

# Rapid Assessment of Riparian Cottonwood Recruitment: Middle Fork John Day River, Northeastern Oregon

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Assessment leads  
researchers to think  
that long-term  
browsing by ungulates  
has stunted cotton-  
wood growth along  
the Middle Fork of  
the John Day River.

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The authors of *Riparian Areas: Functions and Strategies for Management* (National Research Council 2002) concluded that researchers and managers generally fail to use standardized protocols for assessing the ecological status or functioning of riparian ecosystems. Yet, it is widely recognized that information about these systems is increasingly needed, especially as issues arise regarding the role of streamside management practices on riparian plant communities and, in turn, the effects of these practices on riparian and aquatic habitats. Such information is not only important for spatially disjunct portions of a stream or river but also for assessing the continuum of spatially heterogeneous river environments or “riverscapes” (Fausch and others 2002). Riparian information at long-reach scales (those that are tens of miles or longer) is particularly needed as it could improve 1) our understanding of the structure and distribution of streamside plant communities at large scales, 2) our ability to delineate the ecological integrity and sustainability of specific communities, and 3) our assessments of how historical and ongoing management practices have affected these systems. Unfortunately, studies that have systematically assessed the condition and functioning of riparian plant communities at riverscape scales are relatively uncommon in the western United States (Coles-Ritchie and others 2004).

We recently conducted a vegetation assessment along the Middle Fork of the John Day River in northeastern Oregon. Black cottonwoods (*Populus trichocarpa*) occur along this portion of the river and are also found in many riparian systems throughout the Pacific Northwest. Preliminary observations of streamside areas along the Middle Fork of the John Day River indicated that recruitment of cottonwood and willow (*Salix* spp.) may no longer be occurring in many areas. Because of cottonwood’s overstory dominance in many riparian plant communities, its ease of visual identification relative to other riparian plants, and its overriding importance in the ecological functions of many riparian systems in the western United States, we selected it as the primary species for our study. The objectives of this research were twofold:

- 1) To develop a rapid visual assessment methodology for enumerating black cottonwood, by height class, along an extended reach of river;
- 2) To use the results of this methodology to evaluate the recruitment status of black cottonwood along this reach.

## Study Reach

We chose a 40.6-mi (65-km) long study reach located along the Middle Fork of the John Day River in northeastern Oregon

(Figure 1) for assessment. About half of the annual precipitation in the study area normally occurs from November through February, often in the form of snow. Summers tend to be hot and dry. A mixture of private and public lands (national forest) comprises the streamside areas along the study reach.

Elevations range from 2,950 to 3,940 ft (900-1200 m) along the study reach with an average valley gradient of less than 1 percent. A drainage area of 68 mi<sup>2</sup> (175 km<sup>2</sup>) of mountainous terrain contributes flow to the upper end of the reach increasing in size to 222 mi<sup>2</sup> (575 km<sup>2</sup>) at the downstream end. There are no dams above or within the study reach, and even though a portion of the river's flow is diverted for irrigation in summer, high flows remain unregulated. Long-term streamflow records (water years 1930-2002) for the Middle Fork stream gauge at Ritter (USGS 14044000, drainage area = 515 mi<sup>2</sup> [1,340 km<sup>2</sup>]) indicate average annual snowmelt peak flows of 3.7 ft<sup>3</sup>/s/mi<sup>2</sup> (0.040 m<sup>3</sup>/s/km<sup>2</sup>) and an average annual runoff of 6.8 inches (173 mm).

Gold was discovered along the Middle Fork in the 1860s. During the initial mining period, sluicing, dredging, and other mining operations locally affected floodplains and channels. In particular, a 2.3-mi (3.7-km) section of the study reach experienced extensive dredge mining. As a consequence, the valley bottom along this section of the Middle Fork currently has extensive piles of dredge spoils.

The construction of a narrow-gauge railway up the valley in the early 1900s brought additional floodplain and channel impacts. For instance, at several locations the railroad bed limited the capability of the river's channel to naturally meander. We do not know to what extent large cottonwoods and other trees were removed for firewood, land clearing, or other purposes during the period since Euro-American settlement. However, Grant (1994) documented a 50-percent decline in tree cover from 1939-92 along some portions of the valley.

