Chapter 4: Corridor Benefits

Natural Resources Conservation Service (NRCS)

INTRODUCTION

As habitats continue to be lost to various types of development and landscapes are increasingly fragmented, land managers are relying on the ecological functions of corridors to conserve soil, water, fish and wildlife. Conservation of these basic resources provides benefits for individual landowners and the larger community. The benefits associated with corridors can be grouped into three categories:

- **ENVIRONMENTAL BENEFITS**
- **SOCIAL BENEFITS**
- **ECONOMIC BENEFITS**

The last section of this chapter discusses the potential adverse impacts that also can be associated with corridors.

ENVIRONMENTAL BENEFITS

The environmental benefits of corridors come from those functions that improve the condition of the watershed. Two general kinds of environmental benefits are provided by corridors:

Environmental Services

- Reduced flooding
- Reduced soil erosion
- Improved water quality
- Increased water quantity
- Groundwater recharge
- Bank stabilization
- Improved air quality

Habitat

- Terrestrial
- Aquatic

ENVIRONMENTAL SERVICES

Stream/riparian corridors and attendant wetlands in floodplains provide floodwater storage, desynchronize flood flows and slow flood velocities. Downstream flooding and the potential for flood damage are diminished when floodwater volume and velocity are reduced. Stream banks stabilized by the roots of riparian vegetation reduce bank erosion, a major source of sedimentation in some streams.

Stream corridors also function as sponges retaining soil moisture, and in some locations recharging ground water supplies. Water stored in soil is released slowly back into rivers and streams, which helps maintain stream flows and sustain aquatic life during dry seasons.

During the growing season, healthy riparian vegetation intercepts most of the sediments and agricultural chemicals in sheet and shallow subsurface flow originating in fields and pastures before they can reach streams or rivers. This filter function of riparian buffers protects many wetlands, lakes, and streams at a critical time when they are nutrient stressed and prone to eutrophication. In the fall some of the nutrients produced in riparian corridors are released when leaves, grass, needles and limbs fall or are washed into streams and rivers. This cycling of nutrients supplies the food energy required to support diverse populations of aquatic organisms throughout the stream system. Forested stream corridors are also an extremely important source of woody debris for fish habitat, bank armouring, and as natural grade control structures (Figure 4-1).

Figure 4-1: *The woody debris in this stream channel provides critical habitat for native trout and dampens erosion of the stream bank.*

Continuously vegetated riparian corridors are more effective at maintaining both surface and subsurface water quality than those that are discontinuous. Water quality is strongly influenced by water temperature. A slight increase in water temperatures above 59º F will produce a substantial increase in the release of sedimentary phosphorus, which can result in eutrophication. Thus, a leafy canopy provided by woody riparian vegetation can reduce the adverse affects of pollutants. In addition, cool water, which has a higher oxygen content, is necessary to support populations of many game fish, particularly trout and salmon. A cool, moist microclimate, is also a requisite for many terrestrial species. For a more detailed discussion of the environmental services provided by stream/riparian corridors, see *Stream Corridor Restoration: Principles, Processes, and Practices* (www.usda.gov/stream_restoration).

Introduced upland conservation corridors are usually designed to function as barriers, filters and sinks. They reduce soil erosion caused by wind and water, conserve soil moisture, trap sediments and absorb agricultural chemicals. Shelterbelts reduce wind velocity for a distance of 8 to 10 times their height on the lee side.

When wind velocity is diminished it has less energy to dry out soil and plants and to dislodge and transport soil particles. Continuous windbreaks eliminate the problem of airflow through gaps or around the ends of windbreaks which can significantly diminish their effectiveness. A continuous windbreak or remnant corridor is also more effective at capturing and retaining snow in the field. Captured snow can represent over 20% of the annual soil moisture in north central agricultural areas (Figure 4-2).

Researchers report field barriers of tall wheat grass reduce potential wind erosion to nearly 7% of open field erosion. When the volume of airborne soil particles in the watershed is reduced, air quality is enhanced.

Windbreaks, buffer strips, field borders, grassed waterways, and roadsides, like riparian corridors, are effective sediment traps and nutrient sinks. An estimated 95% of sediments from row crop fields were trapped in grassed waterways in an Iowa study area. In Illinois, grassed waterways and forest buffers reduced nitrates in subsurface water an estimated 80 to 90%. Corridor vegetation can, however, be overwhelmed by sediments and chemicals and absorption capabilities may be reduced significantly.

Figure 4-2: *This windbreak captures snow which increases soil moisture in adjacent fields and provides critical winter wildlife habitat.*

Environmental Services: Value-Added Benefits Of Connectivity

A linked system of various conservation corridor types properly sited will optimize soil and water conservation in the watershed by:

- Increasing efficiencies
- Integrating ecological functions

When terraces, filter strips and other conservation management practices are linked to grassed waterways and riparian buffers, the value-added benefits include longer concentration times for overland water flows, increased infiltration, and increased retention time, which facilitates assimilation of nutrients.

Systems of upland corridors can make a significant contribution in reducing flood water volume, sedimentation, and pollutants in adjacent receiving streams. The Nutrient and Sediment Control System developed by the NRCS in Maine combines sediment basins, filter strips, constructed wetlands, and deep ponds into a single, connected system that has a 90% removal rate for sediment and phosphorus, even after extreme storm events.

Habitat

Habitat is defined here as the ecosystem in which a species lives. Each species responds differently to physical variables in the ecosystem including the pattern of patches, corridors, and matrix. For example, wildlife differ in their ability to disperse. Some species like reptiles have physical limitations, others have behavioral or physiological limitations. Most species are not limited in their ability to use corridors but experience high levels of mortality dispersing across landscapes that do not have corridors.

Many species instinctively seek patterns, which meet their needs for food, cover, water, space, reproduction, and security; others learn this information (Figure 4-3). The high edge to interior ratio of most corridors makes them particularly attractive to edge habitat species. However, because corridors often do not provide all the requisite resources, the home range of many species extends beyond the corridor into adjacent patches and the matrix.

