Restoration and Reclamation Review
Student On-Line Journal
Vol.1, No.4, Spring 1996
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Wetland Creation in a Transportation Corridor

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INTRODUCTION

A federal-aid highway project to re-construct Minnesota trunk highway 65 (TH 65) bypassing Cambridge, Minnesota in Isanti County was proposed during the late 1970's and completed in September of 1993. The highway project eliminated a total of fourteen acres of wetland habitat from nine areas surrounding Cambridge. Mitigation sites were designated to replace the destroyed wetlands; fifteen acres proximal to remaining natural wetlands were set aside within the right-of-way for mitigation. All mitigation wetlands were deep marsh. One pond, JES pond, comprised approximately seven of the fifteen mitigation acres. A restoration project was developed for this pond to augment natural recolonization from adjacent wetlands. The objective of this review is to describe the wetland restoration and the challenges of working in a transportation corridor.

Regional and Site Description.

Isanti County is in east-central Minnesota on the Anoka sandplain in the transition zone between coniferous and deciduous forest. The topography is flat with occasional hills (Wovcha et al. 1995). Scattered among forest and field are a variety of natural wetland complexes: small lakes, streams, bogs, and marshes of the Rum River watershed. Reflecting the regional landscape features, eighty-five percent of the soils in the county are series of loamy fine sand and the remaining 15% are deep peat. Current land use (logging and agriculture) has altered the original forest and wetland communities, leaving few remnants (DNR 1991). The sandy soils tend to be droughty and acidic with low natural fertility and are subject to wind and water erosion if exposed to such elements. Agriculture is the primary land use despite the relatively low fertility of the sandy soils.

The track of TH 65 was aligned to minimize impact on environmentally sensitive areas, e.g. wetlands. Even so, twenty acres of wetland were within the proposed right-of-way, fourteen of these acres were lost directly to pavement. Shrub swamp wetlands incurred the greatest losses, nine of fourteen acres. Other losses included 2.5 acres of deep marsh, 1.5 acres of fresh meadow, and 0.9 acres of shallow marsh. In addition to losses of wetlands, the environmental impact statement projected increases in pollutants entering the watershed (Mn/DOT 1978). All impacts were considered minimal because sufficient wetlands remain in the region to filter the added pollutants and the destroyed wetlands were to be replaced.

Wetland mitigations generally require at least a one-to-one ratio of replacement (mitigated) acres to acres lost. This highway project originally provided 1.3 acres for every acre lost. Eighteen acres were to be divided into six catchment areas, all deep marsh wetland. Following re-evaluation of the environmental impact statement (required by federal law, due to the length of time between the proposal and the implementation of the highway project) the six catchment ponds were combined into three ponding areas totaling fifteen mitigation acres (Mn/DOT 1991). Ponding areas had to occur within the right-of-way and had to be contiguous with natural wetlands. The ponds were to have irregular shorelines, variable depths (ranging from 2-4'), and loafing/nesting islands. Shorelines were to slope gradually (8:1 or less) in order to promote dense emergent vegetation and the surrounding uplands were to be revegetated with compatible plants (Mn/DOT 1978). In all, created ponds were to augment the natural productivity and enhance the intrinsic value of the landscape.

JES pond does not fulfill all of the mitigation criteria. The pond does have loafing/nesting islands in the shapes of the letters J, E, and S (hence the name, JES pond). However, shorelines are not irregular, depth varies little and slopes on the north and east shores are greater than 3:1. The pond was placed in a constrained area between TH 65 and an extensive wooded shrub swamp-fresh meadow wetland complex to the west. The roadway could not be moved further away from the wetland due to rural homes east of the wetland complex. To prevent highway flooding in this constrained, low-lying area, the roadbed was built steeply out of the swamp. The slopes down to the pond are 3:1 or steeper and the pond is approximately thirty meters from the pavement.

