II. Status of WRIA 8 Chinook Salmon

The Puget Sound region uses the Viable Salmonid Population (VSP) concept as its general approach to determine the conservation status of Chinook salmon.[3] A viable salmonid population is defined as an independent population with a negligible risk of extinction over a 100-year time frame. The VSP attributes used by NOAA and others (including WRIA 8) to evaluate the status of Chinook salmon are abundance, population growth rate (also called productivity), population spatial distribution, and diversity (**Table 1**).[4]

Abundance

Abundance is what the public most often thinks of when they consider the status of a population, and is the most commonly reported indicator in the news media. Abundance is measured by counting the number of adults returning to the spawning grounds, either through estimation methods or by directly counting the number of redds (nests) that have been constructed by females.

However, this indicator is often heavily influenced by factors beyond the control of watershed managers (for example, ocean conditions and fishing pressure). Because of this, abundance is not the best overall measure for watershed managers trying to gauge the effects of local actions on salmon conservation and recovery. An accurate abundance estimate is the critical first step, however, in determining egg-to-migrant survival, one of the most important measures of freshwater productivity.

The WRIA 8 Plan lists both short-term (10-year) and long-term (50-year) goals for Chinook salmon abundance (**Figure 1**). Compared to the NOAA Fisheries measures reported at the time of ESA listing of WRIA 8 Chinook salmon, abundance has increased for the Cedar population and remained low for Bear/Cottage Creek (a surrogate measure for the Sammamish population).

Table 1. Monitoring of Chinook salmon in WRIA 8

Parameters for Evaluating Chinook Populations				
Monitoring Program	**Abundance (How many fish?)**	**Productivity (Is the population growing?)**	**Distribution (Where are the fish?)**	**Diversity (Genetics, life history)**
Spawner Surveys	Escapement, Redd Counts (Figure 1, Table 2)	Prespawning mortality rate; Redd:redd productivity (Figure 2)	Redd mapping (Table 2)	Age structure, Hatchery/natural origin (Table 3)
Fry/Parr Trapping	Juvenile abundance (Figure 4)	Egg to migrant survival (%) (Figure 3) Juvenile abundance (Figure 4)		Fry vs. parr (Figure 6), Migration timing
PIT-Tag Monitoring		Migration survival		Migration timing to ocean

[3] McElhany, P., M. Ruckelshaus, and others. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U. S. Department of Commerce. 156 p. *http://www.nwfsc.noaa.gov/assets/25/5561_06162004_143739_tm42.pdf*

[4] Since 1998, annual Chinook salmon population status and trends monitoring has been funded primarily by King Conservation District, with collaboration and support from Washington Department of Fish and Wildlife, Muckleshoot Indian Tribe, Seattle Public Utilities, and King County.

