Update

Current Status of Cottonwood Recruitment on the Naches and Yakima Rivers

With Special Emphasis on the Gap to Gap Reach and the 1135 Ecosystem Restoration Project

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Early in implementation of the Yakima River Basin Water Enhancement Project by Reclamation in Partnership with Ecology and the Yakima Nation, two related sets of studies were undertaken to gather information to be used in the development of Ecosystem Restoration Planning and flow management for the Yakima Basin. These reports were the Reaches Report by the University of Montana's Flathead Lake Biological Station, and a related but separate report on the relationship of river flow to Cottonwood establishment which was considered as a keystone species to riverine function. This report, THE IMPACTS OF FLOW REGULATION ON RIPARIAN COTTONWOOD FORESTS OF THE YAKIMA RIVER (Braatne, 2001) was generally an inventory/characterization of the history and current state of both Cottonwood (*Populus fremontii S. Wats.*) status and flow patterns in three (Cle Elum, Gap to Gap, and Upper Wapato) of the seven main (Also Easton, Kittitas, Selah, Naches) alluvial reaches of the Yakima River. Some years later and related to other works regarding riparian Cottonwood establishment on other rivers, the data was reanalyzed and supplemented to result in another paper, partially funded by BPA and Northwest Power Planning Council due to the importance of Cottonwood Forests in the Columbia Basin as a whole.

That report, INSTREAM FLOWS AND THE DECLINE OF RIPARIAN COTTONWOODS ALONG THE YAKIMA RIVER, WASHINGTON, USA (Braatne, 2007), used additional tree ring core data from the same sites as the 2001 report, made some arresting conclusions regarding the status of Cottonwood recruitment in the basin.

