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Department of Horticultural Science
University of Minnesota, St.Paul, MN

Twenty Years of Platte River Floodplain Restoration (Nebraska)

Jill Liske

Introduction

Historically the Platte River in Nebraska was a wide, shallow braided river characterized by high sediment load and constantly shifting and eroding channel beds. The river banks and midstream sandbars were scoured by springtime peak flows from snowmelt at the river's headwaters in the Rocky Mountains. Pulse flows from upstream rainfall events also provided scouring action which deterred the establishment of woody vegetation. Midstream sandbars in the wide, open river channel provided roosting habitat for migrating sandhill cranes (*Grus canadensis*) and whooping cranes (*Grus americana*) along a 200 mile (320km) stretch of river from west of North Platte to Chapman, Nebraska. Wet meadows and mesic prairie in the floodplain supported diverse plant and invertebrate communities and were prime foraging habitat for cranes.

Since the arrival of European settlers, the face of the Platte River Valley has changed dramatically. As much as 70 % of instream flow is diverted in Nebraska, Colorado and Wyoming for agriculture, hydroelectric power generation, and other human uses. Reduced instream flows, particularly peak and pulse flows, do not provide sandbar scouring action which prevents woody vegetation establishment. Woody vegetation encroachment, primarily cottonwood (*Populus deltoides*) and willow (*Salix exigua*), stabilizes banks and sandbars creating a narrow, stable river channel. More than 80% of pre-European settlement floodplain channel is now wooded. Cranes have virtually abandoned 100 miles (160 km) of former habitat between North Platte and Overton, Nebraska where active river channel is reduced 85-91% and riparian forest increased ~73%. Downstream from Overton to Chapman, an 80 mile (130 km) stretch referred to as the "Big Bend" region, narrowing (73%) and woody vegetation encroachment has occurred but pockets of suitable crane habitat are still available. The Big Bend region is now the prime staging area where 80 % of the midcontinent sandhill crane population congregates each spring migration and the focus of crane habitat maintenance and restoration activities to be described in this paper (Currier 1991, Currier 1997, Sidle et al 1989)(Regional map at http://www.npwrc.usgs.gov/resource/othrdata/platteco/figures/fig1.htm, Big Bend map athttp://www.npwrc.usgs.gov/resource/othrdata/platteco/figures/fig5.htm)

Reduced instream flows have not only impacted the river channel, but also adjacent wet meadows and mesic prairie by lowering groundwater tables and surface flow. The altered hydrologic regime facilitated drainage and conversion of native wet meadows and mesic prairie to cropland. Woody vegetation established in other meadows, some of which have now been forested for 50+ years. The result is that at least 75% of Platte River wet meadows have disappeared since European settlement (Sidle et al 1989, U.S. Fish and Wildlife Service 1997).

The Platte River Trust

The Platte River Trust ("the Trust") was established in 1978 with the explicit mission of protection of migratory bird habitat in the Big Bend region of the Platte River. The staff of biologists developed a crane habitat protection plan which seeks development of habitat complexes totaling ~12,000 hectares over 11 river segments in the Big Bend region. Each habitat complex will consist of river channel roost area ≥300m wide and 3.2 km long. Wetland habitat (260 ha) will be directly adjacent to the roost channel. An additional 700 hectares of grassland/wetland will be located within 5.6 km of the roost channel.

Currently the Trust has 4000 hectares protected through land and conservation easement purchase. Usually conservation easements require willing landowners to maintain current management practices such as grazing and haying and not to convert land to row crop agriculture. Nature Conservancy and Audubon Society ownership protects an additional 1600 ha. This comprises about 40% of the habitat protection goals (Platte River Trust 11/27/2001). Through Geographic Information Systems analysis of the 11 river segments, the Trust determined that insufficient habitat exists for preservation alone to meet habitat protection goals (Currier 1991). Habitat restoration is therefore required. Open river channel and wet meadows are the most limiting, critical crane habitat and have been the focus of Trust habitat maintenance and restoration activities. This paper describes the open river channel and wet meadow restoration activities in which the Trust has participated over the last twenty years in order to create crane roosting and foraging habitat.

