Chapter 3: Corridors - An Overview

Natural Resources Conservation Service (NRCS)

INTRODUCTION

Landscape ecologists Forman and Godron suggest that a landscape is a heterogeneous land area consisting of three fundamental elements: patches, corridors, and a matrix (Figure 3-1). They define each element as follows:

Patch: Generally a plant and animal community that is surrounded by areas with different community structure; however, a patch may be devoid of life.

Corridor: A linear patch that differs from its surroundings.

Matrix: The background within which patches and corridors exist (the matrix defines the flow of energy, matter, and organisms).

Patches, corridors, and the matrix interact in ecologically significant ways. Consequently, this conceptual model is very useful in the study of function, structure, change, and the conservation potential of corridors in the landscape.

TYPES OF CORRIDORS

Corridors can be natural (a tree lined stream channel) or the result of human disturbance to the background matrix (a strip of native prairie left unplowed between two fields). Corridor structure may be very narrow (line) such as a hedgerow, wider than a line (strip) such as a multi-row windbreak, or streamside vegetation (riparian). Corridors may be convex, taller than the surrounding matrix like a shelterbelt between wheat fields; or concave, lower than the surrounding vegetation, such as a grass strip between two woodlots. Line or strip structure may be found in many different kinds of corridors. Five commonly used categories of corridor origin are:

- Environmental corridors
- Remnant corridors
- Introduced corridors
- Disturbance corridors
- Regenerated corridors

In recent years, engineered corridors such as overpasses and underpasses have been designed specifically to accommodate wildlife movement.

***Figure 3-1:** The three elements of landscape structure - patch, corridor, and matrix - are clearly evident in this photograph.*

Figure 3-2

Environmental Corridors

Environmental corridors are the result of vegetation response to an environmental resource such as a stream, soil type, or geologic formation. They are typically winding (curvilinear) in configuration with widths that are highly variable. Sinuous strands of riparian vegetation paralleling stream courses are prominent examples in all regions of the country (Figure 3-2). Environmental corridors are frequently the most important habitats in the watershed.

Figure 3-3

Remnant Corridors

Remnant corridors are the most obvious products of disturbance to the adjacent matrix (Figure 3-3). Strips of vegetation on sites too steep, rocky, or wet to put into production are left as remnants after land is cleared for agriculture or other uses. Some remnants are line corridors left to identify property boundaries. The width and configuration of most remnant corridors vary considerably. Remnant corridors often contain the last assemblages of native flora and fauna in a watershed.

Figure 3-4

Introduced Corridors

Introduced (planted) corridors date back to circa 5000 BC. More corridors may have been planted between the 14th and 19th centuries in England than at any other time or place in history. Under the Statute of Merton, 1236, landlords were granted the right to enclose portions of woodland and pasture. Over the next 500 years, thousands of miles of hedgerows were planted. Some of these hedgerows persist to this day and are valued as national landscape treasures. In the United States the Shelterbelt Project of the 1930s was the largest conservation project of the Depression Era; over 200 million seedlings were planted into shelterbelts and many were maintained by Civilian Conservation Corps (CCC) work crews (Figure 3-4). In agriculturally dominated landscapes, introduced corridors have become critical habitat for many wildlife species.

Figure 3-5

Disturbance Corridors

Disturbance corridors are produced by land management activities that disturb vegetation in a line or strip; a mowed roadside or brush-hogged powerline right-of-way are examples (Figure 3-5). Continued disturbance of the strip is often required to maintain vegetation in the desired successional stage. The widths of disturbance corridors vary, but they tend to be more strip-like. Configuration is typically straight line. They may be sufficiently wide to constitute a barrier for some wildlife species, splitting a population into two metapopulations. Disturbance corridors are often important habitats for native species that require early successional habitat.

