PART I: INTRODUCTION

3. Current and Historic Salmonid Population

3. CURRENT AND HISTORIC SALMONID POPULATION

OVERVIEW OF HISTORIC NATURAL SPAWNING SALMONID POPULATION

Historically, the Duwamish/Green River basin was comprised of a number of subbasins that in the last 100 years been diverted out of the basin. Today, the Duwamish/Green River basin has been extensively altered ecologically and physically. Historically, the White River is believed to have moved between the Puyallup and Green River drainages. During periods of high flows, the White River utilized the Stuck River as an overflow channel and some or all of the flow was transferred to the Puyallup River. However, the movement of water and the size of the basin began to change dramatically, first with the permanent diversion of the White River to the Puyallup drainage in 1906 (natural and man-induced); followed by the diversion of Lake Washington and Cedar River to the Ship Canal in 1916, the construction of the Tacoma Diversion Dam in 1911 and construction of Howard Hansen Dam in 1961. All of these contributed to the elimination of access by anadromous and resident fish to many of the habitats historically present in the basin. These changes have reduced the Green River watershed to approximately 30% of its historical size.

There is very little reliable historical sources of information on anadromous and resident salmonid species abundance in the Duwamish/Green River basin. Historically, runs of chinook (spring and summer/fall stocks), pink, coho, chum salmon, winter steelhead and cutthroat trout were present in the Duwamish/Green River basin. Summer steelhead were also likely present in low numbers. There is limited evidence that sockeye salmon spawn and rear (Jeanes et al 2000).

The only historic data for chinook and coho escapement comes from early hatchery records of the two facilities that began operation in the basin shortly after 1900. Fuerstenberg et al (In Draft 1999) provided a coho salmon escapement number of 36,741 adults annually between 1938 – 1942 and 12,500 for the years between 1987 - 1991, however no citation for these numbers was provided and the Muckleshoot Indian Tribe has not agreed to these figures (R. Malcom pers. comm.).

In response to the construction of the City of Tacoma Diversion Dam in 1911, a hatchery facility, that was actually an egg taking station, was constructed immediately downstream of the Tacoma Headworks Dam that same year. Sometimes referred to as Hatchery Number 2, this facility was closed in 1921. The hatchery records (HSP 1) provide one piece of information into the historic run sizes upstream of the present day Tacoma Headworks project and Howard Hanson Dam.

HSP 1: Numbers of chinook, coho and steelhead females spawned at the Green River Eyeing Station 1911 – 1920 (Source: Grette and Salo 1986)

Reporting Period	Chinook	Coho	Steelhead	Comments
4/1/11 – 3/31/12	0	2248	0	
4/1/12 - 3/31/13	136	3117	1308	
4/1/13 – 3/31/14	116	2757	0	New trap constructed
4/1/14 – 3/31/15	87	604	254	Low water levels
4/1/15 – 11/30/15	101	341	150	
12/1/15 – 11/30/16	61	795	247	
12/1/16 – 3/31/17	0	738	0	
4/1/17 – 3/31/18	280	146	61	
4/1/18 – 3/31/19	259	96	49	
4/1/19 – 3/31/20	40	430	134	
4/1/20 – 3/31/21	16	785	254	

Almost certainly there were inefficiencies in the operation of this eyeing station trap and the actual run size was probably larger. Prior to 1913 the trap was located in the stilling basin of the dam and was believed to be less than successful. In response to the lack of success, during 1913, a new concrete trap was constructed on one of the wings of the dam and at the time was deemed quite successful (Darwin 1916). However, the dam and associated trap almost certainly resulted in fish that were reluctant to enter the trap to spawn downstream of the facility. These fish would have been destined for upriver locations and were not counted.

The construction of the new trap in 1913 is important for at least two reasons. Darwin (1916) stated that: "… every salmon that ascended the stream has been taken …". It is assumed that this statement means every female is spawned and thus counted in the hatchery records presented in Table 1 above. If that assumption is not correct then it would introduce an additional downward bias in counts of fish destined for upriver production. Those records only reflect females spawned and do not account for any mortality. The lack of counting these mortalities almost certainly causes a downward bias in the total run size.

Secondly, the timing of the trap construction may have precluded steelhead trapping during the time period of 4/1/13 to 3/31/14. Winter run steelhead typically spawn beginning in mid-March with the majority spawning after April 1. This timing issue may account for the lack of a steelhead egg take during 1913/14. The current operations of the temporary trap at the Tacoma Headworks facility still reflect that fact as this trap is not put in the river until March 1 and removed in late May or early June.

Based on the numbers in Table 1, Grette and Salo (1986) determined escapement estimates for chinook, coho and steelhead and those numbers are presented in HSP 2 below.

HSP 2: Escapement estimates of coho, chinook and steelhead upstream of Tacoma Headworks project prior to project construction (Source: Grette and Salo 1986)

Species	Range of Adult Returns	Escapement Estimate
Chinook	174-272	No estimate
Coho	4,496 – 6,234	5,400 – 6,200
Steelhead	500-2,616	500 – 2,600

Grette and Salo (1986) determined that the chinook spawned at the Tacoma Headworks project were a spring chinook stock. Certainly, the life history trajectory of spring chinook stocks is to utilize the headwater areas of river systems for spawning and early rearing of juveniles. They felt that the presence of the weir in the lower river at the confluence with Soos Creek captured the summer/fall chinook run. This conclusion is important in that most professional fishery biologists feel that spring chinook are either extinct or returning in such low numbers as to not constitute a distinct stock in the Green River. This is also important from the perspective of holding adult chinook. Unlike summer/fall chinook which only have to be held a matter of weeks for sexual maturation, spring chinook have to be held for up to several months. This longer holding period likely induces a higher mortality in the holding pond.

Fuerstenberg et al (In Draft) provided a chinook salmon escapement number of 55,197 adults annually between 1938 – 1942 and 10,3000 for the years between 1987 - 1991, however no citation for these numbers was provided and the Muckleshoot Indian Tribe has not agreed to these figures (R. Malcom pers. comm.).

