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Abstract: *Franklin and Johnson (2012) proposed a restoration framework for Pacific Northwest forests based on principles of "ecological forestry" that are being incorporated into federal management plans without rigorous testing of assumptions and sufficient input from ecologists. We review their proposals and identify seven major areas where there may be conflict with ecological restoration, biodiversity conservation, and management of fish and wildlife resources. The most significant shortcomings of their approach is that it appears to be motivated largely by economic outputs and political pressures to increase logging on federal lands, uses inappropriate baselines for restoration, will degrade habitat for late-seral species like the northern spotted owl (Strix occidentalis caurina) and other wildlife, will increase aquatic impacts from extensive thinning and road networks, and may create novel ecosystems that tip ecosystem dynamics toward undesirable consequences for biological diversity. Ecological forestry proposals will likely increase tensions over management of federal lands unless they are substantially improved to address shortcomings. Thus, we propose 14 recommendations for strengthening the ecological basis of future proposals for managing federal forests.*

Key Words: ecological restoration, ecological forestry shortcomings, complex early seral forests, late-successional species, Pacific Northwest forests.

Introduction

Franklin and Johnson (2012) outlined elements of what they term an "ecological forestry" strategy for federal forests in the Pacific Northwest. They posit their strategy will produce ecological and economic benefits from federal forests in Oregon and Washington and that economic returns are necessary for their widespread implementation. Thus, the strategy relies heavily on commercial thinning and an unknown amount of regeneration harvests to create economic returns. Many of their recommendations were recently incorporated into the final recovery plan and critical habitat ruling for the northern spotted owl (USDI Fish & Wildlife Service 2012), over repeated objections raised by The Wildlife Society, American Ornithologists' Union, and Society for Conservation Biology concerning untested and risky active management proposals in owl habitat (www.fws.gov/oregonfwo/Species/Data/NorthernSpottedOwl/CriticalHabitat/default.asp; accessed July 12, 2013) .

Franklin and Johnson's framework is based on managing forests under the premise that they will be "restored," while producing timber from sustained yield, yet their recommendations do not adequately recognize fish and wildlife habitat needs, and they rest on inappropriate ecological baselines for judging efficacy of restoration activities. They do, however, acknowledge that their core strategies may face social opposition, insufficient funding for implementation, restrictions due to impacts to spotted owls, and policy conflicts with the sustained yield provisions of the National Forest Management Act.

Here, we identify shortcomings of ecological forestry and how it is being implemented by managers based on our knowledge of the region's ecology, habitat needs of the northern spotted owl and other wildlife, and pertinent published literature related to conservation biology, restoration ecology, and management of wildlife and aquatic resources. While we believe some aspects of ecological forestry may improve on current management, the framework places economic and political interests above ecological concerns in ways likely to generate new controversies and unintended harmful ecological consequences for natural resources.

Importance of Pacific Northwest Forests

Pacific Northwest forests include some of the most important temperate forests on earth. They contain remaining concentrations of older forests that are currently well below historical levels due to logging (Strittholt et al. 2006). Federal forests in this region are known for exceptional biodiversity (DellaSala et al. 2011), carbon storage (Smithwick et al. 2002), late-successional habitat for >1,000 associated species (FEMAT 1993), including spotted owls, marbled murrelets (*Brachyramphus marmoratus*), and relatively intact watersheds for numerous stocks of salmon (*Oncorhynchus* spp.). Due to heated debate over what should be valued most in these "multiple-use" public forests, management has been controversial and mistrust among stakeholders pervasive.

The Northwest Forest Plan (NWFP) is the foundation for management of federal land across nearly 25 million acres (FEMAT 1993) and is considered a global model of ecosystem management and biodiversity conservation (DellaSala and Williams 2006). The NWFP eased controversy over logging of older forests on federal lands to some degree. However, the decline in timber receipts to local counties has resulted in considerable pressure to increase logging from county commissioners, Oregon Governor John Kitzhaber, former Interior Secretary Ken Salazar, and most of the Oregon congressional delegation. This political pressure is most apparent for the approximate 2.1 million acres of O&C (Oregon and California Revested Lands) lands managed by the Bureau of Land Management (BLM) in western Oregon, which has a contentious history (Blumm and Wigington 2013). In response to recent pressures, former Interior Secretary Salazar initiated a series of "pilot projects" to implement ecological forestry in 2009, which could become the foundation for resource management plans across all 2.5 million acres of BLM lands in western Oregon and legislative proposals to address the O&C counties' fiscal issues through increased timber harvests (Wyden 2012).

Positive Attributes of Ecological Forestry

Franklin and Johnson's (2012) framework recognizes the conservation importance of late-successional forests on federal lands under the NWFP, which was reaffirmed in the recovery plan and critical habitat rule for the spotted owl (e.g., USDI Fish and Wildlife Service 2012). The importance of older, fire-resistant tree species in dry forests and the need to protect older trees throughout the landscape is also recognized by them. They reaffirm the NWFP's emphasis on thinning dense, younger (<80 yrs) plantations to accelerate the acquisition of late-successional characteristics and increase the amount of forests under long rotations. Early seral forests are acknowledged by them as an important ecological stage and a distinction is made between forests created by industrial-scale logging that are deficient in biological legacies and biodiversity versus those generated by natural disturbances that are structurally complex and rich in biodiversity (Swanson et al. 2011, DellaSala et al. in press). Franklin and Johnson also recommend a credible adaptive management strategy whereby integrated monitoring and research activities, regional analysis and planning, and systematic assessments of ecological and social outcomes by independent parties are key elements. We generally agree with these aspects of their framework but acknowledge that the details of some of this management are yet to be described.

