Water Resources Reading: Classifying Landuse/Landcover and Wetland Systems in a Dammed Riparian Zone

Riparian Zone Classification Systems

Human activities radically alter natural resources within riparian zones. Timber harvesting, farming, urban development and dam building are but a few of the many activates that transform the quantity, quality, composition, and structure of water resources, vegetation, and morphology within the riparian zone. Wetland destruction along the riparian zone is of particular concern. Water resource planners need to be able to "read" the riparian landscape, in order to better understand how water related resources are impacted. The best method for interpreting a landscape is to classify landuse and landcover from air photography. As water resources students, you must learn how to classify landuse and landcover within a riparian system. I have created two basic classification schemes that holistically evaluate the riparian zone. The first classification system identifies landcover, while the second classification system identifies wetland morphology.

Generalized Landcover Classification Criteria

The landcover classification is a modified version of Anderson's et al. *Land Use and Land Cover Classification System for Use with Remote Sensor Data* (1976). This study utilizes the system primarily in order to identify landcover and, to a lesser degree, to distinguish general land uses associated with human occupance. Each landcover unit is, likewise, a habitat unit for both aquatic and terrestrial fauna and flora. Landcover delineation was limited to:

1. Barren Land -- Sand dunes, rock lands, sandy beaches, dredged material disposal sites, and quarries (95% barren) → code = 1

2. Water Resources -- Ponds, lakes, rivers, sloughs, ox-bow lakes, backwaters, side-arm channels, and artificially cut-off meanders (deep -- open water at least 2 meters -- and are bodies of water with less than 10% emergent vegetation)
→ code = 2 (deep water)

3. Grassland -- Cannery reed grass (95% grassland) → code = 3

4. Wetland/Marsh -- Tidal and non-tidal, cattail, sedge, grass, ponds, shallow lakes, shallow sloughs, backwaters, oxbows, salt marsh, freshwater marsh; the water is shallow enough to support emergent vegetation (usually shallower than 2 meters) → code = 4 (shallow water and wetlands)

5. Shrub/Scrub -- 95% shrub/scrub; power lines, clear cuts → code = 5

6. Savanna-like -- Grassland with scattered trees (75% grasses with < 25% trees)
→ code = 6

7. Forest including: Coniferous forest -- Sitka spruce, Douglas fir, western red cedar; Broad-leaf forest -- Cottonwood, red alder, ash, white oak, big leaf maple, vine maple; Mixed forest → code = 7

8. Agricultural Land -- Field crops, orchards, pasture → code = 8

9. Urban/Developed Land -- Residential, industrial, transportation, mining operations
→ code = 9

10. Forested Wetland -- Wetland/Marsh areas which contain 25% or greater forest density
→ code = 10

Generalized Wetland and Deepwater Habitats Classification Criteria

The wetland and deepwater classification system used in this study is a modified version of the U.S. Fish and Wildlife Service's *Classification of Wetlands and Deepwater Habitats of the United States* (1979). This classification system provides a hierarchical inventory of wetlands and deepwater habitats. Ultimately, it is an attempt to classify wetland habitats indicated by the surficial structure or form. Areas are classified based upon the degree of structural similarity. This system of classification satisfies two critical needs: it refines the general wetland delineation of the landcover classification system; and, it includes areas of deep water, which historically have not been classified as wetlands. Topographic areas which are similar in form are, likewise, similar in function. Similar topographic form and function often provide a niche for specific habitat types. This classification system, utilized over a period of time, provides the means to monitor changes in particular wetland habitats. Wetland and deepwater habitat delineation were limited to:

Marine (M)

From the open ocean (Continental shelf) shoreward. Limits include: a) to the landward splash zone of breaking waves; b) to the seaward limit of emergent vegetation.

Marine subtidal (Ms) -- Continuously submerged

Marine intertidal (Mi) -- Exposed and flooded by tides

Estuarine (E)

Tidal deepwater and wetlands that are semi-enclosed by land with access to the open ocean. Limits include: a) upstream and landward to where ocean salts measure less than .5%; b) seaward to a line closing the mouth; c) to the seaward limit of the wetland.

Estuarine subtidal (Es) -- Continuously submerged

Estuarine intertidal (Ei) -- Exposed and flooded by tides

Riverine (R)

All wetlands and deepwaters contained within channels and are downriver of the saline (7.5%) estuarine environment. Expect a transition zone. Typically, the riverine system is flowing. If persistent emergents (plants that are not periodically washed away) occur within the channel, the classification will not be riverine.

