Compatible Management, and Ecological Forestry, in Pacific Northwest National Forests: Limits to Biodiversity Conservation

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I. INTRODUCTION

In Spies et al. (2018), U.S. Forest Service scientists review the scientific literature relevant to management plan revision for Pacific Northwest national forests (Northwest Forest Plan Area) under the Forest Service's 2012 Planning Rule.[1] The purpose of this Forest Service technical report is to serve as a primary source of scientific information for management plan revision in this region, and, indeed, a recent plan

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1. *See* THOMAS A. SPIES ET AL., SYNTHESIS OF SCIENCE TO INFORM LAND MANAGEMENT WITHIN THE NORTHWEST FOREST PLAN AREA, U.S. FOREST SERV., DEP'T OF AGRICULTURE (2018).

revision guidance document, U.S. Forest Service (2020), cites this report as a major information source.[2]

Spies et al. (2018) endorses an approach to the practice of silviculture known as "ecological forestry."[3] As the authors explain, ecological forestry consists, most fundamentally, of a set of principles that are to guide silvicultural practice, for example, in timber harvesting, closely mimic the effects of natural disturbances such as wind and wildfire, and post-harvest, rely on natural regeneration of harvested areas.[4] The authors consider ecological forestry to be, potentially, an effective means of attaining relatively high and steady timber production on national forestlands in the Pacific Northwest compatibly with the conservation of native biodiversity.[5] Ecological forestry represents, they write, "a potential win-win for biodiversity and socioeconomic values."[6] Recent plan revision guidance, U.S. Forest Service (2020), endorses ecological forestry for this region.[7]

As will be discussed, however, in light of numerous scientific studies from North America and Europe, it does not appear that relatively high and steady timber volumes can be provided compatibly with effective conservation of northern spotted owls (*Strix occidentalis caurina*) and a variety of other mature-forest species, even under retention harvesting and other typical ecological forestry practices.[8] According to scientists, northern spotted owls and many other native species are dependent upon intact, mature and old-growth forests, and it appears that retention harvesting and other ecological forestry practices typically remove too much habitat essential for such forest specialist species.[9] Relatively high timber volumes can be provided compatibly, it seems, with the

2. *See id.*; *see also* U.S. FOREST SERV., DEP'T OF AGRICULTURE, BIOREGIONAL ASSESSMENT OF NORTHWEST FORESTS 5–6 (2020).

3. SPIES ET AL., *supra* note 1, at 169, 187–88, 278, 356, 423, 633, 637, 674, 734, 895, 956.

4. SPIES ET AL., *supra* note 1, at 169, 187–88, 278, 356, 423, 633, 637, 674, 734, 956.

5. SPIES ET AL., *supra* note 1, at 169, 187–88, 356, 423, 734, 956.

6. SPIES ET AL., *supra* note 1, at 964.

7. U.S. FOREST SERV., *supra* note 2, at 33, 47, 49.

8. *See, e.g.*, Lena Gustafsson et al., *Tree Retention as a Conservation Measure in Clear-Cut Forests of Northern Europe: A Review of Ecological Consequences*, 25 SCANDINAVIAN J. OF FOREST RSCH. 295 (2010); Tom Manning et al., *Thinning of Young Douglas-Fir Forests Decreases Density of Northern Flying Squirrels in the Oregon Cascades*, 264 FOREST ECOLOGY AND MGMT. 115, 120–21 (2012).

9. *See, e.g.*, Gustafsson et al., *supra* note 8, at 298–99, 304; Manning et al., *supra* note 8, at 120–21.

persistence of certain generalist species, such as mice and chipmunks, which can live in disturbed conditions.[10]

As will be discussed, within Spies et al. (2018), agency scientists claim potential success at providing relatively high and steady timber volumes compatibly with conserving native biodiversity, even though numerous scientific studies have shown that ecologically-based forestry practices, with an emphasis on relatively high and steady timber production, place severe limits on maintaining mature-forest species.[11] Within Spies et al. (2018), other Forest Service documents, and cited sources, no adequate evaluation has been provided of the biodiversity impacts of ecological forestry as proposed for the Pacific Northwest.[12] Within the Spies et al. (2018) science review, which will be the primary focus in this Article, key cited studies are not adequately considered, and many relevant studies in the literature are not discussed or cited.[13] It will be argued that compatible management by means of ecological forestry, with provision of relatively high and steady timber volumes, and broad native biodiversity, is merely a management ideal, a fabrication or myth, perpetuated by means of a selective use of science.

In management plan revision, the Forest Service is obligated to adopt a more genuinely scientific approach. In accordance with National Environmental Policy Act (NEPA) regulations, within each Environmental Impact Statement prepared for plan revision, agency scientists must provide a full and fair discussion of the environmental impacts of proposed ecological forestry practices, with adequate consideration of the relevant scientific literature.[14] The agency's biodiversity obligations are extensive and challenging, and it will be argued that satisfying them in light of the relevant scientific information will require less intensive silvicultural treatments, with greater emphasis on maintaining intact natural habitat.[15] The result of an improved use of science in management plan revision would be a more appropriate

10. *See, e.g.*, Stephen Polasky et al., *Where to Put Things? Spatial Land Management to Sustain Biodiversity and Economic Returns*, 141 BIOLOGICAL CONSERVATION 1505, 1516–18 (2008).

11. *See* SPIES ET AL., *supra* note 1, at 956; *see also, e.g.*, Gustafsson et al., *supra* note 8, at 298–99; Manning et al., *supra* note 8, at 120–21; Polasky et al., *supra* note 10, at 1505, 1516–18.

12. *See, e.g.*, SPIES ET AL., *supra* note 1; *see also* U.S. FOREST SERV., *supra* note 2 (constituting a recent plan revision guidance document to be discussed later in this Article).

13. *See* SPIES ET AL., *supra* note 1.

14. 40 C.F.R. §§ 1500–1508 (2022).

15. *See, e.g.*, Polasky et al., *supra* note 10, at 1505, 1516–18.

balancing of resources provided within each management area, and more effective biodiversity conservation.

II. ECOLOGICAL FORESTRY PROPOSED FOR PACIFIC NORTHWEST NATIONAL FORESTS

Franklin and Johnson (2012) proposes adoption of ecological forestry for federal forestlands in the Pacific Northwest.[16] Forest management experts, Jerry Franklin and Norman Johnson, recommend continued thinning treatments in this region.[17] The most controversial aspect of their proposal, they acknowledge, is "resumption of regenerative harvesting" in moist (generally west-side) forests, "using variable retention prescriptions."[18] Variable-retention harvesting is clear-cut logging, but with some percentage of pre-harvest vegetation retained in patches across the harvested area, often with retention, as well, of scattered individual trees or small tree clusters.[19] As Franklin and Johnson explain, "Unlike conventional clearcuts, variable retention harvests incorporate significant elements of the preharvest stand . . . including undisturbed forest patches and individual live and dead trees . . . ."[20]

According to Franklin and Johnson (2012), "[R]egeneration [variable-retention] harvests remove larger volumes per acre and include larger trees than are produced in the currently thriving thinning programs."[21] Their proposal would generate "substantial flows of wood products," they add.[22]

Citing Franklin and Johnson (2012), Carey (2003), and other sources, Spies et al. (2018) endorses ecological forestry for national forestlands in the Pacific Northwest (Northwest Forest Plan Area) for

16. Jerry F. Franklin & K. Norman Johnson, *A Restoration Framework for Federal Forests in the Pacific Northwest*, 110 J. FORESTRY 429, 432 (2012).

17. *Id.* at 433, 435–37. Forest thinning is a type of logging with the goal of reducing tree densities; variable-retention thinning, endorsed in Spies et al. (2018), involves thinning in such a way as to create variable tree densities, including leaving some denser areas. *See* SPIES ET AL., *supra* note 1, at 60, 162–63, 173–74, 182–83, 188, 268, 367.

18. Franklin & Johnson, *supra* note 16, at 433. Moist forests are generally located west of the Cascade crest, with Douglas fir (*Pseudostuga menziesii*), western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), and other tree species. SPIES ET AL., *supra* note 1, at 30, 32. Dry forests are located generally east of the Cascade crest, with ponderosa pine (*Pinus ponderosa*), western juniper (*Juniperus occidentalis*), and others. SPIES ET AL., *supra* note 1, at 32.

19. Franklin & Johnson, *supra* note 16, at 433–34.

20. Franklin & Johnson, *supra* note 16, at 433–34; *see also* SPIES ET AL., *supra* note 1 at 366 (defining a "forest stand" as a "contiguous group of trees sufficiently uniform" in age-class, distribution, and composition "to be a distinguishable unit").

21. Franklin & Johnson, *supra* note 16, at 435.

22. Franklin & Johnson, *supra* note 16, at 434.

purposes of forest restoration, fuel reduction, and enhanced timber production.[23] The authors focus their discussion on continued use of variable-density ("restoration") thinning in this region, but also discuss potential application of variable-retention harvesting in moist and dry forests.[24] "The 'ecological forestry' approach," they write, "seeks to use knowledge of disturbance ecology and retention-based management to achieve ecological and commodity goals simultaneously . . . ."[25] "The goal," one chapter states, "is to sustain healthy and productive forests, retain native species, and provide a range of ecosystem services."[26]

Spies et al. (2018) discusses negative effects of restoration thinning on native species, acknowledging, for example, negative impacts of thinning treatments on northern flying squirrels (*Glaucomys sabrinus*), red tree voles (*Arborimus longicaudus*), and other northern spotted owl prey species.[27] Such treatments, authors write, "reduce the abundance of northern flying squirrels and red tree voles for several decades."[28] They also note that thinning "may reduce dead wood, and may present risks, such as development of novel conditions and loss of a particular species or ecological condition."[29] The authors provide only minimal discussion concerning the negative effects of variable-retention harvesting, stating, for example, that this practice "could strongly affect dead wood amounts."[30]

Nevertheless, Spies et al. (2018) presents ecological forestry, and its typical logging practices, in a highly favorable light.[31] Authors write, citing Carey (2003) and other studies, "[t]here are . . . many potential benefits to thinning, including increasing structural diversity, species richness . . . ."[32] According to Spies et al. (2018), restoration thinning, variable-retention harvesting, and other ecological forestry practices may allow "more economically viable and longer term production of wood

23. SPIES ET AL., *supra* note 1, at 169, 638, 674, 734, 895, 956, 964; *see also* A.B. Carey, *Biocomplexity and Restoration of Biodiversity in Temperate Coniferous Forest: Inducing Spatial Heterogeneity with Variable-Density Thinning*, 76 FORESTRY 127 (2003).

24. SPIES ET AL., *supra* note 1, at 169, 188.

25. SPIES ET AL., *supra* note 1, at 169.

26. SPIES ET AL., *supra* note 1, at 734.

27. SPIES ET AL., *supra* note 1, at 263–64.

28. SPIES ET AL., *supra* note 1, at 264.

29. SPIES ET AL., *supra* note 1, at 489.

30. *See* SPIES ET AL., *supra* note 1, at 152; *see also* SPIES ET AL., *supra* note 1, at 168.

31. SPIES ET AL., *supra* note 1, at 169, 734, 956, 964.

32. SPIES ET AL., *supra* note 1, at 493; *see also* SPIES ET AL., *supra* note 1, at 162; Carey, *supra* note 23.

from federal lands," while "help[ing] achieve biodiversity goals."[33] As proposed for this region, ecological forestry represents "a potential win-win for biodiversity and socioeconomic values."[34]

Claims that ecological forestry represents "a potential win-win" rest on several considerations.[35] Spies et al. (2018) asserts the need to restore Pacific Northwest forests, bringing them closer to historic conditions, rendering them more resilient to wildfire, disease, climate change, and other stresses.[36] According to this report, traditional harvesting (clear-cutting) has led to substantial loss of old-growth forest, and these scientists discuss the need to efficiently generate old-growth characteristics by means of variable-density thinning within younger plantations.[37] Variable-retention harvesting allows creation of areas of early-successional (early-seral) forest vegetation, which is sparse in these fire-suppressed forests, benefitting those species dependent upon early-seral conditions.[38] Citing Gustafsson et al. (2012), Halpern et al. (2012), and other studies, Spies et al. (2018) claims that retention harvesting (variable-retention) "can provide habitat and 'life boats' (i.e., refugia) for older forest species," allowing late-successional species to survive until harvested areas develop toward later successional stages.[39]

For the potential "win-win," Spies et al. (2018) discusses potentially attaining relatively high and steady timber production through restoration activities.[40] Importantly, this report does not call for strict protection of existing old-growth forests.[41] The authors claim that restoration by means of thinning and retention harvesting may be appropriate in mature and old-growth forests (over eighty years), within moist and dry forest types, providing "economically valuable wood products."[42] They suggest that

33. SPIES ET AL., *supra* note 1, at 956.

34. SPIES ET AL., *supra* note 1, at 964.

35. SPIES ET AL., *supra* note 1, at 956, 964.

36. SPIES ET AL., *supra* note 1, at 148–53, 172–74, 183, 188.

37. This is the account provided in Spies et al. (2018) specifically for moist forests. SPIES ET AL., *supra* note 1, at 148, 151, 162–68, 182, 186. These authors claim that, with fire suppression, old-growth within dry forests is actually more extensive than it was historically, and restoration of these forests should involve thinning old-growth areas. SPIES ET AL., *supra* note 1, at 183, 186, 188.

38. SPIES ET AL., *supra* note 1, at 169, 281, 411, 423, 633, 637, 964, 973.

39. SPIES ET AL., *supra* note 1, at 169; *see also* Lena Gustafsson et al., *Retention Forestry to Maintain Multifunctional Forests: A World Perspective*, 62 BIOSCIENCE 633 (2012); Charles B. Halpern et al., *Level and Pattern of Overstory Retention Interact to Shape Long-Term Responses of Understories to Timber Harvest*, 22 ECOLOGICAL APPLICATIONS 2049 (2012).

