Optimizing Streamflow Enhancement Phase III

Project Summary

by

Idaho Department of Water Resources

Project Overview

DOC, Financial Assistance Award Number:	NA07NMF4380291
CFDA Number:	11.438
CFDA Project Title:	Optimizing Stream Flow Enhancement Phase 3, State of Idaho
Geographic Area:	Salmon River above the Middle Fork Salmon River, Idaho
OSC Project Number:	006 07 SA B3
Project Sub-grantee:	Idaho Department of Water Resources
Project Contact Information:	Taylor Dixon, Hydrologist 322 E. Front St. PO Box 83720 Boise, ID 83720-0098
Grant Period:	01/01/2009-12/31/2010
Total PCSRF Funds:	181,200.50
Total Non-Federal Match:	100,268.00
Primary PCSRF objectives:	Watershed Subbasin Planning and Assessment

Executive Summary

Streamflow enhancement projects are suggested to the Upper Salmon Basin Watershed Project Technical Team (USBWPTT) by landowners and water users, state and federal agencies, and non -profit organizations. Successful implementation of these projects depends on an accurate understanding of the basin hydrology. An understanding of the water resources, water rights, and hydrologic processes are key to the analysis of current water use and proposed changes and how they may affect fish habitat. The primary purpose of this project is to collect/develop hydrologic and water rights data sets that will help inform managers developing streamflow enhancement projects in the Upper Salmon Basin. Field data for this study was collected to assist in project development and for the calibration or population of the MIKE Basin models, a surface-water hydrologic model. Twenty-four stream gages were maintained during the 2009 irrigation season through OSFE Phase III. These gages were installed at locations identified for potential projects, or locations where additional data is needed to understand the hydrology. Locations were also selected for seepage studies, to better understand the stream gaining and losing reaches and locations of irrigation return flow.

Modeling work consisted of three elements: creation of new models, updating and populating existing models, and application of models to management/streamflow enhancement project questions. The MIKE Basin models were modified and populated to reflect new data and changes to irrigation systems in: Stanley Basin, Upper Lemhi River Basin, lower Lemhi Basin, and Pahsimeroi River Basin. Additional data are still needed to populate and calibrate models many of the reaches in the models. The Upper Lemhi River Basin MIKE Basin Model is partially calibrated for 2008; this model was used in assessing several optimizing stream flow scenarios proposed by and to the USBWPTT.

Introduction

Each year streamflow enhancement projects are considered for implementation in the Upper Salmon Subbasin. Streamflow enhancement projects are suggested to the Upper Salmon Basin Watershed Project Technical Team by landowners and water users, state and federal agencies, and non -profit organizations. Streamflow enhancement projects include: head gate design and installation; diversion consolidations or eliminations; moving diversion structures; canal and ditch enhancements; on-farm delivery design and installation; conservation agreements; and lease or purchase of existing water rights.

A comprehensive understanding of hydrology, water rights and irrigation practices is critical when considering changing irrigation practices to meet instream flow needs. Analysis of the interconnected nature of the water rights on even a small stream can be a very complicated process. Once a project is complete there are often questions regarding implementation of conservation agreements, regulation of water rights under new delivery systems and ways to quantify the positive effect on streamflows. Development of hydrologic models that simulate the hydrology and water usage in a basin can be a useful tool to evaluate the results of proposed streamflow enhancements projects. Insight provided by such a model can help to provide assurance that limited resources are effectively applied. Through this project, the IDWR has continued to develop and improve water distribution models in key basins that will assist with the evaluation of proposed streamflow enhancement projects.

The primary purpose of this project is to collect/develop hydrologic and water rights data sets that will help inform managers developing streamflow enhancement projects in the Upper Salmon Basin. This has been accomplished through the maintenance of stream gages, seepage run studies, and development of hydrologic modeling capabilities.

Fieldwork Summary

The field data collected for this study was primarily selected to assist in the calibration or population of the MIKE Basin models. The primary data needs for a MIKE Basin model are:

- stream flow data above diversions,
- diversion rates,
- evapotranspiration, crop types,
- irrigation methods,
- reach seepage measurements
- stream gaging data below diversions to calibrate the model.

It was determined that stream gaging and seepage run studies would provide the most critical data. Stream gaging provides seasonal trend information, including water supply and timing of runoff. Stream gages also supply the amount of water below an irrigation network, how much flow is passing diversions, and amounts of return flow. Seepage run data provide a detailed picture of the gains and losses of a reach within a stream. The seepage studies are conducted over a short (usually one day) time period and provide information useful in determining return flow location, natural reach losses and gains, and potential for tributary reconnects.

Given the large number of MIKE Basin Models (MBMs) and complexity of each one, data collection efforts had to be prioritized. Feedback was requested from the Upper Salmon Basin Technical Team (USBTT) as to where data acquisition efforts would be most important. The Upper Lemhi River model had projects with immediate demand for model application and was the closest to having the mainstem of the model calibrated. Seepage run studies in the Lemhi River and a few major tributaries near Leadore were conducted in 2009. During 2009, IDWR staff also assisted the USFS with seepage runs in the Stanley area, working on several Valley Creek seepage runs that will be used for calibration of the Upper Salmon MBM.

Stream Gages

Twenty-four stream gages were maintained through PCSRF funding during the 2009 irrigation season.   The location of these gages is described in Table 1 and shown on figure 1. The data from these gages can be viewed in Attachment A. These gages were installed at locations identified for potential flow projects or locations where additional data is needed to understand the local hydrology.

During the spring of 2009, two PCSRF funded gages were moved. Two gages (Pole Creek and Canyon Creek) were taken over by the Columbia Basin Water Transaction Program. As a result, gages funded by PCSRF were installed at two new locations: (1) below diversions on Patterson-Big Springs Creek, and (2) Lee Creek. The Lee Creek gage will be in place for two seasons to assess the impacts that conservation measures on the Cottom Ranch will have on reconnecting Lee Creek.

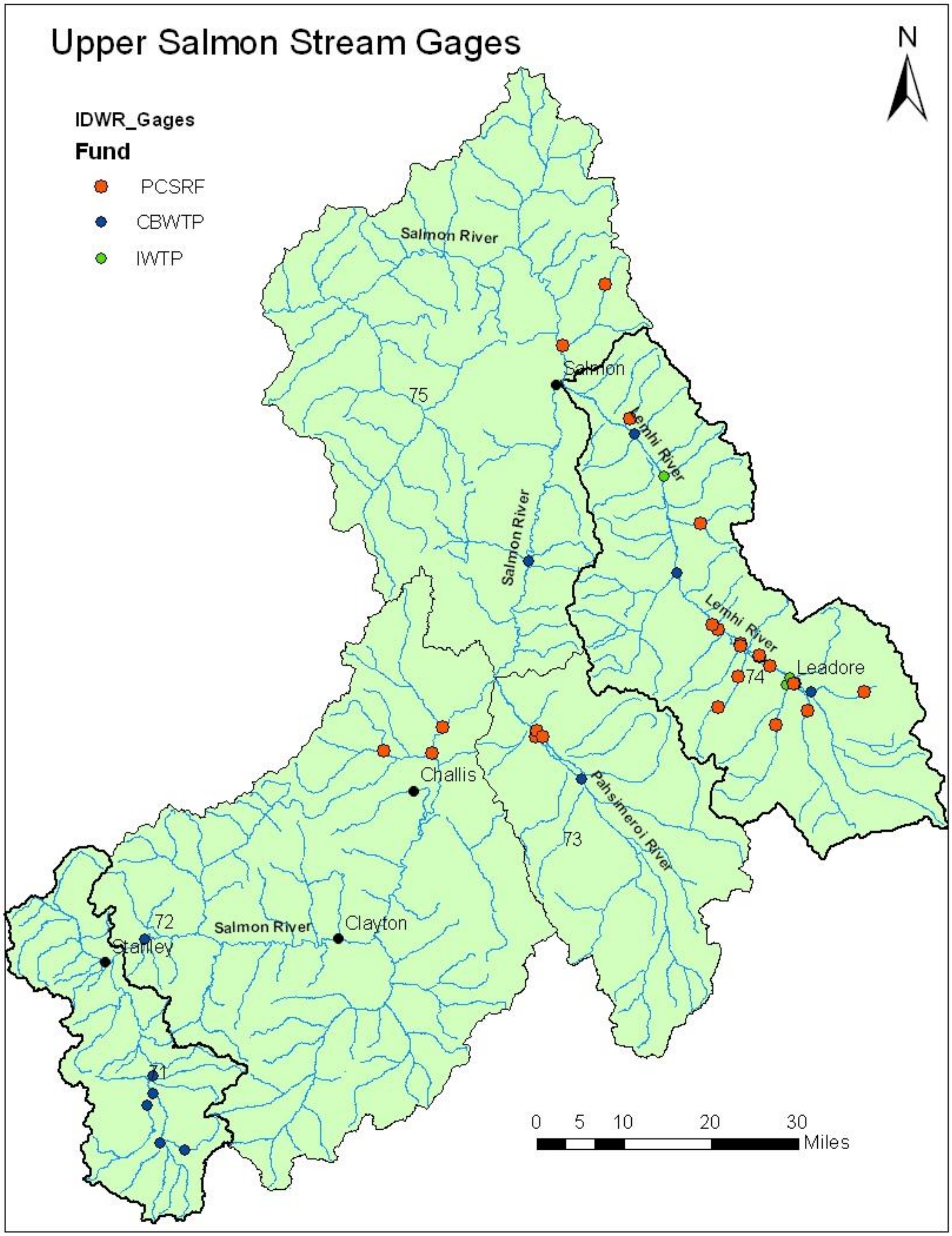


Figure 1. Location of current OSFE Phase III stream gages.

Stream Gage	Period of Record	Maintenance Schedule	Lat	Long	Maintenance
Agency Creek	6/29/2005-present	seasonal	44.94888889	-113.5686111	IPCo
Big Eightmile Creek Above Diversions	6/29/2005-present	seasonal	44.64472222	-113.5288889	IPCo
Bohannon Creek	6/3/2008-present	seasonal	45.12192885	-113.7331272	IPCo
Upper Big Springs Creek	5/7/2008-present	annual	44.711259	-113.40865	IPCo
Lower Big Springs Creek	6/15/2005-present	annual	44.7275	-113.4333333	IPCo
Big Timber above diversions	6/15/2005-present	seasonal	44.61361111	-113.3972222	IPCo
Carmen Creek below diversions	6/14/2005-present	annual	45.24638889	-113.8927778	IPCo
Carmen Creek above diversions	6/29/2005-present	seasonal	45.345	-113.7894444	IPCo
Challis Creek above diversions	6/28/2005-present	seasonal	44.56777778	-114.3669444	IPCo
Challis Creek below diversions	6/14/2005-present	annual	44.56916667	-114.1938889	IPCo
Lower Eighteenmile Ck	6/4/2008-present	seasonal	44.682935	-113.351645	IPCo
Lemhi River abv Big Springs	6/29/2005-present	annual	44.72861111	-113.4333333	IPCo
Lemhi River at Cottom Lane	6/29/2005-present	annual	44.74916667	-113.4761111	IPCo
Lemhi River above L63	5/8/2008-present	annual	44.68360361	-113.35977246	IPCo
Little Springs below diversions	5/31/2008-present	seasonal	44.78101065	-113.5451666	IPCo
Pahsimeroi River below P9	6/14/2005-present	annual	44.59694444	-113.9533333	IPCo
Patterson-Big Springs Creek	5/4/2009-present	annual	44.610083	-113.959667	IPCo
Lower Big Eightmile Creek	5/7/2008-present	seasonal	44.69403942	-113.481541	IDWR
Lee Creek mouth	5/5/2009-present	seasonal	44.7458667	-113.476094	IDWR
Challis Creek Highline Canal	4/30/2007-present	seasonal	44.56038359	-114.272058	IDWR
Hawley Creek	5/8/2008-present	seasonal	44.66655951	-113.1918655	IDWR
Upper Little Springs Creek	5/7/2008-present	seasonal	44.77280619	-113.5280916	IDWR
Morgan Creek	6/11/2007-present	seasonal	44.61160423	-114.1695073	IDWR
Texas Creek	5/8/2008-present	seasonal	44.63636455	-113.3226247	IDWR

Table 1. List of stream gages funded by OSFE phase III project.

Seepage Runs

The seepage studies included measurements of surface water flows (stream flows, diversion rates, and return flows) in key streams in order to quantify gaining and losing reaches. This data is used to analyze stream reconnection and stream flow enhancement projects as well as to calibrate the MIKE Basin Models. The seepage data and a calibrated model together provide a useful tool to analyze stream flow enhancement proposals.

The seepage runs conducted during the study period were: the Lemhi River downstream of Big Springs Creek to McFarland Campground; Big Timber Creek; Jakes Canyon; lower Lee Creek; partial Little Springs Creek; Valley Creek. A summary of each of these studies can be found in Attachment B.

Modeling Summary

Modeling work consisted of three elements: creation of new models, updating and populating existing models, and application of models to management questions. The software used to create these models is MIKE BASIN a product from the Danish Hydraulic Institute (DHI).

The IDWR has concluded that there are currently a sufficient number of models constructed to evaluate the highest priority streams in the Upper Salmon Basin. Future work should focus on refining the existing models to improve the accuracy of each model. It is recommended that data collection efforts be focused on tributaries identified for potential reconnection. Most of these tributaries are in the Lemhi River Basin. However, there are other important tributaries throughout the Upper Salmon, such as: Carmen Creek, Challis Creek, Iron Creek (near Stanley, ID), Goat Creek, and Champion Creek. Once again, a data acquisition plan should be proposed to the USBWPTT and stream gages and seepage studies be performed based on a consensus. Staff modified and populated three water distribution models: the Stanley basin area, Upper Lemhi River basin, and the Pahsimeroi River basin (figure 2). The Upper Lemhi River basin model is the most complete and is partially calibrated for the 2008 water year. This model was used in analysis of several stream flow enhancement projects proposed by the USBWPTT members as described in Attachment C. The Upper Salmon model is being updated and calibrated by the USFS Region 4 Watershed Group in Boise. IDWR staff assisted the USFS in collecting additional data needed for model calibration in the Valley Creek drainage during the 2009 field season (as described in the seepage study section).

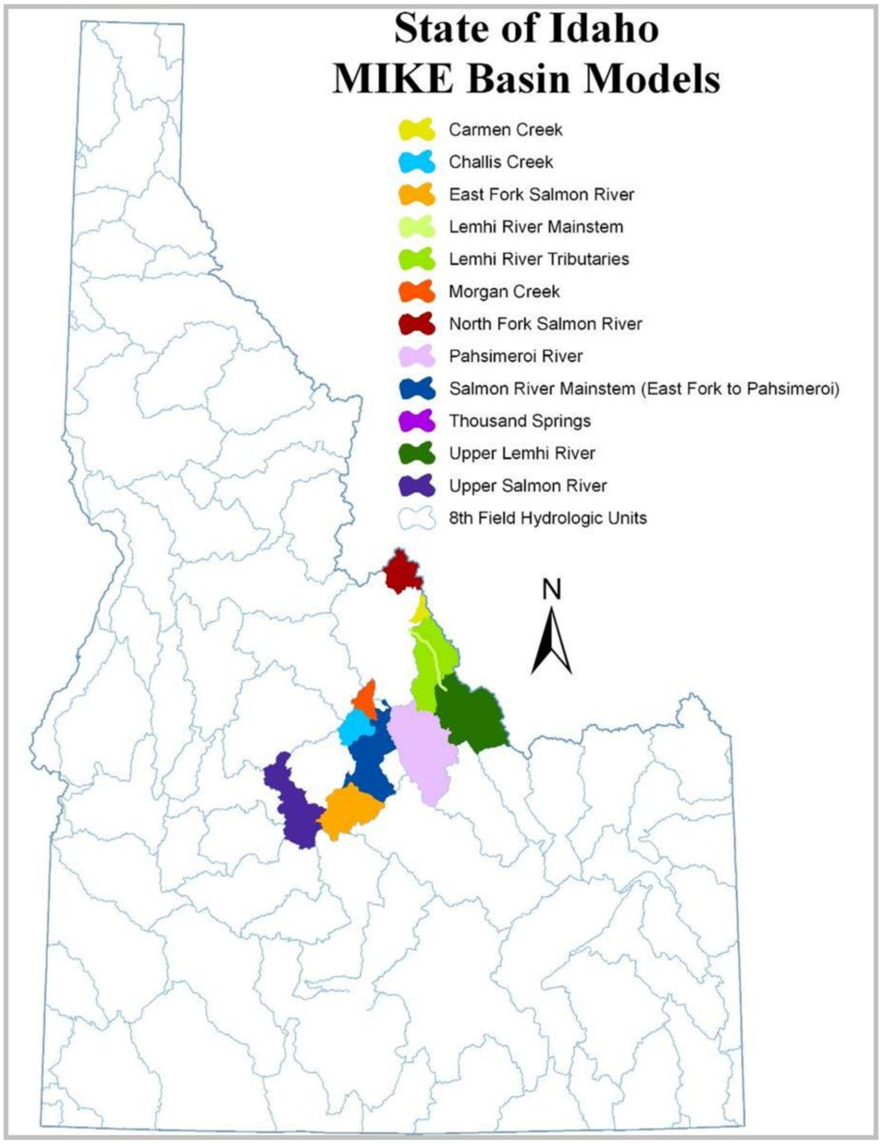


Figure 2. Location of Salmon River basin MIKE Basin models. Models are in varying states of calibration.

Upper Lemhi River Update

The Upper Lemhi River MBM was the primary focus of modeling efforts in the Upper Salmon River Basin in 2009. This was to fulfill requests by USBWPTT partners to analyze potential transactions and easements on several ranches in the Upper Lemhi Basin. I input all 2008 data and calibrated the mainstem Lemhi River from Leadore down to McFarland Campground during 2009. The seepage runs that were conducted in previous years and updated data collected during the 2009 field season were used to proportion gains and losses in the calibration process to specific stream reaches. Several of the key tributaries were also calibrated, most only the lower end where gages exist.

I used the model to evaluate scenarios in which water deals would be done to increase stream flow in tributaries (providing reconnection) and to increase flows through reaches of the Lemhi River (see Attachment C).

A major limitation to the model is the lack of accurate daily diversion records from the tributary water districts and the lack of records on some of the diversions in Water District 74. Another limitation is the lack of knowledge about the groundwater flow paths. While calibrating the models, we use surface water information to infer timing of return flows from irrigation and gains from groundwater, treating the Upper Lemhi River basin groundwater system as a black box. This has been acceptable for many of the analysis applications in the Upper Lemhi.

Multiple modeling scenarios were run through the calibrated portion of the Upper Lemhi River MBM to analyze the effects easements may have on instream flow. A major limitation of these model runs is the lack of data, only one year is calibrated. That being the case the model scenario runs were informative to show where gains in streamflow would occur, the magnitude of the gains, and potential for adverse effects on spring channels. As 2009 irrigation season data is available the model will be updated.

Upper Salmon River Update

Development and calibration of the Upper Salmon River MBM is a collaboration between IDWR and the USFS. USFS have taken over the model calibration after IDWR populated the model with data through 2008. Over the summer of 2009 IDWR personnel worked with the USFS on several seepage studies of Valley Creek and its tributaries. The USFS also contracted seepage studies with the USGS in the Upper Salmon River upstream of Alturas Lake Creek. These seepage studies will be used to calibrate reach gains and return flows in the model. IDWR will provide 2009 irrigation and flow data as it becomes available.

Pahsimeroi River Update

The Pahsimeroi River MBM was updated with 2008 irrigation data and flow data early in 2009. A new stream gage was installed near the mouth of Patterson-Big Springs Creek; this data point and the data will be inserted into the model when it is finalized. Irrigation and flow data from 2009 will also be updated as it is available.

Attachment A. Stream Gage Data

All but two of the following gages were installed prior to 2009. The Lee Creek gage near Highway 28 and the Patterson-Big Springs Creek gage installed below diversions were both installed in May 2009. The Lee Creek gage measures flow past two cross-ditches that have the capability of taking all of the Lee Creek flow during mid to late summer.

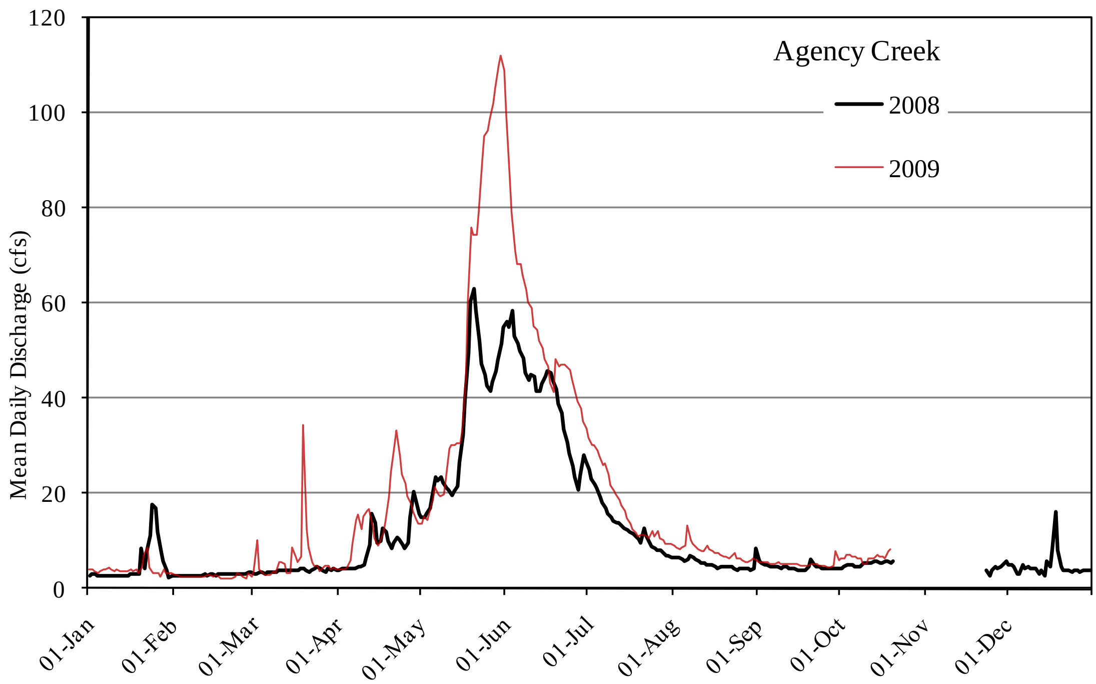


Figure A1. Daily flows measured at the Agency Creek gage during 2008 and 2009.

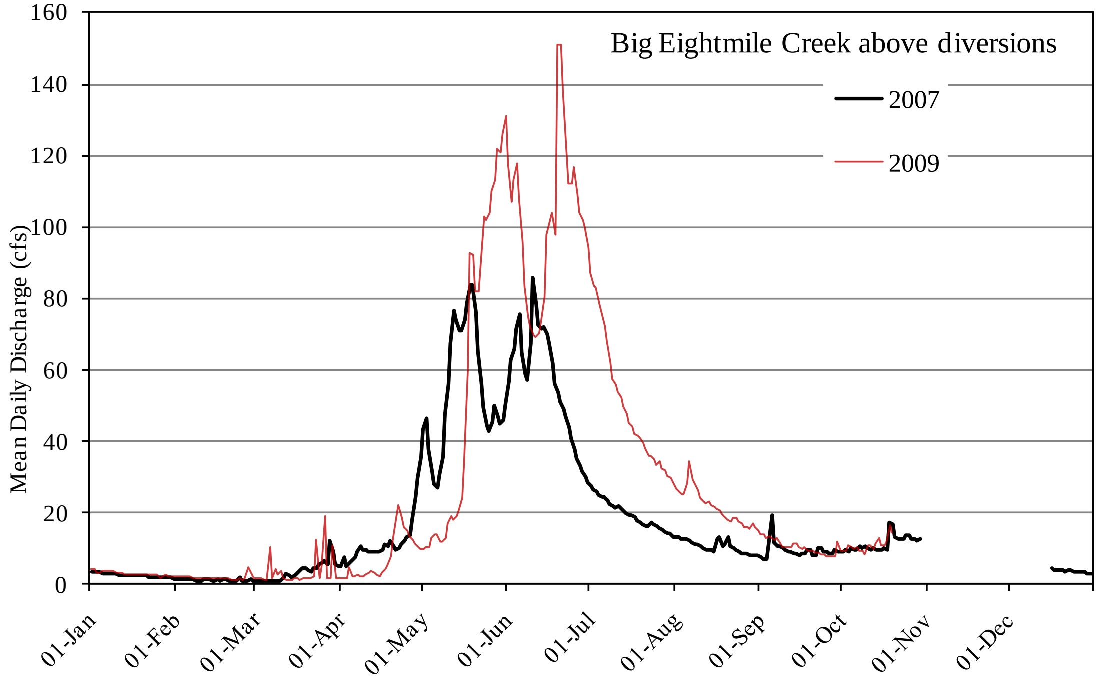


Figure A2. Daily flows measured at the upper Big Eightmile Creek gage during 2008 and 2009.

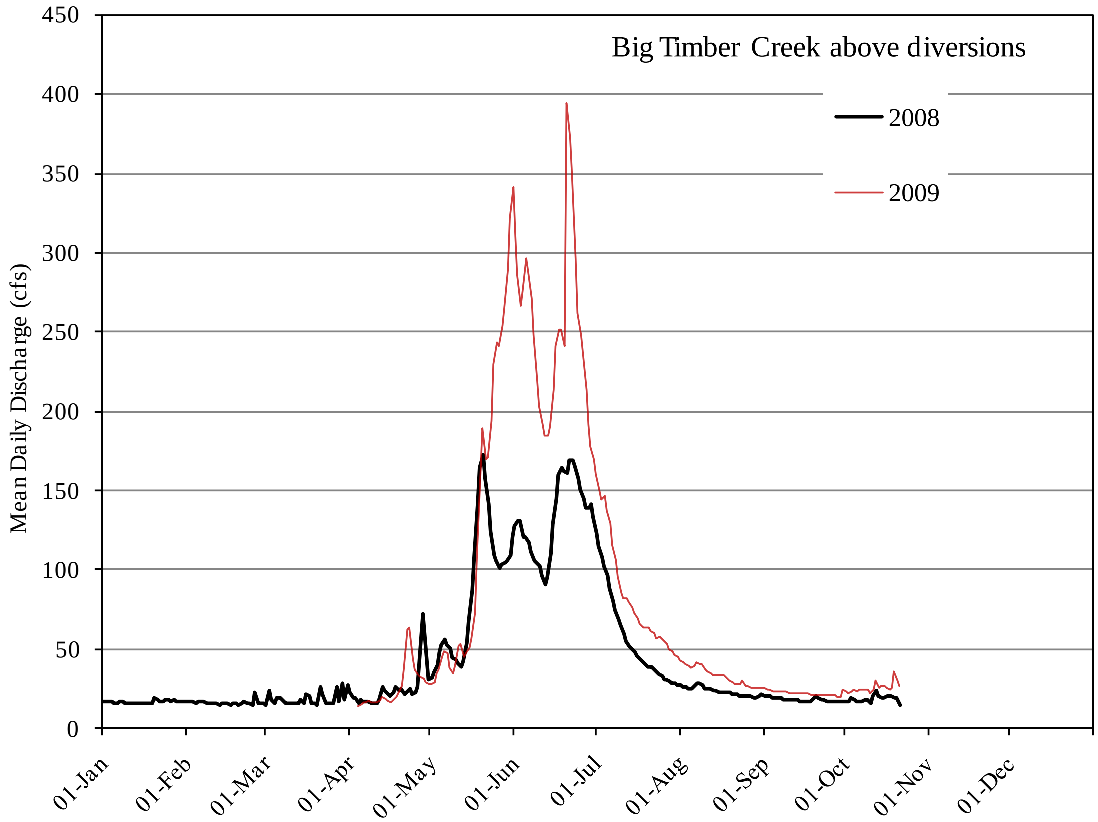


Figure A3. Daily flows measured at the upper Big Timber Creek gage during 2008 and 2009.

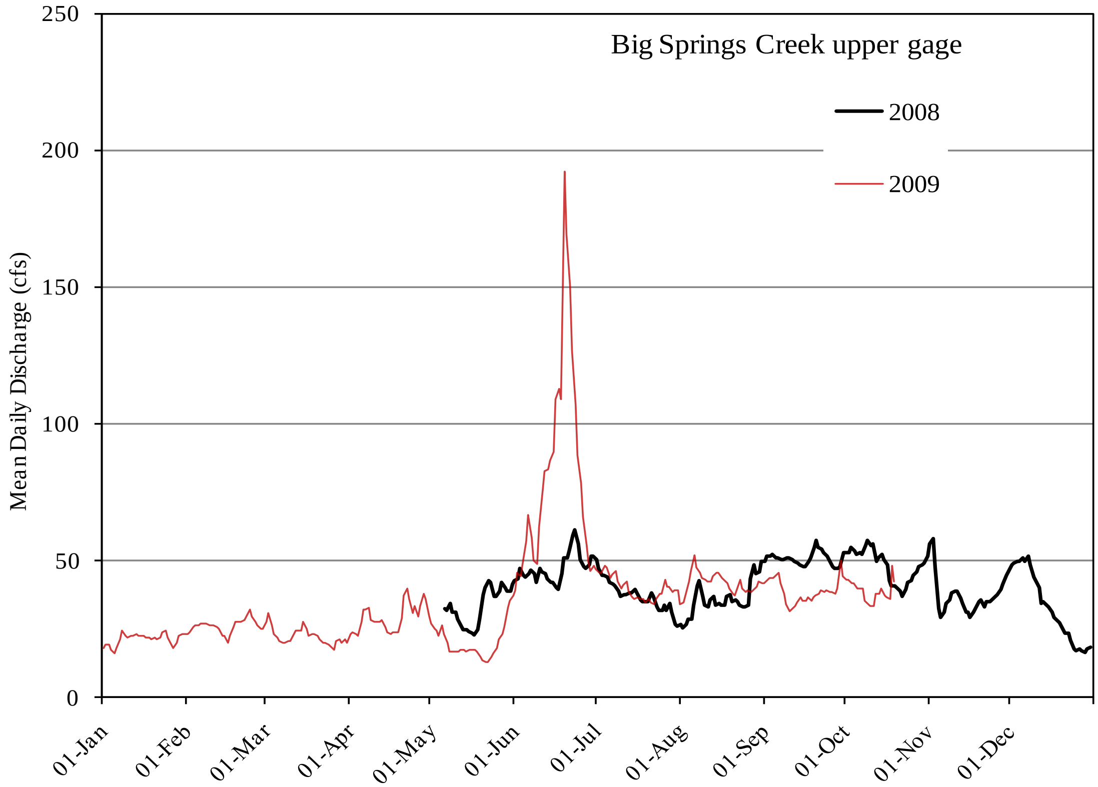


Figure A4. Daily flows measured at the upper Big Springs Creek gage during 2008 and 2009.

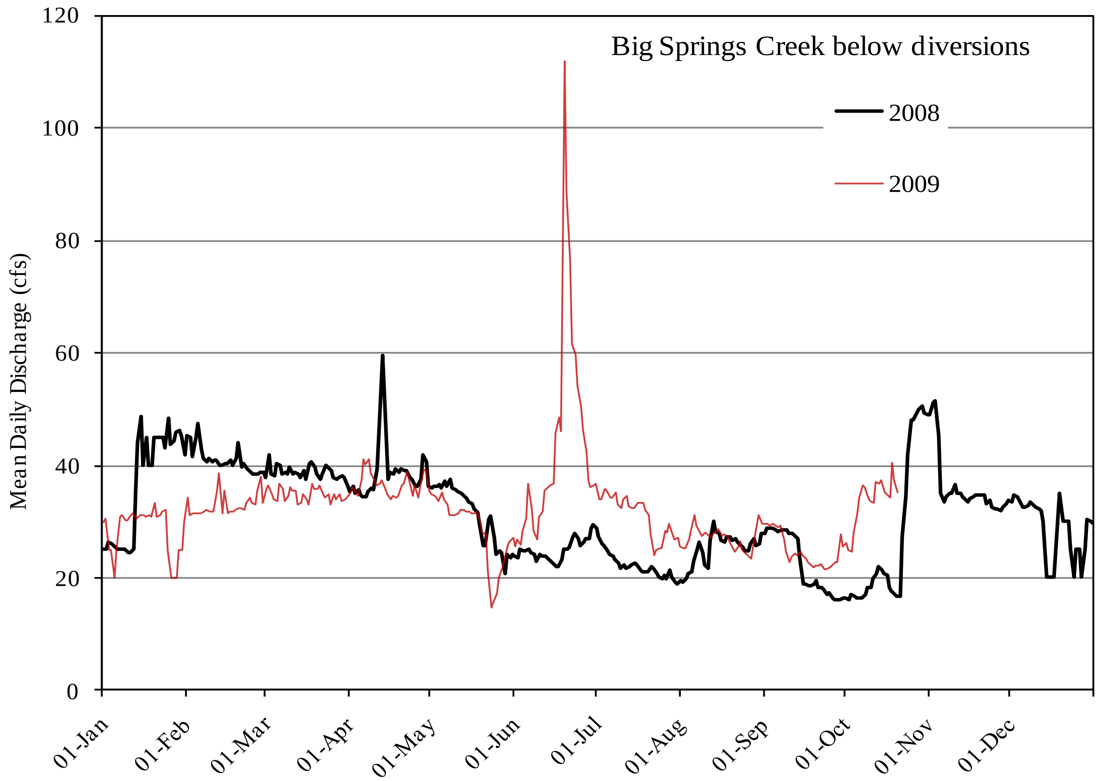


Figure A5. Daily flows measured at the lower Big Springs Creek gage during 2008 and 2009.

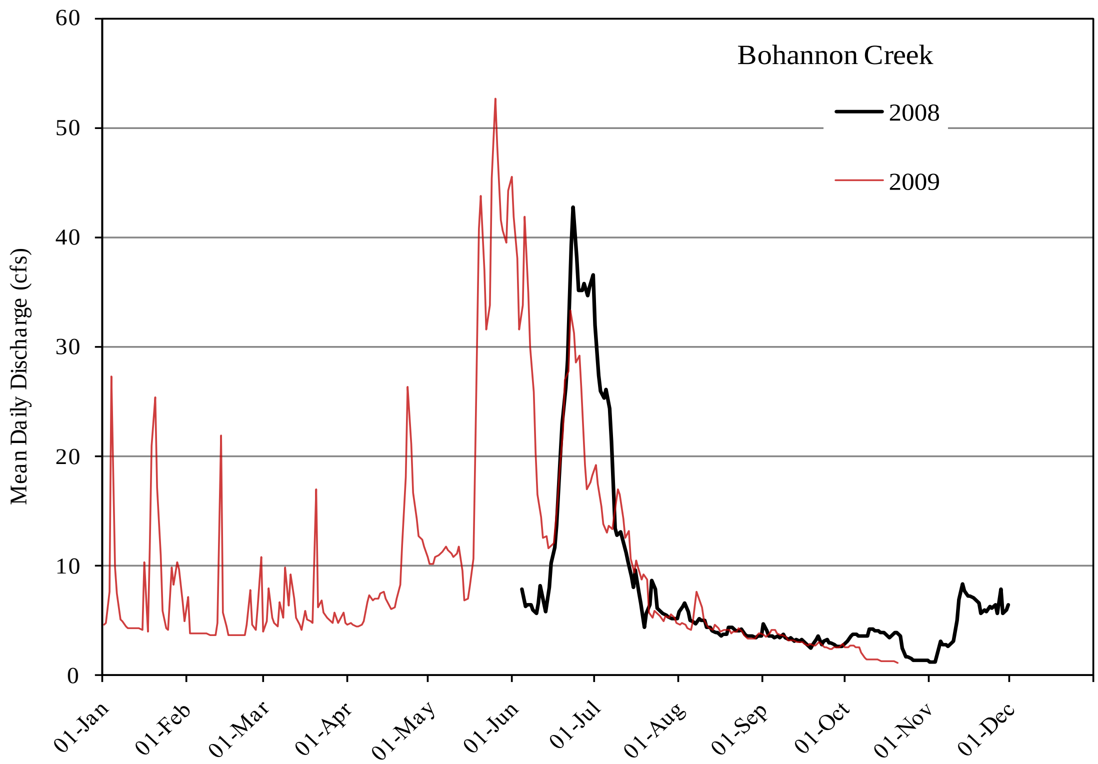


Figure A6. Daily flows measured at the Bohannon Creek gage during 2008 and 2009.

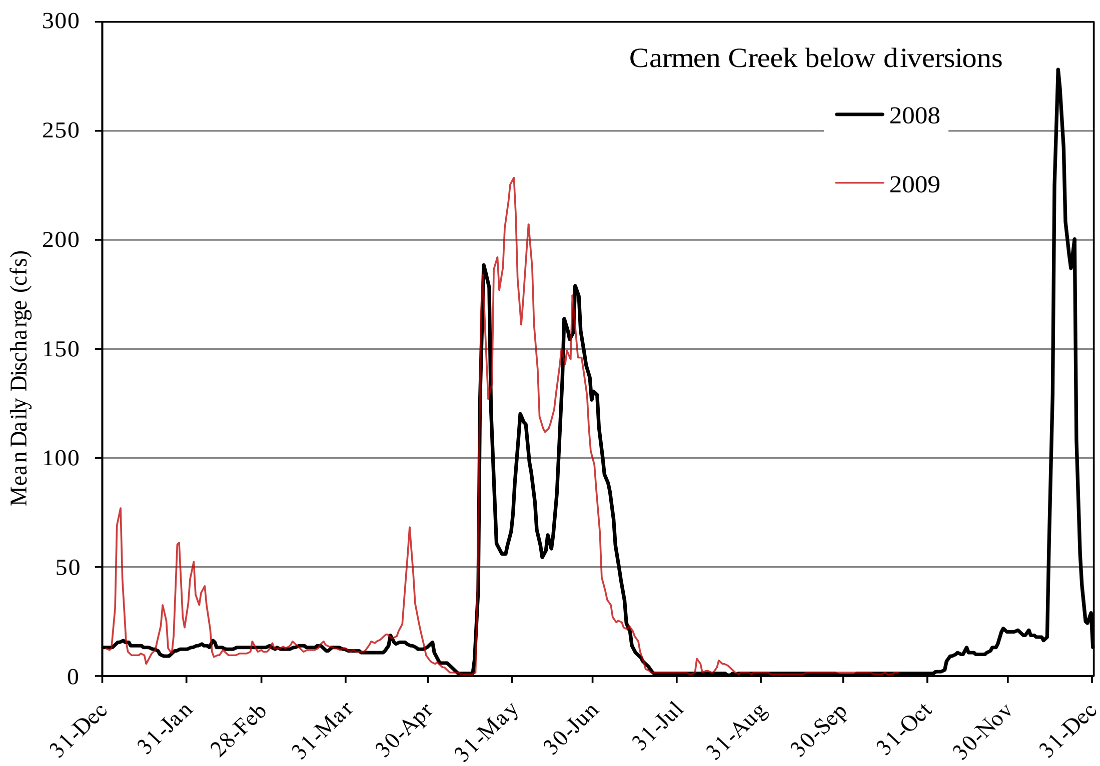


Figure A7. Daily flows measured at the lower Carmen Creek gage during 2008 and 2009.