Ecological Shortcomings of Ecological Forestry

We identify seven major areas where the framework of ecological forestry or its implementation by BLM may create adverse consequences to natural resources and conflicts over forest management.

1. Oversimplified Forest Classifications

Franklin and Johnson (2012) stratify the landscape into moist (MF) and dry (DF) forests. In MF, older stands are reserved and previously logged plantations are logged again using variable retention regeneration harvests (VRHs). In DF, silvicultural treatments retain and release older trees (>150 years old), reduce stand densities, shift composition toward fire- and drought-tolerant species, and incorporate multi-scaled heterogeneity. Unfortunately, the moist-dry classification and associated fire regimes are much too coarse and will create on-the-ground uncertainties where forest communities are highly complex (i.e., fine-grained heterogeneity). For example, inclusion of mixed-conifer forests in the DF type within the Klamath Province of southern Oregon and northern California will subject these forests to inappropriate commercial thinning based on false notions that these forests were historically more open canopies (see below). Plant communities and fire regimes in this region vary widely across moisture gradients, soil types, microclimates, slope exposure, elevation, and bedrock geology with different forest patches grading into one another over short distances (i.e., high beta diversity, Odion et al. 2004). Mixed-severity fires historically created landscape mosaics in this province that included a portion of high severity burn patches (DellaSala 2006, Donato et al. 2009, Halofsky et al. 2011) as well as those in the DF of the eastern Cascades (Hessburg et al. 2007, Baker 2012). These forests do not lend themselves to simplistic binary classifications. We disagree with the generalization of Franklin and Johnson (2012) that climate change is increasingly likely to shift plant associations toward the dry end of the moisture spectrum where plant associations straddle gradients as this assumption is not well-supported and discounts considerable regional climatic variation. For example, Mote (2003) projected increased precipitation in some regions, including summer precipitation, and uncertainties in climate change modeling.

2. Lack of Clarity on Where to Draw the Line on Old Tree and Old Forest Retentions

Franklin and Johnson recognize the importance of both mature (>80-159 yrs.) and old-growth (160+ yrs.) MF but state that the age at which forests are "deemed older is a social decision influenced but not defined by scientific input." The goal of the NWFP is to restore a functional, interconnected late-successional (both mature and old growth) forest ecosystem as well as produce timber. This means building on the NWFP through additional protections for old forests as recommended in critical habitat designations for the spotted owl and marbled murrelet. It also requires clear tree protection standards for older forests with greater recognition of mature forests (>80 years) given their rarity and ecological importance (FEMAT 1993, Strittholt et al. 2006). Instead, Johnson and Franklin (2009) analyzed various tradeoffs of setting tree protection thresholds at 80 to 160 years in MFs and >150 years in DFs, creating uncertainties in what to protect that has resulted in implementation controversies and poor policy choices.

Such lack of clear tree protection standards has generated considerable mistrust among stakeholders who monitor the management practices of BLM pilots in southwest Oregon (Reilly 2013, Wheeler 2013; Photo panels a-d). For instance, of seven recent timber sales monitored on BLM pilot sites (MF) by conservation groups, there were portions of mature forests and owl critical habitat included in logging proposals and one logging site was adjacent to a 450-year old forest occupied by nesting murrelets that will likely create edge effects (Table 1). The net result of these sales was incidental "take" of 4 spotted owls triggering project-level appeals. These are examples of how immediate economic and political pressures have trumped older forest protections because mature forest protections were not clearly defined by the guidelines of ecological forestry. Without clear and ecologically appropriate age class restrictions, unintended ecological consequences will occur in project implementation.

Another example is the O&C legislative principles proposed by Oregon Senator Ron Wyden (2012), which cite Franklin and Johnson, and prescribe tree protection cutoffs at 120 years, thereby missing an important part of the mature forest cohort (80-120 years). The ecological consequences of this cutoff are not evaluated and the guideline appears to be economically and politically motivated, not ecological. For instance, mature forests (80-120 years) —which are well below historical levels— play a critical role as foraging and roosting habitat for spotted owls (Thomas et al. 1990). Without adequate protection of these forests, a successional debt will accrue on federal lands overtime that will reduce ecosystem resilience and habitat for hundreds of associated species.

The latest data from the BLM Forest Cover Operations Inventory for all western Oregon BLM lands (including Public Domain, Acquired, Coos Bay Wagon Road, and O&C lands) is a good example of how successional debt can accrue from not protecting older forests in such policy formulation. For instance, these data indicate that the highest proportion (43%) of the BLM lands are <80 years old, whereas mature forests (80-120 years) account for only 15%, forests 120-150 years account for 11%, and old growth (>150 years) accounts for 24% of BLM lands (Figure 1a). Legislating ecological forestry provisions as proposed (Wyden 2012) would fail to protect the severely under represented mature forest (80-120 years) cohort. Thus, many of the 395,000 acres in this age bracket (moist and dry) would potentially be vulnerable to increased logging. Further, if the age-limit for logging DF was set at 150 years, as proposed by Franklin and Johnson (2012), up to 215,200 acres of DF (80-150) would be potentially at risk (Figure 1b). Importantly, both the critical habitat rule and recovery plan for the spotted owl recommended protecting structurally complex older forests; thus, many mature forests with important habitat attributes could be eliminated by logging under both proposals. Notably, the total amount of mature forest acres open to logging ultimately depends on how spotted owl recovery action 32 and other NWFP regulations and environmental laws are interpreted and maintained. Nonetheless, targeting mature forests for logging would mean federal lands would never attain adequate habitat levels for numerous species associated with late-successional forests.

