Case study: Isle of Wight (UK)

Technique: Wetland creation and restoration

<u>Purpose of wetland creation and restoration and expected results (protection vs. nourishment)</u>

Riparian ecosystems generally compose a minor proportion of surrounding areas, but typically are more structurally diverse and more productive in plant and animal biomass than adjacent upland areas. Riparian areas supply food, cover, and water (especially important in the arid regions) for a large diversity of animals, and serve as migration routes and forest connectors between habitats for a variety of wildlife, particularly ungulates and birds.

Wetland generally occupy relatively small areas, and their occurrence along waterways makes them vulnerable to severe alteration caused by a variety of development activities. Impacts include expanding agriculture; channelization projects; reservoir and dam construction; heavy livestock grazing; road, bridge, and pipeline construction; flood control projects.

Riparian ecosystems generally are more structurally diverse and more productive in terms of plant and animal biomass than surrounding areas.

A number of difficulties are encountered when attempting to restore riparian zones to their original condition: (1) the historical condition of rivers might not be well known; (2) ecological means of returning to a known prior condition are not understood, nor is it certain that this is possible; and (3) presence of man-caused phenomena for long periods of time may genetically alter a species to the extent that restoration may affect it unfavorably.

Success determinations would benefit from an investigation of various functions of riparian wetlands (including wildlife and fish habitat, hydrologic flow, erosion control, water quality improvement, and recreational use).

Because riparian ecosystems often are relatively small areas and occur in conjunction with waterways, they are vulnerable to severe alteration. Wetlands throughout the World have been heavily impacted by man’s activities. Riparian ecosystem creation and restoration have been used as mitigation for project impacts from highway, bridge, and pipeline construction; water development; flood control channel modifications; industrial and residential development; agriculture; irrigation; livestock grazing; mining; and accidental habitat loss.

Creation of a riparian ecosystem requires appropriate water supply and grading the topography to suitable elevations to support plantings of riparian vegetation. Restoration involves returning the ecosystem to pre-disturbance conditions and typically implies re-vegetation. Removing exotic vegetation or restoring water supplies to pre-disturbance level also may be involved.

Enhancement of riparian ecosystems commonly refers to improving existing conditions to increase habitat value, usually by increasing plant or community diversity to increase value for wildlife. Managing a riparian ecosystem typically involves enhancement techniques. However, creation and restoration projects often involve use of techniques considered more management-oriented (e.g., fencing to prevent cattle grazing until planted vegetation of a created or restored wetland is established).

Protection of an existing riparian ecosystem from impact should be of utmost importance during planning and construction phases of development projects. If loss or damage is unavoidable, wetland creation or restoration can be used as mitigation.

The sediment control, bank stabilization, and flood attenuation functions of riparian wetlands had been documented to some degree.

The Isle of Wight Centre for the Coastal Environment has been contributing to the overall objectives of Component 4 by compiling a detailed case study of a recently completed coast protection scheme at Seaview Duver. This scheme includes an excellent example of wetland restoration. The summary included in this progress report provides a general outline of the Seaview Duver Coast Protection Scheme.

Seaview Duver coast protection scheme: general summary

A £4.5 million coast protection scheme for the Seaview Duver frontage between Oakhill Road and Springvale was completed in April 2004. Constructed over a period of one year by Van Oord ACZ the project was commissioned by the Isle of Wight Council's Centre for the Coastal Environment and designed by its coastal consulting engineers, Posford Haskoning. The scheme was grant-aided by the Department for Environment, Food and Rural Affairs (Defra).

The scheme is providing the required standard of protection against coastal erosion and sea flooding for at least the next fifty years taking full account of the predicted impacts of climate change. The scheme comprises a 550m length of stone-faced reinforced concrete seawall protected on the seaward side by a rock armourstone revetment.

Additional facilities include an upgraded slipway and pedestrian walkways on the seaward and landward sides of the wall together with seating. In order to maximise the appearance of the final scheme the Council appointed John Maine RA, a sculptor and artist, to contribute to the aesthetic qualities of the design.

The foreshore and intertidal area along this part of the Seaview coast is designated as a Special Protection Area under the European Birds Directive. In order to mitigate any impacts arising from the civil engineering works on this European site the Council has acquired, for a peppercorn rent for the next fifty years, 20 acres of marshland and reedbeds on the landward side of the former toll road from the Ball family. With the assistance of English Nature, the Environment Agency, local residents and environmental specialist consultants ECOSA a nature reserve has been developed which includes public access and the provision of a hide for bird watching. The area has been improved in order to maximise the environmental quality, particularly for wading birds, ducks and geese.

