U.S. Fish and Wildlife Service
Columbia River Fisheries Program Office

North Fork Walla Walla River Bull Trout Occupancy and Habitat Use Assessment

FY 2012-2013 Annual Report

Marshall G. Barrows, Ryan C. Koch and Brook Pattison Silver

U.S. Fish and Wildlife Service
Columbia River Fisheries Program Office
Vancouver, WA 98683

On the cover: *In the North Fork Walla Walla River, threatened bull trout use critical habitat to overwinter and forage prior to returning to natal headwater reaches of the South Fork Walla Walla River to subsequently spawn. Photograph by Ryan Koch (FWS).*

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NORTH FORK WALLA WALLA RIVER BULL TROUT OCCUPANCY AND HABITAT USE ASSESSMENT

2012-2013 ANNUAL REPORT

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Abstract ─ Effective management and eventual recovery of the threatened bull trout (*Salvelinus confluentus*) requires a sufficient knowledge of their spatial distribution and the ability to assess seasonal movements and habitat use for all life-history stages and strategies. This assessment is a component of a broader effort to describe bull trout habitat use, distribution, migratory patterns and connectivity between bull trout populations within the Walla Walla River Basin. We employed a multifaceted approach to investigate bull trout use of the North Fork Walla Walla River (NFWWR) in northeastern Oregon. We used a full duplex PIT detection array near the mouth of the NFWWR to describe seasonal use by migratory bull trout between 18 May 2012 and 19 April 2013. A total of 16 individual PIT-tagged bull trout were detected at the PIT detection array from 24 May 2012 to 10 December 2012. An examination of PIT detection histories for these fish revealed that both adult and subadult bull trout entered the NFWWR during fall and winter months, likely to utilize overwintering habitat within the subbasin. We also found that some of the subadult bull trout that dispersed from their natal headwaters in the South Fork Walla Walla River during the spring subsequently entered the NFWWR instead of continuing to downstream rearing areas in the mainstem Walla Walla River. Detection histories also revealed that a portion of the adult-sized bull trout that typically migrate from overwintering areas in middle and lower reaches of the mainstem Walla Walla River entered the NFWWR during May and June instead of continuing with the rest of the migratory population to known spawning grounds in the South Fork Walla Walla River. These fish resided within the NFWWR subbasin from 11 to 30 days (average 21.3 days) before exiting on the declining limb of the hydrograph in late June and early July. Several of these fish subsequently moved rapidly to known spawning reaches in the South Fork Walla Walla River. We also conducted a single bull trout redd survey in the headwater reaches of the NFWWR to determine if spawning currently occurs within the subbasin. Four small, unoccupied redds were found on 17 October 2012. The redds may have been constructed by resident-sized bull trout, but this could not be confirmed. In addition to the PIT detection array and the redd survey, we applied Recovery Monitoring and Evaluation Group (RMEG) guidance on monitoring bull trout occupancy and distribution. Occupancy and distribution sampling was conducted using backpack electrofishing between 26 June 2012 and 28 June 2012. A total of seven 50 meter reaches were sampled within the NFWWR patch. No bull trout were captured or observed during this effort. Collectively, our findings help elucidate the importance of understanding bull trout use of tributary habitat and its role in bull trout recovery.

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Introduction

Because of severe population declines, some related to migration impediments and habitat degradation, bull trout (*Salvelinus confluentus*) were listed as threatened throughout the coterminous United States in 1999 (USFWS 2002). Bull trout spawn in cold, headwater streams and express a variety of life history strategies characterized primarily by migration patterns. Anthropogenic changes to migratory corridors (e.g. irrigation diversions, dikes, and dams) potentially impair/hinder connectivity between bull trout spawning and rearing areas as well as connectivity among local populations and between core areas (metapopulations). Migratory corridors lacking sufficient passage and with poor riverine habitat conditions (e.g. low streamflows and high summer temperatures) may impede migration and isolate historically connected populations (Barrows et al. 2012). Resident bull trout complete their life cycle while remaining in their natal stream (Rieman and McIntyre 1995; Pratt 1992; Shepard et al. 1984). After hatching, migratory bull trout generally rear as juveniles for one or more years before migrating downstream as subadults to larger rivers or tributaries to utilize additional rearing habitat and more abundant food resources (Fraley and Shepard 1989, Goetz 1989). Upon reaching maturity, adult bull trout generally return to spawn in their natal stream. Migration is thus a critical component of bull trout life history and directly impacts their growth and reproductive success (Small et al. 2012; Swanberg 1996). Studies are currently underway to assess migration patterns, distribution, and abundance of bull trout as baseline information for recovery planning.

The Bull Trout Draft Recovery Plan (USFWS 2002) recognizes that many uncertainties exist regarding bull trout abundance and distribution and considers it essential to confirm bull trout distribution and seasonal use areas within the Umatilla-Walla Walla Recovery Unit. The Recovery Plan indicates that additional population studies and a better understanding of bull trout fidelity to their natal streams is needed to better define local populations in the Recovery Unit. It specifically mentions the potential to characterize the upper Walla Walla complex into separate South Fork and North Fork local populations. The plan also indicates that tributaries where there is limited scientific data, and isolated or anecdotal reports of bull trout capture have occurred, should be targeted for additional studies to determine whether other local populations might exist. The North Fork Walla Walla River (NFWWR) watershed is specifically noted as one of these areas. The plan explicitly states that bull trout distribution and use of the NFWWR needs further investigation. The Recovery Plan goes on to list specific tasks necessary to work toward recovery in the Umatilla-Walla Walla Recovery Unit. Some of the tasks have since been addressed, many tasks are currently being worked on, and others have not yet been significantly acted upon. Many of the tasks listed call for work in the NFWWR. Task 5.2.2 calls for research into bull trout use and habitat potential in the NFWWR. Task 5.5.2 recommends conducting regular surveys in potential habitat where bull trout status is unknown or re-colonization is anticipated. Task 5.5.3 proposes to identify the extent of use of the NFWWR subbasin by bull trout.

Currently, very little information exists regarding the extent of bull trout use and habitat potential in the NFWWR. Ten presumed bull trout redds were observed during October 2000 in the NFWWR (USFWS 2002), but redd surveys conducted during the early 2000's as part of the EMAP protocol (Jacobs et al. 2009) indicated that little or no spawning activity may have occurred at that time. In addition to spawning ground surveys, bull trout have been observed in the lower reaches of the NFWWR. The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) field staff observed three small bull trout in the NFWWR near its confluence with the South Fork Walla Walla River (SFWWR) during a sampling effort in August 2003 (Contor et al. 2003). In the early 2000's, CTUIR and Oregon Department of Fish and Wildlife (ODFW) staff documented that on more than one occasion, adult migratory bull trout that were originally tagged in the upper SFWWR moved into the NFWWR to presumably overwinter (Mahoney et al. 2006). Brief interviews with local landowners during 2012 indicated that bull trout occurrence in the NFWWR was fairly common in the past (L. Bullock, D. Sams and C. Sams, personal communication). More recently, bull trout were observed near an irrigation diversion structure (D. Sams, personal communication) in the NFWWR. Recently, patches in the Walla Walla River Basin were delineated following guidance from the Recovery Monitoring and Evaluation Group (RMEG) (USFWS 2008). Results of this exercise revealed that the North Fork patch was the largest in the Walla Walla Basin that was not known to be occupied by a biological bull trout population. Considering the conflicting results of past redd surveys and the occasional observations of bull trout within the subbasin, further investigation to assess occupancy and better describe bull trout use of the NFWWR subbasin was warranted.

This assessment is a component of a broader effort to describe bull trout habitat use, distribution, migratory patterns and connectivity between bull trout populations within the Walla Walla River Basin as well as to neighboring basins. The management and eventual recovery of bull trout requires an understanding of spatial and temporal habitat use across systems, life stages and life history strategies. The goal of this project was to use a multifaceted approach to describe current bull trout use and determine habitat potential in the NFWWR. The objectives of this study were to: 1) describe if/when migratory bull trout use the NFWWR, 2) determine if bull trout currently spawn in the NFWWR, 3) assess bull trout occupancy of the NFWWR patch and 4) quantitatively assess bull trout spawning habitat in the NFWWR subbasin. The findings of this assessment will help address several research needs and specific tasks identified in the Recovery Plan and help inform future management actions.

Study Area

Several tributaries to the Columbia River contain bull trout populations, including the Walla Walla River, which supports five known bull trout local populations within two core areas (USFWS 2002). These include three local populations in the Touchet River Core Area (North Fork and South Fork Touchet River, and Wolf Creek), and two populations in the Walla Walla Core Area (SFWWR and Mill Creek). The Walla Walla River Basin has a predominantly dry, continental climate but some marine characteristics are evident (Harrison et al. 1964). Climate in the Walla Walla River Basin is compellingly influenced by elevation, and varies from semiarid (< 10 in. annual precipitation) in the western lowlands that lie in the rain shadow of the Cascade Mountains, to cool and wet (40-60 in. annual precipitation) at higher elevations (Walla Walla Watershed Plan 2005). Winter precipitation often falls as snow in higher elevations and is stored as snowpack until warmer temperatures initialize runoff in the spring and early summer months. The NFWWR flows for 30.2 km from its headwaters in the coniferous forested, western slopes of the Blue Mountains in northeastern Oregon through volcanic canyons to a predominately cottonwood river valley before eventually reaching its confluence with the SFWWR to form the mainstem Walla Walla River at rkm 82 (Figure 1). In general, instream habitat in the headwaters of the NFWWR remains somewhat pristine, but habitat becomes progressively more degraded downstream from the Umatilla National Forest Boundary. At lower elevations, the steepness of the canyon slopes decreases, the valley bottom widens, and accordingly the stream gradient decreases. This geomorphic transition corresponds to a shift in land-use from forested, less disturbed reaches to that of agricultural pasture land and as the canyon gives way to foothills, orchards, vineyards and other agricultural uses predominate the near-river landscape.

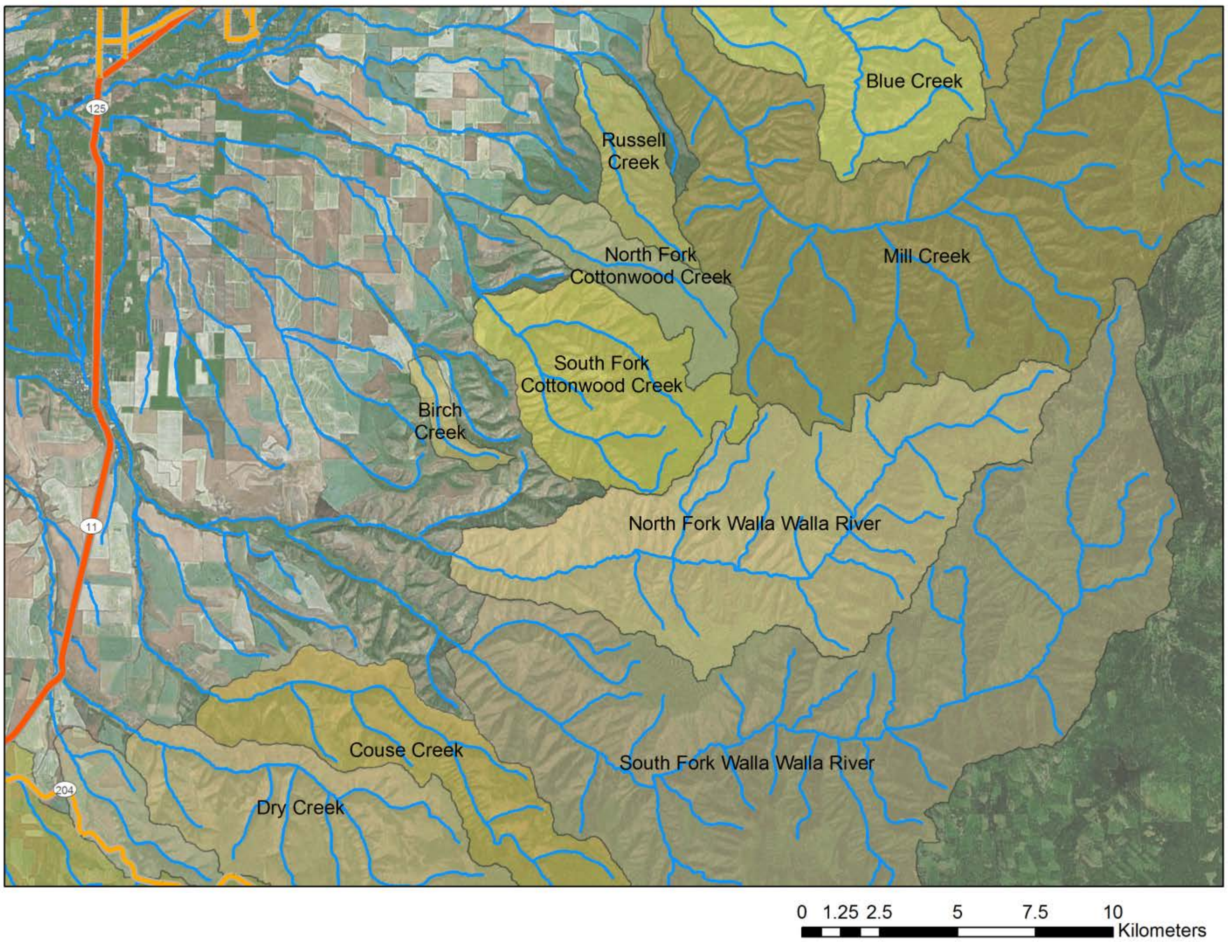

Figure 1. Study area map of the North Fork Walla Walla River near Milton-Freewater, Oregon. Potential patches within the Walla Walla River Basin are denoted.

