ISSUE 3: FOREST LOSS AND FRAGMENTATION

Forest loss and fragmentation are distinct but related phenomena. Forest loss is simply the conversion of forestland to some other land use. Fragmentation is the process by which large continuous tracts of forestland are broken into smaller, disconnected units. Forest loss was greatest in the early 1900s due to agricultural conversion, but continues today most often from urban sprawl and surface mining. The loss of forest acreage during fragmentation may not be great, but the effects can have major implications for the forest community, forest health, and forest sustainability.[88]

Fragmentation typically follows a pattern of increased loss of functionality, as shown in Figure 26. The progress of time is shown from top to bottom, and with different examples of fragmentation from left to right. The example of a new road through a community is known as dissection. It may be followed by more forest loss as openings are created along the road for housing or other uses, a stage called perforation. These openings may be enlarged over time, further fragmented by dissection, or the overall area of the fragments can shrink. Finally, the forest is no longer the main land use but only occurs as isolated patches through attrition.[89]

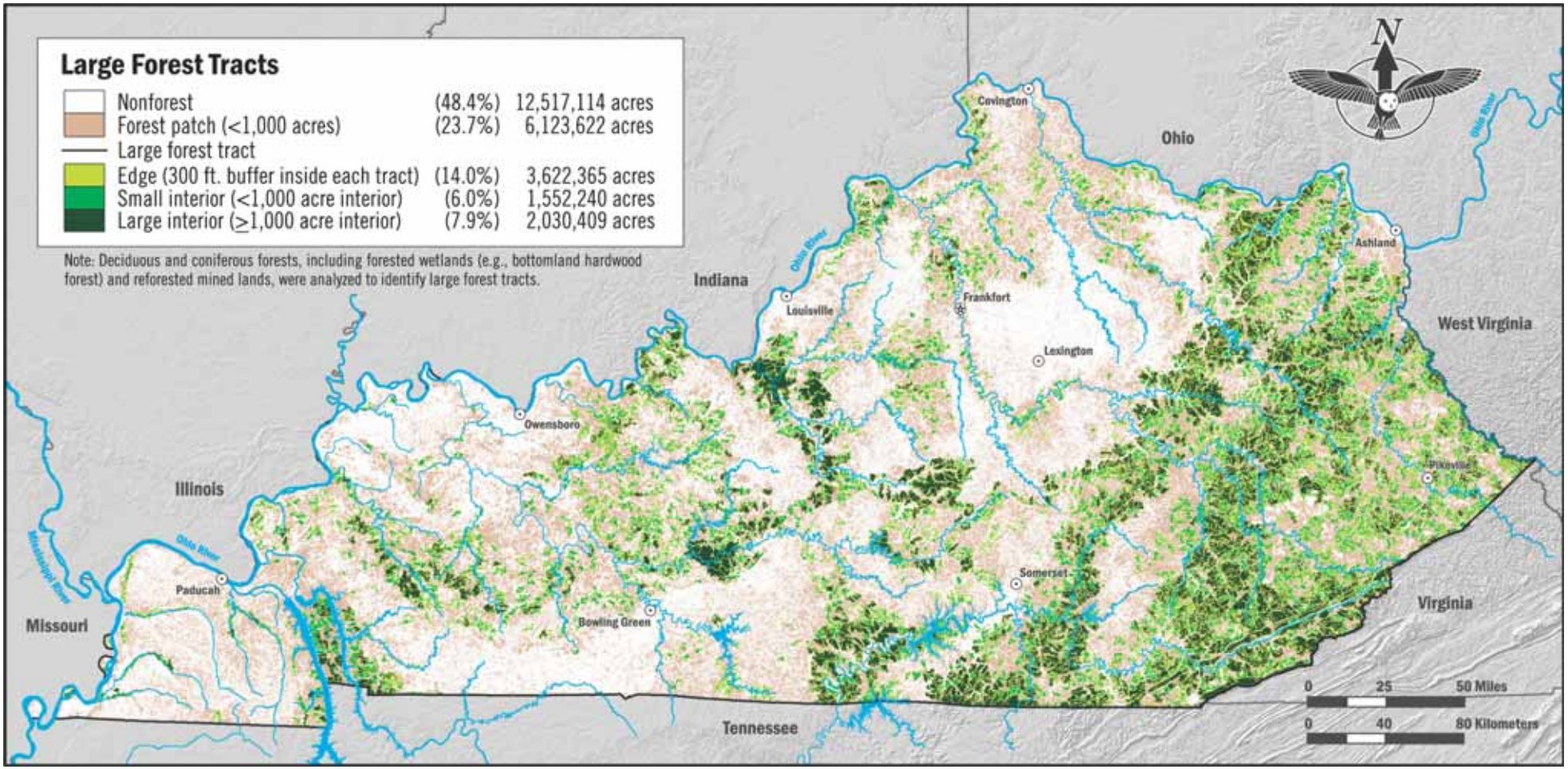
(Source: www.floridahabitat.org)

FIGURE 26 – EXAMPLES OF FRAGMENTATION OVER TIME

Fragmentation can be further classified as temporary or permanent. Temporary loss can result from fire, natural disasters, or timber harvesting. Permanent fragmentation occurs when forestland is converted to a new and relatively permanent land use. It can also occur naturally, through fire, ice storms, hurricanes or tornados, and landslides, or through human activities such as clearing for agriculture, surface mining, urban development, or the construction of highways, powerlines, and pipelines. The causes of natural fragmentation are usually infrequent, local, and temporary, while human activities are usually permanent. This is not always the case, however, as much of eastern Kentucky was cleared and even farmed but has been reclaimed by natural forest regeneration since the mid-twentieth century.