Riverine tidal (Rt) -- Gradient is low, water velocity fluctuates, and is influenced by tides

Riverine lower perennial (Rl) -- Gradient is low, water velocity is not influenced by tides, and some water flows throughout the year

Upper perennial (Ru) -- Gradient is relatively high, velocity is fast and not influenced by tides, and some water flows throughout the year

Lacustrine (L)

All wetlands and deepwaters which include the following characteristics (typically lacustrine refers to lakes): a) situated in a topographic depression; b) lacking persistent emergents (at least 70% of the water must be too deep to support emergents; c) total area must exceed 8 hectares (however, if the lacustrine system is very deep -- 2 meters -- and it does not support emergents, the system is still classified as lacustrine).

Lacustrine limnetic (Ll) -- All deepwaters within the lacustrine system

Lacustrine littoral (Lt) -- Shallow wetlands (< 2 meters) which extend from the shore to the non-persistent emergent deepwaters; this is a potential 30% of the lacustrine system, which is typically found along the shoreline

Palustrine (P)

All non-tidal wetlands documented by persistent emergents, trees, or shrubs; examples may include backwaters, ox-bows, and ponds; also includes the following characteristics: a) areas less than 8 hectares with emergents; b) areas in which the water depth is shallow (< 2 meters); these areas may include areas which are greater than 8 hectares, if emergents persist (marshes and swamps); c) palustrine areas in the tidal zone must contain less than 0.5 parts per thousand salinity.

Terminology

Use of the term “restoration potential” needs to be fully explained. This study does not describe the means for physically restoring a wetland. Rather, the objective is more geographic in nature -- to locate areas which exemplify the qualities needed for restoration to be successful. Restoration of riparian wetlands, strictly defined as a return to natural or original conditions, is unlikely (Frenkel and Morlan 1991). “Natural” may be interpreted by some as “before or without human occupation”. If the term “natural” is translated to mean “before the Euro-American colonization of the past 150 years along the LCR”, then to restore wetlands exactly as they once were would be improbable. Fortunately, it is not necessary to restore wetlands to their original conditions in order to gain benefits. A more realistic definition of restoration acknowledges that historical wetlands need to be brought back into existence; but, the degree to which lost values are replaced is variable. Current societal constraints define the extent to which wetland values are replaced at the point where wetland benefits attained through restoration are outstripped by the consequences to society to replace them. The ecological values associated with riparian wetlands of the LCR 44 years ago were more desirable than they are today. It is more feasible to restore displaced wetlands to their 1948 value than to pre-settlement conditions.

Development is necessary, but should be managed, such that riparian wetlands are not continually degraded or lost. Locations which are currently developed or in use and were historically wetlands have little potential for restoration. It is not likely that the roads, buildings, or productive uses of the land, such as agriculture, will be removed, nor is it possible that the river will be dechannelized, in order to ameliorate floodplain isolation. Full-scale restoration of the LCR is improbable, due to population growth and economic development. The scale of restoration, therefore, is ultimately dependent upon societal consensus. Pockets of restoration may be the best that can be achieved.

Justifying Wetland Restoration

Justification for wetland restoration stems from the fact that wetlands are considered important to society. In addition, most wetlands have already been lost as a resource, and depletion of the remainder continues. Further, national policy favors the protection and restoration of wetlands (Mitsch and Gosselink 1993). The widely touted, less frequently applied policy of “no net loss” requires that unavoidable wetland losses be replaced. The primary objective of the policy is:

> To achieve no overall net loss of the nation’s remaining wetlands base and to create and restore wetlands, where feasible, to increase the quantity and quality of the nations wetland resource base (National Wetland Policy Forum, 1988, cited from Mitsch and Gosselink 1993).

