SNOHOMISH BASIN SALMON RECOVERY FORUM

23 January 2008

TO: Snohomish Basin Partners

SUBJECT: Snohomish Basin Steelhead State of the Knowledge Report

Dear Partners:

With the Snohomish Basin Salmonid Recovery Technical Committee and the Co-managers (WDFW and Tulalip Tribes), Snohomish County contracted the services of R2 Resource Consulting to compile existing information on steelhead in the Snohomish Basin. This information was requested in anticipation of eventual recovery plan development across the Puget Sound Steelhead ESU. The report lays a foundation for technical analysis and planning, but it is not a plan.

The Report fulfilled eight key tasks that help provide baseline information for the planning process:

1. Developed an electronic annotated bibliography documenting sources of data and information on life histories, largely at the basin level.
2. Developed a GIS geodatabase of current and historic life histories in habitats across the basin.
3. Developed a map of known spawning and rearing reaches in the basin.
4. Summarized harvest and hatchery management in cooperation with the co-managers.
5. Described available information on migration, spawning, rearing and overwintering habitats across the basin, by brood year and stock.
6. Described existing data sets and their strengths and limitations for planning.
7. Summarized the knowledge regarding genetic differentiation between hatchery and wild stocks.
8. Coordinated with the Technical Committee, Co-managers and NOAA Fisheries.

Note: the information in this report was collected from all known sources. The Technical Committee and Forum will need to evaluate this information and put it into context when initiating the planning process. The report may raise technical or policy questions to the fore but is not meant as the definitive answer for steelhead management and/or recovery. Issues that arise will be discussed and addressed by the committees as needed.

Sincerely,

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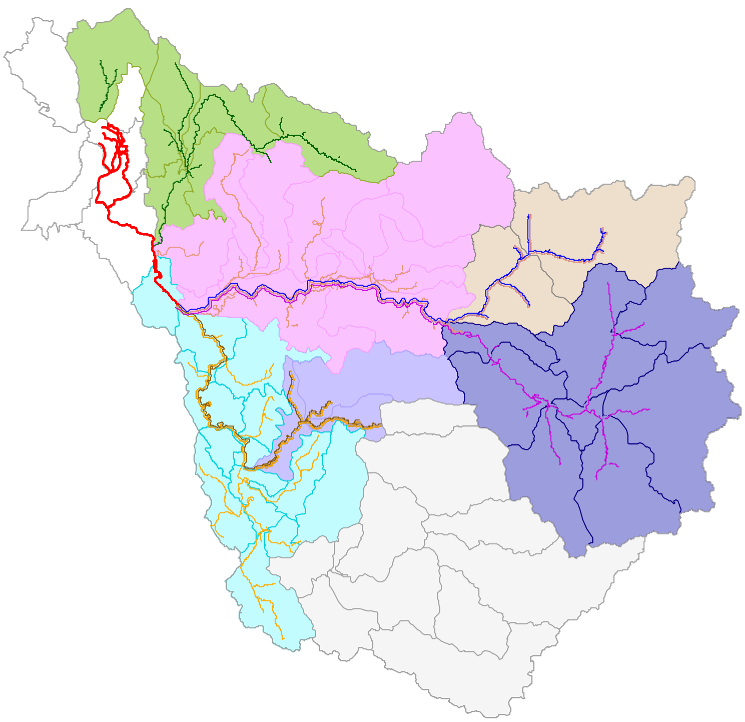
Snohomish Basin
Steelhead Trout (*Oncorhynchus mykiss*)
"State of the Knowledge"

Technical Memorandum



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Prepared for:

Snohomish Basin Recovery Technical Team

Snohomish County under

Surface Water Management Master Agreement No. OC06/6-3(DD) Work Authorization WA#10

January 10, 2008

Snohomish Basin
Steelhead Trout (*Oncorhynchus mykiss*)
"State of the Knowledge"

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<u>Acknowledgements</u>

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1. INTRODUCTION

Steelhead populations are declining throughout the Northwest. In June 2007, the Federal Government listed steelhead, the anadromous form of rainbow trout (*Oncorhynchus mykiss*), as a "threatened" species under the Endangered Species Act (ESA) within the Puget Sound DPS (72 FR 26722). In anticipation of upcoming planning efforts within the Snohomish River Basin for recovery of steelhead trout due to the recent listing, basin staff would like to gather preliminary documentation that would be used as a first step in the development of a steelhead plan, or an addendum to the *Snohomish River Basin Salmon Conservation Plan* (2005). Staff will use this information to work with the Snohomish Basin Salmon Recovery Forum and the Snohomish Basin Salmonid Recovery Technical Committee to develop steelhead trout recovery strategies and targets that may eventually be adopted as part of a regional (Puget Sound Distinct Population Segment) recovery plan fulfilling ESA Section 4. The effort could be used in the future as input for the basin response to federal recovery planning processes and for coordination with any subsequently formed Puget Sound Steelhead Trout Technical Recovery Team (TRT).

Snohomish County retained R2 Resource Consultants, Inc. (R2) under Surface Water Management Master Agreement No. OC06/6-3(DD) Work Authorization WA#10 to gather the available scientific data and historical records related to summarizing the current status of steelhead in the basin. R2 was asked to: (1) review and annotate scientific literature specific to the Snohomish River basin, (2) gather maps of fish distributions including historic and current spawning and rearing distributions, (3) summarize life-history characteristics of six stocks in the basin; (4) summarize the status of both harvest and hatchery management programs influencing steelhead trout in the basin, while identifying recent changes in management strategies due to the ESA-listings of a number of salmonid fish species in Puget Sound; (5) summarize the available knowledge regarding genetic differences between stocks, runs, hatchery and wild fish in the basin and (6) evaluate the usefulness of existing databases for recovery planning purposes.

This technical memorandum is one of several deliverables to the work authorization. The annotated bibliography has been submitted in an EndNote Library database program and GIS mapping products have been submitted to the county via recommended revisions to existing GIS shape files under separate cover. This memorandum includes summary written and tabular documentation. Following this introduction, the report is organized first to describe the basin-specific life history characteristics for steelhead trout in Section 2, including data identifying stock, population status, relative abundance and potential life-history strategies. In Section 3, the historic and current distributions, relative abundances of life history stages and spawning escapements are reviewed. A series of spreadsheet matrices [Step 1 table from the Ecological Analysis of Salmonid Conservation; Snohomish Basin Salmonid Recovery Technical Committee

2005] summarizing stock escapement numbers by brood year for each SASSI stock in specific sub-basins and stream reaches is also presented, where data exist. Information concerning hatchery and harvest management programs in the basin and recent changes or reforms in the various programs and their influence on steelhead stocks in the basin are included in Section 4. Genetic differentiation of the stocks and a summary of the utility of existing databases are provided in Sections 5 and 6, respectively.

2. TIME HISTORY - SNOHOMISH RIVER BASIN

Rainbow trout *(O. mykiss)* likely exhibit the greatest life history diversity of any of the Pacific salmonid fishes (NMFS 2007). Individuals can exhibit anadromous (i.e., steelhead) or resident life history strategies or a combination of the two forms under certain situations. Lack of proper physiological signals related to the smoltification process can lead to freshwater residualization, where juvenile steelhead can remain resident to the river basin. Conversely, the offspring of resident fish can exhibit anadromy (Busby et al. 1996). The diversity of life history strategies allows the species to respond and adapt to changing environmental conditions. Under certain conditions where one life history strategy is not successful, another strategy may become more prevalent

Steelhead reside in freshwater anywhere from 1 to 7 years before smoltification and can spend 0 to 5 years in salt water before returning to spawn (WDFW 2006). For the Snohomish basin, wild steelhead typically spend two years in freshwater and spend 2 or 3 year in the marine environment (refer to subsection 2.5 *Freshwater Age* and subsection 2.6, *Ocean Age*, below).

Unlike other Pacific salmon that only spawn once, steelhead trout can spawn multiple times during their life span. Within a given population, important life history variations exist based on run timing and the level of sexual maturity at the time of entry into fresh water (72FR 2672; May 11, 2007). Most summer steelhead enter fresh water as sexually immature fish between May and October, although some may enter as early as February (C. Kraemer, pers. comm., December 17, 2007). At the time of entry summer steelhead are several months to as much as a year from spawning. Nourishment while holding and maturing in freshwater is minimal, so these maturing steelhead trout rely on their body fat reserves for sustenance. Winter steelhead enter fresh water between November and early May as sexually maturing fish. Most winter-run fish are a few weeks to several months from spawning. The available information for steelhead life history stages specific to the Snohomish basin is reviewed in the following section. In the absence of information specific to the Snohomish basin, information from proximal systems, within the Puget Sound ESU, or throughout their range is provided.

Within the Snohomish basin, the Washington State Salmon and Steelhead Stock Inventory (SASSI) identified three winter-run and three summer-run wild steelhead stocks listed in Table 1 (WDFW and WWTIT 1994). The spawning distribution of each stock is shown in Figure 1. These stocks were delineated based primarily on the geographic and temporal isolation of spawning populations. Adult fish from these stocks may migrate to, hold and mature in other waters in the Snohomish basin than depicted in Figure 1. WDFW and WWTIT (1994) suggest the number of delineated stocks may expand or contract once further genetic analysis has been conducted (see Section 5, *Genetic Differentiation*, below).

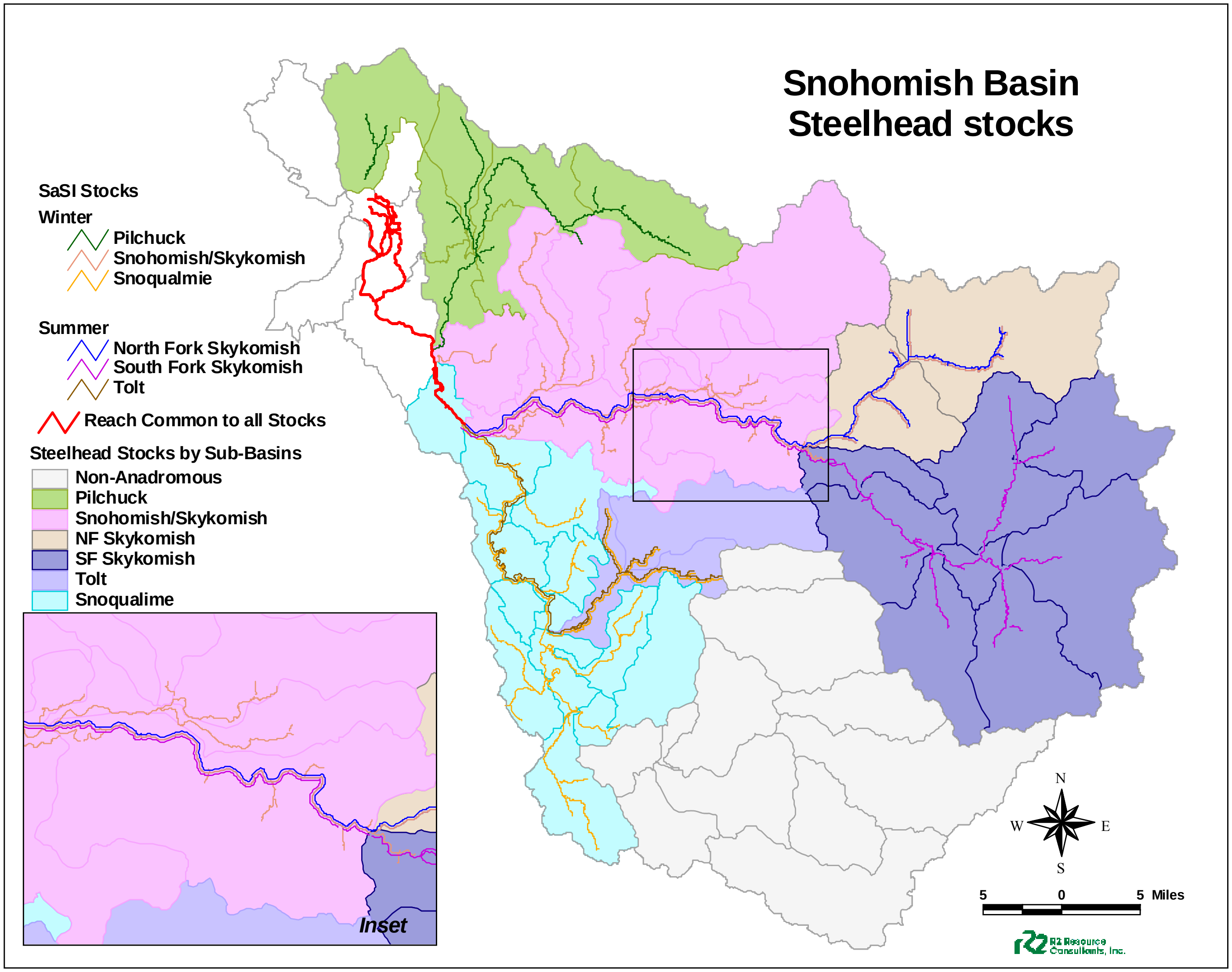


Figure 1. Sub-basins in the Snohomish River Watershed Resource Inventory Area (WRIA 07) supporting individual steelhead trout stocks per SaSI 2002.

Table 1. Snohomish basin steelhead stocks.

Wild Stocks (WDFW and WWTIT 1994)	
Summer Steelhead	Winter Steelhead
Tolt River	Snoqualmie River
North Fork Skykomish River	Snohomish/Skykomish River
South Fork Skykomish River	Pilchuck River
Hatchery Stocks (WDFW 2002, 2003a, 2003b)	
Summer Steelhead	Winter Steelhead
Skamania Stock @ Reiter Ponds	Chambers Creek Stock @ Tokul Creek and Reiter Ponds

A total of 63 subbasins in the Watershed Resource Information Area (WRIA) 07, Snohomish River Basin, were delineated as part of the Snohomish River Basin Salmon Conservation Planning process (Snohomish Basin Salmonid Recovery Forum 2005). The subbasins encompassing the spawning distributions of the six steelhead trout stocks identified in SASSI (WDFW and WWTIT 1994) are highlighted in Figure 1.

2.1 MIGRATION

Adult winter-run steelhead typically return to the Snohomish River from November to early-May (NMFS 2007; Haring 2002; WDFW and WWTIT 1994). Hatchery fish dominate the early part of the run timing, entering between November and February, while the wild winter-run fish typically enter February to April (Table 2). Run-timing for the three wild winter-run stocks is thought to be similar.

Table 2. Adult steelhead river entry for various stocks.

Run/Stock	Hatchery	Wild
Winter-Run; Range	November – February	February – May
Summer-Run; Range	June – January[1/]	May – October
Tolt River	-	May – October
North Fork Skykomish	-	May – July
South Fork Skykomish	-	April – Mid-December

[1] Broodstock collection

Summer steelhead run-timing is typically from May to October but can extend from April to mid-December (Haring 2002). Some variability is thought to occur in the entry timing, especially among the three basin stocks (WDFW and WWTIT 1994). Run-timing is generally from May through October for the Tolt River stock, early May through July when flows are appropriate for upstream passage at Bear Falls for the North Fork Skykomish River stock, and an extended entry from early April through mid-December for the South Fork Skykomish River stock (C. Jackson, pers. comm., December 7, 2007). After entering freshwater, maturing summer-run adults move into upstream holding areas like large pools, log-jam pools, or other habitats with secure holding areas to avoid adverse summer low-flow conditions (C. Kraemer, pers. comm., December 17, 2007). With the onset of cool water temperatures and higher stream flows, it is common to see adult summer-run fish migrate to deep pools for over-wintering habitat where they can hold for extended periods while expending minimal energy (NMFS 2007, C. Kraemer, pers. comm., December 17, 2007). Prior to spawning, the fish may move substantial distances from the holding pools to the spawning grounds either within tributaries where they are holding or conversely, other tributary basins. There are reports of steelhead overwintering in one basin and spawning in yet another river basin (C. Kraemer, pers. comm., December 17, 2007).

Where summer and winter steelhead runs exist in the Snohomish Basin, the summer-run will be found in habitat that favors their life history. Such habitats include areas upstream of seasonal velocity barriers or stream gradient drops where an early returning summer-run fish would be more likely to find favorable and less competitive habitat conditions. Summer steelhead usually spawn further upstream than winter steelhead (NMFS 2007; Behnke 1992). The extended freshwater residence of summer-run steelhead before spawning results in higher pre-spawning mortality compared to winter-run steelhead. According to Hard et al. (2007), this life history strategy may explain why winter-run steelhead are more abundant freshwater migration distances to salt water are less than 200 km (124 miles). The upstream migration of South Fork Skykomish summer-run steelhead is facilitated by a trap and haul operation that provides passage beyond the natural barrier at Sunset Falls. The trap operation typically ends annually in mid-December so very few numbers of winter-run steelhead are transported upstream. Although steelhead use of the South Fork Skykomish River basin did not occur historically, resident rainbow trout were prolific above the falls (C. Kraemer, pers. comm., December 2007).

While summer-run steelhead populations have been historically smaller than the winter-run trout, they represent a unique life history strategy that adds to the ecological and genetic diversity of the entire ESU and helps the populations withstand disturbance events (NMFS 2005).

2.2 SPAWNING

Steelhead spawning typically occurs in moderate to high stream gradient reaches (NMFS 2007). In the Snohomish basin, steelhead spawning can occur anywhere between December to June, depending upon the stock and race in question (Table 3). The majority of spawning activity for hatchery stocks occurs late December through February, while wild fish spawning occurs primarily between March through mid-June. The onset of summer-run steelhead spawning is initiated slightly earlier in the year than winter steelhead (WDFW 2006). Pearson et al. (2003) reports that spawn-timing is positively related to elevation:

$$\textbf{\textit{Eqn-1:}}\quad \textbf{\textit{STSTH}} = \mathbf{0.098}\ (\boldsymbol{E}) + \mathbf{61.1}$$

Where: E = elevation in meters and $STSTH$ = Time of steelhead spawning in Julian Days.

Table 3. Timing of steelhead spawning for various stocks in the Snohomish Basin.

Run/Stock	Hatchery Origin	Wild (Natural Origin)
Winter-Run; Range (Peak)	Late Dec.–Late Feb. (January)	Early March–Mid-June (Late April)
Summer-Run; Range (Peak)	Late Dec.–Early Feb. (January)	Early March–Early-June (April)
Money Creek		Early March–Mid-May
South Fork Tolt; Range		January–May
South Fork Tolt; Bi-Peak		February/mid-April
North Fork Skykomish		Mid-March–Early-June

Although high water events and turbidity in winter and spring can alter the quality of spawning survey data, the Snohomish Basin runs clearer than most glacial and highly erosive river basins. As such, steelhead spawning surveys in most years offer relatively good viewing conditions and there are fairly good estimates of spawn timing for wild winter steelhead and summer steelhead in some locations. However, there is difficulty associated with distinguishing natural and hatchery-origin spawners on redds. Determining accurate estimates of spawn-timing for wild fish are necessary to evaluate potential genetic interactions with adult returns from hatchery programs (WDFW 2006). The hatchery stocks used in the Snohomish Basin have been bred for early winter spawning specifically to minimize the overlap of spawning with wild stocks (see Section4, *Hatchery and Harvest Management Programs in Snohomish Basin* and Section 5, *Genetic Differentiation*, below).

In the Snohomish basin, the spawn-timing of specific wild summer stocks is not well documented. There are nearly three decades of redd surveys in the South Fork of the Tolt River and limited information for the North Fork Skykomish River stock upstream of Bear Falls, and for Money Creek, a spawning tributary to the South Fork Skykomish River upstream of Sunset Falls (Table 3).

Resource biologists have noted peak spawning of wild steelhead stocks appears to be timed for fry emergence to occur on the descending limb of river basin hydrograph (C. Kraemer, pers. comm., December 17, 2007). For example, in some basins in the Skagit River, a large snowmelt driven basin of North Puget Sound, the hydrograph does not recede until early August and spawning occurs in mid-May, whereas on the Washington Coast the rainfall-dominated basins begin to recede in April, and steelhead routinely spawn in late-January and February. Wild steelhead seemingly respond to the environment by adjusting their spawning period to accommodate the optimum timing for fry emergence (C. Kraemer, pers. comm., December 17, 2007). In the Snohomish basin the snowmelt dominated hydrograph begins to decline in early July, which equates to an optimum spawning strategy of mid- to late April.

An example of environmental pressures exerted on natural spawning stocks is described below. The naturalized spawning population in Money Creek, a tributary to the South Fork Skykomish River upstream of Sunset falls, is a composite stock of native summer-run and Skamania Hatchery stock. The hatchery fish likely dominate the mixed-stock in the South Fork Skykomish River basin (Kassler et al. In Press; see Section 5, *Genetic Differentiation*, below). In 1975, when the hatchery stock was introduced upstream of the falls, the hatchery fish typically spawned in January and February annually. Thirty years later, the equivalent of 5 to 6 generations, the natural spawning period for the composite steelhead run in Money Creek currently mirrors the wild stock timing between early-March and mid-May. The observations in Money Creek suggest the introduced hatchery fish altered their spawning period to accommodate the natural flow conditions in the subbasin as a means to increase fry emergence success (C. Kraemer, pers. comm., December 17, 2007). Conversely, two peak periods of abundance occur for the summer-run steelhead trout spawning in the South Fork Tolt River; February and mid-April bi-modal peaks. It appears likely over the last three decades that the hatchery-like fish continue to spawn in the reach of the South Fork earlier than the native run and that they have not altered their early spawning period. It is possible river flows, regulated by the City of Seattle water supply dam, have not exerted sufficient environmental pressure to modify the existing spawning periods of either the hatchery or the wild stock in the South Fork Tolt River from the origin parent stocks (C. Kraemer, pers. comm., December 17, 2007).

The spawn-timing of winter-run steelhead is well known in the Snohomish basin, lasting from early March to mid-June while peaking between April and May (WDG 1986; *Snohomish winter* *steelhead resource inventory*). The spawning period is thought to be similar among the three different winter-run stocks. As an example, wild steelhead (belonging to the Snohomish-Skykomish winter stock) are reported to spawn primarily in April and May in the Sultan River (CH2MHill 2005).

The age class structure of spawning steelhead is very complex as a function of variability in smolt age (see below) and ocean age (see below); repeat spawning (see below), spawning by resident males, and precocity among juvenile steelhead. This complexity can act to reduce the risk of extinction for a given population when a catastrophic event compromises spawning in a particular year.

Most observed redds in the Snohomish Basin may be the result of wild winter-run steelhead constructing more than one redd, on average, per female spawner. The WDFW uses a redd expansion factor of 1.62 in the Snohomish River Basin to approximate the abundance of spawners (1.62 fish per redd; 0.81 females per redd; 1:1 sex ratio) (C. Jackson, pers. comm., December 7, 2007; Dimmitt 2007). Unlike semelparous Pacific salmon that guard their redds, steelhead kelts (post-spawn fish) return to the ocean after spawning (Burgner et al. 1992 as cited *in* NMFS 2007).

2.3 INCUBATION/EMERGENCE

Because there is little information available regarding the incubation and emergence of steelhead in the Snohomish basin, information follows from throughout the species' range. The fecundity of hatchery steelhead from the Alsea River, Oregon that were 22 to 31 inches in fork length (FL) averaged 3,435 eggs and ranged between 2,000 and 5,000 eggs (Wydoski and Whitney 2003). In the Northern Puget Sound streams, wild fish fecundity may be quite a bit higher and varies with the fish's life history. The wild females from the Sauk River in the Skagit River Basin averaged about 6,400 eggs/female. In that case the 2-salt females averaged about 5,000 eggs, the 3-salts about 6,500 and repeat spawners averaged about 8,000 with some having as many as 12,000 eggs (C. Kraemer, pers. comm., December 17, 2007). There is typically a strong relationship between the number of eggs and the size (length and weight) of the individual female fish. Citing unpublished data from the Queets River, Washington, Stober et al. (1983) used the following equation to estimate fecundity for Tolt River females:

Eqn-2: # eggs/female = 1.47 (fork length in mm) + 5,593

Although the observed increase in eggs in repeat spawners might skew this relationship a bit, since repeat spawners do not necessarily grow larger during subsequent trips to the ocean (C.

Kraemer, pers. comm., December 17, 2007). Energy that could go toward growth is being consumed during migrations and gamete production.

According to Wydoski and Whitney (2003), up to 95 percent of the eggs are fertilized, but only 65 to 85 percent survive the embryonic stage depending on site-specific conditions. Survival to fry emergence is subject to intergravel flow of water and oxygen levels, both of which are inversely related to the level of fine sediment accumulations in the redds.

The rate of embryonic development is generally a factor of water temperature. Steelhead eggs can be expected to subsequently eye, hatch and emerge from redds at different rates (Table 4). According to Leitritz and Lewis (1976), hatching steelhead eggs at 10.6°C in hatcheries takes about 30 days. Barnhardt (1986) reports that the time to hatch varies from 19 days at 15° C to 80 days at 5°C. Following hatching, steelhead alevins remain associated with the redd site until they have absorbed the yolk sac and need to forage for food. Fry emergence from the redd can take an additional 3 to 6 weeks of development depending on water temperature. Burton and Little (1997) conclude steelhead embryos need to accumulate 647 celcius temperature units (ATUs), or the cumulative number of degrees above freezing on a daily basis to reach emergence (Table 4).

Additional emergence information specific to the Sultan River Basin was provided by WDG (1982). Observation of redds in 1979 indicated that emergence of steelhead fry required 722 C ATUs. Fry emergence began around the end of May in 1979 and 1980. Emergence appeared to begin first in the lower Sultan River and proceed upstream, which supported the authors' hypothesis that spawning occurs earlier in the lower river and later upstream presumably due to water temperature differences.

Table 4. Accumulated temperature units (ATU's) required to reach important embryonic developmental stages in steelhead trout.

Stage	**ATU °C**	**Source**
Eyed-egg Stage	250 – 270	ADFG (2007)
Hatch	318	Leitritz and Lewis (1976)
	360	ADFG (2007)
	400	Barnhardt (1986)
Emergence	600	ADFG (2007)
	647	Burton and Little (1997)
	722	WDG (1982)

2.4 REARING

Depending on the time of spawning and the water temperature during incubation, fry emerge from the gravel in spring or early summer, 3 or more weeks after hatching (Barnhardt 1986). In the Sultan River, emergence begins in early June and continues through July (CH2MHill 2005). Upon emerging, fry often form schools and remain in shallow and slow moving water along the periphery of pools and stream banks (Wydoski and Whitney 2003; Barnhardt 1986). As they grow throughout their first year, juvenile steelhead begin to distribute themselves throughout a system when they are able to maintain position in fast currents (> 50 mm FL). Johnson (1985), as summarized by Gibbons et al. (1985), found the densities of late-summer steelhead parr varied in accordance with channel gradients and that juveniles preferred pool and run habitats more than riffle and glide habitats. The highest use areas were found between 1 and 5 percent channel gradients [see Section 3.4, *Rearing Habitat Distribution*, below].

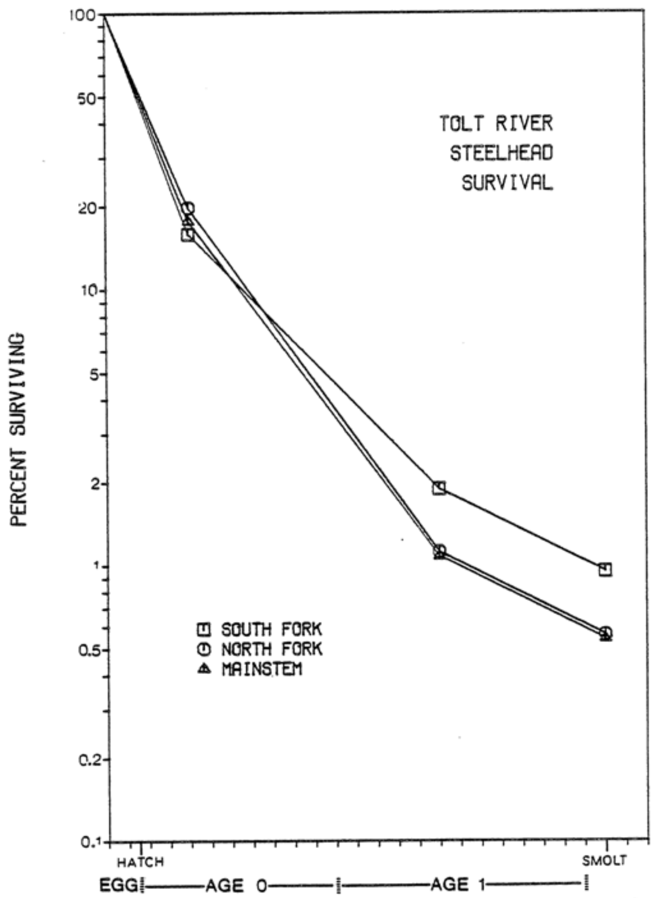
Juvenile surveys in the Sultan River (WDG 1982), showed rapid steelhead fry growth. Mean length doubled from June to November and weights (estimated from published length/weight relationships) increased nearly tenfold (Table 5).

Table 5. Mean length and estimated weight of steelhead fry collected from the Sultan River in 1980 and 1981.

Month	Length (mm)	Estimated Weight (gm)
June	31	0.35
July	34	0.43
August	37	0.49
September	47	1.2
October	56	2.3
November	61	3.2

Source: WDG (1982).

Stober et al. (1983) provided a detailed assessment of early life-stage survival estimates in the South Fork, North Fork, and mainstem Tolt River (Figure 2. Overall egg to smolt survival was 0.94, 0.56, and 0.54 percent, respectively (Table 6).



Source: Stober et al. 1983

Figure 2. Steelhead egg-to-smolt survival estimates for the Tolt River based on 1981-1982 data.

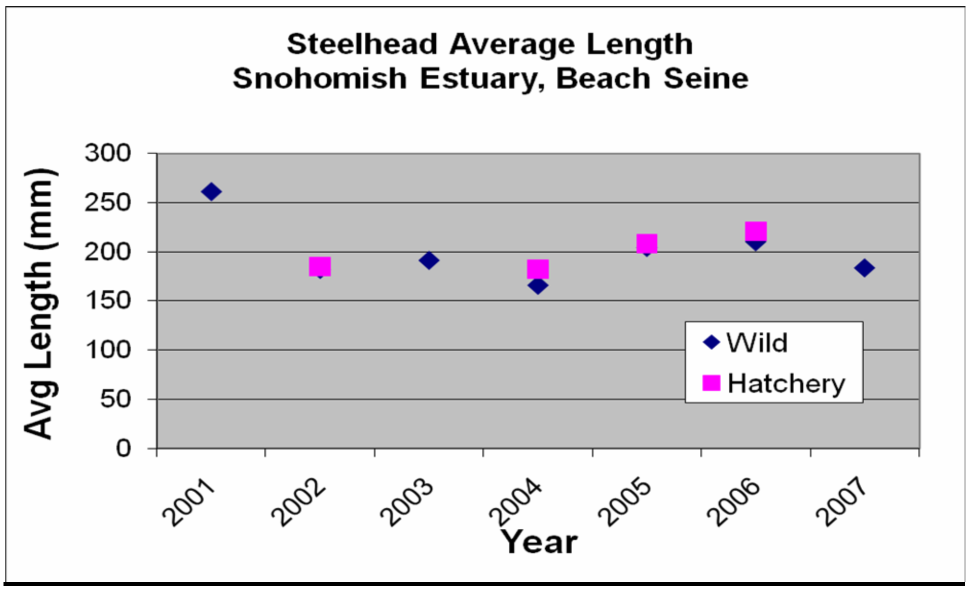
Table 6. Number of spawning females returning to the Tolt River, estimated number of eggs deposited, number of smolts produced, and egg to smolt survival.

Stream	No. of Females (1981-1982)	Potential Egg Deposition	Smolt Production	Egg:smolt Ratio	Egg to smolt Survival
South Fork	34	159,753	1,510	106:1	0.94%
North Fork	85	400,321	2,233	179:1	0.56%
Mainstem	75	353,805	1,902	186:1	0.54%

Source: Stober et al. (1983)

As described below, juvenile steelhead may reside in freshwater anywhere from 1 to 7 years, but most wild steelhead in the Snohomish basin spend two years in freshwater. Conversely, hatchery steelhead are planted as yearlings and out-migrate to the ocean in their first year. Steelhead smolts outmigrate at the largest size of any of the anadromous fish species in the basin.

NMFS provided unpublished data related to their sampling of juvenile steelhead in the Snohomish estuary (M. Rowse, pers. comm., December 17, 2007). The average length of steelhead smolts, for both hatchery and wild fish collected in the estuary, ranged on an annual basis between 170 and 260mm (7 to 10 inches) as shown in Figure 3.



Source: NMFS unpublished data.

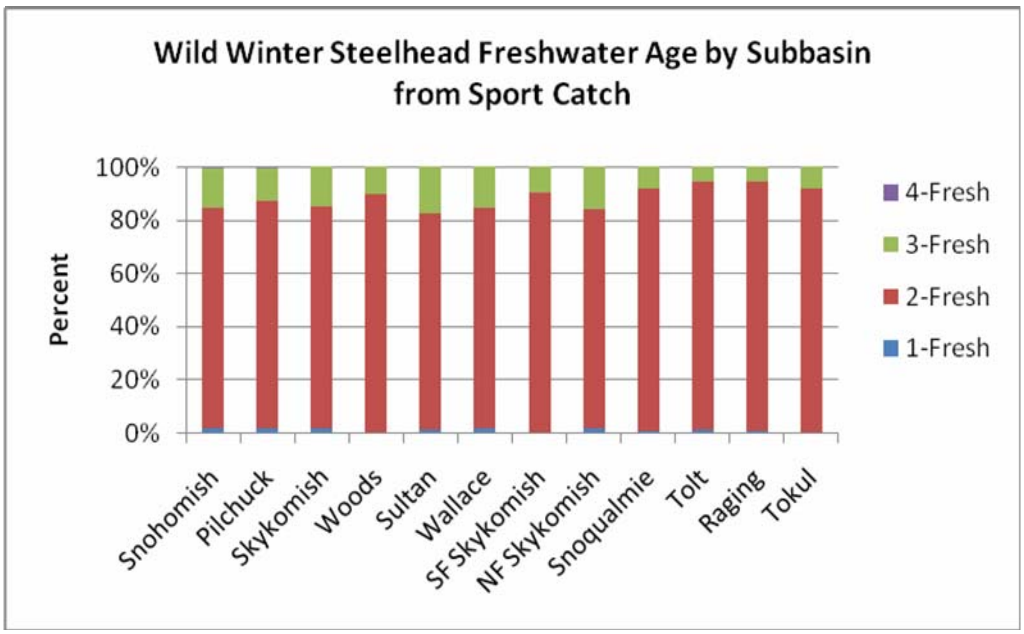
Figure 3. Average length of juvenile steelhead trout collected from the Snohomish estuary, 2001- 2007.

2.5 OUTMIGRATION, FRESHWATER AGE

Most wild steelhead juveniles in Washington spend two years in fresh water before outmigrating as smolts (WDFW 2006). Conversely, yearling hatchery steelhead smolts outmigrate the year they are planted residing in freshwater for only one year (WDG 1986; WDFW 1993). Smoltification and outmigration typically take place from April to mid-May (WDF et al. 1972 as cited in NMFS 2007, Nelson and Kelder 2004). In a study performed at the Skamania Fish Hatchery, Adams et al. (1973) found that rearing water temperatures between 15°C and 20°C can inhibit smoltification and subsequent adaptation to sea water which can increase the level of freshwater residualization for steelhead.

The freshwater age at outmigration for wild winter steelhead smolts in the Snohomish basin is typically 2 years (84 percent), though 15 percent outmigrate at 3 years and 1 percent outmigrate at either 1 or 4 years (WDFW 1994b as cited in Busby et al. 1996). This information is consistent with and was likely derived, in part, from the scale analyses reported in the WDFW Winter Steelhead Resource Inventory binders (WDG 1986, WDFW 1993).

A summary of age-class profile data for wild winter steelhead based on scale samples taken from sport catches throughout the Snohomish basin between 1981 and 1992 (WDG 1986, WDFW 1993) is provided in Table 7 and broken out where information is available by subbasin in Figure 4.



(**Source:** WDFW 1993).

