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FORESTS WITH CROWDED TREES OF SMALL DIAMETERS — A GLOBAL ISSUE AFFECTING FOREST SUSTAINABILITY

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ABSTRACT

Forests with crowded trees of small diameters are common in many developing countries because the decline in subsistence agriculture and grazing combined with increased fire prevention have led to regrowth of forests. By contrast, subsistence agriculture is still leading to deforestation in many underdeveloped regions. Forests where crowded stands predominate—such as the Inland Western United States—commonly do not provide sustainable forests. Thinning these forests to create a landscape of diverse stand structures can make them sustainable; however, the global abundance of wood and the small tree sizes in these crowded stands makes such thinning difficult if the traditional returns from timber are to pay the full cost of all values. The developing world is concerned enough about the global environment that it has developed quite robust criteria for sustaining the world's forests. To be sustainable, each region should provide its "fair share" of the following values: 1) biodiversity, 2) commodities (including timber), 3) forest health, 4) soil and water, 5) carbon sequestration, 6) socio-economic conditions, and 7) the infrastructure to provide #1 through #6. "Fair share" is defined both spatially and temporally—fair to other regions and to present and future generations.

Much of the forestry debate in the United States has concentrated on criteria 1 and 2, and has been unsuccessful in providing sustainable forests for reasons that are both sincere and anachronistic. The anachronism is that United States environmental and timber policies are still oriented toward a "machine" concept of the universe—a concept popular when many of these policies were institutionalized. Viewed as if it were an "efficient machine," forest ecosystems "run best" if kept away from people. Similarly, timber is best produced in factory-like intensive plantations; and society is run as an "extended machine" through central design—a.k.a., central planning. The "machine ecosystem" and "central planning" approaches have been consistently proved wrong; and the intensive plantations are questionable financially, socially, and environmentally. A more effective alternative is consistent with the modern concepts of ecosystems and society as decentralized networks. This alternative concentrates on criterion #6. All sustainable conditions are achieved by providing local communities with the information, decision tools, incentives, and analysis techniques to develop area-specific ways to make the forests sustainable. By considering all values, creative ways to manage the forests will emerge including marketing the wood to special niches, using the wood for non-traditional purposes, and paying for management through carbon credits and other means.

Keywords: Sustainable forestry, thinning, rural development, biodiversity, proactive management

INTRODUCTION

Concerns about forests of small diameter, overly crowded trees in the Inland Western United States are similar to concerns in other places of the developing world—and for similar reasons. This paper will first describe the causes of these forests' conditions. Then, it will examine their effects on forest sustainability for environmental and social values. Following this, it will outline a general approach to ensuring these forests are sustainable.

CAUSES OF THE SMALL DIAMETER FORESTS

The forest area has been increasing in developed parts of the world as subsistence farming and grazing land is abandoned and regrows to forests. Farming and grazing abandonment is because better transportation and agricultural technologies allow food production to be concentrated on few acres and shipped far distances. Commonly, people abandoning their farms move to cities, creating urban issues commonly addressed separately from the forests. The mineral soil of abandoned land allows many tree seeds to germinate, creating crowded forests where the trees do not grow large in diameter.

Under many circumstances, the crowded forests become weak and susceptible to insect attacks, fires, and breakage from wind, snow, or freezing rain. This pattern has been occurring in many parts of the world for the past hundred years (Oliver and Larson 1996; Oliver et al. 1993). Recent subsistence farm and ranch abandonment occurred in many parts of the United States between the 1920s and 1950s. Aggressive forest fire prevention occurred coincidentally with the regrowth following abandonment, so that presently there are many, extremely crowded forests.

Conversely, the forest area has been decreasing in underdeveloped parts of the world as the subsistence agriculture and grazing continues. The subsistence peoples harvest trees for fuelwood; graze, burn, and farm the harvested area; and so prevent the regrowth of forests. New forests are constantly cleared, leading to increasing deforestation (Oliver et al. 2000).

EFFECTS OF THE FORESTS ON SUSTAINABILITY

The concern placed on these small diameter, overly crowded forests depends on the values one places on forests. Recently, much of the world has become wealthy

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enough to become concerned about the effects of their actions on other parts of the world and on future generations. Under the name "sustainable forestry," the concern is that each forest area provides its "fair share" of values so that each forest area and the present and future generations are not adversely impacted by the actions of others. An international group of resource specialists has developed a robust list of criteria for the values to be sustained (Forest Authority 1998, Montreal Process 1999; Table 1). There is not a single criterion to be sustained, but a group that encompasses both human needs and the concern for the environment. Whereas it may be appropriate to revise this list in the future, it does provide a robust way to begin assessing and targeting forest management. There are several dozen "indicators of sustainability" proposed as subcategories of the criteria; for this paper, the more generalized criteria will be addressed.