Figure 4-3: *Many large mammals use traditional migration corridors between summer and winter range.*

Researchers studying roadsides found several factors affected corridor use by wildlife:

- Type of vegetation in the corridor
- Type of vegetation adjacent to the corridor
- Surrounding land uses
- Corridor management
- Geographic location

Many wildlife species in agricultural landscapes have adapted to wooded corridors and expanded their range. Others that require large patches of forest or prairie have been displaced. The habitat value of corridors in highly fragmented landscapes is well documented. Riparian corridors, shelterbelts windbreaks, and roadsides have been extensively researched. Less research has been done on the habitat value of field buffer strips, grassed waterways, conservation terraces, powerline and other introduced corridors.

Stream/Riparian Habitat

Stream corridors are among the most productive habitats in all regions of the country. They are particularly important in arid and semi-arid landscapes. The vegetation in most riparian zones is structurally more diverse and biomass production is higher than the adjacent matrix providing an increased diversity of niches for wildlife to exploit. In addition, water, aquatic insects, and fish provide resources supporting wildlife species that require both aquatic and upland environments.

Wildlife species diversity and density are high in riparian zones. In a Blue Mountain study area in eastern Oregon, 75% of the terrestrial vertebrates were dependent upon or preferred riparian habitat. Biologists Stauffer and Best estimated an average of 500 breeding pairs of birds per 100 acres in riparian corridors in Iowa compared to 340 pairs in upland forests. Bird densities in riparian zones in Arizona were 66% higher than densities in the adjacent desert upland (Figure 4-4). Riparian corridors are also important travel lanes for many species. They may be important for dispersal as well as movement within species home ranges.

Figure 4-4: *Many birds native to Arizona like this cardinal rely on riparian habitats for food and cover.*

Figure 4-5: *Generations of woodpeckers, flickers, and bluebirds have been reared in this windbreak snag.*

Windbreaks and Shelterbelts

The diversity of ecological niches and weather protection afforded wildlife by windbreaks are particularly important in agriculturally dominated landscapes. Windbreaks provide food, nesting, brooding, loafing, thermal, and escape cover for many species of birds and mammals (Figure 4-5). They are also used as travel lanes by both migratory and nonmigratory species. Windbreaks are important resting stops for songbirds during spring and fall migration. At least 108 species of birds are known to use shelterbelts for foraging, nesting, or resting.

In seven Minnesota windbreaks, a mean nest density of 36 nests per acre was reported. Researcher Shalaway reported higher nest success for low and mid-level nesting species in fencerows than in native shrub or woodlands.

Windbreaks are an important habitat component for many game species including: the ring-neck pheasant (*Phasianus ciolchicus*), northern bobwhite (*Colinus virginianus*), mourning dove (*Zenaida macroura*), wild turkey (*Meleagris spp.*), eastern cottontail rabbit (*Sylvilagus floridanus*), western cottontail rabbit (*Sylvilagus audubonii*), gray squirrel (*Sciurus carolinensis*), fox squirrel (*Sciurus niger*), and whitetail deer (*Odocoileus virginianus*). Windbreaks and remnant wooded corridors are used as travel lanes by carnivores like the gray fox (*Urocyon cinereoargenteus*) and other mid-sized predators.

Figure 4-6: *This unmowed grassed waterway offers habitat for ground dwelling bird species.*

Grassed Waterways and Buffer Strips

Grassed waterways and in-field buffer strips are typically seeded in a monoculture of exotic grasses and share similar locations embedded in the agricultural matrix (Figure 4-6). However, they are important habitats for many ground nesting species and species that prefer early successional vegetation. Fourteen bird species were observed nesting in grassed waterways in one Iowa study. Nest densities of over 1,100 nests per 250 acres of grassed waterways were reported. These nest densities exceed densities found in no-till and cropped fields. Dickcissels (*Spiza americana*) daily survival rates when nesting in grassed waterways were the same as those reported for old fields and prairie remnants. Researchers suggest grassed waterway habitats could be even more productive if seeded with a mix of native grasses and forbs.

Figure 4-7: *Pheasants are a primary beneficiary of quality roadside habitat.*

Other Corridors

Roadsides and field borders also share common locational and structural characteristics. Although exceptions exist, they are typically on the edges of the agricultural matrix and are dominated by a few grass species. However, biologists working in Minnesota report that roadsides support over 300 species of plants and wildlife including some of the last remnant populations of native grass and forb species in the state.

Wildlife biologists have extensively researched the value of roadsides as habitat for wildlife, particularly game species (Figure 4-7). In intensively farmed landscapes, roadsides are a particularly important habitat component for ring-neck pheasants, gray partridge, cottontail rabbits, and a number of songbirds. Researcher Lars Anderson reported 27 species of birds using Utah roadsides from April to November; 12 of these species are known to nest in roadsides. Researchers reported relatively high levels of bird species richness in upper Midwest roadsides. An estimated 27% of the pheasants recruited into the fall population in Minnesota were produced in roadsides. Although losses to predation and parasitism for pheasants and songbirds nesting in roadsides are relatively high, they generally do not exceed those of the matrix.

Wildlife Habitat: Value-Added Benefits Of Connectivity

Biologist Reed Noss notes that two effective ways to improve habitat quality while mitigating the effects of fragmentation are to increase effective habitat area and connectivity. Conservation corridors are one tool that can do both. In our highly fragmented landscapes, the value of connecting habitats far outweighs the potential disadvantages. Some of the potential value-added benefits of connecting patches with conservation corridors for wildlife include:

- Increased habitat area
- Increased opportunities for colonization
- Habitat accessibility
- Increased niche diversity
- Escape cover

Increased Habitat Area

Perhaps the most significant benefit of conservation corridors in urban or agriculturally dominated landscapes is increased habitat area. For instance, a continuous 30-foot wide windbreak that surrounds a quarter section of agricultural land can add over 3-1/2 acres of valuable wooded habitat. As Noss points out: "corridors, even narrow ones, provide habitat in which some kinds of organisms will live and reproduce."

Additional habitat benefits can be realized if corridor width is increased (Figure 4-8). Wider corridors obviously increase total area but they also provide for the life requirements for a greater diversity of species. In addition, wider corridors if properly designed may mitigate some of the negative effects of edge and contain some forest interior habitat.