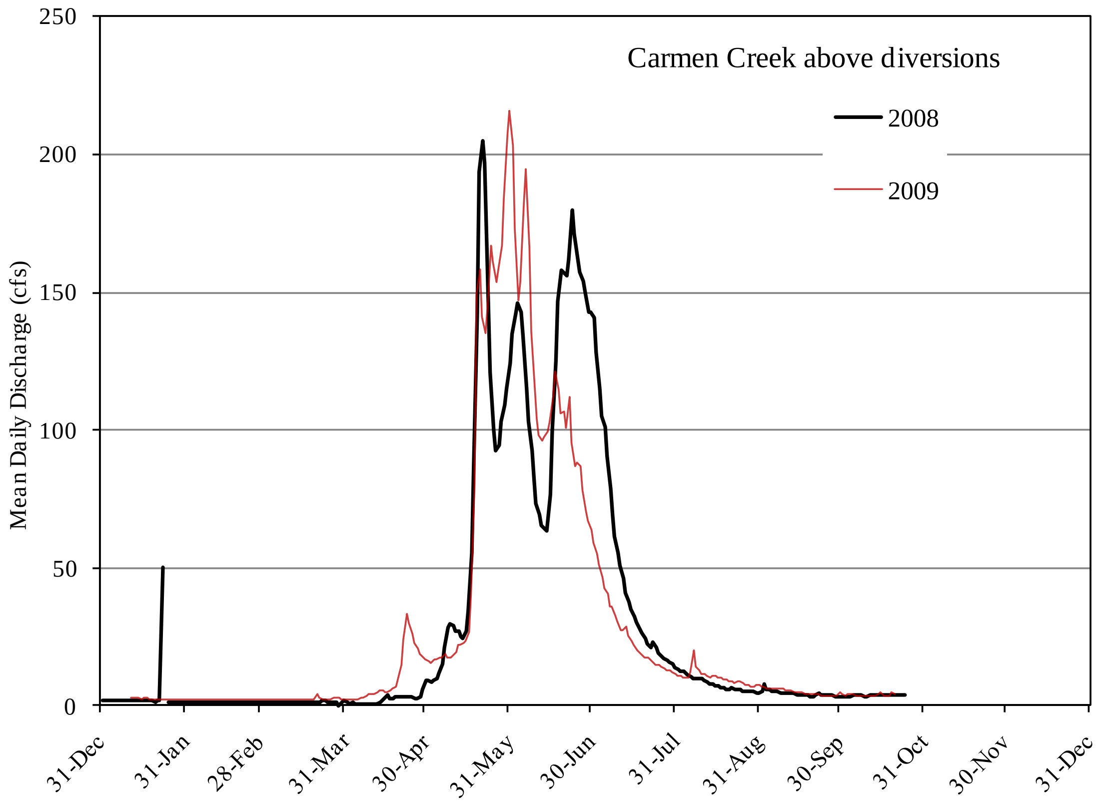


Figure A8. Daily flows measured at the upper Carmen Creek gage during 2008 and 2009.

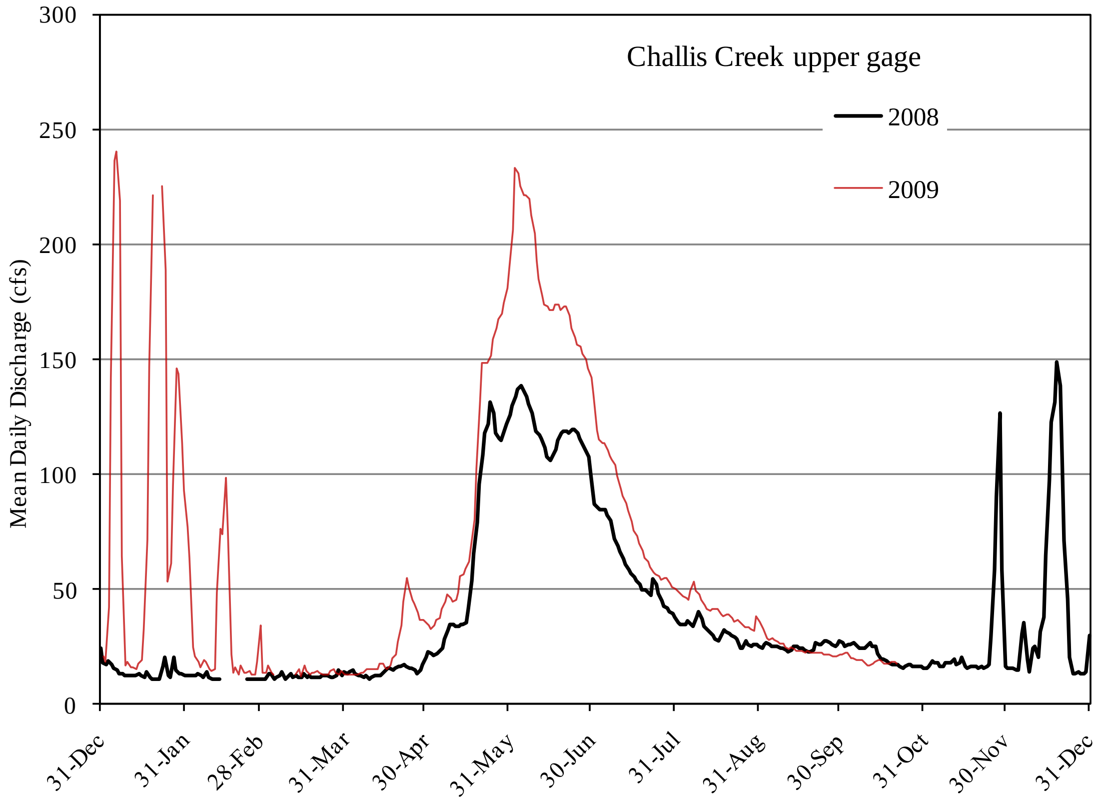


Figure A9. Daily flows measured at the upper Challis Creek gage during 2008 and 2009.

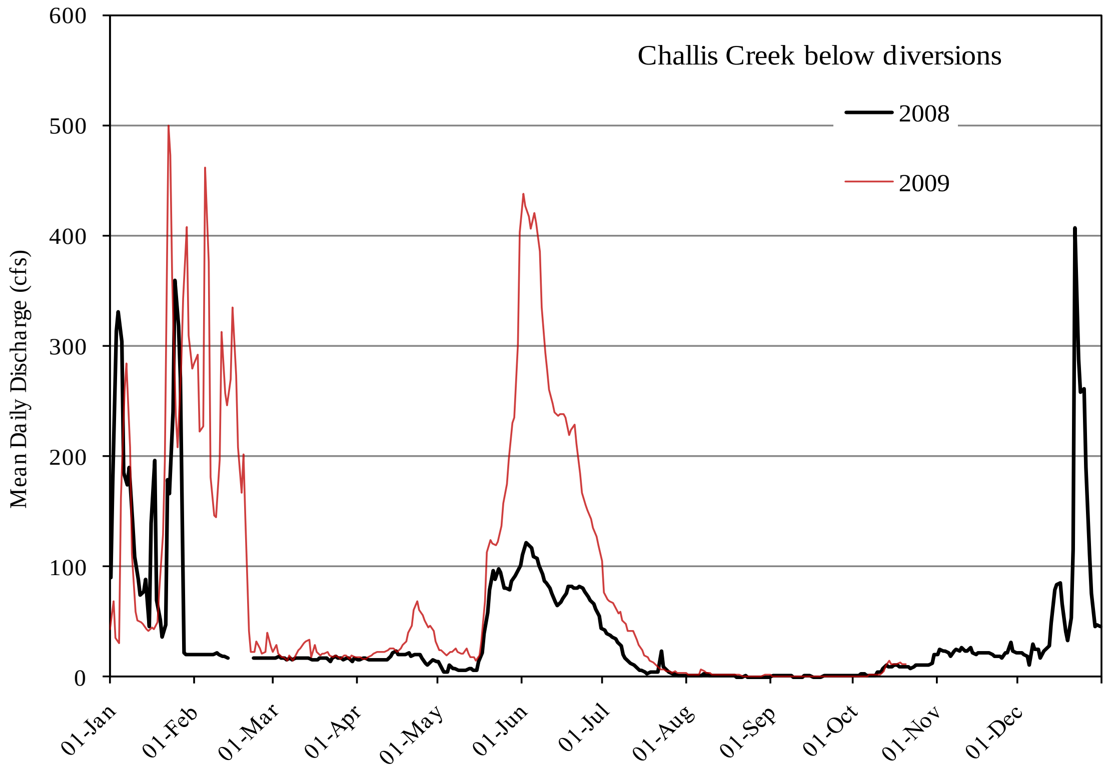


Figure A10. Daily flows measured at the lower Challis Creek gage during 2008 and 2009.

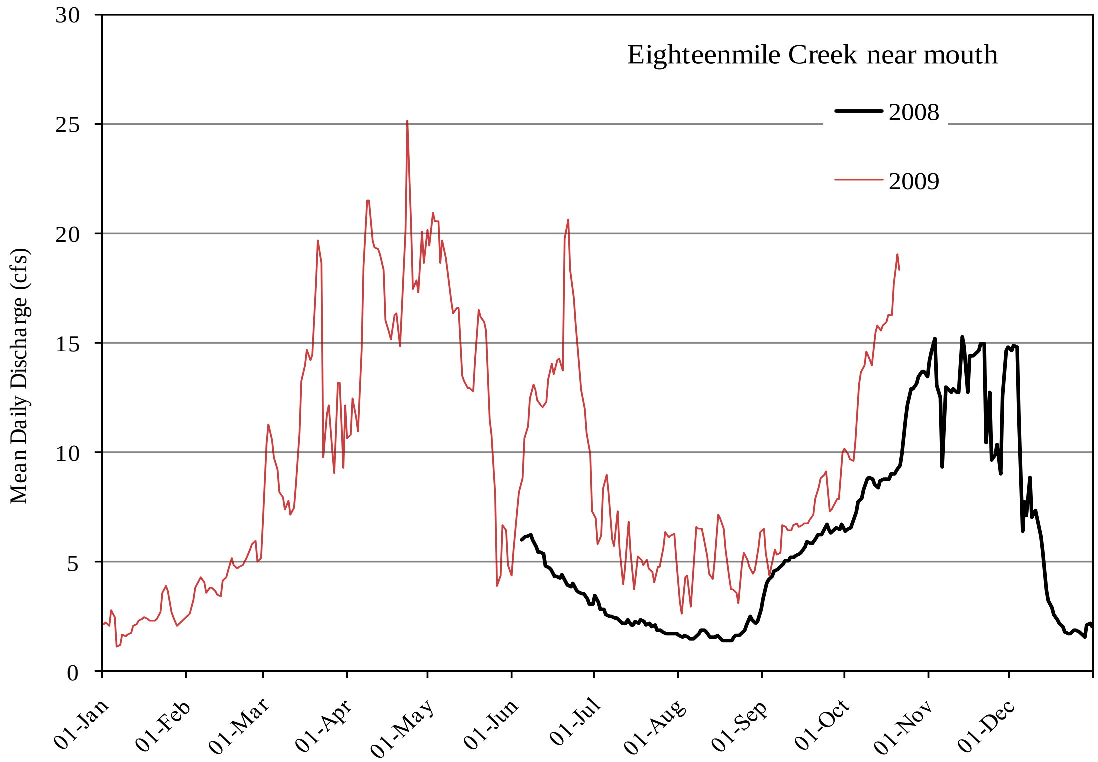


Figure A11. Daily flows measured at the lower Eighteenmile Creek gage during 2008 and 2009.

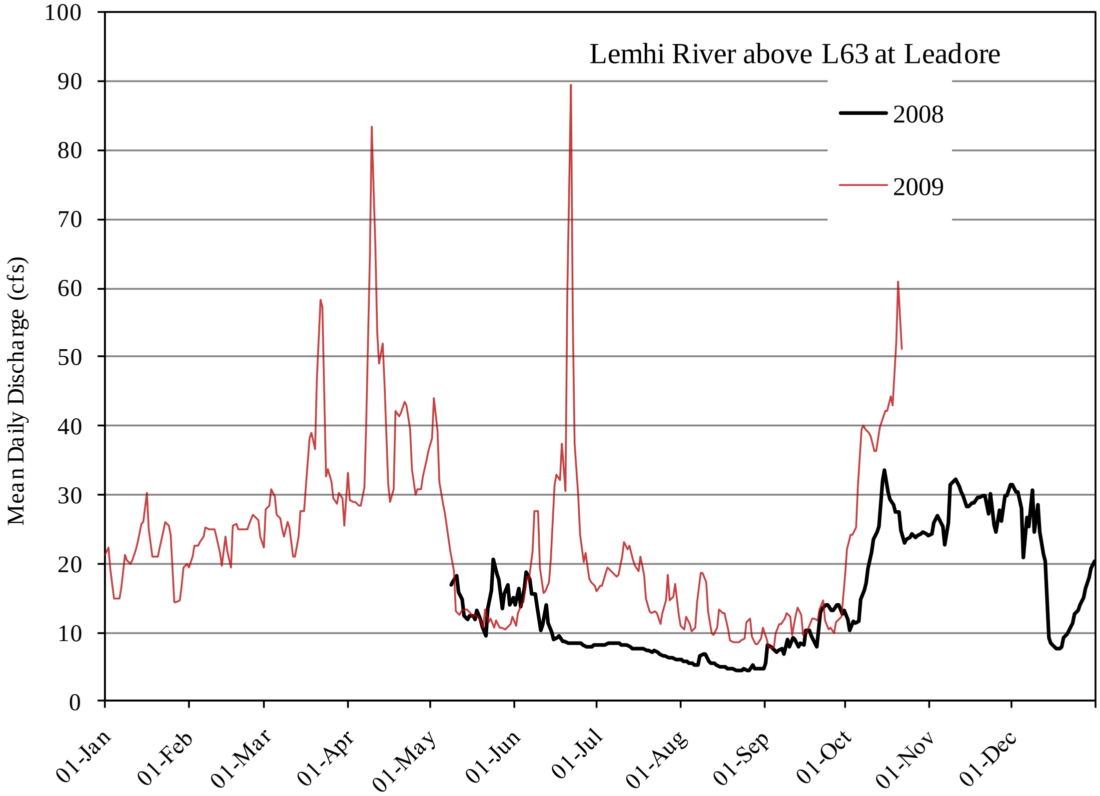


Figure A12. Daily flows measured at the L-63 Lemhi River gage during 2008 and 2009.

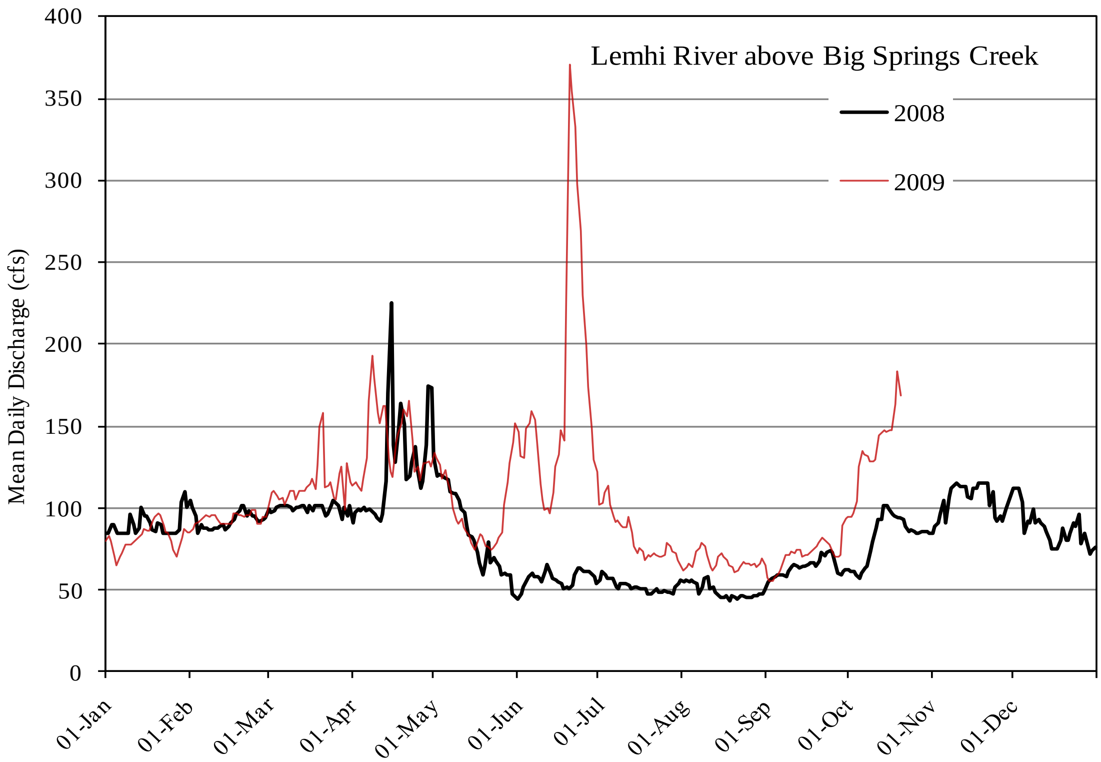


Figure A13. Daily flows measured at the Big Springs Lemhi River gage during 2008 and 2009.

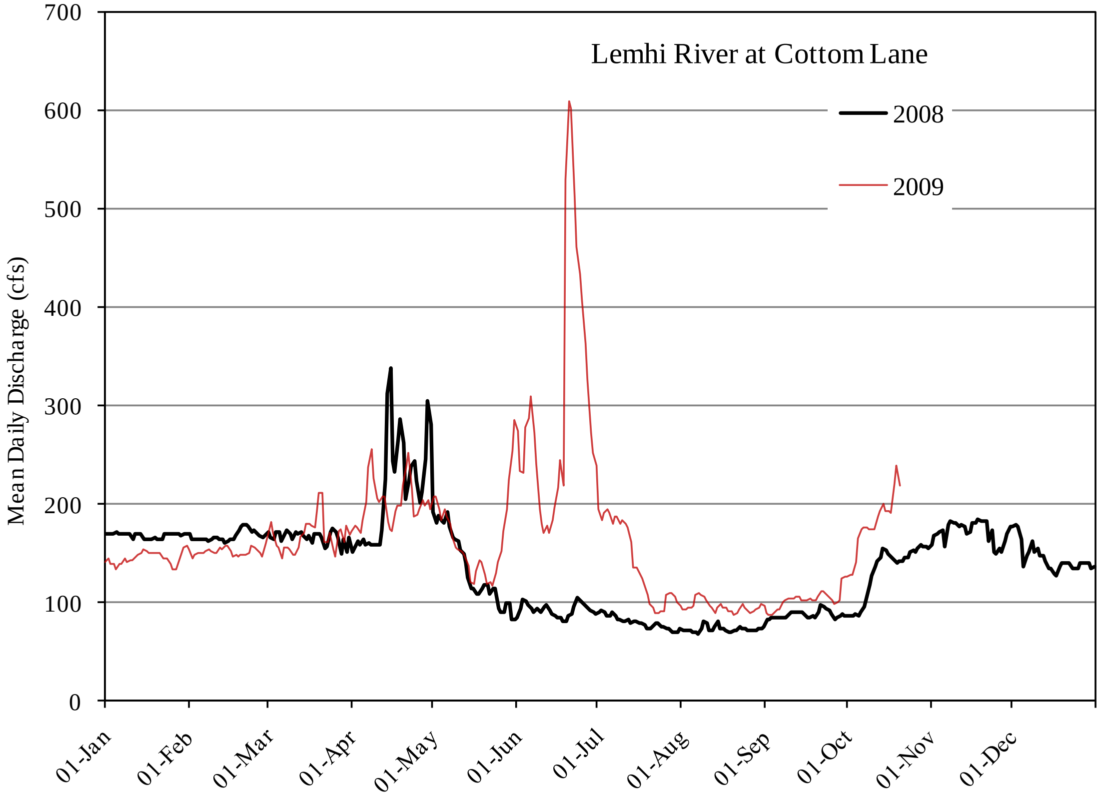


Figure A14. Daily flows measured at the Cottom Lane Lemhi River gage during 2008 and 2009.

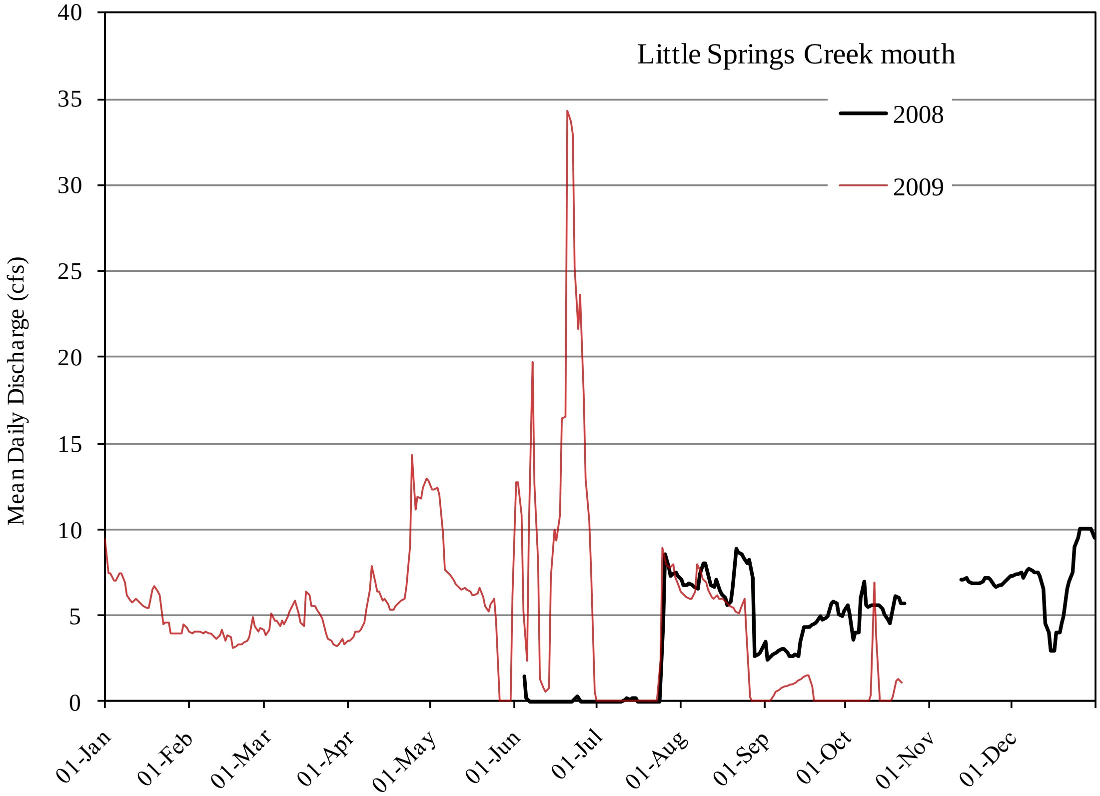


Figure A15. Daily flows measured at the lower Little Springs Creek gage during 2008 and 2009.

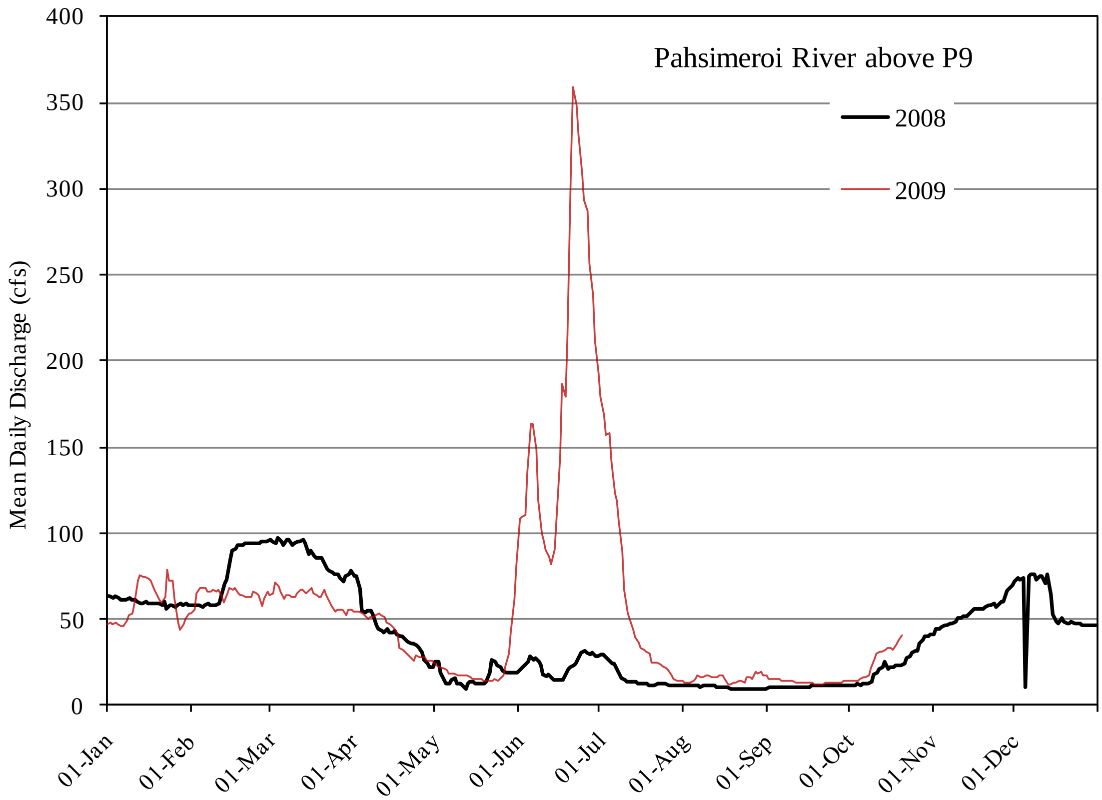


Figure A16. Daily flows measured at the P-9 Pahsimeroi River gage during 2008 and 2009.

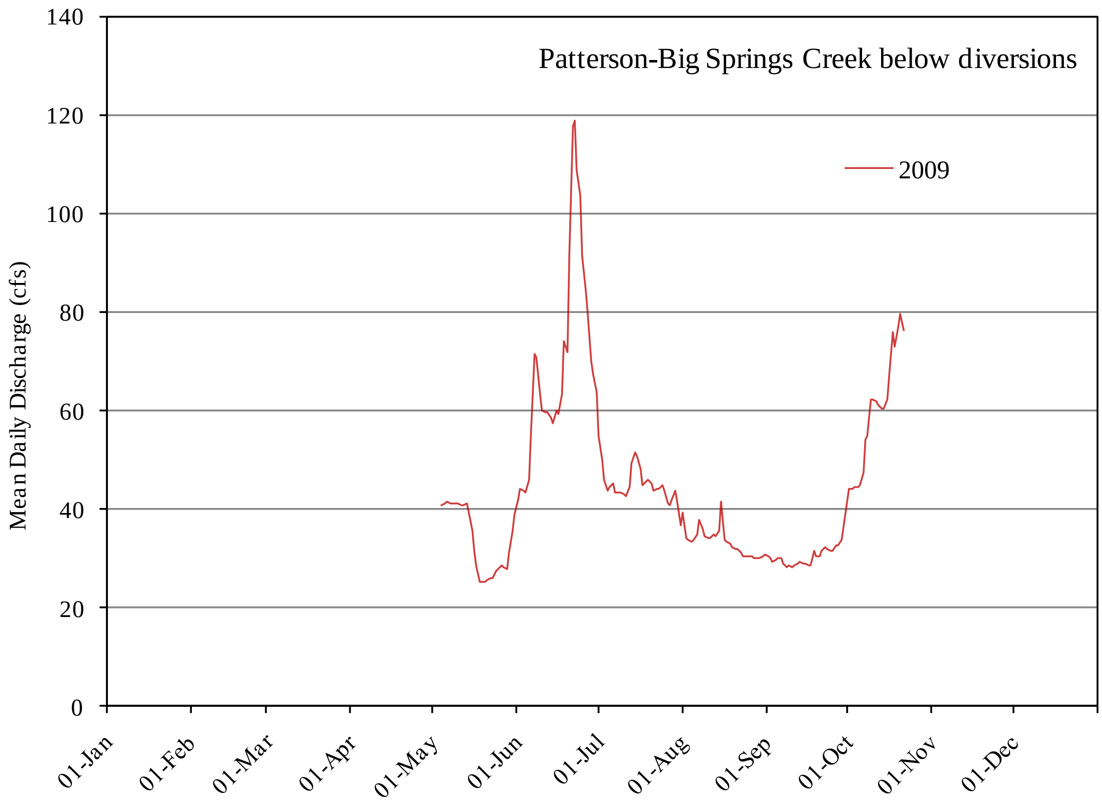


Figure A17. Daily flows measured at the lower Patterson-Big Springs Creek gage during 2009.

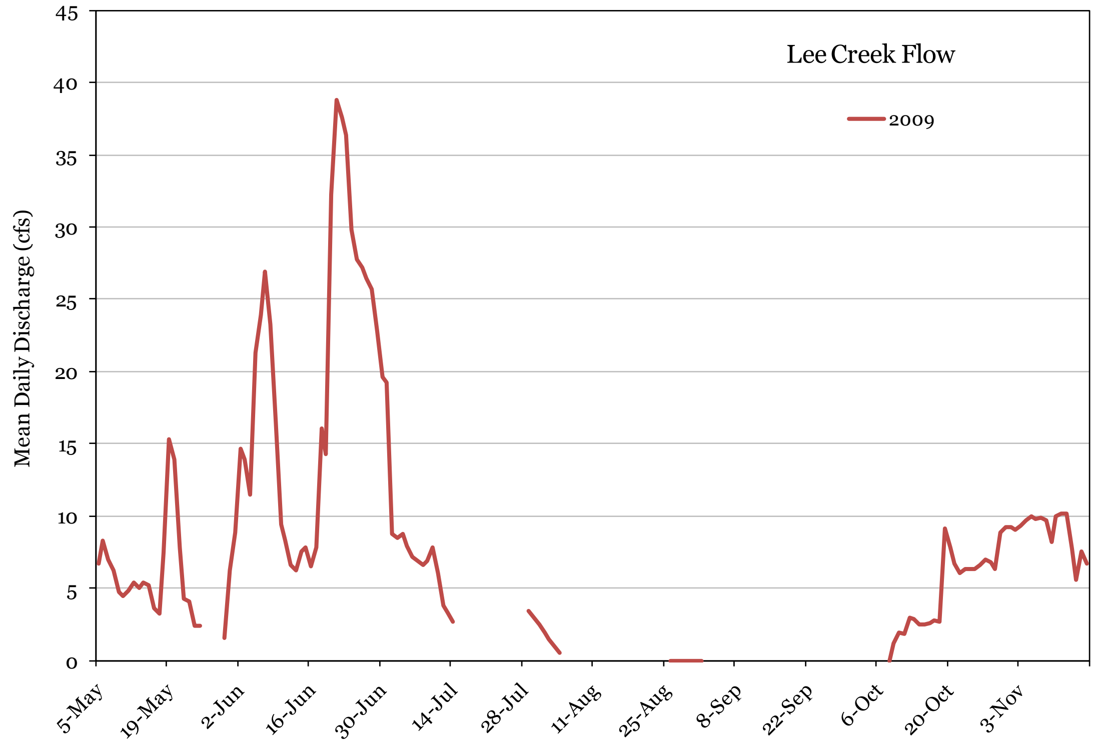


Figure A18. Daily flows measured at the Lee Creek gage during 2009.

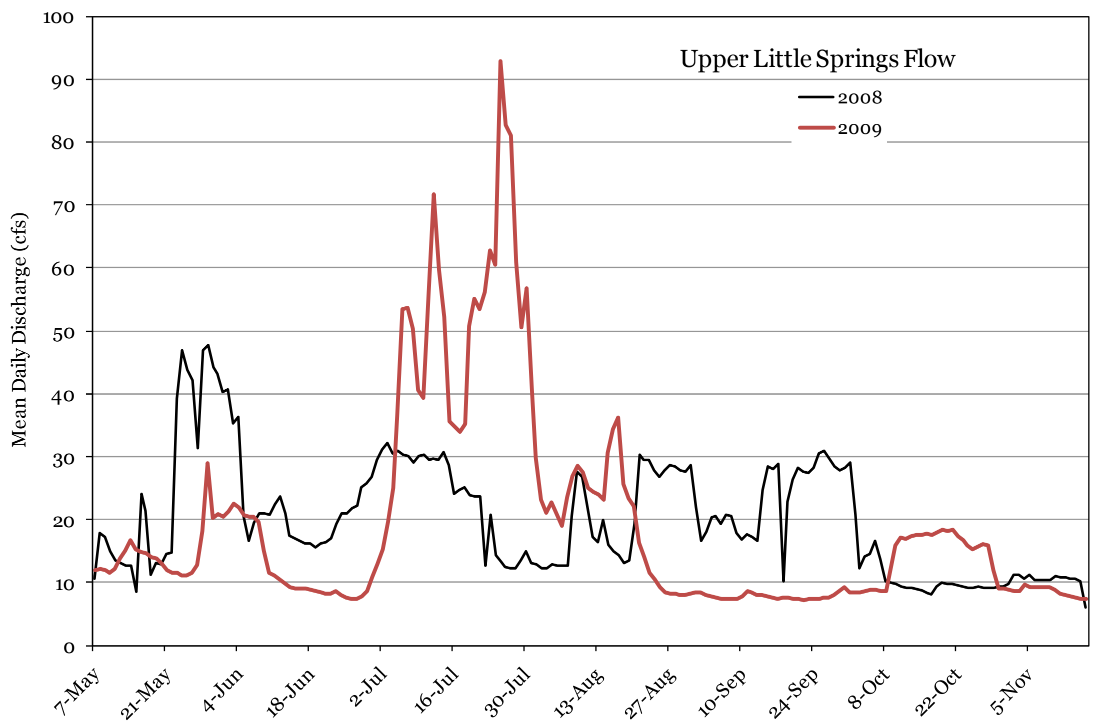


Figure A19. Daily flows measured at the upper Little Springs Creek gage during 2008 and 2009.

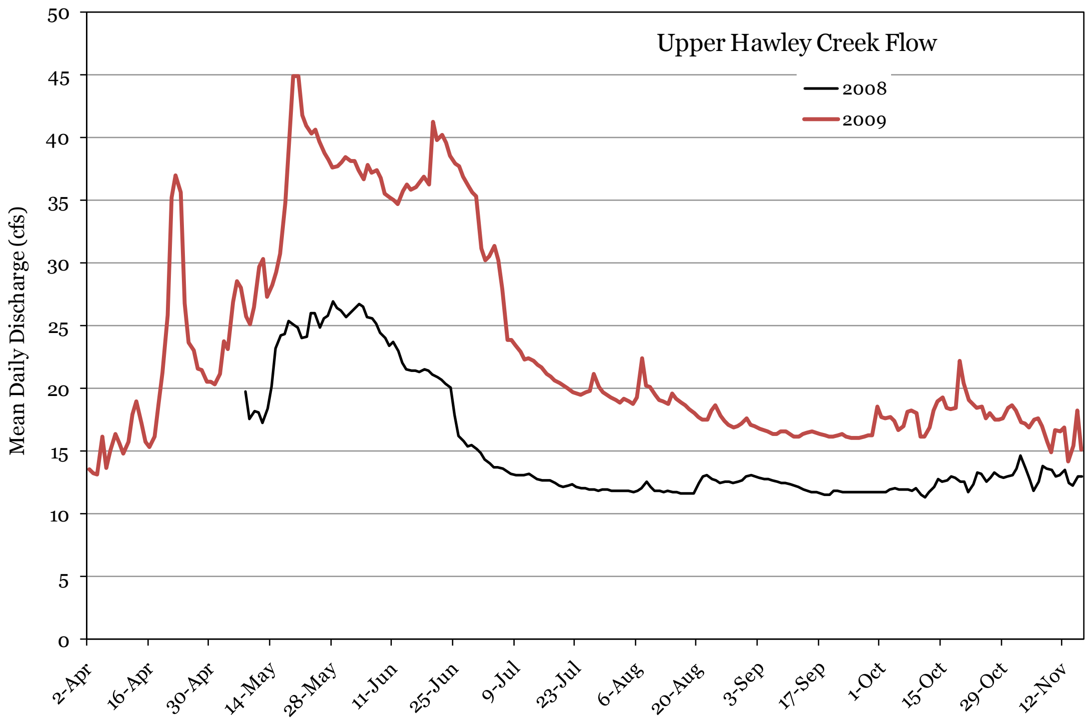


Figure A20. Daily flows measured at the upper Hawley Creek gage during 2008 and 2009.

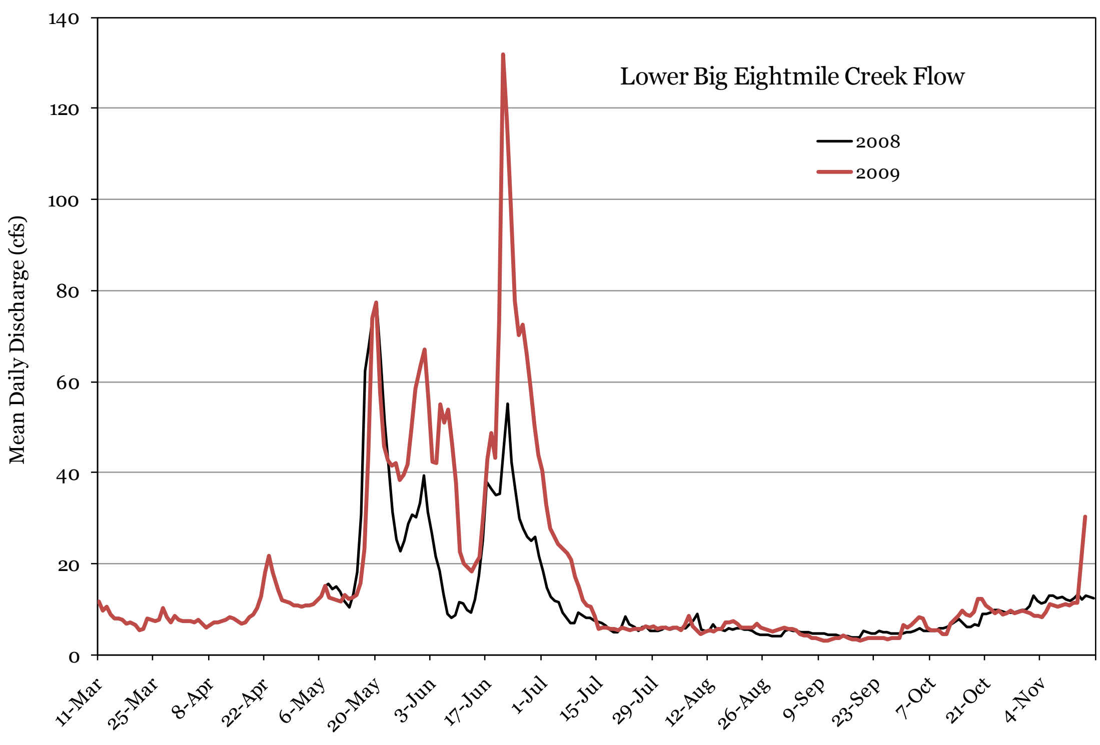


Figure A21. Daily flows measured at the lower Big Eightmile Creek gage during 2008 and 2009.

