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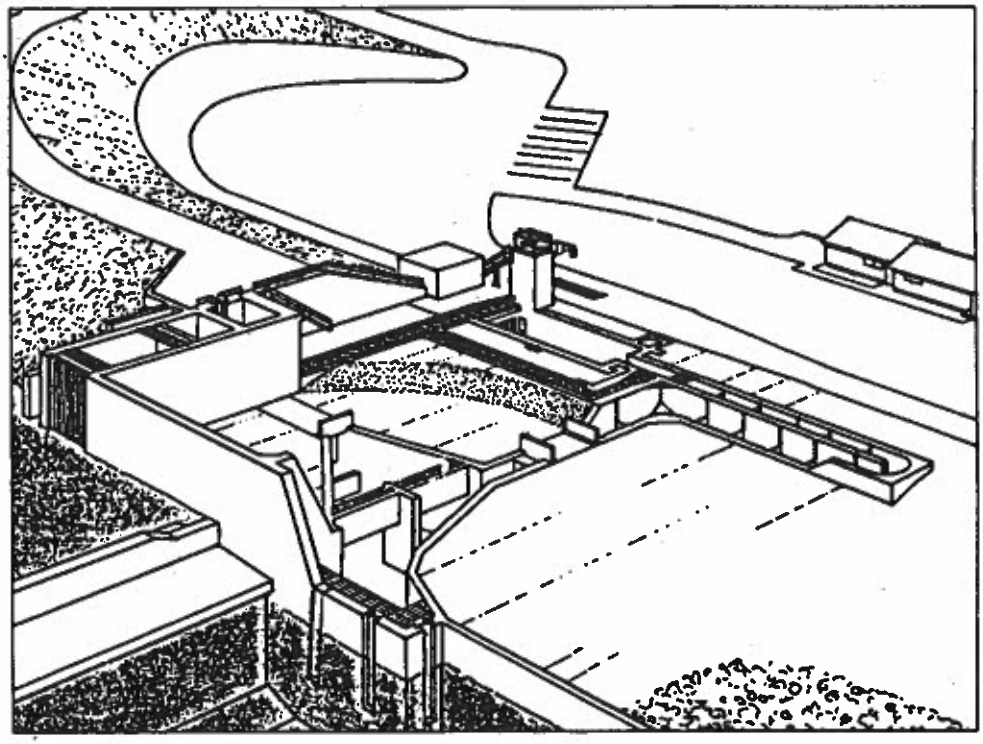
1989 TOUTLE RIVER FISH COLLECTION FACILITY OPERATION AND SALMONID INVESTIGATIONS

By John J. Loch and Paul M. Downing



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Toutle River Fish Collection Facility Operation and Salmonid Investigations, 1989

Report No. 89-13

by

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Introduction

The Toutle River, located in southwest Washington, is an important drainage for salmonid production and sport fishing. It is the largest tributary of the Cowlitz River with a drainage area of 1,334 square kilometers (km^2). The mean annual flow prior to 1980 was 59.4 cubic meters per second (m^3s^{-1}). Lucas (1985) described the three major drainage basins of the Toutle River to include the North Fork Toutle River (453 km^2), the Green River (341 km^2), and the South Fork Toutle River (299 km^2).

On May 18, 1980, Mt. St. Helens erupted sending a large debris mudflow ($2.3 \times 10^9 m^3$) down into the upper 27 km of the North Fork Toutle River, with another flow of about 38 million cubic meters into the South Fork Toutle River. In the Green River 65 percent of the drainage was impacted by ash fall and the initial blast. In the years following the 1980 eruption, efforts by the Corps of Engineers (COE) to reduce movement of mudflow deposits from Toutle River tributaries into the Cowlitz River and Columbia River resulted in the construction of several debris retaining structures on the North and South Fork Toutle River and several sediment stabilization basins in both forks and mainstem of the Toutle River (Schuck and Kurose, 1982). The initial North Fork dam breached on several occasions, while the South Fork dam was later removed by the COE as it was not effective. In 1987, the COE began construction of the Sediment Retention Structure (SRS). Completed in 1990, the SRS stands about 56 m (185 ft.) high by 549 m (1,800 ft.) long. However, no fish ladder for passage was provided. In 1988, the COE began construction of the Toutle River Fish Collection Facility (FCF) about 2.0 km downstream of the SRS.

Major fish species present include anadromous populations of wild winter, wild summer and hatchery summer steelhead (*Oncorhynchus mykiss*), cutthroat trout (*O. clarki*), coho (*O. kisutch*), and spring chinook (*O. tshawytscha*). Historically, wild winter steelhead were dominant in the Toutle River drainage. In the late 1950's to 1980, the Toutle received annual plants of hatchery summer and winter steelhead. Since 1980, no hatchery winter steelhead have been planted in the Toutle. However, hatchery summer steelhead continue to be planted in the lower Toutle River.

The purpose of the facility was to collect returning wild adults and transport them above the SRS to important spawning and rearing habitat and to recycle hatchery adults back into the sports fisheries below the SRS. The FCF is operated by the Washington Department of Wildlife (WDW) in cooperation with the Washington Department of Fisheries (WDF). As of this report, construction was not completed on the FCF. This report summarizes the operation, accomplishments, and biological data collection during the first year of FCF operation.

2.0 Trap Operation and Fish Passage

2.1 Introduction

The FCF began collecting adult salmonids returning to the North Fork Toutle River on February 28, 1989. The FCF was built about 0.2 km up from the confluence of the Green River and the North Fork Toutle River. The COE Sediment Retention Structure, an impassable barrier to upstream migration of fish, is located about 2.0 km above the FCF.

The overriding goal of the Washington Departments of Wildlife (WDW) and Fisheries (WDF) is the restoration of salmonid production above the SRS to levels equal to or greater than the period before Mt.St.Helen's 1980 eruption and devastation of the Toutle River watershed. Our primary objectives during our first year of operation were to:

1) Identify and solve adult salmonid collection problems at the FCF;

2) Locate, construct, and evaluate release sites for adult salmonids above the SRS and below the FCF;

3) Evaluate the fallback rate of transported adults to areas above the SRS;

4) Evaluate salmonid production in release areas above the SRS;

5) Evaluate recycling of summer-run steelhead back into the sport fishery at three downstream locations below the FCF and determine the return rate to the FCF following recycling;

Secondary objectives are:

1) Develop a life history database for Toutle River salmonids;

2) Monitor spawning activity of winter-run steelhead in the Green River and South Fork Toutle River to assess differences in timing and relative number;

3) Evaluate salmonid production in the Green River and South Fork Toutle River compared to that observed for the North Fork Toutle River;

4) Determine the age structure and relative year class strength of returning adult steelhead.

We report findings from observations made at the FCF from February 28, 1989 through October 31, 1989. The study area and FCF location are shown in Figure 1.

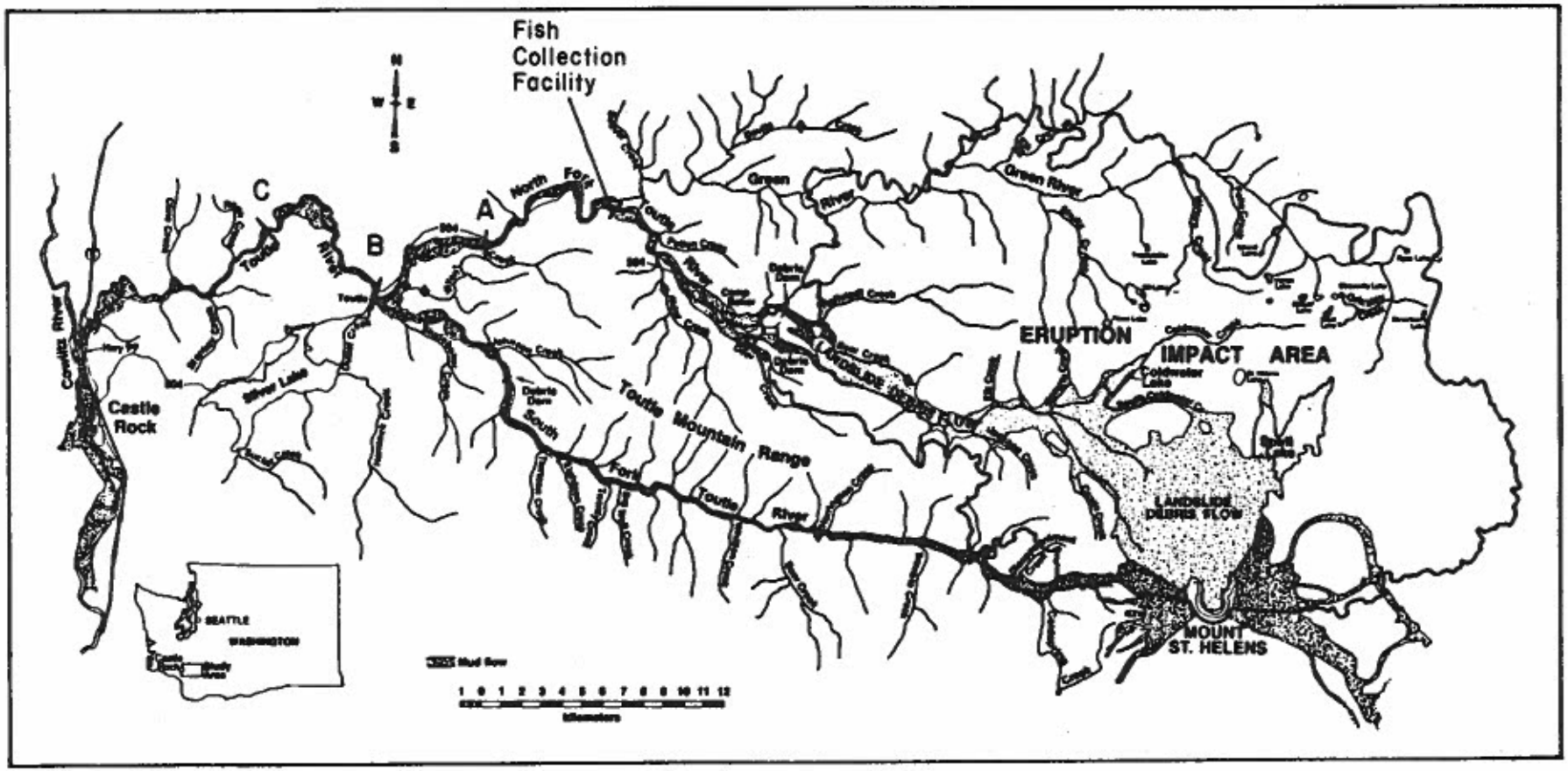


Figure 1. Post-eruption map of Toutle River drainage showing release sites A (8 km), B (16 km), and C (24 km) for adult salmonids. (Map from Martin et al. 1982).

2.2 Methods

2.2.1 Temporary Trap

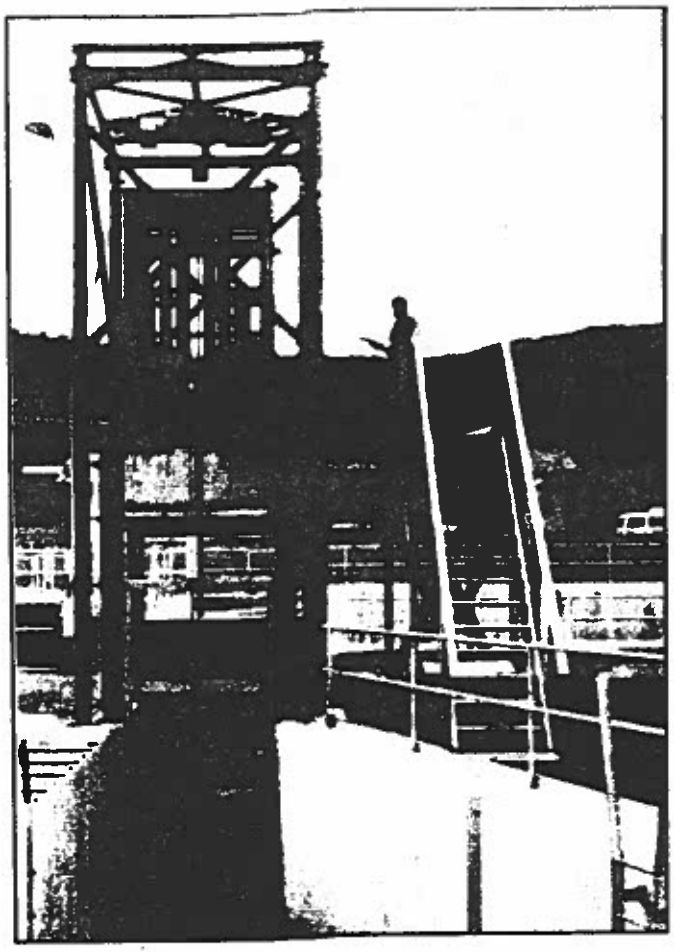
In February before the FCF was fully operational, a temporary trap was constructed to collect North Fork Toutle River wild winter-run steelhead for transporting above the SRS. The V-trap, located near the ladder entrance, measured 3.7 m X 2.4 m X 1.6 m (Figure 2a). Although screens covered the surface of the trap, water and captured fish could only be held in the lower 0.4 m of the trap. The trap was cradled by a lifting frame mounted on the fish ladder walls and was raised and lowered by an electric winch. When not fishing, a gate was lowered to prevent fish from moving into the ladder area above the temporary trap location where construction was still in progress. When construction ended in late June 1989, the temporary trap was no longer used.

