The Timber Wars:

How an Owl Saved the Forests and Divided a Nation


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2,500 words

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[1] strixhunter, *Northern spotted owl (Strix occidentalis caurina): Adult female*, photograph, Flickr, June 5, 2014, https://flic.kr/p/nS67xc.

Introduction

In the late twentieth century, the United States radically changed how it viewed and interacted with its forests. Seminal scientific studies in the 1980s first defined and analyzed American old growth forests, sparking the desire to conserve these unique ecosystems on western federal lands lest they succumb to the same fate of clear-cutting as had eastern old growth long ago.[2] Regional timber companies who saw patches of old growth as a valuable economic resource to be exploited opposed this move towards environmentalism, and as both conservationists and industry escalated their demands, the conflict was referred to as the Timber Wars. Over the years this nominal war was fought on three main fronts: in the forests, in academic journals, and in the courts.

Most visible were the radical environmental groups like Earth First! fighting loggers and law enforcement *in situ* by building barricades to timber stands and chaining themselves to trees, and who through their mostly nonviolent resistance converted many Americans to the new goal of forest preservation. Meanwhile, the scientific community provided the Timber Wars with both a mascot and a surrogate for the forests in the form of the spotted owl. Lastly, a legal team of the Sierra Club Legal Defense Fund (SCLDF) utilized existing environmental legislation to combat the US Forest Service (USFS) by enjoining timber sales across the region. Although the Timber Wars greatly increased the social and political divisiveness of ecological preservation, the trifecta of involved protestors, scientists, and lawyers was ultimately successful in producing President Clinton's Northwest Forest Plan (NWFP), a policy which significantly limited destructive logging.

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[2] *See, e.g.,* U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, *Ecological Characteristics of Old-Growth Douglas-Fir Forests*, by Jerry F. Franklin et al., General Technical Report PNW-GTR-118 (Portland, Oregon, 1981), https://www.fs.usda.gov/treesearch/pubs/5546.

Radical Environmental Activism

The Timber Wars began and concluded with dramatic demonstrations in the forest by radical environmentalist groups that, although generally ineffective in preventing much destructive logging, constituted some of the movement's most memorable moments and ignited public support for the forests. Many environmentalists and loggers consider the 1989 protest of the North Roaring Devil timber sale in Breitenbush Hot Springs, Oregon, by the radical environmental group Earth First! to be one of the first events of the Timber Wars. Protesters chained themselves to trees and buried themselves in rock barricades in an attempt to halt logging which (since the trees would already have been felled) would render moot their upcoming legal hearing. Although their legal case failed, the North Roaring Devil protest garnered unprecedented media attention for the environmentalists.[3]

Most subsequent Earth First! activities followed this pattern. Tactics ranged from civil disobedience (impeding movement of logging machinery or standing between loggers and old growth trees) to "monkey wrenching" or ecological sabotage as outlined by co-founder Dave Foreman (disabling bulldozers or spiking trees with large nails that destroyed chainsaws).[4] Although generally unsuccessful in preventing logging (e.g., 70% of Murrelet Grove, one of the forests protected during Earth First!'s "Redwood Summer," was cut by the fall), protests were at least able to raise awareness.[5,6]

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[3] Aaron Scott, "The Last Stand," podcast, *Timber Wars*, September 22, 2020, https://www.opb.org/article/2020/09/22/timber-wars-episode-1-the-last-stand/.
[4] Trip Gabriel, "If a Tree Falls in the Forest: They Hear It," *New York Times*, November 4, 1990, https://www.proquest.com/historical-newspapers/if-tree-falls-forest/docview/108475539/se-2?accountid=41494.
[5] Gabriel, "If a Tree Falls in the Forest."
[6] In rare circumstances, however, protests were also able to directly save the trees. In 1996, a Salvage Logging Rider threatened to challenge some of the NWFP's key conservation achievements by allowing loosely defined salvage sales of sick or dead trees to be exempt from environmental legislation. Arguing that "when environmental laws are outlawed, it takes environmental outlaws to uphold the law," protesters again arranged physical barriers to logging in Warner Creek and declared the Cascadia Free State, marking one of their few truly successful protests, although only on a limited scale. Tahoma, "Cascadia Rising: The Warner Creek Victory," *Earth First!*, November 1, 2000,

Activist Tim Ream described how the fact that "there's somebody up in a platform on a tree that loves the tree so much, they're … endangering their life" was a powerful symbol that converted many Americans to supporting conservation,[7] and other environmentalists Craig Beneville and Mike Scott claimed that Earth First! actions caused the California governor to support saving the forests.[8] Still more importantly, contemporary commentators recognized that Earth First! "drew the Sierra Club and other more conventional environmentalists" (who would initiate much of the ensuing litigation) towards protecting the forest.[9] Overall, activists effectively drew press coverage (even if partially negative) that promoted their cause and thereby galvanized the public.[10]

Scientists and the Spotted Owl

The true Timber Wars occurred less visibly as conservationists seeking to effect permanent forestry reform (rather than simply delay individual timber cuttings) quickly realized that a coordinated plan of legal action would be much more effective than isolated demonstrations. Recognizing that little legal protection existed for ecosystems, activists instead framed their cases around the northern spotted owl (*Strix occidentalis caurina*), using scientific evidence to prove that the legal mandate to protect the viability of all species in national forests necessitated the conservation of old growth. Eric Forsman's (the first person to thoroughly

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14, https://www.proquest.com/magazines/cascadia-rising-warner-creek-victory/docview/221816409/se-2?accountid=41494.
[7] Aaron Scott, "The Backlash," podcast, *Timber Wars*, September 22, 2020, https://www.opb.org/article/2020/09/23/timber-wars-episode-6-the-backlash/.
[8] Jeffrey A. Perlman, "Monkey-Wrench Gang Sequel Earth First! just Rude, Not Violent, in Attempts to Stop Local Projects," *Los Angeles Times*, Jul 04, 1992, Orange County edition, https://www.proquest.com/newspapers/monkey-wrench-gang-sequel-earth-first-just-rude/docview/281673878/se-2.
[9] Gabriel, "If a Tree Falls in the Forest."
[10] Horacio R. Trujillo, "The Radical Environmentalist Movement," in *Aptitude for Destruction*, vol. 2, *Case Studies of Organizational Learning in Five Terrorist Groups*, by Brian A. Jackson et al. (Santa Monica, California: RAND Corporation, 2005), 149, https://www.jstor.org/stable/10.7249/mg332nij.13.

examine the species) landmark study of the spotted owl concluded that 95% of sites where spotted owls were located were old growth forests, firmly tying the owl to the ecosystem as an indicator species.[11]

As of 1987, mathematical models created by Russell Lande demonstrated that the spotted owl population had a growth rate statistically equivalent to a stable population, but that after the already high rate of adult survival, the rate of successful dispersion (which relies on the existence of old growth forests) was the most important factor in determining the spotted owl's growth rate.[12] Ecologically, moreover, a species will not occupy all potential habitat (due to difficulty for the young in finding territory), and consequently a species can go extinct even with a theoretically sufficient amount of habitat. Specifically, Lande's model showed that the spotted owl requires at least 21% of its territory to be old growth forest in order to survive, a much higher percentage than the 7%–16% old growth conservation proposed by USFS.[13] This evidence was so irrefutable that, despite having more than 2 years to create an opposing model before the results were used in court, neither the government nor the timber companies attempted to scientifically rebut it.[14] Furthermore, Lande's associates have explained that "[his] method is now the accepted way of designing natural areas, national parks, [and] species conservation programs," and so is itself a victory for environmentalists.[15]

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[11] Eric Forsman, "A Preliminary Investigation of the Spotted Owl in Oregon" (M.S. thesis, Oregon State University, 1976), 4, https://ir.library.oregonstate.edu/concern/graduate_thesis_or_dissertations/pv63g313j.
[12] R. Lande, "Demographic Models of the Northern Spotted Owl (*Strix occidentalis caurina*)," *Oecologia* 75, no. 4 (1988): 602–603, https://www.jstor.org/stable/4218620.
[13] Lande, "Demographic Models of the Northern Spotted Owl," 605–606.
[14] Brendon Swedlow, "Scientists, Judges, and Spotted Owls: Policymakers in the Pacific Northwest," *Duke Environmental Law & Policy Forum* 13 (2003): 196, https://scholarship.law.duke.edu/delpf/vol13/iss2/2.
[15] Aaron Scott, "The Owl," podcast, *Timber Wars*, September 22, 2020, https://www.opb.org/article/2020/09/22/timber-wars-episode-3-the-owl/.

Legal Battles

With the spotted owl established as a surrogate for old growth, environmental lawyers began several lines of cases to protect the forests. Conservationists sued the Fish and Wildlife Service (FWS) to list the spotted owl under the Endangered Species Act, prompting the bird's designation as "threatened" in June 1990, but (notwithstanding further court orders) the FWS was slow to designate the owl's critical habitat.[16] Lawyers then began to structure their cases around USFS and Bureau of Land Management (BLM) violations of both the National Environmental Policy Act (NEPA) (asserting that they had failed to provide supplemental environmental impact statements (SEIS) in light of new scientific information) and the National Forest Management Act (NFMA) (arguing that foresters were not providing for the viability of all forest species).[17] Pursuant to these arguments and despite Congressional riders that temporarily restricted the courts' ability to enjoin timber sales, in July 1993 the Ninth Circuit upheld district court injunctions against the USFS and BLM until they considered newly available scientific evidence.[18]

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[16] Victor M. Sher, "Travels with Strix: The Spotted Owl's Journey through the Federal Courts," *Public Land & Resources Law Review* 14 (1993): 45–49, https://scholarworks.umt.edu/plrlr/vol14/iss1/4/.

[17] Andrea L. Hungerford, "Changing the Management of Public Land Forests: The Role of the Spotted Owl Injunctions," *Environmental Law* 24, no. 3 (1994): 1399–1406, https://www.jstor.org/stable/43266643.

[18] The precise sequence of legal events here is somewhat convoluted. Essentially there were three strands of major litigation in support of the spotted owl: against FWS, against USFS, and against BLM. In the litigation against FWS, in *Northern Spotted Owl v. Hodel* (1988), Judge Thomas Zilly forced FWS to list the spotted owl as threatened under ESA; in *Northern Spotted Owl v. Lujan* (1991), Judge Zilly ordered FWS to designate the owl's critical habitat, although FWS stalled; and in *Lane County Audubon Society v. Jamison* (1992), Judge Robert Jones enjoined implementation of a BLM land management strategy for failing to consult the FWS under ESA, a decision which was upheld and strengthened on appeal by the Ninth Circuit's injunction of BLM sales that would affect the owl. In the litigation against USFS, in *Seattle Audubon Society v. Robertson* (1989), Judge William Dwyer preliminarily enjoined USFS timber sales until environmentalists' arguments regarding NEPA violations could be heard; the section 318 congressional appropriations rider (1989) forced Judge Dwyer to dissolve his injunction until the rider expired at the end of 1990; in *Seattle Audubon Society v. Evans* (1991), Judge Dwyer permanently enjoined the USFS's timber sales under NFMA violations; and in *Seattle Audubon Society v. Moseley* (1992), Judge Dwyer again enjoined timber sales under further NEPA and NFMA violations in the USFS's latest plans, which decision was upheld by the Ninth Circuit in *Seattle Audubon Society v. Espy* (1993). In the litigation against BLM, in *Portland Audubon Society v. Hodel* (1988), environmentalists accused the BLM of violating NEPA; the section 314 congressional appropriations rider (1987) prohibited judicial review in such cases, inhibiting environmental lawyers until it expired in 1990; in *Portland Audubon Society v. Lujan* (1992), Judge Helen Frye enjoined the BLM for its

Significantly, as Vic Sher (a lawyer involved in the Timber War cases) has explained, "each of these lawsuits should have been unnecessary [since] most involved no novel or complicated questions of law."[19] Rather, FWS, BLM, and USFS simply "chose to ignore" their "clear, well-established obligations under existing laws," further demonstrated by the fact that "the judiciary can only enforce the irreducible minimum requirements of a statute."[20] Despite the clarity of the violations, however, environmental progress was made "only following lawsuits."[21]

By 1993, the courts had halted nearly all timber sales under five separate injunctions.[22] These were so severe and comprehensive that they effectively forced an "executive remand," prompting the Clinton administration to completely reconsider all Northwest forestry practices rather than address each individual injunction.[23] This was a particularly efficient success for the environmentalists' legal team, as it protected entire swaths of forests with just a few court cases whereas demonstrators had (at best) only saved individual stands. These court rulings also established the important environmental legal precedent that government agencies must at least consider whether new scientific information requires a SEIS, even if not ultimately preparing one.[24]

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violation of NEPA, which decision the Ninth Circuit upheld in *Portland Audubon Society v. Babbitt* (1993). *For further details, see* Sher, "Travels with Strix"; Hungerford, "Changing the Management of Public Land Forests"; and Michael C. Blumm, Susan Jane M. Brown, and Chelsea Stweart-Fusek, "The World's Largest Ecosystem Management Plan," *Environmental Law* 52, no. 2 (2022), https://www.jstor.org/stable/48682787.

[19] Sher, "Travels with Strix," 77.

[20] Sher, "Travels with Strix," 76–77.

[21] Sher, "Travels with Strix," 77.

[22] Blumm, Brown, and Steward-Fusek, "The World's Largest Ecosystem Management Plan," 167.

[23] Hungerford, "Changing the Management of Public Land Forests," 1429.

[24] Hungerford, "Changing the Management of Public Land Forests," 1425–1428.

Environmental Polarization

After activists had framed their cause around saving the spotted owl, however, the local working class increasingly felt ignored and persecuted by conservationists, creating partisanship regarding environmental issues that has lasted for decades. Historically, landmark environmental legislation (e.g., the Clean Air Act, the Clean Water Act, the creation of the Environmental Protection Agency, etc.) had bipartisan support, largely because non-radical environmentalism focused on the human (especially working class) impacts of many issues.[25] Moreover, before the Timber Wars, loggers felt united to the forests and sometimes even protested with environmentalists against capitalist clearcutting practices that would deplete the region's natural resources.[26]

However, using environmental legislation as a "blunt instrument" throughout the Timber Wars both increased the national divisiveness of environmental issues and created a general regional hostility.[27] In fact, conservationists were initially opposed to protecting the spotted owl through the ESA lest Congress weaken ESA in response (indeed President Bush's proposed solution).[28] Although ESA ultimately was not affected, logging companies used the Timber Wars to blame rising unemployment (caused by multiple factors including increased efficiency and the exportation of raw logs) and increasing national lumber prices (which were partially instances of opportunistic "price-gouging" by the timber companies) on the spotted owl injunctions.[29,30]

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[25] Erik Loomis and Ryan Edgington, "Lives Under the Canopy: Spotted Owls and Loggers in Western Forests," *Natural Resources Journal* 52, no. 1 (2012): 103–104, https://www.jstor.org/stable/24889599.
[26] Loomis and Edgington, "Lives Under the Canopy," 109–110.
[27] Loomis and Edgington, "Lives Under the Canopy," 99, 117.
[28] Blumm, Brown, and Stweart-Fusek, "The World's Largest Ecosystem Management Plan," 165, 168.
[29] Loomis and Edgington, "Lives Under the Canopy," 113–115.
[30] Timothy R. Dougherty, "Fowl Play. Some Builders Say Lumber Producers Used Owl as Excuse for Price-Gouging," *Newsday*, August 3, 1991, Nassau and Suffolk edition, https://www.proquest.com/newspapers/fowl-play-some-builders-say-lumber-producers-used/docview/278432911/se-2.

Quickly, local restaurants began serving parody dishes such as “pickled spotted owl egg” and “fried or broasted spotted owl.”[31,32]

Some environmentalists did attempt to appeal to workers, with Judi Bari (a former union organizer) advocating for loggers to organize against their employers since clearcutting uses the least labor of any logging practice and because unsustainable yields would lead to even greater unemployment as tree stands were depleted.[33] Despite this, the majority of loggers still despised environmentalists because they were outsiders in the community (and so easy scapegoats) and because of “the utter lack of class analysis by virtually all environmental groups,” many of which ignored Bari’s empathetic distinction between loggers and industry.[34] Although economic losses due to the NWFP were ultimately much lower than expected (9,300 lost jobs as opposed to government expectations of 31,000 or industry estimates of 150,000) as technology and burgeoning service industries offset the decline of logging, economic prospects nevertheless diminished for many locals who still consider the Timber Wars to have ruined their communities.[35,36]

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[31] “Loggers Don’t Give Hoot for Owl,” *Chicago Tribune*, April 27, 1989, https://www.proquest.com/historical-newspapers/loggers-dont-give-hoot-owl/docview/1015400744/se-2.