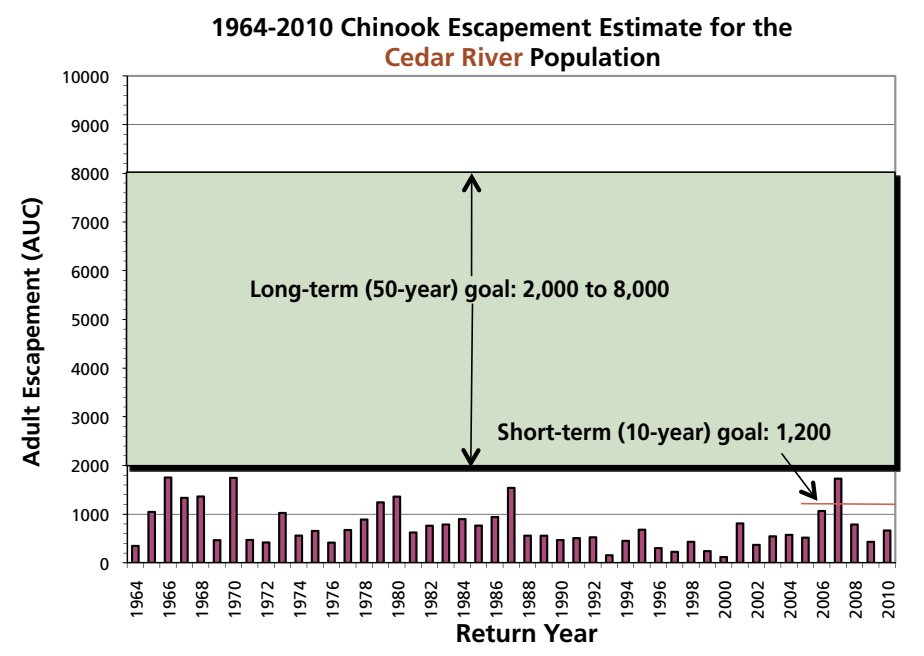
Productivity

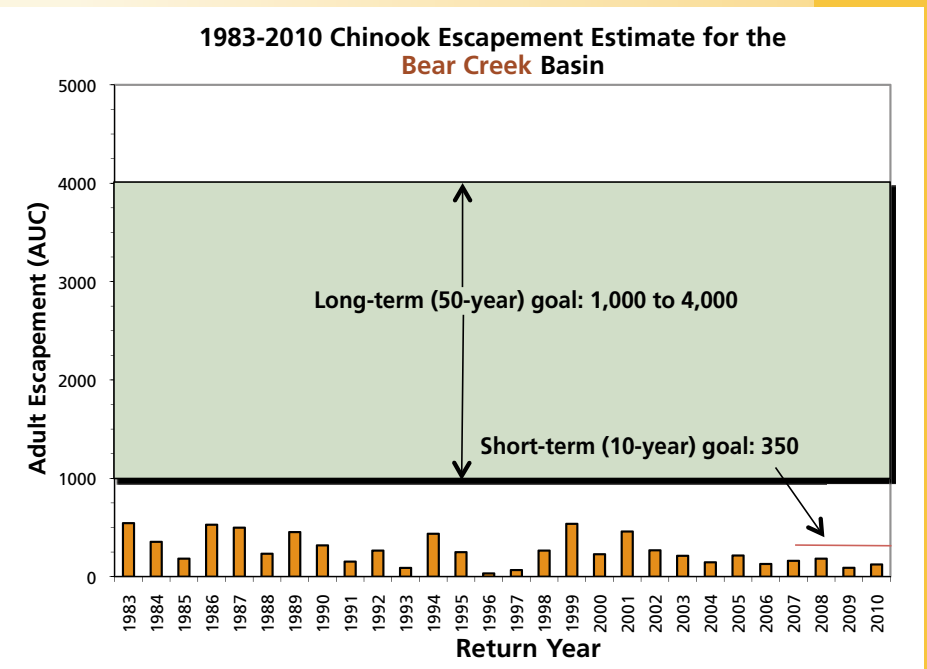
Productivity indicates whether a population is growing or shrinking over time. A productivity value of one indicates that for each fish returning, one fish is produced – that is, the population is essentially replacing itself. A value greater than one indicates that the population is increasing, while a value less than one indicates the population is decreasing.

Scientists can measure overall population productivity (whether the number of Chinook salmon returning to a watershed is increasing from year to year), which includes survival throughout the entire salmon life-cycle. This is complicated by a number of factors, including the variable return age for Chinook salmon (they may return to spawn after two, three, four, or even five years at sea). Redd-to-redd productivity (**Figure 2**) is WRIA 8's indicator of productivity over the entire Chinook life cycle, and incorporates age class proportions into the productivity estimate.

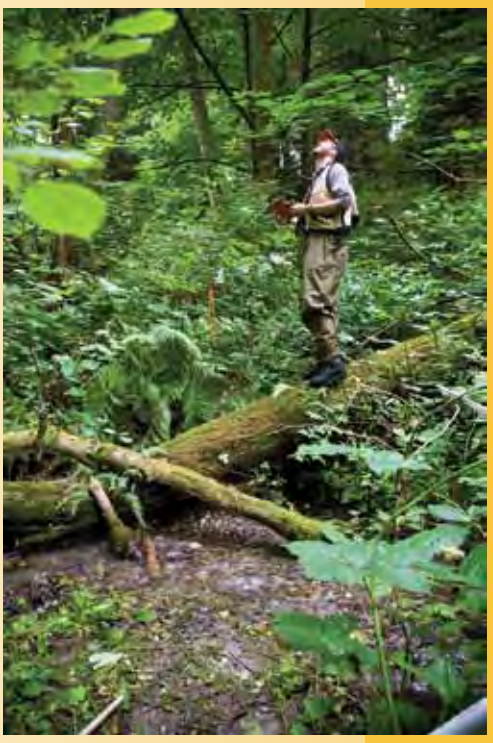
Freshwater productivity. Two indicators of freshwater salmon productivity that are especially important for watershed managers are *egg-to-migrant survival* (**Figure 3**) and *overall juvenile output* (**Figure 4** and **5**). Egg-to-migrant survival compares the estimated number of eggs deposited by spawning Chinook salmon in the fall (through redd counts) against the number of juvenile Chinook salmon migrating out of the watershed the following spring. This number can be compared over time as well as against regional averages. Overall juvenile outmigrant abundance provides an estimate of the overall numbers of juvenile Chinook produced in the Bear Creek and Cedar River basins. Ideally, both these numbers should increase over time if freshwater restoration and conservation efforts are successful.