40. SPIES ET AL., *supra* note 1, at 691–92.

41. SPIES ET AL., *supra* note 1, at 153, 168–69.

42. *See* SPIES ET AL., *supra* note 1, at 153, 169, 188.

restoration thinning in older stands (over eighty years) within Late Successional Reserves, in moist forests, may occasionally be appropriate.[43]

Within Spies et al. (2018), claims of a potential "win-win" also rest upon suggested mitigation measures intended to minimize harm to native species.[44] According to authors, restoration thinning within younger-forest plantations in Late Successional Reserves, in moist forests, "can provide jobs and economic returns."[45] "[T]here will be tradeoffs with ecological goals," they add, for example, "amounts of dead wood," which "may need mitigation."[46] In certain circumstances, restoration efforts may involve "encouraging development of dead wood," they state, by "[p]roviding more naturally regenerating . . . complex early successional stands."[47] It may be necessary to leave "some thinned trees . . . on the site."[48] The Spies report places much emphasis on the need for mitigation.[49]

Yet many of the mitigation measures suggested within Spies et al. (2018) are quite vague.[50] For example, a suggested measure is to retain "old legacy trees in younger stands," and "older forest patches in cutting units," with no indication of precise legacy-tree densities that should be retained in thinned younger stands, or precisely how large older-forest retention patches should be in harvested areas.[51] Authors suggest "[p]roviding more naturally regenerating . . . complex early-successional stands," and leaving "some thinned trees . . . on the site," with no indication of precise quantities.[52] Spies et al. (2018) conveys the recommendation to retain "large live and dead" trees of several species for pileated woodpecker (*Dryocopus pileatus*) nesting.[53] In this report,

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43. *See* SPIES ET AL., *supra* note 1, at 168. Spies et al. (2018) notes that the Northwest Forest Plan generally forbids thinning and other silvicultural treatments within older stands (over eighty years) in Late Successional Reserves in moist forests, yet allows such activities in older stands outside the reserves. SPIES ET AL., *supra* note 1, at 168. The authors question the appropriateness of this "one-size-fits-all approach." SPIES ET AL., *supra* note 1, at 168. The Northwest Forest Plan allows silvicultural treatments within older stands in Late Successional Reserves in dry forests. SPIES ET AL., *supra* note 1, at 155–56.

44. SPIES ET AL., *supra* note 1, at 183, 956.

45. SPIES ET AL., *supra* note 1, at 183.

46. SPIES ET AL., *supra* note 1, at 183.

47. SPIES ET AL., *supra* note 1, at 425.

48. SPIES ET AL., *supra* note 1, at 963.

49. *See, e.g.*, SPIES ET AL., *supra* note 1, at 183, 963.

50. *See, e.g.*, SPIES ET AL., *supra* note 1, at 383, 398, 425, 963.

51. *See* SPIES ET AL., *supra* note 1, at 383.

52. SPIES ET AL., *supra* note 1, at 425, 963.

53. SPIES ET AL., *supra* note 1, at 398.

with few exceptions, precise retention percentages are not specified; there are no indications of precisely how much dead wood should be maintained onsite.[54] The vagueness of suggested mitigation is presumably intended to allow managers the flexibility to achieve, in later planning, a proper balance, from site to site, between restoration and species conservation.[55]

A major difficulty, however, is that Spies et al. (2018) does not adequately evaluate the negative effects of ecological forestry practices, as proposed for this region, on native biodiversity.[56] Specifically, the authors do not acknowledge the extent and severity of the impacts of variable-retention harvesting on mature-forest species, failing to adequately consider key cited studies, and failing to discuss or cite important studies in the literature.[57]

In support of the claim that retention "can provide habitat and 'life boats' for older forest species," Spies et al. (2018) cites (among other studies) Gustafsson et al. (2012), in which forest management experts from different regions of the world discuss the biodiversity benefits of variable-retention harvesting.[58] According to Lena Gustafsson and others, this "scientifically validated" approach can reduce conflicts between timber production and biodiversity conservation.[59] "More aboveground species are maintained," they claim, "in stands with retained structures" in comparison to clear-cut harvesting, including some late-successional forest species (life-boating).[60] Yet these authors also conclude, "Many but not all natural structures and their associated organisms may be maintained through retention."[61] They add, "Some highly sensitive or area-demanding species may have requirements that cannot be met at the scale of harvesting and retention units . . . ."[62]

Gustafsson et al. (2010), not discussed or cited in Spies et al. (2018), presents a literature review of the effectiveness of variable-retention harvesting in boreal forests in Finland, Norway, and Sweden.[63] Gustafsson et al. (2010) states, "Tree retention alleviates the dramatic

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54. *See generally* SPIES ET AL., *supra* note 1.
55. *See, e.g.*, SPIES ET AL., *supra* note 1, at 405.
56. *See generally* SPIES ET AL., *supra* note 1.
57. SPIES ET AL., *supra* note 1.
58. SPIES ET AL., *supra* note 1, at 169; *see also* Gustafsson et al., *supra* note 39, at 633–35.
59. *See* Gustafsson et al., *supra* note 39, at 633.
60. Gustafsson et al., *supra* note 39, at 638.
61. Gustafsson et al., *supra* note 39, at 639.
62. Gustafsson et al., *supra* note 39, at 639.
63. Gustafsson et al., *supra* note 8, at 295.

consequences that clear-cutting has on boreal biotas since it maintains assemblages and structures of mature forests to some extent."[64] Yet, according to these researchers, "[R]etention trees have noticeable effects on forest characteristics, including biodiversity patterns."[65] They conclude, "[T]ree retention cannot maintain the structures and the microclimate that are important for species living in mature and old-growth forests."[66] In a discussion of the effects of retention harvesting on forest beetles, Gustafsson and others state (citing studies), "even very high retention amounts or large groups cannot maintain the forest interior species that are typical in mature and old-growth forests."[67] These researchers note that, generally, with respect to red-listed (at-risk) species, the "advantages that retention trees provide . . . have often been questioned."[68]

As mentioned, Spies et al. (2018) discusses negative effects of restoration thinning on native species, writing that thinning treatments "can reduce habitat quality for species that use dense older forests," and that such treatments "could also reduce habitat for at-risk, older forest species."[69] Authors acknowledge that thinning "can have adverse effects" on Pacific fishers (*Martes pennanti*), Pacific martens (*Martes caurina*), northern spotted owls, and others.[70] Although they endorse use of variable-retention harvesting, they write little concerning its negative effects, failing to disclose biodiversity impacts as discussed in Gustafsson (2010, 2012) and other studies.[71] According to Gustafsson et al. (2010, 2012), variable-retention logging eliminates habitat characteristics (structure, microclimate) that are essential for species dependent upon mature and old-growth forests, and especially those species that are highly sensitive or area-demanding cannot persist, even at higher retention levels.[72] The impacts are severe in certain taxonomic groups—with respect to forest beetles, they state (again), "even very high retention

64. Gustafsson et al., *supra* note 8, at 304.
65. Gustafsson et al., *supra* note 8, at 298.
66. Gustafsson et al., *supra* note 8, at 304.
67. Gustafsson et al., *supra* note 8, at 299; *see also* Gustafsson et al., *supra* note 8, at 306–07 (indicating that these scientists are referring to ground-dwelling (carabid) beetles).
68. Gustafsson et al., *supra* note 8, at 304.
69. SPIES ET AL., *supra* note 1, at 168, 975.
70. SPIES ET AL., *supra* note 1, at 963.
71. *See generally* SPIES ET AL., *supra* note 1; *see, e.g.*, Gustafsson et al., *supra* note 8, at 298, 304.
72. Gustafsson et al., *supra* note 8, at 299, 304; Gustafsson et al., *supra* note 39, at 633, 639.

amounts . . . cannot maintain" the specialist species typical of mature and old-growth forests.[73]

As will be discussed in the next Part, a general theme within the scientific literature is that ecologically-based forestry practices, with selective thinning and partial harvesting (including variable-retention), and a focus on relatively high and steady timber production, eliminates habitat characteristics essential for the persistence of mature-forest birds, mammals, beetles, fungi, lichens, herbs, and other taxa.[74] Variable-retention harvesting, at typical retention levels, is especially detrimental to native biodiversity, having been linked to severe loses of mature-forest species within a number of taxonomic groups.[75] The negative impacts of ecologically-based forestry have been documented within various forest types, and in different regions of the world.[76]

III. Biodiversity Impacts of "Ecological" Timber Harvesting

A. A Science Review

This Part briefly reviews studies from North America and Europe concerned with the biodiversity impacts of ecologically-based forestry practices, which include use of selective thinning techniques and partial harvesting (for example, variable-retention). This Part begins with consideration of Carey (2003), an experimental study of variable-density thinning.[77] Spies et al. (2018) cites this study in support of claims concerning the potential compatibility of timber production and biodiversity conservation, but Carey (2003) reports mixed results.[78]

Carey (2003) claims that, in a second-growth (previously logged) study area in the Pacific Northwest, variable-density thinning treatments "had immediate positive effects on forest-floor mammals."[79] Andrew Carey reports that deer mice (*Peromyscus maniculatus*), creeping voles (*Microtus oregoni*), and vagrant shrews (*Sorex vagrans*) increased in abundance following treatments, while no species of forest-floor mammals declined in abundance.[80] Chipmunks (*Tamias townsendii*) substantially increased in abundance.[81] According to Carey, species

73. Gustafsson et al., *supra* note 8, at 299.
74. *See, e.g.*, Gustafsson et al., *supra* note 8, at 299, 304.
75. *See, e.g.*, Gustafsson et al., *supra* note 8, at 299, 304.
76. *See, e.g.*, Gustafsson et al., *supra* note 8, at 299, 304; *see* discussion *infra* Part III.A.
77. *See generally* Carey, *supra* note 23.
78. Spies et al., *supra* note 1, at 162, 493, 889; Carey, *supra* note 23, at 133–34.
79. Carey, *supra* note 23, at 134.
80. Carey, *supra* note 23, at 133.
81. Carey, *supra* note 23, at 133–34.

richness (number of species) of winter birds was consistently higher in experimental plots compared to untreated, second-growth controls.[82]

Yet Carey (2003) reports that Douglas squirrels (*Tamiasciurus douglasii*) were low in abundance in all plots and did not appear to respond to thinning in the short term, while northern flying squirrels decreased in abundance following treatments, but "recovered within 5 years."[83] Long-term results of thinning treatments on Douglas squirrels and northern flying squirrels remains to be observed, Carey adds.[84] Cavity-excavating birds (*Picidae* or woodpeckers) were present in all plots, but were low in abundance.[85] Carey does not claim that thinning treatments will allow for the continued persistence of northern spotted owls, Pacific fishers, and other high-level predators, which were not monitored during the study.[86] Carey expresses optimism, claiming that variable-density thinning will likely "prove important in restoring and maintaining biodiversity in second-growth . . . forests."[87]

Yet later experimental studies of thinning, and variable-density thinning, have shown longer-term negative effects on northern flying squirrels and other mature-forest species.[88] Manning et al. (2012) discusses the effects of thinning on northern flying squirrel densities in the Cascade Mountains of Oregon, these authors writing, "[o]ur longer-term study provides evidence that the negative impacts of commercial thinning on northern flying squirrel can persist even after 11–13 years."[89] Tom Manning and others discuss Wilson (2010), a study in which Carey's experimental and control plots (Carey (2003)) were resampled twelve years after his variable-density thinning treatments.[90] As Manning et al. (2012) states, Wilson (2010) "found that flying squirrel densities were very low in both thinned and unthinned stands."[91] According to Manning

82. Carey, *supra* note 23, at 133.
83. Carey, *supra* note 23, at 133.
84. Carey, *supra* note 23, at 133.
85. Carey, *supra* note 23, at 133.
86. Carey, *supra* note 23, at 131.
87. Carey, *supra* note 23, at 133.
88. *See, e.g.*, Manning et al., *supra* note 8, at 115; *see also* Todd M. Wilson, LIMITING FACTORS FOR NORTHERN FLYING SQUIRRELS (*GLAUCOMYS SABRINUS*) IN THE PACIFIC NORTHWEST: A SPATIO-TEMPORAL ANALYSIS 139 (2010) (Ph.D. dissertation, Union Institute & University, Cincinnati, Ohio) (on file with author).
89. Manning et al., *supra* note 8, at 120–21.
90. Manning et al., *supra* note 8, at 116, 121; *see also* Wilson, *supra* note 88, at 36–39; Carey, *supra* note 23.
91. Manning et al., *supra* note 8, at 116; *see also* Wilson, *supra* note 88, at 139; Winston P. Smith, *Sentinels of Ecological Processes: The Case of the Northern Flying Squirrel*, 62

et al. (2012), "Wilson's work, like ours reported here, found no support for the hypothesis that thinning for increased forest complexity results in habitat that supports high densities of northern flying squirrels . . . ."[92]

In a literature review, Wilson and Forsman (2013) discusses the effects of thinning, and variable-density thinning, on northern flying squirrels and other spotted owl prey species.[93] According to Todd Wilson and Eric Forsman, "Population studies have shown early and positive responses to thinning by some small forest-floor mammals (primarily mice, terrestrial voles, and shrews)."[94] Yet they add (referring to variable-density thinning), "[T]hinning reduces the abundance of some tree-dwelling rodents, especially Northern Flying Squirrels and Red Tree Voles, that are important prey species for Northern Spotted Owls."[95] These authors believe that thinning reduces "occlusion," that is, "the degree to which physical structures inhibit detection of [northern flying] squirrels by predators," for example, as they glide between trees.[96] Red tree voles are arboreal rodents that live in the canopies of mature forests, and are a candidate for listing under the federal Endangered Species Act.[97] These small mammals have limited mobility, and, as these authors state, "may not be able to disperse across broad areas of intensively managed forests."[98]

Spies et al. (2018) acknowledges decades-long, negative impacts of restoration thinning on northern flying squirrels, red tree voles, and other northern spotted owl prey species, citing Manning et al. (2012), and Wilson and Forsman (2013).[99] Spies et al. (2018) endorses this practice, however, citing Carey (2003) and other studies, stating, "there are . . . many potential benefits to thinning . . . ," and, indeed, Carey (2003) has shown, for example, that thinning may enhance winter bird species

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BIOSCIENCE 950, 954 (2012) ("Northern flying squirrels have an acute sensitivity to disturbance.").

92. Manning et al., *supra* note 8, at 121.

93. Todd M. Wilson & Eric D. Forsman, *Thinning Effects on Spotted Owl Prey and Other Forest-Dwelling Small Mammals*, DENSITY MANAGEMENT IN THE 21ST CENTURY: WEST SIDE STORY 79, 79 (2013).

94. *Id.*

95. *Id.*; *see* SPIES ET AL., *supra* note 1, at 245–46 (stating that northern spotted owls are listed as threatened under the federal Endangered Species Act, and that their numbers continue to steadily decline).

