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 to 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 manuscripts that describe gypsy moth population dynamics, the ecological effects of gypsy moth, mortality agents of oak, and secondary pests of oaks. I worked with Kurt Gottschalk on several manuscripts, which are described below and attached to this statement for consideration.

8. I have published in a number of peer-reviewed journals including: Forest Science; Forest Ecology & Management; Ecological Monographs; Populations Dynamics; 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 following Journals: Northern Journal of Applied Ecology; Ecological Monograph; 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 the Advancement of Science; The Forest History Society, and the American Society of Environmental History.

B. Project Review

11. I have reviewed all publicly available project documents for the U.S. Forest Service's (USFS) proposed Eastern Divide Gypsy Moth Phase II Project on the Eastern Divide District of the Jefferson National Forest.

12. I have also reviewed Forest Service documents provided to me by the Southern Environmental Law Center (SELC) by June 17, 2019. I understand SELC received these documents in response to Freedom of Information Act requests.

13. I have also reviewed the Insect and Disease Categorical Exclusion provided for in the Farm Bill of 2014.

C. Gypsy moth within the project area and surrounding landscape

14. The best scientific information is clear that site-specific data are critical to deciding if active forest management is appropriate for a forest stand and selecting from a suite of appropriate silvicultural treatments: "This process requires stand examination to determine the present overstory, understory, and site conditions; stand analysis to assess the stand's characteristics and potential for future growth and regeneration; [and] gypsy moth population monitoring to determine the potential for defoliation."[1] Field data are also critical for making an informed decision that active management is not necessary.[2]

15. This project area lies within a generally infested area, which means that reproducing gypsy moth populations occur in this area. This landscape condition, however, does not mean that gypsy moths are present at all sites within the infested area. Accordingly, it is incorrect to assume those gypsy moths are present or an imminent threat in all stands of oak forest within the project area. Nor can one assume that previous outbreaks and defoliation within the generally infested area occurred within all oak stands contained in the project area. Rather, gypsy moths are likely present in various stands, at varying population levels, causing varying degrees of risk and/or damage, at various times.

16. There are several ways to estimate the gypsy moth population levels across the landscape and in the proposed units, including (A) gypsy moth trap counts, (B) aerial survey to delineate defoliation, and (C) egg mass surveys, and (D) and field surveys of defoliation, damage, and mortality.

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[1] K.W. Gottschalk, Silvicultural Guidelines for Forest Stands Threatened by the Gypsy Moth at 1 (USDA Forest Service General Technical Report NE-171 1993) ("Gottschalk 1993"). *See also* P.H. Brose et al., Prescribing Regeneration Treatments for Mixed-Oak Forests in the Mid-Atlantic Region at 8 (USDA Forest Service General Technical Report NRS-33 2008) ("One of the keys to accurately evaluating the regenerative potential of a mixed-oak stand is to simultaneously consider the species present, the abundance, size, and spatial distribution of reproduction and trees, and factors limiting successful regeneration.") ("Brose et al. 2008"); *and* R. M. Muzika, Opportunities for Silviculture in Management and Restoration of Forests Affected by Invasive Species, 19 Biological Invasions 3419, 3429 (2017) ("Development and use of … [Gottschalk's] silvicultural guidelines require advanced evaluation of specific characteristics of the forest such as the abundance of host species and appropriateness of management or restoration.") ("Muzika 2017").

[2] *See* D.R. Foster & D.A. Orwig, Preemptive and Salvage Harvesting of New England Forests: When Doing Nothing is a Viable Alternative, 20(4) Conservation Biology 959, 966-68 (2006) (Contrasting the relative negative impacts of disturbances, such as insect outbreaks, and active silvicultural management intended to increase resilience to disturbance) ("Foster & Orwig 2006").

Gypsy moth trap counts

17. The Slow the Spread program has used pheromone traps to trap male moths in this general area. Based on trap counts, regular occurrences of gypsy moths have been recorded in the general area since 2006.[3]. Since that time, moth captures have become more common. In 2015 there were several traps with high numbers reported (>300), primarily limited to an area immediately east of the I77 corridor. This high-count area expanded in 2016, to include much of Bland County, and spilled over into a limited area of Wythe and Pulaski. There was then a notable decrease for almost all traps; with counts from 2017 and 2018 approximating the numbers reported in 2014. The below tables provide trap count numbers near the 7 working areas of this project. In 2018, trap counts closest to the proposed units ranged from a low of 44 moths to a high of 175 moths.

Table 1. I-77 Area

	2018	2017	2016	2015
On SR 717 south of units	129	403	400	477
~6 mi to east of above	44	201	350	202

Table 2. Peak Creek

	2018	2017	2016	2015
3-4 miles to northwest	73	188	n/a	n/a
1 mile to west	n/a	n/a	275	425

Table 3. Dismal Area

	2018	2017	2016	2015	2014
1-2 m east of southern unit	175	152	229	250	10

Table 4. Caseknife

	2018	2017	2016	2015	2014
1-1.5 mi to west of units	150	48	250	71	30

Table 5. Gatewood Reservoir

	2018	2017	2016	2015	2014
On SR 710 below units	n/a	n/a	350	200	225

Table 6. Tunnel Hollow

	2018	2017	2016	2015	2014
~2 miles north	n/a	n/a	350	200	225
~3 miles south	n/a	n/a	180	26	12

[3] STS Decision support http://yt.ento.vt.edu/da/

Table 7. Bromley Hollow

	2018	2017	2016	2015	2014	2013	2012
~8 km southwest	73	188	n/a	n/a	n/a	n/a	n/a
~8 km southeast	63	68	n/a	n/a	n/a	n/a	n/a
~2-6 km southwest	n/a	n/a	225	228	44	10	7
~2-6 km southeast	n/a	n/a	225	155	29	125	103

Aerial surveys of defoliation

18. The Virginia Department of Forestry conducts aerial surveys to delineate areas with high levels of defoliation. Results from these surveys conducted in 2016, 2017, and 2018, were provided to SELC upon request.