[32] The centrality of the owl to court rulings coupled with this environmental hostility also means that, as spotted owl populations continue to decline, regional politicians may potentially advocate for resumed logging under the assumption that conservation is hopeless. Loomis and Edgington, “Lives Under the Canopy,” 116.

[33] Judi Bari, “Timber Wars,” *Earth Island Journal* 5, no. 3 (1990): 30–31, https://www.jstor.org/stable/43881250.

[34] Bari, “Timber Wars,” 30–31.

[35] Loomis and Edgington, “Lives Under the Canopy,” 115.

[36] Certain local impacts were more pronounced than regional ones because economic benefits were not distributed evenly. Specifically, close to 33% of communities declined socioeconomically as a result of the NWFP, while another 33% improved. Blumm, Brown, and Stewart-Fusek, “The World’s Largest Ecosystem Management Plan,” 182.

The Northwest Forest Plan

Despite the negative social effects, however, the timber sale injunctions forced by conservationists were ultimately successful in inspiring the Northwest Forest Plan (NWFP), a federal policy that (although imperfect) has substantially improved forestry practices. After he promised to address the conflict in his campaign, the Timber Wars culminated in newly elected President Clinton's "Timber Summit" in Portland, Oregon, an event of "unprecedented" magnitude.[37] As shown by the President's five guiding principles, the summit was designed to resolve each party's concerns:

> First, we must never forget the human and the economic dimensions of these problems. … Second, … we need to protect the long-term health of our forests …. Third, our efforts must be … scientifically sound … and legally responsible. Fourth, the plan should produce a predictable … level of timber sales … that will not degrade … the environment. Fifth, … we will insist on collaboration not confrontation.[38]

After the summit, Clinton created the Forest Ecosystem Management Assessment Team (FEMAT) to develop a number of strategies for the region, of which the President selected "Option 9," the plan with the highest expected timber yield (1.1 billion board feet) of those that achieved ecological criteria.[39] This became the NWFP, "the world's first large-scale ecosystem management plan" and (governing 24.4 million acres of land) "widely recognized as the largest commitment to ecosystem management worldwide."[40,41] Significantly, FEMAT was able to move beyond the primarily species-based protections of the timber sale injunctions (necessitated

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[37] Blumm, Brown, and Stewart-Fusek, "The World's Largest Ecosystem Management Plan," 169.
[38] US Department of Agriculture, *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl*, April 13, 1994, https://www.fs.usda.gov/r6/reo/library/downloads/documents/NWFP-ROD-1994.pdf.
[39] Blumm, Brown, and Stewart-Fusek, "The World's Largest Ecosystem Management Plan," 169–171.
[40] Blumm, Brown, and Stewart-Fusek, "The World's Largest Ecosystem Management Plan," 171, 151.
[41] Impressively, the NWFP still largely survives to this day despite attempts (particularly from the Bush and Trump administrations) to curtail its environmental protections. The only major modification to the plan was the Obama administration's removal of much BLM land from the NWFP, reducing its scope by about 10%. Blumm, Brown, and Stewart-Fusek, "The World's Largest Ecosystem Management Plan," 152, 154.

by the relative lack of legal ecosystem protection) towards a more ecosystem-based approach that better protected the forests and inhabiting species.[42]

Of the federal forests in the Northwest, the NWFP mandated that 78% be reserves, with the remainder divided between matrix areas where timber harvest continues and adaptive management areas where new forestry techniques are tested.[43,44] This has decreased logging by 80–90% in the region (a further reduction from the expected yield due to continuing litigation against timber sales that failed to abide by the "survey and manage" policy, which applied detailed monitoring standards to specific endangered species within each stand) and increased old growth forests by 1.9% annually (a greater growth rate than expected).[45,46]

However, the plan does have faults, such as fire suppression strategies. While the plan is effective in northern wet forests, southern dry forests require controlled thinning and burning to mitigate the impact of climate change-induced wildfires.[47] Moreover, spotted owls are still in danger due to competition with the barred owl, climate change, and even insect infestation leading to defoliation.[48] Nevertheless, although spotted owl populations have continued to

[42] Jerry F. Franklin, "Scientists in Wonderland," *BioScience* 45, supplement (1995): 74–78, https://www.jstor.org/stable/1312448.
[43] Jack Ward Thomas et al., "The Northwest Forest Plan: Origins, Components, Implementation Experience, and Suggestions for Change," *Conservation Biology* 20, no. 2 (2006): 282, http://www.jstor.com/stable/3591336.
[44] Specific breakdowns of the 24.4 million acres regulated by the NWFP are as follows: 7.3 million acres are congressionally-reserved allocations (wilderness areas, national parks, etc.), 7.4 million are late-successional reserves (LSRs), 0.1 million are managed LSRs, 1.47 million are admiratively-withdrawn areas, 2.6 million are riparian reserves, 1.5 million are adaptive management areas (AMAs) (forests allocated to test new systems of management), and 4 million are matrix lands (where the majority of the remaining timber harvest comes from). Only AMAs and matrix lands see substantial levels of for-profit timber harvest. Blumm, Brown, and Stewart-Fusek, "The World's Largest Ecosystem Mangement Plan," 174.
[45] Thomas A. Spies et al., "Twenty-Five Years of the Northwest Forest Plan: What Have We Learned?" *Frontiers in Ecology and the Environment* 17, no. 9 (2019): 516, https://www.jstor.org/stable/10.2307/26835246.
[46] Thomas et al., "The Northwest Forest Plan," 283–284.
[47] Spies et al., "Twenty-Five Years of the Northwest Forest Plan," 514–515.
[48] Barred owl populations (which have a broader diet and so easily outcompete spotted owls) are a particularly acute problem currently, and the only clear solution is to systematically kill these invasive owls. Relatively recent trial implementations of such removals have had promising results for spotted owls: adult survival rates increased 3–8% (in addition to greater reproduction), leading to fairly rapid stabilization of spotted owl populations. (Ashley Braun, "Desperate Measures," *Audubon*, Fall 2022, 26–28.)

decline, the annual rate of population decline is much lower in NWFP areas: a 2.4% decline compared to a 5.8% decline in non-NWFP forests.[49,50] Lastly, one must remember that "science-based policy analyses are not science" and often rely on "incomplete" or even "grossly inadequate knowledge," but that "if scientists fail to make the judgements and do the extrapolations, someone else, perhaps someone much less qualified, is prepared to do so."[51] Overall, therefore, the NWFP was significantly better than the available alternatives, and it constituted the greatest victory of the Timber War protests.

Conclusion: Collaboration and Present Significance

Ultimately, environmentalists in the Timber Wars were successful in reducing destructive logging in the Northwest (even if not in garnering the support of the local working class) principally due to their complementary three-fold strategy of protests, lawsuits, and scientific research. Scientific research was the bedrock of the movement, with seminal studies first detailing the great ecological importance of old growth. Environmental protestors then engaged in dramatic efforts to guard the forests, and although they generally did not save many trees, they did gather enough attention to attract mainstream environmental groups and to increase public support for the forests. Further scientific research provided a legal surrogate for the forests in the form of the spotted owl, and subsequent litigation conducted by the mainstream environmental groups temporarily protected the forests, boosted the protesters' morale, and forced the federal government to fundamentally reevaluate its use of the land. Lastly, scientists and other researchers were instrumental in developing a land management plan focused on the health of

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[49] Spies et al., "Twenty-Five Years of the Northwest Forest Plan," 513.
[50] Robert G. Anthony et al., "Status and Trends in Demography of Northern Spotted Owls, 1985–2003," *Wildlife Monographs* 163, no. 1 (2006): 34, https://doi.org/10.2193/0084-0173(2006)163[1:SATIDO]2.0.CO;2.
[51] Franklin, "Scientists in Wonderland," 78.

old growth ecosystems, and protesters again emerged to protect the trees when the plan was temporarily threatened by congressional intervention.

The movement was certainly flawed in some respects, particularly in how it led to vastly increased environmental polarization. Although environmentalists often ignored or demonized loggers, however, much of the economic downturn felt by timber communities was a result not of the NWFP but of corporate logging practices. Moreover, many felt that, in the words of Forsman, "there were plenty of people speaking for humans … and somebody had to speak for the owls."[52] Under that framework of biocentrism, therefore, the environmentalists achieved their goals. Thus, although the Timber Wars are partially a cautionary tale to move beyond simplistic animosity between environmentalists and workers, the complementary coalition of protesters, scientists, and lawyers serves as both a model and a source of optimism for future environmental action, and the movement's ultimate success has forever changed the relationship between America and its forests.

[52] Scott, "The Owl."

Appendix

No one primary source encapsulates the multifaceted story of the Timber Wars, so much of which was dependent on the interaction of seemingly disparate people and organizations. *Consequently, my research focused around one primary source for each of the groups that I have claimed played an instrumental part in the ultimate success of the timber wars*: radical environmentalists (primary source A, page 14), scientists in their capacity of ecosystem research (primary source B, page 19), lawyers (primary source C, page 26), and scientists in their capacity of developing environmental policy (primary source D, page 33).

Primary source A is a historical newspaper article about EarthFirst!'s actions in the midst of the Timber Wars, including an eyewitness account of one of their protests and material from interviews with multiple activists.

Primary source B is the academic journal article written by Russell Lande that modeled spotted owl populations and unequivocally proved that the existence of the spotted owl depended on substantial quantities of old growth forests, in the process developing modeling methods that have been instrumental to environmentalists since.

Primary source C is a law review article written by Victor "Vic" Sher, the managing attorney of the SCLDF's Northwest Office and one of the lawyers involved in many of the Timber Wars cases. In the article, he gives a clear overview of the legal actions taken up to 1993 (the date of publication) and offers some of his reflections about the importance of the legal dimension of the movement. It is a relatively long article (40 pages), so for the sake of space I elected to include the introduction (where he gives an overview of the litigation) and conclusion (where he presents the lessons he learned).

Similarly, primary source D is an academic journal article written by Jerry Franklin, a scientist and one of the principal architects of the NWFP, in which he both recounts the various scientific commissions he worked with to develop conservation plans for old growth in the Northwest and provides his perspective on lessons he learned from working as a scientist on American environmental policy.

The full bibliographic entries for each of my primary sources (listed A–D) are as follows:

Gabriel, Trip. "If a Tree falls in the Forest: They Hear It." *New York Times*, November 4, 1990. https://www.proquest.com/historical-newspapers/if-tree-falls-forest/docview/108475539/se-2?accountid=41494.

Franklin, Jerry F. "Scientists in Wonderland." *BioScience* 45, supplement (1995): 74–78. https://www.jstor.org/stable/1312448.

Lande, R. "Demographic Models of the Northern Spotted Owl (*Strix occidentalis caurina*)." *Oecologia* 75, no. 4 (1988): 601–607. https://www.jstor.org/stable/4218620.

Sher, Victor M. "Travels with Strix: The Spotted Owl's Journey through the Federal Courts." *Public Land & Resources Law Review* 14 (1993): 41–79. https://scholarworks.umt.edu/plrlr/vol14/iss1/4/.

My bibliography begins on page 38.

Primary Source A

IF A TREE FALLS IN THE FOREST.: THEY HEAR IT EARTH FIRST WILL DO ...
BY TRIP GABRIEL
New York Times (1923-); Nov 4, 1990; ProQuest Historical Newspapers: The New York Times with Index
pg. SM34

IF A TREE FALLS IN THE FOREST, THEY HEAR IT

Earth First will do almost anything to thwart man's assault on nature. but does this radical group really advance the environmental cause?

BY TRIP GABRIEL

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PHOTOGRAPHS BY MICHAEL SCHUMANN/SABA

BY DAY, THE FOREST IS THE PROPerty of the Pacific Lumber Company, but by night it belongs to the radical environmentalists of Earth First.

Under a cloak of darkness, small bands of men and women begin an arduous hike over steep ridges, their flashlights dimmed with blue filters to elude the timber company's security men. After a few hours of stolen sleep on the trail, they meet at midmorning in a clearing.

In all, there are more than 70 intruders in ragtag camouflage fatigues. One man weaves pine sprigs into his epaulets to blend in with the forest. Instructions are whispered and then the eco-guerrillas of Earth First! (the group uses an exclamation point in its name) move out. Their target: Murrelet Grove, 222 acres of virgin redwood trees in Northern California where logging is under way. The objective: to stop the cutting by placing their own bodies in the path of Pacific Lumber's bulldozers and chain saws.

Around 11 A.M. the Earth Firsters climb a steep slope into Murrelet Grove, named for a rare sea bird believed to nest only in virgin forests. The grove is deeply shadowed, with streaky beams of light penetrating the multilayered canopy. But the scars of logging are already to be seen: haul roads and skid tracks used by bulldozers to drag fallen trees off the hillsides.

With whistles, horns and Indian war whoops, the Earth First guerrillas announce their arrival. On the ridge above them, several loggers in steel helmets look up in astonishment. In an effort to halt two men who are cutting apart a fallen tree, one protester shouts: "That tree may roll! You are endangering lives!"

Suddenly, there is the angry growl of a bulldozer from above. It careens into view, pushing an avalanche of dirt before its steel blade. "Whoa," one Earth Firster cries in alarm. "What the. . . ."

Many in the group back away from the charging dozer, but others stand their ground. The machine halts a few feet away, while a handful of protesters clamber onto the pile of dirt it has pushed up, challenging its advance. As the bulldozer retreats up the slope, the Earth Firsters race after it, seizing their victory.

In Murrelet Grove, a bitter controversy over harvesting the last virgin forests has come to a head. Once redwoods as old as one millennium — giant trees with moss-draped boughs — carpeted the foggy coastal mountains of Northern California. Today less than 10 percent of this old-growth forest remains. Some three-quarters of the remnants are in state and national parks, while most of the unprotected trees — on about 24,000 acres in Humboldt County —are held by the Pacific Lumber Company.

Two initiatives on the California ballot this week could sharply curtail the harvesting of the old-growth redwoods. But the militant environmentalists of Earth First couldn't wait for the judgment of the voters. In June, they began a campaign of illegal protests, dubbed "Redwood Summer," to derail the logging. For its part, fearful of the initiatives, the timber company had crews out working six days a weeks to stockpile as many logs as possible. For both Earth First and Pacific Lumber, it has come down to a fight that is being waged grove by grove, tree by tree.

In a forest hollow, the Earth Firsters rush to a redwood that is about to be felled. Some 30 people, forming two circles, link arms around the redwood's giant trunk.

A logger, attempting to ignore them, goes about his job, making two small cuts with a chain saw. He raises his ax to chop out the wedge of wood.

A protester named Dakotah Schrempp places his fingers inches from where the ax blade strikes.

"Let me fall the tree," the logger, 60-year-old Doug Coleman, says in exasperation. But then Coleman sets down his ax. He knows he can't cut down a tree that's surrounded by human bodies. He tries to reason. "When you guys leave, I'm gonna cut this tree anyway," he says, "so why not leave now so I can do my job?"

The Earth Firsters argue their case passionately: the forests are being overcut; at the current harvest rate, the ancient groves will be gone in less than 20 years, and loggers like Coleman will be out of work.

"If we go your way, I'm out of work today," Coleman replies.

"Go on strike! Don't cut old growth," pleads Schrempp, a 36-year-old activist from Louisiana. He hugs the trunk of the redwood, which is so big he can see the man standing next to him, and the man after that — but no one else. Coleman, a logger nearly all his life, tells the tree-huggers this redwood was probably a sapling around the time of Christopher Columbus. When Schrempp hears this, tears spout from his eyes.

Just then someone yells, "Deputies coming with handcuffs." There is instant mayhem. Earth Firsters scatter as furious loggers, along with the sheriff's deputies, give chase. One logger clamps a protester in a headlock.

In all, 37 protesters are arrested on trespassing charges and taken into custody. Meanwhile, the loggers go back to work. Cole- *(Continued on Page 58)*

Trip Gabriel writes frequently about the environment.

In their "Redwood Summer" crusade against logging of old-growth redwoods, militant Earth Firsters and other environmentalists engaged in everything from blockading the Pacific Lumber Company's gates, above, to using their bodies to protect trees, right.

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EARTH FIRST

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man cuts down not only the giant redwood but also many others, and by the end of the summer only about 30 percent of Murrelet Grove is still standing.

EARTH FIRST IS A group that in no way resembles other environmental organizations. Frustrated with the political system, its followers take direct, often unlawful, actions, aimed at timber, mining and other development companies.

