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3.25 ECOSYSTEM IMPACTS

3.25.1 Introduction

Roadway networks and their effects on wildlife have been well documented in published literature (Forman and Alexander 1998, Trombulak and Frissell 2000, Donaldson 2005, Jaeger et al 2005, IOCOET 2001). Roads have been shown to reduce wildlife populations by direct mortality and habitat loss. Roads also cause habitat fragmentation, reduce habitat patch size and can make habitat required by some species inaccessible. How species respond to these factors helps define and prioritize mitigation strategies.

Animal populations with low reproductivity rates, low density and large habitat requirements are most susceptible to the effects of a new roadway. Animals that avoid roadways and require different and/or specialized habitats may be impacted by habitat inaccessibility. Animal species that are habitat generalists or attracted to roads will be vulnerable to mortality from vehicle strikes. Species that avoid roads and are grassland or forest understory specialists will be impacted by fragmentation and habitat loss.

Mitigation strategies for wildlife impacts are most successful if included from the earliest stages of planning a new roadway. Many techniques can reduce wildlife mortality. Most effective mitigation strategies have been focused on large mammals. Mitigating barrier effects using wildlife passages is effective but requires rigorous monitoring and performance evaluations to determine whether they are successful.

3.25.2 Methodology

Natural regions or natural communities within Indiana have been defined and described by numerous authors (Homoya et al 1985, Whitaker et al. 2012). A natural community is a group of organisms that are interrelated to their environment and to one another. Biotic and abiotic features such as glacial history, soil type, soil moisture, vegetation structure and topography define the boundary and extent of a natural community. By calculating impacts to natural regions, we can better understand the types of wildlife potentially impacted within various natural community types. This aids in defining what mitigation strategies will be most beneficial in reducing impacts to natural habitat and wildlife associated with the habitats.

Ten natural regions have been described for Indiana. Several regions have one or more unique subregions. Four of these 10 regions are in the Project Study Area and are briefly described in the paragraphs below. **Figure 3.25-1** shows the natural regions in the project area and the alternatives carried forward for detailed study. A more detailed description of each Natural Region, its subregions and the wildlife associated with the various natural community types is provided in **Appendix HH, Ecosystem Impacts.**

