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

2010 Annual Progress Report

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Table of Contents

Table of Contents…….2
List of Figures……..3
List of Tables……...…….……..…….. 4
Abstract……5
Introduction……..6
Umatilla Basin ……..……..……..……...10
Methods……..10
Movements……. 10
Radio Telemetry…….10
PIT Tag Detection Arrays……..11
Patch Analysis…… 13
Results……13
Movements…… .13
Radio Telemetry…….13
PIT Tag Detection Arrays……..15
Patch Analysis…… 16
Discussion……..18
Movements……. 18
Radio Telemetry…….18
PIT Tag Detection Arrays……..19
Patch Analysis…… 19
Plans for 2011……19
John Day Basin (North Fork John Day Sub-basin)……..…….. 20
Methods…….20
Results……... 20
Discussion……..22
Plans for 2011……22
Acknowledgements……23
References……..24

List of Figures

Figure 1. Map showing the location of Three Mile Falls Dam and relevant landmarks in the Umatilla Basin……..11

Figure 2. PIT tag detection array in the North Fork Umatilla River (UM1). 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……... 12

Figure 3. PIT tag detection array in the Umatilla River at rkm 129 (UM2)……12

Figure 4. Locations where stream temperature data used in a patch analysis of the Umatilla River Basin were collected…… 14

Figure 5. The relationship between maximum stream temperature and elevation in the Umatilla River and selected tributaries……..17

Figure 6. Potential bull trout patches in the Umatilla River Basin……..18

Figure 7. Map showing the location of the North Fork John Day River, the screw trap site, and relevant tributaries and landmarks…….21

List of Tables

Table 1. Date of tagging, radio and PIT tag code, and length of bull trout captured and tagged at Three Mile Falls Dam in the Umatilla River in 2010…….14

Table 2. Locations of radio-tagged bull trout in the Umatilla and North Fork Umatilla rivers in 2010. River kilometers are continuous from the mouth of the Umatilla River upstream into the North Fork Umatilla River. The North Fork Umatilla River enters the Umatilla River at river kilometer 144. River kilometers in italics indicate the fish was recovered as a mortality…….. .15

Table 3. Tagging data, detection histories, and elapsed time from tagging to detection for bull trout PIT-tagged and released in the North Fork Umatilla River in 2003-09 and detected at PIT tag detection arrays in the North Fork Umatilla (UM1) and Umatilla (UM2) rivers in 2010…… ..16

Table 4. Date of tagging, radio tag code, fork length, weight, and capture and release site of bull trout captured in a screw trap in the North Fork John Day River in 2009…...20

Table 5. Locations of radio-tagged bull trout in the North Fork John Day River at release and during tracking events from 13 November 2009 to 23 February 2010. A dash indicates the fish was not located on a given date. River kilometers are continuous from the mouth of the North Fork (rkm 0) upstream to the headwaters……21

Abstract

The goal of the U.S. Fish and Wildlife Service's 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 Ac. In the Umatilla Basin in 2010, we focused on gaining a better understanding of the movement of bull trout trapped at Three Mile Falls Dam (TMFD) in the lower Umatilla River, and on conducting a patch analysis to determine where bull trout local populations might occur in the basin. We also continued to maintain a passive integrated transponder (PIT) tag detection site near the mouth of the North Fork Umatilla River (UM1) and another 15 km downstream in the Umatilla River (UM2). In the John Day Basin, we focused on gaining a better understanding of the seasonal movement and distribution of subadult bull trout in the North Fork John Day River. Three bull trout (365 to 395 mm FL) were trapped in the upstream ladder at TMFD and outfitted with 255-d radio tags and PIT tags. An individual trapped on 12 May successfully negotiated the irrigation dams and fish ladders in the lower Umatilla River and, by 30 June, had migrated onto the spawning grounds in the North Fork Umatilla River, where it stayed throughout the remainder of its tag's life. Two individuals trapped on 8 and 11 June did not make it through the lower river. The carcass of one was recovered 38 km upstream from TMFD in late July, and the fate of the other, which was last located 63 km upstream from the dam in mid-August, was unknown. At UM1 and UM2, only three and two bull trout were detected, respectively. With the exception of the fish tagged at TMFD, which was detected at both UM2 and UM1 as it migrated upstream, the bull trout detected at these sites likely were downstream-migrating subadults when detected, given their small size at tagging in the North Fork Umatilla River in 2009. They were detected at UM1 in April and June, and at UM2 in June. Since 2004, only 9% of the bull trout that were juvenile or subadult sized (<300 mm FL) when tagged in the North Fork have been detected at UM1, suggesting subadult production has been low. The patch analysis indicated there are 24 potential bull trout patches in the Umatilla Basin. In the John Day Basin, we continued to track four radio-tagged subadult bull trout that had been tagged at a screw trap in the North Fork John Day River at river kilometer 97 in November 2009. These fish migrated downstream to, and appeared to have remained in, a section of river between the town of Monument (rkm 24) and rkm 63 during the lives of their 96-d tags. We also operated a screw trap in the North Fork John Day River in spring 2010 to capture additional subadults for radio tagging, but caught none.

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 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 main stem 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 three 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 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 (TMFD) 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 the diversion dams had ladders, but they were designed for passage of salmon and steelhead, and it was not known if bull trout could negotiate them.

Between 2004 and 2010, the conditions in the Umatilla Basin that held the potential to negatively impact bull trout remained relatively unchanged. The population in the North Fork appeared to be small and stable or declining based on redd counts and mark-recapture abundance estimates (P.M.S., unpublished data; Budy et al. 2004, 2005, 2006, 2007, 2008, 2009). 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. Through 2009, we used a combination of trapping, snorkeling, telemetry, and fixed passive integrated transponder (PIT) tag detection sites to determine the subadult population was small and individuals exiting the North Fork (i.e., individuals migrating as subadults for the first time) remained within the upper 40 km of the Umatilla River during their first summer in the Umatilla River. We also determined some of these subadults and older ones rearing in the upper Umatilla River undertook staged downstream migrations, for example, emigrating from the North Fork in spring and rearing in the Umatilla River for several months before again initiating downstream migration in fall. We observed no subadults utilizing the heavily impacted lower river. As a result, we were unable to describe the timing of use, seasonal distribution, and movement of subadults in the lower river and determine how subadults might be negatively affected by conditions there. Since meeting those objectives seemed unlikely given the small size of the subadult population and the low frequency with which subadults migrated to the lower river, we decided to transition in 2010 primarily to monitoring the movements of any bull trout captured at TMFD and identifying potential bull trout spawning and early rearing areas in the basin by conducting a patch analysis (USFWS 2008) to begin to resolve uncertainty about the number and

distribution of local populations. We also continued to maintain two PIT tag arrays in the basin to monitor the movement of bull trout that had been PIT tagged in previous years.

