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3.21 FOREST IMPACTS

3.21.1 Introduction

Approximately 4.8 million acres, or 21 percent of Indiana is forested (USDA Forest Service, 2020). Ownership is 85 percent private, with most tracts less than 40 acres. Most are in the southern half of the state and are dominated by hardwoods. Land use and management practices have caused a shift in dominant forest type from oak-hickory to maple-beech. Evergreen forests of pines, junipers, spruces and hemlocks are uncommon but exist in specific unglaciated areas. Southern Indiana forest types include maple-beech including black cherry, black walnut and yellow birch, oak-hickory including yellow poplar, elm-ash-cottonwood, aspen-birch and Eastern red cedar-oak-pine (Tormoehlen et al., 2000).

Forests are a large and important resource in Indiana. Indiana's forests make significant environmental and economic contributions, including timber, employment, outdoor recreation, protection of soil and water resources, air quality and carbon sequestration, biological diversity and aesthetic beauty. Indiana forest values and potential threats to those values are discussed in the Indiana Forest Action Plan 2020 Update (IDNR 2020) and the Indiana Forest Legacy Program Assessment of Need, 1998, updated 2020 (USFS, IDNR, 2020). Summaries of information presented in these documents are discussed below. Other citations are noted as necessary. Forest fragmentation and core forest habitat are discussed in greater detail in **Appendix H - Forest Impact Analysis**.

3.21.2 Timber

Indiana forests are among the best and most productive hardwood forests in the world, contributing $2.5 billion a year to the state's economy. Forest industries employ 56,000 Hoosiers in Southern Indiana. Southern Indiana produces wood office furniture, kitchen cabinets, veneer and other hardwood products for a national market. Most wood products companies are small family-owned businesses with fewer than 50 employees. These businesses play an important role in rural communities.

3.21.2.1 Recreation

Outdoor recreation in forests includes mountain biking, hiking, camping, horseback riding, multi-use trails, sightseeing, photography, birding, mushroom hunting, swimming, boating, game hunting and fishing. Use of forests for these activities drive conservation, research and federal tax monies appropriated for forests. Recreation creates economic links to the value and benefits of woodlands. Recreation supports education through outdoor experiences. Economic development in southern Indiana is enhanced through outdoor recreation tourism. There are benefits not only for the sites of natural, cultural, or historic resources, but also for travel, food and hospitality industries.

3.21.2.2 Urban Forests

Urban forests play an important role in quality of life. They moderate temperatures, help control pollution and provide habitat for urban wildlife, as well as beautify the community. Sixty-six Indiana cities have been awarded Tree City USA status from the Arbor Day Foundation. This status is achieved by sound urban forestry management which includes maintaining a tree board or department, having a community tree ordinance, spending at least two dollars per capita on urban forestry and celebrating Arbor Day. Near the project working alignments, Bedford has been named a Tree City. Seventeen Indiana schools have been awarded Tree Campus status. None of these schools are located near the project working alignments.

3.21.2.3 Soil and Water Quality

Retaining forests within headwaters and along the edge of streams and rivers is one of the simplest and best ways to preserve and enhance soil resources and water quality. Forest cover around river bottoms, drainages and riparian areas act as a buffer for streams, protecting them from erosion runoff and other pollutants. Forests reduce flooding. Forested riparian areas play an important part in regulating stream temperatures and rate of flow, which is critical for aquatic biology. Woody debris creates riffles, pools and much needed cover for spawning. Karst regions, critical habitat for many federally endangered cave species, benefit from undisturbed forests as they are particularly sensitive to water quality issues due to the many ways surface water can quickly enter the subterranean ecosystem. Maintaining forests in drinking-water supply areas can reduce the need for expensive water treatment.

