

Riparian Vegetation of the Grande Ronde River

by Joseph A. E. Stewart

ABSTRACT

Riparian Vegetation exists in a unique environment characterized by frequent disturbance, spatial and temporal environmental heterogeneity, and abundant water supply. Riparian areas are important due to their disproportionately strong influences on both in stream and terrestrial ecosystems. Because of the importance of riparian areas, scientists and land managers are interested in understanding their dynamics. Many conceptual frameworks exist for examining longitudinal changes in biological function and diversity along rivers. One of these frameworks, the River Continuum Concept (RCC), postulates that longitudinal sections of river show gradients in the physical environmental factors that determine biotic communities. Another conceptual framework that can be applied to river systems is the intermediate disturbance hypothesis, which hypothesizes that the greatest levels of biodiversity will be found at intermediate levels of disturbance. Due to confounding factors, these conceptual frameworks, particularly the RCC, may not be particularly accurate generalizations of the riparian vegetation of the Grande Ronde River.

INTRODUCTION

The term Riparian comes from the Latin word Riparius, meaning “of or pertaining to the bank of a river” (Webster’s Revised Unabridged Dictionary). Our word, riparian, refers to biotic communities that occupy the banks of rivers and streams. Riparian areas are the transition zone between the terrestrial environment and rivers. Riparian areas are characterized by elevated levels of vegetative productivity, high biodiversity and disproportionately strong influences on the surrounding environment (Junk et al. 1989, Niaman et al. 1993, Pollock et al. 1998). This paper will discuss riparian vegetation and distribution of riparian vegetation on the Grande Ronde River in northeast Oregon and southeast Washington. This paper will also examine the distribution of riparian vegetation of the Grand Ronde River in the context of the river continuum concept (RCC) which postulates that the abiotic conditions of rivers follow

longitudinal gradients which, in turn, drive longitudinal gradients in biological communities (Vannote et al. 1980, Hestir, A., this volume).

RIPARIAN ECOLOGY

Riparian areas are transition zones between the river community and the terrestrial community. The riparian zone encompasses the area between low and high water marks and the above area which is influenced by elevated water tables, infrequent flooding or the moderate microclimate associated with proximity to the river (Naiman et al. 1997). Because the influence of these factors decreases gradually as you move away from the river, the boundaries of the riparian area are difficult to define.

A high degree of temporal heterogeneity adds to the difficulty in delineating boundaries for riparian areas. As the river shifts over time so does the extent of the riparian area. Individual extreme rainfall events can flood areas normally not subject to flooding, erode banks, deposit sediment, create environments for new primary succession and permanently change a river's course. Additionally, the slow erosion and corresponding deposition that constantly occurs in rivers creates gradual changes in the riparian environment. The high degree of biodiversity in riparian areas is, in part, a result of the high degree of spatial and temporal heterogeneity within the riparian environment (Naiman et al. 1997). Overlapping variability in soils, disturbance regimes, water tables, in conjunction with temporal variability and successional dynamics creates a diversity of niches.

The river hydrological regime drives riparian communities. The rise and subsequent slow decline of stream flow is essential to the establishment of many riparian species. During seedling establishment roots will follow the water table as it descends with declining stream flow. Ideal conditions are necessary for establishment (Naiman et al. 1997). Seedlings not located at the ideal elevation on the riverbank will not survive (Fig. 1).



Figure 1. Conditions favorable to Cottonwood establishment are limited to confined bands along the bank of a river. The distinct bands of cottonwood on this point bar show how the band ideal for cottonwood establishment shifts as a point bar expands. Seedlings too low on the point bar are uprooted in high water, while seedlings too high on the point bar become desiccated before their root systems develop. (Naiman et al. 2005)

Riparian Functions

Riparian areas are important due to their disproportionately strong influences on both instream and terrestrial ecosystems (Naiman et al. 2005). For the river, riparian vegetation stabilizes banks with extensive root systems, and provides shade, essential to keeping temperatures cool. Riparian vegetation also creates instream micro-habitats, provides allochthonous organic inputs and helps maintain water clarity by trapping sediment. Riparian systems are also biodiversity hotspots and enhance the surrounding terrestrial biodiversity by acting as dispersal corridors for plant and animal species (Niaman et al. 1993).

Succession

Succession occurs as the species that occupy a site change as the environmental conditions change. The riparian environment changes over time in response to the shifting

course of the river as well as in response to the effects of plants on the environment. Alders (*Alnus sp.*) alter their environment favorably for later arrivals by adding nitrogen to the soil through their symbiotic relationship with soil microorganisms. Nearly all species alter their environment in some way that affects succession. Trees and shrubs provide habitat for birds that deposit nutrients and disperse seeds (Naiman et al. 2005). As the river slowly shifts course the ground water moves with it. If the river moves away and the water table drops, drought intolerant species may be slowly replaced by drought tolerant species. Species that are flood intolerant may die if the river rises or moves to encompass them for long enough.

Indicators of Succession

Plant ecologists and resource managers are interested in anticipating changes in plant communities. One method of anticipating vegetative changes is through the presence of indicator species. Long-lived species tend to persist even after their environment has become less suitable for them, but short-lived species respond more quickly to their environment (Wells 2006). Because of this, shorter-lived herbs and shrubs are often used as indicators of succession in tree species.

