Sediment Outcomes for a Small Dam Removal on the Calapooia River, Oregon

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Introduction

Characteristics of the Brownsville Dam

Dimensions: 33.5 m wide, 2 m tall
Location: River km 62, 4 km southeast of Brownsville

Constructed: Late 1960s as a concrete structure to replace log crib dams in place starting in the 1880s
Purpose: Divert water into a canal running through the city of Brownsville and eventually to a variety of mills.
Reservoir: Run-of-river, stored approximately 14,000 m³ of gravel (D₅₀ = 59 mm)

Removed: August 2007. The dam was a safety hazard and a partial barrier to spring Chinook, winter steelhead, and other fish.

Objectives

1) Evaluate the erosion from the reservoir and downstream deposition relative to expectations from a modified channel evolution model and combined translation and dispersion.
2) Compare changes in bar width observed with field surveys to those previously observed with aerial photos for context.

Study area

Reaches: Reservoir (RES) = 400 m long; near downstream (DS1), far downstream (DS2), and upstream control (US) = 670 m long (20x active channel width).

Reach divisions: Channel units: riffles, runs, pools, and glides.
Near downstream reach (DS1) prior to dam removal: Straight (S = 1.0), incised (BHR = 1.8), plane-bed channel with exposed bedrock/hardpan and few small bars.
Far downstream reach (DS2) prior to dam removal: Wider (Wₑst = 45 m), and more open (BHR = 1.5) with large, alternating gravel bars.

Methods

Field surveys during removal year: Topographic surveys consisting of targeted cross sections, a longitudinal profile, and bar mapping were performed pre-removal (summer 2007) and post first winter (summer 2008). Cross sections were at the heads and tails of pools, riffles, glides, and runs as well as trisecting each channel unit.


Data manipulation in ArcGIS™: Bar widths were extracted from field survey and aerial photo data at the locations of the targeted cross sections. Triangulated Irregular Networks (TINs) were created and then converted to grids using 3D Analyst. Spatial Analyst was used to calculate cut/fill for each channel unit in each reach.

Error analysis: Total error relative to the bar width for each cross section (for the field surveys) or each reach (for the aerial photos) was calculated as the sum of position, identification, and wetted boundary datum error.

Results

Reservoir erosion: Due to the remaining pool on river right in the reservoir prior to removal, erosion in the center of the channel, as predicted by channel evolution models, was accompanied by the creation of a mid channel bar with the pool becoming a backwater. The net erosion from the reservoir (4,000 m³) was less than a third (29%) of the estimated volume of sediment in the reservoir (14,000 m³).

Downstream deposition: The only channel units with net deposition after the removal of the dam were in the first reach downstream of the dam (DS1). The majority of the deposition (42% of the net erosion from the reservoir) was in the first two channel units (a run and riffle) where a new bar was created immediately downstream from the dam, and an existing bar greatly increased in size. As a result, the majority and largest (12 ± 2 m) bar width changes (widenings) were within the first two channel units. The restriction of net deposition to near the dam and decreasing effects on bars farther away from the dam are evident of dispersion as the dominant process.

Aerial photo analysis: From analysis of aerial photo and field survey data, the channel and bars were predominantly eroding prior to and after dam removal. From aerial photos prior to the dam removal, the majority and largest (61 ± 16 m) bar width changes (mostly narrowing) are far from the dam in the second downstream reach (DS2).

Error analysis: The largest proportion of error for both field surveys and aerial photos was the wetted boundary datum error due to discharge uncertainty. Identification error was also a large proportion for the aerial photos due to photo quality, while position error was of more concern for the field surveys due to inconsistent monuments.

Conclusions

• Despite the presence of a lateral pool in the reservoir, erosion followed channel evolution mode predictions and was predominantly from the center of the channel.
• With this study, we added to evidence of dispersion being the dominate process directing downstream deposition in gravel bed streams after small dam removals.
• By analyzing aerial photos, we found that the natural variability of the far downstream reach (DS2) made detection of an effect of the dam removal in the DS2 unlikely. In contrast, effects in the near downstream reach were obvious and atypical after the dam removal. This demonstrates the value of using historical aerial photos as part of a baseline assessments of dam removals to establish study extents.

References


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Results

Reservoir


First 2 channel units (190 m)

Downstream from dam


Net Change in Volume per Channel Unit Relative to Distance from Dam

Changes in Bar Width at Cross Sections Relative to Distance from Dam

Reach names are at the top and flow is right to left in the above figures. Average error bars were included for bar width for both aerial photos and field surveys to make a more equitable comparison between the two types of measurement. Changes in bar width were not analyzed in the reservoir as bars were typically submerged when the aerial photos were taken.

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