Optimizing Streamflow Enhancement Phase II

Project Summary

By

Idaho Department of Water Resources

Project Overview

DOC, Financial Assistance Award Number:	NA06NMF4380203
CFDA Number:	11.438
CFDA Project Title:	Salmon Restoration, State of Idaho
Geographic Area:	Salmon River above the Middle Fork Salmon River, Idaho
OSC Project Number:	002 06 SA
Project Sub-grantee:	Idaho Department of Water Resources
Project Contact Information:	Eric Rothwell, Hydrologist 322 E. Front St. PO Box 83720 Boise, ID 83720-0098
Grant Period:	01/01/2007-12/31/2008
Total PCSRF Funds:	$315,325
Total Non-Federal Match:	$105,104
Primary PCSRF objectives:	Watershed Subbasin Planning and Assessment

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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 water rights, basin hydrology, the watershed effects that result from changes to water use and clear guidelines regarding how the altered water rights should be regulated and monitored. 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 collected for this study was primarily selected to assist in the calibration or population of the MIKE Basin models. Nineteen stream gages were maintained in 2007 and 24 in 2008. These gages were installed at locations identified for potential projects, or locations where additional data is needed to understand the hydrology. Twenty-five seepage run studies were done on streams that are potentially flow limited. 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. Two new MIKE Basin models were constructed, the North Fork Salmon River and the main Salmon River from the East Fork Salmon to Pahsimeroi River. The following models were also modified and populated: Stanley Basin, Upper Lemhi River Basin, lower Lemhi Basin, and Pahsimeroi River Basin. Many of the models are now ready to be used to evaluate proposed streamflow enhancement projects. Additional data are still needed to populate and calibrate models.

INTRODUCTION

Study Description

Each year a substantial number of 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; 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.

Study Plan

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. Table 1 shows the project timeline from the project work agreement.

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, and, ideally, stream gaging data below diversions to calibrate the model. It was determined that stream gaging and seepage run studies would obtain the most critical data. Given the large number of MIKE Basin models 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 Salmon basin (above the town of Stanley) was identified as a priority for 2007. Seepage run studies in the Salmon River and Valley Creek basins above Stanley were done in 2007. In 2007, we also started to do seepage runs on tributaries to the Lemhi River. Seepage run studies in the Lemhi Basin were the focus of fieldwork in 2008. Stream gages were maintained in order to obtain inflow data above diversions or flow data for model calibration.

Seepage runs

Sixteen seepage studies were conducted on 25 streams in the Upper Salmon during 2007 and 2008. Figures 1-3 show the locations of these studies. 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 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: Lemhi Big Springs Creek; Bohannon Creek; Canyon Creek; Eighteen Mile Creek; Hawley Creek; Kenny Creek; Upper Lemhi River; Little Eight Mile Creek; Little Springs Creek; the Upper Salmon River, Texas Creek, and Valley Creek. In support of Water District 170, all of the diversion measurements and evaluations will be provided to the watermaster, Nick Miller. Please see attachment A for a summary of each seepage study.

Stream gages

Nineteen stream gages were maintained in 2007 and 24 in 2008. The data from these gages can be viewed in attachment B. These gages were installed at locations identified for potential flow projects, or locations were additional data is needed to understand the local hydrology. Several of the IPCo stream gages were moved in the spring of 2008 (Figure 4). These gages were moved because it was determined that sufficient data had been obtained to evaluate streamflow conditions. Gages that were move are Falls Creek, Little Morgan Creek, Garden Creek, Herd Creek, and North Fork Salmon River. The moving of these gages and the new locations was discussed with the USBTT. The locations for the new gages are Lemhi Little Springs Creek below diversions, Upper Lemhi Big Springs Creek, Bohannon Creek above the lowest major diversion (BC2), mouth of 18 Mile Creek, and the Lemhi River above L63.

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). Two new MIKE Basin models were constructed, the North Fork Salmon River and the main Salmon River from the East Fork Salmon to Pahsimeroi River. Staff also modified and populated three water distribution models: the Stanley basin area, Upper Lemhi River basin, and the Pahsimeroi River basin (Figure 1).

Upper Lemhi River Update

The Upper Lemhi MIKE Basin model was used to address questions from the Idaho Attorney General’s office about high flow conditions in the Upper Lemhi

Basin. This effort is important to the development of the Endangered Species Act Section 6 conservation agreement in the Upper Lemhi Basin. Staff used the model to evaluate scenarios in which water deals would be done during the month of May to increase flows in the Lemhi River above McFarland campground. Preliminary results were promising, but it was determined that more data was needed to obtain a satisfactory calibration of the model. Hence, the Director of IDWR requested emergency PCSRF funds so that additional data could be collected in the Upper Lemhi. This request led to the granting of PCSRF contract 05204SA. Staff will recalibrate the Upper Lemhi model with these new data once the 2008 watermaster records are available.

Lower Lemhi River Update

IDWR contracted with DHI to make the following updates to this model. The Lemhi River MIKE BASIN Model (LMBM) was updated by developing and populating the supporting MS EXCEL input and calibration workbook for the lower Lemhi Basin (downstream of diversion L-42). Input sheets for the mainstem Lemhi River and the modeled tributaries were created and populated with water rights data, attributes to calculate return flows, and file names and paths to the MIKE BASIN input data files. For the mainstem Lemhi River diversion L-1 through L-42), the stage data for 2005-2007 was entered, reformatted, converted to discharge, and loaded to the model. The conversion from stage to discharge requires developing a rating curve and then applying that rating curve to the stage data to generate a discharge. Following the updating of the input data, the model input files were updated.

In addition to creating and updating the model input data, calibration sheets were developed for each gage. The calibration sheets are intended to expedite refining the calibration and automatically loading the reach gain/loss to the LMBM. The gages where these sheets were applied include the gages at Hayden Creek, Lemhi River at Lemhi, Lemhi River at Baker, Lemhi River at L-5, Lemhi River at L-3a, and the Lemhi River at L-1. Developing the sheets involved expanding the template calibration sheet to include 1999 - 2008 data, mapping the diversion with return flows to the reach in consideration, entering the result node information, loading observed data, and loading the reach gain time series information.

Main Salmon River

The Main Salmon River MIKE Basin Model (MSRMBM) construction occurred from July to October 2008; during this period IDWR personnel compared water right information to on site use, developed the river network, compiled and populated the model with existing data, and identified data gaps. The primary data needed in the development of a calibrated model are the stream flow, seepage studies, and diversion time series data. Upon calibration and incorporation of the stream and diversion flow data into the model will be able to evaluate diversion operations in the Main Salmon River Basin. Although, this reach of the main Salmon River is not considered to be flow limited, excessive summer time stream temperatures could be a limiting factor to native fishes. Results from this model, once populated and calibrated, could be used to assist stream temperature modeling. Please see the attached report "*Main Salmon River MIKE Basin Modeling Update*" (Attachment C3) for a more detailed description of the work done.

North Fork Salmon River

The North Fork Salmon River MIKE Basin Model (NFSRMBM) construction occurred from July to September 2008. During this period, IDWR personnel compared water right information to on-site use, developed the river network, compiled and populated the model with existing data, and identified data gaps. The primary limiting factors in the development of a calibrated model are the stream flow, losing and gaining reaches, and diversion time series data. Upon calibration and incorporation of the stream and diversion flow data, the model will represent diversion operations in the North Fork Salmon River Basin. Model users can then evaluate the impacts of diversion operations on stream flows. Please see the attached report "*North Fork Salmon River MIKE Basin Modeling Update*" (Attachment C4) for a more detailed description of the work done.

Pahsimeroi River Update

Pahsimeroi River MIKE Basin model was initially constructed by DHI (Danish Hydrologic Institute) in 2004. During 2008, this model was modified to reflect the updated water rights information of diversion and place of use location, amount, and timing. Unfortunately, watermaster records were not available during the study period, preventing a complete calibration of the model. However, significant steps were taken towards the development of this model. DHI developed a rainfall-runoff model for the Pahsimeroi. A summary of the rainfall-runoff work can be seen in Attachment C5. The model was also populated with recently decreed water rights information. IDWR is taking steps towards obtaining watermaster records and will input this information when available. Please see the attached report "*Pahsimeroi River MIKE Basin Modeling Update*" (Attachment C5) for a more detailed description of the work done.

Stanley Area Update

The Stanley area MIKE Basin surface water model was updated with hydrologic field data through Sept 30, 2007. Field data collected included stream gaging records, stream flows above diversions, diversion rates, and seepage runs. These additional data have significantly improved the modeling results for the Salmon River basin above Stanley and the Valley Creek basin. However, some data gaps still exist. These gaps are identified and a data acquisition plan is proposed. With the additions of these new data, the model is ready to be used to simulate potential instream flow projects. Please see the attached report "*Stanley Basin MIKE Basin Modeling Update*" (Attachment C6) for a more detailed description of the work done.

WATER TRANSACTIONS MONITORING AND EVALUATION REPORTS

Staff assisted our water transactions program in 2007 and 2008 by helping with monitoring and evaluation field surveys and preparation of annual reports. In 2007, the IWRB completed 13 water transactions in the Upper Salmon River Basin (Alturas Lake – non-pivot, Beaver Creek, Big Hat Creek, Eighteen Mile Creek, Fourth of July Creek, Lower Lemhi River, Morgan Creek, P-9 Dowton, P-9 Charlton, P-9 Elzinga, P-9 Bowles, Pole Creek, and Whitefish Ditch). The P-9 and Whitefish projects represent new transactions. These projects increased flows and provided valuable fish habitat and passage on more than 200 river miles in the Upper Salmon Basin. In 2008, the IWRB also completed 9 water transactions in the Upper Salmon River Basin (Alturas Lake – non-pivot, Alturas Lake – pivot, Beaver Creek, Big Hat Creek, Eighteen Mile Creek, Fourth of July Creek, Lower Lemhi River, Morgan Creek, and Pole Creek). These projects increased flows and provided valuable fish habitat and passage on more than 185 river miles in the Upper Salmon River Basin. For further analysis please see the attached report, "*Water Transactions Program Monitoring and Evaluation Report"*, for 2007-2008 (Attachment D).

COLLABORATION WITH UPPER SALMON BASIN WATERSHED PROJECT

IDWR staff attended every USBTT meeting during the grant period. Staff provided assistance with understanding of water rights and hydrology as they pertain to streamflow enhancement projects. All of the locations for seepage studies in the Lemhi basin were discussed and will aid project planning in the future. Stream gaging sites were also discussed with the USBTT to ensure that the gages would be in locations beneficial to evaluation of future projects.

RECOMMENDATIONS

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 USBTT and stream gages and seepage studies be performed based on a consensus. Continuation of this work through the appropriation of grant number 006 07 SA Phase III ensures IDWR’s role in collecting critical hydrologic information and the support of streamflow enhancement projects.

FIGURES AND TABLES

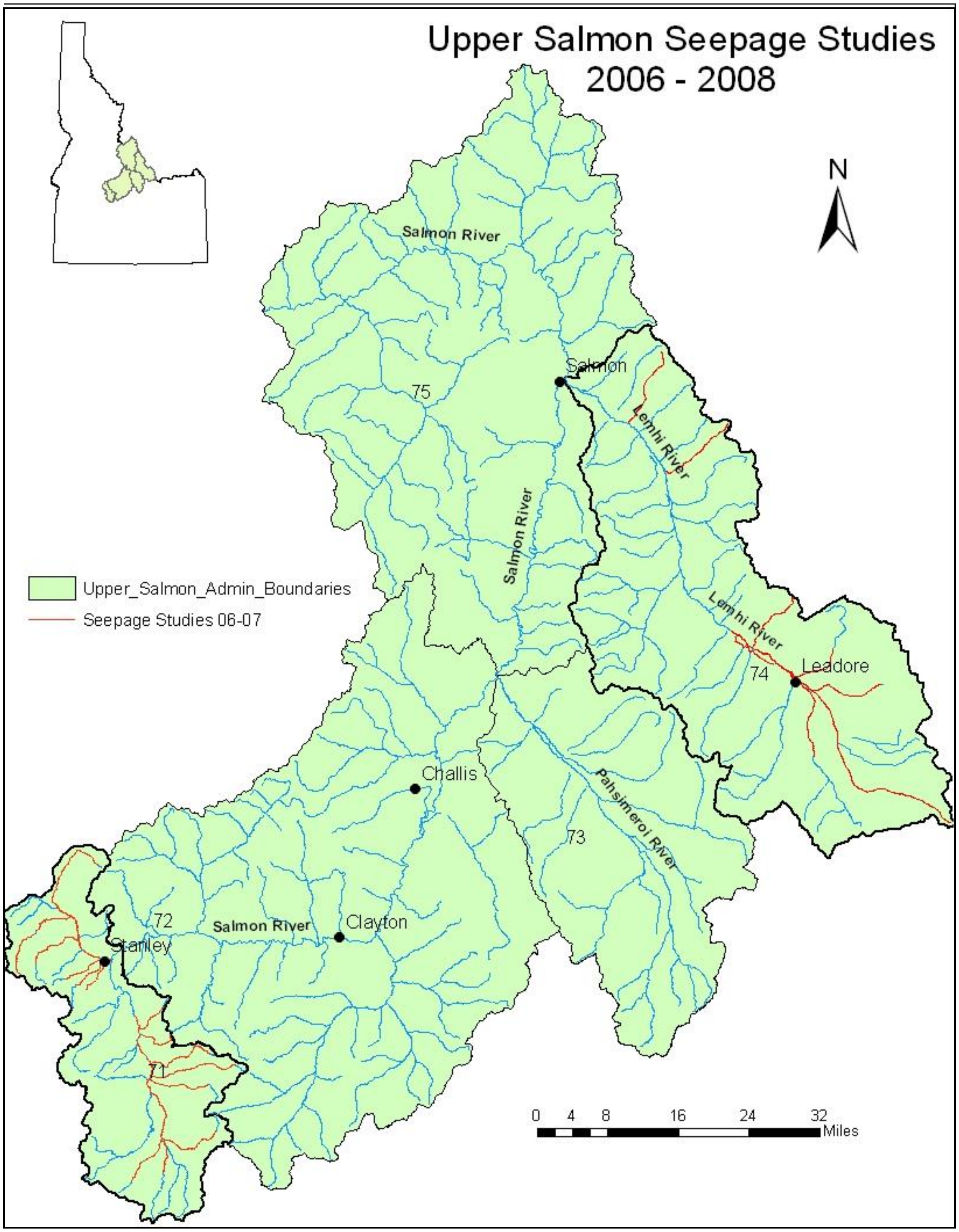

Figure 1. Map of seepage run studies done in the Upper Salmon basin during 2007 and 2008.

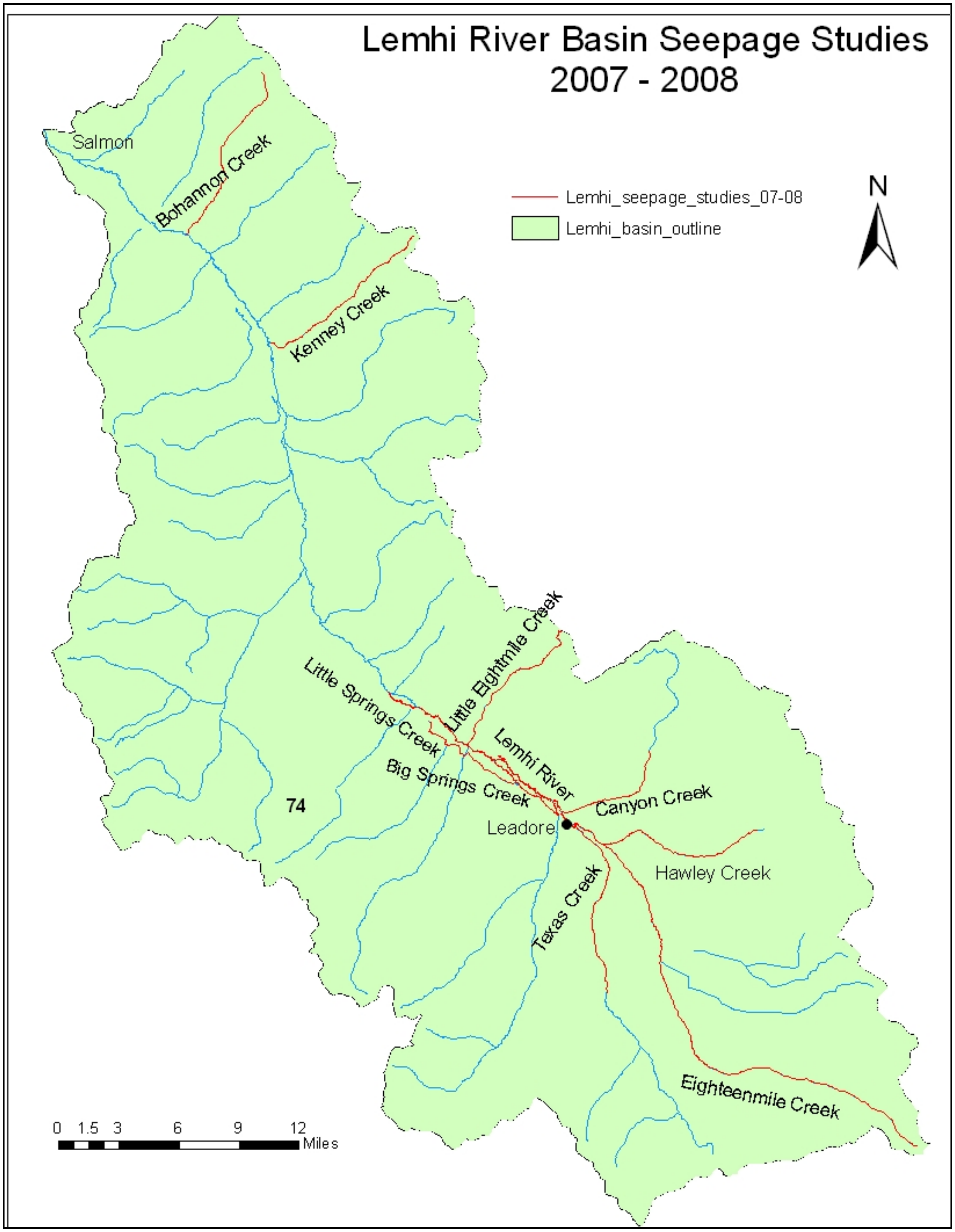

Figure 2. Map of seepage run studies done in the Lemhi River basin during 2007 and 2008.

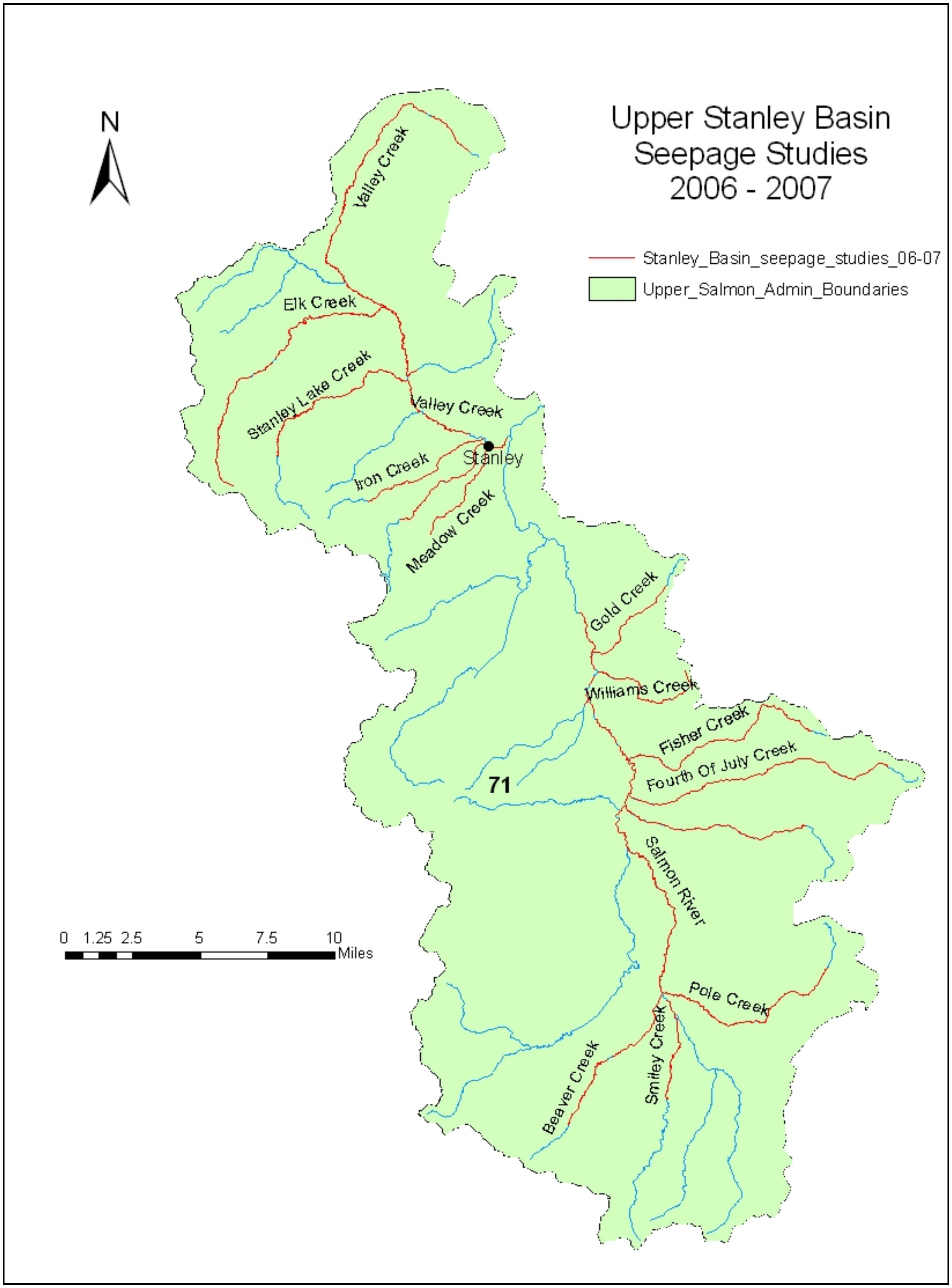

Figure 3. Map of seepage run studies done in Stanley basin during 2007.

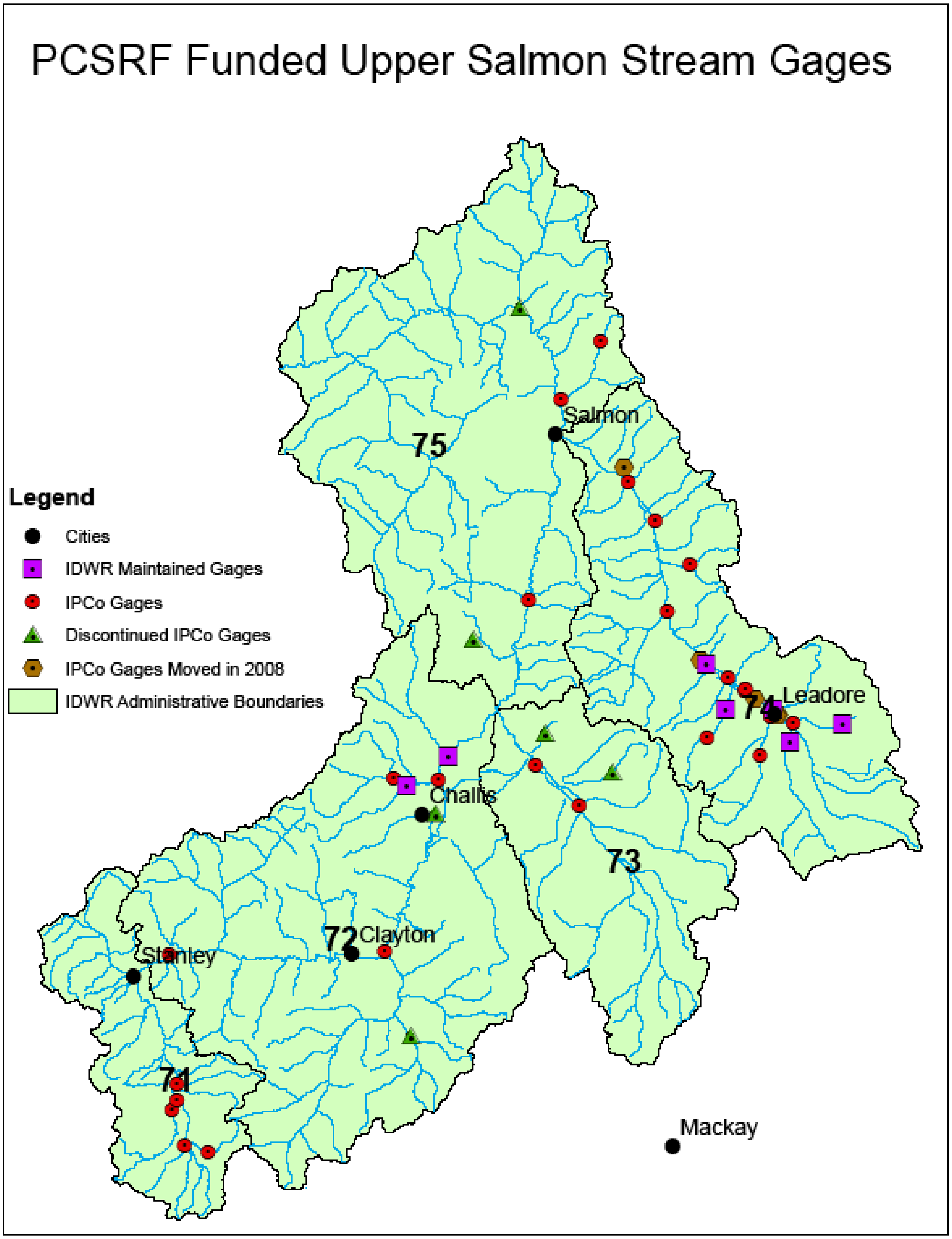

Figure 4. Map of stream gages supported by PCSRF funds.

NO.	DATE	DATE	TASK
1	01 Jan 07	31 Dec 08	Collaborate with Upper Salmon Basin Watershed Project in reviewing and implementing water projects.
2	01 Jan 07 01 Jan 08	31 Mar 07 01 Mar 07	Analyze streamflow and hydrologic data and make available through the IDWR web site.
3	01 Jan 07 01 Jan 08	01 Apr 07 01 Apr 08	Calibrate and populate existing MIKE Basin models in the Pahsimeroi and Stanley Basin. Identify data gaps and collaborate with DHI to improve and expand modeling capabilities. Develop models for the North Fork Salmon and the Salmon River from the East Fork to the Pahsimeroi.
4	01 May 07 01 May 08	30 Oct 07 01 Oct 07	Collect streamflow, diversion and other hydrologic data to evaluate water projects and populate hydrologic models. Provide support to the Water District 170 watermaster.
5	01 Oct 07 01 Oct 08	31 Dec 07 31 Dec 08	Prepare monitoring and evaluation reports for streamflow enhancement projects; evaluate flow data and make recommendations for subsequent years.

Table 1. A general timeline for the project implementation is presented in the following table:

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
Pole Creek	6/28/2005-present	annual	43.90861111	-114.7586111	IPCo
Lower Big Eightmile Creek	5/7/2008-present	seasonal	44.69403942	-113.481541	IDWR
Canyon Creek	5/8/2008-present	seasonal	44.69118549	-113.3633754	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
Garden Creek	6/14/2005-5/9/2008	annual	44.51077778	-114.2029722	IPCo Discontinued
North Fork Salmon River	6/15/2005-6/3/2008	annual	45.40638889	-113.9941667	IPCo Discontinued
Herd Creek	6/28/2005-5/9/2008	annual	44.11916667	-114.265	IPCo Discontinued
Falls Creek	6/29/2005-5/14/2008	seasonal	44.58305556	-113.7655556	IPCo Discontinued
Little Morgan Creek	6/28/2005-5/14/2008	seasonal	44.65305556	-113.9319444	IPCo Discontinued

Table 2. List of stream gages funded by OSFE phase II project.

APPENDICES

ATTACHMENT A. SEEPAGE STUDY REPORTS

Attachment A1. Lemhi Big Springs Creek Seepage Study

Two seepage studies were conducted the August 21-22, 2007 and the second August 19, 2008 by IDWR staff. These studies consisted of measured surface water flows (stream flows, diversion rates, and return flows) in Lemhi Big Springs Creek in order to quantify gaining and losing reaches.

All of the diversions were off during the 2007 seepage run. The subreach from the confluence of what we called the east and west forks to BS 5a/BS 4 had a cumulative reach gain of 28.6 cfs. The reach from BS5a/BS4 down to the mouth lost about -0.80 cfs.

During the 2008 study 13 measurements or observations were taken, including measurements of diversions, stream flows, and return flows. The upper part of Big Springs Creek gains rapidly, this was observed adjacent to the highway gaining flows upstream of the upper most diversion, BS6. The flow measured above BS6 was 17.3cfs; 5.3cfs of this was diverted by BS6. Downstream of BS6 and upstream of BS5 a side channel tributary starts from a man made pond that collects spring water. This channel flows along the south side of the highway until it reaches two culverts, separated by ~150 yards, where the flow is split and flows under the highway into the main stem Big Springs. Big Springs Creek gains 9.3cfs from the side tributary and also gains an additional 13.5cfs in reach gains from BS6 to BS5a. Big Springs 5 (BS5) diverts 3.4cfs and BS5a diverts 1.2cfs. Below BS5 two diversions, CH4 (0.1cfs) and CH3 (0.2cfs), were taking smaller volumes and this reach was losing 0.8cfs due to seepage. BS2 was diverting the most the day of the study at 6.6cfs and BS1 was only diverting 0.3cfs; but downstream of BS3 to the mouth was also a gaining reach that accumulated an additional 4.1cfs.

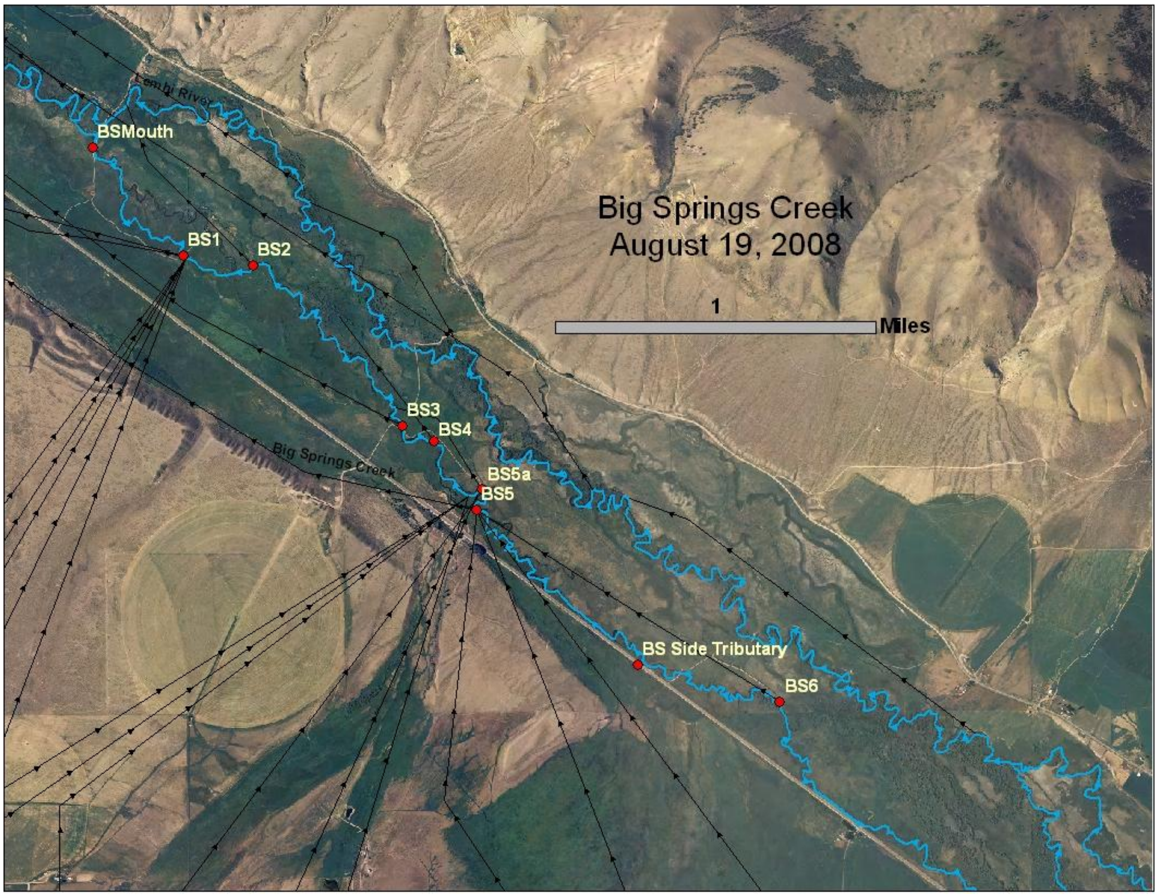

Figure 1. Map of Big Springs Creek with important surface water features labeled. The black lines with arrows represent the MIKE Basin Model diversion reaches.

Main Stream Location	Trib/Div Location	Discharge	Q diverted out	Trib/diversion Q in	Big Springs Creek Q	Seepage	Point_X	Point_Y	X-Section Substrate	Date and time
		(cfs)	(cfs)		(cfs)	(cfs)				
BS East Channel, Abv Diversions		6.93					2548537	1499835.741	Sandy and silt	8/21/2007 4:10-4:40
	BS West Channel Abv diversions	2.20		2.20			2548471	1499815.32	Fine Gravel	8/21/07 14:06
BS East and West Channel Confluence		**9.13**			9.13		2548491	1499854.883		
Between Confluence and BSC6										
Abv BS6		18.2			18.2		2548327	1500228.378	Coarse gravel	8/21/2007 5:30-6:20
	BS6	0.00	0.00							
Blw BS6		**18.2**			18.2					
BS6 to BS5-5A						9.07				
Abv BS5A and BS5		37.7					2546837	1501244.006	Fine Gravel and Coarse Cobbles	8/21/2007 7:00-7:30pm
	BS 5 and BS5A	0.00	0.00							
BS Blw 5 and 5A		**37.7**			37.7					
BS5-5A to BS4						19.5				
BS Abv BS4		**34.4**			34.4					
	BSC4	0.00	0.00							
Blw BS4 and Abv BS3		34.4			34.4		2546412	1501639.711	Gravel	8/21/2007 8:52-9:50
BS4 to BSC3						-3.25				
Big Springs Blw BSC4 and Abv BSC3		34.4			34.4		2546412	1501639.711	Gravel	8/21/2007 8:52-9:50
	BSC3	0.00	0.00							
Big Springs Blw BSC3		**34.4**			34.4					
BS3 to BS2						0.00				
Abv BS2		**40.5**			40.5					
	BSC2	0.00	0.00							
Blw BS2		40.5			40.5		2545661	1502471.016	Gravel	8/22/2007 10:45-11:20
BS2 to BS1						6.11				
Abv BS1		40.5			40.5					
	BS1	0.00	0.00				2545565	1502447.069		
Blw BS1		**40.5**			40.5					
BSC1 to the MOUTH						-3.67				
Big Springs **Mouth**		36.8			36.8		2544878	1503055.192	Gravel + some cobbles	8/22/2007 12:20-12:50

Table 1. Summary of the 2008 seepage study for Big Springs Creek, including reach gains and losses calculated from the measured flows. Location coordinates are in the IDTM projection

Big Springs Creek Summary	
Initial flow/input	6.93
Diverted rate out	0.00
Tributary/injection Input	2.20
Cumulative reach losses	-6.92
Cumulative reach gains	34.6
Calculated output	36.8
Measured output	36.8

Table 2. Summary of the 2008 Big Springs Creek seepage study.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Trib/diversion Q in	Big Springs Creek Q	Seepage	Point_X	Point_Y	Date and time	Notes
Above BS6		17.30			17.30		2548332	1500195	8/19/2008 11:26am	
	BS6	5.30	5.30				2548313	1500297		
Below BS6		**12.00**			12.00					
	Big Springs Side	9.28		9.28			2547600	1500482		
BS below side		**21.28**			21.28		2547600	1500482	8/19/2008 3:00pm	Measured upstream of two culverts that cross under the highway and feed the mainstem Big Springs
Above BS5 and Upper Gauge		34.74			34.74		2546815	1501269	8/19/2008 12:45pm	
	BS5	3.394	3.39				2546788	1501259.6	8/19/2008 3:43pm	Downstream of screen on ditch, screen staff plate read 1.22ft.
Below BS5		**31.35**			31.35					
Above BS5a		**31.35**								
	BS5a	1.24	1.24				2546811	15001411	8/19/08 0:00	Staff plate on screen read 1.77ft.
Below BS5a		**30.10**			30.10					
Above BS6 to BS5a						13.46				
Above BS4		**30.10**								
	BS4	0.10	0.10				2546445	1501760	8/19/2008 1:55pm	
Below BS4		**30.00**			30.00					
Above BS3										
	BS3	0.24	0.24				2546418.5	1501680.5		
Below BS3		28.95			28.95		2546288	1501776	8/19/2008 2:00pm	Light sprinkling during a thunderstorm.
BS5a to BS3						-0.82				
Above BS2		**28.95**								
	BS2	6.55	6.55				2545668	1502483.6		
Below BS2		23.43			23.43		2545647	1502452	8/19/2008 5:20pm	
BS3 to BS 2						1.03				
Above BS1		**23.43**								
	BS1	0.30	0.30				2545317.5	1502535.1	8/19/2008 5:30pm	Visual estimate, very small flow and no good measurement location.
Below BS1		**23.13**			23.13					
Mouth/gauge		26.20			26.20		2544861.4	1503074.4		Stage was 4.00ft at 5:50pm dls. Flow value is from IPCO rating.
BS2 to Mouth						3.08				

Table 3. Summary of the 2008 seepage study for Big Springs Creek, including reach gains and losses calculated from the measured flows. Location coordinates are in the IDTM projection.

Big Springs Creek Summary	cfs
Initial flow/input	**17.30**
Diverted rate out of Big Springs Creek	**17.12**
Tributary/injection Input	**9.28**
Cumulative reach losses	**-0.82**
Cumulative reach gains	**17.56**
Calculated output	**26.20**
Measured output	**26.20**

Table 4. Summary of the 2008 Big Springs Creek seepage study.

Attachment A2. Bohannon Creek Seepage Study

A seepage study was conducted September 16 and 17, 2008 by IDWR staff. The study consisted of measured surface water flows (stream flows, diversion rates, return flows and tributary inputs) in Bohannon Creek and East Fork Bohannon Creek in order to quantify gaining and losing reaches. During the two day study thirty-five measurements or observations were taken, including measurements of the mouth of the East Fork Bohannon Creek (Figure 1; Table 1). The Wimpy Creek injection to East Fork Bohannon Creek was not located, none of the East Fork diversions were being used during the study, and the EF1 diversion does not appear useable.

During the study BC10 and BC3 diverted the entire flow. Below BC3 the channel was nearly dry gaining approximately 0.5cfs to the mouth. Overall Bohannon Creek gains flow downstream of the dewater reach below BC8 to BC3, but currently this stream is disconnected from the Lemhi River during irrigation season (Table 2).

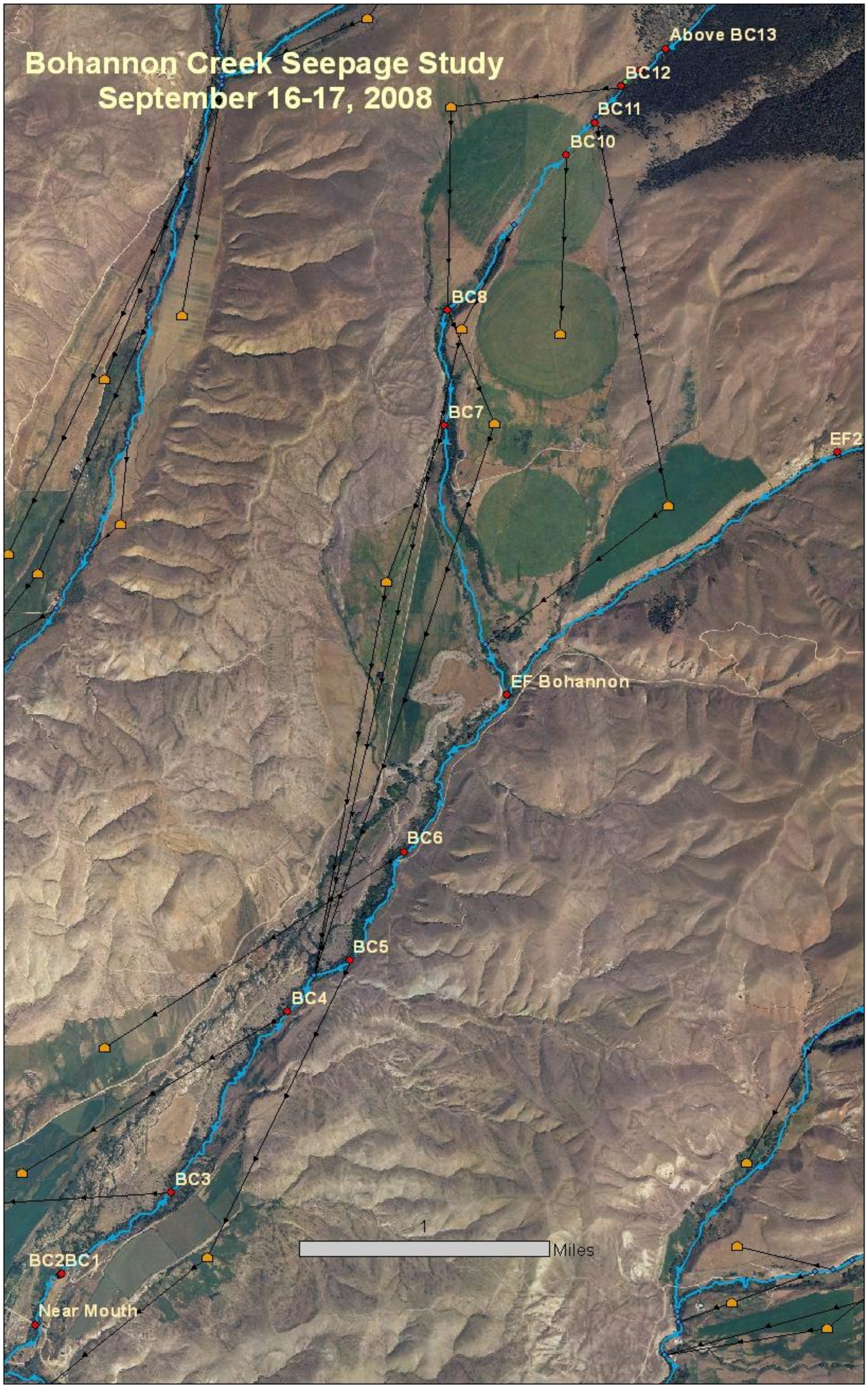

Figure 1. Map of Bohannon Creek with important surface water features labeled. Black lines with arrows represent diversion channels and the yellow shapes represent user nodes in the MIKE Basin Model.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Trib/diversion Q in	Bohannon Creek Q	Seepage	Point_X	Point_Y	Date and Time	Notes
Above all diversions to EF										
Above BC13		6.03			**6.03**		2524224	1554385	9/16/2008 10:10am	This is the uppermost point measured.
	BC13	**2.10**	2.10							
Below BC13		3.94			**3.94**		2524059	1554239	9/16/2008 10:10am	Measurement was below overflow at pipe input for BC13.
Above BC12		**3.94**								
	BC12	0.10	0.10				2523937	1554134	9/16/2008 10:53am	Estimate
Below BC12		**3.86**								
Above BC11		3.86			3.86				9/16/2008 11:35am	Above BC11 by 30ft.
	BC11	1.77	1.77				2523766	1553893	9/16/2008 12:30pm	Cipolletti weir is warped.
Below BC11		2.09			2.09					
Above BC10		1.90			1.90				9/16/2008 12:28pm	Measured 80ft upstream of diversion structure. Steep channel with large substrate.
	BC10	1.65	1.65				2523582	1553680	9/16/2008 1:15pm	BC10 takes most of the flow. Some leaks through diversion dam (wood) and a little more spills at the pipe input. Estimate.
Below BC10		0.25			0.25				9/16/2008 1:15pm	Estimate of flow below diversion.
Above BC9		0.50			0.50		2523240	1553227	9/16/2008 1:55pm	Estimate due to shallow flows and large substrate.
	BC9	0.00	0.00				2553603	1486977	9/16/2008 1:54pm	Diversion does not look like it is used often. Maybe only during high flows.
Below BC9		0.50			0.50					
Above BC8		0.46			0.46					
	BC8	0.20	0.20				2522817	1552649	9/16/2008 2:47pm	Estimate, diversion is off but there is flow in ditch. Culvert in unscreened ditch is a barrier.
Below BC8		0.26			0.26				9/16/2008 2:18pm	Sculpin and 6inch trout near cross-section.
Above BC7		0.87			0.87					
	BC7	0.02	0.02				2522798	1551883	9/16/2008 3:20pm	BC7 is a small culvert with a Cipoletti weir just downstream of the culvert. BC11 is piped under Bohannon Creek to the BC7 ditch. Never found BC7a. 3ft Cipoletti H=0.025ft.
Below BC7		**0.84**			0.84					
Above BC7a		**0.84**								
	BC7a	0.00	0.00							
Below BC7a		0.84			0.84				9/16/2008 3:30pm	
Above all diversions to EF						0.65				
Above EF Bohannon		**1.16**			1.16					
	EF Bohannon	5.40		5.40			2523201	1550095	9/16/2008	
Below EF Bohannon		6.56			6.56				9/16/2008 4:57pm	
Above BC6		6.28			6.28				9/16/2008 6:00pm	This measurement taken again at 7.769cfs 9/17/2008 8:55am.
	BC6	0.00	0.00				2522533	1549051	9/16/2008 5:50pm	Closed headgate.
Below BC6		7.77			7.77				9/17/2008 8:55am	The 7.769cfs flow measured on 9/17/2008 is used for the flow for this point because it the same day as all measurements downstream.
Above BC5		8.42			8.42				9/17/2008 9:53am	
	BC5	2.23	2.23				2522184	1548331	9/17/2008 10:30am	
Below BC5		**6.19**			6.19					
EF Confluence to Below BC5						2.18				
Above BC4		6.05			6.05				9/17/2008 11:46am	Large boulders and tarp force most of the flow down a ditch to the headgate. At the headgate where there is additional return to the channel from the ditch.
	BC4	2.56	2.56				2521787	1547992	9/17/2008 11:20am	3ft Cipoletti downstream of screen, with a head of 0.40ft. Weir is in good shape, level and has slow entrance velocity
Below BC4		**3.50**			3.50					
Above BC3		2.95			2.95				9/17/2008 2:00pm	Diversion captures entire stream. No return from the screen. This measurement was taken 25ft upstream of the IPCO staff plate which measured 0.97 during the measurement, with the -0.08 shift the discharge from rating is 3.03.
	BC3	2.85	2.85				2520990	1546753	9/17/08 0:00	3ft Cipoletti H=0.43. No return flow from fish screen. Bohannon Creek is almost dry other than a little flow getting past the diversion dam.
Below BC3		**0.11**			0.11					
Above BC4 to below BC3						-0.68				
Above BC2		**0.27**			0.27					
	BC2	0.00	0.00						9/17/2008 1:00pm	Ditch has not been used, just a depression.
Below BC2		**0.27**			0.27					
Above BC1		0.27							9/17/2008 1:14pm	Diversion may take 1/3 of the flow. Poor measurement due to substrate size, cross-section, and low flow.
	BC1	**0.09**	0.09				2520327	1546250		
Below BC1		**0.18**			0.18					
Mouth		0.50			0.50		2520156	1545912	9/17/2008 1:28pm	Estimated flow at road culvert. No good place to measure, low flows and large substrate.
Above BC2 to Mouth						0.48				

Table 1. Summary of seepage study for Bohannon Creek, including reach gains and losses calculated from the measured flows.

Bohannon Creek Summary	cfs
Initial flow/input	**6.031**
Diverted rate out of Bohannon Creek	**13.562**
Tributary/injection Input	**5.400**
Cumulative reach losses	**-0.678**
Cumulative reach gains	**3.309**
Calculated output	**0.500**
Measured output	**0.500**

Table 2. Summary of Bohannon Creek seepage study.

Attachment A3. Canyon Creek Seepage Study

A seepage study was conducted August 18-19, 2008 by IDWR staff. The study consisted of measured surface water flows (stream flows, diversion rates, and return flows) in Canyon Creek in order to quantify gaining and losing reaches. During this study nine measurements or observations were taken (Table 1), including measurements of diversions, stream flows, and return flows. Above all diversions Canyon Creek was flowing 6.64 cfs and loses 0.15 cfs of flow between diversions CC3 to CC2. The second diversion, CC2 was the largest taking 5.5cfs down a pipe. During this study the lowest diversion CC1 was not in use. Water from Eighteen Mile Creek contributed 2.15 cfs routed through the White Fish ditch to lower Canyon Creek; this more than doubled the remaining flow in the Canyon Creek at that point. The reach from the lowest diversion gains 0.14 cfs in seepage (Table 2).

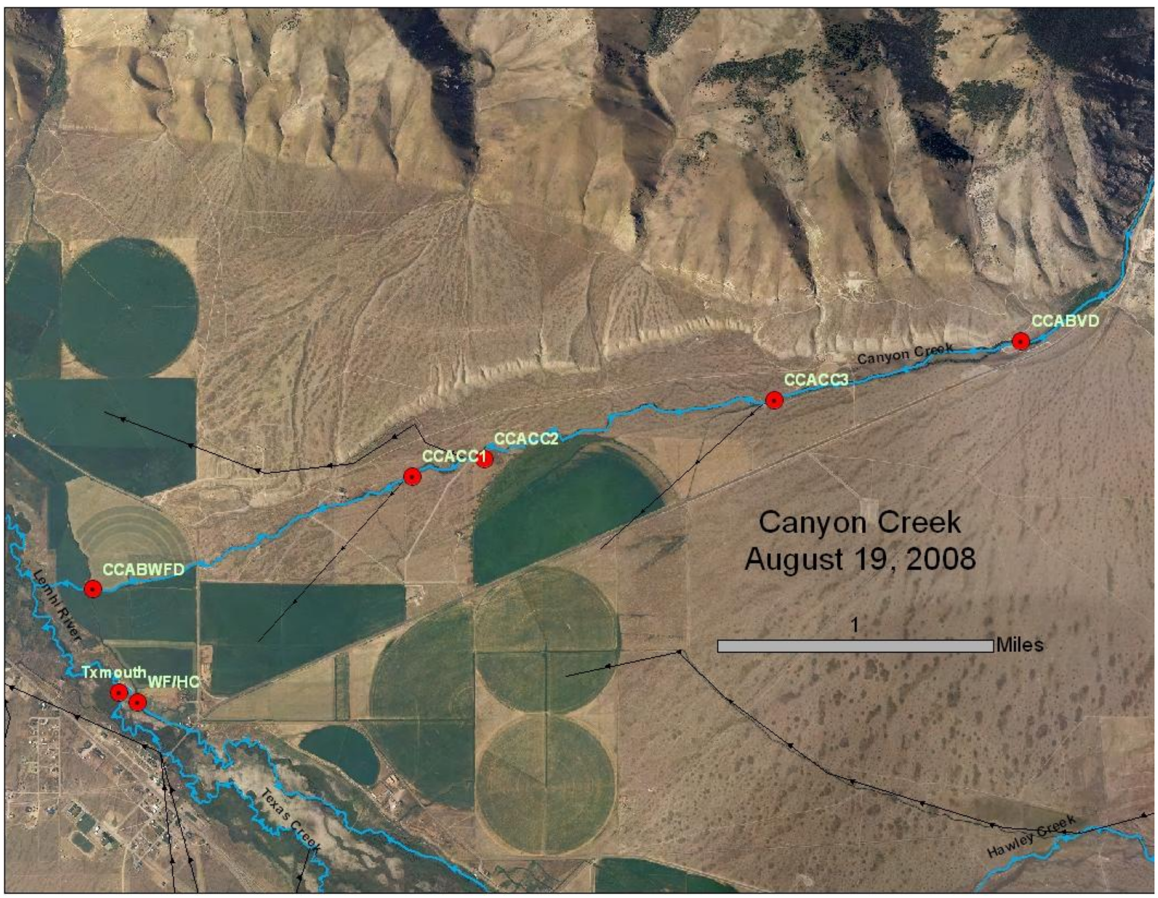

Figure 1. Map of Canyon Creek with important surface water features labeled.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Trib/diversion Q in	Canyon Creek Q	Seepage	Point_X	Point_Y	Date and time	Notes
Above CC3		6.64			6.64				8/18/2008 4:50pm	Salmonid (7in.) in stream.
	CC3	0.10	0.10				2554551	1500141	8/18/2008 5:00pm	Trickle going down ditch. Juvenile salmonid in ditch.
Below CC3		**6.54**			6.54					
Above CC2		6.39			6.39				8/18/2008 5:50pm	
	CC2	**5.47**	**5.47**				2552860	1499798		Diversion is through submerged pipe, we measured above and below to determine diversion rate.
Below CC2		0.91			0.91				8/18/2008 5:45pm	
Above CC3 to CC2						-0.15				
Above CC1		0.86			0.86				8/19/2008 9:00am	CC1 was not running.
	CC1	0.00	0.00				2552443	1499696	8/19/2008 9:00am	Ditch was muddy, looks like it was recently used.
Below CC1		**0.86**			0.86					
CC2 to CC1						-0.05				
Above WF ditch		**1.00**			1.00					
	WF ditch	2.15		2.15			2550576	1499039	8/19/2008 10:00am	
Gauge/mouth		3.15			3.15				8/19/2008 10:00am	Center pivot in adjacent field was off, there was a handline that was on. Seven inch salmonid near measurement site.
CC1 to Mouth						0.14				

Table 1. Summary of seepage study for Canyon Creek, including reach gains and losses calculated from the measured flows. Coordinate values are in IDTM.

Canyon Creek Summary	cfs
Initial flow/input	**6.64**
Diverted rate out of Canyon Creek	**5.57**
Tributary/injection Input	**2.15**
Cumulative reach losses	**-0.20**
Cumulative reach gains	**0.14**
Calculated output	**3.15**
Measured output	**3.15**

Table 2. Summary of Canyon Creek seepage study.

Attachment A4. Eighteenmile Creek Seepage Study

A seepage study was conducted August 26 through 28, 2008 by IDWR staff. The study consisted of measuring surface water flows (stream flows, diversion rates, return flows and tributary inputs) in Eighteenmile Creek in order to quantify gaining and losing reaches. During the two-day study, 39 measurements or observations were taken, including measurements of diversions, stream flows, tributaries, and return flows. Typically seepage studies are conducted by measuring all surface water flows associated with a stream from the headwaters to the mouth. During this study, we took advantage of land owner and irrigator interest and met several of the irrigators at their diversions. Without the local knowledge of the land owners and irrigators, we would not have been able to find the diversions and ditch channels or to discern them from spring and irrigation return flow channels. Parts of Eighteenmile Creek were very complex, and this study does not effectively represent the actual small scale hydrology, but rather gives a better understanding of broad reach characteristics.

