits	Recruits per Spawner	Natural log (R/S)
1964	32	328	383	97	0	839	1.299	0.262
1965	82	290	667	127	0	1,165	1.170	0.157
1966	42	298	805	260	0	1,406	2.488	0.912
1967	713	1,120	4,321	145	0	6,298	15.000	2.708
1968	1,478	2,254	1,244	134	0	5,111	20.301	3.011
1969	560	349	333	160	0	1,402	2.463	0.901
1970	354	216	858	290	0	1,718	1.486	0.396
1971	866	346	1,007	141	0	2,360	1.055	0.054
1972	412	585	528	188	0	1,713	2.700	0.993
1973	98	375	900	236	0	1,609	3.148	1.147
1974	74	659	1,363	370	0	2,465	4.505	1.505
1975	82	537	1,152	234	0	2,005	3.415	1.228
1976	643	703	945	181	0	2,472	7.371	1.998
1977	224	273	894	15	0	1,405	2.449	0.896
1978	484	92	362	81	0	1,019	1.108	0.102
1979	94	353	570	72	0	1,088	1.407	0.342
1980	255	88	481	275	0	1,100	2.201	0.789
1981	61	15	742	114	0	932	2.239	0.806
1982	18	337	698	239	0	1,291	3.929	1.368
1983	240	825	435	563	0	2,063	6.503	1.872
1984	140	177	1,531	884	183	2,914	15.337	2.730
1985	65	347	635	104	14	1,164	1.877	0.630
1986	126	128	129	80	0	463	1.095	0.091
1987	60	79	119	24	0	283	1.896	0.640
1988	24	118	208	49	0	399	0.882	-0.126
1989	28	46	108	84	0	266	0.473	-0.748
1990	19	58	261	63	0	401	1.234	0.210
1991	17	31	34	23	0	105	0.481	-0.731
1992	125	21	155	151	0	451	2.350	0.854
1993	14	47	105	17	0	183	1.233	0.209
1994	3	4	16	15	0	37	0.099	-2.316
1995	0	36	74	73	0	182	1.920	0.653
1996	5	68	300	31				
1997	4	74	390					
1998	27	394						
1999	6							
2000								
2001								

Notes:

Spawning escapement data for 1964-2001 were obtained from the Washington State salmon and steelhead stock inventory (WDF et al. 1993 and WDFW 2003).

Prespawn mortality is assumed to be 5%.

Age composition data for 1964-2001 were calculated from escapement data available in the StreamNet database.

Tributary harvest rate for 1964-1976 was the 5-yr average harvest calculated from the 1980-1984 “big sheets” using the lower river hatchery (LRH) stock: tributary harvest divided by the total run minus the mainstem harvest.

Tributary harvest has been closed since 1977.

Mainstem harvest rate for 1980-2001 was calculated from the “big sheets” using the LRH stock: sum of mainstem harvest divided by the total run.

Mainstem harvest rate for 1964-1979 was the 5-yr average calculated from the 1980-1984 “big sheets” using the LRH stock: sum of mainstem harvest divided by the total run.

Ocean harvest rate for 1964-1989 obtained from the Lewis River Subbasin Plan that summarized CWT recoveries for all available brood years.

Ocean harvest rate for 1990-2000 obtained from the Lewis River Subbasin Plan that summarized CWT recoveries for all available brood years.

Ocean harvest rate for 2001 was estimated (Guy Norman, personal communication).

APPENDIX A-3. North Fork Lewis River Bright Fall Chinook Run Reconstruction Table

	Escapement					Age Composition						Spawners by Age						Tributary Harvest Rate by Age					
Run Year	Total Escapement	Hatchery Proportion of Escapement	Wild Escapement	Prespawn Mortality	Spawning Escapement (wild)	2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7
1964	20,557	0.06	19,324	0.05	18,357	0.180	0.160	0.480	0.180	0.000	0.000	3,304	2,937	8,812	3,304	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1965	9,667	0.06	9,087	0.05	8,633	0.180	0.160	0.480	0.180	0.000	0.000	1,554	1,381	4,144	1,554	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1966	13,176	0.06	12,385	0.05	11,766	0.118	0.245	0.431	0.206	0.000	0.000	1,383	2,883	5,077	2,423	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1967	10,084	0.06	9,479	0.05	9,005	0.037	0.179	0.630	0.154	0.000	0.000	333	1,614	5,672	1,386	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1968	7,344	0.06	6,903	0.05	6,558	0.025	0.080	0.670	0.224	0.000	0.000	164	527	4,395	1,472	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1969	5,774	0.06	5,428	0.05	5,156	0.136	0.150	0.364	0.350	0.000	0.000	704	775	1,874	1,803	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1970	21,726	0.06	20,422	0.05	19,401	0.810	0.068	0.101	0.021	0.000	0.000	15,713	1,312	1,967	409	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1971	20,409	0.06	19,184	0.05	18,225	0.024	0.208	0.638	0.131	0.000	0.000	431	3,787	11,626	2,381	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1972	19,198	0.06	18,046	0.05	17,144	0.037	0.100	0.748	0.115	0.000	0.000	634	1,715	12,827	1,968	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1973	13,029	0.06	12,247	0.05	11,635	0.300	0.126	0.374	0.199	0.000	0.000	3,491	1,467	4,357	2,320	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1974	9,320	0.06	8,761	0.05	8,323	0.190	0.213	0.401	0.196	0.000	0.000	1,582	1,770	3,337	1,634	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1975	14,904	0.06	14,010	0.05	13,309	0.070	0.173	0.542	0.215	0.000	0.000	933	2,301	7,215	2,860	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1976	4,199	0.06	3,947	0.05	3,750	0.197	0.176	0.428	0.198	0.000	0.000	739	662	1,607	742	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1977	7,779	0.06	7,312	0.05	6,947	0.109	0.248	0.473	0.170	0.000	0.000	758	1,726	3,284	1,179	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1978	6,129	0.06	5,761	0.05	5,473	0.125	0.242	0.475	0.158	0.000	0.000	684	1,324	2,600	864	0	0	0.287	0.098	0.070	0.059	0.000	0.000
1979	8,954	0.06	8,417	0.05	7,996	0.132	0.199	0.437	0.221	0.009	0.000	1,055	1,591	3,494	1,767	72	0	0.287	0.098	0.070	0.059	0.000	0.000
1980	13,239	0.085	12,114	0.05	11,508	0.072	0.204	0.617	0.107	0.000	0.000	833	2,352	7,097	1,226	0	0	0.015	0.052	0.065	0.056	0.000	0.000
1981	19,297	0.085	17,657	0.05	16,774	0.093	0.090	0.687	0.130	0.000	0.000	1,560	1,510	11,523	2,181	0	0	0.253	0.035	0.050	0.049	0.000	0.000
1982	8,370	0.085	7,659	0.05	7,276	0.091	0.297	0.333	0.277	0.002	0.000	661	2,158	2,426	2,017	13	0	0.262	0.142	0.050	0.052	0.000	0.000
1983	13,540	0.085	12,389	0.05	11,770	0.082	0.090	0.632	0.196	0.000	0.000	970	1,054	7,442	2,304	0	0	0.339	0.151	0.078	0.050	0.000	0.000
1984	7,132	0.085	6,526	0.05	6,199	0.117	0.148	0.443	0.280	0.012	0.000	727	915	2,749	1,737	73	0	0.483	0.181	0.143	0.094	0.000	0.000
1985	7,491	0.085	6,854	0.05	6,512	0.209	0.200	0.427	0.162	0.002	0.000	1,363	1,302	2,781	1,057	11	0	0.384	0.131	0.104	0.090	0.000	0.000
1986	11,983	0.085	10,964	0.05	10,416	0.177	0.281	0.392	0.145	0.005	0.000	1,844	2,927	4,088	1,511	47	0	0.292	0.186	0.071	0.062	0.005	0.005
1987	12,935	0.085	11,836	0.05	11,244	0.243	0.203	0.405	0.148	0.001	0.000	2,729	2,284	4,557	1,664	11	0	0.136	0.059	0.043	0.040	0.000	0.000
1988	12,052	0.085	11,028	0.05	10,476	0.178	0.122	0.453	0.247	0.000	0.000	1,860	1,280	4,745	2,591	0	0	0.152	0.124	0.085	0.046	0.074	0.074
1989	12,199	0.085	11,162	0.05	10,604	0.077	0.112	0.272	0.531	0.007	0.000	821	1,185	2,889	5,635	74	0	0.209	0.086	0.139	0.082	0.000	0.000
1990	17,506	0.085	16,018	0.05	15,217	0.076	0.050	0.384	0.406	0.084	0.000	1,157	761	5,843	6,178	1,279	0	0.207	0.081	0.086	0.053	0.024	0.024
1991	9,066	0.029	8,803	0.05	8,363	0.059	0.130	0.312	0.459	0.040	0.001	493	1,087	2,608	3,836	334	5	0.238	0.208	0.132	0.095	0.022	0.022
1992	6,307	0.101	5,670	0.05	5,386	0.207	0.055	0.429	0.267	0.040	0.000	1,118	298	2,312	1,440	218	0	0.488	0.246	0.201	0.081	0.160	0.160
1993	7,025	0.078	6,477	0.05	6,153	0.083	0.280	0.159	0.438	0.040	0.000	508	1,725	977	2,694	249	0	0.485	0.266	0.230	0.141	0.000	0.000
1994	9,936	0.13	8,644	0.05	8,212	0.134	0.118	0.604	0.113	0.031	0.000	1,100	973	4,957	927	255	0	0.227	0.092	0.078	0.108	0.000	0.000
1995	9,715	0	9,715	0.05	9,229	0.031	0.084	0.247	0.636	0.002	0.000	282	775	2,281	5,871	20	0	0.467	0.344	0.268	0.162	0.000	0.000
1996	14,166	0.089	12,905	0.05	12,260	0.018	0.090	0.555	0.294	0.042	0.000	227	1,102	6,805	3,607	519	0	0.247	0.033	0.003	0.001	0.000	0.000
1997	8,670	0.058	8,167	0.05	7,759	0.007	0.025	0.490	0.473	0.005	0.000	55	193	3,803	3,666	42	0	0.000	0.017	0.028	0.010	0.000	0.000
1998	5,935	0.124	5,199	0.05	4,939	0.039	0.125	0.215	0.620	0.001	0.000	190	618	1,063	3,064	4	0	0.000	0.000	0.000	0.000	0.000	0.000
1999	3,184	0.233	2,442	0.05	2,320	0.053	0.268	0.495	0.168	0.016	0.000	122	622	1,149	390	37	0	0.000	0.000	0.000	0.000	0.000	0.000
2000	9,820	0.105	8,789	0.05	8,349	0.099	0.171	0.593	0.136	0.001	0.000	830	1,424	4,955	1,133	7	0	0.000	0.000	0.000	0.000	0.000	0.000
2001	15,000	0.06	14,100	0.05	13,395	0.074	0.191	0.540	0.193	0.001	0.000	995	2,565	7,235	2,583	17	0	0.136	0.086	0.017	0.014	0.000	0.000