Figure 3-6

Regenerated Corridors

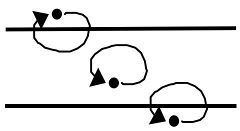
Regenerated corridors result when regrowth occurs in a disturbed line or strip (Figure 3-6). Regrowth may be the product of natural succession or revegetation via planting. Regrowth in abandoned roadways, trails, and railroad right-of-ways are examples. Corridor width and configuration are dependent upon the nature of the previous disturbance. Regenerated corridor vegetation is often dominated by aggressive weedy species during the early stages of succession. East of the Mississippi River, regenerated corridors occur as hedgerows along fence lines and roadside ditches. They are less common in the West. In highly fragmented landscapes, regenerated corridors are often important habitats for small mammals and songbirds.

Corridor Function

Corridors perform important ecological functions including:

- Habitat
- Conduit
- Filter/barrier
- Sink
- Source

These five functions operate simultaneously, fluctuate with changes in seasons and weather and change over time. Their interactions are often complex and in many cases are not well understood.



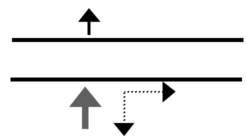
Habitat

A corridor may function as habitat or a component of habitat, particularly for those species with small home ranges and limited mobility, ruffed grouse (*Bonasa umbellus*) for example. For some species, large mammals for instance, a corridor may serve as transitional habitat during seasonal migrations between patches. The habitat function of corridors is discussed in greater detail in Chapter Four.

Conduit

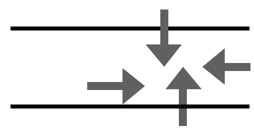
A corridor functions as a conduit when it conveys energy, water, nutrients, genes, seeds, organisms, and other elements. Biologist Michael Soule has identified three general categories of animal need for the conduit function of corridors:

- Periodic migration to breeding or birthing sites; elk migration from wintering habitat to calving grounds, for example.
- Movement between patches within the animals home range to access food, cover, or other resources.
- Some populations must receive immigrants if they are to persist in isolated patches; for example, male cougars migrating from one metapopulation to another to breed.



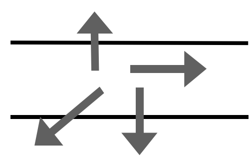
Filter/Barrier

A corridor functions as a filter or barrier when it intercepts wind, wind blown particles, surface/subsurface water, nutrients, genes, and animals. Corridors may filter out sediments and agricultural chemicals from runoff that originates in the adjacent matrix. They may also act as barriers that reduce wind velocity and decrease erosion. Some artificial corridors like highways and canals are barriers to wildlife movement and may genetically isolate populations.



Sink

A corridor functions as a sink when it receives and retains (at least temporarily) objects and substances that originate in the matrix; soil, water, agricultural chemicals, seeds, and animals for example. Corridors can become sinks for wildlife, when the rate of mortality in the corridor from predation and other causes creates a net loss in the population of either corridor residents or migrant species.



Source

A corridor functions as a source when it releases objects and substances into the adjacent matrix. Corridors may be sources of weeds and "pest" species of wildlife. They may also be sources of predatory insects and insect eating birds that keep crop pests in check. High quality corridors are often a source of wildlife; reproduction in the corridor exceeds mortality and individuals are added to the population.

Corridor Structure

The physical and biological characteristics of corridors such as width, connectivity, plant community, structure (architecture), edge to interior ratio, length, and configuration determine how corridors function (Figure 3-7). Corridor width, connectivity, and plant community architecture are both ecologically and visually the most important of these characteristics.

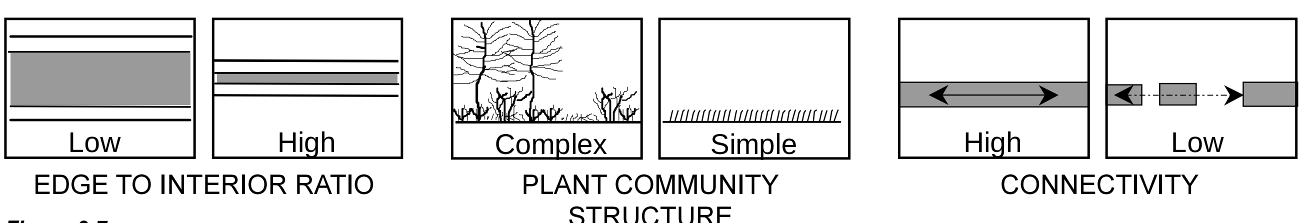


Figure 3-7

Figure 3-8: *The overstory, middlestory, and understory vegetation in this woodlot, its plant community architecture, provide a variety of niches for wildlife.*