Open River Channel Restoration Techniques

Reclamation of river channel habitat through woody vegetation removal on banks and sandbars began in 1982 to create crane roosting habitat. The Trust researched the effectiveness in removal and cost efficiency of several potential mechanical and chemical treatment combinations for clearing operations: shredding (by heavy-duty mower), herbicide application (Roundup or Graslan), shredding + disking, and shredding + herbicide application. Selection of an effective woody vegetation removal method was relatively straightforward. Shredding alone was ineffective; regrowth was rapid and vigorous. Herbicide application, either alone or in combination with shredding, was effective (~95% control). Herbicide application alone was the least expensive treatment tried, but concerns over potential long-term environmental effects made the Trust hesitant to adopt it as a regular practice. Shredding followed by disking was the most effective and environmentally safest treatment attempted (Currier 1991).

Since this early evaluation, Trust river clearing operations have utilized strictly mechanical methods for woody vegetation removal. Clearing is completed in late summer when low river stage permits heavy equipment to be driven across the channel bed. A 93 kW "Klearway", designed for maintenance of transmission line rights-of-way, is used for shredding trees and shrubs <120 cm diameter. A Klearway has two flywheels, each with two 2.5 cm thick blades, on a front-mounted cutter head which is driven through the vegetation. Following Klearway operations, a tractor with disk tills the remaining stubble. The Trust has reclaimed and maintained ~35 km of river channel to date.

In 1998, the Trust began a long-term monitoring program to assess the status of cranes during their spring and fall stopovers in central Nebraska. One of the goals of the program is to evaluate crane roost site use of cleared and maintained river channel. During aerial surveys of the Big Bend river reach, roost size and location are recorded on aerial photos. Roost sites in maintained river channel are noted.

Data from the spring 2001 migration is representative of each year's results. 68% of crane roosts were in river sections that had been mechanically cleared and maintained. Two of the 5 roost sites where whooping cranes were observed were located in maintained river channel (Platter River Trust 2001). In spring 2000, whooping cranes were observed at 3 roost sites, all of which occurred in maintained river channel (Platte River Trust 2000). The high percentage of crane roosts in maintained river channel suggests that efforts have been successful to restore crane roosting habitat.

Wet Meadow Restoration Techniques

Effective river channel clearing techniques, established early in Trust history, are relatively simple and straightforward. In contrast, conversion of sites from row crop agriculture to wet meadows with structure and function similar to native wet meadows continues to be challenging. Wet meadows have complex, dynamic hydrologic cycles and plant communities. Techniques for wet meadow restoration have improved with experience, but restored wet meadows still lack the diversity and complexity of native wet meadows (Pfeiffer 1999).

Meadow hydrology enhancement
Wet meadows are characterized by a complex hydrologic cycle including pooled or standing water for part of the year (Henszey and Wesche 1993). Reduced instream flows have altered the hydrologic regime such that the present day water table is lower than historically. The Trust has made various attempts to re-create wet meadow hydrology but most have failed.

One early attempt at wet meadow restoration entailed pumping groundwater with a windmill to increase standing surface water. However, sandy soils characteristic of the area have high infiltration rate so water did not pool, and the small land area saturated was localized very near the windmill. Establishment of target vegetation was unsuccessful (Currier 1998).

In a later trial, an artificial backwater on a small side channel of the river was constructed using temporary, inflatable dams. The easily eroded channel substrate (silt and sand) was not conducive to the dam type. Water seeped and flowed under the dams. The pools created behind the dams were very small. No measurable change in the hydrology of the adjacent meadow was detected (Currier and Goldowitz 1994).

Starting in 1991, the Trust began using land surface contouring prior to new plantings. Contouring is designed to enhance site hydrology to encourage both wetland and mesic prairie species typical of wet meadows. Rather than attempting to augment existing water levels, heavy equipment is used to excavate to the current water table. Sites that were leveled for agriculture are graded to re-create a semblance of the historical ridge and slough topography typical of Platte River wet meadows. Sites are chosen specifically for existing high water table to both increase the probability of restoration success and decrease excavation costs (K. Pfeiffer, personal communication).

