Bull Trout Life History, Genetics, Habitat Needs, and Limiting Factors in Central and Northeast Oregon

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BULL TROUT LIFE HISTORY, GENETICS, HABITAT NEEDS, AND LIMITING FACTORS IN CENTRAL AND NORTHEAST OREGON

2001 ANNUAL REPORT

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Introduction

Bull trout *Salvelinus confluentus* exhibit a number of life history strategies. Stream-resident bull trout complete their life cycle in their natal tributaries. Migratory bull trout spawn in tributary streams where juvenile fish usually spend from one to four years before migrating to either a larger river (fluvial) or lake (adfluvial) where they rear before returning to the tributary stream to spawn (Fraley and Shepard 1989). These migratory forms occur where conditions allow movement from spawning locations to downstream waters that provide greater foraging opportunities (Dunham and Rieman 1999). Resident and migratory forms may occur together, and either form can produce resident or migratory offspring (Rieman and McIntyre 1993). The ability to migrate is important to the persistence of local bull trout populations (Rieman and McIntyre 1993). The identification of migratory corridors can help focus habitat protection efforts. Determining the life history form(s) that comprise local populations, the timing of seasonal movements, and the geographic extent of these movements are critical to bull trout protection and recovery efforts.

This section describes work accomplished in 2001 that continued to address two objectives of this project. These objectives are 1) determine the distribution of juvenile and adult bull trout and habitats associated with that distribution, and 2) determine fluvial and resident bull trout life history patterns. Completion of these objectives is intended through studies of bull trout in the Grande Ronde, Walla Walla, and John Day basins. These basins were selected because they provide a variety of habitats, from relatively degraded to pristine, and bull trout populations were thought to vary from relatively depressed to robust. In the Grande Ronde and Walla Walla basins, we continued to monitor the movements of bull trout with radio transmitters applied in 1998 (Hemmingsen, Bellerud, Gunckel and Howell 2001) and 1999 (Hemmingsen, Gunckel and Howell 2001). No new radio transmitters were applied to bull trout of the upper John Day River subbasin, Mill Creek (Walla Walla Basin), or the Grande Ronde Basin in 2001.

In Mill Creek, we used traps for the fourth consecutive year to obtain data on migrant bull trout. With these traps, we intended to determine the timing of bull trout movements both upstream and downstream, and to determine the relative abundance and size of migrant fish. No traps were operated in the John Day Basin in 2001.

Methods

In Mill Creek, we trapped upstream migrant bull trout as they exited the fish ladder at the dam (Rkm 40.9) associated with the water intake for the city of Walla Walla, as described in Hemmingsen, Bellerud, Gunckel and Howell (2001). These upstream migrant bull trout were trapped from the first week of June through mid-October. We operated a rotary screw trap (1.5-m diameter) from September 2001 through March 2002 in order to determine the timing and magnitude of the juvenile bull trout migration downstream during fall, winter, and early spring. In the three previous years, we had operated the screw trap from March through mid-October. Juvenile bull trout were captured during all months in each of these years (Hemmingsen, Bellerud, Gunckel and Howell 2001; Hemmingsen, Gunckel and Howell 2001; Hemmingsen, Gunckel, Sankovich and Howell 2001). Whether juveniles continued to migrate downstream, particularly in winter, remained unknown. The screw trap was located upstream of the dam at the same site (Rkm 42) used in 1998, 1999, and 2000.

In both traps, fish of most species captured were anesthetized and measured to fork length. All bull trout were weighed, and all but a few were measured. Scales were collected from a sub-sample of bull trout. Bull trout that were 150 mm fork length or longer were checked for the presence of a 14-mm, 125 KHz, Avid PIT (passive integrated transponder) tag applied during 1997 - 2000. Bull trout captured in 2001 that had not previously received PIT tags were subsequently implanted with them. These PIT tags had a frequency of 134 KHz, and their identification codes were scanned in the office prior to use in the field. Only 125 - KHz tags could be scanned in the field during 2001. A portion of the bull trout captured in the Mill Creek screw trap received a caudal fin mark to identify them for trap efficiency calculations. A maximum of 3 mm was cut from either the top or bottom lobe of the caudal fin. After recovering from anesthesia, these fish and others that were PIT-tagged were released in a pool 112 m upstream of the screw trap. Efficiency of the screw trap was determined monthly from the number of recaptured, fin-marked or PIT-tagged bull trout. Estimated numbers of bull trout that passed the screw trap were calculated by bootstrap methods.

Results and discussion

Trapping

Bull trout captured by traps can be divided into two groups: those captured for the first time in each trap, or those recaptured one or more times in either trap. Recaptured individuals were identified by a fin mark or PIT tag. Figures presented here describe individuals captured for the first time in 2001 in either trap. Recaptured bull trout are discussed in the text or identified in tables.

The upstream migrant trap was installed on 05 June and checked daily all but two days until its removal on 15 October. During its operation, this trap captured 157 bull trout, of which 156 were measured with lengths ranging from 212 to 710 mm, with a mean of 437 mm (Fig. 1). Only four bull trout (2.6%) were less than 300 mm, and two were less than 250 mm.

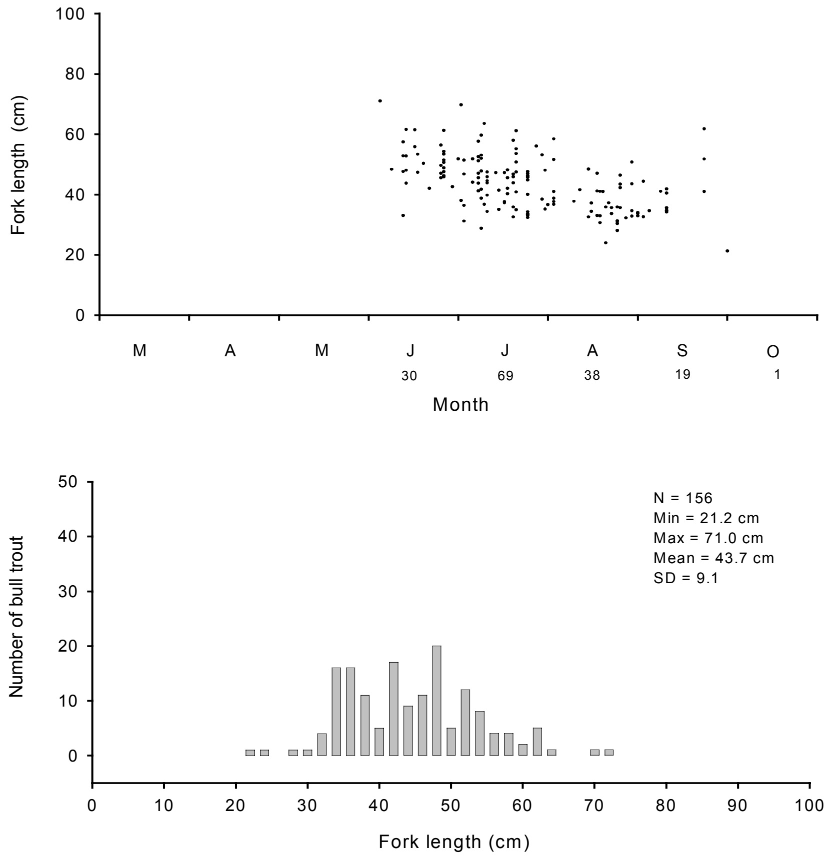

Figure 1. Numbers and lengths of bull trout in Mill Creek captured in the upstream migrant trap in 2001. Monthly totals are shown under corresponding months.

Of the 156 measured bull trout, 106 had PIT tags that were applied in previous years. The remaining 50 bull trout that were PIT-tagged in 2001 tended to be smaller than those tagged previously (Fig 2). In addition to bull trout, this trap captured 25 juvenile *Oncorhynchus tshawytscha*, 10 *O. mykiss* (180-300 mm), 13 *Catostomus spp* (200-300 mm), and 3 *Prosopium williamsoni* (250-420 mm).

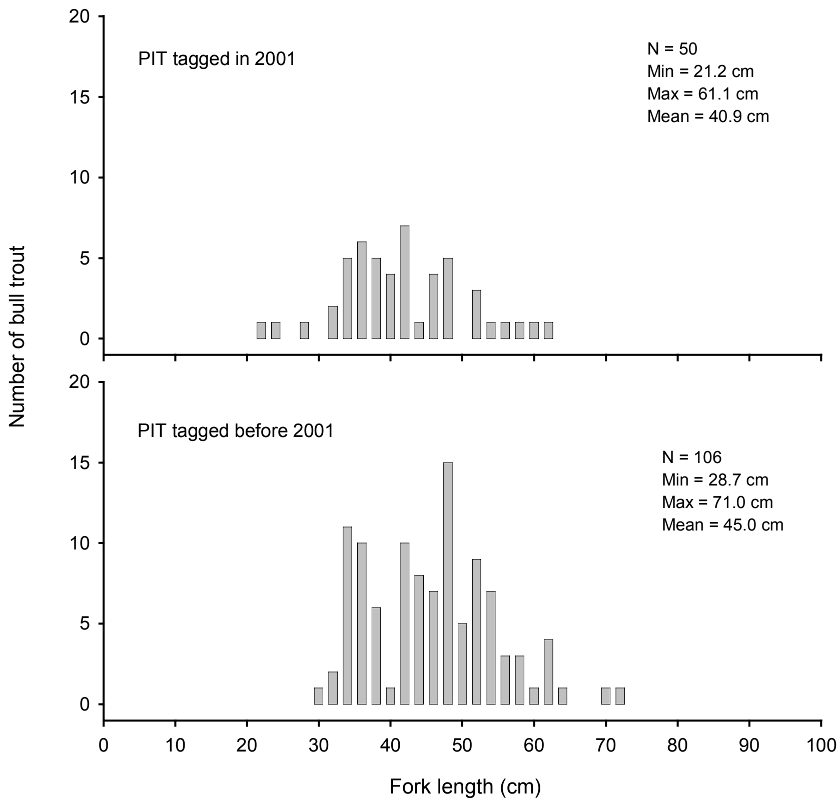

Figure 2. Numbers and lengths of bull trout in Mill Creek captured in the upstream migrant trap in 2001.