Related to fragmentation is parcelization, the dividing of forest property ownership. Through inheritance, the auctioning of large tracts into small units, or subdividing for development, the end result is the same: more owners of a forest tract. This ever-increasing phenomenon may or may not immediately lead to forest fragmentation, but with multiple property owners, it complicates management and preservation of large forest tracts.

FIGURE 27 – LARGE FOREST TRACTS OF KENTUCKY



(Source: KSNPC)

A. Current Status of Fragmentation and Loss in Kentucky

Kentucky's forests show signs of both fragmentation and loss. Rates of forest loss vary over time, but recent rates have increased from past decades. From 1988 to 2004, 729,000 forested acres, or approximately 6% of the forests of Kentucky, were lost.[8] From 2001 to 2005, an estimated 105 acres of forest were lost every day in Kentucky due to conversion.[90] A KSNPC analysis indicates that 46% of Kentucky's forests are in patches of less than 1,000 acres while 53% of forests are in large forest tracts greater than 1,000 acres, as shown in Figure 27. Of these larger tracts, 50% is in edge habitat (defined as a 300 foot buffer inside each tract), 22% is small interior forest (less than 1,000 acres), and 28% is in large interior forest.[91] Although nearly half of the state is forested, only 14% of Kentucky's forest is interior forest. As detailed in the key conditions, small patches and forest edges provide different benefits than interior forests.

The areas of non-forest and the fragmentation patterns are strongly correlated with the physiology of Kentucky, as shown in Figure 28. In the Mississippi Embayment and Mississippi Plateau physiographic regions of the state, the scarcity of forestland use is not as much an indication of loss as it is of geology and the historic dominance of prairie and wetland in these regions. However, in the eastern coalfield region and the Inner and Outer Bluegrass regions, the impacts of forest loss to agricultural, urban, and mining land conversion are more apparent as this land was historically forested.

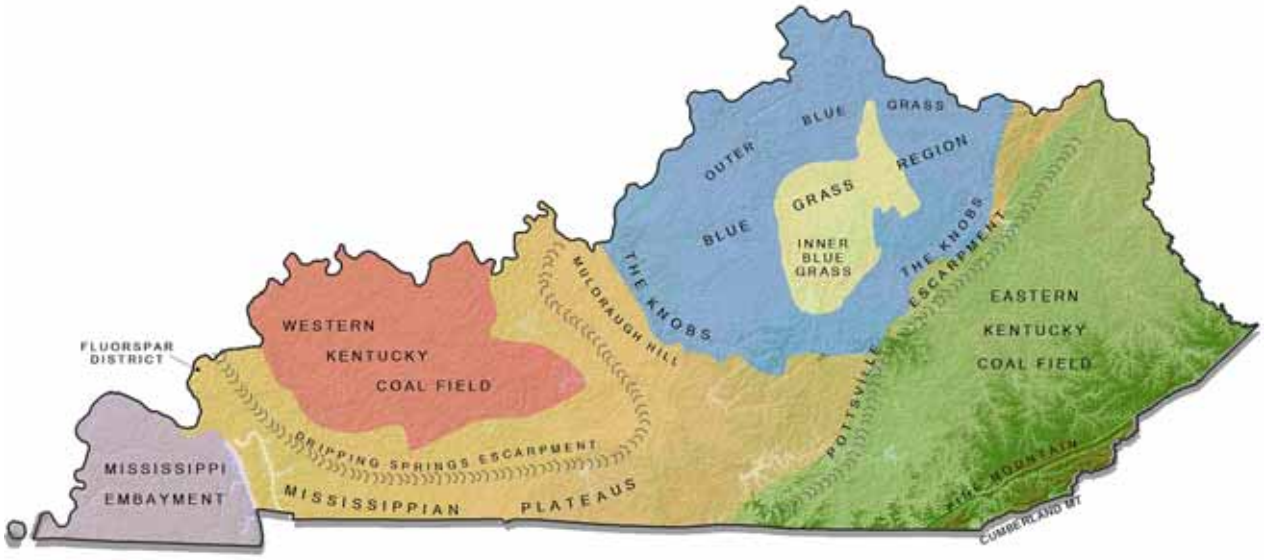


FIGURE 28 – PHYSIOGRAPHIC DIAGRAM OF KENTUCKY

In the Bluegrass Region, Western Kentucky Coalfields, Mississippi Plateau, and Mississippi Embayment, the forest is for the most part in small patches except for protected areas such as wildlife refuges and management areas, recreation areas, and state parks. These small patches are the result of the clearing of uplands for agricultural or urban development. These small patches are usually narrow and branched in shape to follow the streams and rivers.

