ASSESS SALMONIDS IN THE ASOTIN CREEK WATERSHED

2004 ANNUAL REPORT

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Abstract

The Asotin Creek watershed is located in southeast Washington and is a tributary of the Snake River. Originating in the Blue Mountains, Asotin Creek is a historically productive subbasin for steelhead trout (*Oncorhynchus mykiss*) and spring Chinook salmon (*O. tshawytscha*). Many habitat restoration projects, aimed at recovering ESA listed salmonids, have been completed in the subbasin. The Asotin Creek assessment project addresses RPA 180 for population status monitoring. Plans for an adult salmonid trap were completed during the project year. During a short 2004 juvenile trapping season, a 1.52 m rotary migrant trap was operated just below Headgate Dam, at rkm 13.2. Mean trap efficiency was 20.5% for steelhead and 45.7% for Chinook salmon. Of the 8,028 juvenile steelhead captured, 42.0% were parr, 56% were transitional smolts and 2% were fully-smolted juveniles. The estimated population of juvenile steelhead emigrating at rkm 13.2 was 43,457 individuals. One female kelt that we captured was a repeat spawner. In addition, 600 yearling Chinook salmon, 1,273 subyearling Chinook salmon and 4 bull trout were captured. Substantially more emigrating parr and transitionally-smolted juvenile steelhead were captured than expected. This suggests that the Asotin Creek subbasin may be a nursery of the Lower Snake River steelhead ESU. Juvenile steelhead from the subbasin may emigrate from the Asotin Creek subbasin and complete their rearing in the mainstem Snake River or other tributary. This information provides a new perspective on the classification and emigration patterns of juvenile steelhead in Asotin Creek, which may be an important factor in overall survival estimates and management alternatives for the Asotin Creek steelhead population.

Introduction

The Asotin Creek watershed is located in southeast Washington and is a tributary of the Snake River. Originating in the Blue Mountains, the Asotin Creek watershed is a historically productive subbasin for steelhead trout (*Oncorhynchus mykiss*) and spring Chinook salmon (*O. tshawytscha*) (NMFS 1997). Bull trout (*Salvelinus confluentus*) are also present in the subbasin (USFWS 2002). There is no historical record of fall Chinook inhabiting Asotin Creek (ACMWP 1995). However, fall Chinook salmon (probably hatchery strays) have been observed spawning in the mainstem of Asotin Creek within the last several years

All populations of anadromous salmonids in the Snake River Basin are listed as threatened or endangered by the National Marine Fisheries Service (NOAA Fisheries). Bull trout are listed as threatened by the U.S. Fish and Wildlife Service for protection under the endangered species act. Primary threats to salmonid populations in the Asotin Creek subbasin include out-of-subbasin hydroelectric dams and associated reservoirs in the Snake and Columbia Rivers, out-of-subbasin harvest, loss of riparian habitat, water quality, detrimental changes in hydrology, sediment transport, stream channel stability, elevated summer water temperatures and lack of in-stream pools caused by local land use activities (ASP 2004). Many habitat restoration projects have been completed and are on-going in the subbasin with state (Salmon Recovery Funding Board) or federal (BPA) funding to address habitat issues, focusing primarily on population protection and habitat restoration in Asotin Creek (ASP 2004; BPA 2004).

The State of Washington has designated Asotin Creek as a wild steelhead refuge (Glen Mendel, WDFW, pers. comm., 2004), eliminated harvest of adult salmon and steelhead, strictly limited fishing impacts, and ceased all direct hatchery steelhead releases since 1998. With little or no influence from hatchery steelhead, the Asotin Creek watershed provides a wild steelhead system with background population data to monitor steelhead reproductive biology, population variation and status over time.

Because of the complex life history of steelhead trout, accurate estimates of adult steelhead escapement and natural juvenile production, as well as survival rates by life stage, are needed to understand salmonid productivity in Asotin Creek. This assessment is consistent with recommendations for the Tributary Research, Monitoring and Evaluation (RME) plans being developed by NOAA Fisheries, which identify the need to better answer the following questions for indicator steelhead stocks from ESUs within the Columbia Basin:

1) What is the size of the population?
2) What is the annualized growth rate?
3) What is the freshwater productivity?
4) What is the population's age structure?
5) How many are hatchery strays?

In order for appropriate decisions to be made by State, Tribal and Federal fisheries managers, concerning the most effective actions to stabilize and rebuild steelhead and Chinook salmon populations in the Asotin Creek subbasin, accurate data about the life history and reproductive capacity of these salmonids is necessary. Baseline monitoring is crucial in documenting recovery efforts for steelhead persistence, and for the proposed reintroduction of spring Chinook salmon. Fisheries managers will use the data from this project for recovery actions and population management. The Asotin Creek assessment project is necessary to address the reasonable and prudent alternative (RPA 180) for population status monitoring (i.e., abundance, trend, distribution, and variation) required by the 2000 FCRPS Biological Opinion.

The goal of this project is to determine the abundance and current productivity of juvenile and adult anadromous salmonids in Asotin Creek (primarily summer steelhead) above George Creek and estimate life stage survival rates. Estimates of smolt-to-adult and adult-to-adult survival for the natural steelhead populations in Asotin Creek will provide the data necessary to determine if salmonid production in the subbasin is being limited by within-basin or out-of-basin factors

Objective 1 was to estimate escapement of hatchery and wild steelhead and salmon into the Asotin Creek drainage above George Creek. The tasks involved in this objective included: 1) Design and obtain permits to improve fish passage and build an adult salmonid trap at Headgate Dam on Asotin Creek, 2) conduct a NEPA review for these actions, 3) complete an ESA Section 10 Permit Application, and 4) complete the project design, statistical design and operational criteria for the adult (spawner) and smolt (outmigrant) traps to be used on the project.

Objective 2 was to coordinate, compile, analyze and report results. The tasks involved in this objective included: 1) Compile and report results monthly or quarterly from each task to interested parties, co-managers and BPA, 2) provide annual reports in electronic format to BPA and interested parties within the basin, 3) provide data in electronic format to regional database systems such as PITAGIS, RMIS and StreamNet, and 4) coordinate all actions with fishery co-managers, watershed coordinators and other interested parties in the basin. In addition, a sub-goal of this objective was to provide written and oral summaries to interested parties to ensure timely inclusion of results in planning efforts.

Objective 3, added on February 4, 2004, was to document juvenile steelhead and salmon life history patterns, survival rates and smolt production from Asotin Creek. The task for this objective included the operation of a smolt trap during the spring of 2004 near Headgate Dam.