As demonstrated in Murrelet Grove, the radicals have brought a degree of passion to environmental causes that more moderate groups, like the Sierra Club and the National Wildlife Federation, cannot match. To some mainstream environmentalists, the passion of Earth First is an inspiration. But others find it counterproductive, tarring radicals as irresponsible or, in some cases, eco-terrorists.

In May, when two organizers of Redwood Summer were injured in their car by a pipe bomb explosion, the Federal Bureau of Investigation, working with police in Oakland, immediately accused the activists of making the bomb themselves. Further investigation left the Government in the embarrassing position of declining to bring charges for lack of evidence. The contention of the injured activists, Darryl Cherney and Judi Bari, that they were victims of an F.B.I. harassment campaign reminiscent of the 1960's drew more attention to Earth First than it had ever known.

Claiming 15,000 members, Earth First is now one of the most visible environmental groups in the country. Its theatrics have landed on network newscasts and "60 Minutes"; an Earth Firster equipped with a cellular phone once gave live radio interviews while staging a sit-in in a tree, as a roaring chain saw threatened to bring him down. For sheer guerrilla theater, Earth First has outstripped even the anti-whaling commandos of Greenpeace, the one-time fringe organization, which now looks positively moderate. Earth Firsters say that's part of the point: their extremism allows others a bolder field in which to operate.

At the same time, their real impact on the issues, the backlash they may be generating and their underlying philosophy — which is far more revolutionary than many sympathizers may think — have gone largely unexamined.

THE OCCUPATION OF Murrelet Grove was billed as an act of civil disobedience. But Earth First is usually identified with something more serious: ecological sabotage. One of the group's co-founders, Dave Foreman, was co-editor of a book on the subject, "Ecodefense: A Field Guide to Monkeywrenching," which explains in devilish detail how to disable bulldozers — by slashing hydraulic hoses or pouring Drano into the radiator. Other techniques include pulling up road survey stakes, toppling billboards and spiking trees with 60-penny nails that damage loggers' saws.

Radicals call these tactics "monkey wrenching," in homage to the 1975 Edward Abbey novel, "The Monkey Wrench Gang." Earth First's covert image is furthered by the fact that it has no national officers and no offical enrollment — the better to foil investigators. Since Earth First emerged a decade ago, acts of monkey wrenching have risen steadily. Last year, scores of incidents were reported in the Pacific Northwest, and there were at least 12 tree spikings in Northern California; nationally, the cost to the timber industry was as high as $25 million, according to Christopher Manes in his book "Green Rage."

The mainline environmental movement deplores ecological sabotage. "I have no use for tree spiking and other tactics which in their ideal might look like a moral statement, but which threaten to harm people," says Doug W. Scott, associate executive director of the 620,000-member Sierra Club. "Individuals ought to take responsibility for the consequences of their political actions, but action in the night is on a slippery slope down toward terrorism, and that is a slippery slope that I abhor."

Few radicals actually practice monkey wrenching, and not all agree on the need for it. But Dave Foreman, whose lectures, writings and seven arrests have made him the most influential leader of the movement, defends it. He considers it a desperate act in desperate times.

"We're in a war," he says bluntly, "the war of industrial civilization against the natural world. If you look at what the leading scientists are telling us, we could lose one-third of all species in the next 40 years. We're being told that by the end of the century the only large mammals left will be those we choose to allow to continue to exist. We're in one of the great extinction episodes in three and a half billion years of evolution."

Many Earth Firsters make a moral distinction between their actions and terrorist ones because they target only inanimate objects. They say they draw the line at causing harm to people. Yet the potential for injury does exist, as demonstrated by a 1987 tree spiking that seriously injured a California timber worker when his saw shattered. The episode was never officially linked to Earth First, which advocates that spikers mark their trees with a spray-painted "S." But not every spiker complies. The very need to promote a warning proves the possibility of injury.

The controversy doesn't

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bother Foreman much. He can sometimes seem coolly indifferent to human well-being when measured against the fate of the natural world. "To me," he says, "the possibility that we could lose the last 5 percent of the ancient forest and the ecosystem it represents is far more frightening than possible injury.

"It comes down to the point where if you give warnings, who's making which decision? We're saying, just leave the tree alone. It's a totally different thing than what we think of as terrorism. Just leave the goddam place alone. Don't destroy this ecosystem that's been around since the glaciers retreated."

It's no surprise that with such rhetoric Earth First has caught the attention of law-enforcement authorities. In 1988, the F.B.I. succeeded in infiltrating one of its agents into Arizona Earth First, extensively bugging members and recruiting three informants. On the night of May 30, 1989, three Earth Firsters were arrested while allegedly blowtorching a utility tower in the desert west of Phoenix. The next morning, half a dozen officers, with drawn pistols and bulletproof vests, seized Foreman in his bed and charged him as a conspirator. Facing five years in prison, Foreman is scheduled to go on trial early next month. He vehemently denies the charges, claiming he has been targeted for a political reason: to send a message of intimidation to other radicals.

BY DESIGN, EARTH FIRST has no Washington office. Most envrionmental radicals decline to work through the political system, disdaining the process of filing lawsuits, lobbying or even voting. They rally round a simple — some would say simplistic — slogan: "No compromise in the defense of Mother Earth!"

Thus, for example, the group, with a straight face, proposes a Wilderness Preserve System that would encompass one-third of all United States territory outside Alaska. Earth First's mission, as one broadside puts it, is to "move out the cars and civilized people, dismantle the roads and dams, reclaim the plowed land and clearcuts, reintroduce extirpated species."

But this no-compromise stance is criticized by other environmentalists as self-defeating. They contend that Earth First cannot hope to be a player if it won't take a seat at the table; the give-and-take of politics, even the necessity to accept temporary defeat, is part of the democratic process. "Of all the countries in the world, the U.S. has by far the most easily influenced Government," says the Sierra Club chairman, Michael McCloskey. "There's no sense in acting frustrated, like there's no recourse, when there often is a pretty good recourse if you're systematic and organized in how you go about it."

Earth Firsters reply that in Washington and many state capitals during the past decade the political system broke down because public officials are in the thrall of development interests. Agencies like the United States Forest Service and the Bureau of Land Management, which regulate timber, mining and grazing, are accused of failing to exercise stewardship over public lands. Even McCloskey concedes this point: "We have a sit-down strike by the Government on environmental issues. There's this great gap between what the public wants and what it's getting, and this is leading to a radicalizaton of the grass roots."

This has played into Earth First's hands. The radicals have sympathizers in unexpected places. "Boy, I could probably put cement in a bulldozer," said one high-ranking staffer at a Washington environmental group, insisting on anonymity.

Earth Firsters charge that environmentalists who let themselves be drawn into negotiations with public officials end up co-opted. They point to a compromise last year, brokered by Oregon's pro-timber Senator Mark O. Hatfield and reluctantly accepted by the Sierra Club, that released for cutting some 100,000 acres of old-growth forest in the Pacific Northwest previously protected from the chain saw by the courts. The accord incensed many grass-roots activists and led to defections from the Sierra Club.

JUDI BARI LIES stretched full-length on a living-room couch, nerve damage and shattered pelvis making it extremely painful to sit up. Nine weeks after the May car bombing, the Earth First activist was released from a rehabilitation center, but her injuries will probably leave her permanently disabled. She has agreed to a meeting, though only at the home of friends; at the time she was in hiding in Northern California. Today she travels with a bodyguard, still fearful she may be a target of assassins.

Activist insiders say it's absurd to believe that Bari could have knowingly had a bomb in her car, since Northern California Earth First has been moving away from environmental sabotage, or "ecotage," renouncing tree spiking and calling for nonviolent protest during Redwood Summer. Bari, 40 years old, is an assured and articulate speaker who, even before her near martyrdom, was one of Earth First's leaders.

A former union organizer from the East Coast, she became a radical environmentalist while working as a carpenter in Mendocino County. Working on a house one day, she noticed the beauty of the knot-free wood used for siding. "Is this old-growth redwood?" she asked.

"Oh, yeah," her supervisor said offhandedly, "this stuff's a thousand years old."

"I was appalled," Bari recalls. "A light bulb went on: we are cutting down the old-growth forests to make yuppie houses! I was building a

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EARTH FIRST

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25,000-square-foot mansion for a single man to use as a weekend retreat. It was so wasteful. I became obsessed with the forests."

Earth Firsters, especially in Northern California, think of themselves as a tribe, and they have evolved their own life style — more precisely, they've retreaded a quaint and familiar life style. In small towns among the redwoods, new-age settlers have appeared in tie-dyed wardrobes and dreadlocks. They work as carpenters, holistic healers, mandolin players, giving themselves names like "Sequoia" and "The Man Who Walks in the Woods."

Within Earth First, these neo-hippies are known as the "woo-woo element." Their utopia is a concept called "bioregionalism," a vision of people depending only on what's locally grown or made. Timber and other natural resources would cease to be exported from their native region. Thus, Earth Firsters in Northern California are pushing for legalization of a major regional crop — hemp, a form of marijuana that is also used for fiber products.

"Something like Los Angeles," Judi Bari says, "which only exists because they're stealing water from another region, would not exist. Los Angeles is an ecological disaster."

Bari is indifferent to the great hope of mainstream environmentalists in California, the ballot initiative nicknamed "Forests Forever" that would protect the redwoods. "I may vote for it, if I happen to vote," she says casually. "Earth First doesn't really work in the political system. We don't work in the legislative system."

Which raises some questions: How effective can Earth First be in bringing about change? What role does the group play in the environmental movement, and does it make a difference? Answers to these begin to crystallize upon closer inspection of the occupation of Murrelet Grove, an Earth First campaign in microcosm.

The Murrelet Grove activists were among some 3,000 people who heeded the call to participate in Redwood Summer, a name chosen to evoke the early-60's freedom riders of Mississippi Summer. By Labor Day, more than 150 Redwood Summer participants had been arrested. The Murrelet Grove protest was one of the largest "direct actions" of the summer, and yet it slowed down logging for barely an afternoon. It did not even generate the media attention that Earth First protests had in the past, since access to the woods required reporters to risk arrest. The demonstration got only a couple of paragraphs in local and regional papers. Overall, Earth First's Redwood Summer failed almost completely to stop logging activity.

Measured in the short term, direct action usually does fail, and most Earth Firsters know it. The only lasting solutions to conservation of forests have traditionally come through new laws, lawsuits and land purchases. Earth First, while swearing off these kinds of actions, nevertheless concedes the need for other environmental groups to pursue them.

And so, in a broader sense, there is no doubt that the antics of Earth First in the California redwoods have had an impact. In 1987, when the group first targeted the Pacific Lumber Company, owner of the majority of unprotected old-growth redwoods, none of the mainstream environmental groups was much involved. Pacific Lumber had doubled its rate of cutting to pay off junk-bond debts after it was acquired in a hostile takeover, and the company wasn't much interested in selling or donating its trees for parks.

Through attention-grabbing actions, Earth First turned the fate of

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the grand old redwoods into a public issue. And into the fray they drew the Sierra Club and other more conventional environmentalists, who sued to halt the cutting until more was known of the threat to wildlife. With pressure mounting against them, Pacific Lumber and state officials announced a temporary moratorium this spring on harvesting the world's largest unprotected virgin redwood grove, a 3,000-acre tract known as Headwaters Forest. If the Forests Forever initiative passes this Tuesday, Headwaters Forest will be purchased with state funds and officially made a preserve.

"It was the spirit of yahooism that led to the logging restrictions," says Marc Depolo, a longtime Earth First activist. "We stood up for the trees' right to exist. We've ended up where the Headwaters Forest is a statewide issue."

In the Headwaters Forest at least, without Earth First trees might have fallen with no one to hear.

ALL THROUGH THE Pacific Northwest, logging has been a subject of bitter controversy. As tree cutting reached record highs in the late 1980's, timber interests argued that the economy of the region depended on unlimited access to the old-growth trees outside parks and designated wilderness areas. In rebuttal, conservationists contended that, at the rate the trees were being felled, the old growth, mostly on Federal lands on the western slope of the Cascade range, would be gone in 10 to 20 years. These enormous trees, the conservationists also pointed out, are an invaluable habitat for salmon and the spotted owl, which this year made the threatened species list.

The cause of the old-growth forests has become the leading conservation issue in the country. The impetus for the cause didn't come from mainline environmental organizations. It was largely the work of a plethora of obscure grass-roots groups, who, drawing on the research of the Government's own biologists, sounded the alarm. "This is an issue where the grass roots got going first, and the national groups were asked to come join," admits Frances Hunt, a Washington lobbyist for the National Wildlife Federation.

Earth First, which erected its first illegal blockades to protect old growth in 1983, claims to have played a major role in the successful grass-roots campaign. But other environmentalists aren't so sure. They say that the contribution of the radicals was minimal, that — apart from making lots of noise — when it came to the unglamorous work of putting together the coalition necessary to exert poltical muscle, most Earth Firsters were nowhere to be found. "There's a big difference between Earth First actions and grass-roots activism," says George T. Frampton Jr., president of the Wilderness Society. "The real grass-roots activity in the last two to three years has been hard, not very sexy, and not very visible. It doesn't get on television.

"If you read editorials now in the Northwest papers, you will see in almost every editorial the fact that, while saving forests costs jobs, we have to understand this area is in transition and jobs will be lost anyway. Most of the jobs are being lost to technological change. How do you think that argument gets on every editorial page? It's two and a half years of work."

Earth Firsters argue that without a favorable climate of public opinion, mainline groups would not be able to influence politicians. The willingness of the radicals to put their bodies between the trees and the chain saws dramatizes the issue, they say, and taps public sympathy.

To a degree this is true. But while Earth First has won sympathizers, the group's tactics have also alienated many people, particularly in timber country. Earth First's guerrilla theater has led to a backlash that threatens to undo even the small gains already made, such as Headwaters Forest.

In the end, the spirit of Redwood Summer bore scant resemblance to that of Mississippi Summer, with its pursuit of high ideals. Marc Depolo, who, under the nom de guerre "Mokai," helped organize the Murrelet Grove takeover, conceded that its objective was not really to stop logging. "Mostly what we do is get in their face," he says. "It's almost personal. We don't like what you guys are doing, so we're going to come over and tell you."

Not surprisingly, the loggers of Humbolt County took it personally. They felt they were being harassed, and they grew furious at what they saw as the arrogance of the Earth Firsters. In Northern California, the two cultures are bitterly polarized, with condescension, ugly words and sometimes even violence passing back and forth between them.

Just as they'd expected, Redwood Summer demonstrators were the targets of physical abuse: one man was stripped and beaten; others were chased from a town meeting, and several had their heads forcibly shaved, supposedly for lice, in the Humboldt County jail.

Earth First's aggressive confrontations succeeded in

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"getting in their faces." But as for saving trees, which ultimately requires a political solution such as the Forests Forever initiative, the tactic seems to have backfired. "I don't think it has been helpful, because it allowed industry to focus on Earth First and take the light away from the overcutting," says Gail Lucas of the Sierra Club, a prime mover behind the Forests Forever campaign.

As the days dwindle down before the vote, polls show that the initiative, Proposition 130, is in trouble. The timber industry has mounted a $12 million ad campaign, cunningly implying that Earth First was behind the iniative, which it wasn't. "The polling shows that a linking of Prop 130 with Earth First can kill it," Lucas says flatly. "People do not like radical environmentalists."

TACTICS ARE NOT the only way in which Earth First differs from groups in the mainline environmental movement. Its philosophy is also vastly different. Most Earth Firsters espouse a system of belief called "Deep Ecology," which holds, in essence, that a man has the same rights as a mouse. Human beings are not meant to exert dominion over the earth; all species have equal title to the earth's bounty.

Though the theory has a certain noble simplicity, Earth Firsters have used it to arrive at some truly revolutionary conclusions. Our current technological culture is unethical, they say, since it permits humans to prosper while driving other species toward extinction. To protect the rights of trees and wolves — and to save the human species — we must be prepared to give up such planet-destroying extravagances as cars, televisions, planes and computers. A Luddite phobia of technology runs deep through Earth First, whose members have even opposed the University of Arizona's development of a telescope on a fragile desert mountain.

In his recent book, "Green Rage," Earth Firster Chirstopher Manes argues that we must roll back more than just the last century of technology. Manes calls the Enlightenment a "holocaust," because it was during that period that the intellectual distinction between man and nature was first made. Manes suggests that future societies be modeled on hunter-gatherer tribes, quoting one activist as saying, "Many of us in the Earth First movement would like to see human beings live much more like the way they did 15,000 years ago, as opposed to what we see now."