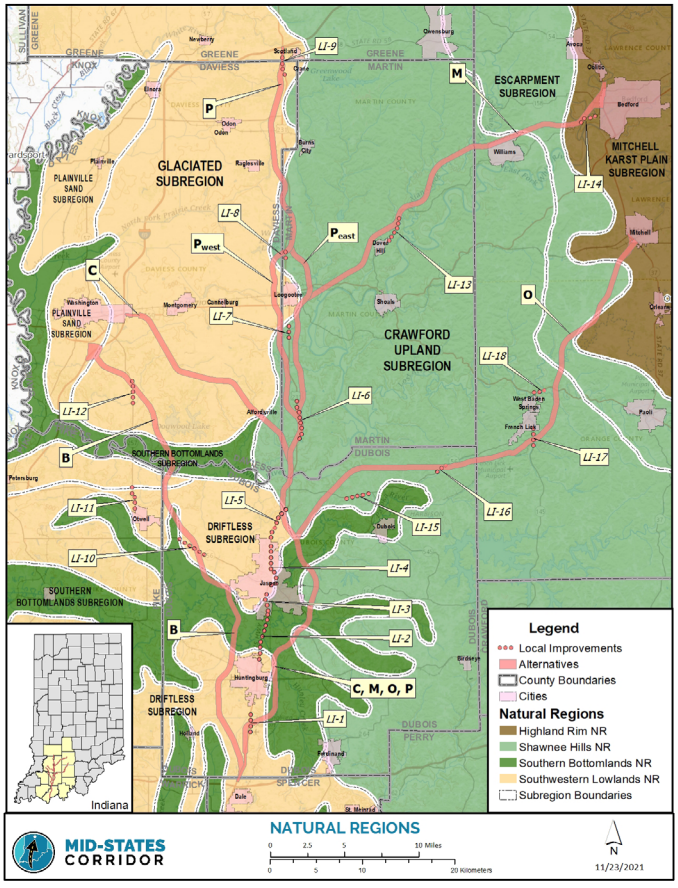

Figure 3.25-1: Natural Regions in Study Area

3.25.2.1 The Southern Bottomlands Natural Region

The Southern Bottomlands Natural Region includes frequently inundated floodplains and alluvial bottomlands along the large rivers and streams in Southwestern Indiana. The Patoka River and its associated floodplain is a prime example of a silt-bottomed, low-gradient stream characteristic of this region. Many species located within the region show an affinity to the lower Mississippi Valley. Natural communities within the region include bottomland forest, swamps, marshes, sloughs and wet prairie. Historically, this region had an equal mix of upland forest and forested wetland complexes covering 76 percent of the region. Within the forest/wetland complexes, fragipans were also common, lending to seasonally ponded water over large areas. The native vegetation consisted of numerous tree species that can withstand seasonal flooding, including pecan, bald cypress, black gum, bur oak, green ash, overcup oak, pin oak, red maple, shellbark hickory, silver maple, swamp white oak and sweet gum. Many other species of plants and animals are restricted to this region (See **Appendix HH**). Currently, 26.5 percent of the region is forested, with agriculture and grassland accounting for 67.5 percent of the land cover.

3.25.2.2 Shawnee Hills Natural Region

The Shawnee Hills Natural Region is in the highly dissected southern portion of Indiana that was primarily forested (at 96 percent) prior to European settlement. The forest composition of the region varied based on physiography, topography and whether the soils were derived from limestone or sandstone and shale. The region is rugged and generally sparsely populated. The majority of natural communities are upland forest types, although there are a few sandstone and limestone glades, gravel washes and barrens. This region's current habitat represents presettlement conditions better than any other terrestrial region in the state. Nearly 57 percent of the region is still forested, while nearly 40 percent has been converted to agriculture or grassland. This region also contains two subregions: the Crawford Upland Subregion and the Escarpment Subregion.

3.25.2.3 Highland Rim Natural Region

The Highland Rim Natural Region is located along relatively hilly terrain from the Bloomington-Nashville area south to the Ohio River. This region has relatively steep valleys with prominent karst topography typified by many sinkholes, dissolution valleys and a lack of surface water drainage. Bedrock is primarily limestone with some chert. Weathered sandstone, siltstone and shale are also parent materials for these soils, as is some wind-blown loess. The steep topography results in thin soils at many locations. Often, there is exposed bedrock. Historically, forest covered the majority (95 percent) of the Highland Rim Natural Region. Today the region is only 49 percent forested. Over 45 percent of the land now is agriculture or grasslands. This natural region is divided into three subregions: the Mitchell Karst Plain Subregion, the Brown County Hills Subregion and the Knobstone Escarpment Subregion. Only the Mitchell Karst Plain and Knobstone Escarpment Subregions exist within the Project Study Area.

3.25.2.4 Southwestern Lowlands Natural Region

The Southwestern Lowlands Natural Region is in the southwestern portion of Indiana just north and east of the confluence of the Ohio and Wabash rivers. It is characterized by nearly level undissected terrain with an abundance of poorly drained soils. Most of the region, except for the southern portion, was glaciated by the Illinois ice sheet. The native vegetation was mixed hardwood forest (76 percent) composed of northern red oak, white oak, black walnut, wild black cherry, sugar maple, white ash, Virginia pine, eastern white pine, and tulip poplar. Other forests of the Region (17 percent) commonly occurred on soils with a fragipan restricting water movement and creating wetland forest complexes. These soils tended to be wet in the spring and drier in the summer and fall. Currently, estimates indicate the Southwestern Lowlands Natural Region is only 28 percent forested. Over 61 percent of the land now is agriculture or grasslands. This region contains three subsections the Plainville Sand Section, the Glaciated Section, and the Driftless Section.