Figure 4-8: *The lower end of this riparian corridor is wide enough to provide habitat for interior dwelling species.*

Increased Opportunities for Colonization

Properly located conservation corridors that connect with each other and adjacent patches may facilitate immigration and colonization of habitat patches within the watershed. Researchers studying white-footed mice (*Peromyscus leucopus*) in Ontario found that a network of corridors which connected shelterbelts to woodlots was beneficial for recolonization of vacant patches.

Corridors designed to meet the specific requirements of species vulnerable to local extinction can reduce their risk. Immigration may help sustain local populations and connected patches may facilitate recolonization of areas within the local species extinction.

When a network of several alternative corridors or "stepping stone" patches are provided within the landscape, additional value-added benefits may be achieved (Figure 4-9). A redundant network may increase dispersal opportunities in the event that one or more of the corridors are blocked, severed, or made temporally dysfunctional by disturbance such as fire, drought, or insect outbreaks.

Figure 4-9: *Parallel windbreaks in this Missouri landscape provide wildlife alternative routes from upland patches to the riparian corridor.*

Habitat Accessibility

Corridors connecting patches increase overall habitat quality within the watershed. They provide wildlife relatively safe access to a diversity of habitat resources, which are typically dispersed across the landscape and may change with climate and seasons. Corridors facilitate dispersal among subpopulations increasing the growth rate and stability of these populations through recruitment and colonization. Researchers found corridors that connected drainageways to ridges supported greater species richness and abundance than corridors limited to a single topographic setting (Figure 4-10). Introduced corridors aligned perpendicular to stream corridors facilitate wildlife migration from uplands to riparian areas and wetlands during times of drought. When corridors are aligned with natural wildlife travel patterns, movement and access to different habitats are greatly enhanced; for wide-ranging species, effective foraging area also may be increased.

Figure 4-10: *This network of interconnected riparian and upland corridors will provide for greater wildlife diversity in this agricultural landscape.*

Increased Niche Diversity

Connected landscapes can facilitate natural ecological functioning, which in turn may increase niche diversity. Connectivity, perpendicular to the long axis of a corridor (lateral connectivity), can be as important as connectivity along the long axis.

Natural flooding, channel meandering, scouring, and sediment deposition all require lateral connectivity. Natural flooding, which creates conditions for plant succession, can reset forest stand age diversity and increase the diversity of niches. Indeed, some species like the least bell's vireo (*Vireo bellii pusillus*) are highly dependent on the 3 to 5 year old riparian vegetation fostered by periodic flooding. Increased niche diversity may also increase wildlife species richness. Biologist Schroeder and others found breeding bird species richness increased in shelterbelts as niche diversification was improved by the addition of snags and increased foliage height diversity (Figure 4-11). The same is true for bats.

Figure 4-11: *Diverse vegetation types, heights, and spacing make this corridor a rich habitat for many species.*

Escape Cover

Generalist carnivores and omnivores appear to benefit from fragmented landscapes and may be a strong factor in the decline of prey species in agricultural landscapes. Corridors connecting patches may bring prey/predator relationships into a better balance by allowing prey species more options to move with greater safety among patches.

SOCIAL BENEFITS

Perhaps the most important social benefits are the environmental services corridors provide. After all, clear air, an adequate supply of clean water, and productive farm, forest and range lands are essential to all life including humans. Other significant social benefits that corridors provide include:

- Recreation
- Education
- Aesthetics

RECREATION

Outdoor recreation has always been a significant part of American social life. In today's fitness conscious society, demands for outdoor recreation are increasing. Much of the demand has focused on the recreation opportunities corridors afford. The linear configuration of corridors makes them well suited for a variety of recreational activities, especially trail oriented sports. Trails provide a venue for:

- Hiking
- Walking
- Jogging
- In-line skating
- Cycling
- Cross-country skiing
- Horseback riding
- Nature photography
- Wildlife viewing

Figure 4-12: *Walkers enjoy a cool spring afternoon in an urban greenway.*

Riparian corridors are especially attractive locations for trails (Figure 4-12). The presence of water, diverse vegetation, moderated climate, and abundant wildlife enhances the recreation trail experience. Boating, rafting, kayaking, tubing, fishing, and hunting are popular non-trail activities in many corridors with perennial flowing water. Some riparian corridors have become so popular that demand frequently exceeds the social and ecological carrying capacity. Social conflicts between different types of users and degradation of the riparian resource often result.

Other types of corridors are used extensively by recreationists. The highly successful Rails-to-Trails program has converted thousands of miles of abandoned railroad ROWs into recreational trails. An excellent example is the 12-mile trail along the Wood River between Hailey and Ketchum, Idaho, used by commuters as well as recreational cyclists.

Shelterbelts, field borders, grassed waterways, canals, and other types of strip corridors become important recreational resources during the hunting season (Figure 4-13). Pheasant and quail hunters appear to be more successful in areas with shelterbelts and other types of woody cover. Research findings indicate Kansas hunters spent an average of 40% of their hunting time in or near shelterbelts, more than 80% spent at least some time hunting in shelterbelts during the season. These figures are particularly impressive given the small percentage of the Kansas landscape devoted to shelterbelts.

Figure 4-13: *Three good friends enjoy a hunt in quality habitat.*

Recreation: Value-Added Benefits of Connectivity

- Continuity of experience
- Safety

One of the value-added benefits of corridor connected landscapes for recreationists is the continuity of experience that connectivity provides. Hunters prefer to hunt in loops to and from the point where the hunt begins allowing continual hunting in promising habitat. A system of connected corridors and patches provides this opportunity. When rivers and streams are free of obstructions like culverts, dams, or diversions, water related recreationists can kayak, tube, and fish without having to continually get in and out of the water. In both cases, recreationists are free to concentrate on their recreational pursuit in an environment that adds richness to the experience.

A safe corridor can reinforce recreational experiences. Continuously linked corridors with trails are safer than corridors crossed by roads or railroads, pastures, fields or fences. The City of Boulder, Colorado installed expensive trail underpasses at all road crossings along Boulder Creek to minimize risks for recreationists. If road crossings and other barriers are minimized, costly retrofits can be avoided later.