Needless to say, few Earth Firsters actually practice Deep Ecology. Not many have given up their cars or unplugged their word processors. Even Dave Foreman, wearing a Hawaiian shirt and chomping on a cheeseburger in a Ramada Inn in downtown Tucson, Ariz., his home city, looks every bit the middle-class American he admits to being. "Certainly I recognize the contradiction in flying all over the country to give speeches about not doing that sort of thing," Foreman says casually between bites. "There are constantly contradictions."

While the mainstream of the environmental movement is absorbed with issues like clean air, clean water and the greenhouse effect, the radicals of Earth First dismiss these efforts as nothing but attempts to preserve the high standard of living in advanced industrial society. For Deep Ecologists, the real hot-button issues are overconsumption and overpopulation.

Foreman isn't sure how many human beings the earth could support in a society that gave equal rights to all creatures. But Arne Naess, a Norwegian philosopher who coined the term Deep Ecology, once suggested, in all seriousness, a target population for the globe of 100 million people.

Such thinking has lead some Earth Firsters to view human beings as, in Foreman's words, "a cancer on nature." Indeed, Foreman goes so far as to argue that the United States ought to be closed to immigration. His reasoning is that an influx of people striving to live a middle-class life in America will deplete our resources faster than if they'd remained home in the third world.

Foreman has also suggested that such human tragedies as the AIDS epidemic and African famines can be viewed as examples of nature healing itself. Rather than send foreign aid to Ethiopia, he once argued, "the best thing would be to just let nature seek its own balance, to let the people there just starve."

Such views lead critics to label Foreman an "eco-fascist." He claims, however, that he is merely the bearer of bad news, not its advocate. "I don't think the earth can sustain this population of five and a half billion," he asserts. "People are going to die. It's not because I want them to. It's because they've overshot the carrying capacity of the planet. I really think there is going to be a major ecological collapse. There's going to be a concomitant die-off of the human population. The next 20 years aren't going to be very pleasant."

Foreman speaks matter-of-factly, bloodlessly, as if all this were self-evident. In his youth, before he discovered Deep Ecology, he campaigned for Barry Goldwater and led a state chapter of the far-right Young Americans for Freedom. His stands today on immigration and foreign aid are in perfect sync with the archconservative positions of his past. He is a man at home on the edges, where the issues are always black and white.

Even fellow Earth Firsters are concerned about Foreman's shocking indifference to human suffering, fearing that their leader has gone beyond Deep Ecology to advance the cause of other species at man's expense. Recently Foreman's anti-humanism precipitated a schism in the movement. A few months ago — when some Earth Firsters in Northern California started to embrace such traditional political causes as labor reform in an effort, they say, to change society before it's too late — Foreman resigned from the group he co-founded. He immediately announced plans for a new organization to focus narrowly on wilderness preservation. As one Earth Firster put it, "Foreman takes the mission of environmentalism at this point as a holding action while creatures wait for the demise of modern civilization."

If environmental extremism has made an impact, it is by dint of the alarm bells it has set off. The calls of Earth First have not fallen on deaf ears. Environmentalists of all stripes share the anxiety that the life-support system of the planet is perilously out of balance, that we are running out of natural resources, while we choke on toxins and subvert our own climate.

But a huge gap has developed between diagnosing the problem and prescribing the cure. Many environmentalists worry that the solutions of Earth First are so extreme, and often so merciless in their implications for present society, that people will be convinced the situation is hopeless. And that is something no environmentalist believes the earth can afford. ■

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Primary Source B

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Demographic models of the northern spotted owl (*Strix occidentalis caurina*)

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Summary. Classical demographic methods applied to life history data on the northern spotted owl yield an estimate of the annual geometric rate of increase for the population of $\lambda = 0.96 \pm 0.03$, which is not significantly different from that for a stable population ($\lambda = 1.00$). Sensitivity analysis indicates that adult annual survivorship has by far the largest influence on λ, followed by the probability that juveniles survive dispersal, and the adult annual fecundity. Substantial temporal fluctuations in demographic parameters have little effect on the long-run growth rate of the population because of the long adult life expectancy. A model of dispersal and territory occupancy that assumes demographic equilibrium is evaluated using data on the amount of old forest habitat remaining in the Pacific Northwest and the current occupancy of this habitat by northern spotted owls. This model is employed to predict the effect of future habitat loss and fragmentation on the population, implying that extinction will result if the old forest is reduced to less than a proportion 0.21 ± 0.02 of the total area in a large region. The estimated minimum habitat requirement for the population is greater than that allowed in management plans by the USDA Forest Service.

Key words: Demography – Territoriality – Dispersal – Colonization – Extinction

The northern spotted owl (*Strix occidentalis caurina*) is a monogamous, territorial subspecies that inhabits old coniferous forests in western Washington, Oregon and northern California. Each pair utilizes about one to three square miles of forest more than about 250 years old and below an elevation of roughly 4000 ft., nesting in hollow trees and preying on small mammals, birds and insects (Forsman et al. 1984; Gutiérrez 1985). Heavy logging, especially on private land, in recent decades has destroyed most of the old forest upon which these owls depend, and the great majority of that remaining is concentrated in areas managed by the U.S. Forest Service, the National Park Service, and the Bureau of Land Management (Society of American Foresters 1984). The total population of the northern spotted owl in the Pacific Northwest region was recently estimated to be about 2500 pairs (USDI Fish and Wildlife Service 1982; Dawson et al. 1987).

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The National Forest Management Act of 1976 (16 U.S.C. §1600 et seq.) and its implementing regulations 36 C.F.R. §219) require that viable populations of all native species of vertebrates be maintained well-distributed through their range. Under opposing pressures from conservationists and the timber industry, the U.S. Forest Service formulated guidelines for the management of spotted owl habitat. The management plan, as originally proposed (USDA Forest Service 1984), suggested preservation of enough old-forest habitat to maintain a population of the minimum size that has been thought sufficient to ensure long-term persistence on population genetic grounds (Franklin 1980). Recognizing that demographic factors also need to be considered, later management recommendations have been based on extensive computer simulations of population growth models (USDA Forest Service 1986).

Here I apply simple analytical models to (1) estimate the geometric growth rate of the northern spotted owl population, and (2) predict the effect of future habitat loss and fragmentation on the equilibrium occupancy of suitable territory. The first model uses a standard demographic method for projecting the growth of a population from age-specific fecundity and mortality rates (Lotka 1956; Keyfitz 1977). The second model generalizes Levins' (1969, 1970) analysis of a metapopulation maintained through a balance of local extinction and colonization, by incorporating life history, territoriality and dispersal behavior in a patchy environment (Lande 1987).

Geometric growth rate of the population

Characteristic equation

In a population with overlapping generations, reproducing at discrete yearly intervals, the annual geometric growth rate of the population, λ, is the (unique) positive real solution of the Euler-Lotka or characteristic equation,

$$\sum_{x=0}^{\infty} \lambda^{-x} l_x b_x = 1. \tag{1}$$

Here l_x is the probability of survival from birth or fledging to age x. Letting s_i be the probability of survival from ages i to $i+1$, define $l_x = s_0 s_1 \ldots s_{x-1}$, and b_x as the rate of production of female offspring per female of age x (Leslie 1966; Mertz 1971). If these parameters do not change with time,

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Table 1. Basic demographic statistics for the northern spotted owl

Parameter estimate	Sample size	Reference
Fledgling survival probability (pre dispersal), $s_0'=0.60$	$N_0=135$	Marcot and Holthausen (1987)
Probability of successful dispersal, $s_d=0.18$	$N_d=44$	Marcot and Holthausen (1987)
Subadult annual survival probability, $s_1=0.71$	$N_1=7$	Franklin et al. (1986)
Adult annual survival probability, $s=0.942$	$N_s=69$	Franklin et al. (1986)
Adult female ave. annual fecundity, $b=0.24$	$N_b=438$	Marcot and Holthausen (1987)
Age at first breeding (in years), $\alpha=3$	general observations	Forsman et al. (1984); Gutiérrez (1985)

Table 2. Sensitivity of λ to changes in estimated demographic parameters of the northern spotted owl, and their contributions to the sampling variance in λ, from Eqs. (3), (4) and Table 1

Parameter	Sensitivity of λ	Contribution to $\sigma_\lambda^2(\times 10^4)$
s_0'	0.030	0.016
s_d	0.102	0.349
s_1	0.026	0.199
s	0.981	7.620
b	0.076	0.041
α	−0.000	0.000
	Total	8.225×10^{-4}

and there is a constant sex-ratio at fledging, the size of the total population at year t can be predicted approximately from the geometric formula, $N(t)=\lambda^t N(0)$, apart from fluctuations in age structure during the first few generations (Keyfitz 1977).

In many avian species the expected mortality and reproductive rates of adults are nearly constant and independent of age (Deevey 1947). Denoting the age of first reproduction as α, and the adult annual survivorship as s, for such species we can write $l_x=l_\alpha s^{x-\alpha}$ and $b_x=b$ for $x\geq\alpha$ (with $b_x=0$ for $x<\alpha$). The series in the characteristic equation can then be summed to give

$$\lambda^\alpha(1-s/\lambda)=l_\alpha b. \tag{2}$$

Because $l_\alpha b\geq 0$, the positive real solution of this equation must be such that $\lambda\geq s$.

Field data indicate that northern spotted owls usually start breeding at an age of $\alpha=3$ years (Forsman et al. 1984; Gutiérrez 1985). In this case, the characteristic equation is cubic and can be easily solved numerically. The probability of survival through the first year of adulthood can be written as $l_3=s_0' s_d s_1 s$, where the first year survivorship, s_0, has been expressed as the probability of successful dispersal, s_d, times that of surviving the first year excluding the risk of dispersal s_0'. Estimates of the demographic parameters in Table 1 give the probability of survival to reproductive age as $l_3=0.0722$, the adult annual survivorship as $s=0.942$, and the average reproductive rate of $b=0.24$ female offspring fledged per adult female per year. From these data and formula (2) it can readily be found that $\lambda=0.961$.

Sensitivity analysis

The sensitivities (or partial derivatives) of λ with respect to small changes in the life history parameters indicate which of the parameters has the largest impact on the geometric growth rate of the population; they also are important in calculating the standard error of λ and in determining the effect of stochastic variation in life history parameters on the long-run growth rate of the population. The sensitivities are found by implicit differentiation of the characteristic Eq. (2), as in Goodman (1971),

$$\partial\lambda/\partial\pi=\lambda/(\pi T),\quad \partial\lambda/\partial s=\lambda(T-\alpha+1)/(sT),$$
$$\partial\lambda/\partial\alpha=-\lambda[\ln(\lambda/s)]/T \tag{3}$$

where π represents any of the statistics s_0', s_d, s_1, or b, and $T=\alpha+s/(\lambda-s)$ is the generation time of the population, defined as the average age of mothers of newborn individuals in a population with a stable age distribution (Leslie 1966; Mertz 1971).

Using the data on the northern spotted owl, the sensitivity coefficients are evaluated in Table 2. The geometric growth rate of the population is by far most sensitive to changes in the probability of adult annual survival, and is next most sensitive to the probability of finding a territory and the average reproductive rate. However, adult survivorship is already quite high, and may have little possibility of further improvement. The age of first reproduction is relatively unimportant because increasing the reproductive age by 1 year would decrease the geometric growth rate of the population by less than 0.1%.

Standard error of λ

The sensitivities in equations (3) appear in the approximate formula for the sampling variance of an estimated value of λ,

$$\sigma_\lambda^2=\sum_\pi(\partial\lambda/\partial\pi)^2\sigma_\pi^2 \tag{4}$$

where π here represents each of the parameters, and σ_π^2 is the sampling variance of π estimated from N_π individuals in the population (Kendall and Stuart 1977, Ch. 10.6). Most of the parameters are survival probabilities with binomial sampling distributions for which $\sigma_\pi^2=\pi(1-\pi)/N_\pi$; for estimates of b or α the sampling variance is the variance of annual fecundity or age at first reproduction among females in the population divided by the appropriate sample size. Formula (4) omits possible covariances between the sample statistics which could arise for example if some of the parameters are estimated from the same individuals, or are measured on genetic relatives. It also neglects sampling variance caused by spatial and temporal inhomogeneity of the population, and possible biases such as increased mortality of dispersing juveniles carrying radio transmitters.

Components of the sampling variance of λ were calculated from formula (4), using the demographic statistics in Table 1 and the sensitivity coefficients in Table 2. Following

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the analysis by Barrowclough and Coats (1985) of reproductive statistics for the northern spotted owl, and various other owl species, I assumed that the variance in fecundity among adult females is 1.3 times its mean value shown in Table 1. The sensitivity coefficient of the age at first reproduction is so small that intrapopulation variation in α contributes a negligible amount to the sampling variance in λ. It is therefore sufficient to use $\alpha=3$, based on general observations that breeding usually begins in the third year (Forsman et al. 1984; Gutiérrez 1985), and to ignore variation in this parameter, i.e. occasional observations of breeding in the second year (Gutiérrez 1985), or that many females must first successfully fledge female offspring in their fourth or fifth year (which is implied by the low mean fecundity, $b \ll 1$).

The standard error of the estimate of λ, obtained as the square root of the sampling variance in formula (4), for the spotted owl is ± 0.029. The estimated value of $\lambda=0.961$ is less than twice its standard error from 1.000 and is therefore not significantly different from that for a stable population, supporting the contention that the population currently may be near a demographic equilibrium. The estimated rate of change in population size, representing an annual increment of $\lambda-1=-4\%$, also is not significantly different from the approximate 1% annual decline estimated from long-term surveys in Oregon (Forsman et al. 1984; Forsman 1986).

Stochastic variation in demographic parameters

So far the analysis has dealt only with the average demographic parameters in the population. The conclusion that the population is nearly stable may be overly optimistic because it does not account for temporal fluctuation in age-specific fecundity and mortality rates around their average values (the "environmental stochasticity" of Shaffer [1981]), which tends to diminish the long-run growth rate of the population, if there is no serial correlation (autocorrelation) in the fluctuations (Tuljapurkar 1982). In species with long-lived adults, the population may be maintained by occasional good years for reproduction and juvenile survival. Long-term weather records in the continental United States show very little autocorrelation on a yearly time scale (Namias 1978; Nicholls 1980). For species that reproduce at annual intervals, such as the spotted owl, this justifies in part the assumption of no autocorrelation in demographic parameters, although long-term fluctuations or cycles in prey abundance may cause some autocorrelation.

According to a general formula of Tuljapurkar (1982), the long-run (geometric average) growth rate of a population, Λ, subject to small fluctuations in demographic parameters with no serial correlation is approximately

$$\Lambda = \lambda \exp\{-\tfrac{1}{2}\lambda^{-2}[(\partial\lambda/\partial s)^2 v_s^2 + (\partial\lambda/\partial\pi)^2 v_\pi^2 + 2(\partial\lambda/\partial s)(\partial\lambda/\partial\pi)\, v_s v_\pi r_{s,\pi}]\} \quad (5)$$

where λ is the geometric growth rate of the population calculated from the average demographic statistics (Eq. 2 and Table 1). v_s^2 is the yearly variance in adult annual survival, and the sensitivity coefficients have the forms shown in equations (3), but here $\pi=l_2 b$ with the yearly variance v_π^2, and $r_{s,\pi}$ is the correlation between s and π.

To gain some impression of the magnitude of this effect, suppose that adult annual survivorship has a coefficient of variation among years of 10%, $v_s/s=0.1$ (which indicates roughly the range of values used in different models), that $\pi=l_2 b$ undergoes much larger fluctuations with a coefficient of variation of $v_\pi/\pi=5$ representing frequent poor years and occasional good years for reproduction and juvenile survival (Forsman et al. 1984; Barrows 1985), and that fluctuations in s and π are highly correlated, $r_{s,\pi}=1$. Utilizing the information in Tables 1 and 2, the long-run growth rate of the population, $\Lambda=(0.98)\lambda$, is only slightly smaller than in a constant environment with the average demographic parameters. Because of the long life expectancy of adults, $1/(1-s)\cong 17\frac{1}{4}$ years, substantial yearly fluctuations in demographic parameters have little effect on the long-run growth rate of the population, at least in the absence of serial correlation.

Truncation of the life table

Demographic models of the northern spotted owl population constructed by the USDA Forest Service (1986, Appendix B) and by Marcot and Holthausen (1987) assumed a maximum age for survival and reproduction of 10 or 15 years. The amount by which truncation of the life table, without changing the other life history parameters, decreases λ can be seen by including in the present model a maximum age for survival, ω, as done by Mertz (1971), so that the characteristic equation becomes

$$\lambda^\alpha(1-s/\lambda)/[1-(s/\lambda)^{\omega-\alpha+1}] = l_\alpha b. \quad (6)$$

With truncation of the life table, λ may be less than s.

