Alex Harrington
(b) (6) [redacted]

Mr. Chris Thornton
District Ranger, Tell City Ranger District – Hoosier National Forest
(b) (6) [redacted]

Attn: Responsible Official Christopher Thornton & Administrative Review Staff

RE: Buffalo Springs Restoration Project, Hoosier National Forest, District 9 - Responsible Official: Christopher Thornton, District Ranger

Dear Mr. Thornton,

I formally object to your recent *Draft Decision Notice (DDN)* and *Finding Of No Significant Impact (FONSI)* for the Buffalo Springs Restoration Project located on the Tell City Ranger District of the Hoosier National Forest.

One of my comments during the draft Environmental Assessment comment period was not sufficiently addressed. I noted that, “should the Forest Service [FS] enact the management as described in the Buffalo Springs Restoration Project the trail users’ experience would be negatively impacted and wouldn’t recover in my lifetime. Others who enjoy the natural wonders found within the Project Area would be similarly affected.” The Agency Consideration responded that, “Recreation and Visual Quality have been analyzed as Issues 4 and 5 in the EA.” The FS states in the Final Environmental Assessment (EA) Issue 4 analysis that, “although silvicultural treatments and prescribed burns would temporarily affect trail use and other recreational activities in the project area, the long-term benefit of improved forest diversity and health, restoration of early successional habitat, and the perpetuation of the oak-hickory community substantiates the need for short-term impacts to recreation” (Buffalo Springs Project EA, 51). The FS makes two mistakes with this argument; 1) that impacts to recreation are conclusively short-term (a point I will address later) and, 2) Offsetting an action’s adverse effects to recreation with other so-called beneficial effects (oak-hickory perpetuation, early successional habitat, etc) to determine significance. The latter is contrary to 40 CFR 1501.3(d) (incorporated by reference).

To elaborate on the negative impact on recreationists note that recreational opportunity within the project area is limited. Thirty-three point six (32.3) miles of trail are located in the Buffalo Springs Project area (FS-R9-017-12/2016). The Buffalo Springs Project EA proposes 9 miles of trail closures for silviculture treatment and 6.65 miles of closure for prescribed burning. An additional 2.2 miles of trail will be reconstructed to a temporary road to facilitate timber harvesting (Buffalo Springs Project Final Environmental Assessment, 50). In particular, Youngs Creek trail is acutely impacted by proposed silvicultural treatment. Seven point three (7.3) miles of Youngs Creek are slated for silvicultural treatment and an additional 1.7 miles of trail will be developed in to temporary road. Nine miles out of 12.6 miles is 71% of Youngs Creek trail that will be negatively affected from a recreationist's perspective. Recreationists fond of this particular trail will be disproportionately negatively impacted by this project.

In total, 17.85 miles of trail will be impacted. That is 55% of the trails located within the project area that will be negatively affected by silvicultural and prescribed fire treatment and subsequently provide a diminished recreational experience. That's a *significant* impact to local and regional recreationists who depend on recreational access to natural areas for the many healthy physical and mental health benefits such access provides. The American Trails association has cataloged the many healthy benefits trail access provides communities in an article titled *The Health Benefits of Trails* (American Trails Staff, 2020). The sources cited include the American Journal of Public Health, American Heart Association, and the International Journal of Exercise Science. The latter describes the health benefits of horseback riding which is a very popular recreational activity within the Buffalo Springs Project area. The Buffalo Springs Project, impacting more than half of available trail mileage in the project area has the potential to significantly and adversely affect public health. This meets the threshold of significance determination per 40 CFR 1501.3(d) 2(i) and therefore an Environmental Impact Statement is required.

Additionally, the Forest Service's (FS) analysis of Issue 4 uses a spatial boundary of the Buffalo Springs Restoration Project area to address cumulative affects toward recreation but, as remedy to negative impacts on recreationists in the Buffalo Springs Project area, offers that the HNF, "overall, has approximately 260 miles of recreation trails (USDA FS 2006a)." This cited total trail mileage amount uncommonly rounds up the sum of 251.4 miles of trails named in the 2016 Trails Hoosier National Forest document FS-R9-017-12/2016 and may unduly diminish perceived impacts on available trails. Regardless, the implication is that impacts to recreation are insignificant when compared to total available recreation in the Hoosier National Forest. This analysis is insufficient.

What this omits are the truly cumulative impacts of *all* vegetation treatment projects within the HNF. If the FS is going to use trails located *outside* the project area to justify low cumulative impact to trails *inside* the project area then we also need to consider negative impacts to trails outside the project area. For example, in the Houston South Vegetation Management and Restoration Project, "approximately 11.5 miles of identified trail systems within the project area would be affected by silvicultural treatments," and, "an additional three miles of trails could be affected by skidding and hauling timber" (Houston South Vegetation Management and

Restoration Project Final Environmental Assessment, Page 33). Interestingly, the FS suggests the Shirley Creek trail system as an alternate trail system for recreationists affected by *both* the Houston South and Buffalo Springs Projects. Where is the analysis that demonstrates that trail system can absorb all the displaced trail users?

The Buffalo Springs Restoration Project EA also fails to mention past projects' (such as the Oriole Restoration Project or the German Ridge Restoration Project) impacts to recreationists that may still not have fully recovered. How many cumulative miles of recreational trail are impacted by past, present and future FS projects and are recreational needs being met by the Forest Service? A more comprehensive Environmental Impact Statement could include this analysis. As it stands, it certainly seems that timber production is the Forest Service's priority rather than recreational development.

The project's negative recreational impacts aren't limited to trail users. Youngs Creek Campground is located in the Buffalo Springs Project area and serves as a trailhead for the popular Youngs Creek trail. A recent study published in September, 2023 *after* the Buffalo Springs EA publication shows that in FS Regions 1 through 6 there are, "significant negative effects to campground utilization during harvest operations in the Western U.S. within a 5-km buffer around campgrounds…[and] evidence suggests that campground utilization is impacted *up to one year* [emphasis added] after harvesting occurs" (Wallace, K. et al., 2023). Furthermore, the study concludes that, "visitors to national forests are changing their camping behavior in response to timber harvesting, indicating potential decreases in welfare. If visitors choose not to camp because of a timber harvest nearby, they may miss out on positive benefits derived from outdoor recreation such as exercise and health effects and connection to nature" (ibid).

The study used a 5-km buffer to include areas that can be easily accessed by visitors walking from the campground. If the FS desires to not negatively impact the Youngs Creek Campground a 5-km circular buffer can be enacted that prohibits any silviculture treatment within the buffer. As the study shows this would preserve and protect the recreational experience of the *only* campground located in the project area. Further, the FS should reconsider the amount of silvicultural treatment impacting the trail itself as I've noted how disproportionately affected by timber harvest this trail is compared with others in the project area. Perhaps a recreational buffer on this trail and others in the project area or a reduction in trail mileage impacted by the Buffalo Springs project could be a possible remedy for the conflicts between timber harvesting and recreational use. Regardless, due to this significant impact to the recreational experience and, by association the health of trail users who would be impacted during this project a thorough Environmental Impact Statement would be helpful to understand all options.

Degrading the project area's recreational experience is, in addition to potentially harming the local and regional health, also harmful to local communities that receive economic benefits from recreation in the Buffalo Springs Project area. In a

2018 study titled *Balancing Landscape Level Forest Management Between Recreation and Wood Production,* the authors have shown that "people in general prefer mature forests with good visibility and little or no obvious signs of human interventions, such as large clear-cuts, residues from felling activities and ground damage" (Eggers, et al, 2018). The Buffalo Springs Restoration Project will not result in a forest with no obvious signs of human interventions and one can reasonably infer that a reduction of recreational visitors would result from timber harvesting activities. And, the associated economic benefit of outdoor recreation would also decrease. An aforementioned study noted that, "decreases in campground visitation may have significant effects on nearby tourism-dependent gateway communities. Due to the reduction in individuals deciding to recreate at certain campgrounds because of timber harvesting, fewer individuals may make recreation trips to the impacted area, and spending in gateway communities near those campgrounds may decrease. This has direct, indirect, and induced economic impacts" (Wallace, K., et al., 2023).

Local governmental and economic organizations recognize this and have expressed strong opposition to the project. The Commissioners of Orange, Crawford, Monroe and Brown Counties, the Paoli Town Board, the Orange County Farm Bureau, the Orange County Economic Development Partnership, the Crawford County Economic Development Corporation, The Milltown Economic Development Committee, and the Paoli Chamber of Commerce all oppose the project. The mission of the HNF, "is to continue to make it possible for people to enjoy the values and benefits [of natural resources, biological diversity, recreational opportunities and other commodities society has come to expect rom the Forest] through responsible resource management *tailored to meet public desires* [emphasis added]" (USDA 2006 HNF Forest Plan, 2-1). The local public, clearly, does not desire this project! This project cannot be considered to be adhering to the 2006 HNF Forest Plan.

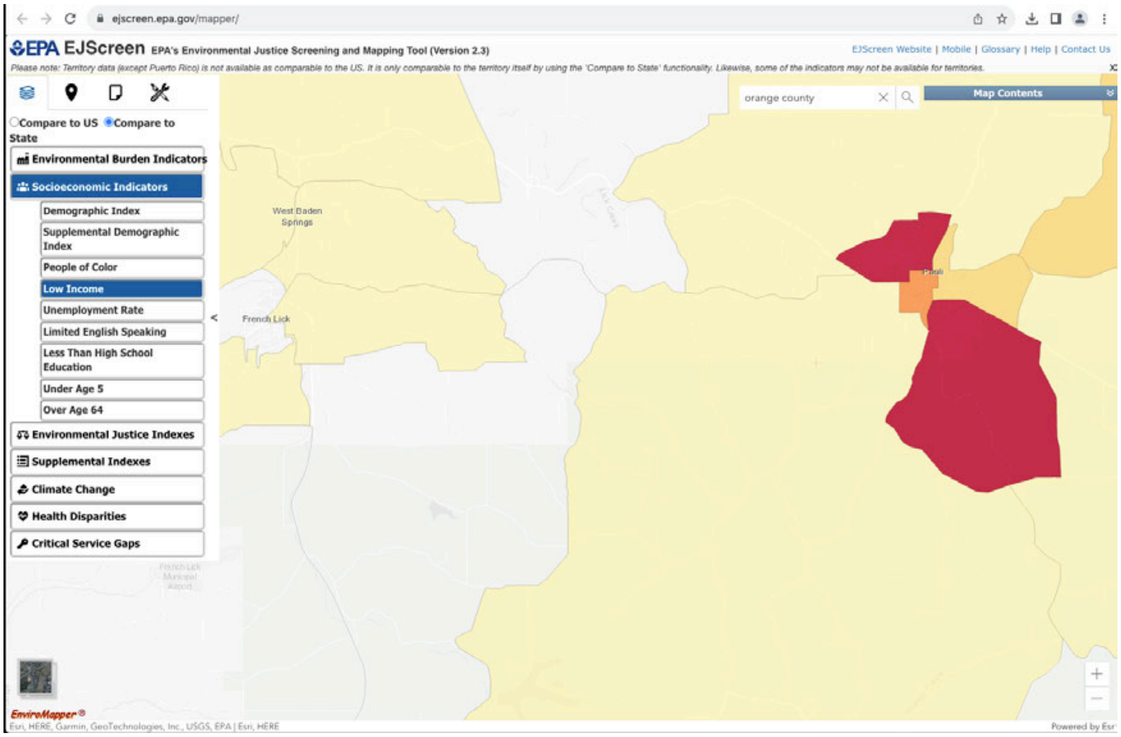
The socioeconomic impact of recreation is recognized too at the state level. The U.S. Department of Commerce Bureau of Economic Analysis reports that in 2022 Indiana outdoor recreation generated $16.0 Billion in value added to Indiana's gross domestic product, supported 111,982 direct jobs, and generated $7.5 Billion in wages and salaries (BEA, 2022). Whereas, the Indiana forest products industry supports only 70,000 jobs and has an economic impact of $10 Billion (Indiana DNR-Forestry, 2024). Economically, outdoor recreation is more impactful to the state's economy than timber production.

The Buffalo Springs Project EA neither analyzes the *value* of recreation in the project area nor the negative economic *impact* that degrading the recreational experience through harms to trails and campground utilization will cause. The FS states in the Buffalo Springs EA Appendix D that, "many values generated, both positive and negative, involve goods and services not priced in the marketplace. This comparison does not represent those values. These goods and services involve such things as the value of a hunting experience, a hike in the woods, wildlife viewing or the water quality of streams and lakes. For purposes of this discussion, the only revenues considered are those with more finite estimates associated with timber production." Again, only timber production is considered instead of a more comprehensive analysis that includes recreational values—a glaring omission. Why does the FS advocate so strongly for timber production instead of recreation? What role do timber targets play in HNF decision-making? What are the timber targets for the HNF and how does the Buffalo Springs Restoration Project contribute toward meeting those targets? Does the setting of those timber targets comply with the National Environmental Policy Act (NEPA)?

Further, Appendix E (not originally included in the Buffalo Springs EA and therefore, unavailable for comment) states that, "socioeconomic effects, such as changes in tourism patterns or resident use, resulting from this displacement [of recreationists] would occur locally over the short-term, for the duration of project implementation or shortly thereafter. These impacts would be *minor and would not result in measurable disruption* [emphasis added] to local socioeconomic conditions." I've already noted an objection to the notion of "short-term" recreational impacts and also object to the iEA that socioeconomic disruptions would be minor or immeasurable.

The Forest Service has studied how to determine economic values of recreational activity and has developed methodology to address "goods and services not priced in the marketplace" via benefit transfer methods as described in *Recreation Economic Values for Estimating Outdoor Recreation Economic Benefits From the National Forest System* authored by Randall Rosenberger et al. in 2017. Analyzing Region 9, utilizing the National Visitor Use Monitoring Results through FY2020 we can estimate that the 13,092,000 National Forest Region 9 visits (utilizing the weighted activity average of 1.2 and the weighted average of economic value of $55.93) generated $878,682,672 of economic value in FY2020. A significant amount! Methodology is available for analysts to estimate the economic value at the individual forest level too however the EA economic analysis does not include this information. It should be revised to include the economic value of recreation and the estimate economic impact of degrading the experience through vegetation management activities.

The Buffalo Springs Project EA Appendix E also notes that the population below poverty in Orange County is higher than the state average but then concludes the Buffalo Spring Project would not disproportionally adversely affect low-income people. A map from the same source showing, in more detail, the project area tells a different story:



The areas in dark red indicate areas where 73% and 75% of the population is considered low income. The dark orange color southwest of Paoli indicates 66% of the population is low income and the light yellow indicates 32% of the population is low income. This clearly shows that the Buffalo Springs Project area located in near proximity to low-income areas. When considering the recreation needs of area residents it's clear the project will disproportionally and adversely affect low-income areas. This significant environmental injustice requires that a full environmental impact statement be prepared. In that analysis, the full recreational economic value of the Buffalo Springs Project can be included. The aforementioned recreational economic value of FS Region 9 certainly seems significant enough to warrant further study and clarification as to why timber harvesting is prioritized over recreation.

The omission of recreation's economic value because it's "not priced in the marketplace" may also be a violation of NEPA 42 USC 4332 (B) which directs that, "all agencies of the Federal Government shall identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by subchapter II of this chapter, which will ensure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations." A full analysis of the Buffalo Springs Project's recreational economic impact needs to be performed. Only then can the FS determine whether socioeconomic impacts would be "minor" or not resulting in "measureable disruption".

I thank you for your consideration of my further objection regarding the Buffalo Springs Final Environmental Assessment of the project's negative impact to the recreational experience and its associated significant negative socioeconomic and significant negative environmental justice impacts both locally and statewide. This project will cause significant impact and I urge you to reconsider your Finding Of No Significant Impact and instead withdraw the project until either a full Environmental Impact Statement is prepared that fully accounts for all the impacts to the recreational experience or, better yet, an updated HNF Forest Plan is prepared that may or may not negate the purpose and need of the project entirely.

Respectfully,

Alex Harrington

Enclosed:

- American Trails Staff. "Health Benefits of Trails: Does access to trail really lead to healthier communities? According to research the answer is a resounding yes." (Feb. 20, 2020): Online. Available: WWW (www.americantrails.org/resources/health-benefits-of-trails)
- Eggers, Jeannette, et al. "Balancing landscape-level forest management between recreation and wood production." Urban Forestry & Urban Greening., 2018
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Keyword Search

Health Benefits of Trails

Does access to trails really lead to healthier communities? According to research the answer is a resounding yes.

by American Trails Staff (https://www.americantrails.org/presenters-and-authors/american-trails-staff)

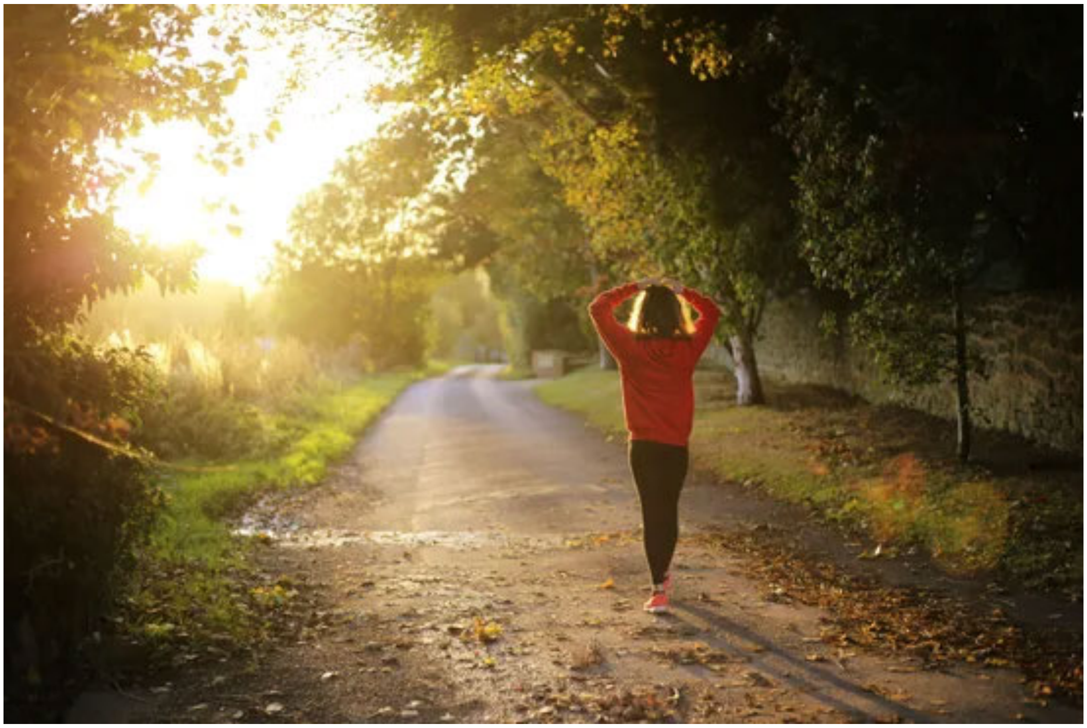
(PHOTO CREDIT: JON FLOBRANT, UNSPLASH)

Does access to trails really lead to healthier communities? According to research the answer is a resounding yes. In fact, according to a study (https://ajph.aphapublications.org/doi/full/10.2105/AJPH.2014.302059) released in 2014 by the American Journal of Public Health, there is a direct and significant measurable correlation between how close people live to biking and walking infrastructure and the amount of weekly exercise they get. The study was conducted on three communities who were upgrading their walking and biking infrastructure, measuring the exercise habits of the residents both before the trails went in, and after. The results showed that those living within less than a mile of the new trails were getting on average 45 minutes more exercise a week after the trails were built than they were before they had that available infrastructure. The amount of increased exercise per week went down the further away people lived from the new trails, but benefits were still seen up to those who lived 2.5 miles away. As the lead author of the study, Dr. Anne Goodman, noted, “These findings support the case for changing the environment to promote physical activity by making walking and cycling safer, more convenient, and more attractive.”

Not only do communities with high quality trail infrastructure see health improvements in their citizens, those health improvements translate into real medical savings for those communities. In fact, in

PHOTO CREDIT: EMMA SIMPSON, UNSPLASH

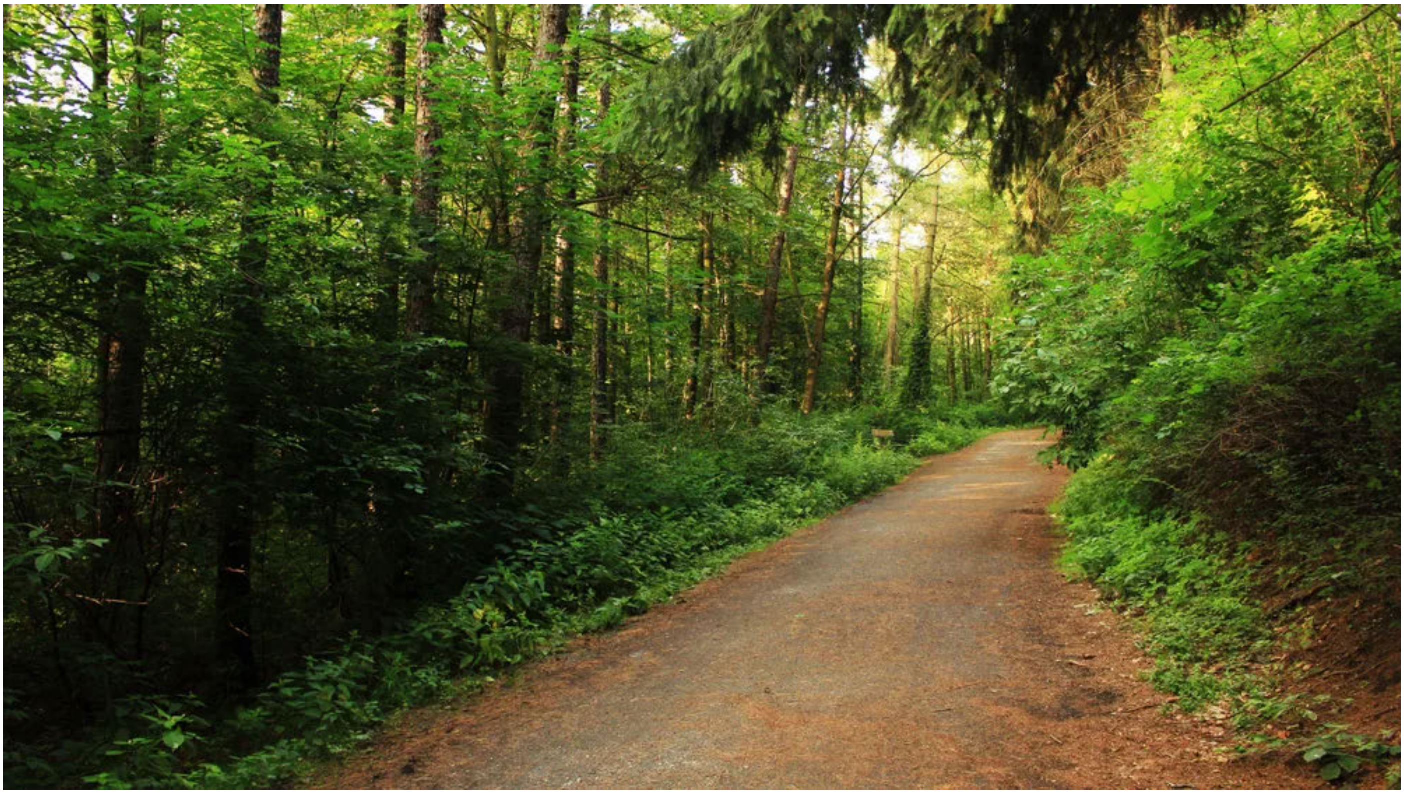
a 2011 literature review



(https://www.heart.org/-/media/files/about-us/policy-research/fact-sheets/physical-activity/active-transportation-fact-sheet-2019.pdf?la=en&hash=F98B6BE12D9C61B6AEAB157B51FE2A89845B6C90) by the American Heart Association, they found that for every $1 invested in building trails there is a direct correlation to $3 of saved medical costs. One community who put this information into action is Brownsville, Texas. The city of 180,000 mostly Spanish speaking residents is both the poorest in the region, and has in the last few decades been plagued by health problems, including leading the state of Texas in limb amputations, mostly related to obesity and type 2 diabetes. Beginning in 2001 the city leaders starting building partnerships to tackle this issue, culminating in the 2016 Lower Rio Grande Valley Active Transportation and Tourism Plan (https://www.railstotrails.org/our-work/trailnation/lower-rio-grande-valley-active-plan/), or simply, “The Active Plan.”

This plan brings in partners such as Rails to Trails Conservancy, the Valley Baptist Legacy Foundation, the University of Texas Health Science Center of Brownsville, and ten surrounding municipalities in order to create a culture of trails in the region. The plan, which is both building new trails and upgrading existing ones, will result in 428 miles of multi-use trail in the region, including paddling trails. The estimated health related cost savings to the region over the next decade as a result of this plan is between 3 million and 6 million dollars, which is even more significant when taking into account that Brownsville is a community where an estimated 48% of children live under the poverty line, and 67% of citizens lack health insurance.

PHOTO CREDIT: LUCIE HOSOVA, UNSPLASH



The healthcare savings associated with trails come from several factors, the largest being that increased cardiovascular exercise leads to healthier citizens. Studies show that with trails the saying “if you build it, they will come” is extremely apt. People will use the trails available to them in their community, and due to that, citizens are getting exercise they wouldn’t otherwise be benefiting from. There are many studies that show the benefits of walking and cycling on health, including a recent large scale multi-year study (http://headwaterseconomics.org/wp-content/uploads/Trail_Study_133-UK-CVD-Active-Commuting.pdf) from the U.K. which showed that those who commute on foot or by bike have significantly lower rates of cardiovascular disease and cancer than those who commute by car. This study is being used as a reason to build more trail infrastructure in urban settings across the U.K.

Health benefits are not exclusive to walking, hiking, and cycling trails however, they are seen across all trail user groups. For example, equestrian trail users are often excluded from this data, but do see similar cardiovascular benefits, as shown in this study (https://digitalcommons.wku.edu/cgi/viewcontent.cgi?referer=http://www.successful-horse-training-and-care.com/this-is-how-many-calories-you-burn-while-horseback-riding.html&httpsredir=1&article=2268&context=ijesab) through A&M Agrilife Extension Services. Equestrians are exercising core muscle groups while on a horse, building muscle tone, flexibility, and coordination. Alternatively, while studies show horseback riding builds muscle tone in the legs and lower body, paddling and water trail use builds muscle tone in the upper body, including arms, back, and abdominal muscles.

One category of trail use which is perhaps least recognized for its physical health benefits, motorized trail use, was shown in a 2016 report (http://www.trf.org.uk/wp-content/uploads/2016/05/Health-Benefits-Document-FINAL-01.pdf) by Dr. Sean Comber to meet the criteria of moderate exercise, and shows both measurable cardiovascular and muscle strengthening benefits. As this data reveals, **all trail use is beneficial for physical health**, and the best recipe for a robustly healthy community is access to trails for all trail user types.

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posted Jul 12, 2023

This article is intended to inspire and support trail managers, designers, volunteer groups, and individuals with information you can use, whether you want to get out and explore an existing water trail or begin the process of designating a new water trail in your community.

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Balancing landscape-level forest management between recreation and wood production

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Recreation index

ABSTRACT

Although many forested landscapes are used for both wood production and outdoor recreation, intensive forest management can negatively impact the recreational value of forests, including in Sweden, a country with rich forest resources and a strong forest industry. In Sweden, urbanization has increased the importance of, and demand for, urban and peri-urban recreational green areas such as forests. It is the responsibility of the local government – i.e., the municipalities – to provide a good living environment for its inhabitants, including recreational areas. However, most of the forest areas in Sweden are owned by private individuals and companies, which have a large degree of freedom in their forest management decisions. Municipalities can make formal agreements with forest owners to protect forests with high recreational values, but this requires financial resources, which are often scarce. Thus, tools are needed to identify the forest areas that should be prioritized for the use of forest management strategies that maintain or increase the recreational value of forests. In this study, we elaborate an approach that balances economic and recreational forest values within a forest decision support system (DSS) and test the approach for a case study area in southern Sweden. The recreation model included in the forest DSS links locational aspects, such as population density and proximity to water, with forest structure aspects, which are simulated over time under different management strategies. Our results suggest that the model could be useful for more efficient planning of the recreational potential of forests at the landscape level. The results from the case study indicate that substantial increases in the recreational value of a forest landscape can be achieved with relatively small overall economic losses, for example, by extending rotation periods in forests close to densely populated areas.

1. Introduction

The importance and use of forests for recreational activities has been frequently recognized (Eriksson et al., 2012; Konijnendijk, 2003; Lindhagen, 1996; Olsson, 2013), and efforts are made to implement recreational and scenic values in forest planning, management, and governance (Mattila et al., 2015; Sténs et al., 2016). In Sweden and other Nordic countries, forest recreation is very popular, has a long tradition and is part of a sense of national identity (Vistad et al., 2010). At the same time, wood production continues to be an important economic activity in many forest-rich countries, including Sweden, and is likely to remain strong because of the expected increases in biomass demand due to demographic trends and the rise of a bio-based economy (Beland Lindahl and Westholm, 2010). Unfortunately, intensive forest management for wood production is often in conflict with recreational forest values (Kangas et al., 2008), as numerous studies have shown that people in general prefer mature forests with good visibility and little or no obvious signs of human interventions, such as large clear-cuts, residues from felling activities, and ground damage (Gundersen and Frivold, 2008). Most forest visits take place close to where people live. In Sweden, 85% of the population lives in cities or urban areas (Olsson, 2013), a demographic trend that emphasizes the important role of urban and peri-urban forests for recreation. Even though urban woodlands are still common in Sweden, a lack of legal protection and continuing urbanization may lead to the loss and further fragmentation of these woodlands, particularly in urban areas with an expected population increase (Hedblom and Söderström, 2008). Ultimately, it is the municipalities' responsibility to consider the demand for and supply of recreational areas in their planning (SFS, 2010; Swedish Ministry of Finance, 2004). Most Swedish municipalities own some urban forest land, however, a large share of urban and peri-urban forests is owned by private individual owners and private forest companies (Olsson,

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2013). Although all forests in Sweden are accessible to everybody for recreation under the Right of Public Access (Swedish Environmental Protection Agency, 2017), their attractiveness for recreational activities largely depends on the management choices of the forest owners. Forest-related legislation (SFS, 1979) and other governance instruments, such as certification and the national objectives for outdoor recreation (Regeringen, 2012), require forest owners to consider recreation in their management decisions. Nevertheless, forest owners have a large degree of freedom in their management decisions, and forest policy objectives are mainly pursued through information, advice, and recommendations. Although private forest owners in general feel a responsibility for social values, including recreation, their knowledge of such values and how to enhance them in forest management is perceived as low according to a self-assessment of private forest owners (Bjärstig and Kvastegård, 2016). The need to safeguard privately owned forest with high recreational value is reflected in a newly implemented policy that allows landowners to make voluntary agreements to protect forests with high recreational values and provides compensation for missed income from harvesting (Swedish Forest Agency, 2014). However, money set aside for compensation is often scarce, and exempting wood production from all forests with high recreational value is not a viable strategy. Instead, it is important to find site-specific management strategies that balance wood production with recreational value over time and to identify forests where adapted management should be used to maintain or increase the recreational value of forest areas. Thus, efficient planning requires tools that assess the impact of management strategies on the recreational value of forests and economic value of wood production and that identify management strategies that succeed in balancing economic and recreational values. Such tools could be useful for the planning of municipalities' own forests as well as for identifying which forest owners should be approached to maintain and develop high quality recreational areas for the municipalities' inhabitants.

The objective of this study was to develop and test an approach that balances economic and recreational values in a forest landscape by strategically distributing different forest management strategies throughout the landscape. We aimed for a method that should be able to identify forest areas to prioritize for recreation, suggest suitable management alternatives in such areas and be useful in communication processes with forest owners. The developed approach builds on a model that calculates the recreational value of the forest landscape in a forest decision support system (DSS). This model combines two important aspects that define the recreational value of the forest: locational aspects such as population density in the vicinity and stand-based forest structure aspects. In the DSS, alternative developments of the stand-based forest structure aspects are simulated over time under different management strategies. Next, a set of mixed integer optimization models strategically distributes the management strategies throughout the landscape for different levels of consideration for recreation. The model was tested on a landscape in southern Sweden of almost 14 000 ha of productive forest area. The following sections describe the method for calculating the recreation index, the applied forest DSS, and the case study.

2. Methods

2.1. Landscape recreation index

A **landscape recreation index** was calculated by multiplying a location index and a forest stand index (Eq. (1)). While the location index was assumed to be constant over time (i.e., no change in population density or location), the forest stand index changes over time subject to stand development and forest management:

$$R_p = \mathrm{L}^* S_p \tag{1}$$

where R_p is the landscape recreation index for period p, L is the location index, and S_p is the forest stand index for period p. All indices in Eq. (1) were calculated on the stand level.

The **location index** is based on an expert model and gives a value between 0 and 1, where a value close to 1 indicates that the forest stand is potentially very valuable for recreation for a large population as it is close to urban areas. The most important factors in the model are the number of people living within 300 m and number of people living between 300 m and 2000 m. Earlier studies have shown that there is a negative correlation between visiting frequencies and the distance to the closest recreational forest (Hörnsten, 2000). 250–300 m was identified as a critical walking distance to recreational areas during weekdays (Nordisk ministerråd, 1996), and 300 m is also the preferred median distance to the closest recreational forest according to a survey conducted in Sweden (Hörnsten and Fredman, 2000). Visiting frequencies drop notably when the distance exceeded 2000 m (Hörnsten, 2000). The distances included in the function correspond with shorter forest visits made during weekdays and weekends. More long-distance forest visits are a small proportion of the number of total forest visits and are not included in this function. The model also includes a positive effect of proximity to water, as water bodies increase the value for recreation and rehabilitation (Hannerz et al., 2016; Nordström et al., 2015), and a negative effect of noise disturbances caused by major roads. The location index is calculated as follows:

$$\mathrm{L} = 1 - e^{-(0.01x+0.001y+0.15v-0.15r)} \tag{2}$$

where x is the population within 300 m from the stand, y is the population within between 300 and 2000 m from the stand, v is the presence of open water within 50 m from the stand (dummy), and r is the presence of a major road within 100 m from the stand (dummy).

The **forest stand index model** was developed using visual interpretation of a long range of forest variables in photographs that were included in surveys of recreational preferences made in Sweden and Denmark during the 1990s (Hörnsten, 2000; Koch and Jensen, 1988; Lindhagen, 1996). Stepwise regression was used to assess the impact of the interpreted forest variables on the values for outdoor recreation suitability that were obtained among the adult population. The work resulted in three different linear functions to be used in forests of different heights: one for bare land and very young forests, one for young forests, and one for mature forests (Table 1). The function applied is regulated by the mean tree height of the stand where each function applies to a certain height interval. For a smooth transition between the functions, results are weighted when the height is in the transition zone between two functions ($>$ 1–3 m and $>$ 12–16 m).

The functions result in index values between 0 and 1, with higher index values indicating higher suitability for recreation. The functions are subject to various variables, whose parameter values are given in Table 1. For bare land and newly regenerated forests (Function 1), index values increase with increased tree size diversity, while the occurrence of deadwood or harvest residues decrease index values. For young stands (Function 2), in addition to the above, increased conifer proportion decreases index values, i.e. broadleaves are preferred. For older stands (Function 3), there are additional variables for the number of stems (many large trees are preferred over small trees) and soil damage (the occurrence of soil damage from e.g. thinning operations has a negative impact on index values).

The developed functions conform with results from other studies on public preferences for forest structures, which have shown that stand age or phase of development are very important for recreational values (Edwards et al., 2012a,b), with tree size being positively correlated with recreational value (Gundersen and Frivold, 2008 and references therein). Large fresh clear-cuts are disliked by the majority of forest visitors, while seed or retention trees can improve people's perception of a felling site (Gundersen and Frivold, 2008; Rydberg and Falck, 2000). Consequently, the intercept for bare land or newly regenerated forest (Function 1) is low (0.3), which means that these forests receive a low stand index, which can only be increased if these stands have an

Table 1
Linear functions and their parameters used for calculating the forest stand index. Which function applies depends on basal area weighted tree height. Variables (first column) are described in Table 2.

	Mean tree height				
	≤1 m Function 1	> 1–3 m *w1 * Function1 + w2 * Function2*	> 3–12 m Function 2	< 12–16 m *w2 * Function2 + w3 * Function3*	> 16 m Function 3
Intercept	0.3		0.568		0.569
Uneven	0.1		0.169		0.0491
Deadtr	−0.01		−0.063		−0.058
Lystem	−0.02		−0.0965		−0.099
Res	−0.01		−0.019		−0.0693
Pinepr			−0.0004		
Sprucpr			−0.0202		
Broadpr					0.0106
Stsm			−0.0009		−0.000076
Stmed					0.000103
Stla					0.00176
Grodam					−0.0549
w1		1 − w2			
w2		(height − 1)/2		1 − w3	
w3				(height − 12)/4	

uneven diameter distribution due to tree retention. Open forests with possibilities for views of the surroundings are often preferred over dense forest (Edwards et al., 2012b; Gundersen and Frivold, 2008). Therefore, thinning is usually positive as it decreases forest density. This is reflected in the parameters for the number of stems in older forests (Function 3), where higher numbers of small stems, which hinder visibility, have a negative impact on the stand index, while larger stems are positive. An uneven diameter class distribution has a positive impact on the stand index at all stages of stand development, reflecting the fact that people prefer irregular stands with a mixture of trees of varying sizes (Gundersen and Frivold, 2008). There seems to be no clear preference for tree species and species composition (Edwards et al., 2012a,b; Gundersen and Frivold, 2008); however, a certain admixture of broadleaves in conifer-dominated stands (which make up the majority of Swedish forests) is likely to be positive for recreation as it increases variation within stands (Hannerz et al., 2016). Consequently,

Table 2
Description of the function variables in Table 1.

Variable	Potential values	Description
S	0–1	Recreational value between 0 and 1, where 0 is the lowest possible and 1 is the highest possible value
Uneven		Diameter class distribution Homogeneous = 0 Inverse J shaped = 1 Trees are grouped into four diameter classes, with class width = $(dbh_{max} - dbh_{min})/4$. If the number of trees in $class_i > class_{i+1}$, the diameter class distribution is set as Inverse J Shaped, otherwise as Homogeneous.
Deadtr	0–3	Standing deadwood, user can define volume limits 0 = no deadwood 1 = small amounts of deadwood 2 = large amounts of deadwood 3 = stand dominated by deadwood
Lystem	0–3	Lying deadwood, user can define volume limits 0 = no deadwood 1 = small amounts of deadwood 2 = large amounts of deadwood 3 = stand dominated by deadwood
Res	0–3	Amount of residues 0 = none (no cuttings during current and last two periods, or residue removal in previous period) 1 = little (final felling two periods ago or thinning during previous period, or residue removal after final felling or thinning in current period) 2 = much (final felling two periods ago, or (pre-commercial) thinning during current period 3 = very much (final felling during current period)
Pinepr[a]	0–10	Share of pine (tenth)
Sprucpr[a]	0–10	Share of spruce (tenth)
Broadpr[a]	0–10	Share of broadleaves (tenth)
Stsm		Number of stems per ha in diameter class d < 20 cm
Stmed		Number of stems per ha in diameter class 20 ≤ d < 48 cm
Stla		Number of stems per ha in diameter class d ≥ 48 cm
Grodam	0–3	Degree of soil damage. The value is calculated based on exponential recovery functions, with one function each for stump extraction, soil preparation, final felling and thinning. The maximum value from the four different functions is selected. The function is: $RemainingDamage(t) = Damage(t0)/e^{-Ct}$ where t is year, t0 is operation year, C is a user-defined coefficient, and Damage(t0) is the damage caused by the operation at time t0. The coefficients are −0.1 for stump extraction, −0.2 for soil preparation, −0.23 for final felling, and −0.3 for thinning. The user has the possibility to change the coefficients.

[a] Tree species shares were based on number of stems for young stands (< 7 m mean height) and on basal areas for older stands (≥7 m mean height).

an increasing share of broadleaves increases the stand index for medium-aged and mature forest (Function 3). Standing or downed deadwood, both naturally occurring as well as felling residue, is usually disliked (Gundersen et al., 2017; Gundersen and Frivold, 2011), which is reflected by the negative parameters for standing and downed deadwood and felling residues. Soil damage from forestry operations, such as rutting, is strongly disliked by many forest visitors (Hannerz et al., 2016), which is reflected by the negative sign of the ground damage parameter.

2.2. The applied forest decision support system

The model for calculating the recreation value of the forest is included in the forest decision support tool (DSS) Heureka PlanWise (version 2.6.0.10) (Wikström et al., 2011), which is used to project the development of the forest over time under different management strategies. The core of the PlanWise model consists of a set of empirical growth and yield models that project the tree layer development, including models for stand establishment, diameter growth, height growth, in-growth, and mortality. These models were developed by means of regression analysis using data from the National Forest Inventory, long-term experiments, and yield plots (Fahlvik et al., 2014; Fridman and Ståhl, 2001; Wikberg, 2004). PlanWise allows the user to choose between several management systems (unmanaged, even-aged, and uneven-aged) and in detail specify different silvicultural practices, including soil scarification, regeneration method, thinning, final felling, and fertilization. Various management strategies can be defined for different groups of stands, depending on the management objectives. Management strategies can differ in management system and in the type of silvicultural practices. For example, different strategies can be developed for even-aged management with long or short rotation periods, different levels of admixture of broadleaves or different regeneration measures. In PlanWise, projections of future forest development and associated ecosystem services are made in two steps: (1) treatment simulation and (2) treatment selection.

In the first step, a set of alternative treatment schedules (i.e., a sequence of treatments such as thinning and final felling) are created for each stand for one or several management strategies. Treatment schedules differ in the timing of specified management activities within each management strategy. For each stand and all its treatment schedules, the resulting net present value (NPV) is calculated as well as the period-wise development of several forest attributes, including harvest volumes and forest stand structure indices. In step two, each stand is assigned a treatment schedule using a linear or mixed integer optimization model – i.e., a user-defined objective function and a set of user-defined constraints. In this study, we used several mixed integer optimization models. First the area-weighted sum of recreation indices over all stands and time steps (R_{tot}) was maximized (Max R_{tot}) to identify the highest possible total landscape recreation index over time (R_{max}). Then a set of optimization models maximizing NPV with a minimum level of R_{tot} required was solved (Max NPV with restriction for minimum R_{tot}). All optimization models contain an even timber volume harvest constraint and a constraint limiting the decrease in the landscape recreation index between consecutive periods. Consequently, the models are an example of a standard Model I formulation (Johnson and Scheurman, 1977). The details of the optimization models are given in Table 3.

Eqs. (3a) and (3b) in Table 3 specify the objective function, i.e. to maximize the total landscape recreation index (summed over the whole landscape and the whole planning horizon) (3a) or to maximize net present value (3b). Eq. (4) restricts the minimum fraction of the maximum landscape recreation index (R_{max}) that is required when NPV is maximized; this constraint is only used together with objective function 3b. Parameter α takes a value between 0 and 1 and is changed step-wise downwards from 0.99 until a further decrease no longer affects the outcome, i.e. until the constraint becomes redundant. Eq. (5) restricts the decrease in R (summed over all stands) that is permitted between consecutive periods. This restriction intends to ensure that there is a relative evenness in the recreational potential of the landscape over time. Eqs. (6) and (7) limit differences in timber harvest volume between consecutive time periods, ensuring relatively even harvest volumes over the planning horizon. Finally, Eqs. (8) and (9) ensure that all stands are assigned exactly one treatment schedule.

2.3. Case study

The suggested approach was tested for a landscape in southern Sweden, with a total area of approximately 30 000 ha. Input data for the forest model were based on a country-wide forest map combined with complementary data from National Forest Inventory plots (Reese et al., 2003) and spatial information on protected forest areas and key habitats (Skogsstyrelsen, 2015). Key habitats, i.e. habitat patches where red-listed species can be expected to occur (Timonen et al., 2010), are not formally protected. However, in practice they are seldom harvested due to restrictions given by forest certification schemes. The input data contained stand-level information on the productive forest area, illustrating the state of the forest in 2007. Almost half of the total case study area (13 636 ha) is productive forest and is divided into 4534 forest stands (Fig. 1).

The mean age of the forest is 46 years. 77% of the forest is under 60 years, and less than 2% is older than 120 years. More than half of the growing stock consists of broadleaved species (*Fagus sylvatica* 19%, *Quercus* spp. 11%, *Betula* spp. 13%, and other broadleaved 13%). *Picea abies* dominates the share of coniferous species (37%) and *Pinus sylvestris* makes up the remaining 7%.

To calculate the location index L, the number of people living within 300 m and at a distance between 300 m and 2000 m was calculated for each forest stand using population density information from 2013 (SCB, 2013). The population density layer had a resolution of 250 × 250 m (1 * 1 km in areas with few people, which were broken down to 250 * 250 m cells in the analysis). For the distance calculations, cell midpoints of the population grid were used together with the outlines of the forest stands. Dummy variables were used to identify stands with nearby water bodies (at least 6 m wide, source: Lantmäteriet, 2014) as well as stands within a distance of 100 m from major roads (at least 7 m wide, source: Lantmäteriet, 2014). The location index L was calculated in ArcMap 10.4 and was subsequently imported into the Heureka PlanWise system together with the forest data. Projections of future forest development and the calculation of the stand index S_p and the associated landscape recreation index R_p were then done with the help of the two basic steps of Heureka PlanWise: (1) treatment simulation and (2) treatment selection (see the section “The applied forest decision support system” above). Deadwood was excluded in the calculation of the stand index as the input data did not include sufficiently detailed information on initial dead wood levels in the landscape.

2.3.1. Treatment simulation

Six management strategies were defined that aimed to include both wood production-oriented as well as recreation-oriented strategies relevant for the study area. The defined management strategies were as follows:

- Production (PlanWise default settings for management, but with residue removal in final fellings on spruce-dominated stands, and tree breeding. In the default settings, minimum felling ages are set according to the limits given by the Swedish Forestry Act (SFS, 1979));
- 25% longer rotations (as production, but 25% longer rotations);
- 50% longer rotations and more broadleaves (by retention of more broadleaves in pre-commercial and commercial thinnings);
- CCF (continuous cover forestry); and
- Shelterwood (as Production, but regeneration exclusively with

Table 3
Optimization models.

Objective function	$\text{Max } Z = \sum_{i \in I} \sum_{j \in J_i} \sum_{p \in P} R_{ijp} x_{ij}$	Max R_{tot}	(3a)
	$\text{Max } Z = \sum_{i \in I} \sum_{j \in J_i} D_{ij} x_{ij}$	Max NPV with restrictions for minimum R_{tot}	(3b)
Specific constraints	$\sum_{i \in I} \sum_{j \in J_i} \sum_{p \in P} R_{ijp} x_{ij} \geq \alpha R_{\max}$	(only together with objective function (4b))	(4)
General constraints	$\sum_{i \in I} \sum_{j \in J_i} R_{ijp} x_{ij} \geq \sum_{i \in I} \sum_{j \in J_i} \beta R_{ij(p-1)} x_{ij}$	$p = 1,..., P - 1$	(5)
	$(1 - \chi) \sum_{i \in I} \sum_{j \in J_i} V_{ijp} x_{ij} \leq \sum_{i \in I} \sum_{j \in J_i} V_{ij(p+1)} x_{ij}$	$p = 1,..., P - 1$	(6)
	$(1 + \delta) \sum_{i \in I} \sum_{j \in J_i} V_{ijp} x_{ij} \geq \sum_{i \in I} \sum_{j \in J_i} V_{ij(p+1)} x_{ij}$	$p = 1,..., P - 1$	(7)
	$\sum_{j \in J_i} x_{ij} = 1$	$\forall\, i \in I$	(8)
	$x_{ij} = \{0,1\}$	$\forall\, i \in I, \forall\, j \in J_i$	(9)
Variables	x_{ij}	Binary decision variable that takes the value of 1 if treatment schedule j is assigned to stand i, otherwise zero	
	R_{ijp}	Recreation index of stand i and treatment schedule j in period p	
	V_{ijp}	Harvest volume (from thinnings, selection and final fellings) of stand i and treatment schedule j in period p	
Sets	P	Set of all periods	
	I	Set of all stands	
	J	Set of all treatment schedules	
	J_i	Set of treatment schedules for stand i, $J_i \subseteq J$	
Parameters	D_{ij}	NPV from period 1 to infinity from stand i and treatment schedule j	
Constants	$R_{\max}$	Maximum potential R_{tot} (summed over all stands and periods)	
	α	Minimum fraction of $R_{\max}$ required	
	β	Maximum fractional decrease in R (summed over all stands) permitted from period to period	
	χ	Maximum fractional increase in harvested volume permitted from period to period	
	δ	Maximum fractional decrease in harvested volume permitted from period to period	

shelterwood); and
- No management.

All protected forest and key habitats (in total 2% of the productive forest area) were assigned the no management strategy. For all other stands, a set of alternative treatment schedules was created for each of the strategies, apart from the CCF and shelterwood strategies. The CCF management strategy was only applied in spruce and beech dominated forest, while the shelterwood strategy was applied in forests dominated by other tree species. To conform to certification standards, 5% of the remaining forest area was set aside with no management by randomly selecting forest stands until the area requirement of 5% was fulfilled. Additionally, 10 living trees as well as three high stumps were left per ha on final felling sites in all management strategies. For all management strategies, the default price lists were updated with current timber prices and sapling costs (Södra, 2017; Svenska Skogsplantor, 2017).

When simulating the treatment schedules, we applied a 2% real discount rate to calculate the NPV of costs for silvicultural and harvesting activities and incomes from timber and forest fuel. The total simulation period was 50 years, with time steps of five years.

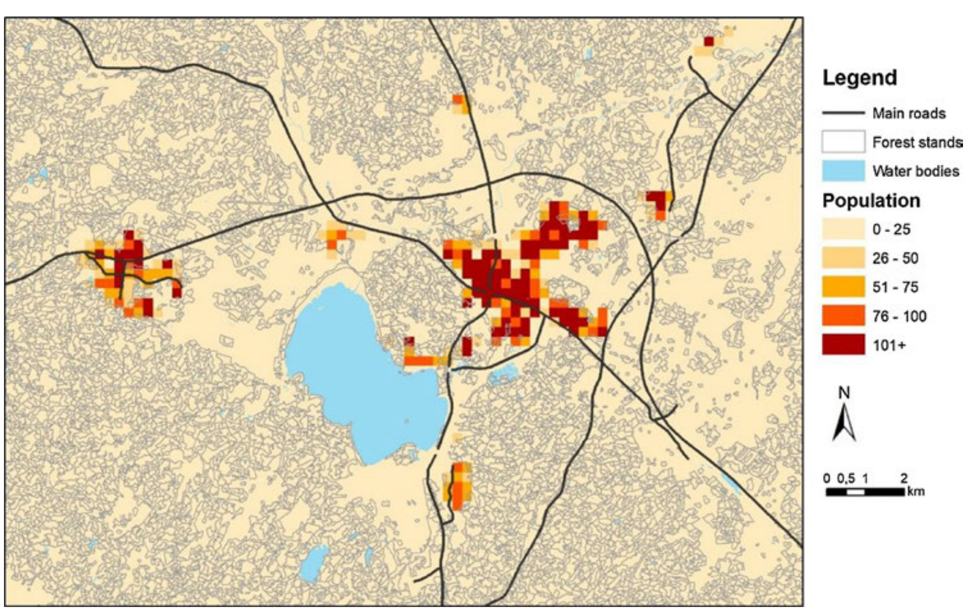

Fig. 1. Map of case study area. The population density raster has a cell size of 250 m.

Table 4
Optimization models (scenarios) chosen for further analysis.

Scenario	Description
Max NPV	NPV maximized with no constraints for R_{tot} ($\alpha = 0$)
R 0.9	NPV maximized with $\alpha = 0.9$
R 0.95	NPV maximized with $\alpha = 0.95$
Max R	R_{tot} maximized

2.3.2. Treatment selection

In the optimization model, harvest levels were limited to increase or decrease with, at most, 25% between consecutive five-year periods (i.e., χ and δ in Eqs. (6) and (7), respectively, were set to 0.25). The landscape recreation index was not allowed to decrease more than 10% between consecutive five-year periods (β set to 0.9 in Eq. (5)). The minimum fraction of R_{max} required (α) was changed in steps of 0.01 from 0.99 downwards until a further reduction no longer affected the outcome (i.e., until the minimum R_{tot} required did not pose any restriction anymore).

Four of the optimization models were chosen for further analysis in the results section: the model where R_{tot} was maximized (Max R), the model where NPV was maximized with no restriction on R_{tot} (Max NPV), and two models where NPV was maximized with a restriction of minimum R_{tot} of 0.9 and 0.95, R 0.9 and R 0.95, respectively (Table 4). The models were formulated within the Heureka PlanWise system using the ZIMPL optimization modelling language (Koch, 2005) and solved from within Heureka with Gurobi 6.0 using a traditional branch and bound algorithm with a convergence bound of 0.01%.

3. Results

The location-based recreation index was highest close to densely populated areas, while proximity to water only had a minor influence on the location-based recreation index (Fig. 2). Almost one-fifth of the productive forest area (19%) had a location-based recreation index larger than 0.8, whereas 30% of the productive forest area had an index smaller than 0.2. The initial area-weighted forest stand index was 0.47, with only 6% of the productive forest area having a value larger than 0.8 and 26% of the area having index values smaller than 0.2. The initial forest stand index varied throughout the landscape and was not correlated with the location index (Pearson's r = −0.055). The initial landscape recreation index, calculated by multiplying the location and the forest stand indices for each stand, was highest close to densely populated areas.

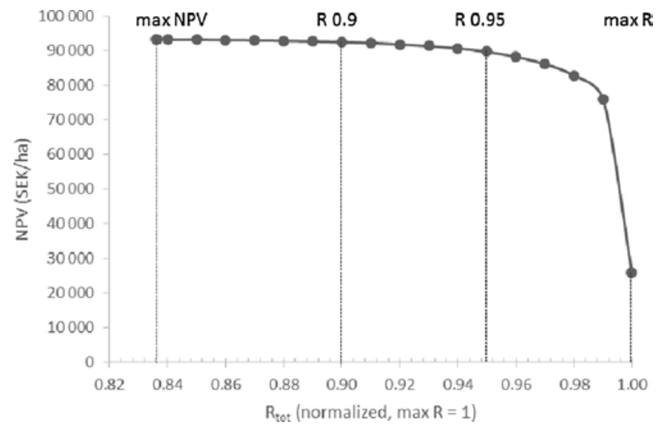

Fig. 3. Relationship between NPV and R_{tot}. The loss in NPV was 0.8% for R 0.9, 3.8% for R 0.95, and 72% for Max R.

Net present value varied between 93 233 SEK/ha when NPV was maximized (scenario Max NPV) and 25 743 SEK/ha when R_{tot} was maximized (scenario Max R). R_{tot} increased by 20% when R_{tot} was maximized instead of NPV. When the restrictions for minimum R_{tot} were increased, NPV decreased very slowly in the beginning (Fig. 3): 90% of the maximum possible R_{tot} (scenario R 0.9) could be achieved with an average loss in NPV of 0.8% and 95% (scenario R 0.95) with an average loss of 3.8%. As R_{tot} was increased further and approached the

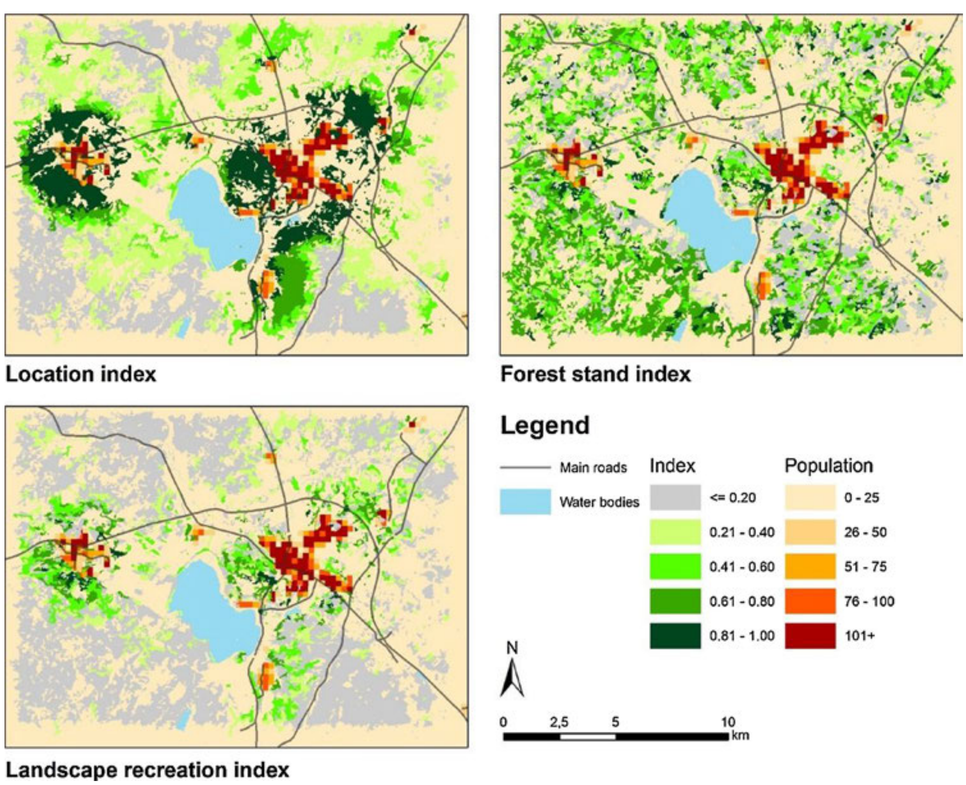

Fig. 2. Initial location, forest stand, and landscape recreation index for forest stands in case study area. Population refers to 250 * 250 m cells.

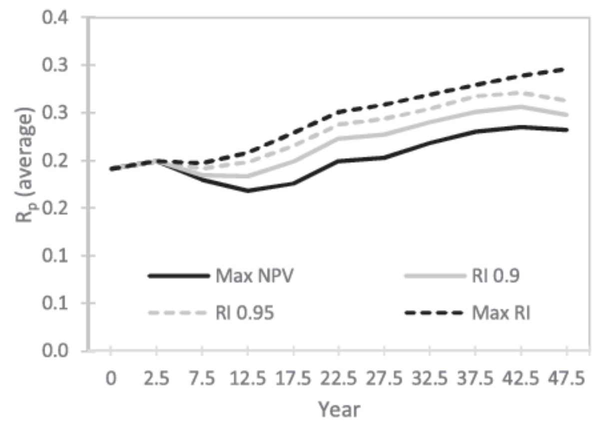

Fig. 4. Change in average landscape recreation index (area-weighted mean over whole landscape) over time.

maximum possible R_{tot}, the losses in NPV enlarged, with a severe drop in NPV between 99% of potential R_{tot} to maximizing R_{tot}. The NPV of Max R was just 28% of Max NPV.

On average over the whole landscape, the area-weighted mean landscape recreation index increased over time in all scenarios, apart from a decrease after approximately 10 years, which was strongest in the Max NPV scenario (Fig. 4), and a slight decrease in the end for all but the Max R scenario. The decreases, which were constrained to a maximum of 10% between consecutive periods in the optimization model, followed periods with a larger than average area being final felled, leading to a higher than average share of young forest (< 20 years) in the following periods. No other silvicultural measure affects the stand index as drastically as final felling, and young forests typically have a very low stand index. Therefore, an increase of the share of young forests can lead to a decrease in the landscape recreation index. At the end of the simulation, the average landscape recreation index had increased by 21% in the Max NPV scenario and 55% in the Max R scenario, compared to the initial situation. At the end of the 50-year planning horizon, the spatial distribution of the landscape index revealed increased landscape index values for scenarios with more consideration for recreation compared to the Max NPV scenario, which was especially pronounced in areas with a high location index (Fig. 5, compare also Fig. 2). As the location index remained constant throughout the simulation period, the differences between the scenarios were due to differences in forest stand index as a result of different distributions in management strategies.

In the Max NPV scenario, about one-quarter each of the forest area was managed with the production, CCF, and 25% longer rotation strategies and 17% with shelterwood (Fig. 6). With increasing restrictions for recreational value (scenarios R 0.9 and R 0.95), the share managed with long rotations with more broadleaves and CCF was increasing at the expense of the share managed with the production strategy. This change was especially noticeable in areas with a high location index (Fig. 7, compare also Fig. 2). When the landscape recreation index was maximized, the dominating management strategies were no management and long rotations with more broadleaves, with more than 40% each. It was mainly mature forest that was left unmanaged in the Max R scenario. The mean age of the forest in that strategy was 68 years, compared with a mean age of 31 years for forests that were assigned the long rotations and more broadleaves strategy. Also in the other scenarios, the mean age of forests that were assigned the no management strategy was well above the mean age of the remainder of the forest.

Naturally, the difference in management strategy distribution between the four scenarios affected harvest volumes. Aggregated over the 50 years, total harvest volume in the R 0.9 and R 0.95 scenarios exceeded the volume harvested in the Max NPV scenario with 2% and 4%, respectively. On the other hand, in the Max R scenario, total harvest volume was less than half (41%) of the volume harvested in the Max NPV scenario.

4. Discussion

From a forest recreational perspective, the main conflict in the Nordic countries (Finland, Sweden and Norway) is with timber production (Bell et al., 2007). In this study, we tested how a recreation index incorporated in a forest decision support system can help to balance wood production and recreational values in a forest landscape over time. The recreation index combines two important aspects of a forest's recreational value – location and stand structure – that enable the model to prioritize management strategies that result in higher recreational value of forest stands in areas where there is a high demand for recreation. Our results suggest that increasing the recreational value of a forest landscape by changing management strategy leads to a financial loss compared with a scenario where NPV is maximized. However, in our case study as much as 95% of the maximum potential recreation index could be achieved with only a loss of 3.8% of the potential average NPV if management changes are placed strategically throughout the landscape. Model results suggest that extending rotation periods in areas with high recreational demand is a beneficial strategy as this practice increases recreational value without banning wood production in the prioritized areas.

Most of the forests in the case study area are owned by small-scale private owners. As previous research has shown, private forest owners have a large variety of management objectives and management styles and rarely manage their forests solely for wood production (Eggers et al., 2014; Ingemarson et al., 2006; Richnau et al., 2013). Research has also shown that private forest owners feel a general responsibility for social values even though their knowledge on these values and on how to enhance them in forest management may be low (Bjärstig and Kvastegård, 2016). Although municipalities have limited possibilities to regulate the management of forests owned by others, the modelling results from using the approach we present in this paper can be useful for identifying areas to prioritize, and for serving as a basis in discussions with owners whose forest is important for recreation. By adding a property map to the input data for the forest DSS, analysis results for single forest properties could be easily accessed. Model results can be used both to illustrate where the need for recreational forests is highest throughout the landscape and to show long-term consequences of different management strategies at different spatial scales. Similar approaches have shown promising results. For example, a project in southern Sweden with the aim to inspire forest owners to allow for a higher share of broadleaves in forest management showed that personal contact with forest owners successfully affected management choices (County Administrative Board Jönköping, 2017; SLU, 2017). In that project, forest owners were shown the potential long-term consequences of different management strategies based on model results from the Heureka system. A similar project where Heureka scenario analysis has been used as a base for a dialogue process with forest owners to enhance threatened species has been performed in northern Sweden (County Administrative Board Västerbotten, 2011). Our approach can also be used in planning activities of large forest owners that wish to consider recreation opportunities in their forest management. Incorporating important ecosystem services – on top of traditional timber production – in forest decision support tools supports planning for truly multifunctional forest landscapes and sustainable forest management.

Although this study produced promising results, several things could be improved in future applications. The location index, while covering proximity to densely populated areas, does not include accessibility barriers such as major roads and railways. The presence and nature of recreational infrastructure is also not included, despite its importance for accessibility as trails and forest roads are used by most

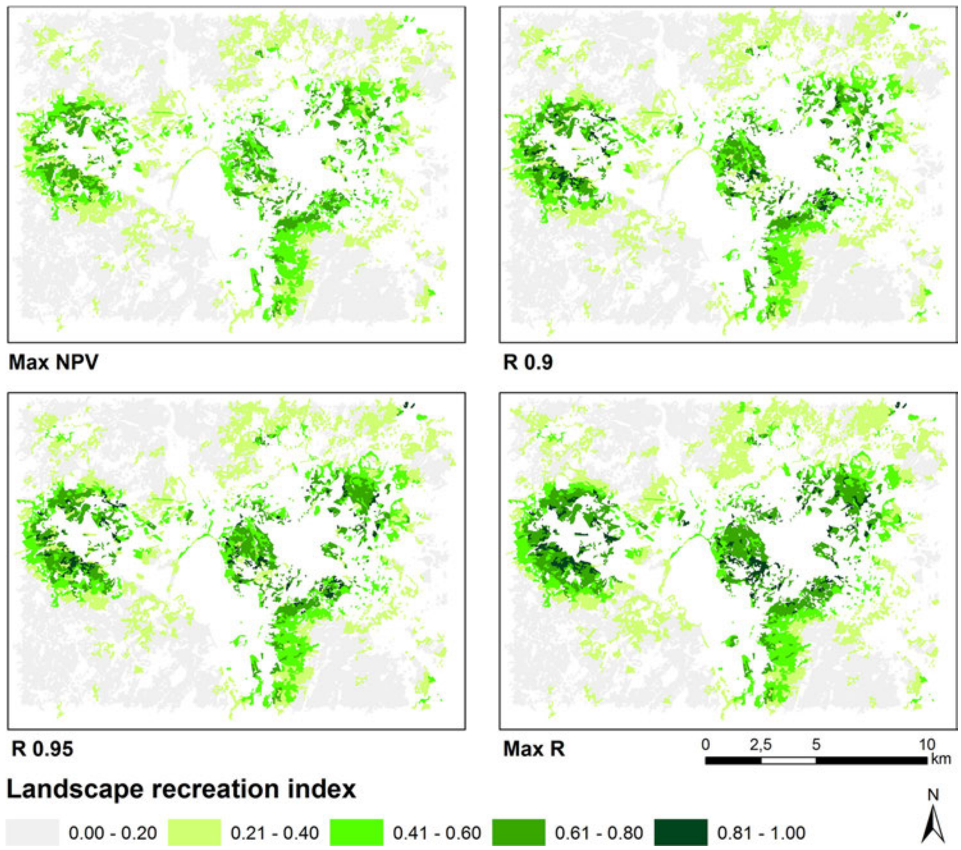

Fig. 5. Landscape recreation index in 10th five-year period (after 47.5 years).

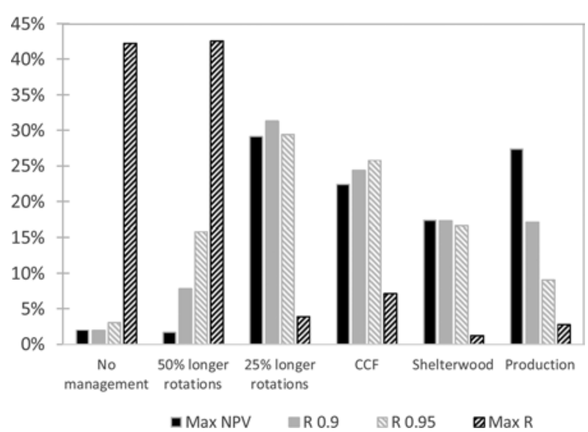

Fig. 6. Area proportions per management strategy (excluding set-asides) for the scenarios Max NPV, R 0.9, R 0.95 and Max R.

forest visitors (Gundersen and Vistad, 2016). In future analysis, a map of forest roads, trails and other forest infrastructure, possibly together with measured or estimated visitor numbers, could be added to the location index. This would allow giving higher index values to forests surrounding highly frequented trails, and identifying areas suitable for different user groups along the recreation opportunity spectrum (Gundersen et al., 2015). Pre-defining zones with different management priorities would also allow to adjust the forest management strategies applicable in these zones. For example, in dedicated wilderness areas, the only applicable management strategies could be leaving the forest unmanaged or low-intensity management. In its current form, the location index focuses on every-day recreation close to residential areas, and does not account for designated recreational destinations at a longer distance that might be of interest for weekend or holiday recreation. In future applications, the location index could be refined or replaced with other methods, such as municipalities' own mapping of recreational demand and well-visited green spaces (Swedish Environmental Protection Agency, 2016), and extended with collaborative planning elements such as communication with stakeholders. Other methods that have been used to take account of place-specific social values in planning include zonation along the recreation opportunity spectrum (Buist and Hoots, 1982; Gundersen et al., 2015), as well as participatory methods such as social values mapping (Kangas et al., 2008) or other participation mapping approaches (Brown et al., 2012), which may help identify recreational hot spots. However, the location index is easily available and can be calculated wall-to-wall for the area of interest. The index, however, may not work well for rural areas. In this study, the location index was static, but it may be possible to implement a dynamic location index in future studies to account for planned developments such as new residential or commercial areas or the building of infrastructure. Hence, expected changes in the demand for recreation could be accounted for and forest stands that are planned to be converted to other land uses soon could be excluded from the analysis.

The stand index has several weaknesses. It does not account for the perspectives of user groups not included in the surveys it is based on, such as children, teenagers, immigrants and foreign tourists. Nor does it distinguish between different popular recreational activities that may place different requirements on forest characteristics, such as walking and berry and mushroom picking. Future studies could extend the stand index so that it differentiates between popular activities and/or the preferences of user groups, for example by including blueberry cover projections as a proxy for the suitability of the forest for berry picking. A specific stand index defining the preferences of, for example, children would allow to select forest management strategies resulting in preferred forest conditions in pre-defined locations, such as around daycares.

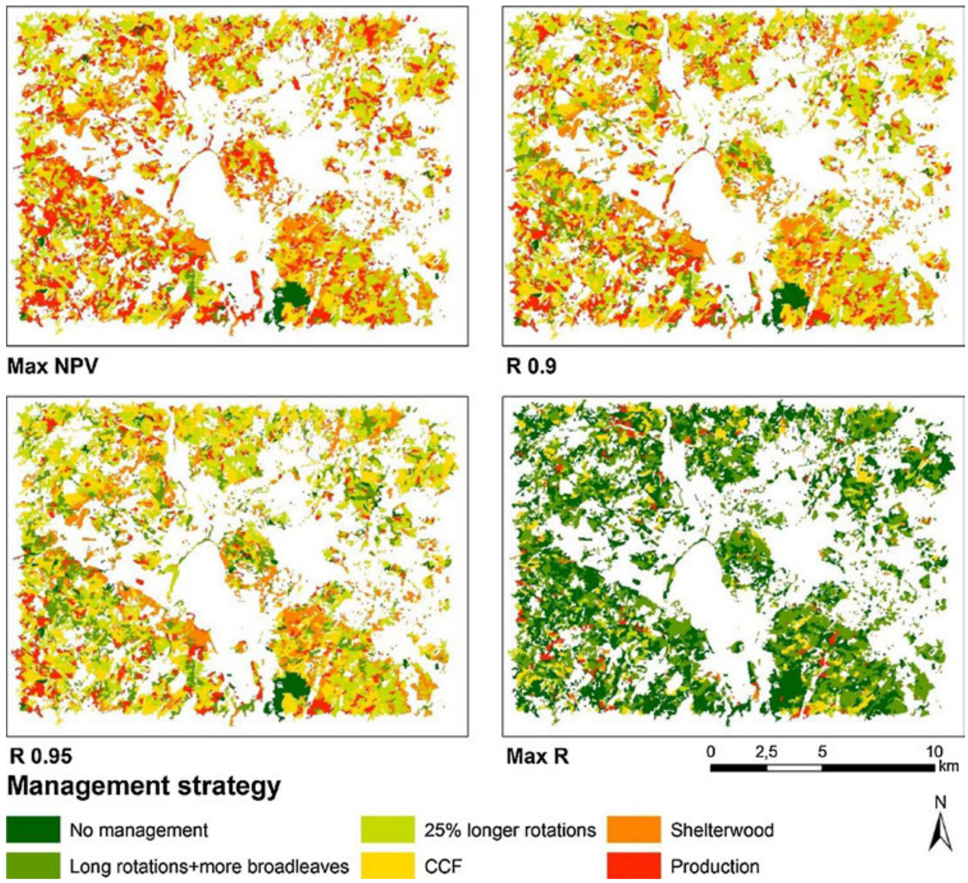

Fig. 7. Spatial distribution of management strategies for scenarios Max NPV, R 0.9, R 0.95, and Max R.

Furthermore, it has been shown that large amounts of deadwood, especially windfall and fresh woody debris, are disliked, even though dead and downed trees are more accepted in natural forest settings (Gundersen et al., 2017; Gundersen and Frivold, 2008, 2011). In theory, the deadwood parameter in the stand index model would decrease the stand index when deadwood volumes reach certain user-defined limits. However, the lack of reliable input data on the amount of current deadwood volumes prevented us from using the deadwood parameter in the stand index model. As the amount of deadwood accumulates over time in stands that are left unmanaged, we might overestimate the recreational value of stands that were assigned the no management strategy. In practice, "salvage logging" of dead trees (at some cost) is an option, or providing information about the ecological role of deadwood, as this has been shown to increase preference values for forest settings containing deadwood (Gundersen et al., 2017). While the forest DSS provides the option to remove user-defined shares of deadwood, this comes at a cost that is not currently available in the model. Another weakness is that only the tree layer is included in the stand index calculation, even though non-tree forest vegetation is also very important for recreation as it affects accessibility, visibility and the aesthetic quality of the forest (Nielsen et al., 2018). Work is ongoing to incorporate non-tree vegetation in the Heureka forest DSS based on a new approach combining field survey biophysical data from environmental monitoring programmes like the Swedish National Forest Inventory and remote sensing data (Lidar and satellite images). When this work is completed, it will be possible to improve the stand index by incorporating non-tree vegetation. Another aspect not accounted for in the recreation model is spatial variation. Variation is considered to be positive for recreation, both variation between different types of land cover, such as forest, agriculture, and water, as well as variation in forest structure between different forest stands (Hannerz et al., 2016). However, research on how exactly variation affects the recreational value of a landscape is scarce (Hannerz et al., 2016), making it difficult to model the effects. Furthermore, consideration of spatial relationships would make the optimization process more complicated. In this study, the location index and the forest stand index were given equal weight in the calculation of the landscape recreation index. In future studies, different weights may be considered, for example to reflect that a shorter distance to the forest was considered to be a more important factor to increase the frequency of forest visits than changing forest characteristics in a Swedish study (Hörnsten and Fredman, 2000).

Another uncertainty is related to the economic effects on prolonged rotation periods. Longer rotations are known to increase the risk for storm and other damages, such as root rot, which can cause large economic losses predominantly in mature spruce stands (Thor et al., 2005). This is not reflected in the management projections, so it is possible that the economic outcome of longer rotation periods is overestimated to some extent.

The management strategies and optimization models could easily be adapted to account for local conditions and preferences. The discount rate – in this study 2% real discount rate – affects the choice of management strategies and the number and timing of management actions and thereby, e.g., rotation length and harvest volumes over time (Bettinger et al., 2009). Future analysis could investigate what the results look like under different discount rate levels. In addition, the time frame of the analysis could be changed. In this study, a time frame of 50 years was chosen, as it takes time to see an effect of differences in management on a landscape scale. The results indicate that the landscape recreation index starts decreasing towards the end of the 50-year period, and it might therefore be of interest to study even longer periods. However, for municipality planning, near and medium term planning of recreational values is likely to be of more interest than changes in the distant future. Discounting the recreation index or giving near future periods more weight than distant future developments when the recreation index is summarized in the optimization constitute potential options to account for the disparate aims to focus on the near and medium future while covering long time horizons in forest planning.

In conclusion, we found that the elaborated method worked well for the case study and may constitute a useful approach for balancing economic and recreational values on landscape scale. The method is flexible enough to account for place-specific conditions and can be improved in various ways in future applications. It considers forest dynamics over time under varying management strategies. It also allows including recreational values in strategic forest planning at landscape level and investigating trade-offs with other ecosystem services.

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Indiana Forest Industry Overview

The Indiana forest products industry is the sixth largest manufacturing industry in the state, supporting 70,000 jobs — 44,000 in primary and secondary manufacturing and 26,000 in ancillary sectors. Forest-based manufacturing provides an annual economic impact of more than $10 billion. It ranks first nationwide in the production of wood office furniture, wood kitchen cabinets, and hardwood veneer, along with several other products. As small family-owned businesses, wood products companies average less than 50 employees and play an important role in rural communities.

- Indiana Forest Facts

For more information about Indiana's hardwoods industry please visit the Indiana State Department of Agriculture or contact:

Indiana DNR-Forestry
Utilization & Marketing Specialist
Forest Resources Information
Indiana Department of Natural Resources
Division of Forestry
402 W. Washington Street, Room W296
Indianapolis, IN 46204-2739
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Email: forestryinfo@dnr.IN.gov

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Land and Resource Management Plan

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Land and Resource Management Plan

Hoosier National Forest

Brown, Crawford, Dubois, Jackson, Lawrence, Martin, Monroe, Orange, and Perry Counties, Indiana

USDA Forest Service

Eastern Region

Milwaukee, Wisconsin

2006

Responsible Official	Randy Moore, Regional Forester 626 East Wisconsin Avenue Milwaukee, WI 53202 414-297-3600
For further information contact	Judi Perez, Forest Planner Hoosier National Forest 811 Constitution Avenue Bedford, IN 47421 812-275-5987 TDD Relay: 1-800-877-8339

Table of Contents

Appendices

List of Figures

List of Tables

List of Administrative Corrections

CORRECTION	WHERE INSERTED OR PAGE REPLACED	TOPIC	APPROVAL DATE
1	Table of Contents	Tracking Corrections and Amendments	March 20, 2007; *replaced by #7, 9/14/2007*
2	Appendix J, Maps 1A, 1B, 1C, and 1D	Inclusion of acres	March 20, 2007; *replaced by #5, 9/11/2007*
3	Appendix B, page B-11	Vegetation Treatments	March 20, 2007
4	Appendix B, page B-18	Timber Stand Improvement Tables	March 20, 2007
5	Appendix J, Maps 1A, 1B, 1C, and 1D	Correction of Table	September 11, 2007
6	Forest Plan, Chapter 3, pages 3-2 through 3-13, and Appendix C pages C-1 through C-4	Delisting of Bald Eagle	September 14, 2007
7	Table of Contents	Tracking Corrections and Amendments	September 14, 2007; *replaced by #10, 4//9/2010*
8	Forest Plan pages 3-20, 3-20a, Clarification of Forest-wide Driection	Clarification of Forest-wide Direction	April 9, 2010
9	Forest Plan pages 3-39 – 3-42, Clarification of Management Area Direction,	Tracking Corrections and Amendments and Clarification of Management Area Direction	April 9, 2010
10	Table of Contents	Tracking Corrections and Amenedements	April 9, 2010

Narrative for Administrative Corrections should be placed following this page in *Forest Plan*.

List of Amendments

AMENDMENT	WHERE INSERTED OR PAGE REPLACED	TOPIC	APPROVAL DATE

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Chapter 1

FOREST PLAN INTRODUCTION

Purpose of the Forest Plan

The Land and Resource Management Plan (Forest Plan) guides all natural resource management activities and establishes management guidance for the Hoosier National Forest. The Forest Plan describes resource management opportunities and the availability and suitability of lands for resource management.

The Forest Plan embodies the provisions of the National Forest Management Act (NFMA), the implementing regulations, and other guiding documents. Land use determinations, goals, and guidance constitute a statement of the management direction. The projected outputs, services, and rates of implementing these activities are dependent on the annual budgeting process, additional public involvement, and site-specific project environmental analyses.

The Plan will be revised in accordance with planning regulations or whenever conditions have changed significantly. Site-specific treatments and actions are not included in the Forest Plan. Site-specific analyses and decisions will be done at the project level. The contents of a forest plan include:

- Establishment of forest-wide, multiple-use goals and objectives [36 CFR 219.11(b)];
- Establishment of forest-wide management requirements (guidance or standards and guidelines) to fulfill requirements of NFMA applying to future activities (resource integration requirements of 36 CFR 219.13 to 219.26 and the requirements of 36 CFR 219.27);
- Establishment of management area direction applying to future management activities in that management area [36 CFR 219.11(c)];
- Establishment of allowable timber sale quantity and designation of suitable timber land [36 CFR 219.16 and 219.14];
- Monitoring and evaluation requirements [36 CFR 219.11(d)]; and
- Recommendations to Congress, if any, on designations of additional Wilderness or Wild, Scenic, and Recreational Rivers [36 CFR 219.17 and 219.18].

Relationship of the Forest Plan to Other Documents

The Forest Plan sets the direction for managing the land and resources of the Hoosier National Forest. Once finalized, the Plan replaces the 1985 Forest Plan and subsequent amendments. The Plan results from extensive analyses and considerations addressed in the accompanying Final Environmental Impact Statement (FEIS).

The planning process and the analysis procedures used to develop the Forest Plan are described in the FEIS, Appendix B. The FEIS also describes the range of alternatives considered in Chapter 2 and discloses their significant environmental effects in Chapter 3.

Site-specific projects will be planned and implemented to carry out the direction in this Plan. Environmental analyses will be performed as needed. These subsequent environmental analyses use data and evaluations in the Forest Plan and FEIS as their basis. Environmental analyses of projects will be tiered to the FEIS accompanying the Forest Plan.

Organization of the Forest Plan

The Forest Plan document consists of two parts, the Plan and the appendices. The Plan is organized into four chapters.

- Chapter 1 - Introduces the structure of the Forest Plan.
- Chapter 2 - Describes the role of the Hoosier National Forest, its goals and objectives.
- Chapter 3 - Establishes guidance for future management activities. By following this direction, the Forest hopes to achieve the desired conditions.
- Chapter 4 - Explains how management direction will be monitored, evaluated, and kept current in light of changing conditions and assumptions. This chapter also looks at research needs for the Hoosier.
- Appendices - Includes information such as a glossary, detailed summaries, and other required data on specific management practices or outputs.
- Maps, which show National Forest System (NFS) lands and management area boundaries, are included in Appendix J.

In this document the Hoosier National Forest may be referred to as either the "Hoosier" or the "Forest." Either term includes the NFS land base in Indiana, as well as the Forest Service administrative structure.

In this document, the term "Plan" or "Forest Plan" refers to this revised Forest Plan and not to the 1985 Hoosier Forest Plan or the 1991 Forest Plan Amendment, unless clearly referring to a previous forest plan.

Forest Location

The Hoosier National Forest is located in nine counties in southern Indiana (Figure 1.1). Bounded by the Ohio River to the south, the Forest is within a two-hour drive of the metropolitan centers of Cincinnati, Evansville, Indianapolis, and Louisville. The Forest is located among timeless hills and sharp ridges, lakes and streams, diverse stands of hardwoods and pine, springs, caves, and sinkholes.

Principal access routes to the Hoosier are State Route 37 (in a north-south direction from Indianapolis), U.S. Highways 50 and 150, State Highway 64, 66, and 446, and Interstate 64 in an east-west direction.

Management Direction

Management direction provides guidance for managing resources and multiple uses on NFS land. This direction has been developed for resources (for instance, wildlife and vegetation) on a Forest-wide basis and for management areas. Chapter 2 contains management direction that applies Forest-wide, and more specific direction for management areas.

Goals, desired conditions, and objectives always form the purpose and need for site-specific projects. Not every project will further every goal or objective.

Goals, Desired Conditions, and Objectives

Goals and desired conditions are broad statements that describe the situation that the Forest Service will strive to achieve. They are generally timeless and not measurable. Goals and desired conditions describe the ends to be achieved, rather than the means of doing so. They are a narrative description of the state of the land and resources expected when objectives and their associated guidance are fully implemented.

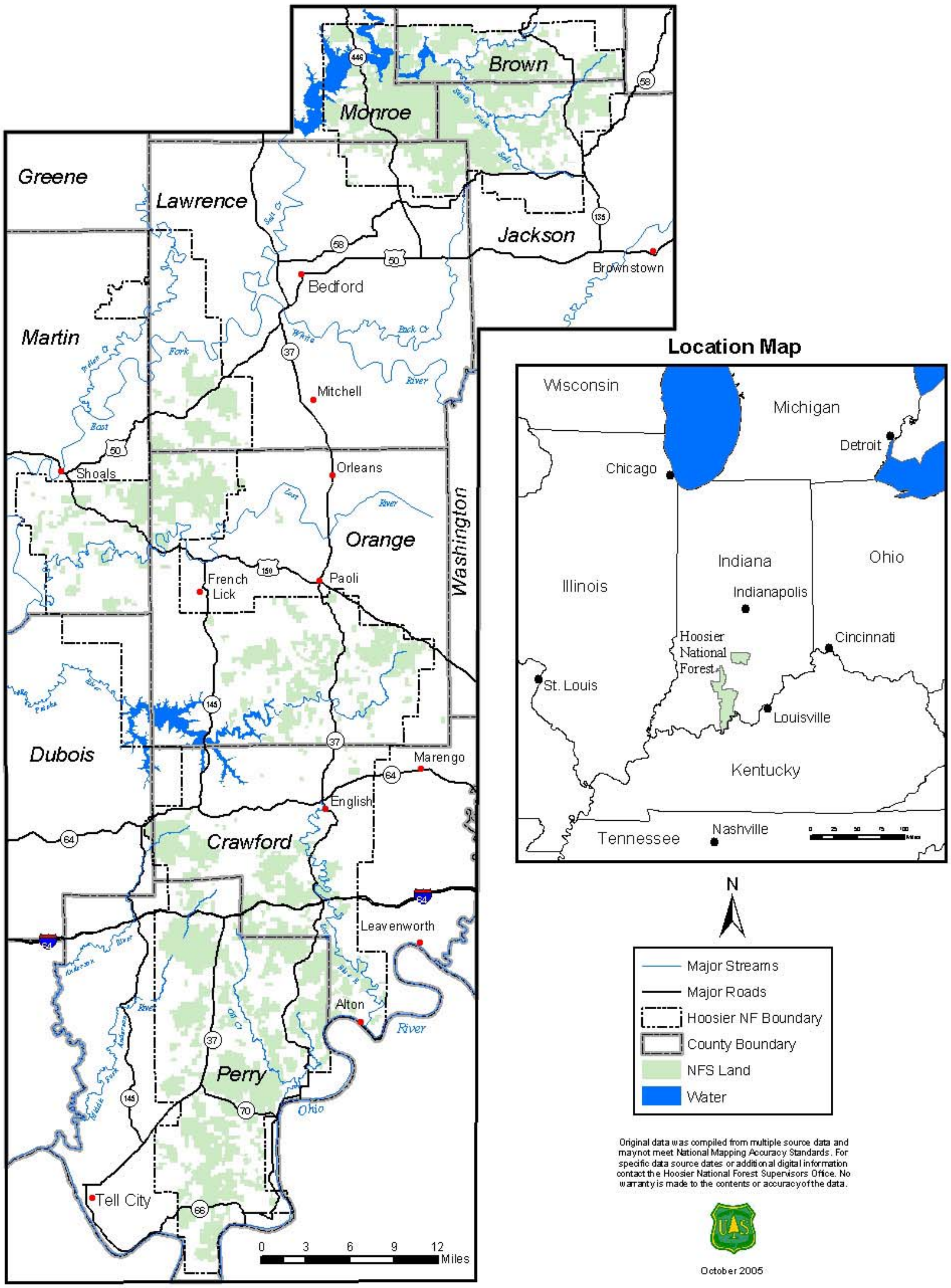
Goals and desired conditions are not absolutes. Their purpose is to ensure that they are considered when planning management activities and that efforts are made to move components toward desired conditions.

In many cases, there will be short-term impediments to reaching desired conditions, such as the current state of the resource, but the long-term aim would be to reach the desired conditions. Some areas on the landscape may be far from the desired condition, while other parts may already be in the desired condition or have a greater likelihood of reaching it soon.

The eight goals are broad statements of the Forest's overall purpose. Desired conditions are described by management areas and provide a vision of what the Forest should look like in the future.

Figure 1.1

Hoosier National Forest Vicinity Map



Objectives are measurable steps taken within a specified timeframe to move toward a desired condition. Objectives are generally achieved by implementing site-specific projects or activities. However, objectives are not targets. Targets for outputs are dependent upon budgets and may or may not reflect Forest Plan emphasis areas.

Forest-wide objectives have been developed for some resources (see Chapter 2).

Guidance

Guidance or standards and guidelines, found in Chapter 3, are the specific technical direction for managing resources. They provide guidance to implement projects that will move resources toward the desired conditions.

Guidance may apply Forest-wide to NFS land, or may apply specifically to different management areas.

Only measures that are specific to the Hoosier National Forest are included in the guidance. Laws, regulations, and policies that apply to the entire NFS are not reiterated in this guidance section.

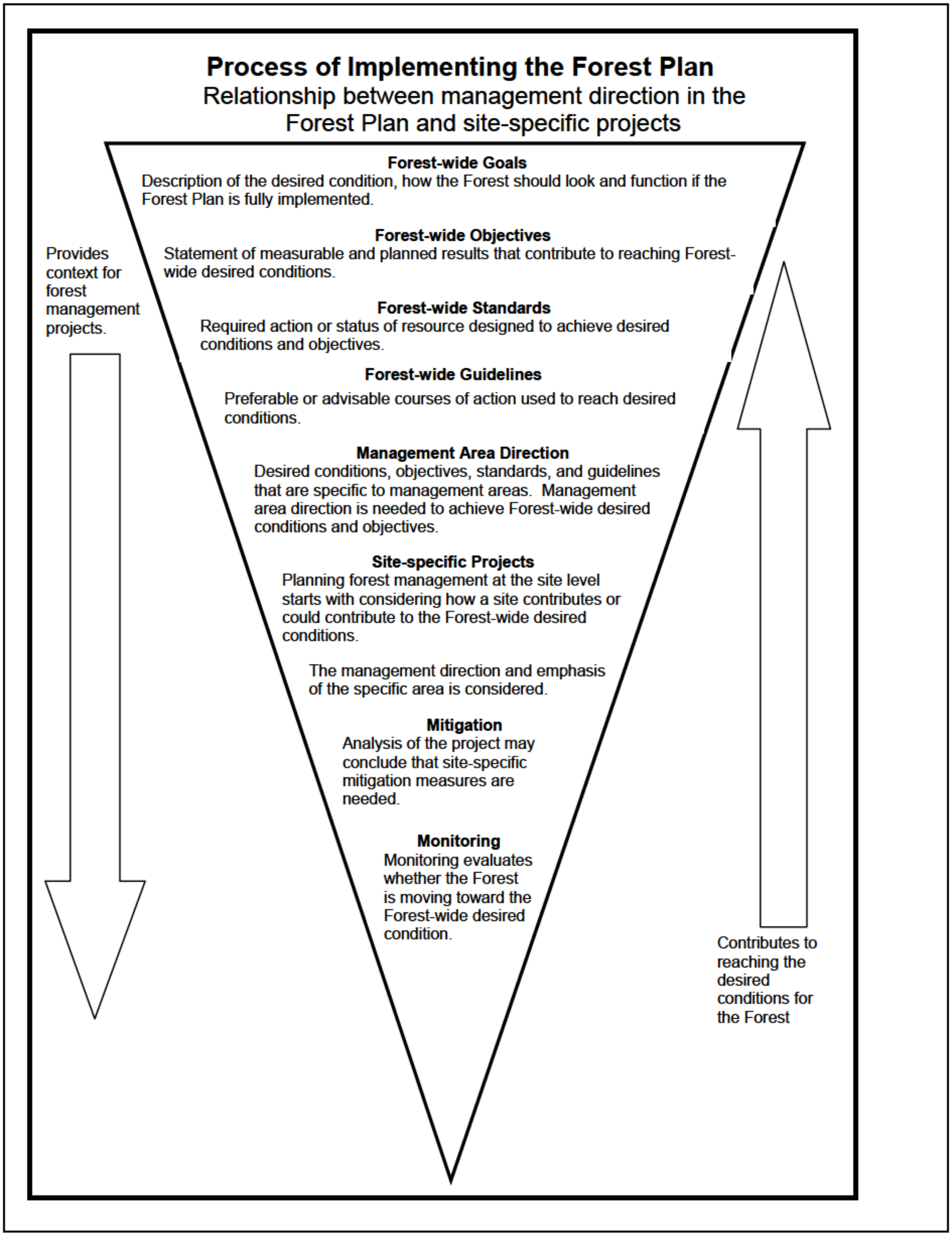
Standards are required limits to activities. These limitations help the Forest reach the desired conditions and objectives. Standards also ensure compliance with laws, regulations, executive orders, and policy direction. Deviations from standards must be analyzed and documented in Forest Plan amendments.

Guidelines are preferable limits or permissions for management actions that may be followed to achieve desired conditions. Guidelines are generally expected to be implemented. They help the Forest reach the desired conditions and objectives in a way that permits operational flexibility to respond to variations over time. Deviations from guidelines must be analyzed during project-level analysis and documented in a project decision, but these deviations do not require a Forest Plan amendment.

Implementing the Forest Plan

The Forest Plan provides a framework to guide the Hoosier National Forest's day-to-day resource management operations (Figure 1.2). It is a strategic, programmatic document that does not make project-level decisions.

Figure 1.2



Process of Implementing the Forest Plan
Relationship between management direction in the Forest Plan and site-specific projects
Forest-wide Goals
Description of the desired condition, how the Forest should look and function if the Forest Plan is fully implemented.
Forest-wide Objectives
Statement of measurable and planned results that contribute to reaching Forest-wide desired conditions.
Forest-wide Standards
Required action or status of resource designed to achieve desired conditions and objectives.
Forest-wide Guidelines
Preferable or advisable courses of action used to reach desired conditions.
Management Area Direction
Desired conditions, objectives, standards, and guidelines that are specific to management areas. Management area direction is needed to achieve Forest-wide desired conditions and objectives.
Site-specific Projects
Planning forest management at the site level starts with considering how a site contributes or could contribute to the Forest-wide desired conditions.
The management direction and emphasis of the specific area is considered.
Mitigation
Analysis of the project may conclude that site-specific mitigation measures are needed.
Monitoring
Monitoring evaluates whether the Forest is moving toward the Forest-wide desired condition.
Provides context for forest management projects.
Contributes to reaching the desired conditions for the Forest

The National Forest Management Act requires that resource plans and permits, contracts, and other instruments issued for the use and occupancy of NFS land be consistent with the Forest Plan. All outstanding and future contracts, cooperative agreements, and other instruments for use and occupancy will be brought into compliance with the Forest Plan as soon as practical.