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.

The John Day River Recovery Unit Team identified seven local populations of bull trout in the North Fork John Day River Sub-basin: 1) upper North Fork John Day River (includes Crawfish, Baldy, Cunningham, Trail, Onion, and Crane Creeks and the main stem upstream from Granite Creek), 2) upper Granite Creek (includes Bull Run, Deep, and Boundary creeks), 3) Boulder Creek, 4) Clear/Lightning creeks above the Pete Mann ditch (includes Salmon Creek), 5) Clear Creek below the Pete Mann ditch (includes Lightning Creek below the ditch), 6) Desolation Creek (includes South Fork Desolation Creek below a barrier falls and North Fork Desolation Creek), and 7) South Fork Desolation Creek upstream from the barrier falls (U. S. Fish and Wildlife Service 2002). Leading up to our study, there were no reliable abundance estimates for these populations, but because much of the upper main stem 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. 2001b; T. Unterwegner, ODFW retired, 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. 2001b).

There are no dams on the 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 retired, 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 in-stream 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 main stem and its tributaries, or any coldwater refuges downstream, during summer. They might also form a thermal block to migration for individuals that fail to ascend the river system in a timely manner.

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. Information on both fluvial adult and subadult migrations was limited when we initiated work in the North Fork John Day River in 2005, but we elected to begin by studying the adults. While angling and operating an upstream migrant trap in the North Fork in 2005-07, we captured only eight large-bodied (>300 mm FL) char, three of which appeared to be brook trout (*Salvelinus fontinalis*) x bull trout hybrids rather than pure bull trout. We tagged seven of these fish, including the apparent hybrids. All remained in the upper 77 km of the 180 km-long North Fork throughout the lives of their two-year tags, and none appeared to encounter impediments to their movement. Given the low abundance of fluvial adults, we transitioned to studying the seasonal distribution and movement of subadult bull trout in 2009 and maintained that objective in 2010.

Umatilla Basin

Methods

Movements

Radio Telemetry

We used telemetry to monitor the movement of bull trout captured at TMFD. Radio-tagged bull trout were secondarily marked with PIT tags so they might by detected at PIT tag detection arrays in the Umatilla and North Fork Umatilla rivers, or at detection sites at dams in the Columbia River. Personnel from the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) operated a trap in the east bank ladder at TMFD (Figure 1) and notified us when bull trout were captured there. The bull trout were held in a live cage in the anadromous adult holding pond at TMFD and tagged the morning following their capture. Our radio tagging methods followed those described by Anglin (2008). We used model NTC-6-1 tags (Lotek Wireless Fish and Wildlife Monitoring) that weighed 2.8 g in air, had an 8 s burst rate, a 12 hr on and 12 hr off duty cycle, and a warranty life of 255 d. The PIT tags were 23 mm long and were inserted into the abdomen through an approximately 4 mm long incision made with a surgical

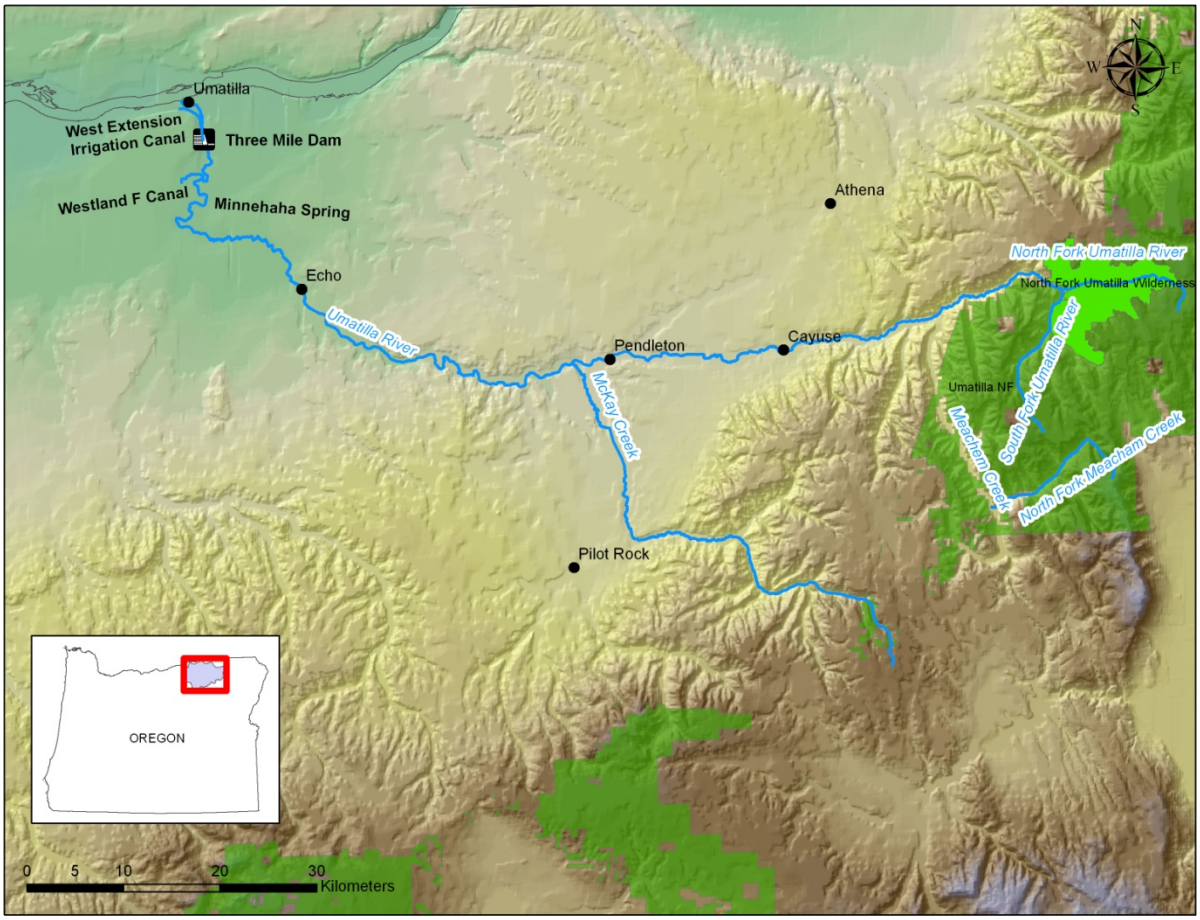

Figure 1. Map showing the location of Three Mile Falls Dam and relevant landmarks in the Umatilla Basin.

blade anterior to the pelvic girdle and slightly off the mid-line. We did not weigh the bull trout we tagged, but given a length versus weight equation developed for bull trout in the North Fork Umatilla River (Budy et al. 2004), the combined weight of the radio and PIT tags should have been less than 2% of the host's weight, as recommended by Winter (1996). We collected duplicate fin tissue samples from each fish for subsequent genetic analyses, to determine if they originated in- or outside the Umatilla Basin. The samples were stored in vials in 95% ethanol. All tagged fish were released in the pool upstream from TMFD following their recovery from anesthesia.

