Attributes and Performance of Yearling and Subyearling Fall Chinook Salmon *Oncorhynchus tshawytscha* Released from Acclimation Facilities Upstream of Lower Granite Dam

Annual Report
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EXECUTIVE SUMMARY

The Nez Perce Tribe, in partnership with the U.S. Fish and Wildlife Service and Washington Department of Fish and Wildlife, conducted monitoring and evaluation studies on Lyons Ferry Hatchery reared yearling and subyearling fall Chinook salmon *Oncorhynchus tshawytscha* that were acclimated and released at three Fall Chinook Acclimation Project (FCAP) sites upstream of Lower Granite Dam in 2005. This was the tenth year of a long-term project to supplement the natural spawning population of Snake River fall Chinook salmon upstream of Lower Granite Dam. Due to a shortage of yearlings transferred from Lyons Ferry Hatchery, releases from the Fall Chinook Acclimation Project facilities were short of the 450,000 fish target. Release numbers were 150,706 from Pittsburg Landing and 139,509 from Big Canyon totaling 290,215. The Captain John Rapids facility did not receive any yearlings. In addition, a total of 1,413,017 subyearlings were released from the three acclimation facilities. We use Passive Integrated Transponder (PIT) tag technology to monitor key performance measures of survival to mainstem dams and migration timing as well as coded wire tags to monitor smolt-to-adult return rates and adult abundance at Lower Granite Dam. We also monitor size, condition and tag/mark retention at release.

We marked and released 4,997 PIT tagged yearlings from Pittsburg Landing, 4,988 from Big Canyon, and zero from Captain John Rapids. We marked and released 2,492 PIT tagged subyearlings from Pittsburg Landing, 2,498 from Big Canyon, and 3,494 from Captain John Rapids. Fish health sampling indicated that, on the whole, bacterial kidney disease levels in all yearling and subyearling groups were considered low with 96-100% rating low to not detected.

Mean fork lengths (95% confidence interval) of the PIT tagged yearling groups were 157.0 mm (156.3-157.7 mm) at Pittsburg Landing and 156.0 mm (155.5-156.5 mm) at Big Canyon. Mean yearling condition factors were 1.14 at Pittsburg Landing and 1.10 at Big Canyon. Mean fork lengths (95% confidence interval) of the subyearling groups at release were 85.9 mm (85.6-86.2 mm) at Pittsburg Landing, 90.3 mm (90.0-90.6 mm) at Big Canyon and 86.7 mm (86.4-87.0 mm) at Captain John Rapids. Mean subyearling condition factors were 1.14 at Pittsburg Landing, 1.10 at Big Canyon and 1.10 at Captain John Rapids.

Estimated survival (95% confidence interval) of PIT tagged yearlings from release to Lower Granite Dam was 86.7% (85.4-87.9%) for Pittsburg Landing and 82.0% (80.6-83.4%) for Big Canyon. Estimated survival from release to McNary Dam was 67.3% (61.1-73.6%) for Pittsburg Landing and 56.3% (50.8-61.8%) for Big Canyon. The estimated joint probability of survival and emigration (95% confidence interval) of PIT tagged subyearlings from release to Lower Granite Dam was 81.1% (78.4-83.8%) for Pittsburg Landing, 68.9% (64.7-73.1%) for Big Canyon and 84.6% (81.8-87.5%) for Captain John Rapids. The estimated joint probability of survival and emigration from release to McNary Dam was 49.3% (41.9-56.7%) for Pittsburg Landing, 56.7% (37.4-76.0%) for Big Canyon and 51.3% (43.0-59.7%) for Captain John Rapids.

Median migration rates to Lower Granite Dam, based on all observations of PIT tagged yearlings, were 15.6 river kilometers per day (rkm/d) for Pittsburg Landing and 7.2 rkm/d for Big Canyon. Median migration rates to McNary Dam were 15.0 rkm/d for Pittsburg Landing and 9.5 rkm/d for Big Canyon. Median yearling travel times from the FCAP facilities were

about 11-15 days to Lower Granite Dam and 26-35 days to McNary Dam. Median migration rates to Lower Granite Dam, based on all observations of PIT tagged subyearlings, were 31.0 rkm/d for Pittsburg Landing and 20.2 rkm/d for Big Canyon. Median migration rates to McNary Dam were 20.7 rkm/d for Pittsburg Landing and 15.2 rkm/d for Big Canyon. Median subyearling travel times from the FCAP facilities were about 5-9 days to Lower Granite Dam and 19-26 days to McNary Dam.

Median arrival dates at Lower Granite Dam, based on all observations of PIT tagged yearlings, were April 25 for Pittsburg Landing and April 20 for Big Canyon. Median arrival dates at McNary Dam were May 10 for both Pittsburg Landing and Big Canyon. Median arrival dates at Lower Granite Dam, based on all observations of PIT tagged subyearlings, were June 1 for Pittsburg Landing and June 9 for Big Canyon. Median arrival dates at McNary Dam were June 14 for Pittsburg Landing and June 26 for Big Canyon.

ACKNOWLEDGEMENTS

We would like to thank the Washington Department of Fish and Wildlife which provided the fish from the Lyons Ferry Hatchery Complex. A special thanks to the Snake River Laboratory and the U.S. Fish and Wildlife Service – Idaho Fishery Resource Office for their cooperation and assistance. Bonneville Power Administration for the funding and administrative support, particularly Deborah Docherty, our Contracting Officer's Technical Representative.

Thanks to the Nez Perce Tribe Department of Fisheries Resources Management research and production divisions for sharing personnel and equipment necessary to carry out this project.

We would like to extend our appreciation to the Nez Perce Tribe personnel whose coordination efforts and assistance in the field make this project successful: Bruce McLeod, Dale Kellar, Mark Pishl, Bill Arnsberg, Mike Key, Scott Everett, Brenda Axtell, Arnold Henry, Austin Samuels, Lou Ann Laswell, Charles Axtell, and Raphael Johnnie.

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INTRODUCTION

Historically, the Snake River basin represented a significant portion of the fall Chinook salmon *Oncorhynchus tshawytscha* production in the Columbia River system. However, construction of the Lewiston Dam in 1927 nearly eliminated Chinook salmon from the Clearwater River subbasin (CBFWA 1990; Fulton 1968) and construction of the Hell's Canyon complex of dams on the Snake River blocked salmon migration to the upper Snake River basin. Fall Chinook salmon escapement to the Snake River basin was estimated to exceed 500,000 fish pre-1940's, average 72,000 adults annually from 1939-1949, and further declining to an average of 29,000 adults from 1950-1959 (Bjornn and Horner 1980). Even as recently as 1968, fall Chinook salmon counts at Ice Harbor Dam were about 20,000 fish. Since Lower Granite Dam was constructed on the Snake River in 1975, adult fall Chinook salmon counts decreased to an average of 600 fish between 1975 and 1980. Natural-origin fall Chinook salmon returns fell to a low of 78 in 1990, then increased to 318 in 1991, 533 in 1992 (WDF 1993) and 742 in 1993 (WDF 1994). Counts declined again in 1994 and 1995 to 406 and 350, respectively. Since 1995 there has been an upward trend in the number of fall Chinook salmon adults counted at Lower Granite Dam. The National Marine Fisheries Service (NMFS) listed Snake River fall Chinook salmon as "threatened" in 1992 in accordance with provisions of the Endangered Species Act (NMFS 1992). The status was reclassified as "endangered" under emergency action in 1994 and restored to "threatened" in 1995.

In 1994, through *U.S. v. Oregon*, the Nez Perce Tribe reached an agreement with States and Federal agencies to release yearling fall Chinook salmon beginning in 1996 as replacement of lost production from adults trapped at Lower Granite Dam and hauled to Lyons Ferry Hatchery (LFH) for broodstock needs and to cull non-Snake River Basin strays. The agreement stipulated the release of 450,000 yearlings annually on-station from LFH and outplanting of an additional 450,000 to acclimation facilities upstream of Lower Granite Dam to supplement natural fall Chinook salmon production. The Nez Perce Tribe (NPT) operates the Fall Chinook Acclimation Project (FCAP), which consists of three juvenile acclimation facilities along the Snake and Clearwater rivers with the intent of effectively enhancing population size and distributing natural fall Chinook salmon spawning throughout the existing habitat areas above Lower Granite Dam. The FCAP facilities began operation at Pittsburg Landing (PL) on the Snake River in 1996, Big Canyon Creek (BC) on the Clearwater River in 1997 and at Captain John Rapids (CJ) on the Snake River in 1998. In addition, due to sufficient broodstock levels at LFH, subyearling fall Chinook salmon have been available for release from the FCAP facilities since 1997.

The Nez Perce Tribe, in cooperation with the Washington Department of Fish and Wildlife (WDFW) and U.S. Fish and Wildlife Service (USFWS), conducted monitoring and evaluation studies on yearling and subyearling fall Chinook salmon that were acclimated and released from the FCAP facilities in 2005. This was the tenth year of a long-term project to monitor and evaluate the success of efforts to supplement natural spawning populations of fall Chinook salmon upstream of Lower Granite Dam.

The objective of this project in the fall Chinook salmon supplementation program is to monitor and evaluate pre- and post-release performance of yearling and subyearling fall Chinook salmon from the FCAP facilities. We estimate pre-release size, condition, and post-release emigration

characteristics and survival through the Federal Columbia River Power System using passive integrated transponder (PIT) tagging. In this report, we present a summary of the activities and data collection in 2005. In addition, we are part of a multi-agency effort to conduct fall Chinook salmon spawning ground surveys in the Snake River basin above Lower Granite Dam. Our role consists of conducting aerial spawning ground surveys in the Grande Ronde, Imnaha and Salmon rivers. The results of these surveys have been published by the USFWS under Bonneville Power Administration (BPA) project number 199801003 and are accessible on the BPA website at http://www.efw.bpa.gov/searchpublications/. For detailed discussion of monitoring and evaluation activities, procedures and analyses for on-station yearling fall Chinook salmon releases from LFH in 2001-2002 please see Milks et al. (2005) at the WDFW website: http://wdfw.wa.gov/fish/papers/se_wash_reports/lyonsferry_fallchinook01-02.html.
Annual report detailing LFH activities for 2003-2004 can be obtained at:
http://wdfw.wa.gov/fish/papers/se_wash_reports/lyonsferry_fallchinook03-04.html.
The 2005 activity results can be found at:
http://wdfw.wa.gov/fish/papers/se_wash_reports/lyonsferry_fallchinook05.html.

PROJECT OBJECTIVES

The objectives of this project are to quantify and evaluate pre-release fish health, condition and mark retention as well as post-release survival, migration timing, migration rates, travel times and movement patterns of juvenile fall Chinook salmon from supplementation releases at the FCAP facilities, then provide feedback to co-managers for project specific and basin wide management decision-making.

METHODS

Study Area Description

The FCAP facilities are located on the Snake River at Pittsburg Landing (rkm 346) and Captain John Rapids (rkm 263) and on the Clearwater River at Big Canyon Creek (rkm 57) (Figure 1). Lyons Ferry Hatchery is located at rkm 95 on the Snake River. Our study area continues downstream from the FCAP facilities to Bonneville Dam (rkm 234) on the Columbia River.

Fish Handling and Anesthetization

Yearlings at Pittsburg Landing and Big Canyon were acclimated in 16 tanks (6 m diameter) and released in stages over three consecutive days. No yearlings were transferred to the Captain John Rapids facility. Traditionally, yearlings at Captain John Rapids are acclimated in a single in-ground 150’X 50’ acclimation pond and released volitionally with any fish remaining by the final release date forced out by draining the pond.

Fish sampled for PIT tagging were captured with dip nets from tanks 7 and 9 at Pittsburg Landing and tanks 8 and 9 at Big Canyon. Subyearlings sampled for PIT tagging were captured with dip nets from tank 9 at both Pittsburg Landing and Big Canyon. A screen was used to crowd fish in the tanks to improve capture efficiency and to obtain a representative subsample. Subyearlings at Captain John Rapids were captured using a cast-net. Fish captured for PIT tagging were anesthetized in an MS-222 bath consisting of 3 mL stock solution (100 g/L) per 8 L of water buffered with sodium bicarbonate solution. PIT tagging at the FCAP facilities took place about one week prior to release. For a detailed description of typical fall Chinook salmon broodstock collection, incubation, rearing, and marking procedures at LFH please reference Milks et al. (2005).

Fish Health

To monitor fish health, USFWS personnel from the Idaho Fish Health Center sampled yearlings and subyearlings at the FCAP facilities and LFH approximately one week prior to release. The sample size goal was 60 fish from each release group. Enzyme-linked immunosorbent assays (ELISA) were performed following methods as described in Chapter 6 of the U.S. Fish and Wildlife Service National Wild Fish Health Survey Laboratory Procedure Manual (True 2001, 2004) to determine the level of Bacterial Kidney Disease (BKD), *Renibacterium salmoninarum,* antigen in each of the fish. Infections levels were categorized as not detected, low, medium or high.

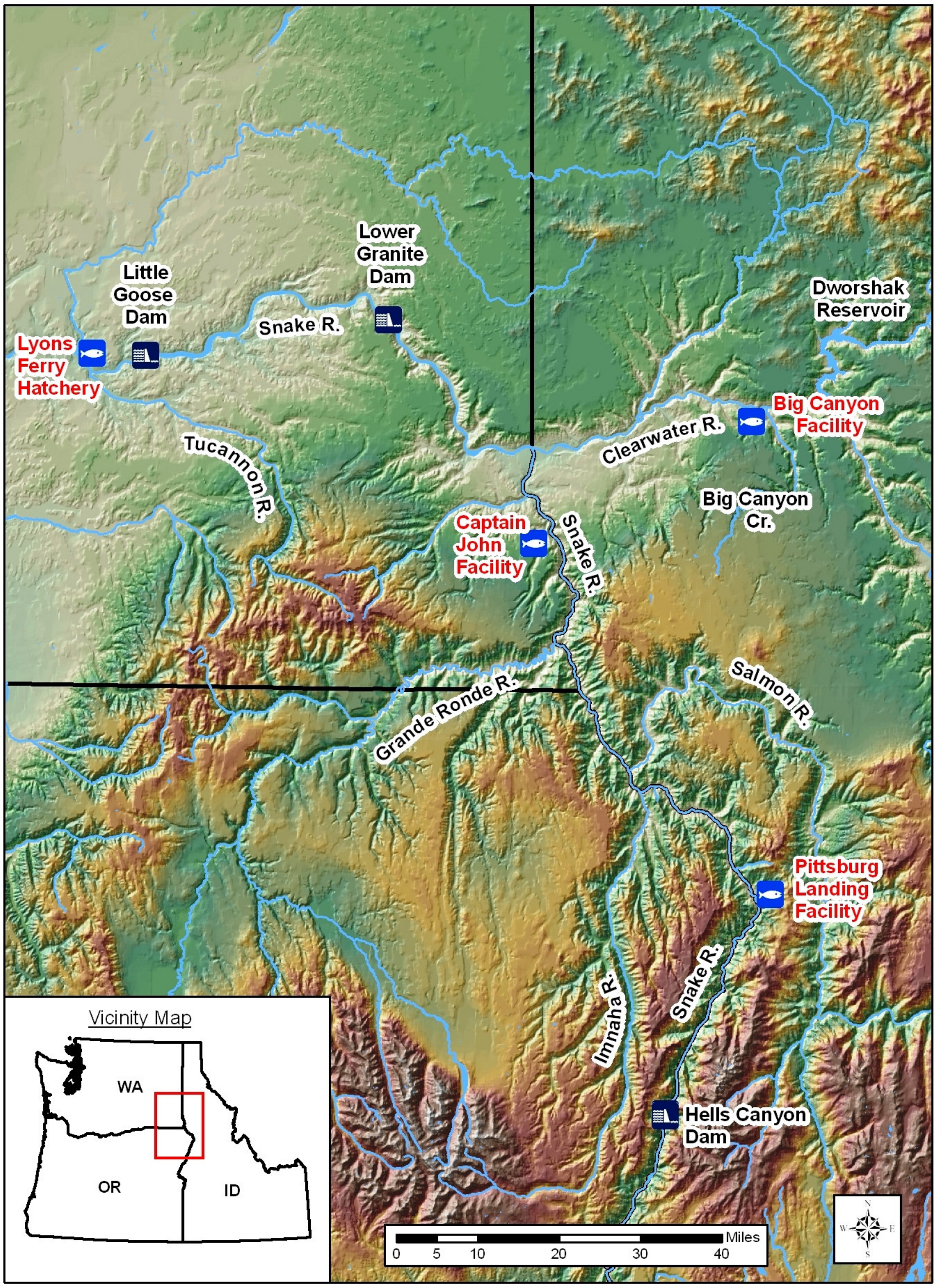

Figure 1.—Map of primary study area highlighting FCAP facilities, Lyons Ferry Hatchery and various Snake River dams.

Flow and Temperature

Flow data for the Clearwater River at Peck (Station 13341050), Snake River near Hell's Canyon Dam (Station 13290450) and Snake River at Anatone (Station 13334300) were obtained online from the U.S. Geological Survey (USGS) at http://waterdata.usgs.gov/nwis/nwis. River temperature data for these sites (except for Hell's Canyon Dam where continuous temperature is not monitored) were obtained from the USGS Water Resources Division in Boise, Idaho. It is important to note that flows measured at the Snake River gauge near Hell's Canyon Dam are controlled and more reflective of dam operations within the Hell's Canyon complex of dams rather than indicative of actual flow contribution from the Snake River basin above Hell's Canyon. Flow, spill and temperature data for the Snake River at Lower Granite Dam and the Columbia River at McNary Dam were provided by the U.S. Army Corps of Engineers (USACE) and obtained online from Columbia River DART at http://www.cqs.washington.edu/dart. There are gaps in some of the flow and temperature data, which are reflected in the figures as missing (or blank) segments.

We used the Pearson product moment correlation coefficient ($\alpha = 0.05$) to examine the relationship between yearling migration rates to Lower Granite Dam with flows at Hell's Canyon Dam and flows and temperatures at Anatone and Peck.

PIT Tagging

Our yearling PIT tagging goal was 5,000 at each FCAP facility. Our subyearling PIT tagging goal was 2,500 at each Pittsburg Landing and Big Canyon and 3,500 at Captain John Rapids. NPT personnel conducted PIT tagging at all FCAP facilities. All PIT tagged fish had the default passage route designation of "return-to-river" for all dam collection and bypass facilities.

All fish selected for tagging were examined for existing PIT tags with a subsample examined for presence of coded wire tag (CWT). The fish were then PIT tagged, measured and examined for general condition, with a subsample weighed and examined for adipose fin (AD) clip. All tag, length, weight, mark retention and general condition data were recorded using a computerized data collection station manufactured by Biomark Inc. (Boise, Idaho). PIT tags were injected into the abdomen using manual hypodermic injectors following the general methods described by Prentice et al. (1986, 1990) and Matthews et al. (1990, 1992). Hypodermic injectors and PIT tags were sterilized in ethanol for at least ten minutes and allowed to dry prior to each usage. Tagging data were proofed for mistakes, validated for format compliance and uploaded to the Pacific States Marine Fisheries Commission (PSMFC) PIT Tag Information System (PTAGIS) database.

Biological Characteristics

Fork lengths and weights of yearlings and subyearlings were collected during PIT tagging. Fork lengths and weights of subyearlings were also collected at time of release. Approximately 100 subyearlings were sampled from each tank prior to release. Fork lengths were measured to the nearest 1.0 mm using a CalComp 2000 digitized measuring board. The lengths were then categorized into 5 mm increment groups to calculate the frequency distributions. Weights were collected to the nearest 0.1 g using an Ohaus FY-3000 balance. Fulton's condition factor was calculated by

$$K = (\text{Weight (g)}/\text{Length (mm)}^3) \times 10^5$$

and categorized into increments of 0.05 for frequency distributions (Murphy and Willis 1996).

