

U.S. Fish and Wildlife Service

Migration Patterns of Adult Fluvial Bull Trout in the Methow and Columbia Rivers During 2007



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On the cover: Adult fluvial bull trout in the Lost River. USFWS photo by Mark C. Nelson.

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Upper Columbia Recovery Unit
Bull Trout Telemetry Project
Methow Core Area

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MIGRATION PATTERNS OF ADULT FLUVIAL BULL TROUT IN THE METHOW AND COLUMBIA RIVERS DURING 2007

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Abstract- In 2007, the USFWS Mid-Columbia River Fishery Resource Office continued a multiyear radio-telemetry study of the movement patterns of adult fluvial bull trout *Salvelinus confluentus* in the Methow Core Area of the Upper Columbia Recovery Unit in Washington. This study is concurrent with the bull trout monitoring programs of the public utility districts (PUDs) of Chelan and Douglas counties. We radio-tracked a total of thirty-six bull trout, including eighteen tagged in 2007, seventeen in 2006, and one in 2005. Of the eighteen bull trout tagged in 2007, five were tagged in the Methow River watershed by USFWS, ten at Wells Dam in the Columbia River by Douglas County PUD, and three at Rocky Reach on the Columbia River by Chelan County PUD. In the Columbia River, migration rate in the reservoirs between dams ranged from 15.8 to 58.7 km/day. The overall migration rate (including the time spent passing each dam) in the Columbia River ranged from 3.9 to 16.1 km/day (mean 8.8 km/day) and in the Methow River ranged from 3.2 to 10.1 km/day (mean 5.6 km/day). Bull trout migrated into the Methow River from May 22 to July 9, after peak discharge when flows declined from 10500 ft³/s to 1500 ft³/s. The diel movement periods of tagged bull trout in the Columbia River and Methow River varied according to location and season. Pre-spawn movements in the Columbia River occurred mostly during the day, but as migration progressed upstream in the Methow River movements shifted to the night. Most tagged bull trout entered spawning tributaries by early July and were detected on or near spawning areas by mid-July, well in advance of spawning season. The minimum known upstream migration distances to spawning areas ranged from 14.8 to 226.6 km. Fidelity to local populations was observed, as ten bull trout tagged in previous years returned to the same spawning area in 2007. Fluvial bull trout were detected in Foggy Dew Creek and on the spawning grounds in upper Lake Creek for the first time. Three tagged bull trout were tracked to a different core area in 2007. A total of eleven radio-tagged bull trout were isolated upstream of seasonal dry reaches in the Methow River basin during the fall of 2007 (seven in the upper Twisp River and four in the upper Methow River) and four died. During post-spawn migrations, movements were mostly at night in the Methow River, with a shift towards day in the Columbia River. Sixty-two percent of the bull trout tagged in the Columbia River overwintered in the main-stem Methow River compared to only eight percent in 2006. All bull trout tagged in the Methow River overwintered in the Methow River system. Understanding the factors affecting adult bull trout migration patterns, including migration rate, diel movement patterns, homing and navigation, and isolation by dry reaches, is necessary in order to facilitate recovery of bull trout in the Methow Core Area.

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Introduction

The Mid Columbia River Fishery Resource Office (MCRFRO) of the U.S. Fish and Wildlife Service (USFWS) is conducting a multi-year radio-telemetry study of the movements of adult fluvial bull trout *Salvelinus confluentus* in the Methow Core Area of the Upper Columbia Recovery Unit (Nelson et al. 2007). This study is concurrent with the bull trout monitoring programs of the mid-Columbia Public Utility Districts (PUDs) of Chelan County and Douglas County (DCPUD 2004; CCPUD 2005) and a cooperative approach of monitoring tagged bull trout allowed extensive information on movement patterns of bull trout within the Upper Columbia River Recovery Unit to be collected and reported in a cost effective manner. MCRFRO radio-tagged and monitored bull trout in the Methow River while CCPUD and DCPUD radio-tagged and monitored movements of bull trout at their mid-Columbia River hydroelectric projects. Movement patterns at Rock Island, Rocky Reach, and Wells dams are reported by CCPUD and DCPUD (Stevenson et al. 2008; LGL and DCPUD 2008) while detailed information on movements of all tagged bull trout in the tributaries are reported by MCRFRO (Nelson and Nelle 2007; Nelson et al. 2007; Nelson and Nelle 2008).

The draft bull trout recovery plan identified a need for research associated with bull trout migratory patterns and habitat use in the Methow River watershed (USFWS 2002 and 2004). A better understanding of the life history of bull trout in the Methow River watershed will provide managers with information related to critical habitat, migratory corridors and barriers, and migratory timing. This information will be crucial in developing future species habitat plans and the eventual recovery of bull trout.

The objectives of this study are to define seasonal movements, migration timing and obstacles or barriers, and spawning locations of adult migratory bull trout in the Methow River Core Area. This annual report details the migration patterns of all the tagged bull trout that utilized the Methow Core Area in 2007. The data presented here are provisional and may be interpreted differently in other agency reports as well as the final report to be issued at the conclusion of the study.

Study Area

The Methow River, tributary to the Columbia River at river kilometer (rkm) 843.3, drains an area of approximately 4895 km² (Figure 1). Mean stream discharge is 1592 ft³/s; base flow is 264 ft³/s and flood stage can be as high as 46700 ft³/s (Mullan et al. 1992). Snowmelt from the upper elevations of the Methow basin in spring and early summer generates most of the runoff in the basin, with 44 to 71% of the annual runoff volume occurring during May and June (NPCC 2004). The lowest stream flows occur in mid-winter (December to February) and early autumn (September) when stream flow is primarily the result of groundwater discharge. Several reaches dewater and flow subsurface at base flows, including the upper Methow River near the town of Mazama, the Lost River between Eureka and Monument creeks, Goat Creek at the mouth, and Twisp River at Poplar Flat Campground (Figure 1).

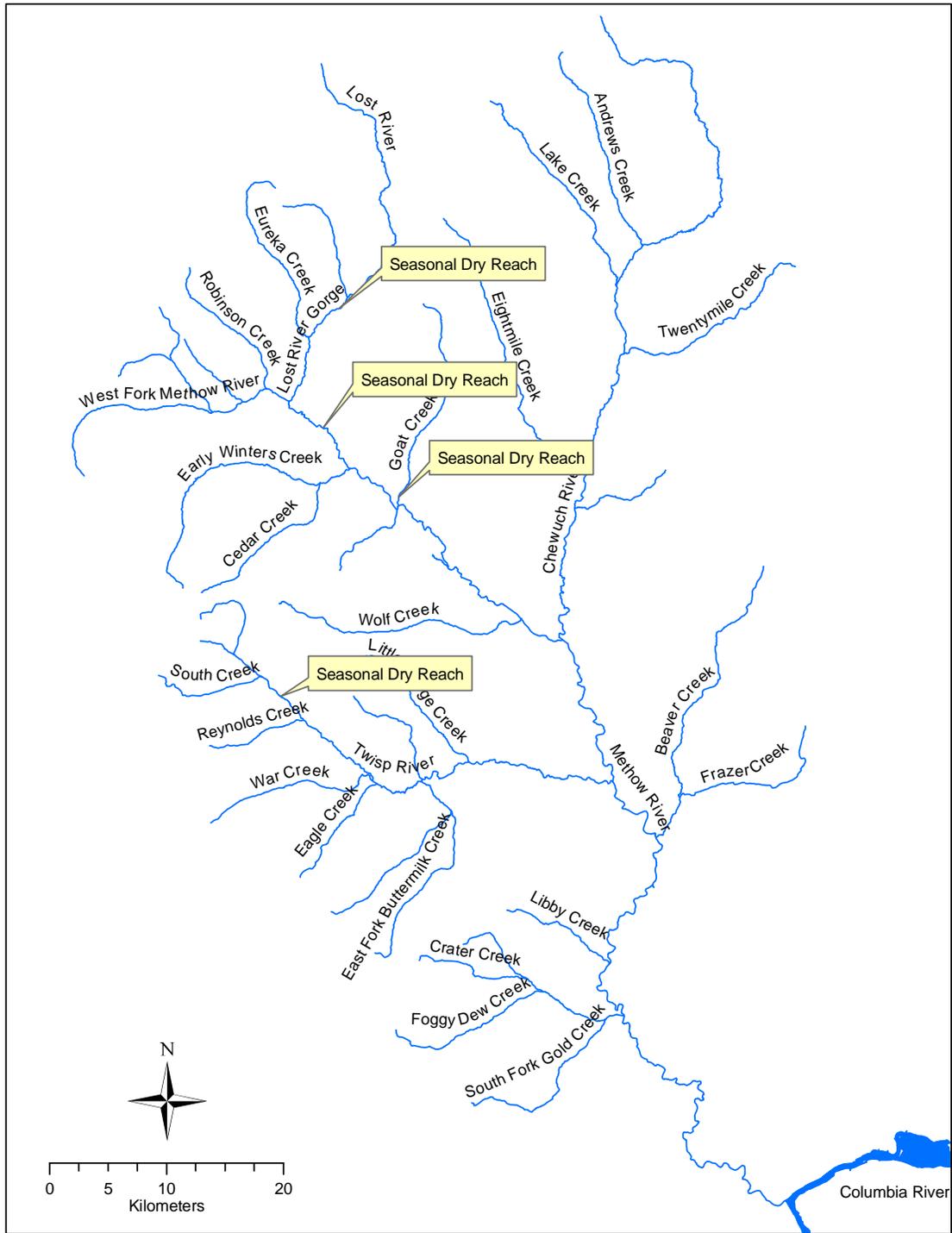


Figure 1. Map of the Methow River watershed, showing major tributaries and locations of seasonal dry reaches.

Methods

Capture

See Nelson *et al.* (2007) for a description of the capture method used during the study.

Radio transmitters and PIT tags

See Nelson *et al.* (2007) for a description of the radio transmitters and PIT tags used during the study.

Tag implantation procedure

Radio transmitters were surgically implanted in bull trout following the guidelines of Mulcahy (2003) and the methods described by Summerfelt and Smith (1990) and Ross and Kleiner (1982). For a detailed description of the implantation procedure, see Nelson *et al.* (2007).

Monitoring of radio-tagged bull trout

Bull trout locations were recorded using five monitoring methods: fixed receiver telemetry stations, truck surveys, boat surveys, foot surveys, and aerial surveys. See Nelson *et al.* (2007) for mapping and data recording procedures and descriptions of the telemetry equipment used during the study.

Fixed stations- Fixed receiver telemetry stations were set up at 8 locations in the Methow watershed (Figure 2). Each station was designated by a two letter site code referencing its location or other information (Nelson *et al.* 2007). Fixed telemetry stations were set up and maintained by Chelan and Douglas PUDs at mid-Columbia hydropower dams and tributary entrances (Figure 3). For details of the extensive telemetry systems monitoring their respective hydro-projects see BioAnalysts (2004), Stevenson *et al.* (2008), and LGL and DCPUD (2006). Telemetry data of the movements of tagged bull trout at the hydro-projects was entered into an Access database maintained by BioAnalysts and shared with all cooperating agencies (BioAnalysts 2008). MCRFRO also maintained fixed telemetry stations in the Entiat River and Icicle Creek (Figure 3).

Mobile surveys- See Nelson *et al.* (2007) for descriptions of the mobile survey methods.

Stream flow data

Stream flows in the Methow River basin are monitored at several locations in the U.S. Geological Survey gaging station network (USGS 2007). Data on stream discharge (ft³/s) was used from the following stations: 12447383 (Methow River above Goat Creek near Mazama, WA), 12448000 (Chewuch River at Winthrop, WA), 12448500 (Methow River at Winthrop, WA), 12448998 (Twisp River near Twisp, WA), 12449500 (Methow River at Twisp, WA), and 12449950 (Methow River near Pateros, WA). Data on the stream flow in Wolf Creek at the mouth was provided by the Okanogan Conservation District.

Bull trout redd counts

Bull trout redd surveys were conducted by several agencies and the data were compiled by the Methow Valley Ranger District of the U.S. Forest Service (USFS 2008).

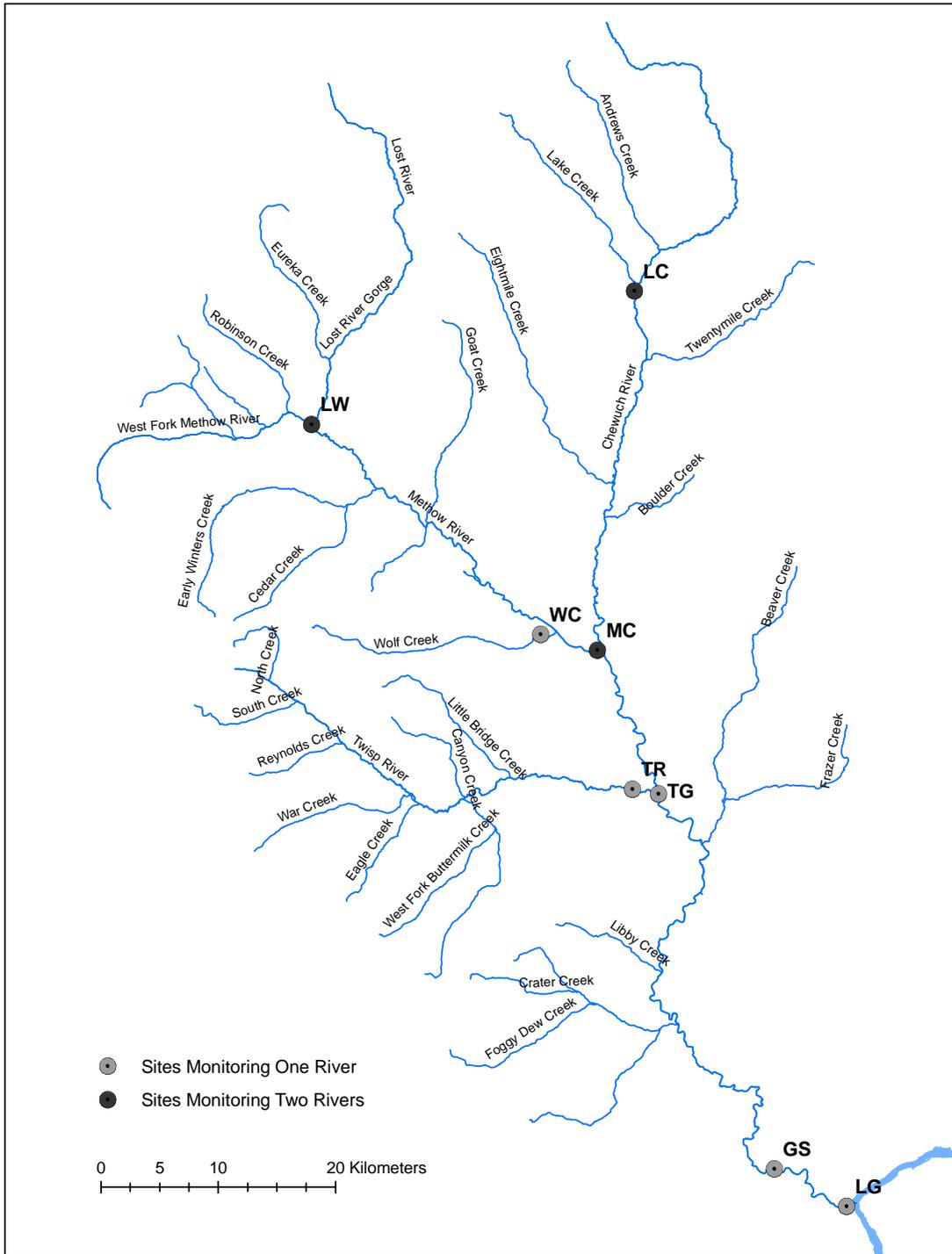


Figure 2. Map of fixed receiver telemetry stations in the Methow River watershed in 2007.

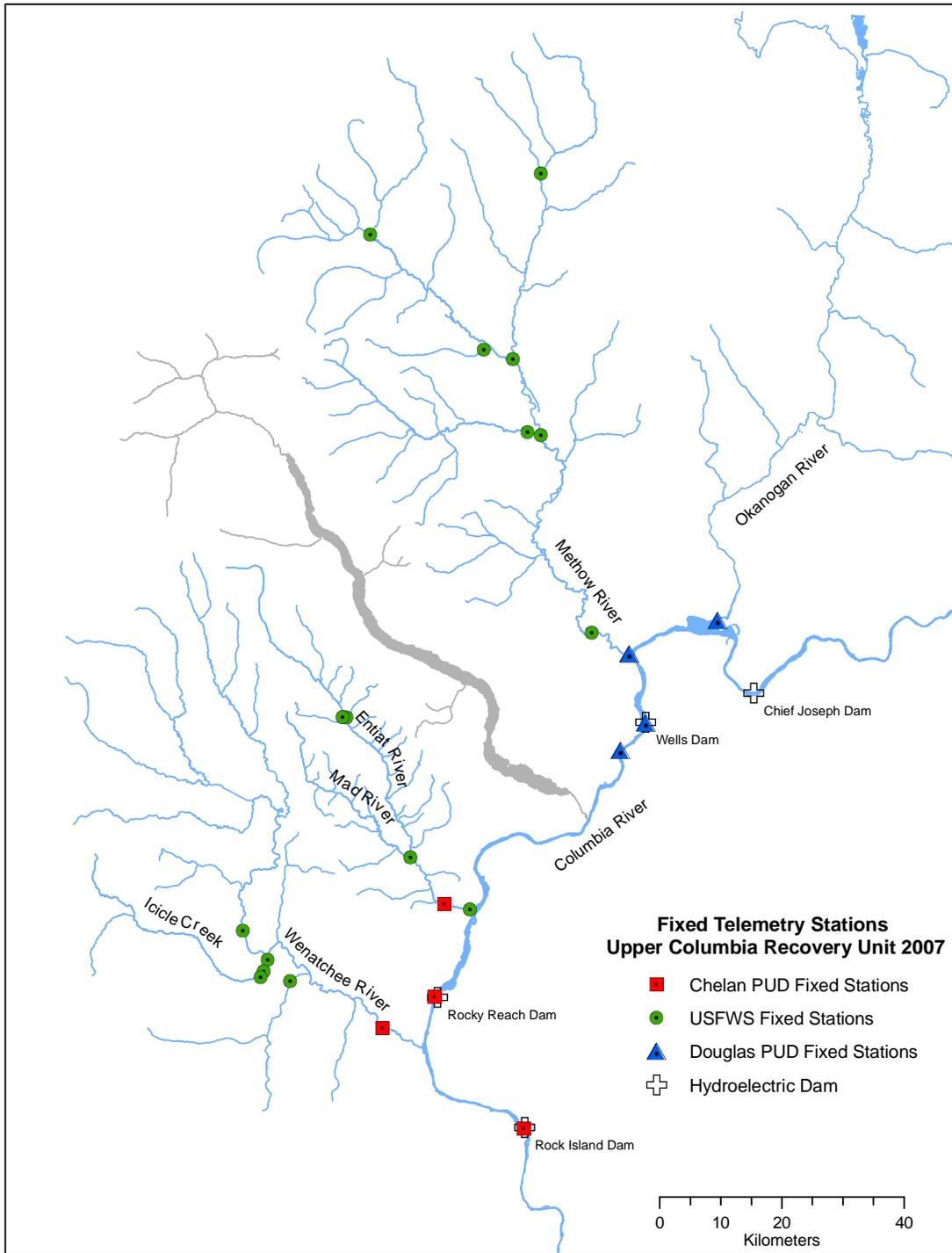


Figure 3. Map of fixed receiver telemetry stations in the Upper Columbia Recovery Unit in 2007.

Results

Radio-tagging

Eighteen adult fluvial bull trout were radio-tagged during the 2007 field season and subsequently utilized the Methow Core Area. Of these, 5 were tagged in the Methow River watershed by USFWS, 10 at Wells Dam in the Columbia River by Douglas County PUD, and 3 at Rocky Reach on the Columbia River by Chelan County PUD.

USFWS tagged bull trout- A total of five bull trout were tagged by USFWS in the Methow River watershed in 2007 (Table 1). Three were tagged in the Chewuch River (rkm 13) during June and one each in the West Fork Methow River (rkm 4.8) and Wolf Creek (rkm 11) during July (Figure 4). Fork lengths of tagged bull trout were 500 to 736 mm and weights were 1350 to 5500 g (Table 1).

Table 1. Bull trout tagged by USFWS: Tag channel and code, tagging location, date, fork length and weight of adult fluvial bull trout radio-tagged in the Methow River watershed in 2007.

Channel	Code	River Tagged	Date Tagged	Length (mm)	Weight (g)
1	83	Chewuch River	20-Jun-07	658	5500
1	84	Chewuch River	21-Jun-07	535	1700
1	85	Chewuch River	21-Jun-07	565	2100
1	86	West Fork Methow	17-Jul-07	736	4850
1	87	Wolf Creek	24-Jul-07	500	1350

Angling effort- Angling for bull trout in the Methow Core Area occurred from June 20 to July 26. In the Chewuch River (rkm 0.1 to rkm 50) a total of 50 hours were spent angling and 5 adult bull trout were caught, for a catch per unit effort (cpue) of 0.1 bull trout/hour. Two of these fish were not tagged- one escaped and the other had a previous injury to the lower jaw. In the West Fork Methow River (rkm 1 to rkm 5), 2 bull trout were caught during 10 angling hours (cpue = 0.2 bull trout/hour) and one was a recapture of a 2006 fish (code 80). In Wolf Creek (rkm 6.5 to rkm 12), 3 bull trout were caught during 6 angling hours (cpue = 0.5 bull trout/hour); one was a recapture of a 2006 fish (code 75) and the other was too small to tag (370 mm).

Columbia River tagged bull trout- In 2007, Douglas County PUD radio-tagged 10 bull trout at Wells Dam and Chelan County PUD radio-tagged 3 bull trout at Rocky Reach Dam that used the Methow River. Bull trout tagged at Wells Dam were 540 to 640 mm and 2022 to 3950 g (Table 2). Bull trout tagged at Rocky Reach Dam were 590 to 685 mm and 2576 to 4157 g (Table 3).

Correlation of length to weight was variable for bull trout tagged in 2007, but the trend was similar for all three tagging areas (Figure 5).

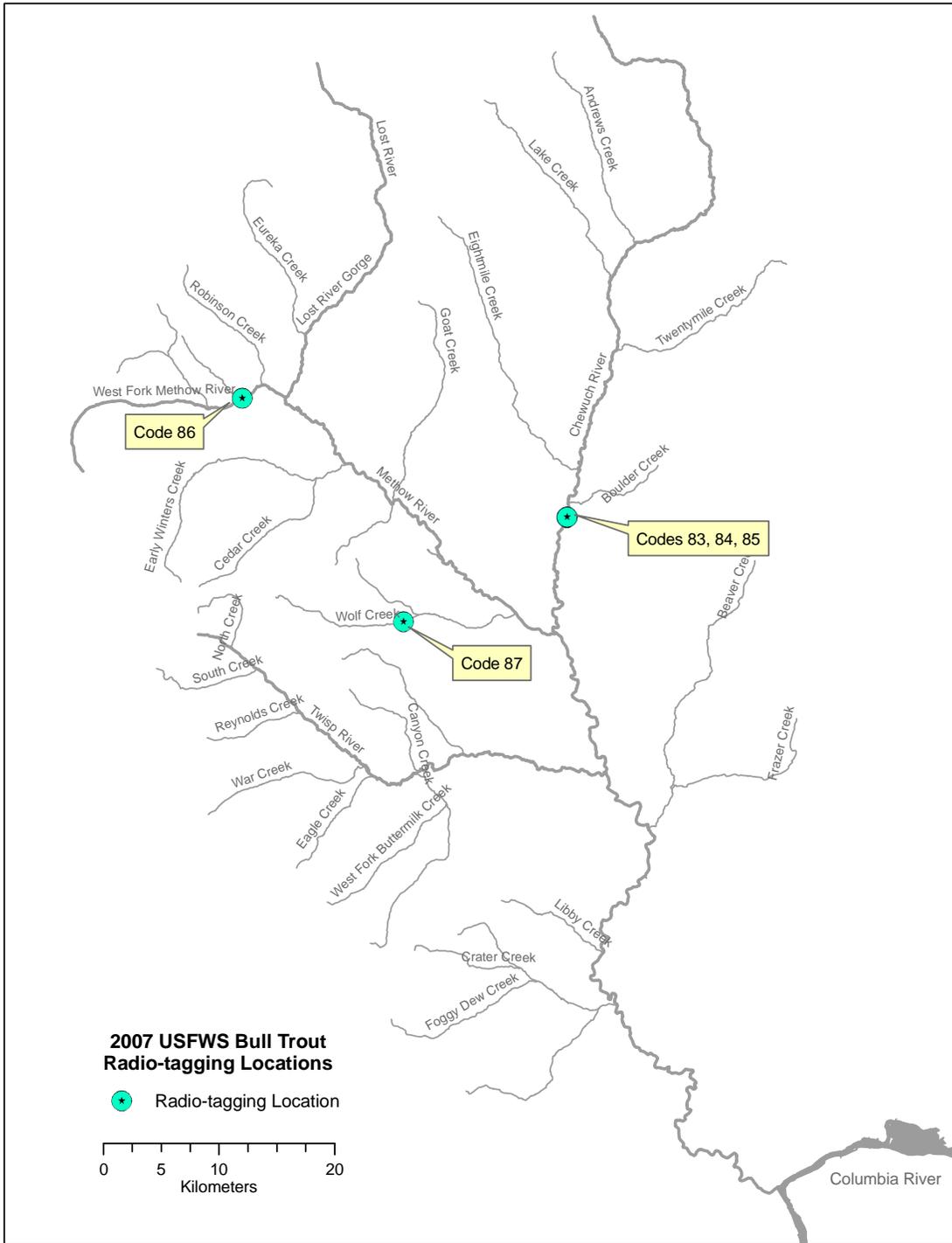


Figure 4. Locations where adult fluvial bull trout were captured and radio-tagged in the Methow Core Area by USFWS in 2007.

Table 2. Bull trout tagged by Douglas PUD: Tag channel and code, tagging location, date, fork length (FL) and weight of adult fluvial bull trout radio-tagged at Wells Dam in 2007 that utilized the Methow River.