Additionally, Grette and Salo (1986) placed some doubt that the numbers of chinook returning to the Diversion Dam were similar before and after construction. They based this doubt on the amount of habitat available upstream of the project and poaching of adult salmon in the pools below the diversion dam (R. Wolschlagel, pers. comm. contained in Grette and Salo 1986).

Additional insight into escapement records comes from Riseland (1913). He provides some data on eggs taken from the Green River at the location of the then newly constructed Tacoma Headworks Dam and insight of historic anadromous populations that would have migrated upstream of this location. Those escapement estimates are shown in HSP 3.

HSP 3: Escapement estimates for spring chinook, coho and winter steelhead to Upper Green River subbasin pre-1911 (Source: Riseland 1913)

Species	Range
Spring Chinook	150 - 300
Coho	9,000 – 25,000
Winter Steelhead	500 – 2,500

Finally, Chapman (1981) developed estimated smolt and adult returns for chinook, coho and steelhead upstream of the Headworks. In the development of these estimates he assumed pristine habitat conditions and the absence of HHD. Those estimates are shown below in HSP 4.

HSP 4: Estimated chinook, coho and winter steelhead smolts produced and adult returns under pristine conditions for the upper Green River subbasin (Source: Chapman 1981)

Species	Smolts produced	Adult Escapement
Chinook	128,644	1,286
Coho	213,516	4,270
Winter Steelhead	20,079	437

Sockeye salmon adults are reported annually in the vicinity of the Headworks. Estimates range from 100 to 400 adults. It is unknown if these fish are successfully reproducing. Eagle Lake (sometimes referred to as Enapooh Lake) is the only lake of sufficient size (53.2 surface acres) to have historically provided a rearing opportunity for sockeye juveniles in this subbasin. However, it is no longer accessible to anadromous fish.

A comparison of the escapement and predicted returns from the individual sources above is shown in HSP 5.

HSP 5: A comparison of predicted escapement estimates and returns of adult chinook, coho and steelhead from three historical perspectives for the Green River upstream of the Tacoma Headworks project.

Species	Grette and Salo	Riseland	Chapman
Chinook	No estimate	150 - 300	1,286
Coho	5,400 – 6,200	9,000 – 25,000	4,270
Steelhead	500 – 2,600	500 – 2,500	437

The first anadromous salmon hatchery facility in the Green River basin, the Green River Hatchery State Fish Hatchery (SFH) on Soos Creek was constructed in 1904. Egg takes had begun on Soos Creek in 1903 but it is not clear where those eggs were taken. Run size, harvest and spawning escapement data for the Green River (and other Puget Sound drainages) chinook and coho are unavailable prior to the mid-1960s. However, early trap records at the Soos Creek SFH do provide some insight into returns of these species. A weir was constructed across Soos Creek beginning in 1903 for the purpose of obtaining hatchery broodstock and supplying the Soos Creek SFH with coho and chinook eggs. Grette back calculated the numbers of female chinook and coho salmon spawned and Salo (1986) based on egg take and literature obtained fecundity averages. Those calculations show a low of 192 female coho spawned in 1903 (the first year of operation) to a high of 6,013 in 1924. Numbers of adult female chinook spawned range from a low of 192 in 1903 to a high of 7,308 in 1935. It is highly probable that escapement for these two species was higher because the weir often washed out during October when leaf fall along with heavy rains would have made maintaining the weir structure very difficult (Beckler 1967).

Total escapement estimates for winter steelhead prior to the 1977-78 (WDFW and WWTIT 1992) run year are not available. Run size and escapement estimates of winter steelhead to the upper portions of the Green River basin were reported on earlier in this chapter. Fuerstenberg et

al (In Draft) provided a winter steelhead escapement number of 4,400 adults annually between 1938 – 1942 and 1,600 for the years between 1987 - 1991, however no citation for these numbers was provided and the Muckleshoot Indian Tribe has not agreed to these figures (R. Malcom pers. comm.).

Summer steelhead in the Green River are near the edge of the geographic range for this species. The run size and estimated escapement of this species is not available. The best indication of a historic run comes from Washington Department of Fish and Wildlife (formerly Washington Departments of Fisheries and Game/Wildlife) harvest records. Harvest was very small prior to the initiation of a hatchery program in the mid-1960's. Those harvest numbers are shown in HSP 6.

HSP 6: Historic sport catches of summer-run steelhead in the Green River 1962 – 1982.

Year	Catch
1962	3
1963	44
1964	0
1965	3
1966	53
1967	163
1968	254
1969	221
1970	180
1971	277
1972	1794
1973	1781
1974	647
1975	1014
1976	1722
1977	1664
1978	2477
1979	1196
1980	1528
1981	3398
1982	1934

Note: Catch numbers prior to 1974 are not corrected for non-response bias, resulting in a value that is probably higher than actual.

Historic run sizes and escapement estimates for chum salmon are more difficult to quantify. Williams (1975) reported an average annual escapement for the Duwamish/Green River basin of 11,300 for the years 1966 – 71 inclusive. There is no terminal area harvest data available prior to 1974 that would assist in determining run size to the Duwamish/Green River. Spawning ground counts for chum salmon are scarce. From the available information we were not able to determine historic run sizes or escapement estimates. Fuerstenberg et al (In Draft) provided a chum salmon escapement number of 12,750 adults annually between 1938 – 1942 and 3,000 for the

years between 1987 - 1991, however no citation for these numbers was provided and the Muckleshoot Indian Tribe has not agreed to these figures (R. Malcom pers. comm.).

Pink salmon have historically been present in low numbers in the lower and middle Green River basin. Williams (1975) stated that pink salmon have been extinct in the Green River basin since the 1930's but provided no insight into that determination. Grette and Salo (1986) cited Williams (1975) and stated that they have been "… eliminated from the drainage…". They also stated that an occasional pink salmon adult is captured in mainstem Green River fisheries. Fuerstenberg et al (In Draft) provided a pink salmon escapement number of 1,000 adults in odd numbered years between 1938 – 1942, however no citation for this number was provided and the Muckleshoot Indian Tribe has not agreed to these figures (R. Malcom pers. comm.). Historic spawning ground surveys for pink salmon in the Green River basin are scarce and do not provide enough data to assist in escapement determination. Indeed for the Green River basin there are only 14 entries from three streams in a database that contains approximately 150,000 entries from WRIAs 1 – 19. The current status of this species is discussed further elsewhere in this report.