Above all diversions, Eighteenmile Creek flows out of a steep, confined mountain reach into a willow complex on BLM land (Figure 1). The stream flow was measured at 2.2 cfs near the upper most diversion, EM19, which was off. The uppermost four diversions were off during the three day seepage study; these-diversions are probably only used during high flows. Eighteenmile Creek gains 1.3 cfs before the first active diversion EM15 diverts 0.3 cfs. The riparian area along the stream changes in this reach as well with less willows, a smaller channel, and a loss in flow (1.3 cfs from EM16 to EM13).. From EM13 to above EM10A and EM10B the stream gained 3.7 cfs; we did not visit Divide Creek nor did we see the EM12 diversions but were told by the landowner that both were dry. For the upper part of the Eighteenmile Creek we relied on Mr. Whittaker to locate the channel and diversions.

Eighteenmile Creek gains flow in the reach below EM8 to EM9 due to a complex of return flows, spring channels, and general wetland area; this reach was very complex and we relied heavily on the local knowledge of the irrigators (Mr. Drake and Mr. Wilson) to locate diversions, return flows, and the main channel. Downstream of EM9 to EM2, Eighteenmile Creek gained 12 cfs and 8 cfs was diverted for irrigation during this study. From NAIP imagery it appears that many of the springs and reach gains are related to Tenmile Creek, Clear Creek, and upstream diversions (Figure 2).

The lowest reach of Eighteenmile Creek, below the pivot associated with EM3, is dry sagebrush flat with very little riparian vegetation. Downstream of EM2 to EM1, Eighteenmile Creek lost 0.7cfs.

Figure 1. Map of Eighteenmile Creek with important surface water features labeled.

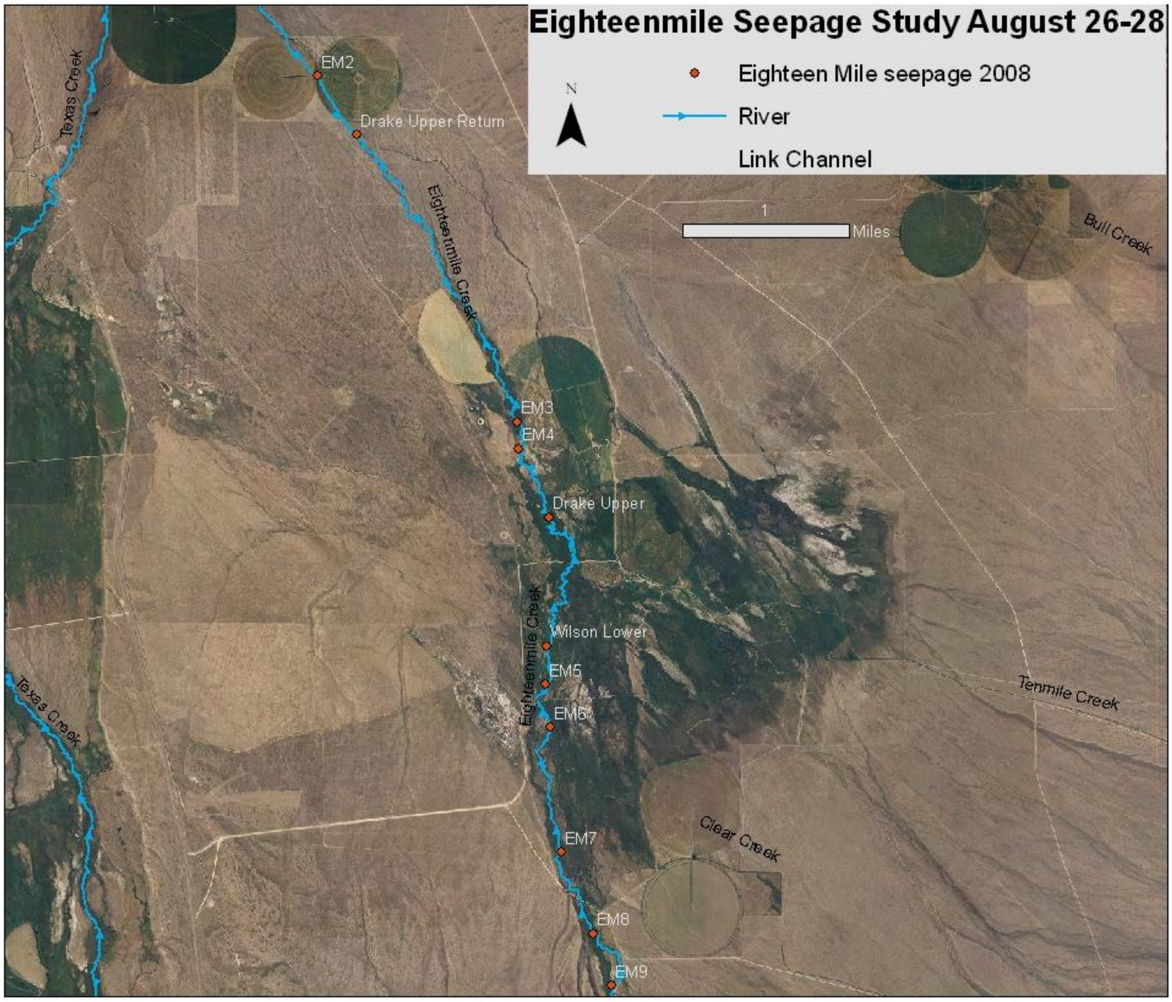

Figure 2. Detailed areal view of Eighteenmile Creek displaying area where reach gains and springs are associated with Clear Creek, Tenmile Creek, and diversion returns.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Trib/diversion Q in	Eightteenmile Creek Q	Seepage	Point_X	Point_Y	Date and time	Notes
Above EM19		**2.20**			2.20					
	Em19	0.00	0.00				2573529	1476307		EM19 does not have a headgate, is diverted off of south side of Eighteen Mile Creek probably only during high flows.
Below EM19		2.20			2.20					35ft downstream of EM19.
Above EM18		2.20			2.20					
	Em18	0.00	0.00				2571602	1477087		
Below EM18		**3.47**			3.47					
Above EM17		3.47			3.47		2571050	1477216	8/26/2008 3:40pm DL	EM17 and EM18 are dry.
	EM17	0.00	0.00				2570533	1477354		
Below EM17		3.47			3.47					
Above EM19 to Below EM17						1.27				
Above EM16		3.48			3.48		2520270	1477476	8/26/2008 3:14pm	
	EM16	0.00	0.00				2570187	1477477		
Below EM16		**3.48**			3.48					
Above EM15		**2.65**			2.65					
	EM15	0.30	0.30				2566601	1478590	8/26/2008 2:20pm	Estimate of flow
Below EM15		2.35			2.35		2566202	1478624	8/26/2008 2:00pm	Springs in willow complex upstream
Above EM14		1.89			1.89		2564068	1478444	8/26/2008 12:50pm	Narrow and shallow, upstream of public road and Whittakers fence line.
	EM14	1.50	1.50				2563934	1478448	8/26/2008 1:20pm	Diversion is not consolidated, dispersed with side channels so we did not measure. Main Eighteen Mile was only a trickle as seen in photos.
Below EM14		**0.39**			0.39					
Above EM16 to Below EM14						-1.28				
Above EM13		**0.39**			0.39					
	EM13	0.31	0.31				2562415	1478959	8/26/2008 12:58pm	This is EM13 in the model.
Below EM13		0.00			0.00		2562433	1478961	8/26/2008 12:58pm	
Above Divide Ck		0.00								
	Divide Creek	0.00		0.00			2561701	1478936		
Below Divide Ck		0.00								
Above EM12		0.00								
	EM12	0.00	0.00				25615446	1479058		
Below EM12		0.00			0.00					
Above EM13 to Below EM12						-0.08				

Table 1a. Summary of seepage study for Eighteenmile Creek, including reach gains and losses calculated from the measured flows. Location coordinates are in the IDTM projection.

Above EM10A		**3.67**			3.67					
	EM10A	0.00	0.00				2560436	1481649	8/26/2008 11:10am	
Below EM10A		**3.67**								
Above EM10B		**3.67**			3.67					
	EM10B	0.31	0.31				2560408	1481573	8/26/2008 10:51am	
Below EM10B		3.36			3.36					
Above EM10		**3.36**								
	EM10	0.00	0.00				2559171	1483975	8/27/2008 10:00am	Does not look like it has been used or will be used. There is a second unused/abandoned ditch up stream.
Below EM10		3.36			3.36		2559184	1483988	8/27/2008 10:10am	Good measurement location, 30ft downstream of EM10 diversion.
Above EM9		**2.98**			2.98					
	EM9	2.88	2.88				2558836	1484731	8/27/2008 10:41am	
Below EM9		0.10			0.10				8/27/2008 11:05am	Estimate of flow remaining in creek.
Above EM10A to Below EM9						3.29				
Above EM8		**2.45**			2.45					
	EM8	0.00	0.00				2558655.5	1485228.7		EM8 does not look like it is used.
Below EM8		2.45			2.45		2558595	1485293	8/27/2008 11:45am	EM8 does not look like it is used.
	EM8b	0.60	0.60				2558810	1485096	8/28/2008 12:05pm	This is the headgate the actual point where flow is diverted from the stream is ~400yards upstream..
Below EM8b		2.00			2.00		2558634	1485255	8/28/2008 11:44am	Confluence below EM8b, estimated flows.
Above EM7		**2.57**			2.57					
	EM7	1.87	1.87				2558350	1486011	8/27/2008 12:11pm	
Below EM7		0.70			0.70				8/27/2008 12:35pm	Estimate of flow passing diversion.
Above EM6		**2.35**			2.35					
	EM6	2.35	2.35				2558247	1487216	8/27/2008 1:30pm	Looked like a rainbow (7inches) in ditch. This measurement was behind the Wilson house. This measurement is downstream of the pond near their house.
Below EM6		0.00			0.00					From Nick's sketch. This area rapidly gains flows from returns and springs. Complex channel network with return channels, diversions, and springs.
Above EM5		**3.67**			3.67					This is a measurement of all the returns and seeps downstream of EM5.
	EM5	0.00	0.00				2558198	1487625	8/27/2008	Looks like a return flow channel not a diversion.
Below EM5		3.67			**3.67**		2558242	1487747	8/27/2008 2:40pm	This measurement is below a willow complex and several channels that have been carved out of a wetland area, including irrigation returns, springs and seeps. This area was very complex, uncertain where main channel was.
Above Wilson lower ditch		**3.67**								
	Wilson's lower ditch	1.58	1.58				2558207	1487997	8/28/2008 11:30am	A rock berm forces flow down the ditch, potentially a fish barrier.
Below Wilson lower ditch		2.26			2.26		2558207	1487997	8/28/2008 12:10pm	
Above EM8 to Below Wilson Lower Ditch						8.55				

Table 1b. Summary of seepage study for Eighteenmile Creek, including reach gains and losses calculated from the measured flows. Location coordinates are in the IDTM projection.

Above Drake's upper ditch		**4.69**			4.69					
	Drake's upper ditch	1.33	1.33				2558235	1489235	8/28/2008 10:20am	
Below Drake's upper ditch		3.36			3.36		2558207	1489249	8/28/2008 10:15am	Stable bank, mature willows, clean gravels.
Above EM4		3.45			3.45		2557984	1489946	8/26/2008 4:05pm	EM4 was not in use. Nick measured on the lip of a culvert.
	EM4	0.00	0.00				2557945	1489893		
Below EM4		**3.45**								
Above EM3		**3.45**			3.45					
	EM3	3.47	3.47				2557579	14090981	8/28/2008 1:20pm	Pump is located 100yds down from diversion, 2557507 1491011. There is a backwater channel below the measurement location that may contributea little flow to the pump-pond (ditch where water is pumped from).
Below EM3		0.00			0.00					
Above Drake's to Below EM3						2.55				
Above Drake Return		1.02			1.02		2556378	1492909	8/28/2008 2:35pm	
	Drake Return, from upper Drake diversion	1.32		1.32			2556388	1492917	8/28/2008 2:34pm	This is a return from the upper Drake ditch that feeds a pivot. This ditch travels over an unirrigated sage brush flat.
Below Drake return		**2.34**			2.34					
Above EM2		**2.34**								
	EM2	0.00	0.00				2556009	1493481	8/28/2008 3:05pm	Lower Drake pivot, not running does not look like it has run this year.
Below EM2		**2.34**			2.34					
Above Hawley Creek		1.65			1.65		2554572	1496561	8/26/2008 9:10am	Hawley Creek and Eighteen Mile 1 are dry.
Hawley Creek		0.00		0.00						
	EM1	0.00	0.00				2554606	1496599		
Below Hawley Creek and EM1, upper EM gauge		2.24			2.24				8/28/2008 3:40pm	Stage was measured as 7.09ft the IPCO rating will be used for the flow.
Lower EM gauge		1.41			1.41				8/28/2008 3:55pm	Near Leadore. Stage was measured as 1.45ft the IPCO rating will be used to determine the flow.
Above Drake's Return to Lower Gage near mouth						0.09				

Table 1c. Summary of seepage study for Eighteenmile Creek, including reach gains and losses calculated from the measured flows. Location coordinates are in the IDTM projection.

Eighteenmile Creek Summary	
Initial flow/input	**2.20**
Diverted rate out of Eighteenmile Creek	**16.497**
Tributary/injection Input	**1.320**
Cumulative reach losses	**-1.359**
Cumulative reach gains	**15.751**
Calculated output	**1.413**
Measured output	**1.410**

Table 2. Summary of Eighteenmile Creek seepage study.

Attachment A5. Hawley Creek Seepage Study

Hawley Creek Seepage Run Summary 2007-2008

The Hawley Creek basin is a tributary to the Upper Lemhi River system with high quality aquatic habitat in the upper reaches. Hawley Creek has only three major diversions (Figure 1). During summer months, the stream is entirely diverted at HC2. During these periods the natural channel below this point is typically dry down to the HC2 return flow. Two reconnect scenarios for this reach have been discussed by the Upper Salmon Basin Technical Team in order to allow aquatic species to migrate from the main Lemhi River system to upper Hawley Creek. One is to provide additional flow to the natural channel below HC2. It has been said that this portion of the natural channel loses a significant amount of flow to the ground. During the 2008 seepage run, flows also exceeded the lower channel capacity downstream of the HC2 diversion (Figure 2). The other reconnect project scenario is to leave flow in the HC2 ditch using the ditch as the reconnected channel; this scenario would potentially provide a longer period of time that fish could migrate from the lower river system to upper Hawley Creek as the ditch loses less water. To evaluate the potential of each scenario, a study plan was designed to measure flows along both the natural channel below HC2 and the HC2 ditch to determine the relative seepage loss.

During the 2007 seepage study (Tables 1 and 2) Hawley Creek gained 17 cfs upstream of HC2; the reach above HC2 to above HC1 Hawley Creek was losing flow. The flow loss from the channel combined with the diversions at HC3 (~17cfs), HC2 (11cfs), and HC1 (6 cfs) left lower Hawley Creek dry. This is typical of Hawley Creek during the irrigation season.

During the 2008 seepage study (Tables 3 and 4) Hawley Creek again gained flow above HC2 but at a much lower rate. The diversions during the 2008 study were also diverting at a much smaller rate allowing some flow past HC1 (~9 cfs). The losing trend below HC2 was again present but at a much higher rate (10 cfs from the Kauer ditch return to HC1 and an additional 1.7 cfs from lower Hawley Creek). Also of note is the lack of capacity for flow in the historical lower Hawley Creek channel (Figure 2).

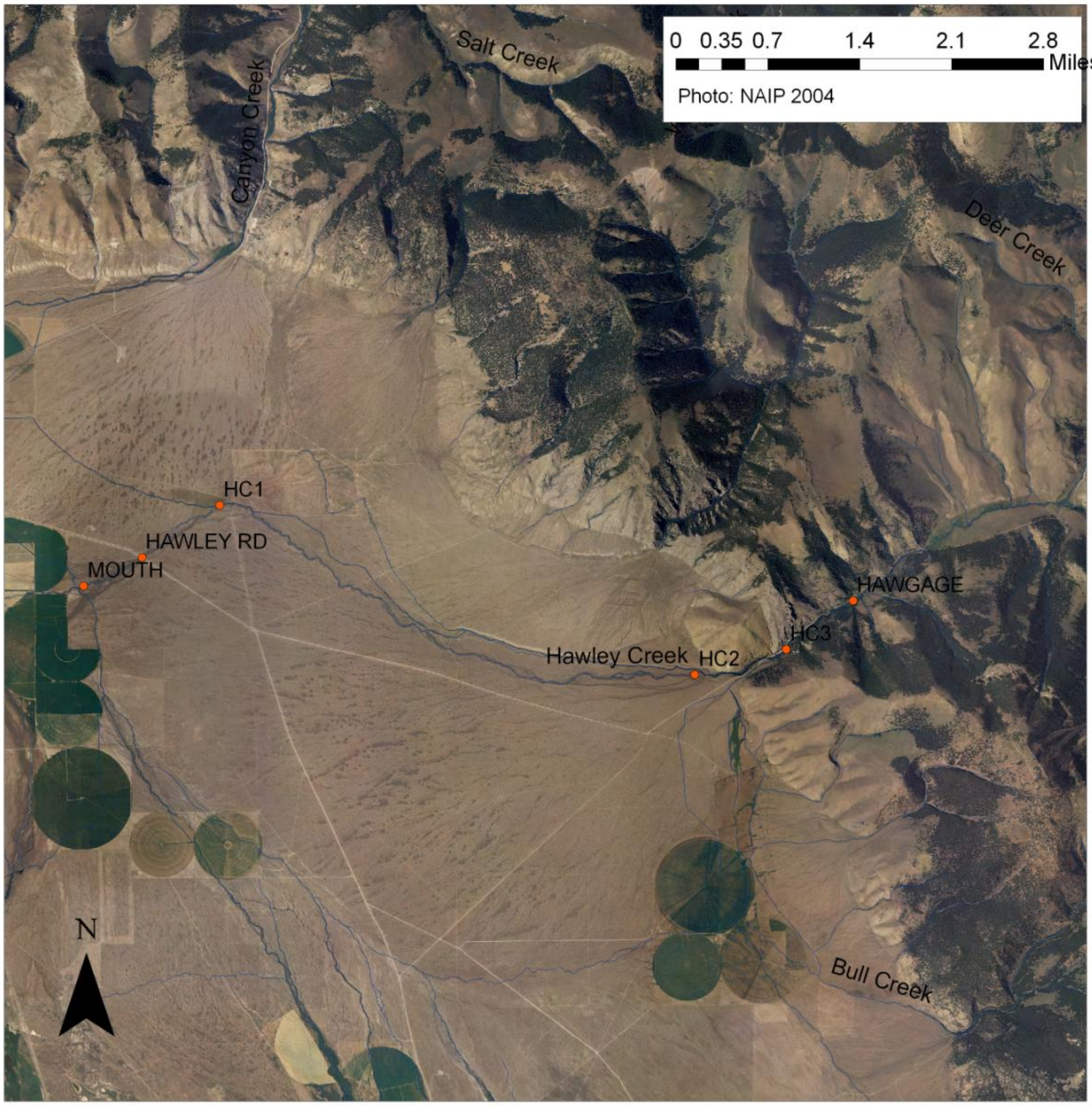

Figure 1. Map of Hawley Creek with labeled diversions (HC1, HC2, and HC3) and points of reference concerning the seepage measurement points.

Figure 2. Photo of lower Hawley Creek with flows exceeding channel . Notice lack of riparian vegetation, this channel is typically dry.

Mainstem Location	Trib/Div Location	Discharge (cfs)	Q diverted out (cfs)	Trib/div Q in (cfs)	Hawley Ck Q (cfs)	Seepage	Point_X	Point_Y
Hawley Gage/Abv Diversions		19.862			19.86			
Hawley Abv HC3		20.656			20.66		2563243	1495852
	HC3		16.694				2562631	1495452
Hawley below HC3		20.656			20.656			
Above diversions to below HC3						17.49		
Above HC2		11.159			11.159			
	HC2		11.159					
Hawley Ck below HC2		0			0		2562099	1495541
Hawley Ck old channel mid point		**8.955**			8.955		2559689	1495685
Above HC2 to Below HC2						-0.542		
Hawley Above Kauer Ditch Return		8.955			8.955			
	Kauer Ditch Return			0				
Hawley Below Kauer Ditch		**6.433**			6.433			
Above HC1		**6.433**			6.433			
	HC1		6.433				2556301	1497619
Blw HC1		*0*			0			
Above Kauer Ditch to below HC1						-2.52		
Hawley Ck below Road		0.00			0.00		2555349	1496977
Hawley Ck Mouth		0			0.00		2554635	1496627
Hawley Creek above road to Mouth						0.00		

Table 1. Seepage study conducted May 1, 2007. (Projection - Idaho Transverse Mercator 1983)

Hawley Ck 2007 Summary	
Initial Flow/input	19.86
Diverted rate out	34.29
Diversion Return	0
Cumulative reach losses	-2.52
Cumulative reach gains	16.95
Calculated output	0.00
Measured output	0.00

Table 2. Summary of 2007 seepage study.

Mainstem Location	Trib/Div Location	Discharge (cfs)	Q diverted out (cfs)	Trib/div Q in (cfs)	Hawley Ck Q (cfs)	Seepage	Point_X	Point_Y
Hawley Gage		15.1			15.10			
Hawley Abv HC3		16.9			16.9		2563243	1495852
	HC3	0	0		0		2562631	1495452
Hawley below HC3		16.9			16.9			
Above diversions to below HC3						1.80		
Above HC2		23.7			23.7			
	HC2		2.88					
Hawley Ck below HC2		16.9			16.9		2562099	1495541
Hawley Ck old channel mid point		14.3			14.3		2559689	1495685
Above HC2 to Below HC2						0.28		
Hawley Above Kauer Ditch Return		4.39			4.39			
	Kauer Ditch Return			5.77				
Hawley Below Kauer Ditch		**10.16**						
Above HC1		**10.16**			10.16			
	HC1		1.50				2556301	1497619
Blw HC1		8.66			8.66			
Above Kauer Ditch to below HC1						-9.91		
Hawley Ck below Road		8.20			8.20		2555349	1496977
Hawley Ck Mouth		6.48			6.48		2554635	1496627
Hawley Creek above road to Mouth						-1.72		

Table 3. Seepage study conducted May 13, 2008. (Projection - Idaho Transverse Mercator 1983)

Hawley Ck 2008 Summary	
Initial Flow/input	15.10
Diverted rate out	4.38
Diversion Return	5.77
Cumulative reach losses	-11.63
Cumulative reach gains	2.08
Calculated output	6.94
Measured output	6.48

Table 4. Summary of 2008 seepage study.

Attachment A6. Kenney Creek Seepage Study

A seepage study was conducted August 25, 2008 by IDWR staff accompanied by Mark Davidson of The Nature Conservancy. The study consisted of measured surface water flows (stream flows, diversion rates, and return flows) in Kenney Creek in order to quantify gaining and losing reaches. During this study six measurements or observations were taken, including measurements of diversions, stream flows, and return flows. This study was conducted with a duel purpose of calibration of a hydrologic model (understanding of the basin hydrology); and to examine the feasibility of a water deal.

Above all diversions a flow of 5.5 cfs was measured; below the upper most diversion KC-3 to the lower diversion KC-2 flows decrease slightly. The lower diversion KC-2 takes most of the flow, 4.8 cfs; there is a measuring device on the KC-2 ditch but it under estimates the diversion rate due to fast approach velocities KC-2 is also screened and the return flow from the screen is 0.8 cfs. Below KC-2 to the lower Kenney Creek gauge, near 17-Mile Road, Kenney Creek gains 0.45 cfs of flow. Currently lower Kenney Creek is connected to the Lemhi River but the reach below KC-2 is flow limited.

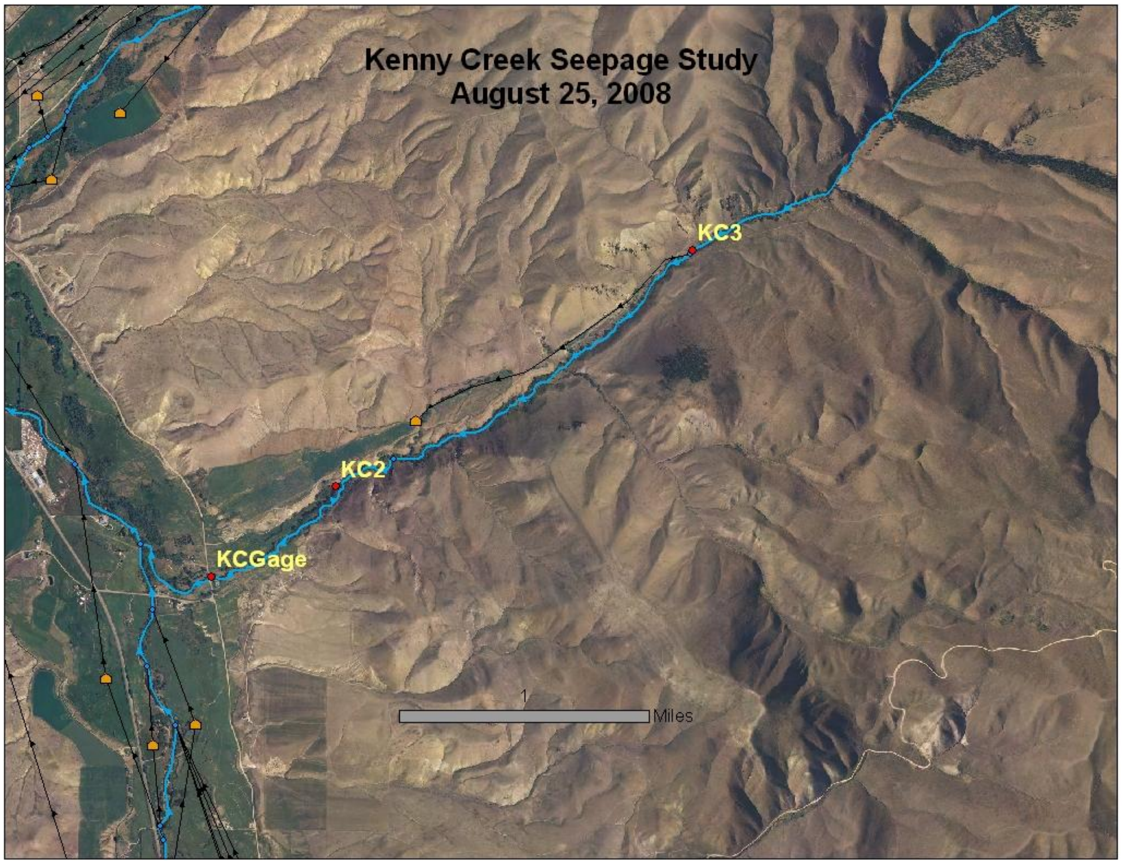

Figure 1. Map of Kenney Creek with important surface water features labeled.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Trib/diversion Q in	Kenney Creek Q	Seepage	Point_X	Point_Y	Date and time	Notes
Upstream of KC3 to KC2										
Above KC3		5.48			5.48		2530369	1538343	8/25/2008 3:24pm DLS	Water temperatue was 52F as measured by the FlowTracker.
	KC3	**0.32**	**0.32**				2527983	1536668		
Below KC3		5.16			5.16		2530312	1538292	8/25/2008 3:25pm	
Above KC2		4.97			4.97		2528195	1536926	8/25/2008 4:27pm	
	KC2	4.82	4.82				2528079	1536825		The flume (a 3ft wide Parshall) read 0.39 equivalent to 2.75 cfs, but the approach velocities were very high so we measured the flow.
Below KC2 and above screen return		0.47			0.47				8/25/2008 2:05pm	The short reach between the headgate for the KC2 diversion and before the KC2 screen return flow Kenny Creek only has 0.47cfs (measured at 2:05pm).
Upstream of KC3 to KC2						0.13				
	Screen Return	**0.80**		**0.80**						Assuming a 0.8cfs screen return.
Below KC2 and screen return		1.28			1.28		2528143	1536854	8/25/2008 4:30pm DLS	Below the screen return 1.284cfs was measured. Above the return 0.471cfs was measured in stream at 2:05pm; this was remeasured at a different cross-section at 5:22pm at 0.285cfs.
Gauge/Mouth		1.72			1.72		2527200	1536236		The stage for the IPCO gauge is 4.14, the flow is calculated from the IPCO rating.
KC2 to mouth						0.45				

Table 1. Summary of seepage study for Kenney Creek, including reach gains and losses calculated from the measured flows. Location coordinates are in IDTM.

Kenney Creek Summary	cfs
Initial flow/input	**5.478**
Diverted rate out of Kenny Creek	**5.134**
Tributary/injection Input	**0.800**
Cumulative reach losses	**0.000**
Cumulative reach gains	**0.576**
Calculated output	**1.720**
Measured output	**1.720**

Table 2. Summary of Kenney Creek seepage study.

Attachment A7. Upper Lemhi River Seepage Study

A seepage study was conducted the afternoon of July 23 and July 24, 2008 by IDWR staff on the Lemhi River from the town of Leadore just upstream of the L63 diversion to just below the confluence with Big Springs Creek. The study consisted of measured surface water flows (stream flows, diversion rates, return flows and tributary inputs) in the Lemhi River in order to quantify gaining and losing reaches. During the two day study fifteen measurements or observations were taken, including measurements of diversions (L63, L62, L61, L60, L59) and tributaries (Canyon Creek, Big Timber Creek, Big Springs Creek)(Figure 1; Table 1). Three Idaho Power Company maintained gauges were referred to in this study: Lemhi River above L63; Lemhi River above Big Springs Creek; and the Big Springs Creek above the Lemhi River. The Lemhi River above L63 station was used to compare flows between the two days to ensure that conditions had not changed; the stage was the same both days.

During the study L63 diverted the entire flow but the Lemhi River gains flows rapidly in this reach accumulating 14 cfs above the mouth of Canyon Creek. Below Canyon Creek to the mouth of Big Timber Creek the Lemhi River gains 16.17 cfs in flow while almost 6 cfs is diverted in this reach. Below Big Timber Creek to L61 the Lemhi River loses less than 1.5 cfs and from L61 to Big Springs Creek the Lemhi River gains an additional 26 cfs. With the inflow of Big Springs Creek the flow in the Lemhi River at the bottom of this study reach was almost 57 cfs with a total diversion rate of 30.5cfs.

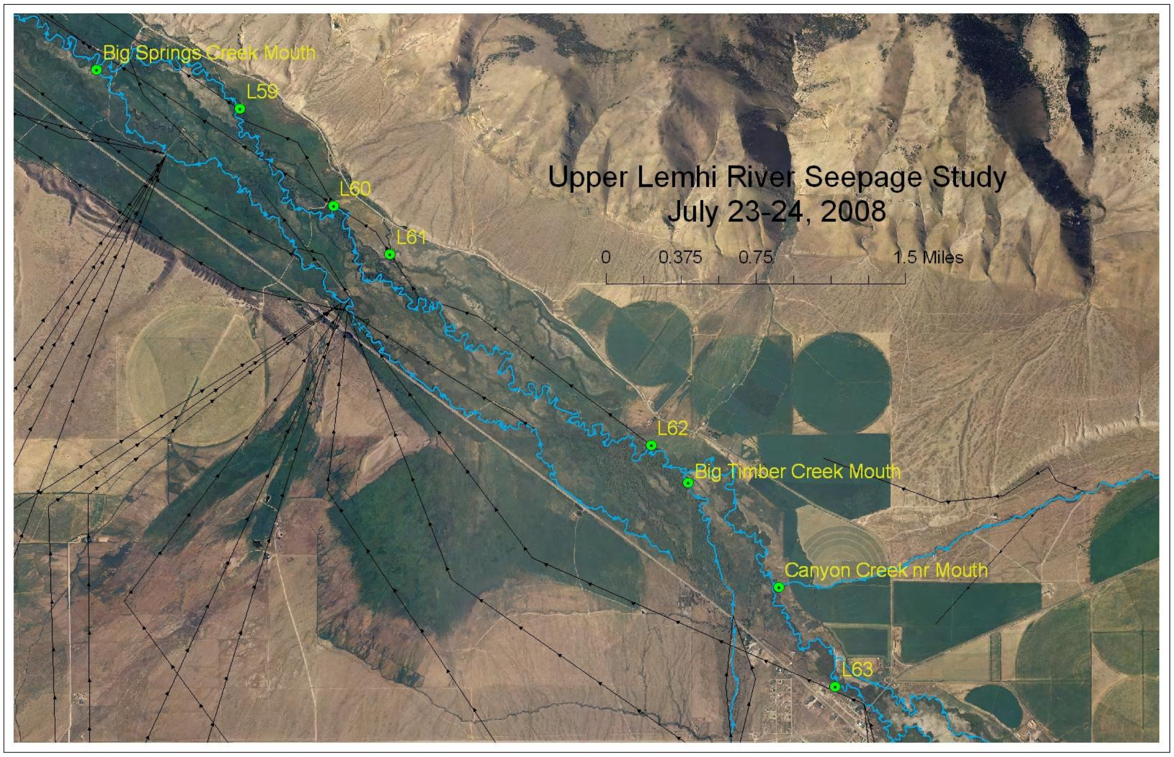

Figure 1. Map of Lemhi River with important surface water features labeled.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Trib/diversion Q in	Lemhi R. Q	Seepage	Point_X	Point_Y	Date and time	Notes
		(cfs)	**(cfs)**	(cfs)	(cfs)	(cfs)				
Above L63		6.91			6.91				7/23/2008 3:20pm	The staff plate at the IPCo gauge read 0.99 and was the same the following morning when we continued this seepage run.
	L63	7.17	7.17				2550942	1498101	7/23/2008 3:48pm	Accessed from Leadore, through Doris' property.
Below L63		**0.00**			0.00					No flow past L63 but it was muddy and marshy, gaining flow.
Above L63 to Lemhi above Canyon Ck						0.26				
Above Canyon		14.19			14.19		2550215	1499012	7/23/2008 5:55pm	Near exclosure fence, 150ft upstream of Canyon Creek
Canyon Creek		3.66		3.66					7/23/2008 4:52pm	Measured at the Canyon Creek gauge which is ~225ft upstream of Lemhi River, but below Whitefish ditch.
Below Canyon		**17.85**			17.85					
Big Timber Creek		2.19		2.19	2.19		2549672	1499724	7/24/2008 11:23am	
Below BT Creek		**36.21**								
Canyon Creek to BT Mouth						30.36				
Above L62		36.21			36.21		2549374	1500009	7/24/2008 9:48am	Checked Lemhi Gauge above L63 before continuing seepage run on 7/24. Silt lenses on substrate.
	L62	5.36	5.36				2549087	1500251	7/24/2008 9:26am	Stage measurement on North side of screen, flow measurement below return flow and up from pump. Stage = 1.55
Below L62		**30.85**								
Above L61		19.20			19.20		2547233	1501632	7/24/2008 1:18pm	
	L61	10.22	10.22				2549097	1500261		Measured 10.007 in ditch below screen the flume value for H=0.99 is 10.22cfs. Due to poor location of measurement in ditch we used the flume value. Q=10.2*(H+0.011)^1.621
Below L61		**8.98**			8.98					
Big Timber to L61						-11.65				
Above L60		35.15			35.15		2546734	1502085	7/24/2008 3:30pm	
	L60	5.20	5.20				2546555	1502216	7/24/2008 2:47pm	Staff plate on screen is out of water on North side of screen.
Above L59 below L60		**29.95**			29.95					
	L59	2.59	*2.59*							
Below L59		37.16			37.16		2545783	1503108	7/24/2008 5:20pm	
L61 to L59						35.97				
Lemhi above Big Springs Creek		37.16								Measured at IPCo gauge, 15ft below bridge. The IPCo rating flow is calculated at 37.0 based on the 0.60ft stage measurement.
Big Springs Creek		**19.60**		19.60						Flow from stage measurement and IPCo rating curve.
Below BS Creek		**56.76**			56.76					

Table 1. Summary of seepage study for the Upper Lemhi River (above L63 to below the Big Springs Creek confluence), including reach gains and losses calculated from the measured flows.

Lemhi River Summary	**cfs**
Initial flow/input	**6.912**
Diverted rate out of the Lemhi River	**30.542**
Tributary/injection Input	**25.445**
Cumulative reach losses	**-11.646**
Cumulative reach gains	**66.590**
Calculated output	**56.759**
Measured output	**56.759**

Table 2. Summary of the Upper Lemhi River seepage study.

Attachment A8. Lemhi Little Springs Creek Seepage Study

Two seepage study was conducted the first study August 20-21, 2007 and the second occurred from July 22 and the morning of July 23, 2008 by IDWR staff. These studies consisted of measured surface water flows (stream flows, diversion rates, return flows and tributary inputs) in Little Springs Creek in order to quantify gaining and losing reaches.

During the two day 2008 study twenty measurements or observations were taken, including measurements of L52 injection and extraction, L50 diversion, LS2, LS3, and LS4 diversions; there were also inputs from a pond channel upstream of the L52 extraction and Mill Creek that were measured (Figure 1; Table 1). During the study LS2 and LS4 diverted the entire flow. Below LS2 the channel was dry to the mouth and at the Idaho Power Company maintained gauge near the mouth. Below the LS4 diversion there was some seepage around the diversion and due to the saturated nature of the valley bottom, largely associated with irrigation, Little Springs gained flow rapidly measured at 9.4 cfs above LS3. Overall Little Springs Creek gains flow downstream, but currently this stream is disconnected from the Lemhi River during irrigation season (Table 2). Light rains the morning of July 22 did not seem to affect the flows in Little Springs Creek; the IDWR stream gauge stage (LS Gauge in Figure 1) was consistent between the two days of measurements.

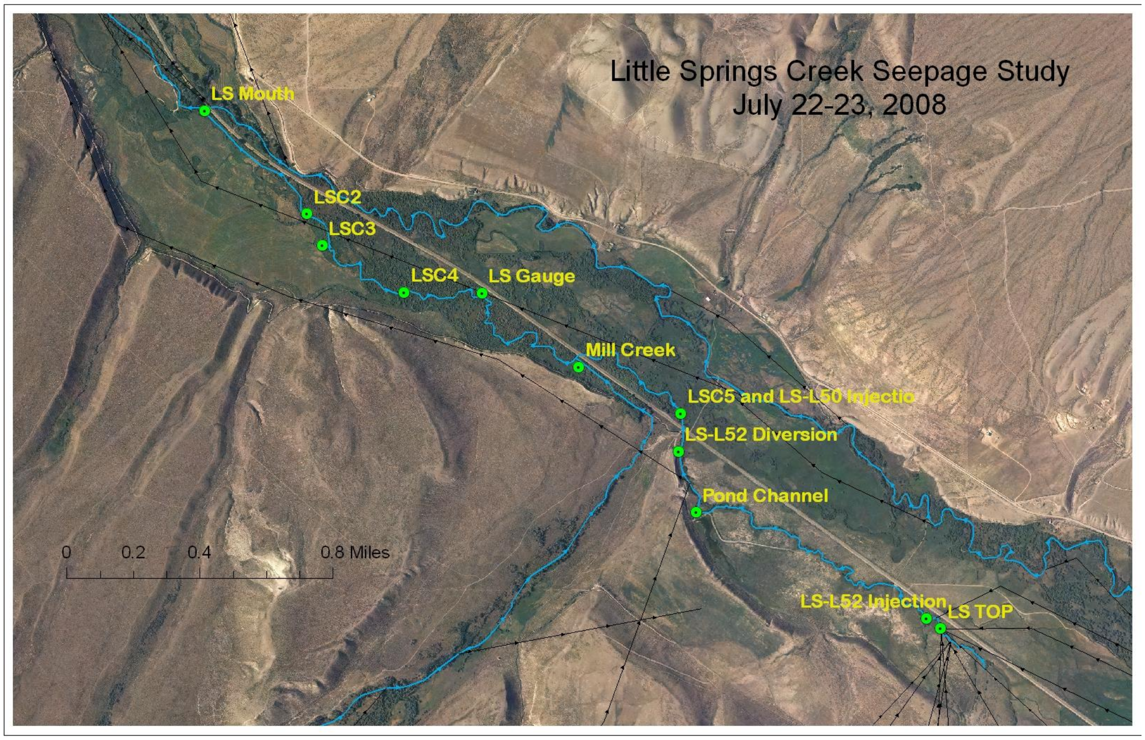

Figure 1. Map of Little Springs Creek with important surface water features labeled.

Main stream location	Trib/diversion location	Discharge	diverted out	Trib/diversion Q in	Little Springs Qs	Seepage	Point_X	Point_Y	Date and time	Notes
		(cfs)	**(cfs)**	(cfs)	(cfs)	(cfs)		(cfs)		
Above L-52 injection		4.36			4.36		2539532	1506434	7/22/2008 9:27am	Rained the previous evening, grass was damp. Sprinkled during measurement.
	L-52 injection	12.64		12.64			2539515	1506468	7/22/08 10:12 AM	350ft upstream of highway
Below L-52 Injection		**17.00**			17.00					
Above LS-Pond channel		21.85			21.85		none	none	7/22/2008 11:02am	
	Pond Channel	3.34		3.34			2538352	1506981	7/22/2008 12:07pm	This flow was taken near the mouth of the pond channel, The culvert coming out of the pond is 22in in diameter and the height of flow was 0.8ft.
Above L-52 extraction		**18.20**			18.20		2538283	1507165	7/22/2008 11:15am	Poor measurement, tried to clear ditch channel of weeds but the 0.8ft depth measurements of the 0.2/0.8 had many errors.
	L-52 extraction	4.36	4.36							
Below L-52 extraction		13.85			13.85		2538296	1507336	7/22/2008 1:35pm	
L-52 injection to L-52 extraction						-2.13				
Above L-50 injection and LSC-5		13.85			13.85					
	L-50 injection	0.00		0.00						
	LSC5	0.50	0.50						7/22/2008 2:20pm	This flow is an estimate, no measurement device and no suitable location (too small) to measure.
Little Springs Blw LSC5		**14.65**			14.65					
L-52 extraction to LSC-5						1.30				
Above Mill Ck		**14.65**			14.65					
	Mill Ck	0.51		0.51			2537169	1507724	7/22/2008 1:18pm	Thunder storm rolled in during measurement.
Below Mill Ck		15.16			15.16		25377739	1507708	7/22/2008 3:35pm	Thunder storms forced postponement of this measurment for 40minutes. Had to start this measurement over. No measureable precipitation, flows were uneffected.
Above L-50 extraction		16.19			16.19					The measurement was taken at the Little Springs Gauge, the seepage run was continued here the next day 7/23/2008 and the stage was the same 0.97-0.98 at 10:31am so flow measurements from each day are comparable.
	L-50 extraction	5.28	5.28							
Below L-50 extraction		**10.91**			10.91		2537100	1507989	7/22/2008 5:10pm	
Above LSC-4		6.24			6.24		2536947	1508054	7/23/2008 11:18am	Little flow passes LS4, 0.25 to 0.5cfs.
	LSC-4	7.15	7.15							
Below LSC-4		**0.50**			0.50					This flow is an estimate, very little passes this diversion.
LSC-5 to LSC-4						-2.23				
Above LSC-3		9.42			9.42		2536585	1508234	7/23/2008 12:32pm	
	LSC-3	2.72	2.72				2536468	1508240	7/23/2008 12:25pm	
Below LSC-3		**6.70**			6.70					
LSC-4 to LSC3						8.92				
Above LSC-2		**6.70**			6.70					
	LSC-2	6.73	*6.73*				2536319	1508391	7/23/2008 1:15pm	
Below LSC-2		0.00			0.00					
LSC-3 to LSC-2						0.03				
Little Springs MOUTH		0.00			0.00					
LSC-2 to MOUTH						0.00				

Table 1. Summary of the 2008 seepage study for Little Springs Creek, including reach gains and losses calculated from the measured flows.

Little Springs Creek Summary	**cfs**
Initial flow/input	**4.355**
Diverted rate out of Little Springs Creek	**26.742**
Tributary/injection Input	**16.488**
Cumulative reach losses	**-4.355**
Cumulative reach gains	**10.254**
Calculated output	**0.000**
Measured output	**0.000**

Table 2. Summary of the 2008 Little Springs Creek seepage study.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Trib/diversion Q in	Little Springs Qs	Seepage	Point_X	Point_Y	X-Section Substrate	Date and time	Notes	File name
		(cfs)	**(cfs)**	(cfs)	(cfs)	(cfs)		(cfs)				
L-52 injection to L-52 extraction						7.4200						
Above L-52 injection		3.06			3.06		2539521	1506453.458	Gravel	8/20/07 17:03	FT as BSTOP while it should have been LSTOP. It was	**BSTOP.WAD**
	L-52 injection	1.76		1.76			2539588	1506522.194	Silt and some Cobbles	8/20/2007 5:15-5:45	Flowtracker: Planning. Cutbanks on both sides…very hard to find a good location.	**L52Q.WAD**
Below L-52 Injection		**4.82**			**4.82**							
Above L-52 extraction		**12.2**			**12.2**							
	L-52 extraction	6.44	6.44				2538192	1507403.281	Coarse Gravel-Sma	8/20/2007 5:15-5:45pm	Flowtracker: Planning. Pt of measurment is at the best location found, however, it has a wide cross section where the right bank has high velocity angles. The Spring below this point is extreamly vegetated.	**LSBLL52.WAD**
Below L-52 extraction		5.80			5.80		2538315	1507134.472	Gravel	8/20/07 18:21	Flowtracker: OLD/Corbin	**LSL52DIV.WAD**
L-52 extraction to LSC-5						-0.3500						
Above L-50 injection and LSC-5		5.45					2538276	1507458.602	Coarse Gravel	8/21/07 10:10	Flowtracker: Planning; Nick cleared the water! Raked the vegetation up to 5 ft upstream of the cross-section. Diverted amount ~ 0.5 cfs	**LS5ABV.WAD**
	L-50 injection	0		0.00			none	none			The L-50 injection is just above LSC5 and there is no place to measure in between the two points.	
	LSC5	**0.4**	0.4000				none	none			Visual estimation, ditch is too narrow to measure.	
Little Springs Blw LSC5		**5.05**			**5.05**							
LSC-5 to LSC-4						4.2200						
Above Mill Ck							none	none				
	Mill Ck	0.0000		0.00			none	none				
Below Mill Ck							none	none				
Above L-50 extraction		**8.12**			**8.12**							
	L-50 extraction	**0.500**	0.50				2537131	1508011.144			Not measured…this is just a visual estimate of flow	
Below L-50 extraction		7.62			7.62		2537106	1508019.411	Fine Gravel	8/21/07 11:55	Flowtracker: Planning.	**LSAL50.WAD**
Above LSC-4		8.77			8.77		2536938	1508044.456	Gravel + small cobb	8/21/2007 1:20-2:00	Flowtracker: OLD/Corbin, very silty banks.	**LS4ABV.WAD**
	LSC-4	0.00	0.0000				2536910	1508037.966				
Below LSC-4		**8.77**										
LSC-4 to LSC3						-1.0500						
Above LSC-3		7.72			7.72		2536541	1508271.788	Fine Gravel+ Silt	8/21/07 0:00	Flowtracker: Planning; very silty banks	**LS3ABV.WAD**
	LSC-3	0.00					2536529	1508270.548				
Below LSC-3		**7.72**										
LSC-3 to LSC-2						-0.7300						
Above LSC-2		6.99			6.99		2536468	1508425.396	Fine Gravel	8/21/07 13:21	Flowtracker: OLD/Corbin. File name was mislabeled. It said LSC3ABV when it should have been LSC2ABV. It is correct in the GPS	**LS3ABV.WAD**
	LSC-2	0.00					2536450	1508409.139				
Below LSC-2		**6.99**										
LSC-2 to MOUTH						-0.9500						
Little Springs MOUTH		6.04			6.04		2535985	1508947.607	Gravel + small cobb	8/21/2007 2:45-3:10pm	Flowtracker: Planning; We had to clear some of the branches…stupid stinging nedle!	**LSMOUTH.WAD**

Table 3. Summary of the 2007 seepage study for Little Springs Creek, including reach gains and losses calculated from the measured flows.

Little Springs Creek Summary	**cfs**
Initial flow/input	**3.060**
Diverted rate out of Little Springs Creek	**7.340**
Tributary/injection Input	**1.760**
Cumulative reach losses	**-3.080**
Cumulative reach gains	**11.640**
Calculated output	**6.040**
Measured output	**6.040**

Table 4. Summary of the 2007 Little Springs Creek seepage study.

Attachment A9. Little Eight Mile Creek Seepage Study

A seepage study was conducted August 20, 2008 by IDWR staff. The study consisted of measured surface water flows (stream flows, diversion rates, and return flows) in Little Eightmile Creek in order to quantify gaining and losing reaches. During this study twelve measurements or observations were taken, including measurements of diversions, a tributary, stream flows, and return flows. This study was conducted with a duel purpose of calibration of a hydrologic model (understanding of the basin hydrology); and to examine the feasibility of a water deals for Lemhi River tributary reconnection.

Little Eightmile Creek has five diversions (Figure 1) but only 3 of those were active during this study. The upper most diversions, LE5 did not divert any water from Little Eightmile Creek but did capture a tributary that was flowing an estimated 0.5 cfs. Nearly 4 cfs (3.9 cfs Table 1) was measured in Little Eightmile Creek just below the LE5 diversion, because this diversion was not running during this seepage study the 3.9 cfs measured represents a flow amount above all diversions. Below LE5 the valley containing Little Eightmile Creek widens slightly, the next diversion downstream, EM4, is the first with any withdrawal at 2.75 cfs. The stream reach between LE5 and LE4 loses less than a tenth of a cfs. Downstream of LE4 to LE2 there are visible returns flowing off of the hillside irrigated by LE5, LE4, and LE3 but the measured flows do not show a significant gain. Diversion LE3 diverted 1 cfs of 1.1 cfs in stream at that point, the remaining flow and gained flow, totaling a around 0.1 cfs was all diverted down LE2. Below LE2 Little Eightmile Creek was dry until Lemhi River water is spilled down the lowest reach, below LE1.

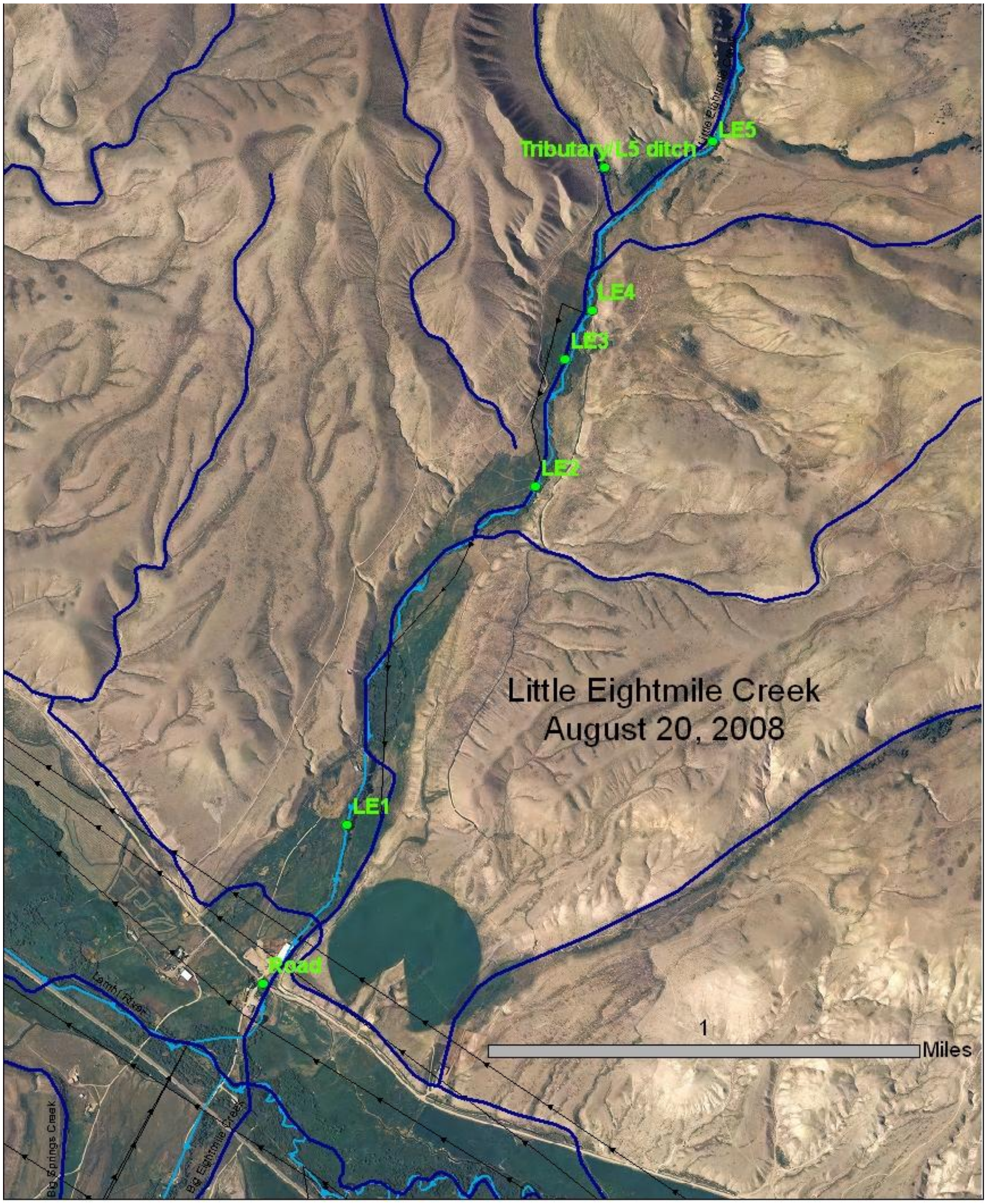

Figure 1. Map of Little Eightmile Creek with important surface water features labeled.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Trib/diversion Q in	Little Eightmile Creek Q	Seepage	Point_X	Point_Y	Date and time	Notes
Above LE5		**3.90**			3.896					
	LE5	0.00	**0.00**				2544459	1507874	8/20/2008 12:11pm	LE5 captures a tributary that was flowing around half a cfs, this flow irrigates a pasture that is very wet and adds seepage to Little Eightmile downstream of LE5 diversion.
Below LE5		3.90			3.896				8/20/2008 12:50pm	
Above LE4		3.80			3.803				8/20/2008 12:50pm	One-hundred feet upstream of LE4
	LE4	2.75	**2.75**				2544010	1507246		
Below LE4		**1.06**			1.055					
Above LE5 to LE4						-0.09				
Above LE3		**1.10**			1.098					
	LE3	1.00	1.00				2543910	1507063	8/20/2008 2:50pm	Creek at this point. About 0.1cfs flows past LE3.
Below LE3		0.10			0.100				8/20/2008 2:30pm	
Above LE2		0.10			0.100					
	LE2	0.10	0.10				2543799	1506588	8/20/2008 2:30pm	LE2 takes what was left in the stream by LE3 and all gained flow.
Below LE2		**0.00**			0.000					Channel is dry.
Above LE3 to LE2						0.04				
Above LE1		0.00			0.000					
	LE1	0.00					2543098	1505329		
Below LE1		**0.00**			0.000					
LE2 to LE1										
Below LE1		0.00			0.000					
Lemhi cross-ditch		0.70		0.70			2542784	1504735	8/20/2008 4:00pm	Appears that Lemhi River water flows through the Little Eightmile Creek channel at the road.
Mouth		**0.70**								
LE1 to Mouth						0.00				

Table 1. Summary of seepage study for Little Eightmile Creek, including reach gains and losses calculated from the measured flows. Location coordinates are in IDTM.