3. Lack of Appropriate Baseline Compromises Restoration in Mixed Severity Fire Regions

Franklin and Johnson's (2012) approach to restoration focuses on commercial thinning to achieve desired conditions; however, for restoration to be ecologically based, foresters need an appropriate baseline from which to gauge the efficacy of restorative actions. For instance, under ecological forestry what does a restored site look like if not compared to an appropriate reference condition (e.g., comparable area of high ecological integrity, DellaSala et al. 2003) or historical baseline? How will managers know when a site is restored given the long time periods necessary to restore degraded sites?

In particular, baseline studies in the Klamath-Siskiyou ecoregion have questioned dry fuel models that are being incorrectly applied to justify VRHs and thinning in BLM pilots. For example, fire regimes in this region are of mixed severity (DellaSala 2006, Halofsky et al. 2011), are within historical bounds (Colombaroli and Gavin 2010), and open plant communities were of minor importance historically (Leiberg 1900, Duren et al. 2012). Hessburg et al. (2007) and Baker (2012) also demonstrated that small (<16 in dbh) trees were abundant historically and actually numerically dominant in forests east of the Cascades in Oregon and Washington, and that open stands were less common than assumed. Thus, this lack of appropriate baseline may result in approaches that appear restorative because they are based on presumed historical conditions but that incorrectly calibrate a forest stand against a baseline that instead represents significant departures from an earlier state not considered (Papworth et al. 2009), and that could lead to novel ecosystems (Figure 2). Novel ecosystems—systems that have been sufficiently altered in structure and function most often by human action—can favor non-native species and flip ecosystem dynamics to altered states (Lindenmayer et al. 2011). The altered state may not be resilient to climate change due to accumulating land-use stressors, particularly from multiple stand entries that can compound effects of ecological perturbations (Paine et al. 1998).

Franklin and Johnson (2012) and many managers assume the absence of fire at the stand or landscape level constitutes an *a priori* risk due to a build-up of hazardous fuels in dry forests. However, empirical studies have not shown this to be the case in the Klamath-Siskiyou ecoregion (Odion et al. 2004, Halofsky et al. 2011) where fire severity declined as time between fire return intervals increased (Odion et al. 2010). Thus, the more complex systematics and processes at play in regions of mixed-severity fires require precautionary principles that first define and then test assumptions about baselines before deciding on what desired future conditions should be, let alone the interventions necessary to attain them.

4. Impacts to Aquatic Ecosystems Will Likely Increase

Franklin and Johnson (2012) acknowledged they did not adequately address aquatic and riparian impacts, and this omission error can be costly to aquatic ecosystems in implementation. Freshwater and forest ecosystems share the same landscape. Because water quality and habitat conditions for fish and wildlife are determined in part by the condition of roads, vegetation, and erosion processes across the landscape, any forest management plan or conceptual framework should account for these factors *a priori*. For instance, Colomborali and Gavin (2010) offered a critical environmental context across a 2000-year sediment core record where logging events over the past century have pushed sedimentation rates far outside the range attributable to fires and climate variability.

Implementing the timber prescriptions of Franklin and Johnson (2012) would create a need to maintain or expand the already extensive road system. Yet, roads and associated landings are the primary cause of landslides and chronic elevation of sediment delivery to streams, lakes, and wetlands (Gucinski et al. 2001). Roads permanently distort surface and subsurface drainage patterns that may trigger slope failure and channel erosion. Forest roads deliver sediment- and nutrient-laden runoff directly to surface drainage networks. Road densities are currently very high on previously logged lands in western

Oregon (Firman et al. 2011), and agency resources are already insufficient to maintain the existing road network to prevent ongoing harm to watersheds. Stream conditions have improved markedly only where large reductions of roads have occurred under the NWFP (Reeves et al. 2006). Climate change forecasts indicate increasing hydrologic stress on road systems that will place additional strain on watershed resilience in the future (Furniss et al. 2010). Whatever the silvicultural objective, any restoration-focused management must reduce the forest road network and its impact on streams. Moreover, depletion of near- and medium-term large-wood recruitment can result from thinning in and near riparian areas (Spies et al. 2013), and more extensive ground disturbance from logging in and near headwater riparian areas will likely increase chronic sediment delivery to streams (Rashin et al 2006).

5. Impacts to Northern Spotted Owls Are Grossly Underestimated

Extensive commercial thinning and/or regeneration harvest in stands >80 years will degrade spotted owl habitat with likely negative consequences on their movements and habitat use (Forsman et al. 1984, Thomas et al. 1990, Meimann et al. 2003). Spotted owls nest and roost in forests with high canopy closure, large trees, large woody debris, and vertical and horizontal diversity in stand structure (Thomas et al. 1990), all characteristics that thinning and logging will affect negatively. Franklin and Johnson (2012) assume that skips and gaps in thinning and retention of dense patches in places will provide for spotted owls but there is no empirical evidence to support this claim. They also assume that retaining one-third to one-half of DFs on public lands in dense forest condition is sufficient for spotted owls; however, only about half the forest landscape is publicly owned in the BLM checkerboard lands of western Oregon. Since many private forest lands are managed under short rotations, maintenance of this amount of public lands as dense forests represents only one-fourth to one-sixth of the entire forest landscape. To compound this problem, survival rates of owls decline dramatically when home ranges include <50-60% late-successional forest (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005). Unfortunately, the DF provisions call for extensive thinning in the Klamath Province where spotted owl populations are most numerous and currently most stable (Forsman et al. 2011). Pilot projects on BLM lands also have proposed controversial VRHs and thinning in critical habitat in mature MF (>80 years), leading to incidental take of owls (Table 1; photo plates).