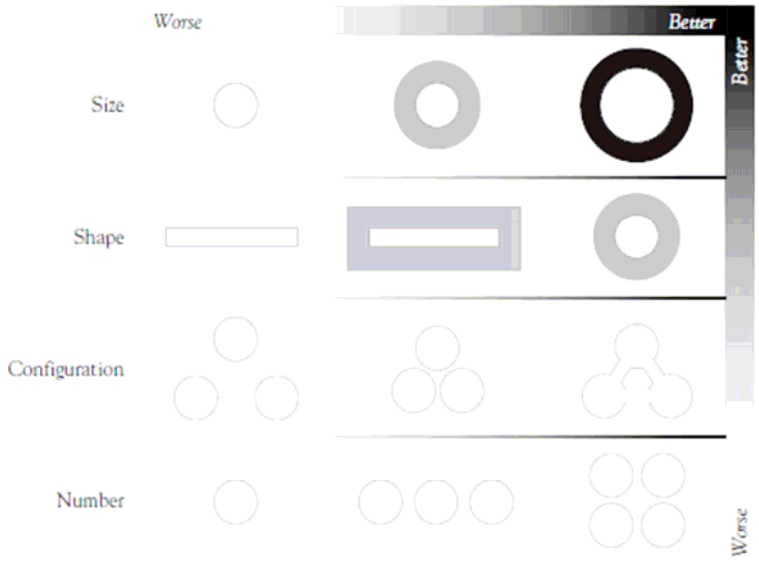
In the mountains of eastern Kentucky, however, the fragmentation pattern is reversed. The uplands remain heavily forested with little loss because of the steep slopes. The loss and fragmentation occurs along the bottomlands and stream borders where the land is flat enough to build roadways and small towns. Because of terrain, most of the large tracts of interior forest are located in eastern Kentucky. Other sources

of fragmentation and loss in this eastern region include wide-scale surface mining and urban and agricultural land conversion.

B. Key Conditions

Perhaps the most import factor in considering the effect of fragmentation and loss on forestland is the location and contents of the forest. The loss of an abandoned lot of volunteer trees does not have near the value of a forest containing a population of endangered species or old-growth, a high level of diversity, or a stand of well managed timber. The location of the resource is also important. Forest with hiking trails in proximity to an urban area may be considered more desirable for recreational use and aesthetics than one in a remote area. Forests located along a riparian zone will also provide more water quality benefits than those on an upland slope.

However, the benefits provided by forests are often dependent of the on the size, shape, configuration, slope, the relative abundance of forest cover, and the resource benefits.[92] In general, the relative value of forest patches is greater on larger tracts with more interior area in greater connectivity and proximity to other tracts, as shown in Figure 29.



(Source: Barnes, Landscape Ecology and Ecosystem Management)

FIGURE 29 – VALUE OF FOREST PATCHES IN RELATION TO SIZE, SHAPE, CONFIGURATION AND NUMBER

1. Edge and Interior

Edge habitat is simply the margin where two or more different habitat types meet and, in natural situations, often occurs in a gradual transition from one habitat to another with a diversity of plants of differing vertical heights and ages. When humans cause fragmentation and loss, forest edges are often abrupt. According to the KDFWR, the potential value of edge habitat to wildlife depends on the 1) width, 2) species diversity, and 3) diversity of vertical structure in that habitat.[93]

Predation and nest parasitism often demonstrate the importance of edge width to wildlife. Predators, such as coyotes, can hunt a narrow strip easier than a wide one. Brood parasitism by brown-headed cowbirds is

prevalent in the first 50 yards from the forest edge but drops off significantly beyond that distance.[94] The width of edge varies, but the KDFWR recommends a 150-foot wide belt of edge habitat divided into at least three zones comprised of vegetation of different thickness and height.[93] High species diversity creates the "edge-effect" by providing an abundance of food and cover for many species within a small area. The variety of vertical structure is important because abrupt edges may exclude species such as eastern cottontails, Carolina wrens, and golden mice, which inhabit briars or shrub areas along edges.

Although good edge habitat and small forest patches may be beneficial to habitat generalists such as deer, turkey, bobwhite quail, rabbits, and raccoons, species such as the Cerulean warbler require interior forest habitat isolated from disturbance for survival. Because interior forests occupy only 14% of the state, the rarity of interior forest habitat makes retention of these areas key. Edge and small forest patches occupy 37% of the state (assuming a 300 foot edge). Although riparian forest may provide excellent water quality and quantity benefit, these areas often have no interior forest because of their long, narrow shape. Large circular shapes, as shown in Figure 29, maximize the interior forest habitat.

2. Forest Size, Connectivity, and Relative Abundance

The size of a forest patch is important because, all other factors being equal, larger forest patches have more interior area. Larger patches can also support larger and more diverse plant and animal populations that may be spread over the larger area. Forest management techniques that focus on maintaining the large patches of forestland or expanding them through restoration will be the most successful.

