Evaluate Factors Limiting Columbia River Gorge ChumSalmon Populations

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Evaluate Factors Limiting Columbia River Gorge Chum Salmon Populations

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Abstract

Adult and juvenile chum salmon were monitored during November 2002 through May 2003 to estimate abundance and determine biological characteristics, with the intent to generate information to assist in evaluating factors affecting production. A weir and trap was periodically operated for about a month in Hamilton Springs, with which 115 adult chum salmon were captured and released upstream. Biological information was collected from chum salmon carcasses in both Hardy Creek (284) and Hamilton Springs (466). Thirty-seven adult chum salmon were captured in the mainstem Columbia River and Hamilton Springs, and implanted with radio tags to investigate their movements. Abundances of juvenile chum salmon emigrating from Hardy Creek and Hamilton Springs were estimated using fyke nets during February through May 2003.

Abundance of adult was estimated using the area-under-the-curve method and various residence times (6, 7.5, and 10 days). Estimates of abundance for adult chum salmon in Hardy Creek were 285-474, and 538-897 for Hamilton Springs. Movements were detected for about a third of the adults implanted with radio tags. Males exhibited a greater tendency to move than females. Estimates of abundance (95% confidence interval) for juvenile chum salmon were 79,147 (± 13,360) for Hardy Creek and 458,813 (± 18,541) for Hamilton Springs.

Introduction

Historically, chum salmon (*Oncorhynchus keta*) had the widest distribution of all Pacific salmon, and are thought to have contributed up to 50% of the annual biomass of the seven salmon species (Nehlsen et al. 1991). In the Columbia River basin, chum salmon may have spawned as far upstream as the Walla Walla River drainage. Although there are no historic run-size data for chum salmon in the Columbia River, the maximum historical commercial fishery harvest was approximately 700,000 fish in 1928 (Columbia Basin Fish and Wildlife Authority (CBFWA) 1991). Harvest declined to about 10,000 fish annually during the 1950s. On 24 May 1999, NOAA-Fisheries (formally the National Marine Fisheries Service (NMFS)) listed the Columbia River chum salmon Evolutionary Significant Unit as threatened under the Endangered Species Act (NMFS 1999).

Chum salmon spawning is limited to Columbia River tributaries and some mainstem areas downstream of Bonneville dam. Substantial numbers of chum salmon spawn in the Grays River drainage in the lower portion of the Columbia River, whereas immediately downstream of Bonneville Dam, substantial numbers of chum salmon spawn in Hardy Creek, Hamilton Springs, and the Columbia River side channel adjacent to Pierce and Ives islands. Spawning habitat in Hardy Creek and Hamilton Springs is located the farthest upstream than other occupied spawning habitat in the basin. Hardy Creek and Hamilton Springs are about 227 km within the basin, which is about 5 km downstream of Bonneville Dam.

The United States Fish and Wildlife Service (USFWS), Columbia River Fisheries Program Office (CRFPO), has monitored adult and juvenile chum salmon in Hardy Creek since 1997. In 1999, Bonneville Power Administration provided funding to the CRFPO to monitor chum salmon in Hardy Creek and Hamilton Springs. Adult chum salmon in these streams have

been monitored during the fall by operating adult weirs, conducting spawning ground surveys, and investigating fish movement using radio telemetry. Juvenile chum salmon have been monitored during the spring by operating fyke nets to trap emigrating fish. Continued monitoring will provide a better understanding of life history requirements for Columbia River chum salmon.

The objectives of this ongoing project are to: 1. Examine factors limiting chum salmon production in Hardy Creek and Hamilton Springs, 2. Enhance and restore chum salmon production in Hamilton Springs and Hardy Creek, and 3. Evaluate relationships between chum salmon spawning in the mainstem Columbia River and those in the two tributaries.

Study Area

Hardy Creek

Chum salmon access in Hardy Creek (Figure 1) is restricted to the lower portion of the stream because a railroad culvert forms an impassable barrier. Areas upstream of the culvert are not likely to contain suitable spawning habitat due to inappropriate gradient (2-10%) and substrate composition. The lower portion of Hardy Creek was re-routed and dredged in the early 1900s creating a relatively straight, entrenched channel. During this project, the lower section of Hardy Creek (downstream of the culvert) was monitored. Every 2-5 years during high runoff events and detrimental backwater effects, fine sediments deposit on available spawning habitat in lower Hardy Creek (USFWS unpubl. data).