96. Wilson & Forsman, *supra* note 93, at 82.

97. *Red Tree Vole*, U.S. FISH & WILDLIFE SERV., https://www.fws.gov/species/red-tree-vole-arborimus-longicaudus *(last visited Mar. 22, 2023)*.

98. Wilson & Forsman, *supra* note 93, at 83.

99. SPIES ET AL., *supra* note 1, at 264.

richness.[100] Manning et al. (2012) recommends caution in the use of commercial thinning over large areas of forest, arguing that impacts on northern spotted owl prey species are not well understood.[101]

Vanderwel et al. (2007) reviews studies of the effects of dispersed retention harvesting on North American birds.[102] Mark Vanderwel and others found that, of thirty-four bird species examined in the reviewed studies, fourteen experienced negative effects of harvesting and six experienced positive effects.[103] "Species differ in their tolerances to habitat alteration," they write, adding, "[s]pecies that responded negatively to harvesting were generally those associated with mature forest habitat."[104] They found significant population declines in several sensitive species at higher retention levels of 50, 70, and 85 percent.[105] Vanderwel et al. (2007) recommends, for the "stand-level management of late successional bird species," engaging primarily in light-intensity harvesting, with retention levels of greater than 70 percent, and, to a lesser extent, use of moderate-intensity harvesting, with retention of 50 to 70 percent.[106] These authors add that more intensive harvesting, with retention of less than 50 percent, "is expected to cause serious drops in abundance for some bird species and might exclude selected species . . . ."[107]

Harrison et al. (2005) is concerned with the responses of songbirds to variable-retention harvesting in a boreal forest study area in northwestern Alberta, Canada.[108] Blocks harvested at retention levels of 0, 10, 20, 50, 75, and 100 percent (controls) were replicated in four cover types, including conifer-dominated and deciduous-dominated forest.[109]

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100. SPIES ET AL., *supra* note 1, at 493; *see* Carey, *supra* note 23, at 133–34.

101. Manning et al., *supra* note 8, at 123.

102. Mark C. Vanderwel et al., *A Meta-analysis of Bird Responses to Uniform Partial Harvesting Across North America*, 21 CONSERVATION BIOLOGY 1230 (2007). Dispersed-retention harvesting consists of trees left scattered across the harvested area individually or in small clusters; variable-retention harvesting consists of some percentage of trees and other pre-harvest vegetation retained in patches or aggregates within a harvested area, and typically includes some dispersed retention as well. *See* SPIES ET AL., *supra* note 1, at 637; Franklin & Johnson, *supra* note 16, at 433–34.

103. Vanderwel et al., *supra* note 102, at 1230, 1234.

104. Vanderwel et al., *supra* note 102, at 1231, 1235.

105. Vanderwel et al., *supra* note 102, at 1230.

106. Vanderwel et al., *supra* note 102, at 1238.

107. Vanderwel et al., *supra* note 102, at 1238.

108. R. Bruce Harrison et al., *Stand-Level Response of Breeding Forest Songbirds to Multiple Levels of Partial-Cut Harvest in Four Boreal Forest Types*, 35 CAN. J. FOREST RSCH. 1553, 1553 (2005).

109. *Id*. at 1554.

Bruce Harrison and others obtained results that, as they note, fit well within a pattern reflected in other studies of forest birds: mature-forest species display increasing abundances with increasing retention levels, while open-habitat species display decreasing abundances.[110] "All studies report loss of some mature forest-dependent species," even at higher retention levels.[111] As they report, their data show that two species, provincially designated as sensitive, "exhibited significant decreases in [all] harvest treatments."[112] Harrison and others write, "We suggest that lower-retention treatments (10%, 20%) cannot . . . be justified from a short-term avian diversity perspective."[113]

Price et al. (2020) discusses a long-term study of bird responses to variable-retention harvesting in temperate conifer forests in northwestern British Columbia, Canada.[114] Karen Price and others measured bird species abundances at 40 and 70 percent retention, comparing these values to abundances in clear-cuts and unharvested conifer forest, over twenty-four years after harvesting.[115] They found that species richness, composition, and abundances responded to retention at these levels, "with communities in 70 percent retention similar to controls [uncut forest]," and "those in 40 percent different from controls."[116] Some species associated with mature conifer forests responded linearly, they report, gradually increasing in abundance from clear-cuts, through 40 and 70 percent retention, with highs in uncut forest.[117] Two highly sensitive species distinguished between 70 percent retention and unharvested forest "up to 10 or 24 years after harvest," yet most mature-forest species "treated 70% retention as equivalent to unharvested controls."[118]

On the other hand, early-successional forest species and generalists were highest in abundance in clear-cuts, and were higher in abundance in retention patches as compared to uncut forest.[119] Price et al. (2020) concludes, "[F]or groups of forest birds on each end of the successional

110. *Id.* at 1559.

111. *Id.*; *see id.* at 1556 (indicating that to "glean bark" means to forage on the bark of trees).

112. *Id.* at 1561.

113. *Id.* at 1563.

114. Karen Price et al., *Long-Term Response of Forest Bird Communities to Retention Forestry in Northern Temperate Coniferous Forests*, 462 FOREST ECOLOGY AND MGMT. 1, 2–4 (2020).

115. *Id.*

116. *Id.* at 8.

117. *Id.*

118. *Id.* at 9.

119. *Id.* at 8.

stage spectrum, 40–70% retention leaves habitat that is intermediate between clearcuts and mature forest or similar to unharvested habitat."[120] Citing studies (including Harrison et al. (2005)), Price and others also conclude, "The maintained abundance of most mature-conifer bird species at 70% retention matches findings elsewhere."[121] "[R]etention below 15–20% has limited benefits for forest specialists," they add.[122]

In Spies et al. (2018), authors of a later chapter explain variable-retention harvesting, using as examples 10 or 15 percent retention, and these are, indeed, percentages typically applied (Franklin and Johnson (2012) provides photos of logged areas at 15 percent retention).[123] Yet, in accordance with the above studies, such low retention levels provide only limited benefit to mature-forest birds.[124] Spies et al. (2018) includes a short section on forest birds (other than northern spotted owls and marbled murrelets), briefly discussing the negative effects of management activities on a few sensitive species, but the authors do not mention the quite high retention levels, up to 70 percent, that are apparently required to maintain most mature-forest bird species in harvested areas.[125]

DellaSala et al. (2013) is critical of the ecological forestry proposals presented by Franklin and Johnson (2012) for federal forestlands in the Pacific Northwest.[126] Franklin and Johnson convey a proposal to maintain, in dry forests subjected to thinning and other treatments, "denser patches of multilayered forest" over approximately 30 percent of a landscape, for northern spotted owl conservation.[127] According to DellaSala et al. (2013), citing studies, "[S]urvival rates of owls decline dramatically when home ranges include <50–60% late-successional forest," which implies that requiring retention of approximately 30

120. *Id.*

121. *Id.* at 9.

122. *Id.*

123. SPIES ET AL., *supra* note 1, at 637; Franklin & Johnson, *supra* note 16, at 434; *see also* RICHARD B. PRIMACK, ESSENTIALS OF CONSERVATION BIOLOGY 434 (2014) ("Typically about 15% of the trees remain after this type of logging . . .").

124. Harrison et al., *supra* note 108, at 1563; Price et al., *supra* note 114, at 2, 9; *see also* Clint R.V. Otto & Gary J. Roloff, *Songbird Response to Green-Tree Retention Prescriptions in Clearcut Forests*, 284 FOREST ECOLOGY AND MGMT. 241, 248 (2012).

125. SPIES ET AL., *supra* note 1, at 397–98, 411–12; *see also* Vanderwel et al., *supra* note 102, at 1230, 1238; Harrison et al., *supra* note 108, at 1560, 1563; Price et al., *supra* note 114, at 8–9.

126. See Dominick DellaSala et al., *Alternative Views of a Restoration Framework for Federal Forests in the Pacific Northwest*, 111 J. FORESTRY 420, 420 (2013); *see also generally* Franklin & Johnson, supra note 16.

127. *See* Franklin & Johnson, *supra* note 16, at 435.

percent late-successional forest over an entire landscape is too minimal, and will not ensure spotted owl survival.[128]

Bart (1995) provides an estimate of the extent of suitable habitat required over a landscape for northern spotted owl population viability, claiming that viability (a stable population) is achieved "when suitable habitat covers 30%–50% of the landscape."[129] Jonathan Bart cautions, however, that the estimated range of required suitable habitat values he provides results from use, in his calculations, of a broad range of juvenile owl survivorship values, with the minimum required suitable habitat level corresponding to maximum juvenile survivorship.[130] There is much uncertainty, however, concerning juvenile survivorship; as Bart writes, "[m]any juveniles move long distances during their first fall and spring," and "pass[] through a wide range of forest conditions."[131] "Juvenile survivorship in the future," he states, "when much suitable habitat may have been altered or removed, may be considerably lower."[132]

In light of Bart (1995), considering current and potential future losses of habitat within the region, the most reasonable strategy is to maintain 50 percent, or higher, suitable habitat across a landscape as a buffer against declining regional conditions.[133] The minimum value of 30 percent seems unreasonably low, given regional habitat losses.[134]

Franklin and Johnson (2012) conveys the proposal to maintain, in dry forests, "denser patches of multilayered forest" on approximately 30 percent of a landscape, for northern spotted owls; Spies et al. (2018) also conveys this proposal.[135] In addition, Franklin and Johnson (2012) proposes, for moist forests, "retention of approximately 30% of the preharvest stand as patches, plus some additional retention (typically of green trees . . .) on harvested portions," for northern spotted owls.[136] Studies indicate, however, that these proposals are not adequate, that for spotted owl viability the most reasonable strategy is to maintain at least

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128. DellaSala et al., *supra* note 126, at 424; see Katie M. Dugger et al., *The Relationship Between Habitat Characteristics and Demographic Performance of Northern Spotted Owls in Southern Oregon*, 107 CONDOR 863, 875–76 (2005).

129. Jonathan Bart, *Amount of Suitable Habitat and Viability of Northern Spotted Owls*, 9 CONSERVATION BIOLOGY 943, 944 (1995). By "suitable habitat," Bart is referring to old-growth and, presumably, high-quality, mature-forest habitat generally. *Id*. at 943, 946.

130. *Id*. at 944.

131. *Id*.

132. *Id*.

133. *Id*.

134. *Id*.

135. SPIES ET AL., *supra* note 1, at 278; Franklin & Johnson, *supra* note 16, at 435.

136. Franklin & Johnson, *supra* note 16, at 434.

50 percent intact, mature-forest habitat over a landscape, and, as recommended by DellaSala et al. (2013), greater than 50 percent such habitat at the territory scale.[137]

According to Moriarty et al. (2016), Pacific martens are typically associated with dense forests with complex structure, including a multi-layered canopy with large trees, numerous smaller diameter trees, and many large snags and downed logs.[138] Using GPS telemetry to track movement patterns, Katie Moriarty and others found that, within their home ranges, martens forage in areas that have such complex forest structure, and they largely avoid stands that have been simplified through thinning and other fuel-reduction treatments.[139] "Martens are able to find and kill prey more successfully in complex stand types," they write; in addition, martens are more successful at avoiding predators in stands with complex structure.[140] Moriarty and others state, "Fuels treatments that simplify forest structure (e.g., removal of small diameter trees, downed logs) have negative effects on marten movement dynamics."[141]

Moriarty et al. (2016) recommends that agency managers "apply[] treatments below elevations where martens typically occur," arguing that these higher elevations are not, at least in the near term, in need of fuel-reduction treatments.[142] These authors add, citing studies concerning American martens (*Martes americana*), "marten populations may decline sharply with relatively modest amounts (<35%) of forest loss," referring to forest losses within a landscape.[143]

Indeed, according to a cited study, Hargis et al. (1999), American martens "were nearly absent from landscapes having >25% non-forest cover . . . ."[144] Christina Hargis and others write, "Martens appeared to respond negatively to low levels of habitat fragmentation."[145] "We recommend," they add, "that the combination of timber harvests and

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137. *See* DellaSala et al., *supra* note 126, at 426; Bart, *supra* note 129, at 944; *see also* SPIES ET AL., *supra* note 1, at 268 (indicating that northern spotted owl "territory scale" is approximately 500 to 1500 ha).

138. Katie M. Moriarty et al., *Forest Thinning Changes Movement Patterns and Habitat Use by Pacific Marten*, 80 J. WILDLIFE MGMT. 621, 622 (2016).

139. *Id.* at 621, 627–30.

140. *Id.* at 629.

141. *Id.* at 630.

142. *Id.* at 621; *see also id.* at 630.

143. *Id.* at 622.

144. Christina D. Hargis et al., *The Influence of Forest Fragmentation and Landscape Pattern on American Martens*, 36 J. APPLIED ECOLOGY 157, 157 (1999).

145. *Id.* at 165.

natural openings comprise <25% of landscapes . . . ."[146] In a discussion of previous studies of American martens, Fuller and Harrison (2005) notes, "martens do not establish home ranges in areas >25-40% early-successional forest."[147] Lavoie et al. (2019) states, "The American marten is a small carnivore species that is sensitive to forest perturbations," adding, "marten do not tolerate more than 30 to 40% of poor quality habitat within their home range."[148]

In Spies et al. (2018), authors briefly consider Moriarty et al. (2016), declining to accept the recommendation to apply treatments "at elevations lower than where martens typically occur," arguing for the need for a more comprehensive scientific analysis.[149] According to Spies et al. (2018), "[T]o minimize impacts to martens," fuel-reduction treatments "could be carefully designed to minimize their overlap with habitats supporting important aspects of marten life history . . . ."[150] Yet these authors do not present information from Moriarty et al. (2016), or other studies, concerning the sensitivity of martens to management disturbance, and the extent of high-quality habitat (dense forests with complex structure) that, it seems, must be present for persistence: at least 60 to 75 percent of landscapes.[151]

Spies et al. (2018) cites Halpern et al. (2012) in support of the claim that retention harvesting can provide "life-boats" for older forest species, yet, according to the Halpern study, any life-boating function is limited.[152] Halpern et al. (2012) discusses the effects of variable-retention harvesting on understory vegetation in conifer forests in western Oregon and Washington, with aggregate and dispersed retention levels of 15, 40, and 100 percent (controls).[153] With respect to bryophytes (mosses and liverworts), these researchers found a linear pattern: increasing bryophyte cover with higher retention, yet they observed large losses in bryophyte

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146. *Id.* at 157.