Riparian systems along the Middle Fork have also experienced the effects of long-term cattle grazing, with grazing/browsing occurring each summer. Wild

ungulate browsing of deciduous woody species by white-tailed deer (*Odocoileus virginianus ochrourus*), mule deer (*O. hemionus*), and elk (*Cervus elaphus*) can also occur along these riparian systems. Portions of the reach provide spawning and rearing habitat for threatened anadromous fish, such as chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*).

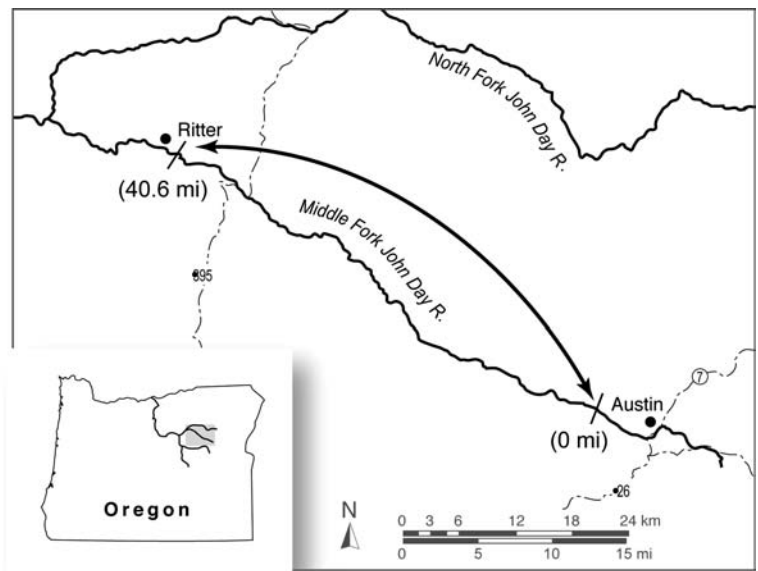
Deciduous woody species that are often found within riparian plant communities along the Middle Fork include black cottonwood, various willow species, black hawthorn (*Crataegus douglasii*), Wood's rose (*Rosa woodsii*), mountain alder (*Alnus incana*), and others. For some portions of the study reach, sedges (*Carex* spp.) are common along channel margins. Hillslope vegetation is generally dominated by ponderosa pine (*Pinus ponderosa*) on south-facing hillslopes with a mixture of other conifers occurring on north-facing hillslopes (Grant 1994).

## Methods

Starting at the upstream end of the study reach (river mile "0"), where a highway bridge crosses the river (UTM 370333, 4944668, zone 11), we recorded the road distance in a down-valley direction for each cottonwood site we encountered.

Reported road distances for this study do not match exactly with river distances since the road follows the general orientation of the valley and the river is typically more sinuous. As we proceeded down-valley along the road, we made continuous observations of cottonwoods except for the 2.3-mi (3.7 km) valley segment that had been highly modified by mining and which contained the historic mining town of Galena.

Our approach emphasized both rapid (all field data were collected during a two-day period in late June 2002) and "remote detection" components whereby all tree counts along floodplains and on streambanks were made visually from a valley-bottom road that occurred along the entire study reach. From the road, we were able to easily count individual trees comprising various cottonwood groves and estimate their heights (usually with the aid of binoculars). As we progressed down-valley, a measurement "site" occurred whenever we observed one or more cottonwoods 13 ft (4 m) or more in height. At each site, we determined the number of pole-sized trees (those 13-26 ft or 4-8 m in height) and the number of mature trees (those greater than 26 ft or 8 m in height). Visual height estimates were periodically checked against a survey pole. In addition,



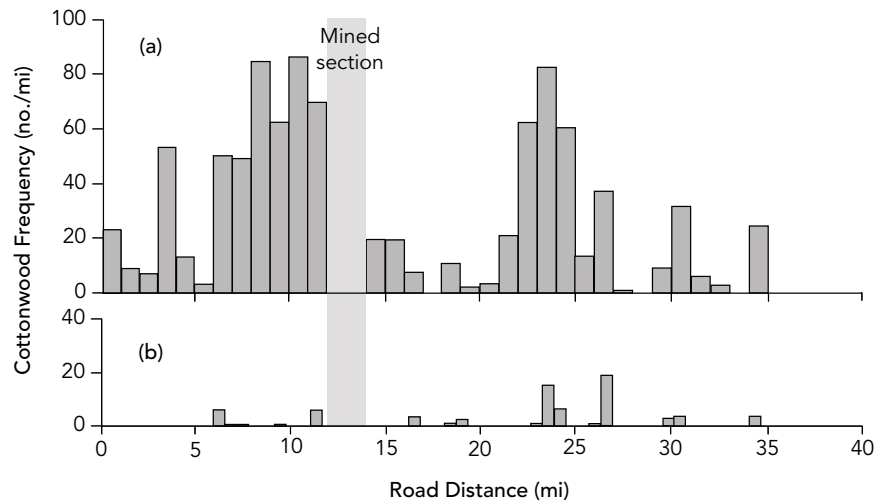
**Figure 1.** Location of the 40.6-mile study reach along the Middle Fork of the John Day River in northeastern Oregon, USA.