	Lewis River Run Size by Age						Mainstem Harvest Rate by Age						Columbia River Run Size by Age						Ocean Harvest Rate by Age						Ocean Escapement by Age					
Run Year	2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7	2	3	4	5	6	7
1964	4,631	3,255	9,471	3,512	0	0	0.272	0.220	0.217	0.323	0.185	0.185	6,366	4,175	12,099	5,186	0	0	0.260	0.260	0.260	0.260	0.260	0.260	8,602	5,642	16,349	7,008	0	0
1965	2,178	1,531	4,453	1,652	0	0	0.272	0.220	0.217	0.323	0.185	0.185	2,994	1,964	5,689	2,439	0	0	0.260	0.260	0.260	0.260	0.260	0.260	4,045	2,654	7,688	3,296	0	0
1966	1,939	3,195	5,456	2,575	0	0	0.272	0.220	0.217	0.323	0.185	0.185	2,665	4,099	6,970	3,803	0	0	0.260	0.260	0.260	0.260	0.260	0.260	3,601	5,539	9,419	5,139	0	0
1967	467	1,788	6,096	1,473	0	0	0.272	0.220	0.217	0.323	0.185	0.185	642	2,294	7,788	2,175	0	0	0.260	0.260	0.260	0.260	0.260	0.260	867	3,100	10,524	2,940	0	0
1968	230	584	4,724	1,564	0	0	0.272	0.220	0.217	0.323	0.185	0.185	317	749	6,035	2,310	0	0	0.260	0.260	0.260	0.260	0.260	0.260	428	1,012	8,155	3,121	0	0
1969	986	859	2,014	1,917	0	0	0.272	0.220	0.217	0.323	0.185	0.185	1,356	1,102	2,573	2,830	0	0	0.260	0.260	0.260	0.260	0.260	0.260	1,832	1,489	3,478	3,824	0	0
1970	22,024	1,454	2,114	435	0	0	0.272	0.220	0.217	0.323	0.185	0.185	30,273	1,865	2,701	642	0	0	0.260	0.260	0.260	0.260	0.260	0.260	40,910	2,520	3,650	867	0	0
1971	605	4,197	12,495	2,531	0	0	0.272	0.220	0.217	0.323	0.185	0.185	831	5,383	15,962	3,737	0	0	0.260	0.260	0.260	0.260	0.260	0.260	1,123	7,275	21,570	5,050	0	0
1972	889	1,900	13,786	2,092	0	0	0.272	0.220	0.217	0.323	0.185	0.185	1,222	2,437	17,611	3,089	0	0	0.260	0.260	0.260	0.260	0.260	0.260	1,651	3,293	23,798	4,174	0	0
1973	4,893	1,626	4,683	2,466	0	0	0.272	0.220	0.217	0.323	0.185	0.185	6,725	2,086	5,982	3,641	0	0	0.260	0.260	0.260	0.260	0.260	0.260	9,088	2,818	8,084	4,921	0	0
1974	2,217	1,961	3,587	1,737	0	0	0.272	0.220	0.217	0.323	0.185	0.185	3,047	2,516	4,582	2,565	0	0	0.260	0.260	0.260	0.260	0.260	0.260	4,117	3,400	6,191	3,466	0	0
1975	1,308	2,550	7,754	3,041	0	0	0.272	0.220	0.217	0.323	0.185	0.185	1,798	3,271	9,905	4,489	0	0	0.260	0.260	0.260	0.260	0.260	0.260	2,430	4,420	13,385	6,067	0	0
1976	1,036	733	1,727	789	0	0	0.272	0.220	0.217	0.323	0.185	0.185	1,425	941	2,206	1,165	0	0	0.260	0.260	0.260	0.260	0.260	0.260	1,925	1,271	2,981	1,574	0	0
1977	1,063	1,913	3,529	1,253	0	0	0.272	0.220	0.217	0.323	0.185	0.185	1,461	2,454	4,508	1,850	0	0	0.260	0.260	0.260	0.260	0.260	0.260	1,974	3,316	6,092	2,500	0	0
1978	959	1,468	2,795	919	0	0	0.272	0.220	0.217	0.323	0.185	0.185	1,318	1,882	3,570	1,357	0	0	0.260	0.260	0.260	0.260	0.260	0.260	1,781	2,544	4,825	1,833	0	0
1979	1,479	1,763	3,755	1,878	72	0	0.272	0.220	0.217	0.323	0.185	0.185	2,033	2,262	4,797	2,774	88	0	0.260	0.260	0.260	0.260	0.260	0.260	2,748	3,057	6,483	3,748	119	0
1980	846	2,481	7,593	1,298	0	0	0.414	0.357	0.439	0.711	0.000	0.000	1,443	3,856	13,539	4,498	0	0	0.260	0.260	0.260	0.260	0.260	0.260	1,950	5,211	18,297	6,079	0	0
1981	2,088	1,564	12,125	2,293	0	0	0.184	0.086	0.064	0.012	0.000	0.000	2,560	1,711	12,951	2,320	0	0	0.260	0.260	0.260	0.260	0.260	0.260	3,460	2,312	17,501	3,136	0	0
1982	896	2,514	2,555	2,127	13	0	0.448	0.142	0.101	0.045	0.620	0.620	1,623	2,930	2,843	2,227	35	0	0.260	0.260	0.260	0.260	0.260	0.260	2,194	3,959	3,842	3,009	48	0
1983	1,468	1,243	8,072	2,424	0	0	0.186	0.099	0.043	0.047	0.000	0.000	1,802	1,378	8,439	2,543	0	0	0.260	0.260	0.260	0.260	0.260	0.260	2,435	1,863	11,403	3,436	0	0
1984	1,405	1,116	3,208	1,916	73	0	0.202	0.256	0.229	0.293	0.000	0.000	1,760	1,500	4,163	2,712	73	0	0.260	0.260	0.260	0.260	0.260	0.260	2,379	2,027	5,626	3,664	99	0
1985	2,215	1,498	3,102	1,161	11	0	0.161	0.320	0.174	0.437	0.158	0.158	2,639	2,202	3,756	2,064	13	0	0.260	0.260	0.260	0.260	0.260	0.260	3,566	2,976	5,076	2,790	18	0
1986	2,605	3,593	4,399	1,611	47	0	0.207	0.409	0.442	0.515	0.020	0.020	3,287	6,082	7,888	3,319	48	0	0.260	0.260	0.260	0.260	0.260	0.260	4,442	8,219	10,659	4,485	65	0
1987	3,159	2,427	4,760	1,732	11	0	0.097	0.125	0.051	0.005	0.186	0.186	3,500	2,774	5,016	1,740	14	0	0.260	0.260	0.260	0.260	0.260	0.260	4,730	3,748	6,778	2,352	19	0
1988	2,193	1,462	5,184	2,715	0	0	0.143	0.306	0.476	0.628	0.557	0.557	2,559	2,107	9,899	7,290	0	0	0.260	0.260	0.260	0.260	0.260	0.260	3,459	2,848	13,377	9,851	0	0
1989	1,037	1,297	3,355	6,136	74	0	0.197	0.282	0.198	0.211	0.683	0.683	1,291	1,805	4,183	7,781	233	0	0.260	0.260	0.260	0.260	0.260	0.260	1,745	2,439	5,652	10,515	314	0
1990	1,458	828	6,396	6,522	1,310	0	0.002	0.265	0.161	0.050	0.000	0.000	1,460	1,127	7,619	6,866	1,310	0	0.170	0.170	0.170	0.170	0.170	0.170	1,759	1,358	9,180	8,272	1,578	0
1991	647	1,373	3,004	4,237	342	5	0.046	0.647	0.318	0.174	0.165	0.165	678	3,891	4,402	5,132	409	6	0.170	0.170	0.170	0.170	0.170	0.170	817	4,689	5,304	6,183	493	8
1992	2,181	396	2,895	1,568	259	0	0.081	0.022	0.281	0.164	0.346	0.346	2,374	405	4,028	1,876	397	0	0.170	0.170	0.170	0.170	0.170	0.170	2,860	488	4,853	2,260	478	0
1993	986	2,350	1,269	3,135	249	0	0.100	0.186	0.223	0.092	0.127	0.127	1,096	2,889	1,632	3,453	285	0	0.170	0.170	0.170	0.170	0.170	0.170	1,320	3,480	1,967	4,161	344	0
1994	1,424	1,071	5,374	1,039	255	0	0.005	0.000	0.036	0.063	0.678	0.678	1,432	1,071	5,573	1,109	791	0	0.170	0.170	0.170	0.170	0.170	0.170	1,725	1,291	6,714	1,337	953	0
1995	528	1,181	3,116	7,005	20	0	0.253	0.005	0.141	0.027	0.404	0.404	707	1,187	3,629	7,198	34	0	0.170	0.170	0.170	0.170	0.170	0.170	852	1,430	4,372	8,673	41	0
1996	301	1,139	6,827	3,611	519	0	0.000	0.000	0.026	0.053	0.050	0.050	301	1,139	7,008	3,813	547	0	0.170	0.170	0.170	0.170	0.170	0.170	362	1,373	8,443	4,594	659	0
1997	55	196	3,915	3,705	42	0	0.000	0.310	0.019	0.081	0.000	0.000	55	284	3,991	4,031	42	0	0.170	0.170	0.170	0.170	0.170	0.170	66	343	4,809	4,856	50	0
1998	190	618	1,063	3,064	4	0	0.000	0.000	0.000	0.086	0.000	0.000	190	618	1,063	3,351	4	0	0.170	0.170	0.170	0.170	0.170	0.170	229	744	1,280	4,038	5	0
1999	122	622	1,149	390	37	0	0.000	0.000	0.000	0.000	0.237	0.000	122	622	1,149	390	49	0	0.170	0.170	0.170	0.170	0.170	0.170	147	749	1,384	470	59	0
2000	830	1,424	4,955	1,133	7	0	0.182	0.166	0.023	0.000	0.000	0.000	1,015	1,707	5,074	1,133	7	0	0.170	0.170	0.170	0.170	0.170	0.170	1,223	2,057	6,113	1,365	8	0
2001	1,152	2,807	7,361	2,621	17	0	0.000	0.355	0.064	0.000	0.000	0.000	1,152	4,352	7,867	2,621	17	0	0.170	0.170	0.170	0.170	0.170	0.170	1,388	5,244	9,479	3,157	20	0

Results											
Brood Year	2	3	4	5	6	7	Total Recruits	Wild Outmigrants	Smolt to Adult Survival	Recruits per Spawner	Natural log (R/S)
1964	3,601	3,100	8,155	3,824	0	0	18,680			1.018	0.017
1965	867	1,012	3,478	867	0	0	6,224			0.721	-0.327
1966	428	1,489	3,650	5,050	0	0	10,616			0.902	-0.103
1967	1,832	2,520	21,570	4,174	0	0	30,096			3.342	1.207
1968	40,910	7,275	23,798	4,921	0	0	76,904			11.726	2.462
1969	1,123	3,293	8,084	3,466	0	0	15,966			3.097	1.130
1970	1,651	2,818	6,191	6,067	0	0	16,727			0.862	-0.148
1971	9,088	3,400	13,385	1,574	0	0	27,447			1.506	0.409
1972	4,117	4,420	2,981	2,500	0	0	14,019			0.818	-0.201
1973	2,430	1,271	6,092	1,833	119	0	11,745			1.010	0.009
1974	1,925	3,316	4,825	3,748	0	0	13,814			1.660	0.507
1975	1,974	2,544	6,483	6,079	0	0	17,079			1.283	0.249
1976	1,781	3,057	18,297	3,136	48	0	26,317			7.019	1.949
1977	2,748	5,211	17,501	3,009	0	0	28,470	2,620,000	0.011	4.098	1.411
1978	1,950	2,312	3,842	3,436	99	0	11,639	2,800,000	0.004	2.127	0.755
1979	3,460	3,959	11,403	3,664	18	0	22,504	2,410,000	0.009	2.814	1.035
1980	2,194	1,863	5,626	2,790	65	0	12,537			1.089	0.086
1981	2,435	2,027	5,076	4,485	19	0	14,041			0.837	-0.178
1982	2,379	2,976	10,659	2,352	0	0	18,365	2,880,000	0.006	2.524	0.926
1983	3,566	8,219	6,778	9,851	314	0	28,729	4,650,000	0.006	2.441	0.892
1984	4,442	3,748	13,377	10,515	1,578	8	33,668	3,430,000	0.010	5.431	1.692
1985	4,730	2,848	5,652	8,272	493	0	21,995	3,010,000	0.007	3.378	1.217
1986	3,459	2,439	9,180	6,183	478	0	21,738	1,540,000	0.014	2.087	0.736
1987	1,745	1,358	5,304	2,260	344	0	11,009	1,740,000	0.006	0.979	-0.021
1988	1,759	4,689	4,853	4,161	953	0	16,414			1.567	0.449
1989	817	488	1,967	1,337	41	0	4,649			0.438	-0.825
1990	2,860	3,480	6,714	8,673	659	0	22,386			1.471	0.386
1991	1,320	1,291	4,372	4,594	50	0	11,628			1.390	0.330
1992	1,725	1,430	8,443	4,856	5	0	16,459			3.056	1.117
1993	852	1,373	4,809	4,038	59	0	11,130			1.809	0.593
1994	362	343	1,280	470	8	0	2,463			0.300	-1.204
1995	66	744	1,384	1,365	20		3,580			0.388	-0.947
1996	229	749	6,113	3,157							
1997	147	2,057	9,479								
1998	1,223	5,244									
1999	1,388										
2000											
2001											

Notes:
Spawning escapement data for 1964-2001 were obtained from the Washington State salmon and steelhead stock inventory (WDF et al. 1993 and WDFW 2003).
Proportion of hatchery spawners for 1964-1979 and 2001 was estimated from the LCTRT escapement analysis (Myers et al. 2002).
Proportion of hatchery spawners for 1980-2000 was obtained from the NMFS SimSalmon database.
Prespawn mortality is assumed to be 5%.
Age composition data for years 1964 to 2001 (excluding 1979) were obtained from the StreamNet database.
Age composition data for 1979 is the average composition based on data in Myers et al. 2002 with reference to Hymer et al. 1992. StreamNet data for 1979 were not complete.
Tributary, mainstem, and ocean annual harvest rates for 7 year olds are assumed to equal the annual harvest rate in each area for 6 year olds.
Tributary harvest rate for 1980-2001 was calculated from the “big sheets” using lower river wild (LRW) stock: tributary harvest divided by the total run minus the mainstem harvest.
Tributary harvest rate for 1964-1979 was the 5-yr average calculated from the 1980-1984 “big sheets” using LRW stock: tributary harvest divided by the total run minus the mainstem harvest.
Mainstem harvest rate for 1980-2001 was calculated from the “big sheets” using LRW stock: sum of mainstem harvest divided by the total run.
Mainstem harvest rate for 1964-1979 was the 5-yr average calculated from the 1980-1984 “big sheets” using LRW stock: sum of mainstem harvest divided by the total run.
Ocean harvest rate for 1964-1989 was obtained from the Lewis River Subbasin Plan that summarized CWT recoveries for all available brood years.
Ocean harvest rate for 1990-2001 was obtained from the Lewis River Subbasin Plan that summarized CWT recoveries for all available brood years.
Wild outmigrant numbers were obtained from Table 17 in the Stock summary reports for Columbia River anadromous salmonids, Volume III: Washington. (Hymer et al. 1992).

