Bull Trout Distribution, Movements and Habitat Use in the Umatilla and John Day River Basins

2006 Annual Progress Report

Prepared by:

Paul M. Sankovich
Donald R. Anglin

Department of the Interior
U.S. Fish and Wildlife Service
Columbia River Fisheries Program Office
1211 SE Cardinal Court, Suite 100
Vancouver, WA 98683

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Table of Contents

List of Figures

List of Tables

Abstract

The goal of U.S. Fish and Wildlife Service studies in the Umatilla and John Day basins is to provide information that can be used to develop recovery actions for bull trout (*Salvelinus confluentus*) listed as threatened under the Endangered Species Act. In 2006, we focused on gaining a better understanding of the seasonal distribution and movement of subadult bull trout in the Umatilla Basin and fluvial adult bull trout in the John Day Basin. In the Umatilla Basin, we operated a screw trap in spring and snorkeled at night in late summer and fall in the upper Umatilla River to capture subadults for radio or passive integrated transponder (PIT) tagging. We also maintained a PIT tag detection array near the mouth of the North Fork Umatilla River. Thirty-five subadult-sized bull trout were captured in the screw trap. Twenty-four were outfitted with radio tags (45-293 d battery lives) and eight were PIT tagged. The radio-tagged fish displayed three general patterns of movement, travelling up- or downstream an appreciable distance (>1 km) or remaining near the release site. The upstream or limited movement by some individuals suggests they were moving locally rather than undertaking a directed downstream migration when trapped. The fish that moved downstream travelled between 3 and 18 km from the release site. Most arrived within 1 to 7 d at a location where they resided throughout the remainder of their tag's life. One of two radio-tagged bull trout captured by snorkeling and dip netting at night remained at its release site during the summer and moved downstream 7 km to river km 136 (near Bobsled Creek) in the fall. The other, which was 298 mm in fork length when tagged in August, was located on the spawning grounds in the North Fork Umatilla River in September, and presumably was an adult rather than a subadult. Eleven bull trout that were subadult-sized when tagged in the North Fork by researchers from Utah State University were detected at the PIT tag array. The peak in detections occurred in the spring. In the John Day Basin, we operated a weir trap in the upper North Fork John Day River in summer to capture fluvial adult bull trout for radio tagging. We also conducted spawning ground surveys in the North Fork and its tributaries Baldy and South Fork Desolation creeks to gather information on abundance and distribution. Three bull trout and three apparent brook trout x bull trout hybrids that were fluvial adult-sized were trapped. One of the apparent hybrids had been tagged in the upper North Fork in 2005. It had wintered in the North Fork, 71 km downstream from its upstream-most location on the spawning grounds. There appeared to be no impediments to its movement between its wintering site and the spawning grounds in 2005 and 2006. All the fish tagged in 2006 migrated upstream onto the spawning grounds. Two hybrids were recaptured in late September, when they exhibited no secondary sexual characteristics and no milt or eggs could be stripped from them. They and the hybrid tagged in 2005 were never observed displaying spawning behavior during tracking events. We were unable to track the movements of the tagged fish in late fall and winter because all of our scheduled flights were cancelled due to inclement weather. During the spawning ground surveys, we counted only six redds in the North Fork John Day River and Baldy Creek (three and one, respectively, appeared to have been made by fluvial females based on their size) and no redds in South Fork Desolation Creek. These results, along with the weir trap count, suggest fluvial adult bull trout abundance was low.

Introduction

Bull trout (*Salvelinus confluentus*) were officially listed as a Threatened Species under the Endangered Species Act (ESA) in 1998. The U.S. Fish and Wildlife Service (FWS) subsequently issued a Draft Recovery Plan (U.S. Fish and Wildlife Service 2002) which included chapters for the John Day Recovery Unit (Chapter 9) and the Umatilla-Walla Walla Recovery Unit (Chapter 10). The two chapters were updated in 2004 (U.S. Fish and Wildlife Service 2004a, 2004b) and they are the current guide for recovery actions in the Umatilla and John Day basins. The goal of bull trout recovery planning by the FWS is to describe courses of action necessary for the ultimate delisting of this species, and to ensure the long-term persistence of self-sustaining, complex interacting groups of bull trout distributed across the species' native range (U.S. Fish and Wildlife Service 2004a, 2004b).

Bull trout are native to the Umatilla and John Day basins, and they exhibit two different life history strategies in those systems. Fluvial bull trout spawn in headwater streams and juveniles rear in these streams for one to four years before migrating downstream as subadults to larger mainstem areas, and possibly to the Columbia River, where they grow and mature, returning to the tributary stream to spawn (Fraley and Shepard 1989). Downstream migration of subadults generally occurs during the spring, although it can occur throughout the year (Hemmingsen et. al. 2001a, 2002). These migratory forms occur in areas where conditions allow for movement from upper watershed spawning streams to larger downstream waters that contain greater foraging opportunities (Dunham and Rieman 1999). Stream-resident bull trout also occur in the two basins, and they complete their entire life cycle in the tributary streams where they spawn and rear. Resident and migratory forms of bull trout may be found living together for portions of their life cycle, but it is unknown if they can give rise to one another (Rieman and McIntyre 1993). Bull trout size is variable depending on life history strategy. Resident adult bull trout tend to be smaller than fluvial adult bull trout (Goetz 1989). Under appropriate conditions, bull trout regularly live to 10 years, and under exceptional circumstances, reach ages in excess of 20 years. They normally reach sexual maturity in four to seven years (Fraley and Shepard 1989; McPhail and Baxter 1996).

When compared to other North American salmonids, bull trout have more specific habitat requirements. The habitat components that shape bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrates, and migratory corridors (U.S. Fish and Wildlife Service 1998). Throughout their lives, bull trout require complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989; Watson and Hillman 1997). Juveniles and adults frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997). McPhail and Baxter (1996) reported that newly emerged fry are secretive and hide in gravel along stream edges and in side channels. They also reported that juveniles are found in pools, riffles, and runs where they maintain focal sites near the bottom, and that they are strongly associated with instream cover, particularly overhead cover. Bull trout have been observed over-wintering in deep beaver ponds or pools containing large woody debris (Jakober et. al. 1998). Habitat degradation and fragmentation (Fraley and Shepard 1989), barriers to migration (Rieman and McIntyre 1995), and reduced instream flows have all contributed to the decline in bull trout populations in the Columbia River Basin.

In summary, bull trout need adequate stream flows and temperatures, and the corresponding habitat for each of the different life history functions at specific times of the year in order to persist. Habitat conditions must be adequate to provide spawning, rearing, and migration opportunities, cover, forage, seasonal movement, and over-wintering refuges.

The goal of FWS studies in the Umatilla and John Day basins is to develop information and analyses to assist in assessing the relative merit of potential action strategies in making progress towards meeting the requirements outlined in the Umatilla-Walla Walla and John Day Day Recovery Unit chapters of the Draft Recovery Plan (U.S. Fish and Wildlife Service 2004a, 2004b) for the recovery and delisting of bull trout. Specifically, FWS studies were designed to address the following recovery plan objectives:

- Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and
- Conserve genetic diversity and provide opportunity for genetic exchange.

The habitat objective should be accomplished through a series of steps designed to restore and maintain suitable habitat conditions for all bull trout life history stages and strategies. The first step should consist of defining the physical conditions that comprise suitable bull trout habitat. The second step should be application of these habitat “criteria” to current conditions to determine the extent of the relevant stream that currently provides suitable habitat. The third step should consist of determination of the changes required to improve habitat in areas indicated in the recovery plan that do not currently provide suitable conditions. The fourth step should consist of implementing changes to restore and maintain suitable habitat conditions for all bull trout life history stages and strategies.

The genetic diversity objective should be accomplished by maintaining connectivity among local populations of bull trout to facilitate gene flow and genetic diversity. As the recovery plan discusses, connectivity consists of maintaining the fluvial component of each local population which includes providing conditions that allow fluvial adults to effectively move between spawning and wintering areas, and ensuring that movement of both fluvial adult and subadult bull trout can occur, at least seasonally, between local populations within each core area in the recovery unit. This includes establishing the physical conditions necessary for up- and down-stream fish passage, and providing a continuum of suitable physical habitat to ensure the persistence of fluvial life stages and provide the opportunity for genetic interchange between local populations within each core area.

The approach FWS used to plan studies in the two basins consisted of the following steps:

- Identify information needed to assess if criteria for recovery objectives are being achieved;
- To that end, design and implement studies to describe bull trout distribution, movement, and seasonal habitat use patterns;
- Use this information and results from these studies to assist in guiding actions that will make progress towards bull trout recovery.

We previously described what was known about the abundance, distribution, and migratory patterns of bull trout and potentially limiting physical conditions in the Umatilla Basin when we initiated our study there in 2004 (Anglin et al. 2008). To summarize, at that time, the only viable population of bull trout appeared to occur in the North Fork Umatilla River, and it appeared to be relatively small. Telemetry studies had shown fluvial adult bull trout did not migrate extensively, remaining within the upper Umatilla River and the North Fork to complete their life cycle (Sankovich et al. 2003, 2004; Oregon Department of Fish and Wildlife [ODFW], unpublished report). Little was known about the movement and seasonal distribution of subadults, but the available evidence suggested they also were not prone to undertake extensive migrations. Five bull trout had been captured in a ladder at Three Mile Falls Dam in the lower Umatilla River at river kilometer (rkm) 6 between 1995 and 2004. These fish were 254 to 330 mm in fork length (FL), indicating they were either subadults or first-time maturing adults when captured. Thus, assuming these fish originated in the Umatilla Basin, it appeared at least a small number of subadults produced there continued to migrate to and use the lower Umatilla and Columbia rivers. Although there were human impacts to the upper basin due to development, agriculture, and forest management, the major impacts occurred in the lower basin where there were six irrigation dams and diversions, and sections of the river were sometimes dewatered seasonally. All but one of the diversion dams had ladders, but the ladders were designed for passage of salmon and steelhead, and it was not known if bull trout could negotiate them.