**Figure 2.** A site between road and steep cut-slope that serves a vegetative refugia from herbivory by grazing animals. Photos courtesy of the authors.

we noted the presence or absence of cottonwood saplings (6.5-13 ft or 2-4 m in height) at each site. At some sites the foliage of herbaceous plants or branches, stems, and leaves of shrubs or taller cottonwoods obscured our view for assessing the presence of saplings. In such situations we recorded an “unobservable” for the sapling height class. We also recorded miscellaneous observations about land-ownership changes, fence lines, road intersections and major topographic features, and photographed specific reaches and examples of riparian vegetation.

Upon completing the survey, we calculated a ratio (expressed as a percent) of the number of pole-sized trees to the number of mature trees for two general categories of sites: 1) sites easily accessible to domestic and wild ungulates and 2) sites that were relatively inaccessible to ungulates or refugia sites, and thus unaffected by browsing from domestic or wild ungulates (Ripple and Beschta 2005). We categorized sites as refugia when obstructions to access for both domestic and wild ungulates were present at, or near, the site. These situations typically arose when cottonwoods occurred between a road and a steep toeslope of the adjacent hillside (Figure 2), between the river and an adjacent roadfill, or at fence junctions in combination with other physical features such



**Figure 3.** Frequency of cottonwood trees (a) greater than 26 ft and (b) 13-26 ft in height along the 40.6-mi study reach, exclusive of the historically mined section.

as an adjacent road, stream or short pitches of steep terrain. Such refugia were relatively limited in number (3 percent of the inventoried cottonwood sites) along the study reach.

Since the establishment of cottonwood seedlings along free-flowing riverine systems is often associated with high flows (Rood and Mahoney 1990), we also evaluated seven decades of streamflow records for the Middle Fork of the John Day River with regard to the temporal occurrence of relatively large peak flows—those with recurrence intervals of five years or more.

## Results

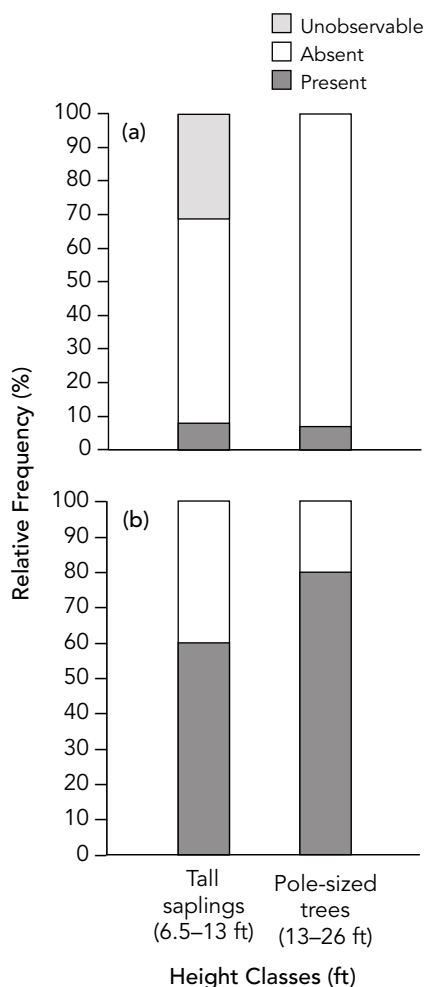
Exclusive of the intensively mined portion of the study reach, we counted a total of 916 cottonwoods greater than 26 ft (greater than 8 m) in height on 171 sites. The frequency of mature cottonwoods averaged 24 trees/mi (15 trees/km) for the

entire reach (exclusive of the mined section) and attained a maximum of 86 trees/mi (53 trees/km) for road mile 10 (road km 16). Two major concentrations of mature cottonwoods occurred within the 6-12 mi (10-19 km) and 22-27 mi (35-43 km) segments of the study reach (Figure 3a); slightly more than half of all trees occurred upstream of the mined reach (the up-valley of road mile 11.7 or road km 18.8). The number of mature cottonwoods per site was highly varied. Forty-two percent of the sites had only 1-2 trees, 37 percent had 3-8 trees, 16 percent had 9-16 trees, and the remaining 5 percent had 17-30 trees.