For a population with the parameters used by the USDA Forest Service (1986, p. B-24), $s_0=0.20$, $s_1=s=0.85$, $b=0.275$, $\alpha=3$ and $\omega=10$, the positive real solution of Eq. (6) is $\lambda=0.77$. At this rate of decline, starting from the current estimated population size of 2500 pairs (USDI Fish and Wildlife Service 1982; Dawson et al. 1987) or $N=5000$ individuals, the population is expected to become extinct (reduced to a single individual) in roughly $\tau=-\ln N/\ln\lambda$ years, or about 33 years. This agrees with the precipitous population crash forecast by the USDA Forest Service (1986, p. B-25). Using the same statistics, but without truncating the life table, $\omega=\infty$, Eq. (2) yields $\lambda=0.90$, which is close to my initial estimate of 0.92 from similar data (Lande 1985).

For the demographic parameters used by Marcot and Holthausen (1987), $s_0=0.11$, $s_1=s=0.96$, $b=0.24$, $\alpha=3$ and $\omega=15$, the geometric growth rate of the population becomes $\lambda=0.86$, indicating extinction of the present population in about 56 years. If their life table is not truncated, $\omega=\infty$, Eq. (2) gives the more realistic growth rate of $\lambda=0.985$, nearly identical to the approximate long-term trend (Forsman et al. 1984; Forsman 1986).

Dispersal and territory occupancy

Basic theory

Utilizing the concept of a metapopulation maintained by a balance between local extinction and colonization, Levins (1969, 1970) pointed out that a species may not occupy all of the habitat available to it, and a population may go extinct in the presence of suitable patches of habitat. Shaffer (1985) discussed the relevance of these ideas for conservation of the northern spotted owl. Lande (1987) ex-

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tended the metapopulation concept to a territorial population by identifying the individual territory as the unit of local extinction and colonization, and incorporating life history and the dispersal behavior of individuals in a patchy environment. On the assumption that environmental patches suitable for survival and reproduction of the species are randomly or evenly distributed across a large region, interspersed with uninhabitable patches, the model predicts the equilibrium occupancy of suitable habitat by females, $\hat{p}$, as a function of the proportion of the region that is suitable (habitable), h, and the demographic potential of the population, k, which is determined by the life history and dispersal behavior. k is called the demographic potential because it gives the equilibrium proportion of territories that would be occupied by females in a completely suitable region. Knowing the amount of suitable habitat in a large region, h, and estimating the proportion of it currently occupied by females, p, assuming the population is at a demographic equilibrium, the structure of the model allows us to estimate k and to predict the effect of future environmental alterations on the equilibrium occupancy of suitable habitat, $\hat{p}$.

Let the probability that a juvenile (female) inherits the home territory of its (female) parent be ε, which is assumed to be constant. If the natal territory is not inherited, juveniles disperse and are assumed capable of searching m territories to find a suitable unoccupied patch of habitat, before perishing from predation, starvation, etc. Then the probability of not inheriting the home territory, and upon dispersal not finding a suitable unoccupied territory in m trials is $(1-\varepsilon)(ph+1-h)^m$. The characteristic equation for a territorial population at demographic equilibrium ($\lambda = 1$) can thus be written by separating from the other parameters the probability of successful dispersal, i.e. inheriting or finding a suitable unoccupied territory,

$$[1-(1-\varepsilon)(\hat{p}h+1-h)^m]\, R'_0 = 1 \tag{7}$$

where

$$R'_0 = \sum_{x=0}^{\infty} l'_x b_x \tag{8}$$

is the mean lifetime production of female offspring per female, conditional on the mother finding a suitable territory, with l'_x denoting the probability of survival until age x under the same condition. For the avian life history given above (without truncation of the life table) $R'_0 = l'_\alpha b/(1-s)$. This model encompasses a range of possible density-dependent population dynamics, from $m = 1$ as in Levins' model involving logistic growth, to $m = \infty$ which allows density-independent exponential growth up to a ceiling ($\hat{p} = 1$).

Solving Eq. (7) for the equilibrium occupancy of territories by females gives

$$\hat{p} = \begin{cases} 1-(1-k)/h & \text{for } h > 1-k \\ 0 & \text{for } h \le 1-k \end{cases} \tag{9}$$

where the demographic potential of the population is

$$k = [(1-1/R'_0)/(1-\varepsilon)]^{1/m}. \tag{10}$$

Assuming that $0 < k < 1$, Eq. (9) describes the equilibrium occupancy of suitable habitat in a large region. The demographic potential then gives the equilibrium occupancy of suitable territories by females in a large region that is completely habitable ($\hat{p} = k$ when $h = 1$). The population can persist only if the proportion of suitable habitat in the region, h, is greater than $1-k$. The minimum proportion of suitable habitat in a large region is termed the extinction threshold for the population (Lande 1987).

From current estimates of p and h in the population, assuming it is at a demographic equilibrium, Eq. (9) can be solved for the demographic potential containing all of the (unknown) demographic parameters, $k = 1-(1-\hat{p})\,h$. This procedure allows k to be estimated directly from p and h without detailed information on the parameters of life history and dispersal behavior in Eq. (10). If h is known exactly, the sampling variance of an estimate of k is approximately $\sigma_k^2 = h^2\sigma_p^2$ where $\sigma_p^2 = p(1-p)/N_p$ and N_p is the number of suitable territories sampled for occupancy. Having estimated k, and supposing it is constant, past and future values of the equilibrium occupancy of suitable habitat can be estimated from Eq. (9) for regions in which h was, or will be, different from its present value.

The habitat occupancy model depends strongly on the assumption of a random or even distribution of suitable territories in a region, but is largely independent of the dispersal strategy of individuals, provided they are capable of moving much farther than the average distance between their natal territory and the nearest suitable site. Since dispersing individuals may settle on the first suitable unoccupied territory they encounter, while the parameter m describes the number of potential territories that a dispersing individual can search, the model allows for adjustment of realized dispersal patterns and changes in the probability of successful dispersal with changes in the amount of suitable habitat and its occupancy. This type of mass action model (like Levins') does not account for the detailed spatial distribution of suitable habitat, or chance clumping of individuals as a result of dispersal, mating and reproduction, but it should be valid as long as the population density is not so low that demographic and environmental stochasticity are likely to cause rapid extinction (cf. Lande 1987).

Application to the northern spotted owl

Before 1800, roughly 60% to 70% of the forested regions of the Pacific Northwest consisted of coniferous forest more than 200 years old, with the remaining areas in younger age categories due to fire and other natural catastrophes (Franklin and Spies 1984). National forests in the Douglas-fir region of western Washington and Oregon currently contain about 38% old forest greater than 200 years old (Society of American Foresters 1984), thus $h \cong 0.38$. Although there is some ambiguity in the Forest Service guidelines (USDA Forest Service 1984, 1986), they appear to call for 550 pairs of owls distributed on one-pair and three-pair Spotted Owl Management Areas (SOMAs) spaced respectively within 6 and 12 miles apart in 12 national forests in Washington and Oregon, with a minimum of 1000 acres and a maximum of 2200 acres of (nearly) contiguous old forest per pair. (Among six pairs studied by radiotelemetry in northwestern Oregon, 1008 acres was the smallest amount of old growth included in a home range, with the average being 2264 acres of old growth [Forsman and Meslow 1985].) This totals a minimum of 0.55 million acres and a maximum of 1.21 million acres of old forest in about 7.6 million acres of forested land (Society of American Foresters 1984). Under the guidelines the future proportion of

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suitable habitat for northern spotted owls in national forests would be in the range of about 7% to 16%.

Young spotted owls are fledged in the summer and disperse long distances in the fall (dozens of kilometers) (Gutiérrez 1985; Gutiérrez et al. 1985), so there may seem to be no difficulty for juveniles searching for potential territories up to 6 to 12 miles away during dispersal. However, the low density of suitable habitats in the future may pose serious problems for dispersing juvenile spotted owls searching for a suitable unoccupied territory.

Surveys of 46 SOMAs designated by the Forest Service on national forests in western Washington during the three years 1984–1986 (giving $N_p = 138$) indicate that on average each year 22% of SOMAs were confirmed occupied by a pair of owls and an additional 22% of SOMAs were confirmed occupied by single owls (Allen et al. 1987), giving an average annual occupancy of $p \cong 0.44 \pm 0.04$. (43% of the SOMAs were confirmed occupied by a pair of spotted owls in at least one of the three years.) SOMAs were confirmed to be occupied through daytime visual sighting after day or night response(s) to artificial calls. This figure probably overestimates female occupancy because some of the single owls may have been males; in northern California, most of the single owls occupying territories were males (Franklin et al. 1986, Table 7).

From current estimates of $h \cong 0.38$ and $\hat{p} \cong 0.44$, assuming the population is stable, the demographic potential estimated from the above formulas is $k = 0.79 \pm 0.02$. The model of Eq. (9) then suggests that under primitive conditions with $h = 0.6$ to 0.7 the proportion of suitable habitat occupied by females was high, $\hat{p} \cong 0.7$. Furthermore, it appears that in large regions where a proportion less than $1 - k = 0.21 \pm 0.02$ of the area is composed of suitable habitat (coniferous forest more than 200 years old) northern spotted owls can not persist. This model therefore predicts that the effect of implementing Forest Service guidelines and recommendations (USDA Forest Service 1984, 1986), with future $h \cong 0.07$ to 0.16, will be to cause the extinction of spotted owls from the region. Even a plan that would double or triple the number of SOMAs, assuming these to consist each of 1000 acres of old growth (Shaffer 1985), would be likely to rapidly extinguish the population. The predicted extinction of the population is robust to substantial error in estimating the current occupancy, for if $\hat{p} = 0.60$ then $k = 0.85$, or if $\hat{p} = 0.25$ then $k = 0.72$, and in either case the population is still likely to become extinct under the proposed plan.

This model of dispersal and habitat occupancy is optimistic in several respects because of the assumptions that there is no difficulty in finding a mate, no dispersal out of regions containing suitable habitat, no demographic or environmental stochasticity (including environmental catastrophes – see Forsman 1986), and no loss of fitness from inbreeding depression in small populations. In addition it is assumed that the suitability of SOMAs designated by the Forest Service is now high and will not decline in the future (e.g., due to increasing fragmentation of old forest within individual territories, or local extinction of prey species that are incapable of dispersing between SOMAs). Violation of any of these assumptions would render population persistence more difficult (Levins 1969; Shaffer 1981; Lande 1987), hence this model is likely to underestimate the extinction threshold, or minimum proportion of suitable habitat in a region necessary to sustain the population.

Discussion

The annual geometric growth rate of the northern spotted owl population estimated from currently available demographic data (Table 1) is $\lambda = 0.96 \pm 0.03$, which is statistically not significantly different from that for a stable population ($\lambda = 1.00$) or from the approximate 1% annual decline estimated from long-term surveys by Forsman et al. (1984) and Forsman (1986). This is larger than earlier estimates of the geometric growth rate by Lande (1985), the USDA Forest Service (1986), and Dawson et al. (1987), all of which predicted rapid extinction under current conditions. The discrepancies between the present estimate and previous ones can be explained as follows. My initial estimate of $\lambda = 0.92$ was based on earlier data that indicated higher juvenile survival and adult fecundity, but somewhat lower adult survivorship. The sensitivity coefficients in Table 2 indicate that changes in the latter parameter have the largest effect on λ, which explains why my initial estimate was less than the present one.

Dawson et al. (1987) used data similar to those in Table 1, but with an adult annual survival of only 0.80, which from formula (2) yields $\lambda = 0.83$. Although this would imply rapid extinction of the population, the decline would not be nearly as rapid as they claimed because they incorrectly used R_0 (the mean number of female offspring fledged by females in their lifetime) instead of λ to project future population changes.

The USDA Forest Service (1986) estimated a much more rapid decline under current conditions, based on essentially the same statistics as in my earlier report, but they assumed a maximum longevity of 10 years, which as shown above produces $\lambda = 0.77$. Arbitrary truncation of the life table is largely responsible for their extreme results. The practice of assigning the observed adult annual survival probability, s, to adults up to some age, and setting annual survival to zero thereafter (USDA Forest Service 1986; Marcot and Holthausen 1987), is actually inconsistent with the data since in such a model the average annual survival probability of adults in the population is less than s because of certain death at the maximum age. In the absence of data on the age-specific survivorship of adults, it seems more reasonable to equate s with the observed average annual adult survivorship without truncating the life table. For the purpose of computer simulation it may be convenient to truncate the life table at some age, or to otherwise limit adult longevity (Botkin and Miller 1974), but for avian species there is little biological justification for setting the maximum adult longevity less than four times the average adult longevity in nature (Deevey 1947, Fig. 4). The maximum lifespan should therefore be at least $\alpha + 4/(1 - s)$, which for the northern spotted owl is about 72 years (Table 1). Several eagle owls (*Bubo bubo*) are reported to have lived more than sixty years, and one individual 68 years, in captivity (Pettingill 1970, p. 399; Grzimek 1972, p. 407). Since maximum longevity in animals scales as body weight to the 0.15 power (Blueweiss et al. 1978), and spotted owls weight about one fourth as much as eagle owls (Grzimek 1972, p. 406; Dawson et al. 1987), this suggests a maximum longevity of roughly 55 years for spotted owls. Had the Forest Service not truncated the life table of the northern spotted owl at such an early age, they would not have found it necessary to "recalibrate" their model by increasing juvenile survivorship and adult fecundity beyond what was warranted by the data in order

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to achieve a current population growth rate comparable to the 1% annual decline estimated from long-term surveys prior to investigating a range of management alternatives.

Formal sensitivity analysis provides the best method for planning an efficient sampling program to estimate the life history parameters contributing to population growth. As a general rule, sampling effort to measure the basic demographic statistics should be proportional to their contribution to the sampling variance of λ (or if possible the sampling variance of Λ, the long-term geometric growth rate). Applying this rule to the present data on the northern spotted owl suggests that future field studies should concentrate most sampling effort on adult survivorship within and between years, since this has by far the largest sensitivity coefficient and accounts for the vast majority of the sampling variance of λ, if the life table is not truncated (Table 2). The second most important parameter in both respects is the probability of successful dispersal. Subadult survival contributes the third largest amount to the sampling variance in λ because of the small sample size, although it has only the fifth largest sensitivity coefficient. The least important parameter is the age at first breeding, which has a sensitivity coefficient so low that its contribution to the sampling variance of λ is negligible. In contrast, previous numerical analyses by the USDA Forest Service (1986, Appendix B) and Marcot and Holthausen (1987) concluded that juvenile survival and adult fecundity are the two most important parameters in determining the growth rate of the population, followed by the ages of first and last reproduction; those results are apparently an artifact of truncation of the life table. Without the benefit of a sensitivity analysis, Dawson et al. (1987) recommended that top priority in future demographic research should be given to pre-adult survival, age at first reproduction, and age-specific reproductive rate, and that relatively low priority should be assigned to adult survivorship.

The present analysis indicates that substantial yearly fluctuations in demographic statistics have only a small effect in decreasing the long-run growth rate of the population (assuming no serial correlation) because of the long expected adult longevity of $17\frac{1}{2}$ years. In this regard, a coefficient of variation of 10% in adult annual survival probability is almost equivalent to a coefficient of variation of 500% in the product of survival probability through age 2 and adult annual fecundity, because of the relatively large sensitivity coefficient of the former parameter (Eq. 5 and Table 2). In contrast with the present analysis, the USDA Forest Service (1986, p. S-11) concluded that the greatest risks to the northern spotted owl population are "reduction in habitat combined with the low reproductive rate for the species and variations in reproductive rate over time." Marcot and Holthausen (1987) concluded that demographic stochasticity poses the most immediate threat to continued persistence of the northern spotted owl population. The importance these authors place on stochastic variation in demographic parameters may in part be an artifact of their truncation of the life table. Dawson et al. (1987) recognized the prime importance of habitat destruction, but also placed great emphasis on demographic stochasticity in small populations, based on case studies of other species. Long-term surveys in Oregon (Forsman et al. 1984; Forsman 1986) and California (Gould 1985), the present analysis of stochastic demography, and the present deterministic model of territory occupancy, concur that destruction of old-forest habitat by logging constitutes the major threat to the continued existence of the northern spotted owl.