However, this is not to say that small forest patches are unimportant, particularly when they are close or connected to other small patches. As the Kentucky Forest Landowner's Handbook states: "Maintain as many small patches of forest as possible. A small patch of forest is better than no forest at all. Even a small patch or forested corridor will provide habitat not otherwise available in a field or pasture. Small patches can also protect landscape features like sinkholes and erodible soil. Maintain and create corridors between forested areas along streams and rivers, fencerows, and natural features. Even small corridors provide a valuable wildlife highway for mammals, amphibians, and reptiles that travel on the ground and have limited mobility."[95]

The federally endangered Indiana bat provides an example of a species affected by the relative abundance of forest cover in an area. To protect the species, increased mitigation and minimization is required for projects that either result in a loss of more than 250 acres of forested bat habitat or decrease the percent forested area below a specified level near locations of winter hibernation or summer habitat for reproductive females.[96] These measures show the importance of the forest size and relative abundance within an area. In areas such as Jefferson County, which is only 35% forested, losses of forestland will have a greater impact than losses in Harlan County, which is 86% forested.

The importance of forest size, abundance, and connectivity extends to more than just wildlife. For example, the aesthetic benefits of urban forests are maximized in large parks distanced from the noise of traffic or with extended greenways connecting multiple park areas. In the timber industry as well, harvesting costs per acre increase as the size of landholdings decrease making harvesting more cost-effective on larger tracts.[8] The increased benefits of larger, more connected forest areas should encourage increased planning to maintain these benefits.

C. Direct Threats and Contributing Factors

1. Effects and Threat of Fragmentation

Fragmentation of forestland typically begins when human environments are connected through the installation of roadways, powerlines, and pipelines. Conversion of rural to urban land use generally comes at the expense of agricultural land, but loss and fragmentation of forestland is not infrequent.[8] Urban sprawl dissects forested or agricultural lands because construction is generally more cost-effective on these lands rather than on previously developed areas. When a roadway, powerline, or pipeline dissects a large, forested landscape, the disturbance can cause loss of interior forest habitat, barriers to plant and animal movement, increase in invasive species, reduction in water quality, and loss of diversity and health of the remaining forest.[97]

Forest fragmentation alters the interior forest habitat. It generally increases wind and sunshine, creating drier conditions. These conditions change the decomposition rates of the ground leaf layer, decrease growth rates for shade-tolerant plants, and alter the habitat for soil invertebrates, small mammals, amphibians, ground nesting birds, and other interior forest species. For example, wild turkeys and cerulean warblers each show decreased nest success as a result of fragmentation. Ground predators such as raccoons, skunks, opossums, and coyotes are less likely to hunt the interior of a forest than the edge. [97]

Fragmentation can also create barriers to small animal and plant movement and their gene flow. For example, a study in the Land Between the Lakes Recreation Area found evidence that traffic exerts a negative effect on amphibian populations due to increased mortality.[98] Because of the barriers caused by roadways, the State Wildlife Action Plan lists incorporation of wildlife friendly features into construction and maintenance projects to decrease impacts to wildlife (Conservation Action 41).[67]

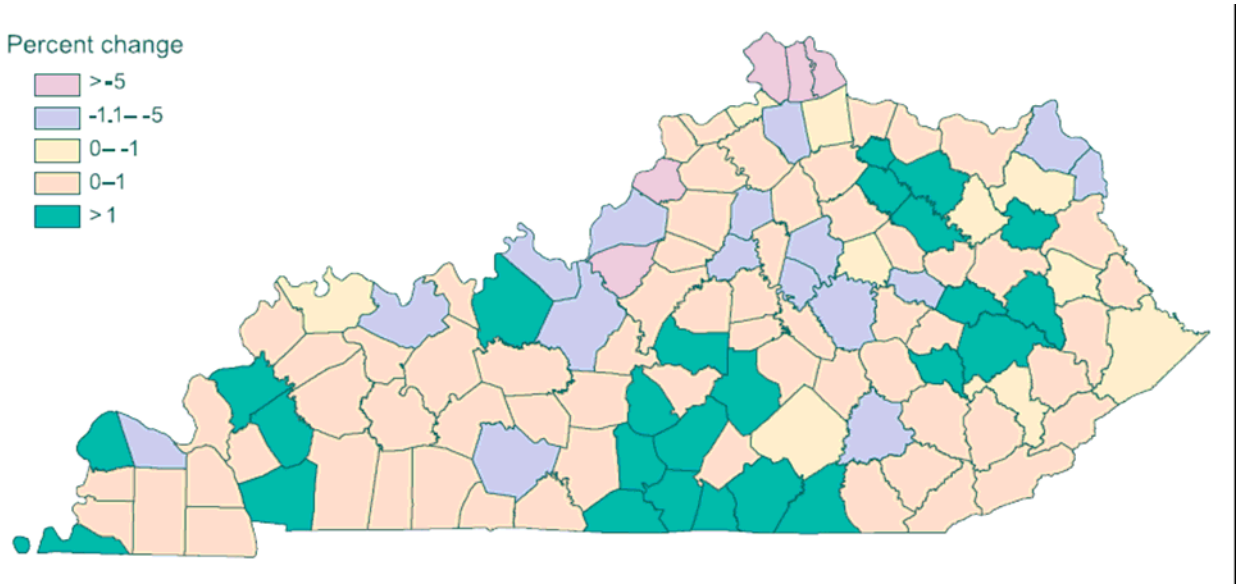
Fragmentation also provides an avenue for the introduction of exotic, invasive plant species, particularly along roadways. [99] Numerous invasive plants can have long-term effects on the health and composition of a forest. Bush honeysuckle has been found to decrease forest floor herbaceous cover and tree seedling density and success.[100] Other invasive species in Kentucky that can have similar effects include privet, Oriental bittersweet, kudzu, Chinese yam, Japanese stiltgrass, and Japanese knotweed. The effects of these invasive plants may not be apparent until canopy trees begin to die and there are no saplings to replace them.