19. Based on the survey results, very few stands included in the project have experienced severe defoliation during the past three years.[4]

20. Defoliation was not recorded in the units proposed in the Peak Creek, Caseknife, Tunnel Hollow, or Gatewood Reservoir areas.[5] With the exception of a small pocket detected in 2018 on Chestnut Mountain, north of the Gatewood Reservoir Area, defoliation was also not reported in nearby areas.[6]

21. In the Dismal Area, defoliation was documented in 2018, but was limited to portions of the two northernmost units.[7] In the Bromley Hollow Area, defoliation was recorded in 2016 in the eastern units.[8] Defoliation in the Walker Mountain Area was recorded in 2016 in almost all of Unit 1, a small portion of Unit 2, and the southern half of Unit 3.[9]

22. When considering intervention related to gypsy moth, it is critical to remember that other defoliators are responsible for some of the defoliation in the area.[10] For example, Ms. Bier documented the presence of larvae of the oak sawfly, a native defoliator, which were seen actively feeding on oak leaves. [11] Oak blotch leafminers and oak shothole leafminers are also likely to be present in the units, based on the appearance of herbivory damage.[12]

Field surveys in the proposed units

23. Trap counts and aerial defoliation surveys can help provide a big-picture understanding of the landscape-scale status of gypsy moth over time. However, they are of very limited use

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[4] *See* attached maps generated by SELC.
[5] *See id.*
[6] *See id.*
[7] *See id.*
[8] *See id.*
[9] *See id.*
[10] J. Bier Eastern Divide Insect and Disease Project Phase II, Jefferson National Forest, Summary of fieldwork at 3 ("Bier report").
[11] *Id.* at 15, 18.
[12] *Id.* at 4.

when considering, developing, and evaluating a proposed silvicultural project in specific stands to respond to gypsy moth. Site-specific field data is required for that.[13] Field data are also critical for making an informed decision as to whether active management is not necessary.[14]

24. The scoping notice and project file provide little to no current information regarding gypsy moth population monitoring information in the proposed units. Consequently, I was unable to review any site-specific data that the Forest Service may have considered prior to developing Phase 2 of the Eastern Divide project and proposing silvicultural prescriptions.

25. It was thus necessary to collect site-specific data in order to overcome this critical information gap. SELC hired Jessica Bier to visit each of the proposed treatment areas and (1) assess impacts from defoliation that may have occurred in recent years (e.g., crown damage, mortality); and (2) determine the levels of current gypsy moth populations in the areas.[15] I provided guidance to Jessica Bier regarding survey methods, which she applied. I have reviewed the data from her fieldwork.

26. Within plots in each working area, Ms. Bier recorded crown condition (as a measure of vigor and tree health); the presence of mortality, egg masses and defoliation; and tree species composition.[16] Ms. Bier found that many of the units had no notable damage and/or mortality from gypsy moth.[17] To the extent there was damage, it was generally at low to moderate levels and patchily distributed.

27. The majority of trees surveyed within the plots appear to be in good health. Ms. Bier classified 77% of the overstory trees surveyed in plots as having Good vigor.[18] Good vigor is characterized by extensive lateral branching; absent or minimal dieback, absent or minor wounds/canker, little or no epicormic branching; healthy foliage.[19]

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[13] Gottschalk 1993 at 1. *See also* Brose et al. 2008 at 8 ("One of the keys to accurately evaluating the regenerative potential of a mixed-oak stand is to simultaneously consider the species present, the abundance, size, and spatial distribution of reproduction and trees, and factors limiting successful regeneration."); *and* Muzika 2017 at 3429 ("Development and use of … [Gottschalk's] silvicultural guidelines require advanced evaluation of specific characteristics of the forest such as the abundance of host species and appropriateness of management or restoration.").

[14] *See* Foster & Orwig 2006 at 966-68 (Contrasting the relative negative impacts of disturbances, such as insect outbreaks, and active silvicultural management intended to increase resilience to disturbance).

[15] Bier report at 1.

[16] *Id.* at 1.

[17] *Id.* at 3.

[18] *Id.* at 3.

[19] *Id.* at 2.

Sixteen percent were classified as Fair vigor.[20] Fair vigor is characterized by moderate dieback (25-49% of branches are dead), possible epicormic branching, and subnormal foliage density, size, and coloration.[21]

Only 1% were classified as Poor vigor.[22] Poor vigor is characterized by major dieback (50% or more of branches are dead), heavy epicormic branching, extensive wounds/cankers, signs of decay, and subnormal foliage density, size, and coloration.[23] Six percent of the overstory plot trees were dead.[24]

28. Ms. Bier also found very few indications of live gypsy moths across the 7 working units. This included:
    - 6 gypsy moth caterpillars seen in 2 units (in the Caseknife and Tunnel Hollow areas, and
    - 3 egg masses that were, based on appearance, probably from the current season (2 in Dismal area, 1 in Caseknife area).
29. Ms. Bier also found very low levels of defoliation (<10%) in the areas she visited following leaf out in mid-May (Caseknife, Bromley Hollow, Tunnel Hollow, Gatewood Reservoir). Widespread defoliation and persistent mortality seem unlikely. Furthermore, there is no indication that a buildup of the population is occurring and therefore an outbreak in the next few years is unlikely. Consequently, there is no imminent threat of gypsy moth damage in the near future.

D. <u>The best scientific information regarding gypsy moth does not support Gottschalk's Silvicultural Guidelines.</u>

30. I understand the Farm Bill's Insect and Disease Infestation Categorical Exclusion (CE) applies to "priority projects … to reduce the risk or extent of, or increase resilience to, insect or disease infestation."[25] These must be "qualifying insect and disease projects" that "consider[ ] the best available scientific information to maintain or restore the ecological integrity, including maintaining or restoring structure, function, composition, and connectivity…."[26,27]

31. The Forest Service contends that the proposed regeneration logging "are based on the findings in <u>Silvicultural Guidelines for Forest Stands Threatened by Gypsy Moth</u> by Kurt W. Gottschalk."[28]

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[20] *Id.* at 3.
[21] *Id.* at 2.
[22] *Id.* at 3.
[23] *Id.* at 2.
[24] *Id.* at 3.
[25] 16 U.S.C. 6591a(d)(1).
[26] *See* FSH 1909.15 chapter 30, section 32.3(3).
[27] 16 U.S.C. 6591b(b)(1).
[28] Gottschalk 1993.

32. Gottschalk's recommendations were largely untested when they were published in 1993. In the introduction to his report, the author stated "[m]ost of the prescriptions have not been extensively tested. They are guides subject to modification using professional judgment to make them fit specific stands or management objectives." [29] Twenty-six years later, Gottschalk's guidelines remain largely unsupported by science.[30] In fact, "[d]espite decades of research and extensive implementation, there remains uncertainty about how successful these established [silvicultural] approaches are for limiting damage and mortality" from gypsy moth.[31]

33. The 1993 Silvicultural Guidelines highlighted stand susceptibility and stand vulnerability as determinants of potential impacts of gypsy moths on forests.[32] Gottschalk defined stand susceptibility as the probability of defoliation, given gypsy moth are present in a stand.[33] He defined stand vulnerability as the probability of tree mortality, given gypsy moths have defoliated a stand.[34] Decreasing stand susceptibility and vulnerability are objectives of silvicultural treatments directed at mitigating gypsy moth impacts.[35]

<u>Silviculture does not reduce susceptibility of oak-dominated ecosystems to gypsy moths.</u>

34. Theoretically, silviculture could reduce susceptibility of oak-dominated ecosystems to gypsy moths by (A) removing preferred host tree species; (B) improving conditions for gypsy moth predators and pathogens; and (C) increasing the health and vigor of oaks retained following thinning. In practice, however, silviculture has not succeeded in reducing susceptibility to gypsy moths.

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[29] Gottschalk 1993 at 1 ("Most of the prescriptions have not been extensively tested. They are guides subject to modification using professional judgment to make them fit specific stands or management objectives."). *See also id.* at 38 ("[T]hese results have not been extensively tested…").