3.21.2.4 Habitat

Oaks and hickories are currently the dominant canopy species in the hardwood forests. Oak species are a good indicator of high biodiversity as they support the greatest number of butterfly and moth species, whose caterpillars are the food source for neotropical migratory birds like the cerulean warbler (*Setophaga cerulean*). Lack of fire, lack of succession with open canopy conditions and browsing from deer have left few oak-hickory seedlings to replace the old canopy trees. Indiana forest canopy composition is shifting from shade-intolerant oak-hickory types to shade-tolerant maple-beech types that can regenerate under closed canopies.

Larger forest patches generally present a greater capacity of the forest to adapt to change. Species richness and biodiversity are increased by larger forest patches, more forests around wetlands and increased forested connectivity of riparian corridors. Many birds on the state or federal species concern lists use trees for cavities or nesting at both edge and interior forests. Core forests are important to avoid predation. Songbird nests near forest edges are at risk of parasitism from brown-headed cowbirds (*Molothrus ater*). Neotropical migratory birds use forests along their flyway for stop-over habitat during the spring and fall migration seasons (Audubon 2021). Amphibians such as the pickerel frog (*Rana palustris*) depend on forested streams to stay cool, clear and clean. All mammals on the State's species concern lists use some aspect of forests. All listed bat species, including the federally endangered Indiana bat (*Myotis sodalis*), gray bat (*Myotis grisescens*) and northern long-eared bat (*Myotis septentrionalis*), forage in and around tree canopies of the forests. They use tree cavities and loose or sloughing bark as roost sites in the summer months. The Allegheny woodrat (*Neotoma magister*) uses oak-hickory forests in rocky areas. Bobcats (*Lynx rufus*) are found in second growth timber and brushy fields and openings. River otters (*Lontra canadensis*) use riparian forests for cover and undercuts along stream banks for dens. Swamp rabbits (*Sylvilagus aquaticus*) are dependent on floodplain bottomland forests and shelter in standing hollow trees. A more detailed discussion of sensitive species and habitats in the Study Area is presented in **Section 3.16**.

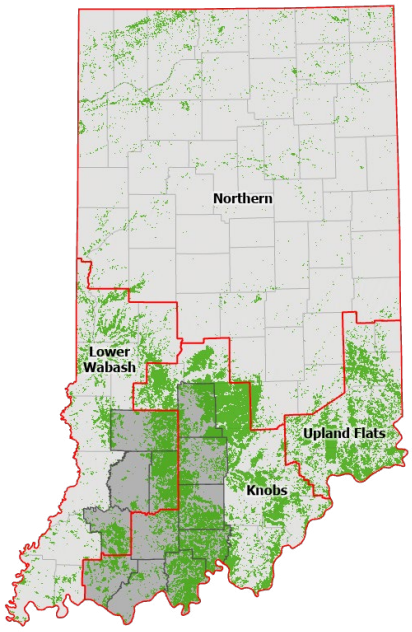

Figure 3.21-1: U.S. Forest Service, Forest Inventory Analysis (FIA) Survey Units in the Study Area

3.21.2.5 Study Area Forests Descriptions

The Study Area is located in two U.S. Forest Service (USFS) Forest Inventory and Analysis (FIA) survey units. One is the Lower Wabash Unit consisting of Pike, Daviess, Martin and Greene counties. The other is the Knobs Unit consisting of Warrick, Spencer, Dubois, Perry, Crawford, Orange, Lawrence, and Monroe counties. See **Figure 3.21-1**. Timber

volume is growing at more than twice the rate of removal in these units. Across both units, most trees are 31 - 60 years old, and the next largest cohort is in the age of 61 – 80 years. (Tormoehlen et al., 2000)

The hilly terrain in the Knobs Unit contains the highest number of trees in the state. It is the only unit where the oak-hickory forest type is more abundant than the maple-beech forest type. Major forest type percentages (1998) in this unit are 48 percent oak-hickory, 35 percent maple-beech, seven percent elm-ash-cottonwood, six percent eastern red cedar-oak-pine, three percent southern pine and one percent other. (Tormoehlen et al., 2000). In the Lower Wabash Unit, the maple-beech forest type is the more abundant. Major forest type percentages (1998) in this unit are 37 percent maple-beech, 35 percent oak-hickory, 20 percent elm-ash-cottonwood, five percent other and three percent Eastern red cedar-oak-pine. (Tormoehlen et al., 2000). **Figure 3.21-2** shows a typical forest in the project Study Area, courtesy of US National Park Service.

