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4.13 EVALUATION OF ANADROMOUS SALMON BEHAVIOR AND HABITAT SELECTION IN THE UPPER LEWIS RIVER WATERSHED, PHASE 2 (AQU 13)

4.13.1 Background

As discussed in previous Lewis River relicensing documents (PacifiCorp and Cowlitz PUD 2000, PacifiCorp and Cowlitz PUD 2002), anadromous salmonid access into the upper Lewis River basin has been blocked for more than 50 years. As a result, there is a limited amount of biological data describing the behavior, habitat selection, potential productivity and life histories of key analysis species that may be reintroduced upstream of Merwin Dam. Due to this lack of site-specific information, analysis of anadromous fish reintroduction alternatives is proceeding with a high level of uncertainty.

To address some of this uncertainty, the Aquatic Resources Group (ARG) developed a study plan designed to (1) evaluate fingerling to smolt production in the upper watershed; (2) estimate the survival and movement patterns of salmon smolts from the upper Lewis River through Swift Reservoir; and (3) help establish where juvenile salmon collection efforts would be most effective (PacifiCorp and Cowlitz PUD 2001). There was uncertainty whether salmon fry could occupy the habitat in the mainstem of the Lewis River and its tributaries, or if they would be swept out of the river system into Swift Reservoir.

Phase 1 of this study (conducted during November and December of 2000) demonstrated that adult radio-tagged hatchery coho did not appear to utilize bull trout spawning areas above Swift Reservoir (PacifiCorp and Cowlitz PUD 2000). Ground and aerial radio tracking and redd surveys did not detect coho activity in either Pine or Rush creeks, two of the primary bull trout spawning and early rearing areas upstream of Swift Dam. Several coho did show a preference for the Muddy River system. Coho use of the Muddy River and its major tributaries is also noted in Chambers (1957).

Phase 2 of this study was initiated in the spring of 2001 and reported in a previous publication (PacifiCorp and Cowlitz PUD 2002). The report that follows summarizes the Phase 2 study results and documents the results of additional sampling in 2002. This report also incorporates the results of a 2002 juvenile coho survey conducted in upper basin tributaries by the USDA Forest Service (USFS). A draft report documenting the results of the USFS survey was originally submitted to the ARG (via email) on November 20, 2002.

4.13.2 Study Objectives

The 5 primary objectives of AQU 13 Phase 2 (as modified by WDFW and submitted to the ARG on January 23, 2002)[1] are to:

- Determine timing and migration of hatchery origin fry in the natural environment of the upper Lewis sub-basin.

[1] WDFW's rational for the modification of the original study objectives is included in AQU 13 Appendix 1 (PacifiCorp and Cowlitz PUD 2004).

- Identify adult spawning locations and reintroduce marine nutrients.
- Estimate smolt survival through Swift Reservoir.
- Monitor the movements of smolts through Swift Reservoir and its major tributaries.
- Provide empirical data in lieu of current estimated figures of smolt survival in the Fish Passage Feasibility Study (PacifiCorp and Cowlitz PUD 2004: AQU 5).

This report responds to the first objective. Estimates of smolt survival and migration through Swift Reservoir are addressed in the results of AQU 14 *Migratory Behavior of Coho Salmon Smolts Through Swift Reservoir, with Implications of Fish Collection at Swift Dam, 2001* (PacifiCorp and Cowlitz PUD 2001; PacifiCorp and Cowlitz PUD 2004).

4.13.3 Study Area

This study documents fish movement in the upper Lewis River, Muddy River, and other upper Lewis River basin tributaries.

4.13.4 Methods

Phase 2 of this study was initiated in the spring of 2001 when WDFW released 290,000 juvenile spring Chinook and 200,665 juvenile coho into the upper Lewis River basin (Table 4.13-1). Release locations included the mainstem Lewis River near Crab Creek, the upper Muddy River, the lower Muddy River and an unnamed tributary to the upper Muddy River near the confluence with Smith Creek. Thirty adult female and 90 adult male coho were also released in the upper Lewis River in the fall of 2000 (Phase 1 of AQU 13).

Table 4.13-1. The number of spring Chinook and type-N coho released into the upper Lewis River basin in the spring of 2001.

Species	Number Released	Release Date	Marked (Y/N)	Release Location
Spring Chinook	150,000	3/27/01	N	Lewis River near Crab Creek
Spring Chinook	140,000	4/2/01	N	Upper Muddy River
Type N Coho	100,266	4/23/01	N	Lower Muddy River
Type N Coho	100,399	5/24/01	Y	Unnamed Upper Muddy River tributary

WDFW then released 3,505 female and 3,506 male adult coho salmon (a mix of both early and late-run fish) into Swift Reservoir in the fall of 2001. Forty-seven male and 35 female adult spring Chinook were also released into Swift Reservoir in the late summer of 2001. These adult fish were allowed to spawn naturally in the upper mainstem Lewis River and its tributaries. Unlike 2001, no juvenile anadromous salmonids were planted in the upper basin in 2002.

To evaluate juvenile salmonid outmigration timing and other biological data in 2001 and 2002, PacifiCorp and Cowlitz PUD installed an 8-foot-diameter EG Solutions, Inc. screw trap in the mainstem Lewis River at Eagle Cliff (just upstream from the Forest Road 90 Bridge) (Figure 4.13-1). The trap was positioned in the river thalweg to maximize downstream migrant capture rates. Fish that were captured during sampling were removed from the live box on a daily basis, identified to species, measured for fork length. In 2001, captured smolts were marked with a differentiating fin clip. All fish except bull trout were clipped, transported, and released at a site approximately 0.75 miles upstream from the confluence of Pine Creek and the Lewis River. In 2002, no fish were clipped or transported upstream of the trap; however, those larger than 12 inches received a small floy tag to determine their location and migration rate if caught again at a lower trap positioned in the Swift No. 1 tailrace. No tagged fish were recovered at the Swift No. 1 trap. Bull trout, because of their federal threatened status under the Endangered Species Act (ESA), were not fin clipped and were released at the capture site in both 2001 and 2002 (PacifiCorp and Cowlitz PUD 2004).

Figure 4.13-1. Photograph of the screw trap located in the mainstem Lewis River at Eagle Cliff.

The collection of fish at the Eagle Cliff location represents a sampling of the species composition, size distribution, and timing of movement of fish that are migrating between upper watershed tributaries and Swift Reservoir.

4.13.5 Key Questions

The following key questions identified during the Lewis River watershed studies scoping process relate to this study:

- How may hatcheries be used to help restore naturally reproducing stocks of salmonids in the watershed?

  Trapping indicated that both planted (hatchery) and naturally produced sub-yearlings and yearlings moved from the upper Lewis River system into Swift Reservoir. Downstream movement of Chinook and coho increased in early-July, peaked in mid-July, and slowly declined through late August and early-September. Supplementation using either adult or juvenile hatchery salmonids appears to be a viable means of reintroducing anadromous salmonids into the upper basin.

- What benefits to aquatic and terrestrial communities and ecosystems might accrue from the reintroduction of anadromous fish (e.g., nutrient enrichment of headwater streams, important seasonal food source for terrestrial species)?

  This is addressed in the Phase 1 study results, reported in the 2001 technical studies report (PacifiCorp and Cowlitz PUD 2002).

- What is the estimated potential for production of each species that may occur with reintroduction to upstream areas?

  Trapping conducted in 2002, described in this report, indicated that a substantial number of spring Chinook and coho were produced as a result of natural spawning in the upper basin. Quantitative estimates of production potential are not presented in this report.

- Where do natural and artificial barriers to anadromous fish movement currently occur upstream of Swift Reservoir?

  This is addressed in study AQU 4, *Assessment of Potential Anadromous Fish Habitat Upstream of Merwin Dam* (PacifiCorp and Cowlitz PUD 2004).

- What types of reintroduction methods might be successful in the Lewis River watershed and what is the potential cost and engineering feasibility of each of these methods (e.g., trapping and hauling, construction of fishways, screening, stocking of fry, planting of eggs)?

  This question is partially addressed in this report and also is addressed in AQU 5, *Engineering Feasibility of Fish Passage Facilities* (PacifiCorp and Cowlitz PUD 2004).

Although identified in the study plan for AQU 13, the methods were not designed to answer the following key questions:

- Is there potential for habitat enhancement to increase the quality and/or quantity of habitat that would become available to anadromous fish? Where might habitat enhancements occur and what types would be suitable for the watershed?
- How would reintroduction of anadromous fish affect bull trout and kokanee populations?
- What physical, chemical, and biological conditions currently exist in project reservoirs or stream habitats that may affect anadromous fish movements and migrations and how might potential impacts resulting from these conditions be reduced?
- What types of interspecific interactions may occur with various options for reintroducing anadromous fish?
- What types of reservoir management alternatives might increase the potential success of anadromous fish reintroduction efforts (e.g., reservoir drawdown to facilitate downstream migration of smolts)?
- How would the creation of fish passage benefit or impact reservoir ecosystems and the overall ecological integrity of the watershed?

4.13.6 Results

4.13.6.1 2001 Eagle Cliff Trapping Results

In 2001, the Eagle Cliff screw trap was operated from May 17 through June 28. During this period, spring Chinook were the most abundant fish species captured, comprising 65 percent of the total trap catch (Table 4.13-2). Coho were the second most abundant, comprising 13 percent of the total catch. Steelhead, bull trout, cutthroat trout, and rainbow trout were less abundant (Table 4.13-2).

Table 4.13-2. The number of each species of fish trapped in the Eagle Cliff screw trap, the average trapping efficiency (where applicable), and the estimated number of each species moving past Eagle Cliff, May 17, 2001 through June 28, 2001.

Species	Number Trapped	Average Trap Efficiency	Estimated Number of Fish Moving Past Eagle Cliff
Spring Chinook	1,940	40.41%	6,113
Coho	401	13.31%	3,242
Steelhead	95	10.65%	2,579
Bull Trout	83	NA	NA
Cutthroat Trout	102	13.71%	1,065
Rainbow Trout	81	12.64%	1,011

NA = Not Applicable.

