

# **2018 Bull Trout Redd Monitoring in the Wallowa Mountains**



**Prepared by:  
Gretchen Sausen  
U.S. Fish and Wildlife Service  
La Grande Field Office  
April 8, 2019**

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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 bull trout in subbasins where little is known about the populations, including the Grande Ronde and Imnaha subbasins. Spawning survey data is important for determining relative abundance and distribution trends in bull trout populations. This report summarizes the 2018 bull trout spawning data collected in the Willowa Mountains of northeast Oregon and compares this with past years' data. Bull trout spawning surveys have been conducted on similar index areas for selected Grande Ronde and Imnaha River streams from 1999 to 2018. These surveyed streams are located within the Willowa River/Minam River, Lookingglass Creek/Wenaha River and Imnaha River bull trout core areas. In 2018, the Wenaha and Minam Rivers, and additional locations on Big Sheep Creek were added to the regular annual redd surveys. Surveys in 2018 were conducted by the Nez Perce Tribe (NPT), the Oregon Department of Fish and Wildlife (ODFW), the Service, U.S. Forest Service (USFS), Anderson Perry, Inc., and fisheries consultants. Objectives of the survey included: (1) locate bull trout spawning areas; (2) determine redd characteristics; (3) determine bull trout timing of spawning; (4) collect spawning density data; (5) determine and compare the spatial distribution of redds along the Lostine River in 2006 through 2018; (6) document redd locations on the Wenaha, Upper Minam, Imnaha, Big Sheep, and Bear Creek in 2018; and (7) 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 (1999-2018). There was a decrease in redd numbers in Big Sheep Creek in 2017-2018 compared to 2016 for the comparable reaches. In 2018, additional reaches were surveyed on Big Sheep and the miles surveyed and number of redds and redds/mile increased compared to 2016 and 2017. Lick Creek survey in 2018 was a one-time survey conducted at the lower reach. There was an increase in redd numbers on the Imnaha River, the Lostine River, and Bear/Goat Creek in 2017 and 2018 compared to 2016. The increases were not significant for the Imnaha, the redd numbers were still low compared to 2014 and previous years. However, the increases were significant for the Lostine and Bear/Goat Creek. The Imnaha population is one of the strongholds within the Imnaha Subbasin. The Wenaha system is believed to contain a healthy population of bull trout but prior to this year, has had little previous spawning data, in part, due to its remoteness. In 2018, the Wenaha surveys documented 269 redds in 21.5 total miles surveyed, or 12.5 redds/mile. The Minam is also a Grande Ronde system stream that has limited bull trout data due to its remoteness. In 2018, surveys in the Upper Minam documented 41 redds for 6.9 miles

of survey, or 5.9 redds per mile. 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. In 2018, surveys on Big Sheep were extended above the canal (resident fish) and below the 39 Road to the mouth of Lick Creek as per recommendation from Phil Howell (P. Howell, pers. comm. 2018). Twenty two resident size redds were documented above the canal and 0 redds were documented below the 39 Rd. The Lostine River and Bear Creek contain brook trout and hybridization is likely occurring. In 2010 and 2012, bull trout and brook trout were documented paired up for spawning on the Lostine River. Brook trout are known to be present in the upper Minam River and tributaries. No brook trout were observed during the 2018 Minam River survey. The Wenaha River, Deer Creek, Imnaha River, Big Sheep, and Lick Creeks do not contain brook trout.

## **ACKNOWLEDGMENTS**

For the past fifteen years, the Service has provided staff time necessary for the coordination, implementation, and analysis and report summarization of this project. However, this project would not have been possible without the dedication, hard work, funding, and assistance provided by all the partners. Oregon Watershed Enhancement Board (OWEB) funding from 2007-2018 allowed the use of Del Sol Wilderness Adventures 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. The Forest Service and a volunteer packed gear into the Minam River in 2018. In 2018, Del Sol Wilderness Adventures also packed into the Wenaha, besides the annual Imnaha trip. I would like to thank the partners in 2016-2018, which included the Nez Perce Tribe (NPT), Oregon Department of Fish and Wildlife (ODFW), the United States Forest Service (USFS), OWEB, Grande Ronde Model Watershed (GRMW), the Service, Anderson Perry, Inc., Wallowa Resources, and several fisheries consultants. Special thanks to the people in 2016-2018 who walked the streams, helped with scheduling surveys and surveyors, provided access to private property, packed us into remote areas to survey, helped with planning, assisted with the OWEB grants, produced maps with the GIS data, or summarized the data. These included: Gary Miller, Marisa Meyer, Justin Martens (Service); Sarah Brandy, Richard Castillo, Alan Miller, John Hollenbeak, (USFS), Russ Westlake (volunteer), Barry and Shirley Cox, Paul Arentsen, and crew (Del Sol Wilderness Adventures Horse/Mule Packers and Winding Waters River Expeditions); Jeff Oveson, Mary Estes, Alex Towne, and Jessica Humphreys (GRMW); Lynne Price, Jocelyn Hatch, Phil Howell, Matt King, Jim Soupir (consultants); Shane Vatland, Gus Johnson, Ryan Rumelhart, Lynne Price, Aaron Maxwell, Lora Tennant, Tyler Stright, Brian Simmons, and Jim Harbeck (NPT); Kyle Bratcher, Jeff Yanke (ODFW); Sue Brady (Anderson Perry, Inc.), Kyle Petrocine (Wallowa Resources), and private property landowners on the Lostine River.

## **INTRODUCTION**

Bull trout were listed as threatened under the Endangered Species Act in 1998 due to declining populations. The Service recommends monitoring bull trout in subbasins where little is known about populations, 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 Service's 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).

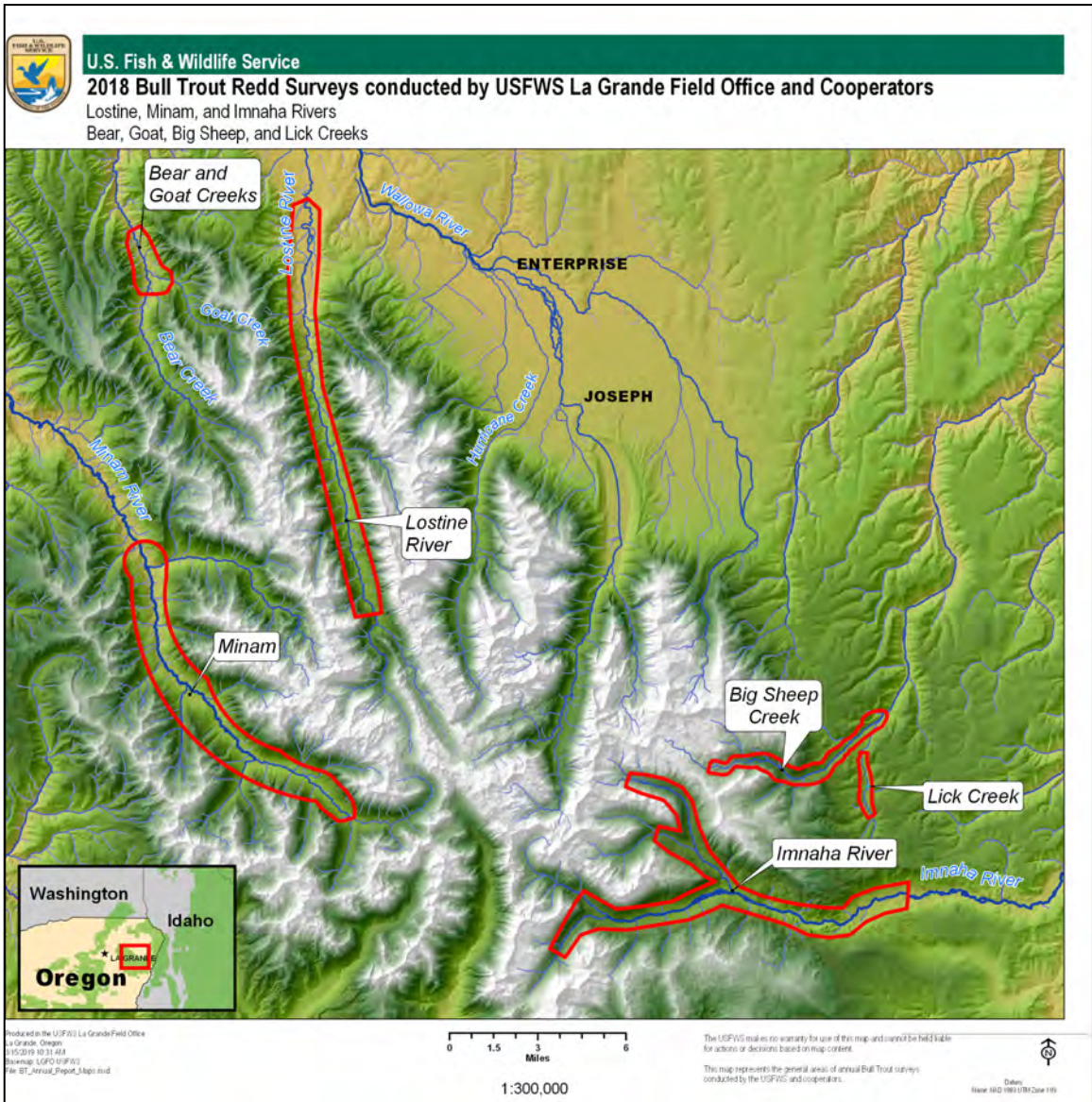
Without adequate funding, it was difficult to find sufficient numbers of experienced bull trout surveyors and packers for surveys in the backcountry, and to obtain adequate supplies to get the work accomplished. However, OWEB funding for the project supported the continued survey of bull trout spawning areas in years 2007 through 2018 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 18 to 20 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 2018. Collect UTM spatial redd data on Big Sheep, Lick Creek, and Middle Imnaha, and other streams 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 2018 on selected streams in the Grande Ronde and Imnaha Sub-Basins. These streams are located within the Lookingglass/Wenaha, Wallowa River/Minam River and Imnaha River bull trout core areas. Stream systems surveyed in 2018 for bull trout redds included; the Minam River, Wenaha River, Lostine River, Bear and Goat Creeks, the Imnaha River, Big Sheep Creek and Lick Creek (Figures 1a. and 1b.). Deer Creek was surveyed in 2017 but not in 2018.



**Figure 1a. Wallowa Mountain Bull Trout Redd Survey Areas in 2018, Map 1**

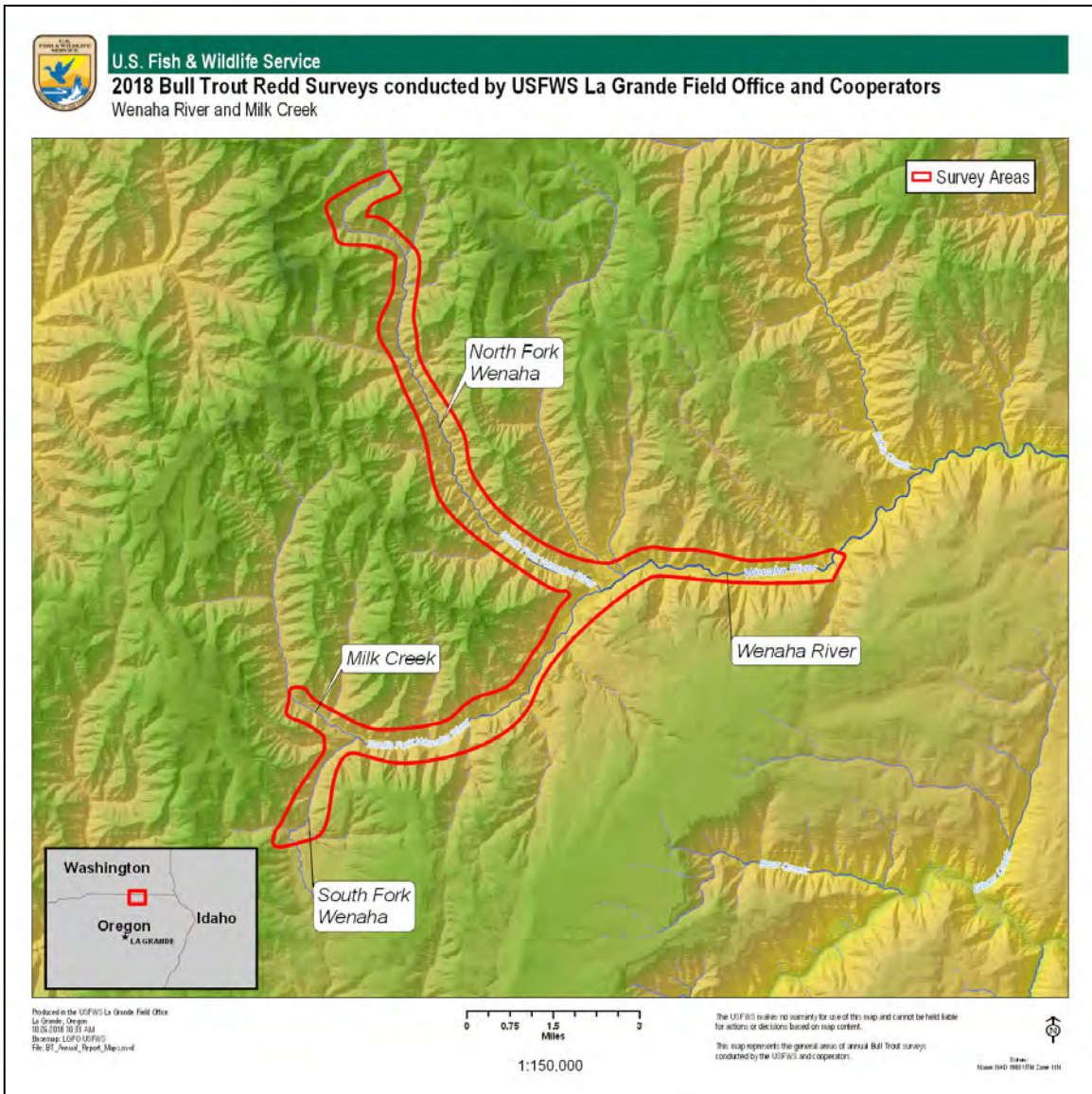


Figure 1b. Wallowa Mountain Bull Trout Redd Survey Areas in 2018, Map 2.

## 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, Middle Imnaha (Blue Hole to Indian Crossing), and Bear and Goat Creeks. One-time surveys

were conducted late in the spawning season in 2018 (as in past years), on the Upper Innaha River and tributaries, due to access and funding limitations. In 2018, the Wenaha, Minam and additional locations on Big Sheep were added to the regular annual redd surveys. In 2018, Lick Creek was only surveyed once in the lower reach. An exploratory survey was conducted on Deer Creek for approximately 0.8 stream miles in 2017, but not in 2016 and 2018. Appendix B, Table 1 compares survey data and survey frequency for 1999-2018 bull trout spawning surveys on selected Grande Ronde and Innaha 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 and 2016, 41.1 in 2017 and 72.6 in 2018. In 2013, there were less stream miles surveyed in the Upper Innaha 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 (for inexperienced surveyors, when needed); 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.



**Lora Tennant (NPT) measuring bull trout redd on the Minam River.  
Lynne Price (consultant) taking photo, 2018.**

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 2018, in addition to the above, bull trout redd UTM locations on the Lostine River, Big Sheep Creek, Lick Creek, and Middle Innaha within the “index areas” also were collected. In 2018, bull trout redd UTM locations were collected on all streams surveyed in 2018. 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).