Little Eightmile Creek Summary	cfs
Initial flow/input	**3.896**
Diverted rate out of Little Eightmile Creek	**3.846**
Tributary/injection Input	**0.700**
Cumulative reach losses	**-0.093**
Cumulative reach gains	**0.043**
Calculated output	**0.700**
Measured output	**0.700**

Table 2. Summary of Little Eightmile Creek seepage study.

Attachment A10. Texas Creek Seepage Study

A seepage study was conducted September 18, 2008 by IDWR staff. The study consisted of measured surface water flows (stream flows, diversion rates, return flows and tributary inputs) in Texas Creek in order to quantify gaining and losing reaches. This study was conducted from a measurement above TC6 to below diversions on Texas Creek. During the study thirteen measurements or observations were taken (Figure 1; Table 1). TX3 diverted all of Texas Creek, 4.6 cfs, but Texas Creek gained nearly 6 cfs above TX1 and TX2. The combination of diversions TX1 and TX2 diverted the entire flow, including the inflow from the Big Timber Creek Carey Act diversion (3.7 cfs). Lower Texas Creek, below significant returns (6 cfs), meanders through pastures with little riparian vegetation. The lower reach of this study was not examined in detail so that the location and rate of the return flow below TX1 and TX2 is not known.

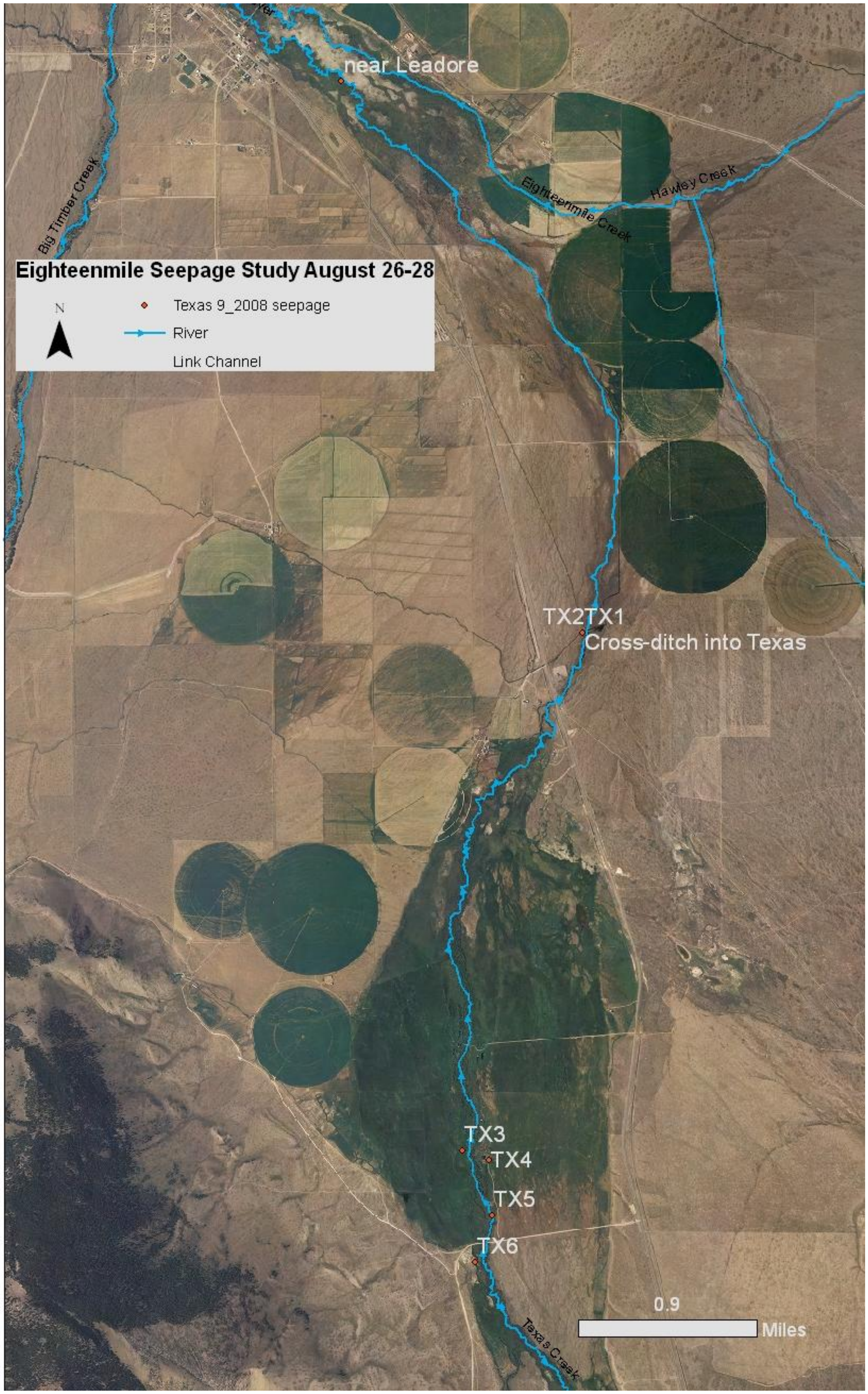

Figure 1. Map of Texas Creek with important surface water features labeled.

Main stream location	Trib/diversion location	Discharge	Q diverted out	Trib/diversion Q in	Texas Creek Q	Seepage	Point_X	Point_Y	Date and time	Notes
Above TX6		**15.17**			15.17					
	TX6	5.60	5.60				2552855	1487979	9/18/2008 1:48pm	4ft Cipoletti Weir H=0.55 Q=5.493cfs
Below TX6		9.57			9.57		2552988	1487772	9/18/2008 2:25pm	Below TX6 in willow complex. Several large trout 12-15 inches.
Above TX6 to Below TX6						0.00				
Above TX5		10.43			10.43		2552974	1488296	9/18/2008 3:50pm	
	TX5	1.98	1.98				2552991	1488358	9/18/2008 3:50pm	Adjustible measuring device is not level and has fast approach velocities. Read 2cfs on left side and 1.5cfs on the right.
Below TX5		**8.45**			8.45					
Above TX4		**8.03**			8.03					
	TX4	3.22	3.22				2552967	1488804	9/18/2008 3:30pm	
Below TX4		**4.81**			4.81					
Above TX3		**4.81**								
	TX3	4.61	4.61				2552749	1488881	9/18/2008 3:12pm	Measuring device is a NU-Way Flume, is not level. It read 2.3cfs on the left and 3.7cfs on the right. The diversion has a push up dam that blocks the strea and takes all but a trickle.
Below TX3		0.20			**0.20**				9/18/2008 3:12pm	Stream is a trickle, flow was estimated.
Above TX5 to below TX3						0.45				
Gauge/above TX2 and TX1		5.83			5.83				9/18/2008 12:22pm	
	TX2	2.36	2.36						9/18/2008 12:12pm	Flume read 4cfs on one side and 4.5cfs on the other.
Carey Act	**Cross-ditch into Texas**	3.73		3.73			2553721	1493085	9/18/2008 12:40pm	
	TX1	8.01	8.01				2553721	1493085	9/18/2008 11:20am	Rectangular weir (6ft) on ditch ~250ft downstream of diversion read 0.5ft equal to 7.06cfs.
Below TX2 and TX1		0.00			0.00					
Mouth/upstream of Leadore		6.22			6.22		2551767	1497561	9/18/2008 5:28pm	Visible seeps with small return channels, not sure if this is still considered Texas Creek or the beginning of the Lemhi River.
TX3 to mouth						12.67				

Table 1. Summary of seepage study for Texas Creek, including reach gains and losses calculated from the measured flows.

Texas Creek Summary	
Initial flow/input	**15.17**
Diverted rate out of Texas Creek	**25.79**
Tributary/injection Input	**3.73**
Cumulative reach losses	**0.00**
Cumulative reach gains	**13.11**
Calculated output	**6.22**
Measured output	**6.22**

Table 2. Summary of Texas Creek seepage study.

Attachment B. STREAM GAGING DATA

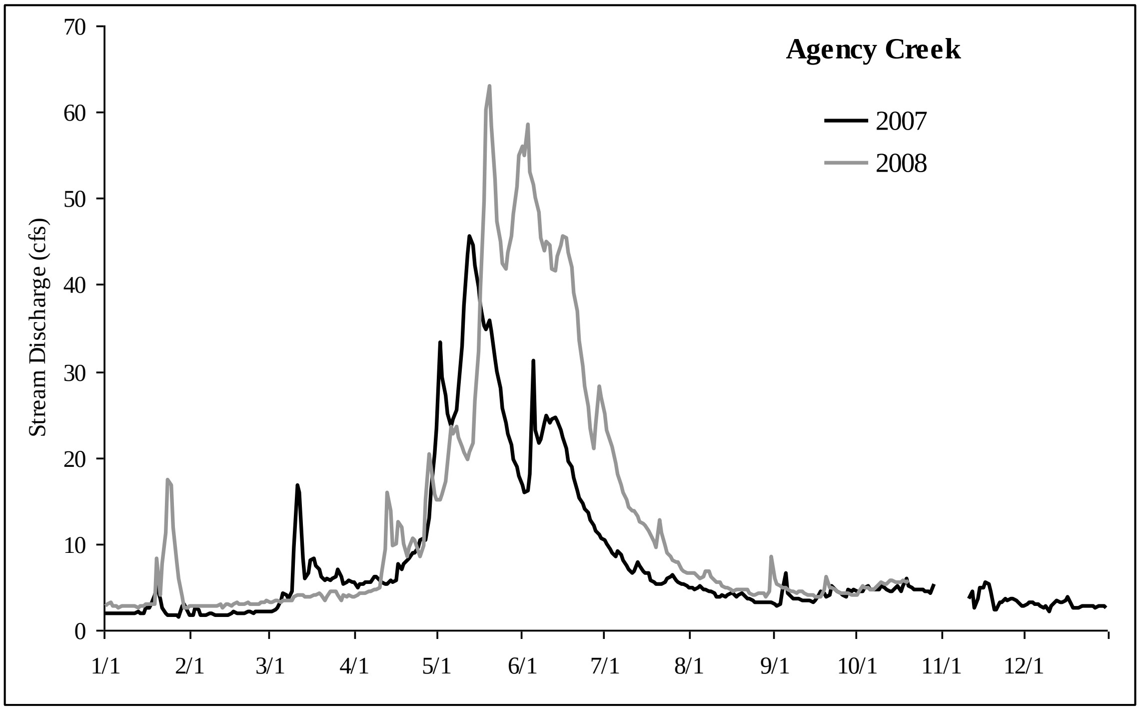

Figure 1. Agency Creek above major diversions.

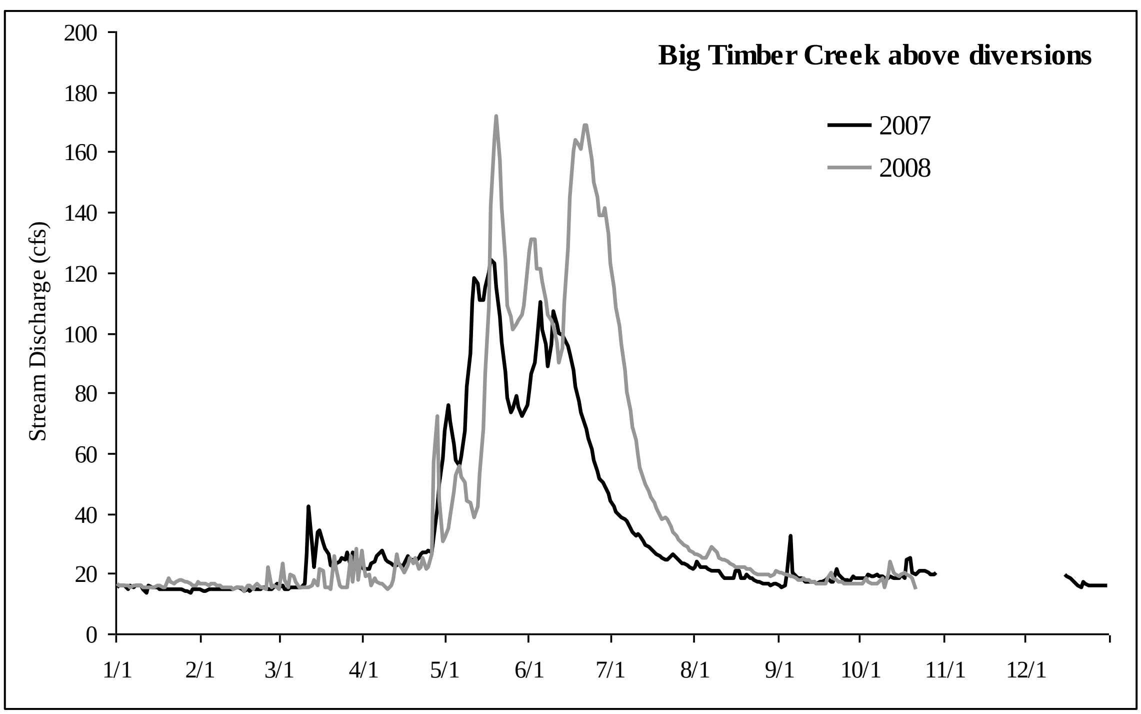

Figure 2. Big Timber Creek above major diversions.

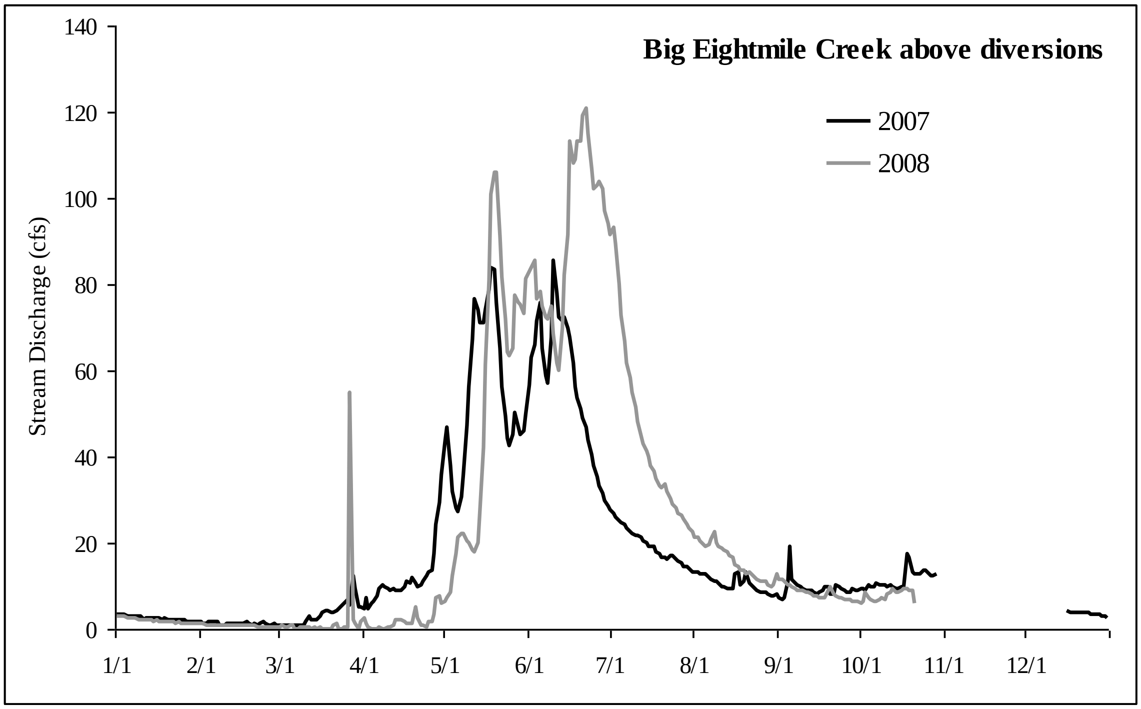

Figure 3. Big Eightmile Creek above all diversions.

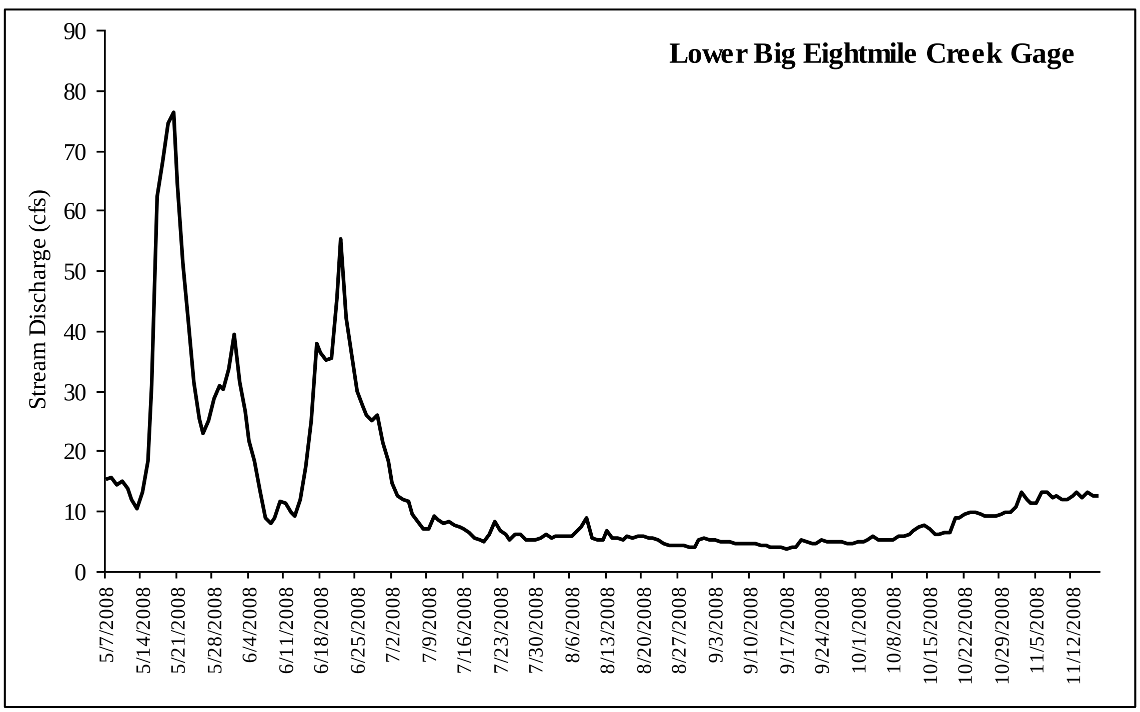

Figure 4. Big Eight Mile Creek above the lowest two diversions.

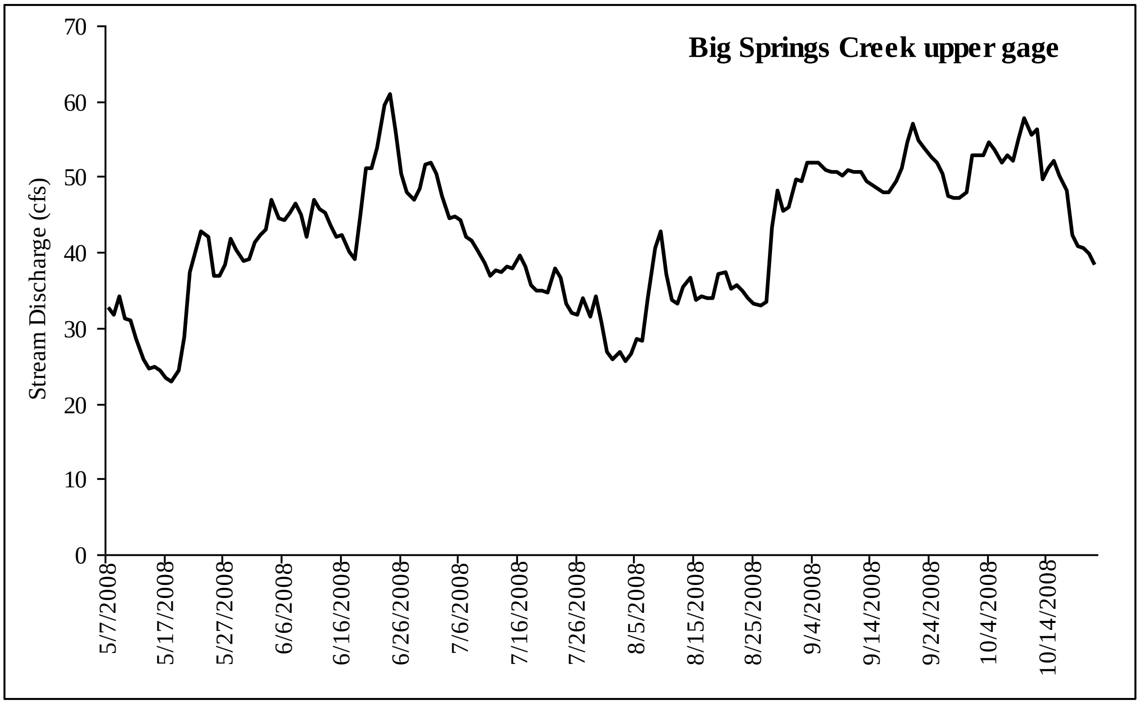

Figure 5. Lemhi Big Springs Creek above BSC5a and BSC5.

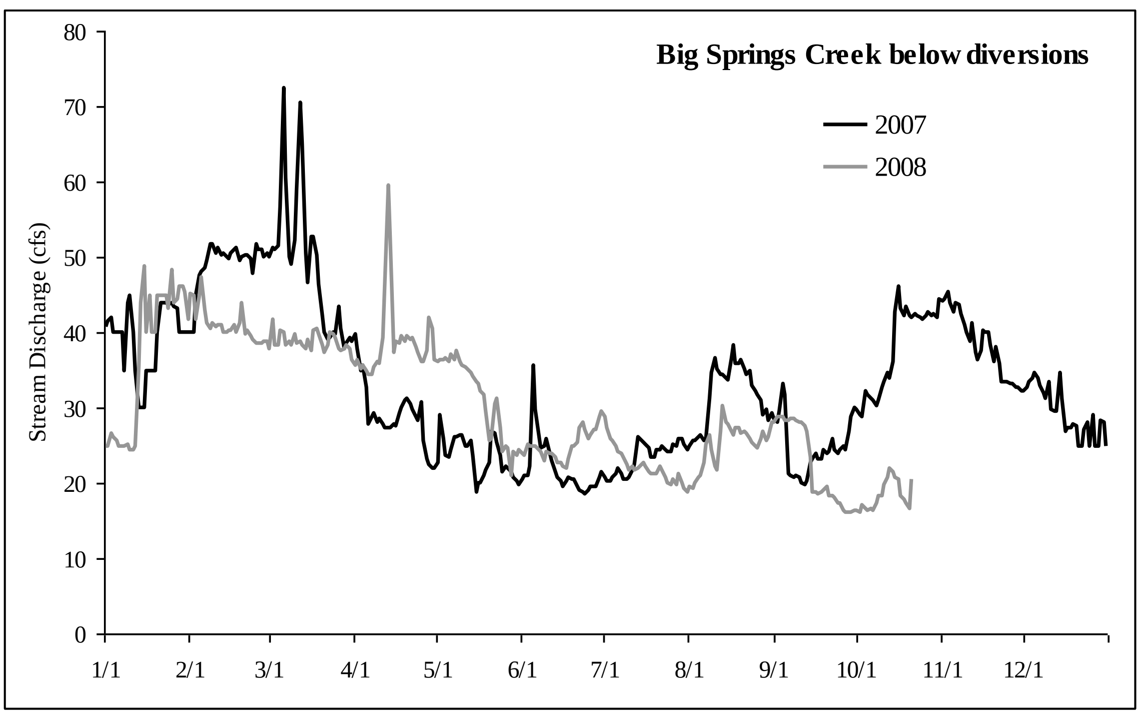

Figure 6. Big Springs Creek below diversions near mouth.

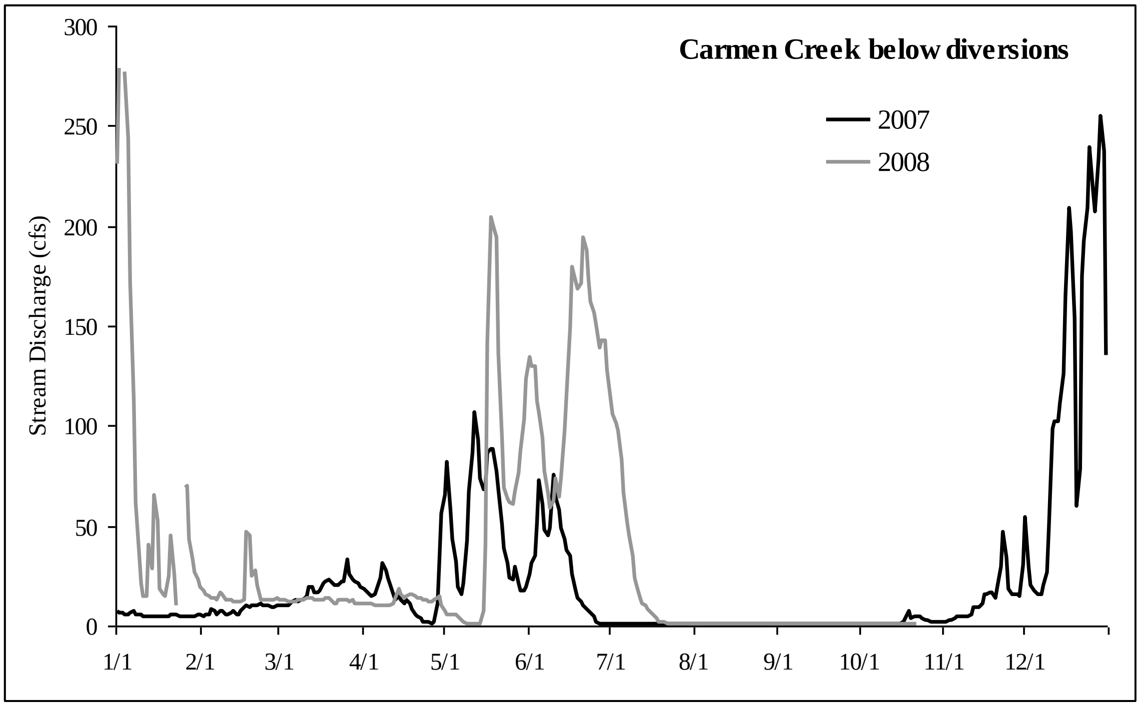

Figure 7. Carmen Creek below diversions near mouth.

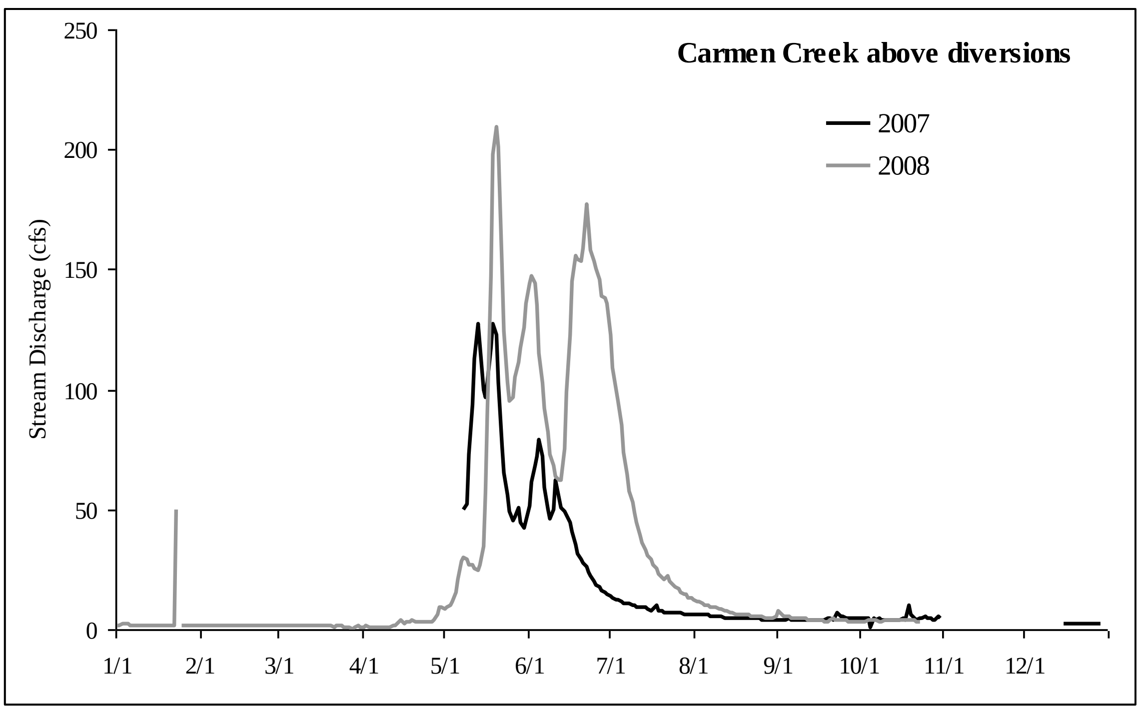

Figure 8. Carmen Creek above all diversions.

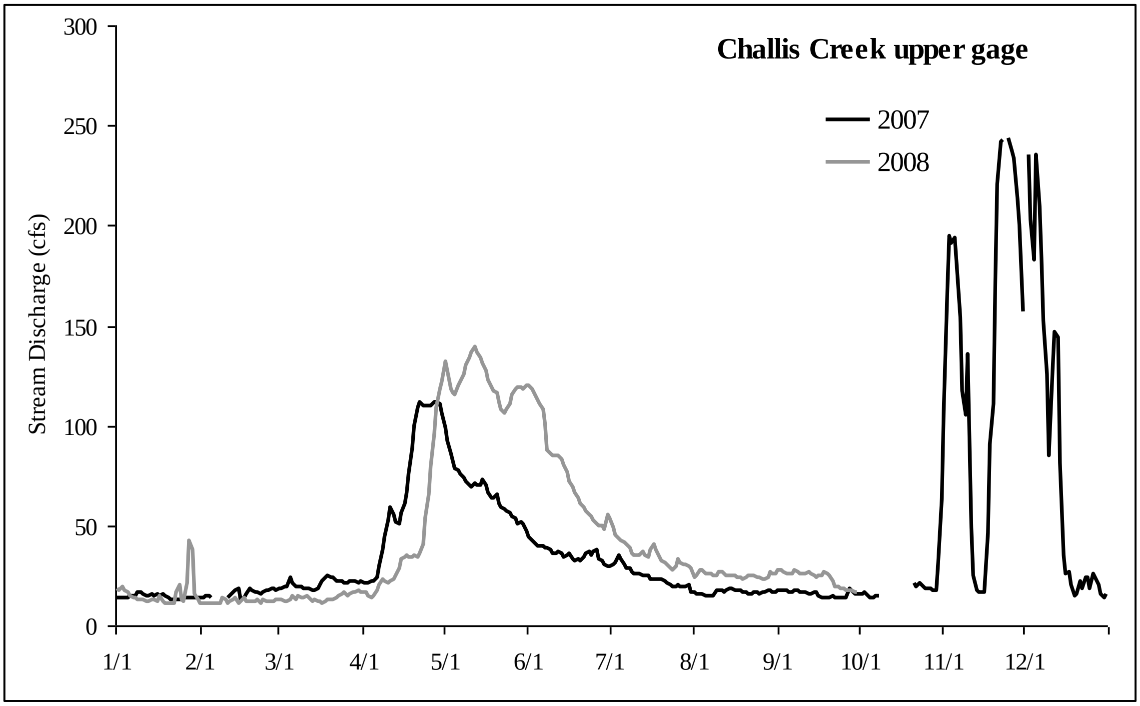

Figure 9. Challis Creek below Eddy Creek.

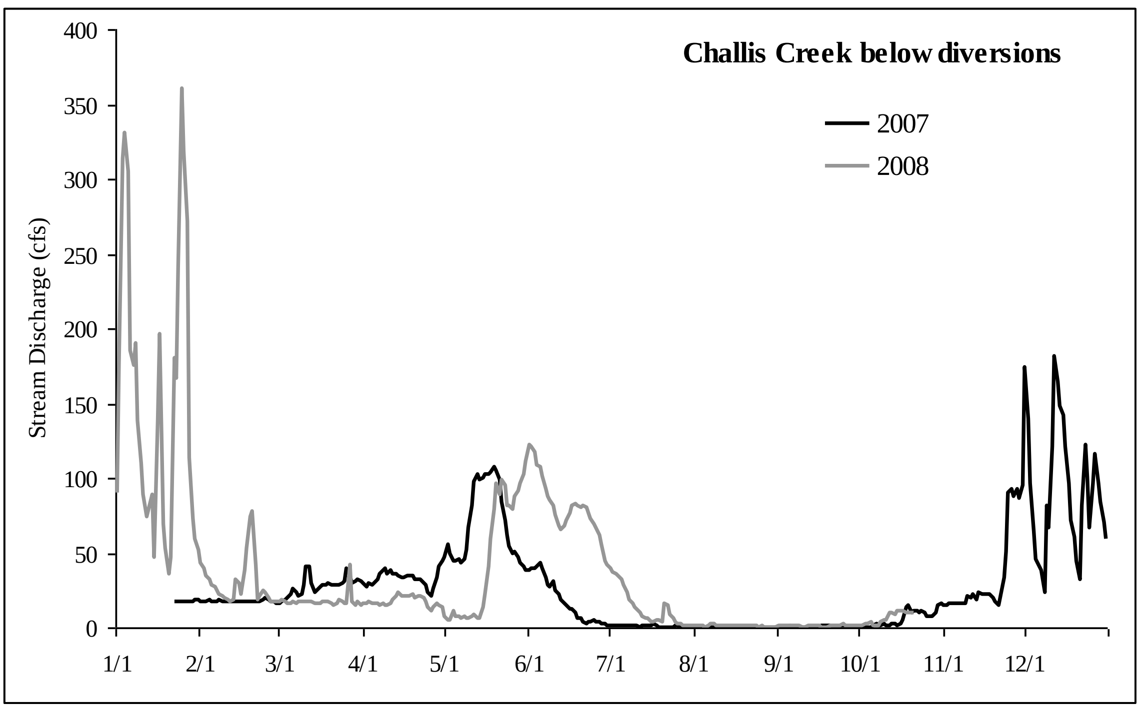

Figure 10. Challis Creek below diversions at Highway 93 crossing. High flows during the winter months is most likely erroneous data due to icing effects.

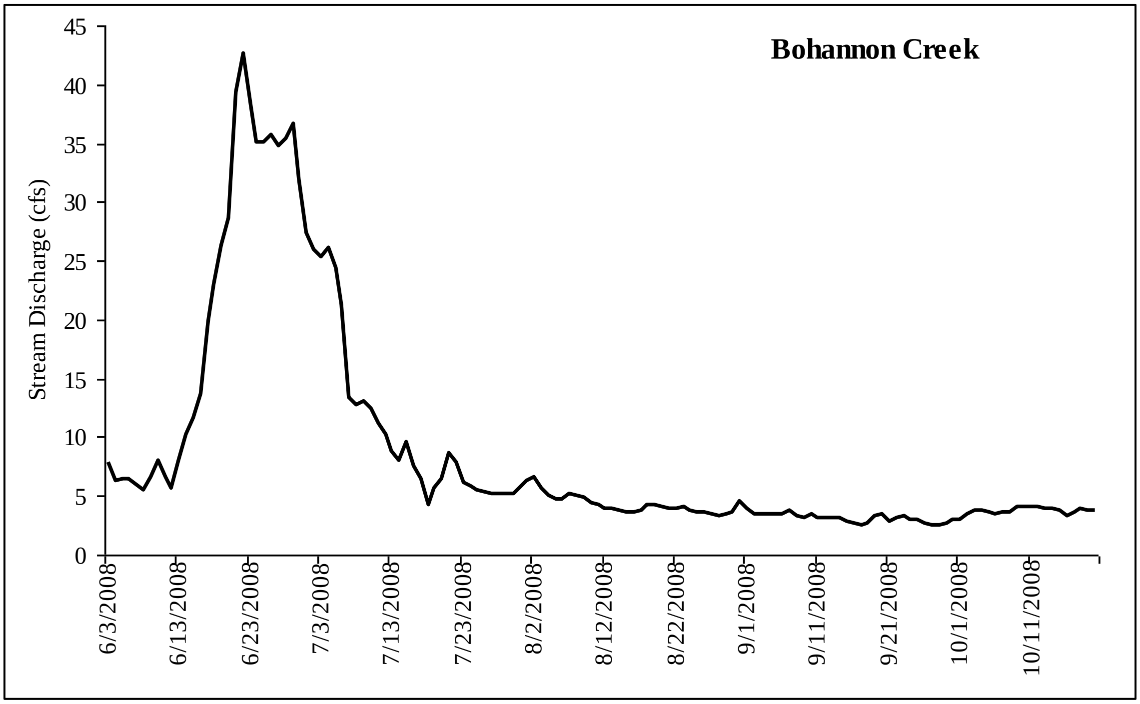

Figure 11. Bohannon Creek above lowest major diversion, BC2.

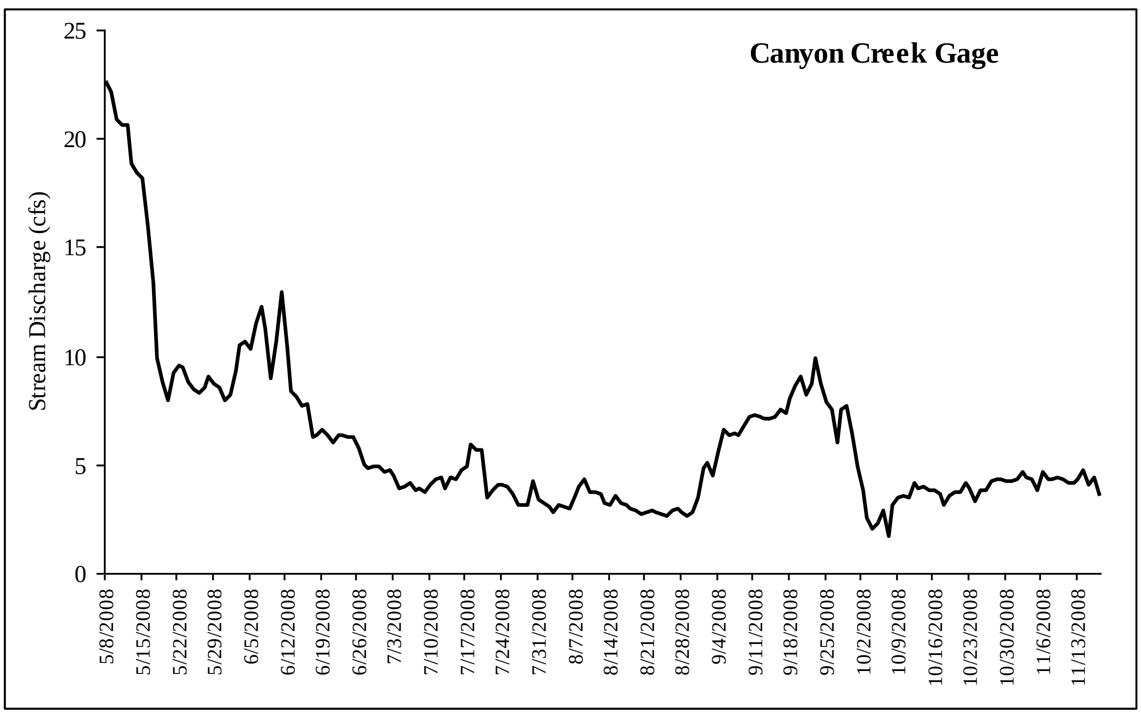

Figure 12. Canyon Creek below diversions near mouth.

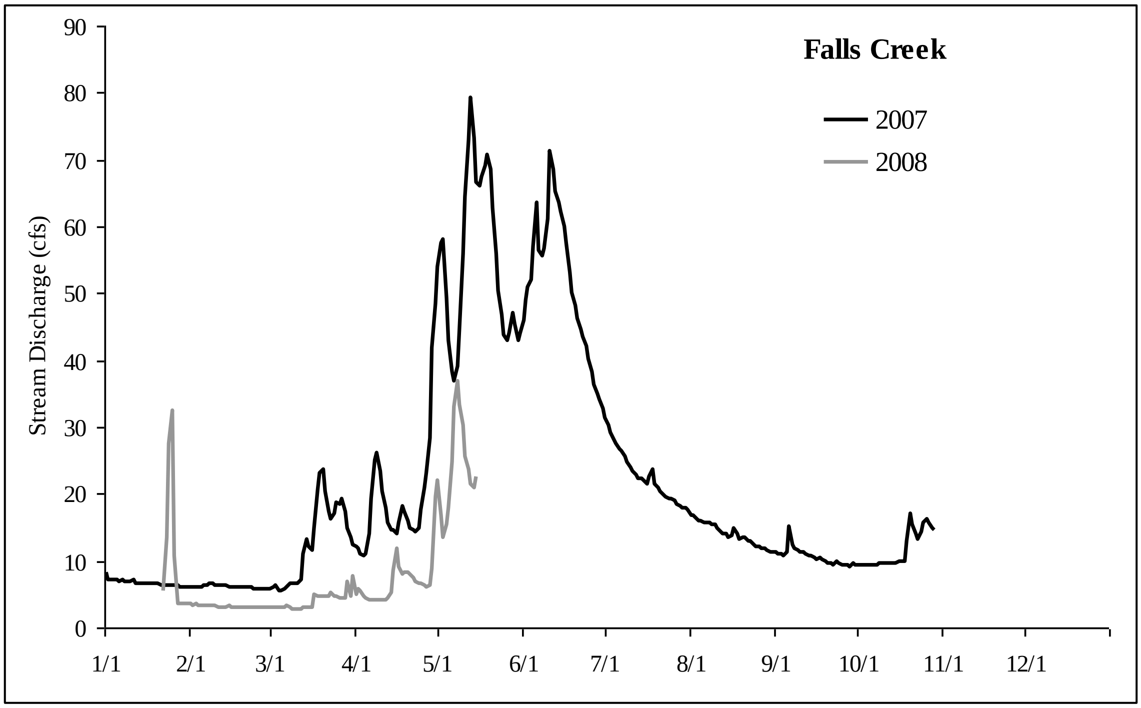

Figure 13. Falls Creek above diversions.

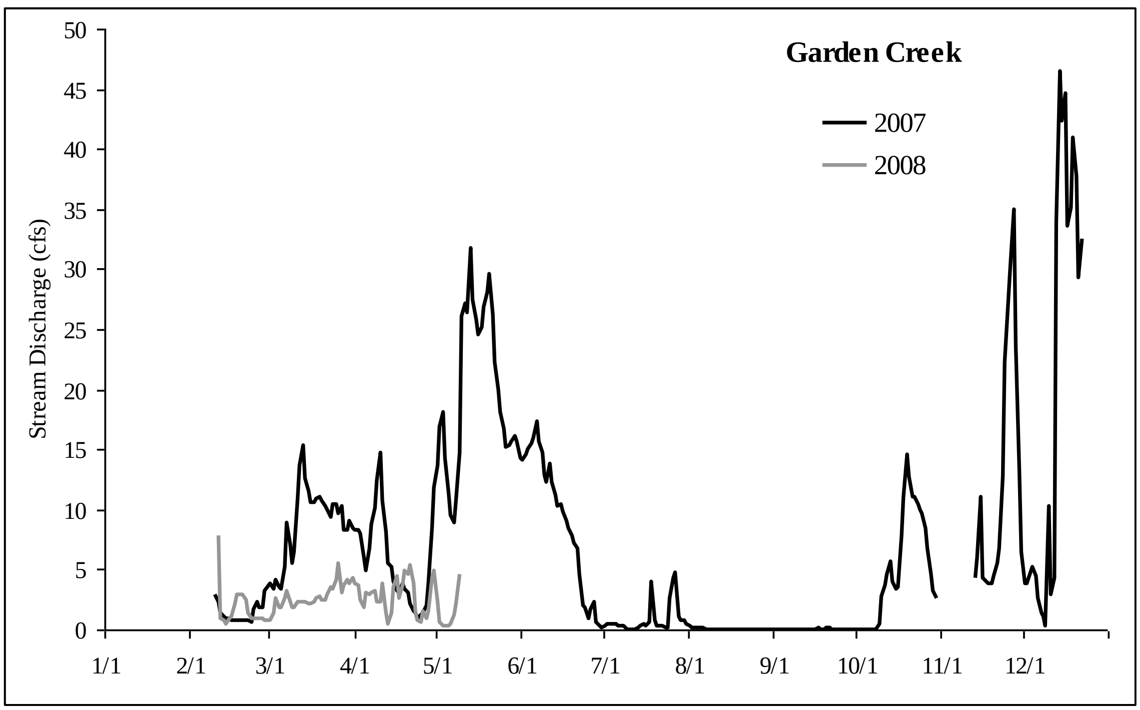

Figure 14. Garden Creek below diversions. High flows during the winter months is most likely erroneous data due to icing effects.

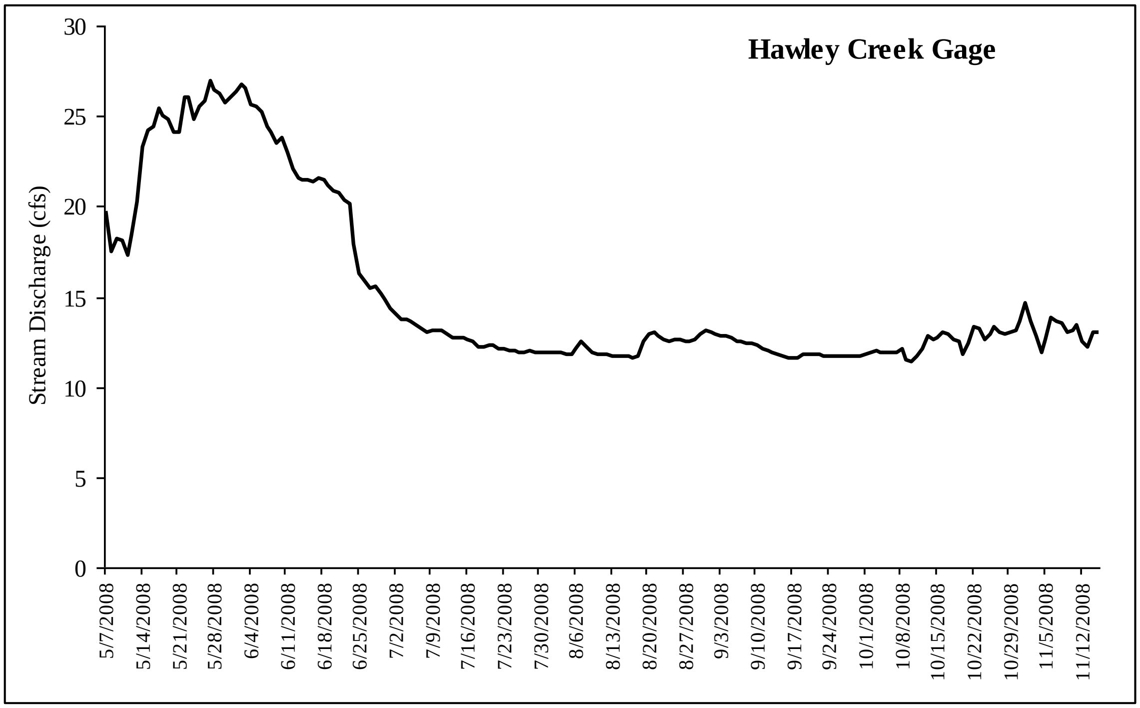

Figure 15. Hawley Creek above major diversions.

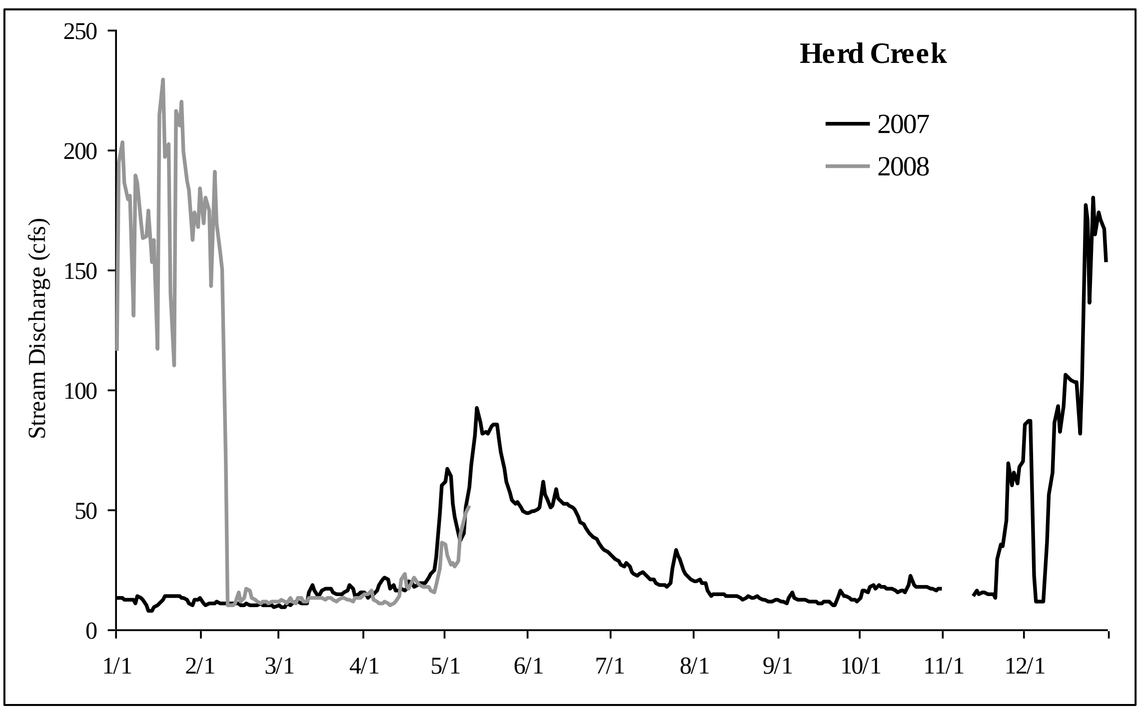

Figure 16. Herd Creek below diversions. High flows during the winter months are most likely erroneous data due to icing effects.

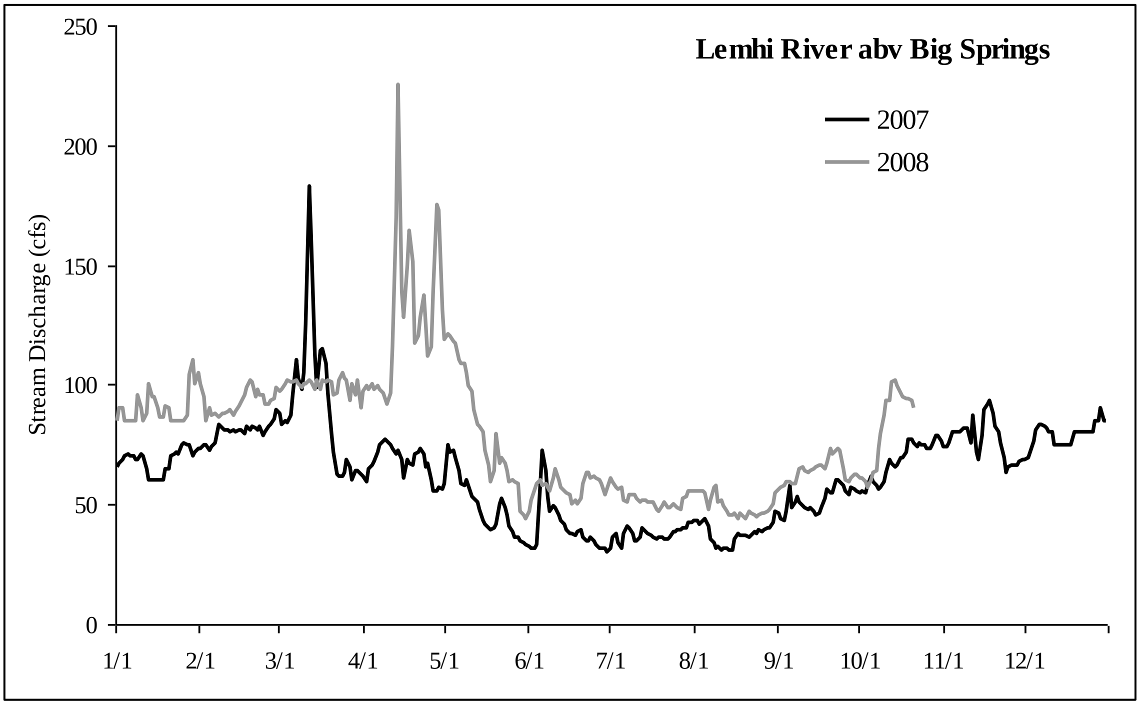

Figure 17. Lemhi River above Big Springs Creek.

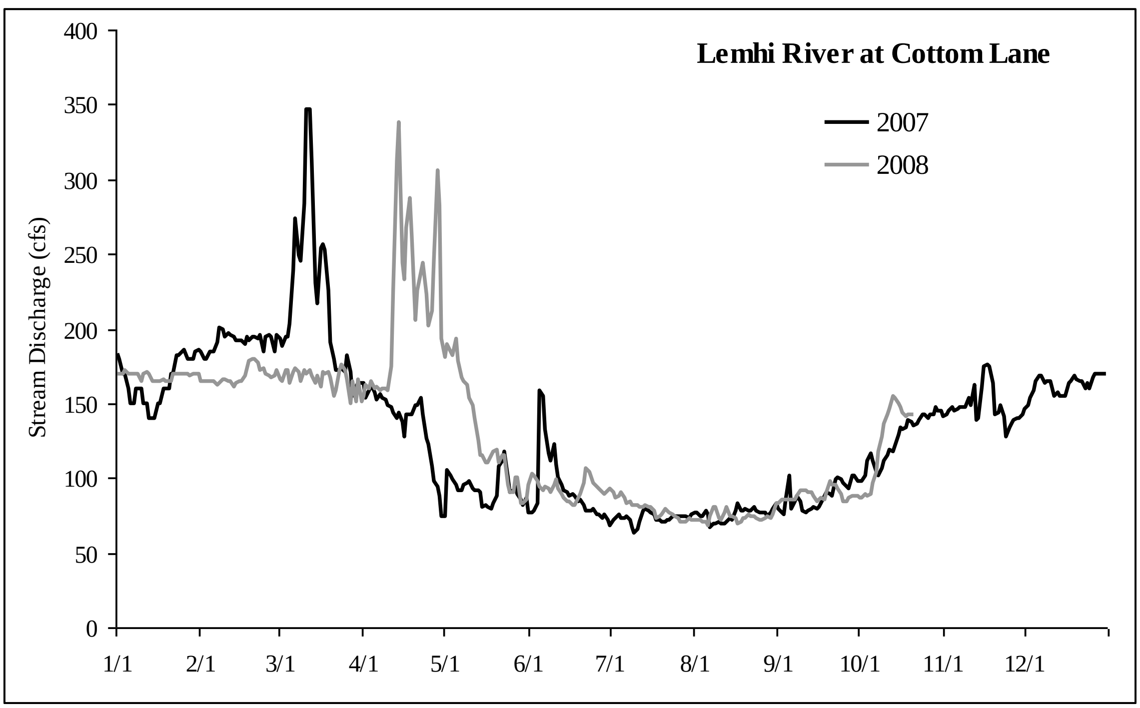

Figure 18. Lemhi Rive at Cottom Lane.