Channel	Code	River	Dam	Date	FL (mm)	Weight (g)
1	51	Columbia	Wells	5-Jun-07	610	2654
1	53	Columbia	Wells	4-Jun-07	630	2720
1	55	Columbia	Wells	4-Jun-07	640	3020
1	57	Columbia	Wells	4-Jun-07	585	2180
1	59	Columbia	Wells	4-Jun-07	580	2220
1	61	Columbia	Wells	2-Jun-07	560	1840
1	63	Columbia	Wells	29-May-07	540	--
1	65	Columbia	Wells	25-May-07	630	3950
1	67	Columbia	Wells	20-May-07	608	2770
1	69	Columbia	Wells	19-May-07	545	2022

Data from LGL and DCPUD (2008)

Table 3. Bull trout tagged by Chelan PUD: Tag channel and code, tagging location, date, fork length (FL) and weight of adult fluvial bull trout radio-tagged at Rock Island and Rocky Reach Dams in 2007 that utilized the Methow River.

Channel	Code	River	Dam	Date	FL (mm)	Weight (g)
14	111	Columbia	Rocky Reach	16-May-07	590	2576
14	115	Columbia	Rocky Reach	24-May-07	685	4157
14	116	Columbia	Rocky Reach	29-May-07	650	3547

Data from Stevenson et al. (2008)

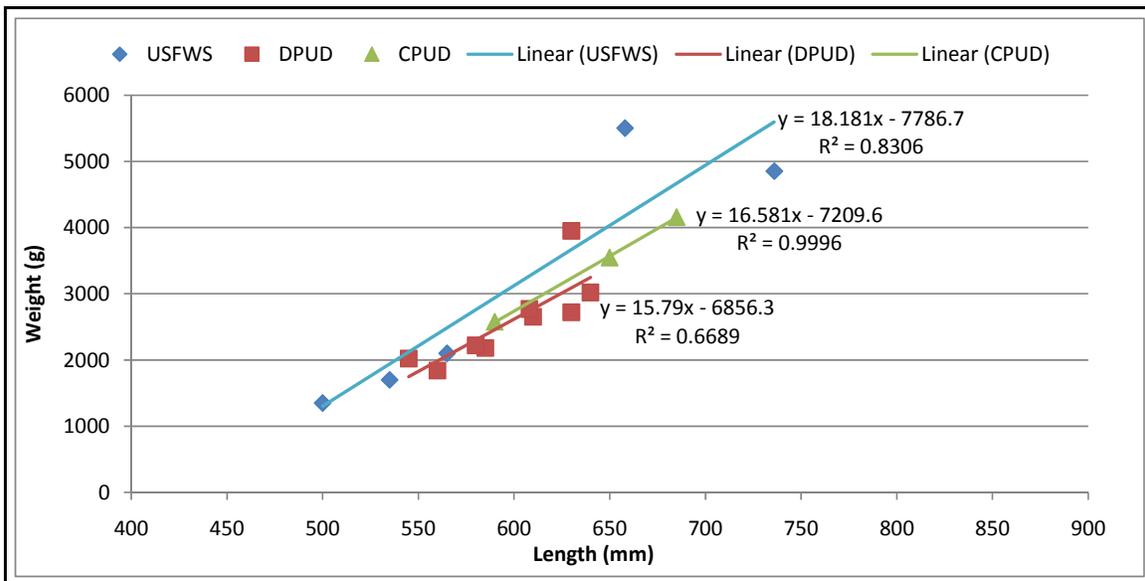


Figure 5. Scatter plot of length vs. weight for radio-tagged adult fluvial bull trout that utilized the Methow River, with trend lines for bull trout tagged during 2007 in the Methow River (USFWS), and in the Columbia River at Rocky Reach Dam (CCPUD) and Wells Dam (DCPUD).

Holdover bull trout- A total of 18 previously tagged bull trout (1 from 2005 and 17 from 2006) were tracked in the Methow River Core Area in 2007 (Table 4). Six of these were tagged by DCPUD (at Wells Dam), 6 by CCPUD (1 at Rock Island Dam and 5 at Rocky Reach Dam) and 6 by USFWS (in the Methow River basin).

Table 4. Table of adult fluvial bull trout radio-tagged in previous years that were tracked in the Methow Core Area during 2007, showing tagging agency, code, river and date tagged, and the tributaries used in 2006 and 2007.

Agency	Code	River Tagged	Date Tagged	2006 Tributary	2007 Tributary
DCPUD	52	Columbia	16-May-06	Twisp River	Twisp River
DCPUD	54	Columbia	24-May-06	Entiat River	Twisp River
DCPUD	56	Columbia	16-May-06	Twisp River	Columbia R
DCPUD	58	Columbia	19-May-06	Twisp River	Methow R (main)
DCPUD	62	Columbia	24-May-06	WF Methow	Methow R (main)
DCPUD	66	Columbia	24-May-06	Entiat River	Twisp River
USFWS	70	Lost River	4-Apr-06	Lost River	Lost River
USFWS	71	Lost River	4-Apr-06	Lost River	Lost River
USFWS	73	Methow	6-Apr-06	Chewuch R	Chewuch River
USFWS	75	Wolf Creek	18-Jul-06	Wolf Creek	Wolf Creek
USFWS	80	WF Methow	26-Jul-06	WF Methow	WF Methow
USFWS	82	WF Methow	2-Aug-06	WF Methow	WF Methow
CCPUD	3	Columbia	30-May-05	Twisp River	Twisp River
CCPUD	171	Columbia	25-May-06	Early Winters	Early Winters
CCPUD	177	Columbia	30-May-06	Foggy Dew	Foggy Dew
CCPUD	184	Columbia	5-Jun-06	Twisp River	Twisp River
CCPUD	188	Columbia	22-Jun-06	Wolf Creek	Wolf Creek
CCPUD	190	Columbia	29-Jun-06	Columbia R	Twisp River

Total number of bull trout tracked in 2007- A total of 36 tagged bull trout were tracked in the Methow Core Area in 2007 (Table 5). Of these, 18 were tagged in 2007, 17 in 2006, and 1 in 2005.

Table 5. Total number of adult fluvial bull trout tracked in the Methow Core Area during 2007, by year the bull trout was radio-tagged and by tagging agency.

Year Tagged	USFWS	DCPUD	CCPUD	Total
2007	5	10	3	18
2006	6	6	5	17
2005	--	0	1	1
Totals	11	16	9	36

Recaptured bull trout- Four bull trout tagged during 2006 were recaptured and measured in 2007 (Table 6). Two of these were tagged by USFWS and two by DCPUD. On July 26, 2007, Code 80 was recaptured in the same pool of the West Fork Methow River where it was tagged on July 26, 2006. Code 75, tagged in Wolf Creek on July 18, 2006 was recaptured in Wolf Creek on July 24, 2007. In the Columbia River, 2 bull trout tagged at Wells Dam in 2006 were recaptured and measured at the dam in 2007 by Douglas County PUD. Growth rates ranged from 0.033 to 0.119 mm/day (Table 6). The smaller bull trout grew faster than larger bull trout and the Columbia River fish grew faster the Methow River fish at comparable sizes (Figure 6).

Table 6. Data of adult fluvial bull trout tagged in 2006 that were recaptured and measured in 2007.

Code	Tagging Date	Recapture Date	2006 Fork Length (mm)	2007 Fork Length (mm)	Growth (mm)	Rate (mm/day)
52	16-May-06	21-May-07	700	725	25	0.068
62	24/May-06	4-Jun-07	555	600	45	0.119
75	18-Jul-06	24-Jul-07	475	517	42	0.113
80	26-Jul-06	26-Jul-07	630	642	12	0.033

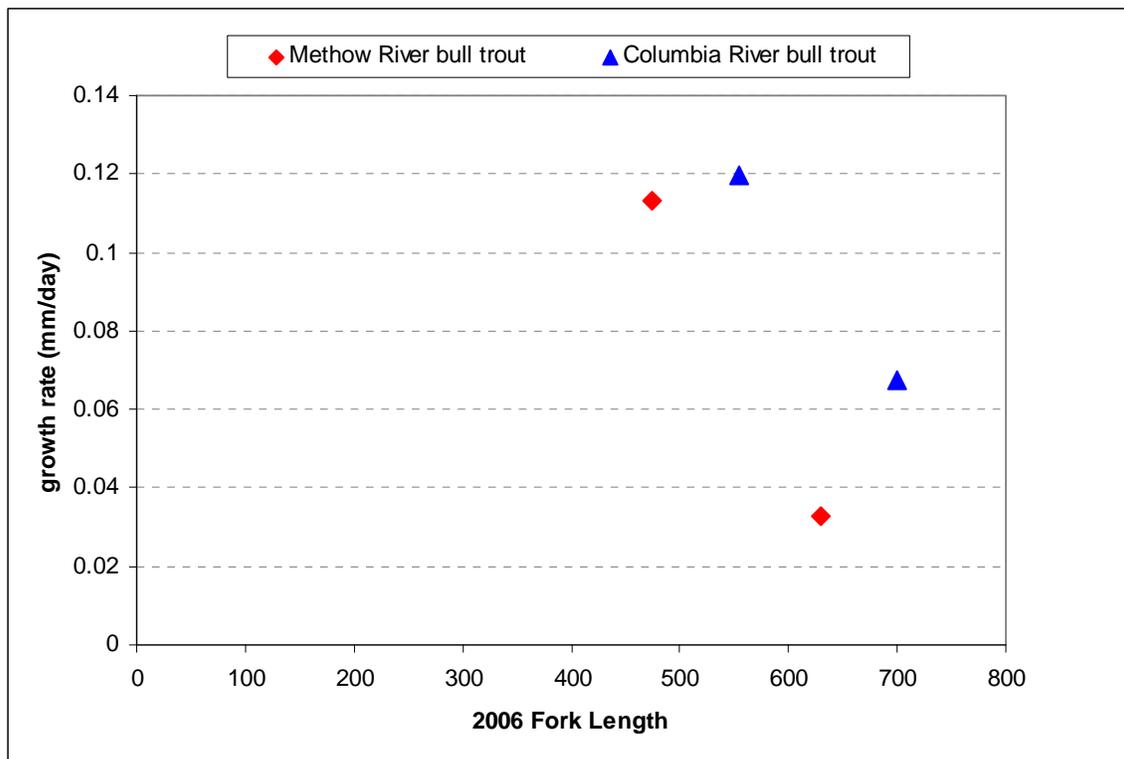


Figure 6. Growth rate (mm/day) versus 2006 fork length of four radio-tagged adult fluvial bull trout recaptured in the Methow and Columbia rivers in 2007.

Pre-spawn migrations

See Nelson et al. (2007) for the 2006/2007 winter locations of bull trout tagged in 2006. For detailed descriptions and maps of individual bull trout during 2007, see Appendix 1.

OK fixed station (mouth of Okanogan river at rkm 859 of Columbia River)- Three bull trout tagged in the Columbia River were detected from June 10 to June 17, 2007 at the mouth of the Okanogan River (Table 7; data from BioAnalysts 2008, LGL and DCPUD 2008). Okanogan River discharge declined from 9000 ft³/s to 6000 ft³/s during the detections (Figure 7). Two bull trout (codes 66 and 190) initially moved upstream in the Columbia River past the Methow River and entered the Okanogan. The other bull trout (code 65) spent 17 days in the Methow River before it traveled to the mouth of the Okanogan River where it was briefly detected; it then returned to the Methow River and migrated to the Twisp River. Code 190 entered and exited the Okanogan River two times, spending 5.5 hours in the Okanogan River on the first occasion and 13 hours on the second while code 65 spent 5 days in the Okanogan River. It is not known how far either bull trout moved upstream of the mouth. Both bull trout then migrated to the Methow River and were detected on the spawning grounds in the Twisp River.

Table 7. OK fixed station data: dates and times that radio-tagged adult fluvial bull trout were detected at the mouth of the Okanogan River during pre-spawn movements in 2007.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
DCPUD	1	66	OK	upstream	Okanogan	10-Jun-07	03:08
CCPUD	14	190	OK	upstream	Okanogan	11-Jun-07	21:56
CCPUD	14	190	OK	downstream	Okanogan	12-Jun-07	03:32
DCPUD	1	65	OK	at mouth	Okanogan	12-Jun-07	20:04
CCPUD	14	190	OK	upstream	Okanogan	15-Jun-07	15:27
CCPUD	14	190	OK	downstream	Okanogan	16-Jun-07	04:37
DCPUD	1	66	OK	downstream	Okanogan	17-Jun-07	13:27

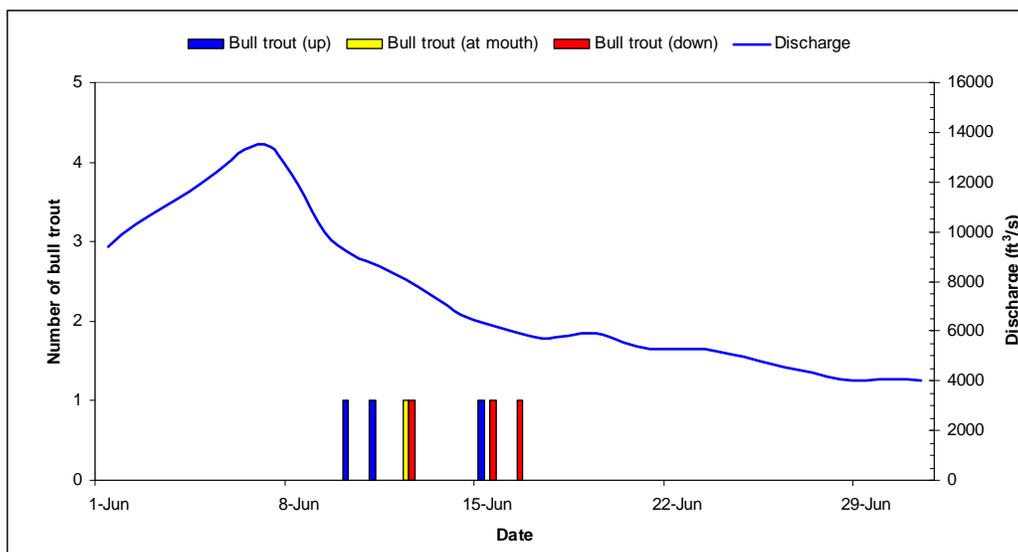


Figure 7. Okanogan River discharge and dates radio-tagged adult fluvial bull trout were detected at the OK fixed telemetry station at the mouth of the Okanogan River during 2007.

LG fixed station (rkm 1.1 of Methow River)- Bull trout radio-tagged in the Columbia River migrated into the Methow River and passed the LG station from May 22 to July 9, 2007 (Table 8). Bull trout entered after an initial peak in Methow River discharge and during pre-spawn migration flows ranged from 10500 ft³/s to 1500 ft³/s (Figure 8). Peak flows were lower than in 2006, but entry dates were similar in both years (Figure 8).

Three bull trout (codes 171, 67, 52) staged in or near the mouth prior to entering the Methow River in 2007. Length of staging ranged from 1 to 5 days. Staging at the mouth was not detected in previous years.

Three bull trout moved to the Columbia River in late June and early July (Table 8). Before exiting, code 57 spent 20 days in the Methow River, with its farthest upstream detection at rkm 40.7 (see Appendix 1). Code 56 spent 10 days in the Methow River and was detected at rkm 21.7 before returning to the Columbia River, where it transmitted the motionless signal on July 27 at rkm 806; it was not recovered (see Appendix 1). Code 83 was tagged in the lower Chewuch River but moved downstream and was recovered in the Columbia River at rkm 803 (see Appendix 1).

Table 8. LG fixed station data: dates and times in 2007 that radio-tagged adult bull trout first arrived during pre-spawn migrations past the station located at rkm 1.1 of the Methow River.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
DCPUD	1	69	LG	upstream	Methow	22-May-07	4:20
DCPUD	1	67	LG	upstream	Methow	23-May-07	6:41
DCPUD	1	52	LG	upstream	Methow	25-May-07	8:22
CCPUD	14	171	LG	upstream	Methow	26-May-07	0:47
DCPUD	1	65	LG	upstream	Methow	26-May-07	12:36
CCPUD	14	115	LG	upstream	Methow	31-May-07	17:07
DCPUD	1	54	LG	upstream	Methow	31-May-07	23:47
DCPUD	1	61	LG	upstream	Methow	3-Jun-07	6:11
CCPUD	14	111	LG	upstream	Methow	3-Jun-07	12:41
DCPUD	1	57	LG	upstream	Methow	6-Jun-07	23:39
DCPUD	1	51	LG	upstream	Methow	7-Jun-07	17:05
DCPUD	1	53	LG	upstream	Methow	7-Jun-07	18:49
DCPUD	1	55	LG	upstream	Methow	7-Jun-07	19:05
DCPUD	1	59	LG	upstream	Methow	8-Jun-07	1:00
DCPUD	1	65	LG	downstream	Methow	12-Jun-07	6:48
CCPUD	14	190	LG	upstream	Methow	16-Jun-07	21:20
CCPUD	1	66	LG	upstream	Methow	17-Jun-07	10:21
DCPUD	1	65	LG	upstream	Methow	20-Jun-07	1:53
CCPUD	14	188	LG	upstream	Methow	20-Jun-07	3:58
DCPUD	1	56	LG	upstream	Methow	20-Jun-07	10:18
DCPUD	1	62	LG	upstream	Methow	23-Jun-07	14:53
DCPUD	1	57	LG	downstream	Methow	26-Jun-07	4:59
DCPUD	1	56	LG	downstream	Methow	30-Jun-07	10:14
USFWS	1	83	LG	downstream	Methow	5-Jul-07	14:11
CCPUD	14	184	LG	upstream	Methow	9-Jul-07	16:32

Data from LGL and DCPUD (2008) and BioAnalysts (2008)

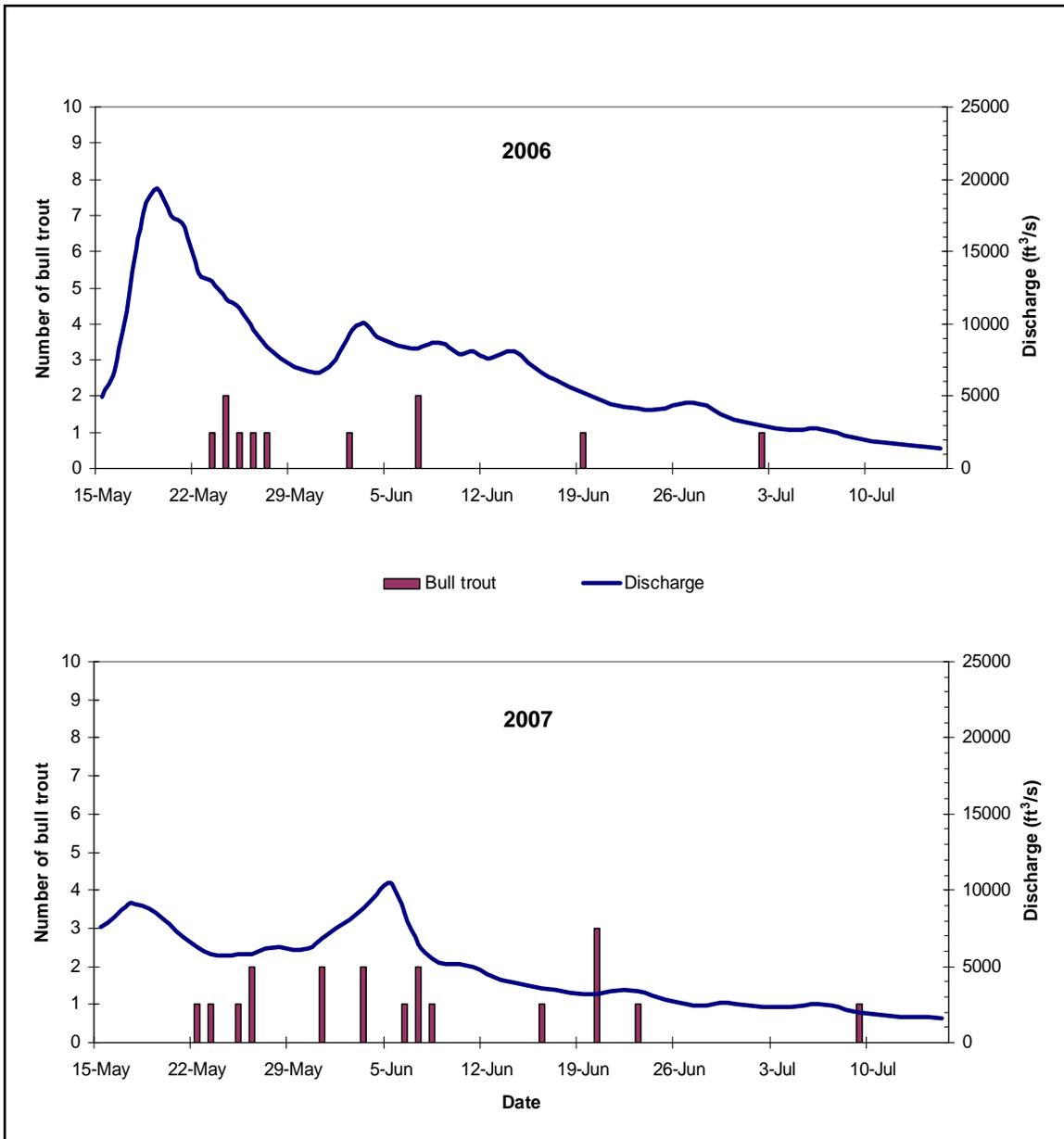


Figure 8. Methow River discharge and dates that radio-tagged adult fluvial bull trout migrated upstream past the LG fixed station (rkm 1.1) during 2006 and 2007.

GS fixed station (rkm 10.6 of Methow River)- Code 71 overwintered in the vicinity of the station and was detected at the station on January 29 and February 6, 2007 (Table 9) and mobile tracking indicated these were local movements rather than migratory in nature. During pre-spawn migrations, tagged bull trout moved upstream past the GS fixed station from May 27 to July 9, 2007 (Table 9). The majority of the upstream movements past the station occurred on declining flows after discharge peaked at 10500 ft³/s (Figure 9).

Table 9. GS fixed station data: dates and times in 2007 that radio-tagged adult bull trout first arrived during pre-spawn migrations past the station located at rkm 10.6 of the Methow River.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
USFWS	1	71	GS	downstream	Methow	29-Jan-07	22:00
USFWS	1	71	GS	upstream	Methow	6-Feb-07	17:00
CCPUD	14	171	GS	upstream	Methow	27-May-07	14:51
DCPUD	1	67	GS	upstream	Methow	27-May-07	17:55
DCPUD	1	65	GS	upstream	Methow	30-May-07	15:26
DCPUD	1	69	GS	upstream	Methow	31-May-07	14:15
CCPUD	14	3	GS	upstream	Methow	7-Jun-07	01:44
CCPUD	14	111	GS	upstream	Methow	7-Jun-07	12:26
CCPUD	14	115	GS	upstream	Methow	8-Jun-07	01:09
DCPUD	1	54	GS	upstream	Methow	8-Jun-07	08:06
DCPUD	1	61	GS	upstream	Methow	9-Jun-07	05:49
DCPUD	1	63	GS	upstream	Methow	9-Jun-07	05:42
DCPUD	1	52	GS	upstream	Methow	9-Jun-07	14:02
DCPUD	1	53	GS	upstream	Methow	11-Jun-07	02:02
DCPUD	1	65	GS	downstream	Methow	11-Jun-07	14:58
DCPUD	1	57	GS	upstream	Methow	12-Jun-07	14:18
DCPUD	1	51	GS	upstream	Methow	13-Jun-07	04:08
DCPUD	1	55	GS	upstream	Methow	13-Jun-07	17:30
DCPUD	1	59	GS	upstream	Methow	15-Jun-07	00:05
CCPUD	14	190	GS	upstream	Methow	17-Jun-07	16:48
DCPUD	1	66	GS	upstream	Methow	18-Jun-07	19:17
CCPUD	14	116	GS	upstream	Methow	19-Jun-07	04:16
CCPUD	14	188	GS	upstream	Methow	20-Jun-07	16:17
DCPUD	1	65	GS	upstream	Methow	20-Jun-07	16:29
DCPUD	1	62	GS	upstream	Methow	24-Jun-07	00:21
DCPUD	1	56	GS	upstream	Methow	24-Jun-07	05:56
DCPUD	1	57	GS	downstream	Methow	25-Jun-07	15:03
DCPUD	1	56	GS	downstream	Methow	29-Jun-07	19:49
USFWS	1	83	GS	downstream	Methow	5-Jul-07	00:32
CCPUD	14	184	GS	upstream	Methow	9-Jul-07	20:46

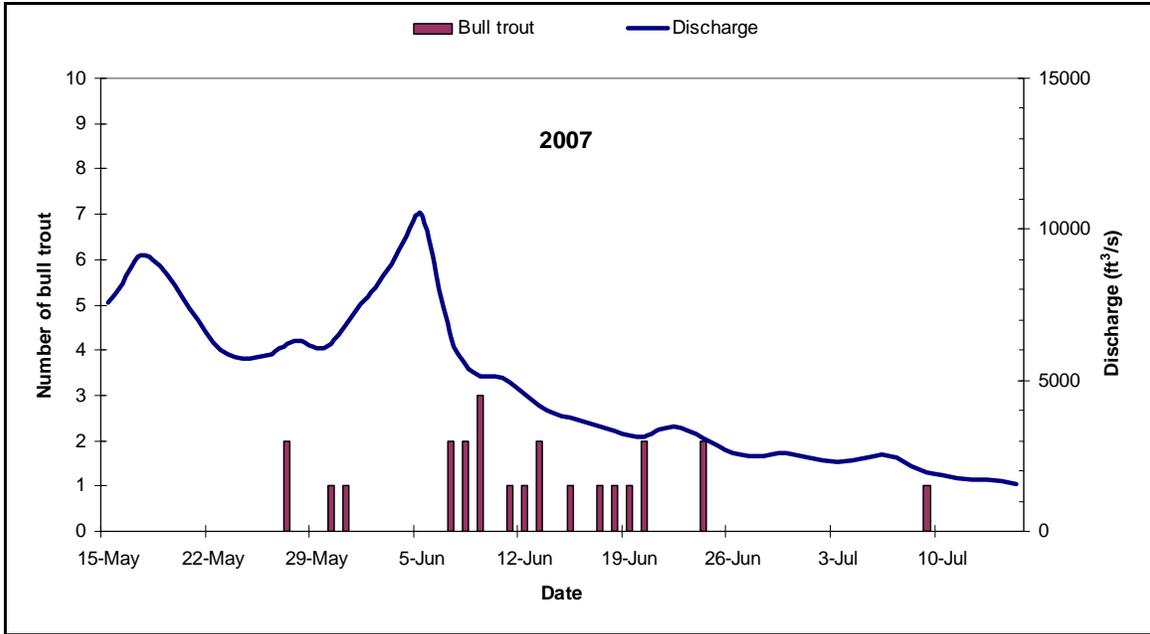


Figure 9. Methow River discharge and dates that radio-tagged adult fluvial bull trout migrated upstream past the GS fixed receiver station (rkm 10.6) during 2007.