Sixty-three percent of the upstream migrant bull trout were captured by 01 August, nearly two thirds of these during July (Table 1). Larger bull trout tended to appear in the trap earlier than smaller bull trout, which has occurred all four years we have trapped bull trout in Mill Creek (Fig. 3).

Table 1. Lengths of Mill Creek bull trout captured in the upstream migrant trap during 2001.

Month	N	FL (mm) Min	Max	$\bar{x}$
Jun	29	330	710	512
Jul	69	287	697	447
Aug	38	239	584	385
Sep	19	326	617	398
Oct	1	--	--	212

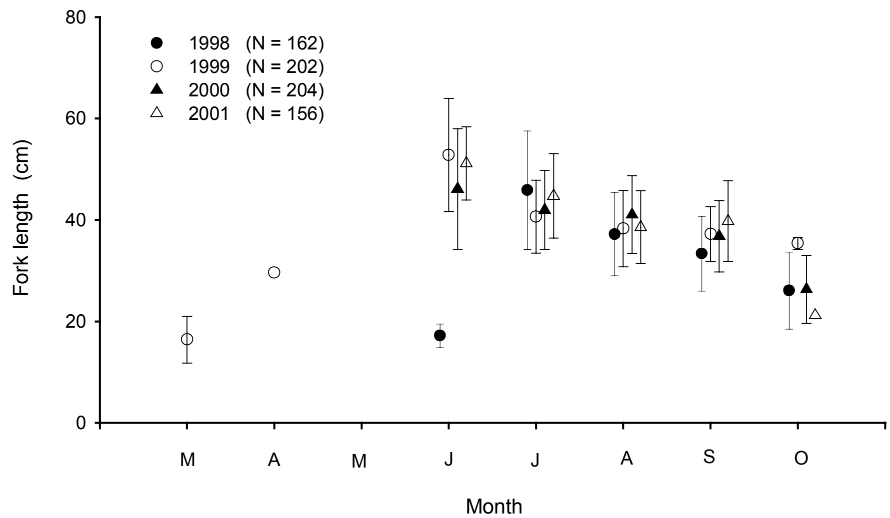

Figure 3. Monthly mean fork lengths ($\pm$ SD) of Mill Creek bull trout captured in the upstream migrant trap during four years.

We installed the rotary screw trap in Mill Creek on 04 September 2001 and operated it continuously through 25 March 2002, except for three consecutive days late in February. This trap was checked daily all but 10 days of operation. It captured 215 bull trout, 212 of which were measured with lengths ranging from 36 to 607 mm, with a mean of 187 mm (Fig. 4). These length statistics are similar to those of bull trout captured by screw trap during March through October 2000 (range = 34-611 mm, mean = 162 mm; Hemmingsen, Gunckel, Sankovich and Howell 2001).

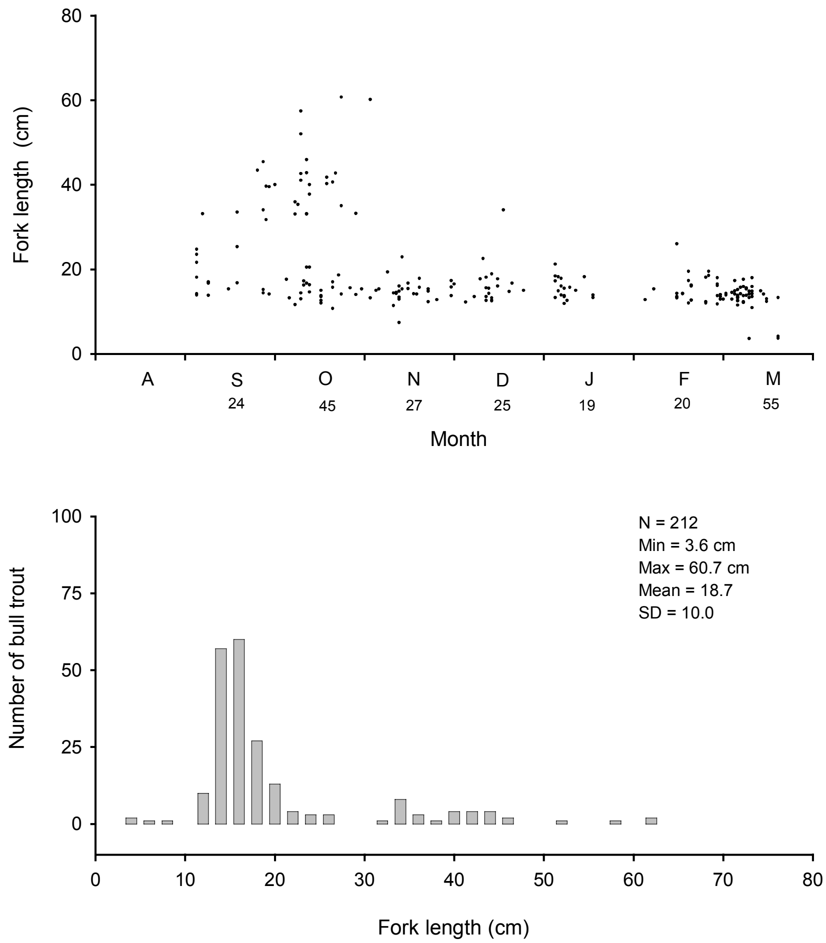

Figure 4. Numbers and lengths of bull trout in Mill Creek captured in the screw trap in 2001. Monthly totals are shown under corresponding months.

Eighty-five percent (n = 181) of the bull trout captured by the screw trap from September 2001 through March 2002 were less than 300 mm; 29% of these (n = 53) were captured in March. The length distributions of these bull trout were similar each month (Table 2). We have captured bull trout of similar lengths during March through October of 1998-2000 (Hemmingsen, Gunckel, Sankovich and Howell 2001). Together, these data indicate emigration of juvenile bull trout year-round in Mill Creek, and that this emigration occurs at a critical size range. Fifteen percent (n = 31) of the bull trout captured by the screw trap were 300 mm or larger. All but two were captured during September and October; none were captured after December.

In addition to bull trout, the screw trap captured 329 juvenile *Oncorhynchus tshawytscha* (4-78 mm), 45 *O. mykiss* (25-360 mm), 5 *Catostomus spp* (160-230 mm), 7 *Prosopium williamsoni* (195-440 mm), and 35 *Cottus spp* (60-110 mm) from September 2001 through March 2002.

Table 2. Mill Creek bull trout captured in the screw trap during 2001-02.

		FL (mm)			
Month	**N**	**Min**	**Max**	$\bar{x}$	**SD**
		< 300 mm FL			
Sep	15	138	253	176	41
Oct	24	107	205	152	26
Nov	26	74	229	148	27
Dec	24	122	225	156	25
Jan	19	119	212	155	24
Feb	20	120	260	151	34
Mar	53	36	195	138	31
		≥ 300 mm FL			
Sep	12	304	330	375	52
Oct	21	302	607	411	76
Nov	1	--	--	601	--
Dec	1	--	--	340	--
Jan	0	--	--	--	--
Feb	0	--	--	--	--
Mar	0	--	--	--	--

The efficiency at which the Mill Creek rotary screw trap captured bull trout of all sizes during September 2001 through March 2002 averaged 35%, although there was considerable monthly variation (Table 3). The overall average, however, is similar to the estimated overall average of 38% in 2000 (Hemmingsen, Gunckel, Sankovich and Howell 2001). Using bootstrap methods, we estimated that between 463 and 741 bull trout (602 ± 139) passed downstream at this location. It should be noted that the estimated number of bull trout assumes that these fish pass the trap only once. Based on evidence from PIT tags however, a small number of bull trout can be recaptured more than once and thereby cause over-estimation of the actual number that passed downstream. Calculation of the estimated number also assumes that all marked bull trout placed upstream move back downstream past the trap. Marked bull trout that do not move back downstream cause the total number to be under-estimated.

Table 3. Efficiencies at which the Mill Creek rotary screw trap captured bull trout, and the estimated numbers of them that passed downstream in 2001-2002.

	Sep	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Sep-Mar**
Trap efficiency (%)[a]	5.6	18.5	46.2	30.8	47.4	20.0	53.1	35.1
Estimated number of bull trout	218	292	60	83	43	126	96	602
95% confidence interval	383	366	33	69	30	167	32	139

[a] Proportion of fin-marked and PIT-tagged fish released 112 m upstream of the trap and subsequently recaptured.

Of the 31 bull trout greater than 300mm captured in the rotary screw trap, 14 had PIT tags (125 KHz) applied in years prior to 2001. Because the PIT tag scanner used in the field read only 125 KHz tags, these 14 bull trout were used to estimate the time spent on a spawning migration upstream of the Mill Creek dam during 2001. This time period was defined as the elapsed days between captures in both traps. These 14 bull trout (range = 331-514 mm, mean = 414 mm) were captured in the upstream migrant trap at the ladder from 28 June to 13 August. An average of 65 days (range = 25-156 days) had elapsed by the time they were recaptured in the screw trap. Generally, bull trout captured in the upstream migrant trap early in the run were recaptured in the screw trap later than bull trout that had been captured in the upstream trap relatively late in the run.

Telemetry

We conducted 27 telemetry surveys in Mill Creek during January (5), February (4), March (4), April (4), May (5), June (4), and August (1) of 2001. These surveys were conducted by foot or by truck because surveys late in 2000 indicated all active transmitters were located between the water intake dam (Rkm 40.9) and the city of Walla Walla. On 04 January, the first survey of 2001, we located 10 transmitters that still produced signals. Six of these 10 transmitters remained at the locations where they were detected on the first survey. The remaining four transmitters were tracked downstream 0.5 - 20 km by 05 April to 15 May, where they remained until late June (Table 4). One additional transmitter was located three times at Rkm 38.6 during June. No telemetry surveys were conducted during July; no signals were detected when the final survey was conducted in August.

No transmitter located during 2001 moved upstream during spring and early summer, which we had frequently observed in previous years. All transmitters were located from three to 27 times at their final destinations, and no bull trout were observed at these destinations. Therefore, we concluded that for most of 2001, the transmitters had been rejected by the bull trout that originally carried them, or that these bull trout were dead. Of the 11 transmitters we located in Mill Creek during 2001, seven were implanted in bull trout during 1998 and four were implanted during 1999.

