This research combines the best available science from the fields of riverine and cultural ecology into a holistic assessment of current conditions on seven alluvial floodplains in the Yakima River basin. Using a summary of conditions for each floodplain as a case study in the evolution of cultural landscapes, this discussion focuses on how cultures define resources and how the application of those definitions affects biophysical systems.

Since Euroamerican settlement of the Yakima River basin began, resource use has focused on extraction activities. These activities have altered the fluvial geomorphic processes that sustain and regulate the ecological structure and function of the basin's large alluvial floodplains. Flow regulation and reductions in lateral connectivity are two fundamental factors responsible for these alterations. Flow regulation alters the timing and size of peak flow events, while the loss of lateral connectivity extends the effects of flow regulation across its lateral scale and further along the longitudinal scale of the river than would otherwise occur.

Because cultural ecology acknowledges the essential and variable interactions of people to the landscapes they inhabit, it is an appropriate tool for understanding how and why the alluvial floodplain reaches of the Yakima basin have been altered.

**CULTURAL ECOLOGY**

Rivers underscore the foundation of nearly all cultures, but our perception of what rivers are and of our relationship to them varies widely. Consequently, as resource thresholds are approached or crossed, conflicting interests within and between cultures usually arise. This is the case in the Yakima River basin today.

Cultural appraisals of available resources help define and justify strategies for utilizing, maintaining, and enhancing those resources. How we assess our resources ultimately dictates the value we place upon them. These values have been translated into a system of various policies, laws, and regulations now governing land and water resources that define their distribution and use at the local, regional, and national scales (Fraser 1996). Intensifying land use across all of these scales has begun to alter how rivers are perceived, used, and managed. Some individuals and groups now place a higher value and meaning on rivers that function like rivers, rather than just for the resources they provide. The Independent Scientific Group highlights this new value, embodied in the concept of a normative river:

We recognize that, because we are dealing with an ecosystem that has sustained extensive human development for over 150 years, numerous social and biophysical constraints exist for enhancing normative conditions. The challenge before the region is to reach consensus on the extent to which these constraints can be relaxed or removed to achieve Fish and Wildlife Program goals. Nevertheless, we believe strongly that approaching more normative ecosystem conditions is the only way in which Fish and Wildlife Program goals for recovery of salmonids and other fishes can be met (Independent Scientific Group 1999).

Given the Yakima River basin’s critical role within the broader context of anadromous fish recovery throughout the Pacific Northwest, it is imperative that we as a culture adopt this concept.

**THE CULTURAL ECOLOGY OF THE YAKIMA RIVER FLOODPLAINS**

Cultural alterations to the large alluvial floodplains of the Yakima Basin result from how we have chosen to define them as a resource. Current and popular uses range from the obvious: transportation corridors for railroad and road systems, irrigation and its attendant structures, gravel mines, flood levees, farming, ranching, logging, agricultural processing facilities, sewage treatment facilities, hydroelectric plants, primary and secondary residences, scrap yards, landfills, and a host of recreational activities—to their less obvious affects: altered thermal regimes, reductions of sediment transport, reductions in surface water/groundwater interactions, altered groundwater flow paths, exotic species introductions, and truncated lateral connectivity. These activities reflect our culture’s appraisal of the Yakima River’s value and are part of a larger, complex cultural landscape focused on and supported by its large alluvial floodplains (Johnson 1994). The cultural ecology of today’s river is the primary force directing the evolution, persistence and extinction of species, populations, communities, landforms, and ecosystems. It is within the context of cultural ecology that resource management opportunities must be considered.

**RESOURCE MANAGEMENT**

Since they are inseparable, it is necessary to understand the interconnectness of cultural activities and resource management (Hayden 1997). Cultural ecology can impede or facilitate efforts toward preservation, enhancement, and management of fish and wildlife within the Yakima River basin. Therefore, the adaptation and survival of most riverine populations depends on how resource management systems handle the details of river ecology (Arango 2001).