Table 1.—A robust set of criteria has been internationally developed to gauge whether forests are being sustainably managed.

Biodiversity
Commodities
Forest health
Soil and Water Conservation
Forest Health
Carbon Sequestration
Socio Economic Condition
Infrastructure

The criteria in Table 1 will be described and related to the current condition of the Inland West's forests, to assess the condition of the Inland West's forests. More detailed analyses may increase the precision of information shown below; however, the trends described will probably not change.

Biodiversity

Biodiversity is concerned with maintaining viable populations of all organisms. Since each ecological region often has its own unique species, each region needs to be addressed. The three means of providing biodiversity are:

Providing adequate amounts of all habitats

This is done by maintaining all structures (Fig. 1) within the region, since different species depend on each structure (Oliver and Larson 1996). The overly crowded forests in the Inland West have created excessive amounts of the "dense" structure, which means there is a relative shortage of the other structures. When catastrophic fires burn these stands, then excessive amounts of the "open" structure are created in the tens of thousands of acres of burned area. Consequently, these forests are not providing adequate amounts of all habitats.

Providing a "fair share" of reserves

There is not yet a global consensus of how much forest should be in reserves in each region or what activities should be allowed in reserves; however, an extraordinary amount of the United States' current reserves are in the western United States even though most forest area is in the eastern United States (Fig. 2; USDA Forest Service 1982 [Numbers have not changed significantly in more recent analyses]). The disproportionately large amount of reserves in the western United States becomes even greater if one considers National Forests as reserves—a possibly appropriate consideration if these forests are not actively managed.

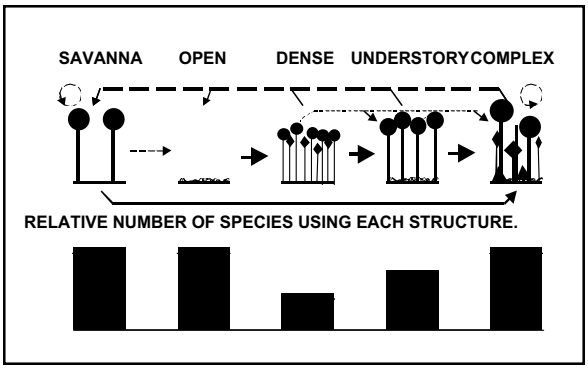

Figure 1.—Forests are dynamic, constantly changing in structure through growth and disturbances, as shown by this example of a structure classification. Different species—and numbers of species—depend on each structure.

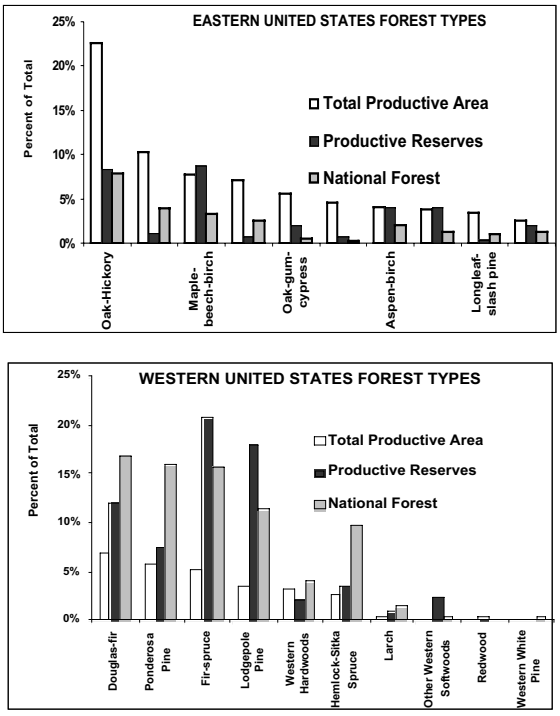

Figure 2.—Forest reserve areas are disproportionately distributed in the western United States, although most forest area is in the east. If National Forest land is treated as reserves, the imbalance will be exacerbated.