All five corridor functions are enhanced by increased width and connectivity. Corridors with the fewest number of gaps have the highest levels of connectivity. As gap width increases, the number of wildlife species for which the corridor functions as a conduit decreases. Biologist Michael Soule emphasizes the importance of connectivity for maintaining wildlife population viability in highly developed landscapes. Ecologist Richard Forman suggests that there is value in maintaining several parallel connecting corridors or patch "stepping stones" between large patches. Some ecologists caution that corridors can also be conduits for diseases, predators, exotic species, and fire which can threaten populations. However, corridors remain among the best options for maintaining biodiversity in agricultural landscapes.

The vertical and horizontal structural characteristics of vegetation within a corridor, its architecture, also influence ecological function. The vegetative structure of corridors may vary from a single layer in a grassed waterway to four or more layers in a remnant woodlot or riparian corridor. Vertical structure is a particularly important habitat characteristic for some species of birds. Horizontal structure within corridors also varies. Patchiness (the density of patches of all types) is most common in remnant and riparian corridors. Researchers report a direct correlation between an increase in plant spacing heterogeneity and an increase in bird species diversity. In general, the greater the structural diversity within a corridor, the greater the habitat value for an array of species (Figure 3-8).

Change

Plant communities change over time. Corridors typically have fewer plant species than larger patches but species diversity appears to increase with corridor age. Disturbance and consequent succession are the principal agents of change in corridor vegetation. Disturbance may be natural, wildfire for example, or induced by land management activities in or adjacent to the corridor such as mowing or grazing. Because most corridors have a high edge to interior ratio they are particularly prone to the effects of disturbance in the adjoining matrix. Human-induced disturbance has the potential to push corridor vegetation beyond the point where it can recover through natural processes. This may lead to degradation of the corridor ecosystem and a successional path that differs significantly from the norm.

Changes in plant community function and structure as a result of plant succession have significant effects on wildlife. Both species composition and density may be altered. However, mature corridors, with the exception of riparian corridors, seldom achieve the wildlife species diversity of large patches.

Wildlife biologists have advocated managing successional change in corridors to meet a variety of outcomes. Sensitivity to biodiversity is growing, however, even in situations driven by single species management.

Changes in plant community structure caused by disturbance or succession also affect other corridor functions. For example, windbreak efficiencies decline dramatically when the shrub layer is removed, a common occurrence when livestock are allowed to graze unmanaged in windbreaks.

Expanding Perspective

NRCS project-scale conservation practices capitalized on the function and structure of corridors. Windbreaks, grassed waterways, field borders and other conservation practices, functioning as filters, barriers, and sinks, have reduced soil erosion, improved water quality and increased crop and livestock production. Both native and introduced plants and wildlife have been the indirect beneficiaries of the habitats created by these practices.

Conservation corridors planned specifically for wildlife have tremendous potential to preserve and enhance biodiversity at a landscape scale. Land managers now realize that by emphasizing wildlife planning at these larger scales they can:

Maintain within the landscape or watershed diverse self-sustaining wildlife populations of both native and introduced species at population levels in harmony with the resource base and local social and economic values.

What is the Current Status of Corridors?

The limited information on the quantity and quality of the nation's corridors suggests:

- A decline in the number, length, and area of some types of corridors.
- A significant degradation of the function and structure of many types of corridors, especially stream/riparian corridors.
- A general reduction in the value of corridors for human use and environmental services.

In 1992, the National Research Council completed an extensive study of aquatic ecosystems including stream corridors. They concluded that the function and structure of many stream/riparian corridors have been substantially altered and their ecological integrity compromised. Agricultural chemicals, feedlot effluent, urban runoff, and municipal sewage discharge were noted as major causes of water quality degradation. Increased sediment loading from urbanization, agriculture, grazing, and forestry and the construction of dams, channelization and water diversions have further compounded the problem.