Figure 3.21-2: Typical Forest in Mid-States Project Area

Working alignments intersect the following natural regions and sections: Mitchell Karst Plain section in the Highland Rim region, Escarpment and Crawford Upland sections in the Shawnee Hills region, Southern Bottomlands region and Glaciated and Driftless sections in the Southwestern Lowlands region (**Figure 3.21-3**). Further discussion of the natural regions is presented in **Section 3.25**.

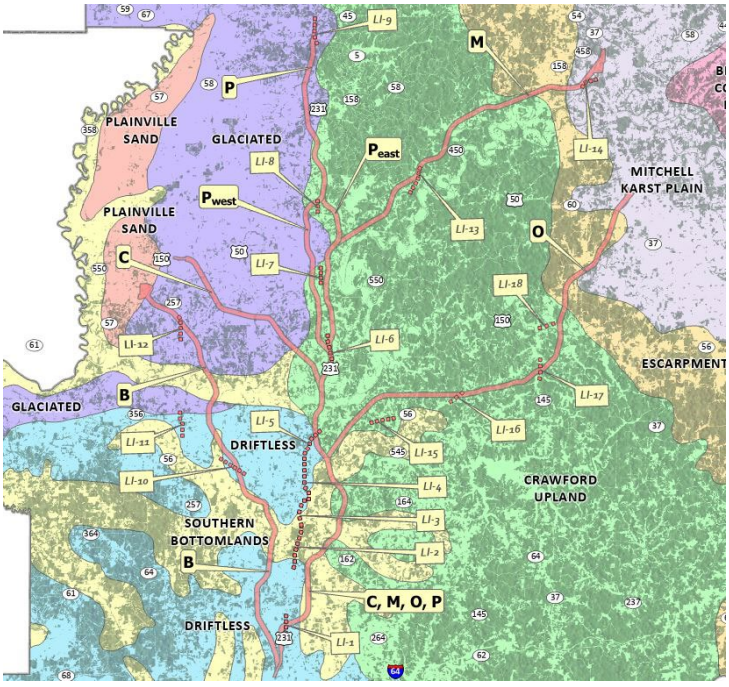

Figure 3.21-3: Natural Region Sections and Forests in the Study Area

Homoya et al. (1985) described Indiana natural regions, including the forest composition in each region. From the project's southern terminus to the north side of Huntingburg, all alternatives pass through the Driftless section of the Southwestern Lowlands region. The Driftless section is characterized by low hills and broad valleys with upland oak-hickory forest types on well-drained slopes. Upland forest species include southern red oak (*Quercus falcata*), post oak (*Q. stellata*) and blackjack oak (*Q. marilandica*). The floodplains are occupied by southern flatwoods. Characteristic flatwoods species include cherry bark oak (*Q. falcate var. pagodaefolia*), sweetgum (*Liquidambar styraciflua*), shellbark hickory (*Carya laciniosa*), pin oak (*Q. palustris*), swamp white oak (*Q. bicolor*), Shumard's oak (*Q. shumardii*), green ash (*Fraxinus pennsylvanica*) and black gum (*Nyssa sylvatica*).

All alternatives traverse the Southern Bottomlands region, associated with the Patoka River floodplain from Huntingburg to the north side of Jasper. Alternative B traverses this region further north, associated with the White River. The Southern Bottomlands region includes the alluvial lands along rivers and large streams. The major community

is bottomland forest, characterized by the following species: pecan *(Carya illinoensis*), sugarberry (*Celtis laevigata*), swamp chestnut oak (*Q. michauxii*), pin oak (*Q. palustris*), swamp white oak (*Q. bicolor*), red maple (*Acer rubrum*), silver maple (*A. saccharinum*), honey locust (*Gleditsia triacanthos*), catalpa (*Catalpa speciosa*), shellbark hickory, sycamore (*Platanus occidentalis*) and green ash. In the swamps there are bald cypress (*Taxodium distichum*), swamp cottonwood (*Populus heterophylla*), water locust (*Gieditsia aquatica*), pumpkin ash (*Fraxinus tomentosa*) and overcup oak (*Q. lyrata*).