Principles of Management on the Hoosier National Forest

Fundamental principles guide management on the Forest. Direction in the Forest Plan adds to and qualifies these principles.

Principle 1

The Forest Service will follow laws and regulations as well as policies in Forest Service Manuals that relate to managing NFS land. The Plan is designed to supplement, not replace, direction from these sources.

Principle 2

The Forest Service will coordinate management activities with the appropriate local, State, or Tribal governments, as well as other Federal agencies.

Principle 3

The Forest Service will collaborate with interested organizations, groups, and individuals.

Principle 4

The Forest Service will manage the Hoosier for multiple uses. The Hoosier is open for any legal public activity or management action, unless restricted by law, policy, or the Forest Plan. While allowed, such activities and actions may require administrative review and authorization before they are implemented.

Tools and Techniques

The Forest will reach its desired vegetative conditions through natural ecological processes and by using a diverse range of management tools and techniques.

To the extent practical, timber management will be used to emulate naturally occurring disturbances (fire and windstorms for instance). These management practices will include both even-aged and uneven-aged techniques. The Forest will use group selection, individual tree selection, and other methods of harvesting to create or maintain uneven-aged stands. The Forest will use shelterwood and clearcutting to create even-aged stands. Clearcutting will only be used when it is the optimal method for resource objectives.

Prescribed fire will be used alone or with silvicultural treatments to mimic the effects of historic fire regimes. Controlled fire will help maintain, enhance, and restore natural ecological processes. Minimum impact fire suppression tactics should be considered in wildland fire suppression and prescribed fire application to reduce adverse effects.

The Forest will promote re-growth of harvested or other disturbed forests with a variety of regeneration practices. This includes regenerating forests through natural regeneration, tree planting, and seeding. Areas will naturally change through forest succession.

The Forest will also reach desired conditions for human uses by using a diverse range of management tools and techniques. This will include providing recreational opportunities, special forest products, and commodity resources.

Ecological functions of watersheds and riparian areas will be enhanced or restored through techniques such as reconstructing or improving road and trail crossings, decommissioning unneeded roads, using silvicultural treatments or fire to enhance shade, recruiting coarse woody debris, or stabilizing banks in riparian areas.

The Forest may create new roads and trails for site-specific projects or to respond to increased demand. The majority of these roads will be temporary and will be decommissioned when no longer needed.

Site-Specific Projects

Implementing the Forest Plan means developing and implementing site-specific projects to move toward the desired conditions established in the Forest Plan (Figure 1.2).

Project-level compliance with the National Forest Management Act is primarily concerned with consistency with the Plan and the Act's regulations.

Compliance with the National Environmental Policy Act (NEPA) involves the environmental analysis process for the specific proposal, proper documentation, and public disclosure of effects in an environmental assessment, environmental impact statement, or decision document. When necessary, the Forest will perform environmental analysis on site-specific projects and activities. When required, an analysis file or project file is available for public review, but it is not always necessary to document the analysis in the form of an environmental assessment or environmental impact statement.

Environmental analysis of site-specific projects will use as its basis the data and evaluations in the Forest Plan and the FEIS for the Forest Plan. Environmental analysis of site-specific projects will be tiered to the FEIS accompanying the Plan. By referencing discussions in the Plan and FEIS, subsequent documents will be able to concentrate on issues specific to the proposed action. Discussing environmental effects at the time the project is designed allows for better management decisions.

Thus, there are two levels of decision-making. The first is the development of the Forest Plan, which provides direction for all management programs, practices, uses, and future decisions. The second level is the analysis and implementation of projects. Each of these projects must consider the goals and objectives in this Plan. This process requires land managers to take an integrated look before they make their final project-level decisions.

Site-specific decisions are postponed to the project level, allowing for focused public involvement. By waiting until a project is proposed and then asking for public comments and involvement, the Forest can ensure people are better informed of the specific activity and its effects, as well as alternative activities.

Project level decisions will be documented following NEPA guidelines.

Budgets

Congress approves the Forest Service's budget on an annual basis. The National Forest System appropriation from Congress provides funds for stewardship and management of all 192 million acres of Federal land and the ecosystems on that land across the country. These appropriated funds are key for translating desired conditions and objectives to on-the-ground results.

This budget results in program development, annual work planning, and monitoring. These processes fund implementation of the Forest Plan and make annual adjustments and changes to reflect current priorities within the overall management direction contained in the Plan. Therefore, the funding distribution between program components and intensity or level of activities in those programs is a reflection of the Plan as well as the will of Congress. The final determining factor in carrying out the intent of the Forest Plan is the level of funding, which dictates the rate of implementation of the Plan.

Forest Plan Amendments and Revisions

One of the important lessons learned during the years of developing and working with forest plans is the unpredictability of the future. Forest Plans must remain flexible even as they guide us toward the desired conditions.

A number of possibilities could prompt consideration of amending or revising the Forest Plan in the future. Every contingency cannot be considered, but the Plan establishes a basic framework for making sound management decisions.

Amendments to the Forest Plan may be recommended if the Forest finds that the prescribed activities are not resolving the issues, that new and more important challenges have been identified that should be addressed, that there are significant changes in demands, that some basic assumptions of the Plan are not valid, or that activities prescribed by the Plan are not achieving desired objectives.

The Forest Supervisor will determine whether an amendment to the Plan would be significant. Amendments will not be considered significant if they only adjust the implementation to reflect differences between proposed and appropriated funding, if they modify a prescription, or if they are minor changes when direction has been found to be unproductive, inefficient, unnecessary, or damaging. An amendment is only considered significant if the change affects the intent of the Plan. If the amendment is not significant, the Forest Supervisor may implement the change following public notification and completion of appropriate environmental analysis (Reference FSM 1922.51 and 1922.52).

If the proposed amendment is found to be significant, it could only be implemented by following the same procedure required for development and approval of this Forest Plan.

Forest Plan amendments, if any, will be incorporated into this Plan as an addition, and made available to the public. This ensures the Plan is kept current.

The Forest Plan will be revised pursuant to 36 CFR 219. It also may be revised when the Forest Supervisor determines that changes in conditions of the land, in public demands, or in Resources Planning Act policies, goals, or objectives would have a significant effect on the Forest program. Any revision would go through the same process required for development and approval of this Forest Plan.

Chapter 2

GOALS AND OBJECTIVES

INTRODUCTION

This section defines the role of the Hoosier National Forest and outlines goals set for the Forest. The role identifies the Hoosier's niche as a national forest in south-central Indiana and how the Forest intends to care for the land while serving the people.

ROLE OF THE FOREST

National forests have many inherent values that contribute to the quality of life of the American people. Air quality, cave systems, heritage resources, minerals, natural areas, recreation opportunities, scenery, soil, terrestrial and aquatic ecosystems, timber, water, and wilderness all contribute to the values that people expect to find on their national forests. The USDA Forest Service has the responsibility of managing the Hoosier to provide natural resources in a combination that best meets the needs of people now and in the future. The Hoosier provides leadership in natural resource management.

The Forest comprises much of the public forest land in Indiana. As a result, it continues to be at the forefront of forest management issues. As one of the largest public land holders in the State, the Hoosier plays a major role in providing forest ecosystems that enhance biological diversity on a regional scale and high quality recreation opportunities. Management for large, linked, natural-forest ecosystems and native plant and animal communities provides biological diversity, including genetic diversity and ecological processes, not found in other areas.

Part of the Forest Service's role is providing leadership in working with state agencies, other Federal agencies, and private landowners to link together forest ecosystems on a larger landscape level. No other area in Indiana, and few in the Midwest, offers such an opportunity to restore a portion of the forest ecosystems that were once extensive in this region.

The Forest is a precious asset to the public. Each decision the Forest makes with the public demonstrates our commitment to enhancing the character of southern Indiana and accepting our supporting role in local communities. The Hoosier has worked with the public to develop a shared vision of how the Forest should be managed and keeps them involved in deciding what path the national forest should take.

The Forest can provide natural resources, biological diversity, recreational opportunities, and other commodities society has come to expect from the Forest. The Forest's staff is committed to helping people understand why NFS lands are managed and making them partners in management decisions. Our mission is to continue to make it possible for people to enjoy the values and benefits through responsible resource management tailored to meet public desires.

GOALS

The following eight goals present broad statements of the overall purpose of the Forest.

Conservation of Threatened and Endangered Species Habitat

The Hoosier will aid in delisting endangered and threatened species, maintain an array of habitats to meet the needs of a variety of species, and potentially prevent the need to list additional sensitive species. The Forest is committed to the conservation and recovery of threatened, endangered, and proposed species and their habitats. As a Forest, we consistently put a high value on the restoration and recovery of native plant and wildlife species and the protection and conservation of those species that most need help to ensure they continue to be a viable component of the Hoosier National Forest.

In cooperation with the USDI Fish and Wildlife Service and appropriate State agencies, the Forest has established management objectives, including mitigating measures, for conservation of these species. This Plan fulfills Endangered Species Act Section 7(a)(1) obligations for conservation of Federally listed threatened, endangered, and proposed species. The basic objective is to design projects in a manner that ensures management activities will not adversely affect habitat of threatened or endangered species.

Objective

- Maintain, protect, or improve the habitat for threatened and endangered species by working toward the goals and objectives of Federal recovery plans and management direction in the Forest Plan.

Maintain and Restore Sustainable Ecosystems

The Forest recognizes the inherent value of evolving natural in the area it manages. Their variety adds value to our lives and reflects the power and permanence of our natural world. These ecosystems are a barometer of the quality of land management. Ecosystems, with their natural variety of species, genetic make-up, and ecological processes, are key to providing the diversity needed to be resilient in the face of environmental disturbances. To be sustainable, each ecosystem must include viable populations of its component species. The Forest intends to maintain and restore individual communities within the ecological capabilities of the landscape.

This goal includes restoration and maintenance of plant and wildlife species and their habitat components. All ecosystems will be recognized and enhanced, based on site capabilities. The capabilities of each site will be identified at a site-specific level and the basic integrity of air, soil, and water resources protected.

Some components of this goal are:

- Emphasize native plant and animal species and communities in management.
- Develop and maintain stands of the appropriate composition and structure to meet management goals; and when possible, provide for interconnecting corridors.
- Use vegetation management to perpetuate and enhance biological diversity. Intersperse vegetative types to provide viable habitat for native species.
- Protect cave resources from potential surface and subterranean impacts.
- Protect areas that have significant natural characteristics or represent relatively undisturbed examples of important forest ecosystems.
- Emphasize prevention and control in the integrated pest management program through appropriate means.
- Use prescribed fire to maintain fire-adapted ecosystems, to promote a more diverse community of plants and animals, and to manage accumulated fuels.
- Control and prevent the spread of nonnative invasive species.

Objectives

- Provide the diversity of habitats needed for viable populations of all native and desired nonnative species.
- Use prescribed fire to restore ecological processes and provide habitat for RFSS and other wildlife and plant species. A minimum of five prescribed burns will occur in barrens communities (average of one site every other year).
- Benefit RFSS by improving hydrologic connectivity of aquatic ecosystems by improving stream crossing structures to assure passage of water, sediment, nutrients, wood, invertebrates, fish, and to facilitate freshwater mussel dispersal. Restore up to 10 (average of one site per year) stream crossings.
- Cooperate with adjacent landowners, towns, state agencies, and private organizations to prevent the spread and establishment of non-native invasive species that pose a risk to native ecosystems.
- Develop conservation assessments for sensitive species within five years of listing.

Maintain and Restore Watershed Health

The goal of watershed health reaffirms the historic mission of the Hoosier for watershed protection and restoration. The driving force for establishing the Hoosier was to stabilize and restore eroding lands and protect watersheds from sediment. This goal emphasizes collaborative stewardship of watersheds and interrelated biological, economic, and social factors that affect these areas. The Forest will contribute to the restoration of water quality and soil productivity to improve the condition of those watersheds impacted by past land use practices.

Protect our Cultural Heritage

The goal is to protect significant heritage resources, to share their values with the American people, and to contribute relevant information and perspectives to natural resource management.

Some components of this goal are:

- Stewardship emphasizes protection of heritage resources including identification, evaluation, preservation, scientific investigation, interpretation, and proactive law enforcement.
- Interprets a variety of sites for the public to bring the past alive and illustrate relevance to the issues and challenges of today and the future.
- Provide opportunities for recreation experiences, public education, development of a conservation ethic, and an appreciation of common links with the past.
- Integrate historical and cultural data at the landscape level to provide context for natural resource management.

Provide for Visually Pleasing Landscape

Emphasize natural-appearing landscapes, with attention given to views from roads, trails, and high use areas. Visual quality will be considered in all management activities.

To the extent possible, Forest management activities, roads, and facilities are to blend with their settings. With design, timing, and care, minimal disturbance and disruption of the natural setting will occur. Long-term visual goals are not necessarily negated by short-term disruption of visual character.

Provide for Recreation Use in Harmony with Natural Communities

The Forest provides an opportunity for outdoor recreational experiences consistent with protection of the Forest's natural resources.

The Forest fills a much-needed niche in Indiana by offering recreational experiences not readily available or otherwise in short supply such as long distance trails, wilderness, water-based, and dispersed.

The recreation program strives to provide a range of opportunities from wilderness to developed recreation areas.

Some components of this goal are:

- Provide a trail system for use by hikers, mountain bikers, and horse riders.
- Create and maintain a variety of dispersed and developed recreational opportunities.
- Protect and enhance wilderness values.

Provide a Useable Landbase

The Forest strives to provide a landbase for biological diversity, recreational opportunities, and management efficiency. National Forest System land will be identifiable by the public.

The Forest will strive to provide public access. We are committed to an acquisition and exchange program to consolidate NFS lands, to resolve encroachments, and to protect significant cultural resources, areas of historical interest, and unusual habitats.

Provide for Human and Community Development

The Forest meets certain individual, community, and national needs such as clean water, minerals, recreation, timber, and wilderness values. The knowledge that the forest is there and that natural wild places are preserved and available is important to many people, whether or not they ever visit the Hoosier.

The Forest contributes to local economies and provides commodities, products, and services to people and local communities.

Some components of this goal are:

- Reduce wildfire risk to communities, municipal water supplies, and at-risk Federal land.
- Provide interpretive services to enhance the visitor's experience, to assist with management issues, or to protect forest resources whenever possible.
- Provide for a balance of forest products within the capabilities of the ecosystems.
- Support regional tourism development.

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Chapter 3

MANAGEMENT DIRECTION

INTRODUCTION

This is the heart of the Plan. This section contains guidance needed to help meet goals and objectives. The Forest has identified environmentally sound management practices to help achieve these goals and assured the needs of the public are met. Some guidance is applied Forest-wide, while other parts are specific to individual management areas. This guidance sets the framework for making future site-specific decisions at the project level. The management area maps in Appendix J show the location of different management areas.

Guidance

The goals discussed in Chapter 2 necessitate different treatment in different areas of the Hoosier National Forest. Management direction provides guidance for managing resources and uses on NFS lands.

Guidance is the direction governing how and where management activities can take place. The guidance includes both standards and guidelines as prescribed by the implementing regulations for the National Forest Management Act (36 CFR 219.11[c]).

We present guidance in two sections. The first section is Forest-wide guidance, applicable to all but specifically noted exceptions. The second section presents guidance for specific management areas, but does not repeat Forest-wide guidance. It further refines Forest-wide guidance by providing additional considerations, restrictions, activities, and direction that are to be applied to meet the specific objectives of each management area. Consult both sections before determining which management activities are appropriate in a management area.

We incorporate by reference the direction and guidance from Forest Service manuals and handbooks. The plan is designed to supplement, not replace, direction from laws and regulations.

This document identifies management areas, outlines activities compatible in each one, and provides guidance toward designing projects. Final decisions, however, will be based on project implementation and additional site-specific analysis.

Standards and guidelines are the specific technical direction for managing resources on the ground. They provide another link in moving toward the desired condition.

Only measures that are specific to the Hoosier are included in the standards and guidelines. Laws, regulations, and policies that apply to the entire National Forest System are not reiterated in the standards and guidelines. In addition, desired conditions and objectives that have a prescriptive component are not reiterated in the standards and guidelines.

Guidance includes standards and guidelines.

∗ **Standards** are shown with an asterisk. These must be implemented to achieve Forest goals and objectives. Deviation from a standard requires an amendment to the Forest Plan.

Guidelines (shown without an asterisk) should be implemented in most cases to achieve the goals and objectives. Deviation from a guideline does not require a Forest Plan amendment, but the rationale must be disclosed in the project decision documents. In some cases a guideline grants permission.

Forest-wide Guidance

Conservation of Threatened and Endangered Species Habitat

Refer to Appendix C for more information on threatened and endangered species on the Forest.

∗ Evaluate lands affected by Federal land adjustment activities and evaluate management activities to avoid or minimize effects on Federally designated threatened and endangered species habitat.

∗ Identify lands with known threatened or endangered species habitat as a top priority for acquisition.

Determine and implement management activities that will maintain and improve habitat features for threatened and endangered species.

Locate new activities away from areas that might negatively impact any threatened or endangered species.

Bald Eagle

∗ Aerial flights associated with national forest projects will not be permitted within ¼ mile horizontal distance and 500 feet vertical distance of any known active nest.

When vegetation management is planned within one mile of a body of water greater than 40 acres, the USDI Fish and Wildlife Service will be consulted about protection of potential nesting, roosting, and feeding areas.

Human entry within ¼ mile horizontal distance of an active nest during bald eagle courtship, nest building, incubation, or brooding periods will be discouraged.

Indiana Bat

Management of Hibernacula

* Establish a zone with a one-quarter mile radius around each known hibernacula of Indiana bats on the Forest. This zone may be irregular in shape to take into account likely flight paths, foraging habitat, and areas where Indiana bats are likely to swarm. Prohibit new construction activities within this zone.

* Considering both public and private ownerships, maintain or promote at least 70 percent forest canopy cover within a one mile radius of known hibernacula of Indiana bats. Timber harvest should be conducted within this zone only during hibernation and is restricted to single-tree and group selection.

* Implement prescribed fire within a five mile zone around hibernacula only when bats are unlikely to be swarming or staging. Burns should be conducted under conditions that will reduce or eliminate smoke dispersing into hibernacula.

* Develop management goals and directives (conservation plan) for each known hibernaculum at micro-topographical level, taking into consideration current conditions and future restraints and/or challenges. A five mile radius should be included from the entrance of the known hibernacula.

Management of Roosting Habitat

* Maintain a component of large, mature trees in harvest areas, retaining at least three live trees per acre greater than 20 inches diameter at breast height (DBH) of these preferred species (leave trees will be located along edges of the harvest area or in clumps to maximize their benefit to bats):
  - silver maple (*Acer saccharinum*)
  - bitternut hickory (C*arya cordiformis*)
  - shellbark hickory (C*arya laciniosa*)
  - shagbark hickory (*Carya ovata*)
  - white ash (*Fraxinus americana*)
  - green ash (*Fraxinus pennsylvanica*)
  - eastern cottonwood (*Populus deltoides*)
  - white oak (*Quercus alba*)
  - northern red oak (*Quercus rubra*)
  - post oak (*Quercus stellata*)
  - black locust (*Robinia pseudoacacia*)
  - American elm (*Ulmus americana*)
  - slippery elm (*Ulmus rubra*)

* If a stand possesses no trees greater than 20 inches DBH, leave 16 live trees per acre (leave trees will be located along edges of the harvest area or in clumps to maximize their benefit to bats) of these preferred species remaining in the stand.

* Shellbark hickory or shagbark hickory trees will not be harvested or killed for the purpose of timber stand improvement, unless the density of trees of these two species combined exceeds 16 trees per acre. If present, at least 16 live shagbark and shellbark hickory trees (combined) greater than 11 inches DBH must be maintained per acre.

* Firewood cutting permits must clearly state that standing dead trees may not be taken unless specific trees are identified in the permit by the Forest Service. When approved for removal, standing dead trees would be designated by Forest Service personnel and described in the firewood cutting permit.

* When demolition of abandoned buildings is considered, inspect buildings as necessary to confirm the presence or absence of maternal roosts prior to initiating operations. Delay operations until bats have departed buildings used as maternal roosts and provide suitable roost replacement.

* Any hazard tree that has characteristics of a potential maternal roost tree (splintered bole that provides crevices, evidence of decay so that either their bark is exfoliating, it possesses cavities, or dead portions of the tree have been used, excavated, or occupied by species such as woodpeckers or other cavity nesting birds and, most importantly, exposure of the roost to sunlight) will not be removed until consultation with a Forest Service biologist has been completed. An exception is, trees may be cut that are an immediate saftey danger to an individual.

* Consultation will occur with the USFWS any time a hazard tree is identified as being used by bats.

* Develop management goals and directives (conservation plan) for each known maternity colony at micro-topographic level, taking into consideration current conditions and future restraints and/or challenges.

* Perform emergence counts on all trees targeted for removal during the bats' active period (April 15 – September 15) that exhibit maternity roost tree characteristics.

* Any dead bats located on the Forest, regardless of species, should be immediately reported to the Bloomington Field Office (BFO) [(812)334-4261], and subsequently transported to the BFO. No attempt should be made to handle any live bat, regardless of its condition; report bats that appear to be sick or injured to the BFO.

* Conduct pre-harvest environmental meeting with contractors and their employees on-site before any activities associated with timber harvest and/or removal; emphasize strict adherence to Standards and Guidelines; discuss life history and habitat needs of Indiana bats; adequately describe roost tree characteristics and the critical role they play for bats, and the subsequent importance in avoiding these trees during harvest operations.

  All personnel tasked with the removal of hazard trees will attend training with a biologist to learn how to identify potential maternal roost trees.

  When even-aged management is conducted, leave trees will be left along the edges of clearcuts or in large clumps (1/10th acre) to maximize their benefit to bats.

Retain dead and dying trees that have characteristics for potential maternal roost trees (leave trees) unless they are safety hazards. Characteristics for leave trees include evidence of decay so that either their bark is exfoliating, they possess cavities, or dead portions of the tree have been used, excavated, or occupied by species such as woodpeckers or other cavity nesting birds and, most importantly, exposure of the roost to sunlight. In addition,retain any tree that has a splintered bole providing crevices that can be used as roosts by eastern forest bats.

When possible, delay removal of hazard trees until bats are likely to occupy hibernacula, between September 15 and April 15.

If potential primary roosts are located during single-tree and group selection harvest planning, design harvests to create gaps that border these trees so as to improve their suitability as roosts.

When there are not at least three standing dead trees greater than 11 inches DBH per acre during single-tree or group selection harvest, consider girdling live trees.

In the event that an occupied primary roost is located on NFS land, designate a zone extending in a radius of 300 feet from the roost. Prohibit land management activities within this zone during the breeding season (April 15 – September 15).

Restrict prescribed burning within a radius of one mile from occupied roosts during the breeding season.

<u>Management of Foraging Habitat</u>

∗ When conducting uneven-aged hardwood timber harvests or conducting hardwood timber stand improvements, maintain at least 60 percent canopy cover on a stand-by-stand basis. Design boundaries of timber harvest areas to be irregular in shape so as to enhance foraging by bats.

<u>Management of Water Sources</u>

When conditions allow and need is determined, create shallow water extensions of existing waterholes and ponds to enhance insect diversity and abundance for foraging bats.

Gray Bat

∗ When caves are found to contain gray bats, coordinate with the USDI Fish and Wildlife Service and other appropriate groups or agencies to determine if access to caves needs to be restricted.

∗ Establish a zone with a one-quarter mile radius around each known hibernacula of gray bat on the Forest. This zone may be irregular in shape to take into account likely flight paths, foraging habitat, and areas where gray bats are likely to swarm. Prohibit new construction activities within this zone.

* Considering both public and private ownerships, maintain or promote at least 70 percent forest canopy cover within a one mile radius of known hibernacula of gray bats. Timber harvest should be restricted to single-tree and group selection within this zone. Implement vegetation management to maintain or improve bat habitat for staging, swarming, roosting, or foraging. Implement prescribed fire within this zone only when bats are unlikely to be swarming, hibernating, or staging.

Fanshell

* Prohibit any activity that might negatively affect the known but limited population in the East Fork of the White River, or any population located in the future.

* Prohibit the application of pesticides within the riparian corridors of the sixth level watersheds of the East Fork White River where the species has known occurrences. Currently, known sites in sixth level watersheds that contain some parcels of NFS lands are the E. Fork White River – Henshaw Bend and the E. Fork White River – Poplar/Willow Creeks.

Rough Pigtoe

* Prohibit any activity that might negatively affect recovery of the rough pigtoe in the East Fork of the White River or any population located in the future.

* Prohibit the application of pesticides within the riparian corridors of the sixth level watersheds of the East Fork White River where the species has known occurrences. Currently, known sites in sixth level watersheds that contain some parcels of NFS lands are the E. Fork White River – Henshaw Bend and the E. Fork White River – Poplar/Willow Creeks.

Maintain and Restore Sustainable Ecosystems

Manage Vegetation to Provide Diverse Ecosystems

* Prohibit adverse modifications to the landscape within 660 feet of known active osprey nests and heron rookeries. Seasonally restrict management activities within ¼ mile of known osprey nests and heron rookeries to avoid disturbance during nest building, egg laying, incubation, and fledgling stages.

Design projects in a manner that ensures management activities would not adversely affect habitat of sensitive species, unless there is a higher priority concern, such as habitat for threatened and endangered species.

Avoid planting, seeding, or introducing nonnative species.

Consider planting mixed species where suitable to reduce insect and disease damage, increase visual variety, and add habitat diversity.

Where possible, restore native ecosystems.

Retain where appropriate large diameter trees and mature or over-mature stands around ponds, lakes, wetlands, and stream shorelines.

Wherever appropriate, manage cliff faces, springs, caves, barrens, and glades as special habitats to protect or enhance physical, historical, and ecological characteristics.

Leave downed logs, limbs, and other scattered ground materials resulting from vegetative management or natural causes on the site where appropriate.

Use sanitation and salvage harvests to remove dead, dying, diseased, or potentially affected trees except in Management Areas 5.1 and 8.1.

Skid roads should be designated by Forest Service personnel and should not exceed a gradient of 35 percent.

Where applicable, clearcutting may only be used where it has been found to be the optimum method of regeneration to meet multiple-use objectives and is essential to meet forest plan objectives, involving one or more of the following circumstances:

- To establish, enhance, or maintain habitat for threatened, endangered, or sensitive species.
- To enhance wildlife habitat or water yield values or to provide for recreation, scenic vistas, utility lines, road corridors, facility sites, reservoirs, or similar development.
- To rehabilitate lands adversely impacted by events such as fire, windstorms, or insect or disease infestations.
- To preclude or minimize the occurrence of potentially adverse impacts or disease infestations, windthrow, or other factors affecting forest health.

- To provide for the establishment and growth of desired trees or other vegetative species that are shade intolerant.
- To rehabilitate poorly stocked stands due to past management practices or natural events.

Accomplish regeneration primarily through natural means. Planting or seeding may be used if adequate stocking, desired species composition, or acceptable genetic quality cannot otherwise be achieved. Refer to Appendix B for minimum stocking standards following timber harvest for even-aged management and uneven-aged management using group selection.

As needed, use salvage to reduce hazardous fuels from disturbances such as storm events, fires, and insect or disease infestations.

Consider the experience of trail users when conducting activities near and along trails.

Regional Forester Sensitive Species

∗ Prohibit adverse modifications to the landscape within 660 feet of known nests of sensitive raptor species. Seasonally restrict management activities within ¼ mile of known sensitive raptor species nests to avoid disturbance during nest building, egg laying, incubation, and fledgling stages.

∗ Prohibit timber harvests within a distance of 100 feet from the top and base of large cliffs or overhangs (see Appendix A, Glossary) except for the salvage of dead and dying trees, or sanitation harvest. Trees harvested outside but near this zone would require directional felling away from the cliff area. These rock outcrop habitats are not limited to solid cliffs and may include discontinuous rock faces (i.e. fractured cliffs, discontinuous large blocks).

∗ Prohibit planting of exotic or nonnative invasive plants within or near barrens, glades, and other sensitive plant communities.

When evaluating the need for harvest within 50 feet of a perennial or intermittent stream, consider the presence of sensitive species and potential effects.

In areas potentially affected by land exchange, surface-disturbing activities or vegetation management, assess the need for and, as needed, conduct surveys or inventories for Regional Forester sensitive species.

Maintain or enhance barrens or glades habitat. Removal of woody vegetation by burning, cutting, or mowing may be desirable to maintain or enhance these areas.

Avoid soil-disturbing activities in barrens or glades unless required to meet management objectives (i.e. provide for management access, put in fire lines for prescribed burns, or remove tall fescue or other nonnative invasive plants).

Identify other areas that are not barrens or glades, that harbor botanical Regional Forester sensitive species requiring full sun.

Nest Boxes and Other Structures

For conservation and educational purposes, supplement natural cavities with nest boxes for cavity-nesting mammals and birds. Use nesting platforms or other structures as appropriate.

Forest Openings

Whenever possible, create and maintain larger openings or opening complexes to provide habitat for species that are area sensitive.

Generally manage forest openings to provide early successional habitat to benefit wildlife species, provide habitat for native plant communities, add visual variety, and provide for recreation opportunities. Manage the edges of most forest openings as shrubby edge or thickets. Develop and maintain other areas, or portions of shrubby areas, in native forbs and grasses.

Where possible, improve wildlife forage and native plant diversity on transmission lines and pipeline right-of-ways.

Where conditions allow, locate openings away from heavily traveled roadways.

Consider public access and recreation when establishing openings.

Mow openings from August to October when possible to minimize disturbance to nesting birds while maintaining some herbaceous food and cover over winter.

Restore native plant communities and replace exotic pasture grasses and other nonnative plants wherever possible.

Retain standing dead trees in created openings as needed, in conjunction with opening development and maintenance.

Caves and Other Karst Features

* Prohibit timber harvesting and prescribed burning within 200 feet of cave entrances, direct drainage inputs, such as sinkholes and swallow holes, and any streams flowing into a known cave, except for research purposes.

* Do not discharge drilling muds into a karst hydrologic system.

* Do not conduct surface disturbing activities on any slopes steeper than 30 percent adjacent to cave entrances without use of mitigation measures.

* Do not promote caves as available for general public use unless the Forest develops adequate protection measures to control and manage this use and can clearly establish that no substantial risk, harm, or vandalism of the cave would occur.

* Do not conduct seismic surveys within 200 feet of known cave passages or conduits.

* Location of caves on NFS lands will not be disclosed.

* Cave management will be integrated into general land management practices to protect cave resources from subterranean and surface impacts.

* Inventory and evaluate caves in accordance with the Federal Cave Resources Protection Act, Forest Service Manual direction, and Memorandum of Understandings with other organizations.

* All caves and karst features shall be excluded from leasing and mineral activities and no drilling will occur within the boundaries of any cave. Boundaries are defined as the area within the known cave plus a buffer zone of 200 feet around the cave.

  Cease drilling operations and notify the authorized officer when anyone encounters previously undiscovered voids (more than 12 inches) within 300 feet of the surface.

  Do not allow sediment from access roads and other activities to wash into caves or karst features.

  Examine and inventory to the extent possible each cave and karst feature. Prepare management prescriptions and plans describing considerations and criteria for protection of cave resources whenever feasible.

  Where practical and beneficial, restore cave and karst hydrologic systems choked with debris from non-natural causes or sediment.

  Take corrective action if damage to karst or other resources exists and is likely to continue.

  Whenever possible, remove non natural debris from sinkholes to improve water quality entering directly into karst systems.

  Gating of cave entrances will only be considered as a last resort on a case-by-case basis for safety, and after evidence demonstrates this to be the only option to protect cave species and other resources.

  Under normal circumstances, do not place signs with cave names or other information that would reveal cave locations outside of caves. Small signs or registers inside caves (20 to 100 feet) that discuss cave conservation or safety are acceptable.

  The Forest will be careful not to promote or dissuade the recreational use of caves; unless it becomes necessary to control access to protect cave resources.

Information on caving basics, ethics and safety, and locations of broad regions of karst topography may be provided. Information about a particular cave may be exchanged with individuals who demonstrate a pre-existing personal knowledge of a cave's location, extent, and layout.

Aquatic Habitat and Species Management

Manage vegetation canopies in and along streams and other aquatic habitats to maintain appropriate water temperatures and chemistry for fish and other aquatic species.

Incorporate habitat needs of animal and plant communities associated with wetlands into wetland design (islands, peninsulas, and standing live and dead trees). Consider the habitat needs of waterfowl, aquatic flora and other wildlife.

As opportunities arise, restore or enhance fisheries habitat in lakes, ponds, and streams by introducing large woody debris and maintaining or improving streambank and shoreline stability. Trees should be removed from dams of maintained lakes and ponds.

Avoid blocking fish passage in streams.

Consider improvement and enhancement of aquatic habitats in all management activities associated with lakes. Incorporate consideration of habitat needs of animals attracted to lakes into lake design including islands, peninsulas, and standing live and dead trees. Determine the type of access and boat and motor restrictions on lakes on an individual basis.

Maintain or enhance the habitat quality of waterholes as necessary.

Where other objectives do not conflict, reduce aquatic vegetation to 20 to 30 percent coverage on lakes and ponds for the purpose of fisheries.

Maintain, enhance, or create ephemeral wetlands where feasible to provide breeding sites for reptiles and amphibians, as well as to provide drinking sites for bats.

Special Areas and Research Natural Areas

Consider nominating newly acquired land as Special Areas if those areas have significant natural characteristics or represent relatively undisturbed examples of important forest ecosystems.

Pest and Nonnative Invasive Species Management

∗ Evaluate pest and nonnative invasive species problems and use integrated pest management to control them, as needed. This includes manual, mechanical, chemical, and biological control methods.

* When applying pesticides, identify measures required to reduce off-site movement, drift potential, and adverse effects on threatened and endangered species and their habitat, sensitive species and their habitat, human and wildlife health, non-target vegetation, water quality, and any other relevant environmental elements.

* Pesticides will only be applied in accordance with State regulations.

* Include appropriate clauses for the prevention or treatment of nonnative invasive species in Forest contracts and permits.

For projects having moderate to high risk of introducing or spreading nonnative invasive plants, incorporate nonnative invasive species assessments in project planning and include nonnative invasive species prevention and treatment methods in project development, analysis, and implementation.

Generally prioritize nonnative invasive species management as follows:

1. Prevention of new infestations
2. Early detection and treatment of new infestations
3. Treatment of sites with the greatest potential for spreading such as trailheads, boat ramps, parking lots, recreation areas, and administrative sites
4. Protection of known endangered, threatened, and sensitive plant and animal sites susceptible to harm from invasive species
5. Protection of Forest special areas and Research Natural Area
6. Containment and control of established infestations

Fire and Fuels Management

* Suppress all wildfires on NFS land.

Whenever possible maintain or restore ecosystems to a pre-fire suppression condition.

Consider prescribed fire, mechanical treatment, and isolation in addition to timber sales and other utilization options as tools for fuel treatment after natural disturbance events.

Use prescribed fire to accomplish silvicultural objectives such as oak regeneration.

Where possible, use natural or existing man made barriers for fire control and as boundaries on prescribed fire.

When using prescribed fire in riparian areas, use backing fires when possible and avoid lighting directly in the riparian area.

Avoid using tilled fire lines in riparian corridors.

Maintain and Restore Watershed Health

Soil and Water Conservation

* Stabilize areas disturbed by management activities as soon as practical, or at least within the same growing season.

* Improve or maintain water quality by designing and maintaining roads in accordance with Appendix G.

* Reduce compaction and rutting by prohibiting heavy equipment use when the soils are in a saturated condition, thereby reducing surface runoff, soil erosion, and loss of soil nutrients.

With exceptions such as emergency release of water, manage flows from dams and impoundments so that downstream aquatic habitats, reservoir habitats, and aquatic species are minimally impacted.

Permission to remove sand, gravel, or other materials from streams will be considered on a case-by-case basis, and may include, but is not limited to these activities:

- Excavation of deep holes in stream channels to improve fisheries or other wildlife habitat
- Incidental excavation operations for culverts, bridges, fords, dams, trails, or other new or existing facilities.
- Restoration to a more natural or stable stream channel that has been filled by sediment from other land-disturbing activities.
- Removal of materials from sediment basins that have been installed to trap sediment from some upstream activity.

Give priority to stabilizing areas discharging soil into watercourses, especially those that affect the watershed of municipal or recreational reservoirs.

Water bodies may be created if there are adequate watersheds and soil conditions are conducive to construction of water-holding structures.

Maintain functioning wetlands and streams, and restore or enhance wetlands and streams in areas with historical hydrology or appropriate soil characteristics (floodplain characteristics).

Guide soil protection and management for all activities according to site capabilities as identified by interpretation of soil and other ecological site factors.

Prohibit log skidding and heavy equipment within streambeds.

Construct and maintain waterbars on skid trails to slow surface runoff before it creates channels and gullies or moves excessive amounts of sediment into streams.

Soil disturbing operations that extend over a number of operating seasons may require mulching of exposed areas to reduce surface erosion.

Designate log landings on site by Forest Service personnel. Locate landings on upland, well-drained, nearly level sites to minimize surface runoff and soil erosion.

When operations are complete, prepare landings to provide favorable site conditions for seed germination. The landings should be seeded with approved Forest Service seed mixtures and mulched to prevent erosion until vegetation becomes reestablished on the site. These actions should be taken as soon as practical after disturbance.

Logging or site preparation equipment should avoid plastic soils (soils that can be molded or shaped like clay) when the water table is within 12 inches of the surface or when soil moisture exceeds the plastic limit. Soil moisture exceeds the plastic limit if the soil can be rolled to pencil size (approximately ¼ -inch diameter and 6 inches long) without breaking or crumbling.

Resource management activities that may affect soil or water quality must follow Logging and Forestry BMP's for Water Quality in Indiana (IDNR 1998), or most recent version, as a minimum to achieve soil and water quality objectives. When Forest Plan standards exceed Indiana BMPs or water quality standards, Forest Plan standards take precedence.

Where topsoil is less than one inch thick or where organic matter is less than 2 percent, retain logging slash in place (perform limbing at the stump).

Designate the location of roads, trails, main skid trails, and similar features that disturb soils. Stabilize disturbed sites during use and revegatate after use to control erosion.

Utilize the "Indiana Handbook for Erosion Control in Developing Areas" (IDNR 1992) as well as "Best Management Practices for Erosion and Sedimentation Control" (USDOT 1995) for guidance on limiting sedimentation.

In disturbed areas, generally stockpile topsoil and return it to the site.

Restoring natural wetlands will be the highest priority to maintain and restore watershed health.

Riparian Corridors

This guidance is applicable to the entire riparian corridor, which includes the riparian area and a portion of the terrestrial ecosystem along a stream channel. Appendix I further describes the riparian corridor.

Riparian corridors are not excluded from management activities. These are zones where the application of mitigation measures and forethought must be applied to ensure water quality and riparian values are protected.

Protect, enhance, or restore natural water flows when feasible.

Riparian corridors will consist of the riparian area and the adjacent terrestrial ecosystem for a combined 25 to 100-foot corridor depending on the type of stream. Permanent water bodies and perennial streams will consist of a 100-foot riparian corridor. This can be adjusted based on site specific analysis.

Intermittent streams will have a minimum 50 foot corridor from each stream bank and ephemeral streams will have a 25 foot minimum riparian corridor.

Waterholes or small ponds up to 0.5 acre with adjacent slopes no more than 5 percent should have a 25 foot riparian corridor. If adjacent slopes are steeper, wider corridors may be needed.

In general, roads and trails will not be constructed in riparian corridors unless no practical alternatives exist. Road and trail approaches to streams will be located to minimize erosion and sediment introduction to the stream.

Roads and trails will generally cross channels at right angles. Channel crossings will be accomplished using bridges, culverts, fords, or other appropriate crossing structures according to site specific conditions. Remove unnecessary crossings when a road or trail is decommissioned.

Limit heavy equipment crossings in riparian corridors.

Minimize cuts and placement of fills while building new roads in wetlands and riparian corridors in accordance with safety and other engineering road design criteria. Provide sufficient drainage to ensure that the absorption capacity of the riparian corridor is not exceeded.

Reconstruction and stabilization of existing roads, trails, and other facilities within riparian corridors is permitted.

Design and maintain roads and trails in riparian corridors to sustain natural hydrologic patterns and allow for passage of aquatic species. Install appropriate drainage and crossing structures for all new roads and trails to prevent sedimentation.

Road and trail surfaces within riparian corridors should be stabilized with aggregate or other suitable material. Normally, the Hoosier will maintain four inches of gravel surfacing on roads in riparian corridors while they are open to vehicular traffic.

Management within riparian areas will include the maintenance of shade suitable for aquatic organisms over the stream corridor, minimize soil disturbance, and promote mesic native species along perennial, intermittent, and some ephemeral streams dependent on site-specific aquatic resources.

Keep slash out of water bodies, stream channels, floodplains, and areas where it may be swept into streams, rivers, and water bodies except to meet other habitat objectives.

Soil-disturbing activities of approved practices within designated riparian corridors will require effective erosion control. Implement, as needed, erosion control measures such as straw bales in ditch lines and small drainages, berms in road embankments during construction, diversion ditches, slash and unmerchantable logs across slopes and trails, check dams in ditch lines, sediment detention basins, and sediment fences.

Preserve the integrity of stream channels, maintain the beneficial values of floodplains and wetlands, and protect the interest of the public when structures and facilities are constructed or rehabilitated.

Forest openings may be developed and maintained within riparian corridors.

Permit emergency construction of fire lines or other earth disturbing measures within riparian corridors, but these disturbed areas will be stabilized as soon as possible.

Protect Our Cultural Heritage

* Inventory affected lands prior to conducting ground-disturbing projects. This includes, but is not limited to, such activities as prescribed burns, vegetation management, and proposed land exchanges.

* If heritage resources are discovered during project implementation, cease all activity in the vicinity until an archaeologist has made an on-site assessment.

* Conduct inventories in non-project areas to locate and identify all significant heritage resources managed by the Forest.

* Complete all heritage resource investigations with archaeologists, archaeological technicians, or paraprofessional archaeological technicians. Volunteers may assist if under the supervision of an archaeologist.

* Evaluate sites for significance and potential listing to the National Register of Historic Places (NRHP). Nominate significant sites to the NRHP.

* Consider sites that have not been formally evaluated as potentially eligible to the NRHP and protect them. Sites not eligible to the NRHP do not require protection but may have interpretive potential. Protect all unevaluated, eligible, and listed sites from ground-disturbing activities. Implement protective measures, including avoidance buffers and site condition monitoring, as recommended during site-specific project development and analysis. If a project cannot be redesigned and would adversely affect a NRHP-eligible heritage resource, the heritage resource staff will develop and implement a mitigation plan to minimize the affects. Develop the plan in consultation with the State Historic Preservation Office (SHPO).

* Periodically assess the nature and degree of damage to heritage resources due to vandalism, visitor use, and natural deterioration. Identify and implement protective measures.

* Do not disclose heritage site locations without the approval of the Forest Supervisor.

* Appropriately curate heritage resource collections. All archaeological and historic materials recovered from NFS lands are the property of the Federal government.

Design activities to avoid damage to heritage resources.

Conduct stabilization, rehabilitation, and restoration activities when appropriate.

Use accurate and up-to-date site and survey information with a graphic and tabular data base to efficiently and effectively manage the resources.

To the extent possible, offer and maintain an array of heritage interpretive opportunities and experiences including on-site signs, trails, presentations, tours, exhibits, volunteer projects, special events, heritage tourism, and internet web pages. The Forest may develop an interpretive plan to identify specific opportunities and coordinate a systematic approach.

Develop a strategy to systematically evaluate all sites on the Forest through use of thematic evaluations or other applicable models or strategies.

Prefer in-situ (in-place) management as the method for the preservation of human remains and associated grave goods, regardless of age or ethnicity. Treat human remains with dignity and respect.

Provide for a Visually Pleasing Landscape

Meet the visual quality objectives (VQO) indicated on the VQO map in Appendix J where not overridden by management area guidance.

Consult Handbook Number 462, National Forest Landscape Management, Volume 2, Chapter 1 where not overridden by the VQO map in Appendix J.

Rehabilitate the visual aspects of most projects as soon as possible.

Provide for Recreation Use in Harmony with Natural Communities

* Camping is permitted anywhere unless restricted by Forest Order or other regulation.

* Prohibit public off-highway vehicle use.

Prohibit paintball activity in Management Areas 5.1, 7.1, and 8.1 or where otherwise prohibited by regulation. Paintball guns are considered firearms and all applicable firearm regulations apply. Substances used in the paintballs and other devices must be water soluble and biodegradable.

Limit administrative use of off-highway vehicles to activities such as: trail or recreation site maintenance and construction, search and rescue, law enforcement, fire fighting, prescribed fire, permit administration, and maintenance of managed forest communities. Permit use of off-highway vehicles in activities such as contracts, volunteer and cooperative agreements, and special use permits only when specifically authorized by a line officer.

When possible, design roads, trails, and other facilities to enhance recreational experiences. Consider public health and safety, accessibility, and environmental quality as integral parts of recreation facility design and management.

Design or reconstruct roads open to the public to increase recreational opportunities by providing features such as parking, turnouts, overlooks, and points of interest.

Trails

* Design trails to meet the standard of the highest impact user.

* Allow foot travel on any trail as well as off trails, unless otherwise prohibited.

* Allow horses, and other pack stock, on trails designated as open to horse use and on roads open to public vehicle travel, unless prohibited.

* Allow mountain bicycles on trails designated as open to mountain bicycle use, and on roads open to public vehicle travel, unless prohibited.

* Camping is not permitted at or within 300 feet of a designated trailhead, unless located in a campground or otherwise permitted.

Provide single and multiple-use trails.

Harden trails with appropriate material if conditions dictate. Motorized earth moving equipment may be used for trail maintenance.

Designate trails as system trails or special use permit trails.

Maintain a Forest-wide trail plan.

Provide a Useable Landbase

Land Ownership and Adjustment

Give high priority to land adjustments through purchase or exchange, that consolidate forest ownership, provide access to existing NFS land and water, and protect or enhance threatened and endangered species habitat or other special areas.

Give high priority to obtaining lands to protect significant cultural sites; acquire or retain areas with caves or outstanding examples of karst features; permit protection, development, and management of wetlands, lakes, and ponds or recreation facilities; and protect water quality (See Appendix E).

Satisfy one or more of the following purposes when implementing land adjustments:

- Accomplish objectives of Federal law or regulation
- Meet demand for national forest resources, including recognized special areas
- Result in more efficient land ownership patterns
- Result in lower resource management costs

Land adjustments, such as purchases, exchanges, or donations, should assume the land allocation of the surrounding area, unless circumstances warrant placement into Management Area 9.2 for study as a special area or nomination of a research natural area.

Avoid encumbering land available for exchange with land uses that compromise land exchange opportunities.

Do not acquire land by condemnation except in extreme cases to acquire right-of-ways or clear title, if all other reasonable efforts fail. Land acquisition program deals with willing sellers and exchange proponents.

Consider acquiring subsurface rights under NFS land when the rights and funding are available.

Whenever possible, landlines will be located and marked to standard.

Transportation System

Maintain effective closures (to public motorized vehicles) on Maintenance Level 1 (See Appendix A, Glossary) roads. Closure devices should be visually compatible with the surrounding area.

Decommission unneeded roads when possible.

Follow guidelines in Appendix G for Hoosier National Forest road design.

Access Rights

Consider on an individual basis requests for easements or special-use permits for new or improved road access across NFS land by State or local units of government, private landowners, or other interests.

Consider requests for access to other ownerships across NFS land when no other reasonable access exists. Consider alternative access, management area objectives, and public input when evaluating access requests.

Public Parking

Parking lots may be provided.

Avoid locating new parking sites and access points within sight distance of springs, seeps, and mineral licks to minimize disruptions to wildlife.

Provide for Human and Community Development

Special Uses and Utility Corridors

* Do not allow sanitary landfills on or beneath NFS lands.

Wherever possible, combine utility right-of-ways across NFS land into shared right-of-ways or corridors to reduce total forest impacts.

Consider visual qualities in the design of permitted activities and, where feasible, bury all new utility lines.

Approval of applications for distribution systems crossing NFS lands (such as utility right-of-ways serving individual residences) will be determined on a case-by-case basis.

Evaluate applications on an individual basis for other special uses involving NFS lands, including but not limited to wind, solar, and hydro power generation sites and communication towers.

Where possible, manage lands under special-use permits for overall plant and animal diversity and enhancement of native communities.

Base qualification for a special use permit trail on a case-by-case evaluation of ability to meet Forest Service criteria established in the Trail Plan.

Minerals and Geology

* Allow for the exploration and development of gypsum in Martin and Orange counties.

* Prohibit surface disturbing mineral development (including oil and gas) when the Federal government owns the subsurface rights.

* When the minerals are owned by other parties, require reclamation plans for all proposed surface-disturbing activities on Federal lands. The affected lands must be reclaimed to their natural state using the best scientific knowledge and principles available.

Any proposal to lease minerals from the Federal government, with no surface occupancy, would require consultation with USDI Fish and Wildlife Service during environmental analysis or prior to leasing. Such consultation will occur on a project by project basis.

Allow for mineral exploration that does not disturb the land surface.

Do not preclude the ability of private mineral owners to exercise their outstanding or reserved mineral rights as defined by deed and public law.

Recreational gold panning may be allowed except in the Charles C. Deam Wilderness or within 200 feet of caves. Gold panning is restricted to active stream beds or unvegetated gravel bars. Digging in stream banks is not allowed and no more than two cubic yards of material may be moved within the site. Commercial ventures are not allowed and tools are limited to hand tools such as a shovel and a gold pan.

Recreational mineral collection may be allowed except in the Charles C. Deam Wilderness or caves. Only negligible surface disturbance is allowed for recreational mineral collection. Tools are limited to rock hammers, garden trowels, or shovels.

Buildings and Structures

Ensure that building design and appearance are compatible with the forest environment.

Provide communication sites to support resource management objectives. Some commercial use may be provided if space is available and the commercial use would not conflict with Forest equipment or frequencies.

Consider adaptive re-use of historic structures in lieu of constructing new ones.

Public Health

Emphasize and promote “pack-it-in, pack-it-out” methods of disposal and the Leave No Trace ethic.

Provide educational materials at offices and trailheads to aid the public in awareness and avoidance techniques for health risks such as tick borne diseases and poison ivy.

Management Area Guidance

Management area maps in Appendix J show the locations of each of the ten management areas. Also included in Appendix J are maps of visual quality objectives and recreation opportunity spectrum classifications for each area of the Forest.

Management Area 2.4

Desired Condition of Management Area

This management area protects and enhances water-based recreation opportunities, visual quality, and riparian values. This management area is associated with canoeable and fishable streams, rivers, lakes, and reservoirs. Maintain riparian corridors to protect, enhance, or restore channel stability, water flow, and habitat quality. The desired condition includes forested shorelines or corridors up to 1 mile or more in width, with an unbroken canopy in large-diameter trees of a variety of species. Human activities are evident but do not dominate the landscape. There is frequent interaction among visitors.

This management area generally features natural succession. Habitat is best suited to plants and animals of closed-canopied, hardwood forests with large trees, including bottomland species. A variety of tree species are present, including mixed bottomland hardwoods along rivers, streams, and lakes. Limited vegetation management is appropriate to create and improve habitat for wildlife and plant species within riparian corridors. Limited vegetation management includes maintenance of forest openings, wildlife habitat improvement for riparian dependent species, prescribed fire, or salvage and sanitation harvest when it is compatible with overall objectives.

Emphasize water based recreation opportunities such as canoeing, boating, fishing, waterfowl hunting, trapping, and nature watching. Viewing scenery, hunting, trapping, fishing, canoeing, boating, and trail use are key recreation activities. The Forest is generally accessible by canoe (on canoeable streams or lakes), foot travel, and vehicles on State and county roads.

The visual character of these areas emphasizes long corridors of big trees along rivers. In backwater areas of lakes and rivers, the areas have a big-tree character of bottomland hardwoods and riparian vegetation.

The Forest has portions of two U.S. Army Corps of Engineers reservoir shorelines included in the boundaries of this management area -- Monroe and Patoka.

Private lands in Management Area 2.4 are a high priority for acquisition on a "willing seller" basis as funds are available, or through the land exchange program.

Desired Condition for Eligible Wild and Scenic River Areas:

The Lost River and Little Blue River have been determined eligible for Wild and Scenic Rivers. This description applies to Federal lands within each river's corridor, and is designed to protect the potential classification and outstanding values of each river during this planning period.

The Lost River and Little Blue River will be protected from activities that could diminish or change the free-flowing character, water quality and recreational, scenic, heritage, wildlife, and other values.

Guidance

Maintain and Restore Sustainable Ecosystems

Allow limited management of vegetative communities to maintain suitable early successional habitat for wildlife.

Maintain some existing forest openings that have value for wildlife, vegetation, or recreation and are adjacent to roads or have administrative access.

As needed, conduct activities to reduce the spread and potential of insect and disease infestations.

Maintain and Restore Watershed Health

Avoid vegetation management or removal of trees on banks or in associated riparian areas except as necessary to manage threatened, endangered, sensitive, and management indicator species, restore natural wetlands, stabilize banks, develop and maintain access sites for recreation, or restore natural riparian vegetation, which provides shade or nutrients for aquatic communities.

When constructing aquatic habitat structures, allow for safe passage of canoes.

Limit new structures or roads, and avoid management activities on NFS lands within a river's corridor that might degrade rivers.

Provide for Recreation Use in Harmony with Natural Communities

∗ Limit average cumulative trail density to 2.0 miles per square mile or less. The density limit is a cumulative figure for the total Forest acreage for this management area. The density may be exceeded on any given piece of ground as long as it is not exceeded for that management area overall. These density limits are not intended to be a target for miles of a trail in a management area.

Construction of river or lake access points with parking, toilet facilities, garbage pickup, camping, and information boards and other amenities is permitted. Design access points to provide vehicle parking, protect the bank, screen vehicles from the view of river travelers, and facilitate authorized uses.

When possible, locate sanitary facilities outside of riparian corridors and provide drainage from parking lots away from the watercourse.

Dispersed or developed trailheads for mountain bicycle, hiking, and canoe access are permitted.

Trails for horses may pass through this management area but no trailhead specifically designed for horse use will be provided.

Eligible Wild, Scenic, and Recreational River Guidance

These additional Standards and Guidelines provide further protection to the eligible corridors.

* Water supply dams and diversions are prohibited. Water quality is to be protected at its current level, or improved where possible.

* Issuance of licenses or exploratory permits for hydroelectric power development will be opposed until a wild and scenic river suitability study is completed.

* Development of any activity that would diminish the free-flowing character, including but not limited to flood control dams, levees, or channelization, is prohibited within the river's corridors.

* Recreation developments within the scenic and recreational corridors will not be easily viewed from the river.

* New recreation facilities that maintain or enhance river values (such as primitive campsites) are permitted within the scenic and recreational segments.

  New transmission lines, gas lines, and water lines are discouraged. Where no reasonable alternative exists, additional or new facilities shall be restricted to existing rights-of-way.

MANAGEMENT AREA 2.8

Desired Condition of Management Area

The area is general forest with large areas of old forests and scattered openings associated with a variety of forest plant communities. A variety of tree species is present, but shade-tolerant species may dominate some forest communities over time. A natural variety of other tree species intermediate in shade tolerance is perpetuated, and in other forest communities they may dominate. This area provides a variety of forest types, reflecting different ecological sites and management activities. Openings in the canopy result in different canopy levels and animal communities associated with vertically diverse, shade-tolerant vegetation, as well as different successional stages of vegetation. There is a higher percentage of edge habitat in this management area than in most of the forest. Site-specific decisions result in many variations within this management area.

These areas include scattered blocks of NFS land. There is ample evidence of human activities, most of which blends well with the natural environment. Visual quality and recreation opportunities are protected and enhanced. Interaction among visitors is frequent.

Habitat in these areas is best suited to wildlife that uses large hardwood trees and a mosaic of different-aged hardwood forests. The desired condition of this area is to maintain 4 to 12 percent of the area in young forest habitat and up to an additional 3 percent as openings. The Forest manages the area primarily for plant and animal habitat diversity and timber harvest is an appropriate tool for use in this area.

Viewing scenery, hunting, fishing, dispersed camping, gathering forest products, horseback and mountain bike riding, and hiking are key recreation activities. Due to the diversity provided by the area, bird watching, berry picking, and mushroom gathering and other forest products are also common uses of this management area. Some of the areas are surrounded by private lands, but most are generally accessible by foot travel and State and county roads.

Large trees with a continuous canopy characterize much of this area. This area allows a wide variety of management techniques, each resulting in a slightly different visual character.

In areas of fragmented ownership, the visual character is that of islands of large diameter trees. There is often a visual distinction between private and NFS lands.

Guidance

Maintain and Restore Sustainable Ecosystems

- ∗ Limit temporary opening size in a group selection harvest to no larger than 3 acres.
- ∗ Limit temporary openings created by clearcut and shelterwood harvests to 10 acres.

A timber harvest can occur when the adjacent certified re-established stand has reached a height that is greater than 20 percent of the height of the surrounding vegetation.

Provide a variety of opening sizes in character with the landscape.

Blend openings created by harvest with the surrounding area. Distribute openings across the landscape to provide for biological diversity as well as visual and site considerations.

As needed, treat stand understories prior to harvest to promote advanced regeneration of desired plant species.

Consider crop tree release in young hardwood stands to promote oak survival, earlier mast production, forage production, and additional growth on desirable species.

Control grape, ivy, and other vines as necessary to ensure satisfactory regeneration and growth of the desired species. Perpetuate some vines to meet wildlife needs.

Retain a variety of hardwood species in timber stand improvement and thinning operations.

Conduct thinning, improvement cuts, and timber stand improvements.

Establish forest openings on newly acquired land as necessary to meet management area objectives.

Maintain and Restore Watershed Health

Restoring natural wetlands will be the highest priority to maintain and restore watershed health.

Provide for a Visually Pleasing Landscape

Woody debris resulting from vegetative management and prescribed burning should receive special treatment along the visual foreground of frequently traveled roads, trails, and streams to meet the visual quality objective.

Provide for Recreation Use in Harmony with Natural Communities

∗ Limit the average cumulative trail density to 2.5 miles per square mile or less. See the definition of cumulative trail density in Glossary (Appendix A).

Trails and trailheads for horses, mountain bicycles, and hiking are permitted.

Provide for Human and Community Development

Provide fuelwood to the public to better use wood left on the site after project implementation.

Allow for mineral development with no surface occupancy or disturbance in the Crawford Upland and Brown County Hills Ecological subsections.

MANAGEMENT AREA 3.3

Desired Condition of Management Area

This management area emphasizes diversity for wildlife species requiring a mix of early and late successional vegetative types and age classes. It is associated with a mosaic of forest conditions dominated by hardwood trees and their associated understory habitat. Horizontal and vertical diversity are present in the forest. Generally early and late successional stands are found in close proximity to each other to provide for those non-migratory species that require a mix of both of these habitats. Management is more intensive than in other management areas, but blends with the natural environment. There is a higher percentage of edge habitat created in this management area compared to other areas on the Forest. Site-specific decisions result in many variations within this management area.

This area will provide habitat for previously declining populations of wildlife, particularly Neotropical migrants, dependent on or associated with these habitat types. This management area will have the most concentrated areas of vegetative management activities, providing optimum habitat for many species.

Hardwood management is by even-aged methods, emphasizing a diversity of species such as ash, cherry, hickory, oak, yellow-poplar, and walnut to provide valuable habitat for wildlife and plant species. Vegetation management is more intense in this area than elsewhere in the Forest with as much as 16 percent of the forest in the 0-9 age class. Pine will also be harvested and the sites converted to native hardwoods.

To better provide specific requirements for a suite of wildlife species represented by species such as the ruffed grouse, yellow-breasted chat and American woodcock, even-aged harvest areas will not exceed 40 acres in size. The Forest manages the area primarily for plant and animal habitat diversity and timber harvest is an appropriate tool.

Maintained openings for wildlife are of a variety of sizes, well dispersed, and in character with the landscape. This management area also allows for maintaining and providing fishing lakes, marshes, ponds, and waterholes.

These areas include scattered blocks of NFS land. There is ample evidence of human activities, most of which blends well with the natural environment. Visual quality and recreation opportunities are protected and enhanced. Interaction among visitors is frequent.

Viewing scenery, bird-watching, hunting, and trail use are key recreation activities. The Forest is generally accessible by trails and a network of roads.

Guidance

Maintain and Restore Sustainable Ecosystems

* Limit temporary opening size in harvest areas to 40 acres or less.

A timber harvest can occur when the adjacent certified re-established stand has reached a height that is greater than 20 percent of the height of the surrounding vegetation.

Provide a variety of opening sizes in character with the landscape.

Blend openings created by harvest with the surrounding area. Distribute openings across the landscape to provide for biological diversity as well as visual and site considerations.

As needed, treat stand understories prior to harvest to promote advanced regeneration of desired plant species.

Consider crop tree release for young hardwood stands to promote oak survival, earlier mast production, forage production, and additional growth on desirable species.

Control grape, ivy, and other vines as necessary to ensure satisfactory regeneration and growth of the desired species. Perpetuate some vines to meet wildlife needs.

Retain a variety of hardwood species in timber stand improvement and thinning operations.

Conduct thinning, improvement cuts, and timber stand improvements.

Establish forest openings on newly acquired land as necessary to meet management area objectives.

Provide for a Visually Pleasing Landscape

Woody debris resulting from vegetative management and prescribed burning should receive special treatment along the visual foreground of frequently traveled roads, trails, and streams to meet the visual quality objective.

Provide for Recreation Use in Harmony with Natural Communities

* Limit the average cumulative trail density to 2.5 miles per square mile or less. See the definition of cumulative trail density in Glossary (Appendix A).

Trails and trailheads for horses, mountain bicycles, and hiking are permitted.

Provide for Human and Community Development

Provide fuelwood to the public to better use wood left on the site after project implementation.

Allow for mineral development with no surface occupancy or disturbance in the Crawford Upland Ecological subsections.

MANAGEMENT AREA 5.1

Desired Condition of Management Area

This is the Congressionally designated Charles C. Deam Wilderness.

The area provides a recreation experience offering a degree of solitude, physical and mental challenge and risk, inspiration, and primitive recreation. Opportunities exist for non-mechanized recreational activities such as hiking, backpacking, camping, horseback riding, scientific study, hunting, fishing, and nature study.

There is little evidence of human development except remnants of past human occupation such as old roads, ponds, orchard trees and domestic vegetation, stone foundations, and cellar holes that have been overgrown and dilapidated by natural forces. Other than trails, designated campsites, user created campsites, and existing cemeteries and the roads to them, there is little evidence of past human activities, and these remnants will soon deteriorate and become overgrown by natural forces.

Natural succession is the dominant process within the Charles C. Deam Wilderness. In the future there will be extensive areas of old-growth vegetation. Some younger trees and openings occur as a result of natural processes. Timber harvesting is not appropriate in this area.

Interaction with other users is low.

The area primarily along the Tower Ridge Road and State Road 446 is not part of the Congressionally designated wilderness and will be managed under other management area guidance. These areas are:

- Manage the Blackwell Horsecamp and Pond under Management Area 7.1 guidance.
- Manage the 200-foot set-back east of State Road 446, the 100-foot set-back on either side of Tower Ridge Road, the 100-foot set-back along Hunter Creek Road, and other set-backs as identified in the legal description for the Charles C. Deam Wilderness under Management Area 6.2 guidance.

Guidance

Conservation of Endangered and Threatened Species Habitat

Manage habitat when consistent with wilderness management objectives and necessary to meet the needs of Federal endangered and threatened species.

Maintain and Restore Sustainable Ecosystems

* Suppress wildfires using non-motorized equipment. The Forest Supervisor may allow the use of motorized equipment.

Emphasize minimum impact fire suppression tactics to minimize short-term and long-term impacts on resources.

Use pesticides as necessary to prevent the loss of significant aspects of the wilderness, or to prevent significant losses to resource values on private or public lands bordering the wilderness. Pesticide use must be approved by the Regional Forester prior to application.

Emphasize the removal of nonnative invasive plant species, except those associated with heritage resources.

Protect Our Cultural Heritage

* On-site cultural resource interpretation will not occur.

  Off-site cultural resource interpretation of the Charles C. Deam Wilderness area sites may occur.

  Consider heritage resources an integral part of the wilderness and inventory, evaluate, retain, and preserve them whenever possible. These resources are available for scientific study, provided the manner of study is consistent with the concept of wilderness.

Provide for Recreation Use in Harmony with Natural Communities

* Motorized use or mechanized transport is prohibited except for emergencies approved by the Forest Supervisor and cemetery maintenance and access. Non-motorized wheelchairs used by persons with disabilities are permitted.

* Restrict horses and pack stock to those portions of the trail system specifically designated for their use. Prohibit off trail riding.

* Limit the trail system to 40 miles with no connecters to trails outside of the wilderness..

* Limit group size to no more than 10 people.

* There will only be five trailheads.

* Prohibit the use or possession of spray paint, and any paintball activity.

* Prohibit the discharge of firearms for target shooting or reasons other than hunting.

* Prohibit camping within 100 feet of ponds, lakes, trails, or streams except at designated sites. Camping throughout the rest of the wilderness is not restricted. Additional designated camping sites may be provided throughout the wilderness.

* Prohibit roadside parking and camping along Tower Ridge Road except at designated locations. Provide parking and signs at trailheads as needed.

  Emphasize refuse disposal through a pack-it-in and pack-it-out program.

  Maintain trails to a standard as low as possible while still protecting the resources and providing for visitor safety.

  Use native materials in trail construction to the extent possible. Generally utilize native and local materials in completing trail construction and reconstruction. Use nonnative materials if it is determined they are necessary to protect resources. Trail work includes but is not limited to: tread maintenance, diversion ditches, side-sloping and waterbars to divert water from trails and maintain adequate trail drainage, brushing and removing trees that fall across the trails, and removing and scattering vegetation from the tread area to make the materials unobtrusive. Make drainage structures look as natural as possible.

  Only minimal facilities are provided to prevent site deterioration and protect users from safety hazards.

  Design structures such as gates and signs on the periphery of the area according to wilderness policy so that they blend with the wilderness characteristics of the area.

  Designated sites may be provided with a wilderness style fire grate and wilderness privy.

  Use signs to close trails, protect the environment, and provide direction to help correct environmental damage when needed.

  Gathering of fruits, nuts, and mushrooms for private use may occur.

  Emphasize educational programs to help potential wilderness visitors understand wilderness philosophy and management and problem behaviors that affect the wilderness resource.

Provide a Useable Landbase

* Provide public access to cemeteries as stated in the act establishing the wilderness. Maintain access routes as necessary to prevent damage to adjacent lands and resources.

* Keep Tower Ridge Road and Hunter Creek Road open.

Provide for Human and Community Development

- ∗ Prohibit corridors for power projects, transmission lines, and other facilities, except as authorized by the act establishing the wilderness.

- ∗ Do not permit commercial grazing. Consider other special uses on an individual basis. Do not issue outfitter guide permits.

- ∗ Do not allow special use permit trails originating from adjacent private lands. To accommodate adjacent landowners, two of the five allowable trailheads are located for their convenience.

- ∗ Prohibit military maneuvers.

- ∗ The Charles C. Deam Wilderness has been formally withdrawn from mineral leasing. Mineral extraction is prohibited.

Coordinate with the military to restrict flights below 2,000 feet.

Vegetation manipulation occurs in conjunction with trail maintenance, cemetery maintenance, and maintenance of the roads to leading to the cemeteries (including Terrill Ridge Road).

Determine appropriate search and rescue methods for each individual search and rescue, considering primitive means first. The USDA Forest Service will take the lead in protecting wilderness values.

Allow research activities that comply with and promote wilderness values.

Research projects that would yield the same results inside or outside the wilderness should be conducted outside of the wilderness.

Limit interviews and research contact with visitors unless there is a benefit to the wilderness resource.

MANAGEMENT AREA 6.2

Desired Condition of Management Area

This management area creates a physical setting that provides an opportunity for solitude and a feeling of closeness to nature. The area is general forest land with the appearance of extensive stands of forest dominating the landscape.

Over time, extensive stands of natural-appearing forests of shade-tolerant species will characterize the area. Stands will be dominated by large mature trees and will provide habitat for late-successional species. Some younger trees and openings will result from natural causes. Removal of commercial vegetation is not appropriate, other than salvage or sanitation harvest when it is compatible with overall objectives.

Key recreation activities include nature watching, hunting, trail use, and backpacking. The forest is generally accessible by foot travel, and from county or state roads around the perimeter of these areas.

Roads in the interior of these areas are closed to public motorized vehicles.

Interaction between users is low, and there is only subtle evidence of other users. Tranquility and solitude are probable experiences.

Though Management Areas 6.2 and 6.4 are very similar, there are some differences between the two. These differences are:

- In Management Area 6.2 no forest openings, waterholes, or ponds will be created and these existing features will not be maintained and will revert naturally.
- Visual quality objectives are more restrictive in Management Area 6.2 since some vegetative management is allowed in Management Area 6.4.
- Some management of pine is allowed in Management Area 6.4.

Guidance

Maintain and Restore Sustainable Ecosystems

Allow identified research plots to remain active until the research study is complete, but only limited vegetation management could occur.

Provide for Recreation Use in Harmony with Natural Communities

* Limit average cumulative trail density to 2.0 miles per square mile or less. See glossary (Appendix A) for definition of cumulative trail density.

  Limit public motorized access to those roads on the periphery of the area, roads accessing active cemeteries, and roads under other jurisdictions. Use of other Forest roads is limited to resource management, administrative use, and foot travel.

  Trails and trailheads for horses, mountain bikes, and hikers are permitted.

  Minimize other recreation developments, and provide only those that prevent site deterioration or protect the user from health hazards.

Provide a Useable Landbase

* Limit construction of additional roads except for roads associated with development of trailheads, parking lots, and other recreation facilities around the perimeter of these areas.

MANAGEMENT AREA 6.4

Desired Condition of Management Area

This management area creates a physical setting that provides an opportunity for solitude and a feeling of closeness to nature. The area is general forest land with the appearance of extensive stands of forest dominating the landscape with some openings.

Over time, extensive stands of natural-appearing forests will characterize the area. Stands will be dominated by large mature and over-mature trees and will provide habitat for late-successional species.

Natural barrens, glades, wetlands, and dry forest may be restored and perpetuated. Some existing forest openings, ponds, and lakes may be retained. Old roads will grow in and blend with the natural setting. Commercial removal of vegetation is not appropriate, other than salvage or sanitation harvest when it is compatible with overall objectives.

Key recreation activities include nature watching, hunting, trail use, and backpacking. The forest is generally accessible by foot travel, and from county or state roads around the perimeter of these areas.

Roads in the interior of these areas are closed to public motorized vehicles, except seasonal use in Mogan Ridge.

Interaction between users is low, and there is only subtle evidence of other users. Tranquility and solitude are probable experiences.

Though Management Areas 6.2 and 6.4 are very similar there are some significant differences between the two. These differences are:

- In Management Area 6.2 no forest openings, waterholes, or ponds will be created and existing features will not be maintained and will revert naturally.
- Visual quality objectives are more restrictive in Management Area 6.2 since some vegetative management is allowed in Management Area 6.4.
- Some management of pine is allowed in Management Area 6.4.

Guidance

Maintain and Restore Sustainable Ecosystems

Retain the currently maintained openings at Mogan Ridge, Lukes Knob, and Felknor Hollow.

Natural barrens, glades, wetlands, and dry forest that contain sensitive plant communities may be restored and perpetuated.

Allow timber stand improvement to hasten the conversion of pine stands to hardwood stands.

Maintain and Restore Watershed Health

Maintain existing ponds, lakes, and wetlands.

Provide for a Visually Pleasing Landscape

To the extent feasible, maintain visual quality objectives along most streams, trails or roads at a minimum of retention.

Provide For Recreation Use in Harmony with Natural Communities

* Limit average cumulative trail density to 2.0 miles per square mile or less. See glossary (Appendix A) for definition of cumulative trail density.

Limit public motorized access to those roads on the periphery of the area, roads accessing active cemeteries, and roads under other jurisdictions. Use of other Forest roads is limited to resource management, administrative use, and foot travel.

Trails and trailheads for horses, mountain bikes, and hikers are permitted.

Minimize other recreation developments, and provide only those that prevent site deterioration or protect the user from health hazards.

Provide a Useable Landbase

* Construct no new roads unless they would be associated with the development of recreational facilities such as, but not limited to, trailheads, parking lots, or other developments.

* Retain administrative access to existing forest openings at Lukes Knob and Felknor Hollow. Continue to keep these roads closed to public access.

Open the main east-west gravel road through Mogan Ridge that begins at Old State Route 37 to public access during fall deer hunting seasons between the approximate dates of October 1 to January 1 for purposes of managing deer populations.

MANAGEMENT AREA 7.1

Desired Condition of the Management Area

These areas provide for recreational facilities and developed sites. They include campgrounds, picnic areas, boat ramps, swimming beaches, and other areas intended to serve large numbers of people.

These areas vary in size, and the Forest collects user fees at most of them. Use in these areas is high-density, destination-type use.

The area contains a variety of forest types, ages, and size of timber stands. The emphasis is on maintaining large-diameter trees where possible. These areas provide a small number of shrub and herbaceous openings. Vegetative management maintains or enhances existing recreation, road and utility corridors, wildlife habitat, education, watershed values, and visitor safety.

Favor treatment of vegetation on transmission line right-of-ways to improve wildlife habitat and perpetuate a variety of native plant species and communities. Manage plant and animal habitats, including habitat improvements, to enhance visitor enjoyment and maximize sightings while protecting the habitats and populations.

Manage vegetation to ensure the long-term viability, safety, and attractiveness of the area. In these areas, focus vegetative management on hazard tree removal; control of nonnative invasive species; flower, nut, or berry production; scenic enhancement; and specific area objectives. Mowing is common in high-use areas.

Developments are evident and may dominate the landscape. Design, building materials, and placement of facilities and structures are such that they are in harmony with the environment. Accessible facilities are provided.

Management Area 7.1 recreation areas include: Blackwell Horse Camp, Blackwell Pond (Brooks Cabin), Buzzard Roost, Celina Lake, German Ridge, Hardin Ridge, Hickory Ridge Fire Tower, Hickory Ridge Horse Camp, Indian Lake, Mano Point, Saddle Lake, Shirley Creek Horse Camp, Springs Valley, Tipsaw Lake, and Youngs Creek Horse Camp.

The transportation system is designed and constructed to safely and comfortably accommodate both specialized recreation vehicles and associated service vehicles.

The visual character of these areas reflects a higher percentage of open land than is generally found in the Forest, intermingled with trees, trails, roads, powerlines, buildings, and parking lots. The sights and sounds of humans are acceptable here, and a high degree of interaction between users is expected.

Guidance

Maintain and Restore Sustainable Ecosystems

- * Rehabilitate sites and regulate use, to provide erosion control and minimize soil compaction.

  Apply pesticides to control undesirable terrestrial and aquatic vegetation such as but not limited to woody vegetation on dams, poison ivy, Asian milfoil and stinging nettles and to control stinging insects, ticks, or chiggers when needed.

  Maintain vegetation diversity and increase diversity using prescribed fire techniques.

  Permit tree removal when appropriate, for purposes such as safety, facility expansion, vista maintenance, and site maintenance.

  Trees may be cut to promote growth and vigor and to prevent insect and disease infestation.

Protect Our Cultural Heritage

  Encourage on-site interpretation of heritage resources.

Provide for a Visually Pleasing Landscape

- * Visual quality objectives shall meet modification standards or better, within recreation area boundaries.

- * Manage visual quality objectives for forested areas adjacent to entrance roads and trails, and around associated lakes as far as the foreground limit as partial retention or better.

  Provide and maintain scenic vistas where appropriate.

  In developed recreation areas, there may be evidence of routine maintenance, such as mowing grass, pruning brush and trees, maintaining scenic vistas, or removing hazard trees.

Provide For Recreation Use in Harmony with Natural Communities

  Provide trailheads where feasible.

  Prohibit paintball activity.

Design new recreational developments to minimize health and safety problems, protect the environment, complement recreational opportunities, and provide access.

As needed and feasible, include facilities such as beaches, boat ramps, cabins, electricity, fish cleaning stations, flush toilets, hardened campsites, hot showers, parking lots, roads, picnic shelters, sewer or dump stations, water, and user conveniences at developed sites.

Design developments oriented to pedestrians. Design trail access to encourage walking between sites.

Design roads and trails to accommodate the high-density recreation use and related activities associated with the area.

Provide and maintain hiking, horse, mountain bicycle, interpretive trails, and service trails where applicable.

Permit hunting except within the marked recreation area boundaries. Hunting may be permitted within the boundaries if conditions warrant and line officer approves.

Fees may be charged.

Provide a Useable Landbase

Roads in certain areas of developed sites may be closed to allow for recreation site rehabilitation or to concentrate use during off-season to provide services more efficiently.

Provide for Human and Community Development

* Provide and maintain buildings and structures for recreation opportunities. Emphasize visually appealing facilities and safety.

* Dispose of solid waste generated from developed sites at approved sanitary landfills.

Recycling may be provided.

Clearly mark developed recreation area boundaries.

Make dead and down wood available for firewood whenever feasible.

Bury utility lines and pipelines when possible.

MANAGEMENT AREA 8.1

Desired Condition of Management Area

These are the Research Natural Areas (RNAs). This designation allows unique ecosystems to follow natural processes for scientific purposes. Research may be conducted in these areas to improve understanding of natural processes and to increase the benefits from our forests.

The Hoosier has one Research Natural Area, the Pioneer Mothers Memorial Forest, an 88-acre old growth hardwood forest.

The RNA program is a cooperative partnership with Forest Service Research. RNA's require preparation of an Establishment Record, approved by the Forest Supervisor and the Research Station Director. The Chief of the Forest Service has approval authority to designate these areas. No RNA's are proposed at this time. The Forest Supervisor and Station Director have responsibility for record keeping, recommending, reviewing, and approving research and management activities in RNA's.

These nationally significant areas must meet one or more of the following criteria:

- Contributes to the diversity of plant communities and wildlife habitat.
- Typifies important forest, shrubland, grassland, alpine, aquatic or geologic types.
- Represents special or unique characteristics of scientific interest and importance.
- Helps carry out provisions of laws, such as providing habitat for endangered species.
- Protects or maintains special aquatic, geologic, or heritage resources or potential natural communities.

The rare or outstanding values of the areas are the primary consideration. Other resource values and uses are secondary to the protection of the area's special values for public education and enjoyment.

Each research natural area has a specific management plan developed for management of the area. Vegetation management occurs if it is compatible with the purpose of the designation and is addressed in the management plan for the specific area. Commercial timber harvest is not an appropriate tool.

Recreation uses are subject to the regulations that designated the specific areas. Determine access, road construction, reconstruction or closure needs during specific research natural area management plans.

Guidance

Maintain and Restore Sustainable Ecosystems

* Use pesticides if they are compatible with the management plan for the area.

  Protect and preserve to the extent possible the natural condition of the forest or other qualities identified as the reason for its designation, while conducting research within the direction of the management plan written for the area.

Provide for Recreation Use in Harmony with Natural Communities

* Prohibit mountain bike and horse use.
* Prohibit hunting and trapping.
* Prohibit camping.
* Prohibit paintball activity.

  Limit developments to prevent site deterioration or protect the user from health hazards. Developments are subject to the regulations designating the area.

  Permit hiking trails if they are consistent with guidelines established in the RNA management plan.

Provide a Useable Landbase

Limit public motorized access to those roads on the periphery of the area.

Provide for Human and Community Development

* Permit only those special uses and utility corridors that meet the intent of the management plan for the area.

MANAGEMENT AREA 8.2

Desired Condition of Management Area

These are designated special areas, which include unique or unusual botanical, ecological, geological, scenic, historic, prehistoric, or zoological values and other areas which merit special recognition and management. Management of these areas will emphasize the protection, perpetuation, or restoration of their special features and values. Management of these areas will emphasize management for Federally listed threatened, endangered, and proposed species, as well as Regional Forester sensitive species and State listed species if the species or habitat is present or has the potential to exist in the specific area.

The special areas included in Management Area 8.2 guidance as of 2006 are:

Beaver Creek	Horse Mill Branch
Browning Hill	Huron Woods
Boone Creek	Luke Knob
Buzzard Roost	Oil Creek
Carnes Mill	Pioneer Mother Memorial Forest*
Clover Lick	Plaster Creek
Deer Creek	Potts Creek
Faucett Chapel	Rockhouse Hollow
Grease Gravy	Stinking Fork Creek
Gypsy Bill Allen	Tar Springs
Harding Flats	Tincher
Hemlock Cliffs	Wesley Chapel

*Not to be confused with the 88-acre RNA (Management Area 8.1) of the same name.

These regionally or locally significant areas must meet one or both of the following criteria:

- Be representative of unique or unusual geological, ecological, cultural, or other scientific values; or
- Have the potential to be a regional or national landmark based on natural or cultural values.

Special areas occur throughout the forest where there are special characteristics. They include cultural, historic, scientific, and scenic values as well as a variety of ecosystems and forest conditions. Plant and animal species and communities vary depending upon the characteristics of each area.

The rare or outstanding values of the areas are the primary consideration. Other resource values and uses are secondary to the protection, maintenance, and restoration of an area's special values for public education, enjoyment, and study.

Each special area has an establishment record (Appendix H).

A management plan will be prepared for each special area. Management plans identify special features of each area, area boundaries, desired conditions of the area, and specific management direction to achieve desired conditions. A special area may be designated an 8.2 Management Area before a management plan is finalized for it. With appropriate analysis and public involvement, management activities essential for perpetuation of special features, such as unique ecosystems, may take place before final development of an area management plan.

Guidance

Maintain and Restore Sustainable Ecosystems

Inventory and evaluate biological diversity of special areas and adjoining ecosystems to the extent practical. Apply information from the inventory and evaluation to refine area management needs and plans.

Restore disturbed sites to native plant communities typical of the area. Tools applicable in these areas include, but are not limited to, burning, harvesting, seeding, and planting.

Permit research in special areas. Harvest of trees associated with research plots is acceptable.

Control or eliminate, as practical, invasive species of plants with emphasis on nonnative species. This includes native species that are degrading the area (for example, Eastern redcedar in barrens communities). Vegetation control methods include prescribed burning, girdling, cutting, herbicide use, and hand pulling.

Provide for Recreation Use in Harmony with Natural Communities

Provide recreational use that is consistent with protecting the area's unique values. Determine appropriate uses in the management plan for each area based on individual site characteristics and public interest.

Where signs and other developments are used, design and construct them to limit the impacts on significant site features. Determine the compatibility of trails for hiking, mountain bike, and horse use in the special area management plan. Allow the continued use of pre-existing designated trails unless monitoring determines unacceptable resource damage is occurring from such use.

Provide a Useable Landbase

Limit public motorized access to those roads on the periphery of the area. Limit Forest Service road use to administrative use and foot travel.

May provide parking for access on the periphery of each area. Keep developments to a minimum.

Provide For Human and Community Development

Prohibit vegetation management unless necessary to maintain the vegetative character or ecosystem for which the area was established.

Permit pre-existing special uses and utility corridors. Permit new construction of utility corridors and special uses within existing roads and right-of-ways. Prohibit new development outside of the existing utility or road corridors.

MANAGEMENT AREA 8.3

Desired Condition of Management Area

This management area provides for research and scientific study of forest ecosystems. The only experimental forest on the Forest is the Paoli Experimental Forest, a 632-acre area located southwest of Paoli on the Tell City Ranger District.

The Forest Supervisor, Research Station Director, and Regional Forester may cooperatively establish further areas for research. The Forest is not considering any additional experimental forests at this time.

Research at the Paoli Experimental Forest takes an integrated, multidisciplinary approach to research problems in the Central Hardwood Forest from the landscape level to individual stand management.

Guidance

Maintain and Restore Sustainable Ecosystems

Manage the area as needed to complete the assigned research.

Provide and maintain wildlife habitat developments.

Provide for Recreation Use in Harmony with Natural Communities

Do not encourage recreational uses, and provide no developments or facilities for recreation use. Allow foot travel.

Provide a Useable Landbase

Generally, keep this area closed to motorized public vehicles.

Provide for Human and Community Development

Vegetation management will be used to meet research objectives.

MANAGEMENT AREA 9.2

Desired Condition of Management Area

This management area emphasizes the protection and maintenance of environmental values. This designation serves as a holding category until further study and recommendations on specific designation can be made. There are currently no Management Area 9.2 areas on the Forest.

Forest-wide guidance will be followed and individual guidance will be developed as needed.

Chapter 4

MONITORING, EVALUATION, AND RESEARCH

This chapter describes how monitoring and evaluation requirements will be met. Monitoring and evaluation ensure that Forest Plan direction is being carried out and assess the quality of Forest Plan implementation (Table 4.1). In the process of evaluating the Plan, we also become aware of some modifications and changes needed. Monitoring results may be the catalyst for plan revisions or amendments.

The chapter also briefly discusses future research needs on the Forest.

Monitoring

Monitoring is carried out to observe or record the results of management actions. This consists of collecting information from selected sources, usually on a sample basis. There are three levels of monitoring:

- Monitoring Implementation - Was it done right?
  This determines if prescriptions, projects, and activities are implemented as designed and in compliance with Forest Plan goals and guidance.
- Monitoring Effectiveness - Did it work?
  This determines if prescriptions, projects, and activities are effective in meeting management goals and direction.
- Validation Monitoring - Is the guidance appropriate?
  This determines if the initial data and assumptions used in developing the Plan were correct or if there is a better way to meet forest planning regulations, policies, and goals.

A monitoring and evaluation matrix (Table 4.2) contains the items to monitor and evaluate as the Forest Plan is implemented.

The monitoring requirements are designed to meet the legal requirements in 36 CFR 219 (1982). As the Forest Plan is implemented, more specific monitoring direction will be included in the program of work and project plans. This program will be responsive, dynamic, and updated as projects are proposed and added to the program of work for a particular fiscal year.

The monitoring program will be conducted to include a consideration of the effects of national forest management on land, resources, and communities adjacent to or near the Forest, and the effect upon national forest management from activities on nearby lands managed by other government agencies or under the jurisdiction of local governments. The program will be re-evaluated at least every five years (36 CFR 219.7 (f)). Monitoring and evaluation requirements will provide a basis for a periodic determination of the effects of management practices (36 CFR 219.11 (d)).

Evaluation

An evaluation and summary of monitoring results will be written and published in an evaluation report. The report includes:

- A concise display of the results of monitoring and a statement of recommended actions, including changes in management direction, revisions, or amendments to the Forest Plan.
- A summary of available information on management indicator species (MIS) or comparable species.
- A summary of other agency monitoring activities which have a bearing on Forest management.
- A summary of accomplishments and expectations for future activities.
- An update of research needs and accomplishments.
- A summary of large scale or significant projects or programs such as storm recovery.

The report will be made available to the public. Public participation is encouraged in monitoring programs, including involvement of volunteers and partners in the actual monitoring procedures.

Five years after the Forest Plan is approved, the Forest Supervisor will review the land conditions to determine whether conditions or demands of the public have changed significantly (36 CFR 219.10 (g)). Significant changes may trigger a plan amendment or revision.

In 10-15 years, during the revision of the Forest Plan, an overall review of the annual evaluation reports will be used as one measure to analyze the management situation and identify possible needs for change in management direction. This analysis will be submitted to the Regional Forester for review prior to Plan revision.

Management reviews are also an important part of the monitoring and evaluation process. Interdisciplinary teams as well as the Forest Supervisor and Regional Forester perform management reviews periodically. These reviews may focus on information which surfaces through the monitoring and evaluation process.

Table 4.1

MONITORING FRAMEWORK

Forest Plan Monitoring (Chapter 4)	Monitoring and Evaluation Program (2-3 Year Schedule)	Monitoring and Evaluation Report
Broad and Strategic. Provides the monitoring requirements and focuses on what is needed to monitor the Forest Plan. It provides the overall monitoring strategy including specific questions that need to be answered, what will be monitored, timetables for reporting, and other information.	Focused and Technical. Describes how, where, and when to accomplish the monitoring prescribed in the Forest Plan. It provides the specific methods, protocols, and analytical procedures. This program is flexible and is modified by the Forest leadership team in response to new information, emerging issues, species concerns, and budgetary considerations. Identifies precisely what will be monitored and by whom for the upcoming 2-3 years.	Specific, Technical, and Prescriptive. The Forest interdisciplinary team reviews the current year's projects and collects and documents the monitoring and evaluation results. These findings are documented in a report along with recommended changes to project design or implementation, the Monitoring and Evaluation Program, the Forest Plan, or Forest Service Manual or Handbook.

Monitoring and Evaluation Program

Specific monitoring items, measuring frequencies, methodologies, precision, and reliability are identified in the annual Monitoring and Evaluation Plan.

Table 4.2

MONITORING AND EVALUATION MATRIX

Monitoring Requirement or Question	**Method**	**Resource to be Measured**	**Frequency**	**Reliability**
PROGRAM ACCOMPLISHMENTS				
Have objectives been met by a quantitative comparison of outputs and services with those projected by the *Forest Plan?*	Review annual accomplishment report	Various	Annual	High
Determine research opportunities, identify State and Private Forestry (S&PF) support and coordinate needs.	Various	Various	Annual	Good
CONSERVATION OF THREATENED AND ENDANGERED SPECIES HABITAT				
Monitor effects of management on critical habitat for threatened and endangered species and ensure compliance with recovery plan objectives.	Various	T&E Species	As determined by recovery plans	High
Monitor the extent Forest management is contributing to the conservation of threatened and endangered species and moving toward short term (10-20 years) and long term (100 years) objectives for their habitat conditions and population trends.	Various	T&E Species	As determined by recovery plans	High
In cooperation with the USDI Fish and Wildlife Service, track the status of Indiana bats on the Forest by monitoring: • Occupied hibernacula to assess changes in population numbers, changes in microclimate, and the effectiveness of protective	Various	Indiana bat populations and habitat	Annual	Moderate

Monitoring Requirement or Question	**Method**	**Resource to be Measured**	**Frequency**	**Reliability**
structures currently in place • Habitat use at all sites where Indiana bats are documented on the Forest will be quantified at both the local and landscape level using GIS or comparative software. • Annual incidental take	Various	Indiana bat populations and habitat	Annual	Moderate
Determine the number of suitable roost trees available on the Forest.	Forest Inventory Assessment data	Roost trees	1-5 years	Low
MAINTAIN AND RESTORE SUSTAINABLE ECOSYSTEMS				
Is this Forest complying with guidance outlined in *Forest Plan*?	On the ground review	Soil and water resources, and regeneration areas	Annual	High
Has the land suitability classification changed since identified in the *Forest Plan?*	Review acres identified as suitable	Suitable and unsuitable acres	Every 10 years	Moderate
Are insect and disease population levels compatible with objectives for restoring or maintaining healthy forest conditions?	Survey for insects and disease damage	Affected trees	Ongoing with USDA-FS S&PF and Indiana Department of Natural Resources (IDNR)	High
To what extent is Forest management controlling undesirable occurrences of fire, insect, and disease outbreaks?	See above, plus monitor fire reports	Occurrences	Annual	High
What level of prescribed fire should be used to maintain desired fuel levels or mimic natural processes, maintain and improve vegetative conditions, or restore natural processes and functions to ecosystems?	Monitor areas prescribed burned and areas where a fire regime is thought to be appropriate	Affected acres	1-5 years	Moderate

Monitoring Requirement or Question	Method	Resource to be Measured	Frequency	Reliability
To what extent is Forest management contributing or responding to air quality effects on ecosystems, human health, or human enjoyment?	As identified in regulations	Air in vicinity of prescribed burns	Annual *	Moderate
Are harvested lands adequately restocked within 5 years?	Stocking surveys on regenerated acres	Reforested acres	3rd year after activity	High
Are the effects of Forest management resulting in significant changes to productivity of the land?	Varied	Acres affected by management	Annual	Moderate
Have there been changes in cave environments?	Various	Caves	Various *	Moderate
Is the right mix of even-aged and uneven-aged management being used and in the correct forest types to meet objectives?	Monitor size limits of harvest areas	Timber sales	Annual and compare to restocking surveys	Monitor
Does location and shape of even-aged harvests blend with the natural terrain?	Use ELTP boundaries for layout	Regenerated areas	Annual *	High
To what extent are management, natural disturbances, and subsequent recovery processes changing the vegetation composition, special patterns, and structure? Are conditions moving toward short-term and long-term objectives?	Vegetative inventory	Various	Every 5 years	Moderate
Are appropriate harvest methods, management intensity, and utilization standards being used?	On harvest areas, sale administrators will monitor utilization. Stocking surveys will determine if harvest methods was successful.		As EA's and Activity Reviews are done *	High
What are the population trends of management indicator species?	Done in cooperation with IDNR	MIS populations by their relationship to habitat changes	5 years	Moderate

Monitoring Requirement or Question	Method	Resource to be Measured	Frequency	Reliability
Are even-aged management practices benefiting wildlife species?	Done in cooperation with IDNR	Ruffed grouse populations by their relationship to habitat changes	5 years	High
What is the status of oak and hickory on established regeneration plots dating to 1985 Purdue study?	Monitor species data	Plot data on tree species from 1980's clearcuts	Every 15 years	High
To what extent is Forest management contributing or responding to populations of terrestrial or aquatic non-native invasive species that threaten native ecosystems?	Monitor trends in known populations of invasive species	Invasive populations	Monitor some populations	Moderate
How will diversity be affected by various mixes of resource outputs and uses? Ensure that the diversity of plant and animal communities is at least as great as that which would be expected in a natural forest and that reductions in diversity are prescribed only where needed to meet overall multiple use objectives.	Inventory population data on plant and animal communities on established plots or transects	Species observed	5 years	Moderate
MAINTAIN AND RESTORE WATERSHED HEALTH				
To what extent is Forest management affecting water quality, quantity, flow timing, and the physical features of aquatic, riparian, or wetland ecosystems?	Sampling of water features on Forest	Streams, riparian and wetland areas	Various *	Moderate
Have the soil and water mitigation and protection measures been effective as applied to all management activities?	Measure soil compaction and movement	Soil and water mitigation and protection measures	Various Activities Annual *	Moderate

Monitoring Requirement or Question	Method	Resource to be Measured	Frequency	Reliability
PROTECT OUR HERITAGE RESOURCES				
Are mitigation and protection measures correctly applied for ground disturbing activities?	Monitor project design and visual inspection of project areas	Number of heritage sites or projects	Annual	High
Are heritage resources being damaged by vandalism?	Visual inspection of site area	Number of heritage sites	Annual	High
PROVIDE FOR A VISUALLY PLEASING LANDSCAPE				
Is the Forest evaluating the visual resource?	Monitor project design and implementation	Forest-wide landscapes	Annual *	High
PROVIDE FOR RECREATION IN HARMONY WITH NATURAL COMMUNITIES				
Are we limiting and distributing visitor use in wilderness in accord with periodic estimates of the maximum levels of use that allow natural processes to operate freely and so as not to impair the values?	Monitor wilderness resources according to Wilderness Implementation Schedule	Entire wilderness	5 years	High
Consideration of establishment of physical facilities, use regulations, and recreation opportunities responsive to current and anticipated user demands.	Monitor public feedback to trailhead, campground, sign, and restroom designs and functions, including accessibility.	Forest-wide	Annual	High
Is trail use planned and implemented to protect land and other resources, promote public safety, and minimize conflicts, with other users of the NFS lands?	Monitor selected trails. Evaluate the type and amount of use.	Forest-wide	Annual	High

Monitoring Requirement or Question	Method	Resource to be Measured	Frequency	Reliability
PROVIDE A USEABLE LANDBASE				
Does the Forest's land adjustment program support and enhance the Plan's desired conditions and goals and contribute to efficient and effective stewardship?	Monitor public feedback on land adjustment activities	Comments and issues identified	Ongoing	Moderate
Are temporary roads closed and revegetated within 10 years of contract or permit termination?	Inspect temporary roads after closure or permit termination	Miles of temporary road	5 years	High
To what extent is the Forest, in coordination with other public agencies, providing safe, cost effective, minimum necessary road systems for administrative and public use?	Meetings with public agencies and following FSH and FSM guidelines	Miles and standards of roads	*	High
PROVIDE FOR HUMAN AND COMMUNITY DEVELOPMENT				
Are there emerging issues, concerns, and opportunities?	Monitor public comments and contacts in community	--	Ongoing	Moderate
Have output levels and mixes of goods and services demanded by society changed significantly when compared with those levels projected by the Forest Plan?	Demand analysis	Various resources	5 years	Moderate
How do actual costs of carrying out planned management compare to cost estimates?	Budget analysis	Unit costs	Annual	High
Are timber sales meeting Forest Plan ASQ?	Annual sale report	Ccf sold	Annual	High

* As determined by Environmental Assessments, Activity Reviews, or Program Reviews.

