Comments Supporting
"Back Country Area High Conservation Value Forest (HCVF) Proposal Morgan-Monroe State Forest"[1]

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Abstract

The Knobstone Hiking Trail Association (KHTA) has reviewed the Proposal and finds that a High Conservation Value Forest (HCVF) in Brown and Monroe Counties, Township 10 North, Range 1 East, including portions of Sections 1, 2, 11, 12, 13, 14, 23, 24, 25, and 26, would be an asset to the Tecumseh Trail and for the trail system to which it connects. KHTA endorses the Proposal without reservation.

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1 Introduction

Knobstone Hiking Trail Association: The Knobstone Hiking Trail Association (KHTA) formed with the Vision of establishing the Knobstone Trail as the premier hiking trail in Indiana, a high-quality contribution to the network of hiking trails in the USA. Our Mission includes completion of the KT along the best possible route, maintenance and improvement of the KT, providing guidance and assistance to KT hikers, and promotion of the KT within the state and nationally.[2] In consequence, the Knobstone Trail (KT) – a regional asset extending through eight counties in South Central Indiana – will provide the highest-quality wilderness hiking experience and the *greatest possible value* to the citizens of Indiana.

Tecumseh Trail: The Tecumseh is a forested hiking trail extending 42 miles through the Morgan-Monroe Yellowwood SF Complex. It is also the northern-most segment of the 160 mile Knobstone Trail, a regional resource extending from Morgan-Monroe SF headquarters, Morgan County, to Deam Lake in Clark SF, Clark County. As a **recreational resource** the Tecumseh Trail provides a venue for day hikers, long distance hikers, runners, and observers of nature. As a **cultural resource** the Tecumseh is an acknowledgement of the Native Americans who inhabited this land prior to arrival of European settlers. It is named after a great chief of the Shawnee nation, descendants of which presently reside in Indiana, including in Morgan and Brown counties.[3] The trail is serviced by volunteers from among the citizens of Indiana.

[1] Submitted on behalf of the Knobstone Hiking Trail Association (KHTA) by Randall Pflueger, PhD.

[2] *Comment on the proposed Houston South Vegetation Management and Restoration Project*, December 12, 2018, submitted on behalf of the Knobstone Hiking Trail Association.

[3] Private communication between KHTA and Shawnee residents of Brown County.

2 HCVF Impact on the Tecumseh Trail

Impact on Aesthetic and Recreational Value: Benefits to the Tecumseh deriving from the HCVF, both aesthetic and recreational, are readily anticipated and understood. The Tecumseh winds for 3 miles through the heart of the proposed HCVF. If adopted the HCVF will provide a buffer to visual impacts from harvesting and other management interventions ongoing in MMY SF complex. In the short term, the aesthetic experience of hiking, or running, on this section of trail will be protected. In the course of time, as the ecosystem ages, this protection will remain but the aesthetics will more closely reflect those of a late seral forest and the effects of natural forces to which the ecosystem must adapt.

Recreational value of the Tecumseh and Knobstone trails will be enhanced through close association with the HCVF. Hikers, runners, and observers of nature will appreciate the opportunity to view a large section of unmanaged forest while traversing part (or all) of a regional point-to-point trail. How runners view the Tecumseh Trail is mentioned in a recent open letter by D.IN.O, organizer of the Tecumseh Trail Challenge 50 km, Marathon, Half-marathon, and Quarter Marathon trail runs. *"The Tecumseh Trail is one of precious few long-distance forested foot trails in Indiana,"* and *"The Tecumseh Trail Challenge brings hundreds of out-of-town guests that lodge, dine, and shop in Nashville, Columbus, Bloomington, and surrounding areas. The Tecumseh Trail Challenge is considered a "must-do", classic event for trail runners in Indiana and beyond."*[4]

2.1 HCVF Impact on Tecumseh Trail Cultural Value

Understanding cultural impact from the principle objective for creating the HCVF – establishment of a reserve sheltering a wide variety of species important to Indiana within an intact forest ecosystem (c.f. Watson [5]) – is facilitated by close examination of what is being proposed.

Significant High Conservation Value Attributes: The Proposal points to four High Conservation Value attributes as having particular importance.