147. Angela K. Fuller & Daniel J. Harrison, *Influence of Partial Timber Harvesting on American Martens in North-Central Maine*, 69 J. WILDLIFE MGMT. 710, 711 (2005).

148. Maxime Lavoie et al., *Timber Harvest Jeopardize Marten Persistence in the Heart of its Range*, 442 FOREST ECOLOGY AND MGMT. 46, 46 (2019).

149. SPIES ET AL., *supra* note 1, at 411; *see* Moriarty et al., *supra* note 138, at 621.

150. SPIES ET AL., *supra* note 1, at 405.

151. Moriarty et al., *supra* note 138, at 622; Hargis et al., *supra* note 144, at 157; Fuller & Harrison, *supra* note 147, at 711, 719; Lavoie et al., *supra* note 148, at 46.

152. SPIES ET AL., *supra* note 1, at 169; *see* Halpern et al., *supra* note 39, at 2054–55, 2057–61.

153. Halpern et al., *supra* note 39, at 2049–51; *see also* Halpern et al., *supra* note 39, at 2050 (explaining that aggregate-retention harvesting consists of retaining a percentage of pre-harvest vegetation in patches or aggregates within a harvested area).

cover at 40 percent retention.[154] As Charles Halpern and others explain, "[F]orest bryophytes are shade plants, adapted to cool, moist, and low-light environments."[155] "Even at 40% retention," they write, "light, temperature, or humidity may exceed critical thresholds for survival or recolonization."[156] Even decades after harvest, there is "little evidence of bryophyte recovery."[157] As with late-successional herbs, bryophyte recovery is restricted by physiological and dispersal limitations.[158]

According to Halpern et al. (2012), then, retention patches can indeed serve as "life-boats" for mature-forest species, but this function is limited: even at 40 percent retention, bryophytes and late-successional herbs showed significant losses, reflecting sensitivity to changes in light, temperature, and humidity.[159] Halpern and others add, discussing understory vegetation, "current minimum standards of retention (15 percent of the harvest unit) offer marginal, if any, benefit for most forest-dependent species."[160]

Pinzon et al. (2016) discusses the effects of variable-retention harvesting on ground-dwelling spiders in a boreal forest study area in northwestern Alberta, Canada, with retention of 0, 10, 20, 50, 75, and 100 percent (controls) in different cover types.[161] Jamie Pinzon and others state that, consistent with their findings, retention levels of greater than 50 percent "would be required to maintain deep forest species after harvest," but, as their results show, even 75 percent retention did not allow persistence of all mature-forest species.[162] "[I]n cover types with a conifer component," they write, "spider assemblages continued to differ strongly" between harvested units and controls, even at 75 percent retention and even after ten years.[163] These results fit well within the patterns reflected in studies of thinning and retention harvesting previously reviewed in this section: it appears that quite high percentages of dense natural habitat must be maintained, at up to the landscape scale, for persistence of many mature-forest species of various taxa, for example, for ground-dwelling spiders, up to 75 percent or higher within

154. Halpern et al., *supra* note 39, at 2054–55, 2059–60.

155. Halpern et al., *supra* note 39, at 2060.

156. Halpern et al., *supra* note 39, at 2060.

157. Halpern et al., *supra* note 39, at 2060.

158. Halpern et al., *supra* note 39, at 2060.

159. Halpern et al., *supra* note 39, at 2054–55, 2059–60.

160. Halpern et al., *supra* note 39, at 2061.

161. Jaime Pinzon et al., *Ten-Year Responses of Ground-Dwelling Spiders to Retention Harvest in the Boreal Forest*, 26 ECOLOGICAL APPLICATIONS 2581, 2581–82 (2016).

162. *Id.* at 2590, 2595.

163. *Id.* at 2595.

harvest units.[164] Pinzon and others decline to recommend a "threshold" conservation retention value.[165]

According to Pinzon et al. (2016), the data suggests that, for all cover types, "full recovery of forest assemblages following retention harvest will take significant time."[166] Importantly, as these authors write, "Average retention levels >30% are generally not economically feasible at the harvest cut-block level," that is, at the scale of harvesting blocks typically applied in commercial forestry.[167]

In Europe, ecologically-based forestry has been widely practiced for decades, with some variation from region to region.[168] As Nagel et al. (2017) describes, forest managers in Slovenia practice "close-to-nature" silviculture, emphasizing natural regeneration and "relatively small-scale" thinning and logging operations, including irregular shelterwood harvesting.[169] "Although the goals and types of ecological forestry vary," Thomas Nagel and others write, "a central theme is that the structures and processes in forests managed for timber production should reasonably resemble those found in primary forests."[170] In their study of managed beech forests, Nagel and others found that too much mature and old-growth forest, and dead wood, are typically removed in silvicultural operations to meet the needs of white-backed woodpeckers (*Dendrocopos leucotos lilfordi*) and other species dependent upon such resources.[171]

According to Nagel et al. (2017), "integrative management" (compatible management), which includes close-to-nature silviculture,

164. *Id*. at 2590, 2595.

165. *Id*. at 2581.

166. *Id*. at 2594.

167. *Id*. at 2596; *see also id*. at 2595.

168. *See, e.g.*, A. Boncina, *Conceptual Approaches to Integrate Nature Conservation into Forest Management: A Central European Perspective*, 13 INT'L FORESTRY REV. 13, 16 (2011); Thomas A. Nagel et al., *Evaluating the Influence of Integrative Forest Management on Old-Growth Habitat Structures in a Temperate Forest Region*, 216 BIOLOGICAL CONSERVATION 101, 101–02 (2017).

169. Nagel et al., *supra* note 168, at 101–02, 105. In "irregular shelterwood" harvesting, small groups of trees are harvested in an irregular pattern over the landscape, leaving gaps of varying sizes, with some trees left standing in each harvested area to provide seed trees, shade, and protection of the growing new trees. Patricia Raymond et al., *The Irregular Shelterwood System: Review, Classification, and Potential Application to Forests Affected by Partial Disturbances*, 107 J. FORESTRY 405, 406–08 (2009). Retained trees are typically retained for a long period of time. *Id*. at 406. Variable-retention harvesting is similar, but in variable-retention "retained trees . . . do not promote regeneration through shelter." *Id*. at 408.

170. Nagel et al., *supra* note 168, at 101.

171. Nagel et al., *supra* note 168, at 101, 105–06. An important aspect of European studies of ecologically-based silvicultural practices is their emphasis on the need for sufficient deadwood availability. *See, e.g.*, Nagel et al., *supra* note 168, at 101–03, 105–06.

"has . . . resulted in forests lacking in important structures that develop when forests are left unmanaged."[172] Nagel and others conclude that integrative management, with close-to-nature silviculture, "may be insufficient for maintaining biodiversity that would otherwise be present in an unmanaged forest landscape."[173] This problem is likely inevitable, they claim, if timber production is to be at economically viable levels.[174] They note that this general approach to silviculture "has led to alterations in communities of fungi and beetles," citing Gossner et al. (2013) and Bassler et al. (2014).[175] Nagel et al. (2017) faults forest management throughout Europe for its heavy reliance on ecologically-based forestry, and for failing to place sufficient emphasis on the creation of strictly protected reserves.[176]

To conclude this science review, Beese et al. (2019) provides a relatively recent discussion of the literature concerning biodiversity impacts of variable-retention harvesting in British Columbia, Canada.[177] "Over the past two decades," William Beese and others state, "variable retention has become common on forest lands in the temperate rainforests of coastal British Columbia and has been applied to a lesser extent in inland forest types."[178] "[Studies] indicate positive effects," they write, "on many forest-dwelling organisms compared to conventional clear-cutting."[179]

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172. Nagel et al., *supra* note 168, at 105.

173. Nagel et al., *supra* note 168, at 106.

174. Nagel et al., *supra* note 168, at 101, 106; *see also* Martin M. Gossner et al., *Current Near-to-Nature Forest Management Effects on Functional Trait Composition of Saproxylic Beetles in Beech Forests*, 27 CONSERVATION BIOLOGY 605, 613 (2013).

175. Nagel et al., *supra* note 168, at 102; *see* Gossner et al., *supra* note 174, at 605; *see also* Claus Bassler et al., *Near-to-Nature Logging Influences Fungal Community Assembly Processes in a Temperate Forest*, 51 J. APPLIED ECOLOGY 939 (2014). Bassler et al. (2014), a study of commercial beech forests in southern Germany, concludes that near-to-nature practices "are not able to mimic the major processes that shape fungal community assembly in protected forests." *Id.* at 939. "[O]ur results support[] the view," these researchers write, "that logging acts as a habitat filter in promoting species able to respond more flexibly to the patchy resources in managed forests." *Id.* at 943.

176. Nagel et al., *supra* note 168, at 106 (noting that "strict forest reserves cover <1% of the total forest area in the temperate zone of Europe" and recommending the designation of additional reserves).

177. *See* William J. Beese et al., *Two Decades of Variable Retention in British Columbia: A Review of its Implementation and Effectiveness for Biodiversity Conservation*, 8.33 ECOLOGICAL PROCESSES 1 (2019).

178. *Id.*

179. *Id.* at 16.

Yet, as acknowledged in Beese et al. (2019), "[R]etention cutting had negative impacts on some species compared to uncut forest."[180] Studies suggest, Beese and others write, that "fungi and lichens have more species associated with old forests and are of greater concern for losses from harvesting."[181] According to one reviewed study, "[N]one of the patch sizes successfully maintained ectomycorrhizal [fungi] diversity relative to continuous forest."[182] As Beese et al. (2019) discusses, one study suggests that "for forest specialist birds" 40 to 60 percent retention is required "to maintain the same bird assemblage found in unharvested forest."[183] At one study site, northern flying squirrel abundance was higher in uncut forest, and in harvested areas with large retention patches, 75 percent or greater, compared to harvested areas with retention of 15 and 40 percent.[184] This finding "support[s] previous studies showing [northern flying squirrel] sensitivity to forest harvesting."[185]

Beese et al. (2019) states that, with respect to ground-dwelling (carabid) beetles, variable-retention has had mixed success, with certain mature-forest species lost in harvested areas.[186] At one study site, retention of 15 and 50 percent "were largely unsuccessful at maintaining mature-forest carabids."[187] Beese and others claim that gastropods (snails and slugs) "are particularly sensitive to harvest due to their limited dispersal ability and strict moisture requirements."[188] Citing Ovaska et al. (2016), Beese et al. (2019) reports that, at study sites, several snail species were lower in abundance in harvested areas "after 2 to 4 years, relative to . . . controls," with retention providing no benefit compared to clear-cutting.[189]

Beese et al. (2019) concludes, "Retention provides habitat that allows for some forest-associated organisms to persist after harvesting," and these authors recommend variable-retention harvesting for "forests

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180. *Id.* at 8.
181. *Id.* at 12.
182. *Id.* at 14.
183. *Id.* at 12.
184. *Id.* at 13.
185. *Id.*
186. *Id.* at 13–14.
187. *Id.* at 14.
188. *Id.*
189. *Id.*; *see also* Kristiina Ovaska et al., *Short-Term Effects of Variable-Retention Logging Practices on Terrestrial Gastropods in Coastal Forests of British Columbia*, 90 NORTHWEST SCIENCE 260 (2016) (discusses effects of retention harvesting on snail abundances, at up to thirty percent retention).

where timber production is a major goal."[190] Yet this study stresses the essential role of uncut forest reserves in biodiversity conservation.[191] Interestingly, Beese and others suggest that less emphasis be placed on closely mimicking natural disturbances during harvesting, writing, "[t]he very nature of commercial forestry (i.e. removal of wood) makes precise imitation of natural disturbance impossible."[192]

B. *Analysis of Impacts*

Ecologically-based forestry has been practiced for decades in Europe and western Canada, and studies have shown severe limitations of typical practices, including selective thinning and partial-harvesting treatments, with respect to biodiversity conservation.[193] A fundamental difficulty is that ecologically-based silvicultural practices do not closely mimic the effects of wildfire and other natural disturbances.[194] Such practices typically leave behind insufficient forest cover, large trees, dead wood, and other resources essential for the persistence of bryophytes, as well as mature-forest species of birds, mammals, beetles, spiders, gastropods, fungi, lichens, herbs, and other taxa, resulting in documented shifts in species composition.[195] Highly sensitive and area-demanding

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190. Beese et al., *supra* note 177, at 15–16.

191. Beese et al., *supra* note 177, at 15–16.

192. Beese et al., *supra* note 177, at 16–17; *see also* Beese et al., *supra* note 177, at 17 ("Simplification of natural structures and patterns may be necessary to improve the efficiency of management or to meet other societal objectives.").

193. *See, e.g.*, Gustafsson et al., *supra* note 8, at 299, 304; Nagel et al., *supra* note 168, at 101–02, 105–06; Beese et al., *supra* note 177, at 8, 12–14; *see also* ROBERT B. MONSERUD ET AL., COMPATIBLE FOREST MANAGEMENT 89 (2003) (explaining that "partial harvesting" and "partial cutting" are general terms that refer to harvesting methods other than clear-cutting, including variable-retention harvesting as well as irregular shelterwood and other methods).

194. Beese et al., supra note 177, at 16–17; see also Mikko Mönkkönen et al., *Solving Conflicts Among Conservation, Economic, and Social Objectives in Boreal Production Forest Landscapes: Fennoscandian Perspectives*, in ECOSYSTEM SERVICES FROM FOREST LANDSCAPES: BROADSCALE CONSIDERATIONS 1, 47 (A.H. Perera et al. eds., 2018) ("[I]t is important to recognize that natural disturbance and human-induced disturbances differ considerably").

