CONFEDERATED SALISH AND KOOTENAI TRIBES

Jocko River Master Plan

A guide to ecological restoration activities in the lower main stem Jocko River corridor

Appendix F: Reach Succession Scenarios

THE CONFEDERATED SALISH AND KOOTENAI TRIBES OF THE FLATHEAD RESERVATION

Prepared by the CSKT Fish, Wildlife, Conservation, and Wildland Recreation Program

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Jocko River Master Plan: A Guide to Ecological Restoration Activities in the Lower Mainstem Jocko River Corridor: Appendix F

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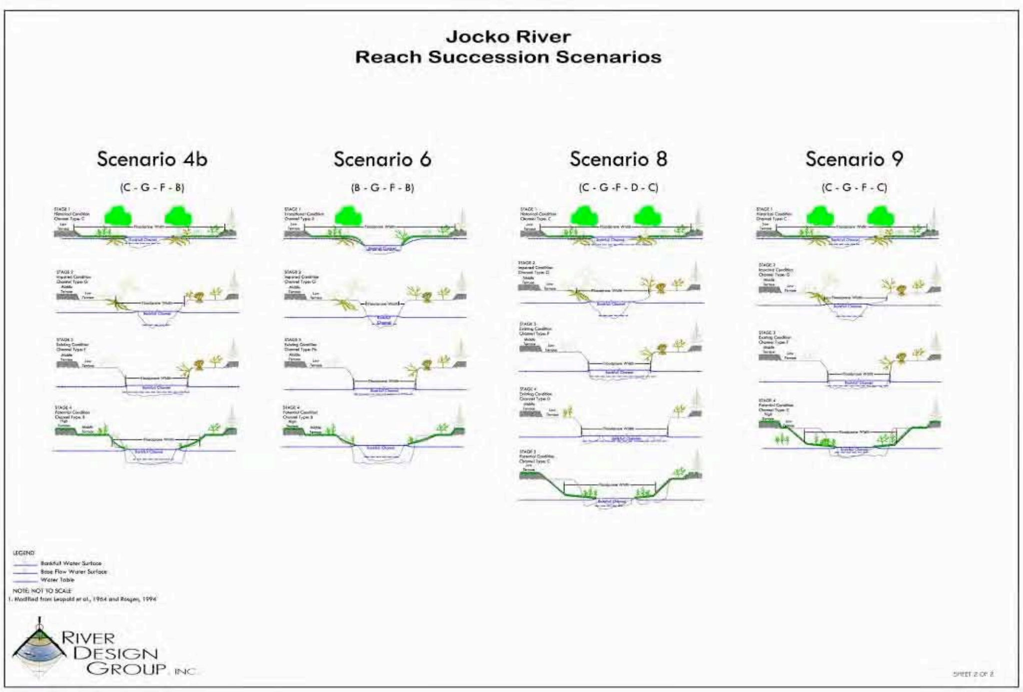
Appendix F – Reach Succession Scenarios

Reach Succession Scenarios

Rivers change when the variables that shape and maintain their form are altered. The factors influencing the adjustment of rivers include both extrinsic controls (e.g. climate, streambed elevational changes) and watershed development activities such as river channelization (e.g. levees), straightening, residential development, water diversions, and riparian vegetation conversion.

These and other changes have dramatically affected how the floodplain functions, how sediment is transported, and the quality of aquatic and riparian habitats. Specific stream reaches have responded in various ways to these alterations. Understanding those responses and the successional tendencies of the river is critical for developing sound restoration projects. Channel succession processes (the gradual and orderly processes of change in a stream channel) can be used to predict future channel conditions if current channel degradation is not addressed.

The following Subsections, based on field investigations and a review of available aerial photographs, describe how the geomorphology or form of the river might change over time. Conceptual cross-section diagrams illustrate the probable stream type succession stages (Figure G-1) (Rosgen 2001).