Methods

A multifaceted approach was used to describe bull trout use and determine habitat potential in the NFWWR. We used a full duplex PIT detection array near the mouth of the NFWWR to describe seasonal use by migratory bull trout. A single bull trout redd survey was conducted in headwater areas to determine if spawning currently occurs in the subbasin. In addition, sampling was conducted for bull trout occupancy and distribution using backpack electrofishing, and spawning and rearing habitat metrics were also recorded.

Monitoring Bull Trout Use of the North Fork Walla Walla River

Fish Sampling

A basin-wide, multi-agency PIT-tagging effort maintains a tagged population of migratory bull trout, steelhead and spring Chinook salmon. These fish can be detected at each of the established PIT detection arrays in the Walla Walla River Basin. Bull trout PIT-tagging efforts by the U.S. Fish and Wildlife Service (FWS) in the middle and lower Walla Walla River, the U.S. Geological Survey-Utah Cooperative Fish and Wildlife Research Unit in the SFWWR, the ODFW and the U.S. Forest Service (USFS) in Mill Creek, the Washington Department of Fish and Wildlife (WDFW) in the Touchet Basin, and the CTUIR at various locations around the Walla Walla Basin have been ongoing since at least 1998 (Anglin et al. 2010). Full duplex ISO 134 kHz PIT tags and compatible detection arrays were employed. To augment the established tagged population, we captured and PIT-tagged additional migratory bull trout within the NFWWR subbasin.

<u>Angling</u> ─ Angling was used to capture bull trout for PIT tag deployment at a single location in the NFWWR subbasin (rkm 9) on two occasions. Sampling was conducted by experienced personnel using lures fitted with barbless hooks.

<u>Electrofishing</u> ─ Electrofishing was conducted for patch occupancy sampling in the NFWWR patch. If bull trout were captured, they were subsequently PIT-tagged. Electrofishing was conducted in the NFWWR and Little Meadow Creek by experienced personnel using a Smith-Root model LR-24 shocker. Within the NFWWR subbasin, seven randomly selected, spatially balanced reaches were sampled via electrofishing. Reaches were 50 meters in length for a total of 350 m sampled. Additional habitat was sampled while training field staff in sampling procedures. Specific sampling methods are described in the occupancy and distribution sampling section.

Tagging

Following capture, bull trout were immediately anesthetized for tagging in a river water bath containing 40 mg/l of tricaine methanesulfonate (MS-222) buffered with sodium bicarbonate at a concentration of 80 mg/l. Once anesthetized, bull trout were measured to the nearest mm (fork length) and weighed to the nearest 0.1 g. The 23 mm long PIT tags were inserted subcutaneously at the abdomen through a shallow 3-mm incision made with a surgical scalpel slightly off the mid-line and anterior to the pelvic girdle (Barrows et al. 2014). Following surgery, the bull trout were recovered from anesthesia to an upright swimming position in an aerated bath of river water and released in an area of reduced water velocity at the capture site.

PIT Detection Array

A PIT detection array was established near the mouth of the NFWWR at rkm 0.3, upstream from its confluence with the SFWWR on 18 May 2012 (Figure 2). The PIT detection array consisted of three pass-over type antennas anchored to the streambed and operated by a Destron Fearing™ Multiplexing Transceiver System FS1001M (Figure 3). The site was monitored bi-weekly to assess equipment function and identify periods of downtime. Interrogation files were manually downloaded and assessed upon return to the office. The resulting PIT detection data was uploaded manually to the PTAGIS database.

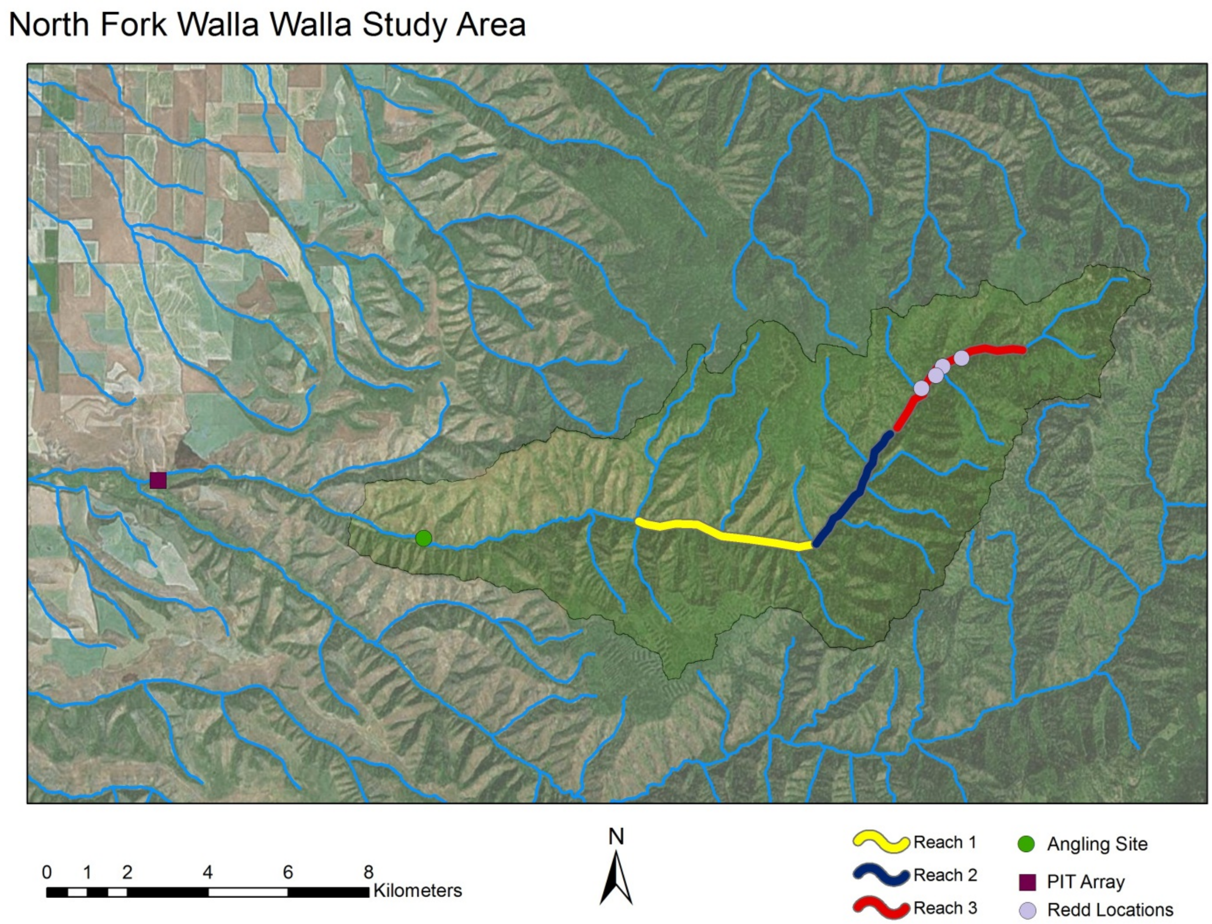

Figure 2. Locations of the PIT array, angling sites, the redd survey reaches and redds in the North Fork Walla Walla River.

Figure 3. North Fork Walla Walla River PIT detection array near Milton-Freewater, OR. Pass-over type antennas are pictured on the left and the Destron Fearing™ Multiplexing Transceiver System FS1001M is pictured on the right.

Comprehensive Detection Histories of PIT Tagged Bull Trout

We used all PIT detection and recapture data from locations throughout the Walla Walla Basin to assemble complete detection histories for each bull trout detected at the NFWWR PIT array.

North Fork Walla Walla River Use Patterns

We examined the complete detection histories of each bull trout detected at the NFWWR PIT array to help identify and describe bull trout temporal use patterns in the NFWWR. We used professional judgment in conjunction with temporal and spatial PIT detection timing to interpret detection histories when identifying and describing bull trout use patterns.

Steelhead Use of the North Fork Walla Walla River

In addition to bull trout, summer steelhead (*Oncorhynchus mykiss*) were also detected at the PIT array. Although the main objectives of this assessment were centered around bull trout use of the NFWWR subbasin, we also summarized and discussed steelhead detections in Appendix B.

Bull Trout Spawning

A single bull trout redd survey was conducted on 17 October 2012 in areas where spawning may historically have been reported (rkm 13.5 – 25.5). The area was divided into three reaches and experienced surveyors began at the downstream end of each reach and walked upstream. Reach one was a 5.5 km reach from the Little Meadow Creek confluence at rkm 14.2 upstream to rkm 19.7, reach two was 3.2 km long from rkm 19.7 to rkm 22.9 and reach three was 3.1 km long from rkm 22.9 to rkm 24 (Figure 2). Redds encountered during surveys were enumerated, measured (length and width to the nearest 0.1 m) and classified as either occupied or unoccupied. A digital photograph of each redd was also taken.

Patch Occupancy and Distribution

Patch Delineation

To determine if the NFWWR was an area with habitat likely to support a population of bull trout, patches in the Walla Walla River Basin were delineated (Figure 4) following guidance from RMEG (USFWS 2008). Patches were identified using temperature-elevation relationships, stream order and by determining minimum catchment areas for watersheds that exceed temperature and stream size thresholds. A maximum instantaneous annual stream temperature of 16°C was used as a threshold to locate the lowest bound of a stream segment that may likely sustain a bull trout population. Temperature data was acquired from water quality monitoring conducted prior to 2012 at various locations within the Walla Walla River Basin. Temperature-elevation relationships were investigated. The majority of the temperature data available for the Walla Walla River subbasin was collected in the SFWWR. The resulting relationship suggested that elevations lower than 520 m would be likely to exceed an annual maximum of water temperature of 16°C. Patches were delineated using ArcGIS. First, watersheds were delineated by removing all areas that were below the 520 m elevation threshold. Remaining areas were eliminated if the watershed exceeded third order (Strahler 1952). Lastly, watersheds that were less than 400 hectares were eliminated. Approximately 24.5 rkm (81%) of the NFWWR fell within the resulting patch.

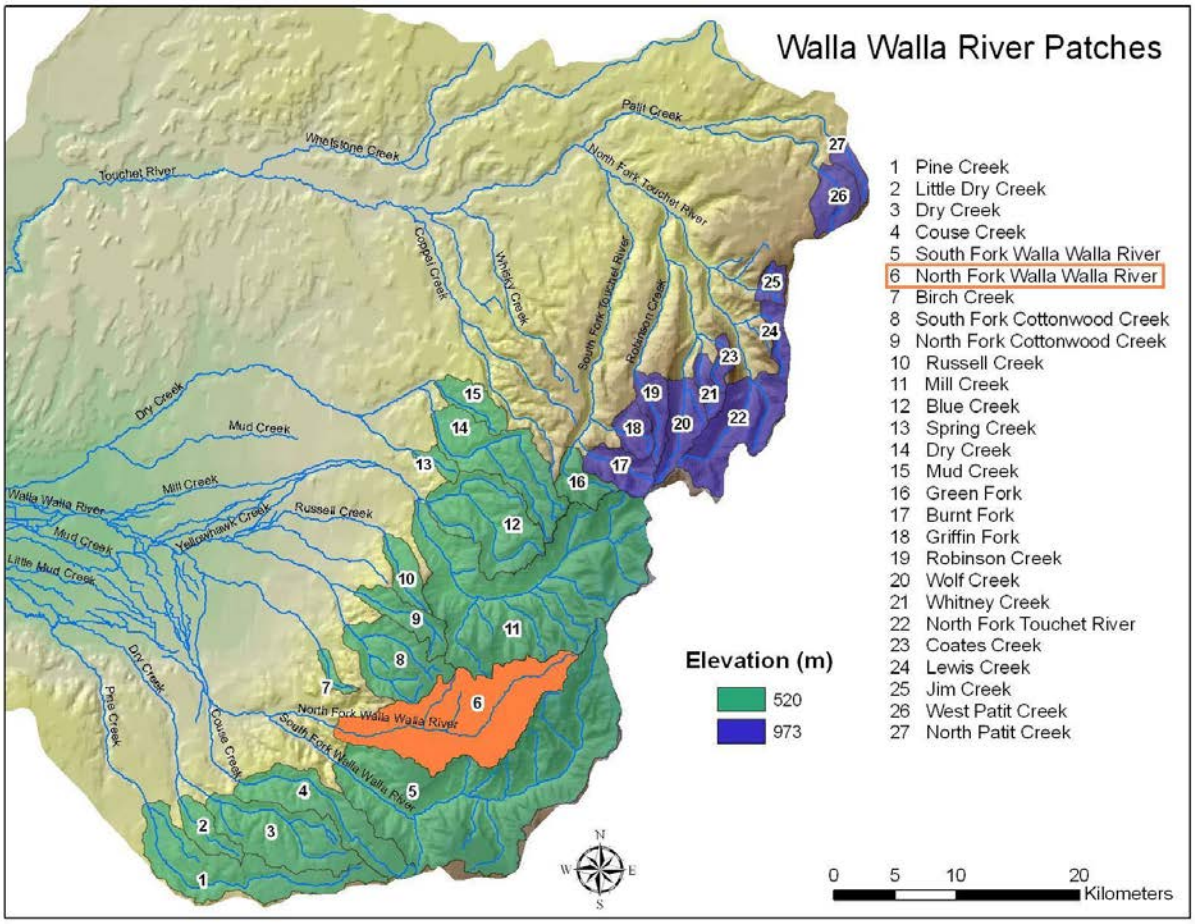

Figure 4. North Fork Walla Walla River subbasin bull trout patches identified by stream temperature, stream order and catchment area. Blue and green patches were delineated using derived temperature-elevation thresholds of 973 m and 520 m respectively. The North Fork Walla Walla patch (#6) was delineated using the 520 m temperature-elevation threshold and is highlighted in orange.

