Little Snake River Channel Monitoring Project
1994 Fall Channel Monitoring Trip Report
November, 1994

A Cooperative Study Conducted by**:**

US Fish and Wildlife Service, National Park Service and Colorado State University

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This document contains the following:

Prepared for the Cooperative Study Team Consisting of:

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Little Snake Channel Monitoring Project
1994 Fall Field Data Collection Report

I. Introduction

This report presents the data and results of the fall, 1994 field data collection trip to the Little Snake River in northwestern Colorado. There were two reaches of interest, the sand bed reach upstream of the Lily gage and the native fish habitat reach in the cobble bed channel near the Wyoming border. This study was undertaken by the cooperative team of the Fish and Wildlife Service (FWS), the National Park Service (NPS) and Colorado State University (CSU). The principal investigators include George Smith (FWS), Ed Wick (NPS), John Hawkins and Rick Patton (CSU) and Jim O'Brien (FLO Engineering).

The purpose of this channel monitoring trip was to establish cross sections and a data base for future hydraulic and channel morphology analyses. The habitat reach was monitored for the purpose of determining channel substrate maintenance flows. The sand bed cross sections upstream of the Lily gage were established for future analysis of sediment load in the Little Snake River. The results of these channel monitoring studies may be applied to develop a Little Snake River management workplan for the Colorado River Endangered Fishes Recovery Implementation Program and to support future flow recommendations for the Little Snake River. The data base will also support the biological investigation of Colorado River native fishes in the upper Little Snake River being conducted by the National Park Service.

II. Field Data Collection and Results

Cross Section Surveys

A total of 14 cross sections were surveyed in two reaches of the Little Snake; six cross sections upstream of the Lily gage (LG-lines) and 8 cross sections in the native fish habitat reach upstream of the Powder Wash road (Loop or L-lines). The field data is presented in Appendix A. The end point elevations of all the cross sections were surveyed relative to each other in each reach and in addition, actual Lily gage cross section elevations were assigned by running a level loop to the nearby Lily gage USGS benchmark (el. 5703.36). The cross section locations are shown on the maps (Figures 1 and 2). A photo log of the cross sections was established and is presented in Appendix B. Four photos were taken at each cross section, one photo across the river from each endpoint and photos looking upstream and downstream in mid-channel.

The cross sections in the habitat Loop reach were setup for a possible Corps of Engineers' HEC-2 simulation to compute velocity, depth and water surface profile. Application of the HEC-2 model requires overbank distances between cross sections. These were measured by extending the cross section cable between the endpoints. The distances are presented in Table 1. Applying the HEC-2 model with appropriate estimates of Manning's n-values for hydraulic roughness will generate a water surface profiles from which bankfull discharge can be estimated. In addition, bed shear stress can be estimated for incipient motion of the bed material in the spawning riffle at both high and low flow conditions.

Table 1. Bank Distance (ft) Between Cross Sections Loop Reach (L-lines)		
Cross Sections	Left Bank	Right Bank
L-1 to L-2	500	805
L-2 to L-3	492	515
L-3 to L-4	480	430
L-4 to L-5	265	118
L-5 to L-6	330	135
L-6 to L-7	490	610
L-7 to L-8	705	705

The downstream cross section in the Loop reach was located in a narrow section of channel where the river flowed over a bedrock outcrop. At this location the river was flowing against the western side of the river valley contacting a bedrock outcrop. This outcrop provided a good hydraulic control for the start of HEC-2 backwater computations. Successive upstream cross sections were located alternately in riffles and pools to effectively model the water surface profile at the identified habitat riffle in the next upstream river bend. Three cross sections were surveyed at this cobble riffle; one at the lower extent of the riffle, one through the center of the riffle and the upstream one at the crest of the adverse bed slope leading to the riffle. Two additional cross sections were surveyed through the pool upstream of the riffle.