Education

Rich in species diversity and typically accessible remnant, riparian, and regenerated corridors are ideally suited to outdoor education. Trails in corridors lend themselves to a variety of formal and self-guided interpretative nature programs and educational experiences including:

- Natural history
- Taxonomy
- Archeology
- History
- Environmental science
- Experimental design
- The arts

Figure 4-14: *The fish and aquatic insects caught by these youngsters will be the basis for a class discussion on the aquatic food chain.*

Increasing numbers of science teachers are taking their classes outdoors, often into corridors to collect specimens and conduct experiments (Figure 4-14). They have discovered that students learn more and retain concepts longer when involved in hands-on educational experience.

Perhaps more importantly, corridors afford opportunities to investigate nature on your own. Harvard historian John Stilgoe noted a strong correlation between adults with a strong environmental ethic and the opportunities they had at an early age to explore nature. Researchers Black and others found people living near riparian corridors were more knowledgeable about wildlife than those living only a few blocks away. The lessons learned in corridors may be extremely important in molding future generations of conservationists.

Archeological and cultural sites are often concentrated in riparian corridors. The juxtaposition of cultural and natural resources presents exciting opportunities to interpret the role societies past and present have played in the evolution of a landscape. These sites are also well suited to illustrating the importance of corridors in maintaining landscape health, stability and quality of life.

Some corridors are a valuable resource for research. National Resource Council researchers argue that ecologically stable stretches of riparian corridors should be preserved as research reference benchmarks. At a smaller scale, remnant plant communities and wildlife populations are occasionally found in roadsides, railroad ROWs and other types of corridors. They are a valuable source of information about the ecology of native plant communities. Remnant plants may also be a source of regionally adapted seed for restoration experiments and projects within a watershed.

Education Value-Added Benefits of Connectivity

- Safety
- Ecosystem transects

Corridors, a great education resource, are even a greater resource when not bisected by roadways. Teachers can focus on teaching rather than worrying about students wandering across roadways. Corridors can be used to connect urban and rural areas. As our society becomes increasingly urbanized, people lose contact with natural ecosystems and the agricultural practices that sustain human life. Corridors that originate in cities and towns and pass through rural environments allow urban residents to experience natural and agrarian landscapes. Winding through a mosaic of hay fields, pastures, and farm buildings, greenways can provide exposure to agricultural environments (Figure 4-15). Such exposure may facilitate better understanding and appreciation of farming and ranching, increasing respect for landscapes that support these activities. Careful trail design is necessary to protect the property rights of landowners.

Aesthetics

Visual resources that define a landscape's aesthetic quality are the lines, forms, spaces, colors, and textures experienced from where people live, work, recreate, and travel. The quality of visual resources is important to those who reside in and travel through a landscape. Wooded corridors are often the most significant visual lines, forms and space defining structures in the landscape. Wooded corridors provide:

- Spatial structure
- Sense of place, identity
- Complexity, legibility, coherence, and mystery
- Seasonal diversity

Many landscapes along the eastern seaboard, in the Midwest, and across the South are a rich mosaic of woody patches and open fields defined by corridors of uncut trees along property lines. On the Great Plains and westward, shelterbelts and windbreaks give a sense of place to homesteads and rootedness to communities. These unnantural blocks and baffles of vegetation punctuate and partition the prairie. They provide a visual structure and scale against which vastness can be measured. In the West, mountains dominate the background but it is the flowing lines of riparian corridors that give human scale to the foothills and valley floor. Place names like Wood River Valley, Verde Valley, and Snake River Plains attest to the impact of riparian corridors on the regional consciousness. Occasionally the visual richness of a riparian corridor is extended into the uplands by canals, ditches, and grassed waterways.

Figure 4-15: *A view from this trail helps the observer understand that agriculture and the natural landscape can co-exist in harmony.*

Corridors also enhance scenic quality at a more intimate scale. Roadsides, railroad ROWs, canal banks, and field borders vegetated with native plants add textural diversity and seasonal color that enrich our experience of the landscape. Corridors also screen unsightly areas and buffer noise from highways and other sources. They make a significant contribution to the quality of rural life.

Figure 4-16: *The broad expense of river, floodplain, bluffs, and prairie make the Minnesota Valley NWR a visual reference for Twin City residents.*

Aesthetic Value Added Benefits of Connectivity

The added visual amenities provided by a system of connected corridors include:

- Enhanced sense of place
- Link to cultural resources

One lesson painting has taught us is that all things are connected. A composition is created by lines, forms, colors, and textures that knit the diverse elements of the painting together into a unified composition. As observers of paintings, humans are frequently fascinated with the skills the artist used to achieve unity.

Connected corridors, particularly wooded corridors are important lines and forms that unify diverse elements in the landscape. Research by Steven and Rachel Kaplan suggests that people prefer landscapes that exhibit coherence, complexity, legibility and mystery. Connected corridors can create these qualities . A landscape of linked corridors and patches is a legible landscape that humans can comprehend and appreciate.

The Minnesota Valley National Wildlife Refuge is a dominant visual element for those living in the Twin Cities metropolitan region (Figure 4-16). Similarly, the Big Sioux River riparian corridor in eastern South Dakota is a visual reference for residents in this rural area.

Linked remnant corridors of woody vegetation in the upper Midwest, east coast, and southeast are visual reminders of historic landscape. Because many of these corridors are still linked, they have a scale that projects an impression far more powerful than disconnected, isolated remnants.

Research has also shown that people appreciate rural settings that have a mixture of cultural and natural resources. Old roads, stone walls, canals, cemeteries and similar historic structures are often concentrated in corridors, and can be incorporated into a conservation corridor program that protects both biological diversity as well as historical character (Figure 4-17). A value-added benefit of connectivity is that we can protect the special sense of place that rural areas enjoy by protecting existing connections and by re-establishing historic linkages.

