Entiatqua Rediscovered Pre-Anthropocene Valleys in North Cascadia, USA

Paul Powers¹, Brian Staab¹, Brian Cluer², and Colin Thorne³

¹USDA Forest Service Pacific Northwest Region
²NOAA Fisheries West Coast Region
³University of Nottingham

January 31, 2022

Abstract

A maturing body of evidence suggests that anthropogenic impacts on river-wetland corridors may be greater and more widespread than previously recognized. We applied the Geomorphic Grade Line (GGL) method to define pre-Anthropocene valley surfaces within segments of the 42-kilometer Entiat River Valley (ERV) of the North Cascade Mountains, USA. We developed GGL-relative elevation models (GGL-REMs) by subtracting, from high-resolution digital elevation data, a detrending surface based on relic fluvial features of the valley floor. We validated the GGL-REMs using surficial geologic maps, C¹⁴-dated soil profiles, and the identifiable remnants of historic dams. We interpreted these data in the context of settlement land use practices including channelization, large wood removal, and beaver (Castor canadensis) trapping. Our analysis indicates that since the early 20th century, the river has incised more than two meters in many areas. This triggered a rapid state and process change, wherein unconfined and partially-confined valleys transitioned from net deposition to erosion and transport environments. The distribution of river types shifted from ecologically rich river-wetland corridors towards simpler, single-threaded channels common in confined valleys. The effects of this state change on salmon productivity were profound. Results from the Entiat and other locales indicate that GGL-REMs can be used to help define the fluvial process-form domains, including the vertical dimension needed to guide valley floor restoration. These tools can be used to envisage pre-degradation riverscapes, especially when used in concert with other datasets. Once the pre-Anthropogenic conditions of rivers like Entiatqua have been recognized, the case for restoring lost river-wetland corridors to unlock their ecological potential becomes compelling.

Hosted file

<table>
<thead>
<tr>
<th>Valley Segment</th>
<th>SEM Stage Designation and Dominant Processes</th>
<th>Predicted Island Braided (Beechie, 2014)</th>
<th>Approximate Change in Wetted Habitats at Baseflow (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VS-1a</td>
<td>mostly Stage 0, moderate deposition, RWC in unconfined and partially-confined areas</td>
<td>mostly Stages 3/4, incision, evacuation</td>
<td>56%</td>
</tr>
<tr>
<td>VS-1b</td>
<td>mostly Stage 1, transport in confined areas</td>
<td>mostly Stage 3 incision, evacuation</td>
<td>48%</td>
</tr>
<tr>
<td>VS-2</td>
<td>mostly Stage 0, deposition, RWC</td>
<td>mostly Stage 3, incision, evacuation</td>
<td>100%</td>
</tr>
<tr>
<td>VS-3a</td>
<td></td>
<td>mostly Stage 3, incision, evacuation</td>
<td>92%</td>
</tr>
<tr>
<td>VS-3b</td>
<td>mostly Stage 1, transport</td>
<td>mostly Stage 3, incision, evacuation</td>
<td>82%</td>
</tr>
<tr>
<td>VS-3c</td>
<td>mostly Stage 0, deposition, RWC</td>
<td>mostly Stage 3, incision, evacuation</td>
<td>81%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>-60%</td>
</tr>
</tbody>
</table>