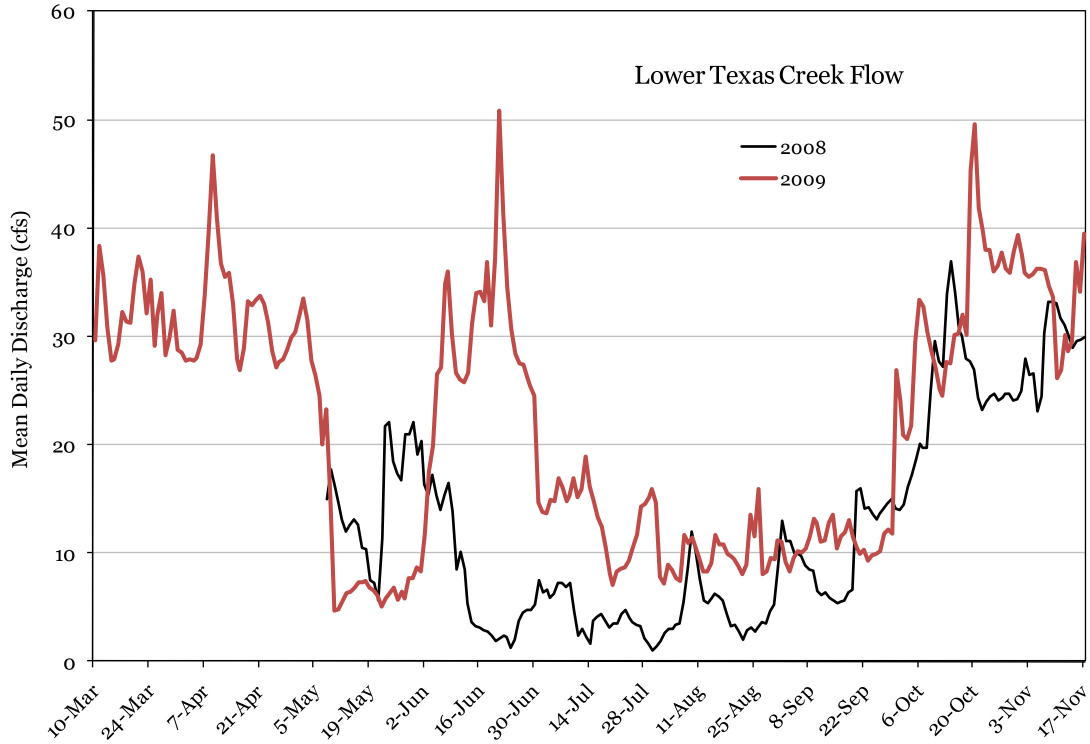


Figure A22. Daily flows measured at the lower Texas Creek gage during 2008 and 2009.

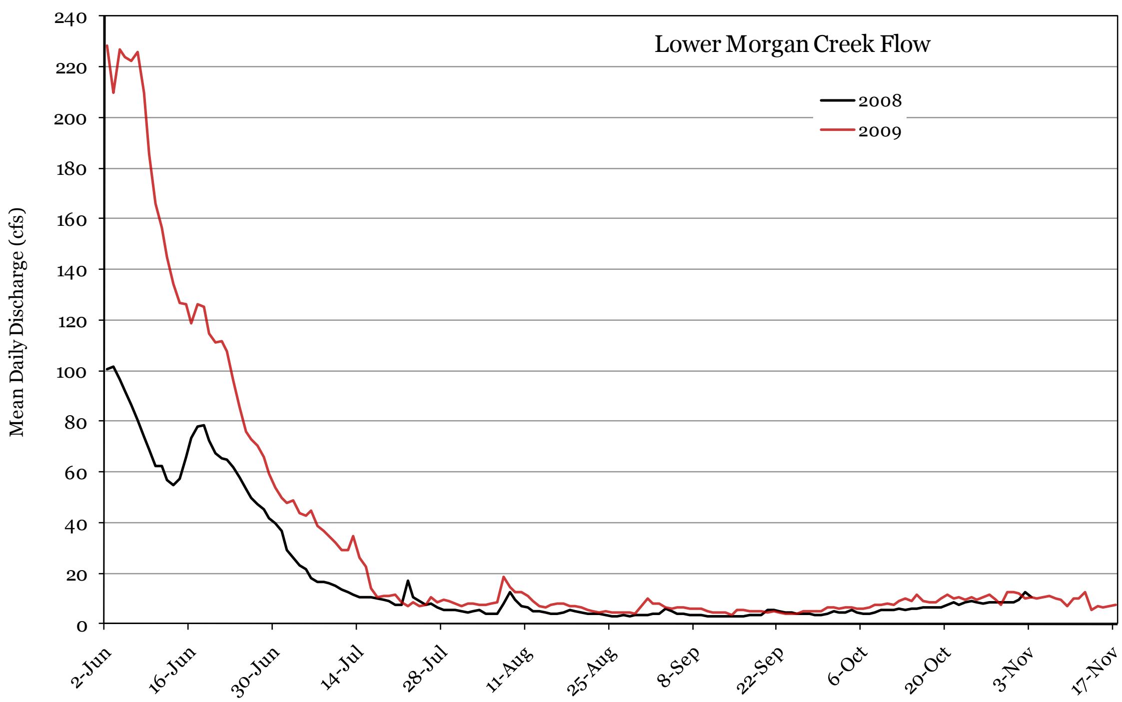


Figure A23. Daily flows measured at the lower Morgan Creek gage during 2008 and 2009.

Attachment B. Seepage Studies

Big Timber Creek Seepage Study 2009: Above Diversions to the Mouth

July, 2009
Eric Rothwell

Introduction
The seepage studies in the Upper Salmon River Basin are conducted to gain an understanding of the surface water hydrology for a specific stream reach; specifically the data is needed to populate hydrology models and to guide decision making by resource management agencies and landowners. An understanding of the seasonal and spatial distribution of surface flows, reach gains and losses, reveals a greater understanding of the groundwater-surface water interactions.

During the summer of 2009, Big Timber Creek experienced some operational and morphological changes. The operational changes were part of a water transaction that shut off Big Timber-2 ditch and pumped water out of the Lemhi River to feed new pivots. The water that passes the Big Timber-2 head gate can be pumped out of the Lemhi River at a newly developed pumping station within the maximum diversion rate allowed by the water right. Big Timber-2 was turned off in early August and resulted in a reconnected Big Timber Creek to the Lemhi River. The stream morphology changed in the lower reaches of Big Timber Creek as a result of high flows in June (figures B2 and B3) that resulted in scouring new pools, creating side channels and a couple of places where the channel was blown out and water flowed over the adjacent floodplain/pasture. These areas where scour occur coincide with new losing reaches, it is unclear but probable that these reaches will lose less water as they become more stable. In order to address the newly wetted channel we took a few measurements later in the summer (August 27th and September 1st) in the lower channel.

Earlier in the summer a large flow event resulted by the combination of snow melt and a heavy week of rain, figures B2 and B3 show the hydrographs from the gage above all diversions and the lower gage above Lee Creek Road but downstream of BT2.

IDWR staff measured flows in Big Timber Creek, diversions, and tributaries on July 16, 2009 to calculate the surface-groundwater exchange that occurs at key reaches of Big Timber Creek (figure B1). During the bulk of this study this transaction had not taken place and the lower Big Timber Creek (from BT2 down to ~150 meters upstream of the mouth) was dry.

Methods
This seepage study was conducted by measuring stream flow, diversions, surface returns from diversions and tributary inflows within a short period of time (one day). Seepage (gain or loss) for a reach was determined by deducting the inflows of tributaries and diversion returns and adding back in the outflows. The results are compared to measured flows at the bottom of the reach or sub-reach. If the calculated

water at the bottom of the reach is greater than the measured, then there is a loss of flow to groundwater. If the summed values are less than the measured, then the stream is gaining flow from groundwater. Care was taken to ensure the study represented gains and losses by monitoring stream gages and by re-measuring the stream flow at the upstream measuring point at the end of the study (figures B4 and B5). This ensured that the differences between measurements were related to ground and surface waters interaction not to surface water changes.

Results

During the seepage study the gage above diversions and below diversions remained steady (figures B4 and B5). This allows us to assume our measurements are related to the surface-groundwater interactions. Big Timber Creek loses flow below the mouth of the canyon, where diversions are also concentrated (table B1). Above all diversions Big Timber Creek was flowing around 65 cfs, from Carey Act Dam down to Little Timber Creek, Big Timber Creek loses over 5 cfs. The reach downstream of Little Timber Creek to Lee Creek Road loses another 5 cfs. Below this point during the initial 2009 study Big Timber Creek was relatively dry (less than 0.5 cfs) until lower Big Timber Creek gains flows from return flows and/or groundwater flow. Big Timber Creek at the mouth had increased to 4 cfs, insinuating that the lower 150 to 200 meters of Big Timber Creek remains connected to the Lemhi River (table B2).

The August 27th and September 1st measurements compared the flow measured at the lower gage to flows at the highway and at a short losing reach below the highway (table B3). This losing reach below the highway appears to be losing associated with a channel blowout that occurred during the high spring runoff. The channel is losing at this blowout because part of the stream flows out of the channel into an adjacent pasture; with some natural or manual channel maintenance in stream flow loses would be reduced or this reach could even be gaining flow. There was also a large scour in the Big Timber Creek channel downstream of the gage and upstream of the highway. This also occurred during the spring high flow event and results in a loss of flow (around 2 cfs during the August and September measurements).

Acknowledgements

Jeff Lutch, with IDFG, Stuart VanGreuningen with IDWR, and the local water users and land owners for access to measurement locations on Big Timber Creek.

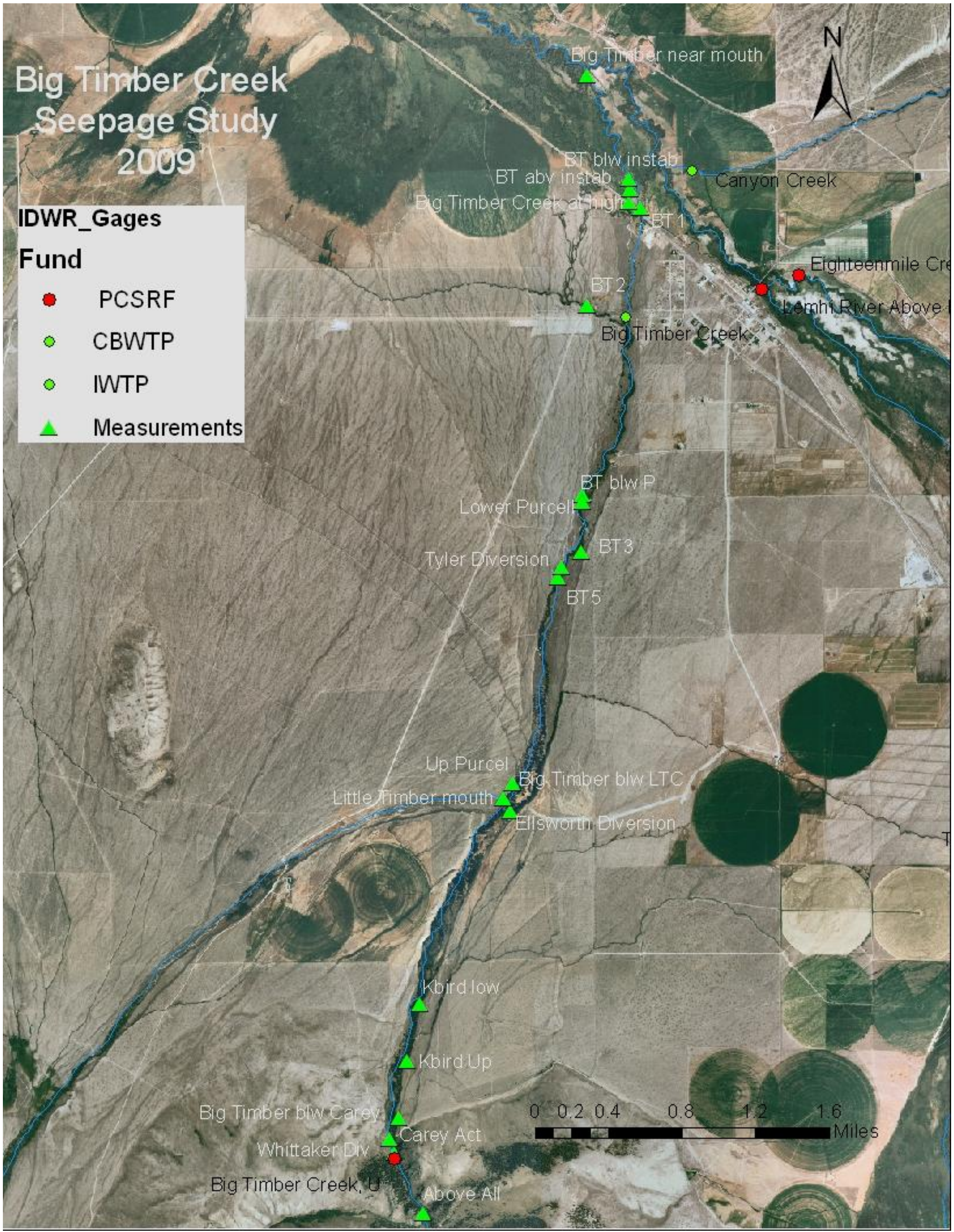
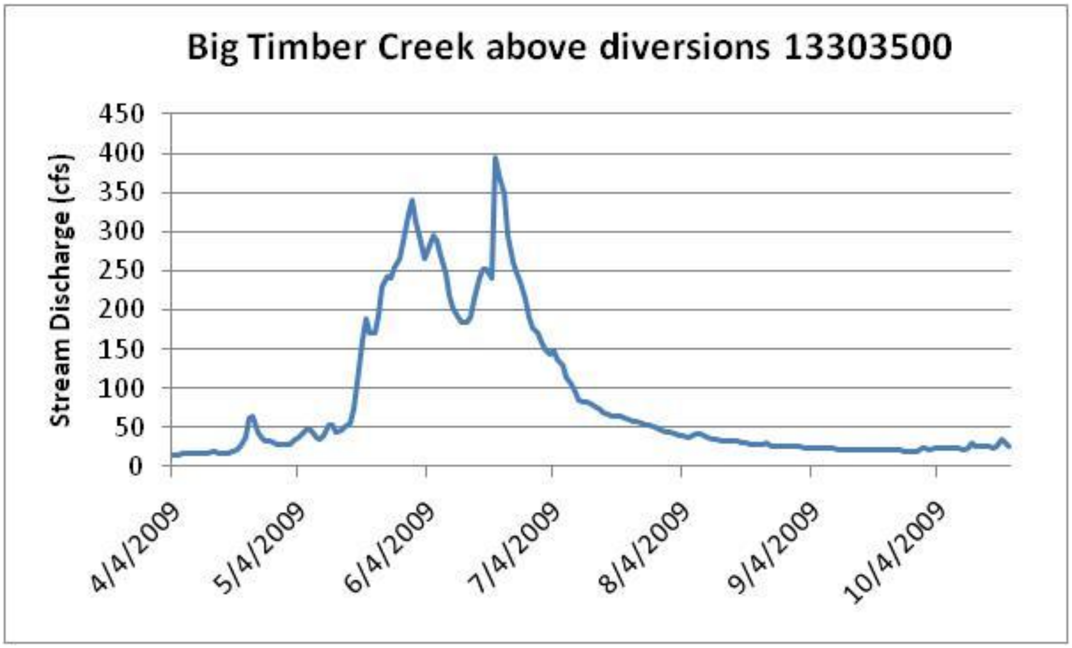
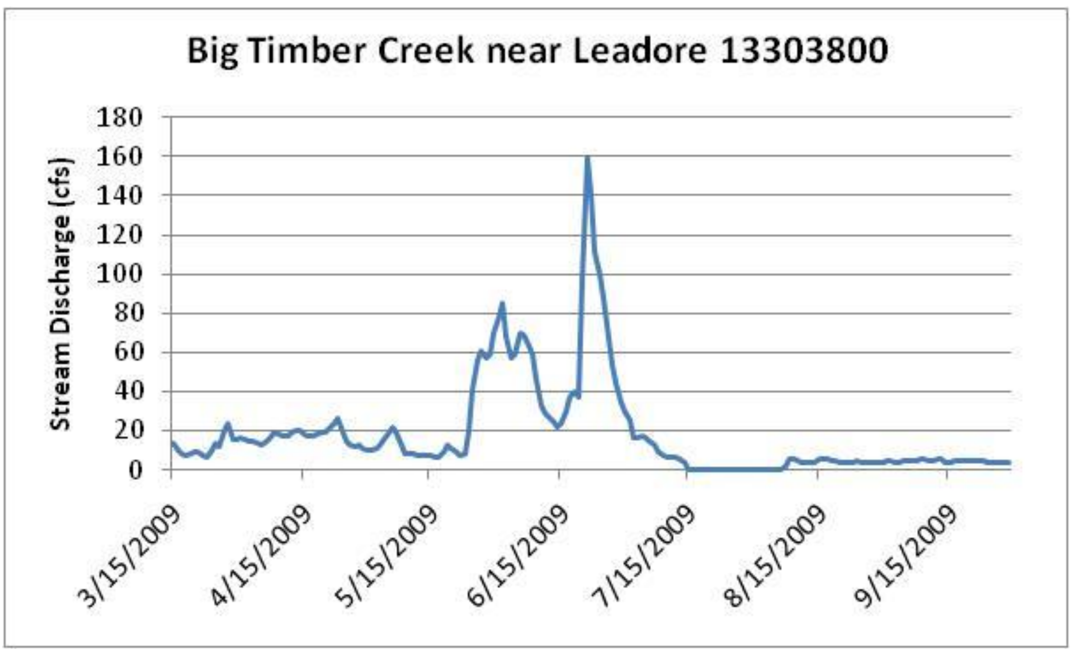


Figure B1. Site map with measurement locations





Figures B2 and B3. Seasonal hydrographs of Big Timber Creek. Above all diversions (B2, top). Above Lee Creek Road (B3, bottom). At the time of this publication the gage 13303800 was complete only through September.

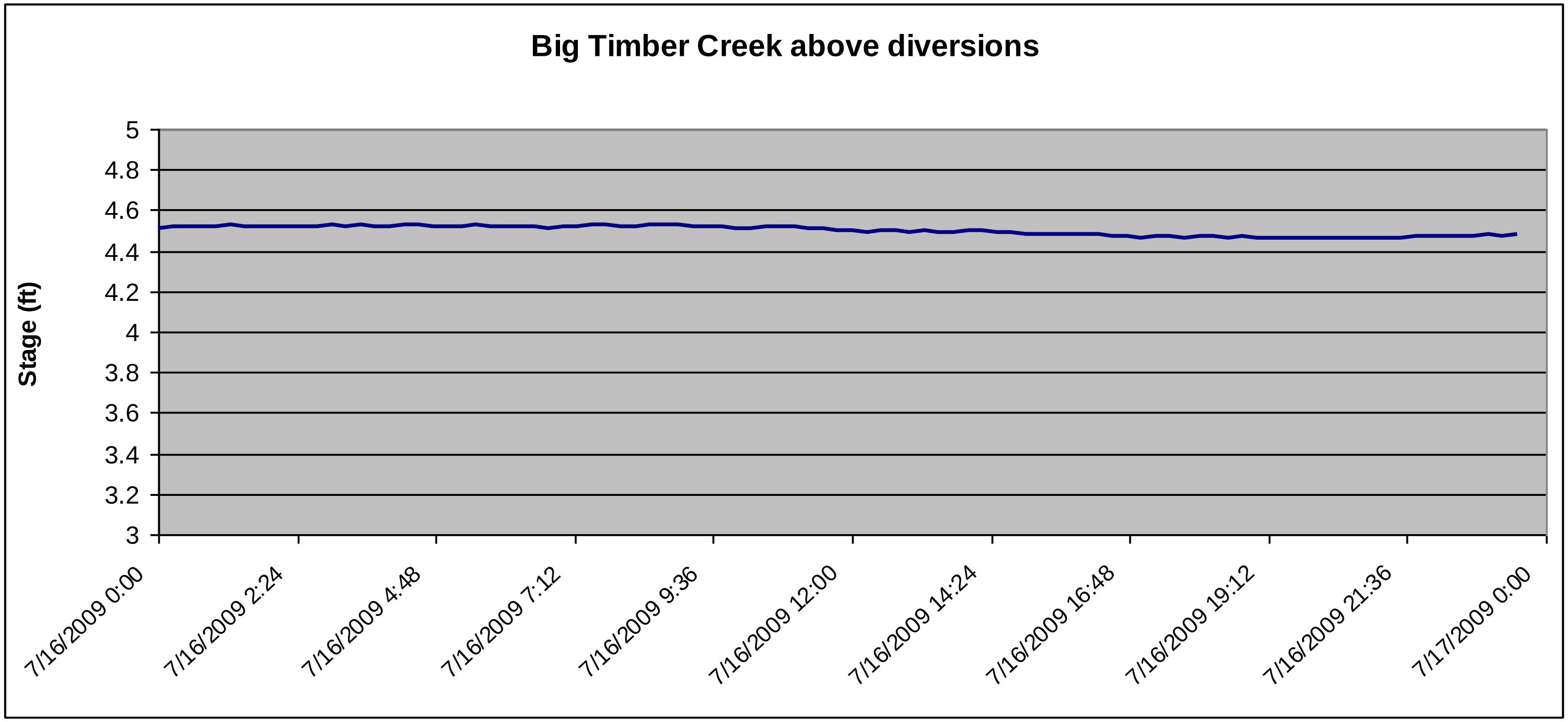


Figure B4. Hydrograph of the stage at the upper Big Timber Creek gage.

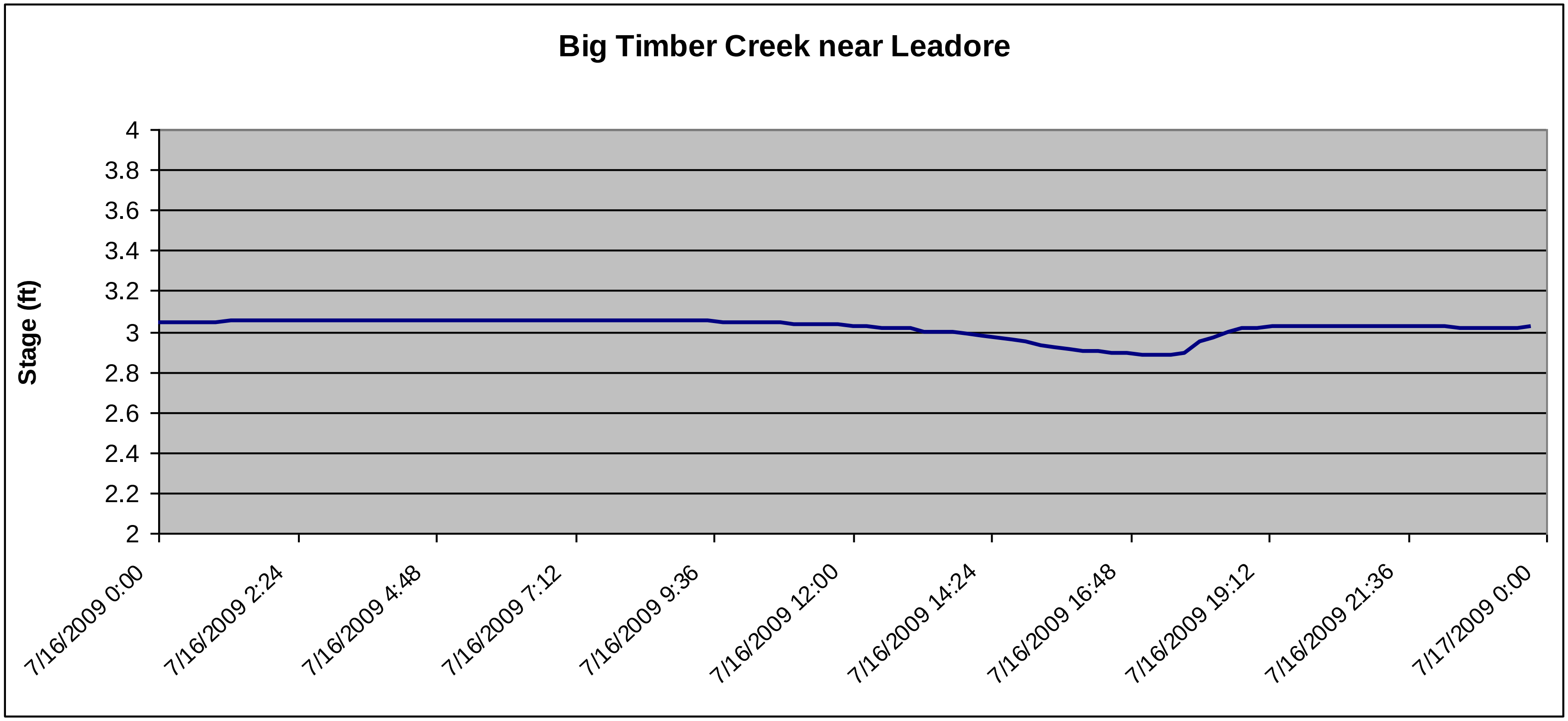


Figure B5. Hydrograph of the stage at the lower Big Timber Creek gage.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Big Timber Creek Q	Seepage	Point_X	Point_Y	Date and time	Notes	File name
Above all diversion to Little Timber Creek										
Above Whittaker's Diversion		65.50		65.50		2548092	1489938	7/16/2009 4:35pm	Flowtracker, due to cross-section the measurement was poor (e≈8%)	BTABV
	Whittaker Div	7.90	7.90			2547840	1490466	7/16/2009 3:15pm		WHIT
	Carey Act diversion	**27.70**	27.70			2547886	1490774	7/16/2009 3:20pm	Eight-foot Cipilletti weir.	
Big Timber Creek below Carey Act		30.60		30.60		2547797	1490592	7/16/2009 4:20pm	Flowtracker, fair measurement.	BTBC
	Kbird Upper	**5.40**	5.40			2547952	1491274	7/16/2009 3:35pm	Five-foot Cipilletti weir.	
	Kbird Lower	1.68	1.68			2548067	1491775	7/16/2009 3:50pm	Four-foot Cipilletti weir.	
Big Timber below Bird Diversions		**23.52**								
Big Timber above Ellsworth Diversion		**23.52**								
	Ellsworth Diversion	**2.80**	2.80			2548859	1493462	7/16/2009 2:00pm	Weir measurement.	
Little Timber Creek		0.00			-5.72	2548798	1493575	7/16/2009 1:10pm	Optical, channel was dry.	
Big Timber below Little Timber to Road										
Big Timber Creek below Little Timber Creek		14.30		14.30		2548799	1493575	7/16/2009 2:05pm	Flowtracker, good measurement.	BTBLT
	Upper Purcel Diversion	3.26	3.26			2548877	1493705	7/16/2009 1:30pm	Five-foot rectangular weir.	
Big Timber below Upper Purcel		**11.04**								
	BT5	0.00	0.00			2549279	1495511	7/16/2009 1:30pm	Observed dry, due to shifting channel	
	Tyler Diversion	0.00	0.00			2549311	1495602	7/16/2009 1:00pm	Dry at road.	
Big Timber Creek above Foster's diversion		7.97		7.97				7/16/2009 12:55pm	Fair measurement.	BTAF
	Foster Diversion (BT3)	2.30	2.30			2549483	1495730	7/16/2009 11:30am	Four-foot Cipilletti weir.	
Big Timber Creek below Fosters		**5.67**		5.67						
BT3	**Big Timber Lower Purcell Diversion**	0.10	0.10			2549489	1496231	7/16/2009 12:00pm	Estimated flow from observation.	
Big Timber below Lower Purcel Diversion		5.90				2549487	1496167	7/16/2009 12:15pm		
Big Timber above BT2		5.90		5.90						
	BT2	2.90	2.90			2549526	1497893		Flowtracker, poor measurement due to narrow ditch, weir underpredicted flow.	BT2
Big Timber below BT2		-3.00								
Big Timber gage, near road		0.40		0.40	-5.34				Trickle.	
Big Timber from road to mouth										
Big Timber Creek at highway		0.00								
	BT1	0.00				2549995	1498745	7/16/2009 11:00am	Optical, ditch was dry.	
Big Timber Creek	**Measured near the mouth.**	**4.00**		4.00	3.60	2549527	1499903	7/16/2009 10:25am	measurement location and the actual mouth there is an estimated gain of	BTMOUTH

Table B1. Summary of the 2009 seepage study for Big Timber Creek, including reach gains and losses calculated from the measured flows. Location coordinates are in the IDTM projection.

Big Timber Creek	cfs
Initial flow/input	**65.50**
Diverted rate out of Big Ti	**54.04**
Tributary/injection Input	**0.00**
Cumulative reach losses	**-11.06**
Cumulative reach gains	**3.60**
Calculated output	**4.00**
Measured output	**4.00**

Table B2. Summary of the 2009 Big Timber Creek seepage study.

Main stream location	Discharge	Seepage	Point_X	Point_Y	Date and time	Notes	File name
Big Timber Creek lower gage	3.7		2549868	1497765	8/27/2009 12:55pm	Good measurement (e<5%)	BTCG827
Big Timber Creek at the highway	1.7	-2.0	2549896	1498791	8/27/2009 11:50am	Poor Measurement (e≈10%)	BTB827
Big Timber Creek lower gage	4.8		2549868	1497765	9/1/2009 3:05pm	From gage rating (e<10%)	
Big Timber Creek at the highway	2.8		2549896	1498791	9/1/2009 1:05pm	Fair to poor (e>8%)	BTHB91
Big Timber Creek above lower blowout	1.9		2549907	1498910	9/1/2009 2:45pm	Good measurement (e<5%)	BTL2
Big Timber Creek below lower blowout	1.4	-3.4	2549898	1499001	9/1/2009 1:50pm	Fair measurement (e≈8%)	BTL

Table B3. Later season 2009 measurements of lower Big Timber Creek.

Lemhi River Seepage Study: Downstream of Big Springs Creek to McFarland Campground

July 13-14, 2009
Eric Rothwell

Introduction

The seepage studies in the Upper Salmon River Basin are conducted to gain an understanding of the surface water hydrology for a specific stream reach; specifically the data is needed to populate hydrology models and to guide decision making by resource management agencies and landowners. An understanding of the seasonal and spatial distribution of surface flows, reach gains and losses, reveals a greater understanding of the groundwater-surface water interactions.

IDWR staff measured flows in the Lemhi River, diversions, and tributaries on July 13-14, 2009 to calculate the surface-groundwater exchange that occurs at key reaches of the Lemhi River (figure B6). This is a continuation of a study done on the Upper Lemhi River in 2008, when a seepage run was conducted from the town of Leadore to the confluence with Big Springs Creek. This seepage run starts where Big Springs Creek flows into the Lemhi River down to McFarland Campground. This is an important river reach for agriculture and for salmon spawning and rearing.

Methods

This seepage study was conducted by measuring stream flow, diversions, surface returns from diversions and tributary inflows within a short period of time (one day). Seepage (gain or loss) for a reach was determined by deducting the inflows of tributaries and diversion returns and adding back in the outflows. The results are compared to measured flows at the bottom of the reach or sub-reach. If the calculated water at the bottom of the reach is greater than the measured, then there is a loss of flow to groundwater. If the summed values are less than the measured, then the stream is gaining flow from groundwater. Care was taken to ensure the study represented gains and losses by monitoring stream gages and by re-measuring the stream flow at the upstream measuring point at the end of the study. This ensured that the differences between measurements were related to ground and surface waters interaction not to daily surface water changes.

Results

During the seepage study several gages were monitored at the top of the study reach and at the bottom (Lemhi River above Big Springs Creek, Big Springs Creek mouth, Lemhi River at Cottom Lane, and Lemhi River at McFarland Campground). This allows us to assume our measurements are related to the surface-groundwater interactions (figures B7, B8, and B9).

The seepage run was conducted over two days with little flow changes measured at the stream gages. Each of the reaches was heavily gaining likely from a combination of natural reach gains and irrigation return flows (tables B4 and B5). Overall 90 cfs was diverted out of the Lemhi River downstream of the confluence with Big Springs Creek and upstream of McFarland Campground. This was offset by a cumulative reach gain for this reach of ~102 cfs and tributary inflows of 54 cfs, netting a flow of ~144 cfs at the McFarland Campground gage.

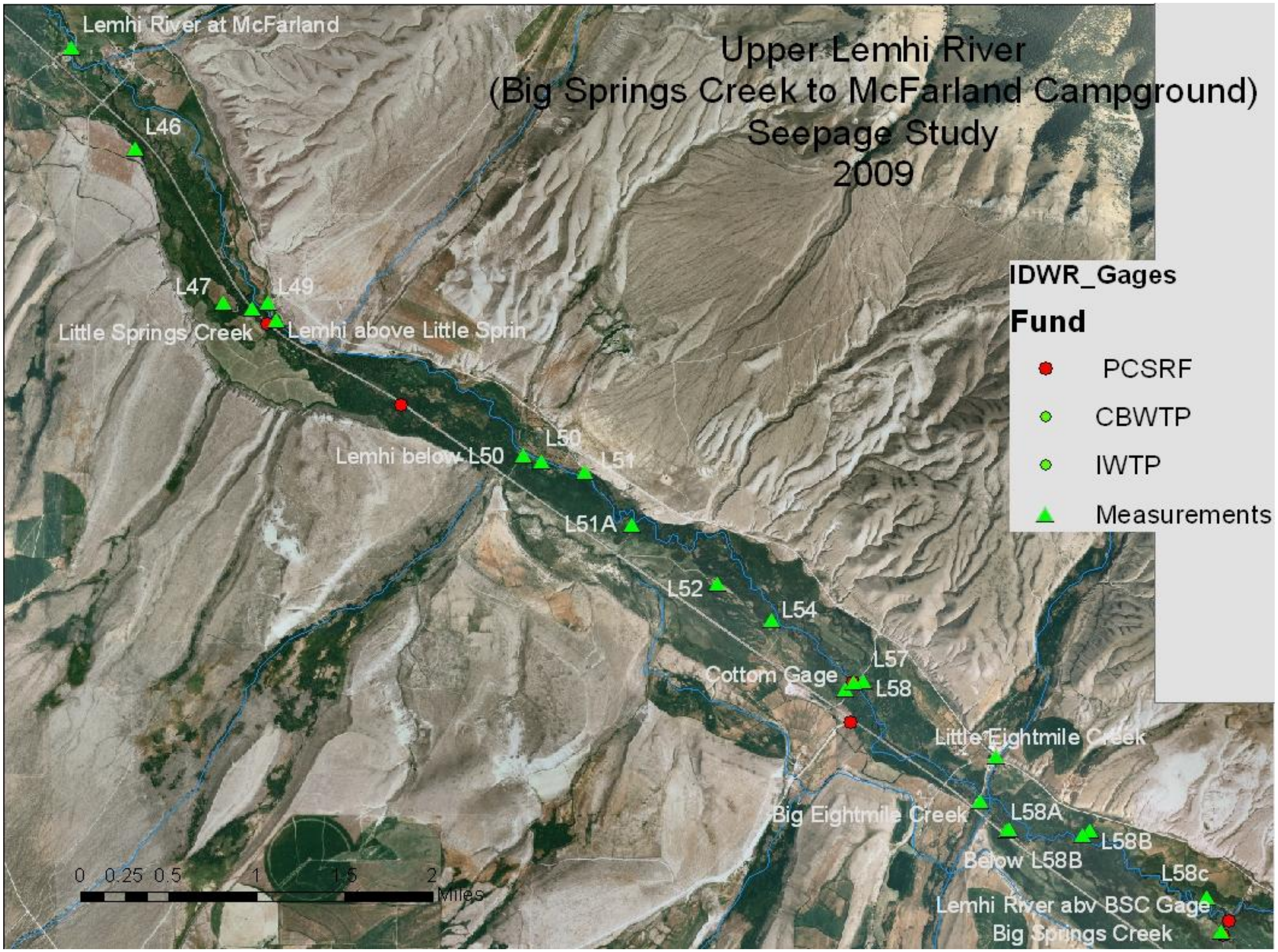


Figure B6. Map of Lemhi River with important surface water features labeled.