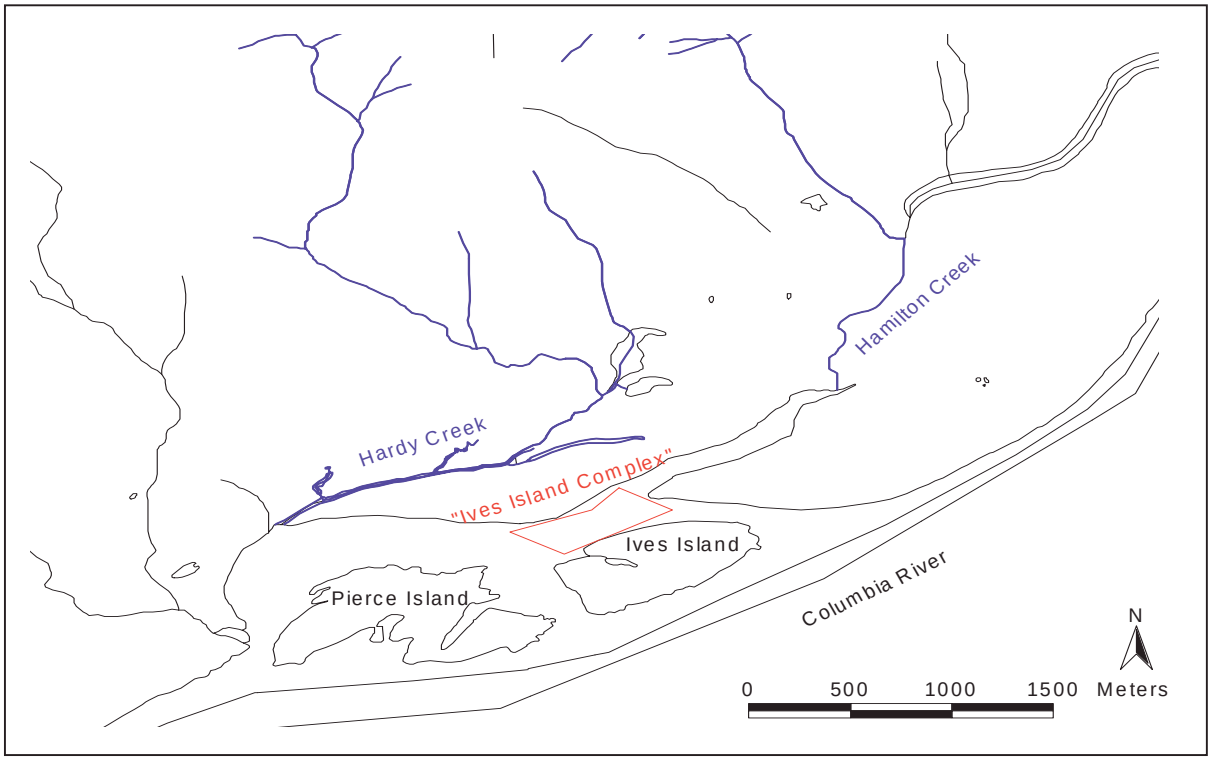

Figure 1. Area map of Hardy and Hamilton creeks, and Pierce and Ives islands.

Most of the Hardy Creek watershed is public land (primarily Washington State Parks) with a small private holding bordering State Route 14. The lower portion of the stream is located on Pierce National Wildlife Refuge. The entire watershed has been logged at least once. However, existing forests are considered second growth (approximately 35 years old) and will not be subject to future logging.

In 1996, the USFWS undertook emergency habitat restoration actions to mitigate for flooding that destroyed essentially all of the spawning habitat available to chum salmon in Hardy Creek. This flood scoured redds and caused egg suffocation through increased sedimentation. The USFWS stabilized eroding banks, restored riparian vegetation, and exposed previously buried spawning areas along a 0.64-km reach. These actions allowed subsequent runs of chum salmon to successfully spawn in much of the lower section of Hardy Creek.

