TRANSITORY HABITAT IN EASTSIDE INDUSTRIAL FORESTS

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SUMMARY

Industrial forests are an important resource in northeastern Oregon. Wood products, forage for livestock, and recreational opportunities support local economies. Industrial forests also provide important habitat for a variety of wildlife including: large herbivore grazers, upland game birds, small non-game birds, and small mammals.

Removal of trees through harvest of overstory has an immediate and visual impact that is often negatively viewed by the general public. An assumption is often made that harvest of "old-growth" and other older-age tree stands has a negative impact on floral and faunal biodiversity, and production potential for non-commodity resources. However, most forest stands are not just trees, they are usually multi-layered with a two-tiered understory consisting of shrubs and herbaceous grasses and forbs. The shrub and herbaceous layers are major components of habitat for wildlife and livestock.

Although changes will definitely occur in forest understories following harvest of overstories, great dissimilarity in results can be expected because of the variability in topo-edaphic characteristics. These characteristics consist of: the site, seedbanks, rootstocks of sprouting plants, intensity of harvest, and site-preparation techniques that are subsequently employed, and subsequent management regimes for burning, cutting, and grazing by large herbivores.

Study results indicate that density and productivity of understories decline as overstories develop (Gruell et al. 1986, Bunting et al. 1987). This decline has been attributed to changes in light quality, increased competition for water and nutrients, interruption of seedling establishment, and alleopathy. Harvest of overstories effectively increases the amount and quality of light reaching understory layers, releases water and nutrients to herbaceous and woody plants, and changes the dynamics of stand and habitat structure.

In reality, information currently available regarding influence of silvicultural practices on forest understories and associated production potential and wildlife habitat is insufficient for management purposes. Quantitative knowledge of how overstory manipulation influences understory composition, structure, and production is essential to enlightened land management wherever multi-resource management is desired. Release of understories has important implications for herbivore-carrying capacity and for planning of grazing management. Similarly, understory dynamics are crucial to many animal populations. For example, neo-tropical birds, many of which are in documented decline, nest in herbaceous and woody vegetation near the forest floor. Thus knowledge of the relationships between understory/overstory dynamics and animal users is crucial for planning ecosystem management.

GOAL AND OBJECTIVES

Boise Cascade Corporation is a major holder of industrial forests in the Pacific Northwest, responsible for management of more than 300,000 acres of forestland in northeastern

Oregon alone. Silvacultural practices employed by Boise Cascade Corp., especially harvest and planting, are generally management practices most visible to the general public. Harvest and other silvacultural practices receive close scrutiny as to their effect on stability and health of riparian and associated forest and range upland communities.

Information regarding the dynamics of overstory-understory relationships in managed forests is required to support ecologically-based management of multi-resource production systems. The goal of this project is to better define overstory/ understory relationships existing on eastside industrial forests to provide forest managers with a greater depth of information relative to the impact of silvicultural practices on habitat needs of forest fauna, and data required to develop ecologically-based multiple-resource management plans.

Specific objectives of the study are:

a. define temporal overstory/understory relationships in selected forest stands within the *Abies grandis* habitat type series, as related to harvest intensity and time since harvest,

b. predict the transitory habitat characteristics resulting from changes in overstory/understory relationship imposed by periodic harvest of overstory,

c. determine the effect of the release of understory herbs and shrubs on large herbivore carrying capacity and avian productivity.

METHODOLOGY

Two study locations on forest land owned and managed by Boise Cascade Corporation were selected in northeastern Oregon. They are the Deep Creek Unit and the Minam Unit, both if which are located in Wallowa County. These units are managed primarily for timber production with seasonal livestock grazing a secondary but important activity. They are also habitat for numerous species of wildlife and fish.

For this study, 80 plots in Grand Fir Habitat Type and mixed conifer stands of various ages relative to time from overstory harvest were established. Vegetation was measured on 25 plots located in the Minam Unit, and 55 plots located in the Deep Creek Unit. Sample stands were distributed randomly across the forested part of the landscape.

Sample points classified by soil types were grouped according to three classifications of overstory cover obtained from PMR maps of each allotment. Overstory cover classifications were 0-25 percent canopy cover, 26-55 percent canopy cover, and >55 percent canopy cover.