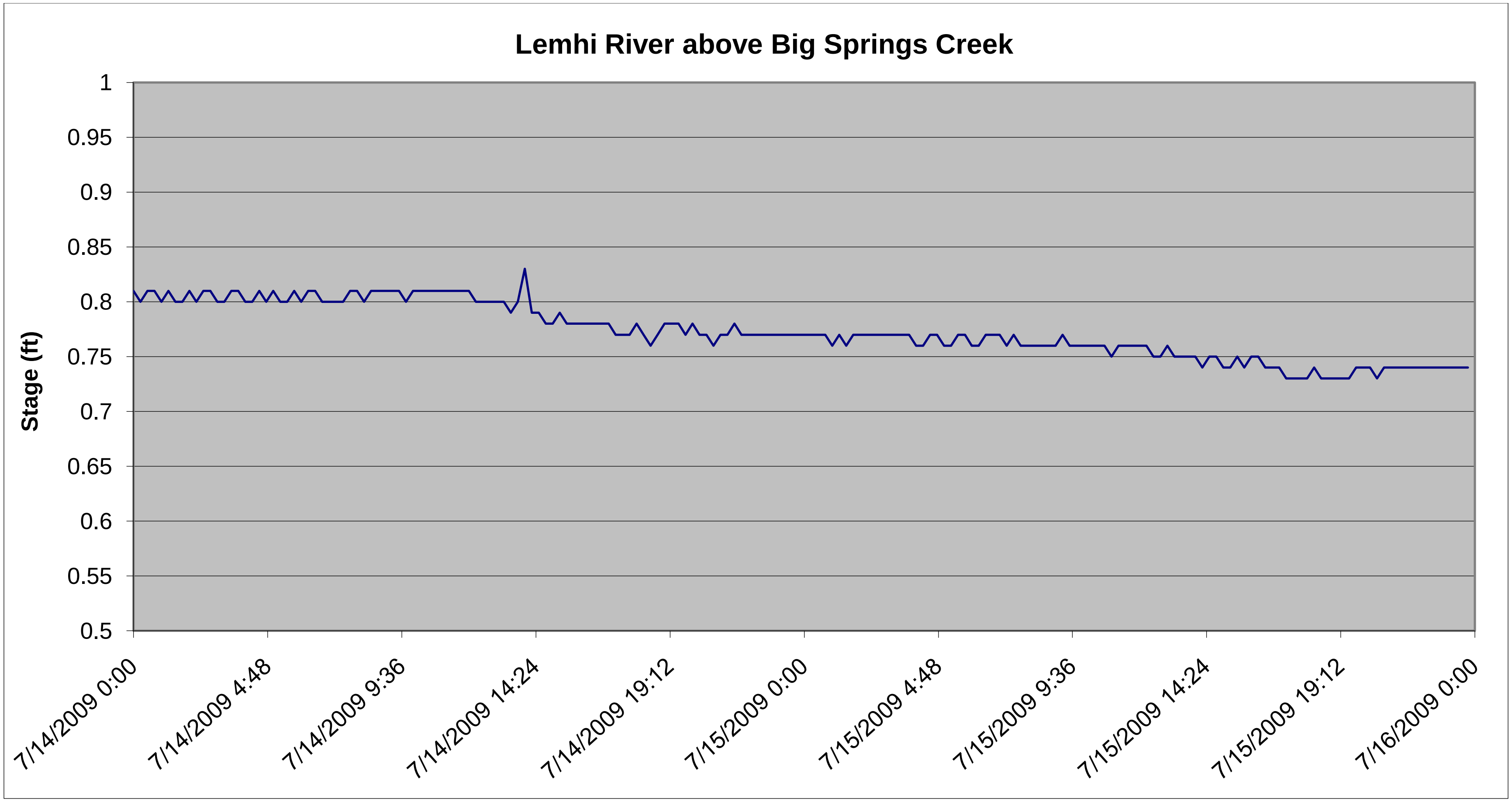


Figure B7. Hydrograph of the stage at Big Springs Lemhi River gage. The Lemhi River at this location dropped by 0.07 feet during the study.

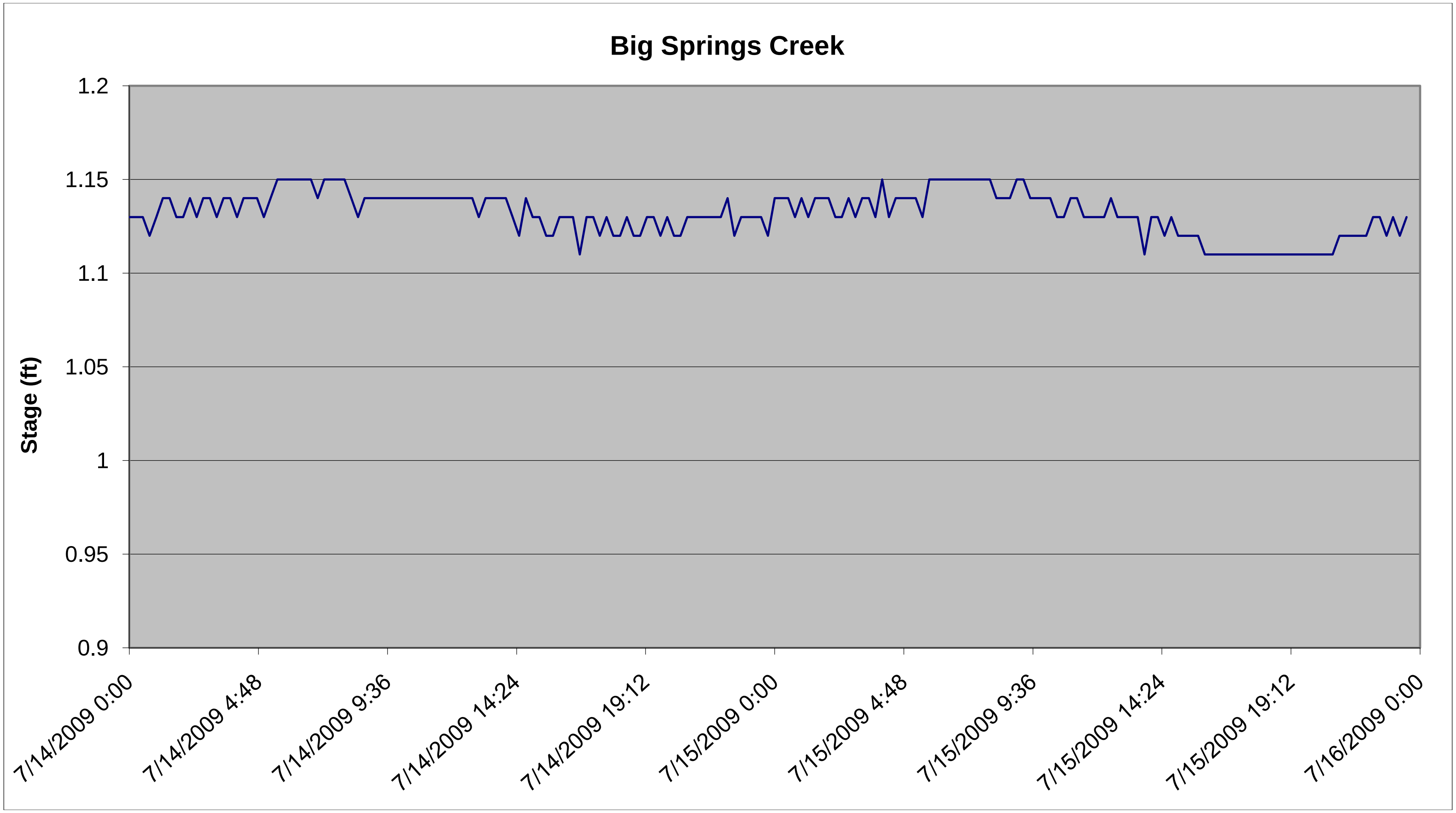


Figure B8. Hydrograph of the stage at the lower Big Springs Creek gage. Big Springs Creek at this location rose 0.01 feet during the study.

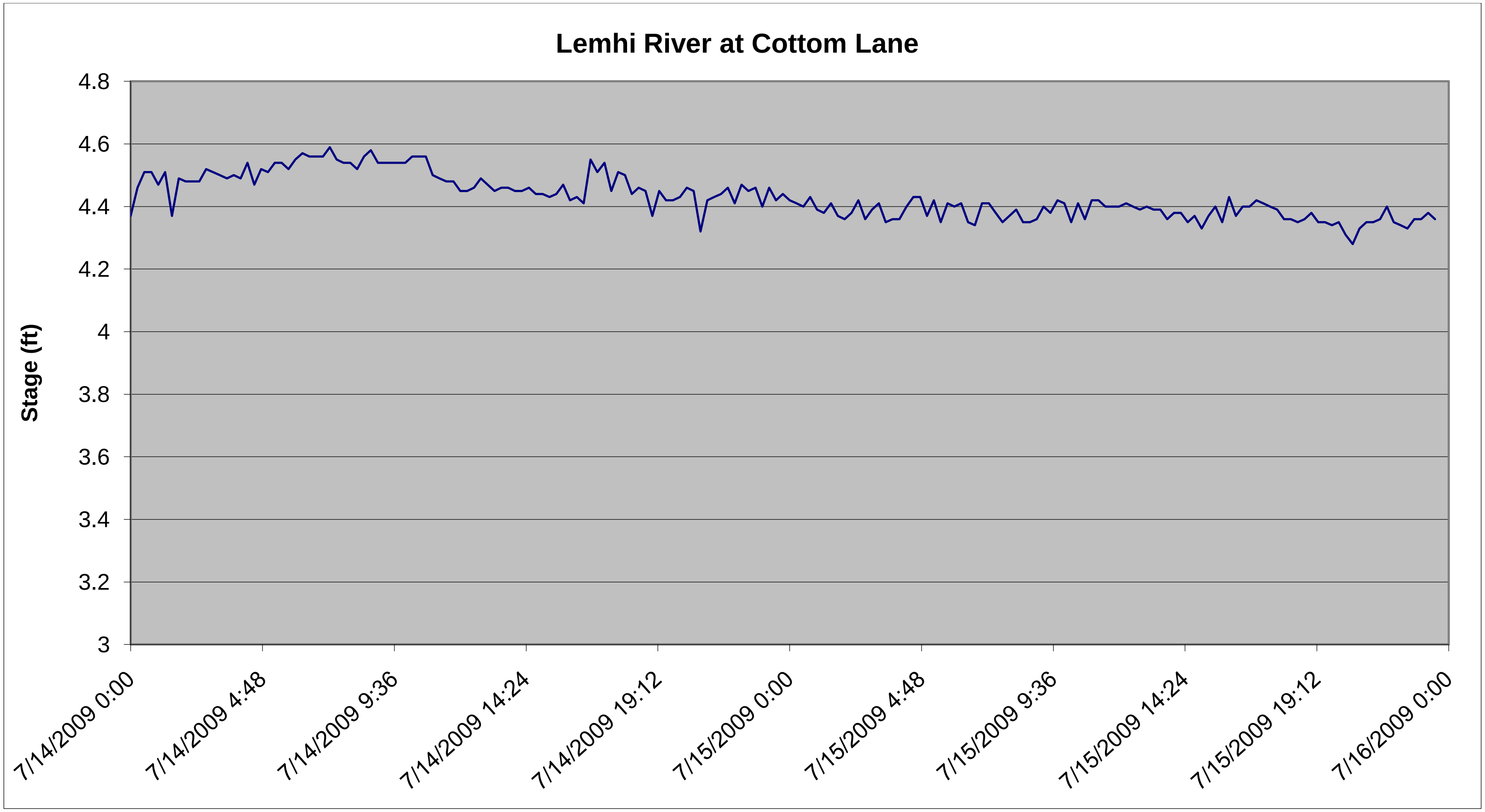


Figure B9. Hydrograph of the stage at the Cottom Lane Lemhi River gage. The Lemhi River at this location dropped 0.01 feet during the study.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Trib/diversion Q in	Lemhi River Q	Seepage	Point_X	Point_Y	X-Section Substrate	Date and time	Notes	File name
Confluence of BSC and Lemhi to Cottom												
Big Springs Creek		39.80		39.80			2544853	1503096		7/14/2009 7:44am	Near mouth at gage.	BSCG714
Lemhi River abv BSC Gage		77.50			77.50		2544720	1503418	gravel-cobble	7/14/2009 9:10am	Near bridge above Big Springs Creek.	LRABSC
Lemhi River below Big Springs Creek		**117.30**										
	L58c	2.10	2.10				2544720	1503418		7/14/2009 10:45am		L58C
Below L58c		**115.20**										
Above L58B		**115.20**										
	L58B	10.70	10.70				2543658	1504049		7/14/2009 10:00am	Custome weir.	
Below L58B		118.8			118.80		2543584	1504009	gravel	7/14/2009 11:15am		LBL58B
Above L58A		**118.80**										
	L58A	7.14	7.14				2542893	1504050		7/14/2009 1:38pm	Good measurement.	L58A
Below L58A		122.20			122.20		2542918	1504065	cobble-gravel	7/11/2009 1:20pm	Excellent measurement.	LBL58A
Big Eightmile Creek		10.00		10.00			2542647	1504323	gravel	7/14/2009 1:00pm	Fair measurement.	B8M
Little Eightmile Creek		4.50		4.50			2542796	1504740	gravel-cobble	7/14/2009 12:30pm	Flowtracker, fair measurement.	L8M
Lemhi blw Eightmile Creeks		**136.70**										
Lemhi above L58		**136.70**										
	L58	0.00	0.00				2541415	1505368		7/14/2009 1:40pm	Observed dry ditch	
	L57	0.00	0.00				2541580	1505446		7/14/2009 1:45pm	Observed dry ditch	
Cottom Gage		149.90			149.90	38.04	2541493	1505439		7/14/2009 2:15pm	Streampro measurement. Staff plate was knocked down by high flows	Cottom

Cottom Gage to Little Springs												
Lemhi above L54		**149.90**										
	L54	0.30	0.30				2540739	1506023		7/14/2009 1:40pm	Return flow is coming into the ditch. Custom weir.	
Below L54		**149.60**										
Above L52		**149.60**										
	L52	3.70	3.70				2540245	1506369		7/14/2009 4:00pm	Custom weir.	
Lemhi below L52A		**145.90**										
Lemhi above L51A		**145.90**										
	L51A	0.50	0.50				2539464	1506923		7/14/2009 4:20pm	Some flow is going under weir, not enough flow to run screen	
Lemhi below L51A		**145.40**										
Lemhi above L51		**145.40**										
	L51	2.50	2.50				2539032	1507419		7/15/2009 9:00am	Adjustable ramp flume.	
Lemhi below L51		**142.90**										
Lemhi above L50		**142.90**										
	L50	0.00	0.00				2538633	1507519				
Lemhi below L50		144.00			144.00		2538465	1507574		7/14/2009 4:50pm	Good measurement, just upsteam of ranch bridge.	LBL50
Lemhi above L49		**144.00**										
	L49	23.80	23.80				2536123	1509001		7/15/2009 9:35am	Measured below fish screen.	L49
	L47	15.20	15.20				2535716	1509001	gravel	7/15/2009 10:45am	Measured below fish screen. Excellent measurement.	L47
Lemhi above Little Springs Creek		131.60			131.60		2536207	1508840	gravel-cobble	7/15/2009 9:35am	Good measurement, above Little Springs Creek.	LALSC
Little Springs Creek		0.10		0.10		27.70				7/15/2009 10:30am	Visual estimate of flow, too small to measure.	
Little Springs Creek to McFarland CG												
Lemhi below Little Springs		**131.70**										
	L46	24.10	24.10				2534915	1510452		7/15/2009 1:30pm	Custom weir.	
Lemhi River at McFarland CG		143.70				36.10				7/15/2009 11:31am		MCF715

Table B4. Summary of the 2009 seepage study for the upper Lemhi River (continued from above), including reach gains and losses calculated from the measured flows.

Lemhi River Summary	**cfs**
Initial flow/input	**77.50**
Diverted rate out of the Lemhi River	**90.04**
Tributary/injection Input	**54.40**
Cumulative reach losses	**0.00**
Cumulative reach gains	**101.84**
Calculated output	**143.70**
Measured output	**143.70**

Table B5. Summary of the 2009 Upper Lemhi River seepage study.

Acknowledgements

Thanks to Rick Sager, Water Master for Water District 74; Stuart VanGreuningen, IDWR; and the local water users and land owners for access to measurement locations on the Lemhi River.

Lower Jake's Canyon

September 1, 2009 several measurements were taken of Jake's Canyon Creek flow, including measurements above and below a bubbler diversion. This information was requested by Jeff Lutch, IDFG to inquire about the potential for reconnecting Jake's Canyon Creek to the Lemhi River and to provide juvenile habitat and refugia.

During the September 1st measurements, the bubbler diversion, located at the canyon mouth, was taking 4.7 cfs of 5.4 cfs available in stream. The stream reach directly upstream of this bubbler diversion was fed by a complex of springs. As Jake's Canyon Creek flows over an alluvial fan used as pasture it loses an additional 0.4 cfs of flow before flowing under the Lemhi back road. It appears that the creek gains flow from this point down to the Lemhi River but no suitable location was found to measure.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Jake's Canyon Q	Seepage	Point_X	Point_Y	Date and time	Notes	File name
Jake's Canyon Above all diversions		5.40		5.40		2550296	1501818	9/1/2009 3:50PM	Accompanied by Jeff Lutch, IDFG. Upstream of measuremnt channel gains flow from springs.	JAKE
	Bubbler Diversion	**4.74**	4.74							
Below Bubbler Diversion		0.66		0.66				9/1/2009 4:30PM	Measurement is 60ft downtream of bubbler.	JAKEBB
Jake's Canyon at Lemhi Back Road		0.25		0.25	-0.41	2549616	1500272	9/1/2009 5:05PM	Stream appears to gain some flow downstream of this point before reaching the Lemhi River.	JAKERD

Table B6. Summary of the 2009 seepage study for lower Jake's Canyon Creek, including reach gains and losses calculated from the measured flows.

Lower Lee Creek

August 27, 2009 several measurements were taken of Lower Lee Creek. These measurements were taken on the Cottom Ranch to investigate the potential for reconnecting Lee Creek to the Lemhi River and providing fish habitat in Lee Creek. The flow measurements above the Lee Creek- Cottom Ranch bubbler diversion summed to 3.4 cfs of in stream flow, the bubbler diversion diverted 2.5 cfs. Lee Creek gained an additional 2.4 cfs before being intercepted by two cross-ditches.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Lee Creek Q	Seepage	Point_X	Point_Y	Date and time	Notes	File name
Lee Creek above Cottom Bubbler diversion - East Channel		2.4				2540794	1503886	8/27/2009 2:50PM	Fair measurement.	LCCB827
Lee Creek above Cottom Bubbler diversion - West Channel		1							Estimate of 1 to 1.2cfs.	
Total above bubbler		**3.4**		3.4						
	Cottom Bubbler Diversion	**2.5**	2.5							
Lee Creek directly below bubbler		0.9		0.9		2540794	1503886	8/27/2009 3:20PM	Poor measurement due to cross-section.	LCBB
Lee Creek below by Lee Creek Road		3.3		3.3	2.4	2540921	1504484	8/27/2009 1:55PM	Upstream of cross ditches.	LEE_COT

Table B7. Summary of the 2009 seepage study for lower Lee Creek, including reach gains and losses calculated from the measured flows.

Valley Creek

This study was conducted by the USFS Region 4 office in Boise (Bob Kenworthy and Tim Page). Eric Rothwell and Nick Miller assisted the USFS in the Valley Creek drainage seepage measurements (table B8). USFS will analyze the data and use it in the Upper Salmon River MBM. The following tables summarize the USFS lead seepage studies in the Valley Creek drainage during the summer and fall of 2009. The USFS also conducted seepage runs in: the Upper Salmon River above Alturas Lake Creek, Champion Creek, Goat Creek, and Iron Creek during the 2009 irrigation season.

Site_Name	Lat	Long	July Date	July Q cfs	Aug Date	Aug Q cfs	Oct Date	Oct Q cfs
VALLEY CREEK and tribs								
Valley Creek Above VC5/6	44.3103300	-115.0560500	7/21/09	25.673	8/25/09	17.552	10/21/09	15.331
VC5/6	44.3089000	-115.0513000	7/21/09	9.320	8/25/09	7.220	10/21/09	off
Meadow Trap Creek below gage	44.3059200	-115.0531300	7/21/09	13.880	8/25/09	6.937	10/21/09	8.406
Valley Creek Above Elk Creek	44.2930000	-115.0245000	7/21/09	37.049	8/25/09	23.460	10/21/09	26.945
Elk Creek abv EC2	44.2887900	-115.0627300	7/21/09	36.601	8/25/09	17.630		
EC2	44.2890200	-115.0614356	7/21/09	off	8/25/09	off	10/21/09	Diversion removed
EC1	44.2900000	-115.0200000	7/21/09	5.500	8/25/09	4.600	10/21/09	off
Elk Creek at Gage	44.2915200	-115.0276200	7/21/09	31.185	8/25/09	14.988	10/21/09	18.902
Elk Creek above Mouth	44.2925300	-115.0250300	7/21/09	31.049	8/25/09	15.376	10/21/09	20.555
Valley Creek Side Channel above VC4	44.2915000	-115.0194700	7/21/09	56.636	8/25/09	31.832	10/21/09	11.603
Valley Creek Side Channel above 1st split	44.2920800	-115.0193700	7/21/09	16.417	8/25/09	9.467	10/21/09	38.246
McGown within Exclosure above diversion	44.3053800	-115.0269000	7/21/09	0.873	8/25/09	0.965	10/21/09	1.217
McGown Above Pond, Above Pond Diversion	44.2975200	-115.0203200	7/21/09	0.834	8/25/09	0.760	10/21/09	1.115
Thompson Creek at Private FS property interface	44.3021200	-115.0207200	7/22/09	dry				
VC4	44.2913000	-115.0178100	7/21/09	1.500	8/25/09	1.100	10/21/09	off
Valley Creek Above VC3	44.2899800	-115.0155600	7/21/09	77.392	8/25/09	42.591	10/21/09	53.825
VC3	44.2880000	-115.0120000	7/21/09	5.000	8/25/09	2.200	10/21/09	off
Tennel Creek above diversion	44.2911700	-115.0007200	7/21/09	0.548	8/25/09	0.402	10/21/09	0.493
Valley Creek abv VC1, abv Sportsman access bridge	44.2797800	-115.0107000	7/21/09	66.868	8/25/09	43.994	10/21/09	48.102
Return flow (EC1?) above VC1	44.2797078	-114.0109906	7/21/09	0.400	8/25/09	1.932	10/21/09	no data
Valley Creek side channel	44.2780200	-115.0098800	7/21/09	12.200	8/25/09	0.000	10/21/09	no data
VC1	44.2700000	-115.0030000	7/21/09	4.500	8/25/09	4.450	10/21/09	dry
Park Creek abovr PKC1/PKC	44.2782200	-115.0179000	7/21/09	1.500	8/25/09	1.500	10/21/09	1.520
PKC1/PKC	44.2782500	-115.0176900	7/21/09	1.500	8/25/09	1.500	10/21/09	0.900
Park Creek return flow 50 ft. US of valley side channel	44.2743300	-115.0107000	7/21/09	0.812	8/25/09	0.051	10/21/09	0.808
Park Creek above Valley Creek est. Q	44.2729500	-115.0105400	7/21/09	0.005	8/25/09	0.019	10/21/09	0.706
Valley Creek at gage	44.2925300	-115.0244000	7/21/09	69.470	8/25/09	38.800	10/21/09	52.410
Valley Creek above Stanley Ck	44.2562654	-115.0056243	7/21/09	67.200	8/25/09	42.000	10/21/09	53.600
NF Stanley Creek	44.2593809	-114.9975739	7/21/09	1.400	8/25/09	1.500	10/21/09	1.900
Stanley Creek	44.2582624	-115.0004494	7/21/09	3.700	8/25/09	4.600	10/21/09	3.200
Valley Creek above Stanley Lake Ck	44.2536679	-115.0050690	7/21/09	67.500	8/25/09	50.800	10/21/09	56.000
Stanley Lake Cr. Abv diversions	44.2585800	-115.0271667	7/21/09	33.409	8/25/09	12.311	10/21/09	16.753
SLC1	44.2589400	-115.0256500	7/21/09	2.470	8/25/09	2.470	10/21/09	no data
Stanley Lake Creek blw diversion - mouth	44.2540300	-115.0108944	7/21/09	35.841	8/25/09	13.067	10/21/09	16.224
Job Creek	44.2342500	-115.0041111	7/21/09	1.865	8/25/09	2.185	10/21/09	1.026
Crooked Creek	44.2365000	-114.9973889	7/21/09	11.930	8/25/09	3.407	10/21/09	4.987
Valley Creek @ Corrals	44.2326773	-114.9860140	7/21/09	124.900	8/25/09	76.600	10/21/09	84.000

Table B8. Summary of the 2009 seepage study for Valley Creek, including reach gains and losses calculated from the measured flows.

Attachment C. Model Scenarios

Upper Lemhi River Basin – Tyler Ranch Scenario

Introduction

The Nature Conservancy has been negotiating a land easement with the Tyler family ranches in the Upper Lemhi River Basin. The negotiations include changes to the irrigation system to increase stream flows in the Lemhi River; we have been working with a technical group including state (IDWR and IDFG) and Federal (BLM) biologists to analyze potential flow enhancement projects. Stream flow, irrigation, and seepage data have been used with the Upper Lemhi MIKE Basin Model to analyze the flow changes associated with the proposed projects. A net flow increase through a key reach of the Lemhi River that is used by Chinook salmon for spawning and rearing was the objective. There were also concerns from local water users and Water District 74 that changing the irrigation practices of the Upper Lemhi River could affect base flow or spring channels that are influenced by return flows.

Methods

The process of analysis was iterative. The technical group would discuss potential flow enhancement projects that could positively influence key stream habitat; from these discussions I would put the scenario into the calibrated upper Lemhi River MBMl and model the potential changes to in stream flow. These draft results would then be presented to the technical group. When a stream flow enhancement scenario was found that would be beneficial to fish, would not critical reduce the function of the ranch, and would not affect other water users the results were presented to the water master of Water District 74 and an advisor to the land owner.

MIKE Basin Model

In general terms, MIKE Basin is a mathematical representation of the river basin, including the configuration of the main rivers and their tributaries, the hydrology of the basin in space and time, and existing as well as potential major water use schemes and their various demands for water. MIKE Basin is a network model in which the rivers and their main tributaries are represented by a network of branches and nodes. The river system is represented in the model by a digitized river network that can be generated directly on the computer screen in ArcMap 9.3 (a GIS software package Basic model inputs are time series data for catchment run-off, diversion, and allocation of water for the off-river nodes. Diversion nodes require either a time series of water allocation to each branch or an equation partitioning flow to each branch based on incoming flows to the diversion node. Irrigation nodes require time series data for demand, fraction of the demand satisfied by ground water, fraction of the demand returning to the river branch, and lag time for the return fraction to re-enter the stream. Once the water usage has been defined, the model simulates the performance of the overall system by applying a water mass balance method at every node. The simulation takes into account the water allocation to multiple usages from individual extraction points throughout the system.

MIKE Basin is not a physically based model and does not model the interaction between surface water and groundwater. Interaction between the surface water and groundwater can be inferred from surface water measurements applied in the model but these results should be used with scrutiny.

Results

Increase to Lemhi River from L63 down to Cottom Lane, slight decrease in Big Springs Creek, although this is likely exaggerated due to the assumption that return flows from land irrigated by L63 go to Big Springs Creek, when in all likelihood they are at least partially intercepted by irrigation ditches and reapplied.

Conclusion

As this report is being written there is no easement in place but the data and analysis provided by IDWR has been a valuable resource for both sides of the negotiation.

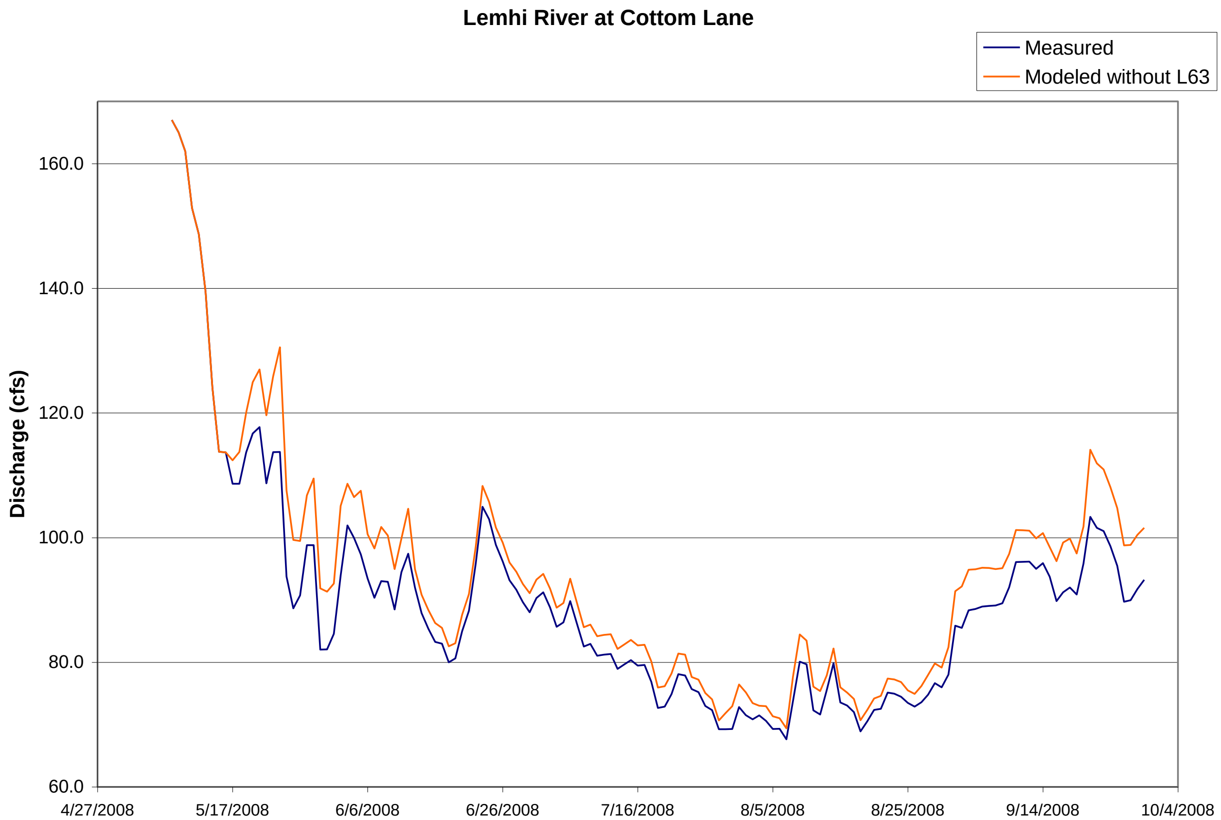


Figure C1. Example of modeling results during the technical meetings to discuss potential easement action for stream flow enhancement. In this example elimination of a diversion was discussed.

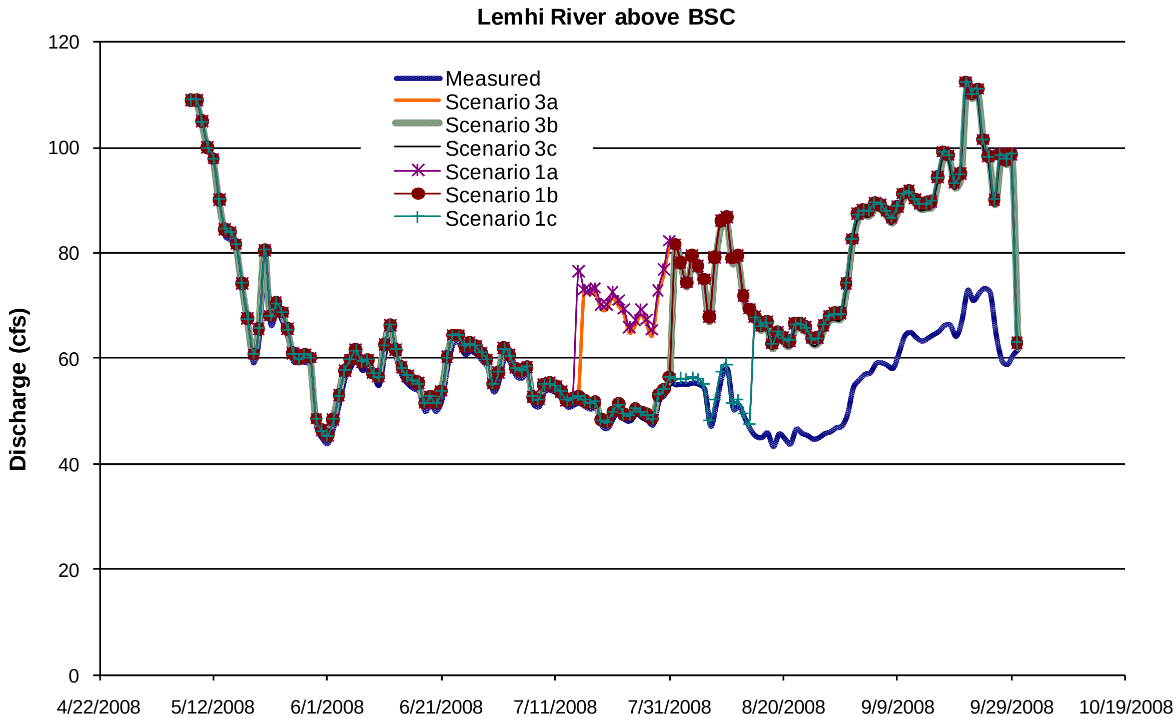


Figure C2. An example of multiple model scenario results used for discussion and optimizing potential stream flow enhancement projects. In this example a partial season irrigation lease was being discussed.

Upper Lemhi River Basin – Cottom Ranch Scenario

The Cottom Ranch was bought by The Nature Conservancy and sold with conservation measures to the Beyeler family. As part of the OSFE phase III, IDWR analyzed the conservation measures to quantify the associated flow benefits. The results from this exercise are draft as the project description has not been completed. We also provide flow data for a baseline understanding of the water resources on the ranch and what measures were feasible for flow improvement.

Upper Lemhi River Basin – Lower Little Springs Creek Scenario

<u>Introduction</u>
The Lemhi River basin is a focus area for state, federal, local, and non-governmental agencies working with land owners and water users on restoring stream habitat and reconnecting tributaries to aid the recovery of listed fish species. A major stream that has been the focus of state agencies (IDFG and IDWR) and the Upper Salmon Basin Watershed Program (USBWP) is Little Springs Creek. Little Springs Creek is located in the upper Lemhi River basin, upstream of the town of Lemhi by ~7 miles. Little Springs Creek, as its name implies, is a spring channel that has relatively steady flow. It is heavily influence by agricultural uses; diverted flows dewater the stream and return flows increase the base flow of the stream.

The current proposal has several forms and iterations; we took a version of the proposal that would assist the project negotiations. The proposal is to consolidate the lower four diversions on Little Springs Creek into one pump location. The land that was irrigated by the four lower diversions by flood would now be irrigated by a half-pivot and a wheel-line, using less water due to conservation. This project then would have two obvious in stream benefits – less diversion points and increased flow. Some local water users, Water District 74, and the water user representatives on the Upper Salmon Basin Watershed Advisory Committee are concerned about ongoing water conservation measures (conversions of flood irrigation to sprinkler irrigation) that may impact base flow.

This report describes the use of data collected by IDWR staff in a surface hydrologic model to analyze the effects on in-stream flow this proposal would have. Does this project: reconnect Little Springs Creek to the Lemhi River; increase flows in the Lemhi River; affect other waters users? I presented the data collected and the modeling results to the Upper Salmon Basin Watershed Program Advisory Committee in October 2009.

<u>Methods</u>
IDWR has two stream gages in Little Springs Creek. The upper gage on Little Springs Creek is located upstream of LSC-4 diversion and downstream of the highway culvert and Mill Creek. The lower Little Springs Creek gage is located below all diversions near the confluence with the Lemhi River. By having these two gages we have a measure of the flow coming into the study reach and below the study reach. In addition to the two

Little Springs Creek gages there is a gage owned by Water District 74 (that IDWR helps maintain) that is used in this modeling scenario to describe the downstream effects from this project.

Little Springs Creek is part of Water District 74 but the Water District does not actively measure diversion rates in this stream. There are some complications upstream of the study reach to understanding the natural flow and irrigation influence, specifically a pond and a diversion from the Lemhi River that uses upper Little Springs Creek as a conveyance for several hundred meters. Often times the L52 diversion puts less water into Little Springs Creek than is extracted (see seepage reports).

Seepage runs have been conducted on this stream reach in 2008 and additional measurements were taken in 2009 by IDWR. This data showed that lower Little Springs Creek gains flow from irrigation return and natural gains. The measurements taken during these seepage runs with the gage data also assisted in estimating the diversion rates for the lower four diversions. It should be clear that the diversion rates used in the hydrologic model are not from the water district but are simple calculations taking into account the seepage runs and the upper and lower stream gages on Little Springs Creek.

The MIKE Basin model (MBM, provided by the DHI) was populated and calibrated by IDWR staff. This model is currently calibrated only for the 2008 irrigation season as this is the year with the most complete data. The Upper Lemhi River Basin MBM will be calibrated using 2009 data when it is available during the winter of 09/10. Population of the model includes: in flows for each tributary above diversions (from gage data or rainfall-runoff modeling); diversion data; calculated return flow data (using mass balance and calculated evapotranspiration for each place of use). The calibration process adjusts return times from diversion points of use and incorporates reach gains or losses that were measured during seepage studies throughout the basin to fit the measured flow at each of the gages in the basin.

After calibration the diversion rates, acres, and application rate were altered in the model to represent the project scenario proposed. The model is then run with the altered diversion and use rates and the resulting in-stream flows can be compared to the measured flows.

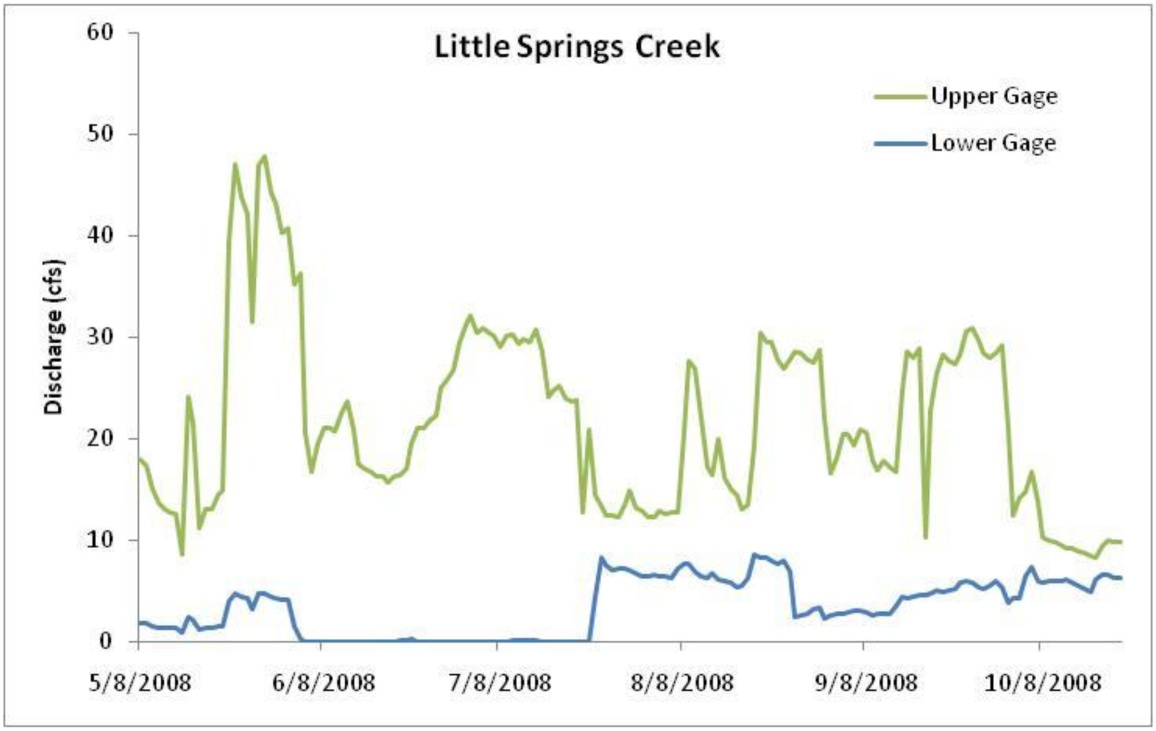


Figure C3. Comparison of the upper and lower Little Springs Creek stream gage shows the amount of dewatering associated with irrigation diversions in the lower stream reach.