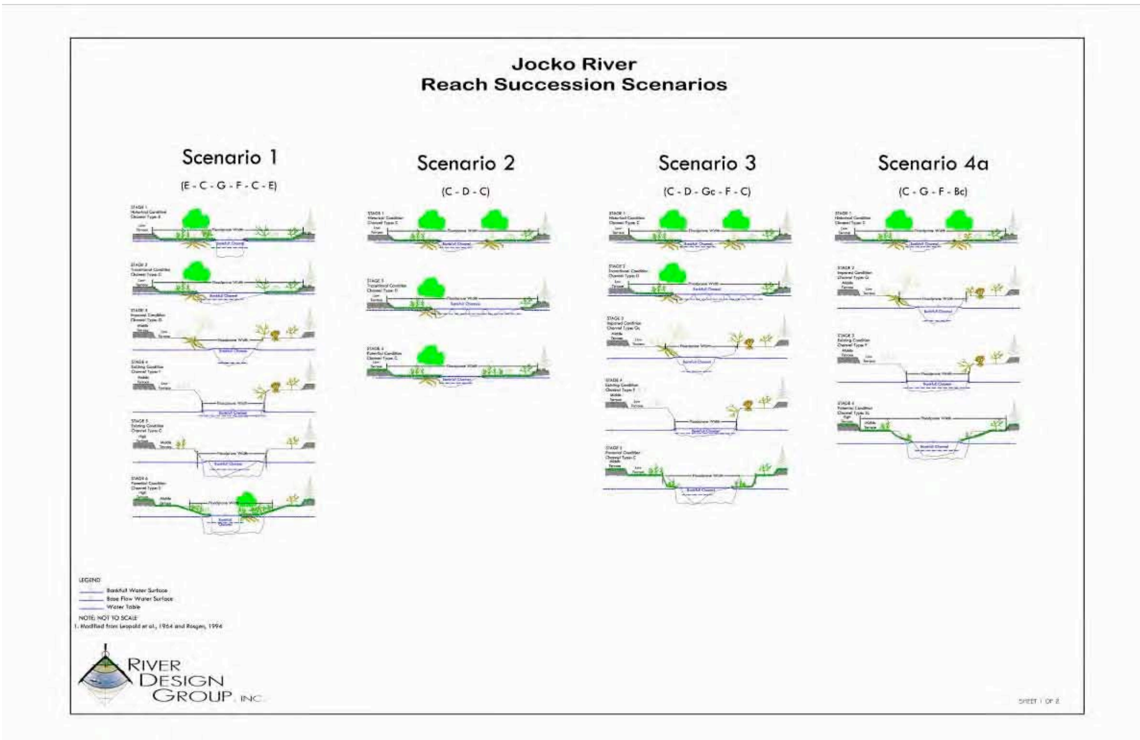


Figure G-1. Conceptual cross-section diagrams illustrate the probable stream type succession stages (from Rosgen 2001).

Reach Succession Scenario 1

This scenario relates only to the spring creek tributaries of the Jocko River. It describes how an E stream type responds to reduced bank stability usually caused by changes in riparian vegetation (Rosgen 2001). As streambank vegetation is removed and streambank integrity degrades, bank resistance to lateral scour is reduced. The channel widens as it migrates laterally and erodes weakened streambanks. In a geomorphic setting typical of the E stream type reaches of low gradient spring creek tributaries to the Jocko River, the stream initially begins to migrate laterally at an accelerated rate, transitioning from a low width-to-depth ratio, stable E stream type to a wider C stream type. Stream competency ultimately exceeds the bed's resistance to scour, and the channel incises vertically, forming a G stream type. This process can also result from an upstream- or downstream-migrating headcut. Eventually the stream reaches an equilibrium point and ceases degradation. At that point, it initiates lateral channel extension, widening the channel belt width and forming an F stream type. Significant sediment mobilization typically occurs as the stream widens to build a new floodplain. As the channel pattern and new floodplain are established, a C stream type develops inside of the over-widened F stream type. Over time, as riparian vegetation colonizes the new floodplain and encroaches on the C stream type, the channel narrows and deepens. The last stage in the succession sequence is a narrow width-to-depth-ratio E stream type inset in a well-vegetated floodplain. Due to the degradation that occurred during the G and F stages, the endpoint E stream type is at a lower elevation than the original E stream type. The ramifications of the degraded channel generally include a lower local water table, a narrowed riparian area, and significant sediment delivery to receiving water during the G and F stream type periods.