Figure 1. Number of adult Chinook on the spawning grounds in the Cedar and Bear/Cottage basins. *Escapement* refers to the number of fish that escaped various causes of mortality to reach the spawning grounds. The numbers include both natural-origin and hatchery-origin adults. Bear/Cottage Creek Chinook surveys began in 1983. *Data source: WDFW.*





Juvenile Chinook productivity is influenced by a number of factors, including restoration efforts, flooding during the incubation and rearing period, and habitat for refuge and rearing. WRIA 8's main objective is to improve the amount and condition of juvenile habitat, which will improve both egg-to-migrant survival and overall juvenile survival. Egg-to-migrant survival in WRIA 8 remains variable, while overall juvenile output in the Cedar River appears fairly constant by comparison (**Figure 4**).



Spatial Distribution

In WRIA 8 our goal is to maintain and increase the spawning and rearing distribution of both Chinook populations throughout the watershed. Annual Chinook spawning ground surveys have been conducted in WRIA 8 Chinook salmon streams since 1999 (**Table 2**). While spawning has varied from year to year, there is no evidence that spawning and rearing distribution has declined, with the exception of the loss of spawning on the Walsh diversion, an artificial tributary to the lower Cedar River. Streamflow from the Walsh diversion was restored to upper Rock Creek in 2009.

The construction of a fish passage facility at the Landsburg diversion dam on the Cedar River in 2003 nearly doubled the length of available habitat for Chinook salmon in that river.[5]

Diversity

Scientists give three primary reasons why genetic and life-history diversity is important for species and population viability *(McElhany et al. 2000)*:

1. Diversity allows a species to use a wider array of environments.
2. Diversity protects a species against short-term spatial and temporal changes in the environment.
3. Genetic diversity provides the raw material for surviving long-term environmental change.

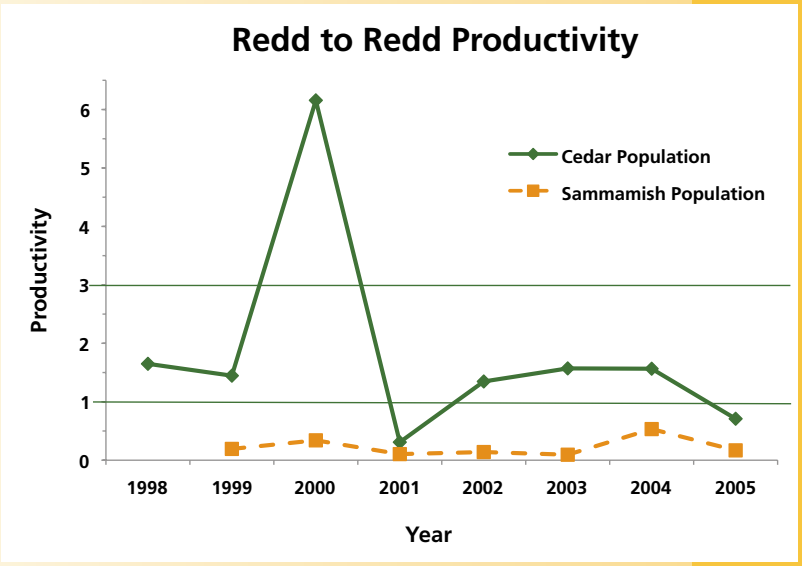


Figure 2. Cedar River and Bear Creek redd productivity. Each point on this graph represents the number of salmon nests (redds) counted each year divided by the number of redds counted in following years, when the salmon that hatched would be returning to create their own redds. Chinook salmon in WRIA 8 spend 2 to 5 years at sea before returning to spawn. Most Chinook in WRIA 8 return after 3 to 4 years. A population replaces itself at a value of 1; the WRIA 8 Plan has a short-term goal of 3 for the Cedar River and Bear Creek (Sammamish) population. In other words, 3 redds would need to be produced for each returning redd in the parent year. (Note: since it may take up to 5 years for Chinook to return to spawn, the 2005 spawning year is the latest for which we can accurately assess productivity.) *Data source: King County unpublished data.*

