

Large wood jam in a fourth-order Rocky Mountain stream

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Introduction

Large accumulations of logs, called log jams, were once common on rivers throughout North America. LYELL (1830) gave accounts of extensive wood jams in the Mississippi and Mackenzie Rivers. However, most jams have been eliminated to clear river channels for navigation (SEDELL & FROGGATT 1984). These log jams were a major factor in structuring rivers and flood plains (HICKIN 1984, TRISKA 1984). The Nyack log jam is one of the largest remaining in the United States. The jam is over 500 m long and averages 45 m wide. Within the past 10 years, Nyack Creek has reclaimed a floodplain paleochannel and now bypasses the log jam except during high flows.

Site description

Nyack Creek is a fourth-order tributary of the Middle Fork of the Flathead River in Glacier National Park, Flathead County, Montana, USA. Stream flow is dominated by snowmelt. Measurements made in 1991–1992 showed a minimum flow of 1.4 m³/s in January and a peak of 22.5 m³/s in May. Average flow in that year was about 8.5 m³/s, representing a fairly typical year. The site is approximately 5 km upstream from the mouth of Nyack Creek. The upstream end of the log jam is at UTM 12, 0298009 E, 5371676 N.

Methods

The length of the log jam was measured along its centerline for 500 m, and the width of the jam and width of the channel were measured every 20 m. At each 20-m interval, all vegetation growing on or among the logs was also recorded. From each 20-m point, a 5- or 10-m line was run in a random direction and the diameter at the point of intersection of each piece of wood greater than 2 cm diameter intersecting the vertical plane of the line was measured. The volume of wood was estimated using the line-intersect method (WARREN & OLSEN 1964, WALLACE & BENKE 1984). Logs with diameters greater than 10 cm nearest each 20-m point were selected and their diameters and lengths measured. Samples were taken

from each of these logs either with a 5-mm diameter increment borer or ax. Where possible (upstream 260 m), two 10-cm+ cores from each of these logs were taken, but where the logs were too decayed to use the increment borer, an ax was used to collect two pieces approximately 5 × 5 × 5 cm. By necessity, these pieces were often from more intact portions of the log, and thus the estimates of density for these logs are probably biased towards higher values. In the laboratory, the cores and pieces were dried to constant weight (60 °C, 3 days). From each core, the piece from 8 to 10 cm from the surface was cut out, dried, and weighed. Similarly, one piece from each of the more decayed logs was weighed, and its volume was measured by submerging it in water in a volumetric cylinder and quickly determining the displacement of water.

At each 20-m point and at some intermediate points, the increment borer was used to take a core from the nearest tree growing in the jam if there was a tree within 10 m. Tree age was determined by counting growth rings.

Results and discussion

Based on the 25 line transects, average wood volume in Nyack Creek was 1290 ± 234 (95% confidence limits) m³/ha. Density of the logs averaged 0.43 ± 0.04 g/mL. The average biomass of 55 kg/m³ is among the highest ever reported. The only streams with higher wood biomass are in the Pacific Northwest (ANDERSON et al. 1978, HARMON et al. 1986), and these measurements were for much smaller streams.

Downstream from the head of the jam, the logs were visually more decayed and had lower density (Fig. 1). Though regression of density versus distance was only marginally significant (linear regression, $r^2 = 0.14$, $P = 0.056$), logs in the upstream 250 m were significantly more dense than downstream logs (t -test, $P = 0.009$).

Plants growing on and between the logs

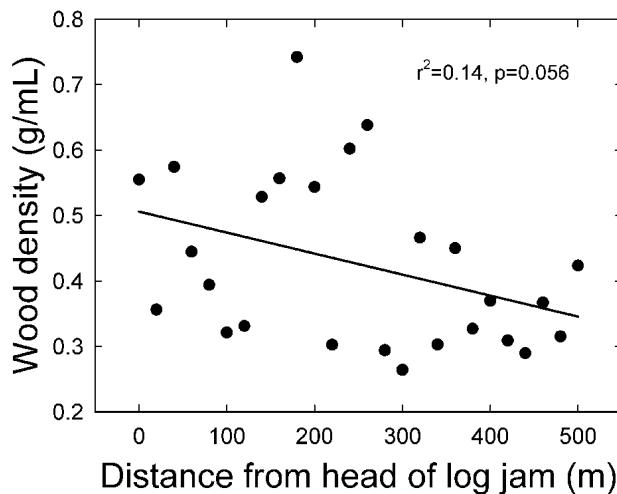


Fig. 1. Wood density of samples taken from logs in Nyack Creek related to distance downstream from the upper end of the log jam. The trend line was calculated by linear regression.

included shrubs such as raspberry (*Rubus idaeus*), twinberry (*Lonicera*) and thimbleberry (*Rubus parviflorus*); herbaceous plants including Canada thistle (*Cirsium arvense*), fireweed (*Epi-lobium angustifolium*), grasses and horsetail (*Equisetum arvense*); and tree seedlings, primarily cottonwood (*Populus trichocarpa*), spruce (*Picea engelmannii*), willow (*Salix*) and alder (*Alnus incana*). At the upstream end of the jam, there were only two to four plant taxa along each cross-section, but this increased significantly (linear regression, $r^2 = 0.65$, $P < 0.0001$) to as many as 15 taxa downstream (Fig. 2). From 0 to 250 m, there were very few trees growing on the jam and the three measured were less than 15 years old (Fig. 3). Beyond 250 m, many trees were from 25 to 30 years old.