195. *See, e.g.*, Gustafsson et al., *supra* note 8, at 299, 304; Manning et al., *supra* note 8, at 120–21; Halpern et al., *supra* note 39, at 2049, 2055, 2058–61; Wilson & Forsman, *supra* note 93, at 79, 82–84; Vanderwel et al., *supra* note 102, at 1230, 1234–38; Harrison et al., *supra* note 108, at 1559–63; Price et al., *supra* note 114, at 8–9; Moriarty et al., *supra* note 138, at 622, 627–30; Hargis et al., *supra* note 144, at 157; Pinzon et al., *supra* note 161, at 2581, 2590, 2594–96; Boncina, *supra* note 168, at 17; Nagel et al., *supra* note 168, at 101–02, 105–06; Beese et al., *supra* note 177, at 8, 11–14.

species cannot survive.[196] The effects of such management manipulations are not short-term, but may last for decades.[197]

The habitat-filtering effects of ecologically-based forestry practices have been noted in various forest types, and in different regions of the world.[198] Variable-retention harvesting, at typical retention levels of 10 to 20 percent, appears to be especially detrimental to native biodiversity, having been linked to large losses of bryophytes, as well as severe losses of mature-forest birds, ground-dwelling beetles and spiders, late-successional herbs, and others.[199] As studies have shown, quite high retention percentages are required for effective conservation of many mature-forest species: over 50 percent (as indicated for ground-dwelling beetles and spiders, and certain mature-forest wildlife species) and up to 75 percent or greater (indicated for mature-forest birds, northern flying squirrels, and ground-dwelling spiders).[200] It is important to note that even higher retention levels of 75 percent or greater in harvest units are associated with significant population declines of certain mature-forest species and species losses.[201]

Studies have shown that, with thinning and other silvicultural treatments, northern spotted owls require for viability at least 50 percent intact, mature-forest habitat over a landscape, and greater than 50 percent

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196. *See supra* note 195.

197. *See* Manning et al., *supra* note 8, at 120–21; Halpern et al., *supra* note 39, at 2060–61; Wilson & Forsman, *supra* note 93, at 79, 84; *see also* Pinzon et al., *supra* note 161, at 2594–95.

198. *See supra* note 195.

199. *See* Gustafsson et al., *supra* note 8, at 299, 304; Halpern et al., *supra* note 39, at 2049, 2055, 2058–61; Vanderwel et al., *supra* note 102, at 1230, 1234–38; Harrison et al., *supra* note 108, at 1559–63; Price et al., *supra* note 114, at 8–9; Otto & Roloff, *supra* note 124, at 248; Pinzon et al., *supra* note 161, at 2581, 2590, 2594–96; Beese et al., *supra* note 177, at 11–14.

200. *See, e.g.*, Vanderwel et al., *supra* note 102, at 1238; Price et al., *supra* note 114, at 9; Pinzon et al., *supra* note 161, at 2595; Beese et al., *supra* note 177, at 12–14. Franklin et al. (2019) discusses the effects of retention harvesting on wildlife use of a boreal forest study area, in northwestern Alberta, Canada, 15 to 18 years post-harvest. *See* Caroline Franklin et al., *Can Retention Harvests Help Conserve Wildlife? Evidence for Vertebrates in the Boreal Forest*, 10(3) ECOSPHERE 1 (2019). Caroline Franklin and others studied responses to retention by red squirrels (*Tamiasciurus hudsonicus*), fishers, wolverines (*Gulo gulo*), woodland caribou (*Rangifer tarandus*), and others, concluding, "[m]any late-seral species revealed notable differences in activity between 20% and 50% retention, and use of stands harvested to at least 50% retention was comparable to use of unharvested stands." *Id*. at 15.

201. *See, e.g.*, Vanderwel et al., *supra* note 102, at 1235–38; Harrison et al., *supra* note 108, at 1559–61; Price et al., *supra* note 114, at 8–9; Pinzon et al., *supra* note 161, at 2581, 2594–96; *see also* Harrison et al., *supra* note 108, at 1561 ("[M]ost studies agree that partial cutting cannot accommodate all native bird species.").

such habitat at the territory scale, while Pacific martens require intact, mature-forest habitat over at least 60 to 75 percent of landscapes.[202]

A critical issue, identified by Nagel et al. (2017) and other studies, is that selective thinning and partial harvesting may not be economically feasible at the retention levels, large-tree densities, and deadwood availabilities required for effective broad biodiversity conservation.[203] In a modeling study of a Finnish boreal forest landscape, Pohjanmies et al. (2017) found that, for most stands in the study area, maintaining sufficiently high levels of woodpecker habitat, deadwood availability, and other non-timber services ruled out commercial timber production, even with retention and other mitigation measures.[204] Provision of high levels of non-timber services and biodiversity is possible, Tahti Pohjanmies and others conclude, only with permanent "set-aside" (removal from timber production) of "large parts of the production forest."[205] Similarly, in a modeling study of intensive land uses in the Willamette Basin, Oregon, Polasky et al. (2008) concludes that, to effectively maintain native biodiversity, including northern spotted owls, Pacific fishers, and others, "large amounts of land" must be removed from timber production, and other intensive uses, and placed into conservation.[206] There must be a shift, these authors claim, toward "natural habitat" at the landscape scale.[207]

Finally, it should be mentioned that, in a meta-analysis of the literature, Fedrowitz et al. (2014) notes the negative effects of retention harvesting on mature-forest species across taxonomic groups.[208] These authors endorse retention harvesting, however, noting the biodiversity benefits this practice may provide: an appropriate balance of early-successional and late-successional forest conditions.[209] As they mention, this practice may also allow satisfactory levels of wood production.[210]

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202. DellaSala et al., *supra* note 126, at 424, 426; Bart, *supra* note 129, at 944; Moriarty et al., *supra* note 138, at 622; Hargis et al., *supra* note 144, at 157; Fuller & Harrison, *supra* note 147, at 711, 719; Lavoie et al., *supra* note 148, at 46.

203. *See* Pinzon et al., *supra* note 161, at 2595; Nagel et al, *supra* note 168, at 101, 106.

204. Tahti Pohjanmies et al., *Conflicting Objectives in Production Forests Pose a Challenge for Forest Management*, 28 ECOSYSTEM SERVS. 298, 305–06 (2017).

205. *Id*. at 306; *see also id*. at 298 ("Our results show that conflicts between timber production and other objectives are typical, severe, and difficult to solve.").

206. Polasky et al., *supra* note 10, at 1516.

207. Polasky et al., *supra* note 10, at 1516.

208. Katja Fedrowitz et al., *Can Retention Harvesting Help Conserve Biodiversity? A Meta-Analysis*, 51 J. APPLIED ECOLOGY 1669, 1669 (2014).

209. *Id*.

210. *Id*. at 1670, 1677.

Fedrowitz et al. (2014) conveys the suggestion to apply 10 to 20 percent retention "for late-seral abundance and diversity."[211] As "retention cuts may not effectively conserve all forest species," these authors add, "large reserves may be critical."[212] However, they do not discuss the reported severity of impacts within certain taxonomic groups, that is, the degrees of species declines at such low retention levels.[213]

IV. AGENCY BIODIVERSITY OBLIGATIONS AND THE MYTH OF COMPATIBLE MANAGEMENT

A. Forest Management Policy and Biodiversity Obligations

In this Part, a primary goal is to establish that within Spies et al. (2018), and cited sources, there is no adequate evaluation of the negative effects of ecological forestry, as proposed for the Pacific Northwest; as will be discussed, much of the science reviewed in the last Part is not considered.[214] It will be argued that compatible management by means of ecological forestry, with provision of relatively high, steady timber volumes, and broad native biodiversity, is a myth not well supported by the scientific literature.[215] The Part begins by considering Forest Service obligations to conserve native biodiversity.[216] These obligations are extensive and challenging, and can be met effectively, it will be argued, only by means of less intensive silvicultural treatments, with higher retention levels and greater emphasis on maintaining intact natural habitat.[217]

The Multiple-Use Sustained-Yield Act of 1960 (MUSYA) was passed to ensure that the national forests are managed for genuinely multiple use, with timber production not automatically given higher priority over other uses.[218] MUSYA states, "The Secretary of Agriculture is authorized and directed to develop and administer the renewable

211. *Id.* at 1676. Fedrowitz et al. (2014) states that some studies suggest applying 10 to 20 percent retention, citing, among others, Halpern et al. (2012), yet in this study Halpern et al. are critical of such low retention values. *Id.*; *see also* Halpern et al., *supra* note 39, at 2049, 2061.

212. Fedrowitz et al., *supra* note 208, at 1675.

213. Fedrowitz et al., *supra* note 208, at 1675.

214. *See, e.g.*, SPIES ET AL., *supra* note 1.

215. *See, e.g.*, SPIES ET AL., *supra* note 1.

216. *See, e.g.*, 36 C.F.R. § 219.9 (2016).

217. *See, e.g.*, Polasky et al., *supra* note 10; Price et al., *supra* note 114; DellaSala et al., *supra* note 126; Moriarty et al., *supra* note 138; *see* discussion *supra* Part III.

218. *See, e.g.*, ANTHONY GODFREY, THE EVER-CHANGING VIEW: A HISTORY OF THE NATIONAL FORESTS IN CALIFORNIA, 1891–1987, 399 (2005) ("For the first time, these five major uses [timber, range, water, recreation, and wildlife] were contained in one law, with no single use having priority over another.").

surface resources of the national forests for multiple use and sustained yield of the several products and services obtained therefrom."[219] The Act requires that the national forests be managed for timber production, livestock grazing, outdoor recreation, watershed, and wildlife and fish.[220] "In the administration of the national forests," MUSYA states, "due consideration shall be given to the relative values of the various resources in particular areas," which indicates that agency managers are not to simply assume that timber production has highest priority in a given area.[221] "[S]ome land will be used for less than all of the resources," MUSYA continues.[222]

The goal of national forest management, according to MUSYA, is to provide "the various renewable surface resources . . . so that they are utilized in the combination that will best meet the needs of the American people."[223] Managers are to "mak[e] the most judicious use of the land."[224]

The National Forest Management Act of 1976 (NFMA) requires that a land management plan be developed for each national forest, and that each management plan "provide for multiple use and sustained yield of the products and services obtained therefrom in accordance with the Multiple-Use Sustained-Yield Act of 1960."[225] "[I]n particular," NFMA continues, each management plan must "include coordination of outdoor recreation, range, timber, watershed, wildlife and fish, and wilderness."[226] According to NFMA, each management plan is to specify a "coordination" or balancing of resources that are to be provided within each management area, including wilderness, which is added to the list of uses required by MUSYA.[227] In addition, NFMA requires that the Secretary of Agriculture "promulgate regulations" for the development and revision of management plans under NFMA, and that these regulations specify guidelines that "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives . . . ."[228]

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219. 16 U.S.C. § 529 (1960).
220. *See id.* § 528.
221. *Id.* § 529.
222. *Id.* § 531(a).
223. *Id.*
224. *Id.*
225. 16 U.S.C. § 1604(a), (e)(1) (2018).
226. *Id.* § 1604(e)(1)
227. *Id.* § 1604(e)
228. *Id.* § 1604(g), (3)(b).

Federal regulations implementing NFMA have been issued through the years, providing clearer direction, including, most recently, the 2012 Planning Rule.[229] The 2012 Planning Rule mandates that, in the development or revision of a land management plan, the agency include components within the plan for maintaining viable populations of agency-designated "species of conservation concern."[230] According to the 2012 Planning Rule, however, if managers ascertain that, for a given species, it is beyond agency authority, or the inherent capability of the plan area, to maintain a viable population in the plan area, the agency must document the decision, and include components for maintaining or restoring conditions in order to contribute to viability within the species' range.[231] The 2012 Planning Rule also requires that the agency include components for maintaining or restoring conditions in order to contribute to the recovery of federally-listed species, and for "conserving" proposed and candidate species for federal listing, which is understood as maintaining or restoring conditions in order to potentially avoid listing.[232]

In summary, MUSYA and NFMA mandate that agency managers provide an appropriate balance of forest resources within each management area, including timber, grazing lands, recreational opportunities, undisturbed watersheds, fish and wildlife, and wilderness; each resource is to be provided to the degree appropriate for a given management area, given its relative value.[233] The goal is to provide the balance of resources that will best meet the needs of American citizens.[234] In addition, under the 2012 Planning Rule, the agency is under strict biodiversity conservation mandates.[235] According to the preamble published with the 2012 Planning Rule, the intention behind the rule is "to provide for the persistence" of all existing native species "within Forest Service authority and the inherent capability of the plan area."[236]

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229. *See* 36 C.F.R. § 219 (2016).

230. *Id.* § 219.9(b)(1).

231. *Id.* § 219.9(b)(2).

232. *Id.* § 219.9(b)(1); *see also id.* § 219.19(2)(ii) (2012) (providing this definition of "conserve"). The Endangered Species Act provides a framework for the conservation of endangered and threatened species, which includes the listing of such species. 16 U.S.C. 35 § 1533.

233. 16 U.S.C. §§ 528, 531; 16 U.S.C. § 1604 (2018).

234. 16 U.S.C. § 531(a).

235. *See* 36 C.F.R. § 219.9 (2016).

236. National Forest System Land Management Planning, 77 FED. REG. 21162, 21175 (Apr. 9, 2012) (codified at 36 C.F.R. § 219). The complete statement is included within a discussion of Modified Alternative A, which was selected as the new planning rule. *Id.* at 21166–68; *see also id.* at 21175–76, 21212–13, 21216–18.

Though qualified, the agency's announced goal is to maintain viability of all existing native species in the national forests.[237]

The Forest Service takes this goal quite seriously, as evidenced by the Interagency Special Status and Sensitive Species Program (ISSSSP) in the Pacific Northwest (jointly administered by the Forest Service and Bureau of Land Management), which maintains a list of species that are not federally-listed, yet are considered rare and of concern with respect to viability.[238] Spies et al. (2018) states, "The ISSSSP list includes a broad array of fungi, lichens, bryophytes, vascular plants, vertebrates, and invertebrates."[239] "[A]ny species with risks to persistence would likely have been included in the list update."[240] In accordance with agency sensitive-species policy, ISSSSP-listed species must be managed in such a way as to not cause loss of viability, or threaten viability to the extent that federal listing becomes significantly more likely.[241]

Considering the 2012 Planning Rule's biodiversity provisions, as well as the ISSSSP species list and agency sensitive-species policy, the Forest Service's biodiversity obligations in the Pacific Northwest are extensive and challenging.[242] As noted in Spies et al. (2018), ISSSSP seeks effective conservation of program-listed species by producing a variety of conservation products, including "species fact sheets, conservation assessments, conservation strategies, inventory reports,

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237. *Id*. at 21166–68, 21175–76, 21212–13, 21216–18.

