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Overcoming America's Wood Deficit: An Overlooked Option

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The United States consumes nearly 20% more wood than it produces each year (Haynes et al. 1993), a sobering fact that probably few Americans realize. This shortfall is largely overcome by importing an average of about 30 million cubic meters of softwood lumber annually (WWPA 1998). However, relying on imports to offset the deficit merely shifts the potential impacts of production to other areas of the world. Should Americans care about this deficit? If so, what might be done about it?

Dekker-Robertson and Libby (1998) spelled out why the United States, the world's largest consumer of natural resources, has an ethical responsibility to produce more of the wood products it uses. They presented several options for overcoming the imbalance between wood consumption and production but dismissed three as inadequate: Reduce demand and recycle; substitute other materials, which are less environmentally friendly than wood; or import more wood, commonly from areas where harvesting has greater environmental impacts. To avoid greater dependence on imported wood or more energy-demanding substitutes for wood, Dekker-Robertson and Libby offered a fourth option: Grow more timber in the United States. To this end, they recommended establishing intensively managed plantations, primarily on national forestlands.

We agree that plantation forestry is one of a number of approaches that would help reduce the nation's wood production deficit. This approach is likely to be appropriate as a dominant wood-growing strategy on privately owned lands, and it may be suitable for selected sites on national forestlands. However, gaining social acceptance of large tracts of intensively managed plantations in this country's national forests would be a formidable challenge. Currently, there is no public support, political will, agency funding, or regulatory framework to support this option. Furthermore, even if large areas were planted in the next 5 years, whether on public or private lands, it would be another 5 to 20 years—depending on species and location—before yields from these plantations would begin to supplement domestic wood supplies.

Moreover, it is unlikely that any single approach can make up the large shortfall in US production versus consumption of wood products, and efforts to reduce consumption should be part of any overall strategy to shrink the deficit. However, there is another option that not only has the potential to produce millions of cubic meters of wood immediately but also stands a reasonable chance of being implemented. In addition, this option could provide a broad range of environmental, economic, and social benefits.

We propose a natural process-based forest management approach for producing timber products. Under this approach, tree cutting and prescribed burning are employed to emulate the scale and intensity of historic disturbances, thereby restoring and sustaining a semblance of natural stand structure and ecological process on millions of hectares of wildland forests. Under natural process-based management (NPM), maintaining forests in sustainable condition and producing timber are complementary goals. The focus of the proposed activity would be on the western national forests, although the concepts and potential benefits of NPM may well apply to many other public and private forestlands. To develop the case for obtaining wood through natural process-based management, we describe wildland forest ecosystems and their extent in the western United States; demonstrate how the proposed approach roughly emulates natural processes; and quantify the contribution that NPM can make to the nation's wood supply.

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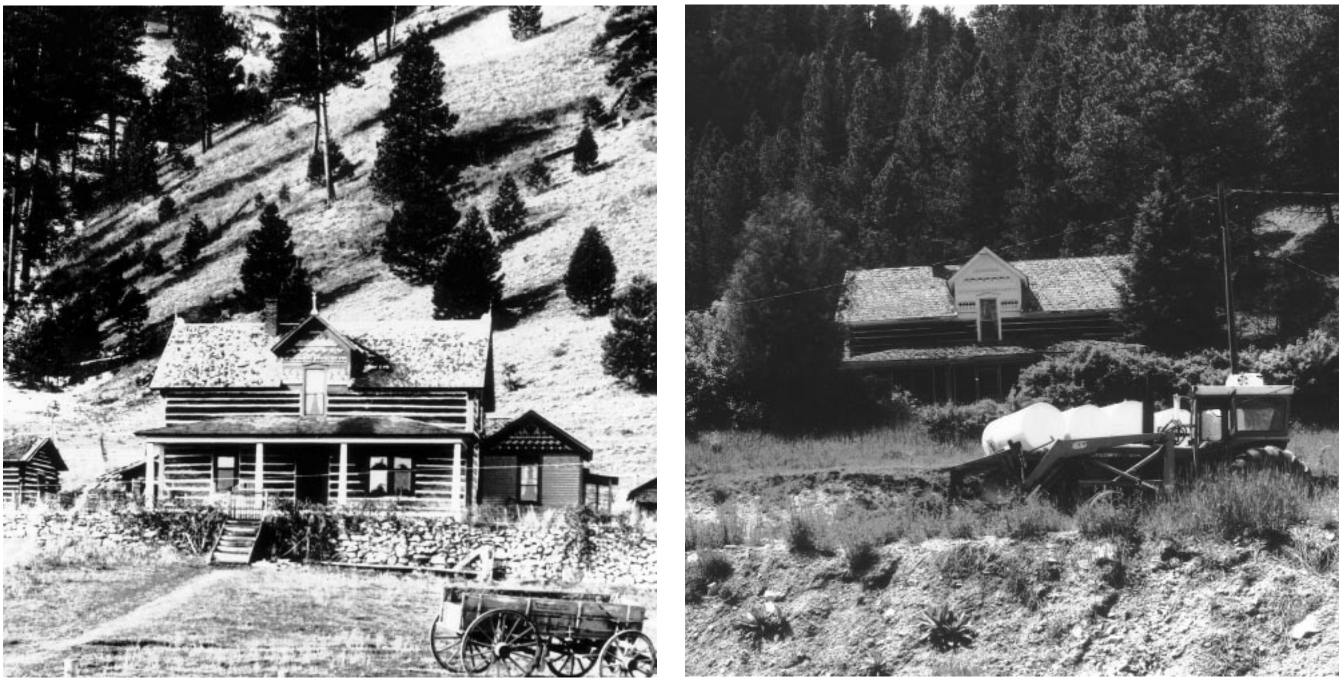