Plot clusters were established in each of the selected forest stands using a modification of a four-plot cluster design (Scott and Bechtold 1995). Each cluster consisted of four fixed-area sample plots that were 0.016 ha (0.04 ac.) in area. If the plot location was located in an open or commercially-thinned forest stand, where a 0.016 ha cluster would sample too few trees, the plot was expanded to 0.04 ha (0.1 ac.). Plot clusters were placed wholly within individual vegetation types. If an individual plot fell within an early-seral patch or opening within a stand, or if a plot straddled the boundary between a later-seral and an early-seral patch, the plot was divided between the two types based on understory vegetation characteristics. Each cluster consisted of a central plot and three other plots located 36.6 m (120 ft.) and 120 degrees from the center of the central plot.

On each plot a complete tree-attributes list was assembled (species, diameter at breast height, tree height, and live crown ratio). Spatial variability within the stand was determined through variable plot measurements of tree diameter, live crown ratio, and nearest neighbor. An efficient measure of tree distribution is provided by the metric "C" developed through a T-square, nearest neighbor sampling and computation process (Ludwig and Reynolds 1988). To develop this metric, two distances were measured on each sample plot. These were the distance from the plot center to the closest tree and the distance from that tree to the next closest tree located beyond a perpendicular line drawn to the vector from plot center to the closest tree.

Other than the variation associated with species composition and ecological site potential, understory production may be expected to respond primarily to variation in the amount of competition for light, water, and nutrients offered by the tree overstory. While it is common to express such competition as a single metric, such as basal area or crown closure, understories in forest stands respond to variation in patchiness within stands and clumpiness within patches, as well as to overall and within-patch variation in stand density. Common measures of overstory density and cover are often inadequate to describe actual variation in understory characteristics.

The procedures followed in inventorying understory shrub and herbaceous vegetation were:

a. locate the center point of the center plot in the 4-plot cluster,

b. from the center point, move 3.6 m due-north and lay out a 1 m^2 plot frame to sample herbaceous understory vegetation,

c. identify and list all plant species in the plot,

d. estimate cover (in 0.1 m^2 area increments)and frequency (presence or absence), visually make a weight-composition estimate of grasses, forbs and shrubs within the plot, and harvest (by species and growth form) standing crop of grass and forbs and foliage of shrubs, and

e. obtain a “moosehorn” estimate of overstory crown closure directly above each plot.

The sampling procedure was repeated at the other three plots in the cluster with the exception of harvesting herbaceous standing crop. In the other three plots, only newly encountered species were harvested by species, but total standing crop in the plot was harvested by growth form.

Harvested samples of standing crop yield were dried in a forced air oven at 30° C for a minimum of 7 days. Dry weights were obtained by weighing samples on a Mettler Balance. After dry weights were obtained, samples were ground in preparation for laboratory analysis to obtain estimates of Crude Protein (CP) and Total Digestible Nutrients (TDN) present in the plant species harvested from the sample plots.

Locations of plots in the cluster were separated by 36.6 m. The second plot in the cluster was located north of the cluster center plot. The third plot in the cluster was located 36.6 m from the center plot at an angle of 120 from due-north. And the fourth plot in the cluster was located

36.6 m from the center plot at an angle of 240° from due-north. Along the three angles from the center plot in the cluster, a 36.6 m x 1m belt transect was established to obtain estimates of shrub cover (i.e., line intercept) and shrub density (from along the three 36.6 m^2 belt transects).

Yield of shrubs occurring as an understory layer was obtained by harvesting shrubs located within the four 1 m^2 plots established in each forested stand. Harvested foliage material was dried, weighed, and analyzed for CP and TDN.

Two small cage exclosures (1 m^2) were placed at each of the 80-forest sample plots to determine yield and the amount of understory herbaceous material removed by ungulate grazing in 1997. Initial harvest of herbaceous standing crop (grass, forb, and shrub) from two 0.25 m^2 non-caged plots occurred during early June 1997, at the time livestock were admitted to the two allotments. In late September, 1997, standing crop was harvested from two caged exclosure plots and two adjacent non-caged plots. Harvested samples of herbaceous standing crop obtained during each sampling period were dried and weighed to obtain yield estimates of understory vegetation in forested stands of the two allotments during the early growing season and at the end of the growing season.

Data collected at the two sampling times were used to create growth curves of understory vegetation occurring on different soil types, and under different types and degree of crown closure. Differences in yield of understory vegetation between caged and non-caged plots were used to estimate potential animal use of understory vegetation.

Preliminary Results

Study results reported here are preliminary and represent only a small portion of the information obtained through the study. The results presented do indicate the study has yielded information that will improve our understanding of changes that occur to understory habitat as overstory tree cover and density change with harvest.