In Eastern Oregon the longevity of an Aspen (*Populus tremuloides*) stand can be inferred from the species present in the under story. Aspen trees are depend on abundant water supply and can tolerate relatively shallow water tables (North Dakota State University 2007). When the under story of an aspen stand is dominated by wooly sedge (*Carex pellita*) it is an indicator that the water table is relatively shallow, typically about 40 cm from the soil surface (Crowe et al. 2004). In this environment, an aspen stand will persist indefinitely. But, when the under story of an aspen stand is dominated by bluejoint reedgrass (*Calamagrostis canadensis*) or Douglass spirea (*Spiraea douglasii*) it indicates that the water table has fallen and that the aspen stand will be slowly replaced by conifers (Crowe et al. 2004).

Adaptations to the riparian environment.

The riparian environment is primarily characterized by two factors: an abundant water supply and frequent flooding. While abundant water allows for rapid growth, frequent flooding creates a number of adaptive challenges for riparian species (Naiman and De'camps 1997). Flooding interferes with root respiration, mechanically disturbs plants, and creates new

depositional environments while destroying others (Naiman and De'Camps 1997). Most riparian species have adapted to one or all of these factors associated with riparian areas.

Adaptations to mechanical disturbances in the riparian environment are increasingly important the closer to the water a plant grows. Most riparian adapted species are winter deciduous (Naiman and De'camps 1997). This reduces the force that flowing water will put on plants in the winter, when floods are most severe. Many riparian shrubs and small trees have flexible stems that ensure that they will bend instead of break during flood events. Additionally, many riparian species are adapted to persist even after they are uprooted or damaged by rapid waters. Small cuttings from willows (*Salix sp.*), cottonwoods (*Populus sp.*), and many other riparian species will readily form roots when they are deposited in suitable environments (Naiman et al. 2005).

Inundation of the root zone creates a special challenge that only some plants can cope with. Typically, plants depend on gas exchange between the soil and the atmosphere for root respiration. When respiration is prevented by soil saturation, roots start to shut down. Local ethylene production acts to inhibit further development of inundated roots and eventually, those roots may die (Visser et al. 1997). To cope with inundated soils plants have various strategies. Perhaps the simplest strategy is to develop channels for gas exchange within the roots and stem. Wetland species in the families juncaceae (rushes) and cyperaceae (sedges) are most effective at utilizing this strategy. Rushes and sedges have canals in their stems and roots filled with a pithy, porous tissue known as aerenchyma tissue. Aerenchyma tissue allows oxygen to reach roots and allows ethylene to leave (Visser et al. 1997). Alders, Cottonwoods and other genera utilize a similar strategy, developing small holes, known as lenticels, in their trunks and root crowns that channel air to the roots. The aerenchyma tissue of Rushes, Sedges and other families is far more effective at delivering oxygen to the root zone than the lenticels of Alders, Cottonwoods and other species (Naiman et al. 2005).

Many species are also suited to rapidly colonize new point bars as they are formed. Cottonwoods, alders and many other genera produce vast quantities of wind, water, or animal dispersed seeds. Cottonwood seeds float through the air or on the waters surface (USFS 2007a), while alder seeds float on the waters surface, but may also be dispersed through the digestive tracts of birds (USFS 2007b).

Naiman and De'camps (1997) classified riparian adaptations into functional adaptation guilds. These adaptation guilds are a useful framework for thinking about adaptations to disturbances. Naiman and De'camps (1997) classified disturbance adaptations to into four categories:

Invader- Produces a large number of wind/water-disseminated seeds to colonize alluvial substrates.

Endurer- Resprouts after breakage or burial of either the stem or roots, from floods, or after herbivory.

Resister- Withstands flooding for weeks during the growing season; also withstands moderate fires or disease epidemics.

Avoider- Lacks adaptations for specific disturbance types; individuals germinating in an unfavorable habitat do not survive.

Classification of a species into one of these adaptations guilds must be in the context of a specific disturbance type. For example, a species may be a fire avoider, but flood resister/endurer.

Black Cottonwood

Cottonwoods depend on ideal establishment conditions and found are found near riverbanks, where they are usually the tallest trees. In northeastern Oregon black cottonwood (*Populus trichocarpa*) is by far the most common cottonwoods species, but narrowleaf cottonwood (*Populus angustifolia*) is also present (Crowe et al. 2004). On the Grand Ronde River they will likely be found at elevations below 5,000 ft (USFS 2007a). Black cottonwoods are highly shade intolerant and generally cannot establish where a forest canopy already exists (Stuart and Sawyer 2001). Cottonwoods are fast growing trees. Black cottonwood is the tallest broad-leaved tree west of the Rocky Mountains, growing up to 200 ft tall and six ft in diameter (USFS 2007a).

Black cottonwood is perhaps the quintessential riparian species. It possesses nearly all the common adaptations to riparian environments. Black cottonwood grows rapidly and effectively colonizes bare alluvial bars (USFS 2007a). The weedy reproductive strategy of black cottonwood involves production of vast quantities of small seeds with cotton-like appendages which aid in both wind (anemochore) and water (hydrochore) dispersal (USFS 2007a). The

minute seeds contain little in the way of energy stores but are packaged ready for photosynthesis (USFS 2007a). The seed is viable for a short span of time, 2 weeks to a month (USFS 2007a). If seeds do not land in a moist and sunny environment, they will not germinate. Further, if the hydrologic conditions of their germination site are not ideal, especially for the first month following germination, they will not survive (USFS 2007a). On newly formed alluvial bars there is generally a narrow band where hydrologic conditions are suitable for cottonwood establishment (Fig. 1).