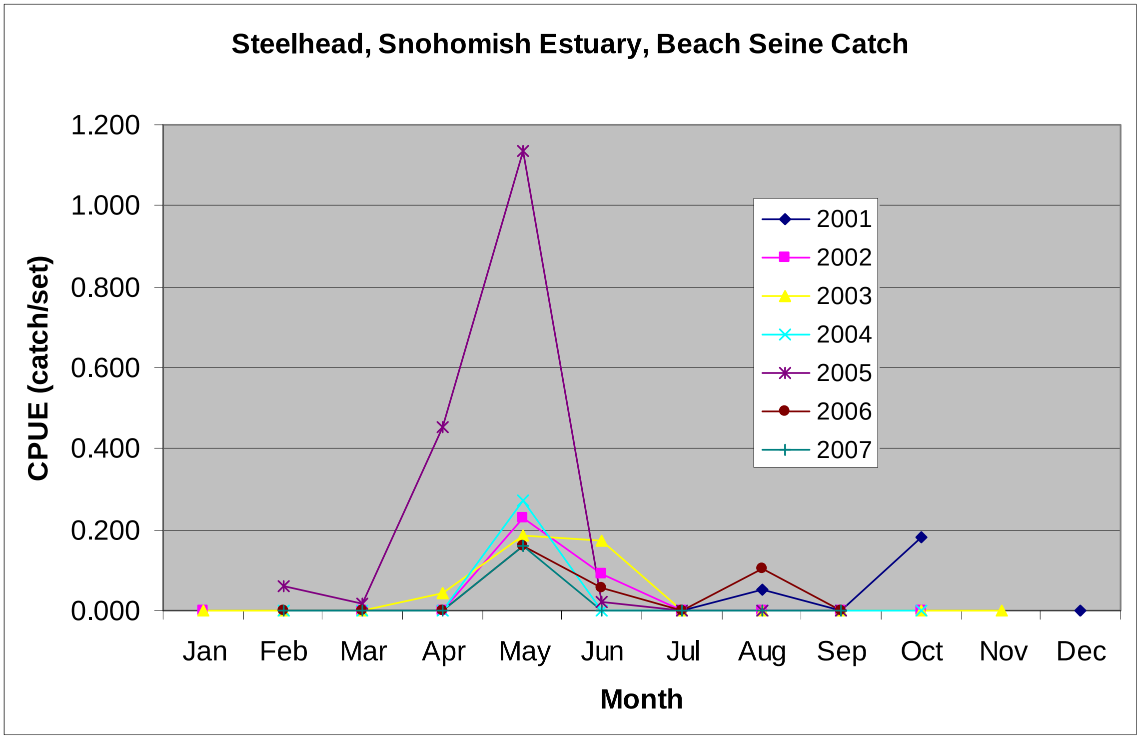
Figure 4. Frequency of freshwater ages for wild winter steelhead trout in the Snohomish River Basin.

Based on a sample of 36 summer steelhead from anglers' creels in the Tolt River (1981-1982), Stober et al. (1983) found 11 percent reared in freshwater for 1 year, 86 percent reared in freshwater for 2 years, and 3 percent reared in freshwater for 3 years. A smaller sampling of winter steelhead from the Tolt River (n=19) showed a similar trend with 26, 63, and 11 percent of fish rearing in freshwater for 1, 2, and 3 years, respectively (Stober et al. 1983). The ability to separate hatchery and wild steelhead from the creel samples during this era might be problematic and confound interpretation of these data.

Smolt trapping in the Snoqualmie River at RM 12.2 in 2002 and 2003 documented peak steelhead smolt outmigration between early and mid-May (Nelson and Kelder 2004). The earliest (wild) steelhead smolt was collected on April 5, 2003. During both years, nearly all of the smolts were captured during a four to five-week period and the peak out-migration for both hatchery and wild steelhead smolts occurred during the same week.

Although not prevalent along nearshore waters of the lower Snohomish River estuary, the occurrence of steelhead smolts in beach seines in the estuary provides an approximation of seasonal estuarine timing and residence. Similar to the smolt trapping data, peak juvenile steelhead collections in the estuary are concentrated between a brief period in May and June annually. Juvenile steelhead observed in beach seine sets from April through October, indicate the potential of an extended estuarine rearing period for a limited number of fish each year (Figure 5). A comparison of the timing of steelhead presence at the smolt traps in the Snoqualmie and SF Skykomish rivers with occurrence in the estuary, suggests the bulk of the freshwater out-migration to the estuary may take on the order of one to four weeks.

Little is known about the nearshore migration patterns of steelhead smolts through Port Gardner Bay. Given the extended rearing period in freshwater and their large size as smolts, it is believed juvenile steelhead smolts outmigrate to offshore areas quickly and the transit time through the estuary is brief. Puget Sound's fjord-like structure may affect steelhead migration patterns from Port Gardner Bay and Port Susan. Hard et al. (2007) speculated Snohomish steelhead trout may spend considerable time as juveniles in the protected marine environment of Puget Sound prior to migrating to the high seas, a feature not readily accessible to steelhead from other ESUs. Although the relative speed of steelhead outmigration to the ocean from Puget Sound is unknown, most local researchers considered the estuarine rearing process to be fairly quick (Pentec, pers. comm., December 7, 2007, C. Kraemer, pers. comm., December 17, 2007). A growing body of literature suggests the survival characteristics of early outmigrants may be poor due to marine environmental conditions in Puget Sound (Pentec, pers. comm., December 7, 2007). Researchers in British Columbia found different survival rates of steelhead migrating from Vancouver Island coastal streams to the continental shelf compared to those discharging into the Strait of Georgia when steelhead populations declined after 1990 (Smith and Ward 2000). Possible reasons for the discrepancy among regions include high angling pressure related to hatchery supplementation, differences in freshwater and marine conditions and smolt migration distance to offshore feeding areas (Smith and Ward 2000). This situation would be commensurate with Washington coastal streams and streams draining into Puget Sound, where regional biologists have noted similar trends in survival (C. Kraemer, pers. comm., December 21, 2007).



Source: M. Rowse, NWFSC, unpublished data, pers. comm., December 17, 2007.

Figure 5. Seasonal observations of juvenile steelhead outmigrants along nearshore waters in the Snohomish River estuary via beach seine collections from 2001 – 2007.

2.6 OCEAN AGE

Although little is known about the marine migration patterns of steelhead, they typically reside in the ocean for 1 to 3 years before returning to freshwater to spawn (NMFS 2007). Most natural- and hatchery-origin Snohomish steelhead spend 2 years in the ocean (WDG 1986, WDFW 1993). Busby et al. (1996, citing WDFW 1994b) reports the ocean age at first spawning of winter steelhead in the Snohomish basin is typically 2 years (57 percent), but 42 percent spend 3 years at sea and 1 percent spends 4 years. The ocean age of summer steelhead in the Tolt River was found to be somewhat more diverse. Only 14 percent spent 2+ years at sea and 28 percent spent 1+ years at sea, while 53 percent spent 3+ years at sea (WDFW and WWTIT 1994). A summary of ocean age-class profile data for wild winter steelhead based on scale samples taken from sport catches throughout the Snohomish basin between 1981 and 1992 (WDG 1986, WFDW 1993) is provided in where information is available by subbasin in Figure 6.

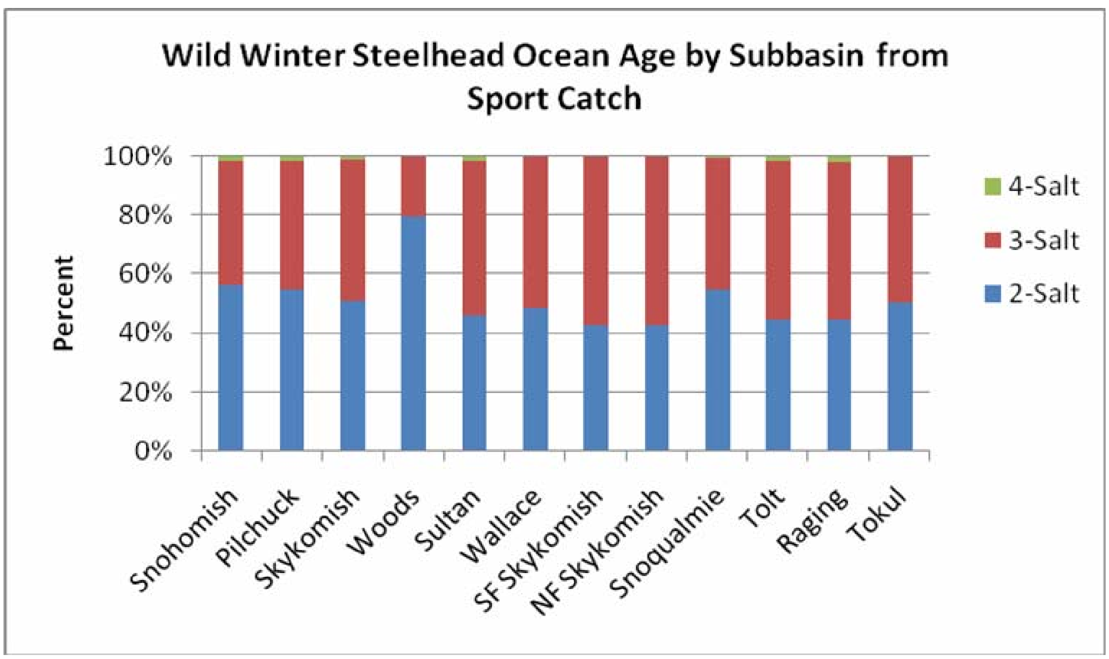
Table 7a. Snohomish Native-origin, Winter Steelhead Age-Class Profile.

		Ocean Age					
		1	2	3	4	5	6
Fresh-water Age	1	-	1%	-	-	-	-
	2	-	51%	34%	3%	-	-
	3	-	6%	4%	-	-	-
	4	-	-	-	-	-	-

Table 7b. Snohomish Hatchery-origin, Winter Steelhead Age-Class Profile.

		Ocean Age					
		1	2	3	4	5	6
Fresh-water Age	1	-	82%	18%	1%	-	-
	2	-	-	-	-	-	-
	3	-	-	-	-	-	-
	4	-	-	-	-	-	-

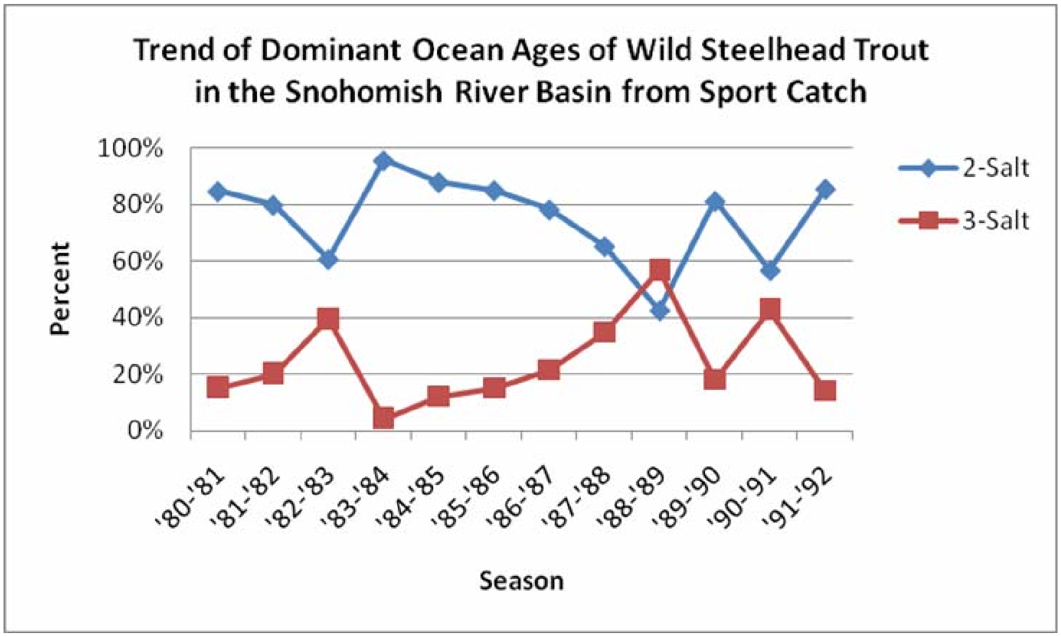
Source: WDG (1986) scale samples from sport and tribal catches (1980 – 1986)**.**



Source: WDFW (1993).

Figure 6. Frequency of ocean ages for wild winter steelhead trout in the Snohomish River Basin.

A 12-year record of scale samples was collected by the state from 1981 to 1992. Although annual variation in the ocean age profiles was apparent, there was no noticeable trend or overall change in the proportions of fish returning as 2-salt, 3-salt or 4-salt fish over the 12-year time frame (Figure 7).



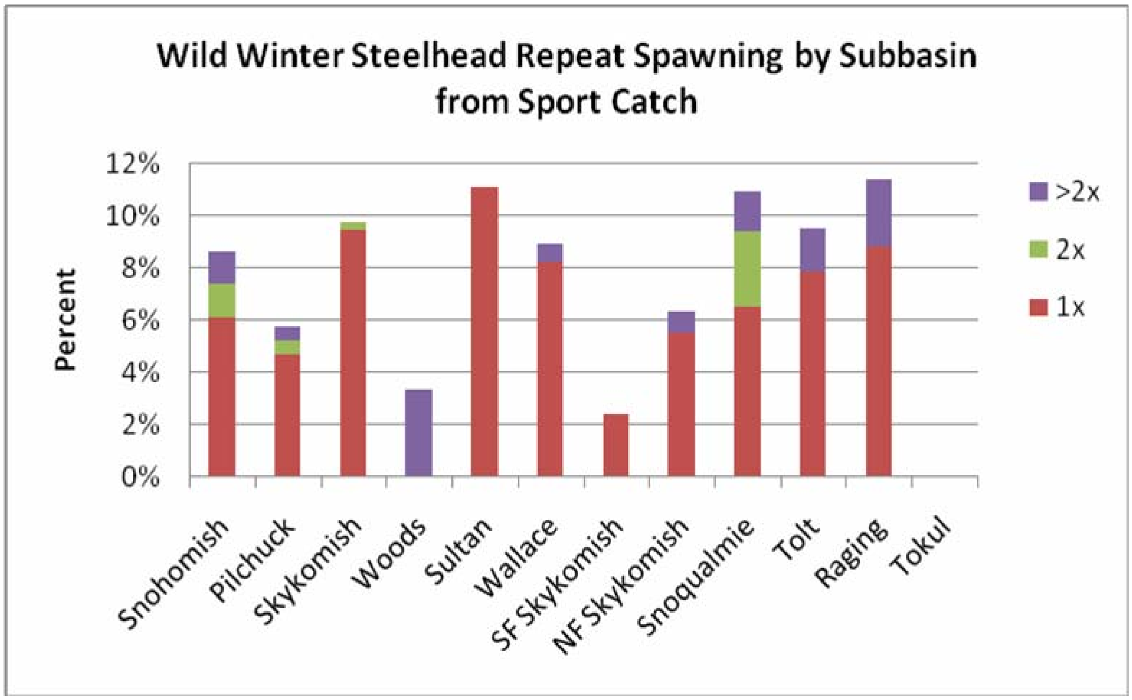
Source: WDFW (1993).

Figure 7. Annual trends of ocean ages for wild winter steelhead trout based on sport catch data from 1980-1992 in the Snohomish River Basin.

2.7 REPEAT SPAWNERS

The incidence of repeat spawning in steelhead trout is highly variable among populations and is thought to decrease for stocks with greater migration distances and at higher latitudes (Busby et al. 1996). Female fish are more frequently repeat spawners than males (Pauley et al. 1986) and upon return they carry substantially greater numbers of eggs to assist in seeding streams. In combination, increased repeat spawning and greater numbers of eggs in larger females suggest the repeat spawners can have a large affect on the total fecundity in the basin.

In Washington, 5-10 percent of winter-run steelhead are comprised of repeat spawners (Johnson 1997; WDFW 2006). In the Snohomish basin, Busby et al. (1996, citing scale analysis from WDFW 1994b) reports that 92 percent of the steelhead (unspecified stock) consisted of first-time spawners, while second and third-time spawners made up 6 and 1 percent of the run, respectively. In the Tolt River, Stober et al. (1983) found that 3.1 percent of angler-caught fish were repeat spawners, though the origin and stock of these fish were unspecified and could be influenced by hatchery-origin fish. The Snohomish winter steelhead resource inventory (WDG 1986; WDFW 1993) report the level of repeat spawners based on scale samples from sport and tribal harvests between 1981 and 1992 (Figure 8). Repeat hatchery spawners ranged between 0 and 10 percent and averaged 3 percent per year. For wild fish, the range of repeat spawners (5 to 20 percent) and the average (13 percent) were higher than recorded for hatchery fish. This finding is consistent with the lack of live-fish spawning at basin hatcheries at the time.



Source: WDFW (1993)

Figure 8. Frequency of repeat wild winter steelhead spawners trout in various sub-basins in the Snohomish River Watershed.

A 12-year record of scale samples was collected by the state from 1981 to 1992. During that time frame, there was no noticeable change in the proportions of fish returning as repeat spawners. Inter-annual variability in the proportion of fish that survived to repeat spawn is relatively large. The highest proportion of repeat wild winter-run spawners apparently occurs in years following higher than normal spring flows (C. Kraemer, pers. comm., December 17, 2007). The summer-run life history strategy of holding over in freshwater six or more months prior to spawning, places the fish in a fairly harsh environment of living off body reserves while ripening. This strategy would likely discourage the frequency and success of repeat spawners.

The proportion of repeat summer-run spawners apparently increases following years of lower summer river flows than normal (C. Kraemer, pers. comm., December 17, 2007).

The considerable proportion of one-time spawners, suggests a high degree of post-spawning mortality. Steelhead redistribute downstream after spawning and often return to marine waters as kelts. Unlike salmon, post-spawning mortality, if it occurs, is often delayed in steelhead. Mortality can occur well downstream, or in estuarine or marine waters. There are occasionally spawned-out carcasses present in the vicinity of the spawning grounds, but unlike salmon, there are rarely large concentrations of adult carcasses.

3. HISTORIC AND CURRENT DISTRIBUTION

3.1 RELATIVE ABUNDANCE

Statewide steelhead stock inventories were completed in 1992 (WDFW and WWTIT 1994) and 2002 (WDFW 2002). In 2002, all three Snohomish basin winter steelhead stocks were rated as depressed based on severe short-term declines in total escapement since 1999 as determined from spawning surveys. The Tolt River summer stock was rated as healthy in 2002 based on a consistent increase in redd counts that exceeded the escapement goal of 121 adults in every year since 1992. However, subsequent to the 2002 SaSI report, the Tolt River summer steelhead escapement has fallen below this escapement goal. The status of North Fork Skykomish River summer stock is considered unknown because escapement is not monitored and sport harvest data is no longer useful with the release of wild steelhead has been required since 1993. The South Fork Skykomish stock was considered healthy in 2002 based on fairly high and stable trap counts at Sunset Falls (Table 8).

Table 8. Status of Snohomish basin steelhead stocks.

Stock	1992 (SASSI)	2002 (SaSI)
Summer Steelhead		
Tolt River	Depressed	Healthy
North Fork Skykomish River	Unknown	Unknown
South Fork Skykomish River	Healthy	Healthy
Winter Steelhead		
Snoqualmie River	Healthy	Depressed
Snohomish/Skykomish River	Healthy	Depressed
Pilchuck River	Healthy	Depressed

Source: WDFW and WWTIT 1994; WDFW 2002

Historic records of relative steelhead abundance in the Snohomish basin are provided below in Table 9. While these determinations are not quantitative and do not identify run-timing or origin, they provide some indication of historic steelhead distribution throughout the basin. The information is most valid where streams and rivers have maintained consistent names since the early 1930s. Un-named slough and tributary reaches, and streams with name changes are of less relative value for historic comparisons.

Table 9. Historic steelhead abundance in the Snohomish basin.

Main River	Tributary	Migration Distance	Survey Date	Abundance
Snohomish River		25.0	6/1/1929	Large
	Heartgravel Slough	N/A	6/1/1929	Absent
	Slough No. 2	N/A	6/2/1929	Absent
	Slough No. 3	N/A	6/2/1929	Absent
Pilchuck River		25.0	6/5/1929	Large
	Sexton Creek	1.0	6/3/1929	Absent
	T N Creek	5.0	6/8/1929	Scarce
	T M Creek	1.0	6/8/1929	Very Scarce
	T L Creek	1.0	6/9/1929	Very Scarce
	T H Creek	N/A	6/10/1929	Absent
	West Branch	8.0	6/15/1929	Scarce
	T O Creek	3.0	6/16/1929	Very Scarce
	T R Creek	4.0	6/18/1929	Very Scarce
	T P Creek	1.0	6/17/1929	Very Scarce
	French Creek	2.0	6/19/1929	Absent
Skykomish River		40.0	6/28/1929	Large
	Woods Creek	7.0	7/2/1929	Medium
	WF Woods Creek	12.0	7/3/1929	Scarce
	Ki Creek	1.0	6/28/1929	Absent
	Sultan River	8.0	6/20/1929	Large
	Elwell Creek	N/A	6/24/1929	Scarce
	Proctor Creek	1.0	7/15/1929	Scarce
	Wallace River	N/A	6/24/1929	Medium
	SF Skykomish River	3.0	6/27/1929	Medium
	NF Skykomish River	15.0	7/1/1929	Medium
	Salmon Creek	3.0	7/1/1929	Scarce
Snoqualmie River		48.0	8/1/1929	Medium
	Cherry Creek	8.0	8/2/1929	Scarce
	Harris Creek	3.0	7/25/1929	Scarce
	Griffin Creek	2.0	7/25/1929	Scarce
	Tark Creek	N/A	7/24/1929	Absent
Tolt River		10.0	9/1/1929	Large
	SF Tolt River	7.5	9/1/1929	Medium
	NF Tolt River	5.0	9/1/1929	Large
	Lynch Creek	2.0	9/2/1929	Scarce
	Stossel River	2.5	9/2/1929	Scarce
	N. Fork Creek	5.0	9/3/1929	Scarce
	Raging River	9.0	9/4/1929	Medium

Source: WDG (1932) as cited in NMFS (2007)

Total run size estimates and spawning escapement levels for the Snohomish basin since 1981 are summarized in Table 10 and provided in detail in Appendix A (Table A-1). EDT modeling runs estimating either historic steelhead production under pristine conditions or current steelhead production under developed conditions with an ongoing harvest practice have not been performed for the Snohomish Basin. Light (1907) estimated combined [hatchery and wild, summer and winter] steelhead abundance for the basin should have been in the range of 23,000 returning fish.

3.2 MATRIX TABLE

Using primarily the spawning survey database maintained by WDFW, a matrix table was constructed after the Step-1 Tables for Chinook and coho salmon provided in the Snohomish River Basin Ecological Analysis for Salmonid Conservation (EASC; Snohomish Basin Salmonid Recovery Technical Committee 2005). This table is provided in Appendix B in four separate figures. The information was used to identify areas within the basin where steelhead spawning has been observed and the relative ranking of various reaches in the basin with respect to spawner densities over the years. The methodology for ranking reaches and results are presented in Appendix B.

3.3 SPAWNING ESCAPEMENT/DISTRIBUTION

Escapement estimates for the six stocks are included in Appendix C (Table C-1) and graphed by individual stock (Figures C-1 through C-7). Escapement summaries for the major river basins have been included in Table 10 of the text. The current distribution of steelhead in the basin, according to Snohomish County's GIS data layers, is shown in Figure 9. Based on our review of the WDFW spawner ground survey database, we found only minor modifications to this distribution would be waranteed with respect to the stream reaches accessible to anadromous steelhead trout.

Known distributions of the six wild stocks are based on spawning locations. It is possible fish from various stocks may temporarily use accessible waters anywhere in the basin. However, observations of such use may not necessarily indicate the spawning distributions require modification. Refer to the discussion of migratory behavior of steelhead, especially summer-run fish in Section 2 *Life-History,* 2.1 *Migration*, regarding holding fish and strays. There is evidence of summer-run adult steelhead use of waters in the Snoqualmie River Basin including both Tokul Creek and the Raging River. Neither of these two basins are known to offer substantial summer steelhead trout spawning habitat (C. Jackson, pers. comm., December 7, 2007). The state also plants juvenile summer-run hatchery steelhead smolts from Reiter Ponds into the Raging River and in the mainstem Snoqualmie River at the confluence of Tokul Creek.

Since these two subbasins are the upper extent of the steelhead distribution in the Snoqualmie River, occurring immediately downstream of Snoqualmie Falls, it is possible either Tolt River summer-run steelhead or summer-run hatchery stock strays may, at certain times, hold in these tributaries. Until wild summer-run or winter-run steelhead trout spawning is confirmed elsewhere in the basin, we do not recommend altering the SASSI stock distributions at this time.

The relative value of various stream reaches throughout the accessible portion of the Snohomish Basin for steelhead trout spawning and rearing is identified in Figures 10 and 11, respectively, based on the output of the Step-1 Matrix Table identified in Section 3.2 above. A summary of the spawning reach rankings based on the quartile distribution of mean number of spawners per mile per the Step-1 Matrix Table is shown in Table 11.

3.4 REARING HABITAT DISTRIBUTION

Little information is available on quality and quantity of rearing habitats in the basin. Some site-specific surveys are available at a relatively small scale in a number of locations (e.g., Tolt, Sultan, Tye, Griffin/Tokul, Skykomish River reaches). However, data to identify high priority sub-basins for restoration efforts are lacking in most areas. Ecosystem, Diagnostic and Treatment (EDT) reaches have been established in the basin for assessing other species (Mobrand Biometrics 2002), but no effort has been extended to estimate their relative value for steelhead trout rearing capacity or productivity. Regardless, the EDT ‘stream-reach editor’ portion of modeling for other salmonid fish species in the basin includes habitat quantity and quality estimates for existing conditions. Some of these ratings are based on specific data, while others are assumed based on similar channel conditions and/or biologists’ familiarity with the area. The Level 2 EDT ratings for each reach could be used in the future as a rank measure of importance for steelhead rearing.

In general, rearing habitats for juvenile steelhead trout exist throughout the basin where anadromous steelhead occur (Figure 9). The capacity of these habitats to produce steelhead vary by the quantity and quality of desirable channel features, water quality and food resources. In general, via intensive snorkel surveys reported in Johnson (1985) and summarized by Gibbons et al. (1985), the authors found the densities of late summer steelhead parr varied in accordance with channel gradients and that the juveniles preferred pool and run habitats more than riffle and glide habitats. The authors divided mainstem river habitats into 7 gradient zones and summarized observed juvenile steelhead densities as shown in Table 12.

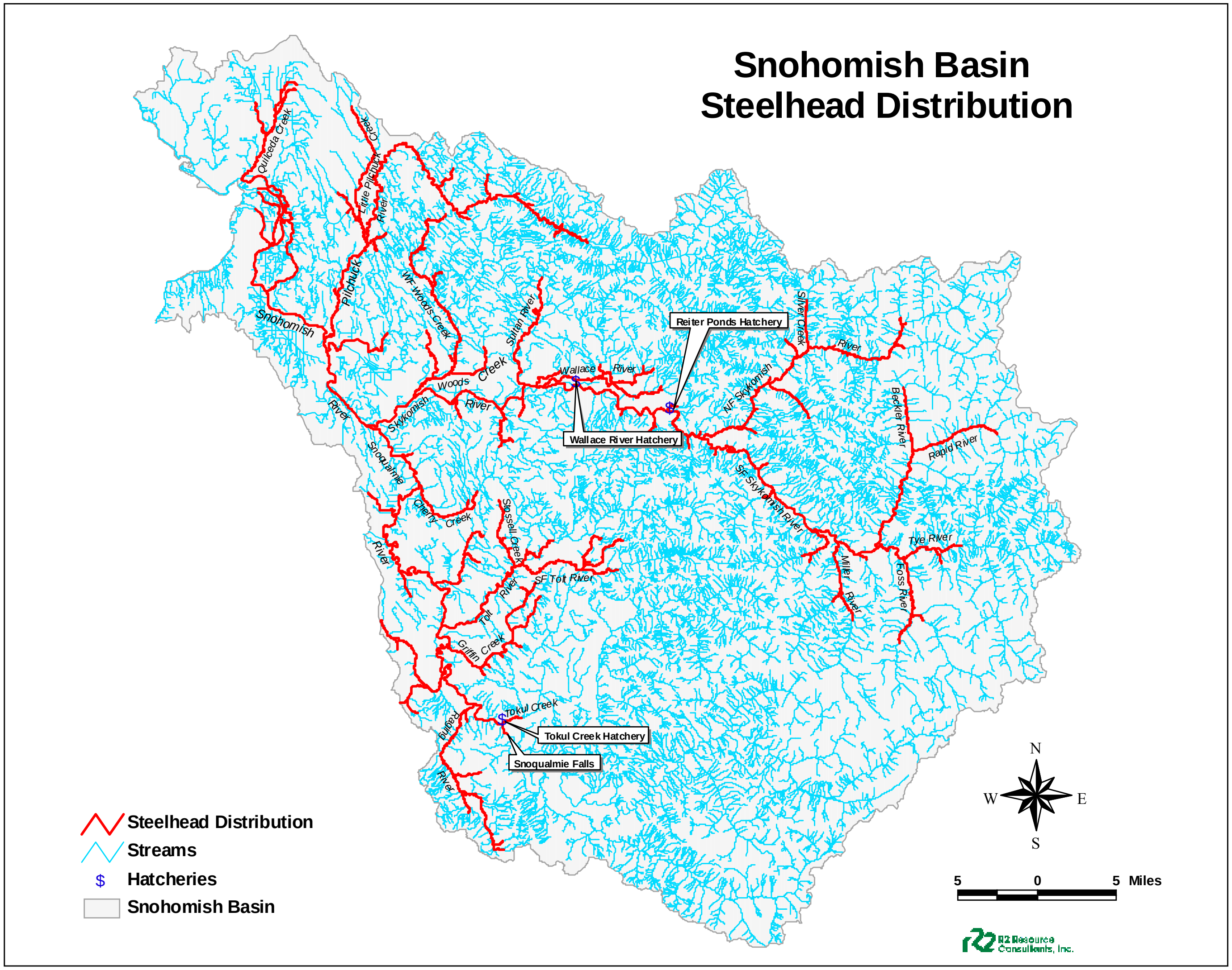


Figure 9. Steelhead Distribution, Snohomish County.

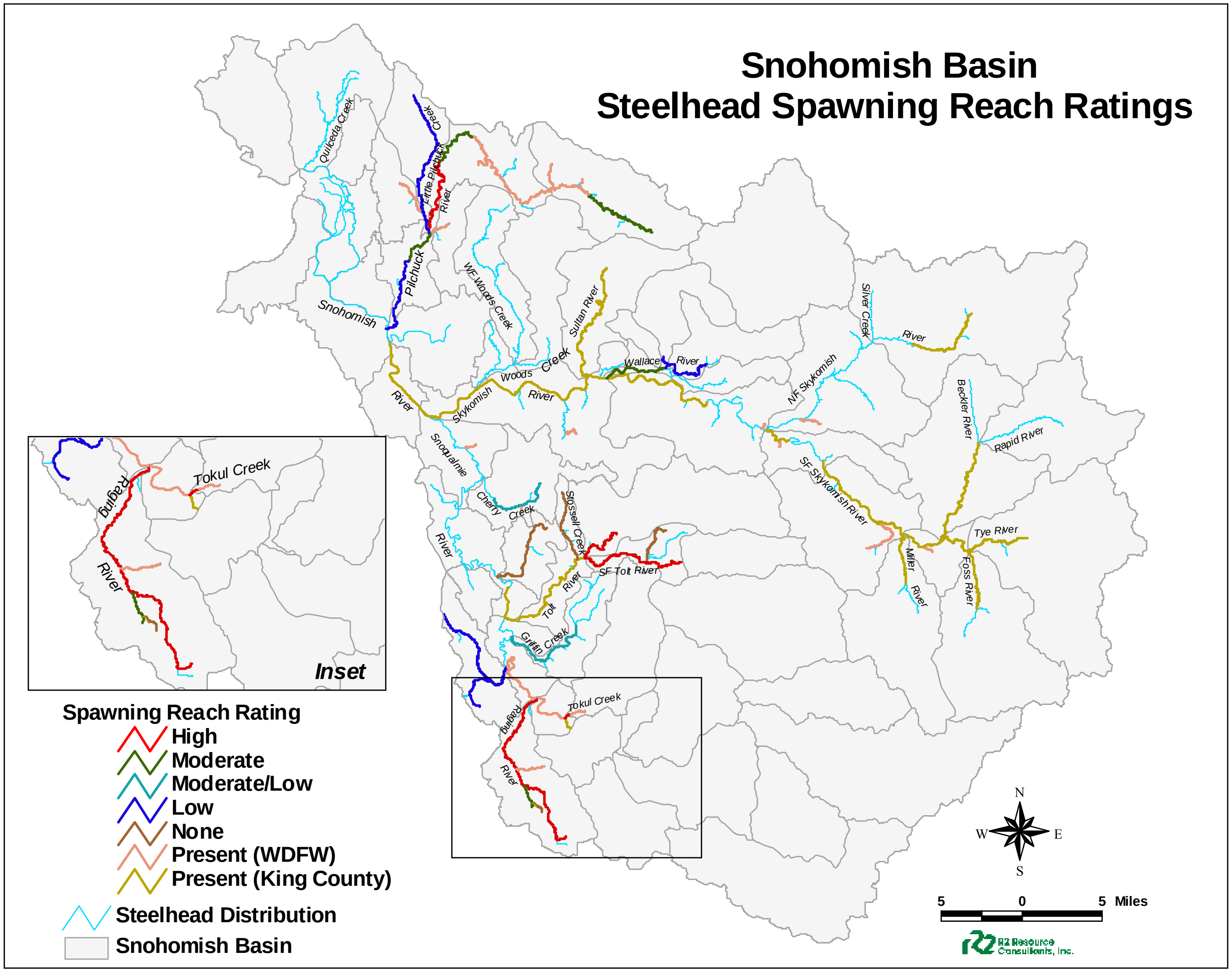


Figure 10. Relative rating of various steelhead spawning reaches in the Snohomish River Watershed Inventory Area (WRIA 07).

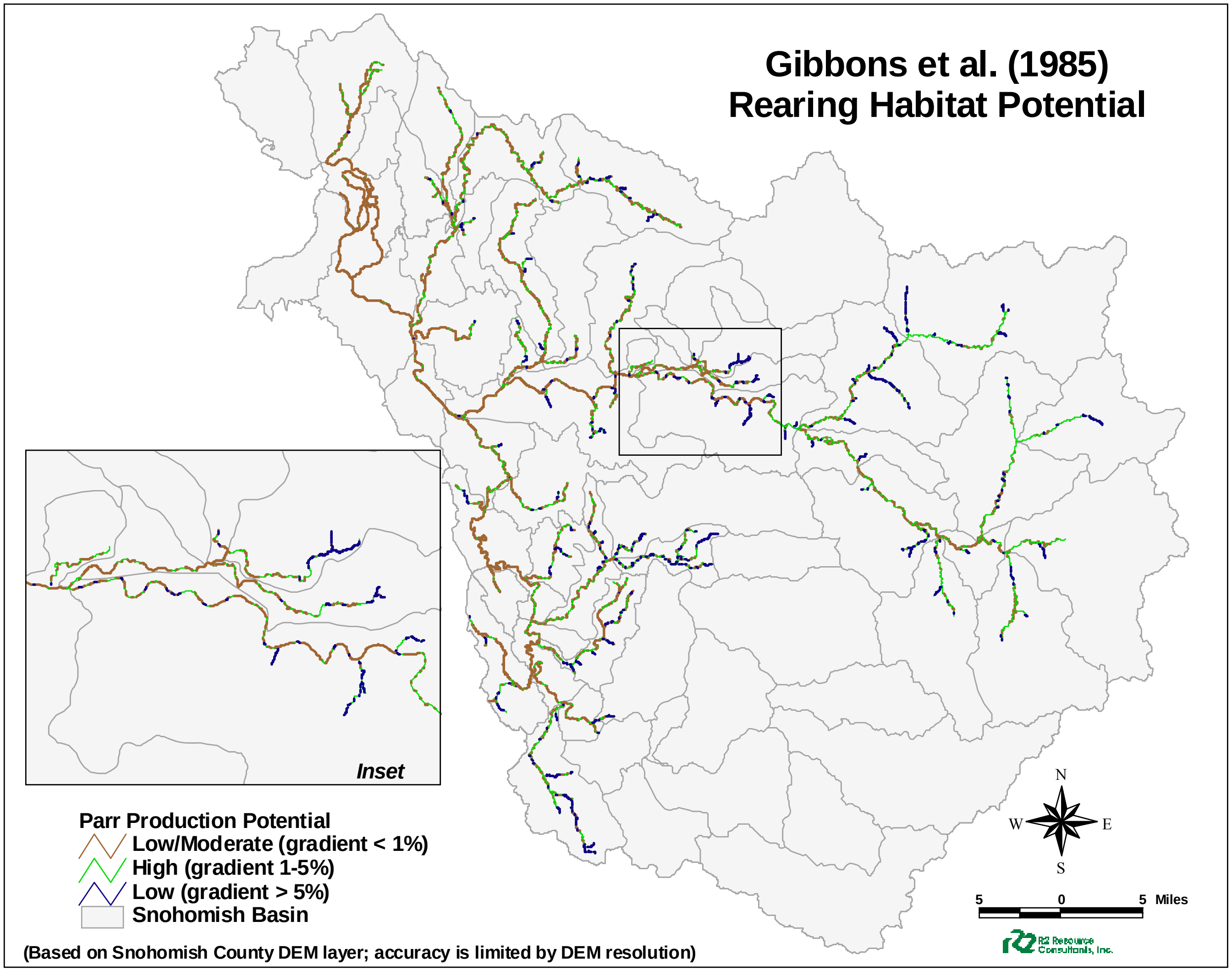


Figure 11. Relative rating of various steelhead rearing reaches in the Snohomish River Watershed Inventory Area (WRIA 07) based on stream gradient.