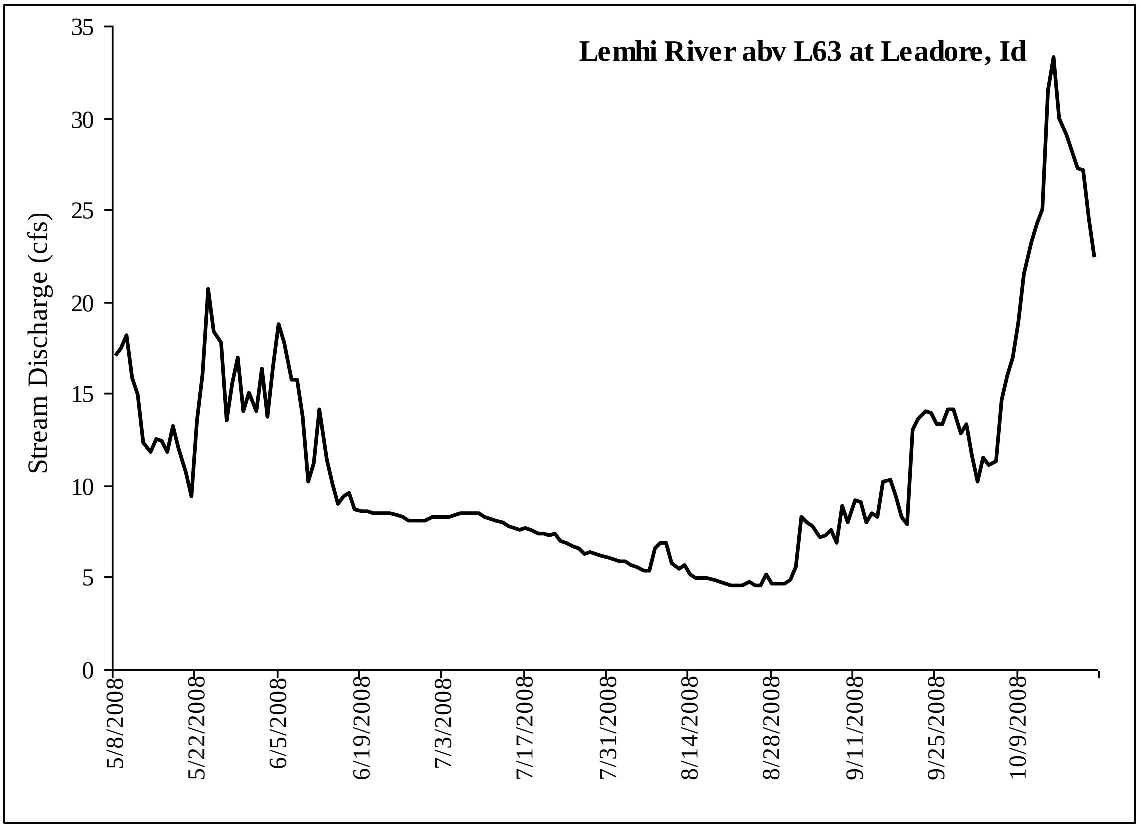

Figure 19. Lemhi River/Texas Creek above L63 diversion.

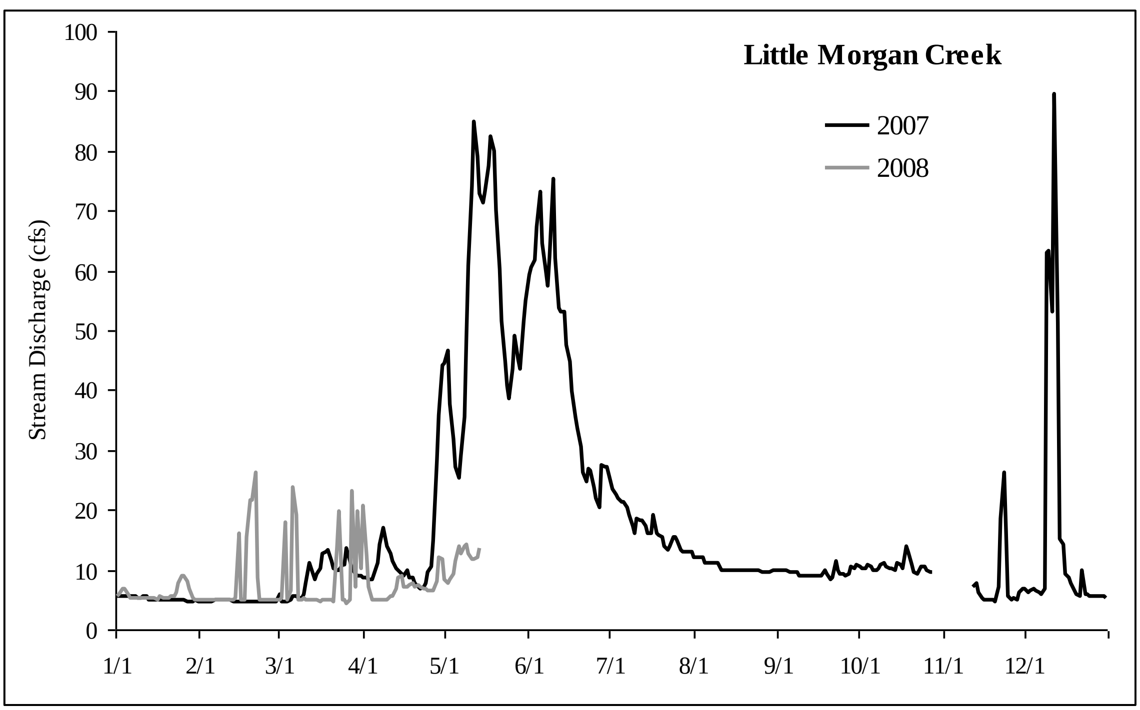

Figure 20. Little Morgan Creek above diversions.

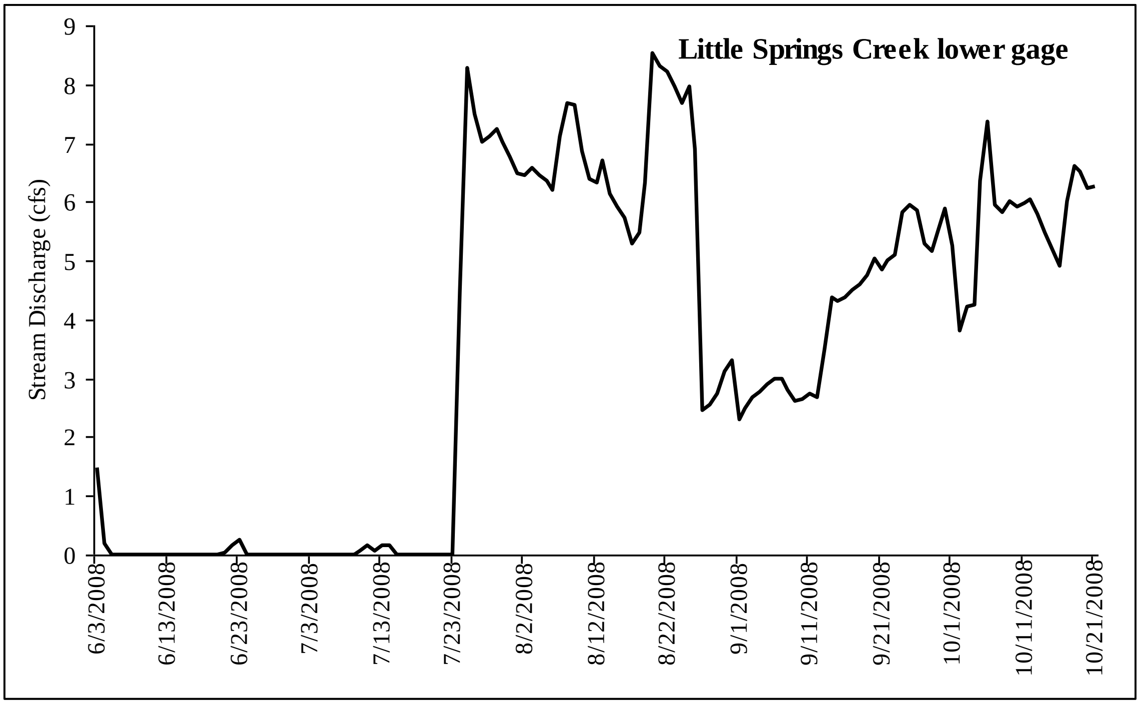

Figure 21. Lemhi Little Springs Creek below diversions near mouth.

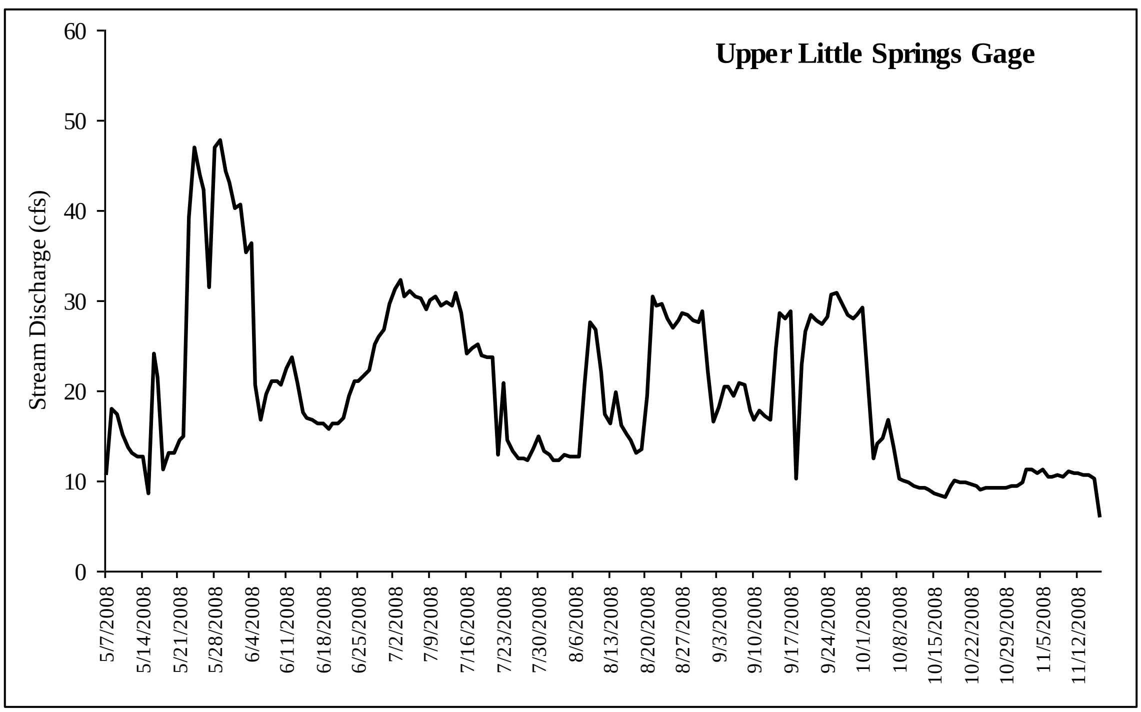

Figure 22. Lemhi Little Springs Creek above major lower diversions.

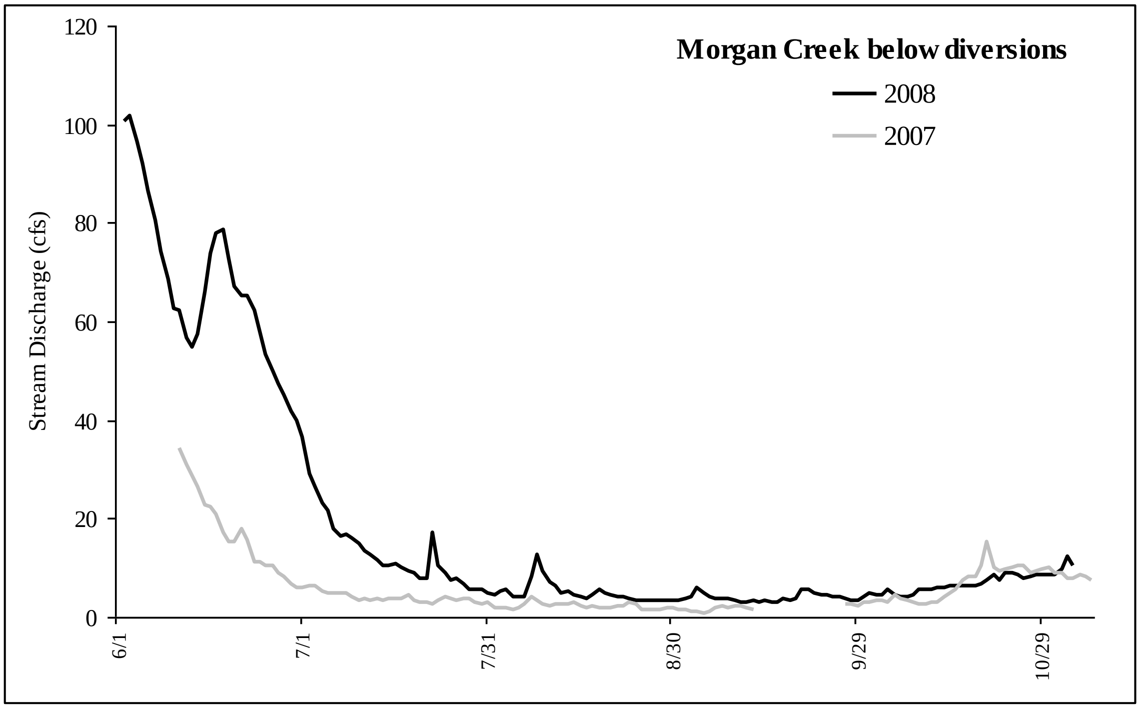

Figure 23. Morgan Creek below diversions.

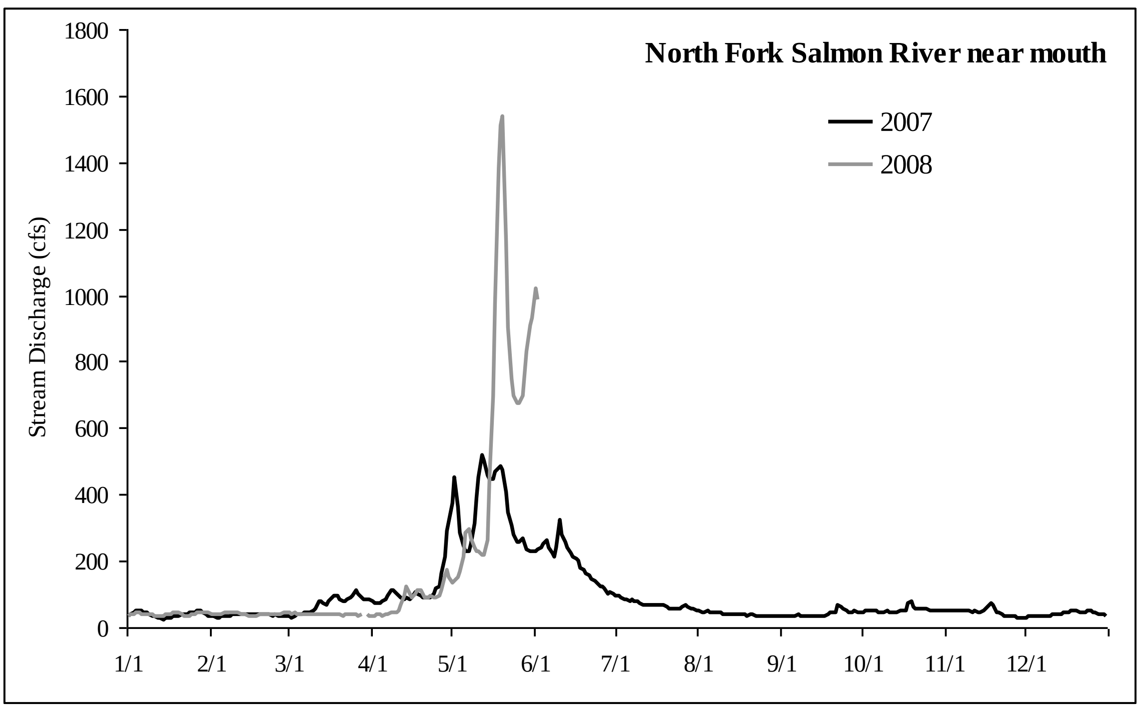

Figure 24. North Fork Salmon River below diversions near mouth.

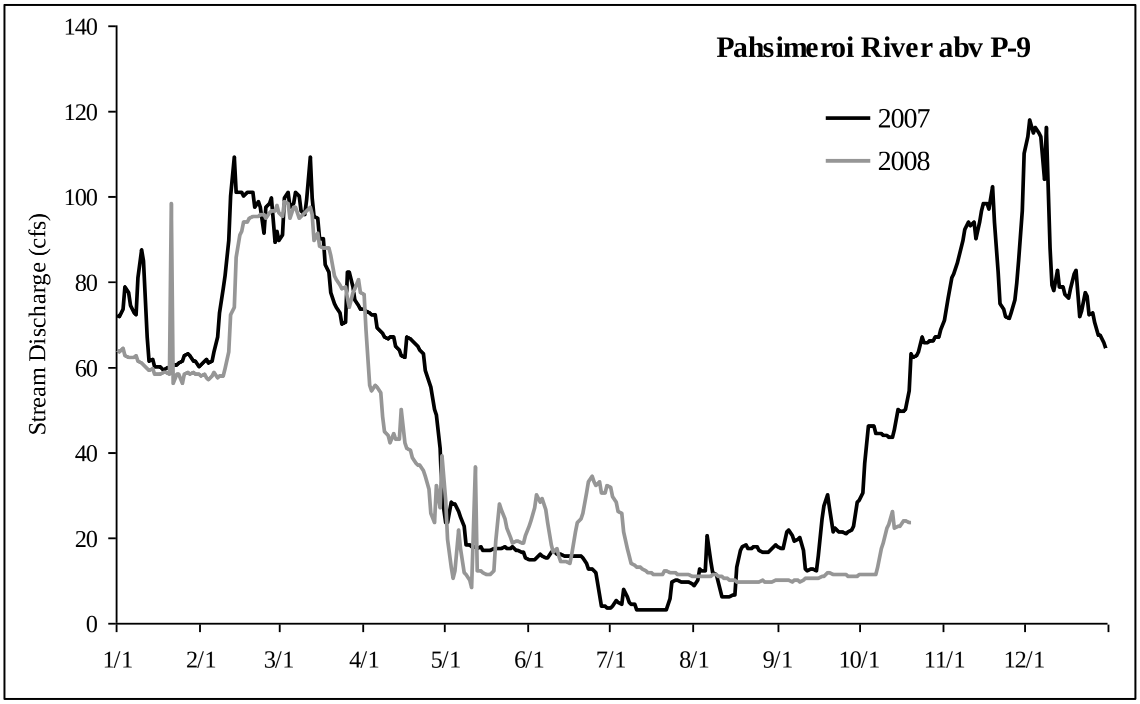

Figure 25. Pahsimeroi River below P9 diversion.

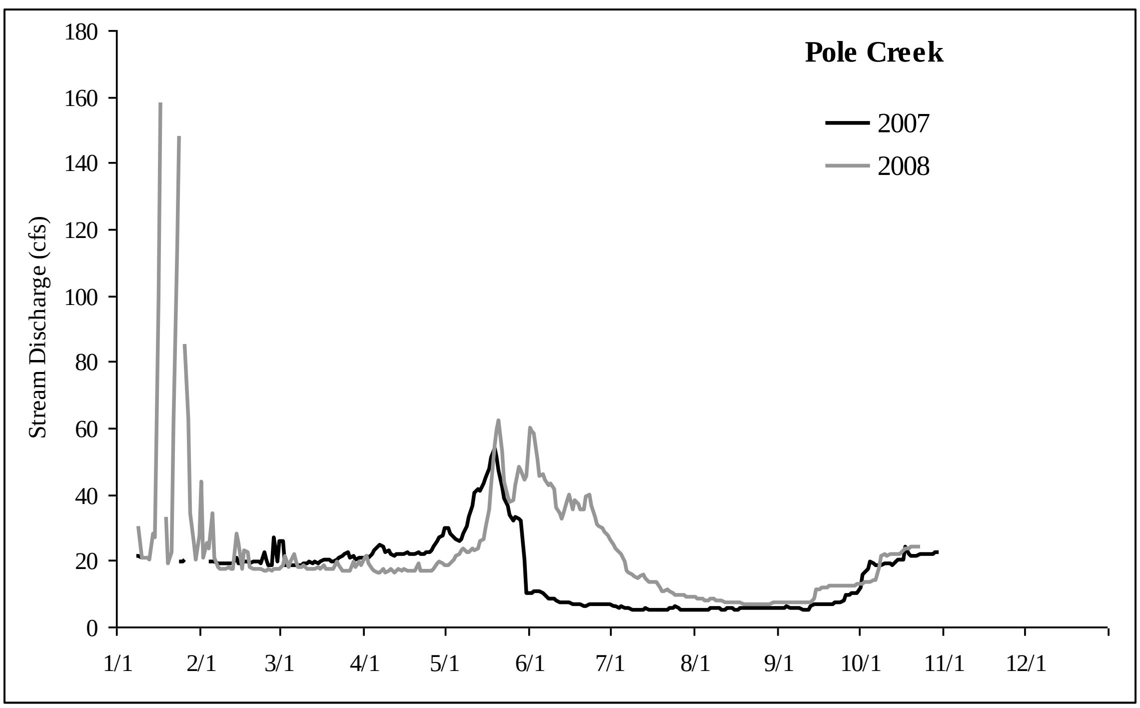

Figure 26. Pole Creek below the only diversion, PC7.

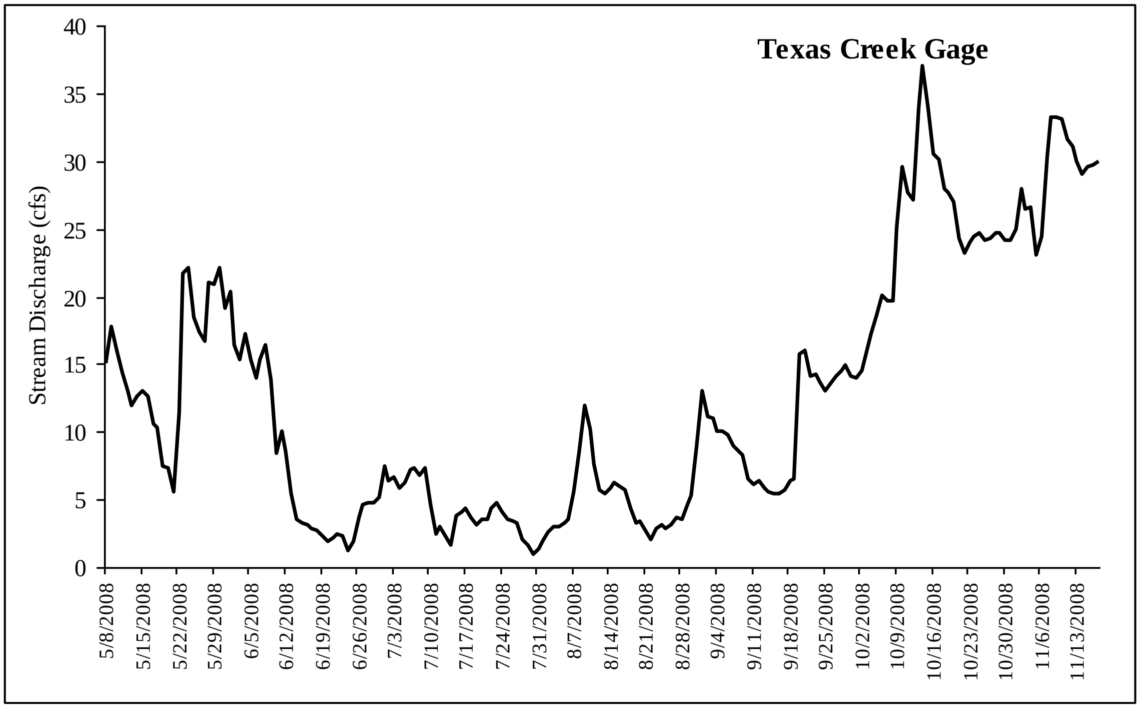

Figure 27. Texas Creek above the lowest diversions TC1 and TC2.

Attachment C. MODELING REPORTS

Attachment C1. Main Salmon River MIKE Basin Model

EXECUTIVE SUMMARY

Stream flow 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. IDWR is developing water distribution models in key basins that will act as protocols for communication between the various agencies, individuals, and organizations trying to develop and implement stream flow enhancement projects. The water distribution model developed for the Main Salmon River is a MIKE Basin Model, an integrated water resource management and planning computer model that integrates a Geographic Information System (GIS) with water resource modeling (DHI 2003). The Main Salmon River MIKE Basin Model (MSRMBM) construction occurred from July to October 2008; during this period, IDWR personnel compared water right information to on site use, developed the river network, compiled and populated the model with existing data, and identified data gaps. The primary limiting factors in the development of a calibrated model are the stream flow, losing and gaining reaches, and diversion time series data. Upon calibration and incorporation of the stream and diversion flow data into the model will be able to evaluate diversion operations in the Main Salmon River Basin.

INTRODUCTION

The Main Salmon River starts in the headwaters upstream of Stanley, Idaho and terminates at its mouth in the Snake River. This model focuses on the mainstem Salmon River downstream of the East Fork Salmon River at the top to the confluence with the Pahsimeroi River. The construction of the Main Salmon River MIKE Basin model was necessary for a greater understanding of the surface water as part of the Upper Salmon watershed Optimizing Stream Flow Enhancement work plan. There are dozens of stream flow enhancement projects considered for development annually in the Upper Salmon watershed. Currently, many people developing projects do not have a good working knowledge of water rights and potential water regulation issues. Analysis of the interconnected nature of water rights on even a small stream can be very complicated. A calibrated surface water model will assist in evaluation and promotion of efficient implementation of effective stream flow enhancement projects.

The model construction occurred from July to September 2008. During this period IDWR personnel compared water right information to on site use, developed the river network, compiled and populated the model with existing data, and identified data gaps. The result of this phase is a skeleton model with a defined network, data files ready for population with data, and customized supporting spreadsheet files for processing and loading data and aiding in the calibration of the model. A calibrated model is not possible at the conclusion of this phase due to insufficient stream and diversion flow data throughout the basin.

MODELING

MIKE Basin is an integrated water resource management and planning computer model that integrates a Geographic Information System (GIS) with water resource modeling (DHI 2003). 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.x (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. The model can represent current conditions of surface water based on measurements taken in the basin, without calibration and an understanding of the surface water system the model is simply a frame work of the stream channels and irrigation network.

Setup

Developing the skeleton model of the MSRMBM involved building the river network; compiling, formatting, and inputting the available data; and modifying customized MS-Excel spreadsheets. The MSRMBM starts below the mouth of the East Fork Salmon River and continues to the confluence of the main Salmon River with the Pahsimeroi River. This model includes catchment inputs from the

Upper Salmon River, the East Fork Salmon River, Bayhorse Creek, Garden Creek, Lyon Creek, Challis Creek and Morgan Creek.; river channels and water use for the main Salmon River;   There was limited surface water data incorporated into this model including: the USGS gages of the Salmon River below the Yankee Fork, Morgan Creek maintained by IDWR, and two stream gauges operated by Idaho Power Company the East Fork Salmon River and Challis Creek (Table 1). Water right information was used to represent the irrigation system in the model (Point of Diversion, Maximum Diversion Rate, Point of Use, total acres).

Name	Ownership	Period of Record
Salmon River downstream of Yankee Fork	USGS	10/1/1921 – Present with missing data
EF Salmon River	IPCo	4/22/2004 – Present with missing data
Garden Creek	IPCo	6/14/2005 – 5/9/2008 with missing data
Challis Creek	IPCo	6/14/2005 – Present with missing data
Morgan Creek	IDWR	3/23/2006 – Present with missing data

Table 1. Summary of the stream gauges used in the MSRMBM and the period of record available.

The model simulations are run on a daily time step for 15 diversion nodes, with the two major user nodes being the Challis Ditch and the Gini Ditch both operated by the Challis Irrigation Company. This represents approximately 10,926 acres of irrigated area associated with these diversions. Generally a diversion node is connected to one irrigation node, and the irrigation node represents one user, but often a group of smaller users use the same point of diversion. When this occurs the model represents them as a group, with one diversion node feeding the user node. Return locations for each irrigation node represent the downstream location where the majority of the return fraction is expected to have returned to the Main or its tributaries. A MS-Excel spreadsheet calculator is used to determine the return fraction parameter for an irrigation node. In addition, this spreadsheet allows for simple upload of time series records, such as gauge readings, into the model.

Water rights information including the points of diversion and points of use were used in conjunction with the two day field trip to develop the initial layout of the MSRMBM.   Other available data that would be useful for the initial setup of the model includes water master records, screen tender data, and miscellaneous measurements. Catchment nodes at upstream network boundaries of the Main Salmon River and selected tributaries represent direct flow input into the model. StreamStats, a regional regression equation developed by the USGS, was used for the Catchment input flows due to the lack of available measured flow data. It is unclear if StreamStats is indicative of actual source flows for the headwaters and tributaries.

Results

The modeling results are not indicative of the basin hydrology as the model currently operates, due to lack of knowledge about the tributary inputs, actual diversion rate time series, irrigation return flows, and natural gaining and losing reaches.

RECOMMENDATIONS FOR FURTHER DEVELOPMENT OF THE MSRMBM

Though IDWR personnel completed the initial phase of the MSRMBM, additional analysis and data collection are required to develop a calibrated model. These recommendations do not reflect any additional data and analysis that may be required to address specific question posed to the model in the future. However, implementing these recommendations will provide greater insight into water movement in the Main Salmon River and its tributaries, and thus can provide a greater foundation for the MSRMBM.

The primary remaining modeling tasks are populating the MSRMBM with data and calibrating the model. This includes investigating and incorporating natural reach gain and loss location, timing, and quantity; as well as incorporating the location, timing, and quantity of irrigation return flows, which rely on the practices and physical conditions of the irrigated lands. In many cases, irrigation returns re-enter the river through both surface and subsurface paths that are dispersed along reaches bordering the irrigated fields. Calibration involves adjusting the lag times and values to attempt to match the simulated and observed water discharges. Other potential future tasks include inclusion of ditch conveyance capacity and seepage losses, application of precipitation records, and refinement of crop consumptive uses (ET).

DATA COLLECTION

The quantity and location of data collection will be a function of time, budget, and the questions users would like to address using the PRMBM. As the limiting element in the calibration of the PRMBM is the stream flow, seepage data, and diversion discharge time series information, these are of utmost importance for development of the model.

Specific data needs are:

- *Daily inflow rates for all tributaries* - At the completion of the first phase, no current discharge data exists for any of the tributaries in the study area.
- *Stream gauging upstream and downstream of sensitive areas* –The MSRMBM does not account for contributions to the Main from precipitation, ground water gains/losses, irrigation returns, and tributary inflow. Therefore, to determine the absolute quantity of water in the river throughout the system, the model must be “updated” by using observed

flow in the stream: The difference between the observed and simulated results is the reach gains/losses. To obtain the observed values, stream gauging is necessary. This will be especially important at the bottom of the model to calibrate the model output to actual observed outflows.

- *Daily diversion discharge* – Operation of irrigation diversions significantly influences flow in the Main and its tributaries. To quantify the influence of diversions, daily measurements of discharge should be made and recorded. Past records from the Water Master may be used as daily diversion records.
- *Seepage Run* - A concurrent seepage run and simulation would provide greater foundation for calibrating and refining the MSRMBM.

CONCLUSIONS

The completed first phase in the MSRMBM development has resulted in a skeleton surface water budget model and Microsoft Excel interface. Developing the skeleton MSRMBM involved building the river network and compiling, computing, formatting, and inputting the data. The primary limiting factors in the development of a calibrated model are the stream flow and diversion time series data. Once collected, MS-Excel interfaces allow users to automate loading of time series data and expedite calibration of the model. Upon calibration, this tool will enable the user to evaluate operation plans by viewing the simulation results with a GIS background that can show the river, points of diversion and return flows, and the irrigation system superimposed on aerial photography of the area.

Model data required includes stream gauge records; daily discharge data for each diversion; and irrigated area, ET rates, crop type, and area serviced by sprinkler irrigation within each irrigated area. At the completion of the first phase of the PRMBM development, insufficient time series data existed to develop a calibrated model.

REFERENCES

DHI 2003. *Evaluation of Diversion Operation Plans to Meet Negotiated Flow Targets for Salmon and Steelhead in the Lemhi River Basin Using the MIKE Basin Model*

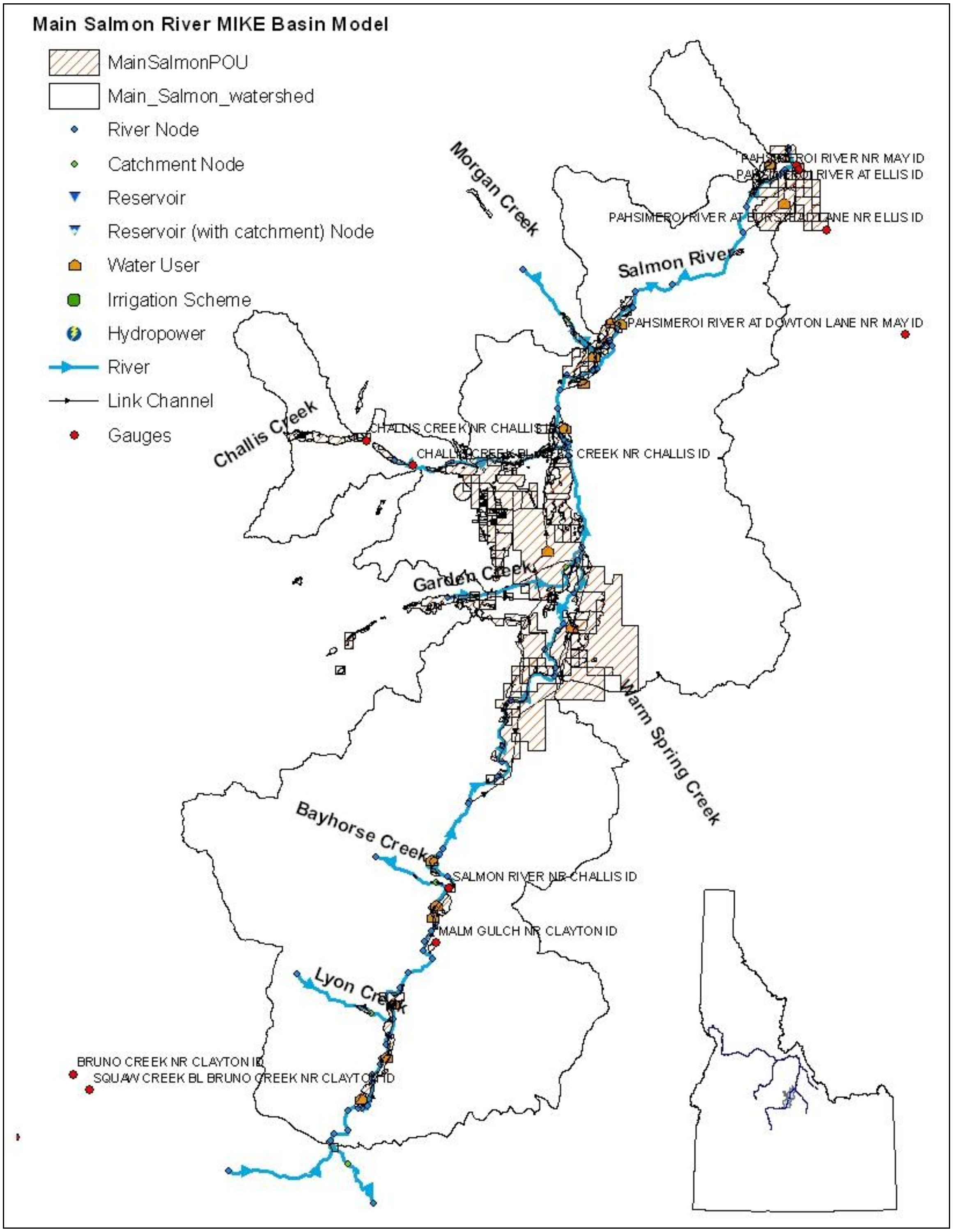

Figure 1. Salmon River Basin WD#72. The Salmon River MIKE Basin model includes the mainstem of the Salmon River downstream of the East Fork Salmon River to the confluence with the Pahsimeroi River.

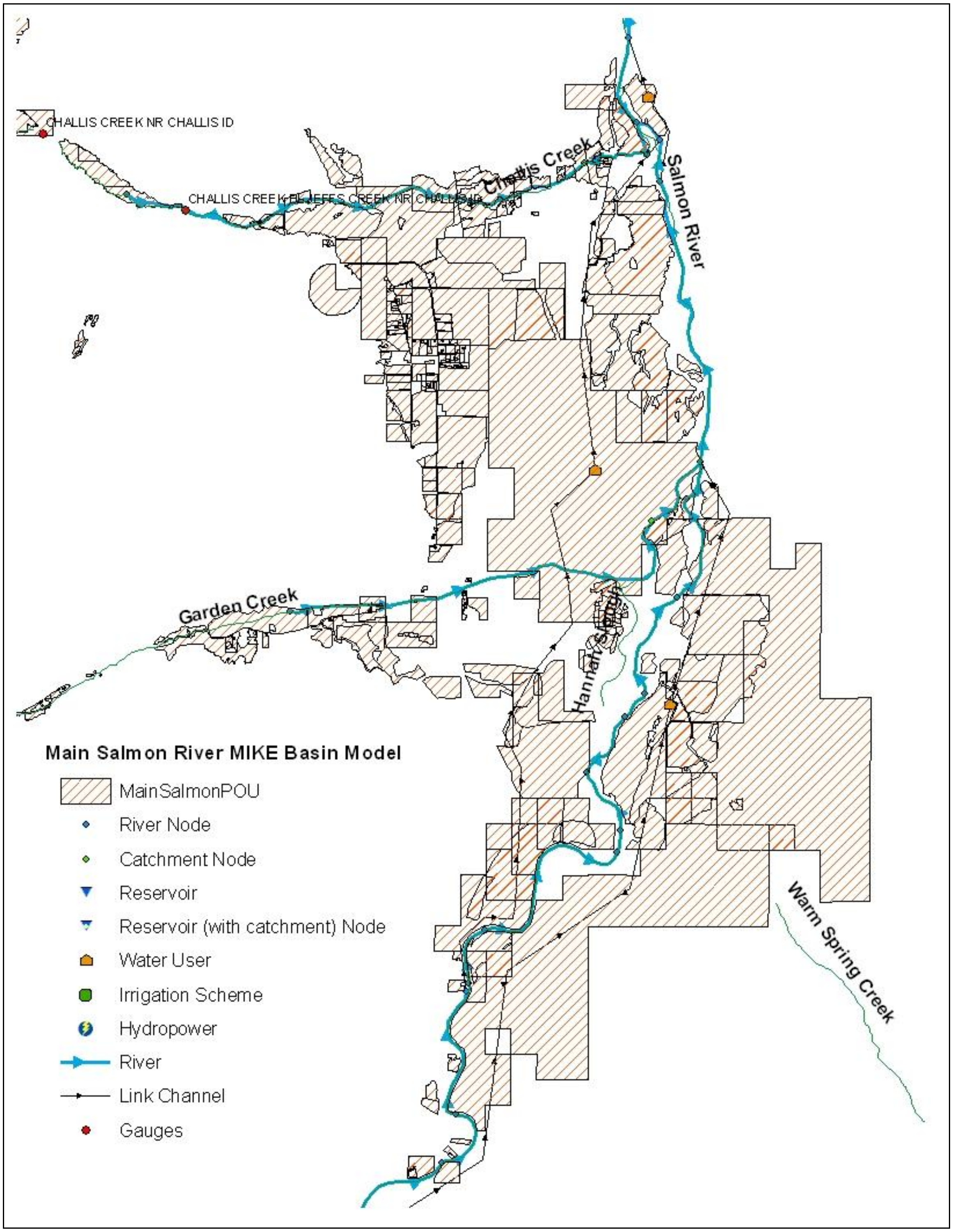

Figure 2. Salmon River Basin MIKE Basin model, view of Challis Irrigation Company administered irrigation system.

Attachment C2. North Fork Salmon MIKE Basin Modeling

EXECUTIVE SUMMARY

Stream flow 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. IDWR is developing water distribution models in key basins that will act as protocols for communication between the various agencies, individuals, and organizations trying to develop and implement stream flow enhancement projects. The water distribution model developed for the North Fork Salmon River is a MIKE Basin Model, an integrated water resource management and planning computer model that integrates a Geographic Information System (GIS) with water resource modeling (DHI 2003). The North Fork Salmon River MIKE Basin Model (NFSRMBM) construction occurred from July to September 2008; during this period, IDWR personnel compared water right information to on site use, developed the river network, compiled and populated the model with existing data, and identified data gaps. The primary limiting factors in the development of a calibrated model are the stream flow, losing and gaining reaches, and diversion time series data. Upon calibration and incorporation of the stream and diversion flow data, the model will be used to evaluate diversion operations in the North Fork Salmon River Basin.

INTRODUCTION

The North Fork Salmon River drains from the continental divide south to its confluence with main Salmon River at 3645ft above sea level. The North Fork basin is a mostly forested steep basin with water use occurring in the valley bottoms, mostly as grass pasture. The construction of the North Fork Salmon River MIKE Basin model was necessary for a greater understanding of the surface water as part of the Upper Salmon watershed Optimizing Stream Flow Enhancement work plan. There are dozens of stream flow enhancement projects considered for development annually in the Upper Salmon watershed. Currently, many people developing projects do not have a good working knowledge of water rights and potential water regulation issues. Analysis of the interconnected nature of water rights on even a small stream can be very complicated. A calibrated surface water model will assist in evaluation and promotion of efficient implementation of effective stream flow enhancement projects.

The model construction occurred from July to September 2008. During this period IDWR personnel compared water right information to on site use, developed the river network, compiled and populated the model with existing data, and identified data gaps. The result of this phase is a skeleton model with a defined network, data files ready for population with data, and customized supporting spreadsheet files for processing and loading data and aiding in the calibration of the model. A calibrated model is not possible at the conclusion of this phase due to insufficient stream and diversion flow data throughout the basin.

As this report supplies a summary of the activities for the North fork Salmon River MIKE Basin Model, much of the background material for the modeling effort can be found in *Evaluation of Diversion Operation Plans to Meet Negotiated Flow Targets for Salmon and Steelhead in the Lemhi River Basin Using the MIKE Basin Model* (DHI 2003). For the Lemhi River, sufficient data was available to construct a calibrated surface water budget model. With sufficient data, the North Fork model may be expected to perform similar analyses in the NF Salmon River Basin.

MODELING

MIKE Basin is an integrated water resource management and planning computer model that integrates a Geographic Information System (GIS) with water resource modeling (DHI 2003). 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.x (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. The model can represent current conditions of surface water based on measurements taken in the basin, without calibration and an understanding of the surface water system the model is simply a frame work of the stream channels and irrigation network.

Setup

Developing the skeleton model of the NFMBM involved building the river network; compiling, formatting, and inputting the available data; and modifying customized MS-Excel spreadsheets. The NFMBM starts upstream of the confluence of the North Fork Salmon River with State Creek and the bottom of the model is located at the mouth, where the North Fork flows into the mainstem Salmon River. This model includes catchment, river channels and water use for major tributaries to the North Fork: State Creek; Dahlonega Creek; Sheep Creek; Unnamed tributary; Hughes Creek; and Hull Creek. There was limited surface water data incorporated into this model including: one stream gauge operated by Idaho Power Company near the mouth from June 15-2005 to June 3, 2008; water right information (Point of Diversion, Maximum Diversion Rate, Point of Use, total acres).

The model simulations are run on a daily time step for 34 diversion nodes along the North Fork and its tributaries. This represents approximately 850 acres of irrigated area associated with these diversions. Generally a diversion node is connected to one irrigation node, and the irrigation node represents one user, but often a group of smaller users use the same point of diversion. When this occurs the model represents them as a group, with one diversion node feeding the user node. Return locations for each irrigation node represent the downstream location where the majority of the return fraction is expected to have returned to the North Fork or its tributaries. A MS-Excel spreadsheet calculator is used to determine the return fraction parameter for an irrigation node. In addition, this spreadsheet allows for simple upload of time series records, such as gauge readings, into the model.

Water rights information including the points of diversion and points of use were used in conjunction with the two day field trip to develop the initial layout of the NFSRMBM. From June 15, 2005 until June 3, 2008 Idaho Power Company maintained a stream gauge near the mouth of the North Fork Salmon River, this data will be eventually used with other future data collections to calibrate the North Fork MBM model. Other available data that is used for the initial setup of the model includes watermaster records, screen tender data, and miscellaneous measurements (don't have any of these yet). Catchment nodes at upstream network boundaries of the North Fork Salmon River and selected tributaries represent direct flow input into the model. StreamStats, a regional regression equation developed by the USGS, was used for the Catchment input flows due to the lack of available measured flow data. It is unclear if StreamStats is indicative of actual source flows for the headwaters and tributaries.

Results

The modeling results are not indicative of the basin hydrology as the model currently operates, due to lack of knowledge about the tributary inputs, actual diversion rate time series, irrigation return flows, and natural gaining and losing reaches.

RECOMMENDATIONS FOR FURTHER DEVELOPMENT OF THE NFSRMBM

Though IDWR personnel completed the initial phase of the NFSRMBM, additional analysis and data collection are required to develop a calibrated model. These recommendations do not reflect any additional data and analysis that may be required to address specific question posed to the model in the future. However, implementing these recommendations will provide greater insight into water movement in the North Fork Salmon River and its tributaries, and thus can provide a greater foundation for the NFSRMBM.

The primary remaining modeling tasks are populating the NFSRMBM with data and calibrating the model. This includes investigating and incorporating natural reach gain and loss location, timing, and quantity; as well as incorporating the location, timing, and quantity of irrigation return flows, which rely on the practices and physical conditions of the irrigated lands. In many cases, irrigation returns re-enter the river through both surface and subsurface paths that are dispersed along reaches bordering the irrigated fields. Calibration involves adjusting the lag times and values to attempt to match the simulated and observed water discharges. Other potential future tasks include inclusion of ditch conveyance capacity and seepage losses, application of precipitation records, and refinement of crop consumptive uses (ET).

Data Collection

The quantity and location of data collection will be a function of time, budget, and the questions users would like to address using the PRMBM. As the limiting element in the calibration of the PRMBM is the stream flow, seepage data, and diversion discharge time series information, these are of utmost importance for development of the model.

Specific data needs are:

- *Daily inflow rates for all tributaries* - At the completion of the first phase, no current discharge data exists for any of the tributaries in the study area.
- *Daily diversion discharge* – Operation of irrigation diversions significantly influences flow in the North Fork and its tributaries. To quantify the influence of diversions, daily measurements of discharge should be made and recorded. Past records from the watermaster may be used as daily diversion records.
- *Seepage Run* - A concurrent seepage run and simulation would provide greater foundation for calibrating and refining the NFSRMBM.

CONCLUSIONS

The completed first phase in the NFSRMBM development has resulted in a skeleton surface water budget model and Microsoft Excel interface. Developing the skeleton NFSRMBM involved building the river network and compiling, computing, formatting, and inputting the data. The primary limiting factors in the development of a calibrated model are the stream flow and diversion time series data. Once collected, MS-Excel interfaces allow users to automate loading of time series data and expedite calibration of the model. Upon calibration, this tool will enable the user to evaluate operation plans by viewing the simulation results with a GIS background that can show the river, points of diversion and return flows, and the irrigation system superimposed on aerial photography of the area.

Model data required includes stream gauge records; daily discharge data for each diversion; and irrigated area, ET rates, crop type, and area serviced by sprinkler irrigation within each irrigated area. At the completion of the first phase of the PRMBM development, insufficient time series data existed to develop a calibrated model.

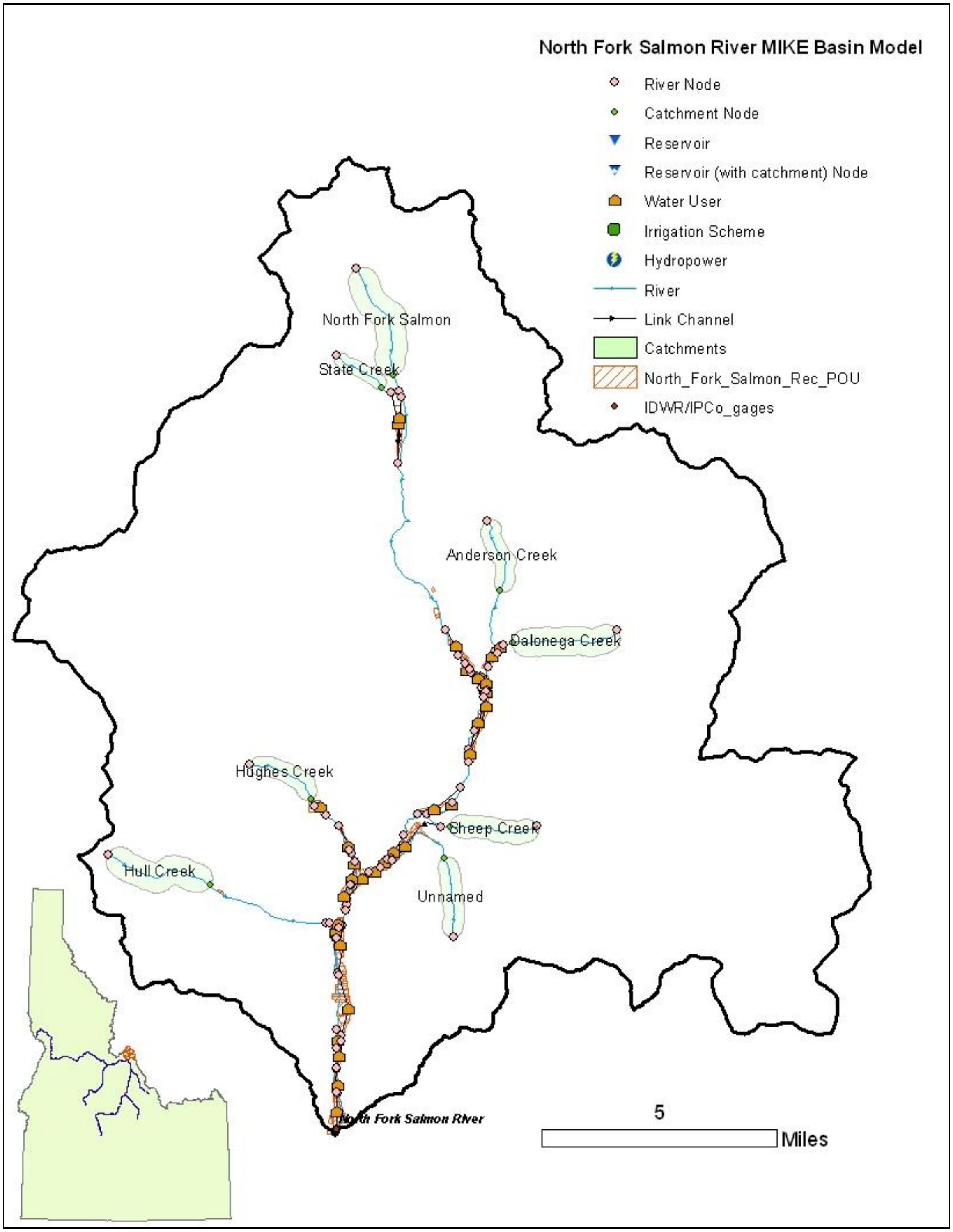

Figure 1. North Fork Salmon River Basin. The North Fork Salmon River MIKE Basin model includes the mainstem and tributaries State, Dahlonega (including Anderson Creek), Sheep, unnamed, Hughes, Hull and Big Silverlead Creeks.

Attachment C3. Pahsimeroi River MIKE Basin Modeling Update

Update of the Pahsimeroi River MIKE Basin Model

EXECUTIVE SUMMARY

Stream flow 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. IDWR is developing water distribution models in key basins that will act as protocols for communication between the various agencies, individuals, and organizations trying to develop and implement stream flow enhancement projects. The water distribution model developed for the Pahsimeroi River is a MIKE Basin Model, an integrated water resource management and planning computer model that integrates a Geographic Information System (GIS) with water resource modeling (DHI 2003). The Pahsimeroi River MIKE Basin Model (PRMBM) construction occurred from October and November 2008; during this period IDWR personnel compiled water rights information, developed the river network, compiled and populated the model with existing data, and identified data gaps. The primary limiting factors in the development of a calibrated model are diversion time series data. Upon calibration and incorporation of the stream and diversion flow data, the model will be used to evaluate diversion operations in the Pahsimeroi River Basin.

INTRODUCTION

The Pahsimeroi River is a major tributary of the Salmon River that is agriculturally developed and a key stream for native and anadromous fish. The construction of the Pahsimeroi River MIKE Basin model was necessary for a greater understanding of the surface water as part of the Upper Salmon watershed Optimizing Stream Flow Enhancement work plan. There are dozens of stream flow enhancement projects considered for development annually in the Upper Salmon watershed. Currently, many people developing projects do not have a good working knowledge of water rights and potential water regulation issues. Analysis of the interconnected nature of water rights on even a small stream can be very complicated. A calibrated surface water model will assist in evaluation and promotion of efficient implementation of effective stream flow enhancement projects.

The model update occurred from October to December 2008. During this period IDWR personnel compared water right information to on site use, developed the river network, compiled and populated the model with existing data, and identified data gaps. The result of this phase is a skeleton model with a defined network, data files ready for population with data, and customized supporting spreadsheet files for processing and loading data and aiding in the calibration of the model. A calibrated model is not possible at the conclusion of this phase due to the lack of diversion flow data throughout the basin.

MODELING

MIKE Basin is an integrated water resource management and planning computer model that integrates a Geographic Information System (GIS) with water resource modeling (DHI 2003). 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.x (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.

Setup

Developing the skeleton model of the PRMBM involved building the river network; compiling, formatting, and inputting the available data; and modifying customized MS-Excel spreadsheets. The PRMBM starts and continues to the mouth where the Pasimeroi River flows into the Salmon River. This model includes catchment inputs from the Upper Pahsimeroi River, Falls Creek, Little Morgan Creek, Goldburg Creek, Patterson Creek, Sulphur Creek, Big Creek; river channels and water use for the Pahsimeroi River and select tributaries. There was limited surface water data incorporated into this model including: (Table 1). Water right information was used to represent the irrigation system in the model (Point of Diversion, Maximum Diversion Rate, Point of Use, total acres).

Name	Ownership	Period of Record
Pahsimeroi River at Ellis	USGS	10/1/1984 – 07/16/2008
Pahsimeroi River blw P9	IPCo	6/14/2006 – Present
Pahsimeroi River at Furey Lane	IPCo	5/11/2004 - Present
Falls Creek	IPCo	6/29/2005 – 5/14/2008
Little Morgan Creek	IPCo	6/28/2005 – 5/14/2008
Upper Pahsimeroi	Whittier reference	8//2005 – 9//2008
Upper Goldburg Creek	Whittier	9//2005 – 9//2007
Big Creek	Whittier	11//2005 – 4//2007
Patterson Creek	Whittier	6//2007 – 9//2008
Sulphur Creek	Whittier	11//2005 – 9//2007

Table 1. Summary of the stream gauges used in the PRMBM and the period of record available.

Results

The model has been populated with available data and is running. However, calibration of the model will not be possible until watermaster records become available. IDWR will calibrate the model once these records are available.