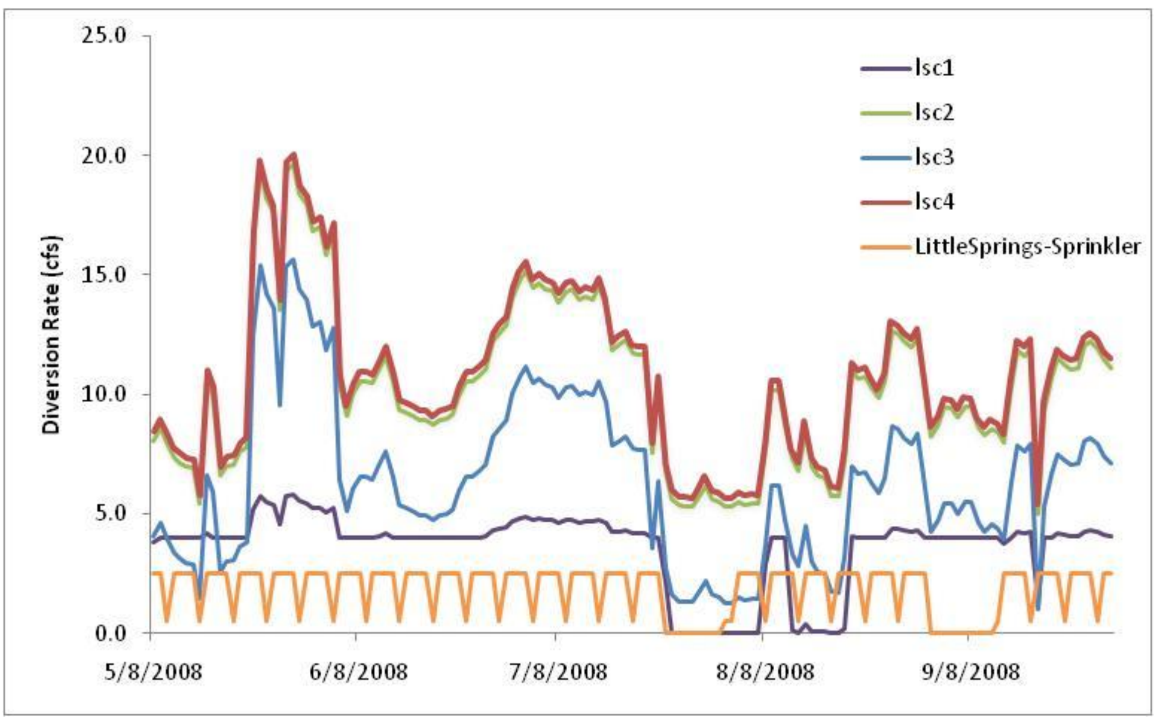


Figure C4. The calculated diversion rates from the difference between the upper and lower gages, point diversion measurements, and seepage data. Little Springs-Sprinkler is the Little Springs Scenario described in this report.

Results

By changing the diversion rates, application (flood to sprinkler), and eliminating the diversions that are no longer in use in the model the model predicts large gains in flow in lower Little Springs Creek, hydraulically reconnecting the surface flow with the Lemhi River.

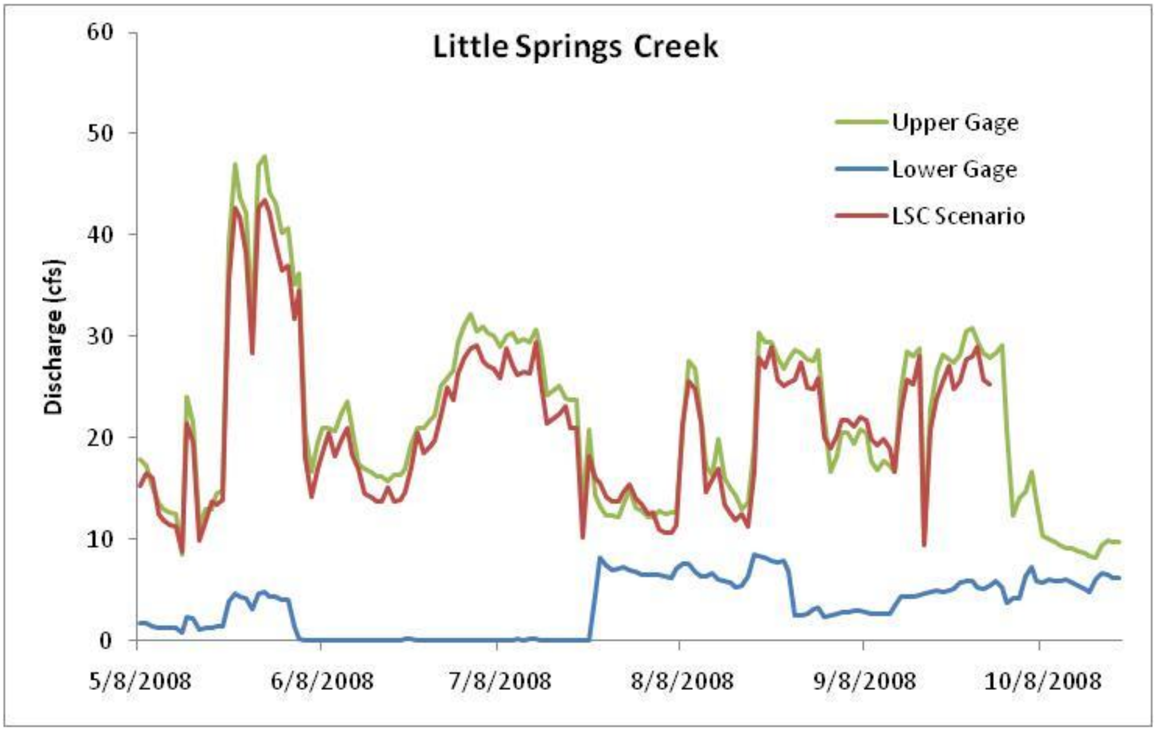


Figure C5. Comparison of the upper and lower Little Springs Creek gages to the model scenario results. The line depicted as LSC Scenario represents the model results at the lower gage location for the Little Springs scenario described in this report and shown in figure C4 as LittleSprings-Sprinkler.

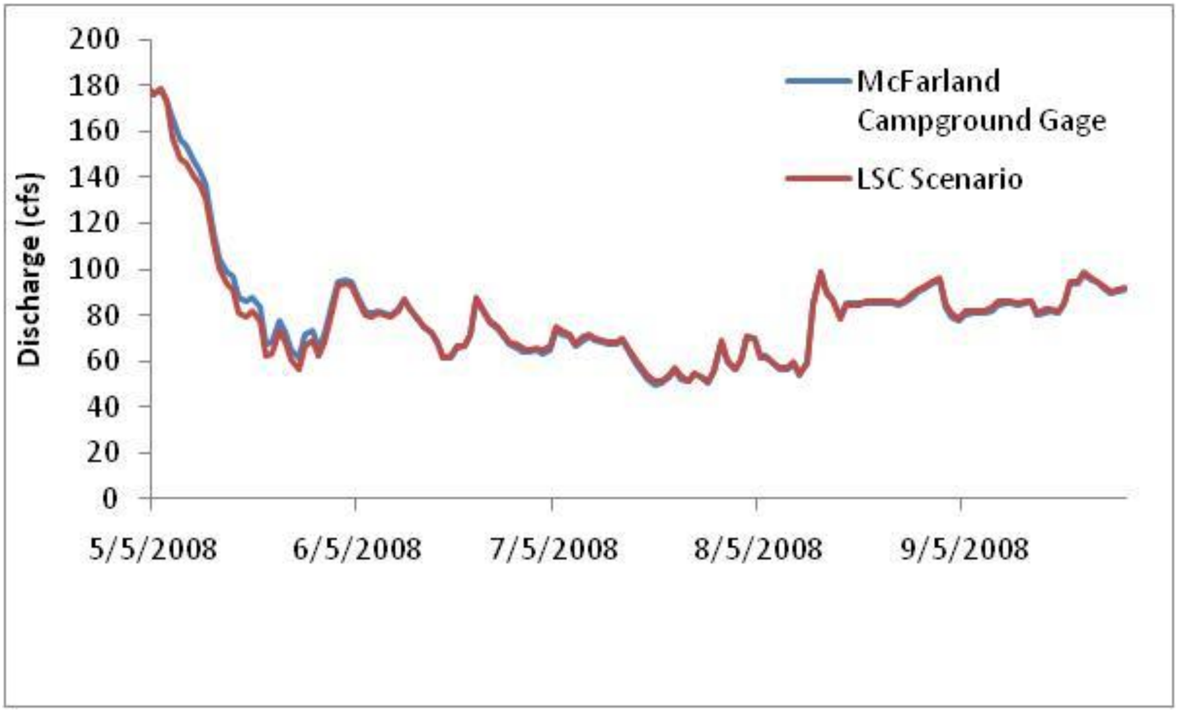


Figure C6. Comparison of the Lemhi River flow measured at McFarland Campground. The model results indicate the scenario will not significantly (less than 10%) impact stream flow at this location.

<u>Discussion</u>

Assumed that return flows from LSC 1 – 4 is to the Little Springs Creek or the Lemhi River, when actually they are probably picked up by L47 ditch. So the Lemhi River below the Little Springs Creek confluence will gain flows from this scenario, this is not represented in figure C6 because the in the model the loss of return flow from LSC 1-4 is roughly equal to the gains in flow for Little Springs Creek.

Idaho Water Transaction Program
2009 Monitoring and Evaluation Report

Introduction

During 2009, the Idaho Water Resource Board (IWRB) monitored the following 21 water transactions in the Upper Salmon River Basin:

- Alturas Lake Creek non-pivot (2007 – 2011)
- Beaver Creek and Salmon River above Alturas Lake Creek (2005-2014)
- Big Hat Creek (2009)
- Lower Eighteenmile Creek – Ellsworth (2006-2015)
- Fourth of July Creek (2009-2028)
- Iron Creek 2007 – Phase II (2007-2026)
- Lower Lemhi (2009)
- Lower Lemhi Permanent – Bird
- Lower Lemhi Permanent – Cheney
- Lower Lemhi Permanent – Demick
- Lower Lemhi Permanent – Fisher
- Lower Lemhi Permanent – Bob Thomas
- Lower Lemhi Permanent – Kim Thomas
- Lower Lemhi Permanent - Wolters
- Morgan Creek (2009-2013)
- Pahsimeroi P-9 Bowles (2008-2027)
- Pahsimeroi P-9 Charlton (2008-2027)
- Pahsimeroi P-9 Dowton (2008-2027)
- Pahsimeroi P-9 Elzinga (2008-2027)
- Pole Creek (2006-2010)
- Whitefish Ditch (2008-2026)

These projects increased flows and provided valuable fish habitat and passage on more than 186 river miles in the Upper Salmon River Basin.

Alturas Lake Creek – Stanley Basin

IDWR negotiated a transaction with Katie Breckenridge in 2007. The Alturas Lake Creek non-pivot 2007 project is a five-year lease which leaves 2.66 cfs, formerly irrigating 45 acres, in the creek. The water is leased from May 1st through October 31st. The leased water restores the natural flow to Alturas Lake Creek, improving fish habitat.

A site visit to Alturas Lake Creek 8/4/2009 confirmed that the landowner was complying with the terms of the lease. Landsat images also show that the leased water was not being used to irrigate land (Appendix A). A gage in Alturas Lake Creek monitored flow in the river during the irrigation season (Figures 1 and 2).

Idaho Department of Fish and Game (IDFG) conducted Chinook salmon redd surveys in 2009 and found the following:

- 19 redds in the Salmon River within 2.4 miles of the mouth of Alturas Lake Creek
- 4 redds in Alturas Lake Creek below the original point of diversion

There has been no PHABSIM modeling of Alturas Lake Creek.

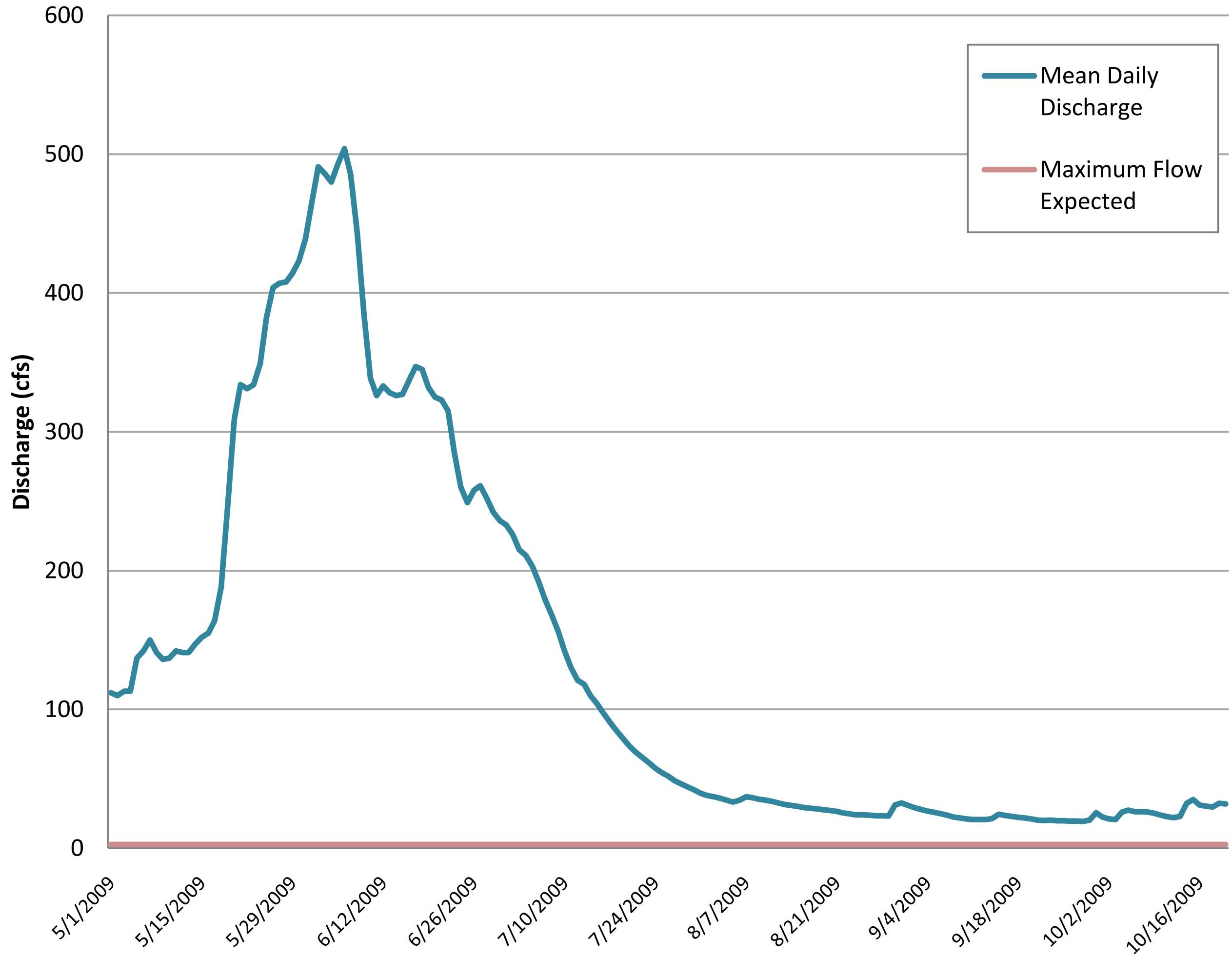


Figure 1. Alturas Lake Creek mean daily flow at Pettit Lane, May 1 to October 22.

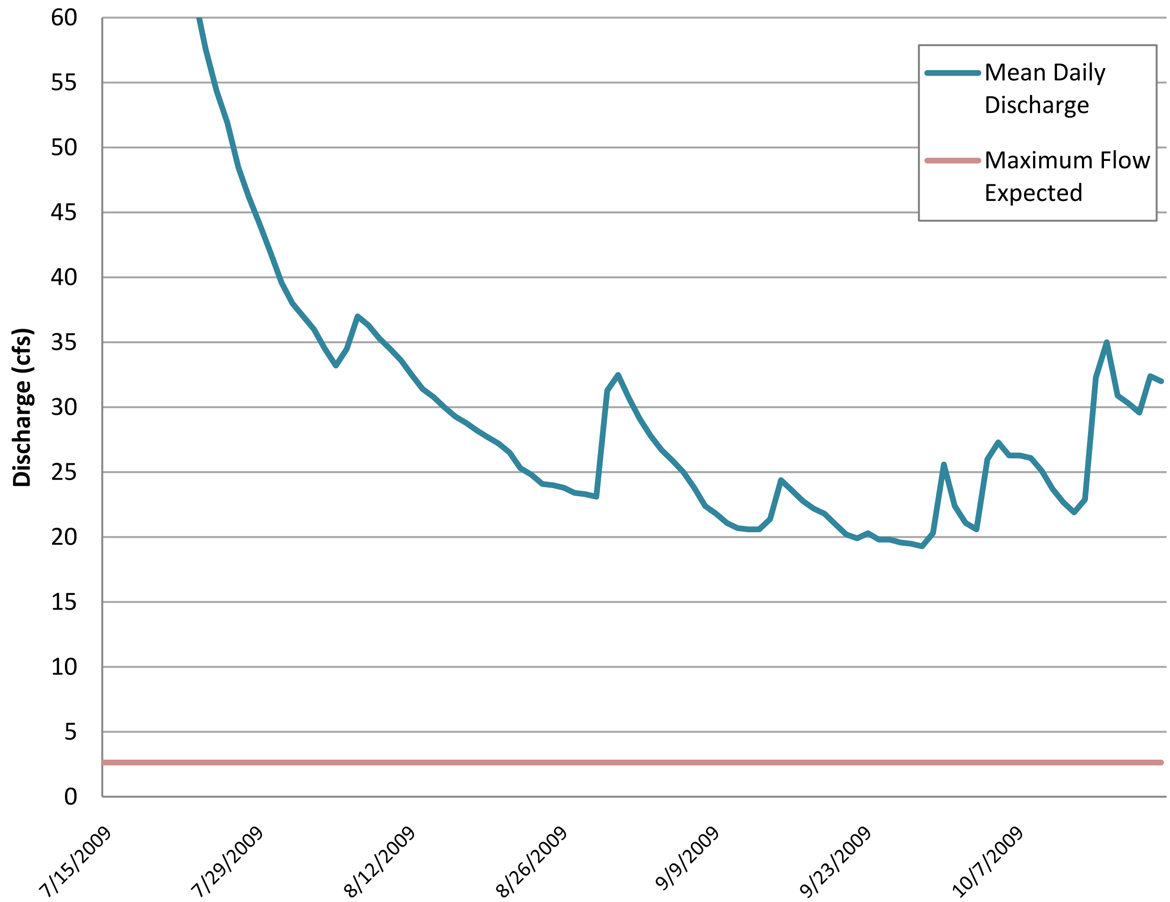


Figure 2. Alturas Lake Creek mean daily flow at Pettit Lane, July 15 to October 22, 2009.

Beaver Creek – Stanley Basin

The Beaver Creek project was IDWR's first long-term lease. In the fifth year of the ten-year transaction, D.O.T., LLP leased 8.77 cfs, formerly irrigating 241 acres. The water is leased from May 1st through October 15th. When the water is available, this connects approximately 0.8 miles of lower Beaver Creek to the Salmon River, providing cool water and fish access to the upper reaches of Beaver Creek.

Site visits to Beaver Creek on 8/4/2009 and 9/3/2009 confirmed that the landowner was complying with the terms of the lease. Landsat images also show that the leased water was not being used to irrigate land (Appendix A). A gage in Beaver Creek monitored flow in the river during the irrigation season (Figures 3 and 4). The leased water provided a reconnect to Beaver Creek through early July. After early July, the flow in Beaver Creek dropped below levels that would provide reconnection. Although the flows did not provide fish passage, they most likely provided groundwater recharge and cooler sub-surface flows to the upper Salmon River.

Idaho Department of Fish and Game (IDFG) conducted Chinook salmon redd surveys in 2009 and found 10 Chinook salmon redds in the Salmon River within 8 miles of the mouth of Beaver Creek.

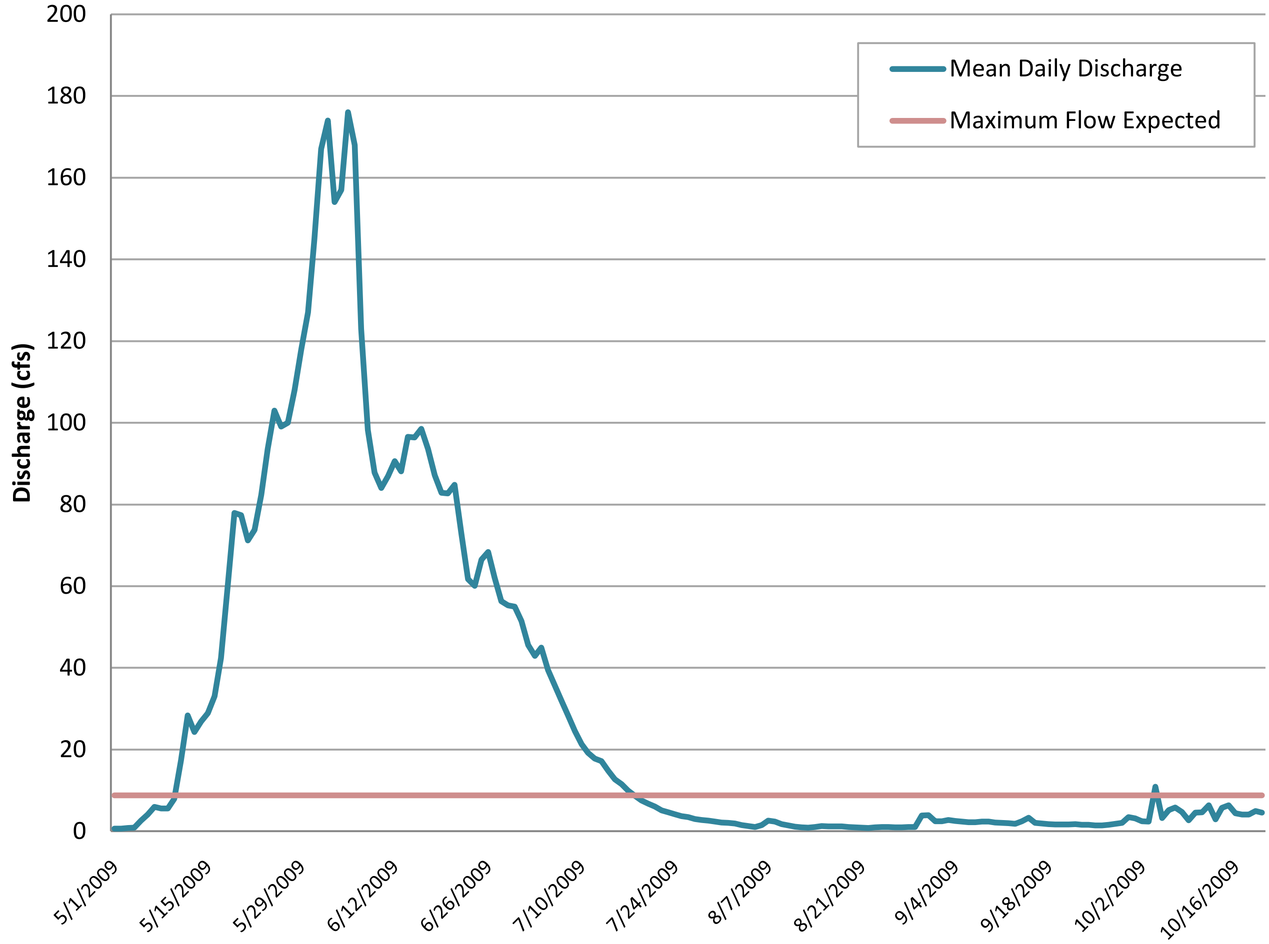


Figure 3. Beaver Creek mean daily flow at Highway 93, May 1 to October 31.

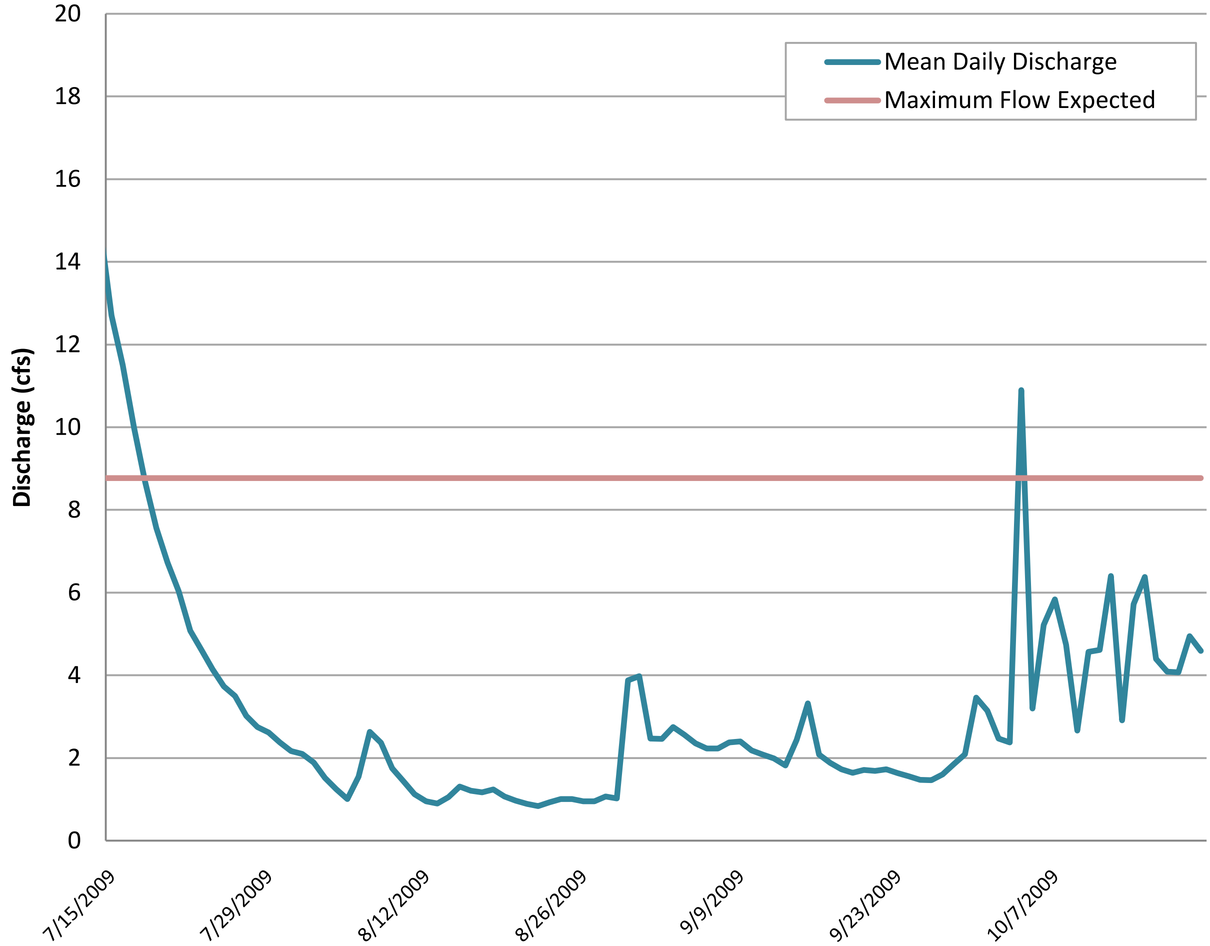


Figure 4. Beaver Creek mean daily flow at Highway 93, July 15 to October 31.

Physical Habitat Simulation (PHABSIM) results from a study on Beaver Creek (Maret et al. 2005) were used to develop habitat availability with and without the 8.77 cfs of leased water. Figures 5-7 represent the percentage of usable area for each species of concern. Juvenile habitat is not included due to limitations of the PHABSIM model.

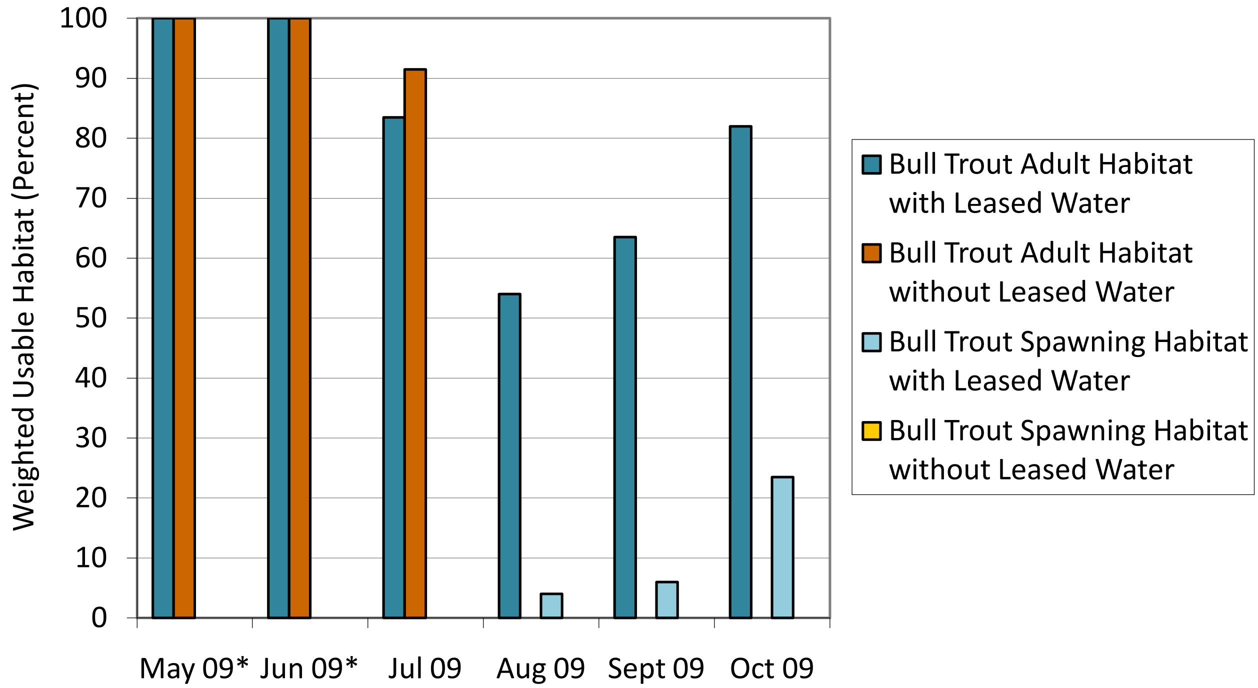


Figure 5. Percent usable habitat for adult and spawning bull trout at mean monthly flows in 2009, including and excluding the leased 8.77 cfs. * Flows in May and June were beyond the modeled range.

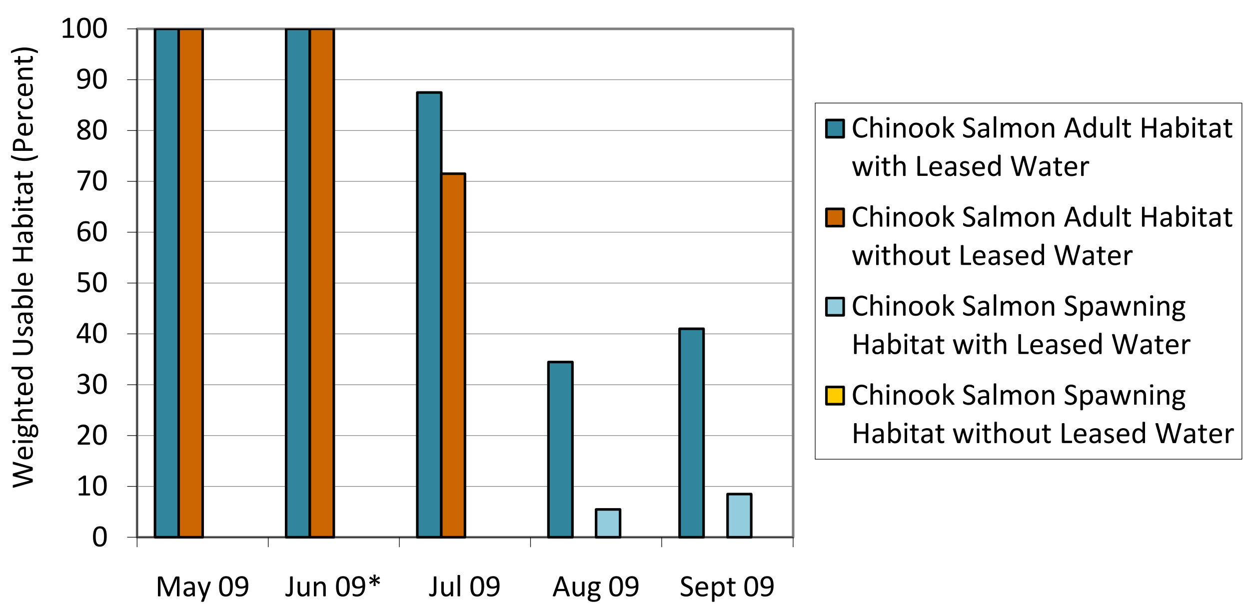


Figure 6. Percent usable habitat for adult and spawning Chinook salmon at mean monthly flows in 2009, including and excluding the leased 8.77 cfs. * Flows in May and June were beyond the modeled range.

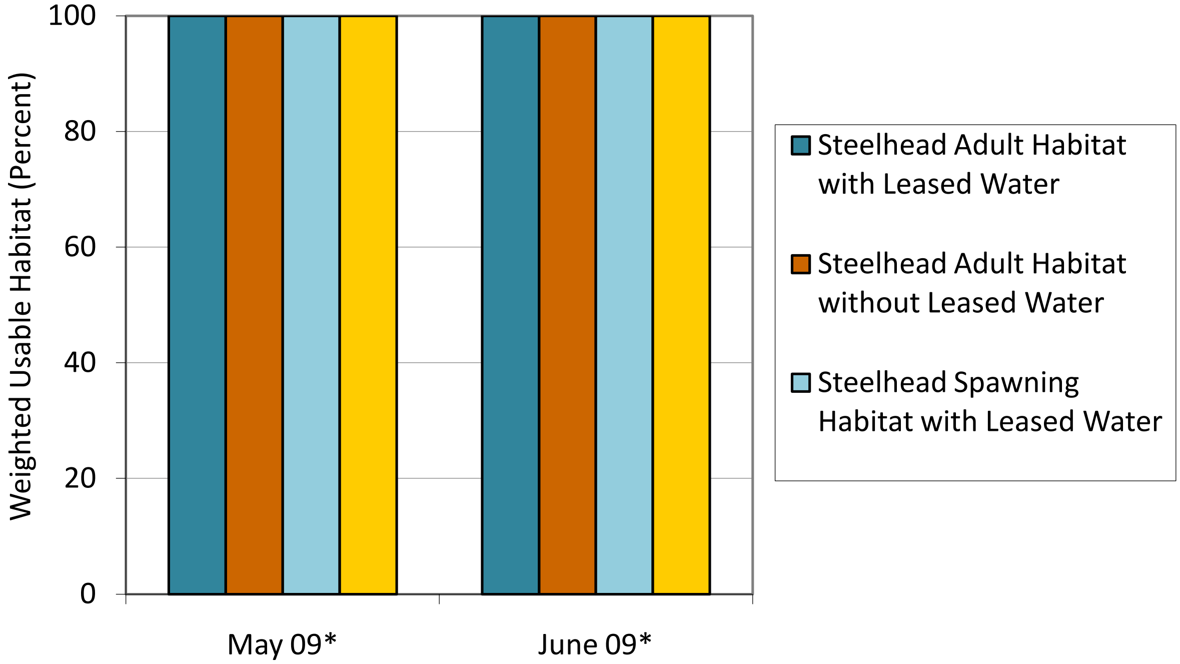


Figure 7. Percent usable habitat for adult and spawning steelhead at mean monthly flows in 2009, including and excluding the leased 8.77 cfs. * Flows in May and June were beyond the modeled range.

The Shoshone Bannock Tribes collected temperature and fish presence data in Beaver Creek during the summer of 2009 (Tsosie 2009). The snorkel survey found only brook trout present. A temperature logger near the Highway 93 bridge showed several instances of temperature levels elevated above the EPA recommended criteria for cold water refugia protection for salmon and trout migration in July and August (EPA 2003). Recovery of the willow complex along the creek may improve temperatures in that reach over time.

Fourth of July Creek – Stanley Basin

IDWR negotiated a 20-year lease to place 2.9 cfs (formerly irrigating 43.1 acres) into the Water Supply Bank. The water was leased from May 1 to Oct. 31. Approximately 2.0 miles of lower Fourth of July Creek were reconnected to the Salmon River. This provided fish access to the upper reaches.

A site visit to Fourth of July Creek on 9/3/2009 confirmed that the landowners were complying with the terms of the lease. Landsat images also show that the leased water was not being used to irrigate land (Appendix A). A gage in Fourth of July Creek monitored flow in the river during the irrigation season (Figures 8 and 9). The leased water provided a reconnect to the Salmon River throughout most of the irrigation season for juvenile salmon, steelhead and bull trout.

Idaho Department of Fish and Game (IDFG) conducted Chinook salmon redd surveys in 2009 and found 53 redds in the reach of the Salmon River that extends from the mouth of Fourth of July Creek 10.8 miles downstream to the Stanley hatchery.

