Validation of Aquatic Habitat Quality and Fish Population Assumptions Used to Predict Effects of Activities and Cutthroat Trout Population in Relation to Habitat Changes Items 21 and 41

OBJECTIVES: Monitor fish populations and trends. Determine fish population/habitat relationships. Determine indicators of aquatic habitat quality and effective monitoring methodologies. Monitor the population trends of management indicator species (westslope cutthroat trout) and determine the relation to habitat changes.

DATA SOURCE: Fish population census, habitat inventory and condition, channel structure, redd counts, radio-telemetry and streambank vegetation data. Data collected cooperatively with the Montana Department of Fish, Wildlife, and Parks (MFWP).

FREQUENCY: Annually.

REPORTING PERIOD: 2010-2013.

VARIABILITY: A decline in aquatic habitat quality and/or fish population for more than one year (Item 21); 10 percent difference from projected cutthroat trout yield (Item 41).

INTRODUCTION:

Forest monitoring of the fisheries and aquatic environment in 2010-2013 exceeded the minimum requirements set in the 1987 Forest Plan. Research and analysis of fisheries and fish populations since the Forest Plan was signed have shown that the ten percent annual variability noted above is too narrow given the natural annual variation in fish populations. Based on our ongoing long-term monitoring, westslope cutthroat trout populations are stable on the Bitterroot National Forest, while bull trout populations are declining. Habitat quality is either being maintained or improving. Individual measures and evaluations are discussed further in the following sections.

The current emphasis of the Bitterroot National Forest's fisheries monitoring program is to:

1. Monitor population densities and distributions of resident trout and assist the State in monitoring migratory native trout.
2. Determine viability trends of bull trout and westslope cutthroat trout populations on the Forest scale.
3. Validate fish/habitat relationships.
4. Monitor the status of the strongest bulltrout populations.
5. Monitor compliance with Anadromous Fisheries (PACFISH) and Inland Native Fish (INFISH) requirements.

MONITORING RESULTS AND EVALUATION:

The following monitoring was accomplished in 2010-2013 and is discussed and evaluated in this section:

- Fish Habitat Inventories
- Fish Population Monitoring
- Mountain Lake Surveys
- Viability of Bull Trout and Westslope Cutthroat Trout Populations
- Water Temperature Monitoring
- Bull Trout Redd Surveys
- Mussel Surveys
- Research
- Culvert Inventories and Replacements

· Project Level Monitoring of Fisheries/Watershed Improvement Projects

FISH HABITAT INVENTORIES:

Table 1 lists the fisheries habitat inventories that were conducted by Forest fisheries biologists in support of project planning and monitoring efforts in 2010-13. The inventories supply information used at a variety of scales to address short-term and long-term aquatic issues on and off the Forest.

Table 1- Fish Habitat Inventories Conducted in 2010-2013

Stream	Year	District	Inventory Length (mi.)	Inventory Method[1]	Purpose
Skalkaho Creek	2010	Darby	0.4	I-walk	NEPA analysis
Daly Creek	2010	Darby	0.6	I-walk	NEPA analysis
Cameron Creek	2010	Sula	1.8	I-walk	NEPA analysis
Cameron Creek, tributary 13.1	2010	Sula	0.2	I-walk	NEPA analysis
East Fork Camp Creek	2010	Sula	2.2	I-walk	NEPA monitoring
East Fork Bitterroot River	2010	Sula	1.9	I-walk	TMDL monitoring
Medicine Tree Creek	2010	Sula	0.2	I-walk	Post-fire monitor
Hughes Creek	2010	West Fork	1.0	I-walk	TMDL monitoring
Willow Creek	2011	Stevensville	1.0	I-walk	NEPA analysis
East Fork Camp Creek	2011	Sula	1.7	I-walk	NEPA analysis
Lick Creek	2011	Sula	0.8	I-walk	NEPA analysis
Nez Perce Fork	2012	West Fork	3.4	I-walk	NEPA analysis
Sheephead Creek	2012	West Fork	1.8	I-walk	NEPA analysis
North Fork Sheephead Creek	2012	West Fork	1.3	I-walk	NEPA analysis
Watchtower Creek	2012	West Fork	1.7	I-walk	NEPA analysis
Flat Creek	2012	West Fork	1.2	I-walk	NEPA analysis
West Fork Bitterroot River	2012	West Fork	3.9	I-walk	TMDL monitoring
Ditch Creek	2012	West Fork	0.2	I-walk	TMDL monitoring
Lick Creek	2013	Darby	1.0	I-walk	NEPA analysis
East Fork Bitterroot River	2013	Sula	7.9	I-walk	NEPA analysis
Moose Creek	2013	Sula	2.0	I-walk	NEPA analysis
Meadow Creek	2013	Sula	2.7	I-walk	NEPA analysis
Needle Creek	2013	Sula	0.5	I-walk	NEPA analysis
Taylor Creek	2013	West Fork	1.4	I-walk	NEPA analysis
Sheep Creek	2013	West Fork	0.9	I-walk	Post-fire monitor
East Fork Bitterroot River	2013	Sula	4.3	I-walk	TMDL monitoring
West Fork Bitterroot River	2013	West Fork	5.0	I-walk	TMDL monitoring
Total			**51**		

In 2010-2013, fish habitat inventories were conducted in 51 miles of streams in all the Ranger Districts (Table 1). Habitat data was collected using the I-walk methodology, which is a reach-based walk-through inventory method that focuses on collecting basic INFISH Riparian Management Objective (RMO) data. The majority of inventories were conducted to gather baseline habitat data in support of various NEPA projects. Inventories were also conducted in designated TMDL monitoring reaches in 2010 (East Fork Bitterroot River, Hughes Creek), 2012 (West Fork Bitterroot River, Ditch Creek), and 2013 (East Fork Bitterroot River, West Fork Bitterroot River) to monitor the pool and large woody debris (LWD) supplemental targets in the Bitterroot Headwaters TMDL. The Monitoring Strategy in the Headwaters TMDL recommends re-survey of the reaches at least once every five years, which is being done and is ongoing. Figures 1 and 2 compare the results of the TMDL monitoring surveys.

[1] I-walk: A survey method that looks at pool quality, substrate composition, large wood, and pools per mile to quantify fish habitat as described by INFISH.

Figure 1 – Pool Frequencies in Bitterroot Headwater TMDL Monitoring Reaches

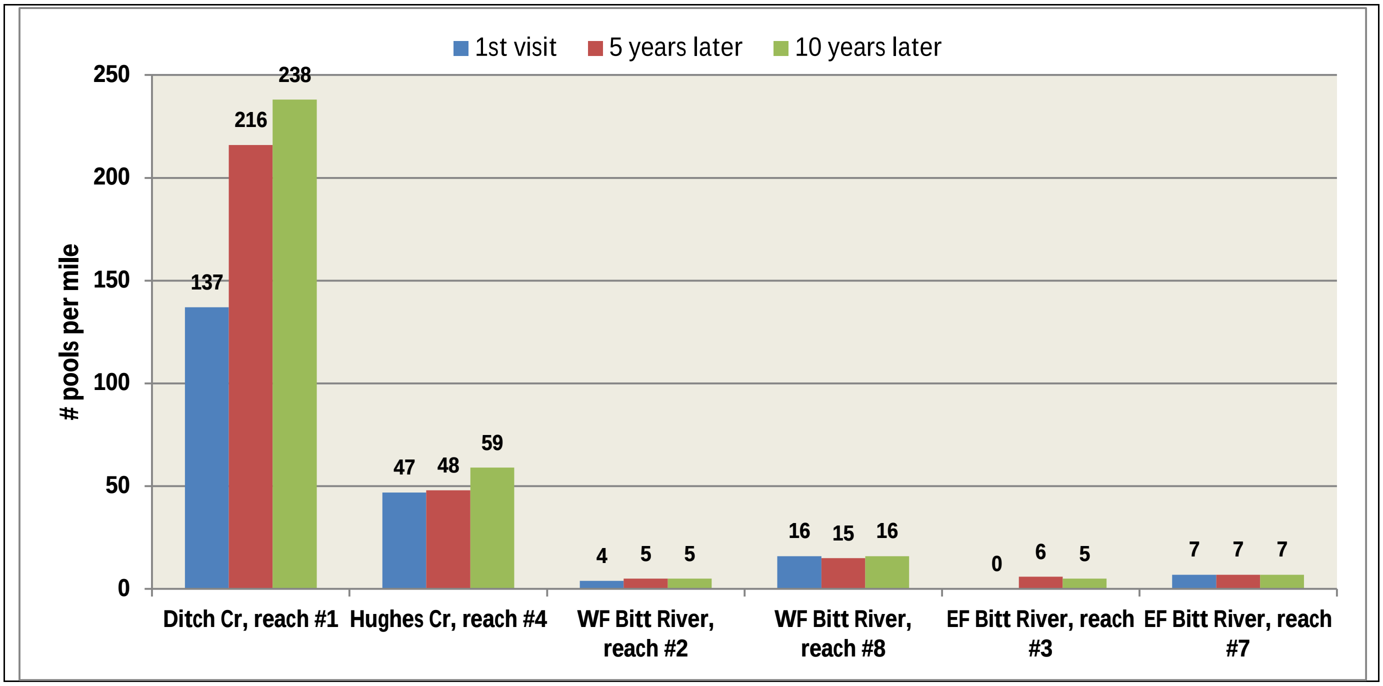
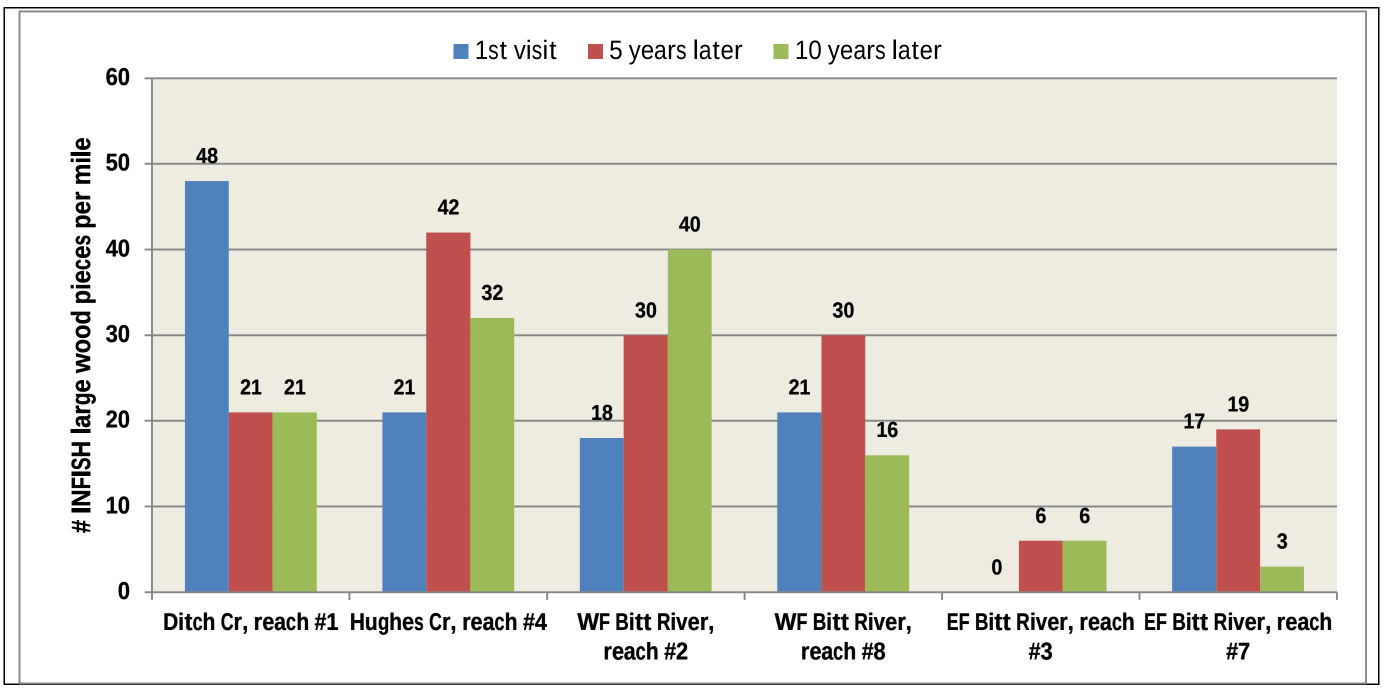


Figure 2– Large Wood Frequencies in Bitterroot Headwater TMDL Monitoring Reaches



Ditch Creek, reach #1 – Ditch Creek is a small (base flow wetted width is about 3 feet) tributary to the West Fork Bitterroot River with high sediment infill and shallow, poorly-defined pools. Ditch Creek was determined to be impaired by sediment in the Headwaters TMDL. The TMDL monitoring reach is a 1000-foot long B4 reach that starts at the West Fork Highway crossing. The reach was surveyed in 2002, 2007, and 2012. The data suggests that pools have increased over the past decade (Figure 1) but large wood has declined by about half (Figure 2). The increase in pools may be more attributable to sampling bias than actual changes. There can be a lot of sampler variability when counting pools in small, shallow streams such as Ditch Creek. We try to have the same people conduct the repeat surveys, but even that doesn't eliminate all bias. Counting large wood pieces is usually a more reliable indicator in repeat surveys. The decline in large wood between 2002 and 2012 is believed to be attributable to the rotting and breakdown of alder and cottonwood pieces that were initially counted as large wood in 2002. Alder and cottonwood provide the majority of lower Ditch Creek's wood supply. Large wood counts were identical in 2007 and 2012 – frequency was low (21 pieces per mile) in both years (Figure 2). Road encroachment is believed to be the reason for the low amount of large wood in Ditch Creek reach #1.

Hughes Creek, reach #4 – This reach is a 1-mile long C4 section of Hughes Creek between Chrandal Creek and private land. Hughes Creek was determined to be impaired by both sediment and thermal modification in the Headwaters TMDL. Reach #4 was surveyed in 1999, 2005, and 2010. The data suggests that pools increased slightly between 1999 and 2010 (Figure 1), while large wood increased between 1999 and 2005, then decreased slightly between 2005 and 2010 (Figure 2).

West Fork Bitterroot River, reach #2 – This reach is a 3.9-mile long C3 section of the lower West Fork Bitterroot River between the Conner Cutoff Bridge and Trapper Creek. The West Fork Bitterroot River was determined to be impaired by both sediment and thermal modification in the Headwaters TMDL. Reach #2 was surveyed in 2002, 2007, and 2012. The data indicates a low and stable trend in pools (Figure 1) and an increasing trend in large wood (Figure 2). Our confidence in the quality of the data is high. Reach #2's pools are large, well-defined, and relatively easy to consistently count in repeat surveys. The West Fork Highway encroaches on the upper half of reach #2, which has resulted in some channelization and loss of meander length. The best and most pools occur in the lower half of the reach where highway impacts are not as pronounced and the river's meanders function more naturally. There is minimal potential for new pool formation considering the size of the river and the impact of the highway. Large wood has been increasing in reach #2 over the past decade (Figure 2) as a result of beaver activity in the lower portion of the reach, and increased recruitment of beetle killed pine trees. However, the river is too large for wood to play a major role in pool formation, and the wood typically gets pushed and deposited along the banks during high flows where it provides some hiding cover and helps facilitate bank scour.

West Fork Bitterroot River, reach #8 – This reach is a 5.0-mile long C4 section of the upper West Fork Bitterroot River between Painted Rocks Reservoir and Hughes Creek. The West Fork Bitterroot River was determined to be impaired by both sediment and thermal modification in the Headwaters TMDL. Reach #8 was surveyed in 2003, 2008, and 2013. The data indicates a stable trend in pools (Figure 1) and an inconsistent trend in large wood (Figure 2). Large wood increased between 2003 and 2008, but then decreased between 2008 and 2013 (Figure 2).

East Fork Bitterroot River, reach #3 – This reach is a 1.9-mile long C3 section of the East Fork Bitterroot River between Robbins Gulch and Hughes Creek. The East Fork Bitterroot River was determined to be impaired by both sediment and thermal modification in the Headwaters TMDL. Reach #3 was surveyed in 1999, 2005, and 2010. The data indicates a stable trend in pools (Figure 1) and large wood (Figure 2). Large wood was absent in 1999 before the 2000 fires, increased in 2005 because of the recruitment of some burned snags, and then remained stable in 2010 (Figure 2).

East Fork Bitterroot River, reach #7 – This reach is a 4.3-mile long C3 section of the East Fork Bitterroot River between Cameron Creek and Tolan Creek. The East Fork Bitterroot River was determined to be impaired by both sediment and thermal modification in the Headwaters TMDL. Reach #7 was surveyed in 2003, 2008, and 2013. The data indicates a stable trend in pools (Figure 1) and a sharp decline in large wood between 2008 and 2013 (Figure 2).

FISH POPULATION MONITORING:

The Forest Plan recommends monitoring fish populations in six streams annually to meet the Forest objectives. In 2010, fish populations were monitored in 16 streams at 21 monitoring reaches. In 2011, fish populations were monitored in 18 streams at 21 monitoring reaches. In 2012, fish populations were monitored in 16 streams at 19 monitoring reaches. In 2013, fish populations were monitored in 14 streams at 15 monitoring reaches.

At each monitoring reach, we have set a goal of monitoring trout populations for at least three years to serve as a baseline for future population studies. This "pulsed" monitoring technique is necessary for assessing long-term changes in fish populations (Bryant, 1995). Complete methods are described in Clancy (1998). As displayed in Table 2, most of the reaches monitored in 2010-2013 have been sampled for at least three years, and many have been sampled between 5-10 years. Since 1989, the Forest has accomplished its fish population monitoring requirements cooperatively with MFWP biologists.

Table 2 summarizes the fish population estimates that were conducted on the Forest between 1989 and 2013. Years in which a population estimate was conducted in a monitoring reach are denoted with **X**.

Table 2 - Fish Population Estimates Conducted Between 1989 and 2013

Monitoring Site	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13
Ambrose 8.4																				X					
Ambrose 8.6																				X					
Andrews 0.5													X	X	X										
Bear 6.0			X																						
Beaver 0.3			X	X																X				X	
Beaver 3.1																								X	X
Bertie Lord 0.2		X	X								X		X	X	X	X	X	X	X				X	X	
Big 6.5				X																					
Blue Joint 5.9						X	X															X			
Boulder 2.0				X														X							
Bunkhouse 1.3																	X								
Burnt Fork 19.7						X		X				X						X	X	X			X		
Cameron 6.1					X						X								X			X			
Cameron 10.1		X									X		X	X	X	X				X		X			
Camp 2.3															X	X	X	X	X		X		X		X
Camp 3.2										X															
Camp 6.6									X														X		
Castle 0.1																		X							
Chaffin 3.1		X	X														X		X						
Chicken 1.0												X	X	X	X	X			X			X			
Coal 1.3		X												X	X	X	X								
Daly 0.7	X	X						X			X		X	X	X			X	X					X	
Deer 0.3																					X		X		X
Divide 0.1	X	X	X					X					X	X	X										
Doran 0.1					X																				
EF Bitterroot 2.5										X		X	X		X	X	X	X	X			X		X	
EF Bitterroot12.0		X					X		X			X	X	X	X	X	X	X	X		X		X		X
EF Bitterroot 19.1				X																		X			
EF Bitterroot 25.6				X													X				X				
EF Bitterroot 28.4		X																							
EF Bitterroot 31.4				X		X				X		X	X	X	X					X			X		
EF Camp 0.4																					X	X	X		
East Piquett 0.2																		X	X	X					
Fred Burr 9.0										X															
Gilbert 0.1														X	X	X									
Gold 0.3		X	X					X																	
Guide 0.1																	X	X	X			X			
Hart 2.8													X	X	X					X					
Hughes 1.6										X	X													X	
Hughes 9.0								X			X														
Jennings Camp 0.5																	X	X	X			X			
Johnson 0.7			X																	X					
Kootenai 0.3										X															
Laird 1.4		X	X									X		X	X	X	X				X				
Laird 2.3												X		X	X	X	X								
Lavene 0.2																		X	X	X				X	X
Lick 1.9		X	X	X			X		X		X		X		X		X								
Lick 2.1							X		X				X												
L. Blue Joint 1.4												X	X	X	X	X	X						X		
L. Boulder 1.4																						X	X		X
L. Sleep Child 4.2													X	X		X									

Monitoring Site	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13
Little Tin Cup 1.3					X																				
L. West Fork 1.3				X												X	X	X							
L. West Fork 3.1				X																	X				
Martin 1.3			X	X	X	X			X		X		X	X	X							X			X
Martin 7.5				X	X	X	X						X		X										
Maynard 0.1													X	X	X	X									
Meadow 0.3																						X			
Meadow 5.2		X	X																						
Meadow 5.6	X	X	X			X	X	X				X	X	X	X	X		X	X	X			X		
Meadow 7.3	X	X	X										X	X	X							X			
Medicine Tree 1.5													X	X	X	X	X				X	X			
Mine 0.2										X	X		X	X	X										X
Moose 1.4			X	X	X				X		X		X	X	X			X					X		
Moose 3.6				X	X	X												X	X	X					X
NF Sheephead 0.5					X																X				
North Rye 1.9	X	X	X					X	X			X	X	X	X	X	X	X							
Nez Perce 1.2												X	X											X	
Nez Perce 9.8				X								X	X	X	X									X	
Nez Perce 11.8				X																	X			X	
Overwhich 2.0					X	X	X			X	X							X							
Overwhich 8.9					X																				
Pierce 0.5																		X	X	X				X	X
Piquett 1.3		X	X										X	X	X		X	X	X	X					
Praine 1.0							X					X	X	X	X	X					X				
Railroad 1.4				X																					
Reimel 2.6		X	X	X								X	X	X	X	X				X			X		
Reimel 2.9		X	X	X																					
Reimel 3.8		X	X	X								X	X	X	X								X		
Rye 6.6													X	X	X	X	X						X		
Rye 12.4	X	X	X					X	X			X	X	X	X	X	X	X			X				
Salt 0.2								X	X																
Sheep 0.2			X																	X					X
Sheephead 0.2																X	X	X						X	
Sheephead 2.5					X																X				
Skalkaho 0.4		X																							
Skalkaho 5.8								X														X			
Skalkaho 8.1	X																								
Skalkaho 12.5									X																
Skalkaho 13.1			X	X		X				X	X		X		X										X
Skalkaho 16.8	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Skalkaho 17.2												X													
Skalkaho 20.6			X	X	X	X							X		X										
Slate 1.6			X	X	X						X		X	X	X						X				
Sleeping Child 1.9					X																				
Sleeping Child 4.5									X																
Sleep. Child 10.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sleep. Child 14.5	X	X	X					X					X	X	X										

Monitoring Site	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13
Sleep. Child 16.9	X	X	X																						
Soda Springs 0.3																X	X	X							
Sweathouse 5.7			X																						
Swift 0.7							X						X	X	X									X	
Tepee 0.9																	X	X	X				X	X	
Threemile 2.6			X																						
Threemile 3.9				X																					
Threemile 6.3			X																						
Threemile 8.3			X													X						X			
Threemile 10.0																X						X			
Threemile 12.6																		X						X	
Threemile 15.3								X		X			X												
Tin Cup 7.2				X																		X			
Tolan 2.1		X	X										X	X	X			X							
Tolan 5.1	X	X	X					X	X				X	X	X	X			X						
Tolan 7.3	X												X	X	X										
Trapper 1.7				X																					
Trapper 3.5				X													X								
Two Bear 0.8			X										X	X	X	X									
Ward 0.7																		X	X						
Warm Springs 3.5				X	X	X	X					X	X	X	X	X					X				
Warm Springs 5.6		X		X																					
Warm Springs 7.4				X		X	X											X	X	X					
Watchtower 0.1																X	X	X						X	
Watchtower 0.8				X																	X				
Waugh 0.7		X	X										X	X	X	X	X								
WF Bitterroot 1.2							X		X	X				X					X				X		
WF Bitterroot22.2										X															
WF Bitterroot34.0			X	X			X			X	X											X			
WF Bitterroot40.0			X										X	X	X										
WF Camp 0.3					X								X	X	X				X				X		
Willow 12.1		X																		X					
Woods 0.3			X																						
Woods 0.9								X	X				X	X	X					X				X	
Woods 4.4																							X	X	X

The following narratives summarize our most current knowledge of the fish populations in the monitoring reaches that were sampled in 2010-2013.

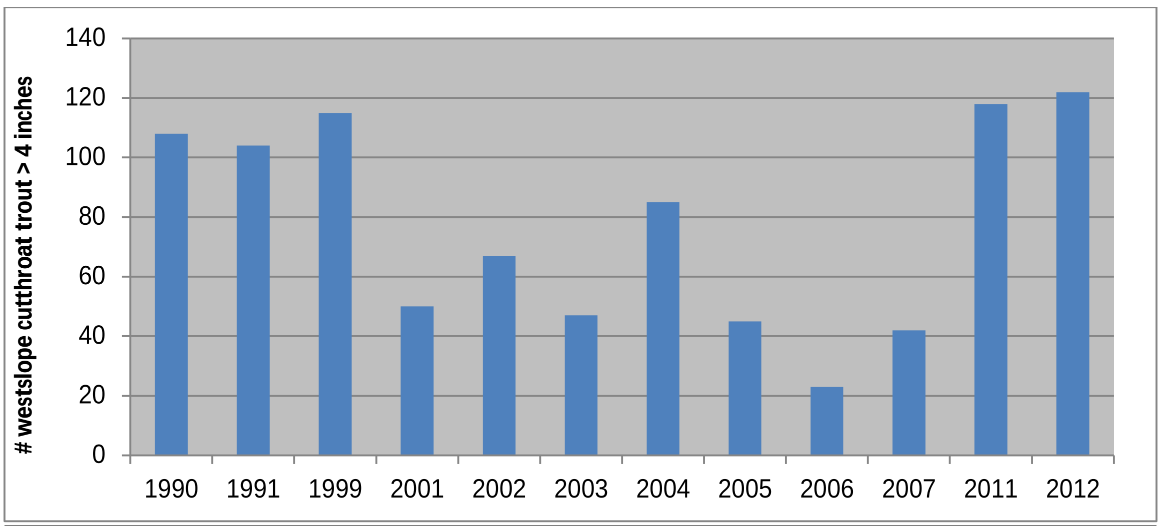
- Ø <u>Beaver Creek 0.3</u> This reach is located near the mouth. It was sampled in 1984, 1991, 1992, 2008, and 2012. The reach was not burned by the 2011 Saddle Complex fire, but moderate severity fire burned the riparian area not too far upstream from the reach. The estimated number of westslope cutthroat trout > 4 inches was lower in 2008 and 2012 than it was in 1991-92. Westslope cutthroat trout numbers were similar in 2008 and 2012. Bull trout numbers were higher in 2012 than in past years. 2012 was the first year in which enough bull trout were captured to be able to calculate a statistically valid estimate. One brook trout was captured in the reach in 1984, 2008, and 2012. A few bull trout X brook trout hybrids have also been found in this reach. The 2012 data indicates that fish populations in the reach were not noticeably affected by the 2011 Saddle Complex fire.

- Ø <u>Beaver Creek 3.1</u> This reach was established in the middle portion of Beaver Creek following the 2011 Saddle Complex fire. The purpose for establishing this reach is to monitor post-fire fish recovery in Beaver

Creek. The reach was burned at moderate to high severity in August, 2011, and a large fish kill occurred. The reach was sampled in 2012 and 2013. Westslope cutthroat trout increased from 27 (2012) to 128 (2013), and bull trout increased from 2 (2012) to 10 (2013). Young-of-the-year of both species were present in 2013.

Ø Bertie Lord Creek 0.2 This reach is located near the confluence with the East Fork Bitterroot River. It was sampled in 1990-91, 1999, 2001-07, 2011, and 2012 (Figure 3). The sampling that occurred in 2005-07 was to gather pre-timber harvest baseline population data for monitoring the effects of the Tepee Blend timber sale (NEPA was the Middle East Fork EIS). Tepee Blend timber harvest occurred in the Bertie Lord Creek drainage in summer, 2011. In 2011 and 2012, after harvest and hauling was completed, the reach was sampled again to compare population changes to the 2005-07 baseline data. The 2011-12 westslope cutthroat trout estimates were higher than the 2005-07 pre-harvest baselines, and similar to the estimates that were made in the 1990's (Figure 3). Brook trout and bull trout are also present in the reach, but not enough of either species was captured in 2005-07 or 2011-12 to calculate a statistically valid estimate. The number of brook trout captured was 2 (2005), 3 (2006), 1 (2007), 1 (2011), and 0 (2012). Prior to 2002, the number of brook trout captured per year ranged between 12 and 16; since 2002, the range has been 0 to 4 per year. The only year that we were able to calculate a statistically valid brook trout estimate was 1999. Bull trout are incidental and rare in the reach. One bull trout was captured in 1990, 1999, 2002, and 2006. Four bull trout were captured in 2011. No bull trout were captured in 2001, 2003-05, 2007, and 2012. Our monitoring data supports the prediction made in the Middle East Fork Final EIS that we would be unable to detect reductions in fish populations as a result of implementing the Middle East Fork timber sales

Figure 3 – Estimated Number of Westslope Cutthroat Trout > 4 Inches in the Bertie Lord Creek 0.2 Monitoring Reach, Before (2005-07) and After (2011-12) Tepee Blend Timber Harvest



Ø Blue Joint Creek 5.9 This reach starts a short distance upstream of the Blue Joint trailhead. It was sampled in 1994-95 and 2010. In 2010, the westslope cutthroat trout population estimate was similar to the 1995 estimate. More bull trout were captured in this reach in 2010 than in the past.

Ø Burnt Fork 19.7 This reach is located at the Burnt Fork trailhead. It was sampled in 1994, 1996, 2000, 2006-08, and 2011. In 2011, the population estimate of westslope cutthroat and bull trout was similar to slightly below the average of the previous years. The number of each species longer than 6 inches was within the normal range, but the number of smaller fish was below previous estimates.

Ø Cameron Creek 6.1 This reach is located on Forest Service land below the Shining Mountain Ranch. It was sampled in 1993, 1999, 2007, and 2010. Brook trout are the predominant salmonid in the reach, with small populations of westslope cutthroat trout and longnose suckers. The brook trout population in 2007 and 2010 was lower than the 1999 estimate. We were able to capture enough westslope cutthroat trout in 2010 to calculate a population estimate (36 cutthroat > 4 inches per 600 feet). The 2010 westslope cutthroat trout estimate was lower than the 1999 estimate.

Ø Cameron Creek 10.1 This reach is located on State land above the Road 311 crossing. It was sampled in 1990, 1999, 2001-04, 2008, and 2010. Westslope cutthroat trout and brook trout are the only two fish species present in the reach, and they occurred in 2010 at roughly equal numbers. In 2010, westslope cutthroat trout and brook trout numbers were similar to those that occurred before the 2000 fires. The estimated number of westslope cutthroat trout and brook trout > 4 inches per 1000 feet was 127 and 115 fish, respectively. It took longer for brook trout to regain their pre-fire abundance than westslope cutthroat trout following the 2000 fires.

- Camp Creek 2.3 This reach is located in the portion of Camp Creek upstream of the Sula Ranger Station that was reconstructed in 2002. It was sampled in 2003-07, 2009, 2011, and 2013. The reach was also sampled in 1999 when Camp Creek was still located in the east ditch of U.S. Highway 93. The reconstructed channel provides better fish habitat than the highway ditch used to, and because of the increased length of stream and the more complex habitat that is available in the reconstructed channel, there has been an increase in the number of trout in the reach, particularly the larger adults. Due to widespread hybridization between westslope cutthroat trout and rainbow trout, the two species are combined in the population estimates. The 2013 cutthroat estimate was numerically similar to past years, and has increased over the lower number in 2011. A major change that occurred in 2011 was a dramatic increase in the number of brown trout. In 2013, the number of brown trout greater than 7 inches was higher than the 2011 estimate, but smaller brown trout were less numerous in 2013. Prior to 2011, brown trout were uncommon in the reach. Brown trout numbers are also way up in the nearby East Fork Bitterroot River, and they appear to be expanding their distribution into the lower ends of the tributaries. Bull trout were rare in the reach prior to the reconstruction and have not been captured since. Brook trout are present in the reach in large enough numbers to calculate statistically valid estimates in some years, but not all. In general, the number of brook trout seems to be decreasing, possibly due to the increasing brown trout population. Rainbow trout are incidental and uncommon in the reach.

- Camp Creek 6.6 This reach is located below the confluence of the East and West Forks of Camp Creek, near the mouth of Dick Creek. It was sampled in 1997 and 2011. In both years, westslope cutthroat trout and brook trout were the only two species of fish captured in the reach. Both species are abundant in the reach, with the number of brook trout being particularly high (e.g. in 2011, 415 brook trout > 3 inches in length were captured per 700 feet of stream). Both species were much more numerous in the 2011 estimate than they were in 1997. It is interesting that brook trout numbers are very high in this reach, but just a short distance upstream (0.5 to 1 mile), they are much less common in the lower ends of the East and West Forks of Camp Creek. Bull trout have not been found in this reach.

- Chicken Creek 1.0 This reach is located at the mouth of the Chicken Creek canyon. It was sampled for the first time in 2000, shortly after being severely burned by the fires of 2000. Additional sampling occurred in 2001-04, 2007, and 2010. Westslope cutthroat trout are abundant in the reach, and have bounced back strong following the 2000 fires and 2001 mudslides. The estimated number of westslope cutthroat trout > 4 inches in the reach was 218 in 2007 and 310 in 2010 (as compared to 37 in October, 2000). The estimated number of brook trout > 4 inches in 2010 was 60, which was higher than the 2001-07 estimates but still a bit lower than the estimate that occurred in October, 2000 (89 brook trout > 4 inches per 1000 feet). Bull trout and bull X brook hybrids are present in the reach at low numbers, and bull trout numbers have increased a small amount in 2007 and 2010. There are also sizeable numbers of longnose suckers that spawn in the reach in mid-summer.

- Daly Creek 0.7 This reach is located in the lower end of Daly Creek along the paved portion of the Skalkaho Highway. It was sampled in 1989-90, 1996, 1999, 2001-03, 2006-07, and 2012. The 2012 population estimates of bull trout and westslope cutthroat trout were within the range of past estimates.

- Deer Creek 0.3 This reach is located near the mouth of Deer Creek. It was sampled in 2009, 2011, and 2013. From most common to least common, the fish species that occur in the reach include westslope cutthroat trout (abundant), slimy sculpin (common), brook trout (common), bull trout (uncommon), mountain whitefish (uncommon), bull trout X brook trout hybrids (uncommon), and longnose sucker (uncommon). The estimated number of westslope cutthroat trout > 5 inches in length per 1000 feet was 95 (2009), 183 (2011), and 73 (2013). In 2011, enough brook trout and bull trout were captured to calculate statistically valid estimates (54 brook trout > 5 inches per 1000 feet; 11 bull trout > 5 inches per 1000 feet). In 2009 and 2013, not enough brook trout and bull trout were captured to calculate estimates. In 2013, only one bull trout was captured. Brook trout outnumber bull trout in the reach by at least a 5 to 1 ratio, and bull trout X brook trout hybrids are present. One 16+ inch migratory adult bull trout was captured in the reach in 2009 and 2011.

- East Fork Bitterroot River 2.5 This reach is located in the U.S. Highway 93 canyon. It starts below Maynard Creek and extends downstream for 0.5 miles. It has been sampled in 1990, 1995, 1997, 2000-07, 2010, and 2012. The reach has traditionally been dominated by rainbow trout, but the fish community has changed over the past decade as rainbow trout have declined and brown trout have increased. The brown trout estimate in 2010 indicates increasing numbers of smaller fish in the population. Whirling disease is believed to be responsible for the rainbow trout decline. Westslope cutthroat trout are present in the reach, but at numbers too small to calculate a statistically valid estimate. A few juvenile bull trout are sometimes captured in the reach, but never in large numbers, and all are usually < 12 inches in length.

- East Fork Bitterroot River 12.0 This reach is located in the U.S. Highway 93 canyon. It starts below Maynard Creek and extends downstream for 0.5 miles. It has been sampled in 1990, 1995, 1997, 2000-07, 2009, 2011, and 2013. The reach has traditionally been dominated by rainbow trout, but the fish community has changed over the past decade as rainbow trout have declined and brown trout have increased. The brown trout estimate in 2013 was the largest ever for fish over 11 inches, but indicated low numbers of fish less than 11 inches. The 2013 rainbow trout population estimate indicates that the rainbow trout population remains lower than in the past. Whirling disease is believed to be responsible for the rainbow trout decline. Westslope cutthroat trout are present in the reach, but at numbers too small to calculate a statistically valid estimate. A few juvenile bull trout are usually captured in the reach each year, but never in large numbers, and all are usually < 12 inches in length.

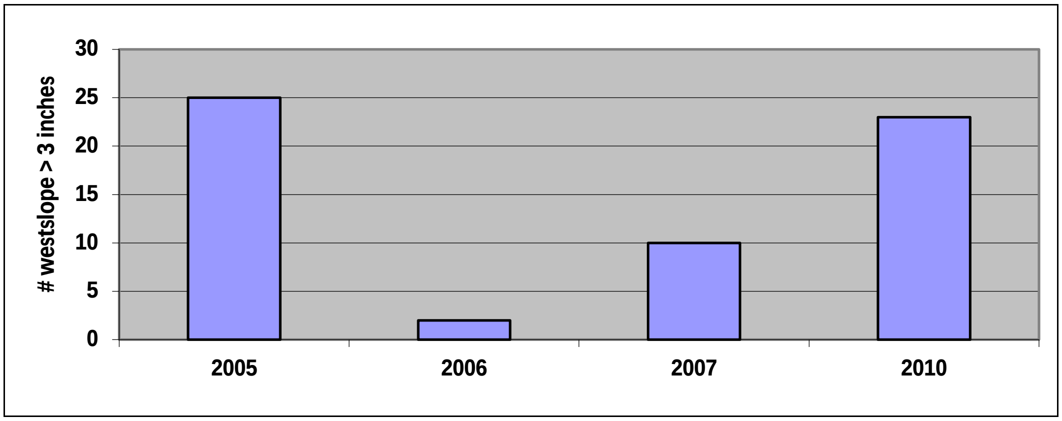
- East Fork Bitterroot River 19.6 This reach is located near the Circle M Ranch upstream of Tolan Creek. The reach starts near the ranch and goes downstream for about 2000 feet. It has only been sampled in 1992 and 2010. Both westslope cutthroat and brown trout have increased in number since 1992. The increase in westslope cutthroat trout is likely due to catch-and-release fishing regulations, while brown trout are expanding in both number and range in the East Fork Bitterroot River due to unknown reasons.