TG fixed station (rkm 64.4 of Methow River)- This fixed telemetry station was set up in the USGS gage station at rkm 64.4 of the Methow River. Methow River discharge declined to 3000 ft³/s when the migrating bull trout reached the station (Figure 10). A total of 23 tagged bull trout moved upstream past the station from June 17 to July 16, 2007 (Table 10).

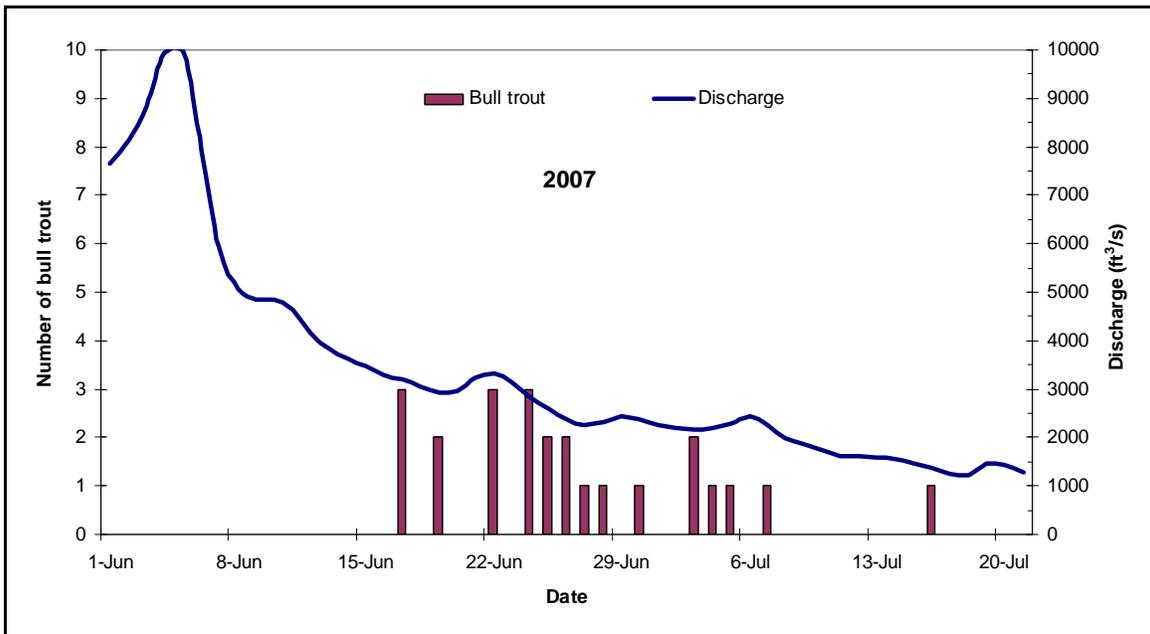


Figure 10. Methow River discharge and dates that radio-tagged adult fluvial bull trout migrated upstream past the TG fixed station (rkm 64.4) during 2007.

Table 10. TG fixed station data: dates and times in 2007 that radio-tagged adult bull trout first arrived during pre-spawn migrations past the station located at rkm 64.4 of the Methow River.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
CCPUD	14	115	TG	upstream	Methow	17-Jun-07	01:23
DCPUD	1	67	TG	upstream	Methow	17-Jun-07	02:56
USFWS	1	71	TG	upstream	Methow	17-Jun-07	23:20
CCPUD	14	111	TG	upstream	Methow	19-Jun-07	05:40
CCPUD	14	171	TG	upstream	Methow	19-Jun-07	22:44
DCPUD	1	63	TG	upstream	Methow	22-Jun-07	00:39
CCPUD	14	3	TG	upstream	Methow	22-Jun-07	02:54
DCPUD	1	54	TG	upstream	Methow	22-Jun-07	03:48
DCPUD	1	51	TG	upstream	Methow	24-Jun-07	00:44
DCPUD	1	53	TG	upstream	Methow	24-Jun-07	01:45
USFWS	1	70	TG	upstream	Methow	24-Jun-07	02:48
DCPUD	1	69	TG	upstream	Methow	25-Jun-07	00:49
DCPUD	1	61	TG	upstream	Methow	25-Jun-07	02:29
DCPUD	1	65	TG	upstream	Methow	26-Jun-07	01:30
DCPUD	1	66	TG	upstream	Methow	26-Jun-07	02:29
DCPUD	1	52	TG	upstream	Methow	27-Jun-07	23:21
DCPUD	1	59	TG	upstream	Methow	28-Jun-07	01:02
CCPUD	14	190	TG	upstream	Methow	30-Jun-07	21:00
USFWS	1	83	TG	downstream	Methow	3-Jul-07	02:14
CCPUD	14	188	TG	upstream	Methow	3-Jul-07	22:23
DCPUD	1	55	TG	upstream	Methow	4-Jul-07	00:16
CCPUD	14	116	TG	upstream	Methow	5-Jul-07	23:24
DCPUD	1	62	TG	upstream	Methow	7-Jul-07	20:27
CCPUD	14	184	TG	upstream	Methow	16-Jul-07	00:58

TR fixed station (rkm 2.1 of Twisp River) - This fixed telemetry station was set up in the Methow Salmon Recovery Foundation pump house at rkm 2.1 of the Twisp River. A total of 15 tagged bull trout migrated into the Twisp River but 1 fish (code 53) was not detected (Table 11). Bull trout were recorded passing the station from June 18 to July 17, after Twisp River discharge declined to less than 1000 ft³/s. A similar pattern was observed in 2006 (Figure 11).

Table 11. TR fixed station data: dates and times in 2007 that radio-tagged adult bull trout first arrived during pre-spawn migrations past the station located at rkm 2.1 of the Twisp River.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
DCPUD	1	67	TR	upstream	Twisp	18-Jun-07	03:14
CCPUD	14	115	TR	upstream	Twisp	19-Jun-07	02:51
DCPUD	1	54	TR	upstream	Twisp	24-Jun-07	22:18
CCPUD	14	3	TR	upstream	Twisp	24-Jun-07	23:24
DCPUD	1	51	TR	upstream	Twisp	25-Jun-07	02:28
DCPUD	1	65	TR	upstream	Twisp	26-Jun-07	21:05
DCPUD	1	63	TR	upstream	Twisp	27-Jun-07	23:26
DCPUD	1	66	TR	upstream	Twisp	28-Jun-07	00:40
DCPUD	1	52	TR	upstream	Twisp	28-Jun-07	21:54
DCPUD	1	59	TR	upstream	Twisp	30-Jun-07	21:53
CCPUD	14	190	TR	upstream	Twisp	1-Jul-07	04:17
DCPUD	1	55	TR	upstream	Twisp	4-Jul-07	23:00
CCPUD	14	116	TR	upstream	Twisp	6-Jul-07	23:02
CCPUD	14	184	TR	upstream	Twisp	17-Jul-07	23:47

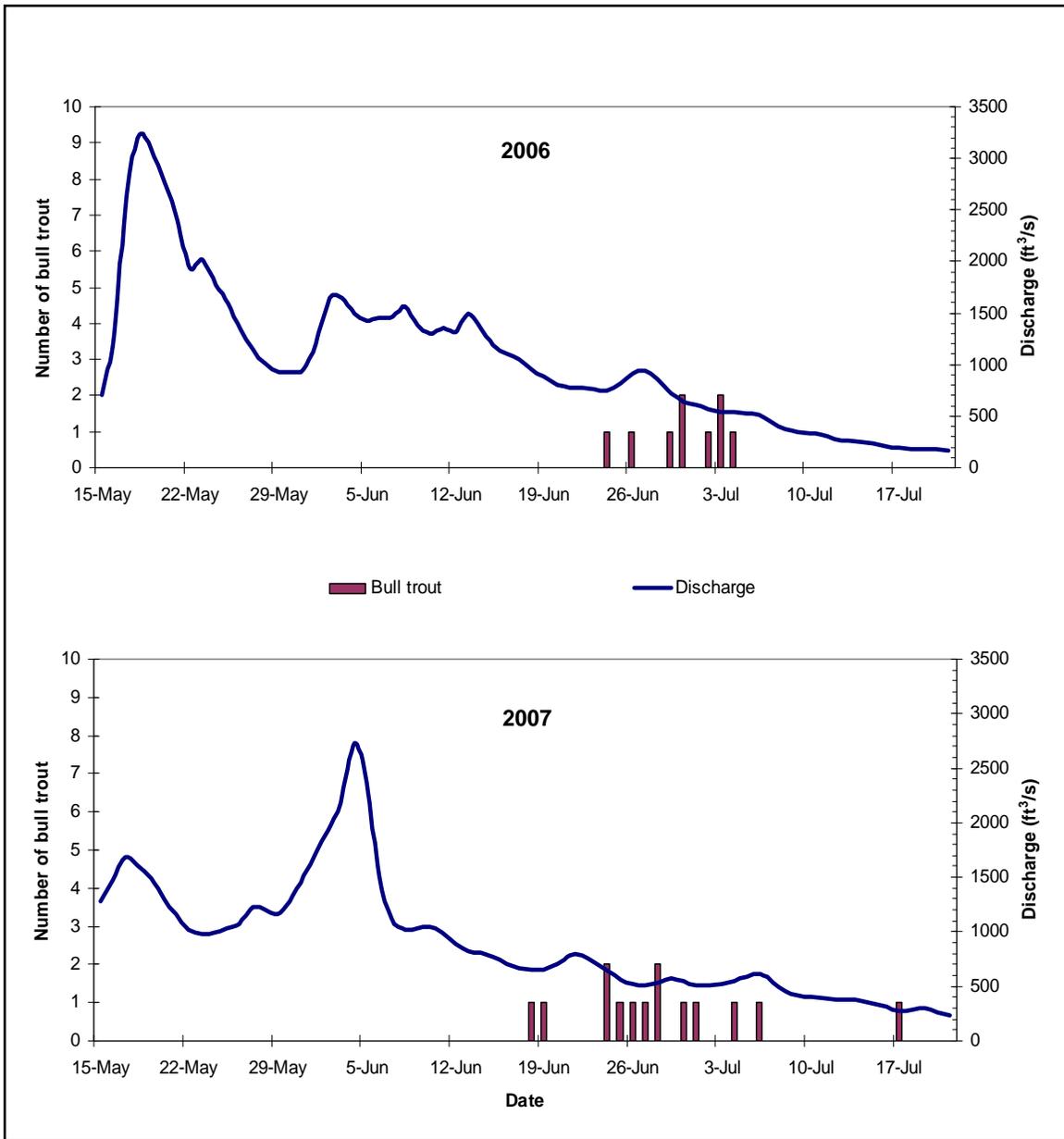


Figure 11. Twisp River discharge and dates that radio-tagged adult fluvial bull trout migrated upstream past the TR fixed station (rkm 2.1) during 2006 and 2007.

MC fixed station (rkm 80.6 of Methow River) - Between June 20 and July 6, a total of 8 tagged bull trout were detected at the MC station at the confluence of the Chewuch River (Table 12). One bull trout (code 73, which overwintered 2 km downstream) migrated into the Chewuch River after flow had declined to 700 ft³/s and similar flows were observed when the 3 bull trout were tagged at rkm 13 (Figure 12). Code 83 moved downstream 9 days after it was tagged and was detected exiting the Chewuch River on June 30 (Table 12). Seven of the tagged bull trout moved upstream in the Methow River as flows in that river declined to 2000 ft³/s (Figure 13).

Table 12. MC fixed station data: dates and times in 2007 that radio-tagged bull trout first arrived during pre-spawn migrations past the station located at rkm 80.6, the confluence of the Methow and Chewuch rivers.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
USFWS	1	71	MC	upstream	Methow	20-Jun-07	01:36
CCPUD	14	111	MC	upstream	Methow	21-Jun-07	22:31
CCPUD	14	171	MC	upstream	Methow	24-Jun-07	03:05
USFWS	1	73	MC	upstream	Chewuch	24-Jun-07	22:06
DCPUD	1	61	MC	upstream	Methow	28-Jun-07	02:58
USFWS	1	70	MC	upstream	Methow	28-Jun-07	03:32
USFWS	1	83	MC	downstream	Methow	30-Jun-07	00:21
DCPUD	1	69	MC	upstream	Methow	1-Jul-07	00:05
CCPUD	14	188	MC	upstream	Methow	6-Jul-07	03:08

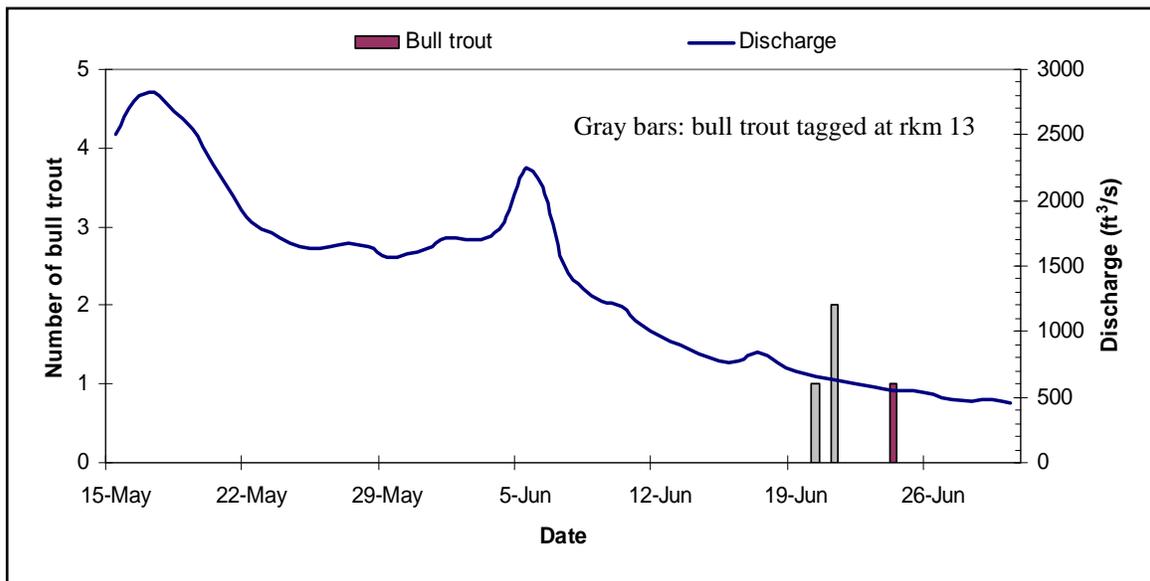


Figure 12. Chewuch River discharge and dates that radio-tagged bull trout migrated upstream past the MC fixed station (rkm 0) into the Chewuch River or when tagged in the Chewuch River (rkm 13) during 2007.

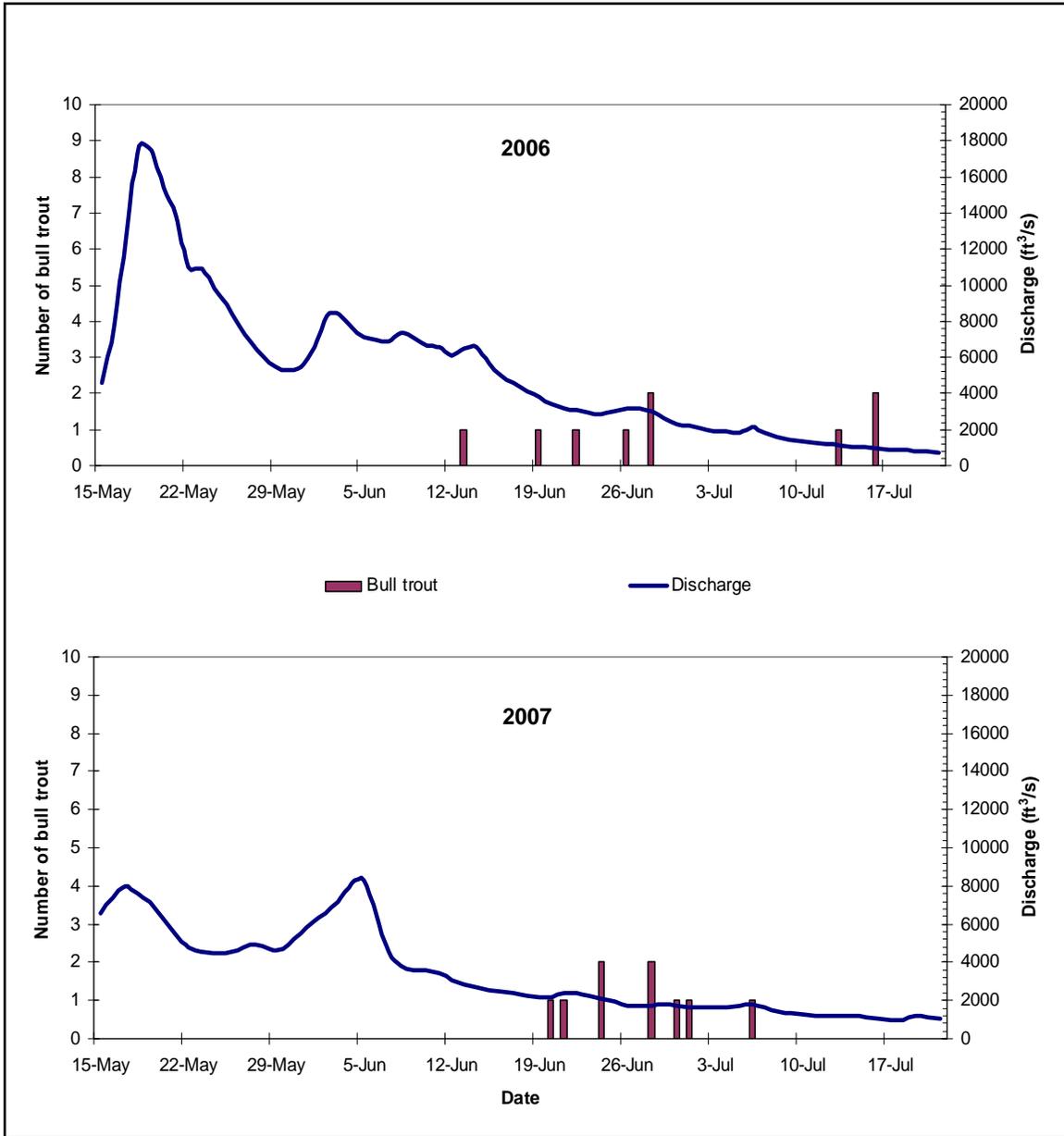


Figure 13. Methow River discharge and dates that radio-tagged adult fluvial bull trout migrated upstream in the Methow River past the MC station (rkm 80.6) during 2006 and 2007.

LC fixed station (rkm 37.5 of Chewuch River)- Two radio-tagged bull trout were detected at the LC station at the confluence of Lake Creek and Chewuch River (Table 13). Bull trout code 73 was recorded moving upstream in the Chewuch River past the station on July 6, 2007. Bull trout code 84 arrived on July 9, and moved upstream in Lake Creek.

Table 13. LC fixed station data: dates and times in 2007 that radio-tagged adult bull trout first arrived during upstream migrations past the station located at the confluence of Lake Creek and Chewuch River (rkm 37.5).

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
USFWS	1	73	LC	upstream	Chewuch	6-Jul-07	21:46
USFWS	1	84	LC	upstream	Lake Creek	9-Jul-07	23:36

WC fixed station (rkm 1.4 of Wolf Creek)- Two tagged bull trout migrated into Wolf Creek and passed the WC station on July 2 and July 7, 2007 (Table 14) before discharge declined to base flows (Figure 14).

Table 14. WC fixed station data: dates and times in 2007 that radio-tagged adult bull trout first arrived during pre-spawn migrations past the station located at rkm 1.4 of Wolf Creek.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
USFWS	1	75	WC	upstream	Wolf Creek	2-Jul-07	21:30
CCPUD	14	188	WC	upstream	Wolf Creek	7-Jul-07	04:37

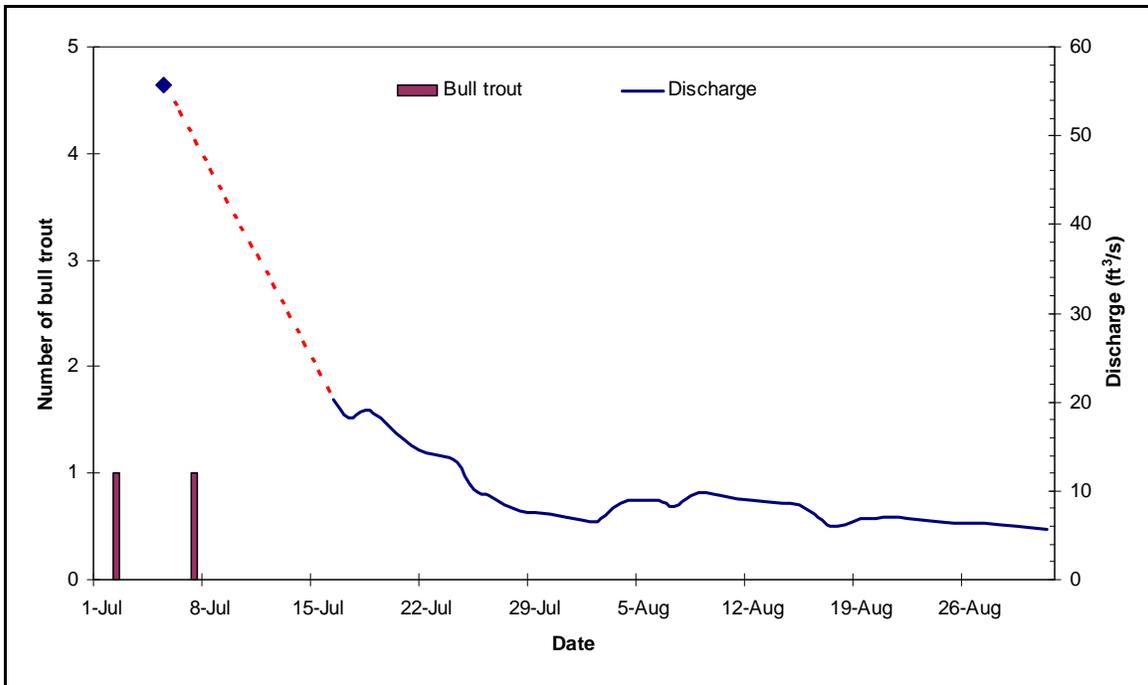


Figure 14. Wolf Creek discharge (red dashed line as interpolated) and dates radio-tagged adult fluvial bull trout migrated upstream past the WC station (rkm 1.4) during 2007.

LW fixed station (rkm 117.5 of Methow River)- Between July 8 and July 18, 2007 four tagged bull trout moved past the LW station at the confluence of the Lost and West Fork Methow rivers. Two bull trout migrated up the Lost River and two up the West Fork Methow (Table 15) when flows declined to less than 1000 ft³/s in the upper main-stem Methow River, similar to 2006 (Figure 15).

Table 15. LW fixed station data: dates and times in 2007 that radio-tagged adult bull trout first arrived during pre-spawn migrations past the station located at rkm 117.5, the confluence of the Lost and West Fork Methow rivers.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
USFWS	1	71	LW	upstream	Lost	8-Jul-07	04:23
DCPUD	1	61	LW	upstream	West Fork	11-Jul-07	23:05
USFWS	1	70	LW	upstream	Lost	12-Jul-07	00:30
USFWS	1	80	LW	upstream	West Fork	18-Jul-07	02:24

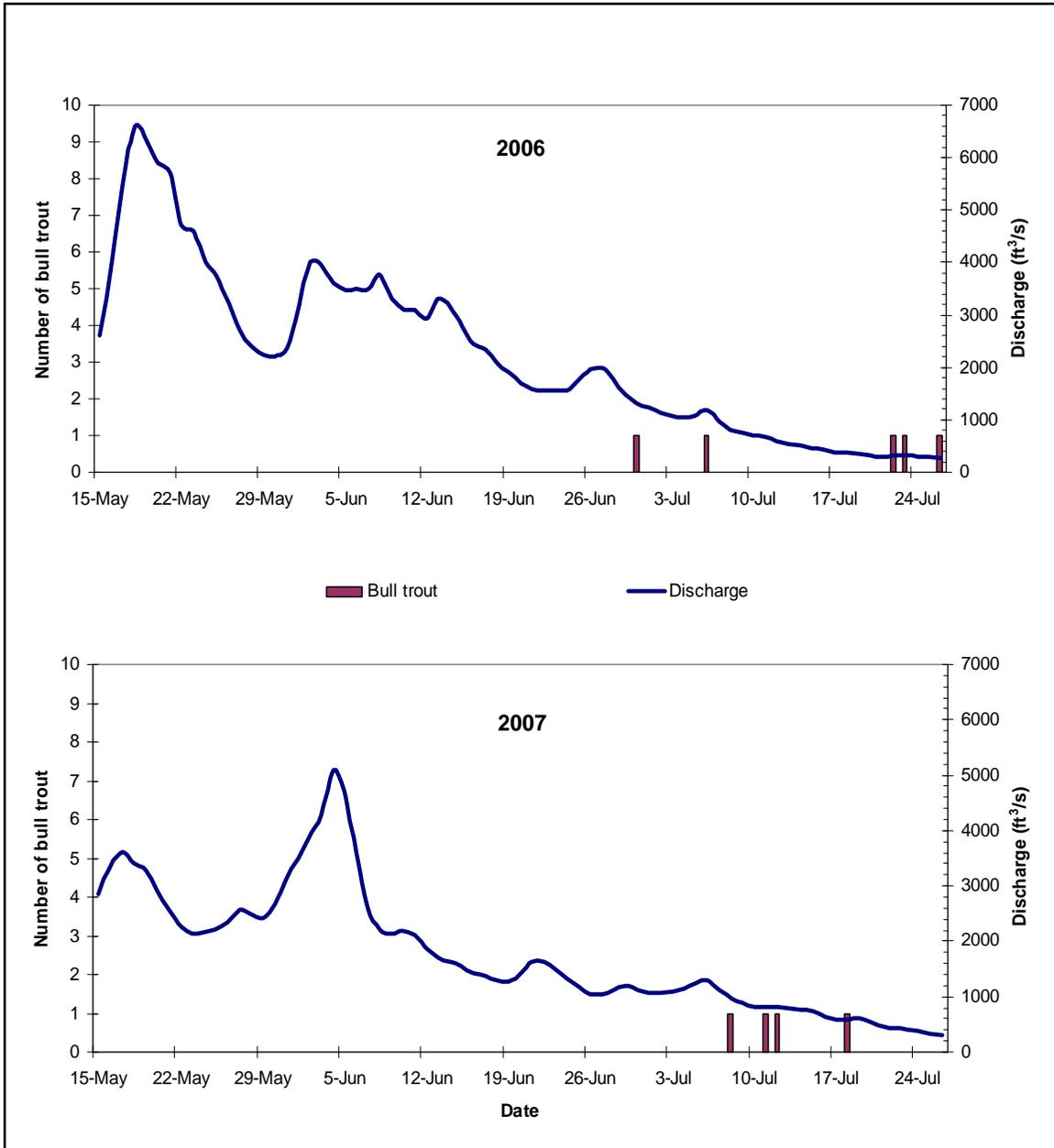


Figure 15. Methow River discharge and dates radio-tagged adult fluvial bull trout migrated upstream past the LW station (rkm 117.5) and entered the Lost and West Fork Methow rivers during 2006 and 2007.

