Chapter 2: Habitat Fragmentation

Natural Resources Conservation Service (NRCS)

Figure 2-1: *In this fragmented landscape, little remains of the prairie and wetlands that once existed here.*

"Not only have the fields become vast flat tracts of land exclusively devoted to a single crop, they have become devoid of many traditional features of the rural landscape. In the quest for large uniform farming surfaces, topographical irregularities such as gullies, washes, sloughs, rises, slopes, and knolls have succumbed to land remodeling. At the same time, features once essential to rural life such as woodlots, windbreaks, ponds, fences, country schools, rural churches, outlying farm buildings are systematically being removed or destroyed." (Carlson 1985)

INTRODUCTION

Fragmentation, the breaking up of large patches of native vegetation into smaller and increasingly isolated patches, is a process as old as civilization (Figure 2-1). It intensified as hunter/gatherer societies settled in permanent locations and began planting crops and herding livestock. Research suggests that the initial impacts on biodiversity were minimal, disturbed areas were small and regenerated when no longer cropped or grazed. But as human populations increased and technology became more sophisticated, the effects of fragmentation spread across the landscape. Archeological evidence suggests that many wildlife species were displaced and local populations eliminated.

Fragmentation continues today, driven by an exploding human population and growing demand to produce more food and fiber from a finite land resource. The contemporary rural landscape is the result of the cumulative impacts of past and present human land use practices including urbanization, agriculture, ranching, and logging.

Fragmentation of a landscape reduces the area of original habitat and increases the total lineal feet of edge, favoring species that inhabit edges at the expense of interior species that require large continuous patches. Ecologists, such as Wilcox and Murphy, believe that habitat fragmentation is the most serious threat to biological diversity and is the primary cause of the present extinction crisis.

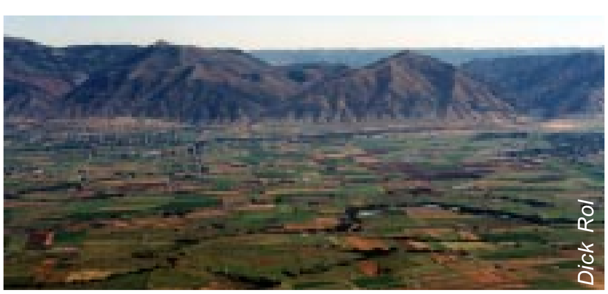

Figure 2-2: *These small Pennsylvania fields have been integrated with patches of non-tillable land, providing habitat for wildlife.*

HABITAT FRAGMENTATION

Prior to the age of mechanized agriculture (circa 1890), rural American landscapes were fine grained. Hedgerows often surrounded small fields of diverse crops while wetlands, steep slopes, swales, and rocky areas were left undisturbed (Figure 2-2). Fields of 40, 80 and 160 acres were common. With today's mechanized agriculture, fragmentation occurs at a much coarser scale resulting in more homogenous landscapes (Figure 2-3). Small fields are combined to form larger tracts of land to accommodate farming with large machinery. Many fields are enlarged at the expense of windbreaks, fence rows and other valuable wildlife habitat. Several areas in the Midwest have lost over 60% of their windbreaks due to the declining health of windbreak trees, expanding field size, and urban sprawl. The resultant loss of habitat diversity in agricultural landscapes has adversely impacted wildlife populations. Wildlife biologists studying bobwhite quail (*Colinus virginianus*) in Nebraska discovered that a county with 5 times more acreage in hedgerows than a neighboring county also had an estimated population of quail almost 4 times greater.

For a species to survive in a landscape or watershed, it must have access to habitat resources sufficient to maintain a viable population. A minimum viable population (MVP) is the smallest number of individuals required to sustain a population for the long-term. A projected MVP is based on estimates of a population size that can counter the negative effects of genetic variation loss, population fluctuations, and environmental changes.

Maintenance of a MVP is often dependent on functioning metapopulations, wildlife populations that are spatially separated but interact through the dispersal of animals.

Metapopulations in small patches can "wink" on or off (experience local extinction) due to local variation in sex ratios, disturbance such as fire, and other local factors. A metapopulation is more likely to persist if immigration and colonization are facilitated by corridors or "stepping stone" patches. Linkage between patches is critical in sustaining healthy metapopulations in highly fragmented landscapes (see the Louisiana Black Bear Case Study, pp. 3-9).

Habitat fragmentation diminishes the landscapes' capacity to sustain healthy populations or metapopulations in four primary ways:

- Loss of original habitat
- Reduced habitat patch size
- Increased edge
- Increased isolation of patches
- Modification of natural disturbance regimes

Figure 2-3: *Large fields of row crops dominate this North Carolina landscape, leaving little habitat for quail or other species.*

Loss of Original Habitat

Perhaps the most significant adverse impact of fragmentation is simply the loss of original habitat. Research findings suggest loss of habitat has a much greater impact on wildlife populations than the change in spatial arrangement of habitat areas.

Over 90% of the grasslands east of the Mississippi River are gone, approximately 90% of Iowa's wetlands have been removed and 80% of Indiana's forests have been eliminated (Figure 2-4). Habitat losses of this magnitude will permanently displace many species and dramatically depress the population levels of others. It forces remaining species into the few remnant patches available, increasing competition, crowding, stress, and the potential for disease outbreaks. The number of currently listed federal and state threatened and endangered species suggests that many populations are at or near MVP levels.

