Population Characteristics of Pacific Salmonines Collected at the Salmon River Hatchery 2006

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Spawning populations of Lake Ontario Chinook and coho salmon (fall) and steelhead rainbow trout (spring) have been monitored annually since the mid-1980s at the Salmon River Hatchery. This report documents the biological characteristics of these populations.

Methods

Hatchery Sampling

Staff at the Salmon River Hatchery processed 2,835 steelhead during the spring 2006 spawning operations (Nelson 2007a). Marked (LV or LVAD) Washington strain (Chamber's Creek) fish originally stocked in the Salmon River system comprised 46% of the run. The remainder of the run was Skamania strain fish marked LPAD (4%), and unmarked fish (49%). The unmarked fish were assumed to be Washington steelhead that were stocked at other sites but had imprinted on the hatchery since they had fin erosion and no other unmarked rainbow trout were stocked or raised at Salmon River.

A total of 1.17 million Washington steelhead eggs were taken from 328 females. The Skamania egg total was 149,500 from 41 females. Biological data were collected from 280 Washington strain steelhead.

Fall returns to the hatchery included 4,921 Chinook salmon and 5,845 coho salmon. The egg totals were 3.53 million Chinook from 681 females and 1.77 million coho from 633 females (Nelson 2007b). Biological data were collected from 630 Chinook and 333 coho.

All statistical analyses were done with PC-SAS rel. 8.0 (SAS Institute 1999). ANOVAs of all weight at age comparisons over a series of years were done with the SAS PROC GLM-Tukey's Studentized Range test multiple comparison procedure with the type I experimentwise error rate set at $\alpha = 0.05$.

Results and Discussion

Chinook Salmon

<u>Growth</u>

The mean weight of age-1 Chinook males (jacks) increased significantly in 2006 following three successive years of poor growth (Figure 1). The only prior years with significantly heavier jacks were 1999, 2000 and 2001. Weights of age 2 and age 3 fish of both sexes also increased in 2006 following the very low levels observed in 2005 (Figure 2). Age 2 fish were about a pound below their long-term average for all of the previous years sampled and age 3 fish were about 1.5 pounds below their historical average. Age 2 fish were significantly heavier in only 7 (males) and 5 (females) of the previous 20 years sampled. Age 3 fish, however, were significantly heavier in 12 (males) and 13 (females) of the previous years. Mean lengths and weights at age for all species sampled in 2006 are provided in Table 1.

Wet weight condition of large Chinook was measured by predicting the weight of a 36 inch fish from linear regressions on natural log transformed lengths and weights. Condition of fish sampled in the hatchery improved in 2006 to 16.1 lbs following the record low (14.8 lbs) observed in 2005 but remains relatively low (Figure 3). The improvements in Chinook growth and condition in 2006 are probably a result of abundant yearling alewives. The 2005 year class of alewife was the largest produced since 1998 (O'Gorman et al. 2007).

<u>Age Structure</u>

The estimated age structure of the 2006 Chinook salmon run to the Salmon River Hatchery was 6% age 1 males, 20% age 2, 70% age 3, and 4% age 4 (Figure 4).