Occupancy and Distribution Surveys

Within the NFWWR patch, randomly selected, spatially balanced sample reaches 50 m in length (Figure 5) were determined following methods specifically described in USFWS (2008). No site-specific detection probability information was available for bull trout in the NFWWR. A specific detection probability was not estimated for this watershed due to the considerable differences between the SFWWR and habitat found in the NFWWR. Based on site specific detection probabilities for bull trout sampled from various other areas (e.g. the Lewis River, WA) (Hudson et al. 2010), site specific detection probability in the NFWWR was estimated to be at least 0.20. At this detection probability, the lowest-ordered seven reaches that could be evaluated were sampled. This ensured at least an 80% confidence level that if bull trout were not detected then they actually were not present. The patch was considered occupied by a biological population if at least two age classes of bull trout were captured during surveys. If a difference of > 30 mm in fork length was observed between bull trout captured, they were considered separate age classes.

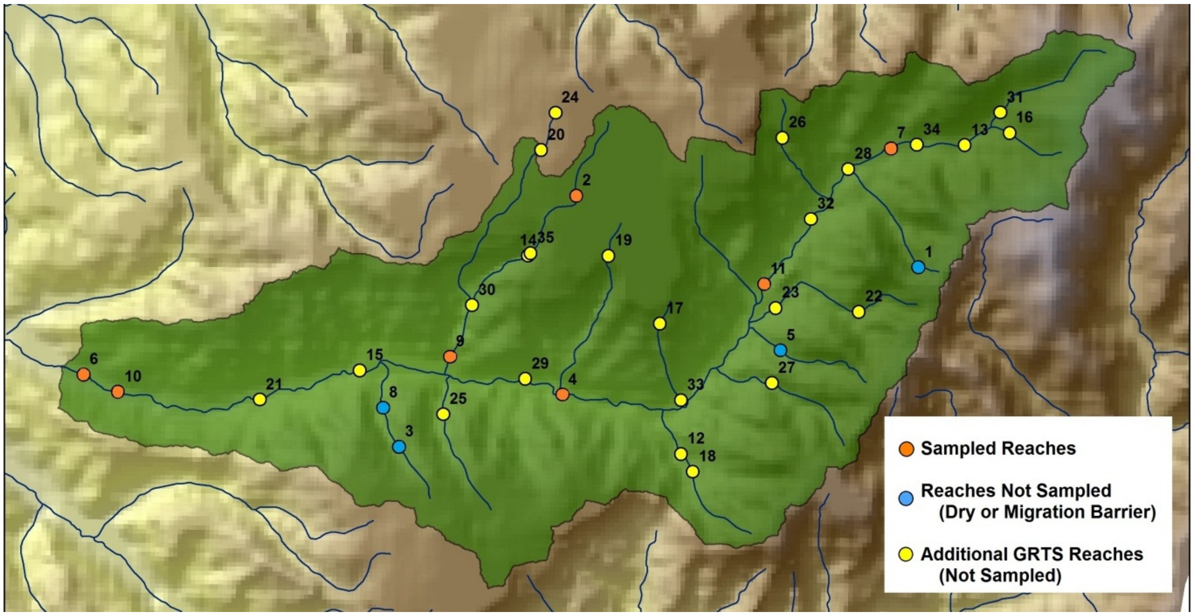

Figure 5. Patch occupancy and distribution survey reaches within the North Fork Walla Walla River patch. Reaches denoted by orange dots are reaches that were sampled. Reaches denoted by blue dots are reaches that were not sampled due to a lack of water or the presence of a migration barrier. Yellow dots denote potential reaches for sampling.

Occupancy and distribution assessments were conducted by experienced personnel using a Smith-Root model LR-24 shocker following sampling methods adapted from Silver et al. (2010). Each 50 m reach was sampled from the downstream to the upstream boundary without blocknets. Electrofishing was conducted using a technique to reduce potential harm to the sampled population. Specifically, all areas considered holding habitat for salmonid species (plunge pools, overhanging banks, debris piles, large wood and pocket pools within riffles) were sampled in a "stalk and shock" approach (Cook et al. 2008). The backpack electrofisher used pulsed direct current set at a frequency of 24 - 26 Hz, 14-18% duty cycle, and voltage between 350 and 475 V. Settings were appropriately modified depending on sampling conditions (i.e. water depth, conductivity, flow). All fish captured were enumerated and identified to species. Fork length and weight was documented to facilitate size class determination for all salmonids captured. Although brook trout (*Salvelinus fontinalis*) are currently found in only one tributary to the Walla Walla River (Big Spring Branch of the East Little Walla Walla River), *Salvelinus* species were closely examined for indicative features (e.g. dark markings on dorsal fin, vermiculation) before identification. A genetic sample was collected from each bull trout encountered for future analysis. All bull trout captured were scanned for existing PIT tags. Bull trout without preexisting tags were PIT-tagged. All fish captured were released within the sample reach.

Habitat Variables

We collected both rearing and spawning habitat data during occupancy surveys. Rearing habitat data was collected to examine the relationship between various habitat variables and site-specific detection probability in the future. Spawning habitat variables were collected to coarsely assess the availability of spawning habitat within the NFWWR patch.

Habitat variables, rearing/detection probability ─ After completing fish sampling in each reach, habitat data was collected following methods described in Silver et al. (2010) for future examination of the relationship between various habitat variables and site-specific detection probability. A hand-held clinometer was used to measure the gradient of each reach. Large woody debris (LWD) was categorized and counted. Wood was classified into the following four categories: LWD > 10 cm in diameter and > 3 m in length, LWD > 60 cm in diameter and > 10 m in length, root wads and LWD piles (aggregates of > 4 pieces). Only wood within the channel or within one meter of the water's surface was considered. The number, type and size of undercut banks were measured along both sides of the sampling reach. For this assessment, undercuts are areas under boulders, banks, or large wood along the stream bank that are at least 5 cm deep, greater than 10 cm in length, and over 5 cm in height (Silver et al. 2010).

Habitat variables, spawning ─ In addition to rearing habitat variables, we collected depth, velocity, and substrate composition data (following Gallion et al., *in prep*) along transects within sample sites to generally assess the availability of spawning habitat within the NFWWR patch. Transects were flagged along the thalweg at every 10 meters from zero to 50 meters. For each transect, the current wetted width, maximum depth along the transect line, and depth recordings at ¼, ½, and ¾ distance across the wetted width was measured. A nose velocity and mean column velocity was also measured at ¼, ½, and ¾ distance across the wetted width with a top-set wading rod and a Marsh-McBirney Flo-Mate Model 2000 flow meter. In addition, dominant and subdominant substrate types and particle sizes within a 0.5 m radius of each depth/flow measurement point were classified by diameter based on visual estimation (Table 1).

Table 1. Substrate types and particle sizes used to classify dominant and subdominant substrates for bull trout spawning habitat surveys.

Substrate Type	Particle size (cm)
Sand	< 0.65
Pebble	0.65 – 2.54
Small Gravel	2.55 – 5.08
Large Gravel	5.09 – 7.62
Cobble	7.63 – 15.24
Boulder	> 15.24

We followed sampling and analysis methods described in Sankovich and Anglin (2013), where data collected from 269 bull trout redds in the SFWWR were used to establish criteria for spawning habitat. We filtered our transect data according to these conditions to identify potential spawning sites (Table 2).

Table 2. Criteria for bull trout spawning habitat derived from data collected from 269 bull trout redds in the South Fork Walla Walla River (Sankovich and Anglin 2013).

Spawning Habitat Variable	Criteria
Water Depth	0.06 − 0.73 m
Water Velocity (Nose)	0.00 – 0.58 m/s
Water Velocity (Mean Column)	0 – 0.86 m/s
Substrate (Dominant)	≤ 7.62 cm
Substrate (Subdominant)	≤ 15.24 cm

Results

Monitoring Bull Trout Use of the North Fork Walla Walla River

Fish Sampling

Angling ─ During a total of 2.5 hours of sampling, four, fluvial adult-sized (≥ 300 mm FL) bull trout were captured, of which all were subsequently tagged with PIT tags. On 14 June 2012, two bull trout were captured and PIT-tagged. Two additional bull trout were captured on 28 June 2012 at the same location and were subsequently PIT-tagged. None of the bull trout captured had been previously PIT-tagged. Juvenile steelhead and rainbow trout (*O. mykiss)* were among the incidental captures.

Electrofishing ─ Patch occupancy and distribution sampling occurred from 26 June 2012 through 28 June 2012. No bull trout were captured via electrofishing during occupancy sampling. Primarily juvenile *O. mykiss* were the primary incidental captures.

Tagging

Sampling efforts within the NFWWR resulted in a total of four adult-sized bull trout, all of which were subsequently PIT-tagged. Tagged bull trout varied in fork length from 345 to 481 mm and their weight ranged from 470.0 to 1226.0 g. Table 3 provides a summary of bull trout captured and PIT tagged in the NFWWR with full duplex ISO 134 kHz PIT tags during FY2012.

Table 3. PIT tag code, tagging date, tagging location, fish length, and fish weight for bull trout tagged in the North Fork Walla Walla River during FY2012.

PIT tag code	Tagging date	Tagging location (rkm)	Capture method	Fork length (mm)	Weight (g)
384.1B795B26F1	6/14/2012	9	Angling	375	569.0
384.1B795B270A	6/14/2012	9	Angling	481	1226.0
384.1B795B26B8	6/28/2012	9	Angling	345	470.0
384.1B795B26C9	6/28/2012	9	Angling	346	478.0

PIT Detection Array

The NFWWR PIT detection array was installed on 18 May 2012 and remained operational until high streamflows dislodged the antennas on 19 April 2013. Electricity to the site was lost on two occasions, from 27 September 2012 to 15 October 2012, and from 11 December 2012 to 2 January 2013. Bull trout PIT detections could have been missed during the lapses in site functionality. A total of 16 individual PIT-tagged bull trout were detected at the array (Figure 6). Of the 16 bull trout detected, five were detected while only moving downstream towards the Walla Walla River confluence, four were detected only moving upstream and five were detected while moving both upstream and downstream past the PIT detection array. Two other PIT tagged bull trout were detected but their direction of movement could not be definitively determined from detection histories. Three of the bull trout detected at the NFWWR PIT detection array were originally tagged in middle and lower portions of the Walla Walla River from Milton-Freewater (rkm 76) downstream. Nine bull trout detected at the NFWWR PIT array were originally tagged in upper Basin areas within the SFWWR upstream from Harris County Park (rkm 97). Four of the bull trout detected at the NFWWR PIT detection array were tagged as part of this project at rkm 9 in the NFWWR.

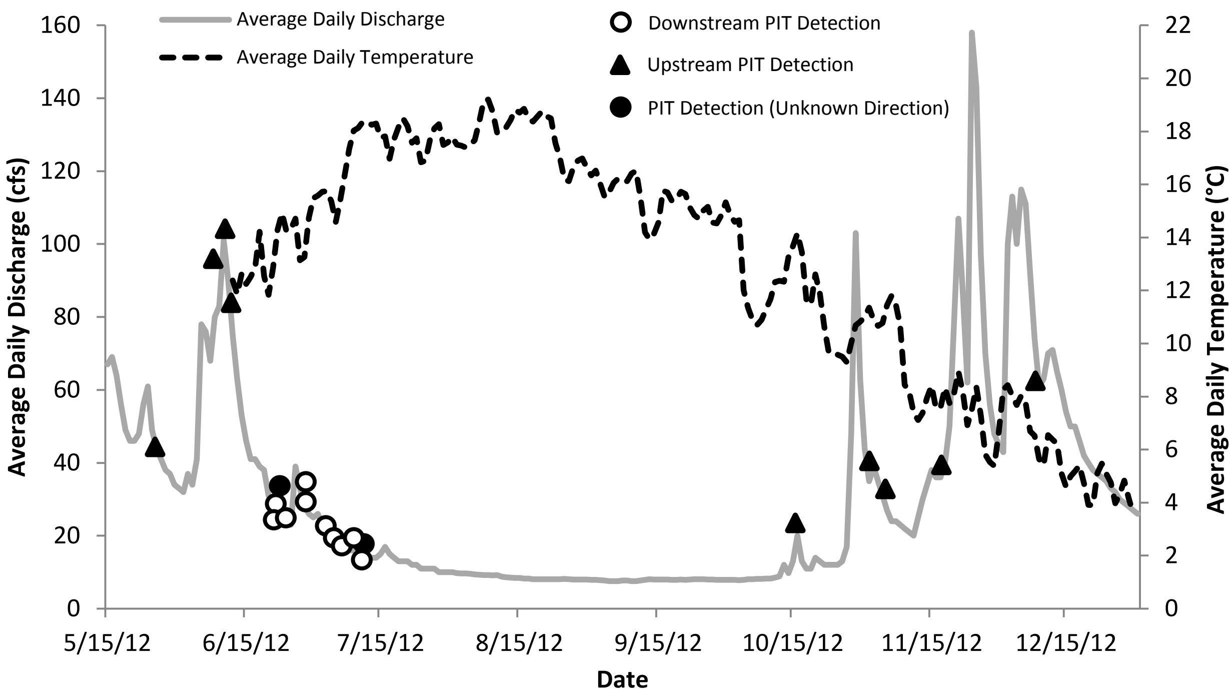

Figure 6. Detections of PIT-tagged bull trout at the North Fork Walla Walla River PIT detection site. The average daily discharge from the OWRD gage station #14010800 in the North Fork Walla Walla River near Milton-Freewater, OR for 15 May 2012 through 31 December 2012 and average daily temperature are also shown.