We used a One-way ANOVA to test the hypotheses: there is no difference in fork length and there is no difference in condition factor between release sites. We then used Tukey's HSD for multiple comparisons. In addition, we used a Kolmogorov-Smirnov two-sample test to test the hypotheses: there is no difference in fork length distribution and there is no difference in condition factor distribution between release sites. Differences were considered significant at $\alpha = 0.05$.

Mark Retention

The marking strategy for yearlings at each FCAP facility is 80,000 fish with CWT and 70,000 fish with CWT plus AD clip. The marking strategy for subyearlings at Pittsburg Landing was 200,000 fish with CWT plus AD clip and 200,000 fish with AD clip only. The marking strategy for subyearlings at Big Canyon and Captain John Rapids was 100,000 fish with CWT, 100,000 fish with CWT plus AD clip and 300,000 fish unmarked. All yearlings and subyearlings at the FCAP facilities and LFH, except Pittsburg Landing subyearlings, were marked at LFH by WDFW personnel. Subyearlings at Pittsburg Landing were marked by ODFW personnel at Umatilla Hatchery. We sampled for CWT at least 30 days after tagging using a Northwest Marine Technologies field sampling detector model FSD-I. We visually determined retention of AD clips. The probability of observing a fish marked with CWT plus AD clip that actually had neither of these marks was calculated by

$$p_0 = p_1 * p_2$$

where p_0 is the proportion of fish expected to have no marks and p_1 and p_2 are the proportions of fish without CWT and AD clip, respectively.

Survival Estimation

Survival probabilities of PIT tagged yearlings and subyearlings from point of release to the Lower Snake River dams were estimated by the Cormack, Jolly, and Seber (1964, 1965, and 1965, respectively, as cited in Smith et al. 1994) methodology using the Survival Under Proportional Hazards (SURPH, version 2.2a) computer modeling program (Lady et al. 2002) as described in Statistical Survival Analysis of Fish and Wildlife Tagging Studies (Smith et. al. 1994). Given the potential for subyearlings to exhibit prolonged rearing and emigration during periods when PIT tag detection systems at mainstem dams are not operational, we present survival estimates as the combined probability of survival and emigration as a subyearling. We used a Z-test to test the hypotheses: there is no difference in survival to Lower Granite Dam and there is no difference in survival to McNary Dam between release sites. Differences were considered significant at $\alpha = 0.05$.

PIT Tag Observation

The six main PIT tag observation (also called detection or interrogation) locations in the study area are Lower Granite (LGR), Little Goose (LGO), Lower Monumental (LMO), McNary (MCN), John Day (JDA) and Bonneville (BON) dams. PIT tag observation data were downloaded from the PTAGIS database. Arrival timing dates, cumulative observations, survival estimates, travel times in days and migration rates in river kilometers per day (rkm/d) to the main observation sites were calculated from these data. Travel times and migration rates for releases from Captain John Rapids were not calculated because a volitional release strategy is employed and the lack of a PIT tag monitoring system at the facility release pipe precludes identifying the precise time a given fish left the facility. Fish with single coil detections or negative travel times were removed from analyses where applicable.

PIT tag observations used for travel times, migration rates and arrival timing were compiled using two methods. Observations were analyzed by first detection only of individual fish regardless of location (hereafter referred to as first obs) and by detections of all individual fish at each dam regardless of detection history at previous dams (hereafter referred to as all obs). Under the first obs method, a fish that is detected at Lower Granite Dam and then again at Little Goose (or any other) Dam will only be included as an observation at Lower Granite Dam and excluded from the observation record at all other dams. Under the all obs method, a fish that is detected at multiple dams will be included in the observation record at each dam where it is detected. It is important to note that, by definition, all observations of FCAP fish at Lower Granite Dam are first observations and therefore both data sets are identical so all analyses are redundant and presented only once.

There are advantages to both methods. The first obs method excludes fish that pass a given dam through the collection and bypass facility from analyses at all other downstream dams where it was observed. Using the first obs method, data collected at each dam are essentially being recorded for completely different groups of fish with no single fish being recorded at more than one dam. This method provides a measure of “in-river” specific migration to the given observation location as these fish have passed previous dams though routes other than the collection and bypass facility (i.e. stayed in the river), thus effectively removing passage through the collection and bypass facility of any dam as a factor from the travel time, migration rate and arrival date calculations.

The all obs method can be considered a “return-to-river” method providing comprehensive detection data for all yearlings at a given dam regardless of how many previous dam collection and bypass facilities they have passed through. Non-PIT tagged fish that enter the collection and bypass facilities of dams are typically loaded to barges and transported for release below Bonneville Dam rather than diverted back to the river, which is the default action for PIT tagged fish. Consequently, the all obs method should not be considered representative of travel times, migration rates and arrival dates for non-PIT tagged fish to dams downstream of Lower Granite, but rather only for those fish that are diverted back to the river for any reason. By including all fish observed at each dam, this method affords a different level of comparability because the observation data at one dam includes some of the same fish as observation data from other dams, providing a more comprehensive assessment of the overall release of PIT tagged fish by including all dam passage routes including the collection and bypass facilities. Estimating the effect on passage rate of non-PIT tagged fish that enter the collection and bypass facilities but get diverted back to the river for various reasons can be useful for management of dam operations. This provides some measure of effects of prior collection and bypass at upstream dams on migration rates and arrival dates at subsequent dams downstream, but not a complete segregation from the "in-river" segment. Therefore, any differences seen in results between first obs and all obs should be considered minimum differences.

The primary differences in river reaches between PIT tag observation sites are the distance and river characteristics from acclimation facility sites (Table 1). The approximate length of free-flowing river from Pittsburg Landing, Big Canyon and Captain John Rapids to the upstream end of Lower Granite pool is 112, 50 and 29 rkm, respectively. The reaches from Lower Monumental Dam to McNary Dam and John Day Dam to Bonneville Dam include two reservoirs between observation sites (Ice Harbor and The Dalles, respectively), which should be kept in mind when considering analyses through these reaches.

We used a Kolmogorov-Smirnov two-Sample Test to test the hypotheses: there is no difference in travel time distribution and there is no difference in arrival date distribution between release sites. We used a One-way ANOVA to test the hypothesis: there is no difference in migration rate to Lower Granite, McNary and Bonneville dams between release sites. We then used Tukey's HSD for multiple comparisons. Differences were considered significant at $\alpha = 0.05$.

Table 1.—Important sites in the study area and associated river kilometers[1].

Location	RKM
Bonneville Dam	234
John Day Dam	347
McNary Dam	470
Columbia/Snake River Confluence	522
Ice Harbor Dam	522.16
Lower Monumental Dam	522.67
Lyons Ferry Hatchery	522.95
Little Goose Dam	522.113
Lower Granite Dam	522.173
Snake/Clearwater River Confluence	522.224
Big Canyon Acclimation Facility	522.224.57
Captain John Rapids Acclimation Facility	522.263
Pittsburg Landing Acclimation Facility	522.346

[1]Kilometers for individual rivers are separated by periods. For Pittsburg Landing, the notation is: From the mouth of the Columbia River upstream 522 km to the mouth of the Snake River, then from the mouth of the Snake River upstream 346 km to Pittsburg Landing.

RESULTS AND DISCUSSION

Fish at Pittsburg Landing and Big Canyon were acclimated in 16 tanks (6 m diameter) and released in stages over two consecutive days. Fish at Captain John Rapids were acclimated in an earthen pond and released volitionally over about one week with any remaining fish forced out at the end of that time. Reports with detailed descriptions of FCAP facilities and operations for projects 199801005 and 199801008 (Pittsburg Landing and Big Canyon, respectively) are accessible on the BPA website at http://www.efw.bpa.gov/searchpublications/.

A total of 150,706 yearlings were released from Pittsburg Landing and 139,509 yearlings from Big Canyon. As a result of a fish shortage at LFH, no yearlings were transferred to the Captain John Rapids facility. Pittsburg Landing was released beginning April 13-14 and Big Canyon from April 4-5. The total FCAP yearling release number of 290,215 fell considerably short of the release allocation of 450,000 yearlings.

A total of 397,704 subyearlings were released from Pittsburg Landing, 510,226 from Big Canyon and 505,087 from Captain John Rapids. Pittsburg Landing was released beginning May 25-26 and Big Canyon from May 30-31. The subyearlings from Captain John Rapids were volitionally released starting on May 28 with any remaining fish forced out on May 31. The total FCAP subyearling release number of 1,413,017 met the program goal.

Fish Health

Hematocrits were taken from 20 fish from each pre-release group. All groups had hematocrit values within the normal range. BKD levels were relatively low in 2005. There were no clinical signs of BKD in any group of fish, yearling or sub-yearling. Descaling and loss of parr marks was evident in all 3 yearling sampling sites.

Individual ELISA assays were run on the yearling groups. The sub-yearlings were pooled because of the small fish size. ELISA values were fairly consistent between all groups in the yearling group at the acclimation sites and in the group held at Lyons Ferry (Table 2). The yearlings groups all had most of their levels in the not detected to low ranges. Sub-yearlings were basically low and below in their ranges.

Infectious Hematopoietic Necrosis Virus (IHNV) was isolated in the pre-release exam on the Big Canyon yearlings and sub-yearlings. There was an increased amount of IHNV throughout the basin this year so this in not a surprise. No mortality was noted as a result of this infection. No other viruses in any other group were detected and no M. cerebralis (sampled only from the LF group) was detected.

Table 2.—Number of yearling and subyearling fall Chinook salmon (with % of number sampled) in each ELISA level category at the FCAP facilities and LFH in 2005.

				ELISA			
Location	Age	Date	*n*	Not Detected	Low	Medium	High
Pittsburg Landing	1+	4/6	55	38 (69%)	15 (27%)	2 (4%)	0 (0%)
Pittsburg Landing	0+	5/20	30	30 (100%)	0 (0%)	0 (0%)	0 (0%)
Big Canyon	1+	3/28	51	43 (84%)	8 (16%)	0 (0%)	0 (0%)
Big Canyon	0+	5/24	12	8 (67%)	4 (33%)	0 (0%)	0 (0%)
Captain John Rapids	0+	5/17	30	19 (63%)	11 (37%)	0 (0%)	0 (0%)
Lyons Ferry Hatchery	1+	3/29	57	51 (89%)	6 (11%)	0 (0%)	0 (0%)
Lyons Ferry Hatchery	0+	5/25	30	28 (93%)	2 (7%)	0 (0%)	0 (0%)

Flow and Temperature

Generally, 2005 was a lower than average water year. Flows in the Snake and Clearwater Rivers were lower than the historical averages throughout most of the year.

The average flow in the Snake River near Hell's Canyon Dam in April was about 56% below the 39-year average from 1966 to 2004. Overall, flows generally fluctuated regularly between about 9,000-20,000 cfs (Figure 2), except for one spike in mid-May that peaked at 40,000 cfs. Spring flow patterns in 2005 did not resemble the historical hydrograph. Flow patterns at the Hell's Canyon gauge location are essentially dictated entirely by operations at Hell's Canyon Dam.

The daily average discharge in the Snake River at Anatone is significantly higher than the discharge at Hell's Canyon Dam due to input from the Salmon, Imnaha and Grande Ronde Rivers. Flows in the Snake River at Anatone in April were about 45% below the 46-year average from 1959 to 2004 (Figure 3). Flows at Anatone peaked at 98,900 cfs on May 21. The daily mean water temperature from April 15 through May 15 ranged from 8.2^{O} to 13.0^{O} C with an overall mean of 11.1^{O} C.

The average daily discharge in the Clearwater River at Peck in April was approximately 27% below the 40-year average from 1965 to 2004, peaking at 45,700 cfs on May 17 (Figure 4). The higher than normal flows seen at Peck in July and August were due to water releases from Dworshak Reservoir on the North Fork.

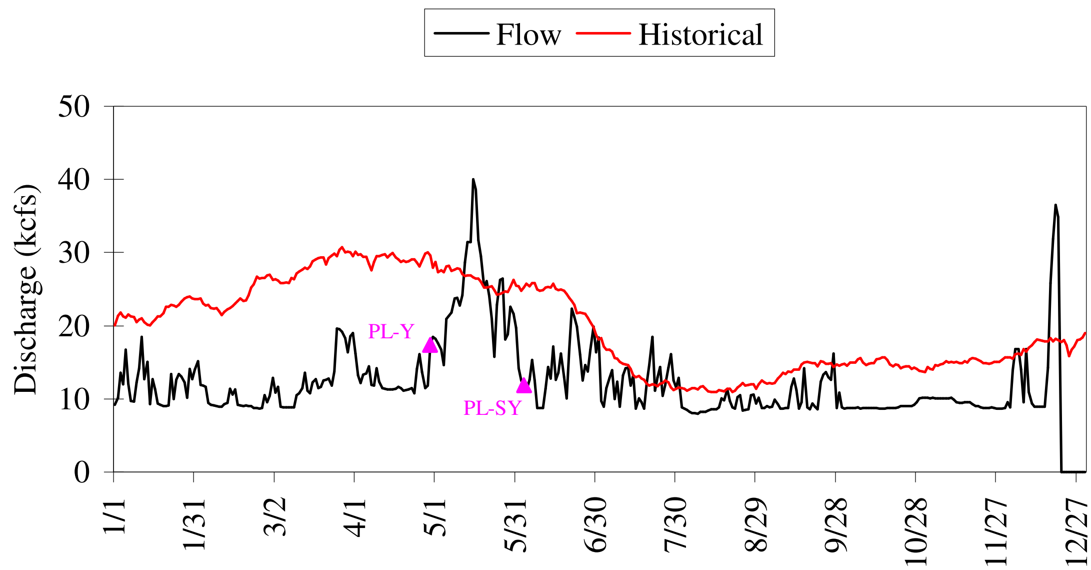

Figure 2.— Pittsburg Landing yearling and subyearling 90% arrival timing at Lower Granite Dam in relation to mean daily flow in 2005 and historical mean flow from 1966-2004 for the Snake River as measured at USGS Station 13290450 near Hell's Canyon Dam. (PL = Pittsburg Landing, Y = Yearling)

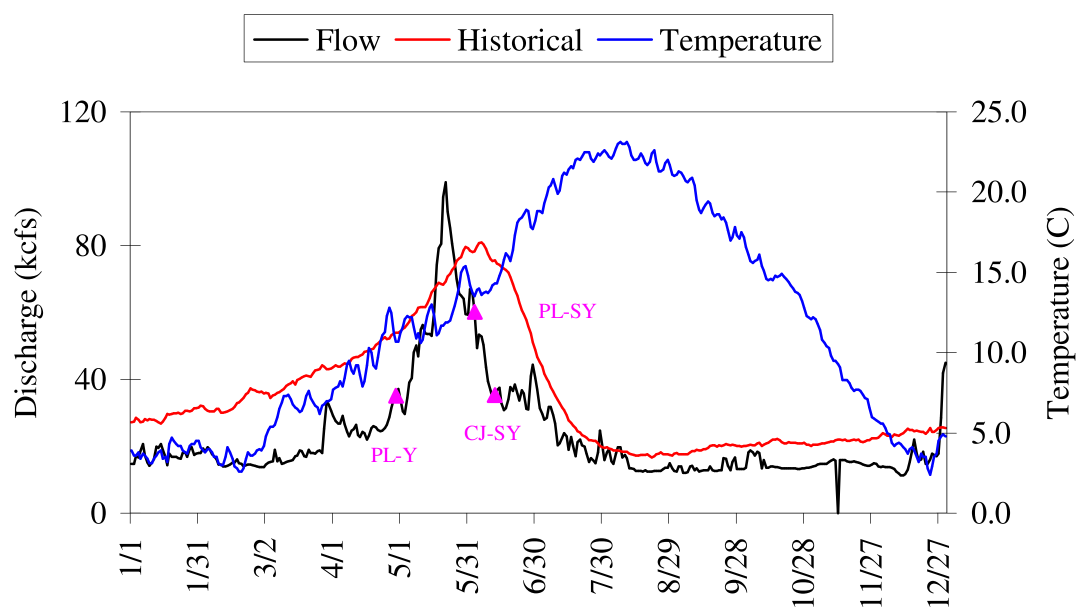

Figure 3.—Pittsburg Landing yearling, and Pittsburg Landing and Captain John Rapids subyearling 90% arrival timing at Lower Granite Dam in relation to mean daily flow and temperature in 2005 and historical mean flow from 1959-2004 for the Snake River as measured at USGS Station 13334300 near Anatone, Washington. (PL = Pittsburg Landing, CJ = Captain John Rapids, Y = Yearling, SY = Subyearling)

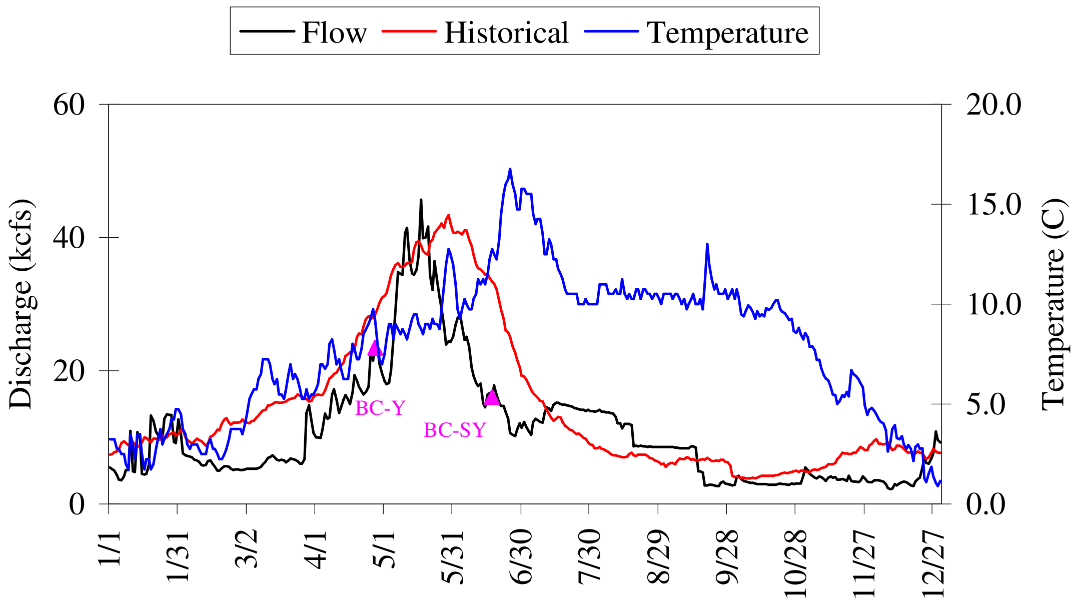

Figure 4.— Big Canyon yearling and subyearling 90% arrival timing at Lower Granite Dam in relation to mean daily flow and temperature in 2005 and historical mean flow from 1965-2004 for the Clearwater River as measured at USGS Station 13341050 near Peck, Idaho. (BC = Big Canyon, Y = Yearling, SY = Subyearling)

Average daily outflow as measured in the tailrace at Lower Granite Dam increased steadily from the beginning of the year until peaking sharply up to 138.0 kcfs on May 21 (Figure 5). The main period of spill was intermittent from April 30 through September 1 with daily spill averaging 14.9 kcfs and peaking at 51.6 kcfs on May 21.