During August-September 2000, the CRFPO constructed an artificial spawning channel adjacent to Hardy Creek. The intent of the channel was to improve chum salmon production by increasing spawning habitat and providing habitat that was not as susceptible to flooding from Columbia River backwater and high flow events as the existing spawning habitat. Because water is supplied to the channel by diverting a portion of the surface flow in Hardy Creek, its operation is dependent upon adequate flows (e.g., during normal or high water years).

Hamilton Creek and Hamilton Springs

Hamilton Creek historically entered a side channel of the Columbia River between the mainland and Hamilton Island. During construction of the second powerhouse at Bonneville Dam, the upstream portion of the side channel was filled to join Hamilton Island to the mainland. Thus, the lower portion of the side channel became an extension of Hamilton Creek (Figure 1).

In the early 1960s, an artificial spawning channel (i.e., Hamilton Springs) was constructed adjacent to Hamilton Creek in the town of North Bonneville. Natural springs provide water to Hamilton Springs, which typically flows during fall through late spring and are dry during summer and early fall. The majority of chum salmon spawning in the Hamilton Creek drainage use Hamilton Springs. We monitored chum salmon only in Hamilton Springs for this project.

Life History

Ages of adult chum salmon returning to the Columbia River are III through VI, with the majority of individuals typically at age IV (WDF et al. 1993. Adults that spawn in Hardy Creek and Hamilton Springs often arrive near the confluences of the creeks in late October to early November, and spawning commences when sufficient stream flows provide access to the creeks. The period of peak spawning activity in the two creeks is late November through early December (USFWS unpubl. data).

Prior to spawning, female chum salmon enter a potential spawning area and swim slowly upstream with their noses down and fins extended. They typically select areas unoccupied by

other fish immediately above turbulence or near areas of upwelling. Redd (nest) construction consists of a female turning on its side and performing a series of 4-6 body flexures that excavates gravel with its tail. A female will typically build 4-6 redds in succession within a single location. Redds are typically 20-50 cm deep in substrate that allows intergravel flow. Females cover redds with gravel within seconds after egg deposition (Groot and Margolis 1991). Compared to redd locations of other Pacific salmon, chum salmon select relatively shallow locations in areas of low water velocity.

Incubation and emergence are affected by numerous factors such as stream flow, water temperature, dissolved oxygen, gravel composition, spawning time, spawner density, and genetic characteristics (Groot and Margolis 1991). Embryos develop into sac fry that remain in the gravel until the yolk sac is completely absorbed. Chum salmon require about 400-600 temperature units to hatch, and 700-1200 for absorption of the yolk sac. Fry begin emerging from the gravel in early to mid-February, smoltify, and outmigrate immediately (USFWS unpubl. data). Smolts migrate downstream to the ocean where they grow and mature. For returning adults, the precision of homing and the degree of straying are not well documented, but indications are that homing tendencies are strong.

Methods

Adult Weir

Adult fish traps and weirs were installed in Hardy Creek and Hamilton Springs, and operated two day a week when stream flow was conducive to trapping. Captured fish were anaesthetized in a water bath containing a solution of MS-222 (tricaine methanesulfonate). Biological characteristics were recorded (i.e., sex, fork length, development stage, and condition) and scale samples collected for age analysis from anaesthetized chum salmon. A Peterson disc tag and opercle punch was applied to a portion of the individuals prior to their recovery and release upstream of the trap. Radio tags were also implanted in the gastric cavity of some fish.

Spawning Ground Surveys

Spawning ground surveys were conducted on Hardy Creek and Hamilton Springs one to five days a week during November through early January. One to three surveyors walked a stream and visually enumerated the number of live fish and carcasses, and noted apparent redds. Surveyors avoided walking through a stream when possible to minimize disturbance to chum salmon. Carcasses of chum salmon were enumerated, and inspected for tags and marks. Biological characteristics were recorded for each carcass (i.e., sex, fork length, postorbital-hypurnal length, gill color, percentage spawned), and scale and tissue samples were collected. Tails were removed from all carcasses to prevent surveyors from sampling these fish during later surveys. Numbers of live chum salmon observed during the spawning ground surveys were used to estimate the abundance of adult chum salmon in each stream using the area-under-the-curve method (see Ames 1982).