In addition, the separation of many floodplains from their stream channels by levees, filling and channel entrenchment have disrupted natural cycles of plant succession (Figure 3-9). These stresses have reduced the value of many corridors for wildlife habitat and for recreation and other human activities. They have also eliminated or greatly curtailed the environmental services normally associated with riparian corridors; particularly flood management, pollution abatement, groundwater recharge, and floodwater dispersal.

Figure 3-9: *This entrenched stream will no longer support the riparian vegetation (wildlife habitat) that lines its upper banks.*

There are an estimated 3.2 million miles of rivers in the United States, yet only 2% of these meet the rigorous criteria for designation as a Wild and Scenic River. An estimated 75% of the nation's streams are degraded to levels where they can only support a low level fishery; only 5% of the streams support a fishery of high quality. A 1995 National Biological Survey report stated that 85 to 95% of southwestern riparian forests have disappeared since the Spaniards first settled the area (Figure 3-10a). The lost scenic values and recreation opportunities are striking. However, these habitats can respond well to proper land management (Figure 3-10b).

Researchers conducting the NRCS Natural Resource Inventory (NRI) estimated there were approximately 160,000 miles of windbreaks in 1982. By 1992, the figure had decreased to roughly 150,000 miles, a reduction of over 6%. During that same 10 year period, the area in windbreaks was also reduced by an estimated 6%. Of equal concern is the decline in windbreak quality, the result of old age, neglect, and poor management practices. Grazing, herbicide damage, and excessive competition from introduced grasses in shelterbelts can contribute to degradation. Degraded shelterbelts are less efficient as filters, barriers, sediment traps, nutrient sinks, and as habitat for wildlife.

Figure 3-10a: *This riparian corridor is in poor condition due to improper grazing management.*

Figure 3-10b: *This photo depicts the same view of the riparian corridor after 10 years of proper grazing management.*

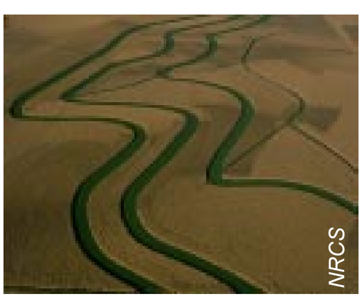
In addition to riparian buffers and windbreaks, the NRCS and others have long advocated the use of other types of conservation corridors including: contour buffers, filter strips, field borders, and grassed waterways. No national database is kept on these corridor types. However, based on a survey of NRCS State and field biologists in each region, a rough estimate of conditions and trends was made.

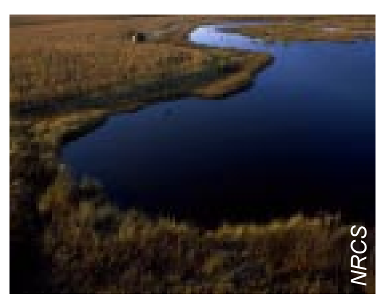
Questionnaires were sent to NRCS State and field biologists in each of the 50 states. Thirty usable questionnaires were returned; a return rate of 60%. At least three questionnaires were returned from each of the six NRCS regions. The results presented below estimate the general status of the nation's corridors.

Type	Increased	Same	Decreased	NA	N
Riparian/stream corridors on 1^{st} & 2^{nd} order streams	4	9	16	0	29
Riparian/stream corridors on 3^{rd} and higher order streams	4	13	13	0	30
Wetland, lake, and reservoir buffers	6	9	13	0	28
Field borders	7	3	18	2	30
Field buffers (in field)	11	10	7	2	30
Filter strips	21	4	5	0	30
Grassed waterways	18	11	1	0	30
Vegetated ditches	4	13	11	2	30
Grassed terraces and diversions	9	10	5	3	27
Windbreaks/shelterbelts	7	9	5	8	29
Hedgerows	1	8	16	3	28

Table 1: *Estimated change in various conservation corridor types from 1988 - 1998. Data indicate the numbers of states responding.*