The inefficiency of the temporary trap in holding fish and poor attraction flow limited capture of winter-run adults. For example, we found that fish entering the trap could readily escape the trap (Appendix 1). A tail bar had been prohibit fish from escaping out of the trap. Once the weir structure was added to the trap, fish were successfully collected. We feel many wild winter-run may have escaped prior to the addition of the weir structure. It might be argued that few wild fish were present during our trapping, yet in the adjacent Green River and South Fork Toutle River, numerous redds constructed by winter-run steelhead were counted by WDW field personnel (Weinheimer et al., 1990).

Attraction flow was sometimes limited by construction work or by heavy sand and silt loads during high water. High flows (February and March) may have discouraged winter-run steelhead from entering the fish entrance to the FCF. A notch in the barrier dam concentrated flows near the fish entrance (Figure 3). This concentrated flow may have deterred immigrating winter-run steelhead from entering the fish entry-way leading to our trap.

2.2.2 Collection Pond

The COE constructed an impassable barrier at the FCF diverting adult salmonids into the FCF. Adult fish were further attracted into the fishway by diverting a portion of the North Fork Toutle River above the barrier through the FCF and down a fish ladder back into the river below the barrier. Adults moved up the fish ladder into a collection pond and were crowded by a traveling screen (Figure 2b) up to the head of the collection pond for processing (Figure 3). A lock tower and automatic lock crowder moved fish from the collection pond to a holding tank on a transport truck. However, minor design problems prevented use during the period of this report. Once crowded fish were hand sorted. Adults were placed into a anesthetic tank and then measured, tagged, and trucked to release sites.



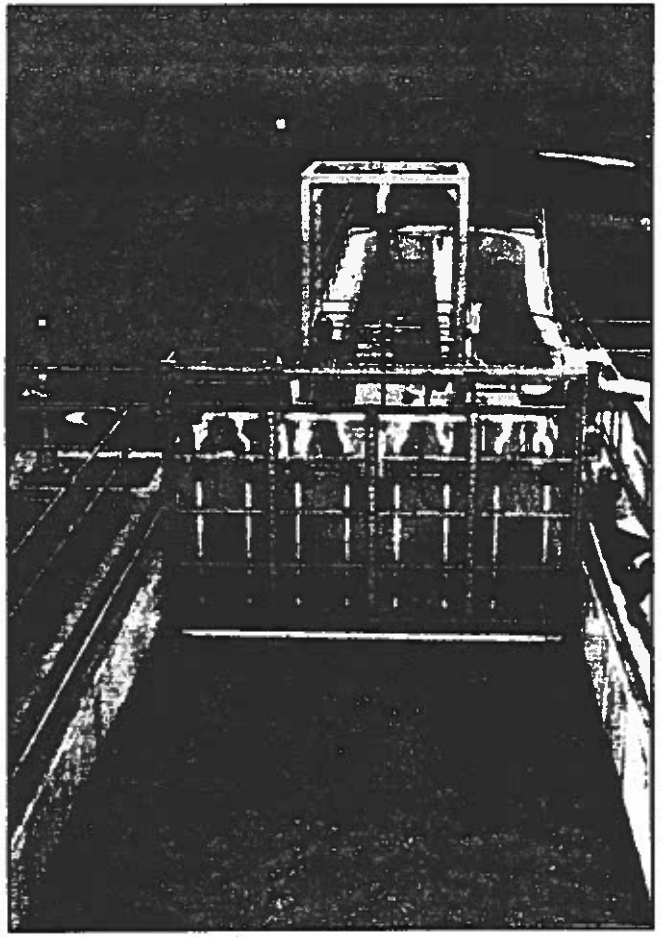


Figure 2. Temporary trap (A) and collection pond and automatic crowder (B) at the Toutle River Fish Collection Facility, 1989.

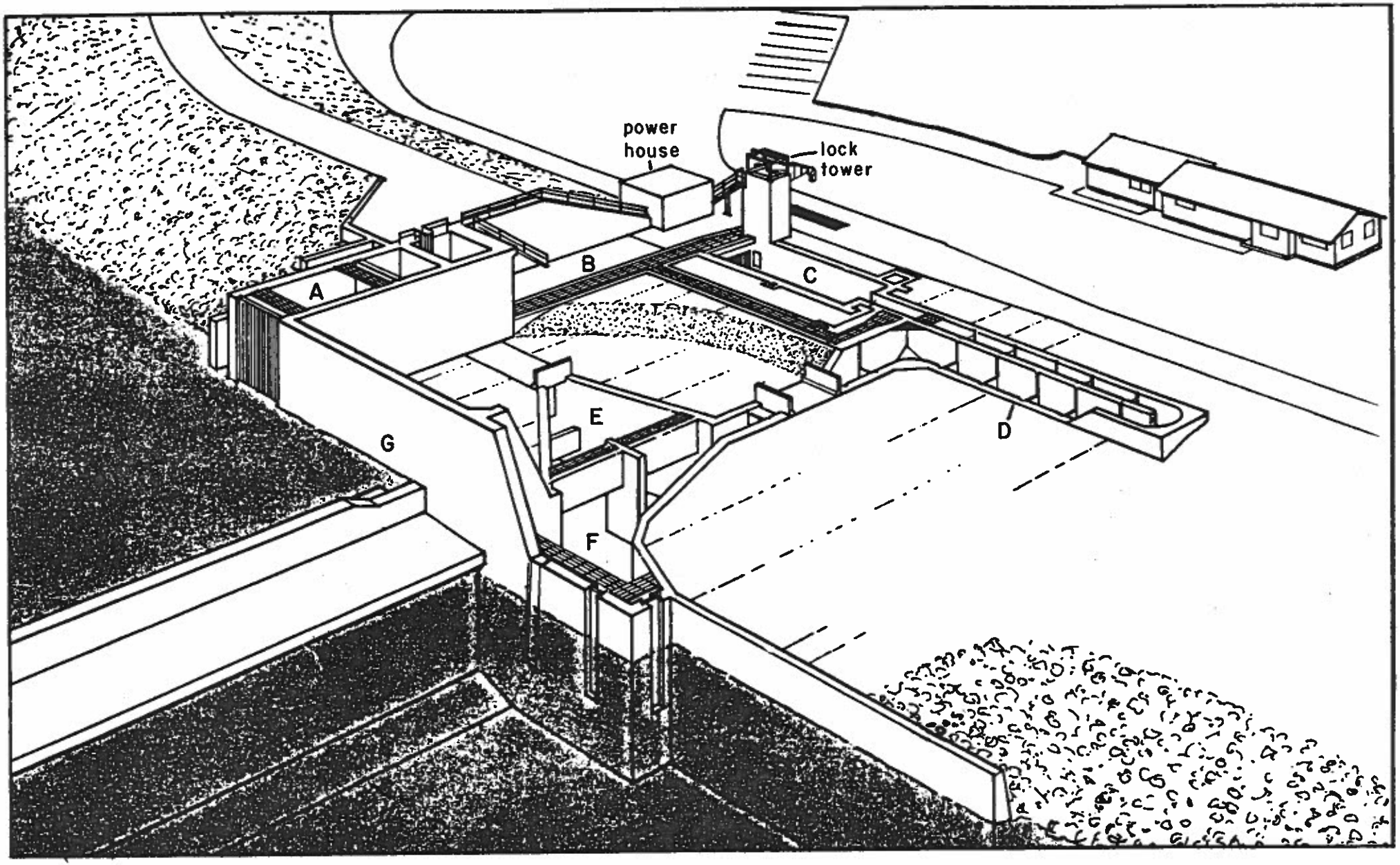


Figure 3. Toutle River Fish Collection Facility, North Fork Toutle River. 1989. A = Water intake box; B = Water supply channel; C = Collection pond; D = Fish ladder; E = Defuser; F = Fish entry way; G = Notched area of barrier Dam.

2.2.3 Fish Handling and Passage

Steelhead, cutthroat trout, and salmon collected at the FCF were anesthetized using carbon dioxide; fork length (FL) measured, race, sex, and origin (hatchery or wild) determined. A subsample of scales was taken for later age determination before trucking adults to release areas. Depending on race and origin, wild steelhead were either trucked above the SRS for release or hatchery fish were recycled back downstream below the FCF.

Colored Floy-anchor tags were used to differentiate races of steelhead and salmon. Tagging enabled an assessment of recaptures or fallbacks, distribution in the watershed following release as determined from sport harvest (tag returns), and whether adults trucked and released above the SRS stayed there. For example; did adults move back downstream over the SRS to relocate in other streams or be re-captured at the FCF, or did they move downstream out of the stream of release and into some other adjacent upper North Fork Toutle River tributary for spawning. Although early coho salmon were tagged the Department of Fisheries requested that floy tagging be stopped. Since the Department of Wildlife is interested in understanding whether coho are handled more than once at the FCF, a left operculum punch mark was applied to a portion of the returning adult coho collected at the FCF.

To reduce confusion with an ongoing study on the Kalama River (Leider et al., 1989), we switched from yellow to white tags for summer-run steelhead in October 1989.

Flow information for the North Fork Toutle River was provided by COE (appendix 2).

2.2.4 Trucking

Wild winter-run steelhead, cutthroat trout and coho salmon were trucked to two streams (Hoffstadt and Alder Creeks) above the SRS using a 1,514 l (400 gal) insulated tank mounted on a Dodge 4 X 4 one ton truck. We also trucked (recycled) fish below the FCF to three release sites. We were able to access many remote sites using this truck. Salmon, steelhead and cutthroat trout were transported in groups no more than 20 to minimize stressing during their short haul before being released above the SRS or recycled below the FCF.

2.2.5 Recycling

Summer-run steelhead and spring chinook salmon were recycled back into the lower Toutle River. We selected three locations for releasing adult fish. Release sites were located at 8 (site A), 16 (site B), and 24 (site C) km downstream of the FCF on the North Fork Toutle, mouth of the South Fork Toutle, and main Toutle Rivers, respectively (Figure 1).

2.3 Results and Discussion

2.3.1 Winter-run Steelhead

Numbers and Timing

A total of 18 wild winter-run steelhead were captured at the FCF (Appendix 3). No hatchery winter-run steelhead were observed at the FCF in 1989.

We collected wild winter-run steelhead at the FCF beginning on March 24, 1989, and captured our last winter-run adult on May 1, 1989. Peak timing was not possible to determine due to the limited numbers captured at the FCF. All wild winter-run steelhead were released 5 km upstream of the FCF into Alder Creek.

Age Composition and Size

Scales from 17 of 18 wild winter-run steelhead were aged but only 12 were readable (Table 1). Mean fork length of females was 635 mm as compared to 584 mm for males.

Table 1. Age composition, sex, number, and mean fork length (mm) of wild winter-run and hatchery summer-run steelhead collected at the Toutle River Fish Collection Facility, 1989.

	Male		Female	
Age[a]	n	Length ± SD	n	Length ± SD
		Winter-run		
1.1+	0	- - - - - -	2	640.5 ± 84.2
2.+	3	478.2 ± 11.6	0	- - - - - -
2.1+	1	(732)	3	579.0 ± 75.0
3.1+	2	667.5 ± 10.6	1	(677)
U.1+	0	- - - - - -	1	(692)
R	0	- - - - - -	4	636.5 ± 94.3
		Summer-run[b]		
1.2	42	698.6 ± 37.7	94	677.5 ± 35.5
1.3	2	771.5 ± 20.5	1	(810)

[a] U = unreadable; R = total regenerated scale

[b] No wild summer-run scales were aged.

Life history characteristics of the 1989 winter-run steelhead data collected at the FCF were compared to scale information analyzed from the 1988 winter-run steelhead sport

fisheries (Appendix 4). A greater number of repeat spawning adults were observed in the sport fisheries than at the FCF (0 and 13, respectively).

2.3.2 Summer-run Steelhead

Numbers and Timing

A total of 831 summer-run steelhead were collected at the FCF in 1989, of which 111 were recaptures (Appendix 3). Wild summer-run adults comprised 1.5 percent (11) of the total number of adults collected at the FCF between February 28, 1989 and October 31, 1989. Wild summer-run were first trapped on July 4, 1989. Sporadic numbers of wild summer-run adults were collected during the season. No peak timing for wild summer-run steelhead was observed. We handled 709 hatchery summer-run adults. Hatchery adults were first captured on April 15, 1989; peak return time for hatchery adults was about the first week in July. Few hatchery adults were collected after mid August (Appendix 3).

Age Composition and Size

We examined scales from 139 (19.8%) hatchery summer-run adults collected at the FCF (Table 1). About 98 percent of the hatchery adults were 2-salts and two percent 3-salts (Table 1).

The size of returning female adults were slightly smaller than hatchery male adults (Table 2).

Recycling

We trucked 820 hatchery summer-run and 11 wild summer-run steelhead downstream to three locations below the FCF. Most adults (82.5%) were released 16 km downstream near the mouth of the South Fork Toutle River. Other adults were taken 8 km (0.7%) and 24 km (16.8%) downstream and released into the North Fork Toutle River and main Toutle River, respectively.