Objectives of the survey included: (1) locate bull trout spawning areas; (2) determine redd characteristics; (3) determine bull trout timing of spawning; (4) collect spawning density data; (5) determine and compare the spatial distribution of redds along the Lostine River in 2006 through 2018; document redd locations on the Wenaha, Upper Minam, and Innaha Rivers, and Big Sheep and Bear Creeks in 2018; and (6) 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.



**Jessica Humphreys, Freshwater Trust  
Collecting bull trout redd data, SF Innaha River, 2017  
Photo by Kyle Bratcher, ODFW**





**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 2018. These surveyed streams are located within the Wallowa River/Minam River and Imnaha River bull trout core areas. In 2018, bull trout spawning surveys were also conducted within the Wenaha System, within the Lookingglass/Wenaha bull trout core area. During these years, bull trout spawning areas have been established for these streams, in particular, the Lostine and Imnaha Rivers. Redd characteristics have also 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 2018, 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 fourteen years because of limited funding, 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.

In 2018, Big Sheep Creek's survey was expanded to include upstream of the canal (resident habitat), and below the 39 road to Lick Creek (fluvial habitat). In 2018, Lick Creek was surveyed once in the lower reach.

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, and 2017 and 2018, 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, 2016, and 2018, 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.

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. This survey was not conducted in 2016, as the Service was not granted access to private property along the East Fork Wallowa River. In 2017 and 2018, the East Fork Wallowa River was surveyed as part of PacifiCorp Energy's Wallowa Falls Hydroelectric Relicense Project (PacifiCorp 2017).

Deer Creek was surveyed in 2017, from Road 8290 junction to upstream 0.8 miles. In addition, the Upper Minam and Wenaha Rivers were surveyed in 2018. Prior to 2017 little effort had been made in surveying the upper Minam River for bull trout spawning due to limited access. In 2017, the Forest Service conducted an exploratory spawning survey to determine the feasibility of spawning surveys and to determine likely spawning

areas. Based on the findings from 2017, four spawning reaches were identified for the 2018 Minam River survey effort. For the Upper Minam River, survey reaches included; Minam River –Trail Creek, Minam River – Wild Sheep, Minam River-Elk Creek Index, and Minam River-Rock Creek (A. Miller, USFS, pers.com. 2018). In 2018, it was determined that a one-time pack in bull trout redd survey to help establish distribution and spawning adult abundance would occur in the Upper Wenaha River and tributaries. ODFW, the NPT, and Phil Howell (Meridian Environmental, Inc. Consulting), coordinated with the Service as to a plan of locations to survey. The exact location of Wenaha reaches were given GPS waypoints in the field by ODFW and the NPT, during a Wenaha chinook survey. The Upper Wenaha River, North Fork Wenaha River, South Fork Wenaha River, and the lower mile of Milk Creek were identified as the locations to survey in 2018.

### **Timing of Bull Trout Spawning**

Bull trout that were radio-tagged in the Snake River began moving into the lower Imnaha River in late-April, and continued upstream through May, June, and July, with all of the fish reaching the upper river by August to escape 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). In 2017, the Imnaha Satellite facility had some problems passing bull trout upstream in the summer/fall. It is not clear how this might have affected upstream spawning and/or migration. 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).

In general, timing of bull trout spawning for our surveyed streams 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 dates are 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 bull trout pass over the falls as timing is dependent on annual flows. Some years we have seen fluvial-size bull trout spawning in the South Fork Imnaha in mid-late September to early October; however, in recent years, excluding 2017 and 2018, we have not. 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 (B. Smith, ODFW, pers. comm., 2005). In 2011, Upper Imnaha had smaller-sized redds reported than in previous years. This could be an indicator of smaller fish; however, the documented fish sizes suggest fluvial fish; or perhaps due to weather and stream conditions, the fish were spawning later and these redds were incomplete. Cliff Creek, a resident bull trout tributary stream to South Fork Imnaha, had several redds that were still in progress at the time of the 2012 survey. In 2017, 100-percent of redds in Cliff Creek

were unoccupied (older redds) (Ryan Rumelhart, pers. comm. NPT, 2017). In 2018, the majority (>86%) of redds on the Imnaha (Blue Hole upstream to Cliff Creek) were completed prior to the September 24-26 survey dates. Additional years of observation and data are needed to fully understand bull trout spawning and adult movement in the Imnaha Subbasin, and Big Sheep and Bear Creek Watersheds.



**Fluvial bull trout spawning pair in the Middle Fork Imnaha River  
Photo by NPT, 2012**



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

The Minam and Wenaha Rivers were surveyed one time, extensively in 2018. In the Minam, the survey was conducted on September 25 and 26, 2018 and 100% of the redds were unoccupied by bull trout. Bull trout redds on the Minam River in years 2017 and 2018 were made sometime post chinook spawning (A. Miller, USFS, pers. com. 2019). We see bull trout redds during the chinook pack trip in the Wenaha the first week of September. By the end of the second week, I have seen as many as 40 of what I would have classified as bull trout redds, but not necessarily every year. There is definitely some variability (K. Bratcher, ODFW, pers.com. 2019). In the Minam, the bull trout are staging

to spawn by the time of the chinook pack trip (last week August) but I have not seen bull trout spawning. Areas where we regularly see bull trout staging are near the mouth of Elk and Rock Creeks. (T. Bailey ODFW, pers.com. 2019). In the Wenaha River and tributary streams, the bull trout survey was conducted on September 28, October 1-2 and 99.6% (the majority) of redds were unoccupied. Bull trout redds have been observed and documented on September 13, 2018, during the chinook surveys on the Wenaha River and tributary streams.

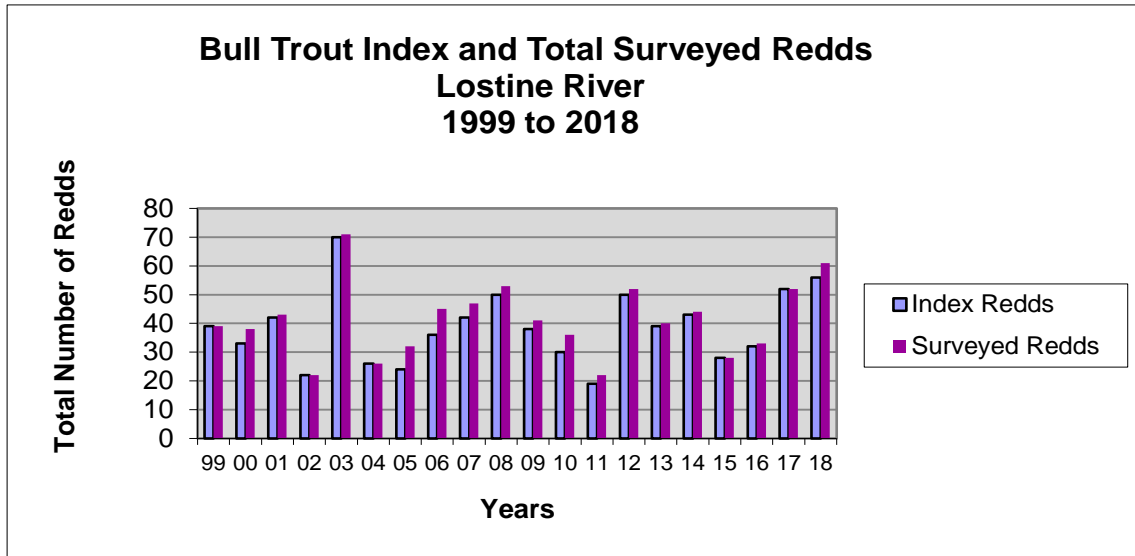


**Phil Howell, contractor  
at bull trout redd area on SF Wenaha River, 2018  
Photo by Lynne Price**

## **Total Number of Bull Trout Redds**

### *Lostine River*

Refer to Appendix B; Table 3a and 3b for bull trout redd count summary data for 2018. In 2018, a total of 61 bull trout redds were documented on 10.1 miles of the Lostine River, including Pole Bridge to Six Mile Bridge. 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 2018, excluding the Pole Bridge to Six Mile section (Figure 3). The Lostine River had a low of 19 redds in 2011, and a high of 70 redds in 2003. If you disregard the 2003 redd count of 70, which appears to be an outlier, 2018 had the highest redd count on the Lostine with a total of 56 redds. The nineteen-year average from 1999 to 2018 (subtracting out 2003, which had an outlier of 70 redds) for the Lostine River is 36.7 redds. 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 2018, both upper reaches, Shady Campground to French Camp and French Camp to Bowman had the highest redd densities, 25 and 23, respectively.

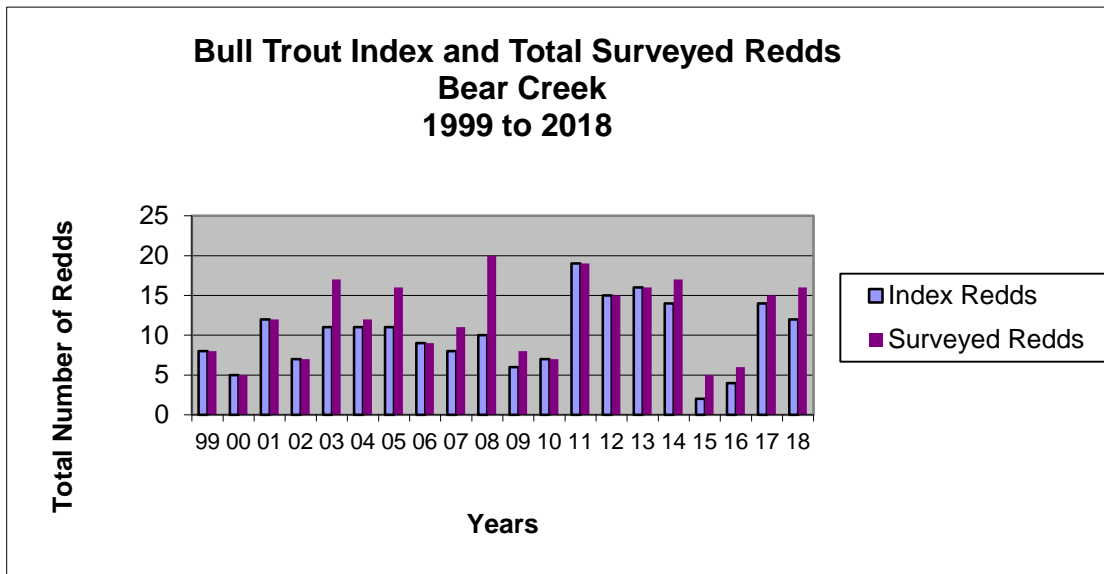


**Figure 2. Comparison of bull trout surveyed redds and index redds (Comparable miles) documented from 1999 to 2018 on the Lostine River.**

*Bear Creek*

In 2018, 16 bull trout redds were documented on 3.8 miles of 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 2018 (Figure 4). Redd counts on Bear Creek and Goat Creek had 12 redds in 2018 and a high of 19 total redds in 2011, which is the highest count for the index area. The twenty-year average from 1999 to 2018 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. The 2008 through 2014 and 2017 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 and 2016, and 2018, 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.

The local bull trout population in the Lostine and Bear Creek surveys appears to be relatively stable for the survey period (1999-2018). Lostine River redd numbers increased to 52 redds in 2017 and 61 redds in 2018, compared to lower redd numbers in years 2013-2016 (39, 43, 28, and 32 redds). Bear Creek redd numbers increased to 14 and 12 redds in 2017 and 2018, compared to lower counts in 2015 and 2016 (2 and 4 redds).



**Figure 3. Comparison of bull trout surveyed redds and index redds (Comparable miles) documented from 1999 to 2018 on Bear Creek, Including Goat Creek.**

*Minam River*

The Minam is a Grande Ronde system that prior to 2017 has had little previous bull trout data, due to its remoteness. In 2018, Minam surveys documented 41 redds for 6.9 miles of survey, or 5.9 redds per mile. The Minam bull trout spawning survey in 2018 was a late season one-time survey. Comparing redd densities for the Minam-Elk Creek Index reach, 3.4 redds/mile were observed in 2017 compared to 4.9 redds/mile in 2018. (A. Miller, USFS pers.com. 2018). Refer to Appendix B, Table 3a.

*Wenaha River*

The Wenaha system is known to contain a healthy population of bull trout but has had, previous to 2018, limited spawning data, due to its remoteness. In 2018, the Wenaha River and tributary stream surveys documented 269 redds in 21.5 total miles surveyed, 12.5 redds/mile. Similar to the Minam, but with more miles surveyed, the Wenaha bull trout spawning survey in 2018 was a late season one time survey. For the reach areas surveyed and miles, refer to Appendix B; Table 3a and 3b for bull trout redd count summary data for 2018.

### *Imnaha River*

In 2018, 161 bull trout redds were documented on 19.4 miles of the Imnaha River, from Indian Crossing to Blue Hole and upstream. In 2018, 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 2018 (Figure 5a). The seventeen-year average from 2001 to 2018 (excluding 2013) was 168.1 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, 2014 through 2015, and 2017, there was a significant shift in documented spawning distribution. In these years, the majority of the spawning bull trout were located from the Imnaha falls to Indian Crossing, whereas, in 2018 and other years the distribution had higher numbers above the Blue Hole (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 evenly distributed between all Imnaha reaches. In 2018, resident Cliff Creek had the highest redd densities, with 59 redds for 2.5 miles surveyed. Upper Imnaha and South Fork Imnaha had the next highest redd densities for 2018 with 44 and 35 redds for 3.3 and 4.6 miles surveyed. Twenty redds in the North Fork Imnaha River for seven miles surveyed and three redds in the Middle Imnaha (Indian Crossing to Blue Hole) for 2 miles surveyed.

In 2009, Cliff Creek, a resident bull trout tributary to South Fork Imnaha, had the greatest total number of redds at 164 redds. However, 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 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 with downward trend in the population in 2014 through 2016. If you subtract the resident Cliff Creek population from the Upper Imnaha redd counts, there is a substantial downward trend from 2009 through 2011. In 2018, 102 bull trout redds were documented on 16.9 miles of the Imnaha River, from Indian Crossing to Blue Hole and upstream (excluding Cliff Creek). The seventeen-year average from 2001 to 2018 (excluding 2013) was 111 redds for the Imnaha River system (excluding Cliff Creek). Within that same time period, total redd numbers (minus resident Cliff Creek) for fluvial/resident bull trout on the Imnaha ranged from 71-236. Cliff Creek and several other Upper Imnaha reaches were not surveyed in 2013 (Figure 5b).



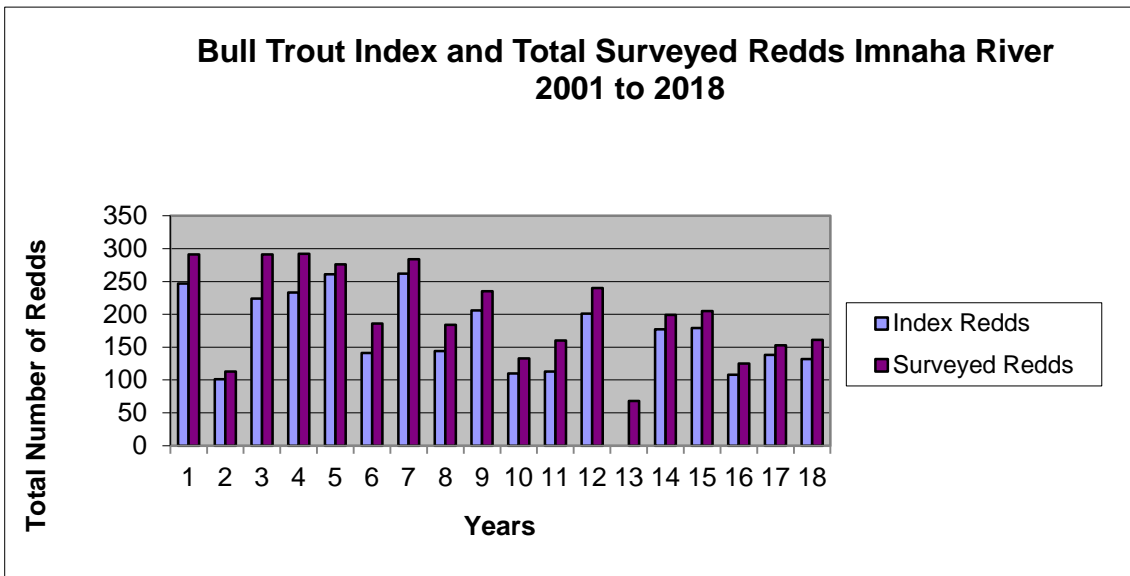


Figure 4a. Comparison of bull trout surveyed redds and index redds (comparable miles) documented from 2001 to 2018 on the Imnaha River. Index redds are not shown in 2013, since locations and miles are not comparable to past years.