Black cottonwood readily sprouts from stumps, following logging or fire (USFS 2007a). Additionally, black cottonwood may reproduce via stem abscission. The tree sheds branch tips complete with green leaves, which land on nearby ground or are carried away by water. Once settled, the branch tips will develop roots and can develop into new, genetically identical trees (Naiman et al. 2005).



Figure 2. Black cottonwoods can be identified by their deltoid, cordate or lanceolate leaves with serrate margins and their deeply furrowed bark (Peck 1961). Cottonwoods like many members of the family salicacea are dioecious. In the spring, male trees bear catkins (not shown) while female trees bear cottony seeds, which float through the air.

(<http://www.for.gov.bc.ca/hfd/library/documents/treebook/blackcottonwood.htm>)

Black cottonwood is moderately tolerant of flooding. Black cottonwood roots possess three strategies that collectively help them survive when soil is inundated. First, cottonwoods develop adventitious roots that reach above the water table and bring oxygen from the upper soil to the submerged roots (Naiman and De'camps 1997). Secondly, black cottonwoods transport some oxygen from the root crown and stem to the root through lenticels, small holes in the stem and root crown that allow gas exchange (Neuman et al. 1996). Finally, black cottonwood roots utilize anaerobic respiration. Anaerobic respiration continues essential metabolic functions, but is not a good long-term strategy; it is highly inefficient and leads to accumulation of toxic

byproducts (Nueman et al. 1996). Cottonwoods can withstand some prolonged flooding of the rhizosphere, but start to show signs of stress after a few weeks (Neuman et al. 1996).

Alders

Alders depend on ample water supply and are found in riparian areas or near subsurface seeps. In the lower elevations of the Grand Ronde watershed white alder, (*Alnus rhombifolia*) is likely to be the most common alder species (Wells 2006). In higher elevation river reaches we will likely see mountain alder (*Alnus incana ssp. tenuifolia*), and Sitka alder (*Alnus viridis ssp. sinuata*) (Mason 1975). While the upland alder species tend toward shrubs, white alder's form is more decidedly tree like. White alder grows up to 80 ft tall (Stuart and Sawyer 2001).

Alders, like cottonwoods, are pioneer species (Naiman and De'camps 1997). Alders perform well in comparison to other species on sites with poor soil fertility. This is due to their symbiotic relationships with soil microorganisms that fix atmospheric nitrogen (Stuart and Sawyer 2001). Alders deliver carbohydrates to bacteria in exchange for absorbable nitrogen (USFS 2007b). Because of their symbiotic nitrogen fixation, alders enhance soil and enable succession by later species that require greater soil fertility (USFS 2007b).

Alders possess the same suite of strategies as cottonwoods for dealing with inundation of the rhizosphere: adventitious roots, lenticels, and anaerobic respiration (USFS 2007b). Shrubby species of alder are adapted to the mechanical disturbances of flooding through their flexible stems and loss of leaves in winter flooding season. Unlike cottonwoods, Alders disperse their seeds in the fall, at the beginning of the winter flooding season. Seeds are dispersed through the intestinal tract of birds (zoochory), or by floating down the river (hyrdochory) (USFS 2007b). Sacs of air in the wing of alder seeds ensure they float (USFS 2007b). Seeds remain viable for a considerably longer period of time than the seeds of cottonwoods (Naiman et al. 2005). Alders respond to catastrophic disturbances such as fire, catastrophic flooding events and clear cutting by stump sprouting (Crowe et al. 2004, USFS 2007b).

Willows

Though some willow species are trees, most willow species take on a shrub like form (Stuart and Sawyer 2001). Different willow species are adapted to survive at in different climates and on the Grand Ronde River willows are likely to exist at all elevations. On the

Grande Ronde River dusky willow (*Salix melanopsis*) may be the dominant willow species at higher elevations while dusky willow (*Salix amygdaloides*) is likely to be the dominant willow species at lower elevations.

Willows are closely related to cottonwoods and share many life history traits with cottonwoods (Peck 1961). Willows seeds have tufts of hair that carry them in the wind and allow them to float on the waters surface. Many willow species are adapted to bend in response to rapidly flowing water (Naiman et al. 2005). When a willow is uprooted, or a portion of it broken off by rapidly flowing water, the plant is capable of re-establishing itself asexually if that portion of the plant is deposited at a suitable site (Stuart and Sawyer 2001). Willows often form dense clonal stands where they have persisted for many years (Stuart and Sawyer 2001).

Willows can be identified by their narrow to linear leaves and proximity to the water. Distinguishing one willow species from another often requires the presence of reproductive or fruiting parts (Stuart and Sawyer 2001).

Rushes and Sedges

Rushes and Sedges are found in wet inundated soil conditions and are likely to be found in all reaches of the Grande Ronde River. Rushes and sedges possess a suite of adaptations to cope with inundated soil conditions for extended periods of time. The presence of aerenchyma tissue in their root and shoot allows gas exchange between submerged roots and the atmosphere (Naiman et al. 2005). Further, rushes and sedges mitigate heavy metal buildup and lack of nitrification in anoxic soil by oxygenating the soil immediately adjacent to the plant's roots (Visser et al. 1997).



Figure 3. Rush and sedge roots stabilize soils. Here a sedge persists long after the bank where it established has washed away. Note the alder growing on the soil stabilized by the sedge. (Stewart 2007)

For rushes and sedges, roots are where the action is. Many species of sedges spread rhizotimously, slowly colonizing ground and out competing other species (Naiman and De'camps 1997). Rhizotimous spreading is also an ideal strategy to deal with silt and sand deposits that cover shoots (Naiman et al. 2005). Additionally, expansive root networks stabilize soil where it would otherwise be washed away by the river (Fig. 3). Rushes can be identified by their distinct perianth parts and often round stems (Peck 1961). Sedges can be identified by their lack of perianth parts and often triangular stems (Peck 1961).