Steps in monitoring and evaluation and procedures to update the Forest Plan

Monitoring

- Forest staff assistance trips
- Management reviews
- Routine observations
- Site-specific observations by specialists
- Accomplishment reports
- Discussion with other agencies and public users

Evaluation

- Annual evaluation of monitoring results by interdisciplinary team and Forest staff
- Forest staff review evaluation on an annual basis
- General management review based on identified problems, generally on a 5-year basis
- Regional management reviews as needed
- Overall evaluation of annual reports by Forest Supervisor

Recommendations

- Monitoring and Evaluation Team conducts annual review and evaluation with recommendation to Forest Supervisor
- Regional management reviews recommendation to Regional Forester
- Forest Supervisor makes recommendation for Plan revision or as needed for a significant amendment

Decision

- Forest Supervisor's decision on nonsignificant amendments to Plan, documented in evaluation report
- Forest Supervisor's decisions on a need to recommend significant amendment or revision
- Regional Forester’s decision on the need for significant amendment or revision

Research Needs

Research and monitoring are related activities that allow for adaptive management of national forests. Research activities include planning, design, quality control, and peer review of studies, and relatively rigid publication standards. Monitoring, in contrast with research, is generally conducted under less controlled conditions and results are often more general. Research needs for management of the National Forests are identified during the planning process and reviewed periodically during monitoring and evaluation of the implemented Forest Plan.

Research is often done on an ad hoc basis as opportunities arise with other agencies or universities. Some needs, included here, have been identified during forest planning; other needs which surface as a result of monitoring will be reported in the annual Monitoring and Evaluation Reports.

Conservation Of Threatened And Endangered Species Habitat

Research is needed to determine the distribution, abundance, genetics, ecology, and needs of endangered and threatened species.

Maintain And Restore Sustainable Ecosystems

Native plant communities need to be better defined in terms of floral composition, distribution, genetics, abundance, site relationships (soil, slope, and aspect), indicator plants, and ecological requirements. The ecological classification system needs further development and analysis to increase understanding of natural communities, particularly site relationships affecting population distribution and abundance.

Research is needed to determine the current and historic distribution and relative abundance of animal species and communities and their ecological relationships with plant communities.

Research is needed to determine the effects of management for early successional forest habitat on biological diversity. Better understanding of the needs of young forest plant and animal species and communities, including Neotropical migrant birds, is a specific research need.

Effects need to be determined on biological diversity of management for extensive, closed-canopied forest; of forested corridors which link forest areas across the landscape; of old growth forests; and of restoration of natural plant communities. Better understanding of the needs of forest interior plant and animal species and communities, including Neotropical migrant birds, is a specific research need.

Research could focus on defining conditions that cause oak to regenerate well within those ecosystems (ECS units) where oak is a natural member of that plant community or successional or seral stage. Research needs to identify methods to ensure desired amounts of oak regeneration and the role of natural species selection in determining the final stand composition.

Better information needs to be developed on what plant species can coexist in a stable community and what appropriate control objectives and activities should be undertaken when these communities become out of balance or are invaded by exotic species. Research is needed to determine what native plants are best suited to what activities and how they can best be established.

More information on vegetation response to prescribed fire is needed to help managers make better decisions for timing and uses of prescribed fire in central hardwoods management. Determine the effects of prescribed fire and various silvicutural treatments on animal and plant species in the area, including beneficial effects to native plants and potential adverse effects to nonnative plants, animals, and karst systems.

Maintain And Restore Watershed Health

Research is needed on the effect of different types of stream crossing structures on aquatic species and stream channel hydrology.

Research is needed on presettlement stream geomorphology and hydrological function.

Protect Our Heritage Resources

Conduct non-project driven surveys to locate heritage resources on the Forest. Work toward completing surveys for all NFS lands.

Continue research of rock shelters including those at the end of their developmental cycle, i.e. those that are collapsed or have completely filled in. Because these may contain the oldest deposits, research will contribute to our understanding of the earliest humans.

Develop heritage contexts as an aid in evaluating the significance of heritage resources. Focus research on each context and identify prominent examples for intensive excavation. Interpret a range of these sites.

Emphasize oral history interviews of local elderly people to record unwritten history.

Research and compile a Forest history to document our contribution to the region and celebrate our organizational past.

Provide For A Visually Pleasing Landscape

Research is needed on the role of the visual management system and its effectiveness in national forest management.

Provide For Recreation In Harmony With Natural Communities

The Forest, working in partnership with interested groups, has the opportunity to develop many options for recreational users. More specific information is needed on current use and demand for recreation facilities now present on the Forest, along with an analysis of developing trends, and emphasis on areas needing future development.

The Forest also needs information on how to best market or de-market recreational opportunities available on the Forest to provide services to a higher percentage of the public.

Provide A Useable Landbase

No research needs identified at this time.

Provide For Human And Community Development

Effects of predicted long-term climate change on biological diversity in the Forest need to be monitored.

Management techniques need to be refined for acceptable hardwood regeneration, harvest schedules, and yield predictions for both even- and uneven-aged management.

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Appendix A

GLOSSARY

Acid Rain – The deposition of a variety of acidic pollutants in either wet (rain, snow, or fog) or dry forms (gas or dust particles).

Acid-Seep Spring – Springs or seeps form at the base of a slope where groundwater intersects with the land. Acid results from the soil type characteristics or from acid mine drainage.

Acid Soil - A soil with a pH value less than 7.0.

Alliance – A level of the National Vegetation Classification of existing vegetation. An alliance is a terrestrial plant community that is distinguished from other alliances by dominant or diagnostic species found in the canopy layer. The concept of an alliance is similar to a "cover type." A cover type includes one or more alliances when the dominant species are widespread over varied environmental conditions.

Allowable Sale Quantity (ASQ) - The quantity of timber that may be sold from the area of (ASQ) suitable land covered by the forest plan for a time period specified by the plan. This quantity is usually expressed on an annual basis as the "average annual allowable sale quantity."

All-Weather Road versus Dry-Weather Road

> ***All-Weather Road*** - A road capable of being used by two-wheel drive sedans or similar vehicles during all weather conditions, with only minor or short-term restrictions, such as following heavy snows. On the Hoosier, all-weather roads would normally be either aggregate surfaced or paved.
>
> ***Dry-Weather Road*** - A road that normally can be used by two- and four-wheel drive trucks and logging equipment without causing environmental damage only during dry weather or during the drier seasons of the year. On the Hoosier, dry-weather roads would normally be unsurfaced dirt roads or roads surfaced with native materials only.

Alternate Roost – While primary roosts typically house substantial aggregations of female bats and their young, smaller numbers of these bats may use alternate trees as roosts depending on weather and ambient temperature. In general, while primary roosts are typically exposed to solar radiation, alternate roosts may be located beneath the forest canopy. Alternate roosts may be widely distributed across the landscape in relation to a maternal colony's primary roost or roosts; presumably this allows a maternal colony to select the most suitable microclimates or foraging area. Alternate roosts tend to be more variable in size than are primary roosts, a maternal colony may use as many as 33 alternate roosts in addition to a primary roost or roosts.

Aquatic Ecosystems - Stream channels, lakes, estuary beds; water; biotic communities; and the habitat features that occur therein.

Arthropod – Any member of a large group of invertebrate animals with jointed legs and a segmented body: the arthropods include crustaceans, arachnids, insects, and myriapods.

Aquatic passage – The ability for aquatic organisms to pass through a stream crossing structure.

Archaeological resource - Any material remains of prehistoric or historic human life or activities which are of archaeological interest and are at least 50 years of age, and the physical site, location, or context in which they are found.

ASQ - See Allowable Sale Quantity.

Barrens – Characterized by species of canopy trees tolerant of xeric conditions, which have a stunted, open-grown appearance, also characterized by the dominance of native warm-season grasses and prairie forbs, and, in glades, significant exposures of bedrock.

Basal Area – The cross sectional area of all stems of a species or all stems in a stand measured at breast height and expressed per unit of land area.

Benchmark - {A part of the analysis} to define the range within which alternatives can be constructed.

Benthic – Pertains to the plan and animal life whose habitat is the bottom of a sea, lake or river.

Best Management Practices (BMPs) – a practice or usually a combination of practices that are determined by a state or a designated planning agency to be the most effective and practicable means (including technological, economic, and institutional considerations) of controlling point and nonpoint source pollutants at levels compatible with environmental quality goals.

BF - See Board Foot.

Biological Diversity – The variety and abundance of life forms, processes, functions, and structures of plants, animals, and other living organisms, including the relative complexity of species, communities, gene pools, and ecosystems at spatial scales that range from local through regional to global.

Blind Valley - A valley that ends suddenly at a point where its stream disappears underground; some blind valleys have no present day streams.

BMPs – See Best Management Practices

Board Foot (BF) – The amount of wood contained in an unfinished board 1 inch thick, 12 inches long, and 12 inches wide. MBF - One thousand board feet. MMBF - One million board feet.

Bottomland – Lowlands along streams and rivers, usually on alluvial flood plains that are periodically flooded. These are usually forested and are sometimes called bottomland hardwood forests.

Canopy – 1. The foliar cover in a forest stand consisting of one or several layers. 2. The overhead branches and leaves of streamside vegetation.

Carrying Capacity –

> ***Ecological***: The maximum number or biomass of organisms of a given species that can be sustained or survive on a long-term basis within an ecosystem.
> ***Recreational:*** The number of recreation users an area can accommodate during a given period of time and still provide protection of the resources and satisfaction of the users.

Cave – Any naturally occurring void, cavity, recess, or system of interconnected passages beneath the surface of the earth or within a cliff or ledge and which is large enough to permit a person to enter, whether the entrance is excavated or naturally formed. Such term shall include any natural pit, sinkhole, or other opening which is an extensive of a cave entrance or which is an integral part of the cave. A significant cave is one which has been designated in accordance with 36 CFR 290.

Caver - One who explores caves as a sport.

Cleaning or Weeding – A release treatment made in an age class not past the sapling stage to free the favored trees from less desirable individuals of the same age class that overtop them or are likely to do so.

Clearcutting – 1. A stand in which essentially all trees have been removed in one operation – note depending on management objectives, a clearcut may or may not have reserved trees left to attain goals other than regeneration 2. A regeneration or harvest method that removes essentially all trees in a stand.

Cliffs or Overhangs – For the purposes of the Hoosier, these terms are defined as rock outcrop areas 15 feet or more in height and 100 feet or more in length.

Colluvial Soils – Mixed deposits of soil material and rock fragments accumulated near the base of steep slopes through soil creep, landslides, and local surface run off.

Commercial Thinning – Any type of thinning producing merchantable material at least equal to the value of the direct costs of harvesting.

Community – An assemblage of plants and animals living together and occupying a given area.

Cord - A stack of fuelwood, pulpwood, or other material that measures 4 x 4 x 8 feet or 128 cubic feet, including wood, bark, and empty space within the stack.

Corridor – 1. A linear strip of land identified for the present or future location of transportation or utility rights-of-way within its boundaries. 2. (Wildlife Corridors) The joining of fragmented habitats which helps to increase the gene flows between the individual habitats improving the fitness of species. Wildlife corridors are created as a means of conservation or general improvement of the environment.

Critical Habitat – 1. The specific areas within the geographic area occupied by a federally listed species on which physical and biological features are found that are essential to the conservation of the species and that may require special management or protection. 2. Specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of Section 4 of ESA, upon a determination by the Secretary that such areas are essential for the conservation of the species.

Crop Tree Release - A treatment designed to free young trees from undesirable, usually overtopping, competing vegetation.

Cumulative Effects – The combined effects resulting from sequential actions on a given area, note significant cumulative effects can result from individually minor but collectively important actions taking place over a period of time because of their being interconnected or synergistic.

Developed Recreation - Activities associated with man-made structures and facilities that result in concentrated use of an area. Examples are campgrounds and picnic areas.

Diameter at Breast Height (DBH, dbh) – The diameter of the stem of a tree measured at breast height (4.5 feet) from the ground.

Disk – A plow drawn by a tractor or skidder having one or more heavy, round, concave, sharpened, freely rotating steel disks angled to cut and turn a furrow, note a disk is used in site preparation or in the construction of firelines.

Dispersed Recreation - In contrast to developed recreation, these activities are associated with low-density use distributed over large expanses of land or water. When provided, facilities are more for protection of the environment than for comfort or convenience of the visitor.

Diversity - The distribution and abundance of different plant and animal communities and species within the area covered by a land and resource management plan.

Duff - The partially decomposed organic material on the forest floor beneath the litter of freshly fallen twigs, needles, and leaves.

Dry-Weather Road - See All-Weather Road.

Ecological Landtype (ELT) - An integrated mapping unit designed at a specific hierarchical level in the ECS. Typical size generally ranges from tens to hundreds of acres.

Ecoregion - A continuous geographic area having a relatively uniform macroclimate, possibly with several vegetation types, used as an ecological basis for management or planning.

Ecosystem – A spatially explicit, relatively homogeneous unit of the earth that includes all interacting organisms and components of the abiotic environment within its boundaries.

Edge – The more or less well-defined boundary between two or more elements of the environment, e.g., a field adjacent to a woodland or the boundary of different silvicultural treatments.

Edge Effect – The modified environmental conditions or habitat along the margins (edges) of forest stands or patches.

Effects – Include: (a) Direct effects, which are caused by the action and occur at the same time and place; (b) Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Endangered Species – Any species which is in danger of extinction throughout all or a significant portion of its range.

Ephemeral Stream - A stream or portion of a stream that flows only in direct response to precipitation, receiving little or no water from springs and no long continued supply from snow or other sources, and whose channel is at all times above the water table.

Erosion - The wearing away of the land's surface by running water, wind, ice, gravity, or other natural or anthropogenic agents, including such processes as gravitational creep and tillage; kinds of erosion include the following:

> ***Geological*** - The normal or natural erosion caused by geological processes acting over long geologic periods and resulting in the wearing away of mountains, the building up of floodplains, coastal plains, etc. Also called natural erosion.
>
> ***Erosion and sedimentation*** - Refer to two phases in the process of detaching material in one place, transporting and depositing in another. *Erosion* refers to the detachment and transport of material and *sedimentation* to its deposition. Particulate material is called *sediment* once transport has begun.

Even-aged Management - The application of a combination of actions that results in the creation of a stand in which trees of essentially the same age grow together. Managed even-aged forests are characterized by a distribution of stands of varying ages (and, therefore, tree sizes throughout the forest area). The difference in age between trees forming the main canopy level of a stand usually does not exceed 20 percent of the age of the stand at harvest rotation age. Regeneration in a particular stand is obtained during a short period at or near the time that a stand has reached the desired age or size for regeneration and is harvested. Clearcut, shelterwood, or seed tree cutting methods produce even-aged stands.

Exotic – A plant or species introduced from another country or geographic region outside its natural range.

Fauna – The animals of a specified region.

Fertility (Soil) – The quality of a soil that enables it to provide nutrients in adequate amounts and in proper balance for the growth of specified plants when other growth factors, such as light, moisture, temperature, and the physical condition of the soil, are favorable.

Fire Intolerant Species - A species with morphological characteristics that give it a higher probability of being injured or killed by fire than a fire-tolerant species, which has a “relatively low” probability of being injured or killed by fire.

Fire Management - All activities required for the protection of burnable wildland values from fire and the use of fire to meet land management goals and objectives.

Fire Tolerant Species - A plant species with morphological characteristics that give it a lower probability of being injured or killed by fire than a fire-intolerant species, which has a relatively high probability of being injured or killed by fire.

Floodplain – 1. A nearly level area situated on either side of a channel which is subject to overflow flooding. 2. As defined by Executive Order 11988, as amended, lowland and relatively flat areas adjoining inland and coastal waters including flood prone areas of offshore islands, including at a minimum, that area subject to a one percent (100 year recurrence) or greater chance of flooding in any given year.

Forage – Browse and herbage that is available either naturally or produced seasonally or annually on a given area that can provide food for grazing animals.

Foreground (Visual Distance Zone) - That part of a scene, landscape, etc., which is nearest to the viewer, and in which detail is evident, usually within 1/4 to 1/2 mile from the viewer.

Forest - When used with a capital F, this term refers to the Hoosier National Forest, including the landbase and administrative staff.

Forest Land - Land at least 10 percent occupied by forest trees of any size or formerly having had such tree cover and not currently developed for nonforest use. Land developed for nonforest use includes areas for crops, improved pasture, residential, or administrative areas, improved roads of any width, and adjoining road clearing and powerline clearing of any width.

(Forest Land) Not Appropriate - Lands not selected for timber production in the Forest plan alternative due to; (1) the multiple-use objectives for the alternative preclude timber production; (2) other management objectives for the alternative limit timber production activities to the point where management requirements set forth in 36 CFR 219.27 cannot be met; and (3) the lands are not cost-efficient, over the planning horizon, in meeting forest objectives that include timber production. Lands not appropriate for timber production shall be designated as unsuitable in the selected alternative and Forest plan.

(Forest Land) Suitable - Lands where timber production is an objective.

(Forest Land) Unsuitable - Forest land that is not managed for timber production because (1) the land has been withdrawn by Congress, the Secretary, or the Chief; (2) the land is not producing or capable of producing crops of industrial wood; (3) technology is not available to prevent irreversible damage to soils, productivity, or watershed conditions; (4) there is no reasonable assurance that lands can be adequately restocked within 5 years after final harvest, based on experience; (5) there is, at present, a lack of adequate information to respond to timber management activities; or (6) timber management is inconsistent with or not cost-efficient in meeting the management requirements and multiple-use objectives specified in the Forest Plan.

Forest Openings - Openings maintained on the Hoosier to provide habitat or habitat components for plants and animals which require or are benefited by early successional stages of vegetation. May include natural openings (barrens) and other openings with native or non-native vegetation. These openings are maintained by periodic treatments, such as mowing, cutting, or prescribed burning. These included openings previously identified as "wildlife openings."

Forest Plan – A document that guides all natural resource management and establishes management standards and guidelines for a national forest, and that embodies the provisions of the National Forest Management Act of 1976.

Forest Road - A road wholly or partly within, or adjacent to, and serving NFS land that is necessary for the protection, administration, and use of NFS land and the use and development of its resources; any road, regardless of jurisdiction (county or Forest Service), class (Arterial, Collector, Local), or standard (Traffic Service Level) that is considered to be on the Forest Road network.

Forest Road System - The inventory or network of roads, under all jurisdictions, that are needed for transporting forest products, accommodating planned motorized access for recreation purposes, and protecting and managing the Hoosier National Forest now and in the future.

Forest Type – A category of forest usually defined by its vegetation, particularly its dominant vegetation as based on percentage cover of trees, e.g., oak-hickory.

Forestry - The profession embracing the science, art, and practice of creating, managing, using, and conserving forests and associated resources for human benefit and in a sustainable manner to meet desired goals, needs, and values.

Fragmentation – The process by which a landscape is broken into small islands of forest within a mosaic of other forms of land use or ownership, note fragmentation is a concern because of the effect of noncontiguous forest cover on connectivity and the movement and dispersal of animals in the landscape.

Fuels - Combustible material. Includes vegetation such as grass, leaves, ground litter, plants, shrubs, and trees that feed a fire.

Goal - A concise statement that describes a desired condition to be achieved sometime in the future. It is normally expressed in broad, general terms and is timeless in that it has no specific date by which it is to be completed.

Grapevine Control - Grapevine control is the practice on the Hoosier of reducing grapevines in a young forested stand. The number of vines is reduced by cutting. Sprouting is minimized by shading from the residual stand. Additional control may be accomplished with herbicides applied directly to the cut surface of grapevines. Small patches of vines may be left intentionally to provide wildlife food and cover.

Groundwater – Water within the earth that supplies wells and springs. Specifically, water in the zone of saturation where all openings in soils and rocks are filled- the upper surface of which forms the water table.

> ***Water Table*** - The upper surface of the ground water, below which the soil is saturated with water.

Group Selection Cutting – Trees are removed and new age classes are established in small groups.

Guidance - A term which includes both standards and guidelines permitted or limitations set on all lands on the Hoosier unless exceptions are stated.

Guidelines – Permissions or limitations that should be implemented in most cases to achieve the goals and objectives. Deviation from a guideline does not require a forest plan amendment, but the rationale must be disclosed in the project decision documents.

Habitat – 1. A unit of the environment. 2. The place, natural or otherwise, (including climate, food, cover, and water) where an animal, plant, or population naturally or normally lives and develops.

Hardwood – Usually broad-leaved and deciduous.

Herbicide - A pesticide used for killing or controlling the growth of plants.

Heritage Resource - Heritage resources are the physical remains of districts, sites, structures, networks, or objects used by humans in the past. They may be historic or prehistoric, archaeological or architectural in nature. Heritage resources on the Hoosier include hunting, quarrying, plant gathering, and living areas from the prehistoric period. Historic period sites (at least 50 years of age) are associated with farming, logging, and a variety of industrial pursuits. Heritage resources are land based and are non-renewable.

Hibernacula – The winter den of a hibernating animal (plural: hibernaculum).

Hoosier - When used in this document, this term refers to NFS lands of the Hoosier National Forest or the Forest Service employees who manage the Forest.

Hydrology – The science dealing with the properties, distribution, and circulation of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere.

Impoundment – A dam or body of water upstream of a dam or weir.

Infiltration - The downward entry of water into the soil to the groundwater system.

Insecticide – A pesticide employed against insects.

Integrated Pest Management (IPM) - A process for selecting strategies to regulate forest pests in which all aspects of a pest-host system are studied and weighed. The information considered in selecting appropriate strategies includes the impact of the unregulated pest population on various resource values, alternative regulatory tactics and strategies, and benefit/cost estimates for these alternative strategies. Regulatory strategies are based on sound silvicultural practices and ecology of the pest-host system and consist of a combination of tactics such as timber stand improvement plus selective use of pesticides. A basic principle in the choice of strategy is that it be ecologically compatible or acceptable.

Intermediate treatment – Any treatment or tending designed to enhance growth, quality, vigor, and composition of the stand after establishment or regeneration and prior to final harvest.

Intermittent Stream – A stream, or portion of a stream, that does not flow year-round but only when it (a) receives base flow solely during wet periods, or (b) receives groundwater discharge or protracted contributions from melting snow or other erratic surface and shallow subsurface sources.

Invasive species – An alien (nonnative) species whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

IPM – See Integrated Pest Management.

K-V Funds - In 1930, Congress passed the Knutson-Vanderberg Act (K-V Act) to authorize collection of funds (K-V Funds) for reforestation and timber stand improvement work, wildlife habitat work, and other resource improvements on areas cut over by timber sales.

Karst Topography - The word karst is taken from an area in Yugoslavia, where karst features were first documented. Karst is a terrain, underlain by limestone, in which the topography is chiefly formed by the dissolving of rock, and which is commonly characterized by closed depressions, subterranean drainage, and caves. Features found in karst terrain include rises, swallowholes, sinking streams, blind valleys, karst valleys, gulfs, cave springs, and other karst features.

Landbase - A specific area of the earth's surface and all its attributes including water bodies, from which goods, services, and uses can be supplied.

Land Easement - An interest in land restricting the manner in which an owner may develop or use his property, or allowing the holder of the easement to use the property in some specified way.

Landform – Term used to describe the many types of land surfaces which exist as a result of geological activity, such as a plateau, plain, basin, mountain, etc.

Landline - Property boundaries located between the NFS lands and other lands.

Land management planning – A formal process of management planning involving four iterative steps: monitoring, assessment, decision-making, and implementation.

Log Landing – A cleared area in the forest to which logs are yarded or skidded for loading onto trucks for transport.

Long Range Planning – (U.S. Forest Service usage) Planning for the period covered by basic resource management plans, usually 10 or more years.

Long-Term Sustained-Yield Timber Capacity (LTSY) - The highest uniform wood yield from lands being managed for timber production that may be sustained under a specified management intensity consistent with multiple-use objectives.

LTSY – See Long-Term Sustained-Yield Timber Capacity above.

MA – See Management Area.

Maintenance Level - A formally established set of objectives which describe the conditions necessary to achieve the planned operation of a road.

> **Maintenance Level 1** - This level is assigned to intermittent service roads during the time management direction requires that the road be closed or otherwise blocked to traffic. Basic custodial maintenance is performed to protect the road investment and to keep damage to adjacent resources to an acceptable level. Drainage facilities and runoff patterns are maintained.
>
> **Maintenance Level 2 -** This level is assigned where management direction requires that

the road be open for limited passage of traffic. Roads in this maintenance level are intended for use by high clearance vehicles. Passenger car traffic is not a consideration. Administrative, permitted, other specialized use, or log haul may occur at this level.

Maintenance Level 3 - This level is assigned where management direction requires the road to be open and maintained for safe travel by a prudent driver in a passenger car. Traffic volumes are minor to moderate. Use, comfort, and convenience are not considered a priority.

Maintenance Level 4 - This level is assigned where management direction requires the road to provide a moderate degree of user comfort and convenience at moderate travel speeds.

Maintenance Level 5 - This level is assigned where management direction requires the road to provide a high degree of user comfort and convenience.

Management Area (MA) - An area with similar management objectives and a common management prescription.

Management Direction - A statement of multiple use and other goals and guidance for attaining them.

Management Indicator Species (MIS) - 1. A species whose condition can be used to assess the impacts of management actions on a particular area. 2. A species whose population changes are believed to indicate the effects of management activities, and is monitored to track population numbers and habitat conditions, as a way of monitoring biodiversity.

Management Practice - A specific activity, measure, course of action, or treatment.

Management Prescription - Management practices and intensity selected and scheduled for application on a specific area to attain multiple use and other goals and objectives.

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Mast - 1. Nuts, acorns, and similar products of hardwood species, which are consumed by animals. 2. The fruit of trees and shrubs.

Maternity Roosts – With respect to the Indiana bat (*Myotis sodalis*), a maternity roost is a site used by a colony of pregnant or nursing female bats and their pups as a resting location within the foraging area of the colony. Indiana bats generally have at least one primary roost which is most frequently used throughout the summer, and a number of alternate roosts which may house a portion of the colony throughout the summer, or may be used as conditions within the primary roost vary. The primary roost is typically located in an area fully exposed to the sun. Indiana bats use maternal roosts in order to provide thermal conditions that favor the development of their young.

MBF - One thousand board feet of timber.

MIS – See Management Indicator Species.

MMBF - One million board feet of timber.

Modification - A visual quality objective in which management activities may dominate the characteristic landscape but at the same time must borrow from naturally established form, line, color, or texture.

Mulch - Leaves, straw, or other loose material spread on the ground around plants to prevent evapotranspiration of water from soil, freezing of roots, etc.

Multiple-Use - The management of all the various renewable resources of the National Forest System so that they are utilized in the combination that will best meet the needs of the American people. The most judicious use will be made of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in the use to conform to changing needs and conditions. Some lands will be used for less than all of the resources and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources. This is not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output.

National Forest System (NFS) - All National Forest lands reserved or withdrawn from the public domain of the United States, all National Forest lands acquired through purchase, exchange, donation, or other means; the National Grasslands and land utilization projects administered under Title III of the Bankhead-Jones Farm Tenant Act (50 Stat. 525, 7 U.S.C. 1010-1012), and other lands, waters, or interests therein which are administered by the Forest Service or are designated for administration through the Forest Service as a part of the system.

National Register of Historic Places - A listing (maintained by the National Park Service) of areas which have been designated as being of historical significance. The Register includes places of local and state significance as well as those of value to the nation as a whole.

Native Species – Animals or plants which originated in the area in which they are found—i.e., were not introduced and naturally occur in that area.

Neotropical Migrant – A songbird that overwinters in Central or South America and breeds in North America.

NEPA - National Environmental Policy Act.

NFS – National Forest System.

NFMA - National Forest Management Act.

NNIS – Nonnative Invasive Species.

Nonforest Land - Lands never having or incapable of having 10 percent or more of the area occupied by forest trees, or lands previously having such cover and currently developed for nonforest use.

Nonnative invasive species (NNIS) – A plant or animal, including its seeds, eggs, spores, or other biological material that is nonnative to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm.

Objective - A concise, time-specific statement of measurable planned results that respond to pre-established goals. An objective forms the basis for further planning to define the precise steps to be taken and the resources to be used in achieving identified goals.

Off-highway vehicle (OHV) - Generally accepted broad term for planning applications when referring to the major types of vehicles used for off-highway motorized recreation.

OHV - See Off-highway Vehicle.

Old-Growth Forest - The (usually) late successional stage of forest development; old growth forests are defined in many ways.

Overstory - That portion of the trees in a forest, with more than one roughly horizontal layer of foliage, which forms the upper or uppermost layer.

Paintball – 1. A game in which players on one team seek to eliminate those on an opposing team by marking them with a water-soluble dye shot in capsules from air guns. 2. The dye-filled gelatinous capsule shot from guns in this game.

Partial Retention – A visual quality objective which in general means man’s activities may be evident but must remain subordinate to the characteristic landscape.

Perennial Stream - Streams that flow throughout the year and from source to mouth.

Pest – 1. An organism that is undesirable or detrimental to the interest of humans. 2. An organism or environmental stress which the land manager determines to be detrimental to achieving resource management objectives.

Pesticide - A general term applied to a variety of chemical pest control measures, including insecticides for insects, herbicides for plants, fungicides for fungi, and rodenticides for rodents.

Planning Area - The area of the National Forest System covered by a regional guide or forest plan.

Policy - A definite course or method of action selected by a governmental agency, institution, group, or individual from among alternatives and, in the light of given conditions, to guide and usually determine present and future decisions.

Precommercial Thinning – The removal of trees not for immediate financial return but to reduce stocking to concentrate growth on the more desirable trees.

Prescribed Burn – To deliberately burn wildland fuels in either their natural or their modified state and under specified environmental conditions, which allows the fire to be confined to a predetermined area and produces the fireline intensity and rate of spread required to attain planned resource management objectives.

Preservation - A visual quality objective that allows for ecological change only.

Primitive – 1. The term "primitive" is often used synonymously with dispersed or undeveloped recreation or camping use. Running water, toilets, showers, and other developed facilities are available at only a limited number of areas on the Hoosier National Forest. Most of the forest can, therefore, provide "primitive" recreation and camping opportunities. 2. A classification in the recreation opportunity spectrum. No areas on the Hoosier can provide Primitive ROS recreation opportunities at present.

Project - A site-specific resources management activity or combination of activities designed to accomplish a distinct on-the-ground purpose or result.

Pruning – The removal, close to the branch collar or flush with the stem, of side branches (live or dead) and multiple leaders from a standing tree.

Public Issue - A subject or question of widespread public interest relating to management of the National Forest System.

Public Road - Any road under the jurisdiction of and maintained by a public road authority that is open to public travel. In the context of this definition, the Forest Service is not a public authority.

Record of Decision – A document signed by a Responsible Official recording a decision that was preceded by preparation of an environmental impact statement.

Recreation Area - A relatively small, distinctly defined portion of a national forest where concentrated public use for the more traditional recreation purposes predominates, e.g., campgrounds, picnic areas, swimming areas, etc.

Recreation Opportunity Spectrum (ROS) - A system of classifying the range of recreational experiences, opportunities, and settings available on a given area of land. Classifications include:

- Primitive (P)
- Semi-primitive, Motorized (SPM)
- Semi-primitive, Nonmotorized (SPNM)
- Roaded Natural (RN)
- Rural (R)
- Urban (U)

Recreational River (Wild and Scenic Rivers Act Usage) - Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

Reforestation – The establishment of forest cover either naturally (by natural seeding, coppice, or root suckers) or artificially (by direct seeding or planting).

Regeneration – The act of renewing tree cover by establishing young trees naturally or artificially.

Removal Cut – In the shelterwood method of stand regeneration, a removal cut releases established regeneration from competition with the overwood. (See also "Shelterwood Cut.")

Research Natural Areas – A designation (by the Chief of the U.S. Forest Service) that allows unique ecosystems to follow natural processes for scientific purposes.

Retention - A visual quality objective in which management activities are not evident to the casual forest visitor.

Riparian – Related to, living in, or located in conjunction with a wetland, on the bank of a river or stream but also at the edge of a lake or tidewater.

Riparian Areas - Geographically delineable areas with distinctive resource values and characteristics that are comprised of the aquatic and riparian ecosystems.

Riparian Ecosystems - A transition area between the aquatic ecosystem and the adjacent terrestrial ecosystems identified by soil characteristics or distinctive vegetation communities that require free or unbound water.

RNA - See Research Natural Area.

RNA-equivalent – An area other than an RNA that can serve as a control or reference area for one or more community types in an ecological unit. To qualify, an area must be…maintained in its natural state with active management which allows for mimicking of natural processes or allows natural disturbance events to proceed without interference.

Road - A general term denoting a way for purposes of travel by vehicles (either motorized or nonmotorized) greater than 40 inches in width.

> **Local Road** - These connect terminal facilities, such as log landings and recreation sites, with forest collector or arterial roads. They are often less than 1.5 miles long and serve a single resource. The vast majority of county and Forest Service roads on the Hoosier National Forest would be classified as local roads, but few would serve just one resource.

Rotation – In even-aged management, the period between regeneration establishment and final cutting.

ROD - Record of Decision.

ROS – Recreation Opportunity Spectrum.

RPA - Forest and Rangeland Renewable Resources Planning Act of 1974.

Runoff – Rain falling on an irregular surface; the amount of runoff corresponds to the amount of rainfall minus the amount of water entering the ground through infiltration.

Sale Schedule - The quantity of timber planned for sale by time period, from the area of suitable land covered by a forest plan. The first period, usually a decade, of the selected sale schedule provides the allowable sale quantity. Future periods are shown to establish that long-term sustained yield will be achieved and maintained.

Salvage Cutting – A timber sale for which an important reason for entry includes the removal of disease- or insect-infested trees, dead, damaged, or down trees, or trees affected by fire or imminently susceptible to fire or insect attack. Such term also includes the removal of associated trees or trees lacking the characteristics of a healthy and viable ecosystem for the purpose of ecosystem improvement or rehabilitation, except that any such sale must include an identifiable salvage component of trees described in the first sentence.

Sanitation Cutting – The removal of trees to improve stand health by stopping or reducing the actual or anticipated spread of insects and disease.

Sapling - A usually young tree larger than a seedling but smaller than a pole.

Sawtimber - Trees or logs cut from trees with minimum diameter and length and with stem quality suitable for conversion to lumber.

Scenic River (Wild and Scenic Rivers Act Usage) – Those rivers or sections of rivers that are free of impoundments with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

Sediment - Solid material, both mineral and organic, that is in suspension and being transported from its site of origin by the forces of air, water, gravity, or ice.

Sediment basin – A basin designed to collect sediment particles that settle out from stream flow or runoff.

Seedbed - In natural regeneration, the soil or forest floor in which seed falls.

Seedling – A tree smaller than a sapling; as typically used in forest surveys, a size class definition meaning trees less than 1 inch at dbh.

Sense of Place – 1. Those things that add up to a feeling that a community is a special place, distinct from anywhere else. 2. A sense of place results gradually and unconsciously from inhabiting a landscape over time, becoming familiar with its physical properties, accruing history within its confines.

Sensitive Species – Plant and animal species designated in the forest plan by the Regional Forester which require special consideration to assure viable populations.

Shade Intolerant – Having the capacity to compete for survival under direct sunlight conditions.

Shade-tolerant – Having the capacity to compete for survival under shaded conditions.

Shelterwood Cutting – The cutting of most trees, leaving those needed to produce sufficient shade to produce a new age class in a moderated environment.

Silvicultural System - A planned series of treatments for tending, harvesting, and re-establishing a stand; the system name is based on the number of age classes.

Sink, Sinkhole – A depression or hole in a low-lying, poorly drained area formed by the dissolution of underlying rock, where waters collect or disappear before sinking down into the ground or by evaporation.

Skid Road/Trail – An access cut through the woods for skidding.

Slash – The residue, e.g., treetops and branches, left on the ground after logging or accumulating as a result of storm, fire, girdling, or delimbing.

Snag – 1. A standing, generally unmerchantable dead tree from which the leaves and most of the branches have fallen. 2. A standing section of the stem of a tree, broken off usually below the crown.

Special Area – Designated areas which include unique or unusual ecological, botanical, zoological, geological, scenic, historic, prehistoric, and other areas which merit special recognition and management.

Special Use Permits - An authorization which provides permission, without conveying an interest in land, to occupy and use National Forest System land or facilities for specified purpose, and which is revocable, terminable and non-compensable.

Standards and Guidelines – Requirements which preclude or impose limitations on resource management activities, generally for the purposes of environmental protection or public safety.

Stand (Stand of Trees) – A contiguous group of trees sufficiently uniform in age-class classification, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit.

Stand Structure – The horizontal and vertical distribution of components of a forest stand including the height, diameter, crown layers and stems of trees, shrubs, herbaceous understory, snags, and down woody debris.

Streambed – Refers to the bottom of the stream channel.

Subsurface Rights (Mineral Rights) - Ownership rights in a parcel of real estate to the water, minerals, gas, oil, and so forth that lie beneath the surface of the property.

Succession - The gradual replacement of one community of plants by another; the sequence of communities is called a seral stage.

Suitability - The appropriateness of applying certain resource management practices to a particular area of land, as determined by an analysis of the economic and environmental consequences and the alternative uses foregone.

Suitable Timber Lands – See Suitability.

Sustained Yield (or Production) – The achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resource without impairment of the productivity of the land.

Thinning – A cultural treatment made to reduce stand density of trees primarily to improve growth, enhance forest health, or recover potential mortality.

Threatened Species - A plant or animal species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Timber Production - The purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use. For planning purposes, the term "timber production" does not include production of fuelwood.

Timber Stand Improvement (TSI) – An intermediate treatment made to improve the composition, structure, condition, health, and growth of even-aged or uneven-aged stands.

Tolerance – See shade tolerant.

Traffic Service Level - The measure of the standard of a road or the level of service provided to the user of the road. Detailed description of the four traffic service levels can be found in Forest Service Handbook 7709.56.

Trail - A trail primarily on NFS land that is designated and maintained by the Forest Service as an official trail.

> ***Single Use Trail:*** A trail that is designated for use by one user group, generally hikers.
> ***Multiple Use Trail:*** A trail that is designated for use by two or more user groups. On the Hoosier National Forest this is limited to horse riders, mountain bikers, and hikers.
> ***Special Use Permit Trail:*** A trail primarily on NFS land that is designated and maintained under a special use permit. The purpose of a special use permit trail is to provide a legal means for adjacent landowners to access Hoosier National Forest system trails.

Trail Density and Cumulative Trail Density - Trail density represents the miles of trail contained in a square mile of land. The cumulative trail density represents a cumulative figure for the total Forest acreage for that management area. The density may be exceeded on any given piece of ground as long as it is not exceeded for that management area overall. These density limits are not intended to be a target for miles of a trail in a management area.

Trail Plan - A strategic forest-wide trail plan that identifies existing and proposed trails, special use trail criteria, supplemental trail standards, and scheduling of proposed projects.

TSI – See Timber Stand Improvement.

Understory - The plants of a forest undergrowth; broadly, an underlying layer of low vegetation; all forest vegetation growing under an overstory.

Uneven-aged Management - The application of a combination of actions needed to simultaneously maintain continuous high-forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes to provide a sustained yield of forest products. Cutting is usually regulated by specifying the number or proportion of trees of particular sizes to retain within each area, thereby maintaining a planned distribution of size classes. Cutting methods that develop and maintain uneven-aged stands are single-tree selection and group selection.

Utility Corridor – See Corridor.

Vegetative Management – The forced change of one vegetative condition to another. It can be done with hand tools, mechanical equipment, chemicals, or fire. Usually this is done to improve habitat for plant and animal species, improve forest stand quality, or provide timber products.

Vegetative Manipulation – Similar to vegetation management although in the context of this plan, the term is used for maintenance activities such as hand pulling of exotics, mowing, limited bushhogging, or trail maintenance activities.

Viable Population - A population of plants or animals whose estimated number and distribution of reproductive individuals provides a high likelihood of continued existence, generally throughout its current range.

Visual Quality Objective (VQO) - A desired level of excellence based on physical and sociological characteristics of an area. Refers to degree of acceptable alteration of the characteristic landscape.

Visual Resource Management - The art and science of planning and administering the use of forest lands in such ways that the visual effects maintain or upgrade man's psychological welfare. It is the planning and design of the visual aspects of the multiple-use land management.

Watershed – 1. A land area that has all the surface drainage within its boundary converging at a single point. 2. Subdivisions within a subbasin. The 5th level (10-digit) in the HU hierarchy.

Water Table - The upper limit of the portion of the ground wholly saturated with water.

Wetland - As defined by Executive Order (E.O.) 11990, those areas that are inundated by surface or ground water with a frequency sufficient to support, and under normal circumstances do support, an abundance of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions (hydric soils) for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds. Wetlands generally are encompassed by the riparian ecosystem.

Wheelchair - A device designed solely for use by a person with mobility impairment for locomotion, that is suitable for use in an indoor pedestrian area.

Wilderness - The National Wilderness Preservation Act of 1964 defines a wilderness as an area of undeveloped, Federally owned land designated by Congress that has the following characteristics: (1) It is affected primarily by the forces of nature, where man is a visitor who does not remain. It may contain ecological, geological, or other features of scientific, education, scenic, or historical value. (2) It possesses outstanding opportunities for solitude or a primitive and unconfined type of recreation. (3) It is an area large enough so that continued use will not change its unspoiled natural condition.

Wildlife Habitat – The place where an animal or plant naturally or normally lives and develops.

Wild River – (**Wild and Scenic Rivers Act usage)** Those rivers or section of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and water unpolluted.

Appendix B

VEGETATIVE MANAGEMENT PRACTICES - RATIONALE FOR CHOICE

INTRODUCTION

The National Forest Management Act of 1976 (Section 6(g)(3), (E)(iv) and (F)(i)), the resulting Secretary's Regulations (36 CFR 219.15), and good management require that vegetation management practices be chosen which are appropriate to meet the objectives and requirements of the Land and Resource Management Plan.

The National Forest Management Act also states that clearcutting may be used only if it is the optimum harvest method. This appendix explains when clearcutting is the optimum harvest method. It also explains the other vegetative management practices, and the conditions for which each practice would be appropriate.

The Eastern Region recognizes 59 different forest types (FSH 2409.21d-R9, Amendment 20 June 1984). Of these, the Hoosier National Forest has 34 types, (FSH R9-Hoosier 2409.21d-200 December 12, 2001).

SILVICULTURAL SYSTEMS AND REGENERATION HARVEST METHODS

Timber harvests are designed to achieve a number of resource management objectives. These include objectives for insect and disease management, species composition, timber quality, visual management, and wildlife habitat. Harvest methods are selected to achieve the management objective. There are two silvicultural systems available-- uneven-aged and even-aged.

The uneven-aged category consists of a selection method, which may be single-tree or group selection harvests. Within the even-aged category, there are three silvicultural harvest methods recognized by the Society of American Foresters (Helms 1998): clearcutting, shelterwood, and seed tree.

Uneven-aged Systems

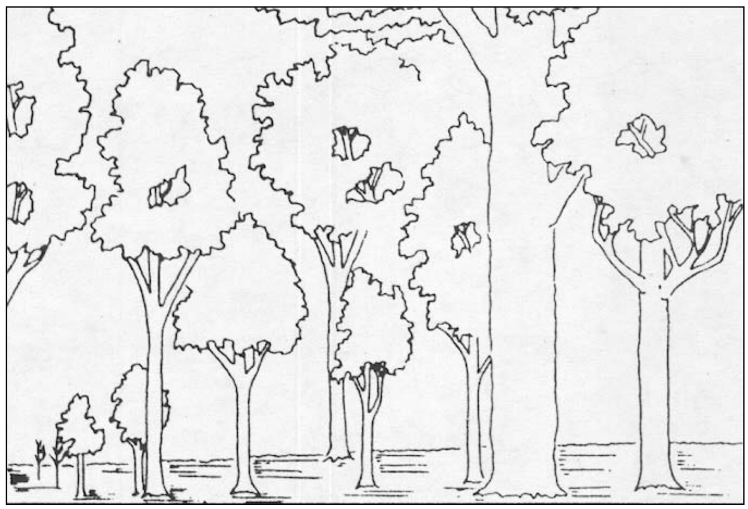
Uneven-aged management is manipulation of a stand for continuous high-forest cover, recurring regeneration of species favored by partial shade, and the orderly growth and development of trees through a range of diameters and age classes. Selection involves the removal of both immature and mature trees, either in groups or individually, to obtain or maintain uneven-aged stand structure.

A stand is considered uneven-aged if three or more 20-year age classes are represented within the stand (Roach 1974). Harvests are conducted at 10 to 30-year intervals to obtain or maintain an uneven-aged character. Assuming trees will be cut when they reach 150 years in age, a system with a 20-year cutting cycle would have harvesting activity on approximately 13 percent of the forestland each year.

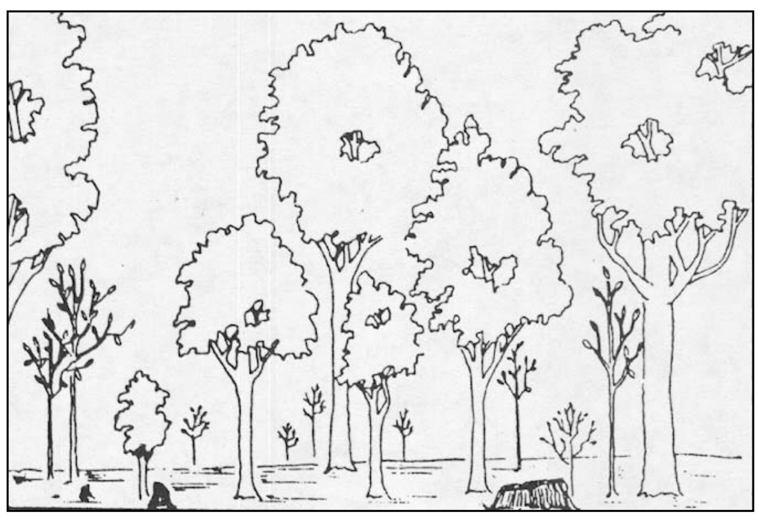
The uneven-aged system generally results in less volume growth than that of the even-aged system (Smith and DeBald 1978). This is due primarily to the high proportion of slower growing species and increased competition.

Single-Tree Selection Method

Single-tree selection is the periodic removal of individual trees. The goal is to maintain a given number of trees per acre in each diameter class. This practice should not be confused with "high grading" where only large trees are cut. For the practice to work, some trees must be cut or killed within most or all diameter classes.



Stand before harvest



Stand after harvest

Harvesting, with repeated entries, is an ongoing process in single-tree selection. Because this method allows only limited light to reach the forest floor, less shade-tolerant species are unlikely to regenerate. As those species, such as oaks and yellow-poplar, drop out of the stand, they are replaced by shade-tolerant species. These species, while less valuable than the oaks for wildlife, do have other benefits such as mast production.

Shade tolerance is a term which refers to the ability of a tree to survive and grow in shaded conditions. The primary shade-tolerant species are beech and maple. Species that are typically more intolerant of shade, include oak, cherry, and black walnut.

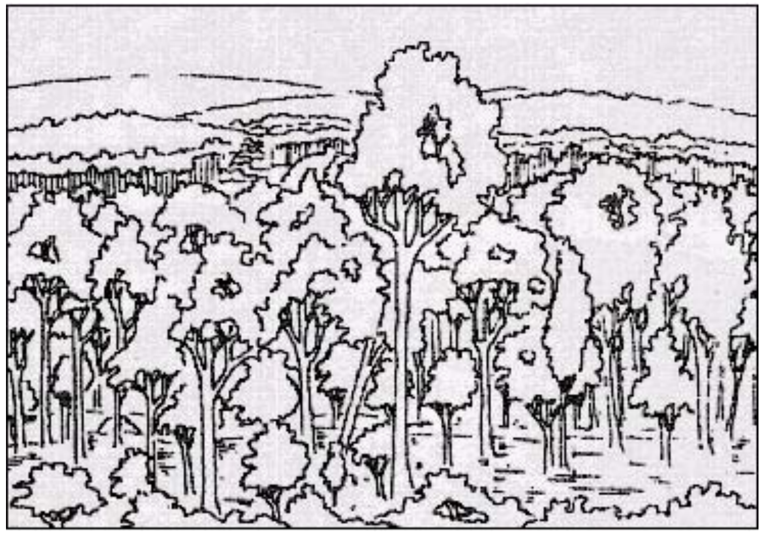
The single-tree selection method meets the needs of most high-forest, cavity dwelling, or closed or layered-canopy wildlife species.

This method is least beneficial for wildlife species which use openings, edges, and low browse.

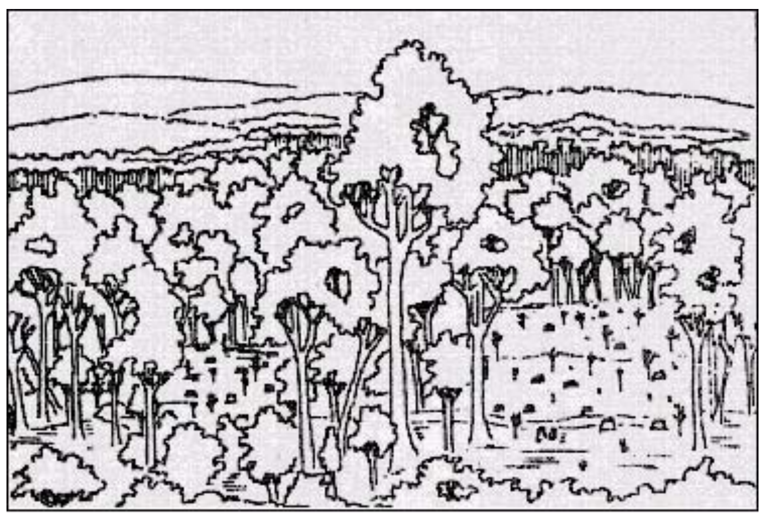
The visual resource is not greatly affected by single tree harvesting. This method provides for retaining a large-tree character in the landscape. Repeated harvest operations on a 10-30 year cycle are necessary to use this method.

Group Selection Method

This cutting method removes trees periodically in small groups. This results in openings that do not exceed 3 acres in size. This leads to an uneven-aged stand because of differing age class groups within the stand.



Stand before harvest



Stand after group selection cut

In the group selection method, the management area is treated as a single stand, and the portion of the stand to be harvested each cutting cycle determines the number of openings to establish. For example, a 40-acre stand on a 30-year cutting cycle and a 150-year rotation would have 8 acres cut each entry (150/30=5; 40/5=8). This could be 8 one-acre openings, 32 one-quarter acre openings, or some combination in between. Single tree selection may also occur between the group selection openings.

The objective of this method is to establish the desired regeneration with each harvest, thereby producing an uneven-aged stand. Because the removal of groups permits more light to reach the forest floor than does single-tree selection, group selection encourages a higher proportion of shade intolerant species such as oaks, cherry, and yellow-poplar (Minckler 1972). Openings of differing sizes and slope position will result in differences in species response (Fisher 1981). Larger openings allow a greater amount of sunlight on the forest floor resulting in more shade intolerant species (Minckler 1989). Table B.5 shows the shade tolerance of selected species occurring in the central hardwood region (Mills *et al* 1987). The aesthetic and wildlife benefits of group selection harvest depend largely upon group size, spacing, and frequency.

In a study of small groups with no pre- or post-harvest treatment, the majority of the groups regenerated to a mixture of sugar maple, yellow poplar, and dogwood (Weigel and Parker 1997).

This system develops a vegetative condition with an interconnected canopy and many small openings (1/10 acre to 3 acres in size) simulating a checkerboard pattern within a forested environment. Wildlife that favor areas of group selection harvests prefer mature forests, forest edges, and small patches of young forest. Small openings and seedling-sapling sized groups are perpetuated throughout the forest, providing the earlier stages of plant succession required by some wildlife. The mosaic of seral stages resulting from several entries of group selection includes interconnected groups of larger trees of different canopy heights, providing habitat for species adapted to a mature forest.

Even-Aged Systems

Even-aged harvest methods create stands in which trees of essentially the same age grow together. A stand is considered even-aged if the difference in age between the oldest and youngest trees of the managed stand does not exceed 20 percent of the length of rotation. This is 24 years for a 120-year rotation. With any of these systems, the size, shape, and dispersion of harvest units are configured to achieve multiple-use management objectives of the area.

The rotation age under an even-aged management system is the number of years between establishment of a stand of timber and when it is considered ready for harvesting and regeneration. If a forested area is being managed on a 100-year rotation, about 10 percent of the area would be regenerated each decade, or 1 percent per year. During a rotation, there may be one or two thinnings before the next regeneration harvest. Individual stands managed under an even-aged system are entered for some type of cutting about one-half as often as stands managed under uneven-aged systems.

Habitats perpetuated through even-aged management activities most closely resemble today's forest of a mixed, predominantly single-aged stand. Oak and hickory species were dominant on the Brown County Hills and Crawford Uplands. American beech, sugar maple, oaks, and hickories were dominant on the limestone soils of the Mitchell Karst Plain and Crawford Escarpment. (Thompson 2004). Many of these old forests had several oak species in their overstories due to the disturbance regimes of the Native American and European settlement periods (DenUyl 1954).

Even-aged management has the potential to provide early successional stages in patch sizes large enough to satisfy life requirements of most species of wildlife that require early successional habitats and still provide large interconnected stands of larger trees.

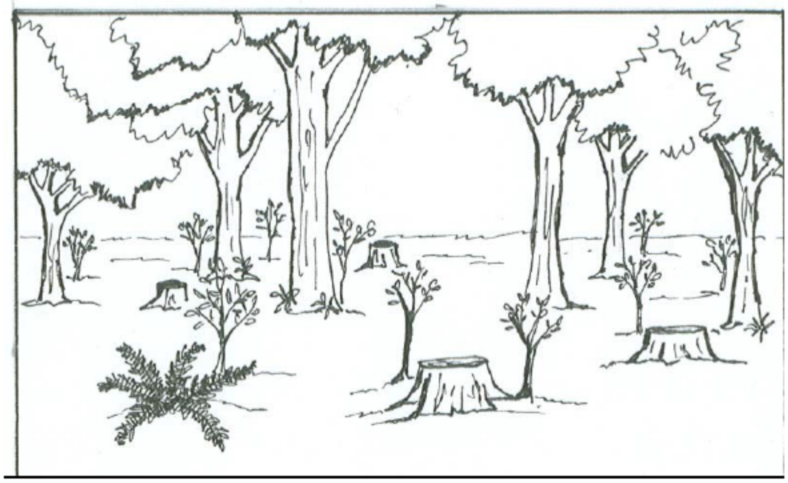
Shelterwood Harvest Method

In the shelterwood method the mature stand is removed in a series of two or three cuts. The early cuts are designed to improve vigor and seed production of the remaining trees while preparing the site for new seedlings. The final harvest is made when a sufficient amount of desirable reproduction has become established and before the regeneration has reached 20 percent of its rotation age. This method provides a partial cover of trees which shelters the new seedlings. When the shelter becomes a hindrance to the growth of the seedlings, rather than a benefit, it is necessary to remove the remainder of the mature stand (Smith *et al* 1997). In central hardwoods, research has found that this will occur within 10 years (Sander and Clark 1971). Some large trees could be left for wildlife and visual purposes.

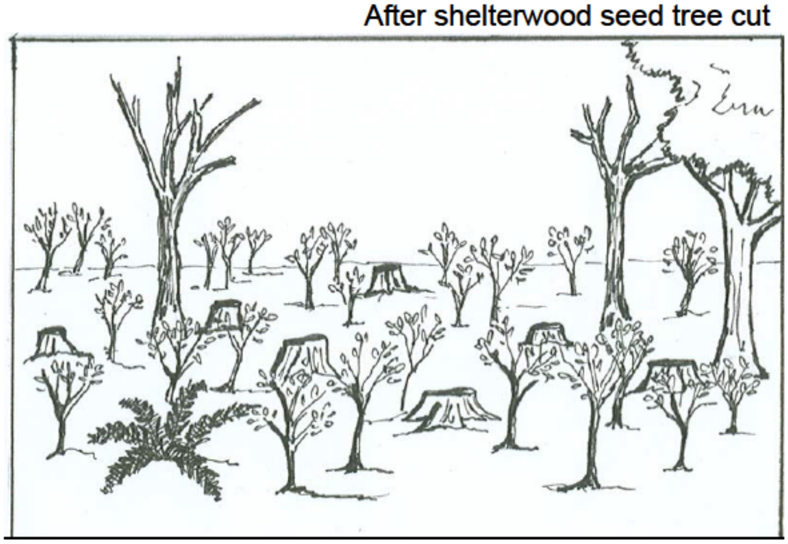
The shelterwood method is most appropriate for tree species or sites where the shelter of a partial overstory is needed for reproduction or where visual concerns warrant.

The method provides conditions favorable to regeneration of a wide variety of hardwood species and has frequently been advocated for oaks (Johnson 1992, Johnson *et al* 2002, Siefert *et al* 2004). The individual species favored depends on several physical and biological factors such as seed source, soil conditions, seedbed conditions, amount of shade, and forest floor microclimatic conditions.

Before harvest



After shelterwood seed tree cut

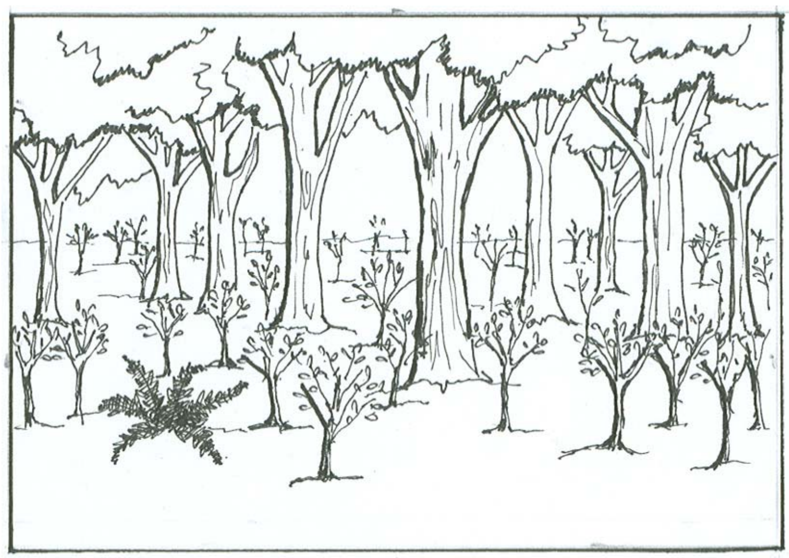


After removal of shelterwood

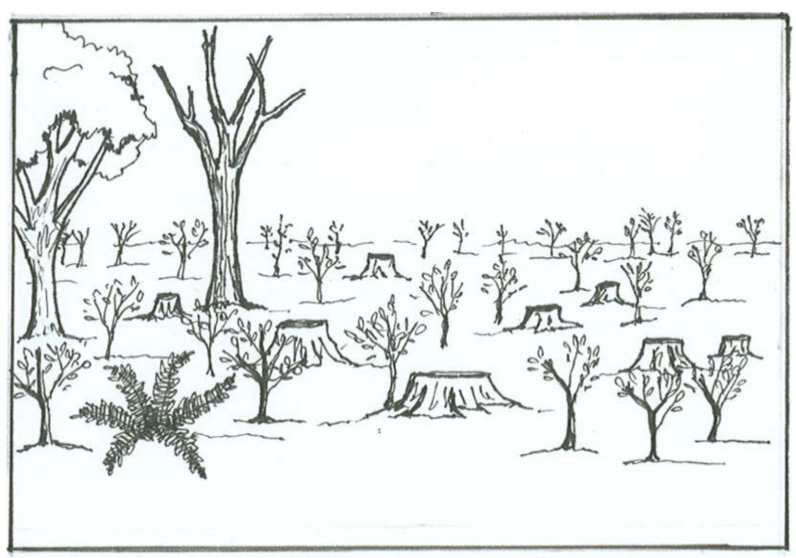
By regulating the density of trees held between the early cuts and the removal cut, the species composition of the new stand can be regulated. Leaving a denser stocking after the early cuts will tend to regenerate more shade-tolerant species, leaving a lighter stocking provides for more shade-intolerant species.

Clearcut Method

In clearcutting, with the exception of trees that may be left for wildlife or visual purposes, all merchantable trees on an area are harvested at one time. Small unmerchantable trees are also felled to eliminate competition with the regeneration. Regeneration develops from natural seeding before or after harvests, advanced regeneration, and the sprouting from cut tree stumps. This regeneration method favors establishment and development of species more intolerant of shade. Clearcutting can slow the change from oak-hickory to the more mesic mixed hardwoods that is presently occurring on the Forest because of the absence of disturbance. Clearcutting provides vegetation in an early successional stage. In an unmanaged situation this successional stage could be caused by wildfire, insects, diseases, or windthrow. Without manmade or natural disturbances, the forest tends to move toward a condition dominated by shade-tolerant, late successional vegetation such as sugar maple and beech.



Even-aged stand before harvest



After harvest by clearcutting

Clearcutting is an effective method used to obtain desirable natural regeneration in central hardwood stands, although the regeneration of the oaks is still a problem (Mills *et al* 1987). Early results from an ongoing study conducted on the Hoosier show natural oak regeneration after clearcutting can result, over time, in a stand with an oak component. In approximately 70 percent of the sampled stands, oak composition has reached pre-harvest levels (Seifert *et al* 2005). Clearcutting normally results in more seedlings and new sprouts than any other harvest method. Where regeneration of oak and hickory is of primary importance, advanced reproduction of these species is essential prior to harvesting the overstory (Sander and Clark 1971). Experience has also shown that other factors, such as site quality, aspect, and slope position affect the composition of natural regeneration. The oaks and hickories compete better on poor, dry sites with south and west exposure. The amount of oak regeneration and ability to occupy the stand can be enhanced through the use of prescribed burning. Burning helps to shift the regeneration from sugar maple, beech and yellow poplar to more oak (Van Lear 2000, Brose *et al* 1999).

Clearcutting is especially appropriate for stands where high grading has been used in the past, or in areas which have insufficient trees to adequately use growing space.

Choice of Harvest Method

Uneven-aged management may be selected and applied to accomplish one or more of the following objectives.

- Provide continuous forest cover
- Meet wildlife habitat composition objectives
- Provide vertical diversity within a stand
- Provide a variety of age and type classes within stands
- Manage certain stands that are visually sensitive
- Protect sensitive riparian areas
- Meet visual quality objectives
- Regenerate shade-intolerant species, such as sugar maple and beech

Even-aged management may be selected and applied to accomplish one or more of the following:

- Meet wildlife habitat composition objectives
- Provide a variety of age and type classes among stands
- Regenerate less shade-tolerant species such as oak and yellow-poplar
- Meet visual quality objectives
- Accomplish conversions from pine to native hardwood species
- Regenerate high-risk and sparse stands
- Prevent the spread of insect and disease damage or related salvage losses

Even-aged management may also be used to harvest stands that are economically marginal. This may be caused by a number of factors including poor quality timber or access problems.

Some forest types can be regenerated successfully by a particular silvicultural system or harvest method, but other types may not. Since a management area typically contains several forest types and diversity is desirable within a management area, more than one harvest method may be used in a management area. Differing systems need to be applied depending on needs and site specific conditions (Minckler 1978).

When conditions warrant, shelterwood cuts will be used to regenerate hardwoods, especially where oak is the desired species. The density of residual stocking will be determined by species composition objectives (tolerant vs. intolerant), visual quality objectives, and the conditions of the stand before cutting.

Clearcuts will be used when they are the optimum harvest method to achieve our stated management objectives such as conversion of pine to hardwood or meet wildlife habitat composition objectives.

Clearcuts will be used to provide habitat for early successional species. This type of habitat is important to many species of wildlife. Oak, yellow-poplar, and cherry are the primary species that are intolerant to intermediate in tolerance to shade and will benefit most from this harvest technique. Where oak is a desired species in the future stand, at least 150 stems per acre of advanced oak-hickory regeneration should be present prior to overstory removal (Brose *et al* 1999). Fire may be used to enhance or sustain oak regeneration in various ecological conditions (Van Lear 2000).

Clearcuts will be used to create openings and vistas where the potential for such areas exists and the vegetative composition and visual quality objectives can be met by such management.

Clearcuts will be used to remove high-risk and sparse stands and create vigorous, healthy young stands that will enhance overall age-class diversity. These stands can usually not be regenerated by any other means because they lack sufficient numbers of acceptable trees. Many of these stands are on good sites and are in their current condition due to past cutting practices. Once regenerated, they will provide improved wildlife habitat, scenic beauty, and high-quality timber.

Clearcutting will also be used in areas so degraded by insects, disease, or weather-related damage that retaining any residual portion of the stand would be futile. Clearcutting will be used to reduce the spread of insect or disease outbreaks.

Single tree selection will be used where shade-tolerant species, vertical diversity, or continuous forest cover are desired.

Group selection will be used when continuous forest cover, vertical diversity, or the regeneration of species intolerant to intermediate in shade tolerance is desired.

Without ecological restoration in the form of silvicultural treatments, oak systems will continue to decline (in terms of species richness and ecological function), converting from oak to mesophytic forests within a generation. Native wildlife species dependent on trees producing large-seeded acorns and nuts may be imperiled (Nowacki and Carr in press). To maintain the oak component, silvicultural systems need to be matched to the site characteristics combining harvest systems with regeneration treatments such as prescribed burning.

Utilization Standards

Utilization standards for commercial timber harvest are shown below in Table B.1; details are available in the Timber Sale Administration Handbook (FSH 2409.15).

Table B.1

UTILIZATION STANDARDS (36 CFR 219.9)

	Minimum Tree[1] Specifications		Minimum Piece Specifications	
Type Product	Diameter inches at breast height	Length[2] (feet)	Diameter Small end/inside Bark (inches)	Percent Sound (without defect)
Hardwood Sawlogs	11.0	8	9.6	40
Softwood Sawlogs	9.0	8	7.6	40
Hardwood Pulpwood Softwood Pulpwood	7.0 5.0	8 8	5.0 4.0	70 % sound [3] and reasonably straight [4]

1 A minimum tree must include at least one piece that meets minimum specs.

2 Plus trim allowance.

3 70 percent applies to rot, voids, and char. Mechanical defects shall not be considered.

4 Reasonably straight: When the true center line of a minimum length piece does not deviate more than one-half the inside diameter of the small end, plus 1 inch from a straight line drawn between the centers of the ends of the piece.

The Forest Supervisor may set more stringent utilization standards if local conditions and markets permit; more liberal standards would require Regional Forester approval.

Because of species variety, products sold, and variation in local requirements, the Forest Supervisor may establish local standards for special products with the approval of the Regional Forester.

Contractual requirements to remove hardwood pulpwood may be met by felling the pulpwood trees.

The schedules shown in Tables B.2 and B.3 meet all the requirements specified in 36 CFR 219.16. This vegetative treatment schedule is based on current conditions and available information at the time the Forest Plan is being revised. If conditions change or new information becomes available, the program may be modified during the implementation of the Plan. The degree of modification will determine whether or not the Plan will need to be amended.

Table B.2

FIRST DECADE VEGETATIVE TREATMENT PROGRAM
Acres by Treatment Type Accomplished by Timber Sales

Clearcut	Shelterwood	Single Tree	Group Selection
2,020	840	1,110	2,850

Table B.3

ESTIMATED DECADE ONE VOLUME - MILLION BOARD FEET

Sawtimber Volume		Pulpwood Volume	
Hardwood	Pine	Hardwood	Pine
28.6	7.6	13.7	7.8

The acreage by treatment type and volumes are estimates only. The actual acreage treated and the volume of timber offered will be determined through site-specific planning at the project level and budget realities. Acres treated and volumes offered will be consistent with the objectives established in this Forest Plan.

There are several possible vegetation management treatments that could occur. Definitions of each of these practices are found in the glossary (Appendix A).

Timber stand improvement practices include: pruning, crop tree release, grapevine control, precommercial and commercial thinning, understory treatments, salvage, sanitation, and prescribed fire. Regeneration practices include planting and site preparation for natural regeneration.

Stocking Levels To Meet Regeneration Objectives

Minimum Hoosier National Forest stocking standards five years after timber harvest for even-aged hardwood management and uneven-aged hardwood management using group selection are:

> Unless a stand specific prescription calls for less, at least 150 potential crop trees per acre are needed to maintain the oak-hickory forest type. Potential crop trees must be generally recognized as having commercial value and be of good form and vigor. The average diameter of potential crop trees must be 0.5 inches dbh or larger. Potential crop trees must be well distributed over the regeneration area.

This stocking level was developed to determine the likelihood of regenerating a fully stocked oak-hickory stand. In many cases, stand prescriptions may call for less oak and hickory due to the many factors that inhibit regeneration of the oak-hickory forest type. In these areas species other than oak and hickory such as yellow-poplar will make up part of the 150 potential crop trees.

Planting For Reforestation

Some planting may be required to protect a site or to increase species diversity. Only native vegetation will be planted. Newly acquired parcels may be planted to reforest open areas.

See Table B.4 on species selection when planting is the option selected and Table B.5 on the shade tolerance of selected species.

Table B.4

SPECIES SELECTION GUIDE FOR REFORESTATION

Common Name	Scientific Name	Site	Shade Tolerance	Notes
shellbark hickory	*Carya laciniosa*	strictly a bottomland species	shade tolerant	grows on sites too wet for shagbark hickory
shagbark hickory	*Carya ovata*	rich alluvial soils along streams	shade tolerant	tolerant of drought
redbud	*Cercis canadensis*	moist, well-drained sites	shade tolerant	will not tolerate wet soil
flowering dogwood	*Cornus florida*	rich well drained soils	somewhat shade tolerant	sensitive to drought
hazelnut	*Corylus americana*	rich moist soil	intermediate	full sun will increase nut production
persimmon	*Diospyros virginiana*	wide range, best on alluvial sites	shade tolerant	drought tolerant
white ash	*Fraxinus americana*	moderately well drained	tolerant as seedling, but becomes intermediate to intolerant as it ages	grows most commonly on fertile soils with a high nitrogen content and a moderate to high calcium content
green ash	*Fraxinus pennsylvanica*	prefers wet sites	intermediate	
Kentucky coffee tree	*Gymnocladus dioicus*	rich alluvial soils along streams and in wooded openings	shade tolerant	prolific root sprouter
butternut	*Juglans cineria*	prefers deep, rich moist soils	intolerant	now a rare tree due to butternut canker
black walnut	*Juglans nigra*	prefers deep, rich moist soils	intolerant	
sweetgum	*Liquidambar styraciflua*	wet, moist alluvial soils	intolerant	few diseases are associated with sweetgum
yellow-poplar	*Liriodendron tulipifera*	deep, rich, well-drained soils	intolerant	seeds must overwinter under natural conditions to overcome dormancy
flowering crab apple	*Malus coronaria*	grows on a wide variety of sites	intolerant	prolific root sprouter
blackgum	*Nyssa sylvatica*	moist alluvial, slightly acidic soils	shade tolerant	
ninebark	*Physocarpus opulifolius*	grows on a wide variety of sites	intermediate	best growth on moist sites

Common Name	Scientific Name	Site	Shade Tolerance	Notes
American sycamore	*Platinus occidentalis*	grows on a wide variety of sites	intolerant	does well on moist bottomlands
bigtooth aspen	*Populus grandidentada*	prefers dry sites	intolerant	can be planted on wet sites
black cherry	*Prunis serotina*	rich moist mesic sites	intolerant	
white oak	*Quercus alba*	well adapted to most soils, but prefers deep moist soils	intermediate, but less tolerant with age	
bur oak	*Quercus macrocarpa*	upland, wet depressional sites	intermediate	often dominates severe sites with thin soils
chinkapin oak	*Quercus muehlenbergii*	dry sites	shade tolerant	is common on southern aspects
pin oak	*Quercus palustris*	grows on poorly drained wet sites	intolerant	can be inundated in water for weeks and survive
chestnut oak	*Quercus prinus*	poor sites, dry rocky uplands	intermediate	usually found in pure stands
northern red oak	*Quercus rubra*	mesic sites	intermediate	
Shumard oak	*Quercus shumardii*	well drained bottomlands	intolerant	
post oak	*Quercus stellata*	dry shallow nutrient poor soils	intolerant	slow growing, usually associated with blackjack oak
black oak	*Quercus velutina*	moist, well drained soils	intermediate	
black locust	*Robina pseudoacacia*	grows on a wide variety of sites	intolerant	good on poor sites

Note: Native species not listed in this table may be planted on appropriate sites.

Table B.5

SHADE TOLERANCE OF SELECTED SPECIES[1]

Very tolerant	Tolerant	Intermediate	Intolerant	Very Intolerant
		White oak	Black walnut	
Beech	Red maple	Red oak	Butternut	Quaking aspen
Sugar maple	Silver maple	Black oak	Hickories	Bigtooth aspen
	Basswood	American elm	Paper birch	Cottonwood
	Buckeye	Rock elm	Yellow-poplar	Black locust
	Boxelder	White ash	Sassafras	Willows
		Green ash	Sweetgum	
		Black ash	Sycamore	
		Hackberry	Black cherry	

[1] (Mills *et al* 1987)

Timber Resource Summaries

Land Suitability

Table B.6 identifies the lands suitable and unsuitable for timber production according to the National Forest Management Act and the implementing regulations. Unsuitable lands for timber production by management area are shown in the footnotes.

Table B.6

LAND SUITABILITY SUMMARY

LAND CLASSIFICATION	**Acres**
Total National Forest System Land	199,150
Nonforest Land[1]	(11,962)
Forest Land Withdrawn from Timber Production[2]	(13,673)
Forest Land Not Producing Crops of Wood	0
Forest Land Physically Not Suited:	
Irreversible Damage Likely to Occur	0
Not Restockable within five years	0
Forest Land with inadequate information	0
Forest Land, Tentatively Suitable	173,515
Forest Land not Appropriate for Timber Production[3]	(92,972)
Total Suitable Forest Land	80,543

[1] Includes all lakes, ponds, waterholes, wetlands, rivers, permanent forest openings, barrens, redcedar glades, roads, rock outcrops, and marginal timberland.

[2] Lands withdrawn from timber production designated by Congress, the Secretary of Agriculture, or the Chief of the Forest Service including the 12,953 acre Charles C. Deam Wilderness, 632 acre Paoli Experimental Forest, and 88 acre Pioneer Mothers Research Natural Area.

[3] Lands identified as not appropriate for timber production for the following reasons: assigned to other resource uses to meet Forest Plan objectives including all existing developed recreation sites; visually sensitive areas; and Management Areas 2.4, 6.2, 6.4, and 8.2; and bottomland areas of Management Area 2.8.

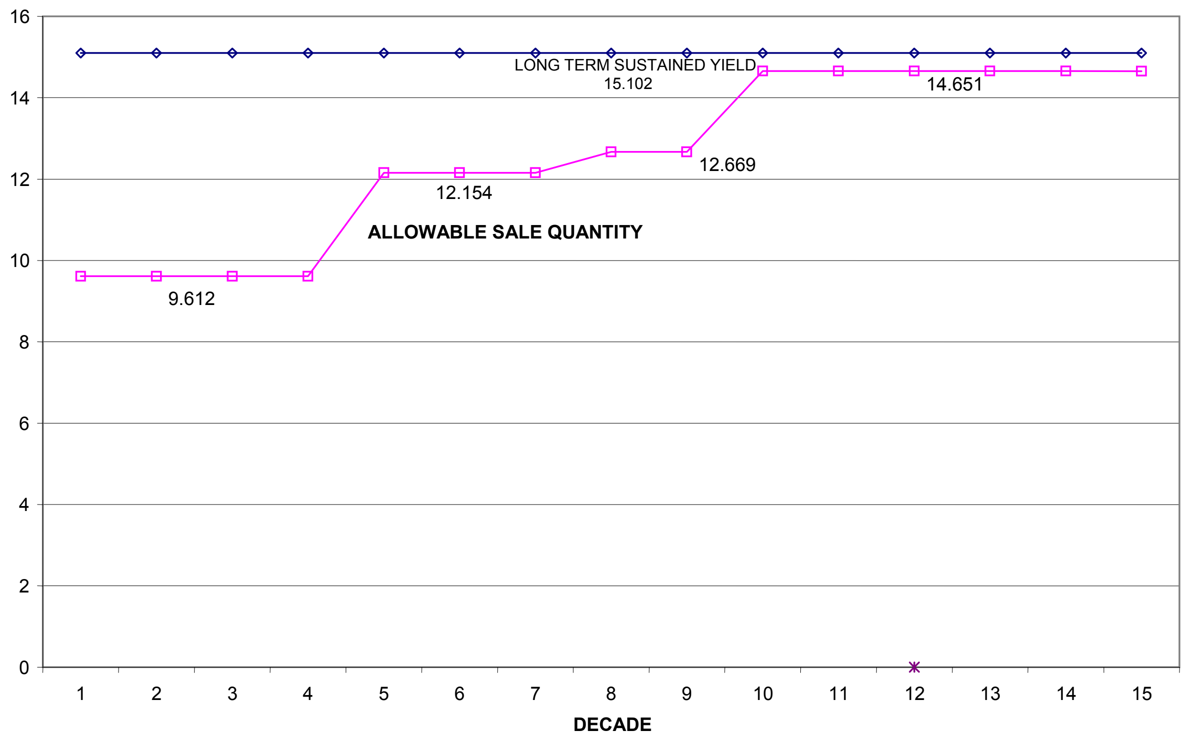
Allowable Sale Quantity and Long-Term Sustained Yield

Figure B.1 displays the relationship between the planned timber sale levels over the planning horizon and the long-term sustained yield of the Forest. Long-term sustained yield is 15.1 million cubic feet/decade (90.6 million board feet/decade) and is not reached in the first 15 decades.

Base Sale Schedule. A base sale schedule is a timber sale schedule formulated on the basis that the quantity of timber planned for sale and harvest for any future decade is equal to or greater than the planned sale harvest for the preceding decade. This planned sale and harvest is not greater that the long-term sustained yield capacity of 15.1 million cubic feet per decade.

Culmination of Mean Annual Increment (CMAI)
The CMAI ranges between 50-60 years for hardwoods and 20-25 years for pine in Indiana.

Figure B.1
PROJECTED ALLOWABLE SALE QUANTITY AND BASE SALE SCHEDULE [1]
Units are MMCF/Decade



[1] To calculate the approximate volume in million board feet, multiply the million cubic feet volumes by the factor of 6.

Allowable Sale Quantity (ASQ) and Vegetation Management Practices

Table B.7 shows the allowable sale quantity in the first decade of the Plan by harvest method. It also shows projections of other intermediate and reforestation activities and the acres by activity.

Table B.7
ALLOWABLE SALE QUANTITY AND VEGETATION MANAGEMENT PRACTICES
(Average Annual - First Decade)

		Allowable Sale Quantity Million Board Feet		
Harvest Method	**Acres**	**Sawtimber** (All Treatments)	**Other Products** (All Treatments)	**Total Products**
REGENERATION HARVEST Even-aged Management Clearcut Shelterwood Uneven-aged Management Group Selection Single Tree Selection	 202 84 285 111	3.62	2.15	5.77
Timber Stand Improvement	571	0	0	0
REFORESTATION 1/	571	0	0	0

1/ Includes natural and artificial. Site preparation and timber stand improvement are estimated on the actual cut acres of the: clearcut, shelterwood, and group selection harvest methods.

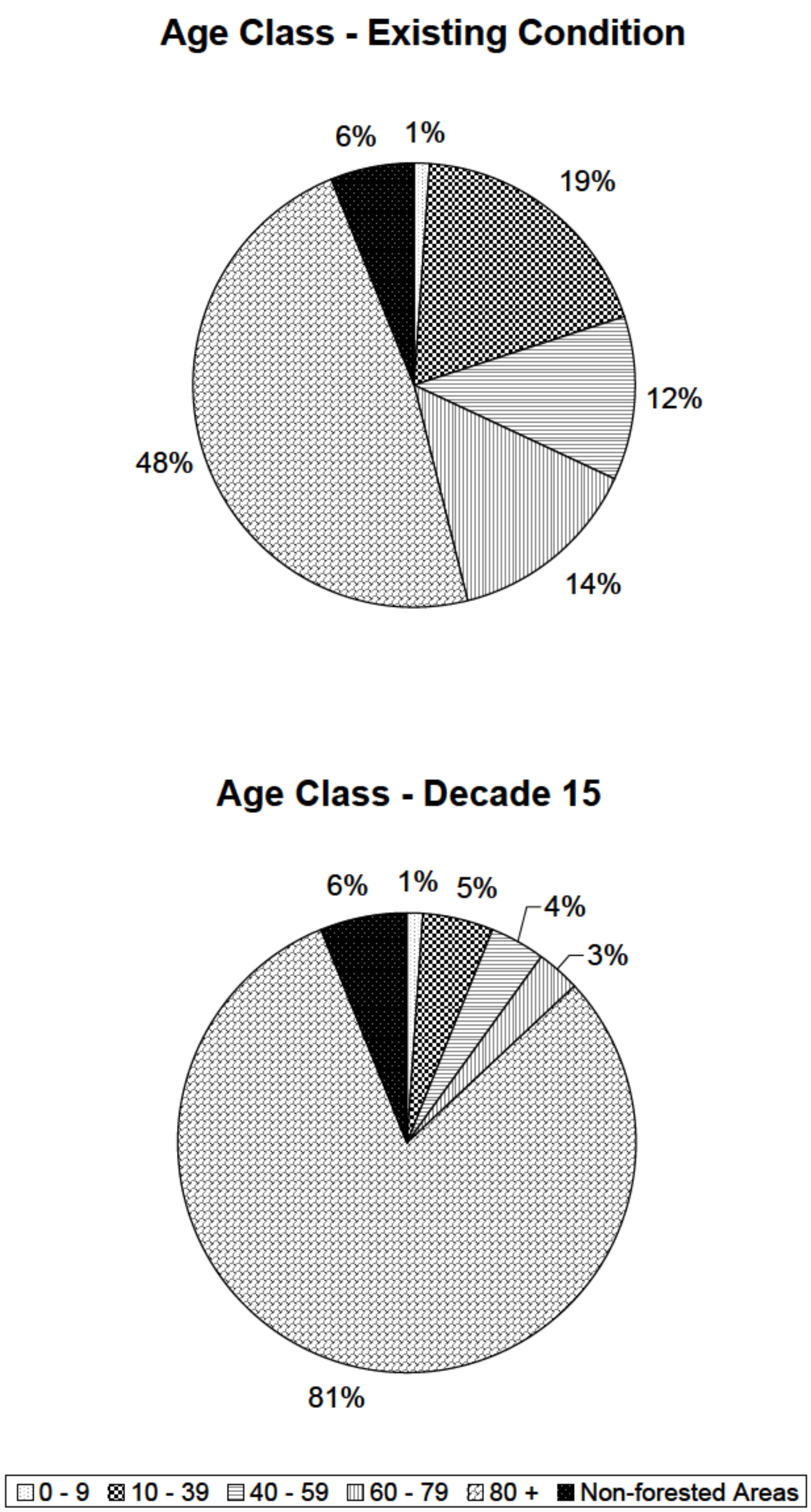
Note: These are projections used in planning. The actual amount of vegetative management practices conducted will be determined at the project level and based on budget realities. Also, year-to-year mixes of activities and volumes are expected to vary, but the allowable sale quantity of 57.7 million board feet for decade one will not be exceeded. It should be noted that this ASQ is higher than the past plan's 44.0 million board feet for decade one. This is due to the growth that has occurred since that planning period. While the ASQ is higher the acres treated remains the same.

Other Timber Information

Figure B.2 displays the age class distribution of the forested stands today and a projection of 150 years from today. It includes non-forested areas which are forest openings, lakes, ponds, streams, and power line rights of way. The projection shows that mature hardwood will increase under the Forest Plan's management from the existing 48 percent to an eventual 81 percent mature hardwood in 150 years.

Figure B.2

EXISTING AND DECADE 15 AGE CLASS PROJECTIONS



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Appendix C

FEDERALLY ENDANGERED AND THREATENED; SENSITIVE SPECIES; MANAGEMENT INDICATOR SPECIES

Federally Endangered, Threatened, and Proposed Species

As a Federal agency, the USDA Forest Service has defined responsibilities in supporting recovery objectives for Federally listed endangered, threatened, and proposed species. Populations of these species will receive individualized attention. Management activities that may affect Federally listed species occur in consultation with the USDI Fish and Wildlife Service**.** If additional species that occur on the Hoosier become listed as endangered or threatened, the Hoosier will consult with USDI Fish and Wildlife Service as appropriate (50 CFR 402.16).

The USDI Fish and Wildlife Service have identified five Federally listed species as having part of their range on the Hoosier National Forest. Indiana bat (*Myotis sodalis*), gray bat (*Myotis grisescens*), rough pigtoe mussell (*Pleurobema plenum*), and eastern fanshell mussel (*Cyprogenia stegaria*) are listed as endangered. The USDI Fish and Wildlife Service list the bald eagle (*Haliaeetus leucocephalus*) as threatened.

Indiana bat is widespread in Indiana and occupies much of the eastern half of the United States, from Oklahoma, Iowa, and Wisconsin east to Vermont, and south to northwestern Florida. Although there are a limited number of occurrence records for this species on the Hoosier National Forest, its habitat occurs throughout the Forest. Gray bat and eastern fanshell are of limited distribution in Indiana. There are only three known records of gray bat and one of the eastern fanshell on or near the Hoosier National Forest. There is evidence that the rough pigtoe mussel occurs or occurred in the Wabash and East Fork White Rivers in Indiana.

Eagles have repeatedly nested on National Forest System lands adjoining Patoka Lake (Castrale and Ferchak 2001), and within the Crooked Creek watershed adjoining Lake Monroe. No less than nine nest attempts were made by bald eagles within the boundary of the Forest in 2004. Two successful nest attempts occurred on NFS lands during the 2004 breeding season, one near Axsom Branch on Lake Monroe (near Crooked Creek) and one other nest on the Lost River near the Narrows Marsh in Martin County.

MANAGEMENT DIRECTION

Conservation Plan for Federally Threatened, Endangered, and Proposed Species

This Plan fulfills Endangered Species Act Section 7(a)(1) obligations for conservation of threatened, endangered, and proposed species. The Hoosier National Forest is committed to conserving, protecting, and maintaining habitat for Federally listed species. The Conservation

Plan of the Hoosier National Forest is, first of all, this Land and Resource Management Plan. The foundation of the Hoosier National Forest's Conservation Plan is the allocation of land into management areas that have the ecological conditions needed by particular species. A primary purpose of management area allocations is protection of biological diversity, including the conservation of threatened and endangered species. Management area desired conditions and guidance aid in conserving threatened and endangered species by providing a variety of ecological conditions.

Management Area (MA) 2.4 protects the shorelines of lakes, a primary nesting habitat for bald eagle. MA 2.8 and 3.3 provide benefits for a variety of users and resources. These management areas allow for vegetation management, which serves a variety of wildlife purposes, including the maintenance or enhancement of roosting habitat for the Indiana bat. MA 5.1 and MA 6.2 provide isolation, opportunity for natural succession, and areas with limited modification. Areas with such characteristics provide important habitat for wildlife, including threatened and endangered species. MA 6.4 primarily provides for natural succession to an old growth (climax) condition and limited modification. The direction for MA 8.1 (Research Natural Areas) includes "providing habitat for endangered species." MA 8.2 areas are Special Areas, and their management emphasizes the protection, perpetuation, or restoration of their special features and values. Special features include barrens, caves, and rock outcrops. The 632-acre Paoli Experimental Forest, which provides opportunities for studying the effects of specific management actions, is presently the only area designated 8.3. Taken together and with other Forest Plan guidance, the management areas provide a variety of habitats for various wildlife and plant species, with emphasis on threatened and endangered species. Approximately 60 percent of the Forest is in areas not appropriate for timber harvesting.

Recovery plans have been prepared for bald eagle, eastern fanshell mussel, gray bat, Indiana bat, and rough pigtoe mussel. The USDA Forest Service will work with the USDI Fish and Wildlife Service to identify and meet recovery objectives for the species on the Forest.

The purpose and goal of any conservation plan is recovery of each species such that there is no longer a need to list it as endangered or threatened under criteria found in Section 4(a)(1) of the Endangered Species Act, as amended. Actions of the Hoosier National Forest are directed toward conservation of listed species and, whenever possible, contributing toward recovery objectives outlined in approved recovery plans.

Relationship to Other Documents

To meet the consultation requirements under Section 7(a)(2), the Hoosier National Forest completed the Programmatic Biological Assessment for Land and Resource Management Plan Hoosier National Forest (Biological Assessment) in April 2000. The Fish and Wildlife Service responded with their Biological Opinion on the Land and Resource Management Plan Hoosier National Forest, Indiana on July 31, 2001. This Biological Opinion provided terms and conditions to ensure that actions carried out under the direction of the Forest Plan would minimize the potential for incidental take. The Biological Assessment included a list of management activities with amounts (acreages, miles, etc.) estimated to occur in the next five years.

Species-specific recovery plans provide additional guidance for conserving and recovering each endangered or threatened species throughout its range. Each recovery plan has been developed by a team of scientists who are experts on the species being addressed. The Hoosier National Forest encompasses only a small part of the range of each of the four endangered or threatened species, so all recovery objectives may not be applicable to the Forest.

Direction

The Endangered Species Act provides authority for the Hoosier National Forest to be involved in and further the protection and recovery of threatened and endangered species. Section 7(a)(1) states, "All other Federal agencies shall, in accordance with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to Section 4 of this Act."

Section 2(b) of the Endangered Species Act states, "The purposes of this Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for conservation of such endangered species and threatened species…"

The policy of Congress, according to Section 2(c)(1), is "that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of this Act."

Biological evaluations or assessments will be conducted as part of site-specific analyses for known populations of Federally listed endangered, threatened, and proposed species (FSM 2672.4). Guidelines and mitigating measures are implemented if a determination is made through a biological evaluation or assessment that a species may be affected.

If it is determined that an endangered, threatened, or proposed species may be affected by a management decision, evaluation criteria will be established in consultation with the USDI Fish and Wildlife Service as early in the process as possible. These criteria will identify: (1) what (if any) additional information is needed and (2) what mitigation measures or course of action is most appropriate for conservation of the species involved. The Forest Service is responsible for collecting additional information if needed.

Current management direction for the Hoosier is not likely to adversely affect gray bat, eastern fanshell or rough pigtoe mussel, or bald eagle, as determined by the July 31, 2001 biological opinion from the USDI Fish and Wildlife Service - Bloomington Field Office. That Biological Opinion also concluded that continued implementation of the Forest Plan was "not likely to result in jeopardy" to the Indiana bat.

Some conservation actions may change if a species recovers and is delisted. The Conservation Plan will evolve as the Forest learns more about individual species, their limiting factors and habitat requirements, and the effects of various activities on these species. The following paragraphs provide direction in various aspects of the management of the Hoosier National Forest with regard to threatened and endangered species.

- Consult with USDI Fish and Wildlife Service to ensure that activities planned and implemented on the Hoosier National Forest meet both the letter and intent of the Endangered Species Act, as amended.

- Cooperate with experts in other agencies, universities, organizations, and Forest Service research to identify objectives and projects that will conserve, protect, and recover populations and habitats of threatened and endangered species.

- Provide training and continuing education to Hoosier National Forest employees to ensure our workforce has the best scientific information available upon which to base decisions concerning threatened and endangered species on the Forest.

- Provide accurate and current information about the threatened and endangered species' life history requirements, habitat needs, threats to survival, and population and habitat status on the Hoosier National Forest, in Indiana, and across the species' ranges to ensure a sound basis for decision-making.

- Provide the public opportunities to learn about and appreciate threatened and endangered species so they will understand the importance of activities designed to maintain, protect, and recover these species and their habitats.

- Devise and implement a plan to guide the silvicultural management of the Forest that is based on sound principles of ecosystem management and works within the capabilities of the land to sustain natural resources, provide biodiversity, including habitat for, and populations of, threatened and endangered species.

- Acquire lands that provide habitat for threatened and endangered species through exchange with, or purchase or donation from, willing landowners.

- Ensure compliance with all laws, regulations, and policies pertaining to endangered and threatened species on the Hoosier National Forest.

- Cooperate with the USDI Fish and Wildlife Service law enforcement and other law enforcement agencies in enforcing laws and regulations pertaining to endangered and threatened species.

The Hoosier will report accomplishments that aid in the conservation of threatened and endangered species in the annual Monitoring and Evaluation Report.