[5] *http://www.seattle.gov/util/About_SPU/Water_System/Habitat_Conservation_Plan/FishPassageAbovetheDam/*

In WRIA 8, we monitor diversity through assessing the age of returning adults, proportion of juvenile salmon migrating as fry or parr (**Figure 6**), overall timing of migration, and proportion of hatchery fish on the spawning grounds (**Table 3**). WRIA 8 goals are to increase the proportion of parr migrants on the Cedar River and to decrease the proportion of hatchery-origin Chinook spawning with natural-origin fish on the spawning grounds.

Figure 3. WRIA 8 Chinook salmon egg-to-migrant survival rates for Bear Creek and Cedar River Basins.
Data source: WDFW.

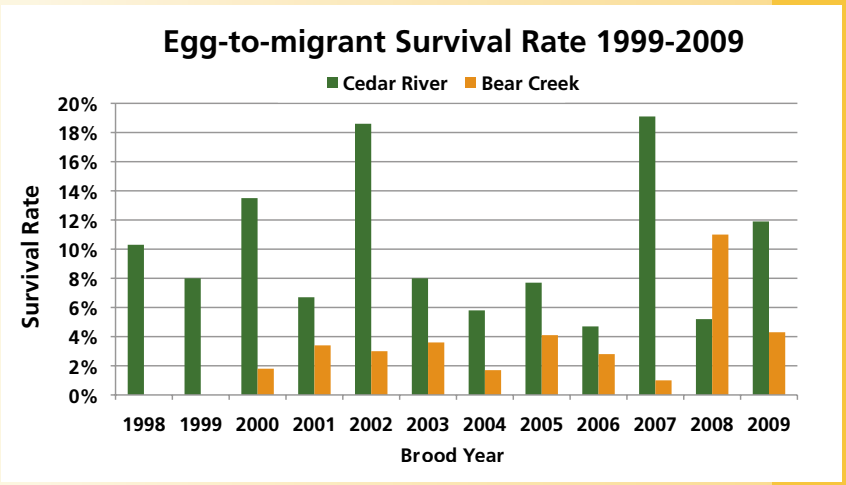


Figure 4. WRIA 8 Chinook salmon juvenile abundance estimates for Bear Creek and Cedar River populations.
Data source: WDFW.

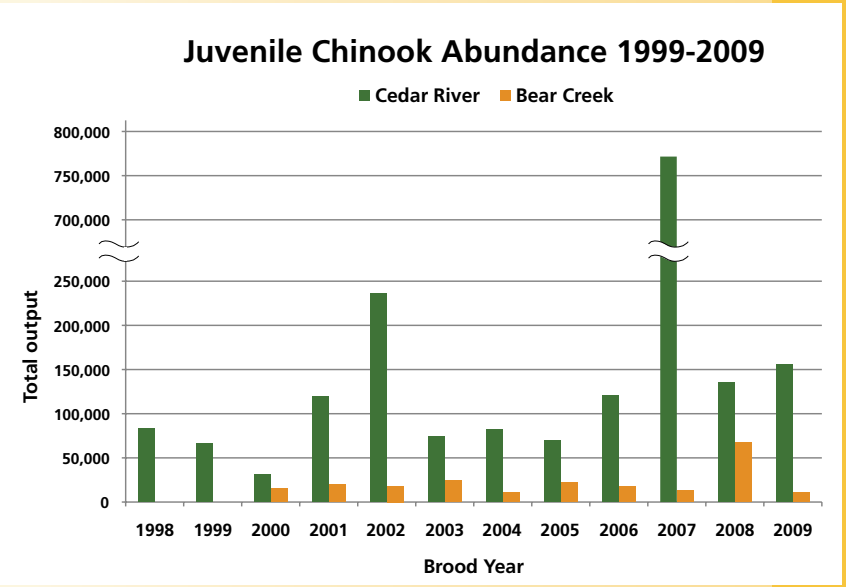


Figure 5. Juvenile Chinook outmigrants in the Cedar and Bear basins. Juvenile Chinook salmon have two different life history strategies. Very small fish called "fry" migrate out of streams into Lake Washington between January and late March, while larger juvenile migrants ("parr") rear in streams for a few more months and migrate later, between May and July. Chinook conservation goals in both basins include increasing the percentage of fish rearing in the basins and migrating to the lake at a larger size. Research has shown that larger migrants have a higher survival rate.
Data source: WDFW.

