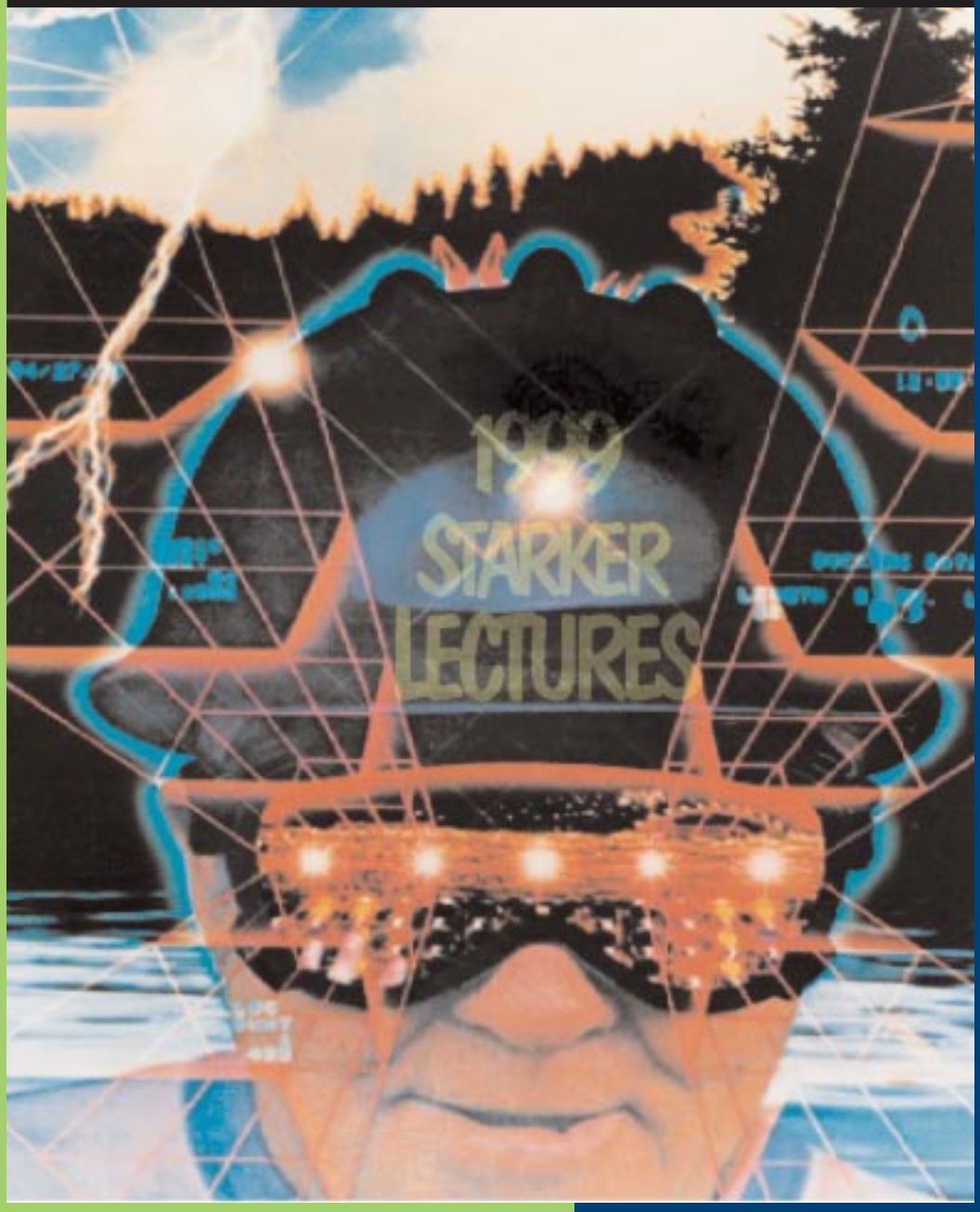
1999 STARKER LECTURES

Natural Resources in a Material World



OREGON STATE UNIVERSITY
COLLEGE OF FORESTRY

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compiled by B. Shelby and S. Arbogast

Acknowledgments

Natural Resources are a crucial part of our world. This year's Starker Lecture theme, "Natural Resources in a Material World," offers a unique attempt to look at complex resource issues. Our speakers come from a variety of backgrounds and offer diverse and thoughtful views.

This lecture series requires a major effort on the part of the Starker Lecture Committee. I thank Steve Daniels, Phil Humphrey, Loren Kellogg, Dick Waring, and Sandie Arbogast for the dedication and creativity that turned disparate ideas into a coherent theme and an outstanding group of speakers.

Manuscripts were edited by Rosanna Mattingly, PhD, Portland, OR, and designed with publishing supervision by Sandie Arbogast, Forestry Communications Group; cover photo illustration courtesy of Boise Cascade Corporation, Boise, Idaho. Reprinted by permission.

We recognize the encouragement and commitment of College of Forestry administrators, students, and friends who support the lectures.

Dedication

T. J. Starker

Bruce Starker

Thurman James Starker, known to all as T. J., was born in Kansas and spent his childhood in Burlington, Iowa. He moved with his family to Portland in 1907 and began working in and studying forestry. T. J. graduated in the first class of foresters at Oregon Agricultural College (OAC), now Oregon State University, in 1910. He then studied two years for an MS degree in forestry at the University of Michigan and returned to Oregon to work for the USDA Forest Service. Subsequent employment with the forest products industry and a variety of summer jobs while he was teaching forestry at OAC/Oregon State College (OSC), gave T. J. broad and thorough experience in all aspects of forestry.

In 1936, T. J. began purchasing second-growth Douglas-fir land, the beginnings of Starker Forests. Through his work experiences and teaching forest management, T. J. had a major influence on sound forestry and community development in Oregon.

Bruce Starker studied forestry at OSC, earning a bachelor degree in 1940 and an MS in 1941. After service with the Coast Guard, Bruce joined his father, T. J., in acquiring and managing Oregon forest land, always with an eye for careful management, sound reforestation, and conservation for multiple benefits and values. He worked with private industry and university, state, and federal forestry agencies to improve reforestation and management, and developed taxation systems that improve forest practices. Bruce continued the family tradition of active community service in many ways, including participating in civic activities and regional forestry work and contributing to the Oregon Forest Practices Act.

Forestry in Starker Forests has changed with advances in knowledge, technology, and public environmental issues; however, the constant value of tending the land remains unchanged. The community spirit and sound progressive forestry of T. J. and Bruce Starker continue today.

James Bolton
Professor, The BioComposites Centre, University College of North Wales, United Kingdom

Making the Most of Plant Resources

As we enter a new century and millennium, I want to present a view of how our use of plant resources may change in the next century. In doing this, I will sketch out how we presently use our resources. I will identify some of the forces that will drive change in this current pattern, and look briefly at how we predict future consumption levels. Finally, I will consider how we can use some of our resources more efficiently, and in new ways.

It is interesting to speculate about what future generations will regard as the most important event or issue of the twentieth century. Possible candidates, depending on one's political persuasion, might include:

- The trend toward equal opportunity.
- The rise of Communism in Russia, and its subsequent collapse after a Cold War that fueled an unparalleled arms race.
- The advent of the computer.
- The beginning of the Biotechnology Revolution—from antibiotics to our understanding and manipulation of genetics.

In my opinion, in the context of plant resources and

perhaps in general, the most far-reaching issue of the twentieth century is that we have allowed the world population to rise to 6 billion persons, almost quadrupling our starting position at the beginning of the century. The growing demands of this burgeoning population have already had a significant effect on our environment, and on our use of plant resources. The effect will be much larger in the future.

Present use of nonfood biomass resources

My main experience is in the nonfood sector, and I will confine my analysis to this. It presents a large enough task in itself. The most important nonfood biomass resource at present is wood. Those of us who live in developed countries may be surprised that over 50 percent of wood is used as fuel, and most of this use is for cooking, generally by people living on very low incomes.

Respective values (in millions of metric tons) for nonfuel products made from roundwood worldwide include: sawn timber, 228; virgin pulp, 168; wood-based panels, 79; and textiles, 24. Virgin pulp constitutes about 80 percent of sawn timber consumption, and is supplemented (approximately 50 percent) by paper recycling. Wood-based panels represent about 30 percent of sawn-timber consumption.

In the nonfood sector, we also use some nonwood biomass, but accurate statistics are harder to find. This is particularly true of plant residues, such as cereal straw. The value of 12,000 x 10^3 tonnes (Table 1) is an estimate of industrial utilization for pulp and board production, and excludes straw used as animal feed and bedding. Such items as seed hairs (e.g., cotton) and fiber bundles (e.g., flax, hemp, jute, and sisal) used in textiles are important commercially, and their use is likely to grow considerably. Nonetheless, they form a minor part (<5 percent) of the total nonfuel biomass used.

Forces that will drive change

The populations of most developing countries have doubled in the past 40 years. Continued growth at this pace is likely for many decades to come. These

Table 1. Commercially important fiber sources worldwide. Source: Bolton (1994); estimates for agricultural residues are based partly on Atchison (1987).

Fiber source	Species	Origin	World production (10^3 tonnes)
Wood	>10,000 spp.	Stem	1,750,000
Cereal straw	mainly *Triticum* spp., *Secale* spp.	Stem	12,000
Bamboo	>1,250 spp.	Stem	10,000
Cotton lint	*Gossypium* spp.	Fruit	18,450
Jute	*Corchorus* spp.	Stem	2,300
Rice straw	*Oryza* spp.	Stem	1,200
Bagasse	*Saccharum* spp.	Stem	2,600
Kenaf	*Hibiscus cannabinus*	Stem	970
Flax	*Linum usitatissimum*	Stem	830
Sisal	*Agave sisilana*	Leaf	378
Roselle	*Hibiscus sabdariffa*	Stem	250
Hemp	*Cannabis sativa*	Stem	214
Coir	*Cocos nucifera*	Fruit	100
Ramie	*Boehmeria nivea*	Stem	100
Abaca	*Musa textilis*	Leaf	70
Sunn hemp	*Crotolaria juncea*	Stem	70

populations inevitably will have a huge impact on consumption. Even more significant is the potential for increased consumption as a result of improvements in standard of living.

A rough calculation suggests that a 0.5 kg per capita increase in consumption in China would require an extra 123,000 hectares (480 square miles) of sustainable, reasonably high-yield forest, 617,000 output tonnes of additional pulping capacity, and perhaps a $0.5 billion investment in pulping and paper-making equipment. All of this would be needed for just 0.5 kg additional per capita consumption, or a few boxes of tissues per person per year. Similar arguments can be made for the potential for increased consumption of sawn timber and wood-based panels through improvements in standard of living.

A second force for change lies in the production of agricultural residues, mainly in the developed world. Agricultural output continues to increase, year after year, and there are signs that emphasis on nonfood crops, or nonfood uses for crops, will increase. For example, soy, rape, and linseed oils will become industrial raw materials alongside petrochemicals. For most agricultural crops, less than 25 percent of the total biomass produced is the desired product. Thus, we need to find uses for the remaining 75 percent of biomass produced. Traditional end-use markets in animal feed and bedding are saturated in the developed world; in fact, animal production is declining in many countries. The challenge is to find new uses for these residues, uses with an increased financial return and reduced energy generation. Many of these residues are fibrous, and this fiber will be used in paper and board products in the future.

In the developing world, a third force lies in the dwindling reserves of wood for fuel. In broad terms, the calorific value of dry biomass is much the same per unit mass, regardless of the type of biomass. However, the higher the density of the biomass, the lower and more uniform the rate of heat release. Anyone who has tried to cook over a cereal-straw fire is familiar with this relationship. Where demand for domestic fuel is high, the priority use is wood for cooking. The pulp and panel industries then have to rely on lower density agricultural crops and residues. This is already the case in India, and in parts of China.

Predicting the rate of change of consumption

Organizations such as the Food and Agriculture Organization of the United Nations (FAO) continuously update and improve models for predicting consumption. The earliest predictive models were based on historical analysis of past patterns and extrapolation from these into the future. The danger of this approach is the assumption that the complete mix of factors that determined consumption in the past will prevail, unchanged, into the future.

Present-day models aim to build up a more detailed understanding of the individual factors influencing demand for a product. These models assess the likelihood of change in each factor in the future, and estimate the net effect. Thus, demand for sawn timber, for example, might be predicted by taking into account, for each country separately, the following:

- Likely increases in population.
- Changes in net disposable income.
- Changes in the number of new homes built.
- Changes in the demand for furniture of different grades and types.
- Changes in public-sector investment and construction.

The difficulty is that this effort remains largely historical in its assumptions. The person developing the model has to

assume that the rules that govern the behavior of peoples and their economies are constant. This assumption ignores the possibility of major step changes resulting from changes in behavior from previous norms. Recently, we have seen several examples of politically driven events that have caused step changes that could not have been predicted by the modelers.

In the Pacific Northwest, reduction in output from British Columbia is linked to indigenous peoples' rights and public concern over extensive clearcutting. Farther south, these and other conservation issues have hit harder. In 1994, the United States became a net importer (volume) for the first time in decades. Where environmental constraints reduce resource availability, it is difficult to know whether or not new management practices will eventually allow the areas affected to return to their former productivity.

The collapse of infrastructure in the Soviet Union has led to a dramatic reduction in output, and the effective disappearance of a major exporter to Europe. What will happen in the future? Will the infrastructure recover? Might the resource then be pillaged for short-term gain, creating a glut?

In the East, there has been economic liberalization in India, and both political and economic liberalization in China. Despite the short-term overheating in the ASEAN economies, these countries, and the ASEAN nations in general, are now set for continued rates of change not allowed for in our long-term predictive models.

Thus, in the past decade alone, we have seen major step changes in supply and demand driven by changes in politics and public opinion which would have been hard to predict. It may be that demand will outstrip supply sooner than we think. It may be that only agricultural fiber resources can be mobilized fast enough to respond to large step changes.

The potential for expanding our resource base

What is the potential for expanding our resource base through greater use of agricultural residues, annually harvested crops, and so forth? In some countries, greater use of residues appears to be the only alternative to greater dependence on imports in the future. This is certainly the case in Malaysia, India, and the People's Republic of China. China could be said to be considerably ahead of the West in that over 65 percent of China's pulp originates from bagasse and straw (Zhong 1990); however, the levels of environmental pollution emanating from many of the mills that produce the pulp are not acceptable. In India, a high proportion of extractions from the forest are used as fuel, and the prospect of replacing this with other energy sources is small. The challenge is to use low-density residues with low fuel value (such as cereal straw and bagasse) for pulping and panel manufacture. In Malaysia, net imports of paper and board were 875,000 tonnes in 1993, an increase of 30,000 tonnes over the previous year. At the same time, Malaysia has huge amounts of unused oil palm residues. These will peak at 29.2 million tonnes per year in 1998 (Husin et al. 1986). A new chemico-thermo-mechanical pulp mill based on this resource is now planned.

The situation is very different in western Europe, because of the overproduction of food. Utilization of residues could increase the financial return to the farm, thereby making it easier to survive with lower prices or reduced crop subsidies. If land is actually taken out of food production in Europe (and estimates suggest that this may have to happen with 10–25 percent of all land), then clearly this land could be used to produce fiber. Nonwood fiber production is seen as preferable to conventional forestry, because of the long rotation in forestry. In addition, the demands for labor and equipment in forestry are very

different, and are likely to destroy the socio-economic structure of the farming community.

In North America, where huge quantities of straw are underused, we see new initiatives in the production of insulation panels, medium-density fiberboard, and particleboard from this material. A significant amount of kenaf is grown specifically for pulping. This activity will expand greatly in the next few decades. On both sides of the Atlantic, the wish to find higher value-added outlets for residues will lead to new products based on hemp and flax shives, and from the meal left behind in the processing of oil seeds—soy, linseed, and rape.

The technological challenges of nonwood fibers

Given that nonwood resources are beginning to be used now, and are likely to be used more in the future, what technological challenges do they present? Leaving aside the textile industry, most plant-fiber processing technologies that have been developed use coniferous softwoods as the starting raw material. Coniferous softwood species are relatively homogeneous in cell structure and composition. Nonwood fiber resources are much more variable. Even varieties of a single species can differ, and the agronomy and time of harvest can influence the properties of the raw material. Nonwood resources are usually different from softwoods in their structure and chemistry. Many of the problems in the processing of nonwood materials are exemplified by cereal straw. The chemical composition of wheat straw (Table 2) and the cell length distribution in barley straw, which is relatively short compared to that of spruce, illustrate these differences.