The nature reserve has been named after Alan Hersey, who was for many years a Parish, Borough and County Councillor who had a great interest in the history and environment of the village of Seaview. A formal opening of the coast protection scheme took place in August 2004. The scheme has recently been awarded a special prize by the Isle of Wight Society for the quality of the conservation and landscaping work.

Basic principles

Two factors are especially important before one can either identify a problem or begin recovery processes in riparian ecosystems: (1) knowledge of the management objectives and (2) knowledge of the physical environment and biotic communities occupying the site, including the hydrologic regime, physical and chemical characteristics of the soils and substrates, potential for the site to support particular species and plant communities, and vegetation successional patterns.

Six basic ingredients for adequate riparian ecosystem mitigation planning: (1) a solid base of data concerning wildlife in the project area and in the area set aside for mitigation; (2) a thorough analysis of the data; (3) creation of predictive models with which to create, in theory, a design for the mitigation; (4) design of required modifications, including site preparation (e.g., clearing, rootripping, leveling, installing an irrigation system), equipment needs, costs, and a careful analysis of probable delays; (5) design implementation, including labor requirements and labor sources; and (6) monitoring, including methods of gathering information, analytical and interpretive techniques, and staff requirements.

When planning a creation or restoration project, close proximity to existing high quality riparian ecosystems is advantageous for the added benefit of recolonization.

Expected benefits

Environmental benefits

Wise management of remaining riparian ecosystems or replacement of these communities is extremely important because of their high value as fish and wildlife habitat. Riparian ecosystems generally are characterized by increased structural diversity of vegetation compared to surrounding plant communities and an increased edge effect for area occupied.

Direct openings to the sea permit water exchange that can prevent stagnation and oxygen depletion, renew organic material and nutrients, and allow export of materials such as detritus, plankton, and aquatic invertebrates to the sea. Fish are known to readily enter backwaters, especially for spawning, and the free movement of fish into and out of these areas in response to changing conditions is important for maintaining healthy populations.

In general, cover increases habitat complexity, which can lead to a richer species complex. Cover provides hiding places for both adults and fry to escape predation. Its slowing effect on water velocity provides a metabolic resting place.

Improvement of riparian ecosystems also may increase groundwater storage

Vegetation influences soil erosion in several ways: foliage and leaf residues intercept rainfall and dissipate energy, root systems physically bind or restrain soil particles, residues increase surface roughness and slow velocity of runoff, roots and residues increase infiltration by maintaining soil porosity and permeability, and plants deplete soil moisture through transpiration, giving the ground a “*sponge effect*” to allow it to absorb water.

Loss of riparian vegetation in the channel has little effect on bank erosion, but loss of riparian vegetation in the floodplain zone does have a major impact on bank erosion. Revegetation in this zone can provide significant resistance to bank scouring because lower velocities permit plant establishment on most of the streambank. If not carefully planned and implemented, stream channel alteration (e.g., narrowing, straightening, diverting) also can greatly increase bank erosion.

Selecting the adequate wetland creation and restoration techniques

Establishing environmental mitigation strategies

A general goal is to reverse (or mitigate) the damage that has or will occur to a wetland, and to answer regulatory concerns. Goals are usually broad and not site specific. Goals direct the project to restore and improve wetland functions, such as flood storage, sediment trapping, food chain support, community diversity, biological productivity, and fish and wildlife habitat. Objectives, on the other hand, are more site specific and direct the actions of the project (e.g., to revegetate disturbed areas with native trees and shrubs to provide wildlife food, cover, and nest sites; to provide an additional 1 acre-foot of storage capacity within the wetland to function as a storm water retention/detention basin).

The goal of a project may not be to re-establish the former riparian situation, if that situation is degraded. The goal should be to establish a new equilibrium condition that supports a viable riparian zone. The overriding consideration in planning a riparian ecosystem rehabilitation program may be to determine the rehabilitation potential of the target area and identify the root causes of the degraded condition. Causes must be resolved before an improvement project is initiated. Riparian zone rehabilitation should not circumvent the real causes of stream degradation. Natural recovery processes must be understood and incorporated in the rehabilitation. Objectives of the rehabilitation program should consider existing and future watershed condition, hydrologic regime, and the desired rate of recovery.