We tracked the radio-tagged fish by road and by airplane in areas not accessible by road. During tracking events, we recorded fish positions 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 Arrays

Bull trout movements were also monitored using two PIT tag detection arrays, one near

the mouth of the North Fork (UM1) and another at rkm 129 on the Umatilla River (UM2), just upstream from the intake to the Imeques acclimation facility (Figures 2 and 3). The two arrays were brought on-line in October 2004 and August 2007, respectively. UM2 was removed in August 2010, but we continued to operate UM1 through the end of the year. Each 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 at the UM1 site was supplied with a combination of solar panels, batteries, and a generator. Remote data upload was accomplished using satellite communications. The UM2 site was powered through a hard wire connection. Data collected there were downloaded manually.

Figure 2. PIT tag detection array in the North Fork Umatilla River (UM1). 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.

Figure 3. PIT tag detection array in the Umatilla River at rkm 129 (UM2).

The PIT tag detection arrays enabled passive monitoring of the movement of bull trout that were PIT-tagged in the North Fork in summer 2003-08 as part of an ongoing population assessment study (Budy et al. 2004, 2005, 2006, 2007). Subadults captured and PIT-tagged at our screw trap in spring and early summer 2005-08 were also available for detection, as were fish we PIT tagged in the North Fork in summer 2009.

Routine inspection and maintenance of the PIT tag detection arrays 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 earlier in this report in Anglin et al. (2008).

Patch Analysis

To identify potential bull trout spawning and early rearing areas (patches) in the basin, we conducted a patch analysis (FWS 2008). A detailed description of patch analysis and the rationale for its use is given in FWS (2008). The basic approach is to use a Geographic Information System (GIS) to identify areas that possess specified characteristics conducive to bull trout spawning and early rearing. In our analysis, we specified that a patch must be a third order or smaller stream (at a 1: 100,000 scale) with a catchment area of at least 500 ha and a maximum stream temperature of 16°C or less. To determine the point in each stream where maximum stream temperature was 16°C, and to assess whether the catchment area upstream from that point met our criterion, we developed temperature:elevation relationships (described in the Results). We used stream temperature data posted on the CTUIR's GIS Program homepage (http://www.data.umatilla.nsn.us/) and data we collected in 2008 and 2010 to develop the relationships. Temperature data from 43 sites (Figure 4) were used. Nine sites in Wildhorse, Squaw, McKay, Butter, and Little Butter creeks that we intended to sample in 2010 to obtain better coverage of the basin were either dry or on inaccessible private land. At the 23 sites we sampled, temperature loggers (HOBO Water Temp Pro v2) housed in open-ended PVC tubes and programmed to record hourly temperatures were placed in the thalweg of the stream in a location where they would not be subjected to direct sunlight. Details regarding the deployment of temperature loggers by CTUIR staff are reported in Contor and Schwartz (2007).

Results

Movements

Radio Telemetry

We tagged three bull trout at TMFD in 2010 (Table 1). They were captured in May and June. We did not tag an additional bull trout captured in late June, because stream temperatures were too warm (21°C the morning the fish was trapped). The tagged bull trout ranged from 365 to 395 mm in fork length (FL) and were likely adults given their size. An individual released on 13 May (code 13) successfully negotiated the irrigation dams and fish ladders in the lower Umatilla River and, by 30 June, had migrated onto the spawning grounds in the North Fork Umatilla River (Table 2). We did not track in the North Fork Umatilla Wilderness after this fish

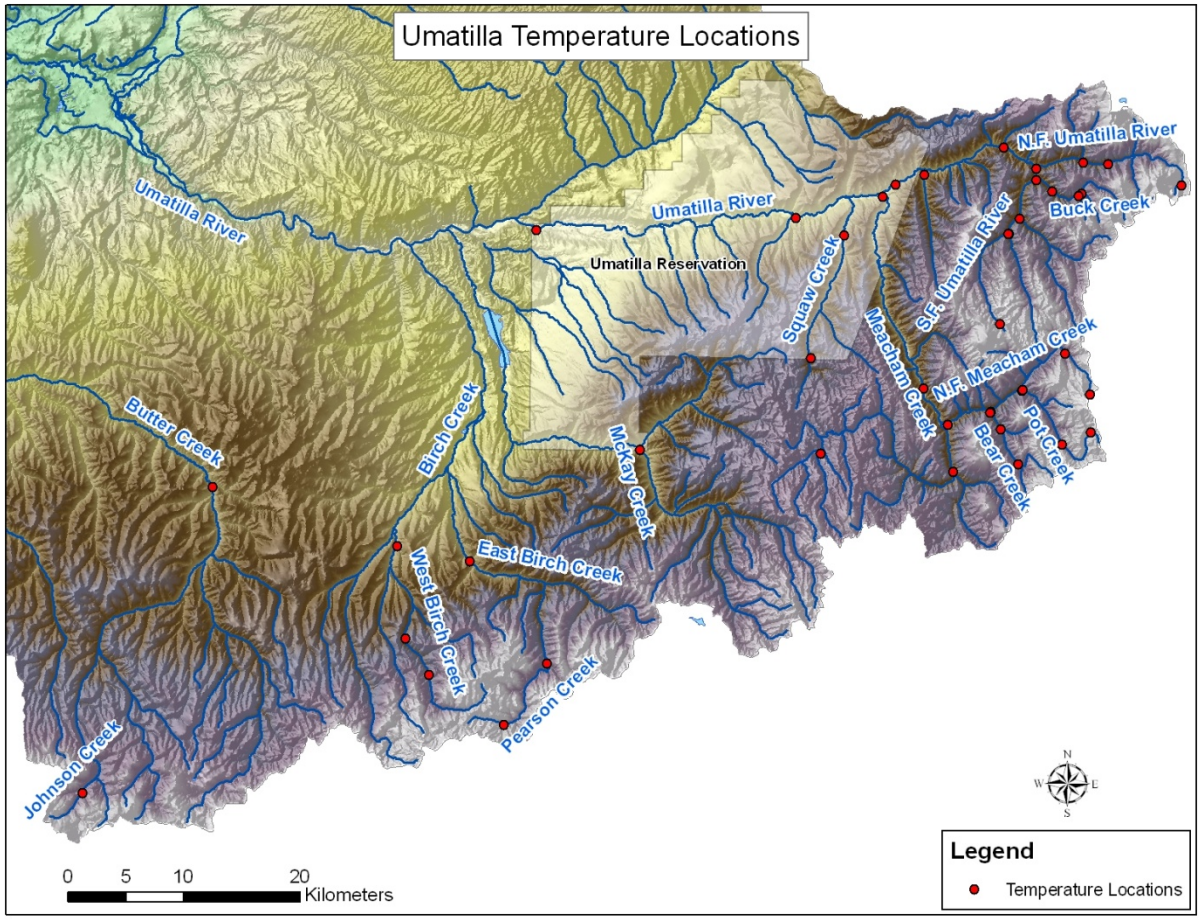

Figure 4. Locations where stream temperature data used in a patch analysis of the Umatilla River Basin were collected.