We conducted nine telemetry surveys in the Grande Ronde Basin during 2001. Three of these surveys were by plane, once during April and twice during July. Four surveys, limited to short portions of the Grande Ronde River, occurred by foot during January, March, May and June. Two surveys were by truck in February and November; the latter occurred on the Grande Ronde River from the bridge on highway 3 to Wildcat Creek. On these surveys, we tracked 12 bull trout captured from the Wenaha River or Lookingglass Creek and implanted with radio transmitters in 1998 or 1999 (Table 5).

Three of these 12 transmitters were located only once in 2001; these locations were in the Grande Ronde River (Rkm 38.6 and 42.2) and the Wenaha River (Rkm 31.2, between Rock Creek and NF Wenaha River). The remaining nine transmitters were each detected two to seven times between 22 February and 31 July. Of these nine transmitters, four remained where they were first detected, two in the Grande Ronde River at about Rkm 52 and two in the Wenaha River (Rkm 28.0 and 29.6). The remaining five of these nine transmitters moved somewhat during the time they were tracked. Three were located in the Grande Ronde River, and moved downstream 1 to 3 km. Only two transmitters indicated any upstream movement in 2001. One (frequency 151.613) was located in the Grande Ronde River at Rkm 86.6 on 22 February. The bull trout carrying this transmitter moved downstream 12.6 km to the Wenaha River, then upstream to Rkm 36.8 of the Wenaha River by the end of July. The other (frequency 151.622) moved from the confluence of the Wenaha River upstream to Rkm 24.3 of the Wenaha River by the end of July.

No telemetry surveys were conducted during August through October because we thought few transmitters were in live fish (this includes rejected tags). No signals were detected when a final survey was conducted in November.

Table 4. Radio-tagged bull trout of Mill Creek that were tracked in 2001.

MHz	L (mm) [a]	LU	TU	LD	TD	Last Found
Tagged in 1998:						
150.073	605	37.4 [b]	04 Jan	--	--	27 Jun
150.105	535	29.8 [b]	04 Jan	--	--	15 May
150.123	520	24.8 [b]	04 Jan	--	--	27 Jun
150.134	545	40.6	04 Jan	20.5	11 Apr	27 Jun
150.192	630	19.2	04 Jan	18.6	15 May	27 Jun
150.343	510	38.6 [b]	14 Jun	--	--	27 Jun
150.713	555	20.3	04 Jan	18.7	15 May	27 Jun
Tagged in 1999:						
151.273	360	38.9 [b]	04 Jan	--	--	08 May
151.312	315	40.6 [b]	04 Jan	--	--	27 Jun
151.343	358	37.0 [b]	04 Jan	--	--	27 Jun
151.681	395	40.6	04 Jan	35.4	05 Apr	05 Apr

LU = maximum known upstream location (Rkm) in 2001.
TU = earliest date of maximum upstream location.
LD = maximum downstream location (Rkm) 2001.
TD = earliest date of maximum downstream location.
[a] Length when implanted with radio transmitters.
[b] Always located here.

Table 5. Radio-tagged bull trout of the Grande Ronde basin that were tracked in 2001. Unless otherwise noted, all were captured and tagged from the Wenaha River. Locations shown are in the Grande Ronde River, unless otherwise noted.

MHz	L (mm) [a]	LU	TU	LD	TD	Last Found
Tagged in 1998:						
150.053	530	38.6	02 Jul	--	--	02 Jul [b]
150.114	520	31.2 [c]	31 Jul	--	--	31 Jul [b]
150.115	535	29.6 [c d]	27 Apr	--	--	02 Jul
150.133	630	42.2	22 Feb	39.8	27 Apr	02 Jul
150.343	483	51.8 [d]	22 Feb	--	--	02 Jul
150.743	565	61.6	22 Feb	58.4	02 Jul	31 Jul
151.223	546	28.0 [c d]	02 Jul	--	--	31 Jul
151.262	444 [e]	85.6	04 Jan	84.5	31 Jul	31 Jul
Tagged in 1999:						
150.032	340	52.0 [d]	22 Feb	--	--	02 July
151.092	375	42.2	22 Feb	--	--	22 Feb [b]
151.613	350	36.8 [c]	31 Jul	86.6	22 Feb	31 Jul
151.622	330	24.3 [c]	31 Jul	73.9	27 Apr	31 Jul

LU = maximum known upstream location (Rkm) in 2001.
TU = earliest date of maximum upstream location.
LD = maximum downstream location (Rkm) 2001.
TD = earliest date of maximum downstream location.
[a] Length when implanted with radio transmitters.
[b] Located once in 2001.
[c] Located in the Wenaha River.
[d] Always located here.
[e] Tagged in Lookingglass Creek.

II. Stream temperature monitoring

Introduction

Bull trout are stenothermic, requiring cold water temperatures to rear and reproduce. Consequently, the distribution of bull trout may be determined, in part, by the stream temperature regime. Elevated water temperature is considered to be a significant factor in the decline of bull trout in Oregon and the Pacific Northwest (Buchanan and Gregory 1997). Although bull trout have been observed in water >20°C, temperatures >16°C are considered unsuitable for long-term survival (Selong *et al*. 2001). Rieman and Chandler (1999) showed that bull trout of the Pacific Northwest were most likely to be found in streams where the summer maximum temperatures were <14°C. Gamett (2002) found bull trout were present at locations where the mean temperature between July 1 and Sept 30 was < 10ºC, and were not found where mean temperature was >12ºC. In laboratory conditions, the fundamental thermal niche of juvenile bull trout was 10.2 - 14.2°C (Selong *et al*. 2001).

Our objective is to describe the relationship between stream temperature and distribution of bull trout in Oregon's portion of the Columbia River Basin. This section describes efforts to measure the thermal characteristics of streams where we are monitoring bull trout movements, including Mill Creek (Walla Walla Basin), the upper John Day River watershed, and the Grande Ronde Basin.

Methods

Thirty-four temperature data loggers (Onset Computer, Inc.) were deployed in the study basins: 9 in Mill Creek, 16 in the John Day River, and 9 in Grande Ronde watersheds (Table 6). Temperature data loggers were launched between December 2000 and July 2001. Data loggers were collected and downloaded from September through November 2001.

Temperature data loggers were programmed with a recording interval of one hour. In small streams and rivers at low flows, data loggers were placed in a sock or mesh bag with a few heavy stones. The bag was placed on the substrate at the edge of the thalweg to ensure its location in an area of adequate mixing. In large rivers or at high winter or spring flows, data loggers were placed in a perforated metal pipe with a screw cap and an eyebolt on one end. The pipe was secured with cable to a stable structure (e.g., a tree) on the stream bank.

Table 6. Location and duration of temperature data loggers deployed in 2001.

Basin	Stream	Launch Date	Re-launch Date[a]	Recovery Date[a]	River Kilometer	Location Description
Mill Creek	Mill Cr.	12-Dec-00	4-Jun	23-Oct	5	Wallula bridge
	"	12-Dec-00	4-Jun	18-Oct	21	5 mile bridge
	"	12-Dec-00	4-Jun	12-Sep	31	Wickersham bridge
	"	12-Dec-00	4-Jun	23-Oct	43	screw trap site
	"	10-Jul-01		18-Oct	49	confluence with North Fork
John Day	NF John Day R.	12-Dec-00		*	4	2 miles above Kimberly
	John Day R.	12-Dec-00*	16-Mar	*	270	Spray boat launch
	"	12-Dec-00		*	414	highway 26 bridge
	"	30-Mar-01*	21-Jun	15-Nov	435	at 1999 screw trap site
	"	12-Dec-00		*	437	at Reynolds Cr. road x-ing
	"	12-Dec-00		15-Nov	444	road 62 bridge
	"	6-Dec-00*	21-Jun	*	455	end of fish use
	Indian Cr.	1-Jun-01		06-Oct	10	confluence with Sheep Cr.
	Dixie Cr.	5-Dec-00		15-Nov	14	2/3 way up Dixie Cr.
	Reynolds Cr.	12-Dec-00		15-Nov	4	USFS boundary
	"	12-Dec-00		15-Nov	7	USFS campground
	Call Cr.	6-Dec-00		15-Nov	0.1	
	"	6-Dec-00		*	3	
Grande Ronde	Grande Ronde R.	29-Nov-00	7-Jul	27-Nov	44	1.6 Km above of Hwy 3 bridge
	"	8-Dec-00*	7-Jul	27-Nov	85	1.2 km below of Wildcat Cr.
	"	15-Aug-01		15-Oct	127	300 m below Rondowa
	"	25-Nov-00	7-Jul	29-Nov	132	1 km below Lookingglas Cr.
Wenaha	Wenaha R.	10-Mar-01	7-Jul	27-Nov	0.8	800m upstream from mouth

* Data logger malfunctioned or was lost.

[a] 2001.

Results and Discussion

Mill Creek

Nine temperature data loggers were deployed at five sites in Mill Creek (Fig. 5). Sites were monitored at various times between 12 December 2000 and 23 October 2001 (Table 6). The seven hottest consecutive days in 2001 occurred between 8 – 14 July. For these days the average maximum stream temperature above Rkm 32 did not exceed 20ºC (Fig 6a). Temperatures at Rkm 32 were above 15ºC for an average of 12 hrs per day and sites upstream did not exceed 15ºC (Fig 6b). Temperatures at RKm 43 did not exceed 13ºC during the week.

The temperature data logger at Rkm 49 did not capture this time period; however, temperatures were typically 1.5ºC (range = 0.8 – 2.3ºC) cooler than at Rkm 43 in late July and September. At Rkm 43 and Rkm 49 the mean temperature 10 July – 30 September was < 10ºC. The average daily fluctuation during July and August was greatest, 7ºC (range = 2.5 - 9.1ºC), at Rkm 32 (Fig 6c). Temperatures at Rkm 49 were the most stable, varying by 1.9ºC (range = 0.6 – 2.6ºC). The greatest temperature fluctuation (9.5ºC) occurred at Rkm 21 on 22 May 2001.