- East Fork Bitterroot River 31.4 This reach is located near the Anaconda Pintlar Wilderness trailhead. It has been sampled in 1992, 1994, 1998, 2000-03, 2008 and 2011. The westslope cutthroat population estimates have been fairly stable since sampling began. However, the bull trout population estimates indicate a significant decline in the past few years. Due to the low number of bull trout handled, we have been unable to calculate a population estimate the past few years. Also, brown trout are now found here in small numbers. When sampling began in the 1990's no brown trout were captured at this site.

- East Fork Camp Creek 0.4 This reach starts at the Forest boundary above the Lost Trail Hot Springs resort. It was sampled in 2009, 2010 and 2011. Westslope cutthroat trout, brook trout, and slimy sculpin are the only fish species found in the reach. Westslope cutthroat trout outnumbered brook trout by about an 8 to 1 ratio. In 2009-11, the estimated number of westslope cutthroat trout > 4 inches per 1000 feet of stream ranged between 131-151 fish, and the estimated number of brook trout > 4 inches ranged between 12-25 fish. Numbers of both species were stable throughout the three year monitoring period.

- Guide Creek 0.1 This reach starts at the Forest boundary. It was sampled for three consecutive years in 2005-07 to gather pre-timber harvest and log hauling baseline population data for monitoring effects of the Middle East Fork timber sales. In 2010, following the completion of all Middle East Fork timber harvest and log hauling activities in the Guide Creek drainage, the reach was sampled again to compare population changes to the 2005-07 baseline data. Guide Creek is a very small stream (2-3' base flow wetted width) that contains low numbers of small (3-6 inch) westslope cutthroat trout. Low flows, drought, and time of year when sampling occurs affects the number of westslope cutthroat trout that are present in the reach. There tends to be more fish in the reach early in the summer when flows are higher than later in summer. The number of westslope cutthroat trout captured in the reach was 25 (2005), 2 (2006), 10 (2007), and 23 (2010) (Figure 4). We were able to calculate population estimates in 2005 and 2010, but did not capture enough fish to calculate estimates in 2006 and 2007. The 2005 (30 cutthroat > 3 inches per 1000 feet) and 2010 (35 cutthroat > 3 inches per 1000 feet) were similar, which supports the prediction made in the Middle East Fork Final EIS that we would be unable to detect changes in the cutthroat population in Guide Creek as a result of implementing the Middle East Fork timber sales.

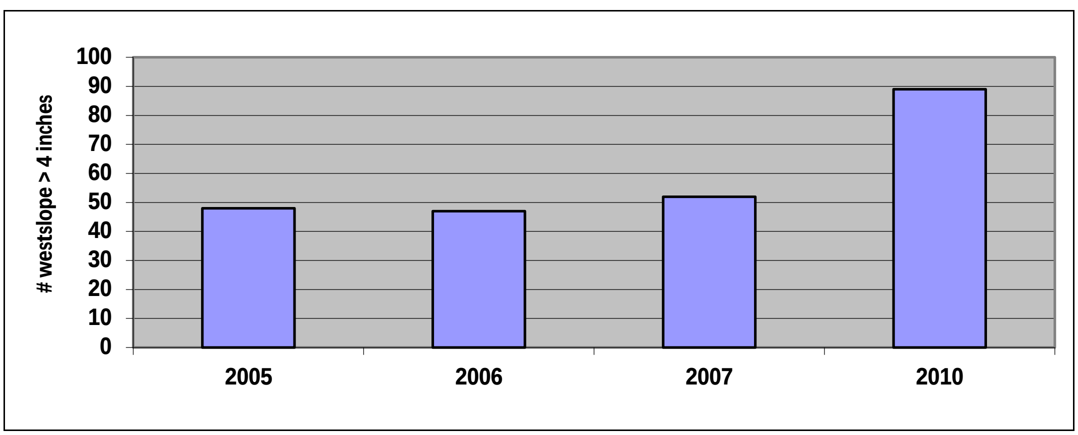
Figure 4 – Number of Westslope Cutthroat Trout Captured in the Guide Creek 0.1 Monitoring Reach, Before (2005-07) and After (2010) Middle East Fork Timber Harvest and Log Hauling



- Ø <u>Hughes Creek 1.6</u> This reach is located on lower Hughes Creek above the Road 5685 bridge. It was sampled in 1998, 1999, and 2012. The number of westslope cutthroat was similar in all three years, but the number of brook trout has declined since sampling began in 1998.

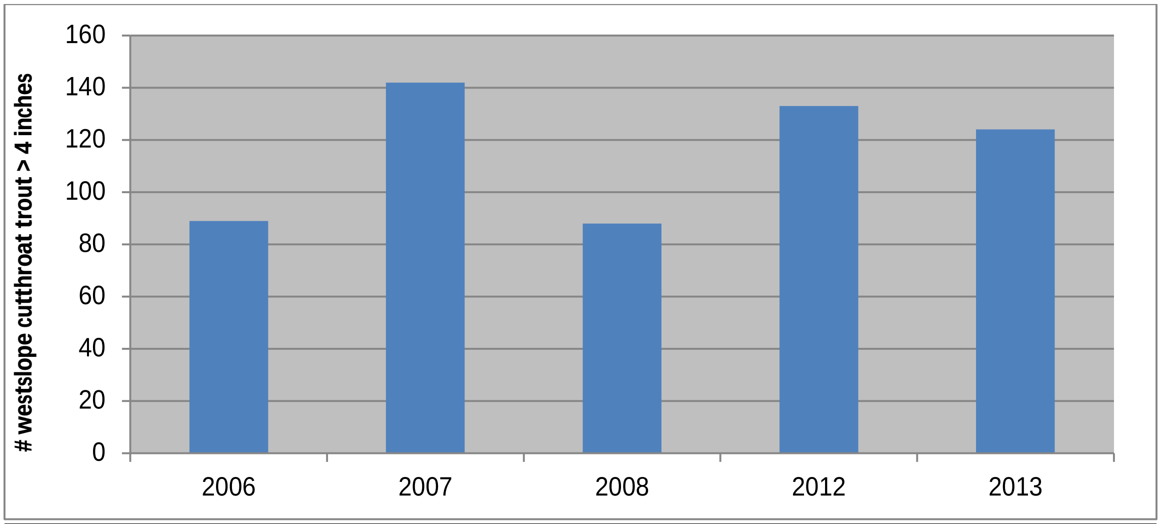
- Ø <u>Jennings Camp Creek 0.5</u> This reach starts about 0.3 miles upstream of the Forest boundary. It was sampled for three consecutive years in 2005-07 to gather pre-timber harvest and log hauling baseline population data for monitoring effects of the Middle East Fork timber sales. In 2010, following the completion of all Middle East Fork timber harvest and log hauling activities in the Jennings Camp Creek drainage, the reach was sampled again to compare population changes to the 2005-07 baseline data. Westslope cutthroat trout are the only fish that have been found in the reach, and they are common. The estimated number of cutthroat > 4 inches in the reach was higher in 2010 (89 fish) than the pre-harvest and hauling baseline population numbers present in 2005-07 (47-52 fish > 4 inches) (Figure 5). This supports the prediction made in the Middle East Fork Final EIS that we would be unable to detect changes in the cutthroat population in Jennings Camp Creek as a result of implementing the Middle East Fork timber sales.

Figure 5 – Estimated Number of Westslope Cutthroat Trout > 4 Inches in the Jennings Camp Creek 0.5 Monitoring Reach, Before (2005-07) and After (2010) Middle East Fork Timber Harvest and Log Hauling



- Ø <u>Lavene Creek 0.2</u> This reach is located at the Forest boundary. It was sampled in 2006-08 (before), 2012 (during), and 2013 (after) the Lower West Fork timber sale (Figure 6). The sampling that occurred in 2006-08 was to gather pre-timber harvest baseline population data. The 2012 sampling occurred while harvest and hauling were ongoing. The 2013 sampling occurred one year after the harvest and hauling was completed. The 2012 and 2013 westslope cutthroat trout estimates were on the high end of the 2006-08 pre-harvest range (Figure 6). No other fish species are present in Lavene Creek. The data supports the prediction made in the Lower West Fork EIS that there would be no detectable declines in the cutthroat population as a result of the timber sale and log hauling.

Figure 6 – Estimated Number of Westslope Cutthroat Trout > 4 Inches in the Lavene Creek 0.2 Monitoring Reach, Before (2006-08), During (2012), and After (2013) the Lower West Fork Timber Harvest and Log Hauling



- Little Blue Joint Creek 1.4 This reach is located near the Forest Road 5658 crossing. It was sampled in 2000-05 and 2011. Westslope cutthroat trout are the most common species in the reach, while brook trout are much less numerous and bull trout/bull trout X brook trout hybrids are rare. In 2011, we captured 203 westslope cutthroat trout, 19 brook trout, and 1 bull trout in the reach. Most of the fish in the reach were killed in the 2000 wildfires. The westslope cutthroat trout population has bounced back strong after the fires. In 2011, the estimated number of westslope cutthroat trout > 4 inches in length per 1000 feet of stream was 275, which was higher than the 2000-05 estimates (40-188). The number of brook trout captured in 2011 (19) was slightly higher than the 2000-05 range (4-16). The number of bull trout and bull trout X brook trout hybrids captured in the reach has remained very low (1-3 per year) since the 2000 fires.

- Little Boulder Creek 1.4 This reach starts at the Forest Road 1130 crossing and goes upstream for 1000 feet. The reach was established to monitor how the fish population responds to the replacement of the fish passage barrier at the Road 1130 culvert. It was sampled in 2010, 2011, and 2013. Westslope cutthroat trout and bull trout are the only fish species in the reach. The estimated number of westslope cutthroat trout > 4 inches in length per 1000 feet of stream was 93 (2010), 114 (2011), and 97 (2013). The estimated number of bull trout > 4 inches in length per 1000 feet of stream was 87 (2010), 60 (2011), and 98 (2013). One large (19 inch) migratory adult bull trout was captured in the reach in 2010. Young-of-the-year and juvenile bull trout are common in the reach.

- Martin Creek 1.3 This reach is located in the lower end of Martin Creek. It was sampled in 1991-94, 1997, 1999, 2001-03, 2010, and 2013. Westslope cutthroat trout and bull trout were the only fish species found in the reach. In 2013, the abundance of both species was within the range of past estimates.

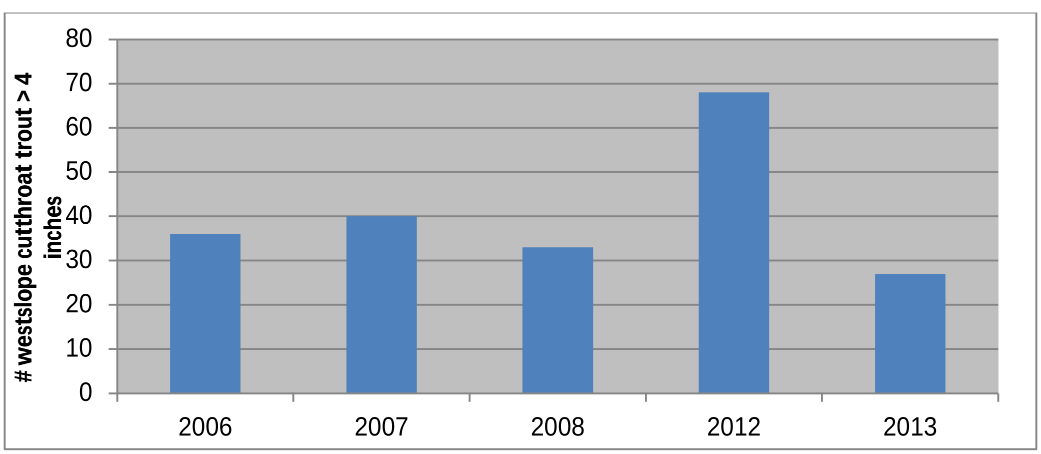
- Meadow Creek 0.3 This reach is located near the mouth of Meadow Creek. It was sampled for the first time in 2010. Westslope cutthroat trout and bull trout were the only fish species found in the reach. Westslope cutthroat trout were abundant, and bull trout were uncommon.

- Meadow Creek 5.6. This reach is located upstream of the Road 5759 bridge. It was sampled in 1989-91, 1994-96, 2000-04, 2007-08 and 2011. The westslope cutthroat trout population has decreased in recent years, but remains within the long-term range. Bull trout numbers were lower than average in 2011.

- Meadow Creek 7.3 This reach is located in upper Meadow Creek downstream of Balsam Creek. It has been sampled in 1989-91, 2001-03 and 2010. The reach was burned at high severity in the 2000 fires. Westslope cutthroat trout and bull trout have usually been the only fish species found in the reach. One brown trout (the same fish in the same pool) was found in the reach in 2002 and 2003. That was the only non-native fish ever found in the reach. The westslope cutthroat trout population has made a strong recovery since the 2000 fires. Cutthroat numbers in 2010 were the highest ever recorded, particularly the number of larger cutthroat > 8 inches in length (90 in 2010). The bull trout estimate in 2010 was lower than the 2001-03 estimates. A couple of large migratory bull trout (14-17 inches in length) were captured in the reach in 2010.

- Medicine Tree Creek 1.5 This reach starts at the Forest boundary. The 2000 fires and 2001 mudslides killed most of the fish in this stream. Since then, the westslope cutthroat trout population has exhibited a strong recovery, despite being at least partially isolated from the East Fork Bitterroot River by several culvert barriers on private land. The estimated number of westslope cutthroat trout (> 4 inches) per 1000 feet was one (2001), two (2002), 14 (2003), 78 (2004), 71 (2005), 101 (2009), and 63 fish in 2010. Non-native trout have not been found in the reach with the exception of one rainbow trout in 2004.
- Mine Creek 0.2 This reach is located in the lower end of Mine Creek. It was sampled in 1998-99, 2001-03, and 2013. Brook trout are abundant in the reach, westslope cutthroat trout are common, and bull trout are incidental and rare. The 2013 brook trout and westslope cutthroat trout populations were similar to previous years' estimates. No discernible effects from the 2012 Chrandal Creek fire were evident in this reach in 2013.
- Moose Creek 1.4 This reach is located downstream of the Lick Creek confluence. It was sampled in 1991-93, 1997, 1999, 2001-03, 2006 and 2011. The number of westslope cutthroat trout was above the long-term range in 2011. Although we captured similar numbers of bull trout as in past years, we were unable to collect a bull trout population estimate in 2011.
- Moose Creek 3.6 This reach is located downstream of the Moose Creek trailhead. It was sampled in 1992-94, 2006-08, and 2013. The number of westslope cutthroat trout and bull trout has been declining in the past few years, possibly due to angler harvest.
- Nez Perce Fork 1.2 This reach is located downstream of the Nelson Creek confluence. It was sampled in 2000, 2001, and 2012. Few fish inhabit this reach of stream, but the numbers appear to be stable since sampling began.
- Nez Perce Fork 9.8 This reach is located upstream of the Watchtower Creek confluence. It was sampled in 1992, 2000-03, and 2012. The populations of westslope cutthroat trout, bull trout and brook trout have been stable since sampling began.
- Nez Perce Fork 11.8 This reach is located about 300 feet upstream of the Sheephead Creek confluence. It has been sampled in 1992, 2009, and 2012. Westslope cutthroat trout, bull trout, brook trout, and bull X brook hybrids are present in the reach. The westslope cutthroat trout population has been stable. Since 2009, bull trout have been declining and brook trout have been increasing. In 2009, the number of bull trout and brook trout captured was roughly equal (about a dozen of each species), but in 2012, 22 brook trout were captured versus only 2 bull trout. Genetic testing indicates that bull trout and brook trout have been hybridizing in this reach since at least 1992.
- Pierce Creek 0.5 This reach is located below the Road 5629 culvert. It was sampled in 2006-08 (before), 2012 (during), and 2013 (after) the Lower West Fork timber sale (Figure 7). The sampling that occurred in 2006-08 was to gather pre-timber harvest baseline population data. The 2012 sampling occurred while harvest and hauling were ongoing. The 2013 sampling occurred one year after the harvest and hauling was completed. The 2012 westslope cutthroat trout estimate was higher than the 2006-08 pre-harvest range (Figure 7). The 2013 estimate was similar to the 2006-08 pre-harvest range (Figure 7). No other fish species are present in Pierce Creek. The data supports the prediction made in the Lower West Fork EIS that there would be no detectable declines in the cutthroat population as a result of the timber sale and log hauling.

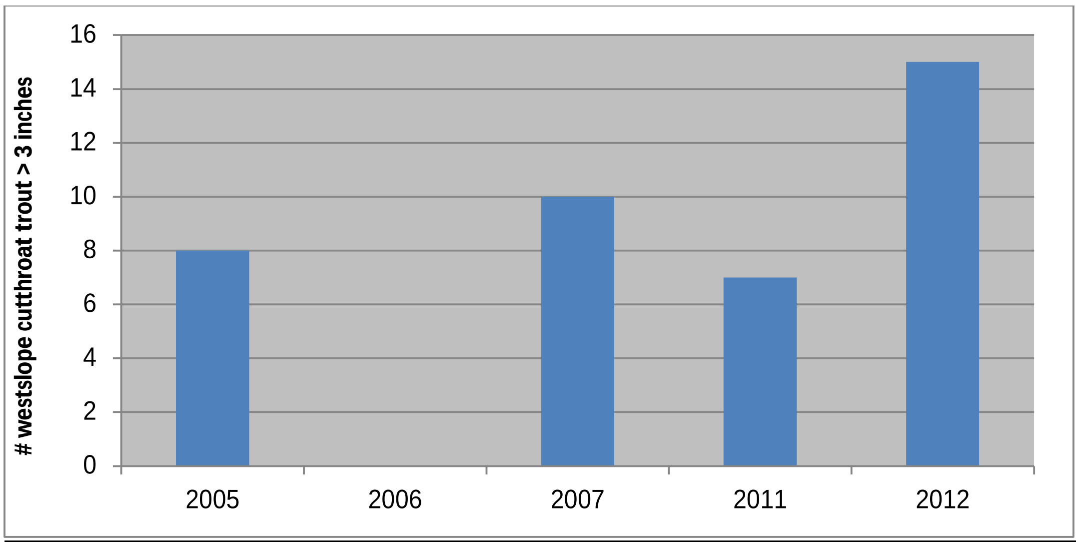
Figure 7– Estimated Number of Westslope Cutthroat Trout > 4 Inches in the Pierce Creek 0.5 Monitoring Reach, Before (2006-08), During (2012), and After (2013) Lower West Fork Timber Harvest and Log Haul



- Ø Reimel Creek 2.6 This reach starts at the Road 727 crossing. It was sampled in 1990-92, 2000-04, 2008 and 2011. Prior to the 2000 fires, brook trout dominated this reach, with lesser numbers of westslope cutthroat trout. Since the 2000 fires, that situation has flip-flopped with westslope cutthroat trout now dominating the reach with only a few brook trout. In the years prior to 2000, an average of 112 brook trout were captured in the reach. In 2008 and 2011, only 8 and 7 brook trout were captured in the reach, respectively. An incidental brown trout or two was captured in the reach in 2001-04, but none have been captured since then.
- Ø Reimel Creek 3.8 This reach is located in a meadow a short distance downstream of Wallace Creek. It was sampled in 1990-92, 2000-03 and 2011. The fish population in Reimel Creek 3.8 has experienced similar changes as the population in Reimel Creek 2.6. Prior to the 2000 fires, brook trout outnumbered westslope cutthroat trout in Reimel Creek 3.8 by about a 3 to 1 ratio. Since the 2000 fires, that situation has flip-flopped with westslope cutthroat trout now dominating the population (77 cutthroat captured in the reach in 2011) with only a few brook trout (5 brook trout captured in the reach in 2011). Brown trout have not been detected in Reimel Creek 3.8.
- Ø Rye Creek 6.6 This reach is located near the Forest boundary above the North Rye confluence. It was sampled in 2001-05 and in 2011. In 2005, westslope cutthroat trout numbers recovered to near pre-mudslide levels and have remained so through 2011. After the 2001 mudslides, the numbers of cutthroat trout and brook trout dropped substantially. In 2002, both brook and cutthroat trout were observed, but there were very few brook trout. No brook trout were found in this reach in 2003 or 2004, which is somewhat odd because brook trout were common and increasing upstream of this reach (in Rye Creek 12.4). In 2005 and 2011, a small number of brook trout were observed.
- Ø Sheep Creek 0.2 This reach is located near the mouth. It was sampled in 1991, 2008, and 2013. Westslope cutthroat trout and bull trout numbers were similar in all years. A brook trout was found in the reach for the first time in 2013. Fish population changes were not evident in 2013 as a result of the 2012 Mustang Complex fire.
- Ø Sheephead Creek 0.2 This reach is located near the Sheephead Creek trailhead. It was sampled in 2004-06 and 2012. Westslope cutthroat trout are abundant in the reach; bull and brook trout are common; and brown trout are incidental and rare. One large (24 inches in length) migratory bull trout spawner was observed in the reach in late August, 2005. The number of westslope cutthroat and bull trout has remained stable and the number of brook trout was higher than average in 2012.
- Ø Skalkaho Creek 5.8 This reach is located immediately upstream of the Big Ditch siphon. It was sampled in 1996 and 2010. The population estimates for brown trout and westslope cutthroat trout were similar in these years.
- Ø Skalkaho Creek 13.1 This reach is located near the Forest boundary. It was sampled in 1991-92, 1994, 1998-99, 2001, 2003, and 2013. The population estimates for westslope cutthroat in larger sizes increased after catch and release regulations were implemented and have been stable since. The number of bull trout has remained stable since sampling began. The number of brown trout has increased but only slightly since sampling began.
- Ø Skalkaho Creek 16.8 This reach is located near the Railroad Creek confluence. It has been sampled every year since 1989. Bull trout and westslope cutthroat trout population numbers are similar to pre-2000 fire levels. The number of larger westslope cutthroat trout and bull trout increased between 2000-11 with the implementation of catch and release fishing regulations. However the number of cutthroat longer than 10 inches has declined in the past two years. The number of bull trout has remained stable.
- Ø Sleeping Child Creek 10.2 This reach is located near the Sleeping Child Hot Springs. It has been sampled every year since 1989. In 2001, post-fire mudslides killed most of the fish in the reach. The westslope cutthroat trout population recovered to its pre-mudslide level in 2004-05. In the past few years, the number of westslope cutthroat has been stable, bull trout have declined and leveled off, and brown trout have increased significantly.
- Ø Swift Creek 0.7 This reach is located near the Swift Creek trailhead. It was sampled in 1996, 2001-03, and 2012. The reach was unburned in 2000, but much of the watershed upstream of the reach was burned at high severity. In 2012, the population of westslope cutthroat was similar to past years, but the number of bull trout was lower than most years.
- Ø Tepee Creek 0.9 This reach is located near the Forest boundary and is closely paralleled by Forest Road 5778. It was sampled in 2005-07, 2011, and 2012 (Figure 8). The sampling that occurred in 2005-07 was to gather pre-timber harvest baseline population data for monitoring the effects of the Tepee Blend timber sale

(NEPA was the Middle East Fork EIS). Tepee Blend timber harvest and log hauling occurred in the Tepee Creek drainage in summer, 2011. In 2011 and 2012, after harvest and hauling was completed, the reach was sampled again to compare population changes to the 2005-07 baseline data. In 2011-12, the number of westslope cutthroat trout captured in the reach was on the upper end of the 2005-07 pre-harvest baselines (Figure 8). Tepee Creek is a very small stream (2-3' base flow wetted width) that contains low numbers of small (3-5 inch) westslope cutthroat trout. Low flows, drought, and time of year when sampling occurs affects the number of westslope cutthroat trout that are present in the reach. The number of westslope cutthroat trout > 3 inches captured in the reach was 8 (2005), 0 (2006), 10 (2007), 7 (2011), and 15 (2012) (Figure 8). We were able to calculate population estimates in 2005 (9 cutthroat > 3 inches per 1000 feet of stream), 2007 (10 cutthroat), and 2011 (6 cutthroat). We captured no fish in the 2006 survey. The average number of westslope cutthroat trout captured in the post-harvest years (11 fish) was higher than the average number captured during the 2005-07 pre-harvest years (6 fish). Our monitoring data supports the prediction made in the Middle East Fork EIS that we would be unable to detect changes in the cutthroat population in Tepee Creek as a result of implementing the Middle East Fork timber sales.

Figure 8 – Number of Westslope Cutthroat Trout > 3 Inches Captured in the Tepee Creek 0.9 Monitoring Reach, Before (2005-07) and After (2011-12) Tepee Blend Timber Harvest and Log Hauling



- Ø Threemile Creek 8.3 This reach is located on private land just upstream of the junction with Wheelbarrow Creek. It was sampled in 2004 and 2010. The purpose of the 2010 sampling was to follow-up on the effect that riparian fencing done in 2004 may have had on the fishery. Brook trout were extremely numerous (over 600 marked in 1000 feet of stream) and cutthroat trout were relatively uncommon (7 marked). Compared to 2004, these numbers were four times higher for brook trout and almost double for cutthroat.
- Ø Threemile Creek 10.0 This reach is located just upstream of the site known as Four Corners. It was sampled in 2004 and 2010. The reach is fenced to limit cattle use, but cattle had obviously been in the fenced-off area as could be seen by the grazed nature of the site. In 2010, brook trout were abundant (170 marked in 1000 feet) and cutthroat were common (48 marked) in the reach. These numbers were about half of what was found in 2004.
- Ø Threemile Creek 12.6 This reach is located just downstream of the Threemile Game Range on Bitterroot National Forest property. It was sampled in 2006 and 2012. The fish in this reach are predominantly westslope cutthroat trout, with brook trout also present in moderate numbers. The populations of both species had increased between 2006 and 2012.
- Ø Tin Cup Creek 7.2 This reach is located about one mile upstream of the Tincup trailhead on private land. It was sampled in 1992 and 2010. The number of brook trout and westslope cutthroat was lower in 2010 than in 1992, but the number of brown trout handled was larger.
- Ø Watchtower Creek 0.1 This reach is located near the Road 468 bridge. It was sampled in 2004-06, and 2012. Westslope cutthroat trout are abundant in the reach; bull and brook trout are generally uncommon; and brown and rainbow trout are incidental and rare. The fish populations in the reach were similar during 2004-06 and 2012.

- Ø <u>West Fork Bitterroot River 1.2</u> This reach is located between the Trapper Creek Job Corps Center and Conner. It was sampled in 1986, 1995, 1997-98, 2002, 2007 and 2011. Since catch and release for cutthroat trout was initiated around 1991, the population of westslope cutthroat has increased, but in 2011 the estimate was lower than the peak. In 2011, the rainbow trout population was lower than previous estimates. The brown trout population appears to be increasing over time.
- Ø <u>West Fork Bitterroot River 34.0</u> This reach is located a short distance upstream of Deer Creek. It was sampled in 1991-92, 1995, 1998-99, and 2010. In 2010, the number of westslope cutthroat trout was similar to the late 1990's but lower than earlier estimates. Brook trout numbers have fluctuated significantly in this reach. In 2010, the number of brook trout captured was low.
- Ø <u>West Fork Camp Creek 0.3</u> This reach is located in the lower end of the West Fork of Camp Creek. It is periodically grazed by livestock in the Waugh Gulch grazing allotment. The reach was sampled in 1993, 2001-03, 2007 and 2011. Westslope cutthroat trout are common and the population appears to be stable. Cutthroat numbers since 2000 have generally been higher than 1993. Bull trout and bull trout X brook trout hybrids are incidental (0-3 fish captured per year) in the reach. Two bull trout and one bull trout X brook trout hybrid were captured in 2011. Brook trout are less common than westslope cutthroat trout in the reach, but much more common than bull trout. More brook trout were captured in 2011 (24 fish) than 2007 (5 fish).
- Ø <u>Woods Creek 0.9</u> This reach is located about a mile upstream from the mouth. It was sampled in 1996-97, 2001-03, 2008, and 2012. The upper end of the reach was burned at low severity by the 2011 Saddle Complex fire. Extensive moderate and high severity fire occurred upstream of this reach. The westslope cutthroat trout population has been stable in all years. The 2012 westslope cutthroat trout estimate was similar to past years. Bull trout have declined considerably since the late 1990's, while brook trout have increased. In 1996-97, the estimated number of brook trout > 4 inches was only 14 (1997) and 16 (1996). By 2012, that number had increased to 70. Bull trout X brook trout hybrids are also present in this reach. The 2012 data suggests that fish populations in the reach were not significantly affected by the 2011 Saddle Complex fire. The bull trout decline and concurrent brook trout increase that we observed in 2008 and 2012 appears to have been occurring for at least several years prior to the 2011 fire.
- Ø <u>Woods Creek 4.4</u> This monitoring reach was established in upper Woods Creek a few weeks after high severity fire (2011 Saddle Complex Fire) burned the area. It was sampled in 2011, 2012, and 2013. The purpose of the reach is to monitor the post-fire recovery of fish populations in Woods Creek. The fire caused a large fish kill in the severely burned portion of Woods Creek. In 2011, a couple of months after the fire, only 16 westslope cutthroat trout and 4 bull trout were captured in two passes in the 1000 foot reach. In 2012, the number increased to 43 westslope and 15 bull trout. In 2013, it was much higher at 165 westslope and 50 bull trout. In 2011, all of the fish captured were > 5 inches in length. In 2012, a few 3-4 inch juveniles were captured, but most of the fish were > 5 inches. In 2013, young-of-the-year westslope and bull trout were common along the stream margins. No brook trout were found in 2011, 2012, and 2013.

In addition to the population estimates described above, numerous presence/absence electrofishing and snorkel surveys were conducted across all districts of the Forest in 2010-2013. Researchers from the University of Montana and the Rocky Mountain Research Station also conducted electrofishing and snorkel surveys on the Forest in 2010. Species presence/absence and relative abundance levels are recorded in a Forest-wide database that is maintained by MFWP biologists in Hamilton. Forest-wide presence/absence of bull trout and westslope cutthroat trout has also been mapped on GIS. A few notable presence/absence electrofishing and snorkel projects that were conducted in 2010-2013 are described below in greater detail.

<u>Saddle Complex Post-Fire Fish Presence/Absence Surveys</u>

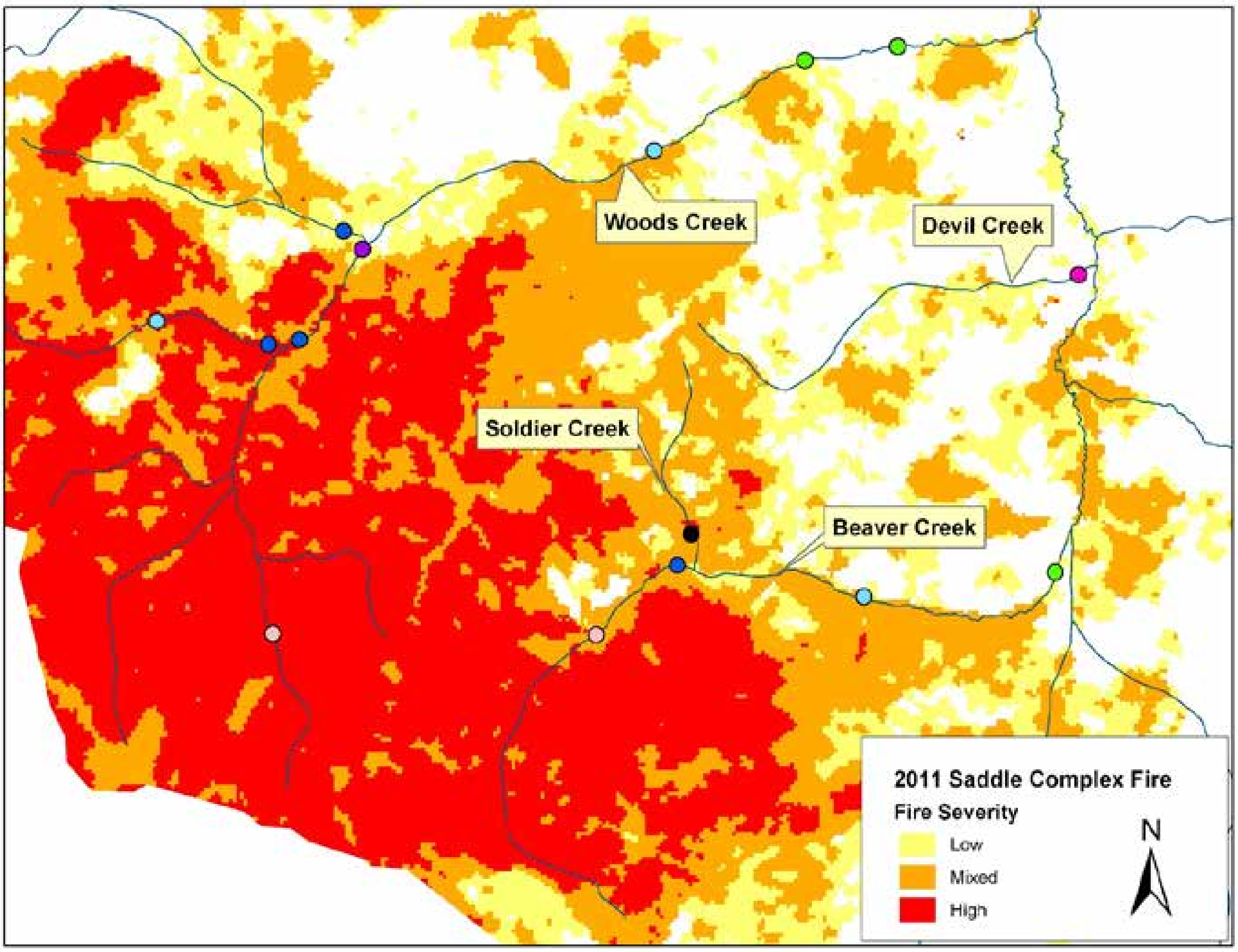
In 2011, Forest fisheries biologists electrofished all of the sites in the Saddle Complex fire area (Beaver, Woods, Soldier, and Devil creeks) where a pre-fire electrofishing survey had been conducted. This amounted to a total of 15 survey sites, which are displayed below as the colored dots in Figure 9. The distribution of westslope cutthroat trout was the same before the fire and after the fire – westslope cutthroat trout were present one year after the fire at all 15 surveys sites, albeit at lower densities in the high severity areas.

The distribution of bull trout and brook trout showed some changes one year after the fire, and these changes are displayed with the colored dots in Figure 9. The colored dots indicate:

- green dots are sites where both bull trout and brook trout were present before and after the fire
- dark blue dots are sites where bull trout were present before and after the fire, and brook trout have not been found

- light blue dots are sites where bull trout were present before and after the fire, but brook trout were found for the first time after the fire
- the purple dot is a site where both bull trout and brook trout were present before the fire, but only bull trout were found after the fire
- rose-colored dots are sites where neither bull trout or brook trout were found before the fire, but bull trout were found for the first time after the fire
- the magenta dot (lower Devil Creek) is a site where neither bull trout or brook trout were found before the fire, but both species were found for the first time after the fire
- the black dot (Soldier Creek) is a site where bull trout were found before the fire and brook trout were not, but neither species was found after the fire

Figure 9 - Distribution of bull trout and brook trout before and one year after the 2011 Saddle Complex Fire



The data in Figure 9 conveys a mixed message. Overall, bull trout were generally present in the same sites that they had been before the fire. We found bull trout in 11 of the 12 sites where they had been found before the fire. The only site where we could not find them was in Soldier Creek, which was burned at mixed severity upstream of a known fish passage culvert barrier. Interestingly, we found a few bull trout for the first time in 3 sites, two of which were high severity sites in the upper reaches of Woods and Beaver creeks. The other site was the lower end of Devil Creek, where two juvenile bull trout were found. We found brook trout at 3 of the 4 sites where they had been found before the fire. In addition to those sites, an incidental adult brook trout was found for the first time in 3 sites after the fire – one site in the middle part of Woods Creek (1 fish), one site in the severely burned headwaters of Woods Creek (1 fish), and one site in the middle part of Beaver Creek (1 fish). This may indicate attempts to invade and colonize previously unoccupied upstream habitats. Similar with bull trout, two juvenile brook trout were also found in the lower end of Devil Creek. Bull trout-brook trout trends in the long-term fish population monitoring reaches located near the mouths of Woods (river mile 0.9) and Beaver (river mile 0.3) are not consistent. At Woods Creek river mile 0.9, bull trout have been declining since the late 1990's, while brook trout are increasing. At Beaver Creek river mile 0.3, bull trout numbers have been stable while brook trout have remained rare and incidental since the early 1990's.

Mustang Complex and Chrandal Creek Post-Fire Fish Presence/Absence Surveys

In 2013, Forest fisheries biologists electrofished all of the sites in the Mustang Complex fire area (Sheep and Johnson Creeks) and Chrandal Creek fire area (Mine and Chrandal Creeks) where a pre-fire electrofishing survey had been conducted. This amounted to a total of 17 survey sites. Fish species distributions and population numbers in 2013 were similar to pre-fire observations. We did find one brook trout in Sheep Creek which was the first documented sighting of that species in that stream.