At one level, there is policy which encourages wetland restoration. At another, there is law which requires restoration. Recent, more rigorous enforcement of Section 404 of the Clean Water Act (1977), requires that wetlands lost due to development be restored or created in another location. It remains difficult for enforcement agencies to track and encourage each isolated mitigation project to comply with regulations; but, the necessary programs to enforce and ensure successful restoration are improving. All adverse impacts to existing wetlands must be avoided to the maximum extent practical, and unavoidable impacts must be minimized, before mitigation permits will be considered. Once guidelines for the avoidance and minimization have been met and adverse impacts are demonstrated to be necessary and unavoidable, compensation and mitigation are required. Compensatory actions are defined as the restoration of existing degraded wetlands or creation of human-made wetlands (Scodari 1997).
At the state level, both Oregon and Washington share similar policies governing the restoration of wetlands. The no-net-loss policy lies at the core of all recent wetland protection programs in the state of

Washington. Protection and restoration programs in Washington include the Puget Sound Water Quality Plan, the 2010 Action Agenda, and the Governor's Executive Orders for Wetlands (Washington State Department of Ecology 1992). The U.S. Fish and Wildlife Service and the Washington Department of Wildlife recently formed a partnership and initiated the implementation of the Washington State Ecosystems Conservation Project. This Project will restore wetlands wildlife habitat on private lands (Washington State Department of Ecology 1992).

Restoration of wetlands in Oregon is an important state-wide objective. The Oregon Removal-Fill law requires mitigation much like the Section 404 program. This law is expanding, as jurisdiction of federal regulatory programs increases. Statewide Planning Goals 16 and 17 of Oregon's land use planning program address wetland restoration. These goals recognize the necessity for restoration and articulate the need to locate sites for regulatory mitigation. The 1989 wetland conservation law addresses restoration (Good and Sawyer 1998). The legislation provides for the development of local conservation plans. In these plans, locating potential wetland restoration sites is required to mitigate for future development that will adversely impact wetlands.

Clearly there is a need to locate potential wetland restoration sites along the LCR. Development and human activities which are destructive to wetlands will continue, despite efforts to moderate the losses. Based upon current trends in wetland degradation along the LCR, it is unlikely that restored wetlands will be as diverse or numerous as wetlands found in the region in 1948. At the very least, restoration increases wetlands within a specific location and partially stems the tide of losses.

Restoration or Creation

Restoration is the preferred solution to compensatory mitigation. An objective of mitigation projects should be the restoration of an ecosystem, rather than creation of artificial wetlands. Between 1948 and 1991, wetlands decreased significantly along the LCR. In many situations, once destroyed wetlands could be restored. With such extensive supplies of "lost" wetlands, mitigation efforts can be focused upon sites where habitat restoration seems the most probable.

Historically degraded wetlands retain some of their former characteristics; thus, restoration increases the likelihood of mitigation success. Pre-existing hydraulic conditions may remain intact for many years. The most notable of these pre-existing characteristics are wetland soil types which maintain their texture for extended periods of time, seedstock which may lie dormant, and fauna which may reestablish themselves from adjacent areas.

Many mitigation sites involve creation exclusively. Created wetlands are not as successful as natural wetlands. They are more costly and require much more engineering of hydrology and soils. They are often built in a location situated far from the original site of the degraded or destroyed wetland. When wetlands are made, pre-existing physical conditions of the land weigh heavily on the type of wetland introduction. It would be difficult to recreate the degraded or destroyed wetland without creating from a similar environment. Many wetland functions are inherent to a specific site. Mitigation for wetlands which were degraded along the LCR should be restored as close to the original site as possible. When wetlands are destroyed or degraded, it would be challenging to create the former ecosystem in an off-site location.

Passive Restoration

Many of the riparian wetlands along the LCR could be restored through passive restoration. Passive restoration may be defined as restoration of historically degraded or destroyed wetlands by means of limited human intervention. Passive restoration is based upon the process of self-design. Wetlands are phenomenally resilient. In some cases, historical wetlands, given the opportunity, will adapt to imposed changes and begin to recover in the absence of continued perturbations. In other cases, imposed changes, in the form of land use, need only be scaled back or removed, and historical wetlands will recover.

Given the opportunity, historical wetlands may recover with minimal human interference. The National Wildlife Refuges located on the riverine tidal section of the LCR reflect this conclusion. Soon after the Lewis and Clark National Wildlife Refuge and the Julia Butler Hansen National Wildlife Refuge were established in the early 1970's, wetlands began to recover. Dikes, levees, and jetties were in disrepair, as agriculture became less productive in these areas. Once the refuges were established, agriculture was abandoned all together. Drainage ditches became plugged, dikes were worn and floodgates leaked; thereby, wetlands started to emerge. By 1991, palustrine wetlands and forested wetlands had reclaimed most of the lowland agriculture. The rapid reestablishment of wetlands in many of the areas in the refuges demonstrates the possibilities of passive restoration.