Pre-spawn migration rates

Bull trout in the Columbia River- The upstream migration rates of six CCPUD radio-tagged bull trout in the Columbia River were calculated. One bull trout (code 188) passed three dams, and five bull trout (codes 111, 184, 115, 116, 190) passed 2 dams. Migration rates in the reservoirs ranged from 15.8 to 58.7 km/day (Table 16). Including the delay of 1.4 to 14.3 days spent passing each dam (see LGL and DCPUD 2008 and Stevenson et al. 2008 for details at the dams), the overall migration rates in the Columbia River ranged from 3.9 to 16.1 km/day (Table 16), with a grand mean of 8.8 km/day during 2007.

Migration rates for these 6 bull trout varied greatly between individual stations in the Methow River and ranged from 1.3 to 53.9 km/day (Table 16). Overall mean migration rates in the Methow River ranged from 3.2 to 10.1 km/day, with a grand mean of 5.6 km/day.

Table 16. Upstream migration rates (km/day) of Columbia River radio-tagged adult fluvial bull trout between telemetry stations in the Columbia and Methow rivers during 2007.

Station to station	code 188 km/day	code 111 km/day	code 184 km/day	code 115 km/day	code 116 km/day	code 190 km/day	mean km/day
RI-RR ^a	21.2						21.2
RR-WL ^a	24.4	20.6	35.6	24.3	15.8	32.1	25.5
WL-LG ^a	43.9	52.1	25.6	58.7	-	-	45.1
WL-OK ^a						44.9	44.9
OK-LG ^a						25.5	25.5
LG-GS ^b	18.5	2.4	53.9	1.3		11.7	17.5
GS-TG ^b	4.1	4.6	8.7	5.9	3.2	4.1	5.1
TG-MC ^b	7.4	6.0					6.7
MC-WC ^b	5.5						5.5
Col R ^c	8.9	4.6	8.0	11.5	3.9	16.1	8.8
Met R ^d	5.1	4.4	10.1	3.9	3.2	4.6	5.6
Col+Met ^e	6.7	4.5	8.8	6.2	3.9	6.1	6.7

a- rate in Columbia River reservoirs, does not include time spent passing each dam. b- rate between stations in the Methow River. c- includes time spent at each dam. d- migration rate calculated from station at mouth to furthest upstream station that detection occurred in the Methow River. e- overall combined migration rate from lowest dam on Columbia River to furthest upstream station on the Methow River.

Bull trout in the Methow River- For all tagged bull trout in the Methow River the mean migration rates between stations were variable and ranged from 2.1 to 7.9 km/day, with the fastest travel occurring in the lower 10.6 km of the river between the LG and GS stations (Table 17). Migration rate in the lower reach was influenced by stream discharge and the fastest rates were attained during the lowest discharge (Figure 16). Rates declined as tagged bull trout moved further upstream and approached their spawning tributary. Bull trout slowed down considerably when entering the Twisp River (the furthest downstream spawning tributary in 2007) while bull trout heading to the upper Methow basin continued upstream past the Twisp River at a faster rate (Table 17).

Most of the bull trout migrated to the Twisp River and their overall migration rate from the LG station to the TR station was 4.1 km/day. For bull trout migrating to the upper

Methow basin the overall mean rate between the LG and LW stations was slightly slower at 3.4 km/day.

Table 17. Migration rates (km/day) of radio-tagged adult fluvial bull trout moving upstream between telemetry stations in the Methow River basin during 2007.

	Stations: (rkm):	LG - GS (1.1 - 10.6)	GS - TG (10.6 - 64.4)	TG - TR 2.6 rkm	TG - MC (64.4 - 80.6)	MC - LW (80.6 - 117.5)	MC - WC rkm	MC-LC (0 - 37.5)
n		20	21	14	7	3	1	1
Mean (km/day)		7.9	4.4	2.1	5.3	2.5	5.5	3.1
SD		12.7	2.0	1.9	1.9	0.4		
Min		0.6	2.2	0.4	2.7	2.0	5.5	3.1
Max		53.9	10.0	7.9	7.7	2.7	5.5	3.1

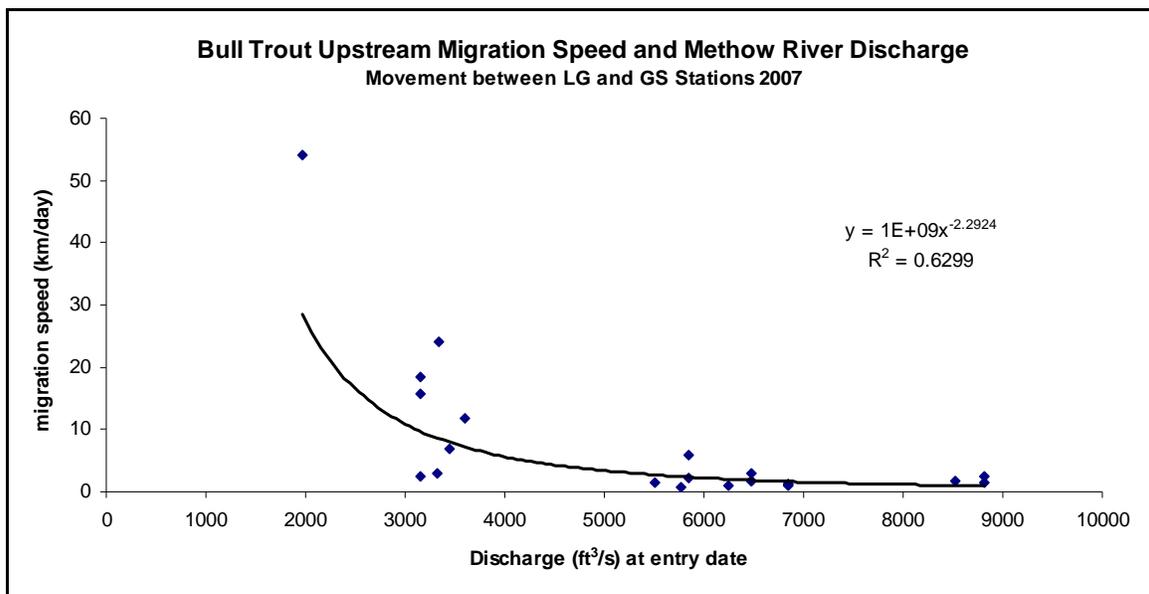


Figure 16. Scatterplot and trend line of upstream migration rates (km/day) of radio-tagged adult fluvial bull trout between the LG and GS telemetry stations versus Methow River discharge (ft³/s) during 2007

Wolf Creek bull trout

Two 2006-tagged bull trout migrated into Wolf Creek in 2007 and provided an interesting contrast in pre-spawn migration strategies (Figure 17). Code 75 migrated downstream from its winter location in the Methow River, traveled 2.2 rkm, and entered Wolf Creek on July 2. Code 188 started its migration before June 7 in the Columbia River, traveled 220 rkm upstream and entered Wolf Creek on July 7, only five days later than code 75.

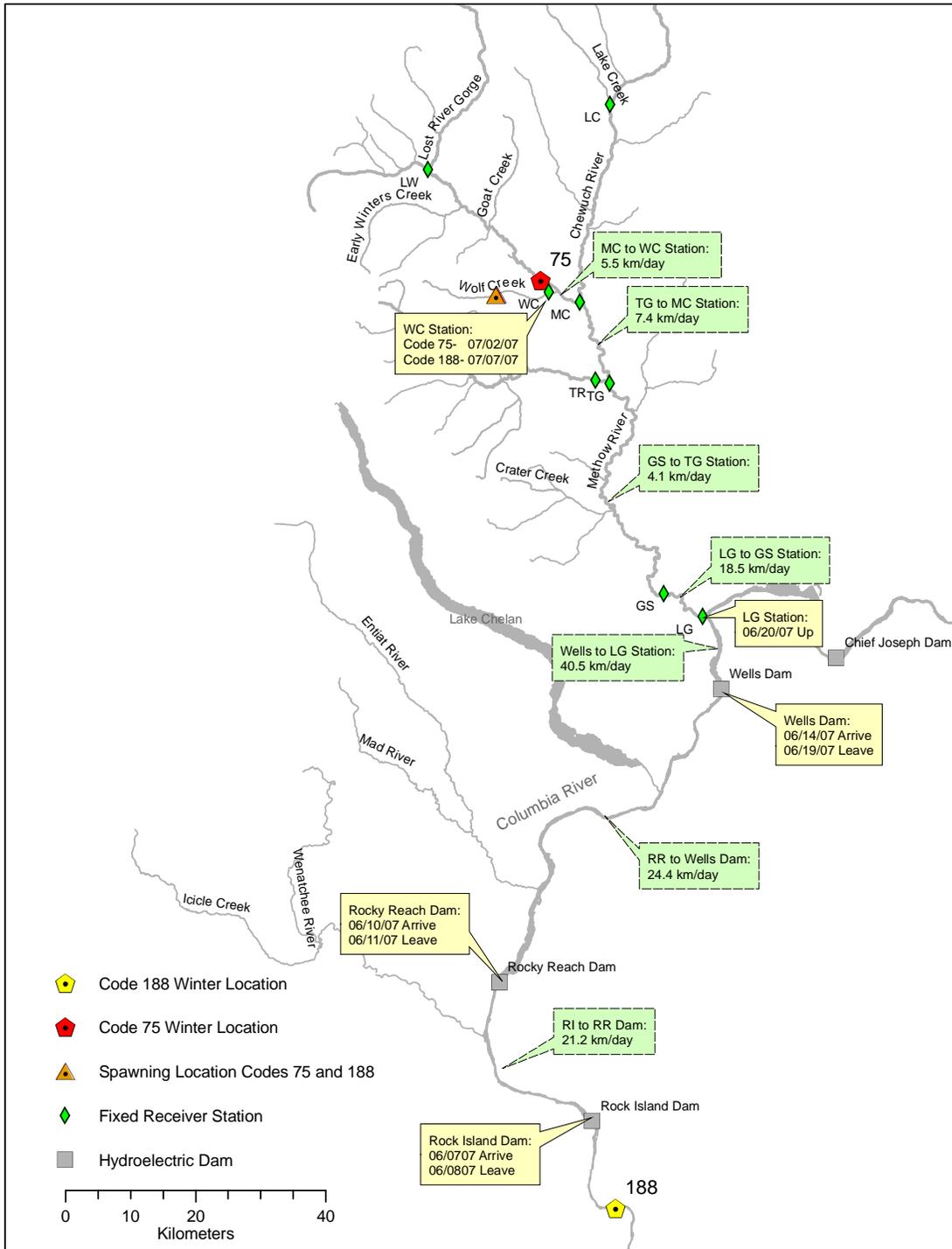


Figure 17. Map showing the migration routes taken by tagged bull trout codes 188 and 75 during their pre-spawn migrations to Wolf Creek during 2007.

Diel period of pre-spawn migrations- During 2006 and 2007, bull trout migrating upstream past the lower stations moved both day and night, but as they moved further upstream the movement period shifted mostly to night (Table 18, Figure 18). The time of day that bull trout moved upstream also influenced migration rates- because the fish apparently did not move in the upper river during the day (twice as long as night during this time), the distance traveled decreased, resulting in a corresponding decrease in the daily rate.

Bull trout migrating upstream in the Columbia River were more likely to move upstream during the day before they reached the hydroelectric dams. At the Rocky Reach tailrace station (located ~1 rkm downstream of the dam) 81% of the radio detections occurred during daylight hours and at the Wells Gateway station (located 7 rkm downstream of Wells Dam) 79% occurred during daylight. As tagged bull trout reached the dams, movement patterns differed at the structures. At Rocky Reach Dam, detections shifted more to the day, when 95% of the detections at the fish ladder entrance and 90% at the exit occurred during daylight. At Wells Dam, detections shifted to the night, with 58% of the detections at the tailrace station (located at the base of the dam), 39% at the fish ladder entrance, and 50% at the exit occurred during daylight (Table 18, Figure 18).

Tagged bull trout were more likely to enter the Methow River and pass the LG telemetry station during the day, similar to movements into the Entiat River and past the ER station (Table 18, Figure 18). (The few tagged bull trout detected moving past the Wenatchee River telemetry station were equally likely to move day or night.) As migration proceeded upstream in the Methow River, movements past telemetry stations shifted mostly to the night (Figure 18).

Table 18. Summary of day versus night movements when radio-tagged adult fluvial bull trout were first detected during pre-spawn migrations past telemetry stations in the Upper Columbia Recovery Unit during 2006 and 2007.

Station	River	rkm	Day	Night
WR	Wenatchee	12.5	5	5
Rocky Reach (RR) tailrace	Columbia	761	26	6
RR ladder entrance	Columbia	762	18	1
RR ladder exit	Columbia	762	19	2
ER	Entiat	5.1	29	22
Wells gateway	Columbia	823	19	5
Wells tailrace	Columbia	830	11	8
Wells ladder entrance	Columbia	830	7	11
Wells ladder exit	Columbia	830	9	9
LG	Methow	1.1	22	11
GS	Methow	10.6	17	8
TG	Methow	64.4	1	23
TR	Twisp	2.1	1	22
MC	Methow/Chewuch	80.6	0	18
LC	Lake/Chewuch	37.5	0	3
WC	Wolf	1.4	2	1
LW	Lost/West Fork Methow	117.5	0	9

Note: Rocky Reach Dam detections also include tagged bull trout migrating to the Entiat or Wenatchee rivers.

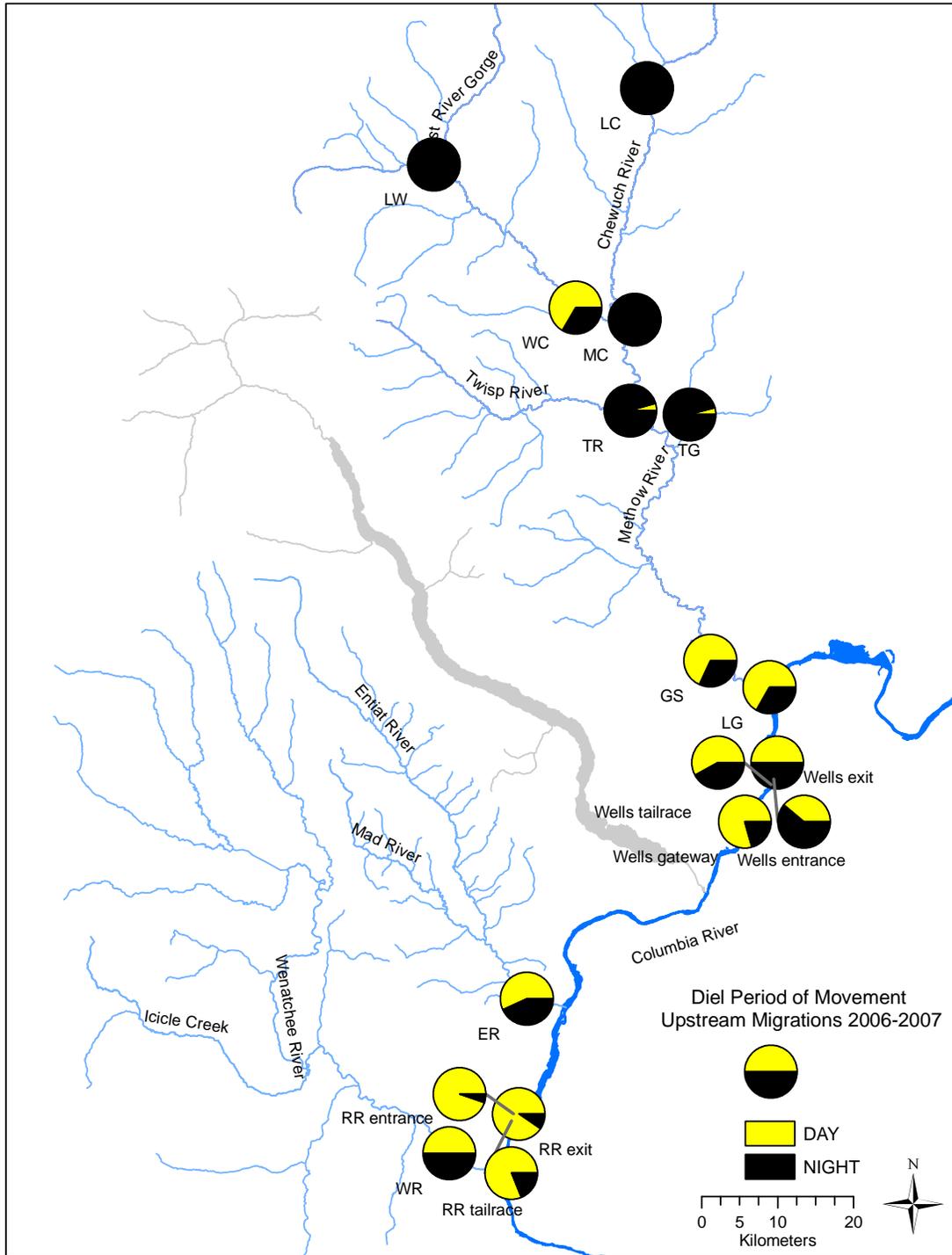


Figure 18. Map with charts showing the diel period (day or night) that radio-tagged adult fluvial bull trout were first detected during pre-spawn migrations past telemetry stations in the Upper Columbia Recovery Unit during 2006 and 2007.

Summer use of the Methow River- Two tagged bull trout (codes 58 and 62) did not enter tributaries and were monitored in the Methow River during 2007.

Code 58 (tagged at Wells Dam by DCPUD in 2006) was located at rkm 49.9 of the Methow River from December 21, 2006 to November 28, 2007 (see Appendix 1). During a snorkel survey on August 21 it was observed in a boulder run near the stream bottom in the vicinity of 10 mountain whitefish *Prosopium williamsoni*. The bull trout appeared healthy but strands of algae were observed on the transmitter antenna.

Code 62 was detected near rkm 77 in the Methow River during the summer and fall of 2007 (see Appendix 1). It was tagged in 2006 at Wells Dam by DCPUD and utilized the West Fork Methow River before returning to the Columbia River. During the 2007 spring migration, it was recaptured and re-measured at Wells Dam, and although it gained length it had lost weight. Code 62 migrated into the Methow River on June 23 and by July 18 it was located at Brandenburg Run (rkm 77). From July 20 to September 28 it was detected in this general vicinity, where it moved in and out of the Barkley Irrigation Ditch (Figure 19). On August 21 it was observed in the ditch near an undercut bank and on August 30 it was detected with a 330 mm bull trout in the Methow River in Peters Hole (rkm 78), upstream of the ditch intake. During snorkeling on September 5 it was observed back in the ditch and was located under the cut bank approximately 100 m downstream of the headgate. Water temperature in the ditch was 10 C at 0800 hours on September 7. During foot tracking on September 26 it was observed with 3 bull trout (210 – 400 mm), 40 adult Chinook salmon *Oncorhynchus tshawytscha*, several mountain whitefish and numerous rainbow trout *O. mykiss* in Peters Hole at the head of the ditch. On October 8, 2007 the WDFW Eastern Washington Water Team conducted a salvage effort to rescue fish stranded in the ditch after draw down (WDFW 2007) and code 62 was captured and released into the Methow River (the bull trout was characterized as “not in good condition- skinny”). Code 62 migrated downstream and passed the TG station (rkm 64.4) on October 17 and the GS station (rkm 10.6) on October 19 and entered the Columbia River. During mobile surveys on November 2, 27 and 28 it was detected downstream of Wells Dam. From January 22 to April 2, 2008 it was detected in the Columbia River at rkm 814, the same location it overwintered in 2006/2007.



Figure 19. Telemetry locations of tagged bull trout code 62 in Barkley Ditch and Methow River during August to October, 2007.

Spawning locations

Twenty seven of twenty nine tagged bull trout were detected in tributaries of the Methow River in 2007 (Figure 20). Eighteen bull trout were located on known spawning grounds during the spawning season and an additional two were presumed to have spawned in Lost River. Six tags were recovered prior to the spawning season and three tagged bull trout did not migrate to spawning areas.

Twisp River- Fourteen of the bull trout entered the Twisp River, but three radio-tags were recovered before reaching the spawning area and one bull trout stayed in the lower river. Of the ten bull trout on the spawning grounds, 6 were located upstream of the dry reach and 4 downstream.

Wolf Creek- Three tagged bull trout passed the log jam at rkm 6.6 and were detected on the Wolf Creek spawning grounds near North Fork Wolf Creek. Twenty seven percent of the bull trout redds in Wolf Creek were counted downstream of the jam in 2007.

Early Winters Creek- Three tagged bull trout entered Early Winters Creek. None of the bull trout moved upstream past the 6 m waterfall located at rkm 13.1. Two bull trout (codes 111 and 171) were located on the fluvial bull trout spawning grounds downstream of the waterfall. The other bull trout (code 69) entered Cedar Creek but apparently did not spawn there- it was observed at a log jam barrier at rkm 1.2 in an area without suitable spawning gravels- and left in early September.

West Fork Methow River- Three tagged bull trout entered the West Fork Methow River- one tag was recovered in the lower river prior to spawning and the other two were located on the spawning grounds.

Lost River- Two bull trout entered the Lost River and were detected during an aerial survey downstream of the landslide and dry reach near Monument Creek; presumably they spawned but the remote area precluded spawning ground surveys.

Chewuch River- Two bull trout migrated up the Chewuch River. One (code 84) entered Lake Creek and migrated upstream of Black Lake to the Lake Creek spawning grounds. The other bull trout (code 73) was depredated and recovered in the upper Chewuch prior to the spawning season.

Foggy Dew Creek- One tagged bull trout (code 177) was recovered in Foggy Dew Creek and the deteriorated condition of the carcass indicated it had died before spawning. This fish apparently entered Foggy Dew Creek in June 2006 and spent the entire year there (see Appendix 1).

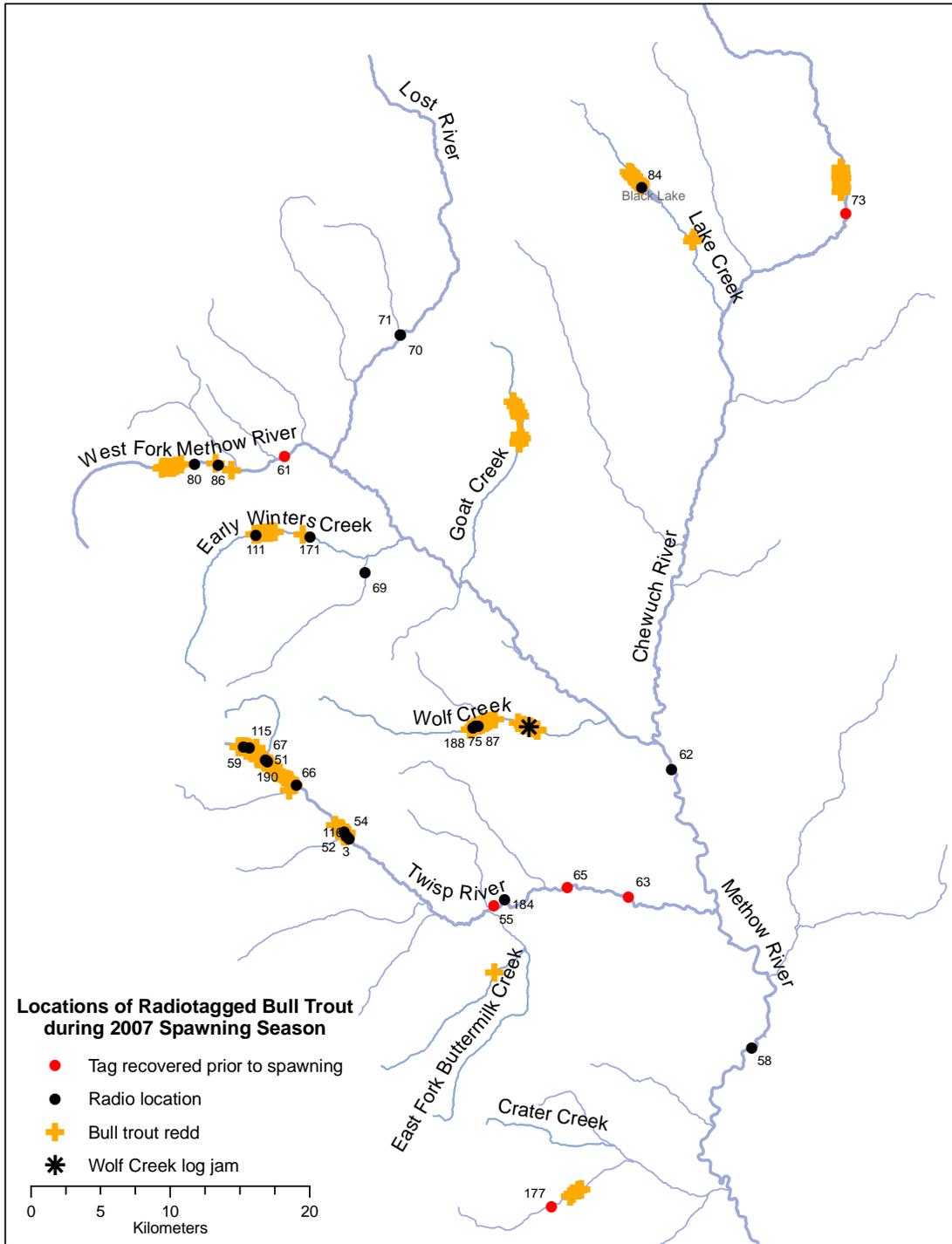


Figure 20. Map of the telemetry locations of radio-tagged adult fluvial bull trout in the Methow River basin during the 2007 bull trout spawning season.