To stabilize the soil on these steep slopes following construction, seed mixes of fast-growing non-native species (*Poa pratensis*, *Bromus inermis*, *Phleum pratensis*) were planted. In response to poor establishment of these species, temporary cover crops of annual ryegrass (*Lolium perenne*), oats (*Avena sativa*) and Re-green (*Elymus trachycaulus X Triticum aestivum*) were planted in the spring of 1994. Native grass mixes were drilled into the cover crops later that spring (R. Jacobsen pers. comm.). The delay in establishment of the seed mixes and continual disturbance caused by erosion provided a window for weedy plant species to colonize the area. Vegetation was surveyed in September of 1995 by Michael Smith for Dr. Iris Charvat of the University of Minnesota. Crabgrass (*Digitaria ischemum*), plantain (*Plantago major*), horseweed (*Conyza canadensis*), foxtail (*Setaria viridis*), and ragweed (*Ambrosia artemisiifolia*) were prevalent in the upland while sticktight (*Bidens cernua*), willow (*Salix sp.*), cattail (*Typha latifolia*), and reed canary grass (*Phalaris arundinacea*) were dominant along the shoreline (Smith 1995). These are all weedy species. However, sedges (*Carex sp*.), rushes (*Juncus effusus*) and spike rushes (*Eleocharis sp*.) also colonized the shoreline (R. Budelsky, pers. comm.). These plant species may have migrated from the adjacent wetlands or may have come from the seed bank of peat and muck used as fill material. Seed bank studies of the upland and submerged soils show potential of more species colonizing the site (see Appendix A for list of seed bank species).

A restoration project was planned to enhance biodiversity at the JES site. Wet prairie and emergent plant species were purchased from Prairie Restorations, Inc. Selection of species was based on commercial availability and probability of success in wet, sandy soils at the JES site (D. Biesboer pers. comm.)(see Appendix B for species list). Three 20 x 6 meter plots were established along the shoreline on the east and south edges of the pond. Finding similar conditions for the three replicate plots was of primary concern; many factors limited the placement of the plots around the pond. The north end of the pond incurred severe erosion and was unsuitable due to its coverage with erosion control devices. The west bank of the pond is a narrow strip between the pond and the shrub swamp with dense herbaceous and woody vegetation. Therefore, two plots were located on the east bank, chosen for their similarity in being open, sandy areas. The third plot was placed at the south end of the pond proximal to the other plots. Iron fence posts delineated the plots along the shoreline and marked the water level at the time of planting. Plots extended five meters upslope and approximately one meter into the pond. (Beyond 0.5 meters, however, the bottom drops off sharply which precluded seedling establishment further from shore.) Based on a model by Mitsch and Gosselink (1993), seedlings were planted in monospecific clusters within the three plots to increase likelihood of pollination. An average of twenty seedlings per species per cluster were planted in the spring of 1995. Given the number of seedlings per cluster and the size of the plots, clusters overlapped considerably.

Site preparation included using wetland fill material and removal of invasives. Peat and muck were dredged from the destroyed wetlands for use as fill material in the mitigation ponds (Mn/DOT, 1978). Peat from a 6-acre shrub swamp north of the JES site was used as fill material in JES pond. The extent of the fill and its location within the pond is unknown. Rodeo herbicide (glyphosate) was used to selectively spray reed canary grass. Spraying occurred in the spring of 1995 before planting and again in the fall. A follow-up application will occur in the spring of 1996 as soon as the plants are identifiable.