Thinning in mature forests (>80 years) also has been shown to have negative effects on the abundance of the owls' primary prey species, including northern flying squirrels (*Glaucomys sabrinus*; Waters and Zabel 1995; Carey 2000, 2001; Gomez et al. 2005; Wilson 2010; Manning et al. 2012, Wilson and Forsman 2013), red-backed voles (*Myodes rutilus*; Suzuki and Hayes 2003), and red tree voles (*Arborimus longicaudus*; Swingle and Forsman 2009, Wilson and Forsman 2013). Further, thinning affects the composition and biomass of hypogeous fungi (Gomez et al. 2003), an important food item for flying squirrels and other small mammals. The food web of mycorrhizal fungi/small mammals/spotted owls is an important ecosystem function (Maser et al. 1978), and it should receive more attention if forest restoration is truly the goal. Franklin and Johnson (2012) note only one of the above references, but acknowledge likely restrictions given the potential effects of thinning on small mammals as spotted owl prey.

Vegetative changes created by commercial thinning of mature MF and extensive thinning (one-half to two-thirds as proposed by ecological forestry) in DFs will likely favor barred owls (*Strix varia*) that use younger and more open forest stands (Wiens 2012). This, in turn, will increase competitive pressures on spotted owls (Dugger et al. 2011). It is unknown whether there are thinning approaches that will not have these negative effects, or whether there will be ample research funds to address this question. This concern needs to be studied in more detail before commercial thinning is implemented beyond the pilot projects on BLM lands.

Notably, at least for California spotted owls, they select high-severity fire areas (unsalvaged) for foraging (Bond et al. 2009), have higher reproduction successes in mixed-severity fire areas than in unburned forests (Roberts et al. 2011), mixed-severity fire without post-fire logging does not reduce occupancy (Lee et al. 2012) nor does it change home-range size (Bond et al. 2013). Thus, whether active management is needed in owl habitat for fire concerns remains questionable. Moreover, estimates of forest disturbance by fire versus natural regrowth in dry forest provinces within the region show an increasing amount of older, closed canopy forests at the landscape scale even with fire (Hanson et al. 2009, Odion et al. in review). Only when the ratio of stand replacing fire to forest regrowth is >1 do closed canopy forests decrease over time. Thus, fire would have to increase about 5 times the current rates in dry provinces before this ratio would switch to a decreasing state (Odion and Hanson 2013, Odion et al. in review). Consequently, the assumptions of high fire risk to closed canopy forests and fire as a risk to spotted owls that are continually used to justify ecological forestry appear to be considerably overstated and lack empirical evidence.

6. Lack of Recognition for Natural Pathways to Complex Early Seral Forests

An important tenet of ecological forestry is that VRHs are needed to produce timber volume while creating early seral habitat for wildlife. VRHs can be an improvement over clearcutting practices depending on structural retentions, but they remain untested hypotheses regarding benefits to early seral communities. Franklin and Johnson omit natural pathways to complex early seral forests and this alternative approach to generate early seral is missing from the BLM pilots. Instead, the contemporary pattern of early seral forests generated by commercial logging has resulted in widespread distribution of more simplistic forests across large landscapes (e.g., “checkerboard” BLM ownerships in southern Oregon) and presumably a lack of complex early seral forests generated by natural disturbance processes (Swanson et al. 2011, DellaSala et al. in press). Notably, some rare wildlife species such as the black-backed woodpecker (*Picoides arcticus*) respond positively to complex early seral habitat created by natural disturbance but negatively to early seral created by even-aged logging (Hutto 2008). The same appears to be true for spotted owls (Lee et al. 2012). Complex early seral forests created by high-severity fire also support species richness comparable to old-growth forests but this stage is ephemeral (lasting <20 years) as conifer crowns close off understory development (Fontaine et al. 2009, Swanson et al. 2011, Donato et al. 2012, DellaSala et al. in press).

Generally, the only known pathway to complex early seral forests is to allow them to go through succession unimpeded following natural disturbance (Swanson et al. 2011, DellaSala et al. in press). Post-fire logging can adversely affect conifer regeneration (Donato et al. 2006), wildlife habitat (Noss and Lindenmayer 2006, Hutto 2008), soils (DellaSala et al. 2006), survival and territory occupancy of spotted owls (Clark et al. 2011, Lee et al. 2012, Clark et al. in press), and aquatic ecosystems (Karr et al. 2004), retarding development of complex early seral forests. Interestingly, post-fire logging represents significant timber volume on BLM lands with some BLM districts reporting 27.5% of Annual Sale Quantity (1995-2006) from “mortality salvage” (e.g., Lakeview BLM District; www.blm.gov/or/districts/salem/plans/salemrmp.php; accessed July 12, 2013). Much of this volume came from forests likely to have complex early seral features such as those in Key Watersheds, Late Successional Reserves, and Riparian Reserves—areas with large, old trees killed by fire or insects are the best places to naturally regenerate complex early seral forests (Swanson et al. 2011). Cessation of post-fire logging would certainly help compensate for the likely under-representation of complex early seral forests across the landscape and alleviate the perceived need to create them silviculturally.

7. Landscape Context Is Often Neglected During Implementation

When it comes to context, managers need to see the forest not just for the trees but for the landscape (Figure 3) before deciding on stand-level prescriptions. For instance, BLM pilots are nested in a landscape highly fragmented by roads and clearcuts and thus creating early seral through VRH at the stand level is not necessary given it is not in short supply nor is VRH a substitute for natural disturbance processes. Additional harvests in remaining older forests to create early seral would also result in cumulative impacts to late-successional species and further contribute to the successional debt of older forests. A more fragmented landscape – where remaining mature forest blocks are broken up into smaller and structurally simplistic patches (Figure 3) lacking interior conditions - is also likely to facilitate barred owl invasions (Wiens 2012) and may exacerbate predation of marbled murrelet nest sites by corvids (Malt and Lank 2009).