Contour design has become more sophisticated with experience and the addition of a hydrologist to the Trust staff. Currently, contour design intentionally does not exactly mimic historical topography. Artificial sloughs are designed to meander more than would occur naturally in order to maximize the amount of wetland in a given area (B. Goldowitz, personal communication).

Increased instream flows would be the most effective means of enhancing meadow hydrology, but instream flow is not within Trust control. Under the current hydrologic regime, the Trust considers land surface contouring to be the most promising technique to increase the probability of successful wet meadow restoration. The concern is that many former wet meadows are located at much higher elevations with respect to the groundwater table than historically. The Trust is unsure if land surface contouring can be cost-effective and successfully enhance meadow hydrology in situations requiring large-scale bioengineering (Currier 1998).

Native vegetation establishment
An early wet meadow restoration technique involved riparian forest clearing (to be described in more detail later). Trees were felled, piled, and burned. Native wet meadow species were expected to recolonize; none were planted. The largest project (160 ha) was completed in 1987.

Most restoration projects are conversion of croplands to wet meadows/mesic prairie. The first attempts at wet meadow restoration involved no more than seeding with a low-diversity (<5 species) CRP-type mix. The federally-funded Conservation Reserve Program required particular seed mix ratios of acceptable grass species. No extensive site preparation was done. Seed was purchased commercially from an eastern Nebraska source. The mix consisted of native warm season grasses, primarily big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). No records were kept of the specific cultivars purchased. From 1981-1991 approximately 178 ha were planted using a seed drill. Some sites were mowed the first 1-2 years for weed management as required by Conservation Reserve Program contract (Pfeiffer 1999, K. Pfeiffer, personal communication).

Since 1992, all wet meadow restorations have been high-diversity (100-225 species) hand plantings of locally-harvested seed. Most projects incorporated land surface contouring (96 of 155 ha), the only site preparation prior to planting. Hand planting is preferred because: 1) some seeds will not go through a seed drill 2) projects are usually small enough (<20 ha) that the staff can hand plant in the same amount of time that drilling would require and 3) hand planting permits localization of sensitive species in appropriate microhabitat.

Soils are generally sandy and infertile which aids in establishment of natives and elimination of locally-occurring weeds which are adapted for highly-fertilized cropland. Weeds have not compromised restoration success so no specific weed control measures are implemented. Mowing is considered unnecessary and possibly detrimental by delaying establishment of the target species (K. Pfeiffer, personal communication).

If litter is sufficient to carry a fire, burning may be used in the second year after planting to promote establishment of native species. Normally, the first burn is implemented in the third year. Burning thereafter is on an "as needed" basis. If exotics or woody species are a problem, the site will be burned as frequently as every other year or in rare cases in subsequent seasons (P. Currier, personal communication).

Wet Meadow Restoration Evaluation

Until recently, more effort has gone into implementation rather than formal evaluation of restoration success. Projects ranging in age up to 20 years since construction afford an excellent opportunity to gauge the rate of succession and the effectiveness of particular techniques.

A recent evaluation of vegetation establishment indicated that the high-diversity plantings, despite their younger age, more closely resemble native wet meadows than low-diversity plantings or cleared forest. Sites representing the three planting techniques, low-diversity, high-diversity, and riparian clearing, were compared to native reference sites. Species were classified into 8 vegetation categories (Table 1). Plant species richness at high-diversity sites was equivalent to native reference sites, but cover values of sedges/rushes (4.9%) and wetland forbs (1.2%) were significantly lower than the native sites (25.6% sedges/rushes, 5.6% wetland forbs). Sedges/rushes and wetland forbs appear to establish at slower rates than mesic prairie species. Reclaimed riparian areas had similar cover values as the reference sites but species richness was low (<50 species) compared to native meadows (120-150 species) (Pfeiffer 1999).