A total of 111 (13.5%) hatchery summer-run adults tagged and recycled downstream of the FCF were recaptured one or more times during 1989. No wild summer-run adult recaptures were observed. Many of these recaptured adults had been handled at least two times (76) at the FCF earlier in the season. The average elapse time for adults recaptured two times was 31 days (Table 3). Interestingly, some adults returned as many as five times (2) to the FCF. Apparently, recycled adults remain in the Toutle River following release for a lengthy period, enabling a greater opportunity for harvest by sport anglers. We will continue to monitor the number and elapsed time to recapture of recycled adults at the FCF to better define release areas for recycled fish. In addition, we will experiment with releases into the Green and South Fork Toutle Rivers.

Table 2. Mean length (mm) of male and female wild winter-run (WSSH) and hatchery summer-run steelhead (HSSH) collected at the Toutle River Fish Facility, 1989.

	Male		Female	
Month	n	Length ± SD	n	Length ± SD
WSSH				
Mar	0	---- ----	3	679.3 ± 48.1
Apr	5	617.6 ± 131.2	9	647.9 ± 65.3
May	0	---- ----	1	(673.0) ----
All	5	671.6 ± 131.2	13	657.1 ± 58.6
HSSH				
Apr	1	(485.0) ----	1	(671.0) ----
May	10	687.1 ± 46.9	23	653.7 ± 70.1
Jun	48	700.8 ± 41.2	91	682.1 ± 34.5
Jul	102	706.7 ± 62.7	197	694.0 ± 40.7
Aug	30	730.7 ± 28.5	105	704.8 ± 29.0
Sept	1	(728.0) ----	12	701.3 ± 23.7
Oct	16	721.4 ± 45.3	24	710.2 ± 29.5
All	208	701.3 ± 112.1	453	693.1 ± 40.0

Table 3. Number of recaptured recycled summer-run adults and elasped time to recapture at the Toutle River Fish Collection Facility, 1989.

Recycle[a] Site	Number of times recaptured	Number handled	Mean elasped time (d)	Percentage total adults rehandled
A	1	1	12	0.9
B	1	77	31	69.4
	2	24	20	21.6
	3	3	13	2.7
	4	2	13	1.8
C	1	4	55	3.6

[a] Distance from trap: A = 8 km; B = 16 km; C = 24 km.

2.3.3 Tag Returns

Sport anglers returned 43 (6.0%) tags from 712 summer-run steelhead recycled (Appendix 5). We determined that from release sites A, B, and C below the FCF, that 2, 31, and 1 tags were recovered, respectively. Average time between recycling and sport capture of summer-run steelhead was 42 (A), 47 (B), and 91 (C) days, respectively (Table 4).

Recycled summer-run steelhead distributed throughout the Toutle watershed and remained available for harvest by sport anglers for a great length of time (Appendix 5). Further evaluation will be required to refine release strategies.

2.3.4 Cutthroat Trout

Numbers and Timing

A total of 17 wild adult cutthroat trout were handled at the FCF between March 24 and October 31, 1989 (Appendix 3). Three (17.7%) fish were recaptured from three releases made below the FCF before the FCF was fully operational. No fallback cutthroat trout were recovered at the FCF in 1989. We first captured cutthroat trout on March 24, 1989. Captures of wild cutthroat after March were sporadic allowing no determination of peak migration timing. Only two cutthroat trout were trucked to Hoffstadt Creek (15 km above FCF) whereas 15 were released in Alder Creek.

Age Composition and Size

Wild cutthroat trout scales were collected from 14 of 17 adults captured at the FCF in 1989. Age composition of cutthroat trout collected at the FCF are given in Table 5. Returning female cutthroat trout were generally larger in size than returning male cutthroat (317.9 mm vs. 286.2 mm FL, respectively). Most returning cutthroat trout were immigrating for the first time; two were respawners. It is likely that many cutthroat were able to escape the temporary trap February through June, 1989. In July, water conditions (high sediment load) may have delayed upstream movement of some adult cutthroat.

Table 4. Release location, distance from trap, and elapsed time to capture by sport anglers of recycled summer-run hatchery adults from the Toutle River Fish Collection Facility, 1989.

Release site	Distance downstream of trap (km)	Total recaptured by sport anglers from release	Mean elapsed time (d)	Percentage total adults recycled
North Fork Toutle	8 (A)[a]	1	42	0.1
Mouth of South Fork Toutle	16 (B)	35	47	4.9
Main Toutle	24 (C)	2	91	0.3

[a] Letters correspond to distance from trap in Figure 1.

Table 5. Age composition, sex, number, and mean fork length (mm) of cutthroat trout collected at the Toutle River Fish Collection Facility, 1989.

	Male		Female	
Age[a]	n	Length ± SD	n	Length ± SD
2.+	4	268.5 ± 19.4	6	310.5 ± 16.4
2.+S+	1	(357) - - -	1	(347) - - -
U.+	0	- - - - - -	1	(333) - - -

[a] One cutthroat excluded - sex unknown; Three recaptures not shown above.

[b] U = unreadable

2.3.5 Coho Salmon

Numbers and Timing

We collected 403 coho salmon between February and October at the FCF in 1989. The first coho appeared on July 5, 1989; peak timing for coho was about the third week in October with numbers dropping off sharply thereafter (Table 6; Appendix 3). All coho collected were trucked above the SRS and released into Hoffstadt Creek.

Two coho fallbacks were observed at locations below the SRS. On October 22, 1989, one coho released on October 9 above the SRS into Hoffstadt Creek was recaptured at the FCF. A second coho was recovered November 3 by a snorkel survey team 7.2 km upstream from the mouth of the Green River about three weeks after being trucked to Hoffstadt Creek (Appendix 4). In addition to fallbacks, one adipose clipped coho was collected October 12.

Table 6. Number and percentage of coho females and males by month collected at the Toutle River Fish Collection Facility, 1989.

Month	Female	Male	Total	Percentage
July	0	1	1	0.2
August	2	0	2	0.5
September	3	4	7	1.7
October	198	195	393	97.6
Total	203	200	403	100.0

Age Composition and Size

No scale samples were collected from coho salmon in 1989, however, some size information was recorded . The size of male and female coho appeared similar (Table 7).

Table 7. Mean length (mm) of male and female coho salmon collected at the Toutle River Fish Collection Facility by month, 1989.

	Male		Female	
Month	n	Length ± SD	n	Length ± SD
July	1	(621.0) ----	0	---- ----
August	0	---- ----	2	538.5 ± 58.7
September	4	585.5 ± 62.1	3	563.7 ± 20.1
October	48	596.9 ± 74.3	29	601.9 ± 67.8

2.3.6 Chinook Salmon

Numbers and Timing

Only one female chinook salmon was collected at the FCF in 1989 (Appendix 3). It was released 16 km downstream of the FCF into the North Fork Toutle River.

2.3.7 Instream Distribution

No steelhead or cutthroat released above the SRS were recovered as fallbacks at the FCF or observed in other streams other than their original release site. However, two coho salmon moved back downstream from release site and over the SRS to locations below the FCF (see section 2.3.4). Both coho salmon had been tagged at the FCF about three weeks earlier.

Observations of fish released above the SRS moving back downstream provide important evidence that some adult salmonids can survive passage over the SRS during certain flow conditions. Flow levels during the coho migration ranged from 100 to 260 cfs (Appendix 1). However, future passage of adult wild winter-run and cutthroat trout emigrating past the SRS during greater flow levels is still questionable. Unlike salmon, a percentage of winter-run steelhead and cutthroat trout survive their first spawning and after migrating to the ocean, may return in following years to spawn again. Presently, adults, after spawning in tributaries, must negotiate debris material in front of the SRS, move through a set of conduits that terminate several meters above a splash pool, then move down a concrete ramp to the river below. It might be expected that as flow conditions vary over the season and conduit height between outlet and splash pool increase, adult survival might decrease thereby lowering or eliminating the number of returning wild adults. More information about adult passage over the SRS following spawning is needed to ascertain the potential impact to emigrating adult wild winter-run steelhead and cutthroat trout survival in the North Fork Toutle River.

Some coho adults bound for the Green River strayed into the North Fork Toutle River and were captured at the FCF. These "strays" were trucked above the SRS. Incidental captures of coho salmon migrating to the Green River that strayed into our FCF, might be expected to fallback over the SRS if trucked. Since future WDF plans involve large releases of coho smolts into the Green River, it is likely that many more of these "strays" will be encountered at the FCF. If not marked, coho counts could be biased. Therefore, tagging should be continued at the FCF to differentiate fish handled more than one time from those being handled for the first time.

2.3.8 Operation Problems and Solutions

Operations at the FCF from February through mid July 1989 were coordinated with COE during ongoing construction of the FCF. During construction all operations of gates and valves

were controlled by COE. Operation of the temporary trap was by WDW personnel. One of the most persistent problems was sediment washed down the North Fork Toutle River by freshets. Care had to be taken when operating water intake systems to allow sufficient attractant flows to successfully operate the trap, but minimize sediment accumulation. For the months March through July, it was common to have several feet of sand throughout the FCF water channel. The greatest amount of sand deposited occurred in July with efforts by the COE and private contractors to dry out a work area and block a 3 m X 1.4 m gate at the SRS. Flows were lowered to 70 cfs. The FCF gates and water intake valves were left open to allow fishing of the temporary trap. Unfortunately, debris material was dislodged by work on the SRS gates. A cofferdam gave way at the SRS sending large amounts of sand and water down to the FCF. About 2 - 3 m of sand was deposited throughout the FCF water system which took several months to remove. We believe this event affected the number of summer steelhead we observed returning in July (Appendix 7d). Water levels in the river below the barrier at the FCF were very low forcing WDW personnel and construction crew to walk out in ankle deep water to hand carry stranded summer steelhead to deeper water. These conditions existed for only a few days. The COE increased river flows to about 300 cfs to correct the problem.

Operation of the automatic crowder was adversely affected by the sand deposition. The traveling screen could not push through small amounts of sand. Hand crowders were constructed and used for crowding fish until conditions improved in early October. A suction pump had been installed on the traveling screen as a means of cleaning the holding pond. However, problems "bleeding" air out of pump lines and check valves during the period when we had large amounts of sand in our holding pond proved the device was useless. We are presently not using the suction pump system as it is ineffective in removing sediment.

The most important goal we have for operating the FCF is the transporting of wild winter-run steelhead and coho above the SRS, and the recycling of hatchery and wild summer-run steelhead and spring chinook downstream of the FCF. To accomplish this task in the most efficient manner better access to working adults in the collection pond are needed. In addition, some method to sort adult fish within the collection pond are needed.

Release sites above the SRS have been used with varying success. At low summer flows, the Hoffstadt Creek release site was found to be inadequate. Therefore, we relocated our Hoffstadt release site 2 km farther upstream near the old North Fork Toutle River debris structure. This site required no construction work - we could back right up to the creek and release fish directly into the water. Although low summer flows had no direct effect on our Alder Creek release site, we expect high flows to eliminate this site. For example, water levels are expected to build up behind the SRS (>20 m) in the future flooding our present release site. Similarly, the 2400 rd bridge to Alder Creek will be flooded - a possible access problem. Two new release sites upstream of the present release site are being investigated. Cooperative efforts with WDF to construct items needed for releasing fish at these

sites will commence this fall. Downstream sites below the FCF have been located in good areas and will continue to be used.

A low flow notch located on the barrier dam at the FCF created some problems for the collection of returning salmonids. The intent of the low flow notch was to keep the river flow near the FCF during summer low flows. However, during high flows (February and March), water is focused near the fish entrance way to the FCF. This focused flow may partially explain why few winter-run adults entered the FCF in 1989. Additionally, at low flows, not enough water flowed through the FCF to attract summer-run adults. A solution to correct both high and low flow problems was to install (July) two metal pins into the barrier wall notch whereby a one foot concrete stop log could be lowered onto the pins to reduce the high velocity flows at the fish entrance way during high flows and allow greater water depth behind the notch to afford better attractant flows through the FCF. A second concrete stop log (two foot) was provided by the COE but was not required in 1989.

3.0 Spawner Surveys

3.1 Introduction

Spawner surveys were conducted within the Toutle River drainage to determine steelhead production and abundance in release areas above the SRS and adjacent Toutle River tributaries. Spawner surveys have been conducted since 1981 in the Toutle River Basin (Lucas 1985, 1986a, 1986b and 1987). Objectives for spawner surveys were:

1) Determine steelhead redd densities for several Toutle River tributaries and release areas;

2) Determine the number of redds produced by wild winter-run steelhead in tributaries above the SRS;

3) Determine peak time intervals for steelhead spawning within Toutle River drainage.

4) Compare escapement in the Green, North Fork and South Fork Toutle Rivers.

3.2 Methods

Methods remained similar to past years. Foot surveys were conducted every two weeks on several tributary streams of the South Fork, North Fork Toutle and Green Rivers in 1989. Only complete redds were counted during each survey. We flagged each redd with surveyors ribbon to mark location, number, and date of observation. Spawner survey data was analyzed as described by Freemond and Weinheimer (1984).

3.3 Results and Discussion

Information was collected on redd numbers in several Toutle River tributaries in 1989. Analysis and interpretation of redd data are reported in Weinheimer et al.(1990).

