

**Population Characteristics of Pacific Salmonines
Collected at the Salmon River Hatchery 2007**

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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 3,131 steelhead during the spring 2007 spawning operations (Nelson 2008a). Washington (Chamber's Creek strain) winter run fish comprised 92% (2,888) of the returns. Skamania strain summer run fish marked LPAD accounted for the remaining 8% (243).

A total of 2.06 million Washington steelhead eggs were taken from 649 females. The Skamania egg total was 58,600 from 19 females. Biological data were collected from 319 Washington strain steelhead.

A combination of low flows and high temperatures in the fall of 2007 reduced Chinook salmon returns to the hatchery and resulted in poorer than normal eye-up of eggs for both Chinook and coho salmon. Returns included 1,891 Chinook salmon (only 276 females) and 6,311 coho salmon. Biological data were collected at the hatchery from 481 Chinook and 220 coho.

The egg totals were 1.01 million Chinook from 224 females and 1.8 million coho from 499 females (Nelson 2008b). The Chinook total was well short of the target (3.5 million). Likely due to temperature stress on female salmon during egg development, egg survival to the eyed stage was reduced to 64% for Chinook eggs (average

84%) and 15% for coho (average 43%) resulting in approximately 639,000 eyed Chinook eggs and 275,000 eyed coho eggs collected at the Salmon River Hatchery. Additional emergency Chinook egg collections conducted at several tributaries resulted in 68,000 eyed-eggs from Black River, 21,000 from Oak Orchard Creek and 366,000 from Eighteenmile Creek. Chinook stocking levels in 2008 will be reduced to approximately 800,000 fish (target 1.76 million) due to reduced egg take and survival in 2007.

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

Growth

The mean weight of age-1 Chinook males (jacks) sampled in 2007 decreased significantly from 2006 returning to the low levels seen in 2003-2005 (Figure 1). Weights of age-2 and age-3 fish of both sexes were at record lows (Figure 2). Age-2 fish were about 3.5 pounds (males) and 4.2 pounds (females) below their long-term averages for all of the previous years sampled and age-3 fish of both sexes were about 4.5 pounds below their historical averages. Age - 2 fish were significantly heavier in 19 (males) and 20 (females) of the previous 21 years sampled. Age-3 fish were significantly heavier in 18 (males) and 19 (females) of the previous years. Mean lengths and weights at age for all species sampled in 2007 are provided in Table 1.