This preliminary evaluation is being followed by a comprehensive 3-yr study to evaluate past wet meadow restorations. Data will be collected over 3 field seasons (2001-2003). Four restored sites of age from 1-12 yrs will be compared to 4 native reference sites. Study methods will include, but are not limited to:

Hydrology:	Surface water, groundwater well and precipitation monitoring
Plant community:	Plant species composition and canopy cover surveys compared to potential natural community (Winward 2000)
Terrestrial invertebrates:	Pitfall traps and sweepnet sampling
Aquatic invertebrates:	Sweepnet sampling
Amphibians:	Drift fences and pitfall trap array sampling
Fish:	Sampling by electroshocking

The final report (expected in 2004) will compare hydrology and the associated biological communities of restored vs. native sites. One goal is to evaluate overall success in mimicking native wet meadows. Additional goals are to understand how restoration characteristics vary with age and to estimate the period of development required before a restored site functions similarly to a native site. Information gathered will help guide future restoration efforts, supplementing the knowledge gained from "trial and error" methods of the past (Platte River Trust 2000).

Forest Clearing

Forest clearing is a technique that may be included in river channel, wet meadow, or prairie restorations, depending on site location in the landscape. In former river bed and other low-lying areas, woody vegetation encroachment began so long ago that forests dominated by >50 yr old cottonwoods are now established. Previous methods described for woody vegetation removal are appropriate only when trees and shrubs are 120 cm diameter or less. Forest clearing is an expensive, labor-intensive operation by which trees >120 cm diameter are felled with chainsaws. Despite the costs, the Trust determined that forest clearing was necessary in order to meet habitat protection goals.

The Trust has undertaken several small projects and one large project. The Johns site near the town of Elm Creek was the last and largest site cleared with completion in 1987. It consisted of a 160 ha stand of 40-60 yr old cottonwoods with a well-developed shrub layer including rough-leaf dogwood*(Cornus drummondii)*, willow *(Salix rigida)*, red cedar *(Juniperus virginiana)*, and other shrub species. Aerial photos from 1938 showed the site as open river channel bounded by wet meadows to the north and south. Restoration to historic conditions was determined infeasible because of the current location of the river channel at a distance of ~1.2 km from the site. Wet meadow/mesic prairie was selected as the target community of the restoration because the site has a high water table. No planting was done because colonization was expected.

The Klearway was used to clear the understory, then trees were felled with chainsaws. The larger trees (~25%) were sold for lumber. The project was costly ($1815 per ha) and required 3 years for completion. High labor and heavy equipment costs were not offset by the minimal proceeds of the lumber sale. Tree and shrub regrowth was a continuing problem. Burning was not initially effective because low cover supported only patchy, cool fires, insufficient to kill regrowth (Currier 1991).

Although forest clearing did not initially appear to be a desirable restoration method, the Johns site has improved in recent years (as measured only by qualitative observations). Frequent burning has finally controlled the woody regrowth problem. Native species diversity has increased. The site seems to be developing characteristics similar to native wet meadow, but has taken longer than other restoration techniques to achieve them. Crane use of restored habitat has increased. The Trust intends to do more forest clearing projects like the Johns site because many forested sites are located within the historic river bed where probability of successful wet meadow restoration is higher (K. Pfeiffer, personal communication).

Conclusion

Considering the relatively young age of the restoration field, it is not surprising that the trial and error method is so often used. The advantage that the Trust has is that it is not engaged in just one restoration project, but multiple, similar projects over the course of decades. Trial and error has yielded an enormous amount of knowledge and expertise. However, the Trust acknowledges that systematic evaluation of past restoration projects will be the true measure of success (Platte River Trust 2000).