RECOMMENDATIONS FOR FURTHER DEVELOPMENT OF THE PRMBM

Though IDWR personnel completed the initial phase of the PRMBM, additional analysis and data collection are required to develop a calibrated model. These recommendations do not reflect any additional data and analysis that may be required to address specific question posed to the model in the future. However, implementing these recommendations will provide greater insight into water use in the Pahsimeroi River and its tributaries, and thus can provide a greater foundation for the PRMBM.

The primary remaining modeling tasks are populating the PRMBM with diversion rate data and calibrating the model. Other potential future tasks include inclusion of ditch conveyance capacity and seepage losses, application of precipitation records, and refinement of crop consumptive uses (ET).

Data Collection

The quantity and location of data collection will be a function of time, budget, and the questions users would like to address using the PRMBM. As the limiting element in the calibration of the PRMBM is the stream flow, seepage data, and diversion discharge time series information, these are of utmost importance for development of the model.

Specific data needs are:

- *Daily diversion discharge* – Operation of irrigation diversions significantly influences flow in the Main and its tributaries. To quantify the influence of diversions, daily measurements of discharge should be made and recorded. Past records from the Water Master may be used as daily diversion records.
- *Seepage Run -* A concurrent seepage run and simulation would provide greater foundation for calibrating and refining the PRMBM.

CONCLUSIONS

The completed first phase in the PRMBM development has resulted in a skeleton surface water budget model and Microsoft Excel interface. Developing the skeleton PRMBM involved building the river network and compiling, computing, formatting, and inputting the data. The primary limiting factors in the development of a calibrated model are the diversion time series data. Once collected, MS-Excel interfaces allow users to automate loading of time series data and expedite calibration of the model. Upon calibration, this tool will enable the user to evaluate operation plans by viewing the simulation results with a GIS background that can show the river, points of diversion and return flows, and the irrigation system superimposed on aerial photography of the area.

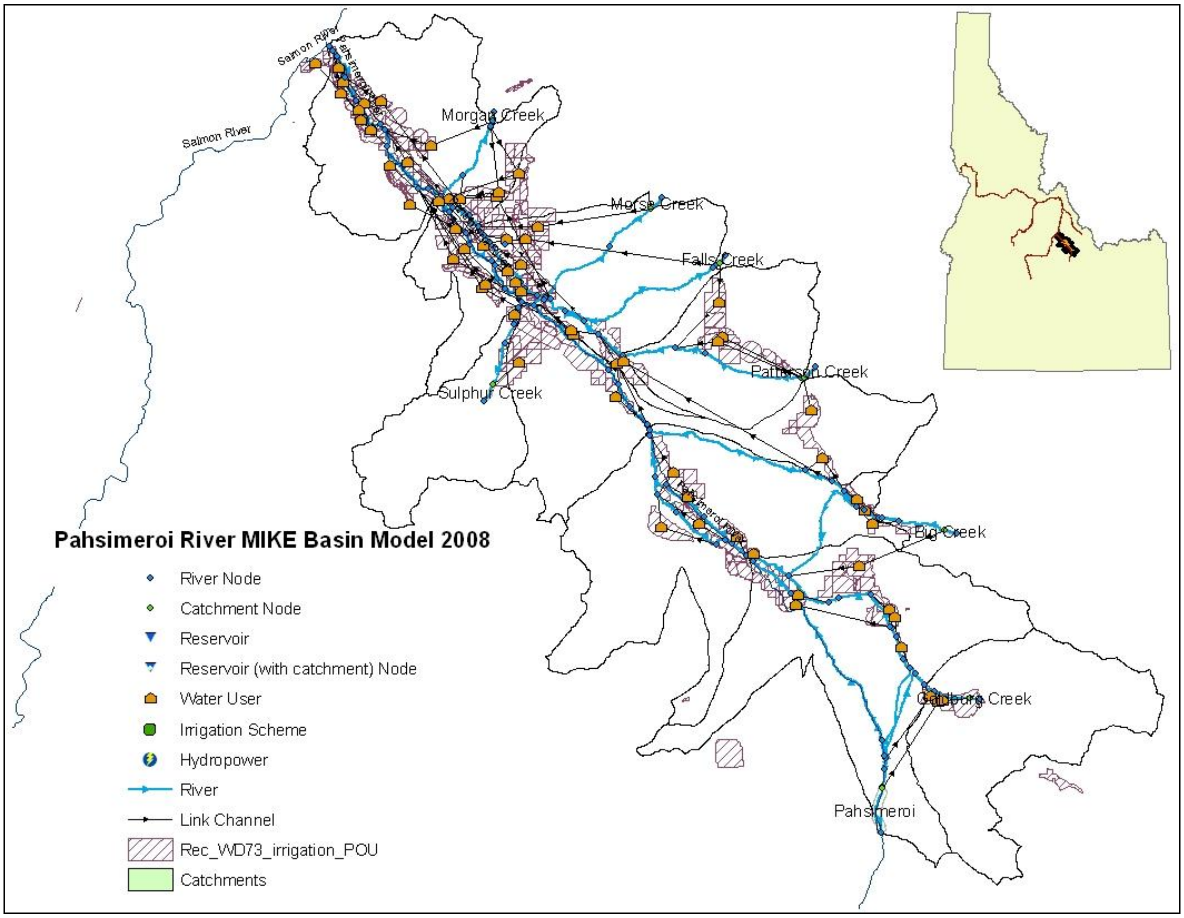

Figure 1. Pahsimeroi River Basin WD#73. The Pahsimeroi River MIKE Basin model includes the mainstem of the Pahsimeroi River

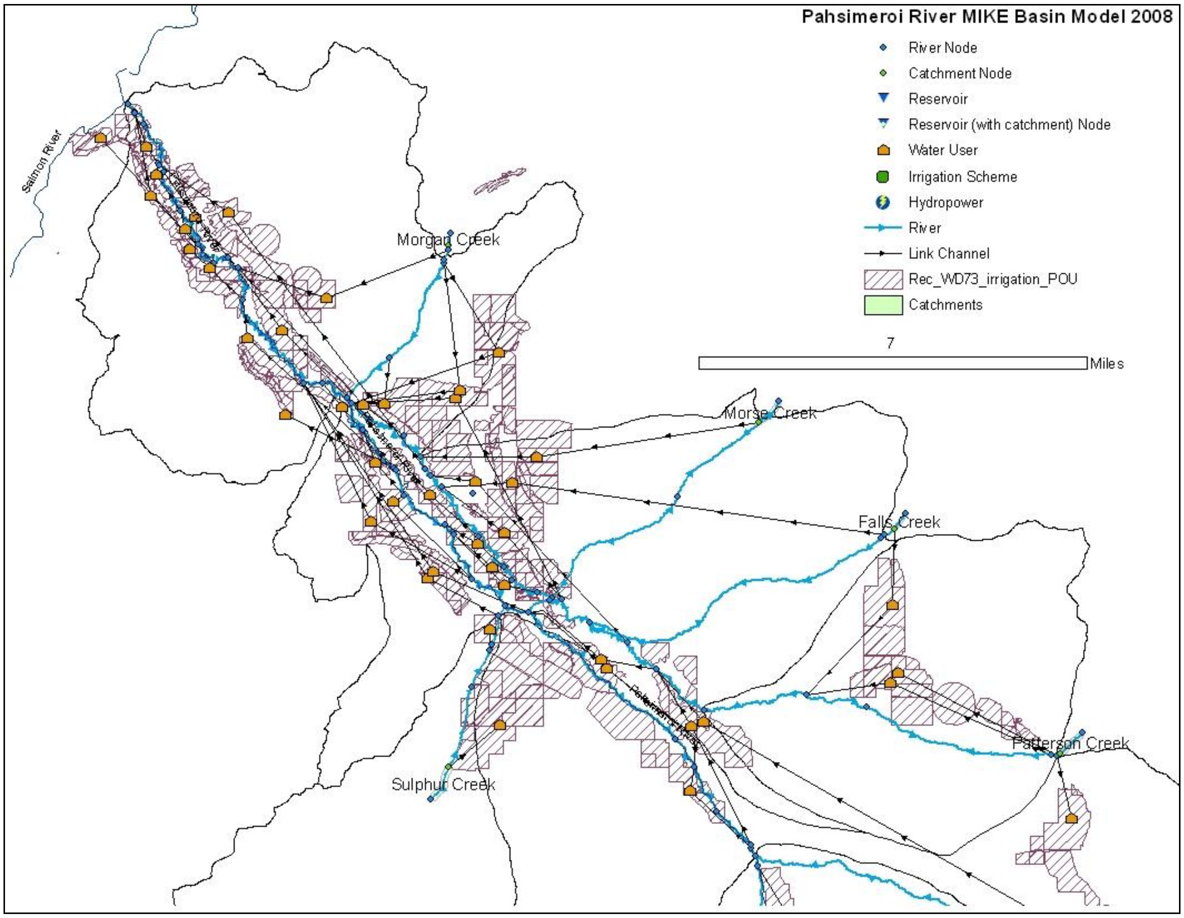

Figure 2a. Pahsimeroi River Basin MIKE Basin model, detailed view of the lower end of the Pahsimeroi River basin.

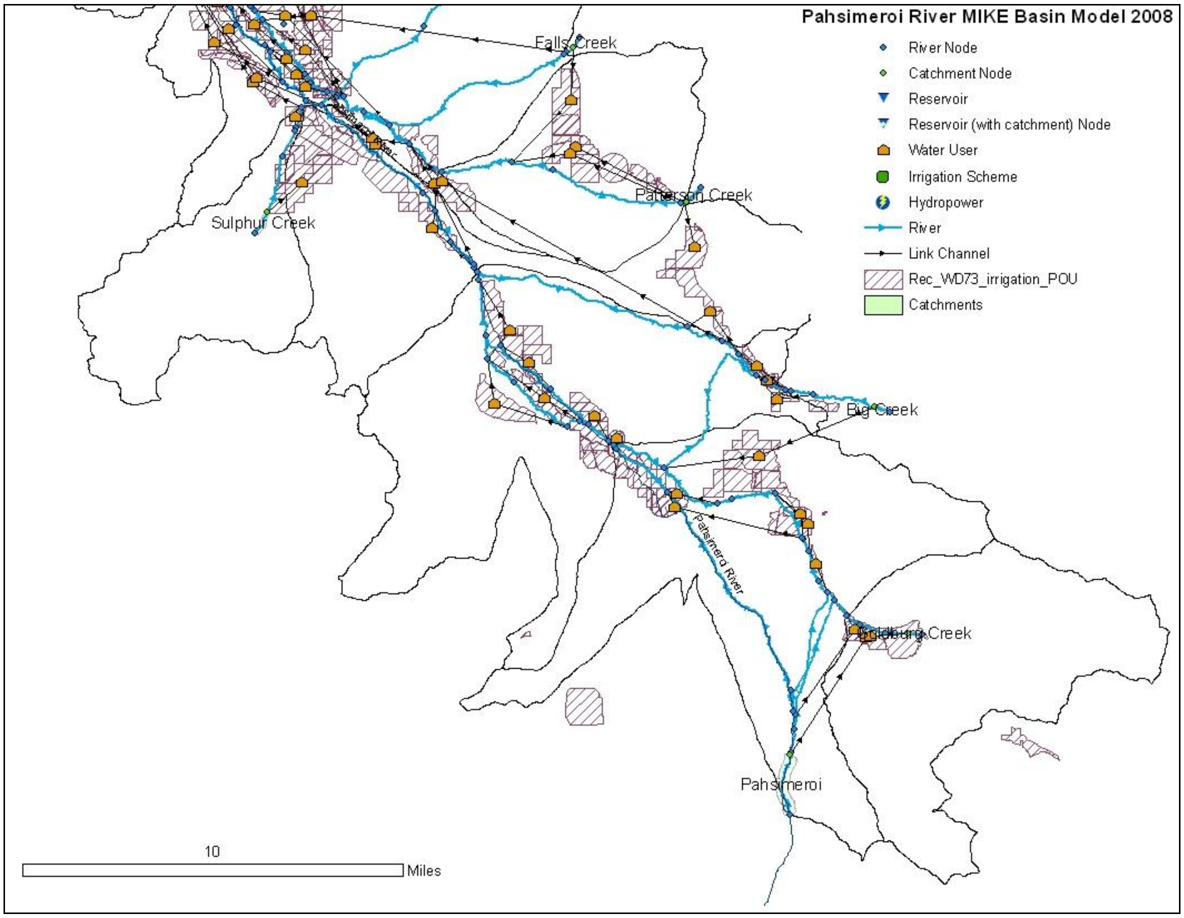

Figure 2b. Pahsimeroi River Basin MIKE Basin model, detailed view of the upper end of the Pahsimeroi River basin.

REFERENCES

DHI 2003. *Evaluation of Diversion Operation Plans to Meet Negotiated Flow Targets for Salmon and Steelhead in the Lemhi River Basin Using the MIKE Basin Model*

King, S. and C. Borden., 2004. Pahsimeroi River MIKE Basin Model Report. Danish Hydrologic Institute provided to the Idaho Department of Water Resources.

Attachment C4. Pahsimeroi River MIKE Basin Rainfall-Runoff Modeling

DEVELOPMENT OF RAINFALL-RUNOFF MODELS FOR THE PAHSIMEROI RIVER BASIN

Prepared for the

Idaho Department of Water Resources

by

DHI, Inc.

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DECEMBER 2008

Generating Streamflow Time Series Background

IDWR and DHI have developed a MIKE BASIN model of the Pahsimeroi River Basin to evaluate water distribution associated with irrigation practices within the basin. The model requires inflow boundary conditions for all simulated tributary streams. As of December 2008, the 7 out of the 8 major tributary streams in the model were gaged during the 2005 – 2007 irrigation season. To be able to run climate change scenarios as well as predict inflows if gaging is discontinued, a method was needed for developing streamflow time series for the inflow boundaries for these tributaries. For a detailed discussion of the various alternatives and their advantages and disadvantages see the report entitled *Rainfall-Runoff Modeling report for the Stanley and East Fork Salmon River Basins*, DHI, 2006.

To predict inflows in tributary basins of the Pahsimeroi River, rainfall-runoff models have been developed to predict runoff for ungaged catchment as well as the ability to evaluate how changing precipitation rates will affect streamflow runoff. This document summarize the data, construction, and preliminary calibration of the rainfall-runoff models. Much of the text in this report originated in Appendix A of the *Upper Lemhi Report*, 2006, but has been modified to the specifics of the Pahsimeroi River Basin.

Model Used: Nedbør-Afrstrømnings-Model (NAM)

DHI's Nedbør-Afrstrømnings-Model (NAM) is a lumped conceptual model for simulating streamflow based on precipitation at a catchment scale. Since its creation in 1973, NAM has been used worldwide in a variety of climatic and hydrologic settings to simulate runoff from precipitation events. The model can be used independently, dynamically with MIKE 11, or to develop input time series for MIKE BASIN catchment nodes.

NAM is a rainfall-runoff model that operates by continuously accounting for the moisture content in three different and mutually interrelated storages that represent overland flow, interflow, and baseflow (DHI, 2003). As NAM is a lumped model, it treats each sub-catchment as one unit, therefore the parameters and variables considered represent average values for the entire sub-catchments. Precipitation in the form of snow is modelled as a fourth storage unit. For catchments with snow falling over a wide elevation range, the storage unit representing snow can be divided in up to ten subunits to represent different elevation zones. Water use associated with irrigation or groundwater pumping can also be accounted for in NAM. The result is a continuous time series of the runoff from the catchment throughout the modelling period. Thus, the NAM model provides both peak and base flow conditions that account for antecedent soil moisture conditions over the modelled time period.

Basic data requirements for the NAM model include catchment area, initial conditions, and concurrent time series of precipitation, potential evapotranspiration (ET), and stream discharge. When snowmelt is included in the model, temperature is required and radiation is optional. If the catchment is divided into elevation zones for the snowmelt calculation, also required are elevation of the precipitation gage, wet and dry adiabatic lapse rates (the rate of decrease of temperature with increasing altitude in the atmosphere), precipitation accumulation per zone, and maximum accumulation per zone.

Calibration of the NAM model involves adjusting the coefficients for the exchange of water between storage units and the storage unit depth so that simulated and observed discharges match as best as possible. A minimum of 3 years including periods of above-average precipitation is recommended for calibration, with longer periods resulting in a more reliable model. Disparity between simulated and observed discharge arise due to quality of time series data or other attributes. For ungaged streams, parameters developed for another catchment with similar topographic, climatic, geologic, vegetative, and land use characteristics can be applied.

Model Construction

IDWR and DHI constructed a NAM model to predict daily streamflow for each tributary in the Upper Pahsimeroi MIKE BASIN Model (PMBM). Catchment boundaries were delineated from a USGS 30 m NED digital elevation model (DEM) (USGS, 2006). The catchments areas were delineated upstream of each catchment node in the PMBM which were located just upstream of the upstream-most active water diversion in the model. The resulting catchments were compared to watershed coverages provided by IDWR to ensure reasonable catchment delineation.

The NAM model for the Pahsimeroi River Basin consists of 8 catchments, each of which were subdivided into four zones in order to accurately account for vertical variability in precipitation and temperature within the basin. The NAM catchments include Morgan Creek, Morse Creek, Falls Creek, Patterson Creek, Big Creek, Goldburg Creek, Upper Pahsimeroi, and Sulphur Creek (Figure 1). The percentage of the catchment area within each elevation zone is given in Table 1.

Table 1. Catchments with drainage area (km^2) and elevation zones (meters).

	Total Drainage Area (km^2)	Elevation Zones [m] 1000-1500	1500-2000	2000-2500	2500-3000	3000-3500	3500-4000
Morgan Creek	56.98	0.00	8.79	23.12	21.43	3.66	0.00
Morse Ck	47.32	0.00	1.83	22.42	22.01	1.08	0.00
Falls Ck	48.85	0.00	1.29	17.69	26.71	3.17	0.00
Patterson Ck	78.19	0.00	0.88	20.21	47.81	9.32	0.00
Big Creek	139.93	0.00	0.07	36.62	85.90	17.38	0.00
Goldburg Ck	103.96	0.00	20.48	57.29	23.14	3.08	0.00
Pahsimeroi	314.78	0.00	0.00	142.98	124.46	45.13	2.29
Sulphur Ck	27.02	0.00	6.07	18.53	2.43	0.00	0.00

Time Series Data

Time series data required for the NAM models include concurrent precipitation, temperature, ET, and streamflow data. A summary of the available time series data and the methodology used to apply the data in the NAM model is provided below.

Climatic Data – The Pahsimeroi River Basin is located near the eastern edge of the Northwestern maritime climate zone and climate is characterized by wet winters and dry summers. Most of the precipitation falls as snow during winter, with local convective storms occurring periodically during the summer months. Due to its mountainous nature, the precipitation and temperature measurements around the basin vary greatly depending on aspect and elevation of the meteorological gages. Precipitation and temperature data were available from three NRCS SNOTEL sites located in or near the basin (NRCS, 2006). These sites include Schwartz Lake, Moonshine, and Hilts Creek. Additionally, precipitation, temperature, and ET data were available from a site within the Pahsimeroi River Basin at a cooperative site located in May, ID. In addition to these station data, spatially continuous monthly and annual precipitation and temperature data is available for the U.S. at a resolution of 2.5 arc-minutes from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) dataset (PRISM, 2006).

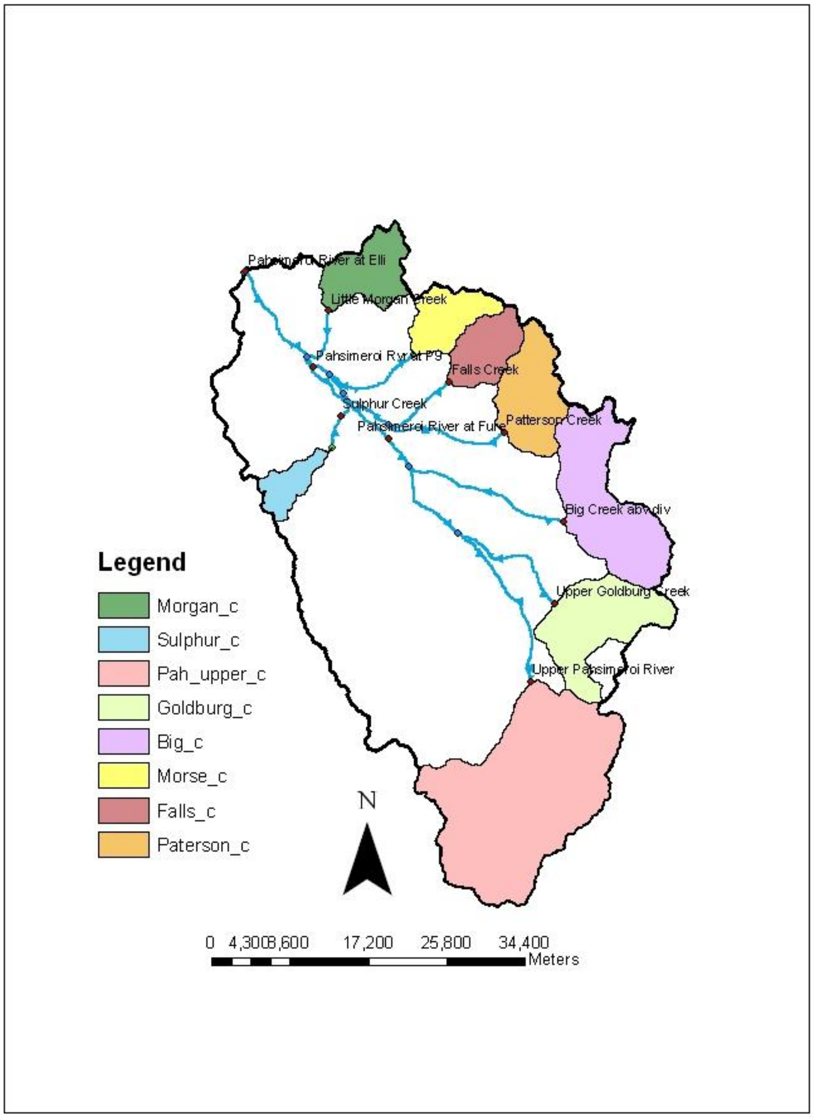

Figure 1. Locations of the catchments and discharge locations used in the NAM modeling of the Pahsimeroi River Basin.

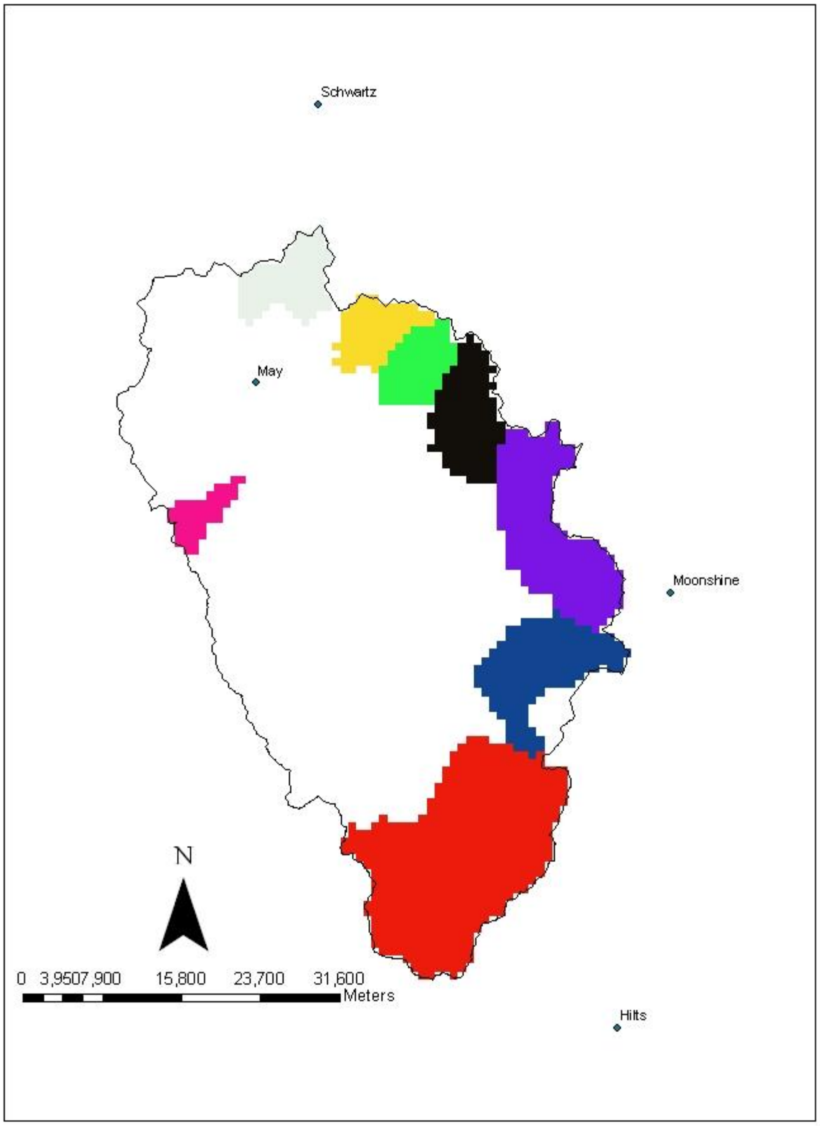

Figure 2. Locations of the catchments and weather station locations used in the NAM modeling of the Pahsimeroi River Basin.

Precipitation and temperature for each basin were developed by the method developed by Di Luzio et al. (2008). This method uses PRISM data to extrapolate the observations at a meteorological site (point measurement) over the basin area. PRISM data are generated from point measurements of precipitation, temperature, and other climatic factors to produce continuous, digital grid estimates of monthly parameters. Combining the monthly PRSIM data with daily precipitation and temperature records from the meteorological stations resulted in basin averaged time series of precipitation and temperature.

Stream Discharge **-** Data from seven discharge measurement sites were used in the Pahsimeroi River Basin, namely Falls Creek, Little Morgan Creek, Goldburg Creek, Big Creek, Patterson Creek, Sulphur Creek and Upper Pahsimeroi River. Data were available at most of these sites beginning in the summer of 2005 and running through the entire water year of 2006 and 2007. Records for Paterson Creek, Big Creek, and Upper Pahsimeroi were complete with the exception of a few missing data points. Missing data were prevalent in 2005 at Goldburg and scattered at the other two sites. Furthermore, the gaging station at Goldburg is downstream of diversions. A gaging station on Sulfur Creek was downstream of a primary diversion during the water year of 2006 and was moved upstream of diversions in February of 2007. The only catchment without gaging station data is Morse Creek.

Results and Discussion

Preliminary calibration results indicate a fair agreement between observed measurements and predicted values in the Falls Creek (Table 2), Big Creek, Patterson Creek, and Big Creek (Figure 3). The calibration generally follows in timing, but the over predicts in magnitude and under predicts in volume.

Preliminary calibration results for Morgan Creek and the Upper Pahsimeroi River Basins resulted with the magnitude and timing of the predicted discharge not accurately matching observed discharge (Figure 4). These systems appear to be snow dominated and some modifications in the timing could be remedied with melt coefficients. The timing at Upper Pahsimeroi River Basin is off with the discharge occurring earlier than measured discharge.

Goldburg and Sulphur Creek Basins were problematic in that the gage was located downstream of diversions and no diversion record was available to quantify the amount of water diverted from the stream upstream of the gage. The discharge on Goldburg Creek was minimal and intermittently spiky in character. The stream gage is downstream of known diversions and was not relied upon for calibration. Also, the discharge at Sulphur Creek was only available above diversions for part of 2007 and was not used for calibration.

These preliminary results are encouraging and with further analysis parameters at these sites, particularly Morgan Creek and Upper Pahsimeroi, would improve.

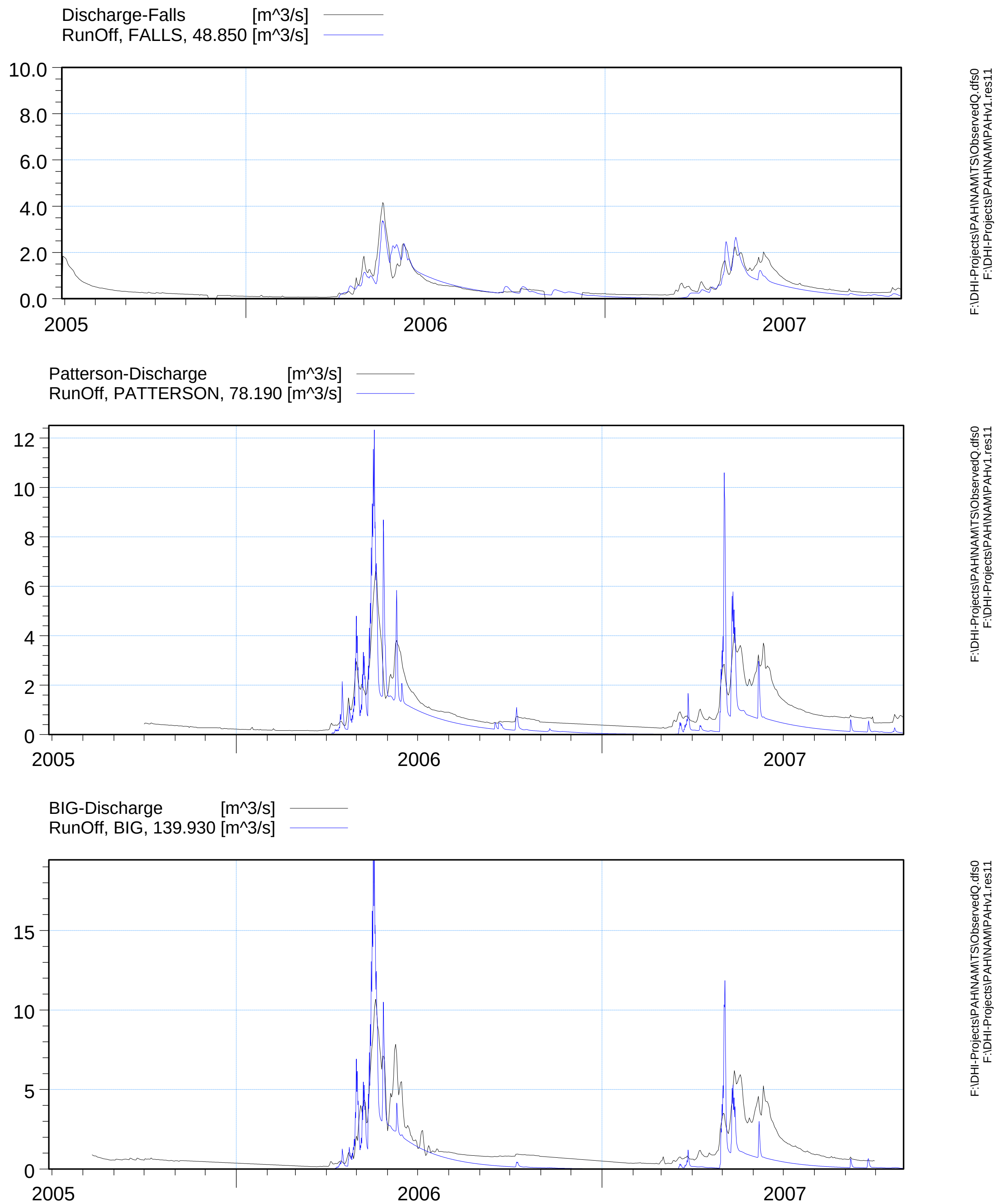

Figure 3. Simulated and observed discharge at Falls Creek (upper panel), Patterson Creek (middle panel), and Big Creek (lower panel).

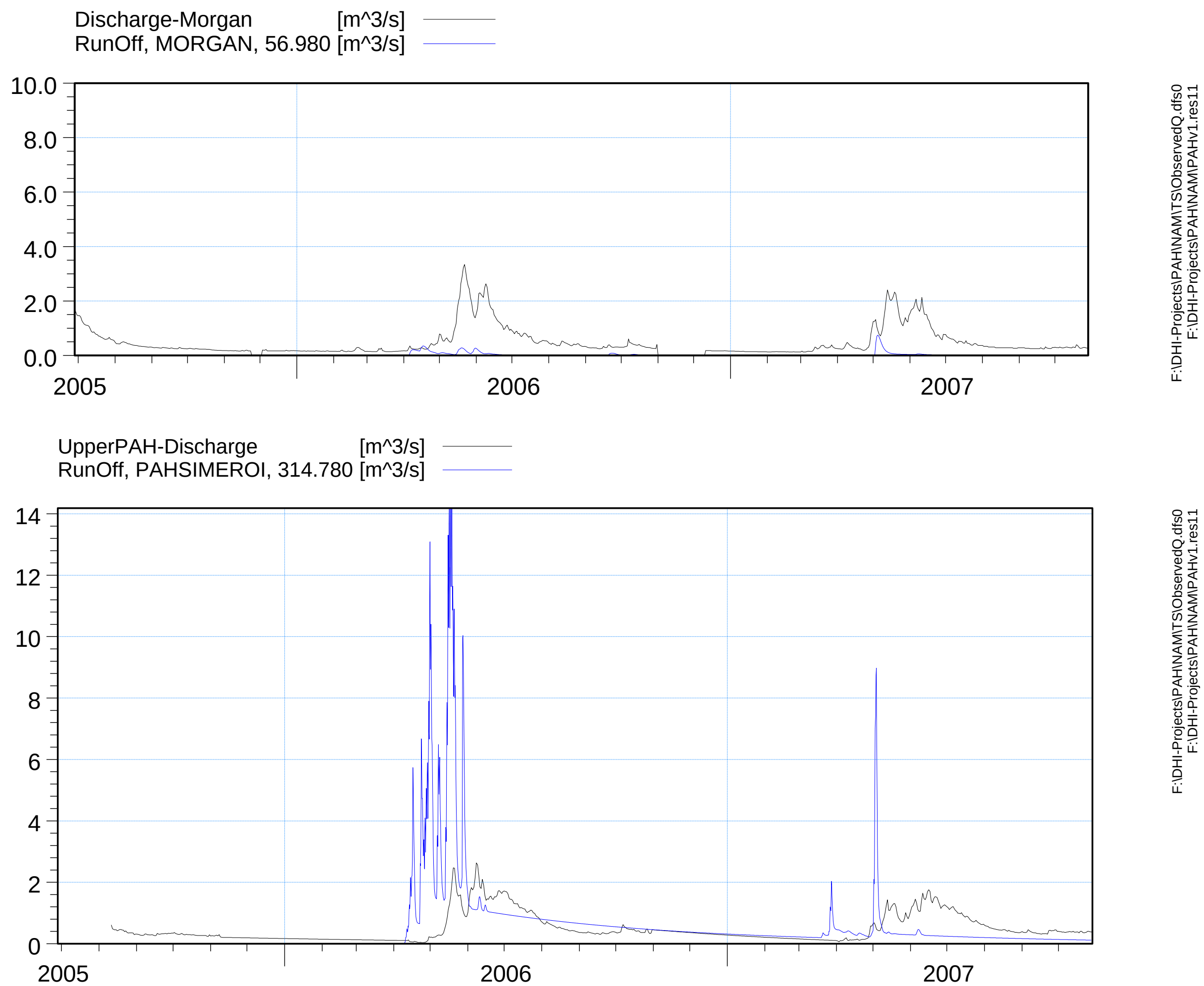

Figure 4. Simulated and observed discharge at Morgan Creek (upper panel) and Upper Pahsimeroi River (lower panel).

Table 2. NAM parameters determined during calibration of Falls Creek catchment and applied to other catchments in the model.

Limitations

Parameter	**Description**	**Value**
Umax	Maximum water content in surface storage	10 mm
Lmax	Maximum water content in root zone storage	100 mm
CQOF	Overland flow runoff coefficient	0.715
CKIF	Time contstant for routing interflow	634 hrs
CK1,2	Time constant for routing overland flow	34 hrs
TOF	Root zone threshold value for overland flow	0.9
TIF	Root zone threshold value for interflow	0.8
Tg	Root zone threshold value for GW recharge	0.003
CKBF	Time constant for routing baseflow	1564 hrs
Carea	Ratio of GW-area to catchment area	0.8
Csnow	Constant degree-day coefficient	1.0-4.5 mm/°C/Day
T_0	Base temperature (snow/rain)	0°C

Several factors represent sources of uncertainty between the model simulated discharges and the actual discharges occurring in the basin, including:

- *Climate Data* – Although there are four weather stations in and around the basin there is only one in the basin which is located in the valley bottom. Upper stations are outside of the basin but should reflect conditions generally for the upper portion of the basin. Additionally, the use of only one gage location to represent ET in the entire basin does not capture the expected degree of variation in ET within the basin. Distributing precipitation, temperature, and ET using numerous gage locations would be particularly desirable in this basin where there is a very large degree of variation in topography, temperature, precipitation, and presumably ET.
- *Stream Gage Data* – The model was tested at seven locations but two locations were not used for calibration due to irrigation reduction in discharge at Goldburg Creek and limited data at Sulphur Creek. The gage used for calibration was available for less than 3 years. This is not ideal, and it would be preferable to have multiple gage locations with multiple years of data spanning a variety of conditions with which to calibrate.
- *Antecedent Conditions* – If the antecedent conditions are unknown, it is preferred to have several years of data to calibrate the model. From the short period of record for the stream gage, the antecedent conditions were assumed for the calibration. Thus, as further steam data is collected, the model can be run to “equilibrate” to know conditions and the model calibration will improve.

Future Efforts

DHI and IDWR constructed the NAM model using the best available data; however more data would lead to a lower degree of uncertainty associated with the results. To improve and augment the NAM model, further data collection and analysis are recommended. Specific recommendations include:

- *Further calibration effort* – Due to limited resources, the calibration effort was not fully completed by the end of the study. Further effort to refine the calibration would result in better calibrations. This is especially true for Morgan Creek and the Upper Pahsimeroi River.
- *Stream flow* – Any information on irrigation use from Sulfur Creek and upstream of the Goldburg discharge station would allow for site specific calibration of these catchments. Understanding timing and magnitude of removal of flow from Sulfur and Goldburg Creek prior to the discharge measurements would facilitate the determination of parameters in these catchments.
- *Evaluate the influences of irrigation* – If irrigation practices are determined to be important in the portions of the basin simulated with the model, the timing and magnitude of water applied for irrigation should be quantified and included in the NAM model.

Conclusions

The NAM model developed to simulate runoff in the Pahsimeroi River Basin was calibrated based on stream discharge from the Falls Creek, Big Creek and Patterson Creek along with precipitation and temperature data from the May, Moonshine, Hilts Creek and Schwartz Lake weather stations, and ET data from the May COOP weather station. The calibration at the snow dominated catchments of Falls Creek, Big Creek, and Patterson Creek resulted in a good visual fit and a quantitatively good fit between the simulated and observed discharges. The calibration at Morgan Creek and Upper Pahsimeroi were not as accurate in depicting measured discharge and so additional analysis at these sites is merited.

References

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Attachment C5. Stanley Basin MIKE Basin Modeling Update

EXECUTIVE SUMMARY

The Idaho Department of Water Resources updated the Stanley basin MIKE Basin surface water model with hydrologic field data through Sept 30, 2007. Field data collected included stream gaging records, streamflows above diversions, diversion rates, and seepage runs. These additional data have significantly improved the modeling results for the Salmon River basin above Stanley and the Valley Creek basin. However, some data gaps still exist. These gaps are identified and a data acquisition plan is suggested. With the additions of these new data the model can be used to simulate proposed streamflow enhancement projects.

INTRODUCTION

Study Description

Each year a substantial number of 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, 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 and irrigation practices is critical when considering change in irrigation practices to meet alternative water resource goals. Streamflow enhancement projects require significant resources and monetary expense. Development of a hydrologic model that simulates 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. The Danish Hydrologic Institute (DHI) developed a hydrologic model of the Upper Salmon River in 2003 using a software package call MIKE Basin (figure 1). The purpose of this study is to update, populate and calibrate this MIKE Basin model with available data. The model will help in the management of available water supplies to meet competing demands between existing users and future water needs.

Study Plan

The primary data needs for a MIKE Basin model are streamflow data above diversions, diversion rates, evapotranspiration rates, crop types, irrigation methods, reach seepage measurements, and, ideally, stream gaging data below diversions to calibrate the model. The data gaps that were identified at the start of this study included a lack of streamflow data above diversions, records of diversion rates, and reach gains/losses between diversions. This study focused mostly on seepage runs to obtain some diversion measurements and streamflow measurements above diversion, but mainly to quantify reach seepage (streamflow gains/losses).

MODELING

Setup

Data collection to populate the model consisted of stream gaging and seepage runs. The only stream gage funded through this project within this modeling area is lower Pole Creek (Figure 3). The other IDWR gages shown in figures 2-3 are funded by the Columbia Basin Water Transactions Program. The IDWR stream gages are maintained by Idaho Power Company. The data from these gages can be seen in figures 4-5, 7-8; or at: http://www.idahopower.com/riversrec/waterlevels/streamflow/basinstationList.cfm?selectS=3 . Gaging data collected by the USGS and USFS were also used for model calibration.

Seepage runs were done in the Salmon River basin above Stanley during summer and fall of 2006 and 2007. Seepage runs were done in the Valley Creek basin during the summer and fall of 2007. A seepage run is a set of discharge measurements done along a stream reach, where measurements are taken any place that surface water enters or leaves the main stream (e.g. tributaries, or diversions). Analysis of seepage data allows the quantification of stream flow losses or gains to the ground water system. Results from these seepage runs were used to help calibrate the model by providing a better understanding of ground water-surface water interactions.

During the 2008 irrigation season the watermaster of Water District 170 (Nick Miller) began to measure diversion rates in Water District 71. This was the first time that diversion rates were consistently measured in Water District 71. Once these data, and the stream gaging and evapotranspiration records for 2008 are finalized, IDWR will populate the model through September 30, 2008.

Stream flow records above diversions, or inflows, were developed using several techniques. The ideal method is to use data from a continuous stream gage. However, most of the tributaries do not have stream gages, so streamflow correlations (linear regressions), drainage area ratio method, and regional regressions (StreamStats) were used to populate ungaged streams or to extend the records of gaged streams. A rainfall-runoff model was considered to estimate inflows, but the streamflow correlation and drainage area ratio technique yielded better results, especially for higher flows. All of the inflows for tributaries to Valley Creek are correlated with the Valley Creek gage at Stanley (Gage #:13294600). The record for the Valley Creek gage is continuous back to October 1992. Thus the Valley Creek side of the model could be run back to this time. Most of the inflows for tributaries to Salmon River are correlated with the Salmon River gage at the Pole Creek Road crossing (Gage #:13292280), which is a seasonal record starting in May 2003. The inflows for the following streams tributary to the Salmon River are populated with median StreamStats data. These streams are relatively small and the greater errors expected with these StreamStats results should not significantly affect modeling results at the nearest calibration point at Salmon River near Casino Creek.

Evapotranspiration rates were obtained from the Stanley Ranger Station National Weather Service weather station (KSNT) near Stanley, Idaho. The only crop type observed in the area was grass. A crop coefficient for grass pasture was applied to the weather station reference ET. No corrections for site variations (e.g. elevation) were applied.

Results

Modeling results for years 2006 and 2007 can be seen in figures 4-8. Since diversion rates were not collected throughout each year, diversion rates measured during the summer seepage runs were applied throughout the irrigation season. It is not valid to believe that the diversion rates were constant throughout the irrigation season. However, a preliminary calibration can still be done to evaluate the responsiveness of the model and annual volumes. The model was calibrated at the following gaging sites: Salmon River at Casino Creek (Figure 4), Salmon River near Obsidian (Figure 5), Valley Creek at Stanley (Figure 6), Fourth of July Creek near mouth (Figure 7), and Elk Creek near mouth (Figure 8). The model accurately simulates the timing of most peak flows and the overall shape of the hydrographs. Comparison of simulated annual streamflow volumes to observed volumes were within plus/minus 2% for each site. Better results can be expected once consistent records of diversion rates can be entered into the model.

RECOMMENDATIONS FOR FURTHER MODEL DEVELOPMENT

The preliminary calibration of the Stanley Basin model yielded promising results. However, there are two major data gaps. The first is a lack of diversion records throughout the modeling area. Secondly, several tributaries could not be fully calibrated due to the absence of stream gages. The next step for this model is to input the 2008 watermaster records and recalibrate the entire model. The IDWR will complete this in 2009. It is also recommended to consider the installation of stream gages on ungaged tributaries where streamflow enhancement projects are proposed.

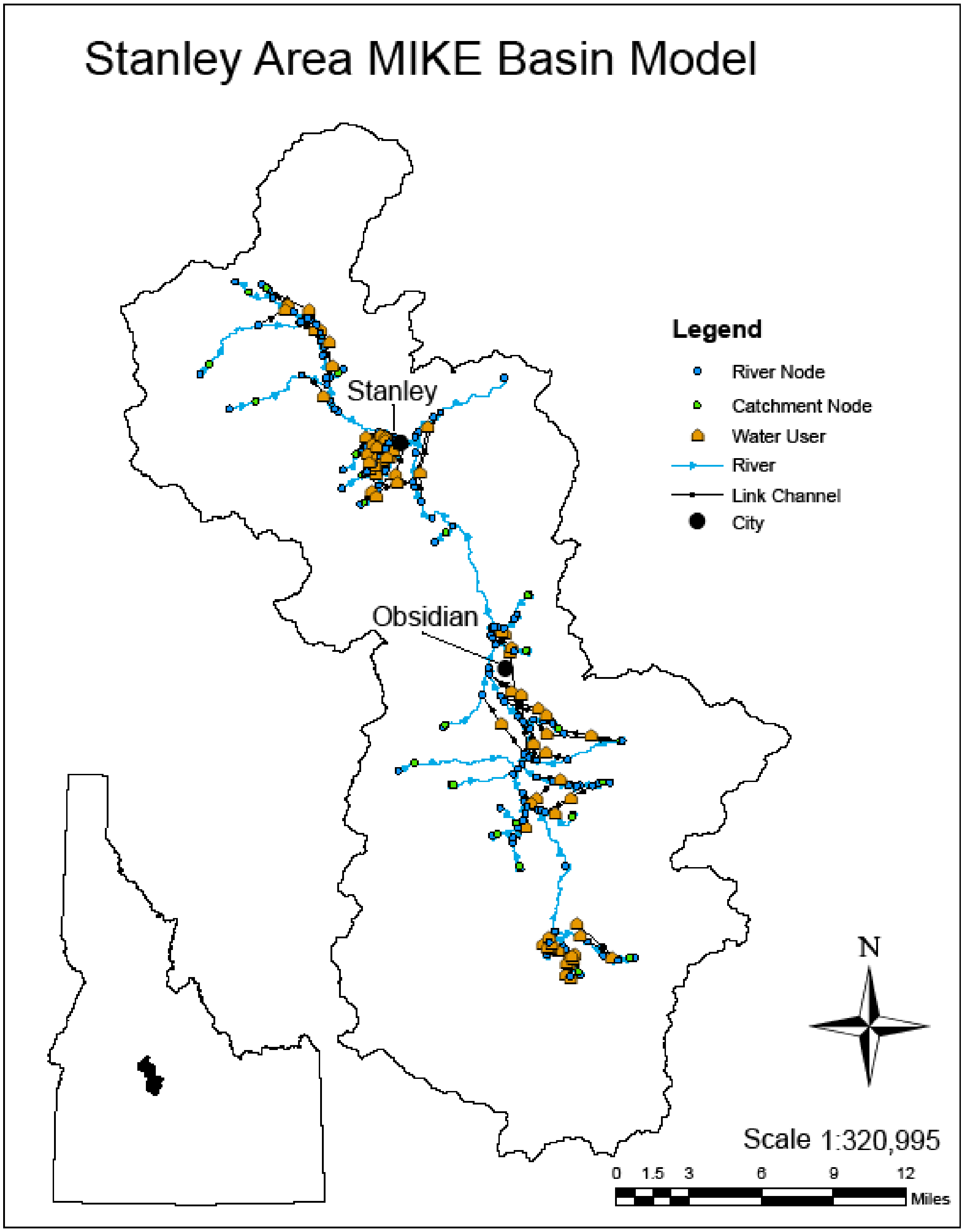

Figure 1. Map of the Stanley basin MIKE Basin model.

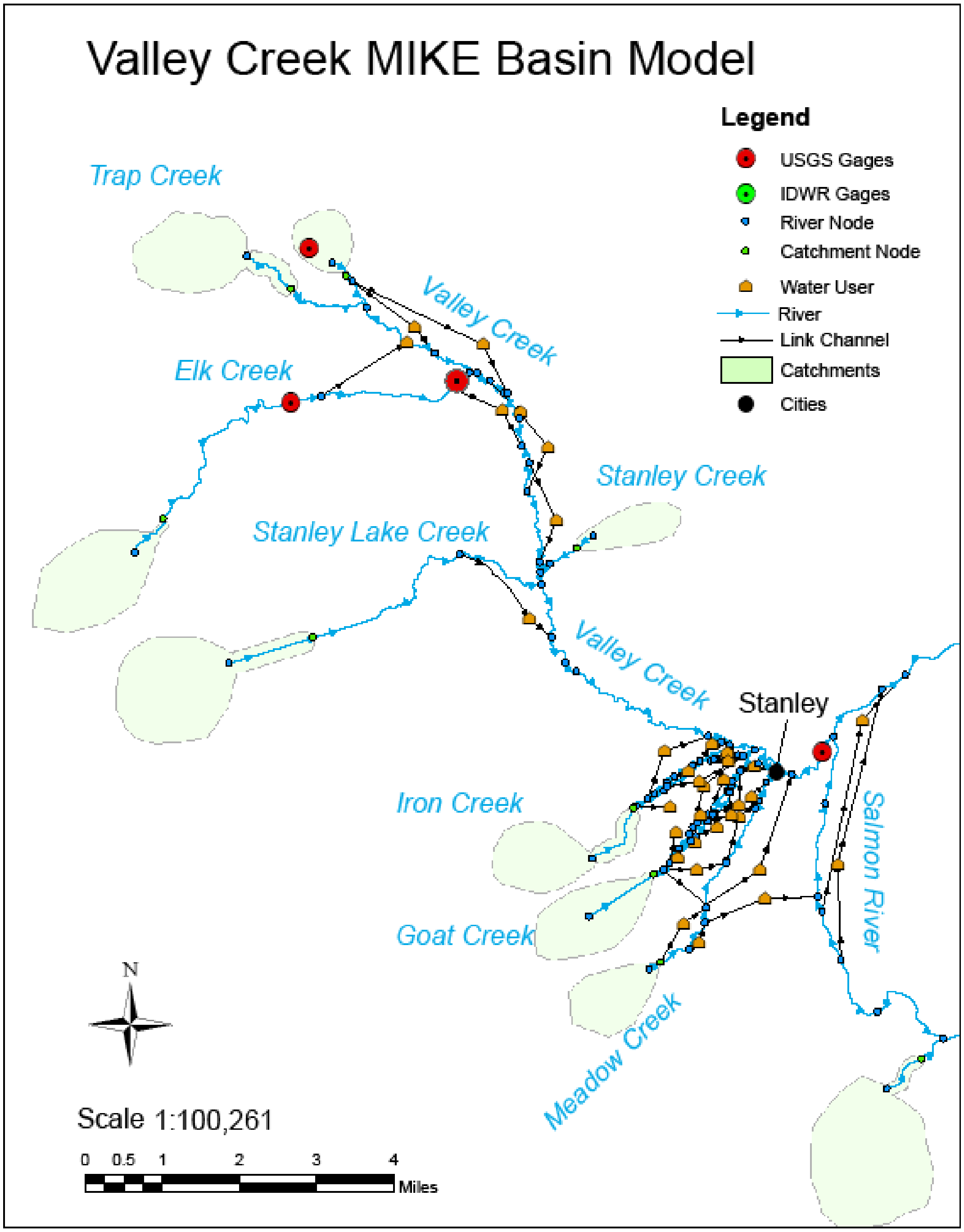

Figure 2. Map of Valley Creek model and stream gages.

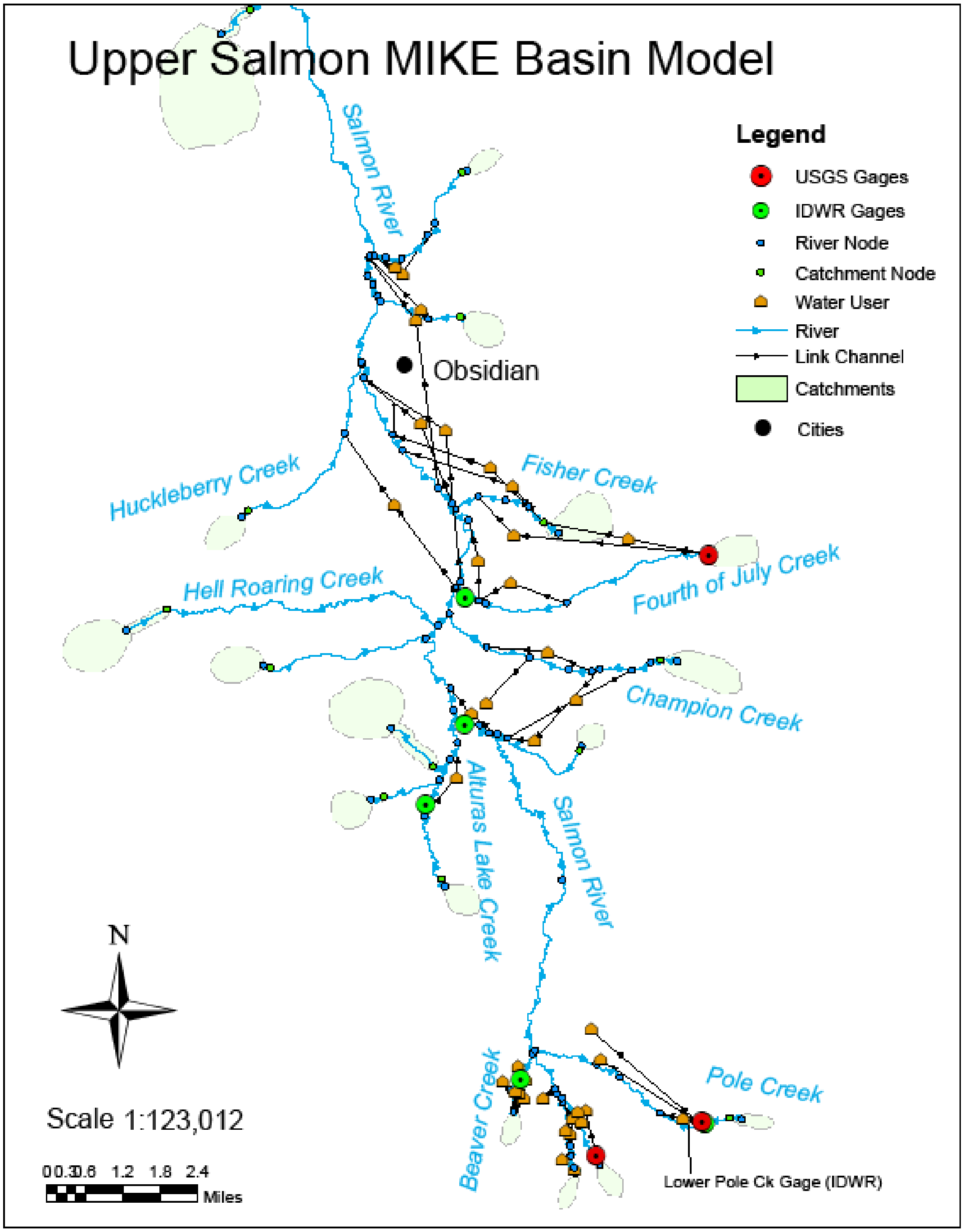

Figure 3. Map of the Upper Salmon River model and stream gages.