Camp Creek Longitudinal Fish Presence/Absence Surveys

Since the Camp Creek 2.3 section has experienced a significant increase in the number of brown trout captured in the section, we sampled upstream in 2012 and 2013. Single pass electrofishing surveys were conducted at stream miles 4.2, 5.1, 5.7 and 6.6. One brown trout was captured at stream mile 4.2 in 2012 and 2013. No brown trout were captured upstream of stream mile 4.2.

Sleeping Child Creek Longitudinal Fish Presence/Absence Surveys

Since the Sleeping Child Creek 10.2 has experienced a significant increase in the number of brown trout captured in the section, we sampled upstream in 2012 and 2013 (Table 3). Single pass electrofishing surveys were conducted at stream miles 11.0, 12.0, 13.0, 14.5 and Divide Creek 0.1 in 2012 and 2013. Brown trout were captured upstream in Sleeping Child Creek as far as stream mile 13.0. Brown trout have not been captured at the confluence of Sleeping Child and Divide creeks, which is at stream mile 14.5.

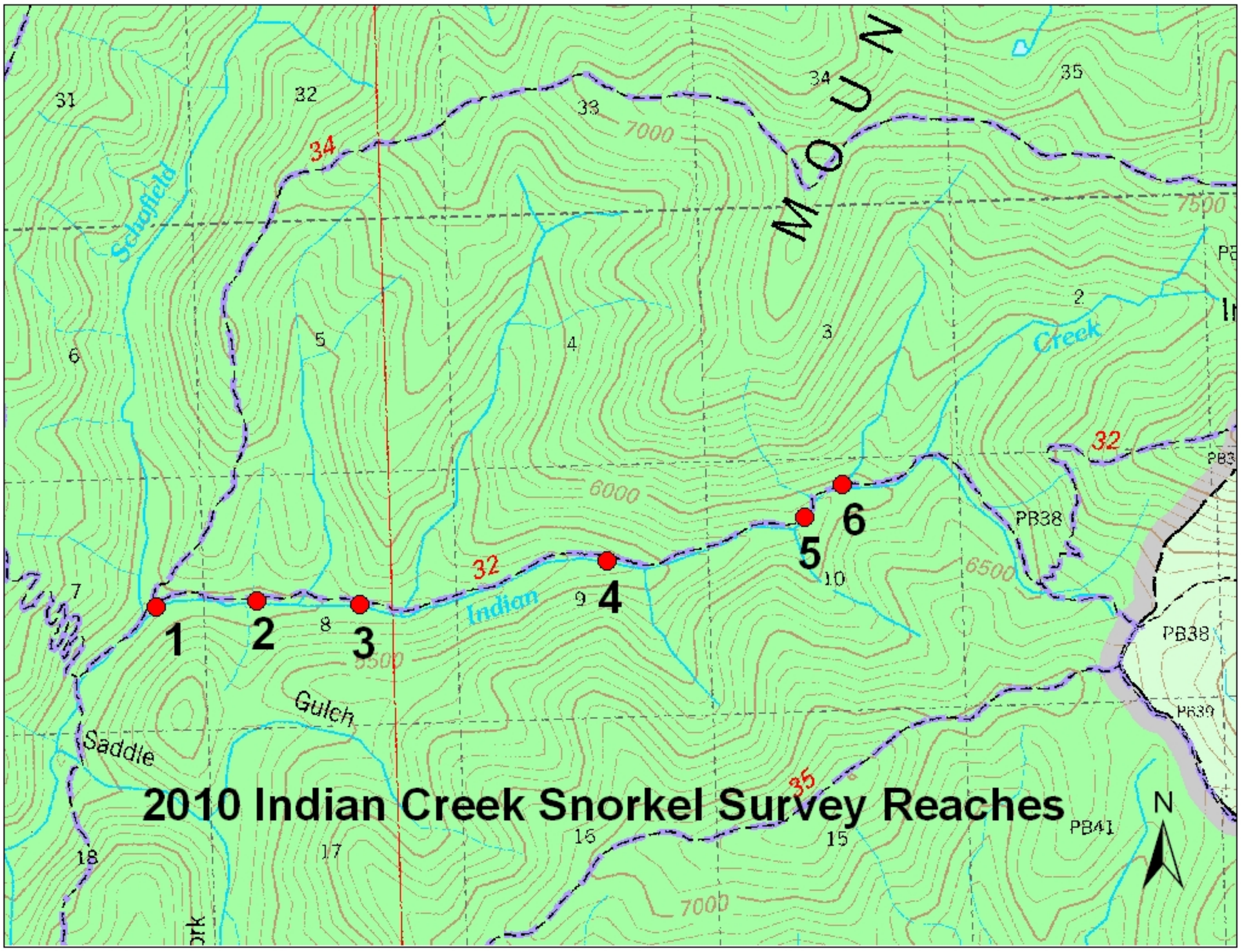
Table 3- The number of brown trout captured in single pass electrofishing sections of Sleeping Child Creek and Divide Creek in 2012 and 2013.

Stream Mile (length in feet)	2012	2013
Sleeping Child Creek 11.0 (300)	Not sampled	7
Sleeping Child Creek 12.0 (351)	4	Not sampled
Sleeping Child Creek 13.0 (300)	2	7
Sleeping Child Creek 14.5 (340)	0	0
Divide Creek 0.1 (330)	0	0

Indian Creek Snorkel Survey

In late July 2010, Forest fisheries biologists conducted a backcountry presence/absence snorkel survey in the upper half of the Indian Creek drainage. The purpose of the survey was to map the current distribution and relative abundance of salmonid species (particularly bull trout, steelhead, and chinook salmon), and compare it with the distribution and abundance data that was collected the last time the area was snorkeled (1993 R1/R4 basinwide survey). In 2010, we snorkeled six 50-meter long reaches in the upper half of Indian Creek between the Schofield Creek confluence and the upper headwaters. The 2010 reaches were located in the same areas that were snorkeled in 1993. Figure 10 displays the locations of the 2010 reaches.

Figure 10 – Locations of 2010 snorkel surveys in Indian Creek



Salmonid distributions were similar in 2010 and 1993. Bull trout, juvenile steelhead, and westslope cutthroat trout were found in all six snorkel reaches, as they were in 1993. Juvenile chinook salmon were not seen in any of the 2010 snorkel reaches, nor were they in 1993. In 2010, sculpins were observed in reaches #1 and #3, and tailed frog adults and larvae were observed in reaches #3 and #5. Both species were also noted in the 1993 survey.

Overall abundance of salmonids was similar in 1993 and 2010. The 1993 survey counted more juvenile steelhead than westslope cutthroat trout, while the 2010 survey counted more westslope cutthroat trout than juvenile steelhead. Because the two species are difficult to distinguish and are often confused with each other, it is impossible to tell if real changes have occurred or if the difference is caused by observer bias. In 2010, westslope cutthroat trout were the most numerous species observed in five of the six reaches. A total of 78 westslope cutthroat trout and 18 juvenile steelhead 0-200 mm in length were counted in 300 m of Indian Creek. Bull trout were the most numerous species observed in reach #5, and bull trout numbers tended to increase as one moved upstream towards the headwaters. A similar pattern occurred in 1993. In 2010, a total of 20 bull trout 0-200 mm in length and one bull trout 200-300 mm in length were observed in 300 m of Indian Creek.

These are the key findings of the Forest's fish population monitoring

- Westslope cutthroat trout populations across the Forest appear to be stable and strong in most streams. Westslope cutthroat trout are present in nearly every fish-bearing reach on the Forest, and are the most common species by far and away. At least at this time, there is no evidence that climate-driven water temperature increases are causing declines in westslope cutthroat trout populations.
- Bull trout populations appear to be declining in most of the Forest's core area streams. The declines first became evident around 2006. The sharpest declines have occurred in the East Fork Bitterroot River and Warm Springs Creek. Both of these streams rely on migratory bull trout to maintain production and

recruitment, and the number of migratory bull trout in the East Fork drainage has declined in our samples since 2000. Of all of the East Fork tributary bull trout populations, the populations in Meadow Creek and Clifford Creek may be the strongest. The status of the resident bull trout populations on the Forest varies by drainage. The bull trout population in Sleeping Child Creek is declining while the brown trout population is expanding. The bull trout population in the Rye Creek drainage appears to be extirpated. The last bull trout sighting occurred in upper Rye Creek a couple of weeks after the 2000 fires. The bull trout populations in Skalkaho and Daly Creeks appear to be stable with good numbers in all size classes. The bull trout populations above Painted Rocks Dam do not show clear trends at this time. Water temperatures have been increasing in Forest streams since 1993 due to climatic warming. If temperatures continue to rise in future years, modeling predicts that bull trout distribution on the Forest will shrink, with the lowest elevations losing their bull trout first.

- Brown trout are increasing their numbers and distributions in the East Fork Bitterroot River, the West Fork Bitterroot River below Painted Rocks Dam, in Sleeping Child Creek, and in the lower ends of some of the warmer tributaries to the East Fork such as Camp and Cameron Creeks. The expansion of brown trout is occurring at the same time that some of the Forest's bull trout populations are declining. Increasing water temperatures are suspected to be an important factor driving the brown trout expansion. Large numbers of brown trout in the lower East Fork are believed to be detrimental to the survival and recruitment of juvenile migratory bull trout.
- For the past couple of decades, Forest and FWP biologists have considered brook trout to be the biggest non-native fish threat to bull trout. In recent years, however, our thinking has changed somewhat. Brown trout have increased their numbers and distribution in several streams in recent years, and may pose more of a long-term threat to bull trout than brook trout do. Warmer water caused by climatic warming is expected to favor brown trout over bull trout. In many streams where they occur together with native trout, brook trout do not appear to be expanding their numbers or distribution.
- Thirteen years after the 2000 fires, westslope cutthroat trout populations are larger and more robust than they were pre-fire in most of the streams burned at high or moderate severity. The bull trout story is a mixed bag. The bull trout populations in Meadow and Skalkaho Creeks are similar to their pre-fire abundance levels, but declines have occurred in the Sleeping Child and Warm Springs Creek populations and the bull trout population in upper Rye Creek appears to be extirpated. The bull trout populations in Laird, Little Blue Joint, and Chicken creeks are too small and incidental to distinguish trends. Most of the brook trout populations in the streams burned at high or moderate severity have still not recovered to their pre-fire abundance levels. A few of the brook trout populations (Praine, Little Blue Joint, and Chicken Creeks) have regained their pre-fire abundance level in recent years.
- Westslope cutthroat trout were present in all (15 of 15) of the Saddle Complex Fire sites where they had been found before the fire, albeit at lower densities in the high severity sites. Bull trout were present in 11 of the 12 sites where they had been found before the fire. Bull trout may have been extirpated from Solider Creek upstream of the Road 091 fish barrier culvert. Bull trout were found for the first time in 3 sites after the fire – two of those sites were located in the severely burned headwaters of Beaver and Woods creeks. Brook trout were found at 3 of the 4 sites where they had been found before the fire. In addition to those sites, an adult brook trout was found for the first time in 3 sites after the fire – one site in the middle part of Woods Creek (1 fish), one site in the severely burned headwaters of Woods Creek (1 fish), and one site in the middle part of Beaver Creek (1 fish). This may indicate attempts to invade and colonize previously unoccupied upstream habitats. Bull trout-brook trout trends in the long-term fish population monitoring reaches located near the mouths of Woods (river mile 0.9) and Beaver (river mile 0.3) are not consistent. At Woods Creek river mile 0.9, bull trout have been declining since the late 1990's, while brook trout are increasing. At Beaver Creek river mile 0.3, bull trout numbers have been stable while brook trout have remained rare and incidental since the early 1990's.
- Significant changes in fish distributions and numbers were not found in Sheep, Johnson, Mine, and Chrandal creeks in 2013, one year after the 2012 Mustang Complex and Chrandal Creek fires.
- Snorkel surveys indicate that the salmonid populations in the upper Indian Creek drainage have changed little between 1993 and 2010

MOUNTAIN LAKE SURVEYS:

Forest and MFWP fisheries biologists surveyed the following mountain lakes in 2010-2013:

- Tin Cup Lake, Darby Ranger District (2010)

- Kerlee Lake, Darby Ranger District (2010)
- Goat Lake, Darby Ranger District (2010)
- Piquett Lake, West Fork Ranger District (2010)
- Shelf Lake, West Fork Ranger District (2010)
- Slate Lake, West Fork Ranger District (2010)
- Hart Lake, Darby Ranger District (2011)
- Tamarack Lake, Darby Ranger District (2011)
- Chaffin Lake, Darby Ranger District (2011)
- Unnamed lakes in Chaffin Creek drainage, Darby Ranger District (2011)
- Peterson Lake, Stevensville Ranger District (2012)
- Duffy lake, Stevensville Ranger District (2012)
- Holloway Lake, Stevensville Ranger District (2012)
- Mills Lake, Stevensville Ranger District (2012)
- Pass Lake, Sula Ranger District (2012)
- Capri Lake, Sula Ranger District (2012)
- Lost Horse Lake, Darby Ranger District (2013)
- White Lake, Darby Ranger District (2013)
- Kelly Lake, Sula Ranger District (2013)
- Hidden Lake, Sula Ranger District (2013)
- Ripple Lake, Sula Ranger District (2013)

Tables 4 and 5 summarize the physical and biological data collected in the mountain lake surveys.

Table 4- Summary of physical data collected during mountain lake surveys.

Lake	Acres[1]	Elev (ft)[2]	Max. Depth (ft)	Secchi Depth (ft)	Temp. at Surface (°F)	Temp. at Shoreline (°F)	Temp. at 5 ft (°F)	Temp. at Max Depth (°F)
Tin Cup	112	6300	137	21	59 @ 1200	n/m	n/m	38.4 @ 64 ft3
Kerlee	42	7000	73	31	67.2 @ 1400	n/m	n/m	41.3 @ 64 ft3
Goat	3.6	7100	12	8.3	62.6 @ 1100	n/m	n/m	58.6 @ 11.8 ft
Piquett	5.3	8001	17.7	n/m	59	n/m	n/m	43.8 @ 17.7 ft
Shelf	7.8	7687	16	n/m	72 @ 1100	n/m	n/m	50 @ 16 ft
Slate	4.7	8033	6.5	n/m	n/m	n/m	n/m	44 @ 6.5 ft
Hart	11	7360	12	>12	n/m	n/m	59	55.7 @ 10.1 ft
Tamarack	28	7437	63	27.3	n/m	55 (outlet) 50 (inlet)	55	41.0 @ 56.4 ft
Chaffin	8.4	7520	32	28	n/m	n/m	48	42.0 @ 20 ft
Unnamed, Chaffin 4	2.3	7513	6.4	n/m	n/m	485	52	49.2 @ 5.9 ft
Upper Pond 6	0.25	8390	n/m	n/m	n/m	42	n/m	n/m
Peterson	16	6511	17	>17	n/m	n/m	61.5	58.5 @ 16 ft
Duffy	15	7343	56	26	n/m	n/m	55.4	40.6 @ 49.5 ft
Holloway	19.5	7809	89	28	n/m	n/m	52.8	39.5 @ 80.3 ft
Mills	7	7821	30	26	n/m	n/m	44.6	42.4 @ 28.2
Pass	4.7	6683	4.5	n/m	n/m	n/m	n/m	n/m
Capri	4.7	6624	6.0	n/m	60 @ 1200	n/m	64.4	60 @ 6.0 ft
Lost Horse	36	7140	48	23	n/m	n/m	68.3	48.6 @ 35 ft
White	17	6970	151	n/m	n/m	62.6	n/m	56.3 @ 30 ft
Kelly	6.2	8032	10.1	10.1	73 @ 1400	n/m	67.2	66.5 @ 10.1 ft
Hidden	11.0	8237	40.0	25.0	77 @ 1250	62.2 @ 1252	62.2	44.2 @ 40.0 ft
Ripple	8.2	7845	17.7	17.0	n/m	n/m	64.7	63.3 @ 17.7 ft

1 –From NAIP2009Imagery, with ArcMap10. 2–Taken from Google Earth. 3–Instrument quit working at that depth. 4-Unnamed lake adjacent to Chaffin Lake. 5–Handheld thermometer at 1300 hrs, unsure why so cold, possible spring nearby. 6-Lowermost of the series of ponds above Chaffin Lake. n/m = not measured.

Table 5- Summary of biological data collected during mountain lake surveys.

Lake	Fish Present	Catch per Angler Hour	Most Recent Fish Stocking	Trout Life Stages Observed or Limiting Factors	Amphibians in or Near Lake
Tin Cup Lake	Rainbow & Cutthroat Trout, & CTxRB Hybrids	6 Fish/Angler Hr. (150 fish in 24hrs.; Range 4 to 12")	1942 Rainbow Trout	Fry, juveniles, & adults present. Good spawning habitat in inlet stream.	0
Kerlee Lake	Cutthroat Trout	1.7 Fish/Angler Hr. (31 fish in 18 hrs; Range 5 to 18")	1990 Westslope Cutthroat Trout	Fry, juveniles, & adults present. Marginal spawning habitat near outlet.	0
Goat Lake	None	0 fish in 3 hrs	None	none	0
Piquett	Westslope Cutthroat Trout	0.16 fish/hour, from 6-14 inches long	2008 Westslope Cutthroat Trout	Only adults seen (no suitable spawning habitat)	None observed
Shelf	None	0 fish in 4 hours of gill netting and 2 hours of fishing	1983 Westslope Cutthroat Trout	none (no suitable spawning habitat)	Numerous juvenile long-toed salamanders
Slate	None	n/a	No record of stocking	none (too shallow)	Numerous Columbia spotted frogs, 1 long-toed salamander adult
Hart Lake	Cutthroat Trout	7.4 Fish/Angler Hr. 81 fish in 11 hrs; Range 3.5 – 10"	No Data	Juveniles & adults present. Good spawning habitat in or near inlet streams and near dam.	Spotted Frogs (3 juveniles in marshes near southern shore)
Tamarack Lake	Cutthroat Trout	3.6 Fish/Angler Hr., 51 fish in 14 hrs; Range 5 - 11.5"	1990 with 1500 WSCT	Juveniles & adults present. Very little spawning habitat in or near inlet stream from Chaffin Lake. Some spawning near dam possible, but not observed.	0
Area downstream of Chaffin Lake[1]	Cutthroat Trout	4.3 Fish/Angler Hr., 15 fish in 3.5 hrs; Range 5 - 9.5"	See Chaffin	Juveniles & adults present. Spawning occurring in inlet from Chaffin near dam.	5 Adult Spotted Frogs

Lake	Fish Present	Catch per Angler Hour	Most Recent Fish Stocking	Trout Life Stages Observed or Limiting Factors	Amphibians in or Near Lake
Chaffin Lake	Cutthroat Trout	6.7 Fish/Angler Hr., 47 fish in 7 hrs; Range 3.5 – 10.5”	1990 with 500 WSCT	No inlets for spawning. Easy passage by trout to & from area downstream of Chaffin Lake	0
Ponds in upper watershed	0	No fish present based on observations from shore	None	N/A	0
Peterson	Rainbow, Cutthroat, and Hybrids	5.8 Fish/Angler Hr. (87 fish in 15 hrs; Range 4.5 to 14”)	1983 WSCT	All life stages present. Spawning in inlet	Columbia Spotted Frog Adults
Duffy	Cutthroat Trout	1.2 Fish/Angler Hr. (15 fish in 13 hrs; Range 8 to 16”)	2008 WSCT; 1940 Rainbow	No redds or young of the year observed	Columbia Spotted Frog Juveniles and Adults
Holloway	Cutthroat Trout	0.1 Fish/Angler Hr. (1 fish in 9 hrs; 16”)	2008 WSCT	Only Adults observed. No spawning habitat found.	1 Columbia Spotted Frog Adult seen
Mills	0	0 Fish/Angler Hr. (0 fish in 1.5 hrs)	1983 WSCT	No fish seen	0
Pass	Cutthroat Trout	0 fish in 1.5 hours. Only 2 fish observed from shore	No record of stocking	Only 2 fish observed (shallow and no spawning habitat), lake level appears to fluctuate substantially	Abundant Columbia spotted frogs (adults, tadpoles), Western toad (tadpoles) and larval salamanders.
Capri	Westslope & Yellowstone Cutthroat Trout	17.5 fish/Angler Hr., 21 fish in 1.20 hrs; Range 5.5-14”	No record of stocking	Juveniles & adults present. Marginal spawning habitat in inlet.	Columbia spotted frog (all life stages), Western toad adult
Lost Horse	Cutthroat trout	1.5 fish/Angler Hr., 20 fish in 13 hrs; Range 8 - 14”	1941 Yellowstone cutthroat	Redds in primary inlet stream. Did not see juvenile fish. Adults common.	Columbia spotted frog adults common
White	0	0	0	No fish seen	0

Lake	Fish Present	Catch per Angler Hour	Most Recent Fish Stocking	Trout Life Stages Observed or Limiting Factors	Amphibians in or Near Lake
Kelly	None	No fish present based on snorkeling and observations from shore	No record of stocking	none (no suitable spawning habitat)	Abundant Columbia spotted frogs, all life stages present
Hidden	Rainbow & Cutthroat Trout, & CTxRB Hybrids	8.5 Fish/Angler Hr. 19 fish in 2.25 hrs; Range 6-15"	1995 with 3000 WSCT	All size classes of fish observed except YOY. Spawning occurring in outlet, redds visible.	None observed
Ripple	Rainbow Trout	3.7 Fish/Angler Hr. 13 fish in 3.5 hrs; Range 7.5-15"	1995 with 1500 WSCT	Inlets too steep, outlet has spawning potential, none observed.	Columbia spotted frog, Western toad tadpoles

1 – A lake-like area separated from Chaffin Lake by low gradient riffles.
2 –Based on Montana FWP information - MFISH. WSCT = Westslope Cutthroat Trout

In August 2010, Forest biologists surveyed Tin Cup Lake, Kerlee Lake, and Goat Lake on the Darby Ranger District. Tin Cup Lake and Kerlee Lake are morphologically similar, sitting at the base of high glacially scoured granite cliffs. These lakes are deep: 137 feet in Tin Cup Lake, and 73 feet in Kerlee. Goat Lake, though adjacent to Kerlee Lake, is very different being surrounded by timber in an alpine basin has a depth of 12 feet and was fishless.

In June and July, 2010, Forest and MFWP biologists surveyed Piquett, Shelf, and Slate Lakes on the West Fork Ranger District. These lakes are located in the headwaters of the Piquett Creek (Piquett and Shelf) and Slate Creek (Slate) drainages near Piquett Mountain. The lakes are located within ½ mile of each other, and their elevations range from 7,687 to 8,033 feet. The lakes lie in glacially scoured cirque basins. Westslope cutthroat trout are present but uncommon in Piquett Lake, while Shelf and Slate Lakes appear to be fishless. The westslope cutthroat trout in Piquett Lake fall into two distinct size ranges – smaller fish around 8-10 inches in length and a few larger fish in the 14-16 inch class. Those fish are believed to be the survivors from the last two stockings which occurred in 2001 and 2008. Westslope cutthroat trout were also stocked in Piquett Lake in 1983, and cutthroat of undetermined genetics were stocked in 1952. Natural reproduction does not appear to be occurring in Piquett Lake, as suitable spawning habitat is not available.

There is no record of Slate Lake ever being stocked with fish. Slate Lake appears to be fishless and is probably too shallow to support fish. Slate Lake contains numerous Columbia spotted frogs (*Rana luteiventris*), and a concentrated breeding mat containing a couple hundred breeding adults was present along the shallow margins of the north shore of the lake. One adult long-toed salamander (*Ambystoma macrodactylum*) was also seen in the shallow outlet area of Slate Lake.

Shelf Lake was stocked with westslope cutthroat trout in 1983, and with cutthroat of undetermined genetics in 1939 and 1952. Shelf Lake appears to be fishless at this time and does not appear to contain suitable spawning habitat for fish. Juvenile long-toed salamanders are common in Shelf Lake. Shelf Lake is more turbid than Piquett or Slate Lakes, and contains abundant submerged large wood along its bottom. The submerged large wood appeared to provide good habitat for the juvenile long-toed salamanders.

In July 2011, Forest biologists surveyed Hart, Tamarack, and Chaffin lakes on the Darby Ranger District. Additionally, the relatively shallow pond between Tamarack and Chaffin lakes was surveyed and the ponds above the falls that feed Chaffin Lake were investigated. Cutthroat trout are abundant in the three named lakes in the Chaffin Creek basin. The cutthroat trout are at high densities, but generally less than 10 inches in length. Tamarack Lake had the largest trout; the biggest were just over 11 inches. Spawning activity in these lakes appeared to be at the peak during this late July survey, which seemed late for cutthroat trout. Trout moving out of Hart Lake (downstream) appear to be stocking upper Chaffin

Creek. At least some of the fish appear to survive the 26-foot falls below this lake that lands on bedrock. The small, fishless ponds upstream of Chaffin Lake were particularly scenic and valuable as a refuge from the effects of lakes historically stocked with fish. Amphibians were observed along Hart Lake and along the marshy area downstream of Chaffin Lake, but not near the fishless ponds. These upper unnamed fishless ponds were surrounded by snow or ice during our survey. Tables 3 and 4 summarize the physical and biological data collected during the mountain lake surveys.

In July 2012, Forest and MFWP biologists surveyed Capri and Pass lakes on the Sula Ranger District. These lakes are located in the headwaters of the Warm Springs Creek drainage and lie within 0.6 miles of each other. Capri is a moraine type lake surrounded by alpine vegetation and wet meadows near the inlet and outlet. Cutthroat trout of multiple sizes (size range 2-14") were common, easy to catch, and appeared to be westslope or yellowstone cutthroat trout or hybrids. Genetic samples (fin clips) were collected and have yet to be analyzed to determine the species. There are no records of Capri Lake being stocked so these fish may be the result of human induced fish introductions. Amphibians (Columbia spotted frog/tadpoles and Western toad) were observed along with one terrestrial garter snake. Pass Lake is located upstream from Capri Lake. There is no connection between the two lakes (the stream goes subterranean) except possibly during spring high flows. Pass Lake is a natural lake surrounded by a forest habitat which burned in 2007. There appear to be no inlets and the outlet likely only connects to Capri Lake during times of high water. The maximum recorded depth is 4.5 feet. Amphibians (frogs and toads) were abundant as was zooplankton and aquatic invertebrates. No fish were captured during angling but 1-2 fish were observed from shore. It is possible that these fish moved upstream from Capri Lake during spring flows when the two lakes may be connected. One American Coot was swimming on the lake during the survey.

In late July 2012 rainbow trout, cutthroat trout, or hybrids of these trout were present in three of four lakes surveyed in the Sweeney basin: Peterson, Duffy, and Holloway lakes, but not Mills Lake. All four lakes had been stocked with trout at least once since 1983.

High densities of trout were present in Peterson Lake, and between Peterson and Duffy lakes in the shallow swale pools of upper Sweeney Creek. The trout present in the swale pools or their predecessors probably endured substantial rocky falls in order to invade this upper section of Sweeney Creek from Duffy or Holloway lakes upstream. Trout in these high density populations were generally less than 10 inches in length, although an occasional larger trout was observed.

Holloway and Duffy lakes had larger trout than those landed in Peterson Lake; the biggest fish photographed was from Holloway Lake and was approximately 18 inches. Large fish in Duffy were observed, but not landed. Mills Lake appears to be fishless.

Redds and all age classes of trout were observed in Sweeney Creek in the area of Peterson Lake and the swale pools upstream. Duffy Lake contained fingerlings, and has not been stocked for four years, so some spawning must be successful. Only mature trout were seen in Holloway Lake leading to a supposition that there is no successful spawning occurring in Holloway Lake.

Trout moving out of Duffy or Holloway, in the downstream direction, appear to have invaded the upper reach of Sweeney Creek. Barriers to upstream movement would block trout moving from Peterson Lake to the swale pools, Mills, Holloway, and Duffy lakes.

Amphibians were most common at Peterson and Duffy Lake areas, rare around Holloway Lake and not observed around Mills Lake. It is possible that later in the summer more amphibians would have been observed at the two highest lakes (Holloway and Mills).

The upper South Lost Horse drainage lakes were surveyed in late August 2013. Lost Horse Lake and Fish Lake were the only lakes found to contain fish. Fish Lake was surveyed in 2007, so very little time was spent there in 2013. Lost Horse Lake contained slender cutthroat that appeared to be Yellowstone cutthroat based on their large spots. Fin clips were collected from several captured fish for genetic samples. Redds were present in the inlet stream, but no juvenile fish were observed. White Lake was incredibly deep (151 feet, measured with sonar) and apparently fishless. Koch Lake was not observed due to the difficult access. Hackney Lake was shallow, considered fishless, and was loaded with Columbia spotted frog tadpoles.

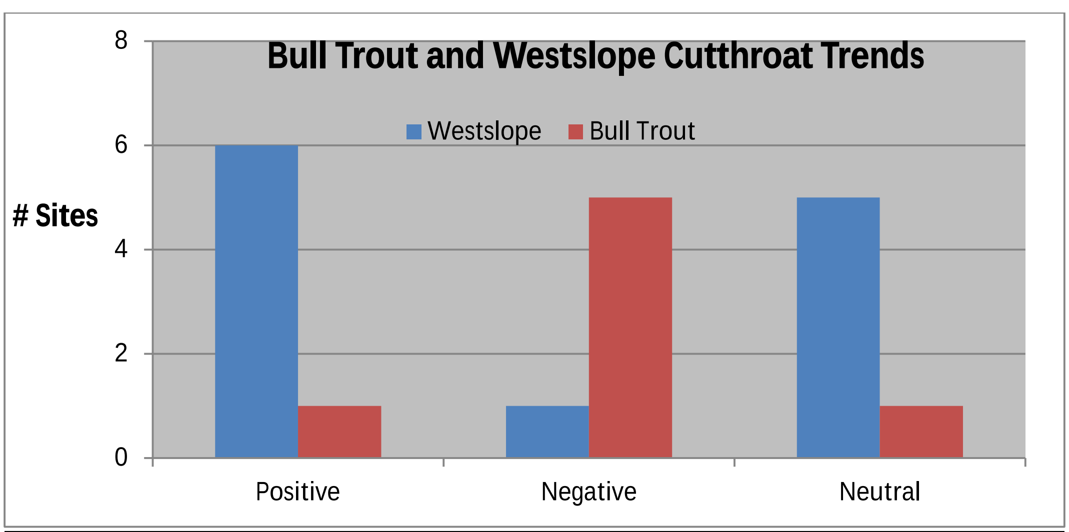
In July 2013, Forest and MFWP biologists surveyed Kelly, Hidden and Ripple lakes on the Sula Ranger District. These lakes are located in the headwaters of the East Fork Bitterroot River and lie entirely within the Anaconda-Pintler Wilderness. Kelly Lake is a cirque lake surrounded by wet meadows. Three inlets were observed, all were springs, 1-2 feet wide with 1-2 cfs of flow or completely dry. The outlet was approximately 15 feet wide, 5-7 inches deep, with 0.5-1 cfs of flow. The lake substrate is detritus, sand, and silts with heavy algae deposits on all substrate. The maximum recorded depth is 10.1 feet. No fish were observed. Columbia spotted frogs (all life stages) were abundant as were leeches, fairy shrimp (Branchiopoda), and aquatic invertebrates. One terrestrial garter snake was observed. There appears to be minimal impacts due to camping and stock. Hidden Lake is a cirque lake surrounded by alpine forest and boulder/talus slopes. The inlet is an intermittent channel near a rock headwall and the outlet is 10 feet wide with a depth of 10 inches and approximately 5 cfs of flow. The maximum recorded depth in Hidden Lake is 40 feet. Rainbow trout were introduced historically and westslope cutthroat trout were stocked in 1995. Fish of multiple sizes (6-15") were observed and captured. Genetic analysis indicates that these fish are a combination of pure westslope cutthroat trout and westslope cutthroat that are hybridized with rainbow trout. Redds were visible in the outlet so natural reproduction is occurring. No amphibians were observed. There is one main campsite near the outlet. Ripple Lake is a cirque lake surrounded by alpine vegetation and talus/boulder fields. There are two bedrock inlets that are very steep in gradient with 1-2 cfs of flow. The outlet is 10-35 feet wide with a flow of 2-3 cfs. There is possible spawning habitat in the outlet. The maximum recorded depth is 17.7 feet. Rainbow trout were introduced historically and westslope cutthroat trout were stocked in 1995. All fish captured appeared to be rainbow trout (size range 4-15"). Genetic analysis indicates these fish are from a hybrid swarm of westslope cutthroat trout and rainbow trout. Columbia spotted frogs and Western toad tadpoles were present along with a variety of aquatic invertebrates. There is evidence of one campsite near the outlet. Barrow's Goldeneyes were observed on all three lakes during the surveys.

VIABILITY OF BULL TROUT AND WESTSLOPE CUTTHROAT TROUT POPULATIONS:

The Forest Plan defined a fish population viability concern as a decline in aquatic habitat quality and/or fish population for more than one year (Item 21), and a 10 percent difference from projected cutthroat trout yield (Item 41). Research and monitoring of fish populations over the two decades on the Forest has shown the Forest Plan viability stated above is too narrow given the natural variation that occurs in fish populations. We have learned that the only way to define the upper and lower bounds of the natural variation in fish populations is through numerous years of population monitoring.

In 2011 and 2012, Forest and MFWP biologists sampled 12 fish population monitoring reaches where enough westslope cutthroat trout were captured to calculate a statistically-valid population estimate and there were enough years of population estimates (generally at least a 10-year period) to consider the site "long-term". Westslope cutthroat trout numbers were up by more than 10% of the long-term average in 6 reaches, within 10% of the long-term average in 5 reaches, and down by more than 10% of the long-term average in 1 reach (Figure 11). Seven reaches were sampled in 2011-2012 that had an estimable bull trout population or a long term data set that allowed comparison of catch per unit effort.

Figure 11 – Bull Trout and Westslope Cutthroat Trout Population Trends on the Bitterroot National Forest in 2011-2012



Westslope cutthroat trout populations are believed to be stable in most of the streams on the Forest, and the data in Figure 11 is consistent with that belief. Populations do fluctuate naturally over time, but the body of our monitoring data indicates a stable trend Forest-wide. An estimated 63% of the westslope cutthroat populations that have been tested on the Forest are genetically unaltered. Despite the presence of healthy populations in most Forest tributaries, the overall viability of westslope cutthroat trout in the Bitterroot River basin is considered to be "depressed", primarily because of the habitat fragmentation that occurs on private land between the Bitterroot River and its tributaries, and the reduced numbers of migratory adult fish in the river. A key problem is the lack of year-round connectivity between the Bitterroot River and its spawning and rearing tributaries on the east and west sides of the valley. Considerable efforts and funds have been expended in recent years to screen irrigation ditches, eliminate fish passage barriers, and secure instream flows in Skalkaho Creek, a key spawning and rearing tributary near Hamilton.

Bull trout populations are believed to be declining in most streams on the Forest. At best, bull trout population trends may be neutral in a few of the stronghold streams such as Skalkaho, Daly, and Meadow creeks. The decline of bull trout in some of the Forest tributaries (e.g. Warm Springs and Sleeping Child creeks) first became evident around 2005-06. Along with the decline in bull trout has been a concurrent expansion of brown trout populations. Over the past decade, brown trout populations have been expanding in the East Fork Bitterroot River, West Fork Bitterroot River, Sleeping Child Creek (Figure 12) and Camp Creek (Figure 13). Pioneering brown trout individuals have also been found in several tributaries to the East and West Forks for the first time in recent years (e.g. Meadow Creek in 2003 and 2013, Praine Creek in 2011). Figures 12 and 13 display the expansion of brown trout populations that has occurred in Sleeping Child Creek (stream mile 10.2) and Camp Creek (stream mile 2.3) in recent years.