The model employed here to predict the effect of future habitat alteration on the northern spotted owl population extends Levins' (1969, 1970) model of a metapopulation maintained by local extinction and colonization by including life history, territoriality, and dispersal behavior in a patchy environment (Lande 1985, 1987). The fundamental results of these models are that in general a population at demographic equilibrium does not occupy all of the patches of suitable habitat available to it, and that a population may become extinct in the presence of suitable habitat because of the difficulty that dispersing juveniles experience in searching for a territory.

The original plan for preserving the northern spotted owl did not recognize these demographic principles (USDA Forest Service 1984), but was based instead on population genetic considerations which are by themselves of dubious value for the conservation of wild populations (Lande and Barrowclough 1987, pp. 119–120). Subsequent computer simulations incorporated stochastic models of demography and dispersal to quantitatively assess a range of management alternatives (USDA Forest Service 1986; Marcot and Holthausen 1987). The management strategy currently preferred by the USDA Forest Service (1986, pp. S-13, 2-20 to 2-22) closely resembles the original plan, despite their own prediction that under the preferred alternative the probability of persistence of a well-distributed population of the northern spotted owl more than 150 years in the future is "low to very low."

Using current estimates of the proportion of old-growth forest remaining in 12 National Forests in Oregon and Washington, and the occupancy of Spotted Owl Management Areas (SOMAs) designated by the Forest Service in Washington, the model of territory occupancy indicates that the northern spotted owl can not persist in any large region where the proportion of old forest is less than 0.21 ± 0.02 of the total area; this figure is likely to be conservative for several reasons outlined above. At present, less than half of the SOMAs designated by the Forest Service in Washington appear to be occupied annually (Allen et al. 1987). With continued reduction of old forest by logging, from the current proportion of about 38% to something in the range of 7% to 16% under the plan preferred by the Forest Service, it should be expected that occupancy of SOMAs by spotted owls will decline until the population is extirpated from the region. This analysis of territory occupancy indicates that only a plan involving preservation of the great majority of the remaining old-growth forest (e.g. Dawson et al. 1987) is likely to promote long-term persistence of the northern spotted owl population.

The results and conclusions presented here are of course subject to revision as more information becomes available. Ongoing studies in different parts of the subspecies range may eventually provide sufficient data to estimate geometric rates of increase and minimum habitat requirements for populations in particular regions rather than for the subspecies as a whole.

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TRAVELS WITH STRIX: THE SPOTTED OWL'S JOURNEY THROUGH THE FEDERAL COURTS

Victor M. Sher*

INTRODUCTION

The courtroom journeys of the northern spotted owl (*strix occidentalis caurina*) have both a text and a subtext. The text concerns what the parties have alleged and what the courts have decided in a series of cases involving several different statutes over the past five years. The story told by this text concerns what one federal judge in 1991 called a "remarkable series of violations of the environmental laws"[1] by the federal agencies entrusted with administering our public forests and protecting species against extinction. The text continues to unfold at all levels of the federal judiciary, and we are still some distance from its end, although the arrival of a new Administration holds some promise for a final resolution to both the court proceedings and the broader controversy over the future of the Northwest's ancient forests.[2]

The subtext involves a shadowy political battle in Congress in which the Bush Administration sought for the last half-decade to obtain exemptions from laws the courts found federal agencies were violating. In no other context since the passage in 1969 of the National Environmental Policy Act (NEPA)[3] has Congress acted so frequently to limit citizen enforcement of federal environmental laws against federal agencies in federal courts as it has concerning the spotted owl.[4] Between 1988 and 1992, the Ninth Circuit considered two court-stripping measures embodied in annual appropriations bills in six published opinions, and even the Supreme Court stepped in to resolve one case. How Congress and the new Administration deal with proposed legislation on spotted owls and ancient forests will provide a strong indication of the current health of, and future

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1. Seattle Audubon Soc'y v. Evans, 771 F. Supp. 1081, 1089 (W.D. Wash.), *aff'd*, 952 F.2d 297 (9th Cir. 1991).

2. *See* Tom Morganthau, et al., *A Lighter Shade of Green*, NEWSWEEK, Apr. 12, 1993, at 24; Ken Miller, *Owl Shows Successes, Failures of ESA*, GANNET NEWS SERVICE, Apr. 2, 1993.

3. Pub. L. No. 91-190, 83 Stat. 852 (1969)(codified as amended at 42 U.S.C. §§ 4321-4370c (1988 & Supp. II 1990)).

4. *See generally* Victor M. Sher & Carol S. Hunting, *Eroding the Landscape, Eroding the Laws: Congressional Exemptions from Judicial Review of Environmental Laws*, 15 HAR. ENVTL. L. REV. 435 (1991)(discussing congressional exemptions from environmental laws over the past twenty years, including in the spotted owl controversy).

prospects for, environmental law in this country.[5]

This article provides an overview of the spotted owl's journey through the federal courts. Section I discusses the owl's significance as an indicator of the health of old-growth forest ecosystems in the Pacific Northwest, and the failure of previous federal land management strategies to protect the species from potential extinction.

Section II analyzes lawsuits brought under the Endangered Species Act (ESA).[6] This set of lawsuits has in just over five years invoked more provisions of the ESA — and uncovered more violations of that law by federal agencies — than any previous litigation effort on behalf of any species or group of species. The courts have considered (and corrected) the federal government's failures to perform its responsibilities to add the northern spotted owl to the list of species protected under the ESA; to designate critical habitat for the owl; to engage in inter-agency consultation to avoid conduct likely to jeopardize the continued survival of the owl; and to comply with NEPA in connection with the decision to designate the owl's critical habitat. The courts have also been called on to examine the scope of the ESA's prohibition against "harm" to a protected species. Furthermore, the Ninth Circuit recently faced a challenge to the only decision by the Endangered Species Committee to grant an exemption from the ESA's prohibition against federal actions likely to jeopardize the continued survival of a species.

Section III examines citizens' efforts since 1987 to compel the federal Bureau of Land Management (BLM) to address current information about the spotted owl's plight. While for several years Congress deprived the courts of jurisdiction to hear plaintiffs' claims that BLM had ignored new, significant and probably accurate information in violation of NEPA, today BLM cannot sell timber from spotted owl habitat until it discloses, analyzes and considers current information about the owl's plight in an Environmental Impact Statement.

Section IV analyzes litigation against the U.S. Forest Service seeking to preserve the owl's viability on the national forests in Oregon, Washington and northern California. Since legislation aimed at foreclosing plaintiffs' access to the courts in this litigation expired, the Forest Service has been enjoined from selling timber in spotted owl habitat until it complies with the National Forest Management Act, as well as NEPA.

Finally, Section V discusses the lessons to be learned from the spotted owl's experience in the courts. In many ways, the ancient forest controversy

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5. *See, e.g.*, Victor M. Sher, *Ancient Forests, Spotted Owls, and the Demise of Federal Environmental Law*, 20 ENVTL. L. REP. 10,469 (1990).

6. Pub. L. No. 93-205, 87 Stat. 884 (codified as amended at 16 U.S.C. §§ 1531-44 (1988 & Supp. 1991)).

in the Pacific Northwest represents an important negative role model, one that federal agencies should strive to avoid in future decisions on managing the public lands. The spotted owl's experience can — and must, if the new Administration is to avoid the mistakes of its immediate predecessors — serve as a valuable guide for approaching issues raised by other species and other ecosystems around the country.

I. Background: The Spotted Owl's Importance As An Indicator Of The Health Of Ancient Forest Ecosystems, And The Failure Of Earlier Management Stategies To Preserve The Species

The northern spotted owl is a medium-sized owl with dark eyes, dark to chestnut brown coloring, whitish spots on the head and neck, and white mottling on the abdomen and breast. Though a secretive, nocturnal owl, it is relatively unafraid of humans. The owl is monogamous, long-lived, highly territorial, and site tenacious; it lives in the forests of southwestern British Columbia, western Washington and Oregon, and northwestern California.[7] Because it is closely associated with old-growth forests, federal agencies have considered the owl an "indicator species" for the health of that ecosystem since the mid-1970s.[8]

As the court explained in *Seattle Audubon Society v. Evans*:

> The fate of the spotted owl has become a battleground largely because the species is a symbol of the remaining old growth forest. As stated in the [Interagency Scientific Committee for the Conservation of the Northern Spotted Owl (May 1990)] Report:
>
> 'Why all the fuss about the status and welfare of this particular bird? The numbers, distribution, and welfare of spotted owls are widely believed to be inextricably tied to mature and old-growth forests. Such forests have been significantly reduced since 1850 (mostly since 1950) by clearing for agriculture, urban development, natural events such as fire and windstorms, and most significantly, by logging in recent decades. Nearly all old growth has been removed on private lands. Most of the remainder is under the management of the BLM, [U.S. Forest Service], and [National Park Service] on Federal lands. As its habitat has declined, the owl has virtually disappeared from some areas and its numbers are decreasing in others.'[9]

7. *See generally* Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Northern Spotted Owl, 55 Fed. Reg. 26,114 (1990) (final rule) (codified at 50 C.F.R. § 17) [hereinafter Final Rule].
8. *See* 36 C.F.R. § 219.19 (1992).
9. 771 F. Supp. 1081, 1088 (W.D. Wash.)(citing INTERAGENCY SCIENTIFIC COMMITTEE, A

. . .

V. Lessons From The Owl Experience

Both the text and the subtext of the spotted owl litigation contain important lessons about how federal agencies have abdicated their responsibilities toward the environment in the past, and what they must do to avoid repeating these mistakes in the future. The public — and future Administrations — must learn these lessons if federal agencies are to effectively address the problems of failing ecosystems around the country.

The cases highlight both the limits of the judiciary and the importance of litigation in reviewing actions of federal agencies. They illustrate the need for a holistic approach by federal agencies to both the law and the land. Finally, the agencies should learn these lessons quickly, because Congress is unlikely to relieve federal land managers of their duty to comply with the law again.

A. *The Limits of Litigation*

The first lesson concerns the limits of litigation. Environmental groups have often been accused of seeking, through the spotted owl litigation, to have the courts manage federal lands. This charge seriously misses the mark. The courts are institutionally incapable of making management decisions delegated by Congress to the discretion of executive agencies, and none of the spotted owl litigation has sought to undercut the appropriate role played by the agencies and the courts.

Litigation plainly cannot require federal agencies to excercise their lawful discretion in the wisest or most environmentally protective manner, nor, for that matter, in any particular way. Rather, courts intervene only to correct misconduct so egregious as to constitute an abuse of the discretion vested by Congress in the Executive Branch. Institutionally, the judiciary can only enforce the irreducible minimum requirements of a statute. The dramatic series of court rulings finding agncy violations of environmental laws concerning the spotted owl illustrates how far below that irreducible minimum federal conduct fell during the past decade.

Courts can correct serious abuses of the laws, like the "deliberate and systematic refusal by [federal agencies] to comply with the laws protecting wildlife"[206] found in the spotted owl cases. The courts cannot, however, require good or wise — much less the best or wisest — stewardship of the public's lands, where Congress only sets the lower boundaries of executive discretion.

206. Seattle Audubon Soc'y v. Evans, 771 F. Supp. 1081, 1090 (W.D. Wash.), *aff'd*, 952 F.2d 297 (9th Cir. 1991).

B. *The Role of Litigation*

The second lesson is that despite the institutional limitations of the judiciary, progress has occurred over the last six years regarding the spotted owl and federal land management in the Northwest only following lawsuits. As a direct result of environmental lawsuits, the spotted owl now enjoys the protection of the Endangered Species Act. The Forest Service is finally developing a new spotted owl management plan, and is now addressing the national forests as communities of species, only after being found in violation of both the National Forest Management Act and NEPA. The BLM has been enjoined from offering timber sales in spotted owl habitat in two lawsuits — in one for violating the Endangered Species Act and in the other for violating NEPA.

Ideally, each of these lawsuits should have been unnecessary. Most involved no novel or complicated questions of law; all involved clear, well-established obligations under existing laws that the FWS, BLM, and Forest Service understood but chose to ignore. Both the public and the environment would have been better served if the government had simply complied with the law from the outset.

C. *The Need For Holistic Ecological And Legal Approaches To Public Land Management*

The third lesson is that agencies should integrate all applicable legal standards and plan for the survival of all affected species at the outset. The spotted owl cases have involved the conduct of four federal agencies — the Fish & Wildlife Service, the BLM, the Forest Service, and the Endangered Species Committee — under several different statutes — the Endangered Species Act, NEPA, NFMA, and others. Frequently, legal problems have arisen because the agencies tried to proceed under only one legal mandate, while ignoring other applicable duties. Thus, for example, the BLM strove to comply with the timber dominant purposes of the Oregon & California Lands Act, to the exclusion of NEPA.[207] Similarly, the Forest Service asserted that once a species was listed under the ESA, the agency's own viability regulation under NFMA no longer applied.[208]

The agencies' legal myopia, moreover, has accompanied a similarly narrow management approach that has focussed on crisis management for individual species, rather than integrated management of whole biological communities. The shortcomings of this approach are evident both in the

207. *See* Portland Audubon Soc'y v. Lujan, 795 F. Supp. 1489 (D. Or. 1992) (rejecting BLM argument that O&C Act overrode NEPA's obligation to update environmental documentation), *modified in part*, No. 87-1160-FR, 1992 WL 176353 (D. Or. July 16, 1992).

208. *See* Seattle Audubon Soc'y v. Evans, 952 F.2d 297 (9th Cir. 1991) (rejecting Forest Service position).

most recent spotted owl rulings, which for the first time order the Forest Service not to delink its indicator species (the spotted owl) from other old-growth dependent species,[209] as well as in other litigation focussing on other species, like the marbled murrelet.[210]

A more sensible approach to both the legal and ecological issues would have been for the agencies to plan systemically, and to address all applicable legal standards — and all affected species on the public's lands — at the outset. Such an approach would have avoided litigation, and would have served the agencies, the public, and the environment far better.

D. *An End To Court-Stripping Legislation*

The final lesson is that placing federal agencies above the law will not solve ecological and legal crises. The early years of the spotted owl controversy focused largely on congressional efforts to close the courthouse doors to citizens seeking to enforce federal enviornmental laws against federal agencies. The Supreme Court ultimately upheld the constitutionality of this practice. Indeed, the Bush Administration made attacks on the existing environmental laws a cornerstone of its federal land management policy.

Fortunately, Congress has evidently kicked the habit of short-term, temporary fixes to environmental issues. Congress, therefore, is unlikely to try to resolve long-term or whole-ecosystem problems by exempting federal agencies from judicial scrutiny. Thus, federal agencies should not look to Congress for relief from their own misconduct.

CONCLUSION

The significance of environmental litigation can be judged by its effects on both governmental conduct and public debate. By these standards, litigation over the spotted owl has played a crucial role. Litigation catalyzed public agencies to abandon outdated management strategies now viewed as a "prescription for the extinction of spotted owls." Litigation compelled those agencies to stop selling timber from spotted owl habitat until they develop and adopt scientifically responsible management strategies. Litigation brought to public attention a "remarkable series of violations of the environmental laws." For the first time, the biological and economic arguments of the environmental community, the government, and the timber industry have been aired in a public forum on a level playing

209. *See* Seattle Audubon Soc'y v. Moseley, 798 F. Supp. 1473 (W.D. Wash. 1992) (ruling on summary judgment); *id.* at 1494 (ruling on motion for stay).

210. In *Marbled Murrelet v. Lujan*, environmental groups challenged the failure to protect murrelet's viability in existing forest plans. Marbled Murrelet v. Lujan, No. C91-522R (W.D. Wash. Sept. 17, 1992) (memorandum opinion granting plaintiffs' second motion for summary judgment).

field.

In addition, litigation has focused judicial and public attention on Congress' use of short-term court-stripping provisions as substitutes for solutions to important long-term environmental problems. Litigation has catalyzed Congress to finally consider long-range solutions for the Northwest's ancient forests, and helped inspire the upcoming forestry summit sponsored by the new Administration.

The best legacy of the litigation over the spotted owl would be wise management of the public lands. Management that strives to comply with — rather than avoid — the requirements of all applicable federal laws at an ecosystem level would better serve government agencies, the public, and the species that reside on the nation's lands. It would also make future litigation unnecessary — or, if brought, unsuccessful.

Primary Source D

Scientists in Wonderland

Experiences in development of forest policy

Jerry F. Franklin

Scientists have assumed a central role in the development, evaluation, and implementation of public policies regarding natural resources and the environment. This role is largely a consequence of the environmental legislation of the 1960s and 1970s—laws such as the National Environmental Policy Act, the National Forest Management Act, and the Endangered Species Act. These laws have spawned fundamental changes in the philosophies and approaches of agencies managing natural resources on federal lands. Many of the changes have come as a result of extensive litigation.