NA - Not Applicable
N - Total Number of States Responding





Type	Excellent	Good	Fair	Poor	NA	N
Riparian/stream corridors on 1st & 2nd order streams	2	10	11	6	0	29
Riparian/stream corridors on 3rd and higher order streams	2	8	13	7	0	30
Wetland, lake, and reservoir buffers	2	10	12	6	0	30
Field borders	0	5	12	13	0	30
Field buffers (in field)	0	2	9	14	5	30
Filter strips	0	7	10	12	0	29
Grassed waterways	0	2	10	14	4	30
Vegetated ditches	0	4	11	11	2	28
Grassed terraces and diversions	0	3	8	15	4	30
Windbreaks/shelterbelts	2	11	4	5	8	30
Hedgerows	2	8	9	4	6	29

Table 2: *Estimated habitat value of various conservation corridor types. Data indicate the number of states responding.*

NA - Not Applicable
N - Total Number of States Responding

Type	Very Important	Important	Somewhat Important	Not Important	Don't Know	N
Roadsides	4	11	10	3	1	29
Powerline ROW's	4	6	12	4	2	28
Railroad ROW's	1	10	15	2	1	29
Pipeline ROW's	4	2	12	7	4	29

Table 3: *Estimated importance of four non-NRCS corridor types as habitat for wildlife. Data indicate the number of states responding.*

NA - Not Applicable
N - Total Number of States Responding

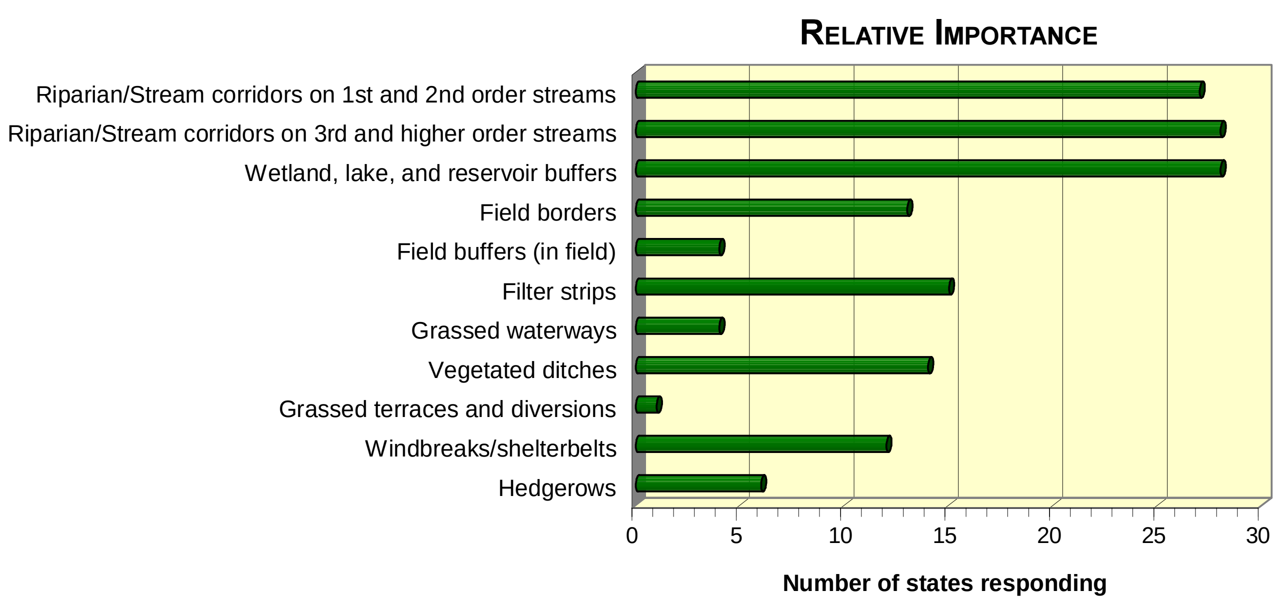


Table 4: *Ranking of the overall importance of various corridor types for conservation of soil, water, air, plants, and wildlife.*

The literally millions of miles of roadside corridors in the United States represent a potentially rich habitat resource. Many roadsides are dominated by a single (often exotic) grass species that is of limited habitat value. Only 10% of the roadsides in Cache County, Utah were rated high quality habitat for pheasants and ground nesting songbirds in a recent study. Roadside management practices further reduce habitat value. Roadside mowing during the nesting season is a common practice that destroys nests, kills adult birds and small mammals and degrades roadside habitat. Roadsides that are disturbed frequently harbor numerous large patches of noxious weeds.