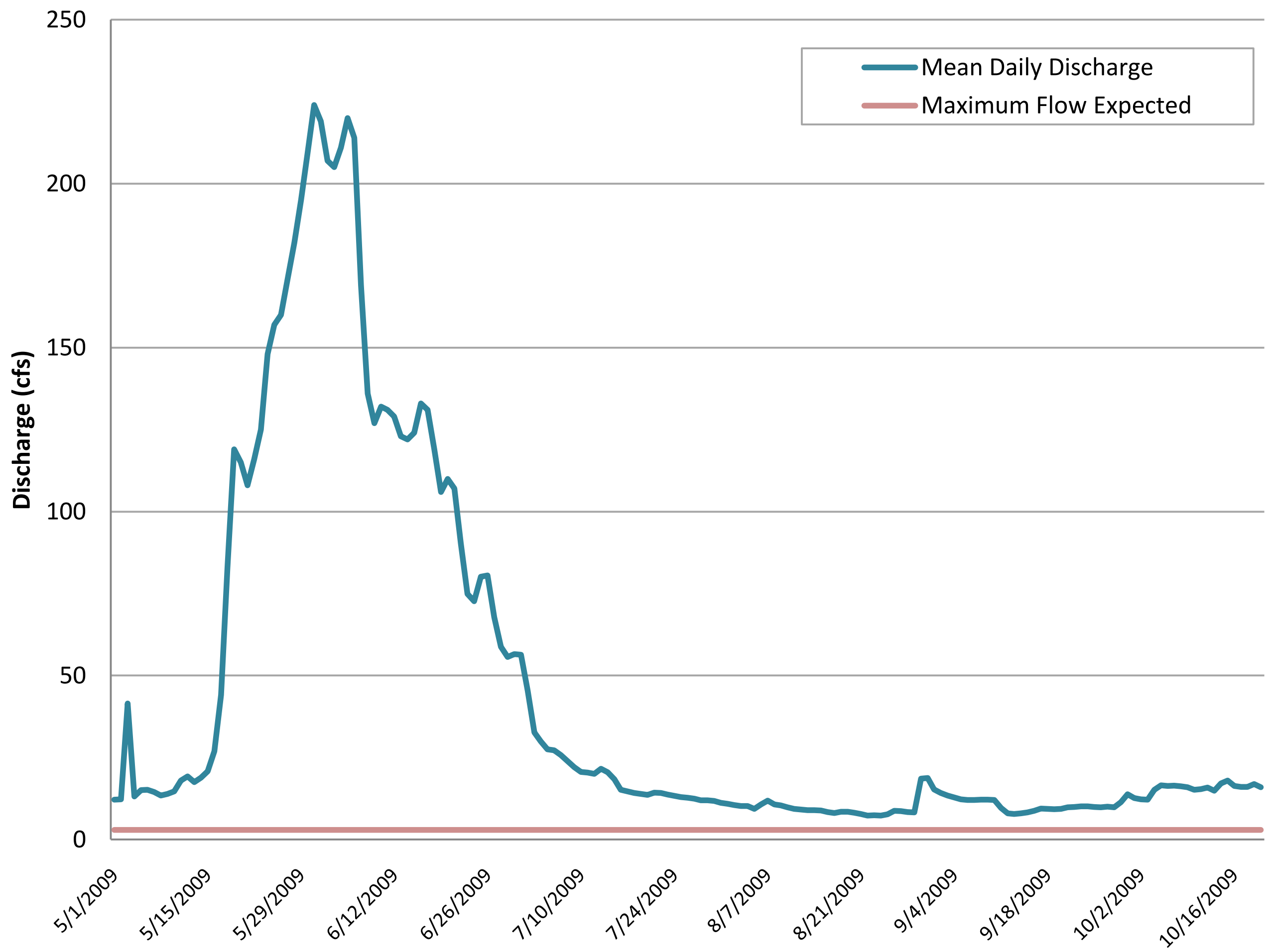


Figure 8. Fourth of July Creek mean daily flow at Highway 93, May 1 to October 31.

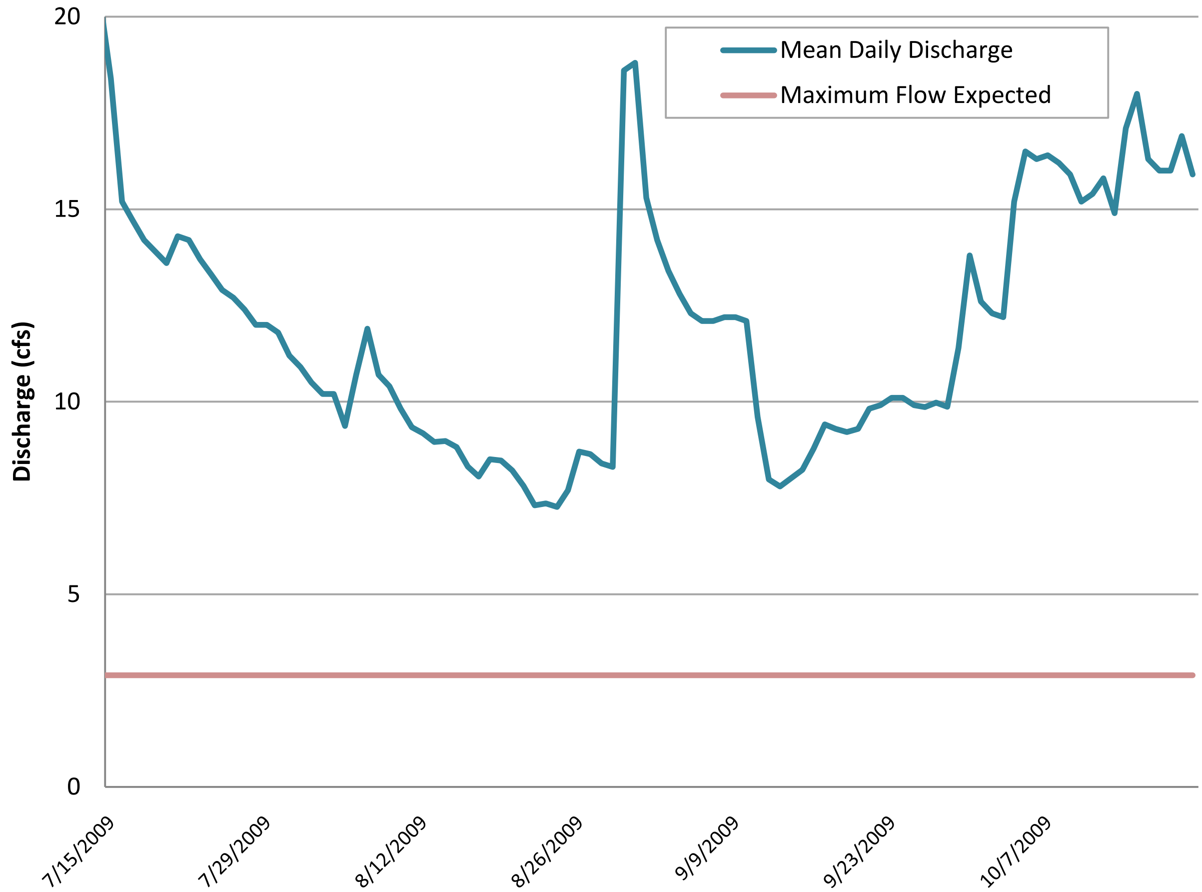


Figure 9. Fourth of July Creek mean daily flow at Highway 93, July 15 to October 31.

Physical Habitat Simulation (PHABSIM) results from a study on Fourth of July Creek (Maret et al. 2005) were used to develop habitat availability with and without the 2.9 cfs of leased water. Figures 10-12 represent the percentage of usable area for each species of concern. Juvenile habitat is not included due to limitations of the PHABSIM model.

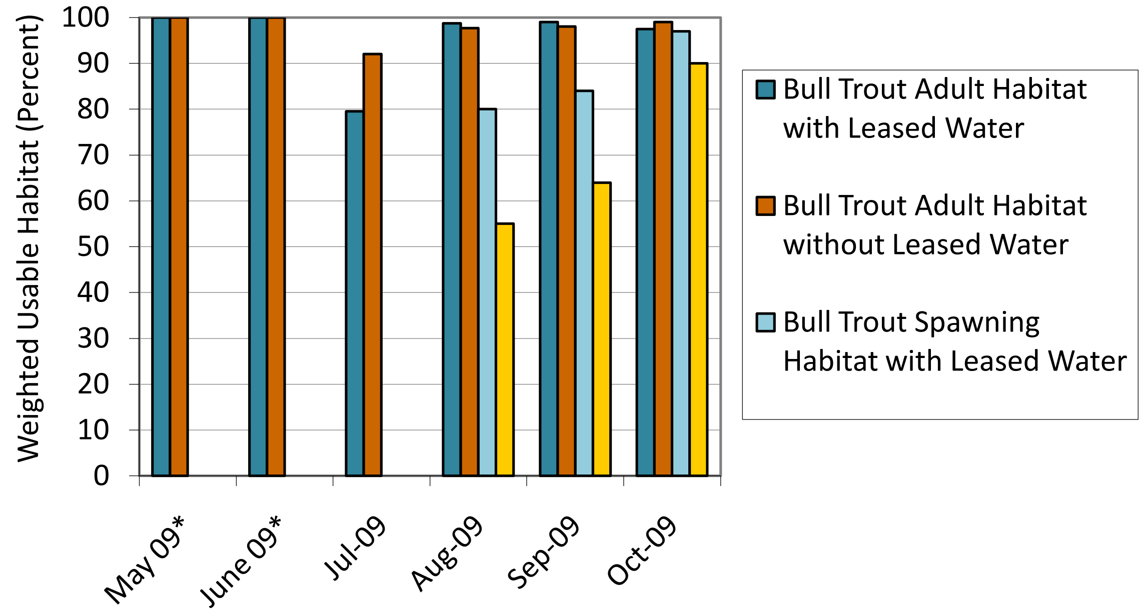


Figure 10. Percent weighted usable habitat for adult and spawning bull trout at mean monthly flows in 2009, including and excluding the leased 2.9 cfs. * Flows in May and June were beyond the modeled range.

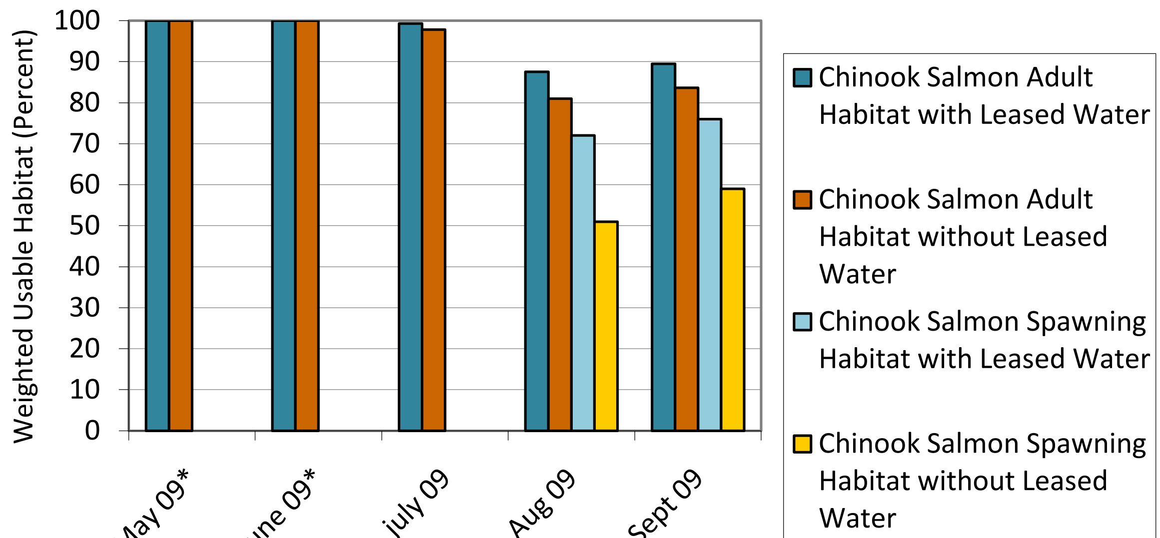


Figure 11. Percent weighted usable habitat for adult and spawning Chinook salmon at mean monthly flows in 2009, including and excluding the leased 2.9 cfs. * Flows in May and June were beyond the modeled range.

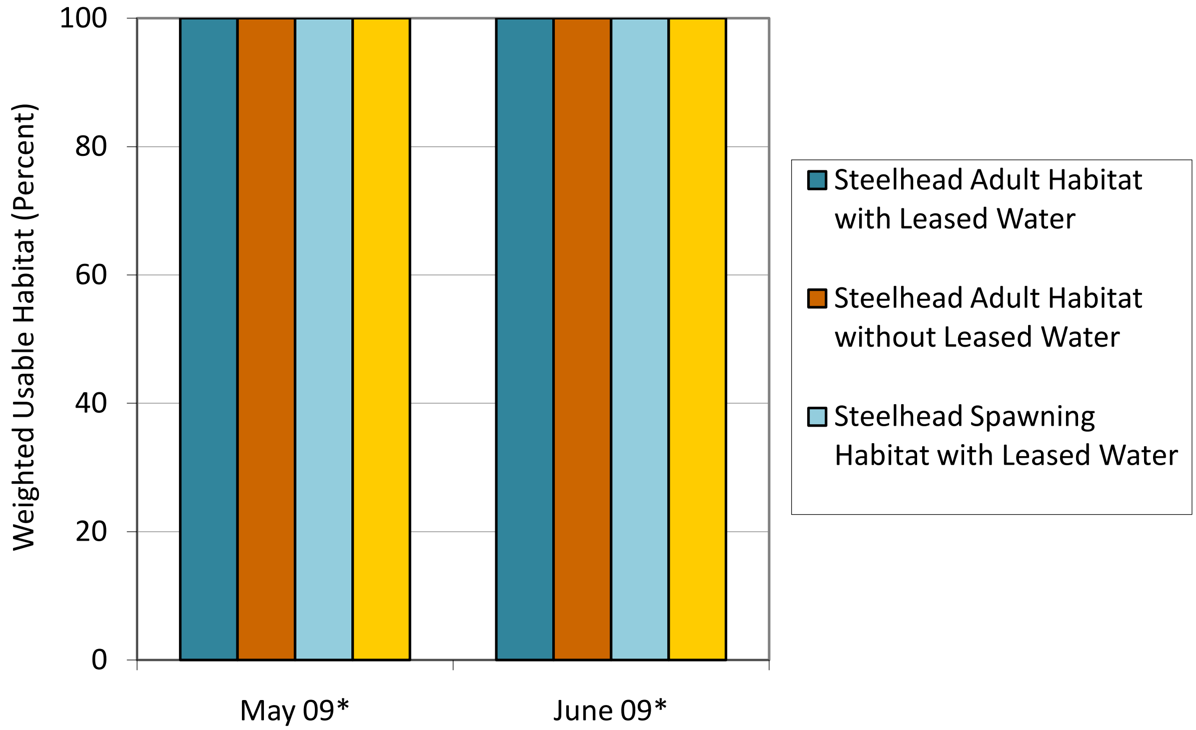


Figure 12. Percent weighted usable habitat for adult and spawning steelhead at mean monthly flows in 2007, including and excluding the leased 2.9 cfs. * Flows in May and June were beyond the modeled range.

Idaho Department of Fish and Game has been conducting bull trout redd counts in Fourth of July Creek since 2003 (Curet 2009). They show a marked increase in the total number of redds every year between 2003 and 2006 (Figure 13). There were declines in 2007 and 2008, which may be due to the effects of the 2005 fire in the basin. There were bull trout redd counts in Fourth of July Creek in 2009. IDFG will continue to monitor redds to see if the recent decreases will be long-lasting.

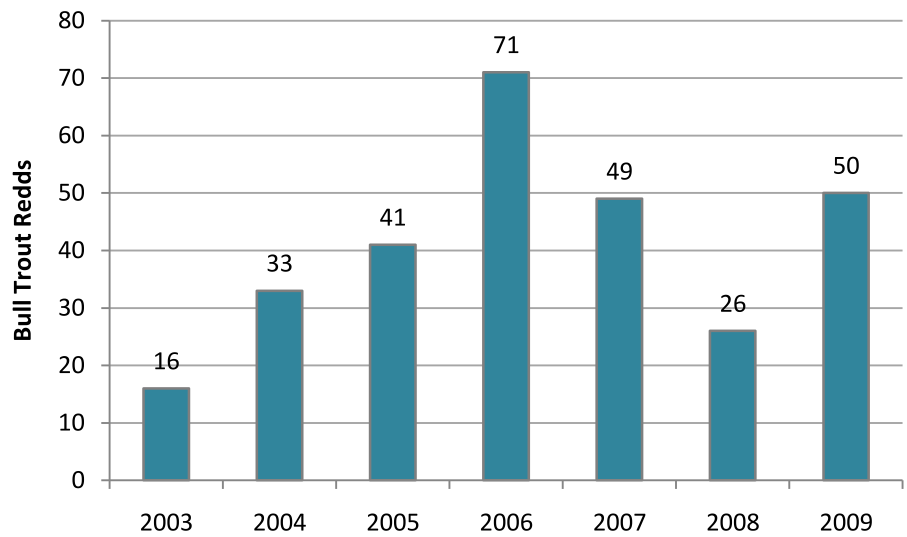


Figure 13. Annual counts of fluvial bull trout redds in Fourth of July Creek from 2003-2009 (Curet 2009).

Pole Creek – Stanley Basin

The Pole Creek project is not a traditional lease that dries up irrigated fields. Salmon Falls Sheep Company holds several water rights from Pole Creek. One of these is a hydropower right for 7 cfs that is used to generate power to operate pivots. This diversion, along with irrigation water rights has the ability to drop flows low enough to impede fish migration, raise temperatures, and reduce available fish habitat. In order prevent the reduction of flow below 5 cfs, IWRB and Salmon Falls Sheep Company initiated an agreement not to divert. In exchange for leaving at least 5 cfs of the hydropower right in Pole Creek during the irrigation season, the landowner is paid the operating cost of a generator to run his pivots. In 2006, IDWR developed a five-year agreement not to divert that will supply the landowner with a generator and the funds for fuel.

A site visit to Pole Creek on 8/4/2009 confirmed that the landowner was complying with the terms of the agreement. A gage in Pole Creek monitored flow in the river during the irrigation season (Figure 14). Flows in Pole Creek during the term of the transaction never fell below 5 cfs. In 2009, higher flows in Pole Creek allowed the landowner to divert his hydropower right for the full irrigation season.

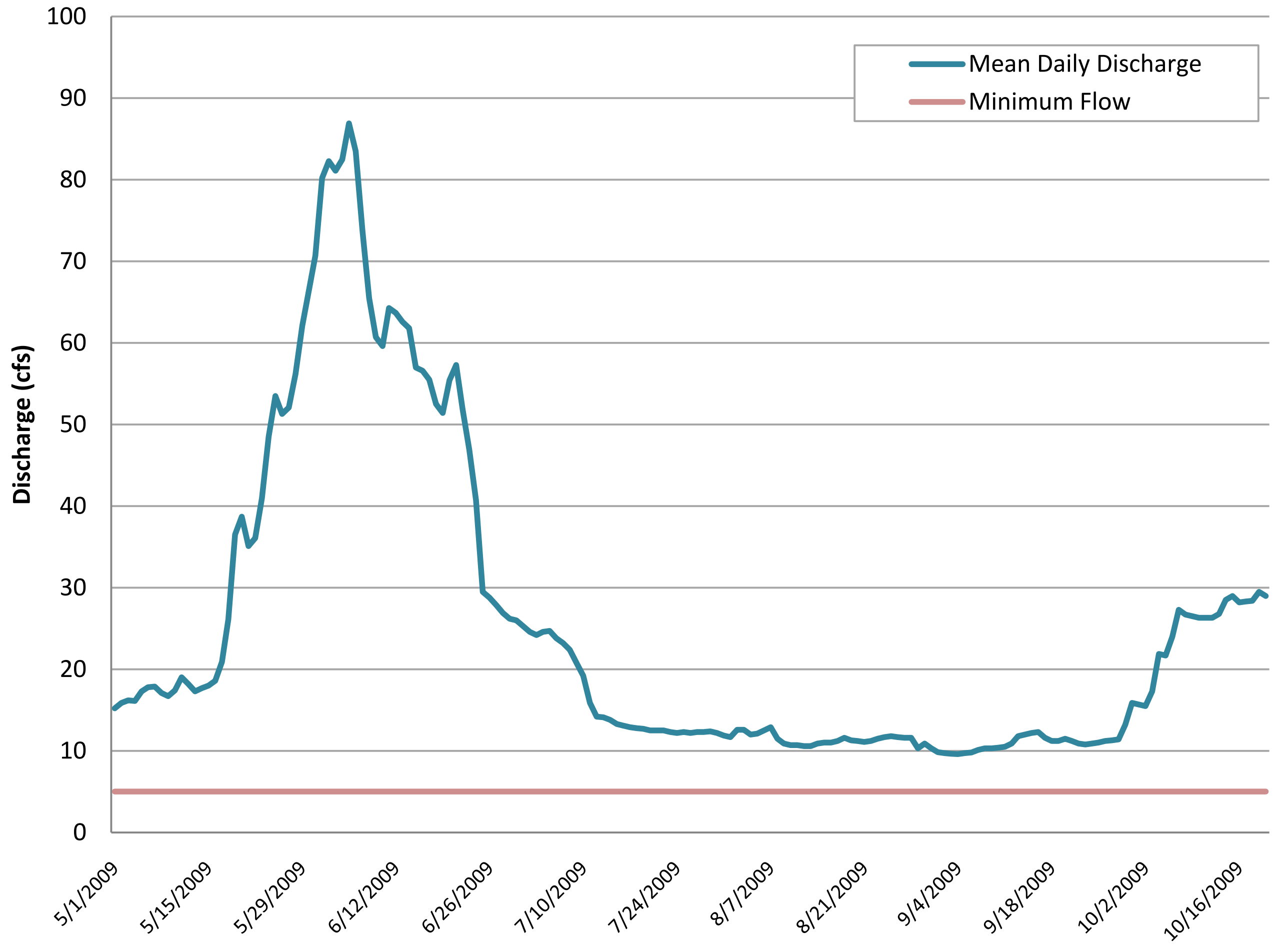


Figure 14. Pole Creek mean daily flow, May 1 to October 22.

Big Hat Creek – Mainstem Salmon River Basin (Valley Creek-Pahsimeroi River)

Erik Storlie and Tamara Kaiser donated 1.23 cfs, formerly irrigating 43.6 acres to the IWRB for rental to the minimum stream flow at the mouth of Hat Creek. The water was leased from April 1 to Oct. 31. Approximately 3.4 miles of lower Big Hat Creek was reconnected to Hat Creek. This provided fish access to the upper reaches of Big Hat Creek.

Landsat images confirmed the leased water was not being used to irrigate land (Appendix A). The gage on Big Hat Creek was transferred to Iron Creek, due to a lack of funds for an additional gage, and the respective importance of the Iron Creek transaction. This Big Hat transaction removes the only diversion on Big Hat Creek, returning the stream to a natural flow. With occasional site visits and Landsat verification, IDWR is confident that stream flows in Big Hat Creek obtain the biological objective of reconnecting Big Hat Creek for threatened bull trout.

There has been no PHABSIM modeling of Big Hat Creek. The USFS conducted electroshock fish surveys in Big Hat Creek on 9/2/2009 and found 29 rainbow trout, 6 cutthroat trout, and 3 young of year salmonids (Garcia 2009). No bull trout were sampled at that time. A temperature logger in Big Hat Creek operated by the USFS confirmed that temperature standards for bull trout rearing (EPA 2003) were not exceeded (Garcia 2009).

Morgan Creek – Mainstem Salmon River Basin (Valley Creek-Pahsimeroi River)

In 2009, IDWR developed two five-year agreements not to divert from Morgan Creek. The agreements provide a minimum flow of 2 cfs in the lower end of Morgan Creek, which would normally run dry. The irrigators agreed to pump water out of a Salmon River ditch instead of drying up Morgan Creek, whenever flows approached 2 cfs. This flow provides a partial reconnection to important spawning and rearing habitat for Chinook salmon and steelhead.

Site visits to Morgan Creek on 6/24/2009, 7/22/2009, 8/6/2009, 9/2/2009, and 10/20/2009 confirmed that the landowners were complying with the terms of the agreement. An Aquarod on loan from the US Forest Service monitored flows at the lower end of the primary reach (Figure 15).

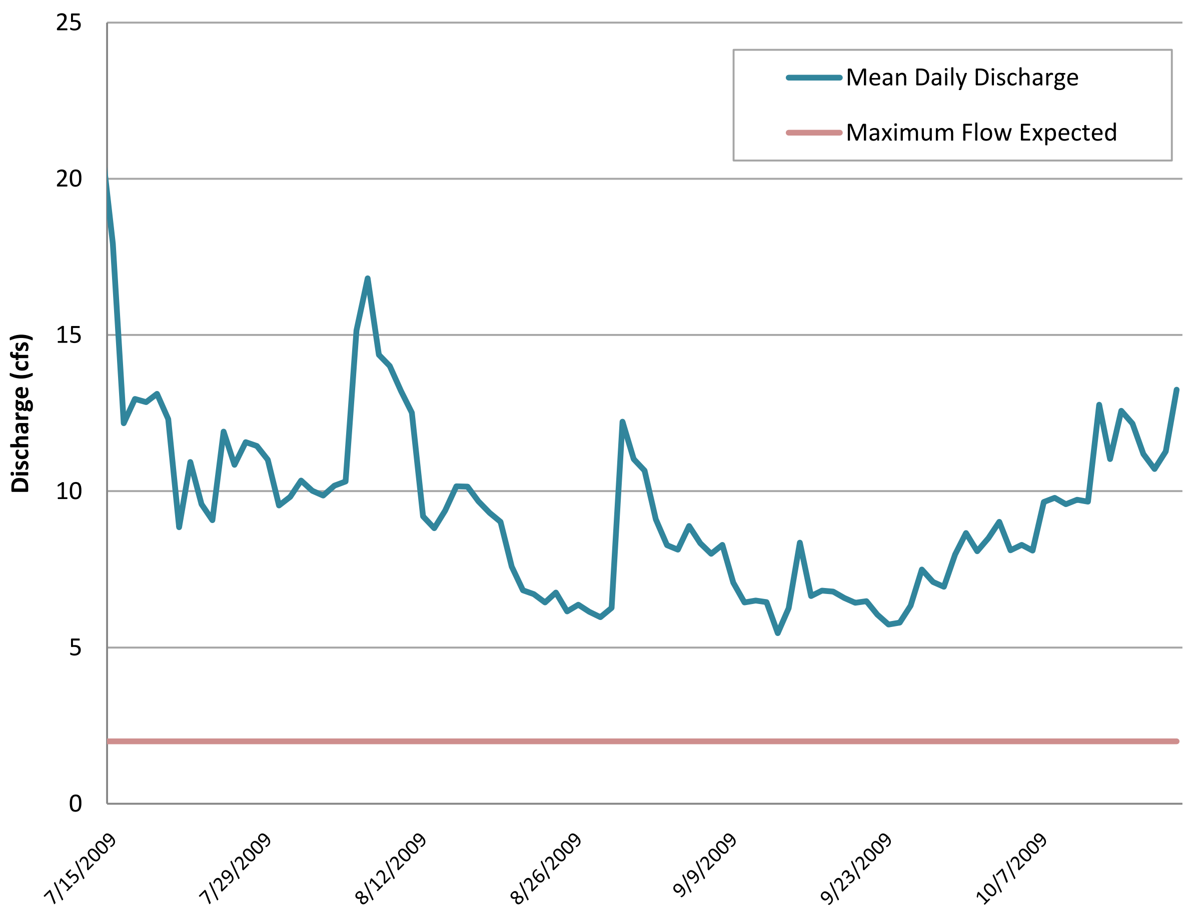


Figure 15. Morgan Creek mean daily flow below Highway 93, July 15 to October 22, 2009.

A PHABSIM study conducted on Morgan Creek in 2005 did not model flows below 10 cfs.

Pahsimeroi P-9 Projects – Pahsimeroi River Basin

The Pahsimeroi P-9 project consisted of a set of four 20-year agreements not to divert. The goal of the P-9 ditch removal project was to remove the P-9 ditch and its associated cross ditch. The cross ditch intercepted flows from two spring creeks and transported the flow across an alkali flat. The cross ditch dumped into the Pahsimeroi River and was then picked up by the P-9 ditch. The P-9 ditch intercepted another spring creek and could cause passage problems at the diversion due to low flows. The project leaves almost 30 cfs in the Pahsimeroi River at P-9, Mud Springs Creek, Patterson/Big Springs Creek, and Duck Springs (distribution of that flow is not well defined). The water is now pumped out of the Pahsimeroi River lower in the system, where flow is not limited.

A site visit on 9/1/2009 confirmed that the landowners were complying with the terms of the agreement. Several gages in the project area monitored flows during the irrigation season. The Pahsimeroi River gage below the P-9 ditch monitored flows during the irrigation season (Figure 18). The Pahsimeroi River maintained a base flow of approximately 13 cfs in 2009, compared to previous years when flow dropped to almost zero intermittently. Two gages on Patterson-Big Springs gage monitored flows below the old cross ditch and below the lowest diversion (Figure 19).

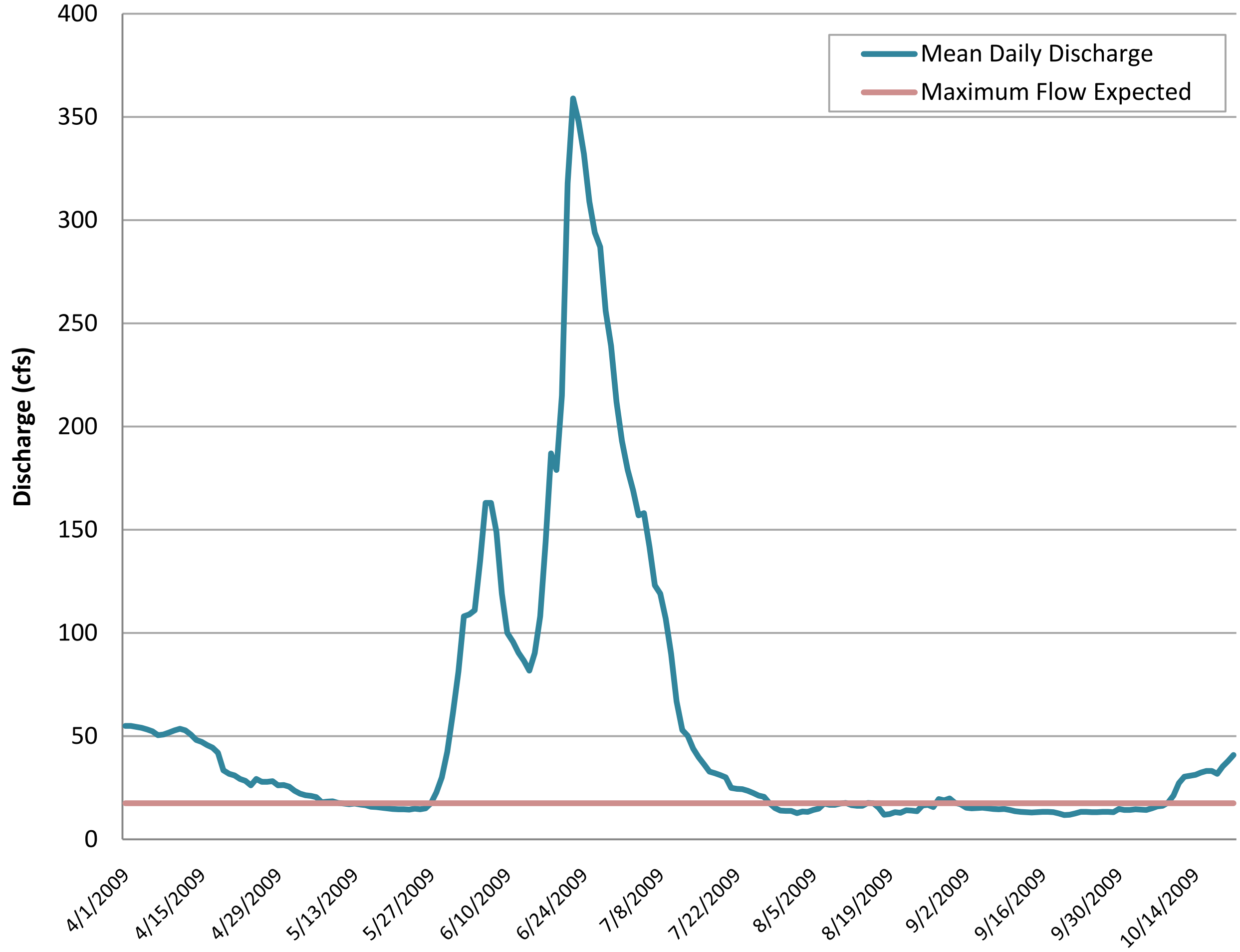


Figure 18. Pahsimeroi River mean daily flow below the P-9 ditch, April 1 to October 22.

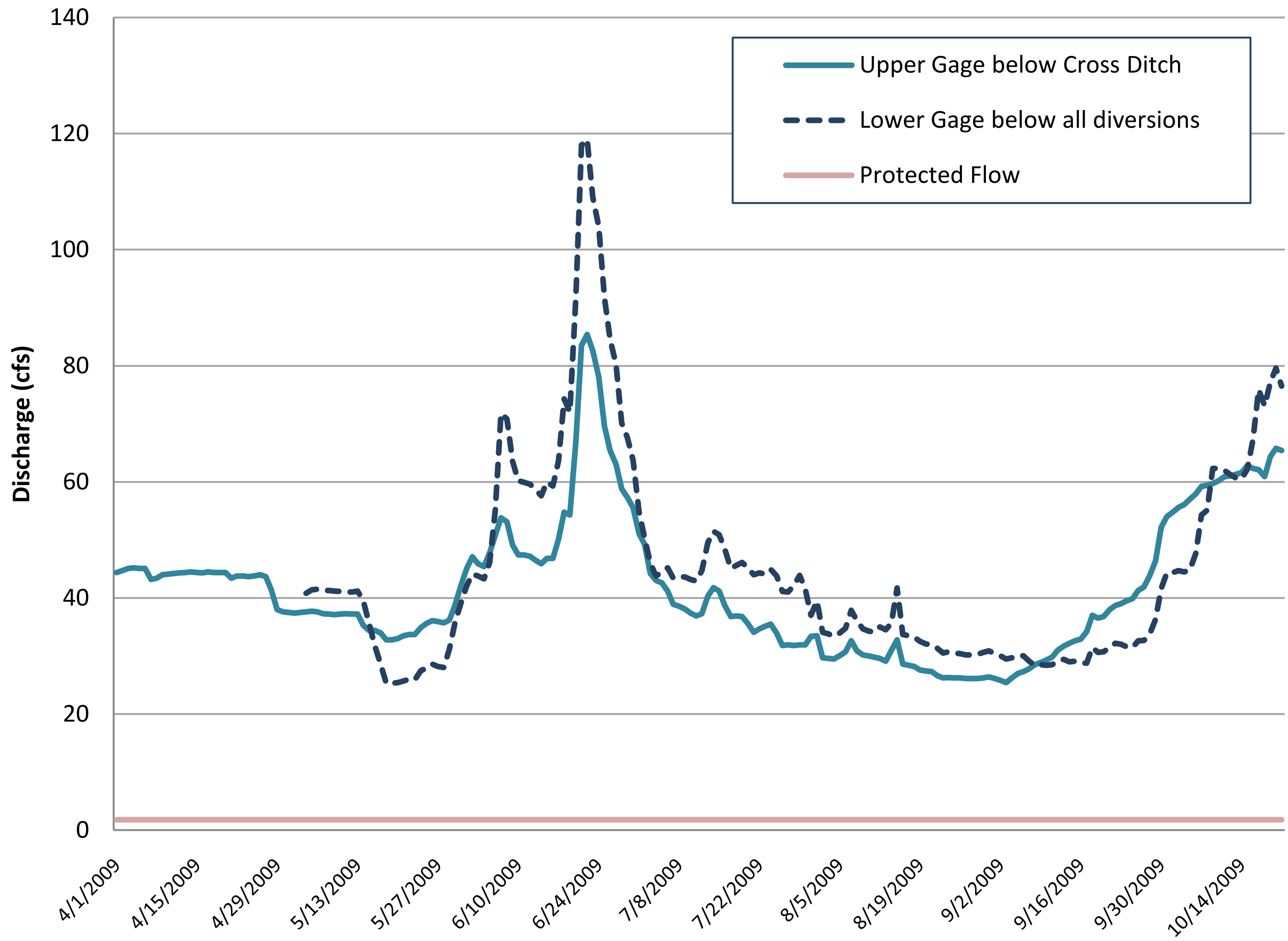


Figure 19. Pahsimeroi River mean daily flow in Patterson-Big Springs Creek, April 1 to October 22.

IDFG conducted Chinook salmon redd counts in Patterson-Big Springs Creek in 2009 and found the following:

- 3 Chinook salmon redds in Patterson/Big Springs below the cross ditch on Sept 10, 2009
- 35 Chinook salmon redds in Patterson/Big Springs above the cross ditch on Sept 10, 2009
- 43 adult Chinook adults in Patterson/Big Springs on Sept 10, 2009
- 2 adult Chinook salmon carcasses in Patterson/Big Springs Creek on Sept 10, 2009
- 1 Chinook salmon redds in Patterson/Big Springs below the cross ditch on Sept 24, 2009
- 68 Chinook salmon redds in Patterson/Big Springs above the cross ditch on Sept 24, 2009
- 7 adult Chinook adults in Patterson/Big Springs on Sept 24, 2009
- 10 adult Chinook salmon carcasses in Patterson/Big Springs Creek on Sept 24, 2009

Habitat assessment was conducted on August 15, 2007 and on September 1, 2009 in a 95 meter section of the previously de-watered reach of Patterson/Big Springs Creek. Riparian shrubs and grasses dominate stream bank vegetation. Ideal Chinook salmon and steelhead spawning substrate particle size in Idaho ranges from fine gravel (6-7mm) to large cobble (128-255 mm) (Maret et al. 2003). Eighty-two percent of the substrate sampled in Patterson/Big Springs Creek fell into the ideal spawning size range for Chinook salmon and steelhead (Figure 20) in 2007. The creek was too deep to safely sample substrate in 2009. The pre-project and post-project assessment showed an increase in wetted width, average depth of the thalweg, and average maximum pool depth.

Table 1. Stream habitat assessment results from sampling on August 15, 2007 and September 1, 2009.