Conclusions and Recommendations

While Franklin and Johnson (2012) offer ecological forestry as a new paradigm for federal lands in the Pacific Northwest, key elements of their proposal and the way it is being implemented by managers conflict with conservation biology, ecological restoration, and prudent management of aquatic and wildlife resources. The most significant shortcomings of their approach are that it is driven largely by economic returns and political pressures, uses an inappropriate baseline for evaluating restoration, will degrade habitat for spotted owls and many other late-seral species, will increase aquatic impacts from extensive thinning and road networks, and may create novel ecosystems that may flip ecosystem dynamics to altered states with undesirable consequences to biological diversity. Implementation problems with the pilot projects further demonstrate how approaches lacking in well-defined tree age cut-offs create mistrust, greater need for multi-disciplinary monitoring, and scientific input from forest and wildlife ecologists.

We offer 14 recommendations to improve the framework and its implementation:

(1). Adhere to the NWFP standards and guidelines, especially the reserve network and riparian and watershed conservation measures in the Aquatic Conservation Strategy as there have been measurable improvements to watersheds under this strategy (Reeves et al. 2006).

(2). In MF and areas with mixed-severity fires, prohibit thinning in forests >80 years and prohibit VRHs in spotted owl and marbled murrelet critical habitat. There is scientific precedent for this age threshold (FEMAT 1993); mature forests are in short supply regionally (Strittholt et al. 2006), are the only precursors to old-growth forests, and are habitat for thse and other imperiled late-seral species such as red-tree voles. Lacking specific prohibition on harvesting of mature forests, we anticipate continued conflict over ecological forestry as evidenced by the BLM pilots.

(3). If experiments with VRHs are done, they should be confined to previously managed stands <80 years outside critical habitat for any listed species or species of concern. The effects on early seral species should be addressed.

(4). In DF, if thinning is conducted in a particular location due to land managers' concern about hazardous fuels, use an upper cut limit (trees ≤80 years or trees <21 in dbh; "eastside screens" USDA 1995) in order to protect large trees that are scarce (Henjum et al. 1994, van Pelt 2008), and to remove small trees for fire concerns (Martinson and Omi 2003). Do not alter the composition of multi-strata stands with large trees or single-stratum stands with large fire-intolerant white firs (*Abies concolor*) below their natural range of variability (e.g., as in the existing eastside ecosystem strategy guidelines in place, http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_033053.pdf;

accessed July 12, 2013). Include snag creation (Hanson et al. 2010) of larger white firs to shift species composition in fire-suppressed forests.

(5). Prioritize managed wildland fire and prescribed fire for ecological restoration.

(6). Retain at least 60% canopy closure in DFs (USDI Fish & Wildlife Service 2012) and >50% late-successional forests at the territory scale (Franklin et al. 2000, Olson et al. 2004, Dugger et al. 2005) for spotted owls and other species associated with closed canopy, older forests. Include high densities of large snags and small/medium-sized trees for late-seral wildlife like Pacific fishers (*Martes pennanti;* Zielinski et al. 2006) and spotted owls (Pidgeon 1995, North et al. 1999), and high snag basal area for black-backed woodpeckers (Hutto 2008).

(7). Avoid creation of novel ecosystems by using both back casting (e.g., stand age reconstructions) and forecasting (e.g., downscaled climate change models) techniques to set restoration targets. We are not suggesting that ecosystems return to some specific past condition; however, clearly defined baselines with historical context or comparable reference areas of high ecological integrity should be a restoration pre-requisite in order to avoid creation of novel ecosystems.

(8). Fully assess impacts of "ecological forestry" and ensure forest restoration addresses the complete range of ecological concerns, including reductions in carbon stores caused by VRHs and thinning (Campbell et al. 2011); soil compaction; reduced recruitment of dead wood; invasive species, roads, and forest fragmentation.

(9). Restore hydrological functions to areas damaged by roads through road obliteration and recontouring of the road prism, and prohibit post-fire logging in riparian reserves and Key Watersheds.

(10). Support well designed and fully funded experiments to resolve conflicts over thinning to spotted owls, prey species, and barred owl invasions.

(11). Develop a finer classification system than moist/dry to resolve uncertainties and place forests with mixed-severity systems in the MF category to limit inappropriate thinning. Forest classifications need to correlate more specifically with plant association groups, site-specific factors, and historical fire regimes before conclusions can be drawn on appropriate management, particularly in mixed-severity systems (Perry et al. 2011, Halofsky et al. 2011). This issue should be periodically reviewed given emerging evidence of climate change.

(12). Conduct research to estimate historical amount and distribution of complex early seral forests versus current spatio-temporal distribution of simple and complex early seral forests to document any current deficiencies and differences in forest quality (Odion and Hanson 2013).

(13). Prohibit post-fire logging and replanting after disturbance to ensure adequate structure and composition of complex early seral forests.

(14). Incorporate landscape context in environmental assessments to determine cumulative effects of thinning and logging on late-seral species and distribution of complex early seral forests.