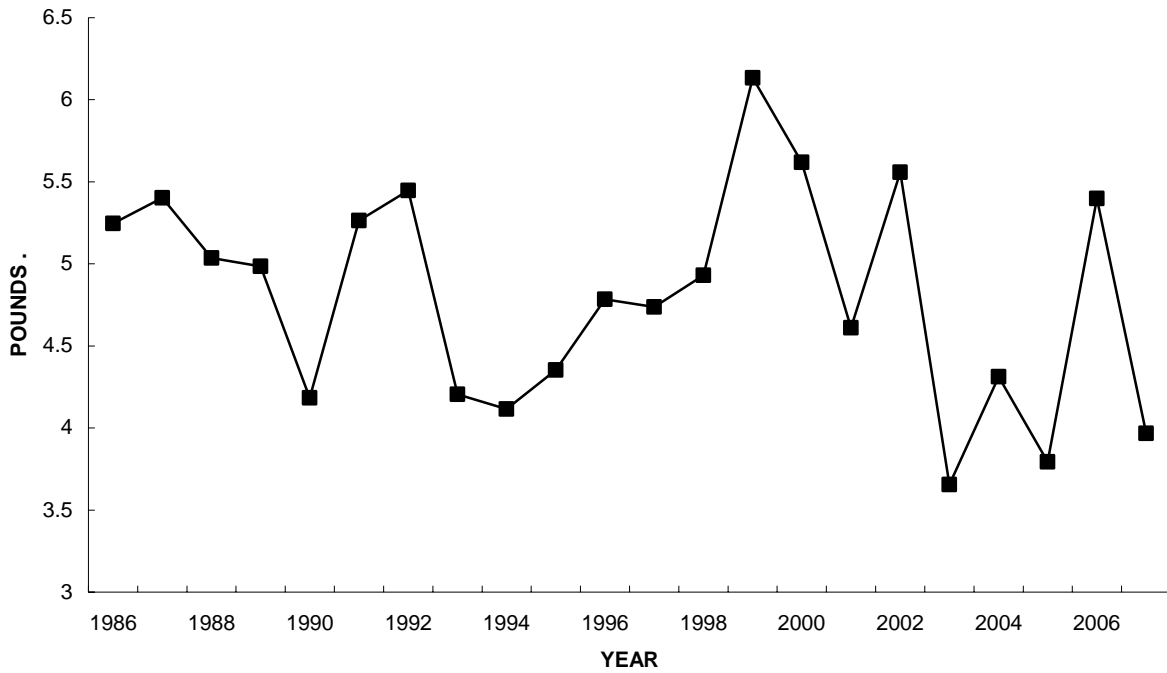


Figure 1. Mean weights of Chinook jacks at Salmon River Hatchery, 1986-2007.

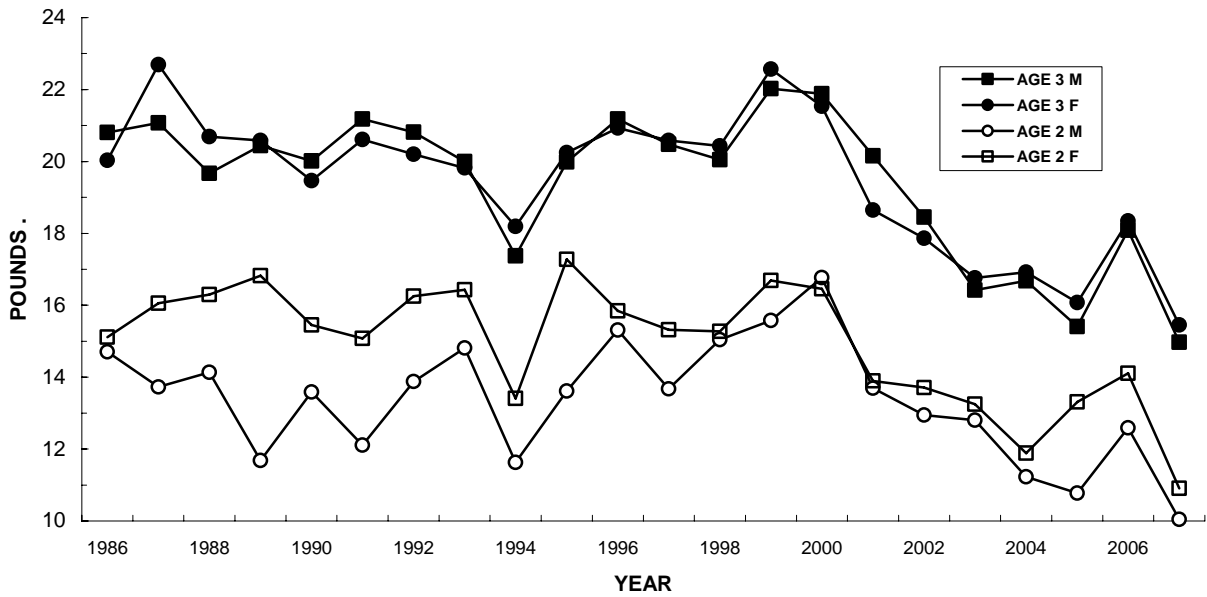


Figure 2. Mean weights of Chinook salmon ages 2-3 at Salmon River Hatchery 1986-2007.

Table 1. Mean lengths and weights of Chinook salmon, coho salmon and Washington steelhead sampled at Salmon River Hatchery 2007. (STD= standard deviation).

