Cispus River Engineered Logjam Restoration Project

Project Overview

The Cispus River is a sixth order stream flowing west of Mt. Adams and the Goat Rocks Range in southwest Washington. Approximately 155,190 acres drain into the project area. The project area is a response reach. It is a highly braided Rosgen D3-type channel. Mean low flow at the site is 250 cubic feet per second, and bankfull is approximately 6,000 cubic feet per second.

During the 1996 flood event, the Cispus River damaged the Tom Music Bridge on the Gifford Pinchot National Forest (site A) to the point that it needed replacement. In addition, the river channel changed position, cutting into the northern bank and threatening both the approach to the new bridge and an archeological site. At site B the river washed out a section of USDA Forest Service Road (FSR) 23, and a small flood/side channel continues to threaten the rebuilt FSR 23. At Site C the river created another channel that cut towards FSR 23.

The primary objective of the project was to protect the sections of roads, the Tom Music Bridge, archeological sites, and streambanks along the Cispus River.

The Cowlitz Valley Ranger District constructed 11 engineered logjams—and a log cribwall—to protect these sites (sites A, B, and C) as part of the Cispus River Engineered Logjam Restoration Project along the Cispus River in 1999 and 2001. Geomorphologist Tim Abbe designed these structures to act as deflectors, which would push the river away from the roads and archeological sites.

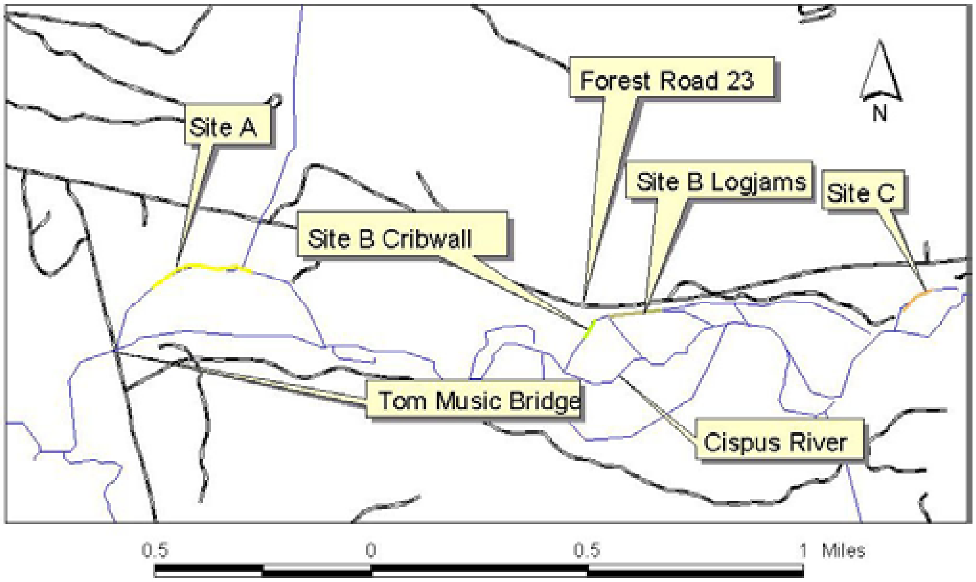

Figure 1—Project locations.

Table 1. Structures and year constructed

Site	Structures	Year Constructed
A	4 engineered logjams	2001
B	4 engineered logjams 1 log crib wall	1999 1996 and 1999
C	3 engineered logjams	1999

These structures have been in place during three small floods, with return intervals of 2 to 10 years (November 1999, 8,840 cubic feet per second; January 2002, 8,480 cubic feet per second; and January 2003, 10,500 cubic feet per second). We estimate the smaller floods as being 2- to 5-year floods and the January 2003 flood as a 5- to 10-year flood. We base these reoccurrence estimates on a bankfull flow of approximately 6,000 cubic feet per second (Mike Philbin, district hydrologist, 1998 to 2000).

Project Methods, Design, and Monitoring

The goal of this monitoring project is to determine if the projects are meeting the objectives of the project and the Northwest Forest Plan and the Salmon Recovery Funding Board.

The two monitoring questions are:

1) Did the improvements protect the existing infrastructure and archeological sites?
2) Are future threats to the sites from the river reduced?