2. Effects and Threat of Forest Loss

Forest loss is the most significant threat to forest health in Kentucky. Forest loss eliminates any benefits provided by the forests. As seen in Figure 30, 31 counties are predicted to lose between 1-5% of their forestland by 2020, but no county will increase its forest by more than 2%.[8] Each of the counties predicted to lose forest is in, or adjacent to, urban areas and does not contain a large acreage of forest.

The loss of forestlands is often a result of parcelization. Although 53% of Kentucky's forests are in large tracts, these tracts are typically divided into numerous ownership parcels. Private individuals own 78% of Kentucky's forests, and parcels greater than 500 acres comprise only 10% of this acreage. In 2004, 55% (by area) of Kentucky's private family-owned forests were less than 100 acres and 32% owned less than 50 acres.[8] As discussed further in Issue 4, most family forest landowners have no plan or plan minimal activity for their forests. However, 12% plan to sell their lands, pass it on to heirs as an inheritance, or convert it to another land use including subdivisions.[101] As an aging population of forest owners passes the land on to family, the parcel sizes often get smaller, and this next generation may have an increased desire to convert the land to another use. Particularly at risk are lands in the Lower Cumberland and Green River

watersheds, which rank 6th and 12th in the U.S. for expected forest fragmentation and loss according to the USFS.[102] Housing density is projected to increase on 259,035 and 215,579 private forested acres in the Lower Cumberland and Green River watersheds, respectively.[103] Research found that inconsistent property valuation methods are significantly contributing to forest fragmentation in these areas.[104]



(Source: Turner et al., 2004)

FIGURE 30 – PREDICTED PERCENT CHANGE IN FORESTLAND, 1992 TO 2020

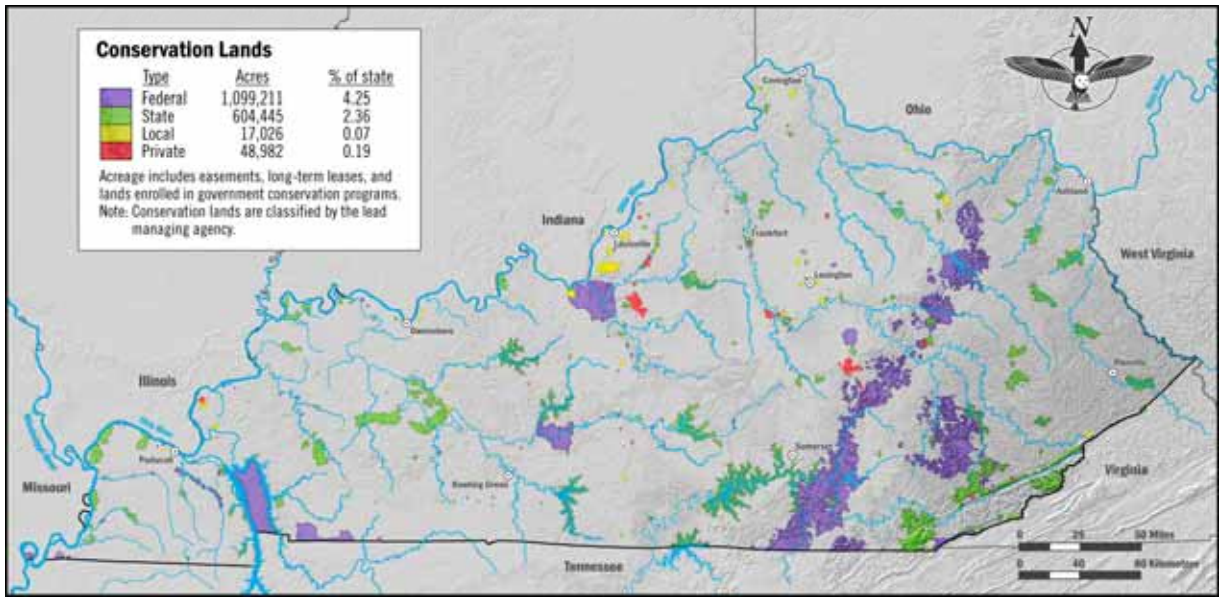
D. Opportunities

The two primary ways to deal with forest loss and fragmentation are prevention and restoration. Prevention focuses on maintaining the current large forested tracts, while restoration seeks to improve connectivity between forested areas and convert other land uses into forest. Opportunities may focus on maintaining current public lands, acquisition of additional lands, public education, smart growth policies, green infrastructure planning, or other financial incentives to decrease fragmentation and loss in the state.