Between 2004 and 2006, the conditions in the Umatilla Basin that held the potential to negatively impact bull trout remained unchanged. The relatively small population in the North Fork appeared to be stable or declining based on redd counts and mark-recapture abundance estimates (P.M.S., unpublished data; Budy et al. 2004, 2005, 2006). Because fluvial adult bull trout migrations had been studied previously and subadult migrations remained largely un-described, we chose to focus on the latter when we began our study in the basin. In 2004-05, we operated a downstream migrant trap in the North Fork in fall (2004) and Umatilla River in spring (2005) and snorkeled at night in the North Fork and upper Umatilla River in winter to capture subadults for radio and passive integrated transponder (PIT) tagging (Anglin et al. 2008; Sankovich and Anglin 2006). Because our sample was small, our objective in 2006 was to continue to capture subadults for tagging and describe their seasonal movement and distribution.

Bull trout in the John Day Basin inhabit the Middle Fork, North Fork, and upper John Day River drainages. When we initiated our study in the basin in 2005, we chose to focus on bull trout from the North Fork. Few migratory individuals remained in the Middle Fork system, and those in the upper John Day River and its tributaries had been studied extensively by ODFW from 1997 to 2001. There were no reliable abundance estimates for bull trout populations in the North Fork John Day Sub-basin, but because much of the upper mainstem flows through a wilderness area, local biologists suspected its bull trout population, in particular, was relatively healthy. Fluvial bull trout were believed to persist only among the upper North Fork John Day, upper Granite Creek, and Desolation Creek local populations (U. S. Fish and Wildlife Service 2002), and there was evidence indicating their abundance in the latter two local populations was extremely low (P. Howell, U. S. Forest Service [USFS], personal communication; P.M.S., unpublished data). Little information was available on the migratory patterns of these bull trout. Based on observations of two radio-tagged subadults and the incidental capture of fluvial adults by steelhead anglers, it was evident the overwintering area extended downstream into the lower North Fork and John Day River (Hemmingsen et al. 2001a; T. Unterwegner, ODFW, personal communication). The telemetry data also showed subadult migrations could be extensive, with one individual traveling at least 220 km between its winter and summer rearing sites (Hemmingsen et al. 2001a).

There are no dams on North Fork John Day River and water withdrawals from it are limited to the lower 24 km, where several irrigation pumps are operated. In all but extreme drought years (e.g., 1977), the lower river has sufficient flow to provide fish passage during the irrigation season (T. Unterwegner, ODFW, personal communication). The Pete Mann Ditch is the only other significant water diversion in the sub-basin. It traverses a number of tributaries to Clear Creek and diverts varying portions of their flow into the Powder River Basin. Because fluvial bull trout are no longer present in the Clear Creek system, the Pete Mann Ditch currently has the potential to impact only resident bull trout and their localized movements.

The major factor limiting the distribution and movement of bull trout in the North Fork John Day River Sub-basin appears to be high summer stream temperatures (Columbia-Blue Mountain Resource Conservation and Development Area 2005). The high stream temperatures are attributed to a lack of streamside shade, increases in fine sediments, altered hydrologic patterns, losses of pool habitat, and low amounts of instream wood (Umatilla National Forest and Walla Walla National Forest 1997a and 1997 b cited in Columbia-Blue Mountain Resource Conservation and Development Area 2005). These conditions are a product of past and, to a lesser extent, continuing forest management practices (e.g., logging and fire suppression), grazing, placer and dredge mining, and road construction (Columbia-Blue Mountain Resource Conservation and Development Area 2005). The lower sub basin’s semi-arid climate and loss of forest canopy due to extensive wildfires might also be important naturally-occurring contributing factors. The elevated stream temperatures presumably force bull trout to seek out and remain in colder headwater reaches of the mainstem and its tributaries, or any coldwater refuges downstream, during summer. They might also form a thermal block to migration for individuals moving up- or downstream.

Although high summer stream temperatures have been proposed as the major factor limiting bull trout in the North Fork John Day River Sub-basin (Columbia-Blue Mountain Resource Conservation and Development Area 2005), a more detailed description of the migratory behavior of the sub-basin’s bull trout is needed to support this contention and determine where thermal barriers or other factors might be restricting the movement and distribution of those fish. We eventually will describe both fluvial adult and subadult migrations. In 2005, we focused on adults and primarily on those using the upper main stem by angling there in summer to capture fish for radio tagging. We had limited success (Sankovich and Anglin 2006), so in 2006, our objective was to continue to target adults and increase the sample size. A secondary objective was to conduct spawning ground surveys in the main stem and its tributaries Baldy and South Fork Desolation creeks to continue to gather information on adult abundance and distribution.

Umatilla Basin

Methods

Radio Telemetry

We used telemetry to monitor the movement of subadult bull trout. To capture subadults for tagging, we operated a 1.5-m diameter rotary screw trap in the Umatilla River. The trap was located about 500 m downstream from the mouth of the North Fork (Figure 1). It operated for 61 of 65 d from 25 April to 28 June 2006. Captured individuals of most non-target species were simply counted and released. Steehead or rainbow trout (*Oncorhynchus mykiss)* were assigned to 50-mm size categories (e.g., 0-49 mm, 50-99 mm) based on visual estimation of their fork lengths. All bull trout were anesthetized in an aerated bath containing 50-70 mg/L tricaine methanesulfonate (MS-222) buffered with 120 mg/L sodium bicarbonate. They were then weighed (nearest 0.1 g), measured (nearest 1 mm), and PIT or radio tagged. The PIT tags were 23 mm long and were inserted into the abdomen through an approximately 4-mm incision made with a surgical blade anterior to the pelvic girdle and slightly off the mid-line. Our radio tagging methods followed those described by Anglin et al. (2008). We used three sizes of radio tags manufactured by Lotek Wireless Fish and Wildlife Monitoring. The model NTC-M-3 tags weighed 0.55 g, had an 8 s burst rate, and a warranty life of 45 d. The model NTC-3-2 tags weighed 1.2 g, had a 9.5 s burst rate, and a warranty life of 96 d. The model NTC-4-2-L tags weighed 2.1 g, had a 12 s burst rate, a 12 h on and 12 h off duty cycle, and a warranty life of 293 d. Based on a length/weight relationship developed for bull trout in the North Fork Umatilla River (Budy et al. 2004), we estimated these tag models would be suitable for individuals as short as 126, 164, and 197 mm FL, respectively, at 3% of the host's weight. For the fish that were tagged, the tags actually averaged 2.1% and ranged from 1.5 to 2.7% of the host's weight. We chose to exceed Winter's (1996) "2% rule" in some cases because Winter (1996) offered no justification for it, and Brown et al. (1999) subsequently showed transmitters weighing up to 12% of a fish's weight had no effect on swimming performance. Also, Jakober et al. (1998) found the distance moved by radio-tagged bull trout did not differ between fish with transmitter weights less or greater than 2% of body weight. We released all but two of the tagged fish in the North Fork Umatilla River, about 100 m upstream from its mouth and 600 m upstream from the screw trap. The others were released about 100 m upstream from the screw trap to avoid overcrowding at the North Fork release site.

The near absence of larger, older subadult bull trout in the trap catch in 2006 and prior years (Sankovich and Anglin 2006; Anglin et al. 2008) indicated most were remaining below the trap site to rear after emigrating from the North Fork as younger fish; therefore, we also snorkeled at night on several occasions from August to October to capture them using a dip net and include them in the sample of radio-tagged fish. We focused our effort upstream from rkm 135 on the Umatilla River. Bull trout are probably restricted to that area during summer due to elevated temperatures in the river downstream (P.M.S., unpublished data). Captured fish of the appropriate size (>196 mm FL, which was large enough for our heaviest radio tags, and <250 mm FL, which appears to be a reasonable, approximate upper length limit for subadult bull trout in northeastern Oregon streams in late summer and fall [P.M.S., unpublished data]) were held in