Objective: Protecting Infrastructure
Table 2 shows the criteria the Gifford Pinchot National Forest (GPNF) used for determining the success of the project or for determining when monitoring indicates that further evaluation is warranted.

Direct Observations
The GPNF examined the Tom Music bridge, roads, and archeological site for damage during and after the floods that occurred since the construction of the structures.

Table 2. Objective: Protect Infrastructure.

Parameter	Methodology	Success Criteria *
Site Integrity	Direct Observations	No damage to nearby roads in 100-year floods or smaller floods.
	Low-level Aerial Photography	No criteria for success (These photographs were used only for getting a bird's-eye view of the sites and validating the findings of the site surveys.)
	Horizontal Bank Pins	Loss of no more than 3 feet of bank or fill during a flood (This is the practical limit, for these sites, at which this method determine how much bank erosion occurred.)
	Site Survey (Total Station)	Loss of no more than a cumulative amount of 10 feet of fill from the sides of the logjams or crib wall. Loss of no more than a cumulative loss 15 feet of fill from the upstream face of the logjams change in channel size or alignment (10-15 percent change in bankfull—Rosgen).

(These are "trigger points" for considering project modifications.)

Low-Level Aerial Photography

The Gifford Pinchot National Forest used low-level aerial photography to document large-scale shifts in the Cispus River channel. We used two photographic flights preproject, July 1999; and post 2003 flood, August 2003, to document the large scale shifts in the Cispus River. These photographs only display bird's-eye views of the sites and document large-scale site changes. We based the criteria for success on the site specific measures (horizontal bank pins and site surveys). Although we took no measurements from the photographs, we used the photographs to document the position of the river channels and proportion of the river flowing in each channel.

Site Survey

In 1999 the GPNF initiated total station surveys as it completed each structure. We resurveyed these sites in the summers of 2002 and 2003, because the sites had changed. The site surveys helped quantify changes to the channels near the roads and archeological sites.

Horizontal Bank Erosion Pins

On July 18, 2001, the GPNF initiated monitoring at the Cispus River engineered log sites, revisiting the bank erosion pins in the late summer and fall to determine the amount of change. We took the measurements of stream width, and stream location from the map generated by the site survey.

Data Limitations and Assumptions

The unstable and braided nature of the Cispus River made it impossible to reliably identify bankfull width and bankfull depth. The proportion of the river flowing in a channel during a flood is similar to the proportion of the river flowing in a channel during low flow.

Monitoring Results and Interpretation

Our initial observation of the parameter "site integrity" for the roads, Tom Music Bridge, and archeological sites indicated no immediate damage to the structures.

Finding no damage to the bridge or road, we turned our attention to future site integrity by monitoring the rate of bank erosion, using site survey and horizontal pins methods.

Site A

Site A is on a large bend in the Cispus River (figures 2 and 3). Four engineered logjams acted as deflectors, protecting the approach to the Tom Music Bridge and the archeological sites scattered in the area behind the structures. The points of interest are the locations of the engineered logjams, the new perennial channel, the bridge, and the area containing archeological sites.

Figure 2. Site A in 1999, no structures installed in 1999.