In winter, the 7-day average minimum temperatures at all sites remained at or below 5ºC through 15 February. The 7-day average minimum temperature at Rkm 21 was consistently cooler than other sites and fluctuated between 1.7ºC and 3.7ºC from 19 December 2000 to 7 March 2000. Rkm 5 was the warmest, fluctuating between 3.4 - 7.1ºC during the same period. Temperatures slowly began to increase in mid-March except at Rkm 5 which started to warm in mid-February.

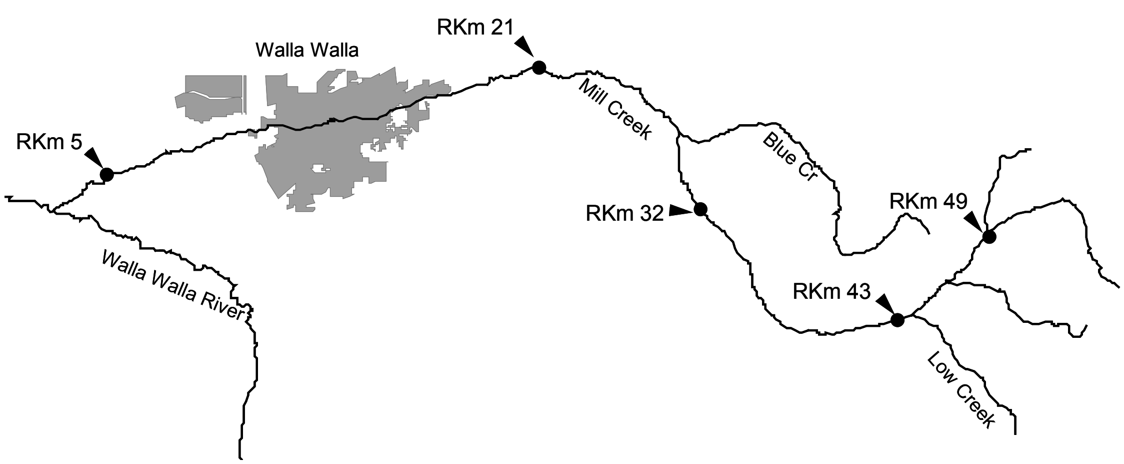

Figure 5. Locations of temperature data loggers in Mill Creek during 2001.

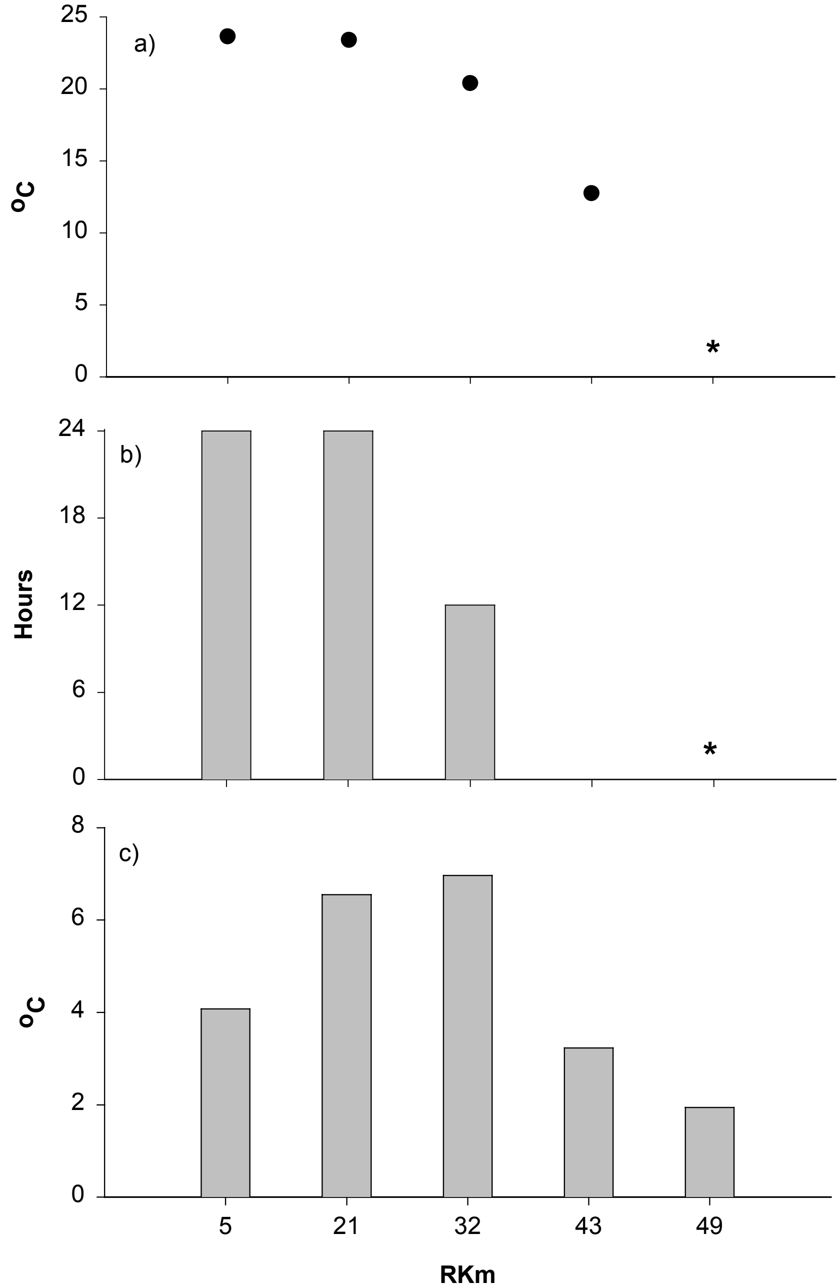

Figure 6. Seven day average a) maximum temperature and b) number of hours > 15º C during 8 - 14 July 2001 in Mill Creek. c) Average degrees of fluctuation during July and August 2001. * The temperature data logger at Rkm 49 was not deployed during this time period.

John Day River

Thirteen temperature data loggers were deployed at 11 sites in both the upper mainstem and tributary streams (Fig. 7). Sites were monitored at various times between 5 December 2000 and 15 November 2001 (Table 6). Six temperature data loggers were lost or malfunctioned. Of these data loggers five were in the mainstem John Day (Rkm 414, Rkm 435 (1 of 2), Rkm 437, Rkm 455 (2) and one was in upper Call Creek. Three temperature data loggers were deployed in the lower John Day, two near Spray and one in the North Fork John Day River near Kimberly. All three data loggers were lost.

The seven hottest consecutive days occurred between 30 June and 6 July. For these days average maximum temperature did not exceed 20ºC at any of the sites (Fig. 8a). The Call Creek site was the coolest where the maximum temperature averaged 11.4ºC. Call Creek and upper Reynolds Creek did not reach 15ºC, whereas RKm 435 and Dixie Creek exceed 15ºC for 11 and 14 hours/day respectively (Fig. 8b). The mean temperature 1 July – 30 September was < 10ºC at Call Creek and Reynolds-2 and < 12ºC at all sites except Rkm 435.

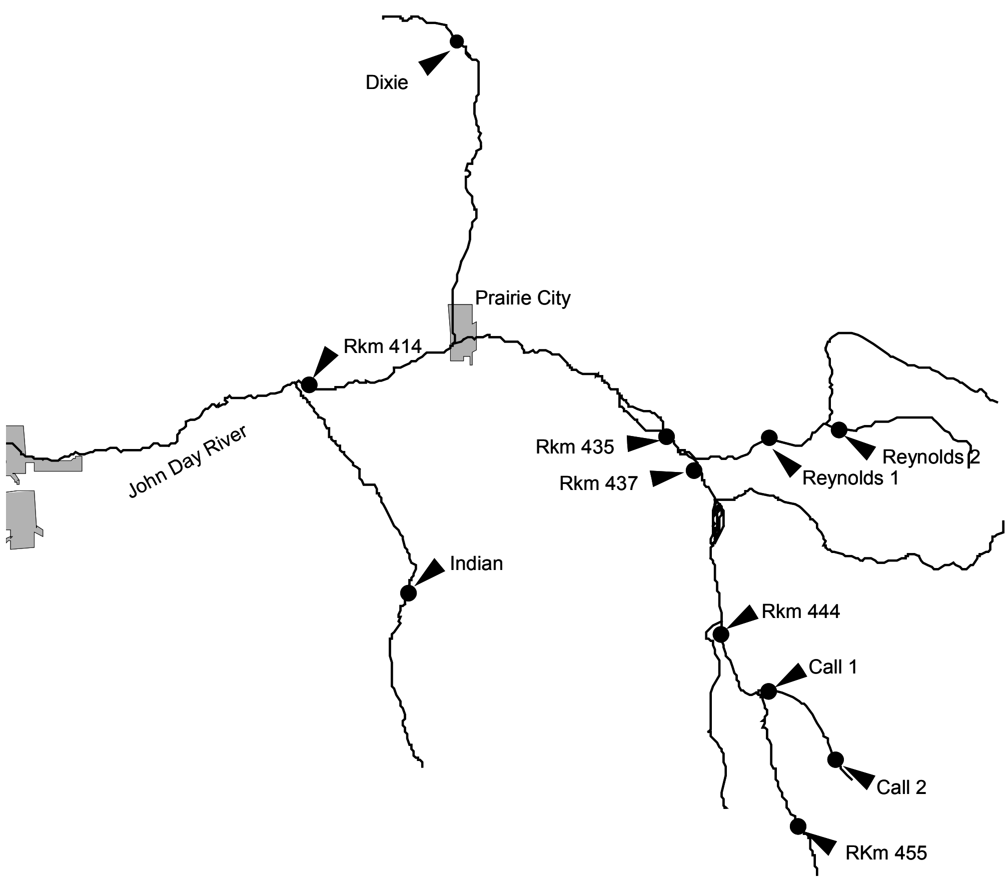

Figure 7. Location of temperature data loggers in the upper John Day Basin during 2001.