4.0 Creel Surveys

4.1 Introduction

A creel survey was conducted on the South Fork Toutle River to assess angler use and catch rate for wild winter-run steelhead. In addition, we collected data from sport-captured tagged adults. Creel surveys were conducted between February 15, 1989 and April 15, 1989. Special harvest regulations were in effect for the wild winter-run fishery. Fishing was allowed from January 1 to April 15 only on Fridays and Saturdays of each week; possession limit was one steelhead. Furthermore, we conducted creel surveys for the South Fork, North Fork Toutle and Green Rivers 1989 summer-run sport

fishery. The summer-run fishing season was from June 15 to November 30 for Toutle watershed rivers. All rivers closed November 30. Our objectives were to:

1) Determine the number of wild adults either landed and released and/or killed by sport anglers during the special two day a week season;

2) Determine whether tagged wild winter-run adults, released above the SRS, fallback over SRS to relocate in the South Fork Toutle River;

3) Determine catch rate and angling effort for winter and summer-run steelhead in the Toutle River drainage;

4) Determine if recycled summer-run steelhead are remaining within release areas.

4.2 Methods

Bank anglers were interviewed on the South Fork Toutle during the winter run steelhead season. Several index sites were established on the South Fork Toutle River (15 km open to fishing; Appendix B). Surveys were done twice each day (morning and evening). Both incomplete and complete anglers were interviewed. All tagged fish were recorded.

During the summer-run sports fishery, we randomly sampled one day each week for the North Fork Toutle. We generally surveyed twice each week the number of anglers on the South Fork Toutle and Green Rivers. However, due to limited staff, we usually could only sample one day every two weeks. Surveys were usually conducted in the morning hours for all rivers.

The total catch (harvested and/or released) of steelhead for a given river was estimated for weekdays and weekends separately. The model follows:

Total Catch: $\hat{TC}_{ij} = n_i c_{ij}$

Where, n_i = Number of days in sample interval (i)
c_{ij} = Mean number of fish (j) captured in interval (i)

Variance estimate:

$$\hat{V}(TC_{ij}) = (1/n_i - 1) \left(\sum_{i=1}^{n_i} (c_{ijk} - c_{ij})^2 \right)$$

Where, c_{ijk} = Number of fish (j) captured on day k (k = 1,2,3, ... n) of the ith interval.

Season total catch (STC) was estimated by summation of total catch estimates for all intervals (weekdays and weekends):

$$\hat{STC}_{ij} = \sum_{i=1}^{I} n_i c_{ij} = \sum_{i=1}^{I} TC_{ij}$$

Variance estimate:

$$\hat{V}(STC_j) = \sum_{i=1}^{I} V(STC_{ij})$$

A 95% confidence interval was estimated by:

$$\hat{STC}_{ij} \pm t_{0.05} \sqrt{V(STC_{ij})}$$

4.3 Results and Discussion

4.3.1 Winter-run Steelhead

An estimated 363 anglers spent 776 hours on the South Fork Toutle River during the special two-day-a-week fishery (Table 8). Mean number of hours fished per angler was 2.13 hours (Table 8). The season mean catch rate was 0.333 for complete anglers and 0.004 for incomplete anglers. Average landing rate (those killed plus released) was estimated to be 0.333 and 0.010 steelhead per hour for complete and incomplete anglers, respectively. Total season catch (harvested and released) was 126 ± 45. Interestingly, a large percentage (90%) of wild winter-runs were released by sport anglers.

No tagged wild winter-run steelhead from the EVF were recovered in the South Fork Toutle River in 1989.

4.3.2 Summer-run Steelhead

Seven hundred and nine anglers were estimated to have spent 1,856 hours fishing for summer run steelhead on the South Fork Toutle River. The number of steelhead landed per hour was 0.281 (complete) and 0.035 (incomplete) (Table 9). The estimated amount of time spent fishing for summer-run steelhead was 4.14 and 2.57 hours for complete and incomplete anglers, respectively. Total season catch was 204 ± 40 summer-run steelhead.

An estimated 715 anglers fished for 1,391 hours on the North Fork Toutle River (Table 8). Estimated number of fish landed per complete and incomplete angler was 0.000 and 0.031, respectively. Estimated total season catch was 159 ± 31 steelhead.

Seven hundred and sixty-nine anglers were estimated to have spent 2,329 hours fishing for summer-run steelhead on the Green River (Table 8). Estimated number of fish landed per complete and incomplete angler was 0.000 and 0.031.

respectively. Total season catch was 164 ± 33 steelhead.

Table 8. Expanded number of anglers, hours fished, and number of steelhead harvested in the Toutle River watershed, 1989.

River	Group	Number Complete	Number Incomplete	Total
Winter-run				
South Fork Toutle	Anglers	30	333	363
	Hours fished	30	746	776
	Fish harvested	10	3	13
	Fish released	0	113	113
	Hours per angler	1.0	2.24	2.13
	Fish per hour (harvested)	0.333	0.004	0.017
	Fish per hour (landed)	0.333	0.010	0.037
Summer-run				
South Fork Toutle	Anglers	188	1554	1742
	Hours fished	778	3998	4777
	Fish harvested	41	65	106
	Fish released	41	57	98
	Hours per angler	4.14	2.57	2.74
	Fish per hour (harvested)	0.053	0.016	0.022
	Fish per hour (landed)	0.053	0.014	0.021
North Fork Toutle	Anglers	40	675	715
	Hours fished	129	1262	1391
	Fish harvested	20	99	119
	Fish released	0	40	40
	Hours per angler	3.23	1.87	1.95
	Fish per hour (harvested)	0.154	0.079	0.086
	Fish per hour (landed)	0.000	0.031	0.029
Green	Anglers	90	679	769
	Hours fished	204	2125	2329
	Fish harvested	25	74	99
	Fish released	8	65	65
	Hours per angler	2.27	3.13	3.03
	Fish per hour (harvested)	0.120	0.035	0.042
	Fish per hour (landed)	0.000	0.031	0.028

5.0 Population and Density Estimates

5.1 Introduction

Tributary streams of the South Fork and North Fork Toutle Rivers and Green River as well as several tributaries of Silver Lake were electroshocked between September 1 and October 31, 1989. Our objective was to determine steelhead, cutthroat trout, and coho salmon juvenile abundance in Toutle River tributaries above and below the SRS.

5.2 Methods

Streams selected for population estimates were those where we observed evidence of spawning (i.e. redds) and locations where we had trucked adults above the SRS in 1989.

We selected and mapped sections to be electrofished for gradient and habitat (pool-riffle-glide). Pool-riffle-glide sections were as described by Bisson et al. (1981). Each section was numbered starting at the mouth with surveyors tape, increasing in order, upstream to where there was an anadromous barrier to fish. Gradients were measured using a clinometer. Sections averaged about 70 m in length.

Two methods were used to determine juvenile populations during summer low flow levels in 1989. A inventory (semi-quantitative) and index (quantitative) survey as described by Johnson (1988) were used. An inventory survey is a survey were only a single removal pass is made through a stream sampling site whereas an index survey consists of two or more removal passes. An inventory survey uses no blocking nets, whereas an index survey uses blocking nets at the head and tail of each sampling site to prevent upstream or downstream movement by juvenile salmonids. Population estimates were calculated using the removal method described by Zippin (1958). Johnson (1985) estimated population size for stream sections having only one pass by calculating the number of fish collected in one pass, then assuming an 80 percent reduction of the single pass for an estimated second pass. He then used both the single and estimated second pass to calculate population size. Similarly, Strange et al. (1980) found no significant difference in using a semi-quantitative and quantitative method for estimating population size in small streams less than 10 m wide and about one meter deep - tributaries sampled in the Toutle River drainage were similar in size (Appendix B). We adopted Johnson (1985) approach for population estimates in streams where we used a single removal pass (inventory survey).

Surveys were conducted using a Smith-Root Model 12 backpack electroshocker. Fish from each depletion pass were anesthetized with MS-222, wet weighed, and fork length (FL) measured to the nearest millimeter (mm). Fish recovered in a holding bucket before released. Fish were separated into age groups by length frequency. A subsample of scales were collected for later age determination.

We determined densities of juveniles in each age class by meter, square meter, and cubic meter.

We used analysis of variance to separately test the hypothesis

of equal density means (number of fish per meter squared) in: 1) gradient zones; 2) between river drainages; and 3) between species within drainages. We used the Newman-Keuls Test (Zar, 1974) to examine differences between all possible pairs of means. Gradient zones are defined as: Low = 0.0 - 1.4%; Moderate = 1.5 - 4.0%; and High = >4.0%. All statistical differences were accepted as significant at $P \leq 0.10$.

5.3 Results and Discussion

We electroshocked 19 sections in 15 tributaries of the North Fork, South Fork Toutle Rivers and Green River (Appendix 8). We index surveyed eight (40%) sections in six (38%) streams whereas inventory surveys were conducted in 11 sections in 9 streams.

No significant differences were found in densities of salmonids from different gradient zones. However, juvenile steelhead were more numerous in moderate and high gradient zones than either cutthroat or coho.

Between drainages, a significantly greater mean density of age 0+ steelhead was found in Green River and South Fork Toutle tributaries than in North Fork Toutle River tributaries (Table 9). No significant difference in mean densities of age 1 and older steelhead was found between drainages. Juvenile cutthroat mean densities in the Green River drainage were significantly greater than in the South Fork or North Fork Toutle River drainages. No significant difference was found in the mean density of cutthroat between the South Fork and North Fork Toutle drainages. Not surprising, mean coho densities did not differ between drainages. Coho have been outplanted into tributaries of all three drainages annually by WDF.

Our estimates of juvenile abundance were similar to Schuck and Kurose (1981) in some South Fork Toutle River tributaries. Schuck and Kurose (1981) estimated an average of 0.20 steelhead (all ages) per square meter for five tributaries. Coho densities (0.08 fish/m^2) were lower than our 1989 mean estimate (0.12 fish/m^2) for South Toutle River tributaries. Cutthroat trout densites were slightly greater in 1981 than in 1989 (<0.01 fish/m^2 and 0.02 fish/m^2, respectively).

We compared our density estimates to those from Gobar Creek, a tributary of the Kalama River. Our estimate of steelhead age 0 and age ≥1 were within the range of population densities observed for a five year period (1975-1980) for Gobar Creek (Chilcote et al. 1983). Gobar Creek steelhead age 0 and age 1 ranges were 0.33 - 0.66 and 0.05 - 0.06 fish/m^2, respectively. Gobar Creek estimated cutthroat trout density ranges (0.01 - 0.03 fish/m^2) were slightly greater than our 1989 density estimates of <0.01 (North Fork), <0.01 (South Fork), and 0.02 fish/m^2 (Green River). Coho densities estimated for Toutle River drainages were greater than the Gobar Creek five year range 0.00 - 0.11 fish/m^2. Toutle River tributaries estimated coho mean densities were 0.04 fish/m^2 (North Fork Toutle River), 0.12 fish/m^2 (South Fork Toutle River), and 0.21 fish/m^2 (Green River).

Table 9. Results of the Newman-Keuls multiple range test for population means (number/m^2) of juvenile salmonids sampled from tributaries of the Green, South Fork Toutle, and North Fork Toutle Rivers, 1989.

Group[a]	Comparison[b]	Difference	SE[c]	q[d]	p[e]	Table q	Conclusion
0+ sthd							
	GRN vs NFT	0.3750	0.1047	3.5806**	3	3.1400	Reject H_o: $u_{grn}=u_{sft}=u_{nft}$
	GRN vs SFT	0.1362	0.1047	1.3005	2	2.4790	Accept H_o: $u_{grn}=u_{sft}$
	SFT vs NFT	0.2388	0.0662	3.6052**	2	2.4790	Reject H_o: $u_{sft}=u_{nft}$
≥1 sthd							
	GRN vs NFT	0.0762	0.0316	2.4097	3	3.6740	Accept H_o: $u_{grn}=u_{sft}=u_{nft}$
	GRN vs SFT	Not Tested					
	SFT vs NFT	Not Tested					
cutt							
	GRN vs SFT	0.0125	0.0031	4.0025*	3	3.6740	Reject H_o: $u_{grn}=u_{sft}=u_{nft}$
	GRN vs NFT	0.0087	0.0031	2.8414	2	3.0140	Accept H_o: $u_{grn}=u_{nft}$
	SFT vs NFT	0.0039	0.0019	1.9623	2	3.0140	Accept H_o: $u_{sft}=u_{nft}$
coho							
	GRN vs NFT	0.1700	0.057	2.982	3	3.6740	Accept H_o: $u_{grn}=u_{sft}=u_{nft}$
	GRN vs SFT	Not Tested					
	SFT vs NFT	Not Tested					

a
sthd = steelhead; cutt = cutthroat.

b
GRN = Green River; SFT = South Fork Toutle; and NFT = North Fork Toutle.

c
Standard error

d
Studentized range; * = 0.05 and ** = 0.10

e
number of means compared

Between species within drainages, mean densities of juvenile steelhead (all ages) were greater than those found for juvenile coho or cutthroat in the Green and South Fork Toutle tributaries (Table 10). Further data collection is needed to understand juvenile abundance in Toutle River tributaries.

Length and weight data collected from juvenile salmonids are reported in Table 10.