Little Snake River enters a narrow bedrock canyon just downstream of the Lily gage. Six Lily gage cross sections were surveyed over a wide sand bed channel established in the mile reach upstream of the gage. These cross sections were evenly spaced with the initial cross section located at the constriction of the channel just upstream of the gage. This constricted cross section will serve as the hydraulic control for hydraulic or sediment transport model application to the reach. The last upstream cross section is located at a sharp bend where the river flows against an alluvial bluff on the east side of the river.

The river at low flow created a wide braided, sand bar channel. Cottonwood and tamarisk seedlings were growing on some of the sand bars. At high flow the channel will be active bank to bank with only slight bank stabilization resulting from tamarisk, willow and Russian olive growth. All the cross section endpoints were set back from the river bank on floodplain terraces in the upland vegetation. Plots of all the cross sections are contained in Appendix D.

Sediment Samples

A total of five bed material samples were collected and sent to the lab for size distribution analysis. Two of the samples were collected in the cobble habitat Loop reach, one at cross section L-1 and the second near cross section L-6. Both samples were taken from a cobble bar near the left edge of water. The surface and subsurface sediment in the cobble reach was not separated. The remaining three samples were collected in the sand channel several hundred feet from the left end point. These samples were collected at cross sections LG-2, LG-3 and LG-4. All the sediment samples were collected with a shovel to a depth of approximately 6 inches. The results of the bed material size distribution analysis are presented in Table 2.

Table 2. Bed Material Size Distribution Analysis

Cross Section	Date m/d/yr	Sample	D_{16} (mm)	D_{50} (mm)	D_{84} (mm)
L-1	10/22/94	1	2.9	41.0	75.0
L-6	10/23/94	1	3.7	56.0	79.0
Average L-lines Cobble Samples			3.3	48.5	77.0
LG-2	10/24/94	1	0.24	0.47	1.05
LG-3	10/24/94	1	0.24	0.40	0.83
LG-4	10/24/94	1	0.10	0.29	1.04
Average LG-lines Sand Samples			0.19	0.39	0.97

The difference in the sediment size in the two reaches of river is pronounced. The average D_{84} size for the sand reach is three times smaller than the D_{16} size for the upstream cobble reach. The average D_{50} size for the Loop reach is two orders of magnitude larger than the sand D_{50} size substrate in Lily gage reach. These sediment samples can be monitored for potential changes in the channel substrate in future data collection trip. The sand bed reach samples can also be compared with historical samples collected at the Lily gage.

III. Discussion

The Little Snake River basin is underlain by very erodible, relatively young sandstone and siltstone geologic formations which include the Green River, Wasatch and Washakie formations. These rather poorly cemented formations contribute significant quantities of sediment throughout the Little Snake Valley. Approximately 70% of the sediment load in the Yampa River in Deerlodge Park is contributed by the Little Snake River. This sediment load is delivered by only 25% of the discharge in the Yampa River at Deerlodge Park. The Little Snake River, therefore, is the primary source of sediment entering the Green River at the Yampa River confluence. Flow recommendations for Flaming Gorge releases should be evaluated with respect to flow recommendations and sediment load in the Little Snake River.

The major tributaries of the Little Snake are Sand Wash, Powder Wash, Sand Creek, Muddy Creek and Fourmile Creek. All these tributaries contribute sediment to the Little Snake River upstream of the USGS Lily Gage. The flow and sediment load at the Lily Gage can be construed to be the sediment load entering the Yampa River on an annual basis. The gage is approximately eight miles upstream of the confluence with the Yampa River and approximately half of that distance the Little Snake flows through a narrow canyon with limited opportunities for sediment storage. Although some storage potential exists in the channel in the last several miles before the Yampa River confluence, it can assumed that over the long term the sediment load measurement at the Lily gage is the sediment load contributed to the Yampa River.

The cross sections establish upstream of the Lily gage can be used in the future to accomplish two objectives:

1) Determine the change in channel morphology over the course of seasonal hydrograph.