Metric	2007	2009
Bankfull width	5.0 m	5.2 m
Wetted width	4.3 m	5.2 m
Average thalweg depth	0.26 m	0.58 m
Average pool max	0.63 m	0.83

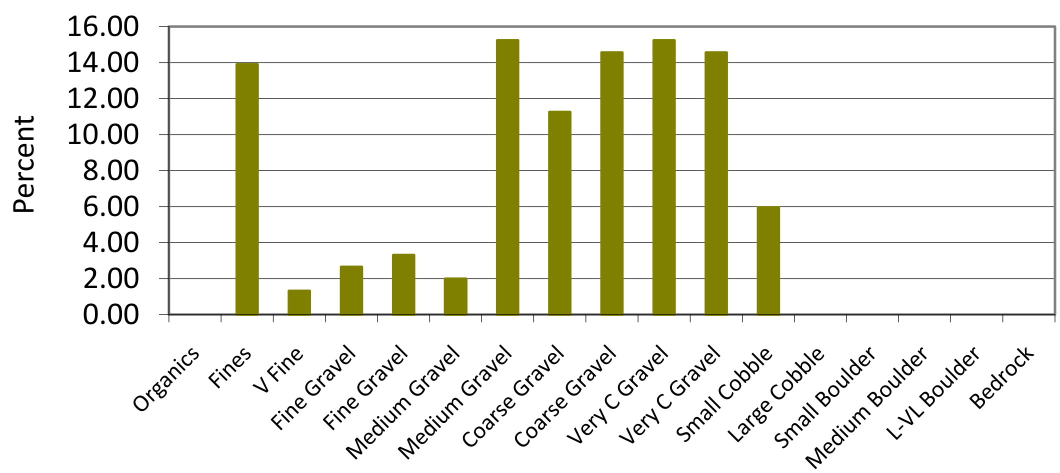


Figure 20. Patterson/Big Springs Creek substrate size distribution as sampled in a 95-meter reach below the cross ditch on August 15, 2007.

Iron Creek Phase II– Mainstem Salmon River Basin (Pahsimeroi River – Lemhi River)

The Iron Creek Phase II project is a twenty-year full-season agreement not to divert. Clyde and Janelle Phillips added a point of diversion on the Salmon River and agreed not to divert 7.08 cfs from Iron Creek, an USBWP SHIPUSS high priority stream. The water provides a reconnection to important spawning and rearing habitat for Chinook salmon and steelhead.

A site visit to Iron Creek on 8/6/2009 confirmed that the landowner was complying with the terms of the agreement. A gage in Iron Creek monitored flow in the river during the irrigation season (Figures 21 and 22).

IDFG conducted biologic monitoring on Iron Creek in the reach affected by the water transaction. They observed 7 adult Chinook salmon and 6 redds in the affected reach (Murphy 2010). There has been no PHABSIM modeling of Iron Creek.

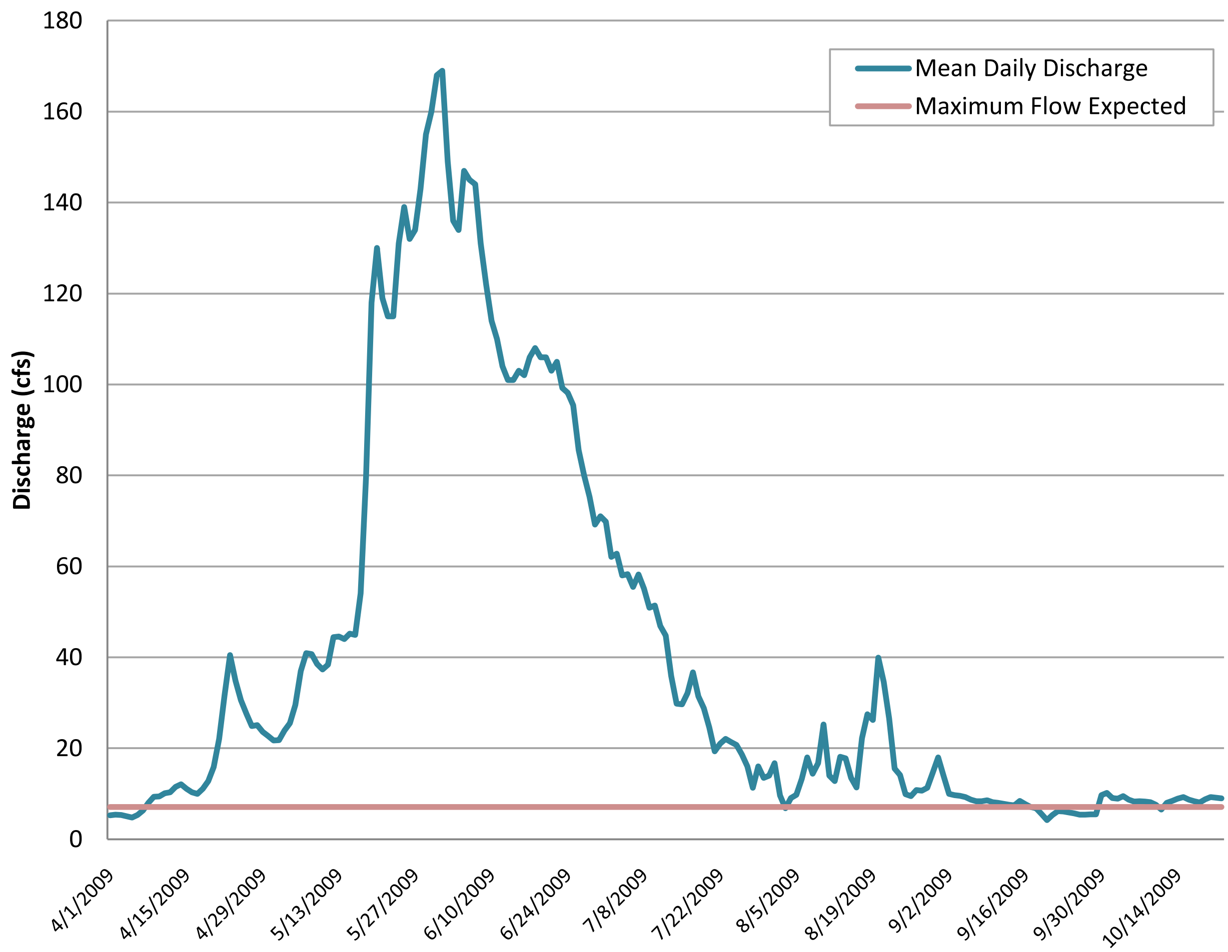


Figure 21. Iron Creek mean daily flow below Phillip's Bridge, April 1 to October 22.

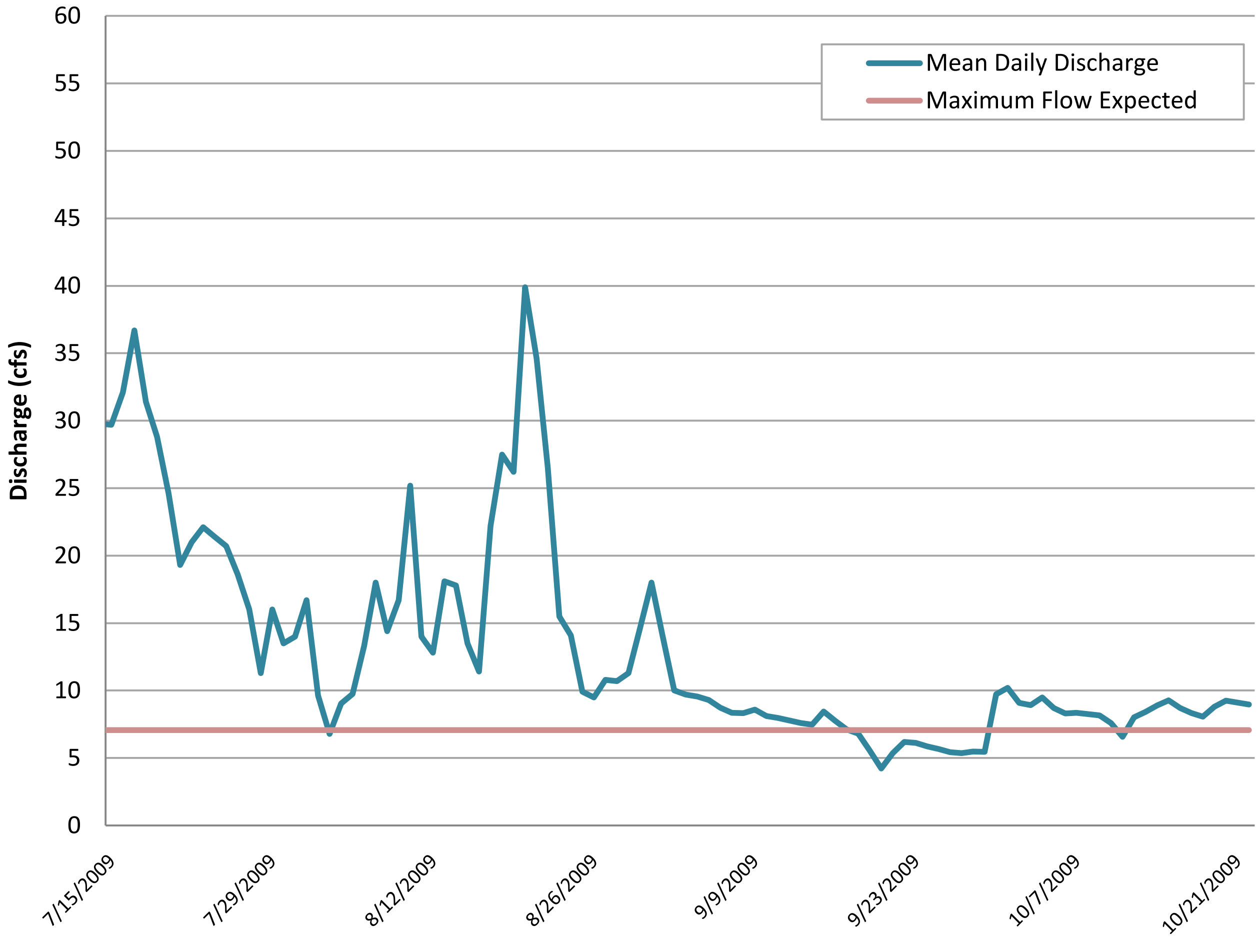


Figure 22. Iron Creek mean daily flow below Phillip's bridge, July 15 to October 22.

Lemhi River Agreement not to Divert - Lemhi River Basin

Through permanent conservation easements (13.97 cfs) and annual agreements not to divert water at the L6 diversion with 11 landowners, in cooperation with Water District 74, water was acquired, as needed, to maintain up to 35 cfs from May 15 through November 15. Water was acquired for 40 days in 2010. The water provided passage flows necessary for in-migrating adult spring Chinook salmon and steelhead, and for out migrating salmon and steelhead smolts.

Rick Sager, the WD 74 Watermaster, administered this project. He adjusted the flows at L6 to meet the Lemhi Conservation Agreement flows. NMFS also monitored the real-time flow at USGS Lemhi River gage at L5, to ensure compliance with the Agreement. Figure 23 shows the flows at L5 when the Lemhi River was in regulation.

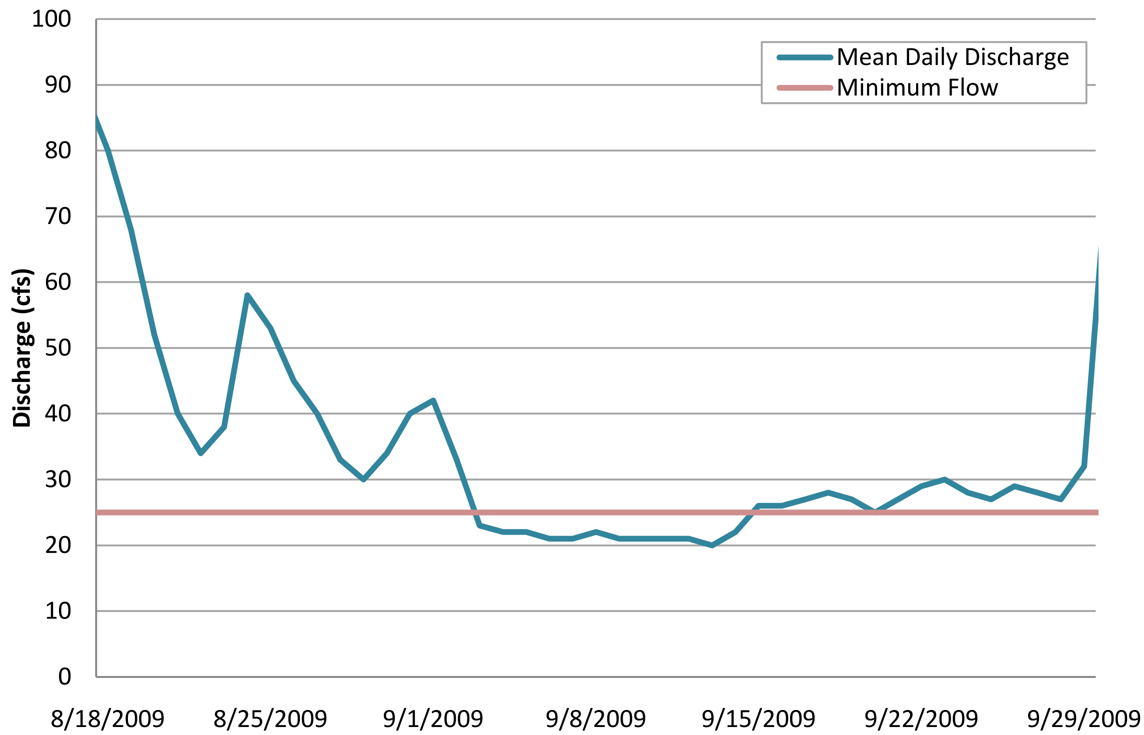


Figure 23. Lemhi River mean daily flow at L5, July 1 to September 30.

IDFG conducted biologic monitoring in the Lemhi Basin in 2009 and found the 91 Chinook salmon redds in the Lemhi River (Figure 24). A screw trap in the lower Lemhi River also sampled juvenile salmonids (Figure 25).

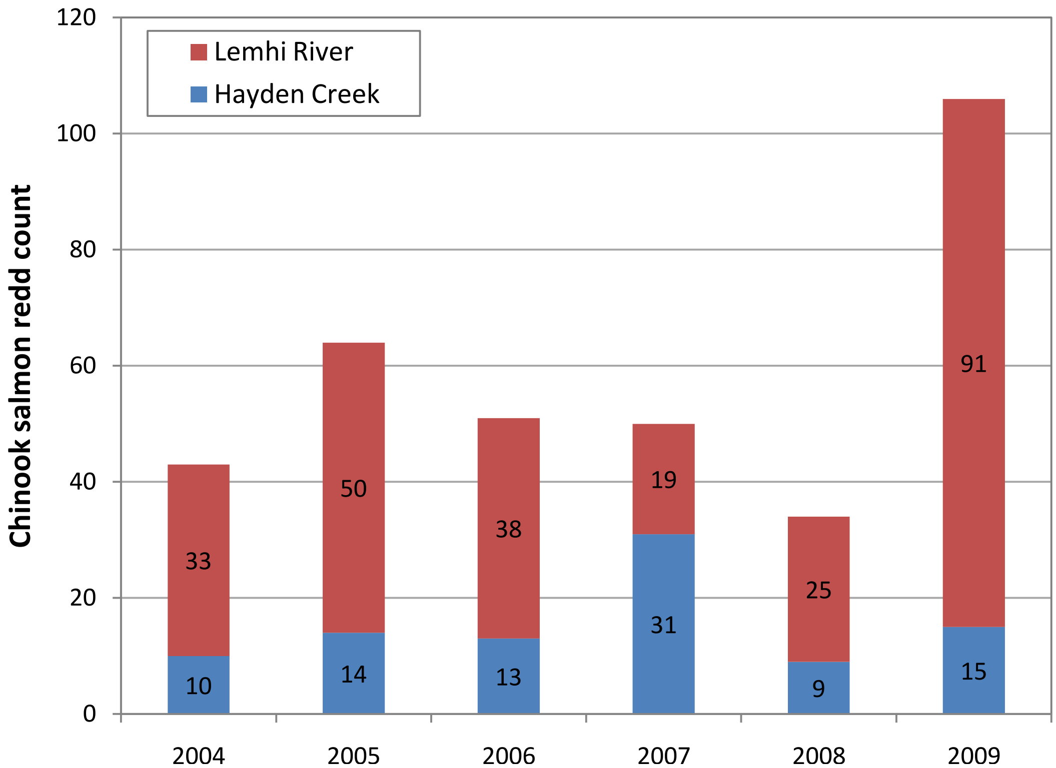


Figure 24. Lemhi River and Hayden Creek Chinook salmon redds 2004-2009 (Lutch 2006, Curet 2008, Biggs 2010).

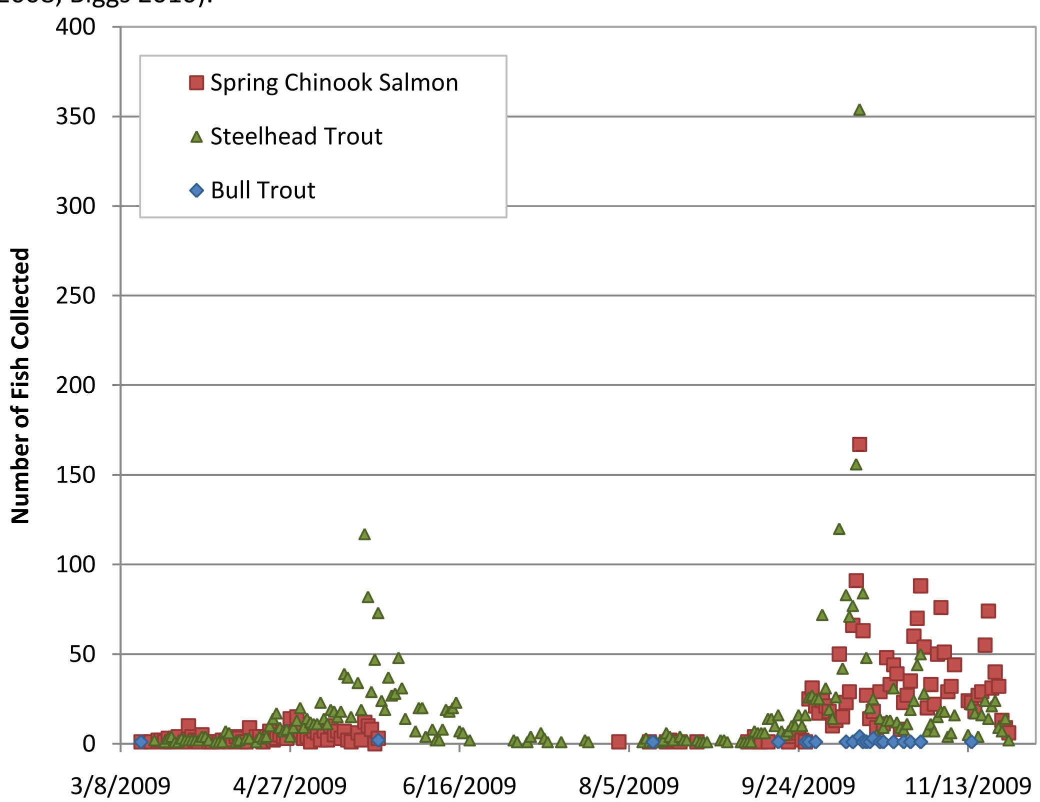


Figure 25. Lower Lemhi River screw trap data showing the number of bull trout, Chinook salmon, and steelhead trout captured in 2009 (Biggs 2010).

Eighteenmile Creek – Upper Lemhi River Basin

The Eighteenmile Creek project is a ten-year partial season lease with the Ellsworth Angus Ranch providing 0.5 cfs, formerly irrigating 26 acres. 2009 was the fifth year of the transaction. The water was leased from June 1 to November 15. This lease eliminates the use of a ditch that crosses Hawley Creek, thus reconnecting Hawley Creek with Eighteenmile Creek, and the Lemhi River, when sufficient flows are present.

Landsat images confirmed that the landowner was complying with the terms of the lease (Appendix A). A gage in Eighteenmile Creek monitored flow during the irrigation season (Figure 26).

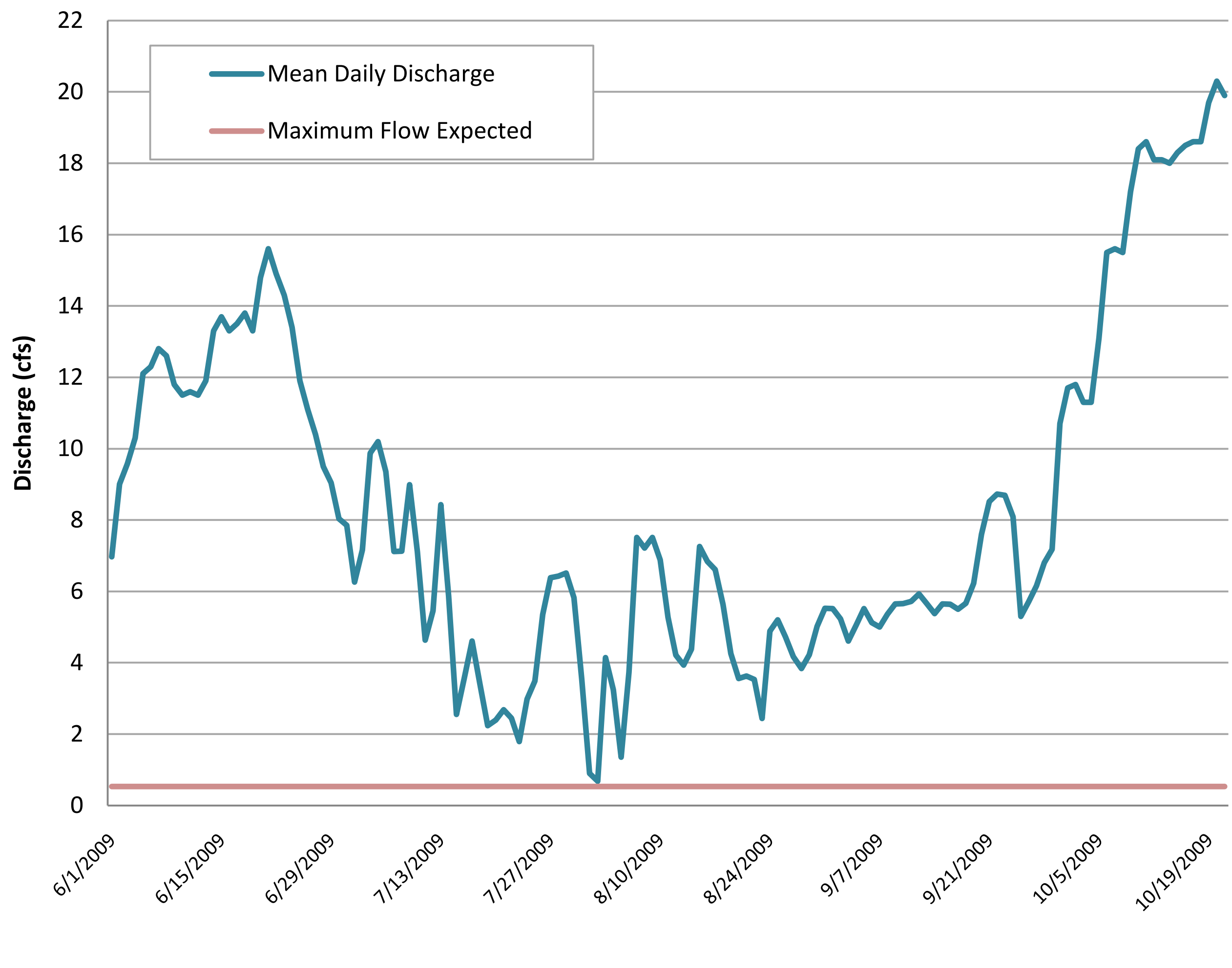


Figure 26. Eighteenmile Creek mean daily flow below confluence with Hawley Creek, June 1 to October 22.

Physical Habitat Simulation (PHABSIM) results from a study on Eighteenmile Creek (Morris and Sutton 2007) were used to develop habitat availability with and without the 0.5 cfs of leased water. Figures 27-29 represent the percentage of usable area for each species of concern. Juvenile habitat is not included due to limitations of the PHABSIM model.

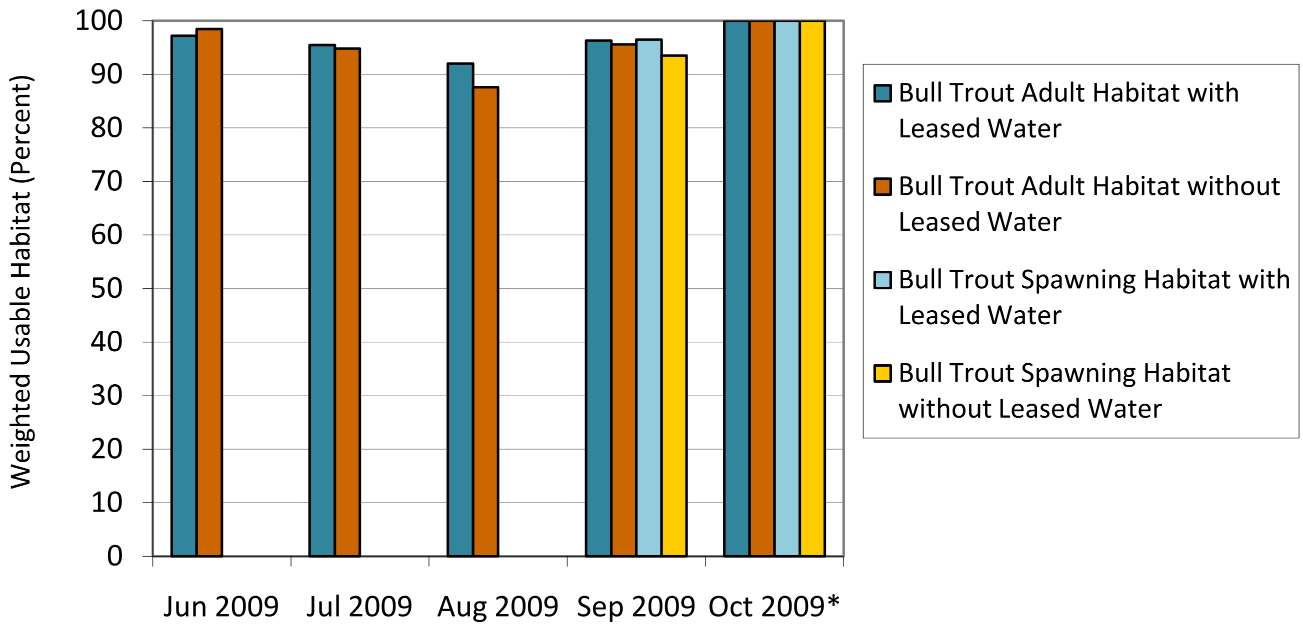


Figure 27. Percent weighted usable habitat for adult and spawning bull trout at mean monthly flows in 2007, including and excluding the leased 0.5 cfs. * Flows in October were beyond the modeled range.

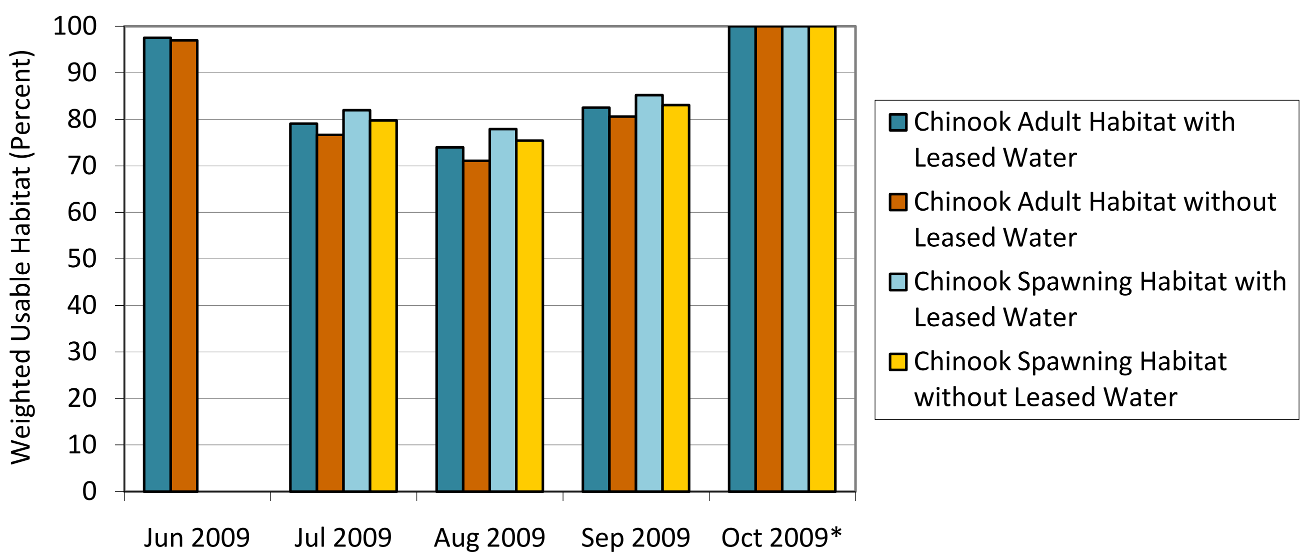


Figure 28. Percent weighted usable habitat for adult and spawning Chinook salmon at mean monthly flows in 2007, including and excluding the leased 0.5 cfs. * Flows in October were beyond the modeled range.

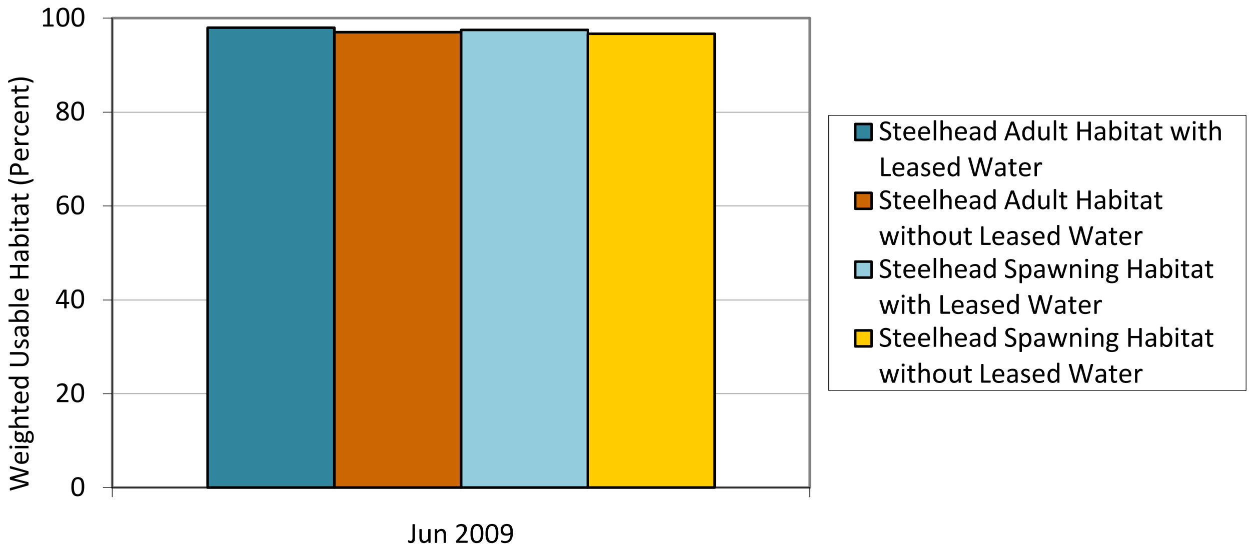


Figure 29. Percent weighted usable habitat for adult and spawning steelhead at mean monthly flows in 2007, including and excluding the leased 0.5 cfs.

Whitefish Ditch – Lemhi River Basin

The Whitefish Ditch project removed a 2.8 mile long ditch that intercepted Eighteenmile Creek, Canyon Creek, and an unnamed stream before arriving at the place of use. This 19-year agreement not to divert leaves up to 7.54 cfs in the upper reaches of the Lemhi River, by moving the point of diversion 2.5 miles downstream. The elimination of this ditch also eliminated passage and flow barriers at Eighteenmile Creek and Canyon Creek.

A site visit on 8/15/2009 confirmed that the landowner was complying with the terms of the agreement. Gages in Canyon Creek and the Lemhi River monitored flow during the irrigation season (Figures 30 and 31). Canyon Creek maintained a base flow of approximately 2-4 cfs, and the Lemhi River stayed between 7 and 20 cfs for the majority of the irrigation season.

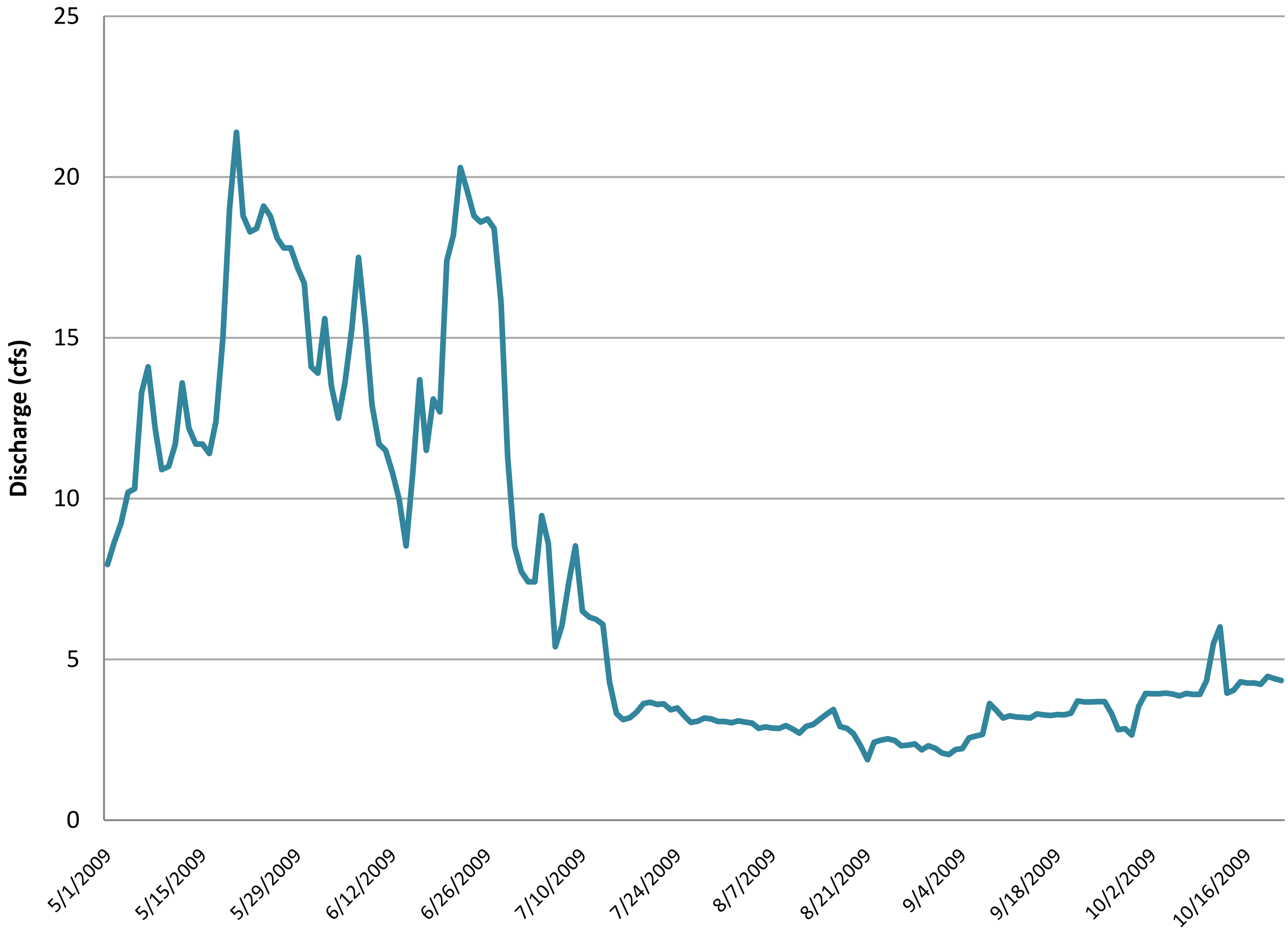


Figure 30. Canyon Creek mean daily flow below confluence with Whitefish Ditch, May 1 to October 22, 2009.

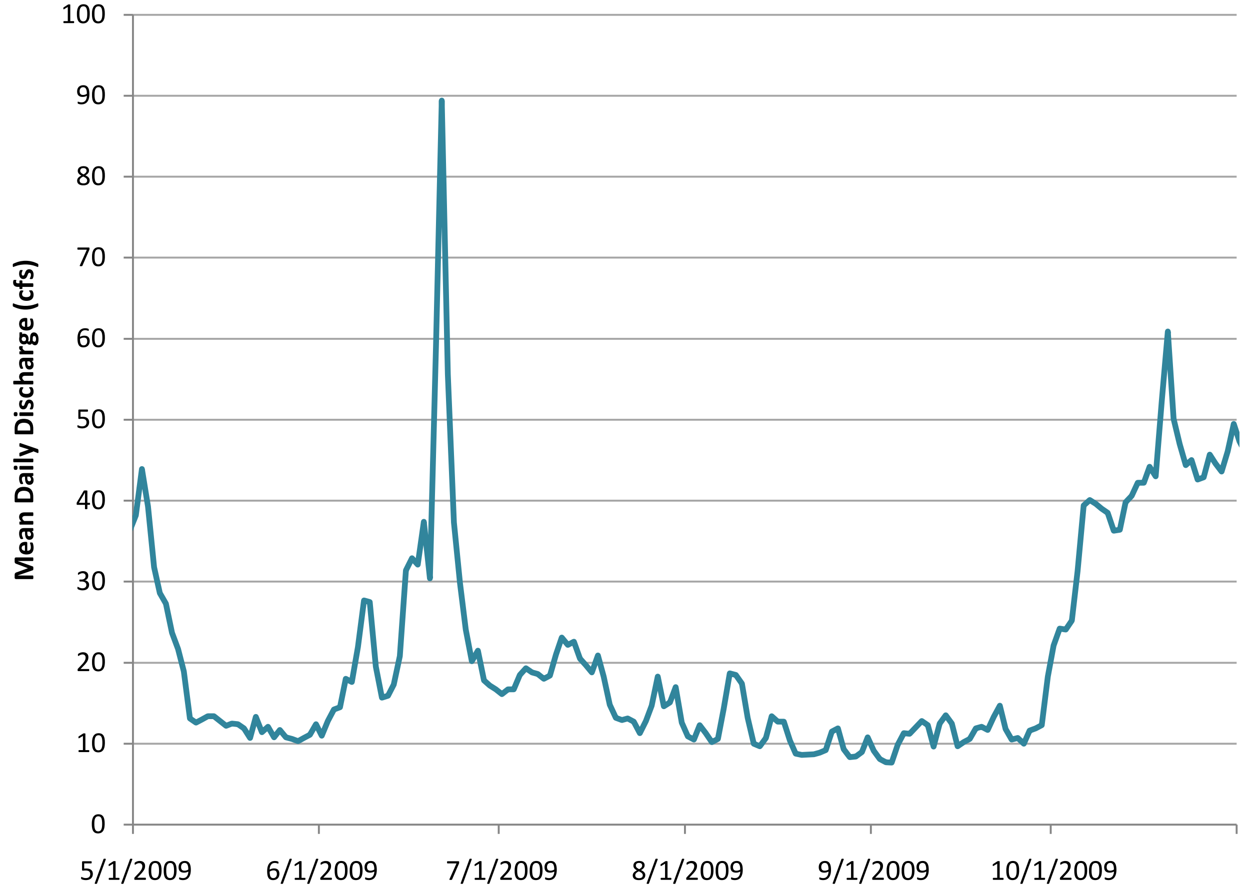


Figure 31. Lemhi River mean daily flow above L-63 diversion, May 1 to October 31, 2009.

