TAKING AN ECOLOGICAL APPROACH TO MULTIPLE USE PLANNING

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This discussion will include a review of livestock grazing and timber management and will be based on examples from the Blue Mountain landmass in central Oregon and southwestern Washington. This five million-acre area has diverse kinds of vegetation which have been classified according to types of plant communities. For example, ponderosa pine/wheatgrass is a savanna community type comprising the forest edge of low tree productivity.

Next is the ponderosa pine/Idaho fescue, moist savanna community type. It is marginally commercial forest land. With increasing elevation, ponderosa pine/elksedge is encountered. It is a commercial forest site in which elksedge dominates ground vegetation. And finally, within the forest zone is found the mixed conifer/pinegrass community type. It is good commercial forest land, and comprises the largest acreage of grazable land in the central and southern Blue Mountains. I will use the mixed conifer/pinegrass community type for all illustrations and data.

CHARACTERISTICS OF MIXED CONIFER/PINEGRASS COMMUNITY TYPE

The mixed conifer/pinegrass community type is often dominated by ponderosa pine (Pinus ponderosa), at least in the overstory. White fir (Abies grandis) and/or Douglas-fir (Pseudotsuga menziesii) vary from sparse reproduction to moderately dense poles to co-dominant in the overstory. Ground vegetation is clearly dominated by pinegrass (Calamagrostis rubescens) with significant amounts of elksedge (Carex geyeri) and heartleaf arnica (Arnica cordifolia), strawberry (Fragaria spp.), vetch (Vicia americana), and several species of balsam woollyweed (Hieracium spp.).

Surface Fire Occurrence

Fire scarred stumps are common in this community type reflecting recurrent ground fires. Before fire control (about 1910) surface fires damaged these trees an average of once every 10 to 12 years. The fires were probably started by lightning strikes which are frequent in the Blue Mountains.

Periodic burning has tended to thin reproducing ponderosa pine by killing young trees thus maintaining open stocking conditions of the stands. With fire control, ponderosa reproduction has not been thinned resulting in thousands of acres in stagnated condition. Universal stagnation of ponderosa pine is highly significant. Ponderosa in the Blue Mountains did not develop according to "normal stand development" concepts which imply

that dominant trees have exerted their influence, killed suppressed trees, and eventually created an old-growth stand. Ponderosa pine cannot develop according to "normal stand development" -- instead it stagnates. This means the land manager must maintain stocking level control to grow usable wood. It also means that pristine grazing conditions of abundant pinegrass under open crown canopies of pine are not possible with fire control.

Surface fires also have tended to selectively kill Douglas-fir and white fir while leaving ponderosa pine. Firs were selectively killed because of their bark characteristics. Ponderosa pine develops a dead, insulating layer of bark by the time the tree is two or three inches in diameter. White fir and Douglas-fir bark remains green, alive, and photosynthetically active until the tree is four to six inches in diameter. This bark is so sensitive that temperatures exceeding 175 degrees F. can kill it. In fact, when a young white fir is suddenly exposed to full sunlight, heat from the sun can scald the tender bark and kill it. Thus, ponderosa pine/pinegrass is a fire climax plant community.

With fire control, fir is free to regenerate and increase underneath the shelterwood of ponderosa pine. Eventually this "pine/pinegrass fire climax" will become a fir/pinegrass climax. Fir crown cover tends to be denser than ponderosa. As fir regenerates and grows under the pine, this dense shade reduces ground vegetation. Under ponderosa of 40 to 60 percent crown cover, pinegrass and elksedge produce 450 to 550 pounds of forage per acre, about five acres per AUM (Animal Unit Month). Under increasing fir cover, pinegrass and elksedge decrease in density and volume and the variety of plant species tends to decrease. Finally, under an overstory of fir and some fir reproduction, little useful livestock forage is produced.

Fire has had another, fortunate effect. It periodically consumed 100 percent of the native plants. In other words, they developed under periodic, 100 percent use and in some shade. This means they have genetically developed with the ability to withstand at least some grazing. The mixed conifer/pinegrass plant community not only produces useful forage but also has the inherent ability to withstand periodic utilization.

Forest Productivity

Mixed conifer/pinegrass is capable of growing three primary trees: white fir, Douglas-fir, and ponderosa pine. In addition, at upper elevations and/or northerly slopes, it will support western larch (Larix occidentalis) and, occasionally, lodgepole pine (Pinus contorta). Table 1 summarizes tree productivity of of this community type.