Regional Forester Sensitive Species

As of October 20, 2003, the Regional Forester has designated 741 species as sensitive in the Eastern Region. This list updated the February 29, 2000 Regional Forester sensitive species lists for both animals and plants. These are plant and animal species for which population viability is recognized as a concern, as evidenced by a downward trend in population or habitat capability.

Regional Office staff maintain the Regional Forester sensitive species list, which is located on the internet site at: http://www.fs.fed.us/r9/wildlife/tes/tes_lists.htm. The current list for the Hoosier National Forest and any future updates are posted there.

Based on the October 2003 list, the Hoosier has 119 species as Regional Forester sensitive species. Of these species, 89 are animals and 30 are plants.

Another 8 animals and 40 plants that are sensitive species within the Eastern Region occur on the Forest. Risk evaluations for those species determined that they were not at risk or there is no concern about their continued viability on the Forest, and therefore, these 48 species are not designated as sensitive for the Hoosier.

Regional Forester sensitive species are designated and considered to be at risk, if they:
- Are candidates for listing under the Endangered Species Act;
- Have been delisted under the Endangered Species Act within the last five years;
- Have The Nature Conservancy species status ranks of G1-G3, T1-T3, N1-N3;
- Or are considered to be at risk based upon their state status ranks (S1-S3) and their respective forest risk evaluation.

Species listed as Regional Forester sensitive species must have at least one documented occurrence within the proclamation boundary of an Eastern Region national forest or grassland and be recognized as a valid species by taxonomic experts. The Regional Forester sensitive species list has been routinely and periodically maintained through a species risk evaluation process.

Direction and methods for maintaining and updating the Regional Forester sensitive species list is contained in a Region 9 supplement to the Forest Service Manual (FSM) 2670. The Forest Service Manual 2670 provides direction for sensitive species protection and management. The primary purpose of this direction is to be proactive and prevent each species from any loss of viability and ensure that any actions are not likely to cause a trend towards that species being listed as Federally endangered or threatened. In addition, it provides a basis for establishing sound management priorities for all Forest wildlife and plants.

As part of site-specific analyses, biologists will conduct biological evaluations to review and evaluate possible effects on sensitive species (FSM 2672.4). Project level analyses would identify and provide other necessary guidelines and mitigating measures not previously mentioned under Forest-wide guidance or management area guidance.

Management Indicator Species

Management Indicator Species Selection Process

The National Forest Management Act directs the Forest Service to select and track species that are of special interest or indicative of management trends. These species are called management indicator species (MIS). These MIS are selected on the basis of being likely candidates to provide information on the effects of management activities. Forest biologists reviewed 31 species identified as MIS in the 1991 Forest Plan Amendment along with the list of proposed MIS species developed in 1994 with the following criteria in mind:
- The diversity of habitats found on the Hoosier,
- Current forest issues,
- Feasibility and cost associated with monitoring populations across the forest,
- Ability to assess the effects of management activities listed in the alternatives on the selected species as well as the effects of additional species that utilize similar habitats, and
- Recommendations of the species viability evaluation panels.

The lack of creel surveys on the forest limited the selection of fish species, and the lack of surveys covering the three terrestrial species limited their selection. Because breeding bird survey routes have already been established on the Forest and breeding bird data has been consistently collected over the last ten years, bird species were chosen as MIS. After this selection, another criterion that was reviewed was whether a bird species was included in Cornell Lab of Ornithology's "Birds in Forested Landscapes Program." Data could be collected for this program with little additional cost, and could provide data regarding the specific habitat requirements of high-priority forest birds across the landscape.

Management Indicator Species Selected

The following five species were selected as MIS to cover a range of habitats, as well as a range of response to the issues presented in the Forest Plan: yellow-breasted chat (*Icteria virens*), American woodcock (*Scolopax minor*), Louisiana waterthrush (*Seiurus motacilla*), wood thrush (*Hylocichla mustelina*), and Acadian flycatcher (*Empidomax virescens*).

Yellow-breasted chat and American woodcock are MIS of early successional hardwood habitats. The effects of forest activities on these species indicate the effects on wildlife associated with early successional upland hardwood forest, open lands including old fields, and herbaceous open lands. The remaining species are associated with mature forests of varying tract sizes ranging from wood thrush on small tracts, to Louisiana waterthrush, to Acadian flycatchers which require much larger tracts of forest interior habitat. These species represent the effects on forest interior and forest fragmentation. Response to fire would vary among the species.

Table C.1 shows the management indicator species selected and the associated habitat conditions or life history traits for each.

Table C.1

MANAGEMENT INDICATOR SPECIES AND ASSOCIATED HABITAT CONDITIONS

Management Indicator Species	Habitat Conditions Associated with Species
yellow-breasted chat	• Early successional habitat; requires moderate to dense understory • Nests are located on lower limbs of trees or shrubs, hidden among leaves in a shady area
American woodcock	• Habitat requirements of woodcock vary with activity, time of day, and season. The birds prefer early successional habitats created by periodic disturbance of the forest. Therefore, young forests and abandoned farmland mixed with forested land are ideal woodcock habitat. • Woodcock use forest openings, clearcuts, fields, roads, pastures, and abandoned farmland as display areas for courtship. • Nests and broods are found in young to mixed-age forests, but young, open, second-growth stands are preferred. Nests are located on the ground. • During summer, young hardwoods and mixed woods with shrubs provide daytime cover for feeding.
Louisiana waterthrush	• Mature deciduous or mixed forests with moderate to sparse undergrowth, near rapid flowing streams. • Nests are located on the ground along stream banks, hidden in the underbrush, or among the roots of fallen trees.
wood thrush	• Inhabits the interior and edges of deciduous and mixed forests, generally in cool, moist sites. • Requires moderate to dense understory and shrub density with a lot of shade. • Nests are located on the lower limbs of a tree or shrub, usually 10 - 13 feet above ground, hidden among leaves in a shady area.
Acadian flycatcher	• Inhabits large tracts of mature, mesic, forests with shrubby understory. • Nests are usually placed on a fork of a horizontal branch well away from the main trunk. Height ranges from 6 – 30 feet.

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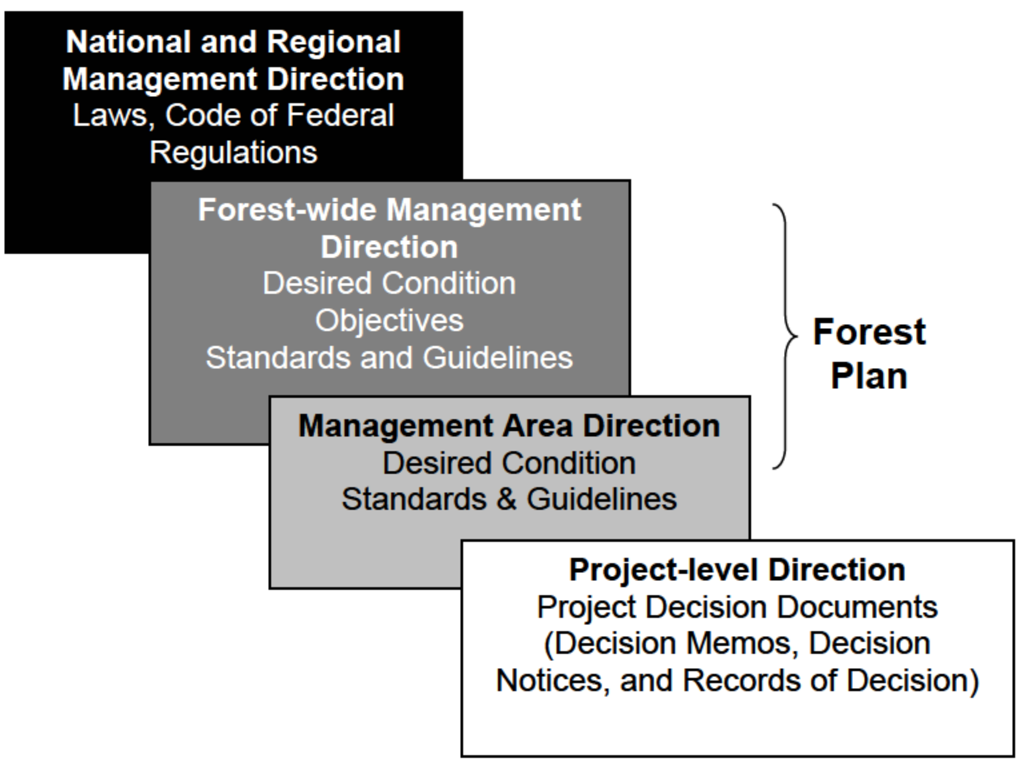
Appendix D

RELEVANT FEDERAL STATUTES, REGULATIONS, POLICY, AND AGREEMENTS

Management direction in the Forest Service Directive System, including the Forest Service Manual (FSM) and the Forest Service Handbook (FSH), is part of the forest plan management direction and is not repeated in the Forest Plan. Management direction also includes applicable laws, regulations, and policies, although they may not be restated in this Forest Plan.

Direction for managing NFS land comes from a variety of levels. National and regional direction includes laws, executive orders, regulations, and Forest Service policy. Figure D-1 illustrates this hierarchy of management direction beginning with national and regional direction at the highest level and ending with site-specific, project-level direction when the Forest Plan is implemented.

Figure D.1
HIERARCHY OF MANAGEMENT DIRECTION FOR NATIONAL FORESTS



FEDERAL STATUTES

The Hoosier National Forest will follow all of the laws listed below to the extent that they pertain to the USDA Forest Service.

Alaska National Interest Lands Conservation Act of December 2, 1980
American Indian Religious Freedom Act of August 11, 1978
American with Disabilities of 1990
Anderson-Mansfield Reforestation and Revegetation Act of October 11, 1949
Antiquities Act of June 8, 1906
Archaeological Resources Protection Act of October 31, 1979, as amended 1988
Architectural Barriers Act of 1968

Bankhead-Jones Farm Tenant Act of July 22, 1937

Clarke McNary Act of June 7 1924
Clean Air Act of July 14, 1955
Clean Air Act of August 7, 1977; Amendments of 1977 and 1990
Clean Water Acts (1948-87)
Clean Water Amendments (to “Federal Water Pollution Control Act Amendments of 1972”)
Color of Title Act of December 22, 1928
Common Varieties of Mineral Materials Act of July 31, 1947
Cooperative Forestry Assistance Act of July 1, 1978

Department of Agriculture Organic Act of August 3, 1956
Disaster Relief Act of May 22, 1974

Eastern Wilderness Act of January 3, 1975
Economy of June 30, 1932
Emergency Flood Prevention (Agricultural Credit Act) Act of August 4, 1978
Endangered Species Act of December 28, 1973
Energy Policy Act of August 8, 2005
Energy Security Act of June 30, 1980

Federal Advisory Committee Act of October 6, 1972
Federal Cave Resources Protection Act of November 18, 1988
Federal Insecticide, Rodenticide, and Fungicide Act of October 21, 1972
Federal Land Exchange Facilitation Act of August 20, 1988
Federal Land Policy and Management Act of October 21, 1976
Federal Noxious Weed Act of January 3, 1975
Federal Power Act of June 10, 1920
Federal Records Act of September 5, 1950
Federal-State Cooperation for Soil Conservation Act of December 22, 1944
Federal Water Pollution Control Act of July 9, 1956, as amended (Water Quality Act of 1965, Clean Water Restoration Act of 1966)
Federal Water Project Recreation Act of July 9, 1965
Fish and Wildlife Conservation Act of September 15, 1960
Fish and Wildlife Coordination Act of March 10, 1934
Forest Highways Act of August 27, 1958

Forest and Rangeland Renewable Resources Planning Act of August 17, 1974
Freedom of Information Act of November 21, 1974

Granger-Thye Act of April 24, 1950

Historic and Archaeological Data Preservation Act of May 24, 1974
Historic Sites Act of August 21, 1935

Knutson-Vandenberg Act of June 9, 1930

Land Acquisition Act of March 3, 1925
Land Acquisition-Declaration of Taking Act of February 26, 1931
Land Acquisition-Title Adjustment Act of July 8, 1943
Land and Water Conservation Fund Act of September 3, 1964
Law Enforcement Authority Act of March 3, 1905

Mineral Leasing Act of February 25, 1920, as amended
Mineral Leasing Act for Acquired Lands Act of August 11, 1955
Mineral Resources on Weeks Law Lands Act of March 4, 1917
Multiple-Use Sustained-Yield Act of June 12, 1960

National Environmental Policy Act of January 1, 1970
National Forest Management Act of October 22, 1976
National Forest Roads and Trails Act of October 13, 1964
National Historic Preservation Act of October 15, 1966, as amended
National Trails System Act of October 2, 1968
Native American Graves Protection and Repatriation Act of January 23, 1990

Occupancy Permits Act of March 4, 1915
Organic Administration Act of June 4, 1897

Pipelines Act of February 25, 1920
Public Land Surveys Act of March 3, 1899

Real Property Quiet Title Actions Act of October 25, 1992
Rehabilitation Act of 1973, as amended
Renewable Resources Improvement Act of June 30, 1978
Research Grants Act of September 6, 1958
Right of Eminent Domain Act of August 1, 1888
Rural Development Act of August 30, 1972

Safe Drinking Water Act of November 16, 1977 and Amendments
Secure Rural Schools and Community Self-Development Act of 2000
Sikes Act of October 18, 1974
Sisk Act of December 4, 1967
Small Tracts Act of January 22, 1983
Soil and Water Resources Conservation Act of November 18, 1977
Solid Waste Disposal (Resource Conservation & Recovery Act) Act of October 21, 1976
Supplemental National Forest Reforestation Fund Act of September 18, 1972
Surface Mining Control and Reclamation Act of August 3, 1977

Timber Export Act of March 4, 1917
Timber Exportation Act of April 12, 1926
Title Adjustment Act of April 28, 1930
Toxic Substances Control Act of October 11, 1976
Transfer Act of February 1, 1905

Uniform Federal Accessibility Standards
Uniform Relocation Assistance and Land Acquisition Policies Act of January 2, 1971
U.S. Criminal Code (Title 18 USC Chapter 91- Public Lands) Act of June 25, 1948

Volunteers in the National Forests Act of May 18, 1972

Water Quality Improvement Act of April 3, 1965
Water Resources Planning Act of July 22, 1965
Watershed Protection and Flood Prevention Act of August 4, 1954
Weeks Act Status for Certain Lands Act of September 2, 1958
Weeks Act of March 1, 1911
Wild and Scenic Rivers Act of October 2, 1968
Wilderness Act of September 3, 1964
Wood Residue Utilization Act of December 19, 1980

Youth Conservation Corps Act of August 13, 1970

Regulations

The Hoosier National Forest will also abide by the regulations listed below as they pertain to the U.S, Forest Service.

36 CFR 60 National Register of Historic Places
36 CFR 63 Determinations of Eligibility for Inclusion in the National Register of Historic Places
36 CFR 68 Secretary of the Interior's Standards for the Treatment of Historic Properties
36 CFR 79 Curation of Federally-Owned and Administered Archeological Collections
36 CFR 212 Forest Development Transportation System

36 CFR 213 Administration Under Bank-Jones Act
36 CFR 219 Planning
36 CFR 221Timber Management Planning
36 CFR 223 Sale and Disposal of NFS Timber
36 CFR 228 Minerals

36 CFR 241 Fish and Wildlife
36 CFR 251 Land Uses
36 CFR 254 Landownership Adjustments
36 CFR 261 Protection of Archaeological Resources
36 CFR 290 Caves as referenced in Appendix A

36 CFR 291 Occupancy and Use of Developed Sites and Area of Concentrated Public Use
36 CFR 293 Wilderness Primitive Areas
36 CFR 294 Special Areas

36 CFR 295 Use of Motor Vehicles off Forest Development Roads
36 CFR 296 Archaeological Resources Protection Act Uniform Regulations
36 CFR 297 Wild and Scenic Rivers
36 CFR 800 Advisory Council on Historic Preservation
36 CFR 1222-1238 Federal Records Act Uniform Regulations
40 CFR 121-135 Watershed Programs

40 CFR 1500-1508 Council on Environmental Quality
43 CFR Part 10 Native American Graves Protection and Repatriation Act Uniform Regulations
American Association of State Highway and Transportation Guidelines for Geometric Design of Very Low-Volume Local Roads, 2001
National Ambient Air Quality Standards
National Electrical Code

National Fire Code
Uniform Building Code
Uniform Mechanical Code
Uniform Plumbing Code

Executive Orders

EO 11593 Protection and Enhancement of the Cultural Environment
EO 11990 Protection of Wetlands
EO 11644/11989 Use of Off-Road Vehicles
EO 11988 Floodplain Management

EO 12088 Federal Compliance with Pollution Control Standards
EO 12898 Environmental Justice

EO 13007 Indian Sacred Sites
EO 13112 Invasive Species
EO 13287 Preserve America

Policy and Guidelines

Forest Service Heritage Strategy
Forest Service Manuals (all)
Forest Service Handbooks (all)
R8/R9 Policy on the Treatment of Human Remains
Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation
Forest Service Heritage Meaningful Measures

State and Local

Indiana State Law IC-14-21 Historic Preservation and Archaeology
Indiana State Law IC-22-1 Human Remains, Burial Objects, and Artifacts

326 Indiana Administrative Code Article 4 4-1-3 Exemptions

Logging and Forestry Best Management Practices for Water Quality in Indiana, 1998

Gray Bat Recovery Plan, U.S. Fish and Wildlife Service, 1982
Fanshell Recovery Plan, U.S. Fish and Wildlife Service, 1991
Indiana Bat Recovery Plan, U.S. Fish and Wildlife Service, 1983
Northern States Bald Eagle Recovery Plan, Northern States Bald Eagle Recovery Team, 1983
Rough Pigtoe Mussel Recovery Plan U.S. Fish and Wildlife Service, 1984

Appendix E

LAND ADJUSTMENT STRATEGY

The intent of this section is to prioritize purchase and exchange activities by management areas. All land acquisition is based on availability and a willing seller. Condemnation will not be used on the Hoosier National Forest except in extreme cases to acquire rights-of-way or to clear title after all other efforts have failed. Following is a list of characteristics of land considered high priority for acquisition by either purchase or exchange.

High Priority Acquisitions

Management Area 2.4

Acquire lands along major fishing and canoeing streams or adjacent to lakes to increase water-based recreation opportunities and to protect and develop wetland and bottomland hardwood resources. Lands that provide consolidation or protect closed-canopy forest along streams are a high priority. Acquiring these lands will protect the aquatic environment and provide consolidated ownership along water or riparian corridors.

Management Area 2.8

Acquire lands surrounded by or adjacent to existing NFS lands to consolidate ownership, increase remote recreation opportunities, or reduce resource management costs.

Management Area 3.3

Acquire lands surrounded by or adjacent to existing NFS lands to consolidate ownership, increase habitat management opportunities, add to biodiversity, or reduce resource management costs.

Management Area 5.1

Acquire lands in or adjacent to this management area to protect the wilderness character of the area.

Management Areas 6.2 and 6.4

Acquire lands, especially those surrounded or adjacent to existing NFS lands, to increase remote recreation opportunities in a natural forest environment, to provide extensive closed-canopied forest areas, or to provide travel corridors between areas. Although designed primarily to enhance biological diversity, these travel corridors provide unique opportunities for trails.

Management Area 7.1

Acquire lands identified as key properties in or adjacent to existing or potential recreation developments to improve dispersed and developed recreation opportunities around developed campgrounds.

Management Areas 8.1, 8.2, and 8.3

Acquire lands identified as key properties in or adjacent to Research Natural Area, Special Areas, or Paoli Experimental Forest. Lands that consolidate ownership or reduce resource management costs are also high priority for acquisition.

Management Area 9.2

Acquire lands identified as potential Research Natural Areas or potential Special Areas to protect the unique resources of those identified areas.

Other Areas

Acquire lands to protect or enhance threatened and endangered species habitat (see Appendix C), significant cultural resources, areas of historical interest, and special or unusual habitats or features such as springs, caves, geologic formation, and wetlands, regardless of management area.

Criteria for Land Exchanges

Land exchanges will be analyzed on a case-by-case basis. Some factors to be analyzed include:

- Accomplishes objectives of Federal law or regulation.
- Meets demand for national forest resources, including Special Areas.
- Results in more efficient land ownership patterns.
- Results in lower resource management costs.
- Needs a minimum of investment for management of tract—for example, extensive reclamation is not needed.
- Provides an opportunity to solve a problem, for example trespasses.
- Offers land that is best suited to other than NFS use.
- Improves or does not reduce access to NFS land.
- Results in more efficient property boundary management.
- Little likelihood of acquiring adjacent land.
- Isolated NFS tracts of 160 acres or less will normally be exchanged in their entirety.
- Lands are not needed for economic development.

Appendix F

PEST AND NONNATIVE INVASIVE SPECIES MANAGEMENT

The Hoosier will evaluate each pest control problem on the Forest using an Integrated Pest Management (IPM) approach before proposing any pest control activity. IPM is a process that attempts to regulate forest pests to achieve resource management objectives. It is the planned and systematic use of detection, evaluation, and monitoring techniques and all appropriate silvicultural, biological, chemical, genetic, and mechanical methods to prevent or reduce adverse effects of pest-caused damages. It is a six-step analysis procedure as follows:

1. Pest identification.
2. Population monitoring - pest biology, natural enemies, population dynamics, etc.
3. Determination of injury level - How much injury or impact must occur before action is taken?
4. Selection of most appropriate control method or methods: biological, chemical, mechanical, genetic, manual, or silvicultural.
5. Determine most effective timing of control application.
6. Monitor and evaluate effectiveness of control project (several years may be needed).

Prevention will be the emphasis of management related to all pest and nonnative invasive species problems. The Forest would also emphasize early detection and treatment of new infestations.

The Forest may use chemicals to control undesirable pests if non-chemical methods are ineffective. In every case, the Forest would carefully consider the effectiveness, specificity, environmental, and economic effects of individual applications. The Hoosier would also involve affected and interested individuals and organizations in our decision.

The Forest would use only Environmental Protection Agency (EPA) registered pesticides. In every case, we would choose the least persistent pesticides to achieve objectives. Application of pesticides would occur in ways that minimize the dose rate, vapor loss, and drift with the lowest toxicity necessary. Pesticides must be used in accordance with State laws.

Prioritization for pest and nonnative invasive species management would follow:
1. Prevention of new infestations
2. Early detection and treatment of new infestations
3. Treatment of sites with the greatest potential for spreading such as trailheads, parking lots, recreation areas, and administrative sites
4. Protection of known endangered, threatened, and sensitive plant and animal sites susceptible to harm from invasive species
5. Protection of Forest special areas and research natural areas
6. Containment and control of established infestations

The most common applications and anticipated needs of pest management include:

Pest and Undesirable Vegetation Control

- In recreation areas: (1) to control poison ivy, (2) to reduce the operational expense of trimming around trees and parking barriers and to maintain grassy and herbaceous vegetation along roadsides when mowing is not feasible, (3) to selectively remove vegetation from ponds and lakes to improve fish habitat, improve the area for people fishing, maintain vegetation-free swimming areas, and (4) dam or dike maintenance.

- Control ticks or chiggers in campgrounds, near trails, and in other places where people congregate: Ticks are becoming an increasingly serious problem in many areas due not only to growing populations, but also because of the diseases they carry.

- Wasps and bees may also be sprayed in areas where people congregate to protect visitors.

Aquatic Invasive Plant Control

- Aquatic weed control keeps boat ramps and beaches from being overrun with submerged or floating aquatic weeds. No equipment has been developed for mechanical control on small-scale applications such as exist on the Forest. Herbicides available for use have been selected for environmental safety; will not harm fish, people, or other aquatic organisms; and do not require closure of the lakes to swimming or fishing.

- In Forest ponds and lakes, fish populations occasionally become unbalanced. Surveys are periodically done in cooperation with IDNR. If a problem is identified, rotenone may be prescribed to kill the existing fish populations. The pond is then restocked with desirable fish species.

Timber Stand Improvement

- Plantation establishment is nearly impossible without control of competing vegetation. Mechanical methods or herbicide use are the preferred treatment methods. It is occasionally necessary to retreat an area after three years to release the seedlings from competing vegetation. The necessity for this type of work is directly related to the acquisition of old open fields.

- Herbicides can be used in improving species composition in young, naturally regenerated hardwood stands. This generally involves control of grapevines but also can include thinning trees to concentrate growth on the higher quality trees in the stand. Herbicides are applied directly to the cut stump of the vine or tree or into a cut "girdle" around the tree to kill it and prevent resprouting.

Forest Openings

- Forest opening and natural plant community maintenance is accomplished by bushhogging, mechanical brush removal, burning, herbicide use, or a combination of these methods. Herbicides can control the reestablishment of undesirable plant species, reducing costs, and increasing the length of time before re-treatment is necessary.

Public Utility Right-Of-Way Management

- Public utility rights-of-way and easements may pose vegetation management problems on the Forest. These treatments are implemented by utility companies with permission by the landowners involved, including the Forest Service. Maintenance work is done to ensure the lines are kept clear for uninterrupted public service. Utility corridors are normally treated selectively on the Forest, with both mowing and selective woody vegetation removal by basal spray application of herbicides. Some broadcast spraying is also permitted. The method of maintenance selected is based on existing vegetative conditions, aesthetics, economics, and proximity to streams, ponds, lakes, homes, gardens, and agricultural crops.

Insect and Disease Management

- Silvicultural changes can be the single most important action used to mitigate impacts of forest pests on the condition of the forest. Healthy well-managed forest vegetation would result in high levels of productivity. Genetically improved seedlings provide an opportunity to grow forests that are more resistant to insects and diseases. With the proper mix of silvicultural treatments, there is little opportunity for pest populations to reach unacceptable limits.

- Using the principles of IPM to control epidemic insect and disease outbreaks helps protect the Forest and surrounding private woodlands. When outbreaks do occur, natural variations in tree species and stand ages or condition of the immediate area may contain them. When these natural barriers are insufficient, the use of pesticides may be required to protect timber and other resources.

- If an outbreak does occur, the Forest could consider the use of biological and chemical pesticides to prevent an epidemic or reduce adverse effects of pests.

- The Hoosier would apply pesticides using the most economical methods that are specific in reaching their target. Pesticides can be indirectly applied by spraying from the air or ground nearby and by directly brushing or injecting undesirable vegetation. The efficiency of treating the pest and the chance of environmental damage would be taken into account when determining the application method.

Nonnative Invasive Plant Control

- Nonnative invasive plants occur across the Forest in scattered locations. Effective control measures are possible for smaller infestations using hand-pulling, mechanical methods, or prescribed burning. However, some invasive plant populations have reached the extent where applying pesticides is the only method feasible to remove or controll these infestations. For these larger infestations, the cost of manual or mechanical methods may be prohibitive and could result in excessive soil disturbance or other resource damage. In some instances, the release of biological control insects can be effective in controlling invasive plants.

- Application of selective herbicides can kill target invasive plants while minimizing the effects to desirable vegetation and animal species. In most cases, herbicides would be applied by spot treatment directly to nonnative invasive plant species. This technique minimizes herbicide drift to avoid adverse effects to desirable vegetation and other organisms, including humans.

- An important last step in nonnative invasive plant management is rehabilitation and restoration activities. These actions aid in reestablishing native vegetation and help minimize or reverse the effects from invasive plants. In 1994, the Forest developed a native seed nursery for native plant propagation. Seeds produced from the nursery or collected native seed from forest openings has been used to re-vegetate disturbed areas across the Forest. The Forest would continue using local native seed sources and under normal circumstances, would avoid planting or seeding with nonnative species. When native seed is unavailable or not feasible, the Hoosier would use nonnative annuals or non-persistent perennial species.

Appendix G

HOOSIER NATIONAL FOREST ROAD DESIGN GUIDELINES

DESIGN GUIDANCE

The following guidelines should be used, when appropriate, when setting design standards in road contracts or road special use permits on NFS lands in Indiana. The guidelines (Table G.1) are in compliance with Forest Service manuals and handbooks, recommended guidance from Hoosier staff, and the Indiana field guide for best management practices (IDNR 1998).

Table G.1

HOOSIER NATIONAL FOREST ROAD GUIDELINES

Type Of Use	Road Width (Feet)	Clearing Widths (Minimum Feet)	Driving Surface	Road Grades (Maximum Percent)	Traffic Svc Level	Maintenance Level	Cut Slope Ratios	Fill Slope Ratios
FS Access Roads non-gated, long term)	12	22	Aggregate	8	B	3-4	1:1-2:1	1½:1
FS Access Roads (gated, long term)	12	22	Native or Aggregate	12	D	1-3	1:1-2:1	1½:1
Driveways:								
1-5 Homes	12	22	Aggregate	8	B	3-4	1:1-2:1	1½:1
>5 Homes	14	24	Aggregate	8	B	3-4	1:1-2:1	1½:1
Recreation Roads:								
Access road (2 lane)	20	30	Asphalt or	8	A	4-5	1:1-2:1	1½:1
Campground loop	12	22	Aggregate	4	B	4-5	1:1-2:1	1½:1
Temporary Roads	10	10	Native or Aggregate	12	D	Obliterate after use	Verticle-2:1	1½:1

Note: All roads above are single lane except the 2-lane Recreation Access road.

ROAD WIDTH

The widths shown above are the recommended road widths; the actual width should be based on the design vehicle for that particular road.

On single lane roads, turnouts should be constructed for safety purposes. The location of turnouts should reflect the proper blend of road user, safety, visuals, and economics. Normally, turnouts should be located on the outside of cuts; outside of curves; low side of fills or at the run out point between through cuts and fills. Turnout widths should be a minimum of 10 feet wide and 50 feet long with 25-foot tapers. Turnout spacing is showing in Table G.2 below (USDA 1994a).

TURNOUT SPACING

Table G.2
TURNOUT SPACING AND OPERATIONAL CONSTRAINTS BY TRAFFIC SERVICE LEVEL

Traffic Service Level	Turnout Spacing	Operational Constraints
A	Make turnouts intervisible unless excessive costs or environmental constraints preclude construction. Closer spacing may contribute to efficiency and convenience. Maximum spacing is 1,000 feet.	Traffic: mixed Capacity: up to 25 vehicles per hour Design Speed: up to 40 mph Delays: 20 seconds/mile or less
B	Intervisible turnouts are highly desirable but may be precluded by excessive costs or environmental constraints. Maximum spacing is 1,000 feet.	Traffic: mixed Capacity: up to 25 vehicles per hour Design Speed: up to 25 mph Delays: should be 30 seconds/mile or less Use signs to warn non-commercial users of the traffic to be expected. Road segments without intervisible turnouts should be signed.
C	Maximum spacing is 1,000 feet. When the environmental impact is low and the investment is economically justifiable, additional turnouts may be constructed.	Traffic: small amount of mixed Capacity: up to 20 vehicles per hour Design Speed: up to 20 mph Delays: up to 60 seconds/mile Road should be managed to minimize conflicts between commercial and noncommercial users.
D	Generally, only naturally occurring turnouts, such as additional widths on ridges or other available areas on flat terrain are used.	Traffic: not intended for mixed Capacity: generally 10 vehicles/hour or less Design Speed: 15 mph or less Delays: up to 60 seconds/mile expected Road should be managed to restrict concurrent use by commercial and noncommercial users.

Note: On roads identified as being subject to the Highway Safety Act, intervisible turnouts or appropriate signing should be provided.

CLEARING WIDTHS

Clearing limits shall be kept to a minimum on all roads. The minimum clearing limits on all roads, not to be obliterated, are 5 feet from the shoulders of the road. On driveways and non-gated roads clearing limits shall be no greater than 5 feet beyond the top of cut and to the toe of fill. On gated access roads, the clearing shall be to the top of cut and toe of fill. On temporary roads clearing shall be enough to allow equipment to use the road without damage to the vehicle.

SLASH DISPOSAL

To meet the visual quality objectives of the *Forest Plan,* slash generated from construction activities should be disposed of in such a manner that large concentrations are not showing. However, not all of the slash needs to be removed from a site in order to meet the ecosystem objectives of the *Forest Plan*. There several ways to handle slash, but recommendations will be based on site-specific analysis. Slash is the tops, limbs, and unmerchantable logs generated by building a road. Possible slash handling recommendations are:

- Lop and scatter:
    - Scatter the slash so that it is generally between 2 feet and 3 feet high. The lowest heights would be recommended on Traffic Service Levels A and B roads, with taller heights allowed on Traffic Service Levels C and D roads.
    - A variation of lop and scatter is to place some of the slash in such a way as to trap sediment and mitigate effects on soil and water, if needed.
- Chip: The slash could be chipped. The chips could be scattered on the site or could be partially scattered and partially removed.
- Burn: If the volume of slash is heavy, some of it could be burned to reduce the fuel loading.
- Bury: Some of the slash and stumps could be buried in the disturbed area.
- Remove: Tree stumps could be removed from the site. Other slash could be partially removed, as listed above.

SURFACING

A minimum of 4 inches of aggregate should be placed on roads to be used year round. This will allow for adequate maintenance of the road surface. On gated roads, native surfacing is acceptable if the road is not to be used during wet times of the year. On temporary roads that are to be used during dry seasons, native surfacing is acceptable. If the road is to be used during wet seasons, the road shall be rocked to accommodate the design vehicle. Temporary roads shall be obliterated after use is terminated.

ROAD GRADES

The desired grade on roads is 8 percent or less. Safety, State laws, and economic and environmental constraints and concerns govern the selection of the maximum grade, or at least require mitigating measures to lessen the impacts of steep grades. The maximum grade varies with the ability of each material type to resist erosion. Steeper grades normally require additional costs for drainage, surface stabilization, maintenance, and use.

ROADWAY CRITERIA

The following recommendations should also be used as guidelines on new road construction.

Type

The travel way should be constructed to the following type for the grades given:

0-2 percent	Crowned
2-4 percent	Insloped or outsloped
4-8 percent	Insloped or outsloped with drain dips
>8 percent	Insloped with ditch

Insloped, outsloped, and crowned travel ways shall have a three percent cross slope (Garland 1983). Shoulders are usually not needed. On side slopes greater than 35 percent, full bench excavation for the roadway shall be used. Slopes less than 35 percent cut and fill excavation for the roadway can be used.

Sight distance

Roads should be evaluated for adequate sight distance on vertical and horizontal curves, intersections, and in passing areas. The ability to see ahead is important in the safe and efficient operation of a vehicle on a road.

Sight distance is the length of roadway ahead visible to the driver. The minimum sight distance available on a roadway should be sufficiently long to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path. At road intersections, this is of great importance to allow vehicles time to see and react to a vehicle turning into the path of another vehicle or slowing to make a turn.

Stopping sight distance should be calculated to arrive at a minimum sight distance needed for a vehicle to see an obstruction and slow enough to avoid a collision. To arrive at the minimum required sight distance refer to one of the following: FSH 7709.56 Road Preconstruction Handbook (USDA 1994a); A Policy on Geometric Design of Highways and Streets (American Association of State Highway and Transportation Officials 1994); or the Indiana Department of Transportation Design Manual, Part V, Volume I, Road Design (INDOT 1994).

Drainage structures

Use drain dips on road grades four to eight percent. Use culverts on grades of eight percent and greater. Install water bars on temporary roads when not in use (Barnickol 1988, IDNR 1998, USDA 1991, and West Virginia Department of Natural Resources Division of Forestry et al. 1980).

Culverts and drain dips should be skewed 30 degrees for ditch relief. Culverts shall consist of corrugated aluminum, galvanized or aluminized steel, or polypropylene. For culverts to be self-cleaning they should have a grade two percent greater than the ditch grade, minimum grade should be three percent (Beschta 1984b). If culverts are used on temporary roads, they shall be removed immediately upon termination of use on the road.

The Forest compared several sources for spacing formulas (Beschta 1984b, Fisher and Taber 1975, Kochenderfer 1970, Pence unknown, Trimble and Sartz 1957, Haussman and Pruett 1973, and USDA Forest Service Manuals and Handbooks). Spacing recommendations for culverts and drain dips are usually based on the Kochenderfer formula in the Eastern U.S. It is the formula that results in the spacing table on page 11 of the Indiana BMP field guide (IDNR 1998). The Kochenderfer formula is: spacing in feet = (400/slope percent) + 100 (Kochenderfer 1970). The formula results in the following spacing for culverts and drain dips by road grade.

Table G.3
RECOMMENDED MAXIMUM SPACING FOR CULVERTS AND DRAIN DIPS

Road Grade (Percent)	Spacing (feet)
1	500
2	300
3	233
4	200
5	180
6	167
7	157
8	150
9	144
10	140
11	136
12	133
13	131
14	129
15	127

Drainage structures should be properly sized. The structure size is dependant on local conditions, but an acceptable starting point is to have the area of the culvert-opening equal the area of the drainage channel at the high-water level. Although a minimum size of 12 inches diameter is recommended in many sources, the Hoosier NF recommends that the minimum culvert diameter be 18 inches due to the leaf litter in southern Indiana (Beschta 1984a, Douglass 1974, Fisher and Taber 1975, and Kochenderfer 1970). Smaller diameter pipes have a greater tendency to become plugged with leaves in the fall and winter. Additional information about installing culverts is found on pages 27 and 28 of the Indiana BMP field guide (IDNR 1998).

There are several methods commonly used to determine the runoff and size for the proper drainage structure. The selection of the method depends on the conditions, availability of reliable information, and judgment of the designer. Several of the procedures and formulas that can be used are:

- Drainage end area calculations
- The Manning Formula *
- The Talbot Formula*
- McMath and Burkli-Ziegler Formulas*
- The Rational Method*
- Computer Programs

*These formulas can be found in most drainage structure books such as the Handbook of Steel Drainage and Highway Construction Products (American Iron and Steel Institute 1971), FSH 7709.56 Drainage Structures Handbook (USDA 1994a and 1994b), and Flood Frequencies and Bridge and Culvert Sizes for Forested Mountains of North Carolina (Douglass 1974), as well as hydraulic manuals.

Appendix H

SPECIAL AREAS

Special Area Establishment

Currently, there are 24 special areas designated on the Hoosier National Forest. These special areas occur throughout the Hoosier National Forest on about 17,500 acres of NFS land. The following section provides a brief description and some of the more important recommended management needs for each special area.

Each special area should have a tailored management plan written, regularly reviewed, and updated. The Forest has completed management plans for some, but not all, special areas. Updates to these plans would occur when necessary and appropriate as new information becomes available.

For those areas that do not have management plans completed, the District Ranger will appoint an interdisciplinary team that will conduct an evaluation and write the management plan. The team will conduct inventories based on issues and resource concerns and develop a prescription framework for specific management of the special area.

The report should include any special or unique features and their locations, past research, interested or affected parties, issues and concerns, past and present uses/ecological conditions, general management needs and desired condition, and the team's recommendations. The plan will include specifics on ecological and use potential for the area, as well as specific management needed to achieve the desired condition. The plan will outline periodical and sequential treatments. A key part of each plan will be the monitoring steps established to evaluate management of the area. The interdisciplinary team then presents the management plan to the District Ranger for approval. Special area management plans must be compatible with *Forest Plan* direction.

Research Natural Area (RNA) Equivalent Designation

As part of a FY 2000 assessment of RNA representation for the Eastern Region some of the Hoosier special areas were noted as being RNA equivalents. For portions of special areas to qualify as RNA equivalents, they must have protection at least equal to that of a RNA. The process involves the identification of natural communities by community pattern and distribution. Each community receives vegetation quality and viability rankings on a scale from probably not viable to excellent quality, according to the best available data for the community. Every community receives three sub-ranks for size, condition, and landscape. To meet the requirement of a RNA equivalent, the area must have an overall ranking better than low quality.

The Forest has designated or incorporated all of the approximately 2,267 acres identified as RNA equivalents in 12 different special areas. The designated special areas provide similar protection for the areas. Each area containing an RNA equivalent is noted as such in the following text.

Special Area Descriptions

Beaver Creek

Location: Beaver Creek is located in Sections 10, 11, 14 and 15 of T3N, R2W, Lawrence County, Brownstown Ranger District.

Area: Approximately 186 acres

Type: Karst geology

General Description: Beaver Creek is an example of a Crawford upland karst valley. Moorestown Rise variously pumps water out of a subterranean conduit in its rise mode, or swallows water when Beaver Creek is in flood.

Management Needs: Recommended studies include dye tracing, water quality testing, and specific conductivity analysis. The gated county road that bisects the area from north to south needs to have erosion control measures installed to reduce sediment entering into the creek.

Browning Hill

Location: Browning Hill is located in Sections 1, 2, 3, 10, 11 and 12 T7N, R2E, and Sections 6 and 7 T7N, R3E, Brown County, Brownstown Ranger District.

Area: Approximately 1,190 acres

Type: Oak-hickory woods on ridge tops, mesophytic woods on a northeast facing slope

General Description: Relatively undisturbed and contains old growth woods containing trees of a noteworthy size for this area of the state.

Management Needs: Use prescribed fire to maintain chestnut oak community on the ridge tops. Illegal horse and bike use is occurring in the area. Management plan needs to address problem and propose potential solutions to curtail this activity.

Boone Creek

Location: Boone Creek is located in Sections 25, 26, 35, and 36 T4S R1W and Sections 30 and 31 T4S R1E, Crawford and Perry Counties, Tell City Ranger District.

Area: Approximately 700 acres

Type: Dry forest and barrens communities. Contains RNA equivalent acres in the little bluestem-sideoats grama, evergreen, or mixed wooded, herbaceous alliance communities.

General Description: The noteworthy features of the site are the barrens community.

Management Needs: Use repeated prescribed fire to restore and maintain the barrens and dry forest communities. Future management proposals are necessary for dealing with nonnative invasive plants.

Buzzard Roost

Location: Buzzard Roost is located in Sections 31, and 32 T4S R1E, Section 36 T4S R1W, and Section 1 T5S R1E, Perry County, Tell City Ranger District.

Area: Approximately 454 acres

Type: River bluffs communities

General Description: The noteworthy features of the site are the bluffs and the associated species.

Management Needs: The Forest needs to make proposals for dealing with nonnative invasive plants, incorporating management of the Buzzard Roost Recreation area, trails, and vistas without degradation to the special features of the area.

Carnes Mill

Location: Carnes Mill is located in Sections 11, 12, 13, and 14 T3S, R1W, and Section 18 T3S R1E, Crawford County, Tell City Ranger District.

Area: Approximately 280 acres

Type: The site is an historic mill site. It is a geologic site with subterranean cutoff forming a cave between the upper and lower curve in the river. The area consists of a dry upland forest community and sandstone cliffs. Contains RNA equivalent acres in the American beech, sugar maple, yellow poplar forest alliance and open bluff/cliff sparse vegetation communities.

General Description: The site is a bluff on the Little Blue River and includes an area across State Road 37 that has sandstone cliff communities. An historic mill took advantage of the subterranean cutoff in its operations. The area has special plant communities.

Management Needs: The Forest needs to develop proposals to deal with nonnative invasive plants.

Clover Lick

Location: Clover Lick is located in Sections 20, 21, 28, 29, 30 and 32, T5S, R1W, Perry County, Tell City Ranger District.

Area: Approximately 1,658 acres

Type: Dry forest and barrens communities. Contains RNA equivalent acres in the little bluestem-sideoats grama, evergreen, or mixed wooded, herbaceous alliance and the black oak – white oak forest alliance communities.

General Description: The noteworthy features of the site are the barrens and associated plant communities.

Management Needs: Removal of planted nonnative pines and encroaching brush would help to restore the barrens to its former size. Conducting periodic prescribed burns will continue the restoration of the barrens and the dry forest community. Several nonnative invasive plants are encroaching upon the barrens and control measures are needed. Removal of woody encroachment within the maintained openings allows for collection of Indian grass seed for future restoration projects both within the special area and in other areas on the forest.

Deer Creek

Location: The Deer Creek site is located in Sections 16, 20, and 21, T6S, R2W, Perry County, Tell City Ranger District.

Area: Approximately 135 acres

Type: Dry forest and sandstone cliff communities. Contains RNA equivalent acres in the American beech, sugar maple, yellow poplar forest alliance and open bluff/cliff sparse vegetation communities.

General Description: The noteworthy feature of this area is the sandstone cliff community and the presence of associated plant communities. Large sandstone boulders in the creek add to the scenic qualities.

Management Needs: Japanese honeysuckle is a nonnative invasive in the area and needs to be controlled.

Faucett Chapel

Location: The Faucett Chapel site is located in portions of Sections 3, 4, 9 and 10 of T2N, R2W, Orange County, Brownstown Ranger District.

Area: Approximately 89 acres

Type: Chinquapin Oak/Twinleaf plant community. Contains RNA equivalent acres in the chinquapin oak forest alliance community.

General Description: The plant community that exists on the site is one that might typically occur on soils derived from limestone. Chinquapin oak and twinleaf are obvious indicators of the site conditions. Removal of some over-story trees in the past had a beneficial effect on this area. Sugar maple in the understory is beginning to limit sunlight reaching the forest floor.

Management Needs: The Forest needs to control sugar maple to restore vigor to the understory plants. Several species of nonnative invasive plants occur within the area, but a recent study considered them as medium to low priority for invasive control.

Grease Gravy

Location: Grease Gravy is located in Sections 28, 29, and 33 T1N, and R1E, Orange County, Tell City Ranger District.

Area: Approximately 254 acres

Type: Karst geology and prehistoric animal features

General Description: Noteworthy karst community with prehistoric animal features found within the karst features.

Management Needs: Monitoring of the karst features should occur to assess public use and determine if it is damaging the special features.

Gypsy Bill Allen

Location: Gypsy Bill Allen is located in Section 31 T3N R2W, Section 36 T3N R3W, and Section 1 T2N R3W, Martin and Orange County, Brownstown Ranger District.

Area: Approximately 85 acres

Type: Karst geology

General Description: Karst features including species dependent upon these features, a spring, and exposed rock cliffs, shelters, and joints in a unique geomorphic weathering feature contained in Pennsylvanian age Mansfield sandstone.

Management Needs: Ensure the recharge area of the karst features does not add more than background levels of sediment to the system.

Harding Flats

Location: Harding Flats is located in Sections 11, 12, 13, 14, 23 T6S, and R2W in Perry County, Tell City Ranger District.

Area: Approximately 782 acres

Type: Dry upland forest community with barrens. Contains RNA equivalent acres in the little bluestem-sideoats grama, evergreen, or mixed wooded, herbaceous alliance and the black oak – white oak alliance communities.

General Description: The area is a dry upland forest with barrens. Eastern redcedar is invading the openings that contain some rare plant species.

Management Needs: The management plan for the area recommends removal of invading redcedars by cutting or burning. The continued use of fire is necessary to restore the barrens community. Removal of the nonnative pines in the northern portion of the area would contribute to restoring the barrens. Japanese honeysuckle is degrading the community and project proposals need to include controlling this nonnative invasive species.

Hemlock Cliffs

Location: Hemlock Cliffs is located in Sections 3, 4, 5, 8, and 9 T3S R1W in Crawford County, Tell City Ranger District.

Area: Approximately 1,860 acres

Type: Dry to mesic upland forest and sandstone cliff communities. Contains RNA equivalent acres in the chinquapin oak woodland alliance community.

General Description: The site contains Eastern hemlock remnants with cliff communities and associated plants.

Management Needs: Maintaining one 26-acre opening by using prescribed fire and mowing will continue. Rock climbing and rappelling have damaged some cliff communities. A forest closure order of the most sensitive part of the cliff has halted the continuation of much of the damage. Trails made by hikers, horse riders, and off-road vehicle users have damaged some areas. Attempts to close the worst of these user made trails has resulted in mixed results. These attempts should continue. The Forest has installed steps on the designated hiking trail to combat erosion on steep portions of the trail, re-routed portions of the trail to higher locations above the drainage, and construction of bridges to reduce impacts. Attempts to vacate old county roads have met with limited success. Before using prescribed fire, the Forest would examine the appropriateness of fire's application as a restoration tool in the upland communities. Several species of nonnative invasive plants have known occurrences within the area. Future control efforts will focus on those invasive species identified as having the greatest threats to the area.

Horse Mill Branch

Location: Horse Mill Branch is located in Section 1, T6S, and R1W, Perry County, Tell City Ranger District.

Area: Approximately 7 acres

Type: Plant community

General Description: The area contains an unusual plant community.

Management Needs: Continue to monitor the plant community and conduct research to determine what management will best encourage the continuation of the plant community. Other needs include careful treatment to control Japanese honeysuckle without damaging the rare plant located within the special area.

Huron Woods

Location: Huron Woods is located in Sections 7 and 18, T3N, R2W, Lawrence County, Brownstown Ranger District.

Area: Approximately 132 acres

Type: Shawnee Hills upland forest community

General Description: One of the least disturbed mesic upland forest communities in the Shawnee Hills Natural Region of Indiana.

Management Needs: Garlic mustard, a nonnative invasive plant occurs in the area and needs to be controlled.

Luke Knob

Location: Luke Knob is located in Sections 26, 27, 34, and 35, T3N, and R2W, Orange County, Brownstown Ranger District.

Area: Approximately 59 acres

Type: Dry mesic upland forest

General Description: One of the least disturbed dry mesic and mesic upland forests occurring in the Shawnee Hills Natural Region of Indiana.

Management Needs: Nonnative invasive inventories identified Bush honeysuckle as a potential problem and it is important to manage for its control.

Oil Creek

Location: Oil Creek is located in Sections 31 and 32, T3S, R1W; Sections 5, 6, 7, 8, and 18 T4S, R1W; and Sections 1, 2, 11, 12, 13 14, 23, 24, 25, and 26 T4S, R2W, Crawford and Perry Counties, Tell City Ranger District.

Area: Approximately 2,037 acres

Type: Cliff communities and associated plants. Contains RNA equivalent acres in the chinquapin oak woodland alliance community.

General Description: Contains Abbots Hollow, Jubin Creek, Bear Hollow, Oil Creek Cliffs, and Smith Hollow. These areas are disjunct sandstone cliff communities that have associated plants.

Management Needs: Monitor for nonnative invasive plants and treat if necessary.

Pioneer Mother's Memorial Forest

Location: The Indiana Pioneer Mother's Memorial Forest is located south of Paoli east of State Highway 37 in Sections 1, 6, 7, 12 T1N, R1W in Orange County, Tell City Ranger District.

Area: Approximately 170 acres.

Type: The major items of interest in the Pioneer Mothers' Memorial Forest are the trees in the 88-acre, old-growth timber area, a prehistoric Native American village site, and the memorial development. Contains RNA equivalent acres in the white oak forest alliance community.

General Description: Pioneer Mothers' Memorial Forest is a 258-acre tract; 88 acres were designated a Research Natural Area by Lyle F. Watts, Chief of the Forest Service, in January 1944. An additional 170 acres provides a protection area around the RNA and is designated the Special Area. The Pioneer Mothers' memorial is located on the trail entering the forest from Forest Road 1022 on the northeast.

Management Needs: Monitor visitor use and manage for scenic qualities. Control and manage the nonnative invasive plant populations that are within the area.

Plaster Creek

Location: The Plaster Creek site is located in portions of Sections 7, 10, 11 12, 14 and 23 of T2N, R4W, Martin County, Brownstown Ranger District.

Area: Approximately 568 acres

Type: The site consists of dry upland forest of chestnut oak/blueberry, sandstone cliff community, acid-seep spring community, bottomland hardwood forest of swamp white oak, sweetgum, and red maple. Contains RNA equivalent acres in the rock chestnut oak forest alliance; the American beech, sugar maple, yellow poplar forest alliance; the little bluestem-sideoats grama, evergreen, or mixed wooded, herbaceous alliance; the fringed sedge – royal fern/sphagnum spp. Saturated herbaceous alliance; the open bluff/cliff sparse vegetation; and the pin oak seasonally flooded forest alliance communities.

General Description: Area occurs adjacent to a series of sandstone bluffs paralleling Plaster Creek. A dry forest of chestnut oak, blackjack oak, and blueberry occur on the uplands. The few-flowered nut rush occurs here. This is the northernmost occurrence of blackjack oak on the Forest. The sandstone cliffs support hay-scented fern and cliff club moss. At Plaster Creek acid-seep, springs occur along the base of the cliffs. Cinnamon fern, royal fern, sphagnum moss, and green wood orchid occur there. The bottomland forest contains swamp white oak, swamp cottonwood, red maple, sweetgum, and yellow poplar with an understory of spicebush and winterberry.

Management Needs: Nonnative shortleaf pine seedlings occur in the dry forest above the seeps. The management plan for the area recommends their removal or killing them before they begin to replace the native plants. Reed canary grass, a nonnative invasive plant, threatens the noteworthy plant communities. Management proposals need to control and manage this species.

Visitors to the site have dislodged some plants from the cliffs, and trampling has occurred in the seep areas. Close monitoring of use should continue and if damage reaches unacceptable levels, the Forest would take appropriate mitigation measures or issue a local closure order.

Potts Creek

Location: Potts Creek is located in Sections 8, 16, 17, 19, 20, 21, 30, 31, and 32 of T3S R1W, Crawford County, Tell City Ranger District.

Area: Approximately 1,722 acres

Type: Plant communities. Contains RNA equivalent acres in the chinquapin oak woodland alliance community.

General Description: The area contains unusual plant association communities, including plants at the edge of their range.

Management Needs: Reducing competition would lead to increased vigor and reproduction of umbrella magnolia.

Rockhouse Hollow

Location: Rockhouse Hollow is located in Sections 24 and 25, T5S, R2W; and Sections 19 and 30, T5S, R1W; Perry County, Tell City Ranger District.

Area: Approximately 201 acres

Type: Dry upland forest community with barrens and sandstone cliffs. Contains RNA equivalent acres in the little bluestem-sideoats grama, evergreen, or mixed wooded, herbaceous alliance and the white oak forest alliance communities.

General Description: The site is an upland forest community ranging from dry to mesic. Sandstone cliffs are also present.

Management Needs: The management plan for the area recommends cutting or burning woody plants that are encroaching upon the barrens. Continuation of burning would also be helpful in restoration of the barrens community.

Stinking Fork Creek

Location: Stinking Fork Creek is located in Sections 28, 33, 34, and 35 T3S, R1W, Sections 2 and 3, T4S, R1W, Crawford and Perry Counties, Tell City Ranger District.

Area: Approximately 579 acres

Type: Perennial stream

General Description: The site is a high quality example of a medium gradient, perennial stream within the Shawnee Hills Natural Region. Included in the boundary are other special features including cliff communities and their associated plants.

Management Needs: Monitor and maintain current health of the stream. Work with Crawford and Perry counties to design in-stream structures for erosion control. Monitor the designated trail (Oriole East) on the south-central boundary of the trail for unacceptable levels of erosion into the creek. If occurring, implement mitigation measures to control this excess erosion.

Tar Springs

Location: Tar Springs is located in Section 15, T3S, and R1W, Crawford County, Tell City Ranger District.

Area: Approximately 20 acres

Type: Petroleum spring

General Description: A spring exists at the site from which flows a mixture of water and petroleum in the form of oil and tar.

Management Needs: Maintain protection around spring where it surfaces above ground.

Tincher

Location: Section 6 T3N, R1W; Sections 1, 2, 3, 4, 5, and 6, T3N, R2W; Sections 15, 16, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30, 31, 33, 34, 35, and 36, T4N, R2W, Lawrence County, Brownstown Ranger District.

Area: Approximately 4,180 acres

Type: Karst geology

General Description: The main features of this area are its karst formations. There are many sinkholes, swallow holes, and caves. A fault in the Tincher Pond area exposes a rock conglomerate not commonly seen exposed on the Forest. Preliminary fieldwork on an ecological classification system has identified some soils/geology differences that are likely to lead to the identification of plant communities not found elsewhere on the Forest.

Management Needs: The management plan for the area includes recommendations to inventory karst features and rare plant communities. The Forest needs to work with Lawrence County to identify county and non-county roads and eliminate unneeded roads not under county jurisdiction, and stabilize those that are to remain open. Clean up illegal trash dumping on NFS property.

Wesley Chapel

Location: Wesley Chapel is located in Section 9, T2N, R1W, Orange County, Brownstown Ranger District.

Area: Approximately 188 acres

Type: Karst geology

General Description: Karst features include caves; sinkholes, and a gulf with a rise recognized as a National Natural Landmark by the USDI National Park Service.

Management Need: A 103-acre opening on the southern half of the special area will be maintained to encourage Henslow's sparrows (*Ammodramus henslowii).*

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Appendix I

DELINEATION OF RIPARIAN AREAS, RIPARIAN CORRIDORS, AND STREAM TYPES

Riparian Area Definition and Delineation

The Forest Service Manual provides for the identification and delineation of riparian areas based on soil characteristics, hydrology, landform, and vegetation (FSM 2526.05). The following definitions apply:

> **Riparian Areas** - Geographically delineable areas with distinctive resource values and characteristics that are comprised of the aquatic and riparian ecosystems.
>
> **Aquatic Ecosystems** - Stream channels, lakes, estuary beds; water; biotic communities; and the habitat features that occur therein.
>
> **Riparian Ecosystems** - A transition area between the aquatic ecosystem and the adjacent terrestrial ecosystems identified by soil characteristics or distinctive vegetation communities that require free or unbound water.

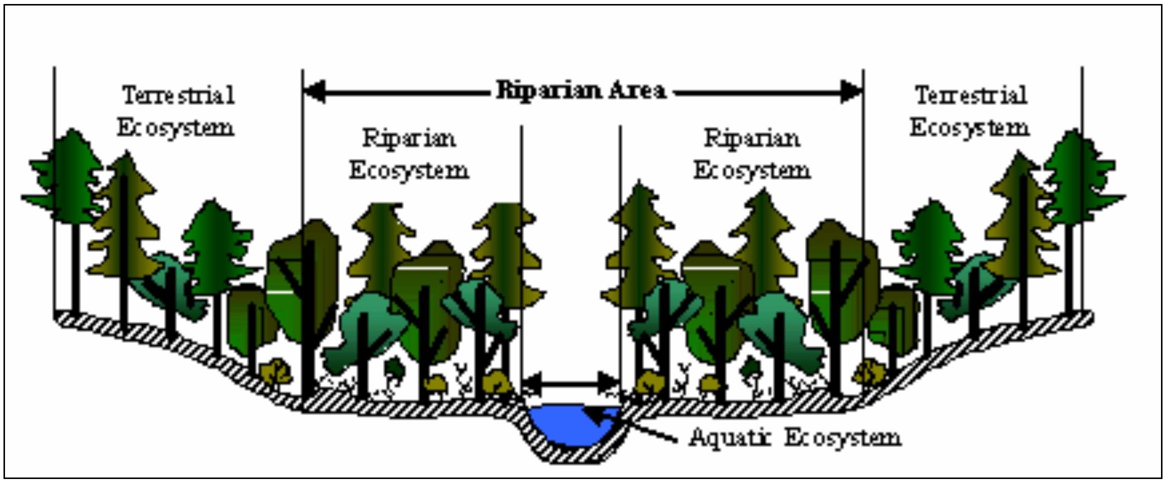
The riparian area definition includes the aquatic ecosystem and that portion of the terrestrial ecosystem substantially affected by the presence of surface and groundwater. Riparian areas consist of perennial and intermittent streams, ponds, lakes (reservoirs), waterholes, wetlands, and adjacent lands with soils, vegetation, and landform indicative of high soil moisture or frequent flooding. They have variable widths that are determined by ecologically significant boundaries rather than arbitrary distances. No single feature is used to delineate these ecosystems. In general, some characteristics common to riparian areas on the Hoosier National Forest include:

- Soils – soils formed in alluvial material, stratified sand, silt, and clay (often with thick, dark surfaces) some underlain with gravel or course fragments of sandstone.
- Landforms – alluvial valleys, their floodplains and terraces. Lakes and ponds with their associated beaches, shorelines, marshes, and swamps.
- Vegetation – Typical Hoosier National Forest riparian area species include sycamore, green ash, American elm, red elm, hackberry, box elder, silver maple, black walnut, river birch, and a variety of sedges, grasses and willows.

Figure I.1 shows a simplified schematic of the riparian area on the Hoosier National Forest.

Figure I.1

SIMPLIFIED SCHEMATIC OF A RIPARIAN AREA AS DEFINED BY FSM 2526.02



Riparian areas often need to be managed in a broader, ecological context. Lands that are not technically part of the riparian area often influence these areas. For example, soil erosion from a steep slope adjacent to a stream could adversely affect the riparian area, even though much of the slope is technically outside of the riparian ecosystem defined by soils, hydrology, and vegetation.

The goal in delineating these corridors is to maintain a stable forest floor to filter sediment and other pollutants before runoff enters the stream, and to protect riparian habitat and species. Riparian corridors are not excluded from management activities, but rather zones where the application of mitigation measures and forethought must be applied to ensure water quality and riparian values are protected.

The Riparian Corridor

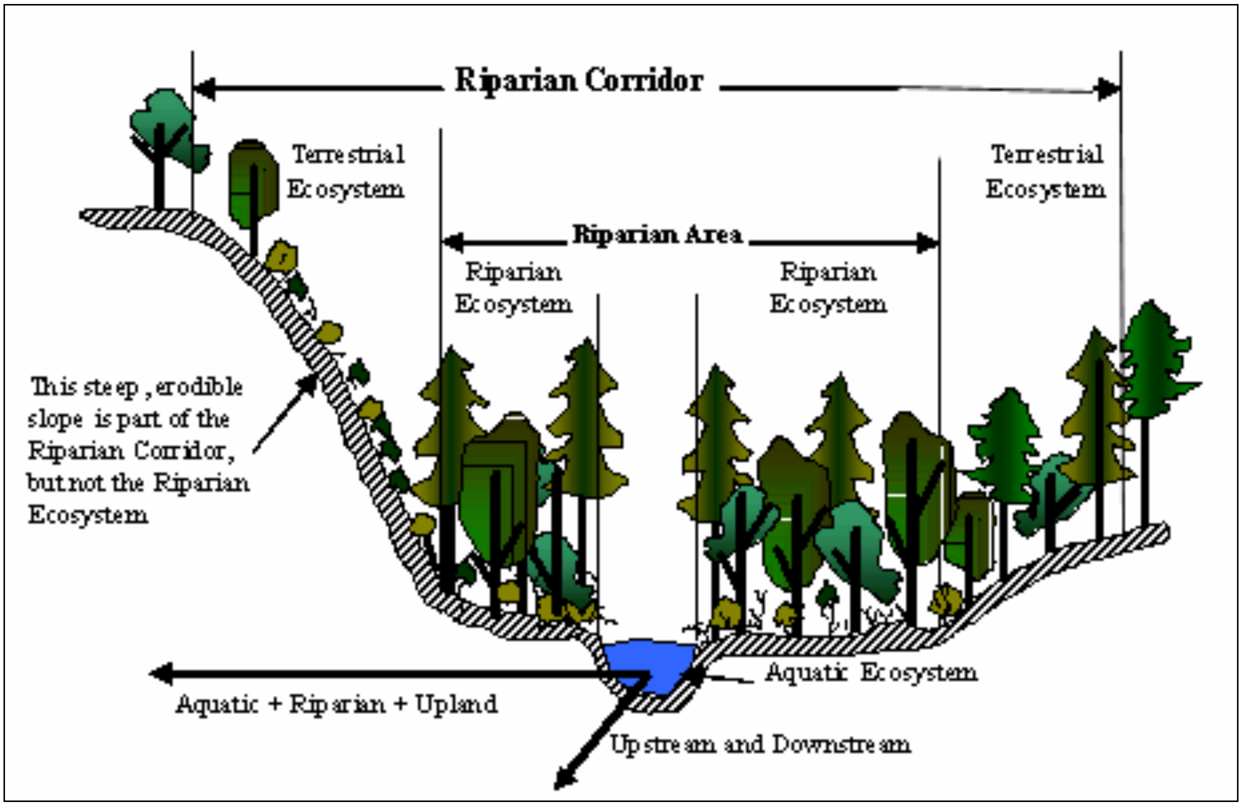
The Forest Service Region 9 terminology for the “adjacent terrestrial area” is riparian corridor.

The riparian corridor encompasses riparian areas, as well as adjacent associated upland components. A riparian area is functionally defined as a three-dimensional ecotone of interaction that includes both terrestrial and aquatic ecosystems. It is identified on the ground as one of the following: a perennial stream or other perennial water body or intermittent stream, as well as the associated soils, vegetation, and hydrology. It extends down into the ground water, up above the canopy, outward across the flood plain, up the near-slopes that drain into the water, laterally into the terrestrial ecosystem, and along the watercourse at a variable width (Ilhardt *et al.* 2000).

The Hoosier National Forest designates a “riparian corridor” as shown in Figure I.2 below.

Figure I.2

SIMPLIFIED SCHEMATIC OF THE RIPARIAN CORRIDOR
AS RECOMMENDED BY REGION 9

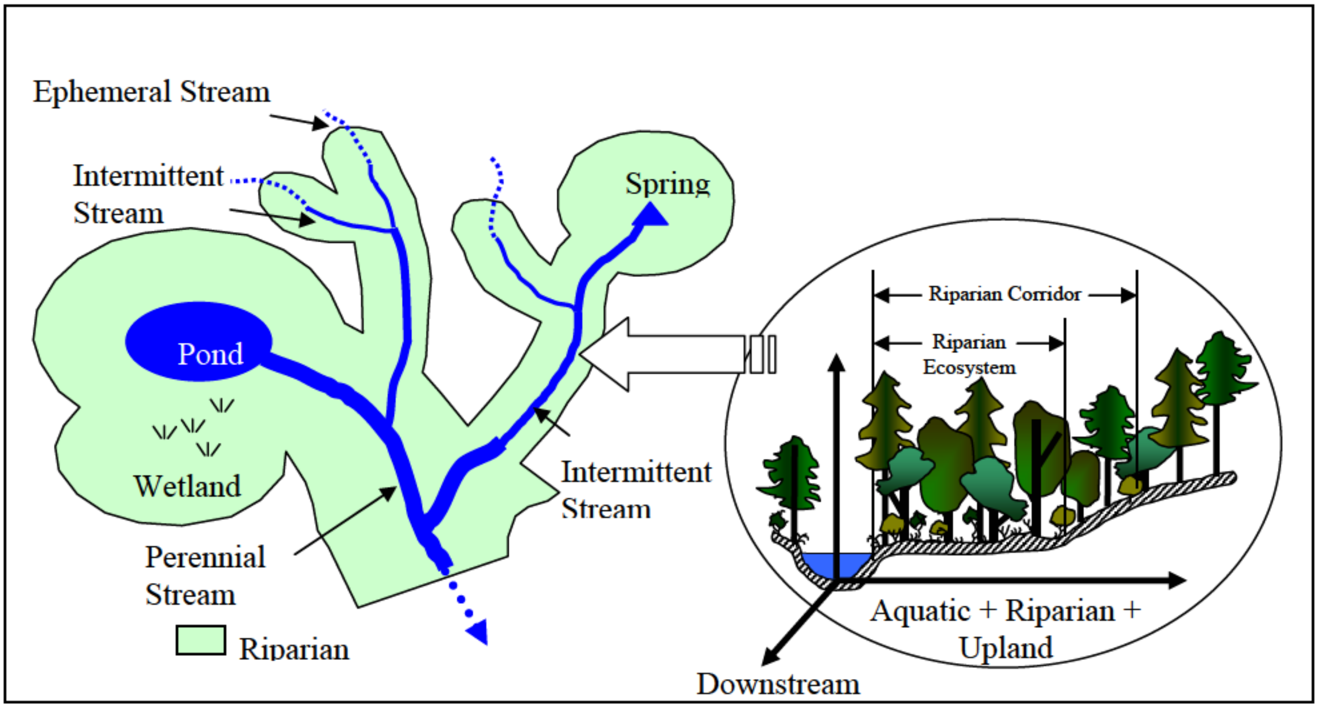


The riparian corridor includes the riparian area along all perennial and intermittent streams with defined, recognizable channels. Where necessary, the riparian corridor also includes any adjacent terrestrial areas needed to protect or restore riparian function. The example in Figure I.2 illustrates how a steep, erodible slope that could adversely affect the riparian area or the stream is included in the riparian corridor, even though it is not technically part of the riparian area.

Riparian corridors also include areas around ponds, lakeshores, wetlands, waterholes, springs, and seeps. Figure I.3 illustrates how the riparian corridor includes wetlands, waterholes, springs, seeps, perennial streams, and those portions of intermittent streams that have a defined, recognizable channel.

Figure I.3

REPRESENTATION OF A RIPARIAN CORRIDOR



Ephemeral streams with recognizable channels will have a 25 foot minimum riparian corridor as measured from each channel or bank.

An **interrupted stream** (a watercourse that goes underground and then reappears) will be measured as if the stream were above ground.

For **braided streams**, the outermost braid will be used as the water's edge.

For **ponds, small lakes, waterholes, wetlands** (including associated seeps or springs), and other water bodies, the measurement begins at the ordinary high water mark.

Appendix J

MAPS

There are three types of maps in this appendix.

Map 1A – 1D - These maps show the management areas delineated for each part of the Forest. The management areas correspond to the guidance described in Chapter 3. Due to the size of the Forest, and in order to show a reasonable level of detail, we've displayed the Forest on four separate map sheets. The Forest is divided up by the most northern block, the block near Shoals, IN, the block near Patoka Lake, and the largest southern block. National Forest System ownership is shown in shaded gray on each map.

Map 2A, 2B - The Visual Quality Objective (VQO) Map shows the visual quality objectives identified for each portion of the Forest. This map is broken into the north and south sections of the Forest.

Map 3 - The Recreation Opportunity Spectrum (ROS) Map shows the recreation opportunity classifications for various portions of the Forest.

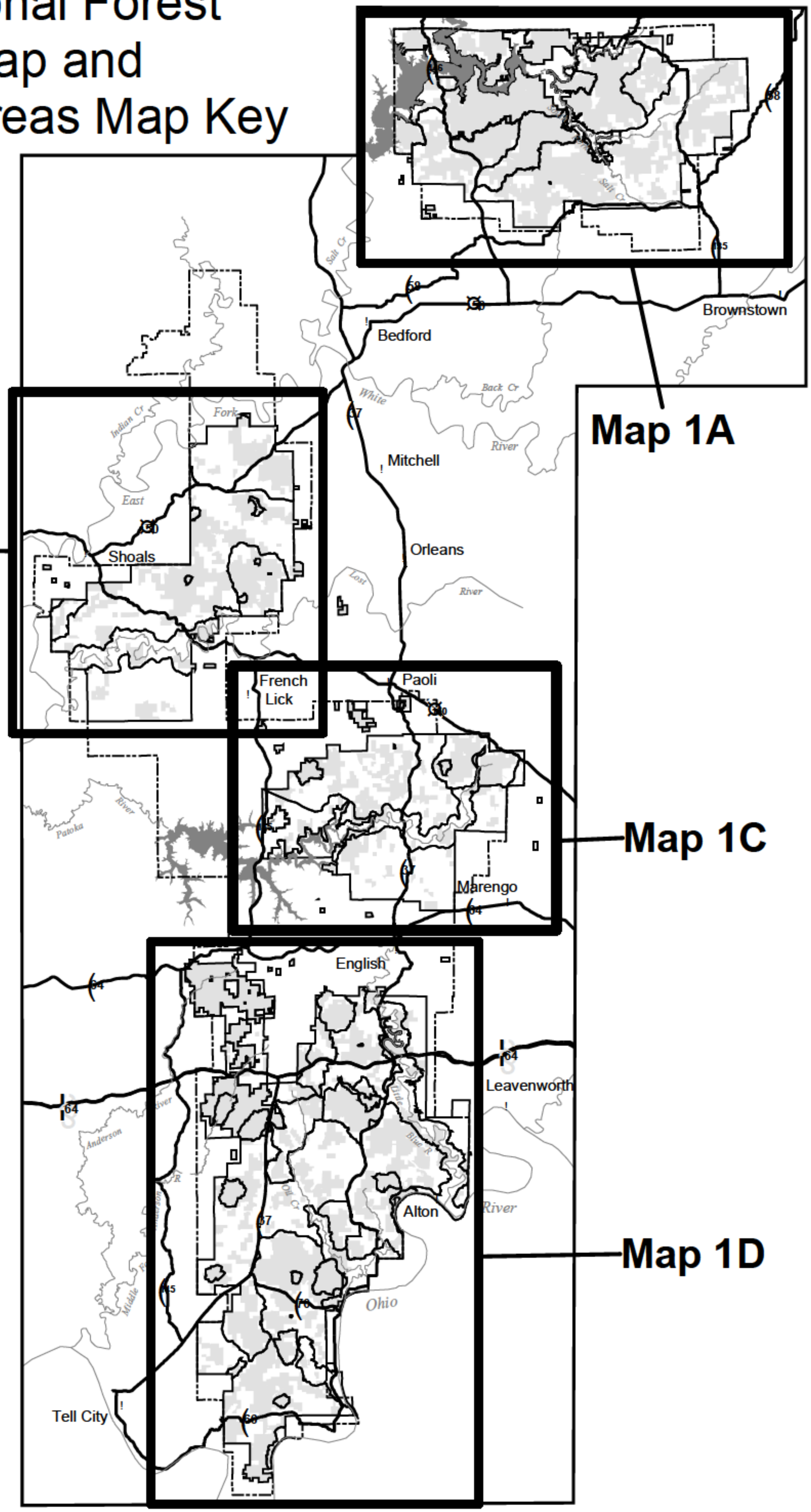
Management Area (MA) Maps

MA Number	Description of Area
2.4	NFS land along streams, some maintenance and restoration of ecosystems
2.8	General Forest, provides young forest, mostly by uneven-aged methods, forest openings, timber products, and some minerals
3.3	General Forest, provides young forest, a mix of even-aged and uneven-aged methods, forest openings, and timber products.
5.1	Congressionally designated Charles C. Deam Wilderness
6.2	General Forest, preservation, limited access, solitude featured in recreation experience
6.4	General Forest, preservation, limited access, minimum management, allows restoration and maintenance of plant communities.
7.1	Developed recreation areas
8.1	Research Natural Areas
8.2	Special Areas
8.3	Experimental Forests
9.2	Candidate Special Areas and Research Natural Areas (none identified at this time)

Management Area map numbers correspond to the condition of the land as described in the Guidance section of Chapter 3.

The management areas identified on these maps and the management direction defined in the Forest Plan apply to NFS lands only. They do not apply to any lands in State, county, private, or other ownership.

Hoosier National Forest Vicinity Map and Management Areas Map Key



Map 1B

0 3 6 9 12 Miles

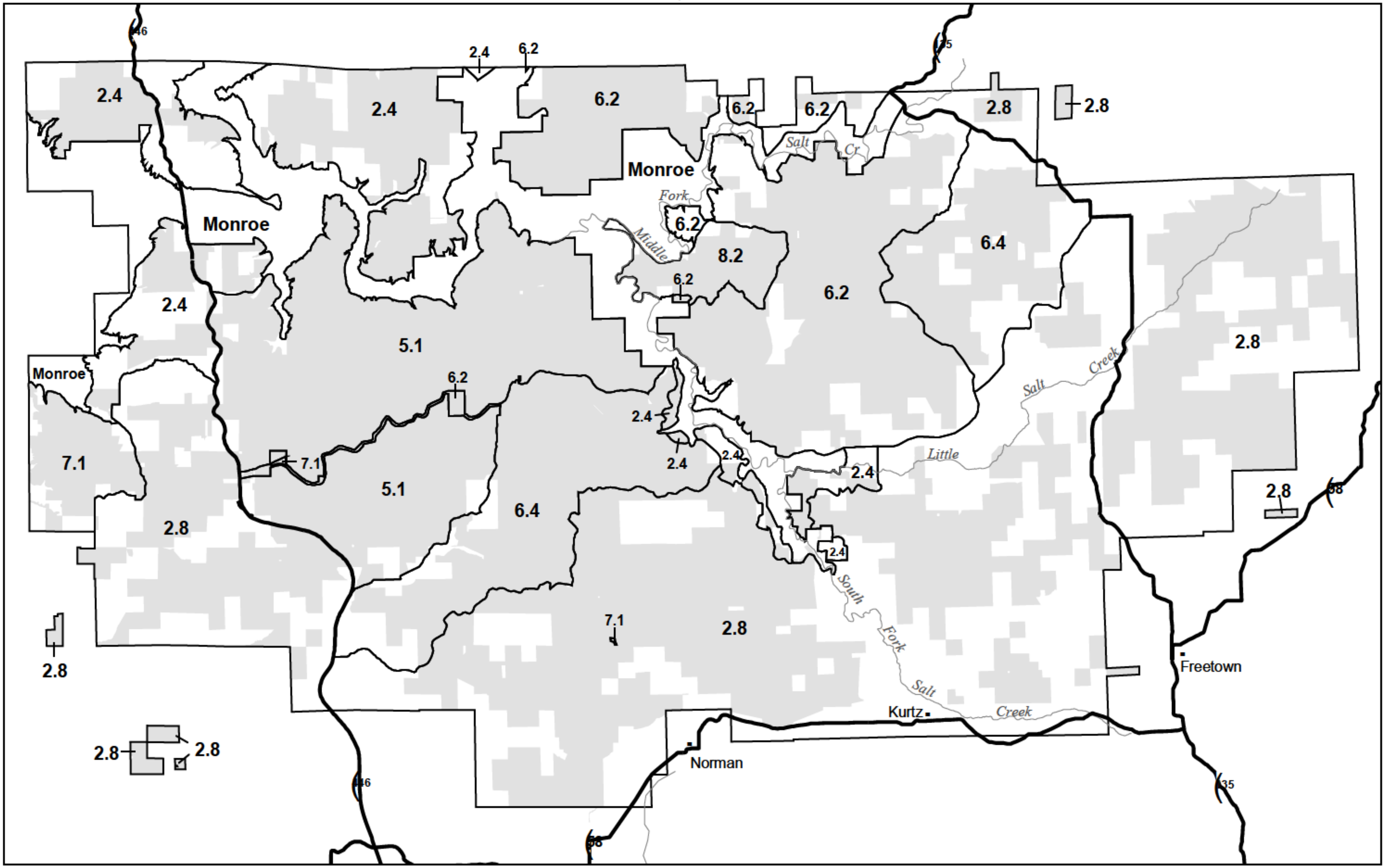
- Major Roads
- Major Streams
- Water
- Management Areas
- Hoosier NF Boundary
- Forest Service

Original data was compiled from multiple source data and may not meet National Mapping Accuracy Standards. For specific data source dates or additional digital information contact the Hoosier National Forest Supervisors Office. No warranty is made to the contents or accuracy of the data.

2006

Management Areas

Map 1A



Management Areas

Forest Service

Highways

Major Streams

0 0.5 1 2 3 4 5 Miles

October 2005

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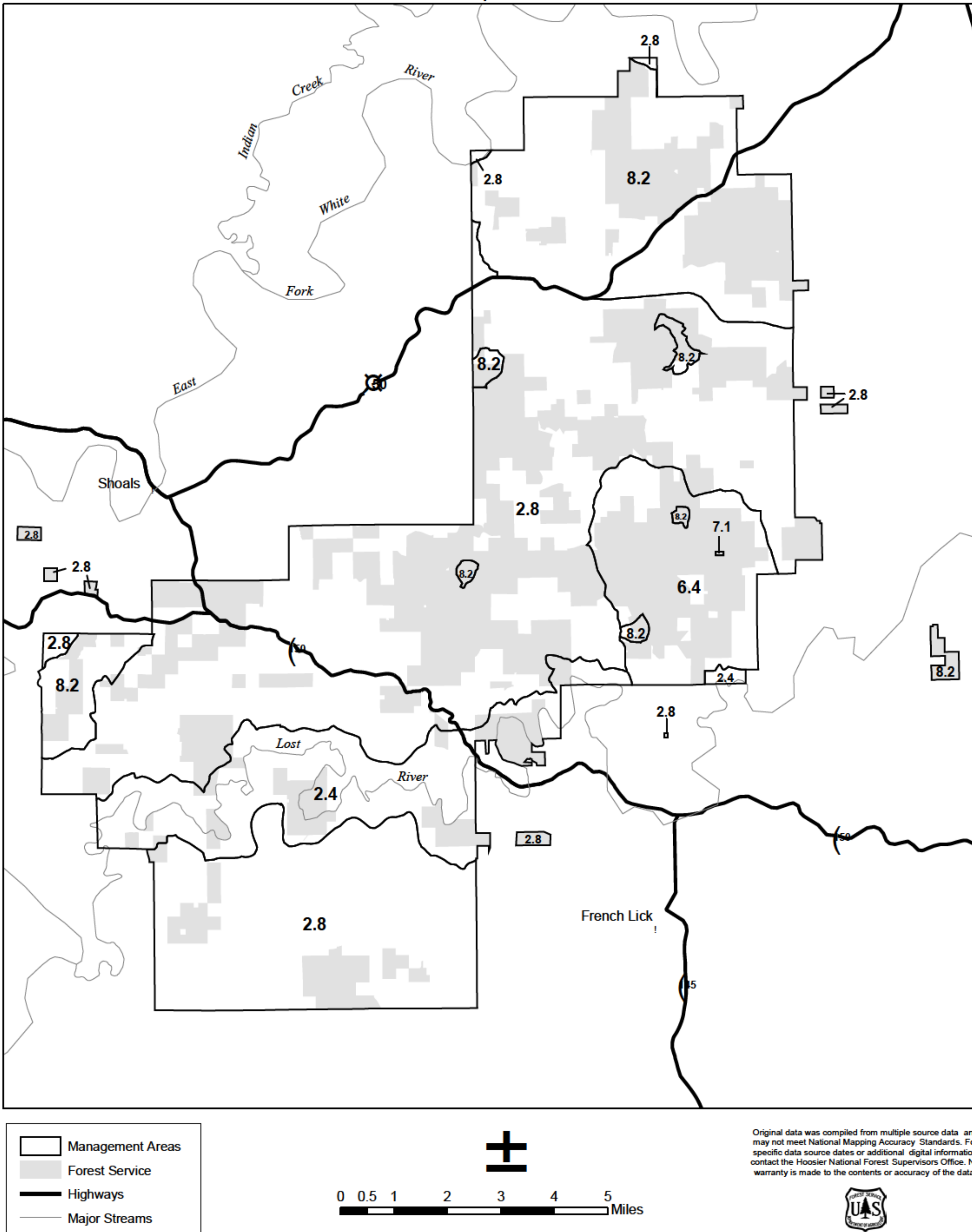
Management Areas

Map 1B



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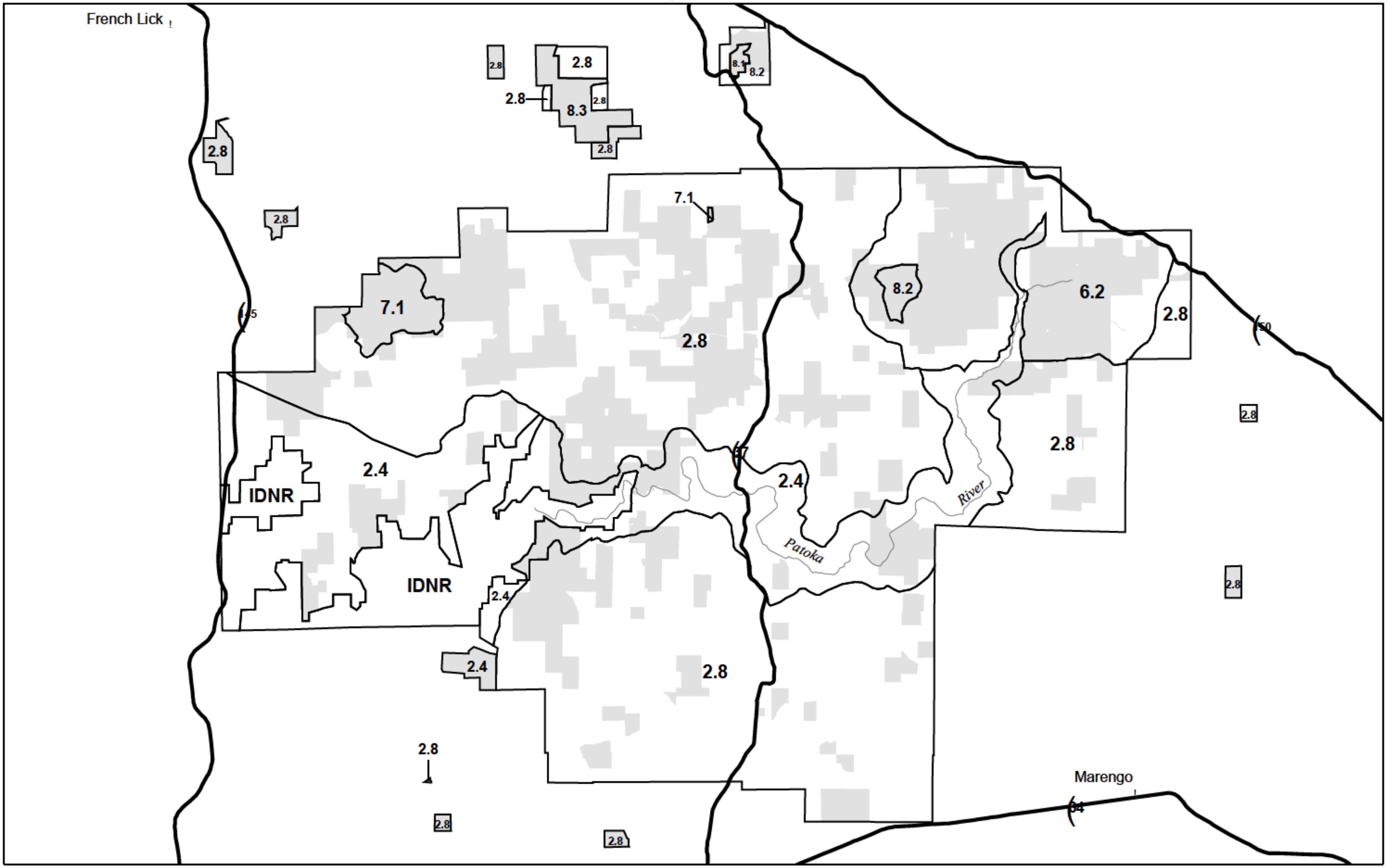
October 2005

Management Areas

Map 1C



Management Areas
Forest Service
Highways
Major Streams

0 0.5 1 2 3 4 5 Miles

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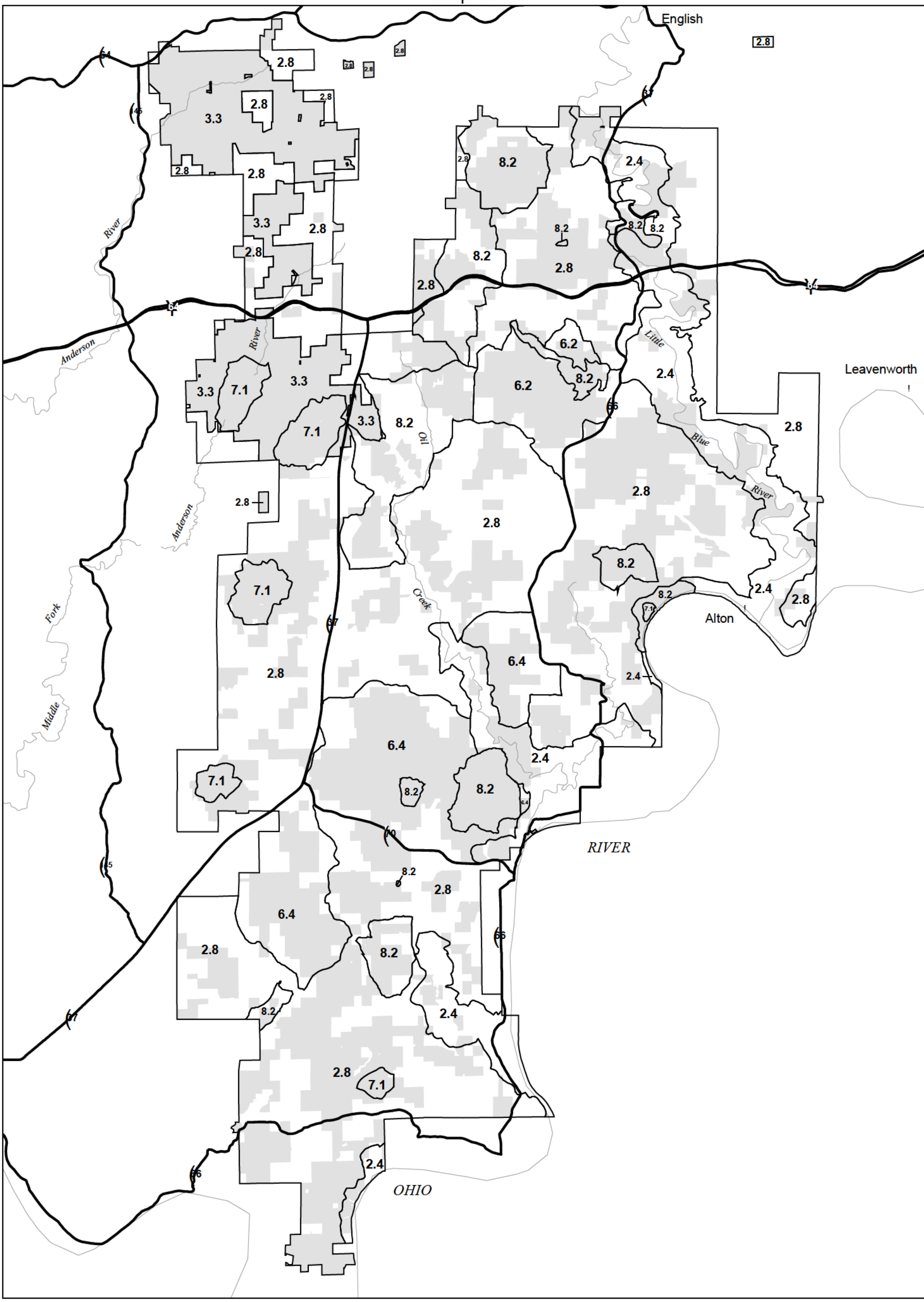
October 2005

Management Areas

Map 1D



Management Areas
Forest Service
Highways
Major Streams

0 0.5 1 2 3 4 5 Miles

October 2005

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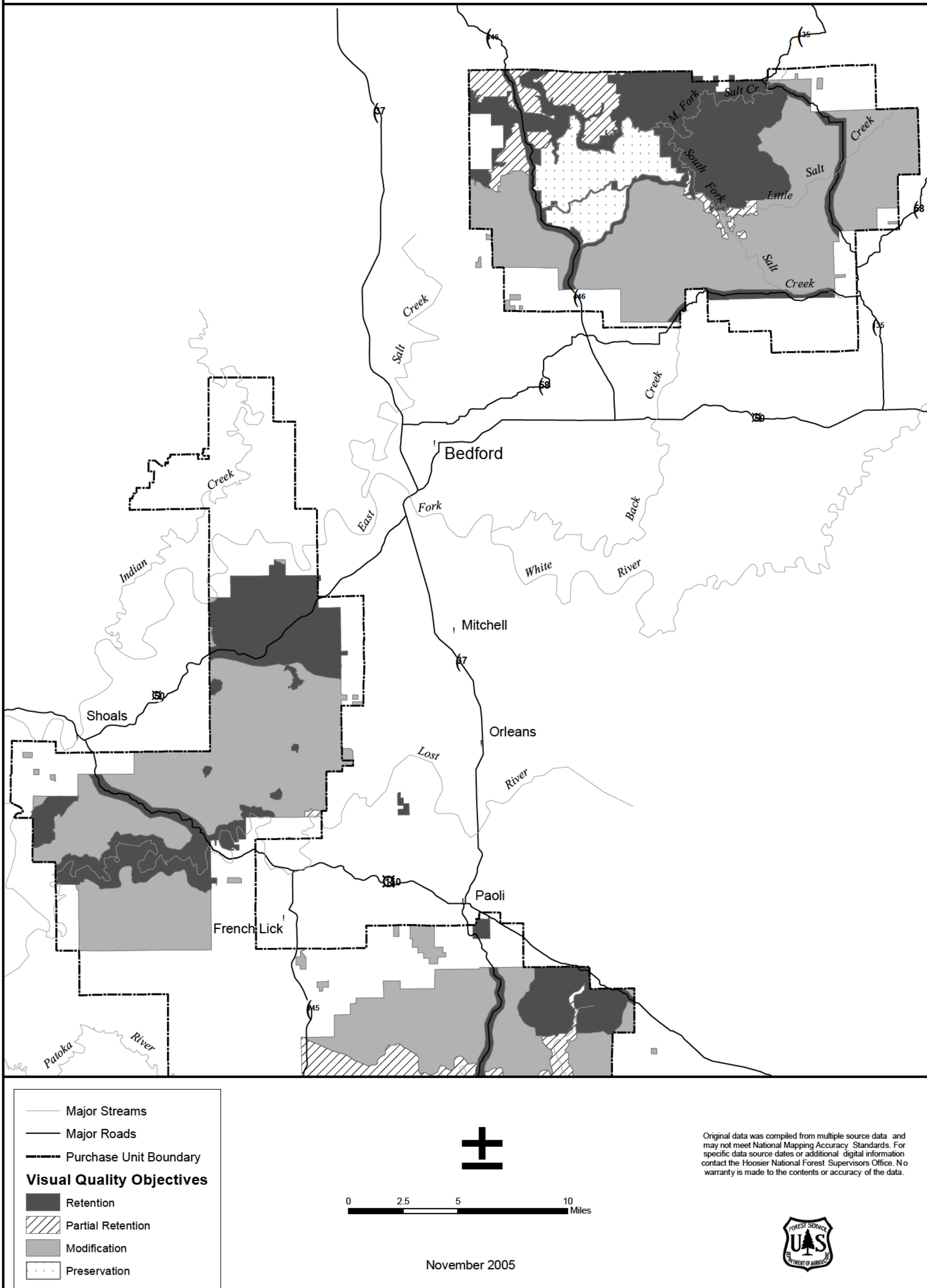
HOOSIER NATIONAL FOREST
Visual Quality Objectives
Map 2A



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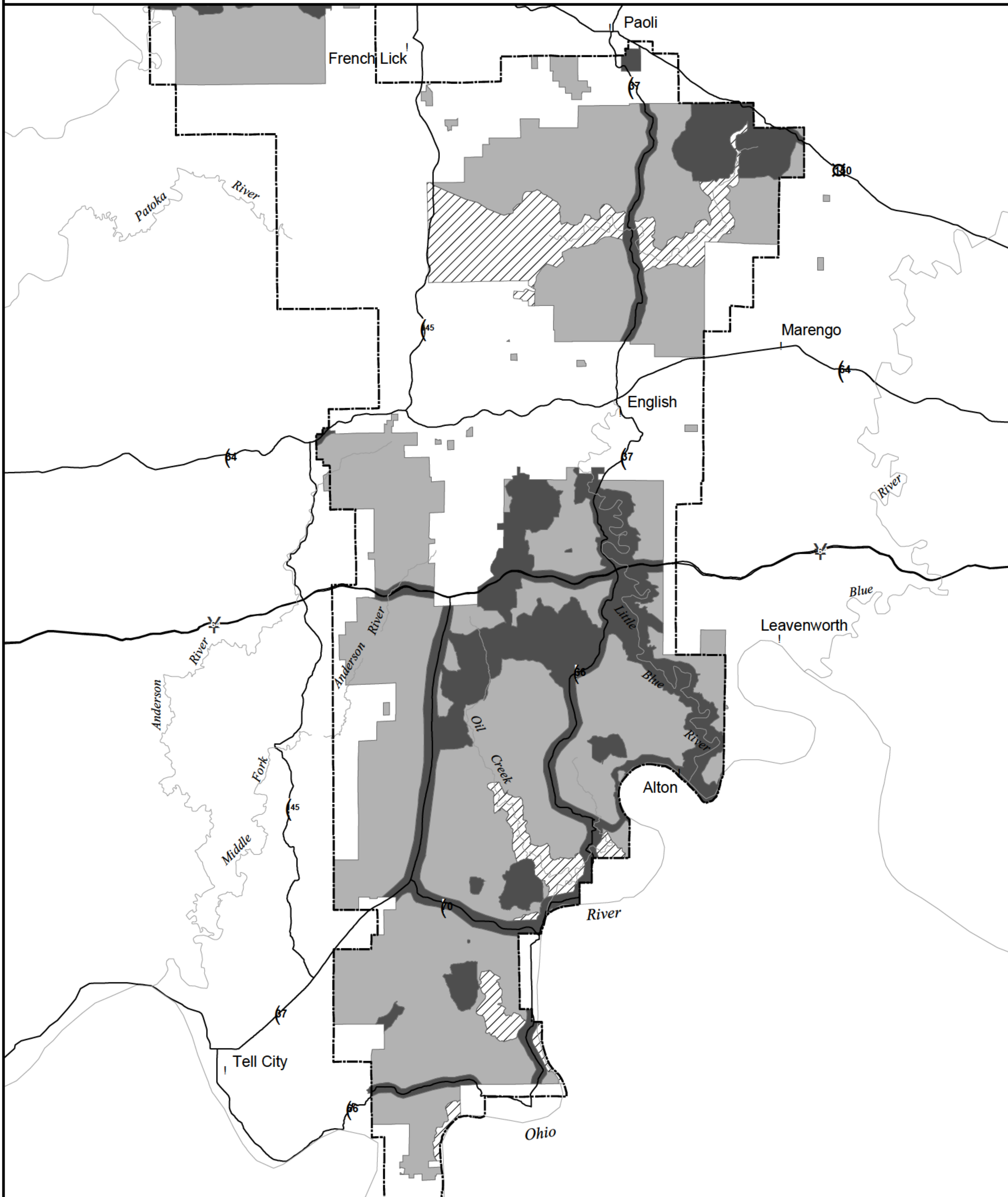
November 2005

HOOSIER NATIONAL FOREST

Visual Quality Objectives

Map 2B



Major Streams
Major Roads
Purchase Unit Boundary

Visual Quality Objectives

Retention
Partial Retention
Modification

0 2.5 5 10 Miles

November 2005

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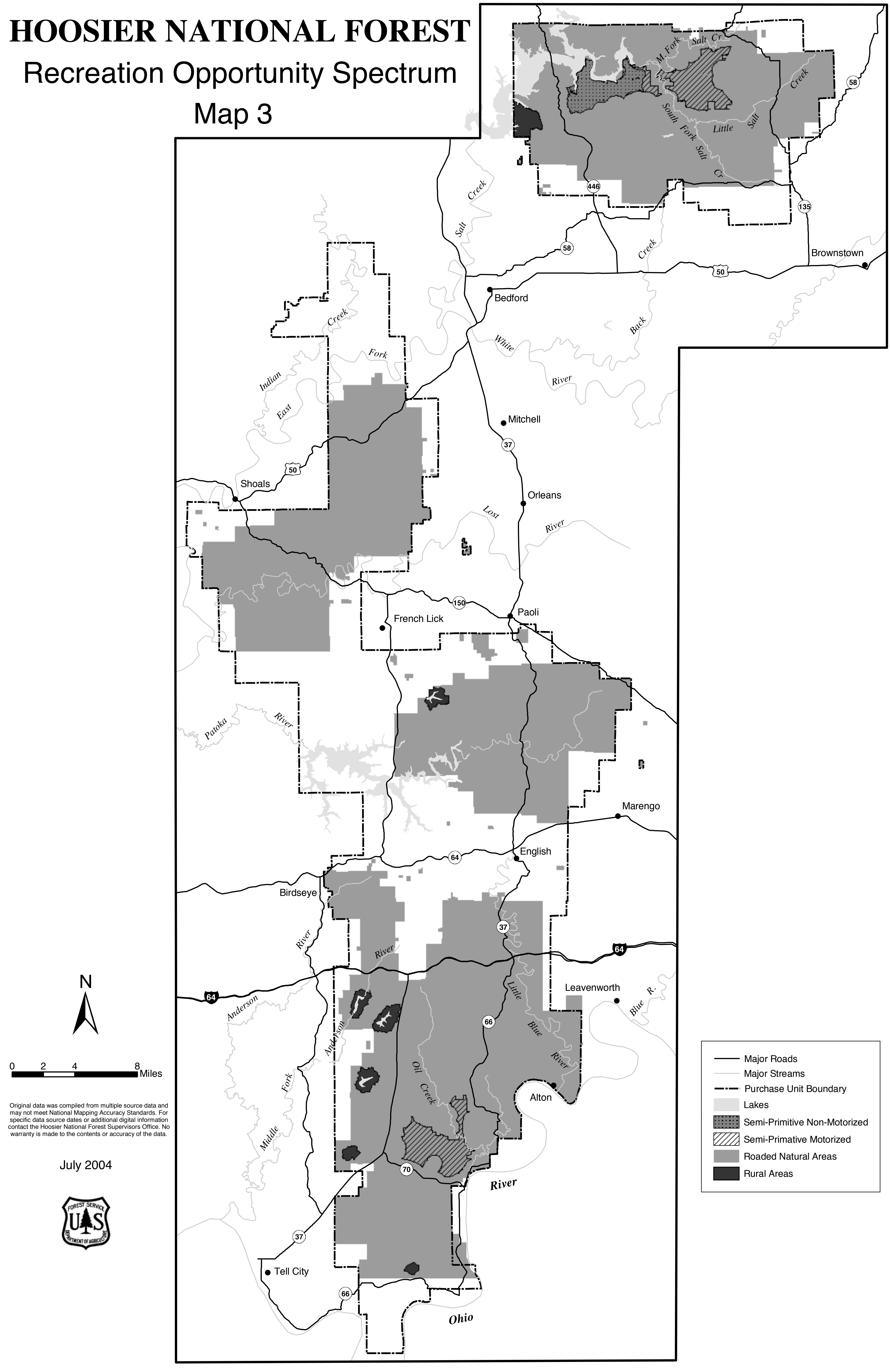
HOOSIER NATIONAL FOREST

Recreation Opportunity Spectrum

Map 3



Original data was compiled from multiple source data and may not meet National Mapping Accuracy Standards. For specific data source dates or additional digital information contact the Hoosier National Forest Supervisors Office. No warranty is made to the contents or accuracy of the data.