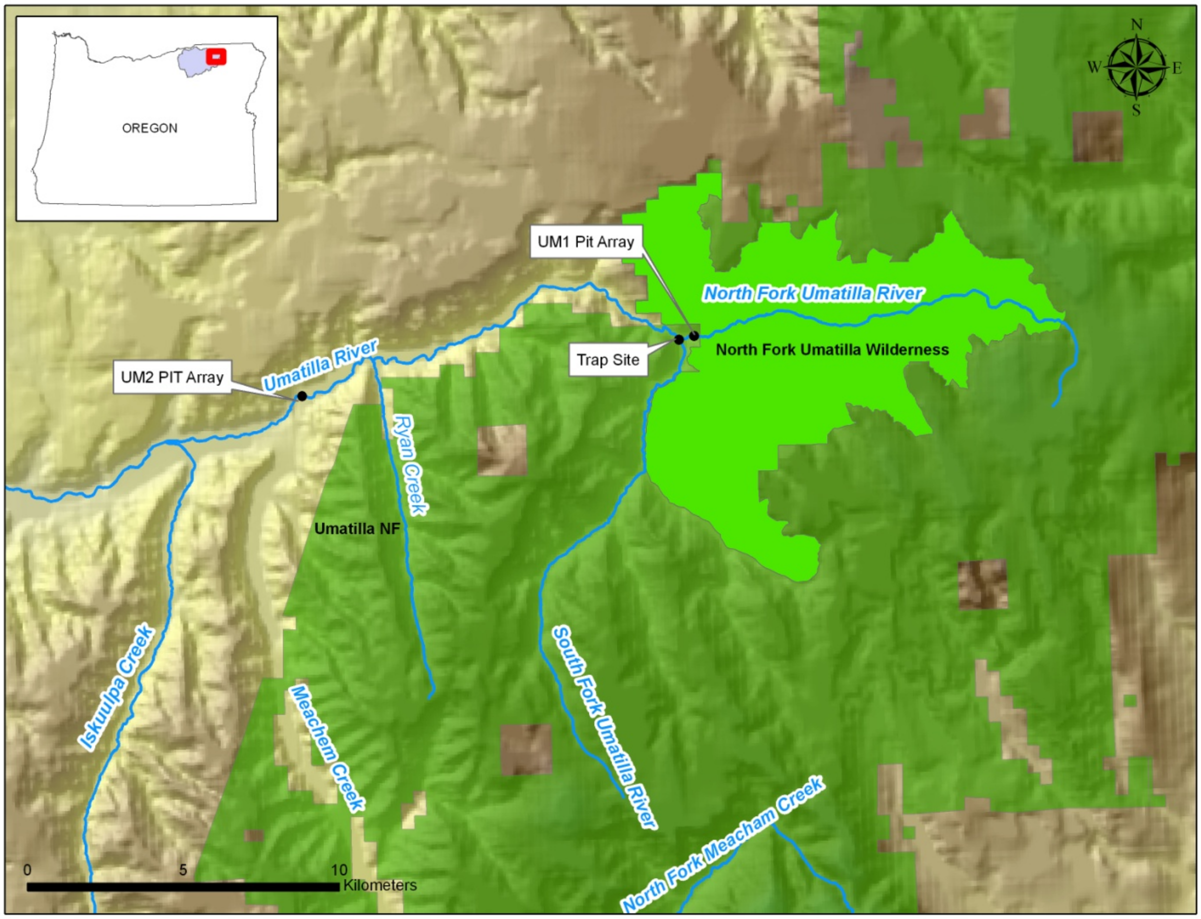

Figure 1. Map showing the locations of the screw trap in the Umatilla River and PIT tag detection array (UM1) in the North Fork Umatilla River.

the river in plastic tubes overnight, tagged the following morning, and released at their capture sites. The plastic tubes were 340 mm long by 80 mm wide and sealed at both ends with fine-mesh, plastic screening material. Snorkelers carried them in a day pack as they worked along the stream and secured them in low velocity areas near the capture sites once fish had been placed in them. The capture sites and the tubes were marked with surveyors flagging so they could be relocated the next morning.

The radio-tagged fish were tracked by road, and by foot and airplane in areas not accessible by road. We tracked at least weekly in spring and early summer, before stream temperatures increased to a point where continued downstream migration was unlikely. Tracking occurred once in early August, twice in September (early and late), and once each in November and December. Fish positions were recorded using a GPS unit. The coordinates were later entered into a mapping program (MAPTECH's Terrain Navigator) to determine the location, in river kilometers, of each individual.

PIT Tag Detection Array

Bull trout movements out of the North Fork Umatilla River were also monitored using a PIT tag detection array near the mouth of the North Fork designated as UM1 (Figure 2). The PIT tag detection array consisted of a full duplex interrogation system (Destron Fearing FS1001A), an antenna array custom built for this application, and a laptop computer equipped with Minimon software (Pacific States Marine Fisheries Commission). Power was supplied with an onsite combination of solar panels, batteries, and a generator. Remote data upload was accomplished using satellite communications (Figure 2).

Figure 2. PIT tag detection array in the North Fork Umatilla River. On the left is the shed that houses the electronics, computer, and generator. Solar panels and satellite dish are visible on the roof. On the right the antenna array can be seen mounted to a bridge.

The PIT tag detection array enabled passive monitoring of the movement of bull trout that were PIT-tagged in the North Fork in summer 2003-06 as part of an ongoing population assessment study (Budy et al. 2004, 2005, 2006). Subadults captured and PIT tagged at our screw trap in spring and early summer 2005-06 were also available for detection. The relatively efficient passive monitoring using PIT tag detection arrays together with the ongoing comprehensive tagging effort is an important part of our goal to better understand migratory bull trout life history, and the temporal and spatial aspects of their distribution and movements.

Routine inspection and maintenance of the PIT tag detection array were conducted to ensure reliable data collection and system operation. Antenna detection efficiency tests were conducted periodically to estimate the proportion of the antenna field that consistently detected a PIT tag that passed through the apparent field. Methods used to conduct efficiency tests were described in Anglin et al (2008).

Results

Radio Telemetry

The screw trap in the Umatilla River captured 35 bull trout, 896 *O. mykiss* (three of which were adult steelhead), 135 juvenile Chinook salmon (*O. tshawytscha*), 11 sculpin (*Cottus spp*.), 6 larval Pacific lamprey (*Lampetra tridentata*), and 4 speckled dace (*Rhinichthys osculus*). The bull trout were captured throughout May and June (Figure 3). Those that were measured ranged from 122 to 204 mm and averaged 151 mm in fork length (Figure 4). One individual that escaped before being measured was estimated to be about 135 mm.

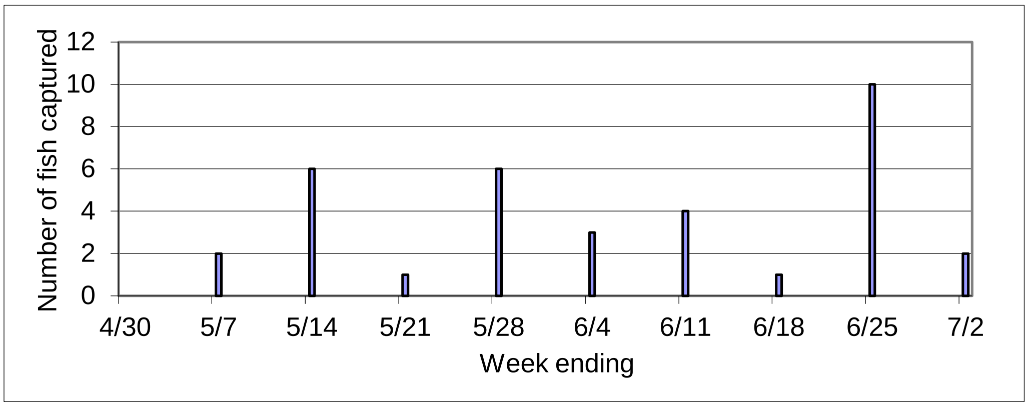

Figure 3. Number and timing of bull trout captured in a screw trap in the Umatilla River (rkm 143.5) in spring and early summer 2006.

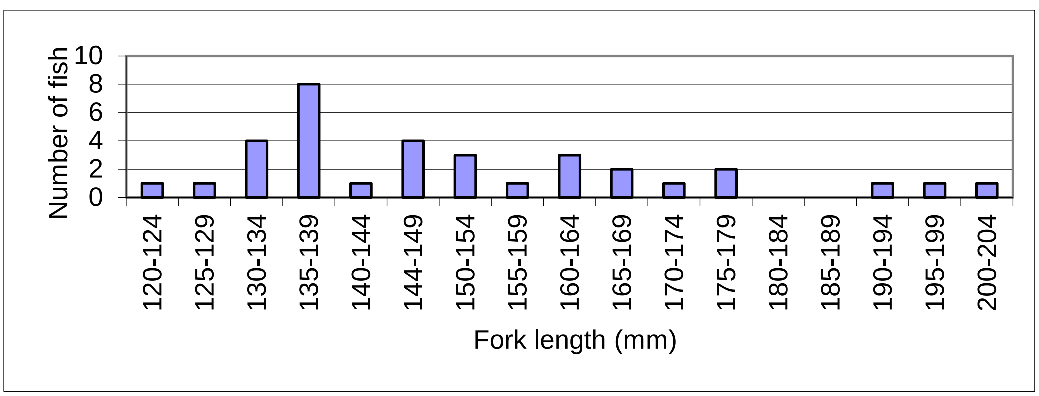

Figure 4. Length frequency distribution of bull trout captured in a screw trap in the Umatilla River (rkm 143.5) in spring and early summer 2006.

We radio tagged 24 of the trapped bull trout ranging from 129 to 204 mm and averaging 154 mm in fork length (Table 1). Fourteen were outfitted with 45-d tags, 8 with 96-d tags, and 2 with 293-d tags. Two of the radio-tagged fish (codes 91 and 94; Table 1) had been PIT tagged previously by researchers from Utah State University (USU). We PIT tagged an additional 8 bull trout. Their fork lengths ranged from 129 to 155 mm and averaged 146 mm (Table 1).

Table 1. Date of capture, radio tag code and model, PIT tag code, fork length (FL), and weight (WT) of bull trout captured and tagged in the Umatilla River in 2006.