Physical measurement data for electrofishing sections are found in Appendix 9.

Table 10. Location, date, distance electroshocked, and densities for juvenile steelhead, cutthroat trout, and coho salmon electrofished in several tributaries of the Toutle River watershed, 1989

			Steelhead						Cutthroat			Coho		
			0+			≥1			≥1			≥1		
Location[a]	Date	Distance (m)	n	m²	m³	n	m²	m³	n	m²	m³	n	m²	m³
Green River														
Cascade	9-28	58	.41	.12	.68	.36	.11	.62	.02	.01	.03	.48	.13	.79
Elk*	9-11	79	2.68	.65	2.91	.39	.09	.43	.06	.02	.07	1.18	.28	1.28
North Fk. Toutle														
Alder (u)*	9-01	66	.23	.04	.13	.08	.01	.04	.00	.00	.00	.24	.04	.14
Alder (l)*	9-04	89	.17	.04	.13	.25	.05	.18	.04	.01	.03	.73	.15	.55
Bear	9-25	111	.00	.00	.00	.08	.01	.07	.03	.01	.02	.56	.08	.48
Castle	9-25	100	.00	.00	.00	.04	.01	.02	.00	.00	.00	.00	.00	.00
Coldwater	9-25	80	.00	.00	.00	.08	.01	.03	.00	.00	.00	.00	.00	.00
Hoffstadt (u)	10-10	85	.00	.00	.00	.25	.04	.22	.13	.02	.11	.06	.01	.07
Hoffstadt (l)*	10-13	128	.02	.01	.02	.16	.03	.12	.01	.01	.01	.00	.00	.00
Jackson	9-25	81	.00	.00	.00	.04	.03	.25	.00	.00	.00	.00	.00	.00
South Fk. Toutle														
Clancy	9-14	42	.50	.08	2.13	.29	.19	1.55	.00	.00	.00	.02	.02	.09
Disappt.	9-14	40	1.06	.19	1.67	.30	.19	.72	.00	.00	.00	.50	.32	1.20
Herrington (u)	9-15	34	.21	.21	1.46	.03	.01	.05	.00	.00	.00	1.03	.24	1.65
Herrington (l)	9-15	61	1.38	.38	2.46	.08	.02	.15	.00	.00	.00	.36	.10	.67
Johnson (u)*	9-06	56	.02	.01	.08	.00	.00	.00	.00	.00	.00	.10	.04	.36
Johnson (l)*	9-04	87	.18	.07	.67	.16	.06	.60	.00	.00	.00	.73	.27	2.63
Studebaker		110	.01	.01	.04	.00	.00	.00	.01	.01	.04	.00	.00	.00
Trouble	9-14	59	1.49	.24	1.42	.14	.02	.13	.05	.01	.05	.00	.00	.00
Silver LK.														
Hemlock	9-12	30	.00	.00	.00	.00	.00	.00	.23	.09	.52	.00	.00	.00

[a] (u) = upper section; (l) = lower section; Index surveys = *.

6.0 Summary

1) The Toutle River Fish Collection Facility began operation on February 28, 1989. Initially, a temporary trap was operated (February through June) while construction of the FCF was ongoing. The collection pond was completed in late June and began operation early July, 1989.

2) Adult salmonids collected at the FCF were either recycled downstream of the FCF or trucked above the Silt Retention Structure for release. The following were recycled: 820 hatchery summer-run steelhead (709 corrected for recaptures); 11 wild summer-run adults; and one chinook salmon. In addition, the following were trucked above the SRS for release: 18 wild winter-run steelhead; 17 cutthroat trout; and 403 coho salmon.

3) A total of 111 (15.8%) of recycled hatchery summer-run steelhead were recaptured at the FCF. Mean elapsed time to first recapture was 31 days. Some adults were recaptured four times at the FCF.

4) Of 403 coho salmon trucked above the SRS, two were found to have moved back downstream past both the SRS and FCF. No steelhead or cutthroat trout fell back over SRS following release above the SRS.

5) Scale samples were aged from wild winter-run and hatchery summer-run steelhead and cutthroat trout collected at the FCF. Four life history patterns were found for wild winter-run steelhead as compared to two for hatchery summer-run adults. Cutthroat were observed to have two age groups. Most cutthroat trout were on their initial immigration from saltwater to freshwater.

6) Sport anglers returned 43 (6.0%) tags from 720 summer-run recycled. From release sites A (5 km), B (16 km), and C (24 km), a total of 2, 31, and 1 tags were recovered, respectively. Average time between recycling and capture by sport anglers was: 42 (A); 47 (B); and 91 (C) days, respectively.

7) One persistent problem at the FCF was sediment loads which affected trapping equipment (February through June). Similarly, heavy sand deposition in July may have affected summer-run steelhead from entering the FCF. Numerous problems with the operation of the automatic crowder were due to heavy sand deposition. In addition, water flows in the North Fork Toutle River were lowered to 70 cfs in early July (during the peak immigration of summer-run steelhead to the FCF) to allow work on the notch in the barrier wall.

8) Spawner surveys were conducted on tributaries of the South

Fork- and North Fork Rivers, and Green River. Results reported in Weiheimer et al. (1990).

9) An estimated 363 sport anglers spent 776 hours fishing on the South Fork Toutle River during the winter-run sports fishery (January 1 through April 15, 1989). The mean number of hours fished per angler was 2.13. Estimated season catch was 127 ± 45 steelhead. Sport anglers released about 90 percent of the wild winter-run adults landed.

10) An estimated 1,742 anglers spent 4,777 hours fishing for summer-run steelhead on the South Fork Toutle river. The mean number of hours fished per angler was 4.14 and 2.57 for complete and incomplete anglers, respectively. Total season catch was 204 ± 40 steelhead.

11) Seven hundred and fifteen anglers were estimated to have expended 1,391 hours fishing on the North Fork Toutle for summer-run steelhead. Estimated total season catch was 159 ± 31 adult fish.

12) An estimated 769 anglers spent 2,329 hours fishing summer-run steelhead on the Green River. The mean number of hours fished per angler (complete and incomplete) was 2.27 and 3.13, respectively. Estimated season total was 164 ± 33 adult fish.

13) Population estimates were conducted in 19 sections of 15 tributaries of the Toutle River drainage to determine relative abundance of juvenile steelhead, cutthroat trout, and coho salmon.

14) No significant difference in mean salmonid densities were found between gradient zones in streams electrofished. Between drainages, steelhead age 0 mean densities were significantly greater in the Green River and South Fork than in the North Fork Toutle River. Similarly, cutthroat trout densities were greater in the Green River tributaries. Coho densities did not differ between drainages.

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Appendix 1. Results of a one day field testing of the temporary trap.at the Toutle River Fish Collection Facility, to hold fish, 1989

We tested whether adult salmonids entering a temporary trap, constructed by the COE to collect returning fish, could escape once inside. The trap was constructed with only a tailbar to prevent adults from leaving trap. Fishing of the trap for wild winter-run steelhead began on February 28, 1989 (see 2.2 Method this report). No adults were captured first several weeks of trap operations. We felt that adults were entering the trap but could swim easily out of it therefore we were not capturing any fish. We believed that a type of weir-like structure (gate) added to the trap opening could increase the traps efficiency to capture adults.

On March 14, 1989, we tested our hypothesis that the present trap design allowed fish to escape by placing tagged adults into the trap and monitoring to see if they could escape. We first tagged three adult steelhead with yellow t-bar floy tags and released them into the trap for a period of one hour before pulling the trap to see if they were still present. After one hour, all adults were accounted for. We then tagged an additional three adults, placing them in with the other three for a total of six adults in the trap. The trap was left for a 24 hour period before pulling it. On pulling the trap the next day, we found that two adults had escaped. We concluded that once adults entered the trap, the tailbar did not prevent adults from swimming out of the trap. We recommended that the COE construct a weir-like structure in the opening of the trap to prevent fish from easily escaping. Once in place, capture of adults increased.

Appendix 2. Estimated North Fork Toutle River flows (cfs) for Water Year 1989 as determined from flow measurements taken at the Sediment Retention Structure.

Day	Month											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	170	260	890	1020	910	680	990	680	560	200	370	140
2	160	330	820	870	880	720	1050	710	570	190	280	150
3	160	660	760	810	780	630	1010	680	590	190	300	150
4	160	670	720	860	760	570	950	670	600	180	430	140
5	160	640	690	960	710	650	1020	640	590	180	390	120
6	160	1050	700	950	670	880	1130	640	580	170	350	100
7	150	1110	740	920	640	1180	1200	640	560	170	290	110
8	150	930	780	840	600	1020	1180	670	530	170	310	160
9	150	850	740	810	560	870	1100	680	520	190	290	160
10	150	800	740	1320	520	1130	960	690	490	200	280	140
11	140	850	720	1330	500	1370	910	660	460	190	240	130
12	140	830	690	1160	490	1610	890	610	460	180	210	120
13	140	900	670	1090	550	1790	880	560	470	180	190	120
14	160	830	720	990	480	1760	880	540	480	180	170	120
15	180	800	670	900	430	1640	930	530	510	170	160	120
16	180	780	620	930	490	1560	920	550	400	100	160	120
17	240	870	600	1200	850	1420	880	600	330	110	160	120
18	200	880	560	1290	860	1250	820	720	300	80	150	120
19	210	820	610	1330	780	1100	780	630	310	70	140	120
20	200	840	620	1220	740	940	830	520	400	80	150	120
21	200	960	640	1240	730	960	930	500	300	80	160	120
22	230	1370	620	1170	810	960	850	500	270	80	230	120
23	240	1680	640	1060	910	880	800	580	250	120	200	120
24	250	1560	660	890	940	840	770	560	250	200	170	120
25	260	1430	630	810	870	1140	750	620	240	260	160	120
26	260	1270	550	760	830	1170	780	550	220	220	140	120
27	260	1070	530	740	760	1130	770	730	200	250	140	130
28	250	1180	520	690	730	1240	740	700	200	240	130	130
29	250	1150	550	650		1220	720	650	200	260	130	130
30	250	1010	940	700		1150	680	620	200	270	140	120
31	250		1100	880		1080		570		330	140	
Total	6060	28380	21440	30390	19780	34540	27100	19200	12040	5490	6760	3810
Mean	195	946	692	980	706	1114	903	619	401	177	218	127

Appendix 3. Daily count of salmonids handled (re-captures included) at the Toutle River Fish Collection Facility, 1989.

	Steelhead													
	Wild winter		Hatchery winter		Wild summer		Hatchery summer		Cutthroat		Coho		Chinook	
Date	male	female	male	female	male	female	male	female	male	female	male	female	male	female
02-28	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-02	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-03	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-04	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-05	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-06	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-07	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-08	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-09	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-19	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-21	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-24	0	3	0	0	0	0	0	0	0	1	0	0	0	0
03-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-27	0	0	0	0	0	0	0	0	0	1	0	0	0	0
03-28	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03-31	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	3	0	0	0	0	0	0	0	2	0	0	0	0

Appendix 3. (cont.,)

	Steelhead													
	Wild winter		Hatchery winter		Wild summer		Hatchery summer		Cutthroat		Coho		Chinook	
DATE	male	female	male	female	male	female	male	female	male	female	male	female	male	female
04-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04-02	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04-03	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04-04	0	1	0	0	0	0	0	0	0	1	0	0	0	0
04-05	0	1	0	0	0	0	0	0	0	0	0	0	0	0
04-06	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04-07	2	0	0	0	0	0	0	0	0	0	0	0	0	0
04-08	0	0	0	0	0	0	0	0	0	2	0	0	0	0
04-09	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04-10	1	0	0	0	0	0	0	0	0	0	0	0	0	0
04-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04-12	0	0	0	0	0	0	0	0	0	2	0	0	0	0
04-13	0	0	0	0	0	0	0	0	0	1	0	0	0	0
04-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04-15	0	0	0	0	0	0	1	0	0	0	0	0	0	0
04-16	0	2	0	0	0	0	0	0	0	0	0	0	0	0
04-17	0	0	0	0	0	0	1	0	0	0	0	0	0	0
04-18	0	1	0	0	0	0	0	0	0	0	0	0	0	0
04-19	0	1	0	0	0	0	0	0	0	0	0	0	0	0
04-20	1	0	0	0	0	0	0	0	0	0	0	0	0	0
04-21	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04-25	1	0	0	0	0	0	0	0	0	0	0	0	0	0
04-26	0	1	0	0	0	0	0	0	0	0	0	0	0	0
04-27	0	1	0	0	0	1	0	0	0	0	0	0	0	0
04-28	0	1	0	0	0	0	0	0	0	0	0	0	0	0
04-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	5	9	0	0	0	1	2	0	0	6	0	0	0	0

Appendix 3. (cont.,)