Table 2. Chemical composition of spruce and wheat straw.

Composition	Spruce	Wheat straw
Bark	10	–
Moisture content	100–150	20
Cellulose	45	40
Hemicellulose	23	28
Pectin	–	8
Lignin	27	14
Wax	–	2
Silica	–	3

Note: figures are percentages based on oven-dry, bark-free weights.

Many nonwood fiber resources contain substantial quantities of parenchymatous pith cells. High pith contents are common in monocotyledons (cereals and palms) and in many plants that provide long fiber bundles (jute, flax, and sisal). They form a very small part of a softwood stem. Pith cells are typically thin-walled compared to the long fibers and tracheids, and sometimes have a higher cellulose content and a lower lignin content as well. Pith cells, therefore, tend to be damaged more readily during mechanical or chemical processing. It would be logical to process them separately from stronger fibers, and more gently, in order to conserve their integrity; this is not done at present. Thus, in chemical pulping of wheat straw, a proportion of the pith cells are destroyed, and this accounts partly for the relatively low yields of pulp from this resource.

In paper-making, particularly of printing and writing papers, a proportion of short cells is useful as filler in the sheet. However, too many short cells can cause an unacceptably low tear strength. If pith cells are separated in the manufacture of particleboard, they create high levels of dust, and a high furnish surface area. In addition, a disproportionate amount of expensive adhesive is absorbed by these small particles. On the other hand, if the weak pith cells are not separated from the surfaces of longer, stronger cells, they become a weak link in interparticle bonds. For these two reasons, particleboard made from pith-rich biomass tends to be weaker than particleboard made from softwoods. This point is illustrated by the data for internal bond strength of *Miscanthus* spp. and wood particleboard (Table 3).

Table 3. Internal Bond Strength (IB), Modulus of Rupture (MOR), Modulus of Elasticity (MOE), and Thickness Swelling (TS) of urea formaldehyde-bonded laboratory particleboard (PB, made at 645 kg/m^3 and 3 minutes press time) and medium-density fiberboard (MDF, made at 872 kg/m^3 and 3.5 minutes press time), including 20 percent of nonwood fiber indicated. Source: Hague 1996.

Raw material	Board type	IB (MPa)	MOR (MPa)	MOE (GPa)	TS (%)
Wood control	PB	1.02	14.93	2.14	14.64
Miscanthus spp.	PB	0.44	12.62	2.10	23.37
Coppice poplar	PB	1.09	13.35	2.07	17.45
Wheat straw	PB	0.27	11.27	2.02	31.25
Rape straw	PB	0.51	13.37	2.12	23.66
Wood control	MDF	0.84	54.46	4.48	43.65
Miscanthus spp.	MDF	0.82	64.05	4.51	28.06

In medium-density fiberboard production, all the biomass is broken down into small groups of cells or individual fibers. Thus, weak links in interparticle bonds present less of an issue. (The internal bond strength data in Table 3 for *Miscanthus* spp. and wood in medium-density fiberboard are relevant here.) However, the high dust content can decrease the permeability of the board being pressed, thus reducing the initial rate of heat transfer. This reduction makes degassing more difficult, and, therefore, increases pressing time (Bolton et al. 1994).

From a chemical standpoint, nonwoods can differ significantly from softwoods (Table 3). Although the absence of bark and the low moisture content of straw can be an asset (reducing drying costs in the production of panel products), the presence of wax and silica can complicate processing considerably. Silica, which can make up as much as 12 percent of rice straw, can cause problems in the recovery boiler of a chemical pulping system and render the material difficult to process. In panel products, silica can cause high tool wear. Again, the waxy surface layers on stems and leaves, and also the proteinaceous layers just beneath the wax, can cause considerable problems with adhesives in particleboard production. All the benefits associated with a lower raw material cost, reduction of particle-generation costs, and reduced drying costs of wheat straw can be offset by the need to replace urea formaldehyde adhesives with more expensive isocyanates more compatible with the wax layers. This problem disappears when straw is fully refined in medium-density fiberboard production.

What is not immediately apparent from Table 3 is that 15–20 percent of the dry weight of straw is soluble in hot water or dilute alkali. The soluble material consists mainly of polysaccharides. If not recovered separately, polysaccharides would add to the pollution load in a conventional alkaline pulping process. Some potential exists for selling them as a byproduct. In addition, a crucial activity in pulping is the softening and/or removal of much of the lignin. This is important, both to allow separation of fibers and to produce bright papers. Superficially, the task ought to be easier with straw, because it has a lower lignin content than softwood. It is now known, however, that wheat straw lignin is composed of three fractions (Lawther et al. 1995, Sun et al. 1995): the first (7 percent of the total biomass) is very loosely bound and readily removed; the second (3 percent) is more tightly bound, and is more typical of a softwood lignin; and the third (4 percent) is covalently bonded to polysaccharides. The last fraction has no counterpart in softwoods, and is very difficult to remove by conventional means. Thus, an optimal delignification process for wheat straw could involve a number of different stages, and be quite different than processes used with softwoods. Almost nothing is known about the lignin character of other nonwood materials.

In processing softwoods, industry generally has had the luxury of making a single product from the raw material. Efficient processing does not usually hinge on the development of markets for byproducts. This luxury is absent with many nonwood resources. Fractions such as pith, silica, wax, and hot-water solubles make up a substantial part of the biomass, and may cause difficulties in processing unless they are removed. We must find end uses to make fractionation and the overall processing operation more viable.

Potential demand for fiber for novel products

Overview

So far the debate has focused on the possibility that the demand for plant fiber in conventional products might not be entirely satisfied by fiber produced in forests, and that fiber harvested annually on agricultural land might supply the deficit. In addition, agricultural fiber might compete with forest fiber in terms of properties and costs.

A rather different argument is that plant fibers might win markets presently dominated by synthetic and nonrenewable materials. These markets include insulation; packaging; geotextiles; composites; and filters, sorbents, and active surfaces. I will review each of these markets briefly (see also Chisholm 1994). Research and development activity in industry or research institutes might be commercialized in the near future. In some cases, the new market could be satisfied equally well by either wood fiber or agricultural fiber. In other cases, the demand would be for a long fiber, which is produced only by annually harvested plants such as flax, hemp, and kenaf in temperate zones, and jute, sisal, and coir in the tropics. (A long fiber is a bundle of short fibers which can be extracted from the plant intact. Long fibers are traditionally important, because they can be spun and woven.)

Insulation

Some commercial use of short-fiber, recycled paper as loose fill insulation already exists. Although the much larger market for rolled insulation quilts is presently satisfied by inorganic fibers such as glass and rockwool, a company in Germany is about to launch a quilt made from long flax fiber. The European glass fiber insulation market was about 460,000 tonnes in 1981.

Packaging

In the United Kingdom, we use about 2.5 million tonnes of paper and board and 1.2 million tonnes of plastics in packaging every year. Environmental concerns are causing some pressure for a move away from nonrenewable materials. For example, molded pulp products, such as the original egg-box, might displace expanded polystyrene in some packaging applications. This end use would employ low-grade pulps (i.e., short fibers). About 30,000 tonnes of expanded polystyrene were used in packaging in the United Kingdom in 1990.

Geotextiles

Thin sheet materials are used extensively in such applications as erosion control, shading, and weed suppression (mulching) in horticulture. At present, the main materials in use are polymeric (e.g., polythene and spun-blown polypropylene), with some glass fibers and some natural fibers. Materials based on long plant fibers may win more of these markets. The predicted world market for geotextiles for the year 2000 is 1,400 million m^2. At an average basis weight of 50 gm per m^2, this would be equivalent to about 70,000 tonnes per year for all applications worldwide.

Composites

A composite is a material consisting of 30–70 percent fiber and 70–30 percent matrix. There is room for confusion about these materials, however. In North America, particleboard and fiber board, which generally contain less than 10 percent adhesive or matrix, are also referred to as “composites.”

Fibers are introduced into plastics to improve physical properties, such as stiffness, impact resistance, bending, and tensile strength. Applications range from the use of short fibers to stiffen injection moldings to the use of parallel yarns to reinforce high-performance structural products. In general, the fibers used are produced artificially, and glass, kevlar, and carbon are the most common. The use of plant fibers in place of these fibers offers considerable cost savings (Table 4). If their lower specific gravity is taken into consideration by calculating what are known as specific strength properties, plant fibers have strength properties similar to these fibers.

Table 4. Typical specific strength properties, cost, and energy content of synthetic and plant fibers. Source: Bolton (1994).

Fiber	Specific gravity	Specific tensile strength (GPa)	Specific tensile modulus (GPa)	Cost (US$/ tonne)	Energy content (GJ/tonne)
Plant	0.6–1.2	1.60–2.95	10–130	200–1,000	4
Glass	2.6	1.35	30	1,200–1,800	30
Kevlar	1.4	2.71	90	7,500	25
Carbon	1.8	1.71	130	12,500	130

Glass-fiber reinforced plastics are among the cheapest and most widely used composites made with artificial fibers. In many applications, the technical demands placed on reinforcing fibers are not high. Therefore, plant fibers are quite likely to be substituted for glass. In 1991, the amount of glass fiber used in composite production in Europe was about 348,000 tonnes, with the United Kingdom's share about 41,000 tonnes. If plant fibers were to replace a proportion of this, the demand would probably be for long fibers. As with geotextiles, UK producers of flax or hemp might be undercut by those who produce lower-cost, imported jute.

The bending strength properties of some commercial and experimental plant-fiber reinforced composites are compared to those of two glass-fiber reinforced materials in Table 5. Although much remains to be done in the optimization of the plant-fiber reinforced materials, they have properties in the same league as those of glass-fiber reinforced systems. Bolton (1994) and Robson et al. (1993) provide a more detailed exposition of the potential for use of plant fibers in composites.

Filters, sorbents, and active surfaces

Fibrous structures have long been used for filtration. Plant fibers, being chemically reactive and having a high surface area, can be chemically modified to provide effective ion exchange systems. The same approach might be used to produce catalyst supports. An obvious application of these concepts is in environmental cleanup. The environmental industry is large and growing fast. In the early 1990s, the UK water treatment and effluent processing industries would have had to invest an estimated £26 billion to meet European Union performance standards. To this must be added the investment of manufacturing companies struggling to meet tighter effluent limits. Two types of environmental cleanup markets into which modified plant fibers could penetrate have been identified: one is oil and organics, and the other is heavy metals.

Table 5. Bending strength properties of natural and glass fiber-reinforced composites. Source: Bolton (1994).

Matrix	Specific gravity	Bending strength (GPa)	Bending modulus (GPa)	Fiber volume (%)
Random wood/phenolic*	1.20	0.110	8.0	65
Woven jute/polyester	1.20	0.090	8.0	50
Felted jute/polyester	1.20	0.100	10.0	60
Cotton/epoxy*	1.36	0.170	8.0	35
Parallel jute/epoxy	1.20	0.450	43.5	70
Parallel kenaf/epoxy	1.20	0.420	39.0	70
Pultruded glass/epoxy	1.70	0.690	42.0	70
Random glass SMC/epoxy	1.90	0.172	10.3	70

*Commercially available materials.

Unmodified plant fiber, or even straw, will pick up oil in the marine environment. However, these materials will also pick up as much water as they do oil. By chemically modifying the fiber, the oil uptake can be increased to 15–30 times the fiber weight, and the water uptake can be greatly decreased.

Marine spillages are the most widely publicized form of oil pollution. In terms of volume, however, they are certainly less important (and less regular, fortunately) than the demand for oil cleanup in industry. Water cleanup problems arise, even in the processing of vegetable oils in the food industry. Probably the largest demand will come from the oil industry. Some wells produce as much water as they do oil; this must be cleaned up before it is returned to the environment.

Regarding much of the industrial and mining effluent, the main concern is transition and heavy metal pollution, with copper, chromium, lead, zinc, nickel, cadmium, cobalt, silver, mercury, and iron among the most important elements. For example, the United Kingdom releases about 1,000 tonnes of both lead and copper into the sea annually.

Traditionally, these pollutants are dealt with by wet chemical, electrochemical, or ion exchange methods. In ion exchange systems, an expensive resin backbone (costing US$3,000–$5,000 per tonne) has metal-sorbing groups attached to it. Once saturated with sorbed metal, the resin is removed from service and the metals are stripped off, thus generating a high-concentration pollutant stream. The resin is then used again. The same concept can be applied to plant fibers, which are much cheaper than resins. In fact, the system could be so cheap that it would be viable to burn the fibers after a single use, thereby eliminating the need for secondary processing of higher-concentration pollutants.

Although the size of this potential end use for plant fibers is difficult to estimate currently, a UK market of 10,000–20,000 tonnes of modified fiber is possible. The fibers involved are likely to be short fibers, although at least a proportion of longer fibers may be needed to produce sheets of nonwoven fabric (e.g., for cartridge filters). If annually harvested fiber begins to become a more important resource, we might then make greater use of one of the advantages of trees: it is seldom a financial disaster if they are not harvested in a particular year. We could make greater use of our forest resource as a fiber buffer or bank.

The potential of plant polymers

Plant oligomers and polymers such as polysaccharides (cellulose, hemicelluloses, starch), phenolics (tannins, lignins, cashew nut shell liquid), and oils (triglycerides) have huge potential in replacing synthetics in the chemical industry. In a rare collective action, the European chemical industry has launched the Sustainable Technology Initiative to explore this potential. New products close to market or already launched include new adhesives and matrix systems based on plant oils. Professor Richard Wool at the University of Delaware has developed new systems based on soy oil. Other systems based on linseed and rape oils are also showing potential in Europe. These include:

- A new family of solvent-free gloss paints based on derivatized starches and hemicelluloses.
- A water-based, formaldehyde-free replacement for synthetic phenol formaldehyde resins developed from cashew nut shell liquid.

A full review of progress in these fields is not possible here. However, at present, industry often chemically modifies nature's polymer to alter its properties. In the future, this modification might be carried out *in vivo*, by controlling existing or introduced genes so that the desired backbone structure, molecular weight, and degree of branching or sub-

stitution are produced by the plant. This would have a huge impact on costs. Even without this benefit, the growth of crops to provide industrial feedstocks will become very important—even within the next decade.

At the moment, apart from starch, the most important plant-derived polymer commercially is high-purity, cellulose-dissolving pulp made from wood. This is the starting point for the manufacture of viscose rayon, cellophane, and many derivatives. The new products may not come from this starting point. Table 6 shows how diverse the chemistry of just a few starting materials can be. It even raises the question of whether or not dissolving pulp should be made from wood. Clearly, we need to select our starting points carefully.

Implications for the Pacific Northwest

1. In the medium term and beyond, demographic pressures will ensure continued growth in the demand for sawn timber, pulp, and panel products.

2. Although other plant fibers can substitute for wood fiber in the pulp and board sectors, the sawn timber (lumber) market has and will have special protection, because it can come only from forests. In general, high-quality timber must come from relatively slow-grown forests. The Northwest is well placed as a provider of quality product.

3. Worldwide, the growth of pulp markets will be large as levels of literacy and standards of living increase. The Northwest could play a significant role in meeting this demand. However, an increasing amount of the fiber required may come from nonwood resources or recycling.

4. Agricultural production of chemical feedstocks for industry will increase, and will lead to increased production of residues.

5. Efficient utilization of residues will require the development of new strategies for mechanical and/or chemical fractionation of heterogeneous feedstocks.

Acknowledgment

This paper draws heavily on information gathered by my colleagues at the BioComposites Centre.

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Table 6. Chemical composition (% dry weight) of some nonwood residues and spruce wood. Source: Bolton 1994, Batchelor et al. 1996.