North of the White River, Alternatives B, C and some eastern areas of Alternative P pass through the Glaciated section of the Southwestern Lowlands region. Flatwoods are common, but differ in composition to the Driftless section, lacking some of the common southern species. Flatwoods species present include: shagbark hickory (*C. ovata*), shellbark hickory (*C. laciniosa*), pin oak, shingle oak (*Q. imbricaria*), hackberry (*Celtis occidentalis*), green ash, red maple and silver maple. Alternative B connects with I-69 at the edge of the Plainville Sand section. The characteristic landscapes of this section have largely been converted, and the forests are similar composition to the Glaciated section.

Much of the Northeastern Family alternatives (Alternatives M and O), and the central and western areas of Alternative P traverse the Crawford Upland of the Shawnee Hills region. This region best represents the general pre-settlement conditions in the state. The Crawford Upland has rugged hills with sandstone cliffs and rockhouses. Dominant forest types include oak-hickory at 47 percent and beech-maple at 33 percent (HNF, 2005). Oak-hickory forests on the upper slopes include black oak (*Q. velutina*), white oak (*Q. alba*), chestnut oak (*Q. prinus*), scarlet oak (*Q. coccinea*), post oak (*Q. stellata*), pignut hickory (*Carya glabra*), small-fruited hickory (*C. ovalis*), shagbark hickory (*C. ovata*) and rarely, sourwood (*Oxydendrum arboreum*). Cove forests have more mixed mesic species including beech (*Fagus grandifolia*), tulip tree (*Liriodendron tulipifera*), red oak (*Quercus rubra*), sugar maple (*Acer saccharum*), black walnut (*Juglans nigra*), and white ash (*Fraxinus americana*).

As Alternatives M and O approach their termini with SR 37, they traverse the Escarpment section of the Shawnee Hills Region. This section has rugged hills with sandstone on the caps and limestone in the lower elevations. Dominant forest types are oak-hickory at 44 percent and beech-maple at 34 percent (HNF, 2005). Forest types are upland dry-mesic and mesic, with similar species composition to the Crawford Upland section.

Alternatives M and O extend east to SR 37 near the edge of the Mitchell Karst Plain section of the Highland Rim region. The region is unglaciated with a large expanse of karst topography. The section is dominated by a level karst plain with many sinkholes and several forest communities. It contains uncommon blocks of evergreen forest, including hemlock forest. In the Mitchell Karst Plain section, dominant forest types are oak-hickory at 60 percent and beech-maple at 24 percent (HNF, 2005). The dominant forest community is western mesophytic forest consisting of white oak (*Quercus alba*), sugar maple (*Acer saccharum*), shagbark hickory (*Carya ovata*), pignut hickory (*C. glabra*) and white ash (*Fraxinus americana*). There are xeric forests associated with glades which include post oak (*Quercus stellata*), chinquapin oak (*Q. muhlenbergii*) and blue ash (*Fraxinus quadrangulata*). Sinkhole swamp forests are dominated by swamp cottonwood (*Populus heterophylla*), pin oak (*Quercus palustris*), swamp white oak (*Q. bicolor*), red maple (*Acer rubrum*) and sweet gum (*Liquidambar styraciflua*).