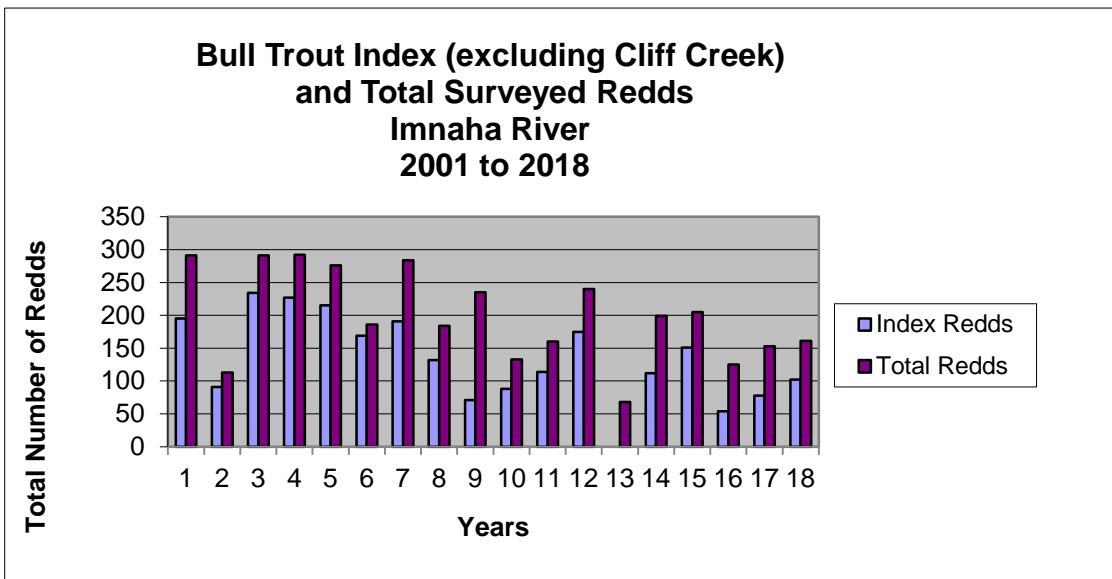
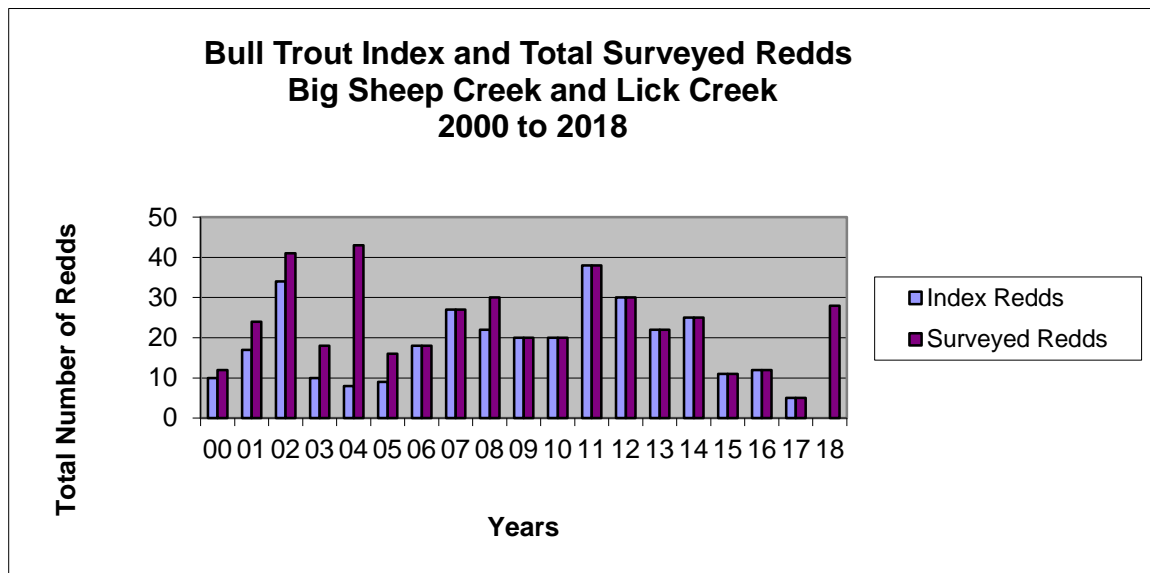


Figure 4b. Comparison of bull trout surveyed redds and index redds (comparable miles, excluding Cliff Creek) documented from 2001 to 2012, and 2014-2018 on the Imnaha River. Index redds are not shown in 2013, since locations and miles are not comparable to past years and Cliff Creek not surveyed in 2013.

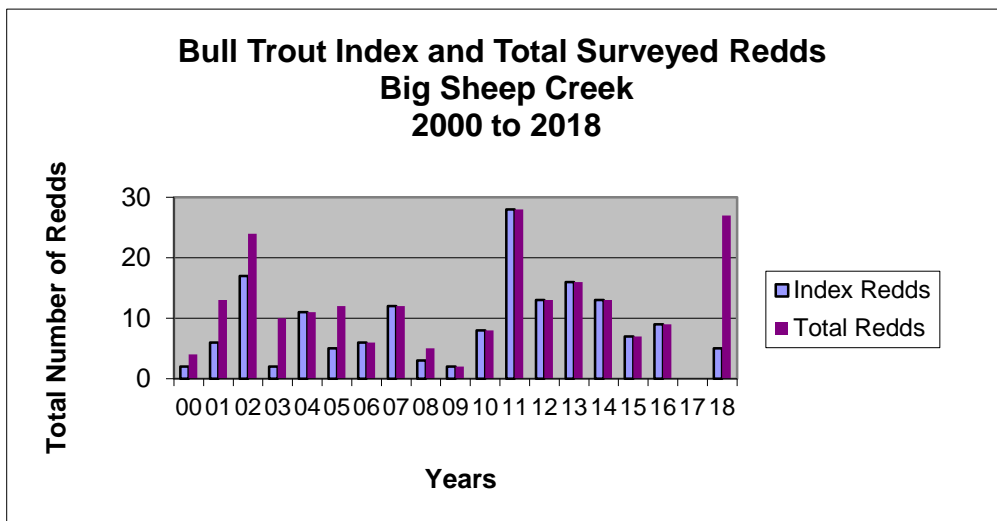
### *Big Sheep Creek and Lick Creek*

In 2018, twenty eight bull trout redds were documented on 9.6 miles of Big Sheep Creek and the lower reach of Lick Creek. These areas were generally surveyed twice in 2018, mid and late spawning season. The survey of Big Sheep in 2018 was different than past years. In 2018, the miles surveyed increased on Big Sheep Creek and decreased on Lick Creek. A reach above the Wallowa Valley Improvement canal and below the 39 Road were added to Big Sheep. The lower reach of Big Sheep (39 Road to Lick Creek) was only surveyed once mid-season due to a lack of spawning habitat. The lower reach of Lick Creek was surveyed once, as well. The following data for Big Sheep Creek compares consistently surveyed index areas on Big Sheep and Lick Creek (7.6 miles) from 2000 to 2017 (Figure 6). The eighteen-year average from 2000 to 2017 was 18.8 redds for the Big Sheep system. Total redd numbers within the Big Sheep system ranged from 5-38 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 frequency and in miles of survey (7.6 to 14.1 miles from 2000 to 2018). Surveys in 2000, 2001, and 2017 were conducted once late season and in 2018, the lower reaches of Big Sheep and Lick Creek were surveyed once. Surveys in 2002, 2003, and 2005 through 2016 and in 2018 the upper reaches of Big Sheep 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.

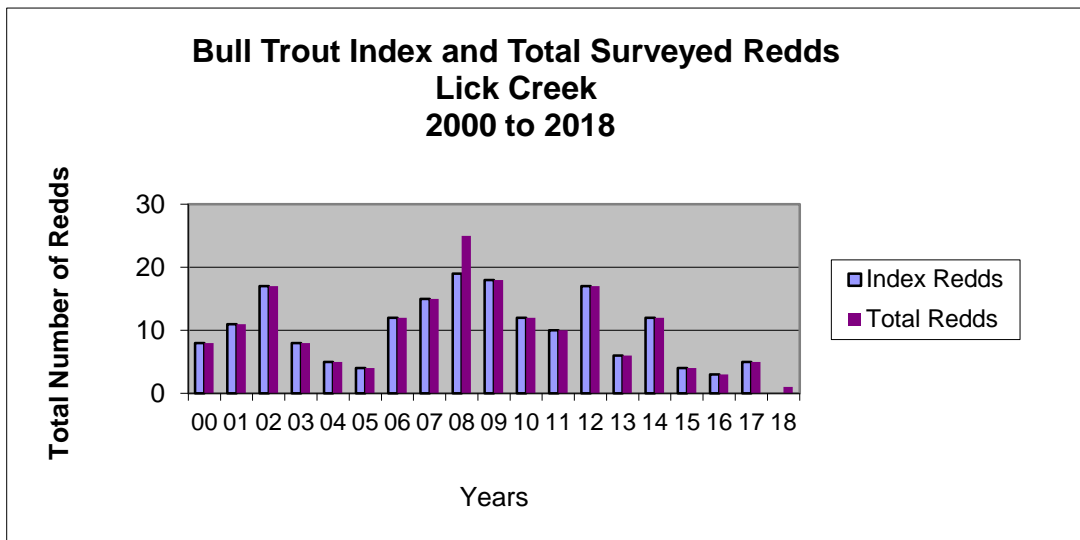


**Figure 5. Comparison of bull trout surveyed redds and index redds (comparable miles) documented from 2000 to 2018 on Big Sheep and Lick Creeks. Index redds are not shown in 2018, since locations and miles are not comparable to past years.**

Howell et al. 2018, pg. 58, recommends separating Big Sheep and Lick Creek redd data due to genetics data that shows a high degree of heterogeneity between the two populations. Below is a comparison of the streams as separate systems.



**Figure 6a.** Comparison of bull trout surveyed redds and index redds (comparable miles) documented from 2000 to 2018 on Big Sheep Creek excluding Lick Creek.



**Figure 6b.** Comparison of bull trout surveyed redds and index redds (comparable miles) documented from 2000 to 2018 on Lick Creek. 2018 survey was limited to the lower reach and only one survey, index data incomplete, it is not comparable to past years.

The local bull trout population, in Big Sheep Creek appear to be relatively stable, and possible decline for the survey period (2000-2018). There was an increase in redd numbers in Big Sheep in 2002 and 2011 and a decrease in redd numbers in 2012-2018. Redd numbers were the lowest in 2017, no redds were observed on Big Sheep Creek in 2017. In 2018, the reach upstream of the WVIC (resident size fish) was surveyed and there was twenty two, or 84.6% redds reported in this reach of Big Sheep Creek. This additional survey reach increased the total redd numbers but was not significant for the total redds/mile compared to past years surveys.

The local bull trout population in Lick Creek appears to be relatively stable, and possible decline for the survey period (2000-2018). There was an increase in redd numbers in Lick

Creek in 2002, 2008, and 2012, and a decrease in redd numbers in 2013-2017, although 2014 had a slight increase. A limited survey was conducted on Lick Creek in 2018, therefore, the 2018 survey on Lick Creek is not comparable to past years.

### **Sizes of Bull Trout Redds**

Bull trout redds were measured using the same methodology in 2004 through 2018, for the majority of streams surveyed. A comparison of bull trout redd sizes, by mean redd area (m<sup>2</sup>), for these years is illustrated below (Figures 7 & 8). In 2018, the redds were measured consistently for length only, instead of area, on the Wenaha River. Phil Howell recommends at a minimum, measuring length only, due to a correlation between redd area and length being 0.99 (P. Howell, pers. comm., 2018, and Howell et al. 2018 pg. 12). 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 pg.11). 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, pg.11) 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 bull trout (<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, pg.186) 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 shown below for the Lostine/Bear and Imnaha systems comparing resident and migratory forms annually for these streams.

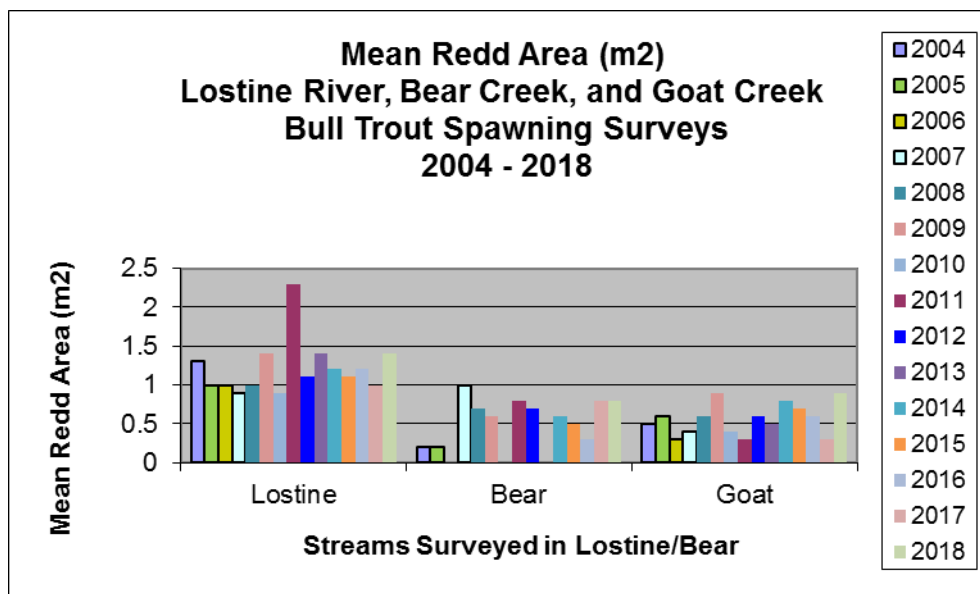
#### *Lostine/Bear/Goat*

Figure 7 compares bull trout redd sizes for the Lostine River, Bear Creek, and Goat Creek in 2004-2018. Mean redd area (m<sup>2</sup>) 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<sup>2</sup>) of 2.3 documented for this stream to date. In 2018, the mean redd area documented was 1.4 (fluvial size redd dominant). The Bear Creek sample area was expanded in miles surveyed in 2007 and in 2015-2016, 2018 (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 eight redds were documented in 2018 with a mean redd area of 0.83 (showing a fluvial size dominance).