Material	Cellulose	Hemicellulose	Starch	Pectin	Lignin	Protein
Spruce wood	45	23			27	
Sugar beet pulp	27	25		24	6	8
Coir	43	<1		3	45	
Rape meal	14	~7	4	~6	5	39
Linseed fiber	81	14		2	3	

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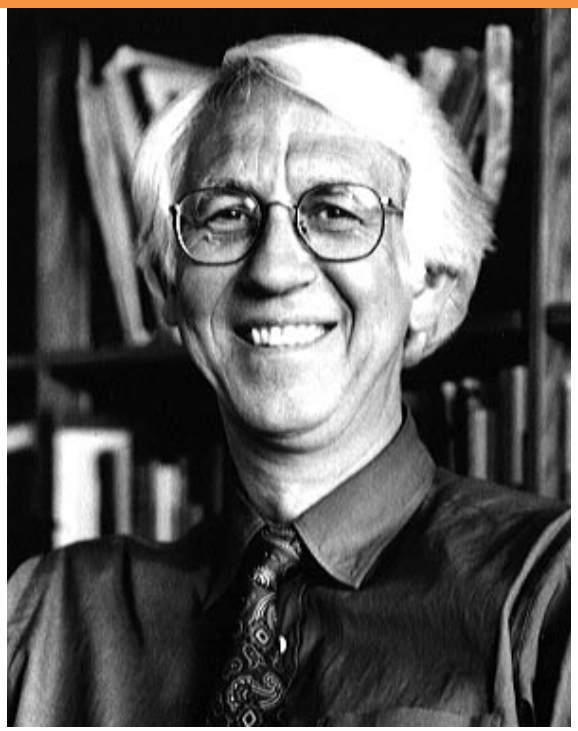

The Transforming Power of Place

I want to thank all of you, and especially the Starker family for making this lecture series possible. I've been very impressed by the people who have been invited to give Starker Lectures in the past, and I am very, very pleased to be in their company.

I want to consider what I've referred to in the title of the talk as "the transforming power of place," and I want to begin with a quote from Wendell Berry (1977, p. 22), one of my favorite writers. Berry, in this particular quote, is picking a bit of a quarrel with the idea of environmentalism. It is not that he's anything less than an ardent environmentalist himself, but the word is giving him a little trouble here.

"The concept of country, homeland, dwelling place becomes simplified as 'the environment'—that is, what surrounds us. Once we see our place, our part of the world, as surrounding us, we have already made a profound division between it and ourselves. We have given up the understanding—dropped it out of our language and so out of our thought—that we and our country create one another, depend on one another, are literally part of one another; that our land passes in and out of our bodies as our bodies pass in and out of our land; that as we and our land are part of one another, so all who are living as neighbors here, human and plant and animal, are part of one another, and so cannot possibly flourish alone; that, therefore, our culture must be our response to our place, our culture and our place are images of each other and inseparable from each other, and so neither can be better than the other."

It's that sort of notion of how we might be shaped by place, and might, in turn, respond to place, that I want to talk about here. I want, first of all, to recognize that, to a substantial extent, I'm clearly out of my own place here. I come from quite a long way away, from quite a different kind of place.

Do places select people?

Part of my thinking over time has to do with the idea that places actually select people, or at least that there was a time when that might have been true. Maybe it still is. One of the ways that I make that argument is to point out a strange kind of phenomenon in the settlement of Montana, particularly eastern Montana where I grew up.

Many people who came to eastern Montana had first come to Oregon as homesteaders, and they found that Oregon did not work for them. As you can imagine, there was one main reason that Oregon didn't work for them—the rain. So they left Oregon and went to a place where it didn't rain all the time, which is certainly true of eastern Montana. Now, if you follow this logic, and if you let yourself imagine that landscape selects people, then you get dry people in dry places and a different kind of people in wet places.

You may be familiar with the work of the Montana author, A. B. Guthrie. *The Big Sky*, his first great novel, was about some of the early fur trappers in the Northwest. One of the main characters in *The Big Sky* is Dick Summers. Guthrie begins a later novel, *Fair Land, Fair Land* (1982, pp. 3–4), by picking up Dick Summers out in Oregon. Summers has apparently just climbed up out of the Columbia Gorge somewhere close enough to the ocean that he can smell it behind him as he turns east.

"Dick Summers climbed the ridge from the channeled valley, glad enough to be leaving Oregon behind him. He hadn't said goodbye to any of the wagon train people who had hired him for a guide. Goodbyes were something like gravestones. Yeah, rest in peace, you sodbusters. May the Lord bless you, good men and weak. Here's hoping your plows pay off in berries or melons or apples or whatever.

"Even high on the ridge the breath of the Pacific reached him, wet enough and salt enough to pickle pork in. Going east he was, going east to find the west, the west of wind and open skies and buffalo. Hurrah for that.

"He squirmed back from the cliff's edge and started walking again. Here had been beaver country all right, but give him the Popo Agie and the Wind and the Seeds-kee-dee and throw in the upper Missouri in spite of the Blackfeet. Give him a far reach of eye, the grasses rippling, the small streams talking, buttes swimming clear a hundred miles away. Give him not Mount Hood but the clean, ungodly upthrust of the Tetons. They were some."

My point here is not at all to suggest that one place is better than another, but simply that there are different ways in which people relate to different landscapes—and that certain landscapes feel more like home to some people than to others. The idea that landscapes somehow select people, and that climates select people, is the beginning, it seems to me, of a way of finding our way into what Wendell Berry is talking about when he says that somehow culture has to come out of our relationship to place. We have to begin by recognizing where we are, and then go from there.

Another western writer, Wallace Stegner, writes about the sense of place, particularizing it to the West. He makes the case that, with any luck, westerners, in our relationship to landscape, will pay enough attention to the landscape to develop a culture—in very much the way that Wendell Berry spoke of.

In order to make that case, Stegner (1992), in one of the last essays he

wrote, speaks about how it is that a lot of people move through western landscapes, but only a few of them become what he calls "stickers." These people stick with the landscape. His argument, of course, is that, whatever it is that makes these people stickers, it is from them that the possibility of a genuine local culture begins to emerge. Using the exception to prove the rule, Stegner speaks in the following quote about people who were not stickers. He begins with one who did not stick in my home town of Missoula, and one who did not stick in this town of Corvallis.

"Leslie Fiedler, an exponent of the Partisan Review subculture, came west to teach in Missoula in the 1950s and discovered 'the Montana face': strong, grave, silent, bland, untroubled by thought, the face of a man playing a role invented for him two centuries earlier and a continent-and-an-ocean away by a French romantic philosopher.

"Bernard Malamud, making a similar pilgrimage to teach at Oregon State University in Corvallis, found the life of that little college town intolerable, and retreated from it to write it up in the novel *A New Life*. His Gogolian antihero, S. Levin, an intellectual, heir to a thousand years of caution, deviousness, spiritual subtlety, and airless city living, was never at home in Corvallis. The faculty he was thrown among were suspiciously open, overfriendly, overhearty, outdoorish. Instead of a commerce in abstract ideas, Levin found among his colleagues a devotion to fly-fishing that simply bewildered him. Grown men!

"If he had waited to write his novel until Norman McClean had written the stories of *A River Runs Through It*, Malamud would have discovered that fly-fishing is not simply an art but a religion, a code of conduct and a language, a way of telling the real from the phony. And if Ivan Doig had written before Leslie Fiedler shook up Missoula by the ears, Fiedler would have had another view of the Montana face. It looks different, depending on whether you encounter it as a bizarre cultural artifact on a Montana railroad platform, or whether you see it as young Ivan Doig saw the face of his dependable, skilled, likable, rootless sheepherder father. Whether, that is, you see it from outside of the culture or from inside.

"In spite of the testimony of Fiedler and Malamud, if I were advising a documentary filmmaker where he might get the most quintessential West in a fifty-six-minute can, I would steer him...to just such a little city as Missoula or Corvallis, some settlement that has managed against difficulty to make itself into a place and is likely to remain one. It wouldn't hurt at all if this little city had a university in it to keep it in touch with its cultural origins and conscious of its changing cultural present. It would do no harm if an occasional Leslie Fiedler came through to stir up its provincialism and set it to some self-questioning. It wouldn't hurt if some native-born writer, some Doig or Hugo or McClean or Welch or Kittredge or Raymond Carver, was around to serve as culture hero—the individual who transcends his culture without abandoning it, who leaves for a while in search of opportunity and enlargement but never forgets where he left his heart. It is in places like these, and through individuals like these, that the West will realize itself, if it ever does: these towns and cities still close to the earth, intimate and interdependent in their shared community, shared optimism, and shared memory. These are the seedbeds of an emergent western culture. They are likely to be there when the agribusiness fields have turned to alkali flats and the dams have silted up, when the waves of overpopulation that have been destroying the West have receded, leaving the stickers to get on with the business of adaptation."

Stegner had a hard time maintaining his own optimism about the West, although, as you'll remember, he had once referred to it as "the native home of hope." Even though he argued that it's almost impossible to be pessimistic about the West, he had to work very hard to maintain his

own optimism about the West—in part because of his very deep intellectual honesty that didn't allow him to be anything less than totally honest about what he saw going on around him. He knew that there was plenty enough going on in the West that was not cause for optimism. I find it extremely interesting that, when he tries to find what it is that might sustain and build culture in the West, Stegner looks to your home, Corvallis, and my home, Missoula, and finds there the roots of that kind of place-based culture that Wendell Berry was talking about.

Spatial and historical contexts

What do we think about that, if we're honest about it? Do we, in fact, think that things are moving in the direction of establishing the kind of culture that might be written about 200–300 years from now? Are we in the process of building a civilization that has some staying power? Where do we stand, any one of us, on that spectrum from pessimism to optimism?

I find myself to be incurably optimistic. Pathologically optimistic, perhaps. I want to share with you a way of seeing what's going on in the world around us that might sustain a well-rooted, well-founded optimism about the places we inhabit. In doing so, I want to put some things that we see going on around us into a historical perspective—a very big-picture historical perspective. I also want to put them in spatial perspective by inviting you to imagine that we are watching satellite photography which begins with a view of the whole Earth and zooms in closer and closer, either to your home town or to mine: Missoula, Montana.

This exercise is also an effort to put things into both spatial and historical context. Any time that I start talking about history, I immediately realize that I'm not a historian. Although I really don't know what I'm talking about when it comes to history, I do have a guide in Winston Churchill. Someone who knew that Churchill had written a lot of history once went up to Churchill and said, "Well, Sir Winston, can you give me your definition of history?" Churchill thought for just a second, and then replied that, as far as he could make out, history was just "one damn thing after another." When I was in the mayor's office, I thought that that was a wonderful way of thinking about my own work. No matter how the day started out, something was bound to come up that would surprise me.

The way I want to approach history here is set out by Hannah Arendt (1958) who, in the late 1950s, talked about how it is that, at certain times in history, something begins to change in human consciousness, and then changes quite rapidly. In these instances, everything about the way we relate to the world around us, and to one another, seems to be altered—almost overnight.

She uses, as her first example of this, the invention of the telescope. She ties her observation into technology, but does not say that the technology actually causes the changes. She claims that, with the invention of the telescope, with the development of the capacity to stand on Earth and look out into what we now call outer space, to actually see the moons of Jupiter and the rings of Saturn, we placed ourselves in the universe in a different way and our relationship to everything around us began to change. We know, of course, that surrounding that event we have the Renaissance and the Reformation and the beginning of a whole scientific revolution. We have a beginning of an age of exploration of every kind, including the physical exploration that led to the European discovery of this hemisphere.

In her writing, shortly after Sputnik had been launched, Arendt made the prediction that the development of satellite technology was going to accompany, if not cause, a similar change in human consciousness. Now, instead of standing on the Earth and looking out, we were

going to stand out there and look in; as that began to happen, she said, everything would change.

And here we are today. We are now familiar with images of the Earth from the surface of the moon. We can imagine the lunar horizon in the foreground, and the Earth in the background. For most of us, pictures of the Earth from the moon have become so familiar that they no longer startle us. But some of us remember what it was like when we first saw the Earth from this perspective, and how the astronauts talked about the startling effect it had on them to be able to see the Earth from outer space. Somehow, in the time since these pictures began to become available to us, at every level, we have begun to come into a different relationship with the places where we have been all along.

Although we might have known intellectually that the Earth was a kind of living organism, that its systems were deeply interconnected with one another, seeing the Earth brought it home to us in a different way. We began to know, not intellectually, but at some other level, that this place was all one place, that it was interconnected, that it was a living Earth.

Global interconnectedness

What is strange is that, in the generation since then, so much of our lives has now been touched by global interconnectedness. It's always been true that Earth's ecological systems have been integrated, yet only within the space of this generation have we begun to affect them in such a way that we have to take responsibility for our actions. Now we're called on to become global citizens, whether we want to or not. We can no longer ignore the effect that we have on the Earth.

It's not just ecologically that the interconnectedness of Earth's systems is being brought home to us. It's almost as if systems of global significance and global scale are being laid on top of each other, one after another, as if a whole new organism is evolving around us, before our eyes. There has always been a global economy, but nothing like there is now. Today, whether we like it or not, we can't escape the globalization of the economy. When the Chinese Premier is called in to ring the bell to start the trading on Wall Street, we know that global capital has become fully integrated at the global scale. The Internet is truly a "worldwide web" of communications. My point is that, in a very short span of historic time, we have developed a different relationship to global systems, one that has never existed until now.

What I want you to do now is visualize moving from a view of Earth as seen from the moon to a view much closer to the surface of Earth. As the view tightens, I want you to consider the many different levels from the global to the continental down to the neighborhood where more organic forms are coming into play, and where many of the old artificial boundaries and, with them, our accustomed ways of doing things are beginning to fade away.

From the satellite images with which we're now familiar, we have become accustomed to seeing that the Earth itself is clearly an organism with its own shape and its own organic, life-giving processes. We don't tell the Earth what shape it's supposed to have, and the same is true of its organic subsystems. As the satellite pictures bring us closer to the surface, we can see other organic entities, for example, continents, emerge, and we are reminded that continentalism has become a fact of life in our time. We're not going to back away from it. We tend to think of something like the North American Free Trade Agreement as something we might have done or not done, as a policy choice that could have gone one way or the other. Yet, I don't think it's like that at all. I think that, in the context of emerging globalism, once one continent, Europe, decided to integrate itself and act as a continent, forces were set in motion that made it inevitable that a continent like North America would have to do the same.

What we don't see in such satellite images, of course, are those artificial boundaries within which we have existed and which we know are increasingly irrelevant to the world we live in. It's this real world that we're now inhabiting, rather than the more artificial world that we created.

Let's consider some map-making that essentially wouldn't have existed 30 years ago (Figure 1). Although we're generally comfortable talking about things like subcontinental regions, we're now recognizing more and more the importance of the idea of subcontinental regions. In my own work at the O'Connor Center for the Rocky Mountain West, I devote every day to dealing with one subcontinental region. Maps of these regions do not have the artificial national boundaries which are becoming less and less important in the global economy.

Figure 1. The Rocky Mountains. Credit: The Ecology Center, www.wildrockies.org/TECI, 6/21/2000.

Consider now one of those satellite pictures that shows the different landforms of a region. In a good satellite photo of the Rocky Mountain West, for example, we could see exactly where such features as the Great Basin exist, and the Great Salt Lake, the Sonoran Desert, the Northern Rockies, the Cascades, and the Sierras. Maps of this kind show us real, physical places.

We can superimpose on such maps the straight lines that give us the illusion that particular areas such as Baja, California, do exist, or that, for example, the Northern Rockies have a sharp edge at the 49th parallel. Of course, we know that that's not the case, that real places do not have those kinds of boundaries. Increasingly, we're occupying those real places.

I want to bring into play here a consideration of what's been going on historically. The prophet and observer, John Wesley Powell, visited the West shortly after the Civil War and made a famous journey down the Green River to the Colorado, and on down the Colorado. He led the first raft expedition there, and went on to become the head of the US Geological Survey. Thus, he became America's chief map-maker. He continued to be very interested in the West, and he made some policy recommendations that were absolutely and totally ignored.

The strongest recommendation that he made was that, given the aridity of the West, the one thing we need to do is to occupy the landscape on its own terms. We need to draw jurisdictional boundaries on the ridge lines. We need to recognize watersheds as the chief organizing principle. "Do not," he said, "draw straight lines on the West."

Well, in looking at maps of the West, we can see how much attention we paid to him. I'm really proud to be part of a state that has a squiggly line for a border. The only difficulty with this border is that, when they were drawing it, the surveyors got to Chief Joseph Pass, got lost, lost the Continental Divide, and continued to draw the boundary along a different divide. If they had followed the Continental Divide, Missoula would have been part of Idaho, which would have been a great thing for Idaho. But at least we do have a squiggly line for a border.