3.21.2.6 Fragmentation

Forest fragmentation is the breaking up of large contiguous forested blocks into smaller and smaller pieces. These pieces may be separated by roads, agriculture, building and/or other development. Over time, as the non-forest patches expand, they become scattered, disconnected forest islands (**Figure 3.21-4**). Any change in the forest canopy affects a forest, but fragmentation from permanent human disturbance is different than a forest of mixed ages with a variety of canopy closures (Snyder, 2014). Sustainable timber harvesting does not cause fragmentation as it is defined here, because openings are temporary, quickly revegetate, and debris creates new successional habitat as regrowth occurs. Disturbance from natural succession is beneficial to species that depend on the forest. Worm-eating warblers (*Helmitheros vermivorum*) and cerulean warblers (*Setophaga cerulean*) need the mature interior forest

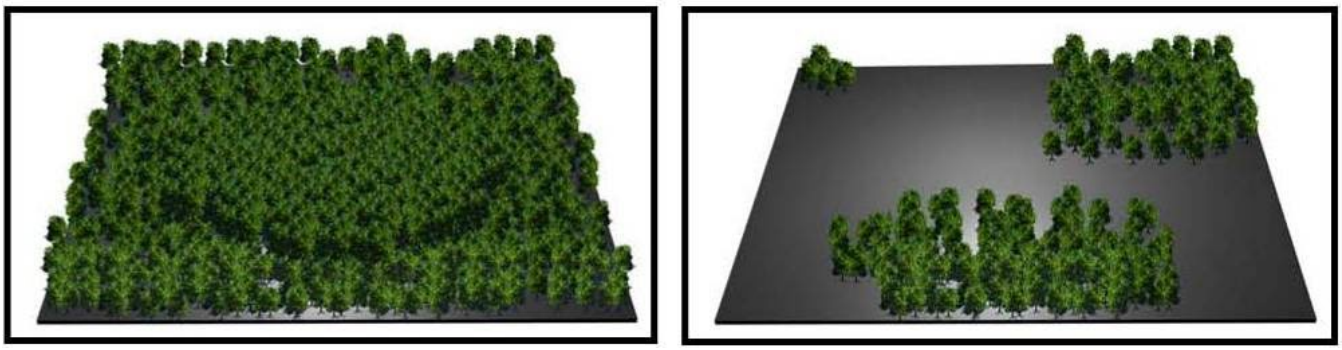

Figure 3.21-4: Forest Fragmentation

to nest, but forage in the early-successional, more open habitat. Bat maternity colonies are frequently found where timber has been recently harvested, and the increased sun exposure increases the energy reserves of the females. (IDNR, https://www.in.gov/dnr/forestry/files/fo-indiana_forest_wildlife_management.pdf).

The Indiana Forest Action Plan (2020) states, "Fragmentation and/or conversion of forests to another land use is the most important threat to the sustainability of Indiana's forests." Likewise, the top threat facing fish and wildlife species of greatest concern is conversion of forested habitats. The need to link the remaining forests to protect timber resources, biological diversity, aesthetic value, and water and air quality has become increasingly evident. Large patches of connected forest are required to provide the resource flows and cycles needed for healthy forest ecosystem function. **Figure 3.21-5** shows the distribution of 2018 forests in Indiana by patch size.