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 2004-2018 that redds in Goat Creek were a combination of resident and fluvial fish, and in 2011, 2012, 2013, and 2017 dominated by

more resident size redds, and in 2014-2016, 2018 dominated by fluvial size redds. In 2018, seven of the eight (87.5%) redds measured on Goat Creek were fluvial size (redd area < 0.32 m<sup>2</sup>). The redd sizes in both the Lostine River and Bear Creek in 2011, 2012, and 2014-2015, and 2018 were dominated by fluvial size fish. In 2017, the Lostine River continued to have dominance in fluvial size redds, and Bear Creek (including Goat Creek), had 60-percent resident and 40-percent fluvial size redds. More years of data collection relative to fish and redd sizes on these streams should help us better understand the resident and fluvial life histories of bull trout in this area.

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. However, to date, genetic sampling for bull trout/brook trout in the Lostine and in Bear Creek has not occurred.



**Figure 7. Comparison of bull trout redd sizes [mean redd area (m<sup>2</sup>)] for Lostine River, Bear, and Goat Creeks sampled during bull trout spawning surveys, 2004-2018.**

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).

### *Minam*

In 2018, mean redd area (m<sup>2</sup>) was 1.4 (fluvial dominant) for 41 redds surveyed and measured on six miles of the Upper Minam River (Refer to Figure 8). Both resident and fluvial redds were observed during the survey though the number of resident redds were low. Resident redds were observed in the Minam-Elk Creek Index reach (1 redd), Minam-Wild Sheep reach (1 redd), and Minam-Trail Creek reach (2 redds). Based on this information the Upper Minam bull trout population appears to be primarily a fluvial population. All bull trout observed during the 2018 survey were larger than 300 mm (A.Miller, USFS, pers.com. 2018).

Brook trout are present in the Upper Minam River and tributaries. However, no brook trout were observed during the 2018 survey. (A. Miller, USFS, pers.com. 2018)

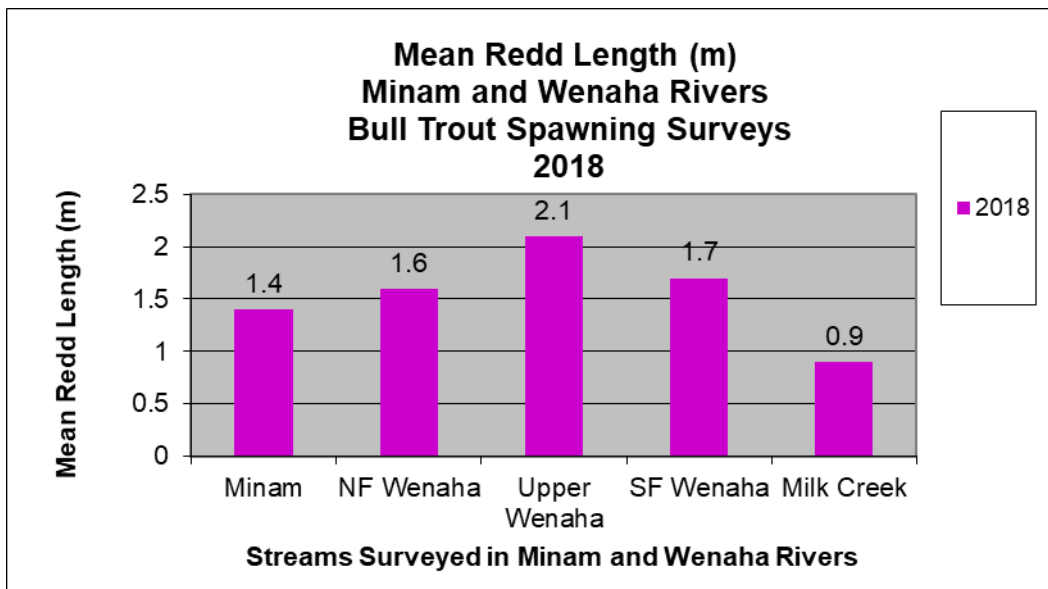


Figure 8. Minam and Wenaha River Mean Redd Lengths (m) in 2018.

### *Wenaha*

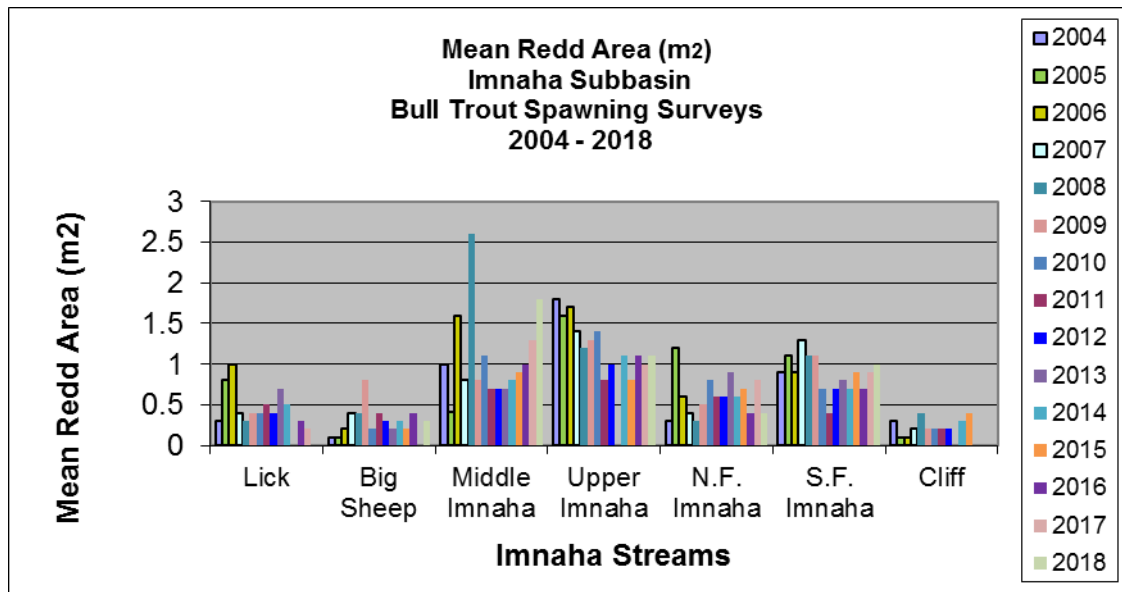
In all reaches surveyed on the Upper Wenaha, there was a fluvial dominance of redds. These redds were large redds with lengths consistently measured. The bull trout redds were often alongside or on top of chinook redds. The Wenaha system had chinook surveys conducted in August and September, prior to the Wenaha bull trout survey. At locations where our crews would survey for bull trout, the flagging was left up along the stream to help identify chinook redds. Leaving the chinook flagging post chinook surveys, helped bull trout surveyors identify new bull trout redds at these locations, amongst the older chinook redds. The flagging was removed post survey.

In 2018, mean length of redd (m) was 2.1 (fluvial dominant) for twelve redds measured on 4.3 miles of the Upper Wenaha River. In 2018, Milk Creek [tributary to the South Fork (SF) Wenaha River] mean length of redd (m) was 0.9 for eleven redds measured on one mile of Milk Creek. In 2018, the SF Wenaha mean length of redd (m) was 1.7 for ninety two redds measured (this does not include the entire redd numbers surveyed) on 7.6 miles of the SF Wenaha River. In 2018, the North Fork (NF) Wenaha mean length of redd (m) was 1.6 for 151 redds measured on 9.5 miles of the NF Wenaha River. Refer to Figure 8.

### *Innaha and Big Sheep*

Figure 9 compares bull trout redd sizes for the sampled streams in the Innaha system in years 2004 through 2018. Mean redd area (m<sup>2</sup>) ranged from 0.3-1.0 for Lick Creek, 0.1-0.8 for Big Sheep Creek, 0.4-2.6 for Middle Innaha, 0.8-1.8 for Upper Innaha, 0.3-1.2 for North Fork Innaha, 0.4-1.3 for South Fork Innaha, and 0.1-0.4 for Cliff Creek. In 2018, Big Sheep had an additional reach surveyed above the canal, with a mean redd area of 0.2 (resident). As shown in Figure 9, very large redds produced by large fluvial bull trout were documented on the Middle Innaha in 2008. In 2018, the mean redd size was 1.8 (fluvial dominant) with only four redds documented in the Middle Innaha. Over the 15-year period (2004-2018), redd sizes have been both fluvial and resident, with a dominance towards fluvial. However, the number of redds in this 2.0 mile reach has

varied through the years with 2014 (17 redds), 2015 (11 redds), and 2017 (11 redds), whereas in 2009, 2010, and 2018 redd numbers were as low as two, four, and four respectively.



**Figure 9. Comparison of bull trout redd sizes [mean redd area (m<sup>2</sup>)] for sampled streams in the Imnaha Subbasin, 2004-2018. (In 2013, no redd size data for Upper Imnaha and Cliff Creek. NF. Imnaha missing upper reach data in 2014. Lick Creek missing 2015 and 2018 due to only one redd measured). Big Sheep Creek had no redds documented in 2017. No data for Cliff Creek in 2016 - 2018, not measured or reported above falls due to known resident population and sufficient past data.**

In some areas, overlap between bull trout and chinook redds may make it difficult to differentiate between the two species spawning nests. Although true, in Lick Creek and the Imnaha River, we have been able to rely on experienced surveyors and recognition of bull trout redds by time of year and size of substrate. In 2017, five redds were measured for Lick Creek and the redd area (m<sup>2</sup>) was 0.2 (resident). In 2018, the survey was reduced to a one time survey mid-season and only the lower reach surveyed, and only one redd documented. In 2018, the one redd documented on Lower Lick Creek was resident size. During 2004 through 2017, approximately 64-percent of the redds have been resident-size dominant, and 36-percent of the redds have been fluvial/resident dominant, and fluvial dominant. In 2017, no redds were documented on Big Sheep Creek. By comparison, Big Sheep Creek was dominated by resident redds in most years sampled, except in 2009 with only one fluvial size and one resident redd. In 2014 and 2015, the mean redd area (m<sup>2</sup>) for Big Sheep was 0.3 and 0.2, respectively (resident size). In 2016, the mean redd area (m<sup>2</sup>) for Big Sheep was 0.4, 67-percent were fluvial size, and 33-percent were resident size (with 10 of the 78 bull trout observed >12 inches). In 2018, the mean redd area (m<sup>2</sup>) for Big Sheep was 0.33, 60-percent were resident size, and 40-percent were fluvial size. In 2018, a resident upper reach was added to the survey, which skews the redd sizes to resident, due to highest abundance in this reach.

In 2018, Upper Imnaha and South Fork Imnaha had redds sizes with a fluvial dominance, 1.1 and 1.0 mean redd area (m<sup>2</sup>), respectively. From 2004 through 2012, and

2014 through 2017, the Upper Imnaha and South Fork Imnaha contained a majority of fluvial redds. The Upper Imnaha was essentially not surveyed in 2013 and South Fork Imnaha data was largely fluvial and sizes similar to 2012. In 2018, North Fork Imnaha had a redd size reflecting fluvial/resident dominance, 0.43 mean redd area (m<sup>2</sup>), 60-percent fluvial and 40-percent resident. Comparing 14 years of data on North Fork Imnaha from 2004 through 2012, and 2014 through 2018, approximately 43-percent (6 out of 14 years) the redds have been fluvial/resident size dominant, 28.5-percent (4 out of 14 years) the redds have been resident size dominant, and approximately 28.5-percent (4 out of 14 years) the redds have been fluvial size dominant.

Cliff Creek is a known resident system due to a waterfall near the mouth. In 2014, the mean redd area (m<sup>2</sup>) for Cliff Creek was 0.3 (resident). In 2015, only two redds were measured below the falls with a mean redd area of 0.4 m<sup>2</sup>. The survey on Cliff Creek in 2004 included a large fluvial size redd near the confluence with the South Fork Imnaha; therefore, the mean redd size was higher than in 2005 and 2006, when no fluvial redds were observed in Cliff Creek below the waterfall. 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, all redds were measured below the falls, but not all of the redds were measured above the falls (31 of 52 total redds, 59.6%). 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, complete 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 through 2017, only redds below the falls were measured (n=2) and in 2015 they were resident size, one redd was occupied by a resident size bull trout, 6 to 12 inches in length. In 2016 -2018 no redds were documented below the falls. Cliff Creek had several redds that were still in progress at the time of the 2012 survey and in 2017, 100-percent of redds in Cliff Creek were unoccupied (older redds), personal communication with Ryan Rumelhart, NPT, 2017. In 2018, 85-percent of the redds documented at Cliff Creek were unoccupied. Refer to Tables 4a and 4b in Appendix B for additional information on 2018 bull trout redd characteristics.

### **Bull Trout Redd Distribution on the Lostine River**

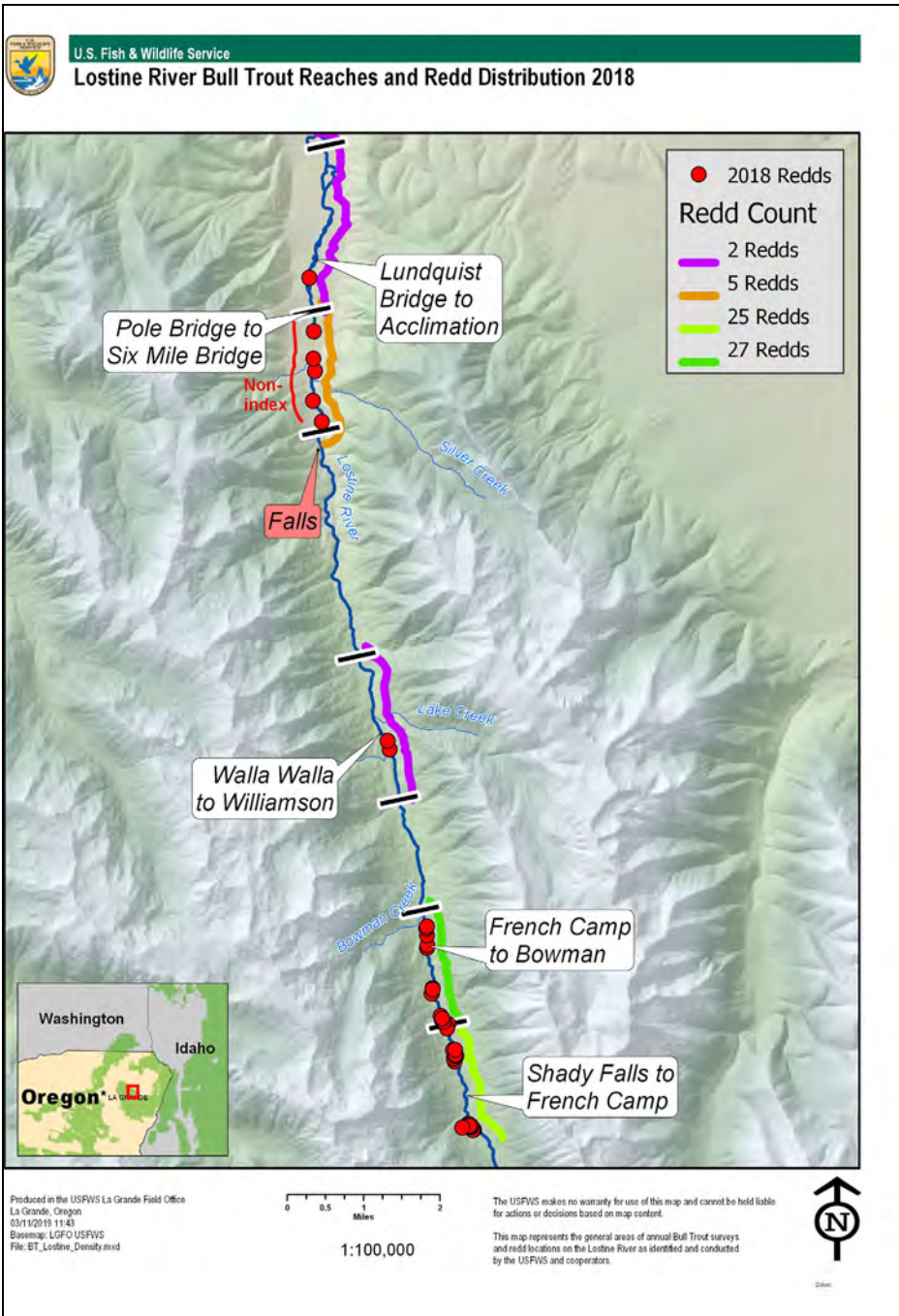
The bull trout spawning surveys on the Lostine River from 2005 through 2018 included collection of UTM coordinate data on the spatial distribution of the bull trout redds observed. Bull trout redds on the Lostine River, as well as in other surveyed streams, were often arranged in complexes (several redds located in close proximity to each other). In 2005, 2006, 2007, 2010, and 2011 through 2016, redds were primarily located in the French Camp to Shady Falls and Bowman to French Camp reaches along the Lostine River and approximately 10 miles downstream of these reaches at the Six Mile Bridge to Pole Bridge reach (except in 2015 and 2017). High site fidelity is documented by the overlapping of bull trout redds from 2005 through 2018, especially in the upper reaches of the Lostine River. In 2017, redd distribution was distributed in the upper two reaches, French Camp to Shady and Bowman to French Camp. In 2003, 2008, 2009, and



2015, a range of 6 to 13 redds were documented in the Williamson to Walla Walla Reach, in other years the range was 0 to 3 redds. In 2008, redd numbers had slightly less abundance, as compared to 2017, but an expanded distribution on the Lostine River. In 2018, redds were widely distributed (similar to 2008) but with a greater abundance. In 2018, 25 redds (41%) were observed in the French Camp to Shady reach and 27 redds (44%) in the Bowman to French Camp reach, 2 redds (3%) in the Walla Walla to Williamson reach, 5 redds (8%) in the Pole Bridge to 6 mile Bridge reach, and 2 redds (3%) in the Lundquist bridge to OC Ranch reach.