1. Opportunity to develop large tract of interior forest as Type 2 Old Growth.
2. Represents a high quality plant community.
3. Habitat for state threatened and state endangered species.
4. Opportunity to enhance existing nature preserve.

These four attributes, specifying a diverse, high quality plant community *including* state threatened and endangered species, sheltered within 2380 contiguous acres of Old Growth forest preserve, are fully explained in pages 2–4 of the Proposal. The first of these, development of Type 2 Old Growth, depends upon processes regulating **convergence** and **adaptation.**

2.1.1 Gauging convergence

Convergence of forests to Old Growth conditions has been studied extensively. Planning for, and assessment of, Old Growth recovery is discussed by Tyrrell [6], and by Trombulak. [7] The set of parameters characterizing the state of a forest and the rate of adaptation to stress is large (c.f. Johnson [8]).

[4] Passages quoted from *An open letter to Indiana Railroad, Brown County Commissioners, Indiana DNR, and all involved with the closure of Indian Hill Road south of IN45*, issued August 9, 2021 by DINO LLC, 6894 N 400 W, McCordsville IN, 46055. For further description, and photos, of DINO Tecumseh Trail running events see `http://www.dinoseries.com/tecumseh-trail-marathon/`

[5] James E.M. Watson. "The exceptional value of intact forest ecosystems". In: *Nature Ecology & Evolution* 2 (2018), pp. 599–610.

[6] Lucy E. Tyrrell. "National forest in the Eastern Region: Land allocation and planning for old growth". In: *Eastern Old-Growth Forests: Prospects For Rediscovery And Recovery.* Ed. by Mary Byrd Davis. Washington, DC: Island Press, 1996. Chap. 17, pp. 245–273.

[7] Trombulak. "The Restoration of Old-Growth: Why and How". In: *Eastern Old-Growth Forests: Prospects For Rediscovery And Recovery.* Ed. by Mary Byrd Davis. Washington, DC: Island Press, 1996. Chap. 21, pp. 305–320.

[8] "Because forests are "open systems," they are continually responding to forces originating from both within and outside the forest itself. Unlike a tree seedling in a growth chamber with precisely fixed growth conditions, trees and other organisms in a forest must continually adjust to changing conditions, many of which are unknown or only occur

Further research on such parameters will refine and extend the range of metrics for assessing convergence. For instance, means for assessing convergence to an Old Growth condition is suggested in a report by Spetich and Parker on evolution of biomass in Indiana Old Growth forests. [9] The character of species inventories, and the integrity and extent of forest mycorrhizal networks (see § 2.1.2.2 in this report) reflect other measures for gauging convergence towards a Type 2 Old Growth state.

2.1.2 Mechanisms for adaptation

Plant community adaptation within a natural forest depends on (1) mechanisms underlying selection and transmission (i.e. heritability) of genotype and phenotype, and (2) on the co-evolving mycorrhizal networks which influence these mechanisms. [10]

2.1.2.1 Genomic and phenotypic plasticity, and heritability Following work by McClintock [11] a more complex and accurate view of heredity has emerged in which adaptation by a species is thought to depend upon a combination of two canonical mechanisms – classical (regulated by exchange of genetic material among individuals) and non-classical (regulated by *epigenetic* processes within single individuals). These following excerpts from recent reports in the technical literature on genetic processes underlying adaptation suggest urgency for, and the direction of, further research on mechanisms of heredity underlying adaptation in Old Growth forests.

1. From Browne *et al.* [12], "Epigenetic modifications are a potential mechanism for long-lived species like trees to cope with rapidly changing environmental conditions within their lifespan. Indeed, variation in DNA methylation, one of the most well-studied epigenetic modifications, has been shown to be associated with ecologically and evolutionarily important phenotypic traits like flowering time and growth in short-lived species, although much less is known for tree species... **we still lack an understanding of the associations between epigenetic variation, gene expression, and phenotypic traits in trees, which are among the most ecologically and economically important plant taxa."**