A comprehensive set of methods used for evaluating riparian habitats. Topics include sampling schemes, measuring vegetation, classifying riparian zone communities, determining various features of the soil, remote sensing, water column measurements, streambank morphology, measuring and mapping organic debris, historical evaluations, and use of benthic macroinvertebrates to evaluate stream riparian zone conditions.

In degraded situations where historical information is insufficient to formulate a design format, the use of comparable areas that have been least disturbed and managed as natural areas may be necessary to guide the revegetation plan. Techniques for assessing vegetative distribution patterns for formulating a working planting design involve a review of historical context and the selection of comparable areas to inventory for distribution, community and soil patterns, canopy heights, and elevational transects in relation to stream flow.

Knowledge of the geologic variability and geomorphological characteristics of drainage patterns can help predict water storage capacity for streams being reclaimed for riparian zone values.

Both site characteristics and the biological aspects of target species need to be considered in the management of riparian systems. Site characteristics include the climate (precipitation cycle, temperature ranges, length of growing season), soils (structure, fertility, topography, residual pesticides), water control potential (water supply/source, levees, control structures, pumps), plants (composition, structure and maturity, seedbank), and disturbance (man-induced perturbations, public use, research and management activities). Biological aspects of target species include chronology (migration, breeding, molt), nutritional requirements (population size, migration, breeding, molt), social behavior (foraging modes, breeding strategies), significance of location (local, regional, continental), status (endangered or rare, recreational value), and multispecies benefits.

Preliminary efforts should entail classification, inventory, and evaluations from which critical aspects of the project design can be determined.

In the past, governmental reclamation agencies have relied heavily on planting design techniques dependent on exotic plant materials to achieve simplistic goals of erosion control, environmental tolerance (e.g., drought for flooding tolerance, soil tolerance, browsing tolerance), and aesthetic improvement. Today, use of exotic plant materials is still entrenched in riparian projects. But the use of native riparian plants should be expected to increase as more managers realize the value and ecological diversity that native riparian systems offer.

Topics include matching original channel length, slope, meander pattern, depth, and width; sloping banks; stabilizing banks with riprap and vegetation; planting trees and shrubs; fencing; using suitable substrates; installing culverts and stream crossings; and using instream structures (boulders, low rock and stone dams, deflectors).

Many techniques involve planting or seeding either as the main technique used or to supplement other techniques (e.g., seeding grasses to accelerate vegetation recovery on fenced sites; planting trees or shrubs to accelerate establishment of riparian growth on banks of relocated streams).

Seeding sites is less expensive than transplanting cuttings or seedlings. Direct seeding eliminates costs associated with growing seedlings in a nursery and is less time-consuming than transplanting seedlings. However, seeding of shrubs and trees is generally less successful than transplanting cuttings or seedlings.

Covering seeds is essential to most germination and seedling establishment. Various methods can be used to enhance success rate of the simple hand broadcast method of seeding, including seed drilling, hydroseeding, or cyclone seeders.

Erosion control matting/blankets of dead plant materials or organic material provide temporary cover for exposed soils and moderate the effects of rainfall impact, runoff velocity, and blowing winds, and are particularly important when seeding slopes to provide protective cover for seedbeds, reduce evaporative losses, and stabilize seed location until germination. Matting made of straw, wood or coconut fibers, or synthetic materials costs more than simple layers of straw, but is more efficient.

Fertilization and irrigation often are used to enhance initial seedling establishment. Fencing may be necessary to protect seedlings from wildlife (e.g., rabbits, deer) or cattle grazing.

Time of planting is important (winter is the best time for planting desert riparian areas due to lower evaporation rates and thus greater saturation of soil from surface to water table). Certain precautions are necessary when using this method, including fencing the area from livestock, avoiding flooding for periods longer than 3 weeks, and controlling beaver activity.

Creation of riparian ecosystems, or restoration of severe channel damage, typically involves some type of landforming. Landforming can consist of relocating a stream, recontouring a channel by sloping banks, building meanders, creating pools, or creating marshes or ponds within the stream.