Figure 4-17: *The ruins of this pre-historic Native American community are located adjacent to the Verde River floodplain in Arizona.*

ECONOMIC BENEFITS

Natural corridors provide economic benefits and values because they satisfy human wants or needs. Often, these values are not readily apparent and are difficult to estimate because they are not traded on a market. Researchers Thibodeau and Ostro used cost/benefit analysis techniques to calculate the value of wetlands in the Charles River riparian corridor near Boston. They estimated the value of land cost increase, water supply, flood prevention, pollution reduction, and recreation at between $153,000 and $190,000 per acre. They noted that some of these benefits were realized by owners of wetlands in the corridor, however, the majority of benefits accrued to the larger community within the watershed.

Benefits from introduced corridors include:

- Environmental services
- Increased crop yields
- Increased crop quality
- Increased livestock production
- Improved livestock health
- Reduced energy consumption
- Increased property values
- Recreation revenues

Environmental Services

Productive topsoil is arguably this country's most valuable resource. An estimated 240 million tons of topsoil are eroded annually from Iowa farms and washed into the Missouri River. In a 1992 report, the National Research Council suggested grassed waterways, field borders, buffer strips, conservation terraces, and other introduced corridors that reduce soil erosion and sedimentation can make a significant contribution to the long-term economy of rural watersheds.

Sediments deposited over river bottom sand and gravel beds are a major cause of decline in Midwest aquatic species diversity. Reduced levels of sedimentation improve fisheries and enhance their economic revenues. Lower sediment loads also reduce the rate of filling in reservoirs, canals, and drainage ditches prolonging their utility. The economic returns from these various environmental services can be substantial.

Increased Yields and Quality

Corridors, like shelterbelts, grassed waterways, terraces, and other corridor type conservation practices generate economic returns exceeding the cost of installation and maintenance. In a study in Kansas and Nebraska, small grain production on the leeward side of windbreaks increased between 18 to 38% for a distance of 3 to 10 times the windbreak height. In a 6-year study in Nebraska, researchers estimated a 15% yield increase in winter wheat in fields protected by shelterbelts. They estimated that shelterbelts would pay for themselves within 15 years.

Increases in yield of 5 to 50% and improved crop quality were reported by agronomists for vegetable and specialty crops protected by windbreaks. Additionally, the climate modification produced by shelterbelts enhanced production of orchard and vineyard crops. Shelterbelts also produce microclimates that reduce stress and increase fitness in livestock and increase honeybee pollination and honey production. Shelterbelts provide protection from wind and snow increasing survival of newborn sheep and cattle. These benefits are maximized when livestock are corralled outside the windbreak on the lee side.

Reduced Energy Consumption

Home heating is a major consumer of energy in rural residences and small communities (Figure 4-18). Properly located and designed windbreaks are a cost-effective way of lowering home energy consumption by 10-25%. Windbreaks can also reduce the time and energy required to remove snow from around farm buildings and rural roads; saving money and improving farm efficiency. Windbreaks on the outskirts of small rural communities in the northern states protect structures and significantly reduce snow removal costs.

Figure 4-18: *Windbreaks surrounding this rural subdivision reduce energy consumption during the winter months and lower snow removal costs.*

Agroforestry Products

Products obtained from windbreaks, riparian buffers, alley cropping, and woodlots are valued in billions of dollars, annually. Farmers, applying agroforestry principles, plant and manage tree and shrub species that bare edible fruits, nuts, and berries. These products are harvested and sold in local markets or to large commercial outlets. Trees in corridors are also harvested for fuel, pulp, posts, speciality woods like walnut, and for use in the horticultural industry. Mushrooms and medicinal plants like ginseng grown in the shade beneath corridor trees are high priced commodities marketed in many regions.

Marketable products can also be obtained from grass corridors. The seed of some native grass species is a high value commodity. In Iowa, for example, the 1998 price of switchgrass seed was $17.00 a pound. Statewide production was unable to meet demand. Wildflowers, native grass stalks, and dried forbs are also harvested in grass corridors and sold in local markets and craft outlets. Providing products for the craft industry is a growing enterprise.

Figure 4-19: *The increased value of homes in this Utah subdivision can be attributed to their proximity to this open space corridor.*

Increased Property Values

Land appraisal information and research findings suggest property adjacent to amenities like riparian corridors is valued higher than property without proximity to these amenities (Figure 4-19). In western states, river and stream frontage property is in high demand, short supply, and 25 to 50% more expensive than property without frontage. Economists Fausold and Lilieholm cited numerous examples of significant increases in property values for land abutting parks or stream corridors. A study of riparian greenbelts in Boulder, Colorado determined that the average value of property adjacent to the greenbelt would be 32% higher than those 3,200 feet away, all other variables being equal.

The influence of corridors on property values also applies to privately held greenbelt land without public access according to a study done near Salem, Oregon. The greenbelt land in the study was composed of rural farmland without trails. The study concluded that land adjacent to the greenbelt was worth approximately $1,200 more per acre than land located 1,000 feet away. The increased economic value these greenbelts generated was based on enhanced visual quality they provided.

In many cases, restoration or enhancement of corridors will be necessary to provide the economic benefits described. In California, homes situated near seven stream restoration projects had property values 3 to 13% higher than similar homes located on unrestored streams.

Recreation Revenues

Trails along corridors can also be important generators of revenue. A 1988 study of the Elroy-Sparta bicycle trail in Wisconsin found that users spent approximately $15 per person per day for trail related expenses for an overall annual economic impact of $1,257,000. In Minnesota, where trail networks are being expanded, the number of local bed and breakfast accommodations catering to trail users has exploded. The revenues these small businesses generate in rural towns can have a significant impact on the local economy and provide employment opportunities for the area's young people. Economic benefits are increased when corridors provide a variety of recreational options, from floating a river to hiking on a trail. In Montana, visitors to the upper Missouri Wild and Scenic River and Lewis and Clark National Historic Trail contribute $750,000 annually to the economy of the area.

The National Research Council estimated the annual economic value of fishing on flowing waters in the United States at $8 billion. Hunting also generates significant revenues. Researchers estimated an annual value for wooded draws in the Great Plains at $26 million for deer hunting and $1 million for turkey hunting. Kansas windbreaks generate an annual net value of $21.5 million for hunting. Many landowners realize direct economic benefits by charging rod or gun fees or leasing hunting or fishing rights on their property. Some landowners use a portion of these revenues to enhance habitat on their farm or ranch.

