

2015 Bull Trout Redd Monitoring in the Wallowa Mountains



**Prepared by:
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La Grande Field Office
February 2016**

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ABSTRACT

Bull trout were listed as threatened under the Endangered Species Act in 1998 due to declining populations. The U. S. Fish and Wildlife Service (Service) recommends monitoring populations in subbasins where little is known, including the Grande Ronde and Imnaha subbasins. Spawning survey data is important for determining relative abundance and distribution trends in bull trout populations. Without adequate funding, it had been difficult to find sufficient numbers of experienced bull trout surveyors and packers for surveys in the back-country, and to obtain adequate supplies to get the work accomplished. Oregon Watershed Enhancement Board (OWEB) funding for Phase III of the project, supported the continued survey of bull trout spawning areas in years 2013 through 2015 in the Willowa Mountains of Northeast Oregon. This report summarizes the 2015 bull trout spawning data collected in the Willowa Mountains of NE Oregon and compares this with past years' data. The report includes a comparison of OWEB Phase III project funded years (2013-2015) as well as previous years' data. Bull trout spawning surveys have been conducted on similar index areas for selected Grande Ronde and Imnaha River streams from 1999 to 2015. These surveyed streams are located within the bull trout core areas of the Willowa River/Minam River and Imnaha River bull trout core areas. Surveys in 2013 through 2015 were conducted by fisheries consultants, the Service, Nez Perce Tribe (NPT), the Oregon Department of Fish and Wildlife (ODFW), U.S. Forest Service (USFS), Freshwater Trust, Anderson Perry, Inc., Grande Ronde Model Watershed, Willowa Resources, and a volunteer. Objectives of the survey included; locate bull trout spawning areas, determine redd characteristics, determine bull trout timing of spawning, collect spawning density data, determine and compare the spatial distribution of redds along the Lostine River in 2006 through 2015, and over time use all of the data to assess local bull trout population trends and the long-term recovery of bull trout. Timing of spawning, total redds, redd sizes, and redd locations are documented in the report. The local bull trout populations were relatively stable for the survey period (1999-2015); there was a decrease in redd numbers on the Lostine River, Big Sheep Creek, and Bear/Goat Creek in 2015 compared to 2014 but an increase in redd numbers on the Imnaha in 2015, compared to 2014. The Imnaha population is one of the strongholds within the Imnaha Subbasin. Big Sheep Creek and Little Sheep Creek populations within the Imnaha River core area are of concern for long-term viability due to issues with stream flows, fish passage, and connectivity. The Lostine River and Bear

Creek contain brook trout and hybridization is likely occurring (the Lostine has had documented bull trout and brook trout pairing up for spawning).

ACKNOWLEDGMENTS

The Service has, for the past twelve years, provided staff time necessary for the coordination, implementation, and analysis and report summarization of this project. This project would not have been possible without the dedication, hard work, funding, and assistance provided by all the partners. OWEB funding from 2007-2015 allowed the use of Del Sol Wilderness Adventures (2008-2015) for a horse/mule packer to pack our gear in and out of the Upper Imnaha to conduct our annual spawning survey in that drainage. I would like to thank the partners in 2013-2015 which included; fisheries consultants, the Service, Nez Perce Tribe (NPT), the Oregon Department of Fish and Wildlife (ODFW), U.S. Forest Service (USFS), Freshwater Trust, Anderson Perry, Inc., Grande Ronde Model Watershed, Wallowa Resources, and a volunteer. Special thanks to the people who walked the streams, helped with scheduling surveys and surveyors, provided access to private property, packed us into remote areas to survey, assisted with the OWEB grants, or summarized the data. These included: Chris Allen, John Stephenson, and Gary Miller (Service); Shannon Archuleta, Jamie Ratliff, and Sarah Brandy (USFS), Barry and Shirley Cox, Paul Arentsen, and Todd Kruger (Del Sol Wilderness Adventures Horse/Mule Packers and Winding Waters River Expeditions); Jeff Oveson, Mary Estes, Leigh Collins, and Lacey Moore (Grande Ronde Model Watershed); Lynne Price, Mac Huff, Jon Rombach, Matt King, and Caitlyn Ecklund (consultants); Shane Vatland, Ian Wilson, Brian Simmons, Devin Olsen, Ryan Rumelhart, Lynne Price, Dave Bright, Marika Dobos, Eric Shoudel, Montana Pagano, Peter Cleary, Mary Edwards, and Jim Harbeck (NPT); Jeff Yanke, Kyle Bratcher, Mike Lance, Ryan Seal, Joel Oploff, Justin Hay, and Elizabeth OsierMoats (ODFW); Aaron Maxwell (Freshwater Trust); Sue Brady (Anderson Perry, Inc.); Kyle Petrocine (Wallowa Resources); and Jack Woods, Nancy Clarke, Stewart and Susan Coleman (landowners that provided access to private properties near the Lostine River). Jon Rombach was a volunteer in 2014.

INTRODUCTION

Bull trout were listed as threatened under the Endangered Species Act in 1998 due to declining populations. The Service recommends monitoring populations in subbasins where little is known including the Grande Ronde and Imnaha subbasins (USFWS 2002). The final bull trout recovery plan states that monitoring may include assessing distribution, population status, life history, migratory movements, and genetic characteristics of bull trout in each recovery unit (USFWS 2015a). The USFWS Mid-Columbia Bull Trout Recovery Unit Implementation Plan recommends continuing to monitor bull trout in the Imnaha Core Area, providing information on distribution and abundance for recovery. It also recommends development of a long term monitoring program to assess distribution, status and trend of bull trout in the Wallowa/Minam Core Area (USFWS 2015a).

Without adequate funding, it has been difficult to find sufficient numbers of experienced bull trout surveyors and packers for surveys in the back-country, and to obtain adequate supplies to get the work accomplished. OWEB funding for the project supported the continued survey of bull trout spawning areas in years 2007 through 2015 in the Wallowa Mountains of northeast Oregon. Bull Trout redd counts (spawning surveys) have been conducted annually on the Wallowa Valley, Hells Canyon National Recreation Areas (HCNRA), and Eagle Cap districts of the USFS and along some sections of private property of the Lostine River by the Service, NPT, contractors, ODFW, USFS, other partner agencies, and volunteers for the past 15 to 17 years.

Objectives of the bull trout spawning surveys include:

- Locate bull trout spawning areas.
- Determine redd (spawning nest) characteristics.
- Determine bull trout timing of spawning.
- Collect spawning density data.
- Map the location of the bull trout spawning reaches.
- Determine and compare the spatial distribution of redds along the Lostine River in 2005 through 2015. Collect UTM spatial redd data on Big Sheep, Lick Creek, and Middle Innaha to compare at a later date.
- Assess population trends for local bull trout populations.
- Use this information for helping assess the long-term recovery of bull trout.

LOCATION

The Service and multiple partners conducted bull trout spawning surveys in 2015 on selected streams in the Grande Ronde and Innaha Sub-Basins. These streams are located within the Wallowa River/Minam River and Innaha River bull trout core areas. Stream systems surveyed in 2015 for bull trout redds included; the Lostine River, Bear and Goat Creeks, the Innaha River, Big Sheep Creek and Lick Creek (Figure 1). In 2014 and 2015, exploratory surveys were conducted on tributary streams to the Wallowa River upstream of Wallowa Lake, the West Fork and East Fork Wallowa Rivers commencing at Wallowa Lake and surveying to the upstream waterfall on the West Fork Wallowa River and surveying the East Fork Wallowa River from the confluence with the West Fork Wallowa River upstream to the first waterfall.

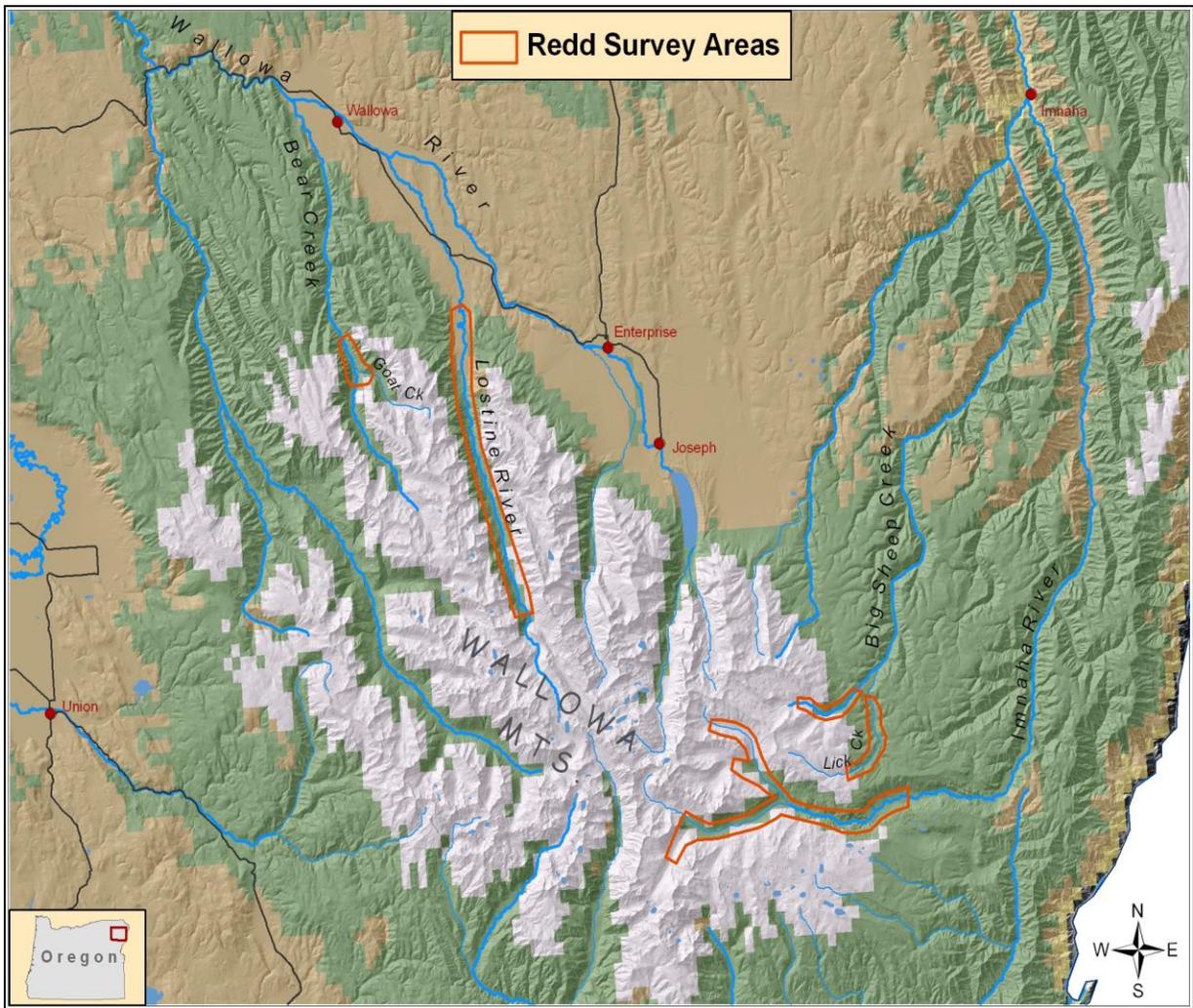


Figure 1. Wallowa Mountain Bull Trout Redd Survey Areas.

METHODS

Bull trout spawning surveys on large rivers require as many as ten to twelve people in one day, to complete the surveys during the spawning period. Surveyors walk the rivers through the selected “index areas” to locate bull trout redds. Index areas in this report refer to known bull trout spawning reaches that have been surveyed in the same consistent locations on an annual basis.