Comprehensive Detection Histories of PIT-Tagged Bull Trout

Detections from PIT arrays and recapture information throughout the Basin were combined to describe the movements of each individual PIT-tagged bull trout as they migrated to and from the NFWWR. Narratives describing the comprehensive detection histories of each PIT tagged bull trout detected at the NFWWR PIT array are provided in Appendix A. Detection histories through 31 December 2013 are included. A summary of detection histories is provided in Table 4.

Table 4. Comprehensive detection histories for PIT tagged bull trout detected at the North Fork Walla Walla PIT detection array. North Fork Walla Walla River PIT detections are signified in bold font.

PIT Tag Code	Date PIT Tagged (*) / Detected / Recaptured	Elapsed Time (days)	Location PIT Tagged (*) / Detected / Recaptured
384.1B795B26E8	11/8/2011*	N/A	Burlingame Diversion Dam (rkm 60)*
(397 Fork Length)	11/8/2011 – 11/9/2011	0	Burlingame PIT Array (rkm 60)
	5/9/2012	183	Burlingame PIT Array (rkm 60)
	5/15/2012 – 5/17/2012	6	Nursery Bridge PIT Array (rkm 74)
	5/24/2012	**9**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	6/23/2012	**30**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	7/8/2012	15	Harris Park Bridge PIT Array (rkm 97)
	9/26/2012	80	Bear Creek PIT Array (rkm 106)
	9/30/2012	4	Harris Park Bridge PIT Array (rkm 97)
3D9.1C2C6B6CD7	7/19/2011*	N/A	Cemetery Bridge Dam (rkm 76)*
(262 Fork Length)	8/26/2011	38	Nursery Bridge PIT Array (rkm 74)
	6/1/2012	280	Nursery Bridge PIT Array (rkm 74)
	6/12/2012	**11**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	6/23/2012	**11**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
384.1B795B26E2	11/8/2011*	N/A	Cemetery Bridge Dam (rkm 76)*
(266 Fork Length)	11/14/2011	6	Nursery Bridge PIT Array (rkm 74)
	5/7/2012	175	Burlingame PIT Array (rkm 60)
	6/2/2012	26	Nursery Bridge PIT Array (rkm 74)
	6/13/2012	**11**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	6/23/2012 – 7/6/2012	**23**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	10/15/2012	114	Nursery Bridge PIT Array (rkm 74)
	11/1/2012	17	Burlingame PIT Array (rkm 60)
3D9.1C2CBE736B	7/13/2009*	N/A	South Fork Walla Walla Headwaters *
(107 Total Length)	**6/14/2012**	**1067**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	7/2/2012	**18**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	7/10/2012	8	Harris Park Bridge PIT Array (rkm 97)
	7/18/2012	8	Bear Creek PIT Array (rkm 106)
	9/28/2012	72	Bear Creek PIT Array (rkm 106)
	10/13/2012	15	Harris Park Bridge PIT Array (rkm 97)
384.1B795B270A	6/14/2012*	N/A	N. F. Walla Walla River (rkm 9)*
(481 Fork Length)	**6/19/2012**	**5**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	6/28/2012	9	Harris Park Bridge PIT Array (rkm 97)
384.1B795B25B7	8/3/2010*	N/A	South Fork Walla Walla Headwaters *
(170 Total Length)	12/18/2010	137	Bear Creek PIT Array (rkm 106)
	6/23/2012 – 6/25/2012	**553**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
384.1B795B26F1	6/14/2012*	N/A	N. F. Walla Walla River (rkm 9)*
(481 Fork Length)	**6/23/2012**	**9**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	7/5/2012	12	Harris Park Bridge PIT Array (rkm 97)
	7/21/2012	16	Bear Creek PIT Array (rkm 106)
	9/29/2012	70	Bear Creek PIT Array (rkm 106)

PIT Tag Code	Date PIT Tagged (*) / Detected / Recaptured	Elapsed Time (days)	Location PIT Tagged (*) / Detected / Recaptured
	9/29/2012	0	Harris Park Bridge PIT Array (rkm 97)
	6/5/2013	249	Harris Park Bridge PIT Array (rkm 97)
	9/28/2013	115	Bear Creek PIT Array (rkm 106)
	9/29/2013	1	Harris Park Bridge PIT Array (rkm 97)
3D9.1C2CBDE09F	7/19/2010*	N/A	South Fork Walla Walla Headwaters*
(162 Total Length)	**6/25/2012**	**707**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	7/8/2012	13	Harris Park Bridge PIT Array (rkm 97)
	8/6/2012	29	Bear Creek PIT Array (rkm 106)
	9/21/2012	46	Harris Park Bridge PIT Array (rkm 97)
	6/17/2013	269	Harris Park Bridge PIT Array (rkm 97)
3D9.1C2C550444	6/30/2009*	N/A	South Fork Walla Walla Headwaters*
(131 Total Length)	**7/3/2012**	**1099**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	7/27/2012	24	Harris Park Bridge PIT Array (rkm 97)
	8/7/2012	11	Bear Creek PIT Array (rkm 106)
	8/12/2012	5	Recap – South Fork Walla Walla Headwaters
	10/16/2012	**65**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	6/21/2013	248	Harris Park Bridge PIT Array (rkm 97)
384.1B795B26B8	6/28/2012*	N/A	N. F. Walla Walla River (rkm 9)*
(345 Fork Length)	**7/7/2012**	**9**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	6/10/2013	338	Harris Park Bridge PIT Array (rkm 97)
384.1B795B26C9	6/28/2012*	N/A	N. F. Walla Walla River (rkm 9)*
(346 Fork Length)	**7/9/2012**	**11**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	7/18/2012	9	Harris Park Bridge PIT Array (rkm 97)
	10/11/2012	85	Harris Park Bridge PIT Array (rkm 97)
	6/6/2013	238	Harris Park Bridge PIT Array (rkm 97)
	9/30/2013	116	Bear Creek PIT Array (rkm 106)
	10/2/2013	2	Harris Park Bridge PIT Array (rkm 97)
384.1B795B277B	7/19/2011*	N/A	South Fork Walla Walla Headwaters*
(170 Total Length)	5/26/2012	312	Bear Creek PIT Array (rkm 106)
	7/11/2012	**46**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	11/01/2012	113	Burlingame PIT Array (rkm 60)
384.1B795B19B9	8/5/2012*	N/A	South Fork Walla Walla Headwaters*
(510 Total Length)	9/23/2012 – 9/30/2012	49	Bear Creek PIT Array (rkm 106)
	10/18/2012 – 10/19/2012	25	Bear Creek PIT Array (rkm 106)
	10/29/2012	**11**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	6/29/2013	243	Harris Park Bridge PIT Array (rkm 97)
	9/29/2013 – 10/2/2013	92	Bear Creek PIT Array (rkm 106)
	12/01/2013	63	Harris Park Bridge PIT Array (rkm 97)
384.1B795B1994	8/2/2012*	N/A	South Fork Walla Walla Headwaters*
(426 Total Length)	10/22/2012	81	Bear Creek PIT Array (rkm 106)
	10/29/2012	7	Harris Park Bridge PIT Array (rkm 97)
	11/4/2012	**6**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
3D9.1BF1B2E7CB	7/24/2009*	N/A	South Fork Walla Walla Headwaters*
(128 Total Length)	7/9/2011	715	Nursery Bridge PIT Array (rkm 74)
	7/26/2011	17	Nursery Bridge PIT Array (rkm 74)

PIT Tag Code	Date PIT Tagged (*) / Detected / Recaptured	Elapsed Time (days)	Location PIT Tagged (*) / Detected / Recaptured
	11/19/2011 – 11/22/2011	116	Burlingame PIT Array (rkm 60)
	6/21/2012	215	Nursery Bridge PIT Array (rkm 74)
	7/8/2012	17	Harris Park Bridge PIT Array (rkm 97)
	7/27/2012	19	Bear Creek PIT Array (rkm 106)
	10/23/2012	88	Harris Park Bridge PIT Array (rkm 97)
	11/17/2012 – 12/7/2012	**25**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**
	7/1/2013	226	Harris Park Bridge PIT Array (rkm 97)
	10/5/2013	96	Bear Creek PIT Array (rkm 106)
	10/5/2013	0	Harris Park Bridge PIT Array (rkm 97)
384.1B795B27C7	7/20/2011*	N/A	South Fork Walla Walla Headwaters*
(146 Total Length)	6/19/2012	335	Bear Creek PIT Array (rkm 106)
	12/10/2012	**174**	**N. F. Walla Walla PIT Array (NF rkm 0.3)**

North Fork Walla Walla River Use Patterns

An examination of the full detection histories of bull trout that were detected at the NFWWR PIT array (Table 4, Appendix A) revealed four general use patterns as discussed below.

Adult Overwintering ─ Postspawning fluvial adult bull trout (≥ 300 mm FL) migrate downstream from spawning areas in the SFWWR during the fall (Schaller et al. 2014). A portion of these fish entered the NFWWR from October to December to overwinter instead of continuing downstream to middle and lower Basin areas. Mean migration time from the Harris Park Bridge PIT detection array (rkm 97) to the NFWWR PIT array was 14 days and ranged from six to 25 days. Mean migration rate was 1.3 km/day and ranged from 0.5 to 2.13 km/day. After spending the winter months in the NFWWR, adult-sized bull trout moved out to the mainstem Walla Walla River from late June to early July on the declining limb of the hydrograph as streamflows neared summer base flows. Most of the adult-sized bull trout that left the NFWWR moved rapidly upstream to spawning grounds in the SFWWR upstream from Harris Park Bridge. Mean migration time from the NFWWR PIT array to the Harris Park Bridge PIT array was 13.8 days and ranged from nine to 24 days. Mean migration rate was 1.0 km/day and ranged from 0.5 to 1.4 km/day. Not all of the adult-sized bull trout that left the NFWWR during June and July subsequently moved upstream to known spawning grounds in the SFWWR. These fish may not have been mature, may have been mortalities, may have spawned elsewhere, or may simply have passed PIT antennas undetected as they entered the spawning grounds.

Subadult Overwintering ─ In the Walla Walla River Basin, fluvial subadult bull trout incrementally migrate downstream during all months until they become sexually mature. After migration from the headwaters peaks in the spring and early summer months, there is a short cessation of movement to lower Basin areas before subadult downstream migration resumes in the fall. A portion of the subadults migrating downstream in the SFWWR during the fall ascended the NFWWR to overwinter instead of continuing to downstream reaches in the mainstem Walla Walla River. The PIT tagged bull trout that exhibited this pattern entered the NFWWR in mid-December 2012 and were not subsequently detected before the PIT array was dislodged in late April 2013.

Adult Upstream "PIT Stop" ─ Many migratory bull trout overwinter in middle and lower portions of the Walla Walla River Basin and in the Columbia River (Schaller et al. 2014; Barrows et al. 2012, 2014). During spring and early summer months, adult-sized bull trout typically migrate from overwintering areas to the upper reaches of the SFWWR prior to spawning. Instead of following this general movement pattern, a portion of the upstream migrating population entered the NFWWR from 24 May 2012 to 14 June 2012. These fish resided within the NFWWR subbasin from 11 to 30 days (averaging 21.3 days) before exiting on the declining limb of the hydrograph in late June and early July. Of the four PIT-tagged bull trout that exhibited this movement pattern, two immediately migrated upstream to known spawning reaches in the SFWWR after exiting the NFWWR. Mean migration time from the NFWWR PIT array to the Harris Park Bridge PIT array was 11.5 days and ranged from eight to 15 days. Mean migration rate was 1.2 km/day and ranged from 0.9 to 1.6 km/day. The two other fish were not subsequently detected moving to the spawning grounds in the upper South Fork. Despite their size, these fish may not have been mature adults, may have been mortalities, may have spawned elsewhere or may have passed the PIT antennas in the SFWWR undetected.

Subadult Oversummering ─ In the Walla Walla River Basin, fluvial subadult bull trout incrementally migrate downstream during all months, but movement from the headwaters generally peaks during the spring. A portion of these fish enter the NFWWR instead of continuing to downstream rearing areas in the mainstem Walla Walla River. The PIT-tagged bull trout that exhibited this movement pattern was detected on the NFWWR PIT array on 11 July 2012. An examination of its detection history indicated that following detection at the Bear Creek PIT array (rkm 106) on 26 May 2012, the subsequent detection at the NFWWR PIT array might have been when it first entered the subbasin. It is also possible that the fish entered the NFWWR sometime between 26 May 2012 and 11 July 2012 undetected, which suggests the detection on the NFWWR PIT array was as it was exiting the subbasin. Regardless, the detection history confirms that a subadult bull trout migrated from the headwaters of the SFWWR during the spring and used the NFWWR during the summer months.

