Bull Trout (Salvelinus confluentus) Population and Habitat Surveys in the McKenzie and Middle Fork Willamette Basins

Annual Report
1999

DOE/BP-00000226-1

July 2000

This Document should be cited as follows:

Taylor, Greg, Andy Reasoner, "Bull Trout (Salvelinus confluentus) Population and Habitat Surveys in the McKenzie and Middle Fork Willamette Basins", Project No. 1995-05300, 28 electronic pages, (BPA Report DOE/BP-00000226-1)

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P.O. Box 3621
Portland, Oregon 97208

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

Bull Trout *Salvelinus confluentus* Population and Habitat Surveys in the McKenzie and Middle Fork Willamette Basins, 1999

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July 07, 2000

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INTRODUCTION

Prior to 1978, Dolly Varden (*Salvelinus malma*) were classified into an anadromous and interior form. Cavender (1978) classified the interior form as a distinct species, *Salvelinus confluentus*, the bull trout. Bull trout are large char weighing up to 18 kg and growing to over one meter in length (Goetz 1989). They are distinguished by a broad flat head, large downward curving maxillaries that extend beyond the eye, a well developed fleshy knob and a notch in the lower terminus of the snout, and light colored spots normally smaller than the pupil of the eye (Cavender 1978).

Bull trout are found throughout northwestern North America from lat. 41°N to lat. 60°N. In Oregon, bull trout were once distributed throughout 12 basins in the Klamath and Columbia River systems including the Clackamas, Santiam, McKenzie and Middle Fork Willamette sub-basins west of the Cascades (Buchanan et al. 1997). However, it is believed bull trout have been extirpated from west of the Cascades with the exception of the McKenzie sub-basin.

Before 1963, bull trout in the McKenzie sub-basin were a contiguous population from the mouth to Tamolitch Falls. Following the construction of Cougar and Trail Bridge Reservoirs there are three isolated populations: 1) mainstem McKenzie and tributaries from the mouth to Trail Bridge Reservoir. 2) mainstem McKenzie and tributaries above Trail Bridge Reservoir to Tamolitch Falls. 3) South Fork McKenzie and tributaries above Cougar Reservoir. The study area includes the three aforementioned McKenzie populations, and the Middle Fork Willamette and tributaries above Hills Creek Reservoir.

We monitored bull trout populations in the McKenzie and Middle Fork Willamette basins using a combination of sampling techniques including: spawning surveys, standard pool counts, juvenile trapping, radio tracking, electronic fish counters, and a modified Hankin and Reeves methodology for juvenile population estimates. In addition, we continued to reintroduce bull trout fry from Anderson Creek (McKenzie Basin) to the Middle Fork Willamette above Hills Creek Reservoir in an attempt to rehabilitate the bull trout population in the Middle Fork Willamette Basin. By monitoring population trends and determining life history characteristics of bull trout in

McKenzie and Middle Fork Willamette basins we can make better informed management decisions that will help maintain long term and sustainable bull trout populations in these systems.

STATUS

On June 10, 1998 the US Fish and Wildlife Service (USFWS) listed the Columbia River bull trout population segment (including the McKenzie sub-basin) as Threatened under the federal Endangered Species Act. Buchanan et al. (1997) listed the bull trout population in the mainstem McKenzie as “of special concern”, the South Fork McKenzie population as “high risk” and the bull trout above Trail Bridge Reservoir as “high risk”. Bull trout in the Middle Fork Willamette are listed as “probably extinct”.

METHODS

Spawning Surveys

We conducted bull trout spawning surveys in three streams in the McKenzie Basin during September and October 1999. Surveys began at the mouth of each stream and progressed upstream to natural barriers for migrating adult bull trout. Each survey was conducted by a team of two with one surveyor walking each side of the stream. We marked each redd observed with flagging and recorded the date, redd number, and the number and size of bull trout present.

Standard Pool Counts

We conducted standard pool counts in the mainstem and South Fork McKenzie from July - September 1999. There are seven standard pools in the mainstem from Olallie Landing downstream to Paradise Campground, a distance of 15 kilometers (km). In the South Fork McKenzie the nine standard pools begin at the confluence of Roaring River and continue downstream to Trap Hole approximately 1.6 km upstream from Cougar Crossing. We surveyed bi-weekly using a team of two divers equipped with snorkeling equipment and dry suits. We recorded the number and size class of bull trout observed in each pool.

Radio Tracking

We captured bull trout at the head of Cougar Reservoir using standard angling equipment in October and November 1998. Radio tags were surgically implanted in bull trout > 20 inches in length using an ODFW protocol (Bellerud 1998). The radio tags are 71 mm x 18 mm, weigh 28 grams, and have a service life of approximately 18 months. We monitored radio tagged bull trout movements approximately weekly by foot, vehicle, or plane using telemetry equipment from Advanced Telemetry System. We recorded the date and location of each bull trout located.

Fish Counter

We installed a Riverwatcher fish counter in Anderson Creek and Roaring River to determine the number of spawning adult bull trout in each stream. The Riverwatcher is a counter that emits infra-red light beams that are interrupted when a fish swims through the counter and produces a silhouette of the fish. The unit records the date, time, water temperature, length, and height for each fish passing up or downstream. We constructed a weir in both streams to restrict fish passage through the counter. We monitored fish passage in Roaring River from 27 August-10 October and in Anderson Creek from 28 August-25 October 1999. Weekly maintenance performed on the counter and weir included removing debris from the weir, changing batteries, and uploading data.

Juvenile Trapping

We trapped juvenile and young-of-the-year bull trout migrating down Anderson Creek using a 5 ft. rotary screw downstream migrant trap. The trap is located immediately downstream of the culvert passing under US 126 approximately 0.4 river kilometers (RK) upstream of the confluence with the mainstem McKenzie. We operated the trap four days each week from 23 February-03 June 1999. We recorded the number, species, and length of all juvenile bull trout and a proportion of the fry captured.