This project is part of a larger effort in NE Oregon and SE Washington that occurs during September through October, the bull trout spawning period. Due to the lack of available experienced surveyors to conduct these surveys, we have had to increase our survey days on the accessible sections of the Lostine and Imnaha Rivers to two days, conducting half of the survey length one day and the other half the following day. Surveys were conducted twice (mid and late bull trout spawning season) on the Lostine River, Big Sheep Creek, Lick Creek, Middle Imnaha (Blue Hole to Indian Crossing), and Bear and Goat Creeks. One-time surveys were conducted late in the spawning season in 2015, on

the Upper Imnaha River and tributaries, due to access and funding limitations. An exploratory survey was conducted on East Fork and West Fork Wallowa Rivers, upstream of Wallowa Lake in 2015 for approximately 2.0 total stream miles. Appendix B, Table 1 compares survey data and survey frequency for 1999-2015 bull trout spawning surveys on selected Grande Ronde and Imnaha River streams. Stream miles surveyed (not including repeat surveys) for the above streams totaled 41.3 in 2007, 46.3 in 2008, 41.8 in 2009, 41.1 in 2010, 41.7 in 2011, 40.9 in 2012, 35.0 in 2013, 42.3 in 2014, and 43.3 in 2015. In 2013, there were less stream miles surveyed in the Upper Imnaha due to lack of personnel and weather conditions. Total redd numbers are all redds documented, and not necessarily comparable river miles (refer to Appendix B, Table 2a-2d for comparable reaches and redd counts for those sections).

The survey protocol (in addition to repeat surveys, or one-time late surveys where feasible) included; 1) visits to known bull trout redds and review of survey form prior to redd count survey, 2) experienced bull trout redd count surveyor(s) paired with less experienced surveyor (on the job training), 3) bull trout redds measured, data recorded, and redds flagged during survey, and 4) all stream flagging removed post-surveys.



Ian Wilson (NPT) and Jon Rombach (consultant) collecting bull trout data on the Imnaha, 2015

Data recorded during the bull trout spawning surveys included; 1) date of survey, 2) stream location, 3) size of redds, 4) visibility of redds, 5) number of redds, and 6) approximate number and sizes of bull trout observed during surveys. In past years, reach locations (upstream and downstream boundary UTM coordinates) were documented. In 2009 through 2015, in addition to the above, bull trout redd UTM locations on the

Lostine River, Big Sheep Creek, Lick Creek, and Middle Imnaha within the “index areas” also were collected. Information collected during the bull trout spawning surveys is compiled and stored by the Service’s La Grande Field Office and made available to other agencies (i.e., this report).



**Sue Brady of Anderson Perry, Inc., with author
Measuring a bull trout redd on the Lostine River, 2014**



**Lynne Price (consultant) near adult spawning bull trout, Lostine River 2013
Photo by Sue Brady, Anderson Perry, Inc.**

RESULTS

Location of Bull Trout Spawning Habitat Areas Surveyed

Bull trout spawning surveys have been conducted on similar index areas for selected Grande Ronde and Imnaha River streams from 1999 to 2015. These surveyed streams are located within the Wallowa River/Minam River and Imnaha River bull trout core areas. During these years, bull trout spawning areas have been established for these streams, in particular, the Lostine and Imnaha Rivers. Redd characteristics also have been measured on these streams. The Middle Imnaha, consisting of the Imnaha River from the fish weir below Gumboot confluence to Indian Crossing, was not surveyed in 2005 through 2015, but this area was surveyed from 1999 to 2004 and is considered bull trout spawning habitat. This portion of known bull trout spawning habitat on the Imnaha was not surveyed for the past eleven years because of limited funding, a lack of experienced surveyors, a minimal number of redds documented in this area in past years, and the fact that this area is used extensively by spring chinook spawners and distinguishing between the two when looking at large bull trout redds or smaller chinook redds can be challenging, to say the least. Bear Creek and Goat Creek were surveyed as in past years but the survey area of Bear Creek and Goat Creek increased from 1.9-3.8 total miles between 1999-2006 to 7.2 in 2007, and the survey frequency increased from generally once during the years 1999-2006 and twice in 2007. Although the survey area increased in 2007, the redd numbers did not increase substantially, especially in the lowermost survey reaches. In 2008 through 2014 the surveys were conducted twice in the spawning season and an additional 1.4 miles of Bear Creek was surveyed upstream of the comparable reach for a total of 3.2 miles. In 2015, one additional reach was surveyed on Bear Creek, from the Boundary Campground Trail Bridge to 1.0 miles downstream at the Forest Rd 8250 bridge on Bear Creek, for a total of 4.2 miles. Deer Creek was surveyed in 2009-2013 for 1.5 miles in 2009 and 0.8 miles in 2010-2013. This survey was discontinued in 2014-2015 due to low flows, lack of personnel, and other higher priority stream locations to survey. In 2014 and 2015, a survey for approximately 1.3 miles of stream was conducted on West Fork Wallowa River and approximately 0.7 miles of stream was surveyed on the East Fork Wallowa River. These are tributaries to the Wallowa River located upstream of Wallowa Lake.

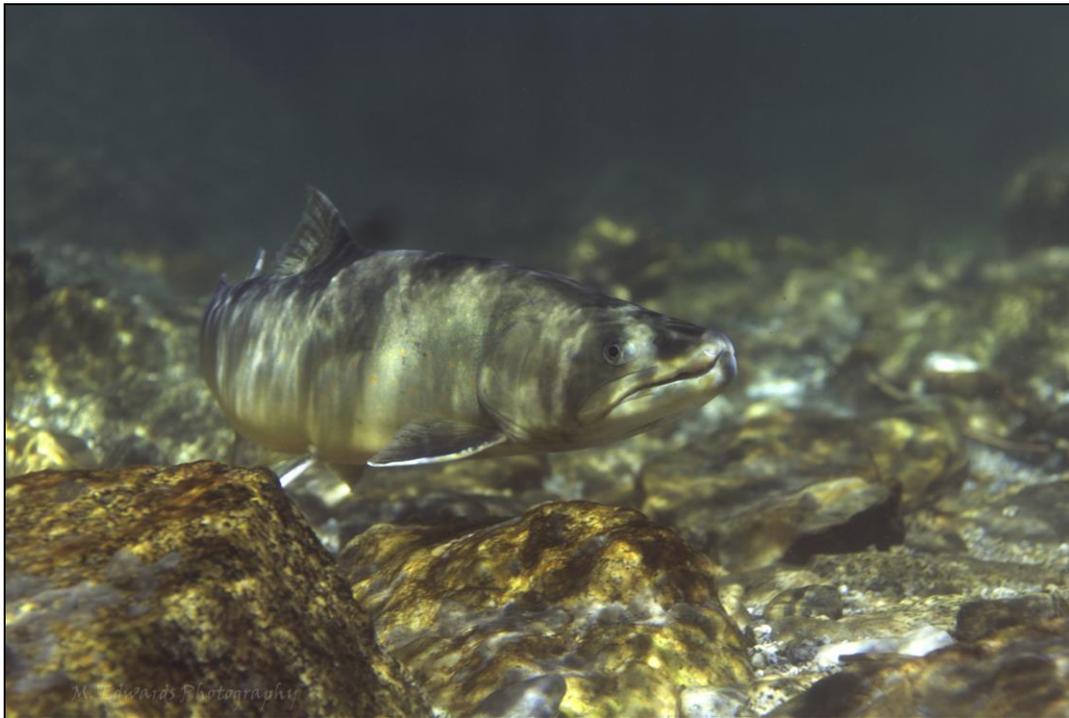
Timing of Bull Trout Spawning

Timing of bull trout spawning for our surveyed streams, in general, is approximately September 1 through October 15, and as early as August 15 in the Imnaha River system. The Lostine River has been very consistent or predictable, with commencement of spawning documented in 2006 as early as the first week in September, but the Imnaha, a much larger system, has been less predictable. The above information is based on documentation during bull trout spawning surveys and chinook surveys where bull trout were spawning.

We are not certain when spawning commences and ends within the Upper Imnaha, which includes; the mainstem, North Fork, South Fork, and Cliff Creek (a resident tributary). There are questions as to what time of the year, dependent on annual flows, bull trout pass over the falls. Some years we have seen fluvial size bull trout spawning in the South Fork Imnaha in mid-late September to early October and in recent years we have not. But in 2013, there were a few redds not measured in the South Fork Imnaha and Imnaha River, from the Upper Falls to Lower Falls, due to the redds still in progress. ODFW observed large fluvial bull trout spawning in the South Fork Imnaha River in mid-August 2005 (B. Knox, ODFW, pers. comm., 2005). ODFW has also observed fluvial bull trout spawning as early as mid-August, during chinook surveys, below the Imnaha falls and as late as early October, during our bull trout surveys, in several years (B. Smith, ODFW , pers. comm., 2005). In 2011, Upper Imnaha had smaller sized redds reported than in previous years, which could be a factor of smaller fish, but the documented fish sizes suggest fluvial fish; or that due to weather and stream conditions the fish are spawning later and these redds are incomplete. The Upper Imnaha survey is a one-time late September survey, so the total count is not expected. Cliff Creek, a resident bull trout tributary stream to South Fork Imnaha, had several redds that were still in progress at the time of both the 2012 and 2015 surveys; 79 percent of redds in Cliff Creek were unoccupied (older redds). In 2015, the majority of redds on the Imnaha (Blue Hole upstream to Cliff Creek) were completed prior to the Sept 28, 29, 30, and Oct 9 survey dates. Additional years of observation and data are needed to fully understand bull trout spawning and adult movement in the Imnaha Sub-Basin, and Big Sheep and Bear Creek Watersheds.

Bull trout that were radio-tagged by Idaho Power in the Snake River began moving into the lower Imnaha River in late-April, and continued upstream through May, June, and July, with all reaching the upper river by August as they escaped increasing water temperatures in the lower river (Idaho Power Company 2015). By late-July/early-August, almost all fluvial bull trout have moved upstream of the Imnaha Satellite Facility (ODFW, unpubl. capture data).

After spawning, adult bull trout soon move back downstream (Ringel et al. 2014). In the Imnaha River, downstream outmigration begins in September and continues through November (Idaho Power Company 2015).



Bull Trout on the Lostine River, 2012
Photo taken by Mary Edwards Photography for FWS LFO



Bull Trout on the Lostine River, 2012
Photo taken by Mary Edwards Photography for FWS LFO

Total Number of Bull Trout Redds

Lostine River

Refer to Appendix B; Table 3a and 3b for bull trout redd count summary data for 2015. Twenty-eight total bull trout redds for 10.1 miles of survey, including Pole Bridge to Six Mile Bridge, were documented in 2015 on the Lostine River. The Pole Bridge to Six Mile Bridge section has not been surveyed every year. The following data for the Lostine River compares consistently surveyed index areas on the Lostine River (8.5 miles) from 1999 to 2015, excluding the Pole Bridge to Six Mile section (Figure 2). The Lostine River had a low of 19 redds in 2011, and a high of 70 redds in 2003. Redd numbers decreased again in 2004 but had been increasing through 2008. Redd numbers decreased in 2009 through 2011, with the lowest redd count in 2011, and increased in 2012 and decreased again in 2013, with a slight increase in 2014, compared to 2013 with a decrease in 2015. The fifteen-year average from 1999 to 2015 (subtracting out 2003, which had an outlier of 70 redds) for the Lostine River is 35.1 redds, approximately 70.2 percent of the high of fifty redds found in 2008 and 2012. The highest bull trout redd numbers (“the bread and butter”) within the Lostine River has consistently been observed and recorded in the headwaters, from Shady Campground to Bowman, at approximately River Mile (RM) 24.5 to RM 22. In 2015, as in most years, the densities were greatest in the uppermost reach, from Shady Campground to French Camp, which is upstream of the chinook spawning index areas. In 2015, both upper reaches, Shady Campground to French Camp and French Camp to Bowman had the highest redd densities (15, and 11, respectively).