Bull Trout Spawning

A total of four small redds were enumerated during the single bull trout redd survey on 17 October 2012 (Table 5), all of which were located within reach 3 (Figure 2). The spatial and temporal nature of these redds in addition to their size indicates that they may have been constructed by small, resident-sized bull trout, although no bull trout were observed. Photographs of redds found in the NFWWR are depicted in Figures 7 and 8. No redds were counted in reaches 1 and 2.

Table 5. Measurements of redds found in the North Fork Walla Walla River on 17 October 2012.

Redd #	Reach #	Length (m)	Width (m)
1	3	0.5	0.3
2	3	0.6	0.6
3	3	0.6	0.3
4	3	0.5	0.3

Figure 7. Photograph depicting redd #1 found during a redd survey on 17 October 2012 in the headwaters of the North Fork Walla Walla River.

Figure 8. Photograph depicting redd # 4 found during a redd survey on 17 October 2012 in the headwaters of the North Fork Walla Walla River.

Patch Occupancy and Distribution

Occupancy and Distribution Surveys

We did not capture any bull trout in the seven reaches sampled within the NFWWR patch. The only fish species captured were steelhead or rainbow trout (*Oncorhynchus mykiss*), sculpin (*Cottus spp.*) and longnose dace (*Rhinichthys cataractae*). *O. mykiss* were captured in all but one of the reaches within the patch (Table 6). *O. mykiss* were most abundant in reach 9 that was located in Little Meadow Creek, a tributary to the NFWWR. The average number of *O. mykiss* captured per sampling site was 3.7. The longnose dace and sculpin were only captured in reaches 6 and 10, near the downstream portion of the NFWWR patch. Despite the relatively low numbers of fish captured during sampling, numerous small *O. mykiss* were observed holding in pocket water and pools within most reaches.

Table 6. Summary of fish species captured in the North Fork Walla Walla River using electofishing during occupancy and distribution surveys. Sampling was conducted from 26 June 2012 through 28 June 2012.

Patch	Reach ID	Date Sampled	Bull Trout	Steelhead/Rainbow	Longnose Dace	Sculpin
NFWW	2	6/26/12	0	0	0	0
NFWW	4	6/28/12	0	4	0	0
NFWW	6	6/26/12	0	4	0	1
NFWW	7	6/27/12	0	2	0	0
NFWW	9	6/28/12	0	10	0	0
NFWW	10	6/26/12	0	1	1	0
NFWW	11	6/27/12	0	4	0	0
Totals			**0**	**25**	**1**	**1**

Habitat Variables

Habitat variables, rearing/detection probability ─ Rearing habitat metrics were collected at all seven survey reaches (Appendix C). These habitat data may eventually be used to evaluate the relationship between detection probability and various habitat variables in the future.

Habitat variables, spawning ─ Spawning habitat metrics were collected in six of the seven survey reaches. No spawning habitat metrics were collected in reach 2 because substrate consisted of only fines, clay and organic material. Of the 108 sites where spawning habitat data were collected, 18 (17%) contained habitat conditions that met the five criteria for spawning habitat (Table 2). No sites within reach 10 met those criteria. Of the remaining five reaches, the percentage of sites meeting all five criteria ranged from 6% in reach 4 to 50% in reach 7 (Table 7). At 22 sites (20%), the dominant substrate size, subdominant substrate size, or both exceeded the size criteria developed from bull trout redds in the SFWWR. At some sites where the substrate size criteria were met, depth was insufficient. Nose velocity exceeded criteria at only 11 (10%) of the sites. Mean column velocities were within ranges observed at redds in the SFWWR at all but 12 (11%) sites where spawning habitat data were collected.

Table 7. Number and percentage of transect spawning habitat sampling points within each reach containing habitat conditions that meet spawning habitat criteria (described in methods section).

Patch	Reach ID	Number of Transects	Number of Sites Sampled	Sites Meeting All Criteria	% of Sites Meeting All Criteria
NFWW	2	0	0	NA	NA
NFWW	4	6	18	1	6%
NFWW	6	6	18	4	22%
NFWW	7	6	18	9	50%
NFWW	9	6	18	2	11%
NFWW	10	6	18	0	0%
NFWW	11	6	18	2	11%
Totals		**36**	**108**	**18**	**17%**

Discussion

Bull trout in the Walla Walla River Basin exhibit a continuum of life histories that include spawning, rearing, foraging and migrating over different spatial scales and time scales ranging from daily to annually or longer. Effective management of this threatened species requires a sufficient knowledge of current bull trout distribution, fundamental habitat requirements and an understanding of spatial and temporal habitat use. The Bull Trout Draft Recovery Plan (USFWS 2002) identified bull trout in the North Fork and South Fork Walla Walla rivers as a single local population labeled the upper Walla Walla complex. The Recovery Plan indicated that additional population studies and a better understanding of bull trout fidelity to their natal streams is needed to better define local populations in the Recovery Unit and mentioned the potential to further separate the upper Walla Walla complex into South Fork and North Fork local populations. This separation potential was based primarily on infrequent observations of suspected bull trout redds in upper reaches of the NFWWR subbasin. Prior to implementing our multifaceted approach to describing bull trout use of the NFWWR, very little information existed.

The use of PIT technology has developed into a fundamental tool for fisheries management and research, and it is particularly useful for describing the variation in migratory bull trout behaviors and life history. In the Walla Walla River Basin, the FWS and others have established and operated a robust network of PIT detection arrays. This network has been instrumental in describing bull trout migration patterns, assessing habitat use and estimating survival. In addition, Walla Walla River Basin bull trout connectivity to the migratory corridors (i.e. unrestricted movement between habitat areas) and between local and core area populations have been assessed by using PIT technology (Small et al. 2012; Barrows et al. 2012, 2014; Anglin et al. 2008). Even though PIT technology has been used to describe bull trout life history in the Walla Walla Basin as a whole, bull trout use of smaller tributaries in the Basin (e.g. NFWWR, Couse Creek, Pine Creek and others) has not been thoroughly investigated. By installing a PIT detection array near the mouth of the NFWWR, we were able to demonstrate that migratory adult and subadult bull trout use this subbasin more than previously known. Since PIT-tagged fish likely represent only a small portion of the total bull trout population that uses the NFWWR, the 16 individual bull trout detections at the PIT array suggest that many more non-tagged fish used the subbasin as well. Although the sample size was small, it is interesting to note that many of the adult-sized bull trout that eventually moved out of the NFWWR in late June and July were among the last of the PIT-tagged migratory bull trout in the Basin to be detected moving upstream past the Harris Park Bridge PIT array (rkm 97) to known spawning areas (Figure 9). Potential reasons for this timing are unknown, but it may be influenced by habitat or fish passage conditions in the NFWWR as instream flows sharply decline. Prior to our study, it was unknown that a notable proportion of migratory bull trout from the SFWWR population use the NFWWR. Seven (10.6%) of the 66 total PIT-tagged migratory bull trout that were detected moving upstream past the Harris Park Bridge PIT array from June to August 2012 were detected in the NFWWR prior to reaching the upper South Fork.

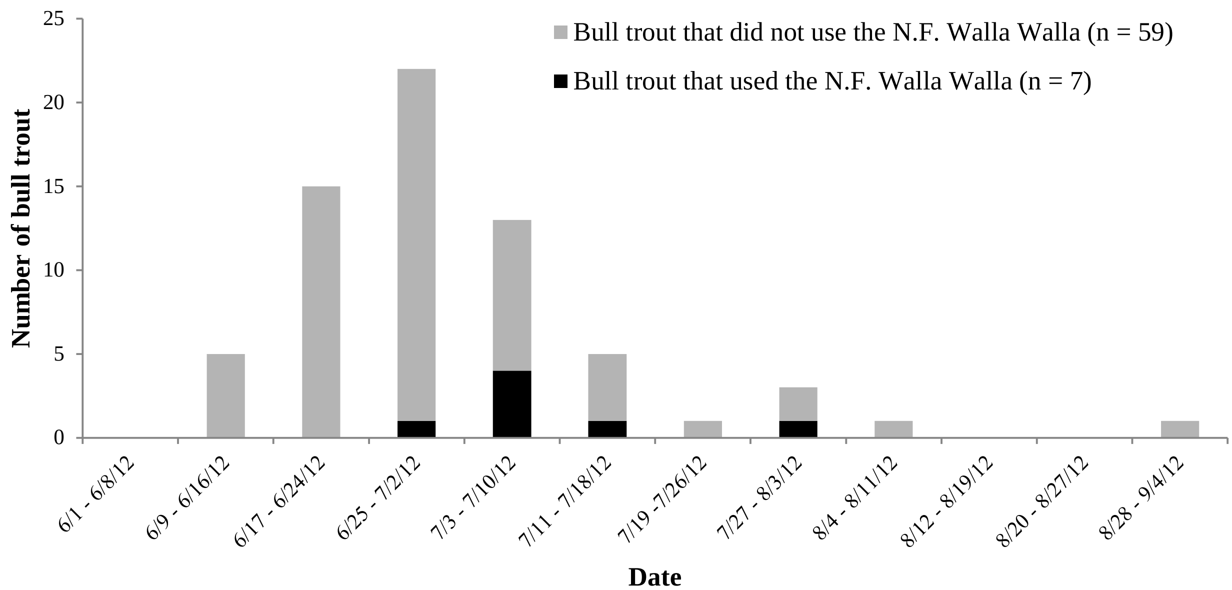

Figure 9. Detections of adult migratory bull trout at the Harris Park Bridge PIT detection array (rkm 97) from 1 June 2012 through 4 September 2012. Bull trout that used the North Fork Walla Walla River prior to reaching the upper South Fork Walla Walla River are denoted in black. Bull trout not detected in the North Fork Walla Walla River prior to reaching the upper South Fork are denoted in grey.

Bull Trout Use Patterns

Bull trout PIT detection histories revealed that fish of multiple life history stages exhibiting differing migratory strategies use the NFWWR during most months of the year. We identified four general use patterns that were exhibited by bull trout that used the NFWWR. We determined that adult-sized bull trout enter the NFWWR in the fall and early winter months to utilize overwintering habitat within the subbasin. Mahoney et al. (2006) found that on more than one occasion, adult-sized bull trout, radio-tagged in the SFWWR, overwintered in the NFWWR before returning to spawning areas in the SFWWR the following summer. Our findings are consistent with this movement pattern and suggest that this strategy is common. In addition to adults, we found that migratory bull trout with tagging and detection histories that indicated they were likely subadults at the time of detection, also moved into the NFWWR instead of continuing to disperse downstream from natal areas in the SFWWR during the fall. A similar migration pattern for Age-2 and older bull trout was described in Ratliff et al. (1996), where a portion of the migratory fish in the Metolius River system did not continue to disperse downstream, but instead moved into adjacent warmer tributaries not used by bull trout for spawning. Bull trout may overwinter in tributaries like the NFWWR to avoid harsh conditions in the mainstem (i.e. winter freshets) or to feed on abundant prey species (e.g. *O. mykiss*, sculpins, and crayfish).

In the Walla Walla River Basin, subadult bull trout disperse downstream during all months, but migration from the headwaters generally peaks during the spring. Most of the spring migrants disperse to oversummering habitat throughout middle Basin reaches within the South Fork and mainstem Walla Walla rivers. We found evidence that at least a portion of these fish enter the NFWWR instead of continuing to downstream rearing areas. The movement of small, subadult bull trout into drainages like the NFWWR from neighboring subbasins could prove problematic when applying the RMEG occupancy sampling protocol. If non-natal subadults are captured within a patch, there is the potential for the patch to be inaccurately classified as occupied by a biological population.

An unexpected migration pattern was observed in the detection histories of multiple adult-sized bull trout, known to have overwintered in middle and lower mainstem Walla Walla River reaches. As part of their upstream migration, these fish ascended the NFWWR in June instead of continuing to known spawning grounds in the SFWWR headwaters and they resided within the subbasin for an average of 21.3 days before exiting on the declining limb of the hydrograph in late June and early July. It is unknown if these fish moved into the NFWWR deliberately to forage, to subsequently spawn, or simply ascended the tributary by mistake. Another possibility is that they moved into the NFWWR to wait for higher flows in the SFWWR to subside before continuing their upstream migration. We were unable to find documented accounts of similar migration patterns in the literature, indicating that this “pit stop” migration pattern may be unique to Walla Walla River Basin bull trout.

Bull trout that enter the NFWWR may be exposed to channel modifications and riparian habitat degradation. Instream habitat and riparian vegetation along the NFWWR has been modified for agricultural purposes and has been affected by flood events. In addition, past logging may have affected the timing and magnitude of flows and increased sedimentation (USFWS 2002). As flows sharply decrease in early summer, migratory bull trout that use the NFWWR may be exposed to high water temperatures and elevated levels of predation as they attempt to migrate through degraded stream reaches. These reaches may lack cover, and inadequate instream passage conditions may exist. These conditions may prevent migratory adults from reaching potential spawning grounds in the headwaters of the NFWWR and possibly impede passage of adults that may attempt to move from the NFWWR to the SFWWR to subsequently spawn. Degraded habitat conditions may influence migration timing, compromise the full expression of life history strategies and profoundly impact survival rates, thus compromising bull trout recovery (Muhlfeld and Marotz 2005; Al-Chokhachy and Budy 2007; Rieman and McIntyre 1993).