River channel restoration is relatively inexpensive, easy, and successful as measured by crane use. Woody vegetation removal techniques were selected nearly 20 years ago and have not been modified. In contrast, wet meadow restoration techniques have been constantly modified over the last 20 years. The Trust is confident that the 20 years of experience resulting in the current practice of high-diversity plantings with land surface contouring offers the most potential for wet meadow restoration (P. Currier, personal communication). Ongoing research will evaluate past projects utilizing this method so that future Trust restoration decisions may supplement knowledge gained from experience with that garnered through quantitative scientific evaluation.

Table 1 – Eight vegetation categories used in wet meadow evaluation with representative species for each category

Category	Representative species
Warm season native grasses:	*Andropogon gerardii* *Sorghastrum nutans* *Panicum virgatum*
Cool season native grasses:	*Agropyron caninum* *Calamagrostis stricta*
Cool season exotic grasses:	*Bromus inermis* *Agrostis stolonifera*
Sedges and rushes:	*Carex aquatilis* *Carex scoparia* *Juncus torreyi* *Juncus tenuis*
Conservative prairie forbs ("sensitive" species):	*Silphium integrifolium* *Dalea purpurea*
Other prairie forbs:	*Aster ericoides* *Glycyrrhiza lepidota* *Rudbeckia hirta*
Wetland forbs:	*Eupatorium perfoliatum* *Helenium autumnale* *Lysmachia thrysifolia*
Exotic forbs:	*Melilotus alba* *Rumex crispus*

Literature Cited

Currier, P.J. 1991. Reclamation of crane roosting habitat on the Platte River and restoration of riverine wetlands. Pp. 403-407 in Proceedings of the International Crane Workshop, May 1-10, 1987, Qiqihar, Peoples Republic of China.

Currier, P.J. 1997. Woody vegetation expansion and continuing declines in open channel habitat on the Platte River in Nebraska. Proceedings North American Crane Workshop 7:141-152.

Currier, P.J. 1998. Wetland restoration on the Platte River floodplain in Nebraska. Pp. 611-627 in S.K. Majumdar, E.W. Miller and F.J. Brenner, eds. Ecology of Wetlands and Associated Systems. Pennsylvania Academy of Sciences.

Currier, P.J. and B.S. Goldowitz. 1994. Artificially constructed backwaters and their impact on groundwater levels beneath an adjacent wet meadow on the Platte River in central Nebraska. Final report, contract study 14-16-0006-90-917, U.S. Fish & Wildlife Service. 20 pp.

Henszey, R.J. and T.A. Wesche. 1993. Hydrologic components influencing the condition of wet meadows along the central Platte River, Nebraska. Report prepared for Nebraska Game & Parks Commission by HabiTech, Inc. Laramie, Wyoming. 84 pp.

Pfeiffer, K. 1999. Evaluation of wet meadow restorations in the Platte River valley. Pp. 202-206 in J. Springer, ed. Proceedings of the Sixteenth North American Prairie Conference. University of Nebraska, Kearney.

Platte River Trust. 2000. Crane and waterfowl migration report-spring 2000. Platte River Trust, Wood River. 8pp.

Platte River Trust. 2000. Draft study plan: evaluating the development and effectiveness of wet meadow restoration in the central Platte river valley. FWS Coop Agr 1448-60181-00-J518. US Fish & Wildlife Service.

Platte River Trust. Last update 11/27/2001. Acc 11/30/2001. http://www.whoopingcrane.org

Platte River Trust. 2001. Crane and waterfowl migration report-spring 2001. Platte River Trust, Wood River. 8 pp.

Sidle, J.G., E.D. Miller and P.J. Currier. 1989. Changing habitats in the Platte River valley of Nebraska. Prairie Naturalist 21:91-104.

U.S. Fish and Wildlife Service. 1997. Biological opinion on the Federal Energy Regulatory Commission's preferred alternative for the Kingsley dam project (project no. 1417) and North Platte/Keystone dam project (project no. 1835). U.S. Fish and Wildlife Service, Grand Island. 174 pp + appendices.

Winward, A.H. 2000. Monitoring the vegetation resources in riparian areas. General Technical Report RMRS-GTR-47. USDA Forest Service, Rocky Mountain Research Station, Ogden, UT. 49 pp.