We observed only 63 pole-sized cottonwoods along the study reach (Figure 3b) with about one-fourth of them occurring upstream of the mined area. The ratio of pole-sized trees to mature trees was only 5 percent for browsed sites, whereas refugia sites had a ratio of 85 percent (Table 1).

**Table 1.** The number of black cottonwoods (*Populus trichocarpa*) by size class and by land use categories occurring along a 40.6-mi reach of the Middle Fork of the John Day River in northeastern Oregon.

Trees Size Class	Land Use Category		Total Number of Trees
	Domestic & Wild Ungulate Browsing	Refugia	
Pole-sized Trees	41	22	63
Mature Trees	890	26	916
Pole/Mature ratio (%)	5	85	—



**Figure 4.** Relative frequency (%) of presence, absence, or unobservable categories, by height class, for (a) cottonwood sites accessible to both domestic and wild ungulates and (b) cottonwood refugia along the 40.6-mi study reach. Note the dramatic increase of cottonwood saplings and poles in the refugia sites. “Unobservable” indicates we were unable to make a presence/absence determination because vegetation (commonly) or topography obstructed our view of the site.

We observed tall saplings at only one site upstream of the mined area and at 15 downstream sites. Tall saplings and pole-sized trees were only observed on 8 percent and 5 percent, respectively, of the 166 sites accessible to both domestic and wild ungulates (Figure 4a). In contrast, tall saplings and pole-sized trees were observed on 60 and 80 percent, respectively, of the refugia sites (Figure 4b).

Frequency analysis of peak flows for the Middle Fork stream gauge during the

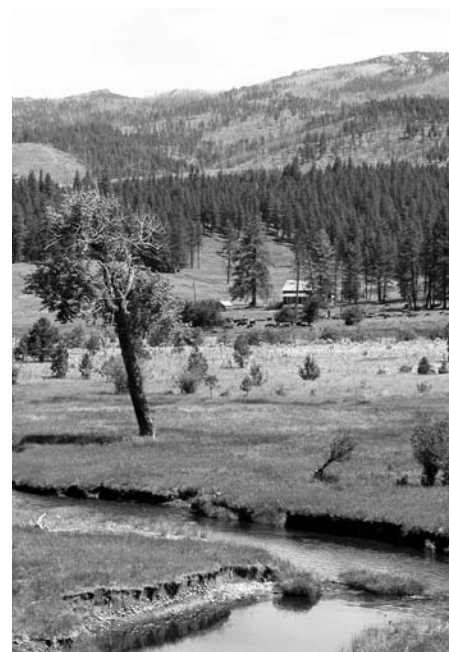
period 1930–2002 indicated that the magnitude of a five-year peak flow event is about  $5.0 \text{ ft}^3/\text{s}/\text{mi}^2$  ( $0.055 \text{ m}^3/\text{s}/\text{km}^2$ ). While peak flows of equal or greater magnitude have occurred 14 times during the 72-year period of record, ten of these events were recorded between 1970 and 2000.

## Discussion

### *Effects of Hydrology and Grazing*

Peak flows are often considered an important factor influencing the sustainability of riparian vegetation. For example, in southwestern Oregon, Chapin and others (2002) found that peak flows with return periods of up to 4.6 years were needed to maintain riparian plant communities. For cottonwoods, high flows are commonly associated with the widespread establishment of cottonwood seedlings because these flows create bare substrates from their scouring action and from the deposition of fresh alluvium (Braatne and others 1996). Analysis of flow records for the Middle Fork of the John Day River indicated that peak flows with magnitudes greater than a five-year event have been relatively frequent in the last three decades of the twentieth century. Even so, young cottonwoods (that is, tall saplings and pole-sized trees) occur sparsely throughout most of the study reach (Figures 4 and 5). These results suggest some factor other than a lack of peak flows has been 1) suppressing the establishments of seedlings or 2) preventing their subsequent growth into intermediate height classes. What could be causing this to happen? We believe that the lack of cottonwood recruitment along the Middle Fork of the John Day River is primarily linked to ungulate browsing.