Physical Habitat Simulation (PHABSIM) results from a study on Canyon Creek and the Upper Lemhi River (Morris and Sutton 2006) were used to develop habitat availability for those streams. Figures 32-37 represent the percentage of usable area for each species of concern. Juvenile habitat is not included due to limitations of the PHABSIM model.

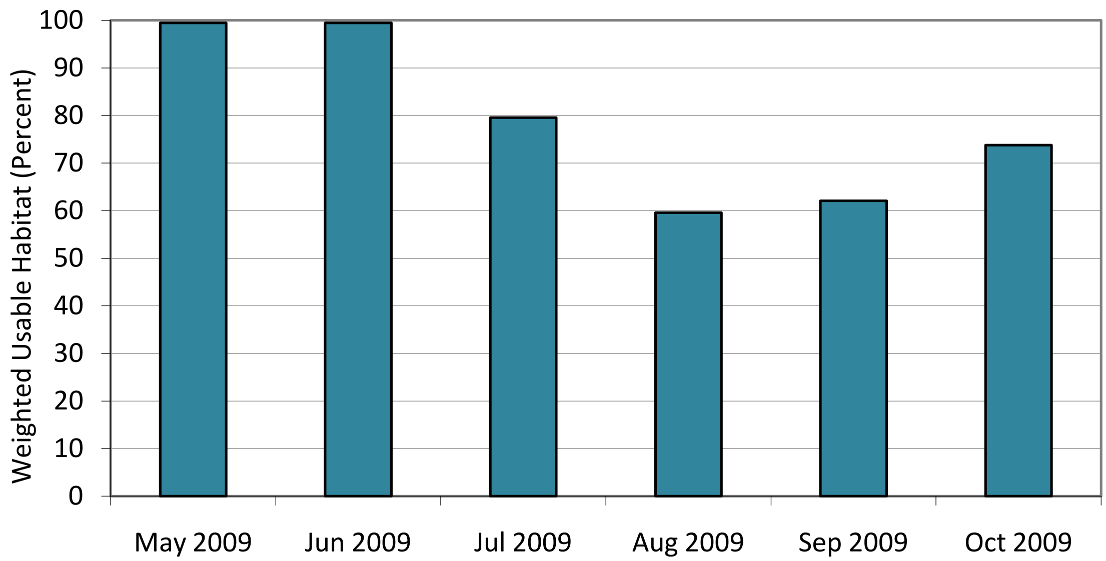


Figure 32. Percent weighted usable habitat for adult bull trout in Canyon Creek at mean monthly flows in 2009. No spawning habitat was available in the lower reach at all sampled flows.

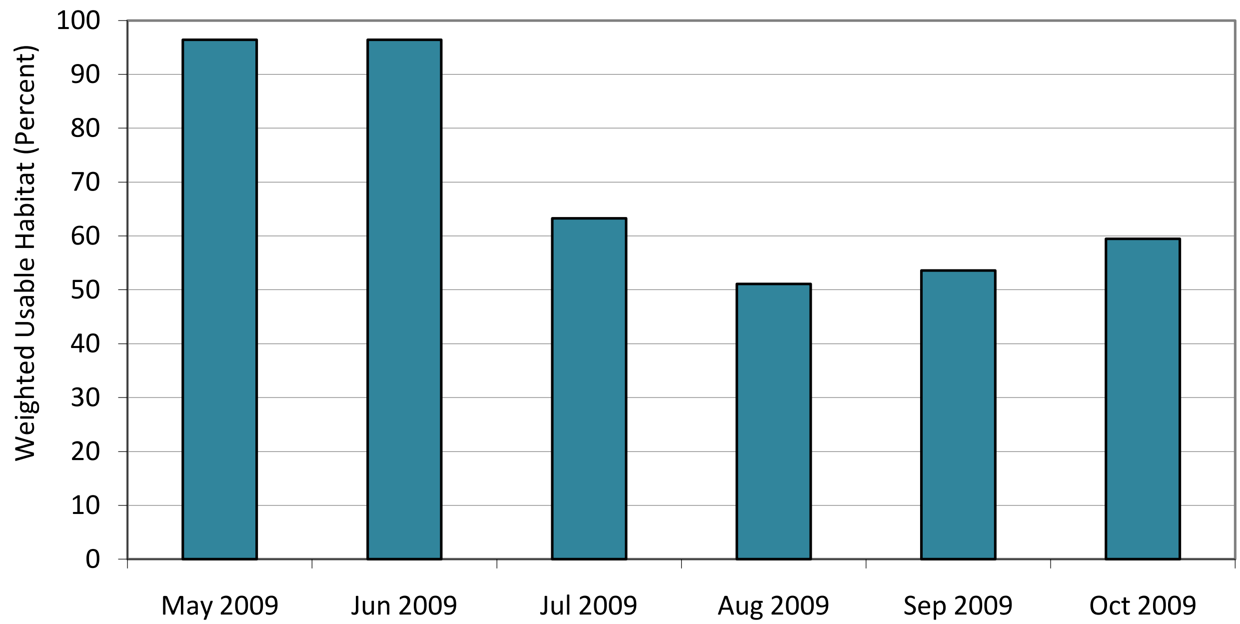


Figure 33. Percent weighted usable habitat for adult Chinook salmon in Canyon Creek at mean monthly flows in 2009. No spawning habitat was available in the lower reach at all sampled flows.

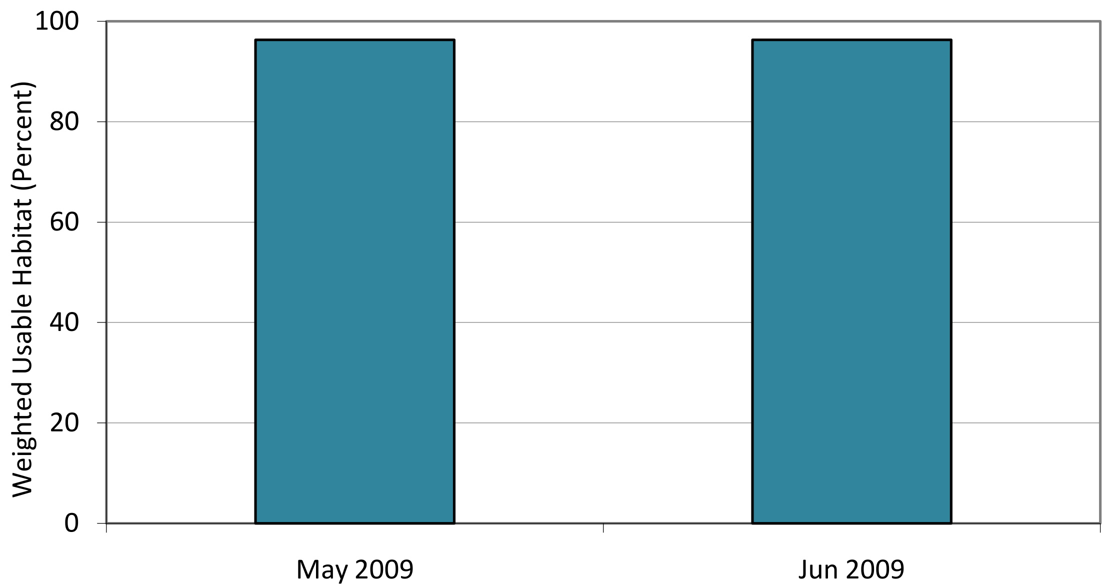


Figure 34. Percent weighted usable habitat for adult steelhead in Canyon Creek at mean monthly flows in 2009. No spawning habitat was available in the lower reach at all sampled flows.

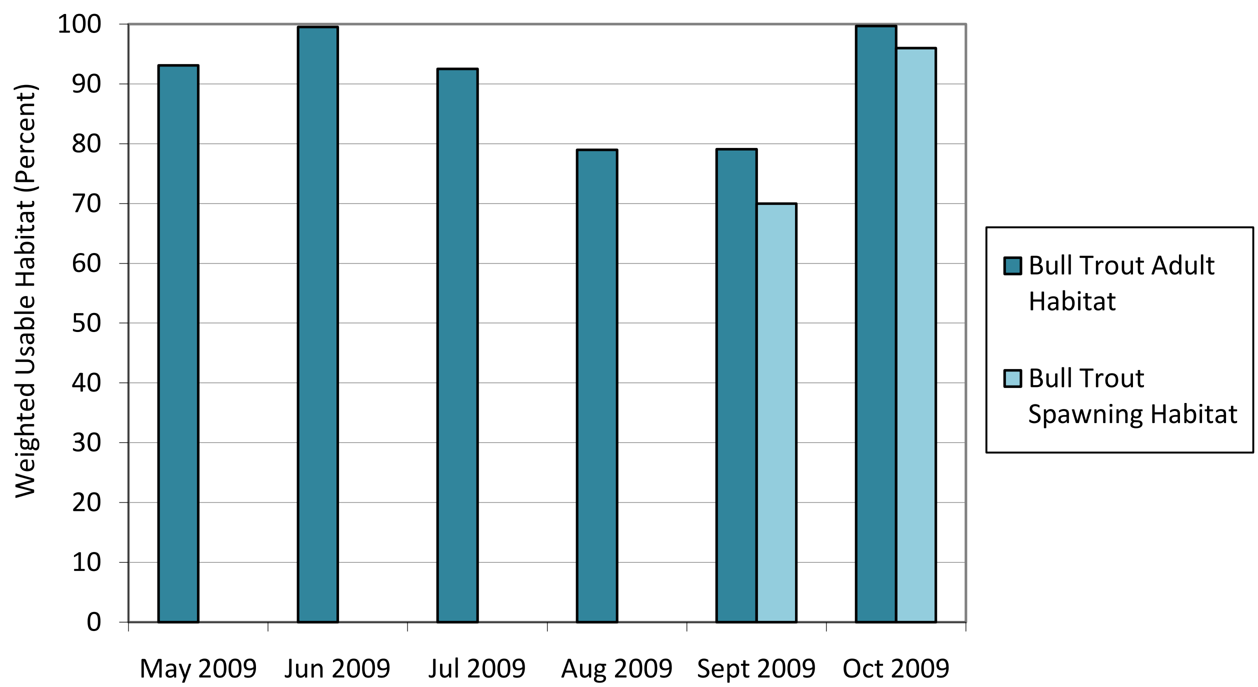


Figure 35. Percent weighted usable habitat for adult and spawning bull trout in the Upper Lemhi River below L-63 at mean monthly flows in 2009

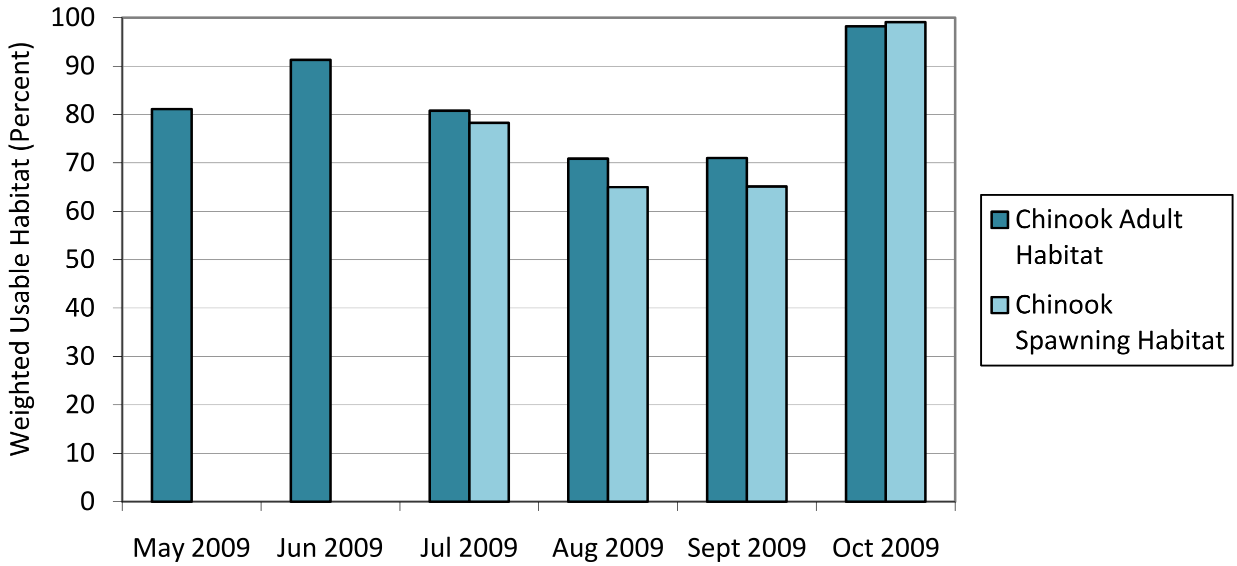


Figure 36. Percent weighted usable habitat for adult and spawning Chinook salmon in the Upper Lemhi River below L-63 at mean monthly flows in 2009. *Flows in August were below the modeled range.

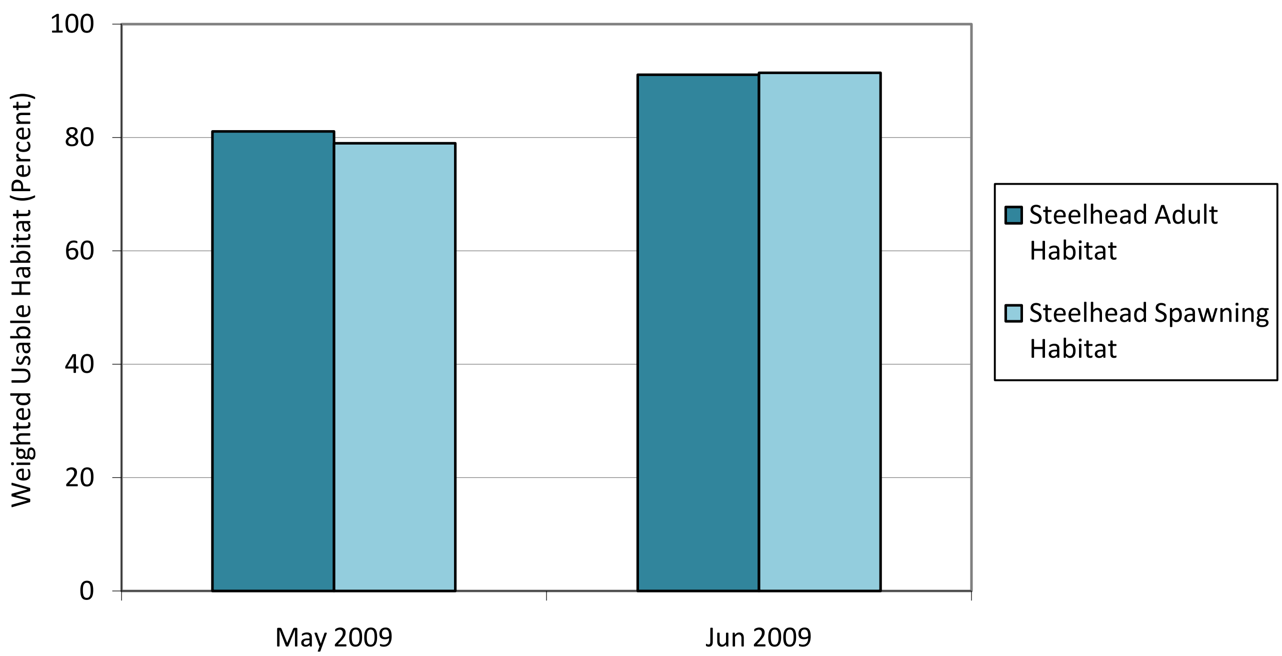


Figure 37. Percent weighted usable habitat for adult and spawning steelhead in the Upper Lemhi River below L-63 at mean monthly flows in 2009.

References

Biggs, M. 2010 Fisheries Biologist. Idaho Fish and Game Screen Shop. Personal communication.

Curet, T. 2008. Fisheries Biologist. Idaho Fish and Game Screen Shop. Personal communication.

Curet, T. 2009. Fisheries Biologist. Idaho Fish and Game Screen Shop. Personal communication.

Garica, D. 2009. Fisheries Biologist. Unites States Forest Service, Salmon-Challis National Forest, Idaho. Personal communication.

Lutch, J. 2006. Fishery Staff Biologist. Idaho Department of Fish and Game. Personal communication.

Maret, T.R., Hortness, J.E., and Ott, D.S. 2005. Instream flow characterization of Upper Salmon River Basin streams, central Idaho, 2004. USGS. Scientific Investigation Report 2005-5212.

Maret, T.R., Hortness, J.E., and Ott, D.S. 2003. Instream flow characterization of Upper Salmon River Basin streams, central Idaho, 2003. USGS. Scientific Investigation Report 2004-5173.

Morris, C. and R. Sutton. 2007. Instream Flow Assessment Hawley Creek and Eighteenmile Creek, Idaho. U.S. Department of the Interior, Bureau of Reclamation Snake River Area Office. Boise, Idaho.

Morris, C. and R. Sutton. 2007. Instream Flow Assessment Upper Lemhi River and Canyon Creek, Idaho. U.S. Department of the Interior, Bureau of Reclamation Snake River Area Office. Boise, Idaho.

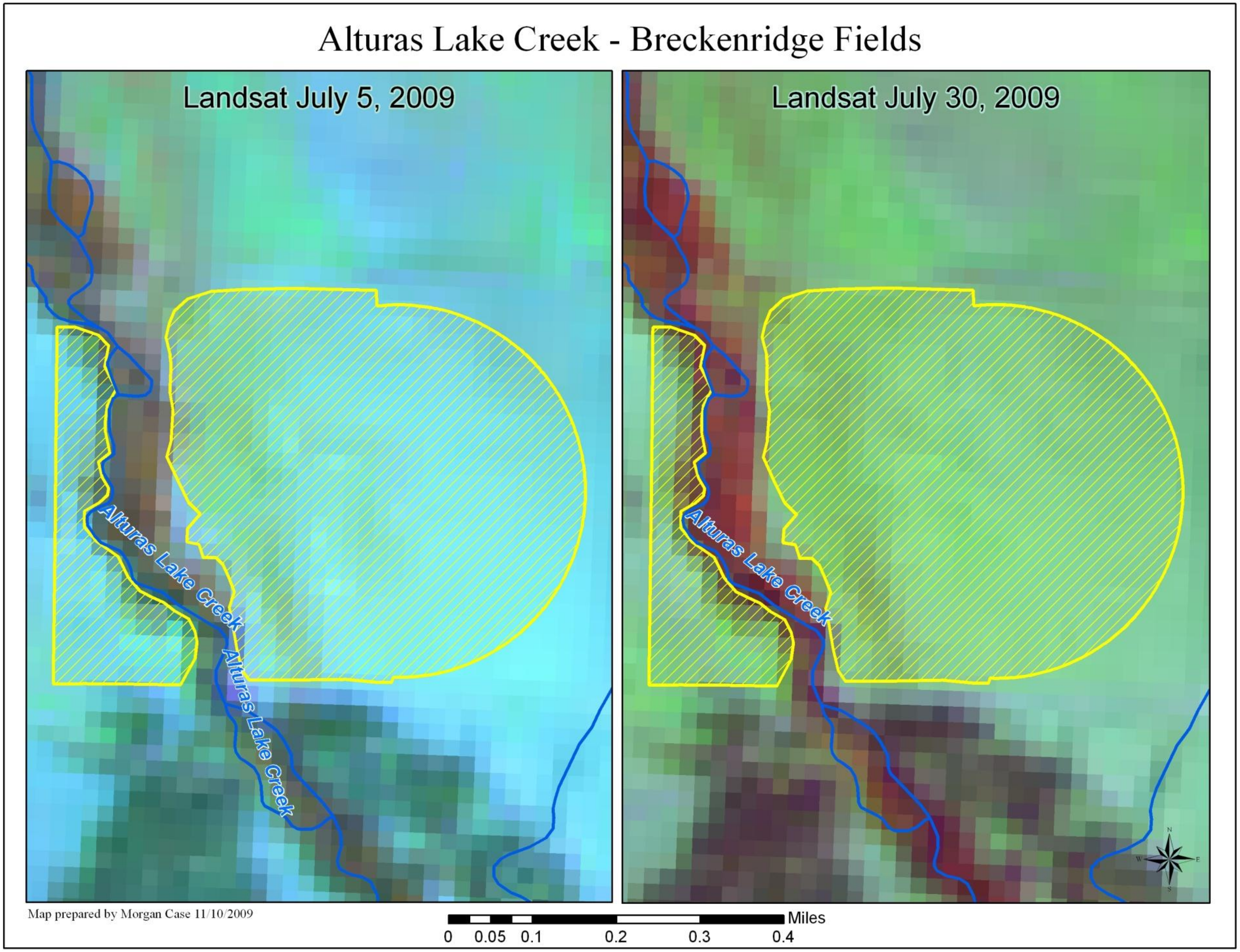
Murphy, P. 2010. Fishery Staff Biologist. Idaho Department of Fish and Game. Personal communication.

Tsosie, T. 2009. Fisheries Biologist. Shoshone Bannock Tribes. Personal communication.

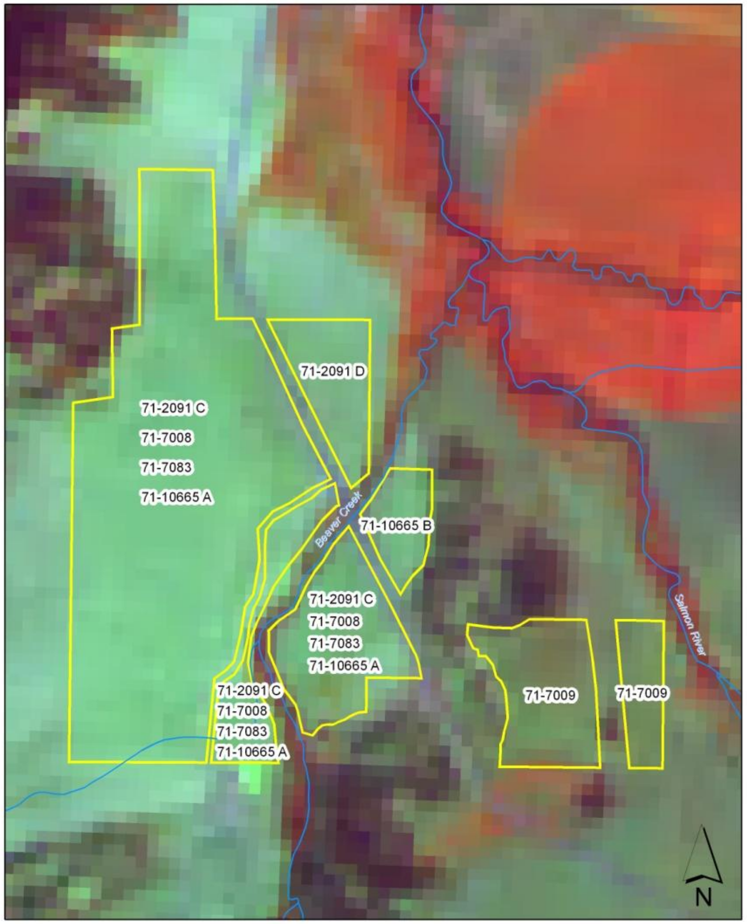
U.S. Environmental Protection Agency. 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards*.* EPA 910-B-03-002. Region 10 Office of Water, Seattle, WA.

Warren, Chuck. 2008. Fisheries Biologist. Idaho Department of Fish and Game. Personal communication.

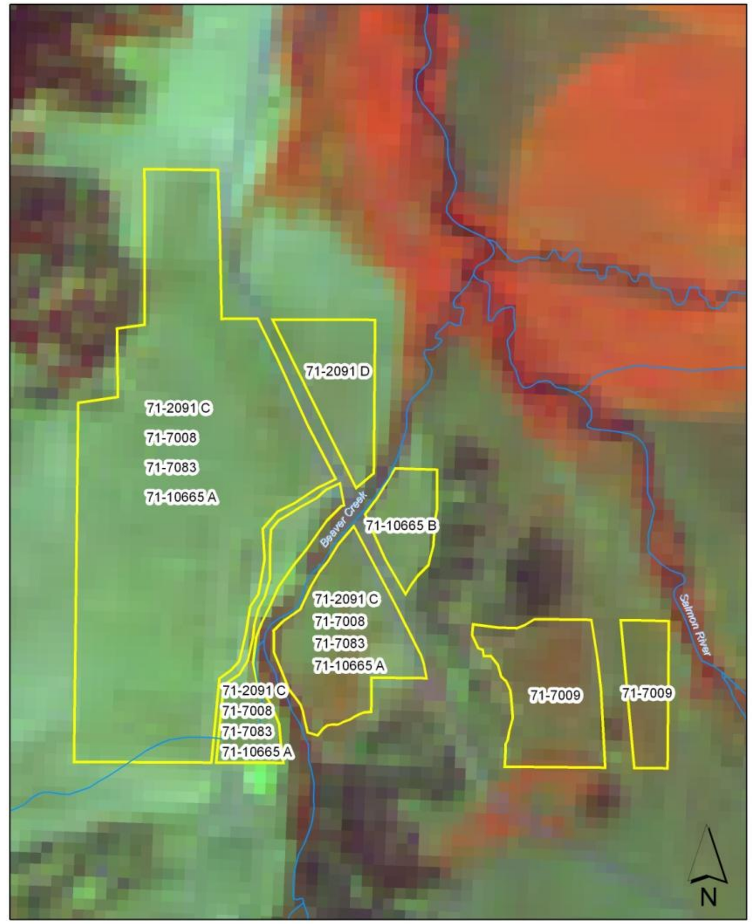
Appendix A
Landsat Images


Alturas Lake Creek - Breckenridge Fields
Landsat July 5, 2009
Landsat July 30, 2009
Alturas Lake Creek
Alturas Lake Creek
Alturas Lake Creek
Map prepared by Morgan Case 11/10/2009
Miles
0
0.05
0.1
0.2
0.3
0.4

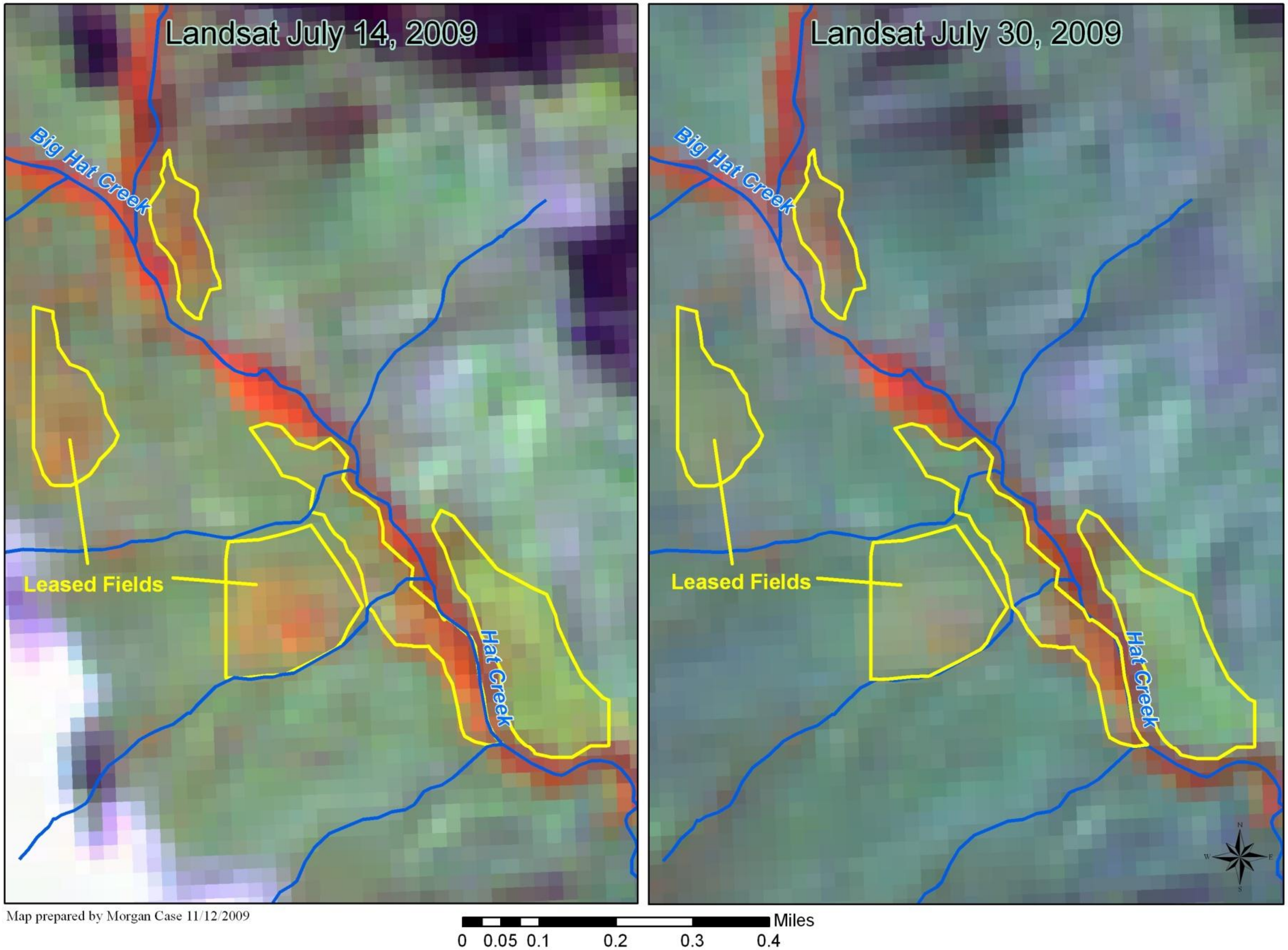
Beaver Creek Leased Fields 2009
LANDSAT Imagery July 30, 2009



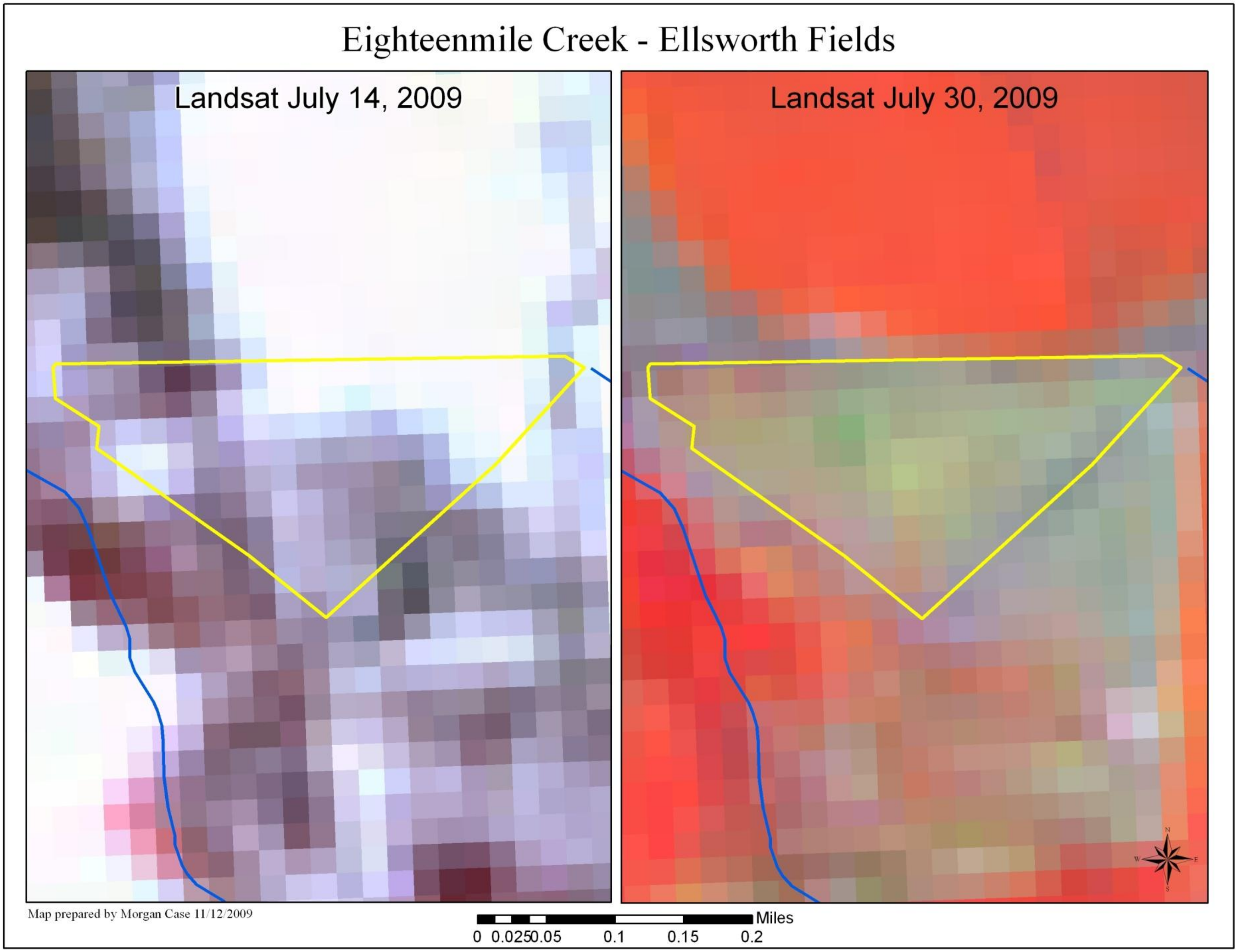
Beaver Creek Leased Fields 2009
LANDSAT Imagery July 14, 2009



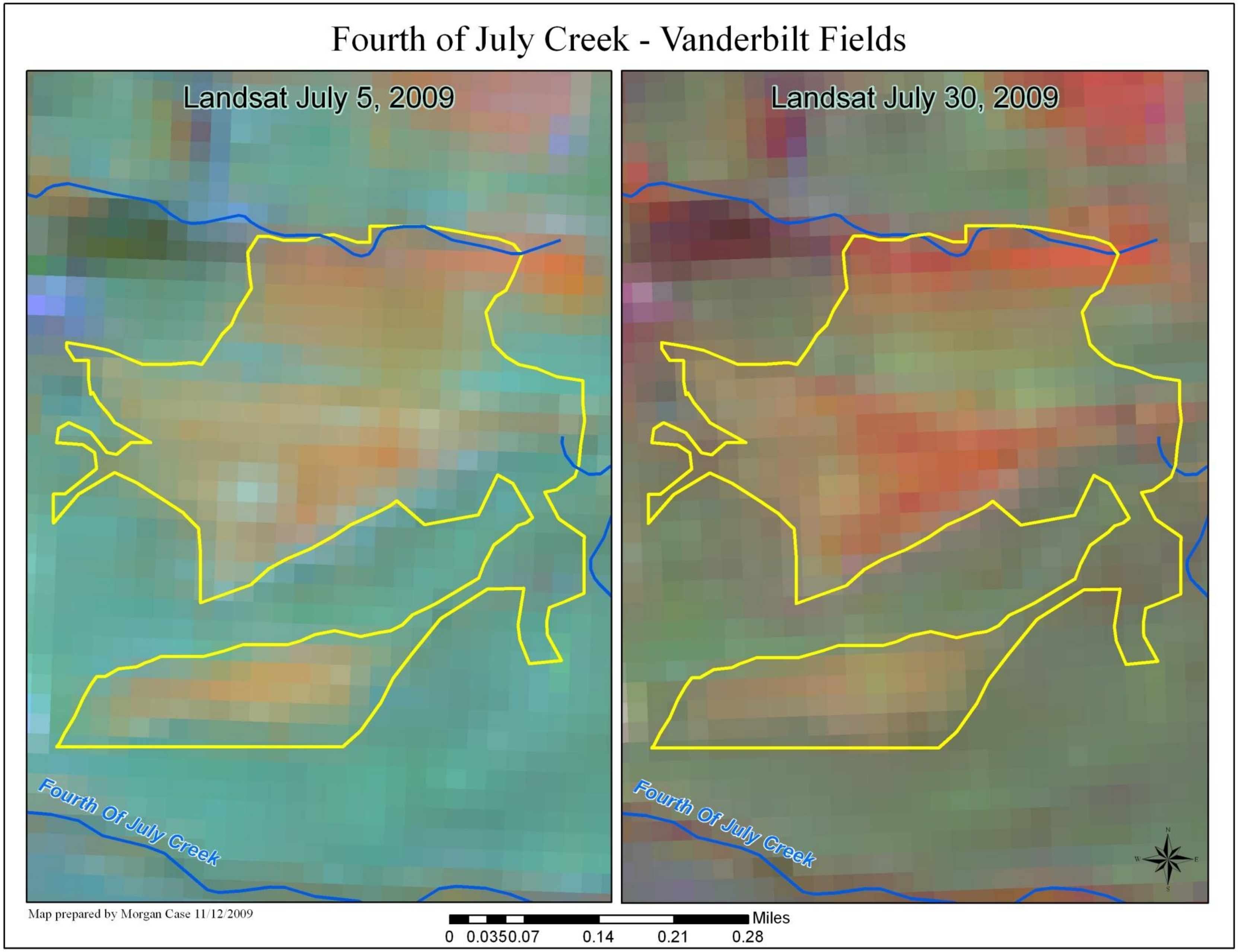
Big Hat Creek - Storlie/Kaiser Fields



Map prepared by Morgan Case 11/12/2009



Eighteenmile Creek - Ellsworth Fields
Landsat July 14, 2009
Landsat July 30, 2009
Map prepared by Morgan Case 11/12/2009
Miles
0 0.025 0.05 0.1 0.15 0.2


Fourth of July Creek - Vanderbilt Fields
Landsat July 5, 2009
Landsat July 30, 2009
Fourth Of July Creek
Fourth Of July Creek
Map prepared by Morgan Case 11/12/2009
Miles
0 0.0350.07 0.14 0.21 0.28