Date	Radio tag code	Radio tag Model	PIT Tag Code	FL (mm)	WT (g)	Capture method
5/9/06	101	NTC-M-3		135	21.6	screw trap
5/9/06	102	NTC-M-3		146	31.6	screw trap
5/10/06	103	NTC-M-3		135	27.4	screw trap
5/10/06	104	NTC-M-3		130	22.1	screw trap
5/11/06	105	NTC-M-3		133	24.9	screw trap
5/12/06	91	NTC-3-2	3D9.1BF1B2A89F	192	81.5	screw trap
5/18/06	106	NTC-M-3		136	27.4	screw trap
5/24/06	107	NTC-M-3		139	29.9	screw trap
5/24/06	108	NTC-M-3		131	25.6	screw trap
5/26/06	109	NTC-M-3		135	22.8	screw trap
5/27/06	92	NTC-3-2		160	45.5	screw trap
5/27/06	110	NTC-M-3		135	34.4	screw trap
5/27/06	111	NTC-M-3		131	23.4	screw trap
5/31/06	112	NTC-M-3		144	35.8	screw trap
6/1/06	113	NTC-M-3		135	26.8	screw trap
6/1/06	93	NTC-3-2		175	58.2	screw trap
6/5/06	114	NTC-M-3		149	35.6	screw trap
6/5/06			3D9.1BF1FDE012	129	24	screw trap
6/9/06			3D9.1BF1FCACED	151	36.7	screw trap
6/9/06			3D9.1BF1FDE500	139	27.5	screw trap
6/13/06			3D9.1BF1FDA004	146	34	screw trap
6/19/06			3D9.1BF1FDD7A8	145	37	screw trap
6/19/06			3D9.1BF1FD22DE	150	33.7	screw trap
6/20/06	94	NTC-3-2	3D9.1B1B2AAG4	170	51.9	screw trap
6/20/06	95	NTC-3-2		167	47.2	screw trap
6/20/06	96	NTC-3-2		179	57.1	screw trap
6/20/06	115	NTC-4-2L		195	69	screw trap
6/22/06			3D9.1BF1FD0833	150	32.4	screw trap
6/22/06			3D9.1BF1FCAB10	155	38	screw trap
6/26/06	116	NTC-4-2L		204	78	screw trap
6/28/06	98	NTC-3-2		167	45.9	screw trap
6/28/06	99	NTC-3-2		164	44.7	screw trap
8/10/06	117	NTC-4-2L		298	295	dip net
8/10/06	120	NTC-4-2L		235	141	dip net

While snorkeling in August, we captured and radio tagged two additional bull trout large enough to accommodate the 293-d tags (Table 1). One was 238 mm FL. The other was 298 mm FL and may have been a small adult rather than a subadult. We observed what appeared to be maturing testes in its body cavity during the surgical procedure. Although our objective was to radio tag subadults, we proceeded to tag this fish because it appeared likely that we would have excess tags. We had snorkeled 6 km of the upper Umatilla River and had observed few bull trout and only two (the aforementioned) in the appropriate size range. As it turned out, we observed no more bull trout in the remaining 2 km of stream that were snorkeled.

The subadults radio tagged at the screw trap showed three general patterns of movement. They either moved up- or downstream (n=2 and 10, respectively) an appreciable distance (at least 1 km) soon after being released, or remained near the release site (n=10; Figures 5, 6, and 7; Appendix Table A1). Most that moved downstream arrived within 1 to 7 d at a location where they resided throughout the remainder of their tag's life (Figure 6). The subadults with tag codes 107 and 108 were possible exceptions. We lost contact with them as they moved downstream and never relocated them despite flying the entire Umatilla River on 20 June. The downstream-most observation of a tagged subadult occurred at rkm 126, near the town of Gibbon and 18 km below the mouth of the North Fork. The remaining fish that moved downstream an appreciable distance were between rkm 130 and 141 (3 to 16 km downstream from the release site) when their tags failed or they were last observed.

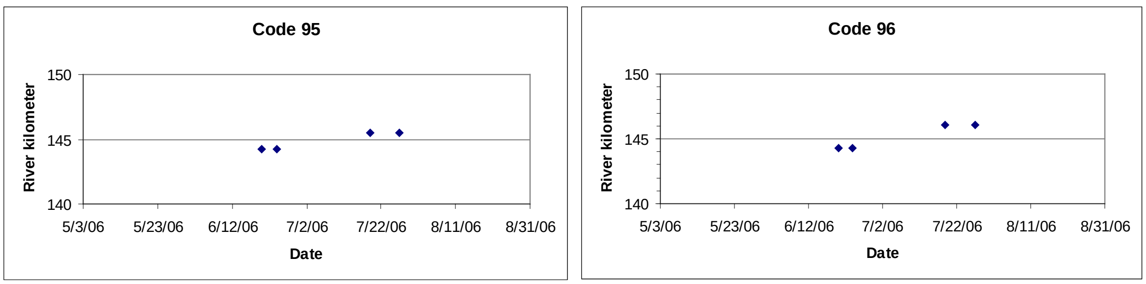

Figure 5. Tracking data for radio-tagged subadult bull trout that moved upstream following their release in the North Fork Umatilla River in spring and early summer 2006. River kilometers are continuous from the mouth the Umatilla River into the North Fork. The North Fork enters the Umatilla River at rkm 144.

We confirmed by snorkeling that at least three of the 10 fish remaining near the release site were alive and in apparently good condition. We were unable to locate the seven others. One of their tags was recovered from the streambed, indicating it had either been shed or the fish carrying it had died. Two fish (codes 115 and 116) were never found during tracking events. We suspect their tags failed almost immediately because the river was tracked the day after their release.

One of the bull trout captured by snorkeling (code 120) remained at its release site from early August until at least mid-September (Figure 8). It moved downstream 7 km to rkm 136 sometime between tracking events on 19 September and 2 November. We could not locate it while tracking along the Umatilla River from the town of Cayuse (rkm 109) to the mouth of the North Fork (rkm 144) in December. This could indicate it had moved downstream from Cayuse into an area that could not be tracked by road; however, there were areas along the reach that was tracked where the fish could have gone undetected because of poor line-of-sight to the stream or excessive distance between the stream and road.

The other bull trout captured by snorkeling (code 117) was located in the North Fork Umatilla River 4 km upstream from the mouth on 20 September after being released near the mouth on 10 August (Figure 8). We did not track the North Fork after 20 September, and this fish was not observed during tracking events along the Umatilla River after that date, so it presumably remained in the North Fork through the end of the year.

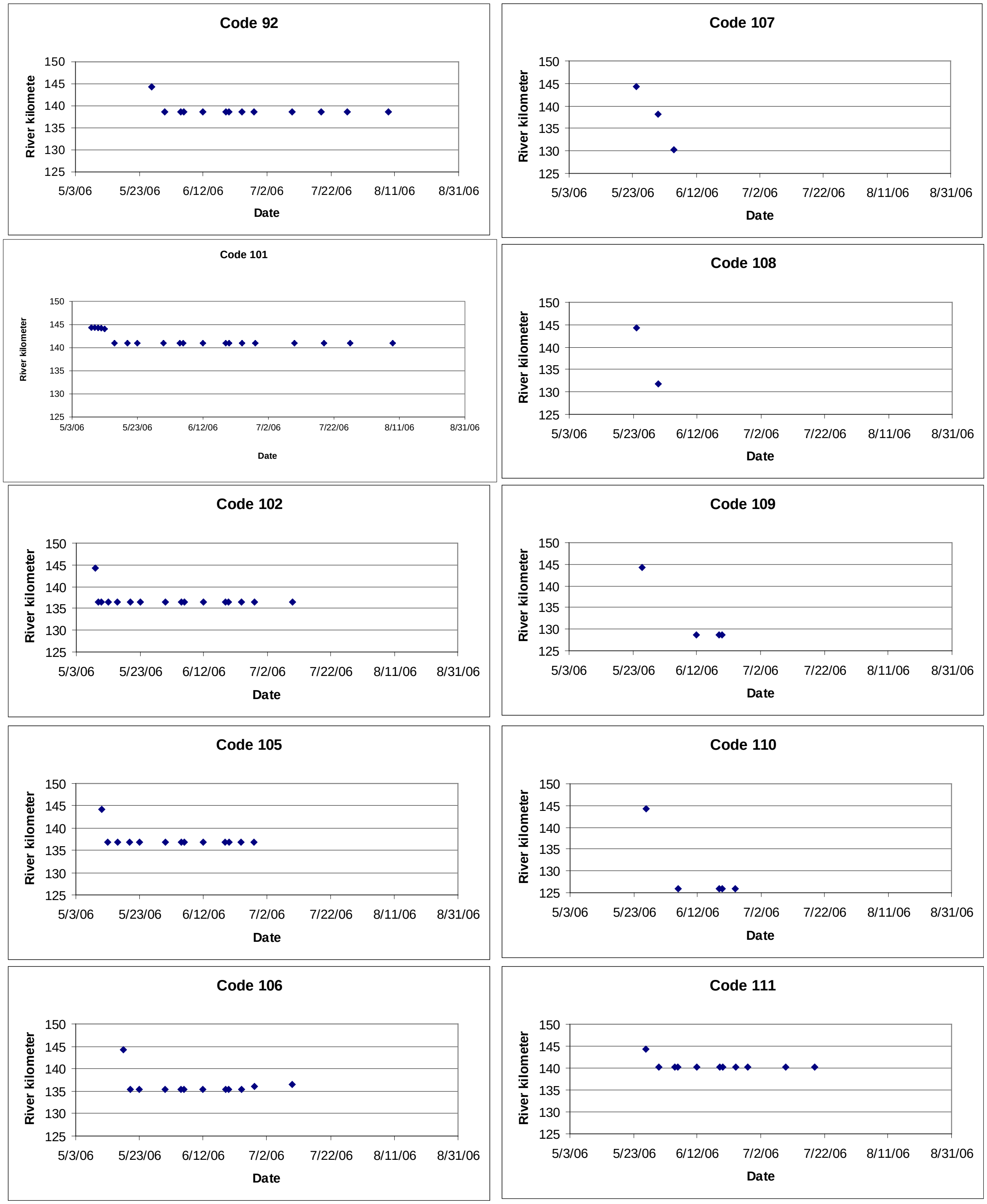

Figure 6. Tracking data for radio-tagged subadult bull trout that migrated downstream following their release in the North Fork Umatilla River in spring and early summer 2006. River kilometers are continuous from the mouth the Umatilla River into the North Fork. The North Fork enters the Umatilla River at rkm 144.