The point I want to make is that now, 100 years and more after Powell made these recommendations and after we totally ignored him, we have begun to divide the West up according to watersheds. All across the West, throughout the last 10 years, there has been a strong, insistent move in the direction of watershed councils. Oregon, of course, has been very much in the lead in these terms, but by no means alone. Although we imposed our own ideas of what this landscape was all about, and drew these lines on it as if we were its masters, in

these last few years we have begun to reinhabit this landscape according to its own idea of what it's all about.

In what's sometimes called the "Four Corners" area, but now is much more often referred to as the "Colorado Plateau," people are getting together in all four states in their part of that landscape and are talking about what they have in common, not as Utahans or Arizonans or New Mexicans or Coloradans, but as residents of the Colorado Plateau. The Greater Yellowstone ecosystem is being recognized as an ecosystem, and increasingly the people in the communities around it are beginning to occupy it as an ecosystem and to think in ecosystem terms.

I think we are moving in this direction, but we're moving slowly. The old straight-line jurisdictional boundaries continue to exist, and to cause problems. The straight line between Montana and Wyoming, for example, is the line that the bison have had so much difficulty understanding the significance of. As they've walked across that invisible line into Montana, they have found that somehow life is supposed to be different there. The fact is that, in some sense, they've been smarter than we are. They can tell that this is all one place. That's the awareness that we're coming to. At this particular time in history, when we would have thought that we were past all of that, natural landforms—whether the Earth itself, or continents, or subcontinental regions, or watersheds—are beginning to play a part in our lives again.

Place matters

Some maps from my work at the Center for the Rocky Mountain West illustrate how it is that this part of the country is different. Figure 2 shows how sparsely populated the interior West is. And Figure 3 shows how quickly that can change. In the past decade, the West became the fastest growing region in the country. This trend is expected to continue.

Federal land ownership totally sets the West apart from the rest of the country.

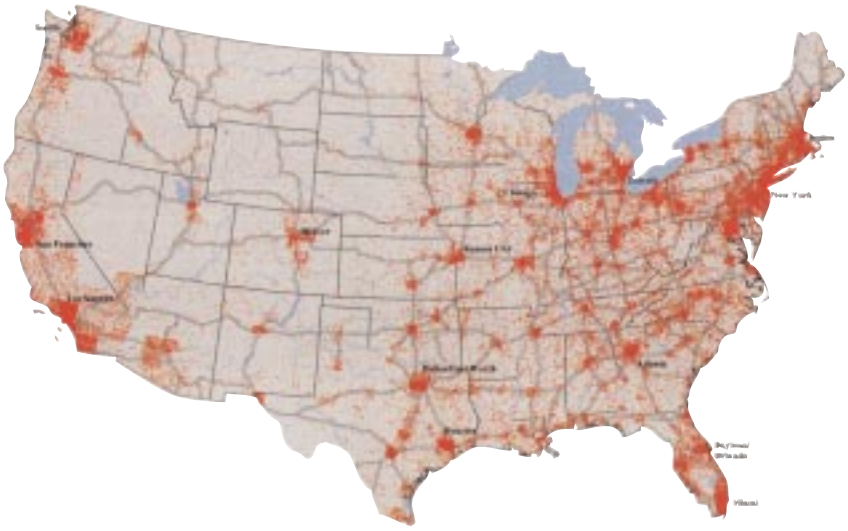

Figure 2. Population density of the contiguous United States by county in 1990. Credit: O'Connor Center for the Rocky Mountain West.

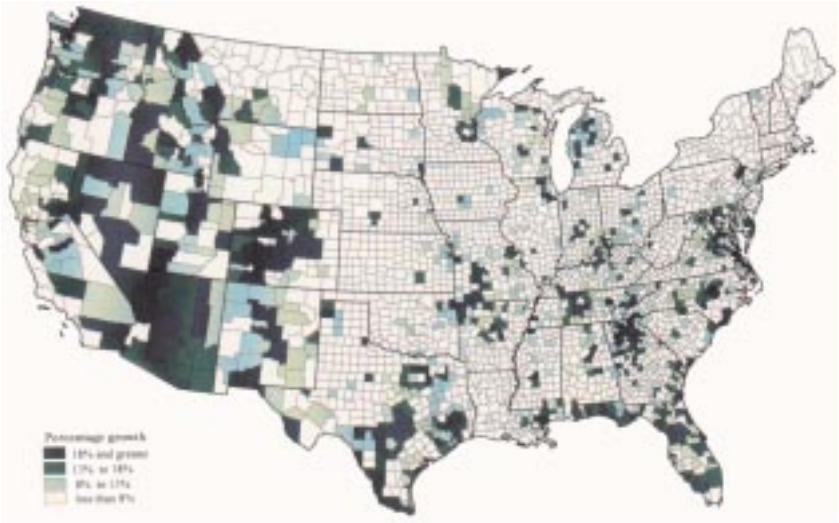

Figure 3. Fast-growing counties in the United States between 1990 and 1996. Credit: O'Connor Center for the Rocky Mountain West.

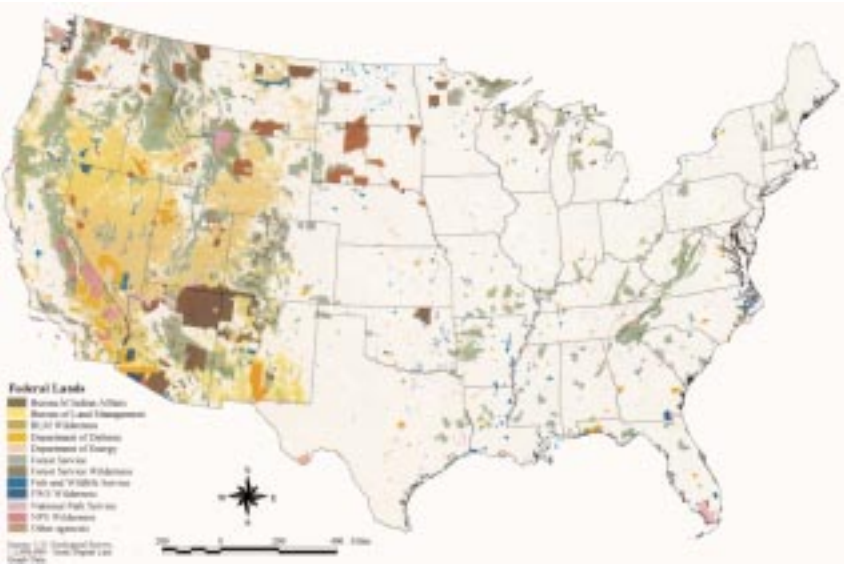

Figure 4. Federal government lands in the United States. Credit: O'Connor Center for the Rocky Mountain West.

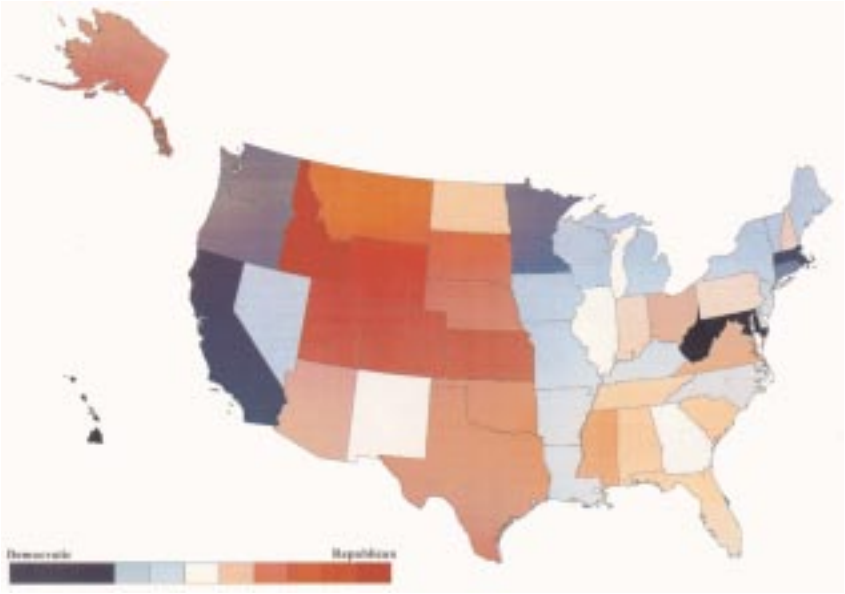

Figure 5. Political complexion of the United States: Composite of election returns from 1996. Credit: O'Connor Center for the Rocky Mountain West.

Add the region's rapid growth to the area comprising federal lands (Figure 4, which essentially maps the places that say "you can't grow here"), and you begin to get some appreciation for the specific challenges that the West faces.

Even politically, place matters (Figure 5). We've often tended to think of the South as having become a one party region dominated by the Republican party. Yet, the real one party region is the interior West. I'm not drawing any conclusions from that, other than to say that place matters in a lot of different ways.

I have another version of this map that delineates congressional districts. Although this map shows that the Pacific Coast states represent an entirely different political geography than the interior West, when you map congressional districts, you find that the dividing line is actually the Sierras and the Cascades. Politically, that's where the division occurs, and once you go over the crest of the Sierras and the Cascades, you're in a different political geography than you were on the other side. All of the coastal states have Democratic governors. It's clear that they have Democratic governors because of the people who live west of the Sierras and the Cascades, not those who live east of them.

Now let's bring the satellite's photography in closer to my own home, Missoula. Envision simultaneously the kind of political jurisdiction that John Wesley Powell said we should form in the West—a river basin like the Clark Fork drainage. Powell would have said that we should draw jurisdictional boundaries along the ridge lines dividing the Clark Fork drainage from the Clearwater and other neighboring watersheds. We would then have a Clark Fork jurisdiction with Butte up at the headwaters of the Clark Fork River, with the Bitterroot flowing north and the Blackfoot flowing west into the Clark Fork, both meeting at Missoula, and with the Flathead flowing into the Clark Fork from the north.

As it turns out, this river basin map corresponds remarkably with the way human activity has arranged itself on the landscape. At the O'Connor Center for the Rocky Mountain West, we have started trying to picture real places, real economies, within the West. We do this by looking at different kinds of economic activity.

The dark blue dots in Figure 6, for example, represent the distribution of the *Billings Gazette*. We can see that the *Billings Gazette* pays no attention to the Wyoming border; however, what it does pay attention to, as it turns out, is the drainage. This area represents essentially the Yellowstone River drainage and all of its tributaries. If we look at the distribution of the *Missoulian* (the green dots), and at the Clark Fork drainage, we see that we're really looking at exactly the same places as well.

In a similar way, when we look at a map of the hospital care service areas (Figure 7), we can see that the hospitals in Billings are major medical centers that serve the Yellowstone drainage. The hospitals in Missoula serve the Clark Fork drainage. We're increasingly recognizing that, in the global economy and the continental economy, places like Missoula and Billings can thrive, in the long term, only if they're aware of their fundamental interconnectedness with other small towns that surround them. It's a natural, organic connectedness that we have to be aware of.

When we use terms like "the Montana economy," we're basically talking nonsense. There isn't such a thing as "the Montana economy." There can't be such a thing as "the Montana economy." But there is *this* economy, surrounding Missoula, or the economy surrounding Billings, reaching into Wyoming. Increasingly we're going to have to pay attention to these real economies if we're going to do well in the very competitive atmosphere of the global economy.

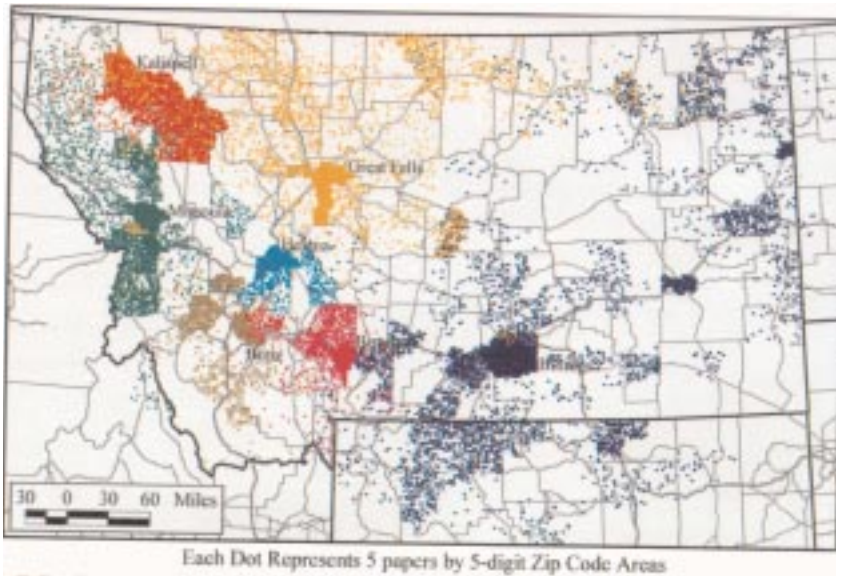

Figure 6. Newspaper distribution areas of Montana's largest daily newspapers. Credit: O'Connor Center for the Rocky Mountain West.

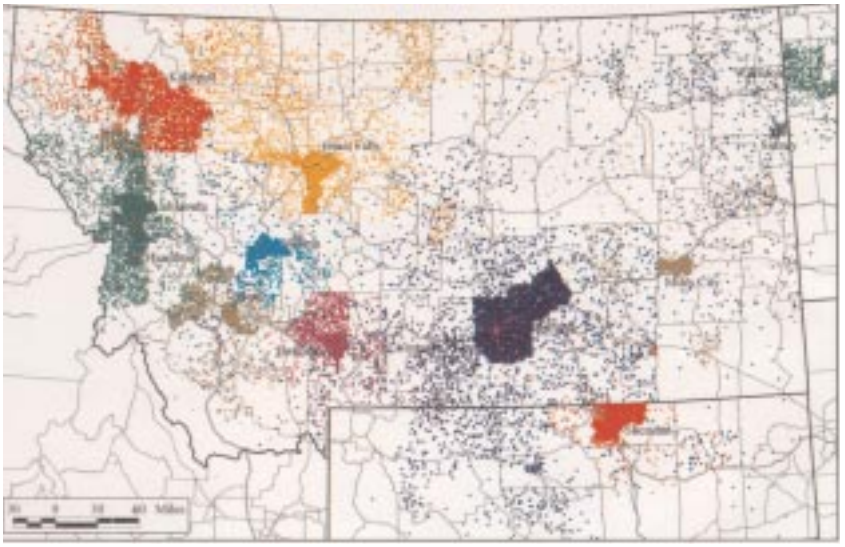

Figure 7. Hospital care service areas of Montana's largest hospitals. Credit: O'Connor Center for the Rocky Mountain West.