Figure 12 – Number of Bull Trout (blue bars), Brown Trout (red bars), and Brook Trout (green bars) captured in Sleeping Child Creek near the Sleeping Child Hot Springs (stream mile 10.2)

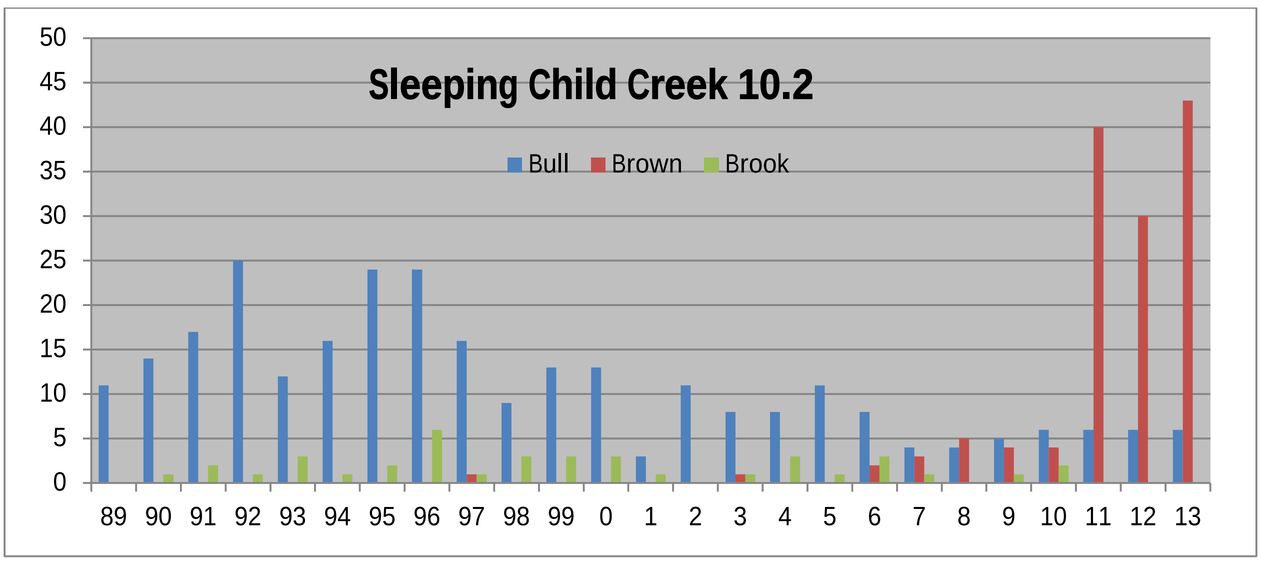
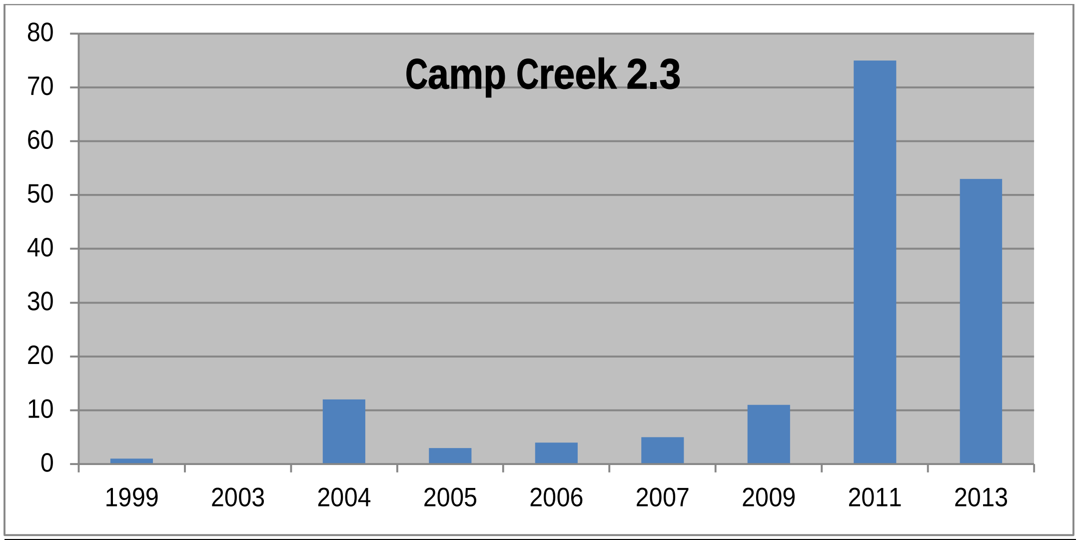


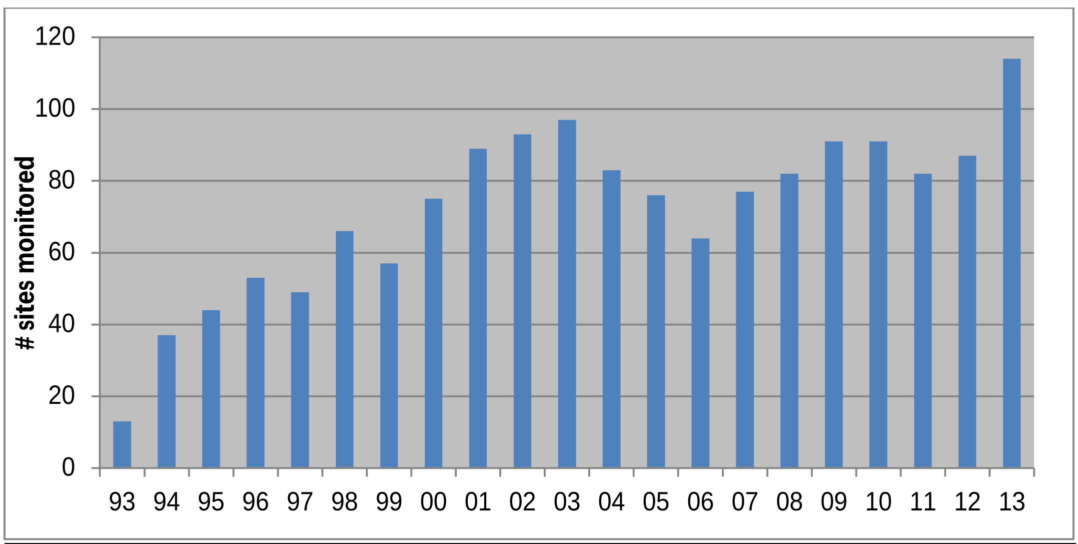
Figure 13 – Number of brown trout captured in Camp Creek near the Sula Ranger Station (stream mile 2.3)



WATER TEMPERATURE MONITORING:

The Forest Plan does not contain water temperature monitoring requirements, but water temperature is a Riparian Management Objective in INFISH (1995). Nevertheless, since 1993 the Bitterroot National Forest and the MFWP have cooperatively developed an extensive system of water temperature monitoring sites in streams across the Forest. Figure 14 displays the number of sites that have been monitored since 1993.

Figure 14 - Number of Water Temperature Monitoring Sites on the Bitterroot National Forest



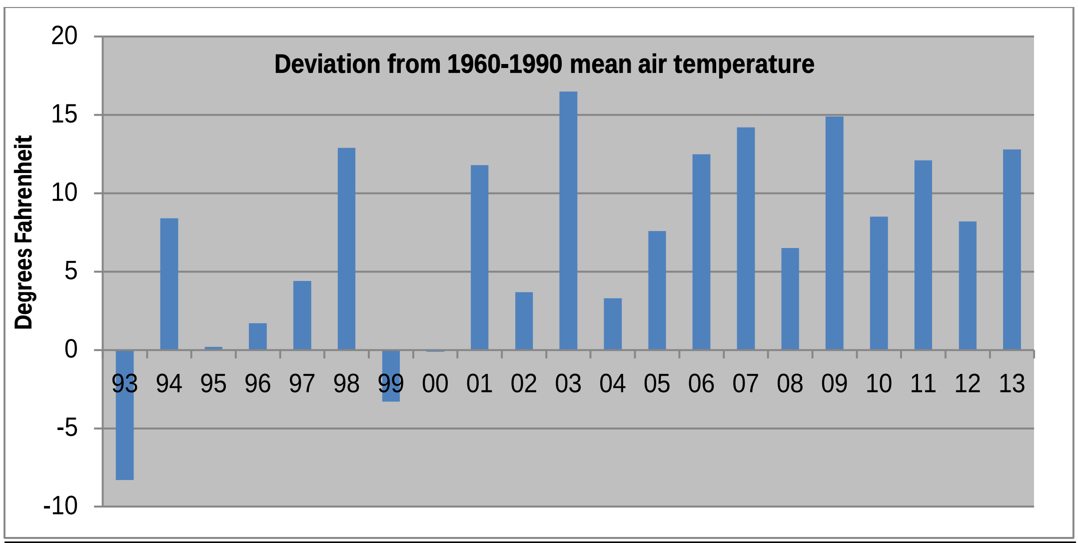
On the Forest, we have established an annual temperature monitoring period that starts on July 18th and ends on October 1st. This 76-day monitoring period usually captures the warmest part of the year, and is the part of the year where water temperatures probably have their greatest influence on native salmonids.

The unit of measure used to compare sites is the degree-day. Degree-days are calculated by summing the mean daily temperature that occurs at each site for every day between July 18th and October 1st (a 76-day monitoring period). For example, summing the 76 mean daily temperatures that occur at a given site between July 18th and October 1st gives you the total number of degree-days that were accumulated at that site. The higher the number of degree-days, the warmer the site. Degree-days are a useful variable because they standardize temperature data and allow comparisons between different years and different size streams.

There is a correlation between summer air temperatures and water temperatures, and this affects the number of degree-days. For example, during hot summers like 2003, most of the monitoring sites on the Forest set their all-time highs for degree-days. During cold summers like 1993, most of the sites set their all-time lows. Because the weather causes a lot of the variation in the degree-days at a given site from year to year, the Forest has established a network of index monitoring sites to reduce some of that variability. Index sites are unburned reference sites that are monitored every year. They function as control sites. By comparing the degree-day trends in the burned and/or managed sites against the degree-day trends in the unburned and/or unmanaged index sites, we can reduce the variability caused by the weather and make some inferences about the influence of the fires and/or management activities on stream temperatures.

Figure 15 displays how mean summer (July-September) air temperatures have varied from the 30-year (1960-1990) mean at the Stevensville Ranger Station weather station since 1993. The 30-year period used for reference is 1960-1990. The mean air temperature for the 1960-1990 period is represented by the “0” horizontal line in the graph. Each bar represents the sum of the deviations from the 30-year mean air temperature for the months of July, August, and September. The bars near the “0” line are the years where the July-September air temperatures were very close to the 30 year average. The bars above the “0” line are the years where the July-September air temperatures were warmer than average. The bars below the “0” line are the years where the July-September air temperatures were colder than average.

Figure 15 – Deviation in mean summer (July-September) air temperatures from the 30-year (1960-1990) mean recorded at the Stevensville Ranger Station Weather Station



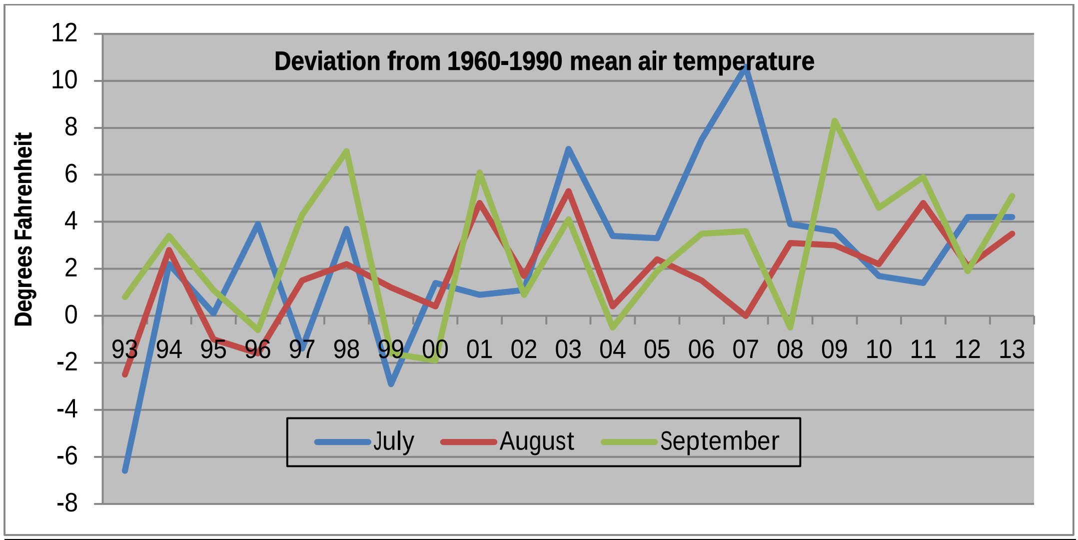
Summer 2013 was the 9th consecutive warmer than average summer on the Bitterroot National Forest. The last summer that was considered to have average temperatures was 2004. The last summer that was colder than average was twenty years ago in 1993.

The trend in air temperatures over the past 20 years indicates that summers are getting warmer on the Bitterroot National Forest. The frequency of hot days (> 90º F) is increasing, and the seasonal window in which those days can occur is widening. These trends are similar to those reported by Pederson et al. (2010).

Pederson, G.T., L.J. Graumlich, D.B. Fagre, T. Kipfer, and C.C. Muhlfeld. 2010. A century of climate and ecosystem change in Western Montana: what do temperature trends portend? Climate Change (2010) 98:133-154.

Figure 16 displays by month, how the mean air temperatures for July, August, and September have varied from the 30-year mean at the Stevensville Ranger Station weather station since 1993. In particular, note the increasing trend for warm Septembers, and the hot Julys that occurred in 2003 and 2007.

Figure 16 – Comparison of July, August, and September mean air temperature deviations from their 30-year (1960-1990) mean at the Stevensville Ranger Station Weather Station



2013 was another warm, droughty year in the Bitterroot basin. The winter snowpack was well below average, and it melted quickly in the spring. Peak flow on the Bitterroot River occurred on May 14, 2013 (about two weeks earlier than average) and did not achieve the bankfull stage. Once again, fire season got off to an early start in July, but this year, a usually wet September extinguished the fires and brought some relief to stream flows. Several small westslope cutthroat trout tributaries (e.g. Taylor, Lyman, Hart, Magpie creeks) were observed to go completely dry for the first time in August, 2013.

Water temperatures were monitored at 114 sites in 2013 (Figure 14). Most of the sites had degree day readings that were higher than their long-term averages, and many experienced their warmest degree day readings on record. None of the sites experienced their coldest degree day readings on record.

In 2013, the emphasis of our water temperature monitoring consisted of a mix of long-term index site monitoring, TMDL monitoring, project monitoring, and post-fire monitoring (2000 Fires, 2011 Saddle Complex Fire, and 2012 Mustang Complex Fire). Our results are discussed below.

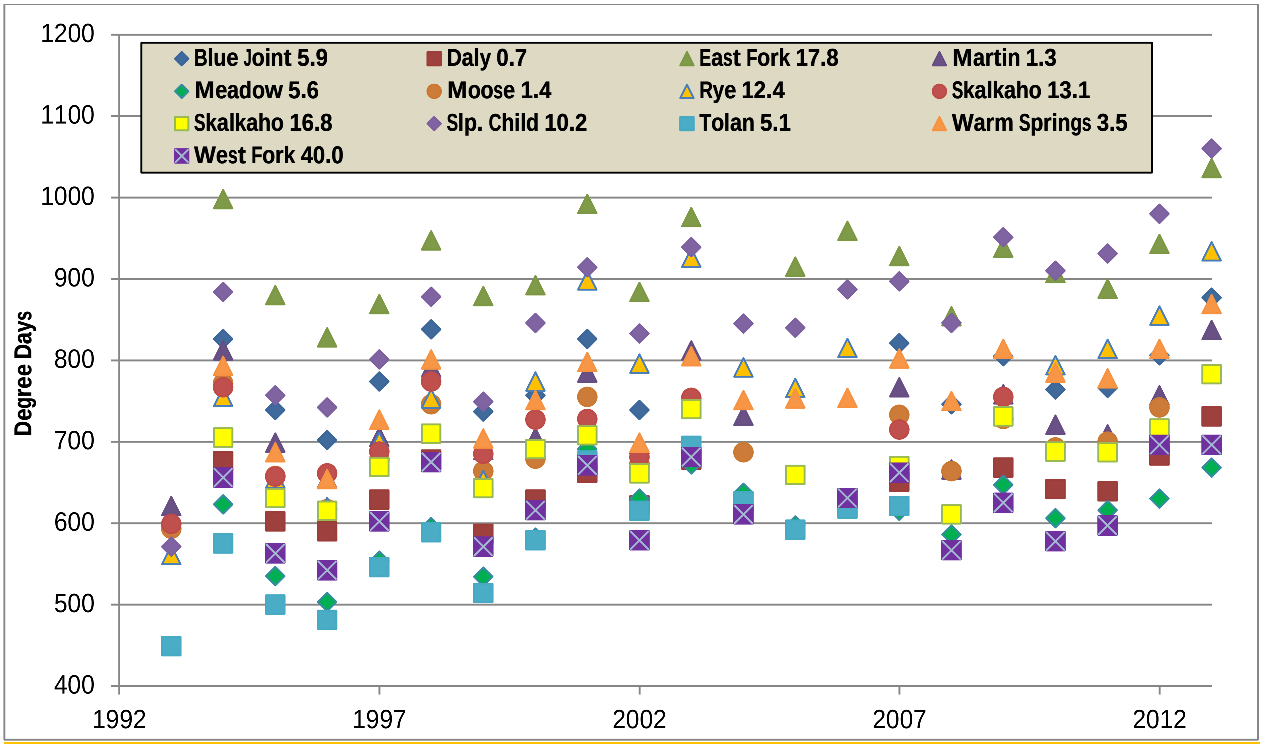
Index Site Monitoring.

Index sites are unburned or lightly burned reference sites that are monitored every year. They function as control sites, and allow us to sort out some of the year-to-year variability that occurs as a result of weather. In the early 1990's, as computerized thermographs became commercially inexpensive and available, Forest and FWP fisheries biologists established a network of 13 index sites on the Montana portion of the Bitterroot National Forest and six index sites on the Idaho portion of the Forest. A few of the index sites (e.g. Rye Creek 12.4 and Tolan Creek 5.1) were significantly burned during the 2000 fires, and probably do not function as good references for the time being.

In 2013, we monitored temperatures at 17 index sites. Eleven of the sites were located on the Montana portion of the Forest; six of the sites were located on the Idaho portion of the Forest. The majority of the index sites have been monitored nearly every year since the early 1990's. The thermograph at one of the index sites in Montana (Moose Creek 1.4) malfunctioned in 2013, so we did not get a reading at that site. Overall, 14 of the 16 index sites had their warmest degree day readings on record in 2013, and it didn't matter if they were located in Montana (9 of 10) or in the Idaho wilderness (5 of 6). The only index sites that didn't have their warmest readings on record were Meadow Creek 5.6 and Whitecap Creek 0.1, which had their second warmest readings on record. Two of the Montana index sites (East Fork Bitterroot River 17.8 and Sleeping Child Creek 10.2) and one of the Idaho index sites (Deep Creek 0.1) exceeded 1000 degree days for the first time.

Figure 17 plots the degree days that have been recorded at the Montana index sites since 1993. The key thing to notice in Figure 17 is the overall rising pattern of the data points – this indicates that the index streams have been warming over the past 20 years.

Figure 17– Degree days recorded at the Montana index sites since 1993



TMDL Monitoring.

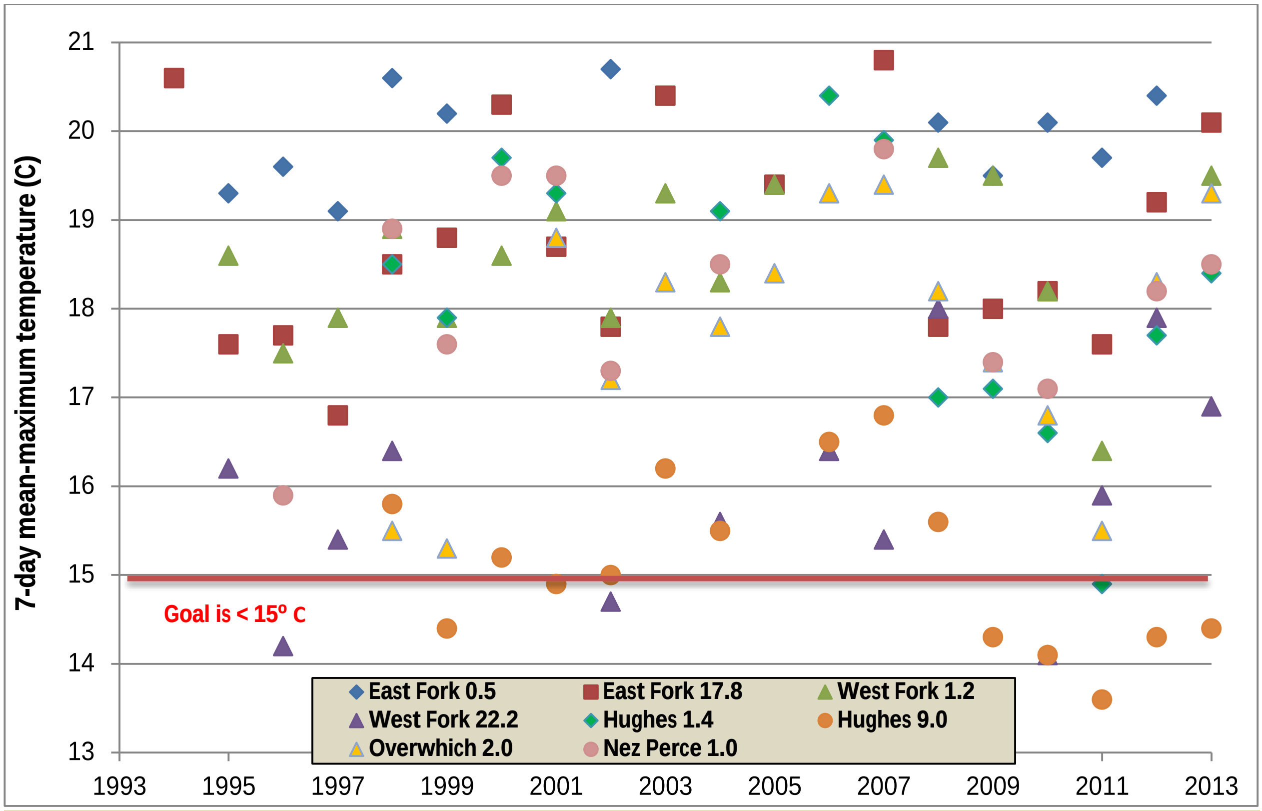
The Bitterroot Headwaters TMDL designated five water bodies as thermally impaired (East Fork Bitterroot River; West Fork Bitterroot River; Hughes Creek; Overwhich Creek; and the Nez Perce Fork). In the TMDL Monitoring Plan, a total of 12 sites were assigned for water temperature monitoring in those five streams, with specific water temperature goals for each site. Table 6 lists the thermally impaired water bodies in the Headwaters TMDL, their specific monitoring sites and temperature goals, and how the 2013 temperatures compared to the goals. The sites that met their TMDL temperature goals in 2013 are highlighted in **BOLD** font.

Table 6 - Bitterroot Headwaters TMDL Water Temperature Monitoring Results

Thermally Impaired Streams	TMDL Monitoring Sites	TMDL Goal (warmest 7-day mean-maximum temp)	2013 Temperature (warmest 7-day mean-maximum temp)
East Fork Bitterroot River	River mile 0.5	< 15.0° C	22.2° C
	River mile 17.8	< 15.0° C	20.1° C
	River mile 31.4	< 12.0° C	17.3° C
West Fork Bitterroot River	River mile 1.2	< 15.0° C	19.5° C
	River mile 22.2	< 15.0° C	16.9° C
	River mile 40.0	< 12.0° C	12.6° C
Hughes Creek	Stream mile 1.4	< 15.0° C	18.4° C
	Stream mile 9.0	< 15.0° C	**14.4° C**
Overwhich Creek	Stream mile 2.0	< 15.0° C	19.3° C
	Stream mile 7.0	< 12.0° C	17.3° C
Nez Perce Fork	Stream mile 1.0	< 15.0° C	18.5° C
	Stream mile 11.0	< 12.0° C	15.8° C

Figure 18 displays the trend in mean-maximum temperatures at the eight Headwaters TMDL monitoring sites that have a temperature goal of < 15° C.

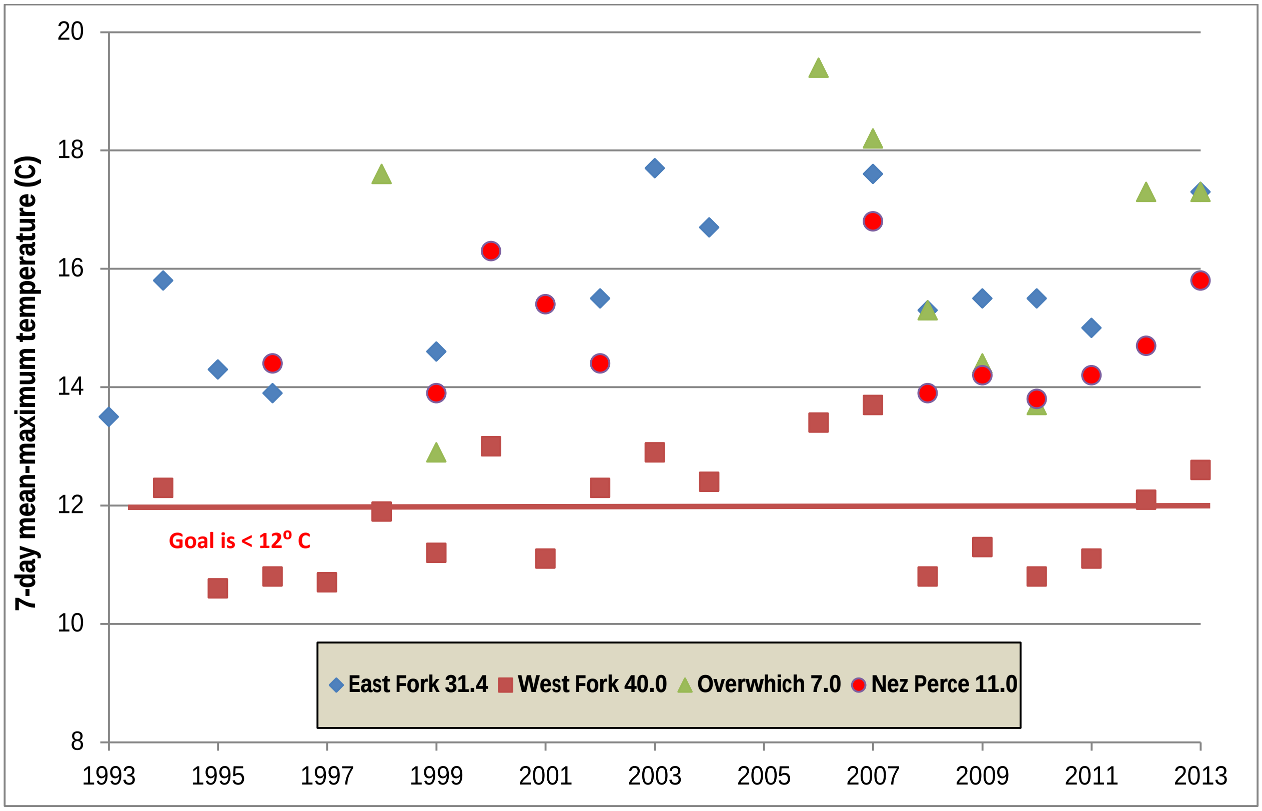
Figure 18 – Mean-maximum temperatures at the eight Headwaters TMDL monitoring sites with a temperature goal of < 15° C



The data points in Figure 18 show that of the eight monitoring sites with a < 15° C TMDL goal, only the Hughes Creek 9.0 site has been able to meet the goal about half the time. The rest of the sites consistently exceed the goal. The West Fork 22.2 site, which is located directly downstream of Painted Rocks Dam, can sometimes meet the goal, but it depends on the timing of water releases from Painted Rocks Dam.

Figure 19 displays the trend in mean-maximum temperatures at the four Headwaters TMDL monitoring sites that have a temperature goal of < 12° C.

Figure 19 – Mean-maximum temperatures at the four Headwaters TMDL monitoring sites with a temperature goal of < 12° C



The data points in Figure 19 show that of the four monitoring sites with a < 12° C TMDL goal, only the West Fork 40.0 site has been able to meet the goal in about half the years. None of the other sites have met the goal.

Figures 20-24 display the trend in degree days at the 12 Headwaters TMDL water temperature monitoring sites. All of the sites show a rising trend (Figures 20, 21, 23, and 24) except for the Hughes Creek sites (Figure 22). The reason for the decreasing trend at both the lower (river mile 1.4) and upper (river mile 9.0) Hughes Creek sites is unknown. Both sites were warmer in 2013 (Figure 22).

Figure 20 - Trend in Degree Days at the Nez Perce Fork River Mile 1.0 and River Mile 11.0 Water Temperature TMDL Monitoring Sites

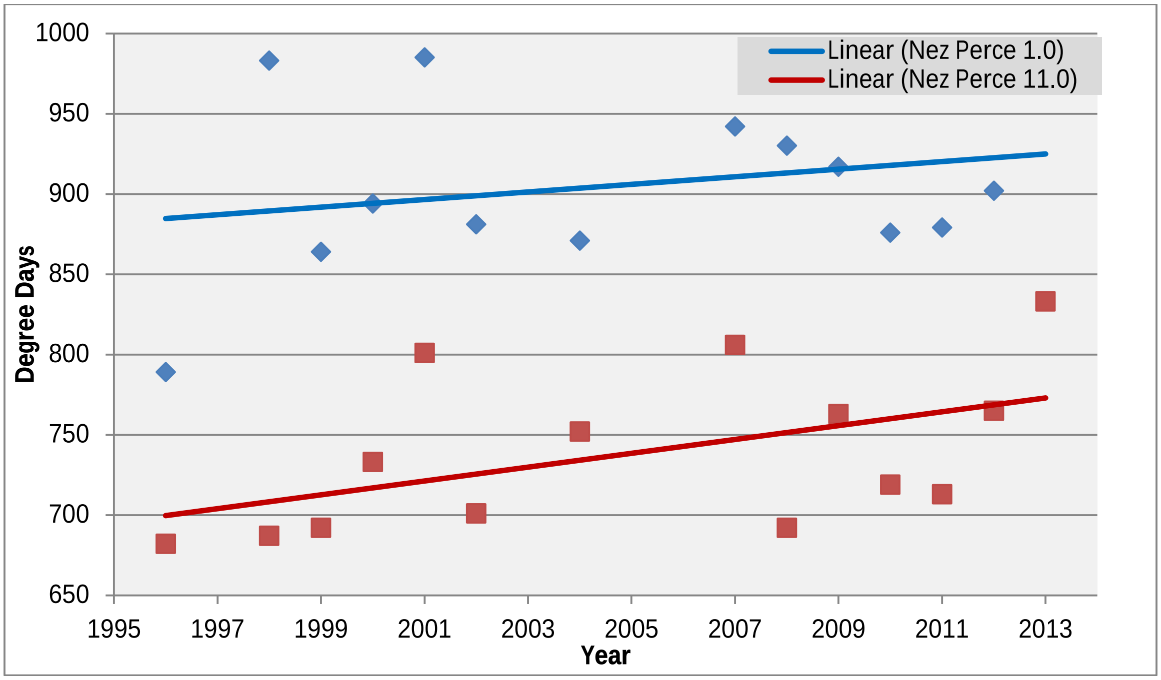


Figure 21 - Trend in Degree Days at the Overwhich Creek River Mile 2.0 and River Mile 7.0 Water Temperature TMDL Monitoring Sites

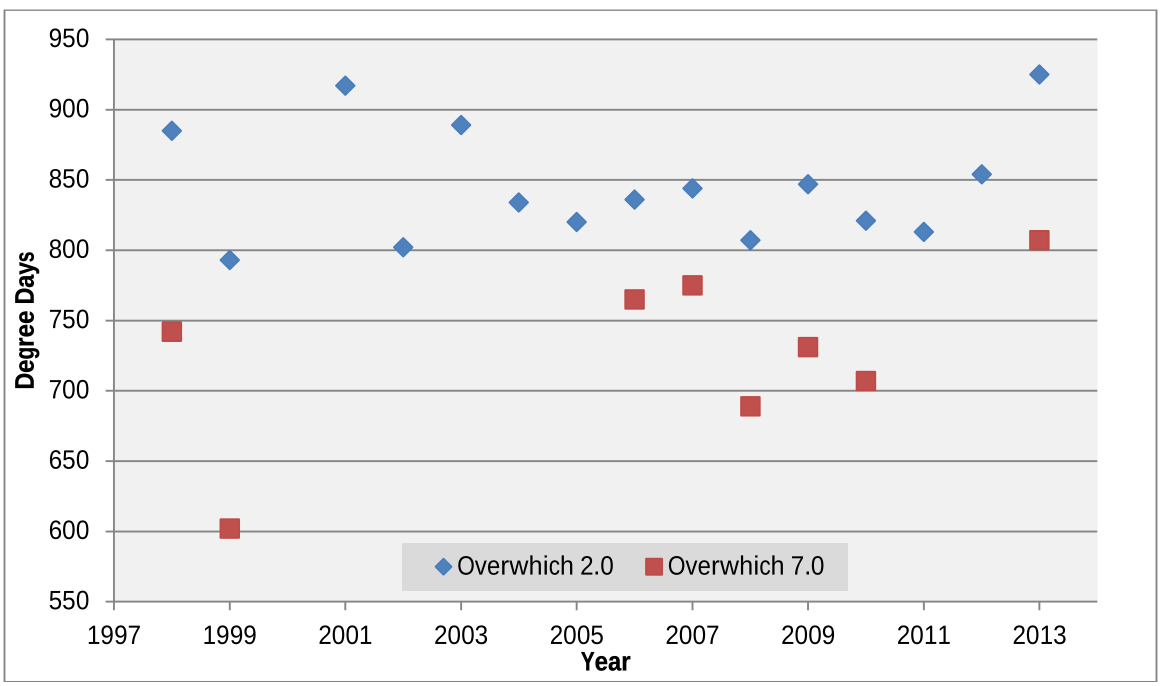


Figure 22 - Trend in Degree Days at the Hughes Creek River Mile 1.4 and River Mile 9.0 Water Temperature TMDL Monitoring Sites

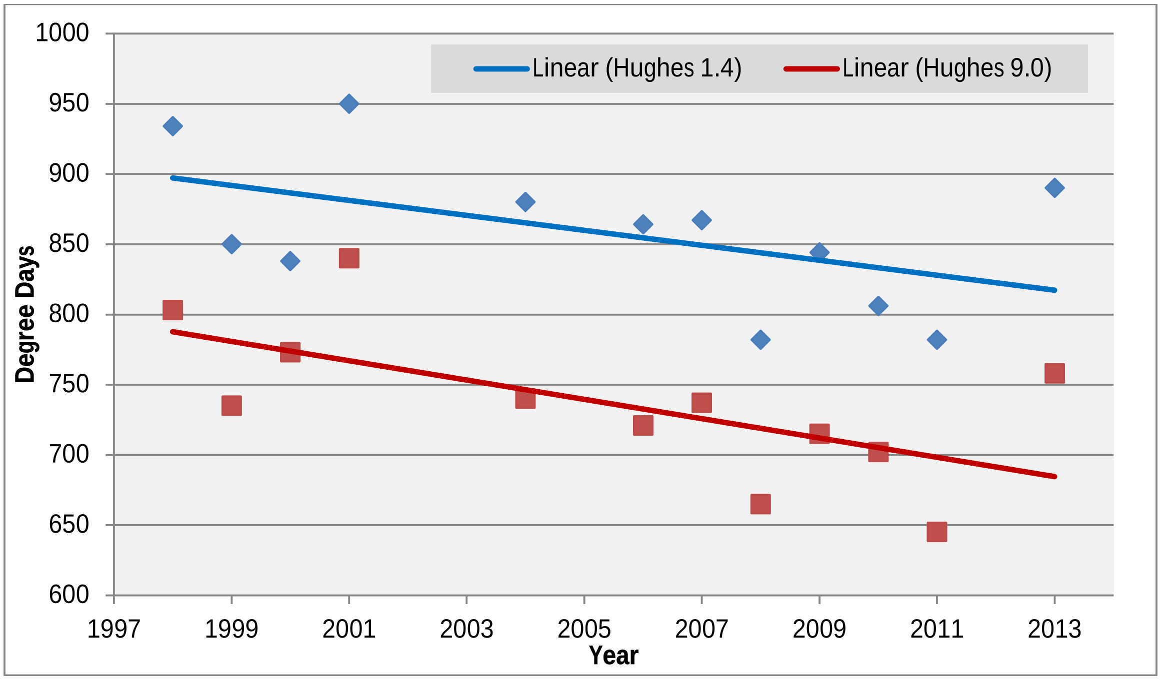


Figure 23 - Trend in Degree Days at the West Fork Bitterroot River Mile 1.2, River Mile 22.2, and River Mile 40.0 Water Temperature TMDL Monitoring Sites