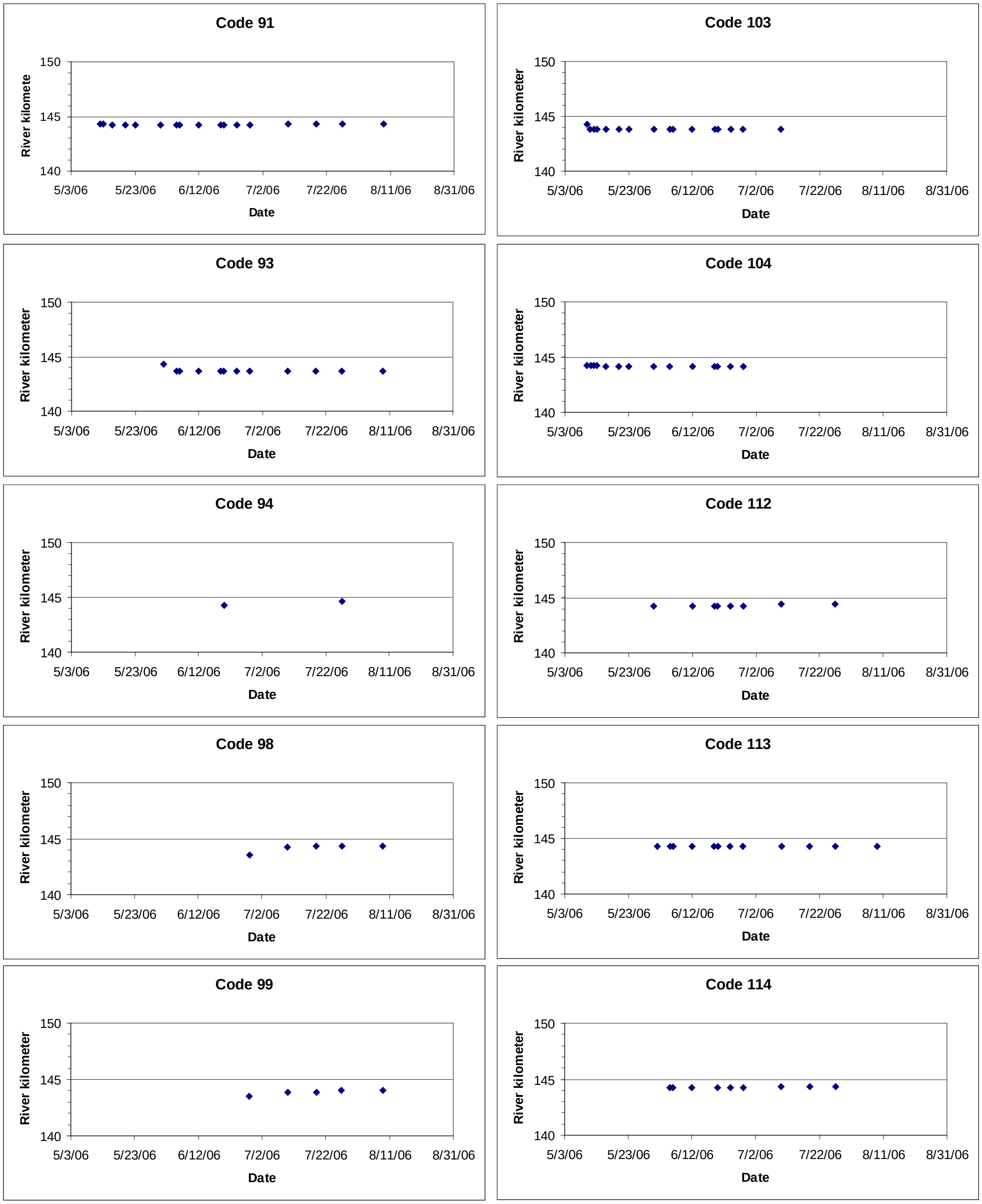

Figure 7. Tracking data for radio-tagged subadult bull trout that moved little following their release in the North Fork Umatilla River in spring and early summer 2006. River kilometers are continuous from the mouth the Umatilla River into the North Fork. The North Fork enters the Umatilla River at rkm 144.

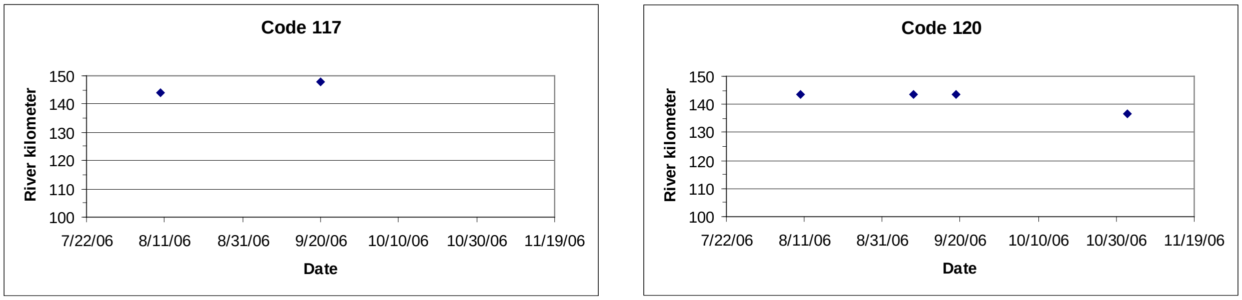

Figure 8. Tracking data for radio-tagged subadult bull trout captured by dip-net in the Umatilla River in August 2006. River kilometers are continuous from the mouth of the Umatilla River into the North Fork. The North Fork enters the Umatilla River and rkm 144.

PIT Tag Detection Array

Eleven bull trout were detected at the PIT tag detection array in the lower North Fork Umatilla River in 2006. Two had been tagged in summer 2006 and the remainder in summer 2005. None had been previously detected. This, coupled with the fact that all were between 132 and 206 mm FL at tagging and had been released upstream from the array, suggests these fish were moving downstream as subadults when detected. The peak in detections occurred in spring (Figure 9).

In 2003-06, 373 bull trout <300 mm FL (i.e., smaller than fluvial adult size) were tagged and released in the North Fork by researchers from USU. The eleven likely subadults detected at the array in 2006 represented 3% of those bull trout. To date, 9% (34) of those bull trout have been detected at the array.

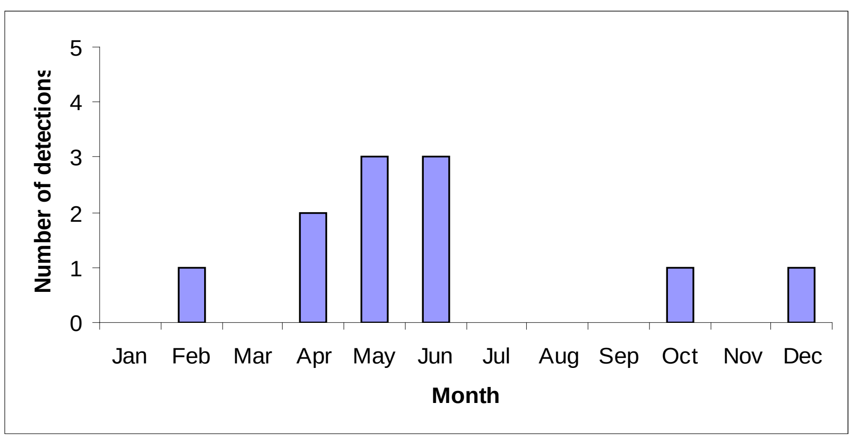

Figure 9. Number and timing of detections of PIT-tagged subadult bull trout at the PIT tag antenna array near the mouth of the North Fork Umatilla River in 2006.

Discussion

Radio Telemetry

The subadult bull trout captured in the screw trap and radio tagged behaved similarly to spring-tagged subadults in the Flathead River system and Mill Creek (Walla Walla River Basin, Washington) with respect to their patterns of movement (upstream, downstream, or sedentary; Muhlfeld and Marotz 2005; P. Howell, USFS, personal communication). The fish in the Flathead River system were collected by electrofishing, so their direction of movement, if any, prior to capture was not known. Those in the Umatilla River and Mill Creek were caught in downstream migrant traps; therefore, the upstream movement or lack of movement by some individuals after being released suggests they were moving locally rather than undertaking a directed downstream migration when trapped. This type of behavior was observed previously among subadult-sized bull trout in Mill Creek that were recaptured one or more times in a season after having been released downstream from a screw trap (P.M.S., unpublished data). Researchers attempting to estimate the efficiency of downstream traps by releasing captured subadult-sized bull trout upstream from them should be aware of the potential for those fish to fail to return downstream. Failure to account for this type of behavior could result in efficiency and migrant abundance estimates that are negatively and positively biased, respectively.

Most of the tagged subadults that migrated downstream in the Umatilla River did so rapidly. The same was true of subadults in the Flathead River system (Muhlfeld and Marotz 2005). Those in Mill Creek took longer to reach their destination, but they appeared to have been delayed by a diversion dam (P. Howell, USFS, personal communication). The subadults in the Umatilla River moved similar distances to those in Mill Creek (P. Howell, USFS personal communication) and far less extensively than those in the Flathead River system (Muhlfeld and Marotz 2005). The relatively short migrations of our study fish could have been partly a function of low subadult density in the upper Umatilla River. The North Fork Umatilla River bull trout population is small (Budy et al. 2004, 2005, 2006) and, as a result, subadults currently may not have to migrate far to find unoccupied rearing sites and foraging opportunities. The unsuitably high summer stream temperatures that have existed for many years in all but the upper portion of the Umatilla River might also have been a factor. Those conditions may have selected against longer range migrants. There is support for this idea in that conditions in Mill Creek are similar, whereas the Flathead River system contains extensive interconnected summer rearing areas. Finally, because most of the fish in our study necessarily had smaller tags with relatively short lives, the movements we observed might not have reflected the full extent of the movement of subadults in the years prior to the time they reach maturity and return to the North Fork Umatilla River to spawn. We may be able to obtain a more complete understanding of subadult movements by capturing older, larger individuals downstream from the screw trap site and outfitting them with longer-lived radio tags, and by operating PIT tag antenna arrays in the Umatilla River downstream from the current array in the North Fork Umatilla River. The limited information we have collected thus far on older subadults (n=4) has shown they may remain at a single site from fall through early summer (Sankovich and Anglin 2006) or begin to move downstream as stream temperatures decrease in the fall.