APPENDIX A-4. Wind River Spring Chinook Run Reconstruction Table

	Escapement			Age Composition				Spawners by Age				Tributary Harvest Rate by Age			
Run Year	Hatchery Releases	Ratio of Hatchery Release/Esc Goals	Effective Spawners	3	4	5	6	3	4	5	6	3	4	5	6
1963			1,698	0.030	0.610	0.359	0.001	51	1,035	610	2	0.089	0.122	0.140	0.133
1964			1,136	0.030	0.610	0.359	0.001	34	693	408	1	0.089	0.122	0.140	0.133
1965	2,411,600	1,420	1,081	0.030	0.610	0.359	0.001	32	659	388	1	0.089	0.122	0.140	0.133
1966	1,613,400	1,420	533	0.030	0.610	0.359	0.001	16	325	192	1	0.089	0.122	0.140	0.133
1967	1,534,500	1,420	829	0.030	0.610	0.359	0.001	25	506	298	1	0.089	0.122	0.140	0.133
1968	757,000	1,420	993	0.030	0.610	0.359	0.001	30	605	357	1	0.089	0.122	0.140	0.133
1969	1,177,700	1,420	1,085	0.030	0.610	0.359	0.001	32	661	390	1	0.089	0.122	0.140	0.133
1970	1,409,400	1,420	1,409	0.045	0.845	0.110	0	63	1,190	156	0	0.063	0.062	0.060	0.000
1971	1,540,600	1,420	1,408	0.224	0.607	0.169	0	315	855	238	0	0.089	0.105	0.114	0.000
1972	2,001,100	1,420	1,752	0.007	0.621	0.372	0	13	1,088	651	0	0.269	0.159	0.155	0.000
1973	1,999,500	1,420	2,159	0.046	0.467	0.487	0.000	100	1,008	1,051	0	0.129	0.165	0.163	0.000
1974	2,488,000	1,420	2,011	0.246	0.579	0.167	0.008	494	1,165	336	17	0.051	0.152	0.110	0.133
1975	3,066,000	1,420	1,262	0.002	0.944	0.054	0.000	3	1,191	68	0	0.333	0.331	0.332	0.000
1976	2,856,100	1,420	2,145	0.052	0.029	0.914	0.004	112	63	1,961	9	0.030	0.030	0.030	0.040
1977	1,791,800	1,420	1,830	0.007	0.977	0.015	0.000	14	1,788	28	0	0.185	0.339	0.342	0.000
1978	3,046,400	1,420	1,816	0.004	0.201	0.793	0.002	7	365	1,441	3	0.333	0.336	0.337	0.375
1979	2,598,912	1,420	1,213	0.002	0.916	0.082	0.000	2	1,111	100	0	0.200	0.224	0.224	0.000
1980	2,578,650	1,420	2,033	0.010	0.180	0.811	0.000	19	366	1,648	0	0.000	0.000	0.000	0.000
1981	1,722,080	1,420	1,684	0.001	0.354	0.631	0.014	2	595	1,063	23	0.000	0.000	0.000	0.000
1982	2,886,560	1,420	1,685	0.013	0.655	0.332	0.000	21	1,104	560	0	0.000	0.000	0.000	0.000
1983	2,390,971	1,420	1,778	0.004	0.430	0.567	0.000	6	764	1,007	0	0.000	0.000	0.000	0.000
1984	2,392,468	1,420	1,378	0.037	0.592	0.366	0.005	51	815	505	7	0.000	0.000	0.000	0.000
1985	2,524,164	1,420	1,397	0.011	0.759	0.230	0.000	16	1,060	322	0	0.000	0.000	0.000	0.000
1986	1,956,220	1,420	1,483	0.011	0.627	0.362	0.000	17	930	536	0	0.111	0.443	0.394	0.000
1987	1,983,639	1,420	1,646	0.002	0.563	0.436	0.000	3	926	717	0	0.100	0.296	0.227	0.000
1988	2,105,281	1,420	1,631	0.034	0.119	0.846	0.000	56	195	1,380	0	0.191	0.315	0.155	0.000
1989	2,336,788	1,420	1,635	0.051	0.820	0.125	0.003	84	1,341	204	6	0.298	0.331	0.179	0.200
1990	2,315,382	1,420	1,437	0.002	0.875	0.123	0.000	3	1,258	176	0	0.805	0.790	0.770	1.000
1991	2,321,285	1,420	1,546	0.009	0.272	0.717	0.003	13	420	1,108	5	0.707	0.693	0.634	0.633
1992	2,040,568	1,420	1,213	0.002	0.738	0.258	0.002	3	895	313	2	0.800	0.656	0.546	0.444
1993	2,195,192	1,420	639	0.003	0.328	0.669	0.000	2	210	428	0	0.843	0.756	0.679	0.000
1994	1,722,621	1,420	1,221	0.008	0.588	0.402	0.002	9	718	491	3	0.000	0.352	0.430	0.333
1995	907,708	1,420	997	0.184	0.639	0.177	0.000	184	637	176	0	0.000	0.000	0.000	0.000
1996	1,734,188	1,420	1,007	0.003	0.980	0.017	0.000	3	987	17	0	0.811	0.644	0.551	0.000
1997	1,415,744	1,420	1,133	0.002	0.855	0.144	0.000	2	968	163	0	0.889	0.814	0.769	0.000
1998	1,430,022	1,420	1,021	0.015	0.433	0.552	0.000	15	442	564	0	0.000	0.474	0.421	0.000
1999	1,608,684	1,420	1,133	0.025	0.946	0.030	0.000	28	1,071	34	0	0.742	0.705	0.647	0.000
2000	1,449,400	1,420	1,021	0.009	0.957	0.035	0.000	9	977	35	0	0.938	0.866	0.831	0.000
2001	1,608,684	1,420	1,178	0.043	0.879	0.079	0.000	50	1,036	93	0	0.882	0.929	0.890	0.000
2002	1,449,361	1,420													
2003	1,673,255	1,420													

	Wind River Run Size by Age				Mainstem Harvest Rate by Age				Columbia River Run Size by Age				Ocean Harvest Rate				Ocean Escapement by Age			
Run Year	3	4	5	6	3	4	5	6	3	4	5	6	3	4	5	6	3	4	5	6
1963	56	1,178	710	2	0.576	0.576	0.576	0.576	131	2,780	1,674	6	0.01	0.01	0.01	0.01	132	2,808	1,691	6
1964	37	788	475	2	0.503	0.503	0.503	0.503	75	1,587	956	3	0.01	0.01	0.01	0.01	76	1,603	965	3
1965	35	750	451	2	0.614	0.614	0.614	0.614	92	1,942	1,169	4	0.01	0.01	0.01	0.01	93	1,962	1,181	4
1966	17	370	223	1	0.374	0.374	0.374	0.374	28	591	356	1	0.01	0.01	0.01	0.01	28	596	359	1
1967	27	576	347	1	0.509	0.509	0.509	0.509	55	1,172	706	2	0.01	0.01	0.01	0.01	56	1,184	713	2
1968	32	689	415	1	0.355	0.355	0.355	0.355	50	1,068	643	2	0.01	0.01	0.01	0.01	51	1,079	650	2
1969	36	753	453	2	0.307	0.307	0.307	0.307	51	1,086	654	2	0.01	0.01	0.01	0.01	52	1,097	660	2
1970	67	1,269	166	0	0.412	0.412	0.412	0.412	115	2,160	282	0	0.01	0.01	0.01	0.01	116	2,181	285	0
1971	346	955	269	0	0.309	0.309	0.309	0.309	501	1,383	389	0	0.01	0.01	0.01	0.01	506	1,397	393	0
1972	18	1,294	771	0	0.439	0.439	0.439	0.439	32	2,308	1,375	0	0.01	0.01	0.01	0.01	32	2,331	1,389	0
1973	114	1,208	1,256	0	0.494	0.494	0.494	0.494	226	2,388	2,483	0	0.01	0.01	0.01	0.01	228	2,412	2,508	0
1974	521	1,373	378	19	0.318	0.318	0.318	0.318	764	2,014	554	28	0.01	0.01	0.01	0.01	772	2,034	559	29
1975	4	1,782	102	0	0.002	0.002	0.002	0.002	4	1,785	102	0	0.01	0.01	0.01	0.01	4	1,803	103	0
1976	116	65	2,022	10	0.004	0.004	0.004	0.004	116	65	2,030	10	0.01	0.01	0.01	0.01	117	66	2,050	10
1977	17	2,705	43	0	0.253	0.253	0.253	0.253	22	3,622	58	0	0.01	0.01	0.01	0.01	22	3,658	58	0
1978	11	550	2,172	5	0.038	0.038	0.038	0.038	11	572	2,258	5	0.01	0.01	0.01	0.01	12	577	2,281	5
1979	2	1,431	129	0	0.030	0.030	0.030	0.030	2	1,476	132	0	0.01	0.01	0.01	0.01	2	1,491	134	0
1980	19	366	1,648	0	0.025	0.025	0.025	0.025	20	375	1,689	0	0.01	0.01	0.01	0.01	20	379	1,706	0
1981	2	595	1,063	23	0.049	0.049	0.049	0.049	2	626	1,118	24	0.01	0.01	0.01	0.01	2	633	1,130	25
1982	21	1,104	560	0	0.066	0.066	0.066	0.066	23	1,182	599	0	0.01	0.01	0.01	0.01	23	1,194	605	0
1983	6	764	1,007	0	0.079	0.079	0.079	0.079	7	830	1,094	0	0.01	0.01	0.01	0.01	7	838	1,105	0
1984	51	815	505	7	0.083	0.083	0.083	0.083	55	889	551	8	0.01	0.01	0.01	0.01	56	898	556	8
1985	16	1,060	322	0	0.062	0.062	0.062	0.062	17	1,129	343	0	0.01	0.01	0.01	0.01	17	1,141	346	0
1986	19	1,669	885	0	0.061	0.061	0.061	0.061	20	1,778	943	0	0.01	0.01	0.01	0.01	20	1,796	953	0
1987	3	1,315	927	0	0.059	0.059	0.059	0.059	4	1,398	985	0	0.01	0.01	0.01	0.01	4	1,412	995	0
1988	69	284	1,633	0	0.116	0.116	0.116	0.116	78	322	1,846	0	0.01	0.01	0.01	0.01	79	325	1,865	0
1989	120	2,003	249	7	0.078	0.078	0.078	0.078	130	2,172	270	8	0.01	0.01	0.01	0.01	131	2,194	273	8
1990	17	5,994	765	0	0.099	0.099	0.099	0.099	19	6,651	848	0	0.01	0.01	0.01	0.01	20	6,718	857	0
1991	45	1,367	3,028	13	0.084	0.084	0.084	0.084	49	1,493	3,307	14	0.01	0.01	0.01	0.01	50	1,508	3,340	14
1992	15	2,603	689	4	0.059	0.059	0.059	0.059	16	2,766	732	4	0.01	0.01	0.01	0.01	16	2,794	740	4
1993	11	860	1,335	0	0.051	0.051	0.051	0.051	11	905	1,406	0	0.01	0.01	0.01	0.01	11	915	1,420	0
1994	9	1,108	862	4	0.078	0.078	0.078	0.078	10	1,201	935	4	0.01	0.01	0.01	0.01	10	1,213	945	4
1995	184	637	176	0	0.040	0.040	0.040	0.040	191	663	184	0	0.01	0.01	0.01	0.01	193	670	186	0
1996	17	2,773	38	0	0.036	0.036	0.036	0.036	18	2,876	39	0	0.01	0.01	0.01	0.01	18	2,905	40	0
1997	18	5,209	706	0	0.048	0.048	0.048	0.048	18	5,469	742	0	0.01	0.01	0.01	0.01	19	5,524	749	0
1998	15	839	974	0	0.038	0.038	0.038	0.038	16	872	1,012	0	0.01	0.01	0.01	0.01	16	881	1,022	0
1999	109	3,627	95	0	0.034	0.034	0.034	0.034	113	3,754	98	0	0.01	0.01	0.01	0.01	114	3,792	99	0
2000	139	7,303	210	0	0.043	0.043	0.043	0.043	145	7,630	220	0	0.01	0.01	0.01	0.01	147	7,707	222	0
2001	426	14,687	843	0	0.145	0.145	0.145	0.145	498	17,186	986	0	0.01	0.01	0.01	0.01	503	17,360	996	0
2002																				
2003																				

Results								
Brood Year	3	4	5	6	Total Recruits	Smolt to Adult Survival	Recruits per Spawner	Natural log (R/S)
1963	28	1,184	650	2	1,864		1.097	0.093
1964	56	1,079	660	0	1,795		1.580	0.457
1965	51	1,097	285	0	1,433	0.001	1.326	0.282
1966	52	2,181	393	0	2,626	0.002	4.925	1.594
1967	116	1,397	1,389	0	2,902	0.002	3.499	1.252
1968	506	2,331	2,508	29	5,374	0.007	5.415	1.689
1969	32	2,412	559	0	3,003	0.003	2.768	1.018
1970	228	2,034	103	10	2,376	0.002	1.686	0.522
1971	772	1,803	2,050	0	4,625	0.003	3.284	1.189
1972	4	66	58	5	133	0.000	0.076	-2.579
1973	117	3,658	2,281	0	6,057	0.003	2.805	1.032
1974	22	577	134	0	734	0.000	0.365	-1.009
1975	12	1,491	1,706	25	3,233	0.001	2.562	0.941
1976	2	379	1,130	0	1,511	0.001	0.704	-0.350
1977	20	633	605	0	1,258	0.001	0.687	-0.375
1978	2	1,194	1,105	8	2,308	0.001	1.271	0.240
1979	23	838	556	0	1,417	0.001	1.169	0.156
1980	7	898	346	0	1,251	0.000	0.616	-0.485
1981	56	1,141	953	0	2,149	0.001	1.276	0.244
1982	17	1,796	995	0	2,808	0.001	1.667	0.511
1983	20	1,412	1,865	8	3,305	0.001	1.859	0.620
1984	4	325	273	0	601	0.000	0.436	-0.829
1985	79	2,194	857	14	3,144	0.001	2.251	0.811
1986	131	6,718	3,340	4	10,194	0.005	6.876	1.928
1987	20	1,508	740	0	2,268	0.001	1.378	0.321
1988	50	2,794	1,420	4	4,267	0.002	2.617	0.962
1989	16	915	945	0	1,875	0.001	1.147	0.137
1990	11	1,213	186	0	1,410	0.001	0.981	-0.019
1991	10	670	40	0	720	0.000	0.466	-0.764
1992	193	2,905	749	0	3,847	0.002	3.171	1.154
1993	18	5,524	1,022	0	6,565	0.003	10.270	2.329
1994	19	881	99	0	999	0.001	0.818	-0.201
1995	16	3,792	222	0	4,029	0.004	4.042	1.397
1996	114	7,707	996					
1997	147	17,360						
1998	503							
1999								
2000								
2001								

Notes:
Hatchery releases obtained from USFWS NFH database (Steve Pastor, personal communication).
Ratio of release goals to escapement goals was based on 2002 production levels reported in the most recent HGMP.
Annual effective spawners calculated by dividing annual hatchery releases by the ratio of release goals/escapement goals.
Age composition for 1970-2001 was calculated from WDFW data on Carson NFH spring chinook escapement by age and return year; age composition for 1965-69 is the average based on all years of available data (i.e. 1970-2001).
Tributary harvest rates for 1970-2001 are derived from WDFW data and were calculated as the Wind river sport harvest plus the Wind River tribal harvest plus Carson NFH tribal distributions divided by total run by age and return year; tributary harvest for 1965-69 is the 5-yr average based on harvest data for 1970-74.
Mainstem harvest rates are from the Biological Assessment Tables, Table 1; calculated as the Zone 1-5 commercial, sport, and miscellaneous harvest plus Zone 6 commercial and ceremonial and subsistence harvest with a 35% reduction (i.e. 65% of zone 6 harvest) divided by the total upriver run; these harvest rates are not age-specific.
Ocean harvest rate was assumed to be 1%.