Providing special conditions for threatened species

Certain places in the world have been described as "biodiversity hotspots" because they contain large numbers of endangered species (Myers et al. 2000). Much of

California and southern Florida are the two areas in the United States designated as these "hotspots," as well as places such as Mesoamerica, Brazil's Cerrado, and parts of Africa and Asia. The Inland West is not considered an area needing such detailed attention.

In summary, the Inland West is providing the "Biodiversity" criterion of sustainability very poorly, since it does not have a robust diversity of forest structures, it is providing far more than its "fair share" of reserves, and the reserves are provided with no compelling reason to single out the areas as a "biodiversity hotspot."

Commodities

Much of the forest conservation movement of the past 100 years has been to avert an impending "timber shortage." Because of these efforts, regrowth of forests on marginal lands, and the ability to transport wood products long distances, the world is now facing a dramatic surplus of timber. In fact, the world's present and foreseeable wood needs could conservatively be met on 60% of its forests—or on about 10% if the wood were grown in intensive plantations (Oliver 1999).

There is, therefore, adequate forest area for each region to provide its "fair share" of timber as well as reserves. Some world regions are consuming more timber than they are growing, through both import and net depletion of their forests, while other regions are growing more than they are consuming (Fig. 3; assuming mean growth of 1.5 cubic meters/ha per year for all regions. Basic data from FAO 1999). North and Central America are growing about as much wood as it is harvesting (probably more wood is growing than is conservatively shown here). Within the United States (Fig. 4), however, the southeast is harvesting an extremely large share (95%) of its growth, while the Inland West in harvesting an extremely small proportion of its growth—less than 25% (Waddell et al. 1989).

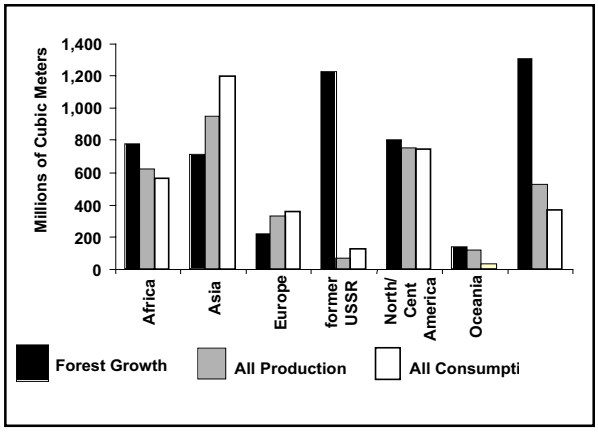

Figure 3.—Wood grown, harvested ("production"), and consumed by different regions of the world (assuming mean growth of 1.5 cubic meters/ha/year).

Global trade models indicate that the southeastern United States and other regions in the world would not harvest such excessively large proportions of their timber if the Inland West and Pacific Coast were to harvest more of its timber (Perez-Garcia 1993, 1995). Consequently, the Inland West is not behaving in a sustainable manner relative to producing commodities.

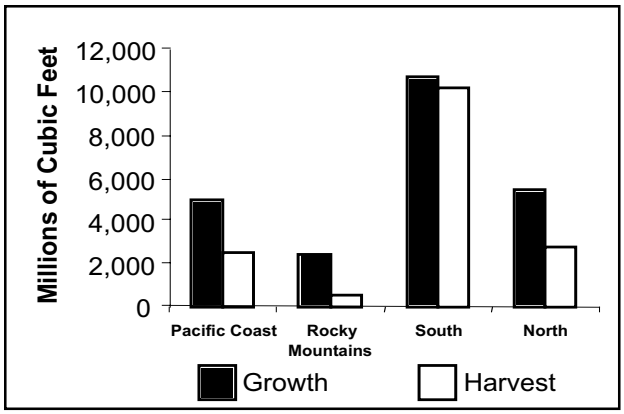

Figure 4.—Although North and Central America are sustainable in aggregate in their growth and harvest (Fig. 3), some regions of the United States contribute proportionately more to the total wood supply than other regions.

Forest Health and Soil and Water Conservation

These two issues will be treated together. Forest Health refers to the condition of forests free from catastrophic insect and disease outbreaks. In many world regions, soil and water conservation are concerned about soil compaction and erosion from improper grazing and similar practices. In the United States, the major soil and water conservation concerns are from fires destroying riparian zones.