PIT Tag Detection Array

The timing of downstream movement of subadult bull trout in the North Fork Umatilla in 2006, as indicated by detections at the PIT tag antenna array, was typical of that seen in other systems, with most individuals initiating downstream migration in spring, but others doing so throughout the year (see, for example, the screw trap data in Hemmingsen et al. 2001a, 2001b; Muhlfeld and Marotz 2005; Downs et al. 2006). The low detection rate in 2006 (3%) and 2004-06 (9%) of bull trout that were <300 mm FL when tagged in the North Fork indicated subadult production was low. Tagged fish that were not detected either were dead, had yet to initiate their downstream migration, had done so but had passed the PIT tag array undetected, or were resident fish. Future data collection at the detection array and through mark-recapture work conducted by USU researchers upstream from the array will be required to shed light on the fate of these fish.

Plans for 2007

In spring and early summer 2007, we will continue to operate a screw trap in the Umatilla River, just downstream from the mouth of the North Fork. We will radio tag up to 35 subadult bull trout with tags having two to twelve month lives, and PIT tag any other subadults that are captured. In late summer and early fall, we will capture larger, older subadults by angling or by snorkeling and dip-netting them and outfit them with 12-month radio tags. A PIT tag detection array will be installed in the Umatilla River at rkm 129. Radio-tagged fish will be tracked at least every other week during periods when they are actively migrating and monthly when they are not. Finally, we will continue to assist ODFW's district fish biologist in conducting spawning ground surveys on the North Fork Umatilla River.

John Day Basin (North Fork John Day Sub-basin)

Methods

Radio Telemetry

We used telemetry to monitor the movement of fluvial adult bull trout. Two fish radio tagged in 2005 (Sankovich and Anglin 2006) were still at large with functioning tags during this reporting period, so we continued to track their movement. We captured additional fish for tagging by operating a weir trap in the North Fork about 30 m downstream from the mouth of Baldy Creek (Figure 10). We also had intended to capture fish in South Fork Desolation Creek by angling in August, but could not access that stream due to the Sharp's Ridge fire.

The weir trap was fished after peak runoff, from 10 July to 3 August 2006. All bull trout captured were anesthetized, weighed (nearest 1 g), measured (nearest 1 mm), and outfitted with a Lotek model MCFT-3FM radio tag using the methods described in Sankovich and Anglin (2006). The radio tags had a 5 s burst rate, 12 hr on and 12 hr off duty cycle, and warranty life of 755 d. They weighed 10 g in air and, based on length/weight relationships developed for other bull trout populations (Budy et al. 2004; P.M.S, unpublished data), were suitable for bull trout

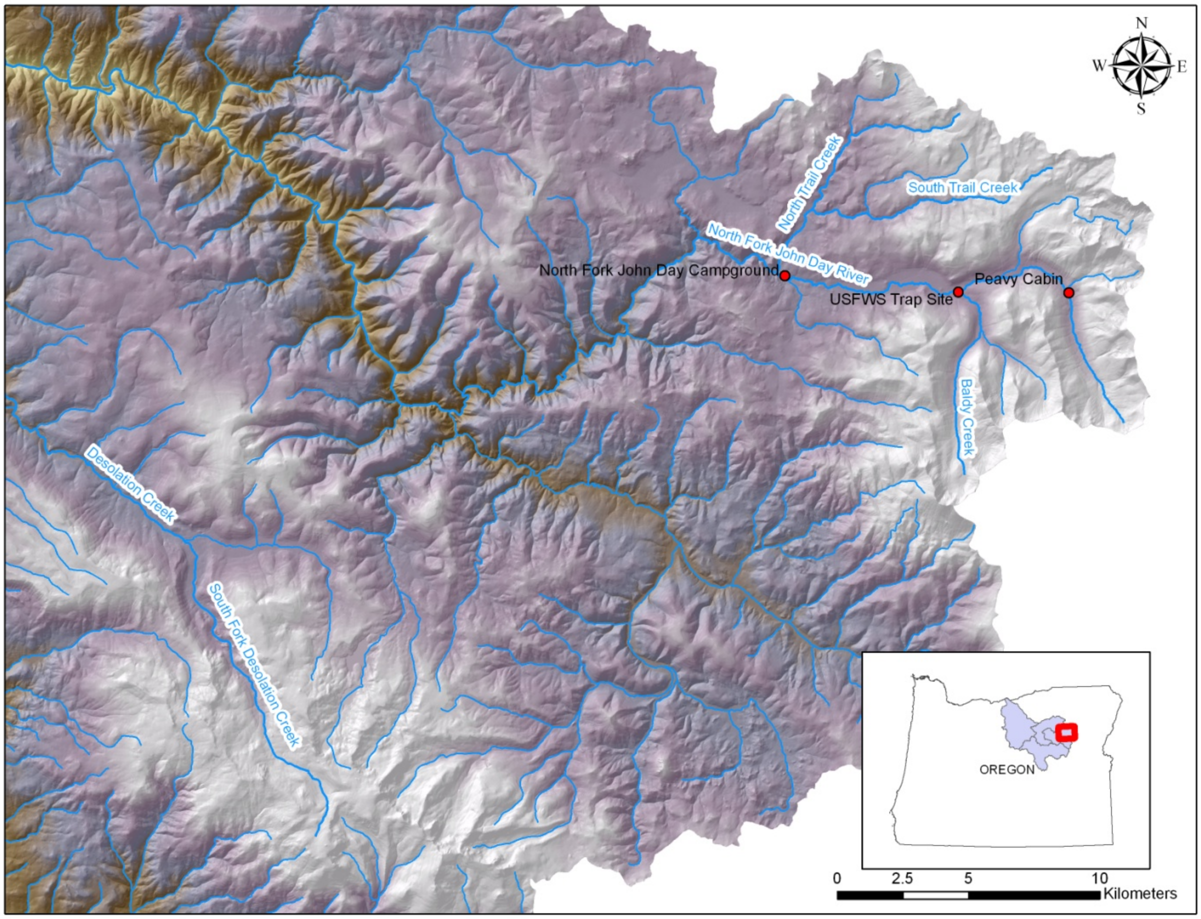

Figure 10. Map showing the location of the North Fork John Day River, the weir trap, and relevant tributaries and landmarks.

approximately 330 mm FL or longer at 3% of the host's weight.

Among the fish captured in the trap were three greater than 400 mm FL (i.e., the size of migratory adult bull trout) that appeared to be brook trout (*Salvelinus fontinalis*) x bull trout hybrids based on spotting in the dorsal fin (Figure 11). One (code 145) had been radio tagged in 2005 (Sankovich and Anglin 2006). We radio tagged the other two so we could subsequently locate and recapture them, along with code 145, to collect genetic samples, determine whether they were mature and participating in spawning activities, and monitor their movements.

We tracked the tagged fish by foot, air, or vehicle at least monthly through October. No tracking was conducted in November. We had planned instead on conducting a telemetry flight in December, after the tagged bull trout had ample time to reach their wintering locations. We were not able to fly in December, however, because our pilot's plane was in the shop for repairs. Fish positions during all tracking events were recorded using a GPS unit. The coordinates were later entered into a mapping program (MAPTECH's Terrain Navigator) to determine the location, in river kilometers, of each individual.

Figure 11. Spotting in the dorsal fins of three fish (codes 145 and 125 [top left and right] and code 127 [bottom]) captured in an upstream migrant trap in the North Fork John Day River in 2006. Tri-coloration in the left ventral fin of 145 is also evident.

Abundance and Distribution

We conducted spawning grounds surveys on the North Fork John Day River and its tributary Baldy Creek twice during the spawning period. We also surveyed South Fork Desolation Creek once in October. The North Fork was surveyed from the mouth of Baldy Creek upstream to a 10-m long cascade in the headwaters at about rkm 178. We believe this reach included all of the spawning habitat in the North Fork for reasons noted previously (Anglin et al. 2008) and because no redds were observed downstream from Baldy Creek in 2005. Baldy Creek was surveyed from its mouth upstream 5 km. This reach did not include all of the bull trout spawning habitat. It included an ODFW index area and the reach of stream below it to the mouth. South Fork Desolation Creek was surveyed from U.S. Forest Service road number 45 (1.6 km above the mouth) upstream approximately 4 km to a falls that appeared to be a significant obstacle to fish passage, but may not have been be totally impassable, particularly under higher flows.

When conducting the spawning ground surveys, we flagged redds with surveyor's tape as they were discovered and gave them a unique number that was written on the flagging along with the date. We also recorded this information in a notebook along with the length and width of each redd and our impression of whether the redd was made by a fluvial or resident female based on its size and the size of the substrate. The length was measured from the upstream end of the pit to the downstream end of the pillow, and the width, at the widest part of the pillow. Personnel from ODFW participating in the surveys on Baldy Creek measured only the width of redds. We subsequently classified the redds they measured as belonging to fluvial or resident females if they were greater than or less than or equal to 50 cm wide, respectively. We based this criterion on data collected in the Little Minam River, which supports only resident bull trout (ODFW, unpublished data).