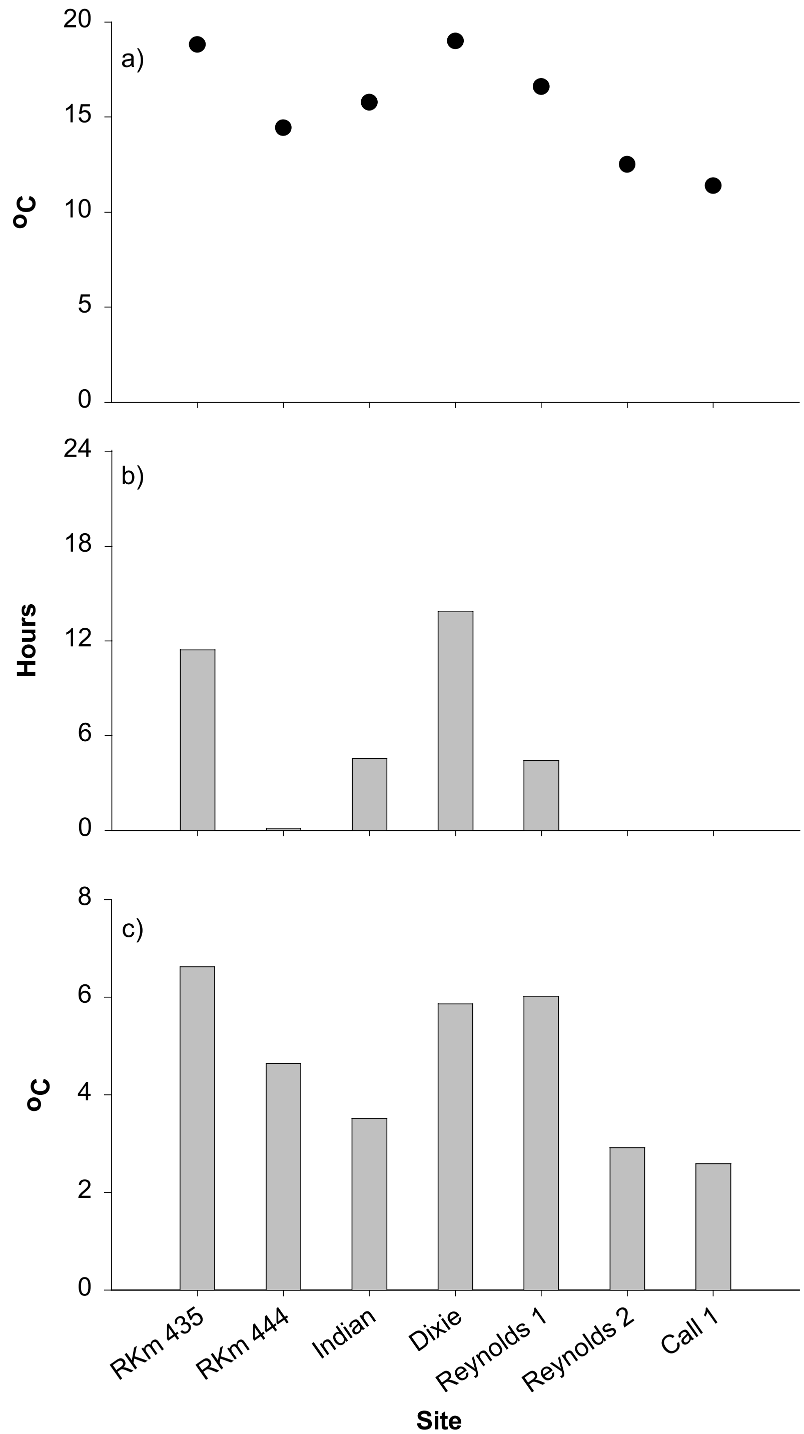

Figure 8. Seven day average a) maximum temperature and b) number of hours > 15ºC during 30 June - 6 July 2001 in the John Day Basin. c) Average degrees of fluctuation during July and August 2001.

Daily temperature fluctuation in July and August was greatest at the Rkm 435, which varied an average of 6.6º C daily (range = 2.5 - 8.5ºC). Call creek was the most stable with daily fluctuations averaging 2.5ºC (range = 0.8 – 3.8ºC)(Fig. 8c). The greatest temperature fluctuation (8.5ºC) occurred at Rkm 435 on 8 August 2001.

In winter, all sites remained above 0ºC except Dixie Creek. The 7-day average minimum temperature at Dixie Creek was at or below 1ºC from 14 December 2000 to 16 April 2001. Reynolds-1 was the warmest with 7-day minimum temperatures fluctuating between 3.9ºC and 1.7ºC between 20 December and 21 March. Water temperatures began increasing in mid-April.

<u>Grande Ronde River</u>

Nine temperature data loggers were located at five sites in the Grande Ronde Basin. Sites were monitored at various times between 25 November 2000 and 29 November 2001 (Fig. 9). Rkm 130 was monitored for 3 months between 16 August and 15 October. The data logger launched at Rkm 85 on 8 December 2000 was lost and replaced on 7 July.

The seven hottest consecutive days in 2001 occurred between 6 to 12 August for all sites except Rkm 132. For these days all temperature loggers except Rkm 132 exceeded 20ºC and were warmer than 15ºC for 24 hours per day (Fig. 10a & b). The hottest consecutive seven days at Rkm 132 was 29 June to 5 July. During this week average maximum temperatures were 23.5ºC and temperatures were >15ºC for 24 hours per day. The mean temperature from 1 July to 30 September was > 12ºC at all sites.

The average daily temperature fluctuation during July and August was greatest at Rkm 132, which varied an average of 8.6ºC daily (range = 2.6 -10.9ºC). Rkm 44 was the most stable with average daily fluctuations of 4.0ºC (range = 9.9-5.6ºC). Stream temperature at the mouth of the Wenaha River during July and August was cooler than at Rkm 85 by an average of 4.7ºC. The degree of fluctuation was similar at these two sites.

Only two sites in the Grand Ronde basin were monitored during winter, Rkm 44 and Rkm 132. The 7-day average minimum temperature remained below 2.1ºC until mid-February, when water temperature began to steadily rise.

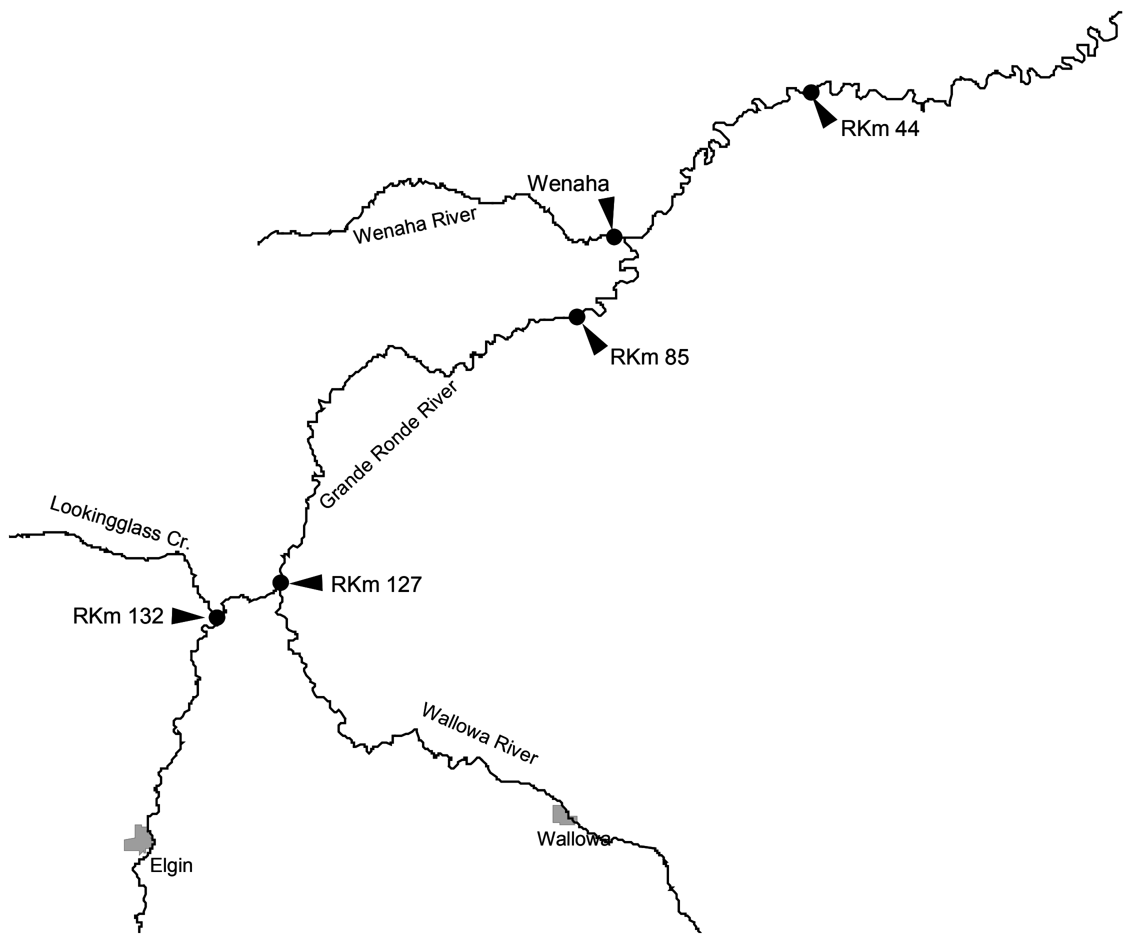

Figure 9. Location of temperature data loggers in the Grande Ronde Basin, during 2001.