Juvenile Population Estimate

We estimated the abundance of juvenile bull trout in Anderson Creek using a modified Hankin and Reeves protocol. The experimental reach began at the culvert crossing US Hwy126 and extended upstream 2.6 km to a barrier falls. We divided the reach into slow and fast water habitat units. We considered pools slow water units and all other habitat as fast water units. Within the fast water units we designated pockets as places within a fast water unit with little or no surface turbulence or velocity. For each habitat unit and pocket identified we recorded length, three width measurements, and a maximum depth. We randomly selected 1/2 of the habitat units for sampling. A flag identifying the unit number was placed at the upper and lower end of each unit. From

these units 1/5 were selected for calibration using the method of bounded counts (4 repeat dive passes).

A team of five divers night snorkeled the sample units on 9-12 August 1999. Divers performed a single pass on all sample units and recorded the number of 0+ and juvenile bull trout ≥ 1+, dive time, and the number of bull trout located within pockets. For calibrate units divers performed four repeat passes within the unit.

RESULTS

Mainstem McKenzie

Spawning Surveys

We conducted weekly spawning surveys of Anderson Creek from 1 September-14 October 1999. Surveys began at the mouth and concluded at a barrier falls 2.6 km upstream. We observed a total of 77 redds, similar to counts from 1995-98 (Table 1).

Table 1. Bull trout redd counts in Anderson and Olallie Creek, 1989-99.

	Number of Redds Observed			
	Anderson		Olallie	Total
	Index Area RK 1.3	Total RK 2.6		
Year				
1989	7			
1990	9			
1991	7			
1992	13			
1993	15			
1994	22	30		
1995	30	77	10	87
1996	26	82	8	90
1997	18	85	9	94
1998	29	79	7	86
1999	47	77	6	83

The density of redds in Anderson Creek is 29.6 / km with an estimated 3.7 fish per redd. No redds were observed in additional surveys above the barrier falls. Spawning timing was similar to previous years (Figure 1). Spawning activity peaked on 23 September with 35 redds and 25 fish observed (Figure 1).

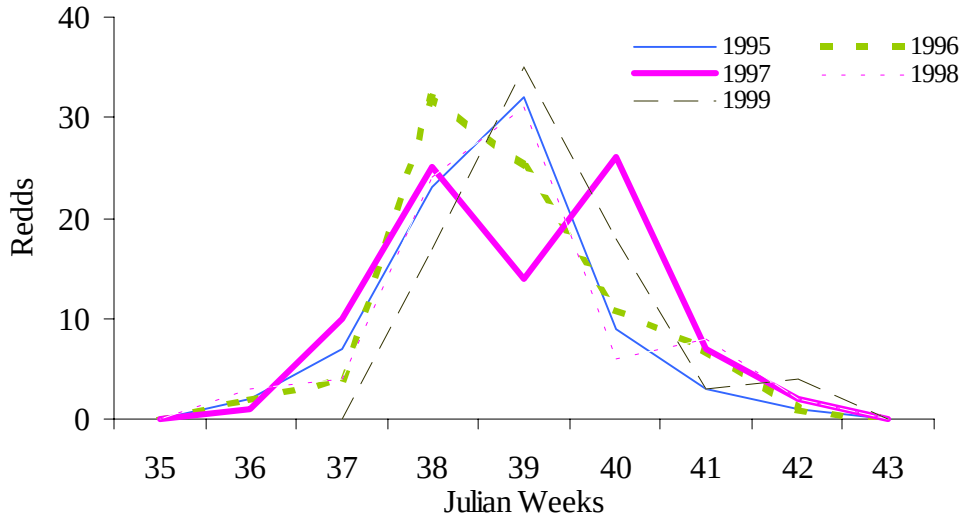

Figure 1. Bull trout spawn timing in Anderson Creek, 1995-99.

We conducted spawning surveys of Olallie Creek on 29 September and 14 October 1999. We observed a total of 6 redds, the lowest total since upstream passage was restored (Table 1). All six redds were observed above the culvert passing under US 126.

Standard Pool Counts

We conducted two standard pool counts in the mainstem McKenzie on 27 July and 25 August 1999. The peak count of 15 fish occurred on 25 August (Table 2). This is the lowest count recorded since surveys began in 1994.

Table 2. Peak number of bull trout observed during standard pool counts in the mainstem McKenzie 1994-99.

Year	Number of Bull Trout
1994	32
1995	33
1996	36
1997	19
1998	30
1999	15 [a]

a *only two counts were conducted in 1999*

Radio Tracking

In 1999 there was only one bull trout (# 104) with a functioning transmitter in the mainstem McKenzie River. This fish was originally tagged in Anderson Creek on 02 October 1997. The fish occupied the same over-wintering site in 1998 and 1999 (Figure 2). In April the fish began to move upstream from the over-wintering site (RK 53) and moved 1.6 km upstream until the beginning of June. In the beginning of July 104 was located at the mouth of Blue River (RK 91). We lost contact with 104 until 14 September when it was located near the mouth of Anderson Creek (RK 130).