Adult Movement

Select chum salmon captured in the weirs at each stream and in tangle nets set in the Columbia River were radio tagged with a LOTEK radio transmitter (gastric implant, 148-152 Mhz). Movements of tagged fish were monitored with fixed radio-receivers at Hardy Creek, Hamilton Creek, mainstem Columbia River, and Ives Island.

Juveniles

Juvenile chum salmon were trapped using a floating fyke net (Davis et al. 1980) in Hardy Creek and a traditionally-set (i.e., net anchored in the stream with leads to the stream margins) in Hamilton Springs. Both nets captured fish moving downstream. The holding boxes for the nets were inspected daily, and all captured fish were removed and identified by species, enumerated, and checked for marks.

To estimate abundance of juveniles emigrating from each stream, trap efficiency was estimated by the capture of marked fish on a weekly basis. When fish were sufficiently abundant, up to 50 juvenile chum salmon were marked about 4 days a week. Marking fish consisted of a bath in Bismark brown, a dye that is absorbed by the fish and temporarily produces brown coloration most prominently in the fins as well as other areas. Fish to be marked were anaesthetized with MS-222, and their fork length recorded. After recovery, they were placed a 0.1 g/l solution of Bismark brown for 30 minutes. Marked fish were released upstream of the fyke net and trap in each stream. Trap efficiency was estimated as the proportion of marked fish released that was recaptured during a week (i.e., marking period). The numbers of marked fish released, marked fish recaptured, and unmarked fish captured during a marking period were tabulated and analyzed according to Arnason (1996) to estimate abundance of juvenile chum salmon and associated measures of confidence.

Intergravel conditions and juvenile emergence

To characterize intergravel water conditions relative to surface flow, piezometers were installed at three locations in Hardy Creek and two in Hamilton Springs. Water samples were periodically collected from the piezometers and each stream. Water temperature, dissolved oxygen, and conductivity were measured using a YSI meter (model 85). An emergence trap was installed over a redd in Hardy Creek to determine timing of juvenile emergence relative to intergravel conditions measured at an additional piezometer installed adjacent to the trap.

Results

Adult Weir

A new trap and weir was constructed and partially installed in Hardy Creek at a location about 400 m downstream from the site where adult traps were located in previous years. The new site was selected for improved access and site characteristics. However, the trap was not

completely installed and operated in 2002 due to extremely low water that would inhibit fish movement into the creek.

A trap and weir was installed in Hamilton Springs at the same location as that used in previous years, upstream from the confluence of Hamilton Springs with Hamilton Creek. The trap was operated twice weekly during 19 November to 14 December, 2002. When the trap was not operated during this period, adult fish were provided passage through the weir by removing bars forming the back of the trap (i.e., along the upstream side).

A total of 115 chum salmon were collected in the trap at Hamilton Springs. The majority of the individuals were males, 87 males compared to 28 females. Ages were determined for 109 individuals, and ranged from ages III through V (Table 1). A slight majority of males were age III, whereas a slight majority of females were age IV. Of the 115 chum salmon encountered at the trap, Petersen disc tags were applied to 58 and radio tags were applied to 17 (12 males and 5 females). All chum salmon captured were released upstream of the trap.

Table 1. Number and mean fork length by age and sex of chum salmon captured in the trap in Hamilton Springs, 2002. Standard deviation is presented in parentheses.

	Number[1]		Fork length (mm)	
Age	Male	Female	Male	Female
III	44	12	719 (44.6)	666 (42.2)
IV	37	14	784 (40.6)	728 (35.5)
V	1	1	810	630

[1] Ages were not determined for 6 males and 1 female that were captured.

Spawning Ground Surveys

Spawning ground surveys were conducted in Hardy Creek during 5 November 2002 through 6 January 2003. Chum salmon were first observed in the index area (i.e., stream reaches containing spawning habitat that have been consistently surveyed in previous years) on 15 November. The peak count of live chum salmon (139 individuals) was observed on 4 December, and counts remained greater than 100 individuals through 17 December. Live chum salmon were last observed on 31 December.

A total of 284 chum salmon carcasses were sampled in Hardy Creek during spawning ground surveys. Of these, 276 were found in the index area and 8 were found in the non-index area (i.e., stream reaches that have been only periodically surveyed in previous years). The majority of the individuals were males, 184 males compared to 100 females. Ages were determined for 278 individuals, and ranged from ages III through V (Table 2). A slight majority of males were age III, whereas a slight majority of females were age IV. Estimated abundance of adult chum salmon in the index area was 284 individuals, calculated by the area-under-the-curve method and assuming 10-day residence time and 100 % visibility of fish.