Bull Trout Spawning

The SFWWR and its headwater tributaries are an important bull trout stronghold (Al-Chokhachy and Budy 2007, Anglin et al. 2008, Mahoney et al. 2006, USFWS 2010). In addition to maintaining the SFWWR source or "anchor" population, it is essential to confirm, describe, restore and maintain the distribution of other potential local populations within the Umatilla-Walla Walla Recovery Unit. Past accounts of possible redds (USFWS 2002) combined with our results from the redd survey conducted during 2012 indicate that bull trout may spawn in the headwaters of the NFWWR. If bull trout spawn in the NFWWR patch, it would appear to be in the form of resident fish and in low abundance. However, redds constructed by resident fish may go undetected due to their small size and location (e.g. steep headwaters with complex habitat versus low gradient, alluvial reaches) or may be dismissed as small disturbances in the gravel (Al-Chokhachy et al. 2005), resulting in an underestimate of spawning. Conversely, disturbances in the gravel may be misidentified as resident bull trout redds. Because we did not observe spawning bull trout on these redds, it is possible that the disturbances were caused by other species or physical disturbances. The difficulty in detecting redds made by small fish may limit managers from determining the occupancy of a patch or accurately monitoring adult abundance (Muhlfeld et al. 2006, Dunham et al. 2001). The Recovery Plan emphasizes the importance of confirming if a remnant population of resident bull trout actually exists in the NFWWR subbasin, and if one is present, determining if it is genetically different from the SFWWR population. Additional redd surveys and possibly more intensive and directed sampling methods (e.g. snorkeling, electrofishing) to confirm the presence of bull trout in the headwaters may be warranted.

Generally, the majority of the sites where spawning habitat data were collected contained habitat conditions that did not meet all of the criteria for spawning habitat we developed from data collected in the SFWWR. However, reach seven had the highest percentage (50%) of sites meeting all of the spawning habitat criteria and was located in the relative vicinity of where the four suspected bull trout redds were found. We did not incorporate water temperature into this assessment, but water temperatures during the spawning period can be an important factor that can limit bull trout spawning (McPhail and Baxter 1996; Walla Walla Subbasin Plan 2004). Although the threshold spawning temperature for bull trout has been reported at approximately 9°C (McPhail and Baxter 1996) and generally occurs from 5 - 9°C (Walla Walla Subbasin Plan 2004), bull trout have been known to spawn in temperatures exceeding the threshold. Moore et al. (2006) reported that bull trout likely spawned while experiencing seven day average daily maximum (7DADM) temperatures ranging from 7°C to 16°C. Water temperature loggers had been previously deployed from 8 August 2009 through 25 August 2009 (Figure 10), prior to when bull trout spawning typically occurs in the Walla Walla River Basin (September and October). This data suggests that temperatures throughout the NFWWR patch may be near or exceed the upper range of typical bull trout spawning thresholds at the beginning of the spawning period (late August). As temperatures decline during September and October, water temperatures throughout much of the patch appear likely to fall within the range when bull trout spawning typically occurs.

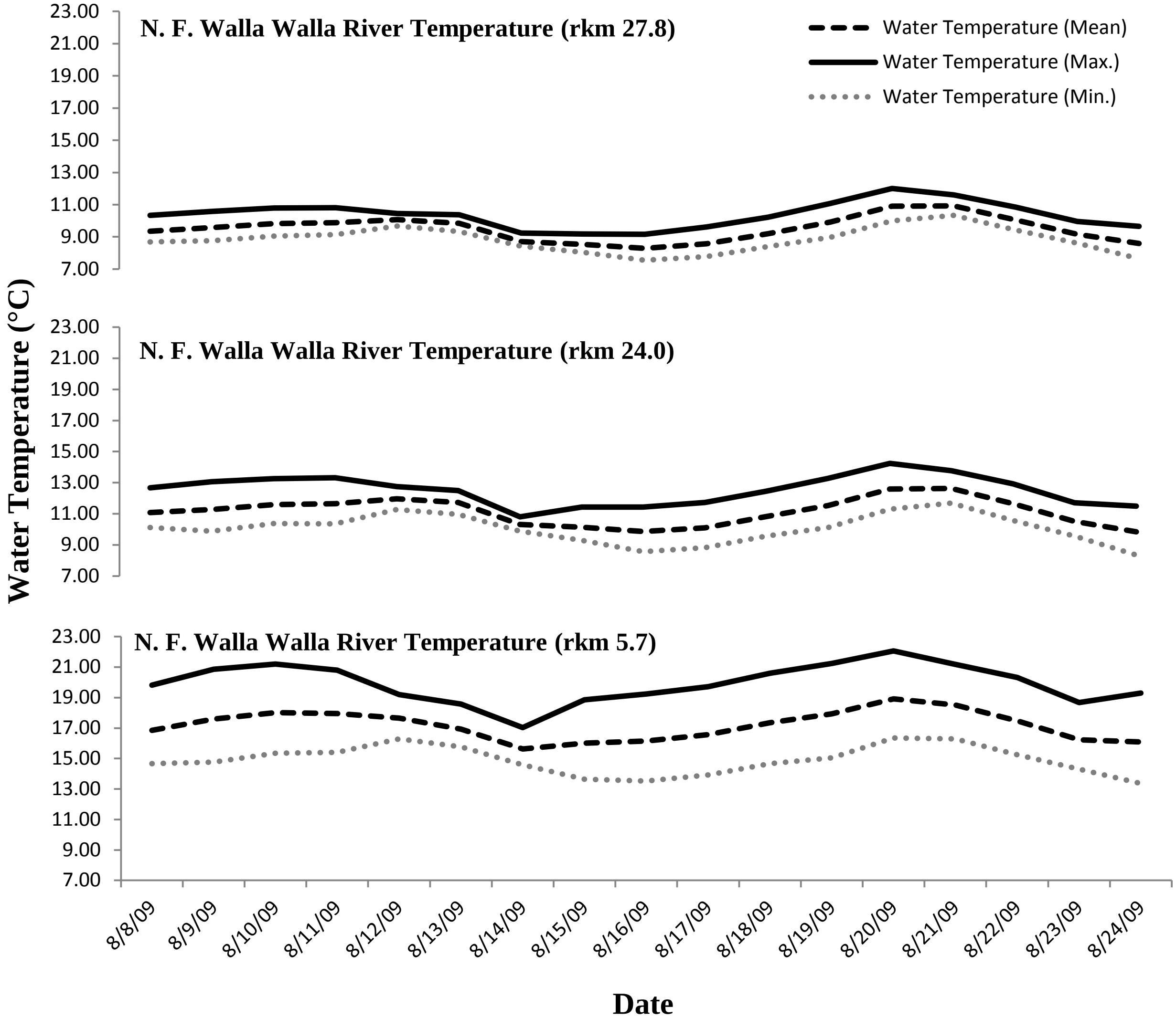

Figure 10. Temperature data from three locations within the North Fork Walla Walla River from 8 August 2009 through 24 August 2009. Temperature loggers were located at rkm's 5.7, 24.0 and 27.8. Mean, maximum and minimum daily temperatures are provided.

There was no indication that the adult-sized migratory bull trout that occupied the lower and middle reaches of the NFWWR during the winter, spring and summer months spawned in the headwaters during the fall. For example, all four of the large fluvial fish that we PIT-tagged at rkm 9 in the NFWWR were subsequently detected while exiting the subbasin on the declining limb of the hydrograph. Three of the four fish rapidly migrated upstream to spawning reaches in the SFWWR. It is possible that migratory bull trout may have moved into one of the major tributary streams of the NFWWR (e.g. Little Meadow Creek) to subsequently spawn, but this was not specifically investigated. In addition, there may be barriers to upstream migration (i.e. low flow barriers) preventing large fluvial fish from ascending to headwater reaches in the NFWWR subbasin, but this was also not investigated. The low surface flows in the NFWWR during the summer and fall may not be conducive to supporting a large bull trout population or one that includes a migratory component. Investigatory redd surveys within Little Meadow Creek and low flow passage surveys in the NFWWR should be considered to address these information gaps and to better understand bull trout use of the NFWWR and its role in the conservation and recovery of bull trout in the Recovery Unit.

Patch Occupancy and Distribution

We did not observe bull trout during monitoring for bull trout occupancy. Therefore, based on the detection probability approach we used to determine sampling effort, we infer that the probability of occupancy is < 20% in the NFWWR patch. We cannot rule out the possibility of the NFWWR supporting a biological population because our probability of detecting bull trout in an occupied patch was < 100%, but it appears unlikely. Considering our findings from occupancy sampling in conjunction with results from the redd survey and the PIT detection array, if a biological population of bull trout does exist in the NFWWR, it likely consists of only resident fish and in very low abundance.

Summary of Observations and Conclusions

Bull trout often exhibit a multitude of life histories involving migrations, spawning and foraging on time scales ranging from daily to annually or longer, and over different spatial scales (Schaller et al. 2014). The relatively short duration and simple nature of this project may not fully describe bull trout use of the NFWWR, but we can conclude that although the NFWWR does not appear to be routinely used for spawning and early rearing, habitat within in the subbasin supports various aspects of bull trout life-history. Migratory bull trout of varying life stages appear to routinely use the NFWWR at various times of the year, and it appears to be a critical component of the habitat bull trout use in the Walla Walla River Basin. Based upon the data collected during this project, we offer the following observations and conclusions:

1. By installing a PIT detection array near the mouth of the NFWWR, we were able to demonstrate that migratory adult and subadult bull trout use this subbasin more than managers previously thought. Since PIT-tagged fish likely represent only a small portion of the total bull trout population, the 16 individual bull trout detections at the PIT array suggest that many more non-tagged fish used the subbasin as well.

2. We were able to capture and implant PIT tags into four bull trout in the NFWWR. Genetic assignment analysis conducted on tissue samples indicated that these bull trout clustered with the nearby SFWWR local population, and were likely part of that population.

3. By evaluating the detection histories of the 16 individual PIT-tagged bull trout that used the NFWWR, we identified four different patterns of use as follows:

    - Adult bull trout migrated from upper Basin areas in the SFWWR during the fall and winter months to overwinter within the NFWWR.

- Subadult bull trout migrated from upper Basin areas in the SFWWR during the fall to overwinter and rear within the NFWWR.

- Subadult bull trout that migrated from upper Basin areas in the SFWWR during the spring, moved into the NFWWR instead of continuing downstream to rear during the summer.

- A portion of the adult-sized migratory bull trout that overwintered in the middle and lower portions of the Walla Walla River migrated upstream and entered the NFWWR during May and June instead of continuing upstream to the known spawning grounds in the SFWWR. These fish resided within the subbasin for up to 30 days before exiting on the declining limb of the hydrograph in late June and early July, some of which then rapidly migrated to spawning grounds in the SFWWR.

4. A total of four small redds were enumerated during the single bull trout redd survey. The spatial and temporal nature of the redds in addition to their size indicate that they may have been constructed by small, resident-sized bull trout, although this could not be confirmed.

5. No bull trout were observed or captured during occupancy sampling. The only fish species captured were steelhead or rainbow trout (*Oncorhynchus mykiss*), sculpin (*Cottus spp.*) and dace. Based on the detection probability approach we used to determine sample effort, we infer that the probability of occupancy is < 20% in the NFWWR patch.

6. Spawning substrate appears to exist in the NFWWR throughout most sampled reaches. Spawning substrate was most plentiful within reach 7 in the upper NFWWR and within reach 9 in Little Meadow Creek, a tributary to the NFWWR.

Management Implications

Effective management and the eventual recovery of bull trout require a thorough understanding of spatial and temporal habitat use across systems, life stages and life-history strategies. Tributaries with little or no evidence of spawning may be viewed by some as inconsequential for bull trout recovery. Prior to our work, the extent to which bull trout use the NFWWR was largely unknown. Our work in the NFWWR subbasin clearly demonstrates the benefits of using a multifaceted approach to more completely investigate bull trout use of the subbasin. Our results signify the importance of investigating bull trout use of tributary habitat to more thoroughly and accurately describe and understand spatial and temporal habitat use, distribution, migratory patterns and connectivity between populations and within migratory corridors. This is consistent with many of the recovery measures and associated tasks outlined in the Bull Trout Draft Recovery Plan. Evaluations of bull trout movement, survival and habitat use in the Walla Walla River Basin that do not include the NFWWR may be incomplete or inaccurate. Without a more robust and inclusive understanding of specific bull trout life-history strategies, including the role of tributary use, managers may not have the necessary information to prescribe actions to effectively manage bull trout and work toward recovery.

Bull trout that use the NFWWR may be exposed to a spectrum of anthropogenic channel modifications and riparian habitat degradation. For decades, instream habitat and riparian vegetation along the NFWWR has been modified for agricultural purposes as well as road and trail construction. In addition, past logging may have affected timing and magnitude of flows and increased sedimentation (USFWS 2002). As the hydrograph declines to summer base flows, migratory bull trout that use the NFWWR may be exposed to elevated levels of mammalian and avian predation, and high water temperatures as they attempt to migrate through degraded stream reaches. These reaches may lack cover, contain limited holding water (e.g. pools) and inadequate instream passage conditions (i.e. low flow passage barriers) may exist. Degraded habitat conditions may influence migration timing, compromise the full expression of life history strategies and profoundly impact survival rates, thus affecting bull trout recovery (Muhlfeld and Marotz 2005; Al-Chokhachy and Budy 2007; Rieman and McIntyre 1993). These conditions may prevent migratory adults from reaching potential spawning grounds in the headwaters of the NFWWR. In addition, non-spawning adults and subadult fish may be deterred from foraging and oversummering within habitat in the lower portions of the subbasin. Further, migratory adults may experience migration delays or passage impediments while attempting to move from the NFWWR to the SFWWR to subsequently spawn.