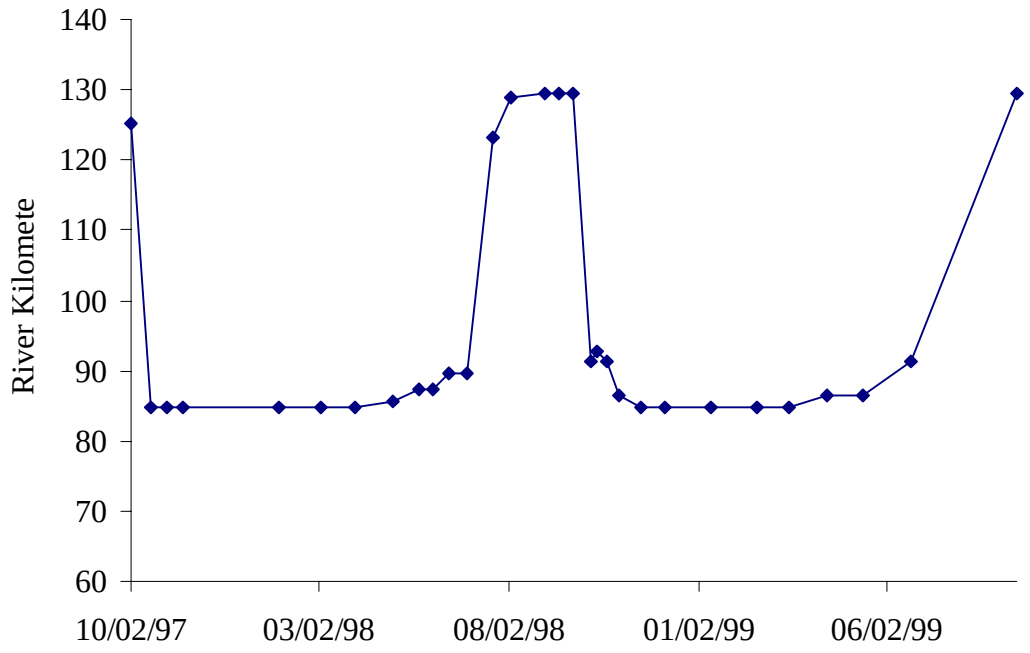

Figure 2. Movement of a radio tagged bull trout (# 104) in the mainstem McKenzie River, 2 October 1997 through 14 September 1999.

Juvenile Trapping

We continued trapping juvenile bull trout migrating down Anderson Creek using a rotary screw downstream migrant trap. The 1999 total of 7,406 fry captured is similar to counts in 1997-98 (Table 3). We transferred a proportion of the fry captured to Sweetwater Creek and the Middle Fork Willamette (Table 4).

Table 3. Number of bull trout fry and juveniles captured in the downstream migrant trap in Anderson Creek, 1994-99.

	Number of fry		Number ≥ 1^{+}	
Date	Captured	Estimated Capture[ab]	Captured	Estimated Capture[ab]
Feb. 15-May 26, 1994	1,808	3,185	129	242
Feb. 15-May 31, 1995	1,877	3,597	261	471
Feb. 19-May 31, 1996	1,995	3,420	179	330
Feb. 11-May 31, 1997	6,540	12,955	64	129
Feb. 10-June 11, 1998	7,902	13,892	151	272
Feb. 23-June 03, 1999	7,406	13,016	100	158

a Estimated number of bull trout fry captured if the trap ran continuously
b Assumes 100% trap efficiency

Table 4. Number of bull trout fry transferred from Anderson Creek to Sweetwater Creek, Olallie Creek, and the Middle Fork Willamette, 1993-99.

	Number of fry transferred		
Year	Sweetwater Cr.	Olallie Cr.	MF Willamette
1993	308	0	0
1994	507	245	0
1995	589	313	0
1996	894	0	0
1997	1,193	112	178
1998	1,889	0	1,497
1999	997	0	1,976
Totals:	6,377	670	3,475

Fish Counter

We monitored bull trout migration in Anderson Creek from 28 August-25 October 1999 using an electronic fish counter. The counter recorded 249 bull trout passing upstream and 214 downstream. Bull trout migrated at a higher rate during day

light up (69%) and downstream (61%) (Figure 3). Peak migration of bull trout through the fish counter up and downstream occurred from 10-17 September 1999 (Figure 4).

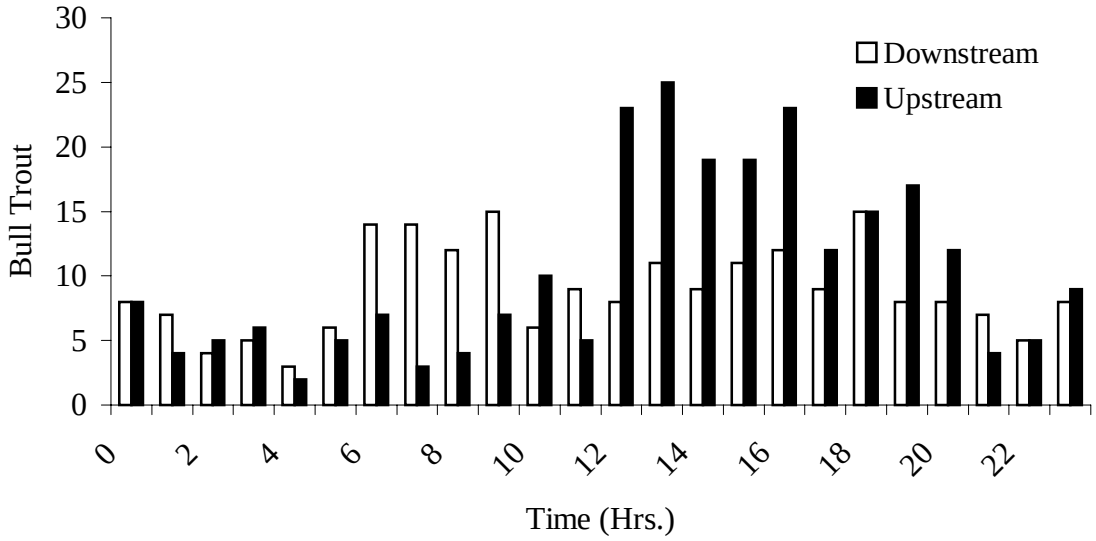

Figure 3. Migration time up and downstream for adult bull trout through the fish counter in Anderson Creek, 28 August-25 October 1999.