Spawning ground surveys were conducted in Hamilton Springs during 15 November 2002 through 6 January 2003. Chum salmon were first observed on 18 November. The peak count of live chum salmon (373 individuals) was observed on 29 November, and counts remained greater than 200 individuals through 4 December. Numbers of live chum salmon observed declined to 25 individuals on 9 December, but increased to above 200 during 13-14 December. Live chum salmon were last observed on 31 December.

A total of 466 chum salmon carcasses were sampled in Hamilton Springs during spawning ground surveys. The majority of the individuals were males, 258 males compared to 204 females. Ages were determined for 462 individuals, and ranged from ages III through V (Table 2). The majority of both sexes were age IV. Estimated abundance of adult chum salmon was 538 individuals, calculated by the area-under-the-curve method and assuming 10-day residence time and 100 % visibility of fish.

Table 2. Number, mean fork length, and postorbital-hypural length by age and sex of chum salmon carcasses in Hardy Creek and Hamilton Springs, 2002. Standard deviation is presented in parentheses.

	Number		Fork length (mm)		Postorbital-hypural length (mm)	
Age	Male	Female	Male	Female	Male	Female
			Hardy Creek			
III	92	45	737 (37.5)	668 (34.3)	559 (30.2)	533 (28.4)
IV	71	50	797 (37.2)	729 (40.1)	601 (30.1)	580 (33.7)
V	10	2	822 (28.1)	706 (7.8)	618 (32.8)	563 (6.4)
			Hamilton Springs			
III	113	64	733 (31.7)	666 (31.3)	565 (23.4)	536 (29.1)
IV	138	132	795 (34.7)	724 (41.7)	610 (31.0)	580 (38.3)
V	7	8	826 (22.6)	726 (24.5)	633 (14.7)	585 (17.1)

Thirty-two of the chum salmon carcasses surveyed in Hamilton Springs were from fish that had been captured and tagged (Petersen disc tag, radio tag, or both) at the trap. Eighteen of the individuals were males and 14 were females (Table 3). The residence time of individuals were estimated using the date of capture at the trap and the estimated date of death (i.e., midpoint date between the date of the carcass survey in which a fish was found and the date of the preceding survey). Mean residence time was slightly lower for males (7.3 days, range 1-21 days) compared to females (7.9 days, range 1-12 days). Mean residence for both sexes combined was 7.5 days.

Table 3. Residence time in days by age and sex of adult chum salmon tagged at the weir in Hamilton Springs, 2002.

	Number		Residence time in days (SD, range)		
Age	Male	Female	Male	Female	Combined
III	9	6	8.6 (5.7, 1-21)	8.3 (4.4, 1-12)	8.5 (5.0, 1-21)
IV	9	7	6.1 (3.9, 1-12)	7.3 (3.0, 1-10)	6.6 (3.5, 1-12)
V	0	1	-	9	9
--Ages combined by sex			7.3 (4.9, 1-21)	7.9 (5.0, 1-12)	-
--Ages and sex combined			-	-	7.5 (4.3, 1-21)

Adult Movement

Thirty-seven adult chum salmon were fitted with radio tags. Seventeen fish (12 males and 5 females) were captured at the weir in Hamilton Springs and released upstream. Carcasses of 9 fish (5 males and 4 females) that were tagged at the weir in Hamilton Springs were later recovered in Hamilton Springs. One male tagged at the weir resided in Hamilton Springs for 19 days, and was then detected in the Columbia River. The carcass of this fish was recovered at Beacon Rock 5 days later. Neither carcasses nor radio records were found for the remaining 7 fish tagged at the weir.

Twenty fish (11 males and 9 females) were captured in the Columbia River using tangle nets, and released in the river. One female was detected in Hardy Creek three days after tagging, and its carcass recovered three days later. Three other females were detected in Hamilton Creek for periods ranging from less than a day to about seven days. Only one of these fish was later detected in the Columbia River. Five males were detected one or more times moving between the Columbia River and Hamilton Creek for periods of less than a day to about 9 days. One of these individuals was also detected in Hardy Creek for less than a day.