Spring Chinook

A total of 1,940 spring Chinook were captured in the Eagle Cliff trap in the spring of 2001 (Table 4.13.2). The majority were collected in June. Fork lengths of captured Chinook ranged from about 90 to 130 mm and there was no bi-modal distribution (i.e., indicating only one age class). Spring Chinook trap efficiencies averaged 40.41 percent. Statistically, there was a highly significant increase in the number of spring Chinook captured each day of sampling ($r=0.80$, $r^2=0.65$, $p=0.000$) (i.e., daily catches increased up until the trap was removed). Emigration did not appear to diminish prior to trap removal (June 28), and as a result, it is unknown if the peak migration period was actually reached during the 2001 sampling period. WDFW personnel conducting the trapping indicated that approximately 40 percent of the spring Chinook collected in late June (8 out of 20 sampled fish) were actively migrating smolts (ATPase levels in the 4 through 6 µmoles P/hr/mg protein range).

Coho

A total of 401 coho were recovered during screw trap sampling in 2001 (Table 4.13.2). Approximately 67 percent of these were fish released in the lower Muddy River (unmarked fish). Marked coho (those released into the unnamed upper Muddy River tributary) represented the remaining 33 percent. Most coho captured in 2001 were in the 55 to 85mm range. Smaller fork lengths most likely represent young-of-the-year progeny of 30 female coho that were allowed to spawn in the upper Lewis River the previous fall. Coho trap efficiencies ranged from 5.13 percent to 19.05 percent and averaged 13.31 percent (Table 4.13-2). Like spring Chinook, there was a highly significant statistical increase in coho captures over time ($r=0.57$, $r^2=0.32$, $p=0.000$), with peak emigration occurring in late June.

Steelhead

Steelhead have been excluded from the upper Lewis River since the late 1930s. In 1999 however, 93,700 steelhead fry were released into Swift Reservoir to make up for a shortfall in the numbers of rainbow trout available for release due to IHNV mortality at the Merwin Trout Hatchery. In the spring of 2001, WDFW personnel captured 95 steelhead in the Eagle Cliff trap[2], the result of 1999 plants (Table 4.13-2). These fish spent 2 years in the wild since release, and most were much longer than what would be considered large hatchery smolts. Steelhead were trapped throughout the study period. Fork lengths of recovered fish ranged from 255 mm (10 inches) to 350 mm (13.5 inches), greater than WDFW's hatchery target steelhead fork length of 190 to 210 mm. Steelhead trap efficiencies ranged from 2.70 to 28.57 percent and averaged 10.65 percent (Table 4.13-2).

[2] Steelhead were identified based on the following visual criteria: steelhead were much more silvery, had lower condition factors (slimmer), and had dark margins on their caudal fins compared to their resident rainbow trout counterparts.

Bull Trout

Bull trout were trapped throughout the 2001 survey period, with most of the 83 captures reported early in the trapping period (Table 4.13.2). Captured bull trout fork length frequencies showed peaks at 130, 160, 180, and 200 mm. Due to endangered species concerns, bull trout scales were not removed for age analysis, nor were fins clipped to determine trap efficiency. Peak emigration appeared to occur in late May and early June. Bull trout showed a relatively steady but negatively correlated emigration rate over the sampling period ($r = -0.34$, $r^2 = 0.12$, $p=0.027$).

Cutthroat Trout

Of 102 cutthroat trout captured in 2001, only 2 fish (2 percent) were greater than 250 mm (10 inches) in length (Table 4.13.2). Cutthroat trout fork lengths ranged from 40 to 344 mm, with frequencies peaking at 130 mm and 180 mm. Larger individual fish measured 250, 290 and 340 mm. There was a statistically significant increase in cutthroat captures over the sampling period ($r = 0.37$, $r^2 = 0.14$, $p=0.016$). This was caused in large part by 21 recoveries on June 27 (the end of the sampling period), when 0.61 inches of rain was recorded at Swift Dam. Cutthroat trap efficiencies ranged from 5.26 percent to 33.33 percent and averaged 13.71 percent (Table 4.13-2).

Rainbow Trout

A total of 81 rainbow trout were captured in the Eagle Cliff screw trap in 2001 (Table 4.13.2). Captures were generally less than 4 per day except on June 28, the final day of sampling, when 16 were captured. The single largest daily rainfall (1.25 inches) recorded for the trap period occurred on this day and may have flushed rainbow trout downstream into the trap. Fork lengths ranged from 69 to 408 mm; however, there were only 14 rainbow trout above 250 mm (10 inches). Rainbow trout trap efficiencies ranged from 4.76 percent to 18.75 percent and averaged 12.64 percent (Table 4.13-2).

Other Species

Although the emphasis of this study was on salmonid trapping, 239 sculpin (Cottidae), 20 suckers (Catostomidae), 11 mountain whitefish (*Prosopium williamsoni*), and 15 sticklebacks (*Gasterosteus aculeatus*) were also captured. No attempt was made to identify sculpin or suckers to the species level. Many of the sculpin captures were associated with rain events. Mountain whitefish and sucker recoveries occurred primarily in May and tapered off in June. Trap efficiencies are not available for these species.

4.13.6.2 2002 Eagle Cliff Trapping Results

The screw trap was reinstalled at the Eagle Cliff site in 2002 during the week of March 25; however, after just 5 days of sampling, a high flow event severely damaged the trap. Extensive repairs to the screw trap and high flows precluded reinstallation until June 17, 2002. Sampling continued until September 13, 2002. All trapping data were entered into an MS Access relational database designed for the study. This facilitated data analysis

and allowed the fish collection information to be related to other watershed parameters that have the potential to influence the migratory behavior (e.g., average daily stream flows).

Because of trap damage, sampling in 2002 was limited to 66 days, most of which occurred during the summer season (Table 4.13-3).

Table 4.13-3. Eagle Cliff trap sampling periods and the number of sample blocks (days) in 2002.

Season	Sampling Period	Number of Sample Blocks (Days)
Winter	December 2001 – February 2002	0
Spring	March – May 2002	5
Summer	June – August 2002	41
Fall	September – November 2002	10

Rainbow trout were the most abundant species captured in the Eagle Cliff trap in 2002, representing 49 percent of the total catch (Table 4.13-4). Spring Chinook and coho were the second and third most abundant species captured, each representing about 24 percent of the catch. The least abundant species trapped in 2002 were cutthroat trout (2 percent), bull trout (1 percent), and mountain whitefish (1 percent). The month of July resulted in the greatest number of fish trapped compared to other months. The total number of fish trapped in July was approximately 3.5 times greater than the number of fish captured in September, the month that had the second greatest number of fish trapped.

Table 4.13-4. Number of each species captured in the Eagle Cliff trap and the number of sampling days each month, March 30 through September 13, 2002.

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Bull Trout	4	1		9	6	1		**21**
Coho	34	16		8	442	58	116	**674**
Cutthroat				6	45		1	**52**
Mountain Whitefish				1	2	1	21	**25**
Rainbow	2	13		37	896	48	406	**1,402**
Spring Chinook				28	599	55		**682**
Total	**40**	**30**	**0**	**89**	**1,990**	**163**	**544**	**2,856**
Number of Sample Days	2	3	0	10	16	15	10	56

Spring Chinook

A total of 682 spring Chinook entered the trap between June 20 and August 29, 2002 (Table 4.13-3). The majority these (24 percent) were collected in the month of July, with peak emigration occurring on July 16 (Figure 4.13-2).

As can be seen in Figure 4.13-3, fork lengths of captured spring Chinook ranged from about 30 to 210 mm. Peaks were observed at 70, 120, and 180 mm; however, only two age classes of spring Chinook were present in the upper basin in 2002. The smaller spring Chinook (30 to 110 mm in length) most likely represent young-of-the-year - progeny of the 47 male and 35 female adult spring Chinook that were released in the fall

of 2001. The larger spring Chinook (150 to 210 mm in length) were likely yearlings resulting from hatchery plants in the spring of 2001 (Section 4.13.4). Unlike 2001, no juvenile anadromous salmonids were planted in the upper basin in 2002. The relatively large number of spring Chinook captured in the 120 mm size class represent either fast growing sub-yearlings or slow growing yearlings. Estimates of fish length made in the field to facilitate data collection during days when large numbers of fish were captured may have also slightly skewed these data. In 2001, 40 percent of the spring Chinook captured were in the 110 mm range were sub-yearling smolts.

Coho

Coho was the third most abundant species captured during screw trap sampling in 2002 (Table 4.13-4). Six-hundred-and-seventy-four coho salmon were recovered, representing 24 percent of all fish captured. Like spring Chinook, the majority of these were collected in the month of July (Figure 4.13-4). Peak coho emigration (135 fish) occurred on July 16.

Captured coho fork lengths are depicted in Figure 4.13-5. Like spring Chinook, it appears that at least 2 age classes of coho emigrated in 2002. Peaks were observed at 60 and 110 mm. The smaller coho (30 to 80 mm in length) most likely represent young-of-the-year fish resulting from natural spawning (3,505 female and 3,506 male adult coho salmon were planted in the upper basin in the fall of 2001). The larger coho (90 to 140 mm in length) are likely yearlings that resulted from hatchery plants in the spring of 2001 (Section 4.13.4). No juvenile coho were planted in the upper basin in 2002.