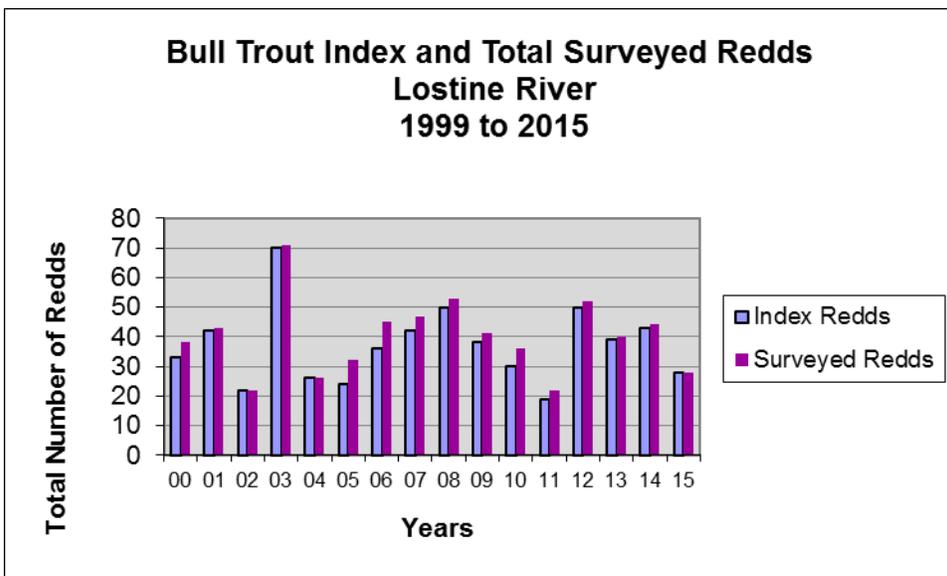


Figure 2. Comparison of bull trout surveyed redds and index redds (comparable miles) documented from 1999 to 2015 on the Lostine River.

Bear Creek

Five total bull trout redds for 4.2 miles of survey were documented in 2015 on Bear Creek (including Goat Creek). The following data for Bear Creek compares consistently surveyed index areas on Bear Creek and Goat Creek (1.9 miles) from 1999 to 2015 (Figure 3). Redd counts on Bear Creek and Goat Creek had a low of 2 redds in 2015 and a high of 19 total redds in 2011, which is the highest count for the index area. The seventeen-year average from 1999 to 2015 is 10.0 redds for Bear and Goat Creeks. Bear Creek/Goat Creek spawning data collected from 1999 to 2006 is restricted in scope due to access and funding limitations, and surveys in 2007 were expanded to help identify total spawning area for bull trout in Bear and Goat Creeks. Although the survey area increased in 2007, the redd numbers did not increase substantially, especially in the lowermost survey reaches. In 2008 through 2014, the surveys were conducted twice in the spawning season and an additional 1.4 miles of Bear Creek was surveyed upstream of the comparable reach for a total of 3.2 miles. In 2015, one additional reach was surveyed on Bear Creek, from the Boundary Campground Trail Bridge to 1.0 miles downstream at the Forest Rd 8250 bridge on Bear Creek, for a total of 4.2 miles. The highest bull trout redd counts for the survey sections on Bear/Goat Creeks have been recorded in Goat Creek, from the mouth to the waterfall, (RM 0 to RM 0.9), except in 2008, when more redds were documented in Bear Creek than in Goat Creek.

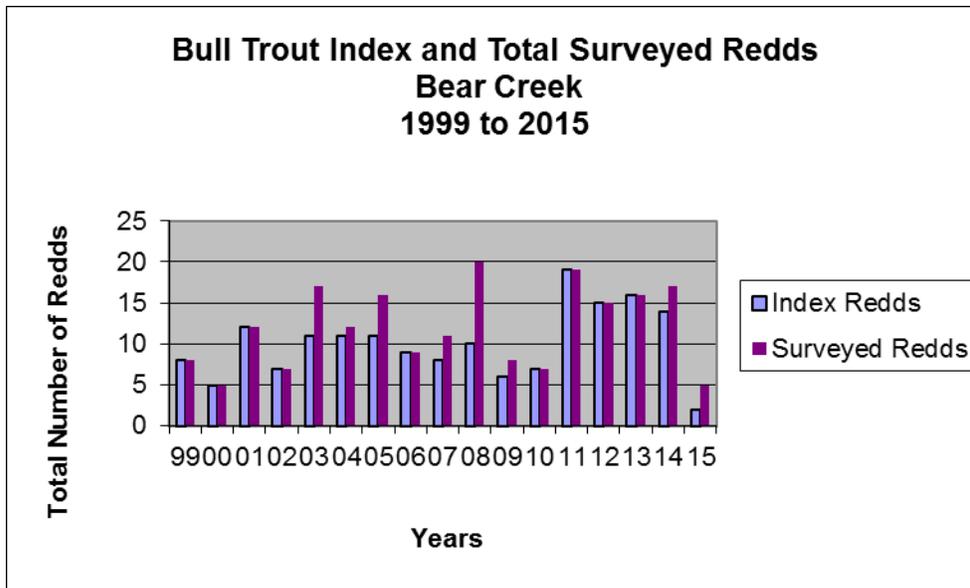


Figure 3. Comparison of bull trout surveyed redds and index redds (comparable miles) documented from 1999 to 2015 on Bear Creek, including Goat Creek.

The local bull trout population in the Lostine and Bear Creek surveys appears to be relatively stable for the survey period (1999-2015). Lostine River redd numbers decreased to 28 redds in 2015, compared to redds in 2012-2014 (50, 39, and 43). Bear Creek redd numbers decreased significantly to 2 redds in 2015 compared to 2012-2014 (15, 15, 14 redds).

East Fork and West Fork Wallowa Rivers

In 2014 and 2015, a survey for approximately 1.3 miles of stream was conducted on West Fork Wallowa River and approximately 0.7 miles of stream was surveyed on the East Fork Wallowa River. These are tributaries to the Wallowa River located upstream of Wallowa Lake. The surveys were conducted twice in both years and no bull trout or confirmed redds were documented on the West Fork Wallowa River in both 2014 and 2015 and one resident size redd was observed on the East Fork Wallowa River in both 2014 and 2015.

Imnaha River

Two hundred and five total bull trout redds for 19.4 miles of survey were documented in 2015 on the Imnaha River, from Indian Crossing to Blue Hole and upstream. In 2015, Indian Crossing to Blue Hole was surveyed twice, mid and late spawning season, and upstream areas were surveyed once, mid spawning season. The following data for the Imnaha River compares consistently surveyed index areas on the Imnaha River (17.5 miles) from 2001 to 2015 (Figure 4a). The fourteen-year average from 2001 to 2015 (excluding 2013) was 218 redds for the Imnaha River system. Total redd numbers on the Imnaha ranged from 101-262 within that period. The highest bull trout redd counts for the Imnaha River from 2001 to 2012 was recorded in the Upper Imnaha from Blue Hole to Cliff Creek, including Upper Imnaha tributaries. In 2006 through 2008, there was a significant shift in documented spawning distribution from past years. In 2006 through 2008, the majority of the spawning bull trout were located from the Imnaha falls to Indian Crossing, whereas, in past years the distribution had higher numbers above the Blue Hole, which is located two miles upstream of Indian Crossing, as well as distribution of spawning bull trout in the upper tributary streams (South Fork and North Fork Imnaha River). In 2014, the distribution was fairly evenly distributed between all Imnaha reaches. In 2015, the uppermost reaches had the highest redd densities; 52 redds in resident Cliff Creek, 60 redds in the South Fork Imnaha, and 49 redds in the North Fork Imnaha River.

In 2009, Cliff Creek, a resident bull trout tributary to South Fork Imnaha, had the greatest total number of redds at 164 redds. But in 2010, 2011, and 2012 the redd count in this stream decreased to 45, 46, and 65, respectively. This lower count in Cliff Creek created a large decrease in the total count for the Imnaha count during 2010 and 2011. Sixty nine percent of the total redds counted on the Imnaha in 2009 were from Cliff Creek and in 2010 and 2011 this percentage decreased to 34 percent. In 2012, 175 redds, (73%) of the total redds documented on the Imnaha, were fluvial and resident redds as compared to 71 redds (30%) in 2009. There was an upward trend in the Imnaha River population in 2012 and downward trend in the population in 2014, and an upward trend in the population in 2015 compared to 2014. If you subtract the resident Cliff Creek population from the Upper Imnaha redd counts, there is a substantial downward trend from 2009 through 2011. One hundred and fifty one bull trout redds for 16.9 miles of survey were documented in 2015 on the Imnaha River, from Indian Crossing to Blue Hole and upstream (excluding resident Cliff Creek). The fourteen-year average from 2001 to 2015 (excluding 2013) was 152 redds for the Imnaha River system (excluding Cliff Creek). Total redd numbers (minus resident Cliff Creek) for fluvial/resident bull trout on the

Innaha ranged from 71-236 within that period. Cliff Creek and several other Upper Innaha reaches were not surveyed in 2013 (Figure 4b).

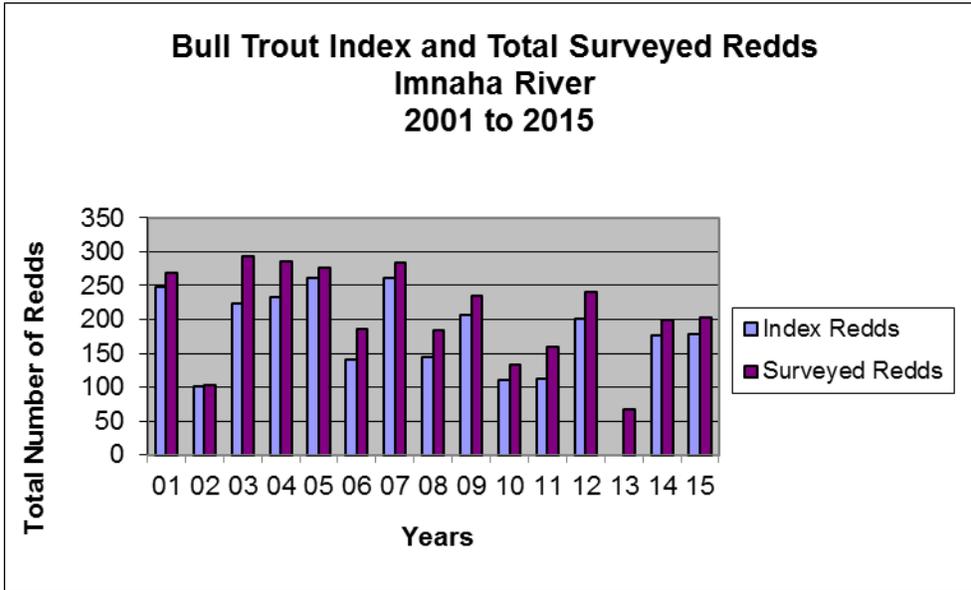


Figure 4a. Comparison of bull trout surveyed redds and index redds (comparable miles) documented from 2001 to 2015 on the Innaha River. Index redds are not shown in 2013, since locations and miles are not comparable to past years.

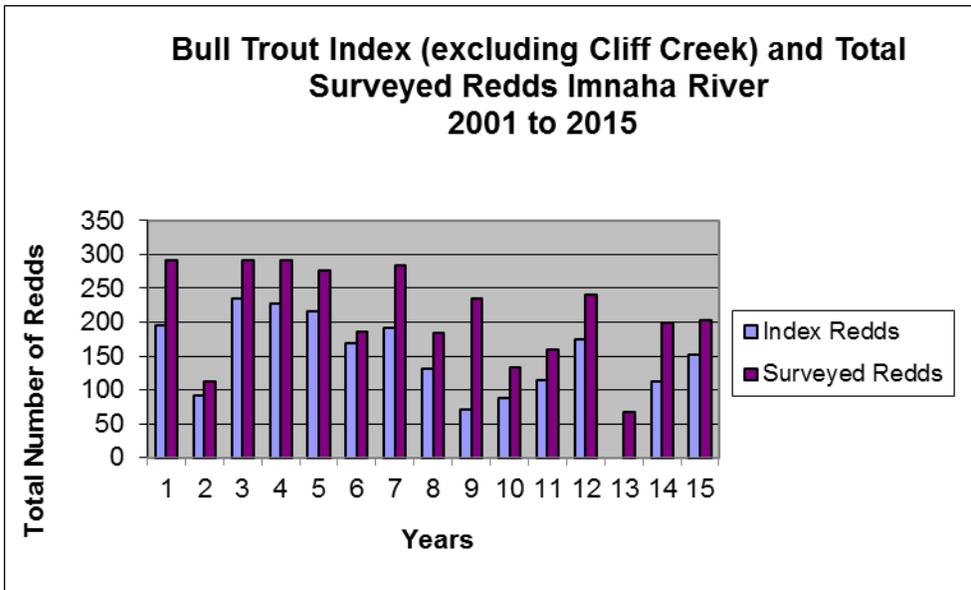


Figure 4b. Comparison of bull trout surveyed redds and index redds (comparable miles excluding Cliff Creek) documented from 2001 to 2012, and 2014-2015 on the Innaha River. Index redds are not shown in 2013, since locations and miles are not comparable to past years and Cliff Creek not surveyed in 2013.