Because scientific issues are central to much of the direction provided in environmental laws, science and scientists have, not surprisingly, assumed an increasingly important role in attempts to resolve conflicts. Traditionally, agencies have been the primary sources and interpreters of science. For example, the US Forest Service (USFS) provided scientific information relevant to the national forests. However, over the last 20 years, federal agencies have increasingly lost credibility as objective scientific sources. Consequently, judges, legislators, and other decision makers have increasingly sought the direct involvement of scientists as independent sources of scientific information and judgments and, in some cases, as creators of science-based management plans or policy alternatives.

Forest issues in western North America have provided unusual opportunities for direct involvement of scientists

Forest issues in western North America have provided (and are continuing to provide) unusual opportunities for the direct involvement of scientists in policy. One example, on the federal timberlands administered by USFS and the Bureau of Land Management, is the conflict between timber harvest, on the one hand, and provisions for northern spotted owls, old-growth ecosystems, and anadromous fish, on the other. The legal, social, and some aspects of the scientific history of this conflict have been reviewed by Yaffee (1994).

This northwestern-forest issue has been addressed in a series of significant scientific assessments led by scientists (Figure 1). Frustrated with nearly complete gridlock in management of the national forests, Dale Robertson, who was then chief of the National Forest Service, chartered the first of the independent scientific assessments in 1989. Wildlife researcher Jack Ward Thomas was asked to organize an independent scientific committee—called the Interagency Scientific Committee for Recovery of the Northern Spotted Owl—to create a "credible scientific plan" for management of the northern spotted owl. For various reasons, primarily political (impacts on timber harvest were too high), the plan that resulted (Thomas et al. 1990) was never formally adopted. Several other assessments followed: the 1991 Scientific Panel on Late-Successional Forest Ecosystems (labeled the "Gang of Four," because it was composed of four principal scientists), which was chartered by two congressional committees; the Scientific Analysis Team (SAT 1993), a group put together to respond to a series of scientific questions raised by Judge William Dwyer; and the Forest Ecosystem Management Assessment Team (FEMAT 1993) chartered by President Clinton. The last-named effort produced an alternative plan that was recently accepted by the courts as scientifically credible and adopted by President Clinton.

The use of scientists to construct science-based policy alternatives has spread to other parts of western North America. In the Sierra Nevada Range of California, an agency-based science effort has provided interim management direction for the California spotted owl (Verner et al. 1992), and in a program called the Sierra Nevada Ecosystem Project (SNEP), an independent, academic team is currently assessing conditions and developing policy alternatives (SNEP 1994) under both a congressional and USFS charter. The US Congress also chartered an independent scientific review of Indian forest lands and management—the In-

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dian Forest Management Assessment Team (IFMAT 1993). In British Columbia, Premier Michael Harcourt has established an independent group called the Scientific Panel for Sustainable Forest Practices in Clayoquot Sound (1994) to assess the adequacy of current forest practices. And other studies by scientists have been completed or are underway.

These studies are challenging experiences for the natural scientists who participate, because traditionally scientists are not educated in technical aspects of policy development, the practice of politics, and interactions with other professional and social groups. Consequently, these studies have provided the scientists with valuable lessons in how scientific knowledge is effectively used in developing natural resource policy. In this article, I identify some lessons that I consider important based upon my experiences as a participant in several scientific analyses—the Gang of Four, FEMAT, SNEP, IFMAT, and the Clayoquot panel.

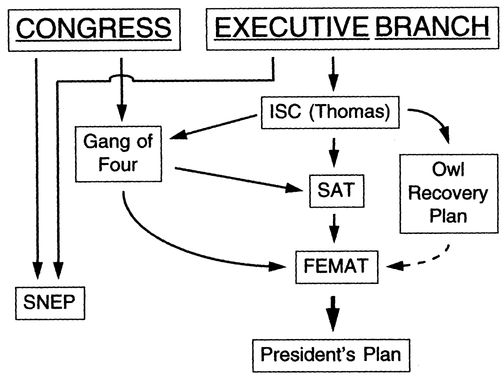

Figure 1. The "genealogy" of several major forest policy analyses conducted for federal timberlands in western North America. These analyses built on concepts developed in preceding efforts as shown by the arrows. ISC = Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl (Thomas et al. 1990); Gang of Four = Scientific Committee on Late Successional Forest Ecosystems (Johnson et al. 1991); SAT = Scientific Analysis Team (1993); Owl Recovery Plan = Northern Spotted Owl Recovery Team (1992); FEMAT = Forest Ecosystem Management Assessment Team (1993); and SNEP = Sierra Nevada Ecosystem Project (1994).

Creating and evaluating multiple alternatives

Creating and evaluating a range of alternatives can be an effective approach in applying scientific information in policy development. Most scientific and technical personnel are trained to solve problems rather than to develop and evaluate alternatives. Sometimes scientists are directed to provide a solution or a plan, as in the case of the Interagency Committee (Thomas et al. 1990). Generally the possibilities are multiple rather than singular. Sometimes scientists are instructed to describe alternatives that may provide for a range of outcomes—such as varying probabilities of achieving some objective—or for alternative ways of achieving similar outcomes.

The contrast between having a single solution and having multiple alternative plans is illustrated by comparing the Interagency Scientific Committee (Thomas et al. 1990) with the Gang of Four (Johnson et al. 1991). As requested, the Interagency Committee developed a plan for protection of the northern spotted owl, much of which was later adopted in the recovery plan (Northern Spotted Owl Recovery Team 1992).

In contrast, the congressional direction to the Gang of Four encouraged consideration of multiple alternatives. Fourteen major alternatives were evaluated. They varied in their emphasis, which ranged from timber production to protection and restoration of late-successional forest conditions. In addition, variations in potential treatment of the unreserved forest lands (lands still available for timber harvest and typically referred to as matrix lands) produced 34 alternatives. Selected variables, such as the amount of land to be held in reserves, were systematically altered across the alternatives to facilitate analysis of the marginal costs-and-benefits obtained from each increment of change. Evaluations of alternatives emphasized the probability of achieving specific ecological objectives for the next 100 years and specific levels of timber harvest (Figure 2).

Like the Gang of Four, FEMAT followed the strategy of developing and evaluating multiple alternatives (Thomas 1994). Reserve area and distribution, riparian zones, width, allowed levels of management, and many other variables were changed among ten alternatives. However, the alternatives were not incremental (i.e., several variables were changed simultaneously), making marginal analyses difficult. Evaluation of social (including economic) and ecological consequences were much more comprehensive in FEMAT than in the Gang of Four analysis.

Development and evaluation of multiple alternatives allows decision makers—and everyone else—to see the range of possibilities and the probable consequences of each possibility. I have often heard the objection to this approach that decision makers, provided with multiple alternatives, are likely to choose the one that provides greatest economic benefits. My experience has been that the truly viable alternatives—alternatives that achieve legal goals and other societal objectives at acceptable levels of probability—tend to be obvious in such an analysis.

For example, a conservative congressman, then Representative Robert Smith of Oregon, viewing the projected outcomes for the Gang of Four alternatives immediately noted that Congress would not legislate anything below alternative 8 (see Figure 2)—because any alternative with ecological ratings that included a low probability of success in achieving the ecological goals was unacceptable. The critical point is that (regardless of his particular interest in the economic goals) the range of viable alternatives (the so-

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called decision space) was immediately apparent to him.

Perhaps most fundamental, in democratic societies decision makers are elected to make choices among alternatives. The policy choice is not the prerogative of scientists. By developing and evaluating alternatives, scientists can clearly and objectively display the costs and benefits, based on the best available information, of different choices. If credible, such analyses can be powerful in holding decision makers accountable for their actions—such as by making it clear that there is no free lunch, that is, no choices without costs (Johnson et al. 1991).

Value of spatially explicit information

Spatially explicit information (e.g., maps and geographic-information-system data layers) is critical in development of meaningful policy alternatives. Many (if not most) of the first generation of plans for the national forests produced in the late 1970s and 1980s foundered in subsequent judicial challenges, in part, because outputs were based upon Forest Plan Model Simulator runs that were not spatially explicit. Plans projected specific permissable levels of timber harvest based upon acres available and tree growth rates. But when resource managers began to identify areas for cutting, numerous spatial constraints made it impossible to find enough acres available for harvest to meet the projected cut levels. Examples of spatial constraints are the cumulative effects of harvest on hydrologic regimes and limits (so-called greenup requirements) on cutting of areas adjacent to old clear-cuts until the forest on the previously cut area had achieved a specified miminal height and cover. In effect, it is not enough to know that there are a certain number of acres of land in a given condition or allocated to a particular use; it is also necessary to know where those acres are, the size and shape of patches, and the condition and allocation of the adjacent acres.

In the Pacific Northwest, spatially explicit data have been critical in both developing and evaluating credible alternatives and in presenting the results to scientific peers, decision makers, and the public. Geographic information systems have been valuable in manipulating and presenting these databases and are increasingly likely to be a vehicle for communicating accurate representations of alternatives (Franklin 1994).

Use of resource specialists

Resource specialists can be one of the most valuable resources for scientific policy analyses. Today most agencies engaged in managing natural resources (and many involved in enforcing environmental laws) have resource specialists representing a broad range of disciplines—including physical sciences (e.g., geologists and hydrologists) and biological sciences (e.g., silviculturists and zoologists). Many of these staff specialists have spent years, even lifetimes, working in specific geographic regions. Their on-the-ground knowledge of, for example, forests, wildlife, and fisheries is typically unparalleled. Accessing this knowledge to assess conditions and evaluate alternative management strategies can greatly strengthen a scientific policy assessment.

The resource specialists are often overlooked by scientific teams chartered to conduct policy analyses. Traditional resources—such as aerial photographs and other forms of remotely sensed data, maps, academic specialists, and sample-based datasets—are often more obvious and easier to access. While acknowledging resource specialists' familiarity with the resource, scientists sometimes question the technical competence and, more often, the objectivity of agency-based personnel.

It is critical that a scientific team identify the key resource specialists, provide adequate direction and quality control, and empower the specialists to share their knowledge. Key elements of this empowerment process include: clear direction as to overall objectives of the exercise and the information and interpretation that are sought and provision of a safe working environment where specialists can provide accurate information without fear of retribution by a supervisor or an agency.

More than 100 agency resource specialists were involved in the Gang of Four and FEMAT analyses, and some of them plus others are currently participating in the SNEP analysis for the Sierra Nevada. They have participated primarily in interpreting various imagery and databases to produce maps and new databases on forest and wildlife habitat conditions, such as the quality of late-successional forest habitat. Their on-the-ground knowledge has proven critical to the success and credibility of these exercises. As part of the empowerment process, the activities of these specialists were concentrated at a location isolated from their normal work environment and excluded line managers and supervisory personnel. In my experience, these specialists consistently provided accurate and objective information that was otherwise unavailable. It is tragic that resource management agencies have failed to harness fully the knowledge and creativity of their resource specialists and to display it to decision makers and the public.

The concept of flagship species is dangerous

Much has been (and much more is likely to be) written about the relative merits of conservation strategies based upon individual species versus those based upon ecosystems. It has been argued that, even though species-based approaches have limitations, high-profile species with major habitat requirements (e.g., northern spotted owls or grizzly bears) can function as so-called flagships or surrogates for major ecosystems (see, for example, Wilcove 1993); for example, in providing for the habitat requirements for northern spotted owls one is likely to simultaneously provide for old-growth forest ecosystems and other related organisms.

Societal experiences in policy analysis in the Pacific Northwest suggests that such assumptions are dangerous. In the genealogy of the northwestern policy analyses (Figure 1), activities began with a species-based effort (Thomas et al. 1990) and progressed to exercises

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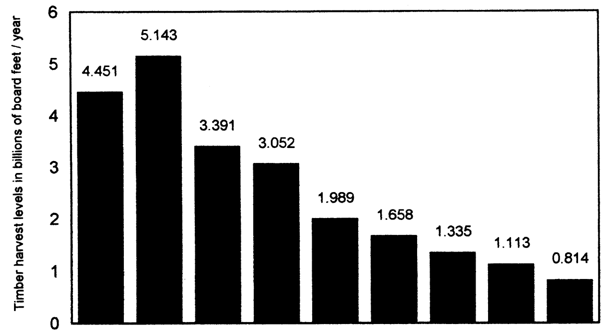
(FEMAT 1993, Johnson et al. 1991) that included alternatives that took more ecosystem-based approaches (i.e., concerns with old-growth forest and aquatic ecosystems rather than simply with northern spotted owls or marbled murrelets). It was not possible to move to entirely ecosystem-based approaches because many of the laws (the National Forest Management Act and the Endangered Species Act) relate to specific species. Nevertheless, some useful comparisons are possible.

The Interagency Committee (Thomas et al. 1990) developed, as requested, a plan specific to the northern spotted owl. The plan recommended a heroic shift in strategy from the protection of isolated individual owl territories (known as owl circles) to protection of large reserves for multiple owl pairs spaced at regular geographic intervals. It also broke important ground in recommending that federal forest areas between reserves (the matrix) be managed so as to improve the potential for successful dispersal of owls. Developing a plan that also protected high-quality, old-growth forests was not a part of the committee's charter except as necessary to provide for viable populations of northern spotted owls. In fact, the committee designed its reserve system of habitat conservation areas so as to achieve the plan's objective (viable owl populations) while minimizing impacts on timber harvest levels.

Subsequent analyses (FEMAT 1993, Johnson et al. 1991) showed that, even though of extraordinary magnitude, the system of habitat conservation areas developed for the northern spotted owl did not do a good job of protecting old-growth forest ecosystems or habitat for the anadromous fisheries (Figure 2). These results were not surprising—habitat conservation areas were not designed to achieve these objectives. Specific examples of how bad can be the fit between owl-based and ecosystem-based plans are illustrative: In the Umpqua National Forest, Oregon, the areas proposed as owl habitat conservation areas (Northern Spotted Owl Recovery Team 1992, Thomas et al. 1990) incorporated less than 50% of the most significant late-successional/old-growth forest (also called LS/OG1) identified by the Gang of Four (Johnson et al. 1991). A similar lack-of-fit existed between habitat conservation areas and high-quality, late-successional forest areas in several other Cascade Range national forests. As another example, in FEMAT, resource specialists focusing on marbled murrelets preferred to use high-quality, old-growth forest areas (identified in Johnson et al. 1991) as the basis for murrelet reserves rather than the owl-oriented habitat conservation areas.

SAT (1993) and FEMAT (1993) demonstrated that it is impossible to use a species-by-species approach in developing a comprehensive plan. Regional plans of this type potentially involve thousands of species, many unknown; even among the known species, there are hundreds with conflicting and contrasting habitat requirements. These exercises provide clear evidence of the absolute necessity of devising habitat-based, multispecies approaches.



Selected "Gang-of-Four" alternatives	1980-89 Level	1	2	3	4A	6A	8A	12A	12C
Functional Old-Growth Network	n/a	VL	VL	L	ML	M	M	MH	VH
Viab Spotted Owl Population	n/a	VL	L	ML	H	H	H	VH	VH
Marbled Murr Nesting Hab	n/a	VL	L	L	ML	M	M	MH	H
Other Old-Growth Species	n/a	VL	VL	L	ML	M	MH	H	VH
Sensitive Fish Stocks	n/a	VL	VL/L	VL/L	L	ML	MH	MH	VH

Probability of retention for a century or longer

Figure 2. Timber harvest and probability of achieving various objectives under historic rates of timber harvest (1980–1989) and under eight selected alternatives from the "Gang of Four" (Johnson et al. 1991). Ratings under probability of retention are VL = very low, L= low, ML = medium low, M = medium, H = high, and VH = very high (estimated 50% probability of achieving goal).

Limitations of scientists

The exercises in western North America have highlighted several important limitations on scientists as creators and evaluators of policy. Scientists tend to think in terms of a single solution to a problem, scientists do not like to base proposals on incomplete information, and faced with incomplete information, scientists are usually conservative. In addition, scientists lack training or experience in policy analysis, have difficulties in communication, and often suffer from hubris.