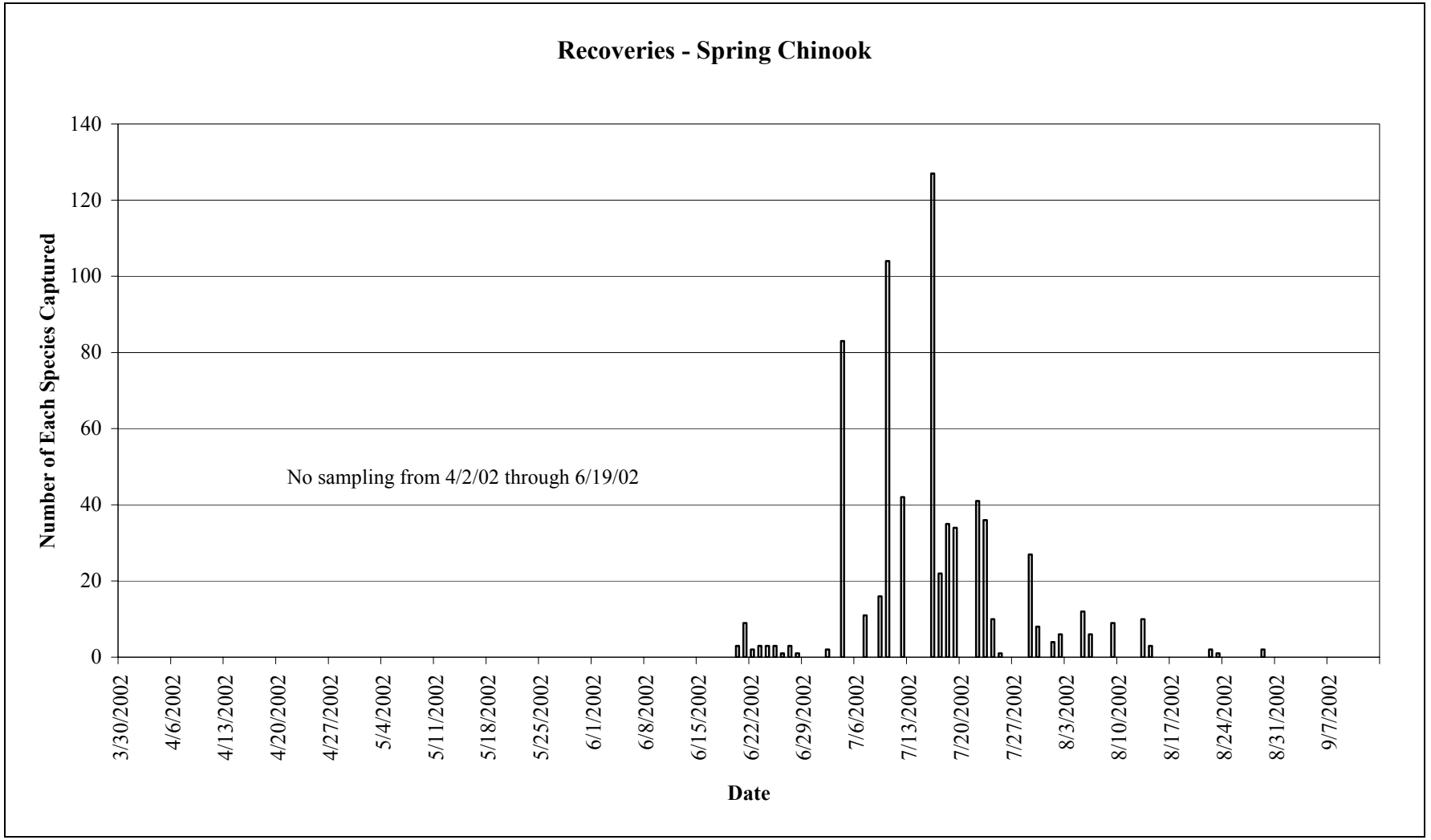

Figure 4.13-2. Eagle Cliff screw trap spring Chinook recoveries, March 30 through September 13, 2002.

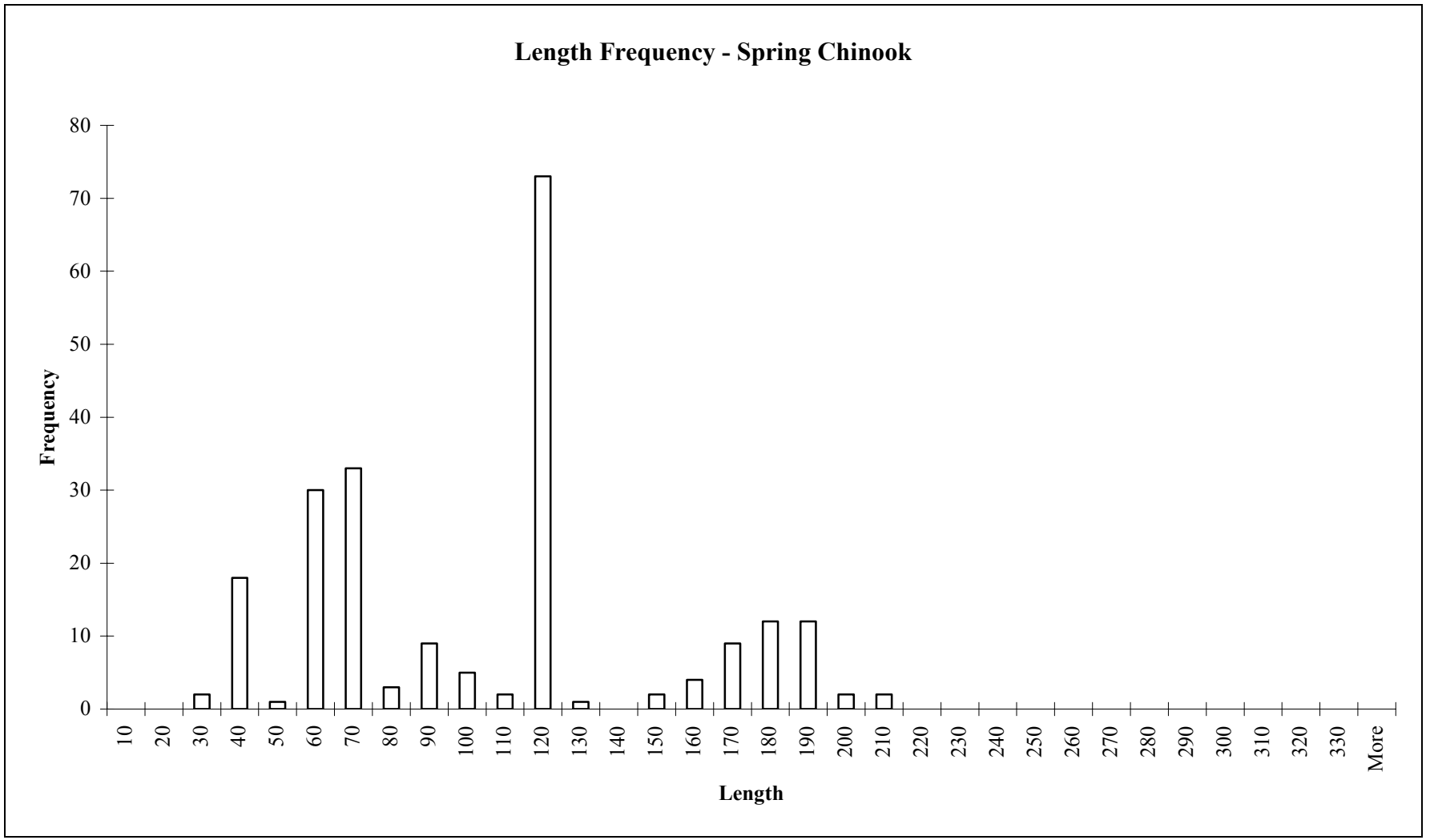

Figure 4.13-3. Length frequencies of spring Chinook recoveries in the Eagle Cliff screw trap, March 30 through September 13, 2002.

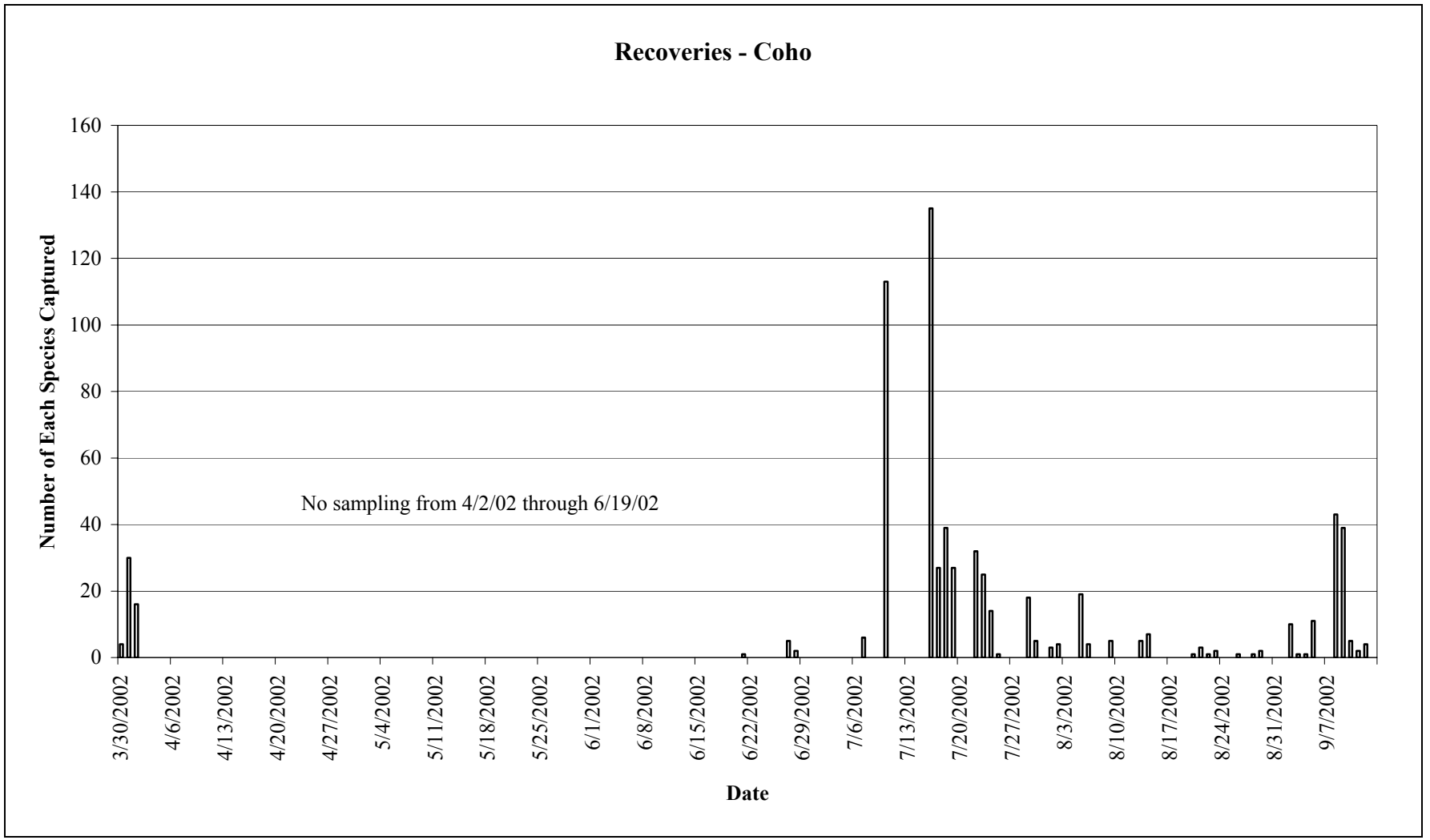

Figure 4.13-4. Eagle Cliff screw trap coho recoveries, March 30 through September 13, 2002.