238. SPIES ET AL., *supra* note 1, at 374–78.

239. SPIES ET AL., *supra* note 1, at 422.

240. SPIES ET AL., *supra* note 1, at 422.

241. *See* U.S. FOREST SERV., FOREST SERVICE MANUAL, SUPPLEMENT NO. 2600-2011-1, THREATENED, ENDANGERED, AND SENSITIVE PLANTS AND ANIMALS § 2670.32 (2005) (with respect to sensitive species, agency decisions "must not result in loss of species viability or create significant trends toward Federal listing"). The ISSSSP website states that management of sensitive species identified by this program is to follow sensitive-species policy as outlined in Forest Service Manual 2670. U.S. Forest Serv. & Bureau of Land Mgmt., *Agency Policies & Lists*, INTERAGENCY SPECIAL STATUS/SENSITIVE SPECIES PROGRAM, https://www.fs.usda.gov/r6/isssssp/policy/ (last visited Apr. 26, 2023).

242. *See* 36 C.F.R. §219.9 (2016); *see also* U.S. FOREST SERV., *supra* note 241, § 2670.32. The agency's sensitive-species policy provides biodiversity obligations in addition to those arising from the 2012 Planning Rule. *See* U.S. FOREST SERV., *supra* note 241, § 2670.32. The preamble published with the 2012 Planning Rule briefly discusses "regional forester sensitive species" (RFSS) and provides examples of their conservation under the 2012 Planning Rule. National Forest System Land Management Planning, 77 FED. REG. 21162, 21175, 21212 (Apr. 9, 2012) (codified at 36 C.F.R. § 219). In the Pacific Northwest, as well as other regions of the country, the agency maintains various lists of rare and sensitive species, and, under its sensitive-species policy, the agency is obligated to manage and maintain these species to ensure population viability and avoid significant trends toward federal listing. U.S. FOREST SERV., *supra* note 241, § 2670.32.

inventory and survey protocols and methods workshops, and results of studies . . . ."[243]

B. The Myth of Compatibility

Spies et al. (2018) acknowledges that ecological forestry treatments, as proposed for the Pacific Northwest, have little empirical support.[244] "[T]here is little research and management experience in this type of restoration," authors write.[245] In the Spies report, claims of potentially successful compatible management on federal forestlands in the Pacific Northwest (a potential "win-win"), with relatively high and steady timber production, and effective biodiversity conservation, rest not primarily on empirical studies, but on confidence in intensive management and the efficacy of proposed treatments, which represent accepted tradeoffs.[246] These authors suggest mitigation measures to minimize harm to native species (for example, leave "some thinned trees . . . on the site"), and they emphasize the need to practice "adaptive management," which involves monitoring the effects of management actions, and adjusting treatments and mitigation as needed.[247]

Spies et al. (2018) also relies on the protected reserves for effective biodiversity conservation.[248] Spies et al. (2018), Franklin et al. (2018) (cited in Spies et al. (2018)), and other sources endorse an apparently reasonable strategy: apply lower retention levels in harvested matrix lands (10, 20, or 30 percent) for enhanced timber production, relying upon protected reserves for effective conservation of those mature-forest species that cannot persist in harvested matrix lands.[249] Franklin et al.

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243. SPIES ET AL., *supra* note 1, at 378.

244. SPIES ET AL., *supra* note 1, at 378.

245. SPIES ET AL., *supra* note 1, at 964.

246. *See, e.g.*, SPIES ET AL., *supra* note 1, at 378, 964. Historian Paul Hirt discusses the "conspiracy of optimism" within the Forest Service, which involves, in part, the assumption that "choices [do] not really have to be made" if scientifically trained foresters "simply appl[y] more intensive management." PAUL W. HIRT, A CONSPIRACY OF OPTIMISM: MANAGEMENT OF THE NATIONAL FORESTS SINCE WORLD WAR TWO xxi (1994).

247. *See* SPIES ET AL., *supra* note 1, at 425, 894–95, 957–58, 963, 966–69.

248. *See* SPIES ET AL., *supra* note 1, at 5, 153–54, 187, 256–58, 337.

249. *See* SPIES ET AL., *supra* note 1, at 637; *see also* SPIES ET AL., *supra* note 1, at 361 (defining "matrix lands" as lands located outside reserves that "are managed for timber production and other objectives"); Fedrowitz et al., *supra* note 208 at 1675–76 (explicitly conveying this strategy); *see also* JERRY FRANKLIN ET AL., ECOLOGICAL FOREST MANAGEMENT 123–24 (Jeni Ogilvie ed., 1st ed. 2018).

(2018) generally recommends applying approximately 30 percent retention, in moist and dry forest types.[250]

The problem with this strategy is that, according to experts, given invasive species, climate change, and other stresses, effective conservation of northern spotted owls and other mature-forest species requires that matrix lands be managed to provide substantial contributions to viability, which makes necessary less intensive silvicultural treatments in these areas, with use of higher retention levels.[251] It appears that Spies et al. (2018), Franklin et al. (2018), and others rely too heavily upon reserve areas for effective broad biodiversity conservation, and are at fault for not adequately evaluating biodiversity impacts of proposed treatments within matrix lands.[252]

Authors of Spies et al. (2018) discuss the importance of protecting suitable spotted owl habitat outside reserves, within existing parks and wilderness areas, and within managed matrix lands.[253] "Greater clarity," they write, "has been developed on the role of retaining old-forest components and substrates in the managed forest matrix to serve as connections among the reserves."[254] Suitable habitat connections between reserves are considered essential for effective conservation of "a wide variety" of late-successional forest species, according to these authors, including northern spotted owls, Pacific martens, northern flying squirrels, and red tree voles.[255] As argued in Spies et al. (2018), it is essential to conserve rare fungal species "outside reserves . . . to help ensure conservation of the entire late-successional . . . fungal biota."[256] In short, it is essential that managed matrix lands provide substantial contributions to the conservation of a wide array of mature-forest species, including rare fungi, since designated reserves are not sufficient for effective conservation of these species.[257]

It appears, from the literature, that effective conservation of many mature-forest species of various taxa (birds, mammals, bryophytes, herbs,

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250. FRANKLIN ET AL., *supra* note 249, at 104, 108. Franklin et al. recommend retention of approximately thirty percent of a harvested area as "intact forest patches," as well as some additional retention of dispersed individual trees and small tree clusters, making clear that this recommendation is not based on empirical studies, but on "expert opinion." FRANKLIN ET AL., *supra* note 249, at 104, 108.

251. *See, e.g.*, SPIES ET AL., *supra* note 1, at 258, 280, 380, 414, 425.

252. *See generally* SPIES ET AL., *supra* note 1; FRANKLIN ET AL., *supra* note 249.

253. SPIES ET AL., *supra* note 1, at 258, 279–80.

254. SPIES ET AL., *supra* note 1, at 425.

255. SPIES ET AL., *supra* note 1, at 414, 425.

256. *See* SPIES ET AL., *supra* note 1, at 380.

257. SPIES ET AL., *supra* note 1, at 258, 280, 380, 414, 425.

fungi, lichens, gastropods, ground-dwelling beetles and spiders, and others) is possible only by means of less intensive silvicultural treatments, with higher retention applied in harvesting—as indicated by studies, over 50 percent and up to 75 percent or greater, within harvest units.[258] Yet, again, even higher retention levels of 75 percent or greater are associated with population declines and species losses.[259] As studies indicate, certain mature-forest species are highly sensitive to management manipulations of habitat, including northern flying squirrels, red tree voles, Pacific martens, as well as bryophytes and species within other groups of concern to ISSSSP (fungi, lichens, invertebrates, etc.).[260] These considerations suggest that the Forest Service should engage in retention-harvesting treatments only to a limited extent within matrix lands, which must substantially contribute to the conservation of late-successional species, and only with use of higher retention values to mitigate, to some extent, biodiversity impacts.[261]

Most reasonably, the agency's extensive biodiversity obligations can be met effectively only by means of general management prescriptions (within revised management plans) that limit the extent of thinning and retention-harvesting treatments within matrix lands, and that specify use of appropriately high retention levels in retention harvesting where it occurs.[262] In addition, management prescriptions must require that sufficient large-tree densities, and deadwood availabilities, be maintained

258. *See, e.g.*, Vanderwel et al., *supra* note 102, at 1238; Price et al., *supra* note 114, at 9; Pinzon et al., *supra* note 161, at 2595; Beese et al., *supra* note 177, at 12–14; Franklin et al., *supra* note 200, at 15.

259. *See, e.g.*, Vanderwel et al., *supra* note 102, at 1235–38; Harrison et al., *supra* note 108, at 1559–61; Price et al., *supra* note 114, at 8–9; Pinzon et al., *supra* note 161, at 2581, 2594–96.

260. *See* Gustafsson et al., *supra* note 8, at 299, 304; Manning et al., *supra* note 8, at 120–21; Halpern et al., *supra* note 39, at 2049, 2055, 2058–61; Wilson & Forsman, *supra* note 93, at 79, 82–84; Vanderwel et al., *supra* note 102, at 1230, 1234–38; Harrison et al., *supra* note 108, at 1559–63; Price et al., *supra* note 114, at 8–9; Moriarty et al., *supra* note 138, at 622; Hargis et al., *supra* note 144, at 157; Pinzon et al., *supra* note 161, at 2581, 2590, 2594–96; Beese et al., *supra* note 177, at 11–14.

261. *See* SPIES ET AL., *supra* note 1, at 258, 280, 380, 414, 425; Price et al, *supra* note 114, at 13 (stating that use of higher retention in harvesting can mitigate impacts on mature-forest birds). Certain "rare and poorly known species in the Pacific Northwest," including some fungi and lichens, are "difficult to detect, inventory, monitor, and study." SPIES ET AL., *supra* note 1, at 383. This is further argument for limiting the extent of thinning and logging operations in matrix lands.

262. DellaSala et al. (2013) notes that thinning has negative impacts on northern spotted owl habitat and prey species, and sensibly recommends prohibiting thinning and retention harvesting in mature moist and dry forests (over eighty years). DellaSala et al., *supra* note 126, at 424, 426.

in thinning and harvesting operations.[263] Management prescriptions must place greater emphasis on maintaining intact natural habitat within reserves and matrix lands.[264]

Spies et al. (2018) does not adequately consider Halpern et al. (2012), failing to disclose information from this study concerning losses of bryophytes and late-successional herbs at even relatively high retention levels, nor do they adequately consider DellaSala et al. (2013) and Moriarty et al. (2016), missing information concerning the percentages of intact, mature-forest habitat that, it seems, are required for effective conservation of northern spotted owls and martens, at up to the landscape scale.[265] In addition, Spies et al. (2018), and Franklin et al. (2018), do not discuss or cite relevant studies, including Harrison et al. (2005), Vanderwel et al. (2007), Gustafsson et al. (2010), Pinzon et al. (2016), Ovaska et al. (2016), Nagel et al. (2017), and others that indicate the biodiversity impacts of typical ecologically-based forestry practices, and the higher retention percentages that must be applied for effective conservation of many mature-forest species.[266]

Franklin et al. (2018) claims that variable-retention harvesting will enhance timber production while "sustaining *most* forest structures, functions, and organisms," which is misleading, the authors failing to acknowledge the extent and severity of the impacts of this harvesting practice on mature-forest species.[267] Franklin et al. (2018) does not discuss or cite Halpern et al. (2012) or DellaSala et al. (2013).[268]

It seems fair to say that compatible management for relatively high and steady wood production, and effective broad biodiversity

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263. Nagel et al., *supra* note 168, at 104–05.

264. *See* Polasky et al., *supra* note 10, at 1516; Pohjanmies et al., *supra* note 204, at 306.

265. SPIES ET AL., *supra* note 1, at 152, 162, 169–70, 278, 383–84, 401, 405, 410–11, 412–13, 426, 493, 734, 956; *see also* Halpern et al., *supra* note 39; DellaSala et al., *supra* note 126; Moriarty et al., *supra* note 138.

266. *See generally* SPIES ET AL., *supra* note 1; FRANKLIN ET AL., *supra* note 249; *see also* Gustafsson et al., *supra* note 8; Vanderwel et al, *supra* note 102; Harrison et al., *supra* note 108; Pinzon et al., *supra* note 161; Ovaska et al., *supra* note 189.

267. FRANKLIN ET AL., *supra* note 249, at 108 (emphasis added) (discussing variable-retention harvesting as proposed by Franklin & Johnson (2012)) (citing Franklin & Johnson, *supra* note 16). Citing Fedrowitz et al. (2014), Franklin et al. (2018) claims that ecological forestry practices have positive effects on biodiversity, failing to mention that, according to the Fedrowitz study, such practices have negative biodiversity effects as well. FRANKLIN ET AL., *supra* note 249, at 115; Fedrowitz et al., *supra* note 208, at 1669, 1675–76.

268. *See generally* FRANKLIN ET AL., *supra* note 249. Franklin and Johnson (2012) fails to consider earlier relevant studies, including Vanderwel et al. (2007), Harrison et al. (2005), Hargis et al. (1999), and others. *See generally* Franklin & Johnson, *supra* note 16; *see also* Vanderwel et al., *supra* note 102; Harrison et al., *supra* note 108; Hargis et al., *supra* note 144.

conservation, by means of restoration thinning, variable-retention harvesting, and other ecological forestry practices, is merely a management ideal, a fabrication or myth, perpetuated within Spies et al. (2018), Franklin et al. (2018), and other sources by means of a selective use of science.[269] Spies et al. (2018) acknowledges that ecological forestry practices, as proposed for the Pacific Northwest, have little empirical support, and much support these authors attempt to provide is questionable.[270] They claim that retention provides "life boats" for older-forest species, citing Halpern et al. (2012) and Gustafsson et al. (2012), yet according to these studies, as well as Gustafsson et al. (2010), any life-boating is limited at typical, and even higher, retention levels.[271]

As another example of questionable support, Spies et al. (2018) states that, according to a modeling study, Kline et al. (2016), timber harvesting can be compatible with provision of northern spotted owl habitat "depending on the characteristics of the management regime examined."[272] Yet, according to the cited study, at retention levels and timber removal schedules similar to those applied in "current industrial practices" under state standards, the relationship between timber harvesting and spotted owl habitat is highly competitive.[273]

It should be mentioned that Spies et al. (2018), Franklin et al. (2018), and other sources do not adequately discuss the negative effects of variable-retention harvesting on *early*-successional species.[274] Spies et al. (2018), and Franklin et al. (2018), argue that variable-retention harvesting enables creation of early-successional forest conditions, which are scarce in these fire-suppressed forests, benefitting early-seral species, but, in accordance with studies, the impacts of such harvesting on early-successional species and processes are complex and can be unexpected.[275]

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269. *See generally* SPIES ET AL., *supra* note 1; FRANKLIN ET AL., *supra* note 249.