Average daily outflow as measured in the tailrace at McNary Dam averaged about 143.9 kcfs daily until it began increasing with spring runoff in mid May to peak at 290.5 kcfs on May 21 (Figure 6). The main period of spill was from April 1 through September 1 with daily spill averaging 82.7 kcfs and peaking at 175.3 kcfs on July 1. During periods of spill, spill to some extent represented the total outflow pattern.

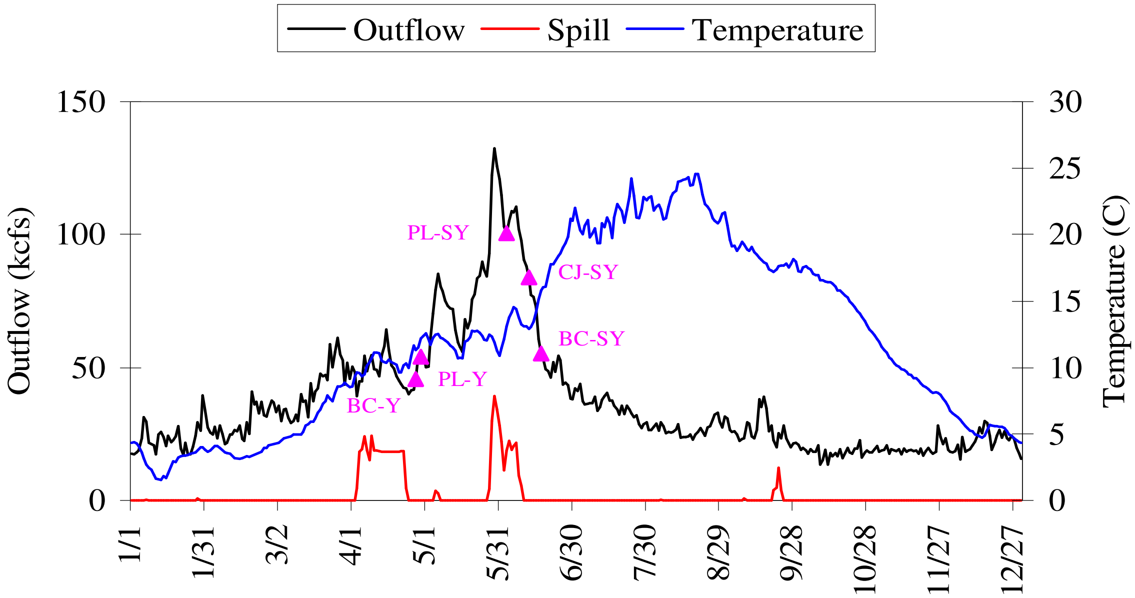

Figure 5.— Pittsburg Landing and Big Canyon yearling, Pittsburg Landing, Captain John Rapids and Big Canyon subyearling 90% arrival timing at Lower Granite Dam in relation to mean daily flow, spill, and temperature for the Snake River in 2005 as measured by the USACE at Lower Granite Dam. (PL = Pittsburg Landing, BC = Big Canyon, CJ = Captain John Rapids, Y = Yearling, SY = Subyearling)

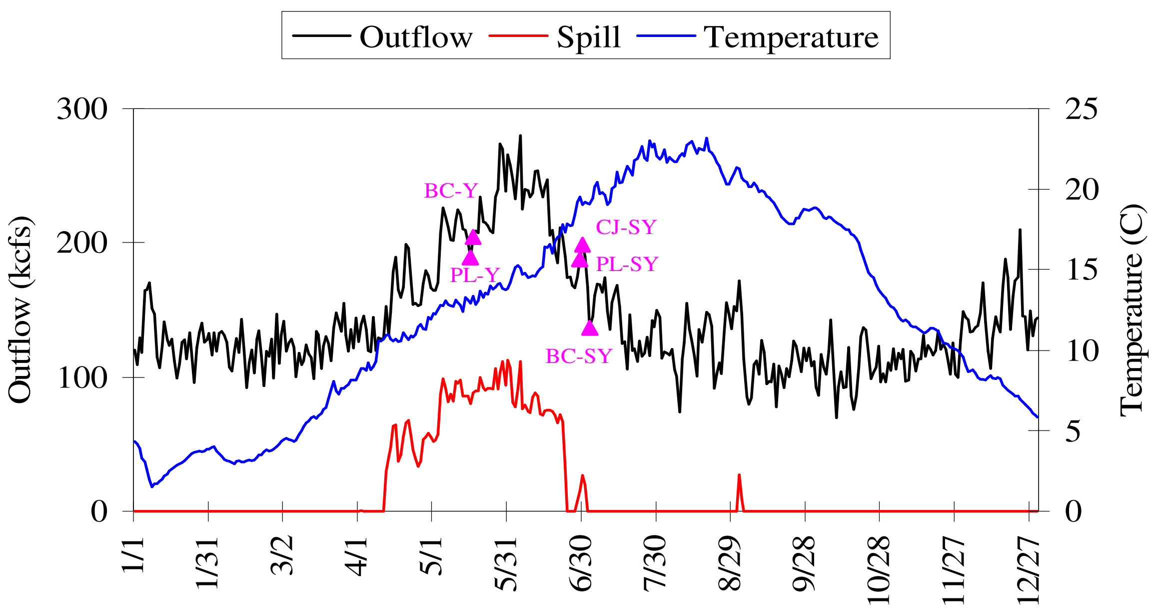

Figure 6.— Pittsburg Landing and Big Canyon yearling, Pittsburg Landing, Captain John Rapids and Big Canyon subyearling 90% arrival timing at McNary Dam in relation to mean daily flow, spill, and temperature for the Columbia River in 2005 as measured by the USACE at McNary Dam. (PL = Pittsburg Landing, BC = Big Canyon, CJ = Captain John Rapids, Y = Yearling, SY = Subyearling)

PIT Tagging

PIT tagging operations occurred without any problems this year. No mechanical or electronic problems were encountered with the equipment and there was no immediate post-tagging mortality. A total of 4,997 and 4,988 yearling fall Chinook salmon were PIT tagged at Pittsburg Landing and Big Canyon, respectively (Table 3). A total of 2,492, 2,498 and 3,494 subyearlings were PIT tagged at Pittsburg Landing, Big Canyon and Captain John Rapids, respectively. See Appendix A for a list of PIT tag files and synopsis of PIT tag observations at Lower Granite, Little Goose, Lower Monumental, McNary, John Day and Bonneville dams.

Table 3.—Number of yearling and subyearling fall Chinook salmon PIT tagged and released from the FCAP facilities in 2005.

Facility	Age	Date Tagged	Number Tagged	Date Released
Pittsburg Landing	1+	4/5	2,499	4/13
		4/6	2,498	4/14
	0+	5/5	2,492	5/26
Big Canyon	1+	3/23	2,493	4/4
		3/24	2,495	4/5
	0+	5/17	2,498	5/31
Captain John Rapids	0+	5/9	1,496	5/28-30
		5/10	1,998	5/28-30

Biological Characteristics

Yearling mean lengths at Pittsburg Landing and Big Canyon were very similar to each other (Table 4). The ANOVA on fork lengths shows a significant between-groups effect ($P = 0.0285$; Appendix B, Table B.1). However, this does not represent a biological difference between the groups. The statistical difference was due to the large sample sizes. Fork length distributions (Figure 7) of yearlings from Pittsburg Landing and Big Canyon also differed significantly ($P < 0.001$; Appendix B, Table B.2).

Subyearling mean lengths at Pittsburg Landing and Captain John Rapids were very similar to each other, while Big Canyon was a bit larger (Table 4). The ANOVA on fork lengths shows a significant between-groups effect ($P < 0.0001$; Appendix B, Table B.1). This does not represent a biological difference between Pittsburg Landing and Captain John Rapids, but the difference in the Big Canyon group may be biologically significant. The statistical difference between Pittsburg Landing and Captain John Rapids was due to the large sample sizes. Fork length

Table 4.—Fork length (mm), weight (g) and condition factor (K) of PIT tagged yearling and subyearling fall Chinook salmon at the FCAP facilities in 2005.

Facility	Age		Number Sampled	Mean	Standard Deviation	95% C.I. (+/- mean)	Median	Range
Pittsburg Landing	1+	Fork Length	1,961	157.0	15.7	0.7	160	79 - 216
		Weight	507	45.6	12.1	1.1	46.7	7.0 - 106.0
		K	507	1.14	0.07	0.01	1.15	0.94 - 1.34
Pittsburg Landing	0+	Fork Length	2,414	85.9	6.7	0.3	86	60 - 110
		Weight	254	7.1	1.6	0.2	7.1	3.3 - 11.4
		K	254	1.14	0.08	0.01	1.15	0.95 - 1.33
Big Canyon	1+	Fork Length	2,101	156.0	11.2	0.5	157	106 - 206
		Weight	501	48.4	11.5	0.9	48.0	13.6 - 165.3
		K	501	1.10	0.06	0.01	1.09	0.87 - 1.35
Big Canyon	0+	Fork Length	2,494	90.3	8.1	0.3	91	61 - 111
		Weight	261	8.3	2.0	0.2	8.2	2.8 - 14.2
		K	261	1.10	0.10	0.01	1.10	0.78 - 1.37
Captain John Rapids	0+	Fork Length	3,492	86.7	9.9	0.3	87	57 - 124
		Weight	372	7.0	2.4	0.2	7.0	2.0 - 14.4
		K	372	1.10	0.09	0.01	1.10	0.84 - 1.31

distributions (Figure 7) of subyearlings from all locations also differed significantly ($P < 0.001$; Appendix B, Table B.2).

The development of differences in fork length distribution between groups is possible for a number of reasons. To start with, the fish are distinctively marked at LFH and must be reared separately afterward. Furthermore, the Captain John Rapids facility is a single permanent pond and the Pittsburg Landing and Big Canyon facilities consist of 16 temporarily constructed aluminum tanks. It is likely that growth rates may differ due to differences in rearing conditions (such as loading densities, exchange rates, etc.), feeding behavior between the facilities, feed distribution efficiency between personnel at each facility. In addition, each FCAP facility uses river water as its source as opposed to the well water source used at LFH. Differences in water temperature could account for the differences in growth rate as well; however this should not cause a change in the length distribution, only the mean length. It is also possible that there was a bias due to sampling methods. The fish at Pittsburg Landing and Big Canyon were crowded in the tanks and captured by dip net while the fish at Captain John Rapids were captured from the pond using a cast net.

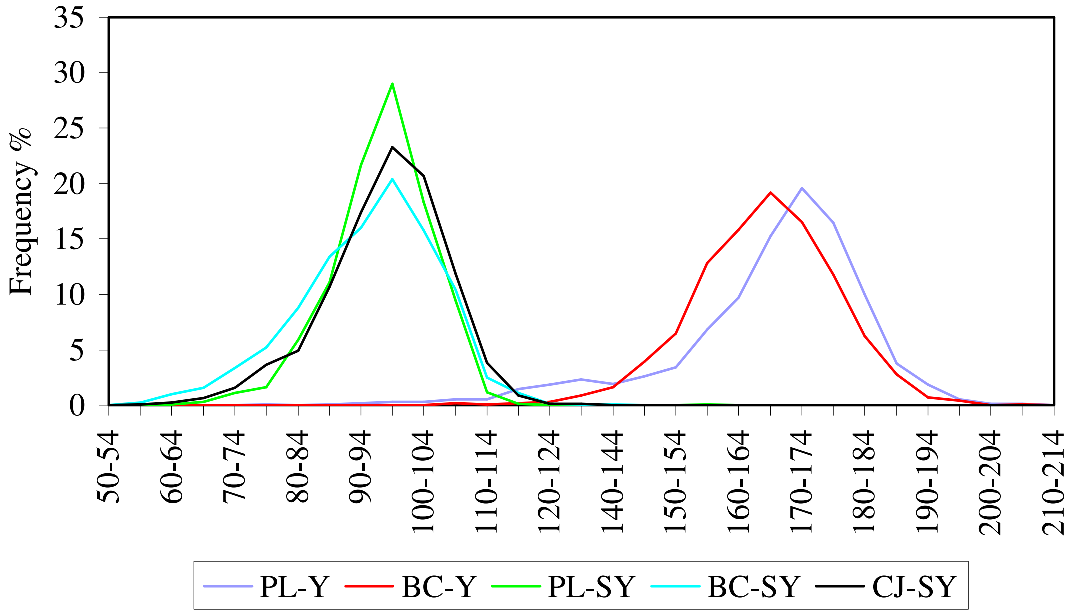

Figure 7.—Fork length frequency of yearling and subyearling fall Chinook salmon at the FCAP facilities and LFH in 2005.

The ANOVA on yearling condition factors also showed a significant difference between Pittsburg Landing and Big Canyon ($P = 0.0394$; Appendix B, Table B.1). However, there was no significant difference in yearling condition factor distributions between Pittsburg Landing and Big Canyon ($P = 0.1138$; Appendix B; Table B.2).

The ANOVA on subyearling condition factors also showed a significant difference between Pittsburg Landing and Big Canyon ($P = 0.0030$; Appendix B, Table B.1). There was also a significant difference in yearling condition factor distributions between all FCAP locations ($P < 0.0001$; Appendix B; Table B.2).

Mark Retention

Marking fish with externally identifiable marks or tags is an important management tool for identification of adults captured at Lower Granite Dam. Quantifying tag and mark retention is important for expanding sample counts during run reconstruction at Lower Granite Dam and from ocean and in-river harvest CWT sampling. Retention of CWTs and adipose fin clips was similar to what we have seen in past years (Rocklage 2004, 2005; Rocklage and Kellar 2005a, 2005b, 2005c, 2005d). In 2005, we discontinued the use of VIE tags because a new adult sampling method was employed at Lower Granite Dam making the need for a visible external mark unnecessary.

Coded wire tag retention ranged from 89.1% for Captain John Rapids subyearlings to 99.6% for Pittsburg Landing subyearlings. Adipose fin clip retention ranged from 99.4% for Pittsburg Landing yearlings to 100% for Pittsburg landing subyearlings (Table 5). A total of 31 yearlings from Pittsburg Landing and 11 yearlings from Big Canyon (0.002% and 0.001% of each release, respectively) were estimated to have been released with no marks. These numbers will be accounted for in the run reconstruction.

Table 5.—Retention of coded wire tags and adipose fin clips in yearling and subyearling fall Chinook salmon at the FCAP facilities and LFH in 2005.

		% Retention				Probability of no	Estimated number with
	Age	*n*	CWT	*n*	AD	marks	no marks
Pittsburg Landing	1+	1,993	96.6	2,380	99.4	0.00020	31
Pittsburg Landing	0+	507	99.6	507	100.0	0.00000	0
Big Canyon	1+	2,076	97.4	2,076	99.6	0.00010	11
Big Canyon	0+	2,000	99.4	500	99.6	0.00003	3
Captain John Rapids	0+	2,063	89.1	0	n/a	n/a	n/a

Survival

The SURPH model analyzes PIT tag detections and provides a point estimate for survival and standard error, from which we calculated 95% confidence intervals for each release group. The primary points to where we estimate survival are Lower Granite and McNary Dams. Estimated survivals (95% confidence interval) from release to Lower Granite Dam were 86.7% (85.4-87.9%) for Pittsburg Landing and 82.0% (80.6-83.4%) for Big Canyon yearlings. Estimated survival from release to McNary Dam was 67.3% (61.1-73.8%) for Pittsburg Landing and 56.3% (50.8-61.8%) for Big Canyon (Table 6) yearlings. Survival estimates between the Pittsburg Landing and Big Canyon groups differed significantly to both Lower Granite ($P < 0.00001$) and McNary ($P < 0.01$) Dams (Table 7).

The estimated joint probability of survival and subyearling emigration (95% confidence interval) from release to Lower Granite Dam were 81.1% (78.4-83.8%) for Pittsburg Landing, 68.9% (64.7-73.1%) for Big Canyon and 84.6% (81.8-87.5%) for Captain John Rapids subyearlings. The estimated joint probability of survival and emigration as a subyearling from release to McNary Dam was 49.3% (41.9-56.7%) for Pittsburg Landing, 56.7% (37.4-76.0%) for Big Canyon and 51.3% (43.0-59.7%) for Captain John Rapids (Table 6) subyearlings. The joint probability of survival and emigration from Pittsburg Landing to Lower Granite Dam differed significantly from Big Canyon (P < 0.0001), but not Captain John Rapids (P = 0.0774). The joint probability of survival and emigration from Big Canyon to Lower Granite Dam differed significantly from Captain John Rapids (P < 0.0001). No significant differences were found between FCAP facilities for survival to McNary Dam (Table 7). See Appendix C for annual yearling and subyearling survival estimates to Lower Granite and McNary dams from 1996-2005.

Table 6.—Estimated survivals and 95% confidence intervals of PIT tagged yearling and estimated joint probability of survival and emigration as a subyearling fall Chinook salmon from the FCAP facilities to Lower Granite and McNary dams in 2005.

Facility	Age	Evaluation Point	Estimated Survival	S.E.	95% C.I.
Pittsburg Landing	1+	Lower Granite	0.867	0.006	0.854 - 0.879
		McNary	0.673	0.032	0.610 - 0.736
Pittsburg Landing	0+	Lower Granite	0.811	0.014	0.784 - 0.838
		McNary	0.493	0.038	0.419 - 0.567
Big Canyon	1+	Lower Granite	0.820	0.007	0.806 - 0.834
		McNary	0.563	0.028	0.508 - 0.618
Big Canyon	0+	Lower Granite	0.689	0.021	0.647 - 0.731
		McNary	0.567	0.099	0.374 - 0.760
Captain John Rapids	0+	Lower Granite	0.846	0.014	0.818 - 0.875
		McNary	0.513	0.043	0.430 - 0.597

Table 7.—Results of the Z-test for pairwise comparisons of SURPH estimates to Lower Granite and McNary dams for yearling fall Chinook salmon PIT tagged at the FCAP facilities in 2005.

To Lower Granite Dam

	BC	CJ
PL	$P < 0.0001$	$P = 0.0774$
BC		$P < 0.0001$

To McNary Dam

	BC	CJ
PL	$P = 0.4848$	$P = 0.7238$
BC		$P = 0.6173$

One issue of concern with estimating survival of subyearling fall Chinook salmon is with those fish that overwinter in the lower Snake and Columbia River reservoirs and complete migration the following spring. Connor et al. (2005) defined these fish as "reservoir-type" life history. They found that the reservoir-type juvenile was more prevalent in Clearwater River fish than in those produced in the Snake River. They hypothesized that this was due to the higher growth rate in the warmer, more productive Snake River relative to the cooler, less productive Clearwater River. From our subyearling PIT tags from 1997-2004, we have found that at least 0.1-2.7% of our PIT tagged fish exhibited the reservoir-type life history based on detections at dams in the spring the year after release. However, due to restricted winter operations of the dam collection and bypass facilities, we cannot account for passage and mortality during this period. While we can demonstrate that subyearlings released from the FCAP facilities do exhibit at least a low level of the reservoir-type life history, our data are insufficient to determine if the reservoir-type life history is significant within the FCAP release groups. We have proposed to investigate this question in future years.

Travel Time and Migration Rate

In 2005, contrasting most previous years, median yearling travel times based on all obs were similar to those based on first obs. Median yearling travel times from the FCAP facilities were about 11-15 days to Lower Granite Dam and about 27-35 days to McNary Dam. Median subyearling travel times from the FCAP facilities were about 5-9 days to Lower Granite Dam and about 19-26 days to McNary Dam. For this study, travel time from release to a given point is of limited utility due to differences in distance between release points to a given observation. As would be anticipated median travel time increases from point of release to successive observation points downstream (Appendix D, Tables D.1 and D.2).