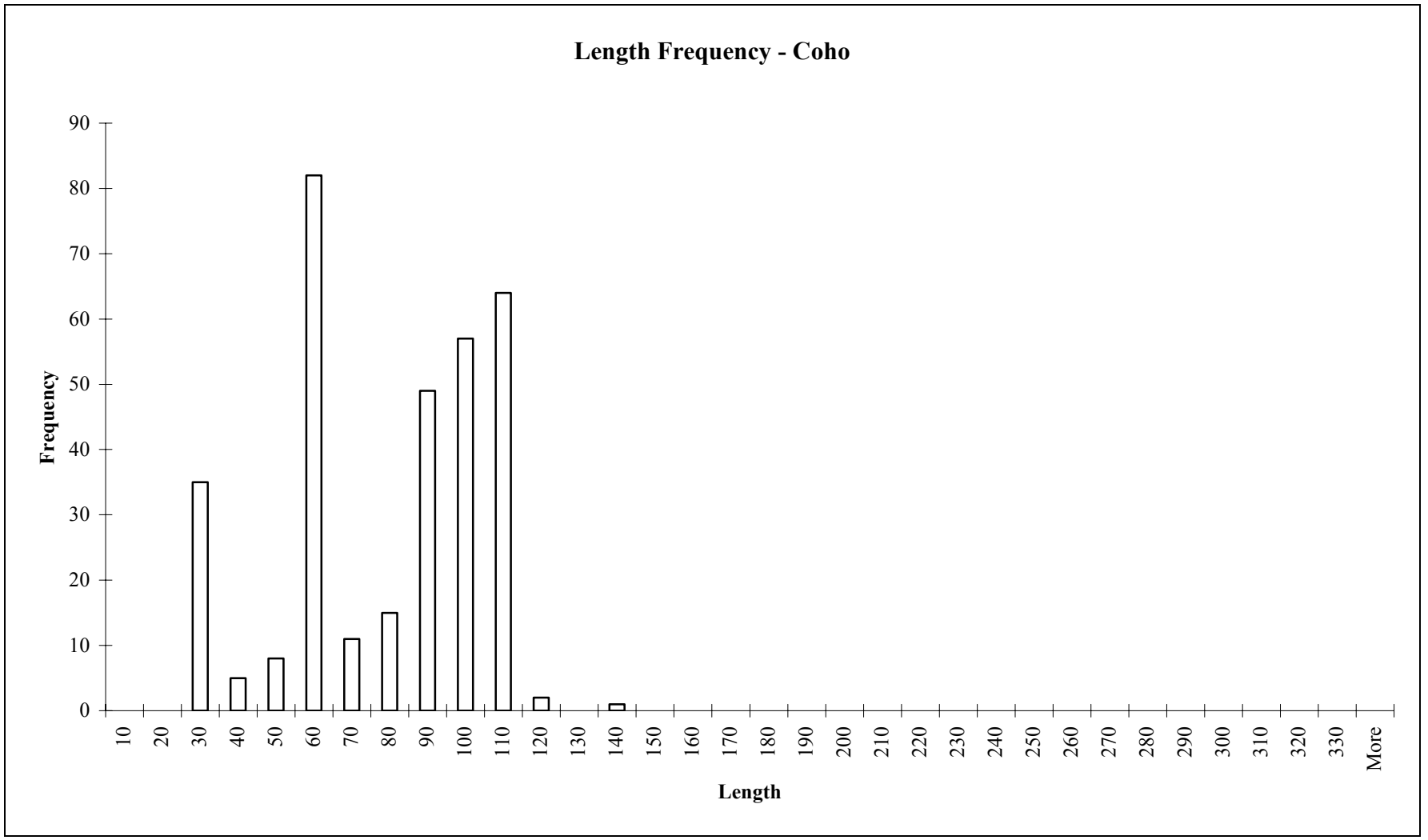

Figure 4.13-5. Length frequencies of coho recoveries in the Eagle Cliff screw trap, March 30 through September 13, 2002.

Rainbow Trout

Rainbow trout (the resident form of *O. mykiss*) was the most abundant species captured in 2002, representing 49 percent of the total catch (Table 4.13-4). Like Chinook and coho, the majority of these were captured in July (Figure 4.13-6); however, a substantial peak in migration (collection) was also observed in early September. Unlike 2001, no steelhead smolts were reported to enter the trap in 2002. The steelhead smolts collected during trapping in 2001 were believed to be 2 year old fish that were planted in Swift Reservoir in 1999 (to make up for a shortfall in rainbow trout numbers due to an IHNV outbreak at Merwin Hatchery). Steelhead were not planted in 2000 or 2001.

It appears that several age classes of rainbow trout were captured in the Eagle Cliff trap in 2002 (Figure 4.13-7). Clear peaks were observed at 40 to 50 mm and at 100 to 120 mm. Several fish in the 300 mm range were also captured in 2002. The smaller rainbow trout (30 to 70 mm in length) most likely represent young-of-the-year fish resulting from natural spawning or recent hatchery plants. The larger rainbow trout were also the result of either natural production or annual releases in Swift Reservoir. Non-native stocks of rainbow trout have been planted in Swift Reservoir since at least 1978 (PacifiCorp and Cowlitz PUD 2000). The primary stock source is from the Goldendale Hatchery in Washington; however, rainbow trout stocks from the Spokane Hatchery (Washington) and Mt. Whitney Hatchery (California) have also been planted. Since 1978, between 800,000 and 1,000,000 rainbow trout fry (at 25 to 40 fish per pound) have been stocked in Swift Reservoir annually (as required by Article 51 of the existing Merwin Project FERC license). These fish are incubated and reared at the Merwin Trout Hatchery.

Bull Trout

A total of 21 bull trout were captured in the Eagle Cliff screw trap from late March through early August 2002 (Table 4.13.4). The greatest number captured in one day of sampling was 4 fish (on March 31). Throughout its range, juvenile bull trout emigration has been reported to occur during the spring, summer and fall (Goetz 1989). Although a true peak in upper Lewis River migration timing is difficult to determine from the 2002 data (due to the small number of bull trout captured), most were collected between late June and early July (Figure 4.13-8). This emigration period is consistent with that described in previous Lewis River studies (PacifiCorp and Cowlitz PUD 2002: AQU 1). It should be noted, however, that the trap was not operated during most of April and May.

Length frequencies for bull trout captured in 2002 are provided in Figure 4.13-9. There was a clear frequency peak at 130 mm. Other age classes were not as evident due to the small sample size; however, 4 captured bull trout in the 170 to 190 mm range.