(From Allen, T. Areal Distribution, and Restoration Potential of Wetlands within the Lower Columbia River Riparian Zone.)

CHAPTER VIII. CONCLUSIONS

Research Basis and Objectives

The LCR riparian zone is a resource which attracts habitation by humans and wildlife alike. Human activities were characterized in this study as encroaching or displacing natural habitats. Wetland habitats, among the most biologically productive areas on earth, have suffered the greatest impacts. Wetlands which were once contiguously draped along the linear features of the river, are decreasing in size and becoming fragmented. Perturbations identified by this research which destroy or degrade wetlands within the riparian zone, such as in-water activities, agriculture, and urban/development, should be managed in order to curb current rates of wetlands losses.

The basis of this research was tied to several concerns: a) wetlands have been deemed important, thereby focusing efforts on conservation and protection; b) wetland losses along the LCR are not well known, and losses need to be documented and data input into a GIS for easy use (Lower Columbia River Bi_State Program 1993); and, c) despite limited information, it is clear that the primary ecological concern along the LCR is habitat loss (Lower Columbia River Estuary Program Survey 1998).

This study addressed these concerns. The objectives were to: a) quantify the extent and location of habitat change along the LCR riparian zone from 1948 to 1991; b) determine the factors and patterns which influenced wetland habitat change; and, c) develop regional wetland habitat models which ranks areas most conducive to restoration efforts. Each of these study objectives was achieved. The locations of wetlands change were identified through the use of aerial photography and quantified via a GIS. Factors and patterns which influence wetlands change were examined through research and comparative area analyses. Potential restoration sites were located by ranking historical wetlands according to specific GIS queries.

Extent of Wetlands Change

Assessment of the extent, distribution, and type of riparian habitats associated with the LCR was necessary in order to understand why wetland habitats changed. As a result, greater awareness of the overall health of the system was achieved. A comparison of the total area of wetland habitats between each of the five coverages provided change data. Between 1948 and 1991, wetlands decreased in the estuarine section by 25%, increased in the riverine tidal section by 1%, and decreased in the riverine lower perennial section by 37%. In total, wetlands within the LCR riparian zone decreased by 12%.

The largest decrease in the estuarine section occurred within estuarine intertidal wetlands. Between 1948 and 1973 these wetlands decreased by 1284.6 hectares. In the riverine tidal section, the single largest decrease of wetlands occurred within riverine tidal wetlands. These wetlands decreased by 1777.6 hectares between 1948 and 1961. In the riverine lower perennial section, the greatest loss of wetlands occurred between 1961 and 1973 within palustrine wetlands. These wetlands decreased during this period by 1609.3 hectares.

The extent of changes in non-wetland habitats and landcover were calculated. It was necessary to determine the extent of changes in non-wetland habitats and landcover, because they provided information related to changes in wetlands distribution. Changes in agriculture, for example, impacted wetlands. Agriculture generally decreased in the estuarine section, but increased in the riverine tidal section. In the riverine lower perennial section, it increased greatly, before decreasing in 1973. Forested habitats marginally increased within the estuarine section; however, they generally declined within the riverine tidal and riverine lower perennial sections. The largest and most consistent increases in landcover were unquestionably attributed to urban development. Within the estuarine section, urban landcover expanded the least. The riverine tidal section witnessed steady urban increases, and the riverine lower perennial section consistently doubled the total amount of urban area between each of the coverage years. In the riverine lower perennial section urban landcover became more uniform, and wetlands subsequently became more fragmented.

Factors Which Influenced Wetland Change: Estuarine Section

The causes for wetland losses in the estuarine section were largely related to in-water activities, such as channelization, dredge disposal, pile dike and jetty construction, and upstream damming. Numerous cases were cited where channelization and subsequent fill disposal degraded, depleted, or precluded growth of estuarine intertidal and palustrine wetlands. Evidence supported the fact that watershed activities such as timber harvesting, agriculture, and urban/development had comparatively minor impacts on wetlands losses. For example, between 1948 and 1991, the amount of land in service for agriculture steadily declined by 43.7%. In reality, between those years, more land changed from agriculture to wetlands than did wetlands to agriculture. A mere 1.6 hectares of 1948 estuarine intertidal wetlands became agriculture by 1991.