[30] *See* R.M. Muzika & A.M. Liebhold, <u>A Critique of Silvicultural Approaches to Managing Defoliating Insects in North America</u>, 2 Agricultural and Forest Entomology 97, 98 (2000) ("Examples demonstrating the use of silviculture to successfully mitigate the impacts of defoliating insects are…limited.") ("Muzika & Liebhold 2000"); *and* Muzika 2017 at 3429 ("Despite the thoroughness of the development of [Gottschalks' 1993] guidelines, there have been few evaluations of them.") ("Muzika 2017"); *and* C. Schweitzer et al., <u>Proactive Restoration: Planning, Implementation, and Early Results of Silvicultural Strategies for Increasing Resilience against Gypsy Moth Infestation in Upland Oak Forests on the Daniel Boone National Forest, Kentucky</u>, 112 J. of Forestry 401, 402 (2014) ("A variety of both regeneration and intermediate stand treatments, …, need to be tested for their efficacy in mitigating for the susceptibility and vulnerability to gypsy moth and oak decline.") ("Schweitzer et al. 2000").

[31] Muzika 2017 at 3421. *See also id.* at 3429 ("Despite the thoroughness of the development of [Gottschalk's 1993] guidelines, there have been few evaluations of them."); *and* Muzika & Liebhold 2000 at 98.

[32] Gottschalk 1993 at 7-8.

[33] *Id.* at 7.

[34] *Id.* at 8.

[35] *See* Muzika & Liebhold 2000 at 98.

35. Forest stands that are most susceptible to defoliating insects are those in which preferred host tree species are abundant.[36] The proportion of a stand comprised of preferred host tree species is a powerful predictor of defoliation potential.[37] Oaks, in general, are highly preferred by gypsy moths.[38] Throughout their range in North America, gypsy moths are most commonly defoliating red oaks and white oaks.[39] Reducing susceptibility thus tends to focus on reducing the prevalence of preferred host trees within a stand.[40] The most common silvicultural means of doing so is by selectively thinning oak and other preferred host species.[41]

36. While the precise interrelationship of gypsy moths and oaks at large spatial scales remains undefined, there is scant evidence that changing stand composition through silviculture has any effect on gypsy moths.[42] Changing stand composition to one with a reduced density of preferred species and a higher density of non-preferred species renders a treated stand less appetizing to gypsy moths. [43] However, "it is not possible to reduce the actual spread of defoliating insect populations [through silviculture]."[44] In other words, even if gypsy moth density in a treated stand is decreased by reducing the density of highly preferred oak trees, gypsy moth spread into other areas is not reduced. There is not a "net loss" of gypsy moth density across the landscape.

    There are several possible explanations for this: (A) the scale at which silviculture is practiced – forest stands – is too small to affect processes that control gypsy moth spread

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[36] *See* Gottschalk 1993 at 7. *See also* Guo et al., Tree Diversity Regulates Forest Pest Invasion, 116(15) Proceedings of the National Academy of Sciences 7382, 7385 (2019) (finding greater tree species diversity diminished insect invasion success by reducing the availability of susceptible species) ("Guo et al. 2019").
[37] *See* C.B. Davidson et al., Tree Mortality Following Defoliation by the European Gypsy Moth (Lymantra dispar L.) in the United States: a Review, 45(1) Forest Science 74, 75 (1999) ("Davidson et al. 1999"). *See also* C. Hartl-Meier et al., Effects of Host Abundance on Larch Budmoth Outbreaks in the European Alps, 19 Agricultural and Forest Entomology 376, 376 (2017) (documenting the correlation between outbreaks of larch budworm and availability of their preferred host tree species, the European larch.).
[38] Davidson et al. 1999 at 75 tbl. 1..
[39] *See* Haynes et al., Geographic Variation in Forest Composition and Precipitation Predict the Synchrony of Forest Insect Outbreaks, 127(4) Oikos 634, 635 (2018) (citation omitted) ("Haynes et al. 2018").
[40] *See* Muzika & Liebhold 2000 at 99.
[41] *See id.*; Muzika 2017 at 3424; Davidson et al. 1999 at 75.
[42] *See* Muzika & Liebhold 2000 at 101 ("Actual empirical evidence to suggest that management aimed at changing species composition could be used to successfully control defoliators is scant.").
[43] Muzika & Liebhold 2000 at 103 ("There is little or no evidence that silviculture can be used for altering susceptibility other than by eliminating host species.").
[44] *Id.* at 101.

across a landscape;[45] (B) gypsy moth dynamics are controlled by a complex web of biological, chemical, and physical processes[46]; and (C) irrespective of the gypsy moth, landscape-scale oak dynamics in eastern North America are controlled by numerous factors including disturbance, climate, herbivory and land use.[47]

Accordingly, there is no compelling evidence that the ecological integrity of the area surrounding the treated stands (i.e., the surrounding landscape) is improved with silvicultural treatment.

37. Additionally, there is no evidence that silviculture reduces susceptibility to gypsy moths by improving conditions for gypsy moth predators and pathogens. In 1998, Kurt Gottschalk, Andrew Liebhold (Research Entomologist for the Forest Service's North Research Station), and I published results from a long-term study of the effects of presalvage and sanitation thinning on gypsy moth dynamics. We tested how thinning affected changes in gypsy moth egg mass density, patterns of within-generation gypsy moth survivorship, gypsy moth mortality caused by various parasitoids and pathogens, forest vegetation following thinning, and the long-term impact of gypsy moth populations.[48]

    In stands where oak accounted for less than 50% of the basal area, we applied a sanitation thinning. [49] Objectives were to reduce total stand basal area and preferentially remove species preferred by the gypsy moth (e.g. oak). [50] In stands where oak accounted for more than 50% of the basal area, we applied a presalvage thinning, with the objective of removing trees in poor condition regardless of species or their preference by gypsy moth.[51]

    We examined results from 2 years of severe defoliation (>60% of canopy) on 3 pairs of stands (each pair with 1 thinned and 1 unthinned/control stand). One pair had identical defoliation, a second pair had greater defoliation in the unthinned/control stand, and a third pair had greater defoliation in the thinned stand.[52]

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[45] *Id.* at 99 ("[A]lthough silviculture is implemented at the stand level, it is obvious … that the influence of insects occurs at the landscape level."). *See also* Muzika 2017 at 3430 (citation omitted).

[46] *See* A.M. Liebhold et al., What Causes Outbreaks of Gypsy Moth in North America?, 42 Population Ecology 257, 263-65 (2000) ("Liebhold et al. 2000"). *Accord* Muzika & Liebhold 2000 at 103 ("Most defoliator species exist in a highly complex trophic web with their hosts and natural enemies. As a result of this complexity, manipulation of the habitat to enhance a single part of this food web may not always result in the expected outcome.").

[47] *See* R.W. McEwan et al., Multiple Interacting Ecosystem Drivers: Toward an Encompassing Hypothesis of Oak Forest Dynamics Across Eastern North America, 34 Ecography 244, 253 (2011); *see also* D.C. Dey et al., An Ecologically Based Approach to Oak Silviculture: A Synthesis of 50 Years of Oak Ecosystem Research in North America, 13(2) Revista Columbia Forestal 201, 202 (2010) ("Dey et al. 2010").