Historic data concerning coastal cutthroat trout in the Duwamish/Green River basin is scarce. Williams (1975) indicated the presence of cutthroat trout in this basin but provided no abundance or life history information. Cummins (1980) stated that the run and harvest is small in comparison to other river systems in northern Puget Sound. Only small numbers of cutthroat are reported captured during sampling in the Duwamish Estuary (Meyer et al 1981, Weitkamp and Campbell 1980, Weitkamp and Schadt 1982).

OVERVIEW OF CURRENT SALMONID POPULATION

The 1992 Washington State Salmon and Steelhead Inventory (SASSI) (WDFW and WWTIT, 1994) listed the stock status of Green River summer/fall chinook, Crisp Creek fall chum, Soos Creek coho, both summer and winter steelhead stock as healthy. The stock status of Green River fall chum, sockeye, and bull trout were listed as unknown. Pink salmon are believed by many to have been extirpated in WRIA 9 and were not identified as a stock present in this system. However, adult pink salmon have been observed spawning in the mainstem and juvenile pink salmon have been captured. A summary of salmon and steelhead usage in major subbasins is presented in table CSP-1. The Green River winter steelhead, bull trout and coastal cutthroat trout are defined as a native stock. The origin of Green River sockeye salmon is unknown. Both chinook stocks, Soos Creek coho are of a mixed stock origin while Crisp Creek fall chum, early timing winter steelhead and summer steelhead are of a non-native origin. The National Marine Fisheries Service (NMFS) includes the naturally produced fall chinook stock population in the Puget Sound Evolutionary Significant Unit (ESU) and has listed that ESU as Threatened under the Endangered Species Act. There have only been occasional observations of adult spring chinook in this system. The stock status of Green River native winter steelhead was listed as healthy in SASSI, but recent population trends indicate that may be optimistic.

Table CSP-1. Salmon Species and Stocks Found in the Green/Duwamish (SASSI 1994). The NMFS and USFWS listed or proposed Endangered Species Act (ESA) listing status are also shown as of January 2000.

Stock[1]	Stock Origin[2]	Production Type[3]	Stock Status (SASSI)	ESA Status (NMFS & USFWS)
Green/Duwamish River Summer/Fall Chinook	Mixed[4]	Composite[7]	Healthy	Listed as Threatened
Newaukum Creek Summer/Fall Chinook	Mixed	Wild[8]	Healthy	Listed as Threatened
Green/Duwamish River Fall Chum	Mixed	Composite	Unknown	Not Warranted
Crisp (Keta) Creek Fall Chum	Non-native[5]	Cultured [9]	Healthy	Not Warranted
Green River/Soos Creek Coho	Mixed	Composite	Healthy	Candidate
Newaukum Creek Coho	Mixed	Composite	Depressed	Candidate
Green/Duwamish River Summer Steelhead	Non-native	Composite	Healthy	Not Warranted
Green/Duwamish River Winter Steelhead	Native[6]	Wild	Healthy	Not Warranted
Green/Duwamish River Early Winter Steelhead	Non-native	Cultured	Healthy	Not Warranted
Green River Pink	Native	Wild	Unknown But Presumed Depressed	Not Warranted
Green River Sockeye[10]	Unknown	Wild	Unknown	Uncertain
Green River Bull Trout[11]	Native	Wild	Unknown	Listed as Threatened
Green River Coastal Cutthroat Trout[12]	Native	Wild	Unknown	Protection Unnecessary At This Time

Notes

As defined in WDFW and WWTT (1994), the fish spawning in a particular lake or stream(s) at a particular season, which fish to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season.

The genetic history of the stock

The method of spawning and rearing that produced the fish that constitutes the stock.

A stock whose individuals originated from commingled native and non-native parents, and/or by mating between native and non-native fish (hybridization) or a previously native stock that has undergone substantial genetic alteration.

A stock that has become established outside of its original range

An indigenous stock of fish that have not been substantially impacted by genetic interactions with non-native stocks, or by other factors, and is still present in all or part of its original range.

A stock sustained by both wild and artificial production.

A stock that is sustained by natural spawning and rearing in the natural habitat, regardless of parentage (includes native)

A stock that depends on spawning, incubation, hatching, or rearing in a hatchery or other artificial production facility.

Not listed in WDFW and WWTT (1994).

Listed in WDFW SaSI (1998).

WDFW (2000).

GREEN/DUWAMISH RIVER BASIN SUMMER/FALL CHINOOK SALMON POPULATION TRENDS

Chinook salmon in the Green River consist primarily of summer/fall run fish. Historically, a spring run also occurred in the watershed but re-routing of the White River to the Puyallup drainage in 1906 (natural and man-induced), re-routing of Lake Washington and Cedar River to the Ship Canal in 1916, construction of the Tacoma Diversion Dam in 1913 and construction of Howard Hansen Dam in 1961 eliminated access to much of the headwater habitat typically needed by spring chinook salmon in this region (Grette and Salo 1986). These changes reduced the Green River watershed to approximately 30percent of its historical size. Presently, nearly all of the natural chinook production occurs in the mainstem Green River below the Tacoma Diversion Dam, Soos Creek, and Newaukum Creek. Chinook in WRIA 9 are separated into two stocks (WDFW and WWTIT, 1994), the Green/Duwamish and the Newaukum Creek summer/fall stocks. Escapement for the Green/Duwamish River summer/fall chinook stock from 1986 to 1997 is shown in Figure CSP-1, averaged 6,031 and ranged from 2,027 to 10,059. Between those dates the escapement of naturally spawning fish has varied substantially. Although spring chinook salmon are occasionally found in the Green River it is not known if these fish constitute a self-sustained run.

Chinook salmon returning to the Green River have been a mixture of natural spawning and hatchery chinook salmon since approximately 1904 when the first hatchery fish returned to the Green River Hatchery on Soos Creek. Harvest and spawning escapement data for the Green River (and other Puget Sound drainages) are unavailable prior to the mid-1960s. The only index of chinook salmon returns to Puget Sound during the early 1900s is commercial and sport harvests in the Strait of Juan de Fuca and Puget Sound. However, these data are confounded by the presence of chinook salmon destined for British Columbia and the interception of Puget Sound-bound chinook in Washington coastal troll and other interception fisheries.