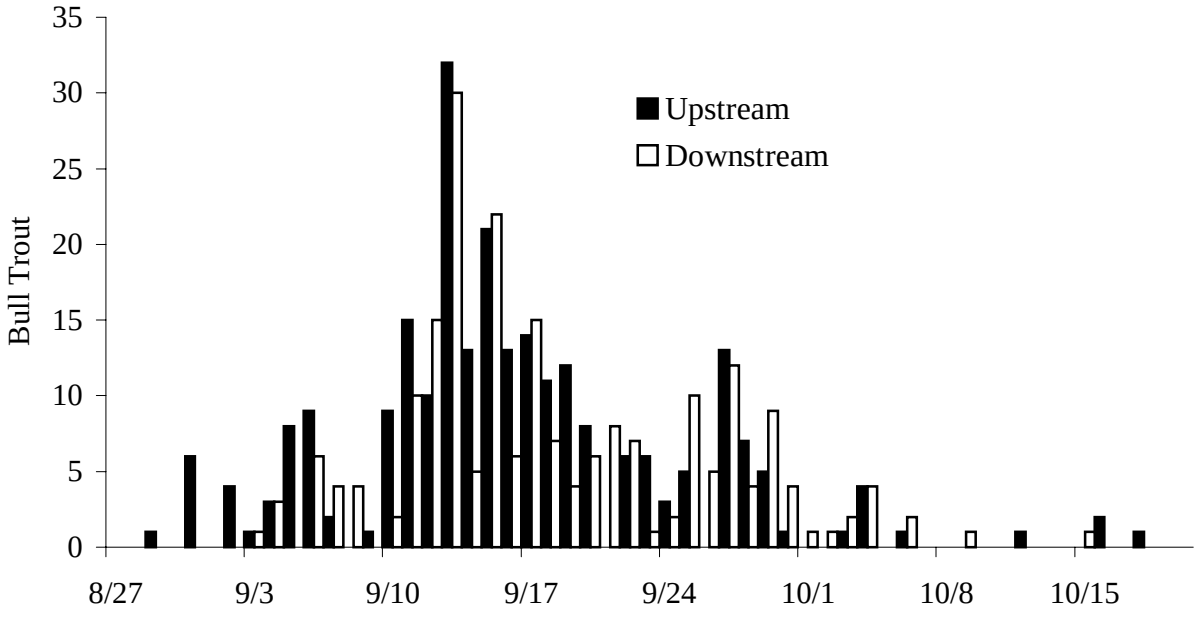

Figure 4. Run timing of adult bull trout through the fish counter in Anderson Creek, 28 August-25 October 1999.

The counter recorded the size of bull trout migrating up and downstream based on a depth measurement and a length to depth ratio we supplied (4.6 / 1). Mean length of fish passing upstream was significantly larger (48 cm) than fish passing downstream (40 cm) ($p < 0.05$). Bull trout ranged in size from 18-81 cm (Figure 5).

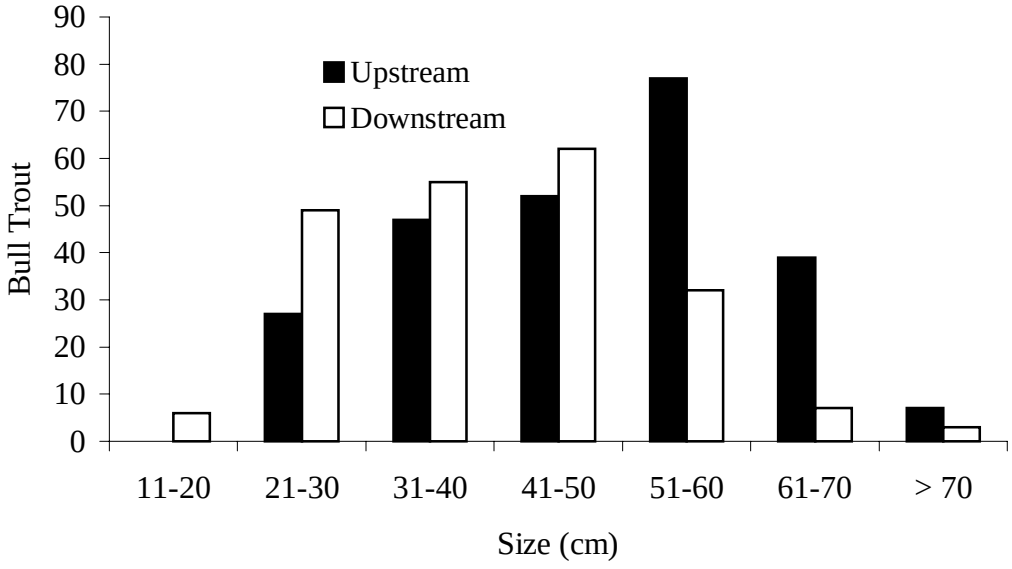

Figure 5. Number and size (cm) of bull trout passing up and downstream through a fish counter in Anderson Creek, 28 August-25 October 1999.

Juvenile Population Estimates

We conducted a population estimate of juvenile bull trout in Anderson Creek from 03-12 August 1999. We used a modified Hankin and Reeves protocol. Habitat typing identified 122 habitat units over a distance of 2.5 RK with 114 fast water and eight slow water units. A total of 122 pockets were identified within fast water habitat units. Some habitat units contain multiple pockets and others contain no pockets. The mean length, width, and depth were calculated for all habitat and pocket units (Table 5).

Table 5. Unit type, number, average length, width, and depth in Anderson Creek for 122 habitat and pocket units.