Table 1. Date of tagging, radio and PIT tag code, and length of bull trout captured and tagged at Three Mile Falls Dam in the Umatilla River in 2010.

Date	Radio tag code	PIT tag code	FL (mm)
5/13/2010	13	3D9.1BF1FD0EB5	365
6/9/2010	15	3D9.1BF1B2DA44	375
6/12/2010	16	3D9.1BF1B2E8E4	395

was located there, but since it was not subsequently detected at UM1 returning downstream or located during tracking events in the Umatilla River, it presumably remained in the North Fork throughout the remainder of its radio tag's life. Two individuals released on 9 June (code 15) and 12 June (code 16) did not make it through the lower Umatilla River. The fish released on 9

Table 2. Locations of radio-tagged bull trout in the Umatilla and North Fork Umatilla rivers in 2010. River kilometers are continuous from the mouth of the Umatilla River upstream into the North Fork Umatilla River. The North Fork Umatilla River enters the Umatilla River at river kilometer 144. River kilometers in italics indicate the fish was recovered as a mortality.

	Radio tag code		
Date	13	15	16
5/13/2010	6.4		
5/25/2010	66.6		
6/9/2010		6.4	
6/12/2010			6.4
6/14/2010	117.4	43.4	14.5
6/19/2010[a]	128.7[a]		
6/26/2010[b]	144.3[b]		
6/30/2010	147.2	43.9	72.7
7/26/2010		*44.2*	
8/11/2010			69.5

[a]Detection at a PIT tag detection array (UM2).
[b]Detection at a PIT tag detection array (UM1).

June had migrated upstream 30 km to a location near the town of Echo by 14 June. It was found in the same area 16 days later on 30 June, and was recovered as a mortality 0.25 km downstream from the Westland diversion dam (about 300 m upstream of its previously estimated position) in late July. Between 14 and 30 June, maximum daily stream temperatures at a monitoring site approximately 2 km upstream from this fish's position ranged from 11.38 to 23.6^{o}C. From 1 July until the fish was recovered on 26 July, maximum daily stream temperatures at that site ranged from 18.9 to 23.5^{o}C. The fish released on 12 June (code 16) had moved upstream past the irrigation dams in the lower Umatilla River by 30 June, to a location near Barnhart about 66 km upstream from TMFD (Table 2). This fish remained in that area through 11 August, when it was last located. It did not pass a fixed telemetry site 10 km upstream from its last known location, nor one 17 km downstream, after 11 August (K. Reznicek, CTUIR, personal communication), and its ultimate fate was unknown. Maximum daily stream temperatures near this fish's location ranged from 18.8 to 21.7^{o}C between 8 July and 11 August (no records were available for the period 30 June - 7 July).

PIT Tag Detection Arrays

There were only two detections of bull trout that were likely subadults at UM1 in 2010 (Table 3). These fish were 144 and 139 mm FL when tagged in the North Fork Umatilla River in summer 2009 and were detected at UM1 in April and June, 266 and 310 d, respectively, post-tagging. Only one likely subadult was detected at UM2 (Table 3). It was 110 mm FL when tagged in the North Fork Umatilla River in summer 2009 and was detected at UM2 in July, 337 d post-tagging. The only other fish detected at UM1 and UM2 was the individual (code 13) tagged at TMFD that migrated into the North Fork Umatilla River (Table 2). Since 2004, only 9% of

Table 3. Tagging data, detection histories, and elapsed time from tagging to detection for bull trout PIT-tagged and released in the North Fork Umatilla River in 2003-09 and detected at PIT tag detection arrays in the North Fork Umatilla (UM1) and Umatilla (UM2) rivers in 2010.

Tag ID	Date tagged	Length at tagging (mm)	Date of detection		Elapsed time (d)
			UM1	UM2	
3D9.1C2C688A25	7/29/09	144	4/21/10		266
3D9.1C2C6CAF5D	7/29/09	139	6/4/10		310
3D9.1C2CBE1630	7/29/09	110		7/1/10	337

530 bull trout that were juvenile or subadult sized (<300 mm FL) when tagged in the North Fork have been detected at UM1, suggesting subadult production has been low.

Patch Analysis

Qualitative analysis of the temperature and elevation data indicated considerable differences existed in temperature:elevation relationships among some streams. We, therefore, developed several temperature:elevation relationships rather than a single, basin-wide relationship (Figure 5). All of the relationships were best described by a curve. For the combined data from Birch and Butter creeks, however, the curvilinear relationship indicated the 16°C criterion never was met, so we used a linear relationship. The "general" relationship included data from all sites except those in Meacham Creek and indicated maximum stream temperature was 16°C at 3,157 ft (962 m) in elevation. That elevation was used in identifying patches upstream from the mouth of McKay Creek, except those in the South Fork Umatilla and Meacham Creek drainages. The South Fork Umatilla River relationship was developed from data collected in the South Fork Umatilla River and was used to identify patches in it and its tributaries. The relationship indicated maximum stream temperature was 16°C at 2,960 ft (902 m). The Meacham Creek relationship was developed from data collected in Meacham Creek and was used to identify patches throughout the Meacham Creek drainage, except in North Fork Meacham Creek and its tributaries. None of the sites in Meacham Creek within the range of elevations where stream temperatures were collected had maximum stream temperatures less than or equal to 16°C. Thus, we extrapolated the relationship to estimate that maximum stream temperature was 16°C at 3,987ft (1,215 m). The North Fork Meacham Creek relationship was developed from data collected in North Fork Meacham Creek and its tributaries Bear and Pot creeks and was used to identify patches in the North Fork Meacham Creek drainage. The relationship indicated maximum stream temperature was 16°C at 3,501ft (1,067 m). The Butter/Birch Creek relationship was developed using data from the McKay Creek, Birch Creek, and Butter Creek drainages and was used to identify patches in those drainages. It indicated maximum stream temperature was 16°C at 4,146 (1,264 m).