2. From Braütigam *et al.*, [13] "Forest trees are long-lived organisms with complex life cycles, which must contend with a variable environment over their long lifetimes. The long generation times impose limits on natural selection under rapidly changing climate conditions. Consequently, trees must be highly adaptable, displaying a wide range of phenotypes as a function of their environments, known as **phenotypic plasticity.** Phenotypic plasticity is likely to be of great importance for both individual trees and forest populations over near- and long-term time scales." [14] "Epigenetic variation is likely to contribute to the **phenotypic plasticity and adaptative capacity of plant species, and may be especially important for long-lived organisms with complex life cycles, including forest trees.** Diverse environmental stresses and hybridization/polyploidization events can create reversible heritable epigenetic marks that can be transmitted to subsequent generations as a form of molecular "memory". Epigenetic changes might also contribute to the ability of plants to colonize or persist in variable environments." [15]

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probabilistically. The list of factors that can change are indeterminate, i.e., they are so numerous and often unknown that we are unable to list all of them even for a single acre of forest. They include both physical and biological factors. Some factors produce effects that are sudden and result in major changes, while others operate more slowly and subtly." Paul Johnson. "Thinking about oak forests as responsive ecosystems". In: *Upland oak ecology symposium: history, current conditions, and sustainability.* Ed. by Martin A. Spetich. Tech . Rep. SRS-73. Asheville, NC: U. S. Department of Agriculture, Forest Service, Southern Research. 2004, pp. 13–18.

[9] Martin A. Spetich and George R. Parker. "Distribution of Biomass in an Indiana Old-growth Forest from 1926 to 1992". In: *American Midland Naturalist* 139 (1998), pp. 90–107.

[10] Scott F Gilbert et al. "Symbiosis as a source of selectable epigenetic variation: taking the heat for the big guy". In: *Philosophical Transactions of the Royal Society B: Biological Sciences* 365.1540 (2010), pp. 671–678.

[11] Barbara McClintock. "The significance of responses of the genome to challenges". In: *Science* 226 (1984). Text of Nobel lecture, 8 December, 1983. Stockholm, Sweden, pp. 792–801.

[12] Luke Browne et al. "Experimental DNA Demethylation Associates with Changes in Growth and Gene Expression of Oak Tree Seedlings". In: *G3 Genes—Genomes—Genetics* 10 (Mar. 2020), pp. 1019–1028

[13] Katharina Braütigam et al. "Epigenetic regulation of adaptive responses of forest tree species to the environment". In: *Ecology and Evolution* 3.2 (2013), pp. 399–415.

[14] ibid., p.401.

[15] ibid., p. 399

"Despite this, knowledge of the extent and underlying mechanisms of phenotypic plasticity in response to a variety of stress responses and developmental traits in trees is rudimentary" [16]

3. Similarly, from Johannes *et al.* [17], "The heritable basis of complex traits is classically thought to rest solely on the transmission from parents to offspring of multiple DNA sequence variants that are stable and causative. However, accumulating evidence suggests that this view may be too restrictive ...,"
however,
"... there has been little effort to date to quantify the impact of epigenetic factors on complex traits and to assess their role in the creation and maintenance of phenotypic diversity in experimental or natural settings." [18]

4. Finally, from Miryeganeh and Saze [19]: "Heritability of phenotypic variation determines the potential for evolutionary change of affected traits. Plants often show phenotypic plasticity in natural environments, where the same genotype expresses different phenotypes under different conditions, contributing to **adaptation and evolution...,"**
however,
"There have been many studies about epigenetic modifications and their impacts on traits ...
still very little is known about potential phenotypic and ecological consequences of epigenetic variation in natural plant populations." [20].

2.1.2.2 Stimulus of adaptive mechanisms by mycorrhizal networks Recent research indicates the central function of mycorrhizal networks (MNs) in mediating plant adaptation based on ambient conditions. *"Adaptive behaviour of plants, including rapid changes in physiology, gene regulation and defence response, can be altered when linked to neighbouring plants by a mycorrhizal network (MN). Mechanisms underlying the behavioural changes include mycorrhizal fungal colonization by the MN or interplant communication via transfer of nutrients, defence signals or allelochemicals."*[21] It is known *"...that symbiotic plants activate defense mechanisms more quickly than non-symbiotic plants after pathogen chellenge,"*[22] Two themes common to all of the (very recent) articles consulted for these comments, on the role of MNs within plant communities, are (1) that mediating function has been established (at least) by correlations arising from experiments, but that (2) mechanisms underlying these correlations are not yet determined. In particular, there are many hypotheses yet untested through long term observation of natural forest ecosystems.