[48] Muzika et al. 1998 at 261.

[49] *Id.*

[50] *Id.*

[51] Muzika et al. 1998 at 261.

[52] Muzika & Liebhold 2000 at 101.

While there was less overstory mortality in thinned stands than unthinned stands with comparable levels of defoliation, we were unable to determine that thinning significantly altered rates of gypsy moth mortality caused by parasitoids or pathogens. [53] Ultimately, results revealed that egg mass densities, moth survivorship, and gypsy moth mortality from natural enemies differed little between stands that received silvicultural treatments and those that did not.[54]

Our study comported with previous research that silvicultural thinning had no effect on predation of gypsy moth.[55] We concluded that "… it seems unlikely the thinning could reduce the frequency or intensity of gypsy moth outbreaks by enhancing the activity of natural enemies."[56]

38. In 2014, Callie Schweitzer and her colleagues published the results of a study that investigated the possibility of regenerating oak and increasing oak vigor with silvicultural treatments.[57] Treatments implemented during the study are summarized below.

    A. Shelterwood with reserves- Residual basal area of 10-25 ft^2 per acre. Oaks were favored for residual trees to promote increased forest health and improve habitat for wildlife and plant species. Regeneration beneath reserve trees intended to create a two-aged stand structure;

    B. Oak woodland- Thinning to 45–70 ft^2 per acre followed by prescribed burning every 3–5 years. White oaks favored as residual trees to increase hard mast production and bat habitat;

    C. Thinning- Reducing tree density allows residual trees to take advantage of improved growing conditions. Result should be increased tree vigor, larger crown diameters, continued or improved diameter growth, and increased capacity to survive defoliation;

    D. Oak shelterwood- All basal area removed from midstory and understory without making canopy gaps in the overstory. Undesirable tree species in midstories and understories treated with chemical herbicide. Overstory to be removed after sufficient advanced oak regeneration present in order to create even-aged, oak-dominated stand;

    E. Control- No treatment.[58]

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[53] Muzika et al. 1998 at 261.
[54] *Id.*
[55] *Id.* at 267 (citing S.T. Grushecky, Effects of Gypsy Moth-Oriented Silvicultural Thinnings on Small Mammal Populations and Rates of Predation on Gypsy Moth Larvae and Pupae, M.S. Thesis (West Virginia University 1995). *See also* Muzika & Liebhold 2000 at 102 ("Many authors have advocated silvicultural procedures that might increase natural enemy abundance and/or activity. The logic behind these mechanisms is easy to understand … the evidence supporting these mechanisms is … scant.").
[56] Muzika et al. 1998 at 267.
[57] Schweitzer et al. 2014 at 401.
[58] *Id.* at 403.

39. It is not clear that the modest increases of oak regeneration observed with some treatments in this study were enough to ensure oak would remain a significant component of the treated stands.[59] Advanced regeneration of oaks that are greater than 7 feet tall is preferred when evaluating oak regeneration potential of mixed hardwood stands.[60] The authors measured oak regeneration in response to Treatments A, B, and D, and the Control Treatment. In this study, there was very little regeneration of 4.5 feet or taller oak.[61] The Control plots had the same or greater regeneration of this size class than that recorded in Treatments B and D.[62]

40. Total oak regeneration in the Control plots was greater than in any single treatment.[63] In fact, the only size class for which there was greater oak regeneration than in the Control plots was > 4.5 foot tall oaks in Treatment A.[64] In other words, it is arguable that the silvicultural treatments had no effect on oak regeneration at all.

41. Even if the silvicultural treatments increased oak regeneration to some degree, it is unlikely that the observed regeneration was enough to maintain oak in the treated plots. Across all treatments and size classes, regeneration of red maple – which is not favored by gypsy moths – was greater than oak regeneration.[65] For the > 4.5 feet tall size class, red maple regeneration was 3 to 12 times greater than oak regeneration.[66] The dominance of red maple is significant because "[w]hen stands that are dominated by oaks in the overstory and non-oaks (e.g. maples) in the mid and understory are harvested, prolific stump sprouting of the non-oaks readily outcompetes the small oak reproduction."[67]

42. As with regeneration, it is likely that the silvicultural treatments in this study had no positive effect on oak vigor at all. Tree vigor is "the overall physiological condition or 'health' of a tree in a given environment."[68] In 2000, I authored a paper with Andrew Liebhold in which we stated "… effective use of vigour classifications for determining potential mortality has not been demonstrated with defoliators."[69]

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[59] *See id.* at 406 tbl. 3.
[60] *See* Brose et al. 2008 at 9 tbl. 2.1 (assigning greater weight to oaks more than 7 feet tall observed during regeneration plot assessment). *See also* Dey et al. 2010 at 214 ("[H]aving an abundance of large advance reproduction is key to successful oak regeneration.").
[61] *See* Schweitzer et al. 2014 at 406 tbl. 3 (three years after treatment density of > 4.5 feet tall oak was 17 stems per acre (SPA) in Treatment A; 2 SPA in Treatment B; 4 SPA in Treatment D; 4 SPA in the Control).
[62] *Id.*
[63] *Id.*
[64] *Id.*
[65] *Id.*
[66] *Id.*
[67] Dey et al. 2010 at 208.
[68] *See* Gottschalk 1993 at 35 (citation omitted).
[69] Muzika & Liebhold 2000 at 101.

43. Schweitzer et al. theorized that silvicultural treatments would increase the vigor of trees retained following silvicultural treatments.[70] Their data, however, do not support this. Across all size classes, oak vigor in the Control plots increased by 0.15.[71] This improvement was approximately equal to the increase in oak vigor for Treatment C and more than double the increase for Treatment B.[72] Oak vigor for Treatment A decreased from 1.88 to 2.49.[73] Only Treatment D resulted in oak vigor that was appreciably greater than oak vigor observed in the Control plots.[74]

However, vigor of oaks ≥ 23.6 inches dbh decreased in all four treatments and the Control.[75] The decrease in Treatment D was less than that observed for the control; however, reductions in vigor following Treatments A, B, and C, were 7 to 27 times greater than that in the Control.[76]

44. Nor did Schweitzer et al. achieve their goals "to improve forest health and productivity and to increase resilience to … insect defoliation and oak decline."[77] There is no evidence that the silvicultural treatments implemented in the study improved forest health and productivity. More importantly, their study did not evaluate the resilience of the treated stands to gypsy moths because gypsy moths were not present in their study area.[78]

In short, the best scientific information does not support theories in Gottschalk's Silvicultural Guidelines that timber harvest—especially a clearcut with reserves treatment—will reduce susceptibility to gypsy moth defoliation.

<u>Predicting vulnerability to mortality from gypsy moth defoliation is very difficult, if not impossible.</u>

45. Reducing vulnerability to gypsy moth would require evaluation and successful manipulation of many interrelated factors. Researchers have not found this to be practical at the stand or landscape level.