AGE	SEX	N	MEAN	STD	MEAN	STD
			LENGTH (in)		WEIGHT (lbs)	
CHINOOK SALMON						
1	M	78	22.6	1.5	4.0	0.8
2	M	129	31.4	4.3	10.1	3.5
2	F	19	31.1	3.3	10.9	3.0
3	M	148	36.4	2.8	15.0	3.3
3	F	80	35.5	2.7	15.5	3.2
COHO SALMON						
1	M	95	16.2	3.0	1.6	0.9
2	M	67	28.7	2.1	7.7	2.0
2	F	52	28.5	1.3	8.3	1.2
WASHINGTON STEELHEAD						
3	M	105	25.9	2.2	5.8	1.3
3	F	86	25.7	1.4	6.1	1.2
4	M	39	27.9	2.6	7.2	1.8
4	F	64	28.0	2.0	7.9	1.8
5	M	4	31.9	3.0	10.8	2.3
5	F	10	30.8	2.4	10.0	1.9

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. The predicted weight was the second lowest on record at 15.5 pounds compared to a mean of 16.7 pounds for the previous years sampled (Figure 3). The poor growth seen in 2007 is likely the result of relatively low alewife abundance in the Lake Ontario (O’Gorman et al. 2008).

Age Structure

The estimated age structure of the 2007 Chinook salmon run to the Salmon River Hatchery was 22% age-1 males, 30% age-2, 43% age-3, and 5% age-4 (Figure 4).

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 2006 year class of Chinook

salmon returned 414 jacks to the hatchery in 2007. This was the fifth lowest jack return on record. Harvest per unit of effort of age-1 Chinook from the New York Lake Ontario Fishing Boat Census was estimated at 4,404 fish per 150,000 boat trips which was the fourth lowest on record (Eckert 2008). These indices suggest that the 2006 year class of Chinook is not particularly strong.

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.

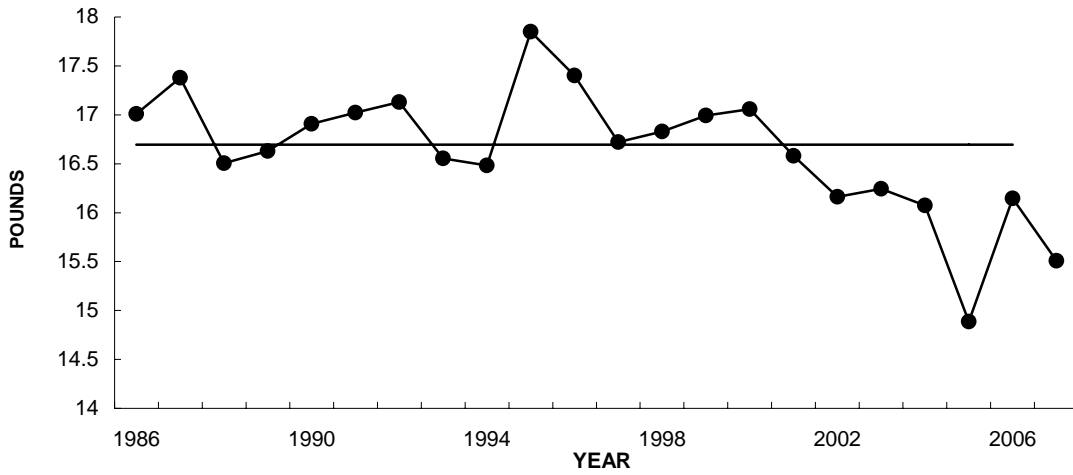


Figure 3. Estimated weights of 36 inch Chinook salmon from the Salmon River Hatchery fall (October) collections 1986-2007.