Figure 1. Left, typical pre-1900 ponderosa pine forest in the Bitterroot Valley, near Sula, Montana (circa 1895). Right, same scene in 1980, showing dense ponderosa pine–fir forest resulting from successional advancement in the absence of fire. The forest in this scene burned in a stand-replacement wildfire in August 2000. Photos: George Gruell Collection, courtesy of the University of Montana Archives.

Wildland forest ecosystems

Wildland forest ecosystems primarily comprise native species of plants and animals under the influence of, and interacting with, natural ecological processes. Restoring and sustaining wildland ecosystems has become a broad management goal on about 50 million hectares of federally owned lands in the western United States. The US Forest Service and the US Bureau of Land Management oversee these forests in accordance with the National Environmental Policy Act of 1969 (revised 1988), the National Forest Management Act of 1976, and other environmental legislation enacted by Congress over the past 30 years.

Maintaining or restoring wildland ecosystems requires management approaches quite different from those used in the intensively managed plantations that are the focus of forestry operations in much of the world. Plantations are uniform cultivated forests that are regenerated by planting or seeding. In contrast, most wildland forests in the western United States were largely shaped by the historic role of fire (Agee 1993). Detailed fire history data covering the last 2 millennia show that fire regimes have varied from frequent, low-intensity fires (underburns) in some forest types to infrequent, high-intensity (stand-replacing) fires in others, with mixed-severity fire regimes at intermediate frequencies in still others (Brown 1995, Agee 1998).

Since the early 1900s, natural fires have been suppressed in most areas of the West. Exclusion of fire, combined with the effects of logging and grazing, has greatly altered the composition and structure of many wildland forests. The most dramatic changes have occurred in forests that historically experienced relatively frequent low-intensity or mixed-severity fires. These changes include significantly greater stand density due to the absence of the thinning effects of periodic fire (Covington and Moore 1994), low tree vigor due to intense competition for nutrients and water (Stone et al. 1999), and shifts in stand composition from shade-intolerant to shade-tolerant species (Habeck 1994).

Furthermore, a buildup of fuels, including thickets of understory trees, now predispose many wildland forests to damage from severe wildfires (Figure 1). In 1995 the Forest Service estimated that western forests at risk of large, uncontrollable wildfire comprise an area larger than Massachusetts, New Hampshire, Vermont, and Maine combined. These lands are located mostly in lower-elevation forests dominated by ponderosa pine (GAO 1999). Because of the gradual buildup of fuels, suppression efforts are no longer adequate to contain wildfires in these forests during drought years (Figure 2). In the last decade alone, severe fires burned over 1 million hectares of forests in the West; 96% of national forest lands burned by wildfire have been in this region (GAO 1999).