Redd counts

The bull trout redd counts for 2007 are summarized in Figure 21 (data from USFS 2008). A total of 231 redds were counted, with the highest number located in the Twisp River (92 redds). In 2007, 67% of bull trout redds in the upper Twisp River watershed (including North Creek) were constructed upstream of the dry reach, compared to a low of 52% in 2005 (Figure 22). From 2001 to 2007, on average 70% of redds have been constructed upstream of the dry reach.

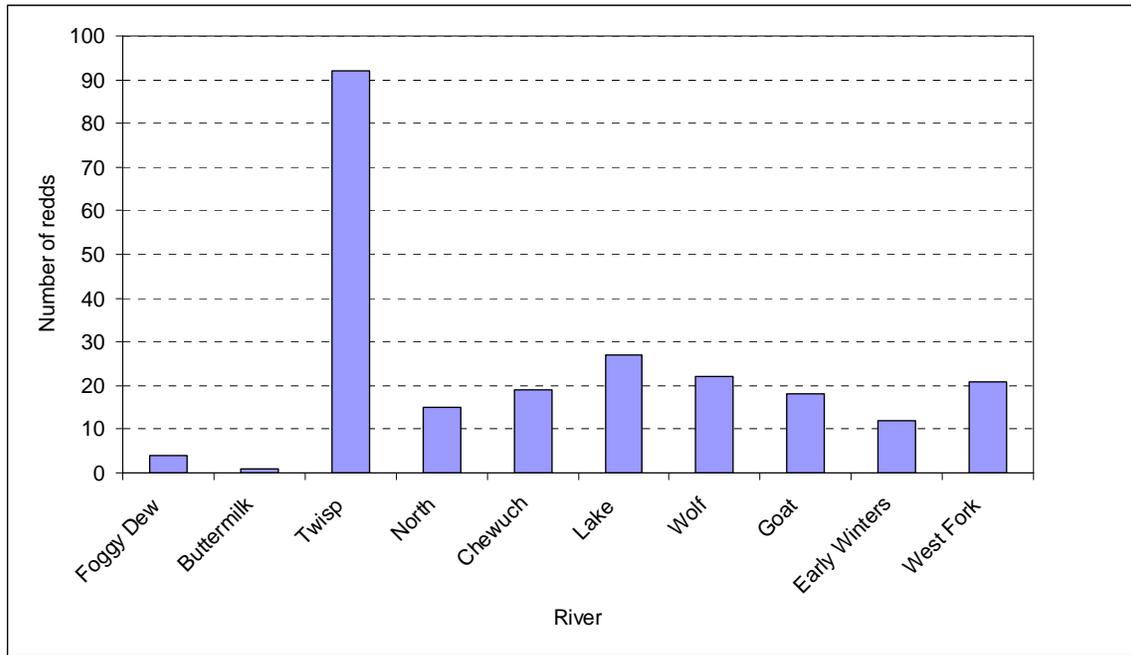


Figure 21. Number of bull trout redds counted in tributaries of the Methow River during 2007.

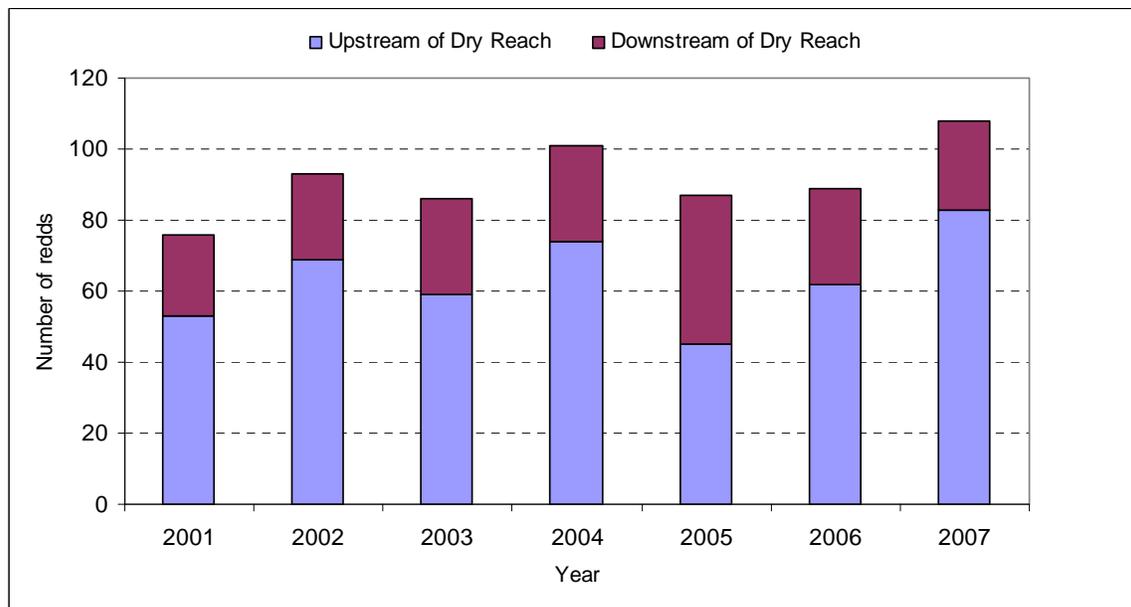


Figure 22. Number of bull trout redds constructed downstream and upstream of the seasonal dry reach in the Twisp River, 2001 to 2007.

Post-spawn migrations

LW fixed station (rkm 117.5 of Methow River)- Three tagged bull trout were detected moving downstream at this station at the confluence of the West Fork Methow and Lost rivers (Table 19). After spawning, code 80 moved downstream in the West Fork but overwintered upstream of the confluence and thus was not detected at the station. Codes 70 and 86 initially moved downstream past the confluence on September 30 and October 25, respectively. Code 70 encountered the dry reach and immediately moved back upstream in the Lost River. Code 86 moved upstream into the Lost River on November 1. Code 71 remained near the dry edge after its downstream movement from the Lost River on October 4.

Table 19. LW fixed station data: dates and times in 2007 that radio-tagged fluvial adult bull trout first arrived during post-spawn migrations past the station located at rkm 117.5, the confluence of the Lost and West Fork Methow rivers.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
USFWS	1	70	LW	downstream	Lost	30-Sep-07	00:10
USFWS	1	70	LW	upstream	Lost	30-Sep-07	02:19
USFWS	1	71	LW	downstream	Lost	4-Oct-07	23:10
USFWS	1	86	LW	downstream	West Fork	25-Oct-07	20:04
USFWS	1	86	LW	upstream	Lost	1-Nov-07	04:13
USFWS	1	70	LW	downstream	Lost	8-Nov-07	19:05

The dry reach was first noted near Goat Wall Creek during a mobile survey on September 13, 2007. The USGS gage station (12447383 near Goat Creek) recorded a minimum discharge of 2.2 ft³/s on September 28, due to the influence of Early Winters Creek (Figure 23). In contrast to 2006, the river remained dry upstream of Early Winters Creek in 2007 and isolated the Lost and West Fork Methow bull trout. However, occasional rains resulted in fluctuations in the location of the dry edge and may have induced downstream movements in two bull trout (Figure 23). Code 70 moved downstream past the station on November 8 and the carcass was recovered on November 20 in the dry reach. The tag of code 71 was recovered in the dry reach on November 28 (see section on mortality and recovered tags). Code 80 overwintered in the West Fork Methow River while code 86 overwintered in the Lost River and both remained well upstream of the dry edge.

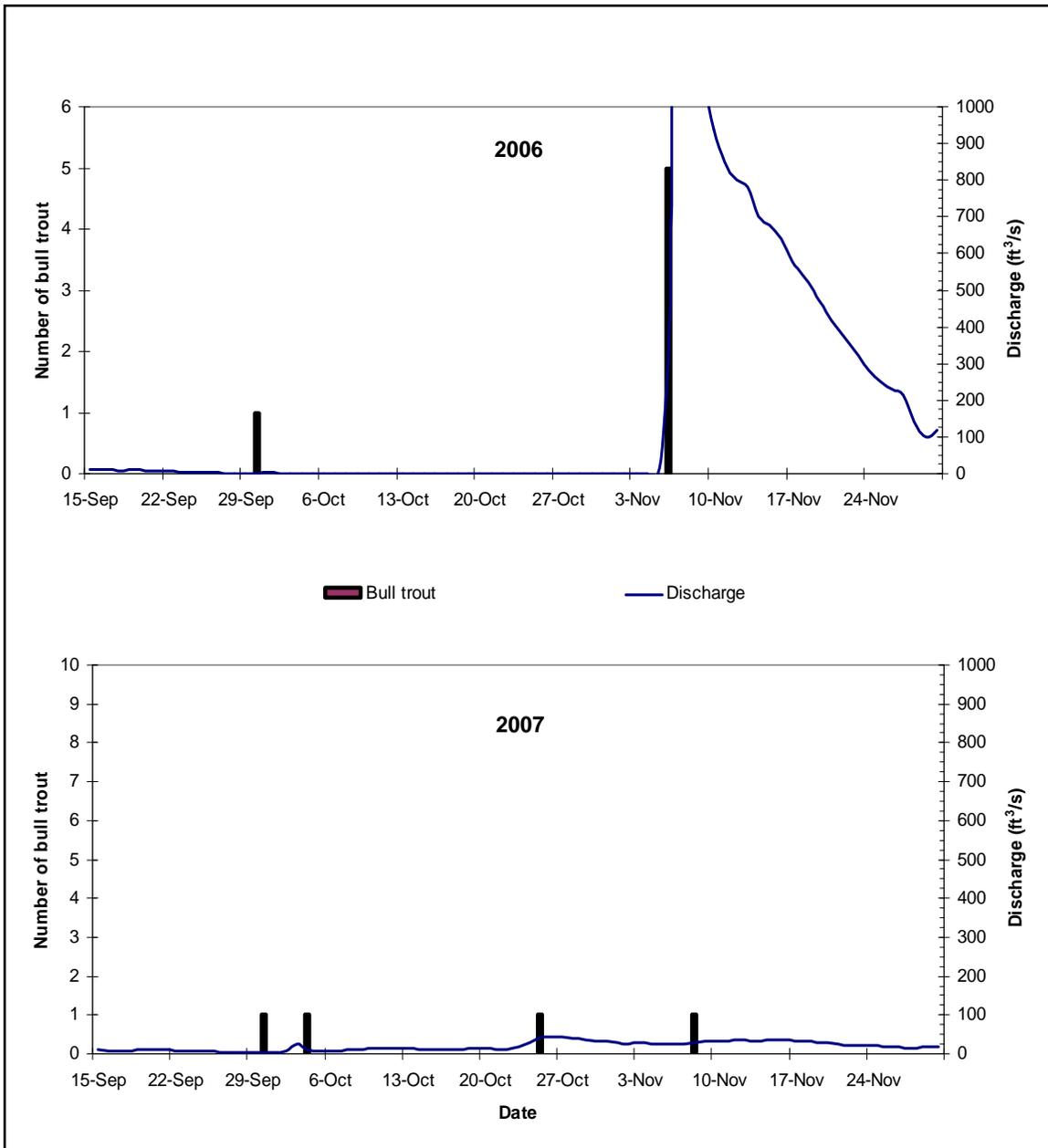


Figure 23. Methow River discharge and dates radio-tagged adult fluvial bull trout moved past the LW telemetry station (rkm 117.5) during post-spawn migration in the Methow River during 2007.

WC fixed station (rkm 1.4 of Wolf Creek)- All three tagged bull trout remained over winter in Wolf Creek and none were detected at the WC station.

LC fixed station (rkm 37.5 of Chewuch River)- No tagged bull trout were detected moving downstream past the LC station. Code 84 overwintered in Black Lake and code 73 was depredated prior to the spawning season.

MC fixed station (rkm 80.6 of Methow River) - Only two tagged bull trout migrated downstream past the MC station in 2007 (Table 20). Code 69 initially moved past the

station but then spent the winter just upstream of the station. In contrast to 2006, flows in the Methow River remained low during the outmigration period in 2007 (Figure 24).

Table 20. MC fixed station data: dates and times in 2007 that radio-tagged adult fluvial bull trout first arrived during post-spawn migrations past the station located at rkm 80.6.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
CCPUD	14	111	MC	downstream	Methow	27-Oct-07	20:24
DCPUD	1	69	MC	downstream	Methow	9-Dec-07	07:55
DCPUD	1	69	MC	upstream	Methow	20-Dec-07	20:17

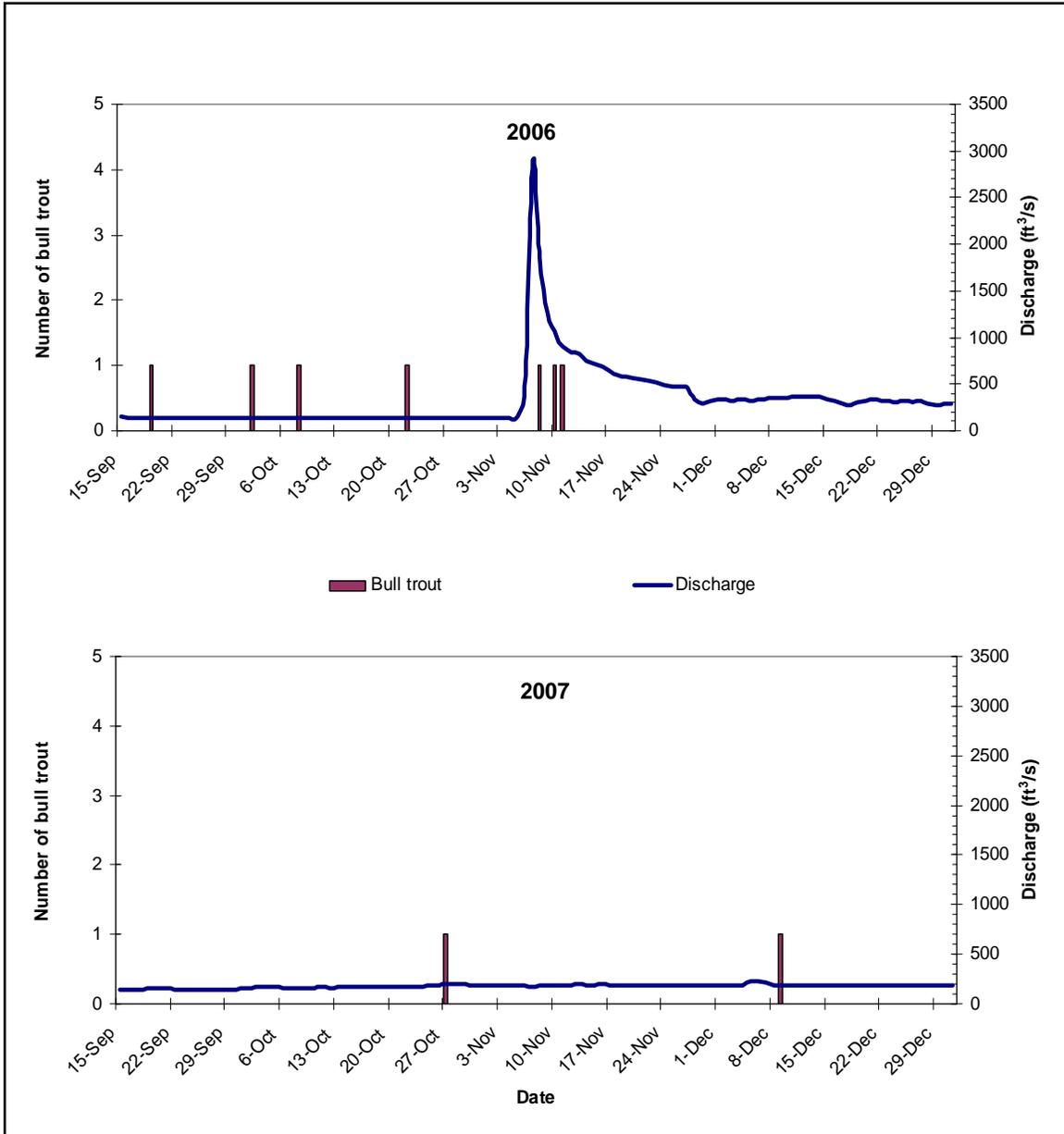


Figure 24. Methow River discharge and dates radio-tagged adult fluvial bull trout moved past the MC telemetry station (rkm 80.6) during post-spawn migration in the Methow River during 2006 and 2007.

TR fixed station (rkm 2.1 of Twisp River) - Seven tagged bull trout were recorded passing the TR station from September 3 to November 11, 2007 (Table 21). The Twisp River was noted as dry at Poplar Flat during a mobile survey on September 6, 2007. Four of the bull trout were located on the spawning grounds downstream of the dry reach and one bull trout left prior to spawning; these fish exited the Twisp River by October 2. Seven tagged bull trout were isolated upstream of the dry reach until occasional rains re-watered the dry reach long enough for some of the isolated bull trout to move downstream (Figure 25). Codes 59 and 53 exited on October 26 and November 11, but the carcasses of code 51 and 190 were recovered in the dry reach (see mortality and tag recovery section). Two tagged bull trout (codes 66 and 67) did not move downstream and remained isolated. The signal of code 115 disappeared and was not detected again so its fate is unknown.

Tagged bull trout were also isolated by the dry reach in 2006, but a major rainstorm in early November re-watered the dry reach and all but one tagged bull trout migrated downstream (Figure 25). The tag (and bones) of that fish was recovered in the summer of 2007.

Table 21. TR fixed station data: dates and times in 2007 that radio-tagged adult fluvial bull trout first arrived during post-spawn migrations past the station located at rkm 2.1 of the Twisp River.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
CCPUD	14	184	TR	downstream	Twisp	3-Sep-07	01:47
DCPUD	1	54	TR	downstream	Twisp	19-Sep-07	03:17
DCPUD	1	52	TR	downstream	Twisp	20-Sep-07	03:45
CCPUD	14	3	TR	downstream	Twisp	1-Oct-07	21:58
CCPUD	14	116	TR	downstream	Twisp	2-Oct-07	05:05
DCPUD	1	59	TR	downstream	Twisp	26-Oct-07	00:04
DCPUD	1	53	TR	downstream	Twisp	11-Nov-07	19:33

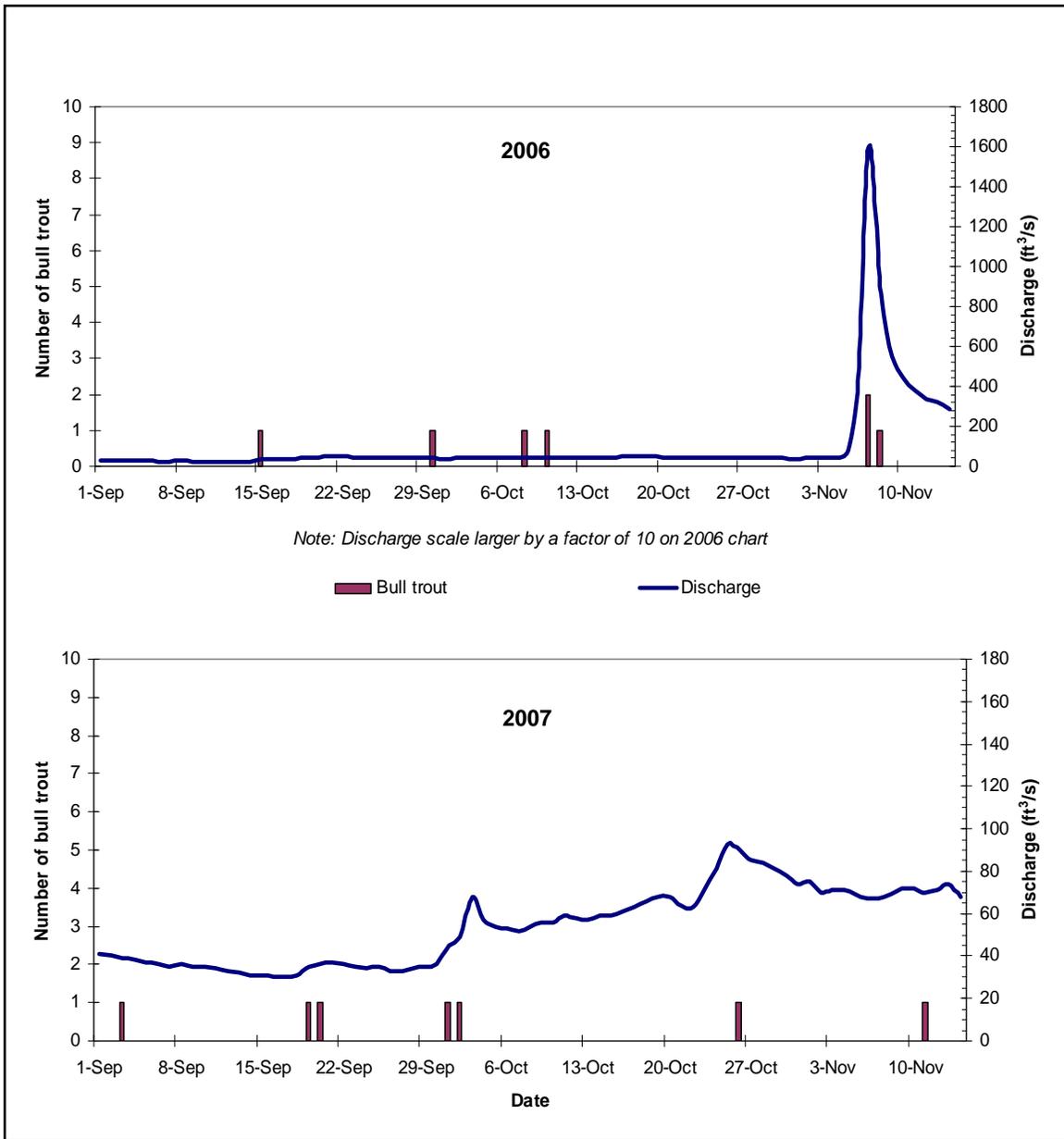


Figure 25. Twisp River discharge and dates radio-tagged adult fluvial bull trout moved past the TR telemetry station (rkm 2.1) during post-spawn migrations in the Twisp River during 2006 and 2007.

TG fixed station (rkm 64.4 of Methow River)- Tagged bull trout that migrated downstream from the Twisp River, Early Winters Creek, and Methow River moved past this station from September 3 to November 11, 2007 (Table 22). Discharge was low and varied between 300 and 450 ft³/s during the migration period (Figure 26).

Table 22. TG fixed station data: dates and times in 2007 that radio-tagged adult fluvial bull trout first arrived during post-spawn migrations past the station located at rkm 64.4 of the Methow River.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
CCPUD	14	184	TG	downstream	Methow	3-Sep-07	20:28
DCPUD	1	54	TG	downstream	Methow	19-Sep-07	04:11
DCPUD	1	52	TG	downstream	Methow	20-Sep-07	05:01
CCPUD	14	3	TG	downstream	Methow	1-Oct-07	23:30
CCPUD	14	116	TG	downstream	Methow	2-Oct-07	19:54
DCPUD	1	62	TG	downstream	Methow	17-Oct-07	00:49
DCPUD	1	59	TG	downstream	Methow	26-Oct-07	01:38
CCPUD	14	111	TG	downstream	Methow	29-Oct-07	19:58
DCPUD	1	53	TG	downstream	Methow	11-Nov-07	21:40

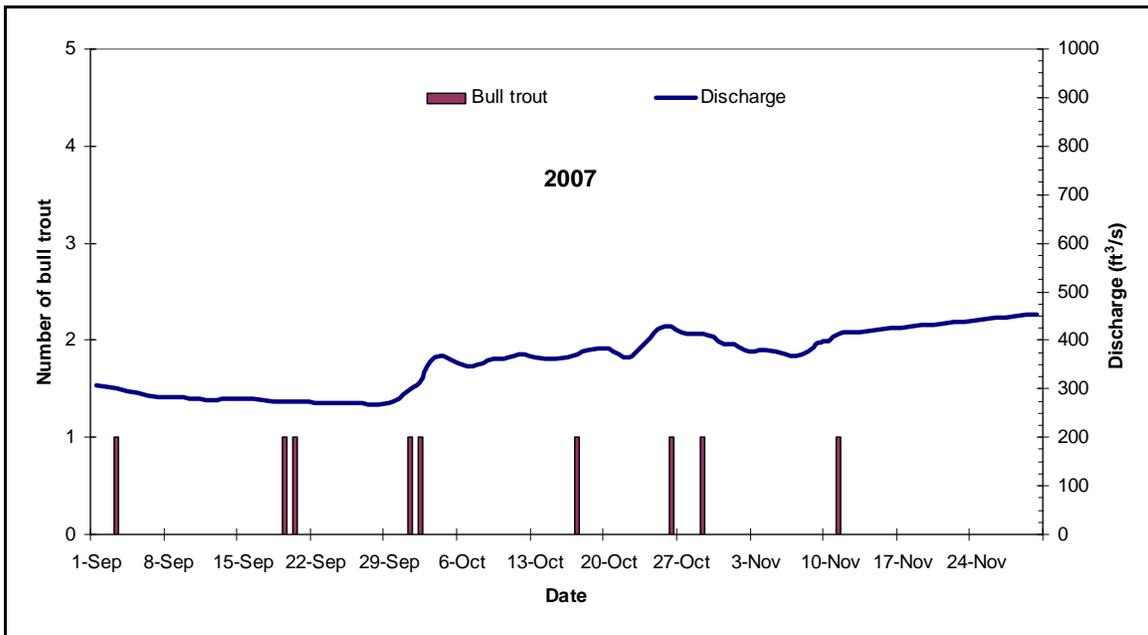


Figure 26. Methow River discharge and dates radio-tagged adult fluvial bull trout moved past the TG station (rkm 64.4) during post-spawn migrations in the Methow River during 2007.