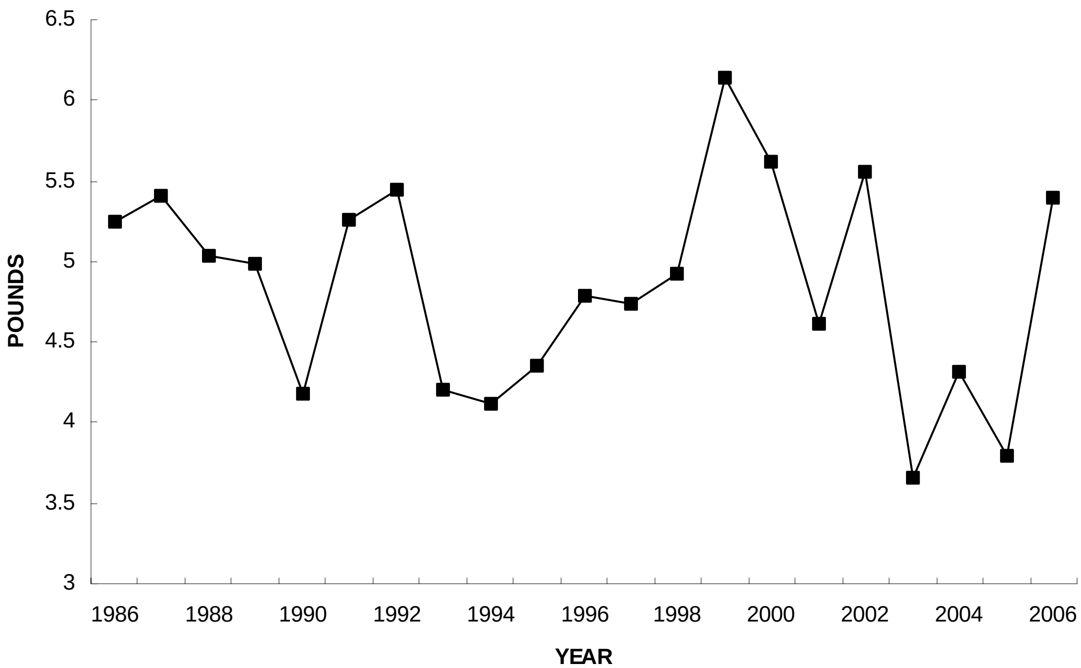

Figure 1. Mean weights of Chinook jacks at Salmon River Hatchery, 1986-2006.

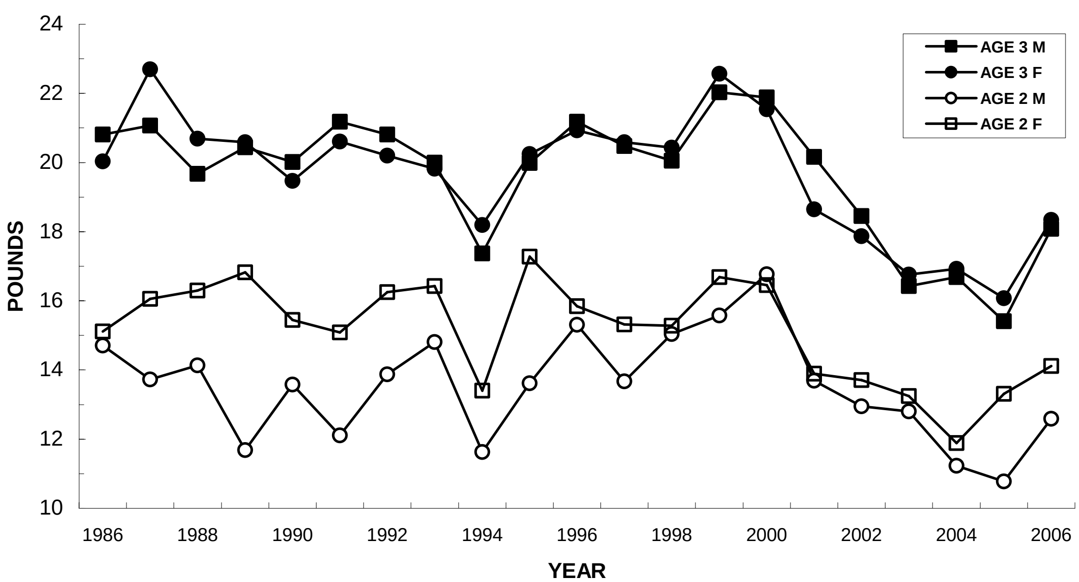

Figure 2. Mean weights of Chinook salmon ages 2-3 at Salmon River Hatchery 1986-2006.

Table 1. Mean lengths and weights of Chinook salmon, coho salmon and Washington steelhead sampled at Salmon River Hatchery 2006. (STD= standard deviation).