Results

Radio Telemetry

During the previous reporting period, the two bull trout we radio were last observed in the North Fork John Day River at rkm 161 on 7 November 2005 (code 144) and rkm 176 on 4 September 2005 (code 145)(Appendix Table A2). In 2006, we continued to locate code 144 at rkm 161 (the North Fork John Day campground) through 11 July (Figure 12), when we determined its tag was buried in the streambed. The other fish (code 145, the apparent hybrid)

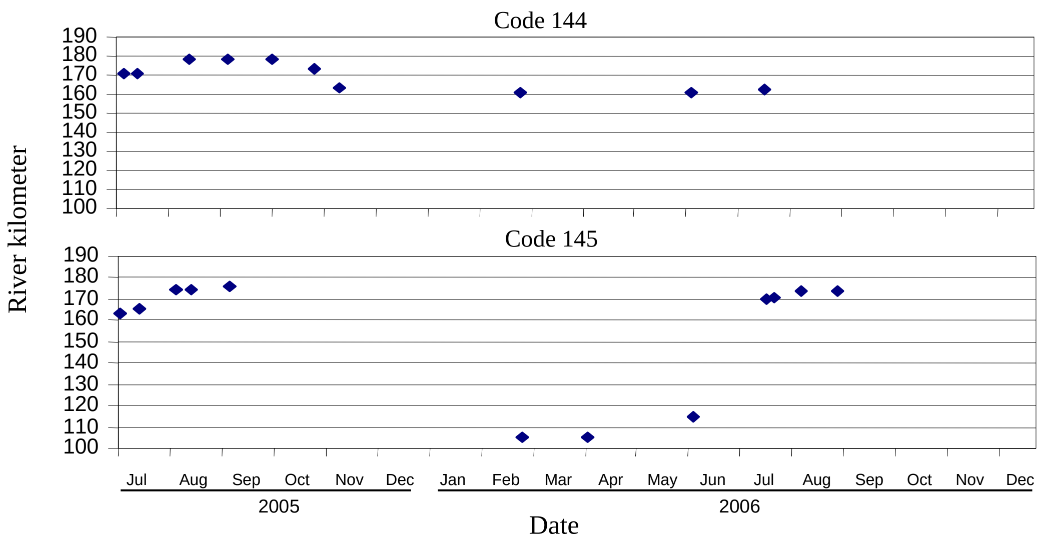

Figure 12. Tracking data for a bull trout (code 144) and an apparent brook trout x bull trout (code 145) radio tagged on the North Fork John Day River in summer 2005.

was located at rkm 105 in February, began moving upstream between tracking events on 30 March and 30 May, and was just downstream from the weir trap site (rkm 170) on 11 July (Figure 12), one day after the trap was closed. There appeared to be no impediments to the movement of this fish between its wintering location and the spawning grounds (Figure 12).

We captured three bull trout, three apparent brook trout x bull trout hybrids (including the one radio tagged in 2005; Table 2), and five adult Chinook salmon in the weir trap on the North Fork. The bull trout were captured during the first two days of trapping, indicating perhaps that a portion of the run passed the trap site before the trap was installed. All of the apparent hybrids were trapped shortly afterward, on the same day (16 July). The Chinook salmon were captured between 25 and 29 July. Four were males and the sex of one was not determined.

Table 2. Date of capture, radio tag code, fork length (FL), and weight (WT) of fluvial adult bull trout and apparent brook trout x bull trout hybrids in the North Fork John Day River in 2006.

Date	Tag code	FL (mm)	WT (g)	Comments
7/11/2006	129	424	806	
7/12/2006	130	420	775	
7/12/2006	128	420	837	female
7/16/2006	127	442	902	apparent hybrid
7/16/2006	145	403	716	apparent hybrid; tagged in 2005
7/16/2006	125	455	944	apparent hybrid

The trapped bull trout and hybrids were fairly uniform in size, ranging from 420 to 455 mm FL (Table 2). All continued to move upstream after being released (Figure 13; Appendix Table A2). One (code 130) entered Baldy Creek and was about 4 km above its mouth when last observed in that stream on 8 August. The others were distributed in the North Fork between rkm 173 and 177 in late August as the spawning season approached (Figure 13). The hybrid tagged in 2005 (code 145) and codes 128 and 129 presumably moved downstream into the lower North Fork John Day wilderness between tracking events on 21 August and 22 September, because we we could not locate them upstream (where we restricted our tracking during the spawning season) on the latter date or thereafter. The hybrid behaved similarly in 2005, exiting the headwaters between 4 and 29 September (Figure 13).

The two remaining tagged fish in the mainstem (codes 125 and 127), both apparent hybrids, were recaptured in a pool at rkm 176 using a dip net on 22 September. They had developed no secondary sexual characteristics, and no milt or eggs could be stripped from them. We never observed them or 145 displaying spawning behavior during tracking events. Instead, these fish were always found in habitat typically used by staging individuals (e.g., log jams and undercut banks). Because we were unable to conduct an aerial telemetry survey in December, the wintering locations of our study fish were not known at the end of this reporting period.

Abundance and Distribution

During the spawning ground surveys, we counted three redds each in the North Fork John

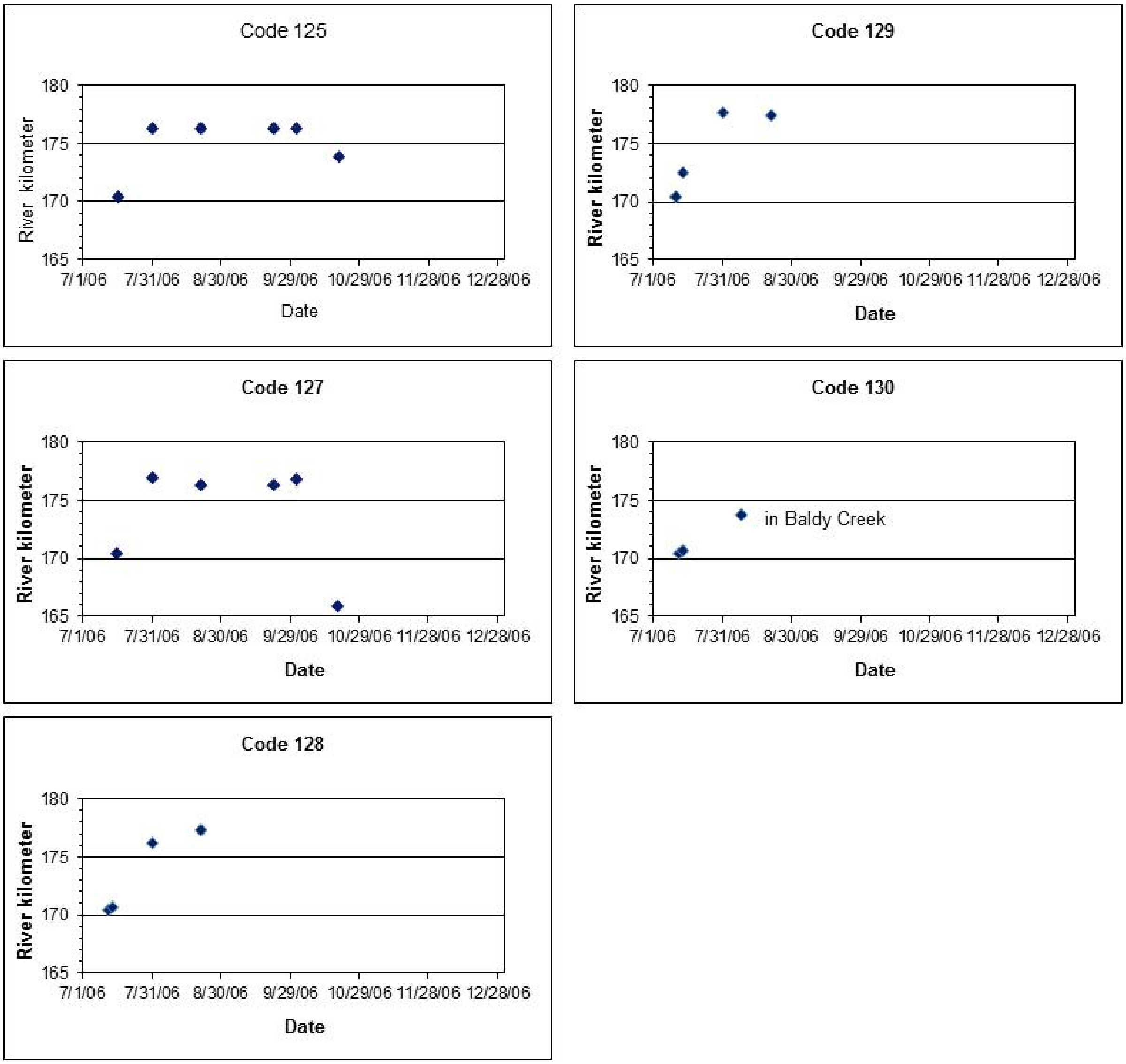

Figure 13. Tracking data for bull trout and apparent brook trout x bull trout hybrids (codes 125 and 127) radio tagged on the North Fork John Day River in summer 2006. River kilometers are continuous from the mouth of the North Fork into its headwaters or tributaries. Baldy Creek enters the North Fork at rkm 170.

Day River and Baldy Creek (Table 3). All of the redds in the North Fork were upstream from the trailhead at Peavy Cabin and appeared to have been made by fluvial females. One of the redds in Baldy Creek may have been made by a resident female based on its size (about 46 cm in width), but the two others were greater than 76 cm in width and were likely made by fluvial females. No redds were found in South Fork Desolation Creek.

Table 3. Redd counts in the North Fork John Day River (NFJD), Baldy Creek, and South Fork Desolation Creek (SFD) in 2006. Sections 1 and 2 in the NFJD were from the mouth of Baldy Creek upstream to the Peavy Cabin trailhead, and from the Peavy Cabin trailhead upstream to the headwaters. Sections in 1 and 2 in Baldy Creek were from the mouth upstream to the ODFW index area, and the ODFW index area. Section 1 in SFD extended from the Forest Road 45 crossing upstream approximately 3.2 km to a potential barrier falls.

		New Redds		
Stream	Date	Section 1	Section 2	Total redds
NFJD	26 Sep	0	2	2
	30 Oct	0	1	1
				3
Baldy Cr	4 Oct	0	3	3
	7 Nov	0	0	0
				3
SFD	28 Oct	0		0

Discussion

Based on the trap catch in 2006, our results from angling in 2005, and redd counts in both years (Sankovich and Anglin 2006; herein), it is evident the abundance of fluvial adult bull trout in the North Fork John Day River and Baldy Creek is low. Some bull trout may have passed the trap site before the trap was installed in 2006, but the number presumably would have been small given the subsequent count of redds attributed to fluvial females (5). There also appeared to be a low abundance (if not absence) of fluvial adults in South Fork Desolation Creek based on the redd count in 2006. This finding is consistent with results from snorkeling surveys conducted in that stream in August 2003 (I. Tattam, Oregon State University, personal communication).