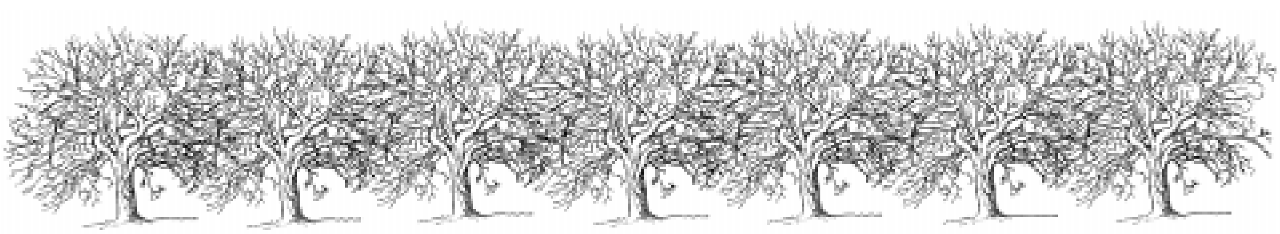
Some states have initiated integrated vegetation management or roadside wildflower programs that emphasize native plants and ecologically based management practices. However, the habitat and aesthetic benefits roadside corridors could provide generally go unrealized. The status of powerline, pipeline, canal, and railroad corridors is unknown. The quality of these corridor types may be similar to those of roadsides.

SUMMARY

The nation's corridors are clearly in decline. Yet the need for conservation corridors as part of an integrated approach to conserving biodiversity has never been greater. Why the apparent indifference to the loss of some types of corridors? Biologist Allen Cooperrider argues that the underlying causes of indifference toward environmental decline in general are perceptual and attitudinal. He suggests that we must begin to see, think, and act more holistically and reestablish an attachment to the land as an ecological system, of which we are an integral part, if we are to become good stewards.

"*The farmer identifies with the agricultural landscape, and this landscape represents the farmer. A farmer's work is constantly on view, and the farmer's care of the land can be readily judged by his peers. Consequently, the agricultural landscape becomes a display of the farmer's knowledge, values, and work ethic.*" (Nassauer and Westmacott 1987: pg 199).

Landscapes managed on cultural concepts of nature that embrace neatness and productivity can be quite different than those managed on scientific concepts of ecological function and structure.



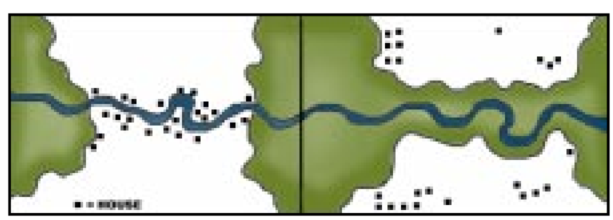
Yesterday a thousand mile wind stilled here. Waxwings fleeing winter's wrath stopped briefly. Hunters stalk quail in the frosty edges. The farmer's soul warmed by fall's flaming foilage. Gifts of an autumn windbreak. *Poem by Craig Johnson Drawing by Kyle Johnson*

Case Study:

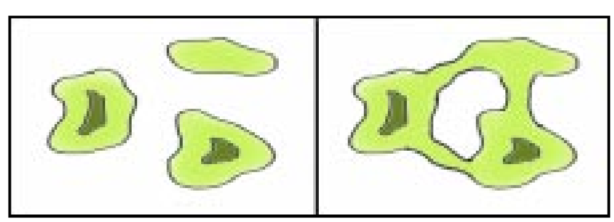
LOUISIANA BLACK BEAR USE OF CORRIDORS

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

NATURAL CONNECTIVITY SHOULD BE MAINTAINED OR RESTORED.



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



Case Study: Louisiana Black Bear Use of Corridors

This case study illustrates the importance of conservation corridors in maintaining viable populations of large mammals in fragmented landscapes.