The dense forests in the Inland West are leading to catastrophic insect outbreaks—bark beetles and leaf predators (spruce budworm and tussock moth, for example; Sampson and Adams 1994; Everett et al. 1993). With or without these insects, they are also leading to increasing forest fires (Fig. 5, from Oliver et al. 1997). Although fires have been common for thousands of years in much of the Inland West, the intensity of these fires is often greater than in the past because of the buildup of fuels and the density of the regrowing forests (Oliver et al. 1993). The fires are especially intense in riparian zones, where the productive soils have allowed the forests to grow to dense, flammable conditions. Fires that ruin riparian zones and disrupt water supplies are occurring.

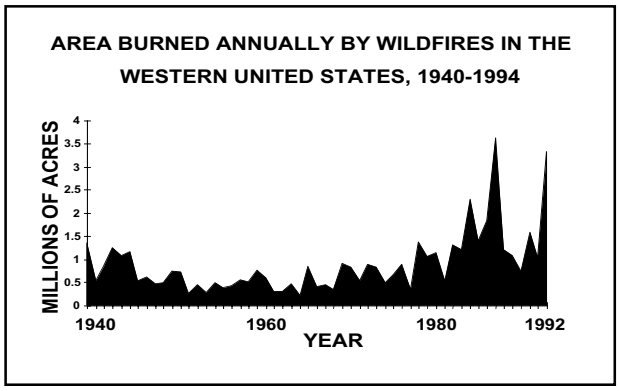

Figure 5.—Abandoning subsistence agriculture and grazing in the 1920s through 1950s, accompanied by very active fire suppression, has led to a buildup of flammable stands that are now burning at an increasing rate.

The crowded forests with their insect and fire problems cause the Inland West not to be sustainable for the values of forest health and soil and water conservation.

Carbon Sequestration

There is legitimate concern that the global increase in carbon dioxide in the earth's atmosphere may be leading to harmful effects; and, there are active measures being taken to reduce the carbon dioxide input to the atmosphere. Forests can play a primary role in reducing the carbon dioxide in the atmosphere in three ways (Oliver et al. 1991; Kershaw et al. 1993; Perez-Garcia et al. 1997):

a. First, growing forests actually remove carbon dioxide from the atmosphere through photosynthesis, by breaking down the carbon dioxide and storing the carbon in cellulose (and its derivative) molecules that make up wood. If the wood burns or rots, carbon dioxide is again produced and released to the atmosphere. Therefore, a growing forest is removing carbon dioxide from the atmosphere; and a standing forest is sequestering the carbon—storing it so it will not return to the atmosphere.
b. Second, wood products also sequester carbon until they rot or burn. Furniture or a building made of wood that lasts 100 years would sequester carbon for that length of time.
c. Third, manufacture of houses from wood consumes much less fossil fuels than manufacture of similar structures from steel, aluminum, concrete, or brick. When fossil fuels are burned, they convert the carbon in the fuel to carbon dioxide in the atmosphere. Therefore, if houses are manufactured from wood, they keep carbon dioxide out of the atmosphere by preventing fossil fuels from being converted to carbon dioxide (Koch 1991).

The Inland West is not contributing very much to the sequestration of carbon dioxide because the forests are burning, thus releasing carbon dioxide to the atmosphere, and they are not being used for construction—which would further sequester carbon dioxide in both the wood material and by keeping fossil fuels in the ground.

Socio Economic Conditions

About one thousand years ago and again within the last one hundred and fifty years, there have been large population movements from rural to urban areas as agriculture became more efficient and required less labor. There currently seems to be a further labor movement to cities from forested areas of the Inland West as the amount of forest harvest has declined on federal lands.

In cities, these people are not available for pro-active forest management to provide sustainable forests, and the lack of management increases pressure on other forests in the world to act unsustainably. Movement of potential rural labor to cities also strains the social services in cities (Stauber 2001). This movement to cities is masked in some places by "rural gentrification"—movement of wealthy people to rural areas. These wealthy people are not a resource labor pool that proactively manages the forest. The Inland West is not providing adequate socio-economic conditions; rather, it is exporting its human issues to other regions by avoiding proactive management of its forests. In addition to this "rural cleansing" (urban migration of traditionally rural people), there is evidence that wages earned in rural forest areas is getting increasingly lower than in urban areas, further reducing the socio-economic conditions of these rural areas (CINTRAFOR 1999).

Infrastructure

The last criterion of "sustainable forestry" is the infrastructure needed to provide the other six criteria. This criteria will be discussed in detail in the next section.