Reach Succession Scenario 2

Scenario 2 describes how a C stream type responds to increased sediment delivery (Rosgen 2001). As streambank vegetation is removed and streambank integrity degrades, bank resistance to lateral scour is lost. The channel widens as it migrates laterally and erodes the weakened streambanks. In a setting typical of the C stream type sections on the Jocko River, the stream initially begins to migrate laterally at an accelerated rate, transitioning from a moderate width-to-depth ratio, stable C stream type to an over-widened, high width-to-depth ratio C or D stream type (Rosgen 1996). The D stream type has an over-widened channel with low stream competency. Channel aggradation ensues. The braided channel continues to aggrade, and fish habitat is compromised as pool filling and bank erosion impair water and habitat quality. The braided channel condition can persist for varying periods of time, depending on the frequency of elevated runoff events, fluctuations in sediment loading, the amount of large woody debris, and structure of the riparian plant community. A similar process can occur when sediment supply increases beyond the sediment transport capacity. Deposition in the channel will usually increase shear stress on adjacent banks, which can lead to a braided D stream type condition.

Typically, the D stream type eventually evolves to a C stream type through a process of channel narrowing and deepening. The process can start several ways: with a reduction in sediment inputs to the channel; with vegetation colonization of channel deposits, which results in channel narrowing; with large woody debris accumulations that influence thalweg formation; or through the formation of a single thalweg created by concentrated channel scour. The endpoint of Scenario 2 is a C stream type at the historical channel elevation. Typical consequences of this scenario include accelerated sediment delivery to the channel, the loss of aquatic habitat, increases in water temperature, and impaired riparian condition.

Reach Succession Scenario 3

Scenario 3 describes how a C stream type responds to lateral and vertical channel instability. When streambank vegetation is removed and streambanks lose their ability to resist the erosion during high runoff periods, stream channel widening can occur. In a setting typical of the Jocko River, the stream initially begins to migrate laterally at an accelerated rate, transitioning from a moderate width-to-depth ratio, stable C stream type to an over-widened, high width-to-depth ratio C or D stream type (Rosgen 1996). The D stream type has an over-widened channel with low stream power, which results in channel aggradation. At some point, the existing channel fills, causing the stream to form a new channel following the fall line of the valley, usually cutting off meander bends and steepening the energy gradient. The cutoffs are called avulsions or chute cutoffs. This natural straightening process increases the stream gradient and energy until the bed material can no longer withstand the increased shear stress. The increase in energy causes channel down-cutting, or degradation, which incises the channel within the floodplain. Because the channel bed is now lower than the root structure of the bank vegetation, the streambanks are less stable, and erosion increases. Over time, the process of bank erosion during lateral migration widens the channel, forming a high sediment supply, entrenched F channel. This sequence is similar to the process explained in Scenario 1.

Unlike Scenario 2 where the base elevation of the channel did not fluctuate dramatically through the succession sequence, the endpoint is at a lower elevation relative to the original C stream type. The consequences resemble those outlined in Scenario 1.

Reach Succession Scenario 4a

Scenario 4 (Rosgen 2001) describes the response of a C stream type to vertical and then lateral channel instability. The conversion of the C stream type to a G stream type is typically caused by a downstream disturbance that results in the formation of a headcut. The headcut advances upstream, lowering the channel's base elevation. Significant volumes of sediment are mobilized as the G stream type transitions to an over-widened F stream type similar to the process described in Scenario 3. Over time, the F stream type transitions to a Bc stream type.