The Louisiana black bear (*Ursus americanus luteolus*) was once abundant in east Texas, southern Mississippi and all of Louisiana. Habitat loss and fragmentation have diminished the range of the black bear by 90 to 95%. In January 1992, the U.S. Fish and Wildlife Service designated the Louisiana black bear as threatened under authority of the Endangered Species Act.

In 1994, wildlife biologists at the University of Tennessee initiated a study of corridor use and feeding ecology of black bears in the Tensas River Basin in northern Louisiana. The 350 km^2 privately owned study area contained four major isolated hardwood patches, some linked by wooded corridors. The patches were surrounded by agricultural fields of corn, soybeans, cotton, wheat, and other small grains.

Corridors in the study area are rivers, bayous, and ditches bordered by wooded strips 5 to 75 m wide. The corridors are typically linked to wooded tracts. Four major corridors in the study area ranged from 50 to 73 m in width. The height and density of vegetation in most corridors was sufficient to conceal bear movements.

***Figure 1:** This cub will use corridors to access food resources outside of the wooded patches.*

***Figure 2:** Wooded corridors become important conduits for bear movement between wooded patches, particularly during the mating season.*

Radio collars were placed on 19 Louisiana black bears, 6 males and 13 females and their movement was tracked over 18 months. Analysis of the telemetry data indicates that the bears were located in forested patches and corridors more than expected in proportion to their occurrence in the landscape. All 6 male bears in the study moved to a wooded patch other than the patch they were originally captured in; only 3 females moved to another patch. Fifty-two percent of the male bear patch-to-patch movement and 100% of all female bear movement were between patches connected by corridors. Adult male bears used the corridors most intensively in June and July, the breeding season. Sub-adult bears used the corridors for dispersal from their natal home range. Bears also used the corridors to access food resources outside wooded patches.

Tensas River Basin, Louisiana

Researchers concluded that:

- Bears preferred corridors to agricultural fields when outside of a forest tract.
- Corridors allowed bears to move farther away from forested tracts.
- Bear movement between wooded patches connected by corridors was more frequent than between patches that were not connected.

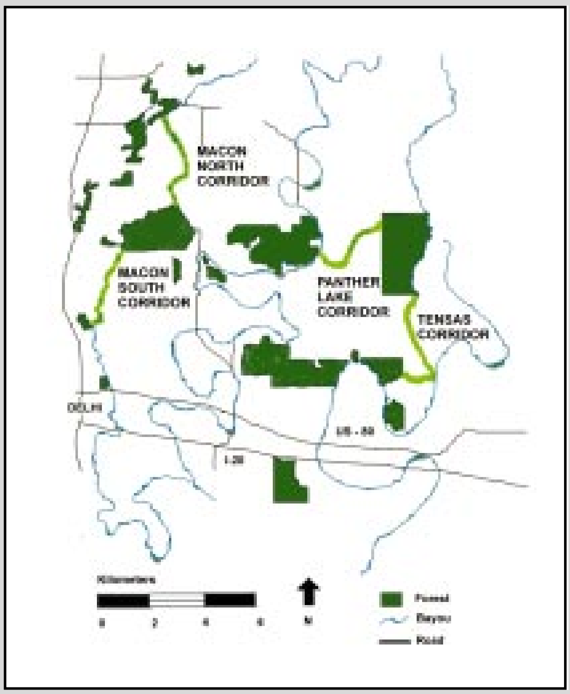


Figure 3: *The importance of wooded corridors in linking wooded patches in Louisiana is clearly illustrated in this diagram.*

This study demonstrates that wooded corridors between forested tracts were used by both male and female bears. Long-term management should include maintenance and enhancement of wooded corridors that link substantial forested patches and construction of new corridors.

Numerous research projects report black bears require large unbroken tracts of suitable habitat to sustain a population. This study suggests that corridors may be vital to the survival of Louisiana black bear in highly fragmented landscapes.

The material for this case study was abstracted with permission from Anderson, D.R. 1997, *Corridor use, feeding ecology, and habitat relationships of black bears in a fragmented landscape in Louisiana*, Masters thesis, University of Tennessee, Knoxville.


NRCS