Sections of the Lostine River were not surveyed during the survey period of years (1999-2018) due to insufficient spawning gravels, boulder and cobble being the dominant substrate, and/or difficult access. These non-surveyed areas included Bowman to Walla Walla (approximately 2.2 miles) and Williamson to Pole Bridge (approximately 3.5 miles). Additionally, 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.

The size and distribution of bounded alluvial valley segments on the landscape influence the distribution and abundance of bull trout spawning. Baxter and Hauer (2000, pg. 1475), report that in northwestern Montana spawning tributary streams, the abundance of bull trout redds increased with increased area of alluvial valley segments that were longitudinally confined by geomorphic knickpoints. These bounded alluvial valley segments possessed complex patterns of hyporheic exchange and extensive upwelling zones. Bull trout used stream reaches for spawning that were strongly influenced by upwelling. However, within these reaches, bull trout redds were primarily located in transitional bedforms that possessed strong localized downwelling and high intragravel flow rates. These patterns may be occurring in the Lostine River and other surveyed streams.



**Figure 10. Map of the Lostine River showing bull trout redd survey reaches and bull trout redd locations in 2018.**

Figure 11 shows survey reaches and redd locations for Bear Creek and Goat Creek in 2018. Highest abundance and distribution was primarily found in Goat Creek and Bear Creek from Goat Creek to the wilderness boundary. In 2018, there was a similar pattern with locations and densities of redds compared to 2017, but in 2018, the Trail Bridge to Road bridge upstream of Little Bear was surveyed with two redds documented. The reach between the wilderness boundary and the trail bridge was not surveyed in most years due to difficult access. This three mile boulder dominant confined reach was surveyed in 2007. Only one redd was located in this reach; therefore, future survey of this reach for bull trout was not deemed practical due to low redd density and access issues.

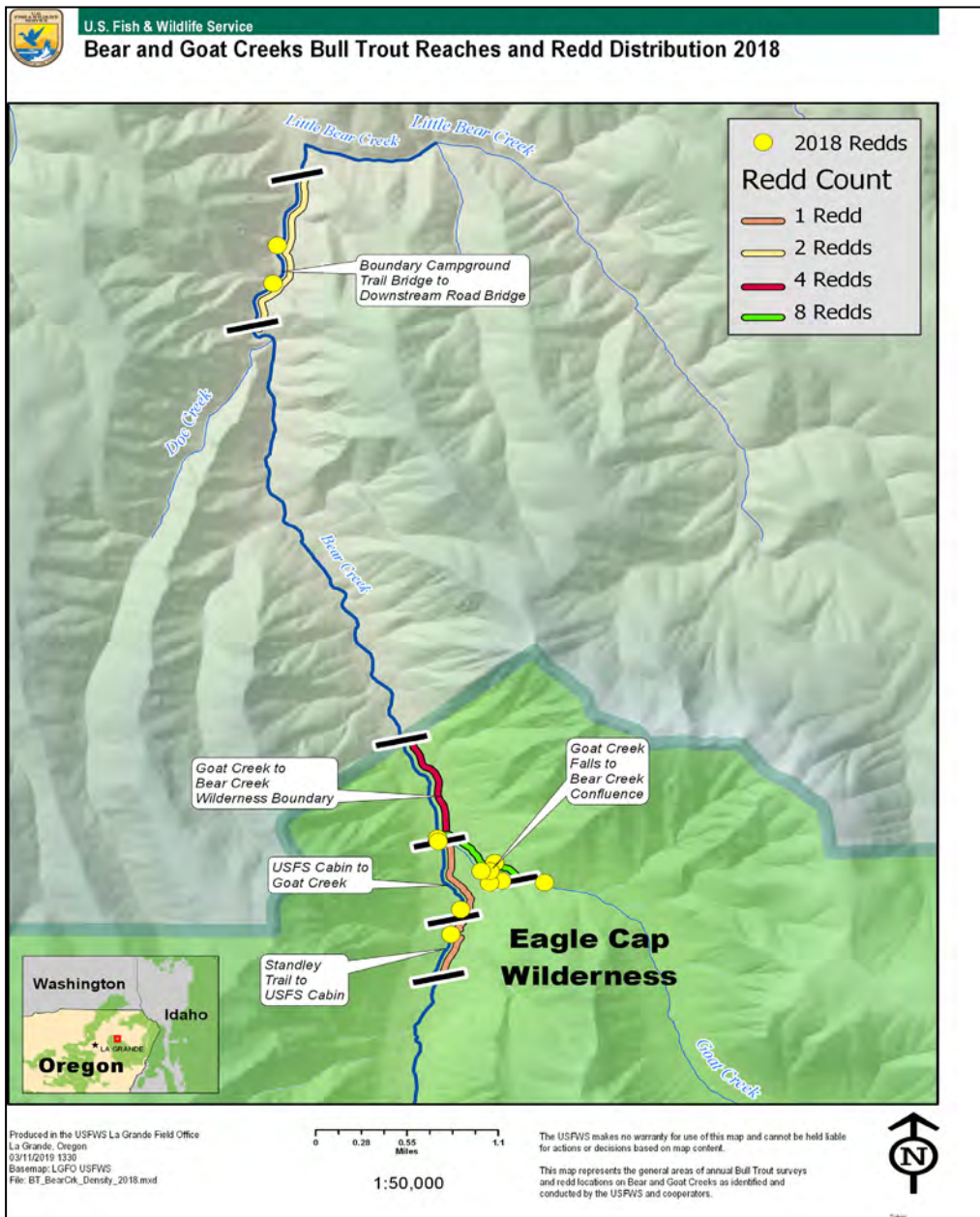
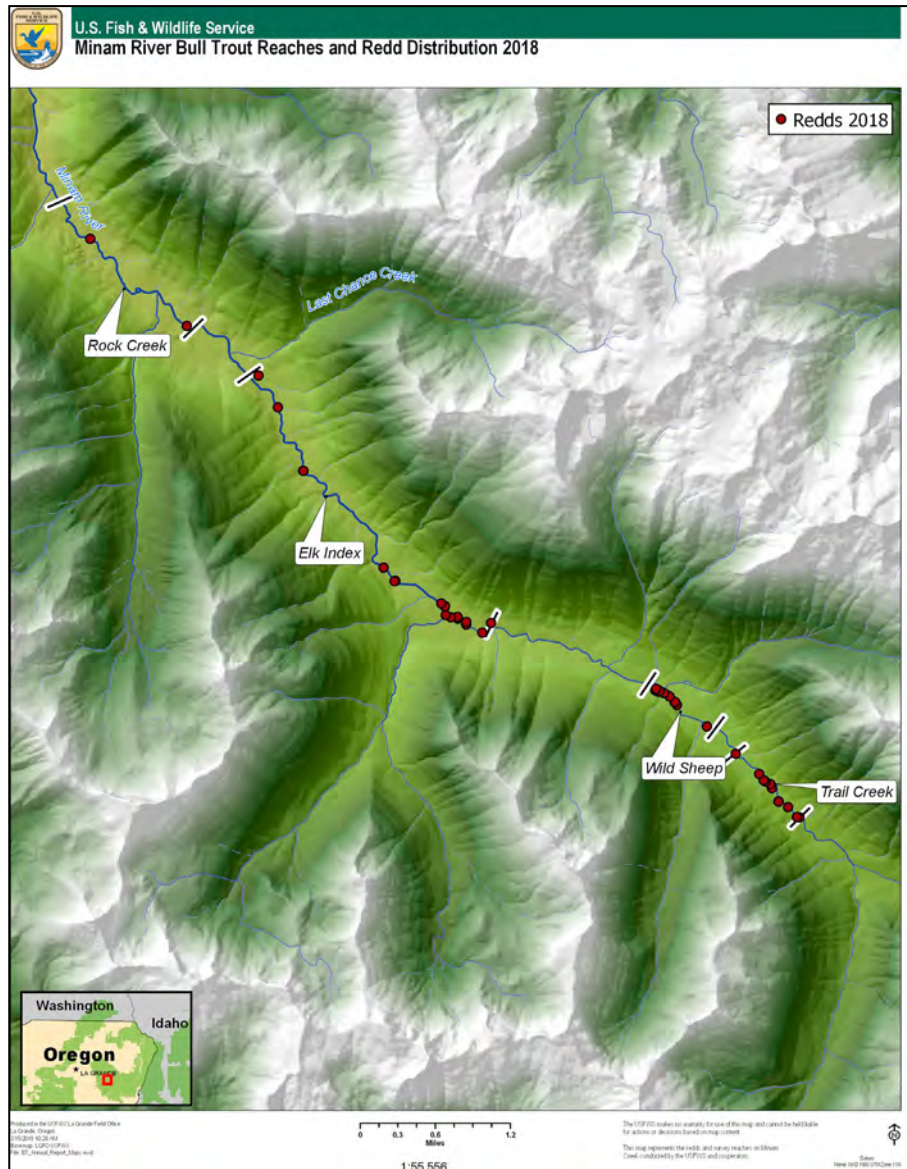


Figure 11. Map of Bear Creek and tributary stream Goat Creek showing bull trout redd survey reaches and bull trout redd locations in 2018.

## *Bull Trout Redd Distribution on the Minam and Wenaha Rivers*

### *Minam River*

For the Upper Minam River survey reaches included; Minam River –Trail Creek, Minam River – Wild Sheep, Minam River-Elk Creek Index, and Minam River-Rock Creek. The highest redd densities (redds per mile) were found in 1) Minam-Wild Sheep with 16.2 redds/mile, 2) Minam River-Trail Creek with 11.3 redds/mile, 3) Minam-Elk Creek index, 4.9 redds/mile, and 4) Rock creek with 1.1 redds/mile, refer to Appendix B, table 3a. Based on the distribution of redds, it appears that the majority of the bull trout spawning is occurring on the Minam River, upstream of the mouth of Last Chance Creek (RM 37.25) (A. Miller, USFS, pers.com. 2018). Refer to Figure 12.



**Figure 12.** Map of Minam River showing bull trout redd survey reaches and bull trout redd locations in 2018.

## Wenaha River

For the Upper Wenaha surveys were conducted on NF Wenaha, SF Wenaha, Milk Creek, and the Wenaha. The highest redd densities were found in 1) the NF Wenaha, 151 redds for 9.5 miles of survey, or 15.9 redds/mile, 2) the SF Wenaha, 120 redds for 7.6 miles or 15.8 redds/mile, 3) Milk Creek, 11 redds for 1.0 miles or 10.1 redds/mile, and 4) the Wenaha River 10 redds for 4.3 miles or 2.3 redds/mile. Refer to Appendix B, table 3a and Figure 13a and 13b.