Bird watchers and other non-consumptive users of wildlife resources also contribute to the local economy. Motel rooms in North Platte, Nebraska filled with bird watchers are at a premium during the spring sandhill crane migration. Economists estimated active birders spend between $1,500 and $3,400 on birding each year; often their activities are in or adjacent to corridors (Figure 4-20).

Figure 4-20: *This series of pictures depict some of the many recreational opportunities corridors can provide.*

POTENTIAL ADVERSE IMPACTS

The list of benefits associated with corridors is impressive and well documented. There are however, potential adverse impacts that may originate in corridors:

- Crop damage
- Disease and weed infestations
- Predation/parasitism
- Social impacts
- Visual impacts

Many of these impacts can be mitigated through proper planning, design, and management.

Crop Damage

There is a perception in rural America that untended vegetation in natural patches and corridors is a major source of insects that infest crops. Corridors do in fact provide habitat for both pest and beneficial species of insects. Occasionally pest populations in corridors erupt causing significant damage to adjacent crops. Researchers in Texas reported a $50 per acre reduction in cotton yields in fields adjacent to windbreaks that overwintered large populations of boll weevils (*Anthonmus gradis*). Alfalfa weevils (*Hypera postica*) which also overwinter in windbreak litter can cause similar reductions in alfalfa production.

Birds and mammals that inhabit or move through corridors can also damage crops in the adjacent matrix. Some evidence suggests that crop losses caused by birds is higher in fields adjacent to windbreaks. Damage to grain and forage crops by deer and elk is a significant problem in many states. In Wisconsin, most farmers report only a few hundred dollars worth of deer damage to corn and hay crops each year. However, in areas where deer densities approach 90 deer per square mile, damage claims average $9,000 per farm. Browsing deer, elk, rabbits, and rodents can also injure or kill nursery and orchard stock. Beaver frequently raise havoc with trees in urban greenways and decimate expensive stream restoration projects (Figure 4-21). However, in other settings, beaver can be important in watershed restoration and provide an important succession of snags for wildlife.

Figure 4-21: *This cottonwood planting was cut by beaver.*

Figure 4-22: The ubiquitous tumbleweed is using this roadside corridor to spread into the adjacent desert grassland matrix.

Disease and Weed Conduit

Simberloff (in Mann and Plummer) noted that corridors can be conduits for diseases, predators, exotic species, and fire. Poorly managed roadside corridors are notorious conduits for noxious weeds (Figure 4-22). Seeds and suckers from corridors may spread into the adjacent matrix. For example, cheatgrass (*Bromus tectorum*) dominates many roadsides in the Great Basin and spreads rapidly into abutting rangeland. This early curing, flashy fuel is the ignition source for many range fires.

Predation / Parasitism

Narrow corridors are prone to high levels of predation and parasitism. Biologist Best reported that 29% of the songbird nests in an Iowa study plots were parasitized by brown-headed cowbirds (*Molothrus ater*). Large ground nesting birds like the ring-neck pheasant and ducks may be particularly susceptible to predation in corridors. In one eastern Colorado study, an estimated 55% of roadside pheasant nests were terminated by predation. Biologists acknowledge high rates of pheasant mortality in roadsides but argue that roadsides and other types of strip cover are not sinks; production exceeds losses to predation.

Michael Soule suggests disease, predation, and parasitism concerns are most applicable for threatened and endangered species. In highly developed landscapes, he argues the benefits of corridors for most species far outweigh their potential adverse impacts.

Figure 4-23: *This riparian corridor has been severely impacted by fishermen and other recreationists.*

Social Impacts

Riparian corridors seem to be particularly susceptible to adverse impacts from recreation (Figure 4-23). The high levels of recreation activity in some riparian corridors may be sufficient to displace some species of wildlife. Often the vacated habitat niches are occupied by less desirable species. Intense recreation activity may also lead to the degradation of the corridor's ecosystem with potentially long-term adverse consequences.

Visual Impacts

The alignment and management of some corridors produce highly contrasting lines and forms in the landscape. Highway, pipeline and powerline corridors routed through forests frequently produce unsightly swaths. Power transmission lines that march across farmland and prairie are viewed as equally unattractive. In some cases, woody introduced corridors block desirable views.

Other Potential Impacts

Networks of corridors may not always be desirable. For example, two spatially separated populations of the same species may each have developed different genetic adaptations to their unique environmental condition. If these patches are linked and species move between them and interbreed, these adaptations could be lost. Both populations could decline or go extinct.

These potential adverse impacts may be inherent in corridors or the way society chooses to manage them. Many can be mitigated by consulting with biologists when planning, designing, and managing corridors.

CORRIDOR BENEFITS SUMMARY

Corridors within a watershed provide a multitude of economically and socially significant benefits for individual landowners and the larger community. Many of these benefits are complementary but, not infrequently, they conflict; intense recreation and wildlife habitat, for example. Reed Noss acknowledges these potential conflicts and argues that the primary goal for conservation corridors in general should be to preserve and enhance biological diversity. Corridors are not a panacea; a landscape of corridors is a landscape populated by edge species and limited in its diversity. Patches of plant community types indigenous to a watershed and large enough to support viable populations of native wildlife species within a well managed matrix are essential to maintaining biodiversity.

The challenge for land managers is to accommodate uses compatible with corridor resources while maintaining the ecological integrity of existing corridors. Planting new corridors to conserve soil and water and to provide connectivity between patches for vulnerable species of wildlife will be equally important. **The challenge must be extended to conservation of existing patches, patch restoration and ecologically sound management of the matrix.** This will require a detailed knowledge of corridor and patch resources, management practices, user demands, and landowner and agency concerns. The following chapters in this handbook outline a planning process that will address these issues at both watershed and conservation plan scales. As recommended by the National Research Council in 1992, the process emphasizes the integration of existing conservation practices to optimize the benefits corridors provide (Figure 4-24).