2) To calibrate appropriate sediment transport equations to predict the response to altered flow regimes.

The sediment transport capacity in Lily reach determines the sediment load to the Yampa River. By using the historical daily sediment load data base at the Lily gage and the surveyed cross sections, it will be possible to calibrate a sediment transport model and apply it to proposed Little Snake flow recommendations. It would be possible to compare the sediment load for a selected period of historical flows. This procedure would enable prediction of new sediment rating curves corresponding to the proposed flow regimes.

The Loop reach cross sections upstream of the Powder Wash road bridge are located in a narrow river valley where the Little Snake is partially entrenched in the valley alluvium to the extent that bedrock is exposed in the channel. A small floodplain does exist in portions of this reach. Upstream of these cross sections Muddy Creek, Sand Creek and Fourmile Creek enter the Little Snake River. All of the tributaries contribute significant amounts of sediment to the river which then pass through this Loop reach of cross sections. Based on field observations, significant quantities of sand sediment are not found in the channel, inferring that the sand size and smaller sediment load is essentially wash load in this reach. It is interesting to note that during the cross section surveys, the water turbidity was high in response to recent storms in the Little Snake basin and yet very little sand storage was apparent in the channel. It is concluded that this set of cross sections will not be significantly effected by tributary sediment loads.

IV. Recommendations

Future resurvey of the Loop cross sections is not recommended at this time. These cross sections should not experience significant changes in channel geometry during normal spring peak flows. If significant sand deposits are noted after spring flows, resurvey of the cross sections can be considered. The cross section data can be used with the HEC-2 model to determine bankful discharge and hydraulic flow conditions for bed material mobility. The analysis can then be applied to determine flow recommendations for habitat maintenance. The National Park Service and CSU plan to conduct this analysis.

The Lily reach cross sections, combined with potential cross sections between Lily and the Yampa confluence should be monitored three times: pre-spring runoff, during high flows near the end of May and late summer to assess the magnitude of channel change during the spring runoff. During the pre-spring runoff, additional cross sections in the Lily reach can be considered.

Cross sections were established in the Deerlodge Park reach of the Yampa River in 1984. These should be surveyed once, preferably in the spring prior to runoff to determine channel geometry changes since 1984. Sediment transport capacity in this reach constitutes the sediment load to the Yampa Canyon and to the Green River in Echo Park. These cross sections can provide important information related to channel activity and sediment load in the Yampa River in Dinosaur National Monument. It is important to understand the nature of sediment movement through this reach in response to sediment loads in the Little Snake River.

The four major tributaries to the Little Snake River can be considered for potential channel monitoring. A suggested approach is to establish two or three cross sections at each tributary mouth, one cross section on the tributary and one or two cross sections downstream on the Little Snake River. These cross sections would be valuable for long term tributary monitoring of sediment delivery. The river cross sections would indicate the river response to increased sediment loading and would show its ability to assimilate the sediment load into its system. It is recommended that the potential survey of these tributary cross sections be considered in the Little Snake River Management Workplan study being undertaken by the cooperative team of the FWS, NPS and CSU.