July 2004

United States Department of Agriculture

Houston South Vegetation Management and Restoration Project

Final Environmental Assessment

Forest Service
Hoosier National Forest

November 2019

For More Information Contact:

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(1) mail: U.S. Department of Agriculture
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, SW
Washington, D.C. 20250-9410;

(2) fax: (202) 690-7442; or

(3) email: program.intake@usda.gov.

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Contents

Tables

Figures

Introduction

We are proposing to treat vegetation and conduct related management activities improving forest health and sustainability of the oak-hickory ecosystems while also improving wildlife habitat. The proposed project would move the Forest toward its desired future condition as identified in the 2006 Hoosier National Forest Land and Resource Management Plan (Forest Plan). These actions are proposed to be implemented on the Brownstown Ranger District of the Hoosier National Forest.

The 2006 Forest Plan with accompanying Environmental Impact Statement (EIS) and Record of Decision (ROD) as well as all subject matter expert professional reports are hereby incorporated into this Environmental Assessment (EA). We prepared this environmental assessment (EA) to determine whether to prepare an environmental impact statement or a finding of no significant impact.

Proposed Project Location

The majority of the project area is in the northwest corner of Jackson County on the Brownstown Ranger District. A small portion overlaps into the northeast corner of Lawrence County. All proposed harvests would occur on National Forest System (NFS) lands. Prescribed fire could be applied where adjoining U.S. Army Corps of Engineers land and private landowners express interest and are willing to enter into an agreement, and the proposed aquatic organism passages would be implemented on county roads and possibly near private land on the downstream side of one passage with prior approval.

The legal descriptions for the project area include:

- T7N, R2E, all or portions of Sections 14-16, 21-28 and 33-36
- T7N, R3E, all or portions of Sections 22-23, 26-30, and 31-36
- T6N, R3W, all or portions of Sections 2-6, 7-11, and 14-18
- T6N, R2E, all or portions of Sections 1-4, 10-12, and 13

Please refer to the attached maps for specific locations of proposed actions. Maps can also be viewed at our website at https://www.fs.usda.gov/project/?project=55119.

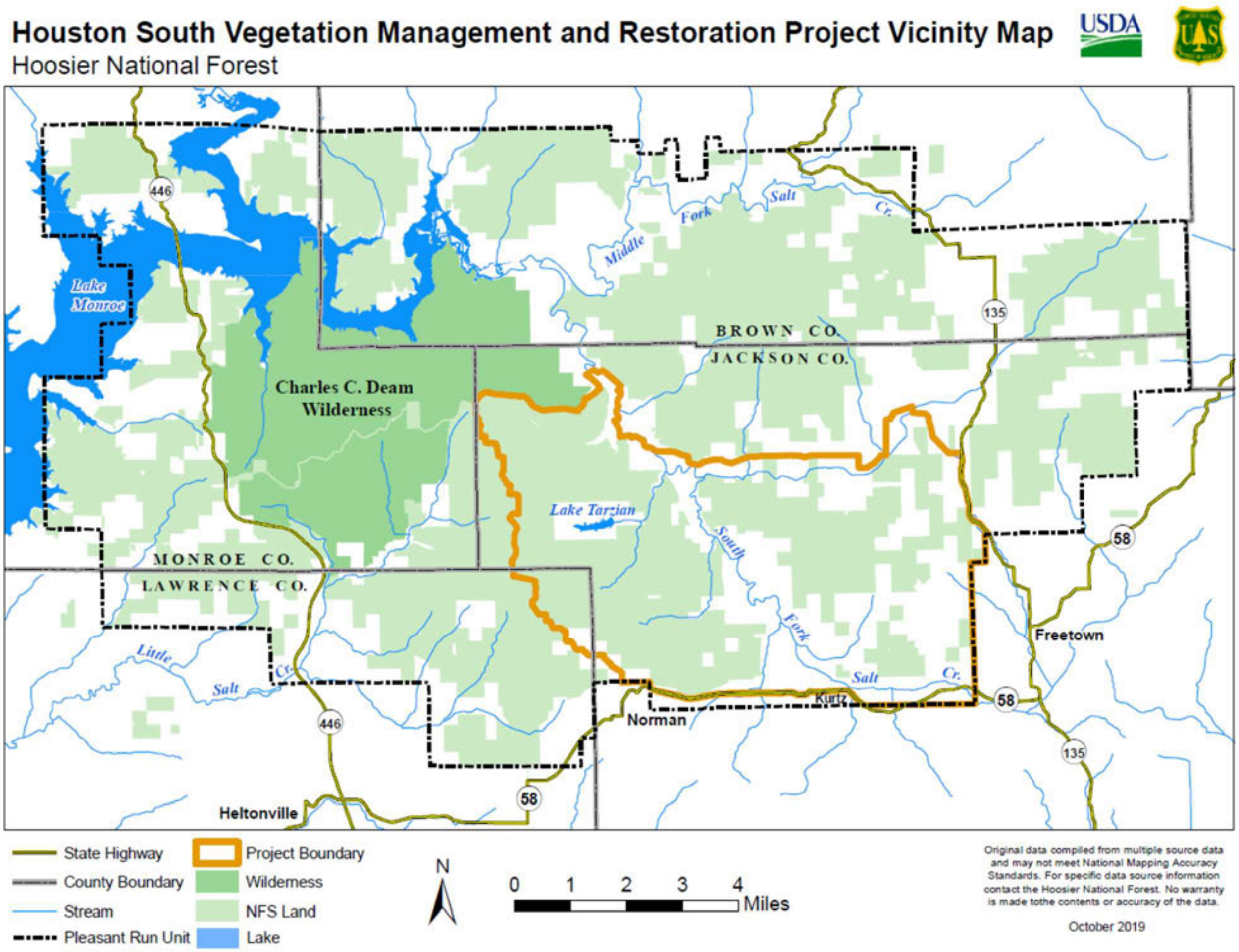

Figure 1. Vicinity map

Need for the Proposal

The Houston South Vegetation Management and Restoration Project (Houston South Project) proposed action is based on and would fulfill Forest Plan direction associated with the goal of maintaining and restoring sustainable ecosystems.

Current Conditions

The project area is currently dominated by mature forest. Stand data in the proposed silvicultural treatment area shows no stands in the 0 to 9-year age class, therefore the desired amount of early successional forest habitat described in the Forest Plan (4-12 percent) is not being met. Many stands are dominated by mixed-oak and oak-hickory canopies, but competitive oak regeneration does not exist across a majority of the project area. Understories and mid-stories in these stands typically consist of shade-tolerant species such as American beech and sugar maple, leaving very few areas where oak or hickory species are able to compete to be a part of a future stand. This trend is typical in contemporary forests where fire and management activities have been excluded for multiple decades.

The Forest Plan tells us "Without ecological restoration in the form of silvicultural treatments, oak systems will continue to decline (in terms of species richness and ecological function), converting from oak to mesophytic forests within a generation. Native wildlife species dependent on trees producing large-seeded acorns and nuts may be imperiled. To maintain the oak component, silvicultural systems need to be matched to the site characteristics combining harvest systems with regeneration treatments such as prescribed burning" (USDA FS 2006a).

There are approximately 500 acres of pine in the proposed silvicultural treatment area that is not native to the Hoosier National Forest. Pine plantations provide less suitable habitat and less biodiversity than native forests.

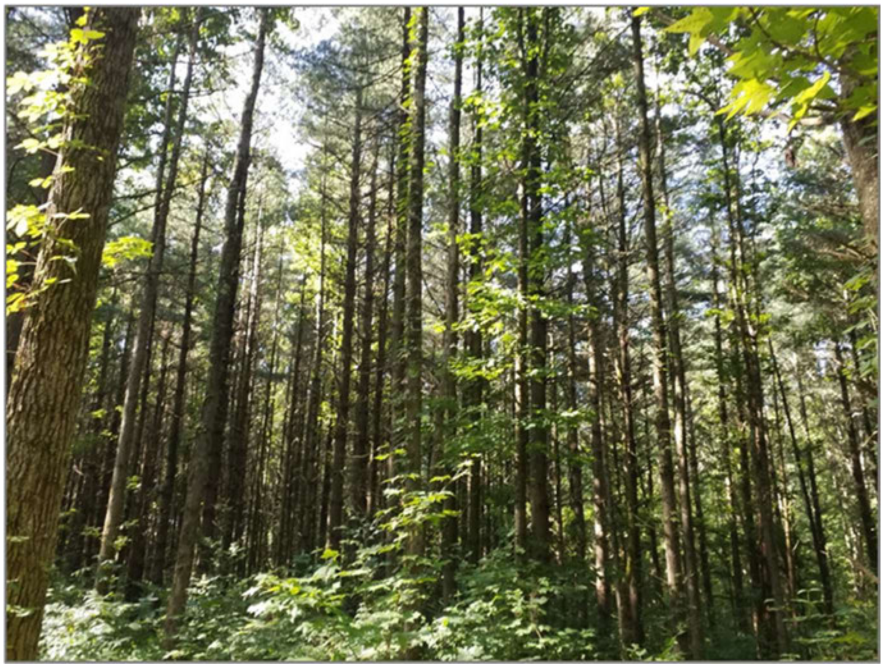

Figure 2: Overstocked non-native pine in the project area

Both the Houston South Restoration Project and the Hoosier National Forest fall within the Central Hardwood Region (CHR) as described by Johnson et al. (2009). The project area is typical of the CHR in both forest type and age class with the exception of the non-native pine plantations. Existing conditions for the project area are listed in Table 1.

Much of the project area is characterized by mature to over mature hardwood stands. Stands over 80 years old are typical, covering 55 percent of NFS lands in the project. Many of these stands consist of mature to over mature chestnut oak, white oak, and black oak as dominant canopy components. Many of these trees are at an age where they begin to naturally senesce (Figures 3 and 4).

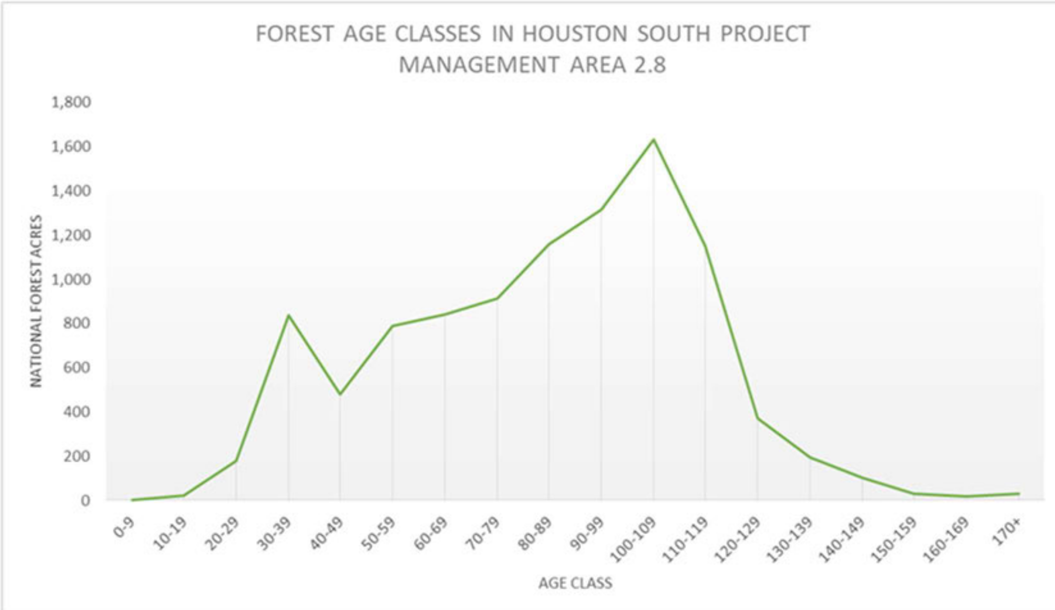

Figure 3. Forest age class distribution in the Houston South Project (Management Area 2.8)

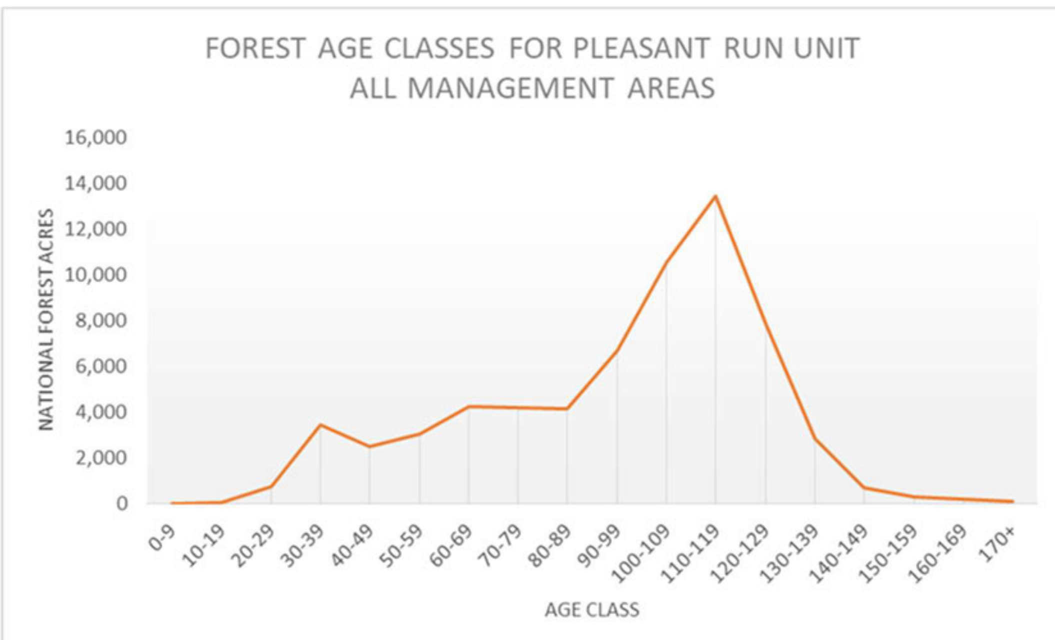

Figure 4. Forest age class distribution for the Pleasant Run Unit, Hoosier National Forest

Table 1: Summary of forest type by age class on NFS land in the Project Area (acres).

AGE CLASS	FOREST TYPE							
	Elm-Ash-Sycamore	Maple-Beech	Mixed Pine	Oak-Hickory	Oak-Pine	Shortleaf-Virginia Pine	White Pine	Grand Total
0-9	-	-	-	-	-	-	-	0
10-19	20	51	-	28	-	-	8	108
20-29	19	243	-	66	-	3	1	332
30-39	94	240	-	337	2	7	15	696
40-49	53	153	-	263	36	26	104	635
50-59	8	208	5	359	17	77	61	736
60-69	12	353	-	484	85	34	80	1,048
70-79	-	391	-	576	18	-	2	987
80-89	-	199	-	1,037	22	-	-	1,258
90-99	-	136	-	1,188	-	-	-	1,325
100-109	-	157	-	1,473	-	-	-	1,631
110-119	-	71	-	772	-	-	-	843
120-129	-	75	-	150	-	-	-	225
130-139	-	-	-	166	-	-	-	166
140+	-	-	-	80	-	-	-	80
Grand Total	**207**	**2,280**	**5**	**6,978**	**180**	**148**	**272**	**10,071**

For several millennia, oaks have been the predominate species on upland sites throughout much of the Central Hardwood Region (Abrams 2005). According to contemporary estimates, oak forest types comprise 51% of all forest lands in the east (Spetich et al. 2002), with the upland oak-hickory forest type covering over 100 million acres in the region (Sander et al. 1983). The oak-hickory forest type currently dominates canopies in the Houston South Project, covering 69 percent of all forested NFS land within the project boundary. Despite their widespread canopy dominance, the inability of oak reproduction to compete with large shade-tolerant advance reproduction and aggressive pioneer species has created concern about the sustainability of oak ecosystems (Lorimer 1993; Dey 2002; Brose et al. 2012).

Desired Conditions and Management Direction

The majority of the project is in Management Area 2.8. The desired conditions include maintaining 4 to 12 percent of the area in young forest habitat and diversity of age class and forest structure. The Forest Plan states, "The Forest manages the area primarily for plant and animal habitat diversity, and timber harvest is an appropriate tool for use in this area" (USDA FS 2006a). Portions of Management Areas 2.4, and 6.4 are included for prescribed burning, recognizing linkages between natural communities regardless of Management Areas and allowing the advantages of natural features as boundaries.

The diversity of age class and forest structure can be seen in Table 1, the forest is aging with nearly 76 percent of NFS forest stands over the age of 60 years and a lack of early successional (0-9 years) forest habitat.

Prescribed fire can create habitat conditions that are conducive to oak and hickory regeneration. Forest Plan guidance states, “use prescribed fire to accomplish silvicultural objectives such as oak regeneration” (USDA FS 2006a).

Purpose for Action

This proposal meets Forest Plan direction to promote tree growth, reduce insect and disease levels and move the landscape toward desired conditions. It would also increase the resiliency and structure of forested areas (stands) by restoring the composition, structure, pattern and ecological processes necessary to make these ecosystems sustainable.

Need for Action

This proposal is needed to provide a mosaic of forest conditions dominated by hardwoods and restore dry hardwood forest ecosystems that have not experienced periodic disturbance similar to fire or other naturally occurring events.

As maturing oaks and hickories age and die, they are being replaced by trees such as maple and beech. The hard-mast provided by oak-hickory species provides crucial food sources for a wide array of wildlife. Without management to limit competition from less desirable species, oak-hickory regeneration will continue to decline allowing demographic shifts to forested stands in the project area.

A lack of fire is also causing oak-hickory seedlings to be suppressed by a shade-tolerant mid-story. Reintroducing fire would promote regeneration and maintenance of mast producing oak and hickory.

There is a need to reduce the amount of pine in the project area to provide more suitable habitat to a wider array of wildlife species.

Pines were planted in the 1940’s to the 1970’s to aid in erosion control. Pines are not native to the Hoosier National Forest. As the nonnative pine stands mature, the canopy grows closer together and reduces the amount of sunlight reaching the forest floor. The ground beneath the stands, in many places, has little (if any) other plants growing to provide cover or food sources for wildlife.

By removing the pine plantations, the amount of forested habitat that is between 0 and 9 years of age would increase. The Forest Plan states the desired condition of this area is to maintain 4 to 12 percent of the area in young forest habitat. This creates important early successional habitat for a wide variety of songbirds, as well as ruffed grouse and American woodcock, both are Regional Forester Sensitive Species (See Figures 3 and 4). To provide for diversity in wildlife species, a range of habitats should occur across the landscape. Many wildlife species do not find browsing and other foraging habitat in mature and maturing forests. Instead, they find the fruits, seeds, insects, and other food items they seek mostly in early successional habitat.

One of the reasons the proposal would occur in this area, is because stand densities are very high in portions of the project area and mortality is occurring. The proposal would reduce the density of the trees, improving forest health. Promoting healthy forest conditions and improving stand structure within the project area would improve the overall health of vegetation, creating an ecosystem more resilient to the effects of insects, disease, and climate change.

The Forest Leadership Team decided with input from specialists from different resource areas, that the Houston South area would be the next area to focus management activities to further support the implementation of the Forest Plan and to improve forest health. The Forest Plan, with extensive input from the public, designated this area as management area 2.8. The desired condition of this management area is a diversity of plant and animal habitat. Active forest management is an appropriate tool in this area. Since the 2006 Forest Plan was implemented, active forest management including timber harvest and other vegetation management activities has focused on the southern end of the forest over the course of four different project areas, two of which were in management area 2.8. The Forest Leadership team decided it was appropriate for the next active forest management proposal to be in the Houston South area.

There are also opportunities to repair poorly maintained roads and eroded areas to reduce sediment deposition into streams and lakes in the project area. Additionally, roads and trails may be better located to reduce sedimentation and increase viability of aquatic organisms. These actions may include relocating, reconstructing, or obliterating roads and possible placement of aquatic organism passages (large culverts) in the project area.

Figures 5 and 6 are images of early successional forest habitat created as part of the Oriole Restoration Project on the Tell City Ranger District.

Figure 5: Clearcut, 2 years post-harvest

Figure 6: Clearcut, 4 years post-harvest

Public Involvement and Tribal Consultation

On September 6, 2018 staff of the Hoosier presented and discussed the early stages of this proposal at a public meeting in Bedford, Indiana. Forest Supervisor Michael Chaveas delivered a presentation that included the proposal and took questions at the Monroe County public library on October 25, 2018.

On November 26, 2018, the scoping letter (USDA FS 2018) was posted on our website, 218 hardcopy letters were mailed, and 84 emails were sent with the scoping letter attached. Press releases were sent to multiple newspapers announcing the proposed project. We received questions and comments from 93 respondents. All comments and our responses to them can be found on the project website: https://www.fs.usda.gov/project/?project=55119. All comment letters are in the project record at the Hoosier National Forest Supervisor's Office in Bedford, Indiana.

The Forest also published project information in the Schedule of Proposed Actions (SOPA), which lists project and contact information. The Hoosier's SOPA, can be found at http://www.fs.fed.us/sopa/forest-level.php?110912.

The project was first introduced to our tribal partners in a conference call presentation on October 19, 2015. The project was then presented formally in a consultation letter to the State Historic Preservation Officer on November 4, 2015 requesting concurrence to findings of the first archaeological report of investigations for the project. On November 16, 2018, invitations to consult on the project were sent to the six federally recognized tribes that consider southern Indiana their ancestral homelands. These tribes are the Absentee Shawnee Tribe of Indians of Oklahoma, Delaware Tribe of Indians, Eastern Shawnee Tribe of Oklahoma, Miami Tribe of Oklahoma, Peoria Tribe of Indians of Oklahoma, and the Shawnee Tribe. The Absentee Shawnee Tribe of Oklahoma had no objection to the project and requests notification in the event human remains or other cultural resources are discovered. The Miami Tribe of Oklahoma responded that they had no objection to the project and requested immediate consultation if any human remains or Native American cultural items falling under the Native American Graves Protection and Repatriation Act or other archaeological evidence is discovered during any phase of this project. The Shawnee Tribe responded that they had no issues or concerns but request notification if archaeological material is discovered during project implementation.

Proposed Action and Alternatives

Proposed Action

The Forest Service is proposing to conduct approximately 1,104 acres of even-aged management, 2,405 acres of thinning in both pine stands and hardwoods, and 462 acres of selection harvest in hardwood stands. Approximately 234 acres are proposed for midstory removal treatments. Midstory removal treatments remove trees in the mid-story without breaking the canopy. This produces light conditions below the canopy that allows oak seedlings to develop without increasing the competition from shade-intolerant species. Approximately 170 acres are proposed for crop tree release. Crop tree release is a treatment designed to free young trees from competing vegetation. The enclosed map displays the proposed silvicultural treatments in the project area.

Table 2 lists the proposed activities. These figures are approximate and represent the maximum.

Table 2: Proposed activities in the project area

Proposed Activity	~ Unit of Measure
Clearcut (Pine)	401 acres
Shelterwood	703 acres
Thinning (Pine)	78 acres
Thinning (Hardwood)	2,327 acres
Selection	462 acres
Midstory Removal	234 acres
Crop Tree Release	170 acres
Total silvicultural treatments	**4,375 acres**
Herbicide Spot Treatment	1,970 acres (allowed within)
Prescribe Fire	13,500 acres
New Road Construction	3.2 miles
Temporary Road Construction	8.3
Road Reconstruction	4.9 miles
Road Decommission	2.7 miles
Aquatic Organism Passages	3 structures

Clearcut – 401 acres

Clearcut harvests are regeneration cutting methods in even-aged management. This treatment is assigned to non-native pine plantations. Per the Forest Plan, clearcut harvests are used when they are the optimum harvest method to achieve stated management objectives such as conversion of non-native pine to native hardwoods and providing habitat for early successional forest species. For this treatment, with the exception of trees that are left for wildlife, all trees in an area would be harvested at one time.

Shelterwood - 703 acres

Shelterwood harvests are regeneration cutting methods in even-aged management. Shelterwood harvests are defined as the cutting of most trees, leaving those needed to produce sufficient shade to produce a new age class in a moderated microenvironment (Helms 1998). The goal of the shelterwood system in this project is to establish and foster advance oak and hickory seedlings to ensure oak ecosystems are perpetuated on the landscape following the final overstory removal. Shelterwood systems can be completed in either two or three stages.

Hardwood and Pine Thinning - 2,327 and 78 acres, respectively

This treatment is assigned to overstocked hardwood and pine stands. Thinning is considered an intermediate treatment aimed at reducing stand densities to improve growth, enhance forest health, and recover potential mortality (Helms 1998). Thinning is considered an appropriate treatment for stands without adequate regeneration in place prior to harvest. In general, thinning prescriptions would reduce stand densities by approximately one-third.

Selection - 462 acres

Selection harvests are a form of uneven-aged management. Single-tree selection seeks to remove individual trees from all size classes more or less uniformly throughout the stand. The objective of this treatment is to promote growth of the remaining trees and provide space for regeneration (Helms 1998). It also promotes age class diversity by removing large, senescing trees to create individual tree gaps capable of recruiting younger midstory trees to the upper canopy. This technique often favors shade-tolerant trees and is prescribed on mesic sites. Approximately one-third of the density would be removed from the stand.

Group Selection is a system in which trees are removed and new age classes are established in small groups (Helms 1998). Individual groups may not be larger than 3 acres (USDA FS 2006a). Single-tree selection would be implemented between the groups. Groups are determined at the time of sale layout by evaluating ground conditions.

Midstory Removal - 234 Acres

Midstory removal is assigned to stands where oak-hickory species dominate canopies but little to no oak-hickory regeneration is apparent. This treatment involves, with the exception of trees left for wildlife, removal of all midstory stems to enhance light conditions below the upper canopy. This is not a commercial treatment.

Crop Tree Release - 170 Acres

Crop tree release is a widely applicable technique used to enhance the performance of individual trees (Miller et al. 2007). It is an intermediate silvicultural treatment intended to provide increased growing space to selected trees through the removal of crown competition from adjacent trees. This is not a commercial treatment.

Selective herbicide applications are proposed for site preparation and stand improvement activities on 1,970 acres. Herbicide would be applied specifically to the trunks and stumps of targeted woody vegetation resulting in a relatively small area of application with little to no herbicide contacting the soil.

Prescribed fire is proposed to create habitat conditions that are conducive to oak and hickory regeneration and reduce fuels created through timber harvest. Depending on adjacent landowner participation, approximately 9,700 to 13,500 acres of prescribed burning is proposed. Prescribed burning would only take place on private land with the approval of the land owner through a formal agreement and after all appropriate surveys have been completed.

Not all available acreage would be burned during any given year. The burn acreage would be split up into smaller units in areas with or without timber harvest across the project area. Annual acres burned for this project would average approximately 1,500 acres. These treatments would be repeated periodically to reach and then maintain the desired condition. Burning under a suitable prescription would return the vegetation to a vigorous condition that would benefit wildlife and promote oak and hickory regeneration.

The boundaries for these treatments would largely take advantage of topography and other features such as roads and trails. Fire lines that are necessary to control fire on the landscape would be constructed using non-ground disturbing tools such as leaf blowers and chainsaws. These tools allow crews to remove fuels from the forest floor and above, reducing the chances that a fire would be carried outside of the desired burn location. While creation of fire lines in this manner changes habitat in the short-term, they tend to return to their previous state more quickly than when constructing fire lines down to bare mineral soil.

To access the areas proposed for treatment, approximately 3.2 miles of new road construction would be added to the current road system and 8.3 miles of temporary road, totaling 11.5 miles of road construction, as well as road reconstruction for approximately 5 miles. All standards and guidelines prescribed in the Forest Plan related to this type of work would be followed. Proposed lengths of roads are estimates.

When practical, roads would be rehabilitated to reduce erosion, correct drainage problems, and reduce illegal access from all-terrain vehicles. Approximately 3 miles of roads no longer needed would be removed from the system by decommissioning. Installation of vernal pools at some decommissioned road sites could occur to prevent illegal off-road vehicles use while benefiting wildlife.

There may be an opportunity to replace two undersized culverts and one undersized concrete structure with appropriately sized structures that would allow for aquatic organism passage (AOP) and allow natural material transfer that is currently stored unnaturally upstream. Removal and replacement of these crossings is needed because the structures do not allow for upstream passage of native fish species as well as other aquatic organisms. Proper sized crossings also restore a more natural flow regime with less impedance. Natural flow regimes promote less excessive bank erosion and helps mitigate channel incision.

If implemented, the AOPs would be constructed on Tower Ridge Road at Combs Branch, County Road 825 North at Callahan Branch, and County Road 980 West at a tributary to Tipton Creek. The implementation of these AOPs would help improve approximately 14 miles of upstream habitat. The three proposed AOPs are located within the South Fork Salt Creek Watershed.

The project proposes to use sections of trails during the timber harvests, potentially affecting portions of Hickory Ridge trail system and the Fork Ridge Trail. During project implementation, we would close certain sections of these trails for safety. We would stage project implementation appropriately to minimize impacts on trail use.

There are known cultural resources in the project area. To avoid inadvertent disturbance of these areas, 10 to 20-meter buffer zones would be established to protect potentially significant cultural resource sites. Any cultural resource sites that require protection from fire would require both indirect and direct methods of protection. Examples include placing protective fire shelters over vulnerable features or using leaf blowers to reduce fuels adjacent to protected resources.

It is expected that project implementation would begin in 2020 and would take place in stages over time taking several years to complete. The work would be completed using contracts as well as Forest Service employees.

Design Measures included in the Proposed Actions

As part of project development, the ID team developed design measures (or implementation requirements). Appendix A contains design measures that would be required if the decision maker decides to implement the action alternative. The Environmental Effects section describes the effects of implementing the alternatives with design measures included.

No Action Alternative

The No Action Alternative is the continuation of the current level of management and use. There would be no project-related treatment with this alternative. Under the No Action Alternative, the existing conditions would continue. The No Action Alternative provides a baseline to compare the environmental effects of the action alternative.

Environmental Effects

Issues

This section includes the issues that have been identified for detailed analysis because the impacts of the proposed action and alternatives may be related to potential significance or the ability to meet the need of the project. The following issues were identified and analyzed to determine the potential for significance:

Effects Related to Relevant Issues

This section discloses the environmental impacts.

Issue 1: Prescribed burning could have negative effects on water quality, soils, and air quality; could cause loss of herbaceous layer, invasive plant introduction, soil acidification, nutrient runoff, greenhouse gas release, and carbon release.

Indicators:

- Particulate matter (PM 2.5)
- Erosion and sedimentation rates from prescribed fire

- Potential to further spread non-native invasive plants
- Local GHGs emissions
- Carbon release from prescribed fire
- Miles disturbed for fire line construction

For Issue 1: Analysis Area:
The spatial boundary used to evaluate direct and indirect effects is the Houston South Vegetation and Restoration Project boundary. The spatial boundary to evaluate cumulative effects is the Project Boundary with an additional 1000-foot buffer (NNIS introduction), South Fork Salt Creek Watershed (soils, water quality, nutrient run-off), Brownstown Ranger District boundary (air quality), Hoosier National Forest boundary (carbon release), and the global atmosphere (GHG emissions). The temporal consideration for cumulative effects is 20 years, as prescribed fire treatments would be likely completed in this timeframe.

Direct and Indirect Effects for Issue 1

Proposed Action
Hoosier fire monitoring data shows that prescribed burning under normal circumstances has no effect on soil and water resources due to the thick duff layer remaining post-burn, preventing soil displacement until the area re-vegetates (which usually occurs in 45 days or less in this project area). Fire effects monitoring has found evidence of ample vegetative regrowth six months after prescribed burning (Rigg and Larson 2007).

Prescribed burning on the Hoosier typically occurs in the cool season, with low intensity fires. This helps lessen the loss of nutrients and reduce the overall level of sediment runoff into streams. Moist riparian areas do not carry fire well, so these would likely remain unburned, retaining their filtering capabilities.

Fire lines necessary to contain prescribed fire would be constructed in appropriate areas within the project area. These lines are generally placed a short time before the burn is to occur and are constructed using mowers, chainsaws and leaf blowers. Creation of fire lines in this manner would alter the immediate habitat for the short-term, and these features will return to their previous state more quickly than when fire lines are constructed to bare mineral soil using shovels, heavy equipment, or other tools. A limited amount of fire line may need to be constructed using heavy equipment (159 feet). If heavy equipment is used, Forest Plan standards and guidelines and BMPs would be used to avoid negative effects.

Prescribed fires on the Hoosier typically are lower intensity due to climate and vegetation, so substantial effects to nutrients and organic matter breakdown are not expected.

Low-severity prescribed fire has a minimal effect on soil biota. The maximum temperatures are generally nonlethal, except for the upper litter layer, and therefore the consumption of forest floor habitat is limited (Neary et al. 2005).

A study by Elliot and Vose (2005) to investigate effects of prescribed burning on soil solution chemistry and streamwater quality suggest that low intensity, low severity prescribed burns could be used to restore vegetation structure and composition in mixed pine-hardwood ecosystems without negatively impacting water quality.

Figure 7: Fork Ridge approximately 2 months post-burn

A prescribed fire was completed at Fork Ridge April 3, 2019. Shortly after the burn, several areas were checked to see the amount of O layer (organic matter such as decomposing leaves) that was consumed on different facing slopes. Unburned areas and differences in O layers showed that fire has a negligible effect in relation to organic material. Visual observation had a similar mosaic burn pattern throughout.

Soil-stabilizing vegetation after burning recovers within six months of the prescribed burn (Rigg and Larson, 2007). Figure 7 was taken of the Fork Ridge burn on June 13, 2019 verifying quick re-vegetative growth.

The direct and indirect effects to air quality of the proposed prescribed burning would be of short duration (less than 24-hours). As a federal agency, the Forest Service must comply with all federal, state, and local laws and regulations concerning air quality. In Indiana these include State Implementation Plans for attaining and maintaining national ambient air quality standards (NAAQS) and visibility goals under the Regional Haze Rule. The desired condition for air quality is continued compliance with the NAAQS within the analysis area and minimizing the intermittent impacts of smoke to all sensitive areas.

Air quality within the analysis area is currently meeting the NAAQS for ozone and fine particulates. This means that current sources of pollution, including intermittent emissions from prescribed fire, are not causing air quality to exceed the current thresholds established to protect human health and welfare. Based on existing air quality information, no long-term adverse impacts to air quality standards are expected from the proposed project (Ash and Kolaks 2019). The proposed project is designed to ensure that the Basic Smoke Management Practices are followed and does not threaten to lead to a violation of any Federal, State or Local law or regulation related to air quality. However, there may be times when smoke from the proposed prescribed fires causes short-term respiratory discomfort, is a nuisance, or reduces visibility of those near the burn units. Although burns are planned to minimize these impacts to smoke sensitive areas and nearby residents, there is the potential for the smoke plume to change direction and temporarily affect those in its path. These impacts are short-lived and last less than 24 hours. Impacts may also occur some distance downwind depending on the weather conditions. This is particularly the case for burn units that may contain higher than normal fuel loads due to insect and storm damage, and lack of regular fire treatments. For these reasons, smoke management planning is an integral part of each prescribed burn operation.

Prescribed burning produces mixed effects on nonnative invasive species (NNIS) plants depending on the individual species, the timing of the burn, and fire intensity. Burning contributes to disturbance that can create conditions susceptible for new invasive plant invasion or expansion of existing infestations. Fire would create a nutrient flush for a short period that would benefit both native and invasive plants.

Where appropriate and feasible, the Forest would implement actions that would include the use of manual, mechanical, and herbicide techniques for control of NNIS plants according to the Nonnative Invasive Species Plant Control Program Analysis (USDA FS 2009a).

Design measures, such as requiring equipment to be cleaned and inspected before entering the project area, were developed to decrease NNIS introduction and spread. Appendix A contains the list of project design measures.

Carbon emissions during the implementation of the proposed action would have only a temporary influence on atmospheric carbon. The proposed activities in the Houston South project are not considered a major source of greenhouse gas (GHG) emissions. Forested land will not be converted into a developed or agricultural condition or otherwise result in the loss of forested area. In fact, forest stands are being retained and harvested and prescribed burned to maintain a vigorous condition that promotes tree growth and productivity, reduces insect and disease levels and supports sustainable ecosystems, thus contributing to long-term carbon uptake and storage (Dugan 2019).

Forest management activities such as harvests and prescribed burns have characteristics similar to disturbances that reduce stand density and promote regrowth through thinning and removal, making stands and carbon stores more resilient to environmental change (McKinley et al. 2011). The relatively small quantity of carbon released to the atmosphere and the short-term nature of the effect of the proposed actions on the forest ecosystem are justified, given the overall change in condition increases the resistance to insects, disease, wildfire, age related declines in productivity, or a combination of factors that can reduce carbon storage and alter ecosystem functions (Millar et al. 2007, D’Amato et al. 2011). Furthermore, any initial carbon emissions from this proposed action will be balanced and possibly eliminated as the stand recovers and regenerates, because the remaining trees and newly established trees typically have higher rates of growth and carbon storage (Hurteau and North 2009, Dwyer et al. 2010, McKinley et al. 2011).

No Action

If the no action alternative were to be selected, no prescribed burning would occur in the project area, resulting in a continuation of present natural community succession and lend to the decline in oak/hickory regeneration.

This alternative would have no direct effects on air quality since no actions would be implemented. Indirectly, this alternative could impact air quality later due to resulting build-up of forest fuels, which could cause more smoke over longer durations if intense wildfires were to burn areas not treated (unlikely except in a drought year).

Active nonnative invasive plant colonization and establishment as influenced by ongoing activities within the project area would continue at current rates. Any change to the rate of spread of NNIS plants would depend upon existing Forest projects that overlap the project area and any other future invasive plant control done according to the Nonnative Invasive Species Plant Control Program Analysis within or adjacent to the project area (Table 6). The rate of spread, however, under the no action alternative for the action area and for lands immediately adjacent would be less because it would not increase ground disturbance. Risks to rates of NNIS plant expansion under this alternative would depend upon human disturbances and available funding to mitigate effects caused by those actions not associated with the Houston South project.

There would be no timber or prescribed fire treatments implemented under this alternative. In the absence of timber harvesting on the stands where proposed under the Proposed Action, stand densities would continue to increase causing competition for limited resources. This could lead to tree stressors that lend themselves to increased insect and disease outbreaks and mortality, decreasing the resilience of forests to climate-related environmental changes. Eventually, the forest would thin naturally resulting in dead trees that would decay in the long-term, emitting some carbon to the atmosphere, which may or may not be offset by forest growth.

Cumulative Effects for Issue 1

Multiple prescribed fires could occur on the same day within the analysis area if burning conditions were favorable, and equipment and staffing were available. Multiple burns occurring at the same time could cumulatively increase particulate levels. Should other burns be scheduled, communication between prescribed fire managers is essential to minimize the chances of smoke from multiple burns merging, whether they are ignited on the same or consecutive days.

As a result of the pre-planning and effective smoke management as required throughout the burns, the overall magnitude of effects are within the standards set to protect public health and safety. No significant cumulative effects would result from implementation of the proposed action.

Invasive plants will continue to invade and spread across the landscape. The cumulative effect of implementing the action alternative combined with ongoing human and natural disturbances is the continuing spread of these species. The actions and processes differ in various locations in the project area and across the Forest, so the rate of spread would also differ. Vehicles, equipment, wind, rain, animals, and humans have the potential to carry invasive plant seed to new and currently uninfested areas. This spread really has no limit other than the susceptibility of the receiving habitats. Given the inherent susceptibility of some habitats across the Forest and within the project area, spread is likely. At the same time, Forest-wide NNIS plant management and site-specific project level control activities are increasing, which could result in reduced invasive plant populations in areas of treatment for the Houston South project.

Past and present disturbances, when added to reasonably foreseeable actions, have an effect on the expansion of NNIS through distribution of seed, ground disturbance, and the creation or perpetuation of spread vectors. The degree of effects would vary depending on the number of entrances over time, distribution of disturbance across the Forest, the proximity of infestations, and number of acres disturbed. The Hoosier is intermixed with lands of other ownerships. Since invasive plant infestations occur at widely scattered locations on both private and NFS lands, land use decisions made by other owners may affect the spread of invasive plants as much as activities carried out by the Hoosier.

Continued implementation of the Nonnative Invasive Species Plant Control Program Analysis (USDA FS 2009a) in selected portions of the project area where most needed according to the identified treatment priorities, would work against the cumulative effect of many other activities, which are creating conditions for the spread of NNIS.

Because the direct and indirect effects of prescribed burning related to GHG release and carbon release would be negligible, the proposed action’s contribution to cumulative effects on global GHGs and climate change would also be negligible. Carbon would be removed from the atmosphere with time as the forest regrows, further minimizing or mitigating any potential cumulative effects.

Issue 2: Concern that trails used for hauling timber could cause erosion

Indicators:

- Miles of trails used for harvest

Issue 3: Concern that timber harvest could cause soil erosion during and after harvest

Indicators:

- Percent of project area affected by soil disturbance

Issue 4: Concern that timber harvest and road construction could cause sedimentation and nutrient loading in the watersheds of Lake Monroe

Indicators:

- Percent of project area affected by soil disturbance
- Miles of new road construction

For Issues 2-4: Analysis Area:
The spatial boundaries used to evaluate direct effects are the areas with proposed actions within the Houston South Project boundary. This spatial boundary was chosen because it can be used to determine threshold effects to soil and water quality from proposed actions.

The spatial boundary used to evaluate indirect and cumulative impacts is the 10-digit hydrologic unit (HUC 10) South Fork Salt Creek watershed. This cumulative effects boundary permits the assessment of effects from any past, present, and reasonably foreseeable future projects that overlap in time and space with effects to soil and water from the proposed action. Cumulative effects, beyond the project site watershed boundary, diminish below measurable levels and cannot be meaningfully evaluated. The timeframe of consideration for effects to soil and water is 12 to 15 years because silvicultural treatments would be complete by this period. Sedimentation effects to water resources are not expected to exceed one complete vegetative growing cycle after project completion because the combination of vegetative growth and lessened disturbance provide protection from sediment movement.

Direct and Indirect Effects for Issues 2-4

Proposed Action

Direct effects to soil and water from initial disturbance which may affect soil productivity and water quality are: soil decomposition (compaction, rutting, and movement), localized erosion/sedimentation, and water pollution. “Localized” infers that qualitative and quantitative measurable impacts do not progress beyond the project boundary.

Although new roads on undisturbed ground would be needed, there are many old road corridors throughout the project area that follow ridge tops. When planning the transportation system for the project, these existing linear scars were used to minimize soil and watershed impacts. New construction would convert these old road corridors to new roads. Road reconstruction would require maintenance to bring old roads up to current transportation specifications. Landings and skid trails would be used mostly on ridgetops and flat areas to minimize disturbance.

A total of 16.4 miles of road work is proposed to access timber. Road construction/ reconstruction activities that would impact the landscape include, but are not limited to: culvert installations, natural material fords, drainage dip construction, clearing corridors, aggregate placement, and earthwork. Effects from the road work would be short-term sedimentation of drainages and movement of some of the earthwork material downhill. Erosion control methods, along with seeding and mulching of disturbed areas, would minimize these effects. It has been found that disturbed areas heal themselves within two to three years. Long-term effects may include blockage of aquatic organism passage in drainages due to improper culvert installations, taking ground out of production, degradation of drainages due to ford crossings, and movement of aggregate surfacing off the roadway due to routine road maintenance and during heavy rain events. Compaction, loss of water infiltration, and loss of overall long-term soil productivity are to be expected with road construction.

Proposed constructed road locations are mainly on high ground and only intermittent or ephemeral streams would be crossed for new road construction. Road approaches to streams would be located to minimize erosion and sediment introduction to the stream. Roads would generally cross channels at right angles. Channel crossings would be accomplished using appropriate crossing structures according to site specific conditions. Natural hydrologic drainage regime should be maintained with adequate drainage structures and design. Road surfaces should be maintained using aggregate or suitable erosion control cover within riparian corridors (USDA FS 2006a).

There are several degrading roads and trails that are negatively impacting the South Fork Salt Creek Watershed due to sedimentation. Rehabilitating these roads and trails to specification would minimize erosion instead of exacerbating at the current rate.

Timber harvest activities have the potential to cause detrimental soil disturbances. These disturbances can adversely affect soil productivity and water quality. The Forest Service has a practical method of monitoring soil disturbance with set thresholds. Site quality is projected to be maintained if detrimental soil disturbance (DSD) is less than 15% of an area (Powers 1998). Approximately 454 acres (10% of harvest area) of soil would potentially be detrimentally disturbed due to road construction and reconstruction, as well as landing, skid trail, AOP, and fire line construction.

A complete soil analysis was conducted based on risks posed by harvesting. Many of the soils are moderate to high risk erodible silt loams based on structure and slope. Table 3 displays interpretations for activities for the soil map units inventoried and delineated for the entire the Houston South proposed action area. Soil interpretations related to use of ground-based equipment, excerpted from NRCS soil survey include interpretations of hazard or risk for erosion hazard and harvest equipment operability. Detailed descriptions of these interpretations are in the project file for the Houston South project.

Table 3: Soil types and soil ratings in the project area

Map Unit Symbol	Map Unit Name & Percent Slope	Erosion Rating	Harvest Equipment Operability
AddA	Avonburg silt loam, 0 - 2%	Slight	Moderately suited
BbhA	Bartle silt loam, 0 - 2%	Slight	Moderately suited
BcrAW	Beanblossom silt loam, 1 - 3%	Moderate	Moderately suited
BdoB	Bedford silt loam, 2 - 6%	Moderate	Moderately suited
BnwD2	Bonnell silt loam, 12 - 18%	Very Severe	Moderately suited
BocD3	Bonnell silty clay loam, 10 - 18%	Severe	Moderately suited

BvmG	Brownstown channery silt loam, 25 - 75%	Very Severe	Poorly suited
BvoG	Brownstown-Gilwood silt loams, 25 - 75%	Very Severe	Poorly suited
CkkB2	Cincinnati silt loam, 2 - 6%	Moderate	Moderately suited
CkkC2	Cincinnati silt loam, 6 - 12%	Severe	Moderately suited
CkkC3	Cincinnati silt loam, 6 - 12%	Severe	Moderately suited
ComD	Coolville silt loam, 12 - 20 %	Very Severe	Moderately suited
DfnA	Dubois silt loam, 0 - 2%	Slight	Moderately suited
DfnB2	Dubois silt loam, 2 - 6%	Moderate	Moderately suited
FkoD2	Frederick-Crider-Gilwood silt loams, 6 - 18%	Severe	Moderately suited
GgeD	Gilwood-Crider silt loams, 6 - 20%	Severe	Moderately suited
GghD	Gilwood-Wrays silt loams, 10 - 25%	Very Severe	Moderately suited
GmrD3	Gnawbone silt loam, 12 - 18%	Severe	Moderately suited
GmrF	Gnawbone silt loam, 25 - 55%	Very Severe	Poorly suited
HccA	Haubstadt silt loam, 0 - 2%	Slight	Moderately suited
HccB2	Haubstadt silt loam, 2 - 6%	Moderate	Moderately suited
HcgAH	Haymond silt loam, 0 - 2%	Slight	Moderately suited
HheF	Hickory loam, 15 - 45%	Very Severe	Moderately suited
HsaB2	Hosmer silt loam, 2 - 6	Moderate	Moderately suited
KxvD2	Knobcreek-Crider-Gilwood silt loams, 6 - 18%	Severe	Moderately suited
MhyB2	Medora silt loam, 2 - 6%	Moderate	Moderately suited
MwhA	Muren silt loam, 1 - 3	Slight	Moderately suited
NaaB2	Nabb silt loam, 2 - 6%	Moderate	Moderately suited
NehF	Negley loam, 18 - 35%	Severe	Moderately suited
NerD2	Negley silt loam, 12 - 18%	Severe	Moderately suited
OmkC2	Otwell silt loam, 6 - 12%	Severe	Moderately suited
OmkC3	Otwell silt loam, 6 - 12%	Severe	Moderately suited
Omz	Orthents, earthen dam	Not rated	Not rated
PcrB2	Pekin silt loam, 2 - 6%	Moderate	Moderately suited
PhaA	Peoga silt loam, 0 - 1%	Slight	Moderately suited
PlpAH	Piopolis silty clay loam, 0 - 1%	Slight	Poorly suited
PlpAHU	Piopolis silty clay loam, 0 - 1%	Slight	Poorly suited
RblD3	Rarden silty clay loam, 12 - 18%	Severe	Moderately suited
RcsC3	Rarden silt loam, 6 - 12%	Severe	Moderately suited
SoaB2	Spickert silt loam, 2 - 6%	Moderate	Moderately suited
SoaC2	Spickert silt loam, 6 - 12%	Severe	Moderately suited
StaAH	Steff silt loam, 0 - 2%	Slight	Moderately suited
StaAQ	Steff silt loam, 0 - 2%	Slight	Moderately suited
StdAH	Stendal silt loam, 0 - 2%	Slight	Moderately suited
StdAQ	Stendal silt loam, 0 - 2%	Slight	Moderately suited
SukC2	Stonehead silt loam, 4 - 12%	Severe	Moderately suited
SvgA	Stoy silt loam, 0 -2%	Slight	Moderately suited
WgwD2	Wellrock silt loam, 12 - 18%	Severe	Moderately suited

A combination of soil and site physical properties or characteristics in six soil map units identify “soils of concern” for the project area. These soil map units require additional consideration and management throughout the various phases of activity to maintain or enhance soil quality and productivity in its existing condition. These map units are: Brownstown channery silt loam (BvmG), a Brownstown-Gilwood silt loams (BvoG), Coolville silt loam (ComD), Gilwood-Wrays silt loams (GghD), Gnawbone silt loam (GmrF) and Hickory loam (HheF). The properties of concern are related to very steep slope gradient, 45% or higher, shallow soils, and soil moisture conditions. These soil map units have high erosion potential, slope failure potential and present challenges to equipment operation.

Soil erosion risk on these soils of concern is minimized by reducing the areas where equipment operates, locating landings on relatively flat ground that can be properly drained, locating skid trails on slopes less than 35 percent, and using erosion control features such as water bars and leaving woody debris on site following harvest operations. The debris would protect the soil from splash erosion impacts and presents physical barriers to soil movement (USDA FS 2006b). Further erosion risks can be minimized with pre-operation location and design of access routes, avoiding existing or predicted unstable slope areas where possible, installation of adequate road drainage during and after operation periods, and prompt rehabilitation of disturbed or excavated soils to restore protection from storm flow and maintain soil productivity. Additionally, harvest operations in a specific harvest unit are generally conducted in one season, and this would typically have fewer impacts on soils resources than operations that continue season after season (USDA FS 2006b).

The normal operating season in our contracts is in the driest part of the year (summer/ fall), further limiting soil compaction possibility and other impacts. Contractually, restrictions on operations on the most sensitive soils can be made to avoid resource impacts.

The contract can define the types of equipment allowed, such as dozer only areas, restricting equipment to staying on designated trails, or having purchasers winch trees to equipment on the trails, etc. Frequent timber sale inspections, especially on areas of high concern or marginal weather days, would occur.

This proposed disturbed area would be evaluated by implementing the Forest Disturbance Monitoring Protocol (USDA FS 2009b). Pre-harvest and post-harvest monitoring activities would be implemented at the start and end of the Houston South project to assess that the 15 percent of detrimental disturbance has not been exceeded. Forest Disturbance Monitoring Protocol rates disturbance using these indicators: reduction in organic soil layers, soil displacement, rutting, charred soil (light, moderate, severe) and compaction (platy or massive soil structure).

There are inherent risks to soil and water resources just by removing trees. One risk is initial higher water yields (moisture and run-off) reducing tree canopy and water uptake. Tree canopies intercept many raindrops that never hit the forest floor. These droplets are returned to the atmosphere through evapotranspiration. Tree removal can increase soil moisture due to lack of interception and water uptake (NRC 2008). Soils are then exposed to higher and longer periods of moisture. Increased and longer soil moisture periods can impose higher risk of slumps and slides based on local soil characteristics. Slumps and slides can cause detrimental impacts to water quality due to increased sediment loads in drainages and streams. This risk would be quickly reduced with regeneration of understory species. Various practices during timber harvesting could reduce the erosion potential. Leaving woody debris on site following harvest operations is one such practice. The debris would protect the soil from splash erosion impacts and presents physical barriers to soil movement (USDA FS 2006b). Additionally, all clearcuts are proposed on lesser-sloped ground, which should reduce risk of slumps and slides.

Prolonged erosion can be a major negative effect. Not only does sediment contaminate water, the nutrients living in sediment can pose risks to water. Excessive nutrient and sediment run off can contribute to increases in eutrophication rates of streams and lakes. This flush of nutrients can cause harmful algae blooms within the watershed. Overload of nutrients are a common problem and are usually caused from agricultural practices such as row crops and pasture/rangelands (Bunch 2016). Because adequate BMPs can keep excessive soil erosion from being detrimental to water quality (Jones et al. 1997), both managed and unmanaged forests have long been associated with the highest water quality when compared to other land uses (Brown and Binkley 1994). The Pate Hollow Water Quality Study, which had similar soil types and topography, states that 10-15 percent of the watershed would need to be clearcut for any changes in water quality to be observable (Moss 1995). The Houston South Project proposes 401 acres of clearcut, 0.6 percent of the South Fork Salt Creek watershed. Best Management Practices (BMPs) are implemented for any harvesting activity on the Hoosier. These BMPs are monitored to check for efficiency in reducing erosion. When a system of BMPs are implemented, the loss of sediment and nutrients can be greatly reduced as a result of silvicultural activities (Wynn et al. 2000).

Although forest cover provides maximum run-off and erosion control benefits, steep slopes on much of the forested land exist in the South Fork Salt Creek watershed. These conditions encourage greater run-off, sediment and nutrient losses than otherwise observed on flatter slopes. Ground disturbing activities must be designed and implemented appropriately. There are adequate BMPs that can be used for this terrain (Jones et al 1997). It was found that there is a 96.5 percent effectiveness of BMPs on federal lands (McCoy and Sobecki 2017).

Harvesting causes different levels of impacts to soil and water resources based on the type of activity within the harvest unit. Landings, roads, and skid trails have had the most potential for detrimental soil disturbance. These areas are impacted due to longer term heavy equipment use during harvesting. Incorporating appropriate BMPs would mitigate these detrimental impacts.

Aust and Blinn (2004) synthesized research of forestry BMPs on the effects to water quality and productivity over a 20-year period in the Eastern United States. The results from the large amount of research indicate that BMPs that minimize soil and litter layer disturbance, facilitate rapid regeneration and control overland flow of water do effectively minimize negative water quality effects of harvesting and site preparation. Most water quality problems associated with forest harvesting are actually problems caused by poorly designed and constructed roads and skid trails, inadequate closure of roads and skid trails, stream crossings, excessive exposure of bare soil, or lack of adequate Streamside Management Zones (SMZs) (Aust and Blinn, 2004).

The use of SMZs or riparian buffer zones in harvest operations can help protect biological communities that rely on riparian habitat. Maigret et al. (2014) found that when ephemeral streams are protected with SMZ regulations, declines in salamander abundances can be mitigated. Results from Semlitsch et al. (2008), strengthen recommendations to manage and harvest timber in small plots to allow forest dependent, pond breeding amphibians to shift habitat to increase survival and increase the potential for subsequent recolonization after succession. Their results also show that evacuation of pond breeding salamanders is reduced by the presence of high amounts of down wood and strengthens management recommendations to retain down wood on clearcuts. Sampling done by Hoosier biologists in ponds in or near clearcuts in the Jeffries timber sale in 2016 showed over 400 adult breeding salamanders in 4 minnow traps. The clearcut took place in 2014 and 2 years later showed little negative affect on the native salamander population.

Log landings are areas where logs are sorted and loaded for transportation. The intense use of these areas creates a risk to soil and water quality. Skid trails are also a risk to soil and water resources in the harvest unit. Skidders traverse the terrain hauling timber from the cut area to the landing area. Soil compaction is a potential risk which limits root growth for vegetation cover, accelerates surface erosion, and inhibits soils processes. Forest Plan guidance and design measures (Appendix A) would minimize these risks.

Although much of the terrain in Houston South is relatively steep, harvesting can be completed with Forest Plan guidance, BMPs and appropriate equipment. Tracked equipment is preferred on steep terrain because of its evenly distributed weight. This distribution gives these vehicles the ability to maneuver with less disturbance. Skid trails would generally be located on the stable high point of a ridge to ensure minimal soil disturbance.

The Forest Plan (USDA FS 2006a) has many management requirements that address soil disturbance and water quality risks that can be identified and used at the project level to reduce impacts. Design measures and BMPs are listed in Appendix A of this EA.

The Forest Plan contains provisions for timber harvesting near riparian areas. Permanent water bodies have a 100-foot buffer from any activity. Ephemeral streams require a minimum of 25-foot buffer and intermittent streams require a minimum of 50-foot buffer (USDA FS 2006a). Waterholes or small ponds up to a half acre with slopes no more than 5 percent, have a 25-foot buffer. Soil-disturbing activities within designated riparian corridors require effective erosion control. Erosion control measures such as straw bales in ditch lines and small drainages, berms in road embankments during construction, diversion ditches, slash and unmerchantable logs across slopes and trails, check dams in ditch lines, sediment detention basins, and sediment fences (USDA FS 2006a) would be implemented.

Three AOPs are proposed within the project boundary. Approximately four acres would be disturbed during new crossing construction. However, once completed, the natural flow regime would promote less excessive bank erosion and help mitigate channel incision.

Watershed restoration techniques in headwater streams for erosion control would occur to repair head cut and gullying that is occurring in the project area. Watershed restoration would have minimal disturbance due to the small sections of stream rehabilitated.

The Pate Hollow Study documents that water quality is not detrimentally affected by harvests in similar geological, topographic and soils regimes as Houston South (Moss 1995). Managed and unmanaged forests have long been associated with highest water quality when compared to other land uses (Brown and Binkley 1994). Long-term water quality within the Houston South Project should remain the same or be slightly improved based on initial disturbances and long-term improvements if Forest Plan standards and guidelines, BMPs, and mitigation practices are followed.

The Forest Service follows BMP monitoring guidelines to protect water quality using the National Best Management Practices for Water Quality Management on National Forest System Lands Technical Guide (USDA FS 2012). The National BMP Program consists of four main components: (1) a set of National Core BMPs, (2) a set of standardized monitoring protocols to evaluate implementation and effectiveness of those BMPs, (3) a data management and reporting structure, and (4) corresponding national direction (USDA, 2012). All management activities of other resources are to be designed to minimize short-term impacts on the soil and water resources and maintain or enhance long-term productivity, water quantity, and water quality. BMP monitoring focuses around projects within the aquatic management zones. An Aquatic Management Zone (AMZ) is a designated area near or around a stream channel and other waterbodies. AMZ delineation is site specific and may encompass floodplain and riparian areas (USDA 2012). The AMZ is monitored for implementation and effectiveness of BMPs. Chemical treatments, road reconstruction and construction, skid trail use, pond and wetland construction/ restoration, stream bank re-stabilization, facility use, prescribed burning, recreational trails and facilities are all addressed within the National BMP monitoring protocol. All these activities would be monitored within the Houston South Project.

Since the South Fork Salt Creek watershed borders the municipal Lake Monroe-Salt Creek watershed, four sites are currently being monitored for stage, discharge and turbidity. The sites are: South Fork Salt Creek at Kurtz, South Fork Salt Creek near Maumee, Negro Creek and Callahan Branch.

Background information on these sites is being collected to assess current water quality in relation to sediment. Soil disturbance would be the main risk to the watershed if BMPs fail or insufficient BMPs are used. Along with BMP inspections, turbidity would also be an indicator of water quality. Turbidity is the measure of clarity of water. Material that causes turbidity includes clay, silt, inorganic and organic matter, algae, and dissolved colored organic compounds. Turbidity readings are commonly used to indicate increased sedimentation during soil disturbing projects. Baseline turbidity readings have been collected in association with discharges since stage (water levels) cannot be directly associated with turbidity due to backwater effects on South Fork Salt Creek from Lake Monroe. Backwater affect is pooling of accumulated water in a stream channel indicating high flow stages, but less discharge associated with it. A non-backwater affect at the same location may have the same high flow stage but a greater discharge. There is not a linear relationship between turbidity and discharge, but higher turbidity readings are typically justified by higher flows. Baseline information shows pre-harvest and pre-burn turbidity conditions driven by natural erosion, private land use, and seasonal plant and algae growth. Turbidity monitoring would be ongoing throughout the life of the Houston South Project to ensure BMPs are effective. Higher turbidity can be associated with lower discharges depending on land use disturbances (agriculture, timber harvest, etc.) within the area. If turbidity levels are monitored higher than control background information, further investigation and monitoring would be deployed to ensure BMPs are effective within the harvest unit.

No Action

With the No Action Alternative, no management-related changes in soil productivity would occur. Current runoff and erosion patterns would be expected to remain the same, decreasing water quality and available aquatic habitat over time. This alternative makes no plans to take action on roads and trails that are in poor condition and likely contributing sediment to streams. The three aquatic organism passages that are proposed to widen channel flows through crossings which could reduce channel incision, erosion and sedimentation would not be constructed. The restoration of head-cut streams, which could reduce sedimentation of streams, would not occur.

Cumulative Effects for Issues 2-4

Ongoing and past activities on private land include timber harvesting, grazing, agriculture activities, and other minor residential disturbances, all of which can impair soil and water quality. Approximately 1,153 acres of agricultural land exists within the South Fork Salt Creek watershed floodplain.

Historically, best management practices may not have been applied commonly on private lands. Private land owners have been encouraged over the last decades to adopt soil and water conservation practices. However, even when such practices are employed during an activity, consistent long-term maintenance practices to control erosion and sedimentation from disturbances are less likely to have been (or be) implemented for many private land uses. Agriculture, timbering, residential development and associated activities are expected to continue in the future.

Figure 8: Tractor with South Fork Salt Creek Flood debris

Additional new soil disturbances have been occurring on private land, including recreational use of off-road vehicles. Future actions will likely add to historic soil disturbances, resulting in more soil and water quality degradation.

Furthermore, since private lands have typically been less regulated and are expected to remain less regulated in the future, soil-disturbing activities that negatively affect soil and water quality will likely persist.

Issue 5: Concern that closing trails during periods of timber management could have negative impacts to recreationists

Indicators:

- Miles of affected trail in or adjacent to areas proposed for treatment
- Duration of trail closures

For Issue 5: Analysis Area:
The spatial boundary used to evaluate direct, indirect, and cumulative effects is the Houston South Vegetation and Restoration Project boundary. The timeframe of consideration for effects to recreation is approximately 12-15 years for harvest activities and up to 20 years intermittently for post-harvest burning activities.

Direct and Indirect Effects for Issue 5

Proposed Action

The proposed Houston South Vegetation Management and Restoration Project would have both positive and negative impacts to recreation trail users, and other modes of recreation; depending on the perspective of the observer, and time of use. Approximately 26 miles of the Hickory Ridge trail system and the 3.5 miles of the Fork Ridge trail are within the project area. Trail users would be affected by approximately 14.5 miles of temporary trail closures during the time period of timber sales, intermittently, over 12 to 15 years. Approximately 11.5 miles of trails could be affected by silvicultural treatments and an additional three miles of trails could be affected by skidding and hauling timber. Not all 14.5 miles would be closed at the same time.

All trails within the project boundary would not be impacted at once, and some trails segments and sections may not be impacted at all. Silvicultural treatments affecting trail corridors would include approximately 9.5 miles of the Hickory Ridge trail system and two miles of the Fork Ridge trail. While harvesting is being actively implemented these trails would be signed as “closed”. Timber sales typically last one to three years, and trail segments affected would only be closed during active removal within the timeframe.

Table 4: Approximate miles of trail affected by silvicultural treatments

Silvicultural Treatment	Trail Miles Affected
Clearcut	2 miles
Shelterwood	1.5 miles
Selection	0.5 miles
Hardwood Thinning	5.5 miles
Midstory Removal	1.5 miles
Crop Tree release	0.5 miles
Totals	**11.5 miles**

Some trail segments would be developed into temporary roads to effectively cut and remove timber (USDA FS 2018). There are 8.7 miles of existing system roads that coincide with trails in the project area, of which approximately 2 miles would be maintained or reconstructed and approximately 3 miles of the trail would be upgraded to system or temporary roads by new road construction. Additionally, approximately 1 mile of existing road with trail attached would be decommissioned and returned to trail only status. Any road reconstruction or construction that occurs on an existing designated trail would be rehabilitated per design measures and returned to its original condition (or improved condition) upon road use expiration. It may be determined that the location of the temporary road that is not a designated trail is a more sustainable location than the nearby existing trail location, thus trails may be relocated to where the road would be constructed. If a trail segment is relocated to a more sustainable location, the pre-existing trail would be obliterated and closed. Any newly located trail would meet Forest Service trail standards. Long term trail conditions would improve in these cases, thus improving the recreation experience. Because the location of an existing designated trail may change slightly the overall trail mileage may increase or decrease up to 2 miles within the project area.

Figure 9: Hickory Ridge Trail #11 (May 2019)

Trails within the project boundary may also be used for skidding timber. Trails impacted by skid use would be returned to their pre-existing state by the contractor if determined that the trail is in the best location from a sustainability standpoint. Trails would follow Forest Service design measures for rehabilitation after use for silvicultural treatments.

Trail re-routes may occur on trails that are in riparian areas or in poor locations including trail #15, #20, and the conjoining system area of #11, #12, #3, and #13, regardless of project impacts (figure 9). Additionally, a short spur trail (approximately 0.2 mile) with limited parking, would be added as a connector trail to trail #15. A permanent trail closure would occur on trail #20 starting at County Road 925N to the junction of trail #18, due to poor trail condition and low use. Total mileage of the proposed trail closure segment is approximately 0.5 mile. Trail mileage would not greatly change but may increase or decrease up to two miles overall depending on the best sustainable locations of trails affected. Because contractor work would vary, additional mitigation measures may be determined after treatments to restore the trail corridor, including determining if a re-route is needed.

Beginning in 2020, silvicultural treatments would be based on identified treatment units, affecting approximately 11.5 miles of trail. This disturbance would be distributed throughout the implementation period of 10-15 years and not all at once. Approximately three miles of additional trail would be impacted by skidding and hauling timber. Recreation impacts would be considered in the scheduling of sale units. Treatment units would be staggered, and adjoining units would not be impacted at the same time. Treatments may occur in one area, and then followed by another area within the project boundary but not directly next to the previously treated unit. Staggering of units would alleviate some impacts to recreation. The least amount of trail closure needed to ensure safety and project success would be applied, but only during active sales and active prescribed burning.

Although silvicultural treatments and prescribed burns would negatively affect trail use and other recreational activities in the project area, the long-term benefit of restoring early successional habitat and the regeneration of oak and hickory trees substantiates the need for short term impacts to recreation. Similar recreation opportunities are offered nearby on other Hickory Ridge trails outside of the project area (approximately 25 miles of trails), the Nebo Ridge and D trail (approximately seven miles of trails), as well as further south on the Forest at the Shirley Creek trail system (nearly 20 miles of trails). Additional recreation trails are also available nearby in the Charles C. Deam Wilderness. Overall, the Hoosier National Forest has approximately 260 miles of recreation trails (USDA FS 2006a).

Signage of educational and interpretive value may be installed along affected trails to better inform the public and trail users of forest management techniques.

No Action

Under the No Action Alternative, no vegetation treatments would be implemented, no road work would occur, and there would be no effect to users of the Hickory Ridge and Fork Ridge trail systems and associated roadways in the short or long term. Trail maintenance and trail use would continue uninterrupted except for strong wind events resulting in down trees. In those cases, the trail would be temporarily closed for safety concerns while it is cut out. The non-native pine trees, particularly along the trail, would continue to be susceptible to disease and die off and be prone to blow down during wind events. An increase of hazard trees would be likely as trees continue to age and mature along trail and road corridors.

Cumulative Effects for Issue 5

The geographic boundary for cumulative effects to visuals and recreation is the proposed Houston South Vegetation and Restoration Project boundary. No additional cumulative effects to recreation resources are anticipated as there are no other past, present, or future recreation actions predicted to contribute aggregated effects. The time period is from the beginning of the proposed project, 2020 through 2040 when the Houston South project treatments would be complete, bearing in mind most silvicultural treatments would be complete within 12-15 years, and prescribed burning effects are short-term and intermittent, within the 20-year window.

Issue 6: Concern that prescribed burning could have negative impacts on recreational opportunities

Indicators:

- Miles of affected trail in or adjacent to areas proposed for treatment
- Miles of roads in or adjacent to areas proposed for treatment

For Issue 6: Analysis Area:
The spatial boundary used to evaluate direct, indirect, and cumulative impacts is the Houston South Vegetation and Restoration Project boundary. The timeframe of consideration for effects to recreation from prescribed burning is 20 years, however burn units typically impact recreation for only a day or two, with trail closures occurring up to five days depending on unit conditions following the burn.

Direct and Indirect Effects for Issue 6

Proposed Action

Approximately 26 miles of trails of the Hickory Ridge trail system and 3.5 miles of the Fork Ridge trail are within the project boundary and may be used for prescribed burning fire lines and access. Of the 16.4 miles of FS system roads within the project area, currently 1.2 miles are open to public motorized vehicle use. Proposed prescribed fire activities and associated road and trail closures would create some inconvenience for users and disruptions to recreational activities. However, any disruption would be temporary in nature (approximately five days), and closures would only be needed during the active time of the burn. Burns would be scheduled by units, and the entire project area would not be impacted at the same time, but instead spread out over several years. Annual acres burned for this project would average approximately 1,500 acres. Trails within a burn unit would be signed “closed” during the burn, with public notice via social media outlets and press releases.

During prescribed burning, trail users would be displaced for a short time because of trail closures. Similar recreation opportunities are offered nearby on other Hickory Ridge trails outside of the project area (approximately 25 miles of trails), the Nebo Ridge and D trail (approximately seven miles of trails), as well as further south on the Forest at the Shirley Creek trail system (nearly 20 miles of trails). Additional recreation trails are also available nearby in the Charles C. Deam Wilderness.

No Action

Under the No Action Alternative, no vegetation treatments would be implemented, no road work would occur, no prescribed burning would occur and there would be no direct effect to recreational activities. Habitat diversity would not be increased, and oak and hickory species would continue to decline, which may impact recreationist who seek a diversity in wildlife.

Cumulative Effects

No additional cumulative effects to recreation resources are anticipated as there are no other past, present, or future actions predicted to contribute aggregated effects. The time period is from the beginning of the proposed project, 2020 through 2040 when the Houston South project treatments would be complete, bearing in mind prescribed burning effects are short-term and intermittent, within the 20-year window.

Issue 7: Concern that proposed harvest treatments and prescribed fire treatments could degrade the visual quality along trail corridors

Indicators:

- Visual Quality Objectives

For Issue 7: Analysis Area:

The spatial boundary used to evaluate direct, indirect, and cumulative impacts is the Houston South Vegetation and Restoration Project boundary. The timeframe of consideration for effects to visuals is twenty years, to allow for substantial rejuvenation of grasses, brush, and other vegetation.

Direct and Indirect Effects for Issue 7

Proposed Action

The proposed Houston South Vegetation Management Restoration Project would have both positive and negative effects on the visual quality of the viewing area along trails and roads within the project boundary, depending on the perspective of the observer and time of use. Silvicultural treatments would change the visual character of the area, particularly within the first several years. Forest visitors using trails in the project area and travelers along associated roads bordering the project would see a landscape with a

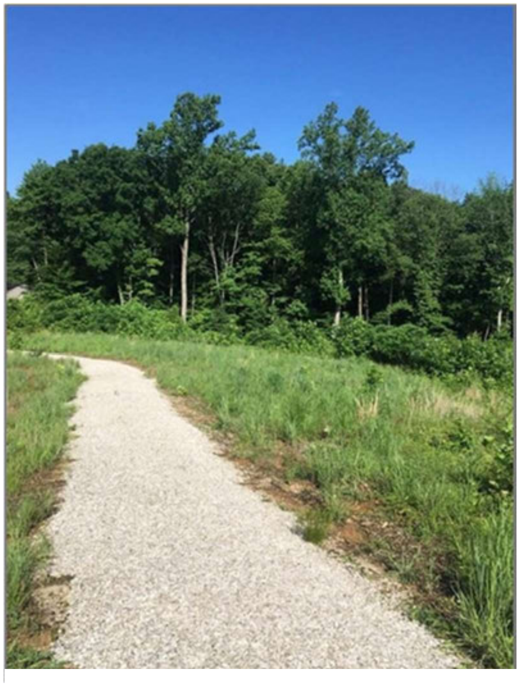

Figure 10: Two Lakes Trail in 2014 harvest unit (2019 Photo)

more open appearance in areas, rather than stands of trees throughout. Treatments would vary; thus, the level of visible impact would also vary. A mosaic of forest conditions would be visible in the treated areas, providing diverse forest age classes and habitat types, thus increasing the diversity of viewable wildlife and other visual qualities. In several years, the stands would appear more natural as regeneration proceeds. The visual evidence of woody debris and stumps would diminish as new vegetation grows. Portions of the treatment areas would appear as a heavily disturbed landscape at first but would eventually blend in during later growing seasons. Although the current landscape would be altered in treatment areas, the proposed activities would promote a landscape dominated by hardwoods, create early successional habitat, and restore dry hardwood forest ecosystems that have not experienced periodic disturbance due to fire or other naturally occurring events (USDA FS 2018).

Approximately 11.5 miles of the identified trail systems within the project area would be affected by silvicultural treatments. An additional three miles of trails could be affected by skidding and hauling timber.

In addition to silvicultural treatments, prescribed burning would take place within the Houston South Vegetation and Restoration Project boundary, having short term negative effects on visual quality. Techniques applied are generally considered “light”, or low to moderate intensity burning. In most instances, burned areas are relatively indistinguishable from adjacent unburned areas unless the burned area is part of a restoration effort (Kolaks 2011). Prescribed burning would occur within control lines and smoke would be visible during the burns and within a short window of time following the burn. Any burn scars on trees within site distance of the Hickory Ridge and Fork Ridge trail systems and associated roadways would have a short-term negative effect on visual quality. Soon, the positive visual effects of burning would dominate by enhancing aesthetics by maintaining open stands, increasing numbers of flowering annuals and biennials, increasing herbaceous cover and maintaining open spaces such as vistas. In terms of silviculture, fire promotes the release of existing oak reproduction, thus supporting the purpose and need of the proposed project (Kolaks 2011).

The visual impact of silvicultural treatments and prescribed burning would not be occurring all at once for the entire identified project area. Silvicultural treatments and burns would be scheduled in units. Silvicultural treatment and associated sales within an identified unit typically occur for 1 to 3 years. Prescribed burns typically take a day or two per unit, with trail closures occurring up to five days depending on conditions. All debris resulting from vegetative management and prescribed fire use would be treated to maintain the visual foreground along frequently traveled roads, trails, and streams to meet visual quality objectives defined in the Forest Plan (USDA FS 2006a).

No Action

Under the No Action Alternative, no vegetation treatments would be implemented, no road work would occur, and there would be no effect to users of the Hickory Ridge and Fork Ridge trail systems. Vegetation would continue to grow and die naturally, thus visuals would be affected by natural conditions. Conversely, the non-native pine trees, particularly along the trail, would continue to be susceptible to disease and die off and be prone to blow down during wind events. Habitat diversity would not be increased, and oak and hickory species would continue to decline, which may impact the visual enjoyment of some, especially for users who are seeking a diversity of wildlife.

Cumulative Effects for Issue 7

The geographic boundary for cumulative effects to recreation is the proposed Houston South Vegetation and Restoration Project boundary. No additional cumulative effects to visual quality are anticipated as there are no other past, present, or future actions predicted to contribute aggregated effects.

Issue 8: Concern that vegetation management and the use of herbicide treatment could have negative effects to the Salt Creek watershed

Indicator:

- Chemical contaminants from herbicides

For Issue 8: Analysis Area:
The spatial boundary used to evaluate direct, indirect effects is the project boundary. The spatial boundary used to evaluate cumulative effects is the South Fork Salt Creek watershed. The timeframe of consideration for effects of herbicide treatment is 12-15 years because silvicultural treatments would be complete by this period.

Direct and Indirect Effects for Issue 8

Proposed Action

Selective herbicide applications are proposed for site preparation and stand improvement activities on 1,970 acres. Forestry herbicides are a versatile, cost-effective tool that can be used in a variety of ways to help manage forest vegetation (Kochenderfer et al. 2012). Table 4 shows average stems per acre to be treated in each area proposed for herbicide use.

Table 5: Proposed areas for selective herbicide treatments and average stems per acre to be treated with herbicide

Treatment Area	Acres	Objective	Average stems per acre to be treated
Clearcut	401	Site preparation for natural regeneration; post-harvest	219
Shelterwood	703	Site preparation for oak-hickory regeneration; pre- and/or post-harvest	238
Selection	462	Site preparation for natural regeneration in group selection areas; post-harvest	179
Midstory Removal	234	Site preparation for oak-hickory regeneration	226
Crop Tree Release	170	Release of crop trees	80
Total	**1,970**		

Herbicide use for stand improvement and site prep activities typically requires a single application to attain the desired effects. Herbicide would be applied specifically to the trunks and stumps of targeted woody vegetation resulting in a relatively small area of application with little to no herbicide contacting the soil. The maximum amount of herbicide used in a given treatment should remain well below the maximum forestry use rate per year as identified on the manufacturer's label. For example, when using Arsenal® (imazapyr) for stem injection treatments (hack and squirt), the maximum use rate for forestry treatments is 96 ounces/acre/year. Assuming three-inch-wide hacks and an average tree diameter at breast height (dbh) of six inches, 705 stems could be treated with a concentrate treatment or 9,600 stems could be treated with a dilute treatment. The average number of stems per acre to be treated in this project (Table 4) are considerably lower than the number that could be treated without exceeding the maximum use rate of the herbicide

Numerous studies have demonstrated that modern herbicides can be safely applied in forests. Forestry herbicides inhibit biochemical pathways that are specific to plants. Commonly used and recommended forestry herbicides are very low in animal toxicity and do not bioaccumulate. Because of their low toxicity and minimal environmental hazards, most herbicides used in forestry operations are classified as "non-restricted use" meaning they are available to the general public and no license is required for landowners to buy them and apply them on their own land. Research has shown that herbicides used in forestry biodegrade relatively fast after application (Kochenderfer et al. 2012). See Tables 7 and 8 for herbicide risk characterizations for wildlife and the environment.

Proposed herbicides for this project would include a subset of those identified for use under previous decisions in which a Finding of No Significant Impact (FONSI) was prepared (USDA FS 2009a, USDA FS 2018). A list of proposed herbicides and targeted use can be found in Table 6.

Table 6: Proposed herbicides and targeted use for undesirable native species

Chemical Name	Examples of Trade Names	Targeted Use	Examples of Native Trees to be Targeted	Risk Assessment
Glyphosate	Accord®	Cut-Stump Treatment	Sugar maple, red maple, American beech	SERA 2011a
Imazapyr	Arsenal®	Stem Injection	Sugar maple, red maple, American beech	SERA 2011b
Triclopyr	Garlon®3A Garlon®4	Cut-Stump and/or Basal-Spray Treatment	Sugar maple, red maple, American beech	SERA 2011c

Table 7: Herbicide risk characterization for wildlife

Herbicide Risk Characterizations for Wildlife	
Glyphosate (SERA 2011a)	
Mammals, Birds, and Terrestrial Invertebrates	Effects to birds, mammals, fish, and invetebrates are minimal. Based on the typical application rate of 2 lbs. a.e./acre, none of the hazard quotients for acute or chronic scenarios reach a level of concern even at the upper ranges of exposure. For the application of 7lbs. a.e./acre, there is some level of concern with direct spray of honey bees, for large mammals consuming contaminated vegetation, and smallbirds consuming contaminated insects. These concerns are based on conservative dosing studies and environmental conditions that are not likely to occur in the field. The studies showing adverse effects are using formulations that are not legal, or available, in the U.S.
Aquatic Organisms	Some formulations of glyphosate are much more acutely toxic to fish and aquatic invertebrates than technical grade glyphosate or other formulations of glyphosate. This difference in acute toxicity among formulations appears to be due largely to the use of surfactants that are toxic to fish and invertebrates.
Soil Microorganisms	Transient decreases in the population of soil fungi and bacteria may occur in the field after the application of glyphosate at application rates that are substantially less than those used in Forest Service programs. However, several field studies have noted an increase rather than decrease in soil microorganisms or microbial activity, including populations of fungal plant pathogens, in soil after glyphosate exposures. While the mechanism of this apparent enhancement is unclear, it is plausible that glyphosate treatment resulted in an increase in the population of microorganisms in soil because glyphosate was used as a carbon source and/or treatment with glyphosate resulting in increased nutrients for microorganisms in the soil secondary to damage to plants.
Imazapyr (SERA 2011b)	
Mammals, Birds, and	In terrestrial animals and birds, imazapyr is practically non-toxic. Adverse effects in terrestrial or aquatic animals do not appear to be likely. The

Herbicide Risk Characterizations for Wildlife	
Terrestrial Invertebrates	weight of evidence suggests that no adverse effects in mammals, birds, fish, and terrestrial or aquatic invertebrates are plausible using typical or worst-case exposure assumptions at the typical application rate of 0.45 lb/acre or the maximum application rate of 1.25 lb/acre. Although imazapyr has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging non-target organisms, the available data are sufficient to assert that no adverse effects on animals are anticipated based on the information that is available.
Aquatic Organisms	Imazapyr does not appear to be very toxic to aquatic fish or invertebrates.
Soil Microorganisms	Imazapyr is relatively non-toxic to soil microorganisms, aquatic invertebrates, and fish. Imazapyr is not expected to bioaccumulate in the food chain.
Triclopyr (SERA 2011c)	
Mammals, Birds, and Terrestrial Invertebrates	Contaminated vegetation is the primary concern in the use of triclopyr and that high application rates will exceed the level of concern for both birds and mammals in longer exposure scenarios.
Aquatic Organisms	An application rate of 1 lb/acre, acute and chronic risks to aquatic animals, fish or invertebrates, as well as risk to aquatic plants are low with use of the salt form of triclopyr. At the highest application considered in this risk assessment, 9 lbs a.e./acre, the risks to aquatic animals remain substantially below a level of concern. The ester form of triclopyr is projected to be somewhat more hazardous when used near bodies of water where runoff to open water may occur. Applications of the ester formulation can reach levels of concern at 3 lb. a.e./ac for fish and amphibians, 1.5 lb. q.e/ac for aquatic insects and 1.0 lb. a.e./ac for aquatic plants.
Soil Microorganisms	The potential for substantial effects on soil microorganisms appears to be low. An application rate of 1 lb/acre is estimated to result in longer term soil concentrations that range from 0.24ppm to 2.2 ppm – which are a factor of 3 below chronic levels for earthworms (6.0ppm). Using the laboratory studies to characterize risk, transient inhibition in the growth of some bacteria or fungi might be expected. This could result in a shift in the population structure of microbial soil communities but substantial impacts on soil – i.e., gross changes in capacity of soil to support vegetation – do not seem plausible. This is consistent with the field experience in the use of triclopyr to manage vegetation.

Table 8: Herbicide risk characterization for the environment

Herbicide Risk Characterization for the Environment	
Glyphosate (SERA 2011a)	
Solubility	Glyphosate is strongly adsorbed to soil particles, which prevents it from excessive leaching or from being taken-up from the soil by non-target plants. Glyphosate is degraded primarily by microbial metabolism, but strong adsorption to soil can inhibit microbial metabolism and slow degradation. Photo- and chemical degradation are not significant in the dissipation of glyphosate from soils.
Half Life	For glyphosate, the half-life ranges from several weeks to years, but averages two months. In water, glyphosate is rapidly dissipated through adsorption to suspended and bottom sediments, and has a half-life of 12 days to 10 weeks. Foliar half life averages 7-10 days.
Toxicity	By itself, glyphosate has relatively low toxicity to birds, mammals, and fish, and at least one formulation (Rodeo®) is registered for aquatic use. Some surfactants that are included in some formulations of glyphosate are highly toxic to aquatic organisms, and these formulations are not registered for aquatic use.
Imazapyr (SERA 2011b)	
Solubility	Imazapyr is a weak acid herbicide and environmental pH will determine its chemical structure, which in turn determines its environmental persistence and mobility. Below pH5, the adsorption capacity of imazapyr increases which limits its movement in soil. Above pH 5, greater concentrations of imazapyr become negatively charged, fail to bind tightly with soils, and remain available for plant uptake and/or microbial breakdown. Imazapyr has not been reported in water runoff despite its potential mobility.
Half Life	The half-life of imazapyr in soil ranges from one to five months, and in aqueous solutions, imazapyr may undergo photodegradation with a half-life of two days. Foliar half life ranges from 15-27 days.
Toxicity	Imazapyr has low toxicity to fish, yet algae and submersed vegetation are not affected. Imazapyr is not highly toxic to mammals or birds. This herbicide is excreted from mammalian systems rapidly with no bioaccumulation in tissues.
Triclopyr (SERA 2011c)	
Solubility	Triclopyr is relatively persistent and has only moderate rates of adsorption to soil particles, therefore, offsite movement through surface or sub-surface runoff is a possibility. In water, the salt formulation is soluble, and with adequate sunlight, may degrade in several hours. The ester is not water soluble and can take significantly longer to degrade. Because it can bind with the organic fraction of the water column, it can be transported to the sediments.
Half Life	Degradation occurs primarily through microbial metabolism in soils, but photolysis and hydrolysis can be important as well. The average half-life of triclopyr acid in soils is 30 days. Foliar half life is 15 days.

Toxicity	Triclopyr can cause eye damage (corrosive/irreversible) if splashed into the eyes during application. Both the salt and ester formulatons are relatively non-toxic to terrestrial vertebrates and invertebrates. However, the ester forumulation can be extremely toxic to fish and aquatic invertebrates.

No Action
With no action, no additional herbicides would be applied to the project area. There would be no additional direct or indirect effects related to herbicide use from implementing silvicultural treatments.

Cumulative Effects for Issue 8
Alternative A proposes select herbicides to treat native undesirable vegetation. Proposed herbicides were selected largely for their low toxicity to humans and the environment. Foreseeable future activities in the project area include possible treatment of non-native invasive vegetation with the same herbicides proposed in this project. It is possible that these treatments could overlap spatially, but precautions would be taken to ensure they do not overlap temporally. This will ensure application rates do not exceed those recommended on the manufacturers' labels, therefore there are no cumulative effects from overlapping herbicide applications.

Within the project boundary there are an estimated 2,600 acres of agricultural land on private ground. It is safe to assume that herbicides are used on much of this land either to spot-treat pastures or to treat entire fields, sometimes multiple times each year. These applications are not considered because it is unlikely that herbicides applied on NFS lands would translocate sufficiently to combine with them. Nor would National Forest applications involve the treatment of food crops.

Issue 9: Concern that prescribed burning could harm or displace wildlife

Indicator:
- Habitat condition

For Issue 9: Analysis Area:
The spatial boundary used to evaluate direct and indirect effects is based on the Ecological Classification System and primary habitat association. The project area is within the Brown County Hills Subsection (222Em). Because bat species that can forage over longer distances, a 5-mile buffer was established for the cumulative effects geographical boundary. The temporal consideration for cumulative effects is 20 years, as prescribed fire treatments would likely be completed in this timeframe.