Based on the three criteria we used (third order or larger stream, 500 ha catchment area, and maximum stream temperature of 16°C), 24 potential bull trout patches were identified (Figure 6). These included the North Fork Umatilla River patch, the only patch known to support a bull trout local population.

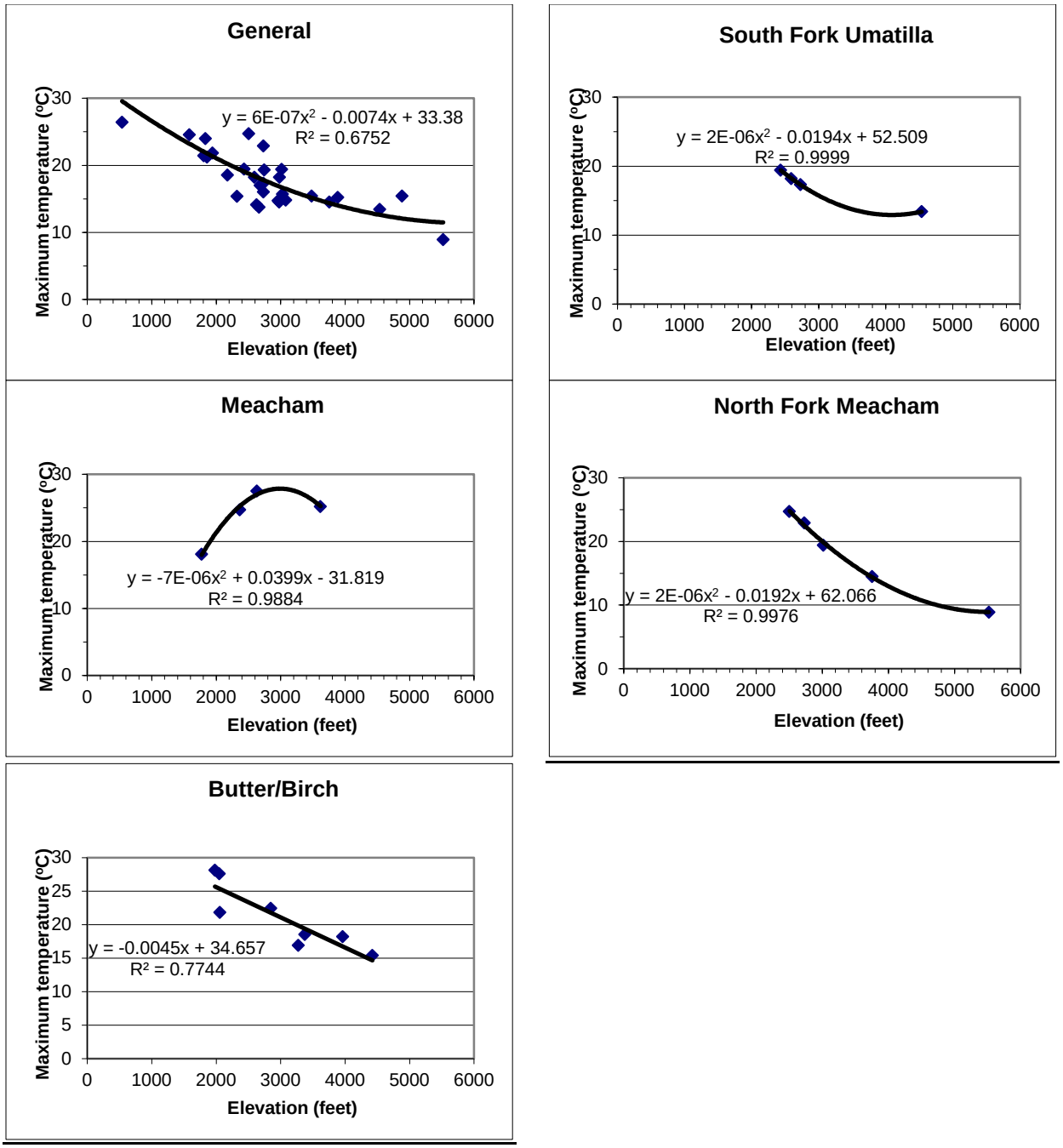

Figure 5. The relationship between maximum stream temperature and elevation in the Umatilla River and selected tributaries.

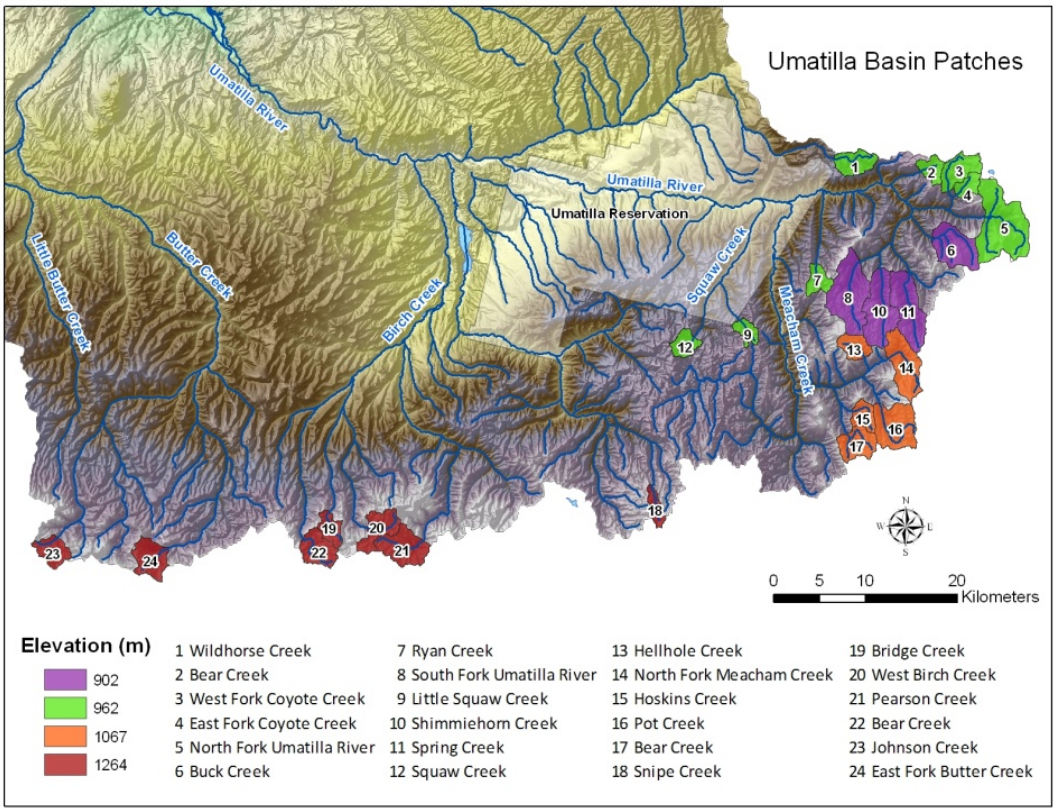

Figure 6. Potential bull trout patches in the Umatilla River Basin.