In summary, using the international criteria of "sustainable forestry" and examining the Inland West's forest conditions, the Inland West falls far short of being sustainable—providing its fair share of the world's forest values. It primarily falls short because it has a very large number of overly crowded stands that do not provide a diversity of habitats, that are being destroyed by insects and fires that also destroy riparian conditions, and that do not sequester carbon effectively because they burn up and so are not used for products. In addition to the Inland West providing more than its "fair share" of reserves, the U.S. Forest Service is harvesting very little timber on its forests, forcing other regions of the United States and world to harvest more than their "fair share" of timber. The lack of proactive management that could address these other shortfalls is forcing the people who traditionally have managed the resources to migrate to cities where other places are forced to address their needs.

HOW DID THE FOREST GET TO ITS PRESENT CONDITION, AND HOW CAN THIS BE CHANGED?

The forest reached its present condition through a combination of factors. To change these factors, it is first important to understand them. The first factor, the overly crowded forests of small diameter trees, has already been discussed. In the late 19th and early 20th century, other factors were developing that have had large influences on these forests. Several of these factors are discussed below.

Changing Concept of How Forests Behave

The late 19th and early 20th centuries were times when science, society, and the arts were fascinated with organization, machines, and efficiency. Great technological strides were made in machines and factory organization. The attitude extended into other areas as well. Natural communities were viewed in the light of highly efficient machines, where each species had a necessary function. This perspective led to the concept of ecosystems being "equilibrium" machines. Nature, it was presumed, was in a "delicate balance" that could easily be upset by people. Human intervention was not unlike "tinkering" with a well-tuned machine; removing a part could cause malfunction of the entire ecosystem.

This concept has predominated ecological circles until very recently (Stevens 1990), and is still common in the

non-scientific environmental and policy communities. Early in this century, it led to the concept that avoiding all disturbances—such as fires in forests—was the best way to protect "nature." More recently, it has led to the concept that forest values are best protected if the forest is "preserved" from human intervention.

Plant and animal communities are now appreciated as being much more dynamic than the "machine forest" approach that led to preservation policies—as is evidenced by the many windstorms, natural fires and insect outbreaks in unmanaged forests (Botkin 1990; Oliver and Larson 1996). The forest can be more accurately regarded by the recent "network" paradigm, where each species interacts with others, but is not closely coevolved with the others (except possibly in the case of some plant-animal interactions). Consequently, the forest is much more resilient than previously thought, it can exist in many "natural" states (Fig. 1), and species may be better protected by having a variety of interactions—some of them promoted by active management.

To maintain all species and provide other values, therefore, a management approach may be appropriate that uses a variety of techniques—from reserves to areas with silvicultural (a.k.a. "restoration") practices to provide a variety of stand structures across the landscape (Oliver 1992). Using this variety of techniques for protecting species reduces the risk of choosing the wrong technique.

Changing Concepts of Management

Another product of the "production-efficiency" era was the concept that large social entities could be managed like a factory—through efficiency with central planning and control. Later studies have shown such central planning to be theoretically and practically not successful. Theoretically, variation becomes additive in sequential steps of a system; therefore, a closely organized system with too many sequential steps becomes gridlocked by the variation. Practically, the collapse of the Soviet Union has shown the gridlock of central planning. Attempts at centrally planning the management of National Forests led to gridlock, such that revision of most U.S. National Forest plans are difficult to undertake.

Management of social entities is also being viewed recently from the "network" perspective (Johnson 2001). Using this approach, there is a need for recognition of common goals, and coordination among local areas for achieving these goals. At the same time, it is recognized that most of the activities to achieve these common goals will need to be initiated and done at the local level. This local application is being recognized by the recent emphasis on "stewardship" management of National Forests by local entities. Local people now potentially have access to the information (e.g., through the web), the tools (e.g., personal computers), and technologies (e.g., Geographic Information Systems and the Landscape Management System [McCarter et al. 1998]). If this access can become reliable through an appropriate information infrastructure (e.g., see Lippke, paper in this symposium), then the forests can become sustainable through the help of local people.