Table 11. Prioritization of spawning reaches based on quantitative results of WDFW spawner ground survey database in the Snohomish Basin.

NAME	REACH_ID	Stream Id	Length (miles)	Category
Snohomish River	Snohomish_1	7.0012	1.9	P
Snohomish River	Snohomish_2	7.0012	4.5	P
Pilchuck River	Pilchuck_1	7.0125	1.7	3
Pilchuck River	Pilchuck_2	7.0125	4.1	3
Pilchuck River	Pilchuck_3	7.0125	2.7	2
Pilchuck River	Pilchuck_4	7.0125	6.9	1
Pilchuck River	Pilchuck_5	7.0125	4.0	2
Pilchuck River	Pilchuck_6	7.0125	7.5	P
Pilchuck River	Pilchuck_7	7.0125	1.9	P
Pilchuck River	Pilchuck_8	7.0125	3.1	P
Pilchuck River	Pilchuck_9	7.0125	6.7	2
Dubuque Creek	Dubuque_1	7.0139	1.7	P
Little Pilchuck Creek	LittlePilchuck_1	7.0146	1.7	3
Little Pilchuck Creek	LittlePilchuck_2	7.0146	8.8	3
Catherine Creek	Catherine_1	7.0148	2.7	P
Bosworth Lake Creek		7.0163	1.5	P
Worthy Creek	Worthy_1	7.0166	1.7	P
Snoqualmie River	Snoqualmie_3	7.0219	2.1	P
Snoqualmie River	Snoqualmie_5	7.0219	4.9	P
Snoqualmie River	Snoqualmie_6	7.0219	3.3	P
Peoples Creek	Peoples_1	7.0236	0.8	P
Cherry Creek	Cherry_2	7.0240	4.5	2,3
Unnamed Cherry Cr. Trib.		7.0247	0.5	P
Harris Creek	Harris_1	7.0283	6.4	N
North Fork Tolt River	Tolt_3	7.0291	3.9	1
Tolt River	Tolt_1	7.0291	4.5	P
Tolt River	Tolt_2	7.0291	3.9	P
Stossell Creek	Stossell_1	7.0300	4.9	N
South Fork Tolt River	SFTolt_1	7.0302	1.3	1
South Fork Tolt River	SFTolt_2	7.0302	7.2	1
Unnamed SF Tolt Rv. trib	SFTolt2_Trib1_2	7.0306	3.0	N
Griffin Creek	Griffin_1	7.0364	1.1	2,3
Griffin Creek	Griffin_2	7.0364	5.7	2,3
Patterson Creek	Patterson_1	7.0376	2.0	3
Patterson Creek	Patterson_2	7.0376	6.4	3
Canyon Creek	Canyon_1	7.0382	3.2	3
Raging River	Raging_1	7.0384	4.5	1
Raging River	Raging_2	7.0384	6.6	1

Table 11. Prioritization of spawning reaches based on quantitative results of WDFW spawner ground survey database in the Snohomish Basin.

NAME	REACH_ID	Stream Id	Length (miles)	Category
Raging River	Raging_3	7.0384	2.3	1
Lake Creek	Raging_2_Trib	7.0393	1.9	P
Deep Creek	Deep_1	7.0396	1.5	2
Unnamed Deep Cr. Trib.		7.0399	0.1	1
Unnamed Deep Cr. Trib.		7.0399	0.9	N
Tokul Creek	Tokul_1	7.0440	0.5	1
Tokul Creek	Tokul_2	7.0440	1.0	P
North Fork Snoqualmie River	Snoqualmie_7	7.0527	0.8	P
Youngs Creek	Youngs_1	7.0870	1.2	P
Sultan River	Sultan_1	7.0881	2.8	P
Sultan River	Sultan_2	7.0881	6.9	P
Wallace River	Wallace_1	7.0940	4.5	2
Wallace River	Wallace_2	7.0940	4.1	3
Olney Creek	Olney_1	7.0946	0.8	3
Deer Creek		7.0979	0.4	P
North Fork Skykomish River	NFSkykomish_2B	7.0982	5.9	P
Lewis Creek	Lewis_1	7.0983	1.4	P
Bridal Veil Creek	BridalVeil_1	7.1248	0.5	P
Money Creek	Money_1	7.1300	3.5	P
Miller River	Miller_1	7.1329	3.6	P
Maloney Creek	Maloney_1	7.1407	0.7	P
Beckler River	Beckler_1	7.1413	8.1	P
Foss River	Foss_1	7.1562	4.7	P
Unnamed Pilchuck River. Trib.		7.0000	0.3	P
Skykomish River	Skykomish_2	7.0012A	10.9	P
Skykomish River	Skykomish_3	7.0012A	2.6	P
Skykomish River	Skykomish_4	7.0012A	1.0	P
Skykomish River	Skykomish_5	7.0012A	4.8	P
Skykomish River	Skykomish_6	7.0012A	4.0	P
South Fork Skykomish River	SFSkykomish_1	7.0012B	2.1	P
South Fork Skykomish River	SFSkykomish_3	7.0012B	8.1	P
South Fork Skykomish River	SFSkykomish_4	7.0012B	3.1	P
South Fork Skykomish River	SFSkykomish_5	7.0012B	2.7	P
Tye River	Tye_1	7.0012C	4.8	P

(1) Spawning ranking category from Step-1 Table; 1=**high,** > 75th percentile (26.7 mean spawners per mile) 2 = **moderate**, 25th - 75th percentile (8.6 to 26.7 mean spawners/mile; 3 = **low,** < 25th percentile; (8.6 spawners/mile); P =redds or fish present; non-quantitative supplemental survey; N = survey revealed no live fish or spawning activity.

Table 12. Juvenile steelhead trout densities by channel gradient class used for estimating parr production potential and subsequent spawning escapement required to adequately seed such habitats.

Gradient Zone	Reach Slope Class (%)	Mean Mainstem Densities (parr/100m^2)	Tributary Densities (parr/100m^2)	Relative Production Potential Rating
1	0.00 – 0.25	1.05	1/	Low
2	0.25 – 0.50	2.07	1/	Low
3	0.50 – 1.0	4.10	1/	Moderate
4	1.0 – 3.0	6.68	1/	High
5	3.0 – 5.0	6.68	1/	High
6	5.0 – 7.0	-	1/	Low
7	> 7.0	-	1/	Low
PPP[2/]		205,775	39,225	
MSH[3/] Spawning Escapement Estimate[1/]		5,450	1,050	

Source: Johnson (1985) and Gibbons et al. (1985)

1) Gibbons et al. (1985) used steelhead densities for tributary waters for estimating MSH steelhead spawning escapement needs based on site-specific snorkel survey observations in each watershed. They observed steelhead parr in the Tolt River in gradient zone 3 at a density of 4.74 parr/100m^2. Tributary reaches in the Snohomish River Basin were combined with the basin-specific distribution of mainstem gradient zones to approximate the potential parr production and spawning escapement to support such production.
2) PPP = Potential Parr Production.
3) MSH = Maximum Sustainable Harvest

Stober et al. (1983) estimated steelhead smolt yield in the Tolt River in the early 1980s basin as a function of lineal channel length. Smolt yield in the Tolt River (mean 264 smolts/mile) was far greater than the reported values for the Chehalis basin (26 to 48 smolts/mile) but somewhat less than the relatively pristine Kalama basin (301 to 489 smolts/mile). On an area basis, Stober et al. (1983) provided estimated average smolt yields in the South Fork, North Fork, and mainstem Tolt River as 0.97, 1.56, and 0.59 smolts/100 m^2, respectively. The overall weighted mean for the Tolt River was 0.91 smolts/100 m^2. Conversely, Johnson (1985) found 4.74 parr/100 m^2 in a moderate gradient (0.5 – 1.0%) reach in the Tolt mainstem at RM 4.0. Assuming 70 percent overwinter survival, this density equates to a probable density of 3.32 smolts/m^2, considerable more abundance than found by Stober et al. (1983) a few years earlier.

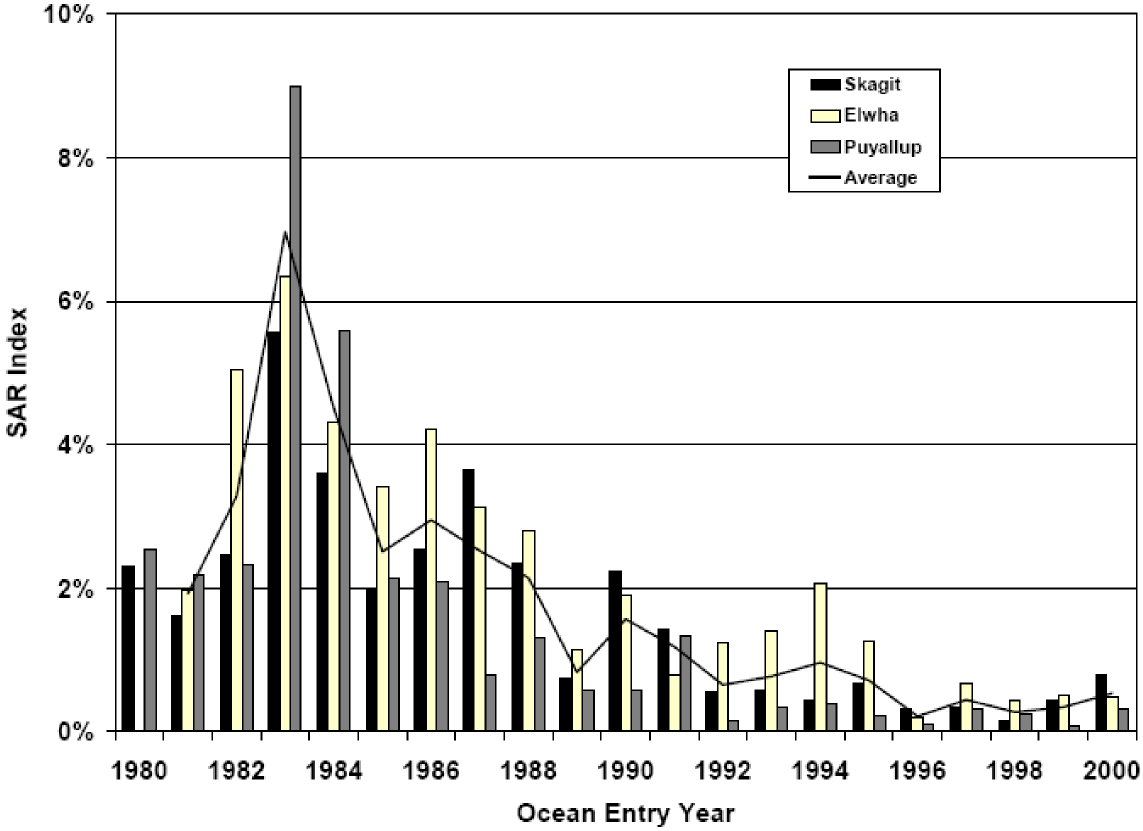
Based on a review of western Washington and British Columbia streams, Stober et al. (1983) also estimated that steelhead smolt yield should be at least 2.0 smolts/100 m2 to meet an "optimal production goal." Based on this criterion, the authors concluded the available rearing habitat in the Tolt Basin likely was underutilized in the early 1980s. Compared to other steelhead populations, the estimated egg to smolt survival in the Tolt River reported in the Life History section above (<=0.94%) is generally low. Stober et al. (1983) state a reasonable goal for egg to smolt survival should be 1.4 percent. The implication of reduced smolt survival in the basin would be related to poor quality of rearing habitat conditions.

Since such detailed studies are not available at many locales, we used Gibbons et al. (1985) stream gradient approach to help identify reaches in the Snohomish Basin that might offer enhanced rearing production for steelhead juveniles. Stream channels throughout the steelhead trout distribution area in the Snohomish Basin were separated into gradient classes using the Snohomish County GIS Digital Elevation Model (DEM) topography layer. With the use of Gibbons et al. (1985) summary data in Table 12, the relative juvenile steelhead production capacity rating of available channel reaches to juvenile steelhead production was estimated and plotted in Figure 11 *(Snohomish County DEM data for channel gradients and relative use by juvenile steelhead trout).* Since the freshwater rearing life-history phases are thought to limit overall steelhead production in the basin, the information can be used by basin staff to help prioritize site-specific recovery projects.

3.5 SMOLT TO ADULT RETURNS (SARS)

Estimates of wild smolt-to-adult returns (SARs) can be difficult and expensive to obtain. Without such estimates, SARs from hatchery-origin smolts can provide a relative index and be used as a surrogate for wild stocks (WDFW 2006). Although wild fish generally return at higher rates than hatchery stock, the overall trends typically track together (C Kraemer, pers. comm., December 17, 2007). Based on returns of hatchery releases, SARs for Puget Sound stocks have exhibited declining trends in recent years (NMFS 2007; WDFW 2006). Similar trends in SAR rates have been observed over the past 3 decades from hatchery-released smolts in the Skagit, Puyallup, and Elwha rivers (Figure 12).

The average SAR index fell from a peak of 7.0 percent in 1983 (year of ocean entry) to 0.2 percent in 1996. The SAR index has remained low since 1996, averaging between 0.2 and 0.5 percent (WDFW 2006). A similar trend was reported by Ward (2000) for SARs in the Keogh River (Vancouver Island). Wild smolt-to-adult survival averaged 15 percent from 1976 to 1989, but fell to an average of 3.5 percent from 1990 to 1995.



Source: WDFW 2006

Figure 12. SAR indices for hatchery-origin winter steelhead smolts released into the Skagit, Elwha, and Puyallup rivers.

Smolt to adult return ratios for hatchery stocks and certain outplantings in the Snohomish Basin been included in Section 4, *Hatchery and Harvest Management Programs in the Snohomish Basin*. The details of these estimates are included in Appendix D. The SARs are based on adult returns and hatchery release numbers from two years prior [HGMP updates (Dimmitt 2007)]. Although adult production levels may be calculated, precise SAR ratios cannot be determined since not all fish are accounted as either harvested or as returns to the hatchery racks (spawned in the wild). The hatchery facilities outplant yearlings that outmigrate as smolts shortly following the release date in several locations in the Snohomish system. However, adult collection opportunities are limited. Adult recruitment levels are underestimated since trapping sites are limited for the various release locations. Similarly, once broodstock goals are met at the facilities, the hatchery traps are closed to maximize recreational harvest opportunities. Thus, the total number of hatchery-origin fish returning to an area is underestimated. Several data gaps in hatchery returns and tribal harvest records also exist (Appendix D). Although the estimates may not provide precise point estimates on a year-to-year basis, as long as the methods for calculation remain consistent, trends of the SAR data over time are valid for assessing population status. The existing hatchery stock SAR estimates are summarized in various regions of the basin in Table 13 and recent 15-year to 10-year time series (1991 – 2006) of data are depicted in Figure 13.

Table 13. Smolt to Adult Return (SAR) ratios for hatchery steelhead stocks in the Snohomish River Basin.

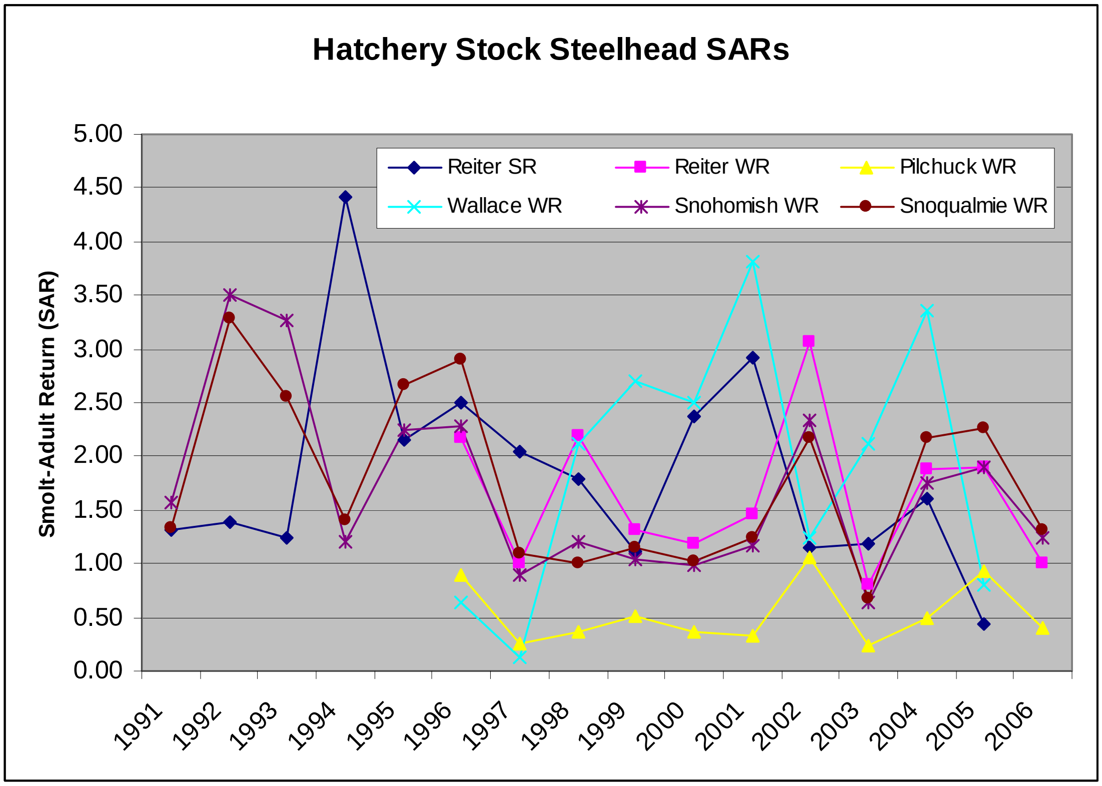
	Average		**Range**
Race/Location	**Period of Record Mean (%)**	**10-year Mean (%)**	**(%)**
Winter-Run			
Skykomish/Snohomish			
Pilchuck River[1/]	0.53	0.49	0.23 – 1.05
Wallace River[1/]	1.94	1.94	0.12 – 3.82
Reiter Ponds	1.55	1.58	0.80 – 3.06
Snoqualmie			
Tokul Hatchery	1.65	1.31	0.68 – 3.29
Snohomish Total	1.68	1.31	0.64 – 3.50
Summer-Run			
Reiter Ponds	1.77	1.71	0.43 – 4.41

Source: WDFW preliminary updated HGMP data from Dimmitt (2007).

1) Estimates based on sports catch records only of returning adults from smolt releases in specific tributaries.

WDFW data are provided for various returns in the basin including Reiter summer and winter-run fish, as well as winter-run fish returning specifically to the Wallace and Pilchuck rivers, and combined summaries of winter-run fish to both the Snohomish and the Snoqualmie basins. The data do not extend back to the early 1980s, so comparison of Snohomish with regional information shown in Figure 12 can only occur over the last 15 years. Basin specific data indicate slightly declining hatchery SAR trends for Reiter summer-run, and combined Snoqualmie and Snohomish winter-run stocks over the last 15 years. When viewed over the last

10-year period, SARs are stable or increasing in all winter-run hatchery stocks, but continuing declines are evident with summer-run stocks.



Source: WDFW preliminary updated HGMP data from Dimmitt (2007).

Figure 13. Time series of SAR indices for hatchery-origin steelhead smolts released into the Snohomish River Basin.

4. HATCHERY AND HARVEST MANAGEMENT PROGRAMS IN SNOHOMISH BASIN

4.1 DESCRIPTION OF HATCHERY MANAGEMENT PROGRAMS

Steelhead trout production facilities in the Snohomish Basin include Tokul Creek Hatchery, Reiter Ponds and Wallace River Hatchery for winter-run steelhead and Reiter Ponds for summer-run steelhead (Figure 9). Artificial production of steelhead in the Snohomish basin began in the early 1930s with construction of the Tokul Creek Hatchery (WDG 1986, WDFW 2002), but effective hatchery production techniques did not occur until methods shifted to planting yearlings in the 1950s (Pautzke and Meigs 1941). The facility at Reiter Ponds was developed on the Skykomish River in 1974 (HSRG 2002). The Wallace River Hatchery is temporarily used to rear a small portion of juvenile winter-run steelhead derived from broodstock and egg take collections at the Tokul Creek Hatchery (WDFW 2003a) and summer-run fish from egg take collections at Reiter Ponds Hatchery (WDFW 2003b; WDFW 2007). The purpose of these production programs is to generate recreational and tribal harvest opportunities, which currently provide approximately 8,000 winter and summer steelhead annually. Nearly 85 percent of the total hatchery run size is harvested on an annual basis when the adults return to the basin.

Like many of the Puget Sound area steelhead hatchery programs, winter-run steelhead hatchery production in the Snohomish Basin originates from the Chambers Creek steelhead program. The summer-run production originates from Skamania Hatchery stock (WDFW 2003b).

The NMFS describes the Chambers Creek stock as one that has substantially diverged from local natural populations (NMFS 2007). The Chambers Creek winter-run steelhead stock was founded in 1945 with the trapping of steelhead returning to Chambers Creek (Crawford 1979). However, the run is a composite stock derived initially from Green River stock among other local Puget Sound steelhead. It also consists of mixtures of non-local stocks including Nemah River and possibly other steelhead from the Washington coast (Royal 1972; Osteberg and Thorgaard 1999). The Chambers Creek individuals observed by Thorgaard (1983) had 59 chromosomes and may represent hybridization between 60 chromosome fish from Puget Sound and 58 chromosome fish from the Washington coast (Osteberg and Thorgaard 1999; refer to Section 5 *Genetic Differentiation*).

Through the use of warm well water, maturation of Chambers Creek steelhead adults was accelerated to provide an early and more uniform spawn timing. Subsequent egg incubation and rearing in warm water, in combination with the development of improved dry feeds, accelerated growth to produce larger smolts than normal. Throughout time, the earliest maturing fish were selected for spawning in the program, resulting in the advancement of average spawn timing from April to December and January for the Chambers Creek stock.

Hatchery, winter-run steelhead were transferred to Tokul Creek among many other hatcheries in the state. In the early years, local Tokul Creek native winter-run steelhead may have been incorporated into broodstock collections (integrated production). Currently, the program type is segregated. All hatchery fish are marked and only hatchery-origin fish are retained for broodstock (WDFW 2002; WDFW 2007).

The Skamania hatchery summer-run steelhead stock was founded in the 1950s from wild fish collected in the Washougal and Klickitat rivers in the lower Columbia River basin, Washington, and transferred to several other facilities where broodstock are now collected. As with the Chambers Creek winter-run steelhead stock, continued use of the earliest spawning summer-run adults resulted in an advancement in spawn timing.

Skamania hatchery-origin summer-run steelhead programs continue in the Snohomish River Basin. Hatchery populations founded using Skamania Hatchery summer-run steelhead are genetically distinct from Puget Sound populations (Busby et al. 1996; Phelps et al. 1997). Skamania summer-run steelhead differ from Puget Sound steelhead populations since they possess 58 chromosomes, in contrast to the 60 chromosomes commonly found in Puget Sound steelhead [see Section 5, *Genetic Differentiation*]. The NMFS describes the Skamania stock as one that has been derived from sources out of the Puget Sound Region and has undergone extreme divergence from local natural populations (NMFS 2007).

In the nearly 10 years since steelhead artificial propagation programs in Puget Sound were reviewed by Busby et al. (1996) there have been a number of independent studies of these programs, most notably by the Hatchery Scientific Review Group (HSRG 2002, 2003, 2004). Information from WDFW include recent release levels for winter-run and summer-run steelhead in the Snohomish Basin (Table 14).

In general, release levels of hatchery steelhead have remained relatively constant over the last two decades. Given declining SARs (Figures 12 and 13), it is reasonable to assume the level of hatchery adults returning to the basin over the last two decades has been decreasing despite stable juvenile releases. Hatchery-produced winter-run steelhead have been released in both the Snoqualmie and Skykomish basins (WDFW 2002, 2003a, 2003b). Hatchery produced summer-run steelhead have been similarly released in the Snoqualmie and Skykomish basins but they are of lower magnitude than the winter-run plants (Table 14).

Specific details of steelhead production at the facilities have been derived from the WDFW Future Brood Document (WDFW 2007), the Department's Hatchery Genetics Management

Plans (HGMPs) (WDFW 2002, 2003a, 2003b) as updated by Dimmitt (2007) with information generated from the WDFW Fish Plant database (Henderson 2008), WDFW historical database files (Gill 2006) and the SaSI plant database. Specific annual records of broodstock collections, egg take, station releases and subsequent sport and tribal catch, where available are included in Appendix D.

4.1.1 Basin Hatcheries

4.1.1.1 Tokul Creek Hatchery

The WDFW Tokul Creek hatchery is located at RM 0.5 on Tokul Creek, an eastbank tributary to the Snoqualmie River at RM 39.6 (Figure 9). Tokul Creek enters the Snoqualmie River immediately below Snoqualmie Falls, the upper limit for anadromous salmonid fishes. Tokul Creek Hatchery is a harvest-oriented facility that produces winter-run steelhead for the local fisheries. The WDFW anticipates releasing approximately 190,000 yearlings into the Snohomish basin (150,000 from Tokul Creek Hatchery and 20,000 each in the mainstem Snoqualmie River at the confluence of the Tolt River (RM 24.9), and in Raging River at Preston, WA (RM 7.5). Eggs for this purpose are collected and incubated at Tokul Creek Hatchery, where the resulting progeny are reared until release at 5 to 6 fish per pound (fpp). Operational considerations include marking all released juvenile fish and returning adults surplus to broodstock needs are released to the river at Tokul Creek to provide for sports fishing. The hatchery operation at this facility is anticipated to continue in a segregated (hatchery/wild) manner. A summary of key information related to winter-run steelhead production at the facility is included in Table 14 and itemized below:

- Tokul Creek Hatchery is the sole source of hatchery winter steelhead eggs for the Snohomish Watershed. It also serves as an egg source for other systems like the Green and the Skagit during years when shortages occur.

- The adult trap is located on a small feeder stream that drains into Tokul Creek. The adult trap is open from November through March, however, actual trapping of brood stock occurs from mid- to late-December through early February. The first spawning event is usually one of the days during Christmas week and spawning at this station occurs weekly through early-February.

- Egg take goal for the in-basin Snohomish Watershed programs is 640,000. However, total egg take may be more if other programs need to fill shortages with Tokul Creek eggs. Up to 2,000,000 eggs have been collected in the past.

- Tokul Creek performs the early rearing (i.e., hatching, button up, early fry). In August, Tokul Creek transfers 300,000 fry (100 fpp) to Wallace River for the Reiter Pond program and moves the remaining fry outside into earthen ponds at Tokul Creek.
- Fry are raised outside at Tokul Creek until they smolt and are released into the Snohomish River during the month of May. Production goal is for 190,000 smolts to be released into various areas of the Snoqualmie basin, with most being released on station (Table 14). Actual release may be slightly above or below the goal.

4.1.1.2 Reiter Ponds Hatchery

The Reiter Ponds Hatchery is a WDFW facility located just east of the town of Gold Bar on the mainstem of the Skykomish River at river mile 46 (Figure 9). Original operations began in 1974 and included the rearing ponds and migrant fish traps. Additional construction in 1988 included an incubation building, adult holding pond and fish ladder. Reiter Ponds is limited in its ability to incubate eggs so the operation of the hatchery is closely linked to WDFW's Wallace River and Tokul Creek hatcheries. Typically, eggs are eyed at Reiter Ponds and then shipped to either Tokul Creek Hatchery (if winter-run eggs are taken) or Wallace River Hatchery (summer-run) for final incubation and initial fry rearing. The juvenile fish are subsequently returned to Reiter Ponds in the fall (October) for final rearing and spring release. WDFW anticipates releasing 250,000 winter-run yearlings into the Skykomish River (145,000 at Reiter Ponds, 35,000 in the Pilchuck River, 15,000 each in the Sultan and Pilchuck rivers and 40,000 in the mainstem Skykomish River release site at RM 25.1; Table 14). Eggs for this purpose are collected from adults returning to Tokul Creek Hatchery, where they are incubated and the hatch early-reared prior to transport to Reiter Ponds.

WDFW also anticipates releasing 250,000 summer-run yearlings (WDFW 2007; Dimmitt 2007). Nearly two-thirds (160,000) are released on-site and additional 30,000 each are released in the Raging River, the mainstem Snoqualmie River and the Sultan River (Table 14).

Operational considerations at Reiter Ponds Hatchery include: (1) marking all released juvenile fish, (2) returning adults surplus to broodstock needs are released to the Skykomish river at Reiter to provide for sports fishing, (3) decreasing the overlap in spawn timing with the natural summer steelhead by early broodstock collection practices. Currently, summer steelhead broodstock collection at Reiter Ponds uses only the first 500 fish that return, a procedure that continues to select for early spawners to help decrease overlap in spawn timing with that of naturally spawning summer steelhead, (4) releasing juveniles in the mainstem Skykomish well downstream of areas used by naturally spawning summer steelhead to minimize interactions, (5) timing the releases when juveniles are ready for rapid outmigration (within a week of release). A summary of key information related to both summer- and winter-run steelhead production at the facility is included in Table 14 and itemized below:

- Reiter Ponds Hatchery is the sole source of summer steelhead eggs for the Snohomish Watershed. It also serves as an egg source for the Soos Creek and Whitehorse hatcheries.
- The adult trap is located on a small feeder stream along the Skykomish River. For summer steelhead, the trap is open from June through July or until brood stock collection efforts are complete. After sufficient brood stock is collected the trap is closed.
- The summer-run egg take goal is 950,000. Most eggs are transferred to Wallace River Hatchery for early rearing and the remainder is sent to Soos Creek (130,000) and Whitehorse (120,000) hatcheries.
- In October, Wallace transfers back 300,000 summer steelhead fry at 25 fish per pound to Reiter Ponds for final rearing to smolt size.
- The summer-run production goal is 250,000 smolts. Smolts are released into areas of the Snoqualmie and Skykomish basins during the month of May, but most are released on-site at Reiter Ponds.
- The winter-run production goal is also 250,000 smolts that are released into the Skykomish basin and Pilchuck River as itemized in Table 14.

4.1.1.3 Wallace River Hatchery

The Wallace River Hatchery is located between the confluence of May Creek and the Wallace River, near the town of Startup, Washington. The hatchery was originally known as the Skykomish Hatchery and dates back to 1907. The Wallace River Hatchery rears Reiter Ponds summer steelhead production from the time the eggs are eyed until the fish reach a size of 25 fish per pound, at which time they are transferred back to Reiter Ponds for final rearing. In addition, Wallace River Hatchery receives winter steelhead fry from Tokul Creek Hatchery, at 100 fish per pound that are eventually destined for Reiter Ponds. These fish are transferred to Reiter Ponds at the same time as summer steelhead, usually in October when the fish are approximately 25 fish per pound. A summary of key information related to winter-run steelhead production at the facility is included in Table 14 and itemized below:

- Wallace River Hatchery rears winter and summer steelhead for the Reiter Ponds steelhead programs.

- Wallace River Hatchery receives 300,000 summer steelhead eggs from Reiter Ponds and raised them to fry (25 fpp) prior to transferring them back to Reiter in October.

- Wallace River Hatchery receives 300,000 winter steelhead fry (100 fpp) from Tokul Creek Hatchery in August. Wallace River Hatchery rears winter steelhead fry until October to 25 fpp. Subsequently, fry are transferred to Reiter Ponds Hatchery for rearing until smolting (6 fpp).

- All fish are released under the Reiter pond program as described above, with the exception of 20,000 winter-run yearlings released on station directly into the Wallace River.

4.1.2 Hatchery Influence on Natural-Origin Steelhead Stocks

4.1.2.1 Ecological Interactions

Ecological interactions between hatchery and wild fish could take such forms as disease transmission or competition for food and space. Interaction between hatchery and natural stocks is minimized in the Snohomish Basin based on hatchery stock selection and broodstock collection timing. There is little overlap in spawning between natural and hatchery stocks of winter steelhead throughout the basin (Kraemer 1995). For more than a decade, spawning of returning hatchery stocks for brood stock replacement has been completed prior to the end of February (C. Kraemer, pers. comm., December 17, 2007). The initiation of wild fish spawning in the basin does not occur until early March, annually [Subsection 2.2, *Life-History, Spawning*; Table 3]. Steelhead trout in Washington have been bred to return early in the year with the hope that genetic, ecological and fisheries interactions with wild fish can be minimized (HSRG 2002, 2004). According to NMFS, the concept of temporal segregation of the stocks is scientifically supportable, however some small level of risk related to hatchery and wild fish interaction remains in some watersheds (NMFS 2007). Estimates of hatchery fish escaping to spawn naturally in the Snohomish Basin, based on known adult releases from the hatcheries, are less than 10 percent of total natural escapement (Table 15).

Table 14. Steelhead broodstock collections, egg take and juvenile releases from artificial propagation facilities in the Snohomish River Basin.

	Reiter Ponds		Tokul Creek	Wallace River Hatchery	
	Summer	Winter	Winter	Winter	Summer
Broodstock:					
Origin	Skamania	Chambers Creek	Chambers Creek	Chambers Creek	Skamania
Number Collected	300 - 600	[2/]	350 - 1,000	[2/]	[1/]
Annual Egg Take	0.6 to 1.0M	[2/]	0.64 to 2.0M	[2/]	[1/]
Annual Juvenile Releases					
Yearling Smolts	5.4 - 7.0 fpp	5.8 - 7.3 fpp	4.8 - 6.0 fpp		
Historical Planting Record	127,000 - 266,000	69,000 - 250,000	127,000 - 230,000	5,200 - 22,000	
Proposed Releases:					
<u>On-station</u>	160,000	145,000	150,000	20,000	*On-station*
<u>Off-station</u>					*Off-station*
Skykomish R. (33.3) @ Sultan R.		15,000			
Skykomish R. (25.1)		40,000			
Sultan River	30,000				
Snoqualmie R. (39.6)	30,000				
Snoqualmie R. (24.9) @ Tolt R.			20,000		
Raging R. (7.5) @ Preston			20,000		
Raging R. (0.0)	30,000				
Pilchuck R. (6.9)		35,000			
Wallace River		15,000			
<u>Out-of-Basin</u>					*Out-of-Basin*
Whitehorse Ponds (NF Stillaguamish)	30,000				
Soos Creek Hatchery (Green River)	112,000				
Total In-Basin Releases	250,000	250,000	190,000	20,000	*Total In-Basin*
Smolt to Adult Returns (SARs) [4/]					
Range	0.43 - 4.41%	0.80 - 3.06% [3/]	0.68 - 3.29%	0.12 - 3.82%	
Total mean	1.77%	1.55% [3/]	1.65%	1.94%	
10-yr mean	1.71%	1.58% [3/]	1.41%	1.94%	
5-yr mean	1.46%	1.73% [3/]	1.72%	2.27%	
Pilchuck R. Off-station SAR range		0.23 - 1.05%			

1) From Reiter Pond summer broodstock collection and egg take
2) From Tokul Creek winter broodstock collection and egg take
3) Combined Reiter Ponds and Wallace River production SARs
4) True SARs cannot be calcuated since not all fish accounted for as either harvest or returns to the basin.
Off-station returns and on-station fish recycled after meeting broodstock collection goals are not included in the SAR calculations.

Source: Dimmitt (2007); WDFW (2007)

4.1.2.2 Genetic Introgression

Domestication

Of the 30 steelhead programs reviewed by the Hatchery Scientific Review Group (HSRG) within the Puget Sound region, all but three (90%) utilized fish derived from either Chambers Creek winter-run steelhead or Skamania summer-run steelhead (HSRG 2002, 2003, 2004). The use of these two stocks, accounting for all of steelhead hatchery production in the Snohomish basin, raises concerns about their influence on the genetic diversity. The sole use of Chambers Creek stock for winter-run and Skamania stock for summer-run steelhead could increase genetic homogenization of the resource despite management efforts to minimize introgression of the hatchery gene pool into natural populations via separation of hatchery and natural run timing and high harvest rates focused on hatchery runs (NMFS 2005).