Indiana Natural Regions *					
Alternatives**	HIGHLAND RIM	SHAWNEE HILLS	SOUTHERN BOTTOMLANDS	SOUTHWESTERN LOWLANDS	Total ROW
	acres	acres	acres	acres	
B	- - -	- - -	550 - 625	1,671-1,900	2,220 - 2,525
C	- - -	496 - 658	545 - 684	859 - 1,061	1,900 - 2,403
M	825 - 879	2,418 - 2,900	534 - 671	361 - 450	4,138 - 4,900
O	145 - 310	2,181 - 2,387	531 - 667	305 - 366	3,162 - 3,730
P	- - -	1,074 - 1,615	534 - 671	770 - 1,121	2,497 - 3,226
* Tier 1 Route impacts are reported in ranges including all the alternative bypass and facility type options.					
**Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.					

Table 3.25-1: Acres of Impacts by Natural Region

Indiana Natural Regions *				
Alternatives**	HIGHLAND RIM	SHAWNEE HILLS	SOUTHERN BOTTOMLANDS	SOUTHWESTERN LOWLANDS
	miles	miles	miles	miles
B	- - -	- - -	13.89	30.94
C	- - -	11.60	14.37	26.02
M	5.26	47.76	14.12	13.80
O	3.23 -3.53	40.64	14.12	12.12
P	- - -	28.59 - 32.57	14.12	25.13 - 29.38
* Tier 1 Route impacts are reported in ranges including all the alternative bypass and facility type options.				
**Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities, but are included				

Table 3.25-2: Linear Miles of Impacts by Natural Region

Habitat Fragmentation Potential *			
Alternatives**	# of Forest Blocks > 10 Hectares Crossed	# of Core Forest Crossed	# of Crossings of Named Streams
	Count	Count	Count
B	13	3	22
C	35	9	27
M	57	24	51
O	68	32	23
P	44 - 47	10 - 13	32 - 36
* Tier 1 Route impacts are reported in ranges including all the alternative bypass and facility type options.			
**Facility type 1, freeways, has been removed from consideration. Therefore, no modifications to existing US 231 in Section 1 and existing SR 37 in Section 3 are anticipated. No impacts are anticipated on either of these facilities.			

Table 3.25-3: Habitat Fragmentation Potential

3.25.3 Analysis

A GIS analysis identified the acreage (**Table 3.25-1**) and linear miles (**Table 3.25-2**) of each type of natural region and its subregions (**Appendix HH**) impacted by each alternative. Habitat Fragmentation Potential was also assessed by calculating how many forest patches of at least 10 hectares, about 25 acres, were bisected (2016 Land Cover Data). The total number of crossings of named streams (**Table 3.25-3**) also was calculated. The impacts in each of these tables are for the entire end-to-end alternative. See **Appendix HH** for impacts by project section.

Alternative B is the only alternative entirely to the west of Jasper and Huntingburg. This alternative has the potential for the least number of impacts to natural habitats, since it primarily is within the Southwestern Lowlands and Southern Bottomlands natural regions. It fragments the least amount of large forest patches including core forests, and crosses only 13 named streams. Most impacts are to portions of disturbed agricultural habitat that have the

least amount of diversity. The alternative would also cross the least number of streams and is also the shortest; however, it would require a new bridge over the White River.

Alternative C is located east of Jasper and Huntingburg. It diverges to the west after crossing the White River. This alternative crosses three natural regions, and would bisect nearly three times as many large forest patches and core forest as Alternative B.

Alternative M is the longest of the five alignments and crosses through four natural regions, including two subregions with sensitive habitats, Escarpment and Mitchell Karst Plain. This alternative has the potential to fragment numerous large forest blocks in the Shawnee Hills Natural Region and potentially affect karst habitats. However, it crosses only five named streams due to the karst nature of the natural region.