Habitat Units				
		Average (meters)		
Type	Number	Length	Width	Depth
Slow	8	17.3	6.2	1.0
Fast	114	20.8	7.6	0.6
Pocket	122	3.4	1.4	0.4

Divers night snorkeled 60 of the 122 habitat units identified. Divers calibrated seven of eight slow water habitat units and 15 fast water units using the method of bounded counts with four repeat dives. Divers night snorkeled the remaining fast water sample units (38) with a single pass. We observed 106 juvenile bull trout ≥ 1+ in 60 sampled habitat units with a mean of 1.8 bull trout per unit. Juvenile bull trout density was highest in pockets and lowest in fast water units (Table 6).

Table 6. The number and density of bull trout ≥ 1+ observed by divers in three habitat units in Anderson Creek, 1999.

	BUT ≥ 1+	
Unit Type	Number	Density (/100 m^2)
Fast	66	0.8
Slow	10	1.2
Pocket	30	9.7

South Fork McKenzie

Spawning Surveys

We conducted spawning surveys of Roaring River on 22 September and 11 October 1999. Surveys began at the mouth and continued upstream to a 1.5 m falls located 1.1 km above the first bridge crossing Roaring River. We observed a total of 13 redds and nine bull trout. Of these, 10 redds and nine fish were identified during the first survey on 22 September. We identified only one redd below Rd. 19 crossing Roaring River and no redds were observed above the 1.5 m falls. The estimated number of fish per redd was 3.2 in Roaring River.

Standard Pool Counts

We snorkeled nine standard pools biweekly in the South Fork McKenzie River from 27 July to 09 September 1999. The highest number of bull trout observed was 13 on 19 August (Table 7).

Table 7. Peak number of bull trout observed during standard pool counts in the South Fork McKenzie River, 1995-99.

Year	Number of Bull Trout
1995	17
1996	9
1997	10
1998	17
1999	13

Radio Tracking

In January 1999 four bull trout with functioning transmitters remained in the South Fork McKenzie. One bull trout moved below Cougar Dam in the middle of January and the three other tagged fish remained in the reservoir until the end of April (Figure 6). Those fish entered the South Fork in early May and two of the fish entered Roaring River in late August and early September. Both fish reentered the reservoir by the middle of October.

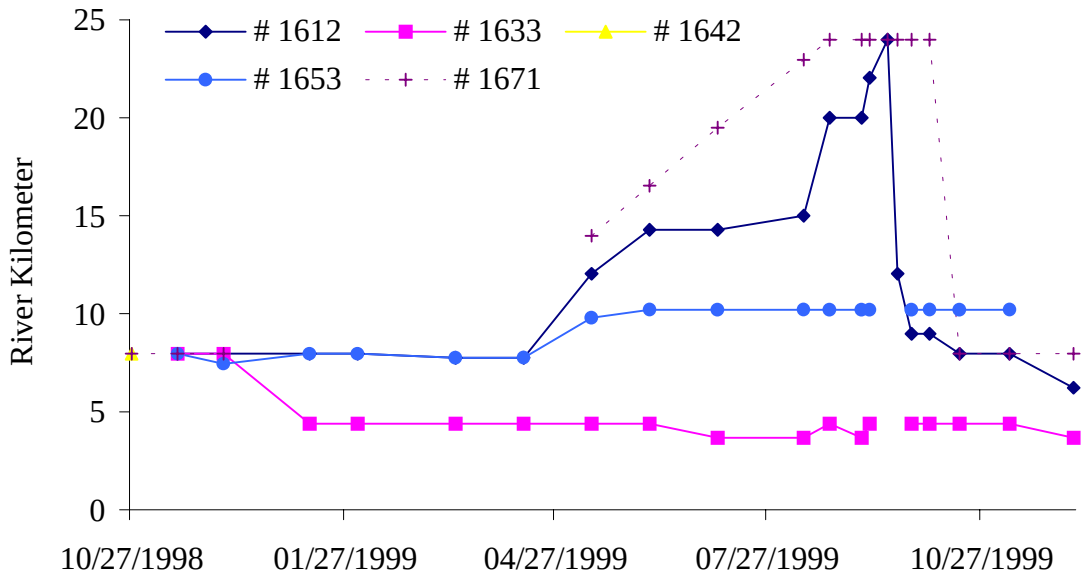

Figure 6. Distribution of five radio tagged bull trout in the South Fork McKenzie River 1998-99.

Fish Counter

We monitored bull trout migration in Roaring River from 27 August-10 October 1999 using an electronic fish counter. The counter recorded 41 fish passing upstream and 39 passing downstream. Most bull trout migrated downstream (71%) at night, while most upstream passage (66%) occurred in the daylight (Figure 7). Most bull trout migrated (83%) into Roaring River from 27 August-11 September 1999 (Figure 8).