APPENDIX A-5. Little White Salmon Spring Chinook Run Reconstruction Table

	Escapement			Age Composition				Spawners by Age				Tributary Harvest Rate by Age			
Run Year	Hatchery Releases	Ratio of Hatchery Release/Esc Goals	Effective Spawners	3	4	5	6	3	4	5	6	3	4	5	6
1965			177	0.050	0.704	0.244	0.002	9	124	43	0	0.037	0.000	0.000	0.000
1966			304	0.050	0.704	0.244	0.002	15	214	74	1	0.037	0.000	0.000	0.000
1967	265,100	1,500	465	0.050	0.704	0.244	0.002	23	327	113	1	0.037	0.000	0.000	0.000
1968	456,700	1,500	384	0.050	0.704	0.244	0.002	19	270	94	1	0.037	0.000	0.000	0.000
1969	696,900	1,500	384	0.050	0.704	0.244	0.002	19	270	94	1	0.037	0.000	0.000	0.000
1970	576,300	1,500	709	0.159	0.201	0.582	0.059	113	142	413	42	0.000	0.000	0.000	0.000
1971	575,900	1,500	672	0.119	0.851	0.030	0.000	80	572	20	0	0.020	0.000	0.000	0.000
1972	1,063,900	1,500	381	0.060	0.501	0.439	0.000	23	191	167	0	0.000	0.000	0.000	0.000
1973	1,007,400	1,500	463	0.050	0.480	0.453	0.017	23	222	209	8	0.250	0.000	0.000	0.000
1974	571,700	1,500	414	0.194	0.222	0.500	0.083	81	92	207	35	0.125	0.000	0.000	0.000
1975	694,000	1,500	527	0.019	0.820	0.152	0.009	10	432	80	4	0.000	0.000	0.000	0.000
1976	621,100	1,500	490	0.218	0.350	0.433	0.000	107	171	212	0	0.000	0.000	0.000	0.000
1977	790,400	1,500	430	0.020	0.889	0.088	0.003	9	383	38	1	0.000	0.000	0.000	0.000
1978	734,800	1,500	456	0.111	0.190	0.687	0.012	51	87	313	5	0.059	0.000	0.000	0.000
1979	645,680	1,500	500	0.023	0.842	0.125	0.010	12	421	63	5	0.000	0.125	0.088	0.000
1980	683,682	1,500	142	0.106	0.551	0.343	0.000	15	78	49	0	0.000	0.000	0.000	0.000
1981	750,262	1,500	903	0.000	0.950	0.049	0.000	0	858	45	0	0.000	0.002	0.023	0.000
1982	212,994	1,500	275	0.045	0.131	0.823	0.001	12	36	226	0	0.000	0.735	0.743	0.875
1983	1,354,959	1,500	344	0.005	0.360	0.635	0.000	2	124	218	0	0.000	0.047	0.038	0.000
1984	412,212	1,500	345	0.092	0.432	0.477	0.000	32	149	164	0	0.000	0.000	0.000	0.000
1985	516,252	1,500	333	0.045	0.873	0.081	0.000	15	291	27	0	0.044	0.385	0.403	0.000
1986	517,446	1,500	308	0.192	0.611	0.197	0.000	59	188	61	0	0.060	0.961	0.996	0.000
1987	499,796	1,500	678	0.124	0.807	0.069	0.000	84	547	47	0	0.105	0.574	0.577	0.000
1988	461,446	1,500	1,118	0.048	0.355	0.594	0.003	54	397	664	3	0.199	0.581	0.641	0.462
1989	1,016,706	1,500	539	0.040	0.900	0.060	0.000	21	485	33	0	0.265	0.546	0.452	1.000
1990	1,677,694	1,500	663	0.013	0.849	0.138	0.000	8	563	92	0	0.342	0.509	0.481	0.000
1991	809,079	1,500	705	0.037	0.377	0.586	0.000	26	266	413	0	0.120	0.260	0.350	0.000
1992	994,588	1,500	641	0.012	0.883	0.105	0.000	8	566	67	0	0.514	0.650	0.713	0.000
1993	1,057,864	1,500	455	0.005	0.343	0.648	0.004	2	156	295	2	0.500	0.737	0.687	0.467
1994	961,515	1,500	711	0.007	0.576	0.413	0.005	5	409	294	3	0.000	0.194	0.312	0.667
1995	682,623	1,500	716	0.285	0.546	0.166	0.003	204	391	119	2	0.000	0.000	0.000	0.000
1996	1,066,702	1,500	744	0.015	0.965	0.019	0.000	11	718	14	0	0.763	0.650	0.603	0.000
1997	1,074,173	1,500	678	0.011	0.553	0.436	0.000	7	375	295	0	0.231	0.814	0.719	0.000
1998	1,115,384	1,500	692	0.020	0.528	0.452	0.000	14	365	313	0	0.000	0.000	0.000	0.000
1999	1,016,574	1,500	678	0.033	0.933	0.034	0.000	22	632	23	0	0.442	0.371	0.353	0.000
2000	1,037,400	1,500	692	0.009	0.904	0.088	0.000	6	625	61	0	0.830	0.677	0.691	0.000
2001	1,016,574	1,500	675	0.013	0.935	0.052	0.000	9	631	35	0	0.858	0.697	0.753	0.000
2002	1,037,382	1,500		0.006	0.909	0.085	0.000	0	0	0	0	0.798	0.853	0.803	0.000
2003	1,012,339	1,500													

	LWS River Run Size by Age				Mainstem Harvest Rate by Age				Columbia River Run Size by Age				Ocean Harvest Rate				Ocean Escapement by Age			
Run Year	3	4	5	6	3	4	5	6	3	4	5	6	3	4	5	6	3	4	5	6
1965	9	124	43	0	0.626	0.626	0.626	0.626	25	332	115	1	0.01	0.01	0.01	0.01	25	336	117	1
1966	16	214	74	1	0.375	0.375	0.375	0.375	26	343	119	1	0.01	0.01	0.01	0.01	26	346	120	1
1967	24	327	113	1	0.517	0.517	0.517	0.517	50	677	235	2	0.01	0.01	0.01	0.01	51	684	237	2
1968	20	270	94	1	0.368	0.368	0.368	0.368	32	428	149	1	0.01	0.01	0.01	0.01	32	432	150	1
1969	20	270	94	1	0.323	0.323	0.323	0.323	30	399	139	1	0.01	0.01	0.01	0.01	30	403	140	1
1970	113	142	413	42	0.421	0.421	0.421	0.421	195	246	712	72	0.01	0.01	0.01	0.01	197	248	720	72
1971	81	572	20	0	0.318	0.318	0.318	0.318	119	838	29	0	0.01	0.01	0.01	0.01	121	846	30	0
1972	23	191	167	0	0.455	0.455	0.455	0.455	42	351	307	0	0.01	0.01	0.01	0.01	42	354	310	0
1973	31	222	209	8	0.510	0.510	0.510	0.510	63	453	427	16	0.01	0.01	0.01	0.01	64	458	431	16
1974	92	92	207	35	0.336	0.336	0.336	0.336	139	139	312	52	0.01	0.01	0.01	0.01	140	140	315	52
1975	10	432	80	4	0.002	0.002	0.002	0.002	10	433	80	5	0.01	0.01	0.01	0.01	10	437	81	5
1976	107	171	212	0	0.005	0.005	0.005	0.005	107	172	213	0	0.01	0.01	0.01	0.01	108	174	215	0
1977	9	383	38	1	0.267	0.267	0.267	0.267	12	522	52	2	0.01	0.01	0.01	0.01	12	527	52	2
1978	54	87	313	5	0.044	0.044	0.044	0.044	56	91	328	6	0.01	0.01	0.01	0.01	57	92	331	6
1979	12	481	69	5	0.034	0.034	0.034	0.034	12	498	71	5	0.01	0.01	0.01	0.01	12	503	72	5
1980	15	78	49	0	0.028	0.028	0.028	0.028	15	81	50	0	0.01	0.01	0.01	0.01	16	81	51	0
1981	0	860	46	0	0.055	0.055	0.055	0.055	0	910	48	0	0.01	0.01	0.01	0.01	0	919	49	0
1982	12	136	879	3	0.073	0.073	0.073	0.073	13	147	948	3	0.01	0.01	0.01	0.01	13	149	958	3
1983	2	130	227	0	0.083	0.083	0.083	0.083	2	142	248	0	0.01	0.01	0.01	0.01	2	143	250	0
1984	32	149	164	0	0.090	0.090	0.090	0.090	35	164	181	0	0.01	0.01	0.01	0.01	35	165	183	0
1985	16	473	45	0	0.065	0.065	0.065	0.065	17	506	49	0	0.01	0.01	0.01	0.01	17	511	49	0
1986	63	4,766	15,852	0	0.067	0.067	0.067	0.067	67	5,110	16,996	0	0.01	0.01	0.01	0.01	68	5,161	17,168	0
1987	94	1,284	111	0	0.066	0.066	0.066	0.066	101	1,375	118	0	0.01	0.01	0.01	0.01	102	1,389	120	0
1988	67	947	1,849	6	0.123	0.123	0.123	0.123	76	1,080	2,109	7	0.01	0.01	0.01	0.01	77	1,091	2,130	7
1989	29	1,069	59	0	0.086	0.086	0.086	0.086	32	1,169	65	0	0.01	0.01	0.01	0.01	32	1,181	66	0
1990	13	1,146	177	0	0.106	0.106	0.106	0.106	14	1,281	197	0	0.01	0.01	0.01	0.01	14	1,294	199	0
1991	30	359	636	0	0.091	0.091	0.091	0.091	32	395	700	0	0.01	0.01	0.01	0.01	33	399	707	0
1992	16	1,618	234	0	0.065	0.065	0.065	0.065	17	1,731	250	0	0.01	0.01	0.01	0.01	17	1,749	253	0
1993	5	593	943	3	0.057	0.057	0.057	0.057	5	629	1,000	3	0.01	0.01	0.01	0.01	5	635	1,011	3
1994	5	508	427	10	0.083	0.083	0.083	0.083	5	554	465	11	0.01	0.01	0.01	0.01	5	559	470	11
1995	204	391	119	2	0.046	0.046	0.046	0.046	214	410	124	2	0.01	0.01	0.01	0.01	216	414	126	2
1996	47	2,050	37	0	0.041	0.041	0.041	0.041	49	2,138	38	0	0.01	0.01	0.01	0.01	50	2,160	38	0
1997	10	2,021	1,051	0	0.055	0.055	0.055	0.055	10	2,138	1,112	0	0.01	0.01	0.01	0.01	10	2,160	1,124	0
1998	14	365	313	0	0.044	0.044	0.044	0.044	15	382	327	0	0.01	0.01	0.01	0.01	15	386	330	0
1999	40	1,005	36	0	0.039	0.039	0.039	0.039	41	1,045	38	0	0.01	0.01	0.01	0.01	42	1,056	38	0
2000	36	1,934	196	0	0.049	0.049	0.049	0.049	38	2,034	206	0	0.01	0.01	0.01	0.01	38	2,054	208	0
2001	61	2,084	141	0	0.159	0.159	0.159	0.159	73	2,477	168	0	0.01	0.01	0.01	0.01	73	2,502	169	0
2002	0	0	0	0	0.107	0.107	0.107	0.107	0	0	0	0	0.01	0.01	0.01	0.01	0	0	0	0
2003																				

Results								
Brood Year	3	4	5	6	Total Recruits	Smolt to Adult Survival	Recruits/Spawner	Natural Log (R/S)
1965	32	403	720	0	1,155		6.534	1.877
1966	30	248	30	0	308		1.012	0.012
1967	197	846	310	16	1,369	0.005	2.947	1.081
1968	121	354	431	52	958	0.002	2.494	0.914
1969	42	458	315	5	820	0.001	2.135	0.759
1970	64	140	81	0	285	0.000	0.402	-0.912
1971	140	437	215	2	794	0.001	1.183	0.168
1972	10	174	52	6	242	0.000	0.635	-0.454
1973	108	527	331	5	971	0.001	2.099	0.742
1974	12	92	72	0	175	0.000	0.423	-0.860
1975	57	503	51	0	611	0.001	1.159	0.147
1976	12	81	49	3	145	0.000	0.296	-1.217
1977	16	919	958	0	1,892	0.002	4.396	1.481
1978	0	149	250	0	399	0.001	0.875	-0.133
1979	13	143	183	0	339	0.001	0.678	-0.388
1980	2	165	49	0	216	0.000	1.524	0.422
1981	35	511	17,168	0	17,714	0.024	19.610	2.976
1982	17	5,161	120	7	5,305	0.025	19.306	2.960
1983	68	1,389	2,130	0	3,587	0.003	10.422	2.344
1984	102	1,091	66	0	1,258	0.003	3.648	1.294
1985	77	1,181	199	0	1,458	0.003	4.375	1.476
1986	32	1,294	707	0	2,033	0.004	6.609	1.889
1987	14	399	253	3	670	0.001	0.988	-0.012
1988	33	1,749	1,011	11	2,803	0.006	2.506	0.919
1989	17	635	470	2	1,125	0.001	2.085	0.735
1990	5	559	126	0	690	0.000	1.040	0.040
1991	5	414	38	0	458	0.001	0.649	-0.433
1992	216	2,160	1,124	0	3,500	0.004	5.460	1.697
1993	50	2,160	330	0	2,539	0.002	5.580	1.719
1994	10	386	38	0	434	0.000	0.610	-0.495
1995	15	1,056	208	0	1,279	0.002	1.786	0.580
1996	42	2,054	169	0				
1997	38	2,502	0					
1998	73	0						
1999	0							
2000								
2001								
2002								