In the Yakima basin, an increasingly complex mosaic of cultural uses has incrementally altered landscape-scale processes that created and maintained a functional ecological legacy.
The consequences of lateral confinement are nowhere more obvious than in the Selah floodplain. The log drives of 1902-1913 initiated confinement followed by reductions in flood frequencies and flood peaks attributable to upstream irrigation storage. Cumulatively, this led to fewer channel-forming flows, increased channel stability, and reduced channel migration (Ligon, Dietrich, and Trush 1995). Floodplain mining necessitated extensive flood control systems, and expanded confinement-initiated channel degradation, which further reduced floodplain inundation and channel connectivity. Elaboration of railroads, roads, and flood revetments exacerbated the consequences of lateral confinement and flow regulation. Today the river expresses channel forms similar to a gorge functional sector. Structural and functional restoration of the shifting habitat mosaic typical of the historic floodplain is problematic.

The Selah floodplain was a premier indigenous fishery for people. I am now in the very heart of the Yakama Country; this river abounds with fish, and is a real resort for the Indians early in the season. This river also is at the present time, an hour ride from the Yakama about five miles below this point; hence I am within an hours ride of all the great fisheries of the Yakamas (Knight) ones, May 18, 1856.

Where Selah represents a worst-case scenario in terms of floodplain degradation, the Wapato floodplain comprises 39% of the total remaining Holocene floodplain and 49% of the total remaining hydrologically active floodplain in the basin across the seven floodplains are examined. All but half of the hydrologically active floodplain area in the Yakima Basin is found in the Wapato reach alone, underlining the scale of loss to the Yakima Basin through flow alteration and lateral confinement processes on this floodplain. The Wapato reach is a gateway to enter or leave the basin from the other floodplains. As such, its geographic position amplifies the significance of inadequate flow and excessive thermal conditions to migrating fish and ecological connectivity (Liiga 1998; Conservation Advisory Group 1997; Pearson et al. 1996).

Flow alterations through the Wapato floodplain seriously diminish its ecological structure and function by desiccating floodplain water bodies and reducing channel connectivity. Irrigation withdrawal throughout the summer exacerbates these problems by reducing flow stage. Preservation and restoration of critical floodplain habitat would result from increased summer flows (Stanford et al. 1996) and would augment longitudinal connectivity within the larger Yakima River watershed. Current habitat acquisitions by the Yakama Nation, combined with lands managed by Washington Department of Fish and Wildlife and others, are important steps toward preserving and expanding critical floodplain habitat; however, these efforts must be accompanied by changes in flow regulation strategies that create and maintain a shifting habitat mosaic.

The Union Gap floodplain, downstream from the Wapato, is associated with the most intensive land use in the Yakima River basin. The urban-industrial matrix has radically transformed its planimetric configuration, most obviously in the upper three-quarters of the floodplain. The lower end of the Union Gap floodplain has significant potential for preservation and enhancement of ecological connectivity, especially in the legacy of channel complexity east of the river (Snyder and Stanford 2001). Restoring fluvial geomorphic processes would necessitate bridge redesign, flood revetment setback, and a normalized flow regime, activities requiring substantial land acquisition for their full effect to be realized.

Truncation of peak flows from the Tieton Reservoir and lateral confinement has altered ecological processes on the Naches floodplain. However, the Naches floodplain maintains a structural mosaic that resembles what one would expect in an unaltered cut and fill alluvial floodplain when compared to the Union Gap, Selah, Kittitas, Cle Elum, and Easton floodplains. In part, this results from the normal timing of spring peak flows despite the scaling down of their magnitude by 25% from estimated unregulated peak flow. In contrast, the distinctly aberrant late summer spike in flow (plate VIII) is unprecedented in the natural hydrographs of western rivers. Although the magnitude of high-flow discharge in the Naches system does not equal the spring melt, this abnormal flow peak likely has a profound impact at multiple ecosystem levels. Additionally, flow withdrawal at Wapato Power Canal initiates low flow conditions and reduces longitudinal channel connectivity for several kilometers downstream from the diversion point in July, August, and November (Croci 2002). However, the Wapato Power Canal exacerbates low flow conditions that exist because of BOR’s flow storage for the annual spill operation. Preservation and expansion of the potentially active floodplain area is critical in the Naches and expansion is essential in areas where lateral confinement creates gorge-like conditions and alters sediment transport processes.