Description of Project Area

Asotin Creek originates in the northeast corner of the Blue Mountains and drains about 48,158 hectares (479 km^2 or 185 mi^2) above George Creek. Elevations range from 232 meters to 1,897 meters. Major tributaries of the mainstem include George Creek, Charley Creek, and the North and South Forks of Asotin Creek (Figure 1). The name "Asotin" is derived from the Nez Perce word "Hesut'iin", which means "place of eels", a reference to a historically abundant population of lamprey.

The project activities during the contract year were located in Asotin Creek near Headgate Dam, located in Headgate County Park (46° 19' 32"N, 117° 12' 32" W) at road kilometer (km) 13.2 in Asotin County, Washington, and encompasses the mainstem and its tributaries above Headgate Dam. Access to the site was via Asotin Creek Road from the town of Asotin, Washington.

The Asotin Creek watershed is generally composed of V-shaped drainages with steep, narrow, canyons. Asotin Creek historically had a less severe gradient and a meandering flow pattern than under current conditions. Much of Asotin Creek and its tributaries have been straightened, diked or relocated, and is now wider and shallower than it was in the past.

United States Geological Survey (USGS) records (from 1929–1960) indicate a mean annual flow of 74 cfs upstream of Headgate Dam. Normal low flow in late summer is 15-30 cfs, and normal high flow in the spring and early summer (February to June) is from 200 to 400 cfs. Riparian conditions in the Asotin Creek subbasin vary widely by location and land use.

The Asotin Creek subbasin has a mean annual precipitation of 58 centimeters (23 inches), including a mean annual snowfall of 165 cm (65 inches). Ninety percent of the precipitation occurs between September and May. The mean annual temperature for the basin is 17°C (63°F), with temperatures typically ranging from –32°C (-25°F) in winter to 41°C (105°F) in summer. The WDOE classifies Asotin Creek and its tributaries as Class A (excellent) surface waters. Waters within the National Forest in the subbasin are considered Class AA (extraordinary).

The Asotin Creek watershed has approximately 579 kilometers (360 miles) of perennial and intermittent streams. The mainstem of Asotin Creek is approximately 55 kilometers (34 miles) long, with 42 kilometers (26 miles) designated as Class I (anadromous fish bearing), 8 kilometers (5 miles) designated as Class II (resident fish bearing), and 3 kilometers (2 miles) as Class III (perennial non-fish bearing) (USFWS 2002).

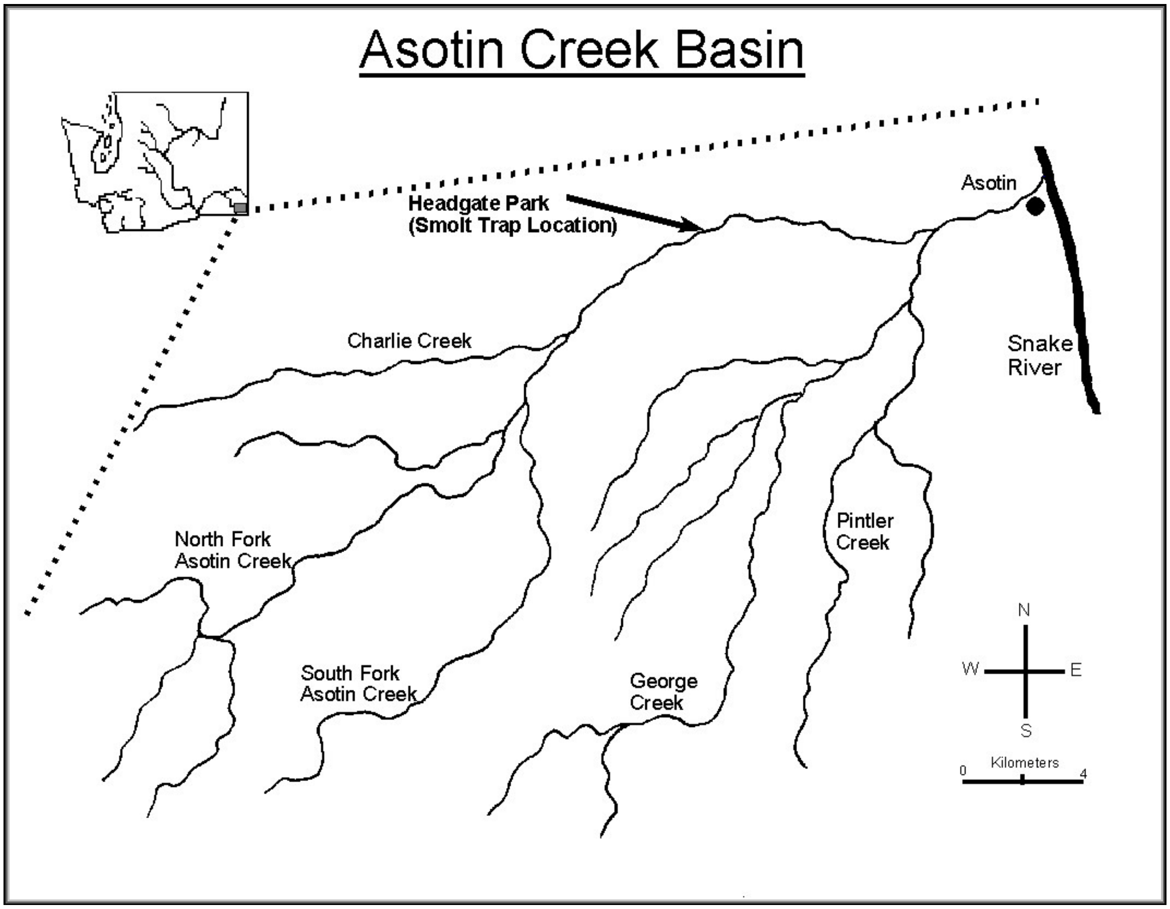

Figure 1. Location of the Asotin Creek subbasin, Washington.

Methods and Materials

A rotary screw (smolt) trap was used to capture and enumerate juvenile steelhead and Chinook salmon emigrants to accomplish the following tasks: Collect length, weight, and scale samples to determine age structure of the population, clip and release migrants for trap efficiency testing, and provide an estimate of the number of juvenile steelhead and Chinook salmon emigrating from the Asotin Creek subbasin. An operational protocol was developed for the smolt trap in February 2004. (A complete version of the smolt trapping procedures can be obtained from the project office). A summary of the smolt trapping procedures is as follows:

A 1.52 m (5 ft) rotary screw (smolt) trap was placed in Asotin Creek, 100 meters downstream of Headgate Dam. The trap was operated 24-hours a day, seven days a week and checked daily. Juvenile salmonids captured in the trap were anesthetized with methane tricaine sulfonate (MS-222), and the species, fork length (± 1.0 mm) and weight (± 0.1 gram) were recorded. Signs of smoltification were also recorded. Weekly scale samples were taken from about 35 fish (when possible) in each of three size categories: 110-139 mm, 140-169 mm and >170 mm to determine the age structure of emigrants. All fish were released 50 meters downstream of the trap. Scale samples were handled according to WDFW protocols and age determinations were made by counting scale annuli.