1. Publicly Owned Forest Lands

Currently, federal, state, or other public institutions own 9% of Kentucky forests, as shown in Figure 31.[8] Comparison of the protected lands in the state with the large forested tracts (Figure 27) reveals that state and national forests, national recreation areas, national parks, wildlife management areas, and nature preserves contain many of the large contiguous blocks of remaining forest. The management policies of each of these publicly-owned forests would indicate to what extent they address forest loss and the prevention and/or restoration of fragmented areas. Policies could be adopted on these lands to minimize fragmentation or loss if not already established.

Outside of publicly-owned lands, however, large areas of forest are in private ownership. Efforts to keep large blocks of privately-owned land intact would require a cooperative effort between various branches of state and local governments, non-profit organizations, the general public, and forest owners. The Kentucky Heritage Land Conservation Fund (HLCF) and the Forest Legacy Program provide two avenues in which additional private land may be acquired and maintained for forest use.

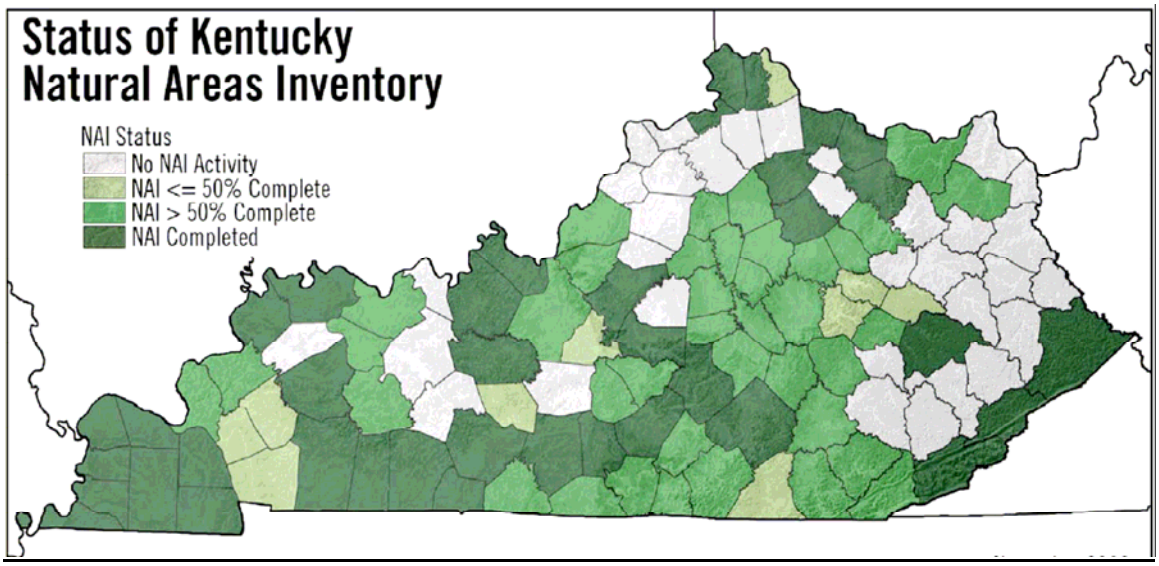


(Source: KSNPC) [105]

FIGURE 31 – CONSERVATION LANDS OF KENTUCKY

2. Kentucky State Nature Preserve Commission

The KSNPC seeks to protect natural areas through land acquisition and preservation by using species inventories, ecological analyses, and conservation planning. While information about the location of large contiguous forests currently exists, data on the quality of these forests are still being developed. Currently, the KSNPC has assessed approximately 50% of the state, as shown in Figure 32.[14] By using the forest patches data in conjunction with an inventory of plant and animal communities of Kentucky, criteria may be developed to prioritize both regions and blocks within regions for both restoration and protection. The HLCF or other funding sources could then be used by the KSNPC in the purchase and maintenance of these critical areas.



(Source: KSNPC)

FIGURE 32 – STATUS OF KENTUCKY NATURAL AREAS INVENTORY

3. Forest Legacy Program

The Forest Legacy Program (FLP) is a federal program that supports state efforts to protect environmentally sensitive forest areas that are threatened by conversion to non-forested uses. Administered by the KDF, the FLP allows for the purchase of forestland from private individuals with the goal of maintaining forests on the land. To qualify, private landowners must have a Forest Stewardship Plan for property which is at least 75% forested and at least 25% located within the designated forest legacy areas. The first FLP Assessment of Need, approved in 2003, was developed with public input to identify environmentally important forestlands for protection from conversion to non-forested uses. Landowners receive gains associated with the sale or donation of property rights and also benefit from reduced taxes. To date, Kentucky has received $5.55 million in FLP funding which has been used to acquire Knobs State Forest and WMA, 1,540 acres in Bullitt County, and Marrowbone State Forest and WMA which is 1,608 acres but will be expanding another 300 to 400 acres in 2010. The priority areas developed as a result of this assessment will serve as new priority areas for the FLP.