GS fixed station (rkm 10.6 of Methow River)- Seven tagged bull trout were detected at the GS station from September 26 to November 20, 2007 (Table 23). Discharge was low and varied between 300 and 450 ft³/s during the migration period in this section of the lower river (Figure 27).

Table 23. GS fixed station data: dates and times in 2007 that radio-tagged adult fluvial bull trout first arrived during post-spawn migrations past the station located at rkm 10.6 of the Methow River.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
DCPUD	1	52	GS	downstream	Methow	26-Sep-07	00:26
DCPUD	1	62	GS	downstream	Methow	19-Oct-07	00:49
DCPUD	1	54	GS	downstream	Methow	28-Oct-07	18:46
CCPUD	14	111	GS	downstream	Methow	3-Nov-07	21:16
CCPUD	14	3	GS	downstream	Methow	16-Nov-07	20:00
DCPUD	1	53	GS	downstream	Methow	16-Nov-07	23:50
CCPUD	14	184	GS	downstream	Methow	20-Nov-07	20:27

LG fixed station (rkm 1.1 of Methow River)- During the post-spawn migration, five radio-tagged bull trout were detected exiting the Methow River from September 26 to November 25, 2007 (Table 24). Two tagged bull trout overwintered in the lower Methow River downstream of the GS station and were therefore not detected at the LG station (see overwintering section). Bull trout code 52 initially moved into the Columbia River on September 26, it re-entered the Methow River on October 3. It was located upstream of the station and was occasionally detected on the upstream antenna. During a mobile survey on October 24, the motionless signal was detected and the tag and bones were recovered at rkm 2.5 (see code 52 section in Appendix 1).

During outmigration into the Columbia River in 2007, stream discharge in the Methow River was low but near average for the season (Figure 28).

Table 24. LG fixed station data: dates and times in 2007 that radio-tagged adult bull trout first arrived during post-spawn migrations past the station located at rkm 1.1 of the Methow River.

Agency	Channel	Code	Station	Migration	River	First Hit Date	Time
DCPUD	1	52	LG	downstream	Methow	26-Sep-07	18:10
DCPUD	1	52	LG	upstream	Methow	3-Oct-07	19:45
DCPUD	1	62	LG	downstream	Methow	19-Oct-07	16:36
DCPUD	1	53	LG	downstream	Methow	18-Nov-07	03:05
CCPUD	14	184	LG	downstream	Methow	21-Nov-07	15:14
DCPUD	1	54	LG	downstream	Methow	25-Nov-07	08:20

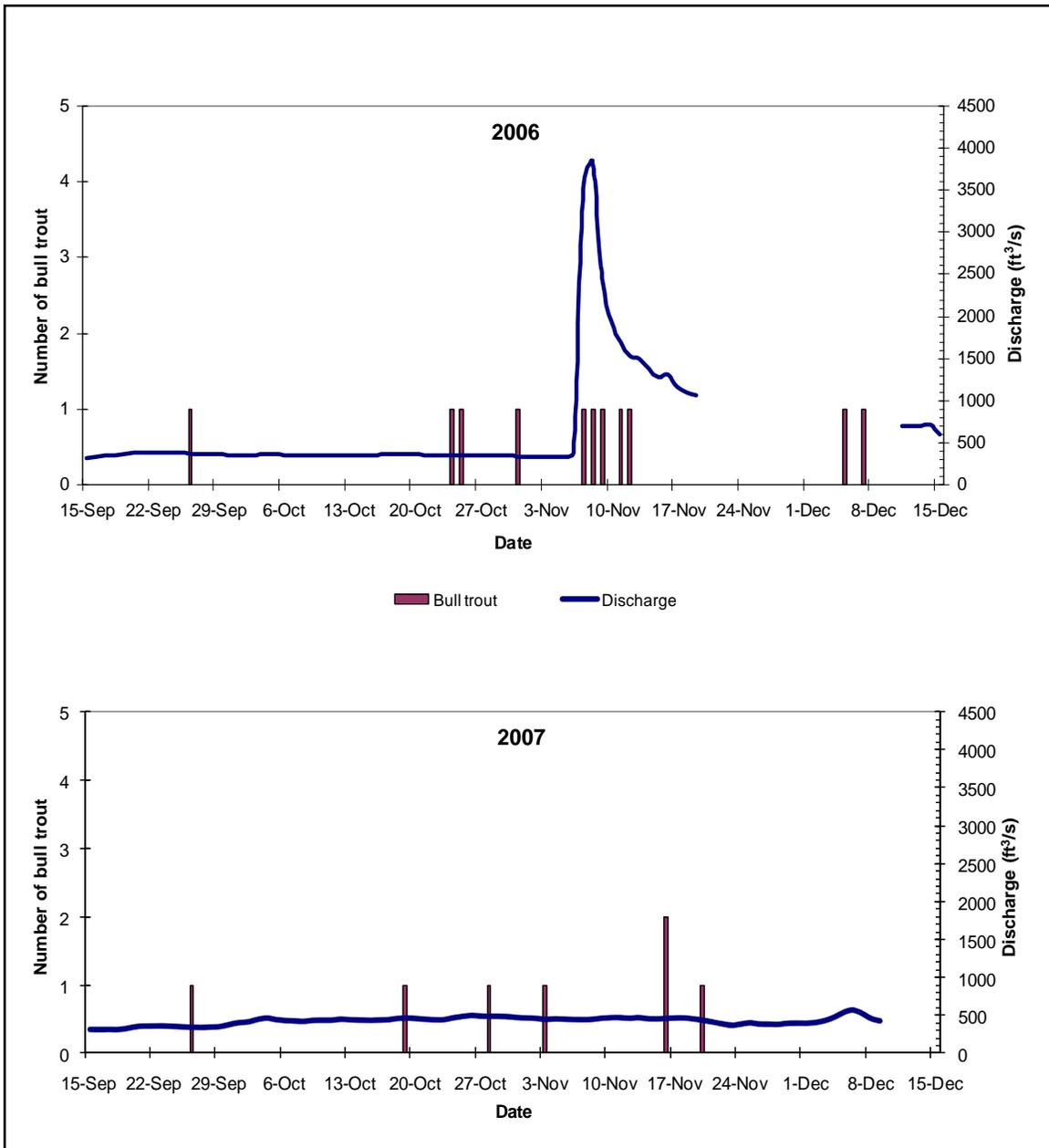


Figure 27. Methow River discharge and dates radio-tagged adult fluvial bull trout moved past the GS telemetry station (rkm 10.6) during post-spawn migrations in the Methow River during 2006 and 2007.

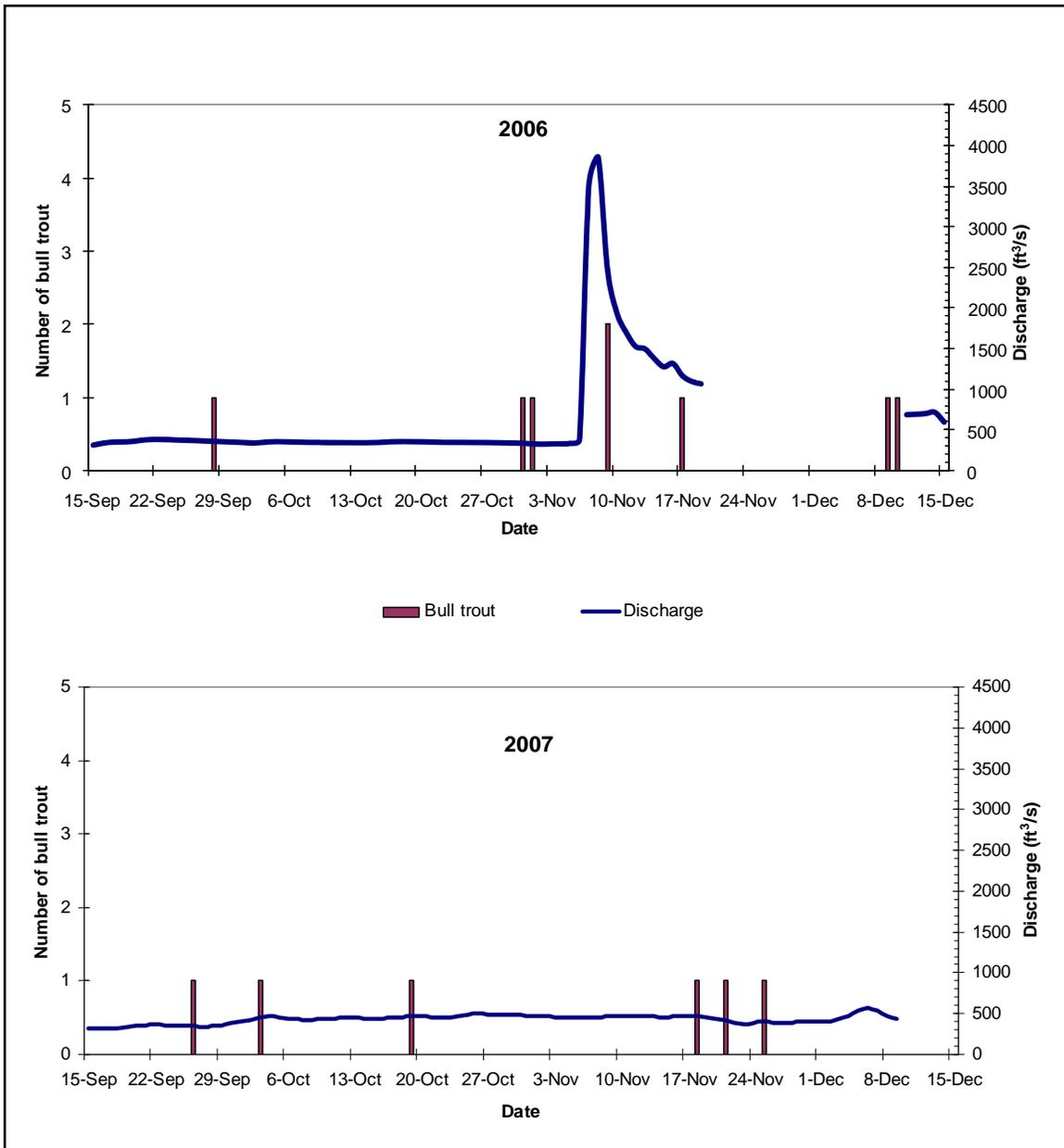


Figure 28. Methow River discharge and dates radio-tagged adult fluvial bull trout moved past the LG telemetry station (rkm 1.1) during post-spawn migrations in the Methow River during 2006 and 2007.

Post-spawn migration rates

Migration rates of post-spawn bull trout between telemetry stations were variable and ranged from 0.34 to 26.9 km/day (Table 25). As bull trout moved further downstream in the Methow River, mean migration rates increased (Table 25). For the five tagged bull trout that migrated into the Columbia River, mean post-spawn migration rate was 9.1 km/day (Table 25). In comparison, the three tagged bull trout that left the Methow River in summer prior to the spawning season moved downstream much faster and averaged 16.3 km/day in the lower river (Table 26).

Table 25. Post-spawn downstream migration rates (km/day) of radio-tagged adult fluvial bull trout in the Methow River during 2007.

	Stations: rkm:	MC – TG (80.6 - 64.4)	TG – GS (64.4 - 10.6)	GS – LG (10.6 - 1.1)	Overall (80.6 - 1.1)
n bull trout		1	7	5	5
Mean (km/day)		8.17	8.66	9.63	9.08
SD		-	9.25	5.65	9.4
Min		8.17	0.69	0.34	0.8
Max		8.17	26.9	14.43	23.81

Table 26. Downstream migration rates of radio-tagged adult fluvial bull trout that moved out of the Methow River in summer prior to spawning during 2007.

	Stations: rkm:	MC – TG (80.6 - 64.4)	TG – GS (r64.4 - 10.6)	GS – LG (10.6 - 1.1)
n bull trout		1	1	3
Mean (km/day)		5.26	27.89	16.28
SD		-	-	0.44
Min		5.26	27.89	15.81
Max		5.26	27.89	16.68

Diel period of post-spawn migrations

During 2006 and 2007, most post-spawn movements past telemetry stations in the Methow River occurred during the night (Table 27). In the upper river, movements past the LW station were probably influenced by the dry reach (all 3 daylight movements occurred in 2006 when high flows finally allowed passage). Movements past the LG station near the mouth shifted to the day, as did movements of tagged bull trout at telemetry stations in the lower Entiat and Wenatchee rivers (Figure 29). Based on a small number of tagged bull trout detected at the Wells Gateway station it appeared the natural movements of bull trout in the Columbia River occur both day and night. Detections of bull trout passing downstream of Rocky Reach showed a similar pattern to Wells Gateway while the few bull trout detected passing Wells Dam occurred at night (Figure 29).

Table 27. Summary of day or night movements when radio-tagged adult fluvial bull trout were first detected during post-spawn migrations past telemetry stations in the Upper Columbia Recovery Unit during 2006 and 2007.

Telemetry Station	River	rkm	Day	Night
WR	Wenatchee	12.5	1	4
RR Dam	Columbia	762	5	7
EM	Entiat	0.4	3	13
ER	Entiat	5.1	0	31
Wells gateway	Columbia	823	1	2
Wells Dam	Columbia	830	0	3
LG	Methow	1.1	9	4
GS	Methow	10.6	2	16
TG	Methow	64.4	2	15
TR	Twisp	2.1	1	13
MC	Methow/Chewuch	80.6	1	9
WC	Wolf	1.4	0	5
LW	Lost/West Fork Methow	117.5	3	7

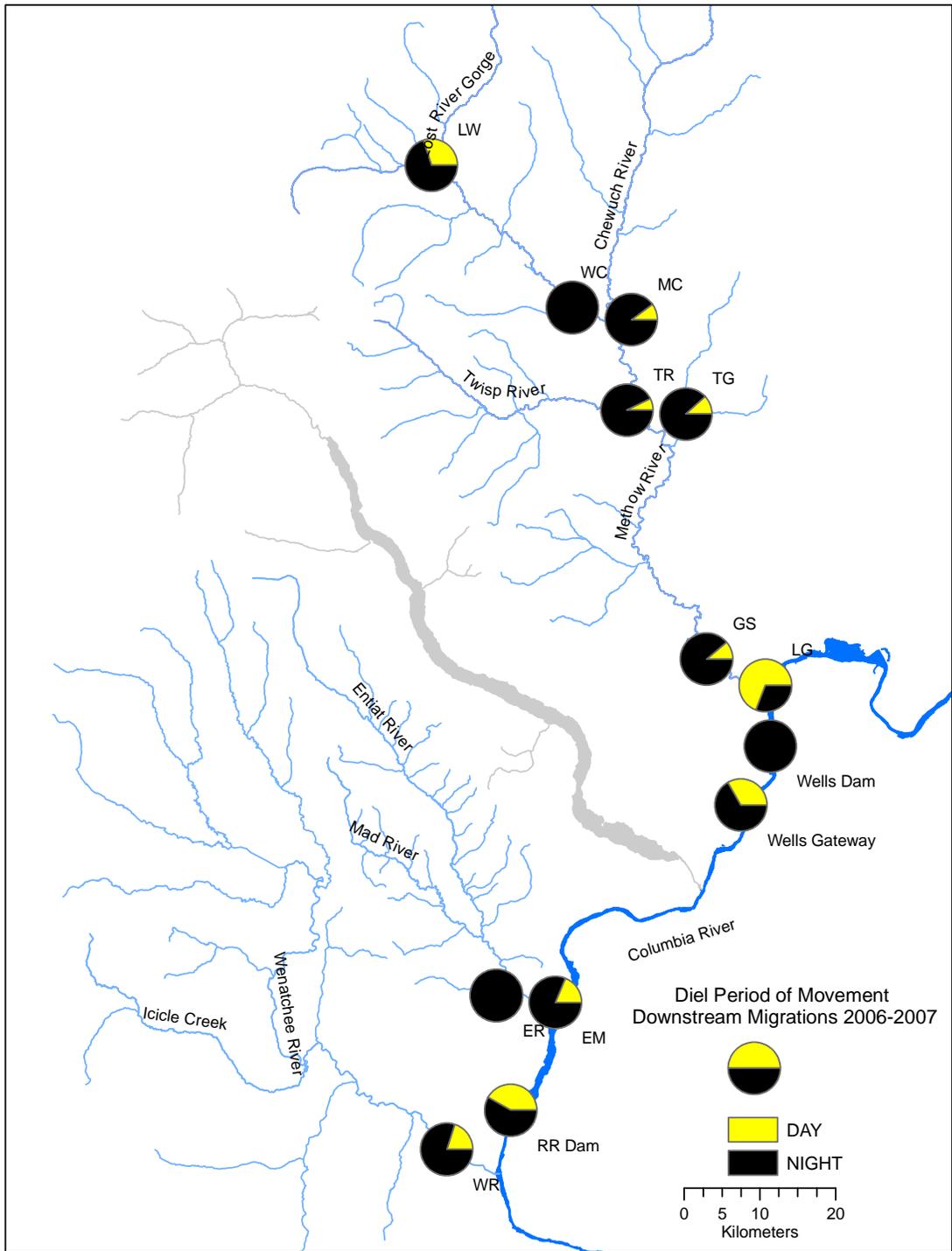


Figure 29. Map with charts showing diel period of movement (day or night) that radio-tagged adult fluvial bull trout were first detected during post-spawn migrations past telemetry stations in the Upper Columbia Recovery Unit during 2006 and 2007.

Isolation

A total of eleven radio-tagged bull trout were isolated upstream of seasonal dry reaches in the Methow River basin during the fall of 2007- seven in the upper Twisp River and four in the upper Methow River. In the Twisp River, two tagged bull trout (codes 51 and 190) died due to stranding or depredation, three successfully passed the dry reach after it re-watered, one unsuccessfully attempted to overwinter upstream of the dry reach (its tag was recovered in the spring of 2008) and the signal of one disappeared. In the upper Methow system, the dry reach did not re-water and two tagged bull trout (codes 70 and 71) died due to stranding or depredation while two survived the winter (one in the West Fork Methow River and one in the Lost River).

Several dead untagged bull trout were recovered or observed at dry reaches in 2007. In the upper Twisp River, eight untagged bull trout were recovered alongside code 51 in a pool within the dry reach area (Figure 30). Circumstances suggest the bull trout were isolated and died just before rain re-watered the reach. USFS spawning ground surveyors observed an additional 5 dead untagged adult fluvial bull trout in the upper Twisp River. Four dead untagged adults were also reported in the upper Methow River in an isolated pool along with 100 dead whitefish and several dead spring Chinook salmon parr.



Figure 30. Recovery of dead bull trout code 51 with eight dead untagged adult fluvial bull trout in the dry reach area of the Twisp River on November 1, 2007 after flows resumed.

The total number of bull trout isolated and the actual number of bull trout that died as a result are unknown. Observations of live bull trout accompanying tagged bull trout indicate relatively large numbers of bull trout are affected by isolation. For example, nine live untagged bull trout were observed with code 71 in the upper Methow River three weeks before it was recovered and five untagged bull trout were with code 67 in the upper Twisp River during its last observation before winter. Several live bull trout were also observed with tagged bull trout that survived isolation in the upper Methow River, including four with code 80 in the West Fork Methow River and sixteen with code 86 in the Lost River.

Mortality and recovered tags

The transmitters of seventeen bull trout were recovered in 2007 (Table 28), mostly in the upper watershed (Figure 31). Although exact determination of the cause of death or tag separation was not always possible, circumstances provided some clues. Carcasses or body parts were recovered with 10 of the transmitters and coyote tracks were observed at one location. Five of the recoveries were associated with dry reaches, including the four described above and one (code 50) that was isolated in the upper Twisp River in 2006. Four transmitters that were implanted at Wells Dam in 2007 were recovered in mid-stream during pre-spawn migration and may have been shed. Circumstances suggest two tagged bull trout (codes 82 and 73) were depredated and two (codes 171 and 52) were either depredated or scavenged. The mortality of two bull trout was probably related to tagging- code 85 was recovered 3 days after tagging and code 83 behaved unusually when it moved quickly downstream to the Columbia River where it was recovered about a month later. The carcass of code 177 was recovered in Foggy Dew Creek prior to the spawning season but no cause could be attributed (see Appendix 1 for a description of the movements of code 177).

Table 28. Recovery of bull trout radio transmitters during 2007: code, recovery date, river, location, and carcass recovery notes.

Code	Date	River	Location	Carcass recovered?
50	18-Jul-07	Twisp	u/s dry reach	Yes (bone)
51	1-Nov-07	Twisp	dry reach	Yes (+ 8 BT)
52	2-Nov-07	Methow	lower river	Yes (bone and fin)
55	18-Jul-07	Twisp	mid river	No (shed?)
61	26-Jul-07	West Fork	lower river	No (shed?)
63	20-Jul-07	Twisp	mid river	No (shed?)
65	20-Jul-07	Twisp	mid river	No (shed?)
70	20-Nov-07	Methow	dry reach	Yes (buried)
71	28-Nov-07	Methow	dry reach	No (coyote tracks)
73	31-Aug-07	Chewuch	upper river	Yes (bone)
78	29-Aug-07	Methow	mid river	No (motionless in 2006)
82	19-Apr-07	West Fork	lower river	Yes (bone)
83	24-Jul-07	Columbia	RR reservoir	Yes (fell apart when collected)
85	26-Jun-07	Chewuch	lower river	Yes
171	8-Nov-07	Methow	d/s dry reach	Yes
177	12-Sep-07	Foggy Dew	u/s road end	Yes
190	1-Nov-07	Twisp	u/s dry reach	Yes (bone)

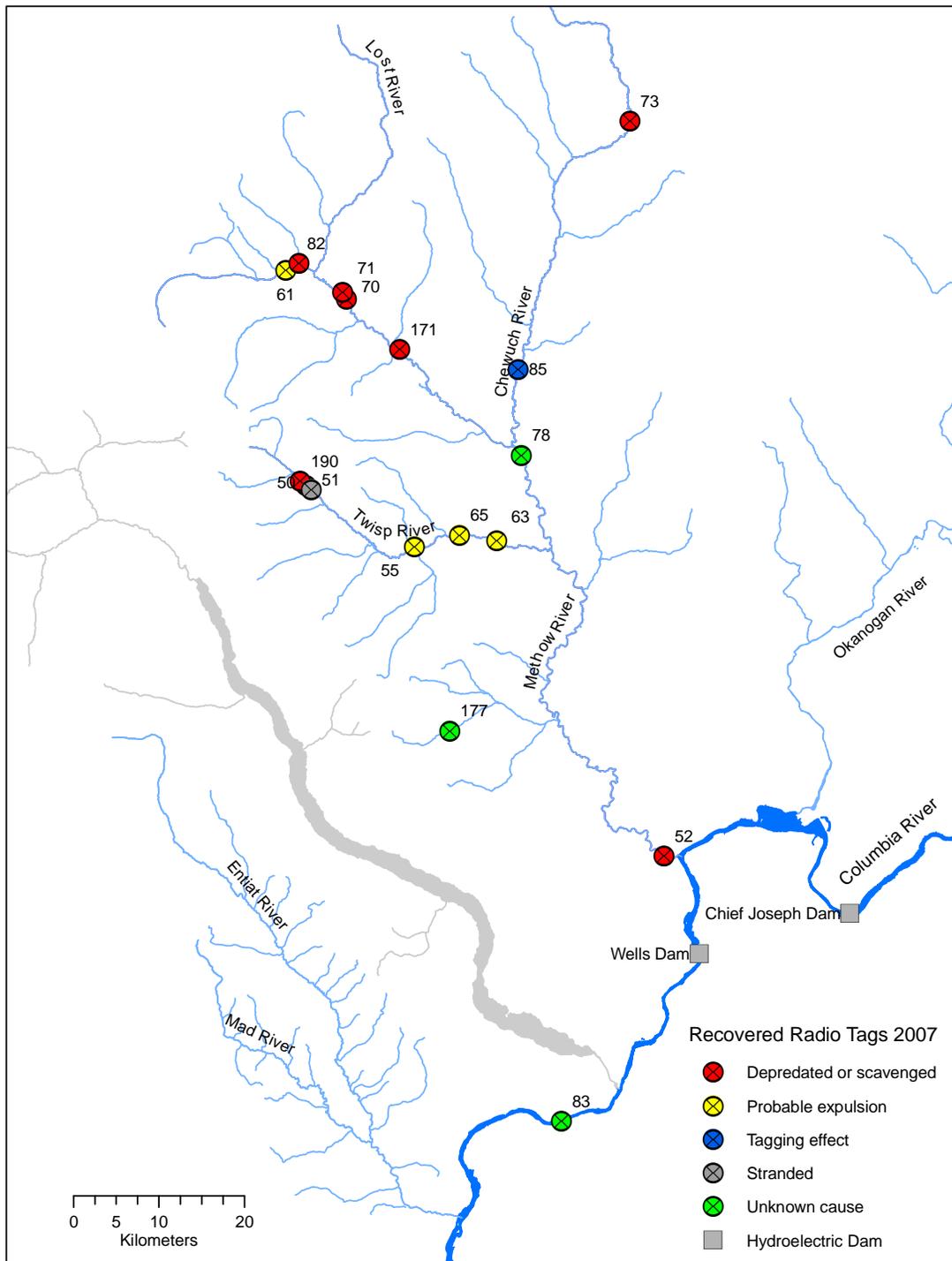


Figure 31. Recovery locations of bull trout radio transmitters during 2007.