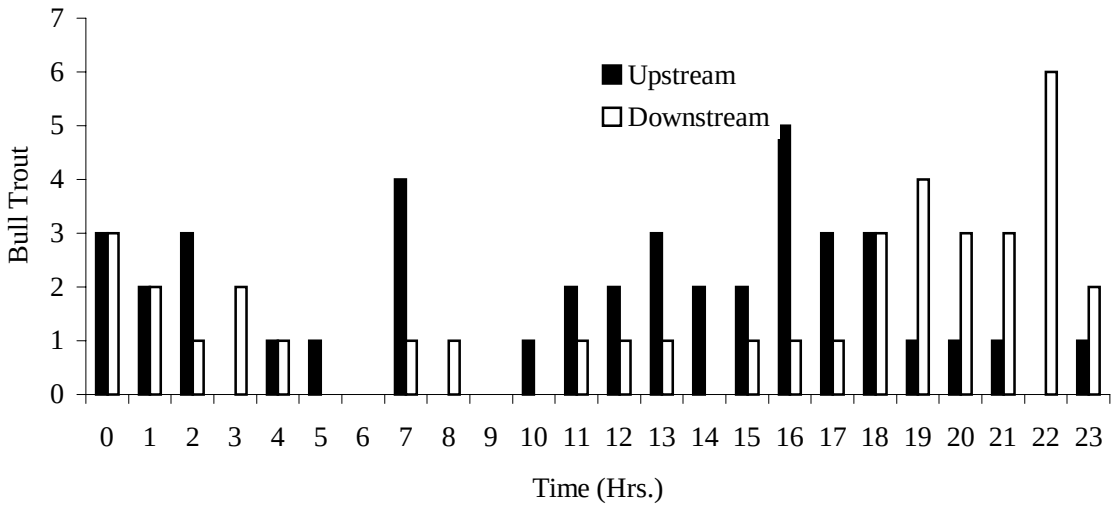

Figure 7. Migration time up and downstream for adult bull trout through the fish counter in Roaring River, 27 August-10 October 1999.

Downstream migration peaked in late September and early October and was complete by 8 October 1999. Mean length of fish passing upstream (42 cm) was significantly larger ($p < 0.05$) than fish passing downstream (35 cm). Bull trout length ranged from 21-58 cm (Figure 9).

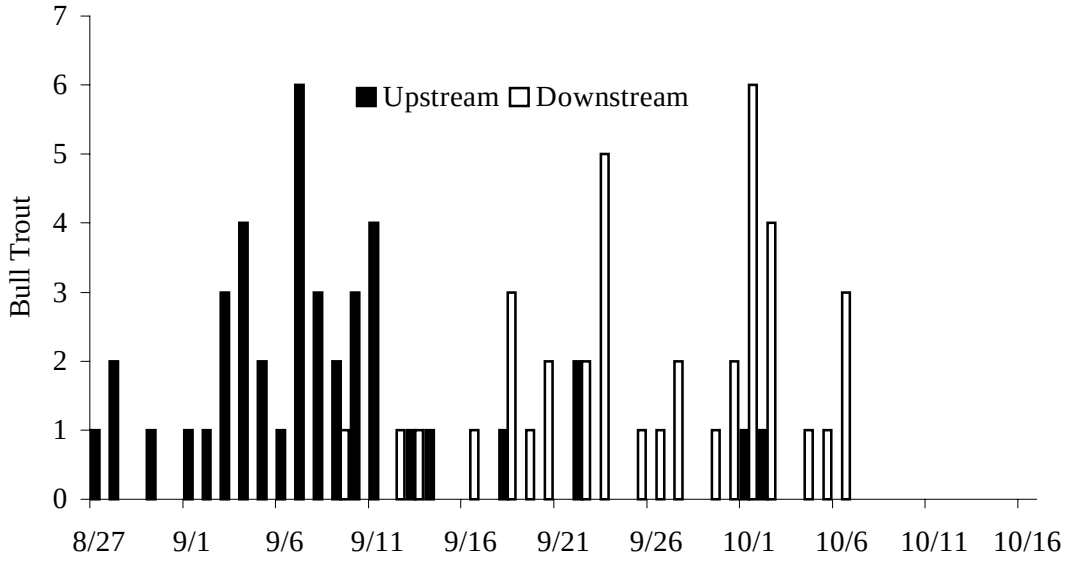

Figure 8. Run timing of bull trout up and downstream through the electronic fish counter in Roaring River, 27 August-10 October 1999.

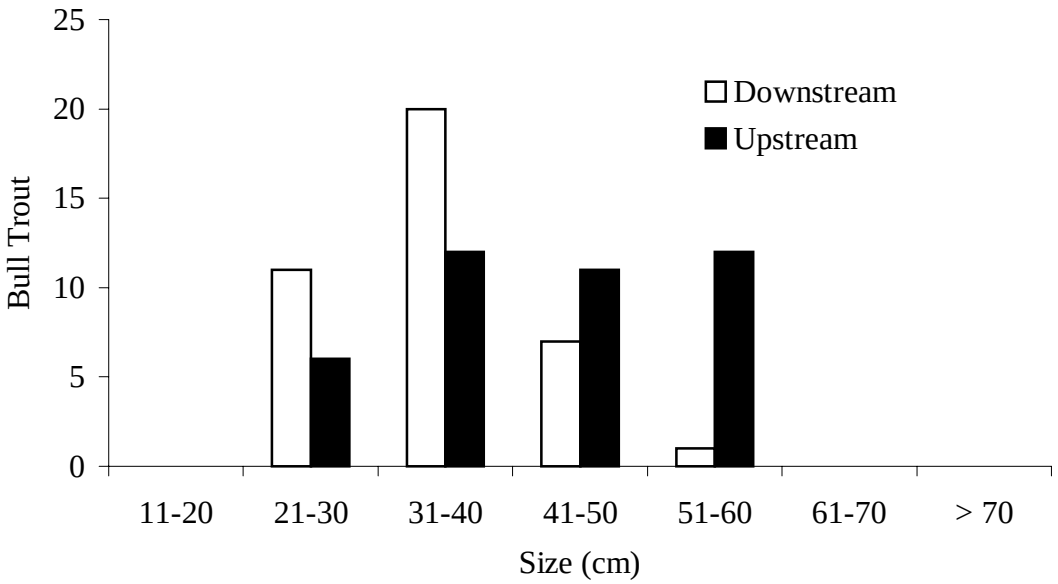

Figure 9. Number and size (cm) of bull trout passing up and downstream through a fish counter in Roaring River, 27 August-10 October 1999.