46. It is very difficult to predict impacts of gypsy moth outbreaks.[79] Even a tree that is completely defoliated may recover if it is not otherwise physiologically stressed.[80]

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[70] *See* Schweitzer et al. at 402.
[71] *Id.* at 407 tbl. 4.
[72] *Id.*
[73] *Id.*
[74] *Id.* (oak vigor increased by 0.33 for Treatment D).
[75] *Id.*
[76] *See id.* (decreases in vigor of oaks ≥ 23.6 inches dbh were: -3.74 in Treatment A; -0.99 in Treatment B; -1.25 in Treatment C; -0.08 in Treatment D; -0.14 in the Control).
[77] *Id.* at 401.
[78] *See id.* at 402 ("Gypsy moth is estimated to spread to the [study area] over the next 15-30 years….").
[79] *See* M.H. Eisenbies et al., <u>Tree Mortality in Mixed Pine-Hardwood Stands Defoliated by the European Gypsy Moth (*Lymantria dispar* L.)</u>, 53(6) Forest Science 683, 689-90 (2007) ("Eisenbies et al. 2007").
[80] Davidson et al. 1999 at 76.

Consequently, trees can withstand multiple episodes of defoliation without dying.[81] For example, one study in Virginia showed that an average of 50% oak mortality was not achieved until three defoliation episodes had occurred.[82]

47. Many factors affect whether a susceptible tree will die as a result of defoliation[83]:

> "Whether a tree succumbs to mortality, or merely experiences a short-term reduction in growth increment following defoliation depends on the following factors: the tree species; the intensity, duration, and frequency of defoliation; the tree's physiological condition at the time of defoliation[84]; and the presence of secondary-action organisms such as *Armillaria* spp. and *Agrilus bilineatus.* These factors do not act independently; rather, it is their action in combination that determines the final outcome."[85]

48. Gottschalk recognized this also, explaining "[v]ulnerability to mortality … is affected by so many interrelated factors and varies so widely that is very difficult, if not impossible, to predict with precision."[86] Additionally, characteristics of the site in which a susceptible tree is located may affect vulnerability.[87]

49. Uncertainty as to whether an individual tree will die as a result of defoliation scales up to the stand and landscape so that it is very difficult to predict whether there will be large-scale

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[81] *Id.* at 76. *Accord* P.J. Burton et al., Options for Promoting the Recovery and Rehabilitation of Forests Affected by Severe Insect Outbreaks, in RESTORATION OF BOREAL AND TEMPERATE FORESTS 495, 506 (John A. Stanturf ed., CRC Press 2d ed. 2015) (citing studies that documented trees recovering from defoliation caused by several defoliator species, including gypsy moth) ("Burton et al. 2015"); *and* Gottschalk 1993 at 36 ("… trees can tolerate several years of defoliation and still survive.").
[82] Davidson et al. 1999 at 76.
[83] Burton et al. 2015 at 504 ("Tree mortality varies widely due to variation in defoliation intensity and duration, tree species, and site and environmental conditions.") (citations omitted); see also Eisenbies et al. 2007 at 684 ("[T]ree species, the frequency, intensity, an duration of defoliation, the physiological condition of the tree before defoliation, and the presence and efficiency of secondary-action organisms all play a potential role in determining post defoliation tree mortality.") (citations omitted).
[84] *See* Davidson et al. 1999 at 77 (stating that a tree's physiological condition is "[t]the greatest single indicator of the likelihood of mortality … at the time of defoliation.").
[85] *Id.* at 76. *See also* Gottschalk 1993 at 32 ("The severity, frequency, and distribution of defoliation, site and stand factors, environmental conditions, invasion by secondary insects and diseases, and tree vigor all interact to produce the effects of defoliation (vulnerability) on the tree and stand.").
[86] Gottschalk 1993 at 8.
[87] *See* Davidson et al. 1999 at 76 (describing "specific site factors" that may determine susceptible and resistant forest types).

mortality following a gypsy moth outbreak.[88] Stands generally need "a relatively high proportion of resistant species (>70% of basal area)" to be considered less vulnerable to large-scale mortality.[89]

50. Consequently, researchers have concluded that "it is difficult to formulate silvicultural treatments that will have consistent results [because] … it is very difficult to predict the repercussions of an attack [by gypsy moths]."[90] Stated differently, while it is theoretically possible to decrease the vulnerability of a stand by selectively removing "the least vigorous trees," identifying trees that are most likely to die as a result of severe defoliation is very difficult. Therefore, managing vulnerability at the stand or landscape level may not be possible. [91]

<u>Harvesting non-preferred tree species will not reduce susceptibility or vulnerability to gypsy moth.</u>

51. Moreover, the Forest Service's proposal for indiscriminate harvest of both oaks and non-oaks[92] contradicts one of the most commonly advocated strategies for reducing risk of forest ecosystems to invasive pests: promoting diversity of tree species.[93] Stands composed of multiple tree species are naturally resistant to gypsy moths because not all tree species will be attacked by moths.[94] Gypsy moths prefer oak species and other species, such as red maple, are less preferred.[95] Additionally, it has been suggested that tree species diversity in a stand confers resistance by hosting a broader array of predators and pathogens than would be found in lower diversity stands.[96] Regardless of the mechanism, "[o]utbreaks rarely occur in stands dominated by nonpreferred host species."[97] Research has shown that mortality rates in stands attacked by gypsy moths are greater in stands with greater

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[88] *See id.* at 77 ("The probability of mortality depends on a complex interaction of many different factors, biotic and abiotic. This … variability makes the … accurate prediction of mortality extremely difficult.").
[89] Eisenbies et al. 2007 at 689 (citing Davidson et al. 1999).
[90] *Id.* at 690 (citing Muzika & Liebhold 2000 at 101) ("Studies have determined that tree mortality often represents a multi-decadal process and that losses in tree vigour may be evident long before an insect defoliation episode…. It therefore becomes difficult to predict which individual trees will die from insect defoliation, given simple defoliation estimate or vigour estimates at a particular point in time. The lack of predictive ability represents a substantial impediment when attempting to pre-empt mortality.").
[91] Muzika & Liebhold 2000 at 103.
[92] Scoping notice at 4.
[93] *See e.g.*, Guo et al. 2019 at 7385.
[94] J.S. Elkington & A.M. Liebhold, <u>Population Dynamics of Gypsy Moth in North America</u>, 35 Annual Review of Entomology 571, 584 (1990) ("Elkington & Liebhold 1990").
[95] Davidson et al. 1999 at 75 tbl. 1.
[96] *See* Burton et al. 2015 at 506.
[97] Elkington & Liebhold 1990 at 584. *See also* Eisenbies et al. 2007 at 689 (citing Davidson et al. 1999) (Stands need "relatively high proportion of resistant species (>70% of basal area)" to be considered less vulnerable to large-scale mortality).

proportions of oaks.[98] In this case, the Forest Service proposes to remove non-oaks in approximately 1,300 acres of national forest with the goal of establishing stands dominated by oak. Research on susceptibility and vulnerability of forest stands to gypsy moths provides no support for this.