Notes:
Hatchery releases were obtained from USFWS NFH database (Steve Pastor, personal communication).
Ratio of release goals to escapement goals were based on 2002 production levels reported in the most recent HGMP.
Annual effective spawners calculated by dividing annual hatchery releases by the ratio of release goals/escapement goals.
Age composition for 1970-2002 was calculated based on WDFW data of Little White Salmon NFH spring chinook escapement by age and return year; age composition for 1967-69 is the average of all years of available data.
Tributary harvest rates for 1970-2001 were derived from WDFW data and calculated as the Little White Salmon River sport harvest plus tribal harvest plus tribal distributions divided by the total run by age and return year.
Tributary harvest rates for 1967-69 was the 5-yr average of harvest for 1970-1974; tributary harvest for 2002 was the 5-yr average harvest for 1997-2001.
Mainstem harvest rates were calculated from the Biological Assessment Tables, Table 1; Zone 1-5 commercial, sport, and miscellaneous harvest plus Zone 6 commercial and ceremonial and subsistence harvest with a 25% reduction (i.e. 75% of zone 6 harvest) divided by the total upriver run; these harvest rates are not age-specific.
Mainstem harvest rate for 2002 was the most recent 5-yr average harvest for 1997-2001.
Ocean harvest rate was assumed to be 1%.

APPENDIX A-6. Kalama Winter Steelhead Run Reconstruction Table

	Escapement						Spawners			Tributary Harvest		Kalama River Run Size		Mainstem Harvest Rate	
Run Year	Total Escapement	Proportion Wild	Wild Escapement	Proportion Hatchery	Hatchery Escapement	Prespawn Mortality	Wild Spawners	Hatchery Spawners	Total Spawners	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery
1976-77	946	0.82	774	0.18	172	0.05	735	163	899	1,229	170	1,964	333	0.007	0.007
1977-78	1,615	0.43	694	0.57	921	0.05	659	875	1,534	1,114	998	1,773	1,873	0.007	0.007
1978-79	521	0.71	371	0.29	150	0.05	352	143	495	647	161	999	304	0.018	0.018
1979-80	1,347	0.76	1,025	0.24	322	0.05	974	306	1,280	1,067	585	2,041	891	0.004	0.004
1980-81	2,770	0.78	2,150	0.22	620	0.05	2,043	589	2,632	2,162	318	4,205	907	0.010	0.010
1981-82	1,108	0.78	869	0.22	239	0.05	826	227	1,053	1,719	453	2,545	680	0.009	0.009
1982-83	874	0.61	532	0.39	342	0.05	505	325	830	1,020	298	1,525	623	0.026	0.026
1983-84	2,007	0.47	943	0.53	1,064	0.05	896	1,011	1,907	959	617	1,855	1,628	0.007	0.007
1984-85	1,067	0.59	632	0.41	435	0.05	600	413	1,014	1,487	1,126	2,087	1,539	0.006	0.006
1985-86	2,532	0.36	919	0.64	1,613	0.05	873	1,532	2,405	643	1,179	1,516	2,711	0.001	0.008
1986-87	1,794	0.55	982	0.45	812	0.05	933	771	1,704	218	647	1,151	1,418	0.002	0.021
1987-88	2,135	0.51	1,079	0.49	1,056	0.05	1,025	1,003	2,028	486	943	1,511	1,946	0.001	0.008
1988-89	770	0.66	506	0.34	264	0.05	481	251	732	571	1,447	1,052	1,698	0.002	0.017
1989-90	756	0.47	356	0.53	400	0.05	338	380	718	424	970	762	1,350	0.000	0.003
1990-91	1,288	0.74	959	0.26	329	0.05	911	313	1,224	26	871	937	1,184	0.002	0.018
1991-92	2,847	0.69	1,974	0.31	873	0.05	1,875	829	2,705	15	1,342	1,890	2,171	0.000	0.005
1992-93	1,155	0.73	843	0.27	312	0.05	801	296	1,097	75	790	876	1,086	0.001	0.009
1993-94	916	0.79	725	0.21	191	0.05	689	181	870	13	195	702	376	0.000	0.003
1994-95	1,315	0.78	1,030	0.22	285	0.05	979	271	1,249	53	270	1,032	541	0.000	0.004
1995-96	1,606	0.45	725	0.55	881	0.05	689	837	1,526	48	1,088	737	1,925	0.000	0.000
1996-97	505	0.9	456	0.1	49	0.05	433	47	480	33	74	466	120	0.000	0.004
1997-98	413	1	413	0	0	0.05	392	0	392	28	0	420	0	0.001	0.007
1998-99	478	1	478	0	0	0.05	454	0	454	46	0	500	0	0.000	0.000
1999-2000	817	1	817	0	0	0.05	776	0	776	99	0	875	0	0.001	0.008
2000-01	922	1	922	0	0	0.05	876	0	876	51	0	927	0	0.001	0.005
2001-02	1,355	1	1,355	0	0	0.05	1,287	0	1,287	59	0	1,346	0	0.025	0.025

	Columbia River Run Size		Ocean Harvest Rate		Ocean Escapement		Wild Age Composition							Hatchery Age Composition						
Run Year	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	2	3	4	5	6	7	8	1	2	3	4	5	6	7
1976-77	1,979	336	0.005	0.005	1,989	338	0.00	0.18	0.44	0.24	0.11	0.03	0.01	0	0.004	0.176	0.441	0.236	0.108	0.035
1977-78	1,786	1,886	0.005	0.005	1,795	1,896	0.00	0.12	0.48	0.36	0.03	0.00	0.00	0	0.003	0.118	0.482	0.358	0.034	0.005
1978-79	1,018	309	0.005	0.005	1,023	311	0.00	0.06	0.52	0.37	0.05	0.00	0.00	0	0.003	0.056	0.524	0.367	0.05	0
1979-80	2,050	895	0.005	0.005	2,060	899	0.00	0.06	0.64	0.26	0.03	0.00	0.00	0	0.001	0.063	0.644	0.264	0.027	0.001
1980-81	4,247	916	0.005	0.005	4,268	921	0.00	0.07	0.44	0.42	0.06	0.00	0.00	0.002	0.835	0.163	0	0		
1981-82	2,568	686	0.005	0.005	2,580	690	0.00	0.06	0.43	0.47	0.04	0.01	0.00	0	0.619	0.371	0.011	0		
1982-83	1,566	640	0.005	0.005	1,574	643	0.00	0.06	0.33	0.55	0.06	0.00	0.00	0	0.487	0.487	0.024	0		
1983-84	1,869	1,640	0.005	0.005	1,878	1,648	0.01	0.13	0.56	0.24	0.05	0.00	0.00	0.039	0.904	0.057	0	0		
1984-85	2,101	1,549	0.005	0.005	2,111	1,557	0.01	0.12	0.45	0.41	0.01	0.00	0.00	0.071	0.753	0.153	0.024	0	0	0
1985-86	1,517	2,733	0.005	0.005	1,525	2,746	0.00	0.11	0.53	0.30	0.05	0.01	0.00	0.012	0.79	0.185	0.012	0	0	0
1986-87	1,153	1,449	0.005	0.005	1,159	1,456	0.01	0.08	0.41	0.44	0.06	0.00	0.00	0.015	0.677	0.293	0.015	0	0	0
1987-88	1,512	1,961	0.005	0.005	1,520	1,971	0.00	0.02	0.56	0.39	0.03	0.00	0.00	0.07	0.79	0.123	0.018	0	0	0
1988-89	1,053	1,727	0.005	0.005	1,059	1,736	0.00	0.09	0.59	0.29	0.03	0.00	0.00	0.013	0.64	0.346	0	0	0	0
1989-90	762	1,354	0.005	0.005	766	1,361	0.00	0.01	0.46	0.48	0.06	0.00	0.00	0.005	0.836	0.158	0	0	0	0
1990-91	939	1,205	0.005	0.005	943	1,211	0.00	0.04	0.43	0.48	0.05	0.00	0.00	0.035	0.769	0.197	0	0	0	0
1991-92	1,891	2,182	0.005	0.005	1,901	2,193	0.00	0.03	0.65	0.29	0.04	0.00	0.00	0.014	0.874	0.112	0	0	0	0
1992-93	877	1,096	0.005	0.005	881	1,102	0.00	0.05	0.32	0.55	0.07	0.00	0.00	0.005	0.791	0.199	0.003	0.003	0	0
1993-94	702	377	0.005	0.005	705	379	0.00	0.04	0.72	0.20	0.04	0.00	0.00	0.004	0.836	0.141	0.019	0	0	0
1994-95	1,032	543	0.005	0.005	1,037	546	0.00	0.03	0.56	0.38	0.03	0.00	0.00	0	0	0.037	0.722	0.202	0.038	0.001
1995-96	737	1,925	0.005	0.005	740	1,935	0.00	0.03	0.62	0.33	0.02	0.00	0.00	0	0	0.027	0.562	0.375	0.035	0.001
1996-97	466	121	0.005	0.005	469	121	0.00	0.05	0.60	0.33	0.02	0.00	0.00	0	0	0.027	0.622	0.328	0.02	0.004
1997-98	421	0	0.005	0.005	423	0	0.00	0.07	0.51	0.37	0.04	0.00	0.00	0	0	0.047	0.602	0.333	0.018	0
1998-99	500	0	0.005	0.005	503	0	0.00	0.07	0.51	0.37	0.04	0.00	0.00	0	0	0.029	0.529	0.394	0.045	0.003
1999-2000	876	0	0.005	0.005	880	0	0.00	0.07	0.51	0.37	0.04	0.00	0.00	0	0	0.03	0.53	0.392	0.046	0.002
2000-01	927	0	0.005	0.005	932	0	0.00	0.07	0.51	0.37	0.04	0.00	0.00	0	0	0.029	0.529	0.393	0.046	0.002
2001-02	1,381	0	0.005	0.005	1,388	0	0.00	0.07	0.51	0.37	0.04	0.00	0.00	0.012	0.442	0.144	0.245	0.142	0.018	0.001

	Hatchery Recruits by Age						
Run Year	1	2	3	4	5	6	7
1976-77	0	1	59	149	80	36	12
1977-78	0	6	224	914	679	64	9
1978-79	0	1	17	163	114	16	0
1979-80	0	1	57	579	237	24	1
1980-81	2	769	150	0	0	0	0
1981-82	0	427	256	8	0	0	0
1982-83	0	313	313	15	0	0	0
1983-84	64	1,490	94	0	0	0	0
1984-85	111	1,172	238	37	0	0	0
1985-86	33	2,170	508	33	0	0	0
1986-87	22	986	427	22	0	0	0
1987-88	138	1,557	242	35	0	0	0
1988-89	23	1,111	601	0	0	0	0
1989-90	7	1,138	215	0	0	0	0
1990-91	42	931	239	0	0	0	0
1991-92	31	1,916	246	0	0	0	0
1992-93	6	871	219	3	3	0	0
1993-94	2	317	53	7	0	0	0
1994-95	0	0	20	394	110	21	1
1995-96	0	0	52	1,087	725	68	2
1996-97	0	0	3	75	40	2	0
1997-98	0	0	0	0	0	0	0
1998-99	0	0	0	0	0	0	0
1999-2000	0	0	0	0	0	0	0
2000-01	0	0	0	0	0	0	0
2001-02	0	0	0	0	0	0	0