Results from this study may have important implications associated with connectivity, habitat use and headwater spawning. A better understanding of bull trout movements, habitat use and confirmation of spawning in the NFWWR is needed before future management actions can be developed.

Future Plans

We recommend that future research be implemented to better understand the role that the NFWWR may play in the long-term persistence and recovery of bull trout in the Walla Walla River Basin. Our results suggest that migratory bull trout of multiple life stages appear to regularly use the NFWWR at various times of the year, and it appears to be a critical component of the habitat bull trout use in the Walla Walla River Basin, but we do not know at this time how many occur within the subbasin temporally, nor do we know the spatial extent of use. Future research to describe seasonal distribution and to estimate abundance within the subbasin should be considered.

We know that bull trout in the NFWWR exit the subbasin as flows approach summer base flows, but it is unknown to what extent bull trout exit the subbasin successfully, if they attempt to exit but fail or if a portion of the fish simply do not exit and remain within the subbasin throughout the summer months. Snorkeling and low flow barrier surveys may be useful to help address these data gaps.

The four small redds that we found suggest that there may be remnant bull trout spawning activity in the headwaters of the NFWWR. Future plans should include confirming if redds found in the NFWWR are in fact bull trout redds. If they are found to belong to bull trout, there should be an effort to compare the genetics between fish from the NFWWR population with that of the neighboring SFWWR population.

We should also consider monitoring other tributaries to the Walla Walla River to assess the extent to which they are used by migratory bull trout (e.g. Couse Creek, Pine Creek, and the Little Walla Walla River).

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Figure 11. Student Temporary Employment Program (STEP) technicians gained experience in capturing and PIT tagging bull trout (pictured on left) as well as sampling via electrofishing (pictured on right) in the North Fork Walla Walla River near Milton-Freewater, OR.

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Appendix A

Comprehensive Detection History Narratives of Bull Trout Detected at the North Fork Walla Walla River PIT Array

Detections from PIT arrays and recapture information throughout the Basin were combined to describe the movements of each individual PIT tagged bull trout as they migrated to and from the NFWWR. The following are comprehensive narratives describing the detection histories of each PIT tagged bull trout detected at the NFWWR PIT array. Detection histories through 31 December 2013 are included.

PIT Tag Code 384.1B795B26E8 – This bull trout was originally captured via hook and line and was PIT tagged near the Burlingame Diversion Dam (rkm 60) in the mainstem Walla Walla River on 8 November 2011. It was an adult-sized bull trout measuring 397 mm (fork length) at the time of capture. The bull trout passed downstream of the Burlingame Diversion Dam on 9 November 2011 and overwintered in the lower Walla Walla River before moving back upstream past the Burlingame Diversion Dam on 9 May 2012. The fish then moved rapidly upstream to pass Nursery Bridge Dam (rkm 74) on 17 May 2012 and entered the NFWWR on 24 May 2012. This bull trout resided within the NFWWR before moving downstream past the NFWWR PIT antenna 30 days later on 23 June 2012 as streamflows sharply declined. This fish was detected 15 days later passing upstream of the Harris Park Bridge PIT detection array to known spawning grounds. After presumably spawning, the bull trout was detected moving downstream past the Bear Creek PIT array (rkm 106) on 26 September 2012 and was last detected moving downstream of Harris Park Bridge (rkm 97) on 30 September 2012.

PIT Tag Code 3D9.1C2C6B6CD7 – This bull trout was captured via hook and line and subsequently PIT tagged near Cemetery Bridge (rkm 76) on 19 July 2011. The subadult-sized bull trout was 262 mm (fork length). Thirty-eight days later the fish moved downstream of Nursery Bridge Dam (rkm 74) and likely overwintered in habitat upstream from rkm 61 in the mainstem Walla Walla River before migrating back upstream of Nursery Bridge Dam on 1 June 2012. Eleven days later, the fish ascended the NFWWR (rkm 84) and remained there for 11 days before moving back downstream to the mainstem Walla Walla River as flows declined. A lack of subsequent PIT detections indicates that this fish likely did not spawn.

PIT Tag Code 384.1B795B26E2 – This bull trout was originally captured via hook and line and PIT tagged near Cemetery Bridge (rkm 76) on 8 November 2011. The subadult-sized bull trout measured 266 mm (fork length). Following release, this fish rapidly moved downstream through the Nursery Bridge Dam fish ladder on 14 November 2011 and overwintered downstream of the Burlingame Diversion Dam (rkm 61). The fish was next detected migrating upstream at the Burlingame Dam PIT array on 7 May 2012. Twenty-six days later this bull trout passed upstream of Nursery Bridge Dam (rkm 74), entered the NFWWR on 13 June 2012 and was last detected at the NFWWR PIT array on 6 July 2012. There is no indication that this fish reached known spawning grounds because it was next detected migrating downstream past Nursery Bridge Dam on 15 October 2012 and Burlingame Diversion Dam on 1 November 2012.

PIT Tag Code 3D9.1C2CBE736B – This bull trout was a juvenile fish that measured 107 mm (total length) when it was originally PIT tagged in the SFWWR headwaters on 13 July 2009. The next detection of this fish was moving upstream into the NFWWR 1067 days later on 14 June 2012. This bull trout stayed in the NFWWR for 18 days before moving back downstream to the mainstem Walla Walla River on 2 July 2012 on the declining limb of the hydrograph. The fish then rapidly migrated upstream past Harris Park Bridge on 10 July 2012 and upstream of the Bear Creek PIT detection array on 18 July. After likely spawning, the bull trout migrated downstream past the Bear Creek PIT array on 28 September 2012 and was last detected moving downstream of Harris Park Bridge on 13 October 2012.

PIT Tag Code 384.1B795B270A – This bull trout was an adult-sized fish that measured 481 mm when captured and PIT tagged on 14 June 2012 via hook and line at rkm nine in the NFWWR as part of this project. This fish was detected on 19 June 2012 at the NFWWR PIT detection array as it moved downstream to the mainstem Walla Walla River. Nine days later the fish was detected moving upstream past Harris Park Bridge (rkm 97) to known spawning grounds.

PIT Tag Code 384.1B795B25B7 – This bull trout was a subadult-sized fish that measured 170 mm (total length) when it was originally PIT tagged in the SFWWR headwaters on 3 August 2010. The fish was detected at the Bear Creek PIT detection array on 18 December 2010. After 553 days, this bull trout was next detected at the NFWWR PIT detection array on 23 June 2012 and again on 25 June 2012. It is unclear whether this fish entered the NFWWR briefly on 23 June 2012 and subsequently left on 25 June 2012 or if it had overwintered in the NFWWR prior to leaving in June 2012. It is possible that this fish remained in the NFWWR, but an examination of the detection histories of other bull trout detected during this time frame suggests that this fish likely overwintered prior to leaving the NFWWR in June.

PIT Tag Code 384.1B795B26F1 – This bull trout was an adult-sized fish that measured 481 mm (fork length) when captured on 14 June 2012 via hook and line at rkm nine in the NFWWR as part of this project. This fish was detected on 23 June 2012 at the NFWWR PIT detection array (rkm 0.3) as it moved downstream to the mainstem Walla Walla River. Twelve days later, the fish was detected moving upstream past Harris Park Bridge (rkm 97) and the Bear Creek PIT array (rkm 106) on 5 July 2012 and 21 July 2012, respectively. The bull trout likely spawned prior to migrating downstream past both of the aforementioned sites on the same day (29 September 2012). This bull trout made another spawning migration the following season passing upstream of Harris Park Bridge on 5 June 2013 and returning downstream past the Bear Creek PIT and Harris Park Bridge PIT arrays on 28 September 2013 and 29 September 2013, respectively.

PIT Tag Code 3D9.1C2CBDE09F – This bull trout was a subadult-sized fish that measured 162 mm (total length) when it was originally PIT tagged in the SFWWR headwaters. This fish was next detected moving downstream out of the NFWWR toward the mainstem Walla Walla River on 25 June 2012, 707 days following tagging. Thirteen days after leaving the NFWWR, this fish was detected moving upstream past the Harris Park Bridge PIT array on 8 July 2012. The bull trout was next detected 29 days later moving downstream past the Bear Creek PIT array following likely spawning and passed downstream of Harris Park Bridge on 21 September 2012.

This fish was last detected moving upstream at the Harris Park Bridge PIT array on 17 June 2013.

PIT Tag Code 3D9.1C2C550444 – This bull trout was a juvenile fish (131 mm total length) and was PIT tagged and released in the SFWWR headwaters on 30 June 2009. The fish was next detected 1099 days later exiting the NFWWR toward the mainstem Walla Walla River on 3 July 2012. Twenty-four days later, the fish passed upstream of Harris Park Bridge (rkm 97) on 27 July 2012 and passed the Bear Creek PIT detection array on 7 August 2012. This fish was recaptured upstream of the Bear Creek confluence (rkm 106) and measured 385 mm (fork length). The fish was next detected at the NFWWR PIT array on 16 October 2012, having been missed by both the Bear Creek and Harris Park Bridge PIT detection arrays. Although it is unclear if it spawned while in the headwaters of the SFWWR, it is likely that it entered the NFWWR in October to overwinter rather than to spawn. This fish was last detected at the Harris Park Bridge PIT array on 21 June 2013.

PIT Tag Code 384.1B795B26B8 – This bull trout was an adult-sized fish that measured 345 mm (fork length) when captured and PIT tagged on 28 June 2012 via hook and line at rkm nine in the NFWWR as part of this project. This fish was detected moving downstream toward the mainstem Walla Walla River on 7 July 2012 as streamflows sharply declined. There is no evidence that this bull trout reached known spawning grounds to spawn during 2012, but on 10 June 2013 it was detected moving upstream at Harris Park Bridge (rkm 97) into known bull trout spawning reaches.

PIT Tag Code 384.1B795B26C9 – This bull trout was an adult-sized fish that measured 346 mm (fork length) when captured on 28 June 2012 via hook and line at rkm 9 in the NFWWR as part of this project. Eleven days later, this fish was detected moving downstream toward the mainstem Walla Walla River on 9 July 2012 as streamflows approached summer base flows. Nine days later, this fish was detected moving upstream at the Harris Park Bridge PIT array (rkm 97) on 18 July 2012. Likely following spawning, it was detected moving downstream at Harris Park Bridge on 11 October 2012. This fish returned upstream of Harris Park Bridge on 6 June 2013 and likely spawned again before heading downstream past the Bear Creek PIT array (rkm 106) and the Harris Park Bridge PIT array on 30 September 2013 and 2 October 2013 respectively.

PIT Tag Code 384.1B795B277B – This bull trout was a subadult fish (170 mm total length) when it was originally PIT tagged in the SFWWR headwaters on 19 July 2011. This fish was next detected as it moved past the Bear Creek PIT array (rkm 106) on 26 May 2012, likely moving downstream. The bull trout was next detected as it moved past the NFWWR PIT array on 11 July 2012, likely in a downstream direction. The last detection for this bull trout was moving downstream past the Burlingame Diversion Dam PIT detection array on 1 November 2012.

PIT Tag Code 384.1B795B19B9 – This bull trout was an adult-sized fish that measured 510 mm (total length) when it was originally PIT tagged in the headwaters of the SFWWR on 5 August 2012. This fish was detected at the Bear Creek PIT detection array (rkm 106) in late September (23 – 30 September 2012) and again in October (18 – 19 October 2012). The bull trout was next detected while entering the NFWWR on 29 October 2012. The fish was subsequently detected passing Harris Park Bridge (rkm 97) on 29 June 2013, the Bear Creek PIT array on 29 September 2013 and last detected moving downstream past the Harris Park Bridge PIT array on 1 December 2013.

PIT Tag Code 384.1B795B1994 – This bull trout was an adult-sized fish that measured 426 mm (total length) when it was originally PIT tagged in the headwaters of the SFWWR on 2 August 2012. This fish was detected moving downstream past the Bear Creek PIT array (rkm 106) and the Harris Park Bridge PIT array (rkm 97) on 22 October 2012 and 29 October 2012, respectively. This fish was last detected entering the NFWWR on 4 November 2012, presumably to overwinter.

PIT Tag Code 3D9.1BF1B2E7CB – This bull trout was a juvenile fish (128 mm total length) and was PIT tagged in the SFWWR headwaters on 24 July 2009. This bull trout was next detected moving upstream past Nursery Bridge Dam (rkm 74) on 9 July 2011 and downstream on 26 July 2011. This fish passed downstream of the Burlingame Diversion Dam PIT detection array (rkm 61) on 22 November 2011 and presumably overwintered in the lower Walla Walla River. The next detection of this fish was 215 days later when it migrated upstream past Nursery Bridge Dam, Harris Park Bridge (rkm 97) and the Bear Creek PIT array (rkm 106) on 21 June 2012, 8 July 2012, and 27 July 2012, respectively. Eighty-eight days later, this fish was detected moving downstream at Harris Park Bridge. This bull trout entered the NFWWR and was detected at the PIT array multiple times from 17 November to 7 December. This fish was next detected 226 days later moving upstream past Harris Park Bridge on 1 July 2013. After likely spawning, this bull trout moved rapidly downstream past both the Bear Creek PIT array and the Harris Park PIT array on 5 October 2013.