Table 1. Timber productivity of mixed conifer/pinegrass community type

	SI_{100}* Mean	GBA_{15}** Mean	Productivity Cu. Ft. Mean	Productivity B. F. Mean
Ponderosa pine	75	105	53	318
White, Douglas, fir	76	122	65	389
Larch	86	98	59	354

*SI = Site Index at age 100 years.

**GBA = Growth Basal Area: that basal area at which dominant trees will grow at 15 rings per inch (1.3 inch diameter growth in 10 years). GBA is a stockability index.

Site index (SI) is based on age 100 while GBA (growth basal area) is a term used to index stockability of a forest stand. It means that dominant trees will grow at a certain rate in diameter when stocked at a specified basal area density. For example, ponderosa pine has a GBA_{15} of 105 square foot basal area. This means that dominant ponderosa will grow at about 15 rings per inch or 1.3 inches DBH (diameter breast height) in 10 years when stocked at 105 square foot basal area. Intermediate and suppressed trees will be growing correspondingly slower.

Firs have a higher GBA: about 122 square foot basal area. This is nearly 20 percent greater stocking density than ponderosa. Since site indexes of pine fir are about the same, 75 and 76, this site will be about 20 percent more productive in fir than it will in producing ponderosa pine. Western larch has a higher site index but lower GBA than pine. It is about as productive as ponderosa.

GBA may be used to set an initial stocking density following regeneration cutting. There is no fixed number of trees that should be planted. Instead, average stand diameter at first commercial entry must be specified and this related to stockabilitty of the site. For example, if products 6 inches DBH and larger can be sold, then average stand diameter for first commercial thinning must be about 8 inches if the stand will be thinned from below. Thus, initial stand density should be 300 trees per acre for ponderosa and 350 for fir. Initial stand density is closely related to forage production in clearcuts. Fir not only has a more dense crown but also can be stocked at 50 more trees per acre than pine.

Condition and Trend

Undergrowth species in the mixed conifer/pinegrass have different palatabilities. Elksedge is the most palatable but is generally not dominant over pinegrass. However, pinegrass and elksedge often grow so closely together, since they are rhizomatous, they can both be considered decreasers under cattle use.

Poor range condition is characterized by low forage production (between 50 and 200 pounds) and dominance of heartleaf arnica, strawberry, some Ross sedge (Carex rossii), and woollyweed. Total plant density in poor condition is only 20 to 30 percent of that in good condition. Instead of increasing, plants like strawberry and heartleaf arnica remain unchanged. Moisture formerly utilized by pinegrass tends to be utilized for some increase in tree growth.

Poor range condition caused by overgrazing not only results in greatly decreased forage production but also results in increased tree regeneration and thus tends to increase the number of acres in stagnated ponderosa pine. Generally, the greatest number of acres and the greatest stand densities of stagnated pine occur on areas formerly heavily grazed.

Density and composition of pinegrass and elksedge on range in poor condition from livestock grazing are similar to density and composition under dense fir cover. There is no significant difference in density or species composition between range in poor condition from livestock overgrazing compared to range under dense fir crown cover.

"Poor range condition" and "downward trend" must be related to causal agents. Were they the result of increasing fir cover? If so, any adjustment in livestock utilization will not alter a downward trend nor improve range condition. Were they related to excessive livestock use with no change in tree overstory? In this case, adjustment in livestock management can have a significant impact on range condition and range trend. But what if overgrazing by livestock and fire control have fostered an increase in fir regeneration? Both tree cover and livestock have been causative factors. Adjustment in livestock management will be only a partial, temporary solution to the problem.

Clearly, data for evaluating range condition and means for interpreting range trend cannot be based on climax vegetation. In forested range, condition and trend must be related to tree cover as well as to livestock use. Methods must be used to evaluate trend that account for changes in tree overstory.

Revegetation

Grasses such as orchardgrass can be seeded effectively in the mixed conifer/pinegrass community type, producing two times more than pinegrass on the same area. It does not compete with tree growth as much as pinegrass and is significantly more nutritious. Pinegrass protein decreases to 7 percent by about July 1 and orchardgrass only decreases to 7 percent by September 15. Also, orchardgrass is easier to control when planting trees. Its bunchgrass habit permits easy elimination in a 3 - 6 foot diameter circle around each planted tree.