The most extensive wildland forest types in the West are pure ponderosa pine (*Pinus ponderosa*) and mixed ponderosa pine–fir forests (hereafter collectively referred to as PP–fir), which occupy about 16 million hectares in the western United States—much of which is owned by the public (Van Hooser and Keegan 1988). PP–fir forests are typically found on gentle to moderate topography at low to medium elevations. This hospitable terrain is generally well accessed by roads; not

Figure 2. Left, landscape view of a ponderosa pine forest in the Bull Mountains of central Montana in 1982, two years before being burned by wildfire. Based on the authors' research, this forest condition is much denser than was typical before 1900. Right, approximately the same scene in 1998, 14 years after burning in the 70,000-ha Hawk Creek wildfire. Much of the area burned in this fire remains deforested today. Photos: Carl Fiedler.

surprisingly, much of the PP–fir forestland was selectively logged for its big trees in the 1900s.

Ponderosa pine historically maintained dominance throughout much of its natural range because of its ability to withstand frequent, low-intensity fires. Based on early written accounts (Meyer 1934) and dendrochronological reconstructions (Covington and Moore 1994, Arno et al. 1995), many historic stands were relatively open and dominated by large trees. Over the years ecologists and foresters (Weaver 1943, Biswell et al. 1973) have recommended the use of prescribed burning as a surrogate to the historic role of low-intensity fire in maintaining open, pine-dominated stands. Besides thinning small trees from understories, such burning serves to reduce fuel buildups before they develop catastrophic potential. However, the opportunity to use prescribed fire alone to either restore or sustain historic conditions is largely past. The extensive area of PP–fir forest that burned in an average year prior to Euro–American settlement vastly exceeds the amount that could reasonably be burned today, given current air quality regulations, the shortage of personnel and funding levels for carrying out the prescribed burning, and the residential and commercial developments within some of these forests. Furthermore, profound changes in many PP–fir forests—increased density, development of a layer of small trees (ladder fuels), and increased forest floor and downed fuels—severely limit the ability to return fire to the forest. Prescribed burning under these conditions would allow surface fires to torch into the main canopy and become lethal crown fires, killing even large pines typically resistant to low-intensity burning.

Natural process-based management of PP–fir wildland forests

Millions of hectares of PP–fir wildland forests were historically shaped and sustained by frequent low-intensity fires; it is these forests that are particularly well suited to NPM. Weaver (1943) reported that much of the western pine forest was characterized by uneven-aged stands made up of even-aged groups in various stages of maturity, and that abundant evidence pointed to frequent surface fires, occasional insect attacks, and windthrown trees as the cause for this condition. Arno and Harrington (1998) noted that a semblance of historical fire effects can be created with carefully applied silvicultural cuttings that remove trees (and potential fuels) that would have been killed by natural fires. Treatments have been designed to mimic the intensity and effects of the kinds of disturbances that Weaver (1943) described (Fiedler et al. 1998, Stone et al. 1999). Treatment effects include increased uptake of nutrients and water, with associated increases in leaf nitrogen content, leaf toughness, growth increment, and resin flow (Feeney et al. 1998, Stone et al. 1999, Fiedler 2000).

Silvicultural cutting is especially appropriate as an initial treatment because of the wide departure of existing conditions from historic conditions, including unprecedented accumulation of forest fuels and poor vigor of tree and undergrowth species (Covington and Moore 1994). Cutting is an effective means of removing trees that cannot be specifically targeted and killed in a prescribed burn (Fiedler et al. 1998). Moreover, the removed trees can both contribute to the domestic wood supply and generate revenue to reduce or offset treatment costs.

The NPM regime we propose for restoring PP–fir forests involves several cutting treatments. Treatment prescriptions would typically include heavy understory thinning of small trees (i.e., less than 18 cm in diameter) to break up the continuity of fuels between the ground and the overstory, selection cutting in the overstory to reduce density and promote regeneration of sun-loving pine, and cutting throughout the canopy to remove most firs (if present) and low-vigor trees of all species not reserved for future wildlife habitat or other ecological purposes.

The NPM treatments are designed to first restore and then sustain conditions that approximate stand structures and species compositions that commonly existed under natural disturbance processes—namely, open stands dominated by large ponderosa pines, but containing trees (ponderosa pines, and sometimes a few firs) of various ages. These conditions are sustainable because they favor regeneration of shade-intolerant pine, rapid development of large-diameter trees (Fiedler 2000), and vital resistance to insects, disease, and fire (Feeney et al. 1998, Kolb et al. 1998).