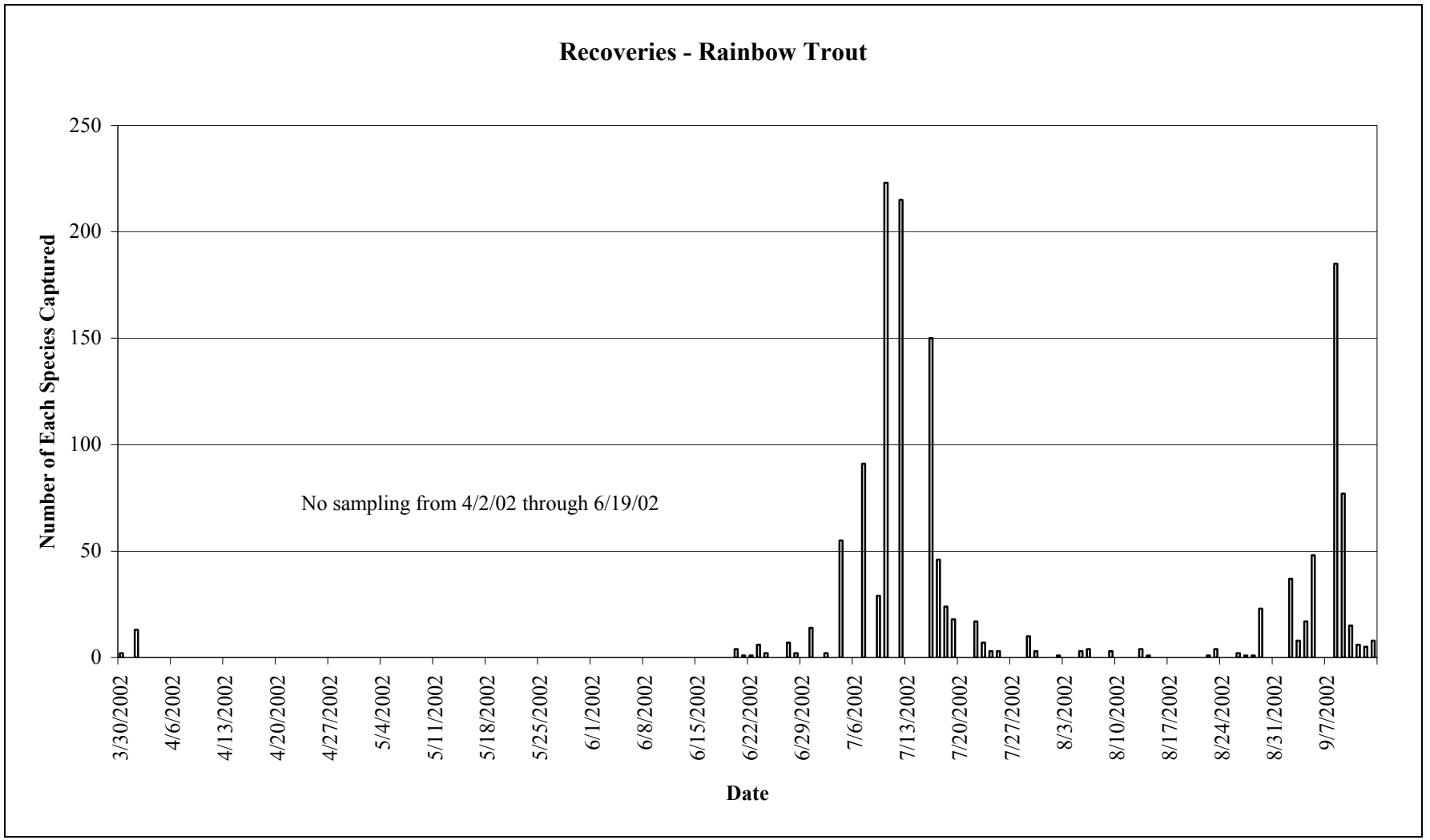

Figure 4.13-6. Eagle Cliff screw trap rainbow trout recoveries, March 30 through September 13, 2002.

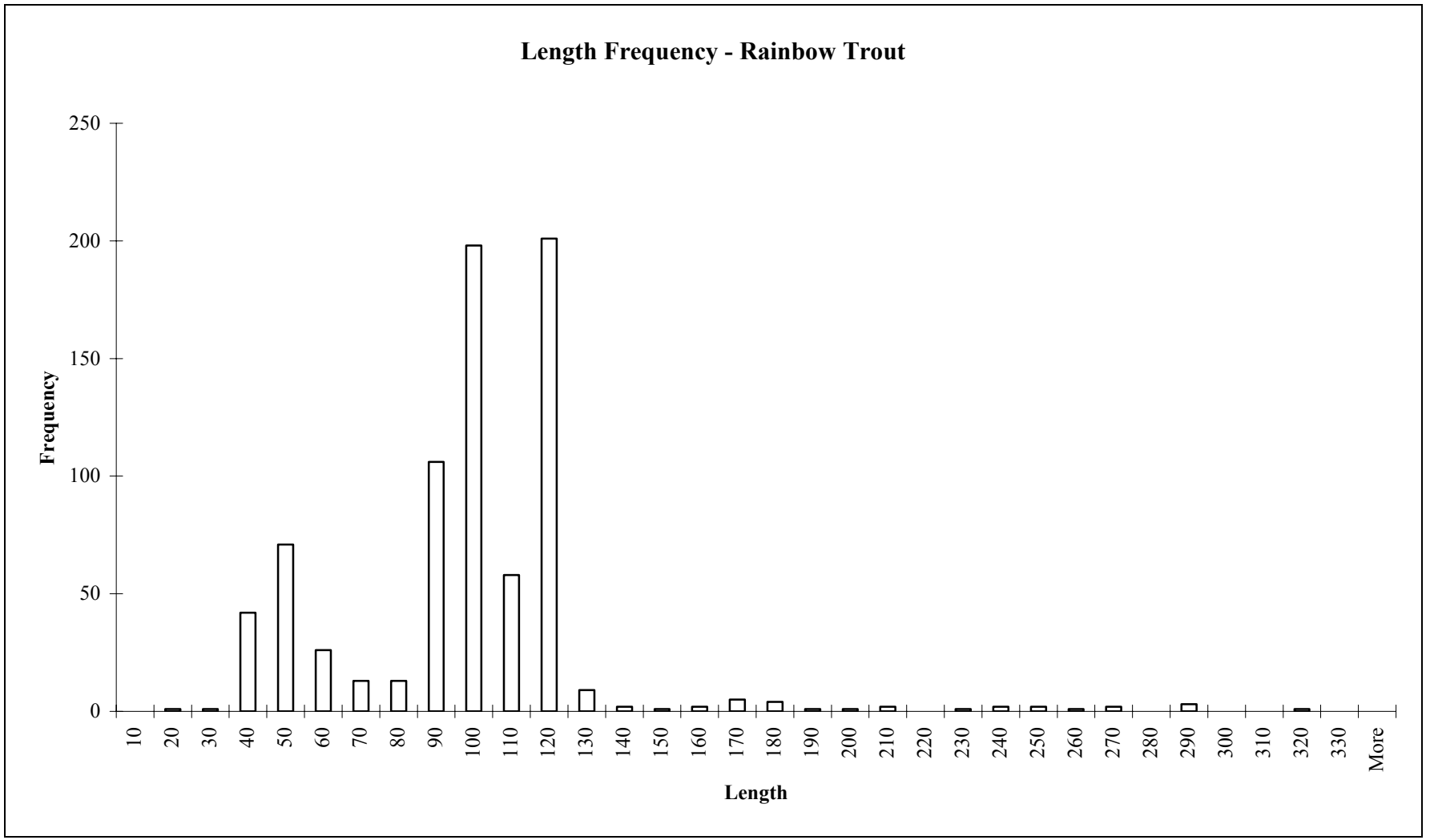

Figure 4.13-7. Length frequencies of rainbow trout recoveries in the Eagle Cliff screw trap, March 30 through September 13, 2002.

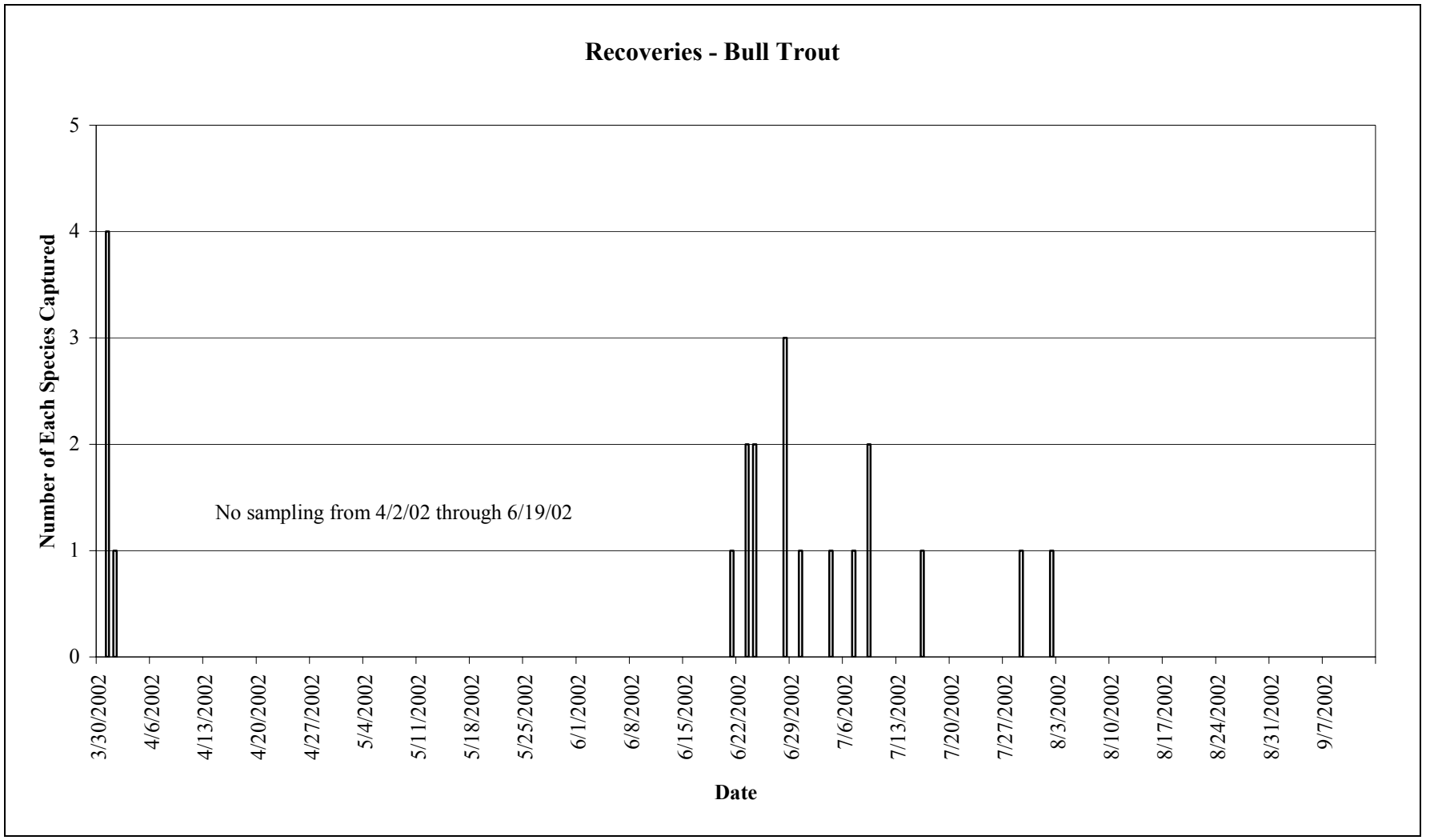

Figure 4.13-8. Eagle Cliff screw trap bull trout recoveries, March 30 through September 13, 2002.