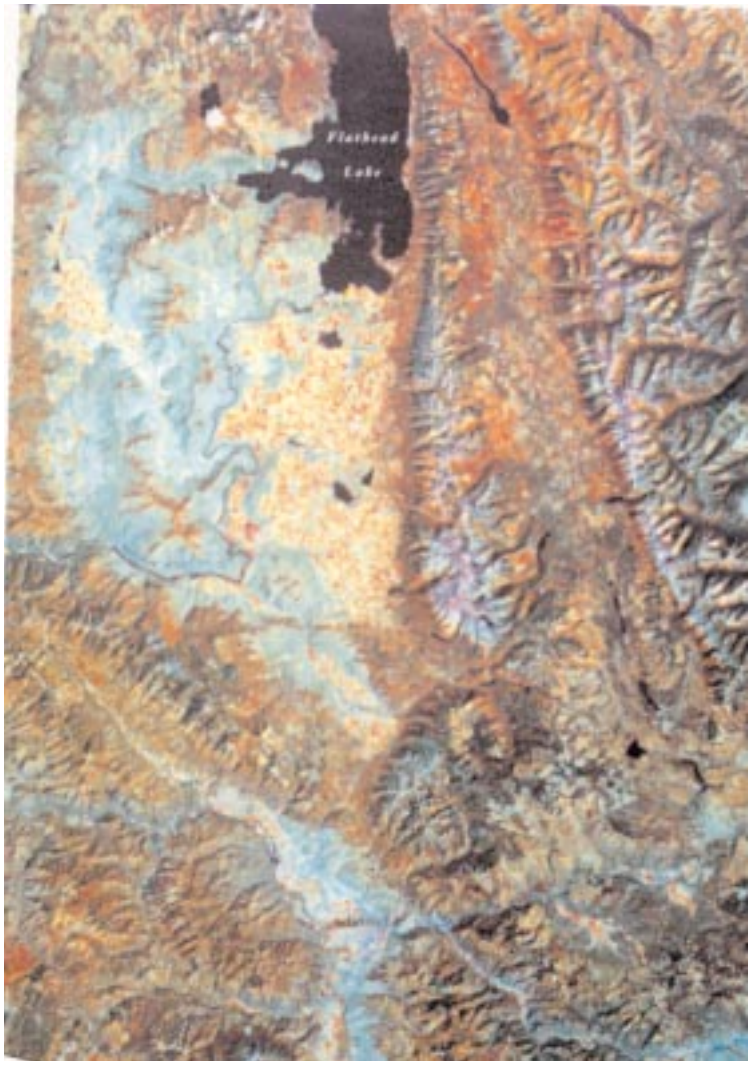

Figure 8. Northwestern Montana from space. Landsat thematic mapper scene acquired July 20, 1991 from 500 miles in space. Produced by: Wildlife Spatial Analysis Lab, Montana Cooperative Wildlife Research Unit, University of Montana. Autumn 1994.

Figure 9. Aerial photograph of Missoula, Montana (October 4, 1989). Credit: Montana Aerial Photography.

In another image made with satellite photography (Figure 8), Flathead Lake shows up clearly. The Mission Range shows up clearly. And, in the midst of all of these ecosystem features, one part of the ecosystem that emerges is Missoula. You can just barely see it beginning at the confluence of the rivers.

As we come down closer to Earth, this time with aerial photography (Figure 9), we see quite clearly how it is that Missoula is placed where it is, at the confluence of the rivers, and we begin to get some sense of how landscape defines the challenges that we face. The question for Missoula is, "Is Missoula's growth going to become compacted, with in-fill development here in the area where the city naturally exists, or is it going to sprawl?" This is the kind of question that, as mayor, I and my colleagues had to work with.

Standing on one of the mountains outside of Missoula and looking down into the valley, we don't even really know that there's a city there (see Figure 10). The clouds that we see might be the clouds we saw swirling around the Earth in the satellite photos. What we're aware of here is the power of the landscape—the mountains in the background, the unfolding of the valley. That's where, in fact, life takes place in Missoula.

Missoula is where it is because of the river, yet, strangely, for most of its history Missoula ignored the river, dumped trash in the river, and essentially treated the river as an intruder in the valley. It was only recently, during the same period of time that I've been talking about all these other things happening, that Missoula began to pay attention to the river, to develop riverfront parks and trails.

Missoula is not alone, by any means. It's only within the last 20–30 years that so many cities have begun to remember where they are. And, as we've remembered where we are and begun to develop these ways of being in these places that matter so much to

Figure 10. Clouds in the valley. Credit: Philip Maechling.

us, I believe that we've also begun to develop some ways of being together that hold great hope and promise.

Building community

Figure 11 shows an event that takes place now in a park that didn't exist 15 years ago in Missoula. Every Wednesday at noon, we have live music in this band shell at Caras Park, food vendors all around, and thousands of people—people of all ages—come down to enjoy just being together. For me as mayor, this kind of thing was very important. I am convinced that, in settings like this, people not only remember where they are, but they begin to remember something about what it takes to be neighbors to one another, how we have to treat each other in order to actually build a good life together.

One day when I was in the mayor's office, I had a call from my front desk to say there was somebody who had just dropped into the mayor's office, and she thought I should come and see him. I was pretty busy, and didn't really want to be interrupted in that way, but she said, "No, I really think you ought to come see this guy." So I went out into the outer office, and there was this guy with a horse in my office. His horse was a beautiful, hand-carved carousel horse.

Figure 11. Missoula's Caras Park during Out to Lunch. Credit: Satya Byock.

So I invited him in to tell me about his horse. It turned out that he had grown up in Butte where they had had a carousel. And he loved the carousel. He went on to become a cabinetmaker, but he kept his great fondness for carousels. He began to study carousels, and he eventually tried his hand at carving horses. He traveled around, and he came across some used carousel machinery. He put a second mortgage on his house, bought the carousel machinery, brought it back to Missoula, and kept carving horses.

When he came to my office, he had carved four horses. He said he was going to carve a whole carousel. He wanted to build that carousel, and he wanted to

know whether or not, when he got it built, the city of Missoula would give it a home.

I asked him how long was it going to take, and he said, "Well, at the rate I'm going, about 30 years." I figured I was in no position to promise him a home for the carousel at that rate. I sent him around to talk to service clubs and the park board and the redevelopment agency. Everyone loved the idea, and everyone started asking him if he could carve a little faster. And he said, "Well, if I didn't have to make cabinets all day, I could devote more time to carving."

Figure 12. Carousel of Missoula. Credit: Satya Byock.

So people started raising money to buy his time so that he could carve. It still wasn't fast enough. People started coming to him and saying, "You know, I've always wanted to carve. I could carve. You could show me how to do this." So he started holding carving classes in his garage. Way too many people showed up, so he approached the vocational technical school. He held classes there, and got many people trained at carving, really good carving. And he got hundreds of people involved in sanding, and varnishing, and painting, and so on.

Within three years we had this beautiful, totally hand-carved carousel that the whole community felt like they owned and were a part of—reaching entirely across generations with a sense of doing something wonderful together (Figure 12). I think it's something like this that people like Berry and Stegner and others are talking about when they say that, if you stick with a place long enough and pay enough attention to it, it starts to work on you in a way that can create something you might call "culture" or "a civilization."

Concluding remarks

Great blue herons nest on the Clark Fork, and we see them there frequently. Missoula artist, Monte Dolack, has whimsically painted what he calls "Heron Blues." He has a great blue flying over downtown Missoula late at night. The city looks like it's asleep. If the city is asleep, however, it seems as if it might be dreaming the heron. And, if it is, it seems like it's a dream of somehow coming back into connection with the place that we inhabit, somehow remembering where we are, and, in that remembering, coming to an awareness of our human potential. That's the potential we lost track of during the times when we had forgotten where we were.

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Ted Strong
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Reasonableness and Natural Resources in a Material World

It really is a pleasure to be here in this very distinguished setting. I would like to thank, first of all, Oregon State University and all of those who have been involved in putting together this remarkable series to help bring about informed discussion on critical issues affecting us in our everyday lives in the Pacific Northwest. I thank all who have taken part in ensuring that my treatment here has been what many of our down-home folk call "plain ol' good hospitality." That's been a large part of the welcoming here, and it's heartwarming to know that these kinds of societal values still exist.

I also thank the Starker family. Families generally will do everything within their power to raise good children, and I believe that the generations that have been a part of this family have exceeded these expectations. In addition to their success in raising great children, the Starkers have succeeded in raising community consciousness about qualitative values of life. We see that consciousness becoming an inherent part of community-based thinking, and we are all enriched for that. Each of us, whether we work in forestry or in finances, whether in politics or in tourism, realizes that we need community-based involvement in order to establish the flexibility and the resilience that are essential for dealing with the hard times we face today. That the Starker family has chosen to endow Oregon State University with funds to be used for these purposes is highly commendable. I hope that the legacy they are establishing is one that becomes a model for others.

Learning and teaching

I want to remind those who are here as students that we are lifetime students—we never stop learning. Our elders tell us that we continue to learn, even until the moment of our death (at which time we learn what the next life holds for us, if one chooses to believe in that). Much of our learning comes through living; life is our most inspiring teacher. When we are blessed enough to be our own teacher through self-realization, we come to realize that we don't know all the answers, and we come to realize that we couldn't craft the perfect solutions for many of our ills today—even if we had the authority and the power to try. Our minds have limitations. As wise philosophers have said, there isn't any one of us who is as smart as all of us. And it takes all of us as a community to advance the goals of better living. Academic institutions were designed with this in mind. They are a departure from the way of teaching in tribal culture.

Our way of learning and teaching proceeds as follows: People get together and talk about their life experiences. There is value in following those who have been down the trail ahead of us, and we rely on the collective recollections and the intellectual thought of elders who have come back to tell us what lies ahead.

We also believe that our elders are truthful. We believe that what is actually experienced in life as truth gives us a foundation upon which to build a core value system. What's different about this setting for learning and contemporary settings is that, from time to time, a place like Oregon State University will bring the public together to talk about things that are affecting us in our lives, and we come together as strangers, for the most part.

In close cultural settings, in close community settings, in the tribal villages, we begin our speeches by addressing our elders and talking about our relations. We acknowledge our clan systems, and we distinguish those who are our friends from those who are our relatives. In some senses of the word, friends have a greater value than relatives, but relatives have the greater strength.

These nuances are very important in how we tend to discuss and be open and honest with one another. Here today we come together as strangers. We require introductions. We sometimes question what is on a person's resume. This approach differs from the tribal one. I think that the challenge here is not so much to differentiate as it is to try to pull things together.

One land with mixed racial groups

Now, my collection of experiences, limited as they are, still gives me reason to hope that the best America is yet to be seen. If it can be said that we learn from our mistakes, then we must have learned an awful lot, because we can see our mistakes across the landscape. Whether that landscape be geophysical or political, we've seen what our mistakes do to us as a

people. Our effort is to be one nation living on one land with mixed racial groups, with a constantly competing political consciousness. If we understand politics as being the conscience of a community, then our community is in a dynamic state of change.

That's what America is all about. America did not start out to be a simple monarchy. America set out to become the very best of what could be—individually and collectively. The challenge is to enjoy our intellectual freedom to bring ourselves back together so that we don't destroy ourselves as a collective people.

A matter of discipline

If we consider natural resources in a tribal cultural setting, we see that *that's* where discipline comes from. We are told that a human can never exceed the boundaries of nature—at least not if he or she expects to survive. We aren't capable, as are aquatic creatures, of living in the water. We don't have wings for flight. We can't go beyond the reaches of the earthly limitations that tie us here. Nor can we get too close to the sun. We are told to keep our distance, to know these limitations.

In forest management, it's the same thing. In salmon management, it is no different. We are today with these vital components in the balance. We know that we recently passed the 6 billion mark in human population. We are outproducing just about every other species on this planet, and there doesn't seem to be any real end to it. At the same time, the US Fish and Wildlife Service, the National Fishery Service, and other relevant agencies say that a number of species go extinct frequently. We don't know if they are, in fact, valuable for our own use or not. We won't know sometimes until after they are gone.

In the Pacific Northwest, the big debates involve whether or not salmon are relevant to our existence, whether or not old-growth forests are undeniably linked to our well-being through health, economy, or otherwise. The foundation for these questions lies in our own community-based conscience. We're not here to judge; rather, we are here to put together, based on what is measured uncertainty, the best possible plans for our future.

Tribal people take their planning from the totally unique role of what we term our "sacred being," our holy people. Going back to the beginning of time, how and why were the first humans brought to this earth, and what is our purpose here? Why do we have such things as families? Why is it important to maintain the integrity of clanships, of tribal memberships, of racial groups? What's the purpose of all of this?

These things are discussed because we need to understand the integrity that is built into nature's ecosystems. Are there different kinds of trees in the forest? Do they have a unique relationship with birds, with other plants and animals, with water and air and light? Does the forest floor have a different impact than the forest canopy? What happens when we mix native and exotic tree species in a forest? What ability do forests have to develop immunity to the viruses and "bugs" that infiltrate them?

Tribal stories

I'm privileged to come here to say a little bit about what the tribes believe in, and I limit my comments to the tribes with which I'm most familiar—the Warm Springs, the Nez Perces, the Umatilla, and my tribe, the Yakama Indian Nation, all of whom I worked for as Executive Director of the Columbia River Inter-Tribal Fish Commission.

When we compare forests and our human families, we find similarities. They may be difficult to discern, because forests have different ways of talking to us. Whether or not we want to listen to our forests is something that we individually have to decide. Nonetheless, the similarities remain.

In the tribal stories of Creation, everything except the humans had a voice.

The humans did not have a voice, it is said, in the beginning. Our stories differ from those which might be considered to be part of Christianity or of evolutionary thinking, and we individually decide whether or not there's credence to these stories.

In the beginning of time, the forests had a voice. The forests were said to be the female species on this earth. The mountains and the rocks were the male species for us here. And each had a place in this beautiful Creation. Each had a very specific purpose. And the way that the male species and the female species were characterized, each with their given powers and each with their own strength and beauty to offer, created life.

The forests were said to be life-giving, beautiful. They were the holders of plants that were medicinal in value. They yielded to us their foods. They provided habitat for an abundance of mammals and birds and fishes. And it is said that the secrets of nature were most easily honored and revered by women, that men did not have that degree of sensitivity. Women were given the authority and the power in their homes to teach their children about what came from the forests, and women told their children what parts of the forests were sacred.

These parts were sacred for many reasons. Some of the parts of the forests we might discuss here today include places similar to the Garden of Eden. We know precisely where in the Pacific Northwest the very first salmon was created. We know precisely where the first steelhead was created. And trout. And sturgeon. We know where these places are, and we have songs about them. We have ceremonial offerings for them. These things are not ordinarily taught in schools of forestry. These are things that are set aside, perhaps as a footnote in mythology. The schools of forestry will describe all of management science, and then add, "Oh, yes, and Indian people believe this...."

This is what we believe, and the beliefs of tribal people have allowed for the development of sustainable forests generation after generation. We didn't have to manage the forests into health. They managed us into health. Their integrity, their power, their beauty, their life-giving powers gave to humans all that we needed.

Wanting more out of the forests

We believe that what is changing is that humans now want even more out of the forests. They want more in terms of economic and material goods. Further, humans seem to have an obsession to have dominion over all natural ecosystems, so we've got to prove that we are the ones in charge. By trying to prove this, we go out and we clearcut and we say it's good for the forest. Or we transplant different species into a forest, because the new species yield greater wood fiber, which converts into more lumber for more economic benefit. We say that we are managing the forests, and we pronounce what we do as "good," and we pronounce it in a way that says that we are in control.

But what has happened in the long run? Whether in the 1960s, when the US Congress passed the Multiple Use-Sustained Yield Act, the National Forest Management Plan Act—along the way, a decade at a time, we have taken our collective historical knowledge of forests, put it into some very good laws, and then ignored those laws.

When the Multiple Use-Sustained Yield Act came into being, forests were suddenly declared to be major watersheds. Multiple uses had to be respected, honored, revered, and utilized in such a way that the forests then would sustain those multiple uses, not for the next decade, but for the next 100 and thereafter hundreds of years.

But politics and economics provide a powerful resistance to these good intentions, and, after a period of time, one of the first mirrors that was held up to us

was the Endangered Species Act. When we looked into that mirror, we saw the ugliness that symptomatically showed us the near-extinction of the spotted owl. We saw that the forests were, in fact, habitat for millions of young salmon. We began to see the marbled murrelet disappear. We began to see the red-cockaded woodpecker disappear. That mirror that we looked into, we didn't like it. Today in Congress, there's a huge debate over whether the Endangered Species Act should be held intact or is costing too much in dollar terms to continue to implement.

Our challenge

The challenge for us here in this kind of a community is to decide what we are going to do about this. We can't blame just the schools. We can't blame just the industry. We can't blame just the environmentalists. We have to come together. We have to bridge these ideological differences. We have to make the best use of foundation money, as Oregon State University has here today. We have to be thoroughly informed. We have to be open-minded. And that's hard to do. But as Senator Inouye from Hawaii has constantly said to tribal peoples, "Before you can open one's mind, you have to open their heart." We've got to speak from where our feelings reside.

It's far too easy to come here and read a speech that was written intellectually, that calls on certain buzz words and phrases. It may sound good in terms of poetry and prose, but may not mean anything if people don't have a feeling to go along with it. We have the opportunity here to acknowledge these differences about feeling and intellect. We have the opportunity to put feeling into planning for forest management, salmon management, water management.