Once the hazard associated with ladder fuels and high stand density has been reduced or removed by appropriate NPM treatments, open pine-dominated forests can be maintained by harvesting at 25- to 35-year intervals, depending upon site productivity. Periodic cutting for restoration can be followed by prescribed low-intensity fire to accomplish other ecological objectives, such as greatly reducing the number of seedlings, especially firs (Habeck 1994); recycling nutrients bound in downed wood or forest floor materials (Covington and Sackett 1992); and stimulating growth of important wildlife forage species (Ayers et al. 1999).

Selecting stands for treatment

The initial step in prioritizing stands for NPM treatment is to focus on sites historically dominated by low- and mixed-intensity disturbances. Density, structure, and species composition criteria can be used to identify high-risk stands on these sites, and relative priority for NPM treatment can then be assigned (Fiedler et al. 1999). Actual prioritization for treatment is accomplished through landscape-level analysis, which provides a basis for comparing conditions among stands and for integrating proposed treatments with other management activities and constraints in time and space (Fiedler and Cully 1995). In the PP–fir stands selected for treatment, all three primary stand attributes—density, structure, and species composition (in mixed-species stands)—must typically be manipulated to meet ecological objectives. Specifically, this approach requires cutting many of the small trees and removing substantial numbers of somewhat larger trees. It is these larger trees with commercial value that provide the considerable volumes of wood products associated with NPM treatments, as well as the revenues to help cover treatment costs.

The typical NPM treatments applied to broadly representative conditions in inland Northwest PP–fir forests remove an average of about 70 m^3•ha (55–85 m^3•ha) of timber products with a positive commercial value, comprising trees with a diameter from 18 to 50 cm (Fiedler et al. 1999). These treatments are moderately more costly to implement than traditional clearcut, seed-tree, or shelterwood methods because they leave greater numbers of trees in the stand (which makes harvesting more difficult) and remove lower volumes of timber per hectare (Keegan et al. 1995). In the inland Northwest, despite these higher costs, the wood recovered under the proposed management regime typically has a value at each treatment entry that exceeds costs, even on steep terrain requiring more expensive cable harvest systems (Fiedler et al. 1999). When these treatments are viewed as a series (regime) through time—beginning with a restoration treatment, followed by maintenance treatments—net present values are also positive. Break-even opportunities would be fewer in areas of the Central Rockies and Southwest that are distant from milling centers, or where volumes recovered are lower and potential product uses more limited. The general inability to process small-diameter timber also limits treatment options in these regions. Conversely, volumes recovered per hectare in California, Washington, and Oregon would commonly be higher.

Current inventory records do not provide the exact acreage of PP–fir forest that could benefit immediately from NPM treatments, but a realistic estimate is one-third to one-half of the total area of such forests (D. D. Van Hooser, USFS Rocky Mountain Research Station—Forest Inventory, personal communication, 2000). If the proposed NPM treatment regime were eventually implemented on just one-third of the total PP–fir forest area at a 35-year harvest interval (which is equivalent to operating on about 1% of the area annually), the wood recovered each year would be sufficient to build more than 100,000 average-sized American homes (D. B. McKeever, USFS Forest Products Laboratory, personal communication, 2000).

Is NPM appropriate for wood production?

Forested ecosystems characterized by low- to mixed-intensity fire regimes typically occur on dry to moderate sites that are not particularly productive, and hence may appear as low-priority candidates for timber production. This view would have merit if such sites required an expenditure of funds to produce commercial-size trees. However, merchantable trees already exist in vast areas of PP–fir forests that would benefit from NPM treatment because, after decades of fire suppression, they have too many trees. Consequently, implementing the recommended treatments in these forests often produces a positive financial return (Fiedler et al. 1999). Under a long-term management regime, NPM cutting treatments (and where possible, prescribed burning) will be used at 25- to 35-year intervals to maintain stand conditions and fuel loadings within a sustainable range, as well as provide a steady flow of wood products.