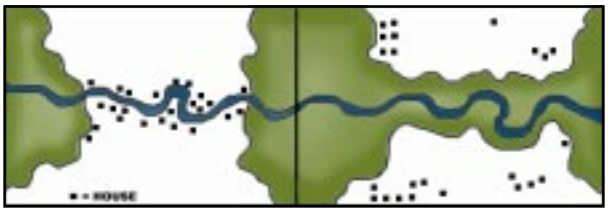
Figure 4-24: *Boulder Creek, Boulder Colorado is a model of integrated riparian corridor resource planning*

Case Study:

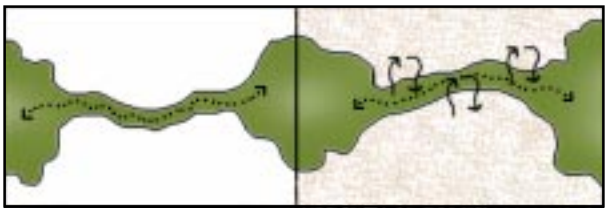
PEQUEA - MILL CREEK WATERSHED

Corridor Planning Principles discussed in Chapter 5 that are exhibited by this case study include:

NATURAL CONNECTIVITY SHOULD BE MAINTAINED OR RESTORED.



MANAGE THE MATRIX WITH WILDLIFE IN MIND.



NATIVE SPECIES ARE BETTER THAN INTRODUCED SPECIES.

Case Study: Pequea - Mill Creek Watershed

This case study illustrates how an extensive watershed wide partnership coordinated by NRCS has produced and implemented a plan for restoring 37 miles of stream corridor and adjacent uplands. The conservation project, an on-going effort, continues to provide economic, wildlife habitat, recreation, and aesthetic benefits to watershed residents.

Figure 1: *The impacts of large numbers of cattle concentrated in a riparian zone for long periods of time can be devastating.*

The Pequea–Mill Creek watersheds are located in central Lancaster County in south–central Pennsylvania. The case study project area encompasses approximately 135,000 acres. Dairy farming is the dominant agricultural enterprise with 55,000 dairy cows distributed among 1,000 small farms located in the watershed.

The Pequea–Mill Creek Hydrological Unit Area Project, initiated in 1991, is focused on reducing potential nutrient, sediment, and bacterial losses from concentrated livestock areas around farmsteads and nutrient and pesticide management in crop fields. Barnyard management, streambank fencing, armored stream crossings, restoration of riparian plant communities, and grazing area management have been emphasized to reduce contamination from farmsteads.

These watersheds were selected under USDA's Water Quality Initiative to coordinate and increase a voluntary approach reducing agricultural nonpoint source pollution. Partners in this effort include Cooperative Extension, NRCS, Farm Service Administration, Lancaster County Conservation District, Pennsylvania Game Commission, Pennsylvania Department of Environmental Quality and numerous other agencies working with farmers, township officials and homeowners.

A partial list of accomplishments to date includes:

- Improved water quality
- 538 farmers have installed at least one conservation practice
- 180 farmers have developed contracts to install conservation practices
- 37 miles of stream have been fenced to exclude livestock on 84 farms in cooperation with the Pennsylvania Game Commission, U.S. Fish and Wildlife Service, and Lancaster County Conservation District
- 25 rotational lot management systems have been implemented to reduce the amount of runoff from livestock exercise areas
- Demonstrations of stream crossings, livestock watering and shading options have been developed with the Lancaster County Conservation District
- Information and education programs have been focused on farmer participation with involvement from the private sector in water quality efforts

Figure 2: *The same reach of creek after exclosure fencing and revegetation.*

Water is a shared resource. By improving a stream, downstream neighbors benefit. Fencing sets a good example, encouraging upstream neighbors to protect their streams. Well-kept streams also make a good impression and provide a positive image of farms to the public.

Figure 3: *Trout, songbirds, and butterflies inhabit this restored reach of Mill Creek.*

There are many other benefits from streambank fencing and planting in riparian corridors in addition to improved water quality. In the Pequea–Mill Creek Project, many farmers have learned that streambank fencing is an integral part of an effective dairy management program. For example, one significant benefit of streambank fencing has been improved dairy herd health. As one local expert says: "*There is nothing in the stream that is good for cows and there is nothing the cows do that is good for the stream."* The Pennsylvania Game Commission has stocked trout in restored sections of the creek providing future recreation benefits for area residents.

Participants in the project report that streambank fencing and other conservation practices have:

- Improved dairy herd health
- Stabilized streambanks and reduced soil erosion
- Provided wildlife habitat
- Improved water quality
- Improved fish habitat
- Promoted rotational grazing

For more information contact:

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The information for this case study was abstracted with permission from Pequea–Mill Creek Information Series Bulletins 28 and 30 prepared by Pennsylvania State University, College of Agricultural Science, Cooperative Extension Service in cooperation with USDA Natural Resources Conservation Service.

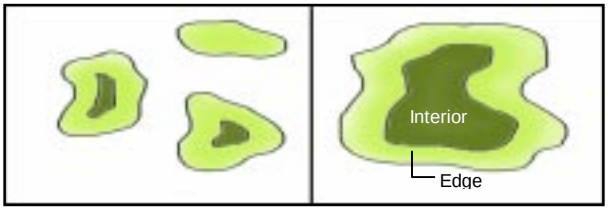

Craig Johnson

Case Study:

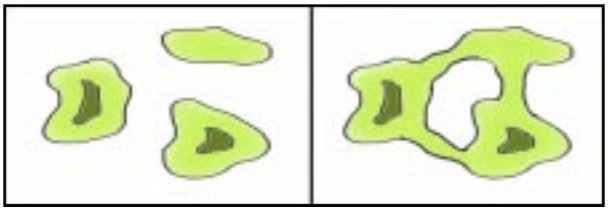
JEFFERSON COUNTY OPEN SPACE PLAN

Corridor Planning Principles discussed in Chapter 5 that are exhibited by this case study include:

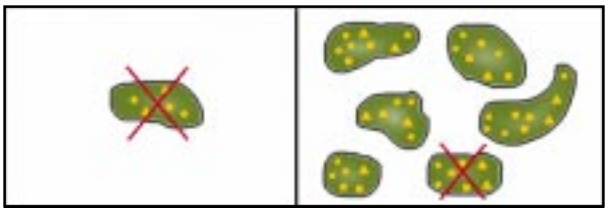
LARGE RESERVES / PATCHES ARE BETTER THAN SMALL RESERVES / PATCHES.