If the population of our world, the nation, and our respective states doubles in the next 50 years, and this urban sprawl that the metropolitan area frets over continues to grow; if we're tired of being in mad, rush-hour cluttered freeway systems each morning and evening, but we don't want to spend money on mass transit; if we're tired of potholes in our roads, but we don't want to pay the taxes to repair them; if we don't like the idea that we're having to rely on imports from other countries while we raise an abundance of agricultural products that we're shipping outside of the United States, then that's *our* problem.

We have a government that says it is a government *of* the people, *by* the people, *for* the people. It's convenient at times just to point to the politicians. Having worked for a number of years with the US Congress, the Administration, and with our governors, and having served on the Pacific Salmon Commission, I can tell you that two countries, supposedly two of the greatest democracies in the world, can't come to agreement on how to allocate salmon. To highlight this, many of you will remember the blockage of that Alaskan ferry boat in Vancouver. It almost set off an international incident. I can tell you that, at the negotiating table between the United States and Canada, that blockage became a divisive point. Our negotiations became stalemated. They virtually stopped. Misunderstandings almost created an international rift that could not be overcome.

My point is that we do this on a local basis as well. Urban dwellers fight with rural dwellers, and we create special-interest groups that put lines in the sand that nobody wants to step over. No one wants to imperil personal well-being to prove a point. When we consider what values we are going to bring to a public discussion, we know that each of us has inherited a legacy. It doesn't matter what walk of life we come from, we all can point to our parents and our grandparents, to our great grandparents and what they did, and to whether or not our ancestors came out here by wagon. If they did, they showed courage. They showed commitment. They died along the way. Many lost their children coming out here. Many children lost their parents.

Some of the most moving stories I have read are of settlers coming out here and of little children reaching Oregon without any parents, without any relatives. Some of them, through that adversity, became the most upstanding leaders of the Northwest.

I know that we have a great legacy that we can look back to. Those who came to experience the Northwest as a first-generation people can provide new perspective, fresh ideas that can help us invigorate our national resources planning. Those who have been here beyond two and three generations have a collective wisdom, tried and tested by time, to prevent us from having a divisive community in the future.

Our responsibility

Tribal knowledge is something that is hard to get across. It's hard to say, "This is how our people existed for hundreds of generations," when there is a scientific debate to be raised even about that. To me, Kenniwick Man is a crazy argument. What is the value of determining whether that skeleton is 4,000 years old, 10,000 years old, or 12,000 years old? What value does it have to say that skeleton was, in fact, a Native American, an Asian, a Northsman, or other? That debate is creating political and racial problems right now. The scientists who are behind this, tribal scientists, federal scientists, scientists from the industry, are being paid extraordinary amounts of money. This is where science acquires some of its own bad name. Almost as bad as lawyers, but not quite. Not yet.

We have the responsibility to ask, "How do we frame this discussion? How do we ensure that reasonableness is going to prevail in these discussions?" That's where academe has a responsibility. I think that sometimes institutions will allow themselves the privilege of selling their expertise for a monetary gain, and it's unlimited. Schools are perhaps the most integrity-filled of the institutions, but it does happen. Those of us who are in some way a minority, whether based on industry or religion or color, sometimes find that majority reports discount even those minorities with generations of knowledge.

We found this when we were dealing with the spotted owl. We found this when we were dealing with the salmon. The scientists of the Pacific Northwest, in speaking about salmon and science, collectively said that the hydrosystems of the majority party were responsible for most of the salmon mortality. Nothing really has been done about the hydrosystems. Harvest management of these same salmon is based on meeting goals and objectives for maintaining their populations prior to any harvest, so that they concur with sustained-yield management in forest operations.

The state, federal, and tribal biologists get together and say, "How many salmon need to pass McNary Dam to provide the spawning escapement and enough progeny to ensure the continued existence of the salmon?" Then 45,000 fall chinook are allowed to escape above McNary Dam before anybody fishes. That 45,000 escapement will multiply into almost 1 billion salmon eggs. After that escapement has been met, those who harvest the salmon are allowed to put their nets in. This happens irrespective of whether it's a traditional Indian dip net, whether it's a gill net, whether it's a weir, or whether it's a hook and line. The biological objective for ensuring the survival of that species has already been met. I believe that the initiative in the state of Washington that banned gill nets for commercial purposes was defeated, and by a large margin, because there was informed discussion about it.

Additional pressures

We are here with additional contemporary pressures—pressures regarding population, urban development, and housing. When I worked in Portland, one of the big issues involved the amount of land that was going to be set aside for

development. Land developers pushed real hard for 10,000 acres of new development lands. The Metro Council, working with others, ultimately approved about 4,000 acres. The fight goes on.

When I lived in the little community of Happy Valley, it was not happy because of development. Where I lived there, in a rather modest kind of home, huge homes were being built around us, the kind of homes that cost $400,000 and $500,000 and $600,000. What was even more strange was that the developers cleared all the trees to make way for development sites, and then started a project to plant trees to create parks.

We do things without really thinking, and we pay the costs. We're faced with overcrowded situations. It hasn't stopped. Nobody really can stop it. In my work with the President's Council on Sustainable Development to assess the quality of life in America relative to the quality of life in Mexico, we compared the city of Seattle with the city of Mexico City. We compared the state of Oregon with a province in China. We brought in scientists from around the world, and asked, "Why did some of the greatest civilizations in the history of humankind disappear? What happened to the Egyptian Empire, and what happened to the Turkish Empire?" These civilizations may have existed as world powers for as long as 700 years, but they disappeared.

Following the way of our natural resources

Some of the scientists told us that, if you look at these great civilizations, they followed the way of their natural resources. How long are we going to sustain our natural resource systems in America? The rivers are overappropriated, the forests are watersheds that are not being allowed to act as watersheds, overpaving is taking place with massive destruction from flooding in the Upper Mississippi and the Missouri, and the Ogalalla Aquifer, the largest in America, has shrunk by as much as 40 percent in the last several decades. I don't think these are just scare stories. I think this is reality.

Sometimes elected officials will say such things as, "There's plenty of bottled water on the shelves. Why are we worried about the Colorado River?" The Colorado River now runs dry in Mexico. It no longer reaches the ocean. We know too well about salinity in the Colorado River, and the impact that this has had on the agricultural community. We compensate by creating more chemicals to increase the soil's fertility. When we take an even broader look at agriculture, we see that experimentation has been taking place in the rapid development of salable food products. We see the absolutely horrible treatment of animals, such as beef fed their own growth hormones so that they will expand faster and be worth more on the market. The President's Council on Sustainable Development looked at human health, at what happens to humans who ingest this ground beef from animals fed literally the ground-up pieces of the stillborn babies of their own species, and at what is happening to our children.

During these sessions, we examined the scientific truth about some things in America. For example, we looked at findings that girls often are developing too quickly because they are eating the growth hormones given to beef as hamburgers at fast-food outlets. We are at the top of that food chain. We are seeing overdevelopment, and premature development of our children. If we look back through issues of *Newsweek* magazine, we see that, in the past few years, several issues have focused on children having children and the imbalance this creates in children's minds, in their physical make-up.

Couple this with our inability to provide adequate spiritual guidance and discipline, and we have a generation that we abuse. We allow these things in the development of America, and our children pay the price.

The President's Council on Sustainable Development tried to have open discussions, but you can imagine what happened. There wasn't anybody who was going to stand out in public and say, "We're going to end these practices." It's political suicide. What are elections about today? Are elections supposed to be about George W. Bush having $60 million and the vote is certain, almost assured? Where do we get the qualitative aspects in which we elect people who represent our own points of view?

The President's Council tried hard to look at public processes—how to get public involvement, what stimulates people to do things at a community-based level. We are the ones who are going to have to be bold enough to put the item, the controversial item, on the agenda and at the same time not raise controversy about it. We are the ones who are going to have to have a respectful discussion about it, to try to inform others in a respectful fashion. This is important to ensure that compromise isn't seen as giving up one's lifestyle, but rather as an accommodation that so many of those who framed the Constitution of the United States thought would occur.

This isn't about government. The early framers of the Constitution felt that government would rest very lightly on its people, that government would not tell us what we can and cannot talk about. We have to be able to convince those in government that these are our priorities. This means that the range of discussion needs to be expanded. We can start with forests, and, because of all of the interconnected issues, we'll branch out quickly to a lot of other things.

Concluding remarks

As I said in the beginning, and it comes down to the human aspect, that the male and the female of this world were given charge of life. We have to take care of what that life is going to be like, what it's going to look like, what it's going to talk like, how it's going to be present. If we don't care enough about the life that we are bringing into this world, then we have no right to complain about things that reflect some of the ills of society, like the shootings that took place in schools near here, and the shootings that took place at Columbine in Colorado, and the killings that took place yesterday in Seattle, and the day before in Hawaii, and so forth.

We don't have to tolerate this kind of violence. We can preach a little bit more about things that are of love, kindness, courtesy, and respect. But we need to do more than preach it. We need to practice it.

I appreciate the opportunity to be here, and again extend my deepest appreciation to the Starker family for making this possible, and to each of you who create the possibility to change things. It's possible that, as we gather to do something about our problems, we're going to touch upon an individual's conscience. We can only hope and pray that each of us individually can work to make this collective realization about community-based planning something that will reflect favorably upon us, that the students who are here will see the value in this, that they will assume their place of responsibility and carry this even further. They have the prerogative to improve upon whatever they see as our limitations.

My challenge to the students who are here is this: Don't just condemn those of us in this generation for not having done everything to your expectations. Make things better. And honor what hard work has been done by those generations who have gone before you.

Questions and Answers

Question: You alluded to the problems with the dams and the rivers, especially the management of the salmon. The Fraser and the Columbia are parallel

streams, and have a great deal in common. One thing that they do not have in common is dams. There are no dams on the Fraser, but the Fraser has seen dramatic drops in its salmon populations, quite parallel to what's happened on the Columbia. Would this argue that something besides the dams is having a massive effect on the salmon? What is the parallel between the Columbia River here and the Fraser River in Canada? Both had abundant salmon populations at one time.

Strong: The Fraser River does not have dams as a major killer of salmon, that's true. What both rivers have, bottom line, are humans, and that's what I think makes the biggest difference. Now, the Fraser River still enjoys sockeye runs that are as large as from 15 to 17 million sockeye a year. This last year they expected a banner run, and it didn't happen. You're correct in saying that some other activities are causing mortality, and overfishing is one of them. That's what the Pacific Salmon Commission negotiations are all about.

One of the other things that are affecting salmon populations is habitat. When we look, for example, at the habitat conditions for the Columbia River salmon, we can ask, "What has the effluent from the Hanford Nuclear Reservation really done?" In the 1940s, studies done by the University of Washington showed that iodine and heavy metals that were in the effluent were destroying the reproductive organs of salmon.

Now Canada is beginning to experience some of its own pollution problems, and pollution in the river creates some of these same problems. Salmon migrate, carry some of these pollutants with them, and this lessens the ability of the salmon, these sockeye salmon, to reproduce.

Some of the salmon seasons in Alaska and Canada are no longer measured in days; rather, they're measured in hours because of our tremendous catch-ability. Some of the ships out there catch more salmon in 4 hours than they used to catch in a week of fishing.

There are these problems, and they all have to be brought to the table. In the Pacific Northwest, these problems are being addressed as the four "H's"—hydrosystems, hatcheries, habitat, and harvest. All four are being put on the table collectively.

Question: You indicate the need for reasonableness in our discussions. I was wondering how you suggest we go about achieving this.

Strong: I think, first of all, reasonableness comes from our actions and our tone of voice. People will come to the table and say, "Well, I'm here to reach consensus." But they're kind of glaring at you, and they're kind of pounding the table.

I think the more dignified approach is for people to come together and talk to each other, and not from prepared scripts, when they want to reach agreement. If my wife and I argue about something, she's sure not going to let me bring a statement from my lawyer and say that this is reasonableness. She wants to talk. And sometimes that talk might get a little animated. But reasonableness has to be there, and trust has to be there, too.

As a society we kind of grow apart. We've become kind of distrusting of each other because we think, "Well, they've got their own agenda. They're going to try to sway me into that kind of thinking." But reasonableness requires that we consider what is at stake, the consequences. Are consequences such that everyone might lose, instead of one person happening to win a court fight, for example?

Some of what we might understand as reasonableness comes from our old-time teaching. For example, my father spoke, for the most part, broken English. The farmers who lived down the road were white farmers who were poorer than us, and I couldn't imagine that. But this was a

Dutch community. People who came here were first-generation. They had nothing.

Reasonableness for them was to come to us, despite our differences, and say, "Can we share our equipment?" My father was the first to have a tractor. And they shared that. And he never asked for anything, but they still would reciprocate. They were good farmers. They would bring back corn, and they would bring back potatoes. They'd help us build underground cellars, and we'd fill them up. And they would come over and take part in our tribal ceremonials. They would come and sit with us all day and all night. That's reasonableness. But it was also survival.

We can't be reasonable when we have an economic goal, when we're pounding the money in our pockets while we're sitting there talking to someone, or when we're feeling like, "Okay. They're going to have this press conference immediately after this meeting, and they're going to go out there, and they're going to put their spin on it, and they're going to make me look stupid." We are in this thing anymore on a quick-fix basis. We want everything done immediately.

Reasonableness means controlling the agenda, setting the proper amount of time aside, acting with sincerity. In some respects, it's not reading the scientific and eloquently written, lawyerly type statements, but rather letting people speak from their hearts and their consciences. Some of that, I think, is what has proven successful in reasonableness for the tribes, states, and federal governments that have been at work.

Nancy Langston
Assistant Professor, Forest Ecology and Management, University of Wisconsin, Madison; author, *Forest Dreams, Forest Nightmares*

An Environmental History of Old Growth in the Blue Mountains of Eastern Oregon

In my work on the causes of the forest health crisis in the Blue Mountains, I meet many people in small timber communities who complain bitterly about the federal agencies, particularly the USDA Forest Service. They feel powerless, hemmed in by regulations they have no control over and by policies they have little hand in shaping. They feel that the Forest Service is not responsive to the needs of their communities for predictable timber supplies.

All this is too often true. But people often go on to tell an interesting—and deeply flawed—story of what life had been like before the Forest Service came to the area. "Before the federal foresters came, it was all different," they say. "We lived in plenty, we worked out our own problems, the trees were abundant, the mills were running, the towns were thriving. Then came the Forest Service, and they took away our access to timber and our control

over our own lives." The implication of these stories is that, if we get rid of the "feds," we will have control over our forests again.

What is wrong with this version of history? In truth, before the Forest Service came to the Blue Mountains, local mills and local communities were often in a much worse situation than they are today. They had very restricted access to resources, because midwestern timber companies had monopolized access to timber and railroads. In Oregon and Washington, large California ranching operations controlled access to water. Locals were locked out. Out-of-state operations controlled resources and were depleting them without any thought for the region's future.

This was not a paradise, a land of free resources or local control. Instead, it was a mess, with rampant abuse of laws and land. Unrestricted exploitation was destroying local hopes for local communities—and, in parts of the timber-dependent West, locals often urged the federal government to come and help regulate disputes. The Forest Service was welcomed by many locals—sheep-herders, small mills, irrigation companies, some ranchers—precisely because they felt that out-of-state monopolies were depleting resources without thought for their communities' future.

One of the Forest Service's central goals was to ensure a stable, continued, fair supply for locals by careful conservation of forests, water, and grasses, so that local communities could use a sustainable amount, for centuries, without depleting the sources of that potential prosperity. Obviously, something went wrong. In the western forests and grasslands, a series of very bad scientific and policy decisions turned this dream into a nightmare for many human communities—and for many forest communities.

Across the Pacific Northwest, Forest Service timber sales have declined precipitously over the past decade. Many mills that depend on Forest Service timber for a substantial part of their supply have been forced to lay off workers or shut their doors entirely. Even though certain sectors of the Northwest's economy are booming, many timber-dependent communities, such as Enterprise, Oregon, are suffering. Not surprisingly, the blame often has been placed on environmentalists keeping trees from the mills, spotted owls, and the Forest Service.

The problem with declining timber harvests lies much deeper than this. Policies that were set in motion nearly a century ago have led to our current troubles. As I'll argue here, federal forest planners during the 1920s knew that timber supplies would collapse by the late 1980s if they continued with their management goals. They decided to proceed anyway.