Middle Fork Willamette

Juvenile Transfer

In 1999, we continued efforts to implement the Rehabilitation Plan (ODFW 1997) for the Middle Fork Willamette bull trout population by transferring fry from Anderson Creek to four locations in the Middle Fork Willamette Basin. A total of 1,976 fry (26-31 mm) were transferred from 05 March-07 May 1999 (Table 8).

Table 8. Location and number of bull trout fry transferred from Anderson Creek to release sites in the Middle Fork Willamette above Hills Creek Reservoir, 1997-99.

	Location						
	Springs				Creeks		
Year	Chuckle	Iko	Indigo	Shadow	Skunk	Swift	Total
1997	96		26		56		178
1998	411	938		150			1,499
1999	302	1,000		148		526	1,976
Total	809	1,938	26	298	56	526	

Monitoring

We monitored juvenile bull trout reintroduced to the Middle Fork Willamette above Hills Creek Reservoir through pipe trapping and snorkel counts. A pipe trap was fished from 22 March-15 April and 5 July-10 Aug 1999 at the mouth of Iko springs to quantify the number of 0^+ and 1^+ bull trout migrating out of Iko Springs to the Middle Fork Willamette. The trap fished for 1,441 hours and no fish were recovered. We snorkeled five times in sections of four release sites to quantify juvenile bull trout survival and growth (Table 9). Divers visually estimated the size of juvenile bull trout observed (Figure 10).

Table 9. Date, location, and number of juvenile bull and cutthroat trout observed during snorkel counts of four release sites in the Middle Fork Willamette above Hills Creek Reservoir.

	Location							
	Iko		Shadow		Chuckle		Swift Cr.	
Date	But	Ct	But	Ct	But	Ct	But	Ct
Jan-20-99	23	30						
Mar-18-99	45	69						
Jly-17-99	8[a]	b						
Aug-19-99	21	b	4		9	17		
Oct-19-99							0[a]	>20

a dives were conducted during daylight hours
b cutthroat observations were not recorded

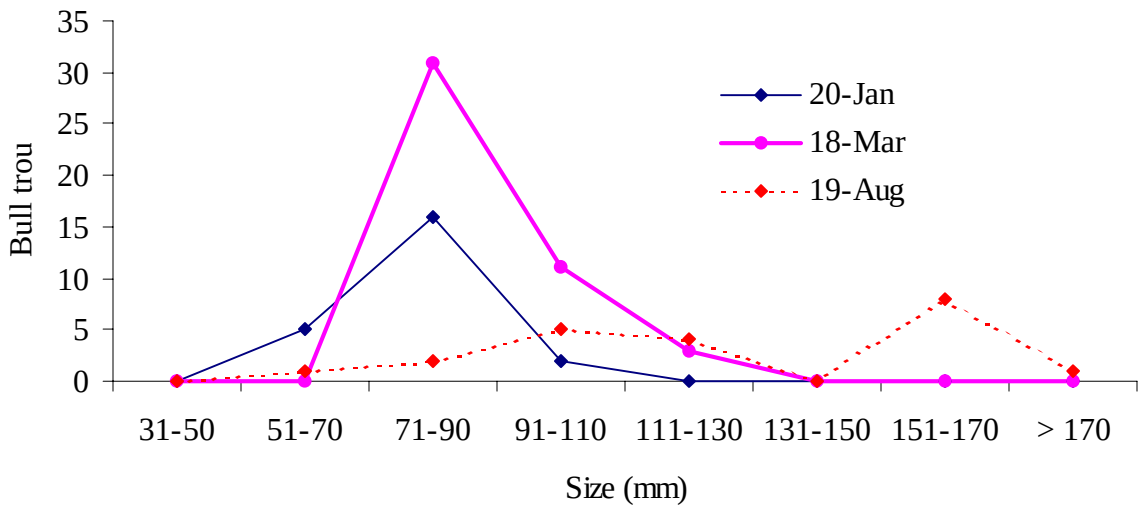

Figure 10. The number and size (diver estimated) of juvenile bull trout observed during three snorkel counts in Iko Springs, 1999.

CONCLUSIONS

Mainstem McKenzie

Spawning surveys conducted in tributaries of the mainstem McKenzie River (Anderson and Olallie Creek) have yielded consistent redd counts since more than doubling in 1995 (Table 1). Redd count data indicate a stable adult spawning population in the mainstem McKenzie River. We calculated a ratio of 3.7 bull trout per redd in Anderson Creek is 3.7. This ratio is similar to those reported for streams in the Metolius Basin (Ratliff et al 1996). The density of redds in Anderson Creek (29.6 / kilometer) is among the highest reported in the state (Buchanan et al. 1996) and spawning habitat may be a limiting factor to increased production in Anderson Creek.

The number of emergent bull trout fry captured in Anderson Creek has been consistent the past three years since a significant increase in 1997. The significant increase in fry correlates with an increase in redd counts, with the exception of 1996. In 1996, we believe the number of emergent fry was impacted by the flood in February 1996. USFS surveys, however, found that embeddedness of substrate in Anderson Creek decreased following the flood and this may have been responsible for an increase in spawning success in 1997-99.

The peak number of bull trout we observed in standard pools in the mainstem McKenzie was 19, the lowest total recorded since surveys began in 1994. However, we conducted only two standard pool counts in the mainstem McKenzie in 1999 and probably missed the peak because of reduced sampling effort. Bull trout were concentrated in Olallie pool near the mouth of Anderson Creek in late August just prior to spawning, similar to past years. The standard pool counts indicate a stable adult population with no change in distribution.

We monitored a single radio tagged bull trout in the mainstem McKenzie during 1999. The fish (104) occupied the same over-wintering site in 1998 and 1999. We are unsure why some bull trout show specificity for over-wintering sites, but this has been observed in other radio tagged bull trout in the mainstem McKenzie River. This fish reached Anderson Creek for the third year in a row and most bull trout in the mainstem

McKenzie have returned to spawn each year. This indicates that most bull trout in the McKenzie Basin spawn annually.