Juveniles

The floating fyke net was operated during 19 February through 17 May in Hardy Creek (Table 4). Juvenile chum salmon (18) were captured the first marking period of operation and a single chum salmon was captured during the final period. The trap was not operated for nine days during a three week period in late February and early March due to high flows and debris loads that would likely injure trapped fish. A total of 8,634 juvenile chum salmon was captured with peak abundance occurring during the last week of March, which corresponded to the time when about 50% of the all juveniles had been captured (Figure 2). Mean water temperature was 9.3º C (SD=1.35, range=6.3-12.0) during the period that the trap was operated. Estimated abundance of juvenile chum salmon passing the trap was 79,147 (Darroch estimator, Arnason et al. 1996), with a 95% confidence interval of 62,787-95,507 individuals. Mean fork length of fish was typically within 1-2 mm among all marking periods. Beginning in mid-April, the abundance

of fish captured and trap efficiency was reduced due to high backwaters from the Columbia River.

Table 4. Trap efficiency, juvenile chum salmon captured, and mean fork length of marked fish by marking period for Hardy Creek, 2003. Standard deviation is presented in parentheses.

Marking Period	Dates (month/day)	Fish marked	Marked fish recaptured	Unmarked fish captured	Trap Efficiency (%)	Fork length of marked fish (mm)
1	2/19-2/22	4	0	14	0	39.8 (1.47)
2	2/23-3/1	7	0	144	0	37.7 (1.11)
3	3/2-3/8	218	43	617	19.7	38.5 (1.20)
4	3/9-3/15	140	21	863	15.0	39.3 (1.64)
5	3/16-3/22	199	22	992	11.1	39.6 (1.74)
6	3/23-3/29	195	24	2894	12.3	39.7 (1.67)
7	3/30-4/5	184	12	1025	6.5	39.9 (1.27)
8	4/6-4/12	195	16	1106	8.2	40.0 (1.47)
9	4/13-4/19	22	0	70	0	40.3 (1.32)
10	4/20-4/26	65	2	10	3.1	40.0 (1.36)
11	4/27-5/3	8	0	7	0	39.9 (1.13)
12	5/4-5/10	6	0	6	0	39.5 (1.51)
13	5/11-5/17	1	0	0	0	46.0 (--)

The fyke net was operated during 19 February through 27 May in Hamilton Springs (Table 5). Juvenile chum salmon (32) were initially captured during the second marking period of operation and individuals (8) were captured during the final period. A total of 160,640 juvenile chum salmon was captured with peak abundance occurring during the first week of April, which corresponded to the time when about 50% of the all juveniles had been captured (Figure 2). Mean water temperature was 8.2º C (SD=0.44, range=7.3-9.6) during the period that the trap was operated. Estimated abundance of juvenile chum salmon passing the trap was 485,813 (Darroch estimator, Arnason et al. 1996), with a 95% confidence interval of 440,272-531,353 individuals. Mean fork length of fish was typically within 1-2 mm among all marking periods.

Table 5. Trap efficiency, juvenile chum salmon captured, and mean fork length of marked fish by marking period for Hamilton Springs, 2003. Standard deviation is presented in parentheses.

Marking period	Dates (month/day)	Fish Marked	Marked fish recaptured	Unmarked fish captured	Trap Efficiency (%)	Fork length of marked fish (mm)
1	2/19-2/22	0	0	0	0	--
2	2/23-3/1	0	0	32	0	--
3	3/2-3/8	74	12	205	16.2	39.0 (1.21)
4	3/9-3/15	219	84	2790	38.4	39.8 (1.31)
5	3/16-3/22	195	78	12150	40.0	40.1 (1.36)
6	3/23-3/29	200	71	39966	35.5	39.9 (1.27)
7	3/30-4/5	195	57	44278	29.2	39.7 (1.29)
8	4/6-4/12	200	79	34850	39.5	39.8 (1.45)
9	4/13-4/19	195	49	16242	25.1	40.1 (1.44)
10	4/20-4/26	200	72	6460	36.0	40.5 (1.49)
11	4/27-5/3	195	64	1276	32.8	40.9 (1.75)
12	5/4-5/10	189	48	396	25.4	39.5 (1.51)
13	5/11-5/17	69	31	28	44.9	41.4 (3.08)
14	5/18-5/24	16	1	12	6.3	44.8 (6.22)
15	5/25-5/27	0	0	8	0	--