Forest Service scientists and planners made their decisions, not because they wanted to destroy the forests or the mills, but because they wanted to make both sustainable. We need to understand the mistakes they made, not so that we can blame them, but so that we can learn from their errors—and from their many successes. If we want to reach a fair and sustainable future for forests and the communities that depend on them, we need to understand our shared forest history.

The Blue Mountains of eastern Oregon

My case study is the Blue Mountains of eastern Oregon, where, for nearly a century, foresters attempted to use the best ecological research of the day to transform old-growth forests into regulated, scientific forests. In 1991, the Forest Service published the *Blue Mountains Forest Health Report* (Gast 1991), which argued that many forests of the Inland West seemed to be on the verge of ecological collapse. Less than a century of Forest Service management had led to substantial changes in forest composition and structure across the West, specifically in the Blue Mountains.

When European settlers first came to the Blue Mountains, they found a land of lovely open forests full of ponderosa pines 5 feet across—fire-resistant, insect-resistant forests that had been growing for centuries. These were forests so promising that immigrants thought they had stumbled into paradise. These forests were nothing like the humid forests to which Easterners were accustomed. Most of the forest communities across the Inland West were semi-arid and fire-adapted, and the newcomers had no idea what to make of the fires.

After 90 years of federal management, millions of acres changed from ponderosa to fir, and then from healthy fir to drought-stressed, insect-defoliated fir. On the Wallowa Whitman National Forest in 1912, 71 percent of the stands were open and full of old ponderosa; by 1991 only 10 percent fit this description. On the Malheur in 1938, 78 percent of the forests were open ponderosa stands; by 1980, less than half those were still ponderosa forests. Most of the remaining forests were dominated by young fir trees (Langston 1995). The pines had resisted most insect attacks, but the firs that replaced the ponderosas were the favored hosts for numerous defoliators, such as spruce budworm and Douglas-fir tussock moth. As firs invaded the old ponderosa forests, insect epidemics became increasingly frequent and extensive throughout the dry western forests. By 1991, on the 5.5 million acres of Forest Service lands in the Blue Mountains, defoliators had attacked half the forest stands; in some stands, nearly 70 percent of the trees were infested (Gast 1991).

Even worse in the view of foresters and many locals is the threat of catastrophic fires. Although light fires had burned through the open pines every 10 years or so, few had become crown fires. As firs grew underneath the pines and succumbed to insect damage, far more fuel became available to sustain major fires. By the beginning of the 1990s, one catastrophic fire after another swept the Inland West, until it seemed as if the forests might go up in smoke entirely.

Old growth faced the most drastic losses; probably less than a tenth of the presettlement old-growth forests remained by the early 1990s. Surviving old growth had become extremely fragmented; by 1993, 91 percent of the old-growth forests existed in patches of less than 100 acres (Eastside Forests Scientific Society Panel 1994). When the Forest Service first arrived, those mature forests stretched for hundreds of thousands of acres. For example, the Malheur National Forest once contained some of the finest stands of open ponderosa pine in the nation. In 1906, one report stated that an open, old-growth ponderosa-larch forest covered 800,000 acres south of the Strawberry Mountains (Erickson 1906). Fewer than 8,000 acres of these same old-growth ponderosa forests remained in 1993—less than 1 percent of what was present before the Forest Service began management. The forester R. M. Evans (1912) wrote that, on the Wallowa and Minam forests in 1912, there were nearly 600,000 acres of uneven-aged forests containing more than 80 percent ponderosa. About half a million acres—or 85 percent—of these ponderosa-dominated forests were old growth. By 1991, only 18 percent of the forests on the Wallowa Whitman National Forest was mature or old-growth stands, and very little of those were ponderosa. The rest of the forests were dominated by young fir trees (Langston 1995).

In part, the landscape changed for straightforward, ecological reasons. When foresters suppressed fires in open forests dominated by ponderosa pine, firs grew faster than pines in the resultant shade, a successional change that left firs dominating forests. Heavy grazing, which eliminated the grasses that had suppressed tree generation and kept forests relatively open, also contributed to the changes. High-grading, logging

that removed old pine and left the firs behind, encouraged the replacement of open pine forests with dense fir stands. When droughts hit, firs growing on dry sites succumbed to insect epidemics (Langston 1995).

But the story is much more complex than this. Changes in the land are never just ecological changes. People made the decisions that led to the ecological changes, and they made those decisions for a complex set of reasons. Many environmentalists claim that things went wrong in the Inland West because of simple greed. The Forest Service worked hand-in-hand with the industry to cut trees as fast as they could, and this action devastated the forests. The problem was too much management. Excessive harvests, soil compaction, high-grading, and even-age management—all of this led to a simplified ecosystem that became increasingly susceptible to epidemics.

Many other people claim just the opposite. The forests fell apart, they say, because the Forest Service bowed to the demands of sentimental preservationists and refused to manage intensively enough to save the forests from natural enemies: fire, insects, and disease. In their view, the best way to make forests healthy is to manage them as intensely as possible.

These two perspectives on the history of forest health problems obviously lead to radically different management prescriptions. Neither of these stories, however, tells the whole truth. Forest problems did not come about because of greed, incompetence, or poor science; better science alone would not have prevented the current crisis.

Across the Inland West, the troubled history of land management has its roots, not in ignorance, but rather in American visions of the proper human relation to nature. Foresters shaped western landscapes according to a complex set of ideals about what the perfect forest ought to look like, and what people's role in shaping that perfect forest ought to be. But foresters' ideals—like all ideals—were also shaped by material reality. Logging technology, developing markets for lumber products, the economics of silvics practices, and what Rich Harmon (1995) calls "the unrelenting pressures...aimed at government officials to make public resources available for private profit" all affected foresters' vision of the ideal forest. These things also shaped the ways foresters managed the land.

Old growth and science in the young Forest Service

What did the Forest Service do to bring about these changes? Many people in the Blues now say that the forests changed because early foresters knew little about ecology or succession or fire suppression. Nobody expected succession to happen. Foresters did not even think about succession; they were ecological innocents out there cutting trees. One day the foresters woke up and noticed, with panic, that their 5 million acres of lovely, open pine stands had changed to tangled forests full of fire and bugs and dead firs. The implied moral of this story is that, now that we know so much science, we will not make any more mistakes; we can use science and salvage logging together to solve the forest health problem. The early silviculture reports, however, make it clear that the first foresters in the Blues were among the best ecologists in the country at the time. For example, many such as Arthur Sampson had been students of the premier American ecologist, Frederic Clements. Moreover, they were obsessed with preventing the succession of pine forests to fir forests. Nevertheless, they accelerated exactly the changes they were trying to prevent (Langston 1995).

To understand what the Forest Service has done with the Inland West, we need to understand foresters' attitudes toward old growth, science, and politics. At the turn of the century, America was

in a furor over land management. Disposal of the vast tracts of western land was an enormously corrupt process, and, to many Americans, the federal government seemed to be more corrupt than anybody else when it came to managing land. The new forest scientists stepped in and said, "Science will show us a way out of this chaos of political corruption, if you just leave it to us." By turning to the clear, calm, seemingly universal rules of science, foresters tried to avoid the mess of contentious politics and the contingencies of history. They believed that they could introduce science into the mess of land management, and make a better society as well as a better nature. As scientists who had the interests of America and American forests at heart, they thought they were beyond criticism. They alone could serve the public good, they felt, because efficiency rather than short-term profit was their goal.

The Forest Service came to the Blues with the best of intentions—to save the forest from the scourges of industrial logging, fire, and decay. When they looked at the Blues, they saw two things: a "human" landscape in need of being saved because it had been ravaged by companies and the profit motive, and a "natural" landscape that also needed saving because it was decadent, wasteful, and inefficient. Not only were federal foresters going to rescue the grand old western forests from the timber barons, they were going to make them better. Using the best possible science, foresters intended to make the best possible forests for the best of all possible societies: America in the brand new 20th century.

In the eyes of the early conservationists, western old-growth forests and timber barons shared a basic flaw: both were wasteful. As the historian Samuel T. Hays argued, the point of American conservation was to reduce waste and increase efficiency. A Umatilla National Forest press release dated September 12, 1906, put it well: The intent of conservation was to "hunt down waste in all its varied forms" in waters, forests, lands, and minerals (Umatilla National Forest 1906). Waste existed, not when people overused resources, but rather when they failed to use them fully enough. Any water that wasn't used for irrigation was lost forever; any grass that wasn't eaten by a cow went to waste—or so the press release insisted. If people did not put everything to full use, it was a moral failure, not just an economic loss.

Early government foresters had several strong articles of faith. First, the point of forestry was to reduce waste and make forests more efficient—which meant making them produce more timber, more quickly. Second, America needed wood, and demands would continue to increase as quickly as they had increased after the Civil War. Third, if harvesting continued as usual, the country would run out of timber in 25–30 years. Fourth, forests ought to be used, scientifically, to ensure a perpetual supply of timber for a growing nation. Finally, scientists were best at solving land-management problems, and so scientists, rather than politicians, ought to control the Forest Service (Clary 1986). Trained scientists—professional foresters—would redesign the old-growth forests to improve them, and thus ensure a perpetual supply of timber for a growing nation.

Two major tenets of scientific forestry were developed during this period. First, foresters should encourage the growth of young trees by suppressing fire, and, second, foresters must replace old growth with regulated, rapidly growing forests. Fire seemed to threaten the forests by killing young trees, and, because foresters were certain that young trees were the future of the forest, fire was clearly the enemy. Sparks from the logging railroads set alight piles of slash and dead wood left after cutting, and the resultant fires burned so hot that little grew afterwards. The foresters decided that, to protect the pine forests and the water supply, they needed to keep fire out and encourage reproduction.

The Forest Service was convinced that, the more young pines they had, the more merchantable pine would necessarily follow. For example, managers suppressed fire because they thought light fires would kill all the young trees. Competition, which is fostered by dense stands of young trees, would surely create vigorous, manly trees; without competition, weaklings would result—or so the foresters reasoned (Guthrie 1933). The opposite turned out to be true, unfortunately. Firs and pines failed to thin themselves, nor did they recover from suppression when they were artificially thinned after their first decade of growth. Without fires to thin them, what resulted was not a few big trees, but a thicket of stagnated trees, all the same age.

The second, related tenet of scientific forestry was to liquidate old growth, and replace it with a young, efficient forest. Attitudes toward old growth played a critical role in how foresters have transformed American forests.

At the turn of the century, European foresters defined old-growth forests (also called "decadent" or "overmature" forests) as forests in which annual growth did not exceed annual decay. In contrast, scientifically regulated forests were young and still growing quickly, such that they added more volume in a year than they lost to death and decay. More importantly, they were growing in an orderly fashion, so that each year the exact same number of trees became available for harvest—ideally, for eternity (Parry et al. 1983). Scientific forestry, later known as sustained-yield forestry, required regulated forests so that the annual net growth could be harvested each year. The reasoning was that, in a regulated forest, loggers could harvest the net annual growth forever, without ever depleting the growing stock. The economic analogy is obvious. The harvest was equal to the interest; the growing stock was equal to capital; and no sensible businessman and no sensible forester would want an investment in a bank that paid no interest, or in an old-growth forest that produced no net growth.

Within American forestry, the emerging hostility toward old growth developed, not directly from European silviculture, but rather from an American anxiety about how different American forests were from European, scientific forests. Most European foresters laughed at the idea of scientific forestry ever succeeding in America. "Too much old growth," they said. "Way too many old trees." German foresters in particular said that American forests were ill-suited to scientific forestry because they were too big, too wild, and too decadent.

American foresters were frustrated by this scorn, because, if the idea of American forestry was absurd, then American foresters were even more absurd. As Gifford Pinchot (1947), the father of the Forest Service and the father of American forestry, wrote in his autobiography, "We distrusted them and their German lack of faith in American forestry." When Pinchot persuaded his family to establish the Yale Forestry School, the school's purpose was avowedly American: "To produce American foresters trained by Americans in American ways for the work ahead in American forests" (Pinchot 1947).

Americans were determined to prove that American forestry was possible, but they did this, not by transforming the ideals of European silviculture to fit American forests, but by transforming American forests to fit European ideals. This meant cutting old growth, because old growth was what made American forests different. Even while American foresters bragged about the grand, huge American trees that outdid anything European forests could offer, American foresters did their best to eliminate those trees and make their forests more European. In Pinchot's writings and in the young Forest Service, a tone of impatience and hostility towards old growth emerged, and the emphasis on eliminating inefficiency and waste increased. The wild forest was not evil, as it had been for the Puritans, but it was thoroughly in the way of progress.

The logic of the new Forest Service was a simple one. If the United States was running out of timber, then the best way to meet future demands was to grow more timber. According to Forest Service surveys in the early 1900s, more than 70 percent of the western forests was old-growth stands, and this meant that western forests were losing as much wood to death and decay as they were gaining from growth. Preserving old growth would only delay the timber famine, and the end of American civilization—it would never prevent it. So, to prevent a famine, old-growth forests needed to be liquidated, and then regulated, sustained-yield forests could be grown instead. The best way to free up the land for growing, regulated production was to push sales of old growth. This logic shaped a Forest Service that believed it necessary first to destroy a forest in order to protect it.

In 1911, C. S. Judd, the assistant forester for the Northwest region, told exactly this to the incoming class of forestry students at the University of Washington. A timber famine was on its way, unless the Forest Service did something quick. Because the forest was running out of trees, the way to fix the problem was to get national forest land to grow trees faster. As Judd put it, "The good of the forest...demands that the ripe timber on the National Forests and above all, the dead, defective, and diseased timber, be removed." The way to accomplish this was to "enter more actively into the timber sale business." This would get rid of the old growth, freeing up land to "start new crops of timber for a future supply" (Judd 1911). As Frederick Ames, another Blues' forester (and eventually Chief of Silviculture for the nation), said at a supervisor's meeting in 1906, "From no point of view can we make any mistake in cutting timber of this class [old growth]. The more sales we make the better"(Ames 1910). The unregulated, old-growth forest was something to be altered as quickly as possible for moral, not just economic, reasons, to alleviate what Blues' forester Thorton Munger termed "the idleness of the great areas of stagnant virgin forest that are getting no selective cutting treatment whatsoever"(Munger 1936).

Armed with their conviction that old growth was decadent and wasteful, foresters set out to clean up the forest, thus making it as productive as possible. Every early sales contract and management plan stipulated that contractors had to remove all snags, dead wood, and insect- and fungi-damaged trees from the cutting site (for example, see Miles 1911). Foresters believed that disease, dead wood, old growth, and fire all detracted from efficient timber production. In other words, they were assuming that the role of the forest was to grow trees as fast as it could, and any element that was not directly contributing to that goal was "bad." Whatever was not producing timber competed with trees that could be producing timber, foresters believed. Any space that a dead tree took up, any light that a fir tree used, any nutrients that an insect chewed up—those were stolen from productive trees. If timber trees did not use all the available water, that water was wasted. If young, vigorous pine trees did not get all the sun, that sun was lost forever. These assumptions made it difficult for foresters to imagine that insects, waste, disease, and decadence might be essential for forest communities, and that indeed the productive part of the forest might depend on the unproductive part of the forest.

Liquidating old growth

What effect did all these grand visions of scientific forestry have on the public forests themselves? Until World War I, the answer is, "Very little." For all the foresters' desire to cut old growth, the Forest Service sold minimal timber in the Blues until after the war. Forest Service timber was inaccessible, prices were set so high that few contractors were willing to invest, and the industry still had enough private stock to make sales of

federal timber unattractive. After the war, however, markets for national forest timber opened up, and the Forest Service began to push sales of ponderosa pine in the Blues. This in turn enabled them to begin the campaign to regulate the forests by liquidating old growth.

The Forest Service believed that, to ensure local prosperity, old-growth forests needed to be converted to regulated forests that could produce harvests forever. To regulate the forests, planners needed markets for the timber, and they needed railroads to get the timber out to the markets. Railroads were extraordinarily expensive, particularly after the First World War. Financing them required capital, which often meant attracting investments by midwestern lumber companies. Yet these companies were going to be interested in spending money on railroads only if they were promised sales large enough and rapid enough to recoup their investments. In the Blues, as across the West, this activity often damaged both the land and the local communities that depended on that land.