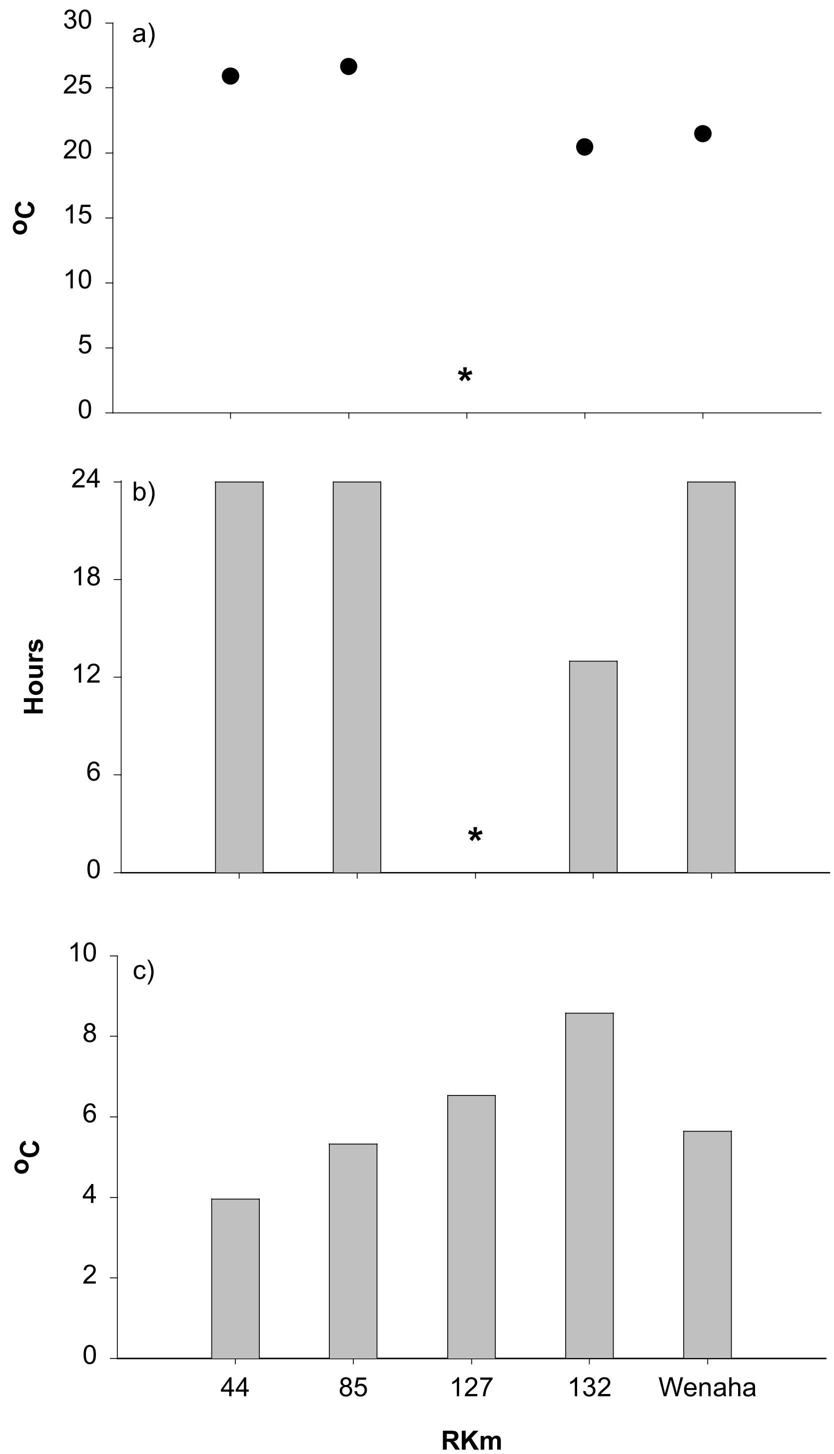

Figure 10. Seven day average a) maximum temperature and b) number of hours > 15ºC during 6 - 12 August 2001 in the Grande Ronde Basin. c) Average degrees of fluctuation during July and August 2001. * The temperature data logger at Rkm 127 was not deployed during this time period.

III. Bull trout spawning surveys

Introduction

Quantitative estimates of bull trout abundance are necessary to determine the status of populations, to monitor changes in population size, and to evaluate the effectiveness of conservation and recovery strategies. This information has been identified as critically needed research (Rieman and McIntyre 1993; Buchanan et al. 1997). Population status may be monitored at any or all life stages. However, it has been difficult for biologists to accurately quantify the abundance of emergent salmonid fry (Hillman et al. 1992) or find consistent measures of juvenile bull trout abundance (Bonneau et al. 1995; Thurow and Schill 1996).

Counting redds is an attractive technique to evaluate population abundance for several reasons. First, since only reproductive adults produce redds, the number of redds should reflect the effective population size of a stock (Meffe and Carroll 1994). However, this assumes that each female makes only one redd. Second, the potential impacts to the population from spawning ground surveys are relatively low when compared to potential injuries that can occur when making population estimates based on multiple-pass removal or mark-recapture techniques using electrofishing (see Hemmingsen et al. 1996). Third, counts of redds can be determined with relative ease. Consequently, numbers of redds are commonly used to evaluate trends in the size of local bull trout populations (Rieman and Myers 1997). Despite their frequent use, the redd count information from spawning surveys may not be sufficient or appropriate to quantify the population status of bull trout. Detection of changes in population size may not be possible using the most extensive sets of redd count data available (7-17 years), (Maxell 1999) and is unlikely for populations with more limited data sets (Rieman and Myers 1997).

This section describes results of bull trout spawning surveys in Mill Creek (Walla Walla basin) and the Little Minam River (Grande Ronde basin). Areas where these surveys occur are relatively pristine and support two life history forms. Mill Creek supports fluvial bull trout while its tributaries are suspected to support resident bull trout. The reaches of the Little Minam River that we surveyed support only resident bull trout. These surveys provide additional data to complement those which began to be collected in 1996 so that we can better describe the population status of bull trout in these watersheds and better understand the spatial variation of redd distribution within each basin.

Methods

We conducted four spawning surveys in Mill Creek and its tributaries from the city of Walla Walla's water intake dam at river kilometer 40.9 (Fig. 11). Two surveys occurred in September (6-7 and 20-21) and two occurred in October (4-5 and 18-19). Tributaries Burnt Fork and Bull creeks were not surveyed during the early October survey, and Deadman Creek was surveyed only during the late September survey. We also conducted four spawning surveys in the Little Minam River (upstream from Boulder Creek) and in its tributary Dobbin Creek (Fig. 12). Two surveys occurred in September (13-14 and 27-28) and two occurred in October (11-12 and 26-27). Survey reach numbers shown in Fig. 11 and Fig. 12 coincide with survey reach boundaries and lengths described by Hemmingsen, Bellerud, Buchanan, Gunckel, Shappart and Howell (2001). Surveys in each watershed were conducted with protocols consistent with surveys conducted from 1996 through 2000 (Hemmingsen, Gunckel, Sankovich and Howell 2001).

We determined the variation in distribution of bull trout redds within both the Mill Creek and Little Minam River watersheds using data collected during six years of surveys. This variation was expressed as the annual percentage of redd abundance that occurred in each stream reach. We expanded annual counts from reaches with low variation by respective six-year mean proportions to obtain annual estimated redd totals (y) within each watershed. We compared y with the annual observed redd totals (x) and determined the percentage error between the two values by the calculation $((y-x)/x)*100$.

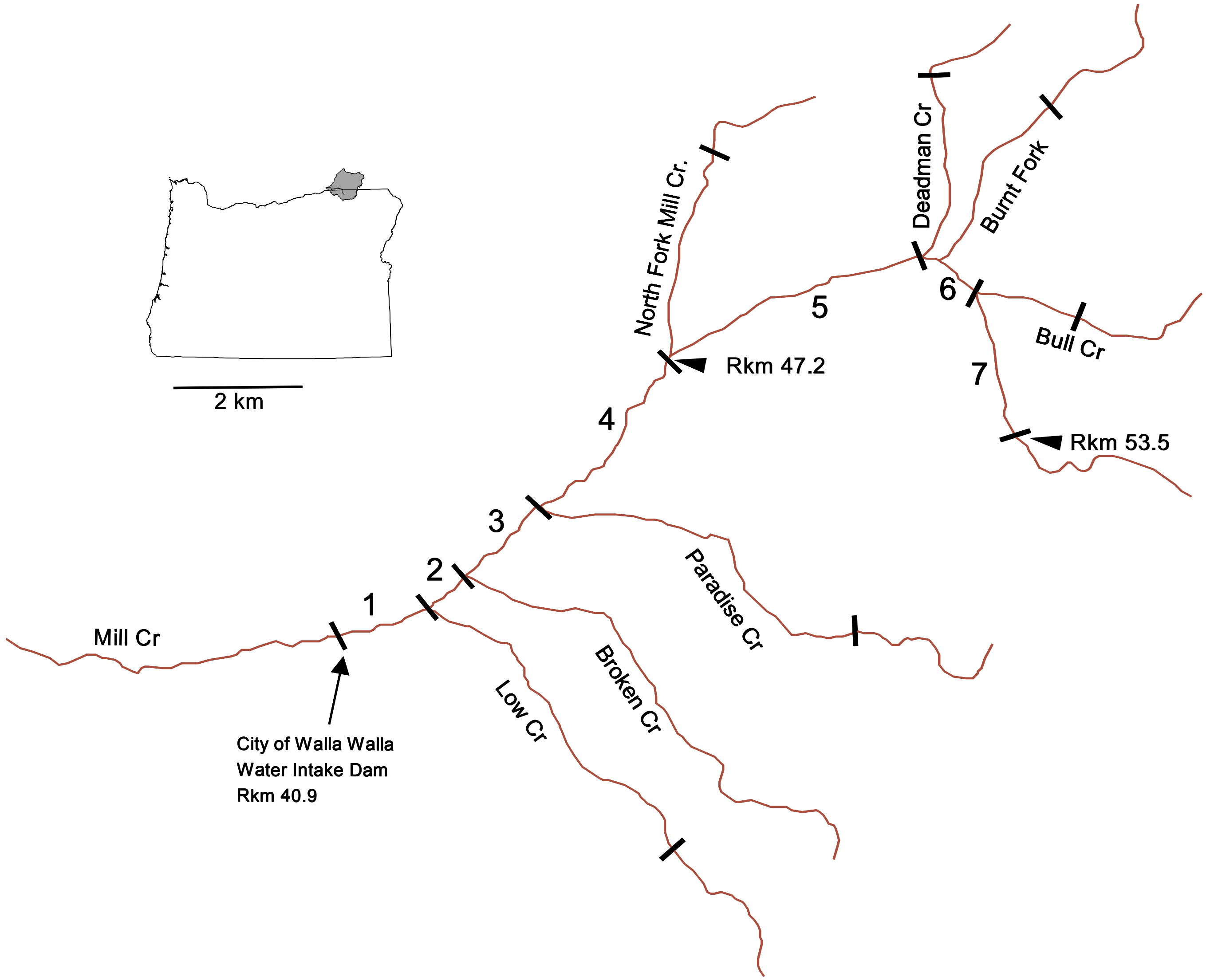

Figure 11. Locations of bull trout spawning survey reaches in Mill Creek and tributaries.