Direct and Indirect Effects for Issue 9

Proposed Action

As maturing oaks and hickories age and die, they are being replaced by trees such as maple and beech. Oak-hickory ecosystems need management activities to regenerate due to severe competition by less desirable species. Although prescribed burning can have an immediate and direct negative impact on wildlife, these effects are usually short-lived. The lasting effects of keeping oak in the ecosystem outweigh the short-term negative effects. For example, at least 534 native species of lepidoptera (e.g. moths and butterflies) consume oak leaves and inhabit the furrowed bark of oak trees, not found on smooth barked maple and beech, that provides shelter from predators (Brose et al. 2014). Stands of oak trees support a significantly higher abundance and species richness of birds, a main predator of insects, during all seasons as compared to red maple stands. Additionally, Brose et al. (2014) predicts the conversion of oak forest to maple forest to have a severe impact on the bird communities of the eastern United States. Furthermore, more than 100 vertebrate species regularly consume acorns (Brose et al. 2014).

A lack of fire in the area is also causing oak-hickory seedlings to be suppressed by a shade-tolerant mid-story species. Reintroducing fire would promote regeneration and maintenance of mast producing oak and hickory. Prescribed burn treatments are proposed to enhance habitat conditions to promote oak and hickory regeneration for mast in Management Area (MA) 2.8 and improve habitat for wildlife and plant species in MA 2.4 and 6.4.

<u>Regional Forester Sensitive Species (RFSS)</u>

A biological evaluation (BE) was prepared to ensure that decisions regarding land management are made with recent scientific information regarding RFSS and the habitats they may occupy on the Hoosier National Forest. The effects related to prescribed fire are presented here, the complete BE can be found in the Houston South Vegetation Management and Restoration Project Record.

Review of the Indiana Heritage Database does indicate presence of Regional Forester Sensitive Species (RFSS) within the project area and the surrounding vicinity (IDNR 2015, 2012). However, during site-specific surveys, no RFSS were located. Additionally, there are no known caves located in the project area.

There are currently 141 RFSS for the Hoosier National Forest. These sensitive species with known occurrences on the Forest inhabit a diverse array of habitat. Animal species include four mammals, six birds, six fish, two amphibians, one reptile, two mollusks, 47 terrestrial invertebrates and 37 karst invertebrates. There are 34 vascular plants and two non-vascular plants on the RFSS list.

The RFSS occur in 10 community types and habitat, plus those wide-ranging species that use diverse habitats. Mesic forests, dry forest types, wetlands, small streams, ponds, open lands plus wide-ranging species that use diverse habitats occur in the project area. Habitats that do not occur within the project area include cliff, barrens and larger rivers.

Therefore, the proposed project would have no effect on populations of sensitive species associated with cliff, barrens, and larger river habitat.

Mammals

The Allegheny woodrat (*Neotoma magister*) is not found on the Brownstown Ranger District and has no habitat inside the project area or cumulative effects area. Due to the lack of suitable habitat (cliff communities), the species is considered not present and there would be no effect to this species or its habitat.

The little brown myotis (*Myotis lucifugus*), tricolored myotis (*Perimyotis subflavus*) and the evening bat (*Nycticeius humeralis*) were the only mammal species, on the current RFSS list that prefer the type of habitat found in the project area. All three bat species on the RFSS list are wide-ranging and could use this area for feeding, roosting, and corridors. All three bats are considered present and were located in the Hoosier National Forest during the 2010 mist-net surveys (McClanahan 2010) or current acoustic monitoring.

The little brown and tricolored bat can be found in a cave inside the cumulative effects boundary, although in low numbers. White-nose syndrome (WNS) is known to occur in this species and has heavily affected Indiana. Large declines have been noted during forest hibernacula surveys (Harriss) and this species is now considered rare.

Project activities could negatively impact these species concerning roosting, staging/swarming and summer habitat. However, growing season burning would be minimal and not likely during the periods when young are born. Removal of hazard trees for fire line preparation may indirectly affect bat species by removing potential roost trees. Crews would remove trees for fire line during the bat's inactive period to avoid any direct effects.

The proposed project would have short-term effects with long-term benefits for these species regarding travel corridors and foraging. Design criteria, vernal pools and existing cover habitat adjacent to the project area would benefit these species, but negative impacts could occur. Therefore, this project may impact the little brown and tricolored bat.

Since both bat species have rare occurrences on the landscape, the availability of existing cover habitat adjacent to the project area and rarity of growing season burns, project activities should not contribute towards federal listing or result in reduced viability of a population or species.

Evening bats have not been located in caves within the cumulative effects area. White Nose Syndrome is not known to directly impact this species. No documented sightings have occurred for the evening bat inside the project area or across the forest with recent mist net surveys (McClanahan 2014, York-Harris 2016). However, acoustical monitoring has found evening bats in the Pleasant Run unit along road corridors and on ridge tops.

The evening bat, though wide-ranging, appears to be most closely associated with mature river bottom habitats where it forms colonies within tree cavities or hollows (Whitaker and Gummer 2003). It is possible that these bats may use other habitat types and foraging areas based on observations while conducting acoustical surveys.

In Indiana, the evening bat has been ranked critically imperiled because of extreme rarity due to very few populations, very steep declines, or other factors making it especially vulnerable to extirpation from the state. Globally they are listed as secure. Locally on the forest, this species has appeared abundant during acoustical surveys.

Project activities may impact this species. Since the evening bat is considered nationally secure and the availability of existing cover habitat adjacent to the project area, project activities would not contribute towards federal listing or result in reduced viability of a population or species.

Vernal pools are a valuable water source for bat species and provides a forage area for insects as well. Sensitive bat species have been captured in a vernal pool complex on the Pleasant Run Unit in 2010 along with other threatened and endangered bat species. Proposed installation of vernal pools at some decommissioned road sites would create a beneficial effect for all bat species.

Birds

The Henslow's sparrow (*Ammodramus henslowii*), ruffed grouse (*Bonasa umbellus*), cerulean warbler (*Dendroica cerulean*), migrant loggerhead shrike (*Lanius ludovicianus migrans*), American woodcock (*Scolopax minor*) and barn owl (*Tyto alba*) were analyzed for this project as habitat types existing in the project area and cumulative effects area. Review of the Indiana Heritage Database indicated species on the RFSS list occur within the project area (IDNR 2012, 2015). Breeding bird survey data was also used for the analysis.

There were 14,280 observations of 84 bird species from 2001 to 2017 (9 years of data) within the project area. The top six species were red-eyed vireo (*Vireo olivaceus*), eastern wood-pewee (*Contopus virens*), Acadian flycatcher (*Empidonax virescens*), worm-eating warbler (*Helmitheros vermivorum*) and wood thrush (*Hylocichla mustelina*). The brown-headed cowbird (*Molothrus ater*) was seventh, but there was as drop with 168 fewer observations (approximately 22% less) (Dunning, Riegel 2017). The Henslow's sparrow, cerulean warbler, loggerhead shrike and barn owl are listed as state endangered in Indiana. The woodcock and grouse are listed as species of special concern for Indiana (IDNR 2018).

Wildlife openings do exist in and near the project area but are too small to support Henslow's sparrow. A larger early successional area, greater than 75 acres, does exist inside the cumulative effects boundary. This area is approximately three miles away from the project area and does contain Henslow's sparrow. With proper timing and return intervals, prescribed burns should have no known negative effects on habitat for this species.

Pre and post-prescribed burn monitoring would be key to determine effects needed and vegetative structure of the area. With the Forest Plan standards and guidelines in place, along with design criteria, the project should have a beneficial impact for the Henslow's sparrow, both short and long-term.

Ruffed grouse are currently thought to exist in 10-13 of the 43 Indiana counties occupied in 1983. Prospects for population recovery are dismal given the continual advancement of forest succession and population levels have likely dropped below "minimal viable population levels" within most of the current grouse range in Indiana. Ruffed grouse appear destined for extirpation unless significant intervention (e.g., extensive timber harvests of sufficient intensity) or sizable natural disturbances occur across the forested landscape in southcentral Indiana to create a large continuum of early successional forest habitats (Backs 2018).

A ruffed grouse survey route runs through the northwest corner of the project area and continues west through the cumulative effects area. Breeding population indices (males heard drumming/stop) have been estimated on the Forest since 1979. The last time a grouse was indicated during the survey was in 2012. Single grouse have been seen on occasion inside the Fork Ridge burn unit in 2012 and along the north end of the project area in 2016.

No male ruffed grouse were heard drumming on 14 roadside routes during the 2018 spring survey. This was the sixth consecutive year that no grouse were heard, with only one heard in the last seven years (Backs 2018).

Proposed timber harvest and prescribed fire would benefit this species and would provide the habitat that this species greatly needs. Short-term impacts of temporary displacement could occur if the species is present. However, without the proposed treatments, the grouse could be negatively impacted through lack of management.

The cerulean warbler prefers large tract of mature forest. It is considered present even though no sightings have been recorded. Cerulean warblers, a species of particular management concern, were not detected in the 2017 breeding bird survey, continuing its decline from five detections in 2015, 14 in 2013 and 2011, 46 in 2009. Twelve were detected in 2007 (Dunning, Riegel 2017).

Alteration of habitat type would occur and possibly impact this species if they are present. Because of their mobility and availability of adjacent habitat, the proposed project should not have adverse effects to the viability of the cerulean warbler.

Concerning the loggerhead shrike and barn owl, past sightings of the shrike are from over 50 years ago and there have been no sightings of the barn owl. Open areas exist in the cumulative effects boundary but these two species are not considered present.

Consequently, there would be no impact to these species. There habitat would be impacted in a beneficial way through prescribed burning and enhancement of early successional areas.

American woodcock is present within the project area. Twelve woodcocks were counted during surveys in 2014 and eight in 2016 (Harriss 2014a, 2016). Project activities would promote habitat for the woodcock by enhancing early successional areas, diversifying botanical resources and the creation of vernal pools. Therefore, the Houston South Project would have a beneficial impact to the American woodcock.

Temporary disturbance to the discussed RFSS bird species may occur if they inhabit these areas, but sufficient amounts of undisturbed habitat exists nearby. Because of their mobility and positive long-term effects to their habitat, there are no any anticipated adverse effects to the viability of these bird species from proposed project activities.

Fish

There are six fish species currently on the RFSS list. The northern cavefish (*Amblyopsis spelaea*) is restricted to springs or subterranean cave waters. No caves were located in the project area. The eel (*Anguilla rostrate*) and lake sturgeon (*Acipenser fulvescens*) have large river requirements that are not present in the project area. The last three fish, the spotted darter (*Etheostoma maculatum*), northern madtom (*Noturus stigmosus*), and channel darter (*Percina copelandi*) have habitat in the area but were not found during surveys. Fish sampling has taken place in the project area since 2017 and these fish are not considered present.

Due to lack of potential habitat or the lack of species in the project area, there would be no impact to any RFSS fish species for the Houston South Project.

Reptiles

The timber rattlesnake (*Crotalus horridus*) has recorded sightings in the Pleasant Run Unit (IDNR 2015, 2012). Dry forest habitat exists in the project area and timber rattlesnakes are likely to be present. However, the project area is not where the majority of consistent sightings have taken place.

Temporary disturbance to individual timber rattlesnakes may occur during project activities, if they do inhabit the project area, but a sufficient amount of undisturbed habitat exists nearby.

Timing of prescribed fire is critical to the timber rattlesnake and is best applied during their natural dormant season. Growing season fires should be expected to produce some mortality and possibly high mortality under some conditions.

If hibernacula occur on the site, burning during the early growing season is more likely to have a direct effect on several snake species than burning during the dormant season before they emerge. However, burning during the early growing season does not necessarily equate to negative effects.

Low-intensity fire does not consume pre-existing large, coarse woody debris that is important as cover for many herpetofauna. Timber rattlesnakes are most vulnerable to fire soon after they emerge from winter hibernacula. Early growing-season fire poses a risk to these animals, especially when burning near known hibernacula and when burning relatively large areas (Harper, C.A., Ford, W.M., Lashley, M.A. et al. 2016).

To date, there are no known rattlesnake hibernacula in the project area. If hibernacula sites are discovered through future research, fire lines and/or restrictive dates may be imposed for that area.

Prescribed fires pose a threat for the timber rattlesnake adjacent to hibernacula; therefore, the Houston South Project may impact the timber rattlesnake. Due to this species being listed as apparently secure (NatureServe 2019), few sightings in the area, design criteria and the availability of existing cover habitat adjacent to the project area, there should be no trend toward federal listing to this species from implementation of this project.

Amphibians

The two listed RFSS amphibians are the green salamander (*Aneides aeneus*) and four-toed salamander (*Hemidactylium scutatum*). The green salamander is in isolated populations found further south on the Tell City Ranger District. Due to the lack of suitable habitat (cliff communities), the species is considered not present and there would be no impact to this species or their habitat.

The four-toed salamander occurs in an isolated population in the Pleasant Run Unit over seven miles from the project site. These species prefer boggy wet sites in forested areas. These areas are not conducive to prescribed fire, any negative impacts from these treatments would be unlikely. If the four-toed salamander is present, it is possible the salamander could be beneficially impacted due to the installment of vernal pools and AOPs. Therefore, the project would result in a beneficial impact to this species if present.

Mollusks

All of the mollusk species on the RFSS list have rivers or large streams habitat requirements that are not present in the project area. For these species, the project proposal would have no impact to these species or their habitat.

Terrestrial Invertebrates

West Virginia white (*Pieris virginiensis*) inhabits mesic forest communities associated with streams. These types of communities are present in the project area. Prescribed burning during the growing season could impact this species however; growing season burns would be less common. The West Virginia white is considered vulnerable in Indiana and nation-wide.

Since the entire project area would not be burned at once and activities would be implemented over a several years, untouched adjacent forest would be available for refugia. Prescribed burns could promote more botanical diversity for this species; therefore, the Houston South Project may impact the West Virginia white. Due to few sightings in the area, few growing season burns and the availability of existing cover habitat adjacent to the project area, there should be no trend toward federal listing.

The monarch butterfly (*Danaus plexippus*) are a wide-ranging species but closely tied to milkweed plants. These plants can be found in early successional areas, roadsides and private lands throughout the project area to varying degrees. Design criteria would promote pollinator/butterfly habitat for the project through seeding and improving forest health.

The Houston South Project may impact and possibly have a beneficial impact to the monarch butterfly. Due to few growing season burns and the availability of existing habitat adjacent to the project area and since this species is listed as apparently secure (NatureServe 2019), there should be no trend toward federal listing.

All other terrestrial invertebrate species on the RFSS list have habitat requirements that are not present in the project area.

Karst Invertebrates

All of the karst invertebrate species on the RFSS list have habitat requirements that are not present in the project area. Due to the distance of caves from the project area (over 3.5 miles), no impacts from prescribed fire are expected.

No Action

With this alternative, none of the proposed action would occur. No action could have negative impacts on the RFSS. Bat species would not have the beneficial effects of vernal pools. Habitat creation for the ruffed grouse would not occur. Improvements to habitat for the American woodcock and Henslow's sparrow would not occur. Opportunities to promote pollinator/ butterfly habitat would be lost. Foraging and travel corridors used by bat species would not be improved.

Cumulative Effects for Issue 9

There are no municipal, county, or state projects known to be proposed within the action analysis area. However, it is assumed that standard maintenance on highways, county roads and rights-of-way would continue. Past activities that have likely affected RFSS species within the Forest boundary include conversion of riparian areas to agricultural or residential uses, timber harvest, wildfire, and grazing. Present or reasonably foreseeable future activities, which may have an impact on these species, include the construction or use of roads, continued agricultural use, timber harvest and activities associated with residential development. Private lands near the proposed action area will continue to be a mix of forest, open pasture and crop fields.

The past, present or foreseeable Forest Service activities near the project area that could directly or indirectly impact the RFSS are: the continuation of early successional management (Forest Openings Maintenance), wetland maintenance, the Buffalo Pike Project, potential trail re-routes, Pleasant Run Road Decommissioning, Lake and Pond Habitat Improvement, Jackson County AOPs, Fork Ridge Restoration, and NNIS herbicide applications.

These activities have been analyzed under separate decisions and would not add any negative impacts to the RFSS. The vast majority of these activities are considered to have a long-term beneficial impact on local bat species.

The Houston South Project would contribute no detrimental cumulative impacts to RFSS species. An ongoing project (Buffalo Pike) has been determined to have beneficial impacts to the ruffed grouse and American woodcock. This would be a cumulative beneficial impact. Also, under this ongoing project, the West Virginia white, timber rattlesnake, little brown bat and tricolored bat had “may impact” determinations. It was also determined for these five species that there would be no negative impacts and no trend toward federal listing. Therefore, there are no cumulative negative effects.

Issue 10: Concern that project activities could increase the potential spread of plant NNIS

Indicator:

- Miles/acres disturbed for road, skid trail, and log landing construction
- Acres of harvest

For Issue 10: Analysis Area:
The spatial boundary used to evaluate direct and indirect effects is the action areas consisting of the proposed project activities. The spatial boundary used to evaluate cumulative impacts is the proposed project area, plus the adjacent lands up to 1,000 feet beyond those areas proposed for ground disturbing activities. Factors influencing the spread of existing infestations or establishment of new populations would result from the start of the disturbance to no more than four years after completion of the activity. Considering project activities may continue for up to 20 years, the temporal consideration for cumulative effects is 24 years.

Direct and Indirect Effects for Issue 10

Proposed Action

Current NNIS populations
Project level site-specific surveys conducted have located NNIS plant infestations both within and near activity areas of the Proposed Action. The primary locations of these populations and areas with the largest existing infestations are along current and past

disturbance corridors: roads, trails, maintained rights-of-way (power and gas lines) and old road corridors (spread vectors). Other sites with infestations are underneath conifer stands in areas with past disturbances and old fields established from past use as pastures and homesteads. Additionally, infestations occur in small wildlife openings, old timber harvest areas, and near areas of past wind throw and blowdown.

Ongoing and future site-specific invasive plant surveys would continue throughout the Houston South project area prior to and during implementation of any ground disturbance associated with this project. The primary focus areas of these surveys are the areas that have the greatest likelihood for spread of invasive plants. These areas consist of proposed harvest and prescribed burn units, as well as proposed road construction and reconstruction, skid trails, and log landing areas. Another focus of these NNIS surveys is to continue locating all high priority species' infestations within the project area for possible inclusion in future control treatment activities.

We estimate that old fields located throughout the project area contain at least some level of infestation containing tall fescue and Chinese lespedeza within the 123 wildlife openings in the project area. These areas could contain an estimated 165 acres of invasive species.

The NNIS located in old fields have a much longer history of establishment and disturbance, so the infestations are often larger and exist with higher infestation rates. Similar results occur for trails, roads, and some ROWs infestations, especially where they occur in close proximity to old fields. The most abundant invasive plants in these old fields are tall fescue, multiflora rose, autumn olive and Japanese honeysuckle, but because of wide dispersal by birds, they also exist in widely scattered locales throughout the project area underneath the forest canopy.

Japanese stiltgrass is commonly seen throughout the Houston South project area along shaded roads, ditches, trails and ROWs. Current surveys estimate that at least 85 percent of the proposed roads and trails to be used for this project contain some level of stiltgrass infestation, with infestations usually reaching an average of 3.5 feet beyond road edges.

Although they are not included on Forest NNIS listings, the various pine species are not native to the Hoosier National Forest. Some of these species have adapted well after tree plantings from the 1930's to the mid 1980's, and from this seed source, new young seedlings are surviving in selected areas of the project area. The project proposal includes removing pines in these pine plantations, a nonnative species that is at least somewhat invasive. Many of these stands have higher infestations of invasives than their neighboring hardwood stands due to past disturbance and the shelter and roosting locations pines provide for NNIS carrying birds. Clearcutting these areas would likely promote the spread of NNIS currently in the understory once the canopy is opened and more light penetrates to the forest floor.

Risk of Spread and New Introductions

The proposed harvest activities would create a mosaic condition of disturbed vegetation that could facilitate the spread of NNIS plants, depending on where these areas are in proximity to current infestations. Nonnative invasive plant populations would likely increase within the project area regardless of the alternative selected, including no action.

By properly implementing project level design measures, the Hoosier anticipates a low to moderate risk for new introductions and possible spread of NNIS plants associated with the project activities. Because NNIS plant infestations occur throughout the project area, there is the likelihood that disturbance from logging activities and subsequent prescribed burning could indirectly spread invasive plants or provide new areas for them to colonize in the action alternative. Current inventories show that NNIS populations exist primarily in old fields and the along roads and trails leading to them. These areas are the locales with the greatest likelihood for project activities directly contributing to the spread of invasive plants. Locales further to the interior of the forest stands, and especially in hardwood stands, contain fewer infestations and much reduced net infested acres of NNIS populations.

By diligent and proper application of invasive plant control treatment using an integrated pest management process in appropriate areas where feasible and necessary, we anticipate a further reduction for the possible spread of NNIS plants through implementation of the Nonnative Invasive Species Plant Control Program Analysis (USDA FS 2009a). Subsequent application of control treatments in future years, plus using an adaptability process to control those infestations not yet known within the project area, would contribute to maintaining the ecosystem and reducing the level of NNIS plant infestations spreading to new areas.

Timber Harvest and Prescribed Burning

Harvest activities increase disturbance, creating potential for NNIS plant spread. The indicator of response area chosen to evaluate the effects of the various resource concerns by the proposed project activities is the 100-foot distance where treatment would occur and its corresponding acreage. There are 25 known species documented within the project area. Ten species, including tall fescue, inhabit open habitat conditions along roadsides or in wildlife openings. Any shade-intolerant NNIS plants invading forests from these open areas would decline as the forest ages through natural succession. Other species most often grow best in open conditions but can also persist underneath the forest canopy. The two invasive plants with occurrences in the project area that inhabit shaded conditions and pose the greatest threat to natural ecosystems are Japanese stiltgrass and garlic mustard. These species are more likely to spread in areas receiving uneven-aged treatments rather than even-age harvests. Infestations of these two species occur primarily along trails or shaded roadside ditches next to forest edges, and riparian stream zones or draws.

Tree-of-heaven occurs in insolated patches in the project area. Where infestations occur within harvest units or they exist nearby, probable expansion of the populations would occur depending on the level of disturbance and age of the trees. Treatment of these patches, prior to implementation of silvicultural or burning activities, would be a high priority.

Japanese stiltgrass prefers moist conditions and is very shade-tolerant. Infestations occur primarily along road shoulders and horse trails. Site-specific surveys reveal that stiltgrass occurs more often and in greater abundance in pine stands than in hardwood stands. The species spreads primarily by movement of seeds and plant fragments; thus roadwork, harvest and fire line activities have the potential to contribute to the expansion of these populations because of ground disturbance or movement of equipment. The extent of possible expansion and new colonization directly or indirectly depends on where these actions occur in proximity to the populations. Pine clearcutting would increase light and create drier conditions that may remove or decrease some existing stilt grass populations that occur within units, but at the same time contribute to spreading the species to other nearby locales. Pine thinning harvesting is not likely to reduce light levels enough or diminish moisture conditions to eliminate existing populations in these units, so ground-disturbing activities in these areas could possibly expand existing stilt grass infestations.

Although existing old-fields and wildlife openings are the sites with a great number of NNIS plants, generally, these fields do not occur within proposed harvest units. In some instances, small portions of wildlife openings and old-fields lie in the units or they occur adjacent to the units. Many of the invasives in these openings include those species that are not shade-tolerant and cannot effectively invade forested areas, only the edges.

The project proposal includes up to 13,500 acres of prescribed fire. Fire is a historic part of the central hardwood ecosystem. The Forest would conduct prescribed fires in large landscape burns to minimize the amount of fire line construction. Where possible, existing roads, trails or ROWs would be used as fire lines. New fire lines necessary to contain prescribed fire would be put in place where needed. These lines are generally placed a short time before the burn and are constructed using chainsaws and leaf blowers. Creation of fire lines in this manner would change habitat for the short-term, returning to their previous state more quickly than when fire lines are constructed to bare mineral soil. The Hoosier would consider burning on private lands, if and after obtaining agreements from landowners, to further minimize soil disturbance from less needed fire lines.

Prescribed burning produces mixed effects on NNIS plants depending on the individual species, the timing of the burn, and fire intensity. Burning contributes to disturbance that can create conditions susceptible for new invasive plant invasion or expansion of existing infestations. Fire would create a nutrient flush for a short period that would benefit both native and invasive plants. In areas where herbicide application may occur, timing the application to follow landscape-burning projects could improve the effectiveness on controlling NNIS plants.

Road Construction, Fire line Construction and Trails

The highest potential for establishment and spread of invasive plants are newly disturbed areas. Reconstructed and some of the newly constructed roads occur along old road beds that already contain NNIS. Trails used to access silviculture treatments would likely be widened and the surfaces impacted by equipment and/or tree skidding. While fire lines would occur on existing corridors (roads, trails, rights-of-ways, etc.) there would be up to approximately 21 miles of newly created fire line to tie into the existing corridors.

System and temporary road reconstruction activities would likely facilitate transport and spread of invasive plants. Ground disturbance would vary among roads proposed for reconstruction, as some require higher levels of work to meet necessary road specifications. Land adjacent to the roadways where clearing would occur provides the most likely site for possible NNIS colonization or spread. Where the proposal uses portions of trails for logging activities, similar if not greater potential exists for possible expansion of NNIS because greater clearings widths are probable, and most areas already have infestations of Japanese stiltgrass. Generally, road maintenance involves less ground disturbance that could potentially spread NNIS infestations, but actions such as ditch work or culvert maintenance and replacement and AOP construction would contribute to spreading invasive plants, depending on proximity of infestations to work performed, into drainages and waterways.

The new system roads would continue to act as potential spread vectors for invasive plants after implementation. The project proposes to close and decommission all temporary roads upon completion of the sale. This action would create some additional disturbance, but it restricts further passage along roadways after road closure, thereby reducing possible spread of invasive plants in the future. The project proposal would also remove approximately 2.7 miles of roads from the system by decommissioning, where they would be brushed in or have barrier posts placed to prevent equipment access and use, also reducing possible spread of existing NNIS in the future.

New fire line construction would be necessary to connect with existing corridors (roads, trails, rights-of-way). Many of these existing corridors are already infested with Japanese stiltgrass and other invasives and could act as potential spread vectors during fire line construction and fire implementation.

The Forest would revegetate some areas (landings, skid trails, etc.) using approved seed mixes that should alleviate some probability for spreading NNIS plants. Where appropriate and feasible, the Hoosier would consider pre-treatment herbicide application on selected NNIS infestations along some roads or roadside shoulders and selected trails prior to these construction activities to reduce the likelihood of plants spreading. Also, treatments would occur post-implementation under the existing NNIS Program of Control (USDA FS 2009a).

Table 8 displays the proposed silvicultural and prescribed fire treatments and the sum of acres located within the 100-foot road and trail buffer area (Indicator of Response). These include both the new disturbances and the use of existing corridors and the AOPs. Overall, the total of these disturbances and their buffers signify the amount of acreage that have the most potential for NNIS spread (Indicator of Response) within the proposed Houston South project area: 3,248 acres.

Table 9: Potential NNIS Indicator of Response

Proposed Activity	Vegetation Type	Vegetation	Roads/ Trails	100 Feet Buffer of Roads and Trails
Silvicultural Treatments				
Clearcut	Pine	401 ac	16.36 mi Road 14.5 mi Trail	748 ac
Shelterwood	Hardwood	703 ac		
Thinning	Pine/Hardwood	2,405 ac		
Selection	Hardwood	462 ac		
Prescribed Burning Treatments				
Burn	Multiple types	Up to 13,500 ac*	40.2 mi Road* 11.6 mi Trail* 19.3 mi Fire line^ 14.9 mi Other[#]	2080 ac
Total Buffered roads/trails			116.86 mi	2,828 ac
Timber Skid Trail and Log Landing areas				417 ac
3 Aquatic Organism Passage (AOP) replacements				~4 ac
TOTAL NNIS Indicator of Response				3,248 ac

*Some Burn miles and acres overlay some of the same areas as those associated with Silvicutural treatments, but they will be impacted differently and at different times, therefore they are recounted for the totals.

^ represents existing and new fire line construction.

[#] includes: ag field edge, pipeline ROW, Skid trails, streams and railroad ROW

The species of most concern for spread in these project areas is Japanese stiltgrass due to its widespread current infestation throughout the road and trail systems. Priority treatments cannot cover all these trails and roads, and would likely instead target skid trails and fire lines, after implementation, where new infestations could be prevented from establishing and spreading beyond current, well-established infestations. Around the proposed AOP sites, garlic mustard and Japanese stiltgrass are present, so in these areas an effort to remove any garlic mustard within the first couple years after construction should prevent establishment and spread along waterways.

The primary objective regarding NNIS plants is to avoid introducing new infestations and slow the spread of existing populations affected by project activities. Prevention measures include equipment cleaning prior to implementation, avoiding increased disturbance near existing populations (particularly for designating log landings), using gravel to cover small bands of NNIS to prevent their spread by equipment, and using native or non-persistent, nonnative species in areas requiring revegetation

A portion of funds from the timber sales would be used to treat invasives within the stands (Knutson-Vandenburg budget authority). These treatments are often planned for three to five consecutive years, after implementation, depending on the invasive species present and their infestation levels. Coordination between timber and botany staff would determine the areas of highest need for treatment, the species to be treated, and the amount of consecutive treatments needed.

No Action

Active nonnative invasive plant colonization and establishment as influenced by ongoing activities within the project area would continue at current rates. Any change to the rate of spread of NNIS plants would depend upon existing Forest projects that overlap the project area and any other future invasive plant control done according to the Nonnative Invasive Species Plant Control Program Analysis within or adjacent to the project area. The rate of spread, however, under the no action alternative would be less because of no increase in ground disturbance. Risks to rates of NNIS plant expansion under this alternative would depend upon human disturbances and available funding to mitigate effects caused by those actions not associated with the Houston South project.

With no action, NNIS would continue to spread and increase and would displace valuable wildlife habitat, threaten biodiversity, and potentially affect rare plant communities or individual rare plant populations. However, this spread and increase would be less than that likely to occur under the Proposed Action.

Cumulative Effects for Issue 10

Nonnative invasive plants occur throughout the cumulative effects area on NFS lands, as well as adjacent private ownership. For many species, establishment of these populations occurred prior to the existence of the Hoosier National Forest or NFS ownership.

Invasive plants will continue to invade and spread across the landscape. The cumulative effect of implementing the action alternative combined with ongoing human and natural disturbances is the continuing spread of these species. The actions and processes differ in various locations in the project area and across the Forest, so the rate of spread would also differ. Vehicles, equipment, wind, rain, animals, and humans have the potential to carry invasive plant seed to uninfested areas. This spread really has no limit other than the susceptibility of the receiving habitats. Given the inherent susceptibility of some habitats across the Forest and within the project area, spread is likely. At the same time, Forest-wide NNIS plant management and site-specific project level control activities are increasing, which could result in reduced invasive plant populations in areas of treatment for the Houston South project. The Hoosier National Forest is currently working with Forest Research staff and specialists from other National Forests in the region to develop protocols for post-treatment of log landings and skid trails to establish native plant species that will benefit pollinators and other wildlife species, while competing with NNIS. Initial efforts by the Hoosier National Forest have been variable, but with continued collaboration, data collection and monitoring, we hope to increase our successful revegetation of these impacted areas.

Ongoing Hoosier National Forest projects within the Houston South projects area such as the Forest Openings Maintenance EA (USDA FS 1999), which continues implementation of both mowing and prescribed burning, may provide some limited NNIS control, but this is not one of its primary objectives. Trail maintenance requires brushing/mowing in some areas to prevent vegetation encroachment on the trail; it also can require gravel placement along the trail with equipment to harden the trail tread. If mowing activities occur outside of the season when stiltgrass reproduces, this would help prevent the movement of seed by mowers during wildlife opening, fire line clearing, and trail maintenance activities.

Private landowners are sporadically taking action against NNIS on their lands, with some actions possibly occurring within the project area. An increased interest of private landowners in controlling of NNIS (SICIM 2019) through local Cooperative Invasive Species Management Areas (CISMAs), will help reduce uncontrolled NNIS spread on private lands and rights-of-way. In 2018, the Jackson County CISMA co-sponsored a workshop on controlling NNIS along ROWs for road maintenance personnel. This group is also raising the awareness of NNIS and their impacts to private landowners in the area.

Past and present disturbances, when added to reasonably foreseeable actions, have an effect on the expansion of NNIS through distribution of seed, ground disturbance, and the creation or perpetuation of spread vectors. The degree of effects would vary depending on the number of entrances over time, distribution of disturbance across the Forest, the proximity of infestations, and number of acres disturbed. The Hoosier manages more than 200,000 acres that are intermixed with lands of other ownerships. Since invasive plant infestations occur at widely scattered locations on both private and NFS lands, land use decisions made by other owners may affect the spread of invasive plants as much as activities carried out by the Hoosier. Land use decisions made by other owners also could influence the effectiveness of the future colonization of NNIS, depending on the proximity of existing infestations to any ground disturbance. Other ownership exists within and around the project area: what and how other landowner’s create disturbance on their lands would affect NNIS spread on these acres.

Continued implementation of the Nonnative Invasive Species Plant Control Program Analysis (USDA FS 2009a) in selected portions of the project area where most needed according to the identified treatment priorities, would work against the cumulative effect of other activities that create conditions for the spread of NNIS. Forest Service regional and national direction for NNIS management emphasizes an approach of early detection and rapid response to detecting new infestations and invasive plant control (USDA FS 2003, 2004). To act quickly in response to any new infestations that may result from project activities, the Forest would use hand, mechanical control, and herbicides on NNIS plants where needed and appropriate to best meet this direction.

The Forest Openings Maintenance project includes prescribed burning and mowing on scattered locations in the Houston South project area (USDA FS 1999). Generally, mowing does not create ground disturbance and would reduce seed production of invasive plants as well as native plant species, depending on timing of mowing and seed development. If the Forest chooses to implement the proposed action, then any future NNIS control treatments would undergo a coordinated effort to provide improved effectiveness where work would occur in the same areas as identified in the Forest Openings Maintenance project.

A related foreseeable project involving old-fields and existing wildlife openings in the project area is the Pleasant Run Habitat Improvement. This future project would include all wildlife openings in the prior Forest Openings Maintenance EA, as well as other new land acquisitions that contain early successional habitat areas managed for wildlife resources. The project would most likely expand the use of treatment techniques beyond just mowing and prescribed burning to include herbicides, chainsaws, machinery, native species planting, road maintenance, and creation of vernal pools. This project would involve ground-disturbing activities that could expand or create new areas for colonization of NNIS plants depending on the proximity of activity areas to existing infestations.

Other reasonably foreseeable projects are ongoing Forest trail maintenance, county and state road maintenance, and utility ROW maintenance. As part of highway maintenance activities, some limited roadside herbicide application has occurred along various highways across the Forest. This action may occur where allowable along state roads 135 and 58. Trucks, with a much greater potential for adversely affecting non-target species, normally do roadside herbicide spraying. County and Township road maintenance has not been observed for NNIS, but more for clearing areas of vegetation around guard rails. All County and Township roads driven in the project were noted to have Japanese stiltgrass somewhere along their length. Likely, the infestation is similar to or higher than that estimated for Forest roads and trails, because of the higher incidence of maintenance (mowing) that spreads NNIS. Many of the utility ROWs have Japanese stiltgrass and other NNIS within them, likely spread during maintenance activities of these areas.

Trail maintenance activities have potential to spread NNIS such as Japanese stiltgrass if it exists where this work would occur. Scattered infestations of stiltgrass occur throughout the Hickory Ridge trail system where trail maintenance work would occur annually. Because the work occurs mostly to the existing trail, there are few affects to nearby vegetation. However, if done at the proper time just before seed set and release, mowing can provide some effective control of Japanese stiltgrass especially if done repeatedly.

Cumulatively, projects that involve direct or indirect NNIS control assist the Hoosier to resist the introduction of NNIS plants within the Houston South project area. Subsequent work under the current Nonnative Invasive Species Plant Control Program Analysis (2009a) could include both NNIS control treatments and restoration activities where appropriate and needed. With implementation of the Proposed Action, the Hoosier would coordinate all of the Forest NNIS control activities where they overlap with actions proposed within the project area to maximize effectiveness for control of and minimize possible negative effects to desirable non-target vegetation.

Issue 11: Concern that vegetation manipulation or timber harvest, coupled with climate change could negatively impact the local environment

Indicator:

- Project activities contributing to greenhouse gasses and climate change

For Issue 11: Analysis Area: The effects analysis for greenhouse gas emissions is the global atmosphere given the mix of atmospheric gases can have no bounds. The timeframe for the analysis is 20 years because all project activities should be completed by then.

Direct and Indirect Effects for Issue 11

Proposed Action

Climate change is a global phenomenon because major greenhouse gasses (GHGs)[1] mix well throughout the planet's lower atmosphere (IPCC 2013). Considering emissions of GHGs in 2010 were estimated at 13,336 ± 1,227 teragrams carbon globally (IPCC 2014) and 1,881 teragrams[2] carbon nationally (US EPA, 2015), the Houston South project makes an extremely small contribution to overall emissions. Because local GHGs emissions mix readily into the global pool of GHGs, it is difficult and highly uncertain to ascertain the indirect effects of emissions from single or multiple projects of this size on global climate. Relative to the amount of carbon stored and sequestered by the Hoosier National Forest, this proposed action's direct and indirect contribution to GHGs and climate change are minor.

From 2000 to 2009, forestry and other land uses contributed 12 percent of the human-caused global CO_2 emissions[3]. The forestry sector's contribution to GHG emissions has declined over the last decade (IPCC 2014, Smith et al. 2014, FAOSTAT 2013). The largest source of GHG emissions in the forestry sector globally is deforestation (e.g., conversion of forest land to agricultural or developed landscapes) (Pan et al. 2011, Houghton et al. 2012, IPCC 2014). However, forest land in the United States has had a net increase since the year 2000, and this trend is expected to continue for at least another decade (Wear et al. 2013, USDA FS 2016).

The relatively small quantity of carbon released to the atmosphere and the short-term nature of the effect of the proposed actions on the forest ecosystem are justified, given the overall change in condition increases the resistance to insects, disease, wildfire, age related declines in productivity, or a combination of factors that can reduce carbon storage and alter ecosystem functions (Millar et al. 2007, D'Amato et al. 2011). Furthermore, any initial carbon emissions from this proposed action will be balanced and possibly eliminated as the stand recovers and regenerates, because the remaining trees and newly established trees typically have higher rates of growth and carbon storage (Hurteau and North 2009, Dwyer et al. 2010, McKinley et al. 2011).

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[1] Major greenhouse gases released as a result of human activity include carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons, and perfluorocarbons.

[2] This report uses carbon mass, not carbon dioxide (CO_2) mass, because carbon is a standard unit and can easily be converted to any other unit. To convert carbon mass to CO_2 mass, multiply by 3.67 to account for the mass of the oxygen (O_2).

[3] Fluxes from forestry and other land use (FOLU) activities are dominated by CO_2 emissions. Non-CO_2 greenhouse gas emissions from FOLU are small and mostly due to peat degradation releasing methane and were not included in this estimate.

The proposed activities in the Houston South project are not considered a major source of GHG emissions. Forested land would not be converted into a developed or agricultural condition or otherwise result in the loss of forested area. In fact, forest stands are being retained and harvested and prescribed burned to maintain a vigorous condition that promotes tree growth and productivity, reduces insect and disease levels and supports sustainable ecosystems, thus contributing to long-term carbon uptake and storage.

Some assessments suggest that the effects of climate change in some United States forests may cause shifts in forest composition and productivity or prevent forests from fully recovering after severe disturbance (Anderson-Teixeira et al. 2013), thus impeding their ability to take up and store carbon[4] and retain other ecosystem functions and services. Climate change is likely already increasing the frequency and extent of droughts, fires, and insect outbreaks, which can influence forest carbon cycling (Kurz et al. 2009, Allen et al. 2010, Joyce et al. 2014). In fact, reducing stand density, one of the goals of the Houston South project, is consistent with adaptation practices to increase resilience of forests to climate-related environmental changes (Joyce et al. 2014). This project is consistent with options proposed by the IPCC for minimizing the impacts of climate change on forests, thus meeting objectives for both adapting to climate change and mitigating GHG emissions (McKinley et al. 2011).

The wood and fiber removed from the forest in this proposed action will be transferred to the wood products sector for a variety of uses, each of which has different effects on carbon (Skog et al. 2014). Carbon can be stored in wood products for a variable length of time, depending on the commodity produced. It can also be burned to produce heat or electrical energy or converted to liquid transportation fuels and chemicals that would otherwise come from fossil fuels. In addition, a substitution effect occurs when wood products are used in place of other products that emit more GHGs in manufacturing, such as concrete and steel (Gustavasson et al. 2006, Lippke et al. 2011, McKinley et al. 2011). Removing carbon from forests for human use can result in a lower net contribution of GHGs to the atmosphere than if the forest were not managed (McKinley et al. 2011, Bergman et al. 2014, Skog et al. 2014). The IPCC recognizes wood and fiber as a renewable resource that can provide lasting climate-related mitigation benefits that can increase over time with active management (IPCC 2000). Furthermore, by reducing stand density and restoring historic composition, structure, and function, the proposed action may also reduce the risk of more severe disturbances, such as insect and disease outbreak and wildfires, which may result in lower forest carbon stocks and greater GHG emissions.

No Action

There would be no vegetation treatments implemented under the No Action Alternative, and thus no removal of trees from the project area. Stand densities would continue to increase causing competition for limited resources. This could lead to tree stressors that lend themselves to increased insect and disease outbreaks and mortality, decreasing the resilience of forests to climate-related environmental changes. Conditions that promote

[4] The term “carbon” is used in this context to refer to carbon dioxide.

tree growth and productivity contributing to long-term carbon uptake and storage would not be achieved.

Cumulative Effects for Issue 11

Because the direct and indirect effects would be negligible, the proposed action's contribution to cumulative effects on global GHGs and climate change would also be negligible. Carbon emissions during the implementation of the proposed action would have only a temporary influence on atmospheric carbon concentrations, because carbon will be removed from the atmosphere with time as the forest regrows, further minimizing or mitigating any potential cumulative effects.

Issue 12: Harvesting timber could decrease the rate of carbon sequestration

Indicator:

- Change in carbon sequestration rates

For Issue 12: Analysis Area: The effects analysis area for carbon includes forested lands within the Hoosier National Forest because this is where timber harvest and prescribed burning treatments are proposed where carbon stocks may be affected. The timeframe for the analysis is 20 years because all project activities should be completed by then.

Forests play an important role in the global carbon cycle by sequestering carbon from the atmosphere and storing it in biomass and soil. Forestry has gained attention in recent decades because of its potential to influence the exchange of carbon with the atmosphere, either by increasing storage or releasing carbon emissions. Forests can take up and store atmospheric carbon through photosynthesis and release carbon through mortality, plant respiration, microbial decay, fire, and use of wood fiber. Forests can store carbon in soils and plant material as well as in harvested wood products that store carbon outside of the forest ecosystem. In addition, wood fiber can be used to substitute for products that are more energy-intensive to produce, such as concrete and steel, creating a substitution effect which can result in lower overall greenhouse gas emissions.

A complete and quantitative assessment of forest carbon stocks and the factors that have influenced carbon trends (management activities, disturbances, and environmental factors) for the Hoosier National Forest is available in the project record (Dugan et al. 2019). This carbon assessment contains additional supporting information as well as references for this proposed action.

Direct and Indirect Effects for Issue 12

Proposed Action

Forests in the Hoosier National Forest are maintaining a carbon sink. Forest carbon stocks have increased by about 34 percent between 1990 and 2013 (USDA FS 2015), and negative impacts on carbon stocks caused by disturbances and climate conditions have been modest and exceeded by forest growth.

Following natural disturbances or harvests, forests regrow, resulting in the uptake and storage of carbon from the atmosphere. Over the long term, forests regrow and often accumulate the same amount of carbon that was emitted from disturbance or mortality (McKinley et al. 2011). Although harvest transfers carbon out of the forest ecosystem, most of that carbon is not lost or emitted directly to the atmosphere. Rather, it can be stored in wood products for a variable duration depending on the commodity produced. Wood products can be used in place of other more emission intensive materials, like steel or concrete, and wood-based energy can displace fossil fuel energy, resulting in a substitution effect (Lippke et al. 2011). Much of the harvested carbon that is initially transferred out of the forest can also be recovered with time as the affected area regrows.

The proposed Houston South project includes both timber harvesting and prescribed burning treatments that would be conducted on approximately 13,500 acres. This scope and degree of change would be minor, affecting seven percent of the approximately 204,000 acres of forested land in the Hoosier National Forest. The effect of the proposed timber harvest focuses on aboveground carbon stocks that is stored in live woody vegetation and comprises about 45 percent of the ecosystem carbon stocks on the Hoosier National Forest. The effect of the proposed prescribed fire focuses on the understory and forest floor, which together comprise about nine percent of the Forest-wide ecosystem carbon stocks (USDA FS 2015). About 33 percent or more of the ecosystem carbon is in mineral soils, a very stable and long-lived carbon pool (McKinley et al. 2011, USDA FS 2015, Domke et al. 2017). The majority of the treatments will not remove 100 percent of the trees so not all of the 45 percent of the above ground carbon stock would leave the site.

Mineral soil is an important consideration for long-term carbon storage capacity in soils in most ecosystems. Timber harvesting generally results in a negligible amount of carbon loss from the mineral soils typically found in the United States, particularly when operations are designed in a way that minimizes soil disturbance (Nave et al. 2010, McKinley et al. 2011). Although timber harvest and prescribed fire can also affect the carbon stored in the understory and forest floor organic layer consisting of debris in various stages of decomposition, the carbon loss would be negligible given it is not stable or long-lived and would be replaced within months to a few years.

Forest management activities such as harvests and prescribed burns have characteristics similar to disturbances that reduce stand density and promote regrowth through thinning and removal, making stands and carbon stores more resilient to environmental change (McKinley et al. 2011). The relatively small quantity of carbon released to the atmosphere and the short-term nature of the effect of the proposed actions on the forest ecosystem are justified, given the overall change in condition increases the resistance to insects, disease, wildfire, age related declines in productivity, or a combination of factors that can reduce carbon storage and alter ecosystem functions (Millar et al. 2007, D’Amato et al. 2011). Furthermore, any initial carbon emissions from this proposed action will be balanced and possibly eliminated as the stand recovers and regenerates, because the remaining trees and newly established trees typically have higher rates of growth and carbon storage (Hurteau and North 2009, Dwyer et al. 2010, McKinley et al. 2011).

No Action

There would be no timber or prescribed fire treatments implemented under this alternative. In the absence of timber harvesting on the stands, the forest would thin naturally resulting in dead trees that would decay in the long-term, emitting some carbon to the atmosphere, which may or may not be offset by forest growth. Over half of the stands on the Hoosier are middle-aged and older (greater than 80 years) and there has been a sharp decline in new stand establishment in recent decades (Birdsey et al., in press). If the Forest continues this aging trajectory, more stands will reach a slower growth stage in coming years and decades, potentially causing the rate carbon accumulation to decline and the Forest may eventually transition to a steady state or to a carbon source.

Cumulative Effects for Issue 12

Because carbon would be removed from the atmosphere with time as the forest regrows, any potential cumulative effects would be minimal or mitigated.

Effects Relative to the Finding of No Significance Impacts (FONSI) Elements

In 1978, the Council on Environmental Quality published regulations for implementing the National Environmental Policy Act (NEPA). These regulations (40 CFR 1500-1508) include a definition of “significant” as used in NEPA. The 10 elements of this definition are critical to reducing paperwork through use of a finding of no significant impact (FONSI) when an action would not have a significant effect on the human environment, and is therefore exempt from requirements to prepare an environmental impact statement (EIS). Significance as used in NEPA requires consideration of the following ten intensity factors in the appropriate context (or reference area) for that factor.

Mitigations and management requirements designed to reduce the potential for adverse impacts were incorporated into the Proposed Action, including standards and guidelines outlined in the Forest Plan, Best Management Practices, and project specific design measures based on resource specialist knowledge and experience. These mitigations and management requirements would minimize or eliminate the potential for adverse impacts caused by the proposed project.

1) Impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.

Direct and Indirect Effects

The analyses prepared in support of this document considered both beneficial and adverse effects. Beneficial impacts have not been used to counterbalance negative impacts.

Adverse impacts were considered, and it was determined that those impacts do not result in a significant impact on the human environment. Although the management activities proposed may have some short-term negative effects to certain resources, impacts are largely beneficial to resources, especially in the mid to long-term and result in the project meeting its purpose and need.

Effects of the Proposed Action compared with No Action are discussed above in Effects Related to Relevant Issues. Although no issues were identified for sensitive plant species, it is Forest Service policy to prevent the loss of viability for sensitive species at the Forest level (Forest Service Manual 2670).

Plant Regional Forester Sensitive Species (RFSS)

Analysis Area: The spatial boundary used to evaluate direct and indirect effects are the action areas consisting of the proposed project activities. The spatial boundary used to evaluate cumulative impacts included a buffer of approximately 1,000 feet around the proposed project boundary.

Implementation of the timber activities would take about 12 years to implement, and the prescribed burns would occur over a 20 year period. Therefore, this analysis is using a 20 year time frame for evaluation of cumulative impacts.

Direct and Indirect Effects

Proposed Action

There are currently 34 plant RFSS (vascular and nonvascular) for the Hoosier National Forest. These sensitive species have known occurrences on the Forest and inhabit a diverse array of habitat.

On the Hoosier National Forest, RFSS occur in 10 community types and habitats, plus those wide-ranging species that use diverse habitats. The 10 community types are: dry forests, mesic forests, barrens, openlands, cliffs, caves and karst, wetlands, ponds and lakes, streams, and larger river habitat.

The proposed project area is in the Brown County Hills subsection on the Brownstown Ranger District and includes dry forests, mesic forests, openlands, wetlands, ponds and lakes, and streams. It does not contain barrens, cliffs, caves and karst, and larger river habitat. Therefore, the proposed project would have no direct, indirect, or cumulative effects to RFSS associated with those habitat types.

The two RFSS plants with known populations within the proposed project areas are Butternut (*Juglans cinerea*) and American ginseng (*Panax quinquefolius*). There are four RFSS with potential habitat in or around the project area: Trailing arbutus (*Epigaea repens*), Large yellow lady's-slipper (*Cypripedium pubescens*), Illinois woodsorrel (*Oxalis illinoensis*), and Yellow nodding ladies'- tresses (*Spiranthes ochroleuca*). We would anticipate similar effects, and apply equal protection measures, for any new RFSS plant populations discovered in the future in the proposed activity areas.

Of the three known butternuts in the project area, all are outside of proposed timber activities, but are inside proposed burn areas. For American ginseng, one population is outside both the proposed timber and burn areas. The remaining six are either in a timber treatment stand and/or a proposed burn area. However, some of these individuals are within stream corridors that would be protected from any timber activity due to Forest Plan (USDA FS 2006a) standards and guidelines. There are likely more undocumented individuals of these two species within the project area.

The remaining four species (Large yellow lady's slipper, Illinois wood-sorrel, yellow nodding ladies'-tresses, trailing arbutus) are not historically known in the project area and were not found during project surveys. They were still analyzed because they may occur in the proposed project areas, and/or have potential habitat that is altered.

Direct effects for all six species would be the loss of individuals during road and log landing construction, skidding, fire line construction or herbicide overspray. Known occurrences of plant RFSS would be protected from timber activities, fire line construction, and herbicide applications. The mesic forest species are highly unlikely to co-occur on ridgetops where road and log landings would be constructed. However, direct impacts to unknown RFSS could occur during timber skidding activities.

Timber herbicide applications would be made with selective applications (cut-stump, basal bark, stem injection, or foliar of seedlings) to individual trees, no broadcasting of herbicide would occur. Therefore, the likelihood of overspray onto unknown individual RFSS, while possible, is minimal. In addition, personnel applying herbicides would abide by project design measures. This would also reduce potential impacts to unknown populations of RFSS.

Possible indirect effects may occur to these six RFSS in the form of lost or altered areas of suitable habitat within the proposed activity areas. Indirect effects from timber activities would be the alteration of habitat to that of more open canopies, resulting in more light to the forest floor. For openland species this would be beneficial. For the dry forest species, this would likely also create beneficial habitat by reducing the canopy cover of shade-tolerant species (beech and maple) and promoting oak and hickory regeneration in this plant communities. All of the mesic forest species can exist in a continuum of different canopy densities. Large yellow lady's slipper would likely benefit from the increased light and butternuts from reduced humidity conditions created. American ginseng and Illinois wood-sorrel, the two most abundant RFSS on the Forest, may be impacted initially but are able to survive and persist in a disturbed landscape.

Burning activities would occur predominantly when plants are dormant, thus direct impacts are unlikely. If growing season burns do occur, fire intensity during green-up would likely be low and only top-kill individuals, leaving their roots to resprout the next year. Indirect effects to these species would be an alteration of habitat to more open midstories. For butternuts, a reduction in understory and midstory canopies (e.g. shrubs) could reduce humidity and reduce impacts of butternut canker. American ginseng has been found in areas of past burns and appears to be tolerant of the disturbance. Likewise, large yellow lady's slipper has been found in areas previously burned and adjacent to permanent roads. This species seems to need the disturbance created by these activities to increase light to the forest floor. Illinois wood-sorrel has also been found in previously burned areas and appears tolerant of disturbance. Yellow nodding ladies'-tresses and trailing arbutus are most threatened by canopy closure and the loss of oak canopy, respectively. Thus, prescribed burns that reduce midstory and select for oaks over shade-tolerant species should be beneficial to these species.

No Action

There would be no timber or prescribed fire treatments implemented under this alternative, thus no direct impacts to any RFSS within the project area. Indirectly, those RFSS of dry forests would continue to have shade-tolerant tree species overtake their communities that could lead to population or habitat potential decline overtime as their habitat changes to a more mesic forest with dense overstory canopies. The openland species could still have open habitat due to wildlife opening maintenance activities. Mesic forest species would likely be unaffected.

Cumulative Effects

The implementation of the Proposed Action Alternative would be over a twelve year period for timber activities and up to 20 years for prescribed fire activities. As such, it is important to realize that proposed activities would not occur in a concentrated time frame and the direct and indirect effects would be spaced out both spatially and temporally.

Historically, the conversion of forest habitat to non-forest uses has contributed to the decline of the native species such as RFSS. Large areas in and around the Hoosier National Forest have been converted from native ecosystems to those characterized by both native and non-native plant monocultures. In addition to row crops, this would include pine plantations and areas dominated by the non-native invasive pasture grasses: tall fescue (*Festuca arundinacea*) and smooth brome (*Bromus inermis*).

Past activities on private land which have probably affected the native species in the vicinity of the action area include conversion of natural forest communities to agricultural or residential uses and high-grading timber harvests. Present or reasonably foreseeable future activities on private land that may affect RFSS include construction or use of roads, agricultural use of riparian areas, high-grading timber harvests, and activities associated with residential development in rural or forested areas. Private lands near the proposed action area would continue to be a mixture of forest, non-native open pastures, crop fields, and residential areas. Those area converted from forest often represent a complete loss of habitat for most plant RFSS and native woodland species.

Past activities on National Forest System lands that may have impacted the plant RFSS are timber harvests, trail reroutes, and prescribed burning. The Buffalo Pike project was implemented with similar mitigations to this proposed project and has had NNIS treatments for several years post-harvest. The harvest did not change the forest type; it was a restoration project similar to this proposed project. Forest Service trail reroutes are often done to move trails from areas where historic use (e.g. old road in riparian corridor) combined with current use are detrimental to natural resources; they are instead placed in more resilient locations. Past burns occurred to manage tornado effects and safety concerns, maintain wildlife openings, and promote oak-hickory regeneration. All of these projects were surveyed for RFSS and analyzed prior to implementation.

Past, ongoing and reasonably foreseeable future activities on National Forest System lands within the project activities area that may affect RFSS include management of early successional habitats and routine maintenance of recreational trails. Without periodic mowing, brushing or burning, naturally occurring changes in vegetation would result in replacement of early successional habitats with forest habitats and loss of associated animal species (e.g. Henslow's sparrow, bobwhite quail, ruffed grouse). Likewise, trails would become unusable if vegetation is not prevented from encroaching on the trails. Other activities on trails include water bar maintenance and placement of rock or other materials to maintain trail surfaces and reduce erosion. Prescribed burning activities that are ongoing are to maintain wildlife openings and/or improve oak/hickory regeneration. These activities were all surveyed and analyzed for RFSS prior to implementation.

One of the greatest concerns, cumulatively for plant RFSS, is the introduction or spread of non-native invasive species (NNIS). Historical land-use in the area (farming, livestock grazing, homesites, roads, etc.) had already introduced some NNIS prior to some federal purchases of properties. Some NNIS were historically encouraged by state and federal agencies to plant for wildlife (autumn olive, multiflora rose, Chinese lespedeza), others were planted for horticultural interest (Japanese honeysuckle, multiflora rose, Japanese barberry, callery pear), or timber production (princess tree, tree-of-heaven), and some were introduced accidentally (Japanese stiltgrass). Today, public use for game and mushroom hunting, hiking, horse and bike riding, and other activities also have the possibility of introducing NNIS through propagule transport on shoes, livestock and equipment. Wildlife opening management, timbering activities, prescribed burning and trail maintenance/relocation activities also cause soil and vegetation disturbance that can increase the capability for NNIS to establish and spread. NNIS introductions and spread also occurs on non-federal lands where disturbance occurs to soil and vegetation.

Generally, for most NNIS plants within the cumulative effects area, their seed remains viable in the soil from two to seven years. For some species, their seed may lie dormant and remain viable for up to 15 or 20 years. Project design measures help reduce the introduction of new NNIS during project implementation. However, in spite of implementing mitigations and control measures, NNIS will continue to spread within the project area and in surrounding non-federal properties. Managing this spread will require long-term monitoring and early detection rapid response by natural resource staff for a decade or two in the project area. Management of NNIS would be done, both pre- and post-implementation under the Non-native Invasive Species Plant Control Program Analysis (USDA FS 2009a).

While all of the above-mentioned activities could have impacts to RFSS and/or their habitat, most of them have been ongoing for decades and have not driven any of the analyzed RFSS to a loss of viability or federal listing. Increased activity by the Forest

Service to treat NNIS within the area (Coon 2019, USDA FS 2009) would reduce introduction and spread potential. Meanwhile, an increased interest of private landowners in controlling of NNIS (SICIM 2019) through local Cooperative Invasive Species Management Areas (CISMAs), will help reduce uncontrolled NNIS spread on private lands and rights-of-way.

While the project cumulative effects may impact the six RFSS analyzed for the proposed project, the cumulative effects would not cause a loss of viability that would push any of the species to federal listing. Therefore, the overall determination for the six RFSS analyzed remains the same after adding the consideration of cumulative effects.

2) The degree to which the proposed action affects public health or safety.

Direct and Indirect Effects

The Proposed Action would not significantly affect public health and safety. Based on the analysis reported in this draft EA, there is no indication that the general public would experience any adverse health or safety effects from the treatments.

Effects of herbicide use can be found on pages 31-36. During project implementation, we would close certain sections of these trails for safety. As a result of the pre-planning and effective smoke management as required throughout the burns, the overall magnitude of effects is within the standards set to protect public health and safety.

Cumulative Effects

There would be no cumulative impacts of the proposed action to public health or safety.

3) Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.

Direct and Indirect Effects

There would be no significant effects on unique characteristics of the area, because there are no parklands, prime farmlands, wild and scenic rivers, or ecologically critical areas affected by the Houston South Project. Any historical or cultural sites in the project area would be protected by applying avoidance methods (see item #8 below). Adherence to Forest Plan standards and guidelines would protect existing wetlands. The project would not negatively affect cave features because there are no known caves located in the project area. If a cave is located during implementation, protection measures would be implemented.

Cumulative Effects

Because there would be no direct or indirect effects on unique characteristics of the area, there would be no cumulative effects of the proposed action.

4) The degree to which the effects on the quality of the human environment are likely to be highly controversial.

Controversy in this context refers to cases where there is substantial dispute as to the effect of Federal action, rather than opposition to its adoption. The proposed project follows the management direction in the Hoosier National Forest Land and Resource Management Plan (USDA FS 2006a). There is no known scientific controversy over the anticipated effects of the proposed activities. The actions in the proposed project are well founded in science, current research, and other available information that is relevant to the actions. The Forest Service considered and reviewed numerous publications and research in support of our conclusions. This analysis integrated studies, professional knowledge, and site-specific surveys of the project area.

5) The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.

Based upon consideration of past projects, the proposed action is not new or unique to the Forest. Projects with similar actions have been implemented on the Forest for many years. There are no unique or unusual effects for this project, which have not been previously encountered, which would constitute an unknown risk to the human environment. Project design measures (Appendix A) included with the Proposed Action, use of BMPs, and adherence to Forest Plan standards and guidelines would reduce and minimize to the point of non-significance any impacts that might have otherwise been uncertain, unique, or unknown. Further, the management actions proposed are consistent with the Hoosier National Forest Land and Resource Management Plan (USDA FS 2006a).

6) The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.

The Proposed Action Alternative would not establish a precedent for future actions. The Responsible Official will base the decision to proceed on the results of site-specific environmental analysis conducted in accordance with the National Environmental Policy Act. Any future actions will be analyzed separately based on its own site-specific analysis.

7) Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.

A cumulative effect is the consequence on the environment that results from the incremental effect of the action when added to the effects of other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes the other actions and regardless of land ownership on which the actions occur. A cumulative effects analysis was completed separately for each resource area. None of the resource specialists found the potential for significant adverse cumulative effects (see individual cumulative effects analyses throughout the EA).

8) The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources.

Direct and Indirect Effects

After incorporating the design measures (see appendix A) that keep project activities from affecting cultural resources, there would be no effect to potentially significant sites. The Forest Heritage Resource Specialist would flag all eligible or potentially eligible National Register of Historic Places sites for avoidance of all ground-disturbing treatments. We would not use heavy machinery within the boundaries of a protected site area. A 10-20 meter (approximately 33-66 feet) zone flagged for avoidance would buffer sites requiring protection. A 30-meter buffer would be established around cemeteries. By following the design measures, there would be no direct or indirect effects to cultural resources.

We would conduct surface inspections of cultural resource sites during and after project implementation to ensure the design measures were effective in protecting the sites.

Cumulative Effects

By implementing required design measures, there would be no direct or indirect effects on heritage resources. Therefore, by definition, there would be no cumulative effects.

9) The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.

In accordance with Forest Service Manual 2672.41, we review all Hoosier National Forests projects for possible effects on endangered, threatened, or proposed species. There are six federally listed species on the Forest, the endangered eastern fanshell mussel (*Cyprogenia stegaria*), the endangered rough pigtoe (*Pleurobema plenum*), the endangered sheepnose muscle (*Plethobasus cyphyus*), the endangered gray bat (*Myotis grisescens*), the endangered Indiana bat (*Myotis sodalis*), and the threatened northern long-eared bat (*Myotis septentrionalis*). Presently, no federally listed endangered, threatened, or proposed plant species have known occurrences on the Forest.

Analysis Area: The geographic scope of the biological analysis for terrestrial plants and animals is based on the Ecological Classification System and determined by the Subsection in which the species are known to occur and/or habitat is present.

Since this project is wide-ranging, would be completed in a longer time span of over 10 years, and may affect bat species that can forage over longer distances, a 5-mile buffer was established for the cumulative effects geographical boundary.

Based on approximate time of the project duration, the cumulative effects temporal boundary is 20 years.

Direct and Indirect Effects

Eastern fanshell, rough pigtoe, and sheepnose mussel

Within the vicinity of the proposed project, there is no habitat for, and no known records of the eastern fanshell, rough pigtoe, or sheepnose mussel (IDNR 2012, 2015). Therefore, there would be no direct, indirect or cumulative effects to these species from implementing this project.

Gray Bat

The gray bat is Indiana's only true cave bat, requiring caves for roosting, breeding, rearing young, and hibernation. Summer habitat requirements for the gray bat include forests near permanent water and caves (NatureServe 2019). There is no designated critical habitat for the gray bat on the Hoosier National Forest.

The gray bat occupies caves for winter hibernation and possibly a different cave for summer roosting. It is not found roosting in trees or foliage. After over 15 years of cave surveys during the winter and summer months, there are no records of caves being used by gray bats on the Hoosier National Forest. There are no known caves inside the project area. Caves over 3.5 miles from the project boundary have been inspected and not shown to have gray bats (Harriss 2018, Lewis 2011).

Project activities may affect summer habitat, foraging habitat and travel corridors but it is not likely to adversely affect this species. Effects to summer habitat would be staggered over 10-20 years and would not occur all at one time. Project activities would show long-term improvements to water quality and riparian habitat, increase in plant and insect diversity, and an increased water supply by vernal pool creation.

Indiana Bat

There are occurrences of the Indiana bat, according to the Indiana Natural Heritage Data Center, within the action area (IDNR 2012, 2015). The most recent in 2010, a single male Indiana bat was captured just over six miles from the action area (McClanahan 2010). It is assumed that they are present in the vicinity because potential habitat exists inside and adjacent to the project area. There is no designated critical habitat for the Indiana bat on the Hoosier National Forest.

The nearest known Indiana bat hibernacula is approximately 16 miles away from the project area. Because there are no known hibernacula in or near the action area, the proposed Houston South Project would not directly or indirectly affect hibernacula of the Indiana bat nor affect swarming/staging behavior of the Indiana bat.

Timber harvest has the potential to directly or indirectly harm Indiana bats in the short-term. The removal of potential roost trees and alternate roost trees during the bat's active season would have possible direct and indirect effects to the Indiana bat. Habitat may be affected in the short-term, but project activities may show long-term improvements. This includes improved foraging and roosting habitat, small gaps creation in the forest canopy allowing increased solar exposure for maternity colonies, new travel corridor creation, and the addition of vernal pools as a water source. Standards and guidelines from the Forest Plan would ensure that timber harvest is done to maximize the benefit to Indiana bats (USDA FS 2006a).

Indiana bats are very well adapted to modifications to their habitat (Gardner et al. 1991) and they have responded to fires throughout their species' existence. They can be considered a fire-adapted species since the majority of its range historically consisted of fire-maintained ecosystems. It is reasonable to predict that adult Indiana bats would successfully flee from burn areas (USDI FWS 2006). Non-volant pups cannot respond if their roost tree is engulfed by fire or exposed to smoke. However, maternity roosts are protected by Forest Plan guidance of restricting prescribed burning within a one-mile radius from occupied roosts during the breeding season (USDA FS 2006a).

The vast majority of prescribed burns would not occur during bat's active period of April 15 to September 15. However, this project was designed to take advantage of potentially longer burn windows and prescribed burn activities could occur during the active period for bats to reach desired conditions.

This project would have no additional effects on the Indiana bat beyond those previously identified and evaluated in the Hoosier National Forest Programmatic Biological Assessment (USDA FS 2005) and the USDI Fish and Wildlife Service Biological Opinion of the Hoosier National Forest Land and Resource Management Plan (USDI FWS 2006).

<u>Northern long-eared bat</u>

There are no known occurrences of the northern long-eared bat within the area of the proposed actions according to the Indiana Heritage Database. The Hoosier National Forest has no critical habitat for this bat species. No known hibernacula exist in the project area. The closest hibernaculum is over 3.5 miles away and there are no known northern long-eared bat maternity trees in the vicinity of the project area. It is assumed however, they are using habitat in the area, but there has been no documentation of northern long-eared maternity roosts on the forest. Suitable spring staging/fall swarming habitat for northern long-eared bat is most typically within 5 miles of a hibernaculum (USDI FWS 2014).

White-nose syndrome (WNS) is known to occur in this species. The northern long-eared bat has experienced sharp declines as evidenced in hibernacula surveys (Harriss 2018). White-nose syndrome is the primary factor affecting the status of the northern long-eared bat, resulting in the local extirpation of the species in some areas. Negative impacts resulting from proposed activities would not exacerbate the effects of WNS at the scale of states within its range.

Project activities should not affect winter hibernacula of the northern long-eared bat directly or indirectly. Project activities may affect summer habitat, swarming/staging habitat, roosting habitat, foraging habitat and travel corridors. Effects are believed to be short-term with project activities showing long-term improvements with increased solar exposure for maternity colonies, potential roost creation, increase in better foraging potential, and an increased water supply by vernal pool creation.

The proposed Houston South Project could affect swarming/staging behavior of the northern long-eared bat, due to prescribed burn activity and timber operations. Timber operation effects to summer, swarming/staging habitat, roosting, foraging habitat and travel corridors are believed to be short-term with long-term benefits.

Because there are no known hibernacula within 0.25 miles of the action area and there are no known maternity roost trees in the action area, incidental take from tree removal activities and prescribed fire is not prohibited under the final 4(d) rule for northern long-eared bat (USDI FWS 2016).

Cumulative Effects

There are no municipal, county, or state projects known to be proposed within the analysis area. However, it is assumed that standard maintenance on highways, county roads and rights-of-way would continue. Past activities that have likely affected Federally listed species include conversion of riparian areas to agricultural or residential uses, timber harvest, wildfire and grazing.

Present or reasonably foreseeable future activities, which may have an impact on these species, include the construction or use of roads, continued agricultural use, timber harvest and activities associated with residential development. Private lands near the proposed action area will continue to be a mix of forest, open pasture and crop fields.

The past, present or foreseeable Forest Service activities near the action area that could potentially cause additive or synergistic adverse cumulative impacts in conjunction with the proposed action are: the continuation of early successional management (Forest Openings Maintenance), wetland maintenance, the Buffalo Pike Project, potential trail re-routes, Pleasant Run Road Decommissioning, Lake and Pond Habitat Improvement, Jackson County AOPs, Fork Ridge Restoration and NNIS herbicide applications. The vast majority of these activities are considered not likely to adversely affect the Indiana bat and have a beneficial effect on local bat species.

Since the Houston South Project would not alter or create habitat suitable for the fanshell mussel, sheepnose mussel or rough pigtoe mussel. The project would contribute no cumulative impacts to these species.

The Buffalo Pike Project BE (Harriss 2014b) did not consider the gray bat to be present. As a result, a no effect determination was used for all bat components of this species. Therefore, there are no cumulative effects for the gray bat.

The only project that was likely to adversely affect the Indiana bat or northern long-eared bat was the Buffalo Pike Project. Timber operations have been completed for this project and incidental take for the Indiana bat has been accounted for in the Biological Opinion (USDI FWS 2006). Any negative effects are no longer occurring. Indirect beneficial effects would be ongoing such as vernal pool installments, new roosting tree creation, and increased solar exposure. Therefore, cumulative effects from both projects could occur but no negative effects are anticipated.

10) Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.

Implementation of the proposed action would not threaten a violation of Federal, State, or local law. The proposed action complies with the National Forest Management Act (NFMA), Endangered Species Act (ESA), Clean Water Act, and the National Historic Preservation Act (NHPA). The proposed action is fully consistent with the Hoosier National Forest Land and Resource Management Plan (USDA FS 2006a) as amended.

Agencies or Persons Consulted

The Forest Service consulted the following individuals, Federal, State, Tribal, and local agencies during the development of this EA:

USDI Fish and Wildlife Service

US Army Corps of Engineers

Indiana Department of Natural Resources

Absentee Shawnee Tribe of Oklahoma

Delaware Tribe of Oklahoma

Eastern Shawnee Tribe of Oklahoma

Miami Tribe of Oklahoma

Peoria Tribe of Indians of Oklahoma

Shawnee Tribe

Comments were also sought from organizations and individuals, including landowners adjacent to the project areas.

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Appendix A - Design Measures

The ID team incorporated management requirements and design measures in the project design to reduce any potential negative impacts of the project. We do not list all Forest Plan standards and guidelines (USDA 2006a) and statewide best management practices (BMPs) here, but they are required of implementers of the project.

Table 10: Design Measures

SITUATION TO BE PREVENTED OR AMELIORATED	MEASURE	RESPONSIBILITY OF
Cultural Resources		
Damage to cultural resource sites	Adequate buffer zones (20 meters in width) will be established and flagged on the ground to avoid all cultural resource sites that require protection during treatment activities.	Heritage resource specialist
Damage to cultural resource sites	Adequate buffer zones (30 meters in width) will be established and marked on the ground to avoid all cemeteries	Heritage resource specialist
Damage to cultural resource sites	Cultural resource sites that require protection from fire will have a buffered fire line laid in with foam or a leaf blower. Regardless of the method, heavy downed fuels located on-site should be hand removed, if possible.	Heritage resource specialist, prescribed burn specialist
Damage to cultural resource sites	If cultural materials or human remains are discovered during project implementation, immediately cease work and notify the Heritage Resource Specialist.	All Implementers
Damage to cultural resource sites	Conduct cultural resource surveys of private lands prior to implementation of prescribed burning or ground disturbance during road construction and reconstruction.	Heritage resource specialist, prescribed burn specialist, engineering
Damage to cultural resource sites	Motorized vehicle/machine work will be limited in duration and occur in favorable weather conditions to avoid ground disturbance at protected sites.	All Implementers
Damage to cultural resource sites	Cut trees near protected sites so they fall away from site features and site boundary.	All Implementers
NNIS		
Potential spread of NNIS plants	Clean equipment before entering work areas. Include equipment cleaning clause in all timber contracts.	Contract administrator
Potential spread of NNIS plants	Clean all equipment to be used for burn implementation (Rx equipment, fire line creation) prior to entry onto the Hoosier Forest.	Prescribed burn specialist/burn boss
Potential NNIS germination and establishment	Reseed disturbed areas created at log landings. Consider reseeding disturbed areas along fire lines, as needed. Use either the Hoosier National Forest seed mix or consult with Forest Botanist on species composition of seed mix.	Timber sale administrator and prescribed burn specialist/burn boss

Herbicide Application		
Effect of herbicides on non-target vegetation	Choose a method that, when applied directly, targets the undesirable plants with little over-spray (e.g. cut-stump, basal bark, hack-n-squirt).	Herbicide applicators
Effect of herbicides on non-target vegetation	Apply herbicide when adjacent native plants are dormant (early spring or late fall).	Herbicide applicators
Effect of herbicides on non-target vegetation	If application is necessary during the growing season, use selective herbicides or a selective method of application to reduce effects to the surrounding non-target vegetation.	Herbicide applicators
Effect of herbicides on non-target vegetation	Apply only formulations approved for aquatic use in or next to surface waters. Minimize the use of triclopyr (ester formulation) or surfactants used with glyphosate (terrestrial version) within ephemeral, intermittent or perennial stream corridors, or within 100 feet of lakes, ponds or wetlands.	Herbicide applicators
Effect of herbicides on non-target vegetation	Follow label directions and not exceed any mixing or application rates. In addition, temporarily close treatment areas when warranted (e.g. heavily used trails near treatments).	Herbicide applicators
Prescribed Fire		
Excess smoke in the air locally	Before beginning ignition, ensure smoke dispersal forecasts as issued by the National Weather Service are conducive to minimizing smoke impacts.	Prescribed burn specialist/burn boss
Excess smoke in the air locally	Do not ignite fire when the area is in nonconformity or when air quality alerts have been issued for the area.	Prescribed burn specialist/burn boss
Excess smoke in the air locally	Develop burn plan parameters that moderate fire behavior.	Prescribed burn specialist/burn boss
Excess smoke around smoke-sensitive targets	Burn only when wind directions would keep smoke away from smoke-sensitive targets.	Prescribed burn specialist/burn boss
Prescribed fire escaping or damaging property	Keep fuel concentrations away from perimeters, power lines, and residences.	Prescribed burn specialist/burn boss
Soil and Water		
Erosion	Erosion control measures will be kept concurrent with operations as dictated by ground and forecasted weather conditions.	Timber sale administrator
Reduce the risk of erosion and to avoid effects to riparian areas	Skid roads and log landings are to be located to minimize soil and stream buffer disturbance; avoid or limit the number of functioning stream crossings; use existing old skid routes where desirable; and avoid the steeper and wetter areas within the units and areas of disturbance when practical. Skid trails should not exceed 35% slope. Consult with soil scientist, fisheries biologist, or botanist to approve log landing locations as needed.	Timber sale administrator
Minimize compaction, rutting, puddling,	Operate tracked or rubber-tired equipment when soils are most resistant to compaction and rutting. Conduct equipment operation between June 1 and	Timber sale administrator

ponding, and soil movement	November 15, when soils are not saturated, unless authorized by a FS representative if suitably dry or frozen soil conditions allow.	
Minimize compaction, rutting, puddling, ponding, and soil movement	Suspend skidding/hauling during periods where soils are: saturated due to high levels of precipitation when air temperatures are above freezing; thawing during winter months after periods of being frozen; and under any other conditions that would appear to be saturated.	Timber sale administrator
Soil movement into streams	Install erosion control measures along road construction when inside filter strips.	Engineering, contractors
Subsurface flows to the surface and creating new water ways on steep hill slope; severe rutting and compaction	To protect areas where water comes to the surface and runs down a skid road, limbs and tops can be placed on the road surface to be run over by equipment to act as a cushion and disperse the weight of heavy equipment thereby preventing severe rutting and compaction.	Timber sale administrator
Minimize sediment reaching streams	Leave a 25 foot no cut filter strip along perennial streams.	Timber sale Administrator and sale prep personnel
Effects to soil and water	In riparian corridors (25 feet for ephemeral, 50 feet for intermittent, and 100 feet for perennial), operate tracked or rubber-tired equipment when soils are most resistant to compaction and rutting.	Timber sale Administrator
Recreation		
Effects to trails	Restore trail tread to its original condition as much as possible after treatment and in a timely manner. Operations including: repair to waterbars, removal of slash and debris, smoothing of ruts in trails, removal of overhead hazards, and brushing in widened trail corridors.	Engineering, recreation personnel, contract administrator
Possible negative effects on Visuals	Lop and scatter slash adjacent to the Hickory Ridge and Fork Ridge Trails for 25 feet.	Contract administrator
Transportation		
Sedimentation in drainage	Install temporary culverts for access for right-of-ways, logging and road construction	Engineering, contractors
Possible negative effects on Visuals	Chip or bury slash generated from roadwork on the trail where practicable.	Engineering, contractors
Possible negative effects to Aquatic Organism Passages	Use bridges, bottomless pipes, or fords to meet guidelines for AOP crossings on drainages.	Engineering, sale administrator
Sediment movement	Install erosion control devices, keep equipment out of drainages, except at approved crossings	Engineering, sale administrator
Wildlife		
Effects to bats	Remove hazard trees for fire line prep prior to April 15 and after September 15	Prescribed burn specialist/burn boss
Effects to bats	Remove midstory and crop tree release prior to April 15 and after September 15	Silviculturist

Effects to bats	Implement Standards and Guidelines from the Forest Plan, maximize the benefit to Indiana bats and protect the gray bat (USDA FS 2006a) pages 3-3 through 3-5)	All implementers
Effects to sensitive species	Dates of prescribed burning and fire line placement may need re-evaluated based on future sensitive species research findings. Coordinate with the wildlife biologist on current findings	Wildlife biologist
RFSS Plants		
Effects to RFSS Plants	Protect known populations of American ginseng from impacts during timber logging activities and fire line construction.	All Implementers
Effects to RFSS Plants	Do not cut or damage any butternut trees without having them evaluated for healthiness. Stop all activity around any butternuts discovered during implementation and protect trees from disturbance until they can be assessed by a Biologist/ Silviculturist for butternut canker resistance.	All Implementers
Effects to RFSS Plants	Report any newly found populations of RFSS to the Forest Botanist and protect them from direct impacts during timber logging activities and fire line construction.	All Implementers

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Recreation Economic Values for Estimating Outdoor Recreation Economic Benefits From the National Forest System

Randall S. Rosenberger, Eric M. White, Jeffrey D. Kline, and Claire Cvitanovich

Forest Service

Pacific Northwest Research Station

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Cover photo by Emily Jane Davis

Abstract

Rosenberger, Randall S.; White, Eric M.; Kline, Jeffrey D.; Cvitanovich, Claire. 2017. Recreation economic values for estimating outdoor recreation economic benefits from the National Forest System. Gen. Tech. Rep. PNW-GTR-957. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 33 p.

Natural resource professionals are often tasked with weighing the benefits and costs of changes in ecosystem services associated with land management alternatives and decisions. In many cases, federal regulations even require land managers and planners to account for these values explicitly. Outdoor recreation is a key ecosystem service provided by national forests and grasslands, and one of significant interest to the public. This report presents the most recent update of the Recreation Use Values Database, based on an exhaustive review of economic studies spanning 1958 to 2015 conducted in the United States and Canada, and provides the most up-to-date recreation economic values available. When combined with data pertaining to recreation activities and the quantity of recreation use, the recreation economic values can be used for estimating the economic benefits of outdoor recreation. The recreation economic value estimates provided in this report, whether from past research literature or from values constructed using our meta-analysis benefit function, are average consumer surplus per person per activity day.

Keywords: Benefit transfer, economic value, ecosystem services, outdoor recreation, recreation benefits, nonmarket valuation, national forest planning and management, NEPA.

Preface

This report was sponsored by the National Center for Natural Resource Economics Research. The center is a virtual collaborative effort of the Washington office and the regional research stations within U.S. Department of Agriculture, Forest Service, Research and Development. The center was founded to respond rapidly to emerging natural resource economic issues of national significance by leveraging expertise across the Forest Service. The center sponsors research with funding from client organizations and regional research station contributions.

Contents

Introduction

Outdoor recreation is one of the most widely recognized ecosystem services provided by national forests and grasslands and is identified as one of five uses under the Multiple-Use Sustained-Yield Act of 1960. The forest reserves, which would eventually become the first national forests, were originally reserved in the late 19th century to conserve timber and water. Those places also rather quickly became destinations for people seeking both primitive and developed recreation opportunities (Waugh 1918). Today's National Forest System (NFS) receives more than 148 million visits annually with visitors engaging in a variety of outdoor pursuits (USDA FS 2017). The continuing role of the Forest Service in providing sustainable recreation opportunities to the public is evident in the agency's current strategic plan. Developing and maintaining sustainable recreation opportunities is identified as one way to achieve the agency's strategic objectives: "Strengthen Communities" and "Connect People to the Outdoors" (USDA FS 2015). Meeting these objectives requires understanding what recreation activities occur on national forests and grasslands, who is involved in that recreation, and how much do they value their recreation experiences. Recreation activities and numbers of participants on national forests are tracked by the National Visitor Use Monitoring (NVUM) program (English et al. 2002). Other federal and state agencies have their own monitoring programs that also provide estimates of recreation use and activity participation. The economic values that people hold for specific recreation activities are primarily tracked through periodic updates to the Recreation Use Value Database (RUVD) (e.g., Rosenberger and Loomis 2001) and in the scientific literature.

Natural resource professionals are often tasked with weighing the benefits provided by natural resources against the costs of management.

Natural resource professionals are often tasked with weighing the benefits provided by natural resources against the costs of management to produce those benefits. Although the social and economic values of ecosystem services, including outdoor recreation opportunities, are widely recognized, they can be difficult to quantify. Yet in many circumstances, federal regulations require land managers and planners to account for those values explicitly. Within the Forest Service, for example, the Renewable Resources Planning Act of 1974 (superseded by the Government Performance and Results Act of 1993), which informs management of national forests and grasslands, includes an assessment phase and a program analysis phase (USDA FS 2000). The assessment phase identifies the supply of, and demand for, renewable resources on the nation's forests and grasslands. The program analysis phase evaluates the benefits and costs associated with the Forest Service's various programs. These requirements demand credible benefit estimates for key ecosystem services associated with Forest Service management and planning. More broadly, the need for credible benefit estimates is underscored by the President Barack Obama administration's 2015 memorandum directing federal agencies to factor the values of ecosystem services into all federal planning and decisionmaking (Office of Management and Budget 2015).

The economic benefits of recreation use of NFS lands can be estimated for given locations using original studies or information transferred from prior studies conducted elsewhere. The latter method—known as "benefit transfer"—applies benefit estimates obtained through primary research for one location to other unstudied locations of interest. Benefit transfer is used by public agencies and other practitioners when (1) available time, funding, or expertise for conducting original studies are limited; (2) there are available data from existing studies conducted elsewhere; and (3) the application of benefit transfer, given the available studies and location of interest, is deemed reasonable by analysts. Benefit transfer and published recreation economic values can also be used to meet the needs of state and local resource management agencies, as well as nongovernment organizations and private consultants.

This report is intended to meet the continuing need for current recreation benefit information by updating the Rosenberger and Loomis (2001) and Loomis (2005) databases of recreation economic values. This update reflects the most recent version of the RUVD, based on an exhaustive review of economic studies spanning 1958 to 2015 conducted in the United States and Canada. The report thus provides the most current and comprehensive set of recreation economic values available. Specifically, this report provides (1) a brief review of economic concepts and benefit transfer methods, (2) estimates of recreation economic values by primary recreation activity and Forest Service region, and (3) additional context and guidance for analysts using these estimates. The appendix provides technical information about benefit transfer and nonmarket values, and an overview of the RUVD itself. Additional information about the RUVD can be found online at: http://recvaluation.forestry.oregonstate.edu/.

The economic value of any given recreation activity is a monetary measure of the economic benefits received by an individual or group doing that activity.

Recreation Economic Value

The economic value of any given recreation activity is a monetary measure of the economic benefits received by an individual or group doing that activity. For any one individual, the net economic value of a given recreation activity is measured as the maximum amount the individual is willing to pay to participate in the activity, less the actual cost incurred by the individual to participate in that activity. The economic value of recreation differs from the economic impact of recreation.

Economic impact (or economic contribution) measures how spending by recreationists affects economies within a given geography (e.g., community, region, state, or nation) by virtue of the influence that spending has on employment and income. Economists typically use an analytical method called economic impact (or input/output) analysis to evaluate economic impacts. In this report, we are focused only on the economic value of recreation benefits and not recreation economic impacts. The economic impacts associated with national forest recreation are reported by other sources (e.g., White et al. 2016).

Benefit-cost analysis is a common method for evaluating the potential influence that planning and management alternatives and decisions might have on outdoor recreation. For example, benefit-cost analysis can be used to address such questions as: What is the relative worth (i.e., benefits generated) from investments in recreation opportunities, settings, and resources? Benefit-cost analysis can include both market and nonmarket values. Market values are those that are readily identifiable and addressed in typical market transactions and usually involve observable prices or the transfer of money, such as the construction costs and entrance fees. Nonmarket values are those that are not addressed or represented in typical market transactions and can include things such as the value someone has for the opportunity to view nature or the loss of well-being from residents who must endure more traffic from people engaging in recreation. Benefit-cost analysis can be used to consider present benefits and costs as well as those that might be experienced in the future. In this report, we focus on the computation of recreation economic values by developing "direct use values" representing the benefits to individual recreationists directly engaged in outdoor recreation activities. These values represent "access" to a recreation site or to an activity, relative to that location or activity not being available or accessible to recreationists. Thus, these economic values measure the total net benefits of doing the recreation activity rather than the total net benefits from changes in the quality or characteristic of that recreation. The resulting recreation economic values enable scientists, resource analysts, and other practitioners to apply benefit transfer methods to compute the economic value of recreation benefits based on recreation participant numbers reported or projected for a location or activity over a given period. The application of these average values to economic assessments is discussed further in the appendix.

Benefit Transfer Methods

Benefit transfer methods include value transfer and function transfer. Value transfer is the use of a single estimate of value or a weighted average of multiple estimates of value obtained from previously published studies and research literature. Value transfer can be an attractive method for estimating recreation economic benefits when time, funding, and expertise are insufficient to conduct an original study. Moreover, new estimates of economic value based on original or primary research are not needed if resulting value estimates are unlikely to statistically differ from estimates derived from benefit transfer methods. However, original or primary research may provide additional information necessary to evaluate or assess management implications at a site—how values relate to changes in resource or site quality, proposed management options, or other attributes held constant in the benefit transfer estimation process, for example.

Function transfer is the use of a statistical model to derive recreation economic values. The model is estimated from participant or survey data available from one or more previously published studies and is adjusted for characteristics of the site or collection of sites being considered. Function transfers can also rely on data summarizing value estimates reported in a body of literature (such as the RUVD), using a technique known as meta-analysis. Function transfer using meta-analysis can be a more statistically rigorous and robust method for conducting benefit transfer, but is dependent on the availability of information about the characteristics of a specific site, or collection of sites, being considered. Rosenberger and Loomis (2001, 2017) provide a thorough conceptual background for different benefit transfer methods. Additional information about the mechanics of benefit transfer methods can be found in the appendix of this report.

Research studies have tested the validity and reliability of benefit transfer methods, and all methods generally do well.

Many research studies have tested the validity and reliability of benefit transfer methods, and all methods generally do well. Function transfers typically outperform value transfers in terms of validity and reliability. A summary of related literature shows median benefit transfer error for function transfers at 36 percent compared to value transfers at 45 percent (Rosenberger 2015). There is significant variability around both median transfer error estimates, which may in part be due to the experimental nature of these evaluations in academic (or research) settings. In actual benefit transfers conducted by economists and analysts, we feel that good judgment will help to avoid excessive transfer errors. The smallest transfer errors are generally found in benefit transfer applications where the study site and the policy site are similar.

How Economic Values for NFS Recreation Were Estimated

We developed estimates of the economic values of recreation benefits for 14 outdoor recreation activity sets (table 1). These recreation activity sets are based on outdoor recreation activities currently recognized by the Forest Service NVUM program

Table 1—Definitions and National Visitor Use Monitoring categories of primary recreation activities represented in the Recreation Use Values Database

Primary activity	Definition	National Visitor Use Monitoring activity represented
Backpacking	Camping at primitive or dispersed backcountry sites	Primitive camping, backpacking
Biking	Mountain and leisure biking	Bicycling
Cross-country skiing	Cross-country skiing	Cross-country skiing and snowshoeing
Developed camping	Camping at sites with developed amenities such as fire pits, electricity, toilets, picnic tables, and parking	Developed camping
Downhill skiing	Downhill skiing and snowboarding	Downhill skiing and snowboarding
Fishing	Freshwater fishing: all species, bodies of water, and angling techniques	Fishing
Hiking	Hiking, walking, jogging, and trail running that does not include backcountry camping	Hiking and walking
Hunting	Big game, small game, and waterfowl hunting	Hunting
Motorized boating	All types of motorized boating	Motorized water activities
Nature related	Nature watching and visitor center use	Nature center activities, nature study, viewing wildlife, viewing natural features, visiting historic sites
Nonmotorized boating	Floating, kayaking, rafting, and all types of nonmotorized boating	Nonmotorized water activities
Off-highway vehicle use, snowmobiling	Snowmobiling and off-road and all-terrain vehicle riding	Off-highway vehicle use, motorized trail activity, snowmobiling, other motorized activity
Other recreation	Primary and general recreation activities not accounted for in other categories	Relaxing, horseback riding, gathering forest products, resort use, other nonmotorized activities, other activities
Picnicking	Picnicking	Picnicking

(USDA Forest Service 2017). Several of the activity sets represent a narrow group of activities (e.g., downhill skiing and snowboarding) while others correspond to a mix of outdoor recreation activities (e.g., off-highway vehicle motorized trail use including snowmobiling). The 14 activity sets also correspond well to recreation activity groupings typically included in the Forest Service's Resource Planning Act (RPA) assessments for recreation (e.g., Bowker et al. 2012), as well as Statewide Comprehensive Outdoor Recreation Plan (SCORP) reports completed for individual states (e.g., California State Parks 2014, Oregon Parks and Recreation Department 2013, Washington State Recreation and Conservation Office 2013).

Data for estimating recreation economic values for the NFS were drawn from the RUVD. The RUVD is based on an exhaustive review of recreation economic value studies spanning 1958 to 2015 conducted in the United States and Canada.

The data were developed following recommended best practices for meta-analysis practitioners (Stanley et al. 2013). The current version of the RUVD contains 3,194 individual recreation economic value estimates from 422 individual studies. For our purposes, we narrowed these estimates to the 14 NVUM recreation activity sets (table 2) by (1) eliminating 180 estimates for Canada; (2) eliminating 231 estimates for irrelevant activities (e.g., saltwater fishing and beach activities); and (3) removing 74 outlier estimates (i.e., unreasonably small or large values, which significantly affect average values) as less than $5 or greater than $500 per person per activity day. These changes resulted in the 2,709 estimates from 342 studies summarized in table 2. It is common for a single study to report several recreation economic value estimates, hence the disparity in the number of estimates and studies.

Table 2—Summary statistics for average recreation economic value estimates of consumer surplus[a] per primary activity day per person from recreation demand studies, 1958 to 2015

Activity	Number of studies[b]	Number of estimates[c]	Mean value estimate	Median value estimate	Standard error of the mean	Range of value estimates	
						Minimum	Maximum
Backpacking	6	41	$17.04	$9.83	2.44	$6.30	$60.16
Biking	13	36	$98.94	$63.48	17.43	$11.78	$499.34
Cross-country skiing	3	5	$36.84	$31.43	6.93	$20.12	$60.18
Developed camping	22	82	$22.99	$16.12	2.47	$5.08	$166.11
Downhill skiing	5	13	$77.63	$30.54	25.62	$7.85	$277.86
Fishing	120	913	$72.59	$53.27	2.22	$5.36	$464.82
Hiking	37	111	$78.19	$47.17	7.97	$5.02	$451.64
Hunting	64	618	$76.72	$63.12	2.38	$5.04	$419.60
Motorized boating	20	83	$42.48	$19.72	6.63	$5.02	$437.18
Nature related	47	431	$63.46	$47.10	2.79	$5.04	$441.26
Nonmotorized boating	23	83	$114.12	$48.95	13.54	$5.18	$473.02
Off-highway vehicle use, snowmobiling	14	49	$60.61	$51.19	9.58	$9.06	$462.96
Other recreation	66	220	$62.06	$30.33	5.02	$5.12	$390.74
Picnicking	8	24	$31.98	$23.62	6.62	$5.03	$149.13

[a] All value estimates in 2016 dollars. These figures are general descriptive statistics from studies contained in the Recreation Use Values Database. These figures are intended to give information about the range and central tendencies of values in the research literature for recreation activities common to national forests and grasslands. The values in this table should not be used for benefit transfer purposes; instead use the values in table 3.

[b] Total number of studies is 342 (some studies report separate value estimates for two or more primary activities).

[c] Total number of estimates is 2,709.

The distribution of study numbers across the 14 activity sets reflects the relative numbers of scientific studies focused on different recreation activities and does not reflect the relative popularity or importance of any one activity set over another. Wildlife-related activities, such as fishing and hunting, have historically been the focus of much recreation benefit research, for example. Conversely, downhill skiing and backpacking have received relatively less attention in the research literature. Most studies included in the database focused on recreation in rural, rather than urban, places. There are wide ranges of recreation economic value estimates across most activities. The range of value estimates reflects variation across individual study sites (e.g., site quality, attributes, and recreation facilities) and study participants, as well as differences in study methods. Accounting for this variation is one reason why meta-analysis is especially attractive for developing economic estimates of recreation values.