Culturally defined by I-90, confinement in the middle of the Kittitas floodplain narrows the active floodplain width to an anthropogenic gorge, simplifying channel forms and complexity. In combination with upriver railroad bridges and flood revetments, I-90 effectively divides the Kittitas into two floodplain areas where cut and fill alluvial processes could potentially function. Lateral confinement and flow regulation in the Kittitas floodplain translates to extreme limitations in the river’s ability to create and maintain a shifting habitat mosaic. Furthermore, irrigation diversions and dewatering of creeks has caused the disconnection of major tributary watersheds from the Kittitas floodplain and Yakima River, a significant loss of watershed connectivity within the Yakima Basin. Reconnecting tributary streams and expanding the Holocene floodplain area available to fluvial processes are essential strategies for increasing biodiversity and biocomplexity. Even more pressing is preservation of areas where connectivity is still high, for example the areas east of Thorp and at the downstream end of the Kittitas floodplain.

The Cle Elum floodplain is characterized by altered flow dynamics and effective lateral confinement from the top of the floodplain to the I-90 Bridge. Upstream from South Cle Elum, the river appears disconnected from the potential floodplain area by entrenchment and confinement against the NPIR bed. The lower end of the floodplain below the I-90 Bridge appears to be less altered than areas upstream. The highly constrained upstream river channel and the marked braiding and anastomosing zone at the lower end of this floodplain suggest anthropogenic activities have led to hydraulic icing (sensu Creuze Des Chaletteurs, Poinsart, and Brisvand 1994). This phenomenon causes the shallow floodplain aquifer to dewater while shifting the zone of groundwater infiltration from upstream to downstream. It is likely that this scenario is occurring on other floodplains in the basin where their upstream end is laterally confined. The downstream zone below the I-90 Bridge is under increasing developmental pressure. Floodplain area preservation strategies are critical and immediately needed if a legacy of increased lateral confinement is to be avoided. Floodplain expansion and increased connectivity at the upstream end of the floodplain may be achieved and probably will require relaxing of lateral constraints in the middle portions of the floodplain.

The Easton floodplain has experienced extreme development pressure, and land ownership maps demonstrate the potential for future development. These factors are problematic to establishing a more normative hydrograph and expanding the lateral extent of the floodplain; processes essential to maintaining cut and fill alluviation required for the habitat template.

The highest restoration potential probably exists at the upper end of the floodplain where current development is less intense. Re-establishing flood flows between Pine Creek and Pine Valley, where subdivisions dominate floodplain land use, will be difficult. However, failure to initiate such flows will further alter cut and fill alluvial processes that provide essential ecological structure and function. Connectivity between the Cle Elum River and the Yakima River at the lower end of the floodplain must be preserved. Reconnection with tributary streams in the middle and upper end of the floodplain will extend connectivity to a larger watershed area.

Conclusions

These floodplains are clearly distinct, set apart by geographic position in a varied landscape, both physical and cultural. Nevertheless, they are clearly connected by biophysical processes at multiple spatial and temporal scales. This complexity requires careful attention. Preservation and restoration strategies need to be developed for all of these floodplains, and the challenges faced will vary within and between each. Clearly, preservation and restoration plans must be ecologically based. Planning for the future of these floodplains must be detailed and carefully coordinated among multiple entities. Plans that work successfully toward re-establishing floodplain biophysical connectivity must begin by recognizing, establishing, and enhancing normative processes.

It is absolutely clear that the hydrographs of all these floodplains exhibit radical departures from historic conditions. It is also obvious that floodplain land use has developed in relationship to these cultural hydrographs, pointing to and implicating an unplanned association between flood regulation and lateral confinement. The combination of aberrant flow dynamics with lateral confinement locks fluvial geomorphic processes in place and precludes the occurrence of normal processes that provide ecological structure and function on the floodplains.

This study has demonstrated that land use activities have truncated lateral connectivity across the major alluvial floodplains of the Yakima Basin. Furthermore, flow regulation has altered the processes that generate and maintain a complex habitat template. Connectivity within an ecosystem is fundamental to its structure, function, and ultimately, the persistence of its given plant and animal communities. If the processes of flow regulation and dewatering are not reversed in Yakima Basin floodplains, they will continue to reduce the capacity of the ecosystem to support a complex and shifting habitat mosaic.

References on next plate.
Plate XXVII. Appendix I and Acknowledgments.