Hatchery-Origin Fish Spawning Naturally

Segregated hatchery steelhead programs in the Snohomish Basin provide an active harvest opportunity. The segregated steelhead programs outplant non-native stock with little provision for the recapture of returning adults. Busby et al. (1996) determined the presence of hatchery fish on the spawning grounds was widespread throughout the Puget Sound DPS, where they spawn naturally with wild fish. The estimated proportion of spawning escapement comprised of hatchery fish in Puget Sound streams ranged from less than 1 percent (Nisqually River, southern Puget Sound) to 51 percent (Morse Creek, along the Strait of Juan de Fuca). According to WDFW hatchery return and release data (Dimmitt 2007), hatchery proportions are on the low end in the Snohomish Basin ranging between 6 and 8 percent for winter and summer-run steelhead, respectively (Table 15). The HSRG determined the widespread stocking and outplanting of steelhead smolts poses ecological and genetic risks to naturally spawning populations, particularly in small streams that receive such outplants or to which hatchery-origin fish stray. The biggest concern is the genetic risk posed by the spawning overlap between the hatchery (Chambers Creek origin), early-timed winter run stock and the native, late-timed winter run stock. Regardless, when the HSRG made specific recommendations for the Snohomish Basin, they recommended the continuation of the segregated hatchery program using the early-timed Chambers Creek stock.

WDFW, on their SaSI website, suggest substantial temporal separation between hatchery and natural winter-run steelhead in this basin (see also HSRG 2002, 2003, 2004). Given the lack of strong trends in abundance for the stocks and the apparently limited contribution of hatchery fish to production of the winter-run stocks (Phelps et al. 1997), Busby et al. (1996) determined hatchery production of winter-run steelhead in Puget Sound contributes little to the viability of the naturally spawning steelhead populations. However, as discussed in Section 5, *Genetic Differentiation*, analysis by Phelps et al. (1994, 1997) indicated there was a high degree of similarity among the winter-run hatchery populations and natural populations collected in the Snohomish River basin. The finding of genetic markers from hatchery fish in juveniles collected throughout the Snohomish Basin suggests the small level of hatchery fish annually finding their way to natural spawning grounds has had, over time, a moderate to large influence related to gene flow (genetic introgression) between the stocks in the mainstem Skykomish and Tolt River reaches, a moderate influence in Raging and Pilchuck River reaches and limited, to no, influence in the NF Skykomish (Table 16). Kassler et al. (In Press) found wild fish in the SF Skykomish River upstream of Sunset Falls were a genetic mixture of wild and hatchery fish, with the parental origin dominated by the hatchery component (Section 5, *Genetic Differentiation)*.

Chilcote et al. (1986) reported reduced productivity of hatchery summer-run steelhead spawning naturally in S.W. Washington streams draining to the lower Columbia River system compared to natural–origin spawners. Similarly, hatchery summer-run steelhead reproductive success in the Clackamas River in Oregon was relatively poor (Kostow et al. 2003). Hatchery-origin spawners produced an estimated one-third the number of smolts per parent that wild steelhead produced (Kostow et al. 2003). There exists potential for a high level of genetic divergence between the hatchery stock and natural populations where straying and natural spawning may occur. Although the natural spawning success of hatchery-origin fish may be less than that of natural-origin fish when they occur in the same stream, the data indicate significant numbers of hatchery-origin fish from non-native or long-standing “domesticated” populations indeed spawn successfully and can contribute significant numbers of progeny to naturally spawning populations over time (Chilcote et al. 1986; Campton et al. 1991; Mackey et al. 2001; Kostow et al. 2003; McLean et al. 2003). There is evidence of naturalized populations of summer-run Skamania hatchery steelhead stocks in both the South Fork Skykomish and Tolt rivers in the Snohomish Basin (Kassler et al. in press; S. Conroy, pers. comm., November 6, 2007). According to the HSRG (2004), segregated hatchery facilities like those in the Snohomish Basin, should strive to maintain less than 5 percent hatchery-origin genes in a co-existing wild population.

4.1.2.3 Residualization

Some hatchery steelhead and other salmonid smolts become residuals (i.e., fail to outmigrate) after release. The problem appears to be particularly acute in hatchery programs that use wild broodstock (HSRG 2004). This practice is becoming increasingly popular as a means to limit genetic risk to wild salmonid fishes. Ironically, high rates of residualism of hatchery fish, if they mature to the point where they can spawn naturally, increase genetic and ecological risks to wild fish. Since the Snohomish steelhead hatchery program is a segregated program, the risk of residualization of hatchery fish is less than with an integrated program.

4.1.2.4 Outplanting

Steelhead programs in the Snohomish Basin use juvenile outplanting to support sport fisheries on returning adults in a number of locations (Table 14). A common feature of this approach is fish are released where no facilities exist to trap returning adults that escape target fisheries. Juvenile outplanting from segregated hatchery programs can be problematic, because of the potentially high level of genetic divergence between the hatchery stock and natural populations where straying and natural spawning may occur.

4.1.2.5 Disease

An additional ecological interaction could take the form of either disease transmission or increased susceptibility to diseases. Hatchery fish after release into the natural environment may harm wild fish populations by transmitting diseases. Currens et al. (1997) concluded genetic introgression with non-native hatchery rainbow trout also reduces the abilities of wild fish to withstand certain lethal diseases. Without such introgression the wild fish exhibited genetic resistance to the lethal disease.

4.1.2.6 Predation

There are several studies concerning potential predation of wild salmonid fry by hatchery produced steelhead but none specifically in the Snohomish River Basin. The regional studies related to the topic offer mixed results, perhaps due to differences in site characteristics and release strategies. Cannamela (1993) estimated that hatchery-reared steelhead smolts consumed up to 24,000 wild Chinook fry in the Salmon River, Idaho (ID), over the course of 50 days. These estimates were based on extrapolation from small sample sizes. Menchen (1981) found steelhead smolts released into Battle Creek, CA, were significant predators on naturally-produced Chinook fry. Beauchamp (1995) reported wild steelhead smolts were the primary predator of sockeye salmon fry in the Cedar River. However, hatchery-reared steelhead smolts, released during the latter half of the sockeye migration, did not appear to prey on sockeye fry. Conversely, Hawkins and Tipping (1999) observed only a small proportion of hatchery-reared steelhead smolts preying on wild Chinook smolts. WDFW looked at the stomachs of hatchery steelhead smolts collected at downstream smolt traps in the Deschutes and Green rivers, and found minimal numbers of salmonid fry (A. Blakely, pers. comm., January 2, 2008).

Given the large size of steelhead smolts released from hatchery programs it is often thought steelhead may prey upon other juvenile salmonid fishes. However, the magnitude of predation will depend upon the characteristic of the listed population of salmonids, the habitat in which the population occurs, and the characteristics of the hatchery program (e.g., release time, release location, number released, and size of fish released). The site specific nature of predation, and the limited number of empirical studies that have been conducted, make it difficult to predict the predation effects of any specific hatchery program.

In the absence of site-specific empirical information, the identification of risk factors may be a useful tool for reviewing hatchery programs. Risk factors for evaluating the potential for significant predation include environmental characteristics, relative body size, release date, location and type, and numbers of fish released. For instance, water clarity and temperature, channel size and configuration, and river flow are among the environmental characteristics that can influence the likelihood that predation will occur WDFW (2002). The potential for predation is greatest in small streams with flow and turbidity conditions conducive to high visibility.

Similarly, the potential for predation is limited by the relative body size of fish released from the program and the size of prey. Pearson and Fritts (1999) cite two studies on steelhead showing predation of salmonids up to 42 and 44 percent, respectively, of their body lengths. Hatchery steelhead in the Snohomish Basin are force-released on station during the first two weeks of May typically around 6 fish per pound to avoid smolt residualization (WDFW, 2002, 2003a, 2003b). Wild salmonid fry during this time period would typically range between 60 and 100 mm (2.5 to 4 inches) depending upon the species and growing conditions.

4.1.2.7 Competition

Studies empirically estimating the competition risks to wild salmonids posed by hatchery programs in the Basin are unavailable. Studies conducted in other areas indicate that hatchery programs are likely to pose a small risk of competition:

Steelhead released from hatchery programs as smolts typically migrate rapidly downstream. The SIWG (1984) concluded that "migrant fish will likely be present for too short a period to compete with resident salmonids." NMFS (2002) also noted that "..where interspecific populations have evolved sympatrically, Chinook salmon and steelhead have evolved slight differences in habitat use patterns that minimize their interactions……. (Nilsson 1967; …..Taylor 1991). Along with the habitat differences,….. steelhead show differences in foraging behavior. Peterson (1966) and Johnston (1967) [*in a tributary to the Pilchuck River*] reported ……that juvenile steelhead are bottom-oriented and feed largely on benthic invertebrates," which is different than most salmonid fishes that are mid-column or surface feeders focusing on invertebrate drift. Flagg et al. (2000) concluded, "By definition, hatchery and wild salmonids will not compete unless they require the same limiting resource. Thus, the enhancement strategy of releasing salmon and steelhead trout as smolts markedly reduces the potential for hatchery and wild fish to compete for resources in the freshwater rearing environment. Miller (1953), Hochachka (1961), and Reimers (1963), among others, have noted that this potential for competition is further reduced by the fact that many hatchery salmonids have developed different habitat and dietary behavior than wild salmonids." Fresh (1997) noted that "few studies have clearly established the role of competition and predation in anadromous population declines. A major reason for the uncertainty in the available data is the complexity and dynamic nature of competition and predation; a small change in one variable (e.g., prey size) significantly changes outcomes of competition and predation. In addition, large data gaps exist in our understanding of these interactions. For instance, evaluating the impact of introduced fishes is impossible because we do not know which non-native fishes occur in many salmon-producing watersheds. Most available information is circumstantial. ……Competition and predation are usually one of several plausible hypotheses explaining observed results."

On the other hand, Kostow et al. (2003) presented data supporting a conclusion that hatchery summer steelhead adults and their offspring may have contributed to wild winter steelhead population declines through competition for spawning and rearing habitats.

4.1.3 Hatchery Reform

In 2000, Congress created the Puget Sound and Coastal Washington Hatchery Reform Project, a systematic, science-based redesign of hatchery programs to help conserve wild salmon and steelhead populations; and to support sustainable fisheries. Funding: (1) established an independent, scientific panel to ensure a scientific foundation for hatchery reform; (2) provided a grant program for research on hatchery impacts, (3) supported state and Tribal efforts to implement new hatchery reforms, and (4) provided facilitation of a reform strategy by an independent third party. As part of the project, Congress established the Hatchery Scientific Review Group (HSRG) as the independent scientific panel at the heart of the reform process, and designated Long Live the Kings (LLTK) as the project's independent, third-party facilitator.

From 2001 through 2003, the HSRG systematically reviewed all hatchery programs in the Puget Sound and Washington coast area. Early in the process, the HSRG and the Coordinating Committee agreed hatchery programs should no longer be seen as surrogates for lost habitat. Instead, hatchery programs must be viewed as tools managed as part of an integrated strategy to meet watershed or regional resource goals, in concert with actions affecting habitat, harvest rates, water allocation, and other factors. They divided Puget Sound and the coast into ten regions, and made region-by-region recommendations based on: (1) regional management goals for conservation, harvest, and other purposes; (2) stock status (biological significance and population viability); (3) habitat status (current and future); and (4) the particulars of each hatchery program. The Snohomish River Basin falls within the HSRG basin:

- Stillaguamish/Snohomish Rivers

The HSRG's selected these two basins for administrative review based on the use of similar hatchery stocks and hatchery management procedures and since the mouths of each basin discharge to the same harvest management region in Puget Sound. They did not consider the genetic differentiation of the wild fish from the northern and southern Puget Sound population clusters as described in Section 5, *Genetic Differentiation*.

The HSRG's regional review process in the Snohomish River produced 12 program-specific recommendations, as well as a number of system-wide recommendations that affect programs across the Puget Sound Region as described below:

4.1.3.1 HSRG Recommendations

Area-Wide Recommendations

The HSRG released their area-wide recommendations for hatchery change in a final report in April 2004 (HSRG 2004). The report contained tools necessary to implement reform, including a scientific framework, a benefit/risk assessment model, a research program, monitoring and evaluation criteria, and new operational guidelines for hatcheries. The report featured nine white papers on emerging issues relevant to current hatchery management, such as the effect of changing ocean conditions on fisheries, preventing hatchery fish from preying on wild fish, and methods for preserving genetic diversity and fitness in hatchery populations. The HSRG area-wide recommendations for Puget Sound and coastal Washington are summarized below. Site-specific recommendations and a discussion of differences between the general and specific recommendations for the Snohomish basin follow in subsequent sections.

Develop a System of Wild Steelhead Management Zones. The Scientific Group recommended co-managers develop a system of “wild steelhead management zones” for each region in Puget Sound and coastal Washington, where streams are not planted with hatchery fish and are instead managed for native stocks.

Outplanting Recommendations. The HSRG recommended reducing risks associated with outplanting releases by reducing the number and/or size of such programs. Recommendations for reducing risks are described below. To remain true to the HSRG recommendation number scheme, we have included each of their outplanting recommendations, even though many appear to be similar or repetitious.

1) intense, selective harvest and/or the use of adult traps;

2 implementing the HSRG's system-wide recommendations for steelhead, to substantially reduce the geographic range of outplanting;

3) restricting release to areas where adult collection facilities are available or can be easily developed;

4 evaluating the benefits and risks of each program every two or three years, and reducing or terminating programs that impose significant risks relative to benefits;

5) monitoring and evaluating high risk programs to ensure that adverse effects to naturally spawning populations are minimal, straying risks are appropriately managed, and off-station releases are appropriately located; and

6) developing system-wide, risk management guidelines and protocols for outplanting programs.

7) Marking all outplanted fish each year, and tagging a significant proportion of released fish with coded-wire tags, to assess the direct contribution of those fish to targeted fisheries and to assess stray rates and biological risks to natural populations. Systematically tagging a portion of the released fish each year, coupled with marking all outplanted fish, will allow the co-managers to assess the degree these programs meet harvest goals while posing risks to natural populations.

8) Conducting intensive harvest of hatchery-origin fish and/or use adult traps to reduce potential natural spawning of unharvested, hatchery-origin fish.

9) Restricting releases of hatchery-origin fish to areas where adult collection facilities exist or can be easily developed. In some cases, adult traps can be added to existing smolt release ponds. In other cases, release sites can be restricted to streams with existing adult collection facilities. The wild steelhead management zones recommendations for steelhead would also help meet this recommendation.

10) Using locally-adapted and genetically integrated hatchery stocks for outplanting wherever possible. Minimize, or eliminate, the use of "out-of region" stocks and fish from genetically segregated hatchery stocks for these high-risk programs. Fish outplanted for harvest-driven programs should be obtained from genetically integrated hatchery stocks and/or stocks native to the region or watershed where the outplanting programs occur. One possible exception to this latter recommendation would be

hatchery populations that have been selectively bred, or otherwise manipulated genetically or phenotypically, for reproductive traits (e.g., spawn timing; Chambers Creek and Skamania stocks) that result in low probabilities of successful natural reproduction in the specific streams or geographic area where smolts are released.

11) Implementing the HSRG's recommendation for wild steelhead management zones to substantially reduce outplanting and thereby reduce risks to naturally spawning populations, especially where no adult collection facilities are present for trapping non-harvested adults.

12) Evaluating the benefits and risks of each program every two to three years. Programs imposing significant risks relative to benefits should be reduced or terminated.

13) Monitoring and evaluating high-risk programs annually to ensure that adverse effects to wild populations are minimal, that straying risks are appropriately managed, and that off-station releases are appropriately located such that non-harvested, hatchery-origin adults do not spawn in undesirable locations.

14) Developing system-wide risk management guidelines and protocols for outplanting programs.

15) On rivers with an upstream hatchery, adult return distribution may be minimally affected by downstream [*off-station*] smolt releases. Slaney et al. (1993) found small but significant release-site fidelity differences, and observed substantial dispersal of lower-river-released fish to the upper river near the rearing hatchery. Tipping and Hillson (2002) found that adult return distributions from downstream smolt releases were only slightly changed for winter steelhead, while summer steelhead were unaffected. The concern here is with imprinting of juvenile fish to their rearing environment and the proper subsequent return of adult fish to the hatchery. Downstream planting programs have a slight potential to increase adult returns to the planting site, increase straying and reduce adult returns to the hatchery.

The HSRG suggested these recommendations could be implemented as soon as possible as an alternative to terminating outplanting programs that are conferring significant fishery benefits.

Ecological Interaction Recommendations. When implementing a segregated steelhead program, it is important to minimize interaction with naturally spawning steelhead, through such tools as differential timing and a decision on benefits versus risks on out-planting in freshwater habitat. Area-wide recommendations to minimize ecological interactions include:

1) Incorporating adult collection procedures to capture adults that are not harvested from the returning segregated population.
2) Determining whether adult fish from the hatchery programs are straying to other regional streams and presenting risks to naturally spawning salmon.
3) Ensuring effective population sizes N(e) are greater than 500 adults to minimize genetic drift and the potential loss of alleles.

Predation Recommendations. Hatchery-reared yearling steelhead smolts have been identified as potential predators of wild salmonid fry. An initial step in hatchery reform to reduce the potential predation, the HWRG suggest tabulating the distribution of hatchery-reared yearling salmonid smolts and their potential salmonid prey to identify basins where predation by hatchery reared fish might be expected to be most important. A comparison of their release dates with the stream residencies of wild fry may identify periods when predation could occur. Hatchery steelhead generally smolt after one year and are released in May from the basin (WDFW 2002, 2003a, 2003b, Dimmett 2007).

The HSRG recommended strategy to estimate to potential risks to wild salmonid populations from hatchery-reared steelhead predation includes:

1) Describe Spatial and Temporal Overlap of Predators and Prey
2) Conduct Research to Estimate Predation Rates on Wild Salmonid Fishes
3) Develop Site-specific Models to Estimate the Risk of Predation by Hatchery-Reared Steelhead Smolts.

Site-Specific Recommendations

In February 2002, the HSRG made site-specific recommendations for hatcheries and all salmonid fish stocks in the 10 regions including the Snohomish River basin (HSRG 2002). Recommendations from the scientific review group for both the winter and summer steelhead hatchery programs in the Snohomish Basin include:

- Implement Area-Wide Recommendations regarding establishing a regional system of “wild steelhead management zones” where streams are not planted with hatchery fish and are instead managed for native stocks. Fishing for steelhead in these zones would be compatible with this approach, but no hatchery-produced steelhead should be introduced. Such zones would reduce the risk of naturally spawning fish interbreeding with hatchery fish, and provide native stocks for future fisheries programs. Establishment of wild steelhead management zones should reduce the chances of ecological and genetic interactions with hatchery steelhead and help to ensure the availability of founding stocks for hatchery purposes should the need for such stocks arise.

- Select streams [for wild steelhead management zones] to represent a balance of large and small streams, productivity, etc. Hatchery production may need to be increased in streams selected for hatchery harvest. The HSRG encourages the use of locally-adapted stocks for those streams.

- Minimize interaction with naturally spawning steelhead when implementing a segregated steelhead program through such tools as differential timing and a decision on benefits versus risks on outplanting in freshwater habitat. In addition, adult collection procedures should be designed to capture as many adults from the returning segregated population as possible. Organize a workshop to develop this concept.

- Include monitoring and evaluation as a basic component of the concept, for both wild steelhead management zones and hatchery harvest streams.

- Manage the hatchery stocks to maintain their current spawn timing. Maintain current summer steelhead broodstock collection practice, as it will help reduce overlaps in spawn timing with naturally spawning summer steelhead.

- Revise the spawning protocol to use single pair matings or five-by-five matings, to help ensure an effective-size spawning population.

- Release hatchery yearling steelhead smolts between May 1 and May 15, at a target size of six to the pound, and a condition factor of less than 1.0. [Condition factor (K) is a weight/length relationship describing the relative robustness, or degree of well-being of a fish. $K < 1.0$ is recommended to minimize the influence of smolt freshwater residualization].

- Continue to use the weir at Tokul Creek Hatchery to trap all salmonids and transport naturally spawning salmonids above the weir, so that these fish can take advantage of existing spawning habitat (an exception to the upstream transport would be naturally spawning salmonids deemed by the managers to pose an unacceptable [disease] risk to fish stocks held at Tokul Creek hatchery).

- Obtain an additional one cubic foot per second of spring water at Tokul Creek Hatchery for incubation and early rearing.

- Expand the Reiter Ponds facility to provide for incubation and early rearing of winter and summer steelhead, so that the need for rearing at Wallace River Hatchery is eliminated.

- Upgrade the water supply at Tokul Creek Hatchery and expand rearing capabilities at Reiter Ponds, for more efficient production of steelhead.
- Upgrade facilities for spawning and handling of adult steelhead.

Discussion of Site-Specific Recommendations

To fit the basin's needs, the HSRG site-specific recommendations for the Stilliguamish/Snohomish Rivers differed from the general area-wide recommendations with respect to the type of hatchery operations and smolt outplantings. The HSRG recommended continuing the segregated hatchery program in the basin, yet moderating the influence on naturally spawning steelhead by: (1) maintaining different spawning timing of the hatchery and wild stocks, (2) maintaining collection timing of hatchery stocks to reduce the overlap with wild fish, (3) specifically evaluating the benefits and risks of various outplantings, and (4) capturing as many returning hatchery adults as possible.

Given the popular steelhead sport fishery in the Snohomish River, this basin was one of the regions where the HSRG recommended the establishment of "wild steelhead management zones." Such zones could be established in the Basin in concert with the ongoing hatchery program. Regional biologists will need to fully evaluate the potential for wild steelhead management zones, but some areas appear well-suited for such management, including: South Fork Skykomish River upstream of Sunset Falls, North Fork Skykomish River upstream of Bear Creek Falls, upper Pilchuck River, and the North and South Forks of the Tolt River (C. Kraemer, pers. comm., December 23, 2007). Similarly, the Raging River upstream of Preston, WA might also fit with this concept. The South Fork of the Skykomish and both forks of the Tolt rivers are no longer planted with hatchery fish, but the wild stocks in these areas include a component of naturalized hatchery stocks (Kassler et al. in press). The upper Raging River is upstream of hatchery plants, but juvenile fish have the ability to migrate upstream. Genes from outmigrating smolts in the Raging River were found to exhibit a bit of hatchery influence (Phelps et al. 1994; Section 5 *Genetic Differentiation*, Table 16). Conversely, the North Fork of the Skykomish and the upper Pilchuck have not been previously planted. Stocks in these reaches are reflective of wild parental stock (Phelps et al. 1994, 1997). These stream reach areas may be more in line with the intent of HSRG recommendations to reduce the risk of naturally spawning fish interbreeding with non-native hatchery fish, and to provide native stocks for future fisheries programs.

The hatchery expansion recommendations at Tokul Creek, Reiter Ponds and Wallace River hatchers were included by the HSRG to minimize transportation of eggs and fry to the various facilities due to limited incubation or rearing space at each of the hatcheries. Upgrading the spawning and handling facilities of adult steelhead trout would allow returning adults to be collected at each hatchery, reducing the numbers of hatchery-origin fish escaping to the natural spawning grounds.

Out-planting at various locations in the basin is a concern for the hatchery program in the basin. At present 29 to 36 percent of the winter and summer-run hatchery yearlings, respectively, are planted off-station without provision for collecting hatchery-origin adults upon their return (Table 14). As an alternative to terminating out-planting programs that are conferring significant fishery benefits, the HSRG suggests hatchery programs implement the area-wide out-planting recommendations and evaluate the benefits and risks of each planting site on a routine basis.

4.2 DESCRIPTION OF HARVEST MANAGEMENT PROGRAMS

Snohomish River basin steelhead are managed by the Tulalip Tribes and the State of Washington pursuant to the Treaty of Point Elliott as interpreted by the federal court in *United States v. Washington* (1974) and subsequent court decisions. The co-managers (WDFW and The Tulalip Tribe) set conservation goals and management objectives for the steelhead resource. Tribal (commercial and subsistence) and non-tribal (sport) harvest seasons and other regulations are developed to meet these conservation and management objectives, subject to providing for equal allocation of harvest opportunity for the fish returning to the Snohomish River system. In recent years, the co-managers have determined harvest regulations based on a segregated hatchery management program with a constant escapement management strategy of 6,500 wild winter steelhead for the Snohomish Basin. Wild summer steelhead are managed to minimize incidental mortality in fisheries directed at other species or hatchery steelhead.

The Washington Department of Fish and Wildlife (WDFW) manages the non-tribal fishery for steelhead according to the jointly developed management plan discussed above. WDFW issues and is responsible for enforcing the state's fishing regulations, which specify fishery openings, gear restrictions, non-retention rules, and other requirements for harvesting steelhead in nearshore and/or freshwater areas. By state law there is no commercial fishing directed at steelhead since they are regarded as a game fish not a food fish. Recreational hook-and-line steelhead harvest occurs mainly in freshwater areas, although anglers are also allowed to target hatchery-origin steelhead in marine waters.

Recreational steelhead harvest is documented by means of catch record cards (CRC), which anglers are required to purchase and use to record all retained steelhead. The recorded catch from a fraction of CRCs is compiled and expanded to estimate the steelhead retained in recreational fisheries by area and month (Hahn 1997).

One of the most significant changes in WDFW harvest regulations occurred in 1993, when the sport harvest of wild winter steelhead was limited full-time to wild steelhead release (WSR) only. The Department used this strategy, as well as reduced daily limits and emergency closures on a sporadic basis since 1984 for both summer- and winter-run stocks when anticipated adult returns fell short of escapement goals. In this manner, sportsmen only harvest hatchery steelhead. The restriction of releasing all wild fish remains in force today for all fresh waters in the Snohomish Basin. All hatchery juveniles are marked with an adipose fin clip such that returning adults can be readily identified for this purpose. There are no comprehensive estimates of steelhead hooked and released in recreational fisheries. Formerly, a number of court-ordered creel censuses occurred to estimate recreational harvest in winter fisheries, but these surveys have been terminated due to lack of funds.

The Tulalip Tribes manages their fishery for steelhead according to the jointly developed management plan discussed above. The tribe issues, and is responsible for enforcing, their own fishing regulations, which specify fishery openings, gear restrictions, non-retention rules, and other requirements for harvesting steelhead in nearshore and/or freshwater areas. Tribal harvest consists of three categories:

- Commercial catch sold into the wholesale or retail markets,
- Subsistence catch for personal consumption, and
- Ceremonial catch taken for religious and other ceremonial purposes.

All catch is verified and recorded by the tribal fisheries management department, and the data entered to a shared database jointly maintained by the tribes and WDFW. Tulalip tribal harvest directed at winter steelhead is currently limited to low levels used for direct sales and ceremonial and subsistence purposes. Incidental harvest of winter and summer steelhead in other tribal fisheries is very small. All harvest of steelhead in Tulalip tribal fisheries is recorded on treaty Indian fish receiving tickets, except for some hook-and-line harvest, which is recorded on tribal catch record cards.

Tribal harvest of wild fish has also been reduced considerably but a small number of wild fish may be inadvertently collected with terminal and in-river fisheries that target hatchery steelhead stocks (December through January). Timing of the harvest to focus on the early returning hatchery winter-run fish helps to minimize the by-catch of wild fish. However, over the past few years, tribal fishing schedules have changed in a manner that winter steelhead fisheries are open during most of the winter (December – March). This shift in fisheries adds a slight risk of landing wild winter steelhead. Nevertheless, reported harvest of wild fish remains very low.

WDFW's shared database, comprised of summaries of tribal and recreational catch of steelhead from the basin, include both summer and winter-run annual harvests for the combined Snohomish basin over the last three decades. WDFW sports' catch record cards (CRC database) can be queried for site-specific information, but the tribal data cannot be separated by major river tributaries.

Current harvest levels (5-yr geometric means) are summarized in Table 15. Results suggest nearly 8,000 hatchery-origin steelhead are harvested from the basin annually. This harvest represents nearly 85 percent of the total hatchery run size returning to the Snohomish River. The ratio of recreational catch between winter and summer-run fish is nearly 2:1. Tribal harvest is nearly 100 percent from the winter run. The Tribes incidentally harvest less than 10 summer-run steelhead per year in fisheries targeting Chinook and coho salmon.

Table 15. Current steelhead escapement, harvest and total run size estimates for the Snohomish River Basin[1/].

	Escapment				Harvest				Total Run		
	Natural Origin	Hatchery Origin (HOR)			Hatchery Origin		Natural Origin (NOR)				% Contribution of Released
Steelhead Race	(NOR)	Return	Broodstock Collection	Released	Sport	Tribal	Sport	Tribal	(NOR)	(HOR)[3/]	HOR to NOR[4/]
Winter-run	4,000	900	660	240	5,200	200[2/]	50	5	4,000	6,300	6%
Summer-run	1,000	500	425	75	2,500		40	5	1,000	3,000	8%
Combined	5,000	1,400	1,085	315	7,700	200	90	10	5,000	9,300	

	Escapment	Harvest	Total Run
Total Run Size[5/]	6,400	8,000	14,400

Source: WDFW Shared Database; WDFW HGMP 2002, 2003a, 2003b as updated by Dimmett (2007)

1) Most recent 5-yr geometric mean (2002-2006) in round numbers.
2) Values are reported from WDFW Shared Database and Dimmitt (2007)
3) Hatchery origin returns represent 65% of the total Snohomish River steelhead run (61% winter-run; 75% summer-run)
4) At the basin scale; does not include hatchery-origin fish returning to off-station release locations.
5) Both races; hatchery and wild.

5. GENETIC DIFFERENTIATION

Allendorf (1975) identified two major steelhead (*O. mykiss)* lineages in Washington, the inland and coastal forms of steelhead trout that are separated by the Cascade Crest. More recent chromosomal studies indicated steelhead from the Puget Sound area have a distinctive karyotype not found in other regions. Chromosome studies of native steelhead and resident rainbow trout populations in western Washington and southern British Columbia revealed the presence of two evolutionarily distinct chromosome lineages Thorgaard (1977, 1983). Populations between the Elwha River, WA and Chillwack River, BC contained 60 chromosomes, while populations on the central Washington coast contained 58 chromosomes. The north Washington coast and western Strait of Juan de Fuca contained individuals with 58, 59 or 60 chromosomes. The authors suggested this area is a transition zone between the 58 and 60 chromosome groups. Further studies by Ostberg and Thorgaard (1994, 1999) verified this pattern through more extensive testing of native-origin populations.

Consistent with the genetic findings of Ostberg and Thorgaard, (1999), there appears to be a sharp transition in life history traits, between steelhead populations from Washington, which smolt primarily at age 2, and those in British Columbia, which most commonly smolt at age 3. This pattern holds for comparisons across the Strait of Juan de Fuca as well as for comparisons of Puget Sound and Strait of Georgia populations. This pattern may be more reflective of thermal regimes experienced during incubation and rearing than genetic differences between the northern and southern populations.

Leider et al. (1994, 1995) and Phelps et al. (1994, 1997) reported results from an extensive survey of Washington State anadromous and resident *O. mykiss* populations. Populations from Puget Sound and the Strait of Juan de Fuca were grouped into three clusters of genetically similar populations: 1) Northern Puget Sound (including the Stillaguamish River and basins to the north, 2) Southern Puget Sound, and 3) the Olympic Peninsula (Leider et al. 1995). Genetic samples from the Nooksack River differ from other Puget Sound populations, and may reflect the genetic transition zone or discontinuity in northern Puget Sound (Hard et al. 2007). The Snohomish Basin steelhead fall into the Southern Puget Sound Genetic Diversity Unit (GDU #2).

5.1 DIFFERENTIATION BETWEEN SNOHOMISH RIVER BASINS

According to Phelps et al. (1994), many distinct gene pools exist for steelhead trout, but Snohomish Basin stocks appeared relatively similar to one another. Summer-run steelhead in the NF Skykomish were genetically the most distinct stock in the basin, showing a close relationship to both wild summer-run stocks in western Washington and to hatchery summer-run Skamania stock. Summer-run steelhead are presumed to have evolved from within both coastal and inland ancestral lineages (Leider et al. 1994). Phelps et al. (1994) felt the genetic relationship of the NF Skykomish summer-run was consistent with both ancestral lineages and the expectation that Bear Creek Falls acts as a partial or complete barrier to winter-run steelhead passage into the upper NF Skykomish River.

Steelhead from the Pilchuck River had a unique allele that had not been observed in any other steelhead or rainbow trout previously examined. Similarly fish collected from the Snoqualmie River exhibited a unique allele. A discovery of localized alleles suggests an extent of reproductive isolation between populations spawning in the various basins Phelps et al. (1994).

Kassler et al. (in press), determined the ancestry of adult summer-run steelhead returning to Sunset Falls on the South Fork of the Skykomish River was mixed but dominated by Skamania hatchery stock planted above the falls between 1975 and 1992. The analysis suggested the hatchery stock had naturalized and had been present in the genetic structure for multiple generations (Kassler et al. in press).

5.2 SUMMER-RUN VS WINTER-RUN

For the most part, summer and winter-run steelhead are quite similar genetically (Chilcote et al. 1980; WDFW 2006). There appears to be some (slight) genetic differentiation between summer and winter run populations in Puget Sound, based on the presumed evolution of summers from two lineages (coastal and inland) and winter-run from within only the Washington coastal lineage (Leider et al. 1994). However, for some stocks, Phelps et al. (1994) suggest summer and winter stocks evolved from within the same original lineage retaining comparable genetic structures. Phelps et al. (1997) found summer and winter-run fish are generally more similar within a given GDU than are fish with the same run timing in different GDUs.

Leider et al. (1994) concluded one should not infer that summer and winter-run fish at a given location form a single interbreeding population. Rather, the inference should be that summer and winter-run fish at a given location may share common ancestry. Although genetically similar and derived from similar evolutionary lines, noted differences in allele frequencies between summer and winter-run fish indicate they should be treated as distinct stocks (Phelps et al. 1997). We found no data from the Snohomish basin indicating substantial genetic differentiation between summer and winter-run stocks.

5.3 HATCHERY VS WILD

Genetic analysis by Phelps et al. (1997) indicated a high degree of similarity among the hatchery populations of winter steelhead trout. Within Puget Sound, hatchery populations of winter-run steelhead in the Skykomish and Tokul rivers, show a high degree of genetic similarity with

Chambers Creek stock (Phelps et al. 1994). There is also a close genetic association between natural and hatchery populations in the Pilchuck, Raging, mainstem Skykomish, South Fork Skykomish and Tolt rivers, suggesting a high level of genetic exchange (Table 16). Conversely, hatchery populations founded using Skamania summer-run steelhead were genetically distinct from native Puget Sound populations (Busby et al. 1996; Phelps et al. 1997). Skamania summer-run steelhead from Puget Sound possessed the 58 chromosomes characteristic of south coast and interior stocks, in contrast to the 60 chromosomes commonly found in Puget Sound steelhead trout. The naturally sustained steelhead population in the North Fork Skykomish River is genetically distinct from other steelhead stocks in the basin, apparently with minimal hatchery introgression (Phelps et al. 1994).

Phelps et al. (1997) were specifically asked in the updated review of their 1994 paper, to examine the genetic impacts due to interbreeding of hatchery and wild steelhead as the result of management practices of stocking hatchery-origin fish into wild populations. Using protein electrophoresis, Phelps et al. (1997) evaluated the amount of gene flow over the last 20 years between Chambers Creek hatchery stock and winter steelhead collected in the wild by comparing genetic chord distance. A narrowing of chord distances would imply stocks have become more similar via flow of genetic material over the 20-year period since Allendorf's (1975) review, while divergence of chord distance would imply gene flow from hatchery to wild fish is small relative to other forces shaping allele frequencies. Since Allendorf (1975) did not include samples from the Snohomish River basin, a site-specific analysis could not be conducted. Comparisons of samples from Northern Puget Sound (GDU #8), indicate gene flow from hatchery to wild populations has been minor and not widespread over the past 20 years. This result suggested a large degree of reproductive divergence between hatchery and wild winter-run steelhead trout. Similarly, the authors concluded the summer-run Skamania Hatchery stock have not had a large amount of gene flow into winter-run populations in Puget Sound (Phelps et al. 1997).

Although information on genetic and ecological interactions between natural and hatchery-origin steelhead within Snohomish Basin populations is largely unavailable, studies conducted by Phelps et al. (1994) indicate hatchery genetic contribution for stocks in the Snohomish basin varied from limited to a large amount depending upon the local population, as shown in Table 16.

Table 16. Estimates of potential hatchery contribution to the genetic structure of collected steelhead trout in the Snohomish River Basin.