PREDICTIONS IN MIXED CONIFER/PINEGRASS

One immediate prediction, based on continued fire control, is that livestock-carrying capacity in the Blue Mountains should decline as fir cover increases. This has happened. In 1940, the Blue Mountains produced enough beef to feed 64,000 people all year. This means 114 pounds of beef, cut and wrapped on the butcher's counter, for each person. By 1970, the Blue Mountains produced enough beef for only 54,000 people.

We can also predict because of increasing population in the United States that there will be an increasing need for wood. We must be able to predict what will happen to the range resource with various kinds of timber management. Three kinds of predictions in the mixed conifer/pinegrass plant community are: treatment of stagnated ponderosa pine, high risk cutting in old growth ponderosa pine, and regeneration cutting.

Treating Stagnated Pine

Stagnated ponderosa pine must be thinned to produce wood and to produce forage. We can predict grass response to tree thinning (Table 2). A stand in the central Blue Mountains which initially was 60 years old, had 2,030 ponderosa pine per acre, 140 square feet basal area, 98 percent crown cover under which pinegrass and elksedge produced 180 pounds of forage per acre. Thinning left 110 ponderosa trees per acre at an initial basal area of 35 square feet and crown cover of 21 percent. Forage production did not instantly respond. Instead, 10 years were required for vegetation to fully occupy the ground. Pine crown cover increased from 21 to 47 percent and basal area increased from 35 square feet to 60 square feet.

We can also predict tremendous slash accumulation in conjunction with thinning stagnated pine. Stand density was reduced from 2,030 trees per acre to 110 meaning that 1920 trees were cut and laid on the ground. This left a residue nearly impenetrable to livestock. Even though forage increased, it was not available for use.

Table 2. Results from a test thinning in mixed conifer/pinegrass Long Creek District, Malheur National Forest (stand was 60 years old in 1963)

Item	1963	1964	1966	1970	1974
Trees/acre	2030	110	110	110	110
Basal area	143	35	41	50	60
Crown cover	98	21	33	44	47
Herbaceous production	180	185	220	340	510

High Risk Cutting in Oldgrowth Pine

High risk cutting in oldgrowth pine is designed to salvage those trees which might die within the next 20 years. A typical example in mixed conifer/pinegrass would be an overstory of ponderosa pine containing 30,000 board feet to the acre and stocked at 150 square feet basal area with an understory of white fir and Douglas-fir averaging 10 feet tall and 150 trees per acre. Typically, about one-third of the pine overstory would be removed in each of three entries. Understory fir would be preserved and skid trails seeded to orchardgrass and timothy as a way to maintain livestock-carrying capacity. It is because of skid road seeding after high risk cutting that livestock production has only decreased 15 percent since 1940.

Rate of height and diameter growth of fir under fully stocked oldgrowth ponderosa are moderate, about 10 inches height growth per year and 8 inches crown diameter growth. After a one-third overstory removal, fir increases from 10 to 18 inches in height growth and from 8 to 12 inches in crown diameter per year.

After the second one-third overstory removal, firs will be essentially free to grow. Their rapid rate of crown spread will decrease forage production until only skid trail seedings are available to support livestock. Three-stage high risk cutting in mixed conifer/pinegrass with a fir understory probably is the best silvicultural treatment to convert the stand from ponderosa pine to fir. Total overstory removal in one cutting is undesirable because of sunscaled problems with white fir and because harvesting all 30,000 board feet of timber would cause serious damage to fir reproduction.

Regeneration Cutting

Clearcutting is a desirable method for regenerating ponderosa pine in the mixed conifer/pinegrass type. Fir reproduces best under a shelterwood. Grass can be seeded after clearcutting if trees are planted at the same time. We can predict 80 percent survival of planted pine if the trees start their first growing season at the same time grass seed is germinating. We can also predict about a 30 percent reduction in survival for each year's delay after grass establishment.

Seeding 3 to 4 pounds of orchardgrass and timothy in a clearcut which has been moderately scarified and broadcast burned should result in enough forage to produce one acre per AUM. This is five times more production than native pinegrass under open pine. However, tree cover will reduce forage production about the 15th year after planting, down to about two acres per AUM. In addition, seeded grass largely will be replaced by native grasses in 15 to 20 years under good livestock management. Under heavy use, domestic grasses will decrease more rapidly because they are more palatable than natives. Planted trees will not be damaged by livestock under proper grazing use, in fact, they tend to get an initial boost in rate of height growth from additional soil moisture made available by utilization of grass plants. After 25 to 30 years, tree cover reduces production to five acres per AUM, equal to native pinegrass production under open pine.