The ANOVA on yearling migration rates to Lower Granite, McNary and Bonneville dams each show significant between-groups effects ($P < 0.0001$ for all; Appendix B, Table B.3). The ANOVA on subyearling migration rates to Lower Granite, McNary and Bonneville dams also show significant between-groups effects ($P < 0.0001$ for all).

Yearling and subyearling migration rate trends in 2005 were similar to most past years in that migration rates from Pittsburg Landing and Big Canyon in the free-flowing reach above Lower Granite Reservoir were higher than through Lower Granite, Little Goose and Lower Monumental reservoirs (Figures 8 and 9). Our data indicate that yearling migration rates generally increase as each release group moves further downstream, while subyearling migration rates remained about level or slightly declined. When considering migration rates from the FCAP facilities to Lower Granite Dam, it is important to remember that these reaches includes about 29-112 rkm of free-flowing river, where our radio telemetry study has shown yearling migration rates to be higher than through the impounded reaches (unpublished data). Migration rates based on first obs and all obs are detailed in Appendix D, Tables D.3 and D.4, respectively.

Modern PIT tag technology is such that effectively segregating the free-flowing reach of the Snake River from the upper reach of Lower Granite pool is not possible. The increasing migration rates in downstream reaches may be due to the fact that these fish have typically been actively migrating for over 3 weeks by the time they reach McNary Dam on the Columbia River and are likely at an advanced stage of smoltification, yet still 470 rkm from the ocean.

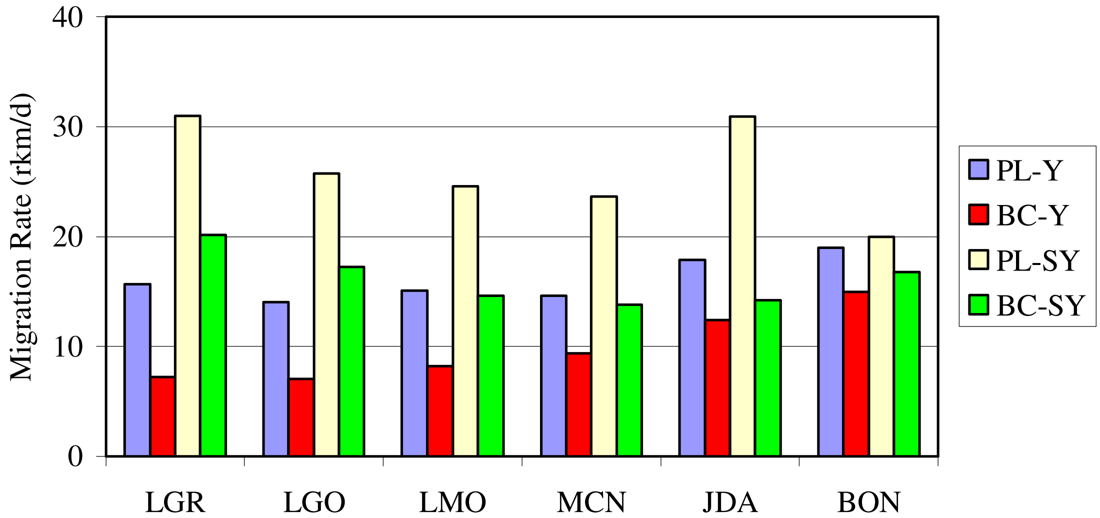

Figure 8.—First obs migration rate (rkm/d) of FCAP yearling fall Chinook salmon to Lower Snake and Columbia River dams in 2005.

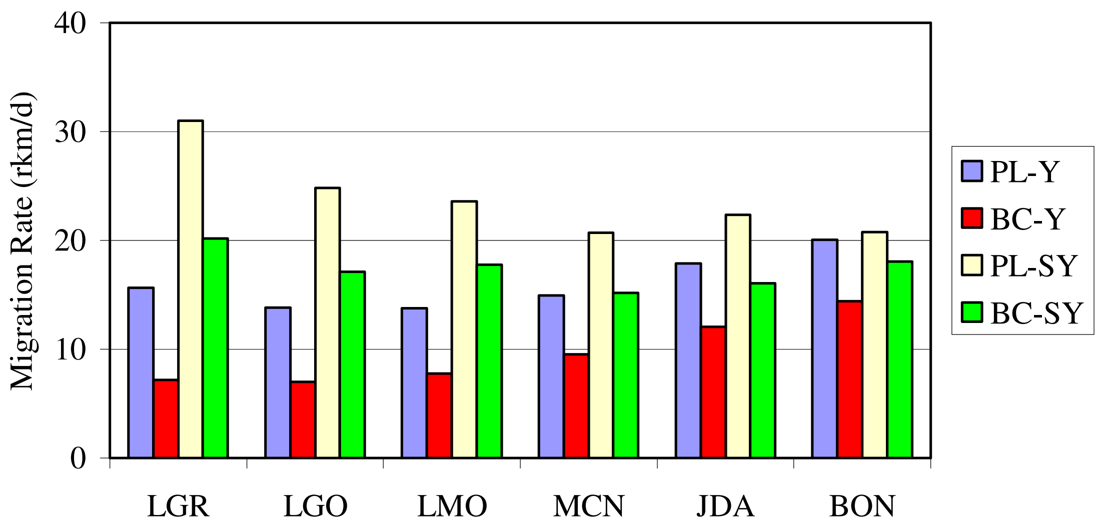

Figure 9.—All obs migration rate (rkm/d) of FCAP yearling fall Chinook salmon to Lower Snake and Columbia River dams in 2005.

Flow patterns do not appear to significantly affect timing of when FCAP yearlings begin to migrate downstream after being released from the acclimation facilities. We have observed that the fish appear to be well into the smoltification process and ready to migrate without delay upon release from the FCAP facilities.

Yearling migration rate from Pittsburg Landing to Lower Granite Dam during 1996-2005 had a significant positive correlation with flow at both Hell's Canyon Dam ($r = 0.9007$, $P = 0.0004$) and Anatone ($r = 0.9303$, $P = 0.0001$), while having for the most part no correlation with temperature at Anatone ($r = -0.1601$, $P = 0.6586$), as illustrated in Figures 10 and 11. Yearling migration rates from Big Canyon to Lower Granite Dam during 1997-2005 also had a significant positive correlation with flow ($r = 0.8207$, $P = 0.0067$) and a significant negative correlation with temperature ($r = -0.7920$, $P = 0.0109$) at Peck (Figures 12 and 13). Equivalent analyses on subyearlings will be reported in the future.

It appears that flow is the primary driving factor for Pittsburg Landing yearlings, while flow and temperature appear to be about equal driving factors in migration rate for yearlings from Big Canyon. Comparative to Pittsburg Landing, migration rate from Big Canyon has to some extent weaker positive correlation with flow but a much stronger negative correlation with temperature. The lower migration rates and correlation to flow for Big Canyon relative to Pittsburg Landing could simply be a result of the relative flow levels between the two rivers or the water velocity. It is also possible that the lower flows work in conjunction with the lower temperatures in the Clearwater River compounding the effect on the early migration rate of yearlings after they are released. Additional comprehensive analyses will be reported as supplementary data are gathered in future years.

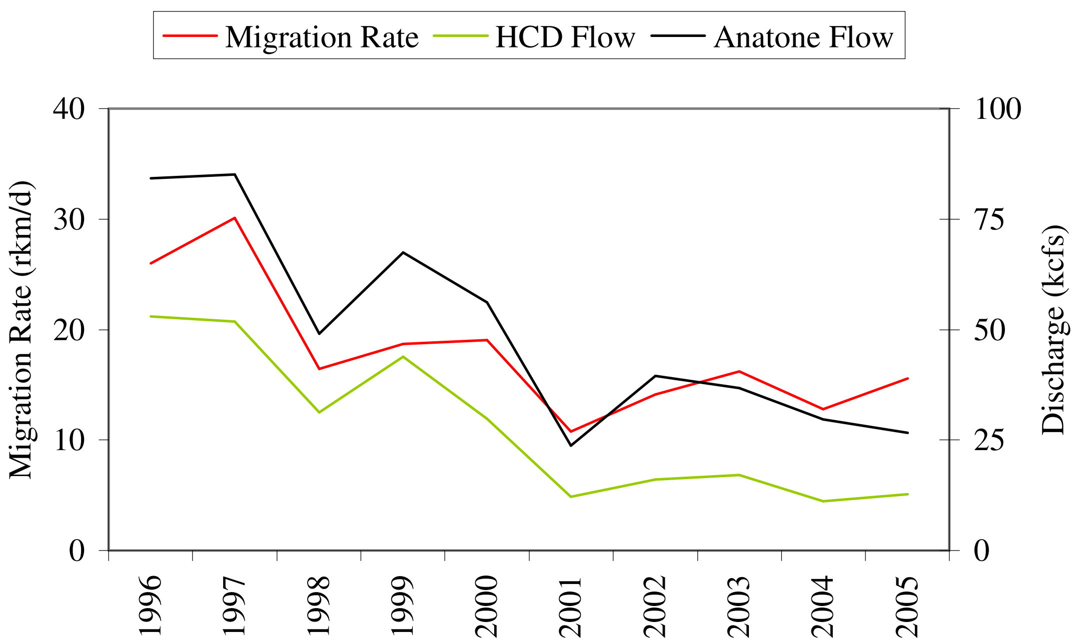

Figure 10.—Yearling migration rate (rkm/d) from Pittsburg Landing to Lower Granite Dam versus Snake River flow at Hell's Canyon Dam and Anatone, 1996-2005.

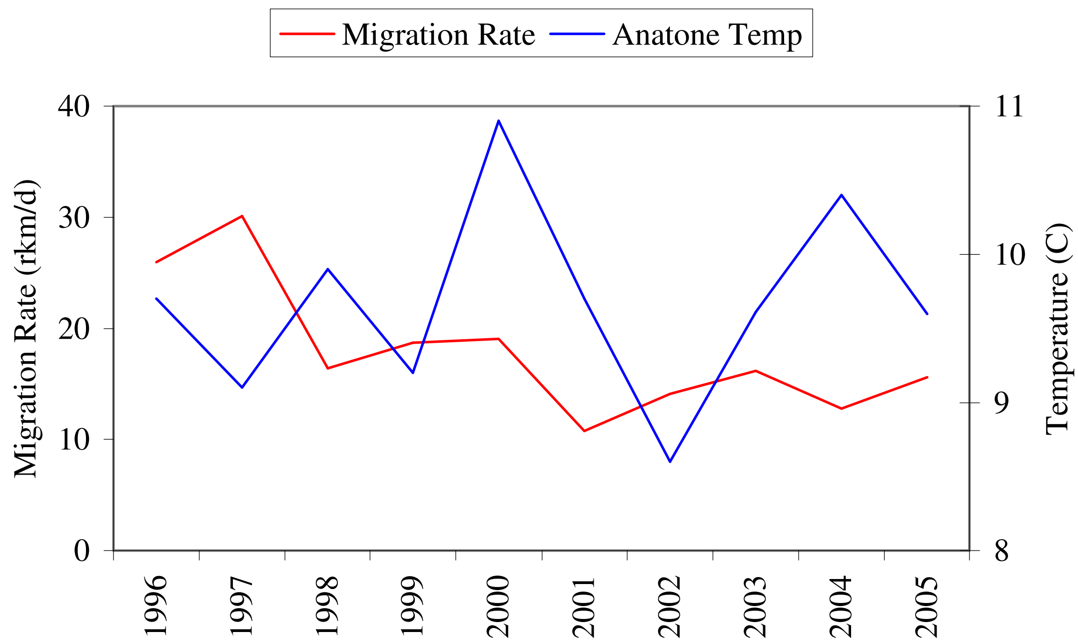

Figure 11.—Yearling migration rate (rkm/d) from Pittsburg Landing to Lower Granite Dam versus Snake River temperature at Anatone, 1996-2005.

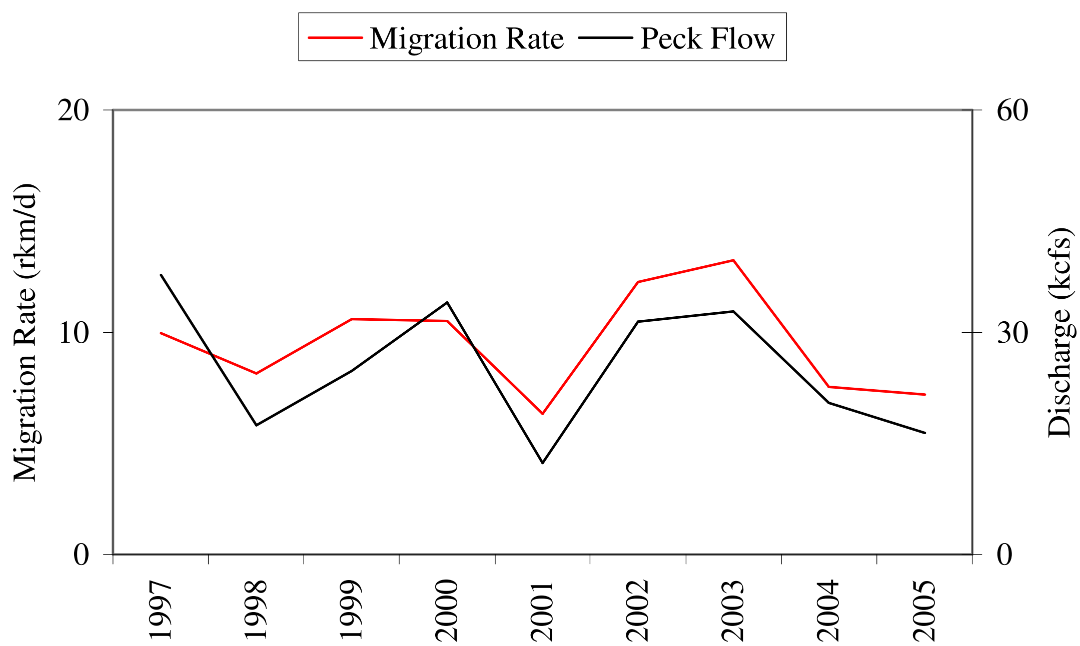

Figure 12.—Yearling migration rate (rkm/d) from Big Canyon to Lower Granite Dam versus Clearwater River flow at Peck, 1997-2005.

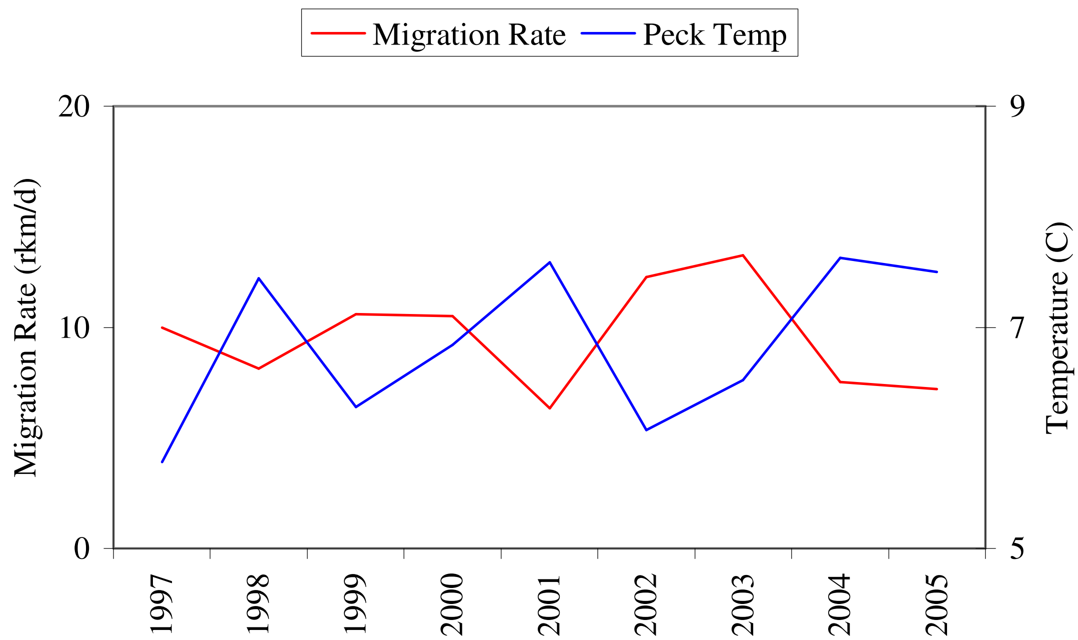

Figure 13.—Yearling migration rate (rkm/d) from Big Canyon to Lower Granite Dam versus Clearwater River temperature at Peck, 1997-2005.

Arrival Timing

Yearling and subyearling arrival date distributions to Lower Granite, McNary and Bonneville dams for all (minus Captain Jon Rapids yearlings) FCAP groups were significantly different (*P* < 0.0001) from each other (Appendix B; Table B.4). These results are not unexpected as none of the release dates coincided (Table 3). Mean, median and 90% arrival dates of all FCAP yearling and subyearling release groups to Lower Granite, Little Goose, Lower Monumental, McNary, John Day and Bonneville dams are detailed in Tables 8 and 9 for first obs and all obs, respectively. A comprehensive summary of arrival timing distributions is presented in Appendix E.

There was a compressed hydrographic peak flow for the Snake River at Hell's Canyon Dam in 2005, which is still not indicative of natural spring flow patterns, so good comparisons to release and arrival timing cannot be done. Pittsburg Landing and Big Canyon FCAP yearling groups achieved 90% passage at Lower Granite Dam about one month before flows peaked at the dam. Subyearlings achieved 90% passage at Lower Granite Dam near peak flow from Pittsburg Landing, on the downward leg after peak flow from Captain John Rapids and at the end of the peak from Big Canyon (Figure 6). Yearlings from Pittsburg Landing and Big Canyon FCAP facilities achieved 90% arrival to McNary Dam about 2 weeks before peak flow while the subyearlings achieved 90% arrival nearly one month after peak flow (Figure 6).

Table 8.—First Obs arrival date at Lower Snake and Columbia River dams of PIT tagged yearling fall Chinook salmon from FCAP facilities in 2005.

Release Group	Age	Interrogation Site	*n*	Median	10%	50%	90%
Pittsburg Landing	1+	Lower Granite	2,884	4/25	4/21	4/25	4/29
		Little Goose	1,071	4/30	4/26	4/30	5/8
		Lower Monumental	100	5/2	4/29	5/2	5/11
		McNary	37	5/11	5/3	5/11	5/16
		John Day	20	5/12	5/10	5/12	5/19
		Bonneville	5	5/16	n/a	n/a	n/a
Pittsburg Landing	0+	Lower Granite	957	6/1	5/30	6/1	6/3
		Little Goose	670	6/4	6/2	6/4	6/11
		Lower Monumental	72	6/6	6/4	6/6	6/14
		McNary	52	6/12	6/7	6/11	6/29
		John Day	5	6/12	n/a	n/a	n/a
		Bonneville	1	6/23	n/a	n/a	n/a
Big Canyon	1+	Lower Granite	2,688	4/20	4/13	4/20	4/27
		Little Goose	923	4/28	4/21	4/28	5/5
		Lower Monumental	120	5/1	4/26	5/1	5/11
		McNary	55	5/10	5/3	5/10	5/17
		John Day	21	5/11	5/5	5/11	5/16
		Bonneville	3	5/12	n/a	n/a	n/a
Big Canyon	0+	Lower Granite	753	6/9	6/5	6/9	6/17
		Little Goose	298	6/14	6/9	6/14	6/20
		Lower Monumental	42	6/19	6/11	6/19	7/8
		McNary	111	6/29	6/23	6/29	7/3
		John Day	16	7/7	7/2	7/6	7/23
		Bonneville	5	7/4	n/a	n/a	n/a
Captain John Rapids	0+	Lower Granite	1,337	6/4	5/31	6/4	6/12
		Little Goose	796	6/9	6/3	6/8	6/15
		Lower Monumental	121	6/12	6/6	6/12	6/19
		McNary	126	6/25	6/14	6/25	6/30
		John Day	6	7/5	n/a	n/a	n/a
		Bonneville	5	6/19	n/a	n/a	n/a

Table 9.—All Obs arrival date to Lower Snake and Columbia River dams of PIT tagged yearling fall Chinook salmon from FCAP facilities in 2005.