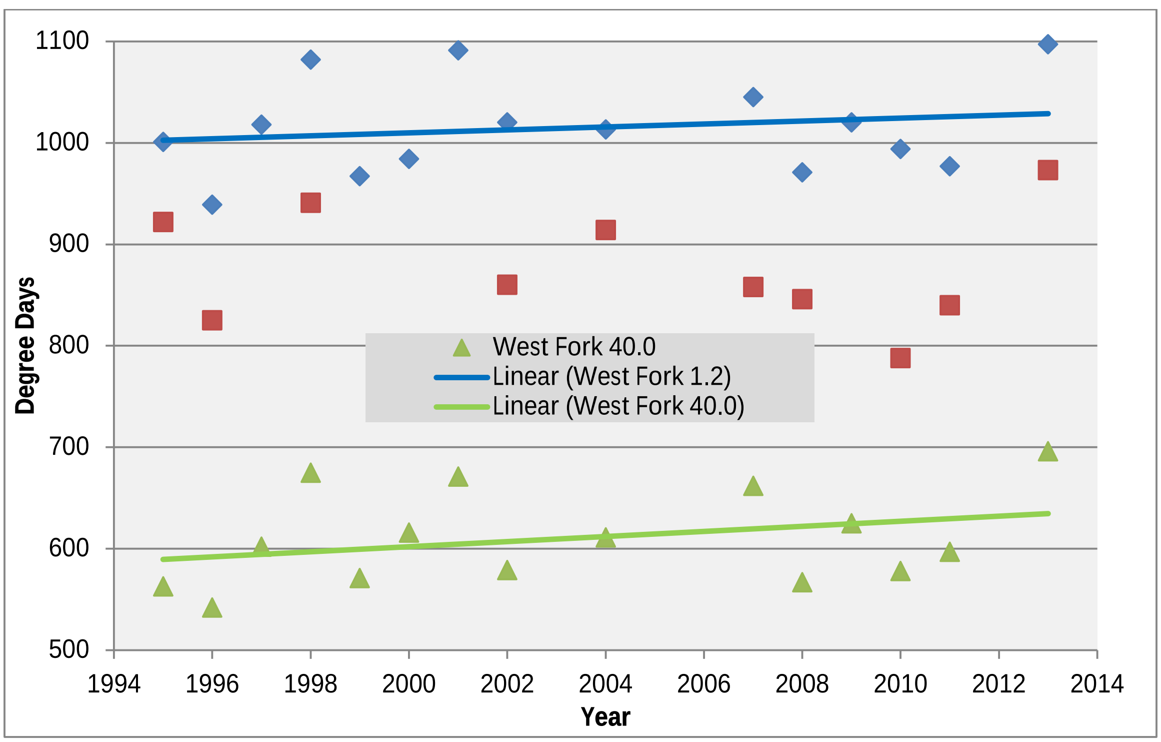
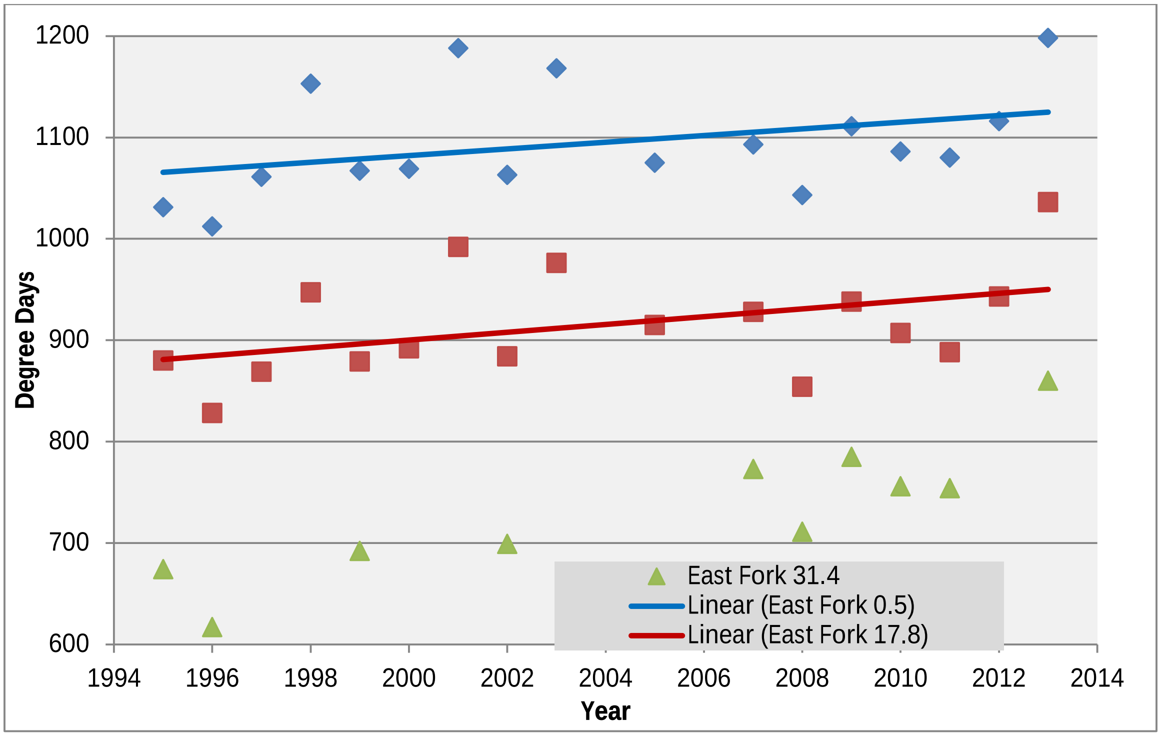
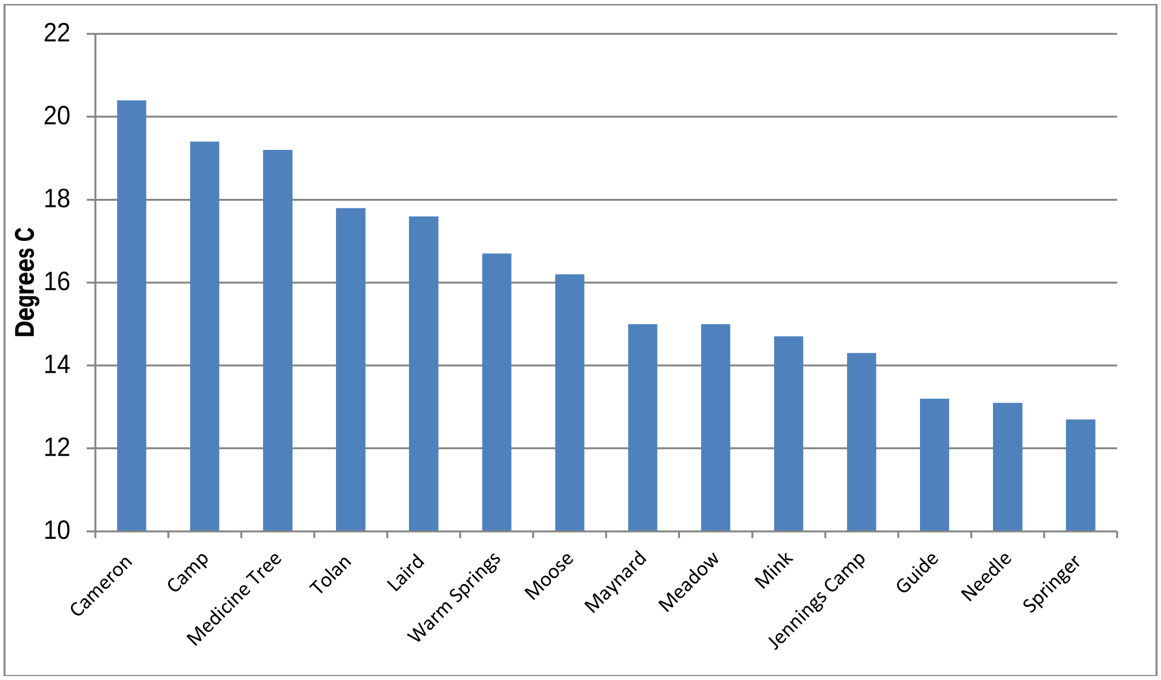


Figure 24 - Trend in Degree Days at the East Fork Bitterroot River Mile 0.5, River Mile 17.8, and River Mile 31.4 Water Temperature TMDL Monitoring Sites



In an attempt to identify which tributaries contribute warm water to the East Fork Bitterroot River, thermographs were placed at the mouths of the named fish-bearing tributaries between Conner and the Anaconda-Pintler wilderness boundary during summer, 2012. Figure 25 displays the 7-day mean-maximum temperatures that were recorded at the mouths of the East Fork tributaries in 2012. The tributaries are listed from warmest to coldest. Bertie Lord Creek is not listed in Figure 25 because its thermograph was lost. The 7-day mean-maximum temperature for Bertie Lord Creek is usually around 15.0° C, which would put it near the bar for Meadow Creek in Figure 25. Reimel and Tepee creeks were not included in Figure 25 because they do not contribute water to the East Fork Bitterroot River during the summer months. The data in Figure 25 indicates that the warmest tributaries enter the East Fork Bitterroot River in or near the Sula basin area. Water temperature restoration projects on tributary streams should focus on those streams, particular Cameron, Camp, Tolan, Laird, and Warm Springs creeks. The tributaries that enter the East Fork upstream of the Sula basin have temperature regimes that are closer to natural conditions.

Figure 25 - 7-day mean-maximum temperature recorded at the mouths of the East Fork Bitterroot River tributaries in 2012



In 2010, MFWP biologists monitored temperatures at four sites in the East Fork Bitterroot River. The purpose of this monitoring was to identify which river reach is responsible for the bulk of the warming that occurs in the East Fork Bitterroot River. The data showed that the section of river between Tolan Creek and the Sula Store warmed at the fastest rate (Table 7). Surprisingly, the section of river between the East Fork trailhead and Tolan Creek warmed at a much faster rate than the Sula canyon section between the Sula Store and Conner. The data in Figure 25 and Table 7 identify the Sula basin area as the highest priority for water temperature restoration projects in the East Fork Bitterroot River.

Table 7 - Rate of River Temperature Warming in the East Fork Bitterroot River (degrees C per mile)

River Reach	Distance in river miles	Rate of Warming (degrees C per river mile)
East Fork Trailhead (river mile 31.4) to Tolan Creek (river mile 17.8)	13.6 miles	0.20° C per river mile
Tolan Creek (river mile 17.8) to Sula Store (river mile 13.3)	4.5 miles	0.24° C per river mile
Sula Store (river mile 13.3) to Conner (river mile 0.5)	12.8 miles	0.06° C per river mile

Project Monitoring

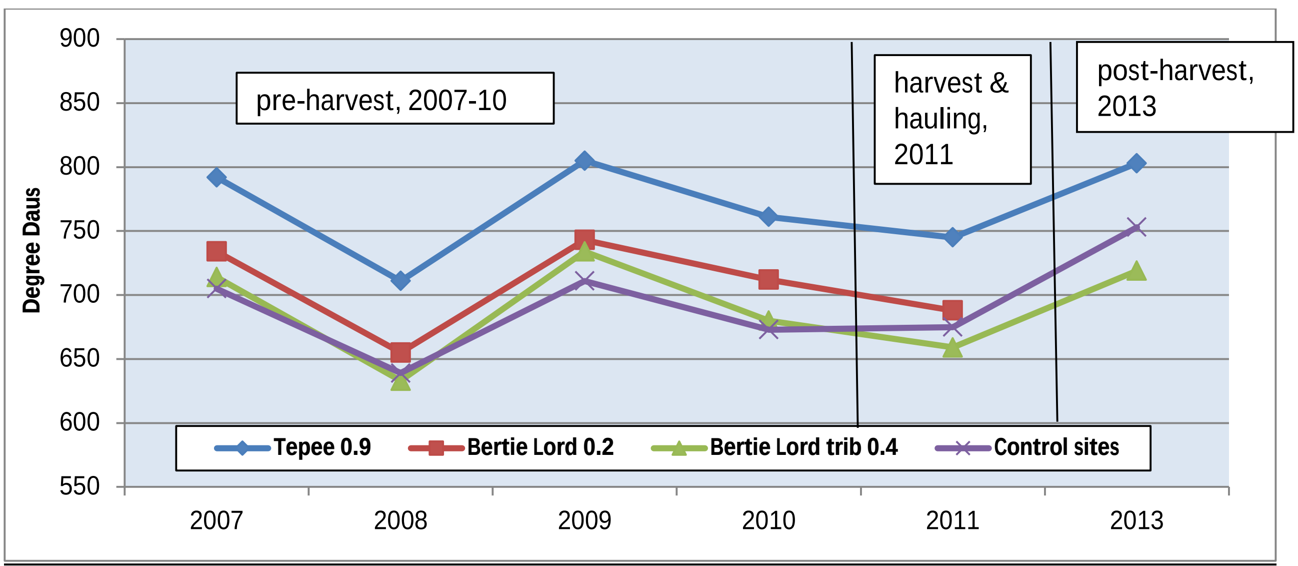
Middle East Fork EIS Timber Sales (Sula Ranger District). The Tepee Blend – Subdivision A timber sale was the last of the timber sales to come out of the Middle East Fork EIS. Tepee Blend timber harvest and log hauling occurred in the Tepee Creek and Bertie Lord Creek drainages (primarily in the Bertie Lord tributary 0.4 watershed) in June-August, 2011. The RHCAs were protected from cutting and skidding, and all of the harvest acreage was skyline yarded. The main haul routes were Road 5778 in the Tepee Creek drainage and Road 13313 in the Bertie Lord Creek drainage. Road 5778 closely parallels Tepee Creek for 0.5 miles before climbing out of the stream bottom. Road 13313 is an upland road that crosses the intermittent upper headwater forks of Tepee Creek and Bertie Lord unnamed tributary 0.4 several times. All of the harvest and hauling was completed in late summer, 2011.

In the Middle East Fork EIS, we made a commitment to monitor water temperatures in Tepee Creek, Bertie Lord Creek, and Bertie Lord tributary 0.4 before (2007-10), during (2011), and one year after (2012-13) all of the timber harvest and log hauling was completed. Those streams were chosen for monitoring because they were the most sensitive to water temperature effects from the timber sale. We attempted to complete the one year post-harvest monitoring in 2012, but our older model thermographs filled up their memory capacity on August 26, 2012, so we were unable to get a degree day reading for the entire July 18 to October 1 monitoring period. Therefore, we monitored temperatures again in 2013.

Water temperature monitoring sites (i.e. treatment sites) were established in Tepee Creek (milepost 0.9, near the Forest boundary), Bertie Lord Creek (milepost 0.2, near the mouth of the stream), and Bertie Lord tributary 0.4 (milepost 0.1, near the mouth of the stream) to monitor potential effects of the Tepee Blend timber sale on stream temperatures. Three nearby index sites (Martin Creek 1.3, Moose Creek 1.4, and Meadow Creek 5.6) served as the control sites. Water temperatures were monitored in the treatment and control sites for four years pre-harvest (2007-10), in 2011 while harvest and hauling was active, and in 2013, nearly two years after the sale was completed.

Figure 26 displays the degree days that we measured at the three treatment sites (Tepee Creek 0.9, Bertie Lord Creek 0.2, and Bertie Lord trib 0.4) and the three control sites (Martin Creek 1.3, Moose Creek 1.4, and Meadow Creek 5.6) between 2007 and 2013. The degree days measured at the three control sites were averaged for each year and displayed as a single line in Figure 26.

Figure 26 – Degree days measured in the three treatment sites (Tepee Creek 0.9, Bertie Lord Creek 0.2, and Bertie Lord trib 0.4) and the control sites before (2007-10), during (2011), and after (2013) the Tepee Blend – Subdivision A timber sale



Data was unavailable for the Bertie Lord 0.2 thermograph in 2013 because an unknown person removed the thermograph from the water.

The Middle East Fork Final EIS predicted that timber harvest and log hauling would maintain the existing water temperature regimes in streams (Final EIS, pg 3.4-29). The monitoring data in Figure 26 supports that prediction. The pattern of degree days in the treatment streams (Tepee Creek, Bertie Lord Creek, and Bertie Lord trib 0.4) closely tracked the pattern of degree days in the control streams in the pre-harvest period (2007-10), while the sale was active (2011), and nearly two years after the sale was completed (2013). The data shows no discernible evidence of stream temperature warming as a result of the Tepee Blend – Subdivision A timber sale.

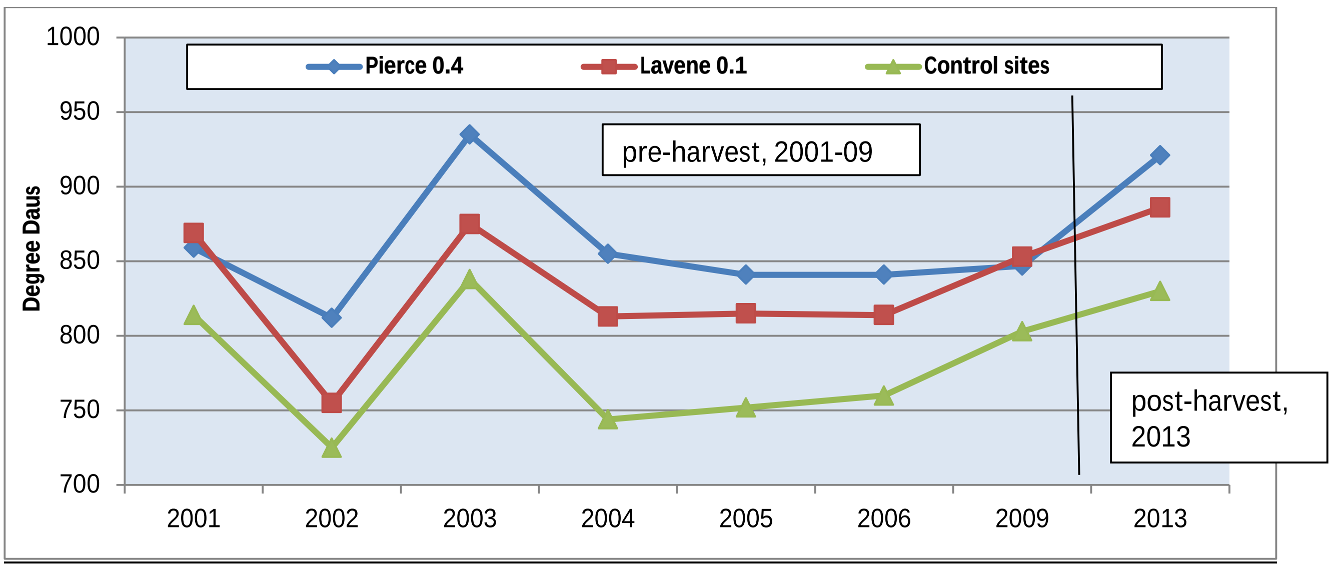
Lower West Fork EIS Timber Sale (West Fork Ranger District). The Lower West Fork timber sale commenced in June, 2012 and was completed in April, 2013. The main prescription was commercial thinning, and the yarding systems were a mix of tractor and skyline. The RHCAs were protected from cutting and skidding. The haul road segments that encroach on Lavene Creek (Road 5630) and Pierce Creek (363) were a key concern in the sale, and those two streams were the focus of our water temperature monitoring efforts. All of the Lower West Fork harvest and hauling was completed by spring, 2013.

In the Lower West Fork EIS, we made a commitment to monitor water temperatures in Pierce Creek, Lavene Creek, Piquett Creek, and East Piquett Creek before (2001-06, 2009), during (2012) and after (2013) all of the timber harvest and log hauling was completed. Those streams were chosen for monitoring because they were the most sensitive to water temperature effects from the timber sale. We only ended up monitoring temperatures in Pierce and Lavene creeks because all of the timber harvest activities in the Piquett Creek drainage were dropped in the Record of Decision. In 2012, our older model thermographs filled up their memory capacity on August 26, 2012, so we were unable to get degree day readings for that year.

Water temperature monitoring sites (i.e. treatment sites) were established in Pierce Creek (milepost 0.4) and Lavene Creek (milepost 0.1) where those streams exit the Forest. Two nearby reference sites (Baker Creek 1.1 and Christisen Creek 0.7) served as the control sites. Water temperatures were monitored in the treatment and control sites for seven years pre-harvest (2001-06, 2009), and in 2013, after all harvest activities were completed.

Figure 27 displays the degree days that we measured at the two treatment sites (Pierce Creek 0.4 and Lavene Creek 0.1) and the two control sites (Baker Creek 1.1 and Christisen Creek 0.7) between 2001 and 2013. The degree days measured at the two control sites were averaged for each year and displayed as a single line in Figure 27.

Figure 27 – Degree days measured in the two treatment sites (Pierce Creek 0.4 and Lavene Creek 0.1) and the control sites before (2001-06, 2009) and after (2013) the Lower West Fork timber sale



The Lower West Fork EIS predicted that timber harvest and log hauling would maintain the existing water temperature regimes in streams. The data in Figure 27 supports that prediction. The pattern of degree days in the treatment streams (Pierce and Lavene creeks) tracked the pattern of degree days in the control streams in the pre-harvest (2001-06, 2009) and post-harvest (2013) periods. The data shows no discernible evidence of stream temperature warming as a result of the Lower West Fork timber sale.

Lost Trail Ski Area Sanitation Salvage Timber Sale (Sula Ranger District). This 250-acre salvage sale was conducted at the Lost Trail Ski Area during the summers and autumns of 2012 and 2013. The timber harvest in the Montana portion of the ski area was completed in autumn, 2012. The Idaho portion of the sale was completed in October, 2013. The prescription was thinning by removing the beetle-killed lodgepole pine. RHCAs were protected from sale activities.

In order to monitor potential stream temperature changes caused by the sale, pre-harvest temperatures were collected in 2011 at six treatment sites (four sites in East Fork Camp Creek, two sites in Camp Creek) and one control site (West Fork Camp Creek). Table 8 lists the six treatment sites and one control site, along with a brief description of their locations:

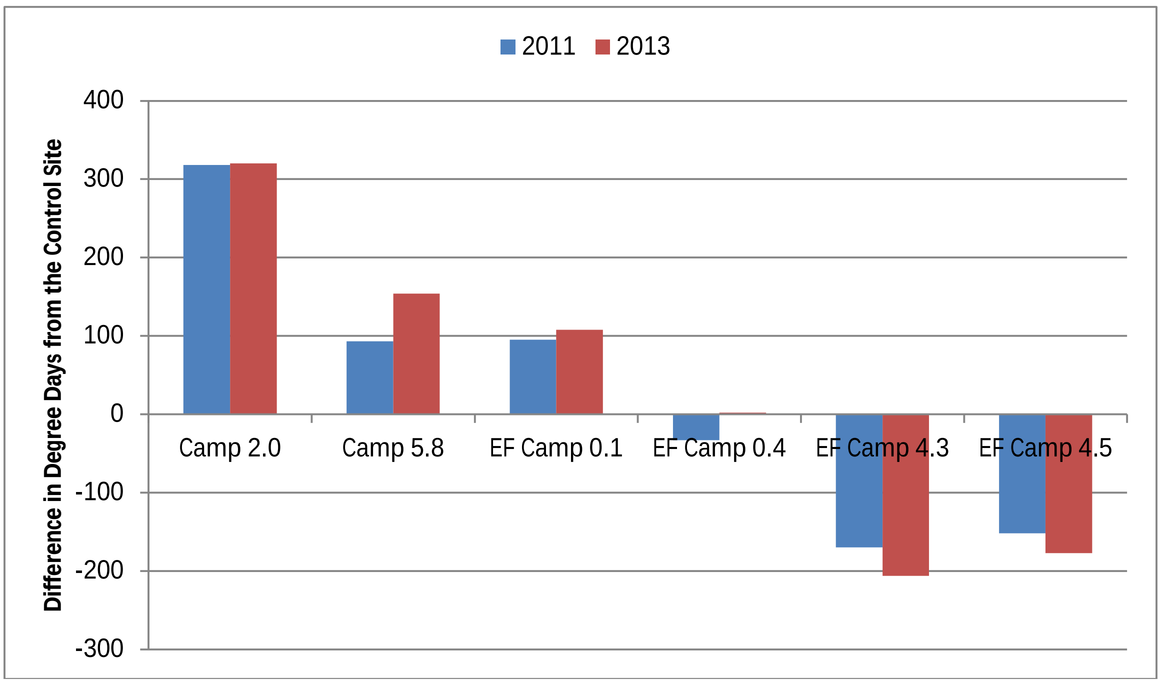
Table 8 - Temperature Monitoring Sites for the Lost Trail Ski Area Sanitation Salvage Timber Sale

Type of Site	Stream	Milepost	Location
Treatment	East Fork Camp Creek	4.5	Upstream end of clearcut corridor for chairlift #3
Treatment	East Fork Camp Creek	4.3	Road 729 crossing

Type of Site	Stream	Milepost	Location
Treatment	East Fork Camp Creek	0.4	Forest boundary above Lost Trail Hot Springs
Treatment	East Fork Camp Creek	0.1	Mouth
Treatment	Camp Creek	5.8	Highway 93 crossing
Treatment	Camp Creek	2.0	Near Sula Ranger Station
Control	West Fork Camp Creek	0.1	Mouth

Stream temperatures were monitored at the sites in Table 8 in 2011, one year before conducting the harvest activities in the Montana portion of the ski area, and in 2013, one year after the harvest activities were completed in the Montana portion of the ski area. Figure 28 displays how the degree days at the treatments sites differed from the control site before (2011) and after (2013) the Montana portion of the sale was completed. The bars in the positive portion of the y-axis are readings that are warmer than the control site. The bars in the negative portion of the y-axis are readings that are colder than the control site. The "0" line on the y-axis indicates the exact same degree day reading for the control site and a treatment site.

Figure 28 – Difference in degree days between the control site (West Fork Camp Creek 0.1) and six treatment sites one year before (2011) and one year after (2013) salvage harvest at the Lost Trail Ski Area



The data in Figure 28 does not show a consistent pattern. The sites in the lower end of East Fork Camp Creek (mileposts 0.1 and 0.4) were slightly warmer in 2013 relative to the control site, but the differences were small (< 35 degree days). The sites in the salvage sale area (mileposts 4.3 and 4.5) were slightly colder in 2013 relative to the control site, but again, the differences were small (< 37 degree days). Further downstream, the two sites in Camp Creek also did not show a consistent trend. Camp Creek 2.0 was nearly the same relative to the control site in 2011 and 2013, while Camp Creek 5.8 was warmer in 2013 relative to the control site. 2011 and 2013 were very different water years and probably account for some of the variability that we see in Figure 28. 2011 was a high water summer with colder temperatures, while 2013 was a low water summer with much warmer temperatures. Using a control site is supposed to minimize the amount of variability between different types of water years, but it isn't perfect. Also, the small differences in degree days that we measured in this study could be attributable to thermograph variability and not actual changes on the ground. Given that there were no harvest activities in RHCAs and the inconsistent pattern of the data (e.g. the sites closest to the harvest appear to have cooled slightly following the sale relative to the control site), it appears that the Lost Trail Ski Area Salvage Sale had an indistinguishable effect on downstream temperatures in East Fork Camp Creek and Camp Creek.

While conducting this study, we also learned some other interesting things about the water temperature regimes in East Fork Camp Creek and Camp Creek.

A substantial amount of warming occurs in Camp Creek between the U.S. Highway 93 crossing (at milepost 5.8) and the Sula Ranger Station (at milepost 2.0). In 2011 and 2013, the mean-maximum temperatures increased by 5.4º C and 5.6º C over that 3.8 mile-long section of stream. Temperatures were still relatively cold at the Highway 93 crossing (mean-maximums of 13.7º C and 15.7º C), but they quickly warmed over the next 3.8 miles to 19.1º C (2011) and 21.3º C (2013). The stream mostly flows through private pastures that have lost considerable amounts of their riparian shrub cover and shade (predominantly provided by willows). This would be a good section of stream to restore riparian vegetation. Collectively, Camp Creek and Cameron Creek are the two tributaries that contribute the warmest water to the lower East Fork Bitterroot River.

The Lost Trail Hot Springs flushes a pulse of warm water down the East Fork of Camp Creek once a week during the summer. This pulse of warm water passes through the system quickly (< 2 hours), but it temporarily raises the temperature in the lower 0.3 miles of the East Fork of Camp Creek by about 3º C (5.4º F).

Temperatures at the mouth of the West Fork of Camp Creek and the East Fork of Camp Creek above the Lost Trail Hot Springs are roughly equivalent. The periodic flushing of water from the Hot Springs makes the East Fork the warmer (by about 1.5º C or 2.7º F) of the two forks at their confluence.

In both 2011 and 2013, we measured cooler temperatures downstream of the chairlift #3 corridor than above. In 2001 and 2002, a couple years after the chairlift #3 corridor was clearcut, the opposite pattern occurred with temperatures being warmer downstream of the clearcut corridor than above. The colder temperatures that are now occurring below the clearcut corridor are attributable to some influx of colder tributary water and the strong recovery of alder shade that has occurred in the clearcut area.

Rombo Campground Thinning (West Fork Ranger District). The Rombo Campground was thinned in the winter of 2011-12. The thinning was part of the Forest-wide Hazard Tree Removal in Recreation Sites project. The thinning occurred in the 300-foot RHCA surrounding the West Fork Bitterroot River. In the bull trout biological assessment and section 7 informal consultation, mitigation measures were agreed upon that retained all trees within 50 feet of the river's edge and only allowed thinning of the sub-dominant trees approved by the fisheries biologist within 50 to 100 feet of the river's edge. Beyond 100 feet, there were no restrictions on thinning. The purpose of these mitigations was to retain all trees that shade the river and could potentially provide woody debris recruitment. The bull trout biological assessment predicted that the thinning would not result in detectable temperature increases in the West Fork Bitterroot River. Not surprisingly, we were not able to detect any temperature effects in the West Fork. However, this was expected because the river is big and its temperature regime is dictated by much larger events, such as the timing of stored water releases from nearby Painted Rocks Reservoir. We did monitor air temperatures at three sites in and near the Rombo Campground in summer, 2012 to try and detect microclimate changes in the RHCA caused by the thinning. Thermographs were deployed on the north side of trees, about eight feet off the ground, at three sites:

- middle of the thinned area inside the campground loop road, 200 feet from the river's edge
- in campground along the untreated riparian area bordering the river, 50 feet from the river's edge
- on the west side of the river, opposite the campground, 300 feet from the river's edge (control site)

Figure 29 displays the trend in daily maximum air temperatures that occurred at the three sites between June 20 and September 16, 2012.

Figure 29 – Daily Maximum Air Temperatures in the Rombo Campground, June 20 to September 16, 2012

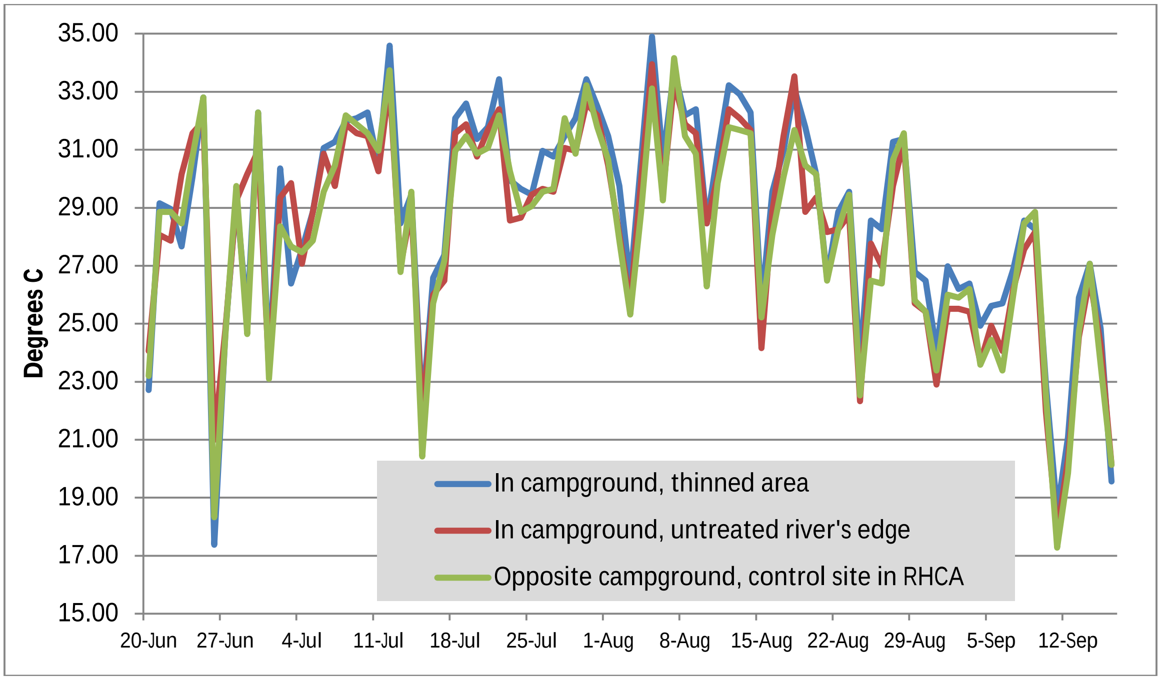


Figure 30 – Thinned area inside the Rombo campground loop road.

Figure 31 – Unthinned riparian area near the river's edge.

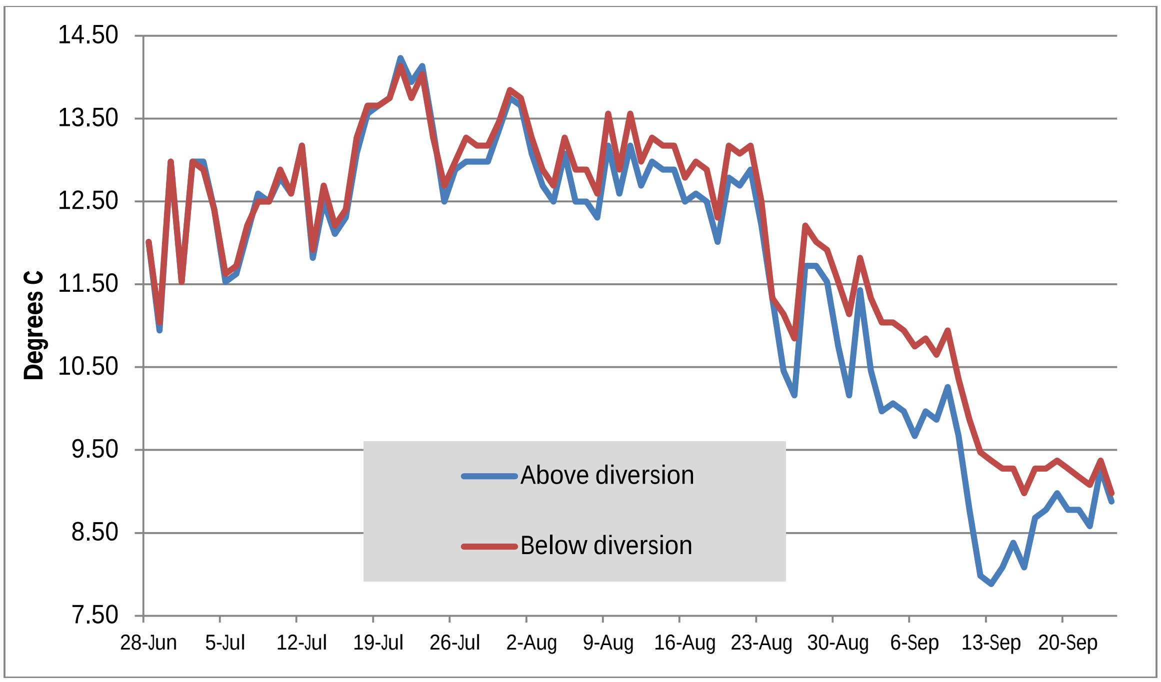
The following mean air temperatures were recorded at the three sites over an 89-day period (June 20 to Sept 16):

- 28.79º C = middle of thinned area inside campground loop road, 200 feet from the river's edge
- 28.29º C = in campground along untreated riparian area bordering the river, 50 feet from the river's edge
- 28.11º C = On the west side of the river, opposite the campground, 300 feet from the river's edge

A one-way analysis of variance test (ANOVA) was applied to the data. Although the means followed the expected pattern (i.e. the thinned area was warmest, the untreated riparian area adjacent to the thinned area was cooler, and the control site on the opposite side of the river was coldest), the differences between the means were small (< 0.7º C), and the means did not statistically differ at the 0.05 probability level. Our results suggest that thinning will increase air temperatures in RHCAs if enough trees are removed, but the temperature increases can be mitigated by a 50-foot wide strip of untreated riparian vegetation to levels that are similar to nearby untreated riparian areas. The temperature increases that resulted from thinning the Rombo campground were too small to measurably affect river temperatures in the West Fork.

Nesler Irrigation Ditch (West Fork Ranger District). The Nesler Irrigation Ditch is a small ditch (removes about 1 cfs of water) that exits the lower end of West Creek on Forest Service land. The ditch was not used for many years, but was re-activated in 2011. A new headgate was constructed in September 2011, and a ¼ inch mesh fish screen was installed on the headgate. The bull trout biological assessment and ESA section 7 informal consultation predicted that the removal of 1 cfs of water from West Creek during late summer base flow conditions would severely dewater, and maybe even cause some areas to go intermittent, the lower end of West Creek below the point of diversion. Temperatures in the dewatered reach below the point of diversion were predicted to be higher than those in the unaffected reach above the point of diversion. In order to monitor temperature effects, we placed one thermograph above the point of diversion, and one thermograph below the point of diversion from June to October, 2012. Temperatures were recorded every hour. Water withdrawals began in late June and continued until the last week of September. Figure 32 displays the daily maximum water temperatures that occurred at the two sites between June 28, 2012 and September 24, 2012.

Figure 32 – Daily Maximum Water Temperatures in West Creek, Above and Below the Nesler Ditch Diversion, June 28 to September 24, 2012



The data in Figure 32 shows that when water first began to be removed in late June, there was little difference in temperatures above and below the diversion. In mid to late July, when natural stream flows began to drop, the difference became more pronounced with temperatures below the diversion becoming 0.3 to 0.5° C warmer than those above. This continued through the latter part of August. In September, when stream flows were at their lowest levels, the temperature gap expanded with temperatures below the diversion getting to about 1.0 to 1.5° C warmer than those above. Somewhat surprisingly, the difference between some of the other temperature metrics was not too pronounced. For example, the site below the diversion accumulated 775 degree days, the site above was 726 degree days. The 7-day mean-maximum temperatures at both sites were nearly identical – 13.75° C below the diversion, 13.80° C above the diversion. Our prediction that water withdrawals would cause portions of West Creek below the diversion to become severely dewatered (and maybe even go dry) did not come true in 2012. Reductions in wetted perimeter below the diversion never became too pronounced, probably because water removals remained well below the allowable 1 cfs, and there likely was some groundwater recharge below the diversion that helped to maintain the wetted perimeter. Also, the temperatures we observed in 2012 were not near the thermal thresholds that could threaten the persistence of native trout species. The ¼ inch mesh fish screen on the headgate functioned successfully in 2012 – no fish were found in the ditch during electrofishing surveys. The rock diversion structure below the headgate also did not appear to be a fish barrier. In July 2012, we captured two bull trout (7.5 and 9 inches long) in West Creek upstream of the point of diversion. This was the first documented occurrence of bull trout in West Creek.

Cameron Blue Ecoburn (Sula Ranger District). In 2010, Forest fisheries biologists monitored summer stream temperatures throughout the Cameron Creek watershed in an effort to collect pre-burn baseline temperature data. In addition to the Cameron Creek watershed, temperature data was also collected in other potentially affected streams such as Bertie Lord Creek, Jennings Camp Creek, Guide Creek, and the East Fork Bitterroot River. A key concern of fisheries is that the Cameron Blue Ecoburn does not exacerbate the post-fire warming that has occurred in the project area since the fires of 2000. Cameron Creek is one of the warmest tributaries in the East Fork Bitterroot River watershed, and its temperatures have increased since the fires of 2000.