Stock/Run/Drainage	Relative Contribution of Hatchery Stock to Natural Stock Gene Structure	Estimates of Maximum Likelihood of Hatchery Contribution	Hatchery Stock
Winter-run			
Skykomish-Mainstem[1/]	Moderate-Large	76%	Chambers Creek
Raging[1/]	Moderate	33%	Chambers Creek
Pilchuck[1/]	Moderate	27%	Chambers Creek
Tolt[1/]	Moderate-Large	58%	Chambers Creek
Summer-run			
NF Skykomish[1/]	Limited		Skamania
SF Skykomish[2/]	Moderate-Large	69 - 81%	Skamania
Tolt[1/]	Moderate-Large	58%	

Source: 1) Phelps et al. (1994); 2) Kassler et al. (in press)

Based on a complement of 58 chromosomes, the authors felt the NF Skykomish stock may have originally been derived from south coast, with limited hatchery introgression in recent times. All fish in the basin, with the exception of the NF Skykomish summer stock, showed moderate to large amounts of introgression from hatchery strains (Phelps et al. 1994).

Kassler et al. (in press), using microsatellite DNA, concluded the steelhead population in the South Fork Skykomish River upstream of Sunset Falls, is dominated by naturalized Skamania Hatchery stock, that were planted above the falls from Reiter Ponds Hatchery between 1975 and 1992. Returning summer steelhead at sunset falls were found to be a mixed genetic sample of two ancestries, a hatchery-origin group characteristic of Skamania summer stock and a natural-origin group representative of North Fork Skykomish wild stock. The authors found the returning steelhead had 69 percent ancestry in the hatchery group and 31 percent ancestry in the natural-origin group (Kassler et al. in press). The mixed ancestry of the South Fork Skykomish population indicated the hatchery steelhead have reproduced naturally for multiple generations (Kassler et al. in press).

A recent pilot study in the Tolt River looking at summer steelhead karyotypes, found fish with 60, 59 and 58 chromosomes confirming the presence of native fish, hatchery fish and fish with native/hatchery hybrid karyotypes in adult Tolt summer steelhead (S. Conroy, pers. comm., November 6, 2007). The sample size was not sufficient to make additional extrapolations concerning the relative abundance or distributions of each group of fish along channels in the Tolt River basin. The summer steelhead karyotypes in the Tolt are consistent with two distinct phenotypes, early-spawning "green back" colored fish (assumed to be naturalized population from hatchery stock) and a late-spawning blue back population characteristic of other wild stocks in the area (C. Kraemer, pers. comm., December 17, 2007).

Despite the divergence in run and spawn times between hatchery-origin and natural-origin winter-run steelhead, a small potential for interbreeding effects remain, given the large number of returning hatchery fish and the small number of natural-origin fish. According to the BRT, a threat from hatcheries to Puget Sound steelhead comes from past and present hatchery practices involving hatchery stocks that were either founded outside the ESU or have undergone extensive hatchery domestication (NMFS 2007, 72 FR 26722).

Low levels (e.g., <5%) of gene flow per year from a non-ESU hatchery stock to a naturally spawning population can have a significant genetic impact after several generations. The presence of the hatchery fish is likely to pose an ecological threat to wild fish through competition in estuaries and marine environments, manifested as reductions in density-dependent growth and survival at critical life-history stages (NMFS 2007, 72 FR 26722). Refer to discussion of ecological interactions between hatchery and wild fish in Section 5.3, *Hatchery Influence on Natural-Origin Steelhead Stocks*

5.4 ANADROMOUS VS RESIDENT

Few specific genetic studies between anadromous and resident life history forms of steelhead trout have been conducted. Current information demonstrates native, resident populations of *O. mykiss* are often similar to the genetic population structure of steelhead. However, the genetic relationship is unclear in Puget Sound streams since some streams show little genetic differentiation between resident rainbow and anadromous steelhead while others streams are differentiated (Phelps et al. 1997). There is genetic support for the hypothesis that resident life-history forms of *O. mykiss* developed from the anadromous form because greater genetic similarity often occurs between the two forms within a basin instead of between the same life-history types in different basins (Phelps et al. 1994; Phelps et al. 1997; Docker and Heath 2003). Leider et al. (1995) indicate a close genetic association between anadromous and resident rainbow trout in both the Cedar and Elwha rivers.

Pearsons et al. (2003) evaluated the potential for gene flow (genetic introgression) between Yakima Basin resident and anadromous *O. mykiss* using ecological and genetic data. Although anadromy appears to have some genetic basis (Phelps et al. 1997; Thrower et al. 2004), Pearsons et al. (2003) found resident and anadromous forms of wild rainbow trout in the North Fork Teanaway River were genetically indistinguishable.

Using otolith microchemistry, Phelps et al. (1997) was able to identify the maternal life-history of the juvenile steelhead from the Hamma Hamma River and found significant differences in allele frequencies between steelhead classified as having either resident or anadromous mothers. This finding suggested the anadromous and resident forms were not interbreeding in the Hamma Hamma system. The authors also noted significant disequilibrium among gametes in 5 of 16 populations (31%) in Puget Sound, implying reproductive isolation between the resident and anadromous fish. The corollary implies 69 percent of the populations did not exhibit reproductive isolation. Samples from two rivers, where both resident and anadromous life history forms occur, were collected from the Snohomish Basin including two years from the Pilchuck River and one from the Tolt River. The Tolt samples were significant at the $P < 0.1$ level, implying the spawning of resident and anadromous steelhead forms was isolated.

Phelps et al. (1997) conclude there is no clear answer on gene flow between resident and anadromous population since the amount of gene flow varies considerably among streams. Site-specific habitat conditions present in each stream will likely dictate the relationship between the two life-history forms.

Whether the resident form contributes to ESU viability through productivity, spatial structure, and diversity remains unknown and is a knowledge gap in the understanding of the relationship between life-history forms of rainbow trout. Evidence is growing from several studies that the resident form can retain the genetic basis for anadromy over periods of several decades or more. Whether the genetic basis of anadromy is maintained in the resident form is not known for any Puget Sound *O. mykiss* population.

6. DATABASE SUMMARY

The following sixteen database files were reviewed for the Snohomish Basin Steelhead Trout, State of the Knowledge report. In this section of the report the information in each database is summarized and a statement concerning their relative value to steelhead recovery planning in the basin is provided:

1) WDFW Steelhead Historical Shared Database Files (Gill 2006).
2) WDFW Fish Plant Database (Henderson 2008).
3) SASSI/SaSI Records.
4) WDFW Catch Record Card (CRC) Database.
5) HGMP Records (Dimmitt 2007).
6) WDFW Spawning Ground Survey Database.
7) WDFW Sunset Falls Fish Trapping Annual and Summary Data Reports.
8) SSHIAP.
9) SalmonScape/StreamNet.
10) Snohomish County GIS Layers.
11) King County GIS Layers.
12) Tulalip Tribes, juvenile steelhead outmigrant trapping data at Skykomish and Snoqualmie Screw Traps (Nelson 2007; Nelson and Kelder 2004).
13) WDG (1986) Snohomish Winter Steelhead Resource Inventory.
14) WFC Culvert Database.
15) WFC Tolt Snorkel Surveys.
16) WFC Water Typing Data Surveys.

6.1 WDFW STEELHEAD HISTORICAL SHARED DATABASE FILES

The WDFW shared steelhead historical database files include sports and tribal harvest estimates, escapement, total adult run size estimates and smolt releases for hatchery and wild winter-run and summer-run steelhead trout from river basins throughout the state. The database for the Snohomish River (WRIA 07) contains summarized information for both winter (1962 to 2005) and summer-run steelhead (1978 – 2005) for all combined watersheds in the basin and for summer-run steelhead (1985 – 2003) in the Tolt River. This database file, current as of July 28, 2006, can be accessed at:

http://wdfw.wa.gov/fish/papers/steelhead/puget_snd_esu.pdf

It represents the co-managers approved annual estimates for these statistics and the controlling numbers to base long term trend information upon. We relied heavily upon these numbers for presentation of materials in this document. Since all of the information incorporated therein has been processed and agreement reached by all parties concerning their applicability as the best available information, we view this database as one of the HIGHEST values for Snohomish Basin staff in their efforts to contribute to the upcoming steelhead recovery planning process for steelhead in the Puget Sound DPS.

There are some shortcomings in the database files. In general, the preponderance of information is summarized for the entire basin and except for summer-run fish in the Tolt River, the data have not been partitioned into various component subbasins in a manner needed to address the status of the six stocks, especially for the winter-run fish. This data gap places the basin staff at a disadvantage with respect to applying information equally for each of the stocks. Tribal harvest data may not be able to be partitioned into fish from various subbasins, since most of the harvest occurs at the mouth or in the lower river. The SaSI database [Database #3] help in differentiating individual stock abundances in this regard.

Specific shortcomings in the database follow:

6.1.1 Winter-Run Steelhead (Basin):

- Tribal harvest is only reported separately for hatchery and wild fish between 1981 and 1993. All other years between 1977 and 2005 are reported as a combined total of hatchery and wild fish.

- Sports harvest is only reported separately for hatchery and wild fish between 1981 and 2005. Between 1962 and 1980 the origin of the fish is not differentiated.
- Hatchery escapements are only reported as the total number of fish trapped at the hatchery. Therefore, total hatchery run size components such as fish that spawn or die below the hatchery, fish that are recycled or released to the stream and become trapped again, or fish that pass the trap undetected are not counted.

6.1.2 Summer-Run Steelhead (Basin)

- Tribal harvest is only reported for hatchery and wild fish combined. Since the late 1980s, the tribal catch of summer-run fish is very low due to seasonal fishery schedules.
- Sport harvest of wild summer-run fish have been wild steelhead release (WSR) since the mid-1980s. C. Kraemer believes the sports harvest numbers for wild fish reported in database must be punch card (CRC) errors (C. Kraemer, pers. comm., December 17, 2007).
- Since there are no reliable escapement estimates for the North Fork Skykomish River system, no basinwide estimates of wild escapements or run size are available.
- Summer-run hatchery escapements and total run size are not included

6.1.3 Summer-Run Steelhead (Tolt)

- Tribal harvest data are not included, but the numbers of summer-run taken by the tribe are inconsequential. The total run size for the wild stock should be properly represented in the database.
- The hatchery escapement and total run size are not reported although hatchery sports harvest from the Tolt River are included. It may be difficult to differentiate fish origin of the redds constructed naturally in the basin each year.

6.2 WDFW FISH PLANT DATABASE

Washington Department of Fish and Wildlife, Historical Fish Planting Database (1933- 1994). This WDFW database has been queried for historical releases of juvenile steelhead trout into WRIA 07 waters. Data include all reported WDFW, Tribal, WDFW-Cooperatives, Regional Enhancement and Sportsman Groups, and federal fish plants. Contact: Kelly Henderson, WDFW. The WDFW caution that the data may be "unverifiable and incomplete."

The database includes fields for:

- Release site
- Location
- County
- Section, Township, Range
- Hatchery Facility
- Date
- Species/Race
- Stock
- Brood Year and Origin
- Life History Class
- Size

Internet access to an electronic database for the historical hatchery plants is not available. WDFW forwarded a excel spreadsheet summary of steelhead planting records in the Snohomish Basin. Hatchery plants from the various artificial production facilities have been summarized in the HGMP (Database #5) and in Tables 20 and 21A in the WDG Snohomish Basin Winter Steelhead Resource Inventory (Database #12). All steelhead releases in the South Fork Skykomish River upstream of Sunset Falls were summarized in Table 1 of Kassler et al. (In Press). Both of these sources are included in Appendix E. The full WDFW fish planting database for rivers, streams and lakes in the anadromous fish zone in Snohomish County is on file at R2 Resource Consultants, Inc.

We anticipate the fish release information will be of MODERATE importance to Snohomish basin staff since off-station hatchery plants can influence the genetic integrity of wild fish. Understanding the history of planting can be used as a diagnostic tool to understand current trend information in various reaches and it might be of HIGH value in helping to define and isolate Wild Steelhead Management Zones in the Snohomish Basin as recommended by the Hatchery Scientific Review Group (HSRG, 2002, 2004).

6.3 SASSI / SASI RECORDS

The Salmonid Stock Inventory (SaSI) tabular database is managed by the Washington Department of Fish and Wildlife (WDFW) Fish Program, Science Division. SaSI is a standardized, uniform approach to identifying and monitoring the status of Washington's salmonid fish stocks. The inventory is a compilation of data on all wild stocks and a scientific determination of each stock's status as: healthy, depressed, critical, unknown, or extinct. SaSI thus is a basis for prioritizing recovery efforts and for measuring the results of future recovery actions. SaSI is a cooperative product of the Washington Department of Fish and Wildlife and the tribal co-managers. SaSI development began in 1992, as an effort by 20 western Washington tribes and the Washington Department of Fish and Wildlife's predecessor agencies, the Washington Department of Fisheries and the Washington Department of Wildlife. At that time the inventory was called the Salmon and Steelhead Stock Inventory (SASSI). The SASSI documents produced in 1993-4, totaling some 2,600 pages described and categorized the status of 435 salmon and steelhead stocks. When the documents were updated to include char and cutthroat trout in the late 1990s, the process was re-named Salmonid Stock Inventory (SaSI). To directly access these databases go to SaSI (2002; http://wdfw.wa.gov/fish/sasi/) and SASSI (1992; http://wdfw.wa.gov/fish/sassi/sassi.htm). An updated stock review would be appropriate since 5 years of additional data have modified a number of stock trends in the basin. Because the tabular data are shown spatially in Database #8 and the original data are included in the WDFW historical shared database files [Database #1] accessing these records are only of MODERATE value for the basin steelhead recovery planning efforts.

6.4 WDFW CATCH RECORD CARD (CRC) DATABASE

This information is included in Database # 1 (WDFW Historical Shared Database files) above. Additional sport catch summaries for winter steelhead based on punchcard returns are provided by subbasin from 1947 to 1986 (see Database # 13 – Snohomish Winter Steelhead Resource Inventory, Table 25 below). Reviewing the CRC database records themselves, would likely be of LOW value for the Snohomish basin staff in assessing the recovery planning efforts. The final results of how the Department uses this information to determine annual escapement estimates reported in Database #1 is of the utmost value.

6.5 WDFW HATCHERY GENETIC MANAGEMENT PLAN (HGMP) RECORDS

Under ESA coordination, the Department of Fish and Wildlife responded to National Marine Fisheries Service (NMFS) request for all artificial propagation facilities to prepare hatchery genetic management plans to minimize adverse effects on listed species. The Department prepared plans for winter steelhead production at Tokul Creek (WDFW 2002) and at Reiter Ponds (WDFW 2003a) and for summer steelhead production at Reiter Ponds (WDFW 2003b) to address the influence of these facilities on listed Chinook salmon and bull trout. The Department is in the process of updating these plans to address the recent steelhead trout listing in Puget Sound. Kent Dimmitt, WDFW, forwarded data tables and draft text of the updated effort to R2 Resource Consultants for this State of the Knowledge Report (Dimmett 2007). The updated HGMP information has been included in its entirety as the attached Appendix D. This information includes proposed production and release data from the Department's annual Northern Puget Sound Future Brood Document (WDFW 2007).

6.6 WDFW SPAWNING GROUND SURVEY DATABASE

An electronic (MS Access) copy of the spawning ground survey database maintained by WDFW was provided by Gil Lensegrav (WDFW Fish Program; Spawning Ground Survey and SaSI data manager). Data included only steelhead surveys from WRIA 7. While the database contained information from a few supplemental surveys dating back to 1976, the earliest data from index surveys was from 1984. However, more comprehensive data are only provided from 1995 to 2003. Very little data were provided from surveys occurring after 2003.

The database is organized by individual survey (i.e., each database record reflects an individual survey) and includes the following relevant fields:

- Survey ID
- Survey date
- Stream name
- Stream catalogue code
- Lower end of survey reach (river mile)
- Upper end of survey reach (river mile)
- Surveying agency
- Survey type (index or supplemental)
- Survey method (foot, boat, raft, helicopter, snorkel)
- Flow (high, medium, low, unknown)
- Visibility (excellent, good, fair, poor, unknown)
- Live count
- Dead count
- Total count
- Percent seen
- New redds
- Comments

Except for two surveys by Beak Consultants (Youngs Creek) and four surveys by the Tulalip Tribes (Pilchuck River and SF Tolt River), all surveys described in the database were completed by WDFW (n=1,186). The total numbers of index and supplemental surveys were 1,107 and 85, respectively.

Discussions with the co-managers following review of the preliminary draft of this report indicated that additional spawning surveys were performed though the data are not included in the database. We reviewed the Snohomish Winter Steelhead Resource Inventory binder (WDG 1986) for additional spawning survey data and identified redd counts reported for the Pilchuck, Wallace, Snohomish/Skykomish, Ragin, Snoqualmie, NF Skykomish, SF Skykomish, and Tolt rivers from 1980/81 to 1985/86. Unlike the electronic database, these records only provide total redd counts for respective subbasins as a whole and do not provide survey reach lengths that would facilitate the calculation of redd/spawner densities. The existence of these records indicates the spawning survey database is not comprehensive.

Because the spawner database provides, by far, the most extensive and detailed record of steelhead distribution and abundance in the Snohomish basin, it is of *HIGH* value to the basin recovery planning efforts, despite apparent data gaps. Conversations with the database manager indicated that data are imported to the database as they are received from district biologists. As such, data from surveys after 2003 will be added to the database as it becomes available. Presumably, earlier data gaps reflect periods where data were not recorded in electronic format, surveys were not conducted, or site conditions precluded quantitative assessment. The co-managers concluded, during years of poor spawning viewing conditions, it was better not to report information than to make gross assumptions that could skew the annual escapement estimates and adversely influence the overall data trends.

6.7 WDFW SUNSET FALLS FISH TRAPPING ANNUAL AND SUMMARY DATA REPORTS

Since the construction of the Sunset Falls fishway in 1958, the number of adult steelhead collected in the fishway trap has been recorded. The trap has typically been operated from mid-July to mid-December. All trapped steelhead have been trucked upstream and released at a site near the mouth of Barclay Creek, with the exception of a few fish pulled from the run for use as broodstock at Reiter Ponds in the mid-1970s to early 1980s. The most recent dataset available from the WDFW website (http://wdfw.wa.gov/hab/tapps/reports/sunsetcount_05.pdf) provides seasonal counts of steelhead trapped from 1958 to 2005. For most of this time period, the origin (hatchery vs. wild) of steelhead trapped at sunset falls was not recorded. Since 1998, fish origin has been documented based on presence/absence of an adipose fin clip. Kassler et al, (in press), report that 26 to 73 percent of steelhead trapped at Sunset Falls were not clipped, though the source of these data is unclear. The most recent annual report from the state's Technical

Applications Division also provides a summary of the number of adult steelhead trapped at Sunset Falls, but no additional information such as fish origin (WDFW 2003; http://wdfw.wa.gov/hab/tapps/reports/2003tapps.pdf).

Because the annual trap counts at Sunset Falls provide the exact number of adult steelhead returning to this reach of the SF Skykomish River it is of *HIGH* value to the recovery planning efforts. Obtaining information on fish origin as well as identifying the possible inclusion of winter steelhead in fish collected at the trap increase the value of this dataset to the basin staff. C. Kraemer (WDFW ret.; pers. comm., December 2007) indicated monthly steelhead catch data from Sunset Falls are available. Such information could possibly help in determining whether any of the steelhead caught at Sunset Falls are of winter stock.

6.8 SSHIAP [INCLUDED IN SALMONSCAPE BELOW]

The Salmon and Steelhead Habitat Inventory and Assessment Program (SSHIAP) is co-managed by WDFW and the Northwest Indian Fisheries Commission and supports a spatial data system to characterize salmonids habitat conditions and distribution of salmonids stocks in Washington (http://wdfw.wa.gov/hab/sshiap/). SSHIAP data can be viewed and downloaded from WDFW's SalmonScape website. Data provided on SalmonScape are described below (Dataset # 9).

The Salmon and Steelhead Habitat and Inventory and Assessment Program (SSHIAP) is a partnership-based information system that began in 1995. The western Washington Treaty Indian Tribes and the Washington Department of Fish and Wildlife are the co-managers on the project. Additional information on SSHIAP can be found at: <http://www.wa.gov/wdfw/hab/sshiap> or <http://www.nwifc.org/sshiap2/index.asp>. Since the SSHIAP information is now included spatially in StreamScape [see database #9 below] the original database file is of low value to the steelhead recovery planning efforts in the basin.

6.9 SALMONSCAPE/STREAMNET

The SalmonScape website (http://wdfw.wa.gov/mapping/salmonscape/index.html) is maintained by WDFW and provides a spatial interface for users to access several of the datasets described above. Specifically, SalmonScape provides the following data layers specific to steelhead within the Snohomish Basin:

- SaSI stock status for winter and summer steelhead
- Summer and winter steelhead distribution in terms of the following categories:
  - Spawning

  - Rearing
  - Presence – documented
  - Presence – presumed
  - Presence – potential
  - Presence – undetected
- Fish passage barriers (identified as stream crossings, dams, or natural barriers) in terms of the following categories:
  - Total barrier
  - Partial barrier
  - Non-barrier
  - Unknown
  - See fishway
  - Non-fish bearing
- Repaired barriers
- Stream attributes
  - Gradient class: 0-1, 1-2, 2-4, 4-8, 8-12, 12-20, or >20% slope.
  - Habitat type: large tributary, small tributary, side channel, side channel slough, distributary slough, lake/pond, wetland/pond complex, seasonal flooded wetland, or no data.
  - Channel confinement: unconfined, moderately confined, confined, or no data

StreamScape also incorporates all of the prior information for the state of Washington housed in StreamNet as described at http://www.streamnet.org

Based on a preliminary review of selected culverts, SalmonScape presumably has incorporated information from the WFC Culvert Database # 14 as described below.

The information is of high value for the recovery planning efforts but many of the features of StreamScape have been incorporated in the Snohomish County GIS layer. At present, the County GIS layers are the controlling documents for base mapping layers related to the Snohomish Basin recovery planning effort.

6.10 SNOHOMISH COUNTY GIS LAYERS

A). Steelhead Distribution Layer [File Name Steelhead_Reaches.shp]:

The County steelhead distribution GIS data, from *StreamNet*, WDFW's *SalmonScape* and Washington State Conservation Commission's *Salmon and Steelhead Habitat Limiting Factors Analysis,* were compiled and their collective "known" and "presumed" steelhead distribution attributes were transferred to Snohomish County's watercourse lines.

Existing EDT reaches in WRIA 07 (Mobrand Biometrics 2002) were overlaid on this new steelhead distribution layer and lines were split at locations corresponding to EDT reach breaks. Reach break locations are approximate (based on stream miles) but generally occur near major tributary junctions, changes in channel morphology and barriers to anadromy.

The steelhead layer attribute table was populated with EDT reach names where the two layers were spatially coincident. Because the EDT reaches generally end at Chinook distribution, new reaches were added above and beyond limits to Chinook anadromy. New reaches were named based on the EDT naming convention. Unnamed streams were given the name of the reach to which they are a tributary followed by "Trib" as well as a number tag for multiple unnamed tributaries to the same reach. Tributaries shorter than 1 km in length were not given reach names unless there was an original EDT name designated for the short reach.

Because the original steelhead line segments and attributes were altered during spatial editing, most of the original fields were removed from the attribute table. The fields remaining in the table are. . .

NAME	Stream/River name from original water course layer
Length_m	Segment length in meters
Checked	Editing Status
LT_1KM	Flag (=1) for non-original EDT reaches shorter than 1 km
Reach_ID	Reach identifier contains EDT and new reaches

The County steelhead distribution layer was used as a base for all of the maps in this document. Its value to the recovery planning efforts is HIGH since it is an accumulation of all of the latest information and the result of extensive coordination between basin staff, the co-managers and biologists with extensive knowledge of the basin. During our review of historical spawning ground information (Database #6), we recommended only a few minor modifications to this coverage.

B). Water Courses Layer [File Name: wtrcrs.shp].

The water course GIS coverage contains a connected network of surface water features including streams, rivers and water body centerlines.

C). Snohomish River Sub-basins [File Name: esa_basins.shp].

The ESA sub-basins data set contains polygons showing distinct areas of 63 individual hydrologic drainages defined under the Salmon Conservation Planning Effort. We used these subbasin division boundaries on the project base map and they are included on all of the GIS mapping products.

D). Snohomish River Basin Stream Gradients [File Name SH_Reach_Slope_Dissolved.shp]:

The County channel gradient map is based on 10m resolution Digital Elevation Model (DEM) topography maps. We used this data layer to approximate the relative value of steelhead rearing reaches in Figure 11 of the document.

6.11 KING COUNTY GIS LAYERS

King County provided two GIS point files (steelhead blockages and steelhead points of interest) and three GIS arc files (extent, spawning areas, holding pools) for the project, but could not locate the metadata from the Snohomish River Basin Fish Mapping project (1995) to support these files. As presently undocumented files, we did not use the information in the final project mapping, with the exception of where the Snoqualmie steelhead fish spawning areas in File Name: [esa_basins.shp] provided non-quantitative (presence/absence) information that may have been lacking in the Snohomish County GIS layers.

6.12 TULALIP TRIBES, JUVENILE STEELHEAD OUTMIGRANT TRAPPING DATA AT SKYKOMISH AND SNOQUALMIE SCREW TRAPS (NELSON 2007; NELSON AND KELDER 2004)

Beginning in 2000, the Tulalip Tribes have been monitoring juvenile salmonid outmigrants using screw traps in the Skykomish (RM 23) and Snoqualmie (RM 12) river mainstems (Nelson and Kelder 2004). Although this effort targets primarily Chinook and coho smolts, steelhead smolts are also monitored. Fish are identified as hatchery or wild origin based on adipose fin-clip status. Kurt Nelson provided unpublished data for steelhead smolts collected from 2000 (partial season) to 2007. This information includes the start and end dates of sampling for each season (typically February to June) and the total hours of sampling effort per season. From these data, the relative abundance of steelhead smolts outmigrating from each subbasin can be calculated for each year as a catch-per-unit-effort (CPUE) to identify annual trends. Estimates of trap collection efficiencies were made for Chinook and coho smolts by releasing marked individuals upstream of each trap throughout the sampling effort. However, estimates of steelhead collection efficiencies were not possible. Estimates of total steelhead smolt production, thus, cannot be made using these data unless trap efficiencies from coho are used as a surrogate. The validity of such an approach is doubtful. Nonetheless, the relative index of steelhead smolt abundance provided by this recent and ongoing dataset will be of *MODERATE* value to the basin staff, mostly related to the seasonal timing, the size of juvenile fish and the hatchery-to-wild composition of the outmigrants. The value of this dataset would increase in the future if estimates of trap efficiency specific to steelhead can be made.

6.13 WDG (1986) SNOHOMISH WINTER STEELHEAD RESOURCE INVENTORY

A copy of the Snohomish River Winter Steelhead Resource Inventory (WDG 1986) was provided by the Tulalip Tribes and the WDFW Mill Creek Office. This binder consists of a series of tables containing a variety of data specific to winter steelhead in the Snohomish basin dating from as early as 1947 (sport catch punch card returns) up to 1986. The majority of the data range between 1980 and 1986. A list of tables contained in the binder is summarized below. Table numbers correspond to the actual table number in the binder, however, the titles have been changed in some cases to provide a more detailed description of table contents. Some tables are presented in the binder as placeholders with no data. Tables without data have been omitted from the following list:

- Table 1. Drainage area; stream length and width; accessible length and area; gradient.
- Table 2. Major spawning areas.
- Table 3. Habitat alterations (adverse) and restoration.
- Table 6. Total run size for winter steelhead: by origin (hatchery vs. wild) from sport and tribal catch and escapement (1976/77 to 1985/86).
- Table 7. Percent hatchery vs. wild winter steelhead from sport and tribal catches (1980/81 to 1985/86).
- Table 8. Run size profile for winter steelhead broken out by age (includes freshwater age, ocean age, and repeat spawning) and wild vs. hatchery origin.

- Table 10. Sport catch summary for winter steelhead by month and subbasin (1976/77 to 1985/86).
- Table 11B. Weekly summary of tribal catch of winter steelhead by marine area (1980/81 to 1985/86).
- Table 12. Escapement of wild winter steelhead by subbasin from redd counts (1980/81 to 1985/86)
- Table 16A. Winter steelhead sport catch broken out by month caught, age, and subbasin (1980/81 to 1985/86).
- Table 16C. Weekly commercial winter steelhead catch broken out by age (1980/81 to 1985/86).
- Table 17. Escapement broken out by age for winter steelhead (1980/81 to 1985/86).
- Table 20. Stocking locations by subbasin and river mile.
- Table 21A. WDG release data for hatchery winter steelhead
- Table 24. Commercial catch of winter steelhead by day/week and by marine area (1978 to 1985).
- Table 25. Sport catch summaries for winter steelhead based on punch card returns, by subbasin (1947 to 1986)
- Table 27A and B. Spawner characteristics for hatchery and wild winter steelhead in sport catch by subbasin, showing age class, sex, fork length, and weight (1983-1984)
- Table 28A and B. Spawner characteristics for hatchery and wild winter steelhead in tribal catch, showing age class, sex, fork length, and weight (1980-1981 to 1982-1983)
- Tables 29-31. Regulations.
- Table 32. Wild winter steelhead spawning timing, including Graphs 1 and 2.

Methods: Provides descriptions of methods used in various management activities, including catch estimates, escapement estimates, escapement goals, and preseason estimation of run size.

Although the resource inventory binder lacks recent data beyond 1986, it contains a large and fairly complete dataset for a variety of parameters, including biological characteristics and population trends. This dataset is therefore considered to be of *HIGH* value to the recovery planning efforts.

An additional binder labeled "WDFW Snohomish Steelhead Resource Inventory Tables" was provided by the WDFW Mill Creek Office. This binder included similar but more recent information dated as late as 1992, such as sports catch and tribal catch broken out by year and age. In addition to more recent data, this binder also included tables of sport catch broken out by age for many subbasins. This document (WDFW 1993) is an important supplement to the earlier resource inventory binder (1986) in that it provides information regarding freshwater age, ocean age, and repeat spawning information for hatchery and wild fish specific to several individual subbasins.

6.14 WFC CULVERT DATABASE

Between 1998 and 2001, Wild Fish Conservancy (WFC) formerly Washington Trout was contracted by the Washington Department of Transportation to conduct culvert inventories and fish passage assessments within the anadromous reaches of the Snohomish Basin using the Salmonid Screening, Habitat Enhancement and Restoration Section (SSHEAR) protocol (http://wdfw.wa.gov/hab/engineer/fishbarr.htm). A total of 467 road crossings (536 individual culverts) were assessed (Figure 14). Culverts within the Skykomish River and tributaries upstream from Sunset Falls were not surveyed because they were upstream of the historical limit of anadromy. The results of this effort were incorporated into a Microsoft Access database provided to WDFW. With assistance from WFC staff, we reviewed several randomly selected culvert locations, which indicated that data from the WFC Culvert Database have been integrated by WDFW into the SalmonScape/SSHIAP system described above.

Using either the SalmonScape interface or the Microsoft Access database provided directly by WFC, the culvert database can provide the basin staff with the following:

- Identification of complete barriers representing upstream limits of steelhead distribution
- Prioritization of partial or complete barriers to steelhead migration for targeted restoration opportunities.

In addition, the culvert database can provide information on the presence of steelhead at specific culverts. Using either biological or physical criteria, WFC identified fish use by species at each location. A preliminary query performed with support of WFC staff indicated steelhead use at 81 culverts. Examples of the data forms from the Culvert Database are provided below in Figure 15.

Because of its geographic scope and its value as a tool for identifying and prioritizing important restoration opportunities, we consider the Culvert Database to have a *MODERATE* value for the recovery planning effort. Since the information has been apparently well-integrated into the SalmonScape geographic database, accessing the information in this manner is likely the favorable approach.

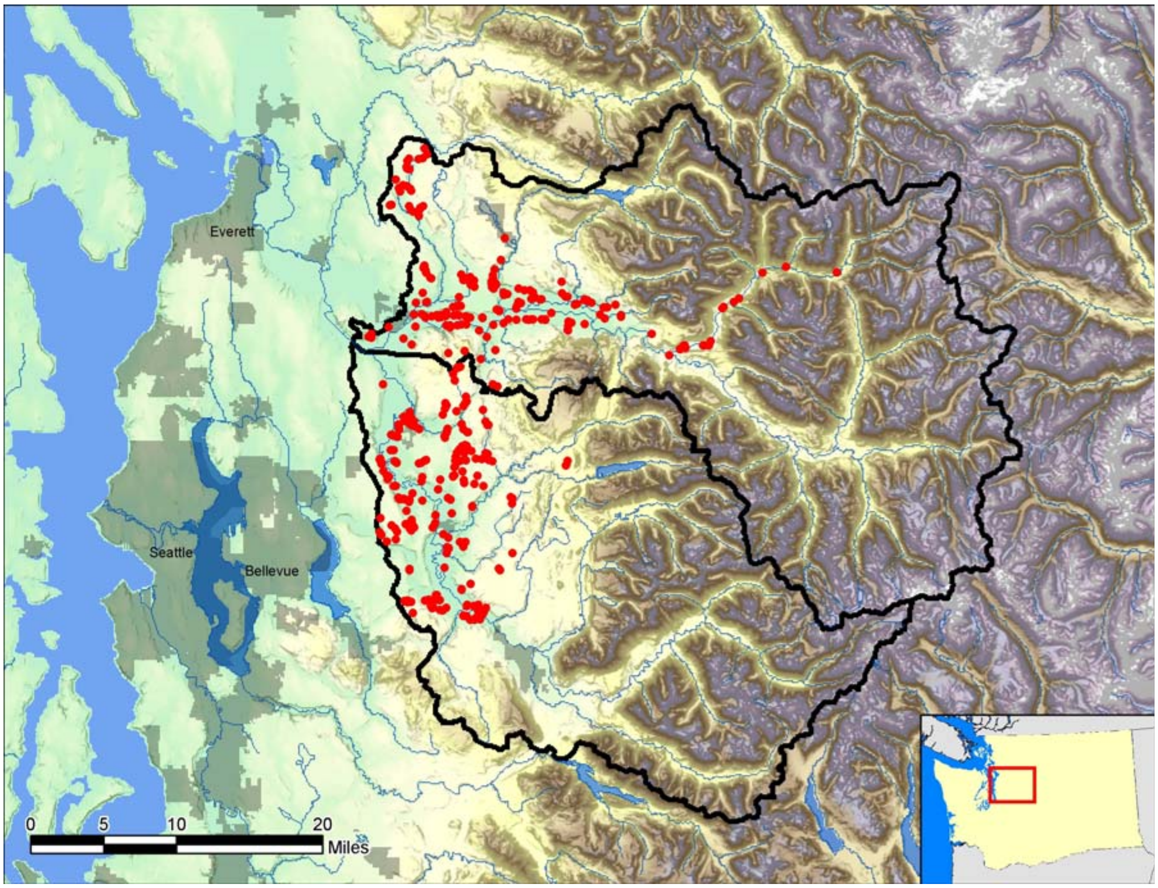
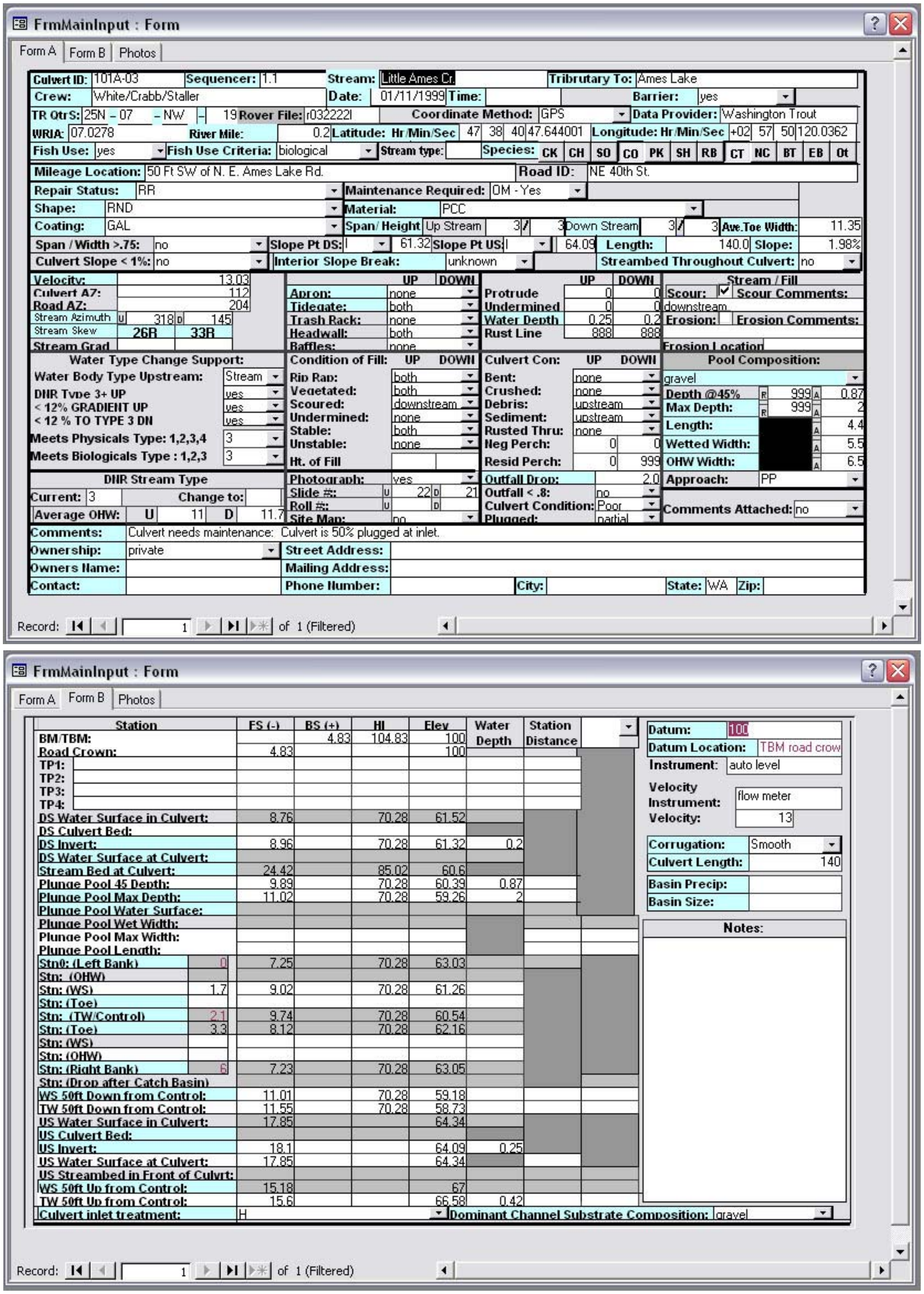


Figure 14. Locations of 536 culverts inventoried and assessed by WFC from 1998 to 2001.