The majority of the 25% decrease in wetlands in the estuarine section occurred within estuarine intertidal wetlands. Because these emergent type wetlands were highly dependent upon the river as their major source of water, in-water activities which altered this source had a considerable impact on their decline. Within a pristine river system, such a rapid decrease in wetlands over a short period of time is not likely to occur. Directly or indirectly, human activities were the chief cause for the changes. Following the flood of 1948, in-water activities continued in earnest, and the regulatory effects of river flow via increased flood storage capacity incrementally increased, as dam construction was completed. These actions guaranteed that the river would become increasingly disconnected from the adjacent terrestrial environment over time. By regulating annual flooding, exchanges between the river and emergent vegetation were reduced, and estuarine intertidal wetlands were not replenished. These wetlands were often displaced by upland woody vegetation such as scrub/shrub. Over time, excess water ceased to be the controlling factor in the composition of the vegetation, and scrub/shrub habitats became the dominant cover.

The effects of flooding and flood control on the LCR were complex. Wetlands responded by both increasing and decreasing. Directly after the 1948 flood, emergent wetlands increased. This flood was the second largest flood on record for the LCR. River regulating effects of upstream dams were largely not in place in 1948. Bonneville Dam, which was completed in 1938, was not specifically designed for flood control; however, it does impound water in a reservoir, thereby partially moderating minor annual flood events. Greater control was exerted over large flood events, following the construction of the John Day Dam (1968), which was designed for flood control. Because of increased flood storage capacities, emergent wetlands, such as estuarine intertidal wetlands, significantly declined on all sections of the river.

The flood of 1948 scoured estuarine intertidal wetlands and all other habitats within the river's floodplain. As the flood receded, estuarine intertidal wetlands were the first vegetated habitat to be quickly reestablished. Other habitats/landcover close or adjacent to the river, such as palustrine wetlands, forested wetlands, lowland forest, agriculture, or scrub/shrub, were, in part, initially reestablished as esturine intertidal wetlands. In essence, the 1948 flood partially reset wetland succession. Such flood events are necessary for the colonization and development of emergent wetlands, but may be very infrequent in the future.

Forested wetlands increased slightly in the estuarine intertidal section, due to the increases in flood storage capacity regulated by upstream dams. The most common trend in wetland change in this section involved estuarine wetlands becoming palustrine wetlands, which, in turn, became forested wetlands or scrub/shrub habitat. Later, successional wetland species developed.

Factors Which Influenced Wetland Change: Riverine Tidal Section

The decline of 1777.6 hectares of riverine tidal wetlands accounts for the majority of all wetland losses in the riverine tidal section. While this decline in wetlands can be partially attributed to the direct and indirect impacts of development, diking, draining, channelization, and erosional activities, most of the losses were directly accounted for as riverine tidal wetlands changed to other wetland types. Specifically, palustrine wetlands accounted for most of the change. The total number of palustrine wetlands in 1948 was relatively few, yet increased by 2644.6 hectares by 1961. The decline in riverine tidal wetlands reflects the extensive increase in palustrine wetlands. This provides further evidence of the regulatory effects of upstream damming and the necessity of flooding in order to maintain a balanced mix of a variety of wetland types.

The second greatest decline in wetlands occurred in this section as agriculture displaced palustrine wetlands. There were 1098.8 hectares of palustrine wetlands in 1948 that changed to agriculture by 1991. Interestingly, agriculture was attributed as the cause for an increase of 891.2 hectares to palustrine wetlands during the same period.

Despite significant decreases in wetlands, the riverine tidal section experienced a slight overall increase in wetlands. Wetland increases were generally caused by the proliferation of palustrine and forested wetlands and the establishment of wildlife refuges. Forested wetlands increased, especially after the late 1960s, because of the lack of flood flows. In the riverine tidal section, emergent wetlands often changed to palustrine wetlands and then to either forested wetlands or scrub/shrub habitat.

The Lewis and Clark National Wildlife Refuge was established in 1971, and the Julia Butler Hansen Wildlife Refuge was established in 1972. Historically, portions of both refuges were diked for agricultural purposes. The Lewis and Clark National Wildlife Refuge was extensively diked. Areas which were not often inundated by annual flooding and could be converted to agricultural land were diked and drained. Over 650 hectares of agricultural land converted to wetlands shortly after the refuges were established. The impacts of passive restoration were visible by 1983. Over time, agricultural land left in disuse reverted to wetlands.