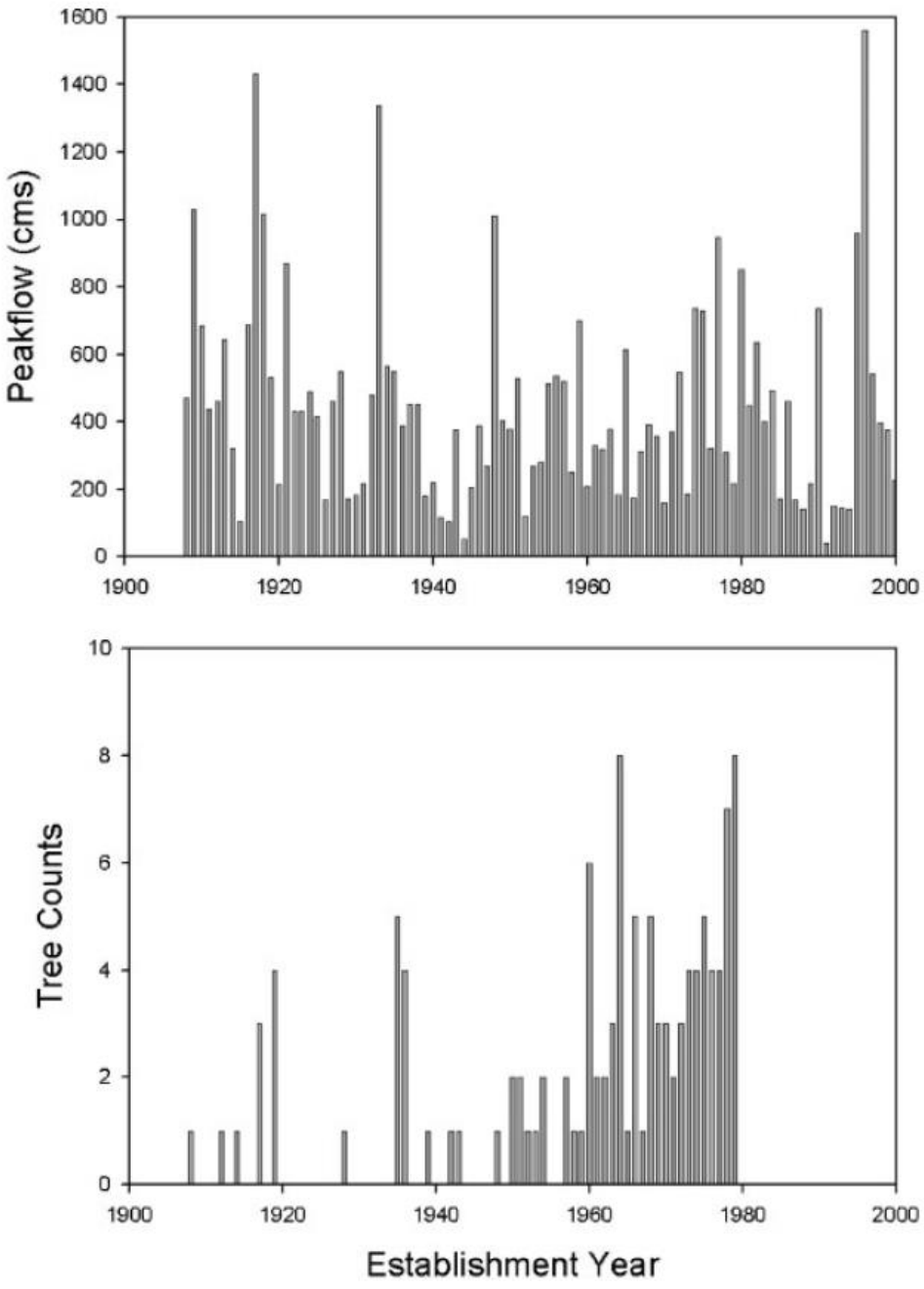
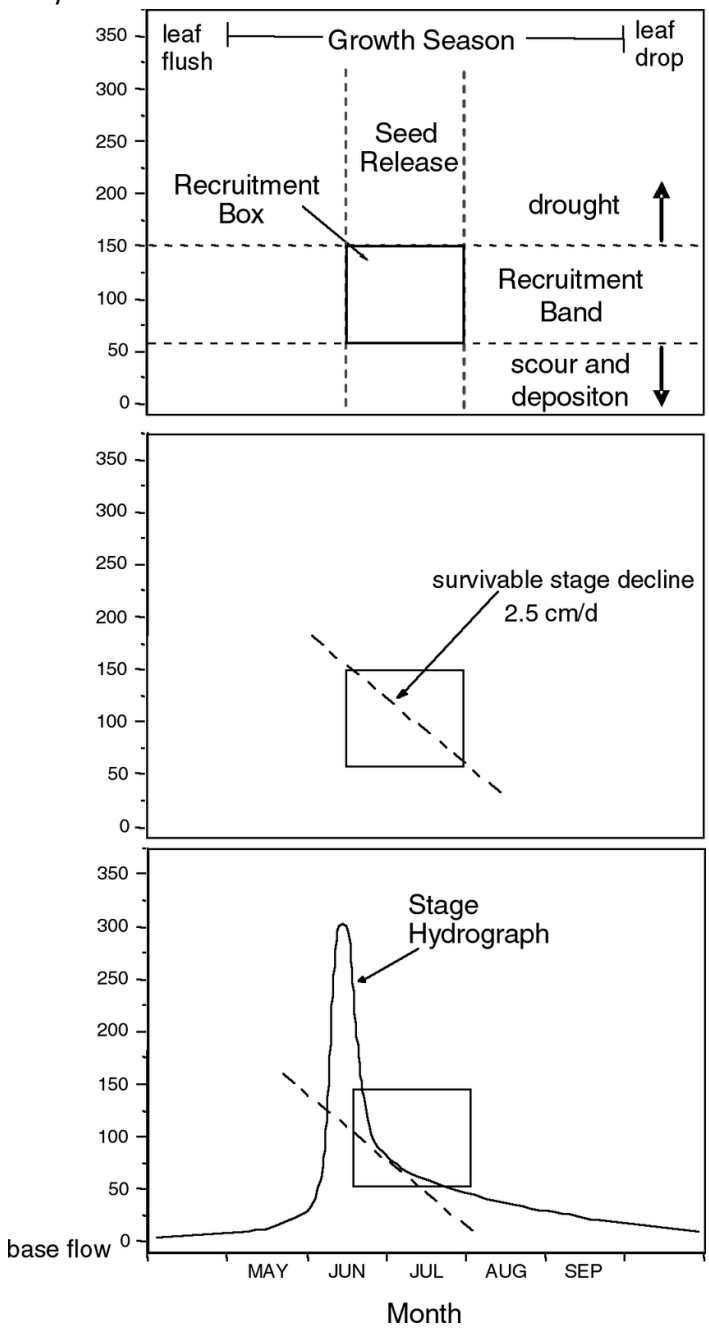