Consider the Bear Valley Working Circle sales on the Malheur National Forest—home of finest stands of old-growth pine in the nation, over 800,000 acres covered with old ponderosa forest (Langston 1995). In 1922, the Forest Service offered nearly 1 billion board feet of government timber in a single sale there. Local residents had petitioned the Forest Service to put the timber on the market—a mill would offer jobs, and, more importantly, a railroad would ship local products such as livestock and minerals, as well as timber, out to eastern markets. Railroad development had stopped short of the Blues, and from the locals' perspective, anything that would end their isolation from national markets was desirable.

The Forest Service angled for a buyer powerful enough to finance 80 miles of main railway line and hundreds of miles of feeder lines, along with a mill which would require several million dollars initial outlay. Only extremely rapid logging could justify these costs. The first contractor, a midwestern company called The Herrick Lumber Company, began work on the railroad—financed not with its own money, but with money raised by selling options on public timber. After selling a good deal of timber to finance a railroad that never appeared, Herrick defaulted. This led to a huge scandal, for local Forest Service employees were accused of collusion in stealing public timber. The Supreme Court eventually ruled in favor of the Forest Service, but the controversy shook the confidence of the Forest Service, which felt compelled to get the railway built.

By lowering prices and promising even more timber, the Forest Service persuaded another midwestern company, Hines Lumber Company, to invest. Three times during mill and railroad construction, the company threatened to default, and three times the Forest Service extended more sales, at lower prices, to keep it from doing so. Eventually, the Forest Service sold a total of 1 billion board feet off of three watersheds—out of only 7 billion board feet on the entire forest—in just 2 decades.

The Forest Service thought it could use pine to finance local development, but hadn't realized how tangled the webs of financial obligation could become. At each step in the contract disputes, the Forest Service ended up selling timber much more quickly than it ever had intended.

Mill capacities soon exceeded 135 million board feet a year—18 times the sustained-yield capacities (which were themselves calculated, not on the basis of the land, but on the basis of what the ideal regulated forest could produce once it was in place—calculations based on much moister, faster growing westside sites). Once the mills were in place, the Forest Service was caught in a tangle of demands, and could never easily resist the pressures to keep the mills running. And so, even though planners realized that they were harvesting pine at much greater than sustainable rates, they felt

they could not reduce the harvest without devastating local communities.

In trying to get contractors to buy timber, the Forest Service made extensive compromises in hopes of attracting business and liquidating the old-growth ponderosa as fast as possible. The Forest Service initially had a strong policy against high-grading—the practice of cutting out only the most valuable ponderosa from a mixed stand, and leaving behind the less-valuable trees to form the basis of the future forest. Correspondence among those planning the sales indicates that contractors were refusing to cut less valuable trees. Rather than force them to meet their contracts, the Forest Service quietly looked the other way. Soon contractors began to demand a reduction in stumpage prices. They claimed that they should be given a discount on ponderosa if they had to cut any other species at all. At this point, in 1922, the Forest Service decided that continuing to insist on cutting firs would mean that no one would buy ponderosa. The policy against high-grading was dropped (Assistant Forester 1922).

Beginning in the 1920s, the Forest Service also decided that the best way to increase harvests was by relaxing its conservative silvicultural ideals. These ideals required light selective logging, encouraged the retention of large trees for reseeding the logged-over site, forbade high-grading, and regulated the use of destructive logging machinery. For example, in 1922, the Forest Service in the Blues began to allow contractors to remove 85–90 percent of the mature forest in each sale, leaving only 10–15 percent as a reserve stand for the next harvest cycle (USDA Forest Service 1922). Loggers were allowed to skid out the timber with caterpillar tractors, even though before 1922 the Forest Service had discouraged tractor skidding because it damaged young growth. In addition, the Forest Service had originally required that big pines be left in the reserve stand as seed trees. In the 1920s, however, the Forest Service abandoned this policy, and told contractors to cut all the pine over 15 inches in diameter on a sale area (USDA Forest Service, no date). Many foresters now argue that light selective cutting destroyed the ponderosa forests by encouraging fir, but the silvicultural compromises of the 1920s, rather than light selective logging, helped ensure that fir would take over the mixed-conifer forests.

Concern about the effects of intense harvests on local communities began to emerge in plans during the late 1920s, even though foresters did not allow this concern to decrease their recommended harvests. To make sure that every sale fit into the overall plan for regulation of the timber in each national forest, planners broke each forest into several units, called “working circles.” Working circles were areas of land with boundaries defined by the markets for the timber. In general, a working circle included all the timber that would feed into a single, large mill. Each working circle had a management plan which outlined the orderly harvest of the timber within that circle. These plans were combined for each forest to produce a forest plan.

In the Malheur River Working Circle Plan, ca. 1927, the planner attempted to calculate the annual yield that would be available for local mills beginning in the 1980s, during the second cutting cycle. He realized, with dismay, that harvests would drop by at least 40 percent in the 1980s if they continued cutting at then current rates (USDA Forest Service, no date). The planner consoled himself with the thought that, because his calculations of growth rates were just rough estimates, perhaps they would turn out to be underestimates, and then there would more timber than anyone expected. He also hoped that “utilization efficiency will greatly increase”—so less waste would mean more wood for future mills.

On the Whitman Forest, letters between sales planners, the Forest Supervisor, and the Regional District Forester show that, by 1927, the Forest Service was

worried about the mill capacities they had encouraged. Acting Forester in Portland, E. A. Sherman, criticized a draft of the management plan for the Baker Working Circle. Sherman complained that the mill at Baker was too large and was using up wood in excess of annual allowable cuts. He wrote that "the present milling capacity at Baker of between 40,000,000 and 50,000,000 feet annually...greatly exceeds the possible sustained yield from the Government lands in this working circle.... It does not look as if a reduction in the milling capacity at Baker sooner or later could be avoided" (Sherman 1927). The sales planner, who had prepared the plan Sherman was criticizing, agreed that harvest reductions would certainly come by the 1980s. Nevertheless, he argued to Sherman that they should do their best to meet the mills' current demands to avert possible immediate closures, even though such harvests would come at the expense of the next cutting cycle. Sherman reluctantly agreed, and high harvests continued.

These documents make clear that, in the 1920s, foresters set up plans with knowledge that harvests would drop by at least 40 percent, and lead to probable mill closures in the 1980s. This, unfortunately, is exactly what happened. Harvests collapsed at the beginning of the 1990s—not because of environmentalists or spruce budworm, but because planners set it up that way in the 1920s. They figured it was a reasonable price to pay for getting forests regulated as fast as possible. Their motive, however, was not to gain profits from sales of old growth, but to reshape the forests to fit their dream of scientific efficiency. They thought their goals were purely rational; their motives, untainted by the desire for gain; their plans, beyond question. What they failed to recognize was the degree to which their culture—a culture that stressed efficiency and loathed waste—had shaped their scientific definitions of an ideal forest. Foresters destroyed the forests, not in spite of their best intentions, but because of them. Foresters' ideas of what was good for the forest were based on an ideal of deliberately transforming nature to serve industrial capitalism.

In their drive to build local support for establishing forest reserves at the turn of the century, federal foresters had insisted on two things: (1) that midwestern timber barons were out to steal resources from local people, and (2) that the foresters were on the side of the locals. All of the inspection reports played the same refrain: Outsiders had plundered the land with their wasteful logging techniques, and only the Forest Service could protect local industry from the depredations of out-of-state capital.

The official policy in the region was to support and promote locally owned mills. Yet internal memos reveal that the Forest Service was actually trying to make them go out of business. As the Umatilla Hilgard Project (in the upper Grande Ronde Watershed) Report stated, the intent was to "vigorously discourage sales to small operators" (USDA Forest Service 1927). The Forest Service was reluctant to work with them, because of their "inability or unwillingness to adhere to contract stipulations," coupled with their financial instability. Most importantly, small sales interfered "with efficient logging by the larger and more important operators" (USDA Forest Service 1927).

The emerging federal bureaucracies found it far easier to work with larger corporations. The larger lumber operators owned substantial private lands, and were better able to institute what the government called "scientific forestry" practices. Small mills and small logging operations were less efficient, and efficiency was something the new Forest Service was unwilling to give up. By the 1920s, the Forest Service had discouraged small local mills and did its best to draw in big capital from out of state. Why? Not because the Forest Service was trying to destabilize local communities, but because the Forest

Service's mission was to regulate the forests. The big companies could do this better than small companies, because they could log faster.

Even though the sales program started out conservatively, it quickly gained momentum. Across the region, foresters set up plans in the 1920s that would ensure that, by the late 1980s at the end of the first cutting cycle, harvests would drop by at least 40 percent, and mills would have little or no ponderosa left to process. When regional foresters of the 1920s objected to these plans, the planners persuaded them that the ultimate future of the region depended on regulated forests—even if that meant mills would run out of timber at the end of the first cutting cycle (Langston 1995). This is what happened. Harvests collapsed in the early 1990s.

What drove the decisions that led to this was a vision—the belief of the young Forest Service that community stability required a stable timber supply, and that old-growth forests could not provide that. Therefore, old growth needed to be liquidated as soon as possible, and replaced with regulated forests. This in turn justified huge mill capacities and investments that destabilized local communities.

What backfired with the attempt to regulate the forests for sustained-yield production and community stability? Early foresters believed that ecological complexity—disease, dead wood, old growth, and fire—detracted from efficient timber production. Any element that was not directly contributing to that goal seemed wasteful. If something wasn't producing timber, it was competing with young trees that would.

The foresters' mission, therefore, seemed to be to make the forest more efficient by simplifying the system and reducing biological diversity. As the Blues' forester George Bright complained in 1913, in a lovely turn of phrase, "In the general riot of the natural forest, many thousands of acres are required to grow the trees that under management, could be grown on far less land" (Bright 1913). Bright went on to argue that, if only they had the money, they could clearcut and plant a forest that would produce 10 times the amount of useful timber this forest was producing. Eventually, when they had the technology and the markets, that's what they tried to do.

The Forest Service hoped that sustained-yield management would lead to a predictable timber supply and stable communities. It was difficult for foresters to imagine that insects, waste, disease, and decadence might be essential for forest communities, or, indeed, that the productive part of the forest might depend on these things. What they saw as inefficiency, however, is central to the forests' ability to sustain both forests and human communities.

Concluding remarks

Human communities depended, and still depend, on the forests. Few people realized that people depend, not just on timber outputs, but on the ecological complexity that—over the long haul—sustains those outputs. Biological diversity and forest complexity aren't merely amenities; rather, they're essential components of resilient forests. Maintaining biological diversity is essential for sustaining the human communities that depend on forests.

In the process of trying to manage extremely complex landscapes, foresters set in motion a chain of events that increasingly swung out of their control. In part, this is certainly a cautionary tale. When I started this project, I was a scientist who felt her mission was to save the wilderness. I felt that science was indisputably on my side. What I learned soon sobered me. The federal scientists had come with attitudes much the same as my own—the certainty that they could use science to fix the forests, and that, with the help of science, they could do no wrong. Foresters got into trouble, not because they were greedy or stupid, but

because they were absolutely certain of their mission to save the forests from the enemy—which they defined as the logging industry, fire, and decay. Their enthusiasm and faith made it difficult for them to see what was going wrong.

Before we can come up with sustainable ways of living on these landscapes, we need to understand how we ended up in the current mess. Without a historical and ecological perspective on what has happened, there is little chance that current restoration efforts will avoid repeating past mistakes. To help us decide how many trees to cut, and how to cut them—how to work with the land instead of against it, we need a new set of stories about the relationship between forests and people. We need stories that avoid the dichotomy of preserve it or turn it into an intensively managed, regulated forest. We need stories that allow for both human and ecological communities to thrive in all their complexity.

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Questions and Answers

Question: You talked about some of the cultural ideas at the turn of the century that led into some of the problems we face today. Could you talk about some of the cultural ideas that we have today that might be leading us into some equally important problems down the road?

Langston: One of the problematic cultural ideas that we still have today involves thinking that, in order to protect a forest, we need to preserve it—that we need to go in and put a circle around it. Everyone has his or her own opinions about this. I've seen a lot of efforts to do restoration by jumping back to a point in history and saying, "Well, historically it must have been fine, so let's go back to it." It's the idea that, in the past, before whites or loggers or the Forest Service or whoever you want to blame came here, everything must have been sustainable; therefore, to solve our problems we need to get back to the past.

I think this is based partly on the idea that, in the past, humans didn't have effects on landscapes. We now know that these landscapes really were managed long before the Forest Service came in, and that very intricate, involved relationships existed between the people who worked in the forests and the forests themselves. I think that this idea that we can just step back to the past is dangerous. I think it's based on an ideal of paradise.

I also think that the idea that we can protect the forests by simply putting a wall around them and keeping humans out, or keeping fire out, or keeping loggers out is ultimately dangerous. I'm not against reserves. I'm not against core zones. But I think that, ultimately, our task is to figure out ways that we can work with the forests instead of just setting them aside or turning them all into plantations.

Some of our cultural ideas about preservation and protection have in the short term helped us make some disastrous mistakes. In the long term, I think we need to come up with much more subtle and much more historically aware ideas about how to coexist with forests. We have this idea that there's a balance of nature, and, even though, as scientists, we all know it's not true, we still have a powerful idea that, if we just get out of the way, nature will be fine. Nature is fine without us, but that doesn't mean there's any kind of balance of nature without us.

Working with these ideas can really get in the way of realizing that, no matter what we do, we're going to change the forests. Many actions people take reduce diversity, but some things people do increase diversity. And there's no simple right answer. A lot of people ask me, "Well, what's the right thing to do?" And, as much as I hate to say there's no right answer—there is no one right answer. I think in some ways the moral of the story is there is no single solution, and that coming up with communities that can persist, both forest communities and human communities, is just going to be a messy process. It's a messy process because there are no simple answers. We need to keep trying things, and, if something does-

n't work, try something else.

Question: What evidence is there that people petitioned the Forest Service? Did many communities support the Forest Service's timber sales?

Langston: I think the example of actually petitioning the Forest Service was probably fairly extreme in most areas that I looked at. In the Blues, it was a little more subtle. Locals certainly agreed with putting the timber up for sale, and sometimes would send memos asking, "Why aren't you putting this timber up for sale?"

Throughout the larger region, though, I'm not sure. I think it was very rarely the case that local communities said, "Wait. Wait. Don't develop our timber. Don't bring in railroads. Don't bring in mills. We want to just live here quietly on our own." That was definitely not the tenor of the time in the American West. Most Euro-Americans jumped head-first into intensive development.

Question: To what degree were values other than timber incorporated into the early decision-making process?

Langston: Grazing was certainly important in early decision-making processes, especially in the Umatilla National Forest which was critical for grazing. And there are all sorts of debates among herders and ranchers and timber managers over policies. It's interesting to read through the memos and surveys from that time, because often the early people in charge of the grazing program could look at the timber program and say to those managers, "Look at what you're doing to reserve trees. I can't believe you're doing this damage to streamside forests. You know, you're doing all of this incredible damage for wildlife and for grazing." At the same time, they would be sort of blind to the things that their own program was doing to reduce diversity.

By the same token, the forest program, the timber program, was incredibly sensitive to overgrazing, incredibly sensitive to everything that their friends over in the grazing program were doing wrong. Yet it was much harder for them to be alert to signs that things were at stake in their own program.

Question: I was interested in your discussion of the whole idea of conversion from decadent old-growth forests to new managed forests. It's something pretty prevalent on both sides of the Cascades, east and west. Yet that was a widely accepted method for management, and I think that we do ourselves a disservice if we call those foresters, the forest scientists who advocated that, "stupid." I interviewed a district forester on the southern coast in 1985 who said something very profound, that every forested corner of the world has taken its turn in the bucket in the conversion process. I think it's pervasive in that generation of trained people, and I wouldn't fault them for saying something they deeply believed. I just wondered if you would comment....

Langston: I'm not quite sure what comment to make, except it's very interesting. In terms of the belief that forests will produce more timber if you remove old growth, I think that's a very powerful belief. You know, there's a lot of work going on at Madison right now—I have to give a little push for Madison. Craig Lorimer, Dave Mladenoff, and others are looking at ways of managing second- and third-growth forests to increase timber production, basically to increase that growth curve while also fostering what we like to call "old growth." There's lots of ways you can play with those curves, lots of ways you can manipulate forests.