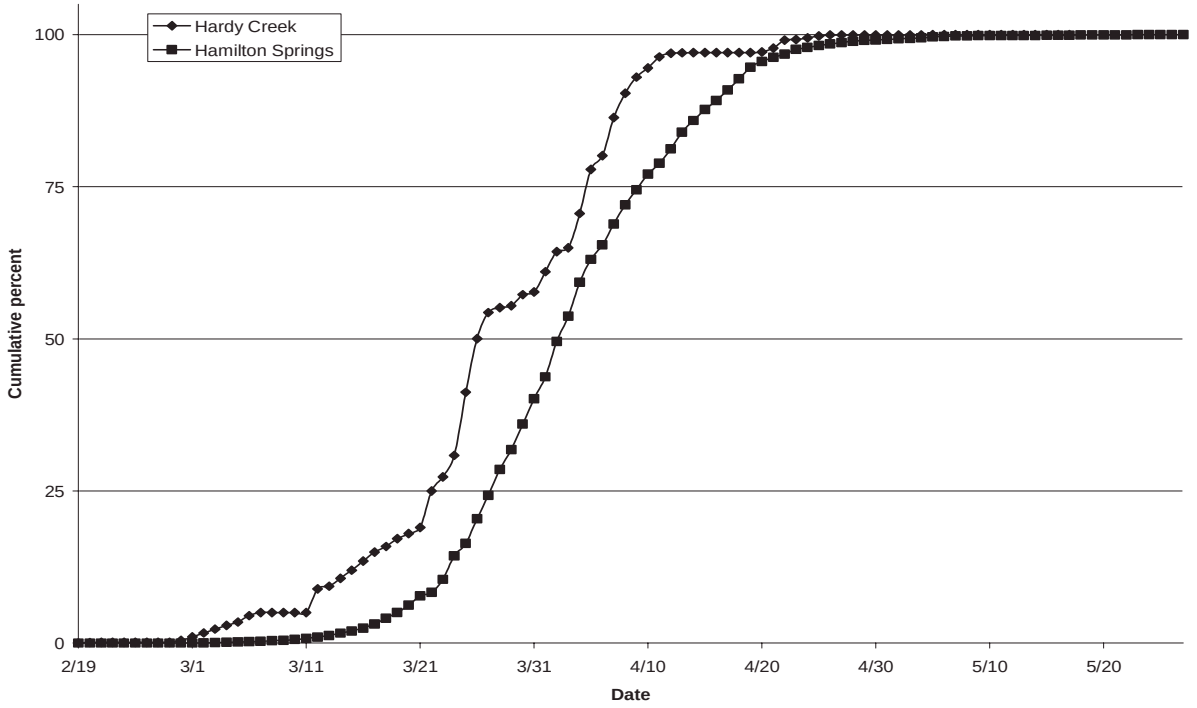

Figure 2. Cumulative percent of juvenile chum salmon captured at Hardy Creek and Hamilton Springs by date, 2003.

Intergravel conditions and juvenile emergence

Piezometers were installed in Hardy Creek and Hamilton Springs, and an emergency trap installed at a chum salmon redd in Hardy Creek. Because extremely high flows destroyed the emergency trap and piezometers in Hardy Creek in January, work on intergravel conditions was discontinued.

Conclusions

Adult Weir

Low stream flows limited the utility of the weirs and traps in Hardy Creek and Hamilton Springs in fall 2002. Because water depths at the trap site in Hardy Creek were too shallow to ensure safe passage and trapping of adults, the trap and weir were not fully installed or operated during the spawning season. The trap in Hamilton Springs was operated twice weekly during about a four-week period. We discontinued operating the trap due to further reductions in stream flow in Hamilton Creek. Moreover, some fish in and below the trap were apparently harassed by vandals at the site.