Appendix A

Cross Section Data

Appendix B

Photo Log

Table B.1 - Photo Description Log

Photo #	Date	Cross Section	Description
1.1.1	10/22/94	L-1	From LEP looking toward REP
1.1.2	10/22/94	L-1	From STA 200 looking upstream
1.1.3	10/22/94	L-1	From STA 200 looking downstream
1.1.4	10/22/94	L-1	From REP looking toward LEP
1.1.5	10/22/94	L-2	From LEP looking toward REP
1.1.6	10/22/94	L-2	From STA 100 looking upstream
1.1.7	10/22/94	L-2	From STA 100 looking downstream
1.1.8	10/22/94	L-2	From REP looking toward LEP
1.1.9	10/22/94	L-3	From LEP looking toward REP
1.1.10	10/22/94	L-3	STA 100 looking upstream
1.1.11	10/22/94	L-3	STA 100 looking downstream
1.1.12	10/22/94	L-3	From REP looking toward LEP
1.1.13	10/23/94	L-4	From LEP looking toward REP
1.1.14	10/23/94	L-4	From STA 60 looking upstream
1.1.15	10/23/94	L-4	From STA 60 looking downstream
1.1.16	10/23/94	L-4	From REP looking toward LEP
1.1.17	10/23/94	L-5	From LEP looking toward REP
1.1.18	10/23/94	L-5	From STA 180 looking upstream
1.1.19	10/23/94	L-5	From STA 180 looking downstream
1.1.20	10/23/94	L-5	From REP looking toward LEP
1.1.21	10/23/94	L-6	From LEP looking toward REP
1.1.22	10/23/94	L-6	From STA 190 looking upstream
1.1.23	10/23/94	L-6	From STA 190 looking downstream
1.1.24	10/23/94	L-6	From REP looking toward LEP
1.2.1	10/23/94	L-7	From LEP looking toward REP
1.2.2	10/23/94	L-7	From STA 100 looking upstream
1.2.3	10/23/94	L-7	From STA 100 looking downstream
1.2.4	10/23/94	L-7	From REP looking toward LEP

Photo #	Date	Cross Section	Description
1.2.5	10/23/94	L-8	From LEP looking toward REP
1.2.6	10/23/94	L-8	From STA 100 looking upstream
1.2.7	10/23/94	L-8	From STA 100 looking downstream
1.2.8	10/23/94	L-8	From REP looking toward LEP
1.2.9	10/24/94	LG-1	From LEP looking toward REP
1.2.10	10/24/94	LG-1	From STA 90 looking upstream
1.2.11	10/24/94	LG-1	From STA 90 looking downstream
1.2.12	10/24/94	LG-1	From REP looking toward LEP
1.2.13	10/24/94	LG-2	From LEP looking toward REP
1.2.14	10/24/94	LG-2	From STA 200 looking upstream
1.2.15	10/24/94	LG-2	From STA 200 looking downstream
1.2.16	10/24/94	LG-2	From REP looking toward LEP
1.2.17	10/24/94	LG-3	From LEP looking toward REP
1.2.18	10/24/94	LG-3	From STA 400 looking upstream
1.2.19	10/24/94	LG-3	From STA 400 looking downstream
1.2.20	10/24/94	LG-3	From REP looking toward LEP
1.2.21	10/24/94	LG-4	From LEP looking toward REP
1.2.22	10/24/94	LG-4	From STA 300 looking upstream
1.2.23	10/24/94	LG-4	From STA 300 looking downstream
1.2.24	10/24/94	LG-4	From REP looking toward LEP
1.3.1	10/24/94	LG-5	From LEP looking toward REP
1.3.2	10/24/94	LG-5	From STA 350 looking upstream
1.3.3	10/24/94	LG-5	From STA 350 looking downstream
1.3.4	10/24/94	LG-5	From REP looking toward LEP
1.3.5	10/24/94	LG-6	From STA 200 looking upstream
1.3.6	10/24/94	LG-6	From STA 200 looking downstream
1.3.7	10/24/94	LG-6	From REP looking toward LEP

Appendix C

Sediment Size Distribution Plots

Appendix D

Cross Section Plots

December 5, 1994

Mr. Ed Wick
National Park Service
1201 Oak Ridge Drive
Suite 250 Rm 49
Fort Collins, CO 80525

Re: Transmittal of Little Snake Channel Monitoring Project Report

Dear Ed:

Please find enclosed two copies of the Little Snake monitoring project report for the 1994 fall data collection trip. This report presents the original field data, sediment size analyses and photo log. The report was brief to conserve the available budget. If you have any questions please call Jim O'Brien at (602) 339-1935.

Sincerely,

J. S. O'Brien, Ph.D., P.E.

cc: George Smith