Stage 0 Restoration Projects in Oregon, USA

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Abstract

Stream restoration is often based on the creation or recreation of a single-thread, meandering channel with a bankfull discharge return period of 1.5 or 2-years. The channel is designed to achieve “sediment-balance”, that is a condition in which the sediment supplied from upstream and local sources is transported downstream (Lane’s balance). This is appropriate in ‘sediment transport or transfer’ valley types, but not in depositional valley types, which are net sediment sinks. There is now overwhelming geologic, historical, empirical and theoretical evidence that natural, sediment sink reaches are characterized by multi-threaded channels that are fully connected to wetland-floodplain complexes. Within the Pacific Northwest Region (PNW) of the Forest Service (USFS), restoration practitioners have been implementing a process-based, unconfined valley restoration approach referred to as “Stage 0”.

Introduction

The Stage 0 methodology breaks away from traditional stream restoration approaches that focus on creating a stable channel pattern, profile and dimension through the balance of the mean annual sediment load (Lane’s balance) to maintain the constructed in-channel habitats. In contrast, the Stage 0 methodology used by the USFS in PNW, is based on the pre-manipulation state (Stage 0) defined in the Cluer and Thorne Stream Evolution Model (Cluer and Thorne 2013). This restoration methodology uses historic valley surfaces and geomorphic controls, referred to as the Geomorphic Grade Line (GGL), as the target elevation of both the low flow shallow groundwater elevation and base flow wetted area (Powers et al. 2018). The primary goals of Stage 0 design are maximum floodplain connectivity at all discharge levels and the ability of the river valley to adjust and shape itself in response to watershed scale drivers. Rather than designing channels that are connected to the floodplain at a channel forming discharge, valley surfaces are activated and maintain a base flow water surface that is at or near the valley floor elevation. The fluvial valley is then able to develop a complex network of anastomosing flow paths, wetlands, vegetated islands, and diverse aquatic habitats in response to watershed and valley scale process drivers. The continued evolution of the river valley including aquatic habitats and riparian vegetation are in response to watershed drivers and not predetermined. Flow paths and riparian forests are allowed to develop and be lost through time as the site responds to disturbance, sediment (bedload and suspended) sorting and colonization of biological drivers.

Completed restoration projects are able to perform the valley scale processes identified in Roni and Beechie 2013, take advantage of dynamic food wed mosaics (Bellmore et. al 2013, 2015, 2017), and are resilient and able to adapt to large disturbances such as fires, floods, and changing conditions driven by climate change. Stage 0 projects provide the greatest amount of resiliency to fluvial systems while providing exceptionally rich, complex and diverse habitats.

Within the PNW Region of the Forest Service, adoption of the Stage 0 restoration approach began on the arid, east side of the Cascade Mountain Range. The earliest projects of this type were designed and implemented in low order streams flowing through headcut/degraded meadow systems. The rapid succession of wetland features and attributes (shallow groundwater recharge, recovery of wetland obligate vegetation, wetlands and anabranch channels) observed in these early projects prompted restoration specialists to expand this approach to larger, bedload dominated stream systems on a variety of landscapes ranging from lacustrine valleys in the Oregon Coast Range, to moderate gradient valleys in the West Cascades and East Cascades (1-2%), to high gradient valleys in the Klamath Basin (6%). The same general approach was followed on all of these landscapes, which included the elimination of anthropogenic confining features and transport channels within depositional valley types and restoration of a depositional environment. These projects rely on the development and construction of a depositional valley as opposed to the design and construction of a "balanced" channel. These project types restore fluvial processes and in turn restore ecological benefits that have been largely lost in many river systems.

Historical evidence underpinning this approach will be presented and case studies used to demonstrate how GIS-based, terrain analysis can be used to differentiate pre- and post-disturbance surfaces and support restoration design.

This presentation briefly illustrates how depositional environments have been altered, discusses how LiDAR is being used to identify historic geomorphic features during Stage 0 design and shows a series of before and after photos of recently completed projects in Oregon.

References:

Bellmore et al. 2013. The floodplain food web mosaic: a study of its importance to salmon and steelhead with implications for their recovery. Ecological Applications, 23(1), pp. 189-207. The Ecological Society of America

Bellmore et al. 2015. Spatial complexity reduces interaction strengths in the meta-food web of a river floodplain mosaic. Ecology, 96(1), 2015, pp. 274-283. The Ecological Society of America

Bellmore et al. 2017. Incorporating food web dynamics into ecological restoration: a modeling approach for river ecosystems. Ecological Applications, 27(3), 2017, pp 814-832 by the Ecological Society of America.

Cluer B. and C. Thorne. 2013. A stream evolution model integrating habitat and ecosystem benefits. River Research and Applications 30: 135-154.

Powers, P., Niezgoda, S., and M. Helstab. *2018.* A Process Based Approach to Restoring Depositional River Valleys to Stage 0, an Anastomosing Channel Network. River Research and Applications 35: 3-13.

Roni, P. and Beechie, T. 2013. Stream and watershed restoration: a guide to restoring riverine processes and habitats. Wiley-Blackwell, Hoboken, NJ. 300 pp.