Release Group	Age	Interrogation Site	*n*	Median	10%	50%	90%
Pittsburg Landing	1+	Lower Granite	2,884	4/25	4/21	4/25	4/29
		Little Goose	3,146	4/30	4/26	4/30	5/8
		Lower Monumental	1,523	5/4	4/28	5/4	5/13
		McNary	953	5/10	5/5	5/10	5/17
		John Day	662	5/13	5/9	5/13	5/18
		Bonneville	215	5/15	5/10	5/15	5/21
Pittsburg Landing	0+	Lower Granite	957	6/1	5/30	6/1	6/3
		Little Goose	1,202	6/4	6/2	6/4	6/11
		Lower Monumental	518	6/7	6/4	6/7	6/15
		McNary	570	6/14	6/7	6/14	6/27
		John Day	122	6/18	6/11	6/18	6/28
		Bonneville	38	6/22	6/12	6/22	7/1
Big Canyon	1+	Lower Granite	2,688	4/20	4/13	4/20	4/27
		Little Goose	2,713	4/29	4/22	4/29	5/5
		Lower Monumental	1,340	5/2	4/27	5/2	5/12
		McNary	824	5/10	5/2	5/10	5/16
		John Day	577	5/12	5/8	5/12	5/18
		Bonneville	189	5/14	5/8	5/14	5/20
Big Canyon	0+	Lower Granite	753	6/9	6/5	6/9	6/17
		Little Goose	532	6/14	6/9	6/14	6/20
		Lower Monumental	194	6/16	6/12	6/16	6/21
		McNary	401	6/26	6/20	6/26	7/1
		John Day	61	7/2	6/21	7/2	7/18
		Bonneville	16	7/1	6/24	7/1	7/8
Captain John Rapids	0+	Lower Granite	1,337	6/4	5/31	6/4	6/12
		Little Goose	1,355	6/9	6/3	6/9	6/17
		Lower Monumental	587	6/13	6/6	6/13	6/19
		McNary	758	6/24	6/13	6/24	6/29
		John Day	117	6/23	6/15	6/23	7/5
		Bonneville	46	6/27	6/15	6/27	7/6

LITERATURE CITED

Bjornn, T. C. and N. Horner. 1980. Biological criteria for classification of Pacific salmon and steelhead as threatened or endangered under the Endangered Species Act.

Budy, P., Thiede, G.P., Bouwes, N., Petrosky, C.E. and H. Schaller. 2002. Evidence Linking Delayed Mortality of Snake River Salmon to Their Earlier Hydrosystem Experience. North American Journal of Fisheries Management 22:35-51.

CBFWA (Columbia Basin Fish and Wildlife Authority). 1990. Proposed mainstem flows for Columbia basin anadromous fish. March 1990.

Connor, W. P., J. G. Sneva, K. F. Tiffan, R. K. Steinhorst and D. Ross. 2005. Two Alternative Life History Types for Fall Chinook Salmon in the Snake River Basin. Transactions of the American Fisheries Society 134(2):291-304.

Fulton, L. 1968. Spawning areas and abundance of Chinook salmon *Oncorhynchus tshawytscha* in the Columbia River – past and present. USFWS, Special Scientific Report – Fisheries No. 571.

Garcia, A., S. Bradbury, B. Arnsberg, S. Rocklage and P. Groves. 2004. Fall Chinook Salmon Spawning Ground Surveys in the Snake River Basin upriver of Lower Granite Dam: Annual Report 2002-2003, Project No. 199801003, 60 electronic pages, (BPA Report DOE/BP-00004700-3).

Lady, J., Westhagen, P., and J.R. Skalski. 2002. SURPH: SURvival Under Proportional Hazards [Computer Program], Version 2.1. Columbia Basin Research, University of Washington, Seattle, WA. Prepared for U.S. Department of Energy, Bonneville Power Administrations, Division of Fish and Wildlife. Contract No. DE-B179-90BP02341

Matthews, G. M., J. R. Harmon, S. Achord, 0. W. Johnson, and L. A. Kubin. 1990. Evaluation of transportation of juvenile salmonids and related research on the Columbia and Snake Rivers, 1989. Report to the U.S. Army Corps of Engineers, Contract DACW68-84-H0034. National Marine Fisheries Service, Seattle, WA.

Matthews, G. M., S. Accord, J. R. Harmon, 0. W. Johnson, D. M. Marsh, B. P. Sandford, N. N. Paasch, K. W. McIntyre, and K. L. Thomas. 1992. Evaluation of transportation of juvenile salmonids and related research on the Columbia and Snake Rivers, 1990. Report the U.S. Army Corps of Engineers, Contract DACW68-84-H0034. National Marine Fisheries Service, Seattle, WA.

Milks, D., M. Varney, M. Schuck and N. Sands. 2005. Lyons Ferry Hatchery Evaluation: Fall Chinook Salmon Annual Report 2001 and 2002. Washington Department of Fish and Wildlife Hatcheries Report # FPA05-02 to U.S. Fish and Wildlife Service, Lower Snake River Compensation Plan Office, Boise, ID.

Murphy, B.R. and D.W. Willis. 1996. Fisheries Techniques, Second Edition. American Fisheries Society, Bethesda, Maryland.

NMFS (National Marine Fisheries Service). 1992. Threatened status for Snake River spring/summer Chinook salmon, threatened status for Snake River fall Chinook salmon. Federal Register [Docket 910847-2043 22 April 1992] 57(78):14653-14663.

Prentice, E. F., D. L. Park, T. A. Flagg, and S. McCutcheon. 1986. A study to determine the biological feasibility of a new fish tagging system, 1985-1986. Report to the Bonneville Power Administration, Contract DE-A179-83BP11982, Project 83-l 19. National Marine Fisheries Service, Seattle, WA.

Prentice, E. F., T. A. Flagg, C. S. McCutcheon, D. F. Brastow, and D. C. Cross. 1990. Equipment, methods, and an automated data-entry station for PIT tagging. American Fisheries Society Symposium 7:335-340.

Rocklage, S.J. 2004. Monitoring and Evaluation of Yearling Fall Chinook Salmon Released from Acclimation Facilities Upstream of Lower Granite Dam: Annual Report 1998, Project No. 1998-01004, 49 electronic pages, (BPA Report DOE/BP-00004025-1)

Rocklage, S.J. 2005. Monitoring and Evaluation of Yearling Fall Chinook Salmon Released from Acclimation Facilities Upstream of Lower Granite Dam: Annual Report 2003, Project No. 1998-01004, In Press.

Rocklage, S.J. and D.S. Kellar. 2005a. Monitoring and Evaluation of Yearling Fall Chinook Salmon Released from Acclimation Facilities Upstream of Lower Granite Dam: Annual Report 1999, Project No. 1998-01004, In Press.

Rocklage, S.J. and D.S. Kellar. 2005b. Monitoring and Evaluation of Yearling Fall Chinook Salmon Released from Acclimation Facilities Upstream of Lower Granite Dam: Annual Report 2000, Project No. 1998-01004, In Press.

Rocklage, S.J. and D.S. Kellar. 2005c. Monitoring and Evaluation of Yearling Fall Chinook Salmon Released from Acclimation Facilities Upstream of Lower Granite Dam: Annual Report 2001, Project No. 1998-01004, In Press.

Rocklage, S.J. and D.S. Kellar. 2005d. Monitoring and Evaluation of Yearling Fall Chinook Salmon Released from Acclimation Facilities Upstream of Lower Granite Dam: Annual Report 2002, Project No. 1998-01004, In Press.

Smith, S.G., J.R. Skalski, J. W. Schlechte, A. Hoffmann, and V. Cassen, J.R.1994. Statistical Survival Analysis of Fish and Wildlife Tagging Studies. Contract DE-BI79-90BP02341. Project 89-107. Bonneville Power Administration. Portland, Oregon.

True, K., (ed.) 2001. Enzyme Linked Immunosorbent Assay (ELISA) for Detection of *Renibacterium salmoninarum* Antigen in Fish Tissue. Chapter 6 *in* National Wild Fish Health Survey Laboratory Procedure Manual, First Edition. U.S. Fish and Wildlife Service.

True, K., (ed.) 2004. Enzyme Linked Immunosorbent Assay (ELISA) for Detection of *Renibacterium salmoninarum* Antigen in Fish Tissue. Chapter 6 *in* National Wild Fish Health Survey Laboratory Procedure Manual, Second Edition. U.S. Fish and Wildlife Service.

WDF (Washington Department of Fisheries). 1993. Stock composition of fall Chinook at Lower Granite Dam in 1992. Columbia River Laboratory Progress Report 93-5. Battleground, WA.

WDF (Washington Department of Fisheries). 1994. Stock composition of fall Chinook at Lower Granite Dam in 1993. Columbia River Laboratory Progress Report 94-10. Battleground, WA.

APPENDICES

Appendix A. List of PIT tag files and observation numbers and rates of PIT tagged yearling and subyearling fall Chinook salmon released from the FCAP facilities at Lower Snake and Columbia River dams in 2005. All PIT tag files reside in the PTAGIS database managed by the PSMFC and are accessible at http://www.pittag.org/Data_and_Reports/index.html.

Table A.1.—List of PIT tagging files for yearling and subyearling fall Chinook salmon from the FCAP facilities in 2005.

Facility	Age	Filename
Pittsburg Landing	1+	SJR05095.P09 SJR05096.P07
Pittsburg Landing	0+	SJR05125.P09
Big Canyon	1+	SJR05082.B08 SJR05083.B09
Big Canyon	0+	SJR05137.B09
Captain John Rapids	0+	SJR05129.CJ1 SJR05130.CJ1

Table A.2.—First obs interrogation rates at Lower Snake and Columbia River dams of PIT tagged yearling and subyearling fall Chinook salmon from the FCAP facilities in 2005.

Release Group	Age	LGR	LGO	LMO	MCN	JDA	BON	Cumulative Observations	Cumulative %
Pittsburg Landing	1+	2,884	1,071	100	37	20	5	4,117	82.4%
Pittsburg Landing	0+	957	670	72	52	5	1	1,757	70.5%
Big Canyon	1+	2,688	923	120	55	21	3	3,810	76.4%
Big Canyon	0+	753	298	42	111	16	5	1,225	49.0%
Captain John Rapids	0+	1,338	797	121	126	6	5	2,393	68.5%

Table A.3.—All obs interrogations at Lower Snake and Columbia River dams of PIT tagged yearling and subyearling fall Chinook salmon from the FCAP facilities in 2005.

Release Group	Age	LGR	LGO	LMO	MCN	JDA	BON	Total Observations
Pittsburg Landing	1+	2,884	3,146	1,523	953	662	215	9,383
Pittsburg Landing	0+	957	1,202	518	570	122	38	3,407
Big Canyon	1+	2,688	2,713	1,340	824	577	189	8,331
Big Canyon	0+	753	532	194	401	61	16	1,957
Captain John Rapids	0+	1,337	1,355	587	758	117	46	4,200

Appendix B. Results of statistical tests on length, condition factor, travel time, migration rate and arrival date for yearling fall Chinook salmon PIT tagged at the FCAP facilities in 2004. Significant differences for the ANOVA and Kolmogorov-Smirnov tests are highlighted in yellow.

Note: For Tukey's HSD multiple comparisons, groups with like numbers do not differ significantly while different numbers indicate significant differences between groups.

Table B.1.—Results of the ANOVA Test and Tukey's HSD multiple comparisons for length and condition factor of yearling and subyearling fall Chinook salmon PIT tagged at the FCAP facilities in 2005.

			Tukey's HSD Multiple Comparisons		
	Age	ANOVA	PL	BC	CJ
Length	1+	$P = 0.0285$	n/a	n/a	n/a
Condition		$P = 0.0394$	n/a	n/a	n/a
Length	0+	$P < 0.0001$	1	2	1
Condition		$P = 0.0030$	1	2	3

Table B.2.—Results of the Kolmogorov-Smirnov Test for length and condition factor distributions yearling and subyearling fall Chinook salmon at the FCAP facilities in 2005.

		Fork Length			Condition Factor	
Age		BC	CJ		BC	CJ
1+	PL	$P < 0.0001$	n/a	PL	$P = 0.1138$	n/a
	BC		n/a	BC		n/a
	CJ			CJ		
0+	PL	$P < 0.0001$	$P = 0.0001$	PL	$P < 0.0001$	$P < 0.0001$
	BC		$P < 0.0001$	BC		$P < 0.0001$
	CJ			CJ		

Table B.3.—Results of the ANOVA Test and Tukey's HSD multiple comparisons for first and all obs migration rates of PIT tagged yearling and subyearling fall Chinook salmon from Pittsburg Landing and Big Canyon to Lower Granite, McNary and Bonneville Dams in 2005.

Age			ANOVA
1+	Lower Granite		$P < 0.0001$
	McNary	First Obs	$P < 0.0001$
		All Obs	$P < 0.0001$
	Bonneville	First Obs	n/a
		All Obs	$P < 0.0001$
0+	Lower Granite		$P < 0.0001$
	McNary	First Obs	$P < 0.0001$
		All Obs	$P < 0.0001$
	Bonneville	First Obs	n/a
		All Obs	n/a

Table B.4.—Results of the Kolmogorov-Smirnov Test for pairwise comparisons of travel time and arrival date distributions to Lower Granite Dam for yearling and subyearling fall Chinook salmon PIT tagged at the FCAP facilities in 2005.

		Travel Time			Arrival Date	
Age		BC	CJ		BC	CJ
1+	PL	$P < 0.0001$	n/a	PL	$P < 0.0001$	n/a
	BC		n/a	BC		n/a
0+	PL	$P < 0.0001$	n/a	PL	$P < 0.0001$	$P < 0.0001$
	BC		n/a	BC		$P < 0.0001$

Table B.5.—Results of the Kolmogorov-Smirnov Test for pairwise comparisons of first and all obs travel time distributions to McNary and Bonneville Dams for yearling and subyearling fall Chinook salmon PIT tagged at the FCAP facilities in 2005.

Age	To McNary Dam	
	1st Obs	All Obs
1+	$P < 0.0001$	$P < 0.0001$
0+	$P < 0.0001$	$P < 0.0001$
	To Bonneville Dam	
	1st Obs	All Obs
1+	n/a	$P < 0.0001$
0+	n/a	n/a

Table B.6.—Results of the Kolmogorov-Smirnov Test for pairwise comparisons of first and all obs arrival date distributions to McNary and Bonneville Dams for yearling and subyearling fall Chinook salmon PIT tagged at the FCAP facilities in 2005.

		To McNary Dam				
		1st Obs			All Obs	
Age		BC	CJ		BC	CJ
1+	PL	$P = 1.00$	n/a	PL	$P = 0.0050$	n/a
	BC		n/a	BC		n/a
0+	PL	$P < 0.0001$	$P < 0.0001$	PL	$P < 0.0001$	$P < 0.0001$
	BC		$P < 0.0001$	BC		$P < 0.0001$
		To Bonneville Dam				
		1st Obs			All Obs	
Age		BC	CJ		BC	CJ
1+	PL	n/a	n/a	PL	$P = 0.0269$	n/a
	BC		n/a	BC		n/a
0+	PL	n/a	n/a	PL	n/a	n/a
	BC		n/a	BC		n/a

Appendix C. SURPH survival estimates for PIT tagged yearling fall Chinook salmon from the FCAP facilities to Lower Snake and Columbia River dams, 1996-2005. In figures, like colors indicate the same year across multiple figures.

Table C.1.—SURPH survival estimates, standard errors and 95% confidence limits for PIT tagged yearling fall Chinook salmon from the FCAP facilities to Lower Granite Dam, 1996-2005.

Release Group	Age	Year	CJS Estimate	S.E.	95% C.I.
Pittsburg	1+	1996	0.988	0.014	0.960 - 1.015
Landing	1+	1997	0.922	0.012	0.899 - 0.946
	1+	1998	0.886	0.009	0.869 - 0.903
	1+	1999	0.900	0.010	0.881 - 0.920
	1+	2000	0.870	0.012	0.847 - 0.894
	0+	2000	0.621	0.038	0.546 - 0.696
	1+	2001	0.749	0.006	0.738 - 0.760
	0+	2001	0.278	0.013	0.253 - 0.302
	1+	2002	0.886	0.013	0.860 - 0.911
	0+	2002	0.435	0.019	0.398 - 0.471
	1+	2003	0.864	0.012	0.840 - 0.888
	0+	2003	0.670	0.015	0.641 - 0.700
	1+	2004	0.785	0.009	0.767 - 0.803
	0+	2004	0.663	0.012	0.639 - 0.687
	1+	2005	0.867	0.006	0.854 - 0.879
	0+	2005	0.811	0.014	0.784 - 0.838
Big Canyon	1+	1997	0.936	0.015	0.907 - 0.965
Surplus	1+	1997	0.933	0.043	0.848 - 1.017
	0+	1997	0.748	0.013	0.724 - 0.773
Large Size	1+	1998	0.847	0.015	0.819 - 0.876
Small Size	1+	1998	0.622	0.020	0.582 - 0.661
	1+	1999	0.900	0.012	0.877 - 0.923
Surplus	1+	1999	0.878	0.029	0.821 - 0.934
	0+	1999	0.697	0.025	0.647 - 0.746
	1+	2000	0.896	0.013	0.869 - 0.922
	0+	2000	0.703	0.027	0.650 - 0.755
	1+	2001	0.744	0.006	0.732 - 0.755
1st Release	0+	2001	0.638	0.015	0.608 - 0.667
2nd Release	0+	2001	0.428	0.016	0.397 - 0.458
	1+	2002	0.895	0.015	0.866 - 0.924
1st Release	0+	2002	0.525	0.017	0.491 - 0.559
2nd Release	0+	2002	0.354	0.014	0.327 - 0.381

Appendix C (continued).

Table C.1. (continued).

Release Group	Age	Year	CJS Estimate	S.E.	95% C.I.
Big Canyon	1+	2003	0.831	0.012	0.807 - 0.855
	0+	2003	0.769	0.018	0.734 - 0.803
	1+	2004	0.747	0.009	0.729 - 0.765
	0+	2004	0.614	0.012	0.591 - 0.638
	1+	2005	0.820	0.007	0.806 - 0.834
	0+	2005	0.689	0.021	0.647 - 0.731
Captain John Rapids	1+	1998	0.770	0.027	0.716 - 0.824
	1+	1999	0.941	0.020	0.901 - 0.980
	0+	1999	0.931	0.029	0.874 - 0.988
	1+	2000	0.952	0.019	0.915 - 0.989
	0+	2000	0.717	0.033	0.653 - 0.782
	1+	2001	0.852	0.009	0.835 - 0.870
	0+	2001	0.705	0.015	0.677 - 0.734
	1+	2002	0.970	0.024	0.924 - 1.017
	0+	2002	0.652	0.021	0.610 - 0.693
	0+	2002	0.448	0.014	0.420 - 0.475
	1+	2003	0.917	0.020	0.877 - 0.957
	0+	2003	0.879	0.021	0.837 - 0.921
	1+	2004	0.881	0.013	0.857 - 0.906
	0+	2004	0.752	0.012	0.729 - 0.775
	0+	2005	0.846	0.014	0.818 - 0.875

Appendix C (continued).