Dilemma for Land Managers

52. Because oak is both ecologically and economically important,[99] managing oak vis à vis gypsy moths may put the Forest Service in a dilemma.[100] Such is the case with the Forest Service's current proposal: the agency desires to "maintain a significant oak component" in an ecosystem infested with gypsy moths, which preferentially attack oak. The Forest Service's current proposal creates the "[o]bvious conflict[]" described by Muzika & Liebhold 2000: increasing resistance to gypsy moths entails reducing the amount of oak on the landscape, but managing for oak preserves both oak's ecological importance and economic importance.[101] Removing oak from the landscape "… would be both economically and ecologically disruptive."[102]

53. This dilemma forces the Forest Service to choose between two different courses of action: (A) manage for ecological integrity in an area generally infested by gypsy moth by managing for non-oaks in order to reduce susceptibility and vulnerability, or (B) managing for oak regeneration.

If the Forest Service decides to prioritize "managing for the gypsy moth," it must consider whether active management is appropriate at all, and if so, whether the best available scientific information supports using any silvicultural method.

If, on the other hand, the Forest Service prioritizes "managing for oak regeneration" in these units, it could consider other silvicultural methods. There is a body of scientific literature related to oak regeneration, which the Forest Service does not appear to be invoking here.[103]

54. It is critical to recognize though that managing for oak regeneration would be an economic rather than an ecological decision. The objective of pre-salvage harvest is to realize the economic potential of an oak stand before it is lost. That is why Gottschalk included it as a possible technique in a "guidebook for foresters whose goal is timber production."[104] No

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[98] *See* Davidson et al. 1999 at 79.
[99] *See* D.C. Dey et al. 2010 at 202; *and* Brose et al. 2008 at 4-5.
[100] Muzika & Liebhold 2000 at 103 (noting that eliminating preferred host species in order to reduce susceptibility ". . . represents an ecological and economic dilemma.").
[101] *Id.* at 101.
[102] *Id.*
[103] *See* Dey et al. 2010 at 202; K.C. Steiner et al., Oak Regeneration Guidelines for the Central Appalachians, 25(1) Northern J. of Applied Forestry 5 (2008); S.L. Clark and C.J. Schweitzer, Stand dynamics of an oak woodland forest and effects of a restoration treatment on forest health, 381 Forest Ecology and Management 258-67 (2016); Brose et al. 2008; J.S. Rentch et al., Crown Class Dynamics of Oaks, Yellow-Poplar, and Red Maple after Commercial Thinning in Appalachian Hardwoods: 20-Year Results, 26(4) Northern J. of Applied Forestry 156 (2009).
[104] *See* Gottschalk 1993 at 1.

published studies of which I am aware have shown (or even attempted to show) that a clearcut with reserves treatment—as proposed by the Forest Service here—will restore or maintain ecological integrity of an oak forest that may be infested by gypsy moths in the future.

In sum, the best available science does not support the use of a clearcut with reserves treatment to reduce the risk or extent of future gypsy moth outbreaks, or to increase forest resilience to possible future defoliation.

Scientific conclusions regarding the Forest Service proposal

55. In my professional opinion, the proposed silvicultural treatment contradicts the best available scientific information regarding ecological integrity in the project area, which lies within an area generally infested by gypsy moth. As explained above, studies generally do not show that silvicultural treatments are effective at reducing susceptibility or vulnerability to gypsy moth infestation.[105] The proposed regeneration treatments using the clearcut with reserves method on 1,366 acres would not reduce the risk or extent of, or increase resilience to gypsy moth.

56. The Forest Service wants to cut live oaks in oak-dominated stands now so that the stands will regenerate to "maintain a significant oak component." The Forest Service also intends to cut non-oak species "to give the oak stump sprouts the best chance to succeed in dominating the regenerated stand." These objectives run counter to body of scientific literature that advises tree species diversity and reducing the component of oak and other highly preferred species. By promoting oak dominance in a regenerated stand, the Forest Service is likely increasing the susceptibility of these stands to future gypsy moth defoliation.

57. Second, even if the Forest Service were decreasing the density of highly preferred oaks in these stands, this would not reduce the spread into other nearby oak forest. Accordingly, changing stand composition through silviculture would not affect gypsy moth populations in the landscape.

58. The proposed regeneration harvest will not reduce susceptibility to gypsy moths by improving conditions for gypsy moth predators and pathogens. Similarly, selective thinning is unlikely to reduce the frequency or intensity of outbreaks by enhancing conditions for natural enemies of the gypsy moth.

59. Even setting aside that oak regeneration is not a legitimate ecological goal to address the presence of gypsy moth, the proposed silvicultural treatments would not likely increase oak regeneration. Tulip poplar and red maple often outcompete oak sprouts unless site indices are low. In that case, oaks already have a chance of rising to dominance without silvicultural intervention.[106] Nor are the silvicultural treatments likely to increase oak vigor.

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[105] *See* Muzika & Liebhold 2000 at 103-104.
[106] Dey et al. 2010 at 931, 933.

60. As Gottschalk acknowledged in 1993, it is "very difficult, if not impossible" to predict vulnerability with any precision. There is no evidence in the project file that the proposed regeneration logging is designed to reduce stand vulnerability to mortality following gypsy moth defoliation. The Forest Service seems not to have even made efforts to develop a project that would do so, having failed to analyze the many relevant site conditions that affect vulnerability, such as the intensity, duration, and frequency of any previous defoliation in the proposed units.

61. Because the best scientific information related to ecological integrity in areas infested by gypsy moth does not support the proposed clearcut with reserves logging to regenerate oak, the Farm Bill's Insect and Disease Infestation CE does not appear to apply to this proposal.

E. **The best available science does not support timber harvest in this situation.**

62. The above scientific information shows that silvicultural practices generally do not reduce susceptibility to gypsy moth defoliation or vulnerability to mortality following defoliation in treated stands or surrounding areas.

There is no evidence that gypsy moth has caused a need for ecological restoration or maintenance in the project area.

63. Based on data from the project area and proposed units, there is no compelling evidence that the ecological integrity of the area is in need of maintenance or restoration simply because gypsy moth is present in the general area. Moreover, it is likely that the proposed management would do more harm than good to the ecological integrity of the area.

64. Ms. Bier's field surveys show that to the extent the gypsy moth is active in the proposed units at all populations are at very low densities. In all seven working areas of the project, Ms. Bier found a total of 6 gypsy moth caterpillars in 2 working areas (Caseknife and Tunnel Hollow).[107] Moreover, only 3 potentially viable gypsy moth egg masses were found: 2 in the Dismal area and 1 in the Caseknife area.[108]

65. In addition, based on the absence and/or minimal amount of notable damage and/or mortality in Ms. Bier's plots, it is unlikely that severe defoliation previously occurred in most units. Lastly, the vigor and health of trees appears good. Of the 870 overstory plot tree crowns sampled, 77% were classified as Good vigor and 16% were classified as Fair vigor. Only 1% were classified as Poor vigor.