Human Influence on Riparian Vegetation of the Grande Ronde

Riparian ecosystems are among the most impacted natural ecosystems. (Naiman et al. 2005). This is certainly the case on the Grande Ronde. The human impacts on the riparian vegetation of the Grande Ronde are many, including notably: grazing by cattle, land use conversion, logging, channelization of some reaches, agricultural water use and pollution (Lawson, this volume).

Cattle

Cattle grazing can be devastating to the riparian area and the river. In areas experiencing summer drought cattle grazing is generally concentrated within riparian areas from mid to late summer when the terrestrial forage quality decreases (Jones, B., personal communication, 2007). In most cases, cattle graze riparian areas much more heavily than native ungulates, which tend to migrate in response to seasonal resource scarcity (Shapiro A., personal communication, 2007). Cattle grazing will immediately decrease the density of shrubby riparian species and will prevent recruitment of new trees (Green and Kauffman 1995). Over time the over story will decline as trees die and new trees fail to take their place (Crowe et al. 2004).

With time the loss of riparian vegetation associated with cattle grazing will lead to erosion and steepening of the riverbank and alteration of the hydrologic regime. Rivers with sloping banks become terraced and riparian habitat is eliminated (Naiman et al. 2005).

Agriculture

The upper Grande Ronde River flows through the agricultural Grand Ronde Valley. A substantial portion of the water entering this valley is removed for agriculture (Grande Ronde Water Quality Committee 2000). Agricultural effluent adds nutrients to the river (Lawson, this volume). This increased river nutrient content benefits weedy species that require higher soil nutrient content (Naiman and De'camps 1997). Removal of water effects hydraulic regime, plant establishment and succession dynamics (Naiman and De'camps 1997). The riparian areas within agricultural reaches of the Grande Ronde are the most highly impacted riparian areas. In many portions of the river, there may be no riparian vegetation at all (Grande Ronde Water Quality Committee, 2000). Invasive species are likely to be abundant due to the proximity to agricultural sources of weed seeds.

RIPARIAN VEGETATION AND THE RCC

Though the RCC was not originally applied to riparian vegetation, application to riparian vegetation is a logical extension of the RCC (Vannote et al. 1980). Other, competing and complementary frameworks for understanding variation longitudinally along a river include Functional Process Zones (Thorpe et al. 2006), the Network Dynamics Hypothesis (Benda et al.

2004), and the Intermediate Disturbance Hypothesis (Connell 1978). The literature on riparian vegetation tends toward supporting alternative explanations of river biogeography rather than the RCC (Naiman et al. 2005, Looy et al. 2006, Thorpe et al. 2006).

To detect gradients and test the RCC some scheme for analyzing the presence of gradients must be utilized. The Functional Adaptation Guilds proposed by Naiman and De'camps (1997) are often thought of as the vegetative analog to the feeding strategies the RCC uses to segregate macro-invertebrates. Naiman and De'camps (1997) suggest that avoiders will be most prevalent in headwater reaches where seasonal flooding plays a minor role and that endurers and resisters will become more prevalent in the lower reaches that experience more flooding.

One study focusing on the riparian wetland vegetation along the impacted Meuse River found avoiders and endurers in the upper reaches gradually giving way to resisters and invaders in the lower reaches (Looy et al. 2006). Regardless, Looy et al. (2006) conclude that the RCC does not significantly explain the biodiversity patterns along the river. Instead Looy et al. (2006) found that there exists significant similarity within reaches, dissimilarity between reaches and significant influence from nearby eco regions. Looy et al. (2006) note that the similarity of plant species within reaches is accompanied by a similarity in the physical environment of that reach. Though Looy et al (2006) do not specifically refer to functional process zones, it appears that the patterns they see may be best described as such.

The intermediate disturbance hypothesis is supported by several studies on riparian biodiversity. Pollock et al. (1998) found that biodiversity on a river peaks at intermediate levels of disturbance (Fig. 4). Dunn et al. (2006) concluded that heightened biodiversity in the middle reaches of a river was due to intermediate levels of disturbance creating both spatial and temporal environmental diversity. Interestingly, the conclusions of Dunn et al. (2006) suggest a longitudinal gradient in level of disturbance. In this instance we see there may be an inkling of truth to the RCC.

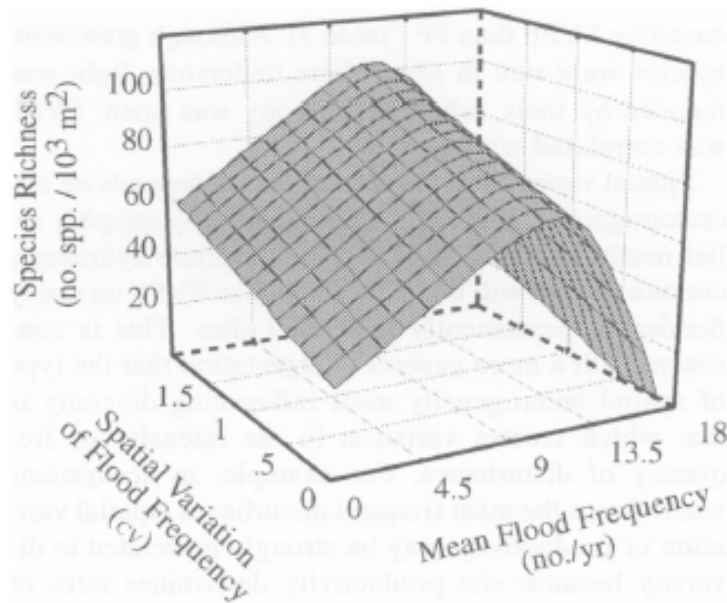


Figure 4. The species richness of riparian wetland vegetation peaks at intermediate levels of disturbance. (Pollock et al. 1998)