Whenever the smolt trap was checked for fish, the following information was recorded: Date, time of day, weather conditions, if the trap was rotating, debris size, water temperature and flow. Water temperature was documented with the use of a thermometer in the live box. Stream flow was recorded via gage heights from USGS stream gages at road km 0.2 (13 km downstream of the site) and road km 23 (9.8 km upstream of the site, at the confluence of the North and South forks).

The goal for trap efficiency testing was to test at least once a week with a minimum of 25 fish of each species for each trap efficiency test. Typically, two trap efficiency tests were conducted per week, on Mondays and Thursdays. Alternating caudal fin clips were used to distinguish between trap efficiency tests. In addition, the 3-day time period between tests allowed fish from the previous test to “clear” the trapping location.

Trap efficiency was estimated based on the proportion of fish recaptured. Fish used for trap efficiency testing were released about 150 m upstream of the trap (about 50 m above Headgate Dam). Trap efficiency was calculated using the following equation:

$$E = R/M;$$

Where: E is the estimated trap efficiency (percent),
R is the number of marked fish recaptured,
M is the total number of fish marked and released for trap efficiency testing.

Trap efficiency was used to calculate population estimates based on the number of steelhead captured. Trap efficiency varied from test to test and the number of days between tests was used for the between-test (i.e., bi-weekly) estimates. The seasonal population estimate for steelhead was calculated using the sum of the bi-weekly estimates. A weighted-mean efficiency was used to calculate the seasonal population estimate for Chinook salmon. The number of migrants was determined using the following equation:

$$N=U/E;$$

Where: N is the estimated number of emigrants,
U is the total unmarked catch,
E is the estimated trap efficiency.

The variance for the estimated number of outmigrants was calculated using a bootstrapping method (Efron and Tibshirani 1986). Ten thousand iterations (number of re-samples) were used in the bootstrapping calculations.

Confidence limits were calculated using the equation:

$$95\%CI = 1.96 * \sqrt{V}$$

Where: V is the variance determined by bootstrapping analysis.

Results and Discussion

In the planning and design phase of Objective 1 (estimate escapement of steelhead and salmon into the Asotin Creek drainage above George Creek) a system to re-route and capture adult salmonids was envisioned. The design of the structure was completed, including a fishway, trap and modifications to Headgate Dam, and the engineering drawings were 90% completed.

The initiation of smolt trapping on Asotin Creek (which began on March 26, 2004) was delayed because of interagency, administrative difficulties. On the first day of smolt trap operation, 43 juvenile steelhead and 19 yearling Chinook salmon were captured. On the last day of smolt trap operation (June 25, 2004), 12 juvenile steelhead and 3 subyearling Chinook salmon were captured. Note: Although fall Chinook salmon were observed spawning above Headgate Dam in the fall of 2003, the distinction between spring Chinook salmon and fall Chinook salmon cannot be made at this time. Therefore, Chinook salmon are referred to either as yearling (age 1) or subyearling (age 0+) Chinook salmon.

Of the 8,028 juvenile steelhead captured during the spring 2004 trapping season on Asotin Creek, 42.0% were parr, 55.9% were transitional smolts and 2.1% were fully-smolted. For steelhead greater than 110 mm in length (assumed to be migrants), 92% were captured by May 21, and 95% were captured by May 25, 2004.

During the 14-week, spring 2004 smolt-trapping season, 29 trap efficiency tests were conducted with juvenile steelhead (an average of twice a week) using 22.9% of fish captured (Table 1). Mean trap efficiency for steelhead was 20.5%. Trap efficiency was variable during the season. Trap efficiency tests were done with juvenile steelhead ≥110 mm (n=27) and ≤109 mm (n=14) in length. There was no statistical difference in trap efficiency between the two size categories (t-test, p = 0.229) (Table 2). On the two days when only steelhead ≤109 mm were tested, trap efficiencies were used to calculate emigration estimates of all juvenile steelhead captured until the next trap efficiency test, which included juvenile steelhead ≥110 mm in length. Eighty-six percent (86%) of the recaptured steelhead that were released for trap efficiency testing occurred within one day of release. Ninety-five percent (95%) of the recaptured steelhead released for trap efficiency testing occurred within five days of release.

For the spring 2004 trapping season, we conducted 22 trap efficiency tests with Chinook salmon, also using 22.9% of Chinook salmon captured (Table 1). Mean trap efficiency for Chinook salmon was 45.7%. Trap efficiency for Chinook salmon was similar at the beginning and at the end of the season.

The estimated population of juvenile steelhead emigrating from the Asotin Creek subbasin above Headgate Dam was 43,457 (95% CI = 37,972 – 48,942 juveniles). The estimated populations of yearling and subyearling Chinook salmon were 1,279 and 2,842 respectively, emigrating from Asotin Creek above Headgate Dam.

Four bull trout were captured during the spring 2004 trapping season. One was 121 mm in length and 2 years old. The other three were 145, 154 and 156 mm in length and 3 years old.

Table 1. Smolt trap efficiency for steelhead and Chinook salmon.

Date (2004)	Steelhead Trap Efficiency (%)	Chinook Trap Efficiency (%)
3/26	31.6	47.4
3/29	19.0	52.2
4/1	35.7	16.7
4/5	20.7	47.4
4/8	23.2	53.1
4/12	24.1	68.0
4/15	35.9	37.5
4/19	25.4	-
4/20	-	66.7
4/22	18.2	-
4/23	-	50.0
4/28	25.8	52.0
4/30	9.0	-
5/1	13.5	-
5/3	20.8	-
5/6	20.8	60.0
5/10	26.7	63.2
5/13	18.3	34.4
5/17	9.7	48.5
5/20	25.9	51.7
5/24	21.4	35.7
5/27	27.3	29.6
5/28	19.6	-
5/31	21.1	52.0
6/3	7.7	42.9
6/7	11.1	26.3
6/10	11.9	55.6
6/14	6.9	42.9
6/17	9.7	-
6/23	11.8	-
6/25	9.5	-

Table 2. Smolt trap efficiencies for steelhead based on size.

Steelhead Size (mm)	Steelhead Trap Efficiency (%)	Number of samples (n)
60-69[1]	50.0	2
70-79	17.6	74
80-89	23.6	165
90-99	15.7	217
100-109	14.4	132
110-119	17.2	122
120-129	26.1	115
130-139	27.2	162
140-149	24.6	228
150-159	20.9	234
160-169	20.8	173
170-179	16.8	119
180-189	13.6	59
190-199	22.2	27
200-209	16.7	6
210-219	0.0	4
220-229[2]	0.0	1

Data from the spring 2004 Asotin Creek smolt-trapping season are depicted in figures 2–8. The total number of fish caught, length, smoltification index and age at migration are presented for steelhead, and the total number of fish caught and length are presented for Chinook salmon.