As a result of recent efforts by the WDFW and tribes, more accurate records of chinook spawning escapement and stock-specific harvests are available since 1968. Enhanced accounting of chinook escapements and runs in Puget Sound drainages arose, in part, as a response to the 1976 Boldt (U.S. vs WA.) decision which influenced managers to switch from harvest rate based management to spawning escapement based management. However, the harvest component in the stock-specific WDFW run reconstruction database is limited to commercial harvests (mainly net harvests) in Puget Sound (treaty and non-treaty Indian). Sport and commercial fishermen in British Columbia harvest many chinook salmon having their origin in Puget Sound. To account for Green River chinook salmon harvested in fisheries other than commercial net harvests in Puget Sound, NRC (1999) integrated annual distributions of total mortalities (including incidental mortalities) associated with each fishery in each geographic region (PSC 1999) with the WDFW harvest data to reconstruct total annual runs of chinook salmon returning to the Green River. The results of this run reconstruction are described below for natural spawning and hatchery summer/fall chinook salmon.

The reconstructed run estimates for Green River chinook salmon are subject to a variety of measurement errors, which are typical of fishery estimates such as these. For example, currently the spawning escapement in the Green River is estimated by counting chinook redds (spawning

nests) in a portion of the basin, expanding redds counts by a factor of 2.5 to account for numbers of fish per redd, then expanding this estimate of spawning fish to the entire basin based on an estimate of total habitat believed to support spawning chinook salmon (Smith and Castle 1994). For mainstem Green River, the latter expansion factor is 2.6, indicating that most of the spawning grounds are not sampled each year. This expansion factor is currently under review and the reanalysis may lead to somewhat lower spawning escapement estimates (Cropp, 1999). Spawning escapement estimates include hatchery strays, a fact that leads to overestimation of the "natural" chinook run produced by naturally spawning parents. Ongoing efforts to remove this bias are discussed below. The most accurate component of fishery statistics is commercial harvest, but significant error may occur when allocating the harvest to the various watersheds in Puget Sound and British Columbia using the Fishery Regulatory Assessment Modeling (FRAM) and Pacific Salmon Commission models.

For this report, we describe Green River chinook runs returning to the hatcheries and to the spawning grounds. The natural spawning population includes hatchery salmon that stray to the spawning grounds. Thus, "natural" chinook, which are produced by naturally spawning parents (wild and hatchery origin), are overestimated to the extent that hatchery chinook stray to the spawning grounds. Because the WDFW and MITFD run reconstruction approach utilizes the ratio of chinook returning to the hatchery compared to the spawning grounds to estimate hatchery versus "natural" chinook salmon in harvests, the true natural run is overestimated and the hatchery run is underestimated. The confounding effect of hatchery strays on natural chinook production estimates in systems such as the Green River was identified in the NMFS status review as a key concern leading to the listing of Puget Sound chinook salmon (Myers et al. 1998).

For this report, we use the term "natural" chinook salmon to mean fish produced by natural spawning parents that return to the spawning grounds plus hatchery fish that stray to the spawning grounds. This terminology is used because existing WDFW and MITFD escapement data can not distinguish between true natural fish and hatchery strays. Ongoing efforts are being made to use coded-wire-tag recoveries in the hatcheries and spawning grounds to estimate stray rates. With the initiation of the "Massmarking" of hatchery produced chinook beginning with brood year 1999 the ability to distinguish on the spawning grounds between hatchery produced and natural produced fish should accomplished beginning in 2003.

NATURALLY PRODUCED GREEN RIVER ORIGIN CHINOOK SALMON

During 1968-1996, the estimated naturally produced run of summer/fall Green River chinook salmon ranged from 5,600 in 1973 to 41,000 in 1983 and averaged 17,400 fish (Figure CSP-2). Run size tended to be higher during recent years (1983-1996) compared to earlier years (1968-1982), indicating the downward trend common to other Puget Sound stocks is not evident among "natural" Green River chinook salmon. The trend of greater runs during recent years compared to earlier years is also evident from WDFW's estimated commercial net harvests of Green River "natural" chinook and spawning ground escapement estimates (Figure CSP-2).

WDFW and the Muckleshoot Indian Tribe (MIT) estimates the spawning population of chinook salmon in the Green River by counting chinook salmon redds (spawning nests) within selected

stream reaches, expanding these redd counts to unsurveyed spawning habitat, then expanding redd counts to the total spawning population. The spawning escapement goal of 5,800 natural spawners was established in the mid-1970s using average escapement of wild and hatchery strays during 1965-1976 (Ames and Phinney 1977). As shown in Figure CSP-1, the estimated spawning escapement during 1986-1997, including unknown hatchery strays, averaged 5,700 fish and it exceeded the goal during 12 (40 percent) of 30 years (Figure CSP-1). During the past 10 years (1988-97), spawning escapements have been relatively large (avg. 7,280 fish) and escapements have exceeded the goal during 7 (70 percent) of 10 years.

It is worth noting that escapements greater that 6,060 fish tended to produce greater returns, on average, compared to somewhat smaller escapement. This suggests the risk of producing small returns is reduced when allowing somewhat larger escapements. Large escapements leading to overcompensation (declining returns from large escapements) was not clearly evident within the range of observed escapements, indicating the risk of reduced returns at escapements less than 10,000 fish is probably low.

This run reconstruction analysis of "natural" chinook salmon includes stray hatchery chinook salmon that spawned in the Green River. Hatchery chinook salmon on the spawning grounds may have originated from fish released from the hatcheries or from off-station releases such as those at Icy Creek and above Howard Hansen Dam. The implication is that the natural run, harvest, and escapement of Green River chinook salmon is overestimated to the extent that hatchery fish contribute to natural spawners on the Green River. Hatchery strays affect harvest estimates of natural chinook because the run reconstruction approach used by WDFW and the MIT is dependent on the estimated escapement to the spawning grounds. For example, if 30 percent of the chinook escaping to the river return to the spawning grounds and 70 percent return to hatcheries, then WDFW and MIT assumes 30 percent of the harvest of Green River chinook (hatchery and wild) is allocated to the "natural" run and 70 percent to the hatchery run.