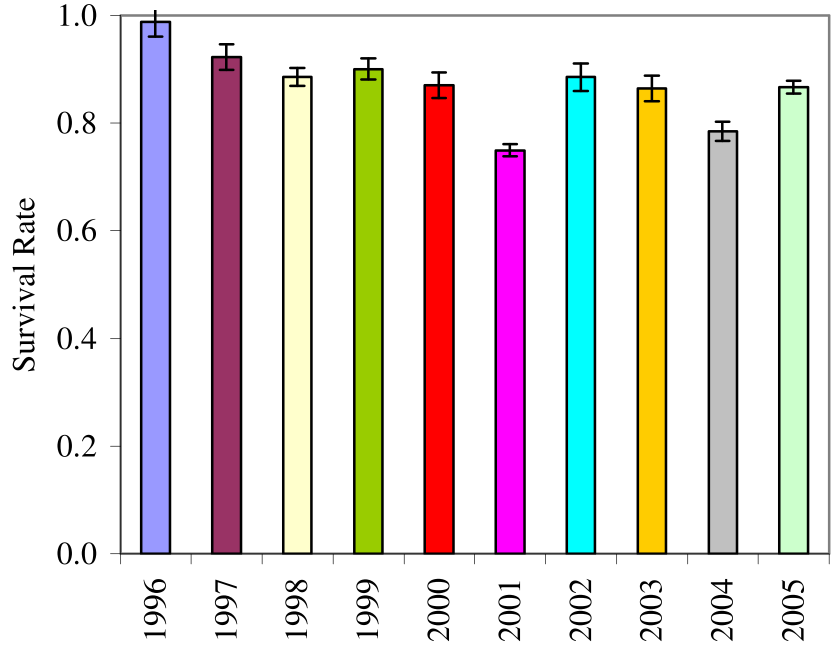

Figure C.1.—Estimated survival (+/- 95% C.I.) of PIT tagged yearling fall Chinook salmon from Pittsburg Landing to Lower Granite Dam, 1996-2005.

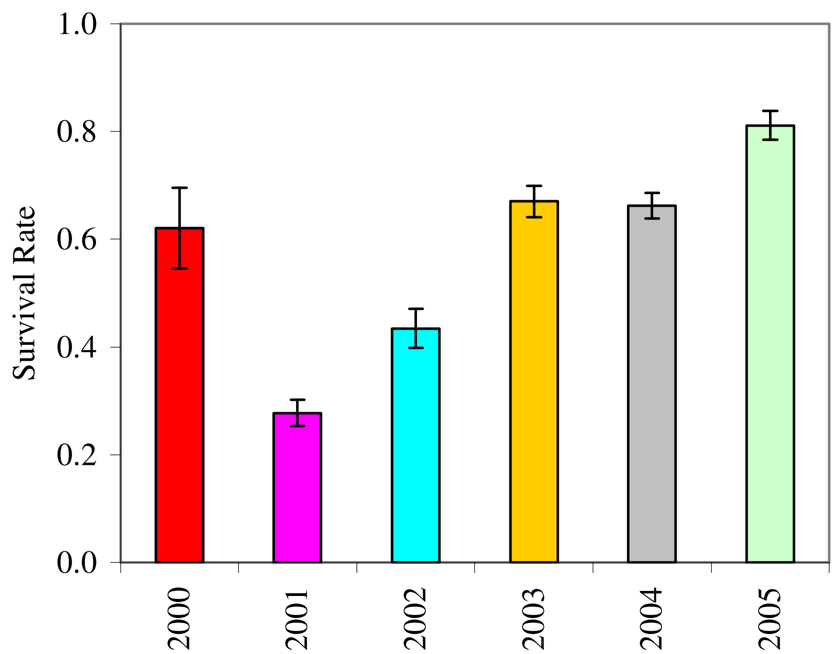

Figure C.2.—Estimated joint probability of survival and subyearling emigration (+/- 95% C.I.) of PIT tagged subyearling fall Chinook salmon from Pittsburg Landing to Lower Granite Dam, 2000-2005.

Appendix C (continued).

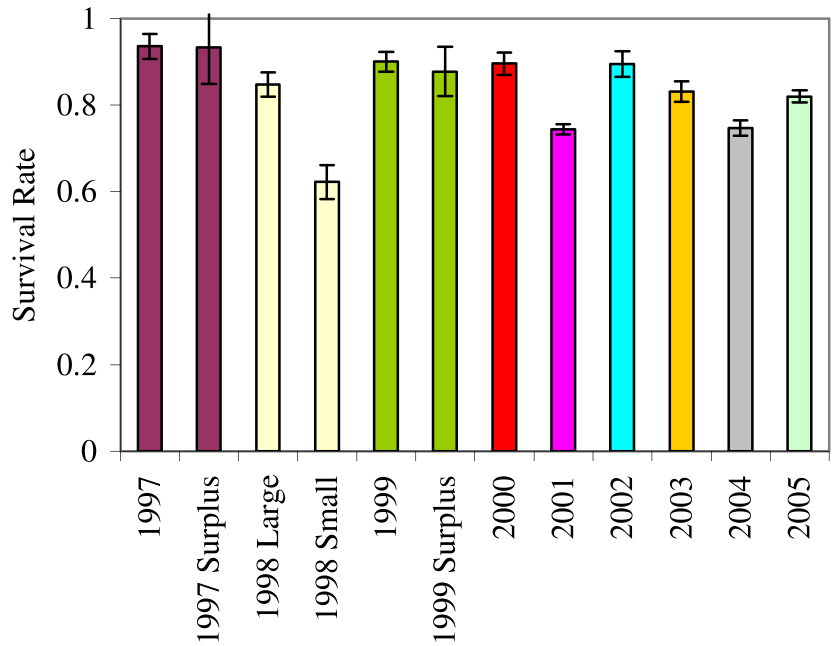

Figure C.3.—Estimated survival (+/- 95% C.I.) of PIT tagged yearling fall Chinook salmon from Big Canyon to Lower Granite Dam, 1997-2005.

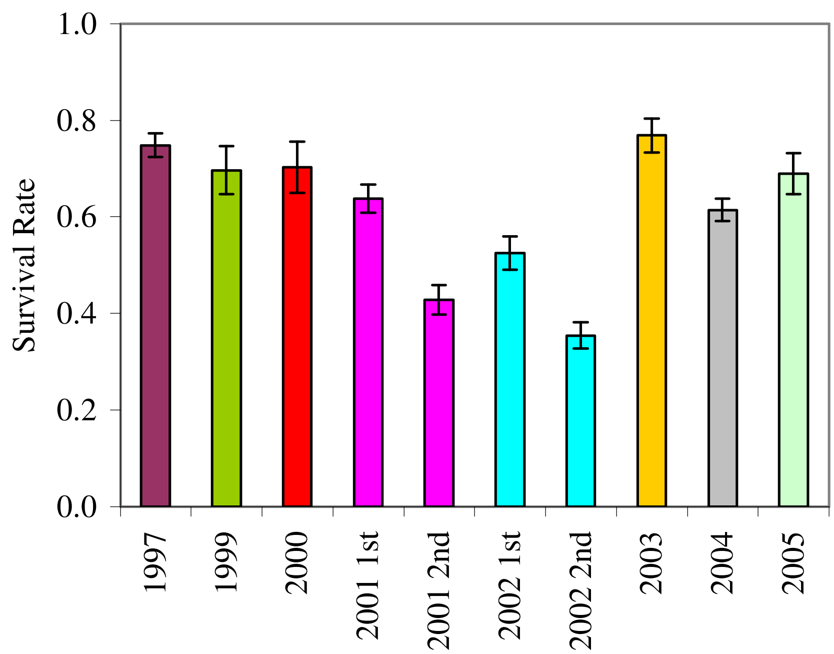

Figure C.4.—Estimated joint probability of survival and subyearling emigration (+/- 95% C.I.) of PIT tagged subyearling fall Chinook salmon from Big Canyon to Lower Granite Dam, 1997-2005.

Appendix C (continued).

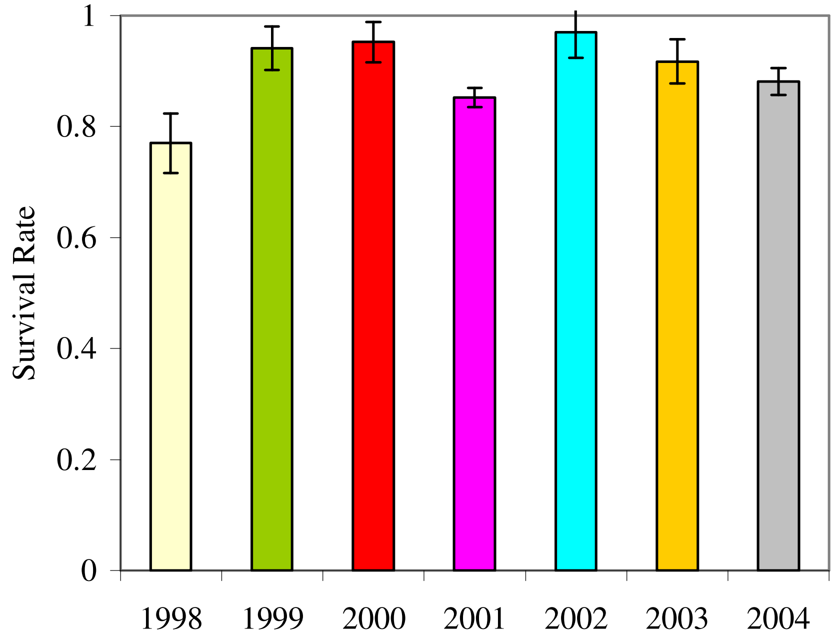

Figure C.5.—Estimated survival (+/- 95% C.I.) of PIT tagged yearling fall Chinook salmon from Captain John Rapids to Lower Granite Dam, 1998-2004.

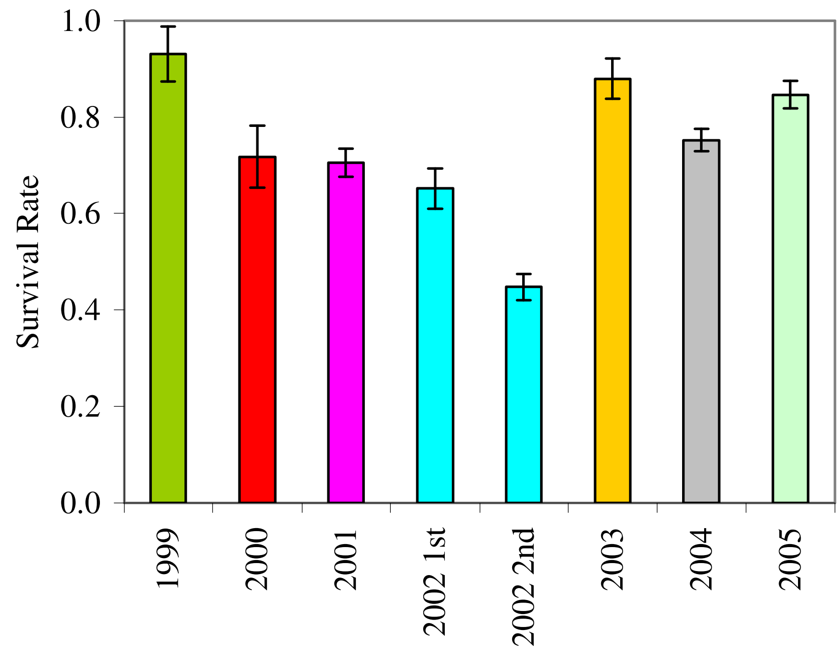

Figure C.6.—Estimated joint probability of survival and subyearling emigration (+/- 95% C.I.) of PIT tagged subyearling fall Chinook salmon from Captain John Rapids to Lower Granite Dam, 1999-2005.

Appendix C (continued).

Table C.2.—SURPH survival estimates, standard errors and 95% confidence limits for PIT tagged yearling and subyearling fall Chinook salmon from the FCAP facilities and LFH to McNary Dam, 1996-2005.

Release Group	Age	Year	CJS Estimate	S.E.	95% C.I. Upper
Pittsburg	1+	1996	0.413	0.074	0.268 - 0.558
Landing	1+	1997	0.818	0.159	0.505 - 1.130
	1+	1998	0.557	0.039	0.480 - 0.634
	1+	1999	0.621	0.024	0.573 - 0.669
	1+	2000	0.666	0.040	0.588 - 0.744
	0+	2000	0.373	0.083	0.209 - 0.536
	1+	2001	0.379	0.009	0.360 - 0.397
	0+	2001	0.062	0.014	0.036 - 0.089
	1+	2002	0.705	0.026	0.654 - 0.755
	0+	2002	0.266	0.032	0.204 - 0.329
	1+	2003	0.623	0.027	0.571 - 0.675
	0+	2003	0.323	0.020	0.284 - 0.361
	1+	2004	0.452	0.032	0.389 - 0.515
	0+	2004	0.446	0.038	0.371 - 0.520
	1+	2005	0.673	0.032	0.610 - 0.736
	0+	2005	0.493	0.038	0.419 - 0.567
Big Canyon	1+	1997	0.833	0.179	0.482 - 1.184
Surplus	1+	1997	0.738	0.713	-0.659 - 2.136
	0+	1997	0.295	0.030	0.236 - 0.355
Large Size	1+	1998	0.517	0.066	0.388 - 0.646
Small Size	1+	1998	0.252	0.045	0.165 - 0.339
	1+	1999	0.661	0.029	0.605 - 0.716
Surplus	1+	1999	0.587	0.048	0.493 - 0.681
	0+	1999	0.357	0.056	0.247 - 0.466
	1+	2000	0.679	0.039	0.603 - 0.754
	0+	2000	0.364	0.067	0.232 - 0.495
	1+	2001	0.395	0.009	0.378 - 0.412
1st Release	0+	2001	0.166	0.021	0.125 - 0.207
2nd Release	0+	2001	0.093	0.016	0.061 - 0.125
	1+	2002	0.543	0.021	0.502 - 0.583
1st Release	0+	2002	0.257	0.026	0.205 - 0.308
2nd Release	0+	2002	0.140	0.019	0.102 - 0.177

Appendix C (continued).

Table C.2. (continued).

Release Group	Age	Year	CJS Estimate	S.E.	95% C.I. Upper
Big Canyon	1+	2003	0.599	0.027	0.546 - 0.652
	0+	2003	0.366	0.024	0.319 - 0.413
	1+	2004	0.521	0.047	0.429 - 0.612
	0+	2004	0.332	0.036	0.261 - 0.402
	1+	2005	0.563	0.028	0.508 - 0.618
	0+	2005	0.567	0.099	0.374 - 0.760
Captain John Rapids	1+	1998	0.505	0.117	0.276 - 0.734
	1+	1999	0.713	0.057	0.601 - 0.825
	0+	1999	0.705	0.118	0.475 - 0.936
	1+	2000	0.840	0.078	0.687 - 0.992
	0+	2000	0.638	0.144	0.355 - 0.921
	1+	2001	0.485	0.015	0.457 - 0.514
	0+	2001	0.178	0.025	0.129 - 0.227
	1+	2002	0.635	0.039	0.559 - 0.712
	0+	2002	0.348	0.030	0.289 - 0.408
	0+	2002	0.242	0.044	0.156 - 0.329
	1+	2003	0.694	0.046	0.605 - 0.783
	0+	2003	0.693	0.039	0.617 - 0.768
	1+	2004	0.508	0.030	0.450 - 0.565
	0+	2004	0.539	0.051	0.440 - 0.638
	0+	2005	0.513	0.043	0.430 - 0.597

Appendix C (continued).

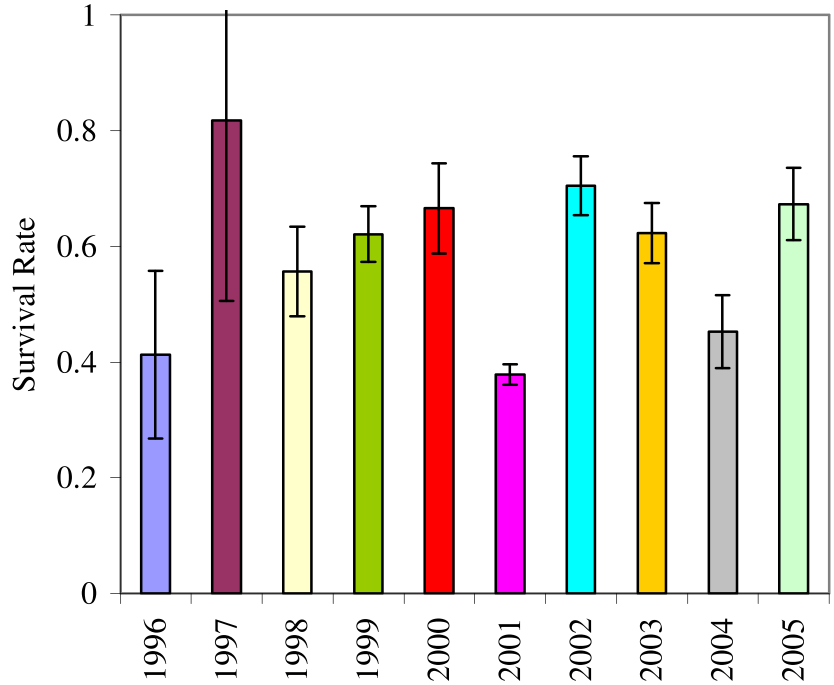

Figure C.7.—Estimated survival (+/- 95% C.I.) of PIT tagged yearling fall Chinook salmon from Pittsburg Landing to McNary Dam, 1996-2005.

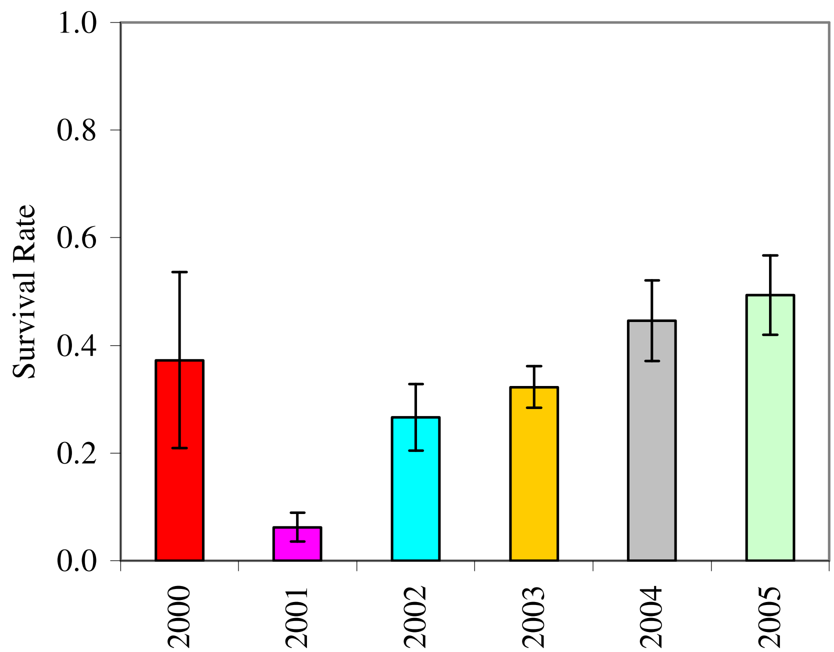

Figure C.8.—Estimated joint probability of survival and subyearling emigration (+/- 95% C.I.) of PIT tagged subyearling fall Chinook salmon from Pittsburg Landing to McNary Dam, 2000-2005.