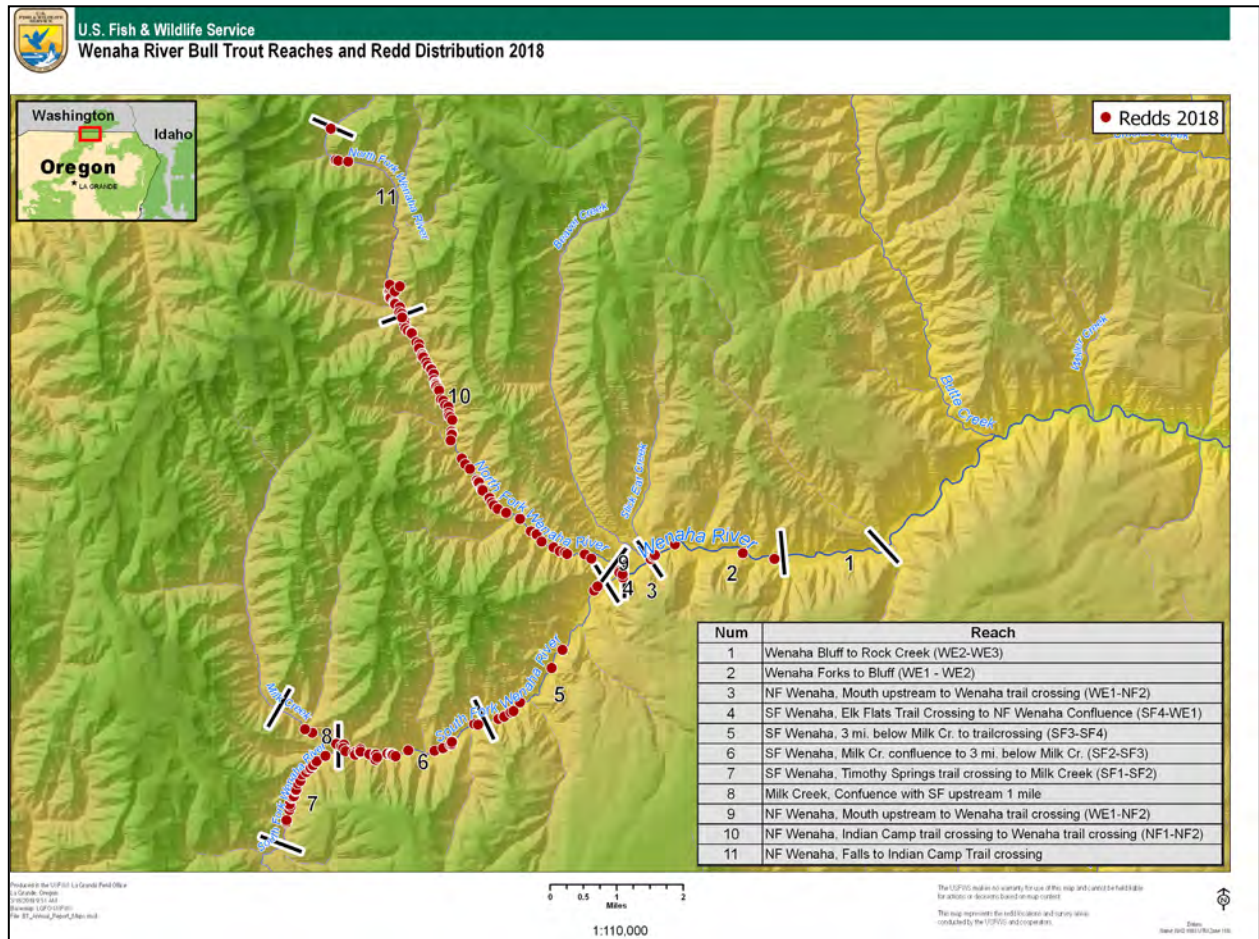
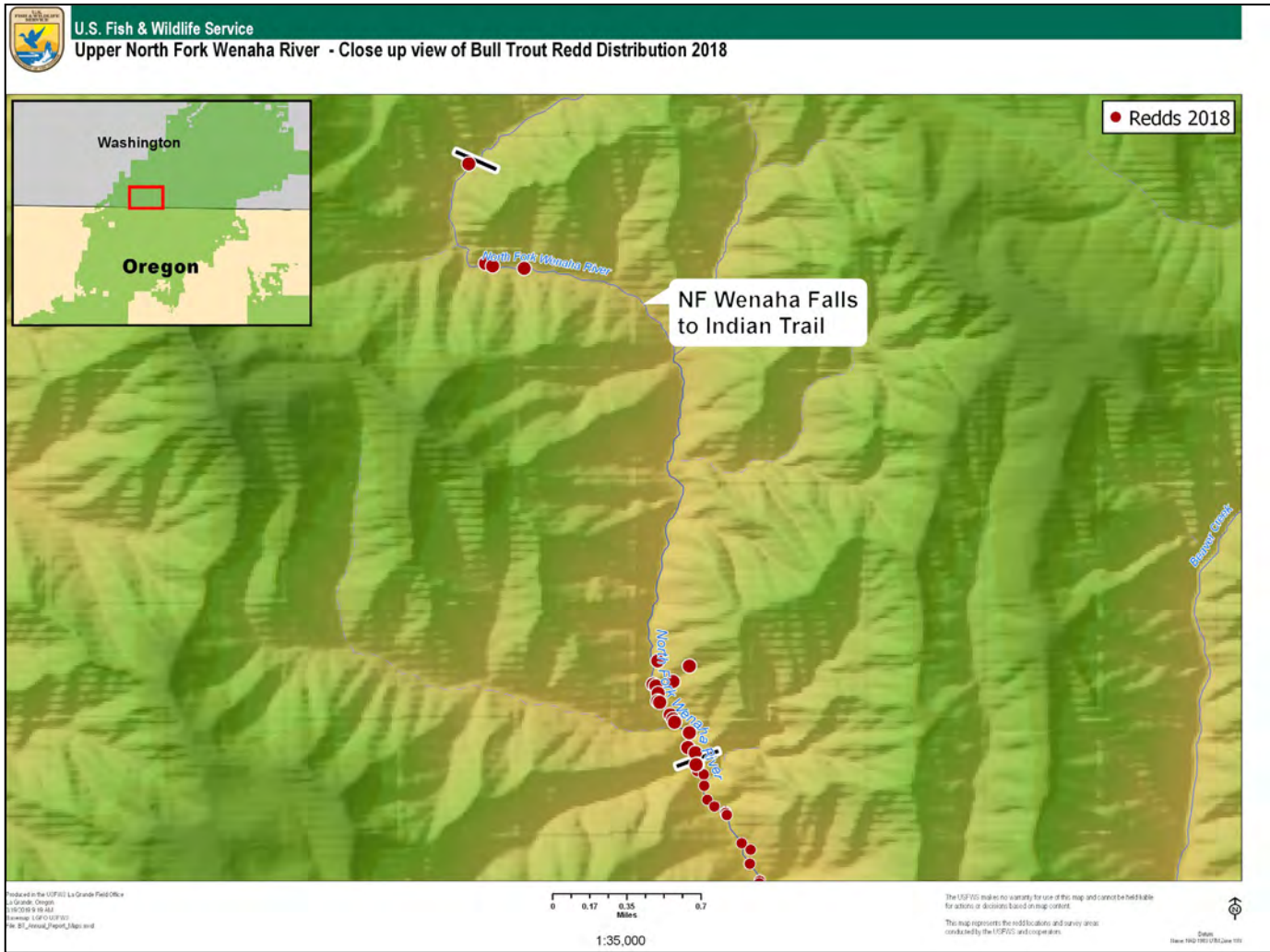


Figure 13a. Map of Wenaha River showing reaches surveyed in 2018 and bull trout redds.

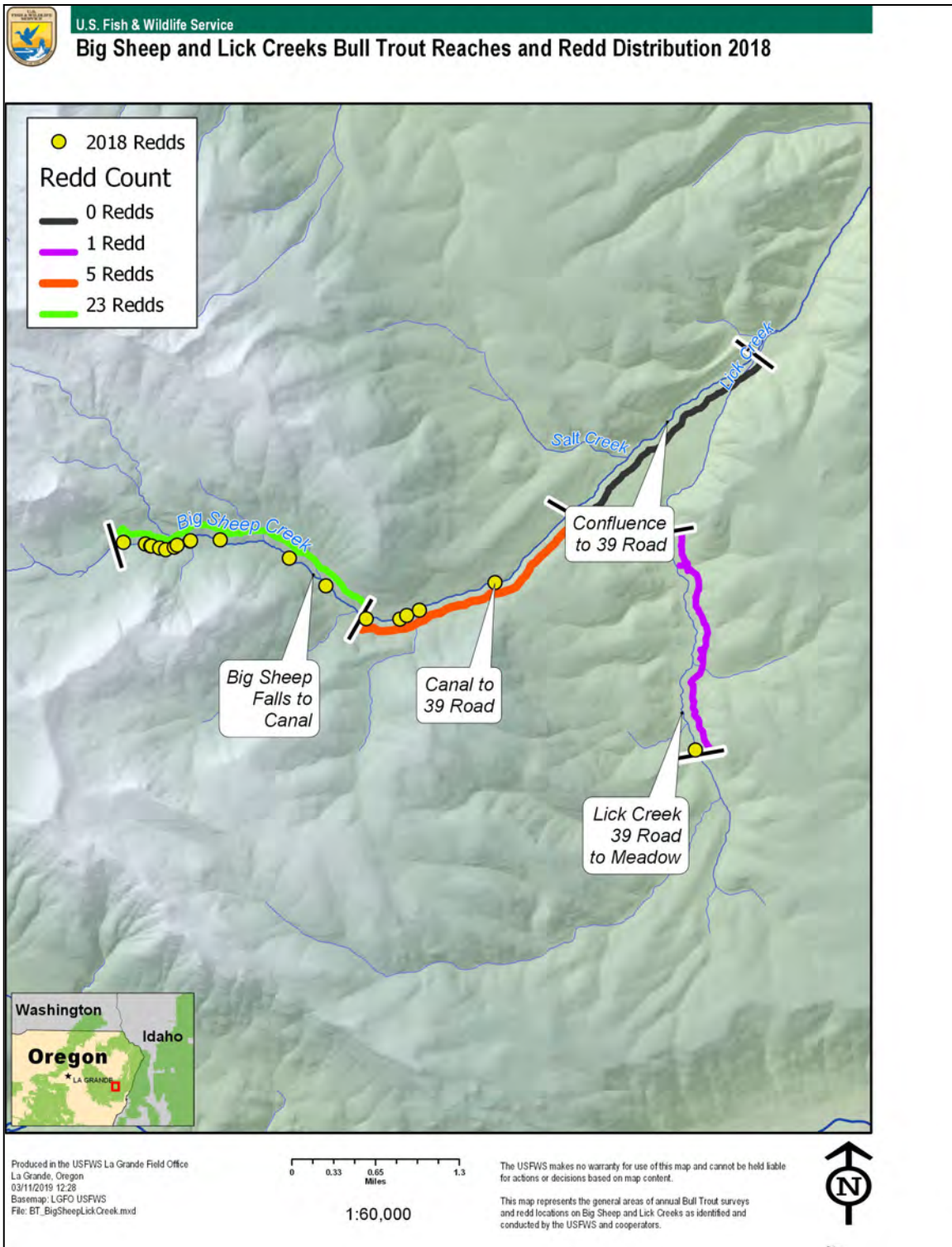


**Figure 13b. Map of upper North Fork Wenaha River (close-up view) showing majority of redds in the lower reach and a few redds in the upper reach.**

### ***Bull Trout Redd Distribution on Big Sheep Creek and the Imnaha River***

Refer to Figure 14, a map of reach and redd locations for Big Sheep and Lick Creeks in 2018. Big Sheep Creek is resident above the diversion and resident/fluvial below the diversion. Lick Creek is resident in the upper reach and fluvial/resident in the lower reach. In 2018, Big Sheep Creek survey reaches were expanded from 2017 and past comparable years, from one reach in 2000 -2017, to three reaches in 2018. In 2018, surveys were conducted: 1) falls to above the canal (resident population); 2) below the canal to the 39 road; and 3) from the 39 Road to Lick Creek (reaches 2 and 3 are fluvial/resident). In 2018, a one-time mid-season survey was conducted on the lower reach of Lick Creek. In 2018, the highest redd densities in Big Sheep were found in 1) falls to above the canal, 22 redds for 1.9 miles of survey or 11.6 redds/mile, 2) below the canal to the 39 road, 5 redds for 1.9 miles of survey, or 2.6 redds/mile, and no redds were found in the lowest reach of Big Sheep Creek (which has very limited spawning habitat).

Figure 15 displays reach and redd densities in 2018 for the Imnaha River and Upper Imnaha tributaries. GPS redd locations are taken for the road/trail accessible reach, the Blue Hole to Indian Crossing two mile reach, and in 2018 also included the Upper Imnaha reaches. Cliff Creek, a resident bull trout stream has the highest abundance, 60 redds for 2.5 miles of stream. The remaining Imnaha reaches contain fluvial/resident bull trout. In 2018, distribution was similar to 2017 and abundance was greater in 2018. In 2018, redd densities were highest in 1) Cliff Creek (a resident stream) with 59 redds in 2.5 miles or 23.6 redds/mile, and 2) Upper Imnaha a fluvial/resident stream with 44 redds in 3.3 miles or 13.3 redds/mile, and 3) SF Imnaha a fluvial/resident stream with 35 redds in 4.6 miles or 7.6 miles of stream, and 4) NF Imnaha fluvial/resident with 20 redds in 7.0 miles of stream.



**Figure 12. Map of Big Sheep Creek and Lick Creek showing bull trout redd survey reaches and trout redd locations in 2018. In 2018, Big Sheep had additional survey reaches compared to past years. Lick Creek had limited survey effort in 2018 due to increased effort on Big Sheep Creek.**



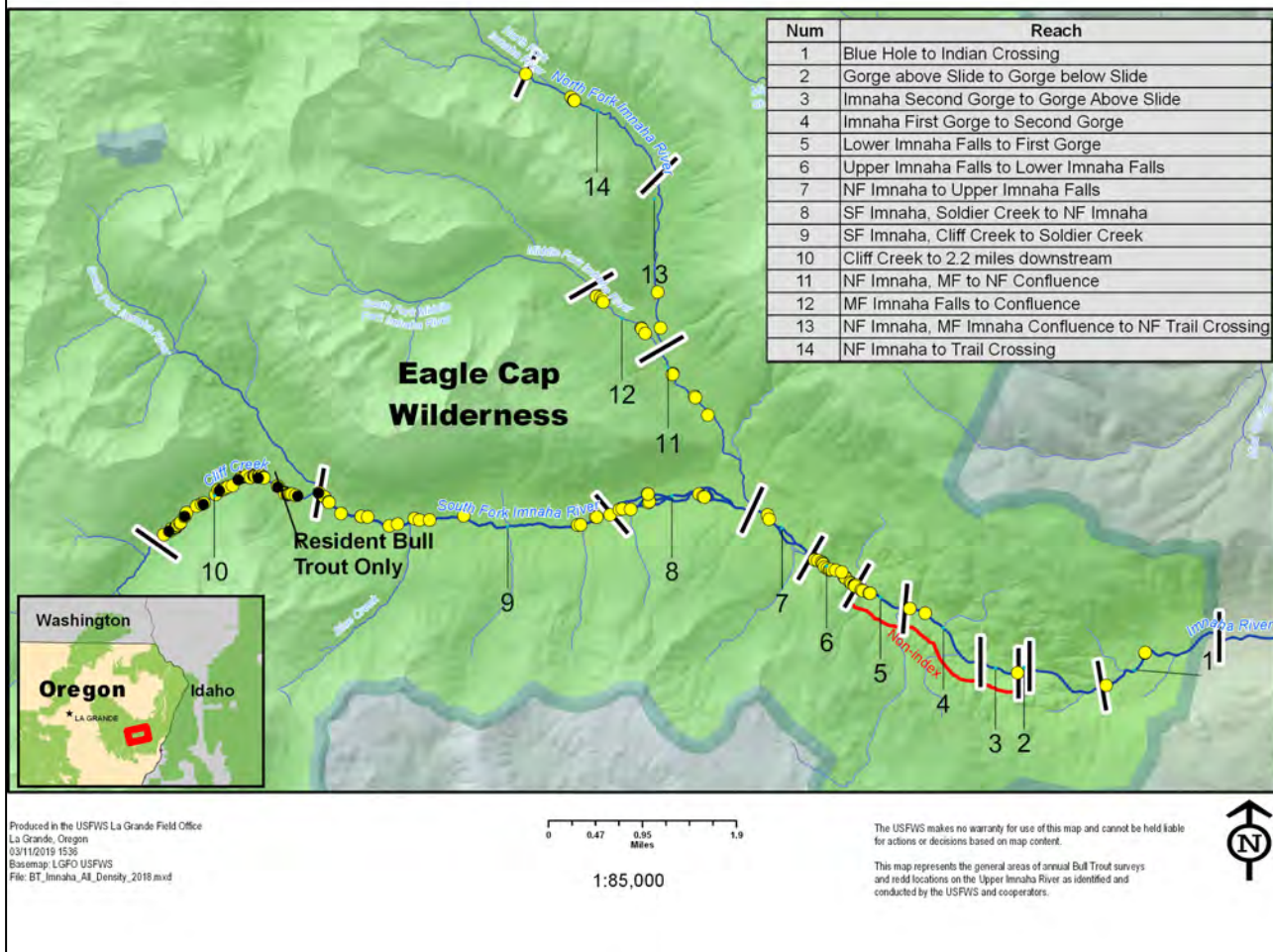


Figure 13. Map of the Upper Imnaha River showing bull trout redd survey reaches and bull trout redds in 2018. Cliff Creek is a resident bull trout stream (due to waterfall near mouth) and the other reaches contain fluvial/resident bull trout.

## DISCUSSION

### *Future Needs*

Bull trout redd monitoring in the Wallowa Mountains was accomplished from 1999 to 2018 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 pg. 11; Dunham et al. 2001, pg.350) 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.

To date, we have comparable bull trout redd data; 20 years completed on Lostine River and Bear Creek; 19 years completed on Big Sheep Creek; and 18 years completed on the Imnaha River. The Service and partners support continuing to build on the existing long-term 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 Service's 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).