This was the first year we used an electronic fish counter to monitor the number, size, date, and time of day of spawning adults entering Anderson Creek. The counter recorded 249 bull trout passing upstream and 214 downstream. The difference in the number of fish recorded is due in part to otter predation and post-spawning mortality. We recovered seven carcasses, but are unsure if the fish were killed and eaten by otters or if otters recovered bull trout that were post-spawning mortalities. This was the first time carcasses have been observed. It is unclear why most bull trout migration occurred during daylight hours. The two peak hours for upstream migration were 1200 and 1300 hours (Figure 3) and little data exists for comparison. Peak migration upstream through the counter occurred one week before the highest redd count and indicates a lag time of one week between fish entering Anderson Creek and returning downstream following spawning. There was a significant difference in size of fish passing up and downstream. Mean length of bull trout passing upstream was 48 cm and on average these fish were 8 cm larger than fish passing downstream. We observed the same trend on Roaring River and believe that the counter is more accurate determining length in one direction, but are unsure which direction. We supplied a length to depth ratio of 4.6 for the counter to convert depth measurements into lengths. This ratio was based on measuring very few bull trout and more bull trout should be measured to increase the precision of length measurements.

The modified Hankin and Reeves protocol used to estimate the abundance of juvenile bull trout in Anderson Creek produced an estimate consistent with trapping data collected in previous years. Density estimates for juvenile bull trout ≥ 1+ in Anderson Creek are similar to those reported by other investigators (Ratliff et al.1996, Goetz 1994, Smith and Knox 1992). Juvenile bull trout densities in pockets were 12 times higher than fast water and eight times higher than slow water (pools) units. This indicates the importance of margin habitat to juvenile bull trout rearing. In 2000 we will better quantify parameters associated with this pocket habitat (velocity, surface turbulence).

South Fork McKenzie

Redd counts in the South Fork McKenzie Basin were the highest (13) recorded. It is unclear whether there has been an increase in redds in 1999 or whether we were not locating redds in the past. Installation of an electronic fish counter and radio tagged bull trout entering Roaring River enabled us to determine spawn timing and location with more precision in 1999. In 1998 USFS personnel identified six redds during spawning surveys conducted on 19 October, however, we conducted subsequent surveys on 27 October and classified only two of the redds as bull trout redds. Based on electronic fish counts and radio tagged bull trout distribution peak upstream migration into Roaring River occurred during the first two weeks of September. This is a month before surveys were conducted in 1998 and it is possible that we could not identify most of the redds in late October. We estimated 3.2 fish per redd in Roaring River. This ratio is similar ratios reported in the Metolius Basin (Ratliff et al 1996).

Peak counts during surveys of standard pools in the South Fork McKenzie were consistent with observations in 1995-98. Bull trout counts were highest in Big Hole (RK 19) during all standard pool counts for the second consecutive year. It is unclear why bull trout concentrate in Big Hole, however, it is one of the largest pools in the South Fork and held the highest concentration of chinook salmon of all the standard pools.

Radio tagged bull trout behavior and distribution in the South Fork McKenzie is similar to radio tagged bull trout in the mainstem McKenzie. The fish over-wintered in the reservoir from October -April. In April they began to move upstream and distribute throughout the South Fork before entering Roaring River in September. The bull trout than moved downstream in late September and early October to the reservoir in approximately one week. While in Roaring River, one bull trout (#1671) remained for five weeks, however, another (#1612) remained for less than a week. We believe that males and females remain in the spawning tributaries for different lengths of time. This would explain the variation in the amount of time the two fish remained in Roaring River. The radio tagged bull trout that moved below the dam in January 1999 has remained within one mile of the dam. We will continue to monitor this fish in 2000.

The electronic fish counter in Roaring River recorded 41 bull trout moving upstream. We believe this count is accurate and these data indicate fish are not moving up and downstream through the counter multiple times, thus inflating the counts. Most bull trout migrated upstream in the daylight (similar to Anderson Creek), but downstream at night. Little data exists for comparison on the daily movements of bull trout. So, without data for comparison we are unsure if a pattern exists. There was little overlap in run timing of bull trout moving up and downstream in Roaring River. Almost all bull trout moved upstream from late August through the middle of September and downstream from the middle of September through early October. Bull trout migrating upstream were 7 cm longer on average. This is the same trend that we observed in Anderson Creek and is inherent to the counter.

Middle Fork Willamette

We continued to implement the Rehabilitation Plan (ODFW 1997) for bull trout in the Middle Fork Willamette Basin. In 1999, we transferred 1,976 bull trout fry to four release sites in the Middle Fork Willamette Basin above Hills Creek Reservoir. Mortality associated with transfer continued to be extremely low (< 1%). Monitoring of bull trout fry (0+) has been difficult, but most effective walking along the release sites during the day. We monitored juveniles (≥ 1+) most successfully with night snorkeling. Divers observed 45 1+ bull trout in Iko Springs one year after releasing 938 bull trout fry. This indicates that at least 4.8% of the transferred fry survived and remained in the release site for 1 year. This number is probably higher because divers did not sample the entire reach and the release site is highly complex which would reduce observation probabilities. Divers estimated the size of juvenile bull trout to determine growth rate. Most bull trout fry (26-31 mm) were estimated to be 70-90 mm one year later. We believe growth rates are higher for juveniles in Iko Springs than in Anderson Creek. We fished a pipe trap at mouth of Iko Springs for 1,441 hours and captured no juvenile bull trout. We believe that very few juveniles are migrating out of Iko Springs into the Middle Fork Willamette.

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