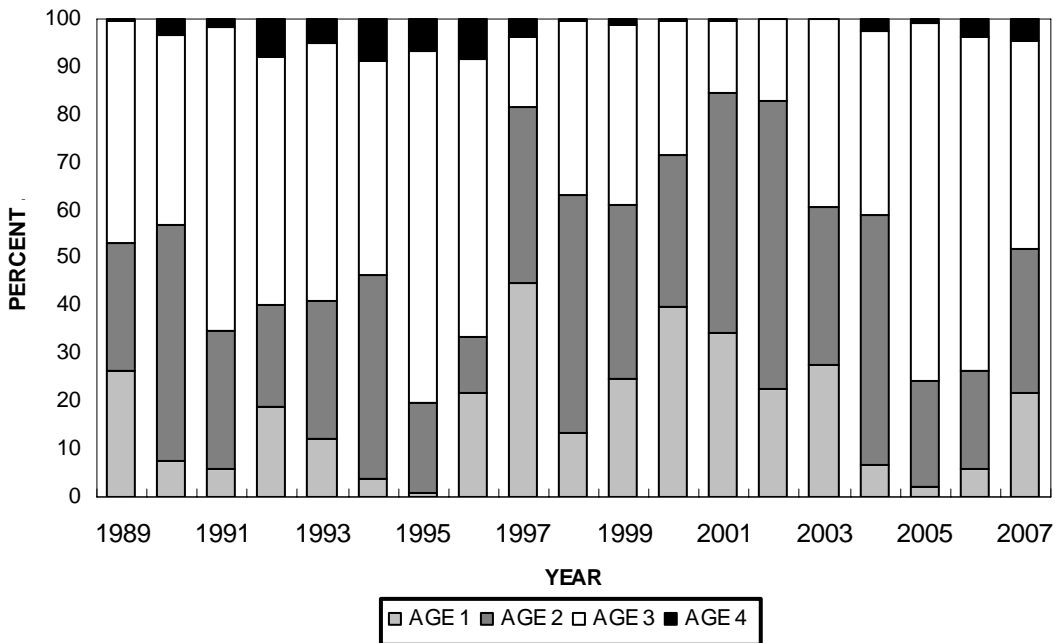


Figure 4. Estimated age structures of Chinook salmon runs at Salmon River Hatchery, 1989-2007.

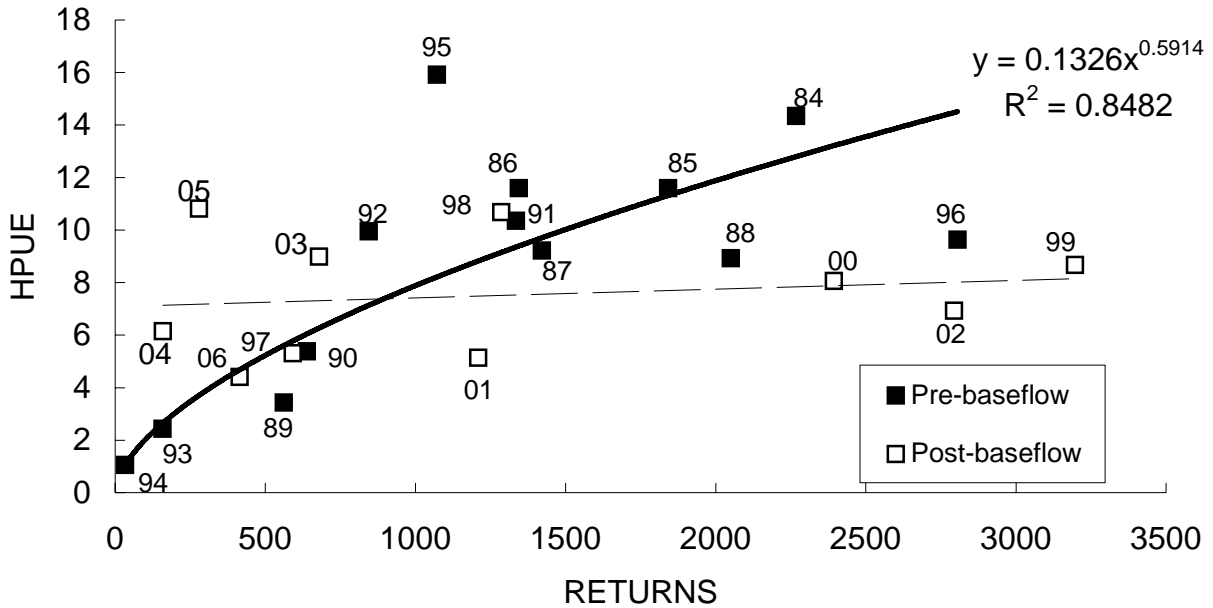


Figure 5. Pre- and post-baseflow Chinook jack returns to Salmon River Hatchery and harvest per unit of effort (HPUE) of age-1 Chinook for the New York Lake Ontario Fishing Boat Census, year classes 1984-2006. HPUEs are estimated numbers of fish harvested adjusted to a common level of effort. The solid curve is fitted to the pre-base flow data and the dashed line is fitted to the post-base flow data.