AGE	SEX	N	MEAN LENGTH (in)	STD	MEAN WEIGHT (lbs)	STD
			CHINOOK SALMON			
1	M	55	24.6	2.5	5.4	2.4
2	M	100	33.0	3.1	12.6	3.3
2	F	27	33.4	2.4	14.1	2.9
3	M	172	37.8	2.6	18.1	3.8
3	F	244	37.0	1.9	18.4	3.0
			COHO SALMON			
1	M	35	17.1	3.0	1.8	1.0
2	M	129	28.5	3.0	8.2	2.5
2	F	167	28.5	1.3	8.5	1.4
			WASHINGTON STEELHEAD			
3	M	74	25.4	1.4	5.5	0.9
3	F	29	25.4	2.6	5.0	1.6
4	M	34	29.7	2.1	8.6	8.5
4	F	113	28.8	1.7	8.5	6.3
5	M	5	26.4	1.0	6.3	10.3
5	F	19	31.4	1.9	10.3	1.5

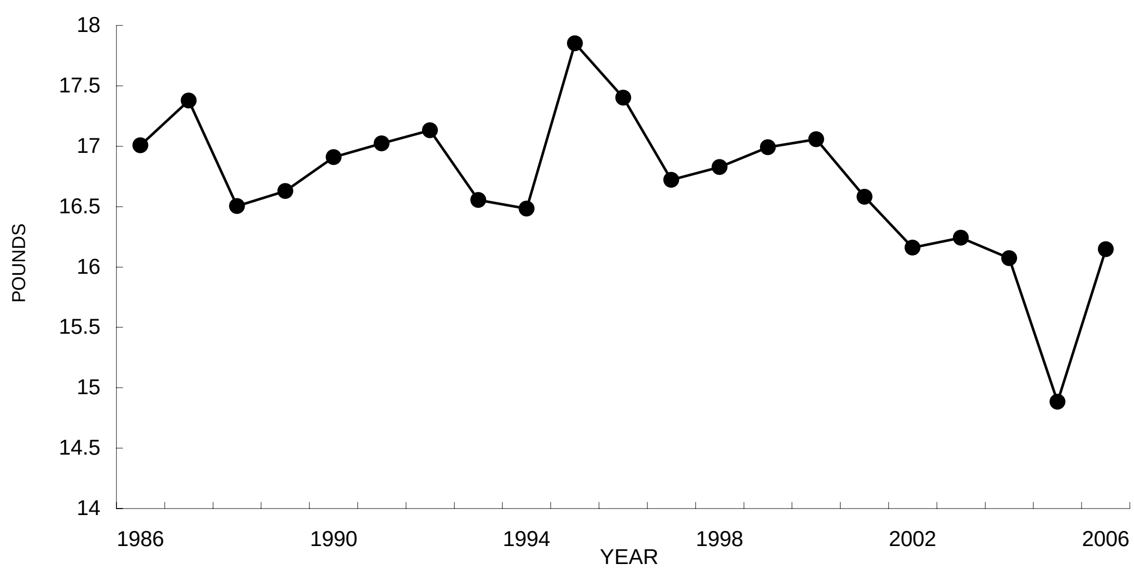

Figure 3. Estimated weights of 36 inch Chinook salmon from the Salmon River Hatchery fall (October) collections 1986-2006.