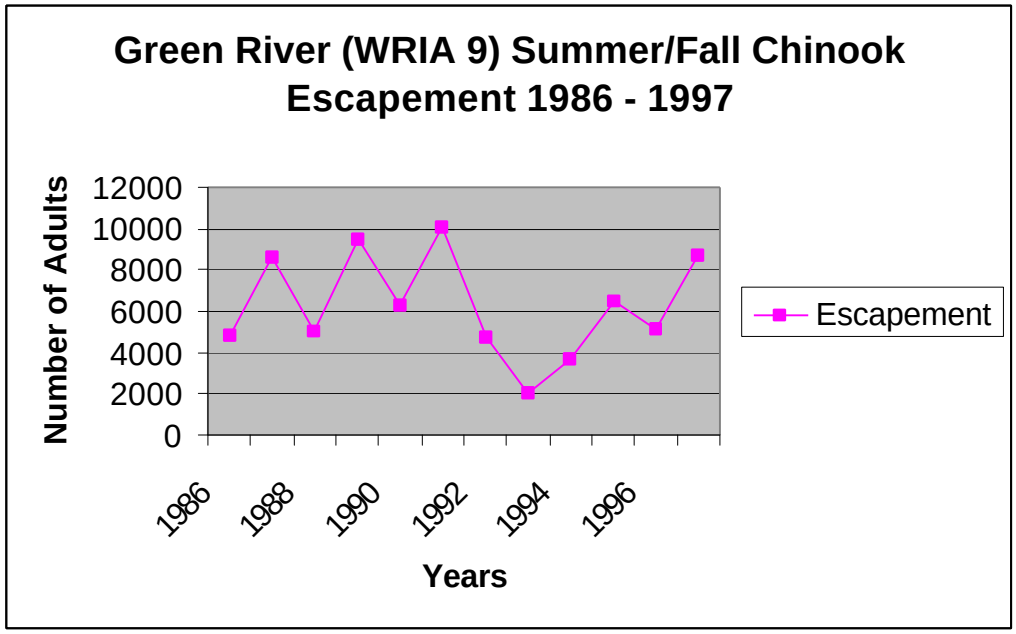
A modeling exercise is underway to reconstruct wild chinook runs and escapements based on a range of stray rates for cultured chinook salmon in the Green River (NRC 1999). The analysis will use recoveries of coded-wire-tagged hatchery salmon recovered on the spawning grounds and hatcheries to estimate stray rates. This analysis removes stray hatchery fish from escapement and harvest estimates during the year of return and it removes estimates of future production produced by stray salmon spawning in the river. Preliminary results suggest that while the revised wild chinook runs and escapements are smaller than those reported above, the productivity of the system, in terms of adult returns per spawner, remains relatively high.

As previously stated, the naturally spawning component of the Green River chinook run contains a mixture of wild and hatchery chinook. The major question pertaining to the status of Green River chinook is the contribution of hatchery chinook to the natural escapement. Draft run-reconstruction information for the years 1989 – 1997 inclusive indicates approximately 56 percent (range: 25 to 83 percent) of the natural escapement in the mainstem Green River of being from hatchery reared and released fish (Cropp, pers. comm.1999). It is not possible to determine to what extent the remaining approximate 40 percent of the mainstem Green River escapement has its ancestry from hatchery origin fish that have spawned for one or more generations in the wild. For the same time period, in Newaukum Creek, the origin of adult chinook is approximately 45

percent (range: 15 to 79 percent) of hatchery origin (Cropp 1999). Additionally, draft data, for the same time period, indicates approximately 39 percent (range: 1 to 76 percent) of the adult chinook returning to the hatchery rack are progeny of natural spawning adults. Newaukum and Soos Creek data is probably quite reliable since sampling rates are relatively high (30 percent and 98 percent respectively) (Cropp 1999). The Green River mainstem sampling rate was roughly 4 percent due to difficulties in locating samples in the large river and is probably less reliable. Sampling efforts in the mainstem Green River were increased beginning in 1998 but the data has not yet been analyzed.

The chinook spawning escapement estimates in Figure CSP-1 include hatchery strays, a fact that leads to overestimation of the "wild" chinook run produced by naturally spawning parents. If large numbers of hatchery strays are included in SASSI escapement estimates, the SASSI status designation for this population could be changed to reflect that contribution.

Figure CSP-1: Green River (WRIA 9) Summer/Fall Chinook Escapement 1986 - 1997.



Newaukum Creek summer/fall chinook escapement from 1987 to 1997 is shown in Figure CSP-2 and averaged 1,135 with a range from 285 to 2,968.

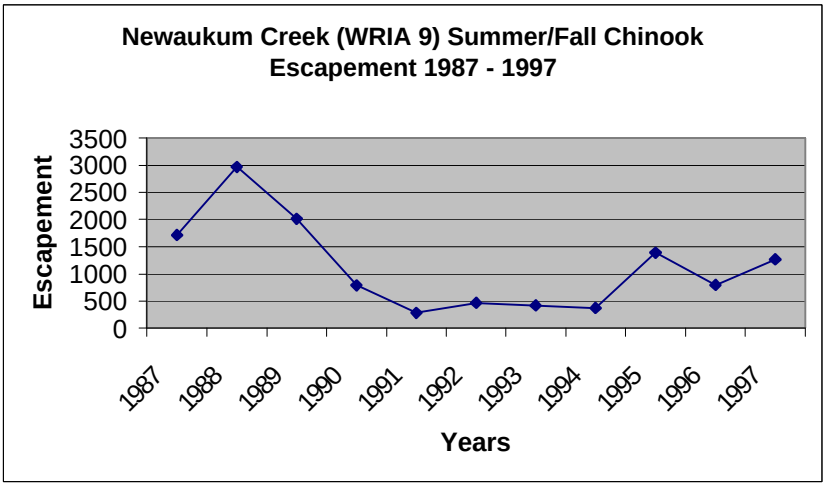
The Green/Duwamish River Basin chinook stock is considered a composite with contributions from hatchery production and natural production. Newaukum Creek fall chinook production is considered wild (WDFW and WWTIT 1994) and is dependent on natural production. Escapement for the Green/Duwamish River summer/fall chinook stock from 1986 to 1997 is shown in Figure CSP-1, averaged 6,031 and ranged from 2,027 to 10,059. Between those dates the escapement of naturally spawning fish has varied substantially. For both stocks, escapement estimates are dependent on redd counts in specified river/creek reaches and expanded by a factor to reflect total escapement to the basin. The counts are accurate for the areas surveyed, but may not be reflective of total escapement (WDFW and WWTIT 1994). Recently, some comparisons