From highest to lowest in the Cameron Creek watershed, temperatures were monitored at the following locations:

- milepost 14.8 - the Road 1398 crossing in the upper headwaters on National Forest land. This site is in the 1961 Sleeping Child Fire area and is unburned
- milepost 10.1 - the Road 311 crossing on State land. This site is located within the 2000 burn (moderate to high severity)
- milepost 8.6 - on private land, just above the mouth of Lyman Creek
- milepost 8.5 - on private land, just below the mouth of Lyman Creek but above the Doran Creek confluence
- milepost 8.4 - on private land, just below the mouth of Doran Creek
- milepost 6.1 – on National Forest land near Pasture Draw
- milepost 0.1 - at the mouth

Temperatures in Cameron Creek were cold at the Road 1398 crossing (7-day mean-max = 10.6° C), but once Cameron Creek left the Sleeping Child Fire area and entered the 2000 fire area, temperatures rose quickly. The mean-maximum increased from 10.6° C at the Road 1398 crossing to 16.7° C at the Road 311 crossing, a 6.1° C increase in only 4.7 stream miles. Another large increase occurred between the Road 311 crossing and the mouth of Lyman Creek on private land. The mean-maximum at the Road 311 crossing was 16.7° C; above the mouth of Lyman Creek it was 19.5° C, an increase of about 3° C over 1.5 stream miles. The influx of warmed surface waters from Schoolmarm Lake (a man-made impoundment in the lower Lyman Creek drainage) had surprisingly little effect on the temperature of Cameron Creek. Mean-maximum temperatures in Cameron Creek above (19.5° C) and below (19.3° C) the mouth of Lyman Creek were essentially unchanged. The water in Doran Creek, another tributary which enters Cameron Creek a couple hundred feet downstream of Lyman Creek, was considerably cooler (mean-max 16.8° C) than the water in Lyman Creek (mean-max 20.0° C). The influx of Doran Creek cooled Cameron Creek from 19.3° C to 18.7° C, but it did not last for long. Between Doran Creek and the National Forest boundary near Pasture Draw, Cameron Creek again heated up from 18.7° C to 21.0° C - an increase of 2.3° C over 2.3 stream miles. Finally, from the Pasture Draw area to the East Fork Bitterroot River (the lowermost 6 stream miles), there was essentially no change in the temperature of Cameron Creek. The mean-maximum near Pasture Draw (milepost 6.1) was 21.0° C, and the mean-maximum entering the East Fork Bitterroot River was also 21.0° C.

Temperatures were also monitored at three locations in the Lyman Creek drainage. From highest to lowest in the drainage, the monitoring locations were:

- milepost 0.7 on the unnamed "North Fork" of Lyman Creek – this is where the stream exits National Forest land and enters State land
- milepost 0.7 on Lyman Creek – the inlet to Schoolmarm Lake
- milepost 0.1 of Lyman Creek – at the Cameron Creek confluence, downstream of Schoolmarm Lake

Temperatures in Lyman Creek and its tributaries have cooled somewhat in recent years on National Forest lands that were burned in 2000. The mean-maximum temperature in the North Fork of Lyman Creek at the National Forest/State land boundary was only 16.0° C in 2010. Back in 2001-05, the mean-maximum usually exceeded 18° C + and sometimes even exceeded 20° C. On State land, the North Fork enters the main "named" channel of Lyman Creek and then flows into Schoolmarm Lake. In 2010, the mean-maximum entering Schoolmarm Lake was 17.2° C. Waters are unnaturally warmed in the lake (a man-made impoundment), which is shallow and gets nearly 100% solar exposure. Below Schoolmarm Lake, Lyman Creek flows across private pasture land for about half a mile before entering Cameron Creek. The mean-maximum temperature of Lyman Creek where it enters Cameron Creek is warm (20° C). However, Lyman Creek water has little effect on the temperature of Cameron Creek because Cameron Creek is also nearly as warm (mean-max 19.5° C) just upstream of Lyman Creek. Despite having very similar mean-maximum temperatures, a key difference between Cameron and Lyman creeks is their degree days. The mouth of Lyman Creek had 1021 degree days in 2010, while Cameron Creek just above the Lyman Creek confluence only had 918 degree days. Diurnal cooling accounted for this difference. The water in Cameron Creek did cool 2-3° C at night, while the water in Lyman Creek changed little at night because it was constantly transporting the heated surface waters of Schoolmarm Lake.

The key finding of our 2010 data collection effort is that Cameron Creek is cold in the Sleeping Child Fire area, but warms quickly when it flows through the 2000 fire area and stays warm all the way to the East Fork Bitterroot River. It is critical to the fishery that this headwater source of cold water is maintained when implementing the Cameron Blue Ecoburn. There are currently no brook trout in the Sleeping Child Fire portions of Cameron Creek, only native westslope cutthroat trout. However, brook trout are common several miles downstream in the warmer sections of Cameron Creek near the Road 311 crossing. The cold water that occurs in the Sleeping Child Fire portion of Cameron Creek provides a headwater refugia for westslope cutthroat trout and helps to exclude brook trout. That cold water needs to be maintained when implementing the Cameron Blue Ecoburn. Table 8 lists the monitoring sites where temperature data was collected for the Cameron Blue Ecoburn project, and the mean-maximum temperatures and degree days recorded at those sites in 2010.

Table 9 - Cameron Blue Ecoburn Water Temperature Monitoring Sites (2010)

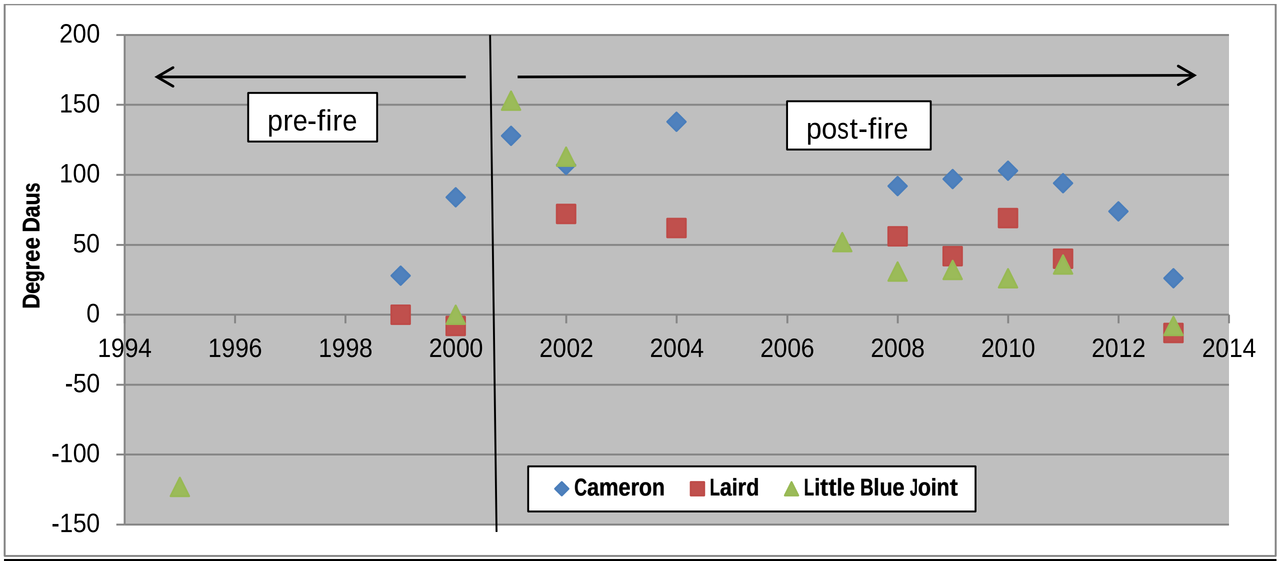
Stream	Milepost	Location Description	Mean-Maximum Temperature (° C)	Degree Days
Cameron Creek	0.1	mouth	21.0°	994
Cameron Creek	6.1	near Pasture Draw	21.0°	944
Cameron Creek	8.4	below Doran Creek	18.7°	884
Cameron Creek	8.5	between Doran and Lyman Creeks	19.3°	918
Cameron Creek	8.6	above Lyman Creek	19.3°	910
Cameron Creek	10.1	Road 311 crossing	16.7°	810
Cameron Creek	14.8	Road 1398 crossing	10.6°	570
Cameron trib 13.1	0.1	mouth	12.6°	666
Lyman Creek	0.1	Mouth (below Schoolmarm Lake)	20.0°	1021
Lyman Creek	0.7	above Schoolmarm Lake	17.2°	881
North Fork Lyman Cr	0.7	National Forest boundary	16.0°	779
Doran Creek	0.1	mouth	16.8°	856
Guide Creek	0.1	mouth	12.3°	658
Jennings Camp Creek	1.1	one mile above East Fork Highway	11.4°	667
Bertie Lord Creek	0.2	near East Fork Highway	14.1°	712
Bertie Lord trib 0.4	0.1	mouth	13.2°	680
East Fork Bitterroot River	13.3	near Sula Store	19.3°	987
East Fork Bitterroot River	17.8	near Tolan Creek	18.2°	907

Fire Monitoring

2000 Fires (Sula and West Fork Ranger Districts). Mahlum et al. (2011) investigated the recovery of post-fire water temperatures on the Bitterroot National Forest seven years following the 2000 fires. Their findings were published in the *International Journal of Wildland Fire.* Mahlum et al. (2011) reported that starting one month after the 2000 fires and in the subsequent year, increases in maximum water temperatures at sites within burns were 1.4–2.28 ° C greater than those at unburned reference sites, with the greatest differences occurring in the months of July and August. Seven years after the fires (2007), there was no evidence that maximum stream temperatures were returning to their pre-fire norms. Mahlum et al. (2011) concluded that temperature increases in these relatively large streams are likely to be long-lasting and exacerbated by climate change.

On a related note, Forest fisheries biologists have monitored water temperatures in Laird Creek (milepost 1.5), Little Blue Joint Creek (milepost 1.5), and Cameron Creek (milepost 10.1) nearly every summer since the 2000 fires. These three sites were also included in the Mahlum et al. (2011) research. Figure 33 shows how the degree days in Laird, Little Blue Joint, and Cameron creeks have changed over the past 13 years relative to their unburned index sites. For Laird and Cameron creeks, the index sites used for comparison were Martin Creek (milepost 1.3) and Moose Creek (milepost 1.4). For Little Blue Joint Creek, the index site used for comparison was Blue Joint Creek (milepost 5.9). Pre-fire data points were available for Little Blue Joint (1995) and Cameron Creek (1999), but not for Laird Creek. In 2012, we deployed thermographs at Laird, Little Blue Joint, and Cameron Creek sites, but were only able to get a degree day reading from the Cameron Creek site because of thermograph malfunctions at the Laird and Little Blue Joint sites. In Figure 33, the "0" line on the y-axis indicates that degree days at a burned site were identical to the degree days at its index site. Negative data points indicate the degree days at a burned site were less than (i.e. colder) than its index site. Positive data points indicate the degree days at a burned site were greater than (i.e. warmer) than its index site. If temperatures are recovering in the burned streams, their data points should be moving closer to the "0" line over time.

Figure 33 – Degree day differences between Laird Creek (milepost 1.5), Cameron Creek (milepost 10.1), and Little Blue Joint Creek (milepost 1.4) and their unburned index sites



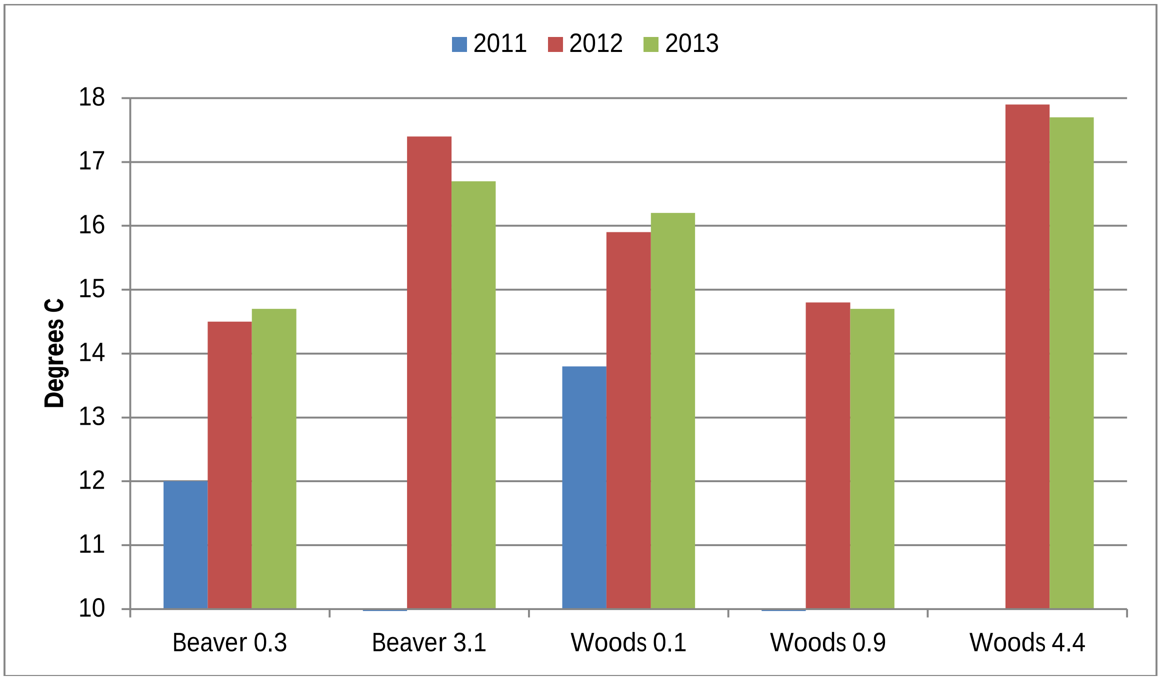
The data in Figure 33 has quite a bit of variability, but it does suggest that some recovery of temperatures is occurring in all three streams (i.e. the data points are moving closer to the "0" over time). In 2013, for instance, both the Laird Creek and Little Blue Joint Creek sites were cooler than their unburned index sites for the first time since the 2000 fires.

2011 Saddle Complex Fire (West Fork Ranger District). The Saddle Complex wildfire burned the upper halves of the Beaver and Woods Creek drainages at high severity in August, 2011. In 2012 and 2013, we monitored water temperatures at five sites in the Beaver and Woods Creek drainages in order to discern water temperature responses to the burn. Our monitoring sites were located at:

- Beaver Creek, milepost 0.3 – near the mouth
- Beaver Creek, milepost 3.1 – near the downstream edge of the high severity burn
- Woods Creek, milepost 0.1 – near the mouth
- Woods Creek, milepost 0.9 – near the downstream edge of the low severity burn
- Woods Creek, milepost 4.4 – near the downstream edge of the high severity burn

The only sites that had 2011 data were Beaver Creek 0.3 and Woods Creek 0.1. Figure 34 displays the 7-day mean-maximum water temperatures that occurred at the monitoring sites in 2011-13.

Figure 34 – 7-Day Mean-Maximum Water Temperatures in Beaver and Woods Creeks before (2011) and After (2012 and 2013) the 2011 Saddle Complex Fire



The data in Figure 34 is consistent with the findings of the Mahlum et al. (2011) research. Mahlum et al. (2011) reported that following the 2000 fires, increases in maximum water temperatures at sites within burns were 1.4–2.28° C greater than those at unburned reference sites. The temperature increases that occurred at the Beaver 0.3 and Woods 0.1 sites before and after the Saddle Complex fire are close to the upper end of Mahlum's reported range. Also, note how warm the maximum temperatures have become in the severely burned headwaters (Beaver 3.1 and Woods 4.4 sites).

2012 Mustang Complex Fire (West Fork Ranger District). The Mustang Complex wildfire burned the West Fork Bitterroot River headwaters and the upper halves of the Sheep and Johnson Creek drainages at mixed severity in August and September, 2012. In 2013, we monitored water temperatures at three sites affected by the fire (Sheep Creek milepost 0.1, Johnson Creek milepost 0.1, and West Fork Bitterroot River milepost 40.0) in order to detect post-fire water temperature changes. Table 10 summarizes how the degree days at the three sites changed before (2011) and one year after (2013) the 2012 Mustang Complex fire.

Table 10 - Change in Degree Days at Three Sites before (2011) and One Year after (2013) the 2012 Mustang Complex Wildfire

Stream	Milepost	2011 Degree Days	2013 Degree Days	Magnitude of Change
Sheep Creek	0.1	458	576	+118
Johnson Creek	0.1	577	702	+125
West Fork Bitterroot River	40.0	597	696	+99

The data in Table 10 indicates that stream temperatures in these three sites have increased as a result of the Mustang Complex fire. However, there are no longer any streams unaffected by fire in the vicinity of these three sites, so we did not have a control site that we could use to pin-point the magnitude of the increase and eliminate some of the year-to-year variability that is caused by the weather. That being said, an increase of +99 to +125 degree days is still a sizeable jump that is undoubtedly fire-influenced.

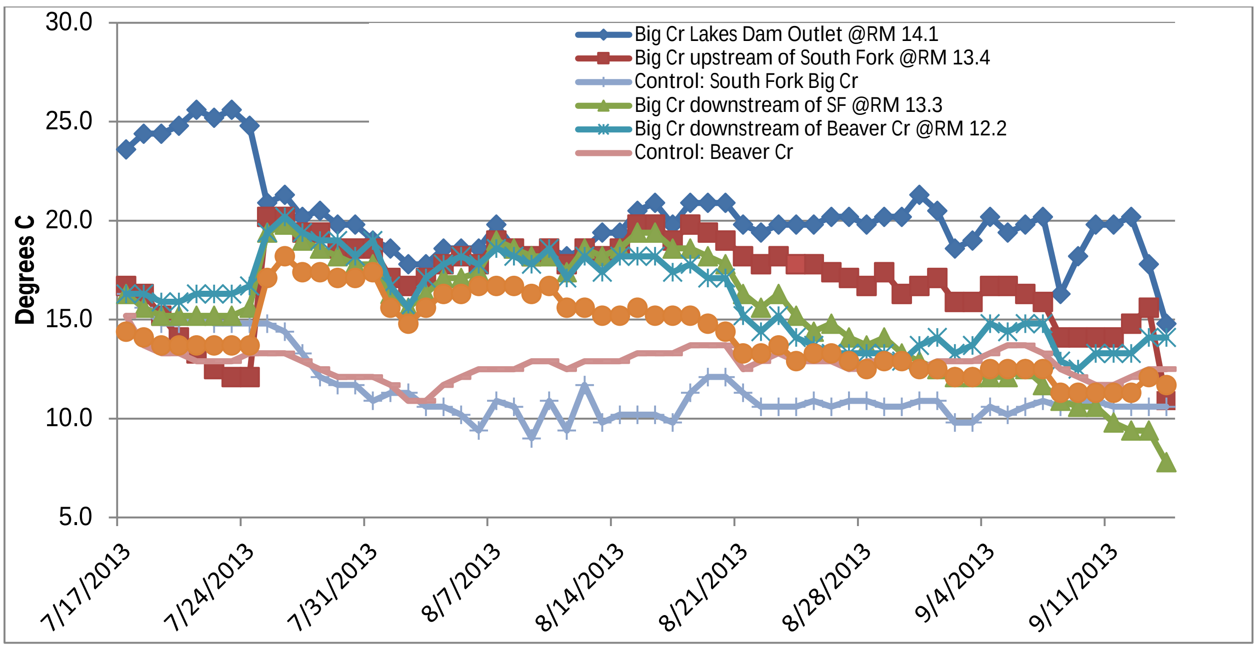
<u>Stream Temperatures and Headwater Reservoirs</u>

Reservoirs within the boundaries of the Bitterroot NF affect the temperature of water downstream. The difference between the temperature effects of lakes and reservoirs is that reservoirs have stored water that is managed for release when that water is needed for a purpose. The release of reservoir water is usually detected by the temperature loggers because there are rapid fluctuations in the temperature of the water downstream from the reservoirs' dam. Three reservoirs in the Bitterroot Range provide examples: Big Creek (Big Creek Lakes), Fred Burr Creek (Fred Burr Reservoir), and Lost Horse Creek (Twin Lakes).

Big Creek (Big Creek Lakes, Stevensville Ranger District). Temperatures were recorded by seven data loggers in upper Big Creek drainage in the summer of 2013. Five were in Big Creek ranging from river mile 10.4 where a fish-barrier falls exists, to the outlet of Big Creek Lakes dam (river mile 14.1). All the sites were in the Selway-Bitterroot Wilderness. There is a dramatic shift in temperatures on July 24 that is apparently a result of release of water from the dam outlet. At the dam outlet water temperatures dropped rapidly from the mid-twenties to the low-twenties. Early July outlet temperatures were especially high because the amount of water in the outlet channel was a trickle and exposed to the sun. The amount of water leaving the reservoir when temperatures were in the low twenties was a relatively large amount of water, and it affected all the downstream temperature loggers. Downstream temperatures rose 3 to 8 degrees C, while the controls were stable.

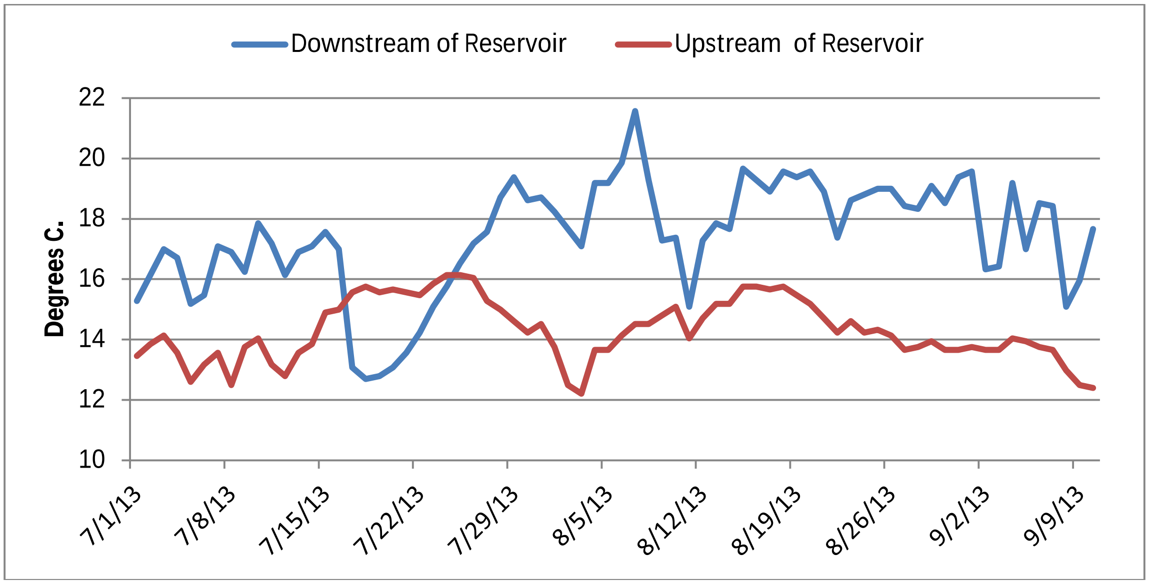
Two tributaries that are unaffected by the Big Creek Lakes water releases are the controls. Beaver Creek, almost 2 miles downstream of the dam, is a relatively large tributary. It did not dilute the reservoir's warm water effect even at river mile 10.4 as expected. It was expected that Beaver creek would hide the effects of the reservoir release on stream temperature and therefore there were no temperature data loggers downstream of that site.

Figure 35 – Daily high water temperatures at seven locations in the Big Creek Drainage in 2013.



Fred Burr Creek (Fred Burr Reservoir, Stevensville Ranger District). Two temperature data loggers have been set near the Fred Burr Reservoir for the last few years: one in Fred Burr Creek as it enters the reservoir (approximately 200 feet upstream of the full pool level) and one approximately 0.2 miles downstream of the dam. The upstream temperatures are illustrative as a control as it is unaffected by the damming of the stream. The temperatures downstream of the reservoir show the effects of the dam and water management. The summer's daily high temperatures in the creek downstream of the reservoir are more variable, and reach temperatures that may be lethal to native trout (>20 degrees C). The downstream temperatures drop lower than the upstream temperatures (July 16 through 23) when the water from the deepest part of the reservoir is released via the dam's deep water outlet. Temperatures climb as the deep water is drained. Data from other years shows a similar trend. Although current water management may favor non-native trout over native trout, it should be noted that fortunately Fred Burr dam is a barrier to non-native fish. Upstream of the dam the only species observed have been native westslope cutthroat trout and bull trout.

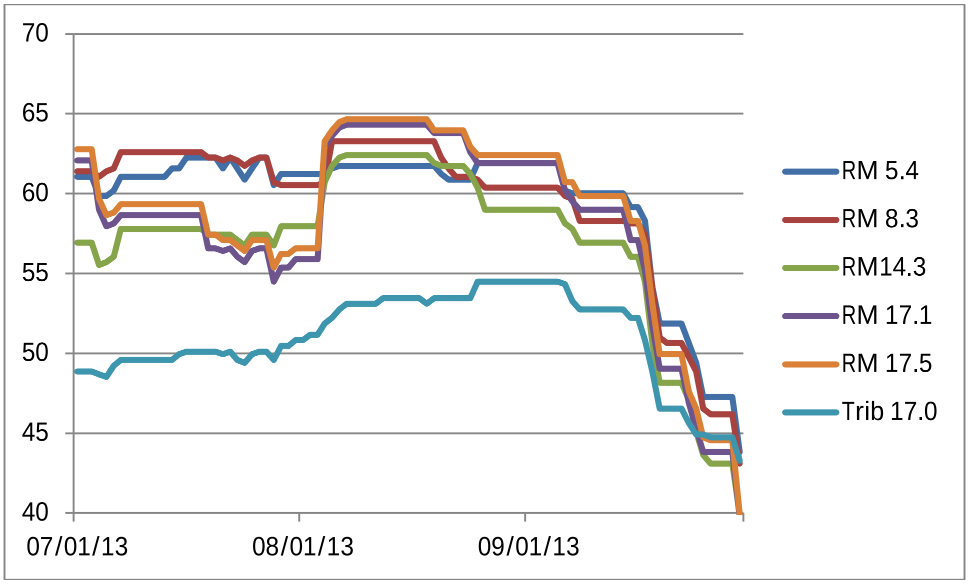
Figure 36 – Daily high water temperatures at upstream and downstream of the Fred Burr Reservoir in 2013.



Lost Horse Creek (Twin Lakes, Darby Ranger District). Figure 37 shows the data from six sites in the Lost Horse drainage. The river mile (distance from the mouth of Lost Horse at the Bitterroot River) is displayed. Note the substantial increase in water temperature at RM 17.5 on August 4th. RM 17.5 was the closest to the reservoir approximately a mile upstream, at RM 18.6.

Tributary 17.0 is not affected by the reservoir, and functions as a control. Its temperature rises slower during that same August period. Based on the sudden rise in temperatures in August, it appears that the effect of reservoir release on water temperature may reach to river mile 14.3 and possibly further downstream. This data will be re-collected in 2014 to see if the data is consistent, and not a chance occurrence or a flaw in the data.

Figure 37 – Daily high water temperatures at six locations in the Lost Horse Drainage in 2013.



From: O:\NFS\Bitterroot\Program\2600FishMgmt\2630FishHabitat\NorthZone\2013Data\HoboData\LostHorse2013ExcelData\LostHorseDailyHigh2013_040114.xlsx

These are the key findings of the Forest's water temperature monitoring:

- Stream temperatures are increasing across the Forest in response to the warming climate. Increases have been observed in all types of streams (big and small) on all parts of the Forest (wilderness and managed).

Degree days have increased by 75 to 150 units in most streams since 1993, which roughly correlates to around a 1-2º C increase in the mean daily water temperature.

- Ø The decline of bull trout populations observed in some streams since 2006 is likely related to stream temperature increases. The most vulnerable reaches occur at the lower elevations where the lower limit of bull trout distribution currently exists and non-native trout competitors are more numerous. If water temperatures continue to rise in future years, bull trout distribution will shrink across the Forest, with the populations at the lowest elevations disappearing first. The most conservative climate models suggest warming in the range of 1.6º C over the next 50 years, which could result in suitable bull trout habitat being reduced by 30-40% on the Forest. Some of the more liberal models suggest warming in the range of 6º C over the next 50 years, which could eliminate suitable bull trout habitat from all but the highest elevations.
- Ø Stream warming is a factor in the recent expansion of brown trout populations in the East Fork Bitterroot River, West Fork Bitterroot River, Sleeping Child Creek, and lower Camp Creek. A cursory comparison of our fish distribution and water temperature data indicates that brown trout are more likely to occur at higher numbers in stream reaches that accumulate more than 800 degree days per summer.
- Ø Most of the Bitterroot Headwaters TMDL water temperature monitoring sites in the East Fork Bitterroot River, West Fork Bitterroot River, Hughes Creek, Overwhich Creek, and Nez Perce Fork have consistently failed to meet their water temperature goals. The upper West Fork Bitterroot River site (river mile 40.0) site has had the best success, meeting its temperature goal in about half of the years since 1993. In the current climate, most of the temperature goals in the Headwaters TMDL appear to be unattainable.
- Ø Temperature restoration projects for the East Fork Bitterroot River should focus on the state and private portions of Cameron, Camp, Medicine Tree, Tolan, Laird, and Warm Springs creeks, and the Sula Basin section of the East Fork between Tolan Creek and the Sula canyon. Above Mink Creek, temperature restoration opportunities are more limited and tributary inputs are closer to natural conditions
- Ø Monitoring indicates that timber sales that retain intact RHCA buffers are not having a detectable effect on stream temperatures
- Ø Commercial thinning of beetle-killed trees occurred in several recreation and administrative sites in 2012. Most of these sites are located in RHCAs adjacent to rivers and streams. The effect of thinning on RHCA microclimate (and potentially stream temperatures) was investigated in the Rombo campground. Thinning resulted in a < 1º C air temperature increase within the RHCA, but the increase was mitigated by a 50-foot wide strip of untreated riparian vegetation along the West Fork Bitterroot River to levels similar to untreated riparian areas. The air temperature increase that resulted from thinning the Rombo campground was too small to have a detectable effect on river temperatures in the West Fork Bitterroot River.
- Ø Three streams that were severely burned in 2000 (Laird Creek, Little Blue Joint Creek, and the middle portion of Cameron Creek) appear to be showing some temperature recovery. In 2013, the Laird Creek and Little Blue Joint Creek sites were cooler than their unburned index sites for the first time since the 2000 fires.
- Ø The 2011 Saddle Complex fire has increased water temperatures in Beaver and Woods creeks. Post-fire increases at the mouths of both streams were in the 2-2.5º C range, while increases in the severely burned headwaters were even higher, in the 4-5º C range.
- Ø The 2012 Mustang Complex fire has increased water temperatures in Sheep Creek, Johnson Creek, and the upper West Fork Bitterroot River. The lack of a suitable control site makes it difficult to accurately pin-point the magnitude of the increases, but the 2013 degree days were 99-125 units higher than the 2011 degree days.
- Ø Reservoirs and dam operations on the Forest affect water temperatures. The influence is site specific because the dams vary in depth and operational procedures. The effect on temperature may be measurable a few miles downstream.

BULL TROUT REDD SURVEYS:

Starting in 1994, Forest and MFWP fisheries biologists have cooperatively conducted annual bull trout redd surveys in three streams: (1) Meadow Creek on the Sula District; (2) Deer Creek on the West Fork District; and (3) Daly Creek on the Darby District. With the exception of a few missed years, redd counts have been conducted in these reaches every year since 1994. In 2000, in response to a bull trout radio telemetry project, a fourth bull trout redd survey reach was added in the upper East Fork Bitterroot River in the Anaconda-Pintler Wilderness Area. In 2005, a fifth bull trout redd survey reach was temporarily added (until 2010) in Chicken

Creek on the West Fork Ranger District in response to a U.S. Fish and Wildlife formal consultation and biological opinion (2006, Litchford and Hawkes Ditch Bill Easements). The Chicken Creek reach was surveyed for the last time in 2010, which completed the monitoring requirement in the Litchford and Hawkes biological opinion.

Meadow Creek Redd Survey (Sula Ranger District). The "Meadow reach" is a two-mile long section of Meadow Creek that the Forest has monitored each autumn for bull trout redds since 1994. In 2013 and 2013, we conducted the redd survey on September 17th and 19th, which was about three weeks earlier than usual. We moved up the date of the redd survey in response to movement data collected by Leslie Nyce (2011) in her Master's research. She found that radio-tracked migratory adult bull trout in the East Fork Bitterroot River drainage had completed their spawning by the last week in September and were already starting to move downstream towards overwintering habitats (Nyce, 2011). Moving the survey date up to September proved to be more successful than our usual October surveys. We counted 17 redds in 2012 and 5 redds in 2013, most of which were the larger redds formed by migratory bull trout. The majority of the redds (14 of 22) were found in a concentrated patch of C-channel habitat downstream of the riparian exclosure fences. This patch of habitat is not fenced, so it will need to be closely watched for bank trampling effects in the years that the Meadow-Tolan allotment is grazed (i.e. the Meadow Creek portion of the allotment was rested in 2011-13). There has not been a good correlation between the number of redds counted and the number of juvenile bull trout captured in electrofishing mark/recapture estimates in Meadow Creek. Redd counts have fluctuated at low numbers, while juvenile bull trout estimates have remained relatively stable. Either we cannot reliably count bull trout redds in Meadow Creek (i.e. most of the bull trout may be resident fish whose small redds are difficult to see), or the bull trout are spawning in areas where we are not looking for them. We plan on conducting the Meadow Creek redd survey again in September, 2014.

Nyce, L.G.N. 2011. Genetic population structure and conservation of bull trout in the East Fork Bitterroot River drainage, Montana. Master's Thesis. University of Montana, Missoula, Montana.

Figure 38 – Migratory bull trout redd in Meadow Creek, September 2013. The white rod is 6 meters long.

Upper East Fork Bitterroot River Redd Survey (Sula Ranger District). This reach was established by MFWP biologists in 2000 in response to several radio-tagged bull trout moving in this reach to spawn from the lower East Fork. Due to the lack of redds found in previous years, MFWP biologists have not surveyed this reach since 2007. It is unknown at this time if the reach will be surveyed in 2014.

Deer Creek Redd Survey (West Fork Ranger District). The Forest has conducted a bull trout redd survey in the lower 1.3 miles of Deer Creek since 1994. In 2012 and 2013, we conducted the redd survey on September 18th and 24th, which was about three weeks earlier than usual. However, in contrast to what happened in Meadow Creek, we did not have a lot more success at finding redds in Deer Creek than what we typically observe in our October surveys. We counted two redds in 2012, and seven redds in 2013, which within the range (0 to 16 redds) observed during 1994-2011. Bull trout and brook trout occur at similar densities in lower Deer Creek. As a result, we are unable to accurately distinguish between the redds of the two species. We have reported the total number redds counted, but some of those could have been made by brook trout. We plan on conducting the Deer Creek redd survey again in September, 2014.

Chicken Creek Redd Survey (West Fork Ranger District). This reach was established by Forest fisheries biologists in 2005 in response to a consultation with the U.S. Fish and Wildlife Service. The reach was surveyed in 2005-2010. The number of redds counted was 13 (2005), 15 (2006), 16 (2007), 21 (2008), 15 (2009), and 16 (2010). The 2010 survey completed the monitoring requirement in the Litchford and Hawkes Ditch Bill Easements biological opinion. Survey of the Chicken Creek reach was discontinued in 2011. At this time, there are no plans to survey redds in Chicken Creek in 2014.

Daly Creek Redd Survey (Darby Ranger District). The Forest has conducted a bull trout redd survey in a 1-mile long reach of Daly Creek since 1994. In the last four years 41 to 49 redds have been counted. This has been surprisingly consistent, and is in the middle of the range (20 to 77 redds) observed since 1994. Redds were the size of those typically made by resident bull trout (1 to 2 ft^2). In recent history, the drainage above the surveyed section has been intermittently affected by small to moderate amounts of fire, consistently affected by a few obvious points where sediment is transported from Hwy 38 to Daly Creek’s ephemeral channels, and a few other disturbances like dispersed camping and illegal near-stream firewood collection. We plan on continuing to survey redds in Daly Creek in early October, 2014.