FrmMainInput : Form

Form A | Form B | Photos

Culvert ID: 101A-03 Sequencer: 1.1 Stream: Little Ames Cr. Tributary To: Ames Lake
Crew: White/Crabb/Staller Date: 01/11/1999 Time: Barrier: yes
TR QtrS: 25N – 07 – NW – 19 Rover File: r032222l Coordinate Method: GPS Data Provider: Washington Trout
WRIA: 07.0278 River Mile: 0.2 Latitude: Hr/Min/Sec 47 38 40 47.644001 Longitude: Hr/Min/Sec +02 57 50 120.0362
Fish Use: yes Fish Use Criteria: biological Stream type: Species: CK CH SO CO PK SH RB CT NC BT EB Ot
Mileage Location: 50 Ft SW of N. E. Ames Lake Rd. Road ID: NE 40th St.
Repair Status: RR Maintenance Required: OM - Yes
Shape: RND Material: PCC
Coating: GAL Span/Height Up Stream 3 / 3 Down Stream 3 / 3 Ave.Toe Width: 11.35
Span / Width >.75: no Slope Pt DS: I 61.32 Slope Pt US: I 64.09 Length: 140.0 Slope: 1.98%
Culvert Slope < 1%: no Interior Slope Break: unknown Streambed Throughout Culvert: no

Velocity: 13.03 | Culvert AZ: 112 | Road AZ: 204 | Stream Azimuth U 318 D 145 | Stream Skew 26R 33R | Stream Grad

	UP	DOWN
Apron:	none	
Tidegate:	both	
Trash Rack:	none	
Headwall:	both	
Baffles:	none	

	UP	DOWN
Protrude	0	0
Undermined	0	0
Water Depth	0.25	0.2
Rust Line	888	888

Stream / Fill: Scour: ☑ Scour Comments: downstream; Erosion: ☐ Erosion Comments:; Erosion Location

Water Type Change Support:
Water Body Type Upstream: Stream
DNR Type 3+ UP: yes
< 12% GRADIENT UP: yes
< 12 % TO TYPE 3 DN: yes
Meets Physicals Type: 1,2,3,4: 3
Meets Biologicals Type : 1,2,3: 3

Condition of Fill:	UP	DOWN
Rip Rap:	both	
Vegetated:	both	
Scoured:	downstream	
Undermined:	none	
Stable:	both	
Unstable:	none	
Ht. of Fill		

Culvert Con:	UP	DOWN
Bent:	none	
Crushed:	none	
Debris:	upstream	
Sediment:	upstream	
Rusted Thru:	none	
Neg Perch:	0	0
Resid Perch:	0	999

Pool Composition: gravel
Depth @45%: R 999 A 0.87
Max Depth: R 999 A 2
Length: A 4.4
Wetted Width: A 5.5
OHW Width: A 6.5
Approach: PP

DNR Stream Type: Current: 3 Change to:
Average OHW: U 11 D 11.7
Photograph: yes
Slide #: U 22 D 21
Roll #: U D
Site Map: no
Outfall Drop: 2.0
Outfall < .8: no
Culvert Condition: Poor
Plugged: partial
Comments Attached: no
Comments: Culvert needs maintenance: Culvert is 50% plugged at inlet.
Ownership: private Street Address:
Owners Name: Mailing Address:
Contact: Phone Number: City: State: WA Zip:

Record: 1 of 1 (Filtered)

FrmMainInput : Form

Form A | Form B | Photos

Station		FS (-)	BS (+)	HI	Elev	Water Depth	Station Distance
BM/TBM:			4.83	104.83	100		
Road Crown:		4.83			100		
TP1:							
TP2:							
TP3:							
TP4:							
DS Water Surface in Culvert:		8.76		70.28	61.52		
DS Culvert Bed:							
DS Invert:		8.96		70.28	61.32	0.2	
DS Water Surface at Culvert:							
Stream Bed at Culvert:		24.42		85.02	60.6		
Plunge Pool 45 Depth:		9.89		70.28	60.39	0.87	
Plunge Pool Max Depth:		11.02		70.28	59.26	2	
Plunge Pool Water Surface:							
Plunge Pool Wet Width:							
Plunge Pool Max Width:							
Plunge Pool Length:							
Stn0: (Left Bank)	0	7.25		70.28	63.03		
Stn: (OHW)							
Stn: (WS)	1.7	9.02		70.28	61.26		
Stn: (Toe)							
Stn: (TW/Control)	2.1	9.74		70.28	60.54		
Stn: (Toe)	3.3	8.12		70.28	62.16		
Stn: (WS)							
Stn: (OHW)							
Stn: (Right Bank)	6	7.23		70.28	63.05		
Stn: (Drop after Catch Basin)							
WS 50ft Down from Control:		11.01		70.28	59.18		
TW 50ft Down from Control:		11.55		70.28	58.73		
US Water Surface in Culvert:		17.85			64.34		
US Culvert Bed:							
US Invert:		18.1			64.09	0.25	
US Water Surface at Culvert:		17.85			64.34		
US Streambed in Front of Culvrt:							
WS 50ft Up from Control:		15.18			67		
TW 50ft Up from Control:		15.6			66.58	0.42	

Culvert inlet treatment: H Dominant Channel Substrate Composition: gravel

Datum: 100
Datum Location: TBM road crow
Instrument: auto level
Velocity Instrument: flow meter
Velocity: 13
Corrugation: Smooth
Culvert Length: 140
Basin Precip:
Basin Size:
Notes:

Record: 1 of 1 (Filtered)

Figure 15. Example forms from WFC's Culvert Database (Source: WFC).

6.15 WFC TOLT RIVER SNORKEL SURVEYS

The Wild Fish Conservancy (WFC) conducted an annual summer steelhead snorkel-census in the Tolt River watershed between 1989 and 2004 (WFC 2007). Monthly snorkel surveys were conducted from May through October as conditions permitted to document steelhead distribution, abundance, and origin (hatchery or wild). Surveys were performed in two study index reaches, one in the North Fork Tolt (1.5 miles) and one in the South Fork Tolt (1.6 miles). In most years, the entire anadromous reaches of both forks were surveyed during the month of September.

The results of this effort by WFC were reported in comments to NOAA Fisheries in response to the proposed issuance of a 4d Rule for the Puget Sound Steelhead Distinct Population Segment (Figure 16). This dataset offers some value to the recover planning efforts as it extends the observations of steelhead spawners in the NF and SF Tolt River beyond the WDFW spawning surveys that only date back to 1996. However, because of the different survey methods used by WDFW (redd counts and live counts) and WFC (snorkel surveys), it may be difficult to integrate these two datasets. As such, we have classified the WFC snorkel survey dataset as having *MODERATE* value to the basin staff as a means to confirm annual trends in the Tolt River Basin.

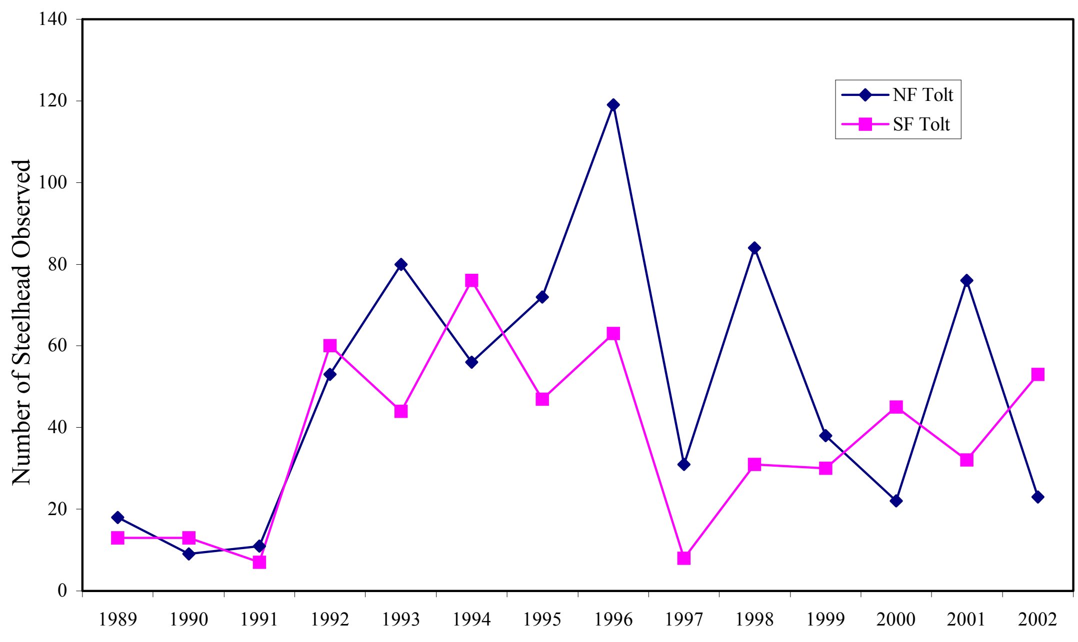
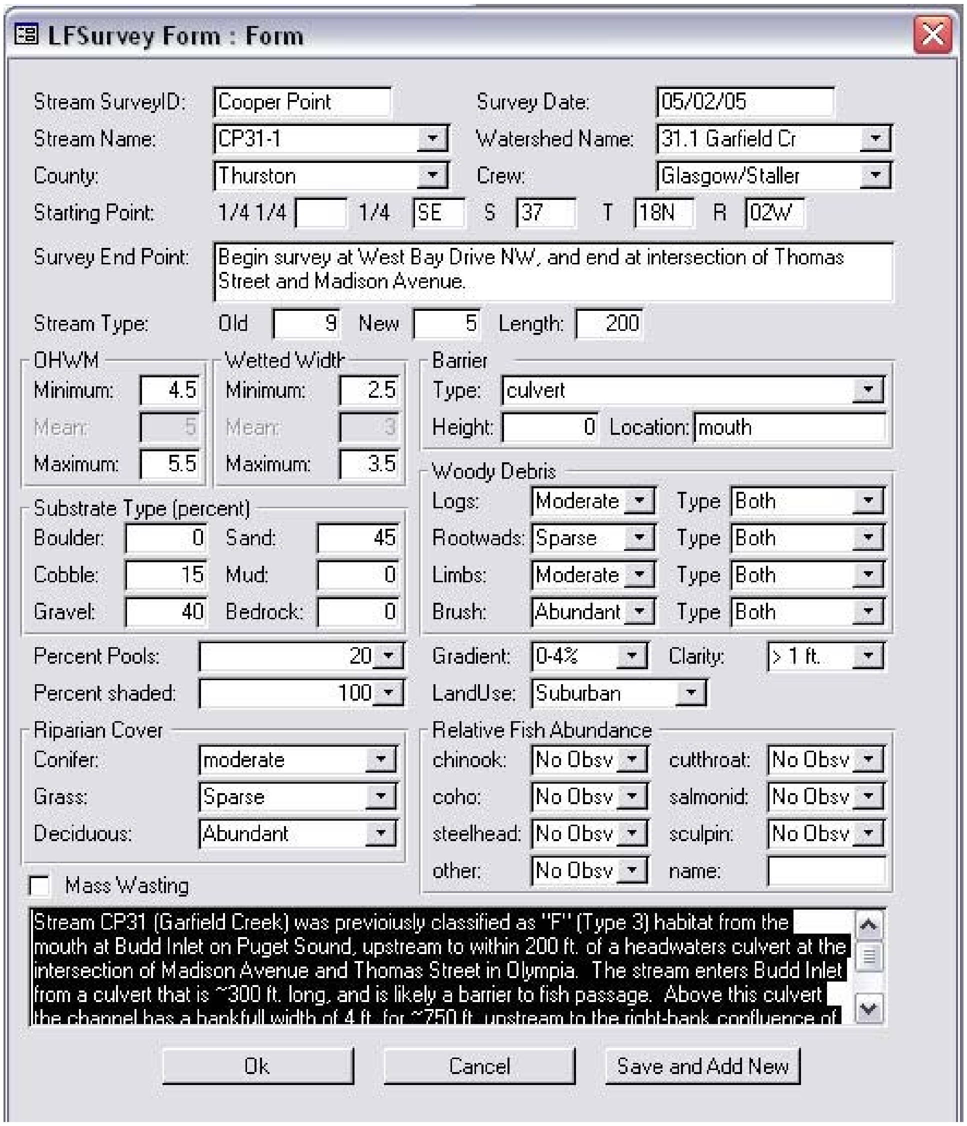


Figure 16. Single highest steelhead counts observed in the NF and SF Tolt River index reaches. (Source: WFC 2007)

6.16 WFC WATER TYPING DATA SURVEYS

The Wild Fish Conservancy (WFC) has been conducting water typing surveys throughout Washington since 1994 and maintains a database containing this information. An example data form from WFC's water typing database is provided below (Figure 17). WFC uses the state-sanctioned methodology described in Section 13 of the Forest Practice Board Manual (http://www.dnr.wa.gov/forestpractices/board/manual/section13.pdf) and WAC 222-16-031, (http://apps.leg.wa.gov/WAC/default.aspx?cite=222-16-031).

In addition to the electronic database, field forms (hard copies) include observations of steelhead and rainbow trout (J. Glasgow, pers. com.). At this time, data retrieval requires querying of the database by WFC staff. Because the full scope of water typing efforts and steelhead observations within this dataset in the Snohomish Basin is unclear, we have classified the database as having *MODERATE* value to the recovery planning efforts. However, if WFC's water typing efforts in the Snohomish Basin are extensive, this dataset might be valuable to the basin staff for classifying steelhead habitat, providing a rigorous check on existing water types, and more accurately delineating steelhead rearing distributions within the basin.



LFSurvey Form : Form

Stream SurveyID: Cooper Point
Survey Date: 05/02/05
Stream Name: CP31-1
Watershed Name: 31.1 Garfield Cr
County: Thurston
Crew: Glasgow/Staller
Starting Point: 1/4 1/4 [ ] 1/4 SE S 37 T 18N R 02W
Survey End Point: Begin survey at West Bay Drive NW, and end at intersection of Thomas Street and Madison Avenue.
Stream Type: Old 9 New 5 Length: 200

OHWM
Minimum: 4.5
Mean: 5
Maximum: 5.5

Wetted Width
Minimum: 2.5
Mean: 3
Maximum: 3.5

Barrier
Type: culvert
Height: 0 Location: mouth

Substrate Type (percent)
Boulder: 0 Sand: 45
Cobble: 15 Mud: 0
Gravel: 40 Bedrock: 0

Woody Debris
Logs: Moderate Type Both
Rootwads: Sparse Type Both
Limbs: Moderate Type Both
Brush: Abundant Type Both

Percent Pools: 20
Percent shaded: 100
Gradient: 0-4% Clarity: > 1 ft.
LandUse: Suburban

Riparian Cover
Conifer: moderate
Grass: Sparse
Deciduous: Abundant

Relative Fish Abundance
chinook: No Obsv cutthroat: No Obsv
coho: No Obsv salmonid: No Obsv
steelhead: No Obsv sculpin: No Obsv
other: No Obsv name:

Mass Wasting

Stream CP31 (Garfield Creek) was previoiusly classified as "F" (Type 3) habitat from the mouth at Budd Inlet on Puget Sound, upstream to within 200 ft. of a headwaters culvert at the intersection of Madison Avenue and Thomas Street in Olympia. The stream enters Budd Inlet from a culvert that is ~300 ft. long, and is likely a barrier to fish passage. Above this culvert the channel has a bankfull width of 4 ft. for ~750 ft. upstream to the right-bank confluence of

Ok Cancel Save and Add New

Figure 17. Example data form from WFC's water typing database (Source: WFC).

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APPENDIX A

Historic Harvest, Escapement and Run Size Estimates for Winter- and Summer-Run Steelhead Trout in the Snohomish River Basin

Appendix Table A-1. Steelhead Trout Harvest, Escapement and Total Run Size Estimates for return Years 1981 – 2006 where data are available.

This table includes sport and tribal harvest, spawning escapement and total run size estimates for natural-origin winter and summer-run steelhead stocks and for hatchery-origin stocks summarized for the entire Snohomish Basin. The data are directly reported from the WDFW shared historical database files from 1981 to 2003 as updated by Dimmitt (2007), [see Appendix D] from 2004 to 2006. Data reported in the highlighted sections of Table A-1 are calculated based on database information provided in other columns of the table. Calculated values should be viewed as a first-level approximation and they are provided for context only.

Total run size in Table A-1, is the estimated abundance of steelhead of a given stock returning from the ocean to the terminal fishing area. In this case, Marine Harvest Area 8A, off the mouth of the Snohomish River in Port Garnder Bay, is regarded at the terminal fishing area for the Snohomish Basin. As fishing harvests of wild fish have declined in recent years, total run size and spawning escapements become more similar over time.

Table A-1. Steelhead Trout Harvest, Escapement and Total Run Size Estimates for return Years 1981 – 2006 where data are available.

	Natural-Origin Winter Steelhead				Natural-Origin Summer Steelhead[1/]				Hatchery-Origin Steelhead							
	Total				Total				Total	Harvest				Return		Total
Return Year	NOR	Harvest		Spawning	NOR	Harvest		Spawning	HOR	Sport		Tribal[3/]	Total Hat.	Hatchery Racks		Steelhead
	Run Size	Sport	Tribal[3/]	Escapement	Run Size	Sport	Tribal[2/]	Escapement	Run Size	Winter	Summer	Winter	Harvest	Winter	Summer	Run
1980 -1981	5464	1004	1506	2954			400		14313	6268		5898	12166	1320	826	
1981 -1982	6643	1086	1397	4160			331		10465	4076		4819	8895	965	604	
1982 -1983	7987	1627	1202	5158			67		10112	4648		3947	8595	933	584	
1983 -1984	7092	423	245	6424			64		15065	8756		4049	12805	1390	870	
1984 -1985	7307	149	622	6536			27		17262	10957		1094	12051	4392	2006	33653
1985 -1986	8812	257	765	7790	2672	1180	163	1329	23355	8947	3020	7885	19852	2155	1349	34839
1986 -1987	9126	1032	630	7464	2059	483	74	1502	25547	9555	2396	9764	21715	2357	1475	36732
1987 -1988	11009	2286	979	7744	3135	990	97	2048	26167	10355	6525	5362	22242	2414	1511	40311
1988 -1989	9821	2250	493	7078	994	413	19	562	11791	5997	2200	1825	10022	1088	681	22606
1989 -1990	7583	1888	197	5498	1659	407	44	1208	15360	6347	3004	3705	13056	1417	887	24602
1990 -1991	7000	839	225	5936	1380	387	12	981	9369	4659	2432	873	7964	923	482	17749
1991 -1992	9832	1209	35	8588	258	143	7	108	17215	10248	2472	1913	14633	2080	502	27305
1992 -1993		1362	39		821	127	0	694	16828	10556	2916	832	14304	1978	546	17649
1993 -1994	7403	411		6992	1075	121	2	952	12924	5299	5601	85	10985	942	996	21402
1994 -1995	7931	209		7722	864	112	1	751	10984	7654	1367	315	9336	1398	250	19779
1995 -1996		379	17		1445	178	1	1266	20769	5269	3762	235	9266	1333	904	22214
1996 -1997		319	23		1081	68	9	1004	15277	3015	3599	218	6832	813	800	16358
1997 -1998	5355	105	3	5250	1327	112	9	1206	13121	2067	3804	55	5926	536	733	19803
1998 -1999	7434	1063	36	6371	979	45	5	929	14790	4307	2273	146	6726	816	522	23203
1999 -2000	3006	184	15	2822	1207	28	0	1179	18212	3958	4374	362	8694	403	421	22425
2000 -2001	3240	118	2	3122	737	54	3	680	21683	4349	5911	64	10324	483	552	25660
2001 -2002	2348	114	7	2234	1119	38	18	1063	28596	8629	4318	538	13485	1148	478	32063
2002 -2003	3263	75	0	3188	1405	29		1376	9744	2281	2087	0	4368	458	550	14412
2003 -2004	5670	62	1	5608	1304			1304	19428	6590	2055	85	8730	1362	606	26402
2004 -2005	3845	3		3842	654			654	18490	7631	780	242	8653	844	340	22989
2005 -2006	5474	0		5474	821			821	9772	3987		198	4185	907	495	16067
2006 -2007		0														
2007 -2008		0														
2008 -2009																
Mean Record	6637	659	384	5563	1286	273	62	1029	16409	6400	3245	2097	10977	1341	768	24465
10-yr	4404	204	12	4212	1063	79	5	1022	16911	4681	3296	191	7792	777	550	21938
5-yr	4120	51	5	4069	1061	39	7	1044	17206	5824	3030	213	7884	944	494	22387
5-yr Geo	3910	4	2	3845	1019	38	3	1005	15779	5239	2434	47	7145	887	485	21417

Notes:

1) Escapment and total run size estimates are exclusive of unknown level of NF Skykomish summer-run spawners.

2) WDFW Historical Steelhead Shared database lists these total as combined hatchery and wild harvest combined. But they differ with respect to the numbers reported in the WDFW Reiter Pond HGMP update.

3) Tribal harvest numbers where available cannot distinguish between wild or hatchery fish after 1993, thereafter the harvest is considered hatchery fish. The difference between Shared Database and HGMP was calculated as wild fish as follows: [H + W - H = W]

[yellow box] = Calculated

APPENDIX B

Step-1 Table
Steelhead Redds, Spawning Escapement Estimates and Observations of Live Fish along Index and Supplemental Reaches in the Snohomish River Basin over Time

Appendix Table B-1. Step-1 Table for Steelhead Trout 1976 – 2006 where data are available. **Source:** WDFW Spawning Ground Survey Database.

The following tables are designed in a consistent manner with the Ecological Analysis for Salmonid Conservation (EASC) Step – 1 Tables for Chinook and coho salmon prepared by the Snohomish Basin Salmonid Recovery Technical Committee (2005). Six tables are included in this appendix; one for each subbasin that is comparable to a delineated steelhead stock. The data include combined numbers for both winter and summer steelhead since they spawn during similar time periods and individual redds developed by the different races cannot be differentiated in the field.

Redd counts are primarily from the WDFW spawning ground database with some inclusions of data reported in the WDFW Snohomish Winter Steelhead Resource Inventory Binder (1986) and in the Snohomish County PUD Sultan River spawner survey data. The methodology for the WDFW annual spawning ground surveys is summarized in Appendix C.

The final output of these tables is a rating of the relative abundance and use of individual stream reaches by steelhead for spawning and rearing. The overall spawning reach relative ratings are based on the mean number of reported spawners per mile. The distribution of mean reach data over the years was assessed based on interquartile points with the highest ratings ("1") awarded to reaches that exceed the 75th percentile of the distribution, moderate ratings ("2") for reaches that fall between the 25th and 75th percentile and low reach ratings ("3") fell below the 25th percentile of the distribution. The Snohomish River basin-specific spawners per mile break points for the distribution follow:

Rating	Percentile	Spawners/mile
High	75th	> 26.7
Moderate	25th – 75th	8 6 – 26 7
Low	25th	0.0 – 8.6

"P" indicates redds present based on supplemental surveys;
"N" indicates no redds observed in any surveys.

Ratings for peak live counts are also based on the mean number of fish per mile.

Rating	Fish/Mile
High	>2.55
Moderate	>0.75 and ≤ 2.55
Low	>0 and ≤ 0.75

"P" indicates live adults present based on supplemental surveys;
"N" indicates no live adults observed in any surveys.

The peak live count data from supplemental surveys were only used to modify the redd count ratings in the “overall reach rating” category in Tables B-1 through B-6, if presence (“P”) was confirmed in reaches where the index surveys recorded no observed fish or redds.

For the rearing distribution assessment:
“P" indicates presumed rearing habitat present at or downstream of area where known spawning occurs, while,
"U" indicates rearing habitat is unknown due to lack of observed spawning upstream.

The information presented in Appendix B is a summary of the complete Step-1 Tables that include all of the data for each year between 1976 and 2006.

Table B-1. Pilchuck River Steelhead Abundance and Distribution (after Step-1 Table from EASC).

Subbasin	Stream	Stream #	Survey Reach (mi)	Redd Counts: Mean # of Spawners	Redd Counts: Mean # Spawners / Mile	Redd Counts: Min # of Spawners / Mile	Redd Counts: Max # of Spawners / Mile	Redd Counts: Rating (Spawners/mi)[1]	Redd Counts: Mean # of Spawners (Suppl. 1976-2006)	Peak Live Counts: Mean Peak Live Counts	Peak Live Counts: Mean FPM	Peak Live Counts: Min FPM	Peak Live Counts: Max FPM	Peak Live Counts: FPM Rating[2]	Peak Live Counts: Total Live Count (Suppl. 1976-2006)	Overall Rating[3]	Rearing Distribution[4]
Pilchuck River	Pilchuck River Mainstem	7.0125	0.0-8.0	69	8.6	8.6	8.6	3		12.0	1.5	1.5	1.5	2		3	P
		7.0125	1.0-7.5					P	92					P	8	P	P
		7.0125	1.0-8.0					P	18					P	2	P	P
		7.0125	1.5-8.0					P	18					P	3	P	P
		7.0125	3.5-7.5					P	51					P	2	P	P
		7.0125	3.6-5.9					N	0					P	1	P	P
		7.0125	7.5-15.3	430	55.2	39.1	83.7	1	31	35.0	4.5	2.9	7.2	1	3	1	P
		7.0125	8.0-14.0	216	36.1	36.1	36.1	1		41.0	6.8	6.8	6.8	1		1	P
		7.0125	8.0-17.5	234	24.6	15.2	34.0	2		31.0	3.3	2.2	4.3	1		2	P
		7.0125	15.3-25.3					P	57					P	9	P	P
		7.0125	26.4-29.3					N	0					P	1	P	P
		7.0125	29.3-31.4					N	0					P	8	P	P
		7.0125	31.4-35.4	69	17.2	3.7	29.5	2		11.5	2.9	0.0	8.5	1		2	P
	Dubuque Creek	7.0139	0.0-0.6	0	0.0	0.0	0.0	N		0.0	0.0	0.0	0.0	N		N	P
		7.0139	1.5-3.8	0	0.0	0.0	0.0	N		0.5	0.2	0.0	0.4	3		P	P
	Little Pilchuck Creek	7.0146	0.0-2.0	2	1.2	0.0	3.3	3		0.2	0.1	0.0	0.5	3		3	P
	Catherine Creek	7.0148	0.0-1.6	0	0.0	0.0	0.0	N	0	3.0	1.9	1.9	1.9	2	3	P	P
	Bosworth Lake Creek	7.0163	0.0-1.4					N	0					P	3	P	P
	Worthy Creek	7.0166	0.0-1.3	0	0.0	0.0	0.0	N		0.3	0.3	0.0	0.8	3		P	P
	Unnamed Trib.[5]	7.0173	0.0-18.2					N	0					~~P~~	~~2937~~	~~P~~	~~P~~
	Pilchuck River Basin[6]			1075													
	Total from Spawner Database			1021					267	134.5					43		

Table B-2. Snohomish/Skykomish River Steelhead Abundance and Distribution (after Step-1 Table from EASC).

Subbasin	Stream	Stream #	Survey Reach (mi)	Redd Counts: Mean # of Spawners	Redd Counts: Mean # Spawners / Mile	Redd Counts: Min # of Spawners / Mile	Redd Counts: Max # of Spawners / Mile	Redd Counts: Rating (Spawners/mi)[1]	Redd Counts: Mean # of Spawners (Suppl. 1976-2006)	Peak Live Counts: Mean Peak Live Counts	Peak Live Counts: Mean FPM	Peak Live Counts: Min FPM	Peak Live Counts: Max FPM	Peak Live Counts: FPM Rating[2]	Peak Live Counts: Total Live Count (Suppl. 1976-2006)	Overall Rating[3]	Rearing Distribution[4]
Snohomish/ Skykomish River	Youngs Creek	7.0870	0.0-1.0					N	0					P	1	P	P
	Sultan River Basin[6]			230													
	Wallace River	7.0940	0.0-4.0	61	15.2	15.2	15.2	2		10.0	2.5	2.5	2.5	2		2	P
		7.0940	0.0-4.5	34	7.7	2.9	12.4	3		6.5	1.4	0.9	2.0	2		3	P
		7.0940	0.0-5.8	140	24.2	17.0	28.3	2		11.0	1.9	1.4	2.4	2		2	P
		7.0940	0.0-6.1	55	9.0	1.1	16.9	2		15.5	2.5	0.2	4.9	2		2	P
		7.0940	0.0-6.6	85	12.9	12.9	12.9	2		8.0	1.2	1.2	1.2	2		2	P
		7.0940	0.0-6.8	51	7.5	7.5	7.5	3		3.0	0.4	0.4	0.4	3		3	P
		7.0940	3.5-4.8	13	10.1	10.1	10.1	2		0.0	0.0	0.0	0.0	N		2	P
		7.0940	4.0-6.1	15	7.0	7.0	7.0	3		3.0	1.4	1.4	1.4	2		3	P
		7.0940	4.5-5.8	6	4.4	3.8	5.0	3		0.5	0.4	0.0	0.8	3		3	P
		7.0940	5.1-6.6					N	0					P	1	P	P
	Unnamed Trib.	7.0945	0.0-0.8	10	12.3	12.3	12.3	2		0.0	0.0	0.0	0.0	N		2	P
	Olney Creek	7.0946	0.0-0.6	8	13.7	0.0	27.3	2		2.0	3.3	0.0	6.7	1		2	P
		7.0946	0.0-1.0	4	4.1	3.3	4.9	3		1.0	1.0	0.0	2.0	2		3	P
		7.0946	0.0-1.1	0	0.0	0.0	0.0	N		0.0	0.0	0.0	0.0	N		N	U
	Wallace River Basin[6]			726													
	Deer Creek	7.0979	0.0-0.2	0	0.0	0.0	0.0	N	0	2.0	10.0	10.0	10.0	1	2	P	P
		7.0979	0.0-2.0					N	0					P	3	P	P
	Unnamed Trib.	7.0979	0.0-0.1	0	0.0	0.0	0.0	N		1.0	10.0	10.0	10.0	1		P	P
	Remainer of Snoho./Sky. Basin[6]			1758													
	Total from Spawner Database			482					0	63.5					7		

Table B-3. Snoqualmie River Steelhead Abundance and Distribution (after Step-1 Table from EASC).

				Redd Counts						Peak Live Counts							
Subbasin	Stream	Stream #	Survey Reach (mi)	Mean # of Spawners	Mean # Spawners / Mile	Min # of Spawners / Mile	Max # of Spawners / Mile	Rating (Spawners/mi)[1]	Mean # of Spawners (Suppl. 1976-2006)	Mean Peak Live Counts	Mean FPM	Min FPM	Max FPM	FPM Rating[2]	Total Live Count (Suppl. 1976-2006)	Overall Rating[3]	Rearing Distribution[4]
Snoqualmie River	Snoqualmie River Mainstem	7.0219	32.8-36.1					N	0					P	2	P	P
	Peoples Creek	7.0236	0.5-0.6	0	0.0	0.0	0.0	N		6.0	60.0	60.0	60.0	1		P	P
		7.0236	0.5-0.9	0	0.0	0.0	0.0	N		3.0	7.5	7.5	7.5	1		P	P
		7.0236	0.6-0.9					N	0					P	3	P	P
	Cherry Creek	7.0240	1.8-3.5	15	8.6	0.0	18.3	3		1.1	0.7	0.0	1.2	3		3	P
		7.0240	3.5-4.8	29	22.4	0.0	61.8	2		1.5	1.2	0.0	3.1	2		2	P
		7.0240	6.0-7.0	7	7.0	0.0	19.7	3		1.4	1.4	0.0	4.0	2		3	P
	Unnamed Trib.	7.0247	0.0-0.5	0	0.0	0.0	0.0	N		2.0	4.0	4.0	4.0	1		P	P
	Harris Creek	7.0283	1.1-1.2	0	0.0	0.0	0.0	N		0.0	0.0	0.0	0.0	N		N	U
		7.0283	1.1-2.1	0	0.0	0.0	0.0	N		0.0	0.0	0.0	0.0	N		N	U
	Griffin Creek	7.0364	0.1-0.7	4	7.0	0.0	19.1	3		0.3	0.5	0.0	1.7	3		3	P
		7.0364	0.7-2.4	17	10.0	0.0	19.3	2		0.9	0.5	0.0	2.4	3		2	P
		7.0364	3.5-4.9	7	5.3	0.0	12.9	3		0.8	0.5	0.0	2.1	3		3	P
	Patterson Creek	7.0376	1.4-2.6	0	0.3	0.0	2.7	3		0.0	0.0	0.0	0.0	N		3	P
	Canyon Creek	7.0382	0.0-0.9					N	0					P	2	P	P
		7.0382	0.0-2.0	1	0.3	0.0	2.5	3		0.0	0.0	0.0	0.0	N		3	P
		7.0382	0.5-0.9					N	0					P	2	P	P
		7.0382	0.9-2.0					N	0					P	3	P	P
	Raging River	7.0384	0.0-2.5	0	0.0	0.0	0.0	N		1.0	0.4	0.4	0.4	3		P	P
		7.0384	0.0-4.8	0	0.0	0.0	0.0	N		5.0	1.0	1.0	1.0	2		P	P
		7.0384	0.0-8.0	0	0.0	0.0	0.0	N		1.0	0.1	0.1	0.1	3		P	P
		7.0384	2.5-4.7	103	47.0	12.7	99.1	1		3.0	1.4	0.5	2.3	2		1	P
		7.0384	7.4-7.9	21	42.2	0.0	137.8	1		0.4	0.8	0.0	4.0	3		1	P
		7.0384	9.3-11.9	95	36.7	20.8	66.2	1		6.9	2.6	0.4	4.6	1		1	P
	Lake Creek	7.0393	0.0-0.7	0	0.0	0.0	0.0	N	0	3.0	4.3	4.3	4.3	1	6	P	P
		7.0393	1.1-1.3					N	0					P	5	P	P
	Deep Creek	7.0396	0.0-1.0	11	11.0	0.0	44.3	2	0	0.8	0.8	0.0	2.0	2	9	2	P
	Unnamed Trib.	7.0399	0.0-0.1	3	32.8	32.8	32.8	1		0.0	0.0	0.0	0.0	N		1	P
		7.0399	0.1-1.0	0	0.0	0.0	0.0	N		0.0	0.0	0.0	0.0	N		N	U
	Raging River Basin[6]			268													
	Tokul Creek	7.0440	0.0-0.3	26	86.1	16.4	191.3	1	0	13.4	44.6	0.0	276.7	1	24	1	P
		7.0440	0.0-0.6					N	0					P	6	P	P
		7.0440	0.0-1.0	0	0.0	0.0	0.0	N		1.0	1.0	1.0	1.0	2		P	P
		7.0440	0.0-6.0	0	0.0	0.0	0.0	N		3.0	0.5	0.5	0.5	3		P	P
	Remainder of Snoqualmie R.[6]			1185													
	Total from Spawner Database			340					0	55.3					62		

Table B-4. NF Skykomish RiverSteelhead Abundance and Distribution (after Step-1 Table from EASC).