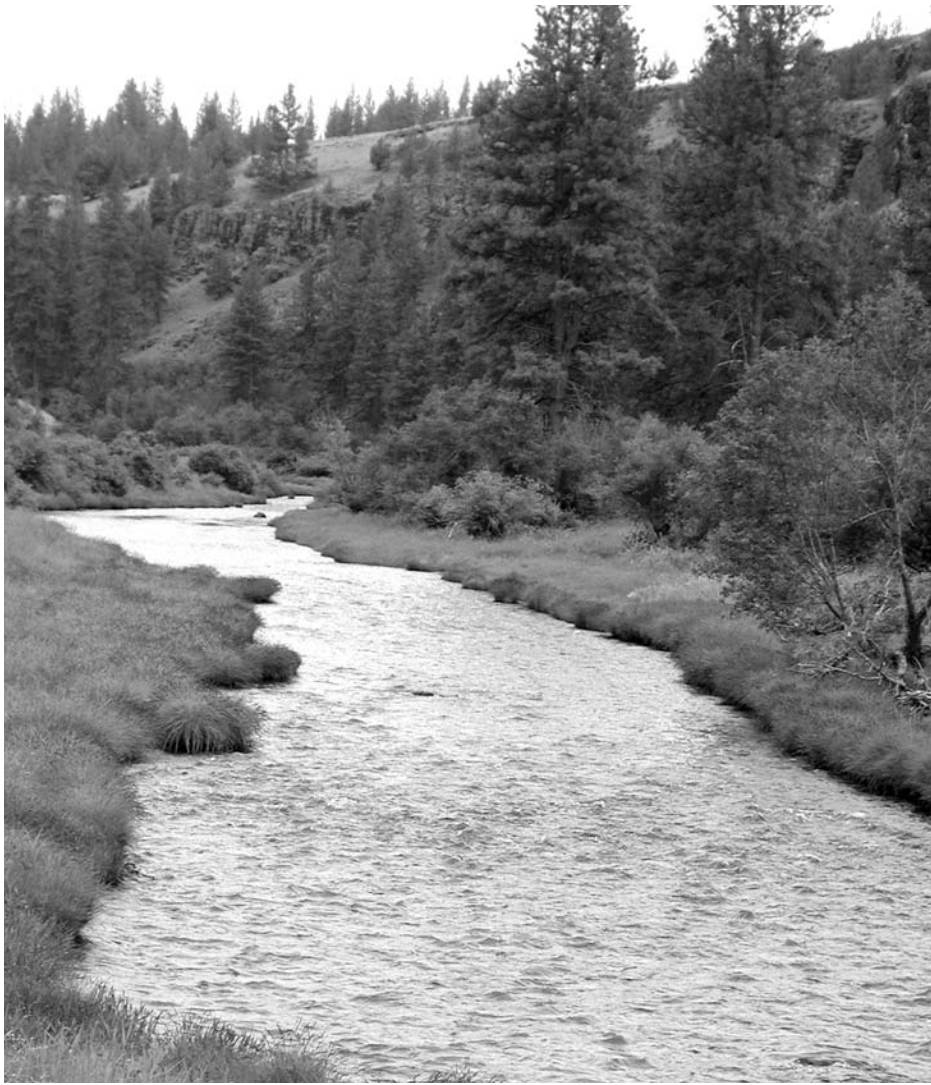
At the time of our survey (late June 2002), one-fifth of the cottonwood sites appeared not to have been grazed by cattle that summer. At these sites, we usually observed channel margins lined with ungrazed sedges (Figure 6). However, when we did observe cottonwood seedlings at these sites, they typically were heavily browsed from previous years. While there was little indication that improved cotton-



**Figure 5.** Middle Fork of the John Day River and floodplain showing a single mature cottonwood and a lack of younger plants. High levels of riparian herbivory are further indicated by sparse and high-lined shrubs as well as a lack of sedges along channel margins. Young conifer establishment indicates floodplain moisture levels may becoming more xeric, perhaps due to eroding banks that widen channels and decrease frequency of overbank flows.

wood recruitment was occurring along most of the study reach, we observed willow recruitment at some locations (Figure 7). The occurrence of mature willows may be the result of several factors: 1) relative to cottonwood, willows are a less-preferred browse species, and 2) the multiple-leader structure of willow plants is more resistant to browsing pressure than the single-leader structure of cottonwood. The recruitment of deciduous woody shrubs was observed in only a few locations throughout the entire study reach.