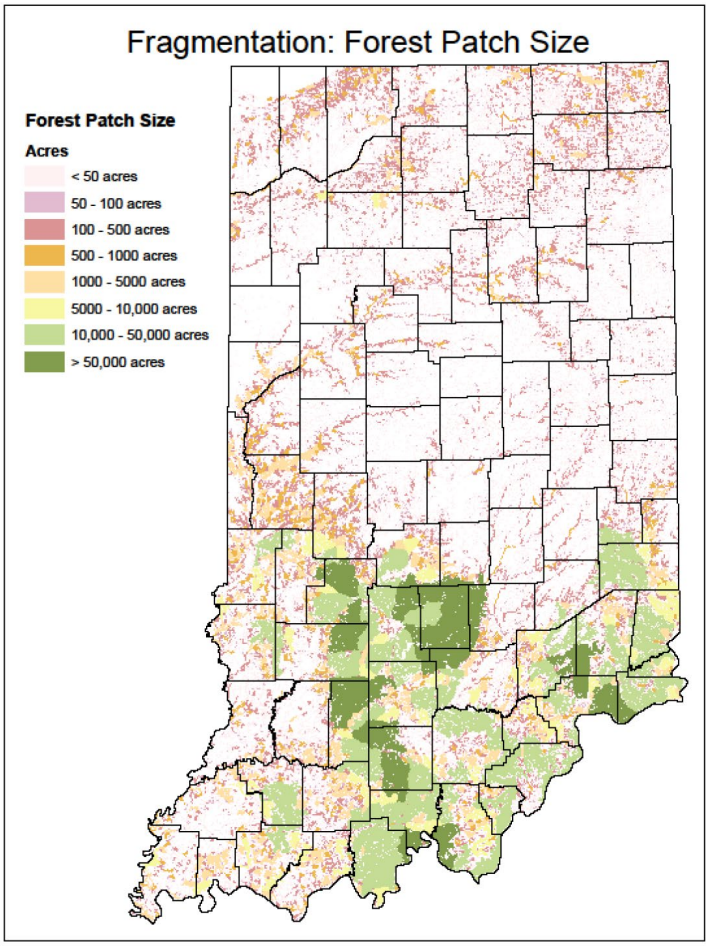

Figure 3.21-5: 2018 Forests in Indiana by Patch Size (IDNR, 2020)

Conversion of forest to annual cropland is a common driver of fragmentation. The building of roads and resulting home building and development are also a cause of fragmentation. Indiana forests are increasingly owned in smaller and smaller tracts, which are becoming isolated. This segmented ownership pattern or "parcelization" makes sustainable forest management increasingly difficult, and short-term profits from land sales to developers become more attractive. As woodland tracts reduce in size, it becomes impractical and not economically viable to harvest timber. Fragmentation from conversion to roads or other impervious surfaces can increase the risk of water quality impacts from hazardous substance runoff not slowed by soil, root, and plant dynamics. Lacking soil and vegetation, these surfaces have their own climate and create heat islands that further separate local ecosystems. Linear development, such as roadways, creates pathways and corridors that can spread invasive species. Roads can be a major barrier

to dispersal for some plants and animals.

Fragmentation leads to forest isolation and increased edge effects. This leads to a loss of biodiversity, increases in invasive plants and reduction in water quality. Fragmentation of forest systems hinders the movement of species, restricts genetics and weakens the ability of this complex system to adapt and respond to change. Edge effects change the climate of what was formerly interior forest, causing shifts in the animal and plant communities. Species using formerly interior forests experience increased predation and nest parasitism. Ecologists suggest that true interior forest conditions for temperature, humidity, light and wind occur 200 – 300 feet inside the forest edge. (Synder 2014).

Forests are legally protected from conversion through public ownership, deed restriction programs such as the Indiana Classified Forests and Wildlands Program, and conservation easements in partnership with private land trusts. The Classified Forest and Wildlands Program, provides private landowners tax incentives to implement a management plan in cooperation with professionals that focuses on timber production, watershed protection and wildlife habitat management. As of November 2019, there are 823,258 acres in 16,785 tracts enrolled in this program. State designated nature preserves have the highest level of legal protection.

3.21.3 Methodology

The calculation of forest impacts included (1) quantifying the direct impacts of each alternative on existing forests and (2) quantifying the estimated loss of interior core forest habitat after the proposed action. These impacts were determined based on the area within or reduced by the ROW of the working alignment of each alternative and facility type.

The direct forest impacts of all working alignments were calculated using spatial geographic information system (GIS) data and tools. A more detailed explanation on the use of GIS to calculate impacts is discussed further in **Section 3.1.** Existing forest land was represented by the 2016 National Land Cover Database (NLCD) layer, which was updated using 2018-19 aerial photography. The layer has a 30-meter resolution. The classes of forests in the dataset which were analyzed for direct impacts were: deciduous forest, evergreen forest, mixed forest and woody wetlands. Both upland and bottomland forests are included in these forest classes. NLCD forest data will duplicate some wetland forests discussed in more detail in the wetlands chapter, **Section 3.18**. Direct impacts to forests are given as ranges to reflect the potential range of facility types for each alternative.