Franklin and Johnson state that stakeholders have created polar opposites for federal lands – either managing them for intensive wood production or for spotted owls. However, the NWFP was designed to meet viability requirements of >1,000 late-successional species – not just owls - and is a compromise between these two competing views. Many scientists and conservation groups have offered ways to restore forests beyond thinning (DellaSala et al. 2003) have proposed thinning measures with less impact (Kerr 2012), and other active management approaches that constitute more comprehensive restoration measures (Hanson et al. 2010). Ecological forestry as currently conceived will create more tension over management of federal forests than it resolves, drawing question to its adequacy as an ecologically credible framework. While we have presented ecological concerns, others have identified significant controversy in policies that seek to increase timber volume by overturning environmental protections (Blumm and Wigington 2013). This is especially the case for BLM lands in western Oregon because these lands have a history of over-cutting and recent proposals to undermine the NWFP; thus, increased logging would come at a significant expense to important ecological values already in short supply and public trust.

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Table 1. BLM ecological forestry pilots in moist forests of western Oregon using variable retention regeneration harvests (VRHs), commercial thin (CT), and density management (DM). Monitoring data provided by F. Eatherington, Cascadia Wildlands.

District	Location	Treatment	Ecological Shortcomings	Status
Roseburg	Myrtle Creek	3,145 acres total pilot; 500 acres VRH, remaining areas CT and DM	Oldest units ~75-124 years; mostly spotted owl critical habitat	Scoping – no Environmental Assessment yet
	Camas Valley 2011 Harvest Plan	1574 acres of CT and 239 acres of VRH	Some spotted owl critical habitat, mostly <70 years	No Environmental Assessment yet
	White Castle	187 acres of VRH	Mature forest ~ 110 years old; critical spotted owl habitat; suitable spotted owl habitat, and core owl areas	Sold and under appeal. Part of Roseburg District demonstration pilot
	Buck Rising	60 acres of VRH and 19 acres of DM	Mostly young forests but includes spotted owl critical habitat	Protest Denied. Logging in progress. Part of

				Roseburg District demonstration pilot
Coos Bay	Soup Creek	300 acres of VRH	Mostly owl critical habitat, ~72 years old, previously commercially thinned	Scoping
	Wagon Road	121 acres of VRH	Formerly considered spotted owl critical habitat in the 1992 determination. Includes a 9-acre alder conversion next to old growth Port Orford cedar (*Chamaecyparis lawsoniana)* and 450-year old occupied marbled murrelet (*Brachyramphus*	Appealed and sold

			marmoratus) habitat. Incidental “take” of 4 spotted owls.	
Eugene	Upper Willamette	2,000 acres of regeneration harvest and CT	Variable retention on 350 acres of a forest 80-90 years old. Regeneration harvest on stands infected with laminated root rot that would otherwise create high-quality early-seral habitat.	Scoping

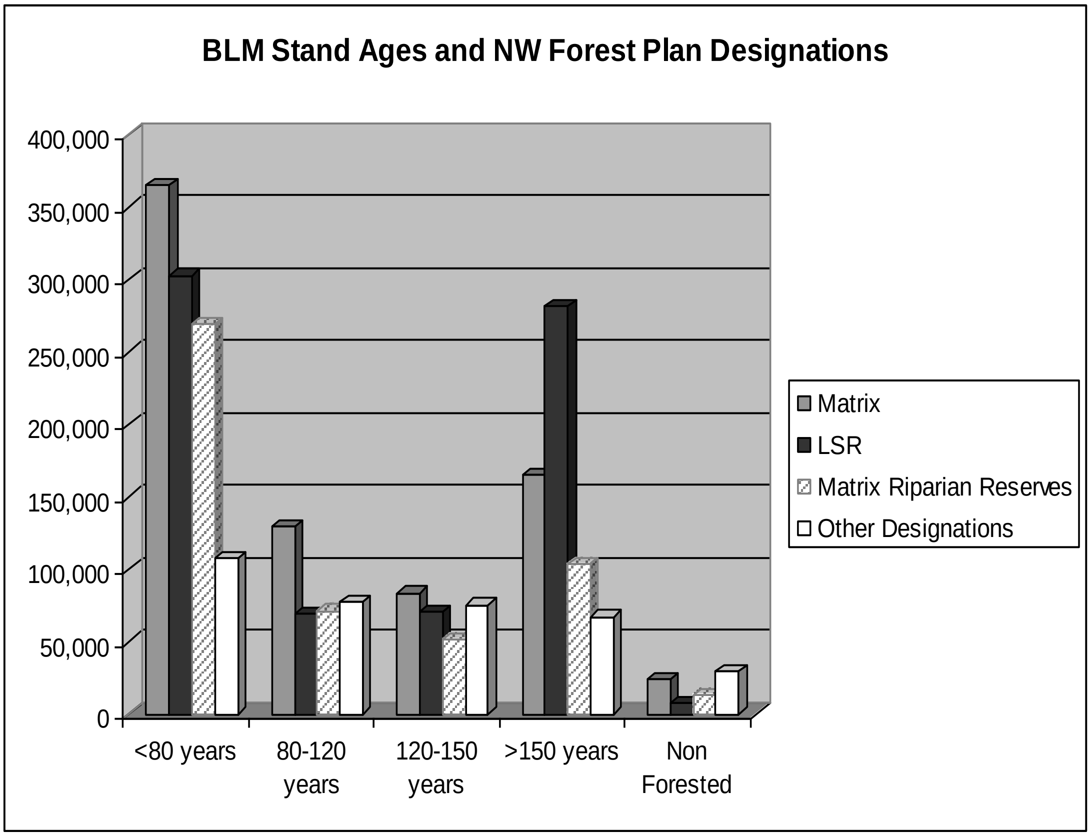

Figure 1a. Stand ages and Northwest Forest Plan land-use allocations (LUAs, units in acres) for BLM lands in western Oregon based on BLM Oregon Forest Cover Operations Inventory (http://www.blm.gov/or/gis/data-details.php?data=ds000045; accessed July 12, 2013) compiled for 2013[†, ††, †††]. No distinction is made between dry vs. moist forest types as Senator Wyden's principles do not differentiate these forest types.