EVALUATION OF SUCCESS

Students from the University of Minnesota will monitor water quality and changes in vegetation for undergraduate research projects. Success of the restoration will be determined from their data as any spread of the restored species to areas outside the three plots (D. Biesboer pers. comm.). Certain features at this site may impede success. The severe slopes surrounding the pond have been continually eroding. As the native grasses continue to establish, this should become less of a problem. Sand from the slopes has completely covered any fill-muck on the northern and eastern shores. This will smother any potential colonization of wetland plants from the seed bank. Also, an Artesian spring on the east shore was uncovered by the road construction. Water flow from this spring has caused slumping of the hillside above. Such erosion endangers the stability of one of the three restoration plots. Water from the spring flows westward across the pond to the lower wetland area. Such outflow has compromised the stability of the bank directly across from the spring, and, consequently, the bank has blown out repeatedly after major storm events. The first blow-out of the 1996 season dropped the water level approximately six inches (R. Jacobsen pers. comm.). This tendency for the banks to blow out moderates bounce during peak flow; annual bounce at JES pond is between 1-2 feet. Seedlings were planted in the spring during a period of high water. Water levels have fluctuated since this planting. An initial drop in water level exposed the submerged seedlings for most of the 1995 growing season. Reconstructions of the west bank (blow-out repairs) restored and even increased water levels this spring (1996). Whether the water levels can be maintained is unknown.

Another problematic feature of the site is the nutrient levels in the pond. Algal blooms have occurred during the summer seasons. The blooms, corralled by prevailing winds, smothered the plot on the south end during 1995. Nutrient levels or pollutants may provide a stable window for cattails, reed canary grass, and algae at the site (Johnstone, 1986). Emergent vegetation may be adversely effected.

CRITIQUE

The restoration project is a small-scale experiment in plant re-colonization and establishment in a drastically altered transportation corridor. The physical and hydrological features at this site are unstable and, therefore, uncertain. Implementation of the project following stabilization of these features may have increased the likelihood of success. The project is a minor intervention beyond the initial plan for these mitigation sites (which did not include action beyond employing fill-muck). Money spent ($2,000) for plant material has been considered by some to be money wasted. The mitigation sites were chosen for their proximity to natural wetlands in order to maximize natural re-colonization. Also, the restoration plots comprise little of the circumference of the entire pond. In any case, it is difficult to suggest that even a major intervention will be successful at this site given its physical and hydrological instability. The design of JES pond is not one to maximize biological success, although such is the goal of mitigation. Specifications for maximizing success were outlined in the final environmental impact statement (FEIS) as already mentioned (Mn/DOT 1978). Key items, however, were not executed in constructing JES pond which suggests that biological success was not the primary goal for this pond. The same document also cites an engineering goal for the mitigation wetlands: to be catchment ponds for run-off, a requirement in compensation for creating impermeable surfaces in the environment. Success of catchment ponds nvolves maximal volume for a given surface area which allows run-off to slow down, thus dissipating destructive energy of the increased water volume. The engineered drainage of this highway project funnels water toward JES pond. Given these facts, JES pond is a better catchment pond than a restoration site, yet even this goal is hampered by the tendency of the west edge to weaken given excessive volume.

JES pond was apparently considered mitigation because it holds water. Yet its design as a catchment pond stymies its effectiveness as a functional replacement of wetland destroyed by the highway project. Where the two aspects of stormwater catchment and wetland mitigation are not compatible, they should be separated. Catchment ponds are necessary, but they should not be allowed to serve as mitigation if they do not meet the standards for re-establishing a wetland ecosystem. Mitigation sites must be located elsewhere if this is the case. The JES pond site does not merge the goals of catchment and mitigation; slopes are too steep and inputs are perhaps too damaging to natural function for it to be mitigation. Stringent biological review of projects and follow-up may decrease the frequency of force-fitting disparate goals onto a single location.

The specifications for mitigation outlined in the FEIS are reasonable for maximizing biological success. Gradual slopes plus irregular shorelines and water depths impose variety within the ecosystem allowing for "small spaces" of diversity and/or function. Further stipulations could include monitoring the sites for invasive species and eradicating them as needed. For a minimal maintenance site like JES pond, however, this may prove impossible.