We developed estimates of the average recreation economic values per person per day for each Forest Service region and the NFS as a whole.

We developed estimates of the average recreation economic values per person per day for each Forest Service region and the NFS as a whole. We developed the estimates by fitting a meta-regression statistical model to the economic estimates of values for recreation activities that are relevant to national forests, and associated data contained in the RUVD. The regression measured the effect or relationship of select independent variables from the RUVD to the recreation economic value data characterizing the standardized consumer surplus per person per day as:

$$\text{Value/person/primary activity day} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_k X_k$$

where there are k explanatory variables ($k = 1 \ldots K$). The βs measure the statistical relationship between the variation in the explanatory variable to the variation in the value estimates, also known as partial effects. The estimates of economic value for all primary recreation activities and regions were then constructed by weighting the measured partial effect (coefficient) of relevant policy site features by database fixed values—the nonactivity and nonregion variables were held constant at their representation in the data (i.e., at their mean value). We then summed across these weighted partial effects to derive recreation economic value. This produces a recreation economic value estimate that adjusts the baseline estimate (by holding all other nonactivity and nonregion effects constant at their mean value) by activity- and region-specific partial effects.

For example, a recreation economic value for developed camping in Region 1 (Northern Region) was derived by setting the partial effects for developed camping and Region 1 at their full level (weights = 1) and removing the partial effects of other recreation activities and regions (weights = 0), while holding all the effects of all other variables at their mean value. We repeated the process for all activities for all regions and the NFS as a whole. The recreation economic values estimated in this manner are intended to be used only to represent the value associated with recreationists' **primary** recreation activities; they do not represent the value for ancillary, or secondary, activities and should not be used to estimate economic benefits for those activities. The recreation economic values we report are robust to the uniqueness of any single study given they rely on contributions from all related studies in the metadata and are systematically adjusted based on measurable differences across the sites being studied. Additional details on this meta-analysis function, along with example applications, are provided in the appendix.

We stress that the recreation economic value estimates provided in this report are average values of consumer surplus per person, per primary activity day. Consumer surplus, or net willingness to pay (i.e., total willingness to pay minus cost to engage in the activity), is a measure of the welfare an individual gains by engaging in an activity or purchasing a good. This measure is commonly used for benefit-cost analysis or economic efficiency analysis by federal agencies such as the U.S. Army Corps of Engineers, Bureau of Reclamation, U.S. Environmental Protection Agency, and the Forest Service (see Forest Service Handbook SFH 1909.17). Additional technical notes on this concept are provided in the appendix.

Economic Values of Recreation Benefit

Average recreation economic values are reported for each of the 14 primary recreation activities for each Forest Service region, and the NFS as a whole in table 3. Nationally, recreation economic values range from about $45 per person per day for camping and backpacking to about $120 per person per day for nonmotorized boating. On average, a day of recreating on national forest lands provides about $80 in benefit to the recreationist. Average recreation economic values across all activities for individual Forest Service regions were calculated as the weighted average of the share of each region's recreation use in each primary activity. Region-level recreation use was drawn from current NVUM estimates (USDA FS 2017). Average recreation economic values for Forest Service regions range from about $63/day for Region 5 (Pacific Southwest Region) national forests to about $77/day for Regions 1 and 4 (Intermountain Region) national forests to $103 for Region 10 (Alaska Region) national forests. The regional-level recreation economic values are influenced by the types of activities popular in each region and the underlying values for those activities.

Analysts need to pay attention to units of measure when applying the recreation economic values reported here to compute aggregate recreation benefits. We report the recreation economic values on an "activity day" basis (i.e., benefit per

Table 3—Estimates of the average economic value of recreation benefits (use value) by primary activity and Forest Service region (average consumer surplus per person per primary activity day)

	Forest Service region									
Primary activity	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R8**	**R9**	**R10**	**National**
Backpacking	39.59	32.81	40.89	42.81	26.64	33.15	32.61	21.10	65.09	44.00
Biking	93.18	86.40	94.48	96.40	80.23	86.74	86.20	74.70	118.69	97.60
Cross-country skiing	62.96	56.18	64.26	66.18	50.01	56.52	55.98	44.47	88.46	67.37
Developed camping	42.06	35.28	43.36	45.27	29.11	35.61	35.07	23.57	67.56	46.47
Downhill skiing	88.67	81.89	89.97	91.88	75.72	82.23	81.68	70.18	114.17	93.08
Fishing	77.96	71.18	79.26	81.18	65.01	71.52	70.98	59.47	103.46	82.37
Hiking	90.90	84.12	92.20	94.12	77.95	84.46	83.91	72.41	116.40	95.31
Hunting	83.86	77.08	85.16	87.07	70.90	77.41	76.87	65.37	109.36	88.27
Motorized boating	64.82	58.04	66.12	68.03	51.87	58.37	57.83	46.33	90.32	69.23
Nature related	66.57	59.79	67.87	69.79	53.62	60.13	59.59	48.09	92.08	70.99
Nonmotorized boating	115.37	108.59	116.67	118.59	102.42	108.93	108.38	96.88	140.87	119.78
Off-highway vehicle use/snowmobiling	56.89	50.11	58.19	60.11	43.94	50.45	49.91	38.40	82.39	61.30
Other recreation	71.45	64.67	72.75	74.66	58.49	65.00	64.46	52.96	96.95	75.86
Picnicking	55.62	48.84	56.92	58.83	42.67	49.17	48.63	37.13	81.12	60.03
Weighted average	76.24	71.88	76.20	77.04	63.19	68.64	66.70	55.93	103.00	79.96

Note: All value estimates are in 2016 dollars. These estimates are computed using a statistical meta-regression model. They represent the average value of the economic benefit to recreationists using national forests and grasslands. These figures represent the value only for those recreationists who engage in the listed activities as their primary activity; these values should not be applied to secondary or ancillary activities done by recreationists. These values do not represent the economic activity generated by national forest recreation.

person per day). An activity day is one person recreating for some portion of a day. For example, an individual whose primary recreation activity is picnicking and who engages in that activity for 2 hours on one day is one primary activity day of picnicking. Six people with the primary activity of picnicking who each spent 2 hours on one day doing that activity is six primary activity days of picnicking. One individual with the primary activity of camping who camps overnight for one night would equal two primary activity days of camping.

Currently, recreation use estimates for most federal agencies managing outdoor recreation opportunities are reported in terms of "visits." For the Forest Service, a national forest visit is defined as "one person participating in one or more recreation activities on a national forest or grassland for an unspecified period of time" (USDA FS 2017). A visit begins when someone enters the national forest and ends when the individual leaves the national forest for the last time that day. A national forest visit may last 1 hour or several days. Analysts will need to convert visits to primary activity days to obtain a quantity of recreation use with which to multiply by the recreation economic values. We provide conversion factors for doing this in table 4 and example computations in the next section of this report. The conversion factors were computed using the NVUM data by estimating the average number of calendar days per visit reported by visitors engaged in each NVUM recreation activity. The values presented here should only be applied to the primary activities of visitors. For instance, recreationists whose primary activity is hiking likely participate in other activities (e.g., viewing nature, viewing wildlife, and photography) during their hikes. However, for those visitors, only the recreation economic value of "hiking" counts for their visit.

Guidance for Analysts

The recreation economic values provided in table 3 may be used in a variety of ways. By themselves, the values show the average economic value of recreation benefit (i.e., consumer surplus) per activity day that accrues to an individual engaged in a type of recreation activity within a Forest Service region. These average value estimates are what we would **expect** the economic benefit to be, conditional on available information and holding all else constant. This expected, or average, value is an estimate within the distribution of all estimates with the highest likelihood of being observed. Thus, these recreation economic value estimates may be multiplied by the number of activity days a location receives to derive the aggregate benefit of recreation. Applications at national, regional, and forest-level aggregations include a mix of recreation sites with different qualities and characteristics, and the use of average values is typically most appropriate at this level of analysis.

To apply the recreation economic values, analysts will multiply the value per person per day by the estimated annual activity days in that primary activity. For national forests under current conditions, the number of activity days can be estimated using visit estimates by activity provided by NVUM reports and conversion factors to translate visits into activity days reported in table 4. Other reliable information on the number of recreation visits can also be used. Reliable information on visits may include counts of recreation use (in per-person activity days) estimated from fee envelopes or permits where all use is covered by those measures, studies by university or agency scientists where the methods are clearly described and replicable, and "engineered" estimates that clearly show assumptions and describe data sources.

We urge users to **not** interpret the relative economic values of activities as indicative of which activities are "best" to promote through management. Just because the average economic value for nonmotorized boating is larger than the average economic value for picnicking, for example, does not necessarily mean

Table 4—Activity days per national forest visit, by primary activity and Forest Service region

	Forest Service region									
Primary activity	R1	R2	R3	R4	R5	R6	R8	R9	R10	National
Backpacking	2.4	2.5	2.1	2.7	2.8	2.6	2.4	2.5	2.7	2.4
Bicycling	1.1	1.1	1.1	1.2	1.1	1.2	1.1	1.1	1.1	1.1
Cross-country skiing	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	2.0	1.0
Developed camping	2.7	2.7	2.6	2.5	2.8	2.8	2.8	2.9	2.5	2.7
Downhill skiing	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.1	1.0
Driving for pleasure	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0	1.1
Fishing	1.3	1.2	1.3	1.5	1.3	1.3	1.1	1.3	1.3	1.3
Gathering forest products	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.1
Hiking, walking	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Horseback riding	1.3	1.3	1.1	1.4	1.2	1.4	1.6	1.4	1.0	1.3
Hunting	1.3	1.3	1.6	1.6	1.5	1.5	1.2	1.2	1.5	1.3
Motorized trail activities	1.3	1.3	1.2	1.4	1.3	1.3	1.1	1.1	1.0	1.3
Motorized water activities	1.3	1.1	1.1	1.2	1.3	1.4	1.2	1.1	1.1	1.3
Nature center activities	1.0	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0
Nonmotorized water activities	1.7	1.1	1.2	1.7	1.4	1.3	1.2	1.3	1.1	1.7
Off-highway vehicle use	1.2	1.2	1.2	1.5	1.2	1.3	1.2	1.2	1.0	1.2
Other motorized activities	1.5	1.2	1.1	1.0	1.2	1.2	1.1	1.1	1.1	1.5
Other nonmotorized	1.1	1.2	1.0	1.2	1.2	1.1	1.1	1.1	1.1	1.1
Picnicking	1.2	1.1	1.1	1.1	1.2	1.2	1.1	1.1	1.2	1.2
Primitive camping	2.8	2.4	2.4	2.5	2.3	2.6	2.3	2.7	2.0	2.8
Relaxing	1.6	1.5	1.4	1.5	1.5	1.5	1.3	1.4	1.4	1.6
Resort use	2.5	2.1	2.6	2.5	3.2	2.3	3.1	2.2	3.1	2.5
Snowmobiling	1.0	1.2	1.0	1.1	1.2	1.2	1.0	1.1	1.1	1.0
Viewing natural features	1.1	1.1	1.1	1.2	1.2	1.1	1.1	1.0	1.1	1.1
Viewing wildlife	1.1	1.1	1.1	1.2	1.1	1.2	1.1	1.1	1.1	1.1
Visiting historic sites	1.1	1.1	1.1	1.1	1.1	1.1	1.0	1.0	2.9	1.1
Other activities	1.1	1.2	1.1	1.2	1.1	1.1	1.0	1.2	1.1	1.1
No activity reported	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Weighted activity average	1.2	1.1	1.2	1.3	1.2	1.2	1.2	1.2	1.2	1.2

Conversion coefficients are the average number of calendar days per national forest visit. These figures can be used to convert Forest Service national forest visits into activity days. The values in the weighted activity average row are average values for each region weighted by the percentage of visits for each primary activity for each region as estimated from National Visitor Use Monitoring. Those values can be used to convert aggregate regional or national level visit estimates to activity days without needing to account for primary activity type.

that management efforts should focus on nonmotorized boating at the expense of opportunities for picnicking. Additionally, managers should also consider the supply of different recreation opportunities. There may be many nonmotorized boating opportunities, and few or no picnic facilities, implying that the incremental benefit from additional picnic sites may be relatively high compared to adding boating sites. Further, there may be numerous people who picnic compared to people who participate in nonmotorized boating activities, meaning that, in aggregate, the total benefit from picnicking is much great than that of boating, despite the average recreation economic value for boating being comparatively large.

These average recreation economic values may not always be appropriate for site-level analyses (e.g., those focused on a specific lake, campground, or trail), but they can be a starting point. The average values here are computed from a wide range of studies conducted in actual recreation settings with varying characteristics and quality. These average economic values may not always be representative of the conditions (including quality) at an individual recreation site or specific recreation setting. The average recreation economic values reported here could be reasonably applied for site-specific analyses if that site was similar to an "average" site studied in the RUVD. In cases where greater specificity is required in the economic value estimate, analysts may want to scale up or down the average value. We recommend that analysts considering rescaling of average values lean toward making conservative alterations, as very low and very high estimates of recreation economic values are the rarest kinds estimated from primary research. An alternative approach would be to use a single point estimate transfer by matching specific studies in the RUVD with the policy site of interest (see the appendix for a description of the steps for conducting point estimate transfers).

The average recreation economic values reported here are likely inappropriate for analyses that involve changes in the quality of recreation sites and settings or the cost of accessing them. For example, the recreation economic values reported here would not be helpful in estimating the benefits to recreationists from a project to increase the screening between campsites that improved the quality of the camping experience. To do that analysis, a primary study would have to be done, or the analyst would need to find a study in the RUVD that covered a comparable site. The recreation economic values reported here might be appropriate for a study focused on added benefit from increasing the number of sites in a campground that was at full capacity (and therefore increases the number of visits) if the addition of sites did not change the quality or cost of camping there. Finally, the recreation economic values here are likely inappropriate to estimate the benefit (or loss) to visitors from a change in fees to access a recreation site.

Example Applications

We provide two examples of how the recreation economic values reported in table 3 can be used to compute aggregated economic benefits of recreation. The first example is an estimate of the aggregated economic benefits of recreation provided collectively by the national forests in each Forest Service region; the second is an estimate of the aggregated economic benefit of recreation provided by a single national forest.

Estimating the Economic Benefit of Recreation for a Single Forest Service Region

We use Forest Service Region 2 (Rocky Mountain Region) as an example for computing aggregated economic benefits for an entire Forest Service region. The aggregate benefit to users who recreate on national forests in Region 2 can be computed by multiplying the number of recreation visits by the conversion coefficient from table 4 and by the average recreation economic value estimate for the region from table 3 as:

Region 2 NVUM 2015 use estimate (1,000s)	X	Conversion coefficient (table 4)	X	Economic value (table 3)	=	Aggregated recreation benefit value ($1,000s)

or:

28,291 visits	X	1.1	X	$71.88	=	$2,236,913

Given these inputs, the economic benefit to individuals who recreated on Region 2 national forests in 2015 is computed as $2.24 billion. That means that the money spent by federal agencies to provide recreation opportunities in Region 2 national forests provided $2.24 billion in well-being to those people who recreated. The $2.24 billion figure does **not** represent the economic contribution or economic activity generated by recreation at Region 2 national forests; computing economic contribution would require an economic impact analysis.

Estimating the Economic Benefit of Recreation for a Single National Forest

We use the Medicine Bow National Forest to show the procedure for estimating the aggregate economic benefit of recreation for an individual national forest (table 5). The computation begins with the estimate of total annual recreation use on the Medicine Bow National Forest (534,871 visits) and the percentage distribution of that use by primary activity. Both the recreation use figure and the distribution of use by recreation activity are drawn from NVUM estimates (USDA FS 2017).

Table 5—Estimate of the annual, aggregate economic benefits accruing to individuals recreating on the Medicine Bow National Forest

Primary activity	Primary activity	National forest visits	Conversion coefficient (table 4)	Primary activity days	Use value (table 3)	Economic benefit[a]
	Percent				*- - - - - Dollars - - - - -*	
Backpacking	0.0	161	2.5	403	32.81	13,209
Bicycling	2.5	13,372	1.1	14,709	86.40	1,270,853
Cross-country skiing	16.8	90,034	1.0	90,034	56.18	5,058,131
Developed camping	0.9	4,804	2.7	12,972	35.28	457,654
Downhill skiing	9.6	51,105	1.0	51,105	81.89	4,185,002
Driving for pleasure	6.0	32,092	1.1	35,301	64.67	2,282,947
Fishing	2.6	14,072	1.2	16,887	71.18	1,201,981
Gathering forest products	0.2	919	1.1	1,010	64.67	65,343
Hiking/walking	15.0	80,231	1.1	88,254	84.12	7,423,903
Horseback riding	1.9	9,976	1.3	12,969	64.67	838,724
Hunting	7.2	38,767	1.3	50,397	77.08	3,884,575
Motorized trail activities	1.7	9,253	1.3	12,029	50.11	602,786
Motorized activities	0.2	918	1.1	1,010	58.04	58,633
Nature center activities	0.0	0	1.0	0	64.67	0
Nature study	0.1	501	1.1	551	64.67	35,605
No activity reported	0.2	1,303	1.0	1,303	64.67	84,258
Nonmotorized water activities	0.2	964	1.1	1,061	108.59	115,183
Off highway vehicle use	4.1	22,094	1.2	26,512	50.11	1,328,540
Other motorized activities	0.2	856	1.2	1,027	50.11	51,461
Other nonmotorized activities	0.6	3,170	1.2	3,804	64.67	246,023
Picnicking	1.0	5,286	1.1	5,814	48.84	283,971
Primitive camping	0.8	4,258	2.4	10,220	32.81	335,302
Relaxing	4.3	22,999	1.5	34,499	64.67	2,231,062
Resort use	0.0	0	2.1	0	64.67	0
Snowmobiling	9.0	48,138	1.2	57,766	50.11	2,894,658
Other activities	6.0	32,092	1.2	38,511	64.67	2,490,488
Viewing natural features	8.0	42,790	1.1	47,069	59.79	2,814,234
Viewing wildlife	0.9	4,716	1.1	5,187	59.79	310,145
Visiting historic sites	0.0	0	1.1	0	59.79	0
Total	100.0	534,871		620,404		40,564,669

[a] Economic benefit values are in 2016 dollars. Visitation figures are from National Visitor Use Monitoring round 3 (fiscal years 2009 to 2014).

Practitioners should focus on the primary recreation activity of visits rather than any secondary (or "participating") activities.

The number of visits by recreation activity is computed by multiplying the appropriate primary activity percentage by the estimate of total use on the national forest. The visits-by-activity figure is then multiplied by the conversion coefficient for each activity for Region 2 (where the Medicine Bow National Forest is located) drawn from table 4 to compute the number of activity days for each activity. The appropriate economic benefit estimate for each activity is drawn from table 3 using the crosswalk to NVUM activities shown in table 2. The economic benefit for each activity is calculated by multiplying activity days by the use value figure. The aggregate economic benefit of recreation on the entire Medicine Bow National Forest is the sum of all the benefit values for each primary activity.

Characterizing and understanding recreation use will continue to be a necessary step in managing national forests.

Recreationists on the Medicine Bow National Forest receive in total $40.6 million in economic benefits from recreating there. Again, that figure does **not** represent the economic impact or economic activity generated from recreation on the national forest, but rather the economic value of the benefit to those who recreated.

Conclusions

Outdoor recreation has been, and likely will continue to be, an important use of national forests, and one that connects the U.S. public and international tourists with the many benefits that public forest lands have to offer. Characterizing and understanding recreation uses of national forests thus will continue to be a necessary step in managing national forests to meet their multiple-use mandate. The economic value estimates reported here thus provide a critical resource for forest planners, managers, and policymakers charged with developing and implementing the stewardship of U.S. public forest lands.

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The RUVD summarizes recreation economic value estimates from more than 50 years of economic research.

Appendix

This appendix provides additional technical information about the methods and techniques described in this document. It begins with a history of the Recreation Use Value Database (RUVD), and then summarizes key economic concepts. A more detailed discussion of benefit transfer methods and how to conduct them is provided, followed by the technical details of the meta-analysis function transfer used in constructing table 3.

History of the Recreation Use Values Database

The RUVD summarizes recreation economic value estimates from more than 50 years of economic research (work published from 1958 to 2015) characterizing the value of outdoor recreation in the United States and Canada. The RUVD includes all documented estimates of recreation economic values published in journal articles, technical reports, book chapters, working papers, conference proceedings, or graduate theses (Stanley 2001). Included studies encompass a variety of methods, regional and activity foci, sample sizes, and site characteristics.

The RUVD is the result of seven separate literature reviews, although it was completely reconstructed in 2006. The first review covered literature on outdoor recreation and forest amenity use values from the 1960s to 1982, with 93 benefit estimates (Sorg and Loomis 1984). The second literature review covered 1968 to 1988, (Walsh et al. 1988) increasing the benefit estimate count to 287. A third literature review, conducted by MacNair (1993), covered estimates from 1968 to 1993 and formally coded information on study attributes. A fourth literature review, conducted by Loomis and others (1999), used an expanded coding protocol and merged with the MacNair database. Kaval and Loomis (2003) updated this expanded database, with emphasis on underrepresented recreation activities. In 2006, the RUVD was rebuilt using an expanded coding protocol with new variables and the database was again updated with new and overlooked valuation studies. Finally, in 2015 the RUVD was updated to include studies from 2006 to 2015. This effort, following the best practice guidelines established by Stanley et al. (2013), brought the number of studies included to 422 and estimates to 3,194.

Primary studies were included if (1) they estimated access values (i.e., with vs. without access to the resource or activity); (2) they followed well-established economic practices for stated or revealed preference, or mixed estimation models (e.g., Champ et al. 2017); (3) they were conducted in the United States or Canada; and (4) they reported an economic value that could be converted into a standardized consumer surplus dollar value per person per day. The RUVD includes the standardized economic value as well as identified information on the document source and study, site, activity, and methodology attributes of each study. Additional information about the RUVD, including studies and coding protocol, can be found at http://recvaluation.forestry.oregonstate.edu/.

Consumer Surplus

Consumer surplus is the economic value of a recreation activity above what must be paid by the recreationist to enjoy the activity (fig. 1). Looking at conditions when demand is D_0, consumer surplus is the area below the demand function (D_0) and above the price or expenditure line (B), or area BCD. Consumer surplus is also referred to as net willingness to pay, or willingness to pay in excess of the cost of the good. Total economic use value is consumer surplus plus the costs of participation, or area 0ACD in figure 1 when demand is D_0 and A is the number of days of participation. Consumer surplus is generally estimated in primary research by inferring it from revealed preference data (i.e., generate the demand function and then calculate consumer surplus), or directly estimated using stated preference data (i.e., where people state their maximum net willingness to pay within constructed market conditions). For more information on nonmarket valuation methods, see Champ et al. (2017).

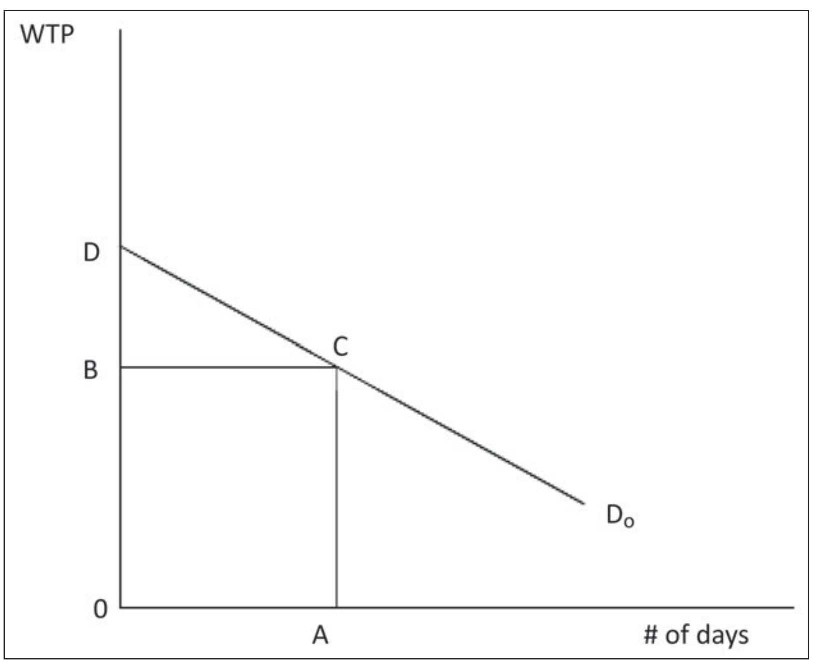

Figure 1—Consumer surplus in demand.

Benefit Transfer

There are two broad approaches to benefit transfer: (1) value transfer and (2) function transfer (fig. 2). Value transfers encompass the transfer of (1-a) a single benefit estimate from a study site, or (1-b) a measure of central tendency (e.g., average or median) for several benefit estimates from a study site or sites, or (1-c) administratively approved estimates. Administratively approved value estimates are discussed in conjunction with the measure of central tendency discussion (hereafter average value transfer will refer to both (1-b) and (1-c)). Function transfers are the transfer of (2-a) a benefit or demand function from a study site, or (2-b) a meta regression analysis function derived from several study sites. Function transfers are adapted to fit the context of the policy site with respect to socioeconomic characteristics, extent of market and environmental impact, and other measurable characteristics that may capture or define the differences between sites with this information and the one where it is needed (i.e., being transferred to). The adapted function is then used to construct a benefit measure for the policy site.

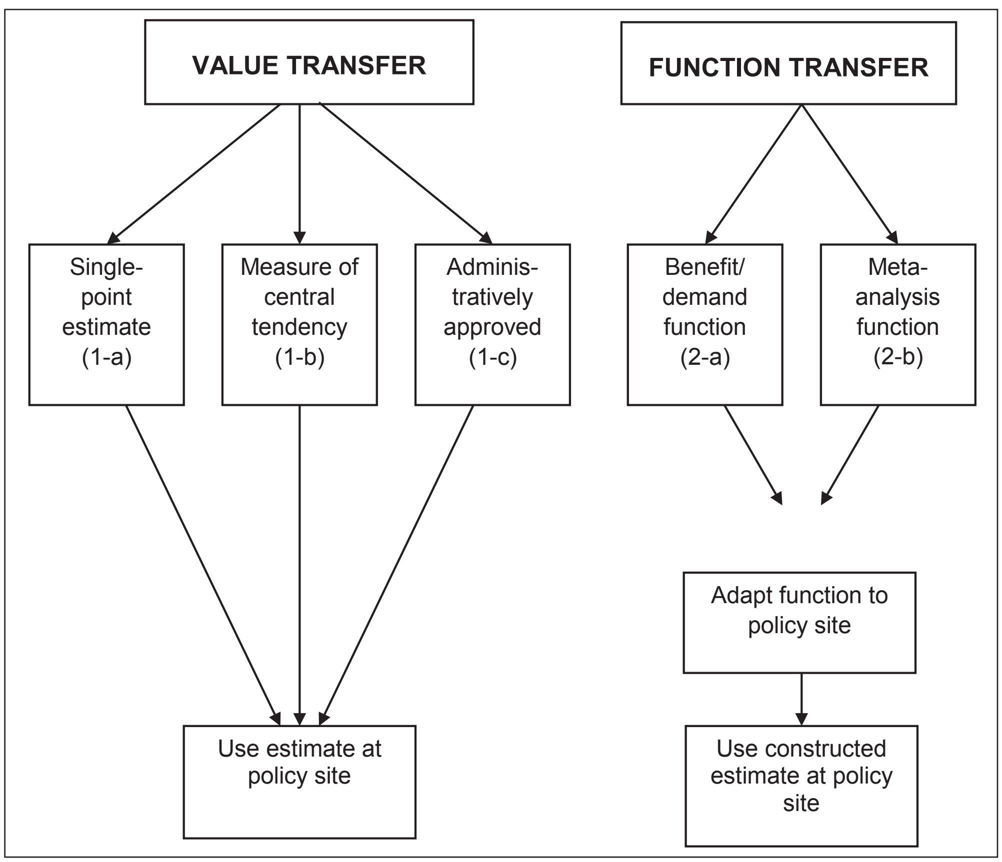

Figure 2—Benefit transfer approaches (adapted from Rosenberger and Loomis 2001).

Applications of benefit transfer methods may or may not be structurally (i.e., directly) related to underlying utility theoretic approaches. The continuum of structural linkages is identified in Bergstrom and Taylor (2006). Additional discussions and comprehensive information on benefit transfers are found in Johnston (2015) and others, including Johnston and Rosenberger (2010), and Rosenberger and Loomis (2017).

Value transfer methods—

Single-point-estimate transfer—A single-point-estimate benefit transfer uses an estimate from a single relevant primary research study (or range of point estimates if more than one study is relevant). The steps to performing a single-point-estimate transfer include identifying and quantifying the management or policy-induced changes on recreation use, and locating and transferring an appropriate "unit" consumer surplus measure. The following is a more detailed list of the steps involved in single-point-estimate transfers:

1. Identify the resources affected by a proposed action.
2. Translate resource impacts to changes in recreational use.
3. Measure recreation use changes.
4. Search the literature for relevant study sites.
1. Assess relevance and applicability of study site data.
5. Select a benefit measure from a single relevant study or a range of benefit measures if more than one study is relevant.
6. Multiply benefit measure by total change in recreation use.

The context surrounding each benefit transfer can be unique, meaning there is no universal protocol that can be objectively followed in any situation.

The simplicity with which these steps are presented may be misleading. Finding a valid and reliable benefit measure can be complex and require the analyst to make many judgments on the comparative structure between two or more sites. These judgments often rely on limited available information about the original study context and may require additional information be gathered about the sites and study methods.

Similarity of sites is a key element in the defense of point-transferred values. Defensibility can be defined on two feasibility dimensions–technical and political. Technical feasibility is inversely related to the degree of technical and theoretical consistency between the study site context and the policy site context. Political feasibility is highly context- and scale-dependent, accounting for an array of social and cultural factors. The context surrounding each benefit transfer can be unique, meaning there is no universal protocol that can be objectively followed in any situation. However, quite often information can be transferred with varying levels of confidence (Johnston and Rosenberger 2010).

Average value transfer methods—An average value transfer is based on using a measure of central tendency of all or subsets of relevant and applicable studies as the transfer measure for a policy site issue. The primary steps to performing an average value transfer include identifying and quantifying the management or policy-induced changes on recreation use, and locating and transferring a "unit" average consumer surplus measure. The following is a more detailed list of the steps involved in average value transfers:

1. Identify the resources affected by a proposed action.
2. Translate resource impacts to changes in recreational use.
3. Measure recreation use changes.
4. Search the literature for relevant study sites.
5. Assess relevance and applicability of study site data.
6. Use average value for the region or use an average of a subset of study measures.
7. Multiply benefit measure by total change in recreation use.

Federal public land agencies commonly use administratively approved average values in assessing management and policy actions. The U.S. Department of Agriculture Forest Service has used Resources Planning Act (RPA) values since 1980 (USDA FS 1991). These RPA values have been provided for groups of activities and Forest Service regions of the country. Similarly, the U.S. Bureau of Reclamation and U.S. Army Corps of Engineers have relied on U.S. Water Resources Council (1973, 1979, 1983) "unit day values" for decades. Although some of the unit day values may not have been based directly on the emerging literature on outdoor recreation economic values and measures, they have all been influenced to a certain degree by this literature. Average value estimates, however, are no better than the data on which they are based. All the issues that could be raised concerning the credibility of any single measure are also relevant for an average value based, in part, on that measure.

Benefit-function-transfer methods—Benefit-function transfers use a model to statistically relate benefit measures to study factors, such as characteristics of the user population and the resource being evaluated. Benefit-function transfers usually come from two sources. First, a benefit function or demand function has been estimated and reported for a recreation activity in a geographic location through primary research. Second, a meta-analysis function can be estimated from several independent primary research projects. In either case, the transfer process entails adapting the function to the characteristics and conditions of the policy site, constructing a benefit measure based on this adaptation of the function, and using the measure for evaluating the policy site.

Demand-function transfer—The transfer of an entire demand function is conceptually more sound than value transfers, because recreation benefit estimates and use rates are a complex function of site and user characteristics, and spatial and temporal dimensions of recreation site quality and site choice. When transferring a point estimate from a study site to a policy site, it is assumed or implied that the two sites are identical across the various factors that determine benefit derived in recreational use of the two sites. An average value transfer assumes the benefits of the policy site are around the mid-level of benefits measured for the study sites incorporated into the average value calculation. However, this is not always the case. The invariance surrounding the transfer of benefit measures alone makes these transfers insensitive or less robust to significant differences between the study site(s) and the policy site. Therefore, the main advantage of transferring an entire demand function to a policy site is the increased relevance of tailoring a benefit measure to fit the characteristics of the policy site. It is in the adaptation stage of constructing a benefit measure from a study site demand function that the additional value of the transfer method is realized. The following is a more detailed list of steps for demand- and benefit-function transfers:

1. Identify the resources affected by a proposed action.
2. Translate resource impacts to changes in recreational use.
3. Measure recreation use changes.
4. Search the literature for relevant study sites.
5. Assess relevance and applicability of study site data and whether demand or benefit function is specified.
6. Adapt demand or benefit function to policy site characteristics and construct benefit measure.
7. Multiply constructed benefit measure by total change in recreation use.

Disadvantages of the method are primarily due to data collection and model specification in the original research effort. Factors in the demand function may be relevant to the study site but not to the policy site. Also, factors that influence demand at the policy site may not have been collected at the study site or were not significant in determining demand at the study site. These factors significantly affect the constructed benefit measures at a policy site.

The specification of demand functions can significantly affect the reliability of their use under varying circumstances. To employ a demand function transfer, the analyst must use insight and judgment concerning the applicability and transferability of demand functions, the details of which are beyond the scope of this report.

Meta-regression analysis is the statistical summarizing of relationships between benefit measures and quantifiable characteristics of studies.

The adaptation of a demand function from a study site to a policy site can be complex and lead to a large error. This error can be influenced by dissimilarities between site and user population characteristics of the study site and policy site. Critical demand/benefit-function transfer requires strong knowledge of economic methodology and estimation of consumer surplus. Therefore, it is highly recommended that when attempting to perform a demand-function transfer you either have the requisite knowledge or solicit the aid of someone who does.

Meta-regression analysis benefit-function transfer—Meta-regression analysis is the statistical summarizing of relationships between benefit measures and quantifiable characteristics of studies. The data for a meta-analysis are generally summary statistics from study site reports and include quantified characteristics of the user population, study site's environmental resources, and valuation methodology used. Coding of the studies included in the literature review lends itself directly to the estimation of a meta-analysis benefit function. However, interpretation of original study results can be a source of error in meta-analysis databases (Stanley et al. 2013).

Meta-analysis has been traditionally concerned with understanding the influence of methodological- and study-specific factors on research outcomes and providing summaries and syntheses of past research. A more recent use of meta-analysis is the systematic use of the existing value estimates from the literature for benefit transfer. Essentially, meta-analysis regression models can be used to construct benefits at policy sites. Meta-analysis has several conceptual advantages over other benefit-transfer methods such as point-estimates and demand-function transfers, which generally revolve around the advantages of broader and more diverse data for adapting meta-regression models to specific policy site valuation needs. The specific steps to conducting a meta-regression analysis function transfer are as follows:

1. Identify the resources affected by a proposed action.
2. Translate resource impacts to changes in recreational use.
3. Measure recreation use changes.
4. Adapt meta-regression analysis benefit function to policy site characteristics and construct benefit measure.
5. Multiply constructed benefit measure by total change in recreation use.

Meta-analysis has many advantages over unit transfer: it uses information from many studies, providing more rigorous value measures sensitive to the underlying distribution of estimates; multiactivity, multisite meta-analyses can construct estimates for regions in which no studies were conducted for an activity; and methodological differences can be controlled when calculating a value. An example of this method is provided in this report. It is the method used to construct the economic values in table 3.

Meta-Regression Analysis Detailed Methods

Panel data and model specification—

Quantitative literature reviews such as meta-analysis may utilize pools of data with panel characteristics (Rosenberger and Loomis 2000). The RUVD includes many empirical studies (e.g., single observations) that provide several estimates of recreation economic value, fewer studies that provide only one estimate, and a handful of studies that provide many (greater than 20) estimates of value. Using a fixed-effects model to correct for intrastudy panel effects, or a random-effects model to correct for interpanel effects is one option. However, these options can add complexity to modeling and decrease degrees of freedom. Random-effects models assume the random error associated with each panel (e.g., primary study) is uncorrelated with other variables, for example region or valuation method. Past meta-analysis has also elected to use only one estimate per study or to average all estimates into one weighted estimate per study (Nelson and Kennedy 2009). However, this approach leaves a lot of information out of the meta-regression. Where individual studies publish multiple estimates, these estimates generally represent different activities at one site, different user groups at one or more sites, or the same activity at multiple sites.

Identification of panel effects or stratification within any panel data can be difficult. In this case, we use a simple correction to identify potential panel effects by publication. A cluster-robust covariance estimator with pooled ordinary least squares (OLS) corrects for potential nonindependence without requiring any assumptions about the error. Clustering covariances by activity, region, or document (individual publication) increased the standard error (SE) of some variables and decreased SE of others but made little difference in the significance of most variables. This indicates there may be some within-group correlation by region, activity, or even publication but not enough to prevent the use of OLS.

Meta-regression—

Ordinary least-squares linear regression is a widely used method for relating the distribution of a dependent variable, here the estimates of use value in the RUVD, with the variation in one or more independent variables. Conventional OLS assumes the dependent variable has similar variance across the range of independent variable values; observations of the dependent variable are independent from one another; and the explanatory variables have no linear relationship. The independent variables included in the model are described in table 6 and include aspects of survey methodology and site characteristics. Our OLS model uses a linear-linear

Table 6—Meta-regression analysis variables definitions

Variable name	Description
Dependent variable:	
Value	Consumer surplus per person per activity day (2016 dollars)
Sample characteristics variables:	
Nonresidents	= 1 if sample contains nonresident visitors only; = 0 otherwise
Residents[a]	= 1 if sample contains local resident visitors only; = 0 otherwise
Mixed residents/nonresidents	=1 if sample contains a mix of resident and nonresident visitors; = 0 otherwise
User sample	=1 if sample derived from user list (e.g., fishing/hunting license holders); = 0 otherwise
Onsite sample	=1 if visitors sampled on-site; = 0 otherwise
General population sample	=1 if sample derived from a general population (e.g., random sample of state residents); = 0 otherwise
Methodology variables:	
Revealed preference	=1 if revealed preference valuation method used; = 0 otherwise
Stated preference	=1 if stated preference valuation method; = 0 otherwise
Substitutes modeled	=1 if substitute sites included in valuation model; = 0 otherwise
Zonal travel cost	=1 if zonal travel cost method used; = 0 otherwise
Individual travel cost	=1 if individual travel cost method used; = 0 otherwise
Resource/site variables:	
Lake	=1 if value reported for a lake/reservoir environment; = 0 otherwise
Forest	= 1 if value reported for a forested environment; = 0 otherwise
Wetland	= 1 if value reported for a wetland environment; = 0 otherwise
River	= 1 if value reported for a river/stream environment; = 0 otherwise
Regional variables:	
Forest Service (FS) Region 1	= 1 if value reported for FS Region 1; = 0 otherwise
FS Region 2	= 1 if value reported for FS Region 2; = 0 otherwise
FS Region 3	= 1 if value reported for FS Region 3; = 0 otherwise
FS Region 4	= 1 if value reported for FS Region 4; = 0 otherwise
FS Region 5	= 1 if value reported for FS Region 5; = 0 otherwise
FS Region 6	= 1 if value reported for FS Region 6; = 0 otherwise
FS Region 8	= 1 if value reported for FS Region 8; = 0 otherwise
FS Region 9	= 1 if value reported for Forest Service Region 9; = 0 otherwise
FS Region 10	= 1 if value reported for FS Region 10; = 0 otherwise
National	= 1 if value reported for national level; = 0 otherwise
Multiple regions	= 1 if value reported for multiple FS Regions; = 0 otherwise

Table 6—Meta-regression analysis variables definitions (continued)

Variable name	Description
NVUM primary recreation activity variables	
Developed camping	= 1 if value reported for developed camping; = 0 otherwise
Backpacking	= 1 if value reported for backpacking; = 0 otherwise
Picnicking	= 1 if value reported for picnicking; = 0 otherwise
Nature related	= 1 if value reported for nature-related; = 0 otherwise
Cross-country skiing	= 1 if value reported for cross-country skiing; = 0 otherwise
Fishing	= 1 if value reported for fishing; = 0 otherwise
Hunting	= 1 if value reported for hunting; = 0 otherwise
Off-highway vehicle use/snowmobiling	= 1 if value reported for off-highway vehicle use use/snowmobiling; = 0 otherwise
Nonmotorized boating	= 1 if value reported for nonmotorized boating; = 0 otherwise
Motorized boating	= 1 if value reported for motorized boating; = 0 otherwise
Hiking	= 1 if value reported for hiking; = 0 otherwise
Biking	= 1 if value reported for biking; = 0 otherwise
Downhill skiing	= 1 if value reported for downhill skiing; = 0 otherwise
Other recreation activity	= 1 if value reported for other recreation activity; = 0 otherwise

Note: Omitted variables are bold.

NVUM = National Visitor Use Monitoring.

functional form to relate the dependent and independent variables as follows.

Equation: $$CS/Day = \sum \beta X_{ik} = \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots \beta_J X_{iK} + \varepsilon_i \quad (2)$$

where there are i estimates, j individual studies and k explanatory variables (k = 1…K) that explain consumer surplus per day (CS/Day). The meta-regression follows the simple equation above where i = 2,709, j =342, and K = 32, where regional and activity comprised 23 of the explanatory independent variables. All statistical analysis was performed in Stata (SE version 14).

Data coding and independent variable selection—

The RUVD includes a master coding sheet with 126 fields. The main coding categories include study, benefit measure, methodology specifics, activity, site characteristics, and user demographics. Table 6 lists and defines the variables from this pool that were included in the meta-regression. Most of the variables are qualitative dummy variables coded as 0 or 1, where 0 means the study does not have a characteristic and 1 means that it does. Independent variables were included in the optimized meta-regression if they were significant at an 80 percent level of confidence or better. A general-to-specific process was used, which began with the full specification of the model using all coded variables. Least significant variables were removed sequentially until remaining variables were significant at the 80 percent confidence level or better ($p \leq 0.20$). The choice of the minimum significance level is arbitrary, but it does reduce the risk of not detecting a difference even though Type I errors are increased at an equal rate. This optimization reduces overspecification of the model when retaining variables whose coefficients are not significantly different than zero. Regional and activity category variables were retained regardless of significance as the purpose of this meta-regression is to construct values for benefits transfer by region and activity, not to study the influence of region and activity on consumer surplus values. The results of this model are presented in table 7.

Outliers—

Outliers are a common occurrence in metadata (Nelson 2015) and the economic values within the RUVD vary widely. Outliers can become influential data points, affecting the meta-regression and weighted means in ways that cloud inference. Based on examination of the methods behind these outliers, and some reasonable assumptions about daily recreation economic values, consumer surplus per day estimates below $5 and above $500 were removed from the meta-analysis

Results—

Table 7 provides results of the meta-regression model fit to the data and used in constructing the values in table 3. The next section provides examples of how average values are constructed, with particular attention to treatment of the region and activity-specific variables. However, as noted elsewhere, the first eight variables, measuring partial effects of study methods and modeling assumptions, population, and site characteristics, are held constant at their mean values. In general, the model accounts for more than 20 percent of the observed variation in the benefit estimates, which is consistent with prior meta-analyses of recreation benefits (Rosenberger and Loomis 2001).

The meta-regression analyzes information on all studies in the database and relates independent variables of interest, such as activity, region, or survey methodology, to the dependent variable, estimated recreation benefit (measured as consumer surplus). Theoretically, when a variable helps explain the variation in recreation benefit measures, its regression coefficient will be significant in the model. Combining these significant variables in a multivariate model provides a transparent and consistent way to estimate average values based on a policy site's specific characteristics. Given the large sample size, the overall model performance has a grand mean—that is, the mean of the sample means—with ±2.5 percent margin of error. Thus, the meta-regression analysis model provides more robust estimates than an average value transfer (e.g., table 3 values).

Table 7–Optimized meta-analysis benefit-transfer model

Variable	Coefficient	Robust SE[a]	Mean of variable
Nonresidents	45.05[b]	9.94	0.07
User sample	22.25[b]	8.27	0.21
Revealed preference	28.06[b]	8.83	0.48
Substitutes modeled	-15.95[b]	6.25	0.25
Zonal travel cost	-47.78[b]	9.53	0.21
Lake	-23.15[b]	7.13	0.19
Forest	-11.84	8.85	0.16
Wetland	187.47[b]	8.87	0.01
Forest Service (FS) Region 1	15.50	11.87	0.04
FS Region 2	8.72	9.51	0.09
FS Region 3	16.80	12.53	0.07
FS Region 4	18.72	12.96	0.09
FS Region 5	2.55	12.04	0.04
FS Region 6	9.06	12.65	0.06
FS Region 8	8.52	8.74	0.19
FS Region 9	-2.98	8.59	0.31
FS Region 10	41.01	22.87	0.03
National	19.92	13.13	0.03
Developed camping	-29.39[b]	10.22	0.02
Backpacking	-31.85[b]	10.63	0.03
Picnicking	-15.83[b]	7.90	0.01
Nature related	-4.87	9.02	0.16
Cross-country skiing	-8.48	9.96	0.01
Fishing	6.51	9.00	0.34
Hunting	12.41	10.10	0.23
Off-highway vehicle use/snowmobiling	-14.55	13.45	0.02
Nonmotorized boating	43.92	30.99	0.03
Motorized boating	-6.63	16.15	0.03
Hiking	19.45	12.63	0.04
Biking	21.74	27.72	0.01
Downhill skiing	17.22	35.75	0.01
Constant	54.77[b]	12.89	1

Summary statistics: N = 2,709, adjusted $R^2 = 0.20$, Root mean squared error = 61.44.

[a] Cluster robust standard error computed in Stata 14.1 using individual study as cluster (n = 342).

[b] Variable is statistically significant at the $p < 0.05$ level or better. Overall margin of error is ±2.5 percent.

Also keep in mind that many qualitative variables reflecting other attributes of the study, site and resource, methods, and values estimates do not exceed the 80 percent significance threshold when specifying the meta-regression model. Empirically these variables are not related to variations in consumer surplus for this set of data, but they may be theoretically significant. Unfortunately, retaining all variables would result in increased multicollinearity and overspecification of the model. Please keep this in mind when conducting single-study transfers where assessing the degree of similarity between sites depends greatly on their characteristics regardless of their significance in the meta-regression model.

Total aggregate benefits are likely greater for locals than nonlocals.

The estimated parameters show the partial effect of each variable on the variation in the dependent variable—value per person per day. For example, people who travel greater distances (nonresidents) from home to recreation sites have higher values, ceteris paribus, than local residents. However, the total aggregate benefits to local residents are likely higher owing to the ability to visit more often at lower overall cost, but people who generally travel greater distances have selected their destination over other sites and activities that are generally closer to home. Also along this same line of reasoning, studies that incorporate substitute sites (substitutes modeled) generally produce lower estimated values, ceteris paribus, as economic theory would expect (see Loomis and Walsh 1997, Rosenthal 1987).

Additional detail and application—

The meta-analysis function is used to construct values by holding all independent or explanatory variables constant at their mean values (last column, table 7), except for the relevant regional and activity variables. These effects are weighted by their mean values—each variable's coefficient is multiplied by its weight, providing the partial consumer surplus owing to that variable. These partial values are then summed along with the constant (intercept) to construct values. To construct estimates for a particular region, that region's variable would be equal to 1, and the full value of its coefficient would be summed into the constructed value.

This procedure is illustrated in the examples presented in table 8 where we calculate the average value of a day of hiking in California (FS Region 5 [Pacific Southwest Region]) and a day of camping in Georgia (FS Region 8 [Southern Region]). The example predictions in table 8 may look simplistic—this is because we have averaged out the many other nonregion and nonactivity variables in the model. However, note that the data behind the meta-analysis is not all specific to hiking or camping, or California or Georgia. Therefore, each of the constructed average values is an estimate for a generic activity similar to hiking in California or to camping in Georgia. There is often a direct correlation between the degree of specificity in the constructed value and the overall representation of a variable

Table 8—Example adaptation of meta-analysis benefit function

		Hiking in California		Camping in Georgia	
Variable	**Coefficient**	**Adaption value**	**Partial CS**	**Adaption value**	**Partial CS**
FS Region 1	15.50	0	0	0	0
FS Region 2	8.72	0	0	0	0
FS Region 3	16.80	0	0	0	0
FS Region 4	18.72	0	0	0	0
FS Region 5	2.55	1	2.55	0	0
FS Region 6	9.06	0	0	0	0
FS Region 8	8.52	0	0	1	8.52
FS Region 9	-2.98	0	0	0	0
FS Region 10	41.01	0	0	0	0
Developed camping	-29.39	0	0	1	-29.39
Backpacking	-31.85	0	0	0	0
Picnicking	-15.83	0	0	0	0
Nature related	-4.87	0	0	0	0
Cross-country skiing	-8.48	0	0	0	0
Fishing	6.51	0	0	0	0
Hunting	12.41	0	0	0	0
OHV use/snowmobiling	-14.55	0	0	0	0
Nonmotorized boating	43.92	0	0	0	0
Motorized boating	-6.63	0	0	0	0
Hiking	19.45	1	19.45	0	0
Biking	21.74	0	0	0	0
Downhill skiing	17.22	0	0	0	0
Constant	54.77	1	54.77	1	54.77
Net of all other variables	NA	NA	1.17	NA	1.17
Total			$77.94		$35.07

CS = consumer surplus, FS = Forest Service, NA = not applicable, and OHV = off-highway vehicle.

in the database. This is due to the statistically discovered variability across these activities, or lack thereof. For example, there are 111 estimates for hiking and 82 estimates for camping included in the database, not all of which are in Region 5 or Region 8. Therefore, the constructed averages take into account the distribution of all values for hiking or camping relative to all values for Regions 5 and 8. These example applications illustrate the degree to which these constructed values are generic estimates when holding everything in the model constant except for region and activity.

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Trails

Hoosier National Forest

FS- R9-017 - 12/2016

Welcome to the Hoosier National Forest trail system. Over 260 miles of trails are available for your hiking, biking, or horse riding pleasure. The following table and Forest map found on the reverse side provide a brief description and general location of trail systems found on the Hoosier National Forest.

Etiquette and Rules

Horse riders and mountain bikers 17 years of age and older are required to have a permit. All riders must stay on trails designated for their use. Annual ($35/year) and day-use ($5/day) permits are available from our offices and several local vendors.

Please observe the following trail courtesy:
- Mountain bikers yield to horse riders & hikers.
- Hikers yield to horse riders.
- Horse riders control your horse.

Motorized travel on trails is not permitted. Check with the Hoosier National Forest for more details on rules and regulations.

Safety

Be aware of hunting seasons. Blaze orange clothing is recommended (do not wear white) during deer season.

Park your vehicle off the roadway in a visable area if a parking lot is not available where you wish to access.

Many trails intersect roadways. If you choose to use a road as part of your trip, be mindful of traffic.

For More Information

Additional free information is available for these trails. A topographic map delineating most of these trail systems sells for $12.79 (includes tax). For specific information contact us:

Hoosier National Forest
811 Constitution Avenue
Bedford, IN 47421
(812) 275-5987

Tell City Ranger District
248 15th Street
Tell City, IN 47586
812-547-7051

Toll Free: 1-866-302-4173
www.fs.usda.gov/hoosier

Federal Relay Number: 1-800-877-8339

Trail Name	Use Type	Approx. Miles	Map Key
Birdseye	Multiple-use*	11.6	1
Brown County D	Multiple-use	2.2	2
Buzzard Roost	Hike	0.5	3
Celina Interpretive	Hike	0.8	4
Fork Ridge	Hike	3.5	5
German Ridge	Multiple-use	22.0	6
German Ridge Lake	Hike	2.1	7
Hardin Ridge	Hike/bike	2.1	8
Hemlock Cliffs	Hike	1.4	9
Hickory Ridge	Multiple-use	45.1	10
Lick Creek	Multiple-use	7.7	11
Mogan Ridge West	Mutliple-use	11.5	12
Mogan Ridge East	Hike	6.4	13
Nebo Ridge	Multiple-use	8.3	14
Oriole West	Multiple-use	7.6	16
Oriole East	Multiple-use	6.0	17
Pate Hollow	Hike	6.9	18
Pioneer Mothers	Hike	1.3	19
Saddle Lake	Hike	2.2	20
Shirley Creek	Multiple-use	16.9	21
Springs Valley	Multiple-use	12.0	22
Tipsaw	Hike/bike	6.5	23
Ted T. Turtle	Hike	0.9	24
Two Lakes Loop	Hike	14.9	25
Wilderness West	Horse/hike	33.7	26
Wilderness Sycamore	Hike	4.7	27
Youngs Creek	Multiple-use	12.6	28

* Multiple-use indicates the trail is available for use by hikers, mountain bikers, and horse riders.

Forest Service

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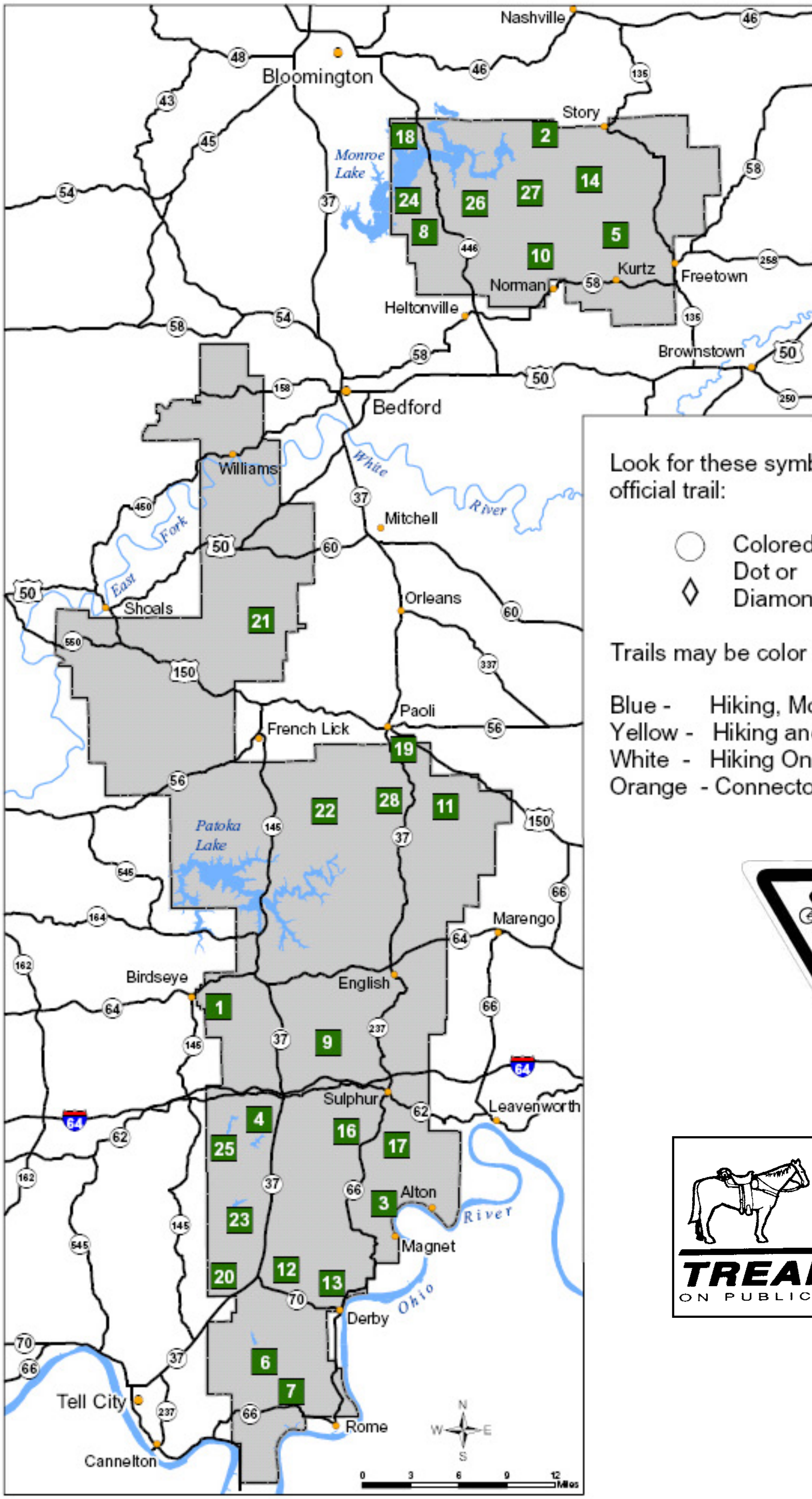

Large print copy available

Look for these symbols to be sure you are on an official trail:

Colored Dot or Diamond

Post with decals

Trails may be color coded to indicate use type:

Blue - Hiking, Mountain Bike, and Horse Riding
Yellow - Hiking and Mountain Biking Only
White - Hiking Only
Orange - Connector Trail

TREAD LIGHTLY!
ON PUBLIC AND PRIVATE LAND

United States Department of Agriculture

U.S. Forest Service
National Visitor Use Monitoring Survey Results
National Summary Report

Data collected FY 2016 through FY 2020

Contents

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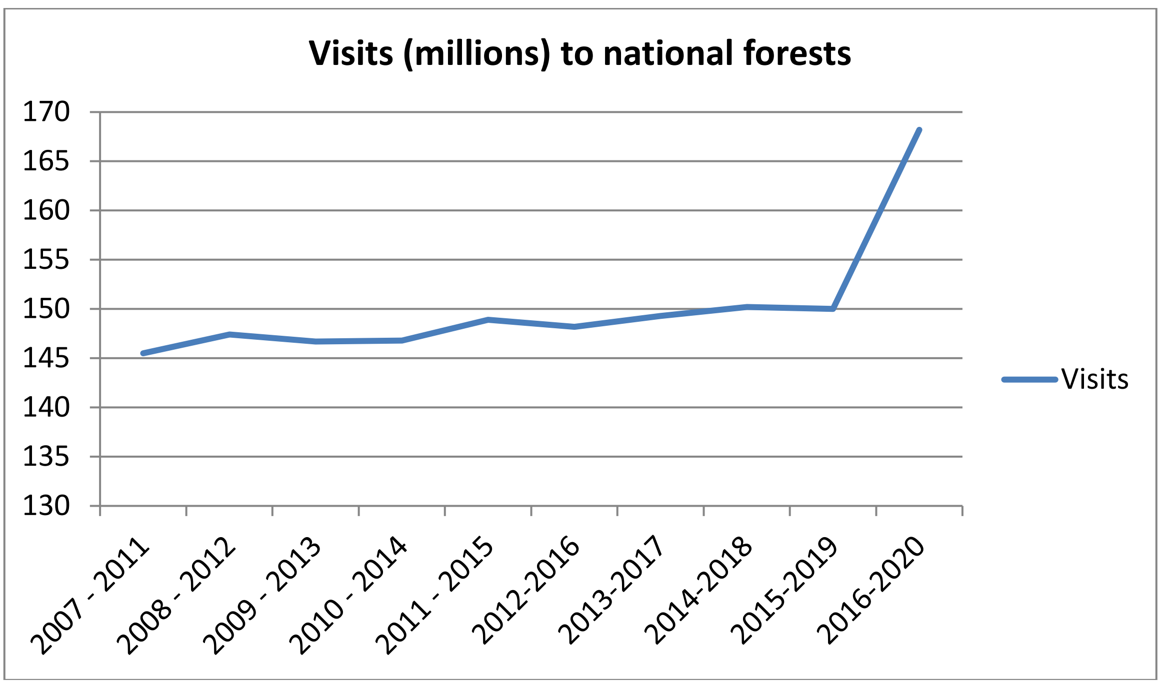
EXECUTIVE SUMMARY

The U.S. Forest Service develops estimates of the volume of recreation use on national forests through the National Visitor Use Monitoring program. Onsite surveys are a key part of the process. These surveys help show the characteristics of recreation-related visits to national forests and the benefits recreation brings to Americans.

Completed in five-year cycles, the National Visitor Use Monitoring results help the Forest Service manage recreational resources in such a way that best meets the needs of visitors while maintaining the quality of the natural resources. Baseline data for examining long-term trends started in 2005. Although trend information is not yet available, the results do provide a snapshot of annual forest visitation.

Results in this report reflect the most recent field data on each national forest and includes FY2016 to FY 2020. We estimate there were about 168 million recreation visits to national forests[1]. That figure reflects a significant change in visitation that resulted from the COVID19 pandemic. Both dispersed settings experienced large increases in daily visitation in the latter part of FY2020 as Americans sought outdoor experiences in socially distanced settings on national forests and grasslands. Estimates for the last ten years are shown below:



The agency also estimates an additional 300 million occasions where people traveled on the 138 scenic byways and other similar routes near, on or through national forests for the purpose of viewing scenery on national forests.

[1] Visitation estimates for forest units surveyed in FY2016-2019 were adjusted to account for the effects of the COVID19 pandemic. For forests surveyed in FY2020, we compared results for visitation data in the last half of the year to results for the last half of FY2015. After adjusting for normal growth rates, the remaining increases or decreases were assumed to represent the effects of the pandemic. The rates of change were applied to forest units not sampled in FY2020, under the assumption that the observed changes happened on all forest units. A similar process will likely be applied for the next several years.

Why people choose to recreate on national forests varies, but most said they do so to improve their physical, psychological and/or spiritual wellbeing. Their chosen activities vary widely, both in character and location. Some relax as they view natural features or wildlife from the roadside, whereas others pursue solitude as they hike in the remote backcountry. Some engage in off highway vehicle use. Others enjoy water-based recreation, hunt, or camp.

The two most common primary recreational activities are hiking/walking and downhill skiing. Just over sixty percent of visitors engage in a primary activity that is physically active, which contribute significantly to the American public's efforts to stay healthy.

The characteristics of recreation visitors are as diverse as their chosen activities.

- About 38 percent of visits to national forests and 42 percent of visits to Wilderness areas are made by females.
- Children under the age of 16 account for about one out of every six visits to national forests.
- All income classes are represented in the recreating public.
- Over half of visits to national forests come from people who live within 50 miles of the forest they visited, while about one-fifth traveled more than 200 miles.
- Many visits – about 58 percent – are by people who visit that forest fewer than 10 times per year.
- Over 15 percent of visits are from people who come back more than 50 times each year.

Our visitors said their visits to national forests and grasslands make them happy:

- 95 percent of visitors are satisfied with their overall experiences, including more than 80 percent who report being very satisfied.
- More than 95 percent are satisfied with their feeling of safety.
- Less than 5 percent reported being dissatisfied with the value received for any fees paid in connection with their visit.

Visitors to national forests and grasslands give back in terms of economic vitality of the nation, especially for rural communities. Annual spending by recreation visitors in areas near national forests and grasslands was about $10 billion in FY2019. Visitors who live more than 50 miles from a forest or grassland account for about half of that total. As visitor spending ripples through the U.S. economy, over $12 billion is reflected in the nation's gross domestic product and sustains about 154,000 full- and part-time jobs.

The survey data highlights the contribution of forest-based recreation in connecting the American people to their natural and cultural heritage, an important element of the Forest Service Recreation Strategy. Such connections are critical to the cultivation of a conservation ethic and sense of resource stewardship among Americans. Recreation also directly facilitates the improvement of American health, a priority in both the Recreation Strategy and among Forest Service leadership. This report also emphasizes the importance of recreation in the creation of rural wealth and vibrant rural economies.

METHODOLOGY AND USE

The National Visitor Use Monitoring program provides estimates of the volume and characteristics of recreation visitation on National Forest System lands. The National Forest System is an area of the agency that oversees 154 national forests and grasslands on 193 million acres of public lands.

Information about the quantity and quality of recreation visits is required for national forest plans; Executive Order 12862, Setting Customer Service Standards; and implementation of the National Recreation Agenda. The agency's Strategic and Annual Performance Plans require the measurement of user satisfaction and use level.

The National Visitor Use Monitoring Program ensures that all visitor statistics for national forests and grasslands produced by the Forest Service use a standardized measure. These standards were originally established by the agency in the 1970s. However, application of those standards is now under stricter protocols. For example, in order to count as a recreation visitor, that person must be physically recreating on Forest Service-managed lands and not merely passing through, stopping to use a facility or viewing a national forest or grassland from a non-Forest Service managed road.

Background and Methods

Results in this report are derived by adding the results from the most recent survey fieldwork for each national forest and grassland. The results included here are from field work completed from FY2016 to FY2020. Each forest is sampled once in five years. That means that in any given year, around 24 forests are engaged in field data collection. Those forests that completed their survey work in 2020 were updating visitation estimates from 2015. This report represents an iteration of the survey process, or a snapshot of the most current visitation patterns and activities on lands managed by the agency.

The basic methodology is explained in detail in Forest Service National Visitor Use Monitoring Process: Research Method Documentation. In essence, visitation is estimated through a combination of exiting traffic counts and surveys of visitors leaving a national forest or grassland. Both are obtained from random locations and days on a national forest or grassland over a period of one year.

Recreation visitors who are surveyed are asked about the length of their visit, activities they participated in while on a national forest or grassland, information about themselves such as where they are from, their age, ethnicity and other information, the distance they traveled, how often they visit and their overall satisfaction. About one-third also were asked a series of detailed satisfaction questions about specific aspects of their visit. Another one-third of visitors were asked to provide information about their income, spending while on their trip, and the next best substitute for the visit.

Adjustments for COVID-19 pandemic. Typically, results from a given sampling effort on any forests are assumed to be valid for 5 years, until the next iteration of NVUM. However, the widespread and major effects of the pandemic led to a shift in the process. Changes in traffic volume and/or proxy counts observed in the last half of FY2020 compared to the last half of FY2015 were assumed to represent the effects of the pandemic. Those changes were projected to corresponding sampling strata on all other forest units. Across most of the country, face-to-face interviewing of exiting visitors was suspended for the last half of FY2020. Individual characteristics from the last half of Fy2015 were assumed to be sufficiently accurate. Responses were reweighted to Fy2020 visitation levels and incorporated into the analysis. Both visitation totals and visitor characteristics reported here take these adjustments into account.

Satisfaction measures

Survey participants were asked to provide an overall rating of their recreation experiences on a 5-point Likert scale. A Likert scale is a numerical measurement of a respondent's level of agreement with a provided statement. About one-third of visitors were asked to rate their satisfaction with and the importance of fourteen items related to the recreation facilities and services at the site or area at which they recreated. The Likert scale for importance ranges from not important to very important. The Likert scale for performance (satisfaction) ranges from very dissatisfied to very satisfied. Results are summarized by site type:

- day use developed
- overnight use developed
- undeveloped general forest, and
- Wilderness

The satisfaction responses are analyzed and reported in several ways.

1. A graph of overall satisfaction is presented in Figure 5.

2. There are two aggregate measures:

    - Percent Satisfied Index is the proportion of all ratings for 14 items in each category in which the satisfaction was denoted as either "Somewhat satisfied" or "Very Satisfied." The Agency's national target for this measure is 85 percent. Table 11 displays the aggregate scores.
    - Percent Meets Expectations aggregate measures the proportion of satisfaction ratings that are equal to or greater than the importance rating for a given item. This indicator tracks the similarity between the Agency's performance and customer evaluations of importance. Figure 6 displays these scores.

    The satisfaction elements most readily controlled by managers were aggregated into four categories:

    - developed facilities
    - access
    - services
    - visitor safety

    The site types sampled were aggregated into three groups:

    - developed sites, which includes day use and overnight developed sites
    - undeveloped areas
    - Wilderness

3. Importance-Performance Analysis was calculated for the mean values of the importance and satisfaction scores. A target level of importance and performance divides the possible set of score pairs into four quadrants. In the context of the recreation visitor survey, the target level for each of the 14 satisfaction items was a numerical average score of 4.0. The quadrant titles help to interpret each score and can provide general guidance for management. The quadrants definitions are:

    - Importance at or above 4.0, Satisfaction at or above 4.0: **Keep up the good work**. These are functions that are important to visitors and which the agency is performing quite well.
    - Importance at or above 4.0, Satisfaction under 4.0: **Concentrate here**. These are functions that are highly important to the public, but performance is not at a satisfactory level. Increasing effort here is likely to have the greatest payoff in overall customer satisfaction.
    - Importance below 4.0, Satisfaction above 4.0: **Possible overkill**. These are functions that are not of the highest importance to visitors but performance is quite good. It may be possible to reduce effort here without greatly harming overall customer satisfaction.
    - Importance below 4.0; Satisfaction below 4.0: **Low priority**. These are functions where performance is not at high levels, but neither are the importance ratings. Focusing effort here is unlikely to have as great an impact on overall satisfaction.

    The numerical scores for visitor satisfaction and importance for each of the satisfaction items by site type are presented in Appendix A (Tables A1 – A4). Special attention should be paid to the numeric scores in the Appendix in reviewing and evaluating the Importance-Performance Analysis results for each item. Particular emphasis should be placed on those ratings that are close to but slightly below the 4.0 value, which separates the four quadrants. For these, the distribution of responses as well as the average rating should be reviewed, as the average value could be affected by a relatively small set of very low ratings.

Visitors rated their perception of how crowded the recreation site or area felt to them. Perceptions take into account the type of site and visitors' expectations. Ratings ranged from 1 (hardly anyone there) to 10 (overcrowded).

Spending and Economic Contributions

Spending by visitors has important effects to the health of forest-depended economies and supports thousands of jobs in communities near NFS lands. To estimate total spending associated with recreation visits this information is collected:

- overall visitation estimate
- proportion of visits in each of a series of visitor types
- average spending total for each of the respective visitor types.

Multiplying these three variables gives the total amount of spending by each type of visitor. Summing over all visitor types gives total spending associated with recreation on national forests and grasslands.

One-third of the visitor surveys included questions about trip-related spending made within 50 miles of the site visited. Dr. Eric White of the U.S. Forest Service Pacific Northwest Research Station developed a typology of visitor types and average spending amounts for each. The spending that occurs on a recreation trip is greatly influenced by the type of trip taken. Visitors on overnight trips away from home pay for some form of lodging, such as hotel rooms or campground fees, while day-trip visitors do not. Visitors on overnight trips also generally purchase more food during their trip in restaurants or grocery stores than visitors on day trips. Visitors who are close to home usually spend less than visitors traveling longer distances, especially on items such as fuel and food.

Analysis of spending patterns has shown that segments of the visitor market with consistent spending patterns are:

- local visitors on day trips
- local visitors on overnight trips staying on the national forest
- local visitors on overnight trips staying off the national forest
- non-local visitors on day trips
- non-local visitors on overnight trips staying on the national forest
- non-local visitors on overnight trips staying off the national forest
- non-primary visitors

In addition, these surveys included questions about household income and what the individual considered to be the most likely substitute for their visit to the forest. National results for the most up to date economic contribution measures available are presented here. In general, the most current economic data lags the visitation estimate by a year or two, as it takes time to assemble and validate the economic model and the interindustry and institutional relationships that it represents. Greater detail on the contribution of visitor spending to economic regions around individual National Forest units is available at the National Forest Recreation Economic Contributions website.

Terms Used in this Report

National forest visit: one person participating in one or more recreation activities on a national forest or grassland for an unspecified period of time. A national forest visit can be composed of multiple site visits.

Site visit: one person participating in one or more recreation activities at a particular national forest or grassland site or area for an unspecified period of time.

Confidence interval: a range of values that is likely to include an unknown population value, where the range is calculated from a given set of sample data. Confidence intervals are always accompanied by a confidence level

Confidence level: tells the degree of certainty that the value lies in the interval. Used together, confidence interval and confidence level define the reliability of the estimate by defining the range of values that are needed to reach the given confidence level. For example, the current national visitation estimate is 149.9 million visits, with a 90 percent confidence interval of 2.7 percent. In other words, given the data, our best estimate is 149.9 million visits, and we are 90 percent certain that the true number is between 146 million and 154 million.

Local visitors: travel less than 50 road miles from home to the recreation site

Non-local visitors: travel greater than 50 road miles

Non-primary visitors: have a primary trip purpose that is something other than recreating on the national forest – it could be to some other recreation destination, or for some reason other than recreation.

Average: values for visit characteristics are calculated by expanding the sample of recreation contacts to the population of national forest visits. On some tables **median** values (the value of the 50^{th} percentile) are also provided, because the averages can be greatly influenced by a few large values.

Using this Report

While the National Visitor Use Monitoring program provides a national standard for measuring recreation visitor use, it currently cannot be used to identify trends or make assumptions about changing use patterns:

- Trend analysis is typically based on four or more data points from the same location. No forest or grassland has yet gone through the survey process that many times.
- Results presented here reflect forest-level data collected during the period FY2016 through FY2020, with an adjustment for the first 4 years' of data to account for the widespread and pervasive effects of the Covid-19 pandemic. The national results summarize the data for all reporting units.

The results do provide a good snapshot representation of the characteristics of visitors, their visitation patterns, activities, satisfactions, expectations, and the benefits they bring to communities surrounding national forests.

This report has been written and formatted for a diverse audience. Readers who are interested in accessing the data utilized here can double click the figures throughout the report (in MS Word) to view a table of the data. More results from the National Visitor Use Monitoring program including results for individual reporting units are available at USDA Forest Service National Visitor Use Monitoring

Forest Service Use of Visitor Data

Results from the National Visitor Use Monitoring Program are used for a number of purposes:

- To report the best current estimate of visitation to national forests and wilderness areas, including the proportion of visits that come from targeted demographic groups, including children and minorities.
- To provide a sense of the recreation niche for individual national forests and their unique contributions to the set of outdoor recreation opportunities available to the public.
- To measure the contribution the Forest Service makes to the health of the American public through participation in active outdoor pursuits.
- To provide guidance for how to maintain and improve the set of recreation opportunities the Agency provides.
- To document the contribution that Forest Service recreation visitation makes to the economic well-being of both forest-dependent communities and the Nation.

Visitation Estimates

Table 1a displays the number of annual national forest visits and national forest site visits for the entire National Forest System estimated for FY2020. The site visit estimate includes visits to Wilderness areas. Table 1b shows the estimates for visitation since FY2016. Table 2 shows the number of national forest and Wilderness visits in each Forest Service region. The current annual visitation estimate is just about 168 million national forest visits. The 90 percent confidence interval for that estimate ranges from 164.5 million to just under 172 million. In 2020, we estimate Wilderness accounted for slightly less than 17 million recreational visits annually, compared to its normal range of around 9 million. The increase is a result of peoples' desires to be outdoors in uncrowded, natural settings during the COVID pandemic.

Most people (84 percent) who recreate on a particular national forest describe recreating on that forest as their primary destination for the trip away from home (Figure 1). That is, the recreation opportunities provided on land managed by the Agency were the main reason these visitors decided to make a trip away from home. The rest were people making a side trip to recreate on the national forest during a trip where the primary trip purpose was recreating elsewhere or some other, non-recreation, purpose.

Table 1a. Overall annual visitation estimate for the National Forest System, for FY2019.

Visit type	Visits (Thousands)	90 Percent Confidence Interval Width (Percent)	90 Percent Confidence Interval Range (Thousands Of Visits)
Total Estimated Site Visits	219,703	2.0	215,309 – 224,097
Designated Wilderness Visits[a]	16,045	3.6	15,467 – 16,623
Total Estimated National Forest Visits	168,244	2.7	164,543 – 171,945

[a] Designated Wilderness visits are included in the Site Visits estimate.

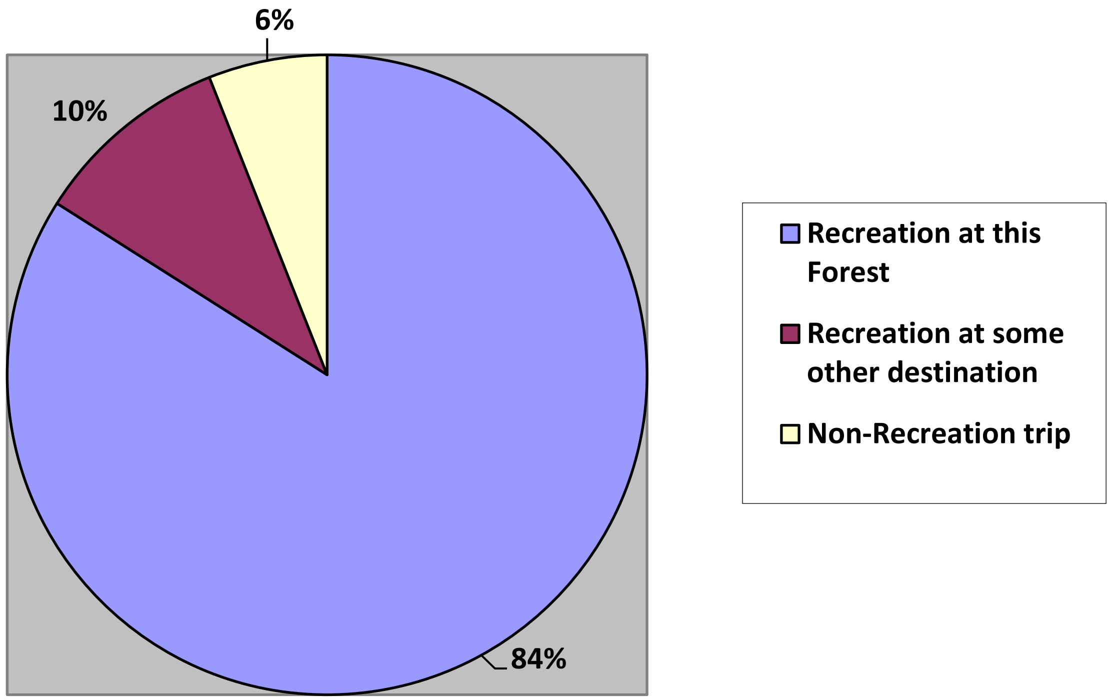
Table 1b. National visitation estimate (in thousands) for the National Forest System, in recent years.

Visit type	FY2012-FY2016	FY2013-FY2017	FY2014-FY2018	FY2015-FY2019	FY2016-FY2020
Day Use Developed Sites	72,656	75,425	76,830	77,420	74,855
Overnight Use Developed Sites	13,242	13,838	14,057	14,228	12,900
General Forest Areas	90,584	90,277	91,807	93,227	115,902
Wilderness	8,977	8,777	8,884	8,981	16,045
Total Site Visits	185,458	188,317	191,578	193,857	219,703
National Forest Visits	148,217	149,268	150,195	149,960	168,244

Table 2. Regional annual visitation estimates for the National Forest System, for FY2016 - FY2020**.**

Region	National Forest Visits (1000s)	90 Percent Confidence Interval, As Percent Of Visits	Wilderness Visits (1000s)	90 Percent Confidence Interval, As Percent Of Visits
01: Northern	11,073	4.8	1,206	7.2
02: Rocky Mountain	32,396	7.3	3,133	8.4
03: Southwestern	16,664	5.1	2,357	12.5
04: Intermountain	22,981	5.6	1,777	10.4
05: Pacific Southwest	24,749	4.7	2,539	6.6
06: Pacific Northwest	20,440	4.8	2,138	9.9
08: Southern	23,919	6.6	1,886	11.6
09: Eastern	13,092	6.5	932	10.8
10: Alaska	2,930	5.1	77	13.5
TOTAL	**168,244**	**2.0**	**16,045**	**3.6**

Figure 1. Purpose of Trip for FY2016 - FY2020.



DESCRIPTION OF THE RECREATION VISIT

Demographics

Demographic characteristics provide an overall picture of the customer base for national forest recreation. Table 3 shows the percentage of visits by men and women. Table 4 presents the racial and ethnic distribution of visits, and Table 5 shows the age distribution. A large proportion of national forest visits and visits to designated wilderness come from people who live nearby (Figure 3). Foreign visitors are not overly common (Table 6); Europeans and Canadians each account for a little more than one-third of all foreign visits.

Table 3. Percent of national forest and wilderness visits by gender, for FY2016 - FY2020**.**

Gender	National Forest Visits (Percent)	Wilderness Visits (Percent)
Female	38.3	42.0
Male	61.7	58.0
Total	100.0	100.0

Table 4. Percent of national forest and wilderness visits by race and ethnicity, for FY2016 - FY2020.

Race/Ethnicity [a]	National Forest Visits (Percent)	Wilderness Visits (Percent)
American Indian/Alaska Native	2.0	1.8
Asian	3.0	4.3
Black/African American	1.2	0.9
Native Hawaiian or other Pacific Islander	0.6	0.6
White	95.2	94.4
Spanish, Hispanic, or Latino	6.9	6.0

[a]"Spanish, Hispanic or Latino" is presented in a separate question because it is an ethnicity, not a race. Respondents first stated whether they were of this ethnicity, then a separate question asked which of the racial categories applied to them. Respondents could choose more than one racial group.

Table 5. Percent of national forest and wilderness visits by age class, for FY2016 - FY2020.

Age	National Forest Visits (Percent)	Wilderness Visits (Percent)
Under 16	16.7	11.0
16-19	3.3	3.4
20-29	14.6	19.8
30-39	16.4	18.4
40-49	15.2	14.7
50-59	15.1	15.2
60-69	13.3	13.5
70 and over	5.4	4.0
Total	**100.0**	**100.0**

Figure 2. Distribution of national forest and Wilderness visits by age group.

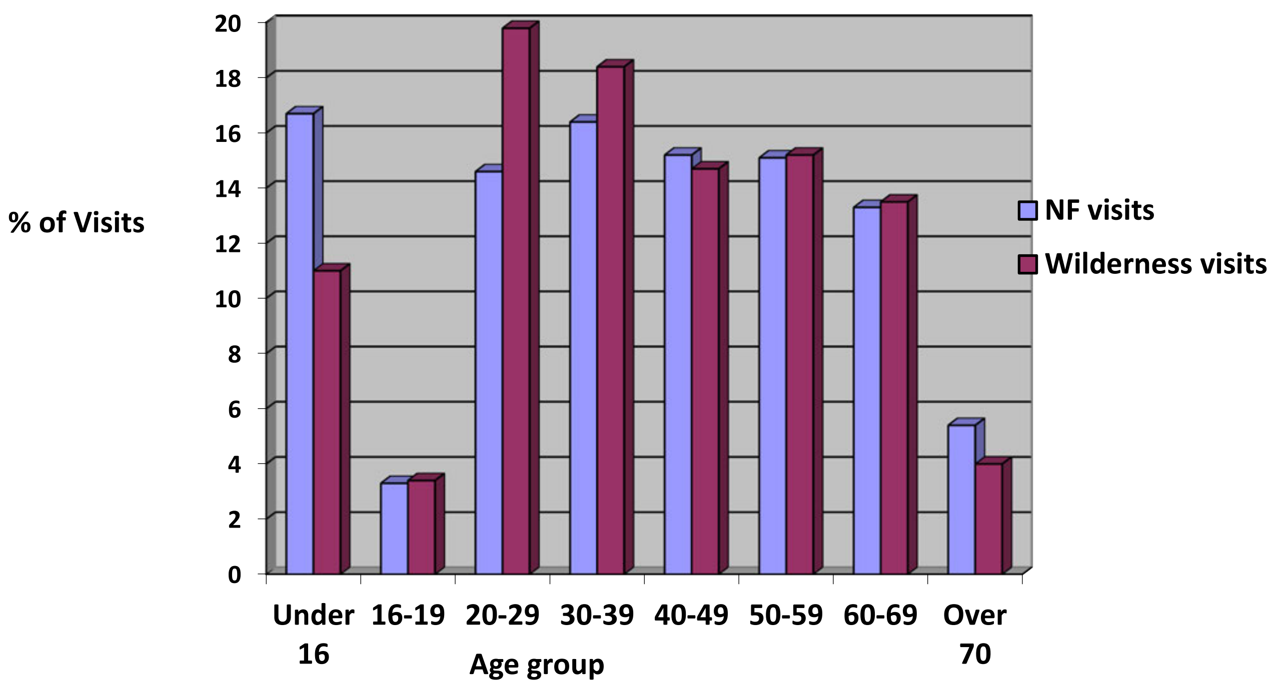


Figure 3. Distribution of national forest visits by travel distance categories, for FY2016 - FY2020.

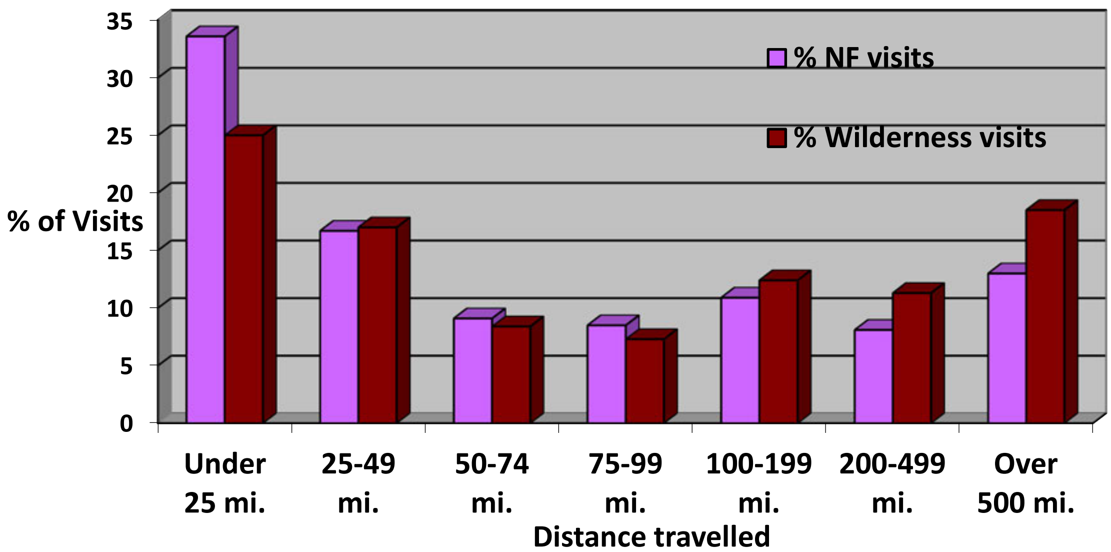


Table 6. Percent of national forest visits by origin for foreign visitors, for FY2016 - FY2020.

Origin	% National Forest Visits
Asia	0.1
Canada	0.6
Europe	0.7
Mexico	0.1
South America	0.0
Some other origin	0.3

Visit Descriptions

Characteristics of the recreation visit such as length of visit, types of sites visited, activity participation and visitor satisfaction with forest facilities are of interest to a variety of stakeholders. Short visits to national forests and wilderness areas are typical (Table 7) and the great majority of visitors to national forests only go to one location on the forest during their visit (Table 8). However, some visitors do go to more than one recreation site or area. Often, these are the people who stay for a relatively long time and visit several different locations. Visitors were asked how often they visit a given national forest for all recreational activities, and how often for their primary activity (Table 9). Most visits are made by people who visit the forest on which they were surveyed only a few times per year Most of the people who visit frequently live close to the national forest they visit.

Table 7. Visit duration for national forest visits, for FY2016 - FY2020.

Visit Type	Average Duration (hours)	Median Duration (hours)
Site Visit	8.7	2.8
Day Use Developed	2.6	2.1
Overnight Use Developed	45.2	39.8
Undeveloped Areas	8.1	2.9
Designated Wilderness	11.5	3.3
National Forest Visit	14.5	3.7

Figure 4. Distribution of national forest and wilderness visits by duration categories, for FY2016 - FY2020.

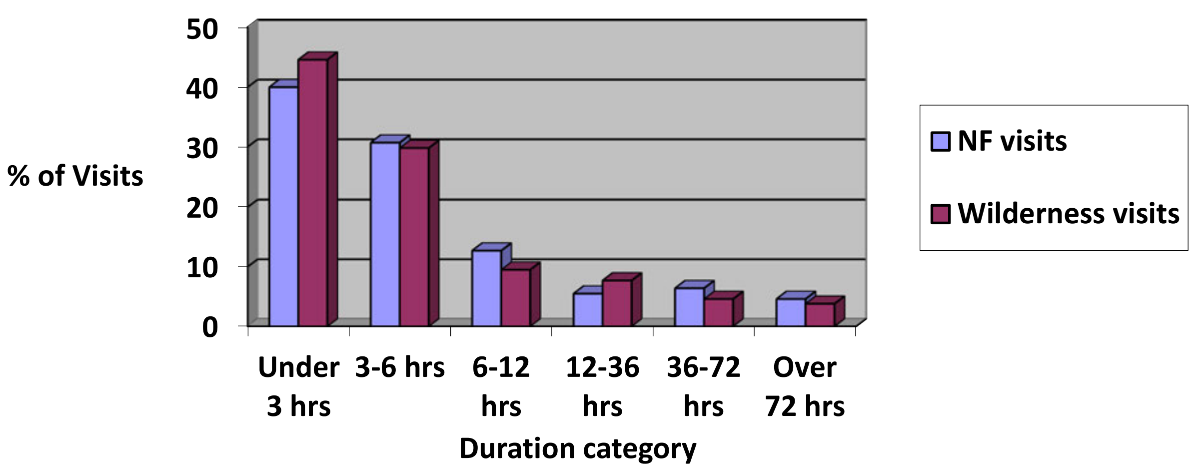


Table 8. Other visit characteristics for national forest recreation visits, for FY2016 - FY2020.

Characteristic	Percent
Percent of recreational visitors who visit just one national forest site during their entire national forest visit	90.8
Average number of national forest sites visited during each national forest visit	1.1
Average group size	2.4

Table 9. Percent of national forest visits by annual visit frequency, for FY2016 - FY2020.

Number of reported annual visits	For All activities	For Just Primary Activity
1 – 5 times per year	47.7	55.8
6 – 10 times per year	10.7	11.7
11 – 15 times per year	6.4	6.2
16 – 20 times per year	5.0	4.7
21 – 25 times per year	3.0	2.5
26 – 30 times per year	3.6	2.9
31 – 35 times per year	0.6	0.7
36 – 40 times per year	2.2	2.0
41 – 50 times per year	5.0	3.5
51 – 100 times per year	7.5	5.3
101 – 200 times per year	5.1	3.0
201 – 300 times per year	2.0	1.0
Over 300 times per year	1.2	0.6

Activities

Most national forest visitors participate in several recreation activities during each visit. However, nearly all can identify a single primary activity on the visit. A small portion list more than one primary activity; a few do not specify any primary activity. Visitors were asked how many hours they spent doing their primary activity (Table 10).

Recreation on national forests also contributes to the overall health of those who visit. Around 60 percent of visits come primarily to engage in a physically active pursuit. On average, these people spend a little less than 5 hours per visit participating in their primary activity.

Table 10. Activity participation for national forest recreation visits, for FY2016 - FY2020.

Activity	% Percent Of Visitors Who Participated In This Activity[a]	% Indicating As Their Primary Activity[b]	Average Hours Spent In Primary Activity[c]
Developed Camping	7.5	3.2	39.9
Primitive Camping	2.8	0.7	36.0
Resort Use	1.5	0.2	36.9
Nature Center Activities	5.8	0.4	1.9
Nature Study	5.5	0.3	4.1
Viewing Wildlife	29.3	1.5	3.7
Viewing Natural Features	44.4	11.7	2.8
Visiting Historic or Prehistoric Sites	5.0	0.3	3.5
Relaxing, Hanging out, Escaping Heat or noise	32.1	4.8	13.1
Picnicking	9.2	1.3	6.5
OHV Use	3.0	1.2	6.1
Motorized Trail Activity	3.1	1.3	5.6
Snowmobiling	1.6	1.4	4.3
Driving for Pleasure	19.7	4.4	3.0
Motorized Water Activities	2.2	0.9	9.6
Other Motorized Activity	0.3	0.1	5.3
Fishing*	9.9	5.9	5.9
Hunting*	4.9	4.2	11.8
Gathering Forest Products*	3.3	0.9	3.5
Hiking / Walking*	48.8	26.8	3.2
Backpacking*	2.1	0.9	31.9
Horseback Riding*	0.7	0.4	5.9
Bicycling*	5.0	3.4	2.7
Downhill Skiing / Snowboarding*	13.5	12.8	4.4
Cross-country Skiing / Snowshoeing*	3.9	3.3	2.8
Non-motorized Water*	3.5	1.9	5.0

Activity	% Percent Of Visitors Who Participated In This Activity[a]	% Indicating As Their Primary Activity[b]	Average Hours Spent In Primary Activity[c]
Other Non-motorized	6.1	2.4	3.2
Some Other Activity	5.2	3.4	3.9
No Activity Reported	0.6	1.3	.

[a] Survey respondents could select multiple activities so this column may total more than 100 percent.

[b] Respondents were asked to select one activity as their main one. Some selected more than one, so this column may total more than 100 percent.

[c] Computed only for those who indicated the activity was the main activity on their visit.

* Indicates that this activity is considered to be physically active.

CUSTOMER SATISFACTION

A critical element of outdoor recreation program delivery is the evaluation of customer satisfaction with the recreation setting, facilities, and services provided. Overall satisfaction levels for national forest visits are quite high (Figure 5).

The Percent Satisfied Index shows very high satisfaction levels for visitors' perceptions of safety (Table 11). Satisfaction levels pertaining to access were above the target of 85 percent satisfied for two of three types of sites. Satisfaction levels with services (signage, information, and employee helpfulness) were between 76 and 87 percent; the lower satisfaction levels occur in dispersed recreation settings, where those services are less common. Comparing these results to the overall satisfaction results indicates that safety and access are likely to be among the most important elements of customer satisfaction.

Most places on national forests do not have any fees associated with recreation use. However for those that do have fees, the majority of visitors are satisfied with the value they receive for the fees they paid. In developed sites, including ski areas and overnight sites, 85 percent are satisfied.

The Percent Meets Expectations (PME) measure shows that the congruence between performance and expectations is quite high for the feeling of safety – greater than 89 percent in each of the three types of sites (Figure 6). Access elements are above 80 percent for each of the site types. The PME levels for developed facility items are above 75 percent for all areas.

National importance-performance results show that there are no elements that fall into the 'Concentrate here' quadrant (Table 12). Nearly all were in the 'Keep up the good work' quadrant. Parking lot conditions and interpretive displays appear to be of somewhat lesser importance to visitors to Wilderness. The overall ratings of road conditions and adequacy of signage were quite good: for over half of all visits both the importance and satisfaction for these items were rated as high as possible (Figures 7a and 7b).