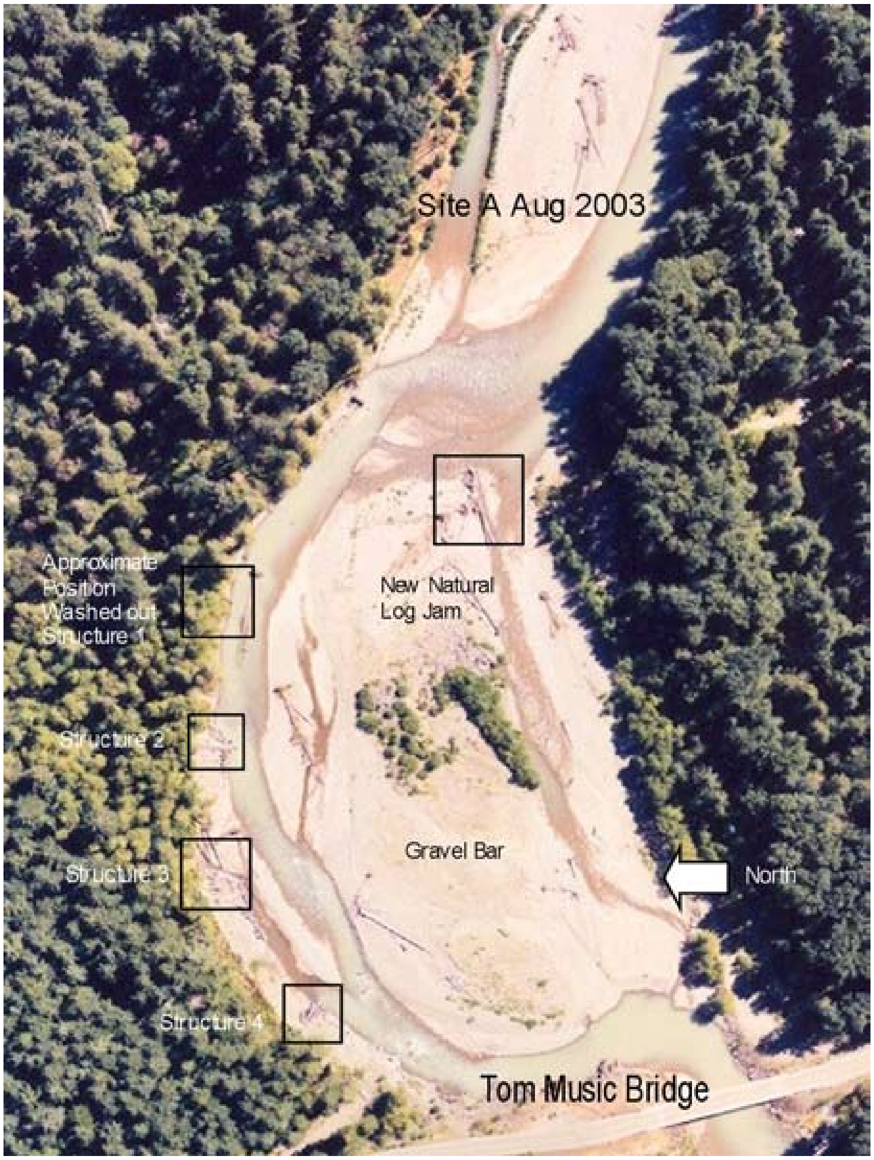

Figure 3 - Site A in 2003, with labels that show the locations of the structures; logjam formed in the flood of 2003.

Aerial Photography

The important points from these photographs are that (1) a greater portion of the river is flowing down the side channel in 2003 than in 1999, (2) new streambanks are building between the existing structures, and (3) the new streambanks provide greater protection for the approach to the bridge and the archeological sites behind the structures.

Sites Surveys

Overall, site surveys show that the risk to the Tom Music Bridge approach and archeological site decreased after the flood of 2003. The perennial river channel has split, and greater proportion of the river is flowing directly under the bridge.