	Wild Recruits by Age								Hatchery Recruits by Age									Total Recruits		Productivity		
Brood Year	2	3	4	5	6	7	Total Wild Recruits	Wild R/S	1	2	3	4	5	6	7	Total Hatchery Recruits	Hatchery R/S	Total Recruits	Total R/S	Natural log (Wild R/S)	Natural log (Hatchery R/S)	Natural log (Total R/S)
1977	2	312	1,102	871	95	0	2,383	3.241	0	1	150	8	0	0	0	159	0.970	2,541	2.828	1.176	-0.030	1.040
1978	0	145	514	458	17	9	1,144	1.735	0	769	256	15	0	0	0	1,040	1.189	2,184	1.423	0.551	0.173	0.353
1979	0	98	1,060	865	74	0	2,096	5.948	2	427	313	0	0	0	0	742	5.205	2,838	5.734	1.783	1.650	1.746
1980	0	252	957	455	71	0	1,735	1.781	0	313	94	37	0	0	0	444	1.453	2,179	1.703	0.577	0.373	0.532
1981	13	256	814	514	44	0	1,640	0.803	0	1,490	238	33	0	0	0	1,761	2.990	3,401	1.293	-0.219	1.095	0.257
1982	17	172	480	586	30	0	1,286	1.557	64	1,172	508	22	0	0	0	1,767	7.780	3,052	2.900	0.443	2.052	1.065
1983	0	88	853	303	42	0	1,286	2.545	111	2,170	427	35	0	0	0	2,742	8.440	4,028	4.852	0.934	2.133	1.579
1984	7	31	622	364	45	0	1,069	1.193	33	986	242	0	0	0	0	1,261	1.248	2,330	1.222	0.176	0.221	0.200
1985	6	99	356	457	71	2	991	1.651	22	1,557	601	0	0	0	0	2,179	5.274	3,171	3.128	0.501	1.663	1.140
1986	5	4	403	542	65	0	1,020	1.168	138	1,111	215	0	0	0	0	1,464	0.955	2,483	1.032	0.155	-0.046	0.032
1987	0	38	1,239	485	26	1	1,790	1.919	23	1,138	239	0	3	0	1	1,403	1.818	3,193	1.873	0.652	0.598	0.628
1988	0	48	286	142	36	2	514	0.501	7	931	246	3	0	21	2	1,210	1.206	1,724	0.850	-0.690	0.187	-0.163
1989	0	43	510	389	15	0	957	1.991	42	1,916	219	7	110	68	0	2,364	9.424	3,321	4.539	0.689	2.243	1.513
1990	0	26	583	242	8	1	861	2.545	31	871	53	394	725	2		2,077	5.467	2,938	4.091	0.934	1.699	1.409
1991	0	28	461	156	19	1	664	0.729	6	317	20	1,087	40							-0.316		
1992	0	20	282	156	22	2	483	0.258	2	0	52	75								-1.357		
1993	0	22	217	186	39	3	466	0.582	0	0	3									-0.541		
1994	0	29	258	326	41	4	657	0.954	0	0										-0.047		
1995	1	34	452	345	62	0	893	0.912	0											-0.092		
1996	1	59	478	513	0																	
1997	2	63	712	0																		
1998	2	94	0																			
1999	3	0																				
2000	0																					
2001																						
2002																						

Notes:
Wild and hatchery spawning escapement numbers were obtained from WDFW Kalama Research Group data.
Wild and hatchery proportions were obtained from WDFW Kalama Research Group data.
Wild tributary harvest numbers for 1977-1996 and 1998-2002 were obtained from WDFW Kalama Research Group data. Harvest for 1997 was the 5-yr average harvest from 1998-2002.
Hatchery tributary harvest numbers from 1977-1996 were obtained from WDFW Kalama Research Group data. Harvest for 1997 was the 5-yr average harvest from 1992-1996. Hatchery harvest since 1998 was zero because no hatchery fish are present in the escapement.
Columbia River wild winter steelhead harvest rates were assumed to be the same as hatchery fish up to 1984; beginning in 1985, incidental harvest mortality was assumed to be 10% of the annual hatchery harvest rate. Harvest rate for 2001-02 was based on the 2002 Spring Chinook Tangle Net Fishery data: WDFW estimated a total of 2.5% mortality: 2% immediate mortality and an assumed 0.5% long term mortality.
Columbia River hatchery winter steelhead harvest rate was calculated as the lower river sport catch (Table 20, Columbia River Status Report) divided by the Columbia river index total run (Table 64, Columbia River Status Report; WDFW and ODFW 2002). Non-indian commercial steelhead harvest has not occurred since 1974. Harvest for 2001 was the most recent 5-yr average harvest (1996-2000). Harvest rate for 2002 was based on the 2002 Spring Chinook Tangle Net Fishery data: WDFW estimated 2.5% total mortality: 2% immediate mortality and an assumed 0.5% long term mortality.
Ocean harvest rate of wild and hatchery steelhead is assumed to be 0.5%.
Wild age composition data for 1976-77 to 2001-2002 from WDFW age data.
Hatchery age composition data for 1980-1983 were obtained from Hymer et al. 1992 (Table 10).
Hatchery age composition data for 1984-1993 were obtained from Hulett et al. 1995 (Table 1.4).
Hatchery age composition data for 1977-1979 and 1994-2001 were obtained from the NMFS SimSalmon database.
Hatchery age composition data for 2001-2002 was the average from all years of available data (1977-2001).

APPENDIX A-7. Kalama River Summer Steelhead Run Reconstruction Table

	Escapement						Spawners			Tributary Harvest		Kalama River Run Size		Mainstem Harvest Rate		Columbia River Run Size	
Run Year	Total Escapement	Proportion Wild	Wild Escape.	Proportion Hatchery	Hatchery Escapement	Prespawn Mortality	Wild Spawners	Hatchery Spawners	Total Spawners	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery
1977	1,469	0.27	400	0.73	1,069	0.05	380	1,016	1,396	633	2,386	1,013	3,402	0.016	0.016	1,030	3,458
1978	4,554	0.22	1,015	0.78	3,539	0.05	964	3,362	4,326	1,079	3,722	2,043	7,084	0.024	0.024	2,093	7,256
1979	2,604	0.19	484	0.81	2,120	0.05	460	2,014	2,474	832	2,965	1,292	4,979	0.018	0.018	1,316	5,072
1980	2,647	0.27	718	0.73	1,929	0.05	682	1,833	2,515	844	1,896	1,526	3,729	0.006	0.006	1,536	3,752
1981	11,524	0.25	2,926	0.75	8,598	0.05	2,780	8,168	10,948	2,978	8,527	5,758	16,695	0.034	0.034	5,958	17,275
1982	13,686	0.1	1,385	0.9	12,301	0.05	1,316	11,686	13,002	1,075	6,993	2,391	18,679	0.037	0.037	2,482	19,390
1983	5,274	0.16	869	0.84	4,405	0.05	826	4,185	5,010	1,621	7,689	2,447	11,874	0.041	0.041	2,550	12,376
1984	1,155	0.21	247	0.79	908	0.05	235	863	1,097	738	2,096	973	2,959	0.039	0.039	1,013	3,080
1985	1,567	0.29	461	0.71	1,106	0.05	438	1,051	1,489	854	2,044	1,292	3,095	0.003	0.032	1,296	3,196
1986	2,897	0.16	473	0.84	2,424	0.05	449	2,303	2,752	799	3,702	1,248	6,005	0.003	0.033	1,253	6,212
1987	5,435	0.14	748	0.86	4,687	0.05	711	4,453	5,163	148	9,214	859	13,667	0.003	0.027	861	14,052
1988	3,149	0.3	950	0.7	2,199	0.05	903	2,089	2,992	217	5,292	1,120	7,381	0.003	0.035	1,123	7,646
1989	3,376	0.2	684	0.8	2,692	0.05	650	2,557	3,207	90	5,394	740	7,951	0.005	0.049	743	8,357
1990	1,669	0.45	745	0.55	924	0.05	708	878	1,586	74	3,609	782	4,487	0.004	0.036	785	4,652
1991	1,738	0.41	704	0.59	1,034	0.05	669	982	1,651	16	2,586	685	3,568	0.004	0.038	687	3,708
1992	2,663	0.4	1,075	0.6	1,588	0.05	1,021	1,509	2,530	5	2,612	1,026	4,121	0.003	0.025	1,029	4,226
1993	7,188	0.32	2,283	0.68	4,905	0.05	2,169	4,660	6,829	204	4,433	2,373	9,093	0.004	0.038	2,382	9,455
1994	3,838	0.27	1,041	0.73	2,797	0.05	989	2,657	3,646	72	2,775	1,061	5,432	0.003	0.025	1,064	5,574
1995	3,043	0.43	1,302	0.57	1,741	0.05	1,237	1,654	2,891	9	1,573	1,246	3,227	0.004	0.036	1,250	3,348
1996	1,764	0.35	614	0.65	1,150	0.05	583	1,093	1,676	15	501	598	1,594	0.003	0.034	600	1,650
1997	2,993	0.2	598	0.8	2,395	0.05	568	2,275	2,843	38	1,012	606	3,287	0.006	0.063	610	3,506
1998	760	0.27	205	0.73	555	0.05	195	527	722	2	946	197	1,473	0.004	0.043	198	1,539
1999	407	0.54	220	0.46	187	0.05	209	178	387	44	372	253	550	0.004	0.041	254	573
2000	170	0.82	140	0.18	30	0.05	133	29	162	36	881	169	909	0.005	0.047	170	954
2001	381	0.86	329	0.14	52	0.05	313	49	362	43	881	356	930	0.005	0.046	357	975
2002	686	0.73	502	0.27	184	0.05	477	175	652	48	881	525	1,056	0.005	0.046	527	1,106
2003	1,600	0.5	800	0.5	800	0.05	760	760	1,520	66	881	826	1,641	0.005	0.046	830	1,719

Run Year	Ocean Harvest Rate		Ocean Escapement		Wild Age Composition							Hatchery Age Composition						Wild Recruits by Age							Hatchery Recruits by Age					
	Wild	Hatchery	Wild	Hatchery	2	3	4	5	6	7	8	2	3	4	5	6	7	2	3	4	5	6	7	8	2	3	4	5	6	7
1977	0.005	0.005	1,035	3,475	0.01	0.15	0.56	0.14	0.14	0.00	0.01	0.011	0.149	0.557	0.137	0.136	0.01	11	154	576	142	141	0	10	38	518	1,936	476	473	35
1978	0.005	0.005	2,103	7,292	0.01	0.27	0.59	0.08	0.04	0.00	0.00	0.009	0.272	0.593	0.08	0.044	0.001	20	572	1,246	169	93	0	3	66	1,983	4,324	583	321	7
1979	0.005	0.005	1,322	5,097	0.03	0.24	0.54	0.12	0.05	0.02	0.01	0.026	0.238	0.539	0.125	0.045	0.027	35	315	712	165	60	26	10	133	1,213	2,747	637	229	138
1980	0.005	0.005	1,543	3,771	0.02	0.26	0.56	0.11	0.05	0.00	0.01	0.017	0.256	0.561	0.109	0.049	0.008	27	394	866	168	76	0	9	64	965	2,116	411	185	30
1981	0.005	0.005	5,988	17,362	0.00	0.17	0.57	0.22	0.03	0.00	0.00	0	0.169	0.571	0.222	0.035	0.004	0	1,010	3,418	1,331	206	22	0	0	2,934	9,914	3,854	608	69
1982	0.005	0.005	2,494	19,487	0.00	0.15	0.61	0.21	0.01	0.01	0.00	0.003	0.147	0.61	0.211	0.014	0.015	8	366	1,522	526	35	37	0	58	2,865	11,887	4,112	273	292
1983	0.005	0.005	2,563	12,439	0.00	0.09	0.68	0.20	0.02	0.01	0.00	0	0.09	0.682	0.196	0.021	0.011	0	230	1,748	502	55	28	0	0	1,119	8,483	2,438	261	137
1984	0.005	0.005	1,018	3,095	0.01	0.20	0.54	0.19	0.04	0.02	0.00	0.017	0.83	0.091	0.023	0.04	0	9	203	554	194	38	19	0	53	2,569	282	71	124	0
1985	0.005	0.005	1,303	3,212	0.01	0.17	0.68	0.09	0.05	0.00	0.00	0.054	0.641	0.288	0.011	0	0.005	10	223	882	118	70	0	0	173	2,059	925	35	0	16
1986	0.005	0.005	1,259	6,243	0.00	0.19	0.56	0.19	0.04	0.02	0.00	0.038	0.735	0.21	0.017	0	0	0	234	709	234	55	28	0	237	4,589	1,311	106	0	0
1987	0.005	0.005	865	14,122	0.00	0.11	0.62	0.14	0.10	0.01	0.02	0.025	0.546	0.405	0.024	0	0	0	96	540	122	85	7	14	353	7,711	5,720	339	0	0
1988	0.005	0.005	1,129	7,684	0.00	0.11	0.68	0.17	0.03	0.00	0.00	0.037	0.673	0.272	0.011	0.007	0	5	125	770	190	34	6	0	284	5,172	2,090	85	54	0
1989	0.005	0.005	747	8,399	0.02	0.15	0.58	0.24	0.01	0.00	0.00	0.021	0.567	0.376	0.031	0.005	0	17	111	436	179	4	0	0	176	4,762	3,158	260	42	0
1990	0.005	0.005	788	4,676	0.00	0.16	0.57	0.23	0.04	0.00	0.00	0.004	0.688	0.288	0.014	0	0	0	129	449	178	33	0	0	19	3,217	1,347	65	0	0
1991	0.005	0.005	691	3,727	0.00	0.06	0.70	0.15	0.08	0.01	0.01	0.009	0.634	0.338	0.009	0	0	0	43	480	101	58	4	4	34	2,363	1,260	34	0	0
1992	0.005	0.005	1,034	4,247	0.01	0.16	0.59	0.20	0.03	0.01	0.00	0.008	0.658	0.316	0.015	0.004	0	6	168	609	210	31	10	0	34	2,795	1,342	64	17	0
1993	0.005	0.005	2,394	9,502	0.00	0.05	0.70	0.17	0.07	0.01	0.00	0.005	0.575	0.392	0.029	0	0	0	109	1,671	418	177	19	0	48	5,464	3,725	276	0	0
1994	0.005	0.005	1,069	5,602	0.00	0.10	0.51	0.30	0.07	0.01	0.01	0	0.099	0.511	0.302	0.073	0.016	0	106	546	323	78	11	6	0	555	2,862	1,692	409	90
1995	0.005	0.005	1,257	3,365	0.00	0.08	0.62	0.17	0.09	0.03	0.01	0	0.082	0.624	0.175	0.087	0.033	0	103	784	220	109	34	7	0	276	2,099	589	293	111
1996	0.005	0.005	603	1,659	0.00	0.11	0.62	0.20	0.07	0.00	0.00	0	0.11	0.62	0.197	0.073	0	0	67	374	119	44	0	0	0	182	1,028	327	121	0
1997	0.005	0.005	613	3,524	0.00	0.09	0.62	0.19	0.09	0.00	0.01	0	0.087	0.619	0.193	0.087	0.014	0	53	380	119	53	0	8	0	307	2,181	680	307	49
1998	0.005	0.005	199	1,547	0.01	0.15	0.61	0.18	0.06	0.01	0.00	0.005	0.115	0.63	0.183	0.053	0.014	1	29	120	35	11	2	1	8	178	975	283	82	22
1999	0.005	0.005	255	576	0.01	0.15	0.61	0.18	0.06	0.01	0.00	0.004	0.114	0.635	0.183	0.053	0.011	1	37	155	45	14	2	1	2	66	366	105	31	6
2000	0.005	0.005	171	959	0.01	0.15	0.61	0.18	0.06	0.01	0.00	0.004	0.115	0.628	0.184	0.056	0.013	1	25	103	30	9	1	1	4	110	602	177	54	12
2001	0.005	0.005	359	980	0.01	0.15	0.61	0.18	0.06	0.01	0.00	0.003	0.117	0.634	0.183	0.054	0.009	2	52	217	63	20	3	1	3	115	621	179	53	9
2002	0.005	0.005	530	1,112	0.01	0.15	0.61	0.18	0.06	0.01	0.00	0.012	0.348	0.480	0.115	0.037	0.008	3	77	321	94	29	4	2	13	387	533	127	42	8
2003	0.005	0.005	834	1,728	0.01	0.15	0.61	0.18	0.06	0.01	0.00	0.012	0.348	0.480	0.115	0.037	0.008	5	121	505	147	46	7	3	21	602	829	198	65	13