of escapement estimates based on a comparison of different methodologies have challenged this assumption. For example, when using a methodology called "Peak-redds-to-total-redds", which has been the traditional methodology of choice on the Green River, the mainstem chinook escapement in 1997 was 11,236 fish. If the escapement estimate is calculated using a methodology called the "Index Expansion" method as used for calculating steelhead escapement then the chinook escapement for 1997 is 5,808 fish. The difference between the two estimates is 5,428 fish (49 percent).

Newaukum Creek summer/fall chinook escapement from 1987 to 1997 is shown in Figure CSP-2 and averaged 1,135 with a range from 285 to 2,968. Based on coded wire tag (CWT) recoveries from adult chinook in Newaukum Creek, Newaukum Creek chinook escapements are strongly influenced from hatchery production strays from the Green River SFH and Icy Creek Rearing Ponds. The extent to which strays from mainstem Green River production are present in Newaukum Creek is unknown. An examination of CWT data from Newaukum Creek indicates that chinook straying from hatchery production into Newaukum Creek provides the majority of chinook spawning population in Newaukum Creek. SASSI (WDFW and WWTIT 1994) listed Newaukum Creek chinook as a separate stock but do to the extent of hatchery straying, geographic proximity of Soos Creek SFH and the Icy Creek SFH it is likely that chinook spawning in Newaukum Creek are part of the same stock as the Green River chinook.

Spring chinook were historically present in the Green/Duwamish River. However this run either returns in such low numbers as to be difficult to detect or became extinct after the diversion of the White River in 1906 and the blockage of the mainstem Green River by the Tacoma Headworks Dam in 1913. These adult spring chinook would have spawned from July through September and typically in the headwater areas where higher gradient habitat exists. There does exist some evidence (R. Malcom 1999) of early September spawning chinook in the higher reaches of the mainstem Green River, but it is unclear if these fish are truly spring chinook or early spawning fall chinook.

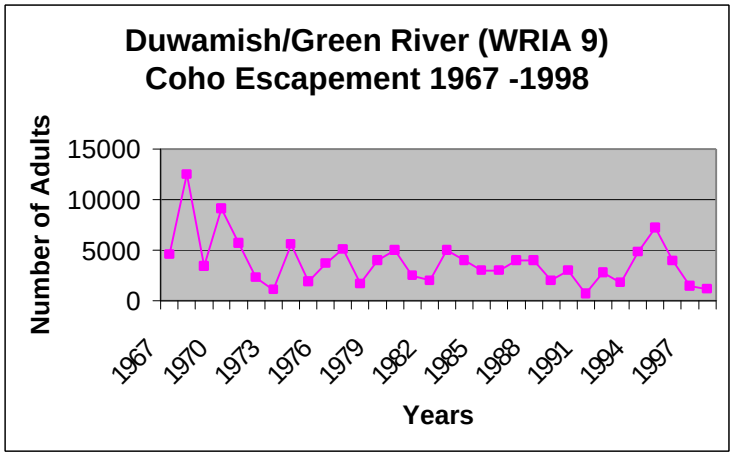
Figure CSP-2: Newaukum Creek (WRIA 9) Summer/Fall Chinook Escapement 1987 - 1997.



GREEN/DUWAMISH RIVER BASIN COHO SALMON POPULATION TRENDS

The coho salmon that enter the Green/Duwamish River basin, WRIA 9, are separated into two stocks (WDFW and WWTIT, 1994), Green/Duwamish and Newaukum Creek stocks. Escapement estimates for the Green/Duwamish River stock from 1967 to 1998 are shown in Figure CSP-3, averaged 3,816 and ranged from 700 to 12,500. Of particular interest is that significant differences exist in spawn timing between these stocks that might be indicative of genetic differences. Coho returning to the Green River typically spawn to mid-November. Newaukum Creek coho may spawn into mid-January (WDFW and WWTIT 1992, WDFW Spawning Ground Survey Database).

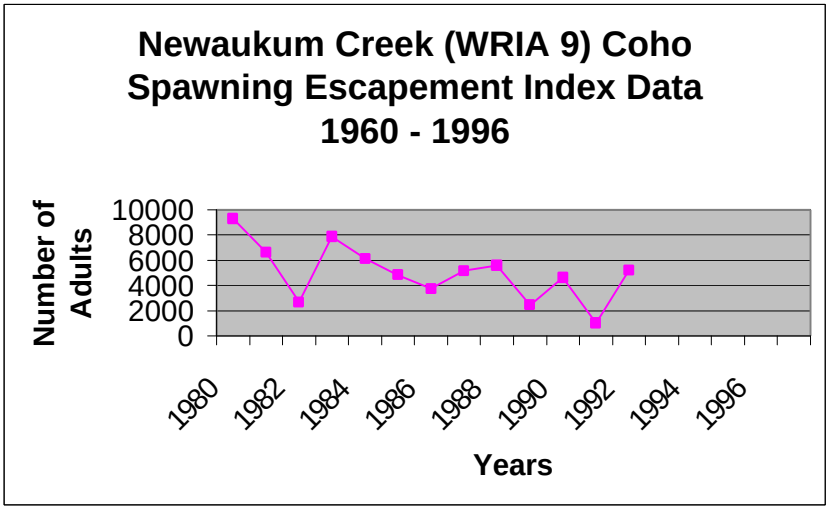
Figure CSP-3: Green/Duwamish River (WRIA 9) Coho Escapement 1967 - 1998.



Newaukum Creek is a left-bank tributary that joins the mainstem Green River at RM 40.7. Spawning escapement index data estimates for this stock from 1960 to 1996 is shown in Figure CSP-4, averaged 5,029 and ranged from 1,034 to 9,300.