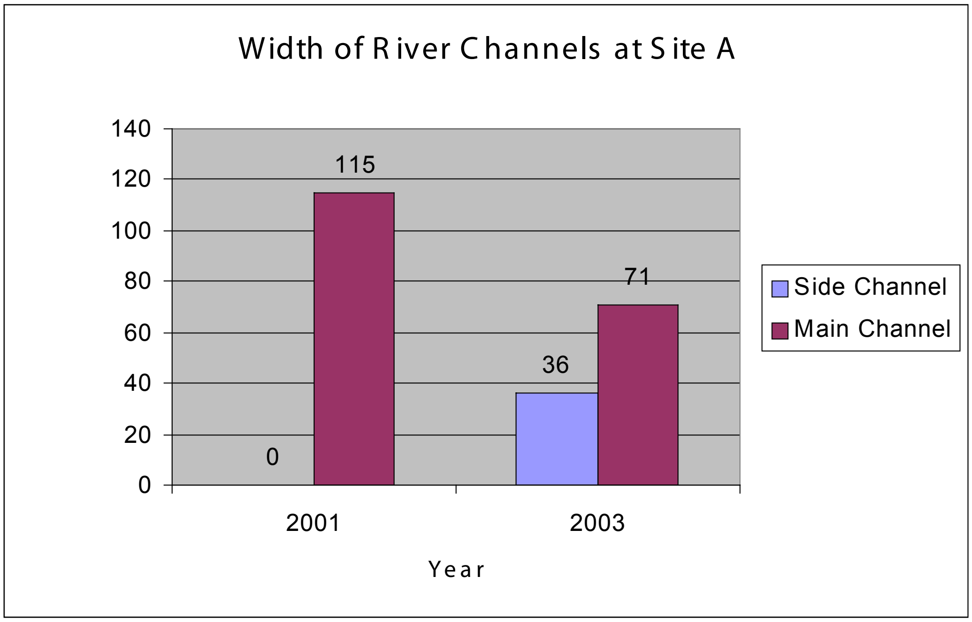

Figure 4. A comparison of the width of the main channel and side channel between years.

An overflow channel is now perennial, carrying approximately 10 percent of streamflow during low flow. This channel goes directly under the bridge, reducing the amount of water flowing in the main channel and reducing erosive forces on the archeological site and bridge approach.

The shift of the channel was unrelated to the structures installed in 2001. During the flood of 2003, a 60-inch-diameter log was recruited and lodged on the upstream portion of the point bar. This log has formed a small natural logjam that deflects the flow of water across the gravel bar and directly under the bridge. This logjam reduces the overall risk to the bridge and archeological sites.

The furthest upstream engineered logjam (one of four, installed in 2001) washed out during the 2003 flood. Therefore, the risk for bank erosion at this logjam location is now the same as that of the preproject condition. The three remaining logjams are structurally sound and functioning as expected. The backwater areas downstream of structures two and three allowed sediment to deposit in these areas. As a result, new banks are building and protecting the area between the structures. In addition, a log was recruited in the area between structures two and three and caused the formation of a gravel bar that deflects flows away from structures three and four. This gravel bar reduces the risk to the bridge approach and archeological sites.

Site B

The site is in a braided section of Cispus River. There are three major channels to this braided area (figures 5 and 6). The points of interest are the three major channels, the logjams and cribwall, and USDA Forest Service Road 23 (FSR 23). We refer to the channels as the South, Middle, and North channels.

Figure 5 - Site B in 1999, before the construction of the logjams.

Figure 6 – The position of the river channels and the structures.

Aerial Photography

The large channel has switched sides of the valley, so that the largest channel is now on the north side of the valley next to FSR 23. The key points are these: (1) the North Channel is carrying a greater proportion of the rivers flow, and (2) the construction of the structures pushed the North Channel away from FSR 23, and (3) the North Channel increased in width while the South Channel is much smaller.

Site Surveys

The threats to FSR 23 increased at site B: Channel migration upstream of site B increased the amount of water flowing by site B.

Table 3. Summary of channel width data site B

Measure	1999	2002	2003
Average Wetted Width n=9	30 feet	28 feet	45 feet
Standard Deviation	10	9	12

The low-flow wetted channel width was 15 feet (50 percent) wider in 2003 than in 1999, meaning that more water is now flowing next to FSR23. This increase in water volume increases the erosive forces close to the FSR 23. Therefore, the potential for the river to damage this road has increased.

The site surveys were not sensitive enough to detect the bank erosion that the horizontal bank pins detected.

Horizontal Bank Erosion-Pin Results

A small but measurable amount of bank erosion occurred throughout site B.

The results from the erosion pin monitoring are:

- At site B, only 3 of the 12 horizontal pins remain functional after the January 2003 flood.
- At the 9 lost pin locations, at least 3 feet of bank was washed away.
- The three remaining pins are associated with the logjams either just upstream of or within the structure. All of the bank erosion pins associated with the cribwall structure have washed out.
- Two of the three remaining bank erosion pins showed a loss of bank material.
- Although the erosion at site B is not threatening FSR 23, the erosion is threatening the integrity of the structures, particularly the cribwall.

Site C

Site C is on a backwater side channel that is disconnected from the river during low-flow periods. Water enters this channel from both the upstream and downstream ends. During floods, the lower end of the channel is a backwater. Water flows across the intervening and downstream bar only during floods that are greater than a 5-year flood.