Core forest impacts measure loss of interior forest habitats not only from direct take by construction, but also by conversion to edge forest habitat as fragmentation increases. Core forest is defined as the central portion of the forest that is at least 100 meters from any forest edge (Temple, 1986) and at least one acre in size. A subset of the updated NLCD Land Cover Database layer combining all forest types (deciduous, evergreen, mixed, and wetland) was used to create a data subset of forest blocks for spatial analysis. The data subset was further refined using inspection of 2018 aerials to accurately reflect edges and interior clearings in forest blocks. GIS tools were used to buffer forest edges and calculate the acres of core forest in the area of the working alignments both before and after the proposed action. Estimated loss of core forest habitat are given as ranges to reflect the potential range of facility types for each alternative. Decisions about facility types, as well as exact alignments, will be made in Tier 2 studies.

Forest Impacts* (acres)		
Alternatives**	**Total Forest (acres)**	**% Working Alignment Forested**
B	312 - 347	14%
C	424 - 556	22%-23%
M	1,994 - 2,311	47% - 48%
O	1,588 - 1,756	47% - 50%
P	629 - 923	25% - 29%

* Forest impacts include all forests in the NLCD land use dataset regardless of type or wetland status. Forested wetlands are analyzed in more detail in Chapter 3.18. Forest impacts will duplicate some forests discussed in the wetlands chapter. The impacts of the two chapters are NOT additive. Forest types will be studied in more detail in Tier 2.

** Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types and bypass variations. Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 are anticipated.

Table 3.21-1: Forest Impacts

3.21.4 Analysis

Table 3.21-1 shows the range of estimated direct impacts on all forests for each alternative. Impacts for each specific alternative variation is explained in greater detail in **Appendix H – Forest Impact Analysis**.

Forest classes were assigned by the data creators from 30-meter satellite imagery and should be considered general. While the classes show a generally similar distribution of forest types throughout the Study Area and between alternatives, detailed field studies of forests in proposed alignments in Tier 2 will be needed to draw meaningful conclusions about forest types and compare impacts specific to forest types across proposed alignments.

For direct forest impacts, the Northeastern Family Alternatives M and O have significantly higher impacts. They are four to six times larger than the Northwestern Family Alternatives B and C, and two to three times larger than North Central Alternative P. The working alignment ROWs for Alternatives M and O are 47 - 50 percent forested. The rugged topography and thin karst region soils of the Northeastern Family ecoregions make them less suitable for development and agriculture, and therefore, less likely to be converted to other land uses. Both M and O pass through the proclamation boundary of the Hoosier National Forest. However, they impact no current federally owned lands. Alternative M impacts one tract of the Martin State Forest (**Section 3.27 – Managed Lands**).

Alternative B has the least direct forest impacts, followed closely by Alternative C. Both the Northwestern Family alternatives cross ecoregions with flat to rolling topography and deep soils which result in much of the ROW land use already converted for development, agriculture or coal extraction. Remaining forests are largely associated with bottomland streams or rivers and occasional hills. Alternative B ROW is 14 percent forested, while Alternative C ROW is 22 to 23 percent forested. Alternative P is the median value in the range of impacts, being higher than Alternatives B and C, but still substantially less than Alternatives M and O. Alternative P is 25 to 29 percent forested.

Table 3.21-2 shows the range of estimated direct impacts on core forests for each alternative. Direct impacts may occur in one of two ways: (1) direct take of the interior core forest area and (2) conversion of core interior habitat to edge habitat as fragmentation increases. Core forest impacts for each specific alternative variation is explained in greater detail in **Appendix H – Forest Impact Analysis**.