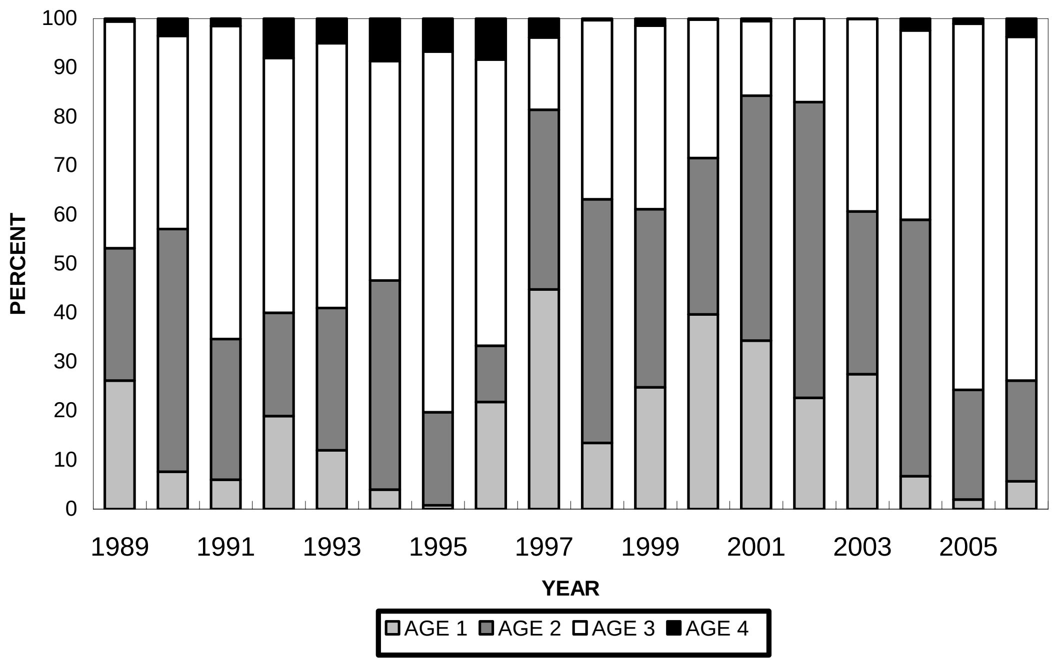

Figure 4. Estimated age structures of Chinook salmon runs at Salmon River Hatchery, 1989-2006.

We have used Chinook jack returns to Salmon River Hatchery and relative harvests per unit of effort (HPUE) of age 1 Chinook from the open lake boat fishery as indices of abundance of age 1 Chinook (i.e., predictors of relative year class strength). The 2005 year class of Chinook salmon returned 279 jacks to the hatchery in 2006. This was the fourth lowest jack return on record. Harvest per unit of effort of age-1 Chinook from the New York Lake Ontario Fishing Boat Census, however, was estimated at 10,812 fish per 150,000 boat trips which was above average (Eckert 2007).

The relationship between jack returns and HPUEs was quite strong prior to the establishment of year-round seasonal base-flows in the Salmon River. The base flows resulted from the 1996 Federal Energy Regulatory Commission licensing of the hydro project on the river (FERC 1996). Prior to the base flows, jack returns to the hatchery explained 85 percent of the variability in HPUEs on the open lake for the 1984-1996 year classes (Figure 5). The relationship between the two indices has, however, completely fallen apart since the base flows began in 1996.

Prior to the license, the hydro project was run in a peaking mode, which resulted in alternating periods of high flows and very low flows when generation stopped. The result was that the majority of the river bed was de-watered during times when generation was not occurring. It is our belief that production of wild Chinook in the Salmon River was very limited at that time. Wild Chinook production increased dramatically when the base-flows became established in 1996. Bishop et al. (2007) provide annual estimates of the relative abundance of naturally reproduced young of the year Chinook in the river since 2001.

Both jack returns and HPUEs from the pre-base flow era varied widely. During the post-base flow era, jack returns have continued to vary widely while the HPUEs have not varied as much. All year classes have produced intermediate HPUEs