Figure 7 – Site C, 1999.

Figure 8 – Site C, 2003, with position of the structures.

Aerial Photography
The key points are as follows: (1) the channel next to the structures is wider and deeper in 2003 than in 1999, despite a decrease in streamflow, and (2) the main channel has shifted away from the channel across the intervening bar.

Site Survey
We did not resurvey site C because the changes were less obvious. This set of structures has not received the direct river flows observed at sites A or B. Direct observations we made after the construction of the structures suggest that this site may be filling in with fine sediments from back eddies and bank sloughing.

Bank Erosion Pins
The amount of bank at site C has increased slightly. Nearly all of the changes at the bank erosion pins are positive, indicating the building of new banks. However, visits to site C have not revealed deposited stream sediments like those observed at site A. What we observed instead is that the upper banks at site C are sloughing material on top of the bank erosion pins. However, we have not determined the exact mechanism of the sloughing.

Table 4 – Data from horizontal bank erosion pins.

Sample ID	Change 2002 (feet)[1]	Change 2003 (feet)	Location
C1	0.5	0.35	Between Structures C1 and C2
C2	0	0.20	Between Structures C1 and C2
C3	0.25	0.50	Between Structures C1 and C2
C4	-0.2	0.10	Between Structures C1 and C2

[1]*The negative numbers represent loss of bank material. Additional observations at the sites indicate that the positive numbers occurred when material sloughed down from the bank above and collected around the bank pin.*

To date, the structures have protected the roads and archeological sites that they were designed to protect. However, we have found several changes in conditions at the sites.

The river channel has shifted at both sites A and B. For both of these sites, recruited woody debris, not the structures themselves, were the cause of the channel shifts.

These shifts in the river channel have different consequences at sites A and B. At site A the shift of the channel redirected part of the river, so that it now flows across a gravel bar, reducing the erosive forces on the bank with structures and decreasing the threat to the bridge and archeological sites. At site B the shift in the river has increased the amount of water flowing next to FSR 23, increasing the threat to that road.

At sites A and B, we found damage to the structures and some bank erosion. One of the logjams was washed out at site A. We found measurable amounts of bank erosion at site B, with the greatest amount at the log cribwall. The erosion at site B was greater than the threshold of concern (table 2). Although this erosion does not threaten the road, it does threaten the integrity of the cribwall. Therefore, we have to explore measures for repairing, redesigning, or replacing this cribwall, which lost 5 to 10 feet of fill material since 1999. The logjams are also losing fill material at this site.

Site C has remained relatively unchanged since the construction of the structures.

Project Monitoring Partnerships and Costs

Mike Kohn, Cowlitz Falls project biologist, conducted biological monitoring at sites B and C between 1999 and 2001. The results of this study are in a report to Interagency Committee for Outdoor Recreation (Kohn 2002).

The following table summarizes the typical annual costs for the USDA Forest Service monitoring of this project.

Table 5 - Summary of estimated annual monitoring costs.

Tasks	People	Days	Cost ($)
Photographs	1	1.5	300
Bank Pins	3	2	1,300
Site Surveys	3	2	1,500
Map Production	1	4	800
Data Analysis Report	1	10	2,500
Materials			200
Total			**8,600**

Lessons Learned

We learned several lessons with this study:

- The total station survey at site B needed to capture both the bankfull channel and the wetted channel.
- The sites were in an area where the general public could easily access them. Some of the public removed or tampered with the some of the bank erosion pins and scour chains. We were therefore unable to use these bank erosion pins and scour chains in the analysis.
- A total station survey before construction would have benefited this project.
- The increased water depth and velocity after the flood of the 2003 made surveying the channel difficult. We were not able to measure the deepest and swiftest parts of the channel.
- The main channel at site A was always too deep and swift for us to measure channel depth in the perennial channel.

For Further Information:
For additional information contact Ken Meyers, district fish biologist, Gifford Pinchot National Forest, North Zone, Amboy, WA, 98601.

References

Kohn, M. S. 2002. Draft Cispus River and Yellowjacket Creek habitat enhancement projects monitor report. Prepared for Interagency Committee for Outdoor Recreation Project Number 9-1733D.