Even in areas where fragmentation is not readily apparent, subtle but equally devastating effects of habitat loss can exist. A grassland invaded by exotic grasses may look natural but be functionally fragmented. For example grasslands infested by cheatgrass (*Bromus tectorum*) look similar to native grass patches, but provide no habitat of value for sensitive species such as the pronghorn (*Antilocapra americana*) and the greater prairie chicken (*Tympanuchus cupido*).

Figure 2-4: *When only disconnected remnants of habitat remain in a watershed, wildlife are often crowded, stressed, and subject to high levels of predation.*

Figure 2-5: *The fragmented landscape on the left has less interior habitat and over 50% more edge than the block of habitat on the right.*

Reduced Habitat Patch Size

Reduction in habitat patch size is a principal consequence of fragmentation. Biologists MacArthur and Wilson suggested that the rate of species extinction in an isolated patch of habitat is inversely related to its size. As remnants of native habitats become smaller, they are less likely to provide food, cover and the other resources necessary to support the native wildlife community. Small patches are also more susceptible to catastrophic disturbance events such as fire or severe weather that can decimate local populations.

Fragmentation also decreases the area of interior habitat (Figure 2-5). Interior habitat is the area far enough from the edge to maintain communities of the original larger habitat. For example, when large tracts of sage/grassland are cleared and seeded into grasses or alfalfa, sage/grassland patch size and interior habitat are reduced. Not surprisingly, populations of an interior-dwelling cold desert species that require large patches of sage brush like the sage grouse (*Centrocercus urophasianus*) are in serious decline.

Increased Edge

Although an increase in edge (the boundary between two plant communities) due to fragmentation may benefit some species, some researchers believe that increasing edge may be detrimental to the protection of native biodiversity. Edges act as barriers causing some predators to travel along them. High predator densities along edges can result in higher mortality for edge dwelling prey species or species moving through narrow corridors. Nest parasitism by brown headed cowbirds (*Molothrus ater*) also appears to be higher in species nesting in edge habitat. Least bell's vireo (*Vireo bellii pusillus*) is an endangered species that inhabits the edges of riparian corridors in southern California. Parasitism by cowbirds appears to be as significant as the loss of riparian habitat in the decline of the least bell's vireo on Camp Pendleton, California.

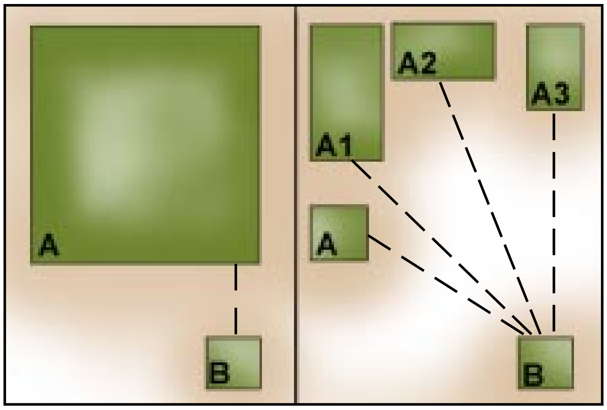

Figure 2-6: *Patch B is more isolated from the remnants of patch A when A is fragmented, limiting movement between A and B for some species of wildlife.*

Increased Isolation

Fragmentation leads to increased isolation of patches (Figure 2-6). Wildlife populations in isolated patches can be sustained by immigration of species from surrounding patches. However, as fragmentation continues, distances between patches get longer and dispersal and immigration rates decrease. The diversity of species moving between patches also decreases; small species with limited mobility are particularly distance sensitive. As immigration rates decrease, factors like inbreeding and catastrophic disturbances can cause the number of species in a patch to decline to zero over a long enough period of time.

Biologists studying chaparral bird species extinction rates in remnant patches in southern California found that on average, less than one chaparral bird species survived after 40 years of isolation in canyons less than 125 acres.

Modified Disturbance Regimes

Fragmentation and associated land management activities like fire suppression alter the flow of natural disturbances. For example, fire, a disturbance factor essential to the maintenance of tall grass prairies, has virtually been eliminated in the Midwest. Remnant prairie plant communities separated by miles of row crops and "protected" from fire are being overtaken by less fire tolerant woody species. Wildlife dependent on prairie ecosystems are being displaced.

Cumulative Effects

The cumulative impact of habitat fragmentation results from the combined incremental effects of habitat loss, reduced patch size, increased edge, and patch isolation. The impacts are cumulative across scales and over time affect populations of organisms as well as individuals. These impacts are not related linearly to the extent of original habitat. There are thresholds where local extinction for a species may be imminent even though only a small percentage of original habitat has been lost. Unfortunately, understanding of these thresholds is limited.

Corridor Connections

In many regions of the country agriculture and urbanization are dominant forces in land conversion; most land is in private ownership, habitat patches are small in size and number and they are often isolated. The probability of increasing the size of existing patches or creating new patches in these landscapes is remote. However, one realistic opportunity to begin to rebuild functional ecosystems and conserve biodiversity is to employ natural and introduced corridors that knit the landscape back together (Figure 2-7). An integrated system of conservation corridors will not only benefit wildlife but conserves soil, water, air, and plants as well.

Figure 2-7: *This recently restored riparian corridor is reconnecting the structural elements in an Iowa watershed.*