Figure 5. Peak flows (top) and apparent establishment years for black cottonwoods along the Yakima (bottom)

The lower figure depicts a crash in the age structure of the cottonwoods studies and indicates no Cottonwood establishment in any of the study reaches since the late 1970s. The report also lays out a somewhat complex relationship between peak flows and Cottonwood establishment and Cottonwood

mortality. Cottonwood establishment is based on the "recruitment box" model, (McGill, 2007) shown below.



The model indicates that there is a given ideal hydrograph for Cottonwood establishment via seed. Key elements are the seasonality of the spring snowmelt peak which occurs before the seed release season (mid and later May to early June in the Yakima Basin), and a gentle recession of the water levels over the summer. Too little recession (or rise as will be seen later) results in mortality due to scour and deposition (which is improbable hydraulically) or drowning of the year 0 seedlings. In general, these flows would occur roughly on the order of every 5 years throughout the range of Fremont Cottonwood, which is the species in the Yakima Basin.

The paper attributes the effect of peak flows to both Cottonwood mortality and ecosystem processes. On one hand, this paper recognizes that flood flows which cause channel movement and erosion can also cause mortality of cottonwood seedlings from previous years. These same flows also drive the development of new substrates and surfaces which create base space for new cottonwood (and other riparian species) recruitment to establish. These processes of "cut and fill alluviation" generate the "shifting habitat mosaic" that is the underpinning of habitat diversity and ecosystem productivity for western US and Canadian alluvial river systems.

The other finding of the paper is a skewed sex ratio among Cottonwoods, specifically in the Wapato Reach where 72% of the trees are male, and only 18% seed producing females. The paper attributes this to some extent as a result of decrease in flow in the Wapato reach, based on other studies which have found a similar relationship between sex ratios and flow. This finding raises concerns for the ability of this population segment to recover/persist as the ability to produce seeds is reduced.

The summation of the paper does draw a direct connection between alteration of the yearly hydrograph and Cottonwood establishment. The bar graphs above do depict peak flows and recruitment over the same time scales but does not really provide direction on specific deficiencies/adequacies of the modern, regulated peak flow regime of the Yakima Basin.

Based on these findings, many of the larger, Basin-scale restoration documents such as the Sub Basin Plan and Salmon Recovery Plans focused on both the annual hydrograph to better sync flows to salmon and Cottonwood life histories, and (while the report did not make the connection between loss of floodplain connectivity to cottonwood recruitment) the restoration of riverine cut and fill alluvial processes through reconfiguration of infrastructure and restoration of sediment transport.

Recent Work

With the funding and design of the Gap to Gap Ecosystem Restoration Project by the Corps of Engineers and related Floodplains by Design funding of the Locally Preferred Alternative to the Corps Project, one of the central question is the degree to which we can expect those actions to contribute to the keystone species that is Cottonwood in the Yakima Basin.

As a first step, I decided to visit and assess the establishment of cottonwood and other native and non-native riparian species at several sites in the Yakima Basin. Implementation of floodplain restoration projects by Yakima County began in the early 2000s and progressed through that decade. Generally these projects consisted of removal or reconfiguration of existing infrastructure, often in response to emergencies and includes projects such as:

2003 - Construction of the New Donald Wapato Road Bridge, and removal of related approach levees

2006 - Removal of the Wrecking Yard from the Wapato Reach adjacent to the new bridge

2009 – Removal of the century old levee systems from the Wapato Reach

2009 – Removal and partial breaching of the old Boise Cascade Levee in the upper part of the Gap to Gap reach

2011 – setback of the levee upstream of SR14, and removal of a large County and former WSDOT levee upstream of the Terrace Heights levee in response to the 2011 flood.

2007 – Reconfiguration of the 16th Avenue Exit/Naches Floodplain by WSDOT along with removal of old City of Yakima levees at the mouth of Cowiche Creek.