[†] BLM GIS data are most accurate in identifying forests <80 years followed by >150 years with lower levels of accuracy for intermediate age classes. Age classifications in southwest Oregon are not as accurate as other regions due to complexity and diversity of stands.

[††] BLM data also include 153,000 acres of null value acres. These are predominately non-forested areas such as lakes and meadows. A small percentage of these stands should have been assigned stand age data as they are forested.

[†††] BLM stand age data extends farther east than our study area and into the Klamath Falls region.

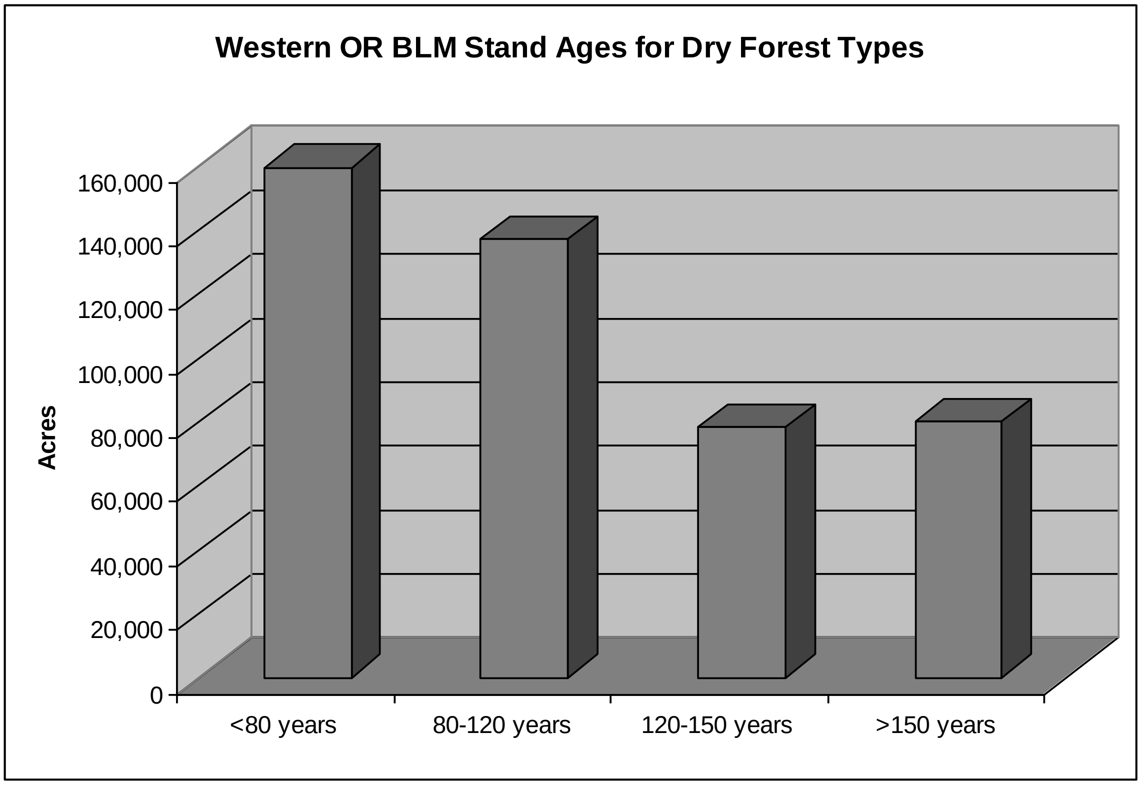

Figure 1b. Stand ages for dry forest types on western Oregon BLM lands. [†,††]

[†] The 159,400-acre of forests <80 years includes 67,200 acres of stands classified by the BLM as having a dominant age <80 years but with a minority component of trees >80 years old.

[††] Oregon Gap Analysis 1998 Land Cover for Oregon GIS data was used as the source data to differentiate moist vs. dry forest types and to mimic the moist-dry breakdowns in Franklin and Johnson (2012). The source data should not be considered an exact match given it is a general overview of plant association groups that we then grouped as moist or dry. This was not an ideal dataset for our study area given classification errors. One example is that the source data incorrectly classified a number of forestlands as agricultural lands in the Roseburg area.