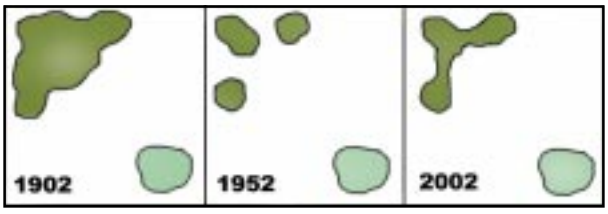
CONNECTED RESERVES / PATCHES ARE BETTER THAN SEPARATED RESERVES / PATCHES.



SEVERAL RESERVES / PATCHES (REDUNDANCY) ARE BETTER THAN ONE RESERVE / PATCH.



INTRODUCED CONNECTIVITY SHOULD BE STUDIED CAREFULLY.



Case Study: Jefferson County Open Space Plan

This case study illustrates the value of regional scale open space planning in rapidly urbanizing watersheds. Conservation, enhancement, and restoration of wildlife habitat is an integral part of the Jefferson County Open Space Plan. Conservation corridors are a key element in linking dispersed patches of wildlife habitat. NRCS plays a major role in providing technical assistance as the plan continues to evolve.

Jefferson County, a progressive and rapidly urbanizing county near Denver, Colorado, initiated an open space preservation program during the early 1970s (Figure 1). This program is funded by a one-half percent sales tax on retail sales in Jefferson County. The goal of the Jefferson County Open Space Program is to preserve open space as a living resource for present and future generations. The primary objectives of the program are to acquire and maintain lands, to ensure the quality of life in the county by providing open space for physical, psychological, and social enjoyment, and preserving the natural and unique landforms that define Jefferson County.

The Jefferson County Open Space planning process is inclusive and collaborative involving many different stakeholder groups. Specific goals and objectives were established through interviews with a variety of groups and extensive public scoping meetings, which provided guidance for the inventory process. Using a geographic information system, inventory maps were prepared and include:

- Existing and proposed open space, parks, and trails
- Key land uses and activities
- Wildlife, archeological, historic, and cultural features
- Vegetation, surface water, and floodplains
- Landforms and geologic hazards
- Existing and proposed roads and infrastructure
- Slopes and viewsheds

Figure 1: *A view of urban development from one of the Jefferson County Open Space Parks.*

From the inception of the Open Space Program, the NRCS has played a valuable role in providing inventory data, data evaluation, and technical assistance. Specific NRCS assistance included:

- Soils information
- Vegetative inventories
- Revegetation plans (native, pasture, hayland, post-wildfire)
- Erosion control (gully, streambank, disturbed upland areas)
- Pasture/hayland management
- Grazing management for native grasslands
- Plant materials
- Pond/water development
- Wildlife habitat development/improvement

The planning process identified lands that should be preserved or managed to provide habitat for valued wildlife species (Figure 2). The proximity of critical habitat lands to urban development, roads, and other recreational resources helped determine the appropriate level and type of management necessary to protect wildlife populations. Mapping wildlife habitat provided a valuable point of discussion between the Open Space Department and appropriate wildlife agencies regarding management and acquisition options.

The plan identified five types of open space and trails. Regional preserves are the keystone elements for the protection of wildlife. They are generally large (> 500 acres) and intended to protect the natural resource or unique feature. Regional preserves are reserved primarily as open space/ habitat with development limited to less than 20% of the site. They protect floodplains, breeding areas, relict plant communities, rare and endangered species habitat, and other sensitive resources. Corridors, some with trails, are being developed to connect these significant resource areas enhancing their value for both wildlife and recreation.

Over the 25 years of its existence, the Jefferson County Open Space Program has acquired approximately 32,000 acres and has constructed over 100 miles of trails (Figure 3). This program demonstrates successful protection of wildlife habitat can be combined successfully with other uses such as recreation and aesthetics in urban/ suburban landscapes. The program also illustrates the importance of building diverse partnerships to accomplish program goals in an urban context.

Figure 3: *A map of existing protected habitat areas and proposed acquisition areas.*

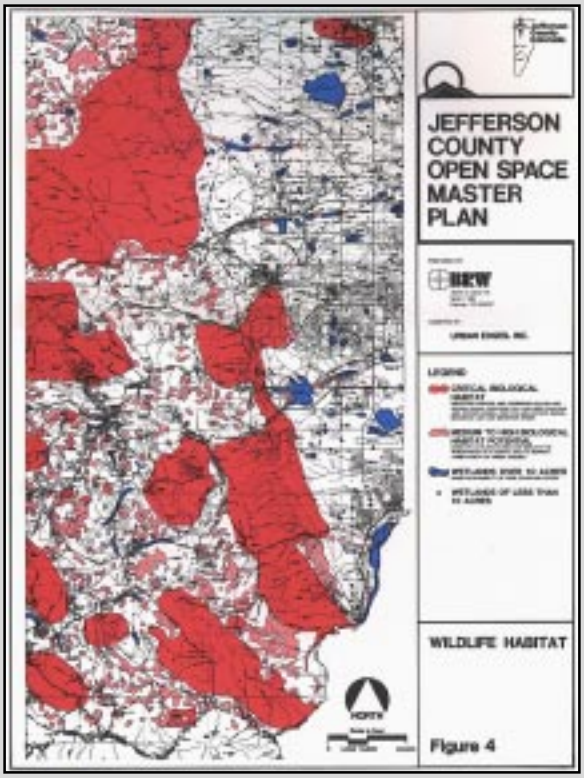


Figure 2: *Mapped critical habitat and wetlands within Jefferson County.*

For more information contact:

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The information for this case study was abstracted with permission from Jefferson County Open Space brochures prepared by the Department of Jefferson County Open Space and from *The Jefferson County Open Space Master Plan, 1989*, prepared by BRW, 4643 South Ulster St., Suite 1180, Denver, CO and Urban Edges, 1624 Humboldt St., Denver, CO.


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