Since young cottonwoods are highly palatable to ungulates (Braatne and other 1996) and cattle grazing is the predominant land use of floodplains along the Middle Fork of the John Day River, our results suggest that long-term grazing/browsing by domestic ungulates has contributed to reduced cottonwood recruitment along the study reach. For example,



**Figure 6.** Sedge-lined streambanks along the Middle Fork of the John Day River in northeastern Oregon.

a relatively large ratio of pole-sized trees to mature trees would indicate significant numbers of pole-sized cottonwoods are available for growth into taller and older age classes. This ratio was 85 percent for the refugia sites, but only 5 percent for sites accessible to ungulate browsing. This order of magnitude difference regarding the occurrence of pole-sized trees provides a general indication of the extent that browsing has reduced recruitment success. If the height growth of young cottonwoods at sites accessible to ungulates continues to be suppressed by browsing, cottonwood groves along the Middle Fork of the John Day will eventu-

ally disappear as the existing mature trees eventually die.

The relatively frequent occurrence of high flows along the study reach in recent decades in conjunction with naturally occurring channel adjustments are processes that normally insure that bare substrates are available for the germination and establishment of cottonwood seedlings. However, as noted previously, whenever young cottonwood seedlings were observed they exhibited high levels of browsing. Thus, continued seedling establishment over time would appear to be of little ecological benefit if high levels of browsing prevent young plants from growing taller.

Wild ungulates may also have a role in reducing cottonwood recruitment. The study reach forms a common boundary for two of Oregon's big game management units (Northside and Desolation), which, in the year 2000, contained an estimated 3,300 elk and 14,300 mule deer (Oregon Department of Fisheries and Wildlife, unpublished data). Since 1950, elk numbers have increased about fivefold in eastern Oregon (Oregon Department of Fish and Wildlife 1992). In addition, white-tailed deer regularly use riparian habitats along the Middle Fork River. In a California study, Opperman and Merenlender (2000) found that herbivory by deer could substantially reduce the rate of recovery of deciduous woody species in riparian systems previously degraded by long-term livestock grazing. In Yellowstone National Park, the absence of wolves allowed native elk populations to severely browse young aspen (Ripple and Larsen 2000) and cottonwood (Beschta 2003, 2005, Ripple and Beschta 2004) such that recruitment to larger tree sizes was effectively curtailed. In the absence of predation by wolves, long-term increases in wild ungulate populations along the Middle Fork of the John Day River may increasingly contribute to reduced cottonwood recruitment.

The results of this study do not allow us to specifically decipher the relative importance of domestic compared to wild ungulate browsing with regard to suppressed cottonwood recruitment. However, because cattle grazing has been the principal land use along riparian systems of the Middle Fork of the John Day River since at least the late 1800s, whereas big game populations have only reached substantial numbers in recent decades, it would appear that historical cattle grazing has been potentially the most important factor contributing to the observed lack of cottonwood recruitment within the study reach.

The long-term reduction in cottonwood recruitment, as well as that of related deciduous woody riparian species, will likely have major long-term ecological consequences for riparian and aquatic ecosystems associated with the floodplains and channels of the Middle Fork of the John Day River. For example, loss of woody



species typically decreases bank stability, reduces hydraulic roughness along streambanks and floodplains during periods of high flow, and contributes to accelerated channel erosion (Figure 7). The loss of woody species can also contribute to major reductions in the efficacy of other ecological functions (for example, shading and thermal moderation of aquatic and riparian habitats, allochthonous inputs to stream, nutrient cycling, food-web support). Such losses can, in turn, negatively affect the availability and quality of habitats for birds and small mammals (Ohmart 1996, Kauffman and others 2001) as well as a wide range of aquatic organisms (Meehan 1991, National Research Council 1996).