Discussion

Movements

Radio Telemetry

Assuming the three bull trout trapped at Three Mile Falls Dam in 2010 originated in the Umatilla Basin, they provided evidence that some of the basin's bull trout continue to migrate through the heavily impacted lower Umatilla River and utilize the Columbia River. Based on the lengths of the ten bull trout trapped at the dam since 1995 (250-395 mm FL), these fish likely were subadults when they emigrated from the Umatilla River. We failed to document this type of behavior probably because it is expressed infrequently and a relatively small number of subadults were radio tagged in previous years of this study. The three fish we tagged at the dam in 2010 probably had reached maturity and were bound for spawning grounds given their size (365-395 mm FL). Although we previously documented successful movement of an individual from Three Mile Falls Dam, past the diversions in the lower Umatilla River, and into the upper Umatilla River (Sankovich and Anglin 2008), we demonstrated for the first time in 2010 that it is possible for at least some bull trout to successfully migrate from Three Mile Falls Dam to the spawning grounds in the North Fork Umatilla River. As in 2007, we also demonstrated that some fish passing Three Mile Falls Dam do not migrate successfully through the lower Umatilla River. The factor(s) influencing these fish's lack of success is not known. Based on our observations from the air and ground while radio tracking, insufficient flows did not appear to be an issue. Below and at the Westland diversion in 2010, in particular, where an individual remained for an extended period, there were sufficient flows for passage. Successful passage of

three other bull trout at the Westland diversion and the remaining diversions in the lower river indicate the ladders at the dams, while designed for anadromous fish, are sufficient for fluvial adult-sized bull trout. In both 2007 and 2010, an individual was last located near Barnhart. Stream temperatures in this reach are influenced by inflow from McKay Creek, which is relatively cool due to hypolimnetic water releases from McKay Reservoir. As we have noted previously (Sankovich and Anglin 2008), it is possible bull trout are attracted to these relatively cool temperatures and remain below the McKay Creek confluence until continued upstream migration in the Umatilla River is not possible due to high stream temperatures. If managers wish to avoid potential bull trout losses associated with McKay Creek's plume, steps will have to be taken to alter how those water releases are made and establish a more natural temperature regime in McKay Creek below the reservoir.

PIT Tag Detection Arrays

The few detections of PIT-tagged bull trout in 2010 shed no new light on the timing or patterns of movement of bull trout at UM1 and UM2. From detections in 2010 and previous years, it is evident bull trout that were likely subadults at detection (given their size at tagging and amount of time elapsed between tagging and detection) moved from the North Fork Umatilla River into the Umatilla River primarily during spring and early summer, but also during most months of the year (Sankovich and Anglin 2006, 2007, 2008, 2009, 2010). Subadults exiting the North Fork during spring and early summer generally were not detected 15 km downstream at UM2, but when they were it was either shortly after being detected at UM1, or several months later in fall (Sankovich and Anglin 2006, 2007, 2008, 2009, 2010). No bull trout detected at UM2 were subsequently detected there either potentially as adults returning to spawn or as subadults attempting to avoid increasing stream temperatures downstream from UM2 that may have become unsuitably high in summer.

Patch Analysis

Results from the patch analysis suggest the potential exists for bull trout local populations to occur or become established in several streams currently not known to support bull trout populations in the Umatilla Basin. However, patch analysis is unlikely to be a perfect tool, and the results, therefore, may not accurately reflect the current distribution of bull trout populations or potential spawning and early rearing habitat (FWS 2008). Our future work will focus on determining which, if any, of the identified patches are actually occupied by bull trout and contain suitable habit conditions.

Plans for 2011

In 2011, we will make site visits to the patches identified in 2010 with which we have no familiarity to determine if they contain sufficient stream flow to support bull trout spawning and early rearing. This will set the stage for future sampling work to establish which patches are and are not occupied by bull trout, and which contain suitable spawning habitat. We will also begin to collect existing information on physical conditions in the Umatilla Basin that when overlaid

on the existing information on the life history and seasonal movement of bull trout will allow us to provide managers with a view of the landscape and the prospects for bull trout within it.

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

Methods

We continued to track four subadult bull trout that were outfitted with 96-d radio tags in the North Fork John Day River in November 2009 (Table 4; Sankovich and Anglin 2010). We used the methods described in Sankovich and Anglin (2010) to track the fish and record their locations. We attempted to capture additional subadults for radio tagging by operating a screw trap at rkm 104 in the North Fork (Figure 4) from 19 April to 30 June. No bull trout were captured, however, so no additional tagged fish were released in 2010.

Table 4. Date of tagging, radio tag code, fork length, weight, and capture and release site of bull trout captured in a screw trap in the North Fork John Day River in 2009.

Date	Radio tag code	FL (mm)	WT (g)	Capture/Release site (rkm)
11/11/09	16	225	112.3	97
11/11/09	17	250		97
11/11/09	18	300		97
11/20/09	19	203	84.3	97

Results

At the end of the last reporting period, the four bull trout radio tagged and released at rkm 97 in the North Fork were believed to be in a section of river between Potamus Creek (rkm 63) and the town of Monument (rkm 24) that could not be tracked by road (Sankovich and Anglin 2010). This could not be confirmed because the telemetry flights scheduled through the end of the year were cancelled due to inclement weather. In 2010, we were unable to conduct a telemetry flight until 23 February, again due to inclement weather. On that date, we flew from the screw trap site to the mouth of the North Fork and downstream in the main stem John Day River to the town of Spray (rkm 274). None of the radio-tagged fish were found (Table 5); however, their radio tags were 10 or more days past their calculated lives and may have been dead.