THE GRAND RONDE RIVER

The headwaters of the Grande Ronde River, (river miles 160-175), are characterized by narrower channel width, relatively high canopy cover (Fig. 6), and steeper gradients (Fig. 7). With these conditions, flooding disturbances should be less severe and more infrequent than in lower reaches. In many areas of the upper watershed, winter minimum temperatures will be a factor excluding riparian vegetation existing at lower elevations (Stuart and Sawyer 2001). Consequently, riparian vegetation of the upper watershed will reflect this less disturbed, colder environment. Vegetation along the headwaters will include riparian adapted species, but will generally reflect the predominant terrestrial vegetation more than in lower reaches of the river.

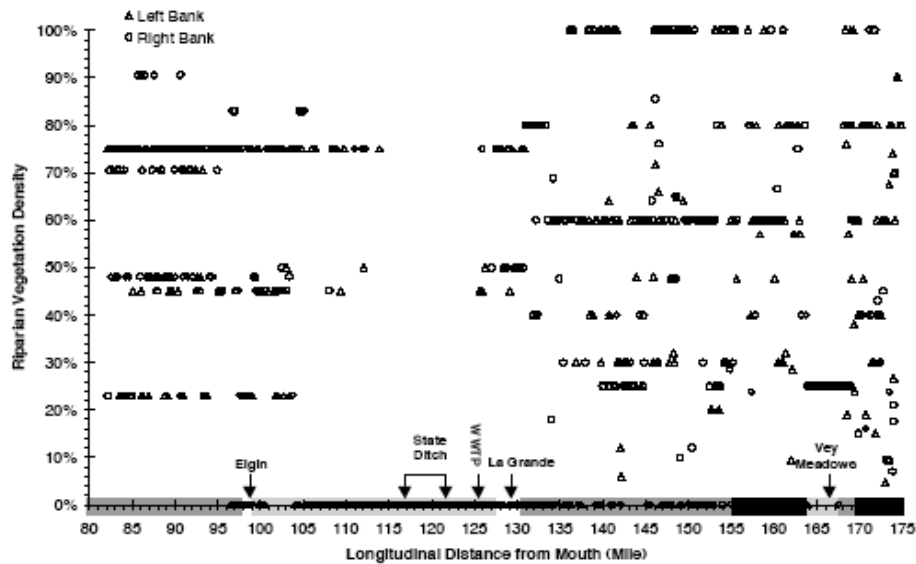


Figure 5. A longitudinal profile of riparian vegetation density along the upper Grande Ronde River. (Grande Ronde Water Quality Committee 2000)

With lack of flooding disturbances, shade intolerant species will have a more difficult time recruiting and fires become more important to the recruitment of these species (Stuart and Sawyer 2001, Crowe et al. 2004). Examples of shade intolerant species found in the headwaters include black cottonwoods, and lodgepole pine (*Pinus contorta*). Many of the coniferous species found in riparian areas at this elevation, like Engleman spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*), are shade tolerant species (Stuart and Sawyer 2001, Crowe et al. 2004, Wells 2006). At these elevations (approx 5,000 ft) black cottonwoods distribution may also be limited by microclimate, with sufficient coldness excluding cottonwoods (Mason 1975). Under story shrubs of the headwaters will include higher elevation willows and alders such as, Sitka Alder (*Alnus viridis*), mountain alder (*Alnus incana*) and dusky willow.

Like most of the rest of the river, the headwaters have been significantly disturbed by human activities and are generally in a state of recovery from logging and cattle grazing (Lawson, this volume). One portion of the headwaters that is still impacted by cattle grazing is the privately owned Vey Meadows (river miles 165-170) (USFS 2007c). Here riparian vegetation becomes nearly absent (Fig. 5), the river widens considerably, and the channel gradient reaches a local minimum (Fig. 7) (Grande Ronde Water Quality Committee 2000). The current lack of riparian vegetation is likely the combined result of continuing cattle grazing and past disturbances. Low growing, and weedy herbaceous species adapted to grazing by cattle are

likely to dominate. Because the lack of riparian cover at this site contributes considerably to TMDL elevated water temperatures there is considerable interest in revegetation of this site, and the Forrest Service has begun attempts to acquire this land (USFS 2007c)