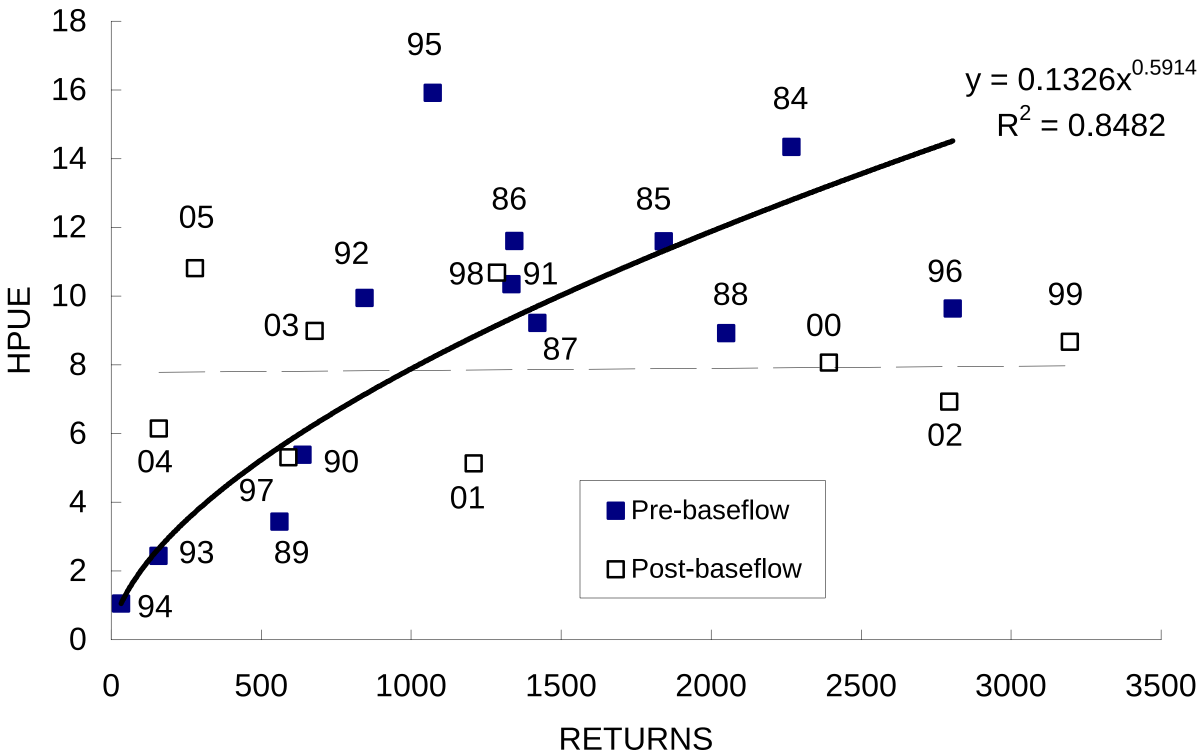

Figure 5. Pre- and post-baseflow Chinook jack returns to Salmon River Hatchery and harvest per unit of effort (HPUE) of age-1 Chinook for the New York Lake Ontario Fishing Boat Census, year classes 1984-2005. HPUEs are estimated numbers of fish harvested adjusted to a common level of effort. The solid curve is fitted to the pre-base flow data and the dashed line is fitted to the post-base flow data.

relative to the historical range of HPUEs recorded during the pre-base flow era. If wild fish produced in the Salmon River contributed substantially to the open lake fishery but did not tend to return to the hatchery because they were imprinted on the river but not the hatchery, then we would expect to see a higher HPUE relative to the jack return as is the case with the 05 year class in Figure 5. If wild fish did have a tendency to return to the hatchery we might expect to see them underneath the curve as was the case with the 99 and 02 year classes. It is also possible that wild fish hatched in the upper end of the river close to the hatchery would tend to return to the hatchery more than fish hatched lower in the river. We do know that there are differences in the spatial distribution of the hatches in different years (Bishop et al. 2007).

Both indices have their potential biases. It seems the HPUEs from the open lake would provide a better overall representation of the total population in the lake because it would include fish from all sources, including any wild fish, and would not be influenced by differential survival of hatchery fish stocked in the Salmon River system opposed to fish stocked at other sites. The jack returns may simply provide an index of the relative survival of stocked fish in the Salmon River System. We do know that there is a great deal of annual variability in numbers of wild fish produced in the river but we do not know how these fish survive relative to hatchery fish. Also, we do not know if, or to what degree, returning wild fish enter the hatchery.

Potential biases with the HPUEs include differing levels of vulnerability of the fish to the fishery in different years. For example, in years when prey fish were relatively scarce, fish may be more vulnerable to the fishery, and HPUEs might over-represent actual abundance. Changing skill levels of anglers (i.e., charter fishermen who are more skilled than casual fishermen making up different proportions of the effort in different years) and the availability of alternate species in different years are also potential biases. For example, fishermen in the east end of the lake may choose to fish for brown trout in the near shore area in years when they are abundant rather than run out to deep water to fish for salmon.