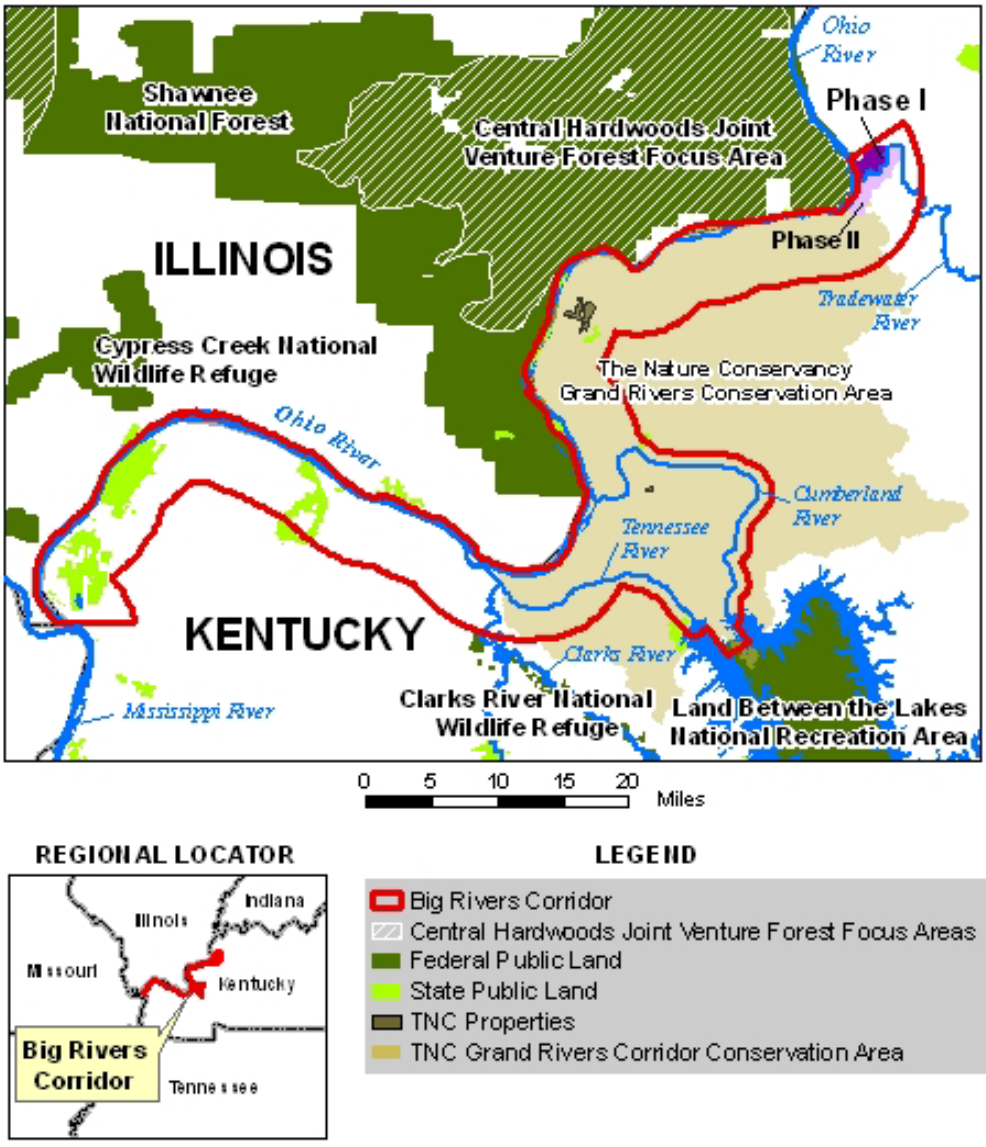


FIGURE 33 – FOREST LEGACY PROGRAM BIG RIVERS CORRIDOR

In some areas, the FLP is working with multiple organizations and across state lines to connect large forested tracts. One such example is the Big Rivers Corridor along the border between Kentucky and Illinois. The Shawnee National Forest and Cypress Creek National Wildlife Refuge in southern Illinois could be connected with the Land Between the Lakes National Recreation Area and the Clarks River National Wildlife Refuge in Kentucky through strategic acquisition as shown in Figure 33. Partnerships with groups such as The Nature Conservancy could make this project, and other similar projects a reality.

4. Financial Incentives for Maintaining Forestland

While acquiring forestland for protection may ensure long-term protection against fragmentation and loss, short-term protection may be provided through monetary incentives to private landowners.