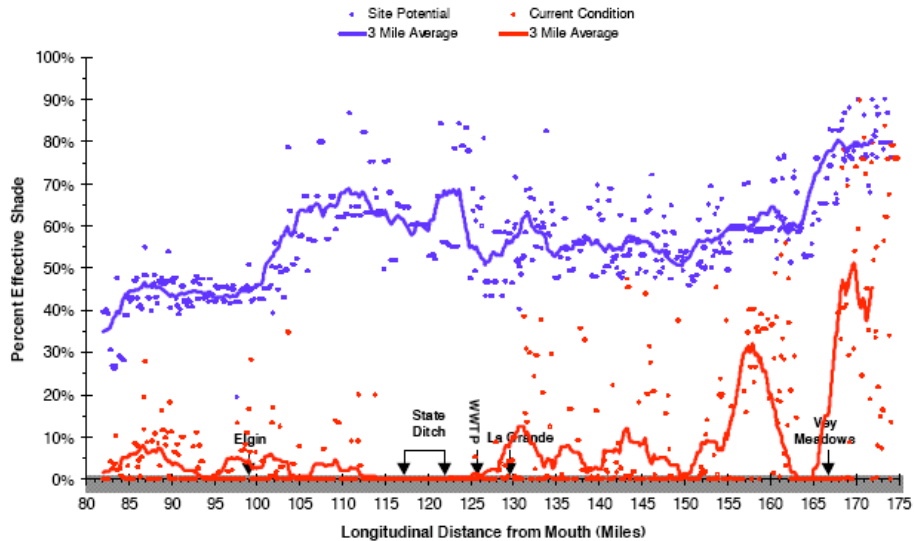


Figure 6. A longitudinal profile of effective shade and site potential on the upper Grande Ronde River. (Grande Ronde Water Quality Committee 2000)

Further downriver the Grande Ronde River flows through the agriculturally dominated Grande Ronde Valley (river miles 98 to 127). This reach of river is highly anthropogenically altered (Grande Ronde Water Quality Committee 2000). Riparian vegetation density is generally very low, with zero riparian vegetation through much of this reach (Fig. 6). A considerable portion of the flow entering this reach is drawn off for agricultural purposes (Grande Ronde Water Quality Committee 2000). Restoration projects are in progress in some portions of this reach (Grande Ronde Water Quality Committee 2000).

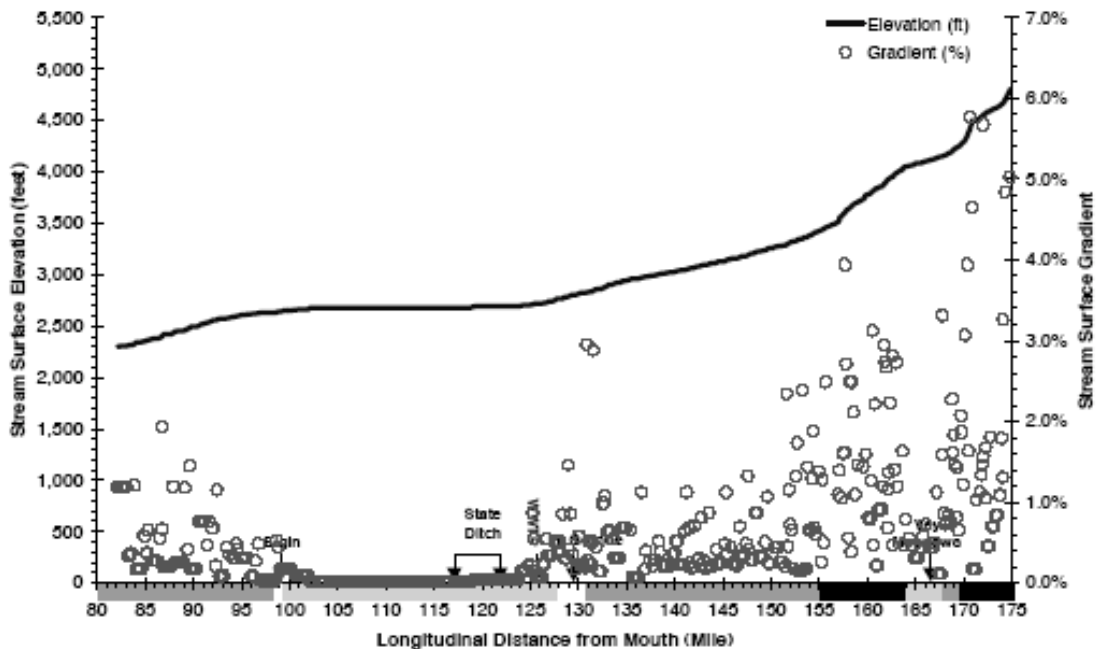


Figure 7. A longitudinal profile of stream elevation and gradient on the upper Grande Ronde River. (Grande Ronde Water Quality Committee 2000)

Downstream from the Grande Ronde Valley the river flows into flood basalt geology. The remaining 95 miles of the Grand Ronde River are generally characterized by steeper gradients, v-shaped valleys, large sediment size, and few sites capable of supporting riparian vegetation (Caldwell, this volume, Jeffres, C., personal communication). Layered on top of this inhospitable geology is an elevation range (2,000ft to 3000ft) that, within adjacent regions, generally supports the greatest diversity of riparian species (Crowe et al. 2004, Wells 2006). This high level of diversity can generally be explained by intermediate levels of disturbance, sufficiently warm winter temperatures, and overlapping species ranges (Naiman and De'camps 1997). Whether this diversity will be manifested in isolated patches on the Grande Ronde will depend on a variety of factors. Even if ideal conditions for heightened biodiversity do exist, realization of biodiversity depends on dispersal mechanisms providing sufficient propagules to that site. Heightened biodiversity may exist where tributaries enter the Grand Ronde and contribute propagule sources (Brenda et al. 2004).