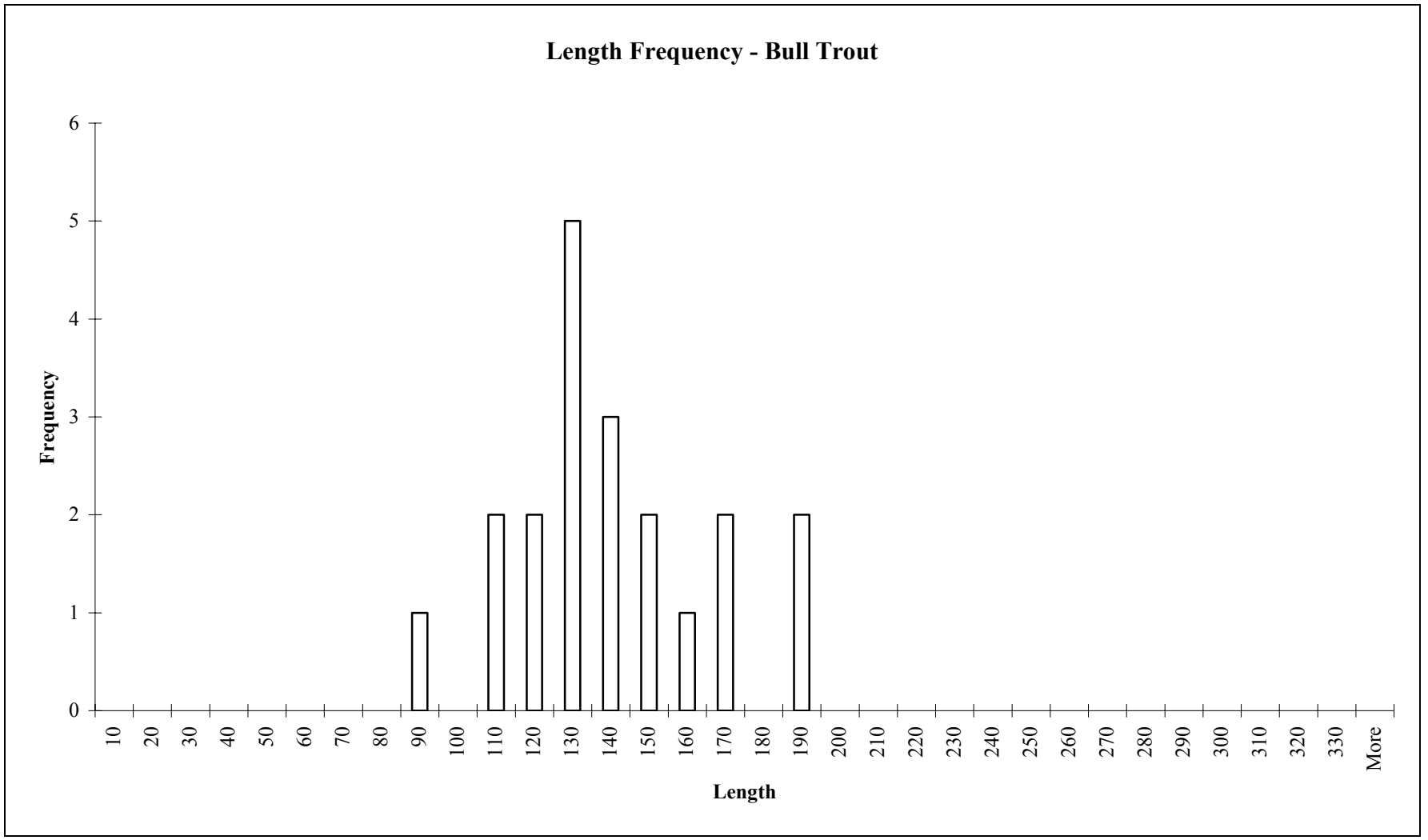

Figure 4.13-9. Length frequencies of bull trout recoveries in the Eagle Cliff screw trap, March 30 through September 13, 2002.

Cutthroat Trout

Fifty-two cutthroat trout were collected in the Eagle Cliff trap in 2002 (Table 4.13.4). The greatest number captured during one day of sampling was 40 on July 18, approximately 1 week later than the peaks observed for spring Chinook, coho and rainbow trout (Figure 4.13-10). As in 2001, all fish captured in 2002 were wild (naturally produced) fish because cutthroat trout are not planted in Swift Reservoir.

The length frequencies of cutthroat trout captured in 2002 are presented in Figure 4.13-11. Because no more than 2 cutthroat trout are included in each length category, clear size classes (modes) are not evident from the data.

Other Species

A total of 25 mountain whitefish, 11 dace, 4 suckers, 7 pikeminnow, and an unidentified number of sculpin were captured in the Eagle Cliff trap in 2002. No attempt was made to identify the sculpin, dace, or suckers to the species level. Twenty-one of the mountain whitefish captured in 2002 entered the trap on a single day, September 10, 2002.

Mortalities

Only 5 dead fish were collected in the Eagle Cliff trap in 2002. This resulted in a mortality rate of captured fish of less than one percent. Table 4.13-5 summarizes information from field data sheets about these individual fish.

Table 4.13-5. Mortalities associated with the Eagle Cliff screw trap operation March 30 through September 13, 2002.

Trap Date	Species	Mortality Note
6/21/02	Spring Chinook	No indication of reason for mortality
6/24/02	Rainbow	1/2 of caudal fin absent
7/22/02	Rainbow	No indication of reason for mortality
8/6/02	Rainbow	No indication of reason for mortality
9/13/02	Rainbow	No indication of reason for mortality

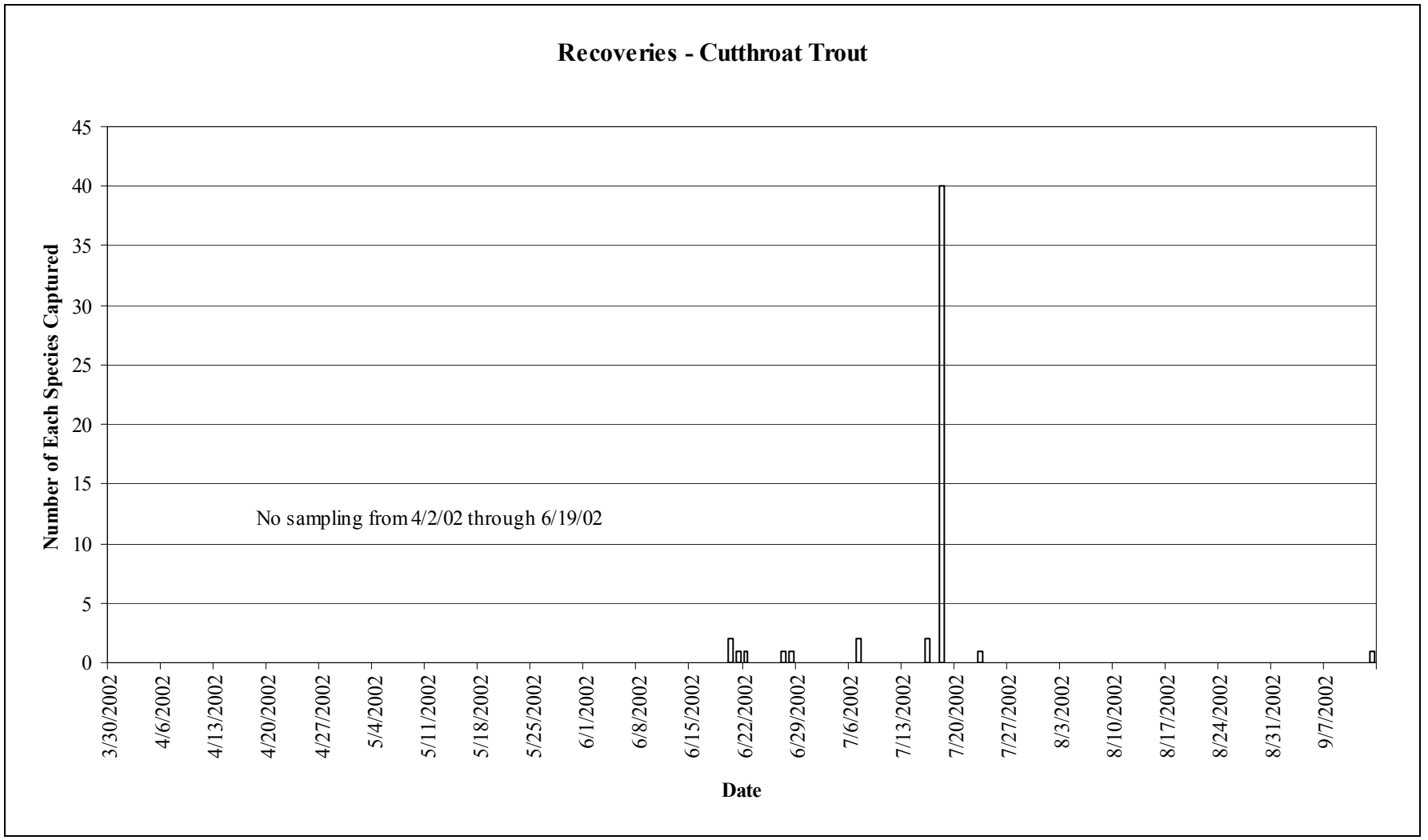

Figure 4.13-10. Eagle Cliff screw trap cutthroat trout recoveries, March 30 through September 13, 2002.

