DECLARATION OF ROSE-MARIE MUZIKA, PH. D.

I, Rose-Marie Muzika, Ph. D., declare as follows:

A. Qualifications

1. My name is Rose-Marie Muzika. I am over 18 years of age and competent to make this declaration.

2. My Curriculum Vitae is attached.

3. I earned a Ph. D. in forestry from Michigan State University in 1989. I earned an M.Sc. degree in biology from Clarion University of Pennsylvania and a BA in biology from Seton Hill University.

4. I was a Professor of Forestry for 19 years at the University of Missouri. I taught courses in Forest Ecology, Forest Health & Protection, Field Ecology, and Silviculture.

5. I have been employed by the US Forest Service as an ecologist and an entomologist. From 1989 and 1991 I was a research entomologist with a Pacific Northwest Research Station Unit I LaGrande, OR. I was then an ecologist on the Monongahela National Forest (1991-1992), and research ecologist at the Forest Service research unit in Morgantown, WV.

6. For the past 25 years, I have conducted research in forest health, forest disturbance ecology, and applied ecology.

7. Among my research publications are:

    - Muzika, RM and RS Morin. 2019. Oak Mortality Patterns in the Midwestern US, North America. International Oaks 30:341-348

    - Maginel, CJ, BO Knapp, JM Kabrick, and RM Muzika. 2019. Landscape and site level responses of woody structure and ground flora to repeated prescribed fire in the Missouri Ozarks. Canadian Journal of Forest Research 49(8):1004-1015

    - Reed, SE, JE English and RM Muzika. 2019. Phytophthora species detected in two Ozark forests with unusual patterns of white oak mortality. Plant Disease 103:102-109. DOI: 10.1094/PDIS-02-18-0253-RE

    - Wood, JD, BO Knapp, RM Muzika, MC Stambaugh and L Gu. 2018. The importance of drought-pathogen interactions in driving oak mortality events in the Ozark Border Region. Environmental Research Letters https://doi.org/10.1088/1748-9326/aa94fa

- Muzika, RM. 2017. Silviculture for management and restoration of forests affected by biological invasions. Biological Invasions doi: 10.1007/s10530-017-1549-3

8. I have published in a number of peer-reviewed journals including: Forest Science; Forest Ecology & Management; Ecological Monographs; Population Dynamics; Biological Invasions; Agricultural and Forest Entomology; Canadian Journal of Forest Research; Plant Disease; Environmental Entomology; among many others.

9. I have served as an Associate Editor for the follow Journals: Northern Journal of Applied Ecology; Ecological Monographic; Ecology; Forest Ecology & Management; Frontiers in Forests and Global Change. I have reviewed manuscripts for at least 15 different journals.

10. I am a member of the Society of American Foresters; the Forest Stewards Guild; American Association for Advancement of Science; The Forest History Society; Blacksmiths Association of Missouri, and the American Society of Environmental History.

B. Project Review

11. I have reviewed the Draft Environmental Assessment and Forest Successional Report for the Eastern Divide Phase II Project on the Eastern Divide District of the Jefferson National Forest.

12. I have also reviewed stand data for the project area provided to me by the Southern Environmental Law Center (SELC).

13. I provided a Declaration on this project in June 2019, which I incorporate by reference into the declaration as well.

14. The best scientific information suggests that oak regeneration is difficult, if not impossible, to achieve in the absence of advance oak regeneration. Additionally, significant increases in light can promote oak competitors, to the detriment of oak regeneration, and subsequent management shown to promote oak regeneration should be considered for incorporation into a project with an oak regeneration objective.

Presence of advance oak regeneration in the treated area is critical to ensuring oak regeneration

15. The Forest Service contends that the proposed Shelterwood and Coppice with Reserves regeneration logging will result in oak regeneration in the project area.

16. I understand from reviewing the Draft EA that the Forest Service has not inventoried the amount of advance oak regeneration in the project area, but that there is "little or no

advanced regeneration of oaks in the understories of these stands." Accordingly, "stump sprouting (coppice) is the most reliable source of regeneration." (Draft EA at 1.)

17. Regarding oak regeneration from stump spouting, in mesic stands, Knapp et al. (2017) found stump sprouting, survival and growth of sprouts indicate that coppice regeneration would favor silver maple, American elm, and American sycamore at the expense of oak species.[1] While the sites in the Eastern Divide are mostly upland, it is important to consider that oaks stumps sprouts do not translate consistently into successful regeneration. Furthermore oak sprout ability declines with age and diameter and over half the units in the Project are nearly or over 100 years of age.[2]

18. The best scientific information shows that regeneration, rather than stump sprouting, is the best indicator of oak regeneration success. Advanced regeneration of oaks that are greater than 7 feet tall is preferred when evaluating oak regeneration potential of mixed hardwood stands.[3] Oak stump sprouting alone cannot sustain current oak stocking, for not all stumps produce sprouts.[4]

19. For example, Shelterwood treatments can benefit regeneration in mature hardwood forests by increasing light levels – critical for oak regeneration recruitment and survival. Harvesting to remove ~50% of the initial basal area may be adequate for 50% of full sunlight, and therefore enough to benefit oak regeneration physiologically, while shading out competition from other species.[5] However, this amount of sunlight can only benefit the stand if advanced regeneration is present. In the absence of advanced regeneration, Shelterwood treatments will likely result in non-oak regeneration.[6]