Appendix C (continued).

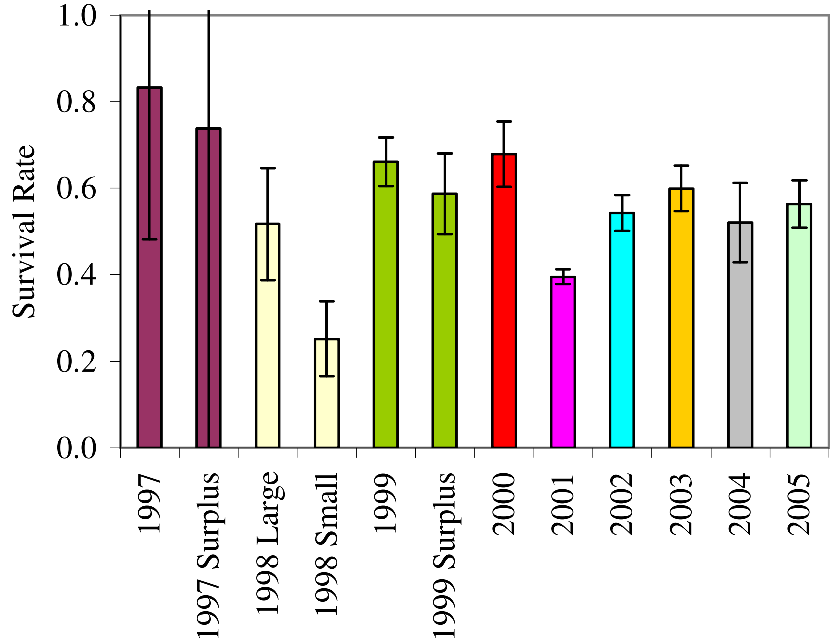

Figure C.9.—Estimated survival (+/- 95% C.I.) of PIT tagged yearling fall Chinook salmon from Big Canyon to McNary Dam, 1997-2005.

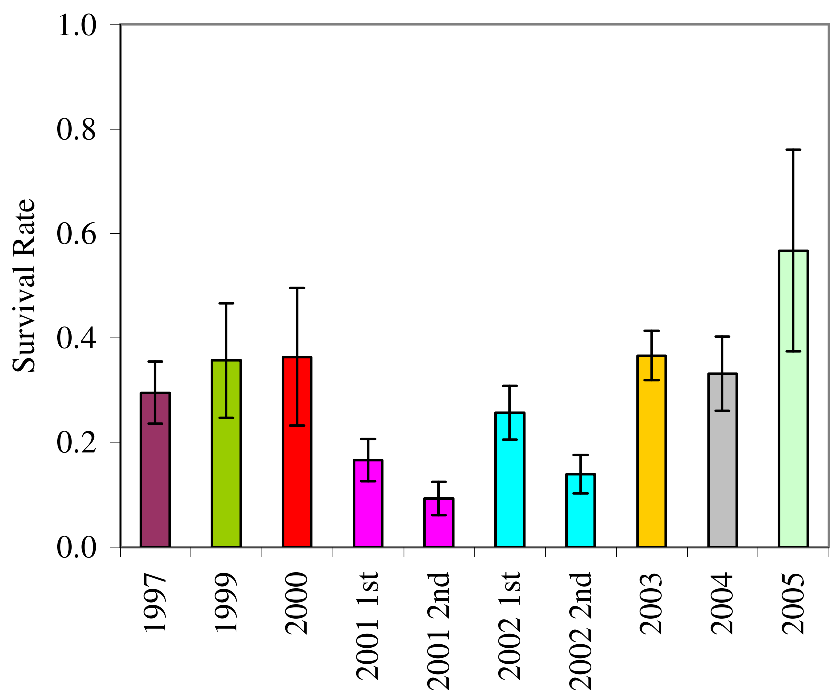

Figure C.10.—Estimated joint probability of survival and subyearling emigration (+/- 95% C.I.) of PIT tagged subyearling fall Chinook salmon from Big Canyon to McNary Dam, 1997-2005.

Appendix C (continued).

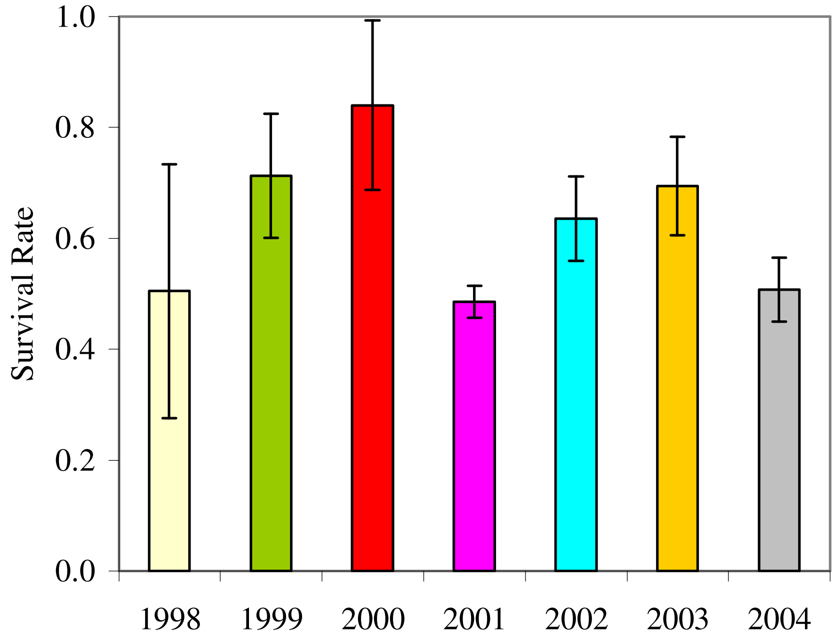

Figure C.11.—Estimated survival (+/- 95% C.I.) of PIT tagged yearling fall Chinook salmon from Captain John Rapids to McNary Dam, 1998-2004.

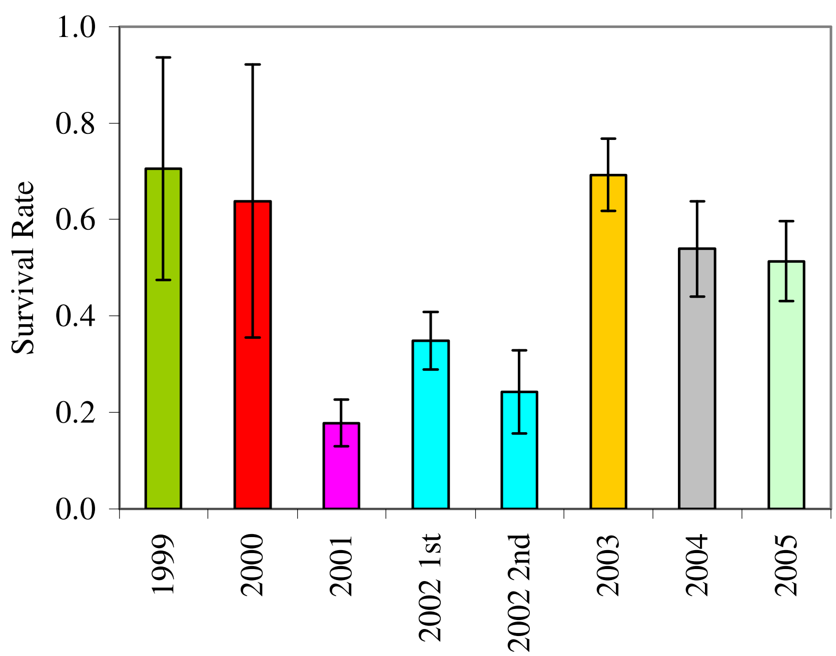

Figure C.12.—Estimated survival (+/- 95% C.I.) of PIT tagged subyearling fall Chinook salmon from Captain John Rapids to McNary Dam, 1999-2005.

Appendix D. Descriptive statistics for travel times (days) and migration rates (rkm/d) of PIT tagged yearling fall Chinook from the FCAP sites to Lower Snake and Columbia River dams in 2005.

Table D.1.—First Obs travel time (days) of FCAP yearling and subyearling fall Chinook salmon to Lower Snake and Columbia River dams in 2005.

Release Group	Age	Interrogation Site	*n*	Mean	Standard Deviation	95% C.I. (+/-)	Median	Range
Pittsburg Landing	1+	Lower Granite	2,884	11.7	4.7	0.2	11.1	4.2 - 59.9
		Little Goose	1,071	17.6	5.8	0.3	16.6	7.8 - 57.4
		Lower Monumental	100	20.4	18.5	1.1	18.5	13.0 - 46.4
		McNary	37	27.8	7.1	2.4	27.3	16.0 - 52.9
		John Day	20	30.5	3.5	1.6	29.1	25.8 - 36.7
		Bonneville	5	32.5	4.1	5.1	33.4	28.2 - 37.4
Pittsburg Landing	0+	Lower Granite	957	6.2	2.2	0.1	5.6	3.1 - 26.8
		Little Goose	670	10.4	3.9	0.3	9.0	5.1 - 36.0
		Lower Monumental	72	12.8	4.6	1.1	11.3	7.4 - 27.6
		McNary	52	21.2	8.6	2.4	16.8	11.4 - 39.1
		John Day	5	21.8	7.6	9.5	16.8	15.6 - 30.9
		Bonneville	1	28.1	n/a	n/a	28.1	28.1 - 28.1
Big Canyon	1+	Lower Granite	2,688	15.5	5.6	0.2	15.0	3.9 - 54.1
		Little Goose	923	23.8	5.8	0.4	23.8	8.8 - 55.9
		Lower Monumental	120	28.2	26.1	1.1	26.1	14.3 - 51.5
		McNary	55	36.3	8.6	2.3	35.5	20.8 - 86.6
		John Day	21	37.0	3.8	1.7	36.7	28.7 - 43.8
		Bonneville	3	37.2	1.6	3.9	38.1	35.4 - 38.2
Big Canyon	0+	Lower Granite	753	10.1	5.1	0.4	8.6	2.1 - 37.6
		Little Goose	298	15.2	7.3	0.8	13.5	5.6 - 70.1
		Lower Monumental	42	21.7	15.2	4.7	19.1	8.4 - 98.1
		McNary	111	28.3	5.1	1.0	28.8	11.1 - 51.0
		John Day	16	41.0	9.4	5.0	36.7	30.5 - 60.5
		Bonneville	5	31.6	8.2	10.2	33.6	22.4 - 42.4

Appendix D (continued).

Table D.2.—All Obs travel time (days) of FCAP yearling and subyearling fall Chinook salmon to Lower Snake and Columbia River dams in 2005.

Release Group	Age	Interrogation Site	*n*	Mean	Standard Deviation	95% C.I. (+/-)	Median	Range
Pittsburg Landing	1+	Lower Granite	2,884	11.7	4.7	0.2	11.1	4.2 - 59.9
		Little Goose	3,146	17.8	5.6	0.2	16.8	7.8 - 63.3
		Lower Monumental	1,523	21.7	20.2	0.3	20.2	11.4 - 66.7
		McNary	953	27.5	6.5	0.4	26.6	15.9 - 72.9
		John Day	662	30.2	6.0	0.5	29.1	19.4 - 122.3
		Bonneville	215	32.1	4.7	0.6	31.6	22.2 - 53.8
Pittsburg Landing	0+	Lower Granite	957	6.2	2.2	0.1	5.6	3.1 - 26.8
		Little Goose	1,202	10.6	3.9	0.2	9.4	5.1 - 36.0
		Lower Monumental	518	13.7	5.0	0.4	11.8	7.4 - 39.4
		McNary	570	21.1	7.6	0.6	19.2	10.0 - 39.1
		John Day	122	23.3	6.6	1.2	23.3	13.5 - 41.7
		Bonneville	38	27.2	7.3	2.4	27.0	16.5 - 41.4
Big Canyon	1+	Lower Granite	2,688	15.5	5.6	0.2	15.0	3.9 - 54.1
		Little Goose	2,713	24.3	5.7	0.2	24.0	8.3 - 57.1
		Lower Monumental	1,340	29.0	27.6	0.3	27.6	13.8 - 72.9
		McNary	824	35.1	6.1	0.4	34.9	17.6 - 86.6
		John Day	577	38.0	4.0	0.3	37.7	24.8 - 57.5
		Bonneville	189	39.9	4.9	0.7	39.5	29.4 - 63.8
Big Canyon	0+	Lower Granite	753	10.1	5.1	0.4	8.6	2.1 - 37.6
		Little Goose	532	14.9	6.1	0.5	13.6	5.6 - 70.1
		Lower Monumental	194	17.5	8.3	1.2	15.7	8.4 - 98.1
		McNary	401	26.7	6.0	0.6	26.2	11.1 - 104.2
		John Day	61	33.0	9.8	2.5	32.4	18.6 - 60.5
		Bonneville	16	31.8	5.8	3.1	31.1	22.4 - 42.4

Appendix D (continued).

Table D.3.—First Obs migration rate (rkm/d) of FCAP yearling and subyearling fall Chinook salmon to Lower Snake and Columbia River dams in 2005.

Release Group	Age	Interrogation Site	*n*	Mean	Median	Range
Pittsburg Landing	1+	Lower Granite	2,884	14.8	15.6	2.9 - 41.2
		Little Goose	1,071	13.2	14.0	4.1 - 29.7
		Lower Monumental	100	13.7	15.1	6.0 - 21.4
		McNary	37	14.3	14.6	7.5 - 24.9
		John Day	20	17.1	17.9	14.2 - 20.2
		Bonneville	5	19.5	19.0	17.0 - 22.5
Pittsburg Landing	0+	Lower Granite	957	28.1	31.0	6.5 - 55.8
		Little Goose	670	22.4	25.8	6.5 - 45.9
		Lower Monumental	72	21.9	24.6	10.1 - 37.6
		McNary	52	18.8	23.7	10.2 - 35.1
		John Day	5	23.9	30.9	16.9 - 33.4
		Bonneville	1	20.0	20.0	20.0 - 20.0
Big Canyon	1+	Lower Granite	2,688	7.0	7.2	2.0 - 27.4
		Little Goose	923	7.1	7.1	3.0 - 19.2
		Lower Monumental	120	7.6	8.2	4.2 - 14.9
		McNary	55	9.2	9.4	3.8 - 16.0
		John Day	21	12.3	12.4	10.4 - 15.9
		Bonneville	3	15.3	14.9	14.9 - 16.1
Big Canyon	0+	Lower Granite	753	17.2	20.2	4.6 - 81.1
		Little Goose	298	15.3	17.2	3.3 - 41.4
		Lower Monumental	42	12.8	14.6	2.8 - 33.2
		McNary	111	14.0	13.8	7.8 - 35.8
		John Day	16	12.7	14.2	8.6 - 17.1
		Bonneville	5	17.8	16.7	13.3 - 25.1

Appendix D (continued).

Table D.4.—All Obs migration rate (rkm/d) of FCAP yearling and subyearling fall Chinook salmon to Lower Snake and Columbia River dams in 2005.

Release Group	Age	Interrogation Site	*n*	Mean	Median	Range
Pittsburg Landing	1+	Lower Granite	2,884	14.8	15.6	2.9 - 41.2
		Little Goose	3,146	13.1	13.8	3.7 - 29.7
		Lower Monumental	1,523	12.9	13.8	4.2 - 24.5
		McNary	953	14.5	15.0	5.5 - 25.0
		John Day	662	17.2	17.9	4.3 - 26.8
		Bonneville	215	19.8	20.1	11.8 - 28.6
Pittsburg Landing	0+	Lower Granite	957	28.1	31.0	6.5 - 55.8
		Little Goose	1,202	22.1	24.8	6.5 - 45.9
		Lower Monumental	518	20.3	23.6	7.1 - 37.9
		McNary	570	18.9	20.7	10.2 - 39.8
		John Day	122	22.4	22.4	12.5 - 38.6
		Bonneville	38	20.6	20.8	13.6 - 34.1
Big Canyon	1+	Lower Granite	2,688	7.0	7.2	2.0 - 27.4
		Little Goose	2,713	6.9	7.0	2.9 - 20.2
		Lower Monumental	1,340	7.4	7.8	2.9 - 15.5
		McNary	824	9.5	9.5	3.8 - 18.9
		John Day	577	12.0	12.1	7.9 - 18.4
		Bonneville	189	14.3	14.4	8.9 - 19.4
Big Canyon	0+	Lower Granite	753	17.2	20.2	4.6 - 81.1
		Little Goose	532	15.7	17.1	3.3 - 41.7
		Lower Monumental	194	16.0	17.8	2.8 - 33.2
		McNary	401	14.9	15.2	3.8 - 35.8
		John Day	61	15.8	16.1	8.6 - 27.9
		Bonneville	16	17.7	18.1	13.3 - 25.1

Appendix E. Arrival date frequency distributions and cumulative frequencies for PIT tagged yearling fall Chinook salmon from the FCAP sites based on first and all obs at Lower Snake and Columbia River dams in 2005.

BASED ON FIRST OBS - Multiple release groups at individual dams

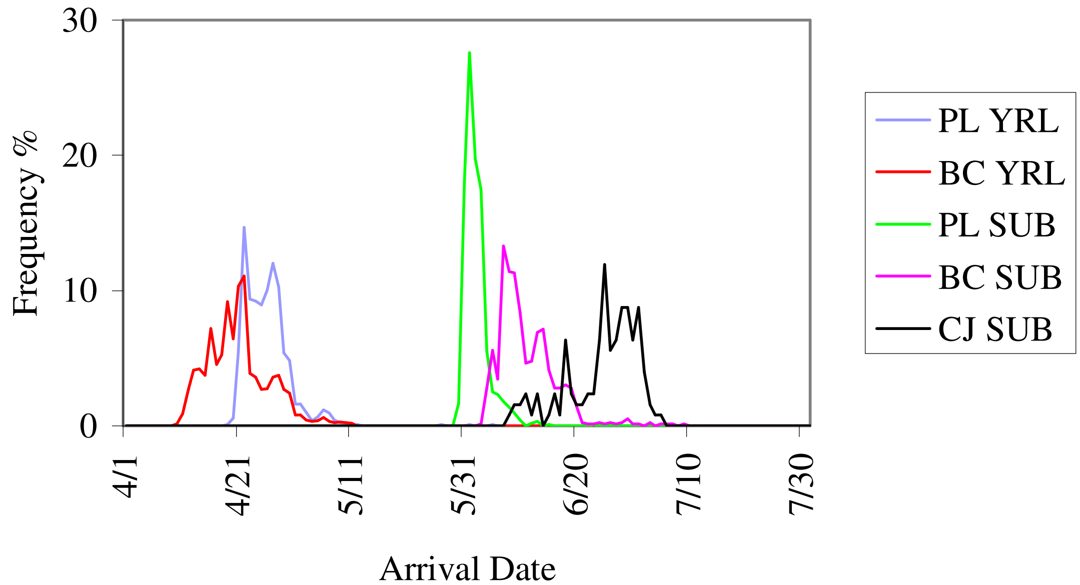

Table E.1.—First obs arrival date frequency of FCAP yearlings and subyearlings at Lower Granite Dam in 2005.