2.1.2.3 Implications for the HCVF As is presently understood, and is the object of increasing research effort, mechanisms mediated by forest mycorrhizal networks and species-specific epigenetic capacities are fundamental in adapting to ambient stresses – environmental or competitive – experienced by natural plant populations. Research cited in § 2.1.2.1 and § 2.1.2.2 points to (1) well-supported hypotheses regarding basic mechanisms, hampered by (2) an absence of data from natural plant populations with which to test hypotheses on the long-term, cohort-wide consequences of these mechanisms. It is also clear that long-term research is necessary to understanding the adaptation particular to Old Growth ecosystems.

In light of these considerations some conclusions are suggested.

- Further study of mechanisms underlying adaptation in natural plant communities is needed.

[16] ibid., p.401.
[17] Frank Johannes et al. "Assessing the impact of transgenerational epigenetic variation on complex traits". In: *PLoS GENETICS* 5.6 (2009), e1000530, p.1.
[18] ibid., p.1.
[19] M. Miryeganeh and H. Saze. "Epigenetic inheritance and plant evolution". In: *Population Ecology* 62 (2020), pp. 17–27, pp. 19-20.
[20] ibid., p. 20.
[21] From p.1 in Monika A Gorzelak et al. "Inter-plant communication through mycorrhizal networks mediates complex adaptive behaviour in plant communities". In: *AoB Plants* 7 (2015).
[22] Russell J Rodriguez, Regina S Redman, and Joan M Henson. "The role of fungal symbioses in the adaptation of plants to high stress environments". In: *Mitigation and adaptation strategies for global change* 9.3 (2004), pp. 261–272, p.269.

- The time scale associated with such studies – on the denoument of long-term adaptive consequences - exceeds the lifespan of the longest-lived forest trees.
- **The preceding excerpts suggest that such studies are near, or at, the cutting edge of forest ecosystem research, and would constitute an especially high-quality addition to the list of High Conservation Value Attributes of the proposed HCVF.**
- The accuracy of these studies, and the potential for correlation with similarly long-term studies of natural ecosystems, depends upon allowing only natural disturbances into the ecosystems from which data is developed.

3 Summary and Conclusion

3.1 Importance of the HCVF

The importance of the HCVF designation in exploiting (or realizing) the High Conservation Value Attributes, and enabling related studies, is reinforced by two statistics provided in the Proposal:

- The proposed High Conservation Value Forest (HCVF) area includes approximately 2,380 acres in Morgan-Monroe/Yellowwood State Forest (a forest unit of 51,000 acres) and will provide the only large tract of interior HCVF within this state forest complex.
- The CFI indicates only 2,711 acres (1.8 %) of forest stands within Indiana state forests are 140 years or older and only 493 acres (0.3%) of state forest stands are 160 years or older.

The HCVF would not only lead to the largest contiguous Old Growth reserve within Indiana public forests, but would nearly double the amount of forested land dedicated to study of this type of ecosystem. It would rank as one of the larger areas reserved for Old Growth forest and would possibly produce correspondingly higher quality data.

3.2 Intrinsic value of Old Growth forest reserve to the Tecumseh Trail

Apart from any other attributes, the Old Growth forest preserve specified in the Proposal has intrinsic cultural and scientific value for the state of Indiana, and in consequence for the Tecumseh Trail. Support by local, state and federal agencies for this resource is a reflection of the commitment of citizens to preserving and understanding the natural world. This large Old Growth forest would be in close proximity to major academic institutions in Bloomington and Indianapolis, facilitating access by faculty and student researchers. It is reasonable to expect that additional resources, human and financial, will be focused in this region as a result. **Close association of the Tecumseh Trail with the Old Growth ecosystem outlined in the Proposal – to which the trail provides scenic, minimally invasive access and egress for the public – adds to the importance of the trail.** Pursuant to the Vision and Mission stated at the beginning of these comments, KHTA recommends that the Proposal be adopted to **designate the Back Country Area as High Conservation Value Forest.**

References

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