DATE	Steelhead								Cutthroat		Coho		Chinook	
	Wild winter		Hatchery winter		Wild summer		Hatchery summer							
	male	female	male	female	male	female	male	female	male	female	male	female	male	female
05-01	0	1	0	0	0	0	1	1	1	0	0	0	0	0
05-02	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-03	0	0	0	0	0	0	0	1	0	0	0	0	0	0
05-04	0	0	0	0	0	0	0	1	0	0	0	0	0	0
05-05	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-06	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-07	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-08	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-09	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-11	0	0	0	0	0	0	0	1	0	0	0	0	0	0
05-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-16	0	0	0	0	0	0	1	1	0	0	0	0	0	0
05-17	0	0	0	0	0	0	0	1	0	0	0	0	0	0
05-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-19	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-20	0	0	0	0	0	0	0	1	0	0	0	0	0	0
05-21	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05-24	0	0	0	0	0	0	1	2	0	0	0	0	0	0
05-25	0	0	0	0	0	0	0	1	0	0	0	0	0	0
05-26	0	0	0	0	0	0	3	2	0	0	0	0	0	0
05-27	0	0	0	0	0	0	0	1	0	0	0	0	0	0
05-28	0	0	0	0	0	0	0	4	0	0	0	0	0	0
05-29	0	0	0	0	0	0	0	1	0	0	0	0	0	0
05-30	0	0	0	0	0	0	3	4	0	0	0	0	0	0
05-31	0	0	0	0	0	0	1	5	0	0	0	0	0	0
Sub-Totai	0	1	0	0	0	0	10	27	1	0	0	0	0	0

Appendix 3. (cont.,)

Date	Steelhead													
	Wild winter		Hatchery winter		Wild summer		Hatchery summer		Cutthroat		Coho		Chinook	
	male	female	male	female	male	female	male	female	male	female	male	female	male	female
06-01	0	0	0	0	0	0	1	1	0	0	0	0	0	0
06-02	0	0	0	0	0	0	0	5	0	0	0	0	0	0
06-03	0	0	0	0	0	0	1	0	0	0	0	0	0	0
06-04	0	0	0	0	0	0	1	3	0	0	0	0	0	0
06-05	0	0	0	0	0	0	2	3	0	0	0	0	0	0
06-06	0	0	0	0	0	0	0	1	1	0	0	0	0	0
06-07	0	0	0	0	0	0	1	3	0	0	0	0	0	0
06-08	0	0	0	0	0	0	1	2	0	0	0	0	0	0
06-09	0	0	0	0	0	0	1	2	0	0	0	0	0	0
06-10	0	0	0	0	0	0	2	6	0	0	0	0	0	0
06-11	0	0	0	0	0	0	1	1	0	0	0	0	0	0
06-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06-15	0	0	0	0	0	0	2	2	0	0	0	0	0	0
06-16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06-19	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06-20	0	0	0	0	0	0	4	1	0	0	0	0	0	0
06-21	0	0	0	0	0	0	3	5	0	0	0	0	0	0
06-22	0	0	0	0	0	0	1	4	0	0	0	0	0	0
06-23	0	0	0	0	0	0	9	21	0	0	0	0	0	0
06-24	0	0	0	0	0	0	4	12	0	0	0	0	0	0
06-25	0	0	0	0	0	0	3	9	0	0	0	0	0	0
06-26	0	0	0	0	0	0	8	5	0	0	0	0	0	0
06-27	0	0	0	0	0	0	2	9	0	0	0	0	0	0
06-28	0	0	0	0	0	0	13	16	0	1	0	0	0	0
06-29	0	0	0	0	0	0	0	1	0	0	0	0	0	0
06-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	0	0	0	0	60	112	1	1	0	0	0	0

Appendix 3. (cont.,)

Date	Steelhead								Cutthroat		Coho		Chinook	
	Wild winter		Hatchery winter		Wild summer		Hatchery summer							
	male	female	male	female	male	female	male	female	male	female	male	female	male	female
07-01	0	0	0	0	0	0	10	37	0	0	0	0	0	0
07-02	0	0	0	0	0	0	2	15	0	0	0	0	0	0
07-03	0	0	0	0	0	0	6	10	0	0	0	0	0	0
07-04	0	0	0	0	1	0	16	20	0	0	0	0	0	0
07-05	0	0	0	0	2	1	14	14	0	0	1	0	0	0
07-06	0	0	0	0	0	0	3	7	0	0	0	0	0	0
07-07	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07-08	0	0	0	0	0	0	29	49	0	0	0	0	0	0
07-09	0	0	0	0	0	0	1	1	0	0	0	0	0	0
07-10	0	0	0	0	0	0	8	14	0	0	0	0	0	0
07-11	0	0	0	0	0	0	1	2	0	0	0	0	0	0
07-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07-16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07-17	0	0	0	0	0	0	0	3	0	0	0	0	0	0
07-18	0	0	0	0	0	0	3	3	0	0	0	0	0	0
07-19	0	0	0	0	0	1	13	21	0	0	0	0	0	0
07-20	0	0	0	0	0	0	6	7	0	0	0	0	0	0
07-21	0	0	0	0	0	0	3	6	0	0	0	0	0	0
07-22	0	0	0	0	0	0	0	5	0	0	0	0	0	0
07-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07-26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07-27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07-28	0	0	0	0	0	0	5	16	0	0	0	0	0	0
07-29	0	0	0	0	0	0	3	6	0	0	0	0	0	0
07-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07-31	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	0	0	3	2	123	236	0	0	1	0	0	0

Appendix 3. (cont.,)

Date	Steelhead								Cutthroat		Coho		Chinook	
	Wild winter		Hatchery winter		Wild summer		Hatchery summer							
	male	female	male	female	male	female	male	female	male	female	male	female	male	female
08-01	0	0	0	0	0	0	0	1	0	0	0	0	0	0
08-02	0	0	0	0	0	0	0	6	0	1	0	0	0	0
08-03	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08-04	0	0	0	0	0	0	4	10	0	0	0	0	0	0
08-05	0	0	0	0	0	1	1	12	0	0	0	0	0	0
08-06	0	0	0	0	0	1	22	59	0	0	0	0	0	0
08-07	0	0	0	0	0	0	3	7	0	0	0	0	0	0
08-08	0	0	0	0	0	0	0	2	0	0	0	0	0	0
08-09	0	0	0	0	0	0	0	3	0	1	0	0	0	0
08-10	0	0	0	0	0	0	2	6	0	0	0	0	0	0
08-11	0	0	0	0	0	0	0	6	0	0	0	1	0	0
08-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08-13	0	0	0	0	0	0	2	7	0	0	0	0	0	0
08-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08-16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08-19	0	0	0	0	0	0	1	5	0	0	0	0	0	0
08-20	0	0	0	0	0	0	1	8	0	0	0	0	0	0
08-21	0	0	0	0	0	0	0	1	0	0	0	0	0	0
08-22	0	0	0	0	0	0	0	1	0	1	0	0	0	0
08-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08-26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08-27	0	0	0	0	0	0	0	0	0	1	0	0	0	0
08-28	0	0	0	0	0	0	0	1	0	0	0	0	0	0
08-29	0	0	0	0	0	0	0	0	1	0	0	1	0	0
08-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08-31	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	0	0	0	2	36	135	1	4	0	2	0	0

Appendix 3. (cont.)

Date	Steelhead								Cutthroat		Coho		Chinook	
	Wild winter		Hatchery winter		Wild summer		Hatchery summer							
	male	female	male	female	male	female	male	female	male	female	male	female	male	female
09-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-02	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-03	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-04	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-05	0	0	0	0	0	0	1	7	0	0	0	0	0	0
09-06	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-07	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-08	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-09	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-10	0	0	0	0	0	0	1	1	0	0	0	1	0	0
09-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-13	0	0	0	0	0	0	0	1	0	0	0	0	0	0
09-14	0	0	0	0	0	0	0	1	0	0	0	0	0	0
09-15	0	0	0	0	0	1	0	1	0	0	1	0	0	0
09-16	0	0	0	0	0	0	0	3	0	0	1	0	0	0
09-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-19	0	0	0	0	0	0	0	1	0	0	0	0	0	0
09-20	0	0	0	0	0	0	0	3	0	1	0	0	0	0
09-21	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-27	0	0	0	0	0	0	0	0	0	0	2	0	0	0
09-28	0	0	0	0	0	0	1	3	0	0	0	0	0	0
09-29	0	0	0	0	0	0	0	0	0	0	0	0	0	0
09-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	0	0	0	0	1	3	21	0	1	4	1	0	0

Appendix 3. (cont..)

Date	Steelhead													
	Wild winter		Hatchery winter		Wild summer		Hatchery summer		Cutthroat		Coho		Chinook	
	male	female	male	female	male	female	male	female	male	female	male	female	male	female
10-01	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-02	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-03	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-04	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-05	0	0	0	0	0	1	0	0	0	0	0	4	0	0
10-06	0	0	0	0	0	0	4	6	0	0	0	0	0	0
10-07	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-08	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-09	0	0	0	0	0	0	5	9	0	1	21	10	0	0
10-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-12	0	0	0	0	0	0	4	7	1	0	26	17	0	0
10-13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-18	0	0	0	0	0	0	0	0	0	1	52	46	0	0
10-19	0	0	0	0	0	0	0	0	0	0	0	1	0	0
10-20	0	1	0	0	0	0	1	0	0	0	4	5	0	0
10-21	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-22	0	0	0	0	0	0	0	0	0	0	39	59	0	0
10-23	0	0	0	0	1	0	4	0	0	0	12	20	0	1
10-24	0	0	0	0	0	0	0	2	0	0	4	10	0	0
10-25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-26	0	0	0	0	0	0	2	5	0	0	17	18	0	0
10-27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-28	0	0	0	0	0	0	2	4	0	1	3	8	0	0
10-29	0	0	0	0	0	0	0	0	0	0	1	0	0	0
10-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10-31	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total	0	1	0	0	1	1	22	33	1	3	196	198	0	1

Appendix 4. Age composition, sex, number, and mean fork length (mm) of wild winter-run steelhead captured by sport anglers during the winter sport fishery on the South Fork Toutle River, 1988.

	Wild Steelhead			
	Male		Female	
Age	n	length ± SD	n	length ± SD
1.1+	1	(620) ----	0	---- ----
2.1+	13	680.9 ± 22.0	21	671.1 ± 23.0
2.2+	0	---- ----	6	783.8 ± 23.6
2.1+3+	3	667.7 ± 45.7	10	745.3 ± 30.2
3.1+	0	---- ----	1	(643) ----
3.2+	0	---- ----	1	(790) ----

Appendix 5 . Tag number, date first handled, date recaptured, number of days available to sports anglers, release site and location of capture for tagged steelhead recycled downriver of the FCF, 1989.

Tag number	Date first handled	Date captured	Number[a] days	release[b] site	Location[c] of capture
00180	June 5	June 30	26	16 km	S.F.T..
00186	June 4	June 22	19	16 km	S.F.T.R.
00172	May 31	June 18	19	16 km	Green R.
00178	June 1	June 21	21	16 km	Green R.
00286	June 25	Sept 26	94	16 km	N.F.T.R.
00526	July 8	July 10	3	16 km	S.F.T.R
00557	July 8	July 10	3	16 km	S.F.T.R
00690	Aug 5	Aug 14	10	16 km	N.F.T.R.
00357	July 1	Aug 4	35	16 km	Green R.
00402	July 3	July 31	29	16 km	Green R.
00226	June 21	Aug 1	42	8 km	Green R.
00204	June 10	June 25	16	16 km	unknown
00491	July 8	July 13	6	16 km	S.F.T.R.
00522	July 8	July 11	4	16 km	S.F.T.R.
00216	June 15	Oct 30	138	16 km	unknown
00318	June 28	Oct 30	126	16 km	unknown
00753	Aug 6	Oct 30	87	24 km	unknown
00459	July 5	Oct 6	94	24 km	S.F.T.R.
00434	July 4	Oct 16	105	16 km	S.F.T.R.
00522	July 8	July 11	4	16 km	S.F.T.R.
00487	July 8	Oct 7	112	16 km	S.F.T.R.
00403	July 3	Sept 24	82	16 km	Green R.
00366	July 1	Oct 2	92	16 km	N.F.T.R.
00621	July 20	Oct 2	73	16 km	N.F.T.R.
00168	May 30	Aug 26	88	16 km	N.F.T.R.
00722	Aug 6	Aug 28	23	16 km	N.F.T.R.
00413	July 3	Sept ?	---	16 km	S.F.T.R.
00895	Oct 12	Oct 18	7	16 km	S.F.T.R.
00525	July 8	July 19	12	16 km	N.F.T.R.
00427	July 4	July 21	18	16 km	N.F.T.R.
00549	July 5	Aug 20	42	16 km	N.F.T.R.
00533	July 8	Sept 1	54	16 km	N.F.T.R.
00433	July 4	Sept 1	58	16 km	N.F.T.R.
00636	July 28	Sept 30	65	16 km	N.F.T.R.
00151	June 2	Sept 4	94	16 km	S.F.T.R.
00671	Aug 6	Oct 5	61	16 km	N.F.T.R.
00584	Oct 5	Oct 1	5	16 km	N.F.T.R.
00506	July 8	Oct 6	89	16 km	Toutle
00838	Sept 15	Oct 10	26	16 km	N.F.T.R.

a) Number of days between time of release and capture plus the day of release (i.e. n + 1 = total days available).

Appendix 5. (cont.,)

b) Locations 8 km, 16 km, and 24 km are the North Fork Toutle River, mouth of the South Fork Toutle River, and main Toutle River, respectively.
c) N.F.T.R. = North Fork Toutle River; S.F.T.R. = South Fork Toutle River.