Factors Which Influenced Wetland Change: Riverine Lower Perennial Section

As a percent of total area, there were fewer wetlands in the riverine lower perennial section than in the other two sections. The upstream half of the riverine lower perennial section is largely confined. The placement of roads on the comparatively smaller floodplain of both sides of the river serves to sever hydraulic linkage between aquatic and terrestrial environments more abruptly than the nearby natural elevation gain. Therefore, there was less suitable lowland space for wetlands to colonize.

The causes for wetlands degradation and destruction in the riverine lower perennial section were correlated with rapid urbanization. By 1991, the urban landscape dominated both sides of the river, forming a near continuous cover along the downstream half of the section. Between 1948 and 1991, urban growth rapidly increased by 5399.7 hectares. By 1991 merely 86.6 hectares of riverine lower perennial wetlands remained. The greatest losses of wetlands occurred within palustrine wetlands. The decline of this habitat between 1961 and 1973 represents one of the most rapid and large losses of wetlands for all wetland types in all sections. During those 12 years, palustrine wetlands were diminished by 1609.3 hectares. More than 1000 hectares of palustrine wetlands were directly displaced by urbanization. Agriculture displaced most of the remaining amount.

Much of the increase in wetlands in this section was caused by the growth of forested wetlands. Forested wetlands sharply increased between 1973 and 1991. This pattern of rapid increase within forested wetlands following 1973 occurred in all sections. With the marked reduction of flooding, forested wetlands had enough time to begin to flourish. The only wetland habitat that consistently increased within all of the river sections was forested wetlands.

Wetlands Restoration Potential

The restoration analysis in this study located historical wetlands which exemplified the best qualities needed for restoration to be successful. The research provided a template for identifying historical wetlands. Through the use of a GIS, each historical wetland was ranked into low, moderate, or high categories, based upon its potential for restoration. By applying focused sequentially-refined queries, sites were identified for restoration potential. Historical wetlands identified in the high potential model were of most importance to restoration efforts, as these sites were limited in number and could be field verified.

In the estuarine section, most historical wetlands fall into the low potential category, and many of these were considered as such because they became submerged. These submerged historical wetlands were impermanent emergent wetlands, which greatly fluctuated over time in response to in-water activities. In total, there were 1149 historical wetlands identified. Greater than 75% of the historical wetlands in the section were located within or adjacent to the active channel. Such a large amount of historical wetlands indicates that there was tremendous change in the estuarine section between 1948 and 1991. Many of the historical wetlands were originally not wetlands, but became wetlands and then changed again to a non-wetland state by 1991. There were merely 74 historical wetlands ranked as high potential for restoration, consisting of 768.5 hectares.

In the riverine tidal section there were 2997 historical wetlands. The preponderance of historical wetlands were identified as having low potential for restoration. Most historical wetlands considered as low potential became urban or were submerged by 1991. Historical wetlands were converted to agriculture were extracted from those sites with high potential for restoration. Not only was agricultural land the most common landcover in the riverine tidal section, but it had the greatest impact on the decline of wetlands. By removing historical wetlands which became agriculture, the total number of high potential sites was significantly reduced. There were 178 historical wetlands consisting of 982 hectares identified as areas with high potential for restoration.

In the riverine lower perennial section, there were 1740 historical wetlands. Of all historical wetlands 57% became urban. These sites were largely located in the downstream half of the section, especially near the confluence of the Willamette and the Columbia Rivers. Such sites were ranked as low potential for restoration. While wetlands have great value, homes, roads, and places of business are basic to human needs and activities, and are not apt to be dismantled to restore wetlands. Developed areas retain very little of their historical wetland character and would require an extensive effort to restore. It is unrealistic to consider restoring wetlands that are now developed, particularly when other, more easily restorable, historical wetlands are present. In the riverine lower perennial section, there were only 105 historical wetlands, consisting of 655 hectares, identified as having high potential for restoration.

While this study advocates restoration potential, restoration is not a surrogate for responsible ecosystem-wide stewardship of the riparian zone. Restoration will not succeed unless degrading elements are mitigated or removed. Wetlands are resilient, and, given the chance, they often recover with minimal intervention.