Salmon River at Casino Creek

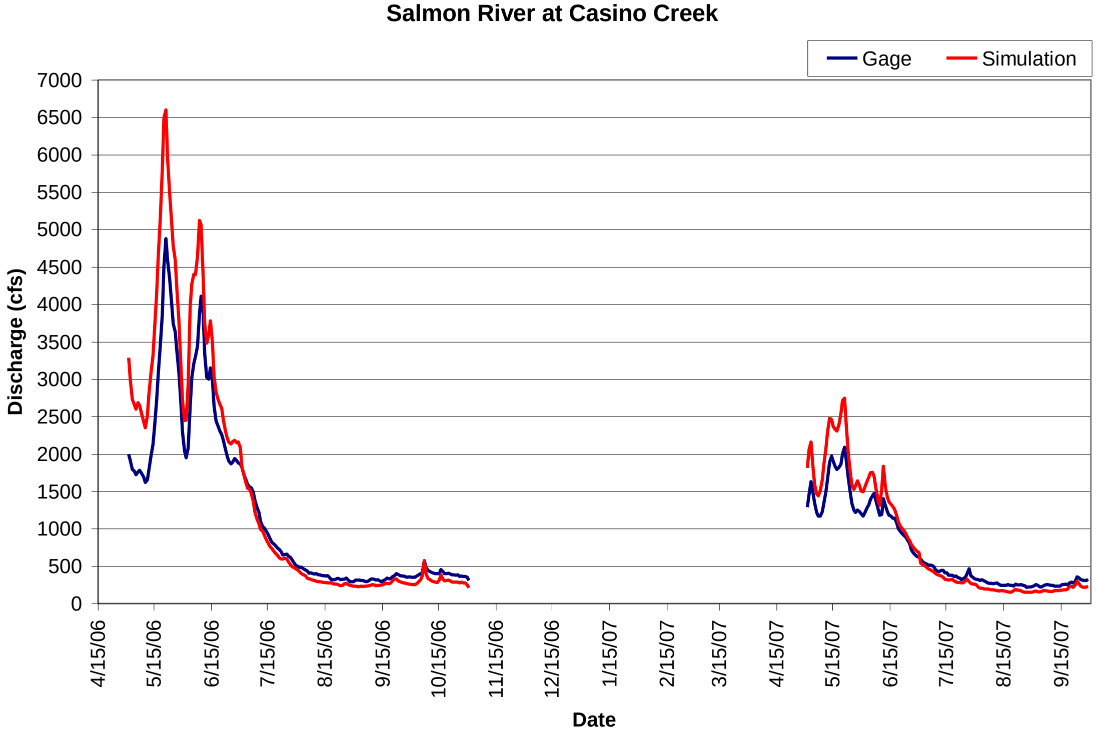

Figure 4. Modeling results for Salmon River at Casino Creek, R^2 =0.978.

Salmon River near Obsidian

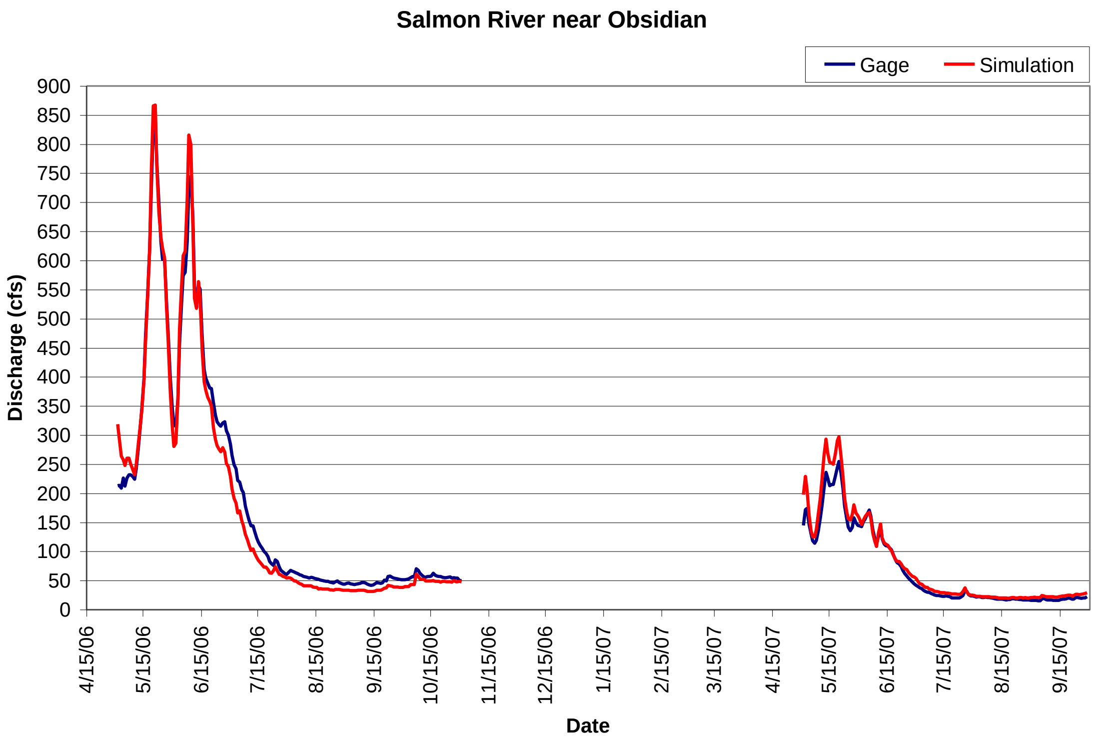

Figure 5. Modeling results for Salmon River at gage near Obsidian, R^2 =0.983.

Valley Creek at Stanley

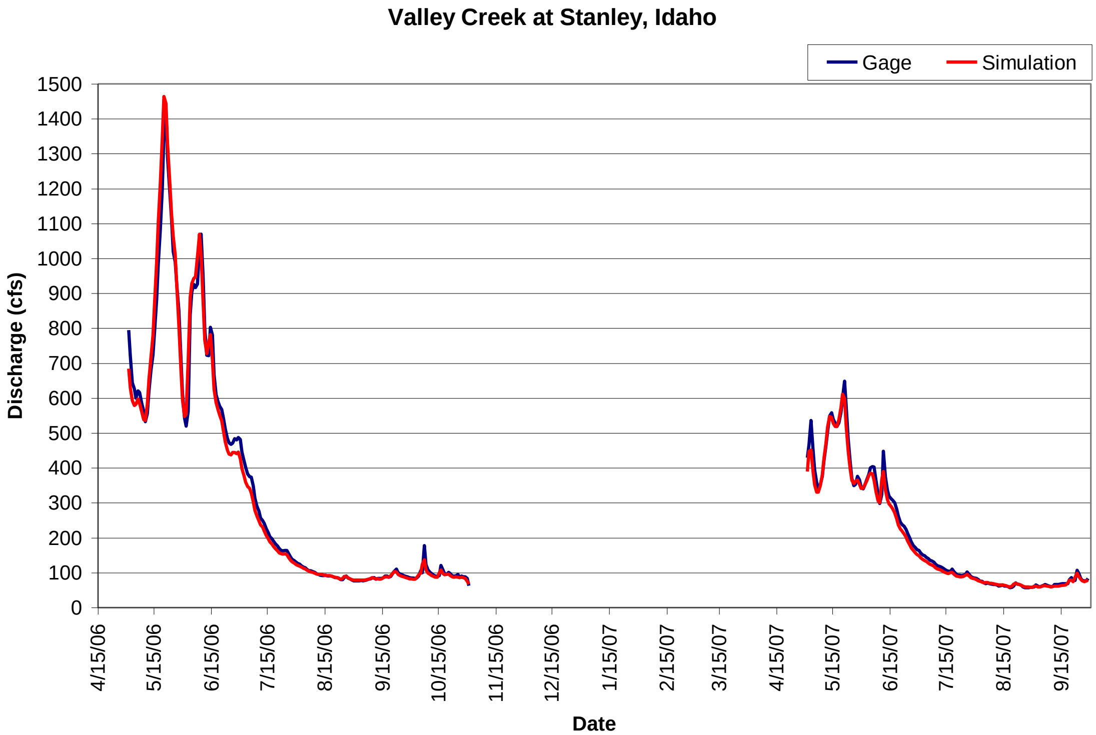

Figure 6. Modeling results for Valley Creek at Stanley, R^2 =0.991.

Fourth of July Creek near mouth

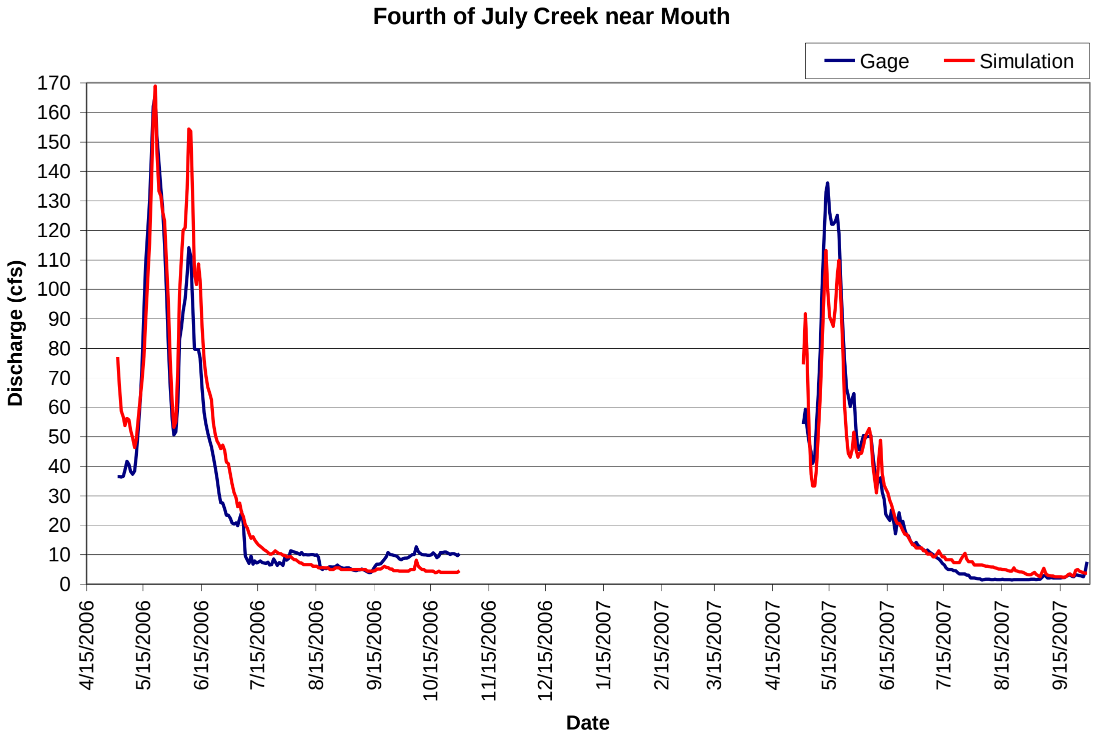

Figure 7. Modeling results for Fourth of July Creek near mouth, R^2 =0.919.

Elk Creek near mouth

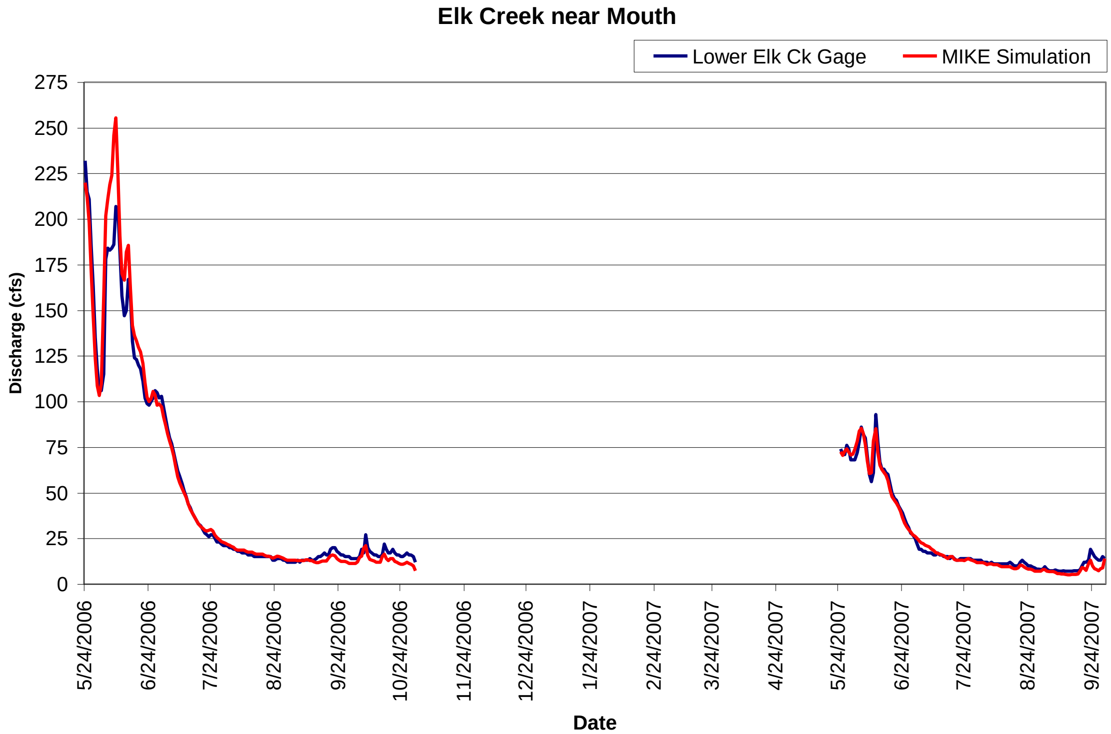

Figure 8. Modeling results for Elk Creek near mouth, R^2 =0.982.

ATTACHMENT D. Water Transactions M & E Report

Water Transactions Program Monitoring and Evaluation Report, for 2007-2008.

Water Transaction Program
2007-2008 Monitoring and Evaluation Report

Introduction

In 2007 and 2008, the Idaho Water Resource Board (IWRB) completed the following 19 water transactions in the Upper Salmon River Basin:

- Alturas Lake Pivot (2007)
- Alturas Lake Creek non-pivot (2007 – 2011)
- Beaver Creek and Salmon River above Alturas Lake Creek (2005-2014)
- Big Hat Creek (2006-2007, 2008)
- Lower Eighteenmile Creek – Ellsworth (2006-2015)
- Fourth of July Creek (2007, 2008)
- Iron Creek 2007 – Phase II (2007-2026)
- Lower Lemhi (2007, 2008)
- Morgan Creek (2007, 2008)
- Pahsimeroi P-9 Bowles (2008-2027)
- Pahsimeroi P-9 Charlton (2008-2027)
- Pahsimeroi P-9 Dowton (2008-2027)
- Pahsimeroi P-9 Elzinga (208-2027)
- 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. IWRB also partnered with Trout Unlimited to complete a transaction on Badger Creek in the Little Lost River Basin that reconnected an important tributary for fluvial bull trout.

Alturas Lake Creek – Stanley Basin

IDWR negotiated two transactions with Katie Breckenridge in 2007. The Alturas Lake Creek Pivot 2007 project is a one-year, full-season lease which leaves 5.86 cfs, formerly irrigating 100 acres in Alturas Lake Creek. 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.

Site visits to Alturas Lake Creek on 8/13/2007 and 8/4/2008 confirmed that the landowner was complying with the terms of the leases. 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 aerial surveys in 2007 and 2008 which showed the following:

- 11 redds in the Salmon River within 1.6 miles of the mouth of Alturas Lake Creek in 2007
- 1 redd in Alturas Lake Creek above the original point of diversion in 2008
- 9 redds in Alturas Lake Creek between the original point of diversion and the mouth in 2008

- 20 redds in the Salmon River within 1.6 miles of the mouth of Alturas Lake Creek in 2008

There has been no PHABSIM modeling of Alturas Lake Creek.

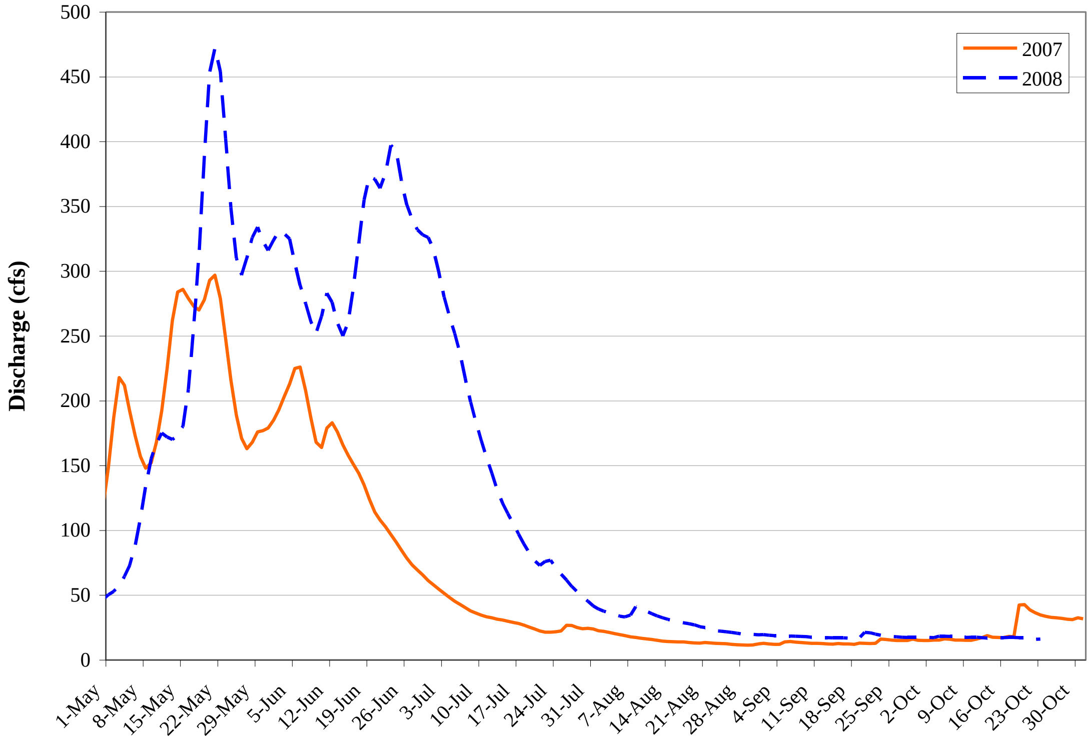

Figure 1. Alturas Lake Creek mean daily flow at Pettit Lane, May 1 to October 31.

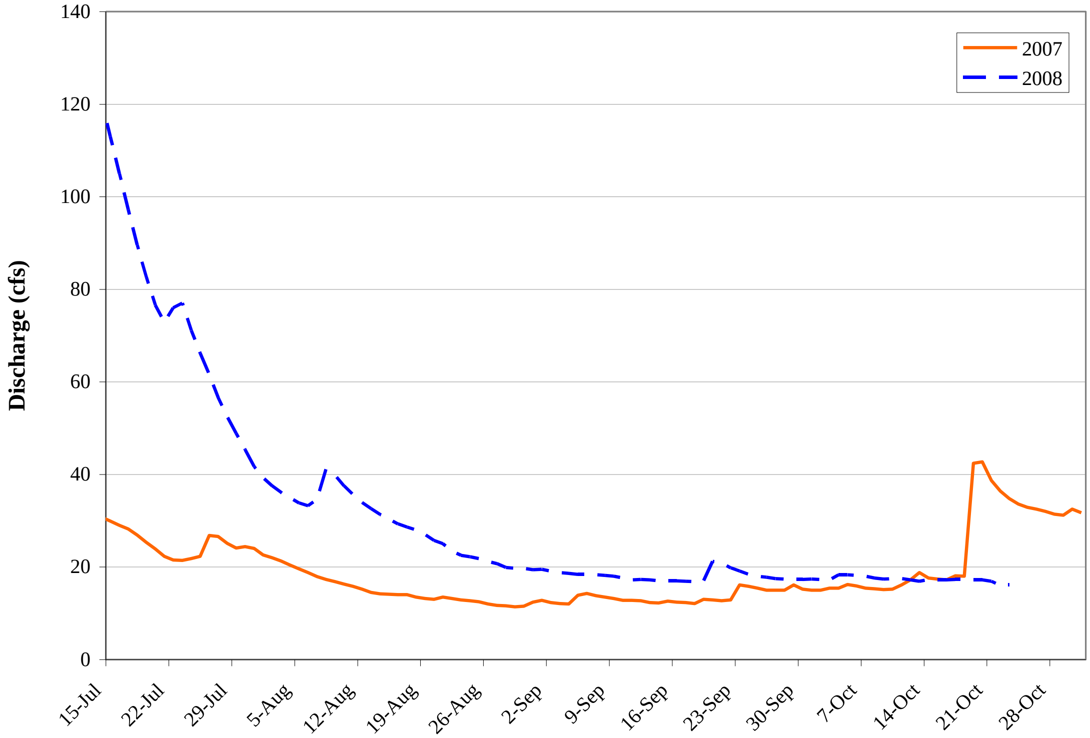

Figure 2. Alturas Lake Creek mean daily flow at Pettit Lane, July 15 to October 31.

Beaver Creek – Stanley Basin

The Beaver Creek project was IDWR's first long-term lease. In the third and fourth 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 7/52/2007, 8/1/2007, 8/13/2007, and 9/2/2008 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). In 2007, 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. In 2008, a base flow of about 5 cfs provided a reconnection for juvenile salmonids throughout the irrigation season.

Idaho Department of Fish and Game (IDFG) conducted Chinook salmon redd aerial surveys in 2007 and 2008 which showed the following:

- 1 redd in the Salmon River within 8.2 miles of the mouth of Beaver Creek in 2007
- 2 redds in the Salmon River above Beaver Creek in 2008
- 13 redds in the Salmon River within 8.2 miles of the mouth of Beaver Creek in 2008

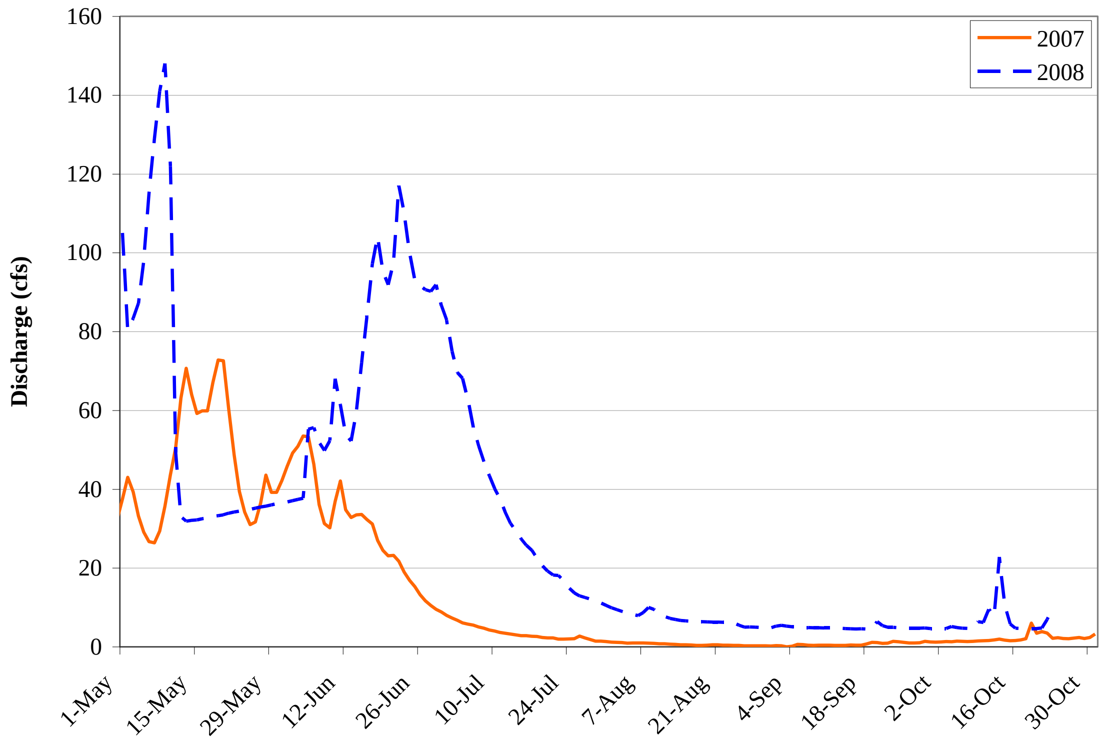

Figure 3. Beaver Creek mean daily flow at Highway 93, May 1 to October 31.

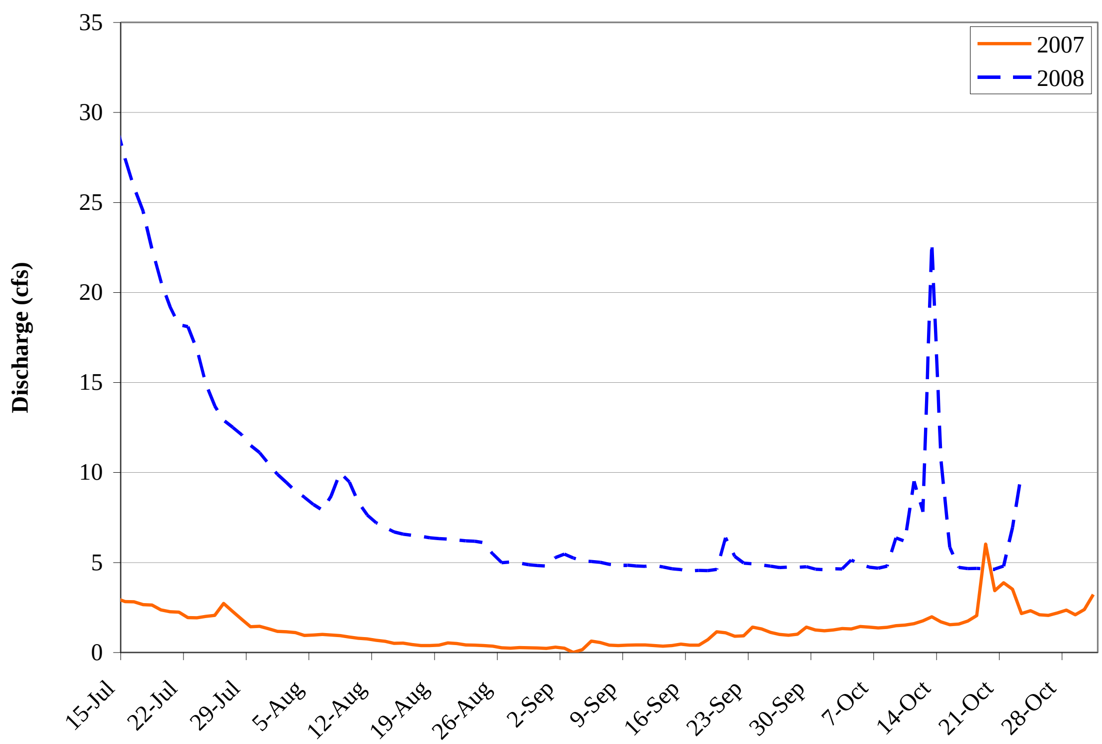

Figure 4. Beaver Creek mean daily flow at Highway 93, July 15 to October 31.

A riparian vegetation survey conducted in 2005 and 2008 showed increases in riparian shrubs, mainly willow and box elder, at both survey locations. Riparian shrubs develop root masses that can stabilize stream banks against cutting action and provide which can lower stream temperatures and provide protective cover from predators. Figures 5 and 6 show changes in vegetative composition at 2 sites in the Beaver Creek channel.

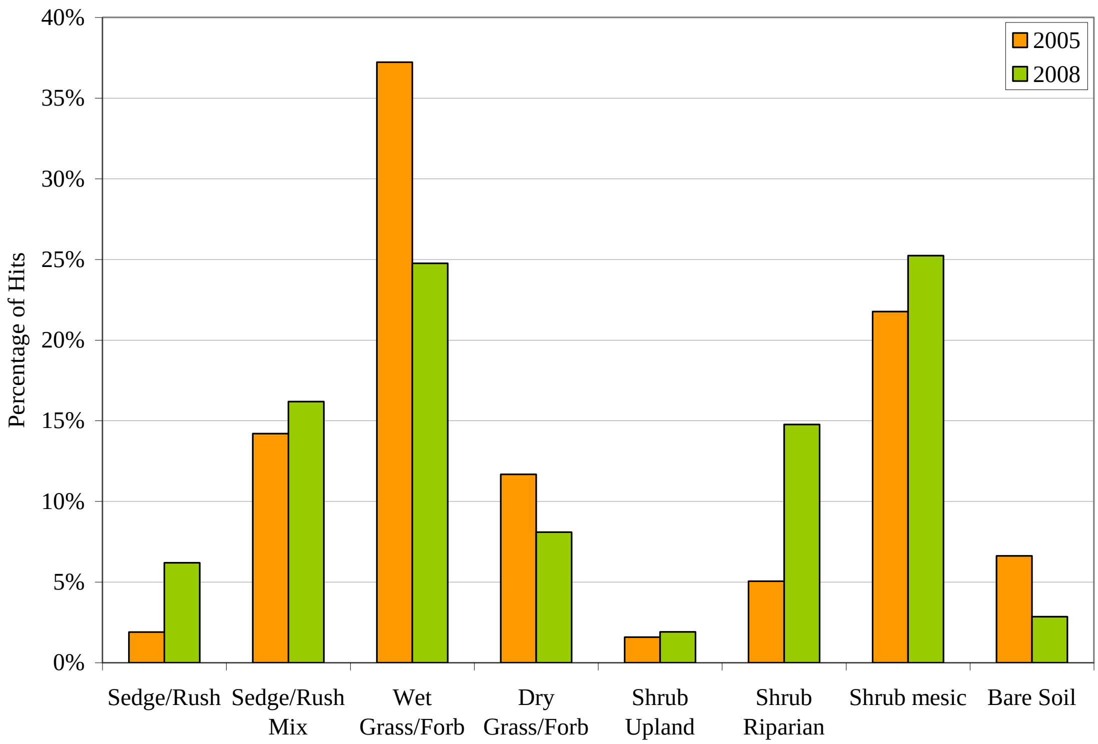

Figure 5. Beaver Creek below Highway 93 green-line vegetative survey results showing the change in riparian vegetation composition between 2005 and 2008.

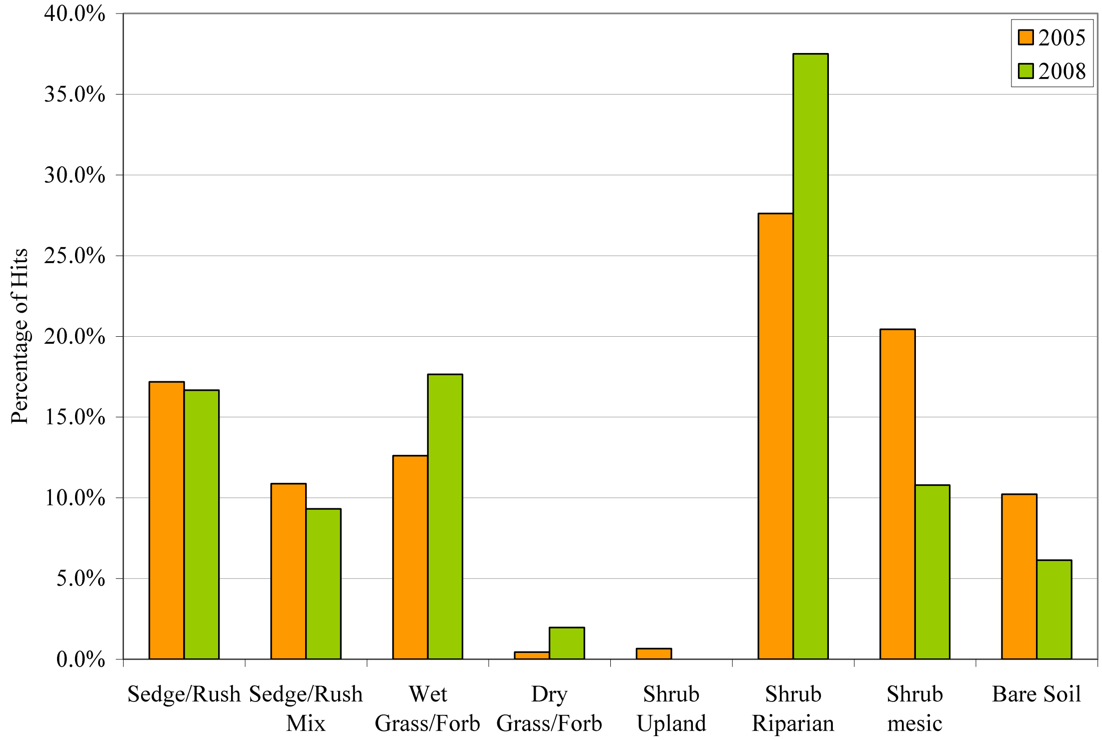

Figure 6. Beaver Creek above Highway 93 green-line vegetative survey results showing the change in riparian vegetation composition between 2005 and 2008.

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 7-12 represent the percentage of usable area for each species of concern. Juvenile habitat is not included due to limitations of the PHABSIM model.

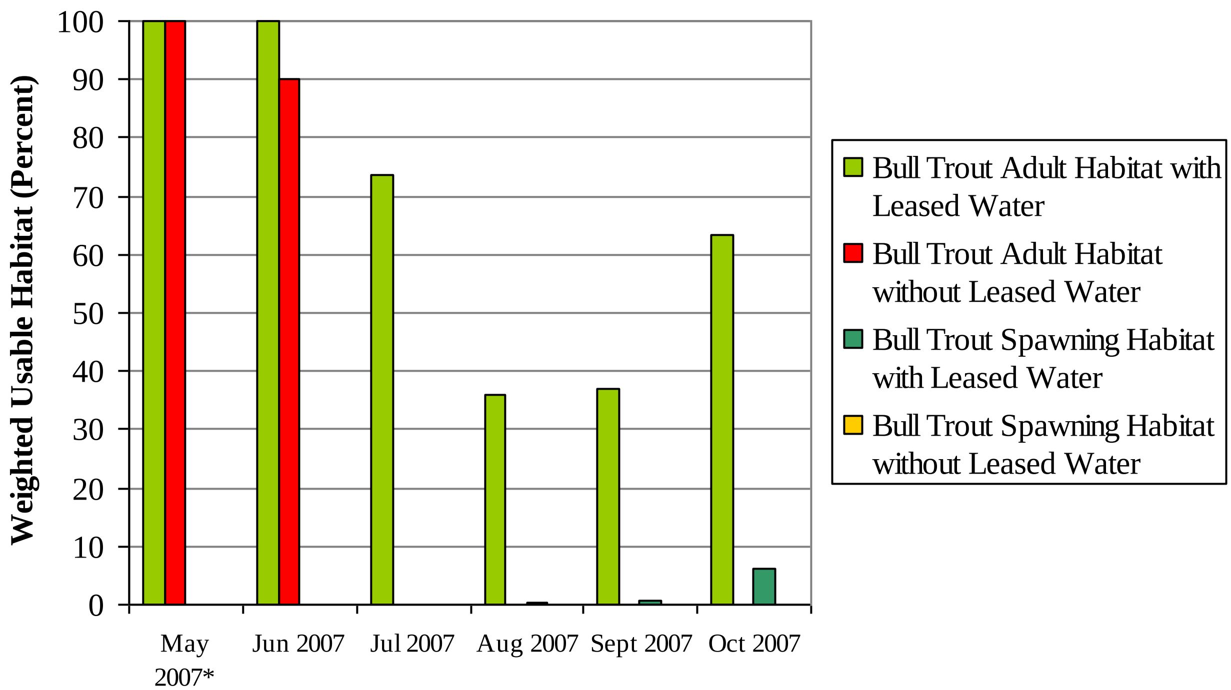

Figure 7. Percent usable habitat for adult and spawning bull trout at mean monthly flows in 2007, including and excluding the leased 8.77 cfs. * Flows in May were beyond the modeled range.

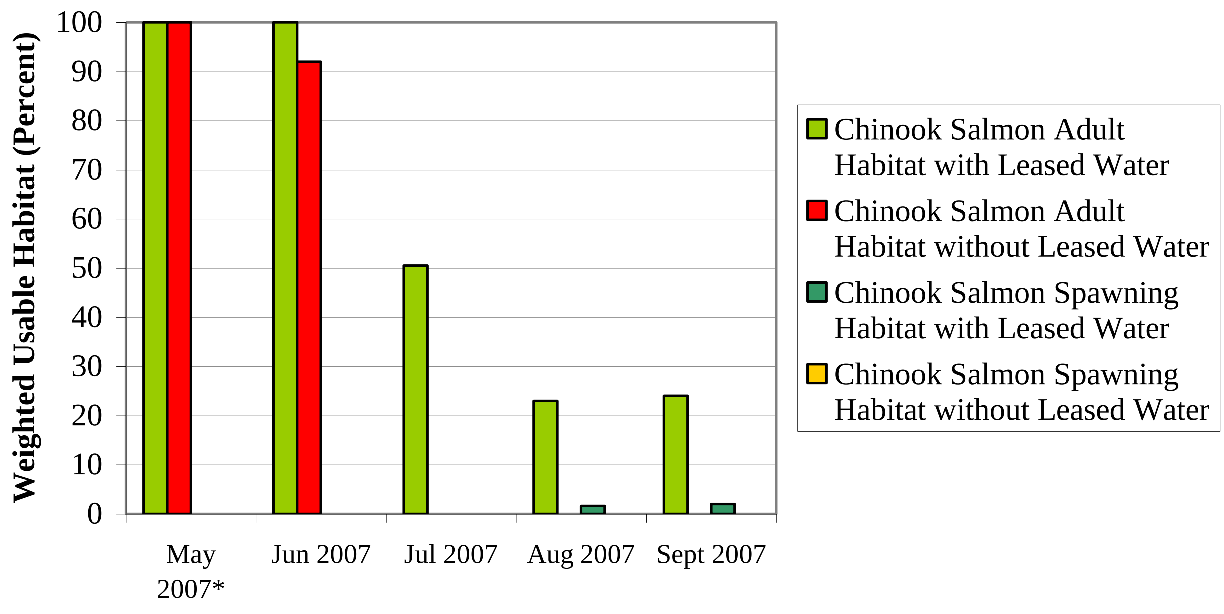

Figure 8. Percent usable habitat for adult and spawning Chinook salmon at mean monthly flows in 2007, including and excluding the leased 8.77 cfs. * Flows in May were beyond the modeled range.

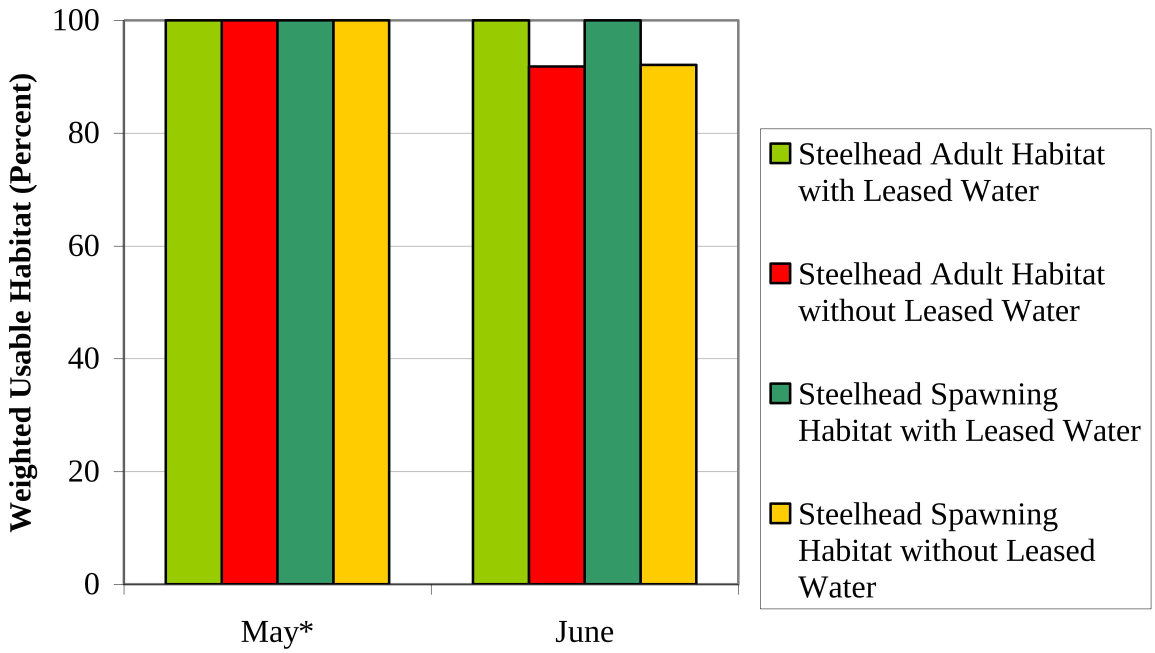

Figure 9. Percent usable habitat for adult and spawning steelhead at mean monthly flows in 2007, including and excluding the leased 8.77 cfs. * Flows in May were beyond the modeled range.

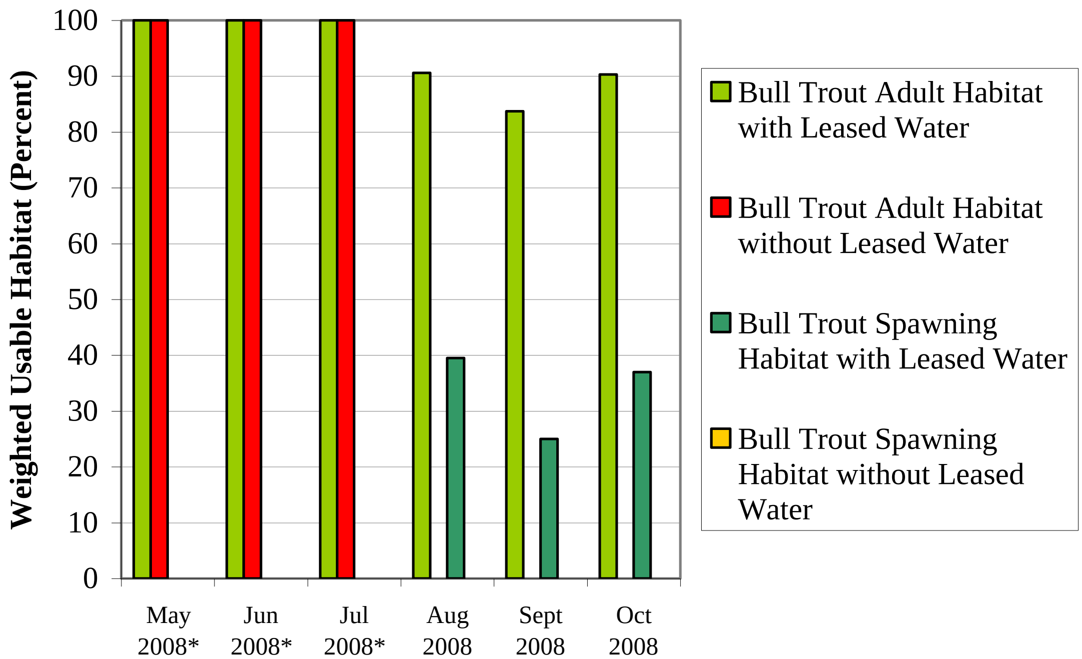

Figure 10. Percent usable habitat for adult and spawning bull trout at mean monthly flows in 2008, including and excluding the leased 8.77 cfs. * Flows in May, June, and July were beyond the modeled range.

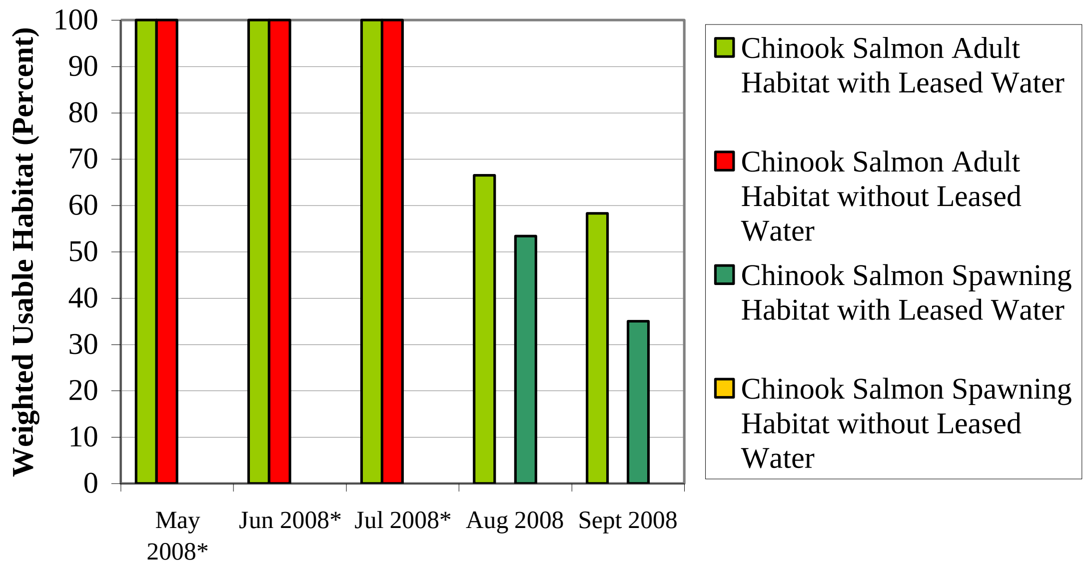

Figure 11. Percent usable habitat for adult and spawning Chinook salmon at mean monthly flows in 2008, including and excluding the leased 8.77 cfs. * Flows in May, June, and July were beyond the modeled range.

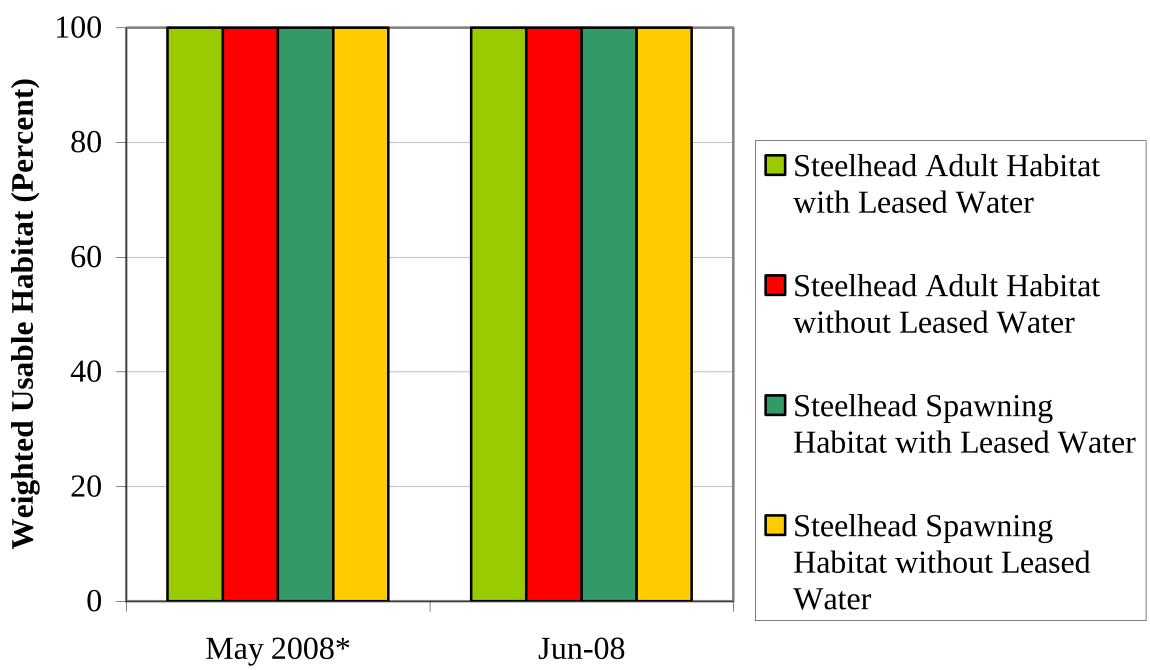

Figure 12. Percent usable habitat for adult and spawning steelhead at mean monthly flows in 2008, including and excluding the leased 8.77 cfs. * Flows in May and June were beyond the modeled range.

Fourth of July Creek – Stanley Basin

The Fourth of July Creek transactions consisted of the second year of a 2-year lease in 2007, and a one-year donated lease in 2008. The Vanderbilts leased 2.9 cfs into the Water Supply Bank which formerly irrigated 43.1 acres. 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.

Site visits to Fourth of July Creek on 6/15/2007, 7/26/2007, 8/13/2007, 9/11/2007 and 8/5/2008 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 13 and 14). 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 aerial surveys in 2007 and 2008 which showed 35 and 54 redds, respectively, in the reach of the Salmon River that extends from 0.52 miles upstream of the mouth of Fourth of July Creek to 10.9 miles downstream of the mouth.

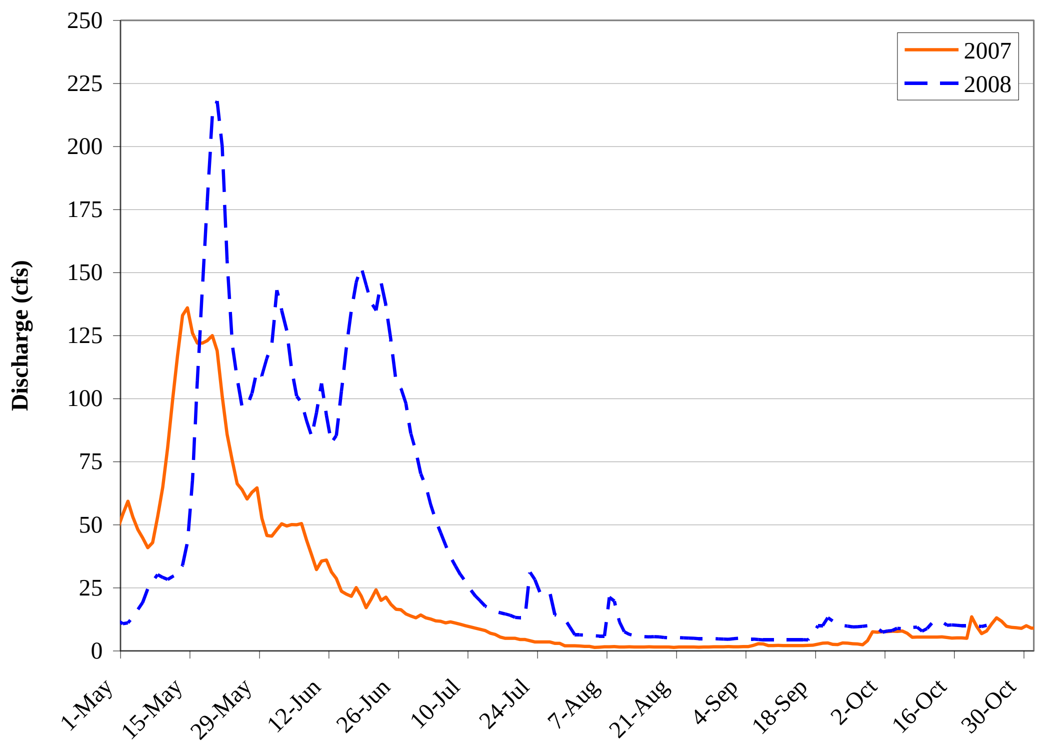

Figure 13. Fourth of July Creek mean daily flow at Highway 93, May 1 to October 31.

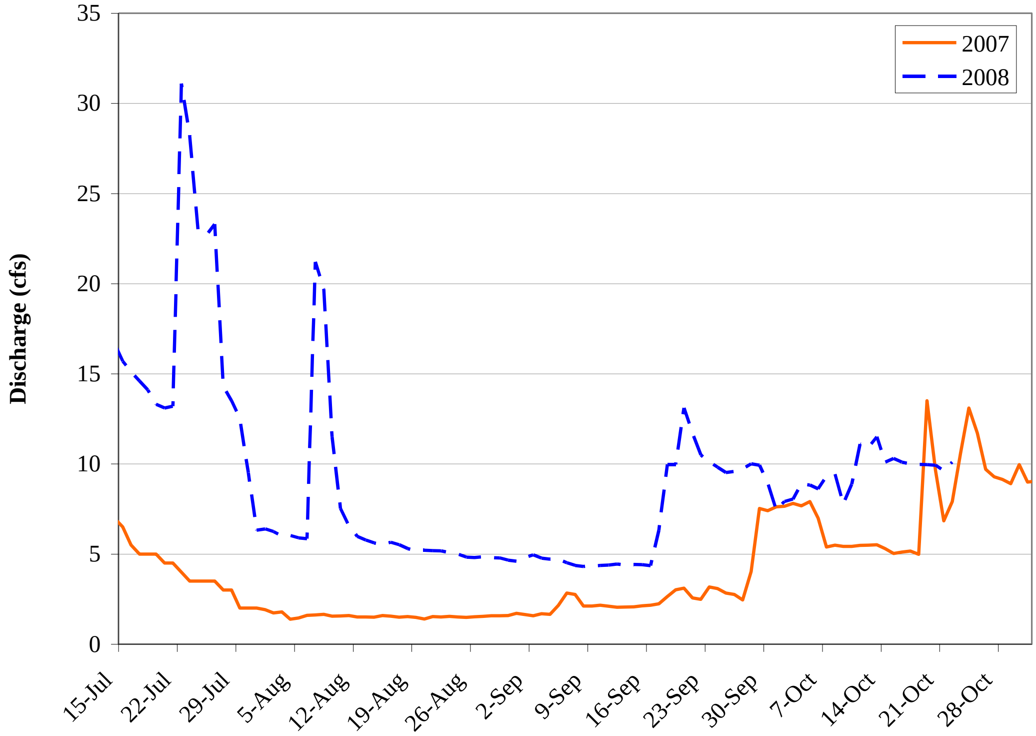

Figure 14. Fourth of July Creek mean daily flow at Highway 93, July 15 to October 31.

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 15-20 represent the percentage of usable area for each species of concern. Juvenile habitat is not included due to limitations of the PHABSIM model.