66. None of these conditions point to a need for ecological maintenance or restoration simply because the project area is within a generally infested area. And certainly none of these conditions indicate these units would be a "priority projects … to reduce the risk or extent of, or increase resilience to, insect or disease infestation."[109]

[107] Bier report at 3.
[108] *Id.*
[109] 16 U.S.C. 6591a(d)(1).

67. The mere presence of gypsy moth in such low densities does not mean defoliation and stand damage are looming. Gypsy moth populations can persist in low densities for long periods of time.[110] And some low-density gypsy moth populations may go extinct without any management.[111] This is true whether the population is within the generally infested area or along or ahead of the leading edge of spread.[112]

68. Many of the dynamics that appear to regulate gypsy moth populations are outside the control of land managers. For example, small mammals appear to be important at regulating low-density gypsy moth populations.[113] Studies indicate that regional weather influences (directly and indirectly) these predators as well as pathogens.[114] For example, the gypsy moth fungal pathogen *Entomophaga maimaiga* appears to "limit the severity, if not the frequency, of outbreaks" during wet weather."[115] The fungus is likely to play an important role in gypsy moth dynamics, given its dependence on moisture-related variables and the relatively wet conditions of this region.[116]

69. It is unpredictable which populations will later reach outbreak levels. It is most likely the interaction of a complex set of abiotic and biotic variables that allow gypsy moth populations to reach outbreak levels.[117]

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[110] *See* A.M. Liebhold et al. at 258 fig. 1 (2000) (showing periods of two decades or more during which gypsy moth activity in New England was very low).
[111] *See* P.C. Tobin et al., The Ecology, Geopolitics, and Economics of Managing *Lymantria dispar* in the United States, 58(3) Int'l. J. of Pest Mgmt. 195, 198 (2012) ("Tobin et al. 2012").
[112] Tobin et al. 2012 at 198.
[113] *See* Elkington & Liebhold 1990 at 574-76; D.M. Johnson et al., Geographical Variation in the Periodicity of Gypsy Moth Outbreaks, 29 Ecography 367, 372 (2006) ("Predation by small mammals is considered the single most important factor affecting low-density gypsy moth populations…"); *and* Muzika & Liebhold 2000 at 102 ("The largest source of mortality affecting low-density gypsy moth populations in North America is predation, mostly caused by small mammal predators").
[114] Liebhold et al. 2000 at 257, 261-263; J.R. Reilly et al., Impact of *Entomophaga maimaiga* (Entomopthorales: Entomopthoraceae) on Outbreak Gypsy Moth Populations (Lepidoptera: Erebidae): The Role of Weather, 43 Environmental Entomology 632 (June 2014) ("Reilly 2014"). *See also* Muzika & Liebhold 2000 at 103-104 (summarizing dearth of scientific evidence that silviculture can increase gypsy moth mortality indirectly by improving habitat for predators); Muzika et al. 1998 at 267 (thinning had no effect on predation of gypsy moth).
[115] C. Asaro & L.A. Chamberlain, Outbreak History (1953-2014) of Spring Defoliators Impacting Oak-Dominated Forests in Virginia, with Emphasis on Gypsy Moth (*Lymantria dispar* L.) and Fall Cankerworm (*Alsophila pometaria* Harris), 61 American Entomologist 174, 181 (2015). *See also* C. Asaro et al., Impacts of oak decline, gypsy moth and native spring defoliators on the oak resource in Virginia, Oak Symposium: Sustaining Oak Forests in the 21st century through Science-based Management, 20 (2019).
[116] *See* Reilly 2014 at 632, 640.
[117] *See* Liebhold et al. 2000 at 263-65. *See also* J.R. Foster *et al.*, Spatial dynamics of a gypsy moth defoliation outbreak and dependence on habitat characteristics, Landscape Ecology, 1-2, 9 (March 2013) ("Spatial propagation of outbreak populations remains poorly understood, in part

70. When considering whether any gypsy moth-related intervention is appropriate, land managers must consider gypsy moth population levels.[118] Two commonly used tools to measure gypsy moth density are pheromone traps and counting overwintering egg masses.[119]

Pheromone traps are useful for detecting and delineating new infestations. [120] Thus, they are "mostly used in isolated populations outside of the generally infested area and in areas along the expanding front of the gypsy moth infestation" as with the Slow the Spread Program.[121] Gypsy moths, however, have been present in the forest surrounding the proposed treatments for over a decade. Thus, "more intensive surveys" are needed to identify "rising populations."[122]

71. Therefore, it is more appropriate to use egg mass counts—a survey method relied upon to make decisions concerning control in "the generally infested area."[123]

72. Although there is considerable variation in the amount of defoliation that occurs in stands where 100 to 1000 egg masses are present, [124] <u>research has shown that oak stands are unlikely to suffer noticeable defoliation when egg mass surveys detect less than 1,000 egg masses per acre.</u>[125] And while a threshold of 250 egg masses per acre has been used for intervention, this threshold would be waste of resources for lad managers trying to reduce susceptibility and vulnerability to gypsy moth for ecological purposes: "[i]f a manager's objective is to prevent noticeable defoliation, growth loss, or mortality, then initiating treatment at 250 egg masses per acre would show little or no return on the expense of treatment."[126] Additionally, intervention at low egg mass densities "… may result in the needless treatment of many stands that would never become defoliated[.]"[127]

Again, Ms. Bier's field surveys of all 7 working areas, including 870 plots, resulted in only 3 potentially viable gypsy moth egg masses: 2 in the Dismal area and 1 in the Caseknife area.[128] The very low numbers that were observed indicate that egg mass densities that are far below thresholds for intervention. The clear conclusion of applying this research to the

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because defoliation effects are often ephemeral and difficult to quantify" but "may reveal processes that drive disturbance behavior….Spatial patterns are increasingly used to explain and predict defoliation outbreaks…") (internal citations omitted).

[118] Liebhold et al. 1994 at 1.

[119] *Id.*

[120] *Id.*

[121] *Id.*

[122] A.M. Liebhold et al., Gypsy Moth Egg Sampling for Decision-Making: a Users' Guide, at 1 (USDA Forest Service NA-TP-04-94 1994) (emphasis added) ("Liebhold et al. 1994").

[123] *See* Liebhold et al. 1994 at 1. *See also* A.M. Liebhold, <u>Forecasting Defoliation Caused by the Gypsy Moth from Field Measurements</u>, 22 Environmental Entomology 26, 26-31 (Feb. 1993).

[124] *Id.* at 16 fig. 7.

[125] *Id.* at 19 fig. 8.

[126] *Id.* at 19-20.

[127] *Id.* at 20.

[128] Bier report at 3.

project area is that there is no justification for invoking gypsy moths as justification for silvicultural intervention at this time.

The proposed silvicultural treatments would likely do more ecological harm than good.