270. SPIES ET AL., *supra* note 1, at 964.

271. *See* SPIES ET AL., *supra* note 1, at 169; *see also* Gustafsson et al., *supra* note 8, at 298–99, 304; Gustafsson et al., *supra* note 39, at 633, 639; Halpern et al., *supra* note 39, at 2054–55, 2057–61.

272. *See* SPIES ET AL., *supra* note 1, at 678; *see also* Jeffrey D. Kline et al., *Evaluating Carbon Storage, Timber Harvest, and Habitat Possibilities for a Western Cascades (USA) Forest Landscape*, 26 ECOLOGICAL APPLICATIONS 2044, 2052 (2016).

273. *See* Kline et al., *supra* note 272, at 2049, 2052, 2056.

274. *See generally* SPIES ET AL., *supra* note 1; FRANKLIN ET AL., *supra* note 249.

275. SPIES ET AL., *supra* note 1, at 168–69, 188, 278, 281, 423, 633; Franklin & Johnson, *supra* note 16, at 433–34; FRANKLIN ET AL., *supra* note 249, at 11, 108, 590–91, 603; *see also, e.g.*, Chris J. Pengelly & Ralph V. Cartar, *Effects of Variable Retention Logging in the Boreal Forest on the Bumble Bee-Influenced Pollination Community, Evaluated 8–9 Years Post-Logging*, 260 FOREST ECOLOGY AND MGMT. 994, 994 (2010).

For example, Pengelly and Cartar (2010) discusses the effects of variable-retention harvesting on bumblebees (*Bombus* spp.) foraging in a boreal forest study area in northwestern Alberta, Canada, concluding that harvesting treatments "disrupt plant-pollinator relationships in seemingly undisturbed, adjacent unlogged areas," even eight to nine years after treatment.[276] Chris Pengelly and Ralph Cartar explain that, as a result of logging, bumblebees foraging in adjacent unlogged areas become out of "sync" with the flowering plants in these areas, with too few bees foraging in flower-rich patches and too many bees foraging in flower-poor patches ("undermatching").[277] "It is unclear," they write, "why bumble bees undermatched in the unlogged forests," but they found this to be a definite, persistent effect of logging.[278]

Pengelly and Cartar (2010) concludes that "10–20% retention is the optimal harvest regime for bumble bees and their food plants" in the long term, but these researchers caution that "a mix of retention levels may be the most beneficial for the bumble bee-plant system," with higher retention, 50–70 percent, used in some areas to buffer short-term logging impacts on bees and understory plants.[279] In addition, Pengelly and Cartar encourage the creation of "large set aside reserves where no logging is allowed," with buffer zones "of appropriate size (yet undetermined)" to protect pollinator-plant relationships within the reserves from the effects of outside logging.[280]

Spies et al. (2018), and Franklin et al. (2018), do not discuss or cite Pengelly and Cartar (2010), and, generally, do not adequately discuss the impacts of proposed silvicultural treatments on early-successional species and essential processes such as pollination.[281] It should not simply be assumed that retention harvesting at typical, low retention levels, over extensive areas, is beneficial for early-seral species.[282] DellaSala et al. (2013) criticizes Franklin and Johnson (2012) for proposing regenerative (variable-retention) harvesting for moist forests in the Pacific Northwest, with a goal of creating early-successional forest conditions.[283] According

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276. Pengelly & Cartar, *supra* note 275, at 999.

277. Pengelly & Cartar, *supra* note 275, at 999, 1001.

278. Pengelly & Cartar, *supra* note 275, at 999; *see also* Pengelly & Cartar, *supra* note 275, at 1001 ("[W]e find a persistent effect of logging in adjacent forest on unlogged controls, in that undermatching obtains in these.").

279. Pengelly & Cartar, *supra* note 275, at 1001.

280. Pengelly & Cartar, *supra* note 275, at 1001.

281. *See generally* SPIES ET AL., *supra* note 1; FRANKLIN ET AL., *supra* note 249.

282. *See, e.g.*, DellaSala et al., *supra* note 126, at 425.

283. DellaSala et al., *supra* note 126, at 425.

to DellaSala et al. (2013), Franklin and Johnson (2012) omits discussion of "the only known pathway" to the creation of early-successional forests of sufficient complexity to provide suitable habitat for certain rare wildlife species, which is occurrence of natural disturbances such as wildfire, windstorms, etc. followed by unimpeded natural succession.[284]

C. Controversy Concerning Forest Restoration

Spies et al. (2018), and Franklin et al. (2018), propose restoration of Pacific Northwest forests through use of ecological forestry practices, one purpose being to bring these forests closer to historic structure and fire regimes, rendering them more resilient to wildfire, diseases, climate change, invasive species, and other stresses.[285] Spies et al. (2018), and Franklin et al. (2018), claim that these forests are currently too dense, have too many smaller trees and too much undergrowth compared to historic conditions, and that they burn at high severity more frequently and extensively compared to historic levels.[286] Yet studies indicate that the views of historic forest conditions accepted by these authors are inaccurate, and that restoration efforts, in the Pacific Northwest and other regions of the western United States, are misguided.[287]

Baker (2012, 2014) present reconstructions of historic forest structure and fire regimes for ponderosa pine and mixed-conifer forests in the Cascade Mountains of Oregon, and the Sierra Nevada Mountains of California.[288] For the reconstructions, William Baker used data gathered during General Land Office surveys conducted in the mid- to late-1800s.[289] As Baker claims, the reconstructions show that historically these forests were quite dense, and were not primarily open and parklike, as depicted by Forest Service documents and cited sources.[290] In addition,

284. DellaSala et al., *supra* note 126, at 425.

285. SPIES ET AL., *supra* note 1, at 153, 162, 169, 172–74, 183, 188; FRANKLIN ET AL., *supra* note 249, at 108.

286. SPIES ET AL., *supra* note 1, at 137–46, 148–53; *see* FRANKLIN ET AL., *supra* note 249, at 78–80, 85, 330, 350–54.

287. *See, e.g*, William L. Baker, *Implications of Spatially Extensive Historical Data from Surveys for Restoring Dry Forests of Oregon's Eastern Cascades*, 3 ECOSPHERE 1 (2012) [hereinafter Baker, Implications]; William L. Baker, *Historical Forest Structure and Fire in Sierran Mixed-Conifer Forests Reconstructed from General Land Office Survey Data*, 5 ECOSPHERE 1 (2014) [hereinafter Baker, Historical Forest Structure].

288. Baker, *Implications*, *supra* note 287, at 1–10; Baker, *Historical Forest Structure*, *supra* note 287, at 1–11.

289. Baker, *Implications*, *supra* note 287, at 1–10; Baker, *Historical Forest Structure*, *supra* note 287, at 1–11.

290. *See* Baker, *Implications*, *supra* note 287, at 1, 14–22; Baker, *Historical Forest Structure*, *supra* note 287, at 1, 22–30.

according to Baker, historically these forests burned at all severities, with substantial high-severity fire, which played a significant role in shaping the structure and composition of these forests.[291]

Levine et al. (2017) is critical of Baker's reconstruction method, stating that, as shown by empirical testing, "the method . . . overestimates tree density"; Spies et al. (2018) briefly discusses the Levine study and this criticism of Baker's method.[292] Baker and Williams (2018) provides a plausible response, however, arguing that the test of Baker's method reported in Levine et al. (2017) was inadequate, and that the method has been confirmed in numerous and varied ways.[293] Spies et al. (2018) does not consider or cite this reply.[294]

Spies et al. (2018), and Franklin et al. (2018), rely on Hagmann et al. (2013, 2014) in discussions of historic tree densities in the Pacific Northwest.[295] Spies et al. (2018) criticizes the reconstruction method in Baker (2012) by pointing out that the Hagmann studies provide significantly lower tree density estimates.[296] Based on Hagmann et al. (2013, 2014), Franklin et al. (2018) states that historic ponderosa pine forests were typically open, parklike, and dominated by large trees—"savanna-like architecture."[297] According to Baker and Hanson (2017), however, the Hagmann studies are methodologically flawed and provide inaccurate estimates.[298] One problem, as William Baker and Chad Hanson explain, is that Hagmann et al. (2013, 2014), and similar studies, analyze data from early-1900s Forest Service timber inventories that generally favored merchantable forests with large trees and low densities, and did not include data from younger, denser forests, or recovering burned

291. Baker, *Implications*, *supra* note 287, at 1, 14–22; Baker, *Historical Forest Structure*, *supra* note 287, at 1, 22–30.

292. *See* SPIES ET AL., *supra* note 1, at 135, 138, 186; *see also* Carrie R. Levine, *Evaluating a New Method for Reconstructing Forest Conditions from General Land Office Survey Records*, 27 ECOLOGICAL APPLICATIONS 1498, 1510 (2017).

293. William L. Baker & Mark A. Williams, *Land Surveys Show Regional Variability of Historical Fire Regimes of the Western United States*, 28 ECOLOGICAL APPLICATIONS 284, 287–88 (2018).

294. *See* SPIES ET AL., *supra* note 1, at 135.

295. *See* SPIES ET AL., *supra* note 1, at 135; *see also* FRANKLIN ET AL., *supra* note 249, at 77; R. Keala Hagmann et al., *Historical Structure and Composition of Ponderosa Pine and Mixed-Conifer Forests in South-Central Oregon*, 304 FOREST ECOLOGY AND MGMT. 492 (2013); R. Keala Hagmann et al., *Historical Conditions in Mixed-Conifer Forests on the Eastern Slopes of the Northern Oregon Cascade Range, USA*, 330 FOREST ECOLOGY AND MGMT. 158 (2014).

296. *See* SPIES ET AL., *supra* note 1, at 135.

297. FRANKLIN ET AL., *supra* note 249, at 77.

298. See William L. Baker & Chad T. Hanson, *Improving the Use of Early Timber Inventories in Reconstructing Historical Dry Forests and Fire in the Western United States*, 8 ECOSPHERE 1, 15 (2017); *see also id*. at 9–10, 13–17.

patches, even those within an inventory area.[299] Use of these uncorrected data, they claim, has resulted in biased density estimates.[300]

Another difficulty, as Baker and Hanson (2017) explains, is that the early-1900s timber-inventory data used in Hagmann (2013, 2014) are unreliable, based on accuracy checks using more reliable methods, and this has been known for many years.[301] Inventory crews had to work quickly and rely on visual estimates of distances, especially of transect widths, as they paced transects.[302] According to Baker and Hanson (2017), even in the early 1900s, "it was well known that early timber inventories were inaccurate and unreliable," and that they underestimated tree densities.[303] Baker and Hanson claim that conclusions reached in Hagmann et al. (2013, 2014), and other early timber-inventory studies, "are . . . invalid for these forests," and they add:

> [I]f uncorrected early timber-inventory estimates are used as a guide for restoring or managing forest structure in general or specific wildlife habitat, it is likely that significant adverse ecological impacts will ensue. For example, forest habitat of the Northern spotted owl, generally associated with denser forests, might be thinned to very low tree densities, damaging owl habitat, based on uncorrected timber-inventory data with large documented errors.[304]

Citing Hagmann et al. (2013, 2014), Spies et al. (2018) and Franklin et al. (2018) argue that Pacific Northwest forests have significantly deviated from historic conditions, and must be restored to render them more resilient to wildfire, climate change, diseases, and other stresses.[305] Yet neither Spies et al. (2018), nor Franklin et al. (2018), discuss the plausible criticisms of Hagmann et al. (2013, 2014) provided by Baker and Hanson (2017), failing to cite this study.[306] Generally, neither Spies

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299. *Id*. at 2–3, 9–10, 13–16; *see also id*. at 3 ("Often no tree tallies or detailed data were collected at all in very young forests, forests with little timber volume, recently burned forests, shrub fields . . .").

300. *Id*. at 9–10, 13–16.

301. *Id*. at 2–4, 6–9, 12–13, 15–17.

302. *Id*. at 4, 6.

303. *Id*. at 12.

304. *Id*. at 15–16.

305. *See* SPIES ET AL., *supra* note 1, at 137–41, 148–53, 162, 169, 172–74, 183, 188; *see also* FRANKLIN ET AL., *supra* note 249, at 108; Hagmann et al., *Historical Structure and Composition*, *supra* note 295; Hagmann et al., *Historical Conditions in Mixed-Conifer Forests*, *supra* note 295.

306. *See generally* SPIES ET AL., *supra* note 1; FRANKLIN ET AL., *supra* note 249; *see also* Baker & Hanson, *supra* note 298, at 9–10, 13–17. Spies et al. (2018) briefly comments on Baker (2015), but does not discuss the criticisms of the Hagmann studies raised by Baker in his 2015 article. *See* SPIES ET AL., *supra* note 1, at 140; *see also* William L. Baker, *Are High-Severity Fires*

et al. (2018), nor Franklin et al. (2018), provide an adequate evaluation of the literature concerning historic forest structure and fire regimes in this region.[307]

V. NEPA: SCIENCE IN THE CONSERVATION OF MATURE-FOREST SPECIES

Beese et al. (2019) recommends variable-retention harvesting for "forests where timber production is a major goal," since such harvesting is more beneficial for conserving native species than clear-cutting.[308] It is important to note that MUSYA's multiple-use mandate does not require timber production as "a major goal" on national forestlands in the Pacific Northwest or other regions.[309] MUSYA calls for flexibility in multiple-use resource provision—much depends upon the area in question and the relative values of the available resources.[310]

The goal of national forest management, MUSYA states, is to provide "the various renewable surface resources . . . so that they are utilized in the combination that will best meet the needs of the American people."[311] "[D]ue consideration shall be given to the relative values of the various resources in particular areas," MUSYA states, adding, "some land will be used for less than all of the resources."[312] Managers are to "mak[e] the most judicious use of the land."[313] According to NFMA, each forest management plan is to specify an appropriate "coordination" or balancing of resources to be provided within each management area, in accordance with MUSYA.[314]

Burning at Much Higher Rates Recently than Historically in Dry-Forest Landscapes of the Western USA? 10 PLOS ONE 1 (2015).