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 and Johnson (2008) 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 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.

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 are 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, 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 males were 0.8 pounds and females were 0.3 pounds below their respective long term-averages (Figure 6).

Washington Steelhead

Growth

Steelhead are sampled in the spring and, unlike Chinook and coho salmon, do not reflect growth during the 2007 growing season. Weights reported here reflect conditions prior to and including 2006. Weights of age-3 fish of both sexes were slightly below their respective long term averages but age-4 males and females were

2.1 and 1.8 pounds, respectively, below their long term averages (Figure 7). The males and females were lighter in only 3 and 1 of the previous 19 years surveyed, respectively, but not significantly so.

Age Structure

Similar to age structures observed in recent years, age-3 and age-4 steelhead dominated the run again in 2007 (Figure 8). The age structure of the fish sampled was 63% age-3, 32% age-4, 4% age-5, and 1% age-6 or older.

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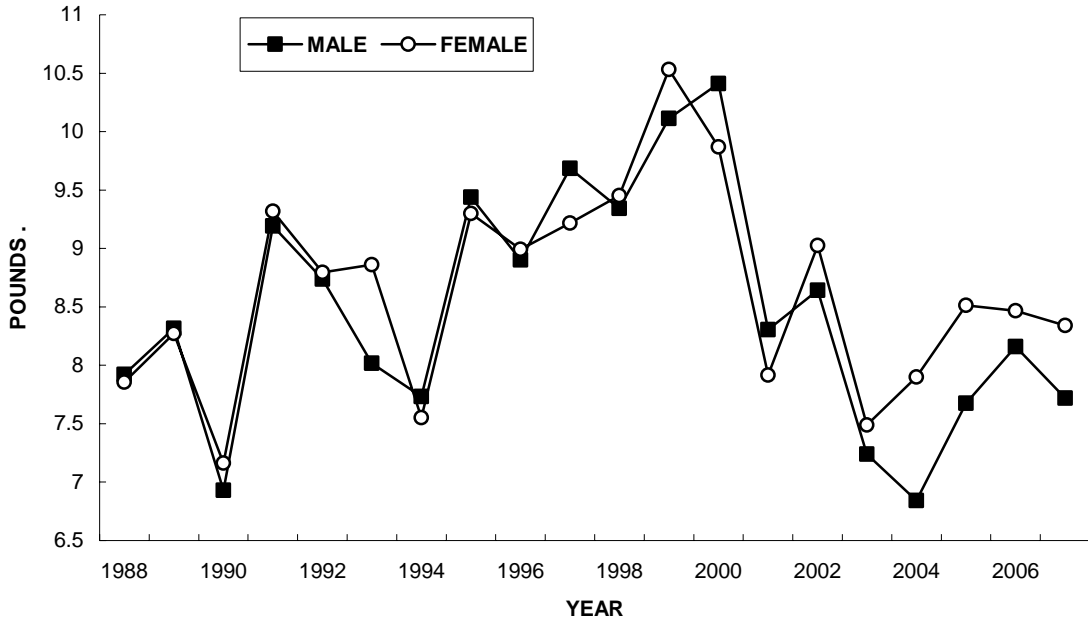


Figure 6. Mean weights of age-2 coho salmon at Salmon River Hatchery 1988-2007.