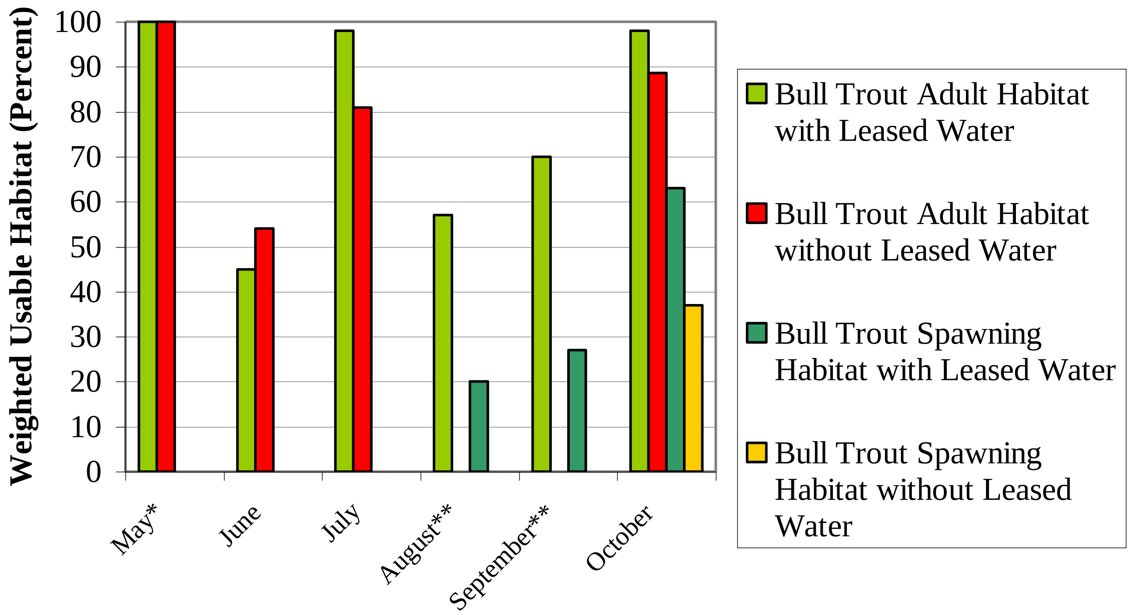

Figure 15. Percent weighted usable habitat for adult and spawning bull trout at mean monthly flows in 2007, including and excluding the leased 2.9 cfs. * Flows in May were beyond the modeled range. ** Flows in August and September were below the modeled range, values were determined by extending modeled curve.

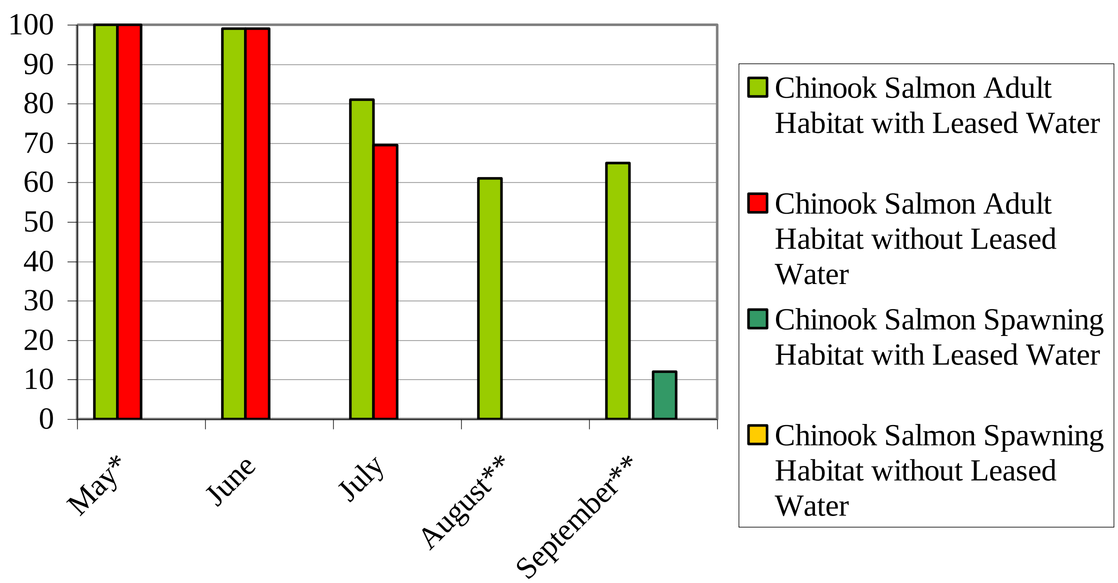

Figure 16. Percent weighted usable habitat for adult and spawning Chinook salmon at mean monthly flows in 2007, including and excluding the leased 2.9 cfs. * Flows in May were beyond the modeled range. ** Flows in August and September were below the modeled range, values were determined by extending modeled curve.

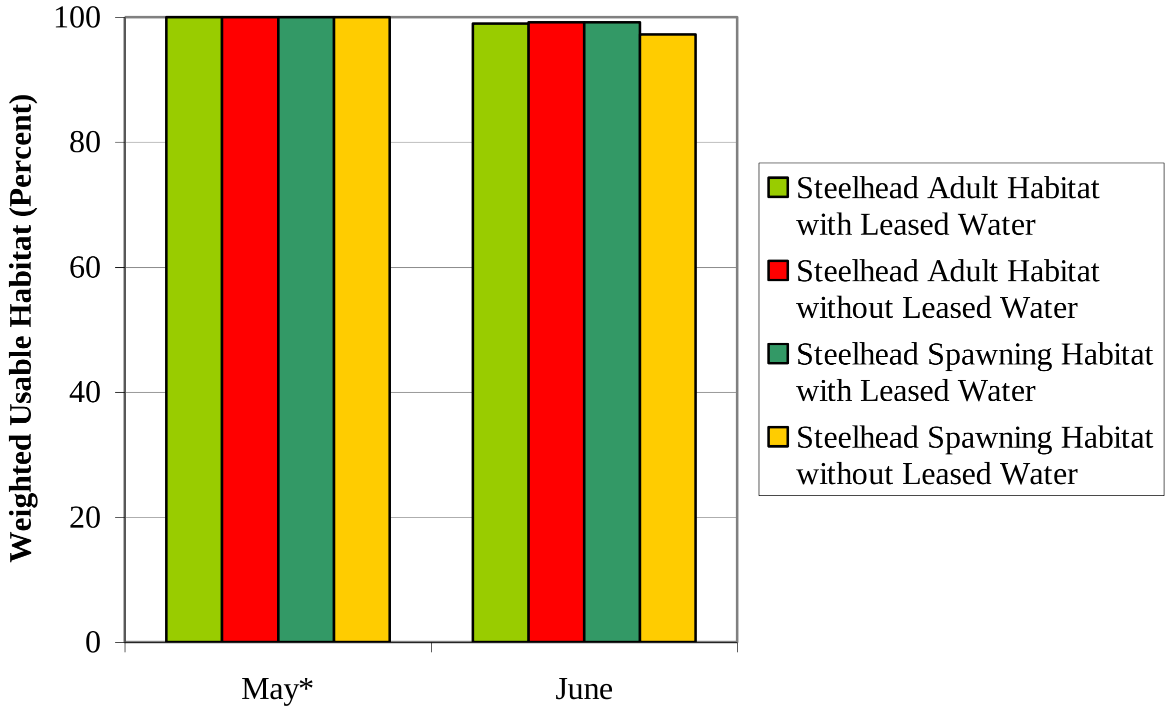

Figure 17. Percent weighted usable habitat for adult and spawning steelhead at mean monthly flows in 2007, including and excluding the leased 2.9 cfs. * Flows in May were beyond the modeled range.

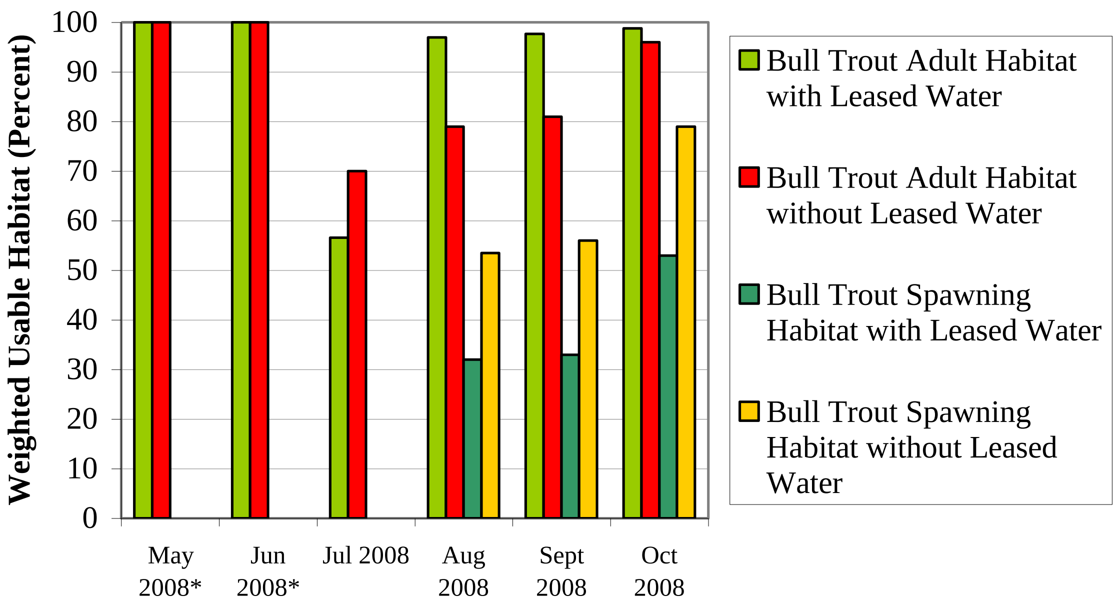

Figure 18. Percent weighted usable habitat for adult and spawning bull trout at mean monthly flows in 2008, including and excluding the leased 2.9 cfs. * Flows in May and June were beyond the modeled range.

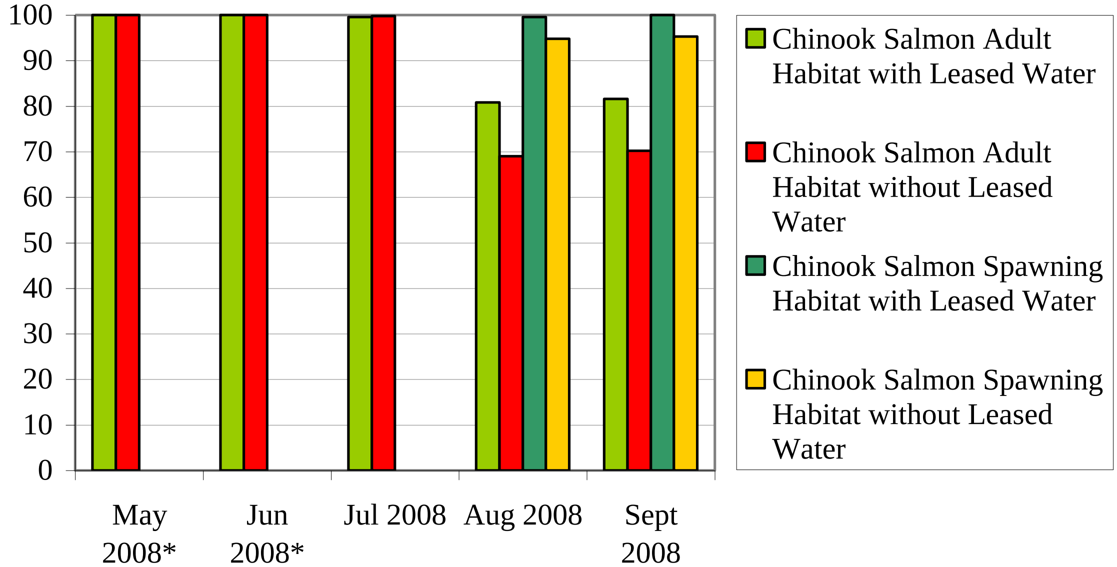

Figure 19. Percent weighted usable habitat for adult and spawning Chinook salmon at mean monthly flows in 2008, including and excluding the leased 2.9 cfs. * Flows in May and June were beyond the modeled range.

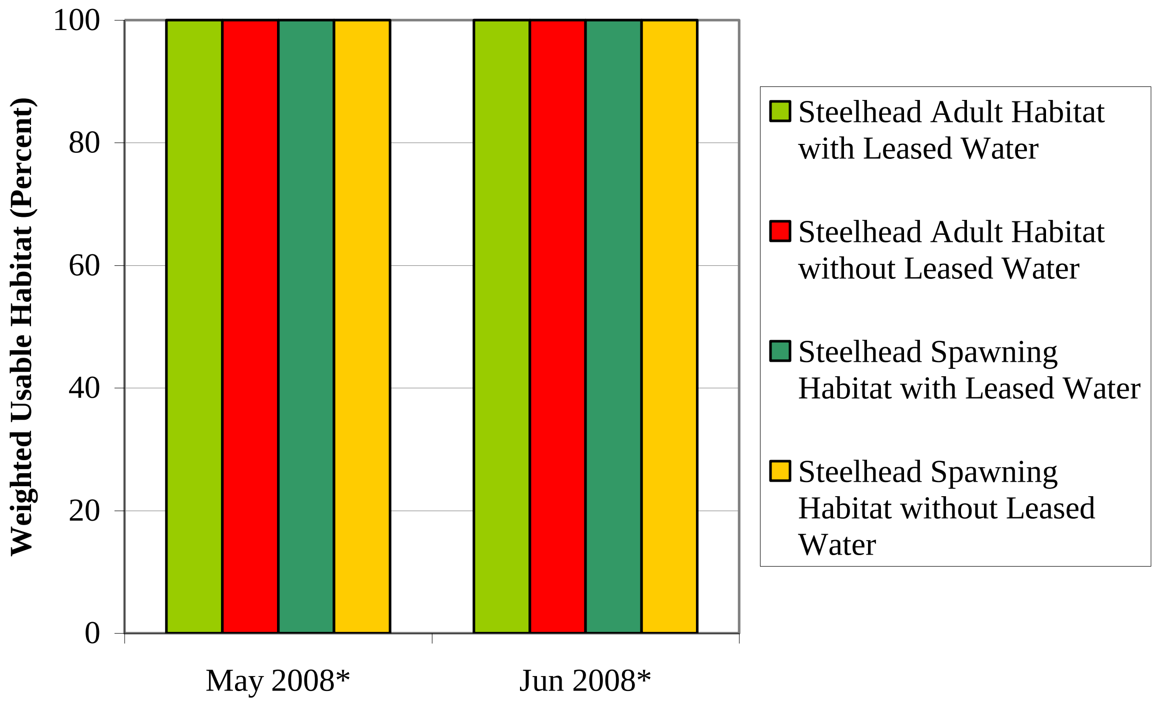

Figure 20. Percent weighted usable habitat for adult and spawning steelhead at mean monthly flows in 2008, including and excluding the leased 2.9 cfs. * Flows in May and June were beyond the modeled range.

Idaho Department of Fish and Game has been conducting bull trout redd counts in Fourth of July Creek since 2003 (Curet 2008). They show a marked increase in the total number of redds every year between 2003 and 2006 (Figure 21). There were declines in 2007 and 2008, which may be due to the effects of the 2005 fire in the basin. IDFG will continue to monitor redds to see if the recent decreases will be long-lasting.

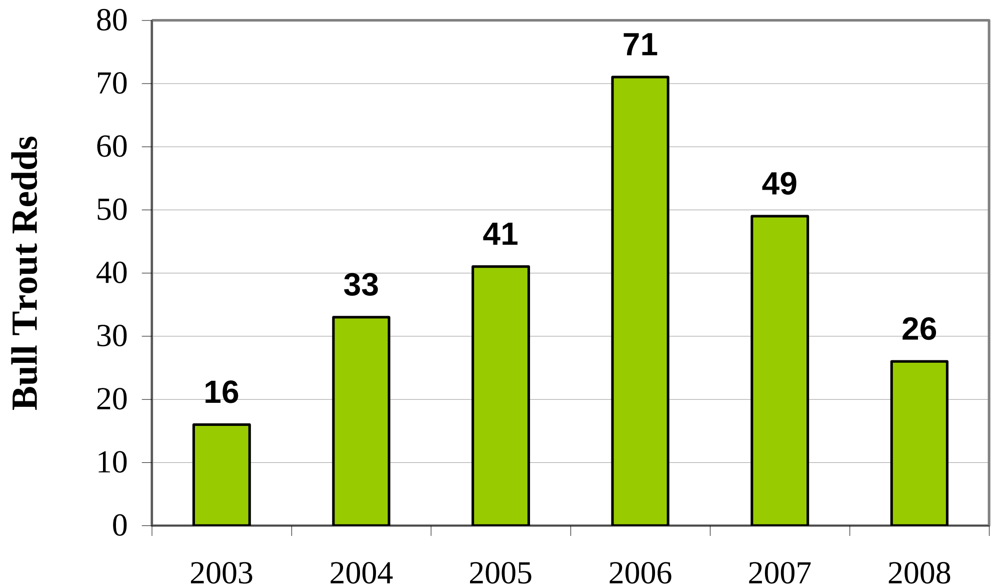

Figure 21. Annual counts of fluvial bull trout redds in Fourth of July Creek from 2003-2008 (Curet 2008).

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, IDWR 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.

Site visits to Pole Creek on 7/25/2007, 8/1/2007, 8/13/2007, and 8/4/2008 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 22). Flows in Pole Creek during the term of the transaction never fell below 5 cfs. In 2007, the landowner utilized the diesel generator from June 26th through September 30th. In 2008, the irrigator had to turn on the generator for only one day in mid-August.

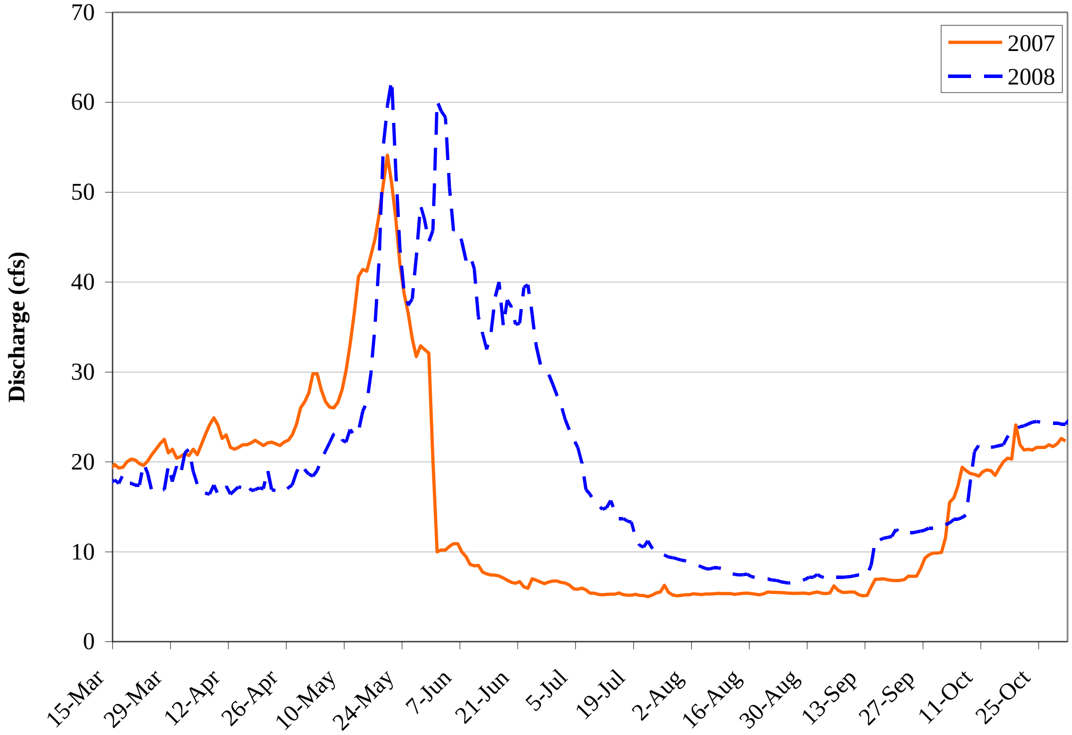

Figure 22. Pole Creek mean daily flow, May 1 to October 31.

Physical Habitat Simulation (PHABSIM) results from a study on Pole Creek (Maret et al. 2005) were used to develop habitat availability with leased water. Figures 23-25 represent the percentage of usable area for each species of concern. Juvenile habitat is not included due to limitations of the PHABSIM model.

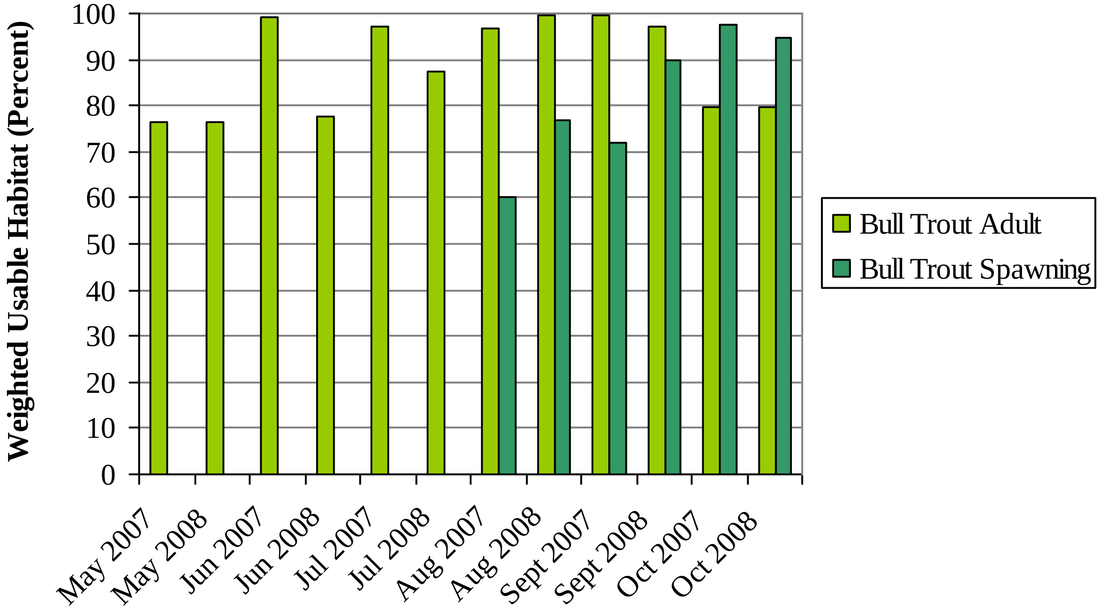

Figure 23. Percent weighted usable habitat for adult and spawning bull trout at mean monthly flows in 2007 and 2008.

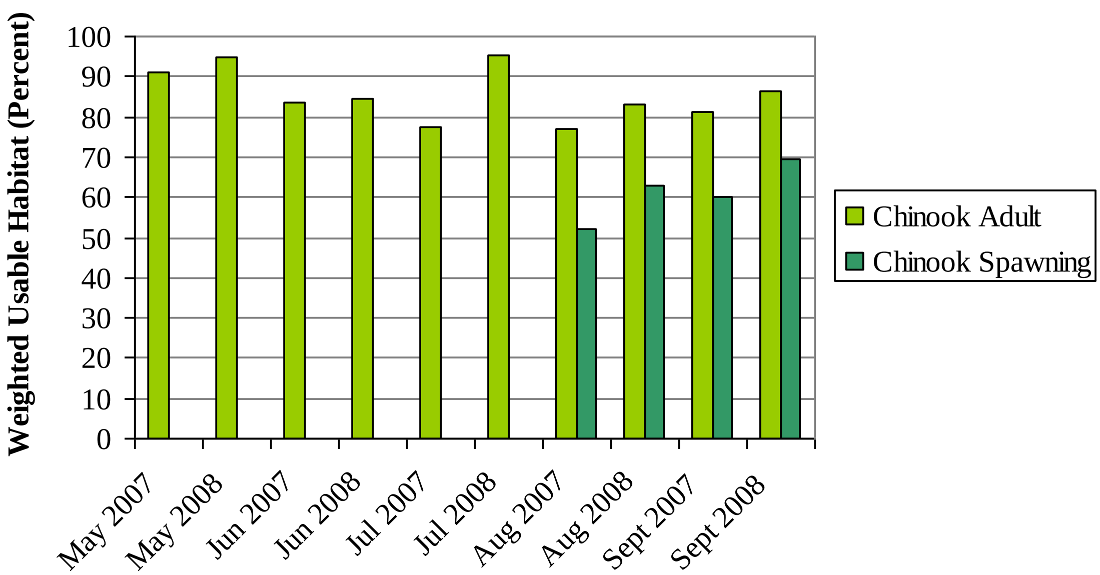

Figure 24. Percent weighted usable habitat for adult and spawning Chinook salmon at mean monthly flows in 2007 and 2008.

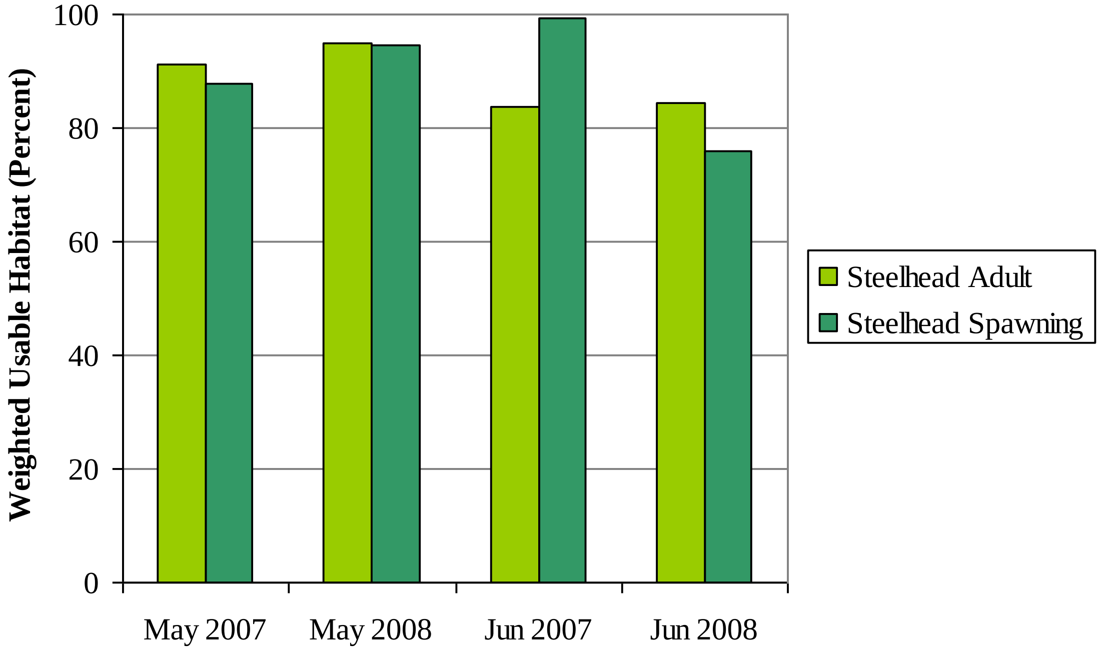

Figure 25. Percent weighted usable habitat for adult and spawning steelhead at mean monthly flows in 2007 and 2008.

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

IDWR negotiated two one-year leases in 2007 and 2008 with Erik Storlie and Tamara Kaiser for 0.5 cfs, formerly irrigating 35 acres. 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.

Site visits to Big Hat Creek on 8/14/2007 and 9/2/2008 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). 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. Flow measurements at the time of the site visits showed 0.9 cfs and 0.6 cfs respectively. This Big Hat transaction removes the only diversion on Big Hat Creek, returning the stream to a natural flow. With seasonal 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 lease is on an Upper Salmon Basin Watershed Program (USBWP) Screening and Habitat Improvement Prioritization in the Upper Salmon Subbasin (SHIPUSS) high priority stream for flow enhancement within an ESU.

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

In early 2007, IDWR developed two one-year agreements not to divert on 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 7/12/2007, 8/13/2007, 9/10/2007, 6/2/2008, 8/5/2008, and 9/15/2008 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 26). Flows did drop below 2 cfs for several days at a time throughout the irrigation season in 2007. A rating curve was developed for the primary reach, making it possible to identify the stage that corresponds to 2 cfs. That information made it easier for the landowners to regulate flows in 2008.

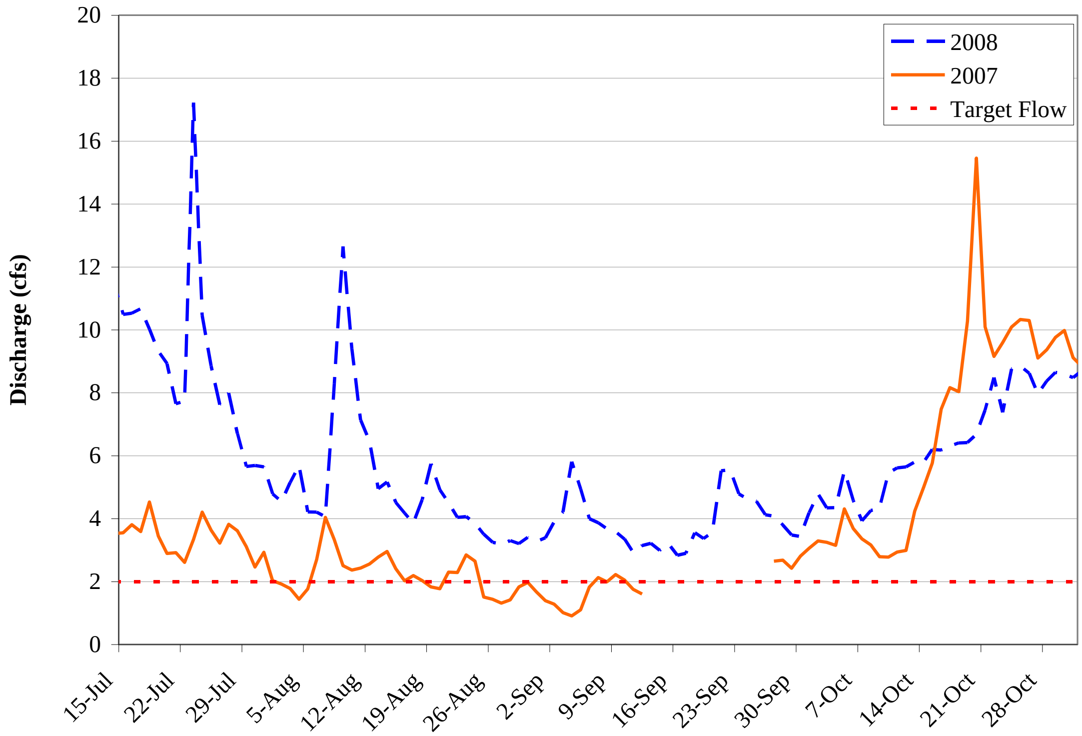

Figure 26. Morgan Creek mean daily flow below Highway 93, July 15 to October 30.

Habitat assessment was conducted on August 9th, 2007 in a 145-meter reach in the previously de-watered reach. Riffle habitat made up 65% of the stream, glide-runs were 11%, and scour pools made up 23% of the habitat. Deciduous trees, with some riparian shrubs, 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-five percent of the substrate sampled in Morgan Creek fell into the ideal spawning size range for Chinook salmon and steelhead (Figure 27). A PHABSIM study conducted on Morgan Creek in 2005 did not model flows below 10 cfs.

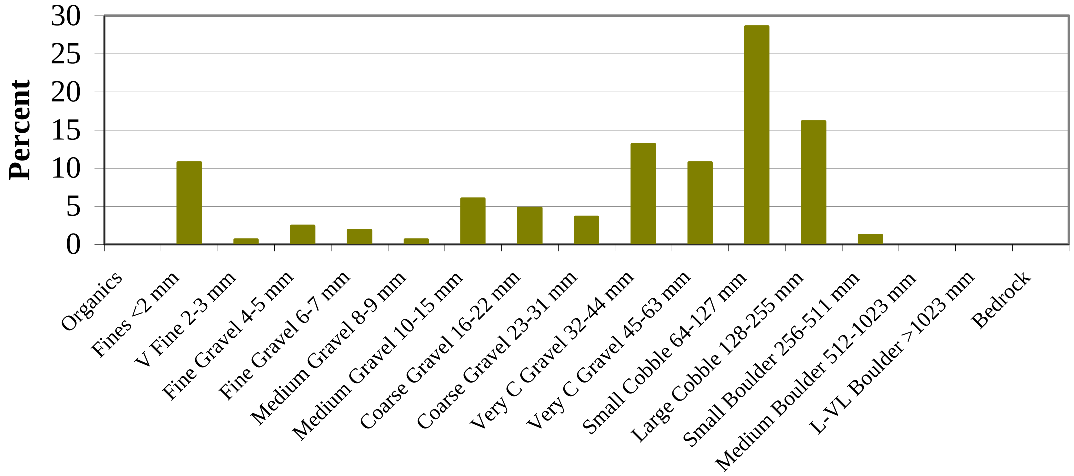

Figure 27. Morgan Creek substrate size distribution as sampled in a 145-meter reach above the Salmon River Ditch on August 10, 2007.

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 lower in the system, where flow is not limited.

Site visits on 6/9/2008, 6/26/2008, and 9/30/2008 confirmed that the landowners were complying with the terms of the agreement. A gage in the Pahsimeroi River monitored flows during the irrigation season (Figure 28). The Pahsimeroi River maintained a base flow of approximately 10 cfs in 2008, compared to previous years when flow dropped to almost zero intermittently. A gage was also installed on Patterson/Big Springs Creek, but that data is not yet available.

IDFG conducted biologic monitoring of the reaches affected by the P-9 projects and found the following (Warren 2008):

- A Chinook salmon redd in Patterson/Big Springs above the cross ditch
- A Chinook salmon redd in Patterson/Big Springs downstream of the cross ditch
- 8 adult Chinook adults observed in Patterson/Big Springs
- Juvenile Chinook in Duck Springs and Muddy Springs Creek in 2007
- Wild rainbow/steelhead, sculpin, and brook trout in the Pahsimeroi River, Duck Springs, and Patterson/Big Springs in 2008

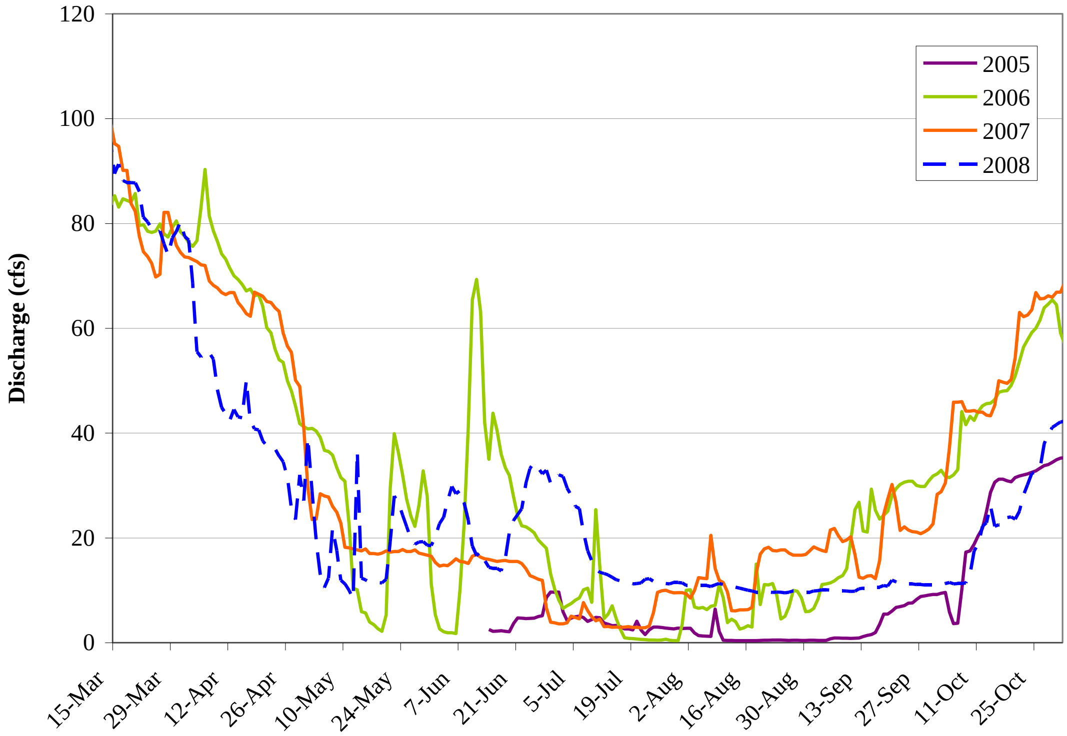

Figure 28. Pahsimeroi River mean daily flow below the P-9 ditch, March 15 to October 30.

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.

Site visits to Iron Creek on 8/15/2007 and 7/23/2008 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 29 and 30).

There has been no PHABSIM modeling of Iron Creek.

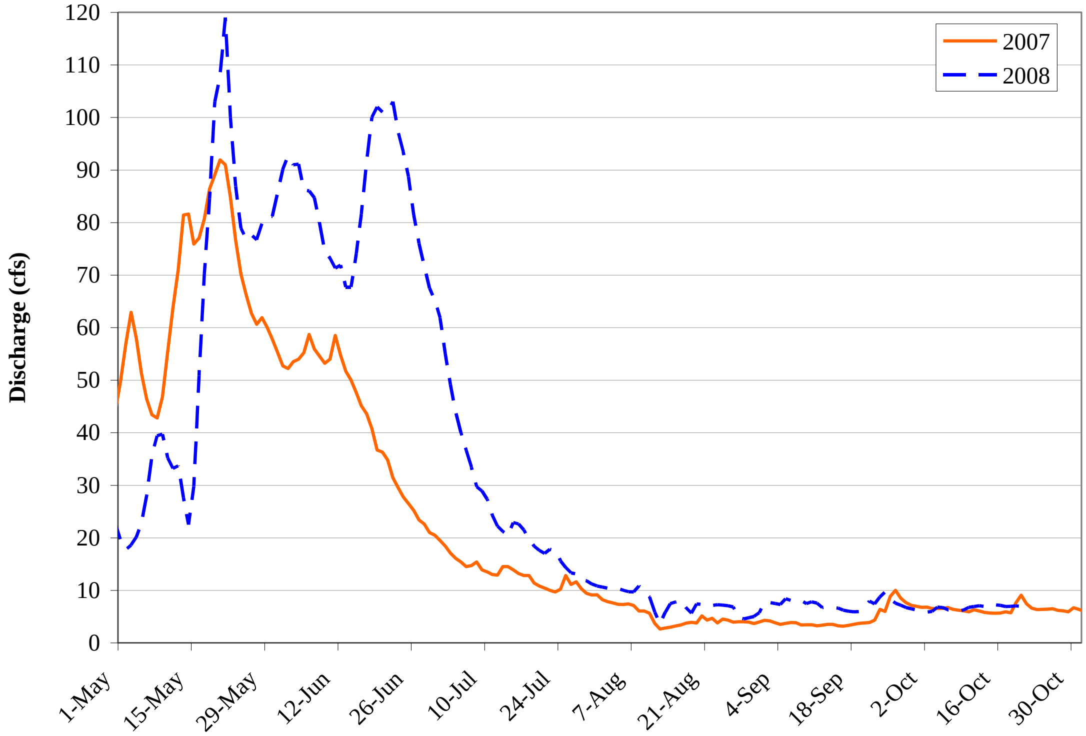

Figure 29. Iron Creek mean daily flow below Phillip's Bridge, May 1 to October 31.

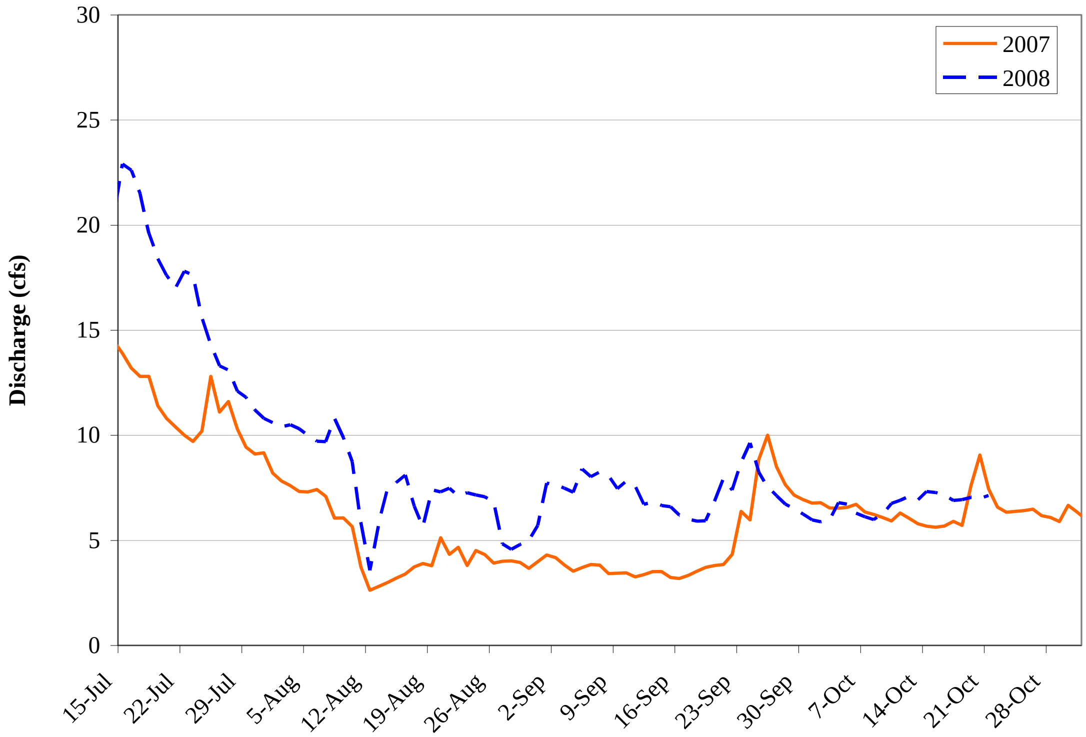

Figure 30. Iron Creek mean daily flow below Phillip's bridge, July 1 to October 31.

Lemhi River Agreement not to Divert - Lemhi River Basin

Through 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 60 days in 2007 and 42 days in 2008. 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 31 shows the flows at L5 when the Lemhi River was in regulation.

IDFG conducted biologic monitoring in the Lemhi Basin and found the following:

- 19 Chinook salmon redds in the Lemhi River in 2007 (Figure 32)
- 25 Chinook salmon redds in the Lemhi River in 2008 (Figure 32)
- Outmigrating steelhead and Chinook salmon in the Lower Lemhi River (Figures 33 and 34)

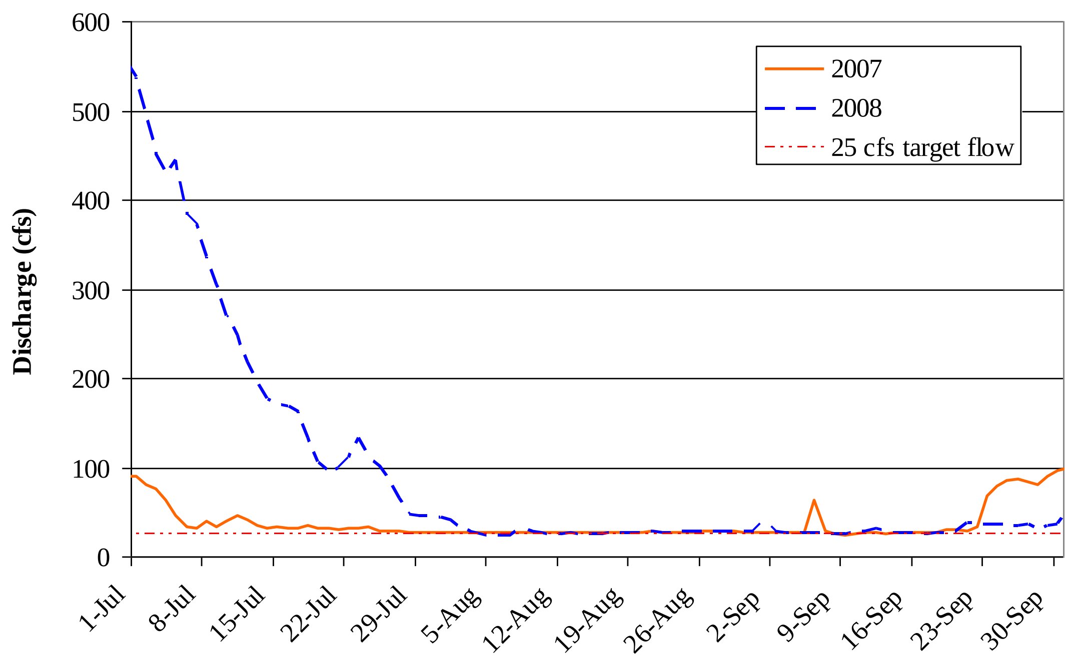

Figure 31. Lemhi River mean daily flow at L5, July 1 to September 30.

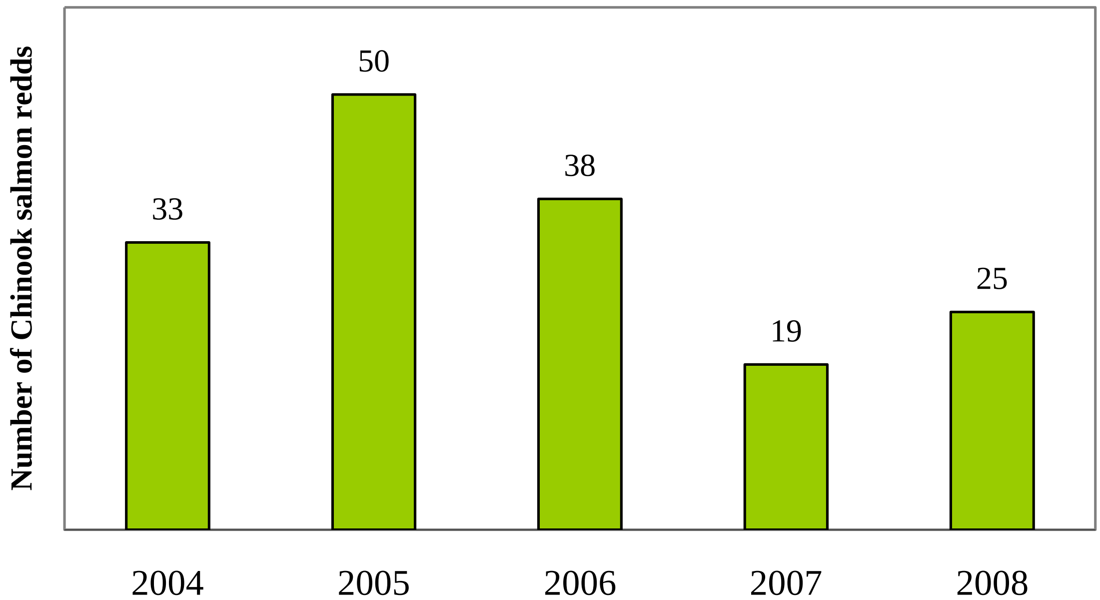

Figure 32. Lemhi River and Hayden Creek Chinook salmon redds 2004-2006 (Lutch 2006, Curet 2008).

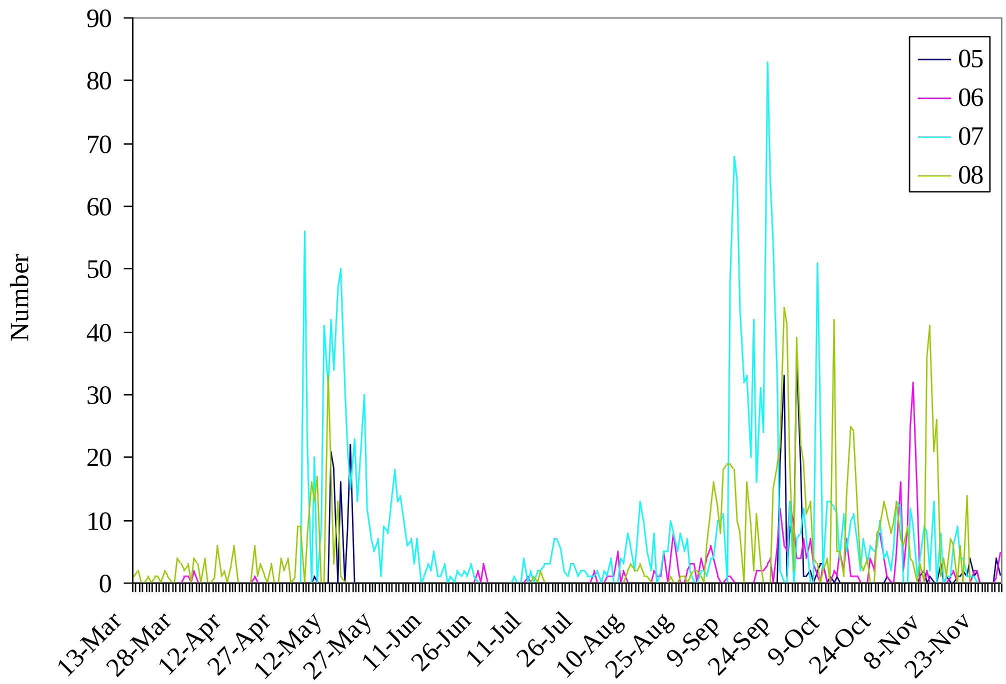

Figure 33. Daily juvenile rainbow/steelhead trout capture at the Lower Lemhi screw trap 2005-2008 (Curet 2008).

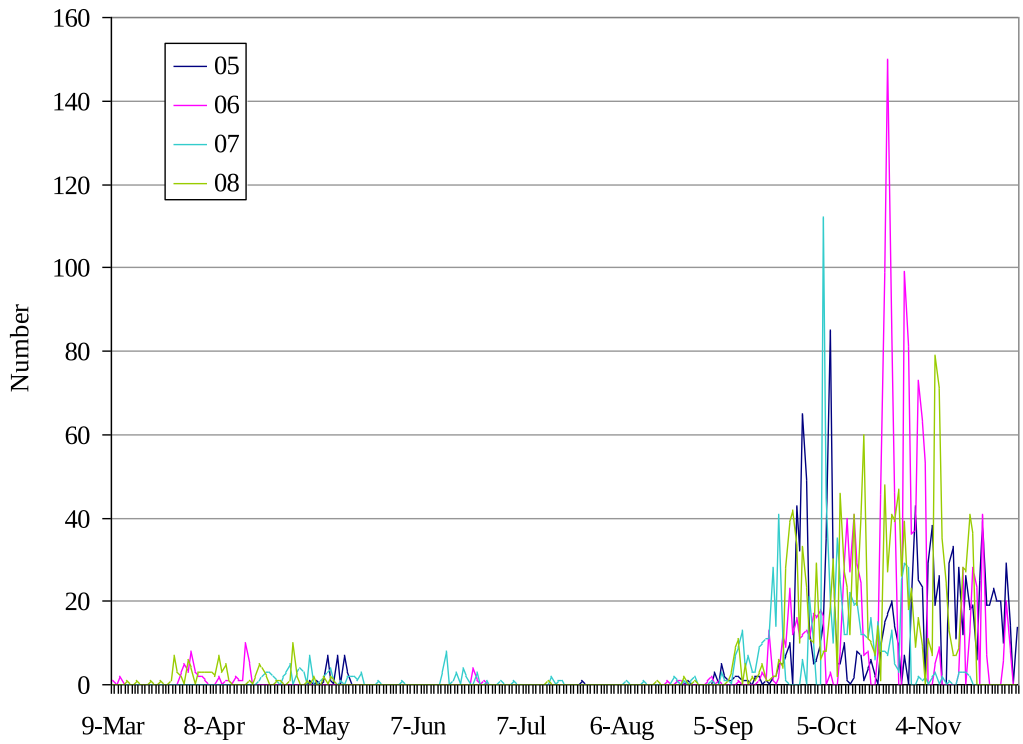

Figure 34. Daily juvenile Chinook salmon capture at the Lower Lemhi screw trap 2005-2008 (Curet 2008).

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. 2007 and 2008 were the third and fourth 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 Eighteen Mile Creek, and the Lemhi River, when sufficient flows are present.

Site visits to Eighteenmile Creek on 6/21/2007, 8/16/2007, and 7/24/2008 confirmed that the landowner was complying with the terms of the leases. Landsat images also show that the leased water was not being used to irrigate land (Appendix A). A gage in Eighteenmile Creek monitored flow during the irrigation season (Figure 35). There was no flow available between June and September during 2007, but Eighteenmile Creek maintained mean monthly flows of 1.4 cfs, 1.6 cfs, and 5.7 cfs during the months of July 2008, August 2008, and September 2008 respectively.

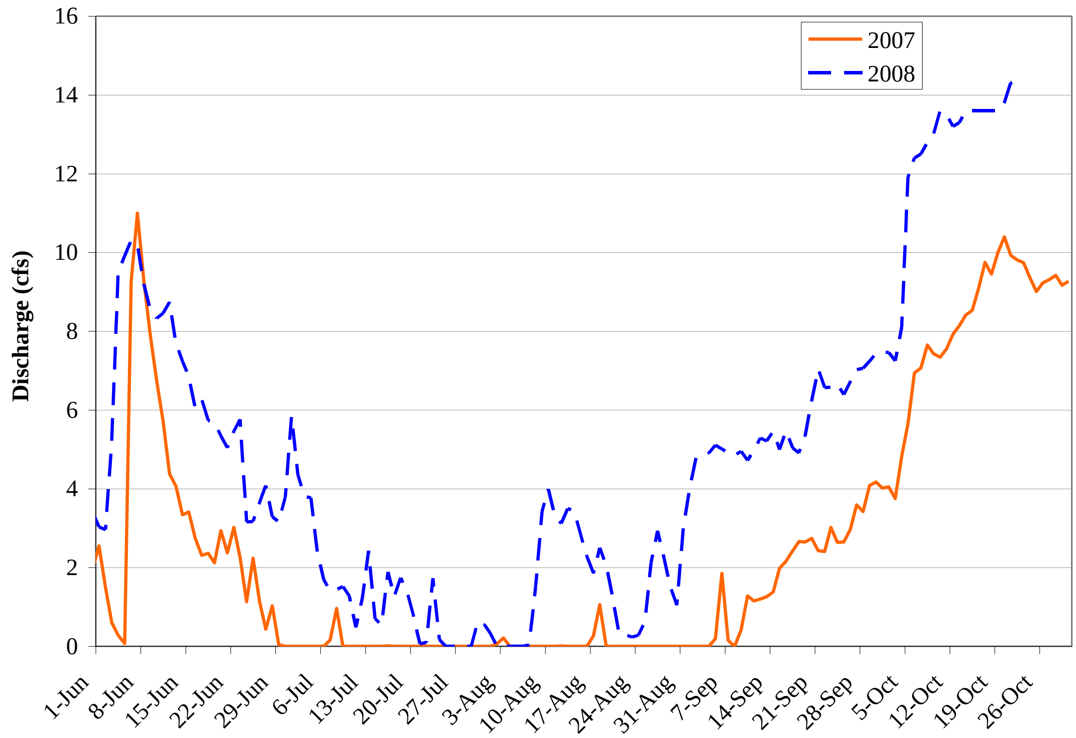

Figure 35. Eighteenmile Creek mean daily flow below confluence with Hawley Creek, June 1 to October 31.

Habitat assessment was conducted on August 10t[h], 2007 in a 242-meter reach below the confluence with Hawley Creek. Unfortunately, the stream was dry during that time, so it was impossible to collect a complete data set. The reach had an average bankful width of 4.0 meters. Riparian vegetation was predominately grass. 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-six percent of the substrate sampled in Eighteenmile Creek fell into the ideal spawning size range for Chinook salmon and steelhead (Figure 36).