				Redd Counts						Peak Live Counts							
Subbasin	Stream	Stream #	Survey Reach (mi)	Mean # of Spawners	Mean # Spawners / Mile	Min # of Spawners / Mile	Max # of Spawners / Mile	Rating (Spawners/mi)[1]	Mean # of Spawners (Suppl. 1976-2006)	Mean Peak Live Counts	Mean FPM	Min FPM	Max FPM	FPM Rating[2]	Total Live Count (Suppl. 1976-2006)	Overall Rating[3]	Rearing Distribution[4]
NF Skykomish River	Lewis Creek	7.0983	0.0-0.4	0	0.0	0.0	0.0	N	0	2.0	5.0	2.5	7.5	1	6	P	P
	NF Skykomish River Basin[6]			140													
	Total from Spawner Database			0					0	2.0					6		

Table B-5. SF Skykomish River Steelhead Abundance and Distribution (after Step-1 Table from EASC).

				Redd Counts						Peak Live Counts							
Subbasin	Stream	Stream #	Survey Reach (mi)	Mean # of Spawners	Mean # Spawners / Mile	Min # of Spawners / Mile	Max # of Spawners / Mile	Rating (Spawners/mi)[1]	Mean # of Spawners (Suppl. 1976-2006)	Mean Peak Live Counts	Mean FPM	Min FPM	Max FPM	FPM Rating[2]	Total Live Count (Suppl. 1976-2006)	Overall Rating[3]	Rearing Distribution[4]
SF Skykomish River	Bridal Veil Creek	7.1248	0.0-0.3	0	0.0	0.0	0.0	N	0	3.0	10.0	6.7	13.3	1	5	P	P
		7.1248	0.0-0.4					N	0					P	1	P	P
		7.1248	0.3-0.4					N	0					P	3	P	P
	Unnamed Trib.	07.1248A	0.0-0.2	0	0.0	0.0	0.0	N	0	1.0	5.0	5.0	5.0	1	2	P	P
	Money Creek	7.1300	0.0-1.5					P	92					P	7	P	P
	Maloney Creek	7.1407	0.0-0.7					P	8					N	0	P	P
	SF Skykomish River Basin[6]			66													
	Total from Spawner Database			0					100	4.0					18		

Table B-6. Tolt River Steelhead Abundance and Distribution (after Step-1 Table from EASC).

				Redd Counts							Peak Live Counts							
				Supplemental (1976-2006)														
Subbasin	Stream	Stream #	Survey Reach (mi)	# of Redds	# of Spawners (1.64 x Redds)	Mean # of Spawners	Mean # Spawners / Mile	Min # of Spawners / Mile	Max # of Spawners / Mile	Rating (Spawners/mi)[1]	Supplemental (1976-2006)	Mean Peak Live Counts	Mean FPM	Min FPM	Max FPM	FPM Rating[2]	Overall Rating[3]	Rearing Distribution[4]
Tolt River	NF Tolt River	7.0291	0.0-6.1	0	0					N	7					P	P	P
		7.0291	0.0-8.8			360	40.9	32.8	49.0	1		6.0	0.7	0.7	0.7	3	1	P
		7.0291	0.0-8.9			618	69.5	69.5	69.5	1		3.0	0.3	0.3	0.3	3	1	P
		7.0291	8.8-9.2			11	26.7	0.0	69.7	1		0.9	2.2	0.0	15.0	2	1	P
		7.0291	9.9-10.8			76	84.3	54.7	113.0	1		2.3	2.5	0.0	8.9	2	1	P
		7.0291	11.1-11.3			8	41.0	0.0	180.4	1		1.6	8.1	0.0	25.0	1	1	P
	Stossel Creek	7.0300	0.0-0.8			0	0.0	0.0	0.0	N		0.0	0.0	0.0	0.0	N	N	U
	South Fork Tolt River	7.0302	0.0-1.6			51	31.8	7.2	62.5	1		0.5	0.3	0.0	0.6	3	1	P
		7.0302	2.5-4.0	0	0					N	7					P	P	P
		7.0302	3.3-6.8			180	51.4	30.0	93.7	1		1.8	0.5	0.3	1.1	3	1	P
		7.0302	5.1-8.0			5	1.7	1.7	1.7	3		1.0	0.3	0.3	0.3	3	3	P
		7.0302	6.8-7.8			50	50.0	8.2	108.2	1		3.7	3.7	1.0	8.0	1	1	P
	Unnamed Trib.	7.0306	0.0-0.4			0	0.0	0.0	0.0	N		0.0	0.0	0.0	0.0	N	N	U
	Tolt River Basin[6]					501												
	Total from Spawner Database			0	0	1359					14	20.667						

[1]Ratings based on "Mean # of Spawners/Mile" from redd counts: "1" > 26.65; "2" >8.61 and <=26.65; "3" >0 and <=8.61. "P" indicates redds present based on supplemental surveys; "N" indicates no redds observed in any surveys.

[2]Ratings based on "Mean FPM" (fish per mile) from peak live counts: "1" >2.55; "2" >0.75 and <=2.55; "3" >0 and <=0.75. "P" indicates live adults present based on supplemental surveys; "N" indicates no live adults observed in any surveys.

[3]Ratings based on "Mean # of Spawners/Mile" from redd counts and presence/absence as derived from peak live counts: "1" > 26.65; "2" >8.61 and <=26.65; "3" >0 and <=8.61. "P" indicates redds and/or live adults present based on supplemental surveys; "N" indicates no redds or live adults observed in any surveys.

[4]"P" indicates presumed rearing habitat present at or downstream of area where known spawning occurs. "U" indicates rearing habitat unknown due to lack of observed spawning upstream.

[5]Excessive value from supplemental survey suggests error in spawning database. Value not included in any calculations.

[6]Redd counts reported in the WDFW Snohomish Winter Steelhead Resource Inventory Binder (1986) except for Sultan River data reported as number of spawners (Snohomish County PUD 2005).

APPENDIX C

Spawning Escapements of Individual Steelhead Trout Stocks in the Snohomish River Basin

Appendix Table C-1. Snohomish River Basin Steelhead Escapement (1986 – 2006) by SASSI Stock.

The numbers for each stock reflect spawner survey data including redd counts from aerial flights, float and pedestrian surveys from index sites in both mainstem and tributary waters. Redd counts are conducted every 2 to 3 weeks from February through June since redds do not remain visible for the entire spawning season. Observed redd counts are factored by the Area-Under-the-Curve (AUC) methodology using system-specific redd-life vs. time curves (WDG 1986). The curves are used to estimate the total redds dug over a season. The total redd count is extrapolated by a factor of 1.64 to estimate spawner abundance to account for an average of 1.22 redds constructed per female (derived from Snow Creek research data 1976- 1985) and a male:female sex ratio of 1:1. The number of redds in unsurveyed waters is approximated by multiplying the mean number of redds per surveyed mile for the mainstem or tributary by the number of unsurveyed miles in each water type. Most of the mainstem waters are surveyed annually, so any extrapolation is small. Surveyed tributaries are selected to be representative of all accessible tributary reaches. The escapement estimates from the index sites are extrapolated to the entire spawning range for each stock in a manner that has been consistently applied for both mainstem and tributary waters since the mid-1980s (C, Jackson, pers. comm., December 12, 2007). Escapements include both wild and hatchery fish spawning naturally. Redds constructed prior to March 15th are assumed to be from hatchery stock and redds constructed after March 15 are assumed to be wild stock. However, both stocks are included in the season total.

As an example, the Tolt summer-run steelhead escapement estimates in Table C-1 include all fish returning to the Tolt River system that spawn naturally. Similarly, the South Fork Skykomish summer-run escapement estimates include all spawning steelhead returning to the South Fork Basin. There are no reliable spawning escapement estimates for the North Fork Skykomish summer-run stock. The winter-run escapements for the Pilchuck, Snoqualmie and Snohomish/Skykomish stocks are estimated in a similar capacity. Total basin escapements are the combination of each stock as summarized in Appendix Table A-1. Live adult fish counts are not used in the escapement estimates to minimize confusion related to spawning, compared to the various in-river locations steelhead trout use during holding and maturing periods.

Table C-1. Snohomish River Basin Steelhead Escapement (1986 – 2006) by SASSI Stock.

	Winter-Run Steelhead Trout						**Summer-Run Steelhead Trout**						
	Snoqualmie		Pilchuck		Snohomish/Skykomish		Tolt			SF Skykomish		NF Skykomish	
	Annual Escapement	Geometric Mean	Annual Escapement	Geometric Mean	Annual Escapement	Geometric Mean	Annual Escapement	Geometric Mean	Total Run Size	Annual Escapement	Geometric Mean	Annual Escapement	Geometric Mean
Year													
1986	2070		1644		4076		84		166	1245			
1987	2420		1416		3628		88		148	1414			
1988	1610		1424		4710					2048			
1989	1810		1650		3618		60		89	502			
1990	1478	1848	1124	1438	2896	3738				1208	1169		
1991	1832	1804	968	1293	3136	3547	45		45	936	1104		
1992	2246	1777	1582	1322	4760	3745	108	74	108				
1993							202	88	202	492	894		
1994	1848	1827	1308	1300	4014	3627	161	99	161	791	739		
1995	2004	1864	1588	1290	4130	3724	151	119	151	600	766	-	-
1996							170	155	170	1096	751	-	-
1997							213	178	213	791	727	-	-
1998	2004	1981	1588	1383	4132	3999	366	200	366	840	809	-	-
1999	2164	2048	1270	1460	2937	3947	214	212	214	715	792	-	-
2000	674	1610	590	1198	1558	3157	185	221	185	994	877	-	-
2001	1395	1522	462	973	1265	2506	167	220	167	513	753	-	-
2002	789	1263	279	687	1166	1946	115	194	115	948	781	-	-
2003	988	1097	696	583	1915	1668	200	172	200	1176	835	-	-
2004	1506	1020	1522	604	3404	1718	34	119	34	1270	937	-	-
2005	1060	1117	604	607	2850	1939	76	100	76	578	841	-	-
2006	1856	1182	580	635	3038	2310	120	93	120	701	895	-	-
2007	-		-		-		-			-		-	-
Mean													
(10-yr)	1444		918		2640		169			853		NA	
(5-Yr)	1240		736		2475		109			935		NA	
Geometric Mean													
(5-Yr)		1182		635		2310		93			895		NA

Source: SaSI Database (WDFW 2002); WDFW Historical Shared Database (Gill 2007).

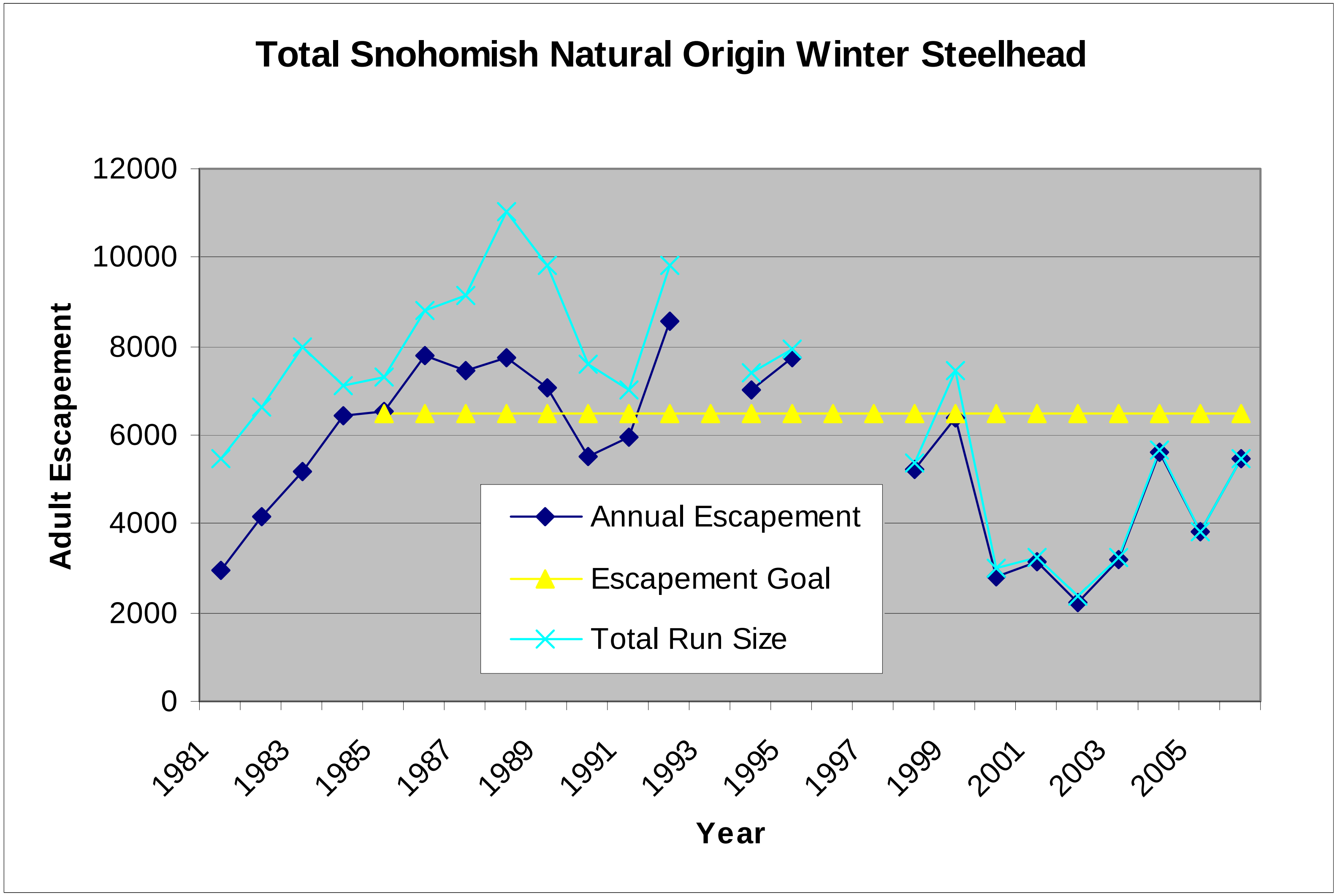

Figure C-1. Total run size and annual escapement for winter-run steelhead trout in the Snohomish River Basin.

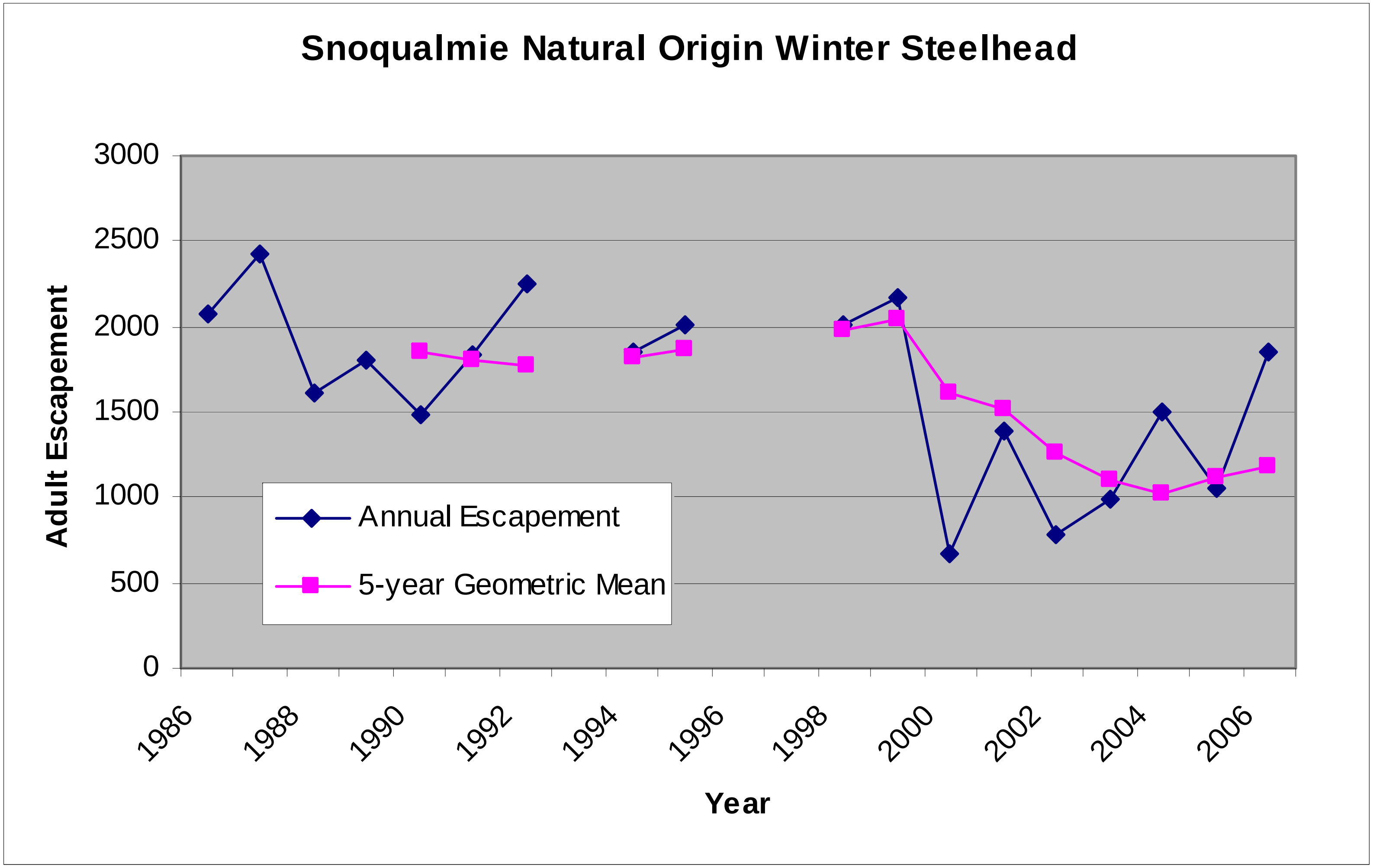

Figure C-2. Annual and 5-year geometric mean spawning escapement for the Snoqualmie winter-run stock.

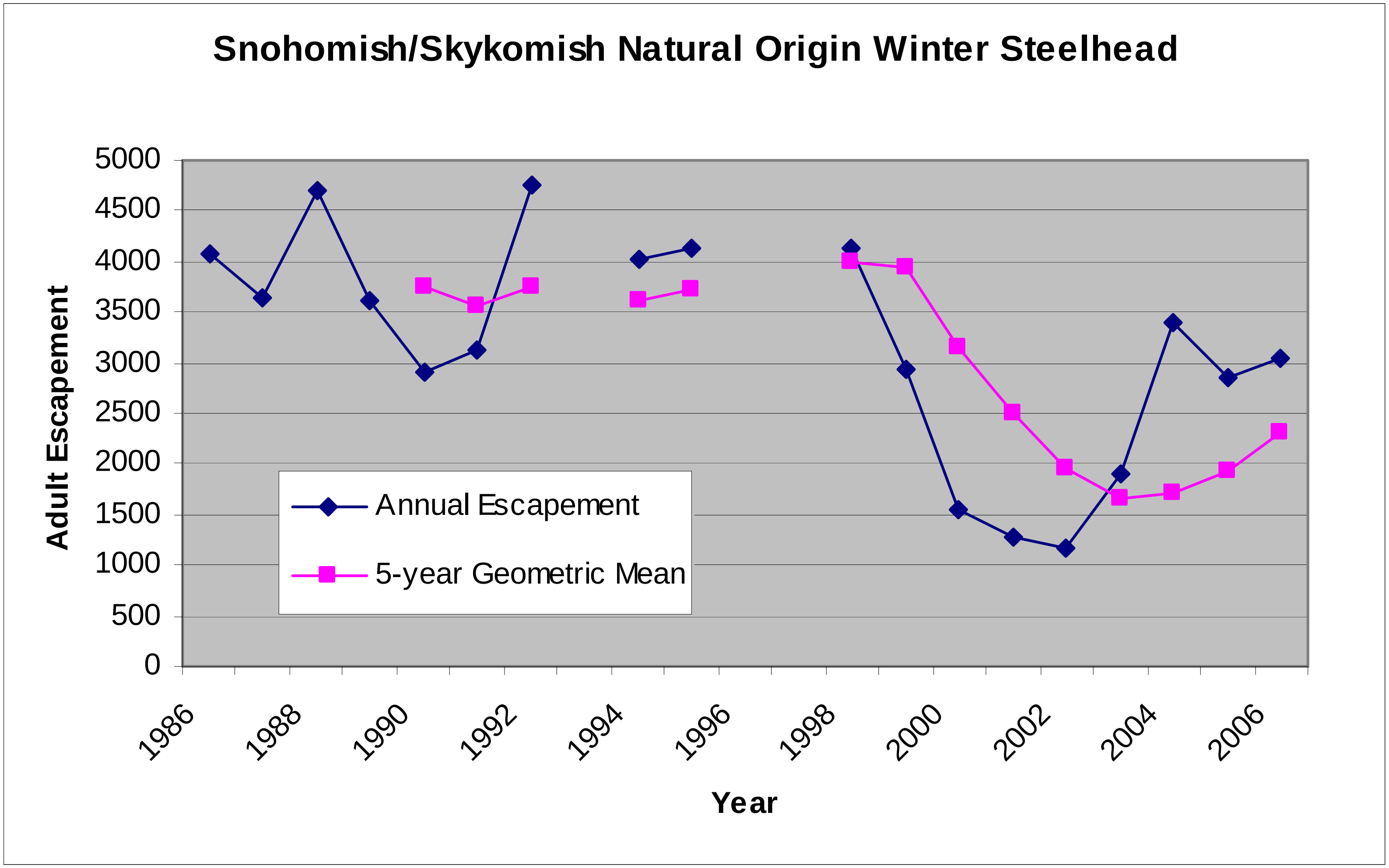

Figure C-3. Annual and 5-year geometric mean spawning escapement for the Snohomish/Skykomish winter-run stock.

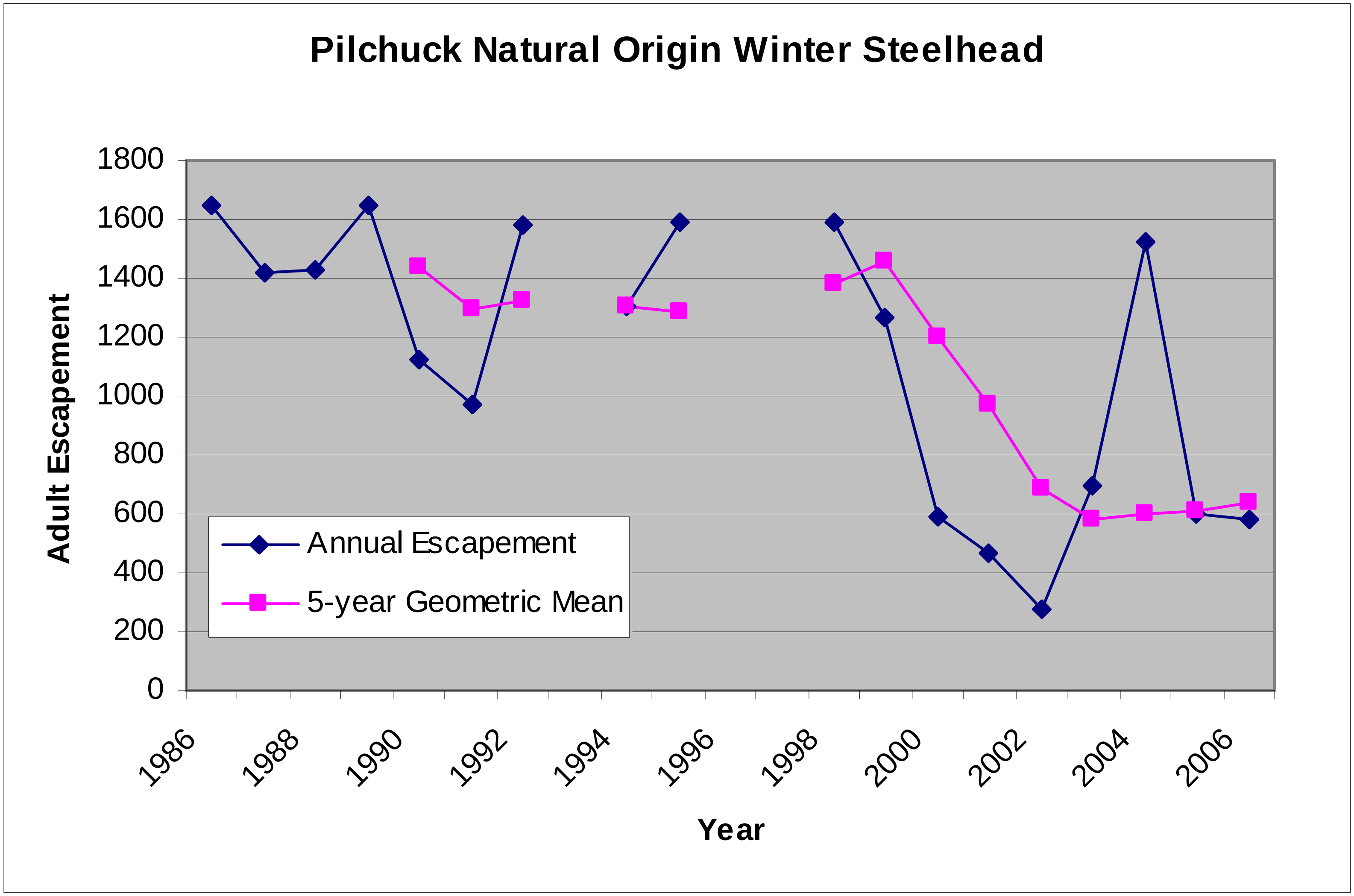

Figure C-4. Annual and 5-year geometric mean spawning escapement for the Pilchuck winter-run stock.

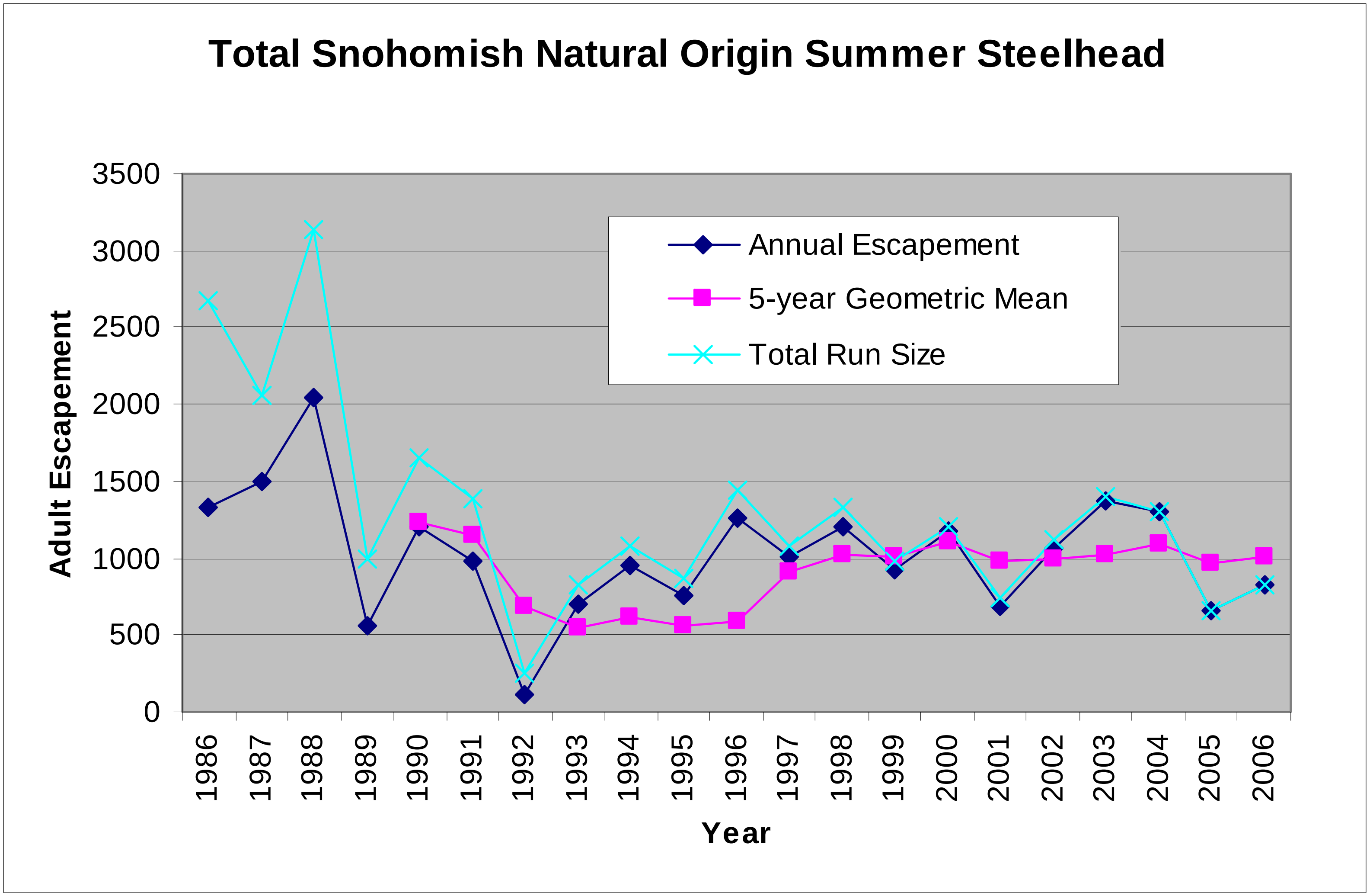

Figure C-5. Total run size and annual escapement for summer-run steelhead trout in the Snohomish River Basin.

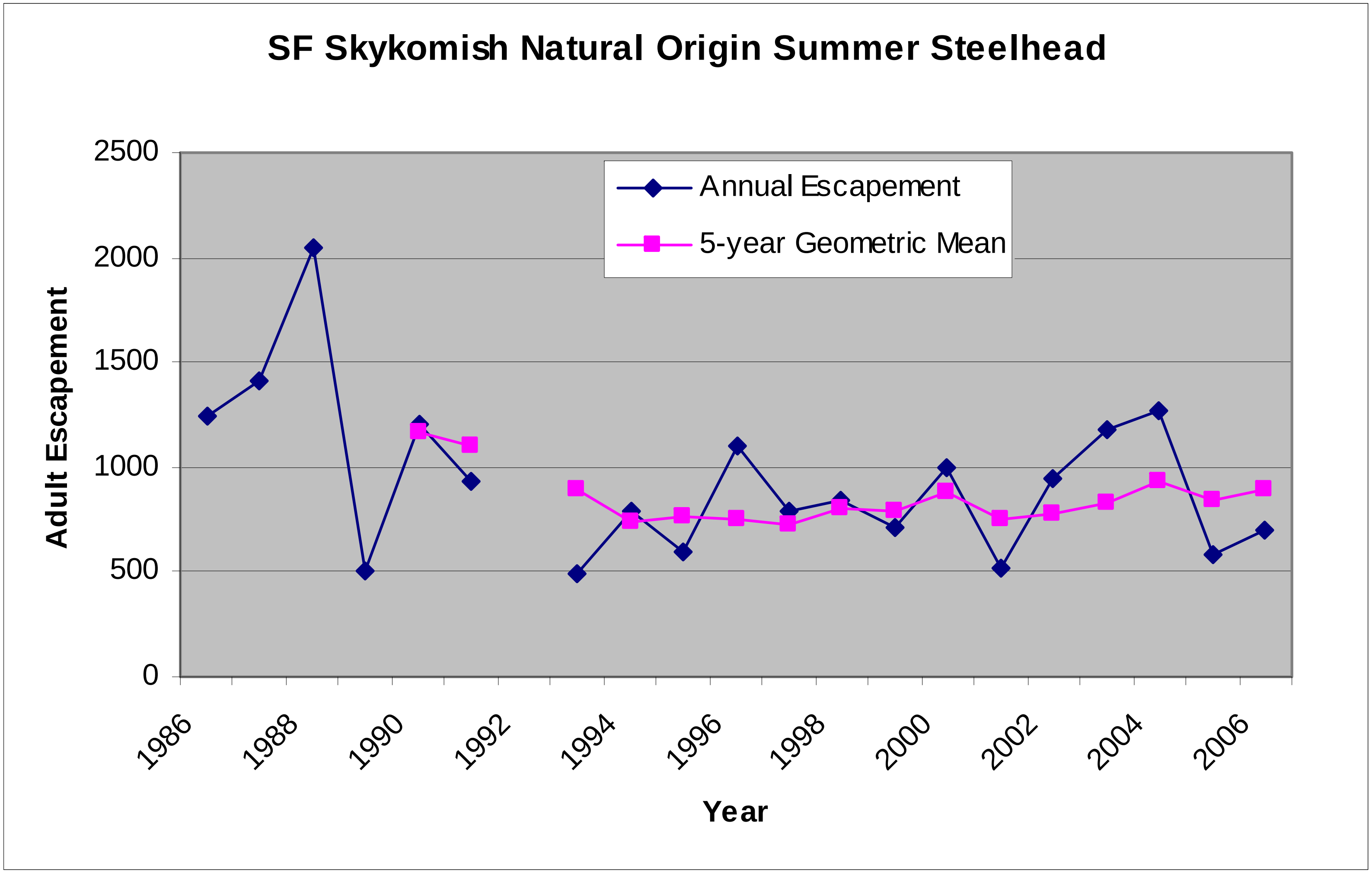

Figure C-6. Annual and 5-year geometric mean spawning escapement for the SF Skykomish summer-run stock.

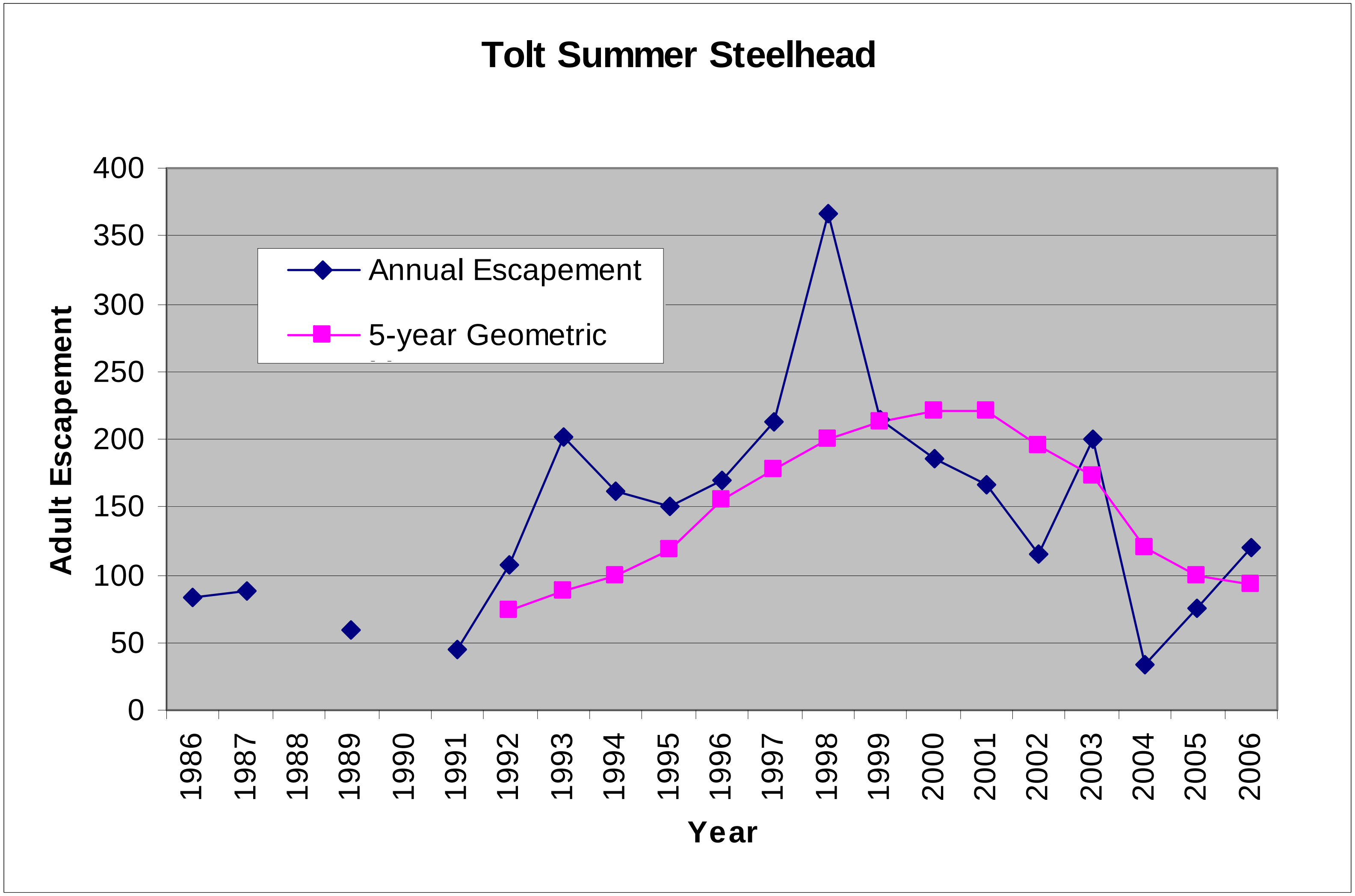

Figure C-7. Annual and 5-year geometric mean spawning escapement for the Tolt summer-run stock.