Of the 1,153 scale samples collected from the juvenile steelhead, 896 scales (77.7%) were readable and 257 scales (22.3%) were unreadable, mainly due to scale regeneration. The unreadable scales occurred most often in fish between 140–190 mm in length. Scale age data indicated that 20.6% of the steelhead sampled were age 1, 55.7% were age 2, 23.0% were age 3 and 0.7% were age 4. Age generally decreased during the trapping season. The mean age of steelhead captured was 2.0 at the beginning of the smolt trapping season and 1.0 at the end of the season. The highest mean age was 2.4 years during the weeks of April 5 and April 12. There was considerable overlap in age versus length distribution of 2-, 3- and 4-year old juvenile steelhead (Figure 5). Additional, multi-year scale sampling will be required to verify this data.

There was a significant decrease in the size and age of juvenile steelhead during the third and fourth weeks in May, resulting in more parr and fewer transitional smolts captured (Figures 3 and 6). These changes were coincidental with the highest flows of the spring 2004 trapping season, measuring 190 cfs at the confluence of the north and south forks. Condition factor generally increased throughout the trapping season, corresponding to the decreasing size of the steelhead captured (Table 3). A statistical summary by week is presented in Table 4.

Table 3. Summary statistics by developmental group (smoltification index) for steelhead captured at the Asotin Creek emigrant trap, 2004.

Smoltification Index	Mean Length (mm)	Mean Weight (g)	Mean Condition Factor (K)	Mean Age	Number captured
Parr	91.8	8.8	1.09	1.3	3369
Transitional	144.6	33.1	1.02	2.1	4490
Smolt	174.0	55.4	1.02	2.3	169

Table 4. Summary statistics by week for steelhead during the 2004 smolt-trapping season.

Week	Date (Week of)	Mean Length (mm)	Mean Age (years)	Mean Condition Factor (K)	Number captured
1	3/26 (1 day)	119.7	2.0	1.05	43
2	3/29 – 4/4	125.3	2.2	1.01	261
3	4/5 – 4/11	131.0	2.4	1.01	508
4	4/12 – 4/18	130.7	2.4	1.04	1273
5	4/19 – 4/25	125.7	2.2	1.06	480
6	4/26 – 5/2	128.6	2.2	1.04	745
7	5/3 – 5/9	139.2	2.3	1.02	1020
8	5/10 – 5/16	133.6	2.2	1.02	1086
9	5/17 – 5/23	114.8	1.8	1.06	951
10	5/24 – 5/30	99.0	1.8	1.11	699
11	5/31 – 6/6	96.9	1.2	1.10	412
12	6/7 – 6/13	94.1	1.1	1.13	296
13	6/14 – 6/20	93.6	1.1	1.10	190
14	6/21 – 6/25	93.2	1.0	1.11	64

There were a total of 12 steelhead mortalities (representing 0.2% of all steelhead captured) and 8 Chinook salmon mortalities (representing 0.4% of all Chinook salmon captured) during the spring 2004 smolt-trapping season.

Three kelts (post-spawned steelhead) were also captured: two females and one male. The females were in good condition and were 68 and 58 cm in length. The life history age of the first female was 2.1.S1, having migrated to the sea as a two-year old, rearing in the ocean for a year and spawning as a 3-year old, and then, following first spawning, returning to the ocean before spawning a second time in Asotin Creek one year later. The second female was a 3.1, having spent three years in fresh water and one year in the ocean before spawning. The male was in poor, post-spawned condition and was not expected to live. He was 76 cm in length and had an age of 2.2, having reared two years in both freshwater and ocean phases before spawning.