Big Sheep Creek/Lick Creek

In 2015, eleven total bull trout redds for 7.6 miles of survey were documented for Big Sheep Creek and Lick Creek. These areas were surveyed twice in 2015, mid to late spawning season. The following data for Big Sheep Creek compares consistently surveyed index areas on Big Sheep and Lick Creek (7.6 miles) from 2000 to 2015 (Figure 5). The sixteen-year average from 2000 to 2015 was 20.1 redds for the Big Sheep system. Total redd numbers within the Big Sheep system ranged from 8-38 within that period; with the highest redd count of 38 in 2011. Redd surveys for bull trout in the Big Sheep system have been limited; in miles of survey, 7.6 to 14.1 miles from 2000 to 2015, and in frequency. Surveys in 2000-2001 were conducted once late season, and in 2002, 2003, and 2005-2015, surveys were conducted twice, mid and late season, except for lower Lick Creek survey area that was monitored only once in 2010, due to lack of surveyors. In 2004, the survey was conducted once late season for Big Sheep and twice, mid and late season for Lick Creek.

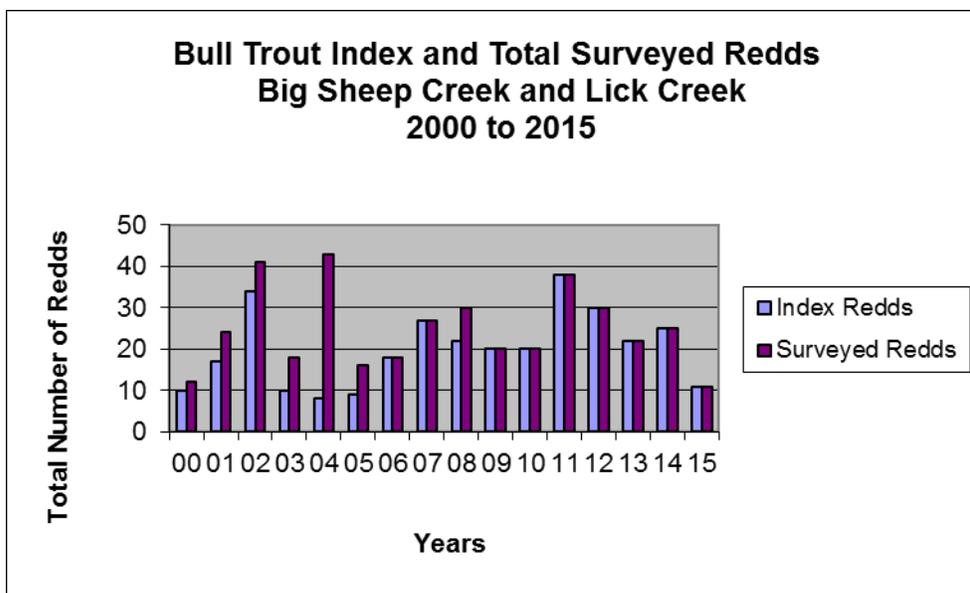


Figure 5. Comparison of bull trout surveyed redds and index redds (comparable miles) documented from 2000 to 2015 on Big Sheep and Lick Creeks.

The local bull trout population, in Big Sheep and Lick Creeks appear to be relatively stable for the survey period (2000-2015), with an increase in redd numbers in Big Sheep in 2011 and a decrease in redd numbers in 2012-2015; with 2015 low redd numbers similar to 2010 (11 and 10, respectively).

Sizes of Bull Trout Redds

Bull trout redds were measured using the same methodology in 2004 through 2015 and comparison of bull trout redd sizes, by mean redd area (m^2), for these years is illustrated below (Figures 6 & 7). There is a relationship between the size of a female salmonid and the size of the redd; large fish make large redds (Bjornn and Reiser 1991; P. Sankovich,

Service, pers. comm., 2006; Howell and Sankovich 2012). In addition, length/frequency distributions of mature resident bull trout and mature fluvial bull trout do not overlap; therefore, there is little overlap in size of redds (P. Sankovich, pers. comm., 2006).

Howell and Sankovich (2012) report that redd surveys that include estimates of redd area and spawner lengths could be used to sort migratory versus resident forms, which are useful attributes in assessing the status of populations. Resident adult bull trout are thought to be smaller than migratory (<300 mm) and continuously reside in the same habitat where spawning and rearing occur (Mullan et al. 1992; Pratt 1992; and Nelson et al. 2002). In bull trout populations, life history forms have been classified as migratory or resident based on general migration patterns and relative body size (Rieman and McIntyre, 1993). Howell et al. 2016 reported in their bull trout demographic study on Mill Creek that although life history terminology is useful for describing broad patterns, it fails to capture the diversity and complexity within and among populations.

Bull trout redd size data is provided below for the Lostine/Bear and Imnaha systems comparing resident and migratory forms annually for these streams.

Lostine/Bear/Goat

Figure 6 compares bull trout redd sizes for the Lostine River, Bear Creek, and Goat Creek in 2004-2015. Mean redd area (m^2) ranged from 0.9-2.3 for the Lostine, 0.3-0.9 for Goat Creek, and 0.2-1.0 for Bear Creek. In 2011, the Lostine River had the largest mean redd area (m^2) of 2.3 documented for this stream to date. In 2015, the mean redd area documented was 1.1 (fluvial size redd dominant). The Bear Creek sample area was expanded in miles surveyed in 2007 and in 2015 (7.2 and 4.2 miles, respectively). In past years the redd area was smaller and more typical of resident redds, but in 2007 the redd area was larger and more typical of fluvial size bull trout redds. Bull trout redds were not observed or documented in Bear Creek within the index area in 2006, a single redd was documented in 2013, and three redds were documented in 2015 with a mean redd area of 0.5 (showing a fluvial/resident size dominance). In 2010, one bull trout redd was documented in Bear Creek. This single redd was much larger than typical, 4.8 mean redd area, and was found among Chinook redds. The survey crew stated that this redd or two redds were superimposed among Chinook redds. It was reported as one fluvial bull trout redd.

Goat Creek is limited in available spawning habitat, but it appears to be the best available spawning habitat for fluvial fish in the Bear/Goat Creek system during drought years. Several miles of upper Bear Creek were dry due to low snowpack and summer drought conditions. It appears from the data in 2004-2015 that redds in Goat Creek were a combination of resident and fluvial fish, and in 2011, 2012, and 2013 dominated by more resident size redds, and in 2014-2015 dominated by fluvial size redds. Two bull trout that were observed occupying one redd on Goat Creek in 2004 were less than 12 inches (<300 mm) and were on a redd that had an area of 0.3 m^2 ; therefore, this size of redd is resident, due to the fish size. The redd sizes in both the Lostine River and Bear Creek in 2011, 2012, and 2014-2015 were dominated by fluvial size fish. More years of data

collection on these streams should help us better understand the resident and fluvial life histories of bull trout in this area, relative to fish and redd sizes.

Brook trout are thought to be abundant in Bear Creek due to historical stocking in the headwater lakes. The Lostine River contains brook trout, but for most survey years, brook trout spawning with bull trout was not observed. This changed in 2008 and more recently in 2012 where they appeared to be spawning together and hybrid fish were observed. To date, reporting of genetic sample data for bull trout/brook trout in the Lostine and in Bear Creek has not occurred.

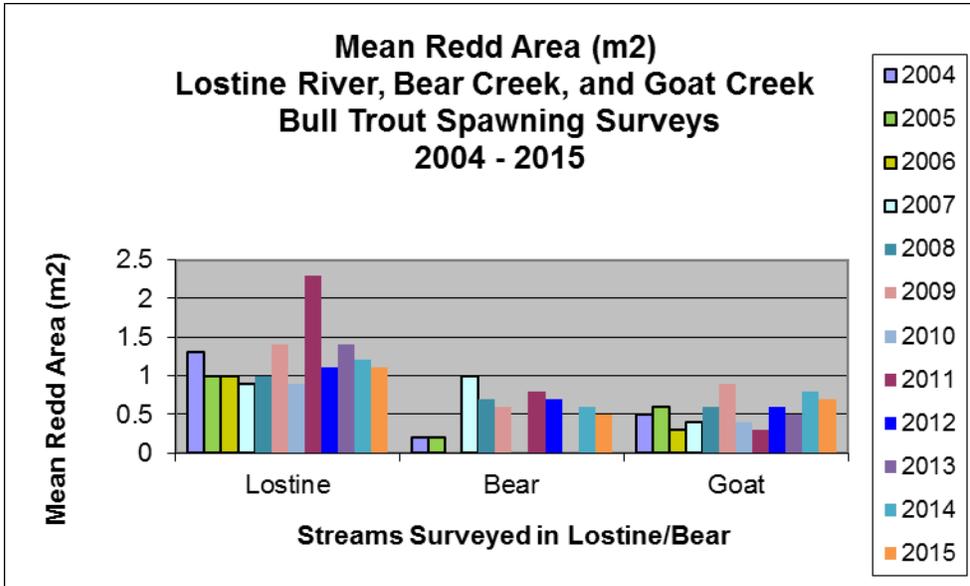


Figure 6. Comparison of bull trout redd sizes [mean redd area (m²)] for Lostine River, Bear, and Goat Creeks sampled during bull trout spawning surveys, 2004-2015.

Footnote: Bull trout redds were not observed in the index area of Bear Creek in 2006 and one extremely large fluvial redd was observed in 2010 (not included on graph, considered an outlier).

Imnaha and Big Sheep

Figure 7 compares bull trout redd sizes for the sampled streams in the Imnaha system in years 2004-2015. Mean redd area (m²) ranged from 0.3-1.0 for Lick Creek, 0.1-0.8 for Big Sheep, 0.4-2.6 for Middle Imnaha, 0.8-1.8 for Upper Imnaha, 0.3-1.2 for N.F. Imnaha, 0.4-1.3 for S.F. Imnaha, and 0.1-0.4 for Cliff Creek. As shown in Figure 7, very large redds produced by large fluvial bull trout were documented on the Middle Imnaha in 2008. In 2015, the mean redd size was 0.9 (fluvial dominant) with 11 redds documented in the Middle Imnaha. Over the 12-year period (2004-2015), redd sizes have been both fluvial and resident, with a dominance towards fluvial, but the number of redds in this reach has varied through the years with 2014 and 2015 having 17 and 11 redds, respectively in this 2.0 mile reach, whereas in 2009 and 2010 redd numbers were as low as two, and four, respectively.

Overlap of bull trout and chinook redds in Lick Creek and the Imnaha River may make it difficult to differentiate between the two species spawning nests. In 2015, only one redd was measured for Lick Creek and the redd area (m²) was 0.3 (resident). During the 2004-2015, 12-year sample period, approximately 58 percent (7 out of 12 years) the redds have been resident size dominant, and 42 percent (5 out of 12 years) the redds have been fluvial/resident dominant, and fluvial dominant. By comparison, Big Sheep Creek was dominated by resident redds in all years sampled, except in 2009 with only one fluvial size and one resident redd. In 2014 and 2015, the mean redd area (m²) for Big Sheep was 0.3 and 0.2, respectively (resident size).