Future needs for this project or similar projects include continued funding from the Service using recovery dollars, potential OWEB funding, and support from all involved parties (Service, Nez Perce Tribe, the Oregon Department of Fish and Wildlife, U.S. Forest Service, private land owners, volunteers, and others) for conducting and reporting bull trout redd counts in the Wallowa Mountains.

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 a demographic monitoring strategy in the upper Grande Ronde, Little Minam, Wallowa/Minam, and Imnaha Core Areas with the help of Phil Howell and others working on the Demographic Monitoring Strategy for Bull Trout Core Areas in Northeastern Oregon and portions of Southeastern Washington (Howell et al 2018).

#### ***Other Riparian/Wetland Dependent Species***

The Upper Imnaha survey includes many spring/wetland areas and several of these bisect the trail. At these areas, we observed much beaver (*Castor canadensis*) activity as seen in the photo below. The beavers are very persistent, the author was told that in 2016, the trail crew had drained this beaver pond, and the beavers soon after, had remade the pond (photo below). Beavers were also present in the Wenaha River surveys as reported by Terry Reynolds, surveying in the North Fork Wenaha River (photo below).

In a wetland area near the Imnaha trail, not far from where the beaver pond photo was taken, an adult western toad (*Anaxyrus boreas*) hides from the author in the nearby vegetation (see photo next page). In 2016, in the South Fork Imnaha River, a river otter (*Luntra canadensis*) was documented by Lynne Price with the NPT and again in 2017, by the author. The author has observed river otters near the Imnaha weir in past years, but was surprised to hear and observe for herself that they were this high up in the Upper Imnaha River system.



**Beaver pond across Imnaha trail, 2016**



**Beaver pond on the Upper North Fork Wenaha River Survey, 2018  
Photo taken by Terry Reynolds**



**Adult western toad hiding from author near Innaha trail, 2016  
(the author observed this same size adult western toad in  
the same location in 2017)!**

## **CONCLUSION**

The local bull trout population, in Big Sheep and Lick Creeks appear to be relatively stable, with a possible decline for the survey period (2000-2018). There was an increase in redd numbers in Big Sheep in 2011-2014, and a decrease in redd numbers in 2015-2018. Redd numbers were the lowest in 2017, no redds were observed on Big Sheep Creek in 2017. In 2018, the reach upstream of the WVIC (resident population) was surveyed and there was twenty-two redds, or 84.6 %, reported in this reach of Big Sheep Creek. This additional survey reach increased the total redd numbers but was not significant for the total redds/mile compared to past years surveys. On Lick Creek, there was an increase in redd numbers in years 2011-2012, 2014, and a decrease in years 2013, 2015-2017. In 2018, a limited survey occurred at Lick Creek, which is not comparable to past years. There was an increase in redd numbers on the Innaha River, the Lostine River, and Bear/Goat Creek in 2017 and 2018 compared to 2016. The increases were not significant for the Innaha, the redd numbers were still low compared to 2014 and previous years. However, the increases were significant for the Lostine River and Bear/Goat Creeks.

The Wenaha system is known to contain a healthy bull trout population. Previous to 2018, there has been limited spawning data collected on the Wenaha, due to its remoteness. In 2018, the Wenaha surveys documented 294 redds in 22.4 total miles surveyed, or 13.1 redds/mile.

The Minam River is another remote tributary stream within the Grande Ronde system, where there has been limited bull trout data collection. In 2018, Minam surveys documented 41 redds for 6.9 miles of survey, or 5.9 redds per mile.

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, remains connected 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. 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. Hudson et al. 2017 reported that multiple pit-tagged bull trout individuals from Big Sheep Creek and Lick Creek were detected moving downstream as far as near the mouth of the Imnaha River. Big Sheep and Little Sheep have some issues with flows, fish passage, and connectivity and loss of fish due to the Wallowa Valley Improvement 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). Hudson et al. 2017 state that the data collected in their project suggests that the WVIC diversion structures may impede direct connectivity of these populations with the Imnaha River. For example, of the 85 fish from Big Sheep Creek detected moving downstream, 26 (31%) were detected moving down the canal. These fish, in addition to others tagged at Salt Creek Summit, Little Sheep Creek, Canal Creek, and Redmont Creek, were not detected moving downstream in Little Sheep Creek. Therefore, the operation of the WVIC diversion structure in Big Sheep Creek may be limiting and the diversion structure in Little Sheep Creek may be limiting/preventing downstream movement of bull trout to the Imnaha River. They also state that this may further suggest limitations to upstream movement. Hudson et al. 2017 state that providing connectivity among bull trout populations will likely ensure their persistence when faced with stochastic events that impact one or more of these populations (e.g. low water year, wildfire).

The Lostine River was considered a moderately-strong population within the Grande Ronde Subbasin (Buchanan et al. 1997). Redd numbers have increased in these locations in 2018 and 2017 (61, 52 and 15) compared to 2016. 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. 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 through 2018, but no underwater photos were taken during this time. 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.



**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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**APPENDIX A – PHOTOS TAKEN AT SURVEY LOCATIONS**



**NF Wenaha River Falls, 2018  
Photo taken by Terry Reynolds, USFS**



**Minam River crew, 2018  
In photo, From left to right; Jim Soupir, Russ Westlake,  
Lynne Price, Alan Miller, John Hollenbeak, and Lora Tennant**



**Ryan Rumelhart, near bull trout redd, below Imnaha Falls  
Shane Vatland, taking photo, 2018**



**Bear Creek survey crew 2017  
From left to right, Aaron Maxwell, Tyler Stright, Ryan Rumelhart, and author**

**APPENDIX B – TABLES**

**Table 1 – Bull Trout Spawning Surveys and Survey Frequencies for selected Grande Ronde River and Imnaha River Streams, 1999-2018**

<b>Stream</b>	<b>Year</b>	<b>Dates</b>	<b>Survey Frequency</b>	<b>Total Redds</b>	<b>Total Miles</b>	<b>Total Redds/Mile</b>
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
	2016	9/19, Oct 6	Twice	33	10.1	3.3
	2017	9/28, Oct 4-5	Twice	52	10.1	5.2
	2018	9/18, 10/10,10/12	Twice	61	10.1	6.1

<b>Stream</b>	<b>Year</b>	<b>Dates</b>	<b>Survey Frequency</b>	<b>Total Redds</b>	<b>Total Miles</b>	<b>Total Redds/Mile</b>
Bear Creek (including Goat Creek)	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
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
	2016	9/23, 10/10	Twice	6	4.2	1.4
	2017	9/24, 10/10	Twice	15	3.2	4.7
	2018	9/19, 10/11	Twice	16	4.2	3.8
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
	2016	9/21, 10/3	Twice	2	0.8	2.5
	2017	9/21, 10/3	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
<b>Stream</b>	<b>Year</b>	<b>Dates</b>	<b>Survey</b>	<b>Total</b>	<b>Total</b>	<b>Total</b>

			Frequency	Redds	Miles	Redds/Mile
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	2000	9/20,22,25,26,27,10/11	Upper = Once, Middle = Twice	92	29.1	3.2
Big Sheep)	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 Hole	2003	9/25-26,9/29-30,10/1,10/8-9	Upper = Once, Middle = Twice	291	31.3	9.3
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

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	203	19.4	10.5
	2016	9/26-28, 9/29, 10/12	Upper = Once, Middle = Twice	125	19.4	6.4
	2017	9/25-9/27, 10/11	Upper = Once, Middle = Twice	152	19.4	7.8
	2018	9/20, 9/24-9/26, 10/3	Upper = Once, Middle = Twice	161	19.4	8.3
Big Sheep [(including Lick, and Salt).	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
Salt Cr. not surveyed post 2003,	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
<b>Stream</b>	<b>Year</b>	<b>Dates</b>	<b>Survey Frequency</b>	<b>Total Redds</b>	<b>Total Miles</b>	<b>Total Redds/Mile</b>



and Upper Big	2004	9/20,9/28-9/29,9/30,10/4,10/19	Once Big Sheep, Twice Lick	43	14.1	3.0
Sheep exploratory in 2004].	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 meadow	30	9.1	3.3
	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
	2016	9/20, 10/11	Twice	12	7.6	1.6
	2017	10/3	Once	5	7.6	0.7
	2018	9/16, 9/17, 9/19, 10/4, 10/8	Twice	28	9.6	2.9

**Table 2a–Bull Trout Spawning Surveys for the Lostine River Comparing 1999 to 2018 Surveys**

<b>Lostine</b>	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18
<b>Reaches (miles surveyed)</b>																				
Lundquist Bridge to OC Ranch (2.8)	1	0	2	3	3	5	0	5	4	5	0	1	1	1	1	1	0	0	0	2
Williamson to Walla Walla (2.2 miles)	0	2	1	0	6	1	3	0	2	13	8	2	0	3	1	7	2	0	0	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	17	25	23
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	15	27	25
<b>Lostine Total Redds (Comparable Reaches)</b>	<b>39</b>	<b>33</b>	<b>42</b>	<b>22</b>	<b>70</b>	<b>26</b>	<b>24</b>	<b>36</b>	<b>42</b>	<b>50</b>	<b>38</b>	<b>30</b>	<b>19</b>	<b>50</b>	<b>39</b>	<b>43</b>	<b>28</b>	<b>32</b>	<b>52</b>	<b>52</b>
<b>Lostine Total Miles of Comparable Stream</b>	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	8.1	8.1	8.1
<b>Lostine Redds/Mile Comparable Stream</b>	<b>4.6</b>	<b>3.9</b>	<b>4.9</b>	<b>2.6</b>	<b>8.2</b>	<b>3.1</b>	<b>2.8</b>	<b>4.2</b>	<b>5.2</b>	<b>6.2</b>	<b>4.7</b>	<b>3.7</b>	<b>2.3</b>	<b>6.2</b>	<b>4.8</b>	<b>5.3</b>	<b>3.5</b>	<b>4.0</b>	<b>6.4</b>	<b>6.4</b>
<b>Total Redds For Year</b>	39	38	43	22	71	26	32	45	47	53	41	36	22	52	40	44	28	33	52	57
<b>Total Miles Surveyed For Year</b>	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	10.1	10.1	10.1
<b>Total Redds/Mile For Year</b>	<b>4.0</b>	<b>2.8</b>	<b>3.0</b>	<b>2.1</b>	<b>6.8</b>	<b>3.1</b>	<b>3.0</b>	<b>4.3</b>	<b>4.6</b>	<b>5.2</b>	<b>4.1</b>	<b>3.6</b>	<b>2.2</b>	<b>5.2</b>	<b>4.0</b>	<b>4.4</b>	<b>2.8</b>	<b>3.3</b>	<b>5.1</b>	<b>5.6</b>

Notes: The Lostine was surveyed three times in 1999 and 2000. Survey years 2001-2018, 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. The Lostine River Ranch (OC Ranch) has been surveyed once (October) in recent years due to lack of access to this private land during hunting season. Pole Bridge to 6 Mile Bridge (included in the total redd numbers and total miles) was surveyed once in 2018. 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 – 2018 Surveys**

<b>Stream</b>																				
<b>Bear Creek</b>	<b>99</b>	<b>00</b>	<b>01</b>	<b>02</b>	<b>03</b>	<b>04</b>	<b>05</b>	<b>06</b>	<b>07</b>	<b>08</b>	<b>09</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>	<b>17</b>	<b>18</b>
<b>Reaches (miles surveyed)</b>																				
Bear: Goat Confluence to Wilderness Boundary (1mile)	0	2	3	1	2	3	5	0	1	6	1	1	4	3	0	2	0	1	5	4
Goat Creek: Mouth to Falls (0.9)	8	3	9	6	9	8	6	9	7	4	5	6	15	12	15	12	2	3	9	8
<b>Bear (and Goat) Total Redds (Comparable Reaches)</b>	<b>8</b>	<b>5</b>	<b>12</b>	<b>7</b>	<b>11</b>	<b>11</b>	<b>11</b>	<b>9</b>	<b>8</b>	<b>10</b>	<b>6</b>	<b>7</b>	<b>19</b>	<b>15</b>	<b>15</b>	<b>14</b>	<b>2</b>	<b>4</b>	<b>14</b>	<b>12</b>
<b>Bear Creek Total Miles of Comparable Stream</b>	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	1.9	1.9	1.9
<b>Bear Creek Redds/Mile Comparable Stream</b>	<b>4.2</b>	<b>2.6</b>	<b>6.3</b>	<b>3.7</b>	<b>5.8</b>	<b>5.8</b>	<b>5.8</b>	<b>4.7</b>	<b>4.2</b>	<b>5.3</b>	<b>3.2</b>	<b>3.2</b>	<b>10</b>	<b>7.9</b>	<b>7.9</b>	<b>7.4</b>	<b>1.0</b>	<b>2.1</b>	<b>7.4</b>	<b>6.3</b>
<b>Total Redds For Year</b>	8	5	12	7	17	12	16	9	11	20	8	7	19	15	16	17	5	6	15	16
<b>Total Miles Surveyed For Year</b>	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	4.2	3.2	4.2
<b>Total Redds/Mile For Year</b>	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	1.4	4.7	5.0

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, and 2017, 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 and 2016, and 2018, the surveys were conducted similar to years 2008-2014 and 2017, but with a one mile reach added.

**Table 2c – Bull Trout Spawning Surveys for the Imnaha River, Comparing 2001 – 2018 Surveys**

<b>Imnaha River</b>	<b>'01</b>	<b>'02</b>	<b>'03</b>	<b>'04</b>	<b>'05</b>	<b>'06</b>	<b>'07</b>	<b>'08</b>	<b>'09</b>	<b>'10</b>	<b>'11</b>	<b>'12</b>	<b>'13</b>	<b>'14</b>	<b>'15</b>	<b>'16</b>	<b>17</b>	<b>18</b>
<b>Reaches (miles surveyed)</b>																		
<b>South Fork Imnaha and tributaries:</b>																		
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	54	60	59
South Fork Imnaha, NF to Soldier (1.5 miles)	6	7	14	12	44	9	30	6	7	2	10	28	NS	9	18	11	11	18
South Fork Imnaha, Soldier to Cliff (3.1 miles)	33	18	37	29	55	26	37	15	8	27	13	54	41	27	40	17	21	17
<b>North Fork Imnaha:</b>																		
North Fork, above Middle Fork (4.1 miles)	49	18	40	68	39	18	30	17	2	4	6	9	5	25	37	9	13	5
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	3	5	5
Middle Fork, mouth to falls (0.8 miles)	12	0	12	6	24	7	17	8	7	5	2	3	3	4	11	4	10	10
<b>Imnaha River:</b>																		
Imnaha River, NF to Falls (0.6 miles)	0	3	5	1	2	3	2	1	0	0	0	6	0	0	2	2	1	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	3	6	13
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	5	11	3
<b>Imnaha Total Redds (Comparable Reaches)</b>	<b>247</b>	<b>101</b>	<b>224</b>	<b>233</b>	<b>261</b>	<b>141</b>	<b>262</b>	<b>144</b>	<b>206</b>	<b>110</b>	<b>113</b>	<b>201</b>	<b>n/a*</b>	<b>177</b>	<b>179</b>	<b>108</b>	<b>138</b>	<b>132</b>

<b>Innaha Total Miles of Comparable Stream</b>	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	n/a	17.5	17.5	17.5	17.5	17.5
<b>Innaha Redds/Mile Comparable Stream</b>	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	6.2	7.9	7.5
<b>Total Redds For Year</b>	269	103	293	286	276	186	284	184	235	133	160	240	68	199	203	125	153	161
<b>Total Miles Surveyed For Year</b>	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	19.4	19.4	19.4
<b>Total Redds/Mile For Year</b>	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	6.4	7.9	8.3

Notes: All reaches except Blue Hole to Indian Crossing were surveyed once in years 2001-2018. The Blue Hole to Indian Crossing was surveyed twice in September and October from 2001-2018, 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. Innaha 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 Innaha 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 – 2018 Surveys**

Stream	Survey Years																		
	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
<b>Big Sheep Creek (including Lick Creek)</b>																			
	<b>Redds Surveyed</b>																		
<b>Reaches (miles surveyed)</b>																			
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	9	0	5
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	0	0	1
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	3	5	N/A
<b>Big Sheep Total Redds (Comparable Reaches)</b>	<b>10</b>	<b>17</b>	<b>34</b>	<b>10</b>	<b>8</b>	<b>9</b>	<b>18</b>	<b>27</b>	<b>22</b>	<b>20</b>	<b>20</b>	<b>38</b>	<b>30</b>	<b>22</b>	<b>25</b>	<b>11</b>	<b>12</b>	<b>5</b>	<b>6</b>
<b>Big Sheep Creek Total Miles of Comparable Stream</b>	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	7.6	7.6	3.4
<b>Big Sheep Creek Redds/Mile Comparable Stream</b>	<b>1.3</b>	<b>2.2</b>	<b>4.5</b>	<b>1.3</b>	<b>1.1</b>	<b>1.2</b>	<b>2.4</b>	<b>4.6</b>	<b>2.9</b>	<b>2.6</b>	<b>2.6</b>	<b>5</b>	<b>3.9</b>	<b>2.9</b>	<b>3.3</b>	<b>1.4</b>	<b>1.6</b>	<b>0.7</b>	<b>1.8</b>
<b>Total Redds For Year</b>	12	24	41	18	43	16	18	27	30	20	20	38	30	22	25	11	12	5	28
<b>Total Miles Surveyed For Year</b>	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	7.6	7.6	9.6
<b>Total Redds/Mile For Year</b>	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	1.6	0.7	2.9

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 2002-2016, except for Big Sheep which was surveyed once in 2004. In 2017, surveys were conducted once in October for both streams. In 2018, surveys were conducted once in September and once in October, except for Lick Creek which was only surveyed once in September and was limited to the lower reach.