Challenges to Range Management

Ecological characteristics of the mixed conifer/pinegrass community type and predicted reactions of this community type to timber management pose challenges to conventional range management concepts. For example:

(1) What is range condition? It cannot be based upon climax vegetation. What is range condition when livestock forage is derived from seeded domestic grass?

(2) What is range trend? Native grasses decrease with increasing tree cover just as they decrease with overgrazing by livestock. Introduced grasses, which should supply a major proportion of livestock forage, tend to decrease without livestock use because native species can outcompete them. How is range trend evaluated in a clearcut which provides the kind of forage most productive for livestock?

(3) What is primary range land? A seeded clearcut, having highly palatable domestic grasses, could be considered primary range until tree crown cover greatly reduces forage availability and productivity. Timber stand treatment influences location of primary range. Therefore, how does a range manager interpret primary range in regard to livestock distribution and management?

(4) What effect will sophisticated grazing systems, such as rest rotation, have on evaluation of range condition, range trend, and interpretation of primary range?

(5) What is proper use of introduced grasses and native grasses? Nearly all introduced grasses are more paltable than the native pinegrass and elksedge. Yet introduced grasses will naturally decrease. What is "enough use" -- the time when livestock should be moved or when different grazing management should be considered?

PRESCRIPTION OF TREATMENT

Prescription is the real challenge for an ecologist or land manager. It means that a treatment must be devised that will result in a predetermined kind of plant community. One must specify the kind of timber stand and kind of range condition desired and devise a treatment that will attain these objectives.

Ability to prescribe a treatment requires comprehensive knowledge of a plant community type's characteristics and extensive experience with predicting what will happen following a treatment. I have found a rather simplistic, three-way approach helpful. First, I formulate a treatment of the stand to maximize timber production and then determine what I must do to get the best range production possible. Next, I devise a treatment of the same stand that will maximize range production and then find out what can be done to get the best timber production. These are the maximums possible for a kind of plant community. They form a framework of reference limits within which is a broad range of middleground opportunities. I then strike some kind of compromise between these extremes whereby I can optimize both timber and range production to meet specified land management objectives.

Maximize Timber Management

Characteristics of the mixed conifer/pinegrass community type state that maximum timber productivity is obtained with white fir and Douglas-fir because they are approximately 20 percent more productive than ponderosa pine. Silviculturally, maximum cubic volume productivity is attained with the greatest number of stems per acre which are practical to handle. Further, maximum board-foot wood production can be attained by reasonably long rotation ages, about 150 years in combination with commercial thinning. First entry can be made at an average stand diameter of eight inches DBH.

Therefore, my objective in converting from pine overstory to white fir and Douglas-fir is to attain, in the minimum time possible, an optimum stocked stand suitable for commercial thinning.

This stand should have 350 trees per acre at eight inches DBH. Dominant trees should have slowed in rate of diamter growth to one inch every 10 years (20 rings per inch), the rate when maximum volume productivity is attained. Fir crown cover would be 80 to 90 percent, allowing only 100 to 200 pounds of low palatability forage per acre for a livestock-carrying capacity of 12 to 20 acres per AUM.

Under these criteria, what can be done to maximize range production? The primary means is to drill orchardgrass, timothy, and smooth brome in all skid trails, skid roads, and access roads. These conditions will produce 100 percent maximum timber productivity and approximately 40 percent maximum livestock productivity. (Forty percent of maximum livestock productivity is not synonymous with native livestock-carrying capacity). These conditions would result in approximately 70 to 80 percent of the grazing capacity attainable under natural conditions of open pine and pinegrass.

Maximized Range Production

Maximizing range productivity in the mixed conifer/pinegrass type has been suggested by prediction of clearcut reactions. Clearcut the forest, treat the residue, broadcase burn the area, and seed orchardgrass and timothy at 3 to 6 pounds per acre in the ashes. These domestic grasses would produce enough forage for one acre per AUM lasting 10 to 15 years. Since these areas are not suitable for cultivation, assume that native grasses will tend to replace seeded grasses. Therefore, devise some means of periodically reseeding grass at minimum cost. Plant ponderosa pine and maintain it at less than 40 percent crown cover because this amount of shade has little effect on orchardgrass production. Disturb as much ground as possible when logging to develop a maximum seedbed area for sowing grass. Use a 50-year rotation to maintain the greatest percentage of land area in clearcuts 10 years or less of age.