Feeling that an area is very crowded can diminish recreation satisfaction. Visitors to both types of developed sites report higher levels of crowding than do users of dispersed sites (Table 13, and Figure 8). For the developed sites, roughly 15 percent of people felt there were high levels (8 or higher) of crowding. In dispersed settings about 47 percent of the visitors felt that the areas were not crowded, giving a rating of 1 – 3. In Wilderness, the percentage giving uncrowded ratings was somewhat lower (40%).

Figure 5. Percent of national forest visits by overall satisfaction rating, for FY2016 - FY2020

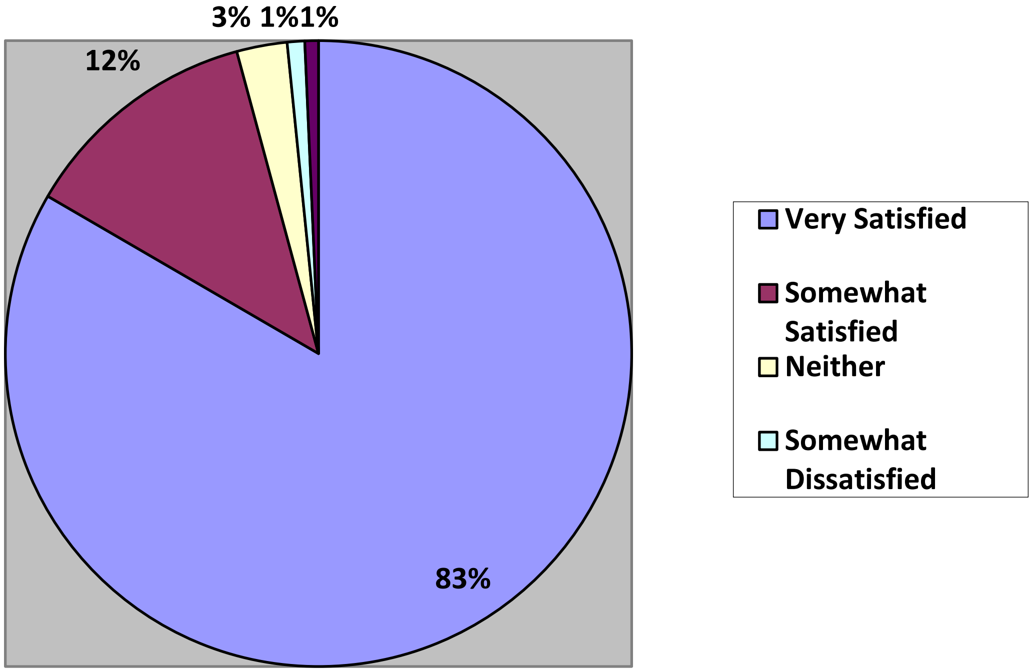


Table 11. National forest visitation percent satisfaction index [a] scores for aggregate categories, for FY2016 - FY2020.

Satisfied Visits (percent)

Items Rated	Developed Sites [b]	General Forest Areas	Designated Wilderness
Developed facilities (includes restroom cleanliness and facility condition)	87.8	81.0	81.6
Access (includes parking availability, parking lot condition, road condition and trail condition)	89.3	84.1	86.6
Services (includes availability of information, signage and employee helpfulness)	87.0	78.3	79.8
Perception of safety	97.3	95.7	97.1
Value received for any fee paid at the site	87.5	88.1	90.2

[a] Composite ratings of the proportion of satisfaction ratings scored by visitors as satisfied or very satisfied. The values are computed as the percentages of all ratings for the elements within the groupings that are at or above the target level, and indicate the percent of all visits where the person was satisfied with agency performance.

[b] This category includes both Day Use and Overnight Use Developed Sites.

Figure 6. Percent meets expectations results for national forest visits by type of site, FY2016 - FY2020.

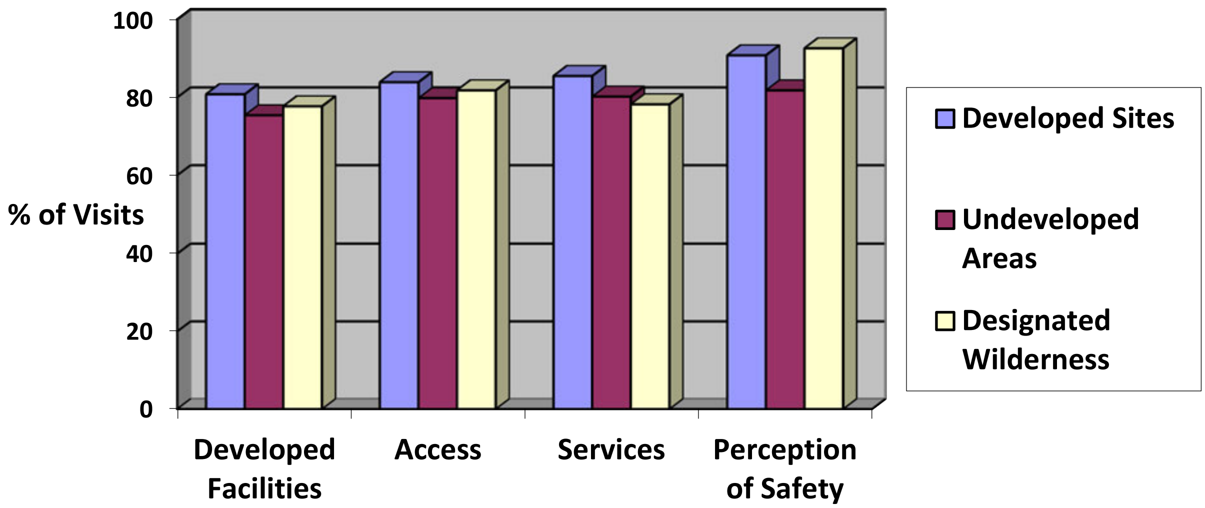


Table 12. Importance-performance ratings for satisfaction items, by type of site.

ITEM	Day Use Developed Sites	Overnight Use Developed Sites	Undeveloped Areas	Designated Wilderness
Restroom cleanliness	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work
Developed facility condition	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work
Condition of environment	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work
Employee helpfulness	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work
Interpretive display	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Possible Overkill
Parking availability	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work
Parking lot condition	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Possible Overkill
Rec. info. available	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work
Road condition	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work
Feeling of safety	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work
Scenery	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work
Signage adequacy	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work
Trail condition	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work
Value for fee paid	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work	Keep up the Good Work

Figure 7a. Overall satisfaction with forest-wide road conditions and signage adequacy, for FY2016 - FY2020.

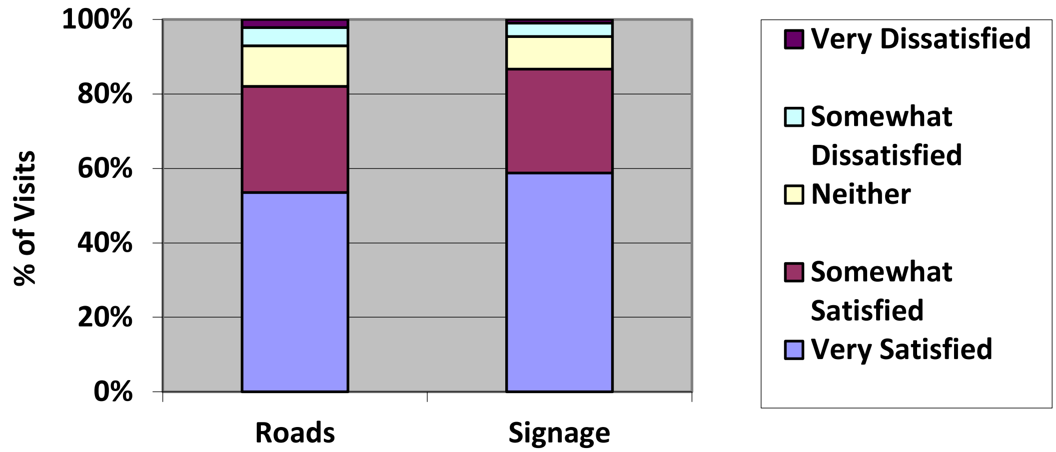


Figure 7b. Overall importance ratings for road condition and signage adequacy, for FY2016 - FY2020.

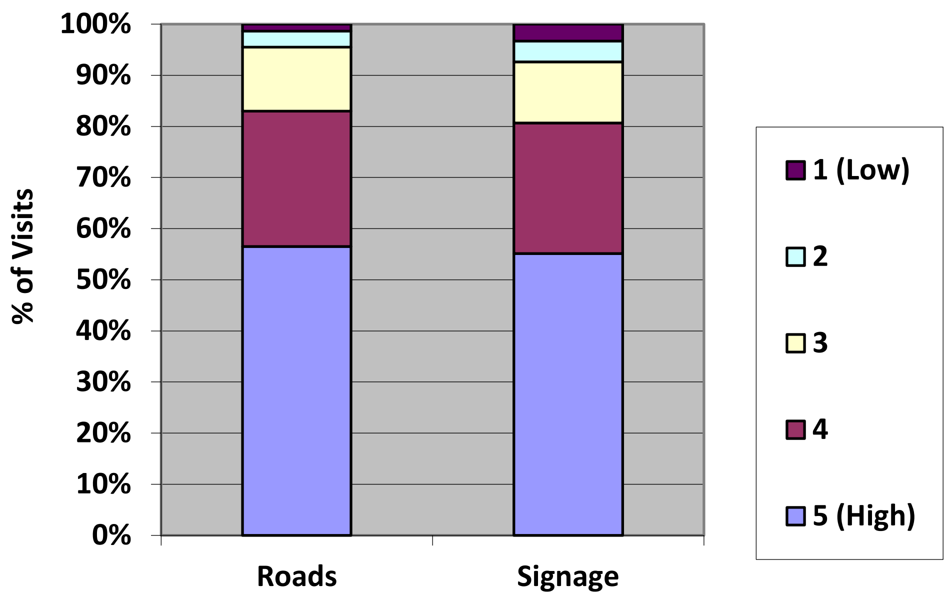
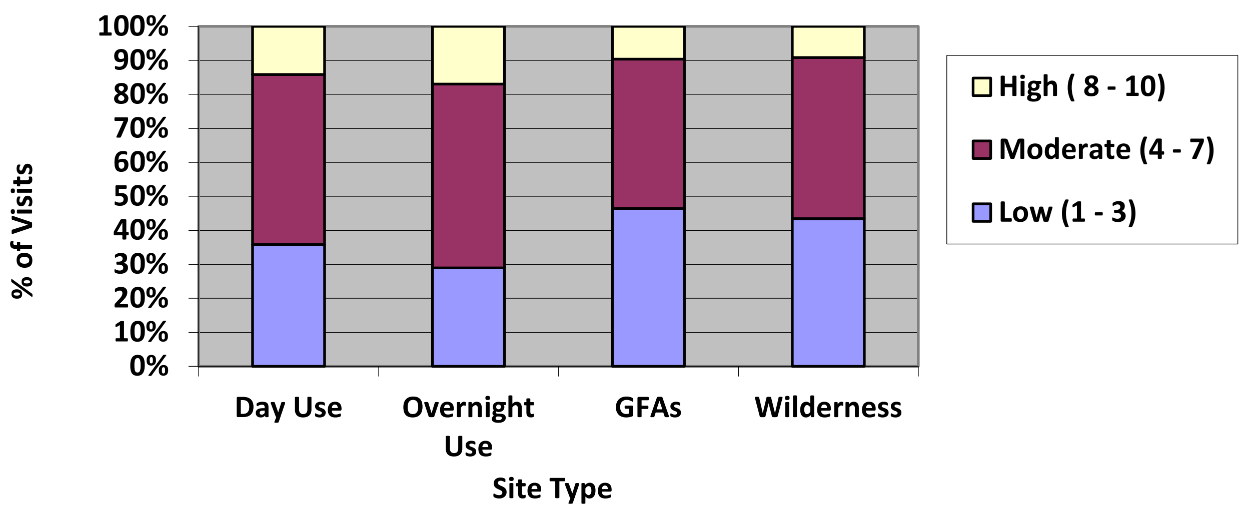


Table 13. National forest visitor perceptions of crowding by site type, for FY2016 - FY2020.

Perception of Crowding by Site Types (Percent site visits percent)

Crowding Rating	Day Use Developed Sites[c]	Overnight Use Developed Sites	General Forest Areas	Designated Wilderness
10 Overcrowded	2.3	2.1	1.3	0.9
9	5.9	6.0	3.1	3.6
8	6.0	9.0	5.2	4.6
7	6.6	8.4	6.1	6.7
6	17.2	21.5	14.4	14.7
5	10.9	11.5	9.5	10.6
4	15.3	12.3	14.0	15.4
3	14.9	11.1	16.2	17.9
2	16.2	15.4	24.6	22.2
1 Hardly anyone there	4.8	2.6	5.5	3.3

Figure 8. Distribution of site visits into general crowding categories.



Disabilities

The Forest Service is committed to integrating accessibility considerations into its sustainable recreation planning so all people, including those with disabilities, can recreate. The accessibility of recreation facilities is an important part of this policy. About seven percent of national forest visits are made by people in groups where one or more group members have a disability (Table 14). For nearly 87 percent of these parties, the facilities they used were rated as accessible.

Table 14. Accessibility for national forest visits by persons with disabilities, for FY2016 - FY2020.

Item	Percent
Percent of visitors interviewed with group member having a disability	7.0
Of this group, percent who said facilities at site visited were accessible	86.5

VISITOR SPENDING AND ECONOMICS

Visitor Spending

Visitors to national forests often spend money in nearby communities during the time they are on their recreation trips. These communities benefit directly from that spending. About 45 percent of visits to national forests are from residents of the local area who are on day trips. Few local residents stay overnight away from their home on or near the forests. About 13 percent of non-local residents make visits while on day trips away from home. More non-locals on overnight trips spend the night in facilities off the forest than on the forest. The national forest was not the primary reason for the trip away from home for about 7 percent of national forest visits.

Visitors spend money in towns that are near national forests for things like gasoline, food, lodging, and souvenirs. The spending segments differ markedly in the amount of money per party. In general, visitors who come from outside the local area spend more than do those who are from the local area. Those parties staying overnight off of national forest lands spend more than those who spend the night on the national forest. Those coming for the primary purpose of downhill skiing typically spend more per visit than for other types of recreation.

The most current economic data on visitor spending and resultant economic effects comes from FY2019. Economic data for 2020 is not yet available to accurately portray the contributions from visitors and their spending in 2020. The annual economic data, paired with forest service visitation and spending, depends on detailed, and ongoing, compilation and estimation of interindustry and institutional relationships in our national and local economies. The 2020 economic data will portray a recession, some recovery, and extraordinary economic circumstances relevant to the recreation related economies surrounding national forests and grasslands. Final analysis of the effects of the 168 million visits in FY2020 will be completed in early 2022 when the economic data is available.

Overall, in FY2019 recreating visitors spent over $10 billion in areas around National Forest System lands (Table 15). Many downhill skiers are from outside the local area and are staying in off-forest lodging. As a result, downhill skiers account for around $3.4 billion in local spending. Visitors for wildlife-related recreation spend least as a group, largely because roughly two-thirds of these visits are made by people on day trips away from home. As visitor spending ripples through the economy, further economic activity is created. In total, spending by visitors to national forests and grasslands contributes about $12.5 billion to the US economy and sustains about 154,000 full-and part-time jobs. Greater spatial detail on the contribution of visitor spending to economic regions around individual National Forest units is available in the Economic Contribution of Recreation: Website User Guide.

Table 15. Visitor spending and associated economic effects of recreation visits to national forest land, for FY2015 - FY2019.

	Downhill Skiing Visits	Wildlife-Related Visits	Other Recreation Visits	TOTAL VISITS
Millions of national forest Visits	23.3	16.8	109.8	150.0
Direct spending in local economies, (millions of $2019)	$3,410	$1,120	$5,560	$10,090
Total GDP contributions (millions of $2019)	$4,480	$1,270	$6,760	$12,510
Full- and part-time jobs sustained, (thousands)	57	15	82	154

About 38 percent of visits to national forests are made by people who are spending at least one night away from home (Table 16). For most of them, it includes at least one night spent within 50 miles of the forest they visited. Those spending the night within 50 miles of the forest stay an average of about 5 nights. For those spending one or more nights on or near the forest, about 40 percent stay in hotels or lodges off the forest. About 20 percent camp at developed campgrounds on the national forest; about 11 percent camp in undeveloped areas of the forest.

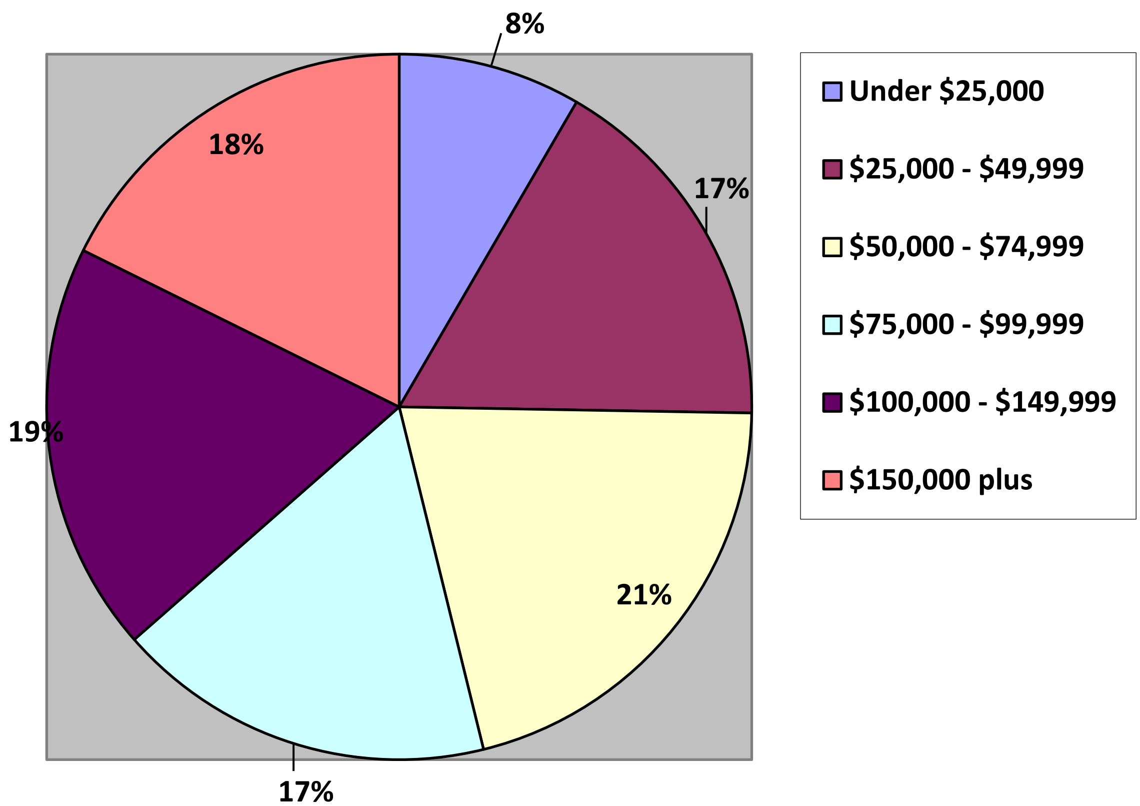
Table 16. Visitor trip information, for FY2016 - FY2020.

Item	**%**
Percent of visits that occur on trips with an overnight stay away from home	35.4
Percent of visits that occur on trips with an overnight stay within 50 miles of the visited forest	32.6
For overnight visits, average number of nights within 50 miles of the forest	5.1
For those staying overnight within 50 miles of the national forest, percent indicating each type of lodging	**%**
NF campgrounds ON the national forest	20.3
Camping in undeveloped areas of the national forest	13.3
Cabins, lodges, hotels or huts ON the national forest	6.3
Other public campgrounds (Park Service, BLM, State Park, other)	4
Private campgrounds NOT on the national forest	2.8
Rented home, condo, cabin, lodge or hotel NOT on the NF	34
Private home of friend or relative	13.6
Home, cabin, or condo owned by visitor	7.7
Other	2.8

Household Income

Visitors to national forests have a variety of household income levels (Figure 9). About seventeen percent of visits are made by individuals whose household income is over $150,000 per year. A smaller percentage (8 percent) comes from people in households earning less than $25,000 per year. Just under forty percent of all visits come from people in households earning between $25,000 and $75,000 per year.

Figure 9. Household income of national forest recreation visits, for FY2016 - FY2020.



Substitute behavior

What other recreation options the visitor considers using provides information about the other outdoor recreation opportunities that are substitutes for the opportunities provided by the Agency. The question we asked was what people would do if the forest was not available for recreation for this visit. Over half (51 percent) indicate that their substitute behavior choice is activity driven – that is, their substitute is going elsewhere for same activity (Figure 10). About sixteen percent indicate they would come back later for the same activity. Less than 20 percent of visitors said they would have gone to work (2 percent) or stayed home (14 percent) instead of recreating. For those visitors, there appears to be no readily accessible substitute for the recreation opportunity provided by the agency. Visitors who said they would have gone somewhere else for recreation also indicated how far from their home this alternate destination was (Figure 11). The distribution of travel distances to alternative locations is very similar to the distribution of travel distances for national forest visits, which may indicate that a reasonable set of alternative destinations indeed exists for most visits.

Figure 10. Substitute behavior choices of national forest visitors, for FY2016 - FY2020.

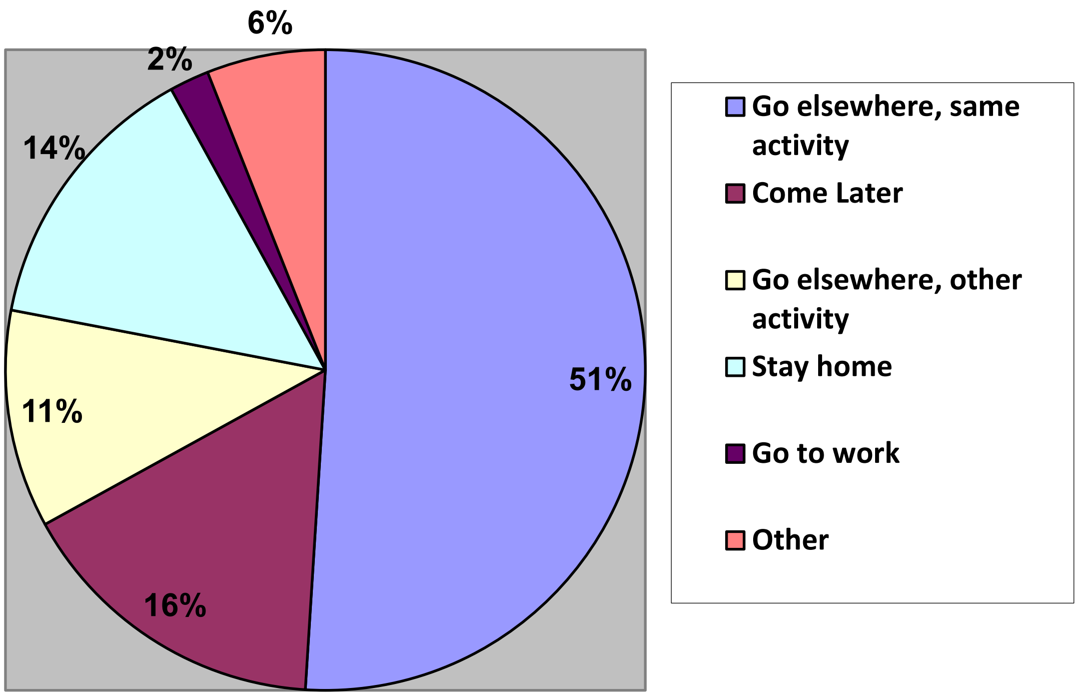
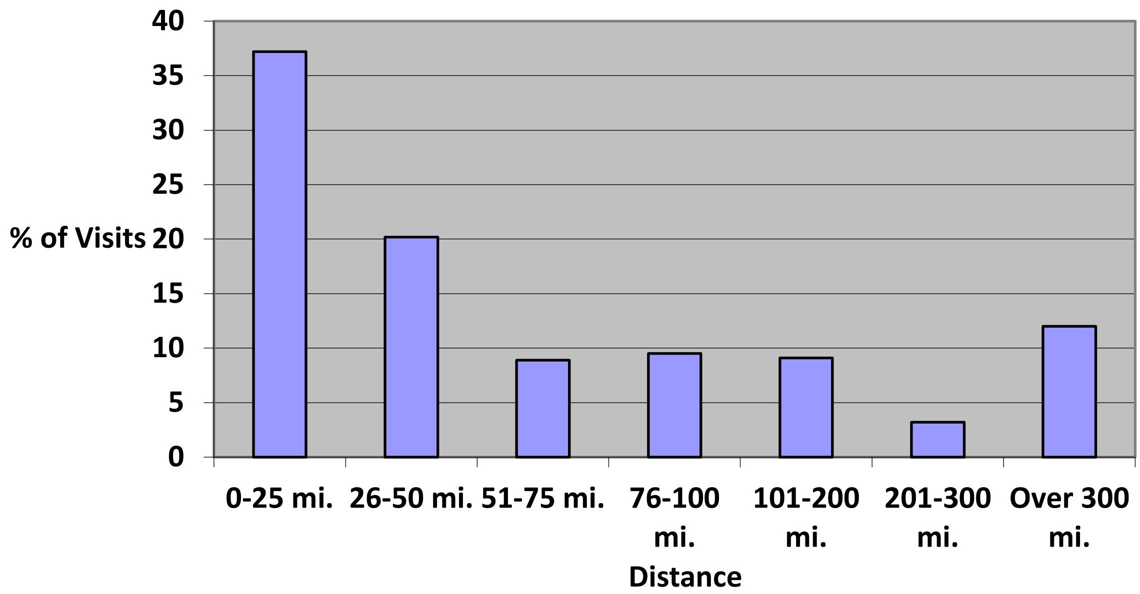


Figure 11. Reported distance visitors would travel to alternative recreation locations, for FY2013 – FY2017.



Appendix A. Detailed Satisfaction Results

Table A-1. Satisfaction of national forest recreation visitors at developed day use sites, for FY2016 - FY2020.

ITEM	Very Dissatisfied	Somewhat Dissatisfied	Neither	Somewhat Satisfied	Very Satisfied	Avg. Rating	Mean Impor tance
Restroom cleanliness	3.2	4.8	9.6	24.6	57.8	4.3	4.5
Developed facility condition	0.3	1.4	5.4	20.8	72.1	4.6	4.4
Condition of environment	0.2	1.5	4.7	17.6	76.0	4.7	4.8
Employee helpfulness	0.4	0.9	4.2	11.9	82.5	4.8	4.6
Interpretive displays	0.8	3.3	13.4	21.3	61.1	4.4	4.1
Parking availability	1.3	4.6	7.5	17.2	69.4	4.5	4.5
Parking lot condition	0.4	2.1	7.3	20.1	70.1	4.6	4.2
Rec. info. availability	0.9	3.8	10.0	23.4	62.0	4.4	4.4
Road condition	0.8	3.0	8.0	24.4	63.8	4.5	4.5
Feeling of safety	0.2	0.3	2.1	12.3	85.1	4.8	4.7
Scenery	0.2	0.4	1.4	8.3	89.8	4.9	4.7
Signage adequacy	1.2	2.6	7.7	20.4	68.1	4.5	4.4
Trail condition	0.4	1.3	5.8	21.7	70.8	4.6	4.6
Value for fee paid	0.8	3.2	8.9	19.8	67.3	4.5	4.6

*Scale is: Very Dissatisfied = 1 Dissatisfied = 2 Neither = 3 Satisfied = 4 Very Satisfied = 5
** Scale is: 1= Not Important 2= Somewhat Important 3= Moderately Important 4= Important 5 = Very Important

Table A-2. Satisfaction of national forest recreation visitors at developed overnight sites, for FY2016 - FY2020.

ITEM	Very Dissatisfied	Somewhat Dissatisfied	Neither	Somewhat Satisfied	Very Satisfied	Avg. Rating	Mean Importance
Restroom cleanliness	3.3	4.3	11.6	25.3	55.6	4.3	4.6
Developed facility condition	1.2	1.6	7.3	23.1	66.7	4.5	4.4
Condition of environment	0.3	1.2	3.5	19.1	75.9	4.7	4.8
Employee helpfulness	1.3	1.1	4.9	10.6	82.0	4.7	4.6
Interpretive displays	1.6	4.1	15.8	25.0	53.5	4.2	4.1
Parking availability	0.9	2.4	5.6	19.5	71.7	4.6	4.4
Parking lot condition	0.2	1.3	6.6	20.7	71.2	4.6	4.1
Rec. info. availability	0.8	5.8	14.2	24.0	55.2	4.3	4.4
Road condition	1.6	3.4	8.7	24.3	62.1	4.4	4.3
Feeling of safety	0.4	0.7	2.0	12.3	84.6	4.8	4.7
Scenery	0.1	0.1	2.8	11.4	85.6	4.8	4.7
Signage adequacy	1.1	3.8	9.2	22.4	63.5	4.4	4.4
Trail condition	0.4	1.3	7.4	24.2	66.7	4.6	4.5
Value for fee paid	1.0	5.0	4.9	19.6	69.5	4.5	4.6

*Scale is: Very Dissatisfied = 1 Dissatisfied = 2 Neither = 3 Satisfied = 4 Very Satisfied = 5
** Scale is: 1= Not Important 2= Somewhat Important 3= Moderately Important 4= Important 5 = Very Important

Table A-3. Satisfaction of national forest recreation visitors in dispersed areas, for FY2016 - FY2020.

ITEM	Very Dissatisfied	Somewhat Dissatisfied	Neither	Somewhat Satisfied	Very Satisfied	Avg. Rating	Mean Importance
Restroom cleanliness	5.7	9.6	12.5	23.6	48.5	4.0	4.3
Developed facility condition	0.8	2.2	7.8	23.4	65.9	4.5	4.2
Condition of environment	0.7	2.3	5.2	20.6	71.3	4.6	4.8
Employee helpfulness	0.8	1.6	7.8	12.1	77.7	4.6	4.4
Interpretive displays	2.1	5.0	18.2	23.7	50.9	4.2	4.0
Parking availability	1.7	4.9	10.9	17.5	65.1	4.4	4.2
Parking lot condition	1.1	2.9	8.9	20.7	66.4	4.5	4.1
Rec. info. availability	1.9	4.9	16.0	25.3	52.0	4.2	4.2
Road condition	3.6	6.9	11.4	26.5	51.6	4.2	4.3
Feeling of safety	0.2	1.1	3.1	12.5	83.2	4.8	4.6
Scenery	0.2	0.8	3.1	11.0	84.9	4.8	4.7
Signage adequacy	2.7	6.0	13.0	22.3	56.0	4.2	4.2
Trail condition	0.9	2.7	7.3	26.3	62.7	4.5	4.5
Value for fee paid	1.3	2.3	8.3	15.1	72.9	4.6	4.4

*Scale is: Very Dissatisfied = 1 Dissatisfied = 2 Neither = 3 Satisfied = 4 Very Satisfied = 5
** Scale is: 1= Not Important 2= Somewhat Important 3= Moderately Important 4= Important 5 = Very Important

Table A-4. Satisfaction of national forest wilderness visitors, for FY2016 - FY2020.

ITEM	Very Dissatisfied	Somewhat Dissatisfied	Neither	Somewhat Satisfied	Very Satisfied	Avg. Rating	Mean Importance
Restroom cleanliness	3.4	8.5	11.9	26.3	49.9	4.1	4.2
Developed facility condition	0.2	1.2	10.1	22.7	65.8	4.5	4.1
Condition of environment	0.3	1.4	2.8	16.2	79.2	4.7	4.8
Employee helpfulness	0.5	0.4	7.4	10.9	80.7	4.7	4.3
Interpretive displays	1.8	5.6	18.1	26.6	47.9	4.1	3.9
Parking availability	2.9	5.9	9.9	17.3	64.1	4.3	4.3
Parking lot condition	0.6	2.3	7.4	18.4	71.4	4.6	3.9
Rec. info. availability	0.8	4.3	13.1	23.6	58.2	4.3	4.3
Road condition	1.9	4.7	10.6	27.2	55.5	4.3	4.3
Feeling of safety	0.1	0.3	2.4	11.7	85.5	4.8	4.5
Scenery	0.1	0.4	1.5	7.7	90.4	4.9	4.8
Signage adequacy	2.0	6.2	13.1	23.7	55.0	4.2	4.4
Trail condition	0.7	2.3	5.1	23.0	68.8	4.6	4.6
Value for fee paid	1.7	0.8	7.3	8.8	81.4	4.7	4.4

*Scale is: Very Dissatisfied = 1 Dissatisfied = 2 Neither = 3 Satisfied = 4 Very Satisfied = 5
** Scale is: 1= Not Important 2= Somewhat Important 3= Moderately Important 4= Important 5 = Very Important

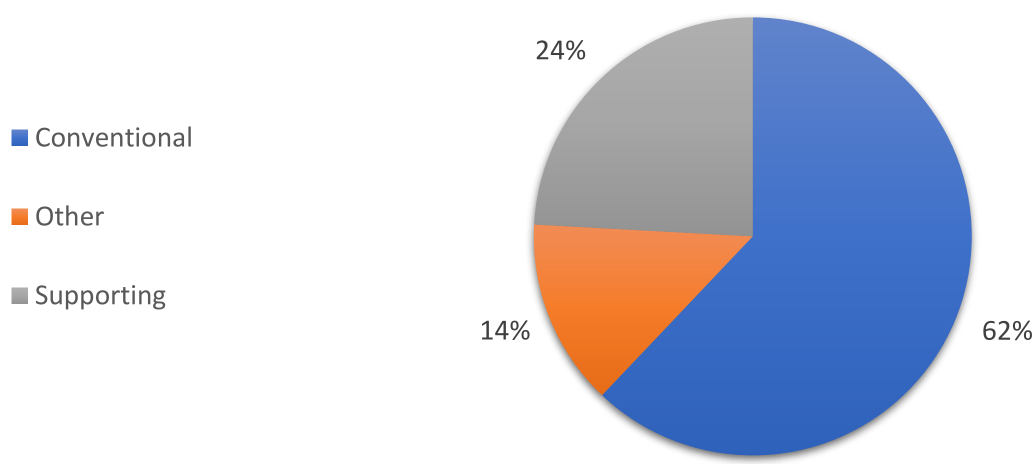
2022—Indiana

Value added [gross domestic product]		Employment		Compensation	
ORSA total	Share of state	ORSA total	Share of state	ORSA total	Share of state
$16.0 billion	3.4%	111,982 jobs	3.4%	$7.5 billion	3.2%

Value Added by Select ORSA Activity
[Thousands of dollars]

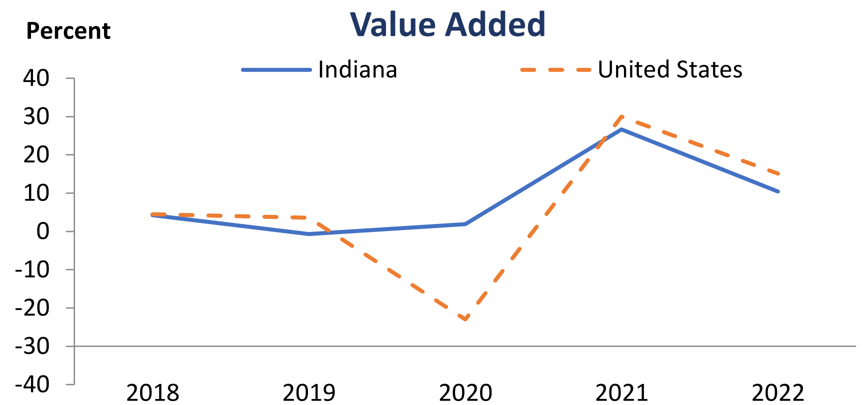
Activity	2020	2021	2022	State rank
RVing	4,475,065	5,644,759	5,860,716	1
Boating / fishing	1,171,565	1,344,187	1,423,251	5
Motorcycling / ATVing	343,474	513,323	551,228	5
Snow activities	122,078	134,790	237,212	7
Hunting / shooting / trapping	150,702	168,698	167,600	23
Equestrian	241,360	145,303	147,967	15
Climbing / hiking / tent camping	87,257	90,818	106,661	22
Bicycling	56,425	53,337	53,899	14
Recreational flying	14,303	21,366	53,664	21

Value-Added Composition of Outdoor Recreation Activities

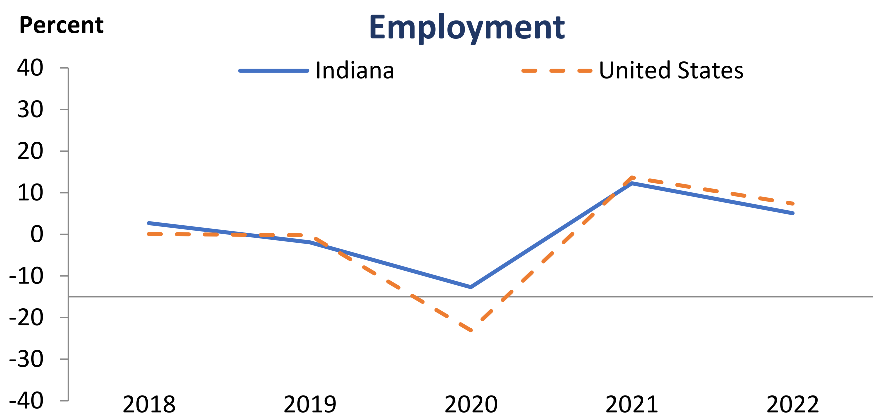


Conventional ORSA activities include traditional outdoor activities, such as camping, hiking, boating, and hunting.
Other ORSA activities include those that take place outside, such as gardening and outdoor concerts.
Supporting ORSA activities are those that contribute to the core activities and include such things as construction, travel and tourism, local trips, and government expenditures.

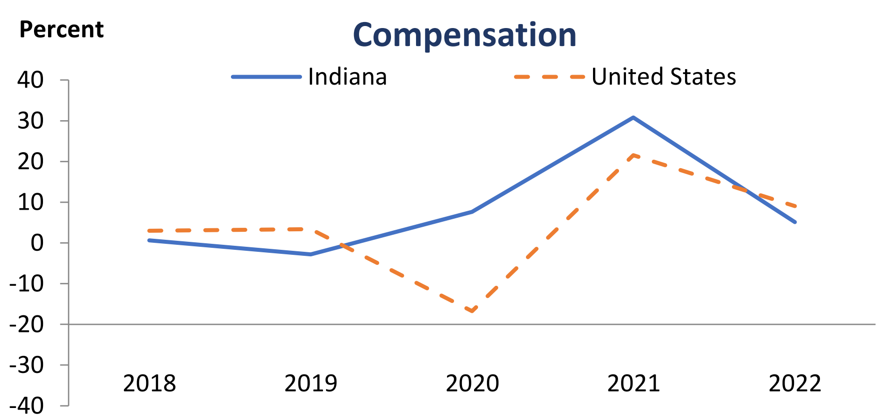
In 2022, Indiana ranked 9th among all states in ORSA value added and 41st among all states in ORSA value-added growth. Since 2021, ORSA value added has grown 10.4 percent in Indiana, compared with an increase of 15.1 percent for the United States.



In 2022, Indiana ranked 15th among all states in ORSA employment and 36th among all states in ORSA employment growth. Since 2021, ORSA employment has grown 5.1 percent in Indiana, compared with an increase of 7.4 percent for the United States.



In 2022, Indiana ranked 9th among all states in ORSA compensation and 44th among all states in ORSA compensation growth. Since 2021, ORSA compensation has grown 5.1 percent in Indiana, compared with an increase of 9.1 percent for the United States. Average compensation per wage-and-salary job in Indiana ORSA industries was $66,984 in 2022, compared with $71,529 for all salaried jobs in the state.



ORSA value added consists of the gross output of an industry less its intermediate inputs; the contribution of an industry to gross domestic product.
ORSA employment consists of all wage-and-salary jobs in which workers are engaged in the production of ORSA goods and services.
ORSA compensation consists of the remuneration (including wages and salaries as well as benefits, such as employer contributions to pension and health funds) payable to employees in return for their ORSA work during a given year.

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Research Article

Camping in clearcuts: The impacts of timber harvesting on USFS campground utilization

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ABSTRACT

This research applies a temporally and spatially explicit model to analyze timber harvesting's impact on campground utilization on United States Forest Service (USFS) land across the Western U.S. Timber harvesting and camping can occur near one another due to multiple-use management strategies used by the USFS. However, intensive forest management can change the degree of perceived naturalness of a forest and may therefore negatively impact recreation. We investigate several facets of harvesting activity, such as proximity to camping, type of harvesting, regional differences, and persisting lagged impacts of timber harvesting. We find that harvesting activity significantly decreases campground reservations during the year of harvest, and this loss in campground utilization can be expected to have negative impacts on nearby tourism-dependent economies.

Management implications:

- Intensive forest management generally negatively impacts campground utilization during the years of operations
- Public land managers, such as the USFS, may seek to locate timber harvesting operations further from campgrounds if they wish to not negatively impact campground usage
- Alternative, less-intensive, forms of forest management decrease nearby campground utilization less than timber harvesting, so do not necessarily need to be located further from campgrounds to avoid losses in their utilization
- Decreased campground visitation due to timber harvesting may imply lower visitation to nearby gateway communities, and therefore less economic stimulation and spending in their economies, which may create an incentive for gateway communities to be involved in the harvest planning process

1. Introduction

Historically, forest management in the U.S. has focused primarily on timber supply. More holistic management emerged in the latter half of the 20th century that placed value on both timber and non-timber ecosystem services, such as outdoor recreation (Rose & Chapman, 2003; USFS, n.d.-c). Presently, the USFS governs its lands with multiple-use management. Lands and forests are managed for more than one purpose or objective to achieve the greatest possible combination of public benefits. Some objectives are compatible, while others are not (Clawson, 1974; Rose & Chapman, 2003; USFS, n.d.-c). Although extractive activities remain important aspects of USFS management and the national economy, demand for recreation on public lands has increased, and must be managed accordingly. Balancing competing demands of forests is inherently heterogeneous and requires spatial analysis. Timber production can alter biodiversity and affect the attractiveness of a site for recreation, while high volumes of outdoor recreation can impede on biodiversity and land available for timber production (Bolund & Hunhammar, 1999). Thus, choices the USFS makes on the location of timber harvests may directly influence demand for nearby campgrounds, and consequently impact communities dependent on visitors to those campgrounds. In this paper, we

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investigate whether timber harvesting on USFS land impacts nearby USFS campground reservations. We also analyze whether impacts vary across regions, by type of harvest, and whether impacts persist after harvesting activity is completed.

This study uses temporal and spatial data on campground reservations and timber harvesting on USFS lands. Campground utilization is modeled as a function of harvesting activity nearby, harvest characteristics, and campground and year fixed effects. Rather than estimating every factor that influences camping demand at a given campground, such as campground amenities, nearby recreation opportunities, or other attractiveness-related factors, these fixed effects allow us to isolate and identify changes to campground utilization caused by timber harvesting. The magnitude of impacts from harvesting are compared to impacts of three other common management activities undertaken by the USFS.

This study builds most directly on research by Harshaw and Sheppard (2013) who evaluated timber harvesting impacts on recreation opportunities in British Columbia, Canada, and Eggers et al. (2018) who studied the relationship between intensive forest management and the recreational value of forests in Sweden. Both studies integrated spatial and temporal forest management and recreation data. This study, to our knowledge, is the first to use historic temporal and spatial data on USFS land to evaluate the relationship between timber harvesting and camping.

This work adds to the growing body of literature that individuals often choose their leisure location based on the attractiveness and aesthetics of a site. This work can inform land managers' decisions on future locations and types of timber harvesting relative to existing campgrounds and inform implications of current and planned timber harvesting on nearby tourism-dependent communities.

2. Background and literature review

2.1. The evolution of USFS policies

The goals of the USFS have evolved to meet the demands of private and public interests. The agency was established in 1905 to provide quality water and timber, and later "[broadened] its management scope for additional multiple uses and benefits and for the sustained yield of renewable resources such as water, forage, wildlife, wood, and recreation" (USFS, n.d.-c). For most of the organization's history, USFS land has been managed mainly for timber production (Rose & Chapman, 2003; USFS, n.d.-c). Today, the "mission of the Forest Service is to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations" (USFS, n.d.-c). Resource conservation, multiple use mandates, and environmental protection have come to the forefront of public lands policies. Importantly, land, natural resources, human resources, budgets, and time are scarce, so the USFS faces tradeoffs and complex management decisions on how to allocate resources.

Before the creation of the USFS, public forest management legislation, such as the Organic Act of 1897, recognized multiple uses of forests (Rose & Chapman, 2003; USFS, n.d.-a). Despite this, timber interests dominated public forest management decisions for the early years of the USFS, so the agency focused on resource exploitation and commodity flows from the land (Kennedy & Quigley, 1998; Rose & Chapman, 2003).

In the 1960s and 70s, shifting public opinions led to legislation, such as the Multiple Use Sustained Yield Act of 1960, the Clean Water Act of 1970, and the National Forest Management Act of 1976, that changed public land management practices (Government Accountability Office [GAO], 1999, p. 20; Rose & Chapman, 2003; USFS, n.d.-b, n.d.-e). Land managers still held timber harvesting as an important land use, but now as a part of a more holistic multiple-use management approach (Rose & Chapman, 2003). The USFS broadened its scope of outputs and sought to enhance public lands while considering both the environment and local economies.

Today, public opinion, agency values, and legislation push the USFS in the direction of environmental protection and multiple-use management. Differing values on public forests' purposes, such as balancing economic, environmental, or recreational values, and the relationship of timber harvesting levels to forest health shape debates over public land management. Supporters of timber harvesting on public lands cite benefits to the local timber industry, rural timber-dependent gateway community economies, and beliefs that timber harvesting is a tool for forest health (Riddle, 2022, p. 23). Opponents of timber harvesting have concerns about its potential negative impacts to ecological (environmental quality or fish and wildlife habitat) or human (recreation, cultural, or aesthetic values) resources (Riddle, 2022, p. 23).

2.2. USFS timber harvesting decisions

The USFS considers many factors, objectives, and policies when deciding which forest parcels are available for timber harvesting. Timber production from federal lands is driven by a complex interaction of environmental factors, market forces, and land management policies. The USFS is one of only two federal agencies, the other being the Bureau of Land Management, to conduct timber sales as an authorized use, and the USFS conducts most harvests (Riddle, 2022, p. 23).

The USFS oversees approximately 193 million acres of land, of which nearly half is forest land that is producing or can produce timber (Riddle, 2022, p. 23; USFS, 2013). Timber sales, the process in which an entity purchases a contract to harvest timber, are the most common way to allow timber harvesting on federal land. Any timber harvesting that takes place must follow relevant statutes pertaining to forest management, such as the National Forest Management Act of 1976, and environmental protection, such as the National Environmental Protection Act of 1969 (Riddle, 2022, p. 23; USFS, n.d.-d).

Harvest volume and value are heterogeneous across regions and time. They are determined by timber type, timber age class, forest condition, ease of operations, land use limitations, and local wood production industries. In the Western U.S., Region 6 (the Pacific Northwest) is the largest producing region in both private and public forestry (Riddle, 2022, p. 23; Sorenson et al., 2016; USFS, 2021b). After a boom in harvesting from the 1950s–80s of around 10 billion board feet[1] per year, harvest volumes in more recent years have remained between 1.8 and 2.8 billion board feet per year (Riddle, 2022, p. 23). The annual dollar value of timber peaked in 1979 at over $3 billion and has since decreased to between $100 million and $300 million since 2001 (Riddle, 2022, p. 23).

Today, less intensive methods of harvest and other management activities are more common. USFS resources are increasingly dedicated to wildfire mitigation and cleanup (Fox, 2020). Other activities besides timber harvesting, such as brush disposal, hazardous fuel reduction, and restoration, are more common USFS management strategies. Rather than focusing on earlier goals of meeting targets for volume sold, the agency is now concerned with treating the right acres at the right time by working with local and tribal governments and partners in the private sector (Fox, 2020).

2.3. Camping management and decisions

Camping is a form of tourism in which individuals spend at least one night away from home in a temporary accommodation, such as a tent, caravan, or recreational vehicle (Brochado & Pereira, 2017; Grande, 2021; Lee et al., 2019). Camping has become a highly specialized tourism sector, and its popularity is rising worldwide (Brochado & Pereira, 2017; Brooker and Joppe, 2013, 2014; Lee et al., 2019; Rice

[1] A "board foot" is a unit of measure for a piece of lumber 12" wide by 12" long by 1" thick.

et al., 2019). Camping in the U.S. alone generates $166 billion annually and is the largest outdoor tourism sub-sector (Outdoor Industry Association, 2017). Current camping and hospitality management literature seeks to understand innovation and competitiveness (Brooker et al., 2012; Grande, 2021), business models in the camping industry (Grande & Camprubi, 2022), determinants of pricing in the camping industry (Saló et al., 2020), and the impact of internal capital (resources and services, such as accommodation facilities) on camping demand (Brooker & Joppe, 2013; Grande, 2021; Lee et al., 2019).

Individuals are motivated to camp for varying reasons, including escaping from routine, enjoying nature, lower accommodation fees, and meeting others (Brochado & Pereira, 2017; Brooker & Joppe, 2013; Lee et al., 2019). A key finding from recent camping management literature is that individuals often choose their leisure location based on the attractiveness and aesthetics of a site (Grande, 2021; Lee, 2020; Ma et al., 2021; Saló et al., 2020). Besides aesthetics and attractiveness, individuals make decisions on where to camp based an interaction of many factors, such as weather and climate (Ma et al., 2020, 2021), amenities and facilities offered at campgrounds (Grande, 2021; Lee, 2020), the price of campgrounds (Saló et al., 2020), seasonality (Ma et al., 2020, 2021; Rice et al., 2019; Saló et al., 2020), and nearby recreation opportunities (Lee, 2020; Saló et al., 2020).

In the context of this study, "camping" means staying overnight for at least one night at a USFS campground. USFS "campgrounds" are designated developed areas designed for camping on USFS land, and many are reservable online. Camping on USFS land can take place in either designated campgrounds, which offer amenities such as water, restrooms, and trash disposal and often require a fee, or in dispersed areas, which are undeveloped and free but rarely offer any services. This research only focuses on developed, reservable campgrounds. Dispersed camping sites are not reservable, so there is a lack of reservation data for these campers. USFS campgrounds are federally owned, though many are operated by private "concessionaires" who take care of routine maintenance, electricity, signage, cleaning, and water management (Bookey, 2011; Carswell, 2014).

2.4. Gateway communities

Gateway communities are towns and cities that border public lands. These communities may be near national or state parks, forests, monuments, grasslands, or bodies of water. They serve as entry points for nearby recreation or natural resource extraction, and therefore, their economies are dependent on the use of nearby public lands.

Resulting from a combination of changing public lands policy, resource exhaustion, and declining profitability, many gateway community economies have become less dependent on natural resource extraction and moved toward tourism and recreation-based economies (Bergstrom & Harrington, 2018; Howe et al., 2012; Keiter, 2013, p. 8; Kurtz, 2010; Stoker et al., 2021). Most of these communities are in the Western U.S. (Stoker et al., 2021). Examples of communities that have moved from extraction-based to tourism-based economies include Estes Park, Colorado (a former mining-based community), Jackson, Wyoming (a former hunting and ranching-based community) and Leavenworth, Washington (a former timber-based community) (Ford, n.d.; Leavenworth Chamber of Commerce, n.d.; Visit Estes Park, n.d.).

However, timber production has historically been, and continues to be, an important economic activity in the U.S. (Eggers et al., 2018; Rose & Chapman, 2003; Sorenson et al., 2016). Harvesting involves planning, preparation, removal, and transportation of trees. All points along this process, and in the processing afterward, sustain jobs and income, particularly in many gateway communities (Sorenson et al., 2016). The U.S. is the world's leading producer of several wood products, as well as the largest single-consumer of those products (Alderman, 2022, p. 31). The highest levels of employment in forestry and logging occur in the Northwestern U.S., where timber is more desirable due to larger trees and non-homogeneous stands and more manual methods of harvest are used (Sorenson et al., 2016).

Recreation is also an important use of public lands and an economic driver, especially in rural communities near national forests. Visitors to national forests often spend money in nearby communities while they are on recreation trips. These direct expenditures create further indirect and induced impacts (Thomas & Koontz, 2021, p. 70; USFS, 2021c, p. 36). The USFS National Visitor Use Monitoring Survey (NVUM) finds that annual spending by recreation visitors in areas near USFS land was about $10 billion in fiscal year 2019 (USFS, 2021c, p. 36). From this direct effect and further indirect and induced effects, about $12.5 billion is reflected in the nation's gross domestic product from visitor spending, and it sustains about 154,000 full and part time jobs (USFS, 2021c, p. 36). White et al. (2013, p. 65) find that among visitors to USFS lands, the lowest average spending of visitors, $33 per party per trip, is from locals on day trips, while the highest average spending, over $983 per party per trip, is from non-locals visiting for skiing and staying overnight nearby.

2.5. Impacts of timber harvesting on recreation

Timber harvesting can alter the amenity value of a forest, either for better or for worse. Depending on the type and intensity of management activity done, wildlife, water supply, and recreation may benefit or suffer. For example, clearcutting can often benefit wildlife that require the thick cover created by a young regenerating forest (Vitz & Rodewald, 2006). However, Eggers et al. (2018) finds that people seeking outdoor recreation prefer mature forests with little sign of human activity, such as clearcuts or ground damage. Harvesting can alter the composition of a forest or a stand, the use of roads, noise levels, and forest aesthetics.

Harshaw and Sheppard (2013) studied timber harvesting's impacts on outdoor recreation in British Columbia, Canada. Evaluating the temporal dimension of forest management is necessary to understand the dynamic nature of forests, changing societal demands for forest products, and visitors' responses to changing resource conditions (Harshaw & Sheppard, 2013). A key insight from this study is that timber harvesting caused a substantial loss of natural settings over several time periods. Once the natural conditions of a forest have been altered, the change may be irreversible. Although individuals engaging in outdoor recreation may seek varying levels of naturalness, if they do seek more natural conditions, it is difficult for a harvested area to appear unchanged from human influence.

Eggers et al. (2018) conducted a similar study in Sweden examining the trade-offs between managing for recreation and wood production. They focused on forests close to urban areas since these forests see the most visitation. They found longer rotation periods in areas with high recreational demand to be beneficial. This practice increased recreational value without banning wood production in prioritized areas.

3. Data

The main empirical analysis uses two spatial datasets available publicly: timber harvest data from the USFS's FSGeodata Clearinghouse and reservation data from the Recreation Information Database (RIDB) (RIDB, 2021; USFS, 2021b). Harvest data include polygons of harvests since the 1800s and reservation data include point locations of all campground reservations made through recreation.gov since 2006.

We combined these datasets to construct a campground capacity utilization metric using camping reservations from 2008 to 2018 and the proportion of harvested area within a 5-km radius of each campground from harvests occurring from 1986 to 2018. The buffered area around campgrounds addresses the aesthetics of a forest, as attractiveness can be an important factor in campground visitors' decisions as addressed in the literature review. Following Rice et al. (2019) and Shartaj and Suter (2020), campground utilization is determined by comparing the total number of sites available to the yearly average number of sites reserved at each campground.

The impacts of three additional management strategies are also estimated. Including these other activities in this study allows us to compare the magnitude of the impact of these activities to the impact of harvesting. These activities, which may overlap, include brush disposal, hazardous fuel reduction, and integrated resource restoration (IRR) (USFS, 2022a; 2022b; 2022c). Polygon data on these three activities are similarly collected from the FSGeodata Clearinghouse and interacted with the RIDB reservation data to determine the impacted campgrounds.

3.1. Timber harvest data

The FSGeodata Clearinghouse is a database provided by the USFS containing spatial data collected and managed by USFS programs. Variables of interest in the harvesting data include the geometry of each harvest, dates of operations, type of harvest, and size of harvest in acres (USFS, 2021b). We subset the harvesting data to the years 1986–2018 and evaluate harvesting activity in the contiguous Western U.S. (USFS Regions 1–6). Fig. 1 depicts a map of the area of study classified by USFS regions (USFS, 2021a).

Duration of harvesting activity is considered in this study. Harvests lasting over multiple years may impact camping in more than one year and are likely to be of larger area or more intensive. However, harvest operations lasting many years are unlikely to have significant activity in each year. Detailed yearly information for harvest activity is not available in the data used, so harvests lasting more than 5 years are excluded. Fig. 2 depicts a histogram of timber harvests classified by the duration of harvesting activity. From Fig. 2, we see that most harvests last 1 year, and Regions 1 (Northern), 5 (Pacific Southwest), and 6 (Pacific Northwest) have the most harvesting activity.

The main methods of harvesting, ranging from most intensive to least intensive, are clearcut, shelterwood and selection (Table 1). Fig. 3 depicts a count of the new USFS harvests each year in the Western U.S. from 1986 to 2018 categorized by type of harvest. There is a general decline in the number of harvests over time. Additionally, the number of clearcut and shelterwood harvests have declined over time, while the selection method remains popular.

3.2. Campground reservation data

Campground reservation data are gathered from the Recreation Information Database (RIDB) spanning the years 2006–2018 (RIDB, 2021). Through recreation.gov, individuals can access recreation site information on federal lands nationwide and make reservations. Historical records of all reservations made through this website are available for download from fiscal year 2006 forward. Variables of interest in the reservation data include the geometry of each site, dates of reservations, type of site (only overnight campgrounds are included), and ownership of the site (only USFS sites are included).

Although data are available starting in 2006, there were no reservations to campgrounds with timber harvesting nearby in 2006 and 2007 (likely due to many campgrounds not yet being available on recreation.gov), so reservation data relevant to this study begins in 2008. In October 2018, the data provider and format of the RIDB historical records changed and cannot be directly compared to the previous format (RIDB, 2021). Therefore, data after 2018 are excluded from this study. The data show the number of campgrounds available for reservation and the number of reservations made on recreation.gov have increased over time. Additionally, the number of reservations made on recreation.gov at campgrounds with some harvesting nearby have increased by over 30 percent between 2008 and 2018.

To determine which campgrounds might be impacted by timber harvesting, we overlaid the campground points and harvest polygons. We created a 5-km buffer around each campground's coordinates to capture areas of forest that are "near" a campground. We chose a 5-km buffer as the main specification as this is the area around a campground that could be easily accessed on foot when campers are moving around their site or recreating nearby. As explored in the literature, campers often make decisions on where to camp with several factors in mind, such as proximity to other recreation destinations, campsite amenities, and campsite aesthetics. The buffering of campground locations addresses the aesthetics of a campground as attractiveness is an important part of the choice of outdoor recreation areas (Grande, 2021; Harshaw & Sheppard, 2013; Lee, 2020; Ma et al., 2020, 2021; Saló et al., 2020). Campgrounds with harvesting activity within their buffer are considered treated, and those without are untreated. Fig. 4 provides an example of the interaction of the reservation data and timber harvesting data.

Table 2 shows the number of treated campgrounds from 1986 to 2018 in all regions. From this table, we see that the number of impacted campgrounds decreases over time. This table also shows that Region 6 (the Pacific Northwest) has the most impacted campgrounds, which is intuitive because this region has one of the highest levels of timber harvesting in the Western U.S., as well as many wood mills (Prestemon et al., 2005; Riddle, 2022, p. 23; Sorenson et al., 2016).

From these impacted campgrounds, we calculate the proportion of harvested area within each buffer, which is our main independent variable. Only the portion of each timber harvest that falls within the buffer is counted toward this total. Both the total proportion harvested and the proportion harvested by type of harvest are calculated. A single timber harvest may impact multiple campgrounds in multiple years. As expected, most campgrounds do not have a large proportion of their buffer area harvested. 63% of campgrounds have less than 5% of their buffer area harvested, and the median percent area harvested is approximately 8%.

3.3. Additional management activities data

In addition to estimating the impact of timber harvesting, the impacts of several other management activities on campgrounds are estimated. Estimating the impacts of these other activities on camping allows us to compare the magnitude of campers' responses to less intensive activities. These activities include brush disposal, hazardous fuel reduction, and IRR. Brush disposal is the cleaning up of left behind brush and other debris resulting from cutting operations (USFS, 2022a). Hazardous fuel reduction projects are aimed at reducing the severity of wildfires by reducing or altering the amount of living or dead fuel through methods such as burning or mechanical treatments (USFS, 2022b). IRR projects include areas treated to sustain watersheds, and treatments can include harvesting, the removal of noxious or invasive plants, or hazardous fuels reduction outside of the wildland-urban interface (USFS, 2022c).

Like timber harvesting data, variables of interest in these datasets include the geometry of each activity and dates of operations. Again, campgrounds impacted by these activities are determined, and the proportion of impacted area within each buffer is calculated.

3.4. Capacity utilization

To create a utilization measure for each campground and year, reservation data for each campsite within the study area are compiled by year.[2] Average utilization is calculated by determining the total number of sites available at a given campground compared to the average number of sites reserved per day. Thus, each campground has one capacity utilization number per year. The data do not include walk-up reservations. Although the number of walk-up reservations to USFS campgrounds is likely a significant portion of campers, to our knowledge, there is no comparable comprehensive dataset detailing these

[2] Following Shartaj and Suter (2020), yearly reservation data is compiled between May 15th to September 15th as nearly all reservations on recreation.gov take place within this range.

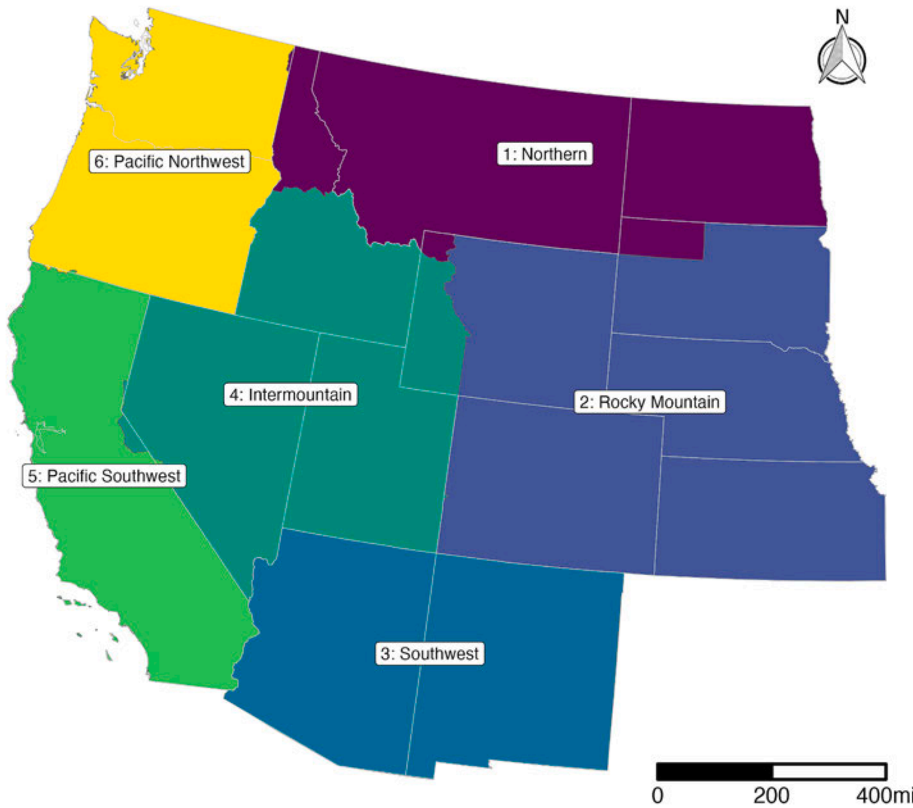

Fig. 1. Map of the USFS regions included in this study.

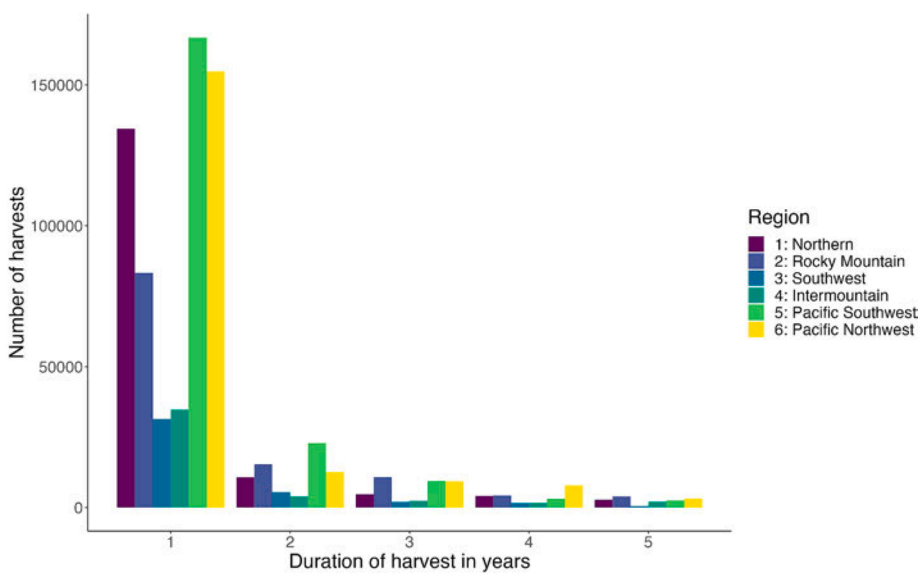

Fig. 2. Duration of timber harvests within 5 kms of campgrounds in the study area, classified by region.

records.

Following Shartaj and Suter (2020), average campsite capacity utilization for campground i in year t is:

$$Capacity\ utilization_{it} = \frac{Campsites\ reserved_{it}}{Campsites\ available_{it}}$$

Campground utilization is a proportion between 0 (no campsites were booked through recreation.gov all season) and 1 (all campsites available for reservation at the campground were reserved every night of the season). Fig. 5 depicts the average capacity utilization of all campgrounds in the Western U.S. On average, approximately one-third of reservable campground sites are reserved. In over half of the regions, average capacity utilization is equal or higher in campgrounds without harvesting nearby (Regions 2: Rocky Mountain, 4: Intermountain, 5: Pacific Southwest, and 6: Pacific Northwest) (Fig. 5).

Furthermore, campground utilization from recreation.gov users has been increasing over the study period. Fig. 6 depicts the evolution of average campground capacity utilization over time in each region. In every region, utilization has increased from 2008 to 2018.

Table 1
Timber harvest methods, adapted from Cook (2014); USFS (n.d.-d).

Clearcut	Shelterwood	Selection
Removes essentially all trees in a stand	Some sheltering trees remain after tree removal	Removes select individual or groups of trees
One operation	Several successive operations	Many individual operations
Produces a new age class	Produces several age classes	Little impact to age classes
Most visually extreme	Moderate visual impact	Least visually extreme
Mainly used for extractive purposes	Used for both extractive purposes and forest health	Mainly used for forest health to remove invasive or unhealthy trees

4. Model

To estimate how timber harvests impact changes in individual campground capacity utilization over time, we estimate several separate panel fixed effect models. Each model includes campground and year fixed effects, and standard errors are clustered by campground. The campground fixed effects account for all time-invariant factors at a given campground, such as campground amenities, nearby recreation opportunities, or other attractiveness-related factors, so that the impacts of harvesting can be isolated and identified. The clustering of standard errors accounts for the fact that capacity utilization at each campground is correlated with itself from year to year.

First, a base model is estimated using all harvests in all regions (Equation (1)). The econometric specification is:

$$Y_{it} = \beta_1 X_{it} + \alpha_i + \gamma_t + \epsilon_{it} \tag{1}$$

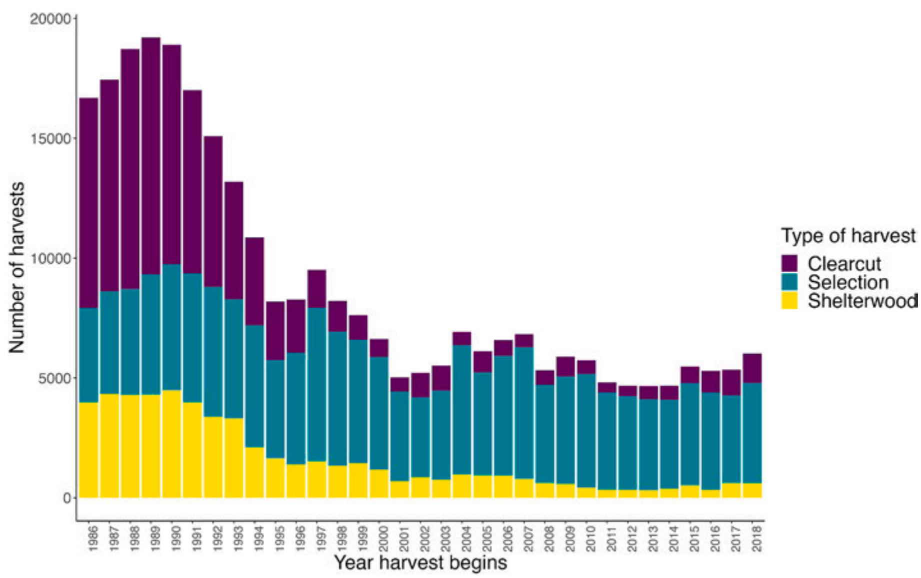

Fig. 3. Number of harvests per year from 1986 to 2018 in the Western U.S.

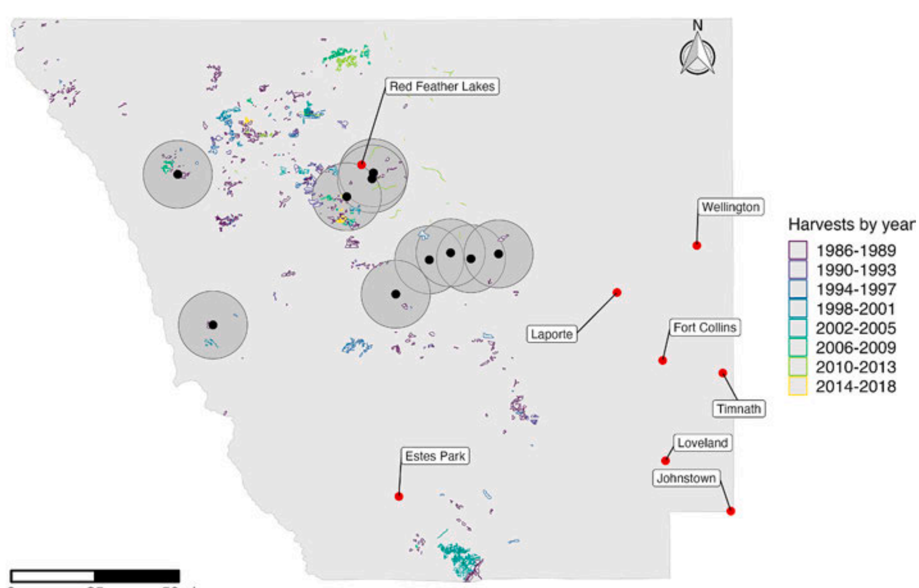

Fig. 4. Timber harvests and all campgrounds in Larimer County, Colorado. Treated campgrounds are indicated by black points. 5-km buffer areas are indicated by gray circles around each treated campground point. Towns and cities are labeled and indicated by red points.

Table 2
Number of campgrounds per year by region with harvesting activity nearby.

Year	Region 1	2	3	4	5	6	Total
1986	104	82	8	33	134	197	558
1987	105	91	21	23	109	188	537
1988	101	63	20	33	116	180	513
1989	93	78	29	33	114	178	525
1990	90	68	27	47	132	192	556
1991	98	66	21	24	124	184	517
1992	91	61	18	29	99	169	467
1993	84	54	23	28	73	156	418
1994	75	41	16	28	64	132	356
1995	86	32	12	26	40	110	306
1996	75	37	5	21	52	117	307
1997	79	37	5	28	69	111	329
1998	54	29	13	48	92	110	346
1999	56	32	13	28	92	72	293
2000	45	38	16	28	87	76	290
2001	36	26	14	21	71	63	231
2002	59	29	3	20	68	51	230
2003	48	30	10	17	67	74	246
2004	53	27	15	24	63	105	287
2005	48	28	13	12	52	90	243
2006	38	23	13	25	84	92	275
2007	38	28	11	27	74	82	260
2008	36	38	10	26	54	50	214
2009	37	50	5	39	49	57	237
2010	41	60	19	47	47	69	283
2011	55	55	18	49	61	76	314
2012	45	58	5	63	54	98	323
2013	43	66	17	42	42	93	303
2014	42	56	22	41	23	77	261
2015	49	43	25	35	40	80	272
2016	46	45	21	36	51	79	277
2017	40	54	13	38	54	61	260
2018	30	39	15	27	39	45	195
Total	2020	1564	496	1046	2390	3514	11030

Note: The horizontal line between 2007 and 2008 indicates when the reservation database allows for the analysis of impacted campgrounds.

where Y_{it} is the capacity utilization of campground i in year t, X_{it} is the proportion of the area near campground i that contains a timber harvest in year t, β_1 is the coefficient for the proportion of buffer harvested variable, α_i is a campground fixed effect, γ_t is a year fixed effect, and ϵ_{it} is the error term.

Next, we separate harvesting impacts by harvest type k (clearcut = C, shelterwood = W, selection = L) (Equation (2)). This econometric specification is:

$$Y_{it} = \beta_C X_{it,C} + \beta_W X_{it,W} + \beta_L X_{it,L} + \alpha_i + \gamma_t + \epsilon_{it}, \tag{2}$$

where Y_{it} is the capacity utilization of campground i in year t, $X_{it,k}$ is the proportion of the area near campground i that contains harvest type k in year t, β_k is the coefficient for the harvest type k variable, α_i is a campground fixed effect, γ_t is a year fixed effect, and ϵ_{it} is the error term.

Then, we separate harvesting impacts by region (Equation (3)). This econometric specification is:

$$Y_{it} = \sum_{n=1}^{6} \beta_n X_{it,n} + \alpha_i + \gamma_t + \epsilon_{it}, \tag{3}$$

where $n = 1:6$ for Regions 1 through 6, Y_{it} is the capacity utilization of campground i in year t, $X_{it,n}$ is the proportion of the area near campground i that contains a timber harvest in year t in Region n, β_n is the coefficient for the timber harvesting variable for each Region n, α_i is a campground fixed effect, γ_t is a year fixed effect, and ϵ_{it} is the error term.

We then model the lagged impacts of timber harvesting activity to investigate whether impacts persist in the years following harvesting activity (Equation (4)). This econometric specification is:

$$Y_{it} = \sum_{j=0}^{J} \beta_j X_{it-j} + \alpha_i + \gamma_t + \epsilon_{it}, \tag{4}$$

where Y_{it} is the capacity utilization of campground i in year t, X_{it} is the proportion of the area near campground i that contains a timber harvest in year t, β_j are a series of coefficients for the lagged timber harvest variables to account for up to J years after a timber harvest, α_i is a campground fixed effect, γ_t is a year fixed effect, and ϵ_{it} is the error term.

Finally, the impact of three additional USFS management activities are estimated using a similar model to the base regression (brush disposal = B, hazardous fuel = H, IRR = R) (Equation (5)). These models are included to compare the magnitudes of impacts to campgrounds by other management activities to the impacts of timber harvesting. This econometric specification is:

$$Y_{it} = \beta_B X_{it,B} + \beta_H X_{it,H} + \beta_R X_{it,R} + \alpha_i + \gamma_t + \epsilon_{it}, \tag{5}$$

where Y_{it} is the capacity utilization of campground i in year t, $X_{it,M}$ is the proportion of the area near campground i that contains management activity M in year t, β_M is the coefficient for activity M, α_i is a camp-

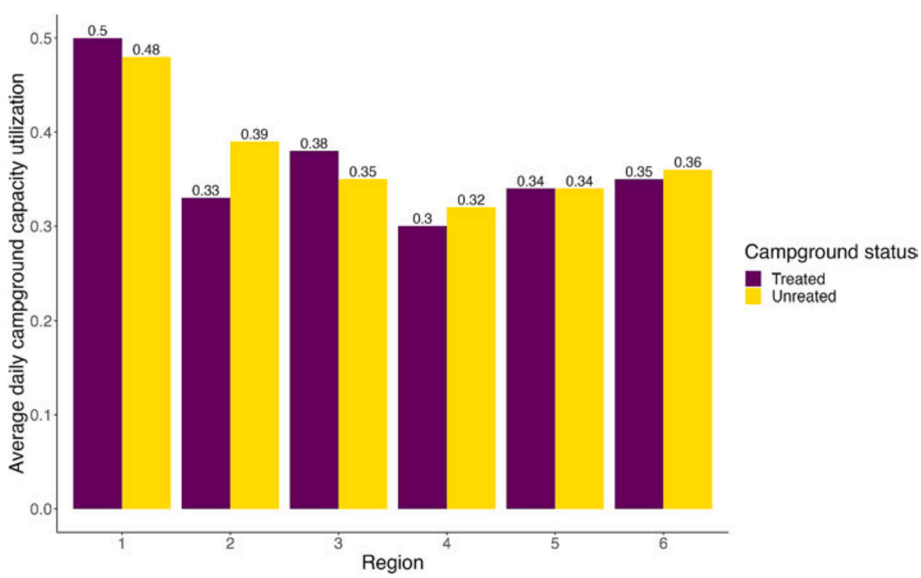

Fig. 5. Average campground capacity utilization across all western regions and all campgrounds, treated vs. untreated, with timber harvesting activity.

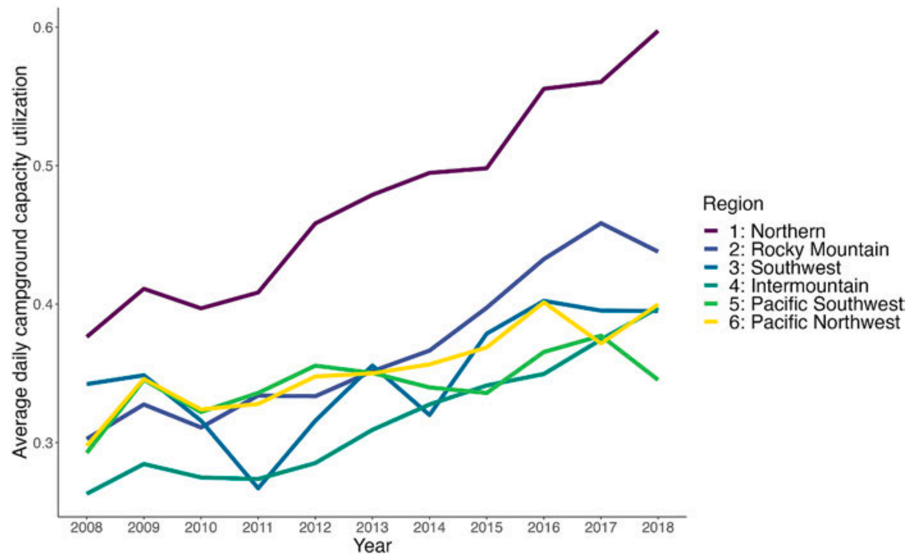

Fig. 6. Average campground capacity utilization for campsites available for reservation across regions and campgrounds (both treated and untreated) over time.

ground fixed effect, γ_t is a year fixed effect, and ϵ_{it} is the error term.

We also performed several robustness checks to investigate our assumptions about which campgrounds were included in the study (restrict to include only campgrounds available for reservation from 2008-2018), how the size of the buffer area impacted our results (change the buffer size to 2km or 10km), and which harvests were included in the lag models (restrict to only harvests lasting one year).

5. Results

Coefficient estimates from the base model are reported in Table 3 and show that the proportion of harvested area within the buffer around a campground reduces capacity utilization in the year a harvest takes place. The base model shows that at the aggregate level, visitors to national forests are changing their camping behavior because of nearby timber harvesting. In the base model, campgrounds are allowed to enter the dataset as they become available to reserve online through recreation.gov. A robustness check that includes only campgrounds available for reservation over the entire duration of study yields similar results to the base model. Therefore, we can conclude that results are not primarily driven by campgrounds entering and exiting the dataset, rather they are driven by individuals' responses to nearby harvesting.

Next, we estimate a model that segments harvesting activity into three types of harvest: clearcut, shelterwood, and selection. Results from the model separated by harvest type show that all harvest types have negative point estimates, but only the selection method has a significantly negative impact on campground utilization (Table 4). The clearcut point estimate is the largest, although it also has a high standard error given the relatively small number of observations (less than half of impacted campgrounds have a clearcut nearby, while over 75% of impacted campgrounds have a selection cut nearby). The results for the selection method are similar to the base regression results, but of slightly smaller magnitude.

Next, we separate campgrounds and harvests by USFS Region to see whether there are regional differences in timber harvesting impacts. We estimate this model both with and without controlling for the type of harvesting done by region. Controlling for the type of harvesting done by region could inform us if any differences observed between regions are driven by regional harvesting trends or by something else. Results from these models separated by region reveal timber harvesting's impact on campground utilization is heterogeneous across the Western U.S. Timber harvests have negative and significant impacts in Regions 1 (Northern) and 2 (Rocky Mountain), but no other region has significant coefficient estimates (Table 5). Separating by region reveals that campers' responses to nearby harvesting varies by region. When the variable controlling for type of harvesting done by region is included, there is very little change to the point estimates. This suggests that regional differences in campground capacity utilization are due to something other than the type of harvesting done by region.

Next, we estimate the model in Equation (4) to see whether impacts to campground demand persist in the years following harvesting activity. If reductions in campground demand persist, gateway communities dependent on the economic stimulation from visitors will be negatively impacted for a longer period of time. For this model, each timber harvest is counted only in the fiscal year it is awarded, rather than allowing

Table 3
Campground capacity utilization, harvesting nearby.

	Capacity utilization
Proportion harvested	−0.204**
	(0.080)
Observations	2940
Fixed effects	*Campground & year*
R^2	0.004
Adjusted R^2	−0.367
F Statistic	7.622***
	(df = 1; 2143)

Note: *p<0.1; **p<0.05; ***p<0.01.

Table 4
Capacity utilization, separated by harvest type.

	Capacity utilization
Clearcut	−0.638
	(0.434)
Shelterwood	−0.189
	(0.662)
Selection	−0.146*
	(0.085)
Observations	2940
Fixed effects	*Campground & year*
R^2	0.004
Adjusted R^2	−0.367
F Statistic	3.201**
	(df = 3; 2141)

Note: *p < 0.1; **p < 0.05; ***p < 0.01.

Table 5
Capacity utilization, separated by region.

	Capacity utilization	
	Without clearcut control	With clearcut control
Region 1	−1.133**	−1.130**
	(0.527)	(0.525)
Region 2	−0.207*	−0.207*
	(0.118)	(0.118)
Region 3	−0.114	−0.116
	(0.103)	(0.103)
Region 4	−0.036	−0.034
	(0.153)	(0.153)
Region 5	−0.726	−0.719
	(0.527)	(0.527)
Region 6	0.181	0.183
	(0.283)	(0.283)
Proportion clearcut	–	−0.003
		(0.015)
Observations	2940	2940
Fixed effects	*Campground & year*	*Campground & year*
R^2	0.008	0.008
Adjusted R^2	−0.364	−0.365
F Statistic	2.771**	2.389**
	(df = 6; 2138)	(df = 7; 2137)

Note: *p < 0.1; **p < 0.05; ***p < 0.01.

harvest activity to occur in multiple years. Results reveal a significant negative response in campground utilization during the year of harvesting operations and strong evidence suggesting lasting impacts in the year following harvesting activity (Table 6). However, negative impacts to campground utilization are not observed past a one-year lag. Table 6 shows several iterations of the lagged impacts model, starting with a model that includes only the year a harvest occurs (results are in the "No lags" column), then adding on one-year lagged impacts ("1 year" column), three years of lagged impacts ("3 years" column"), and finally five years of lagged impacts ("5 years" column). The results in Table 6 suggest that individuals' demand for campgrounds continues to be impacted even after operations have ceased.

However, as stated previously, harvests are only counted as the year they are awarded, so continued operations in subsequent years are unaccounted for. To test whether results from this model are driven by harvests lasting multiple years, we estimate a model that includes only harvests lasting one year and exclude harvests that occur over multiple years but find no significant impacts to campground utilization in any iterations of this model. Therefore, harvests lasting one year are not driving the results observed in the lagged model. However, this does not answer the question of whether results from the lagged model in Table 6 were observed because of the lasting aesthetic impacts to campgrounds from harvesting or from harvests lasting multiple years, which requires further research.

Table 6
Capacity utilization, including several year lags.

	Capacity utilization			
	No lags	1 year	3 years	5 years
Harvest year	−0.248***	−0.255***	−0.255**	−0.220**
	(0.093)	(0.095)	(0.102)	(0.095)
1 lag	–	−0.227***	−0.241***	−0.213**
		(0.086)	(0.086)	(0.089)
2 lags	–	–	0.075	0.099
			(0.106)	(0.102)
3 lags	–	–	−0.091	−0.108
			(0.155)	(0.150)
4 lags	–	–	–	0.218
				(0.134)
5 lags	–	–	–	0.333
				(0.240)
Observations	2157	2157	2157	2157
Fixed effects	*Campground & year*	*Campground & year*	*Campground & year*	*Campground & year*
R^2	0.003	0.006	0.007	0.009
Adjusted R^2	−0.675	−0.671	−0.673	−0.672
F Statistic	4.497**	3.961**	2.102*	1.931*
	(df = 1; 1283)	(df = 2; 1282)	(df = 4; 1280)	(df = 6; 1278)

Note: *p < 0.1; **p < 0.05; ***p < 0.01.

Finally, we analyze the impact of three other USFS management activities on campground demand, which allows us to compare the magnitude of the impact of these activities to the impact of harvesting. In Table 7, the impacts of brush disposal activities, hazardous fuel reduction treatments, and IRR on nearby campground capacity utilization are estimated. Activities are counted as the year they are awarded. The results from these models show that hazardous fuel reduction treatments and IRR activities negatively impact nearby campground capacity utilization, while the coefficient on brush disposal is not statistically significant from zero. These USFS activities may not be mutually exclusive to timber harvesting. For instance, brush disposal activities often take place after a harvest has been completed and debris remains in the impacted area. Compared to timber harvesting, the magnitude of impacts to campgrounds by these other activities is much smaller. Timber harvesting appears to impact campground demand more than these other USFS activities.

Additionally, we tested whether the size of the buffered area around campgrounds affects our results. The 5-km buffer was chosen to capture the area near a campground that is easily accessible on foot which can contribute to the attractiveness of a campground. However, depending on land cover, location, recreation opportunities nearby, individual preferences, or other factors, campers may explore a larger or smaller area around their campsite. Therefore, we both contract the buffer to 2 kms and expand it to 10 kms. Campground utilization is not significantly impacted by nearby harvesting when the buffer is contracted to 2 kms. These results may be in part driven by fewer harvests taking place within a 2-km buffer than a 5-km buffer (1521 versus 2940 impacted campgrounds, respectively). Furthermore, a 1% change in a 2-km buffer (0.1257 square kms) is less than a sixth of the size of a 1% change in a 5-km buffer (0.7854 square kms). When the buffer is expanded to 10 kms, we observe a negative, significant, and larger coefficient on campground capacity utilization compared to the 5-km buffer (campground utilization decreases by 0.3 percentage points with the 10-km buffer, compared to a 0.2 percentage point decrease with the 5-km buffer). This makes intuitive sense because a 1% change in a 10-km buffer (3.142 square kms) is a much larger area than a 1% change in a 5-km buffer (0.7854 square kms). These results show that a larger negative response to campground demand is observed when a larger area of impact is included. The highly localized campground aesthetics are not necessarily the largest driving factor of individuals' decisions.

Table 7
Capacity utilization, other activities nearby: brush disposal activities, hazardous fuel treatment reduction, and IRR.

	Capacity utilization
Brush disposal	0.046
	(0.057)
Hazardous fuel	−0.060***
	(0.021)
IRR	−0.034***
	(0.010)
Observations	8648
Fixed effects	*Campground & year*
R^2	0.003
Adjusted R^2	−0.204
F Statistic	6.462***
	(df = 3; 7164)

Note: *p < 0.1; **p < 0.05; ***p < 0.01.

6. Discussion

This work adds to the literature that individuals change their recreation and leisure location based on the attractiveness of a site (Grande, 2021; Lee, 2020; Ma et al., 2021; Saló et al., 2020), the literature that explores campground management and demand (Ma et al., 2020, 2021; Rice et al., 2019), and the literature on spatial and temporal interactions of timber harvesting and recreation (Eggers et al., 2018; Harshaw & Sheppard, 2013).

However, there are several limitations of this work. First, the RIDB dataset is limited in that it only includes data for campsite reservations made through recreation.gov or entered by campground managers for same-day reservations (Shartaj & Suter, 2020; Shartaj et al., 2022; Rice et al., 2019). Therefore, walk-up visitation to campgrounds is largely excluded from this study. Similarly, reservations made through recreation.gov only indicate the intent to camp, not actual camping behavior, so we cannot be certain that individuals who reserved campsites showed up for their reservations (Shartaj et al., 2022).

Additionally, the decisions the USFS makes on the location of timber harvests may impact the validity of our results. The models used in this study essentially assume that timber harvesting, the primary independent variable, occurs randomly. If harvesting occurs in random locations, then the coefficient estimates from our models could reasonably be seen as causal estimates. However, harvesting decisions are likely not random, and the USFS may consider recreation opportunities when deciding which land is suitable for harvesting. If this is the case, our models would have a problem with causal identification. For example, upward bias may occur if the USFS chooses to harvest near campgrounds that are expected to have the lowest utilization in the coming years (potentially to avoid high-use recreation areas and keep campgrounds natural-looking), the econometric models would show harvesting is associated with lower utilization. In this case, harvesting did not cause low utilization, rather low utilization caused harvesting. Conversely, downward bias of our results may exist as well if, for example, the USFS chooses to harvest near campgrounds that are expected to have the highest utilization (potentially to reduce wildfire risk) then the models would show that harvesting is associated with higher utilization. In this case, harvesting did not cause high utilization, rather high utilization caused harvesting. The likelihood of this type of downward bias may be greater than that of upward bias, as fire mitigation and campground maintenance have become more pressing operations for the USFS in recent years.

Next, this research finds that reservations for campgrounds with timber harvesting nearby decrease during operations. However, we have no information on how individuals know there is harvesting nearby when they make a reservation. Possibilities of how they obtain knowledge of nearby harvesting could include online reviews from other campers, living nearby the campground with harvesting, or having camped at a site with harvesting nearby previously. Further research is needed to understand the link between the information campers have and reservations.

Finally, the empirical analysis does not consider time-variant factors that may impact a campground's attractiveness beyond timber harvesting, due in-part to a lack of data on these factors. This should not, however, bias our empirical results on the impact of harvesting as long as the time-variant factors are not correlated with harvesting decisions.

7. Conclusions and management implications

Through the interaction of USFS historical timber harvesting data and RIDB campground reservation data, we explored several variables that can influence campground demand. We find significant negative effects to campground utilization during harvest operations in the Western U.S. within a 5-km buffer around campgrounds, and responses to harvesting activity are heterogeneous across USFS Regions. Furthermore, evidence suggests that campground utilization is impacted up to one year after harvesting occurs. Other forest management activities undertaken by the USFS appear to be less impactful to campground utilization than timber harvesting.

Overall, visitors to national forests are changing their camping behavior in response to timber harvesting, indicating potential decreases in welfare. If visitors choose not to camp because of a timber harvest nearby, they may miss out on positive benefits derived from outdoor recreation, such as exercise and health effects and connection to nature (Hartig et al., 2014; Schreyer & Driver, 1989; Frumkin et al., 2017; Winter et al., 2019). The physical attributes of the land affected by timber harvested near a campground reduce the capacity utilization of that campground.

Additionally, decreases in campground visitation may have significant effects on nearby tourism-dependent gateway communities. Due to the reduction in individuals deciding to recreate at certain campgrounds because of timber harvesting, fewer individuals may make recreation trips to the impacted area, and spending in gateway communities near those campgrounds may decrease. This has direct, indirect, and induced economic impacts. The negative impact of timber harvesting on camping reservations represents a complex cost to local communities.

There are several policy implications from the insights provided in this analysis. First, because individuals were found to decrease their reservations at campgrounds with harvesting nearby, if the USFS seeks to not impede camping on its lands by altering the attractiveness of a forest through harvesting, they may alter their plans on harvest locations. The USFS could place more weight on considering the location of campgrounds while planning harvesting activities, and potentially locate harvests further from campgrounds. Second, because alternative forms of forest management were found to have a smaller impact on campground demand than timber harvesting, the USFS may not have to consider the location of campgrounds as heavily while planning the locations of these less-intensive operations. Alternatively, because many of the less-intensive operations are aimed at restoration (like IRR) or creating a landscape more resilient to wildfire (like hazardous fuels reduction), the USFS may even consider locating these operations closer to campgrounds to prevent future, potentially even more aesthetically-damaging, harm to campgrounds, like wildfire. Finally, local tourism-dependent economies may feel the effects of decreased visitation to certain campgrounds due to nearby timber harvesting. Thus, there may be potential benefits for coordination among the USFS and gateway communities during the harvest planning process to ensure gateway communities can advocate for tourism to their localities.

There are several future directions to build on this study. First, different spatial definitions of what is considered "near" a campground could be explored (i.e., alternative buffers). The circular buffer was chosen for both ease of analysis due to the large geographical area this study covers and to capture the area around a campground that could be easily accessed on foot. However, other factors, such as roads, proximity to urban areas, hillshade, landcover, or proximity to major recreation destinations, may alter the demand of areas nearby campgrounds. Unique buffers for each campground based on their surroundings may provide further insights, though this was outside of the scope of this analysis. Second, this analysis excludes data past 2018 due to changes in the data structure which made it difficult to compare 2006–2018 data to 2019 and newer data. Additional research could alter the methods of analyzing the reservation data to include observations from more recent years. Additionally, as previously mentioned, further research is needed to understand how campers know that there is harvesting nearby certain campgrounds when they are making reservation decisions. Finally, our analysis uses an annual measure of campground utilization, so we are not able to directly evaluate seasonal impacts of harvesting on campground demand. Future research could do more to evaluate how harvesting activities during specific times of the year influence subsequent camping over the course of the year, as past research has shown the importance of seasonality in recreation decisions (Ma et al., 2020, 2021; Rice et al., 2019; Saló et al., 2020).

CRediT authorship contribution statement

Kelly Wallace: Conceptualization, Methodology, Software, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Jordan Suter:** Conceptualization, Methodology, Writing – review & editing, Supervision, Funding acquisition. **Daniel W. McCollum:** Conceptualization, Writing – review & editing, Supervision, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

Data availability

Data will be made available on request.

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