## Rapid Visual Assessment

### Methodology

In this study, we used a rapid visual or “remote detection” methodology to assess cottonwood stand structure and recruitment status along a 40.6-mi (65-km) reach of the Middle Fork of the John Day River. The methodology and the conditions along this reach had several features that allowed us to collect all field data in only two days: 1) cottonwoods are readily distinguished from other riparian vegetation along the Middle Fork, since they have distinct growth forms and leaf characteristics; 2) pole-sized and mature cottonwood trees and groves were used to delineate measurement sites, which assured complete enumeration of large trees and provided a consistent basis for assessing the occurrence of shorter height classes; and 3) a county road existed parallel to the river making cottonwood sites visually accessible (sometimes with the aid of binoculars). Furthermore, we used only three height classes that were easily distinguishable in the field and made periodic checks of height estimates to minimize observer error.

We also noted two disadvantages to this type of approach: 1) the need to have visually distinctive species, and 2) individual mature trees and their understories may sometimes be visually obscured and, thus, not counted. For example, tall grasses, willows, hawthorn, and taller cottonwoods occasionally prevented us from being able to fully observe the status of



**Figure 7.** Sedge-lined streambanks in combination with recruitment of deciduous woody shrubs (willows, hawthorn, wild rose) and cottonwoods along the Middle Fork of the John Day River in northeastern Oregon.

cottonwoods in the tall sapling height class (Figure 4a).

For this study we were able to conduct a complete census of pole-sized and mature cottonwoods. Given the efficiency of obtaining stand structure information over a relatively long reach of river in a short time, we are surprised that similar approaches have not been employed in assessing the status of riparian plant communities. Although we are not cognizant of other ecologists who have used a similar approach, it should be noted that researchers in other disciplines have successfully used visual methods to address specific issues. For instance, foresters use visual approaches for enumerating trees from aerial photography or characterizing crown conditions from the ground (Avery and Burkhart 2002), biologists use visual assessments along line, strip, and point transects to estimate the density or abundance of wildlife populations (Buckland and others 2001), and point counts for birds along transects often involve both auditory and visual components (Bibby and others 1992). Obviously, not all plant species or communities can be visually surveyed as we did in this study, and sam-

ple plots may be required where more specific information on composition or stand structure dynamics is needed (Mueller-Dombois and Ellenberg 1974).

## Conclusions

We tested a visual methodology for rapid enumeration of cottonwoods. Overall, we found this technique to be efficient for obtaining stand structure and recruitment information along a long reach of river in a short amount of time and at low cost. We recommend the approach to restorationists and others. The methodology we employed perhaps best represents a “coarse-filter” approach for assessing the general status of riparian cottonwood communities as well as associated plant communities, habitats, and ecological functions at a riverscape scale. At landscape scales the methodology could be used to consistently and rapidly assess the effectiveness of alternative-grazing strategies relative to the establishment and recruitment of deciduous woody species in riparian systems. It could also be used in conjunction with local stem analyses and tree-aging methods to more precisely

evaluate vegetation dynamics of existing riparian ecosystems as well as to confirm the historical importance of land use and other environmental factors. After using this method, we believe that the results obtained from a rapid assessment approach can also provide an important context from which plot-scale studies may be efficiently designed to address specific management and research questions about cottonwoods and their associated riparian plant communities.

With the exception of refugia sites, we generally found relatively low levels of tall saplings and pole-sized cottonwoods along the Middle Fork of the John Day River. While the general paucity of small to intermediate height classes of cottonwoods along the study reach may be primarily due to the long-term effects of cattle grazing, increasing numbers of wild ungulates in recent decades represent an additional confounding factor for managers and policymakers to consider. Thus, additional research is needed to better understand and differentiate the individual effects of domestic and wild ungulates on these riparian plant communities.

Since cottonwood may live for up to 200 years, they represent an important long-term biological ledger from which to assess the temporal and spatial patterns of recruitment over the last two centuries. However, the imprint of land uses (for example, grazing, streamside harvest) or historical natural phenomena (for example, occurrence of peak flows, increasing game populations) on patterns of cottonwood recruitment during the last two centuries continues to disappear as cottonwood groves reach maturity and die. This legacy information is irreplaceable and indicates there is a great need for deciphering historical patterns of cottonwood recruitment using rapid visual assessments like this study, aerial photo measurements, plot studies of stand structure in conjunction with tree-aging methods, or other techniques along western stream systems where cottonwood recruitment has been changing over time. With-

out such studies, the potential historical effects of land uses or other factors upon this vital riparian species will eventually be lost.

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