	Wild Recruits by Age									Hatchery Recruits by Age								Total Recruits		Productivity		
Brood Year	2	3	4	5	6	7	8	Total Wild Recruits	Wild R/S	2	3	4	5	6	7	Total Hatchery Recruits	Hatchery R/S	Total Recruits	Total R/S	Natural log (Wild R/S)	Natural log (Hatchery R/S)	Natural log (Total R/S)
1978	27	1,010	1,522	502	38	0	0	3,099	8.155	64	2,934	11,887	2,438	124	16	17,463	17.196	20,562	14.734	2.099	2.845	2.690
1979	0	366	1,748	194	70	28	14	2,420	2.510	0	2,865	8,483	71	0	0	11,419	3.396	13,839	3.199	0.920	1.223	1.163
1980	8	230	554	118	55	7	0	971	2.113	58	1,119	282	35	0	0	1,495	0.742	2,466	0.997	0.748	-0.298	-0.003
1981	0	203	882	234	85	6	0	1,410	2.067	0	2,569	925	106	0	0	3,600	1.965	5,010	1.992	0.726	0.675	0.689
1982	9	223	709	122	34	0	0	1,097	0.395	53	2,059	1,311	339	54	0	3,815	0.467	4,913	0.449	-0.929	-0.761	-0.801
1983	10	234	540	190	4	0	4	982	0.746	173	4,589	5,720	85	42	0	10,608	0.908	11,590	0.891	-0.293	-0.097	-0.115
1984	0	96	770	179	33	4	0	1,082	1.310	237	7,711	2,090	260	0	0	10,299	2.461	11,380	2.271	0.270	0.901	0.820
1985	0	125	436	178	58	10	0	808	3.442	353	5,172	3,158	65	0	0	8,748	10.142	9,556	8.709	1.236	2.317	2.164
1986	5	111	449	101	31	19	6	722	1.648	284	4,762	1,347	34	17	0	6,444	6.133	7,166	4.813	0.500	1.814	1.571
1987	17	129	480	210	177	11	7	1,030	2.292	176	3,217	1,260	64	0	90	4,806	2.087	5,836	2.120	0.829	0.736	0.752
1988	0	43	609	418	78	34	0	1,183	1.664	19	2,363	1,342	276	409	111	4,519	1.015	5,702	1.104	0.509	0.015	0.099
1989	0	168	1,671	323	109	0	8	2,279	2.525	34	2,795	3,725	1,692	293	0	8,538	4.087	10,817	3.616	0.926	1.408	1.285
1990	6	109	546	220	44	0	1	926	1.425	34	5,464	2,862	589	121	49	9,119	3.566	10,045	3.132	0.354	1.271	1.142
1991	0	106	784	119	53	2	1	1,064	1.503	48	555	2,099	327	307	22	3,357	3.824	4,420	2.788	0.407	1.341	1.025
1992	0	103	374	119	11	2	1	609	0.910	0	276	1,028	680	82	6	2,073	2.110	2,681	1.624	-0.094	0.747	0.485
1993	0	67	380	35	14	1	1	498	0.488	0	182	2,181	283	31	12	2,690	1.783	3,188	1.260	-0.717	0.578	0.231
1994	0	53	120	45	9	3	2	233	0.107	0	307	975	105	54	9	1,449	0.311	1,682	0.246	-2.233	-1.168	-1.401
1995	0	29	155	30	20	4	3	241	0.243	0	178	366	177	53	8	782	0.294	1,022	0.280	-1.414	-1.224	-1.272
1996	1	37	103	63	29	7				8	66	602	179	42	13	910	0.550					
1997	1	25	217	94	46					2	110	621	127	65								
1998	1	52	321	147						4	115	533	198									
1999	2	77	505							3	387	829										
2000	3	121								13	602											
2001	5									21												
2002																						
2003																						
2004																						

Notes:
Wild and hatchery spawning escapement numbers were obtained from WDFW Kalama Research Group data.
Wild and hatchery proportions were obtained from WDFW Kalama Research Group data.
Wild tributary harvest numbers for 1977-1996 and 1999-2003 were obtained from WDFW Kalama Research Group data. Harvest numbers for 1997-98 were obtained from Kalama Subbasin Summary 2002, Appendix B.
Hatchery tributary harvest numbers from 1977-1996 were obtained from WDFW Kalama Research Group data. Harvest numbers for 1997-1999 were obtained from Kalama Subbasin Summary 2002, Appendix B. Harvest numbers for 2000-2003 were the most recent 5-year average harvest from 1995-1999.
Columbia River wild summer steelhead harvest rates were assumed to be the same as hatchery fish up to 1984; beginning in 1985, incidental harvest mortality was assumed to be 10% of the annual hatchery harvest rate.
Columbia River hatchery summer steelhead harvest rate was calculated as the lower river sport catch (Table 66, Columbia River Status Report) divided by the lower river minimum run size (Table 65 or 66, Columbia River Status Report; WDFW and ODFW 2002). Harvest rates for 2001-2003 were the most recent 5-yr average (1996-2000). Non-indian commercial harvest has not occurred since 1974.
Ocean harvest rate of wild and hatchery steelhead were assumed to be 0.5%.
Wild age composition data for 1977 to 2003 were obtained from WDFW age data.
Hatchery age composition data for 1984-1993 were from Hulett et al. 1995 (Table 1.2). Hatchery age composition for 1990 RY only sums to .994; thus 0.6% of the run not apportioned to an age class. Hatchery age composition for 1991 RY only sums to .99; thus 1.0% of the run not apportioned to an age class.
Hatchery age composition data for 1977-1983 and 1994-2001 were obtained from the NMFS SimSalmon database.
Hatchery age composition data for 2002-2003 was the average from all years of available data (1977-2001).

APPENDIX A-8. Wind River Summer Steelhead Run Reconstruction Table

	Escapement											Spawners			Tributary Harvest/Rate	
Run Year	Wind River Escapement	Panther Creek Escapement	Trout Creek Escapement	Index Spawning Escapement	Adjustment Factor	Basin Escapement	Total Escapement	Proportion Wild	Wild Escapement	Hatchery Escapement	Prespawn Mortality	Wild Spawners	Hatchery Spawners	Total Spawners	Wild	Hatchery
1985	238	34	162				434	0.76	369	65	0.05	351	61	412	0.010	0.180
1986	216	26	186				428	0.76	370	58	0.05	352	55	407	0.010	0.195
1987	250	28	330				608	0.76	542	66	0.05	515	63	578	0.010	0.540
1988	464	114	248			1,547	1,547	0.66	1,021	526	0.05	970	500	1,470	212	0.448
1989	250	63	151			684	684	0.82	561	123	0.05	533	117	650	103	0.576
1990	98	31	99			807	807	0.74	597	210	0.05	567	199	767	74	0.689
1991	159	26	109			825	825	0.65	536	289	0.05	509	274	784	96	0.578
1992	192	44	51			718	718	0.94	675	43	0.05	641	41	682	107	0.458
1993				101	1	617	617	0.76	469	148	0.05	445	141	586	58	0.458
1994				104	1	718	718	0.76	546	172	0.05	518	164	682	54	0.458
1995				136	1	518	518	0.9	466	52	0.05	443	49	492	49	0.458
1996				94	1	901	901	0.81	730	171	0.05	693	163	856	74	0.458
1997				106	1	382	382	0.84	321	61	0.05	305	58	363	23	0.458
1998				44	1	385	385	0.84	323	62	0.05	307	59	366	22	0.458
1999				43	1	197	197	0.96	189	8	0.05	180	7	187	16	0.458
2000				26	1	508	508	0.98	498	10	0.05	473	10	483	32	0.458
2001						647	647	0.99	641	6	0.05	609	6	615	41	0.458
2002						939	939	0.99	930	9	0.05	883	9	892	59	0.458

	Wind River Run Size		Mainstem Harvest Rate		Columbia River Run Size		Ocean Harvest Rate		Ocean Escapement		Age Composition					Wild Recruits by Age					Hatchery Recruits by Age				
Run Year	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	Wild	Hatchery	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6
1985	354	75	0.028	0.124	364	86	0.005	0.005	366	86	0.004	0.119	0.610	0.197	0.070	1	43	223	72	26	0	10	53	17	6
1986	355	68	0.018	0.104	362	76	0.005	0.005	364	76	0.004	0.119	0.610	0.197	0.070	1	43	222	72	26	0	9	47	15	5
1987	520	137	0.048	0.104	546	153	0.005	0.005	549	153	0.004	0.119	0.610	0.197	0.070	2	65	335	108	39	1	18	94	30	11
1988	1,182	905	0.037	0.123	1,227	1,031	0.005	0.005	1,234	1,037	0.004	0.119	0.610	0.197	0.070	4	146	753	243	87	4	123	632	205	73
1989	636	276	0.034	0.119	658	313	0.005	0.005	662	315	0.022	0.148	0.584	0.240	0.006	15	98	386	159	4	7	47	184	75	2
1990	641	640	0.029	0.129	661	735	0.005	0.005	664	738	0.000	0.162	0.569	0.226	0.042	0	108	378	150	28	0	120	420	167	31
1991	605	650	0.038	0.127	629	745	0.005	0.005	632	749	0.000	0.063	0.697	0.146	0.094	0	40	441	92	59	0	47	522	109	70
1992	748	76	0.026	0.146	768	88	0.005	0.005	772	89	0.005	0.163	0.588	0.203	0.040	4	126	454	157	31	0	14	52	18	4
1993	503	260	0.028	0.138	518	301	0.005	0.005	521	303	0.000	0.046	0.697	0.174	0.082	0	24	363	91	43	0	14	211	53	25
1994	572	302	0.017	0.104	582	337	0.005	0.005	585	339	0.000	0.099	0.511	0.301	0.088	0	58	299	176	52	0	34	173	102	30
1995	492	91	0.014	0.118	499	103	0.005	0.005	501	103	0.000	0.082	0.623	0.175	0.121	0	41	312	88	61	0	8	64	18	13
1996	767	300	0.011	0.083	776	327	0.005	0.005	780	329	0.000	0.110	0.619	0.198	0.074	0	86	483	154	58	0	36	204	65	24
1997	328	107	0.012	0.089	332	118	0.005	0.005	333	118	0.000	0.086	0.620	0.194	0.100	0	29	207	65	33	0	10	73	23	12
1998	329	108	0.024	0.074	337	117	0.005	0.005	339	117	0.004	0.145	0.604	0.176	0.070	1	49	205	60	24	0	17	71	21	8
1999	196	14	0.020	0.074	200	15	0.005	0.005	201	15	0.004	0.146	0.605	0.178	0.067	1	29	121	36	13	0	2	9	3	1
2000	505	18	0.008	0.059	509	19	0.005	0.005	512	19	0.007	0.144	0.608	0.176	0.065	4	74	311	90	33	0	3	12	3	1
2001	650	11	0.015	0.076	659	12	0.005	0.005	663	12	0.005	0.147	0.606	0.178	0.065	3	97	402	118	43	0	2	7	2	1
2002	942	16	0.015	0.076	956	18	0.005	0.005	961	18	0.004	0.119	0.610	0.197	0.070	3	114	586	190	68	0	2	11	4	1

	Wild Recruits by Age							Hatchery Recruits by Age							Total Recruits		Productivity		
Brood Year	2	3	4	5	6	Total Wild Recruits	Wild R/S	2	3	4	5	6	Total Hatchery Recruits	Hatchery R/S	Total Recruits	Total R/S	Natural log (Wild R/S)	Natural log (Hatchery R/S)	Natural log (Total R/S)
1986	4	98	378	92	31	603	1.720	4	47	420	109	4	583	9.485	1,187	2.878	0.542	2.250	1.057
1987	15	108	441	157	43	762	2.166	7	120	522	18	25	691	12.638	1,454	3.575	0.773	2.537	1.274
1988	0	40	454	91	52	636	1.236	0	47	52	53	30	182	2.894	818	1.416	0.211	1.063	0.348
1989	0	126	363	176	61	726	0.748	0	14	211	102	13	340	0.680	1,065	0.725	-0.290	-0.385	-0.322
1990	4	24	299	88	58	472	0.886	0	14	173	18	24	230	1.966	702	1.081	-0.120	0.676	0.078
1991	0	58	312	154	33	558	0.984	0	34	64	65	12	175	0.878	733	0.956	-0.016	-0.130	-0.045
1992	0	41	483	65	24	612	1.202	0	8	204	23	8	243	0.887	855	1.092	0.184	-0.120	0.088
1993	0	86	207	60	13	366	0.570	0	36	73	21	1	131	3.204	497	0.728	-0.562	1.164	-0.317
1994	0	29	205	36	33	302	0.679	0	10	71	3	1	85	0.603	387	0.661	-0.387	-0.506	-0.415
1995	0	49	121	90	43	304	0.586	0	17	9	3	1	30	0.185	334	0.489	-0.535	-1.690	-0.714
1996	1	29	311	118	68	527	1.191	0	2	12	2	1	18	0.359	545	1.107	0.174	-1.024	0.102
1997	1	74	402	190				0	3	7	4								
1998	4	97	586					0	2	11									
1999	3	114						0	2										
2000	3							0											
2001																			
2002																			
2003																			