**Bull Trout Spawning Surveys  
For Some Grande Ronde Tributaries, 2018  
USFWS, La Grande Field Office**

Grande Ronde Basin		Kilometers	Miles		Redds				Total	Bull Trout Observed (mm)			
Stream Reach, Section	Date(s)	Surveyed	Surveyed	Occ	Unocc	Total	Per km	Per Mile	But obs	<6"(150mm)	12" (~300mm)	<18"(450mm)	>18"(450mm)
<b>Bear Creek</b>													
Goat Cr (Mouth to Falls)	19-Sep	1.4	0.9	1.0	6.0	7.0	4.8	7.8	4.0	1.0	3.0	0.0	0.0
Goat Cr (Mouth to Falls)	11-Oct			0.0	1.0	1.0	0.7	0.8	2.0	2.0	0.0	0.0	0.0
Bear Creek (Standley Trail to USFS Cabin)	19-Sep	1.4	0.9	0.0	1.0	1.0	0.7	1.1	0.0	0.0	0.0	0.0	0.0
Bear Creek (Standley Trail to USFS Cabin)	11-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)	19-Sep	0.8	0.5	0.0	1.0	1.0	1.2	2.0	0.0	0.0	0.0	0.0	0.0
Bear Creek (USFS Cabin to Goat Creek)	11-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)	19-Sep	1.4	0.9	1.0	2.0	3.0	2.1	3.3	7.0	4.0	3.0	0.0	0.0
Bear Creek (Goat Creek to Wilderness Boundary)	11-Oct			0.0	1.0	1.0	0.7	0.8	4.0	3.0	1.0	0.0	0.0
Bear Creek (Trail Bridge to Rd Bridge Upstream of L.Bear)	11-Oct	1.6	1.0	0.0	2.0	2.0	1.3	2.0	0.0	0.0	0.0	0.0	0.0
<b>Bear Creek Total</b>		<b>5.1</b>	<b>4.2</b>	<b>2.0</b>	<b>14.0</b>	<b>16.0</b>	<b>3.1</b>	<b>3.8</b>	<b>17.0</b>	<b>10.0</b>	<b>7.0</b>	<b>0.0</b>	<b>0.0</b>
<b>Lostine River</b>													
Lundquist Bridge to OC Ranch	12-Oct	4.4	2.8	0.0	2.0	2.0	0.5	0.7	6.0	0.0	0.0	3.0	3.0
Pole Bridge to 6 Mile Bridge	12-Oct	3.2	2.0	0.0	5.0	5.0	1.6	2.5	0.0	0.0	0.0	0.0	0.0
Williamson to Walla Walla	18-Sep	3.5	2.2	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	1.0
Williamson to Walla Walla	10-Oct			0.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bowman to French Camp	18-Sep	2.6	1.6	5.0	11.0	16.0	6.2	10.0	13.0	0.0	1.0	7.0	5.0
Bowman to French Camp	10-Oct			0.0	11.0	11.0	4.2	6.9	1.0	0.0	0.0	0.0	1.0
French Camp to Shady Falls	18-Sep	2.4	1.5	2.0	12.0	14.0	5.8	9.3	15.0	0.0	6.0	5.0	4.0
French Camp to Shady Falls	10-Oct			1.0	10.0	11.0	4.6	7.3	2.0	0.0	2.0	0.0	0.0
<b>Lostine River Total</b>		<b>16.1</b>	<b>10.1</b>	<b>8.0</b>	<b>53.0</b>	<b>61.0</b>	<b>3.8</b>	<b>6.1</b>	<b>38.0</b>	<b>0.0</b>	<b>9.0</b>	<b>15.0</b>	<b>14.0</b>





Table 2b  
 Bull Trout Spawning Surveys  
 For the Imnaha River, 2018  
 USFWS, La Grande Field Office

Page 1 of 2

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)
<b>Upper Imnaha System</b>														
<b>South Fork Tributaries</b>														
Cliff Cr., mouth to 3.6 km*	25-Sep	4.0	2.5	9.0	50.0	59.0	14.8	23.6	33.0	10.0	23.0	0.0	0.0	
<b>South Fork Tributaries Total</b>		<b>4.0</b>	<b>2.5</b>	<b>9.0</b>	<b>50.0</b>	<b>59.0</b>	<b>0.0</b>	<b>23.6</b>	<b>33.0</b>	<b>10.0</b>	<b>23.0</b>	<b>0.0</b>	<b>0.0</b>	
<b>North Fork</b>														
Middle Fork., mouth to falls	25-Sep	1.3	0.8	1.0	9.0	10.0	7.7	12.4	1.0	0.0	1.0	0.0	0.0	
N. Fk., above M. Fk. (reach 3-7)	24-Sep	6.6	4.1	2.0	3.0	5.0	0.8	1.2	6.0	1.0	5.0	0.0	0.0	
N. Fk., below M. Fk. (reach 1-2)	25-Sep	3.4	2.1	1.0	4.0	5.0	1.5	2.4	3.0	0.0	0.0	2.0	1.0	
<b>North Fork Total</b>		<b>11.3</b>	<b>7.0</b>	<b>4.0</b>	<b>16.0</b>	<b>20.0</b>	<b>1.8</b>	<b>0.3</b>	<b>10.0</b>	<b>1.0</b>	<b>6.0</b>	<b>2.0</b>	<b>1.0</b>	
<b>South Fork</b>														
S. Fk., North Fork to Soldier Cr.	24-Sep	2.4	1.5	3.0	15.0	18.0	7.5	12.1	3.0	0.0	2.0	1.0	0.0	
S. Fk., Soldier to Cliff Cr.	25-Sep	5.0	3.1	1.0	16.0	17.0	3.4	5.5	9.0	3.0	5.0	0.0	1.0	
<b>South Fork Total</b>		<b>7.4</b>	<b>4.6</b>	<b>4.0</b>	<b>31.0</b>	<b>35.0</b>	<b>4.7</b>	<b>7.6</b>	<b>12.0</b>	<b>3.0</b>	<b>7.0</b>	<b>1.0</b>	<b>1.0</b>	
<b>Upper Imnaha</b>														
Upper Imnaha Falls to North Fork	24-Sep	1.0	0.6	0.0	2.0	2.0	2.0	3.2	0.0	0.0	0.0	0.0	0.0	
Upper Imnaha Falls to lower falls	26-Sep	1.3	0.8	0.0	13.0	13.0	10.0	16.1	3.0	0.0	0.0	2.0	1.0	
Falls downstream .67 mi. to beg. of gorge*	26-Sep	1.1	0.7	2.0	24.0	26.0	23.6	38.0	34.0	0.0	6.0	3.0	25.0	
Lower end of gorge to next gorge (.25 mi)*	26-Sep	0.4	0.2	0.0	2.0	2.0	5.0	8.0	0.0	0.0	0.0	0.0	0.0	
Canyon above slide to canyon just above slide*	26-Sep	1.5	0.9	0.0	1.0	1.0	0.7	1.1	1.0	0.0	0.0	0.0	1.0	
<b>Upper Imnaha Total</b>		<b>5.3</b>	<b>3.3</b>	<b>2.0</b>	<b>42.0</b>	<b>44.0</b>	<b>8.3</b>	<b>13.4</b>	<b>38.0</b>	<b>0.0</b>	<b>6.0</b>	<b>5.0</b>	<b>27.0</b>	

Table 2b  
**Bull Trout Spawning Surveys**  
**For the Imnaha River, 2018**  
**USFWS, La Grande Field Office**

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)
<b>Middle Imnaha</b>													
Blue Hole to Indian Crossing	20-Sep	3.2	2.0	1.0	0.0	1.0	0.3	0.5	5.0	0.0	1.0	3.0	1.0
Blue Hole to Indian Crossing	3-Oct			2.0	0.0	2.0			7.0	0.0	0.0	2.0	5.0
<b>Middle Imnaha Total</b>		<b>3.2</b>	<b>2.0</b>	<b>3.0</b>	<b>0.0</b>	<b>3.0</b>	<b>0.3</b>	<b>0.5</b>	<b>12.0</b>	<b>0.0</b>	<b>1.0</b>	<b>5.0</b>	<b>6.0</b>
<b>Big Sheep System</b>													
Big Sheep, Big Sheep Creek Falls to canal	17-Sep	3.1	1.9	2.0	11.0	13.0	4.2	6.8	0.0	0.0	7.0	0.0	0.0
Big Sheep, Big Sheep Creek Falls to canal	4, 8-Oct			1.0	8.0	9.0			2.0	0.0	2.0	0.0	0.0
Big Sheep, Canal to Rd. 39	17-Sep	2.4	1.5	0.0	4.0	4.0	1.7	2.7	3.0	0.0	3.0	0.0	0.0
Big Sheep, Canal to Rd. 39	8-Oct			0.0	1.0	1.0			3.0	3.0	0.0	0.0	0.0
Big Sheep, Rd. 39 to Lick Creek confluence	17-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
Lick Cr. Meadow to 39 rd.	19-Sep	6.8	4.2	1.0	0.0	1.0	0.1	0.2	3.0	1.0	2.0	0.0	0.0
<b>Big Sheep System Total</b>		<b>15.5</b>	<b>9.6</b>	<b>4.0</b>	<b>24.0</b>	<b>28.0</b>	<b>1.8</b>	<b>2.9</b>	<b>11.0</b>	<b>4.0</b>	<b>14.0</b>	<b>0.0</b>	<b>0.0</b>
<b>Imnaha Basin Total (Page 1)</b>													
		<b>24.0</b>	<b>17.4</b>	<b>19.0</b>	<b>139.0</b>	<b>158.0</b>	<b>6.6</b>	<b>9.1</b>	<b>93.0</b>	<b>14.0</b>	<b>42.0</b>	<b>8.0</b>	<b>29.0</b>
<b>Imnaha Basin Total (Page 2)</b>													
		<b>15.5</b>	<b>9.6</b>	<b>7.0</b>	<b>23.0</b>	<b>30.0</b>	<b>1.9</b>	<b>3.1</b>	<b>20.0</b>	<b>1.0</b>	<b>15.0</b>	<b>5.0</b>	<b>6.0</b>
<b>Imnaha Basin Total Pages 1 &amp; 2)</b>													
		<b>39.5</b>	<b>27.0</b>	<b>26.0</b>	<b>162.0</b>	<b>188.0</b>	<b>4.8</b>	<b>7.0</b>	<b>113.0</b>	<b>15.0</b>	<b>57.0</b>	<b>13.0</b>	<b>35.0</b>

**Table 4a –  
Summary of Measured Bull Trout Redds, Grande Ronde River Basin  
Lostine River and Goat Creek 2018**

Stream	n*1		Length (M)	Width (M)	Area (m2)	Length/Width ratio
Lostine	58	mean	1.4	0.9	1.4	1.7
		sd	0.6	0.4	1.2	0.5
		max	3.4	1.9	6.6	3.2
		min	.35	0.3	.10	0.7
Bear	8	mean	0.9	0.8	0.8	1.3
		sd	0.4	0.5	0.6	0.4
		max	1.5	2	2	1.8
		min	.35	.35	0.2	0.5
Goat	8	mean	1	0.7	0.9	1.6
		sd	0.5	0.4	1.1	0.25
		max	2.2	1.6	3.5	2
		min	0.4	0.3	.13	1.3

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

**Table 4b –  
Summary of Measured Bull Trout Redds, Imnaha River Basin 2018**

<b>Stream</b>	<b>n*1</b>		<b>Length (M)</b>	<b>Width (M)</b>	<b>Area (m2)</b>	<b>Length/Width ratio</b>
<b>Big Sheep Creek (Upstream of WVIC)</b>	<b>16</b>	<b>mean</b>	0.6	0.2	0.2	2.7
		<b>sd</b>	0.2	0.1	0.1	0.8
		<b>max</b>	0.9	0.5	0.4	4
		<b>min</b>	0.35	0.1	0.03	1.5
<b>Big Sheep Creek (Downstream of WVIC)</b>	<b>5</b>	<b>mean</b>	0.8	0.4	.33	2.0
		<b>sd</b>	0.3	0.1	0.2	1.6
		<b>max</b>	1.1	0.6	0.6	2.9
		<b>min</b>	0.3	0.2	0.1	1.4
<b>Middle Imnaha</b>	<b>3</b>	<b>mean</b>	1.6	1.1	1.8	1.4
		<b>sd</b>	0.3	0.2	0.4	0.2
		<b>max</b>	1.9	1.3	2.3	1.6
		<b>min</b>	1.4	0.9	1.3	1.1
<b>N.F. Imnaha</b>	<b>20</b>	<b>mean</b>	0.9	0.5	0.4	1.8
		<b>sd</b>	0.3	0.1	0.2	0.4
		<b>max</b>	1.6	0.7	0.9	2.9
		<b>min</b>	0.5	0.3	0.1	1.3
<b>S.F. Imnaha</b>	<b>23</b>	<b>mean</b>	1.3	0.7	1.0	2.0
		<b>sd</b>	0.5	0.2	0.6	0.7
		<b>max</b>	2.4	1.2	2.3	3.5
		<b>min</b>	0.7	0.2	0.1	1.2
<b>Upper Imnaha</b>	<b>23</b>	<b>mean</b>	1.4	0.7	1.1	1.9
		<b>sd</b>	0.4	0.2	0.6	0.4
		<b>max</b>	2.5	1.2	2.8	2.9
		<b>min</b>	0.8	0.4	0.3	1.1

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