These results suggest a major change in the characteristics of the log jam at about 250 m downstream. Wood density was significantly less downstream, evidence that the logs were deposited earlier than upstream logs (Fig. 1). There was considerable variability in wood density since logs didn't necessarily die just before being deposited in the jam but may have died and fallen in the stream years earlier before being transported downstream to the jam. Additionally, more plants were found growing

on the log jam starting at about the same point (Fig. 2), and young trees growing on the jam were generally older downstream (Fig. 3). Based on this evidence, it appears that the log jam did not accumulate slowly and continuously but rather in at least two pulses associated with major floods. Long-term discharge records of the snowmelt-dominated streams of the northern Rocky Mountains are characterized by infrequent, very large floods when rain occurs on high-elevation snow pack. Data from the Middle Fork of the Flathead River show major floods in 1964 and 1975, and anecdotal records from Flathead Lake suggest a similarly large flood in 1886. Movement of large wood and accumulation of large wood jams probably only occurs during these major floods.

Wood in streams is very important in providing a habitat for many stream organisms. In north-west Montana, logs are especially important in creating a spawning habitat for the endangered bull trout (*Salvelinus confluentus*, HAUER et al. 1999). In addition to this relatively localized influence of logs, large log jams have a much larger-scale influence on streams and their flood plains. This was clearly demonstrated by TRISKA (1984) to have once been the case for the Red River in Louisiana, and HICKIN

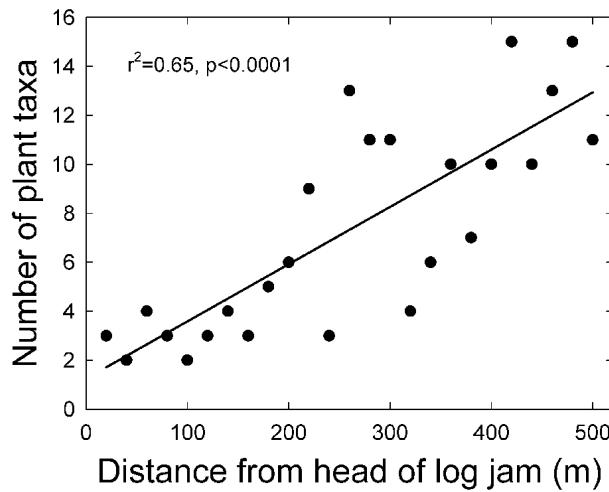


Fig. 2. Number of plant taxa found growing on and within the log jam related to distance downstream from the upper end of the jam. The trend line was calculated by linear regression.

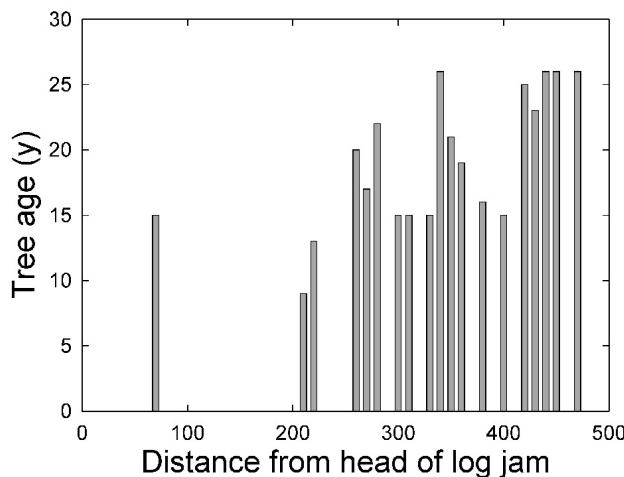


Fig. 3. Age of young trees growing on the log jam.

(1984) noted that most of the major changes in channel pattern of the Squamish River, British Columbia, involved channel abandonment and flow diversion associated with log jams. Similarly, it appears that the Nyack log jam has determined channel changes of Nyack Creek, influencing both characteristics of the stream

and characteristics of the floodplain forest. The downstream end of the log jam, which was once stream channel, is now a young spruce-dominated forest. ABBE & MONTGOMERY (1996) also documented the importance of log jams to riparian forests of the Queets River, Washington.

While there has been considerable recent work on the role of wood in streams, few large log jams still exist. Those still existing in remote areas present an opportunity to study how these large wood accumulations were an important ecological and geomorphological feature influencing stream, wetland, and terrestrial ecosystems.

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