Property and estate taxes are one such incentive. As noted previously, inconsistent property valuation methods were found to be a driver behind fragmentation in the Green and Lower Cumberland watersheds. Because property taxes are often lower on forestlands than in urban areas, individuals are often driven to develop remote areas. However, as the attributes of these areas are increasingly desired, the property values increase and heirs to these rural forestlands often must sell or subdivide inherited land in order to pay property taxes.[106] The fluctuation in properties values and taxes can therefore lead to an increase in the fragmentation of land over time. A more consistent approach to property valuation may lead to decreased fragmentation.

Recent opportunities for financial gain from forestland interest may aid in the stabilization of property values and taxes. Carbon credits are currently sold on the Chicago Climate Exchange, and the Mountain Association for Community Economic Development (MACED) offers enrollment to landowners in the Appalachian region of Kentucky. Low quality and waste wood now has an increasing market for use as woody biomass for energy production. Additional funds might be obtained by leasing hunting rights, recreational uses, or timber harvesting. It is hoped that the risk of conversion of forestland to another land use type will decrease as the monetary benefits associated with maintaining forestland increase.

5. The Wildland-Urban Interface Professional Development Program

Although the goals of natural resource management and urban expansion are often conflicting, the two land uses need not be mutually exclusive. Through smart growth using green infrastructure, proper planning, and low impact development techniques, the impacts to forest resources may be minimized and the benefits of these resources enhanced. However, USFS Chief Dombeck identified the wildland urban interface (WUI) as one of the main challenges of the Forest Service in the South.[107] To address this challenge, the *Changing Roles Wildland-Urban Interface Professional Development Program* was created to develop materials, training programs, and provide guidance to finding solutions to the impact of urban sprawl on forestlands.[107] This program has found that demographic changes, public attitudes and perceptions, taxation issues, land use planning, and change are all significant issues that must be addressed to limit the impact of fragmentation and loss.[108]

Not all areas in Kentucky are predicted to be impacted equally by urban development, so opportunities may exist to focus efforts on WUI areas. Figure 34 shows two types of WUI in Kentucky based on 2000 US Census data and the National Landcover Dataset of 2001. Intermix WUI are areas where a housing density of at least one per 40 acres intermingles with more than 50% continuous wildland vegetation. Interface WUI are areas with the same housing density and less than 50% contiguous wildland vegetation, but within 1.5 miles of an area of over 1,325 acres that is more than 75% vegetated.[109] These areas are most likely to experience forest loss and fragmentation from development.

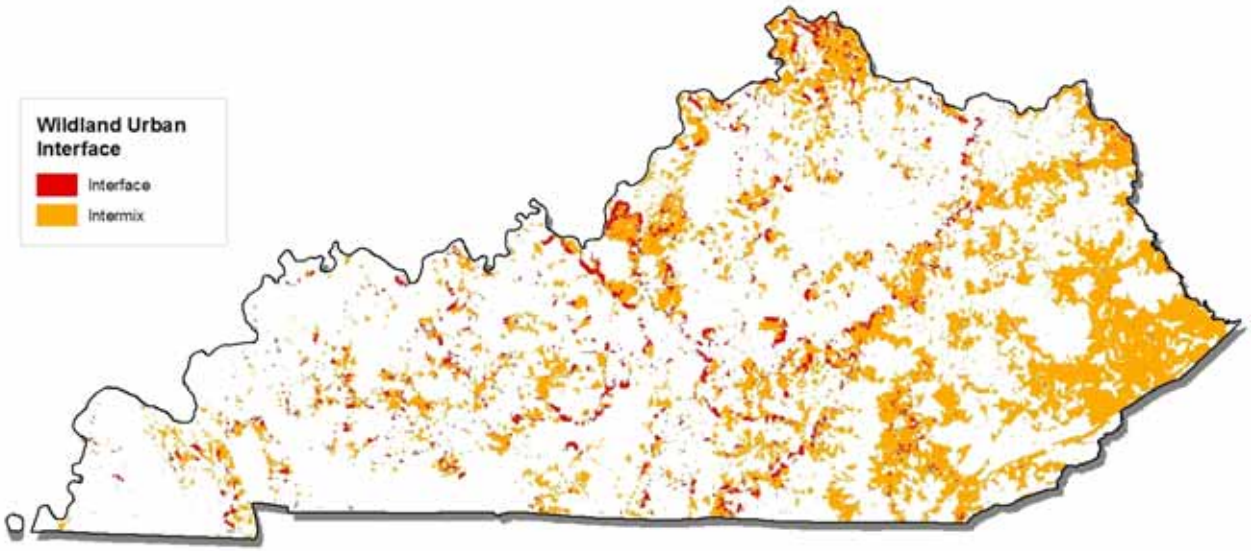


FIGURE 34 – KENTUCKY WILDLIFE URBAN INTERFACE AND INTERMIX IN 2000

Benefits of proper planning are many and various. Low impact development techniques can provide developers with the same numbers of residences while increasing the property value associated with them by maintaining large forest patches. Planning can target fragmentation towards areas less likely to lead to isolation or extirpation of species. Roadway projects reduce fragmentation by incorporation of travel corridors and wildlife passages for connectivity between fragments. Public education through Changing Roles and other similar programs may reduce the rate of fragmentation and loss to urban expansion.