We operated the screw trap in the North Fork for 40 of the 73 days during the trapping period. We could not fish the trap continuously due to intermittent high stream flows and debris loads. When operating, the trap captured 242 Chinook salmon (*Oncorhynchus tshawytscha*) fry, 226 Chinook salmon smolts, 119 steelhead smolts (*O. mykiss*), 1 steelhead kelt, 75 larval lamprey (*Lampetra tridentate* or *richardsoni*), 77 suckers (*Catastomus spp.*), 74 speckled dace

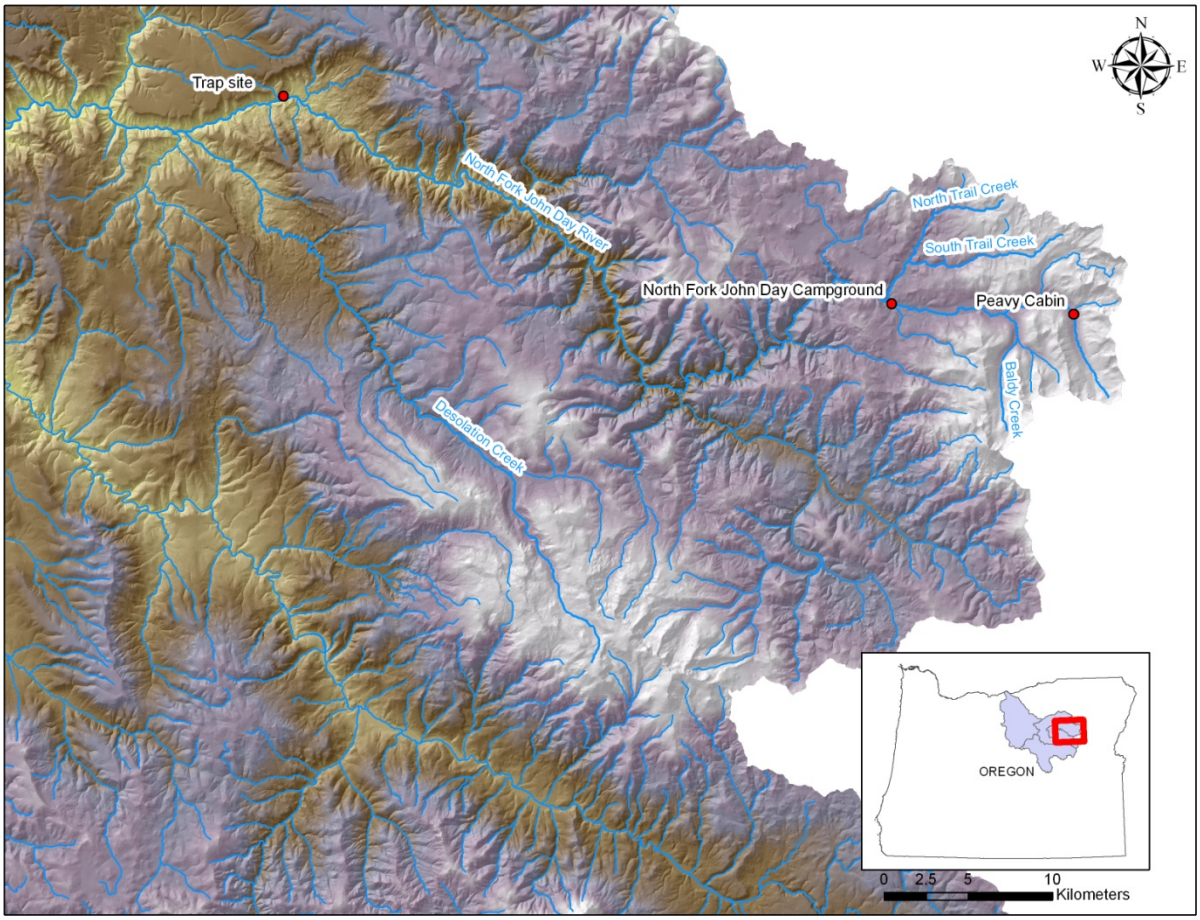

Figure 7. Map showing the location of the North Fork John Day River, the screw trap site, and relevant tributaries and landmarks.

Table 5. Locations of radio-tagged bull trout in the North Fork John Day River at release and during tracking events from 13 November 2009 to 23 February 2010. A dash indicates the fish was not located on a given date. River kilometers are continuous from the mouth of the North Fork (rkm 0) upstream to the headwaters.

	Radio tag code			
Date	16	17	18	19
11/11/09	97.0	97.0	97.0	
11/13/09	-	77.5	91.5	
11/20/09	-	77.5	75.0	97.0
12/8/09	-	-	-	-
12/21/09	-	-	-	-
2/23/10	-	-	-	-

(*Rhinichthys osculus*), 4 redside shiners (*Richardsonius balteatus*), and 4 sculpin (*Cottus spp.*). As noted above, no bull trout were captured.

Discussion

Use of the main stem John Day River by subadult bull trout that likely originated in the North Fork John Day Sub-basin has been demonstrated previously (Hemmingsen et al. 2001a). It appeared that none of the bull trout we tagged in the North Fork migrated to the main stem, but our sample size was exceedingly small. We chose to operate our screw trap relatively low in the North Fork John Day River in order to capture farther-migrating subadults that might be more likely to use the main stem and allow us to gain further insight into their distribution and movement there. That we captured few subadults in the trap probably was due to a combination of low subadult abundance and low trap efficiency, particularly in spring. Since these conditions are likely to remain in the future, tagging a sufficiently large number of subadults to describe the range of behaviors being expressed and identify potential limiting factors likely would not be possible. Our focus in the future, therefore, will be on describing physical conditions in the John Day Basin and assessing how those conditions might be impacting bull trout, given our knowledge of their life history and seasonal movements.

Plans for 2011

In 2011, we will begin to collect existing information on physical conditions in the John Day Basin that, when overlaid on the existing information on the life history and seasonal movement of bull trout, will allow us to provide managers with a view of the landscape and the prospects for bull trout within it.

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References

Anglin, D. R., D. G. Gallion, M. Barrows, C. Newlon, P. Sankovich, T. J. Kisaka, and H. Schaller. 2008. Bull trout distribution, movements, and habitat use in the Walla Walla and Umatilla River basins. 2004 Annual Report. Department of Interior, U.S. Fish and Wildlife Service, Vancouver, Washington.

Budy, P., R. Al-Chokhachy, and G. P. Thiede. 2004. Bull trout population assessment and life-history characteristics in association with habitat quality and land use: a template for recovery planning. Annual Progress Report for 2003. USGS Utah Cooperative Fish and Wildlife Research Unit, Utah State University, Logan, Utah.

Budy, P., R. Al-Chokhachy, K. Homel, and G. P. Thiede. 2005. Bull trout population assessment in northeastern Oregon: a template for recovery planning. Annual Progress Report for 2004. USGS Utah Cooperative Fish and Wildlife Research Unit, Utah State University, Logan, Utah.