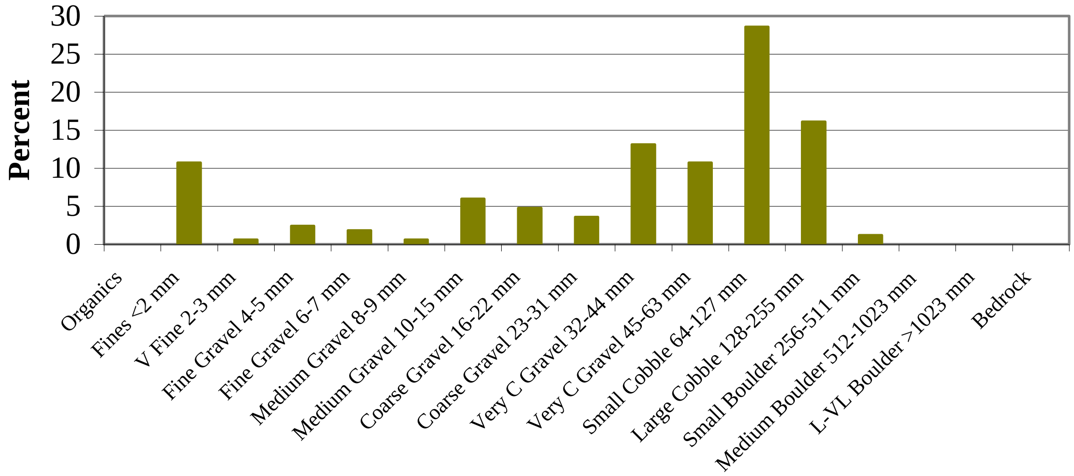

Figure 36. Eighteenmile Creek substrate size distribution as sampled in a 242-meter reach below the confluence with Hawley Creek on August 10, 2007.

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 37-42 represent the percentage of usable area for each species of concern. Juvenile habitat is not included due to limitations of the PHABSIM model.

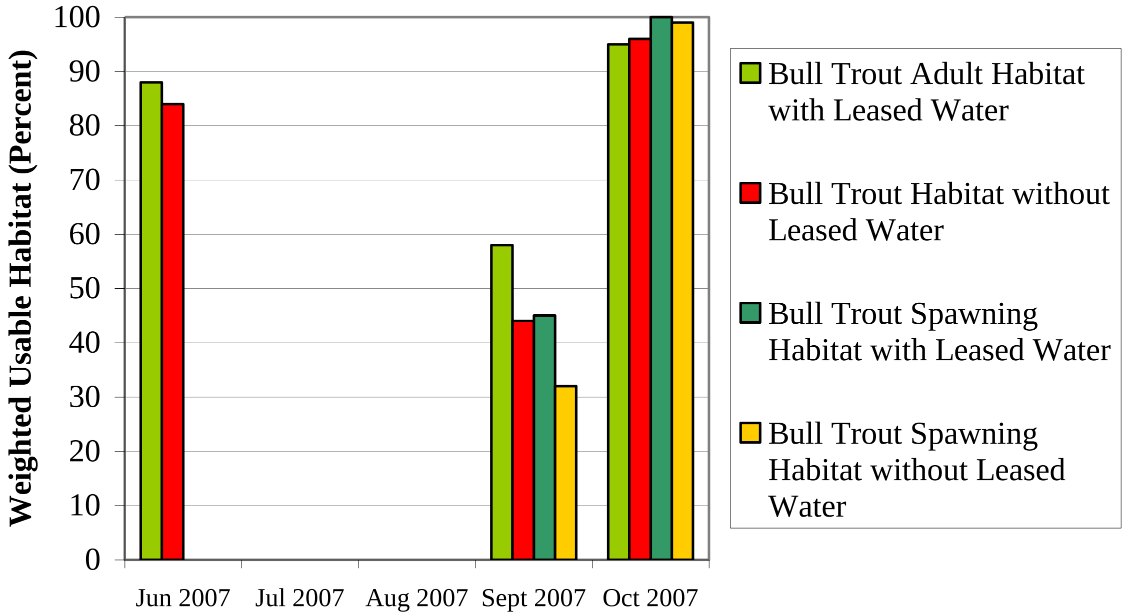

Figure 37. Percent weighted usable habitat for adult and spawning bull trout at mean monthly flows in 2007, including and excluding the leased 0.5 cfs.

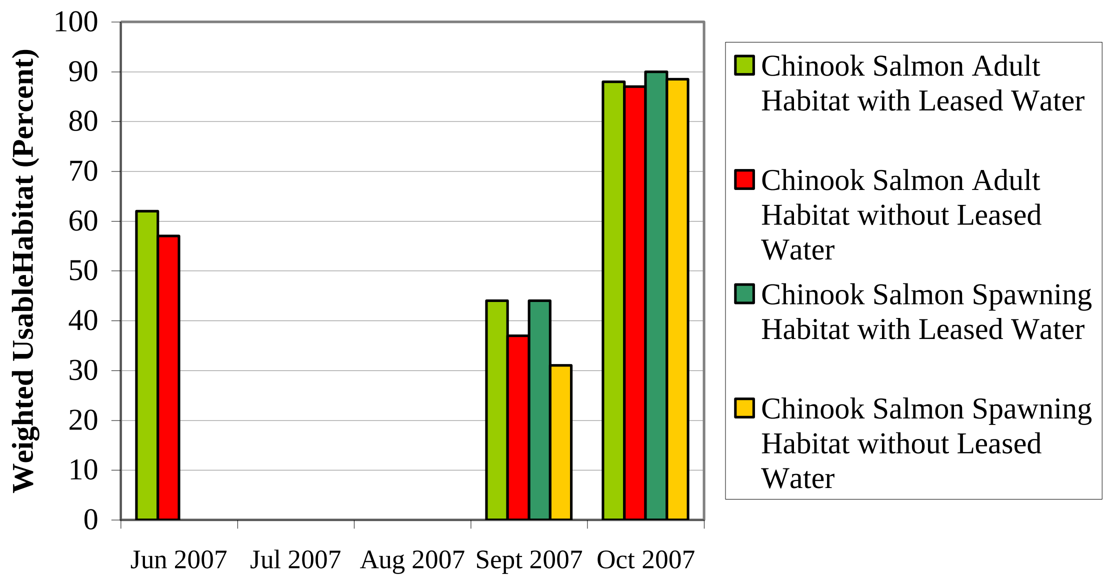

Figure 38. Percent weighted usable habitat for adult and spawning Chinook salmon at mean monthly flows in 2007, including and excluding the leased 0.5 cfs.

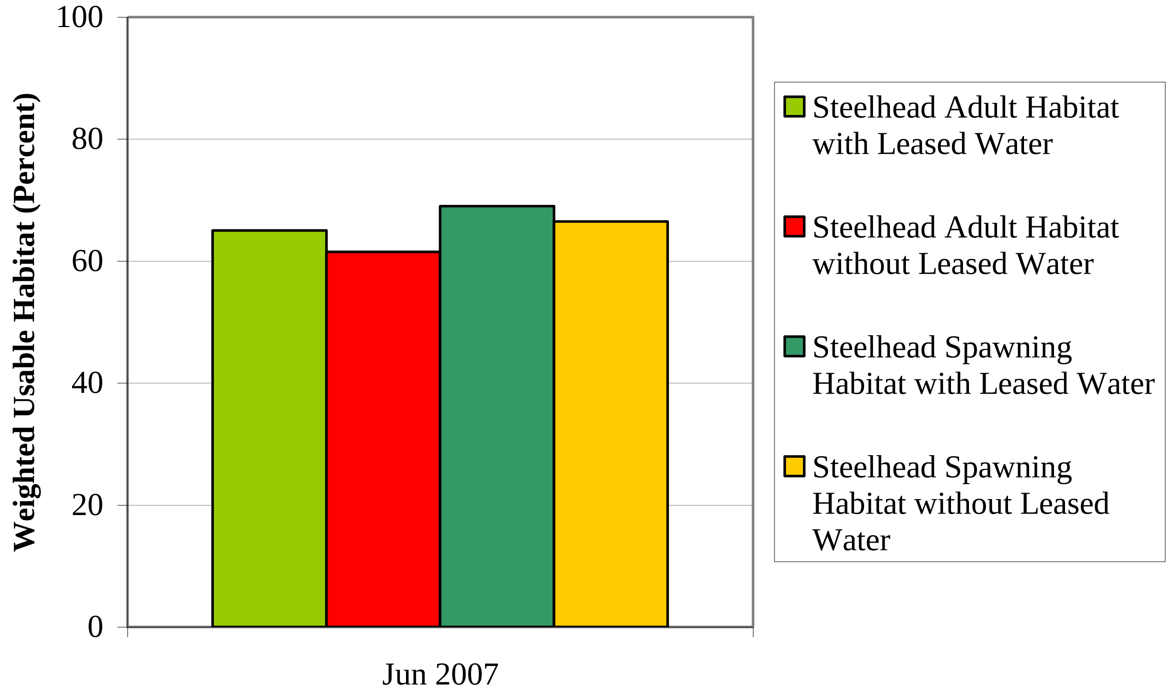

Figure 39. Percent weighted usable habitat for adult and spawning steelhead at mean monthly flows in 2007, including and excluding the leased 0.5 cfs.

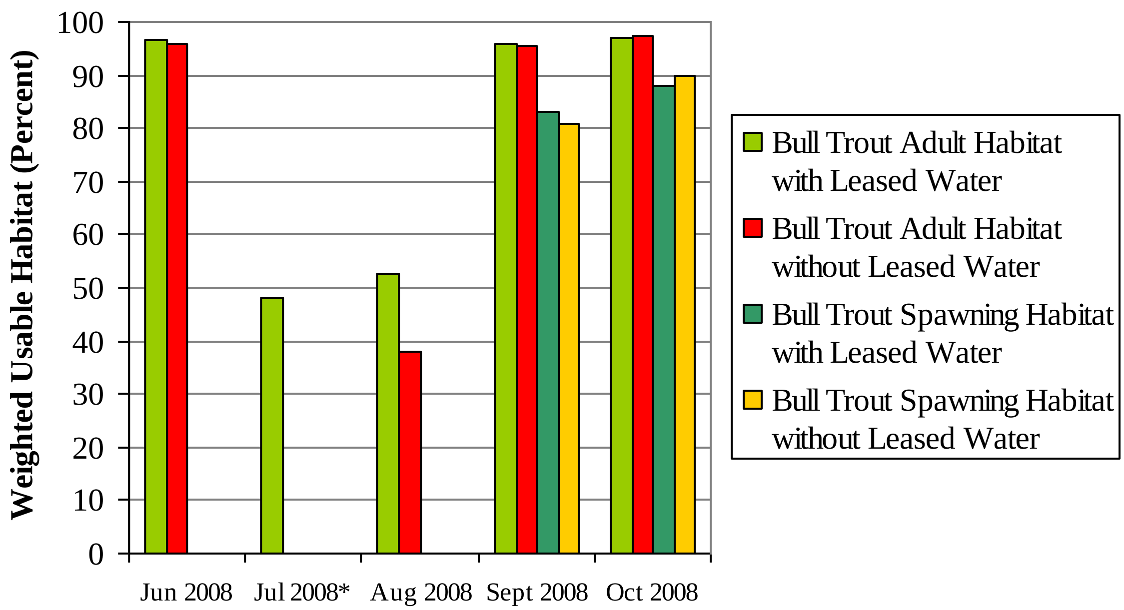

Figure 40. Percent weighted usable habitat for adult and spawning bull trout at mean monthly flows in 2008, including and excluding the leased 0.5 cfs. * Flows in July without leased water were beyond the modeled range.

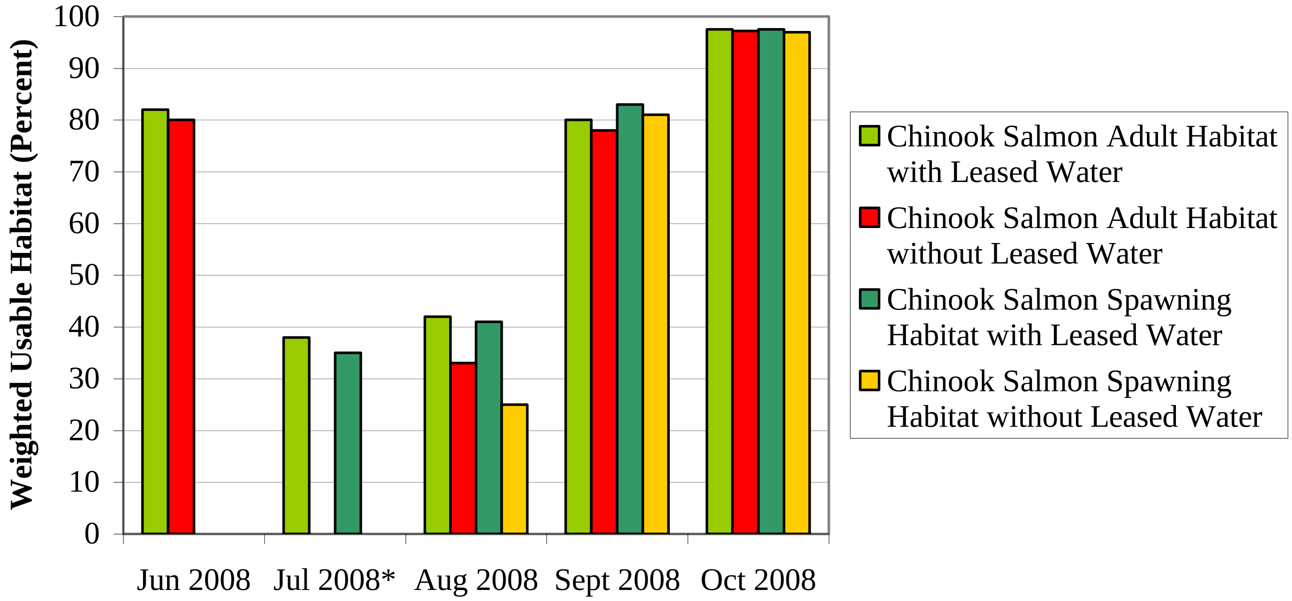

Figure 41. Percent weighted usable habitat for adult and spawning Chinook salmon at mean monthly flows in 2008, including and excluding the leased 0.5 cfs. * Flows in July without leased water were beyond the modeled range.

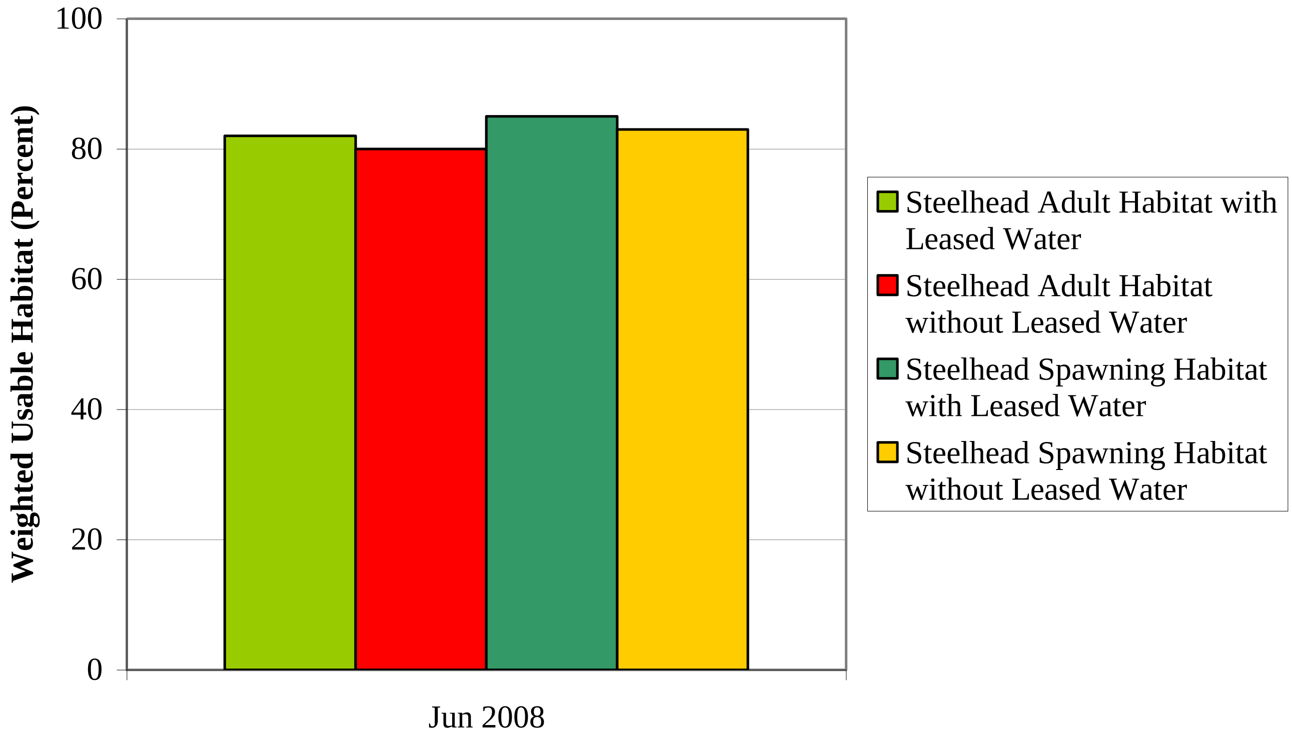

Figure 42. Percent weighted usable habitat for adult and spawning steelhead at mean monthly flows in 2008, including and excluding the leased 0.5 cfs.

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.

Site visits on 7/23/2008 and 8/19/2008 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 43 and 44). Canyon Creek maintained a base flow of approximately 3-4 cfs, and the Lemhi River stayed between 5 and 15 cfs for the majority of the irrigation season.

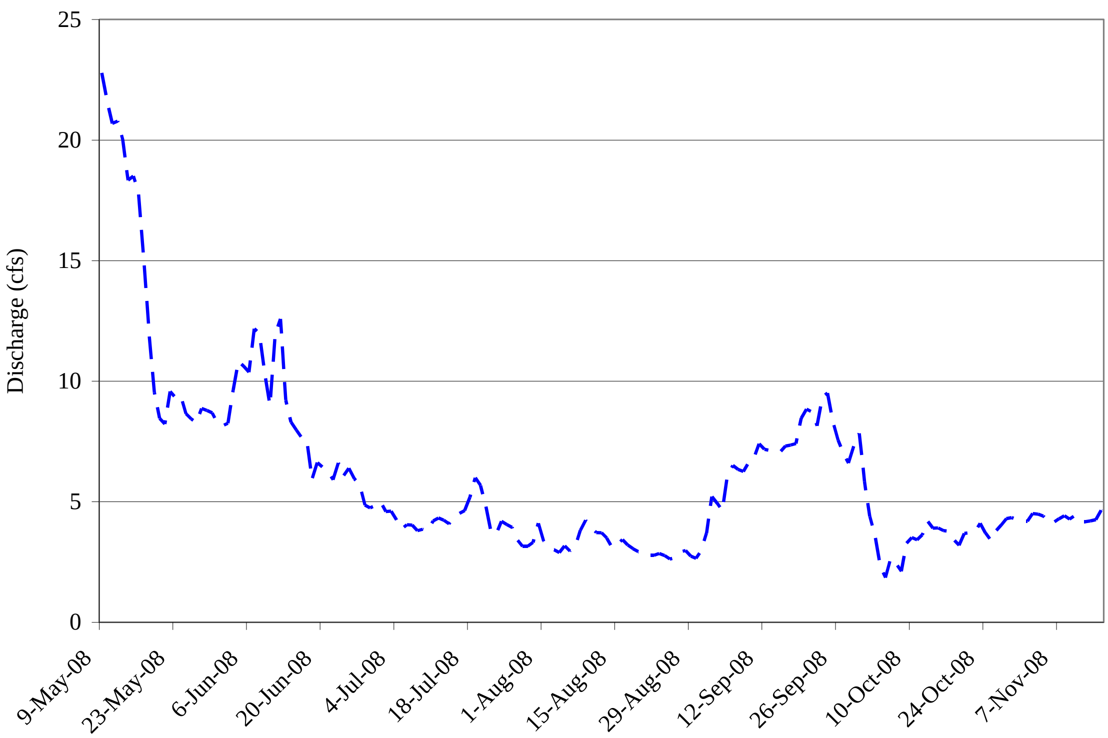

Figure 43. Canyon Creek mean daily flow below confluence with Whitefish Ditch, May 9 to November 15, 2008.

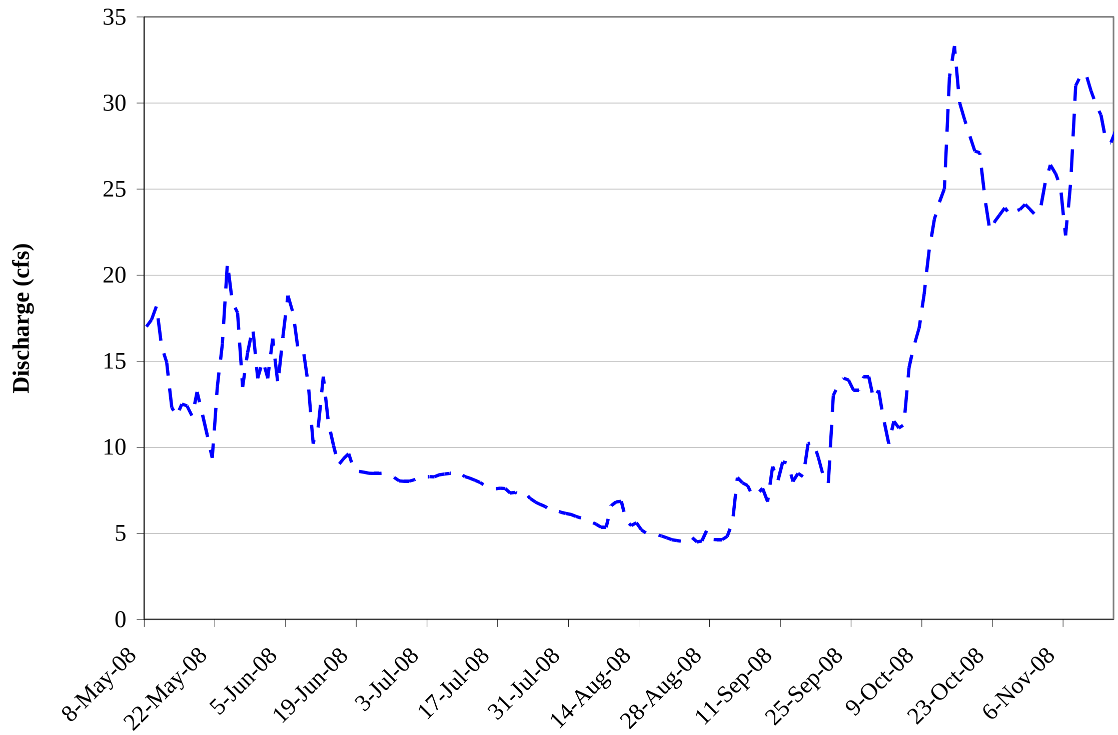

Figure 44. Lemhi River mean daily flow above L-63 diversion, May 8 to November 15, 2008.

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 45-50 represent the percentage of usable area for each species of concern. Juvenile habitat is not included due to limitations of the PHABSIM model.

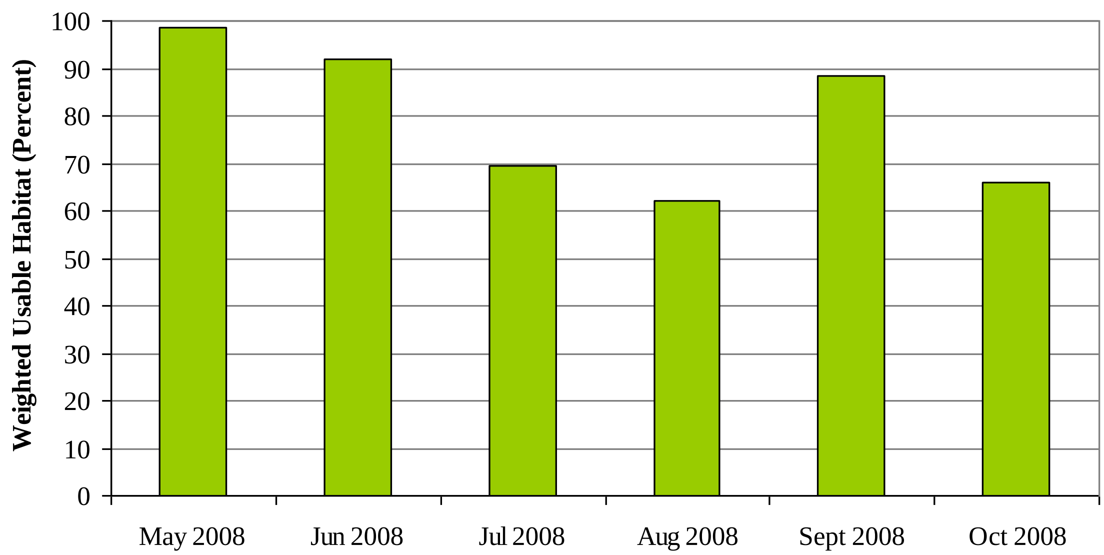

Figure 45. Percent weighted usable habitat for adult bull trout in Canyon Creek at mean monthly flows in 2008. No spawning habitat was available during September and October.

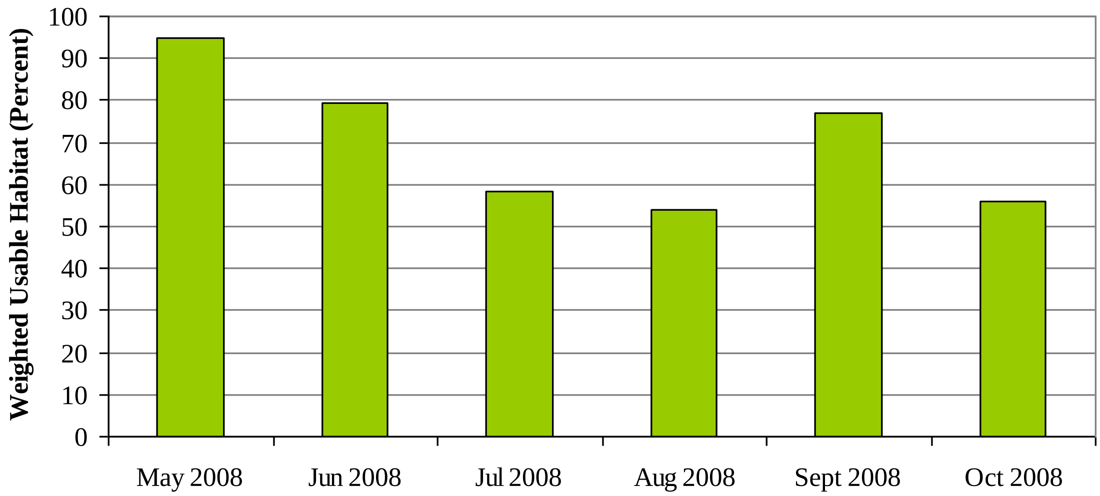

Figure 46. Percent weighted usable habitat for adult Chinook salmon in Canyon Creek at mean monthly flows in 2008. No spawning habitat was available between July and October.

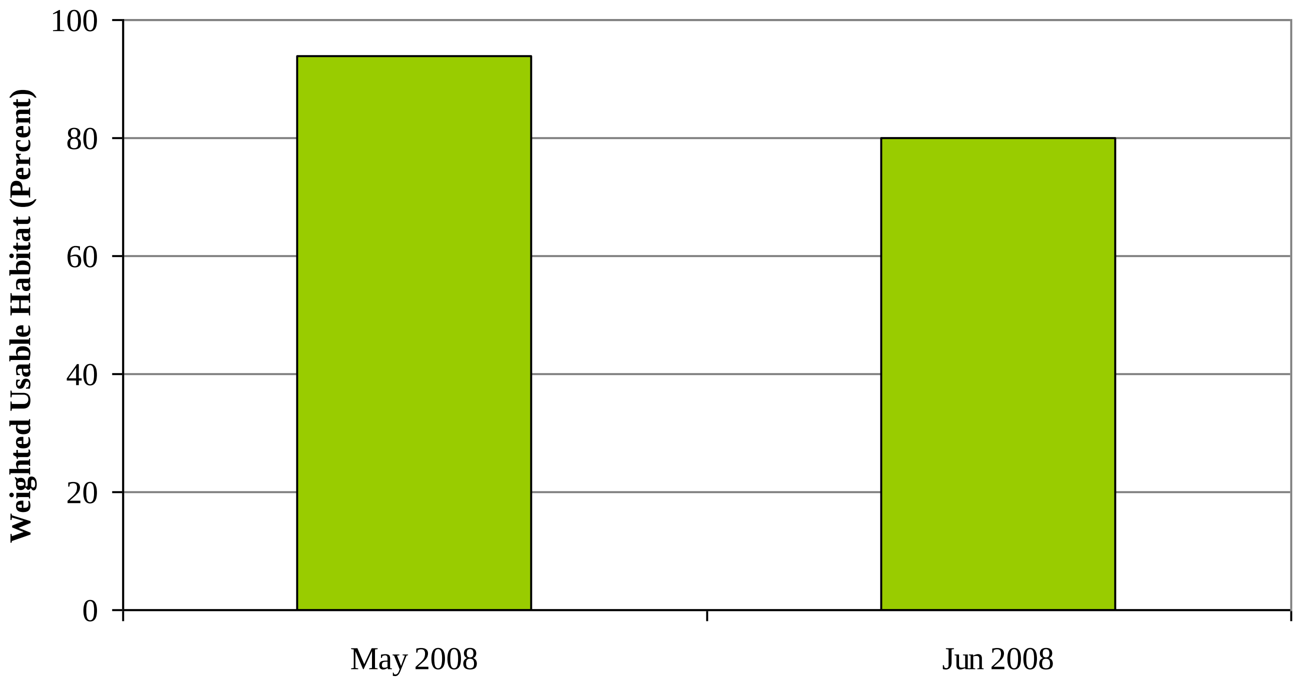

Figure 47. Percent weighted usable habitat for adult steelhead in Canyon Creek at mean monthly flows in 2008. No spawning habitat was available in May and June.

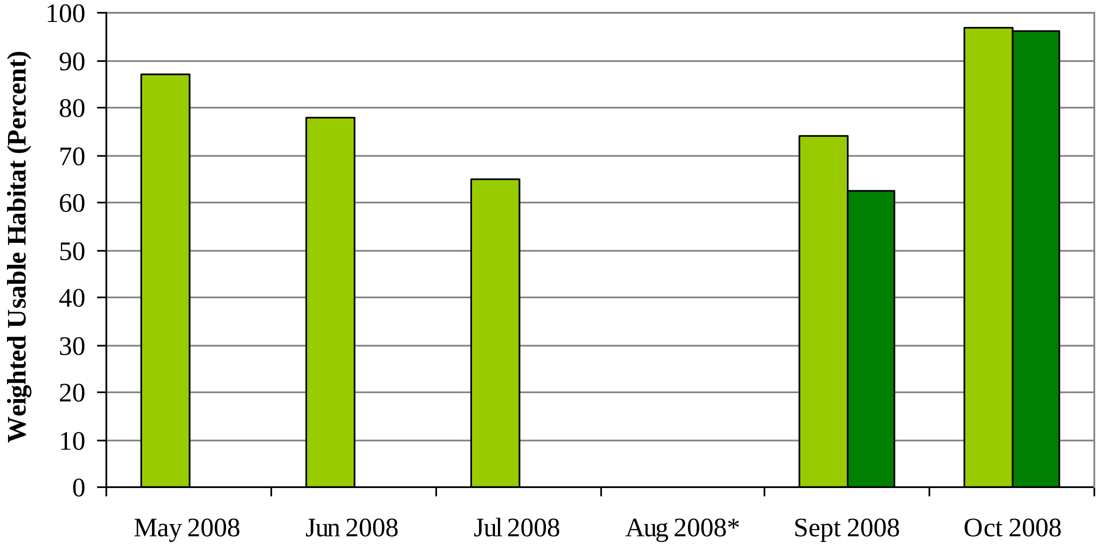

Figure 48. Percent weighted usable habitat for adult and spawning bull trout in the Upper Lemhi River below L-63 at mean monthly flows in 2008. *Flows in August were below the modeled range.

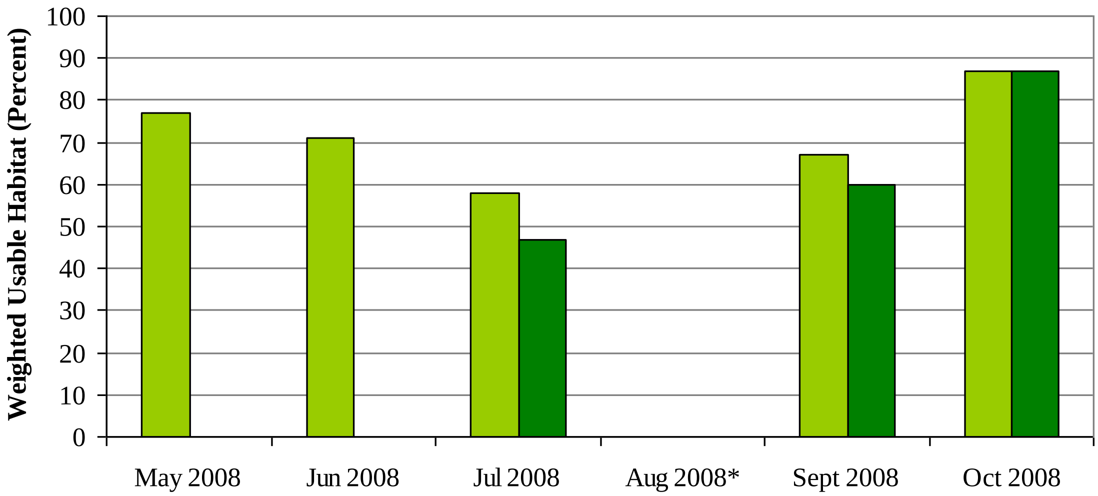

Figure 49. Percent weighted usable habitat for adult and spawning Chinook salmon in the Upper Lemhi River below L-63 at mean monthly flows in 2008. *Flows in August were below the modeled range.

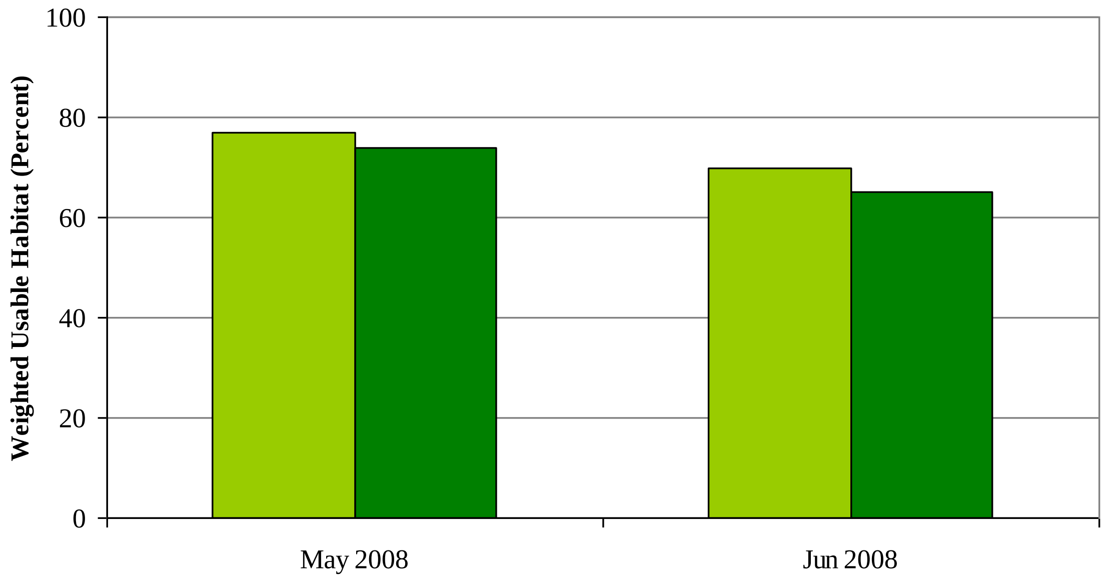

Figure 50. Percent weighted usable habitat for adult and spawning steelhead in the Upper Lemhi River below L-63 at mean monthly flows in 2008.

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

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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.

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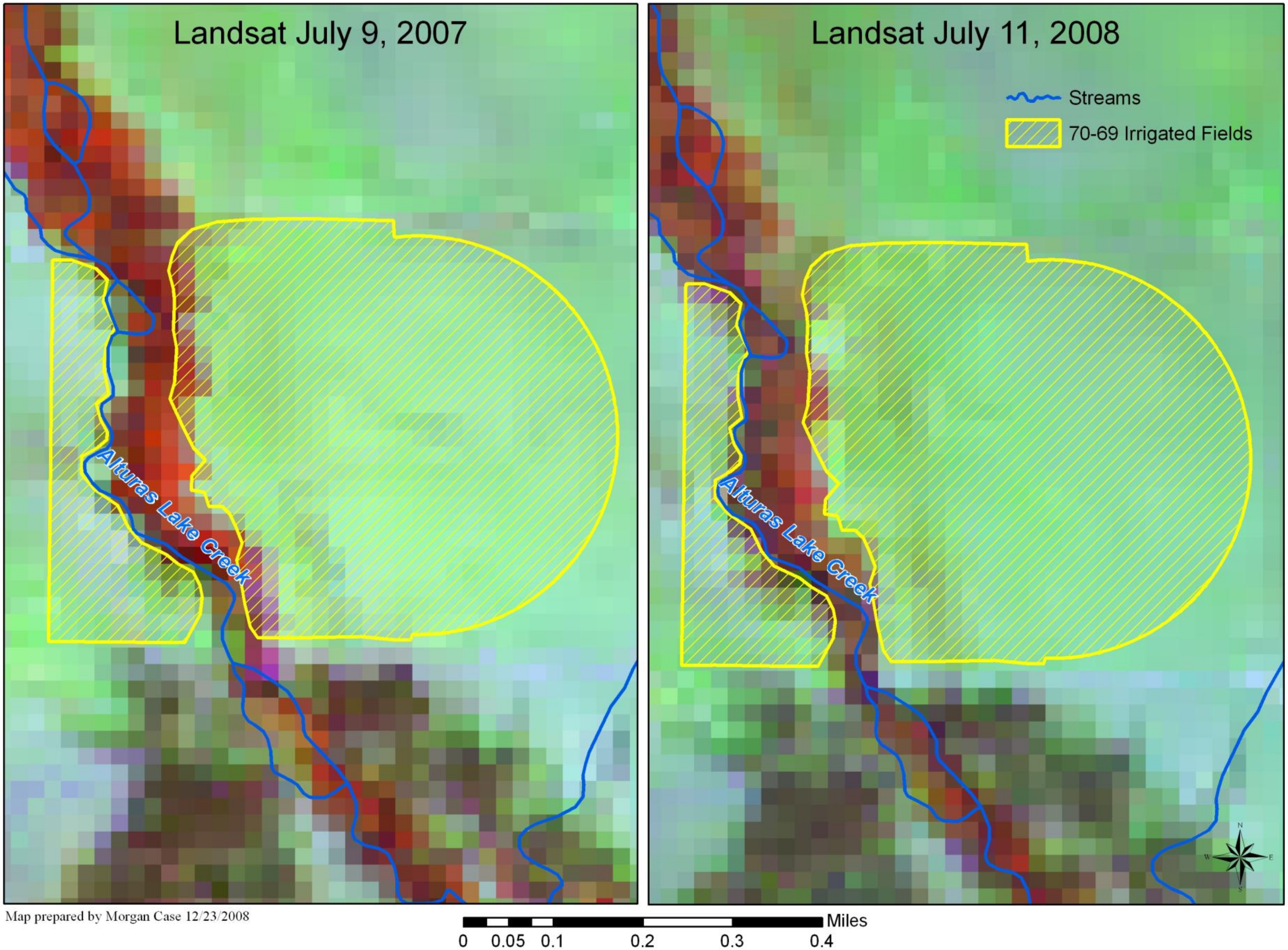
Morris, C. and R. Sutton. Instream Flow Assessment Upper Lemhi River and Canyon Creek, Idaho. 2007. U.S. Department of the Interior, Bureau of Reclamation Snake River Area Office. Boise, Idaho.

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

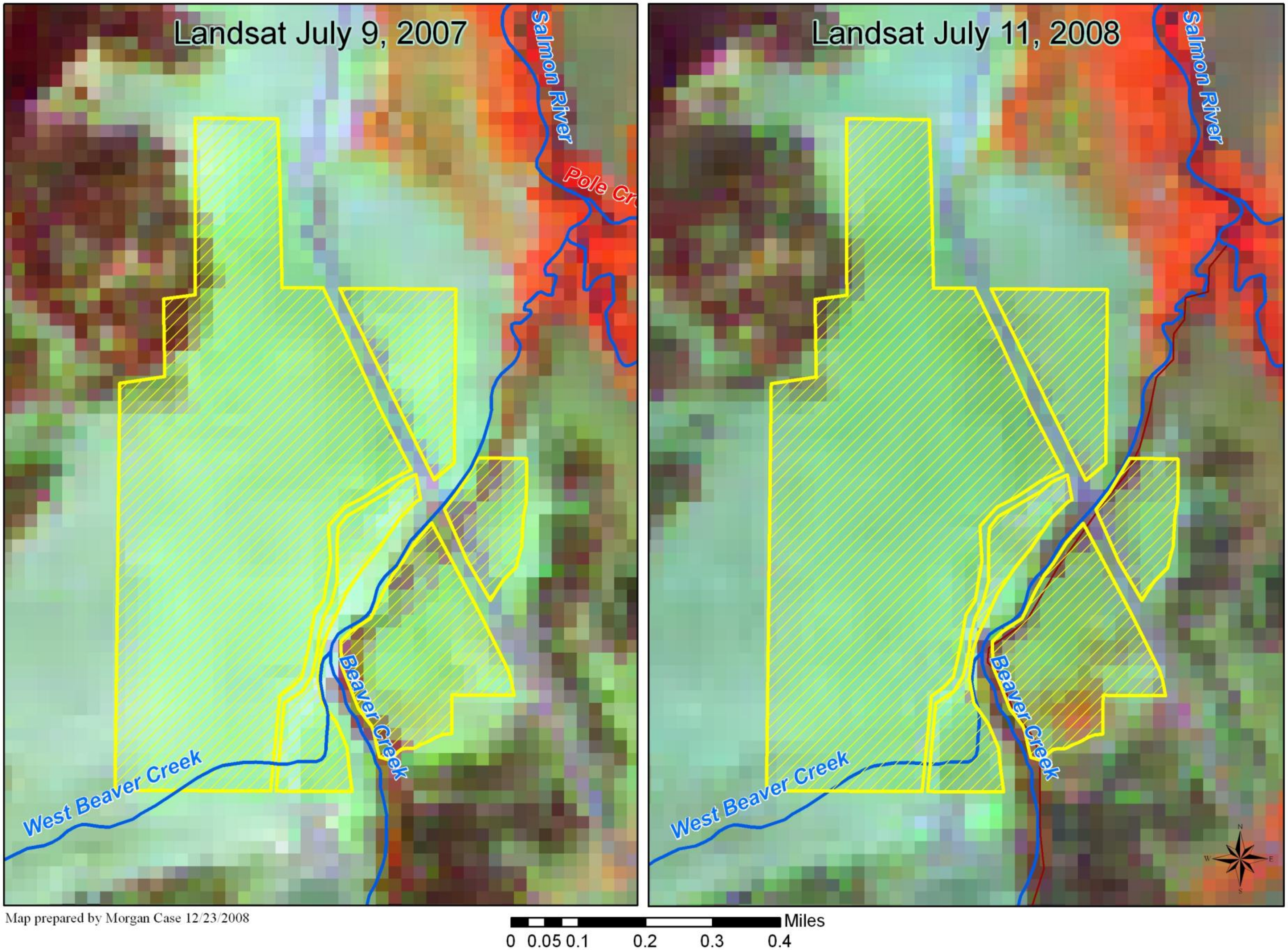
Appendix A
Landsat Images

Alturas Lake Creek - Breckenridge Fields



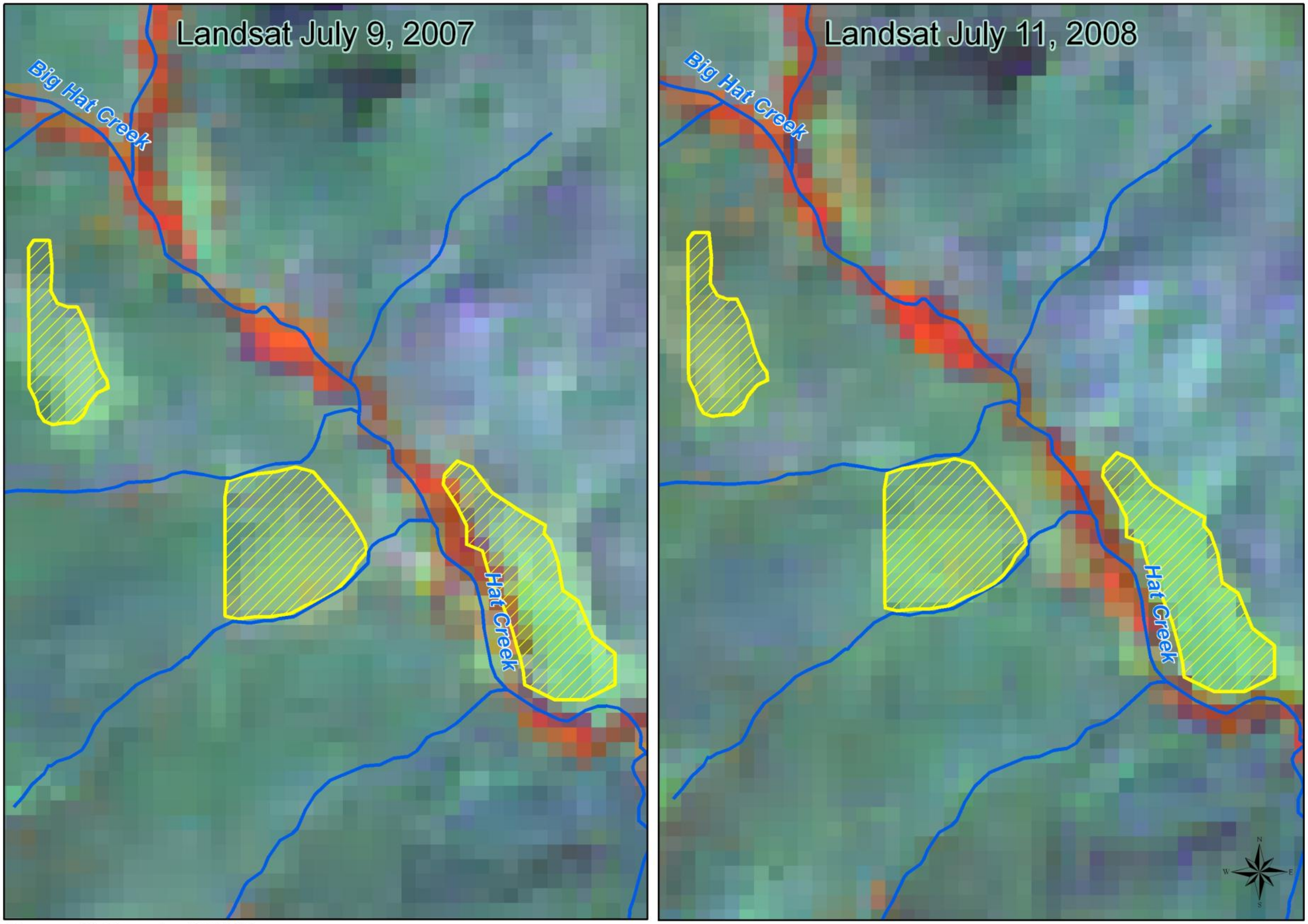
Map prepared by Morgan Case 12/23/2008

Beaver Creek - DOT LLC Fields

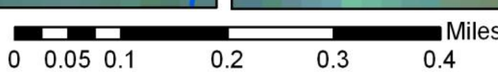


Map prepared by Morgan Case 12/23/2008

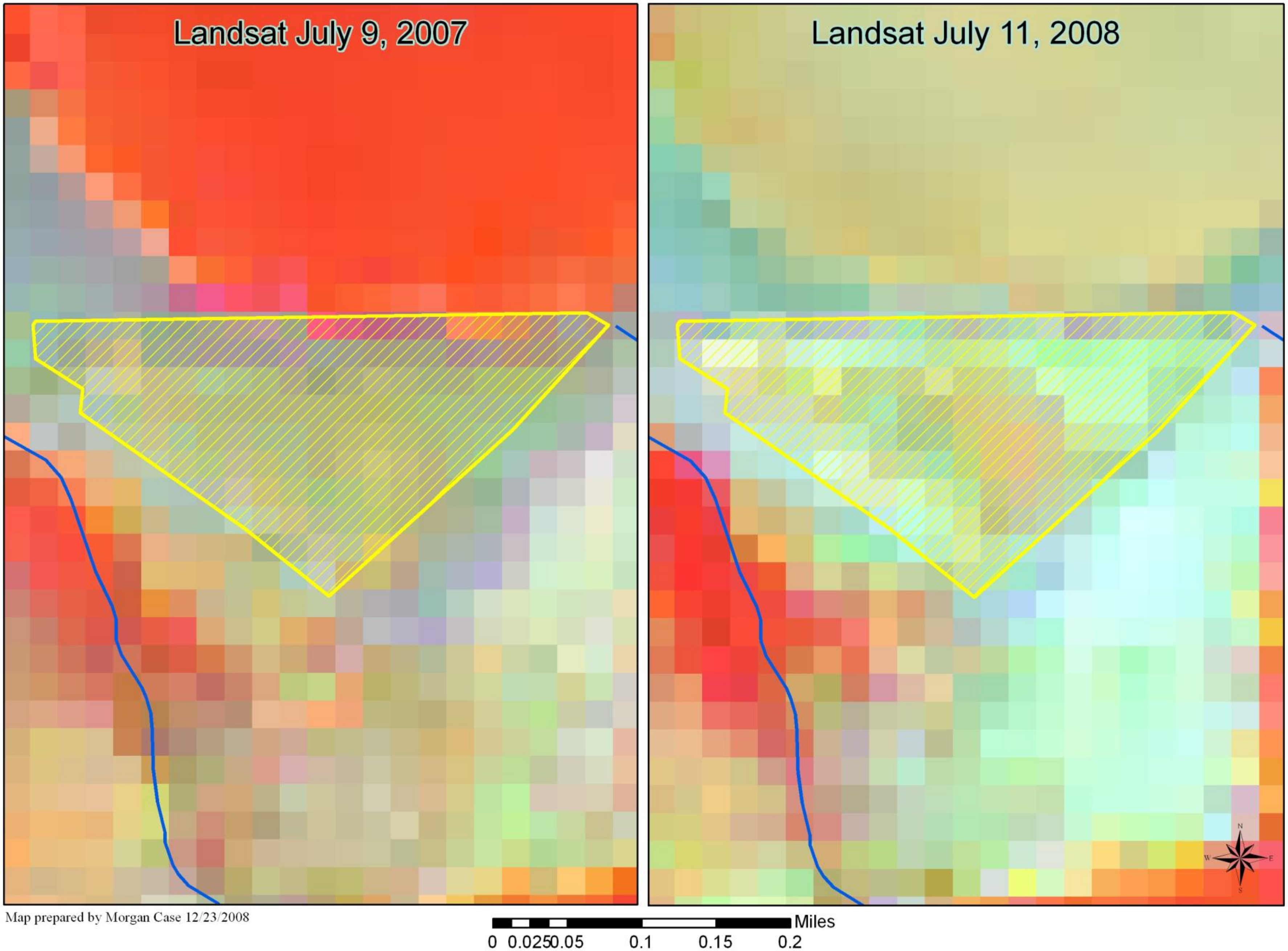
Big Hat Creek - Storlie/Kaiser Fields



Map prepared by Morgan Case 12/23/2008

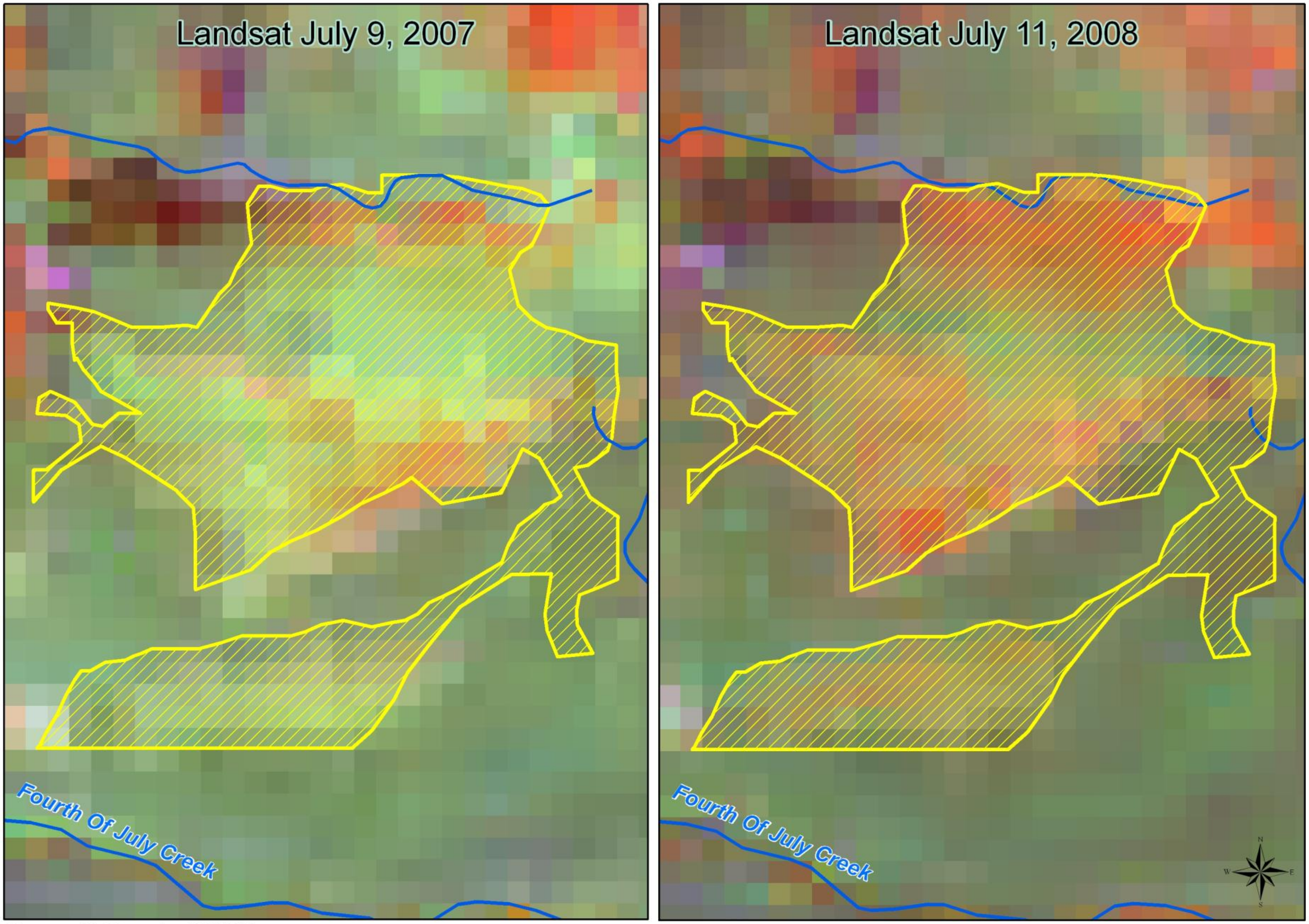


Eighteenmile Creek - Ellsworth Fields



Map prepared by Morgan Case 12/23/2008

Fourth of July Creek - Vanderbilt Fields



Map prepared by Morgan Case 12/23/2008