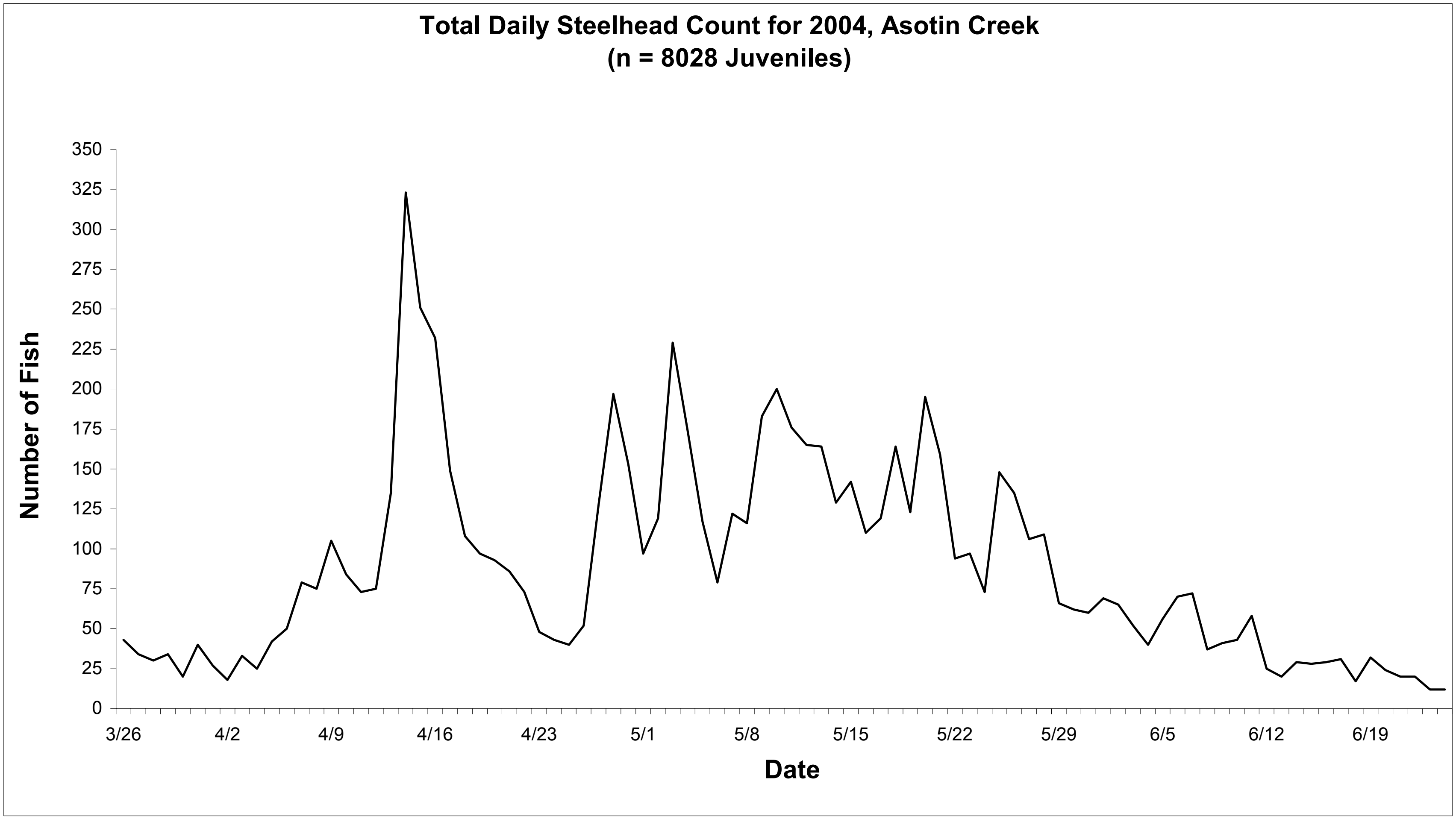

Figure 2. Total Daily Steelhead Count for 2004, Asotin Creek.

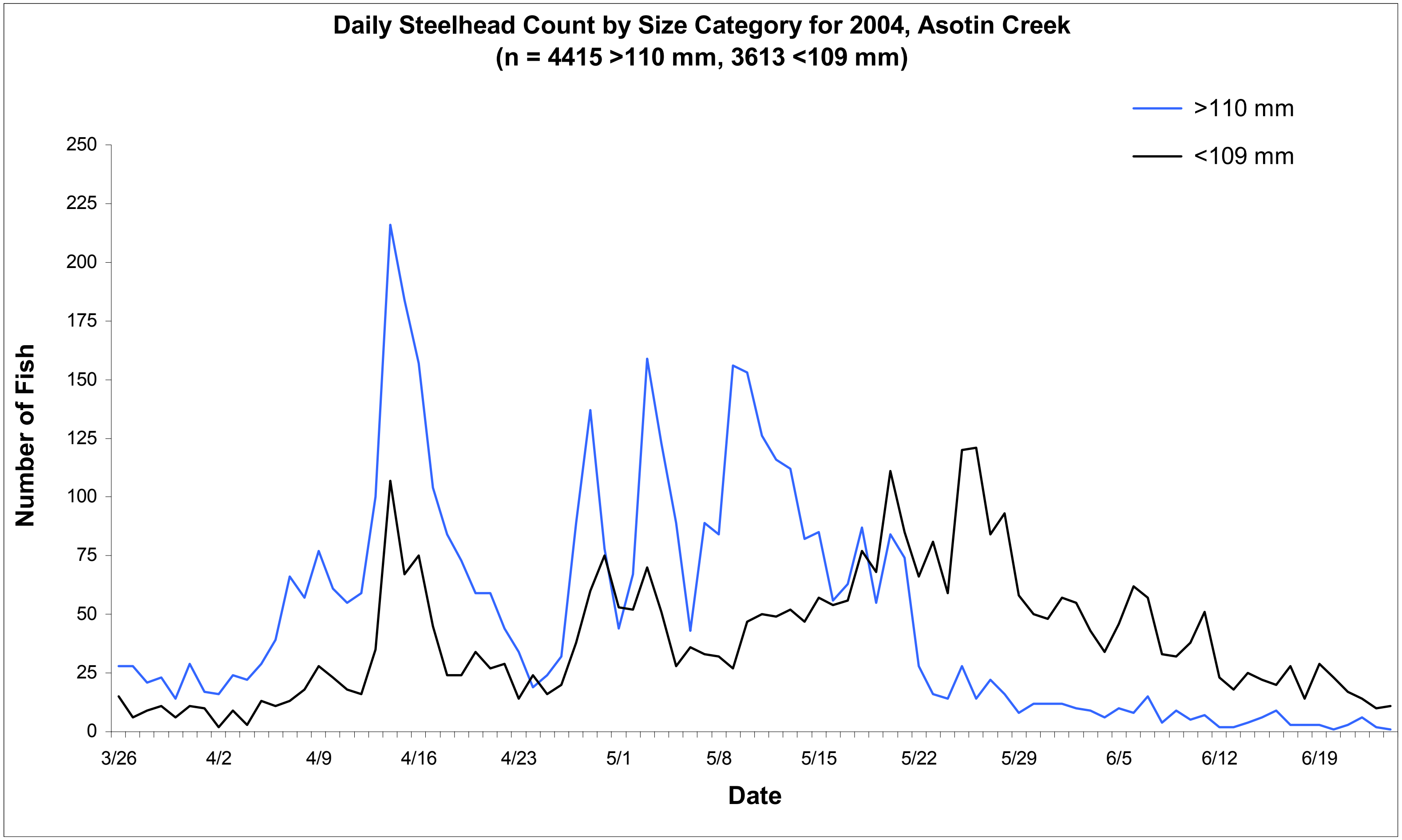

Figure 3. Daily Steelhead Count by Size Category for 2004, Asotin Creek.