The Bc endpoint differs from the Scenario 3 endpoint because of the narrow width of the F stream type and the stream's inability to laterally erode the confined valley bottom to the extent necessary for floodplain formation within the F stream type. Instead, a Bc stream type is established and becomes the stable channel endpoint. The new base elevation results in degraded stream habitat, a lowered water table, and greater stream energy.

Reach Succession Scenario 4b

Scenario 4b (Rosgen 2001) also describes how a C stream type responds to vertical and then lateral channel instability. The primary difference between Scenario 4a and 4b is the channel gradient. The Scenario 4b endpoint channel has a steeper channel gradient reflective of a B stream type.

Reach Succession Scenario 6

Scenario 6 (Rosgen 2001) describes how a B stream type responds to vertical and then lateral channel instability. The conversion of the B stream type to a G stream type is typically caused by a downstream disturbance resulting in the formation of a headcut. The headcut advances upstream, lowering the channel's base elevation. Other types of channel alterations can also result in concentrated scour and subsequent lowering of the channel's base elevation. Significant volumes of sediment are mobilized as the G stream type transitions to an over-widened F stream type. Over time, the F stream type transitions to a B stream type.

The B stream type endpoint is similar to that of Scenario 4b and 4a in that the new base elevation results in a reduced habitat quality, lowered water table, and greater stream energy.

Reach Succession Scenario 8

Scenario 8 (Rosgen 2001) describes how a C stream type responds to vertical and then lateral channel instability. Similar to Scenario 3, the historical condition progresses towards an altered-C stream type. However, Scenario 8 undergoes a complex sequence of channel adjustments prior to arriving at the altered-C stream type endpoint. The channel transitions from the C stream type to a G stream type, followed by channel widening to an F stream type. This sequence is the result of vertical channel instability caused by a headcut or other channel disturbance, such as the straightening of a reach of channel and the construction of levees. Significant volumes of sediment are mobilized as the G stream type transitions to an over-widened F stream type. As the F stream type widens, the sediment contributions to the channel overwhelm the channel's sediment transport capacity, and a braided D channel forms within the F channel. Over time, as the D stream type fills and a new floodplain develops, a single-thread C stream type forms. The endpoint has a new base elevation as a result of channel degradation. Flood flows exceeding the C stream type capacity are confined within the larger F stream type channel, which is now floodplain.

Reach Succession Scenario 9

Scenario 9 (Rosgen 2001) describes how a C stream type responds to vertical and then lateral channel instability. Similar to Scenario 8, the historical condition progresses towards an altered C stream type. However, Scenario 9 does not go through the intermediate D stream type stage. The sequence is the result of initial vertical channel instability in response to a headcut or other channel disturbance. Significant volumes of sediment are mobilized as the G stream type transitions to an over-widened F stream type. Over time, the F stream type transitions to a C stream type within the over-widened F channel.

The endpoint differs from the Scenario 2 result because the new channel has a lower base elevation than the original channel, and as with the endpoint of Scenario 8, the quality of habitat has been reduced, the water table lowered, and flood flows are confined to the F channel.

Reach Succession Summary

Rivers and streams are dynamic systems that maintain a delicate balance between channel dimensions, geometry, and slope and the sediment load and discharge delivered by the watershed. Riparian vegetation and woody debris provide lateral and vertical channel stability essential for maintaining channel form and function. Past and current land management activities have disrupted these complex systems and resulted in a series of changes that result in degraded channel and habitat conditions. Channel responses to these disturbances are often predictable and can be mitigated to reduce the impacts on aquatic habitats.

As the various scenarios illustrate, disturbed river systems move through a series of successional stages, the exact sequence depends on the starting stream type and the kind of disturbance. Understanding these successional processes is essential to the development an effective restoration program. Although passive techniques such as modification of land use provide a means for stream recovery in some situations, streams that have over-widened or incised channels require active measures that employ natural channel design strategies (Subsection 3.3) and a suite of grade control, bank stabilization, and fish habitat structures.

Literature Cited

For references, go to the Literature Cited Section.