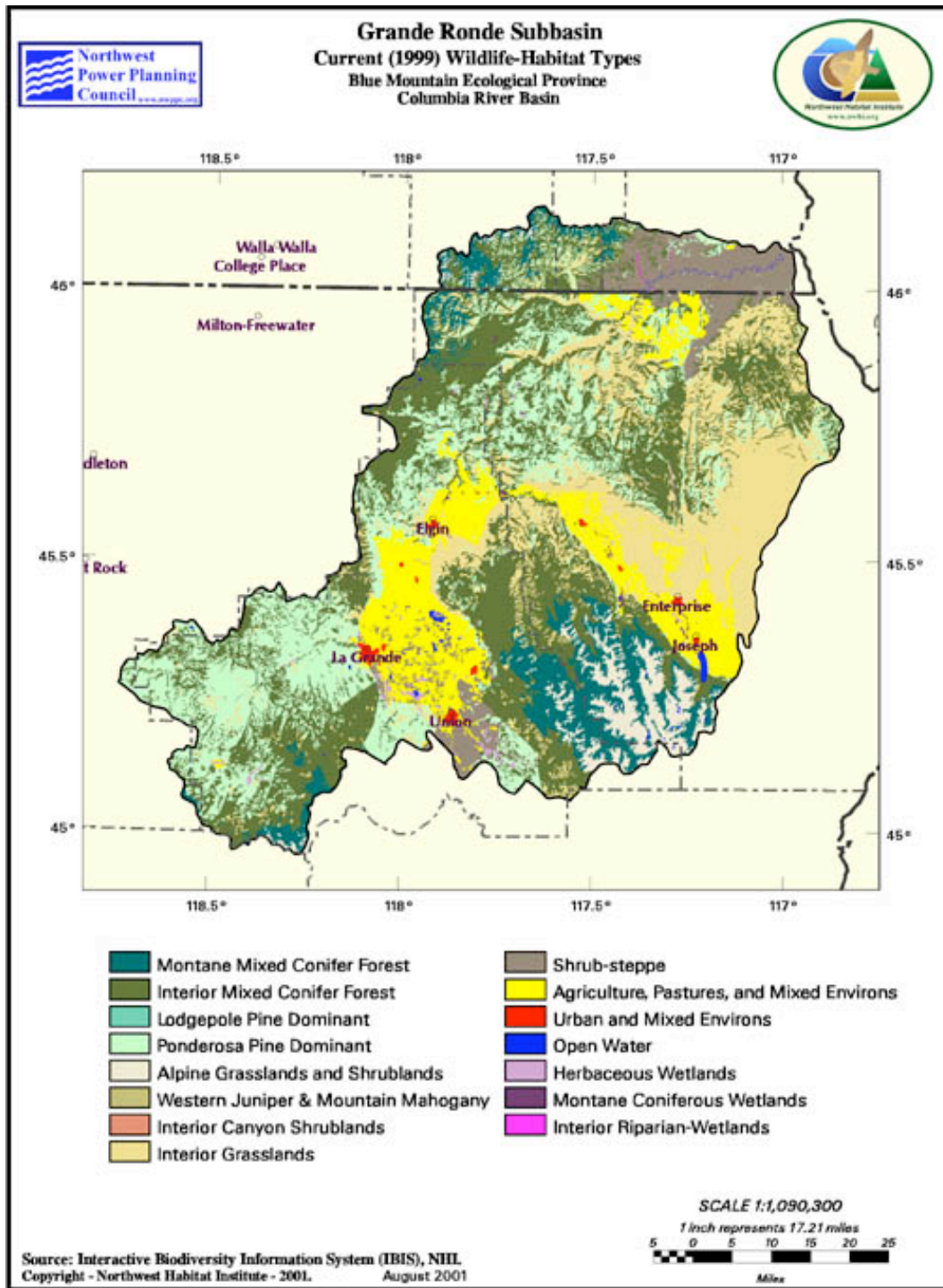


Figure 8. Terrestrial vegetation of the Grande Ronde watershed. (Northwest Habitat Institute 2001)

Trees that would typically be found in these middle elevations riparian areas include characteristic riparian species like red alder (*Alnus rubra*), Quaking aspen, and black cottonwood as well as typical terrestrial species like grand fir (*Abies grandis*), ponderosa pine (*Pinus*

ponderosa), and western white pine (*Pinus monticola*) (Crowe et al. 2004)). Flood intolerant terrestrial species may be abundant on terraced riverbanks. Shrubs include mountain alder, prickly currant (*Ribes lacustre*), stinking swamp currant (*Ribes hudsonianum*), alder buckthorn (*Rhamnus alnifolia*), rocky mountain maple (*Acer glabrum*), Douglas' spirea (*Spiraea douglasii*), shrubby cinquefoil (*Potentilla fruticosai*), silver sagebrush (*Artemisia cana*) and mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*) (Crowe et al. 2004). The terrestrial vegetation of this area will be a mosaic of Ponderosa pine woodland/savannah and mixed coniferous forest, with ponderosa pine forest to woodland on drier south facing slopes and mixed coniferous forest on south facing slopes (Fig. 8).

As we move downriver the terrestrial environment will go from mesic to xeric and the terrestrial vegetation will become a mosaic of sagebrush, Oregon oak and ponderosa pine woodland (Fig. 8). Riparian vegetation commonly found in lower elevations in this region include trees like black cottonwood, Douglass fir (*Pseudotsuga menziesii*), white alder, peachleaf willow, narrowleaf cottonwood, ponderosa pine, and grand fir as well as shrubs like red osier dogwood (*Cornus sericea*), western birch (*Betula occidentalis*), black hawthorn (*Crataegus douglasii*), rocky mountain maple, Lewis' mockorange (*Philadelphus lewisii*), and Net-leaf hackberry (*Celtis reticulata*) (Crowe et al. 2004, Wells 2006). Here, again, it will be curious to find whether the diversity of vegetation in lower reaches of the Grande Ronde River reflects the diversity of the region.