Appendix G. Snorkel survey of the North Fork Toutle and Green Rivers. 1989.

Introduction

Snorkel floats by two or three observers were made on one section of the North Fork Toutle River and Green River in 1989. Section length varied between locations. About 3.2 and 7.2 Km were surveyed by three and two divers for the North Fork Toutle River and Green River, respectively. Divers floated about two meters apart, side by side, counting adults and juvenile steelhead and salmon. Counts were periodically tallied at the bottom of each riffle-run-pool combination. Substrate condition (i.e. plants, silt, and rock) were noted. Our purpose was to assess the relative abundance of adult and juvenile salmonids in the North Fork Toutle River and Green River during early Fall. Observations are reported herein.

North Fork Toutle River

Few adults or juveniles were seen during our float from the barrier at the Toutle River Fish Collection Facility (TCF) downstream 3.2 Km on October 4, 1989. Visibility was very poor throughout the float survey and possibly affected our ability to detect adults or juveniles. However, six adult coho and one jack were counted downstream of the TCF above the confluence of the Green River and North Fork River. At the mouth of the Green River, we observed about 20 adult salmonids, but poor visibility prevented identification. These unidentified adults were likely coho as many coho were returning to the Green River during this time of the year. Three live and two dead spring chinook were counted, also. Numerous whitefish and suckers were observed throughout the survey. Four steelhead adults were observed, two tagged with yellow floy t-bar tags from the TCF. Very few juvenile salmonids were observed during our float.

Interstices between boulders were filled with fines; macrophytes were limited.

Green River

We surveyed the Green River from Devil's Creek, downstream to the mouth (7.2 Km) on November 3, 1989. From Devil's Creek, down river (first 3 Km), we counted 29 female and 37 male coho and 10 jacks. Another 415 coho were counted (sex unknown) within the same area. Many coho were actively digging redds. About 800 adult coho were within 100 m of the old Green River hatchery outlet (remaining 4.2 Km). Only one cutthroat trout and two steelhead parr were seen for 7.2 km. In one area, we counted about 100 coho parr clumped around the roots of a dead tree. Six female and nine male spring chinook and one jack were counted for the 7.2 Km float. A total of 83 steelhead were observed - 51 females and 32 males. Steelhead were equally divided between upper and lower areas of our

survey.

An important find during our float, was a dead tagged coho salmon. This adult had been handled three weeks earlier by the FCF crew, tagged, trucked above the Silt Retention Structure (SRS) to Hoffstadt Creek (about 16 Km) and released. It dropped back over the SRS and the FCF moved up the Green River to spawn. This single tag recovery provides evidence that: 1) some salmonids do not remain in release site areas, but relocate elsewhere; 2) Adults can survive falling back over the SRS during flow condition that existed in early November; and 3) Some Green River coho adults may have been captured at the FCF and once released, may have dropped back downstream to re-enter the Green River or FCF thereby possibly biasing coho counts at the FCF.

Sand was found in many areas and covered most of the substrate. Very little plant life was found.

Appendix 7a. Date, temperature, gate opening (entrance pool) attraction defuser opening, water supply channel opening at the Toutle River Fish Collection Facility: April, 1989.

Date	Temp. (C)	Entrance Pool[a] Outside	Entrance Pool[a] Inside	Attraction Defuser	Water Supply Channel[b]	Comments
04-01	6	2.1	3.0			Defuser being worked on.
04-02	5	2.0	3.0			Defuser being worked on.
04-03	6	2.0	2.9			Defuser being worked on.
04-04	7	2.0	2.9			Defuser being worked on.
04-05	8	2.0	3.0			Defuser being worked on.
04-06	7	2.1	3.0			Defuser being worked on.
04-07		2.2	3.5			@7:40 p.m
04-08	8	2.2	3.5			
04-09	7	2.0	3.4			@ 8:00 a.m.
04-10	8	2.0	3.3			@ 5:00 p.m.
04-11						
04-12	14	1.9	2.9	23.00		@ 4:53 p.m.
04-13	9	1.9	2.9	23.00		@ 6:00 a.m.
04-14	9	1.9	3.1	23.00		@ 6:10 a.m.
04-15	8	2.0	2.9	23.00		@ 9:20 a.m.
04-16	10	2.0	2.9	23.00		@ 1:00 p.m.
01-17	10	1.9	2.3	23.00		@ 11:00 a.m. > 24"
04-18	10	1.9	2.6	24.00		@ 7:00 a.m.; changed to 20"
		1.9	2.9			
04-19	10	2.0	2.9	24.00		@ 4:30 p.pm.
04-20	10	2.1	2.9	24.00		@ 4:00 p.m.
04-21	9	2.0	3.1	23.00		@ 7:30 a.m.
04-22	8	2.0	3.0	24.00		@ 7:40 a.m.
04-23	8	1.7	3.0	21.00		@ 8:00 a.m. < from 24"
04-24		1.6	2.7			@ 7:38 a.m.
04-25	10	1.6	2.7			@ 6:30 a.m.
04-26	10	1.6	2.6	23.00		@ 6:30 a.m.
04-27	10	1.5	2.6	23.00		@ 7:30 a.m.
04-28	12	1.5	2.7	23.00		@ 3:30 p.m.
04-29	11	1.5	2.4	23.00		@ 2:30 p.m.
04-30	11	1.5	2.4	23.00		@ 9:00 a.m.
Mean	9	1.9	2.9	23.12		
Std.	2	0.4	0.6	5.20		

[a] All measurements are in inches for attraction flow/defuser readings.
All measurements for water supply channel and entrance pool are in feet (tenths).

[b] Water supply channel under construction.

Appendix 7b. Date, temperature, gate opening (entrance pool), attraction defuser opening, water supply channel opening at the Toutle River Fish Collection Facility: May, 1989.

Date	Temp. (C)	Entrance Pool		Attraction Defuser	Water Supply Channel	Comments
		Outside	Inside			
05-01	10	1.7	2.7	23.00		
05-02	15	1.6	2.4	23.00		@ 3:00 p.m.; no adjust.
05-03	14	1.7	2.4	23.00		@ 3:00 p.m.; no adjust.
05-04	13	1.6	2.5	23.00		@ 1:00 p.m.; " " "
05-05	13	1.6	2.6	23.00		@ 4:00 p.m.; no adj.
05-06	13	1.6	2.6	23.00		@ 3:00 p.m.; no adj.
05-07	13	1.6	2.6	23.00		@ 3:45 p.m.; no adj.
05-08	12					Change from pipe to ladder flow
05-09	11	1.8	2.6			Adj. continued
05-10	11	1.6	2.4	20.00		@ 9:00 a.m.; no adj.
05-11	11	1.6	2.5	17.00		@ 9:00 a.m.; no adj.
05-12	11	1.6	2.4	16.00		@ 9:00 a.m.; no adj.
05-13	11	1.6	2.0	17.00		@ 9:00 a.m.; no adj.
05-14	11	1.5	2.0	17.00		@ 8:00 a.m.; no adj.
05-15	11	1.5	2.0	24.00	23.00	@ 9:00 a.m.
05-16	11	1.5	2.2			@ 7:00 a.m.
05-17	10	1.5	2.0	17.00	24.00	@ 8:15 a.m.
05-18	11	1.6	1.9	10.00	24.00	@ 9:15 a.m.
05-19	11	1.6	1.8	10.00	24.00	@ 3:00 p.m.
05-20	11	1.6	1.6	7.00	24.00	@ 9:00 a.m.
05-21	11	1.6	1.6	5.00	24.00	@ 3:00 p.m.
05-22	10	1.6	1.6	5.00	23.00	@ 7:30 a.m.
05-23	10	1.6	2.0			@ 6:00 a.m.
05-24	10	1.6	2.2	5.00	24.00	
05-25	9	1.6	2.4	5.00	24.00	
05-26	10	1.6	2.3	6.00	23.00	
05-27	9	1.6	2.6	6.00	23.00	
05-28	9	1.6	3.4	7.75	18.00	
05-29	10	1.5	3.4	7.75	18.00	
05-30	10	1.6	3.2	9.00	14.00	
05-31	11	1.5	3.0	8.25	14.25	@ 9:00 a.m.
Mean	11	1.6	2.4	14.10	21.62	
Std.	2	0.3	0.6	7.44	6.07	

a
All measurements are in inches for attraction flow/defuser readings.
All measurements for water supply channel and entrance pool are in inches.

Appendix 7c. Date, temperature, gate opening (entrance pool), attraction defuser opening, water supply channel opening at the Toutle River Fish Collection Facility: June, 1989.

Date	Temp. (C)	Entrance Pool		Attraction Defuser	Water Supply Channel	Comments
		Outside	Inside			
06-01	12	1.6	3.0	8.25	14.25	
06-02	12	1.6	2.9	8.25	14.25	
06-03	11	1.6	2.7	8.25	14.25	
06-04	12	1.6	3.0	9.50	12.00	
06-05	22	1.6	3.0	9.50	12.00	@ 2:30 p.m.
06-06	13	1.6	3.0	9.00	12.00	@ 8:00 a.m.
06-07	13	1.6	3.2	8.25	14.00	
06-08	13	1.6	3.0	8.25	14.00	
06-09	12	1.5	3.2	8.75	16.75	
06-10	13	1.5	2.8	8.75	16.75	
06-11	13	1.6	2.5	5.75	24.00	
06-12	11	1.5	2.7	6.00	18.00	
06-13						
06-14	15	1.5	3.0	12.00	12.00	
06-15	13	1.5	2.5	8.00	24.00	
06-16	14	1.5	2.8	5.50	24.00	
06-17	15	1.5	2.2	9.00	18.00	
06-18	16	1.1	1.9	9.00	12.00	
06-19	14	1.0	1.8	3.50	14.00	
06-20	16	0.0	0.0	0.00	24.00	opened upstream gate
06-21	16	0.0	0.0	0.00	24.00	
06-22	18	0.0	0.0	0.00	24.00	
06-23	18	0.0	0.0	0.00	19.00	opened holding pond
06-24	19	0.0	0.0	0.00	21.00	
06-25		0.0	0.0	0.00	21.00	
06-26	18	0.0	0.0	0.00	0.00	
06-27	17	0.0	0.0	0.00	16.00	heavy silt throughout
06-28	17	0.0	0.0	0.00	16.00	heavy silt throughout
06-29	16	0.0	0.0	0.00	23.50	heavy silt throughout
06-30		0.0	0.0	0.00	23.50	trap not fished; flush system
Mean	15	0.9	1.7	5.02	17.18	
Std.	4	0.7	1.4	4.14	6.14	

a
All measurements are in inches for attraction flow/defuser readings.
All measurements for water supply channel and entrance pool are in inches.

Appendix 7d. Date, temperature, gate openings (entrance way), attraction defuser opening, water supply channel opening at the Eagle River Fish Collection Facility: July, 1989.

Date	Temp. (C)	Entrance Pool		Attraction Defuser	Water Supply Channel	Comments
		Outside	Inside			
07-01	14	CLOSED	N/A	0.00	24.00	NOT FISHED OVERNIGHT
07-02	16	CLOSED	N/A	0.00	24.00	TO MUCH SILT BUILDUP
07-03	17	CLOSED	N/A	0.00	24.00	
07-04	19	CLOSED	N/A	0.00	24.00	
07-05	17	CLOSED	N/A	0.00	15.00	SILT HEAVY
07-06	16	CLOSED	N/A	OPENED	36.00	FLUSHED SYSTEM COMPLETE
07-07	14	CLOSED	N/A	0.00	24.00	FLUSHING LADDER & DEFUSER OVERNIGHT
07-08	13	CLOSED	N/A	0.00	24.00	FLUSHING LADDER & DEFUSER OVERNIGHT
07-09	11	CLOSED	N/A	0.00	24.00	FISHED ONCE;FLUSHED COLLECTION POND
07-10	11	CLOSED	N/A	0.00	0.00	WORK ON VALVES
07-11	9	CLOSED	N/A	0.00	0.00	WORK ON VALVES
07-12	18	CLOSED	N/A	0.00	0.00	FLUSHED SYSTEM ALL DAY
07-13	14	CLOSED	N/A	0.00	0.00	SHUT DOWN SYSTEM TO MUCH DEBRIS
07-14	13	CLOSED	N/A	0.00	0.00	FLUSHED & CLEANED DEFUSER
07-15	11	CLOSED	N/A	0.00	0.00	NO FISHING
07-16	13	CLOSED	N/A	0.00	0.00	NO FISHING
07-17	15	CLOSED	N/A	0.00	0.00	DEFUSER FULL OF SAND
07-18	19	CLOSED	N/A	0.00	0.00	DEFUSER FULL OF SAND/WORK ON NOTCH
07-19	18	CLOSED	N/A	0.00	0.00	DEFUSER FULL OF SAND/WORK ON NOTCH
07-20	19	CLOSED	N/A	0.00	24.00	DEFUSER FULL OF SAND/WORK ON NOTCH
07-21	19	CLOSED	N/A	0.00	0.00	FLUSHING DEFUSER & COLL. POND
07-22	18	CLOSED	N/A	0.00	0.00	FLUSHING DEFUSER & COLL. POND
07-23	19	CLOSED	N/A	0.00	0.00	FLUSHING DEFUSER & COLL. POND
07-24	19	CLOSED	N/A	0.00	0.00	FLUSHING DEFUSER & COLL. POND
07-25	18	CLOSED	N/A	0.00	0.00	FLUSHING DEFUSER & COLL. POND
07-26	16	CLOSED	N/A	0.00	0.00	FLUSHING DEFUSER & COLL. POND
07-27	19	CLOSED	N/A	0.00	0.00	POND CLEANED
07-28	19	CLOSED	N/A	0.00	0.00	TRAPPING FISH TODAY
07-29	20	CLOSED	N/A	0.00	0.00	TRAPPING FISH TODAY
07-30	18	CLOSED	N/A	0.00	0.00	TRAPPING FISH TODAY
07-31	16	CLOSED	N/A	0.00	0.00	TRAPPING FISH TODAY
Mean	16	0.0	0.0	0.00	7.84	
Std.	4	0.0	0.0	0.00	11.39	

a

All measurements are in inches for attraction flow/defuser readings.
All measurements for water supply channel and entrance way are in inches.