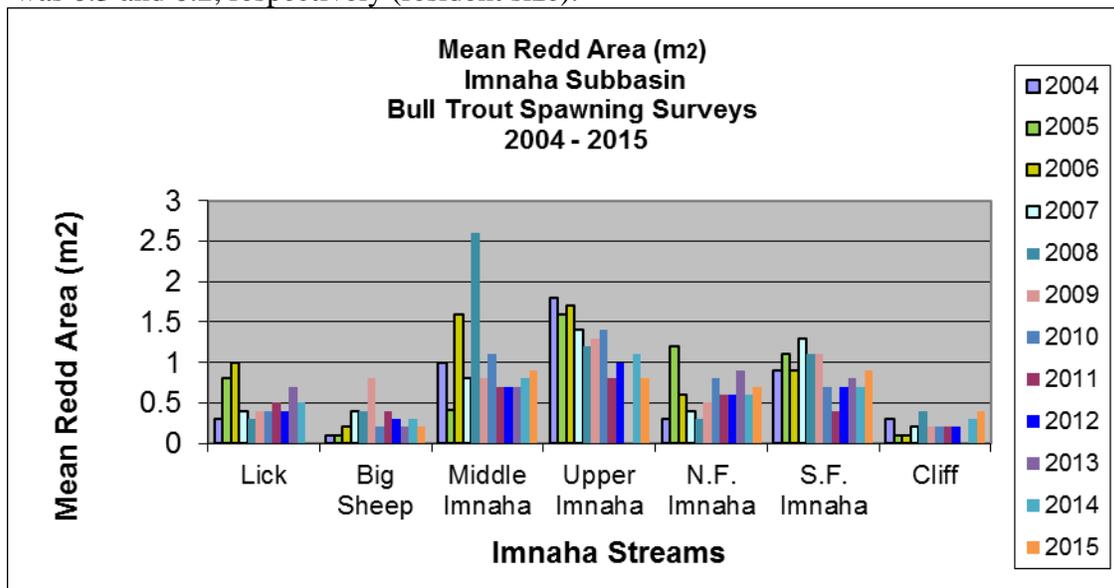


Figure 7. Comparison of bull trout redd sizes [mean redd area (m²)] for sampled streams in the Imnaha Subbasin, 2004-2015. (In 2013, no redd size data for Upper Imnaha and Cliff Creek. NF. Imnaha missing upper reach data in 2014. Lick Creek missing 2015 due to only one redd measured).

In 2015, Upper Imnaha and South Fork Imnaha had redds sizes with a fluvial dominance, 0.8 and 0.9 mean redd area (m²), respectively. Through the 11 year period, 2004-2012, and 2014-2015), Upper Imnaha and South Fork Imnaha contained a majority of fluvial redds. The Upper Imnaha was largely not surveyed in 2013 and South Fork Imnaha data was largely fluvial and sizes similar to 2012. North Fork Imnaha in 2015 had a redd size reflecting fluvial/resident dominance, 0.7 mean redd area (m²). Comparing 10 years of data on North Fork Imnaha from 2004-2012, and 2014-2015, approximately 55 percent (6 out of 11 years) the redds have been fluvial/resident size dominant, 27percent (3 out of 11 years) the redds have been resident dominant, and approximately 18 percent (2 out of 11 years) the redds have been fluvial dominant.

Cliff Creek is a known resident system with a waterfall near the mouth. In 2014, the mean redd area (m²) for Cliff Creek was 0.3 (resident) and in 2015 only two redds were measured below the falls and the mean redd area (m²) for these two redds was 0.4. The survey on Cliff Creek in 2004 included a large fluvial size redd near the confluence with the South Fork Imnaha and therefore the mean redd size was higher than in 2005 and 2006, when no fluvial redds were observed in Cliff Creek below the waterfall. In 2011

and 2012, surveyors reported several redds in progress on Cliff Creek. The 2007 mean redd size included a few larger redds below the falls and near the mouth, which are presumed to be fluvial redds. The 2008 mean redd size was greatest above the falls, likely due to superimpositions of redds above the barrier. In 2008, not all of the redds were measured above the falls (31 of 52 total redds, 59.6%) and all redds were measured below the falls (1 of 1, 100%). The sample size in 2008 was large enough to get a good estimate of sizes of redds above and below the falls and at the same time completing the survey in a reasonable amount of time, while redds were still visible during daylight. Cliff Creek was not surveyed in 2013. In 2014, 51 out of 87 (58.6 %) of redds were measured, and redds below the falls were not measured or documented as either resident or fluvial size. In 2014, as in previous years, the redd sizes above the falls included some large resident redds, likely superimposed redds, but measured as one redd. In 2015, only redds below the falls were measured (n=2) and they were resident size, one redd was occupied by a resident size bull trout, 6-12 inches in length. Refer to Tables 4a and 4b in Appendix B for additional information on 2015 bull trout redd characteristics.

Bull Trout Redd Distribution on the Lostine River

The bull trout spawning surveys on the Lostine River in years 2005 through 2015 included collection of UTM coordinate data on the spatial distribution of the bull trout redds observed. Bull trout redds on the Lostine River, as well as in other surveyed streams, were often arranged in complexes, several redds located in close proximity to each other. Redds were primarily located in the French Camp to Shady Falls and Bowman to French Camp reaches along the Lostine River in 2005-2007, 2010-2015 and several miles (approximately 10 miles) downstream of these reaches at the Six Mile Bridge to Pole Bridge reach (except in 2015). High site fidelity is documented by the overlapping of bull trout redds from 2005-2015, especially in the upper reaches of the Lostine River. In 2015, with a low redd abundance of 28 redds, redd distribution was limited to the upper three reaches, French Camp to Shady, Bowman to French Camp, and Williamson to Walla Walla. In most years, (2005-2007, 2010-2013, and 2015), few redds, 0-3 were documented in the Williamson to Walla Walla Reach. In 2008, 2009, and 2014, densities of bull trout redds were higher in the Williamson to Walla Walla Reach location where several redds, 13, 8, and 7, respectively were documented during these years (Sausen 2013 and Figure 8). In 2015, 15 redds (54%) were observed in the French Camp to Shady reach, 11 redds (39%) in the Bowman to French Camp reach, and 2 redds (2%) in the Williamson to Walla Walla reach. In 2014, with a high redd abundance of 44 redds, redds were distributed throughout all reaches; with highest numbers in the upper 3 reaches (21 redds (48 %) in the French Camp to Shady reach, 14 redds (32 %) in the Bowman to French Camp reach, and 7 redds (16 %) in the Williamson to Walla Walla reach(Figure 8).

Sections of the Lostine River were not surveyed during the survey period of years (1999-2015) due to; insufficient spawning gravels, boulder and cobble being the dominant substrate, and difficult access. These non- surveyed areas included: Bowman to Walla Walla, for approximately 2.2 miles; and Williamson to Pole Bridge, approximately 3.5 miles in length. Downstream of Westside Ditch on the Lostine River, for approximately

9 miles, is private property that is not surveyed due to lack of bull trout spawning gravels, higher stream temperatures, and low flows associated with irrigation withdrawal.

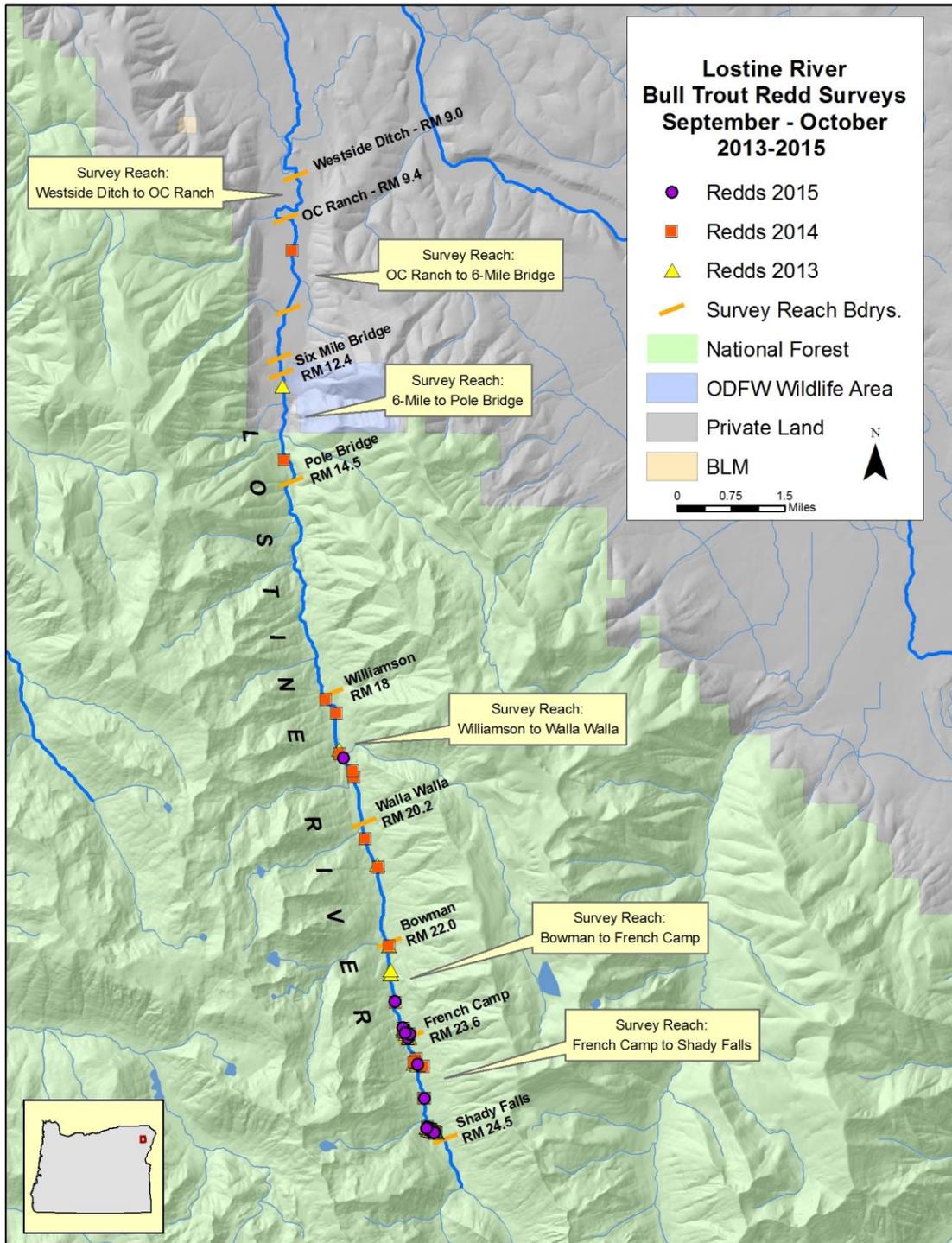


Figure 8. Map of the Lostine River showing bull trout redd survey reaches and bull trout redd locations in 2013- 2015.

Footnote: Due to topography and shade, ten of the 2014 GPS points recorded were showing above the stream, these are not displayed on map. Six of these were documented near Shady Falls upstream reach boundary and four of these were documented below French Camp.

DISCUSSION

Future Needs

Bull trout redd monitoring in the Wallowa Mountains was accomplished from 1999 to 2015 using skilled bull trout redd surveyors (a mix of experienced paired with inexperienced). Skilled surveyors will continue to be needed for future redd surveys. Several studies (Howell and Sankovich 2012; Dunham et al. 2001) point out the importance of using skilled surveyors to reduce measurement error. Training and retaining skilled surveyors to conduct these surveys has been a challenge and will likely remain a challenge into the future.

Currently, there is very limited bull trout redd data available for the mainstem Minam River (and tributaries, excluding the Little Minam River). The author recommends future exploratory redd surveys in the Minam River and upper tributaries to obtain some baseline information on locations and densities of redds in this system. Personal communication between the author and Fisheries Biologist Alan Miller of the Wallowa-Whitman National Forest in October 2015 suggests that he has begun investigation into bull trout distribution in the Minam River (with some recent surveys in the North Fork Minam River) and has future plans to do some exploratory survey in the Minam River headwaters and tributaries possibly as early as the fall of 2016. Dependent on what the Forest finds out about bull trout spawning distribution in the Minam headwaters, future more extensive surveys may be warranted.