There is theoretically an opportunity cost in the form of timber volume forgone under an NPM regime, in which the wood produced is part of an ecological treatment, versus one in which the landowner selects trees for harvest based on product and revenue potential. This opportunity cost would exist on sites where an intensive timber management regime is accepted by the public and favored by the landowner. However, on tens of millions of hectares of public lands, and substantial areas of private (especially nonindustrial) lands, intensive timber management is not consistent with other management goals. The choice on these lands is either to implement socially acceptable management treatments, such as those aimed at restoring desired ecosystem attributes, and recover some wood, or to recover no wood at all.

Benefits of NPM

We recommend implementing natural process-based management treatments on extensive areas of public forestlands in the interior West, both to restore sustainable ecological conditions and to produce substantial volumes of wood. The management regime we propose is designed for PP–fir forests characterized by frequent low- to mixed-intensity disturbances. Conceptually, the NPM approach could be applied to other ecosystems or forest types characterized by mixed-intensity or even stand-replacement disturbances. Appropriate treatment regimes in these cases would differ from the approach proposed for drier PP–fir forests; they would be based on the scale, interval, and intensity of disturbances characteristic of the respective ecosystem.

The NPM approach adds an option for increasing domestic wood supplies that complements other strategic approaches, such as those outlined by Dekker-Robertson and Libby (1998). It provides substantial volumes of wood now—and will do so indefinitely into the future—from forests managed using methods that are compatible with natural ecological processes. Benefits associated with our proposed natural process-based management strategy in PP–fir forests include

- production of nearly 5 million m^3 of lumber annually, which is equivalent to approximately 15–20% of the nation's yearly softwood lumber imports
- avoidance of up-front investment in establishing plantations
- recovery of wood products that generate revenue to offset harvest and administrative costs and perhaps to underwrite costs of other restoration treatments, such as prescribed underburning or tree planting
- development of extensive, early-successional pine forests that are highly fire resistant and sustainable—forests that also protect ecologically important "islands" of late-successional species embedded within them from catastrophic fire (Wilson and Baker 1998)
- resistance of treated stands to severe damage from wildfires (Kalabokidis and Omi 1998), which has substantial value in terms of wildland resources and amenities retained and firefighting costs avoided
- reduction of the risk from fire to people and property (Kalabokidis and Omi 1998)

Kloor (2000) made a compelling case for urgency in restoring ponderosa pine ecosystems in the West. Covington (1995) stressed the immensity of the need, noting that although the fundamental ecological changes caused by fire suppression, logging, and grazing are in differing stages in different forests, they are pervasive in ponderosa pine forests from Canada to Mexico. We reiterate his plea for interagency cooperation to establish a nationally significant level of restoration involving millions of hectares of PP–fir forests. A broad-scale effort is realistic, given that a considerable portion of the PP–fir type is on moderate terrain and accessible. Not all PP–fir forests should receive treatment, however—much less the proposed NPM treatment. For example, some PP–fir forests occupy moist or protected sites historically dominated by stand-replacement disturbance regimes (Shinneman and Baker 1997), which the proposed NPM treatments would not emulate well. Nor will the proposed treatments be uniform in the areas where they are applied, because the objective of treatment is to create a general range of conditions, not a specific condition. In many areas it may be desirable to leave patches and stringers of uncut forest to allow functions that only dense conditions can serve, such as hiding cover or corridors for wildlife movement.

As stated above, the volume of wood produced under the NPM option would be enough to reduce the nation's softwood lumber imports by 15–20% annually. Using appropriate NPM treatments in portions of other disturbance- adapted forest types could boost this contribution significantly. Furthermore, proposed treatments in PP–fir forests would produce additional volumes of small-diameter (less than 18 cm) timber that would be suitable for paper, reconstituted wood products, fuel, and perhaps lumber. Although a few new mills are technologically capable of processing this smaller timber, large-scale utilization is currently not feasible in the inland West (Wagner et al. 1998). Assurance of raw material availability through an aggressive restoration program on national forestlands would most likely spur investment in small-log milling technology, allowing substantial additional volumes of small trees to be used (Wagner et al. 2000).

The nation's appetite for wood products is huge, and the volume of imported wood needed to help meet this demand will very likely continue to grow. The extent of PP–fir forest resources in the United States is also huge, much of it threatened by intense wildfire or successional change. Although entirely fortuitous, these factors are complementary, and together make a compelling case for broad-scale application of NPM treatments in western PP–fir forests.

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