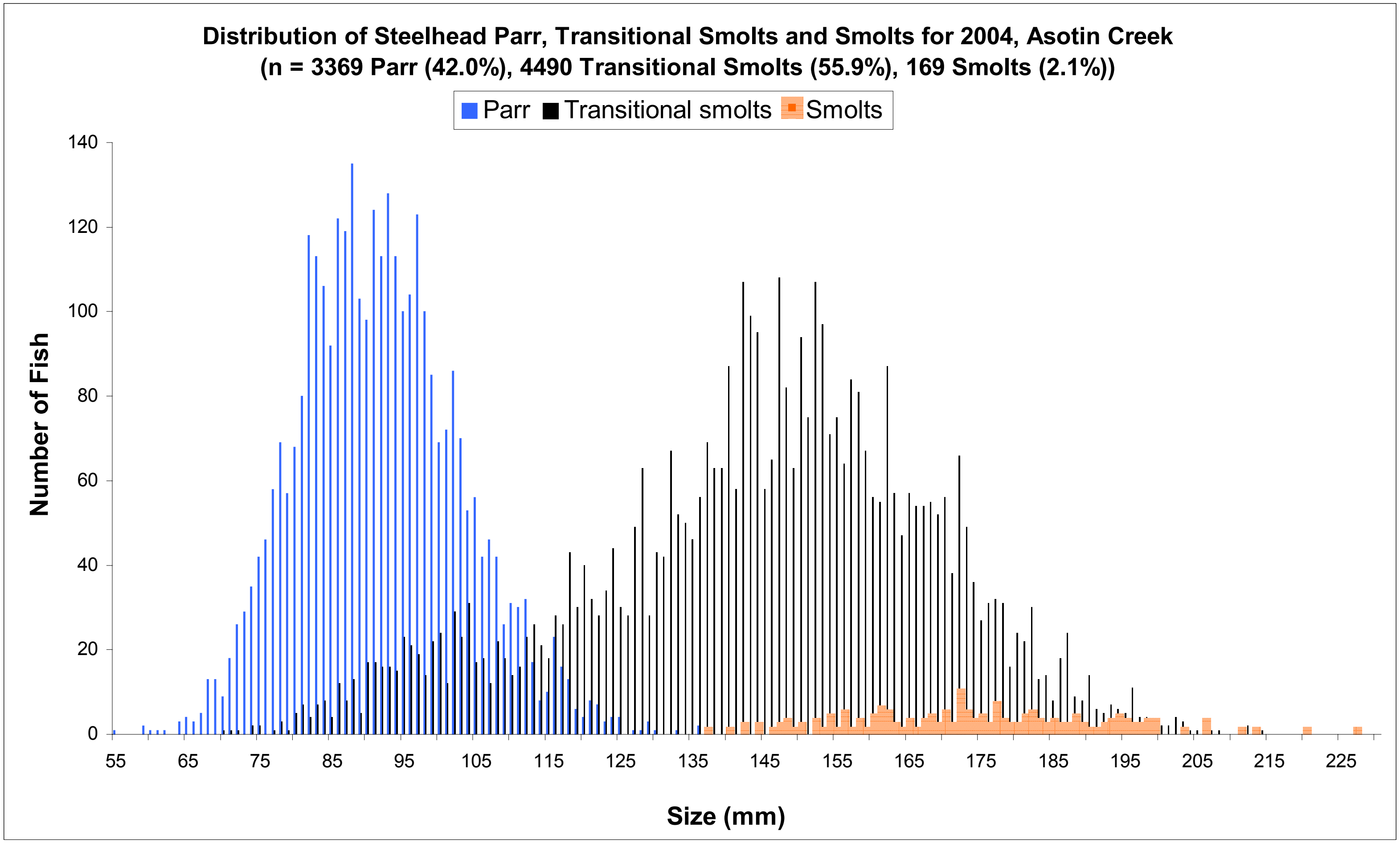

Figure 4. Length distribution of Steelhead Parr, Transitional Smolts and Smolts for 2004, Asotin Creek.

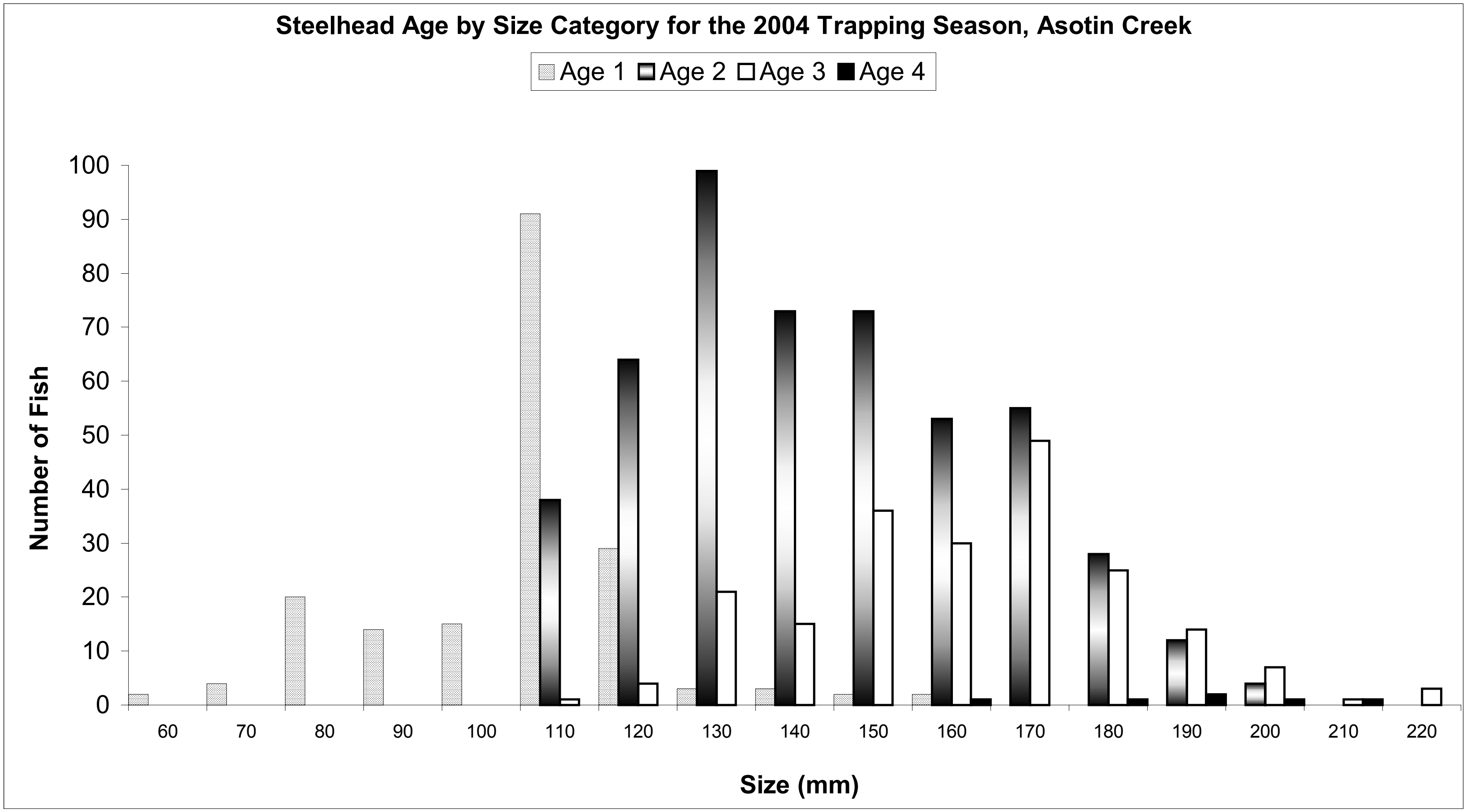

Figure 5. Steelhead Age by Size Category for the 2004 Trapping Season, Asotin Creek.