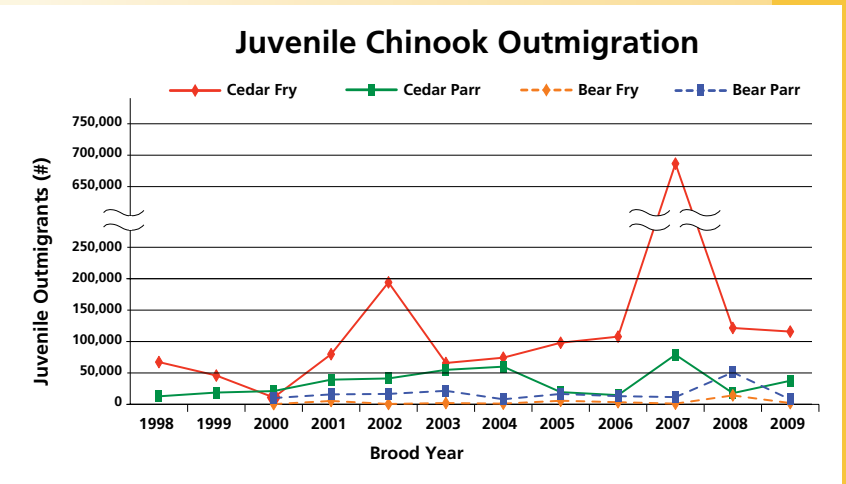


Table 2. WRIA 8 Chinook redd survey results, 1999-2010. Shaded cells represent years when surveys were not performed. Cells with "X" represent an artificial tributary that no longer supports spawning. *Data source: King County unpublished data.*

Creek	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Bear	140	30	42	25	24	25	40	12	20	44	9	1
Cottage	171	103	96	102	120	96	82	119	69	88	60	59
EF Issaquah				0	3	26	8	3	30	3	19	29
Little Bear	1	1	1	3	3	1	0	0	2	1	0	0
North Creek	2	4	6	10	1	4	5	9	3	8	7	3
Kelsey Creek		5	4	4	0	0	4	72	77	8	5	1
May Creek	0	1	3		5	9	1	0	7	1	2	1
Rock Creek (Lower)	0	0	0	0	0	0	0	0	0	0	0	0
Taylor Creek	0	0	7	12	11	8	7	1	30	0	0	1
Peterson Creek	0	0	0	0	1	1	1	0	0	0	0	0
Walsh Diversion	0	0	1	0	6	12	0	0	10	0	X	X
Cedar River Mainstem (and tribs above Landsburg)	182	53	390	269	319	490	331	586	859	599	285	265

Figure 6. Proportion of parr migrants from the Cedar River, 1999-2009.
Data source: WDFW.

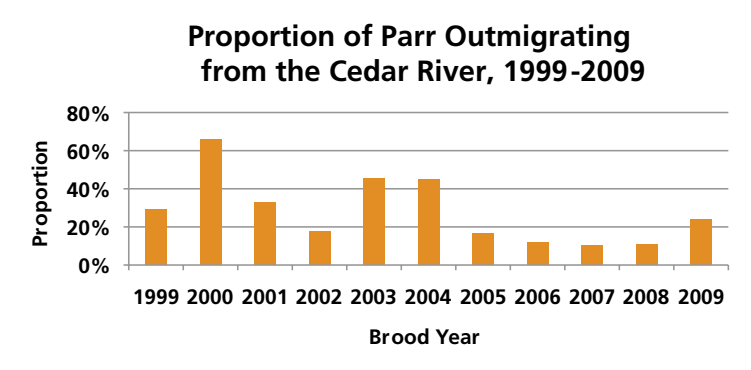


Table 3. Proportion of hatchery-origin Chinook salmon detected in Cedar River and Bear/Cottage Lake Creek spawning surveys since 2004.
Data source: WDFW and King County unpublished data.

	2004	2005	2006	2007	2008	2009
Cedar River	34%	32%	20%	10%	11%	18%
Bear/Cottage Lake Creek		79%	80%	75%	77%	68%