CONCLUSION

The riparian environment along the Grand Ronde River is influenced by different factors in different river reaches. Notably, two factors create abrupt and enduring changes in the riparian physical environment—the agriculture of the Grande Ronde Valley and the Flood Basalt of the lower half of the river. The discontinuity in physical environment and the corresponding biotic community that we see between dissimilar reaches is antithetical to the RCC. Distinct, and dissimilar reaches are better explained as functional process zones. Additionally, significant discontinuities in the physical environment also exist within reaches of the Grand Ronde River. Notably, river gradient varies substantially in the headwaters of the river (Fig. 7). It appears that the riparian environment and vegetation of the Grand Ronde River is not well explained by the RCC.

REFERENCES

- Benda, L., N. L. Poff, D. Miller, T. Dunne, G. Reeves, G. Pess, and M. Pollock. 2004. *The Network Dynamics Hypothesis: How Channel Networks Structure Riverine Habitats*. *BioScience* 54: 213-427.
- Crowe, E.A., B.L. Kovalchik, and M.J. Kerr. 2004. *Riparian and Wetland Vegetation of Central and Eastern Oregon*. Oregon State University, Portland, OR. 473 pp.
- Connell, J. H. 1978. *Diversity in tropical rain forests and coral reefs*. *Science* 199: 1302–1310.
- Dunn, R. D., R. K. Colwell, and C. Nilsson. 2006. *The river domain: why are there more species halfway up the river?* *Ecography* 29, 251-259
- Grande Ronde Water Quality Committee. 2000. *Upper Grande Ronde River Subbasin Water Quality Management Plan*.
- Green, D. M., and J. B. Kauffman. 1995. *Succession and livestock grazing in a northeastern Oregon riparian ecosystem*. *Journal of Rangeland management* 48: 307-313.
- Johnson C. G. 1988. Principle Indicator Species of Forrested Plant Associations on National Forests in Northeastern Oregon and Southeastern Washington. Forest Service, Pacific Northwest Region.
- Junk, W. J., P. B. Bayley, and R. E. Sparks. 1989. *The flood pulse concept in river floodplain systems*. *Proceedings of the International Large River Symposium*. Canadian Special Publications of Fisheries and Aquatic Sciences 106.
- Looy, K. V., O. Honnay, B. Pedroli, and S. Muller. 2006. *Order and disorder in the river continuum: the contribution of continuity and connectivity to floodplain meadow biodiversity*. *Journal of Biogeography* 33:1615-1627.
- Mason, G. 1975. Guide to the Plants of the Willowa Mountains of Northeastern Oregon. Eugene, Special Publication of the University of Oregon Natural History Museum
- Naiman, R.J., H. De´camps, and M. Pollock. 1993. *The role of riparian corridors in maintaining regional biodiversity*. *Ecological Applications* 3: 209–212.
- Naiman, R.J., and H. De´camps. 1997. *The ecology of interfaces: Riparian zones*. *Annual Review of Ecological Systems* 28: 621–658.

Naiman, R. J., H. Decamps, and M. E. McClain. 2005. Riparia: Ecology, Conservation, and Management of Streamside Communities. Burlington, Elsevier Press

Neuman, D.S., M. Wagner, J.H. Braatne, and J. Howe. 1996. Stress physiology abiotic. In: Biology of Populus and Its Implications for Management and Conservation. Ottawa, NRC Research Press.

North Dakota State University. 2007. "Quaking aspen." www.ag.ndsu.edu/trees/handbook/th-3-103.pdf. date accessed: 5/23/07

Northwest Habitat Institute. 2001. "Grande Ronde Subbasin Current (1999) Ecological Types." www.nwhi.org/pix/Subbasins/curhab24_LG.jpg. date accessed: 5/10/07

Peck, M. E. 1961. A Manual of the Higher Plants of Oregon. Portland, Oregon State University Press

Pollock, M. M., R. J. Naiman, and T. A. Hanley. 1998. *Plant Species Richness in Riparian Wetlands--A Test of Biodiversity Theory*. Ecology 79: 94-105.

Stuart, J. D. and J. O. Sawyer. 2001. Trees and Shrubs of California. Berkeley, California, University of California Press.

USFS. 2007a. "Populus Trichocarpa Torr." www.na.fs.fed.us/pubs/silvics_manual/volume_2/populus/trichocarpa.htm. date accessed: 5/23/07

USFS. 2007b. "Ecology of Red Alder." www.fs.fed.us/pnw/olympia/silv/publications/no402_1996harringtonc_ecoredalder.pdf. date accessed: 5/22/07

USFS. 2007c. "Schedule of Proposed Actions: Wallowa-Whitman National Forrest." www.fs.fed.us/sopa/components/reports/sopa-110616-2006-10.html. date accessed: 6/5/07

Vannote, R. L., G. W. Minshall, K. W. Cummins, J. R. Sedell, and C. E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37: 130-137.

Visser, E. J. W., Nabben R. H. M., C. W. P. M. Blom, and L. A. C. J. Voesenek. 1997. *Elongation by primary lateral roots and adventitious roots during conditions of hypoxia and high ethylene concentrations*. Plant Cell and Environment 20: 647-653.

Webster's Revised Unabridged Dictionary. 1913.

Wells, A. F. 2006. Deep Canyon and Subalpine Riparian and wetland plant associations of the Malheur, Umatilla, and Wallowa-Whitman National Forests. Forrest Service, Pacific Northwest Research Station.