Budy, P., R. Al-Chokhachy, K. Homel, and G. P. Thiede. 2006. Bull trout population assessment in northeastern Oregon: a template for recovery planning. Annual Progress Report for 2005. USGS Utah Cooperative Fish and Wildlife Research Unit, Utah State University, Logan, Utah.

Budy, P., R. Al-Chokhachy, and G. P. Thiede. 2007. Bull trout population assessment in northeastern Oregon: a template for recovery planning. Annual Progress Report for 2006. USGS Utah Cooperative Fish and Wildlife Research Unit, Utah State University, Logan, Utah.

Budy, P., R. P. MacKinnon, T. Bowerman, and G. P. Thiede. 2008. Bull trout population assessment in northeastern Oregon: a template for recovery planning. Annual Progress Report for 2007. USGS Utah Cooperative Fish and Wildlife Research Unit, Utah State University, Logan, Utah.

Budy, P., R. P. MacKinnon, T. Bowerman, and G. P. Thiede. 2009. Bull trout population assessment in northeastern Oregon: a template for recovery planning. Annual Progress Report for 2008. USGS Utah Cooperative Fish and Wildlife Research Unit, Utah State University, Logan, Utah.

Columbia-Blue Mountain Resource Conservation and Development Area. 2005. John Day Subbasin Revised Draft Plan. Northwest Power and Conservation Council, Portland, Oregon.

Contor, C., and J. Schwartz. 2007. Umatilla Basin Natural Production Monitoring and Evaluation, 2005 Annual Report. Bonneville Power Administration, Portland, Oregon.

Dunham, J. B., and B. E. Rieman. 1999. Metapopulation structure of bull trout: Influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications. 9: 642-655.

Fraley, J. J., and B. B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (Salvelinus confluentus) in the Flathead Lake and River system, Montana. Northwest Science 63:133-143.

Goetz, F. 1989. Biology of the bull trout. United States Department of Agriculture, Forest Service, Willamette National Forest, literature review, Eugene, Oregon.

Hemmingsen, A. R., S. L. Gunckel, P. M. Sankovich, and P. J. Howell. 2001a. Bull trout life history, genetics, habitat needs, and limiting factors in central and northeast Oregon, 2000 Annual Report. Bonneville Power Administration, Portland, Oregon.

Hemmingsen, A. R., S. L. Gunckel, and P. J. Howell. 2001b. Bull trout life history, genetics, habitat needs, and limiting factors in central and northeast Oregon, 1999 Annual Report. Bonneville Power Administration, Portland, Oregon.

Hemmingsen, A. R., S. L. Gunckel, P. M. Sankovich, and P. J. Howell. 2002. Bull trout life history, genetics, habitat needs, and limiting factors in central and northeast Oregon, 2001 Annual Report. Bonneville Power Administration, Portland, Oregon.

Jakober, M. J., T. E. McMahon, R. F. Thurow, and C. G. Clancy. 1998. Role of stream ice on fall and winter movements and habitat use by bull trout and cutthroat trout in Montana headwater streams. Transactions of the American Fisheries Society 127:223-235.

McPhail, J. D., and J. Baxter. 1996. A Review of bull trout (*Salvelinus confluentus*) life-history and habitat use in relation to compensation and improvement opportunities. Fisheries Management Report No. 104. Department of Zoology, U.B.C., Vancouver, B.C.

Rieman, B. E., and J. D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. United States Department of Agriculture, Forest Service, Intermountain Research Station, General Technical Report INT-302, Ogden, Utah.

Rieman, B. E., and J. D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of the American Fisheries Society. 124:285-296.

Sankovich, P. M., S. L. Gunckel, A. R. Hemmingsen, I. A. Tattam, and P. J. Howell. 2003. Migratory patterns, structure, abundance, and status of bull trout populations from subbasins in the Columbia Plateau, 2002 Annual Report. Bonneville Power Administration, Portland, Oregon.

Sankovich, P. M., S. J. Starcevich, A. R. Hemmingsen, S. L. Gunckel, and P. J. Howell. 2004. Migratory patterns, structure, abundance, and status of bull trout populations from subbasins in the Columbia Plateau, 2003 Annual Report. Bonneville Power Administration, Portland, Oregon.

Sankovich, P. M., and D. R. Anglin. 2006. Bull trout movement, distribution, and habitat use in the Umatilla and John Day River Basins, 2005 annual report. U. S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, Washington.

Sankovich, P. M., and D. R. Anglin. 2007. Bull trout movement, distribution, and habitat use in the Umatilla and John Day River Basins, 2006 annual report. U. S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, Washington.

Sankovich, P. M., and D. R. Anglin. 2008. Bull trout movement, distribution, and habitat use in the Umatilla and John Day River Basins, 2007 annual report. U. S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, Washington.

Sankovich, P. M., and D. R. Anglin. 2009. Bull trout movement, distribution, and habitat use in the Umatilla and John Day River Basins, 2008 annual report. U. S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, Washington.

Sankovich, P. M., and D. R. Anglin. 2010. Bull trout movement, distribution, and habitat use in the Umatilla and John Day River Basins, 2009 annual report. U. S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, Washington.

Sexauer, H. M., and P. W. James. 1997. Microhabitat use by juvenile bull trout in four streams located in the eastern Cascades, Washington. Pp. 361-370 in Friends of the Bull Trout Conference Proceedings (Mackay, W.C., M.K. Brewin, and M. Monita, eds.). Bull Trout Task Force (Alberta), c/o Trout Unlimited Canada, Calgary, AB.

U. S. Fish and Wildlife Service. 1998. Klamath River and Columbia River bull trout population segments: status summary. Prepared by the Service's bull trout listing team.

U. S. Fish and Wildlife Service. 2002. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan, Portland, Oregon.

U. S. Fish and Wildlife Service. 2004a. Unpublished revised draft. Chapter 9, John Day Recovery Unit, Oregon. 164 p. January 14, 2004.

U. S. Fish and Wildlife Service. 2004b. Unpublished revised draft. Chapter 10, Umatilla-Walla Walla Recovery Unit, Oregon and Washington. 160 p. May 10, 2004.

U. S. Fish and Wildlife Service. 2008. Bull Trout Recovery: Monitoring and Evaluation Guidance. Report prepared for the U.S. Fish and Wildlife Service by the Bull Trout Recovery and Monitoring Technical Group (RMEG). Portland, Oregon. *Version 1* – 74 pp.

Watson, G., and T. W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: an investigation at hierarchical scales. North American Journal of Fisheries Management 17:237–252.

Winter, J. 1996. Advances in underwater biotelemetry. Pages 555-590 *in* B. R. Murphy and D. W. Willis, editors. Fisheries Techniques, Second Edition. American Fisheries Society, Bethesda, Maryland.