This project has been referred to as a restoration. In actuality it is more of a small-scale reclamation experiment in plant colonization and succession rather than a restoration to historical conditions prior to disturbance. The location of JES pond was part of the shrub swamp complex before construction of the road. A restoration would attempt to rebuild shrub swamp not deep marsh. Therefore, biological success at the JES site will have to be defined in terms of a functioning deep marsh. Success of the reclamation project should be determined in light of plant competition within the plots. In hindsight, the west bank may have been a better location for the plots. Continual disturbance of the east bank diminishes its ability to support vegetation. Although slopes on the west shore are less steep they are densely vegetated, seedlings would have had to compete with well-established vegetation. Survival of the planted species and successful competition with the existing weedy vegetation will maintain the successional path established by the reclamation project Success of the mitigation site as a whole is another matter.

As a mitigation site, JES pond may be a failure. Inputs into the system cannot be controlled which precludes eradication of stable windows for invasive plants. Vegetation should eventually stabilize the steep slopes and establish a disturbance regime that will define future succession. Increasing biodiversity is a step toward maximizing the resemblance of JES pond to a natural wetland, and it may be the only step available. The weakness of the west bank of JES pond affects the vegetation of the adjacent shrub swamp community. Blow-outs preclude containment of pollutants within the pond and the excessive outflow has created a stream through the swamp. Increasing water flow into the swamp and the arrival of invasive plants has further altered, rather than augmented, the natural vegetation of the surrounding area. Separation of stormwater containment ponds and wetland mitigation ponds may aid in achieving both of these functions.

ACKNOWLEDGEMENTS

Thanks to those taking their personal time to provide information for this review: Dr. David Biesboer, Rachel Budelsky, and Michael Smith. Special thanks to Robert Jacobsen for procuring Mn/DOT information and perspective.

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APPENDIX A: Seed bank species from JES site.

Upland soil	(collected June, 1995)
Chenopodium album	Pigweed
Conyza canadensis	Horseweed
Crepsis tectorum	Hawkweed
Cyperus squarrosus	Flatsedge
Hypericum majus	St. John's wort
Lactuca biennis	Tall blue lettuce
Lepdium virginicum	Poor man's pepper
Oxalis acetosella	Wood sorrel
Plantago major	Common plantain
Rorippa nasturtium-aquaticum	Watercress
R. palustris	Yellow watercress
Silene latifolia	White campion
Wetland soil	(collected Aug,1995)
Bidens cernua	Sticktight
Epilobium ciliatum	American willow herb
Juncus tenuis	Path rush
Lemna minor	Duckweed
Panicum miliaceum	Broomcorn millet
Plantago major	Common plantain

APPENDIX B: Species list purchased for JES "restoration" project

Wet meadow vegetation	
Anemone canadensis	Canada anemone
Asclepias incarnata	Swamp milkweed
Aster novae-angliae	New England aster
Calamagrostis canadensis	Blue joint grass
*Caltha palustris**	Marsh marigold
Carex comosa	Bottlebrush sedge
Chelone glabra	Turtlehead
*Equisetum hyemale**	Horsetail
Eupatorium maculata	Joe-Pye weed
E. perfoliatum	Boneset
Glyceria grandis	Tall manna grass
Gentiana andresii	Bottle gentian
Helianthus giganteus	Giant sunflower
Iris versicolor	Blue-flag iris
Liatris aspera	Rough blazing star
L. pycnostachya	Tall blazing star
Lobelia siphilitica	Great blue lobelia
Lysimachia ciliata	Fringed loosestrife
Mimulus ringens	Monkey flower
Pycnanthemum virginianum	Mountain mint
Sagittaria latifolia	Arrowhead
Scirpus atrovirens	Green bulrush
Scirpus validus	Soft stem bulrush
Spartina pectinata	Prairie cordgrass
Thalictrum dasycarpum	Tall meadow rue
Veronicastrum virginianum	Culver's root
Zizia aurea	Golden alexander

** These species not purchased but relocated from near JES site.*