Overwintering

The locations where tagged bull trout stopped migration and overwintered were distributed throughout the Methow River. Some bull trout remained isolated upstream of the dry reaches in the upper Methow River (codes 80 and 86) and in the upper Twisp River (code 67). Three bull trout (codes 75, 87, and 188) did not exit Wolf Creek and were located between rkm 7 and rkm 8. It is not known if the log jam at rkm 6.6 or other obstacles were factors in their sedentary behavior, but when observed on November 7, bull trout code 188 was located under a boulder at rkm 8 (Figure 32). In Lake Creek, bull trout code 84 overwintered in Black Lake after spawning.

Bull trout that were tagged in the Columbia River overwintered in the mainstem Methow River further downstream than bull trout tagged in the Methow River (Figure 33). Four Columbia River-tagged bull trout migrated back to the Columbia River, but the location of three (codes 53, 54, and 184) were not detected. Bull trout code 62 returned to the same Columbia River location it occupied during the winter of 2006/2007. The Columbia River location of one bull trout (code 174) that spawned in the Twisp River in 2006 but moved to the Entiat River in 2007 (see movements between core area section) was the farthest downstream overwinter location of a tagged Methow Core Area bull trout in 2007 (Figure 33).

In the Columbia River during every winter from 2005 to 2007 the locations of tagged bull trout from the Methow Core Area overlapped with tagged bull trout from the Entiat Core Area and most were downstream of the Entiat and Wenatchee rivers (Figure 34).



Figure 32. Photograph of bull trout code 188 underneath a boulder in Wolf Creek at rkm 8 on November 7, 2007.

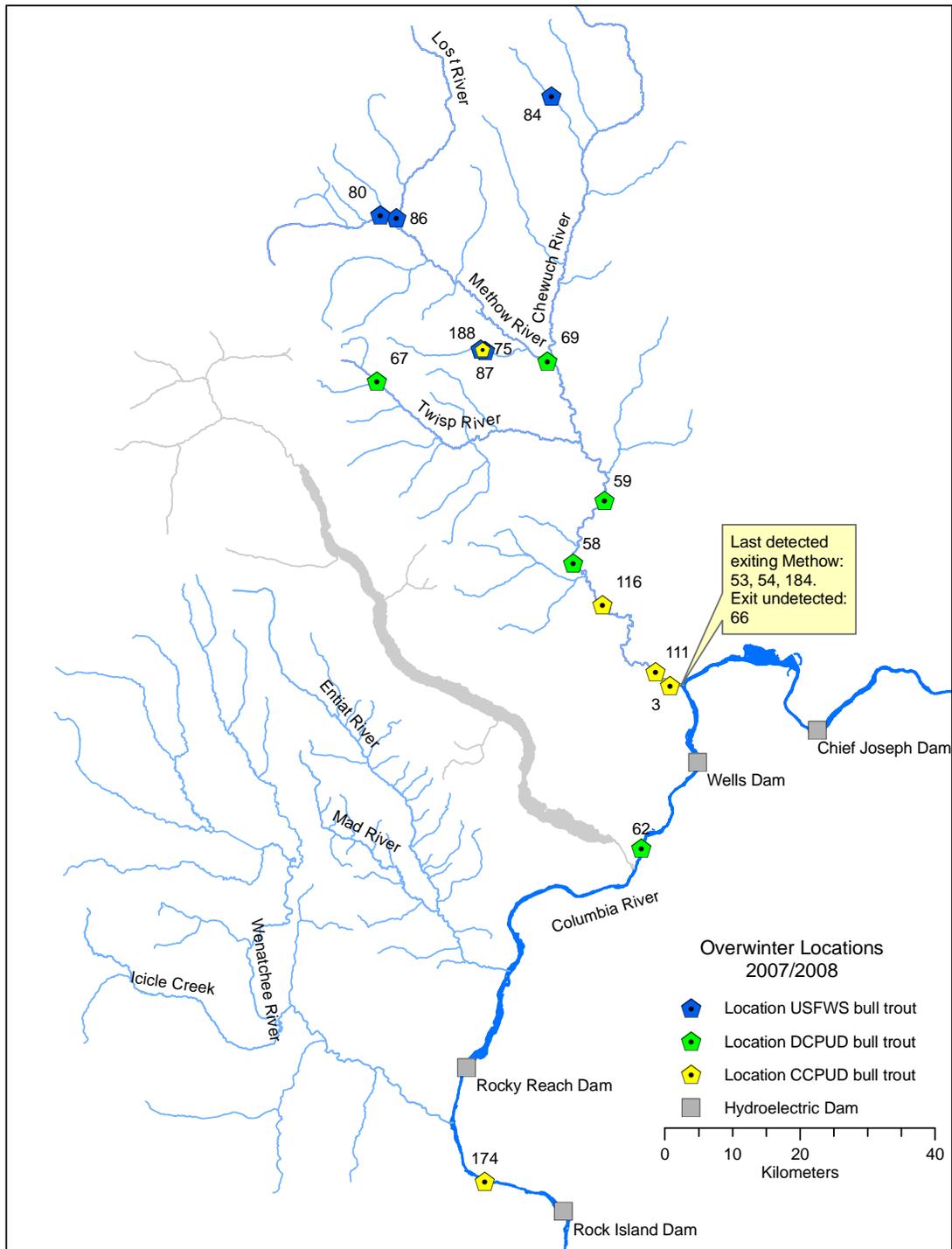


Figure 33. The overwinter locations of radio-tagged adult fluvial bull trout from the Methow Core Area during 2007/2008.

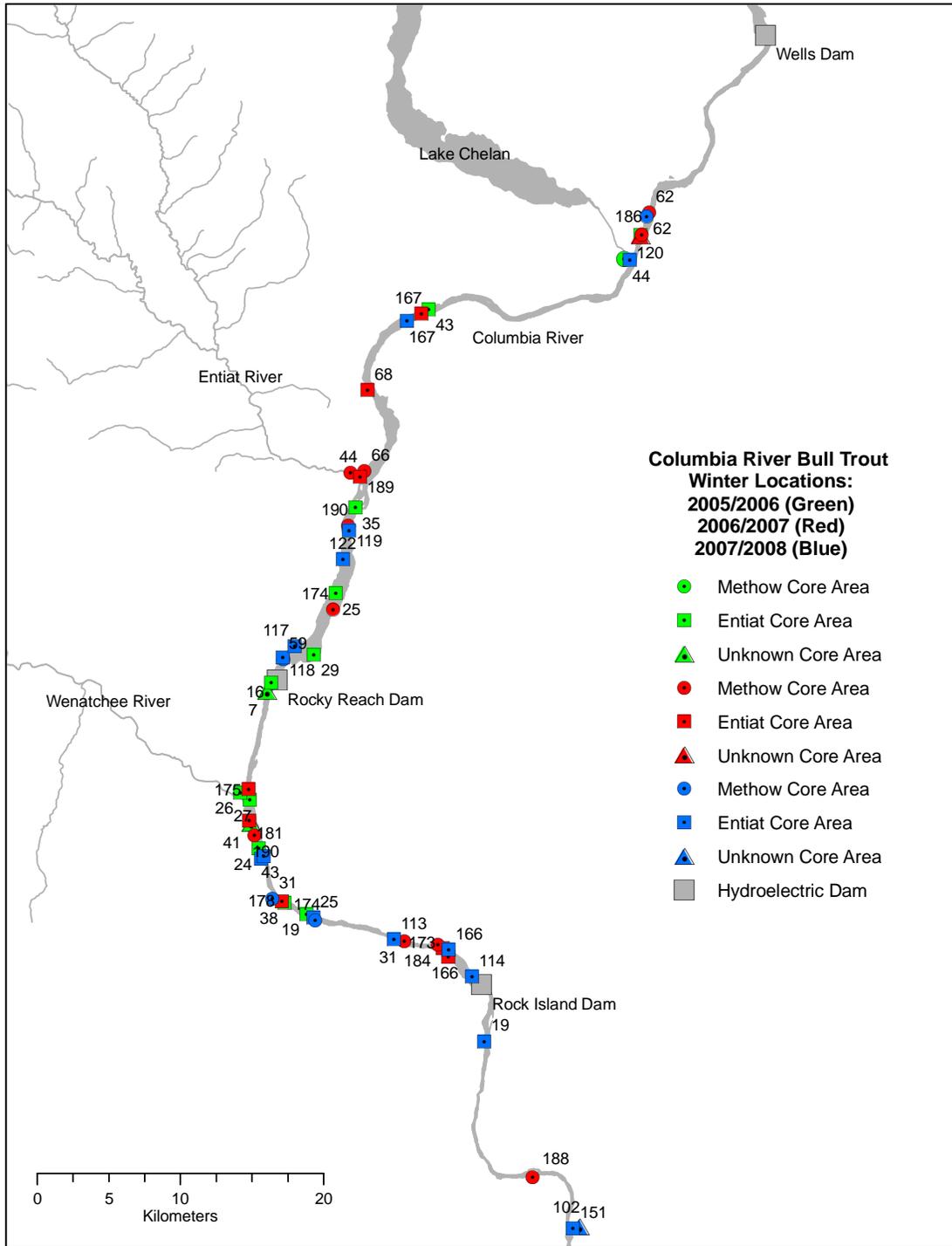


Figure 34. Columbia River winter locations of radio-tagged adult fluvial bull trout from the Methow and Entiat core areas during the winters of 2005/2006, 2006/2007, and 2007/2008.

Migration distances

The minimum known upstream and downstream migration distances are summarized separately for tagged bull trout with known pre-spawn and post spawn locations (Table 29), for tagged bull trout with known pre-spawn but unknown post-spawn locations (Table 30), and for tagged bull trout that died or shed tags before completing either the pre-spawn or post-spawn migration (Table 31). For 2006-tagged bull trout that reached a spawning area in 2007, the minimum known upstream migration distances ranged from 14.8 to 226.6 km.

Of the fourteen tagged bull trout with known pre- and post- spawn locations, two (codes 3, 62) were tracked back to near their 2006 winter locations and two (codes 86, 87) were tracked back to (or downstream of) their 2007 tagging locations. Three bull trout (codes 67, 80, 86) were isolated upstream of dry reaches and their post-spawn migration distances were necessarily shortened. However, for each of the other seven bull trout the downstream migration distance was shorter than the upstream distance (Table 29). Upstream migration distances ranged from 0 to 226.6 km and tagged bull trout migrating from the Columbia River traveled the farthest (Table 29). Downstream migration distances ranged from 1.1 to 116.4 km, and again Columbia River-tagged bull trout traveled the farthest, even if they did not exit the Methow River (Table 29).

Table 29. Minimum known upstream and downstream migration distances (km) of radio-tagged adult fluvial bull trout calculated from known pre-spawn, spawn, and post-spawn locations during 2007.

Code	Pre-spawn location	Upstream km	Downstream km	Post -spawn location	Notes
80	Methow	23.7	9.7	WF Methow	Tagged in 2006 in Methow
86	WF Methow	4.8	10.5	Lost	Tagged 2007 in WF Methow
87	Wolf	0.5	4.0	Wolf	Tagged 2007 in Wolf
188	Columbia	226.6	3.5	Wolf	Tagged in 2006 at Rocky Reach
75	Methow	14.8	3.2	Wolf	Tagged in 2006 in Wolf
84	Chewuch	39.1	1.1	Black Lake	Tagged in 2007 in Chewuch
67	Columbia	124.2	3.9	Twisp	Tagged in 2007 at Wells Dam
69	Columbia	126.7	31.7	Methow	Tagged in 2007 at Wells Dam
59	Columbia	125.2	60.0	Methow	Tagged in 2007 at Wells Dam
58	Methow	0.0	10.5	Methow	Tagged in 2006 at Wells Dam
116	Columbia	184.4	74.2	Methow	Tagged in 2007 at Rocky Reach
3	Methow	91.2	98.8	Methow	Tagged in 2005 at Rock Island
111	Columbia	204.1	116.4	Methow	Tagged in 2007 at Rocky Reach
62	Columbia	108.8	108.8	Columbia	Tagged in 2006 at Wells Dam

The post-spawn location could not be determined for four tagged bull trout in 2007. During pre-spawn migration two bull trout (codes 66, 184) moved into other tributaries prior to entering the Methow River and those movements are included in upstream migration. The minimum upstream migration distances for these fish ranged from 121.4 to 229 km (Table 30). The signal of one bull trout (code 115) was lost after spawning in the Twisp River and the signals of the other three (codes 54, 66, 184) were not detected as they passed the LG station and entered the Columbia River. For these three, the

minimum down downstream migration distance to the LG station ranged from 83.7 to 103.7 km (Table 30).

Table 30. Minimum known upstream and downstream migration distances (km) of radio-tagged adult fluvial bull trout calculated with unknown post-spawn location during 2007.

Code	Pre-spawn location	Upstream km	Downstream km	Post-spawn river	Notes
115	Columbia	190.6	6	Unk	Signal lost after spawn
54	Columbia	121.4	101.1	Columbia	Unk locations in Columbia
184	Columbia	229	83.7	Columbia	Includes Wenatchee in spring
66	Columbia	155.4	103.7	Columbia	Includes Okanogan, post spawn unk

Fifteen tagged bull trout either left the Methow River early, shed their tags prior to reaching a spawning area, or died before completing either the pre- or post-spawn migrations (Table 31). Two bull trout (codes 56, 57) migrated into the Methow River and traveled 53 and 54 km upstream before returning to the Columbia River. One bull trout (code 83) left the Chewuch River after it was tagged and traveled 134.5 km to the Columbia River where it died. Four bull trout (codes 55, 61, 63, 65) tagged at Wells Dam in 2007 entered tributaries of the Methow River and traveled 86 to 134.8 km before apparently shedding their transmitters. Code 73 migrated 54.1 km before it was depredated downstream of the upper Chewuch spawning reach. For the seven bull trout that died after spawning, pre-spawn migration distances ranged from 110.1 to 222.5 km and post-spawn migrations to their recovery locations ranged from 3.1 to 116.2 km (table 31)

Table 31. Minimum known migration distances (km) of radio-tagged adult fluvial bull trout, including fish that left the Methow River early, shed tags, or died before completing either pre- or post- spawn migrations.

Code	Spring location	Upstream km	Downstream km	Recovery location	Notes
70	Methow	110.1	16.9	Methow	Stranded/depredated?
71	Methow	117.7	16.3	Methow	Stranded/depredated?
73	Methow	54.1		Chewuch	Pre spawn depredation
83	Chewuch	0.6	134.5	Columbia	Early out/mortality
51	Columbia	120	3.1	Twisp	Stranded
52	Columbia	114.5	99.7	Methow	Post spawn mortality
53	Columbia	119.8	116.2	Columbia	Post spawn mortality
55	Columbia	98.4		Twisp	Shed ?
56	Columbia	53	59	Columbia	Early out/mortality
57	Columbia	54	40.7		Early out/unknown
61	Columbia	134.8		WF Methow	Shed ?
63	Columbia	86		Twisp	Shed ?
65	Columbia	123.7 ^a		Twisp	shed ?
171	Columbia	164.6	20.3	Methow	Post spawn mort/ depredated?
190	Columbia	222.5 ^a	4.1	Twisp	stranded/depredated?

Notes: a- includes distance moved to and back from detection at the OK station on the Okanogan River

Movements between core areas

Three tagged bull trout (codes 54, 66 and 174) were documented moving to a different core area in 2007 than in 2006 (see Appendix 1 for detailed descriptions of their movements in 2006 and 2007).

Codes 54 and 66 were tracked in the Entiat Core Area in 2006 and the Methow Core Area in 2007 (Figures 35 and 36). After tagging and release upstream of Wells Dam in 2006, these bull trout moved downstream and eventually entered the Entiat River where they were tracked to rkm 46.7, downstream of Box Canyon. Neither of these fish made it to the preferred spawning grounds upstream and it is not known if they attempted to spawn downstream of the canyon. Both exited the Entiat River in the fall and overwintered in the Columbia River. In the spring of 2007, they migrated to the Twisp River, where code 54 was located on the spawning grounds near Reynolds Creek and code 66 on the spawning grounds upstream of the dry reach. Both then migrated back downstream to the Columbia River.

Code 174 was tracked in the Methow Core Area in 2006 and the Entiat Core Area in 2007 (Figure 37). After it was tagged at Rocky Reach in 2006, code 174 migrated to the Twisp River and was located on the spawning grounds near Reynolds Creek. It returned to the Columbia River and overwintered downstream of the Entiat River. In the spring of 2007, code 174 made several movements in the Rocky Reach Reservoir before moving into the Entiat River where it was detected at rkm 41.8 on August 17, downstream of the bull trout spawning reaches. It moved downstream before spawning commenced and exited the Entiat River on August 30.

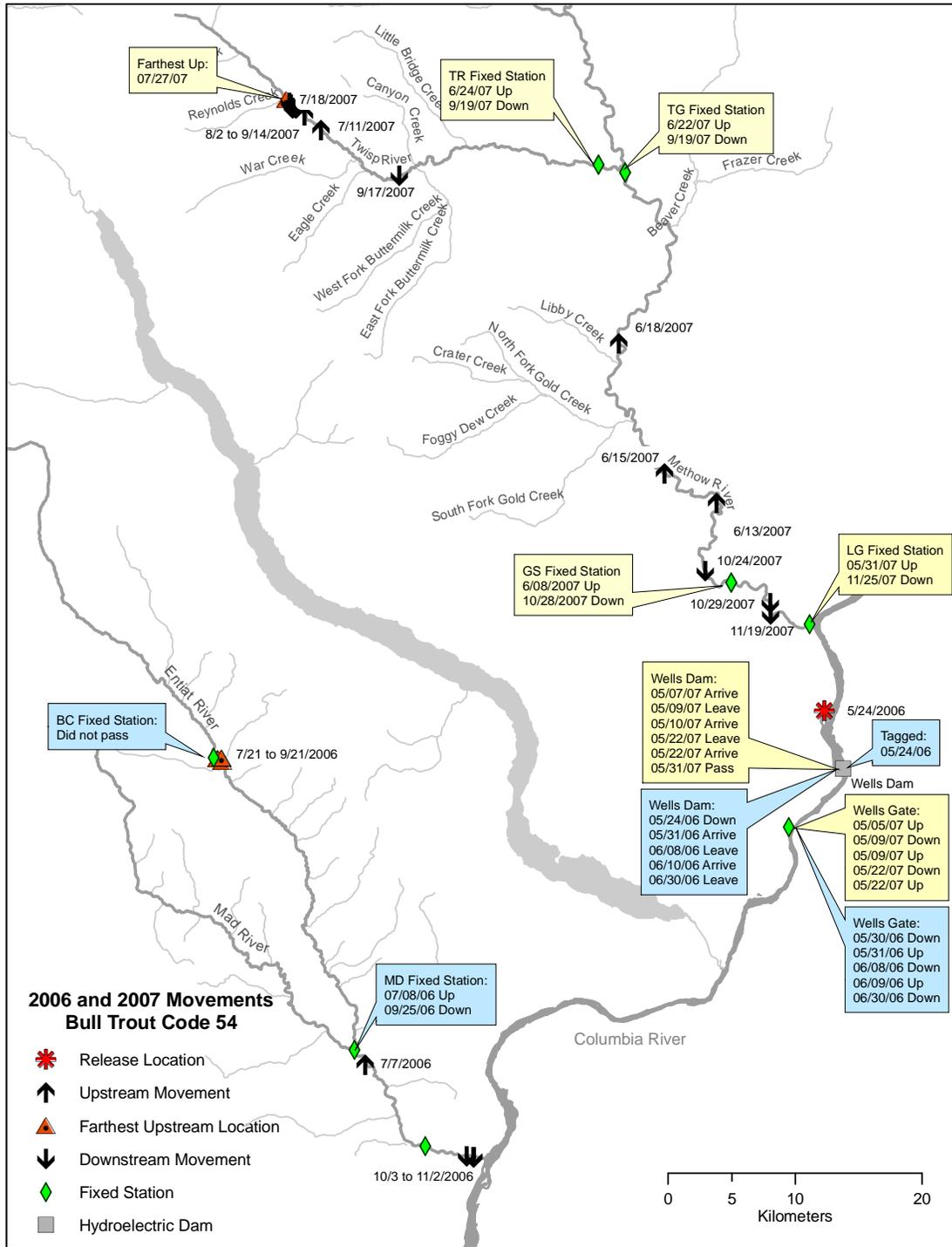


Figure 35. Map of the movements of radio-tagged adult fluvial bull trout code 54 in the Entiat River during 2006 and the Methow River during 2007.

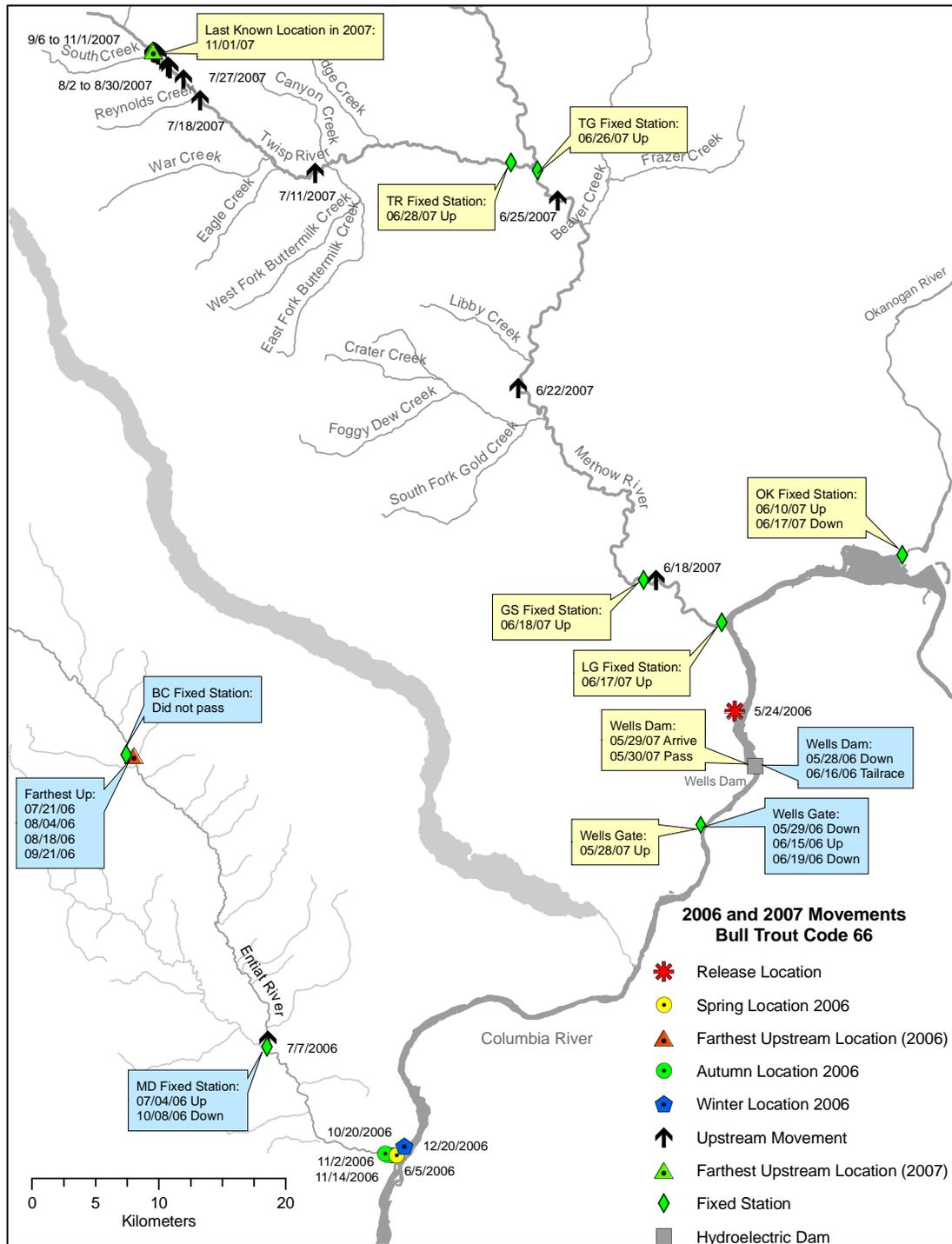


Figure 36. Map of the movements of radio-tagged adult fluvial bull trout code 66 in the Entiat River during 2006 and the Methow River during 2007.

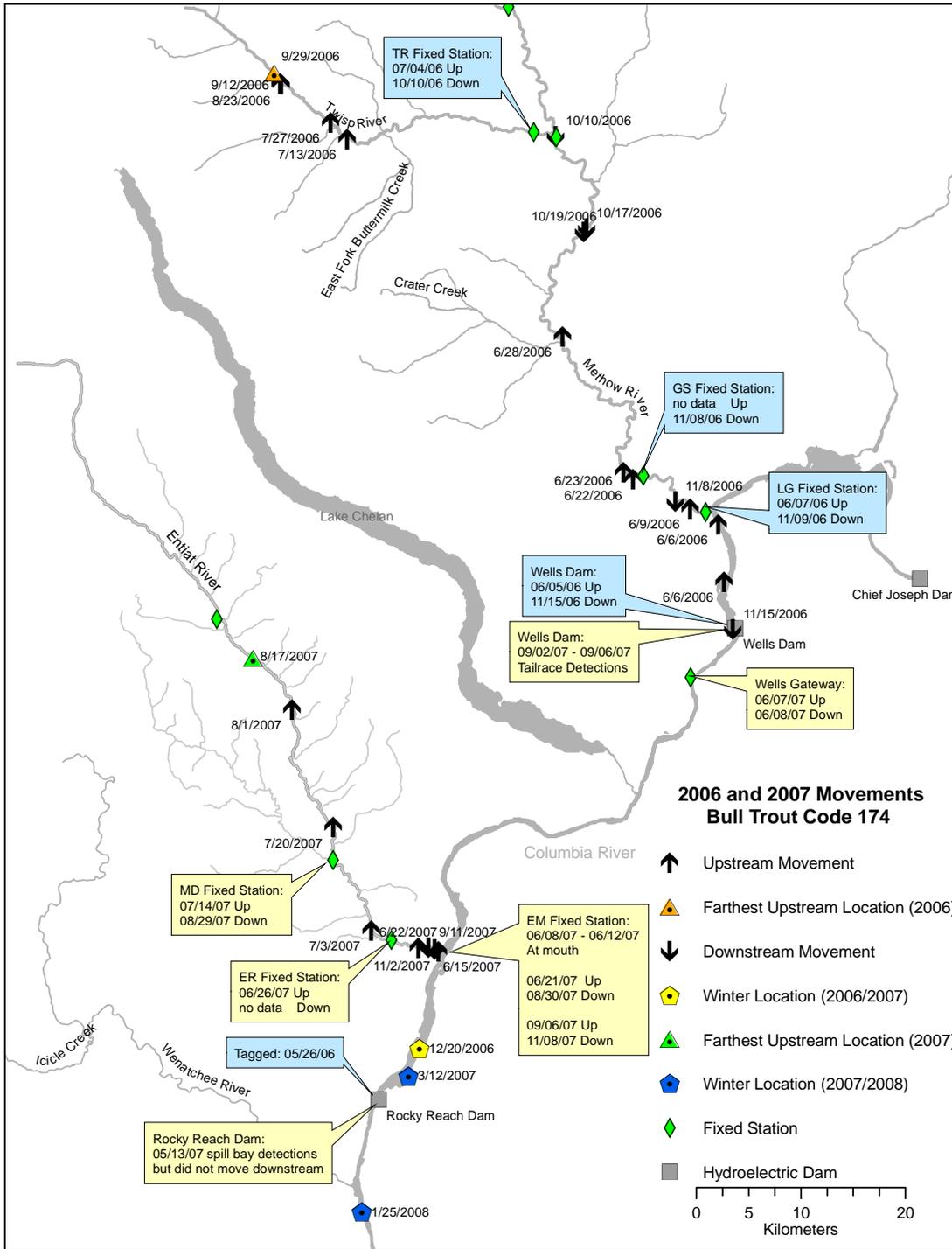


Figure 37. Map of the movements of radio-tagged adult fluvial bull trout code 174 in the Methow River during 2006 and the Entiat River during 2007.