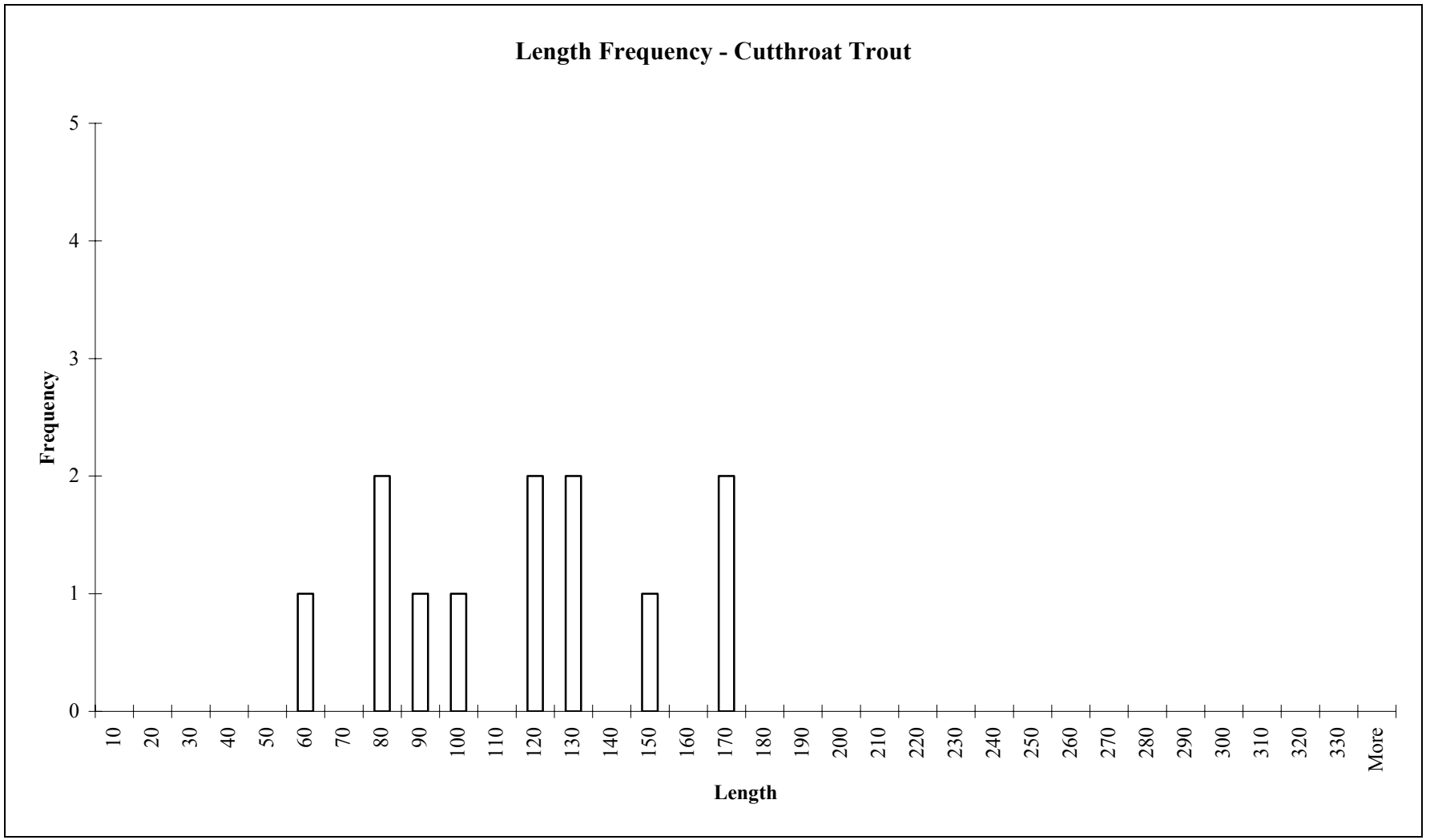

Figure 4.13-11. Length frequencies of cutthroat trout recoveries in the Eagle Cliff screw trap, March 30 through September 13, 2002.

Effects of River Flow on Fish Movement

To evaluate the effect of river flow on trapping success (fish migration), the average daily flow in the Muddy River below Clear Creek was used to estimate the total flow in the Lewis River at the Eagle Cliff site. The results of a regression analysis verified that there was a high correlation (R2 = 0.90) between the historical average daily flows in the Muddy River below Clear Creek and the historical average daily flows in the Lewis River above the Muddy River[3].

Although sampling at the Eagle Cliff site did not occur during periods of relatively high and fluctuating flows, there were 2 peaks in daily fish captures that occurred during periods of relatively stable and slightly declining flows (Figure 4.13-12). This would indicate that the magnitude of flows did not influence the rate of captures at the Eagle Cliff trap site in 2002. In 2001, Chinook and coho migrations increased on days with rain; however, there was no significant correlation between rainfall and fish movement (PacifiCorp and Cowlitz PUD 2004). Rainbow trout captures did show a significant correlation with rainfall in 2001, although the large number trapped on the final day of sampling may have skewed the correlation. Sculpin, a benthic species, had a near significant correlation with rainfall in 2001.

4.13.6.3 2002 Juvenile Coho Survey Results

As a follow-up to the fall 2000 adult coho radio-tracking evaluation (PacifiCorp and Cowlitz PUD 2004: AQU 13, Phase 1), approximately 7,000 coho adults (a mix of early and late-run) were released into Swift Reservoir in the fall of 2001. In addition, 47 male and 35 female adult spring Chinook were released at the Swift Forest Camp in the late summer. The goal of this effort was to observe the distribution and spawning locations of both species through aerial surveys. Unfortunately, weather and high flows limited observation by aerial survey methods. After discussion within the ARG and within a designated sub-group, an alternative approach was developed that involved surveying the upper river tributaries during the low flow period to determine presence/absence of coho fry.

To determine presence/absence of coho fry, Forest Service fisheries biologists conducted surveys in river and stream reaches that were accessible to anadromous fish. These included Drift, Swift, and Range creeks (tributaries to Swift Reservoir), the upper mainstem Lewis River and its tributaries, and the Muddy River and its tributaries. This effort was coupled with the collection of rainbow and cutthroat trout DNA samples.

A 2 or 3 member crew electrofished the first 100 meters of each stream targeted for sampling. The presence/absence survey was considered complete if coho fry were encountered in the 100-meter reach. If not, they were considered absent from that reach. Water temperature and total seconds of shocking were also recorded.

[3] The Muddy River below Clear Creek gage was in operation during the Eagle Cliff trapping period. The Lewis River above Muddy River gage ceased operation in 1970.

Presence/absence surveys were conducted in July, August, and September 2002. Field crews surveyed numerous streams in the upper basin and found coho fry distributed over a wide area (Table 4.13-6). Figure 4.13-13 shows the extent of coho distribution as determined by the 2002 surveys.

Table 4.13-6. Results of USDA Forest Service juvenile coho surveys, trout DNA collection, and other observations (July, August and September, 2002).

Stream	Number of Each Species Captured				Water Temperature
	Rainbow Trout	Cutthroat Trout	Juvenile Coho	Total Seconds Shocked	
Unnamed Tributaries*	2	33	118	3,412	8.5°C average
Clear Cr.	0	0	6	1,677	11°C
Smith Cr.	4	17	0	3,737	14° C average
Clearwater Cr.	5	0	0	8,205	9.5°C average
Muddy River	9	0	>1	480	10°C
NF Lewis River	3	0	0	Angled	13°C
Rush Cr.	0	0	3**	Snorkeled	9°C
Swift Cr.	4	3	2	540	N/A
Range Cr.	3	4	1	320	N/A
Drift Cr.	3	2	1	340	N/A
Cussed Hollow Creek	NA	NA	>10***	NA	N/A

* Unnamed tributaries to the Muddy River.

** Visually observed by Ron McPeak (WDFW biologist) during a bull trout snorkel survey.

*** Ocular survey and collection of one coho juvenile for verification of species. Verification was made by John Kinney, USFS Fish Biologist, and Jim Byrne, WDFW Fish Biologist.

4.13.7 Discussion

Although the 2002 Eagle Cliff trapping effort was compressed due to trap damage, data collected during this second year of sampling provided further insight into the survival, behavior, potential productivity, and life histories of anadromous salmonids released into the upper Lewis River basin. Results also indicated that screw trap sampling at the Eagle Cliff site is an effective means of monitoring sub-yearling and yearling salmonid migration into Swift Reservoir.

In 2001, the Eagle Cliff trap was operated from May 18 through June 28. During this first year of sampling, daily captures of spring Chinook and coho remained relatively low until May 30, increased dramatically in the month June, and did not appear to decline prior to trap removal on June 28. As a result, a peak in the migration of these species was not observed in 2001. Daily captures of bull trout appeared to peak in May and then slowly decreased throughout the month of June. Daily recoveries of steelhead, resident rainbow trout and cutthroat trout remained relatively low and consistent throughout the 2001 sampling period.