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As Thomas has said on numerous occasions, "science-based policy analyses are not science."[1] They involve the synthesis and application of (one hopes) the best available scientifically based information. However, decisions always have to be made with incomplete and, sometimes, grossly inadequate knowledge. Hence, development and evaluation of policy alternatives requires scientists to extrapolate far beyond existing databases and theoretical constructs. Scientists who are uncomfortable with projecting beyond the known had best not apply. But if scientists fail to make the judgments and do the extrapolations, someone else, perhaps someone much less qualified, is prepared to do so. Further, scientists need to understand that policy analysis, however logical or systematic, is not a scientific process, so they must not expect that it will follow traditional scientific methods or be judged primarily by scientific peers. In policy analyses, what is called truth is not singular. It probably is not in ecology either, null hypotheses not withstanding.

Expert systems—such as creation of scientific panels—provide one valuable way for developing a scientific consensus based on current (and typically inadequate) information. Such systems were used by Gang of Four and FEMAT to provide probabilistic judgments about outcomes under various policy alternatives.

Natural scientists often lack training in policy analysis and in relevant communication skills. Few have had any academic exposure to the objectives and mechanics of policy formulation and analysis. The concepts of modular alternatives and marginal analyses are concepts that I learned as I served on policy committees.

Natural scientists often lack communication skills relevant to policy development. The observation that many scientists fail to communicate—or to listen well—is not new. The communication problem can be major in interdisciplinary exercises. Policy analysis teams typically include economists, other social scientists, and various nonscientific participants. The Clayoquot Sound panel incorporates four Native American leaders, one as cochair of the panel. Communicating in plain language, free of disciplinary jargon, is a critical skill. The ability to listen is even more critical, because without it, one cannot hope to understand and incorporate different points of view.

Scientists are often not well adapted to the time and space limits of policy analyses. Analysts must scale their activities to the resources and time available. The large spatial scales of a problem often limit the amount of detail that can be incorporated in an analysis; scientists trained in a reductionist mode may find it difficult to leave behind this detail.

Hubris is, perhaps, the most serious limitation of the scientist involved in policy analysis. Policy exercises clarify, very quickly, the serious limitations of our knowledge and understanding. In developing strategies for the forests on the Pacific Coast, for example, the foci and theories of traditional conservation biology were found to have limited application. Many biologists have biases against ecosystems that incorporate human activities and favor conservation strategies focusing on strict reserves and equating connectivity with corridors. Traditional conservation biology has been strongly oriented to terrestrial habitats and vertebrates.

Why participate in policy analysis?

Despite many difficulties, there are both professional and personal reasons for participating in science-based policy analyses. Such activities can be valuable professionally. They provide real-world experiences in the application of science, experience that brings a freshness and relevance to teaching programs. In terms of research, policy analyses are identifying many of the critical topics or hypotheses in ecological science. Examples include increased interest taken by ecologists in landscape connectivity (not just corridors) and in the role of unreserved lands in maintaining biological diversity.

The personal satisfactions that can come from participating in such activities should be obvious. Prominent is the satisfaction of working to ensure that decisions are based on the best science available and that decision makers (and society) understand clearly the difficult tradeoffs. All those involved in policy decisions need to be reminded regularly that there is no free lunch.

[1]J.W. Thomas, 1991, personal communication. US Forest Service, La Grande, OR.

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This brief historical newspaper article demonstrates the common rhetoric that the Timber Wars injunctions against logging were raising lumber prices and therefore the price of a home.

Bari, Judi. "Our Community Is Under Siege." *Earth Island Journal* 6, no. 3 (1991): 49–50. http://www.jstor.org/stable/43883062.

This article was written by Judi Bari after a bomb exploded in her car and the FBI named her as the only suspect. She argues that the FBI has framed her and is working to undermine the EarthFirst! movement. Her statement is particularly interested to see how environmentalists (i.e., not only loggers) became increasingly radicalized as the Timber Wars progressed.

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In this article, Judi Bari applies a degree of class analysis to the Timber War struggles. She criticizes environmentalists who blindly group loggers and logging companies, and she claims that loggers' true interests lie with the environmentalists. Ultimately, she calls for the loggers to unionize.

Braun, Ashley. "Desperate Measures." *Audubon*, Fall 2022, 20–29.

This recent article for *Audubon* magazine reports on the attempts to support the spotted owl population through killing barred owls. Braun interviews various environmentalists and loggers who have begun the practice, and she evaluates how effective these efforts have been.

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This collection of essays, articles, and newspaper columns written by Timber Wars activist Jim Britell provides a unique view into the beliefs and approaches of environmentalists and provides greater detail on the evolution of the controversy.

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This historical newspaper article details the outrage surrounding Clinton's signing of the Salvage Logging Rider.

Dougherty, Timothy R. "Fowl Play. Some Builders Say Lumber Producers Used Owl as Excuse for Price-Gouging." *Newsday*, August 3, 1991, Nassau and Suffolk edition. https://www.proquest.com/newspapers/fowl-play-some-builders-say-lumber-producers-used/docview/278432911/se-2.

This historical newspaper reports on the traditional claim that the spotted owl injunctions substantially raised lumber prices, but Dougherty questions whether this narrative is entirely true and interviews people from the building industry who believe that timber companies have greatly exaggerated the effects in order to raise prices.

Forsman, Eric. "A Preliminary Investigation of the Spotted Owl in Oregon." M.S. thesis, Oregon State University, 1976. https://ir.library.oregonstate.edu/concern/graduate_thesis_or_dissertations/pv63g313j.

This thesis was the first scientific article to seriously study the spotted owl. Forsman concludes that the owl requires substantial amounts of old growth throughout its terrain and thus links it to the forest as an indicator species.

Franklin, Jerry F. "Scientists in Wonderland." *BioScience* 45, supplement (1995): 74–78. https://www.jstor.org/stable/1312448.

In this journal article, one of the principle architects of the NWFP outlines the progression of land management plans created during the Timber Wars. Franklin also reflects at the end about the lessons he learned from creating public policy as a scientist.

Gabriel, Trip. "If a Tree falls in the Forest: They Hear It." *New York Times*, November 4, 1990. https://www.proquest.com/historical-newspapers/if-tree-falls-forest/docview/108475539/se-2?accountid=41494.

This historical newspaper article reports on EarthFirst!, containing eyewitness accounts of one of their demonstrations and incorporating content from interviews with the movement's leading figures. Ultimately, Gabriel evaluates how much of an impact EarthFirst! has had, and whether this impact has been positive or negative.

Jefferson, Jon. "Timmmberr! How Two Lawyers and a Spotted Owl Took a Cut out of the Logging Industry." *ABA Journal* 79, no. 10 (1993): 80–85. http://www.jstor.org/stable/27835029.

This journalistic peace written right after Clinton's timber summit describes the victory of environmental lawyers such as Vic Sher, incorporating interview material from many major figures. It is useful not only as a source of information on the activities and relative successes of lawyers but also as a piece reflective of the public opinion surrounding the cases.

Kelly, Erin C., and Andrea Tuttle. "Finding Solutions through Politics: One View from Inside the Timber Wars." *Humboldt Journal of Social Relations* 40 (2018): 23–31. http://www.jstor.org/stable/90023261.

Although government bureaucrats are generally not significantly considered in discussions of the Timber Wars, this transcribed and edited interview with Andrea Tuttle illustrates the experience of such regulators. It is particularly relevant to notice both the tension inherent in a bureaucrat's job to mediate between conflicting sides and Tuttle's positive conclusion that society has addressed all of the major issues of the Timber Wars.

Lande, R. "Demographic Models of the Northern Spotted Owl (*Strix occidentalis caurina*)." *Oecologia* 75, no. 4 (1988): 601–607. https://www.jstor.org/stable/4218620.

This scientific journal article was the article that pioneered a new application of population models to environmental conservation, concluding that the remaining spotted owl population required far more old growth than the USFS allotted at the time.

"Loggers Don't Give Hoot for Owl." *Chicago Tribune*, April 27, 1989. https://www.proquest.com/historical-newspapers/loggers-dont-give-hoot-owl/docview/1015400744/se-2.

This historical newspaper article reports on the great hostility felt towards environmentalists and even the spotted owl by many members of the logging community, describing the serving of parody spotted owl dishes.

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This historical newspaper article reports on a resumption of Timber War tensions surrounding Judge Dwyer's decision holding that USFS violated the NWFP's "survey and manage" policies.

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This podcast episode (one of the *Timber Wars* series) traces the resistance to the NWFP after it was designed. The *Timber Wars* series podcasts all do an excellent job of presenting the facts in a compelling, narrative manner, and they also incorporate lots of primary source material through including interviews with many important Timber Wars figures.

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This episode of the *Timber Wars* podcast examines the beginnings of the environmentalist movement and some of their early actions.

------. "The Owl." Podcast. *Timber Wars*, September 22, 2020. https://www.opb.org/article/2020/09/22/timber-wars-episode-3-the-owl/.

This episode of the *Timber Wars* podcast examines the sequence of scientific studies linking the spotted owl to the old growth forests and how environmental lawyers used that information to build their cases.

Sher, Victor M. "Travels with Strix: The Spotted Owl's Journey through the Federal Courts." *Public Land & Resources Law Review* 14 (1993): 41–79. https://scholarworks.umt.edu/plrlr/vol14/iss1/4/.

In this law review article, Vic Sher summarizes the sequence of Timber Wars cases in which he played a significant part as a leading lawyer at the SCLDF and concludes with a reflection on the lessons he learned from the experience.

strixhunter. *Northern spotted owl (Strix occidentalis caurina): Adult female*. Photograph. Flickr. June 5, 2014. https://flic.kr/p/nS67xc.

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Tafluffma. “Warnerizing Your Uprising.” *Earth First!*, September 30, 1997, 3. https://www.proquest.com/magazines/warnerizing-your-uprising/docview/221815342/se-2?accountid=41494.

This essay by an EarthFirst! activist traces the sequence of protests throughout the Timber Wars with the goal of more carefully examining the success of the group’s tactics. Tafluffma (a pen name) pays special attention to the Warner Creek protest of the Salvage Logging Rider, ultimately concluding that it was relatively successful.

Tahoma. “Cascadia Rising: The Warner Creek Victory.” *Earth First!*, November 1, 2000, 14. https://www.proquest.com/magazines/cascadia-rising-warner-creek-victory/docview/221816409/se-2?accountid=41494.

This essay, also by an EarthFirst! activist, examines the Warner Creek protest of the Salvage Logging Rider very specifically, describing the variety of tactics used and arguing for the great success of the protest.

U.S. Department of Agriculture. Forest Service. Pacific Northwest Research Station. *Ecological Characteristics of Old-Growth Douglas-Fir Forests*, by Jerry F. Franklin, Kermit Cromack, Jr., William Denison, Arthur McKee, Chris Maser, James Sedell, Fred Swanson, and Glen Juday. General Technical Report PNW-GTR-118. Portland, Oregon, 1981. https://www.fs.usda.gov/treesearch/pubs/5546. (Primary Source)

This seminal scientific study was one of the first to reveal the great ecological importance of old growth forests, providing in part the justification for the Timber Wars.

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This excellent law review article examines the NWFP in great detail, summarizing the legal action that led to its creation, describing its provisions, evaluating its success, and examining how it has changed up to the modern day.

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This article addresses the Salvage Logging Rider specifically, summarizing the events that led to its passage, describing the provision itself, and describing the legal action taken against it.

Hungerford, Andrea L. “Changing the Management of Public Land Forests: The Role of the Spotted Owl Injunctions.” *Environmental Law* 24, no. 3 (1994): 1395–1434. https://www.jstor.org/stable/43266643.

This exceptional law review article provides one of the most comprehensive yet concise presentations of the legal battles of the Timber Wars, tracing each of the three main lines of cases through the district and circuit courts and summarizing the specific reasons for each decision.

Loomis, Erik, and Ryan Edgington. “Lives Under the Canopy: Spotted Owls and Loggers in Western Forests.” *Natural Resources Journal* 52, no. 1 (2012): 99–134. https://www.jstor.org/stable/24889599.

This article examines the tensions between environmentalists and loggers as fueled by the Timber Wars, describing how hostilities changed the goal of environmental reform from helping the working class to preserving nature for its own sake. Loomis and Edgington also explain how these hostilities have led to much of the polarization over environmental issues present today.

Pitta, Erin. “The ESA and the Spotted Owl.” *Environmental Law* 21, no. 3 (1991): 1175–89. http://www.jstor.org/stable/43265984.

This is another law review article about the spotted owl litigation, more specifically focused on the early cases about the owl’s standing under ESA. Pitta also more comprehensively examined the various legal implications and precedents of these early cases.

Pyne, Stephen J. “Fire and Axe: The First and Second Timber Wars.” In *To the Last Smoke: An Anthology*, 347–58. University of Arizona Press, 2020. https://doi.org/10.2307/j.ctv10h9dr0.40.

This article presents the theory of two timber wars: the Timber War proper and a previous movement to ensure a stable supply of trees specifically for the logging companies. Pyne pays special attention to conservationist’s/preservationist’s stances towards wildfire, which is arguably one of the NWFP’s biggest oversights.

Raphael, Martin G. “Conservation of the Marbled Murrelet under the Northwest Forest Plan.” Conservation Biology 20, no. 2 (2006): 297–305. http://www.jstor.org/stable/3591338.

Although the spotted owl has traditionally received the majority of the attention as an indicator species for the old growth forests, this article briefly examines the marbled murrelet's role and evaluates to what extent the NWFP has helped protect its populations.

Serenari, Christopher, Nils Peterson, and Brett Clark. "Theorizing Logger Religion within the Pacific Northwest Timber Conflict." *Worldviews* 19, no. 3 (2015): 265–81. http://www.jstor.org/stable/43809538.

This paper advances the interesting argument that, in a certain sense, logging culture had developed into a religion. Serenari's theory is helpful for providing potential explanations for loggers' resistance to environmentalists and their interactions with timber corporations more generally.

Spies, Thomas A., Jonathan W. Long, Susan Charnley, Paul F. Hessburg, Bruce G. Marcot, Gordon H. Reeves, Damon B. Lesmeister, Matthew J. Reilly, Lee K. Cerveny, Peter A. Stine, and Martin G. Raphael. "Twenty-Five Years of the Northwest Forest Plan: What Have We Learned?" *Frontiers in Ecology and the Environment* 17, no. 9 (2019): 511–520. https://www.jstor.org/stable/10.2307/26835246.

This article examines the NWFP 25 years after its passage, analyzing the extent to which it has been helpful in reducing logging, saving spotted owls and other species, and protecting workers, etc.

Swedlow, Brendon. "Scientists, Judges, and Spotted Owls: Policymakers in the Pacific Northwest." *Duke Environmental Law & Policy Forum* 13 (2003): 187–278. https://scholarship.law.duke.edu/delpf/vol13/iss2/2.

This long article presents an overview of most major aspects of the Timber Wars. It mainly focusses on the legal battles fought throughout while placing a special emphasis on the importance of scientists and scientific evidence.

Thomas, Jack Ward, Jerry F. Franklin, John Gordon, and K. Norman Johnson. "The Northwest Forest Plan: Origins, Components, Implementation Experience, and Suggestions for Change." *Conservation Biology* 20, no. 2 (2006): 277–287. http://www.jstor.com/stable/3591336.

This article written by many of the creators of the NWFP describes the plan's process of creation, explains its original intentions, and analyzes how effective it has been in fulfilling those.

Trujillo, Horacio R. "The Radical Environmentalist Movement." In *Aptitude for Destruction*. Vol. 2, *Case Studies of Organizational Learning in Five Terrorist Groups*, by Brian A. Jackson, John C. Baker, Kim Cragin, John Parachini, Horacio R. Trujillo, and Peter Chalk, 141–175. Santa Monica, California: RAND Corporation, 2005. https://www.jstor.org/stable/10.7249/mg332nij.13.

This book chapter deals in part with the radical environmentalists of the Timber Wars, portraying them as terrorists and analyzing the rational for many of their actions. Specifically, Trujillo explains that for these groups, even negative press coverage can be incredibly helpful towards promoting their goals.

Widick, Richard. *Trouble in the Forest: California's Redwood Timber Wars*. Minneapolis, University of Minnesota Press, 2009.

This source is one of the relatively few recent, book-length secondary sources available about the Timber Wars. It provides a good synthesis of the content with a special focus on the social causes and effects, but it is limited to the Californian Timber Wars, focusing less on the rest of the Pacific Northwest.

Wilhere, George F., and Timothy Quinn. "How Wide Is Wide Enough?: Science, Values, and Law In Riparian Habitat Conservation." *Natural Resources Journal* 58, no. 2 (2018): 279–318. http://www.jstor.org/stable/26509980.

Through examining several case studies of salmonid conservation (one of which is the NWFP), this article examines the impact on environmental policy of societal values as expressed through the laws.