Specific recommendations for additional information that may help explain many of the questions surrounding the relationship between jack returns to the Salmon River Hatchery and open lake HPUEs of age 1 Chinook salmon, and greatly increase our overall understanding of Chinook salmon dynamics in the Lake Ontario system are annual assessments of:

1) the proportion of wild Chinook in Lake Ontario
2) the proportion of wild Chinook in the Salmon River spawning migration
3) the proportion of wild Chinook in the returns to the Salmon River Hatchery

Coho Salmon

Growth

Weights of age-2 coho salmon of both sexes were slightly below the long-term averages among years sampled. (Figure 6).

Washington Steelhead

Growth

Steelhead are sampled in the spring and, unlike Chinook and coho salmon, do not reflect growth from the 2006 growing season. Sizes reported here reflect conditions prior to and including 2005. Age 3 and age 4 steelhead were relatively light in 2006. Weights of age 3 and age 4 steelhead were about 0.5 and 1.0 pounds below their historical averages, respectively (Figure 7).

Age Structure

Similar to age structures observed in recent years, age 3 and age 4 steelhead dominated the run again in 2006 (Figure 8). The age structure of the fish sampled was 39.5% age-3, 48.5% age-4, 8.5% age-5, and 3.5% age-6.

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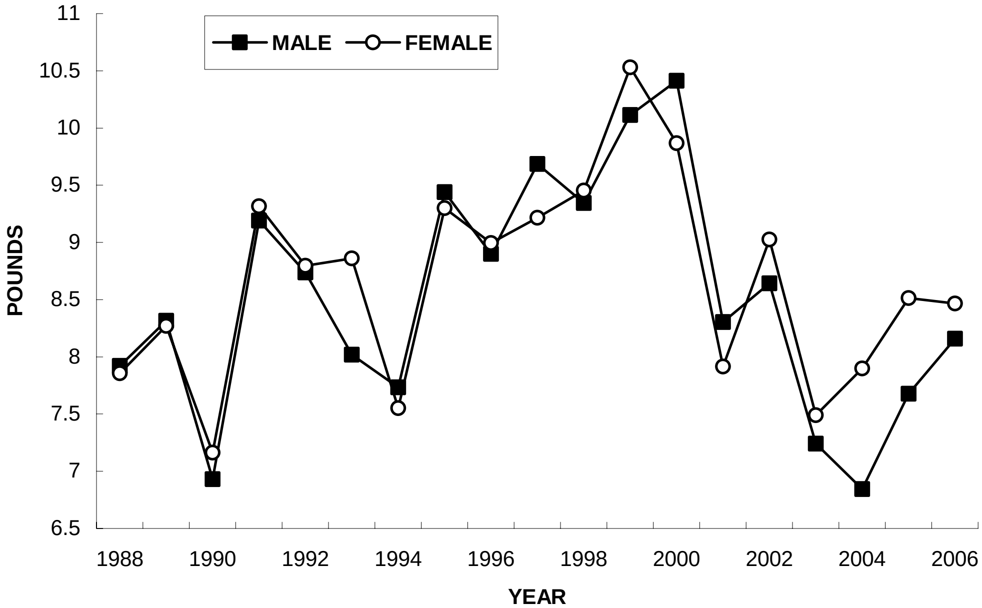

Figure 6. Mean weights of age-2 coho salmon at Salmon River Hatchery 1988-2006.