PIT Tag Code 384.1B795B27C7 – This bull trout was a subadult fish (146 mm total length) when it was originally PIT tagged in the headwaters of the SFWWR on 20 July 2010. This fish was next detected as it likely moved downstream past the Bear Creek PIT detection array (rkm 106) on 19 June 2012. On 10 December 2012 this bull trout moved upstream past the NFWWR PIT detection array to likely overwinter.

Appendix B

Summer Steelhead Detected at the North Fork Walla Walla River PIT Array

We established a PIT detection array near the mouth of the NFWWR in May 2012. The primary purpose of this effort was to describe if/when migratory bull trout use of the NFWWR. In addition to bull trout, steelhead (*Oncorhynchus mykiss*) were also detected at the PIT array. The Confederated Tribes of the Umatilla Indian Reservation have been conducting a summer steelhead population assessment in the Walla Walla River Basin. Objectives of this assessment include describing adult run timing and the spatial structure of spawners in the Walla Walla Basin. Although the main purpose of the PIT array was to describe bull trout use of the NFWWR, the steelhead detections may help describe summer steelhead use of the subbasin. For this reason, summer steelhead detections at the PIT array were summarized and discussed.

Methods

Fish Sampling and Tagging

Field staff from the Confederated Tribes of the Umatilla Indian Reservation operated multiple screw traps throughout the Walla Walla River and Mill Creek to capture out-migrating summer steelhead smolts for subsequent tagging. Full duplex ISO 134 PIT tags were deployed to maintain a tagged population of steelhead for subsequent detection at PIT arrays throughout the Walla Walla River and at mainstem Columbia River dams. In addition, adult steelhead that return from the ocean are PIT-tagged at mainstem dams (e.g. Bonneville Dam Adult Fish Facility) to describe upstream migration timing, straying and survival. Some the summer steelhead PIT-tagged in the mainstem are destined for the Walla Walla River.

PIT Detection Array

We installed a PIT detection array near the mouth of the NFWWR at rkm 0.3 on 18 May 2012. The PIT detection array was operated by a Destron Fearing™ Multiplexing Transceiver System FS1001M and consisted of three pass-over type antennas anchored to the streambed. The PIT array remained operational until high flows dislodged the antennas on 19 April 2013.

Results

Fish Sampling and Tagging

The tagged population of summer steelhead for detection in the Walla Walla River Basin resulted from tagging efforts across numerous years. The results of various tagging efforts can be found in the PTAGIS database (www.ptagis.org).

PIT Detection Array

A total of nine summer steelhead were detected at the NFWWR PIT array from 25 February 2013 through 18 April 2013. Of the nine steelhead, seven were only detected while moving upstream, entering the NFWWR from the Walla Walla River confluence and two were detected while moving both upstream and downstream past the PIT detection array (Figure B1). Additional steelhead detections may have been likely if high streamflows had not dislodged the PIT antennas in late April. Of the nine summer steelhead detected at the site, six were originally PIT tagged in the Walla Walla River during 2010, one was tagged in late December 2009, one in April 2011 and one steelhead was tagged as a returning adult when it moved upstream through Bonneville Dam in June 2012 en route to the Walla Walla River Basin (Table B1).

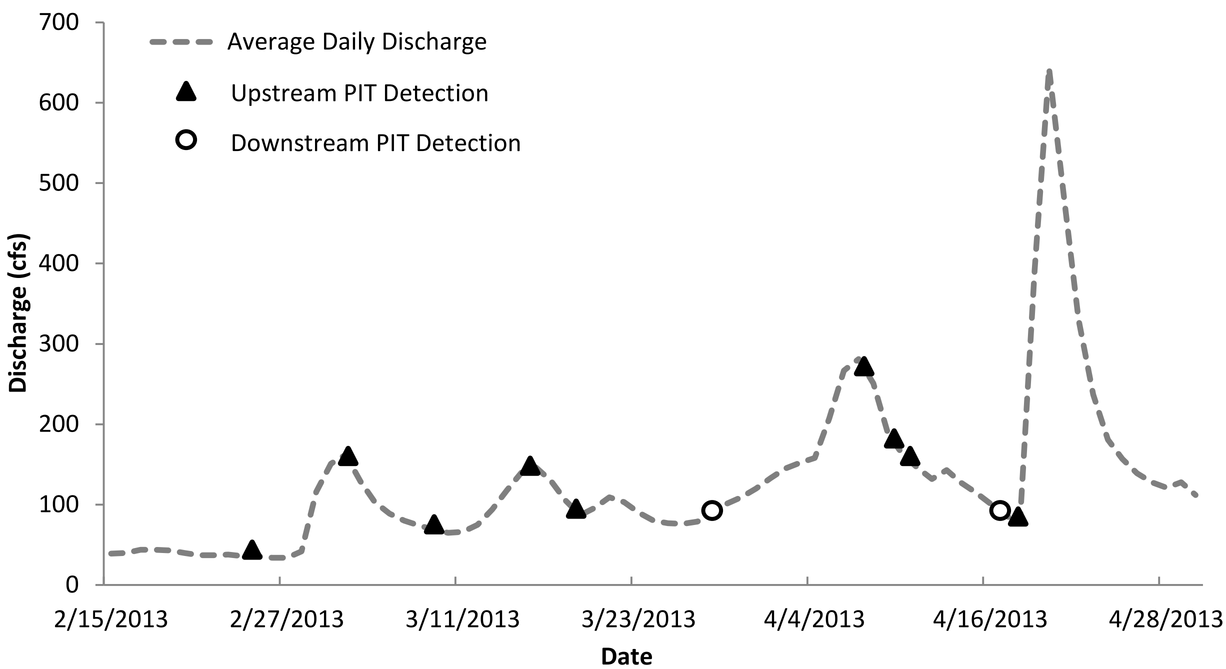

Figure B1. Detections of PIT tagged summer steelhead at the North Fork Walla Walla River PIT detection site. The mean daily discharge from the OWRD gage station #14010800 in the North Fork Walla Walla River near Milton-Freewater, OR for 15 February 2013 through 30 April 2013 is also shown.

Table B1. PIT tagged summer steelhead detected at the North Fork Walla Walla River PIT detection array from February 2013 through April 2013.

PIT Tag Code	Species	Tagging Location	Tagging Date	NFWW Detection (Upstream)	NFWW Detection (Downstream)
3D9.1C2D86C77B	S. Steelhead	WW River	12/1/2010	2/25/2013	3/27/2013
3D9.1C2CE3A42B	S. Steelhead	WW River	12/23/2009	3/1/2013	NA
3D9.1C2D8922FE	S. Steelhead	WW River	11/16/2010	3/10/2013	NA
3D9.1C2DA88AA2	S. Steelhead	WW River	4/12/2011	3/16/2013	NA
3D9.1C2D3371CE	S. Steelhead	WW River	4/27/2010	3/20/2013	NA
3D9.1C2D338CC8	S. Steelhead	WW River	5/14/2010	4/7/2013	NA
3D9.1C2D3339CA	S. Steelhead	WW River	5/5/2010	4/11/2013	4/17/2013
3D9.1C2D2660EA	S. Steelhead	WW River	4/24/2010	4/12/2013	NA
3D9.1C2DE828A0	S. Steelhead	Bonneville Dam	6/21/2012	4/18/2013	NA

Discussion

The NFWWR is an important tributary for summer steelhead spawning and rearing in the Walla Walla River Basin (Brian Mahoney, CTUIR, 2012; Carmichael and Tayler 2010; Mahoney 2002). Telemetry surveys conducted from 2001 to 2002 indicated that approximately 25% of radio-tagged summer steelhead that moved upstream from Milton-Freewater, OR entered the NFWWR (Mahoney 2002). Of the 24 PIT-tagged adult steelhead that were detected moving upstream of the Nursery Bridge Dam PIT array during 2013, eight (33.3%) were subsequently detected at the NFWWR PIT array (www.ptagis.org). Steelhead were detected at the NFWWR PIT array regularly from late February to the middle of April when the PIT antennas were dislodged. Mendel et al. 2014 reported that steelhead escapement in 2013 was estimated to be 503 adults past Nursery Bridge Dam. If PIT-tagged fish were representative of the total population, then approximately 168 (33.3%) adult steelhead may have entered the NFWWR from 25 February 2013 through 18 April 2013. These findings reinforce the importance of the NFWWR subbasin for summer steelhead persistence and recovery in the Walla Walla River Basin.

Literature Cited

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Mahoney, B. 2002. Walla Walla Basin summer steelhead and bull trout radio telemetry project: 2002 Annual Report to the Bonneville Power Administration. Confederated Tribes of the Umatilla Indian Reservation, Milton-Freewater, OR.

Mendel, G., B. Mahoney, R. Weldert, J. Olsen, J. Trump and A. Fitzgerald. 2014. Walla Walla River Subbasin Salmonid Monitoring and Evaluation Project. 2013 Annual Report. Report submitted to Bonneville Power Administration. Project No. 2000-039-00

Appendix C

North Fork Walla Walla River Bull trout Rearing Habitat Data

Site #	Subbasin	Patch	Date	Time Start	Time End	Temp. (°C)	Conductivity (µs)	Reach length (m)	Clinometer Top (%)	Clinometer Bottom (%)	Clinometer Average	#LWD >3 m and > 10 cm	# LWD Piles	# large LWD Pieces	# Root Wads	UC Number	UC length (m)	UC Type	Transect #	Wetted Width (m)	Bankfull Width (m)	Depth .25 (m)	Depth .50 (m)	Depth .75 (m)	Max Depth (m)
6	WW River	NFWW	6/26/2012	9:33	10:49	11.9	62.8	50	4	2	3	1	0	0	0	1	10	BK	1	10.2	12.8	0.25	0.35	0.22	0.4
																2	4	BK	2	9.7	10.8	0.5	0.45	0.38	0.5
																3	5	BK	3	5.6	14.3	0.3	0.65	0.72	0.75
																4	2	LWD	4	12.5	8.4	0.2	0.25	0.31	0.41
																5	5	BK	5	7.4	7.6	0.28	0.47	0.47	0.5
																			6	8.4	8.4	0	0.3	0.35	0.35
10	WW River	NFWW	6/26/2012	11:23	13:00	11.6	58	50			2	8	0	0	1	1	15	BK	1	5.5	12.7	0.48	0.45	0.5	0.5
																			2	6.4	12.4	0.3	0.55	0.53	0.55
																			3	6.4	12.9	0.3	0.55	0.6	0.65
																			4	9.4	13.2	0.2	0.25	0.3	0.5
																			5	11.8	14	0.25	0.36	0.32	0.38
																			6	13.7	13.7	0.34	0.35	0.28	0.35
2	WW River	NFWW	6/26/2012	14:14	14:42	8.5	22.2	50			3	9	0	0	0	1	2	BK	1	1.8	1.8	0.2	0.2	0.2	0.2
																			2	1.8	1.8	0.06	0.13	0.17	0.18
																			3	1.7	1.7	0.01	0.12	0.12	0.15
																			4	2.5	2.5	0.01	0	0.3	0.3
																			5	0.35	5.7	0.1	0.2	0.15	0.25
																			6	3.1	9.1	0.11	0	0.22	0.29
7	WW River	NFWW	6/27/2012	11:15	11:40	6.5	41.8	50			5	12	0	0	0	1	1	BK	1	4.9	4.9	0.2	0.25	0.05	0.27
																2	4	BD	2	3.8	3.8	0.11	0.2	0.11	0.21
																			3	2.6	2.6	0.09	0.21	0.15	0.21
																			4	6.9	6.9	0.11	0.05	0.1	0.15
																			5	4.2	4.2	0.11	0.35	0.3	0.1
																			6	2.5	3.1	0.3	0.27	0.2	0.31
11	WW River	NFWW	6/27/2012	15:10	16:01	11.4	42.6	50	4	5	4.5	14	1	6	0				1	5.6	6.3	0.24	0.2	0.25	0.26
																			2	3.8	5.4	0.1	0.35	0.35	0.41
																			3	7.4	9.3	0.22	0.32	0.4	0.45
																			4	7.9	9.4	0.35	0.1	0	0.35
																			5	3.6	5.4	0.32	0.35	0.2	0.35
																			6	7.2	7.4	0.2	0.1	0	0.2
9	WW River	NFWW	6/28/2012	11:27	12:30	12.9	39.4	50	7	9	7.60	1	0	0	1	1	2	LWD	1	4.1	4.8	0.2	0.1	0.1	0.24
																			2	2	4.2	0.2	0.1	0.2	0.2
																			3	3.8	4.6	0.05	0.15	0.15	0.15
																			4	2.7	4.9	0.05	0.15	0.3	0.3
																			5	2.8	4	0.1	0.2	0.2	0.2
																			6	5.3	8	0.4	0.05	0.1	0.4
4	WW River	NFWW	6/28/2012	13:38	14:00	12.6	42.1	50			4.00	3	0	0	0				1	8.5	9.1	0.2	0.25	0.45	0.45
																			2	4.9	5.5	0.25	0.4	0.45	0.45
																			3	4.8	6.2	0.4	0.6	0.6	0.6
																			4	4.75	7.6	0.2	0.35	0.3	0.35
																			5	5	6.9	0.35	0.3	0.25	0.37
																			6	5.3	6.2	0.32	0.3	0.3	0.4

Table C1. Rearing habitat data collected during bull trout occupancy sampling in the North Fork Walla Walla River near Milton-Freewater, Oregon in 2012.

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