Appendix 7e. Date, Temperature, gate opening (entrance pool), attraction defuser opening, water supply channel opening at the Toutle River Fish Collection Facility: August, 1989.

Date	Temp. (C)	Entrance Pool: Outside	Entrance Pool: Inside	Attraction Defuser	Water Supply Channel	Comments
08-01	18	OPENED	OPENED	OPENED	24.00	GATES BEING REPAIRED
08-02	19	OPENED	OPENED	OPENED	24.00	GATES BEING REPAIRED
08-03	18	OPENED	OPENED	OPENED	24.00	GATES BEING REPAIRED
08-04	17	OPENED	OPENED	0.00	24.00	GATES BEING REPAIRED
08-05	19	OPENED	OPENED	4.00	24.00	GATES BEING REPAIRED
08-06	20	OPENED	OPENED	0.00	24.00	GOOD WATER
08-07	21	OPENED	OPENED	0.00	24.00	SAND DEPOSIT IN POND
08-08	18	OPENED	OPENED	0.00	24.00	USING AUXILLARY H20 SUPPLY
08-09	20	OPENED	OPENED	4.00	24.00	USING AUXILLARY H20 SUPPLY
08-10	20	OPENED	OPENED	0.00	24.00	USING AUXILLARY H20 SUPPLY
08-11	20	OPENED	OPENED	0.00	24.00	USING AUXILLARY H20 SUPPLY
08-12	20	OPENED	OPENED	0.00	24.00	USING AUXILLARY H20 SUPPLY
08-13	21	OPENED	OPENED	0.00	24.00	USING AUXILLARY H20 SUPPLY
08-14		OPENED	OPENED	0.00	24.00	USING AUXILLARY H20 SUPPLY
08-15		OPENED	OPENED	0.00	24.00	USING AUXILLARY H20 SUPPLY
08-16	19	OPENED	OPENED	0.00	24.00	USING AUXILLARY H20 SUPPLY
08-17	20	OPENED	OPENED	0.00	24.00	TRIED TO FLUSH ENTRANCE POOL
08-18	18	OPENED	OPENED	0.00	24.00	TRIED TO FLUSH ENTRANCE POOL
08-18	20	OPENED	OPENED	6.00	24.00	TRIED TO FLUSH ENTRANCE POOL
08-19	19	OPENED	OPENED	8.00	24.00	USING AUXILLARY H20
08-21	19	OPENED	OPENED	8.00	24.00	USING AUXILLARY H20
08-22	19	OPENED	OPENED	6.00	24.00	NOT FISHING: MAINTENANCE
08-23	18	OPENED	OPENED	0.00	24.00	ONLY 1' H20, REST SAND!
08-24		OPENED	1.0	8.00	0.00	ONLY 1' H20, REST SAND!
08-25	20	OPENED	1.0	8.00	24.00	FLUSHING ENTRANCE POOL
08-26	19	OPENED	1.0	4.00	24.00	FLUSHING ENTRANCE POOL
08-27	19	OPENED	1.0	6.00	24.00	LEFT TRAP FISH OVERNIGHT
08-28	21	OPENED	1.0	4.00	24.00	WORK ON COLLECTION POND
08-29	17	OPENED	1.0	0.00	0.00	WORK ON COLLECTION POND
08-30	18	OPENED	1.0	0.00	0.00	WORK ON COLLECTION POND
08-31	15	OPENED	1.0	0.00	0.00	WORK ON COLLECTION POND
Mean	19	0.0	0.3	2.13	20.90	
Std.	4	0.0	0.4	2.97	8.58	

a

All measurement are in inches for attraction flow/defuser readings.
All measurements for water supply channel and entrance pool are in inches.

Appendix 7i. Date, temperature, gate opening (entrance pool), attraction defuser opening, water supply channel opening at the Toutle River Fish Collection Facility: September, 1989.

Date	Temp. (C)	Entrance Pool		Attraction Defuser	Water Supply Channel	Comments
		Outside	Inside			
09-01	16	OPENED	OPENED	0.00	0.00	NO FISHING - HEAVY SAND
09-02	17	OPENED	OPENED	0.00	0.00	NO FISHING - HEAVY SAND
09-03	17	OPENED	OPENED	0.00	0.00	NO FISHING - HEAVY SAND
09-04		OPENED	OPENED	0.00	2.00	FISHED TRAP OVERNIGHT
09-05	17	OPENED	OPENED	0.00	0.00	PULLED TRAP - USING COLL. POND
09-06	17	OPENED	OPENED	0.00	0.00	USING COLLECTION PON
09-07	19	OPENED	OPENED	0.00	0.00	USING COLLECTION PON
09-08	20	OPENED	OPENED	0.00	24.00	USING COLLECTION PON
09-09	20	OPENED	OPENED	0.00	24.00	USING COLLECTION PON
09-10	21	OPENED	OPENED	0.00	24.00	ELECTROFISHING DAY/CHECK AT 5:00
09-11		OPENED	OPENED	8.00	24.00	ELECTROFISHING DAY/CHECK AT 5:00
09-12		OPENED	OPENED	5.00	24.00	ELECTROFISHING DAY/CHECK AT 5:00
09-13	21	OPENED	OPENED	0.00	24.00	ELECTROFISHING DAY/CHECK AT 5:00
09-14	21	OPENED	OPENED	0.00	24.00	
09-15	19	OPENED	OPENED	4.00	24.00	
09-16	19	OPENED	OPENED	0.00	24.00	
09-17	19	OPENED	OPENED	0.00	24.00	
09-18	19	OPENED	OPENED	0.00	24.00	
09-19	19	OPENED	OPENED	2.00	24.00	
09-20	19	OPENED	OPENED	2.00	24.00	
09-21	20	OPENED	OPENED	2.00	24.00	
09-22	20	OPENED	OPENED	3.00	24.00	
09-23	19	OPENED	OPENED	3.00	24.00	
09-24	20	OPENED	1.0	4.00	0.00	
09-25		OPENED	1.0			
09-26		OPENED	1.0			
09-27	19	OPENED	1.0	2.00	24.00	
09-28	19	OPENED	1.0	2.00	24.00	
09-29		OPENED	1.0			
09-30		OPENED	1.0			
Mean	19	0.0	0.8	1.35	16.69	
Std.	4	0.0	0.4	1.87	11.01	

a

All measurements are in inches for attraction flow/defuser readings.
All measurements for water supply channel and entrance pool are in inches.

Appendix 8. Index areas for creel surveys, Toutle River drainage, 1989.

Location		Description	River kilometer
South Fork			
1)	S.F. Toutle River Bridge after leaving town	Area just west of where bridge crosses river, next to river edge; east side of bridge above and below.	1.6
2)	First road on right following bridge site	Parking area above and below	2.4
3)	R & R Bridge	Past Green Mt. Mill; Below bridge and downstream about 500 yds.	4.0
4)	First road to right, down to R & R tracks	Drive road along tracks (back way to 12 mi. camp).	4.3
5)	12 mi. camp	Along length of old log yard.	4.8
6)	Pump House	Length of parking area	6.4
7)	Fish Ladder	Located down river of #4700 on south side of river.	8.0
8)	#4700 Bridge	Fished above and below on either side of river; bridge will permit you to drive down river on south side to rearing pond.	8.8
9)	Devil's Curve	Sharpest corner on 4100 rd; about 20 yds. to river.	11.2
10)	#4100 Bridge	Deadline; survey area downstream of bridge.	14.4
North Forth			
No index sites have been selected. Random surveys only.			
Green River			
1)	Mouth	Fifty yds. off road leading to confluence of N.F. Toutle and Green River.	0.0

Appendix 8. (cont.,)

Location		Description	River kilometer
2)	Old Hatchery	Along river in front of old Green River hatchery, 20 yds. from gate.	1.6
3)	Spillway	From locked gate at Green River Hatchery up river 0.8 km.	3.2
4)	#1000 Bridge	Up river from geologist's shack where bridge crosses river; 10 yds. from main line.	6.4
5)	Canyon	Walk in, no road; about 3.2 km; averages 30 minutes to walk.	8.0
6)	#2550 Bridge	Where rd. #2550 meets #2500; 15 yds. to river.	14.4
7)	Dead Line	Road # 2800 bridge.	20.8

Appendix 7g. Date, temperature, gate openings (entrance pool), attraction defuser valve opening, water supply channel opening at the Toutle River Fish Collection Facility: October, 1989.

Date	Temp. (C)	Entrance Pool		Attraction Defuser	Water Supply Channel	Comments
		Outside	Inside			
10-01				2.00		FISHED OVERNIGHT - FISHING
10-02	18			2.00		FISHED OVERNIGHT - FISHING
10-03						FISHED OVERNIGHT - FISHING
10-04						FISHED OVERNIGHT - FISHING
10-05	14			2.00	18.00	
10-06	15			2.00	16.00	
10-07	15					
10-08	16			4.00	24.00	MORE H20/150-200 CFS MORE
10-09	16	1.0	1.0	4.00	24.00	MORE H20/150-200 CFS MORE
10-10	16	1.0	1.0	4.00	24.00	MORE H20/150-200 CFS MORE
10-11						
10-12						
10-13						
10-14						
10-15						
10-16	13			0.00	24.00	AUX. VALVE 22 : 4" MONO #1
10-17	12	1.0	1.1	0.00	24.00	AUX. VALVE 22 : 4" MONO #1
10-18						
10-19						
10-20						
10-21						
10-22						
10-23	12	1.2	1.3	4.00	24.00	BYPASS VALVE OPENED 6"
10-24	11	1.2	1.4	4.00	24.00	AUX. OPENED 6
10-25		1.2	1.2	0.00	0.00	CLEANING POOL
10-26	11	1.2	1.2	7.00	24.00	
10-27	10	1.3	1.3	0.00	0.00	SLUICE GATE 24" OVERNIGHT
10-28	10	1.3	1.3	0.00	42.00	OPEN SUPPLY CHANNEL & AUX.
10-29	9	1.2	1.2	0.00	0.00	BYPASS - 24" OPENED
10-30	9	1.1	1.1	0.00	0.00	
10-31	9	1.1	1.1	0.00	0.00	
Mean	13	1.2	1.2	1.94	16.75	
Std.	4	0.3	0.3	2.01	12.31	

a
All measurements are in inches for attraction flow/defuser readings.
All measurements for water supply channel and entrance pool are in inches.

Appendix [illegible]. Physical characteristics of stream reaches within the Toutle River drainage, 1985.

River	Date	Stream	Length (m)	Width (m)	Area (m^2)	Depth (m)	Volume (m^3)	Gradient[b]
Green	09-28	Cascade	58	3.6	208.3	0.2	35.4	High
	09-11	Elk	79	4.2	327.0	0.2	72.8	Moderate
North	09-01	Alder (u)	66	6.3	415.9	0.3	112.3	Moderate
Fork	09-04	Alder (l)	89	4.8	425.2	0.3	119.1	Low
Toutle	09-25	Bear	111	6.2	680.4	0.2	128.5	Moderate
	09-25	Castle	100	6.3	630.9	0.4	224.6	High
	09-25	Coldwater	80	8.0	634.4	0.3	201.0	High
	10-10	Hoffstadt (u)	95	6.2	586.8	0.2	107.3	High
	10-15	Hoffstadt (l)	128	6.2	786.9	0.2	181.0	Moderate
	09-25	Jackson	81	1.3	105.3	0.1	10.5	Low
South	09-14	Clancy	42	1.6	64.7	0.2	11.4	Moderate
	09-14	Disappointment	40	1.6	61.8	0.3	16.7	High
	09-15	Herrington (u)	34	4.4	148.9	0.1	21.2	Moderate
	09-15	Herrington (l)	61	3.8	230.5	0.2	34.2	High
	09-06	Johnson (l)	55	2.7	149.2	0.1	14.9	Moderate
	09-04	Johnson (u)	87	2.7	235.7	0.1	23.9	Moderate
	09-12	Studebaker	110	1.5	167.2	0.2	25.0	Low
	09-14	Trouble	59	6.2	364.2	0.2	62.0	High
Silver Lake	09-12	Hemlock	30	2.4	74.4	0.2	13.4	Low

[a] (u) = upper; (l) = lower.

[b] Gradient: Low = 0.0 - 1.5%; Moderate = 1.6 - 4.0%; High = ≥ 4.1%.