Core Forest Impacts						
Alternatives*	Existing Core Forest Connected to the ROW (Acres)	Remaining Core Forest After Action and Edge Redefinement (Acres)	Direct Take of Core Forest (Acres)	Total Loss of Core Forest** (Acres)	% Core Lost from Existing Core^	Loss of Core Forest (Block Count)
B	391	350 - 352	10 - 13	39 - 42	10% - 11%	2
C	679	537 - 549	50 - 67	130 - 143	19% - 21%	7
M	4,867	3,664 - 3,743	484 - 573	1,124 - 1,202	23% - 25%	18
O	4,597	3,552 - 3,588	468 - 509	1,009 - 1,045	22% - 23%	16
P	1,466 - 1,676	1,211 - 1,344	111 - 160	235 - 355	16% - 21%	7 - 10
* Tier 1 Alternative impacts are reported in ranges including all the local improvements, facility types and bypass variations.						
** Core forests loss occurs from direct take from construction and/or conversion to forest edge from fragmentation.						
^ Calculated by Loss of Core Forest divided by Existing Core Forest Connected to the ROW						

Table 3.21-2: Core Forest Impacts

Loss of core forest habitat due to direct take or conversion to edge habitat from fragmentation follows roughly the same trends as the overall impacts to forested land. Northeastern Family Alternatives M and O have the largest core forest impacts. Estimates show 45 times the direct loss and 22 times the loss due to fragmentation compared to Alternative B, the lowest impact alternative. Compared to the Alternative P alternative variations, Alternatives M and O have four times the direct core forest loss and four to five times the core forest loss from fragmentation.

On average, the Northeastern Family alternatives impact 48 percent forested land. Of those forests, 25 percent of Alternative M and 30 percent of Alternative O contains core forest habitat. This reflects the land use trend of lower disturbance of forested tracts in the region. Alternatives C, M, O and P core forest losses occur approximately 50 percent from direct take and 50 percent from habitat conversion to edge from fragmentation. Alternative B core forest losses occur 30 percent from direct take and 70 percent from conversion due to fragmentation.

When an interior forest block has less than one central acre remaining that is more than 100 meters inside the edge, it is no longer core habitat, but has been wholly converted functionally to forest edge. Impacts to core forest are estimated to eliminate 18 core forest blocks in Alternative M and 16 core forest blocks in Alternative O. Alternatives C and P lose seven to 10 core forest blocks. Alternative B losses two small core forest habitat blocks; however, it does remove 10 percent of the limited amount of core forest habitat available in the area. Alternatives C, O and P remove 16 – 23 percent of core forest area. The most core area affected is from Alternative M, estimated to lose 23 - 25 percent.

3.21.5 Mitigation

Forests are not a regulated resource and do not generally require mitigation. However, mitigation for forests may be required if there is a connection to another regulatory requirement. For example, forested wetlands require mitigation as part of the Clean Water Act. In addition, forests serve as habitat for endangered bat species. Forest impacts act as a surrogate to measure potential impacts to these bats. Mitigation for transportation projects in Indiana generally follows a formula based on distance from an existing right-of-way, distance from documented habitat, and the acreage of removal. This mitigation ratio is based on the Compensatory Mitigation Ratio Percent Forest Cover, by county. The Range-Wide Indiana Bat In-Lieu Fee Program established the formula used to calculate the amount in compensatory mitigation for project impacts under that program. Forested wetland areas would generally be mitigated using a 1:4 ratio defined by the U.S. Army Corps of Engineers (USACE). State isolated forested wetlands will be mitigated based on current state isolated wetlands law (See **Section 3.18**).

3.21.6 Summary

All the proposed alternatives of the project will impact Southern Indiana's forest communities. Analysis of forest data and habitats have consistently shown that the Northeastern Family Alternatives M and O have significantly more impacts than other alternatives. Alternative C has the next to lowest impacts. Alternative B consistently has the least impacts for all statistics. Alternative P, the preferred, falls in the middle of the range of impact statistics. It is higher impacts than Alternatives B and C, but has substantially smaller impacts than Alternatives M and O. The No-Build Alternative would not impact any forests.