Figure 39 - Annual Bull Trout Redd Counts, 1994 to 2013

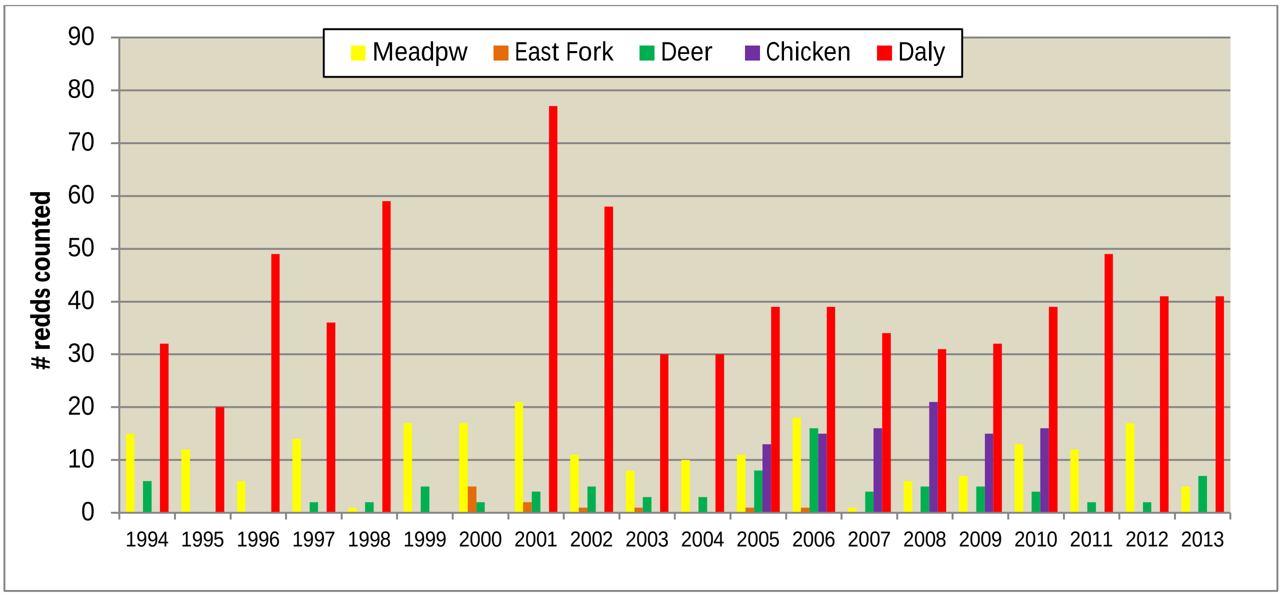


Table 11 - Annual Bull Trout Redd Counts, 1994 to 2013

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Meadow Creek (D3)	15	12	6	14	1	17	17	21	11	8	10	11	18	1	6	7	13	12	17	5
East Fork (D3)	ND	ND	ND	ND	ND	ND	5	2	1	1	0	1	1	0	ND	ND	ND	ND	ND	ND
Deer Creek (D4)	6	0	0	2	2	5	2	4	5	3	3	8	16	4	5	5	4	2	2	7
Chicken Creek (D4)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	15	16	21	15	16	ND	ND	ND
Daly Creek (D2)	32	20	49	36	59	ND	ND	77	58	30	30	39	39	34	31	32	49	49	41	41

ND = No data, not surveyed

These are the key findings of the Forest's monitoring of bull trout redds:

- With the possible exception of Daly Creek, redd counts have not been a reliable index of bull trout population trends on the Bitterroot National Forest. Either we are: (1) looking in the wrong places (e.g. what we think is good spawning habitat is not what most of the bull trout are using for spawning); (2) looking in the right places but cannot reliably identify the redds that are present (e.g. most of the redds are small resident redds that are difficult to see); or (3) there are just very few migratory redds, and the redds that are present are widely scattered. Forest and MFWP biologists are reasonably certain that the poor correlation that occurs between redd counts and the electrofishing data is caused by a combination of (2) and (3). Moving the date of survey up from October to the third week in September definitely helped us find more redds in Meadow Creek, but didn't seem to make much of a difference in Deer Creek or Daly Creek. At least in the East Fork Bitterroot River drainage, it appears to be better to conduct redd surveys in the third week of September rather than October.
- Redd counts are best used as an index of population trend after key spawning areas have been identified. Without knowing where the key spawning areas are, redd counts have very limited utility. In 2008, Leslie Nyce, a University of Montana graduate student, used radio-telemetry to identify that the East Fork Bitterroot River and its larger tributaries (Orphan and Clifford creeks) in the Anaconda-Pintler Wilderness Area appear to be key spawning area for migratory bull trout. Unfortunately, the number of migratory bull trout in the East Fork appears to have declined to such low numbers that it is questionable whether doing more redd surveys would provide any additional information in monitoring population trends. Since 2000, MFWP biologists already had an established redd survey reach (the Upper East Fork redd survey, discussed above) located in the vicinity where the radio-tagged bull trout went. However, the number of redds counted between 2000 and 2007 was so low that MFWP biologists have not surveyed the reach since 2007.
- Daly Creek appears to be the one possibly reliable index of resident bull trout population trends on the Bitterroot National Forest. The resident bull trout spawn in this area at fairly high density, and the area is conducive for red surveys.
- Radio telemetry could be used to determine where the bull trout in Painted Rocks Lake go to spawn. Trapping data collected by researchers working in Slate Creek in 2003 indicate that migratory bull trout in Painted Rocks Reservoir may be more common than was originally believed, but little is known about where those bull trout spawn. In August 2010, a 19-inch migratory adult bull trout spawner was captured in Little Boulder Creek (tributary to Painted Rocks Reservoir), upstream of the Forest Road 1130 culvert. Adult bull trout spawners have also been periodically seen or captured during electroshocking surveys in low numbers in Blue Joint Creek, Deer Creek, Chicken Creek, Hughes Creek, Overwhich Creek, and the upper West Fork. A few adult bull trout spawners have also been seen in Blodgett Creek on the Stevensville Ranger District.

MUSSEL SURVEYS:

The western pearlshell mussel (*Margaritifera falcata*) was added to the Bitterroot National Forest's sensitive species list in 2010. The average life span of *M. falcata* is approximately 60-70 years, and some individuals are thought to live 100 years. It may be an excellent biological indicator of water quality because this species is sedentary, may be sensitive to environmental changes, and long-lived. Since 2007, limited and sporadic mussel surveys have been conducted in Forest streams. So far, western pearlshell mussels have only been found in six streams on or near the Bitterroot National Forest. The six streams are:

1. Cameron Creek (mouth to upper end of Shining Mountain Ranch)
2. Little Sleeping Child Creek (lower reaches downstream of private ponds)
3. East Fork Bitterroot River (near mouths of Laird and Cameron creeks)
4. West Fork Bitterroot River (near Applebury Landing boat launch)
5. Bitterroot River (near Darby)
6. Selway River (near Running Creek)

In 2012 and 2013, mussel surveys were conducted in Cameron Creek, Boulder Creek, Bush Creek, Lick Creek (Darby RD), Little Sleeping Child Creek, Martin Creek, Meadow Creek, Moose Creek, the Nez Perce Fork, Sheephead Creek, Watchtower Creek and the East Fork Bitterroot River (Table 12). Mussels were present in Cameron Creek and Little Sleeping Child Creek in the same locations where they had previously been found in 2007 and in the 1990s. We also found mussels in all parts of Cameron Creek between its confluence with the East Fork Bitterroot River and Doran Creek on the Shining Mountain Ranch. Shells were found in the East Fork Bitterroot River near the mouth of Cameron Creek, but no live mussels. Mussels were not found in the other streams that were surveyed in 2012 and 2013. Table 12 lists the mussel surveys that were conducted on the

Forest in 2012 and 2013.

Table 12 - Mussel Surveys Conducted in 2012 and 2013

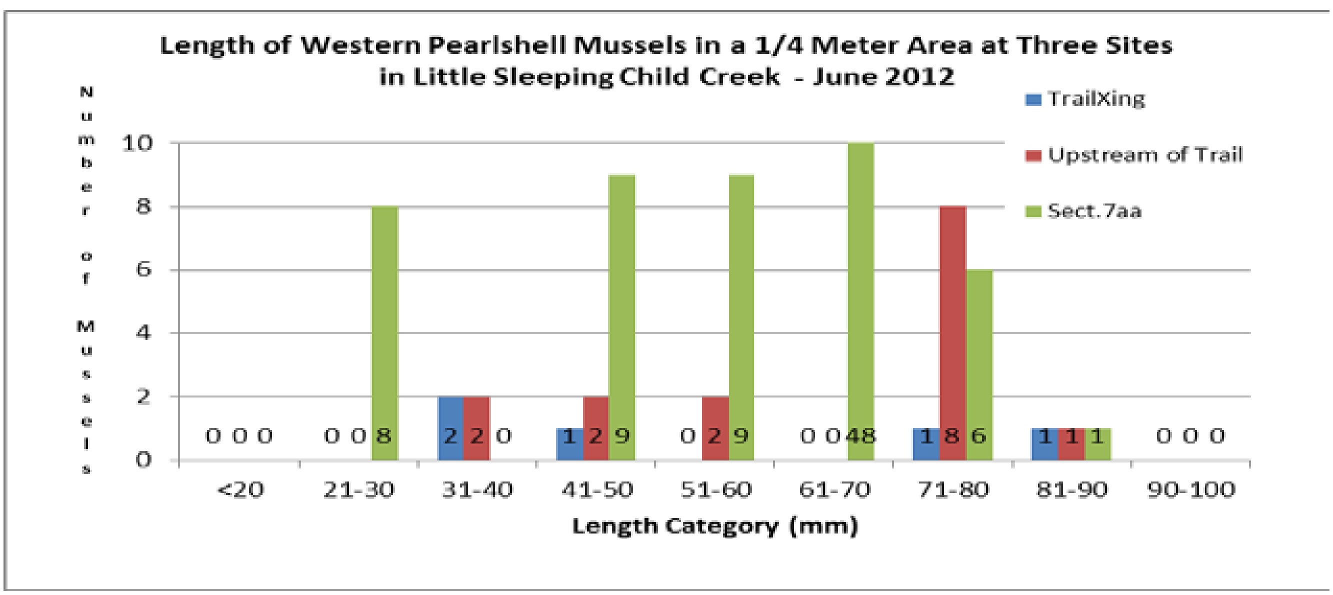
Stream	River Mile	GPS Location	Date of Survey	Length of Survey	Rosgen Channel Type	Mussels Found?	Survey Notes
Boulder	0.6	N45.82268^0 W114.24644^0	9-12-2012	200 feet	C4	No	Habitat appears to be suitable
Bush	0.1	N45.94517^0 W113.73386^0	9-7-2012	200 feet	C5	No	Beaver-impounded reach; lots of sand; may have some suitable habitat
Cameron	0.1	N45.83753^0 W113.98228^0	9-7-2012	200 feet	C3	No	Habitat appears to be suitable; lots of moss on rocks; difficult to see
Cameron	5.3	N45.88705^0 W113.95461^0	9-7-2012	200 feet	C5	Yes	Saw about 11 mussels per 100 feet; mostly adults; found in mix of sand and small gravel
Cameron	6.1	N45.89396^0 W113.95725^0	9-7-2012	200 feet	C5	Yes	Saw about 16 mussels per 100 feet; juveniles and adults; found in mix of sand and small gravel
Cameron	14.5	N45.96658^0 W113.87722^0	9-11-2012	200 feet	C4	No	Substrate appears to be suitable; but stream flows may be too low
Cameron	14.9	N45.96914° W113.87373°	9-11-2012	200 feet	C5	No	Substrate appears to be suitable; but stream flows may be too low
Lick (Darby)	1.9 – 4.0	N46.086° W114.202° to N46.077° W114.245°	8-6-2013	1 mile	B4	No	Only 50% of area effectively surveyed due to brush. Substrate appears to be suitable
Little Sleeping Child		N46.133° W114.127°	6-18-2012 10-31-2013	200 feet	B5	Yes	Substrate data shows d50 is <12mm (dominant particle size is sand and small gravel).
Martin	0.9	N45.94154^0 W113.73189^0	9-7-2012	200 feet	B3	No	Cobble substrates dominate; habitat may be unsuitable due to lack of gravel/fines
Nez Perce Fork	1.2	N45.79874^0 W114.28678^0	9-10-2012	200 feet	C3	No	Cobble substrates dominate; habitat may be unsuitable due to lack of gravel/fines
Nez Perce Fork	3.8	N45.78332^0 W114.32567^0	9-10-2012	200 feet	C3	No	Maybe some suitable habitat; most appears to be unsuitable due to dominance of cobble substrates
Nez Perce Fork	5.1	N45.77125^0 W114.33543^0	9-10-2012	200 feet	C3	No	Cobble substrates dominate; habitat may be unsuitable due to lack of gravel/fines
Nez Perce Fork	7.4	N45.75372^0 W114.37077^0	9-10-2012	200 feet	B3	No	Cobble substrates dominate; habitat may be unsuitable due to lack of gravel/fines
Nez Perce Fork	9.8	N45.74799^0 W114.41832^0	9-12-2012	200 feet	C4	No	Gravel substrates dominate; habitat appears to be suitable
Nez Perce Fork	11.5	N45.74479^0 W114.44197^0	9-12-2012	200 feet	C4	No	Gravel substrates dominate; habitat appears to be suitable
Sheephead	0.2	N45.74690^0 W114.45062^0	9-12-2012	200 feet	B4	No	Gravel substrates dominate; habitat appears to be suitable
Sheephead	0.7	N45.75090^0 W114.45892^0	9-12-2012	200 feet	B3	No	Cobble substrates dominate; habitat may be unsuitable due to lack of gravel/fines

Stream	River Mile	GPS Location	Date of Survey	Length of Survey	Rosgen Channel Type	Mussels Found?	Survey Notes
Watchtower	0.1	N45.74568^0 W114.41248^0	9-12-2012	200 feet	C3	No	Mix of cobble and gravel; habitat looks suitable
Watchtower	0.8	N45.75614^0 W114.42213^0	9-12-2012	200 feet	B3	No	Cobble substrates dominate; habitat may be unsuitable due to lack of gravel/fines
Cameron	0.1	N45.83814^0 W113.98272^0	9-9-2013	200 feet	C3/C4	Yes	Saw 8 mussels in 200 feet; 1.5" to 4.5" long; found in sand/small gravel deposits between cobble
Cameron	2.6	N45.85528^0 W113.96759^0	9-9-2013	200 feet	C4/C5	Yes	Saw 7 mussels in 200 feet; 1.5" to 4.5" long; found in mostly sand; shells common
Cameron	8.4	N45.91310^0 W113.95452^0	9-10-2013	200 feet	C4	Yes	Saw 9 mussels in 200 feet; 1.75" to 3.25" long; found in mix of sand and small gravel
Cameron	9.9	N45.92957^0 W113.94293^0	9-12-2013	200 feet	B4	No	Gravel substrates dominate; habitat appears to be suitable
Cameron	10.1	N45.93791^0 W113.92953^0	9-12-2013	200 feet	B4	No	Gravel/cobble substrates; habitat may be unsuitable due to lack of fines and small channel size
Meadow	0.3	N45.90527^0 W113.77795^0	9-17-2013	200 feet	B3	No	Cobble substrates dominate; habitat may be unsuitable due to lack of gravel/fines
Meadow	3.9	N45.86685^0 W113.80250^0	9-17-2013	200 feet	C4	No	Gravel substrates dominate; habitat appears to be suitable
Moose	0.7	N45.93075^0 W113.72291^0	9-16-2013	200 feet	B3	No	Mix of cobble and gravel; habitat may be suitable
East Fork Bitt River	13.4	N45.83796^0 W113.98404^0	9-16-2013	200 feet	C3	Yes, shells only	Mix of cobble and gravel, more sand near mouth of Cameron Creek, habitat looks suitable
East Fork Bitt River	25.6	N45.90124^0 W113.80754^0	9-10-2013	200 feet	B3	No	Cobble/boulder substrates; habitat may be unsuitable due to lack of gravel/fines
East Fork Bitt River	26.7	N45.90782^0 W113.78027^0	9-16-2013	200 feet	B3	No	Cobble/boulder substrates; habitat may be unsuitable due to lack of gravel/fines
East Fork Bitt River	30.0	N45.92234^0 W113.72860^0	9-16-2013	200 feet	B3	No	Cobble/boulder substrates; habitat may be unsuitable due to lack of gravel/fines
East Fork Bitt River	31.6	N45.90731^0 W113.70558^0	9-16-2013	200 feet	B3	No	Cobble/boulder substrates; habitat may be unsuitable due to lack of gravel/fines

Figure 40 – Mussels found in Cameron Creek at river mile 6.1, September 2012.

Populations of long lived species such as western pearlshell mussels may appear stable, when in fact they are not reproducing. To document whether the population in Little Sleeping Child Creek had more than just old adults we sampled ¼ meter areas within three sites that had groups of mussels. Figure 41 below shows the distribution of mussel sizes in the three sites of Little Sleeping Child Creek. All three sites show some degree of variation in size and that means there is variation in age, and that indicates reproduction has occurred. The three sites are all within one mile and are downstream of and highly influence by management of the creek as it runs through private lands. The private lands include small impoundments in Little Sleeping Child Creek. Considering this situation, the overall outlook for this population is rather precarious.

Figure 41 – Size distribution of Western Pearlshell Mussels at three sites in Little Sleeping Child Creek



RESEARCH:

East Fork Bitterroot River Bull Trout Movement and Genetic Study

Leslie Nyce, a graduate student at the University of Montana and MFWP biologist, started a research project in 2008 investigating the movement and genetic population structure of the bull trout in the East Fork Bitterroot River drainage. Leslie finished her course work in 2010 and completed her thesis in spring, 2011. During March and April 2008 six migratory bull trout were captured in the main stem East Fork River and fitted with radio tags. One individual fish was tracked to each of the following locations: Martin Creek, Orphan Creek, Clifford Creek, the upper East Fork River in the wilderness area, the main stem East Fork River in the vicinity of Meadow Creek and one individual disappeared. MFWP and USFS biologists have surveyed every tributary of the East Fork Bitterroot River and 17 of the 23 main tributaries have documented bull trout occupancy. During 2008 and 2009, the main stem East Fork and the 17 tributaries (where bull trout were previously encountered) were electrofished to obtain non-lethal fin samples from potential spawning populations within the basin. The fin samples were used to obtain DNA which was then used to determine the genetic population structure. A total of 73 fin samples were collected from the main stem East Fork River and 307 fin samples were collected from nine tributaries (Clifford, Martin, Meadow, Moose, Orphan, Star, Swift, Tolan and Warm Springs Creeks). Sizes of individual fish in the main stem East Fork ranged from 102 to 610 mm total length and tributary samples ranged from 25 to 422 mm total length. Five tributaries that were sampled yielded no bull trout captures (Laird, Maynard, Reimel, Needle and Buck Creeks) and three samples were removed from further analyses due to very small sample sizes (≤ 3 fin clips; West Fork Camp, Bertie Lord and Carmine Creeks).

Determining the genetic population structure involves investigating genetic differences within tributary populations and genetic variation among tributary populations. Studies in other areas have found relatively little genetic variation within bull trout populations but substantial divergence among populations, the same is expected for the East Fork. If such genetic structure exists, it will be possible to assign bull trout from the main stem East Fork to the tributaries where they originated, helping to determine where fluvial bull trout come from. This information would be very useful in identifying key spawning areas for fluvial bull trout.

It is important to determine the genetic population structure of bull trout in the East Fork because the findings can help determine the best conservation and management actions. For example, if all of the bull trout populations in the East Fork drainage are genetically identical, they can be managed as one population. However, if the bull trout populations are genetically distinct, they need to be managed as individual populations. This information will help direct the most efficient ways to allocate money for bull trout conservation and management in the East Fork Bitterroot River drainage. Leslie's citation and abstract are listed below:

Nyce, L.G.N. 2011. Genetic population structure and conservation of bull trout in the East Fork Bitterroot River drainage, Montana. Master's Thesis. University of Montana, Missoula, Montana.

Abstract
Investigating the genetic population structure of bull trout *Salvelinus confluentus* can be useful for developing biologically sound conservation and management strategies. We focused on the East Fork Bitterroot River (East Fork) drainage because it is a connected, core conservation area for bull trout that contains a migratory life history component. Non-lethal fin samples were collected from 17 sites: nine East Fork tributaries, the main stem East Fork, and seven other tributaries across the Bitterroot drainage. Considering all the samples, principal component analysis of allele frequencies at 15 microsatellite loci indicated the East Fork samples formed a distinct cluster compared to other tributaries sampled. Within the East Fork drainage, there was significant divergence among samples with pairwise F_{ST} ranging from 0.016 to 0.188. Based on multiple locus genotypes, most individuals assigned to their tributary of capture with over 90% probability, suggesting the tributaries contain genetically divergent populations. The main stem East Fork sample tended to form its own group, but some fish collected from it also assigned to tributaries. Four tributaries had individuals that assigned to the East Fork indicating migration from the East Fork to tributaries. Likewise, four tributaries also had individuals that assigned to tributaries different than where they were collected indicating migration from tributary to tributary. These data suggest the East Fork may contain a mixture of individuals produced from spawning in the upper main stem and migrants from different tributaries. The main stem East Fork appears to be an integral component for maintaining the migratory form of bull trout in the drainage and serves as a vehicle for potential genetic exchange among tributary populations. Thus, conservation and management efforts in the drainage need to simultaneously focus on the tributaries and the main stem East Fork.

Post-Fire Fish Population Recovery Study

Clint Sestrich, a graduate student at Montana State University in 2002-05, conducted a post-fire fish population recovery study on the Bitterroot National Forest in 2001-03. Sestrich used mark-recapture electro fishing to compare pre- and post-fire fish populations in 30 study reaches. The study reaches consisted of a mix of debris flow-affected reaches, unburned control reaches, and reaches that were burned at high, moderate, and low severity. The study reaches had an average of three years of pre-fire, mark-recapture estimates. Sestrich conducted his field work in 2001-03, and completed his M.S. Thesis at Montana State University in 2005. In

2011, Sestrich et al. (2011) published their research findings in the *Transactions of the American Fisheries Society*. The citation and abstract are listed below:

Sestrich C.M., T.E. McMahon, and M.K. Young. 2011. Influence of Fire on Native and Nonnative Salmonid Populations and Habitat in a Western Montana Basin. Transactions of the American Fisheries Society 140: 136-146, 2011.

Abstract
Anticipated increases in the frequency and severity of wildfire may threaten the persistence of native salmonid populations in headwater streams in western North America. This study used extensive pre- and post-fire data to assess whether wildfire leads to hypothesized declines in native westslope cutthroat trout *Oncorhynchus clarkii lewisi* and bull trout *Salvelinus confluentus* populations along with increases in the prevalence and abundance of nonnative brooktrout *S. fontinalis*. Postfire cutthroat trout density was negatively correlated with the proportion of basin area that burned at moderate to high severity, but the declines in density after fires were less pronounced for bull trout and brook trout. Recovery of cutthroat trout was generally rapid in severely affected reaches. Contrary to expectation, there was no evidence of a marked increase in abundance or invasion by brook trout after wildfire. Brook trout exhibit the most severe declines in debris flow–affected reaches among all species and exhibited less recovery in severely burned reaches than did cutthroat trout. Increased stream temperature was the most significant habitat change that followed wildfire, the mean maximum water temperature during summer months increasing by 2–6◦C in severely burned reaches. In contrast, burned area percentage was unrelated to large woody debris density, the percentage of surface fines, substrate diversity, or the percentage of pool habitat. The characteristically high variability in fish and habitat responses to wildfire will continue to pose a challenge for the understanding and management of fire in aquatic ecosystems.

<u>Bull Trout Fire/Climate Distribution Study</u>

During the 2009-11 field seasons, Olga Helmy, a PhD fisheries student at the University of Montana, used presence-absence electroshocking to inventory and map the distribution of bull trout in 77 sites in tributaries to the East Fork Bitterroot River. These sites had been previously sampled in 1993-95 by Rich et al. (2003). The goal of Helmy's field work is to document how climate change and fire have altered the distribution of bull trout on the Bitterroot National Forest since the mid 1990's. In 2012, Lisa Eby, fisheries professor at the University of Montana, continued the bull trout distribution project that was started by Helmy. Eby et al. (2013) found that while bull trout are still widely distributed across the East Fork Bitterroot River basin (i.e. they were found in every tributary they were historically present – but not at every site within that tributary), their distribution is shrinking because of climate-driven losses of suitable habitat at the lower elevations. Eby et al. (2013) detected bull trout at only 26 of the 41 sites where Rich et al. (2003) found them. Of the 36 sites in which Rich et al. (2003) failed to detect bull trout, Eby et al. (2013) found them at 5 sites. The citations for Rich et al. (2003) and Eby et al. (2013) are listed below, along with the Eby et al. (2013) abstract:

Rich, C.F., T.E. McMahon, B.E. Rieman, and W.L. Thompson. 2003. Local-habitat, watershed, and biotic features associated with bull trout occurrence in Montana streams. Transactions of the American Fisheries Society 132:1053-1064.

Eby, L.A., O. Helmy, L. Holsinger, and M.K. Young. 2013. Changes in bull trout (Salvelinus confluentus) occupancy to cooler, higher elevation sites in the East Fork Bitterroot River Basin, Montana. Draft Manuscript. University of Montana, Missoula.

Abstract
Many freshwater fishes are considered to be especially vulnerable to expected stream temperature warming associated with climate change because they are ectothermic organisms, but there are surprisingly few studies documenting changes in distributions. Streams and river systems in the Rocky Mountain region, U.S.A. have been demonstrated to be warming over the last two decades and have seen an increase in the severity and frequency of wildfires which also result in habitat changes including increased temperatures. We repeated a 20th century inventory of bull trout (Rich et al. 2003), a thermally sensitive species of conservation interest, in the East Fork Bitterroot River basin in Montana U.S. to determine whether there were trends in site-level extirpation or colonization probabilities across the landscape associated with temperature, wildfire, or other habitat variables. We found that extirpation probabilities were higher than colonization probabilities indicating a restriction in their occupied habitat. Extirpation probabilities covaried with relative temperature across the basin, but did not vary significantly with the presence of moderate to high severity wildfire. Even though we are seeing evidence of a constriction in bull trout habitat use in the East Fork River basin associated with temperature (and elevation), these fish are still present in every tributary they were historically present. Broadening these types of analyses to additional species is critical if we are going to validate our model bioclimatic predictions and identify

variation across the landscape that will improve our understanding of how fish populations will respond to climate change.

Post-Fire Stream Temperature Recovery Study

Mahlum et al. 2011. Investigated the recovery of post-fire water temperatures on the Bitterroot National Forest seven years following the 2000 fires. In 2011, Mahlum et al. (2011) published their research findings in the International Journal of Wildland Fire. The citation and abstract are listed below:

Mahlum S.K., L.A. Eby, M.K. Young, C.G. Clancy, and M. Jakober. 2011. Effects of Wildfire on Stream Temperatures in the Bitterroot River Basin, Montana. International Journal of Wildland Fire 20: 240-247, 2011.

Abstract
Wildfire is a common natural disturbance that can influence stream ecosystems. Of particular concern are increases in water temperature during and following fires, but studies of these phenomena are uncommon. We examined effects of wildfires in 2000 on maximum water temperature for a suite of second- to fourth-order streams with a range of burn severities in the Bitterroot River basin, Montana. Despite many sites burning at high severity, there were no apparent increases in maximum water temperature during the fires. One month after fire and in the subsequent year, increases in maximum water temperatures at sites within burns were 1.4–2.28 C greater than those at reference sites, with the greatest differences in July and August. Maximum temperature changes at sites 41.7 km downstream from burns did not differ from those at reference sites. Seven years after the fires, there was no evidence that maximum stream temperatures were returning to pre-fire norms. Temperature increases in these relatively large streams are likely to be long-lasting and exacerbated by climate change. These combined effects may alter the distribution of thermally sensitive aquatic species.

Sculpin Distribution/Climate Study

During the 2010-13 field seasons, Mike LeMoine, a PhD fisheries student at the University of Montana, used presence-absence electroshocking to inventory the distribution of sculpin on the Bitterroot National Forest. The goals of Mike's field work are to document how sculpin are responding to warming stream temperatures, and how sculpin distribution has changed on the Bitterroot National Forest over the past 20 years. Mike's abstract is included below:

Abstract
Stream fishes are ectothermic animals whose dispersal is limited within stream networks. Consequently, many stream fishes are expected to be substantially influenced by climate change and by physical barriers that prevent movement into thermally suitable habitats. In western North America, bull trout are considered a good umbrella species for conservation; however, they are more mobile and less impacted by obstacles than many native stream fishes. Using presence–absence records from 1991-1994 and from 2010-2013, we assessed the change in occupancy of native stream fishes with differing dispersal abilities in western Montana. Our results reveal small, weak swimming, coldwater fishes (i.e., sculpin) are negatively responding to changing thermal habitats, more so than bull trout and other native trout species. Sculpin are not regularly monitored and could be quietly disappearing from streams causing larger climate change implications, such as altering food webs and stream biodiversity.

CULVERT INVENTORIES AND REPLACEMENTS:

The Forest Plan as amended by INFISH and PACFISH directs the Forest to "provide and maintain fish passage at all road crossings on existing and potential fish-bearing streams" (INFISH/PACFISH standard RF-5). In order to meet this standard, Forest fisheries biologists and engineers have focused much of their attention in recent years on the identification and elimination of fish passage barriers at culverts.

Culvert Inventories: During the 2003 field season, the majority (> 80%) of the fish-bearing culverts on the Bitterroot National Forest were surveyed with the Fish Crossing protocol to assess whether or not they function as a passage barrier to trout. The FishXing model predictions were checked and validated by Forest fisheries biologists. Most of the fish-bearing culverts that did not receive a Fish Crossing survey in 2003 have been field checked by Forest biologists on at least one occasion.

During the 2007 field season, 43 fish-bearing culverts on five Forest highways were surveyed with the Fish Crossing protocol. The highways surveyed included: (1) U.S. Highway 93 between Darby and Lost Trail Pass; (2) the East Fork Highway; (3) the West Fork Highway; (4) the Skalkaho Highway; and (5) the paved portion of the Nez Perce Road. The results indicate that 58% of the highway culverts are an upstream barrier to juvenile trout during some time of the year, 21% are potential barriers, and 21% provide year-round passage. The results for adult trout were similar, with 51% of the culverts identified as barriers, 28% as potential barriers, and 21% providing year-round passage.

Table 13 summarizes our most current knowledge of fish culvert passage status on the Forest. The numbers in the table may differ from past years reports because they get adjusted as new information becomes available, or as barriers are eliminated through replacement or removal.

Table 13 – Fish Passage Barriers at Culverts

Location	# of fish-bearing culverts	# known or suspected to be passage barriers	# unknown – not seen or surveyed	# likely to be offering suitable fish passage conditions
Sula and W. Fork R.D.	102	59 (58%)	0 (0%)	43 (42%)
Stevensville and Darby R.D.	57	45 (79%)	0 (0%)	12 (21%)
Montana DNRC land	6	1 (17%)	0 (0%)	5 (83%)

The elimination of fish passage barriers at culverts is a key objective for the Forest fisheries and engineering programs. Since 2000, 88 culverts have been replaced or removed to improve fish passage on Bitterroot National Forest and adjacent state lands and highway corridors (Table 14). The Bitterroot National Forest has conducted the bulk of the culvert replacements and removals (79 of 88). The rest have occurred on Sula State Forest lands (5 culverts), U.S. Highway 93 (3 culverts during the Sula North/South reconstruction phase), or the West Fork Highway (1 culvert, Slate Creek).

In 2010-2013, the Forest replaced 16 fish barrier culverts with aquatic organism passable stream simulation structures (i.e. larger culverts, bottomless arches, or bridges), and removed 8 fish barrier culverts. The replacements and removals that occurred in 2010-2013 are listed below:

1. Two Bear Creek, County Road 85D (undersized culvert replaced with bridge, 2010)
2. Mine Creek, Road 5688 (undersized culvert replaced with bottomless arch, 2010)
3. Elk Creek, Upper Road 13833 crossing (culvert removed, 2010)
4. Elk Creek, Lower Road 13833 crossing (culvert removed, 2010)
5. Sawmill Creek, Road 62384 (culvert removed, 2010)
6. Pierce Creek, Road 5629 (undersized culvert replaced with larger culvert, 2011)
7. Warm Springs Creek, Road 370 (undersized culvert replaced with bridge, 2011)
8. West Fork Camp tributary 0.1, Road 729 (undersized culvert replaced with larger culvert, 2011)
9. Castle Creek, Road 49 (middle crossing) (undersized culvert replaced with bottomless arch, 2011)
10. Pete Creek, Road 468 (undersized culvert replaced with bridge, 2011)
11. Baker Creek, north channel, Road 5629 (undersized culvert replaced with larger culvert, 2011)
12. Baker Creek, south channel, Road 5629 (undersized culvert replaced with larger culvert, 2011)
13. South Fork Chaffin Creek, Road 374 (undersized culvert replaced with larger culvert, 2012)
14. South Fork Chaffin Creek, Road 374-A (undersized culvert replaced with larger culvert, 2012)
15. Woods Creek, Road 5672 (culvert removed, 2012)
16. Woods Creek tributary 5.4, Road 5672 (culvert removed, 2012)
17. Skalkaho Creek, Road 75 (undersized culvert replaced with bridge, 2013)
18. Little Boulder Creek, Road 1130 (undersized culvert replaced with bottomless arch, 2013)
19. Halfway Creek, Road 468 (undersized culvert replaced with larger culvert, 2013)
20. Schumaker Creek, Road 468 (undersized culvert replaced with larger culvert, 2013)
21. Scimitar Creek, Road 468 (undersized culvert replaced with larger culvert, 2013)
22. East Piquett Creek tributary 2.0, Road 13411 (culvert removed, 2013)
23. Pierce Creek, Road 13466 (culvert removed, 2013)
24. Lodgepole Creek, Road 73279 (culvert removed, 2013)

Implementation Monitoring of Culvert Replacements: The Bitterroot Headwaters TMDL recommends that the Forest monitor any new culvert replacements to ensure that fish passage is being adequately maintained. Table 14 lists the fish passage culvert replacements and removals that have occurred since 2000, and summarizes their current fish passage status based on our most recent monitoring visits. The current fish passage status of each culvert was classified as "fully functioning", "partially functioning", or "not functioning". These categories are defined as:

- *Fully functioning* = native substrates are present throughout the culvert barrel and appear to be stable; there may be some thinning of substrate material since installation but substrate still covers the entire bottom of the culvert barrel; there are no prohibitive vertical drops on the inlet or outlet; all sizes and species of fish can pass through the culvert at high and low flows
- *Partially functioning* = since replacement, some of the substrate material has been flushed from the culvert barrel and now at least half of the barrel has been scoured bare or contains minimal substrate material; there are no prohibitive vertical drops on the inlet or outlet; culverts that provide good fish passage at high flows but lose their surface water at low flows fall into this category, as do culverts that are undersized but still maintain a roughened bottom of larger substrates throughout their culvert barrel; adult fish can still pass through the culvert at the majority of flows, but passage of juvenile fish is probably restricted at higher flows due to prohibitive water velocities inside of the barrel or at lower flows due to loss of surface water
- *Not functioning* = since replacement, all or most of the substrate material has been scoured from the culvert barrel or prohibitive vertical drops may have developed on the inlet or outlet (in some cases they haven't, but the barrel is still bare of substrate); the majority of adult and juvenile fish probably cannot pass through the culvert at high or low flows

Table 14 – Status of culverts replaced or removed to eliminate fish passage barriers, 2000 to present.

District[1]	Stream	Road	Year replaced or removed?	Fully functioning	Partially functioning	Not functioning
D4	Little Blue Joint Creek	5658	Replaced, 2000		X	
D4	Sheep Creek	6223	Replaced, 2001		X	
D4	Washout Creek	6223	Replaced, 2001			X
D4	Two Creek	732	Replaced, 2001		X	
D4	Trout Creek	Tr #674	Removed, 2001	X		
D4	Nelson Creek	468	Replaced, 2002	X		
D4	Gemmell Creek	468	Replaced, 2002	X		
D4	Sentimental Creek	13482	Replaced, 2003	X		
D4	Sand Creek	362	Replaced, 2003 (BAR)	X		
D4	Magpie Creek	362	Replaced, 2003 (BAR)	X		
D4	Took Creek	362	Replaced, 2003 (BAR)	X		
D4	Took Creek	1303	Replaced, 2003 (BAR)	X		
D4	Gabe Creek	468	New bridge, 2004	X		
D4	Scimitar Creek	Non-syst	Removed, 2007	X		
D4	Coal Creek	5662	Replaced, 2007 (BAR)	X		
D4	Castle Creek (lower)	49	Replaced, 2008 (BAR)	X		
D4	East Piquett Creek	731	Replaced, 2009 (BAR)	X		
D4	Mine Creek	5688	Replaced, 2010 (BAR)	X		
D4	Elk Creek (lower)	13833	Removed, 2010 (BAR)	X		
D4	Elk Creek (upper)	13833	Removed, 2010 (BAR)	X		
D4	Pierce Creek	5629	Replaced, 2011		X	
D4	Castle Creek (middle)	49	Replaced, 2011	X		
D4	Pete Creek	468	New bridge, 2011	X		
D4	Baker Creek (north)	5629	Replaced, 2011	X		
D4	Baker Creek (south)	5629	Replaced, 2011	X		
D4	Woods Creek	5672	Removed, 2012	X		
D4	Woods Creek trib 5.4	5672	Removed, 2012	X		
D4	Little Boulder Creek	1130	Replaced, 2013	X		
D4	Halfway Creek	468	Replaced, 2013	X		
D4	Schumaker Creek	468	Replaced, 2013	X		
D4	Scimitar Creek	468	Replaced, 2013	X		
D4	East Piquett Creek trib 2.0	13411	Removed, 2013	X		
D4	Pierce Creek	13466	Removed, 2013	X		
D3	Gilbert Creek	370	Replaced, 2000	X		

[1] D2 – Darby District, D3 – Sula District, D4 – West Fork District, DNRC – Montana Department of Natural Resources, MDOT – Montana Department of Transportation, FHA – Federal Highway Administration, BAR – Burned Area Recovery Project

District[1]	Stream	Road	Year replaced or removed?	Fully functioning	Partially functioning	Not functioning
D3	Laird Creek	370	Replaced, 2000		X	
D3	Laird Creek	5615	Replaced, 2000	X		
D3	Reimel Creek	727	Replaced, 2000	X		
D3	Needle Creek	724	Replaced, 2001		X	
D3	WF Camp, trib 0.1 (lower)	729-B	Replaced, 2001			X
D3	WF Camp, trib 0.1 (upper)	729-B	Replaced, 2001			X
D3	Cameron Creek	311	Replaced, 2001	X		
D3	Bugle Creek	725	Replaced, 2003 (BAR)	X		
D3	Crazy Creek	370-A	Replaced, 2003 (BAR)	X		
D3	West Fork Camp Creek	729	Replaced, 2003 (BAR)	X		
D3	West Fork Camp, trib 0.9	8112	Replaced, 2003 (BAR)	X		
D3	West Fork Camp, trib 1.0	8112	Replaced, 2003 (BAR)	X		
D3	Diggins Creek	727	Replaced, 2003	X		
D3	Springer Creek	Non-syst	Removed, 2006	X		
D3	West Fork Camp, trib 0.1	13340	Removed, 2006	X		
D3	Lyman Creek, trib 1.8	13304	Removed, 2006	X		
D3	Lyman Creek, trib 1.8	13304	Removed, 2006	X		
D3	Moose Creek	726	New bridge, 2007 (BAR)	X		
D3	Hart Creek	311	Replaced, 2008	X		
D3	Hart Creek	73180	Replaced, 2008	X		
D3	Mink Creek	5753	Replaced, 2008	X		
D3	Meadow Creek	5758	New bridge, 2008	X		
D3	Meadow Creek	725	New bridge, 2009	X		
D3	Warm Springs Creek	370	New bridge, 2011	X		
D3	W. Fork Camp, trib 0.1	729	Replaced, 2011	X		
D3	Lodgepole Creek	73279	Removed, 2013	X		
D2	North Rye Creek, trib 2.1	321	Replaced, 2000			X
D2	Rye Creek, trib 9.1 (lower)	311	Replaced, 2001		X	
D2	Rye Creek, trib 9.1 (upper)	5613	Replaced, 2001	X		
D2	Gird Creek	1365	Replaced, 2001		X	
D2	Railroad Creek	75	Replaced, 2005 (BAR)	X		
D2	Hog Trough Creek	75	Replaced, 2005 (BAR)	X		
D2	Weasel Creek	75	Replaced, 2005 (BAR)	X		
D2	Rye Creek, trib 12.3	75	Replaced, 2005 (BAR)	X		
D2	Rye Creek, trib 12.3	5607	Replaced, 2005 (BAR)	X		
D2	Cathouse Creek	Non-syst	Removed, 2006	X		
D2	Cathouse Creek, trib 0.9	Non-syst	Removed, 2006	X		
D2	North Rye Creek	321	Replaced, 2006 (BAR)	X		
D2	Cathouse Creek	1126	Replaced, 2007	X		
D2	Two Bear Creek	85D	New bridge, 2010	X		
D2	South Fork Chaffin Creek	374	Replaced, 2012	X		
D2	South Fork Chaffin Creek	374-A	Replaced, 2012	X		
D2	Skalkaho Creek	75	New bridge, 2013	X		
D1	North Fork Willow Creek	13131	Removed, 2009	X		
D1	Sawmill Creek	62384	Removed, 2010	X		
DNRC	North Cameron Creek	1397	Replaced, 2000	X		
DNRC	North Cameron Creek	73160	Replaced, 2000	X		
DNRC	Lyman Creek	DNRC	Replaced, 2000	X		
DNRC	Praine Creek	DNRC	Replaced, 2001	X		
DNRC	Andrews Creek	DNRC	Replaced, 2007	X		
MDOT	Warm Springs Creek	Hwy 93	Replaced, 2002		X	
MDOT	Andrews Creek	Hwy 93	Replaced, 2002		X	
MDOT	Praine Creek	Hwy 93	Replaced, 2002		X	
FHA	Slate Creek	WF Hwy	Replaced, 2003	X		

D1-Stevensville District, D2 – Darby District, D3 – Sula District, D4 – West Fork District, DNRC – Montana Department of Natural Resources, MDOT – Montana Department of Transportation, FHA – Federal Highway Administration

Bridges: Since 2004, the Forest has replaced eight fish barrier culverts with new bridges. All of the bridges have been successful at maintaining year-round aquatic organism passage with no adverse channel changes occurring (e.g. headcutting) to threaten passage. There has been no need to install grade control structures at the bridge sites. The bridges that have replaced fish barrier culverts are:

1. Gabe Creek, Road 468 (2004)
2. Moose Creek, Road 726 (2007)
3. Meadow Creek, Road 5758 (2008)
4. Meadow Creek, Road 725 (2009)
5. Two Bear Creek, County Road 85-D (2010)
6. Warm Springs Creek, Road 370 (2011)
7. Pete Creek, Road 468 (2011)
8. Skalkaho Creek, Road 75 (2013)

NEPA Backlog: There are currently 84 fish barrier culvert replacements or removals on the Forest that have NEPA analysis completed, but are awaiting implementation (Table 15). Of those, two (Sheep Creek, FSR 5677 and Soldier Creek, FSR 091) will be contracted in 2014 and implemented in either 2014 or 2015, and three (West Creek trib 2.0, FSR 13410; Arasta Creek, FSR 640; and Sawmill Creek, FSR 62127) are scheduled for removal in 2014. The fish barrier culverts planned for contract award and/or removal in 2014 are highlighted in gray in Table 15.