307. Unfortunately, further discussion of this topic would be beyond the focus of the present Article. Spies et al. (2018) further discusses the literature concerning historic forest structure and fire regimes in the Pacific Northwest, yet the discussion does not give readers a good understanding of the critical issues. *See* SPIES ET AL., *supra* note 1, at 132–37; *see also* William L. Baker et al., *Countering Omitted Evidence of Variable Historical Forests and Fire Regime in Western USA Dry Forests: The Low-Severity-Fire Model Rejected*, 6 FIRE 146 (2023) (providing a recent review of studies concerning historic forest structure and fire in the western United States).

308. Beese et al., *supra* note 177, at 16.

309. 16 U.S.C. §§ 528–531 (2021).

310. *Id.* §§ 529–531. Lichtenstein and Montgomery (2003) note that multiple use under MUSYA "has often been interpreted as managing all land for all uses . . . ." M.E. Lichtenstein & C.A. Montgomery, *Biodiversity and Timber in the Coast Range of Oregon: Inside the Production Possibility Frontier*, 79 LAND ECONOMICS 56, 56 (2003). It is argued here that this common interpretation is not accurate.

311. 16 U.S.C. § 531.

312. *Id.* §§ 529, 531.

313. *Id.* § 531.

314. 16 U.S.C. §§ 529, 531; 16 U.S.C. § 1604.

The agency's extensive biodiversity obligations constrain the provision of timber for harvest in each management area within national forestlands, in the Pacific Northwest and other regions.[315] Whether or not timber production is "a major goal" for a given management area depends upon the coordination or balancing determined for that area, taking into account the "relative values of the various resources," the needs of the American people, and agency obligations to maintain viability, or contribute to range-wide viability, of a broad array of native species.[316] In accordance with federal regulations and agency policy concerning federally-listed species, proposed and candidate species, designated "species of conservation concern," as well as (in the Pacific Northwest) ISSSSP-listed rare and sensitive species, maintaining viability, or providing meaningful contributions to range-wide viability, is the "bottom line" in the determination of appropriate tradeoffs between wood production and species conservation.[317] The need to maintain, or meaningfully contribute to, viability constrains the provision of timber for harvest in the coordination or balancing of resources determined for each management area, under MUSYA and NFMA (and its implementing regulations).[318]

The 2012 Planning Rule mandates use of "the best available scientific information" in the development or revision of land management plans for the national forests, though this mandate is heavily qualified.[319] In addition, the 2012 Planning Rule mandates preparation of an Environmental Impact Statement (EIS) to evaluate the environmental impacts of a newly developed or revised management plan.[320] National Environmental Policy Act (NEPA) regulations mandate use of relevant and reliable scientific information within an EIS and other documents prepared under NEPA, and this mandate is not qualified.[321]

According to NEPA regulations, within an EIS an agency must "provide full and fair discussion" of the significant environmental impacts

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315. *See* 36 C.F.R. § 219.9 (2016); U.S. FOREST SERV., *supra* note 241, § 2670.32.

316. 16 U.S.C. §§ 529, 531; 16 U.S.C. § 1604; 36 C.F.R. § 219.9 (2016).

317. The biodiversity mandates provided within the 2012 Planning Rule, and agency sensitive-species policy, require that agency managers maintain viability, or provide meaningful contributions to range-wide viability, of the broad array of native species included within the various protected-species categories and sensitive-species lists. *See* 36 C.F.R. § 219.9; U.S. FOREST SERV., *supra* note 241, § 2670.32.

318. 16 U.S.C. §§ 529, 531 (MUSYA); 16 U.S.C. § 1604 (NFMA); 36 C.F.R. § 219.9 (2016).

319. 36 C.F.R. § 219.3 (2016).

320. *Id.* § 219.14(a).

321. 40 C.F.R. §§ 1500.1(b), 1502.1, 1502.23 (2022).

of a proposed action.[322] As interpreted by the courts, within an EIS an agency must take a "hard look" at the environmental impacts of the proposed action.[323] In addition, according to these regulations, an agency "shall insure the professional integrity, including the scientific integrity, of the discussions and analyses in environmental impact statements."[324] An agency "shall make use of reliable existing data and resources."[325] In accordance with these requirements, analyses of impacts within an EIS are to be thorough, accurate, well reasoned, and must be based on relevant and reliable scientific information.[326] Surely, use of relevant, reliable scientific information is an essential aspect of providing a "full and fair discussion" of environmental impacts (a "hard look"), and providing a discussion that has professional and scientific integrity.[327]

Management plan revision is currently underway in the Pacific Northwest, and across the country, under the 2012 Planning Rule.[328] The agency recently issued a *Bioregional Assessment of Northwest Forests* (Forest Service (2020)) intended to guide plan revision, and aid in public awareness of the revision process, within the Northwest Forest Plan area.[329] The *Bioregional Assessment* cites Spies et al. (2018) as a major source of scientific information for plan revision, and recommends enhanced timber production in this region by means of ecological forestry practices, including restoration thinning and variable-retention harvesting.[330]

Within revised management plans for the Northwest Forest Plan area, the Forest Service will presumably propose use of ecological forestry practices, as proposed by Franklin and Johnson (2012) and endorsed by Spies et al. (2018), in an effort to enhance timber production compatibly with biodiversity conservation.[331] In accordance with NEPA

322. *Id.* § 1502.1.

323. Blue Mountains Biodiversity Project v. Blackwood, 161 F.3d 1208, 1211–12 (9th Cir. 1998); Ocean Advocates v. United States Army Corps of Engineers, 402 F.3d 846, 864–65, 870–71 (9th Cir. 2004); Earth Island Institute v. U.S. Forest Service, 442 F.3d 1147, 1153–54, 1159–60 (9th Cir. 2006).

324. 40 C.F.R. § 1502.23 (2022) (providing scientific accuracy requirements for preparation of an EIS).

325. *Id.* § 1502.23.

326. *See id.* §§ 1500.1(b), 1502.1, 1502.23.

327. *Id.* §§ 1500.1(b), 1502.1, 1502.23.

328. The Forest Planning Rule, U.S. FOREST SERV., fs.usda.gov/planningrule (last visited Apr. 27, 2023).

329. U.S. FOREST SERV., *supra* note 2, at 1, 3, 79.

330. U.S. FOREST SERV., *supra* note 2, at 5–6, 33.

331. SPIES ET AL., *supra* note 1, at 169, 638, 734, 895, 956, 964; Franklin & Johnson, *supra* note 16, at 429.

regulations, the agency must provide, in the EIS for each revised management plan, a full and fair discussion of the biodiversity impacts of proposed treatments upon early- and late-successional forest species, using relevant and reliable scientific information.[332] The agency must acknowledge the extent and severity of species losses under such practices.[333] The agency must provide information concerning retention levels required, and estimates of large-tree densities and deadwood availabilities required, for effective conservation of mature-forest species.[334]

Within each EIS, the agency must adequately consider the relevant scientific literature, and a critical topic that must be addressed is whether commercial thinning and logging is economically viable given the high retention percentages, large-tree densities, and deadwood availabilities required for effective conservation of mature-forest species.[335] Again, some studies suggest that commercial forestry operations are not economically feasible at these levels.[336]

Additionally, within each EIS, the agency must give assurances that the 2012 Planning Rule's biodiversity provisions have been satisfied, that the revised management plan will contribute to the recovery of federally-listed species, conserve proposed and candidate species for listing (to potentially avoid listing), and maintain viability, or meaningfully contribute to range-wide viability, of species of conservation concern.[337] In accordance with Forest Service policy, the agency must provide assurances that, with respect to ISSSSP-listed rare and sensitive species, the revised plan will not result in losses of viability, or threaten viability to the extent that federal listing is significantly more likely.[338]

Finally, each EIS must include an adequate evaluation of the need to restore Pacific Northwest forests, with a full and fair consideration of studies indicating that the agency's view of historic forest structure and fire regimes is incorrect, and that restoration efforts are misguided.[339]

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332. 40 C.F.R. §§ 1502.1, 1502.23.

333. *See id.* §§ 1502.1, 1502.23.

334. *See, e.g.*, Nagel et al., *supra* note 168, at 104–05.

335. 40 C.F.R. §§ 1500.1(b), 1502.1, 1502.23 (2022).

336. *See* Pinzon et al., *supra* note 161, at 2596; *see also* Nagel et al., *supra* note 168, at 101, 106.

337. 36 C.F.R. § 219.9 (2016).

338. U.S. FOREST SERV., *supra* note 241, § 2670.32.

339. *See* 40 C.F.R. §§ 1502.1, 1502.23 (2022); *see also, e.g.*, Baker, *Implications*, *supra* note 287; Baker, *Historical Forest Structure*, *supra* note 287; Baker & Williams, *supra* note 293; Baker & Hanson, *supra* note 298; Baker et al., *supra* note 307.

An improved use of science in the plan revision process, in accordance with NEPA regulations, will ensure that timber and other forest resources are provided within each management area in the proper combinations, and at the appropriate levels of intensity, taking into account the "relative values of the various resources" and the needs of American citizens, while satisfying the agency's biodiversity obligations.[340] Use of relevant, reliable scientific information, in accordance with NEPA, will appropriately moderate and spatially extend resource provision, helping to ensure genuinely compatible resource provision.[341]

It is argued that in order to satisfy the agency's extensive biodiversity obligations, management prescriptions (within revised management plans) must limit the extent of thinning and retention harvesting, prohibiting such practices in mature forests and placing greater emphasis on maintaining intact natural habitat over entire landscapes.[342] In addition, management prescriptions must specify use of appropriately high retention values to mitigate biodiversity impacts where retention harvesting occurs, and require sufficient large-tree densities, and deadwood availabilities, in thinning and harvesting operations.[343]

VI. CONCLUSION

The *Bioregional Assessment of Northwest Forests* (U.S Forest Service (2020)) discusses the "urgent" need for enhanced restoration treatments within national forests in the Northwest Forest Plan area.[344] The document specifies the millions of acres in urgent need of restoration in all land categories, including reserves and matrix lands.[345] Forest restoration and wood production are definitely a major component of agency-recommended national forest management in this region.[346] "Providing a predictable and sustainable timber supply is a core component of the Forest Service mission," the *Bioregional Assessment* states.[347]

340. 40 C.F.R. §§ 1500.1(b), 1502.1, 1502.23 (2022); *see also* 16 U.S.C. §§ 529, 531; 16 U.S.C. § 1604; 36 C.F.R. § 219.9 (2016).

341. 40 C.F.R. §§ 1500.1(b), 1502.1, 1502.23.

342. Polasky et al., *supra* note 10, at 1516; Pohjanmies et al., *supra* note 204, at 306; *see also* DellaSala et al., *supra* note 126, at 424, 426.

343. Price et al, *supra* note 114, at 13; Nagel et al., *supra* note 168, at 104–05.

344. U.S. FOREST SERV., *supra* note 2, at 69.

345. U.S. FOREST SERV., *supra* note 2, at 66, 69.

346. U.S. FOREST SERV., *supra* note 2, at 33, 66, 69.

347. U.S. FOREST SERV., *supra* note 2, at 73.

The *Bioregional Assessment* (U.S Forest Service (2020)) notes the continuing decline of northern spotted owls, and claims that restoration treatments "could help conserve and develop northern spotted owl habitat in the long term."[348] The document alludes to "evolving timber harvest methods," specifically variable-density thinning and variable-retention harvesting.[349] These authors fail to acknowledge the sensitivity of mature-forest species to such management manipulations.[350] References include Spies et al. (2018), Franklin et al. (2018), and other documents, yet much of the relevant scientific literature is not discussed or cited.[351]

Interestingly, according to the *Bioregional Assessment* (U.S Forest Service (2020)), in past decades timber has not been harvested in the Pacific Northwest at volumes expected and allowed within the Northwest Forest Plan, and the timber industry in this region is lagging to some extent, not contributing to the local economies to the degree agency managers believe it can and should.[352] To an extent, recommended national forest management in the Pacific Northwest, with major emphasis on timber harvesting, is for the sake of a future thriving timber industry as envisioned by the agency.[353]

In closing, it should be mentioned that ecological forestry is frequently praised in textbooks and online sites dedicated to forestry and natural resource management.[354] As portrayed in texts and other sources, modern forestry has arrived at a high point in its development, represents years of accumulated knowledge and experience, and is on the right path.[355] Franklin et al. (2018) states, for example, "The immense increase in our scientific understanding of trees, forests, and, most profoundly, the recognition of forests as ecosystems has both underpinned and driven the movement toward ecologically based forestry."[356] Within management texts, agency planning documents, and online sources, ecological forestry is overrated, or oversold, by means of selective uses of science and

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348. U.S. FOREST SERV., *supra* note 2, at 63.

349. U.S. FOREST SERV., *supra* note 2, at 47.

350. *See* U.S. FOREST SERV., *supra* note 2, at 47, 63.

351. U.S. FOREST SERV., *supra* note 2, at 47, 62–63, 86–89.

352. U.S. FOREST SERV., *supra* note 2, at 18, 47, 59–60.

353. U.S. FOREST SERV., *supra* note 2, at 18, 47, 59–60.

354. *See, e.g.*, *Ecological Forestry*, NORTHWEST NAT. RES. GRP., https://www.nnrg.org/our-services/ecological-forestry-definition/ (last visited Feb. 5, 2022).

355. *See* FRANKLIN ET AL., *supra* note 249, at 5; *see also* BRIAN J. PALIK ET AL., ECOLOGICAL SILVICULTURE: FOUNDATIONS AND APPLICATIONS xiii, 9 (2021).

356. FRANKLIN ET AL., *supra* note 249, at 5; *see also* PALIK ET AL., *supra* note 355, at xiii ("Our perspective for a natural models approach has been decades in the making, representing an accumulation and integration of a wealth of ideas and experiences.").

inadequate discussions of the impacts on native species.[357] Yet the ideal of compatible management for timber production and native biodiversity, by means of such intensive management practices, is inherently attractive, satisfies desires for progress and achievement within forestry, and will not easily be surrendered.[358]

357. *See generally* FRANKLIN ET AL., *supra* note 249; *see also* PALIK ET AL., *supra* note 355.

358. *See* FRANKLIN ET AL., *supra* note 249, at xvii-xviii; 3–10; *see also* PALIK ET AL., *supra* note 355, at xiii, 3–19.