In urban areas, stream restoration is an alternative to conventional channelization involving stream straightening and deepening with heavily riprapped banks. A channelized stream may be restored by removing brush, debris, and dead trees that blocked water flow; sloping banks to less than vertical inclination; sloping meander bends to produce sandbars; seeding banks; and sparingly using riprap along highly erosive slopes. The result is an aesthetically pleasing urban stream with greater wildlife habitat potential and lower flood hazard.

Several studies have used instream devices in conjunction with efforts to restore riparian ecosystems. Instream devices are primarily used to enhance fish habitat by increasing flow, creating riffles and pools, restoring gravel spawning beds, and increasing fish access. Instream devices also can provide bank stability, thereby aiding in restoration of riparian vegetation.

Factors influencing the success of wetland creation and restoration schemes

Knowledge of particular combinations of substrate, microclimate, nutrient and water level regime, and the dynamics of riparian plant communities in both time and space, will greatly aid in riparian ecosystem creation or restoration.

Selection of plants for revegetation may involve not only consideration of native wildlife species, but also of plants that provide necessary resistance to erosive stream flows in heavily eroded areas.

Sediment texture also can influence establishment of riparian seedlings. On gravel bars willow establishment was higher on bars where surface sediment size was less than 0.2. Cottonwood (*Populus fremontii*) established more densely on areas of intermediate and large-sized sediments (0.2-1.0 cm), and mule fat (*Baccharis viminea*) dominated on larger sediments. Changes in gravel bar landforms can result in significant losses of established trees as well as young seedlings and saplings. Areas protected from swiftest currents are best suited to withstand high winter flows that can occur in this area.

A number of limiting factors may affect the success of bottomland hardwood: drought during the growing season or a late freeze following plantings; standing water and high temperature on sites with young seedlings; flooding on sites where the species planted are not adapted for the duration or depth of flooding; damage or destruction of seeds or seedlings by rodents, rabbits, or deer; and poor seed viability or poor quality of nursery stock.

Field and experimental studies have demonstrated the influence of various environmental conditions on the species composition of bottomland hardwoods. Study on the tolerance of various bottomland hardwoods to water-saturated soil indicated that occurrence of continuously saturated soil conditions for long, but varying, periods in bottomlands results in a competitive advantage for certain species (e.g., green ash [*Fraxinus pennsylvanica*], willows) and subsequently affects species composition of bottomland stands. Amount of exposure to direct sunlight and amount of litter and ground cover also can affect species composition, with cottonwood (*Populus deltoides*) and willow seedlings preferring direct sunlight and lack of litter.

Selection of plant species for re-vegetation can be complicated by the fact that riparian communities are not always a distinct climax biotic community.

A properly designed monitoring system is vital to determining success of riparian ecosystem creation/restoration efforts. Equally important is that project objectives be stated in quantifiable and measurable terms. Meeting an objective of returning a riparian site to “original conditions” or a close approximation thereof, may be difficult because those conditions may not be known due to the site’s long history of human impacts. Collection of historical data on the site can greatly aid in development of a restoration site plan and success criteria. Several studies have used historical regional lists to determine desired plant or animal diversity of the completed.

Many techniques used to document and monitor riparian habitats are untested, and some are designed to optimize time rather than accuracy. The value of information obtained from monitoring wetland creation/restoration projects depends on the precision, accuracy, and comprehensiveness of the data used for interpretation and decision making. Because past measurements can seldom be verified for quality, data must be collected with tested methods using a valid sampling design, followed by proper analysis and interpretation.

Guidelines useful for monitoring wetland creation/restoration efforts are included in sections concerning sampling schemes, measuring vegetation, classifying riparian communities, determining various features of the soil, remote sensing, water column measurements, streambank morphology, measuring and mapping organic debris, and use of benthic macroinvertebrates to evaluate stream riparian conditions.

Determination of parameters to be monitored should be based on project goals and objectives and may include both independent (i.e., habitat) and dependent (i.e., population) parameters. Examples of independent parameters include frequency and duration of flooding; groundwater dynamics; channel morphology; streambank stability; streamflow characteristics; water quality; vegetative composition, cover, and production; and stream shading. Dependent parameters may include density and diversity of fish and wildlife populations. Frequency of monitoring is based on project goals and deadlines. Monitoring can be conducted frequently in the beginning and less frequently after rates of trends are determined. By far, the most common monitoring method has been to evaluate plant growth and survival over time. Monitoring plant species distribution below the level of community dominants provides superior benchmark information as well as a more sensitive scale to detect changes in water level, substrate type, and nutrient status.