As we noted previously, it is difficult to assess the abundance of resident adult bull trout in the North Fork and Baldy Creek given the available information (Sankovich and Anglin 2006). Researchers from USU estimated there were 489 and 809 bull trout in the 120-370 mm size class in the respective streams in summer 2006 (R. Al-Chokhachy, USU, personal communication); however, these fish could have been resident juveniles or adults, or fluvial juveniles, subadults, or adults. In addition, the abundance estimate could have been positively biased if some brook trout x bull trout hybrids were visually misclassified as bull trout in the field, as has been shown to occur (Chandler and Richter 2000). Drawing inferences from the count of resident-sized redds is complicated by the presence of brook trout spawners in both streams, and the potential for the counts to have been negatively biased, which is often the case when dealing with resident redds (Hemmingsen et al. 2001b; Starcevich et al. 2005). The presence of brook trout spawners is a less relevant issue given we counted only one resident-sized redd. Surveyor bias, on the other hand, could be a significant problem. Hemmingsen et al. (2001b) counted only 21 redds in a stream supporting an estimated 885 mature resident bull trout. Starcevich et al. (2005) found surveyor bias to be less substantial in another stream, but it was still high, with 45% of the redds made by resident bull trout going undetected. Although the magnitude of any bias in our counts is unknown, it is worth noting the North Fork, Baldy Creek, and the stream in Hemmingsen et al.'s study contain large amounts of fine granitic substrate, unlike the stream in Starcevich et al.'s study (P.M.S., personal observation). Small redds built in fine granitic substrate are difficult to detect. Therefore, we might expect any bias in our counts to be more in line with that evident in Hemmingsen et al.'s study.

Our telemetry data are too limited currently to determine if there are any passage problems in the migratory corridor that might be contributing to the low abundance of fluvial adults. No bull trout have yet been tracked through an annual cycle of movement. One apparent hybrid has been, and there appeared to be no impediments to its movement within the upper 79 km of the North Fork. Information collected on this and additional tagged fish during the spring-summer period as stream temperatures rise and stream flows subside will be key in gaining an understanding of any factors restricting the movement and distribution of fluvial adults.

We previously reported capturing three subadult-sized and one fluvial adult-sized fish that appeared to be hybrids while angling for fluvial adults in the North Fork (Sankovich and Anglin 2006). The subadult-sized fish were caught downstream from spawning and juvenile rearing areas in the North Fork John Day River and Trail and Baldy creeks, indicating they were migratory. Through our telemetry and trapping efforts in 2005 and 2006, we found apparent hybrids were undertaking extensive migrations and attaining sizes comparable to those of fluvial adult bull trout. We also found they were relatively abundant compared to fluvial adult bull trout based on their representation in the trap catch. The genetic analyses needed to confirm the identity of the suspected hybrids have not been conducted yet, but other researchers have documented the existence of migratory brook trout x bull trout hybrids (Chandler and Richter 2000; Kanda et al. 2002). The presence of such fish in the North Fork could add to the threat brook trout pose to bull trout in that system. Larger hybrids, at the least, might compete with fluvial adult bull trout for resources. If fertile, they might also increase the potential for brook trout genes to become incorporated in the bull trout gene pool, and for bull trout reproductive effort to be wasted, because they would not be restricted through size assortive mating from pairing with larger bull trout on the spawning grounds, unlike brook trout and smaller resident hybrids. We found no evidence the apparent hybrids in the North Fork were mature and involved in spawning; however, other researchers have shown brook trout x bull trout hybrids can be fertile (Kanda et al. 2002), so there is still cause for concern.

Plans for 2007

We will once again operate a weir trap in the North Fork in spring and early summer to capture bull trout for radio tagging. We will also radio tag any apparent hybrids and collect genetic tissue from all fish captured. If hybrids are tagged, they will be monitored on the spawning grounds to assess their behavior during the spawning period. We will attempt to recapture them during the spawning period to determine if they have produced eggs or milt. If we fail to capture a sufficient number of fish in the trap because high flows render it inoperable for extended periods, we will angle in summer to supplement the catch. Due to the low abundance of fluvial adult bull trout, no more than six individuals will be tagged. We will also tag any bull trout captured by investigators from ODFW operating screw traps in the North Fork, Middle Fork, and main stem John Day rivers, and seining in the John Day River below the town of Spray. We will track the fish tagged in 2005-07 every other week during periods when they are actively migrating and monthly when they are not. The spawning ground surveys in the North Fork, Baldy Creek, and South Fork Desolation Creek will be continued to gain a better understanding of the distribution and abundance of fluvial adults in the drainage.

Acknowledgements

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Appendix Table A1. Locations of radio-tagged subadult bull trout in the Umatilla and North Fork Umatilla rivers during tracking events from May to December 2006. River kilometers are continuous from the mouth of the Umatilla River into the North Fork. The North Fork enters the Umatilla River at river kilometer 144. River kilometers in italics indicate the fish had died or shed its tag.

	Radio tag code												
Date	91	92	93	94	95	96	98	99	101	102	103	104	105
5/9/06									144.28	144.28			
5/10/06									144.28	136.44	144.28	144.28	
5/11/06									144.23	136.44	143.84	144.28	144.28
5/12/06	144.28								144.17		143.84	144.28	
5/13/06	144.28								144.01	136.44	143.84	144.28	136.77
5/16/06	144.23								140.95	136.44	143.84	144.17	136.93
5/18/06													
5/20/06	144.23								140.95	136.41	143.84	144.17	136.93
5/23/06	144.23								140.95	136.41	143.84	144.17	136.93
5/24/06													
5/26/06													
5/27/06		144.28											
5/31/06	144.23	138.70							140.95	136.44	143.84	144.17	136.93
6/1/06			144.28										
6/5/06	144.23	138.70	143.68						140.95	136.44	143.84	144.17	136.93
6/6/06	144.23	138.70	143.68						140.95	136.44	143.84		136.93
6/12/06	144.23	138.70	143.68						140.95	136.44	143.84	144.17	136.93
6/19/06	144.23	138.70	143.68						140.95	136.44	143.84	144.17	136.93
6/20/06	144.23	138.70	143.68	144.28	144.28	144.28			140.95	136.44	143.84	144.17	136.93
6/24/06	144.23	138.70	143.68		144.28	144.28			140.95	136.44	143.84	144.17	136.93
6/26/06													
6/28/06	144.23	138.70	143.68				143.68	143.68	140.95	136.44	143.84	144.17	136.93
7/10/06	144.30	138.70	143.68				144.28	143.84	140.95	136.44	*143.84*		
7/19/06	144.30	138.70	143.68		145.45	146.10	144.38	143.84	140.95				
7/27/06	144.30	138.70	143.68	144.65	145.45	146.10	144.38	144.07	140.95				
8/9/06	144.28	138.70	143.68				144.38	144.07	140.95				
8/10/06													
9/8/06		138.70	143.68				144.38						
9/19/06		138.70	143.68				144.38						
9/20/06													
11/2/06							144.38						

Appendix Table A1 (continued).

	Radio tag code												
Date	106	107	108	109	110	111	112	113	114	115	116	117	120
5/9/06													
5/10/06													
5/11/06													
5/12/06													
5/13/06													
5/16/06													
5/18/06	144.28												
5/20/06	135.32												
5/23/06	135.32												
5/24/06		144.28	144.28										
5/26/06				144.28									
5/27/06					144.28	144.28							
5/31/06	135.32	138.21	131.78			140.30	144.28						
6/1/06								144.28					
6/5/06	135.32	130.17				140.30		144.28	144.28				
6/6/06	135.32				125.98	140.30		144.28	144.23				
6/12/06	135.32			128.56		140.30	144.28	144.28	144.23				
6/19/06	135.32			128.56	125.98	140.30	144.28	144.28					
6/20/06	135.32			128.56	125.98	140.30	144.28	144.28	144.23	144.28			
6/24/06	135.32				125.98	140.30	144.28	144.28	144.23				
6/26/06											144.28		
6/28/06	135.96					140.30	144.28	144.28	144.23				
7/10/06	136.44					140.30	144.38	144.28	144.38				
7/19/06						140.30		144.28	144.38				
7/27/06							144.38	144.28	144.38				
8/9/06								144.28					
8/10/06												144.17	143.52
9/8/06													143.52
9/19/06													143.52
9/20/06												147.71	
11/2/06													136.60

Appendix Table A2. Locations of radio-tagged bull trout and apparent brook trout x bull trout hybrids (codes 125, 127, and 145) in the North Fork John Day River and Baldy Creek during tracking events from July 2005 to December 2006. River kilometers are continuous from the mouth of the North Fork into Baldy Creek (tag code 130) or the upper main stem. Baldy Creek enters the North Fork at river kilometer 170. River kilometers in italics indicate the fish died or shed its tag.

	Radio tag code						
Date	125	127	128	129	130	144	145
7/2/05							162.9
7/6/05						170.6	
7/13/05						170.6	165.7
8/3/05							174.2
8/12/05						178.6	174.2
9/4/05						178.6	176.0
9/29/05						178.5	
10/17/05							
10/24/05						173.1	
11/7/05						163.0	
2/20/06						161.1	105.2
3/30/06							105.0
5/30/06						161.1	114.9
7/11/06				170.4		*162.5*	170.2
7/12/06			170.4		170.4		
7/14/06			170.7	172.5	170.7		
7/16/06	170.4	170.4					170.4
7/31/06	176.3	177.0	176.2	177.6			173.6
8/8/06					173.7		
8/21/06	176.3	176.3	177.3	177.5			173.6
9/22/06	176.3	176.3					
10/2/06	176.3	176.8					
10/20/06	173.9	165.9					
3/19/07		167.3					104.6
4/20/07	173.9	167.3					103.6
6/28/07		*167.3*					
9/27/07	*173.9*						
11/03/07					*173.7*		