2011 – Setback of the Naches Levee at Ramblers Park

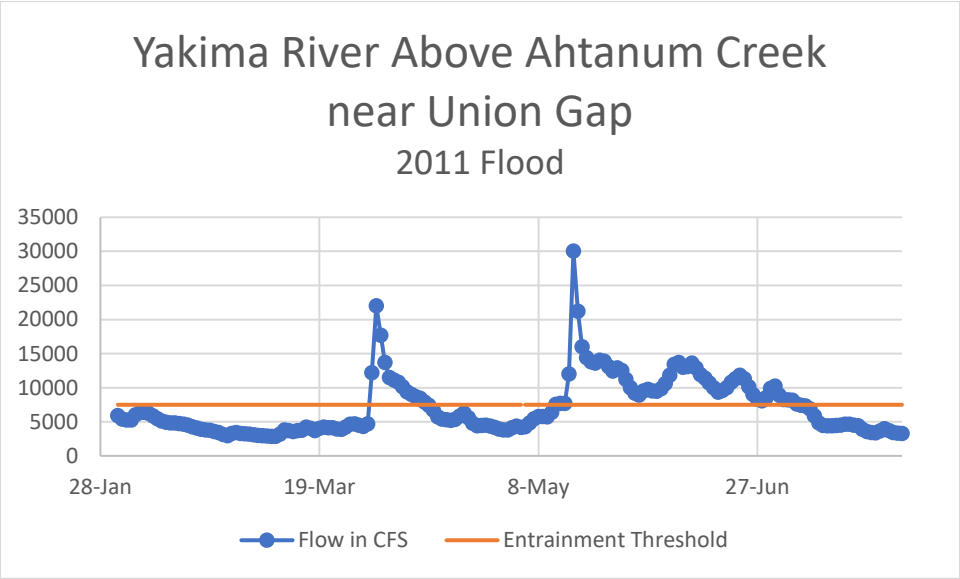
2009 – Removal/setback and floodplain restoration at Eschbach Park on the Naches.

2007 – removal of levees, grade controls, and side channel restoration to forestall avulsion from the City of Yakima's diversion on the Naches

2009 – response to the Nile Landslide, new channel creation, floodplain restoration, levee removal.

Each of these projects shared similar design characteristics of being essentially earthwork project with only minimal reseeding of grasses to reduce potential for invasive species establishment in the restored reaches, with generally large areas of restored floodplain which would allow the channel and floodplain to naturally respond to flood events.

The 2011 flood was the first major flood to interact with these projects and trigger the expected geomorphic response, hopefully improving Cottonwood and other riparian vegetation establishment. That flood had the proper characteristics of the flood hydrograph to trigger that response.



Significant geomorphic work occurs when floods persist over the entrainment threshold – ie the flow at which bedload (sand and gravel) begins to move. In general, the longer the flood event, the more movement as banks become saturated and overall soil strength weakens. The 2011 flood had a fairly long duration of 67 days above bankfull, long enough for significant "cut and fill alluviation" to occur. Even after flows receeded below the entrainment threshold, erosion continued, portions of the federal project levee in the Gap to Gap reach collapsed due to saturated soil and fills during late July.

Higher flows above the entrainment thresholds do usually result in higher rates of channel movement/reworking due to overbank flooding that occurs, increasing bank saturation and water pressure in the soil, further weakening banks, increasing erosion, bank and infrastructure collapse. Local features, such as log jams in natural systems, and infrastructure such as levees, bridges and irrigation diversions, can also experience much higher rates of erosion and sedimentation as the river responds to physical changes in the channel or banks, especially for newly constructed infrastructure which is going through its first flood. Removal or reconfiguration of infrastructure has a similar effect and adjacent river channels will regrade in response to increased access to floodplains or reduced flow constrictions/backwater in the main channel. The 2011 flood had two large, distinct flood pulses. The first pulse on April first was approximately 22,000 cfs, or below a 10 year recurrence interval peak flow, with the second peak on May 16 of 30,000 approximately a 15 year flow.

Overall, this flood was a significant geomorphic event, and all the restoration sites listed above responded, resulting in new, bare surfaces within the channel, and in some cases, on the adjacent

floodplains. Other sites, such as the Yakima River near Valley Mall Boulevard, also responded as the river entered and captured one of the Edler Ponds – a former gravel mine pit. These sites provided a starting point to begin to assess the ability of the existing, native riparian plant communities to respond in a natural way to this largely natural disturbance event.