These conditions would result in 100 percent maximum range productivity which should be approximately 150 percent better than carrying capacity under native pinegrass in open pine. It should result in 40 percent of maximum timber productivity based on an intensive culture of white fir and Douglas-fir.

Optimizing Range and Timber Productivity

With these parameters, consider how to optimize range management and timber management in this mixed conifer/pinegrass community type. The area may be managed at any point between these extremes, or at the extremes themselves. For example, what is required to equally optimize timber productivity and range productivity -- attempt to get 80 percent full timber production while attaining 80 percent maximum range production?

Cultivate both fir and ponderosa pine for good, but not maximum, wood production. Use a moderate rotation age of 100 years and enter the timber stand as often as possible for commercial thinning (Table 3). These conditions should produce 80 percent maximum timber productivity and enhance range production. A moderate rotation age affords a reasonable percentage of the land area in highly productive clearcuts. Frequent entering of the stand and extensive ground disturbance affords the opportunity of continuously rejuvenating seeded domestic grass. In addition, develop water, route skid trails in locations which improve access, and use a grazing system and sale layout program to avoid non-use after grass seeding. These prescriptions should result in 80 percent maximum range productivity. But, understand, this is not 80 percent native pinegrass under open pine. Instead it is approximately 120 percent of native productivity under pristine conditions.

Clearly, prescription of treatment to attain a predetermined objective is the primary tool a land manager has for optimizing use of his resources. However, prescription must be based upon predetermined objectives. Predetermined objectives are derived partly from ecological constraints and partly from social and political demands.

SUMMARY

Livestock and timber, when managed together, are challenging. This paper has covered the ecological characteristics, predictions of reaction to management and prescription of stand treatment for the mixed conifer/pinegrass community type. Other kinds of plant communities differ in their characteristics, in the predicted ways they respond to treatment, and, thus, in prescriptions required to attain a specified objective. Ponderosa pine/fescue is a climax pine site. Fir cannot be grown, orchardgrass cannot be grown, its prediction characteristics and prescription requirements are different. Another community type in the Blue Mountains is white fir/big huckleberry. It is not natural forest range because of dense tree cover, dominance of big huckleberry, and general lack of grass vegetation. However, it does have some qualities which make prescription for range management possible. Livestock grazing can be obtained after commercial thinning by seeding grass on skid trails, skid roads, and access roads. It is possible to obtain livestock grazing from these areas which have not, in the past, contributed to livestock production. Carrying capacity can be obtained from other kinds of forested areas in the Blue Mountains. We could double livestock production in the Blues in 10 years with suitable land management. But, understand that timber management is the greatest factor influencing forest range land plant communities. Stand treatments must be prescribed in conjunction with planning of both timber and range activities to arrive at an optimum land management program.

Table 3. Basic planning data for timber management

Planning Unit = 100,000 acres

Rotation age = 100 years

Management for Ponderosa pine.

Site Potential (SI-GBA) = 75-105 (See Table 1)

318 b.f. per acre per year

53 cu.ft. per acre per year

Allowable Cut = 31.8 MM bf per year
(100,000 acres X 318 bf = 31.8 MM bf)

Regenerate 1000 acre per year (100,000 div. by 100 yrs = 1000 acres)

Cut 75 trees per acre at 70 feet tall, 16 inches DBH

At 150 bf per tree = 11.2M bf per acre,

Harvest 11.2MM bf in regeneration cuts
(1000 acres X 11.2Mbf = 11.2 MMbf)

Thinning harvest = 20.6MM bf per year (31.8MM - 11.2MM = 20.6MM bf)

Cut 4.4M bf per acre in thinning (40% of the volume, 50% of B.A.)

Acres thinned per year = 4700
(4700 acres X 4.4M bf = 20.8MMbf)

NOTE: of 100,000 acre area, 25% is in regeneration stage not available for thinning, 75,000 acres available for thinning.

Average stand entry = 16 years (75,000 acres / 4700 acres = 16 years)