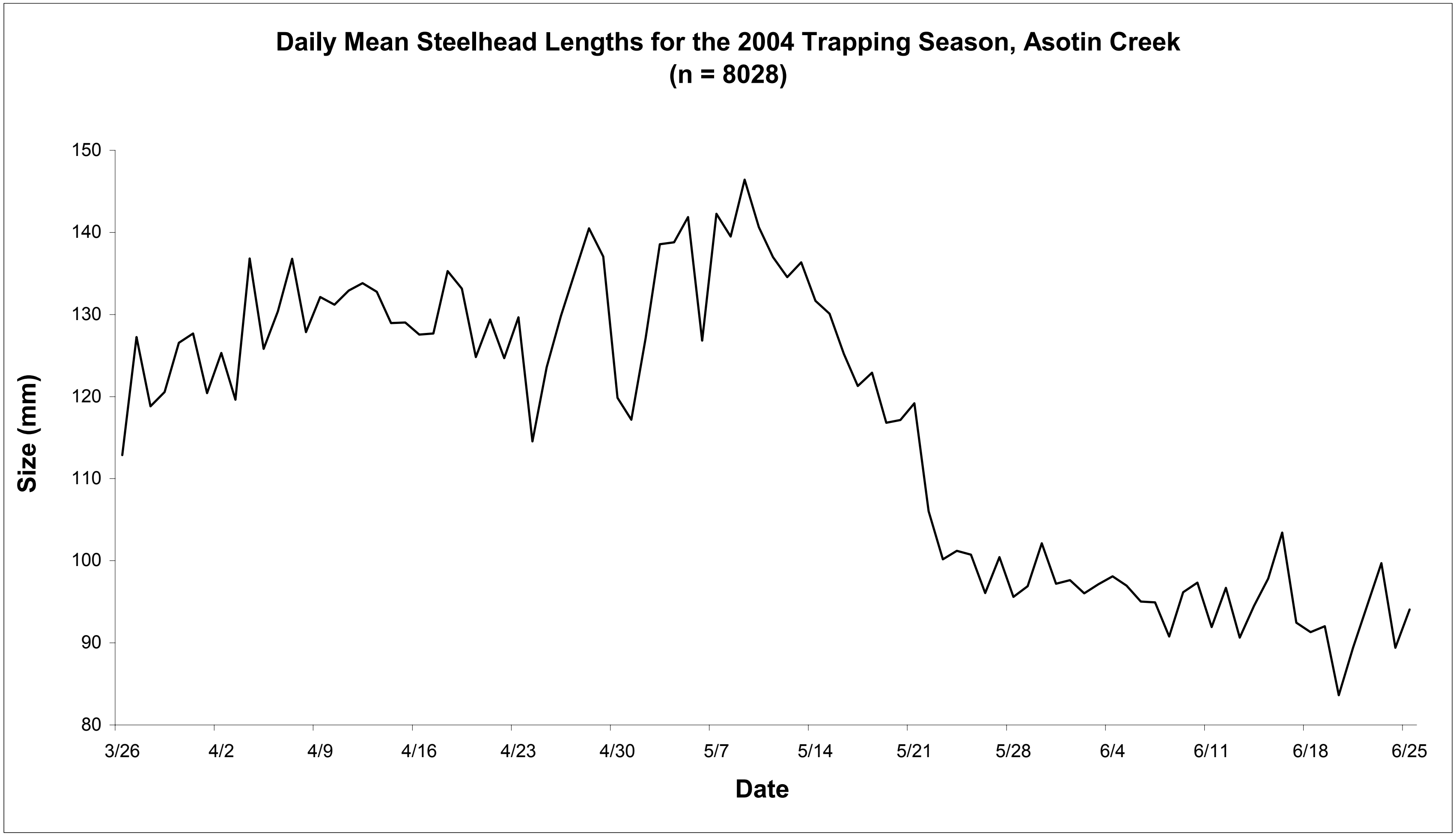

Figure 6. Daily Mean Steelhead Lengths for the 2004 Trapping Season, Asotin Creek.

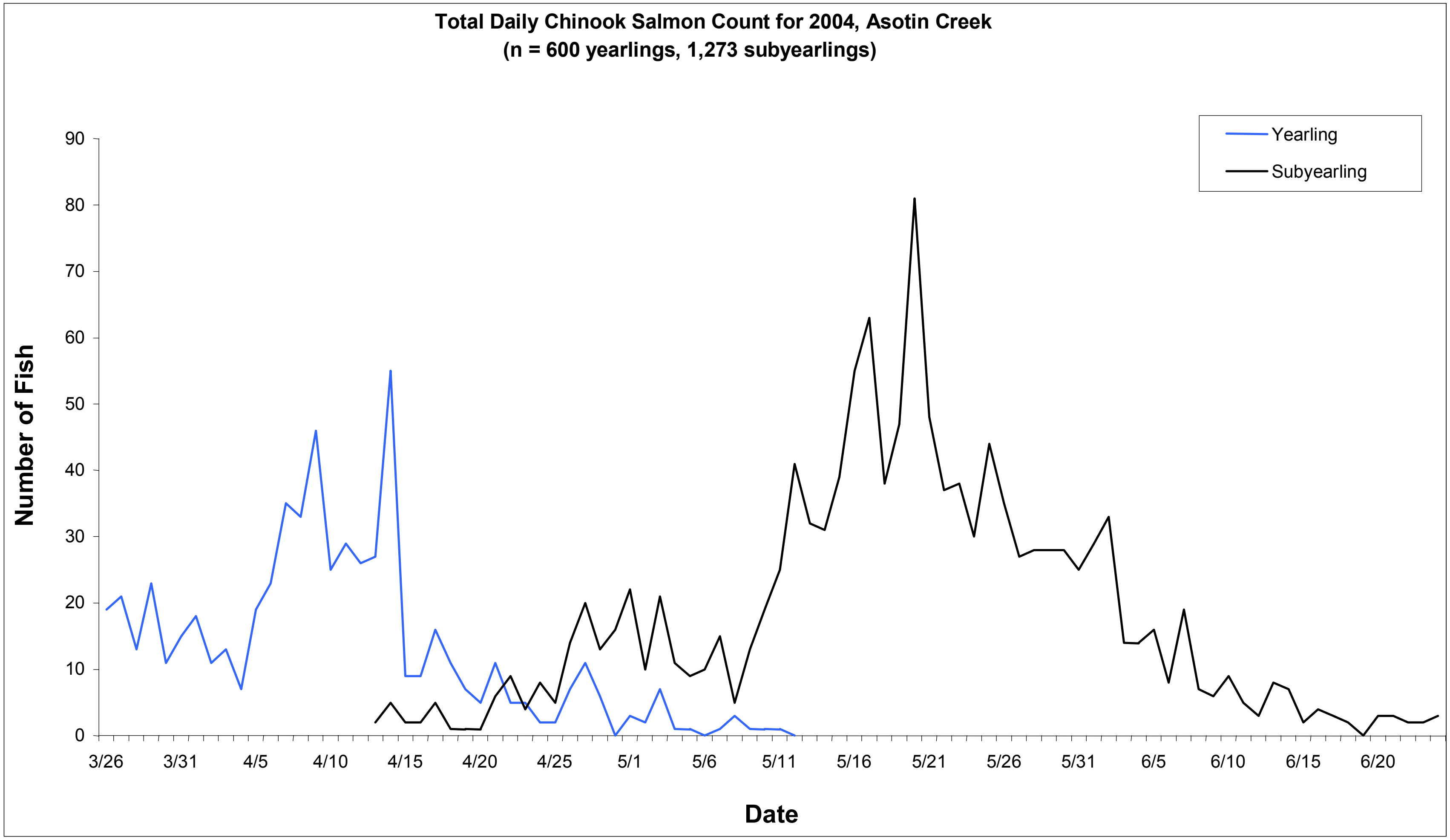

Figure 7. Total Daily Chinook Salmon Count for 2004, Asotin Creek.