The naturally spawning coho population in the Green River basin is comprised of an unknown mixture of natural and hatchery origin fish. The magnitude of adult hatchery fish that contribute to the natural spawning population has not been determined. The spawning escapement estimates in Figures CSP-3 and CSP-4 include hatchery strays, a fact that leads to overestimation of the "wild" coho run produced by naturally spawning parents. If large numbers of hatchery strays are included in SASSI escapement estimates, the SASSI status designation for this population could be changed to reflect that contribution.

Figure CSP-4: Newaukum Creek Coho Spawning Escapement Index Data 1960 - 1996.



GREEN/DUWAMISH RIVER BASIN CHUM SALMON POPULATION TRENDS

The chum salmon that enter the Green River basin are part of the South Puget Sound area chum stocks (Phelps et al. 1995). They are further separated into two stocks (WDFW and WWTIT 1994); Green River fall-run chum and Crisp Creek (also referred to as Keta Creek) fall-run chum salmon. The origin of Green River fall-run chum is an East Kitsap/wild remnant mix, while the Keta Creek fall-run stock is of East Kitsap (Cowling Creek broodstock whose origin is from Chico Creek) origin (Dorn 2000).

Chum salmon escapement for the Green River basin is sparse. Spawner survey data go back as far as 1947 where 452 chum were observed in Burns Creek. More recent surveys have shown significant numbers (nearly 700 adults in November 1987) of fish present but these fish were believed destined for the Keta Creek hatchery program. Spawning information on the remnant mixed origin Green/Duwamish River stock is limited and no attempt is made here to provide escapement estimates.

GREEN/DUWAMISH RIVER BASIN PINK SALMON POPULATION TRENDS

Williams (1975) characterized Green River pink salmon as extinct from this basin. Additionally, no mention of a pink salmon in the Green/Duwamish River basin stock was made in SASSI (WDFW and WWTIT 1994). More recently, Fuerstenberg (In Progress 1998) was unable to locate reports of pink salmon present in the Green River basin. Low numbers of pink salmon adults are observed in odd number years during spawning ground surveys in the mainstem Green River and a few tributaries (WDFW, 1999a). Additionally, personal observations by fisheries biologists in 1999 have confirmed the presence of pink salmon adults in low numbers in the mainstem Green River. Adults have been observed as far upstream as the confluence with Burns Creek (RM 41.5). In 2000, juvenile pink salmon were reported to have been captured in a screw

trap on the mainstem Green River at RM 34.5. This is a clear indication of reproductive success at least through the spawning, incubation and hatching life history trajectories.

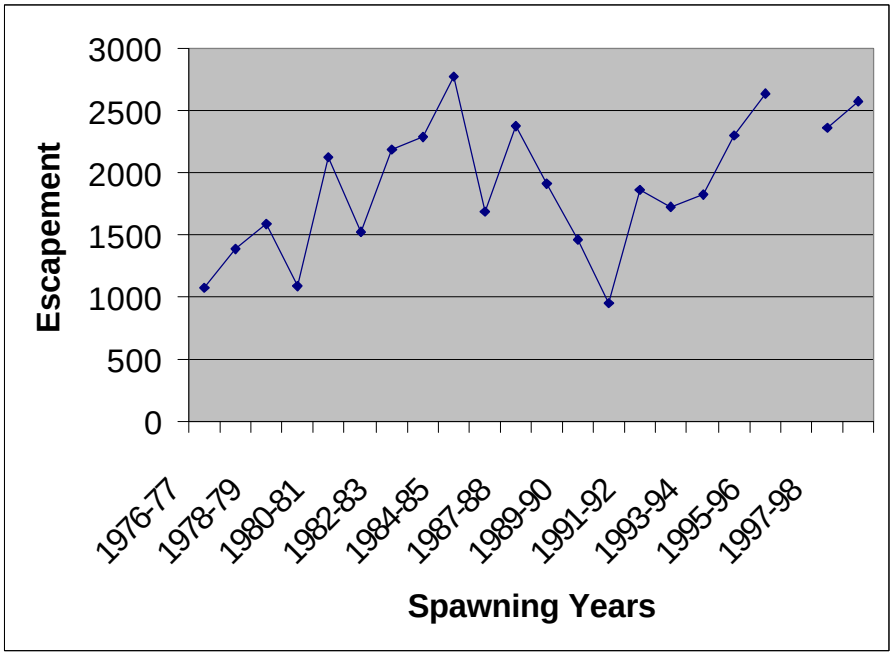
It is not clear if these are strays from other basins attempting to recolonize the Green River or remnant fish from the historic native population. Currently, the stock status for this species is unknown, but because of the low numbers present is believed to be depressed. Observations of spawning adults have been in odd number years only and the stock is believed to return in odd numbered years only.

GREEN/DUWAMISH RIVER BASIN WINTER STEELHEAD POPULATION TRENDS

There are two Green/Duwamish River basin winter steelhead stocks characterized in SASSI (WDFW and WWTIT 1994). These stocks are: the native wild spawning population and; the early timing hatchery stock. The status of both winter steelhead stocks has been characterized as healthy (WDFW and WWTIT 1994). Population trends of Green River wild winter steelhead in the early 1990's began a steady decrease similar to those of many other regional stream systems. Similar to many of those systems, Green River wild winter steelhead have rebounded. Recent (run year 1999-2000) escapement estimates were less than desired and are currently the cause of some concern.

No escapement data for Green/Duwamish River basin origin winter steelhead stocks is available prior to 1978. Escapement estimates are not available for 1997 due to poor water visibility conditions. Winter steelhead escapement to the Green/Duwamish River basin is depicted in Figure CSP-5.

Figure CSP-5: Green/Duwamish River Winter Steelhead Escapement Estimates Run Years 1977/8 – 1998/9. Note: No escapement data is available for run year 1996/97 due to poor water visibility.