Discussion 1 – Site review and evaluation

The sites were examined in the winter and early spring with no leaves on the trees in an attempt to better see individual Cottonwood stems, which are white when the trees are young and stand out against adjacent vegetation and sediment substrates. Without exception, site response to the 2011 disturbance and the flow regimes since then - lack of invasive species, overall native vegetation cover, and presence of different age classes of Cottonwood - was much better than what I had expected to see. In most locations, there appeared to be a strong relationship between establishment of Coyote Willow (*Salix exigua Nutt.)* and Cottonwood, generally

1) willows establish in a meander line in either a narrow or broad meander line.
2) Subsequent flood deposit finer sediments along that line or plot of willow.
3) Cottonwoods establish in that line, growing slowly (allowing their roots to develop)
4) Eventually Cottonwoods overtop the willow and dominate the site.

Yakima River near Valley Mall Boulevard – This photo is the clearest example of establishment of willow in meander bands.

2017 meander scroll (no cottonwood starts visible)

2015 meander scroll (small, sparse starts)

2013 meander scroll (some 3-4 foot tall Cottonwood with 5-20 foot spacing)

2011 meander scroll (Cottonwood beginning to overtop)

Other site photos are shown in Appendix A.

Appendix A – Site photos

Nile Landslide – This area of the Naches River channel had several “pilot channels” constructed across the various bars to try and allow the river to regrade in response to the new channel alignment upstream and removal of a severe constriction at the lower Nile Bridge (just downstream of the photo) those channels became active and all of what you see here was bare gravel after the 2011 flood. Establishment of Cottonwoods at this site was expected as this part of the upper Naches has one of the most “normative” hydrographs in the basin, with less than 8% of the natural runoff stored in Bumping Lake and released during the irrigation season.

Upstream of City of Yakima Water Treatment Plant Diversion on Naches River – bar in foreground was also a completely bare bar after the 2011 flood as a headcut worked through this reach from May-July. Re-establishment of native riparian vegetation here was not expected due to the highly modified hydrograph in this reach. Similar to the Wapato Reach, flows in this reach are severely reduced after the spring freshet, unlike the Wapato Reach, flows dramatically increase in August and September under the “flip flop” operation, which would be expected to drown newly established cottonwood seedlings. Older Cottonwoods in photo center, younger Cottonwoods establishing on downstream portion of bar on left of photo.

Naches River just upstream of 16th Avenue Exit - This is a very densely established stand on a site also bare after the 2011 flood. WSDOT had implemented a bank project here in 2007. The area shown was excavated to allow the river to establish a new channel, but the river never did occupy it. During this 2011 flood, this area was inundated during the first and second flood pluse, but during the second flood pulse the river did create a new channel downstream and avulse through it. This resulted in a fresh floodplain surface being exposed here during the seed release of 2011, and the high flows of that year allowed this example of excellent establishment on the floodplain during that same flood year.

Gap to Gap Reach, just upstream of RR bridge crossing - FCZD removed sections of levee upstream that had been a very severe flow restriction, causing large amounts of sediment to build upstream of the constriction, and gravel starvation downstream. The 2011 flood transported large amounts of the stored sediment and eroded the banks downstream to add even more sediment to the system. This bar, except for the taller Cottonwood in the back ground, was completely bare after the flood. This photo shows two different establishment events, the background line of Cottonwoods and willows likely from the 2012 year, and the foreground line during the 2014 year. Even though this photo was taken only several months ago, this site looks much more dominated by Cottonwoods presently, the long duration spring freshet has allowed for rapid early spring growth, with the Cottonwoods in the foreground already 3-4 feet taller.

Wapato Reach, WDFW land on Mellis Road – Removal of levees here in 2009 resulted in channel avulsions and channel response in 2011 during the overbank flood. The bar above (in left of photo) was bare after flood, now occupied by Coyote Willow and Cottonwood. Portions of channel that had experienced avulsion reacted similar the the 16th Ave site, very heavy establishment of near pure cottonwood stands in former channels and in many areas in the floodplain – on open areas as well as in existing Gallery Forest stands - well away from the river in this reach.