Fifteen of the culverts listed in Table 15 have survey and design completed, but lack funding to contract and implement. The Forest is pursuing opportunities to survey, design, and contract these backlog culverts as opportunities arise, but it is a slow process because the work is expensive and implementation funds are very limited. Culverts that have NEPA completed but the Forest has dropped from consideration for various reasons are not listed in Table 15. The Forest now has NEPA analysis completed for nearly all of its known fish barrier culverts. Table 15 lists the fish barrier culvert replacements or removals that have NEPA analysis completed, but have not been implemented.

Table 15 – Backlog of fish barrier culverts with completed NEPA analysis

Stream	Road #	NEPA Document and Date of Decision
Rye Creek	Road 5612	Burned Area Recovery FEIS/ROD, 2001
North Rye Creek	Road 8111	Burned Area Recovery FEIS/ROD, 2001
Pierce Creek	Road 363	Frazier Interface EA/DN, 2003
Threemile Creek	Road 640	Threemile Bridge and Culvert EA, 2005
Bertie Lord Creek	Road 5786	Middle East Fork FEIS/ROD, 2006
Bertie Lord Creek, trib 3.5	Road 5786	Middle East Fork FEIS/ROD, 2006
Springer Creek	Road 13302	Middle East Fork FEIS/ROD, 2006
Spoon Creek	Road 13225	Trapper Bunkhouse FEIS/ROD, 2008
North Fork Willow Creek	Road 969-A	NF Willow Creek Culvert Replacements For Fish Passage DM, 2008
Beavertail Creek	Road 361-A	West Fork District Fish Culverts EA/DN, 2010
Beavertail Creek	Road 361	West Fork District Fish Culverts EA/DN, 2010
Beavertail Creek	Road 5719	West Fork District Fish Culverts EA/DN, 2010
Blue Joint Creek, trib 3.8	Road 362	West Fork District Fish Culverts EA/DN, 2010
Britts Creek	Road 49	West Fork District Fish Culverts EA/DN, 2010
Coal Creek, trib 2.1	Road 5660	West Fork District Fish Culverts EA/DN, 2010
Devil Creek	Road 091	West Fork District Fish Culverts EA/DN, 2010
Flat Creek	Road 468	West Fork District Fish Culverts EA/DN, 2010
Gemmell Creek (lower)	Road 5633	West Fork District Fish Culverts EA/DN, 2010
Gentile Creek	Road 5703	West Fork District Fish Culverts EA/DN, 2010
Johnson Creek	Road 091	West Fork District Fish Culverts EA/DN, 2010
Johnson Creek	Road 5685	West Fork District Fish Culverts EA/DN, 2010
Lavene Creek (lower)	Road 5630	West Fork District Fish Culverts EA/DN, 2010
Little Blue Joint Creek	Road 5658	West Fork District Fish Culverts EA/DN, 2010

Stream	Road #	NEPA Document and Date of Decision
Nez Perce Fork (lower)	Road 468	West Fork District Fish Culverts EA/DN, 2010
Nez Perce Fork (upper)	Road 468	West Fork District Fish Culverts EA/DN, 2010
Rombo Creek	Road 13462	West Fork District Fish Culverts EA/DN, 2010
Rombo Creek	Road 5715	West Fork District Fish Culverts EA/DN, 2010
Salt Creek	Road 5683	West Fork District Fish Culverts EA/DN, 2010
Sand Creek	Road 1307	West Fork District Fish Culverts EA/DN, 2010
Sheep Creek	Road 5677	West Fork District Fish Culverts EA/DN, 2010
Soldier Creek	Road 091	West Fork District Fish Culverts EA/DN, 2010
Thunder Creek	WF highway	West Fork District Fish Culverts EA/DN, 2010
Tough Creek	Road 13804	West Fork District Fish Culverts EA/DN, 2010
Two Creek	Road 732	West Fork District Fish Culverts EA/DN, 2010
Two Creek	Road 5650	West Fork District Fish Culverts EA/DN, 2010
West Creek, trib 2.0	Road 13410	West Fork District Fish Culverts EA/DN, 2010
Woods Creek, trib 3.8	Road 5669	West Fork District Fish Culverts EA/DN, 2010
Woods Creek, trib 4.5	Road 5669	West Fork District Fish Culverts EA/DN, 2010
Lavene Creek (middle)	Road 5630	Lower West Fork FEIS/ROD, 2010
Lavene Creek (upper)	Road 5630	Lower West Fork FEIS/ROD, 2010
Ward Creek (lower)	Road 373	Lower West Fork FEIS/ROD, 2010
Ward Creek (upper)	Road 373	Lower West Fork FEIS/ROD, 2010
SF Skalkaho Creek 1.6	Road 75	North Zone Fish Culverts DM, 2010
SF Skalkaho Cr, trib 1.4	Road 75	North Zone Fish Culverts DM, 2010
Sleeping Child Creek	Road 75	North Zone Fish Culverts DM, 2010
Sleeping Child Cr, trib 20.1	Road 13235	North Zone Fish Culverts DM, 2010
Sl. Child Cr, trib 3 of 20.1	Road 13234	North Zone Fish Culverts DM, 2010
Divide Creek	Road 75	North Zone Fish Culverts DM, 2010
Threemile Creek	Road 640	North Zone Fish Culverts DM, 2010
Arasta Creek	Road 640	North Zone Fish Culverts DM, 2010
Threemile Creek, trib 12.4	Road 640	North Zone Fish Culverts DM, 2010
Willow Creek	Road 364	North Zone Fish Culverts DM, 2010
Butterfly Creek	Road 364	North Zone Fish Culverts DM, 2010
Deep Creek	Road 364	North Zone Fish Culverts DM, 2010
Bear Trap Creek	Road 364	North Zone Fish Culverts DM, 2010
Little Sleeping Child Creek	Road 5604	North Zone Fish Culverts DM, 2010
Ambrose Creek	Road 62179	North Zone Fish Culverts DM, 2010
Ambrose Creek	Road 428	North Zone Fish Culverts DM, 2010
Lick Creek	Road P-1286	North Zone Fish Culverts DM, 2010
Sawmill Creek (lower)	Road 710	North Zone Fish Culverts DM, 2010
Sawmill Creek (upper)	Road 710	North Zone Fish Culverts DM, 2010
Sawmill Creek	Road 62127	North Zone Fish Culverts DM, 2010
Daly Creek, trib 3.3	Road 711	North Zone Fish Culverts DM, 2010
North Rye Creek, trib 2.1	Road 321	North Zone Fish Culverts DM, 2010
North Rye Creek, trib 4.3	Road 321	North Zone Fish Culverts DM, 2010
North Rye Creek, trib 4.3	Road 1128	North Zone Fish Culverts DM, 2010
North Rye Creek, trib 4.3	Road 62435	North Zone Fish Culverts DM, 2010
North Rye Creek, trib 4.3	Road 13251	North Zone Fish Culverts DM, 2010
Grizzly Creek	Road 312	North Zone Fish Culverts DM, 2010
Arastra Creek	Road 312	North Zone Fish Culverts DM, 2010
Bush Creek	Road 726	Sula District Fish Culverts EA/DN, 2011
Cameron Creek	Road 1398	Sula District Fish Culverts EA/DN, 2011
Camp Creek	Sula RD, north	Sula District Fish Culverts EA/DN, 2011
Camp Creek	Sula RD, south	Sula District Fish Culverts EA/DN, 2011
Dick Creek	Road 729	Sula District Fish Culverts EA/DN, 2011
East Fork Camp Creek	Road 729	Sula District Fish Culverts EA/DN, 2011

Stream	Road #	NEPA Document and Date of Decision
Laird Creek	Road 370	Sula District Fish Culverts EA/DN, 2011
Lick Creek	Road 432	Sula District Fish Culverts EA/DN, 2011
Lick Creek	Road 5771	Sula District Fish Culverts EA/DN, 2011
Needle Creek	Road 724	Sula District Fish Culverts EA/DN, 2011
Reynolds Creek	Road 432	Sula District Fish Culverts EA/DN, 2011
Sign Creek	Road 432	Sula District Fish Culverts EA/DN, 2011
West Fork Camp Cr, trib 0.1	Indian Trees CG, lower	Sula District Fish Culverts EA/DN, 2011
West Fork Camp Cr, trib 0.1	Indian Trees CG, upper	Sula District Fish Culverts EA/DN, 2011

Forest fisheries biologists periodically monitor some of the culvert replacements to document post-replacement changes in fish distributions and construction-generated sediment impacts. In 2011, fish distribution changes were observed in Hog Trough, Elk, and Baker creeks following culvert replacements and removals. In 2011, the amount of sediment produced by replacing culverts was monitored in Baker and Pete creeks. In 2013, the amount and timing of turbidity produced by replacing culverts was monitored in Halfway and Skalkaho creeks. These monitoring efforts are summarized below.

Hog Trough Creek Culvert Replacement (Darby Ranger District): The Road 75 culvert on Hog Trough Creek (tributary to Skalkaho Creek) was replaced with a stream simulation culvert in 2005. Electrofishing surveys conducted in 2011 captured several westslope cutthroat trout and one bull trout. This was the first documentation of bull trout in Hog Trough Creek. The 2005 culvert replacement likely had a positive effect on bull trout apparently expanding their range into this stream.

Elk Creek Culvert Removals (West Fork Ranger District): In Elk Creek (tributary to Slate Creek), electrofishing surveys captured about a dozen yearling westslope cutthroat trout upstream of two Road 13833 crossings where culverts were removed in September, 2010. This was the first documentation of fish occupancy in this section of Elk Creek. The September 2010 culvert removals are believed to be the reason why westslope cutthroat trout have expanded their range further upstream in Elk Creek.

Baker Creek Culvert Replacements (West Fork Ranger District): In September 2011, the Forest removed two fish barrier culverts on the Road 5629 crossings of the north and south channels of Baker Creek and replaced them with bottomless arches. A week after the replacements were completed, Forest fisheries biologists measured the downstream extent of visible sediment deposition in both channels of Baker Creek. In both channels, heavy sediment deposition occurred within the first 200 feet of the stream channel below the new arches. From 200 feet to 600 feet downstream of the arches, a layer of fine grayish-tan silt was visible coating the rocks in the pools, but the riffles were getting cleaner, especially between 400 feet and 600 feet. From 600 feet to 800 feet downstream of the arches, the riffles were clean of visible sediment but there was still a thin layer of silt that was visible on the rocks in the pools. Beyond 800 feet, sediment deposition was indiscernible. The extent of sedimentation that occurred was generally consistent with the 2003 Frazier EA/DN analysis.

In September 2011, about a week after the Baker Creek culvert replacements were completed, electrofishing surveys were conducted in the first 350 feet of both channels below the new arches. Numbers and sizes of westslope cutthroat trout and tailed frogs captured were similar to pre-project surveys, but the sediment deposition caused by the construction activities shifted the distributions of both species slightly downstream. Only a couple of fish and tailed frogs were found in the first 100 feet of stream below the arches where the sediment deposition was heaviest. Most of the fish and tailed frogs were found between 100 feet and 350 feet below the arches where the sediment coverage was thinner. The 2003 Frazier EA/DN predicted that the habitat within the first 150 feet of stream below the arches would be temporarily degraded with sediment to the point that most of the fish would be forced to abandon the area. Our findings generally supported that prediction. By the summer of 2012 it was difficult to distinguish any sizeable patches of construction-caused sediment deposition below the arches.

Pete Creek Bridge Installation (West Fork Ranger District): In July 2011, the Forest removed a fish barrier culvert on the Road 468 crossing of Pete Creek and replaced it with a new bridge. Section 7 bull trout and steelhead consultation was conducted under a 2002 National Marine Fisheries Service (NMFS) Biological Opinion (Gabe Creek and Pete Creek Culvert Replacements, August 14, 2002) and a U.S. Fish and Wildlife Service 10(a)(1a) permit. Forest fisheries biologists walked Pete Creek prior to the start of construction to look for steelhead redds and/or steelhead adults, but none were found. This was to comply with one of the terms & conditions in the

NMFS Biological Opinion. Work in the stream channel intermittently occurred between July 5th and July 29th, 2011. A temporary culvert and road crossing was installed a short distance upstream of the bridge to allow traffic to pass while the new bridge was being constructed. The finished stream channel dimensions and gradients matched those of the undisturbed channel above and below the work site.

Forest fisheries biologists measured the downstream extent of visible sediment deposition in early August about 10 days after the project was completed. Construction-caused sediment deposition was visible throughout the 75 feet of Pete Creek between the new bridge and Deep Creek, and in Deep Creek for a distance of about 250 feet downstream from the mouth of Pete Creek. In Deep Creek, most of the sediment was trapped in a deep pool located immediately downstream from the mouth of Pete Creek. Visible sedimentation quickly thinned out downstream of that pool, and beyond 200 feet from the mouth of Pete Creek, only small pockets of sand were visible in the depositional portions of pools and in the low velocity margins of riffles. At about 200-250 feet from the mouth of Pete Creek, the sediment deposits became too small and scattered to distinguish them from pre-project sediment. Overall, the amount and extent of sedimentation in Pete Creek was within expected amounts, while Deep Creek contained less sediment than expected. Our findings supported the conclusions in the 2006 Idaho Stream Crossing Structures Biological Opinions which stated that sediment deposition from culvert and bridge replacements with BMPs applied should become insignificant further than 600 feet downstream of the stream crossing structure. In the Pete Creek bridge project, the contractor properly implemented the sediment BMPs during the culvert removal and bridge installation, and the project satisfactorily complied with the mitigation measures in the NMFS Biological Opinion and the U.S. Fish and Wildlife Service 10(a)(1a) permit.

Halfway Creek Culvert Replacement (West Fork Ranger District): In July 2013, Forest fisheries biologists monitored the timing and extent of turbidity generated by the Road 468 culvert replacement on Halfway Creek. Halfway Creek is a small westslope cutthroat trout tributary to Deep Creek in the Selway River drainage of Idaho. The purpose of this monitoring was to determine if Idaho water quality standards were maintained during the construction, and to comply with the terms and conditions in the 2012 Idaho Stream Crossing Structures Biological Opinions. Allowable turbidity standards for surface water quality are set individually by each state. The Idaho water quality standard for cold water streams is that turbidity not exceed the background level by more than 50 NTUs (nephelometric turbidity units) at any time, or more than 25 NTUs for more than 10 consecutive days. The Biological Opinions state that turbidity shall not exceed the background level by more than 50 NTUs values 1.5 hours after re-watering the construction site (NMFS BO term and condition 3b). Turbidity samples were collected every half hour at three monitoring stations:

1. In Halfway Creek, 50 feet upstream of the Road 468 culvert (the background control station)
2. In Halfway Creek, 100 feet downstream of the culvert (the 100' station)
3. In Deep Creek, 600 feet downstream of the culvert (the 600' station, or "fully mixed" site)

The Road 468 culvert on Halfway Creek is located about 110 feet upstream from Halfway Creek's confluence with Deep Creek. This put the 100 foot station in Halfway Creek near its mouth, and the 600 foot station in Deep Creek about 490 feet downstream from the mouth of Halfway Creek. Deep Creek is a larger stream than Halfway Creek (bankfull width of 25 feet versus five feet), which diluted the samples at the 600 foot station.

Turbidity was monitored during the de-watering (July 10, 2013) and re-watering (July 17, 2013) phases of the project. On July 10th, grab samples were collected at the 100 and 600 foot stations every 30 minutes for a period of 3.5 hours (0815 to 1145). On July 17th, the procedure was repeated during the re-watering phase. Grab samples were collected every 30 minutes at the 100 and 600 foot stations for a period of eight hours (0730 to 1530). Grab samples were also collected above the construction site on both days to establish the background turbidity level. Sampling ceased on both days when water clarity at the 100 and 600 foot stations had noticeably cleared. Our results are summarized in Table 16.

Table 16 – Turbidity (NTUs) Produced by the Halfway Creek Culvert Replacement

Date and Phase	Time	NTUs at station above work site	NTUs at 100 foot station (Halfway Cr)	NTUs at 600 foot station (Deep Cr)	Comments
7-10-2013, dewatering	0755	0.284			De-watering started 0800; 50% removed at 0800, rest at 0820
	0815-0845		6.52	0.221	
	0915-0945		0.606	0.218	Turbidity not obvious in Deep Creek at 600' station

Date and Phase	Time	NTUs at station above work site	NTUs at 100 foot station (Halfway Cr)	NTUs at 600 foot station (Deep Cr)	Comments
	1015-1045		0.585	0.213	
	1115-1145		0.491	0.217	Last sample taken at 1145; water cleared at both stations
7-17-2013, rewatering	0700	0.272			Re-watering started 0700; coffer dam pulled at 0720
	0730-0800		247	5.79	Gray box indicates exceeding Idaho's standard
	0830-0900		40.8	0.824	
	0930-1000		25.6	0.594	
	1030-1100		26.6	0.525	
	1130-1200		20.2	0.541	
	1230-1300		15.4	0.439	
	1330-1400		11.2	0.424	
	1430-1500		14.0	0.304	Compaction causes pulse of turbidity at the 100' station
	1530	0.275	1.21	0.334	Last sample taken at 1530; 8 hours after starting rewatering

NTUs remained low throughout the de-watering phase. The highest reading was 6.52 NTUs at the 100 foot station, and that occurred during the first hour after diverting Halfway Creek through a temporary culvert. The de-watering phase produced negligible turbidity at the 600 foot station in Deep Creek. The highest reading was 0.221 NTUs, which was less than the background level in Halfway Creek (0.284 NTUs). The turbidity that was created by the de-watering phase of the project met the Idaho water quality standard.

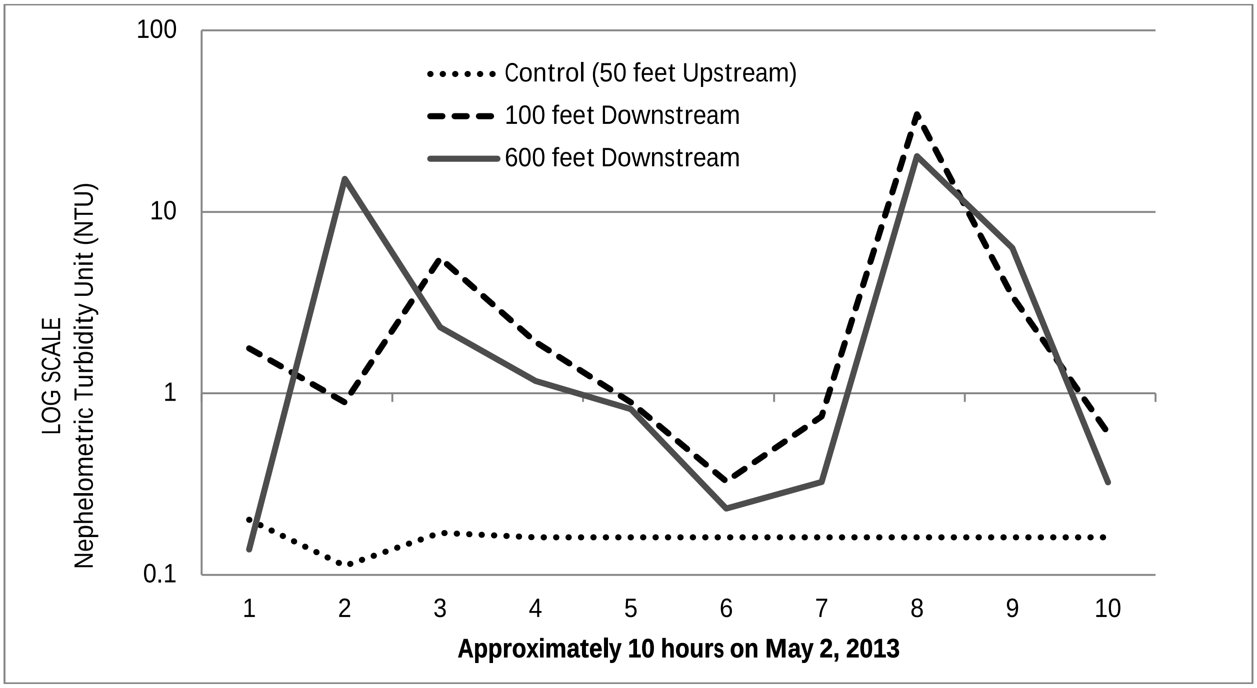
During re-watering of the new culvert, turbidity exceeded 50 NTUs at the 100 foot station during the first hour after re-watering (247), but dropped below (40.8) the 50 NTU Idaho water quality standard 1.5 hours after re-watering had commenced. The 600 foot station in Deep Creek also recorded its highest turbidity during the first hour after starting re-watering (5.79 NTUs), but it remained well below the 50 NTU Idaho water quality standard at all times. Turbidity at both stations gradually declined over the next eight hours. At 8.5 hours after starting re-watering, turbidity at both stations was still higher than the background level in Halfway Creek, but there was < 1 NTU difference.

Our results indicate that turbidity at the 100 foot station in Halfway Creek exceeded Idaho's instantaneous standard of 50 NTUs above background levels during the first hour after re-watering. At 1.5 hours after re-watering, turbidity had dropped to 40.8 NTU, which met the standard. The turbidity standard was met at all times at the 600 foot station in Deep Creek. The turbidity levels we observed in this project were consistent with the Biological Opinions because levels at all stations were less than 50 NTUs 1.5 hours after re-watering.

Skalkaho Creek Bridge Installation (Darby Ranger District): The old culvert in this fairly large stream was replaced with a bridge without dewatering of the site. The work in the stream was limited by doing as much work as possible, such as constructing the bridge abutments, while the culvert was still carrying the stream. There was a need to reshape a portion of the stream bed after the culvert was pulled. There were two pulses of sediment observed and these show clearly in the graph of the turbidity sampling (Figure 42). One pulse occurred during the lifting of the culvert out of the stream channel, and the other was during the reshaping of stream channel.

The average turbidity upstream (control) was 0.161 NTUs, the maximum for the site 100 feet downstream was 34.5 NTU's and the maximum at 600 feet downstream was 20.3 NTUs. Turbidity monitoring indicated that water clarity is substantially affected for one to several hours. It also indicated that by eliminating the dewatering and re-watering processes the stream may have had much less exposure to turbidity and disturbance.

Figure 42 - Turbidity samples were collected from Skalkaho Creek: a control site and two sites downstream of the construction.



The key findings of our culvert monitoring are:

- The majority of the replacements have been successful at eliminating fish passage barriers.
- Success depends on meeting five criteria: (1) the culvert is sized large enough to capture the bankfull width of the stream channel; (2) native material is present and stable throughout the culvert barrel; (3) there are no prohibitive drops on the culvert inlet and outlet; (4) the approach and exit grades of the stream channel near the culvert approximate the natural grade of the channel, with no formation of headcut barriers above and below the culvert; and (5) adequate surface flow (depth and volume) is maintained through the barrel at all discharges. When those five criteria are met, fish passage will be provided for native aquatic species to the same extent as the unaltered stream sections in the area.
- Where culverts have been ineffective or only partially effective, the main reasons have been: (1) undersizing the diameter of the culvert (this confines the channel and increases water velocities inside of the culvert, which flushes the substrate out of the barrel); (2) not installing the culvert deep enough into the streambed (this contributes to the flushing of substrate and the formation of vertical drops on the inlet and/or outlet); (3) not matching the grade of the culvert with the grade of the stream channel (this can cause the formation of headcut barriers); or (4) water flowing subsurface through the barrel at base flows (this is caused by not mixing enough fines into the substrate that is placed inside the barrel).
- An important lesson we have learned during culvert replacement projects on small streams is that a considerable amount of fines must be mixed into the substrate that is placed inside the culvert barrel. Otherwise, the water will flow subsurface through the barrel at base flows (i.e. the French drain effect), forming an impassable seasonal barrier that can last for as long as a decade. Eventually enough fines will get worked into the cracks in the substrate to keep enough water flowing on the surface of the stream bottom through the culvert barrel; however, this may take years to occur.
- Turbidity levels in Halfway Creek 100 feet below the culvert replacement site exceeded Idaho's instantaneous standard of 50 NTUs above background levels during the first hour after re-watering. At 1.5 hours after re-watering, turbidity had dropped to 40.8 NTU, which met the standard. The turbidity standard was met at all times 600 feet below the culvert replacement site in Deep Creek.
- The turbidity levels we observed during the Halfway Creek culvert replacement project were consistent with the 2010 Idaho Stream Crossing Structures Biological Opinions because levels did not exceed 50 NTUs over background levels 1.5 hours after re-watering.

- Obtaining sufficient funding for survey, design, and contract award is a major bottleneck to replacing fish barrier culverts on the Forest.

Forest fisheries biologists intend to continue to monitor the completed culvert replacements and removals in future years to ensure that adequate fish passage conditions are being provided and maintained (INFISH, PACFISH standard RF-5).

PROJECT LEVEL MONITORING OF FISHERIES & WATERSHED IMPROVEMENT PROJECTS:

Bridge Replacements (Sula Ranger District). During the 2012-13 field seasons, Forest fisheries biologists monitored the following new bridges on the Sula Ranger District: Warm Springs Creek, Road 370 (2011), Swift Creek, Road 725 (2010), Meadow Creek, Road 725 (2009), Meadow Creek, Road 5758 (2008), and Moose Creek, Road 726 (2007). No fish passage or channel erosion problems were observed at these bridges. Stream channel dimensions in the vicinity of the bridges matched natural conditions with no problems for aquatic passage. Vegetation was satisfactorily returning to the areas disturbed by construction. The bridges will be monitored on an “as needed” basis in the future.

Martin Creek Watershed Restoration Project (Sula Ranger District): In 2013, Forest fisheries biologists monitored the removal of the Road 73279 culvert on Lodgepole Creek (tributary to Meadow Creek) and the decommissioning (full recontour) of Roads 73279 and 73280. The recontouring was well done. The disturbed areas were seeded, fertilized, and straw mulched. The stream channel work at the culvert removal site on Lodgepole Creek looked good. Removal of the Road 73279 culvert on Lodgepole Creek has re-connected 0.5 miles of juvenile rearing habitat for bull trout and westslope cutthroat upstream of the road crossing.

Bridge Replacements (West Fork Ranger District). During the 2012-13 field seasons, Forest fisheries biologists monitored the following new bridges on the West Fork Ranger District: Indian Creek (2011), Pete Creek (2011), Sheephead Creek (2011), Gabe Creek (2004), and Snake Creek (2004). No fish passage or channel erosion problems were observed at these bridges. Stream channel dimensions in the vicinity of the bridges matched natural conditions with no problems for aquatic passage. Vegetation was satisfactorily returning to the areas disturbed by construction. The bridges will be monitored on an “as needed” basis in the future.

Little West Fork, Road 468 Bridge Area (West Fork Ranger District). In 2011 and 2012, several projects were implemented to prevent annual flooding of Road 468 near the Little West Fork bridge. In October 2011, a contractor removed some of the bedload upstream of the bridge and did some minor instream channel work to force more of the stream flow back into the original channel. In addition to the instream work, two additional overflow culverts were installed under Road 468 west of the bridge, and the road approach on the west side of the bridge was raised by about two feet and graveled. In May 2012, a contractor reconstructed a meander in the Little West Fork on the Nez Perce Ranch to block off a side-channel that annually floods Road 468 near its junction with Road 5635. Section 7 bull trout consultation was addressed using the 2008 Roads Biological Opinion, and 124 permits were obtained prior to implementation. The work satisfactorily complied with the mitigation measures in the Biological Opinion. The 2011 stream channel work was allowed to occur outside of the Biological Opinion’s May 15-Sept 1 in-stream work window because bull trout spawning habitat was not present in the affected area; the 2012 meander reconstruction occurred within the May 15-Sept 1 in-stream work window. The projects were successful in stopping the flooding of Road 468. The side-channel closest to the Road 468/5635 junction was remained dry throughout 2012 and 2013, and flows in the first side-channel to the west of the Little West Fork bridge have been reduced to the point where they no longer threatened to overtop Road 468. Forest biologists will monitor this project during high flows in 2014.

Lavene Creek Woody Debris Addition Project (West Fork Ranger District). In July 2009, Forest fisheries biologists implemented a project to improve westslope cutthroat trout habitat in Lavene Creek, a small tributary to the lower West Fork Bitterroot River. The objective of the project was to increase woody hiding cover for westslope cutthroat trout. A hand crew placed a total of 25 large woody debris pieces (a piece consisted of a conifer rootball with about 5-6 feet of attached bole) throughout a 0.5 mile long reach of Lavene Creek. The reach was bounded by the Forest boundary on the downstream end and the middle crossing of Road 5630 on the upstream end. Forest biologists monitored the Lavene Creek woody debris project in 2011-13. The project has successfully met objectives. The wood has formed more complex hiding cover habitat with some pool scour. The pieces of wood have not drifted or been moved downstream. Where several pieces of wood were placed close together, the stream channel has widened in the immediate vicinity of the accumulation due to bank erosion and scour around some of the ends of the pieces. However, considering the benefits that have been gained by providing much improved hiding cover and complexity, the localized stream channel widening that occurred is not unusual or detrimental to fish habitat. This project will not be regularly monitored in future years. Monitoring will occur opportunistically or on an “as needed” basis.

Hughes Creek Reclamation Project (West Fork Ranger District). In 1998, a mine reclamation project was implemented in the Hughes Creek valley bottom. The project was located along the portion of Hughes Creek between the confluence of Mine Creek and the Forest boundary upstream of Mine Creek. A quarter mile of Hughes Creek was reconstructed back into its historic meander pattern (the stream had been unnaturally straightened by mine tailings). The floodplain and terraces were also reconstructed and planted with grass, shrubs, and conifer seedlings. Supplemental plantings of willow and lodgepole pine were completed between 2000 and 2002. Forest fisheries biologists monitored the Hughes Creek reclamation reach in 2011-13. Many of the lodgepole pine planted in 2002 are now > six feet tall and growing well. The stream channel is stable. Over the past decade, the channel has gradually downcut, which has resulted in some of the large woody debris structures along the stream banks being too high and out of the water at base flows. As a result, they no longer cause as much scour or provide as much fish hiding cover as they did when they were first installed. Willow recovery along the stream banks is steadily increasing, although there are still a few blank spots here and there. Weeds, particularly spotted knapweed, continue to be a problem. The area would benefit from the following actions: (1) spray the weeds in the open patches with herbicides - this would require < 5 acres of spraying; the worst spots are on the north side of the creek in the middle portion of the reach; there are also some patches that need treating on the south side of the creek up on the rocky terrace; (2) after spraying, plant grass seed where the weeds are killed; (3) once residual chemical in the soil is no longer an issue, plant more lodgepole pine in the open patches that were formerly dominated by weeds; and (4) with an excavator, place rock to define vehicle use limits and decompact/seed a short user-created road near the upper end of the reach. Forest fisheries biologists plan on monitoring this project in 2014.

Lower West Fork, Watershed Improvement Phase (Sula Ranger District): In summer 2013, the Forest completed the road decommissioning and storage projects in the Lower West Fork Final EIS/Record of Decision. Forest fisheries biologists monitored the removal of two fish-bearing culverts (Road 13411 crossing of East Piquett Creek tributary 2.0; Road 13466 crossing of Pierce Creek), and a subset of the decommissioned and stored roads. The culvert removal sites were properly shaped to mimic the natural stream channel dimensions and slopes. Removal of the culverts on East Piquett tributary 2.0 and Pierce Creek has re-connected 1.0 miles of juvenile rearing habitat for westslope cutthroat upstream of the road crossings (0.8 miles in East Piquett tributary 2.0 + 0.2 miles in Pierce Creek). The Lower West Fork road decommissioning and storage was satisfactorily implemented. The disturbed areas were seeded, fertilized, and straw mulched. No significant erosion or sediment concerns were observed.

Watershed Modeling and Assumption Monitoring
Items 18 and 20

OBJECTIVES: Assess local concern that timber harvest reduces late season low flows and causes flooding during the runoff period (Item 20). Predict hydrologic recovery rates (Item 18). Formulate storm runoff modeling assumptions. Validate Forest-wide watershed analysis.

DATA SOURCE: Stream flow sampling before and after projects.

FREQUENCY: Annually.

REPORTING PERIOD: 2010-2013

VARIABILITY: 10 percent variation in flow pattern after project is completed or deviation from soil and water objectives.

EVALUATION:

In the original Forest Plan monitoring criteria, we estimated that hydrologic recovery (water yield and visual changes) would average about 20 years. We also expected visual and hydrologic recovery would occur at about the same rate on the sensitive land types. That is, the water yield increases and visual effects of timber harvest would diminish over about 20 years. The maximum area allowed by the Plan to be hydrologically and visually un-recovered ranges from 25 to 40 percent of habitat and land type groups. However, we have found that visual and hydrologic effects seem to recover at different rates. Therefore, the visual monitoring is now focused in Item 4 and all of the hydrologic effects were combined into one monitoring item in 1993 because of the apparent overlap between Items 18 and 20.

Bitterroot National Forest hydrologists conducted a literature review on the state of knowledge related to stream flow modeling and hydrologic recovery. The report found that there is sufficient literature to address the issue of timber harvest effects on late season flows without the Forest undertaking research level studies. In summary, the literature review found that changes in stream flow are mostly dependant upon precipitation, with a smaller influence contributed by vegetation management. Wildfire creates a different scenario by removing extensive ground cover and creating hydrophobic soils. More complete information on findings is published in the 2004 Bitterroot Forest Plan Monitoring Report. The complete report is available in the Bitterroot National Forest Supervisor's Office.

The Bitterroot National Forest hydrology staff continues to monitor the published literature pertaining to water yield increases and timber harvest. If sufficient evidence contrary to the well-documented trends in water yield increases and logging is published, this monitoring item will be revisited and updated at that time.

Research Note

The Forest cooperated with USGS in Helena, Montana, on a study evaluating the effects of fire on stream flow. A USGS Technical Report related to stream flows and rainstorm events has been prepared (Parrett, C.; S.H. Cannon; and K.L. Pierce. Wildfire-Related Floods and Debris Flows in Montana in 2000 and 2001. Water-Resources Investigations Report 03-4319). This report summarizes the complex relationships between fire, stream flows, and debris flows in mountainous terrain on the Bitterroot, Custer, and Helena National Forests.