Trapping adult chum salmon is useful for obtaining biological information from individuals and applying tags, which enables the characterization of a run (e.g., by sex, age, and time of immigration) and may provide information about fish movement and residence time. However, much biological data to characterize a run can be obtained from carcasses recovered during spawning ground surveys. Work conducted by Washington Department of Fish and Wildlife is yielding information on residence time for chum salmon associated with spawning areas in the mainstem Columbia River and other tributaries (Rawding and Hillson 2003), which may be applicable to fish in Hardy Creek and Hamilton Springs. We intend to discontinue use of weirs and traps to capture adult chum salmon during the next field season due to potential negative effects on fish and the availability of alternative methods and sources for information that had previously been obtained using traps.

Spawning ground surveys

Information provided by conducting spawning ground surveys consisted primarily of: 1. Timing of fish presence (e.g., initial, peak, and final observations of live fish); 2. Counts of fish for estimate abundance based on area-under-the-curve method; and 3. Biological information collected from carcasses to characterize the runs. Entry of fish in Hardy Creek and Hamilton Springs and peak abundance (late November through early December) was similar to that observed in previous years. Biological characteristics, such as age structure and sex, were also relatively similar to that of previous years (i.e., predominance of age IV fish and generally greater abundance of male than female individuals).

Estimates of abundance were calculated for Hardy Creek (284 individuals) and Hamilton Springs (538 individuals) by the area-under-the-curve method and assuming 100% visibility and a residence time of 10 days. We estimated mean residence of fish tagged at the trap in Hamilton

Springs to be 7.5 days. Rawding and Hillson (2003) estimated residence time for fish in the Columbia River near Hardy Creek and Hamilton Springs to be about 6 days. Assuming mean residence times of 7.5 and 6 days, abundance estimates for Hardy Creek are 379 and 474 individuals, respectively, and 717 and 897, respectively, for Hamilton Springs. The dependence of abundance estimates on residence time using the area-under-the-curve method highlights the importance of accurate assumptions and multiple methods for estimating abundance. We intend to explore applying alternative methods for abundance estimates (e.g., estimates derived from carcass marking).

Adult movement

Thirty-seven adult chum salmon were implanted with radio tags by the USFWS during 2002 (17 in Hamilton Springs and 20 in the Columbia River). Less than a third of the 37 fish (10 individuals—1 initially tagged in Hamilton Springs and 9 in the Columbia River) were detected by stationary radio receivers in areas other than where they were initially tagged. The majority of these individuals were males. These observations are similar to those made in previous years indicating the proclivity of male chum salmon to move more than females.

Juveniles

Estimates of abundance for juvenile chum salmon in Hardy Creek and Hamilton Springs during 2003 were within the ranges of estimates made in previous years. Estimated abundance for Hardy Creek (79,147) was about six times lower than that estimated for juveniles in Hamilton Springs (458,813). Because estimates of abundance for adults spawning in Hardy Creek during 2002 was about half of the adults estimated in Hamilton Springs, the greater difference in juvenile abundance between the sites was likely related to both differential sampling (i.e., with respect to effort and efficiency) and juvenile survival. Sampling effort was lower in Hardy Creek because we were unable to operate the juvenile trap due to extremely high flows and debris loads, which likely would have increased mortality of captured juveniles. Also, trap efficiency was more variable in Hardy Creek than Hamilton Springs due to stream flow and backwaters from the Columbia River. Incubating chum salmon may have experienced higher mortality in Hardy Creek than Hamilton Springs due to scouring caused by extremely high stream flows in January.

Lowering of capture rates due to backwaters from the Columbia River may have contributed to the earlier date of peak emigration (based on timing when 50% of all juveniles for the season were captured) observed for Hardy Creek compared to Hamilton Springs. However, water temperatures were slightly warmer in Hardy Creek during juvenile trapping, though more variable, than in Hamilton Springs, which may have also contributed to differences in timing between the two sites.

Intergravel conditions and juvenile emergence

The piezometers and emergence trap installed in Hardy Creek were destroyed by extremely high flows in January. This was especially unfortunate because the emergence trap used a design substantially different than traps that had not been successful in Hamilton Springs

in a previous year. We intend to further evaluate the utility of the emergence trap in 2003-2004 by installing more traps in both Hardy Creek and Hamilton Springs. If successful, we believe that information generated from the traps and piezometers will greatly assist in assessing factors influencing chum salmon during early life-history stages in tributaries, which will in part compliment information generated in the Columbia River (e.g., Geist et al. 2001).

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