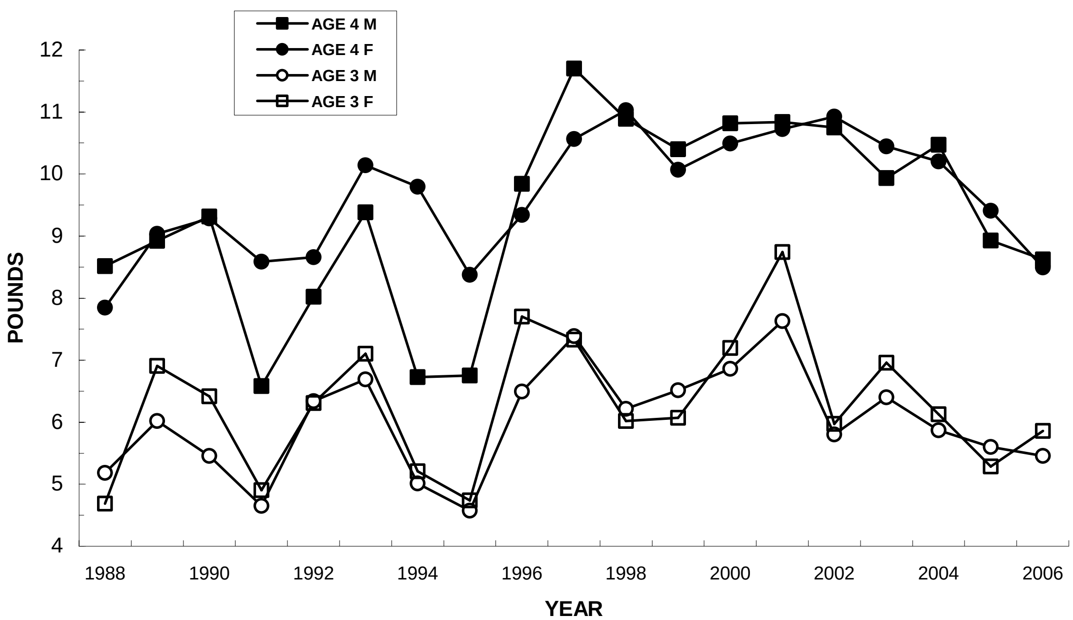

Figure 7. Mean weights of Washington steelhead ages 3-4 at Salmon River Hatchery 1988-2006.

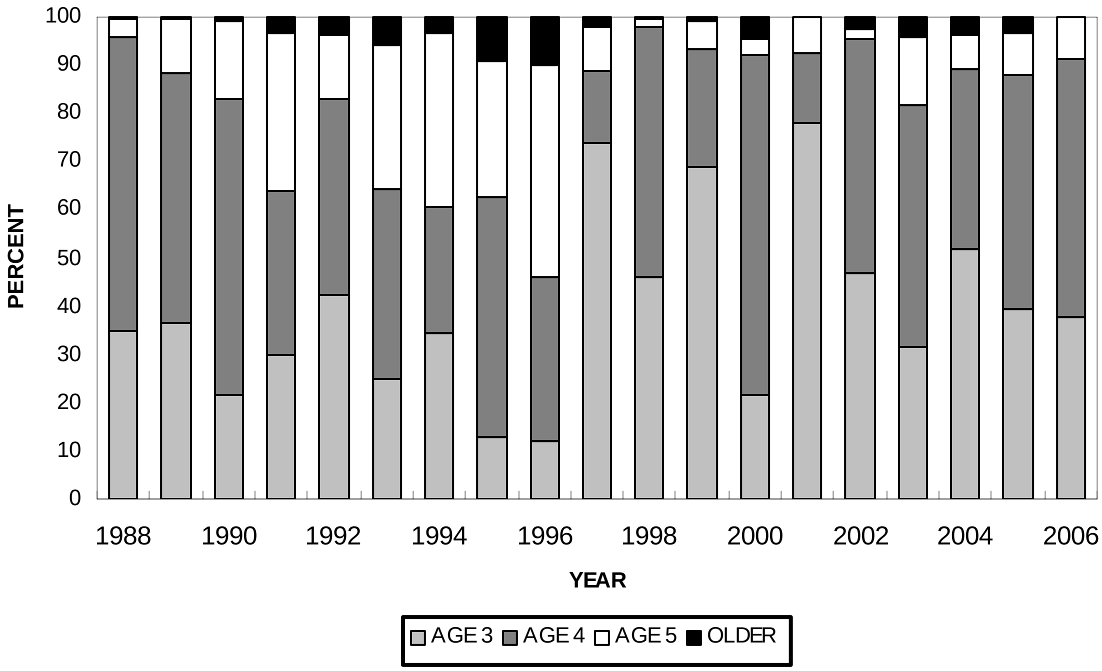

Figure 8. Age structures of Washington steelhead samples at Salmon River Hatchery 1988-2006.