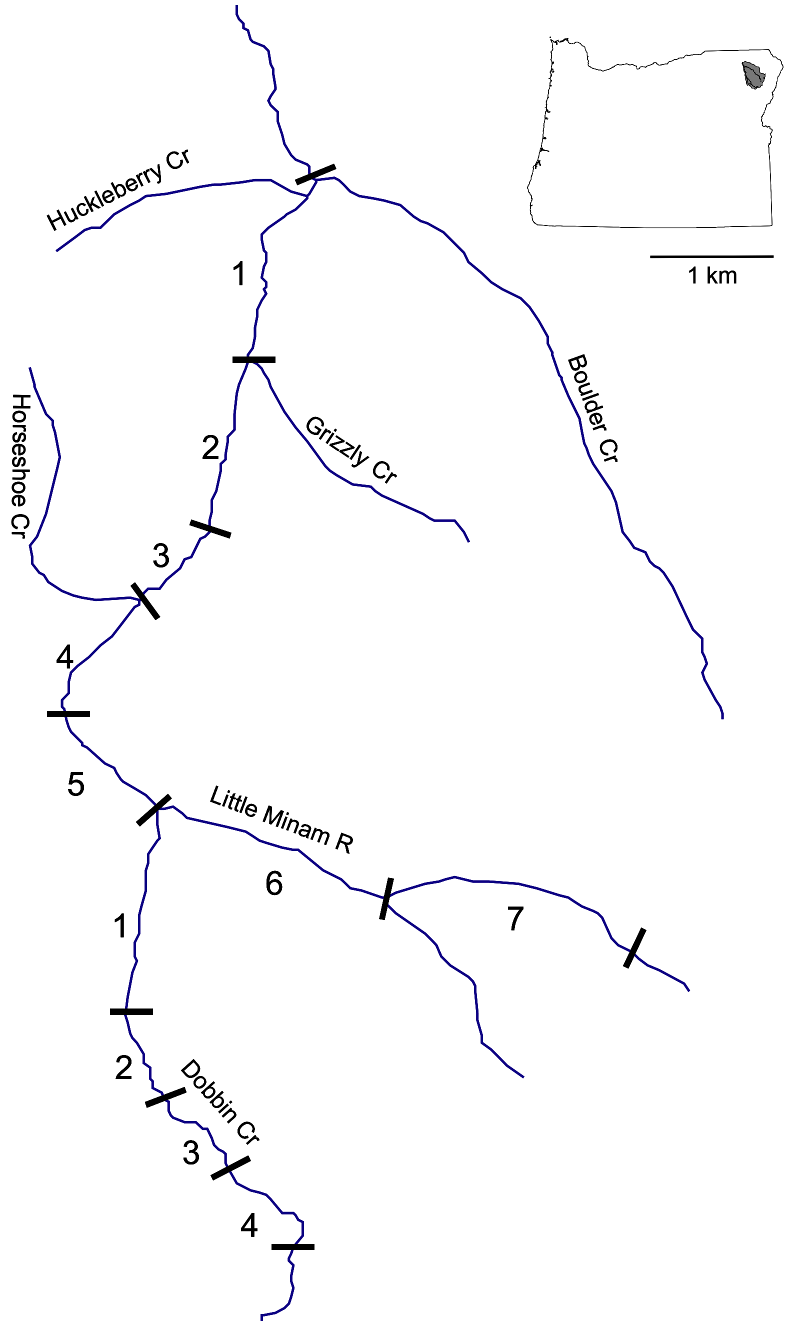

Figure 12. Locations of bull trout spawning survey reaches in Little Minam River and Dobbin Creek.

Results and Discussion

We observed 220 bull trout redds in the Mill Creek watershed during 2001. Of these, 163 (74%) were in Mill Creek and 57 were in tributaries (Fig. 13a). In Mill Creek, 83 redds (51%) were in reach five, between North Fork Mill Creek and Deadman Creek (Fig. 11). Bull trout redds were not observed in reaches one or three of Mill Creek. We observed only three redds in reach two.

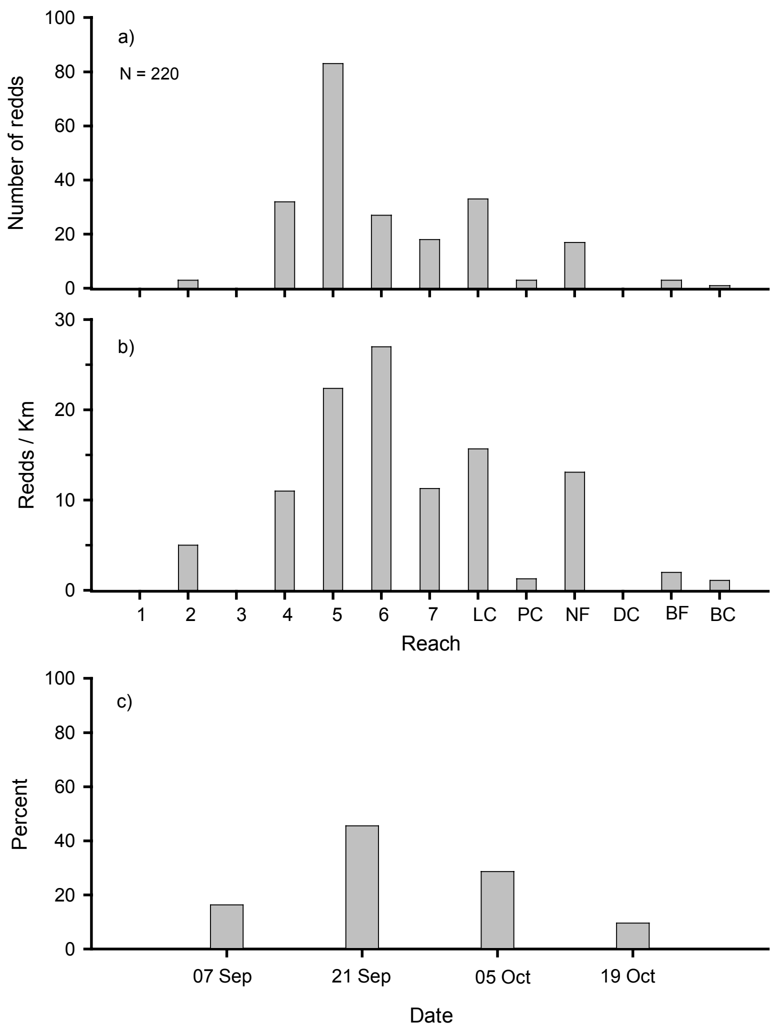

Figure 13. Spawning ground surveys on Mill Creek and tributaries, 2001; a) number and b) density of bull trout redds in each reach, c) proportion of N observed during each survey. LC = Low Creek, PC = Paradise Creek, NF = North Fork Mill Creek, DC = Deadman Creek, BF = Burnt Fork and BC = Bull Creek

The 57 redds in tributaries amounted to 26% of the total redds in the watershed. Tributaries contained 27 to 43% of the total redds during 1996-2000. The percentages of redds in Bull Creek and Burnt Fork Creek in 2001 (2% and 5%, respectively) fell within the ranges observed in those tributaries during the five previous years (Bull Creek range = 0-6%), and Burnt Fork Creek (range = 5-24%). In 2001, 58% of redds in tributaries were in Low Creek (n=33). Low Creek has contained the most redds observed in all tributaries each year since 1996.

In Mill Creek, the densities (n/km) of redds ranged from 5 (reach two) to 27 (reach six) (Fig 13b). Based on their large size, we assume most of these redds were made by fluvial bull trout. In Low Creek, there were 18 redds per km. We presently think Low Creek supports primarily resident spawners. While relatively few bull trout had spawned in Mill Creek and tributaries before mid-September, 66% of all redds observed were counted by late September, and 93% were counted by 11 October (Fig. 13c).

We observed 432 redds in the Little Minam River watershed in 2001. Of these, 337 were in the Little Minam River and 95 were in Dobbin Creek (Fig. 14a). In the Little Minam River, reaches six and seven both upstream of the confluence with Dobbin Creek (Fig 12), contained 185 redds, or 43% of the total observed in the watershed. Reaches one, two, three, and five each contained about 6% of the watershed total.

The 95 redds in Dobbin Creek amounted to 22% of the watershed total, and nearly half (n=43) of these were in reach one. The total observed in Dobbin Creek this year was substantially more than the number observed any year since 1996. Densities (n/km) of redds in the Little Minam River ranged from 14 (reaches one and two) to 48 (reach seven), and averaged 26 in the reaches three through six (Fig. 14b). Densities of redds in the four reaches of Dobbin Creek ranged from 11 to 25. Of all redds observed during 2001, 59% were counted by mid-September and only 13% were counted during October (Fig 14c).

The numbers of bull trout redds observed in both watersheds during 2001 were the highest since surveys began (Fig. 15). However, results of surveys in 1994 and 1995 are not directly comparable since these surveys, conducted by the U.S. Forest Service prior to this study, were not as extensive or frequent as surveys since 1996.