20. The Forest Service should consider whether intermediate treatments like thinning could better achieve the purpose and need of this project. If the goal is to create canopy

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[1] Knapp, B. O., Olson, M. G., & Dey, D. C. (2017). Early stump sprout development after two levels of harvest in a midwestern bottomland hardwood forest. Forest Science, 63(4), 377-387.
[2] Dey, D. C., P.S. Johnson & H.E. Garrett. 1996a. Modeling the regeneration of oak stands in the Missouri Ozark Highlands. Canadian Journal of Forest Research 26 :573-583; Johnson, P. S., S. R. Shifley & R. Rogers. 2009. The ecology and silviculture of oaks. 2nd edition. CABI Publishing. New York, NY, USA. 560 p.
[3] P.H. Brose et al., Prescribing Regeneration Treatments for Mixed-Oak Forests in the Mid-Atlantic Region at 9 tbl. 2.1 (USDA Forest Service General Technical Report NRS-33 2008)
[4] Atwood, C. J., Fox, T. R., & Loftis, D. L. (2011). Effects of various silvicultural systems on regeneration in mixed hardwood stands of the southern appalachians. Journal of Sustainable Forestry, 30(5), 419-440.
[5] Schlesinger, R. C., I. L. Sander & K. R. Davidson. 1993. Oak regeneration potential in-creased by shelterwood treatments. Northern Journal of Applied Forestry 10: 149-153.
[6] Spetich, M. A., D. C. Dey, P. S. Johnson & D. L. Graney. 2002. Competitive capacity of Quercus rubra L. planted in Arkansas Boston Mountains. Forest Science 48: 504-517; Johnson, P. S., S. R. Shifley & R. Rogers. 2009. The ecology and silviculture of oaks. 2nd edition. CABI Publishing. New York, NY, USA. 560 p.

openness for regeneration to develop, a moderate to heavy thinning, which leaves an intact forest while creating opening in the canopy, can serve the same purpose as a Shelterwood treatment, while maintaining wildlife habitat and promoting intactness of the canopy and the forest. As with Shelterwood, the success of this approach is dependent on advanced regeneration.

21. Ultimately, without adequate large oak advance reproduction, oak regeneration failure is all but certain.

Other consideration for oak regeneration silvicultural procedures

22. In addition to adequate oak advance regeneration, the best scientific information shows that other site specific conditions and subsequent management should be considered when proposing silvicultural procedures to regenerate oak.

23. For example, too much light can foster competition from shade intolerant species. If the proposed residual basal area for the Shelterwood with Reserves treatment, 15 to 25 square feet per acre, constitutes more than a 50% reduction of basal area, this would open the canopy substantially more than recommended.[7] Typically, Shelterwood treatments in Appalachian oak forest should be ~20%, otherwise shade intolerant hardwoods are likely to dominate.[8]

24. In order to adequately assess the intensity of removal, and subsequent impact on the likelihood of oak regeneration, the Forest Service should provide more information on the residual basal area proposed. The residual basal area in the Draft EA for both harvest types does not reveal the amount of removal that will take place, only the absolute basal area remaining. It would be meaningful to put this in the context of percent stocking remaining, or percent BA removed. Each compartment and stand must be treated individually since there are differences in basal area and species composition.

25. Site index should also be factored in when deciding the appropriate silvicultural procedure. For example, heavy cutting on high quality sites may actually lead to a loss of oak from increase competition.[9]

26. And in stand with mixed hardwoods/ white pine, Coppice with Reserves will likely result in very different, multi-species hardwood regeneration since all hardwoods sprout. It is not clear whether the white pine represents the residual overwood, but it

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[7] Schlesinger, R. C., I. L. Sander & K. R. Davidson. 1993. Oak regeneration potential increased by Shelterwood treatments. Northern Journal of Applied Forestry 10: 149-153.
[8] Stringer, J., 2006. Oak Shelterwood: A Technique to Improve Oak Regeneration, Professional Harwood Notes: Technical Information on Hardwood Silviculture for Foresters, University of Tennessee Extension.
[9] Dey et al. 2010 An ecologically based approach to oak silviculture: a synthesis of 50 years of oak ecosystem research in North America. Revista Colombia Forestal. 13(2): 201-222.

could be either a regeneration competitor or be eliminated altogether, depending on the amount remaining in the overstory.

27. The Forest Service should also consider subsequent management that would encourage oak regeneration, such as prescribed burning. Oak regeneration can be encouraged following heavy cutting, e.g. coppice, if prescribed burning follows removal.[10] The periodic fires may do little harm to oaks, but can often reduce oak competitors such as tulip poplar or red maple.

C. <u>Relevant Research</u>

28. Relevant research is attached for consideration.

Submitted this 26th day of February, 2019.

Rose-Marie Muzika

[10] Brose, P. H., T. M. Schuler & J. S. Ward. 2006. Responses of oak and other hardwood regeneration to prescribed fire: what we know as of 2005. pp. 123- 135. In: M. B. Dickinson (ed.). General Technical Report NRS-P-1. USDA Forest Service Northern Research Station. Newtown Square, PA, USA.