Alternative O, like Alternative M, follows an eastern route through a portion of the Shawnee Hills Natural region, potentially bisecting many large forest patches in the Escarpment and Mitchell Karst Plain subregions. Alternative O is the only alternative that does not cross the White River. However, it does impact the greatest number of large forest blocks and core forest and crosses the most named streams. Many sensitive habitats with sensitive species are near this alternative, making it potentially the most impactful to wildlife.

Alternative P also is located east of Jasper and Huntingburg. North of the White River, it is parallel with existing US 231. This alternative would bypass Loogootee on either the east or west. Alternative P does impact several large forest blocks. Its range of impacts to core forest and named streams is similar to Alternative C, and much less than Alternatives M and O

3.25.4 Mitigation

Specific mitigation measures for affected species will be included as part of the Tier 2 studies. Some measures have been identified which target specific species and population. See **Section 3.16.6 – TES Mitigation**. Mitigation for listed species occurs as part of formal consultation with the U.S. Fish and Wildlife Service. Other measures provide for conservation of specific ecosystems. See **Section 3.18.4 – Wetland Mitigation** and **Section 3.19.4 – Stream Mitigation**. These categories of mitigation occur as a part of Section 401/404 permitting under the Clean Water Act.

In addition to these specific measures, mitigation strategies appropriate for a Tier 1 analysis have been developed to guide mitigation activities for Tier 2 studies.

One general mitigation strategy is to identify appropriate compensatory mitigation. Compensatory mitigation is most beneficial to the species inhabiting the area if the mitigation is accomplished on site. An example is stream mitigation. However, in other situations, compensatory mitigation will be most beneficial if provided at a location away from the impact areas. An example of this type of mitigation is the creation/enhancement/preservation of a large tract of land adjoining an existing natural community.

A second strategy is to provide mitigation for multiple species at a single location, to achieve more ecologically significant results. An example of this is restoration of degraded stream habitats that have a high potential to support a diversity of aquatic species not currently supported.

A third strategy is to prioritize mitigation for special status species because of their rarity. Such species may be vulnerable to extirpation due to development pressures, habitat loss/degradation and other anthropogenic pressures.

A fourth strategy is to proactively address road-related water quality and runoff issues. This is accomplished by use and design of appropriate best management practices.

A fifth strategy is to develop, implement and document compensatory mitigation goals and objectives for each of the four major natural regions and their associated subregions at the beginning of Tier 2 studies (**See Appendix HH**).

Mitigation studies/actions for consideration in Tier 2 studies may include the following. This is not a comprehensive list. Other strategies may be viable based on agency coordination during Tier 2 studies:

- Culvert and bridge designs which allow for upstream movement of aquatic life
- Lighting and fencing to reduce roadkill
- Avoiding and minimizing forest fragmentation to the greatest extent possible
- Strategically placed wildlife crossings to permit the movements of reptiles, amphibians and mammals in areas with the highest potential for impacts.
- Where feasible, mitigation to include creation of new wetland bank sites

3.25.5 Summary

Alternatives M and O cross the Shawnee Hills Natural Region and have the highest potential for impacts to natural habitats. Habitat fragmentation, from bisecting large contiguous forested tracts, represents the greatest potential for significant impacts to wildlife. Alternative B has the fewest impacts but does require an entirely new crossing of the White River. This may cause significant impacts to sensitive aquatic species, such as mussels (see discussion under “Mussels” in **Section 3.16.4.1**). Other than Alternative O, most alternatives have similar impacts to the named streams. Preferred Alternative P also traverses through a portion of the Shawnee Hills Natural Region; impacting a significant amount of large forest blocks. However, core forest impacts for Alternative P are similar to Alternative C.

Impacts to the various ecosystem natural habitats from the Build alternatives will directly impact wildlife. Direct impacts will occur during and after construction. Wildlife impacts can be minimized through avoidance and minimization and well-designed mitigation. Each of the five alternatives would impact a variety of natural and disturbed habitats within the various natural regions. Some of these habitats have been altered significantly from their presettlement form (i.e., converted to agriculture). Some still represent conditions present prior to presettlement (i.e., forested areas) and thus can support more species.