Changing Concepts of Economic Performance

The "production-efficiency" era also emphasized the low-cost (or maximum profit) provision of target items from a factory. Slowly, other, usually negative, effects of production began to be recognized—initially labeled as "externalities." Society demanded that manufacturing pay the cost of avoiding these negative externalities, and the cost became incorporated into the higher price of the product. The presumed reason for removing trees from the forest has historically been to produce timber products, and the forest industry has borne many costs considered as "externalities"—avoiding silting streams, compacting soils, or leaving fire hazards. With these "externalities," manufacturing is being regarded more as a "network" than as a linear system.

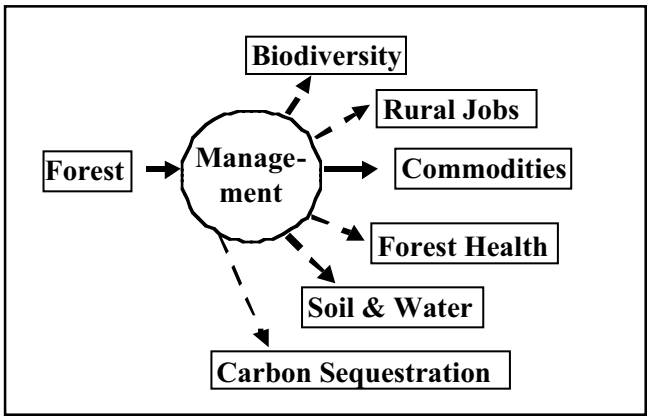

Figure 6.—Early production concentrated on financial efficiency of providing a target item (here "commodities," solid line), with other effects ignored as "externalities" (dashed line). Then, society began demanding the producer pay the cost of "negative externalities." A most recent "network" paradigm is for the producer also to be rewarded for the "positive externalities" provided, thus transforming the activity to a "coproducer" of many goods and services.

A logical extension is now to recognize "positive externalities"—or co-production of multiple goods and services for which the manufacturer is rewarded. Because there is a surplus of other wood, it is probably not financially worthwhile for timber companies to harvest and process the small diameter trees that need to be removed from many forests of the Inland West—if the total management cost is to be borne by profits from the timber. On the other hand, if part of the harvesting and manufacturing process is paid by the "positive externalities"—benefits to society—that accompany harvesting the wood, this wood can probably be removed profitably. "Positive externalities" include prevention of wildfires, providing habitats, sequestering carbon, and providing rural employment. Analyses have shown that a "multi-product" management approach can provide both timber and other benefits to society more cost-effectively than if either the wood is not utilized for timber or the timber is provided in intensive plantations without these side benefits being provided (Oliver and Lippke 1993).

Payment for these benefits are beginning to be incorporated into such concepts as carbon sequestration credits (a non-government carbon tax) and rewarding biodiversity through "certification." Other means of compensating for providing other benefits have also been suggested and analyzed (Lippke and Oliver 1993; Bourland and Stroup 1996; Lippke and Fretwell 1997). It may be appropriate to have direct government subsidy of wood use for energy and fire protection as national policies.

Rural-Urban Contract

In past cultures and until recently in the United States, macroeconomic approaches were taken toward rural development. By these approaches, public investments were made in rural infrastructures to achieve a variety of benefits. The Roman Empire, for example, invested in technology infrastructures in conquered areas to prevent their newly acquired subjects from migrating to Rome—peacefully or otherwise (Perlin 1991). Until the late 1970s, similar investments were made in rural areas of the United States (Stauber 2001). Whereas problems have arisen from injudicious policies to maintain rural jobs, it may be appropriate to begin a policy of re-establishing a rural infrastructure. To make the forests sustainable for all criteria, such an infrastructure would need to avoid fragmenting the forest, such as through subsistence agriculture or dispersed housing. It could have the multiple benefits of:

- preventing overcrowding of cities,
- providing local labor to manage the forest proactively for the many sustainable forestry criteria;
- provide local people to monitor the forest to prevent theft (e.g., timber and animal poaching), exotic insects and diseases, and other unexpected actions just as people using city streets help monitor them to prevent urban crimes (Jacobs 1993).

An alternative being proposed is to concentrate wood production in intensive plantations, presumably to prevent harvesting of other forests (Victor and Ausubel 2000). Oliver (1999) has suggested that this concentration would be a financial mistake for those investing in such plantations, as well as a social and environmental problem for others.

CONCLUSION

By shedding several outdated paradigms regarding forests and management, the problem of small diameter timber in the Inland West can be readily solved. And the forests of the Inland West can become sustainable in all criteria (Table 1). The management can also set an example for many other places in the world that are experiencing similar problems.

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