Discussion

New and additional information on the migration patterns of adult fluvial bull trout in the Methow and Columbia rivers was gathered during 2007. The results should be useful for bull trout recovery planning, watershed planning, stream restoration activities, fisheries management, and ESA consultations. Although the primary purpose of this report is to present this information, discussion of several topics is warranted.

Migration rate- Pre-spawn migrating bull trout moved very fast through the Columbia River reservoirs and traveled at rates of up to 58 km/day during 2007. Migration rate increased as tagged bull trout moved through successive reservoirs but rate declined as migration proceeded up the Methow River. When the amount of time spent at dams is included, the average migration rate in the Columbia River was still faster than the average migration rate in the Methow River. Telemetry studies on steelhead and several salmon species have observed similar patterns of delay at dams followed by high migration rate in the Columbia River and slower movements in tributaries (English et al. 1998; Keefer et al. 2004). Although it appears that the fast migration of bull trout through the reservoirs may somewhat compensate for the apparent delay in passing dams, it is unknown if similar rates would naturally be attained if the Columbia River were not impounded.

Radio-tagged bull trout in the Columbia River exhibited a different pattern of pre-spawn migration than tagged bull trout that had overwintered in the Methow River in 2007. Bull trout began migration in the Columbia River well before bull trout in the Methow River and some actually migrated past the Methow River bull trout before those fish themselves began to move upstream. Thus contrary to what might be expected, bull trout with the shorter pre-spawn migration distances were not necessarily the first individuals to arrive in a spawning tributary. Interestingly, migration rate decreased as bull trout neared or entered their spawning tributary in the Methow Core Area, suggesting bull trout are able to gauge where they are in relation to their destination (see homing section below). Daily migration rate also declined as the fish proceeded further upstream in the core area because movements were primarily confined to the shorter night period and resulted in a correspondingly shorter distance covered during each 24 hour period.

Diel movement periods- The diel movement periods in the Columbia River and Methow River vary according to location and season, similar to bull trout movements in the Entiat River (Nelson and Nelle 2008). In the Columbia River during pre-spawn migrations, movements past the Rocky Reach tailrace station and the Wells Gateway station occurred mostly during the day. Because these stations are downstream of the dams, it is a reasonable assumption this is the natural pattern of upstream movement during spring in the Columbia River. Movements of tagged bull trout in the ladders at Rocky Reach and Wells dams showed only minor shifts- at Rocky Reach Dam movements shifted slightly more to the day while at Wells Dam the shift was to the night. The overall change in behavior was relatively small and may be related to the type of fish passage facility specific to each site. Tagged bull trout were slightly more likely to enter the Methow

River during the day, a pattern similar to entrance into the Wenatchee and Entiat rivers. As pre-spawn migrations continued upstream, movements were mostly at night.

During post-spawn migrations in the fall, movements in the Methow River were mostly at night until tagged bull trout reached the mouth and then some movements shifted towards the day. Movement periods at the Wells Gateway and Rocky Reach Dam were similar, with 60 to 70% of the movements during the night, but at Wells Dam the few movements detected were all at night.

The diel pattern of adult fluvial bull trout movements during migration as described above is more complex than has been previously reported (e.g. Fraley and Shepard 1989; Swanberg 1997). In general, it is thought fluvial bull trout forage at night and seek cover during day for concealment from terrestrial or aerial predators (Al-Chokhachy and Budy 2007). The diel movement pattern during migrations that we observed appears related to stream size and water depth, where deeper water functions as cover for adult fish, allowing them to migrate during daylight. This pattern may be more common than reported in the literature. It appears that studies that report predominately night movement monitored small tributaries of lakes (Downs et al. 2006), only monitored small spawning tributaries in a larger river system (Fraley and Shepard 1989; Lamperth et al. 2007), or trapped mostly during fall post-spawn downstream migration (Salow and Hostettler 2004). Those movements are in areas where we would expect nighttime movements and are consistent with our observations of the pattern within a much larger system.

Spawning areas- Most tagged bull trout entered spawning tributaries by early July and were detected on or near spawning areas by mid-July, well in advance of spawning season. Fidelity to local populations was observed, as ten bull trout tagged in previous years returned to the same spawning area in 2007. No tagged bull trout were tracked to a different spawning area, but three bull trout tagged in 2006 moved to a different core area in 2007 (see core areas discussion section below). Three tagged bull trout exited the Methow River prior to spawning and three bull trout did not migrate to spawning areas during 2007, suggesting some form of alternate year spawning may occur for some bull trout in the Methow Core Area.

Tagged bull trout migrated to three tributaries where movements of fluvial fish had not been detected previous to 2007. It was thought only adfluvial bull trout from Black Lake spawned in Lake Creek (USFWS 2002), but code 84 migrated from its tagging location in the lower Chewuch River to upper Lake Creek. It spawned above Black Lake, and is the first documented fluvial bull trout on that spawning ground. Code 177 was the first fluvial bull trout from the Columbia River documented in Foggy Dew Creek. The carcass was recovered prior to the 2007 spawning season and circumstances indicate it overwintered in the creek after it entered undetected in 2006, but it is unknown if it spawned that year. Code 69 was the first Columbia River bull trout documented in Cedar Creek, but it apparently did not spawn.

Only three limited redd surveys (1995, 1998, 2001) have been conducted in the lower Lost River (from Eureka Creek to Monument Creek) and two redds were observed near Monument Creek in 2001 (USFS 2001). Because two tagged bull trout (codes 70, 71) migrated to that area in both 2006 and 2007, we assumed they spawned there (see barrier section below). Although difficult to access, additional redd surveys should be considered for this area of the Lost River.

There has not yet been any telemetry confirmation of bull trout from the Columbia River migrating to and spawning in the Chewuch River system (Nelson et al. 2007). Three fluvial bull trout were tagged in the lower Chewuch River in 2007, but it is unknown where these fish had reared or overwintered. Bull trout code 83 initially moved upstream after it was tagged in the Chewuch River, but turned around and moved downstream one week later. It traveled very quickly in the Methow River and was briefly detected at the PIT array in Gold Creek before it traveled to Columbia River where it died. This downstream movement suggests code 83 may have been a Columbia River fish, but the erratic behavior indicates the effects of radio-tagging influenced its movements and confound any conclusions. Any Columbia River connection for code 83 will remain unknown, as it died soon after it moved to the Columbia River. Bull trout code 84 overwintered in Black Lake and did not move further downstream after spawning in 2007. Further study is needed to define the interaction between the Columbia River and the Chewuch River for migratory bull trout.

Summertime use of the Methow River- Two radio-tagged bull trout were monitored in the main-stem Methow River during the summer in 2007. Water temperatures are not known during the summer at the locations of these bull trout, but a longitudinal temperature profile for the Methow River was developed during airborne thermal infrared remote (TIR) sensing in 2009 (Watershed Sciences 2009). Water temperature monitoring was also conducted at locations in the Methow River during 2005 (USBR 2008). Therefore, only a general discussion regarding water temperatures at the summer locations of the tagged bull trout is presented here.

Bull trout code 58 remained near rkm 50 in the same area it had overwintered. The TIR temperature profile indicates this reach has few springs or seeps and is warmed by tributary inputs. Water temperature was about 17° C during the flight on August 24, 2009 (Watershed Sciences 2009). Maximum temperatures during monitoring in this area were about 22° C on August 8, 2005 (USBR 2008). Despite the potential for high water temperatures, this bull trout was observed to be in good condition on August 24, 2007. Adult fluvial bull trout have been observed to tolerate temperatures in this range in the Entiat River (Nelson and Nelle 2008) and in the Lostine River, Oregon (Howell et al. 2010). However, the long term effects of elevated stream temperatures on bull trout behavior and survival are not known. During the following winter, code 58 moved a short distance downstream and then coded motionless, but it was not possible to determine if the summer temperatures played a long term role in its apparent demise six months later.

Bull trout code 62 overwintered in the Columbia River before migrating back upstream in the Methow River and was located near rkm 77, where it moved into and out of the

Barkley Irrigation Ditch several times during mid July to early October, 2007. This bull trout was observed to be very thin both when it was recaptured at Wells Dam during the pre-spawn migration (LGL and DCPUD 2008) and when it was caught and moved from the ditch in early October (WDFW 2007). It is unknown if its relatively poor condition was a factor in these movements or if foraging or refuge behavior also played roles. It is possible code 62 was foraging in the ditch, as several hundred fish, including juvenile salmon *Oncorhynchus* spp., steelhead or rainbow trout *O. mykiss*, brook trout *Salvelinus fontinalis*, mountain whitefish *Prosopium williamsoni*, dace *Rhinichthys* spp., sculpins *Cottus* spp., and suckers *Catostomus* spp. were rescued after the ditch was drawn down for the season (WDFW 2007). The TIR temperature profile indicated several seeps in this reach that cool and moderate stream temperature. Water temperature was 15.8° C during the flight on August 24, 2009 (Watershed Sciences 2009) and maximum temperatures recorded during monitoring in the area were 20.6° C on August 8, 2005 (USBR 2008). Stream restoration planning is in progress to modify the ditch to function as off channel habitat and increase fish habitat (R. Parrish, USFWS, pers. comm.). The behavior of bull trout code 62, combined with the relatively moderate temperatures in the reach, suggests the restoration has potential to improve bull trout foraging or refuge habitat as well.

Dry reaches- Subsurface flows occurred in the Methow Core Area during every year of the study. The annual development of the dry reach in the upper Methow River is due to the natural hydrogeology of the area (Konrad et al. 2003; USBR 2008). Upstream of the Lost River, the Methow River and tributaries flow through narrow valleys with only thin alluvial deposits over bedrock. Downstream of the Lost River to Weeman Bridge (rkm 98), the valley significantly widens and alluvium fills a glacial-carved trough to a depth of 300 m. As a result of the increasing width and depth of these unconsolidated deposits, ground-water levels are likely to be lower than the river surface, promoting recharge of the aquifer by loss of water from the river. Eventually flows go subsurface and the dry reach develops. Although not yet investigated, presumably a similar situation results in dry reaches in the upper Twisp River and Lost River.

The seasonal dry reaches appear to be major factors in the movement patterns and population structure of bull trout in the Methow Core Area. The effect of a dry reach depends on the pattern of rainfall during autumn and on the behavior of individual bull trout, but large numbers of adult bull trout can potentially be affected. On average, 70% of the spawning population in the Twisp River and 100% of the population in the West Fork Methow River and Lost River are isolated each year. The spawning populations of Early Winters Creek and Goat Creek can also be isolated. Increased mortality due to de-watering and stranding in a dry reach can be substantial and was estimated at 24 to 63% of the adult spawning population in Gold Creek in the Yakima River system (Wissmar and Craig 2004). Recovery of several dead tagged and untagged bull trout, along with observations of several bull trout accompanying tagged fish that later died, indicates a significant number of adult bull trout died at dry reaches in the Methow Core Area during 2007. As occurred this year, it appears the most dangerous situation for some bull trout is when rains re-water the dry reach enough to induce downstream movement but flows are not high enough to allow clear passage through the entire reach (Nelson 2004). Individual bull trout respond differently to isolation, with those bull trout near the dry

edge facing the highest risk, either from stranding or depredation. Interestingly, several tagged bull trout remain upstream and never approach a dry reach; because the situation has apparently been occurring for a very long time, natural selection may be favoring that behavior.

The seasonal dry reaches may also affect juvenile bull trout survival and movement patterns. Captures of juvenile bull trout at rotary screw traps in the Wenatchee and Entiat river systems indicate distinct peaks in the spring and fall, with the majority of emigration occurring in mid-September to November (Murdoch et al. 2001; Mallas and Nelson 2005). In contrast, in the Twisp River most captures in the rotary screw trap operated by the Washington Department of Fish and Wildlife at rkm 2.1 occur in the spring and a fall peak only occurs in years when rains substantially re-water the river (WDFW, unpublished data from 2005 to 2009). Thus the oldest age class of juveniles that presumably would have emigrated in the fall is instead usually isolated until spring and the resultant higher density of that age class may result in reduced survival of younger age classes (Paul et al. 2000). It is also possible the delayed juvenile emigration may influence the relatively short migration patterns of adult fluvial bull trout in the upper Methow River and may also be selecting for larger resident fish. In addition, increased mortality of emigrating juvenile bull trout may result from stranding throughout the dry reaches.

The effects of dry reaches on all life history stages of bull trout require further study, but it should be noted that even though the majority of seasonally isolated bull trout are in the Twisp River, that local population is the largest and most robust in the Methow Core Area. It appears the favorable spawning and rearing conditions in the upper Twisp River may compensate for the negative effects of isolation. This population has a high number of adults from the Columbia River and the higher fecundity of those larger females may also play a compensatory role. In addition, on average 30% of the bull trout redds are constructed downstream of the dry reach and presumably the survival of their progeny is unaffected by the phenomenon.

Barriers- As in 2006, fluvial bull trout in Early Winters Creek were located on the spawning grounds downstream of the waterfalls at Highway 20 (rkm 13.1). No tagged bull trout were tracked upstream of the falls, and combined with the height of the falls and stream flows during the migration period, indicates to us the waterfalls are a barrier to further upstream migration. Based on the report of a migratory-size bull trout electro-fished upstream of the barrier, it had been suggested the falls were passable to fluvial bull trout (USFWS 2002). However, examination of that electro-fishing data and other survey information indicates the bull trout are resident upstream of the falls (see Appendix 2).

In the Lost River, tagged bull trout were aerially tracked to the vicinity of Monument Creek (rkm 11.2), where an impassable rockslide (and seasonal dry reach) blocked further upstream movements. The rockslide was first documented in 1935 (Bryant and Parkhurst 1950), but it is unknown how long the upper Lost River system has been isolated from migratory bull trout. There is another apparently impassable falls near Drake Creek at rkm 19.3 (Bryant and Parkhursts 1950). It is not known what effect these

natural barriers have on the population structure and life history expression of bull trout in the upper Lost River system. Comparison of the genetic profiles of bull trout upstream and downstream of the barriers may reveal additional insights into the life history strategies in both the Lost River and Early Winters Creek and may also indicate how long the upper populations have been isolated.

The log jam in Wolf Creek (rkm 6.6) appeared to be an obstacle to the migration of some fluvial bull trout to the upper spawning reach and as a result, 27% of the bull trout redds were located downstream of the jam in 2007. Two tagged bull trout were located downstream of the jam until a heavy rainfall in late July provided enough flow for passage. It appeared then the stream flowed over a series of logs in an avulsion on the left bank and provided a temporary step pool avenue for passage around the jam. During annual spawning ground surveys up to 80% of the bull trout redds have been counted downstream of the jam (USFS 2001) so it probable that in some years only a few fluvial bull trout are able to pass the jam. Because resident sized redds are also observed in Wolf Creek (USFS 1996) it may be that in some years only resident bull trout are able to spawn upstream of rkm 6.6.

Overwinter locations- The overwinter locations of bull trout tagged in the Columbia River exhibited a different pattern than was noted during previous years of the study. In 2007, 62% of the Columbia River bull trout overwintered in the main-stem Methow River compared to only 8% in 2006 (Nelson et al. 2007). Similar to 2006, all bull trout tagged in the Methow River overwintered in the Methow River system in 2007. Although the movement distances to overwinter locations for Columbia River-tagged bull trout were shorter in 2007, most Columbia River-tagged fish were located farther downstream than the Methow River-tagged fish. Interestingly, in the Columbia River there does not appear to be segregation of bull trout from different core areas, as tagged bull trout from the Methow Core Area overwintered alongside tagged bull trout from the Entiat Core Area. The majority of tagged bull trout in the Columbia River appear to overwinter in reaches downstream of the confluence of the Entiat River and downstream of the confluence of the Wenatchee River.

Three tagged bull trout overwintered in Wolf Creek, similar to bull trout code 31 in 2005 (Nelson and Nelle 2007). It is not known if low flows and the log jam at rkm 6.6 are a factor or if this behavior is voluntary.

Movements between core areas- Three radio-tagged bull trout have been documented in both the Methow and Entiat core areas in alternate years. All three were located on the Twisp River spawning grounds- one in 2006 (code 174) and two in 2007 (codes 54 and 66). Unfortunately during 2006 and 2007 most bull trout were unable to access the preferred spawning grounds in the upper Entiat River due to obstructions in Box Canyon (Nelson and Nelle 2008) so there is no definitive evidence that any of the Twisp River bull trout actually spawned in the upper Entiat River. However, bull trout codes 54 and 66 were located at the lower limit of the known spawning distribution downstream of the canyon (Nelson et al. 2008) so it cannot be ruled out that they spawned in both core areas in alternate years. Bull trout code 174 did not access any known spawning area and left

the Entiat River prior to the spawning season in 2007, and is only known to have been on spawning grounds in the Methow Core Area. The question of dispersal between core areas is another area where the genotypic baseline of local populations will be useful once it is completed.

Movements to Okanogan River- The historical distribution and possible life history forms of bull trout in the Okanogan River (on the U.S. side of the border) are unknown and the river is currently considered to be nonessential habitat for bull trout (USFWS 2002; USDI 2010). Therefore it is interesting that radio-tagged bull trout were detected at the mouth of the Okanogan River. Telemetry cannot address why the fish moved here, but these movements appeared to have been brief explorations as all three eventually migrated into the Methow River and entered the Twisp River. Two of the bull trout were tagged in 2006 (codes 66 and 190), and both exhibited unusual behavior that year as well- one migrated downstream to the Entiat River after it was tagged at Wells Dam and the other stayed in the Rocky Reach reservoir after it was tagged at Rocky Reach Dam- and it may be the movements into the Okanogan reflect the individual behavior of these fish. It is also possible that during the pre-spawn migration they inadvertently moved past the Methow River and entered the Okanogan River before correcting the mistake and returning to their natal river (overshoot and prove in the terminology of Ricker 1972). The movement of the third bull trout (code 65) was more unusual in that it entered the Methow River the day after it was tagged in 2007 and resided in the lower river for several days before it moved to the Okanogan River. It then re-entered the Methow River and proceeded upstream to the Twisp River. It is possible that this was also proving behavior or that it was a tagging effect (the transmitter was apparently shed in the Twisp River).

Because the only telemetry station on the Okanogan River was at the mouth, it is not known how far the bull trout moved upstream in 2007. However, it is known that adult fluvial bull trout will move to at least rkm 9.0, as two bull trout tagged in 2001 and 2002 entered the Okanogan River and were detected by a telemetry station located at that spot before they left and entered the Methow River (BioAnalysts 2004). Tissue samples were taken from all of these explorers so this is another area where genotypic analysis may provide some additional insights when the baseline genetic profile of local bull trout populations is complete.

Homing behavior- Although little work on homing and navigation has been done on bull trout, studies of other fish indicate several sensory cues may be involved, including audition, chemotaxis, electrolocation, magnetic sense, rheotaxis, thermal gradient, landmarks, and various forms of celestial-compass orientation (Parkyn et al. 2003). Learning can also play an important role in homing migrations (Smith 1985). After anadromous salmonines enter fresh water, olfactory detection appears to be the primary mechanism for homing to the natal stream and two different hypotheses for this mechanism have been proposed (Nordeng 1989): imprinting (juvenile fish are imprinted and respond to abiotic or biotic odors) and pheromone (fish respond to strain specific pheromones).

The migration patterns of bull trout documented in the Upper Columbia Recovery Unit suggest several complex and interacting mechanisms may be involved and some speculation is justified. The overshooting and proving behavior of the bull trout described above indicates that olfaction may be important. As for salmon, stream odor is probably the major cue, but pheromones may also be involved, as has been experimentally documented for Arctic char (Nordeng and Bratland 2006). Interestingly, bull trout are believed to form pairs prior to entering spawning tributaries in the Flathead Lake and River system in Montana (Fraley and Shepard 1989) and during pre-spawn migrations in the Columbia River bull trout are occasionally observed in pairs in the ladders at Rocky Reach and Rock Island dams (S. Hemstrom, CCPUD, pers. comm.; see Figure 38). If we speculate this is early pair bonding behavior, given the fidelity of bull trout to natal area in this recovery unit, it suggests pheromone recognition may also play a role. This is an area which needs substantial investigation before any conclusions are drawn.

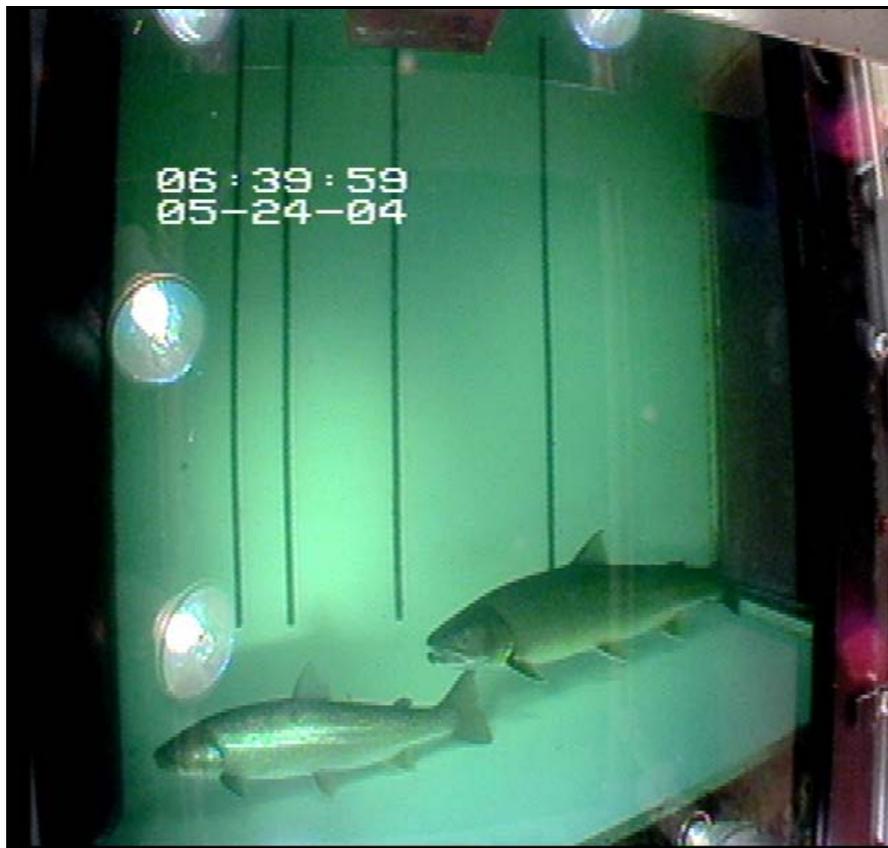


Figure 38. Photograph of female and male adult fluvial bull trout in the fish ladder counting window at Rocky Reach Dam on the Columbia River, May 24, 2004 (photo courtesy of Chelan County PUD).

Most studies of fish migration to spawning areas are conducted on semelparous anadromous salmonids and it is possible different mechanisms other than olfaction are used by iteroparous freshwater species, as indicated by the migration of the two bull trout into Wolf Creek during 2007. Because one had to move 2.2 km downstream, detection of the specific stream odor or use of positive rheotaxis was not possible and some other mechanism must have been used. Bull trout are also known to move downstream to enter spawning tributaries over much farther distances- some Entiat River bull trout overwinter

in the Columbia River upstream of the confluence and must move at least 30 km downstream to enter the tributary (Nelson and Nelle 2008) and in Lake Pend Oreille, Idaho, pre-spawn bull trout must migrate 35 km downstream in the Pend Oreille River to enter the Priest River (DuPont et al. 2007). In Wolf Creek the bull trout entered within five days of each other, even though one traveled 220 km upstream and had to start migration a month earlier, so the celestial cues to initiate movement were different for each fish. Declining flows and increasing temperatures are correlated with migration into tributaries of the Columbia River (BioAnalysts 2004; Nelson and Nelle 2008), but these were also different for the Wolf Creek fish. Thus it appears learning and memory may be important in bull trout migration. Research suggests hypothalamic neurohormones and the brain-pituitary-gonadal axis play a role in homing mechanisms in salmonids (Ueda et al. 2000). Therefore, we speculate that in bull trout this axis may act as a navigation system that includes a “map” for navigation of the route, an “odometer” to indicate how far they moved from the natal stream, a “clock” to determine how fast they must move, and a “calendar” to decide when to begin. Very few studies have been conducted on navigation in freshwater fishes, and our observations indicate that fluvial bull trout are an intriguing candidate for investigation of homing behavior.

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Appendices

The following appendices are contained in a separate document titled: *Appendices for the Report: Migration Patterns of Adult Fluvial Bull Trout in the Methow and Columbia Rivers During 2007*.

Appendix 1: Descriptions and maps of the movements of individual bull trout.

Appendix 2: Analysis of resident bull trout in Early Winters Creek.

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