Notes:
Escapement data by tributary or index count (run year 1985-2000) were obtained from Hymer et al. (1992), WDF et al. (1993), and WDFW (2003). Basin escapement data for 1988-2002 (BY 1989-2003) were expanded escapements from WDFW data. The total escapement values used in the run reconstruction were the tributary escapements for run year 1985-1987 and the basin escapement for run year 1988-2002.
Proportion of wild spawners for 1988-2002 (BY 1989-2003) was from WDFW steelhead data; proportion for years 1985-87 was 5-year average from 1988-1992.
Tributary harvest rate of wild steelhead for 1985-1987 was assumed to be 1%.
Tributary harvest rate of wild steelhead for 1988-2002 was actual harvest (in fish) from WDFW data.
Tributary harvest rate of hatchery steelhead for 1985-1991 was calculated based on Hymer et al. (1992; Table 2); harvest rate for 1992-2000 was the average of all years of available data (1985-1991).
Mainstem harvest rate of wild steelhead was assumed to be 10% of the lower Columbia sport catch of Group A steelhead (WDFW and ODFW 2002; Table 67) plus the Zone 6 number of Wild Group A steelhead in the commercial catch (with a 35% reduction factor; WDFW and ODFW 2002; Table 68) divided by the total minimum run Group A steelhead in the Columbia River (WDFW and ODFW 2002; Table 67).
Mainstem harvest rate of hatchery steelhead was the lower Columbia sport catch of Group A steelhead (WDFW and ODFW 2002; Table 67) plus the Zone 6 number of hatchery Group A steelhead in the commercial catch (with a 35% reduction factor; WDFW and ODFW 2002; Table 68) divided by the total minimum run Group A steelhead in the Columbia River (WDFW and ODFW 2002; Table 67).
Mainstem harvest rate of hatchery and wild steelhead for 2001 and 2002 was the most recent 5-year average (1996-2000).
Ocean harvest rate of wild and hatchery steelhead was assumed to be 0.5%.
Age composition for 1985-1988 and 2002 was average based on the NMFS SimSalmon database covering years 1989-2001.
Age composition for 1989-2001 was actual age composition in NMFS SimSalmon database.

APPENDIX A-9. Grays River Summer Steelhead Run Reconstruction Table

	Escapement						Spawners		Harvest					
Year	Mainstem Natural Escapement	West Fork Natural Escapement	Crazy Johnson Creek	Gorley Creek	Fossil Creek	Total Natural Escapement	Prespawn Mortality	Natural Spawners	Tributary Harvest Rate	Grays River Run Size	Mainstem Harvest Rate	Columbia River Run Size	Ocean Harvest Rate	Ocean Escapement
1959	1,810	666			2	2,478	0.05	2,354	0.01	2,378	0.636	6,539	0.01	6,605
1960	1,180	367			1	1,548	0.05	1,471	0.01	1,485	0.433	2,621	0.01	2,648
1961	1,289	907				2,196	0.05	2,086	0.01	2,107	0.419	3,629	0.01	3,666
1962	468	238				706	0.05	671	0.01	677	0.684	2,145	0.01	2,167
1963	466	420				886	0.05	842	0.01	850	0.400	1,417	0.01	1,431
1964		92			2	94	0.05	89	0.01	90	0.594	222	0.01	224
1965	238	58	89		0	385	0.05	366	0.01	369	0.333	554	0.01	560
1966	1,581	660	102		7	2,350	0.05	2,233	0.01	2,255	0.290	3,178	0.01	3,210
1967	477	371	106		1	955	0.05	907	0.01	916	0.429	1,604	0.01	1,620
1968		90	146		39	275	0.05	261	0.01	264	0.500	528	0.01	533
1969	429	177	71		9	686	0.05	652	0.01	658	0.273	905	0.01	914
1970	84	100	111			295	0.05	280	0.01	283	0.500	566	0.01	572
1971	55	26	311		31	423	0.05	402	0.01	406	0.455	744	0.01	752
1972	1,085	56	81		54	1,276	0.05	1,212	0.01	1,224	0.542	2,672	0.01	2,699
1973	42	48	212		24	326	0.05	310	0.01	313	0.778	1,408	0.01	1,422
1974	12	31	47		31	121	0.05	115	0.01	116	0.750	464	0.01	469
1975	81	45	147		85	358	0.05	340	0.01	344	0.625	916	0.01	925
1976	475	0	16		1	492	0.05	467	0.01	472	0.800	2,361	0.01	2,384
1977	440	63	192		0	695	0.05	660	0.01	667	0.125	762	0.01	770
1978	503	0	76			579	0.05	550	0.01	556	0.789	2,639	0.01	2,666
1979	239	0	21		0	260	0.05	247	0.01	249	0.333	374	0.01	378
1980	192	20	61		1	274	0.05	260	0.01	263	0.400	438	0.01	443
1981		8	13		0	21	0.05	20	0.01	20	0.933	302	0.01	305
1982	1,465	10	102		0	1,577	0.05	1,498	0.01	1,513	0.621	3,990	0.01	4,030
1983	321	8	40			369	0.05	351	0.01	354	0.333	531	0.01	537
1984	1,077	32	41	0	0	1,150	0.05	1,093	0.01	1,104	0.783	5,076	0.01	5,128
1985	1,488	8	0	0	0	1,496	0.05	1,421	0.01	1,436	0.538	3,110	0.01	3,142
1986	904	201	226	480	0	1,811	0.05	1,720	0.01	1,738	0.600	4,345	0.01	4,388
1987	1,571	71	2	4	0	1,648	0.05	1,566	0.01	1,581	0.520	3,295	0.01	3,328
1988	1,073	73	338	847		2,331	0.05	2,214	0.01	2,237	0.521	4,668	0.01	4,715
1989	389	41	140	25		595	0.05	565	0.01	571	0.650	1,631	0.01	1,648
1990	569	0	117	482	2	1,170	0.05	1,112	0.01	1,123	0.276	1,550	0.01	1,566
1991	327	37	239	260		863	0.05	820	0.01	828	0.308	1,196	0.01	1,208
1992	3,881	491	320	611	1	5,304	0.05	5,039	0.01	5,090	0.143	5,938	0.01	5,998
1993	2,334	113	78	256	1	2,782	0.05	2,643	0.01	2,670	0.022	2,730	0.01	2,758
1994	42	0	90	75	0	207	0.05	197	0.01	199	0.083	217	0.01	219
1995	219	0	413	293		925	0.05	879	0.01	888	0.067	951	0.01	961
1996	1,302	408	396	348	0	2,454	0.05	2,331	0.01	2,355	0.030	2,428	0.01	2,453
1997	79	55	485	185		804	0.05	764	0.01	772	0.059	820	0.01	828
1998	154	214	145	430	0	943	0.05	896	0.01	905	0.053	955	0.01	965
1999	222	100	927	496	0	1,745	0.05	1,658	0.01	1,674	0.042	1,747	0.01	1,765
2000	1,124	833	249			2,206	0.05	2,096	0.01	2,117	0.040	2,205	0.01	2,227
2001	759					759	0.05	721	0.01	728	0.042	761	0.01	768

	Age Composition				Ocean Escapement by Age				Results							
Year	3	4	5	6	3	4	5	6	Brood Year	3	4	5	6	Total Recruits	Recruits per Spawner	Natural log (R/S)
1959	0.410	0.570	0.020		2,708	3,765	132		1959	888	816	4		1,709	0.726	-0.320
1960	0.410	0.570	0.020		1,086	1,509	53		1960	587	128	11		726	0.494	-0.706
1961	0.410	0.570	0.020		1,503	2,090	73		1961	92	319	64		475	0.228	-1.479
1962	0.410	0.570	0.020		888	1,235	43		1962	230	1,830	32		2,091	3.118	1.137
1963	0.410	0.570	0.020		587	816	29		1963	1,316	923	11		2,250	2.673	0.983
1964	0.410	0.570	0.020		92	128	4		1964	664	304	18		986	11.045	2.402
1965	0.410	0.570	0.020		230	319	11		1965	219	521	11		751	2.054	0.720
1966	0.410	0.570	0.020		1,316	1,830	64		1966	375	326	15		716	0.321	-1.137
1967	0.410	0.570	0.020		664	923	32		1967	234	428	54		717	0.790	-0.235
1968	0.410	0.570	0.020		219	304	11		1968	308	1,538	28		1,875	7.176	1.971
1969	0.410	0.570	0.020		375	521	18		1969	1,106	811	9		1,926	2.956	1.084
1970	0.410	0.570	0.020		234	326	11		1970	583	267	19		869	3.100	1.132
1971	0.410	0.570	0.020		308	428	15		1971	192	527	48		767	1.910	0.647
1972	0.410	0.570	0.020		1,106	1,538	54		1972	379	1,359	15		1,754	1.447	0.369
1973	0.410	0.570	0.020		583	811	28		1973	978	439	53		1,470	4.746	1.557
1974	0.410	0.570	0.020		192	267	9		1974	316	1,519	0		1,835	15.965	2.770
1975	0.410	0.570	0.020		379	527	19		1975	1,093	63	148		1,304	3.833	1.344
1976	0.410	0.570	0.020		978	1,359	48		1976	315	197	9		521	1.114	0.108
1977	0.410	0.570	0.020		316	439	15		1977	98	218	314	12	642	0.972	-0.028
1978	0.410	0.570	0.020		1,093	1,519	53		1978	78	3,016	83	42	3,220	5.855	1.767
1979	0.833	0.167	0.000		315	63	0		1979	700	441	460		1,602	6.484	1.869
1980	0.222	0.444	0.333		98	197	148		1980	0	4,332	63		4,395	16.885	2.826
1981	0.257	0.714	0.030		78	218	9		1981	293	1,791	88		2,171	108.841	4.690
1982	0.174	0.749	0.078		700	3,016	314		1982	1,288	2,501	67		3,856	2.574	0.945
1983	0.000	0.822	0.156	0.022	0	441	83	12	1983	1,799	1,897	94		3,790	10.813	2.381
1984	0.057	0.845	0.090	0.008	293	4,332	460	42	1984	1,364	2,688	33		4,085	3.739	1.319
1985	0.410	0.570	0.020		1,288	1,791	63		1985	1,933	939	31		2,904	2.043	0.715
1986	0.410	0.570	0.020		1,799	2,501	88		1986	676	893	24		1,592	0.926	-0.077
1987	0.410	0.570	0.020		1,364	1,897	67		1987	642	689	120		1,451	0.927	-0.076
1988	0.410	0.570	0.020		1,933	2,688	94		1988	495	3,419	55		3,969	1.792	0.584
1989	0.410	0.570	0.020		676	939	33		1989	2,459	1,572	4		4,036	7.139	1.966
1990	0.410	0.570	0.020		642	893	31		1990	1,131	125	19		1,275	1.147	0.137
1991	0.410	0.570	0.020		495	689	24		1991	90	548	49		686	0.837	-0.178
1992	0.410	0.570	0.020		2,459	3,419	120		1992	394	1,398	17		1,809	0.359	-1.025
1993	0.410	0.570	0.020		1,131	1,572	55		1993	1,006	472	19		1,497	0.566	-0.568
1994	0.410	0.570	0.020		90	125	4		1994	339	550	35		925	4.702	1.548
1995	0.410	0.570	0.020		394	548	19		1995	396	1,006	45		1,446	1.646	0.498
1996	0.410	0.570	0.020		1,006	1,398	49		1996	724	1,270	15		2,009	0.862	-0.149
1997	0.410	0.570	0.020		339	472	17		1997	913	438					
1998	0.410	0.570	0.020		396	550	19		1998	315						
1999	0.410	0.570	0.020		724	1,006	35		1999							
2000	0.410	0.570	0.020		913	1,270	45		2000							
2001	0.410	0.570	0.020		315	438	15		2001							

Notes:
Escapement data for mainstem and West Fork from 1959-2001 was total live fish counts from WDFW escapement data and WDFW (2003).
Escapement data for Crazy Johnson, Gorley, and Fossil Creeks through 1991 was the expanded population estimates from Hymer (1993; Table 24).
Escapement data for Crazy Johnson, Gorley, and Fossil Creeks from 1992 to present was the peak count from Grays subbasin plan.
Total escapement used in the run reconstruction was the summation of escapement data for each tributary.
Tributary harvest was assumed to be 1%.
Mainstem harvest rate for 1959-2000 was calculated from the commercial catch in Zones 1-5 divided by the minimum Columbia River run size (WDFW and ODFW 2002; Table 62).
Mainstem harvest rate for 2001 was the 5-year average based on 1996-2000 harvest.
Ocean harvest was assumed to be 1%.
Age composition data for 1959-1978 and 1985-present were obtained from the NMFS SimSalmon database.
Age composition data for 1979-1984 were obtained from Hymer et al. (1992).