73. There is an ever-growing body of literature that supports decisions by land managers not to actively intervene, particularly pre-emptively, in response to the presence of gypsy moth or other pests.[129] As several researchers concluded, [s]ince forest managers and researchers both have had limited success in predicting the occurrence of catastrophic events much before they occur, it is not practical to attempt to preempt the role of natural disturbances by harvesting stands prior to their occurrence."[130]

74. In 2006, forest ecology researchers undertook a study to "evaluate the hypothesis that active management can improve long-term ecosystem function by increasing ecosystem resilience and resistance."[131] They did so by comparing the effects of wind and insect disturbance on forest "ecosystem structure, composition, and function[,]" with the effects of "salvage and preemptive [timber] harvesting."[132] Noting that "[i]nsect and disease outbreaks often lead to increased harvesting of the host species, including preemptive cutting… and post-mortality salvage logging," the authors pointed out that the timber harvest "may generate more profound ecosystem disruption than the pest or pathogen itself."[133]

75. Studying the silvicultural interventions related to infestation by hemlock woolly adelgid ("HWA"), an invasive insect, serve as a good example.[134] Kizlinski et al. compared the direct effects of infestation by HWA" and the indirect effects of HWA infestation, namely intensive logging.[135]

Kizlinski et al. found that HWA and logging impacted vegetation composition similarly but at different temporal and spatial scales.[136] HWA resulted in vegetation changes that were more gradual and more localized than vegetation changes following logging.[137] Post-disturbance "forest floor dynamics" differed in HWA-infested and logged sites because of the latter allowing much more light to reach the forest floor.[138] Whereas logging creates

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[129] Even Gottschalk's Silvicultural Guidelines, timber-focused as they were, recognized that in some conditions, it was better not to log trees in response to gypsy moth. *See* Gottschalk 1993 at 2, Figure A (recommendations to defer cutting).
[130] Aber et al. 2000 at 13.
[131] *See e.g.* Foster & Orwig 2006 at 960.
[132] *Id.* at 960.
[133] *Id.* at 963 (citations omitted).
[134] HWA are a more aggressive invasive than gypsy moths because it disperses in a variety of ways, it reproduces twice per year, and it has no predators native to North America. M.L. Kizlinski et al., Direct and Indirect Ecosystem Consequences of an Invasive Pest on Forests Dominated by Eastern Hemlock, 29 Journal of Biogeography 1489, 1490 (2002) ("Kizlinski et al. 2002").*Id.* at 1490.
[135] *Id.* at 1490.
[136] *Id.* at 1500.
[137] *Id.* at 1496-98.
[138] *Id.* at 1498-99.

large and often uniform openings in a forest canopy, HWA disturbance changed forest structure in a manner that is similar to natural disturbances, which create gaps "… of mixed sizes depending on cause."[139]

Unlike HWA, logging "dramatically altered nitrogen cycling" compared to HWA-infested plots and undamaged plots.[140] In addition to causing "rapid nutrient losses from the disturbed area," the authors stated that post-logging nitrification could have long-term effects on "site fertility."[141]

These results bring to mind a cautionary statement made by another team of researchers that included Kurt Gottschalk: "A key objective in management decisions after insect outbreaks should be to reduce susceptibility to future insect attack, so care must be taken to promote rather than to compromise the inherent resilience of temperate and boreal forests."[142]

Indeed, in 2015 a team of researchers, again including Kurt Gottschalk, stated "… that any decision to undertake active management must be explicitly weighed against the option of doing nothing—of letting ecosystem recovery proceed unaided…for which a solid understanding of forest stand dynamics is required."[143] Burton et al. described an "intervention continuum" that included options ranging from intensive management to doing nothing.[144]

They further explained "[t]here is typically no need or incentive for active forest rehabilitation after an insect outbreak if overstory mortality is low, or if the understory is already well stocked with vigorous seedlings and saplings or is soon expected to be so."[145] The authors concluded that, '[p]rocesses of natural ecosystem recovery typically are more desirable, less intrusive, and less costly than active intervention."[146] The researchers concluded "[a]ll evidence suggests that harvesting exerts greater impacts on ecosystem processes than leaving disturbed or stressed forests intact."[147]

76. Here, the conditions do not weigh on favor of the Forest Service's proposed regeneration logging. As explained above, there is no evidence that that the ecological integrity of the area has been reduced because gypsy moth is in the general area or units. The best available scientific information does not support silvicultural activities as an effective way to reduce

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139 J. Aber et al., Applying Ecological Principles to Management of the U.S. National Forests, 6 Issues in Ecology 7 (2000) ("Aber et al. 2000").
140 *Id.* at 1500.
141 *Id.*
142 Burton et al. 2015 at 510.
143 *Id.* at 507.
144 *Id.* at 507-10.
145 *Id.* at 507; *see also id.* at 508 tbl 24.1 (identifying considerations that support no active intervention in response to an insect outbreak including "[n]o personal or community safety concerns" and "[s]atisfactory levels of overstory survival ….").
146 *Id.* at 508.
147 Foster & Orwig 2006 at 966.

susceptibility or vulnerability to gypsy moth.[148] Moreover, the proposed clearcut with reserves treatments would likely to do more ecological harm than good for this the area.

F. Gottschalk's Guidelines improperly prioritize timber production over ecological integrity.

77. In addition to the above, Gottschalk's Silvicultural Guidelines are not suited to this situation.

78. Gottschalk's report is "primarily a guidebook for foresters whose goal is timber production, it does not balance timber production with the various (and sometimes competing) land uses that the Forest Service must provide. [149] Nor does it grapple with how to protect the resources aside from timber that the Forest Service must.

79. The purpose and focus of the Farm Bill Insect and Disease CE, however, is not timber production. Rather, the CE applies only to activities that restore or maintain ecological integrity—which may or may not involve timber production at all. But because prioritization of timber production is "baked into" the Guidelines, the Guidelines do not guide the land manager to consider non-silvicultural options that may better serve ecological integrity.

80. If any silvicultural intervention is appropriate, the Forest Service should consider other guidance or frameworks that prioritize ecological integrity above all (including timber production). While ecological restoration and timber harvest activities are not mutually exclusive, nor are they equivalent. As a result, the Forest Service cannot assume that the recommendations in the Silvicultural Guidelines would constitute ecological restoration or maintenance activities. Indeed, the best available science does not support that the proposed regeneration logging in these units would constitute ecological restoration.

81. In 2015, Gottschalk *et al.* recommend using a "scorecard" approach to identify the urgency and intensity of appropriate forest rehabilitation actions after insect outbreaks.[150] This approach would be more appropriate for the Forest Service than application of the 1993 Silvicultural Guidelines, because it does not assume timber production is the priority. Rather, it is a flexible tool that allows decisionmakers to emphasize ecological integrity as the priority, while also considering other values for land use, as well as the severity of the outbreak, ecological degradation, and environmental impacts. *See* attached.

G. Relevant Research

82. Relevant research is attached for consideration.

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[148] *See, e.g.,* Muzika et al. 1998 261; *and* Muzika & Liebhold 2000 at 193-94.
[149] Gottschalk 1993 at 1.
[150] Burton et al. 2015 at 509.

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