GREEN/DUWAMISH RIVER BASIN SUMMER STEELHEAD POPULATION TRENDS

There may have been a historic native wild summer steelhead stock in the Green River Basin. Prior to 1966, sport angler punch cards indicated an annual summer steelhead harvest of small numbers (<12) fish per year (1962-66). SaSI (WDFW and WWTIT 1994) concluded that adult summer steelhead caught in the Green River basin were the result of strays from other systems or the result of adult winter steelhead caught during the summer steelhead management period (May 1 to October 31). The Green River Basin is within the geographic range of summer steelhead, approaching the northern edge and it is possible that it may have had a small historic summer steelhead population.

The current summer steelhead in the Green River Basin are the result of non-native (hatchery introduced) origin fish from the Skamania summer steelhead stock initially introduced in 1965. Escapement goals are not set for this stock as it is thought to be almost entirely hatchery supported and managed for the recreational sport fishery.

GREEN RIVER BULL TROUT POPULATION TRENDS

The stock status for bull trout in the basin is unknown (WDFW 1998). Information on the presence, abundance, distribution, utilization and life history of bull trout in the Green River basin is either unavailable or extremely limited. Suckey first observed native char in the Duwamish River during June 1856. He observed specimens as large as two feet in length in the Duwamish and another individual fish was captured approximately 35 miles upstream in June 1856 (Suckey and Cooper 1860). These fish were described as “red-spotted salmon trout” with the scientific name of *Salmo spectablis*. Pautzke and Megis (1940) described the presence of a “few” Dolly Varden during the 1930’s in the Green River. More recently, Mongillo (1993) suggested the need for additional data collections. Investigations (Watson and Toth 1994, Tacoma Water HCP 1999 Draft) have not provided any evidence of bull trout spawning in the Green River Basin. However, native char have been captured as far as RM 40 in the Green River (Watson and Toth 1994). Recreational anglers have reported sightings of native char in the lower Green River (H. Boynton, pers. comm.). Native char have not been observed or captured upstream of Howard Hanson Dam as a part of surveys conducted by Plum Creek Timber Company (Watson and Toth, 1994).

Bull trout are reported to have been recovered in the lower mainstem Green/Duwamish River on several occasions. A single bull trout was reported captured at the Soos Creek Hatchery rack in 1956 (Beak 1996). There is no supporting data regarding this reported individual fish. That paper attributed this information to a personnel communication from Fred Goetz (1994). During a fish study conducted by the Port of Seattle, a single adult Dolly Varden was reported captured in the Duwamish River at RM 2.1 (Weitkamp 1980). In 1980 one bull trout/Dolly Varden was collected, downstream of RM 4.0, as part of a juvenile salmonid study in the Duwamish River (Weitkamp 1982). No meristic sampling was conducted on these three fish so it is unclear if they are bull trout or Dolly Varden.

An adult bull trout was captured by the Muckleshoot Indian Tribal staff at approximately RM 5 during juvenile beach seining sampling efforts in 1994 (R. Malcom 1999). This later fish was analyzed by the University of Washington and confirmed to be a bull trout. It is uncertain if these fish were of Green/Duwamish River basin origin, were of non-Green/Duwamish River basin fish temporarily rearing in the Green/Duwamish River basin, or were strays attempting to recolonize the basin.

GREEN RIVER COASTAL CUTTHROAT TROUT STOCK COMPLEX POPULATION TRENDS

Coastal cutthroat trout (*O. clarki clarki*) are a subspecies of cutthroat trout (*O. clarki*) that are believed to have diverged into separate lines about 1 million years ago (Behnke 1997). Currently, WDFW uses the concept of a "Stock Complex" to identify coastal cutthroat stocks. The definition of a Stock Complex is: A group of stocks typically located within a single watershed or other relatively limited geographic area believed to be closely related to one another. This concept was developed in response to genetic analyses conducted by a number of investigators that showed there is a high degree of genetic diversity among coastal cutthroat trout populations even within small stream systems.

SaSI (WDFW 2000) identified a distinct stock of coastal cutthroat trout in the Green River Basin. This unique identification was based on geographic distribution and recognized a lack of data to attain certainty for this conclusion (WDFW 2000). The NMFS ESU for coastal cutthroat trout includes the Green River Basin (Johnson et al 1999). In the NMFS coastal cutthroat status review (Johnson et al 1999) indicated that few data was available concerning historic and present abundance of coastal cutthroat trout in the ESU.

Assessing populations of coastal cutthroat trout in the Green River Basin is particularly difficult. A reduction in habitat capacity within the Puget Sound ecoregion has been widespread as streams were extensively modified beginning in the late 1800's and continuing through today. Data for trends in coastal cutthroat trout abundance in Green River Basin streams is not available at the time of this report. Data from other Puget Sound river systems is mixed and often times coastal cutthroat trout are caught incidentally, in river traps, to a targeted species such as coho.

NMFS found that the scarcity of information available made risk assessments extremely difficult for coastal cutthroat trout. In their final conclusion(Johnson 1999), they determined that there were two alternative conclusions:

- "There is not enough evidence to demonstrate that coastal cutthroat trout are *not* at a significant risk of extinction; and

- "There is not enough evidence to demonstrate that coastal cutthroat trout are *not* at risk."

In SaSI (WDFW 2000), it was the conclusion of the editors that the stock status of Green River Complex coastal cutthroat was unknown. The only data they cited was limited electrofishing surveys conducted in Newaukum Creek.

SALMONID DISTRIBUTION

The current known freshwater distribution of anadromous salmonids within the Green/Duwamish River basin and independent tributaries to Puget Sound in WRIA 9 is illustrated in the Fish Distribution Maps located in the Appendix. Information for the known distribution was obtained from tribal, state, county and federal fishery professionals and published databases (SASSI, WDFW Spawning Ground Survey Database, and StreamNet, etc.).

The current known freshwater distribution potentially underestimates the actual distribution of salmonids because it does not include the presumed distribution. The presumed distribution of salmonids is being addressed through efforts by the Northwest Indian Fish Commission, Salmon and Steelhead Habitat Inventory Project (SSHIAP). In many cases the smaller tributaries have not been surveyed. Often times, private landowners deny survey crews access to creeks. Some reaches of streams and rivers are not surveyed due to difficult access caused by natural terrain. Stream gradient break points are being established and a presumed distribution map should be available later in 2000.

LIST OF TABLES AND FIGURES