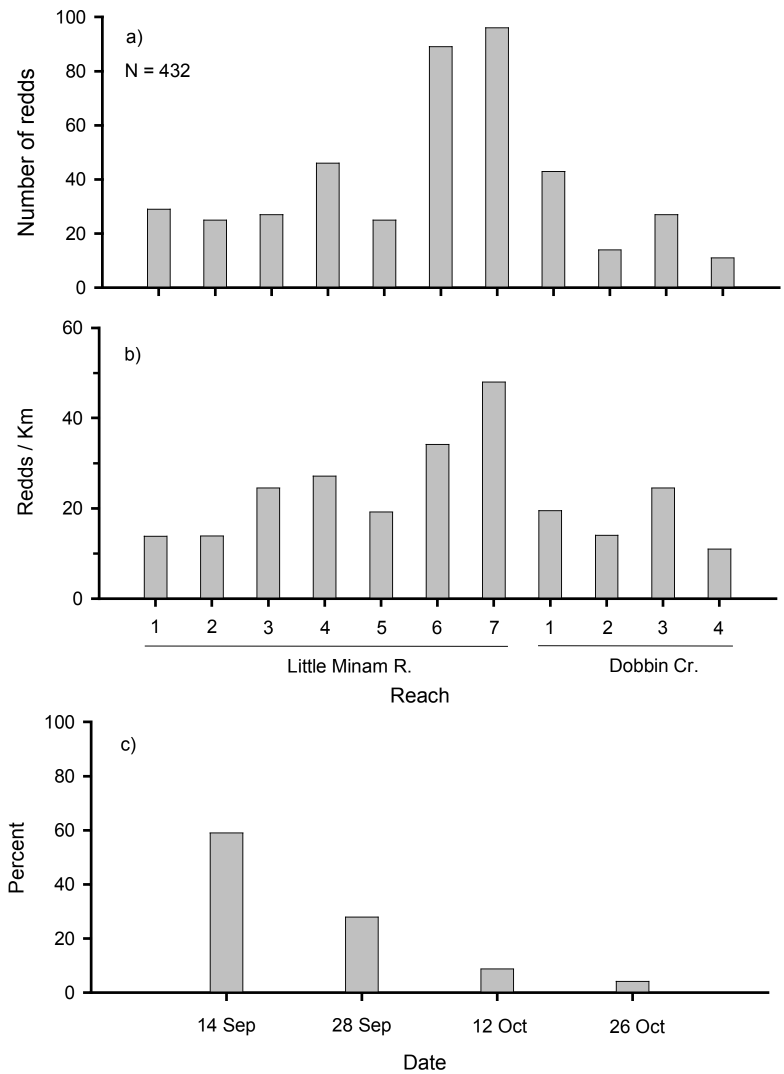

Figure 14. Spawning ground surveys on the Little Minam River and Dobbin Creek, 2001; a) number and b) density of bull trout redds in each reach, c) proportion of N observed during each survey.

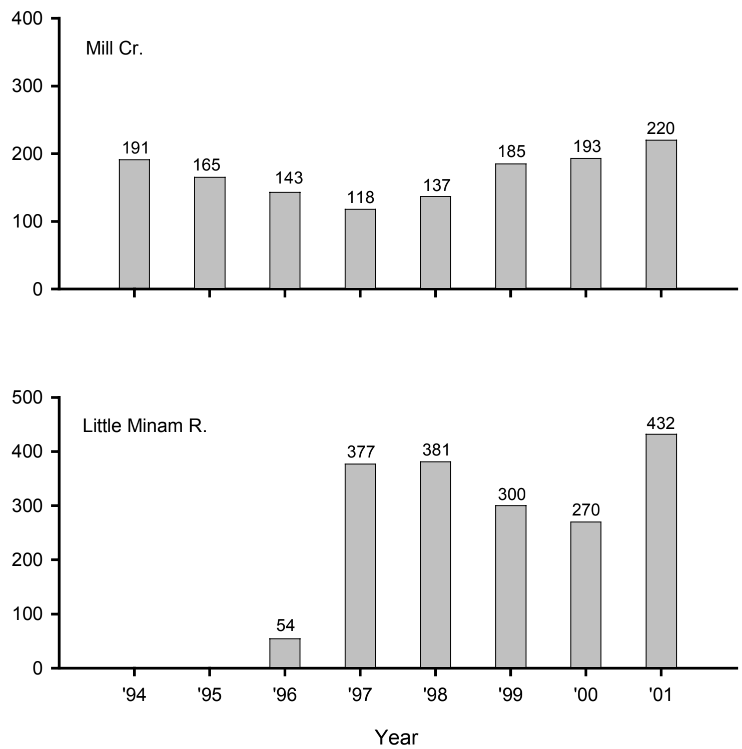

Figure 15. Numbers of bull trout redds observed annually from 1994 -2001. Data from Mill Creek in 1994 and 1995 are courtesy of the USDA Forest Service, Walla Walla, WA. Little Minam River was not surveyed in 1994 and 1995.

In Mill Creek, reach five contained the greatest proportion of redds (range = 31 to 38%; mean = 34.3%) observed annually in the watershed, with the lowest coefficient of variation (cv) which was 9% among all reaches (Table 7). Although redds in Low Creek tend to be smaller and possibly more difficult to observe than those in reach five of Mill Creek, proportions of redds in Low Creek also had relatively low variation (cv = 20%). Together, reach five of Mill Creek and Low Creek produced 48 to 57% (mean = 52.1%) of redds observed annually in the watershed from 1996 through 2001. Expanded numbers of redds counted in reach five and Low Creek differed from observed numbers by less than 3% in three of six years, and never greater than $\pm$ 9% (Table 8).

Table 7. Proportion of bull trout redds observed each year in various survey reaches of Mill Creek and tributaries, and the estimated variation among years.

Survey reach	1996	1997	1998	1999	2000	2001	*mean*	*SD*	*CV*
Mill Cr:									
1	0.7	0.0	0.0	0.0	0.0	0.0	0.1	0.3	245
2	0.0	0.0	0.7	0.0	0.0	1.4	0.3	0.6	165
3	0.0	4.2	2.2	2.2	1.0	0.0	1.6	1.6	102
4	16.9	11.9	10.9	20.5	6.7	14.5	13.6	4.8	36
5	37.3	30.5	32.8	31.4	36.3	37.7	34.3	3.2	9
6	7.7	12.7	10.2	7.0	5.2	12.3	9.2	3.0	33
7	2.1	13.6	12.4	7.6	7.8	8.2	8.6	4.1	47
Low Cr	12.7	16.9	19.7	22.2	20.2	15.0	18.3	3.7	20
Paradise Cr	7.7	1.7	0.7	3.2	2.6	1.4	3.2	2.7	85
NF Mill Cr	4.2	2.5	4.4	3.2	8.8	7.7	4.6	2.5	53
Deadman Cr	2.1	0.8	2.9	0.0	3.6	0.0	1.9	1.5	78
Burnt Cr	8.5	3.4	1.5	2.2	7.3	1.4	4.5	3.1	69
Bull Cr	0.0	1.7	1.5	0.5	0.5	0.5	0.8	0.7	84

Table 8. Comparison of total bull trout redds observed and estimated based on redds observed in two survey reaches (Mill Creek reach five and Low Creek).

Year	Total redds in watershed		% error [a]
	Observed (x)	Estimated (y)	
1996	142	136	-4.0
1997	118	107	-8.9
1998	137	138	0.9
1999	185	190	2.7
2000	193	209	8.4
2001	220	223	1.2

[a] ((y-x)/x)*100.

In the Little Minam River, reach seven has produced 21 to 29% (mean = 24.8%, cv = 11%) of redds observed annually in the watershed (Table 9). Using the six-year mean proportion for reach seven, we calculated the estimated number of redds in the Little Minam watershed as we did for Mill Creek. This analysis showed that expansion of the numbers of redds counted in reach seven alone closely estimated the total numbers observed in 1996, 1997 and 1998 (error = 3-5%). However, this procedure led to a 15% over-estimate of the total redds in 2000 as well as 10 and 17% under-estimates of the total redds in 1999 and 2001, respectively (Table 10). In a second examination for this watershed, we included the numbers of redds counted in reach three of the Little Minam River (cv = 19%) with those counted in reach seven. Together, these survey reaches produced 29 to 37% (mean = 32.6%) of redds observed annually in the watershed. Compared to reach seven alone, the addition of counts of redds in reach three reduced the magnitude of error in 1996, 1999 and 2000, increased the error in 1997 and 2001, and changed the error in 1998 from positive to negative (Table 10). Using counts of redds in both reaches still produced error of nearly $\pm$ 15% in two (2000 and 2001) of six years.

Table 9. Proportion of bull trout redds observed each year in various survey reaches of the Little Minam River and Dobbin Creek, and the estimated variation among years.

Survey reach	1996	1997	1998	1999	2000	2001	*mean*	*SD*	*CV*
L. Minam R:									
1	0.0	12.2	7.9	16.3	8.9	6.7	9.1	6.1	67
2	7.4	6.6	6.6	14.0	5.2	5.8	8.0	3.5	44
3	7.4	9.3	5.8	9.3	8.9	6.3	8.1	1.5	19
4	7.4	5.0	9.7	14.3	10.7	10.6	9.4	3.5	37
5	5.6	6.1	11.3	4.7	3.3	5.8	6.2	3.0	49
6	18.5	16.2	17.1	10.0	22.2	20.6	16.8	4.5	26
7	25.9	25.7	25.7	20.7	28.5	22.2	25.3	2.9	11
Dobbin Cr:									
1	22.2	11.7	3.9	3.3	8.9	10.0	10.0	7.7	77
2	5.6	1.6	2.4	2.0	0.0	3.2	2.3	2.0	88
3-4	0.0	5.6	9.7	5.3	3.3	8.8	4.8	3.5	74

Table 10. Comparison of total bull trout redds observed and estimated based on redds observed in selected survey reaches in the Little Minam River watershed.

Reach, Year	**Total redds**		**% error** [a]
	Observed (x)	**Estimated (y)**	
Reach 7:			
1996	54	56	4.5
1997	377	391	3.8
1998	381	395	3.7
1999	300	250	-16.7
2000	270	310	15.0
2001	432	387	-10.4
Reaches 7 and 3:			
1996	54	55	2.3
1997	377	405	7.4
1998	381	368	-3.4
1999	300	276	-8.0
2000	270	310	14.8
2001	432	377	-12.7

[a] $((y-x)/x)*100$.

Results presented here indicate that numbers of bull trout redds in selected stream reaches can correlate with the total number of redds with relatively small error ($\pm$ 9%) in the Mill Creek watershed. Depending on the objectives of spawning surveys, this precision may be acceptable in lieu of the effort required for annual surveys of entire spawning areas in a watershed. We emphasize that the identification of such reaches required systematic surveys throughout all spawning areas in both watersheds, conducted four times annually for six years. We also do not know how well counts in these reaches correspond with total counts in years with more widely ranging abundances. However, results of similar efforts in the Little Minam River watershed indicated that error in estimation could range from -13 to +15%. This level of precision may or may not be acceptable depending on objectives and desired levels of precision.

IV. Acknowledgments

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