We also recommend continued surveys of bull trout in the Oregon side of the Wenaha with the continued help of ODFW chinook surveyors and potentially a second, later (October) survey; if funds, surveyors, access, and weather make this feasible.

The East Fork Wallowa River, upstream of Wallowa Lake, was surveyed by the author in 2011 for 0.8 miles of stream, to assist PacifiCorp Energy with bull trout spawning data collection as part of the relicense for the Wallowa Falls Hydroelectric Project. No redds were located during this survey. PacifiCorp had surveyed the East Fork Wallowa River previously in 2010 and found two fluvial bull trout paired up on one redd (PacifiCorp 2013). In 2014, the West Fork and East Fork Wallowa Rivers were surveyed from their confluences upstream to barrier falls. All redds were resident size and located in the East Fork Wallowa River. In 2015, the West Fork and East Fork Wallowa Rivers were surveyed in the same locations. One resident bull trout was observed and confirmed on the East Fork Wallowa River. The West Fork Wallowa River is more difficult to survey due to the densities of kokanee redds. Two larger (potentially fluvial size redds) were noted near the confluence with Wallowa Lake on the second October survey. The author reviewed these two redds and made the professional judgment that these were not bull trout redds but likely large kokanee redds. No bull trout were documented at the redds, but it is not uncommon to have unoccupied bull trout redds. We recommend that PacifiCorp, the USFS, ODFW, and/or the Service continue to survey this stream in the future, as part of data for the new license and to further understand the bull trout

spawning population upstream of Wallowa Lake. It has been difficult to find surveyors but if possible, it may be helpful to have the same surveyors do the surveys on both surveys on the East Fork and Wallowa Rivers. I think if that occurred in 2015, that the data would be more consistent. In the future, we may decide to stop surveying the West Fork Wallowa River and just survey the East Fork Wallowa River, but since we have only conducted two years of surveys, it may be prudent to conduct the surveys on both streams for the next two years, at a minimum.

In the future, we recommend an exploratory survey be conducted in the headwaters of Bear Creek to obtain some baseline information on locations and densities for resident bull trout redds in this upper reach. At the same time, observations of densities of brook trout and any potential concerns for interbreeding could be initially assessed.

Overall, future needs for this project include continued funding and support from all involved parties (Service, ODFW, NPT, USFS, private land owners, volunteers, and others) for conducting and reporting bull trout redd counts in the Wallowa Mountains. OWEB Phase II Wallowa Mountains Bull Trout Redd Monitoring (2010-2011) was submitted for funding in October 2009 and received funding for 2010, 2011, and funding was extended into 2012. A Phase III Wallowa Mountains Bull Trout Redd Monitoring (2012-2013) was submitted for OWEB funding in October 2011 and was funded. This Phase III OWEB funding supported these surveys in 2012-2013 and funding was extended into 2014 and 2015.

To date, we have comparable bull trout redd data for several streams; 17 years completed on Lostine River and Bear Creek; 16 years completed on Big Sheep Creek; and 15 years completed on the Imnaha River. The Service and partners support continuing to build on the existing bull trout spawning survey data set as these long-term data sets are limited in bull trout recovery units, including the Mid-Columbia Recovery Unit. As mentioned in the Introduction, the final bull trout recovery plan states that monitoring may include assessing distribution, population status, life history, migratory movements, and genetic characteristics of bull trout in each recovery unit (USFWS 2015a). The USFWS Mid-Columbia Bull Trout Recovery Unit Implementation Plan recommends continuing to monitor bull trout in the Imnaha Core Area, providing information on distribution and abundance for recovery. It also recommends development of a long term monitoring program to assess distribution, status and trend of bull trout in the Wallowa/Minam Core Area (USFWS 2015a).

The Service plans to meet, prior to field season, with the local partner agencies that assist with the bull trout redd surveys and strategize location and intensity of spawning surveys to be conducted in the next several years in the above core areas, as well as a larger discussion on surveys conducted outside of these core areas, within the Mid-Columbia Recovery Unit, including in North Fork Catherine Creek, and in the Upper Grande Ronde River and tributaries.

CONCLUSION

The local bull trout populations have been relatively stable for the survey period (1999-2015), with a decrease in redd numbers on the Lostine River, Big Sheep Creek, and Bear/Goat Creek in 2015 compared to previous years, and an increase in redd numbers on the Imnaha (excluding Cliff Creek, a resident stream) in 2015, compared to 2014. 2013 data for the Imnaha is not comparable due to less stream miles/reaches surveyed that year.

The Imnaha population is one of the strongholds within the Imnaha Subbasin as it has multiple age classes, contains fluvial fish, has an anadromous prey base and connectivity with the Snake River, and bull trout are distributed throughout the habitat. Primary spawning activity on the Imnaha River has been documented to occur in the headwaters which lie within wilderness. Both fluvial and resident life history forms are present. Howell et al. (2016) report that for bull trout in Mill Creek, that life history diversity, including small, resident adult forms in the tributaries and a continuum of distribution for large adults, maximize the use of available habitat and likely contributes to the population's persistence. The Upper Imnaha with its mix of resident and fluvial populations may be similar to Mill Creek for the life history diversity and bull trout use of habitat, likely contributing to the population's persistence. The Imnaha River is rated at low risk of extinction, and Big Sheep is rated "of special concern" (Buchanan et al. 1997). The Recovery goals are to keep the local populations viable within this entire Imnaha core area and allow the local populations to be connected (within themselves) and to one another. The Imnaha weir located downstream of the confluence with Gumboot, is a partial fish passage barrier to bull trout (USFWS 2015b). Adult bull trout need to migrate upstream past the weir to access primary spawning grounds. Lick Creek has no barriers to passage and has a functioning resident and fluvial population. Big Sheep and Little Sheep have some issues with flows, fish passage, and connectivity and loss of fish due to the Wallowa Valley Irrigation Canal (WVIC); as well as fish passage concerns associated with two USFS culverts on Little Sheep Creek. The canal system (WVIC) in Big Sheep and Little Sheep watersheds (within the Imnaha bull trout core area) contributes to the loss of bull trout out of this core area and into the Grande Ronde and most likely to their loss, due to diversions downstream (Whitesel and Hudson, pers.comm 2013).

The Lostine River was considered a moderately-strong population within the Grande Ronde Sub basin (Buchanan et al. 1997). Lostine River and Bear Creek contain brook trout and the degree of hybridization is unknown; although 2010 and 2012 photos by Mary Edwards (NPT) and 2012 spawning data suggests bull trout pairing with brook trout and hybridization much more likely than past information has shown. The Lostine River had a decrease in redd counts in 2015 (28 compared to 44 in 2014). Many of the spawning fish observed in 2012 appeared to have brook trout hybrid phenotypic characteristics, which is alarming. This was not documented in 2013-2015 but no underwater photos were taken during this time (to my knowledge). Limited redd count data is available on Bear Creek and this portion of the Lostine River/Bear Creek local population has been listed as a special concern by Ratliff and Howell (1992). Future

genetic analysis of bull trout and brook trout is critically needed, especially in the Lostine River to help determine the significance of this threat.

Dehaan et al. (2009) studied hybridization between bull trout and brook trout in the Malheur River system and suggest that relative abundance of brook trout and habitat quality are important factors to consider when evaluating the threat of hybridization to bull trout populations. The Lostine River, especially in the spawning reaches, has good habitat quality. So, hopefully this overall good quality spawning habitat in the upper Lostine River will benefit the bull trout and help minimize the odds of hybridization with brook trout in the long-term.



Underwater photo of a pair of fish on the Lostine River, 2012
In front, appears to be a bull trout/brook trout hybrid and in back appears to be a pure bull trout
Photo taken by Mary Edwards Photography for the FWS LFO

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Lower Innaha Falls



Ian Wilson (NPT) surveying bull trout
Photos by Jon Rombach, 2015

APPENDIX A – PHOTOS TAKEN AT SURVEY LOCATIONS



**2015 Upper Imnaha crew (minus author)
Left to right;
Brian Simmons, Jeff Yanke, Devin Olsen, Todd Kruger, Ian Wilson,
Ryan Rumelhart, and Jon Rombach**



**Bull trout spawning pair on redd, Middle Fork Imnaha River, 2012
Photo by Carlos Camacho, NPT**



**Resident adult bull trout in Cliff Creek
Photo by Ian Wilson (NPT), 2015**



**Bull trout fluvial pair spawning in the Lostine River in 2014
Photo by Lynne Price**

APPENDIX B – TABLES

Table 1 – Bull Trout Spawning Surveys and Survey Frequencies for selected Grande Ronde River and Imnaha River Streams, 1999-2015

Stream	Year	Dates	Survey Frequency	Total Redds	Total Miles	Total Redds/Mile
Lostine River	1999	9/16,9/23,10/12	3 Times	39	9.75	4.0
	2000	9/21,9/28,10/12	3 Times	38	13.74	2.8
	2001	9/17-18,10/11-12	Twice	43	14.4	3.0
	2002	9/23-24,10/7-8	Twice	22	10.7	2.1
	2003	9/23-24,10/6-7	Twice	71	10.5	6.8
	2004	9/14-15,10/5-6	Twice	26	8.5	3.1
	2005	9/15, 9/21-22, 10/3-10/4	Twice, and 3 Times in Turkey Flat and Shady Campground areas	32	10.5	3.0
	2006	9/14, 9/20-21, 10/2-10/4	Twice, and 3 Times in Turkey Flat and Shady Campground areas	45	10.5	4.3
	2007	9/19-9/20, 10/3-10/4	Twice	47	10.1	4.7
	2008	9/17, 10/1-10/2, 10/9-10/10	Twice, and 3 Times in Turkey Flat and Shady Campground	53	10.1	5.3
	2009	9/11, 9/23-24, 10/7-10/8	Twice, and 3 Times in French Camp to Bowman	41	10.1	5.2
	2010	9/22, 10/6, 10/7	Twice	36	10.1	3.6
	2011	9/21-9/22, Oct 5-6	Twice	22	10.1	2.2
	2012	9/17, 9/19, Oct 3-4	Twice	52	10.1	5.2
	2013	9/16, 9/18, 9/24, Oct 7-8	Twice	40	10.1	4.0
2014	9/16, 9/23, Oct 6-7	Twice	44	10.1	4.4	
2015	9/22, Oct 6-7	Twice	28	10.1	2.8	
Bear Creek (including Goat Cr)	1999	9/7,9/22	Once Bear, Twice Goat	6	1.8	3.3
	2000	10/18	Once	5	1.8	2.8
	2001	10/16	Once	12	2.3	5.2
	2002	10/15	Once	7	2.3	3.0

	2003	10/16	Once	17	3.8	4.5
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Stream	Year	Dates	Survey Frequency	Total Redds	Total Miles	Total Redds/Mile
Bear Creek	2004	10/1	Once	11	2.3	4.8
	2005	10/11	Once	16	2.8	5.7
	2006	10/10	Once	9	1.9	4.7
	2007	9/17, 10/9	Twice, Exploratory (more reaches than past years)	11	7.2	1.5
	2008	9/30, 10/7	Twice	20	3.2	6.3
	2009	9/22, 10/13	Twice	8	3.2	2.5
	2010	9/16, 10/13	Twice	7	3.2	2.2
	2011	9/20, 10/11	Twice	19	3.2	5.9
	2012	9/20, 10/10	Twice	15	3.2	4.7
	2013	9/19, 10/10	Twice	16	3.2	5.0
	2014	9/18, 10/9	Twice	17	3.2	5.3
	2015	9/24, 10/14	Twice	5	4.2	1.2
Deer Creek	2009	10/14	Once	0	1.5	0
	2010	9/17, 10/4	Twice	12	0.8	15
	2011	9/19, 10/12	Twice	9	0.8	11.3
	2012	9/21, 10/12	Twice	1	0.8	1.0
	2013	9/23, 10/15	Twice	0	0.8	0
EF Wallowa	2011	10/9	Once	0	0.7	0
	2014	9/24, 10/14	Twice	1	0.7	1.4
	2015	9/21, 10/13	Twice	1	0.7	1.4
WF Wallowa	2014	9/24, 10/14	Twice	0	1.3	0
	2015	9/21, 10/13	Twice	0	1.3	0
Imnaha River	1999	9/20,28,10/11	Middle = Thrice	14	15.2	0.9
(excluding Big Sheep)	2000	9/20,22,25,26,27,10/11	Upper = Once, Middle = Twice	92	29.1	3.2
	2001	9/20,21,10/1,2,3,9,10	Upper = Once, Middle = Twice	291	31.3	9.3
	2002	9/25,26,9/30,10/1-2,10/10-11	Upper = Once, Middle = Twice	113	30.5	3.7
Middle=Blue	2003	9/25-26,9/29-	Upper = Once, Middle = Twice	291	31.3	9.3