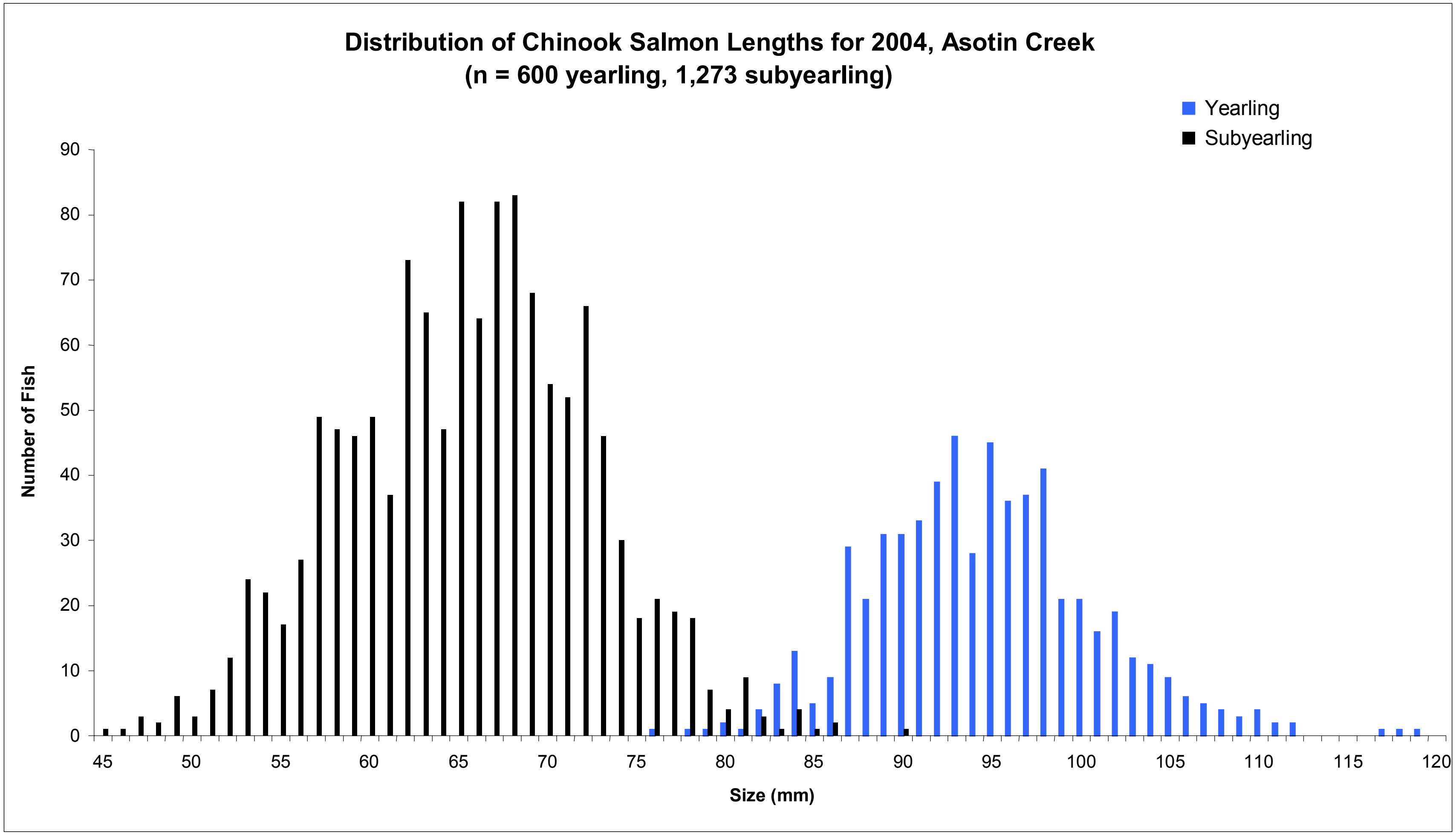

Figure 8. Distribution of Chinook Salmon Lengths for 2004, Asotin Creek.

Summary and Conclusions

Data from the spring 2004 smolt-trapping season provided a new perspective on the classification and emigration patterns of juvenile steelhead in the Asotin Creek subbasin. Substantially more emigrating steelhead parr and transitionally-smolted juveniles were captured than expected, and were represented in a bimodal population that appears to be normally distributed in both modes. In addition, fully-smolted steelhead abundance was unexpectedly low. (Expectation of a higher ratio of emigrating smolts was based on experience with the Tucannon River, where abundant, fully-smolted steelhead are trapped in the spring at WDFW's smolt trap at river km 3.0).

Data from the spring 2004 smolt-trapping season suggests that the Asotin Creek subbasin may be a nursery of the Lower Snake River steelhead ESU. Juvenile steelhead from the subbasin may emigrate from Asotin Creek and complete their rearing phase in the mainstem Snake River or other tributary. However, more information is needed before we can determine if this is a typical life history pattern followed by a significant number of parr from Asotin Creek. There is no way to know what proportion of juvenile steelhead from Asotin Creek historically used this life history strategy (i.e., using Asotin Creek as a nursery and rearing out of the subbasin). Because it appears that a substantial number of juveniles may rear outside of the subbasin, a better understanding this strategy is an important factor in overall survival estimates and management alternatives for the Asotin Creek steelhead population.

For the spring 2005 trapping season, about 20% of the juvenile steelhead will be tagged with passive integrated transponder (PIT) tags, which will allow us to track them as they pass the dams on the Snake and Columbia Rivers. This information will help determine the time between emigration from Asotin Creek and passage over the dams, which should indicate where rearing and early life-stage survival is occurring. In addition, the smolt trap will be moved 6.6 km downstream closer to, but above, George Creek. This location, at road km 6.6, is the closest possible trap site to the confluence with George Creek, thereby maximizing the study area. Relocating the trap from Headgate County Park will also protect it from potential vandalism.

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Summary of Expenditures

Estimated expenditures by Objective:

Objective 1	$66,875
Objective 2	$27,410
Objective 3	$36,930
Unspent	$2,560
Total Budget	$133,775

Major property purchases: Rotary Smolt trap.