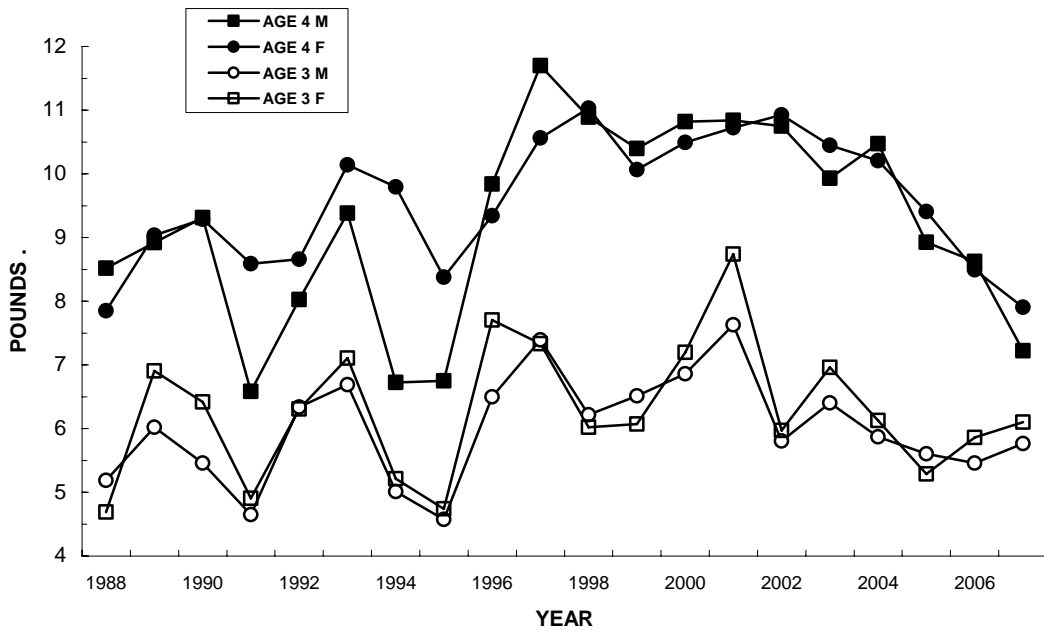


Figure 7. Mean weights of Washington steelhead ages 3-4 at Salmon River Hatchery 1988-2007.

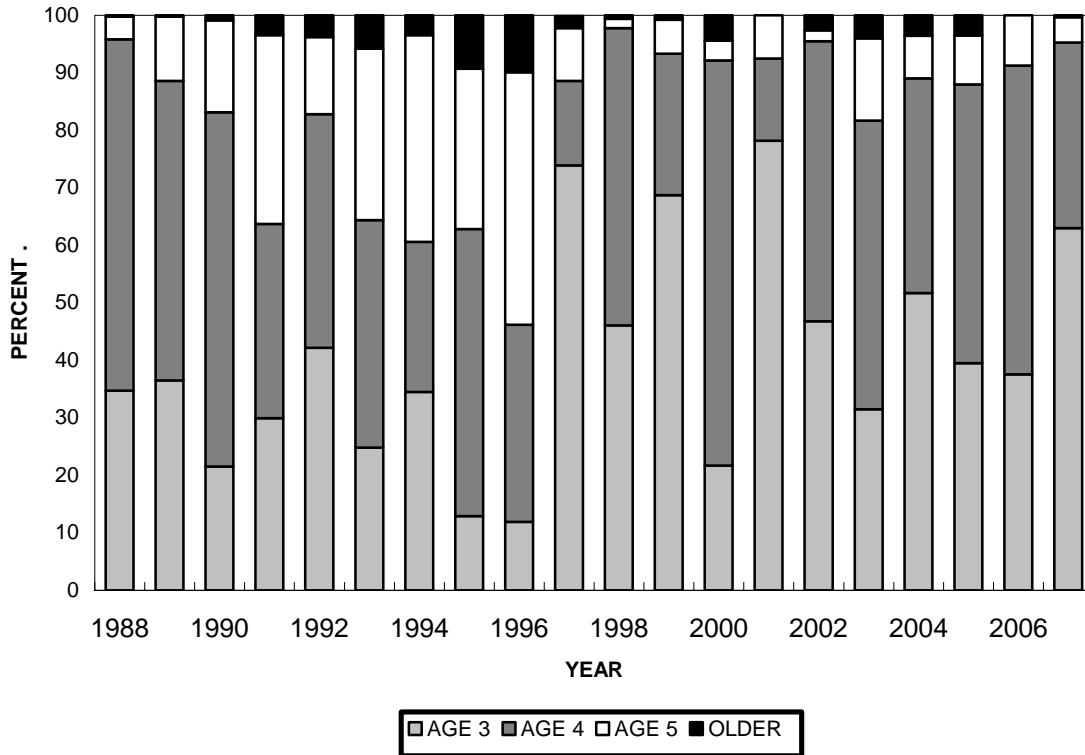


Figure 8. Age structures of Washington steelhead samples at Salmon River Hatchery 1988-2007.