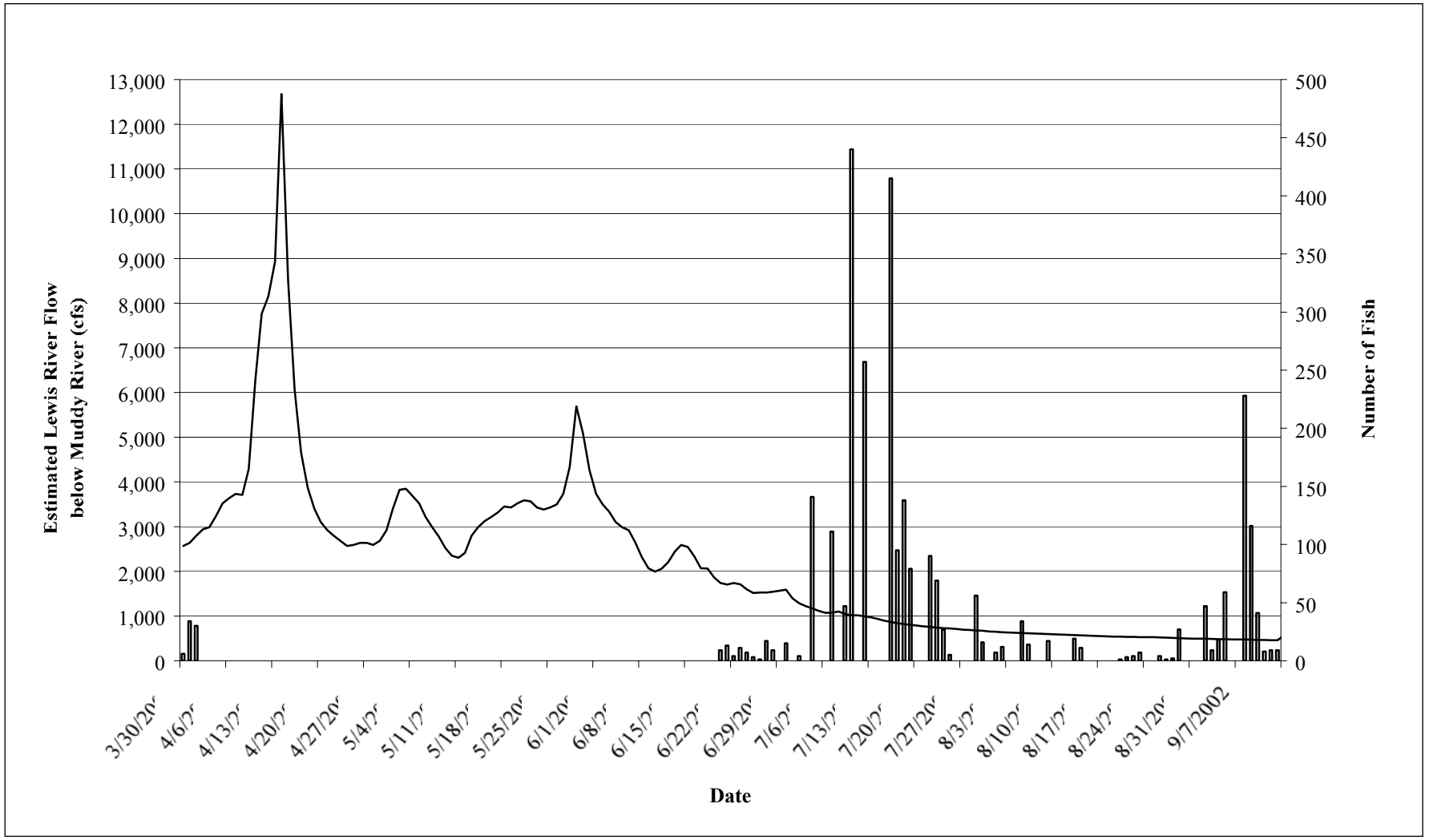

Figure 4.13-12. Estimated flow in the Lewis River downstream of Muddy River and the number of fish captured in the Eagle Cliff screw trap, March 30 through September 13, 2002 (based on correlation of historical Lewis River and Muddy River flow data from 1927-1934, 1954-1970).

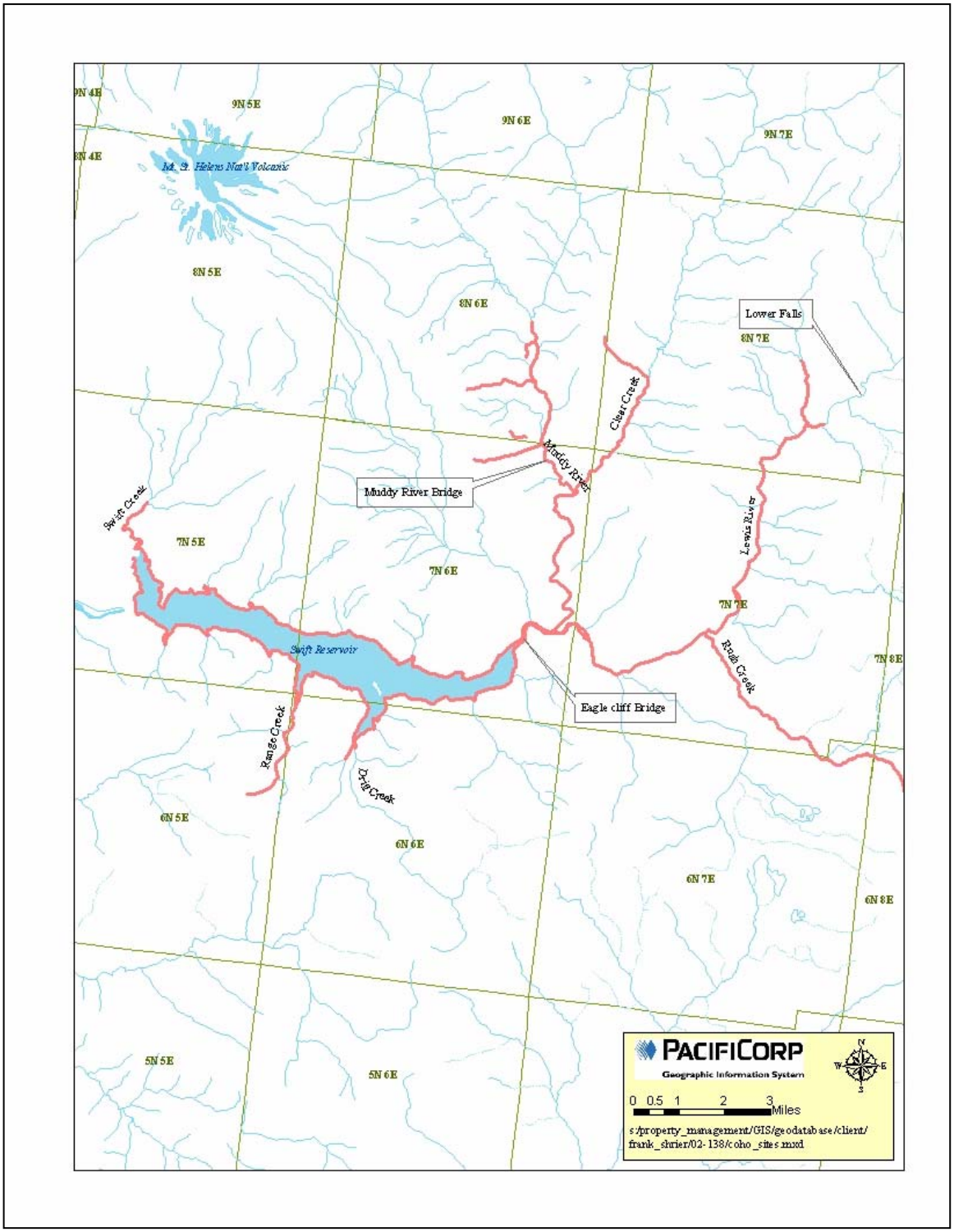

Figure 4.13-13. Distribution map of coho fry observations (salmon-colored bold reaches) in July 2002.

In 2002, the Eagle Cliff trap was operated from March 30 through April 1, and again from June 20 through September 13. No sampling occurred from April 2 through June 19 due to trap damage. During this second year of sampling, the downstream movement of Chinook and coho sub-yearlings and yearlings increased in early-July, peaked in mid-July, and slowly declined through late August and early-September. Daily recoveries of rainbow trout peaked in mid-July and again in early-September; however, the peak observed in July may have been associated with the annual release of hatchery rainbow trout in Swift Reservoir. WDFW typically releases approximately 800,000 rainbow trout into Swift Reservoir in June and July of each year. In 2002, peaks in the number of bull trout captured in the Eagle Cliff trap were observed in late March and again in late June; however, the trap was not operated from April 2 through June 19, 2002. Nearly four times as many bull trout were captured in 2001 as in 2002.

During both 2001 and 2002, the downstream movement of Chinook, coho, rainbow trout, and bull trout did not appear to be correlated with increases in river flow. The trigger leading to this downstream movement is unknown, but may be related to genetic cues, increases in water temperature, increases turbidity due to glacial runoff, moon phase, or other variables.

All spring Chinook captured in the Eagle Cliff trap in 2001 were sub-yearlings, the result of plants that occurred in late-March and early-April of 2001. In 2002, it appeared that both sub-yearling and yearling spring Chinook were recovered in the trap (based on length frequency data). Yearling spring Chinook recovered in the trap were the result of hatchery plants or natural production that over-wintered in the upper basin. During both years of sampling, sub-yearling spring Chinook averaged approximately 70 mm in length (fork length). Yearling spring Chinook averaged about 185 mm in length. In 2001, approximately 40 percent of the spring Chinook collected in late-June were found to be actively migrating smolts (based on ATPase levels). ATPase samples were not collected from spring Chinook captured in 2002; however, it is likely that many of these sub-yearlings and yearlings were also actively migrating smolts. In the Cowlitz River system, a similar watershed with 3 dams and 3 reservoirs, spring Chinook sub-yearlings released in the upper watershed appear smolt-like and are captured in the Cowlitz Falls fish collection facility during July, August and September (Serl and Morrill 2001). Extended spring Chinook migrations throughout the month of August have also been observed in the nearby upper Kalama River (PacifiCorp and Cowlitz PUD 2004). In addition, age analysis of scales from naturally spawning spring-run adults from the Kalama River and lower Lewis River indicate a significant contribution to escapement by fish that entered saltwater as sub-yearlings (Hymer et al. 1992).

Only sub-yearling coho were recovered in the Eagle Cliff trap in 2001 (except for 7 radio-tagged hatchery smolts that were associated with study AQU 14). These fish were the result of either natural spawning or fry plants that occurred in the upper basin earlier that spring. In 2002, it appeared that both sub-yearling and yearling coho were recovered in the trap. Data from both years of sampling demonstrated that planted coho fry remained in the system for several months or longer. During sampling in 2001, WDFW technicians observed numerous young-of-the-year coho in side channels near the Eagle

Cliff trap site. These wild coho, which averaged about 38 mm in length, were significantly smaller than the hatchery coho recovered in the trap, which averaged about 60 to 70 mm in length. Coho yearlings captured in 2002 averaged approximately 90 to 110 mm in length.

Most bull trout captured during sampling in 2001 and 2002 were in the 130 to 140 mm range. Martin et al. (1992) reported one year old bull trout in southeast Washington to be about 110-130 mm, and 2 year old fish to be 140-165 mm.

4.13.8 Schedule

This study is complete.

4.13.9 References

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