Hole		30,10/1,10/8-9				
to Indian 2005-2010	2004	9/15-9/16,9- 27,28,29,10/7-8	Upper = Once, Middle = Twice	292	31.6	9.2

Stream	Year	Dates	Survey Frequency	Total Redds	Total Miles	Total Redds/Mile
Imnaha River	2005	9/26-28, 10/7	Once Upper and Middle	276	19.4	14.2
	2006	9/25-28,10/5	Upper = Once, Middle = Twice	186	19.4	9.6
	2007	9/24-27, 10/5	Upper = Once, Middle = Twice	284	19.4	14.6
	2008	9/22-25, 10/6	Upper = Once, Middle = Twice	190	19.4	9.8
	2009	9/28-30, 10/1, 10/9	Upper = Once, Middle = Twice	235	19.4	12.1
	2010	9/27-29, 9/30, 10/8	Upper = Once, Middle = Twice	133	19.4	6.9
	2011	9/26-28, 9/29, 10/7	Upper = Once, Middle = Twice	160	19.4	8.2
	2012	9/24-26, 9/27, 10/11	Upper = Once, Middle = Twice	240	19.4	12.4
	2013	10/1, 10/2, 10/3, 10/11	Once Upper and Middle	68	13.3	5.1
	2014	9/25, 9/29, 10/1, 10/10	Upper = Once, Middle = Twice	199	19.4	10.3
	2015	9/28, 9/29, 9/30, 10/9	Upper = Once, Middle = Twice	205	19.4	10.5
Big Sheep [(including Lick, and Salt). Salt Cr. not surveyed post 2003, and Upper Big Sheep exploratory in 2004].	1999	9/21,29,30,10/18,19	Once	20	14.2	1.4
	2000	10/13-10/16	Once	12	8.4	1.4
	2001	10/14,10/17	Once	24	8.4	2.9
	2002	9/30,10/1,10/14-15	Twice	41	9.3	4.4
	2003	9/22,10/14	Twice	18	9.3	1.9
	2004	9/20,9/28- 9/29,9/30,10/4,10/19	Once Big Sheep, Twice Lick	43	14.1	3.0
	2005	9/19-20, 10/6	Twice	16	8.6	1.9
	2006	9/19, 10/4	Twice	18	7.6	2.4
	2007	9/21, 10/2	Twice	27	8.6	3.1
	2008	9/29, 10/1, 10/10	Twice except once exploratory Quartz creek tributary to Lick and once Lick Creek 39 Rd to	30	9.1	3.3

			meadow			
	2009	9/16, 10/6	Twice	20	7.6	2.6
Big Sheep	2010	9/15, 10/5	Twice except once Lick Creek 39 Rd. to Meadow	20	7.6	2.6
	2011	9/15, 10/4	Twice	38	7.6	5.0
	2012	9/11, 9/18, 10/9	Twice	30	7.6	3.9
	2013	9/10, 9/17, 10/9	Twice	22	7.6	2.9
	2014	9/17, 10/8	Twice	25	7.6	3.3
	2015	9/23, 10/8	Twice	11	7.6	1.4

Table 2a–Bull Trout Spawning Surveys for the Lostine River Comparing 1999 to 2015 Surveys

Lostine	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15
Reaches (miles surveyed)																	
Lundquist Bridge to OC Ranch (2.8)	1	0	2	3	3	5	0	5	4	5	0	1	1	1	1	1	0
Williamson to Walla Walla (2.2 miles)	0	2	1	0	6	1	3	0	2	13	8	2	0	3	1	7	2
Bowman to French Camp (1.6 miles)	18	19	16	11	18	3	9	9	5	12	7	6	3	18	10	14	11
French Camp to Shady Falls (1.5)	20	12.0	23	8	43	17	12	22	31	20	23	21	15	28	27	21	15
Lostine Total Redds (Comparable Reaches)	39	33	42	22	70	26	24	36	42	50	38	30	19	50	39	43	28
Lostine Total Miles of Comparable Stream	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
Lostine Redds/Mile Comparable Stream	4.6	3.9	4.9	2.6	8.2	3.1	2.8	4.2	5.2	6.2	4.7	3.7	2.3	6.2	4.8	5.3	3.5
Total Redds For Year	39	38	43	22	71	26	32	45	47	53	41	36	22	52	40	44	28
Total Miles Surveyed For Year	9.8	13.7	14.4	10.7	10.5	8.5	10.5	10.5	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
Total Redds/Mile For Year	4.0	2.8	3.0	2.1	6.8	3.1	3.0	4.3	4.6	5.2	4.1	3.6	2.2	5.2	4.0	4.4	2.8

Notes: The Lostine was surveyed three times in 1999 and 2000. Survey years 2001-2015, the Lostine was surveyed twice, (except Shady Campground and Turkey Flat areas were surveyed three times in 2005, 2006, and 2008 and Turkey Flat was surveyed three times in 2009). Dates of Lostine bull trout spawning surveys generally commenced as early as the second or third week in September and the last survey was conducted in the first or second week in October.

Table 2b – Bull Trout Spawning Surveys for Bear and Goat Creeks Comparing 1999 – 2015 Surveys

Stream	Survey Years																
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Redds Surveyed																
Reaches (miles surveyed)																	
Bear: Goat Confluence to Wilderness Boundary (1mile)	0	2	3	1	2	3	5	0	1	6	1	1	4	3	0	2	0
Goat Creek: Mouth to Falls (0.9)	8	3	9	6	9	8	6	9	7	4	5	6	15	12	15	12	2
Bear (and Goat) Total Redds (Comparable Reaches)	8	5	12	7	11	11	11	9	8	10	6	7	19	15	15	14	2
Bear Creek Total Miles of Comparable Stream	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Bear Creek Redds/Mile Comparable Stream	4.2	2.6	6.3	3.7	5.8	5.8	5.8	4.7	4.2	5.3	3.2	3.2	10	7.9	7.9	7.4	1.0
Total Redds For Year	8	5	12	7	17	12	16	9	11	20	8	7	19	15	16	17	5
Total Miles Surveyed For Year	1.9	1.9	2.3	2.3	3.8	2.3	2.8	1.9	7.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	4.2
Total Redds/Mile For Year	4.2	2.6	5.2	3.0	4.5	5.2	5.7	4.7	1.5	6.3	2.5	2.2	5.9	4.7	5.0	5.3	1.2

Notes: These surveys were conducted once from 1999-2006, usually late in the spawning season, the first or second week in October [except in 1999, surveys were conducted in September (on 9/7 and 9/22)]. In 2007, the surveys included several additional “experimental” miles and were conducted twice in the spawning season, once in mid-September and once in early October. In 2008 – 2014, the surveys were conducted twice in the spawning season and an additional 1.4 miles of Bear Creek was surveyed upstream of the comparable reach. In 2015, the surveys were conducted similar to years 2008-2014 with a one mile reach added.

Table 2c – Bull Trout Spawning Surveys for the Imnaha River, Comparing 2001 – 2015 Surveys

Imnaha River	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15
Reaches (miles surveyed)															
South Fork Imnaha and tributaries:															
Cliff Creek, mouth to 2.5 miles (2.5 miles)	96	22	57	65	61	17	93	52	164	45	46	65	NS	87	52
South Fork Imnaha, NF to Soldier (1.5 miles)	6	7	14	12	44	9	30	6	7	2	10	28	NS	9	18
South Fork Imnaha, Soldier to Cliff (3.1 miles)	33	18	37	29	55	26	37	15	8	27	13	54	41	27	42
North Fork Imnaha:															
North Fork, above Middle Fork (4.1 miles)	49	18	40	68	39	18	30	17	2	4	6	9	5	25	37
North Fork, below Middle Fork to mouth (2.1 miles)	2	8	15	9	21	6	7	5	3	12	2	11	6	1	1
Middle Fork, mouth to falls (0.8 miles)	12	0	12	6	24	7	17	8	7	5	2	3	3	4	11
Imnaha River:															
Imnaha River, NF to Falls (0.6 miles)	0	3	5	1	2	3	2	1	0	0	0	6	0	0	2
Imnaha River, Falls to lower falls (0.8 miles)	41	18	35	40	13	37	28	12	13	11	25	21	7	7	7
Imnaha River, Blue Hole to Indian Crossing (2.0 miles)	8	7	9	3	2	18	18	28	2	4	9	4	6	17	11
Imnaha Total Redds (Comparable Reaches)	247	101	224	233	261	141	262	144	206	110	113	201	n/a*	177	179
Imnaha Total Miles of Comparable Stream	17.5	n/a	17.5	17.5											
Imnaha Redds/Mile Comparable Stream	14.1	5.8	12.8	13.3	14.9	8.1	15.0	8.2	11.8	6.3	6.5	11.5	n/a	10.1	10.2

Total Redds For Year	269	103	293	286	276	186	284	184	235	133	160	240	68	199	205
Total Miles Surveyed For Year	19.4	18.3	42.8	41.2	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	13.4	19.4	19.4
Total Redds/Mile For Year	13.9	5.6	6.8	6.9	14.2	9.6	14.6	9.5	12.1	6.9	8.2	12.4	5.1	10.3	10.5

Notes: All reaches except Blue Hole to Indian Crossing were surveyed once in years 2001-2015. The Blue Hole to Indian Crossing was surveyed twice in September and October from 2001-2015, except in 2005 and 2013, it was surveyed once. Due to government shut-down and furlough, and poor late season weather conditions in 2013, fewer personnel were available which caused less miles to get accomplished. S.F. Imnaha Cliff to Soldier was surveyed differently in 2013, the number of redds is for more miles than in past years. N.F to Soldier did not get surveyed in 2013. NF above MF did not get fully surveyed in 2013. Cliff creek did not get surveyed in 2013. The gorge sections of the Upper Imnaha did not get surveyed in 2013. N/A was documented for comparable reaches, as reaches not comparable to past years. Total stream miles surveyed in 2013 (13.4) is estimated. NS=not surveyed.

Table 2d – Bull Trout Spawning Surveys for Big Sheep Creek and Lick Creek, Comparing 2001 – 2015 Surveys

Stream	Survey Years															
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Big Sheep Creek (including Lick Creek)																
Reaches (miles surveyed)	Redds Surveyed															
Big Sheep, canal to 39 rd. (1.9 miles)	2	6	17	2	3	5	6	12	3	2	8	28	13	16	13	7
Lick Creek, Meadow to 39 rd. (1.5 miles)	0	6	3	0	1	3	5	3	4	5	7	4	4	3	5	0
Lick Creek, 39 rd. to Quartz Creek (4.2 miles)	8	5	14	8	4	1	7	12	15	13	5	6	13	3	7	4
Big Sheep Total Redds (Comparable Reaches)	10	17	34	10	8	9	18	27	22	20	20	38	30	22	25	11
Big Sheep Creek Total Miles of Comparable Stream	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
Big Sheep Creek Redds/Mile Comparable Stream	1.3	2.2	4.5	1.3	1.1	1.2	2.4	4.6	2.9	2.6	2.6	5	3.9	2.9	3.3	1.4
Total Redds For Year	12	24	41	18	43	16	18	27	30	20	20	38	30	22	25	11
Total Miles Surveyed For Year	8.4	8.4	9.3	9.3	14.1	8.6	7.6	8.6	9.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6
Total Redds/Mile For Year	1.4	2.9	4.4	1.9	3.0	1.9	2.4	3.1	3.1	2.6	2.6	5	3.9	2.9	3.3	1.4

Notes: Survey frequency varied by year, surveys were conducted once in mid to late October in years 2000 and 2001 for both Big Sheep and Lick Creek, and surveys were conducted twice, once in September and once in October in years 2002-2015, except for Big Sheep which was surveyed once in 2004.