APPENDIX D

Artificial Production Records of Steelhead Trout Hatcheries in the Snohomish River Basin

Source: Dimmitt, K. (2007) "*Snohomish basin steelhead hatchery information.*" Washington Department of Fish and Wildlife (WDFW) email transmittal to R. Campbell R2 Resource Consultants, Inc. on November 28, 2007 regarding updating HGMP materials for steelhead trout production in the Snohomish River Basin.

The following appendix is a draft report prepared by the WDFW in anticipation of updating the Hatchery and Genetic Management Plans (HGMPs) for steelhead artificial production facilities in the Puget Sound Region. The report for the Snohomish Basin is appended in its entirety and remains un-formatted with respect to this document.

Reiter Summer Steelhead

Annual plant level is up to 250,000 smolts. Plant numbers may vary slightly annually depending on the actual survival of fish from egg stage to smolts. Allotments below are subject to change depending on Regional priorities in the future.

Life Stage	Release Location	Annual Release Level
Yearling	Reiter Pond On-Station Plant (RM 46.0)	160,000
Yearling	Sultan River.	30,000
Yearling	Snoqualmie River at the mouth of Tokul Creek (confluence at RM 39.6).	30,000
Yearling	Raging River mouth	30,000
Total Release		250,000

Escapement of winter and summer steelhead stocks in the Snohomish River basin for the past twelve years based on redd expansion and trap counts from SaSI web data base 2007.

Year	Snohomish System Winter Steelhead Stocks			Snohomish System Summer Steelhead Stocks		
	Snoqualmie River[1]	Pilchuck R.	Snohomish/ Skykomish River[1]	Tolt R.	S.F. Skyko-mish	N.F. Skyko-mish
1995	2,004	1,588	4,130	151	600	Na
1996	-	-	-	170	1,096	Na
1997	-	-	-	213	791	Na
1998	2004	1,558	4,132	366	840	Na
1999	2,164	1,270	2,937	214	715	Na
2000	674	590	1,558	185	994	Na
2001	1,395	462	1,265	167	513	Na
2002	789	279	1,166	115	948	Na
2003	988	696	1,915	200	1,176	Na
2004	1,506	1,522	3,404	34	1,270	Na
2005	1,060	604	2,850	76	578	Na
2006	1,856	580	3,038	120	701	Na

[1]Includes major and minor tributary redd counts.

Broodstock collection levels for the last twelve years (e.g., 1988-99), or for most recent years available:

Year	Adults			Eggs
	Females	Males	Jacks	
1995	262	262		882,000
1996	252	285		812,000
1997	300	300		1,005,000
1998	252	117(135 live spawned)		756,000
1999	222	108 (116 live spawned)		735,800
2000	175	124 (60 live spawned)		577,500
2001	227	169 (65 live spawned)		811,500
2002	243	224		850,500
2003	215	185		753,000
2004	214	214		813,200
2005	195	195		682,500
2006	220	220		775,500
2007	Na	Na		Na

Plant data until year 1995 from the WDFW Historical Database Files (2007). From 1996 to present, plant data is from the WDFW Fish Plant Database (K. Henderson 2007).

Release year	Yearling	Avg size
1990	137,700	Na
1991	184,300	Na
1992	179,900	Na
1993	235,100	Na
1994	127,100	Na
1995	230,500	Na
1996	180,900	6.0
1997	226,400	6.0
1998	168,631	6.0
1999	265,300	6.0
2000	266,300	5.0
2001	167,200	5.0
2002	223,400	7.0
2003	221,200	7.0
2004	177,039	5.4
2005	261,770	6.0
2006	234,006	6.6
2007*	245,057	7.0

Adult production levels may be calculated, but overall a true SAR cannot be calculated because of a lack of CWT studies and not all fish are accounted for as being harvested or as back to rack counts. Reiter Ponds plants fish in several locations in the Snohomish system but adult collection opportunities are limited. Production levels are under estimated due to limited trapping sites from various plant locations and once broodstock goals are met at Reiter Ponds, traps have been closed to maximize harvest opportunity. Several data gaps also exist (Table 2). Some adults may be trapped downriver at Wallace

Hatchery (River located at the confluence with May Creek (07.0943) but these have also been returned back to stream for harvest. Plant data below from WDFW Historical Database Files, (B. Gill, May 2007) while plant numbers from 1995 to present are from the current WDFW Fish Plant Database (K. Henderson 2007).

Table 2. Estimated adult production and summer–run smolt-to-adult contribution levels.

Return Year[1]	Smolt Release	Fresh-water Sport[2]	Tribal Harvest[3]	Hatchery Return*	Smolt-to-Adult Contribution %
1990	137,700	Na	44	Na	Na
1991	184,300	2,432	12	Na	1.321%
1992	179,900	2,472	7	Na	1.381%
1993	235,100	2,916	0	Na	1.240%
1994	127,100	5,601	2	Na	4.410%
1995	230,500	1,367	1	1,198	2.152%
1996	180,900	3,762	1	904	2.494%
1997	226,400	3,599	9	800	2.037%
1998	168,631	3,804	9	733	1.785%
1999	265,300	2,273	5	522	1.119%
2000	266,300	4,374	0	421	2.377%
2001	167,200	5,911	3	552	2.923%
2002	223,400	4,318	18	478	1.148%
2003	221,200	2,087	Na	550	***1.193%***
2004	177,849	2,055	***Na***	606	1.603%
2005	***261,770***	780	***Na***	340	0.429%
2006	234,006	Na	***Na***	495	Na
Average					1.77%

[1] Smolt release two years earlier in the spring.

[2] 2 or 3 salt returns cannot be broken out.

[3] Tribal harvest numbers cannot distinguish between wild or hatchery fish and are not added into the total.

* Hatchery returns include only those to Reiter Pond.

Reiter Winter Steelhead (Eggs/fish come from Tokul Cr.)

Proposed annual fish release levels (maximum number) by life stage and location.

Life Stage	Release Location	Annual Release Level
Yearling	Reiter Pond On-Station Plant (RM 46.0)	165,000
Yearling	Skykomish River at mouth of the Sultan River (at ~ RM 33.3)	15,000
Yearling	Skykomish River Mainstem at Lewis Street Bridge (at ~RM 25.1)	40,000
Yearling	Pilchuck River (at ~ RM 6.9)	30,000
Total Release		250,000

Escapement of winter and summer steelhead stocks in the Snohomish River basin for the past twelve years based on redd expansion and trap counts from SaSI web data base 2007.

Year	Snohomish System Winter Steelhead Stocks			Snohomish System Summer Steelhead Stocks		
	Snoqual-mie River[1]	Pilchuck R.	Snohomish/ Skykomish River[1]	Tolt R.	S.F. Skyko-mish	N.F. Skyko-mish
1995	2,004	1,588	4,130	151	600	Na
1996	-	-	-	170	1,096	Na
1997	-	-	-	213	791	Na
1998	2004	1,558	4,132	366	840	Na
1999	2,164	1,270	2,937	214	715	Na
2000	674	590	1,558	185	994	Na
2001	1,395	462	1,265	167	513	Na
2002	789	279	1,166	115	948	Na
2003	988	696	1,915	200	1,176	Na
2004	1,506	1,522	3,404	34	1,270	Na
2005	1,060	604	2,850	76	578	Na
2006	1,856	580	3,038	120	701	Na

[1]Includes major and minor tributary redd counts.

Broodstock collection levels for the last twelve years (e.g., 1988-99), or for most recent years available:

Tokul Creek eggs are taken for the Reiter Ponds program. Live spawned fish have been males and are not released back to stream.

Year	Adults			Eggs
	Females	Males	Jacks	
1995	464	464		1,689,139
1996	451	451		1,398,100
1997	277	280		831,000
1998	189	25 + 172 live spawned		607,000
1999	325	325		1,141,500
2000	273	193		955,500
2001	254	255		938,500
2002	283	283 (195 live spawned)		990,500
2003	169	169 (157 live spawned)		635,600
2004	508	508 (live spawned)		1,957,900
2005	498 + 200 live spawned		1	1,239,000
2006	394 + 291 lived spawned			1,284,800

Actual numbers and sizes of fish released by age class through the program.

Release year	Yearling	Avg size
1995	190,900	6
1996	250,300	6
1997	69,200	6
1998	238,800*	6
1999	234,986*	5
2000	199,521*	5
2001	184,700*	6
2002	202,538*	6
2003	215,034*	5
2004	236,149*	7.3
2005	240,987*	5.9
2006	239.598*	5.8
2007[1]	231,624	5.8

[1] Preliminary data only.

* Note - numbers above, approximately 165,000 are released on-station (Reiter Ponds) with the remainder being acclimated/planted at sites in the Snohomish River system.

Adult production levels may be calculated, but overall a true SAR cannot be calculated because of a lack of CWT studies and not all fish are accounted for as being harvested or as back to rack counts. Reiter Pond production plants in the Skykomish River and tributaries at various locations while Tokul Creek Hatchery plants the Snoqualmie River system and associated tributaries. A smaller group is released from Wallace River Hatchery. Total adult contribution levels below in Table 2 may be underestimated due to limited trapping sites and data gaps including missing tribal harvest data and high flows preventing hatchery collections (Table 2). Hatchery escapement also may only represent a portion of returning fish as once broodstock goals are met, traps have been closed to maximize harvest opportunity. Data is also calculated without escapement numbers from Reiter Ponds from 1998-2002. Until 1996, numbers are cumulative to the Snohomish River system and cannot be separated out (Table 3). Sport harvest in the mainstem Snohomish River system, below the Snoqualmie and Skykomish River confluence, cannot distinguish from which facility fish were released. Therefore, approximately

62% of the mainstem Snohomish River catch is proportioned to the Skykomish River Reiter Pond production (Table 2). Tribal harvest cannot be broken down to system but are cumulative to the Snohomish River system and is included in Table 3.

Table 2. Estimated adult contribution to sport and tribal harvest plus recorded rack returns for combined Reiter Pond, Wallace River and Pilchuck River releases (WDFW Historical Database Files, B. Gill, May 2007).

Combined Reiter Pond and Wallace River production						**Pilchuck River**		
Return Year[1]	**Smolt Release[1]**	**Fresh-water Sport[2]**	**Tribe Har-vest[3]**	**Hatchery Return***	**Smolt-to-Adult Contri-bution %**	**Smolt Release[1]**	**Fresh-water Sport[2]**	**Smolt-to-Adult Contribution %**
1995/96	35,817	2,424 (207)	***Na***	204	2.18%	25,007	227	0.90%
1996/97	225,613	1,797 (208)	***Na***	129	1.01%	21,890	57	0.26%
1997/98	79,965	1,262 (165)	***Na***	227	2.19%	14,806	54	0.36%
1998/99	223,870	2,171 (481)	Na	Na	1.31%	20,737	109	0.52%
1999/00	224,771	2,068 (277)	***Na***	Na	1.19%	31,212	114	0.36%
2000/01	191,418	2,170 (388)	***Na***	Na	1.46%	34,173	112	0.32%
2001/02	175,235	4,521 (525)	***Na***	Na	3.06%	29,035	310	1.05%
2002/03	197,616	1,124 (213)	***Na***	128	0.80%	25,496	62	0.23%
2003/04	209,734	3,227 (336)	Na	193	***1.88%***	35,295	176	***0.49%***
2004/05	226,333	3,447 (425)	***Na***	162	1.89%	38,540	361	0.93%
2005/06	215,879	2,067 (222)	***Na***	119	1.01%	25,108	103	0.41%
2006/07								
Average % thru 2005/06 - 1.55%						Average % thru 2005/06 - 0.525%		

[1]Smolt release two years earlier in the spring.

[2]Number freshwater sport harvested includes 62% of Snohomish River catches (in parenthesis).

[3]Tribal harvest numbers are not available by tributary. See also Table 3 below.

Table 3. Cumulative estimated smolt-to-adult contribution for the Snohomish River system including Reiter Pond and Tokul Creek plants and Wallace River production (WDFW Historical Database). Reiter Pond production is approximately 62% of the total catch figures in the Snohomish River system.

Return Year[1]	**Smolt Release[1]**	**Fresh-water Sport[2]**	**Tribal Harvest[3]**	**Hatchery Return***	**Smolt-to-Adult Contribution %**
1990/91	351,722	4,659	***873***	Na	1.57%
1991/92	347,600	10,248	***1,913***	Na	3.50%
1992/93	349,606	10,556	***832***	Na	3.26%
1993/94	441,519	5,299	***Na***	Na	1.20%
1994/95	341,834	7,654	***Na***	Na	2.24%
1995/96	288,619	5,269	235	1333	2.28%
1996/97	429,934	3,015	218	813	0.89%
1997/98	216,265	2,067	55	536	1.20%
1998/99	489,602	4,307	146	816	1.04%
1999/00	442,722	3,958	362	403	0.98%
2000/01	412,235	4,349	64	483	1.17%
2001/02	418,186	8,629	538	1148	2.33%
2002/03	423,320	2,281	0	458	0.64%
2003/04	453,728	6,590	85	1362	***1.75%***
2004/05	448,016	7,631	242	844	1.89%
2005/06	***404,452***	3,987	198	***907***	1.25%
2006/07					
Average % thru 2005/06 - 1.68%					

[1]Smolt release two years earlier in the spring.

[2]2 or 3 salt returns cannot be broken out.

[3]Tribal harvest numbers if available cannot distinguish between wild or hatchery fish.

*Hatchery returns include only those to Reiter Pond and Tokul Creek

Tokul Creek Winter Steelhead

Proposed annual fish release levels (maximum number) by life stage and location.

Life Stage	Release Location	Annual Release Level
Yearling	Tokul Creek	150,000
Yearling	Snoqualmie River (Mouth of the Tolt River)	20,000
Yearling	Raging River (At Preston at ~ Rm 7.5)	20,000
Total Release	Snoqualmie R. watershed	190,000

Adult production levels may be calculated, but overall a true SAR cannot be calculated because of a lack of CWT studies and not all fish are accounted for as being harvested or as back to rack counts. Hatchery escapement may only represent a portion of returning fish as once broodstock goals are met, traps may have been closed in the past to maximize harvest opportunity. Tokul Creek Hatchery plants the Snoqualmie River system and tributaries while Reiter Pond plants to the Skykomish River at various locations. Because different river locations may be planted, steelhead not harvested may not be effectively collected as they are only trapped at Tokul Creek where they are trapped throughout the season. Adult contribution levels may be under estimated due to the limited trapping sites and some data gaps (Table 2). Sport harvest in the mainstem Snohomish River system below the Snoqualmie and Skykomish River confluence is not distinguish from which facility fish were released. Approximately 38% of the mainstem Snohomish River catch (Tokul Creek production) is proportioned to the Snoqualmie River while 62% was proportioned to the Skykomish River (see also Reiter Pond Winter STHD HGMP) production (Table 2). Tribal harvest cannot be broken down to system but are cumulative to the Snohomish River system that is included in Table 3.

Table 2. Estimated adult contribution to sport and tribal harvest plus recorded rack returns in the Snoqualmie River system (WDFW Historical Database Files, B. Gill, May 2007).

Return Year[1]	Smolt Release[1]	Fresh-water Sport[2]	Tribe Harvest[3]	Hatchery Return	Smolt-to-Adult Contribution %
1990/91	170,145	1,927	Na	360	1.34%
1991/92	143,968	4,041	Na	702	3.29%
1992/93	168,223	3,698	Na	610	2.56%
1993/94	205,668	2,386	Na	511	1.41%
1994/95	158,136	3,253	Na	978	2.67%
1995/96	127,795	2,538 (127)	Na	1,053	2.90%
1996/97	167,423	1,037 (127)	Na	684	1.10%
1997/98	111,519	719 (309)	Na	309	1.01%
1998/99	234,795	1,596 (295)	Na	816	1.15%
1999/00	186,739	1,365 (170)	Na	403	1.03%
2000/01	176,648	1,455 (238)	Na	483	1.24%
2001/02	203,346	2,971 (322)	Na	1,148	2.18%
2002/03	195,506	887 (131)	Na	330	0.68%
2003/04	193,474	2,839 (206)	Na	1,169	2.17%
2004/05	183,143	3,299 (260)	Na	586	2.26%
2005/06	188,573	1,458 (136)	Na	907	1.32%
2006/07					
Average Smolt to Adult Contribution % thru 2005/06 - 1.65%					

[1]Smolt release two years earlier in the spring.

[2]Number freshwater sport harvested includes 38% of Snohomish River catches (in parenthesis). Total Snohomish River mainstem catch: 1995/96 (335), 1996/97 (336), 1997/98 (267), 1998/99 (776), 1999/00 (448), 2000/01 (627), 2001/02 (848), 2002/03 (345), and 2003/04 (543).

[3]Tribal harvest numbers are not available by tributary. See also Table 3 below.

Table 3. Cumulative estimated adult production and winter–run SAR s for the Snohomish River system including Tokul Creek plants and Reiter Pond and Wallace River production (WDFW Historical Database Files, B. Gill, May 2007).

Return Year[1]	Smolt Release[1]	Fresh-water Sport[2]	Tribal Harvest[3]	Hatchery Return*	Smolt-to-Adult Survivals (SAR)
1990/91	351,722	4,659	***873***	Na	1.57%
1991/92	347,600	10,248	***1,913***	Na	3.50%
1992/93	349,606	10,556	***832***	Na	3.26%
1993/94	441,519	5,299	***Na***	Na	1.20%
1994/95	341,834	7,654	***Na***	Na	2.24%
1995/96	288,619	5,269	235	1333	2.28%
1996/97	429,934	3,015	218	813	0.89%
1997/98	216,265	2,067	55	536	1.20%
1998/99	489,602	4,307	146	816	1.04%
1999/00	442,722	3,958	362	403	0.98%
2000/01	412,235	4,349	64	483	1.17%
2001/02	418,186	8,629	538	1148	2.33%
2002/03	423,320	2,281	0	458	0.64%
2003/04	453,728	6,590	85	1362	***1.75%***
2004/05	448,016	7,631	242	844	1.89%
2005/06	***404,452***	Na	198	***907***	1.25%
2006/07					
Average % thru 2005/06 - 1.68 %					

[1]Smolt release two years earlier in the spring.

[2]2 or 3 salt returns cannot be broken out.

[3]Tribal harvest numbers if available cannot distinguish between wild or hatchery fish.

*Hatchery returns include only those to Reiter Pond and Tokul Creek.

Broodstock collection levels for the last twelve years (e.g., 1988-99), or for most recent years available:

Tokul Creek eggs are taken and shipped to Reiter and Wallace. Live spawned fish have been males and are not released back to stream.

Year	Adults			Eggs
	Females	Males	Jacks	
1995	464	464		1,689,139
1996	451	451		1,398,100
1997	277	280		831,000
1998	189	25 + 172 live spawned		607,000
1999	325	325		1,141,500
2000	273	193		955,500
2001	254	255		938,500
2002	283	283 (195 live spawned)		990,500
2003	169	169 (157 live spawned)		635,600
2004	508	508 (live spawned)		1,957,900
2005	498 + 200 live spawned		1	1,239,000
2006	394 + 291 lived spawned			1,284,800

Actual numbers and sizes of fish released by age class through the program.

The following releases include several tributary system plants. Until 1998, some plants were made to Wallace River located on the Skykomish River system. Those numbers are included below.

Release year	Yearling	Avg size	Release year	Yearling	Avg size
1991	143,968	6	2000	176,648	6
1992	168,223	6	2001	198,171	6
1993	205,668	6	2002	195,506	5.5
1994	158,136	6	2003	193,485	5
1995	127,795	6	2004	183,143	5.0 - 6.0
1996	177,631	6	2005	188,573	5.0 - 6.0
1997	137,030	6	2006	180,515	4.8
1998	229,868	6	2007*	197,898	5.5
1999	186,739	6	2008		

*Preliminary data only. Data source: WDFW Historical Database Files until 1994, from 1995 to present (WDFW Fish Plant Database, 2007 (K. Henderson).

Note: Of the numbers above, approximately 150,000 are released at Tokul Creek with approximately 40,000 being directly planted to various sites.

WALLACE RIVER WINTER STEELHEAD

Proposed annual fish release levels (maximum number) by life stage and location.

Life Stage	Release Location	Annual Release Level
Yearling	Wallace River (07.0940)	20,000

Broodstock collection levels for the last twelve years (e.g., 1988-99), or for most recent years available:

Tokul Creek eggs are taken for the Wallace program. Live spawned fish have been males and are not released back to stream.

Year	Adults			Eggs
	Females	Males	Jacks	
1995	464	464		1,689,139
1996	451	451		1,398,100
1997	277	280		831,000
1998	189	25 + 172 live spawned		607,000
1999	325	325		1,141,500
2000	273	193		955,500
2001	254	255		938,500
2002	283	283 (195 live spawned)		990,500
2003	169	169 (157 live spawned)		635,600
2004	508	508 (live spawned)		1,957,900
2005	498 + 200 live spawned		1	1,239,000
2006	394 + 291 lived spawned			1,284,800

Plants in the Skykomish River are also made from Reiter Ponds while Tokul Creek Hatchery plants the Snoqualmie River system and associated tributaries. The Wallace River releases a smaller group directly from Wallace River Hatchery. Available catch record card (WDFW CRC) data for Wallace River is available from 1995 on (Table 2). Overall adult production levels may be under estimated due to not trapping returning fish in the past or portions of tribal harvest data not calculated. Additionally, fish may be harvested in the Skykomish River or portions of the Snohomish River mainstem fishery (Table 3).

Wallace River Plant Data (WDFW Fish Plant Database 2007, K. Henderson) and Steelhead catch (WDFW Catch Record Card - CRC) is available from 1995 on.

Return Year[1]	**Smolt Release[1]**	**Fresh-water Sport[2]**	**Facility Plant**	**Smolt-to-Adult Contributions**
1996/97	12,108	77	From Reiter Ponds	0.63%
1997/98	20,204	25	From Tokul Creek	0.12%
1998/99	13,012	276	From Tokul Creek	2.12%
1999/00	5,198	138	From Tokul Creek	2.70%
2000/01	14,760	380	From Wallace Hatchery	2.5%
2001/02	15,800	604	From Wallace Hatchery	3.82%
2002/03	20,000	251	From Wallace Hatchery	1.25%
2003/04	20,000	422	From Wallace Hatchery	2.11%
2004/05	19,700	663	From Wallace Hatchery	3.36%
2005/06	18,500	148	From Wallace Hatchery	0.80%
2006/07	22,000	Na	From Wallace Hatchery	Na

Estimated adult production and winter–run SAR s for combined Reiter Pond and Wallace River production (WDFW Historical Database Files, B. Gill, May 2007)

Combined Reiter Pond and Wallace River production					
Return Year[1]	**Smolt Release**[1]	**Fresh-water Sport**[2]	**Tribe Harvest**[3]	**Hatchery Return***	**Smolt-to-Adult Contributions**
1995/96	135,817	2,424 (207)	***235***	204	2.18%
1996/97	225,613	1,797 (208)	***218***	129	1.01%
1997/98	79,965	1,262 (165)	***55***	227	2.19%
1998/99	223,870	2,171 (481)	146	Na	1.31%
1999/00	224,771	2,068 (277)	***362***	Na	1.19%
2000/01	191,418	2,170 (388)	***64***	Na	1.46%
2001/02	175,235	4,521 (525)	***538***	Na	3.06%
2002/03	197,616	1,124 (213)	***0***	128	0.80%
2003/04	209,734	3,227 (336)	85	193	***1.88%***
2004/05	226,333	3,447 (425)	***242***	162	1.89%
2005/06	215,879	2,067 (222)	***198***	119	1.01%
2006/07					
Average % thru 2005/06 - 1.55%					

[1]Smolt release two years earlier in the spring.

[2]Number of freshwater sport harvested steelhead includes 62% of Snohomish River catches (in parenthesis). Total Snohomish River mainstem catch: 1995/96 (335), 1996/97 (336), 1997/98 (267), 1998/99 (776), 1999/00 (448), 2000/01 (627), 2001/02 (848), 2002/03 (345), and 2003/04 (543).

[3]Tribal harvest numbers are not available by tributary but for the entire Snohomish River system and not included in smolt-to-adult contribution %.

APPENDIX E

Historical Hatchery Fish Plants in the Snohomish River Basin

Appendix Table E-1. Location, date and quantity of juvenile winter-run steelhead trout planted in the Snohomish River Basin Watershed Inventory Area 07 between 1981 and 1986. [Source: WDG 1986].

Appendix Table E-2. Location, date and quantity of juvenile summer-run steelhead trout planted in the Snohomish River Basin Watershed Inventory Area 07 between 1962 and 2006. [Source: Kassler et al. in press].

Table E-1. Location, date and quantity of juvenile winter-run steelhead trout planted in the Snohomish River Basin Watershed Inventory Area 07 between 1981 and 1986. [Source: WDG 1986].

Subbasin	Stream #	River Mile	Life Stage	Brood Source	Year							Mean Released per year
					1979	1980	1981	1982	1983	1984	1985	
Pilchuck River	7.0125	4.0	smolt	Bogachie	-	-	17,000	-	-	-	-	2,429
		7.0	smolt	Green	-	-	-	-	-	10,083	-	1,440
		8.0	smolt	Chambers	-	-	-	-	-	-	18,793	2,685
		8.8	smolt	Chambers	8,508	-	-	-	-	-	-	1,215
		9.0	smolt	Chambers	-	-	-	11,033	9,585	5,516	-	3,733
		10.0	smolt	Chambers	-	-	-	9,996	-	-	-	1,428
		10.7	smolt	Chambers	-	10,953	-	-	-	-	-	1,565
		15.5	smolt	Chambers	13,218	-	-	-	-	-	-	1,888
		16.0	smolt	Chambers	-	-	-	-	10,005	-	-	1,429
		17.0	smolt	Chambers	-	-	-	-	-	6,254	-	893
		23.0	smolt	Chambers	10,116	18,115	-	-	-	-	-	4,033
		25.0	smolt	Chambers	-	-	-	-	-	6,931	-	990
		Unknown	smolt	Chambers	-	-	8,172	-	-	-	5,512	1,955
		Total			31,842	29,068	25,172	21,029	19,590	28,784	24,305	25,684
Skykomish River Mainstem	7.0012	4.0	smolt	Chambers	-	-	46,245	20,031	-	-	-	9,468
		6.0	smolt	Chambers	-	-	-	38,152	-	-	-	5,450
		7.0	smolt	Chambers	-	-	13,205	9,458	-	-	-	3,238
		12.0	smolt	Bogachie	-	-	35,000	-	-	-	-	5,000
		14.0	smolt	Chambers	-	-	-	-	14,125	-	-	2,018
		20.0	smolt	Bogachie	-	-	15,726	-	-	-	-	2,247
		22.0	smolt	Chambers	-	-	-	30,000	-	-	-	4,286
		23.0	smolt	Chambers	-	-	-	15,000	-	-	-	2,143
		25.0	smolt	Chambers	22,588	31,452	-	42,560	7,475	32,772	27,414	23,466
		27.5	smolt	Chambers	7,050	-	-	-	-	-	-	1,007
		28.0	smolt	Chambers	-	30,790	-	-	32,000	29,400	21,500	16,241
		28.2	smolt	Chambers	15,460	-	-	-	-	-	-	2,209
		34.0	smolt	Chambers	-	-	-	15,301	26,345	21,139	12,558	10,763
		34.4	smolt	Chambers	25,402	9,900	-	-	-	-	-	5,043
		44.0	smolt	Chambers	-	-	-	-	-	-	89,666	12,809
		45.5	smolt	Chambers	11,956	12,654	-	-	-	-	-	3,516
		46.0	smolt	Chambers	-	-	-	-	46,875	28,241	-	10,731
		Unknown	smolt	Chambers	5,486	-	21,611	-	-	-	-	3,871
		Total			87,942	84,796	131,787	170,502	126,820	111,552	151,138	123,505
Woods Creek	7.0826	5.0	smolt	Chambers	5,040	5,130	-	-	-	-	-	1,453
Sultan River	7.0881	2.0	smolt	Chambers	-	-	-	-	-	10,490	-	1,499
		3.0	smolt	Bogachie	-	-	20,000	-	-	-	-	2,857
		3.0	smolt	Chambers	16,927	38,451	-	10,011	20,200	-	-	12,227
		4.0	smolt	Chambers	-	-	-	-	-	-	10,500	1,500
		11.0	smolt	Chambers	-	-	-	5,300	-	-	-	757
		Total			16,927	38,451	20,000	15,311	20,200	10,490	10,500	18,840
Winters Creek	7.0882	Unknown	fry	Chambers	-	-	-	1,750	-	-	-	250
Wallace River	7.0940	3.0	smolt	Chambers	-	-	-	-	-	20,098	-	2,871
		3.6	smolt	Chambers	-	7,718	-	-	-	-	-	1,103
		4.0	smolt	Chambers	-	5,508	-	12,657	-	-	-	2,595
		5.8	smolt	Chambers	10,134	-	-	-	-	-	-	1,448
		6.0	smolt	Chambers	-	-	-	2,990	36,460	-	20,720	8,596
		6.5	smolt	Chambers	-	7,020	-	-	-	-	-	1,003
		7.0	smolt	Chambers	-	-	-	4,378	-	-	-	625
		Unknown	smolt	Chambers	10,090	-	15,024	-	-	-	-	3,588
		Total			20,224	20,246	15,024	20,025	36,460	20,098	20,720	21,828

Table E-1. (continued) Location, date and quantity of juvenile winter-run steelhead trout planted in the Snohomish River Basin Watershed Inventory Area 07 between 1981 and 1986. [Source: WDG 1986].

Subbasin	Stream #	River Mile	Life Stage	Brood Source	Year 1979	1980	1981	1982	1983	1984	1985	Mean Released per year
Olney Creek	7.0946	Unknown	fry	Chambers	-	-	-	19,280	-	-	-	2,754
NF Skykomish River	7.0982	1.0	smolt	Chambers	-	-	-	-	5,800	-	12,100	2,557
		1.4	smolt	Chambers	-	17,558	-	-	-	-	-	2,508
		2.0	smolt	Chambers	-	-	-	-	-	10,000	-	1,429
		9.6	smolt	Chambers	15,236	-	-	-	-	-	-	2,177
		10.0	smolt	Chambers	-	-	-	-	-	10,240	10,000	2,891
		11.0	smolt	Chambers	-	-	-	-	7,175	-	-	1,025
		12.0	smolt	Chambers	5,175	15,304	-	9,528	-	-	-	4,287
		29.0	smolt	Chambers	-	-	-	4,945	-	-	-	706
		Unknown	smolt	Chambers	-	-	20,248	-	-	-	-	2,893
		Total			20,411	32,862	20,248	14,473	12,975	20,240	22,100	20,473
Bear Creek	7.1120	Unknown	fry	Chambers	-	-	-	17,142	-	-	-	2,449
Snoqualmie River Mainstem	7.0219	2.7	smolt	Chambers	-	9,702	-	-	-	-	-	1,386
		9.0	smolt	Chambers	-	-	-	-	-	14,894	18,806	4,814
		9.8	smolt	Chambers	-	12,426	-	-	-	-	-	1,775
		10.0	smolt	Chambers	-	-	-	-	15,236	-	-	2,177
		18.0	smolt	Chambers	-	-	-	15,689	-	-	-	2,241
		23.0	smolt	Chambers	-	-	-	-	19,820	22,462	2,880	6,452
		24.0	smolt	Chambers	-	-	-	9,758	-	-	-	1,394
		24.9	smolt	Chambers	16,248	21,330	-	-	-	-	-	5,368
		25.0	smolt	Chambers	-	-	-	12,545	20,794	17,468	16,739	9,649
		27.0	smolt	Chambers	-	-	-	27,261	-	-	-	3,894
		33.0	smolt	Chambers	-	18,028	-	-	24,892	20,295	6,684	9,986
		36.0	smolt	Chambers	-	-	-	-	-	19,762	16,350	5,159
		36.2	smolt	Chambers	-	21,041	-	-	-	-	-	3,006
		39.0	smolt	Chambers	-	-	-	-	1,976	18,652	32,158	7,541
		39.7	smolt	Chambers	-	22,475	-	-	-	-	-	3,211
		40.0	smolt	Chambers	-	-	-	-	7,038	5,830	-	1,838
		Unknown	smolt	Chambers	91,569	-	100,587	-	-	-	-	27,451
		Total			107,817	105,002	100,587	65,253	89,756	119,363	93,617	97,342
NF Tolt River	7.0291	Unknown	fry	Chambers	-	-	34,000	-	-	-	-	4,857
Tolt River		2.8	smolt	Chambers	11,060	-	-	-	-	-	-	1,580
		6.0	smolt	Chambers	8,120	13,520	-	-	20,010	20,114	-	8,823
		8.0	smolt	Chambers	-	-	16,079	-	-	-	-	2,297
		8.8	smolt	Chambers	21,534	14,880	-	-	-	-	-	5,202
		9.0	smolt	Chambers	-	-	-	16,664	-	-	-	2,381
		Unknown	smolt	Chambers	-	-	10,074	-	-	-	-	1,439
		Total			40,714	28,400	26,153	16,664	20,010	20,114	-	21,722
Stossel Creek	7.0300	Unknown	fry	Chambers	-	-	6,800	-	-	-	-	971
Griffin Creek	7.0364	Unknown	fry	Chambers	-	-	3,400	-	-	-	-	486
Raging River	7.0384	4.8	smolt	Chambers	5,526	4,277	-	-	-	-	-	1,400
		6.2	smolt	Chambers	9,500	10,000	-	-	-	-	-	2,786
		7.0	smolt	Chambers	-	-	-	-	9,998	15,006	16,000	5,858
		12.0	smolt	Chambers	-	-	-	-	4,639	-	-	663
		Unknown	fry	Chambers	-	-	102,000	-	-	-	-	14,571
		Unknown	smolt	Chambers	-	-	10,000	12,000	-	-	-	3,143
		Total			15,026	14,277	112,000	12,000	14,637	15,006	16,000	28,421
Boomers Creek	Unknown	Unknown	fry	Chambers	-	-	-	4,200	-	-	-	600
Grand Total					345,943	358,232	495,171	377,629	340,448	345,647	338,380	371,636

Table E-2. Location, date and quantity of juvenile summer-run steelhead trout planted in the Snohomish River Basin Watershed Inventory Area 07 between 1962 and 2006. [Source: Kassler et al., in press].

Year	Skykomish River Mainstem	NF Skykomish River	SF Skykomish River	Total
1962	44,820	-	-	44,820
1963	-	-	-	-
1964	-	29,230	30,293	59,523
1965	24,350	26,100	-	50,450
1966	11,520	24,223	-	35,743
1967	-	32,860	-	32,860
1968	-	40,005	-	40,005
1969	-	39,322	-	39,322
1970	-	50,078	-	50,078
1971	-	37,183	-	37,183
1972	9,240	28,870	-	38,110
1973	-	57,045	-	57,045
1974	-	66,720	-	66,720
1975	76,374	20,662	11,121	108,157
1976	74,975	10,923	10,278	96,176
1977	62,629	42,460	10,236	115,325
1978	69,237	32,080	-	101,317
1979	74,873	32,500	-	107,373
1980	59,409	41,290	18,469	119,168
1981	24,960	-	25,485	50,445
1982	49,008	13,342	15,000	77,350
1983	65,760	19,147	14,024	98,931
1984	112,063	26,835	17,132	156,030
1985	35,008	16,322	11,665	62,995
1986	95,235	18,092	20,287	133,614
1987	63,059	-	-	63,059
1988	76,400	24,708	19,851	120,959
1989	101,619	-	-	101,619
1990	91,758	14,571	15,929	122,258
1991	104,489	15,276	15,179	134,944
1992	111,547	20,360	20,023	151,930
1993	72,774	7,638	-	80,412
1994	146,232	19,568	-	165,800
1995	120,043	6,741	-	126,784
1996	127,383	15,775	-	143,158
1997	93,745	14,610	-	108,355
1998	175,000	23,337	-	198,337
1999	176,320	17,812	-	194,132
2000	117,363	4,600	-	121,963
2001	136,492	-	-	136,492
2002	-	154,776	-	154,776
2003	107,217	15,282	-	122,499
2004	165,000	20,150	-	185,150
2005	168,800	20,160	-	188,960
2006	149,440	13,398	-	162,838
Mean Released per Year	70,981	24,757	5,666	101,404