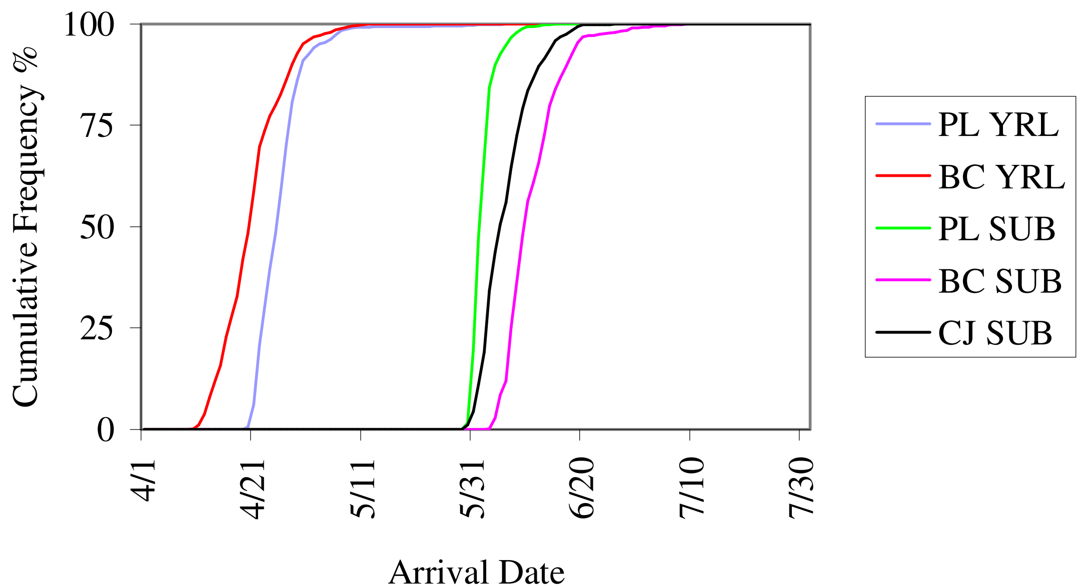

Table E.2.—First obs arrival date cumulative frequency of FCAP yearlings and subyearlings at Lower Granite Dam in 2005.

Appendix E (continued).

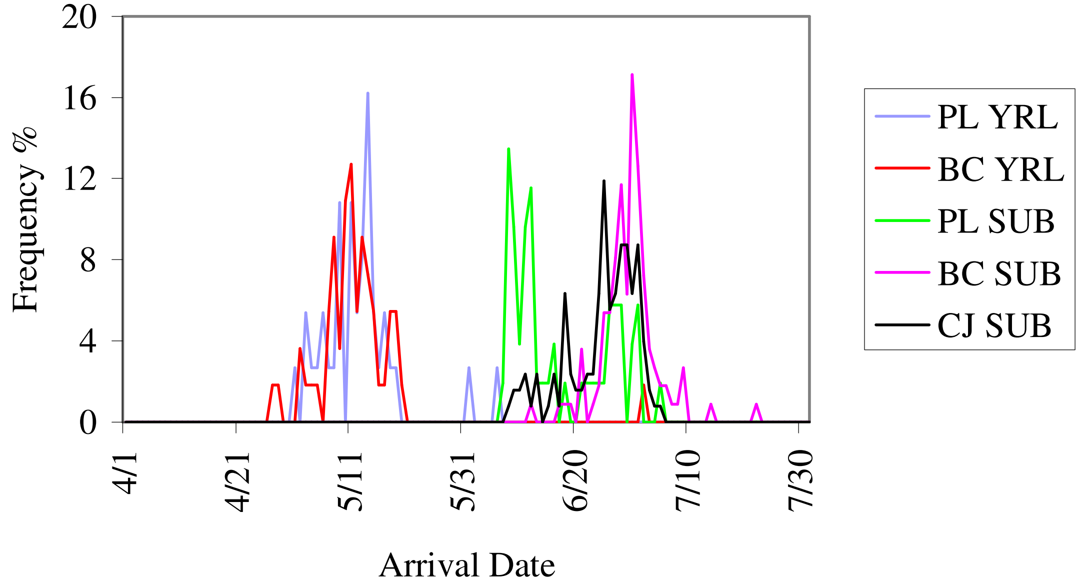

Table E.3.—First obs arrival date frequency of FCAP yearlings and subyearlings at McNary Dam in 2005.

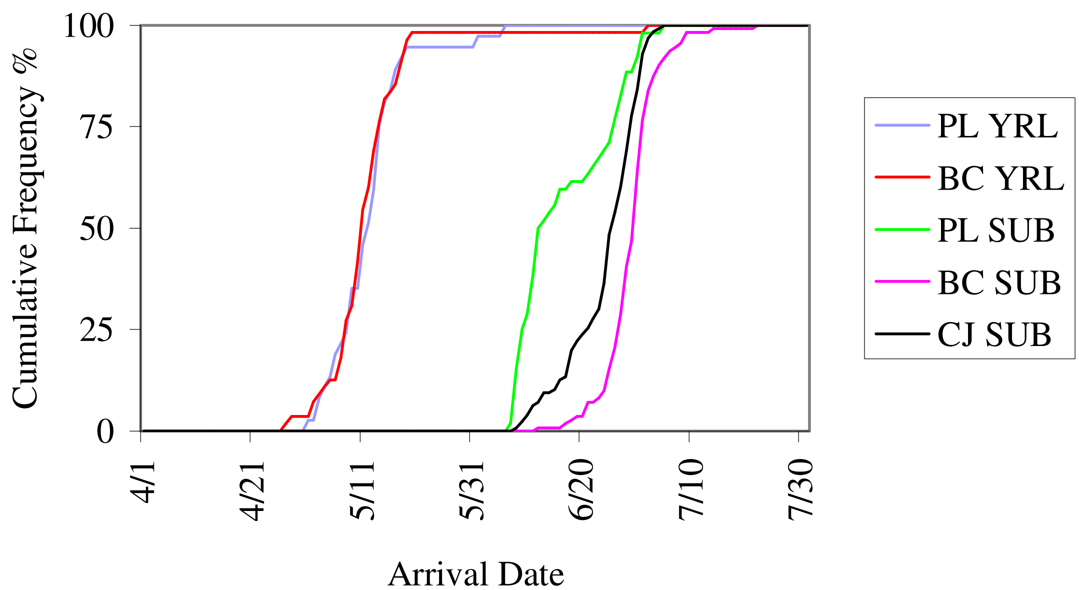

Table E.4.—First obs arrival date cumulative frequency of FCAP yearlings and subyearlings at McNary Dam in 2005.

Appendix E (continued).

BASED ON ALL OBS - Multiple release groups at individual dams

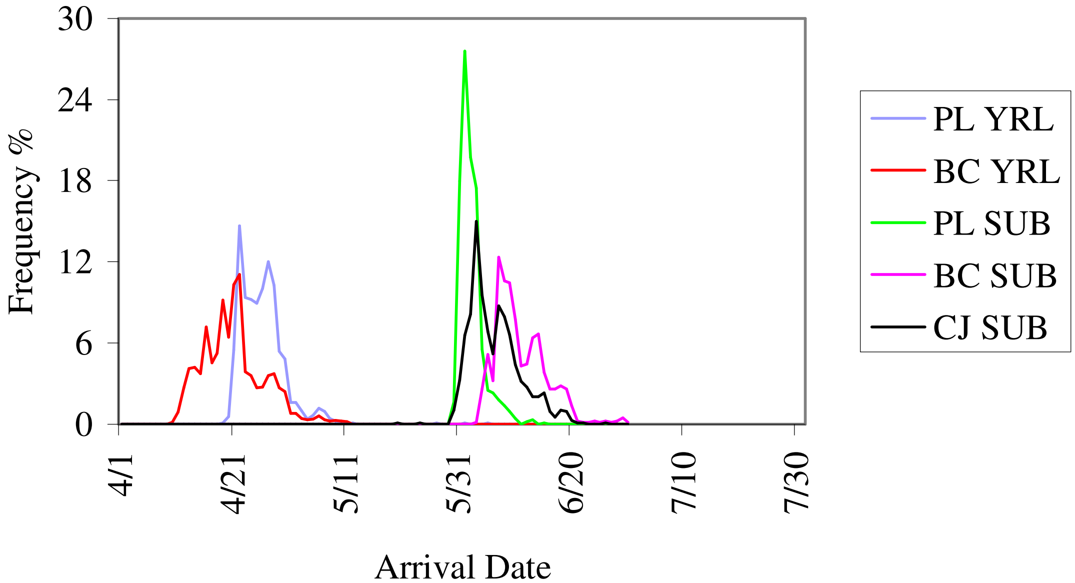

Table E.5.—All obs arrival date frequency of FCAP yearlings and subyearlings at Lower Granite Dam in 2005.

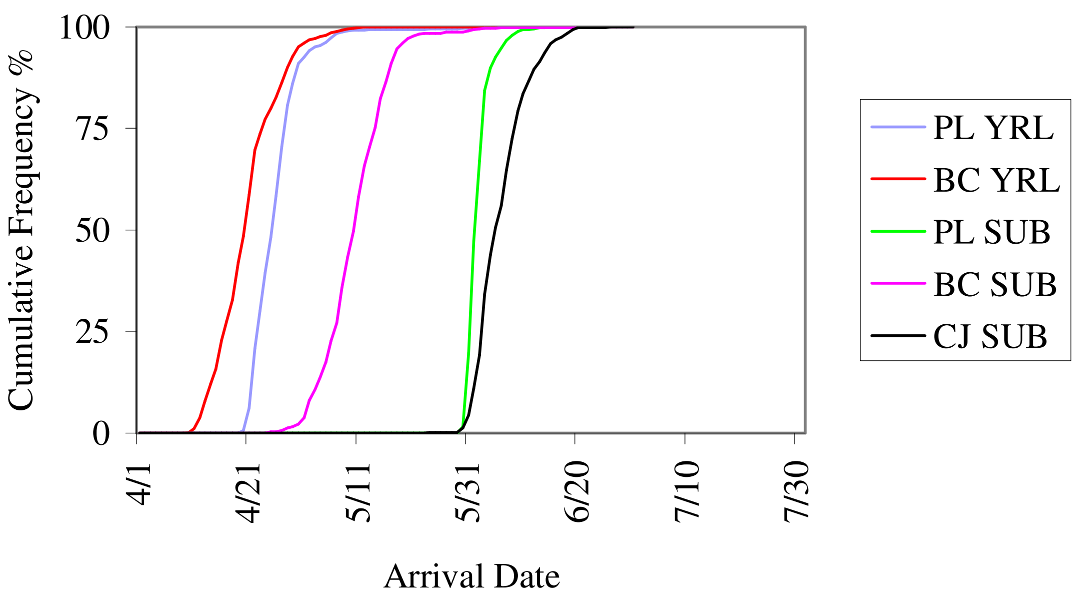

Table E.6.—All obs arrival date cumulative frequency of FCAP yearlings and subyearlings at Lower Granite Dam in 2005.

Appendix E (continued).

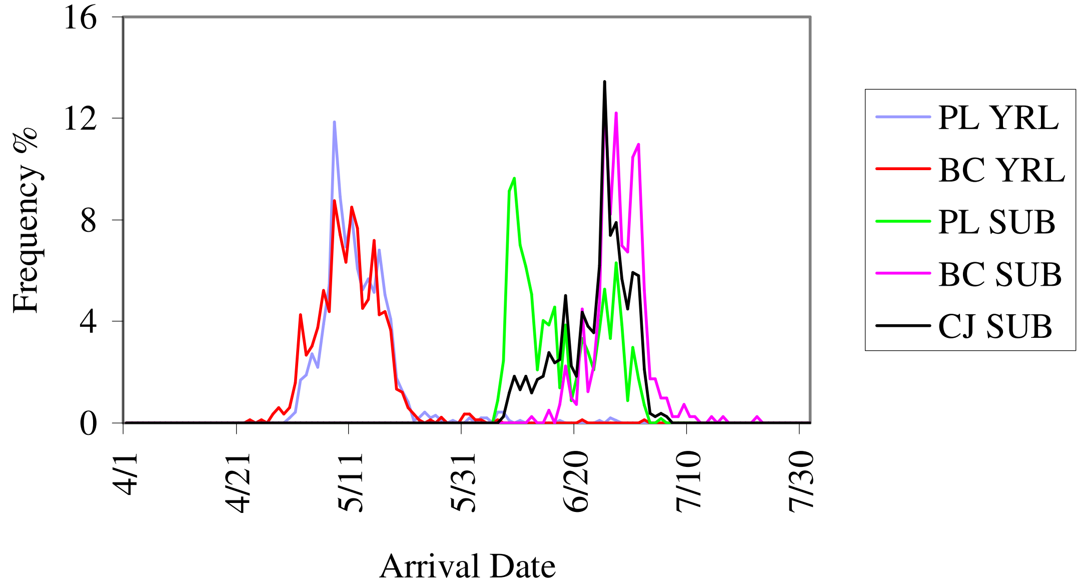

Table E.7.—All obs arrival date frequency of FCAP yearlings and subyearlings at McNary Dam in 2005.

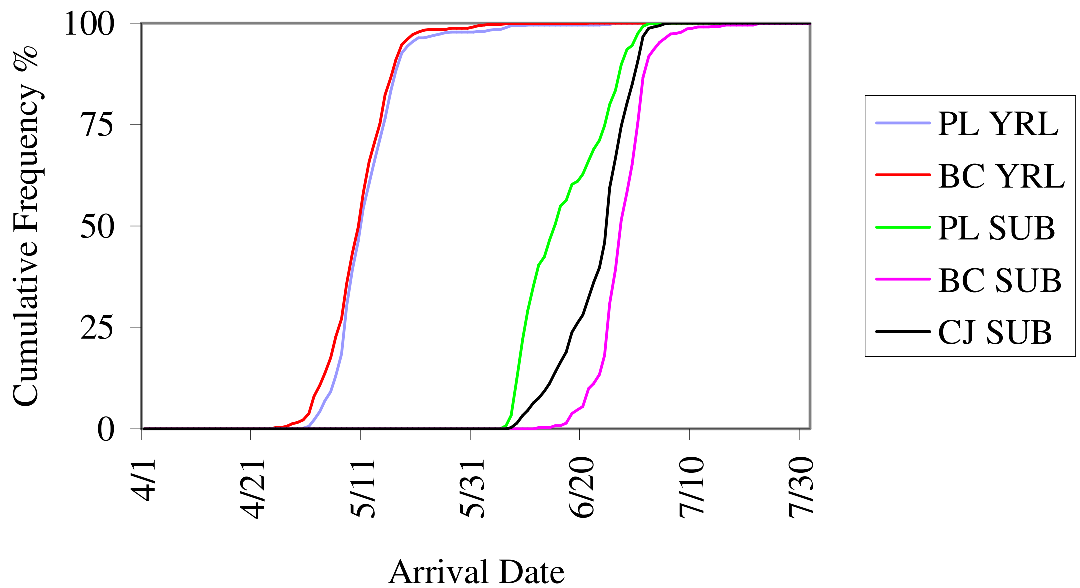

Table E.8.—All obs arrival date cumulative frequency of FCAP yearlings and subyearlings at McNary Dam in 2005.

Appendix E (continued).

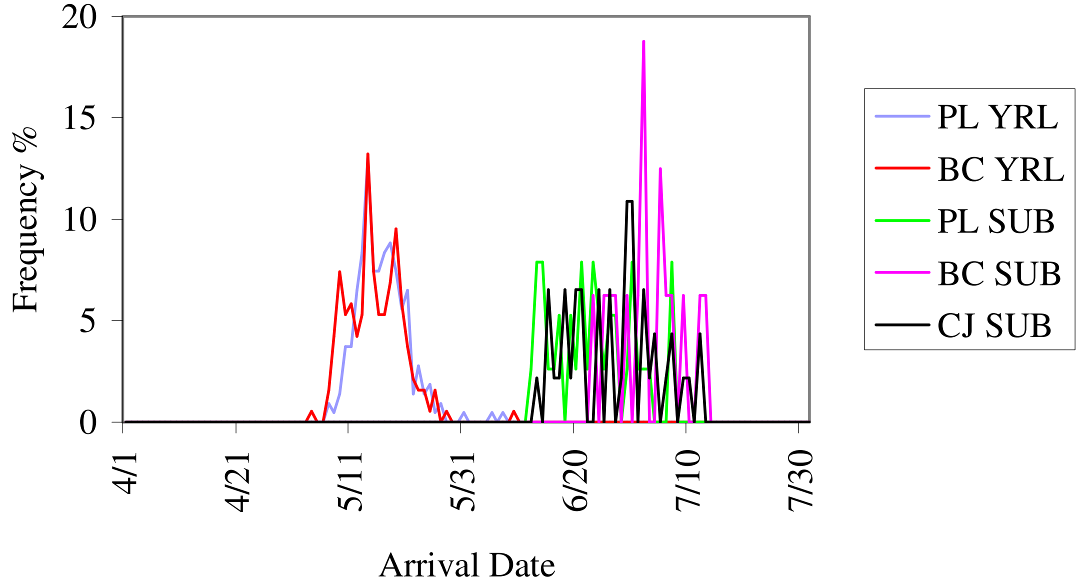

Table E.9.—All obs arrival date frequency of FCAP yearlings and subyearlings at Bonneville Dam in 2005.

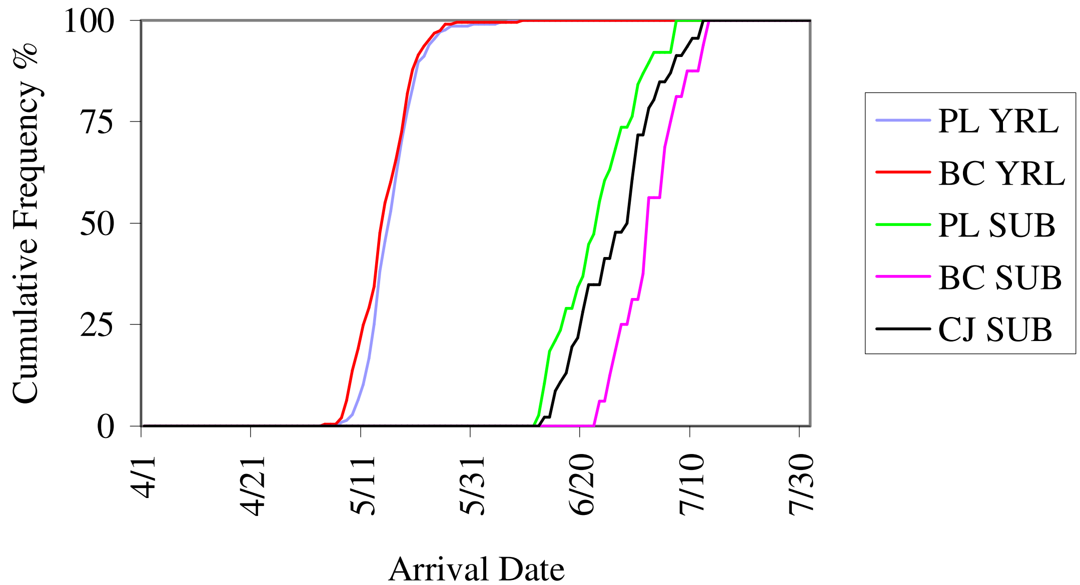

Table E.10.—All obs arrival date cumulative frequency of FCAP yearlings and subyearlings at Bonneville Dam in 2005.