**Bull Trout Spawning Surveys
For Some Grande Ronde Tributaries, 2015
USFWS, La Grande Field Office**

Grande Ronde Basin Stream Reach, Section	Date(s)	Kilometers Surveyed	Miles Surveyed	Occ	Redds			Per km	Per Mile	Total But obs	Bull Trout Observed (mm)			
					Unocc	Total					<6"(150mm)	<12" (~300mm)	<18"(450mm)	>18"(450mm)
Bear Creek														
Goat Cr (Mouth to Falls)	24-Sep	1.4	0.9	0.0	2.0	2.0	1.4	2.2	0.0	0.0	0.0	0.0	0.0	
Goat Cr (Mouth to Falls)	14-Oct			0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0	
Bear Creek (Standley Trail to USFS Cabin)	24-Sep	1.4	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Bear Creek (Standley Trail to USFS Cabin)	14-Oct			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Bear Creek (USFS Cabin to Goat Creek)	24-Sep	0.8	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Bear Creek (USFS Cabin to Goat Creek)	14-Oct			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Bear Creek (Goat Creek to Wilderness Boundary)	24-Sep	1.4	0.9	0.0	0.0	0.0	0.0	0.0	2.0	2.0	0.0	0.0	0.0	
Bear Creek (Goat Creek to Wilderness Boundary)	14-Oct			0.0	0.0	0.0	0.0	0.0	6.0	2.0	3.0	1.0	0.0	
Bear Creek (Trail Bridge to Rd. Bridge Upstream L.Bear)	24-Sep	1.6	1.0	0.0	3.0	3.0	1.9	3.0	0.0	0.0	0.0	0.0	0.0	
Bear Creek (Trail Bridge to Rd. Bridge Upstream L.Bear)	14-Oct			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Bear Creek Total		6.7	4.2	0.0	5.0	5.0	0.7	1.2	9.0	4.0	4.0	1.0	0.0	
Lostine River														
Lundquist Bridge to OC Ranch	7-Oct	4.4	2.8	0.0	0.0	0.0	0.0	0.0	9.0	0.0	0.0	2.0	7.0	
Pole Bridge to 6 Mile Bridge	22-Sep	3.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Pole Bridge to 6 Mile Bridge	7-Oct			0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	
Williamson to Walla Walla	6-Oct	3.5	2.2	0.0	2.0	2.0	0.6	0.9	1.0	0.0	1.0	0.0	0.0	
Bowman to French Camp	22-Sep	2.6	1.6	0.0	9.0	9.0	3.5	5.6	6.0	0.0	3.0	2.0	1.0	
Bowman to French Camp	6-Oct			0.0	2.0	2.0	0.8	1.3	7.0	1.0	5.0	1.0	0.0	
French Camp to Shady Falls	22-Sep	2.4	1.5	0.0	12.0	12.0	5.0	8.0	6.0	1.0	3.0	2.0	0.0	
French Camp to Shady Falls	6-Oct			1.0	2.0	3.0	1.3	2.0	4.0	0.0	3.0	1.0	0.0	
Lostine River Total		16.1	10.1	1.0	27.0	28.0	1.7	2.8	35.0	2.0	15.0	10.0	8.0	
Wallowa River Upstream of Wallowa Lake														
EF Wallowa River, falls to mouth at WF Wallowa River	21-Sep	1.1	0.7	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0	
EF Wallowa River, falls to mouth at WF Wallowa River	13-Oct			0	1	1.0	0.9	1.3	2.0	1	1	0	0	
WF Wallowa River, lake confluence to upstream falls	21-Sep	2.1	1.3	0	0	0.0	0.0	0.0	0.0	0	0	0	0	
WF Wallowa River, lake confluence to upstream falls	13-Oct			0	0	0.0	0.0	0.0	0.0	0	0	0	0	
Wallowa River Upstream of Wallowa Lake Total		3.2	2.0	0.0	1.0	1.0	0.3	0.5	3.0	1.0	2.0	0.0	0.0	
Grande Ronde Basin Total														

Table 2b
 Bull Trout Spawning Surveys
 For the Imnaha River, 2015
 USFWS, La Grande Field Office

Imnaha Basin Stream Reach, Section	Date(s)	Kilometers Surveyed	Miles Surveyed	Occ	Redds			Per km	Per Mile	Total But obs	Bull Trout Observed (mm)			
					Unocc	Total					<6"(150mm)	<12" (~300mm)	<18"(450mm)	>18"(450mm)
Upper Imnaha System														
South Fork Tributaries														
Cliff Cr., mouth to 3.6 km*	29-Sep	4.0	2.5	11.0	41.0	52.0	13.0	20.8	38.0	0.0	38.0	0.0	0.0	
South Fork Tributaries Total		4.0	2.5	11.0	41.0	52.0	0.0	20.8	38.0	0.0	38.0	0.0	0.0	
North Fork														
Middle Fork., mouth to falls	29-Sep	1.3	0.8	0.0	11.0	11.0	8.5	13.6	0.0	0.0	0.0	0.0	0.0	
N. Fk., above M. Fk. (reach 3-7)	28-Sep	6.6	4.1	2.0	35.0	37.0	5.6	9.0	25.0	0.0	25.0	0.0	0.0	
N. Fk., below M. Fk. (reach 1-2)	28-29 Sep	3.4	2.1	1.0	0.0	1.0	0.3	0.5	2.0	0.0	2.0	0.0	0.0	
North Fork Total		11.3	7.0	3.0	46.0	49.0	4.3	0.6	27.0	0.0	27.0	0.0	0.0	
South Fork														
S. Fk., North Fork to Soldier Cr.	29-Sep	2.4	1.5	0.0	18.0	18.0	7.5	12.1	0.0	0.0	0.0	0.0	0.0	
S. Fk., Soldier to Cliff Cr.	28-29 Sep	5.0	3.1	3.0	39.0	42.0	8.4	13.5	10.0	1.0	5.0	2.0	2.0	
South Fork Total		7.4	4.6	3.0	57.0	60.0	8.1	13.0	10.0	1.0	5.0	2.0	2.0	
Upper Imnaha														
Upper Imnaha Falls to North Fork	28-Sep	1.0	0.6	0.0	2.0	2.0	2.0	3.2	12.0	0.0	1.0	0.0	11.0	
Upper Imnaha Falls to lower falls	30-Sep	1.3	0.8	0.0	7.0	7.0	5.4	8.7	0.0	0.0	0.0	0.0	0.0	
Falls downstream .67 mi. to beg. of gorge*	30-Sep	1.1	0.7	0.0	24.0	24.0	21.8	35.1	15.0	0.0	0.0	0.0	15.0	
Lower end of gorge to next gorge (.25 mi)*	30-Sep	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Canyon above slide to canyon just above slide*	30-Sep	1.5	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Upper Imnaha Total		5.3	3.3	0.0	33.0	33.0	6.2	10.0	27.0	0.0	1.0	0.0	26.0	

Table 2b
Bull Trout Spawning Surveys
For the Imnaha River, 2015
USFWS, La Grande Field Office

Page 2 of 2

Imnaha Basin Stream Reach, Section	Date(s)	Kilometers Surveyed	Miles Surveyed	Redds			Per km	Per Mile	Total But obs	Bull Trout Observed (mm)			
				Occ	Unocc	Total				<6"(150mm)	<12" (~300mm)	<18"(450mm)	>18"(450mm)
Middle Imnaha													
Blue Hole to Indian Crossing	29-Sep	3.2	2.0	0.0	9.0	9.0	2.8	4.5	9.0	0.0	0.0	0.0	9.0
Blue Hole to Indian Crossing	9-Oct			0.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Middle Imnaha Total		3.2	2.0	0.0	11.0	11.0	2.8	4.5	9.0	0.0	0.0	0.0	9.0
Big Sheep System													
Big Sheep, Canal to Rd. 39	23-Sep	3.1	1.9	3.0	2.0	5.0	1.6	2.6	25.0	6.0	17.0	2.0	0.0
Big Sheep, Canal to Rd. 39	8-Oct			0.0	2.0	2.0			5.0	4.0	1.0	0.0	0.0
Lick Cr. Meadow to 39 rd.	23-Sep	2.4	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lick Cr. Meadow to 39 rd.	8-Oct			0.0	0.0	0.0			1.0	0.0	1.0	0.0	0.0
Lick Cr. 39 Rd. to Quartz Cr.	23-Sep	6.8	4.2	2.0	1.0	3.0	0.4	0.7	11.0	5.0	6.0	0.0	0.0
Lick Cr. 39 Rd. to Quartz Cr.	8-Oct			1.0	0.0	1.0			6.0	2.0	4.0	0.0	0.0
Big Sheep System Total		12.3	7.6	6.0	5.0	11.0	0.9	1.4	48.0	17.0	29.0	2.0	0.0
Imnaha Basin Total (Page 1)													
		24.0	17.4	17.0	177.0	194.0	8.1	11.1	102.0	1.0	71.0	2.0	28.0
Imnaha Basin Total (Page 2)													
		15.5	9.6	6.0	16.0	22.0	1.4	2.3	57.0	17.0	29.0	2.0	9.0
Imnaha Basin Total Pages 1 & 2)													
		39.5	27.0	23.0	193.0	216.0	5.5	8.0	159.0	18.0	100.0	4.0	37.0

**Table 4a –
Summary of Measured Bull Trout Redds, Grande Ronde River Basin
Lostine River and Goat Creek 2015**

Stream	n*1		Length (M)	Width (M)	Area (m2)	Length/Width ratio
Lostine	27	mean	1.4	0.7	1.1	2.0
		sd	0.4	0.3	0.8	0.6
		max	2.4	1.5	3.4	3.0
		min	0.6	0.2	0.1	1.0
Bear	3	mean	0.7	0.7	0.5	1.1
		sd	0.2	0.1	0.2	0.1
		max	0.9	0.7	0.7	1.3
		min	0.5	0.5	0.2	1.0
Goat	2	mean	1.2	0.6	0.7	2.0
		sd	.03	0	.02	0.1
		max	1.2	0.6	0.7	2.1
		min	1.2	0.6	0.7	2.0

*n = number of redds observed and measured (sample size).

**Table 4b –
Summary of Measured Bull Trout Redds, Imnaha River Basin 2015**

Stream	n*1		Length (M)	Width (M)	Area (m2)	Length/Width ratio
Big Sheep Creek	7	mean	0.6	0.3	0.2	2.0
		sd	0.2	0.2	0.2	0.5
		max	0.9	0.7	0.7	2.7
		min	0.4	0.2	0.1	1.4
Middle Imnaha	11	mean	1.2	0.7	0.9	1.7
		sd	0.3	0.3	0.5	0.4
		max	1.9	1.4	1.8	2.2
		min	0.7	0.3	0.2	0.9
N.F. Imnaha	49	mean	1.1	0.5	0.7	2.2
		sd	0.6	0.2	0.6	0.7
		max	2.5	1.0	2.4	4.0
		min	0.3	0.1	0.1	0.6
S.F. Imnaha	60	mean	1.3	0.7	0.9	1.2
		sd	0.5	0.2	0.5	0.8
		max	2.8	1.1	2.6	4.0
		min	0.6	0.2	0.2	0.6
Upper Imnaha	33	mean	1.2	0.6	0.8	1.8
		sd	0.5	0.2	0.4	0.9
		max	2.8	1.2	2.1	4.0
		min	0.6	0.3	0.2	0.6
Cliff Creek	2	mean	0.95	0.4	0.4	2.2
		sd	0.1	0.03	0.02	0.5
		max	1.0	0.4	0.4	2.6
		min	0.8	0.4	0.4	1.9

**Footnote 1: n = number of redds observed and measured (sample size).
Lick Creek not included in table, only one resident size redd, 0.3 (m2).**