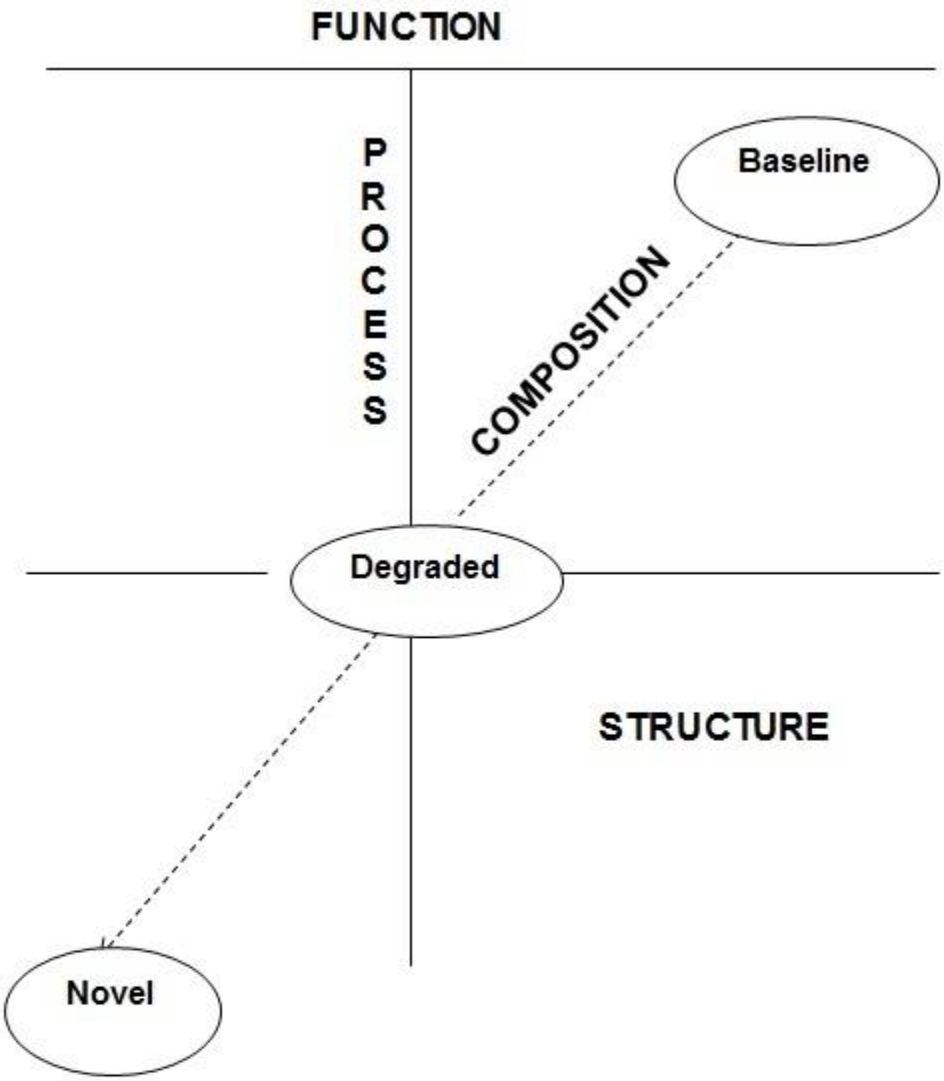

Figure 2. Restoration schematic for forest ecosystems based on comparisons of degraded vs. baseline sites with respect to forest structures, functions, processes, and species composition. Ecological restoration would move a site from low (degraded) to high ecological integrity (upper right) based on comparisons to historic baseline or reference area of high ecological integrity (DellaSala et al. 2003).

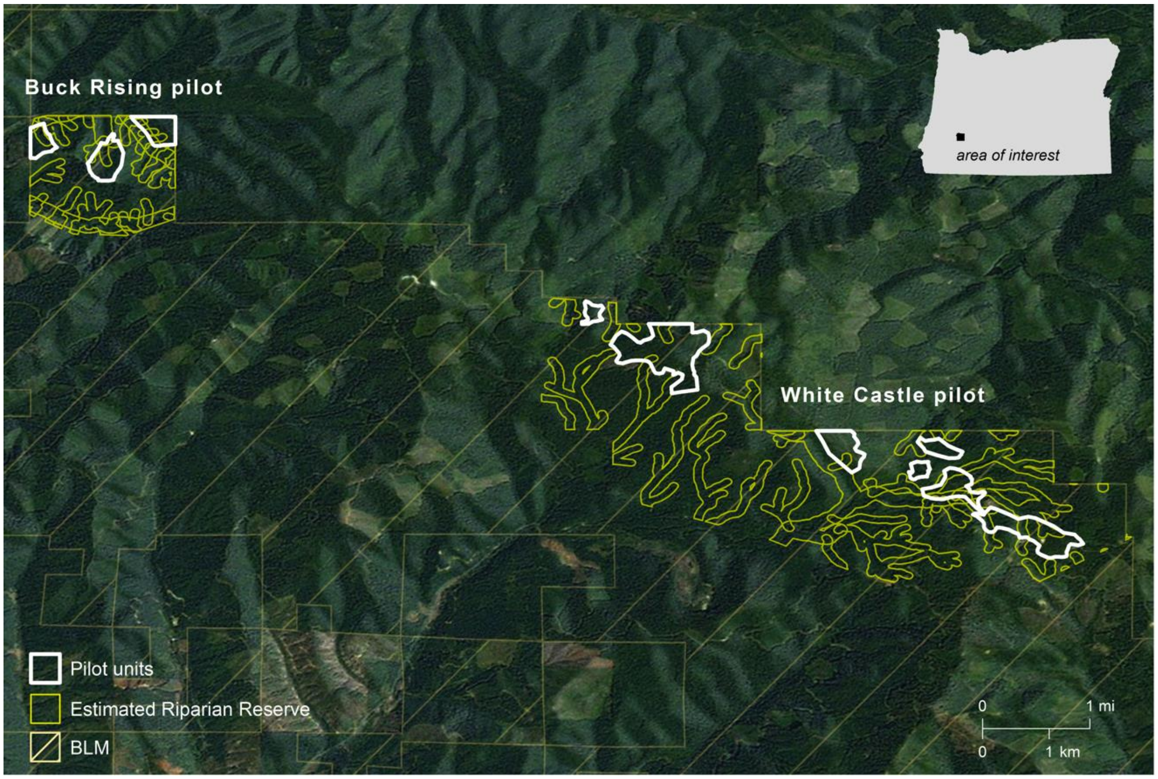

Figure 3. Landsat view of BLM pilots in southwest Oregon showing highly fragmented landscape view with BLM cut units (white polygons) in variable retention harvests and adjoining Riparian Reserve (linear polygons) in “density management” within a surrounding landscape of mostly early seral created by logging. Northwest units (3) are the Buck Rising pilot; other units are in the White Castle pilot. Datasources: Esri, BLM, USDA, i-cubed.