Data from the 80 stands sampled in the Deep Creek and Minam Allotments were examined to obtain a preliminary indication of forest overstory and understory relationships. Correlation (R^2) of specific tree overstory attributes with specific herbaceous understory attributes were used to indicate relationships among stand attributes. An $R^2 > 0.20$ between compared stand attributes indicated that a relationship (either positive or negative) existed between the overstory and understory attributes (Table 1).

Among the possible comparisons of stand attributes, either a positive or a negative $R^2 > 0.20$ existed for 18 comparisons of stand overstory and understory attributes. Overall, overstory shade as measured by the "moosehorn" (i.e., measure of overstory cover directly above the herbaceous plot) had highest R^2 with variables representing herbaceous understory. Shade was positively correlated with Shrub LIC (i.e., shrub line intercept cover), Shrub Plot Cover, Total Yield, and Ground Litter ($R^2 > 30$). Shade was negatively correlated Grass Yield, Forb Yield, and Grass Cover ($R^2 > -0.52$).

Among other overstory variables, Tree dbh (i.e., tree diameter breast high) was positively correlated with Shrub No ($R^2 > 27$), but was negatively correlated with Total Yield and Grass Yield ($R^2 > -0.21$). Tree Height was negatively correlated with Shrub Plot Cover and Total Cover ($R^2 > -0.32$ and $R^2 > -0.20$, respectively). LC Ratio (Live Crown Ratio) was positively correlated with Shrub Plot Cover and Forb Cover ($R^2 > 0.18$), but was negatively correlated with Grass Cover ($R^2 > -0.36$). Overstory Crown Cover was positively correlated with Shrub LIC ($R^2 > 0.33$).

Table 1. Correlation (R^2) of Tree Overstory Characteristics and Herbaceous Understory Characteristics in 80-Forest Stands in Northeastern Oregon.

Attributes			R^2	Slope	Intercept
No. of Trees	vs.	Tree Crown Cover (%)	0.284	0.02	14.15
No. Trees	vs.	Live Crown Ratio (ha)	-0.215	-0.01	60.38
Tree dbh (cm)	vs	Shrub No. (ha)	0.272	183.10	4712.47
Tree dbh (cm)	vs.	Total Yield (kg)	-0.220	-11.47	1120.91
Tree dbh (cm)	vs.	Grass Yield (kg)	-0.217	-6.55	464.07
Tree dbh (cm)	vs.	Tree Crown Cover (%)	0.236	0.18	13.10
Tree dbh (cm)	vs.	Tree Height (m)	0.523	0.28	8.53
Tree Ht. (m)	vs.	Shrub Plot Cover (%)	-0.328	-0.02	17.97
Tree Ht. (m)	vs.	Total Cover (%)	-0.201	-1.47	142.58
Tree Ht. (m)	vs.	Tree Crown Cover (%)	-0.260	0.38	11.77
Tree Ht. (m)	vs.	Live Crown Ratio	-0.190	-0.19	61.51
L.C.Ratio	vs.	Shrub Plot Cover (%)	0.206	0.02	22.64
L.C.Ratio	vs.	Grass Cover (%)	-0.366	-0.92	78.77
L.C.Ratio	vs.	Forb Cover (%)	0.188	0.84	18.85
L.C.Ratio	vs.	Ground Rock (%)	-0.490	-0.39	25.07
L.C.Ratio	vs.	Tree Crown Cover (%)	-0.200	-0.29	34.78
Crown Cov.	vs.	Shrub LIC (%)	0.224	0.19	7.03
Shade (%)	vs.	Shrub LIC (%)	0.334	0.08	6.74
Shade (%)	vs.	Shrub Plot Cover (%)	0.350	0.16	15.91
Shade (%)	vs.	Total Yield (kg)	0.334	-9.43	1295.74
Shade (%)	vs.	Grass yield (kg)	-0.523	-5.85	585.97
Shade (%)	vs.	Forb Yield (kg)	-0.559	-3.57	513.44
Shade (%)	vs.	Grass Cover (%)	-0.541	-0.25	36.88
Shade (%)	vs.	Ground Litter (%)	0.508	0.25	31.35

Comparison of overstory shade with total yield of grasses in the understory illustrates a negative relation between shade and yield in the lower herbaceous understory (Figures 1 and 2). A cluster of grass- and forb-yield values is associated with little or no shade. The general trend of the scatter of points associates declining yield with increasing shade and other attributes of the tree overstory that influence production in the lower herbaceous layer. Although the trend of decreasing yield of herbaceous standing crop as overstory shade increases is evident for both grass and forbs, it is most pronounced for grass.

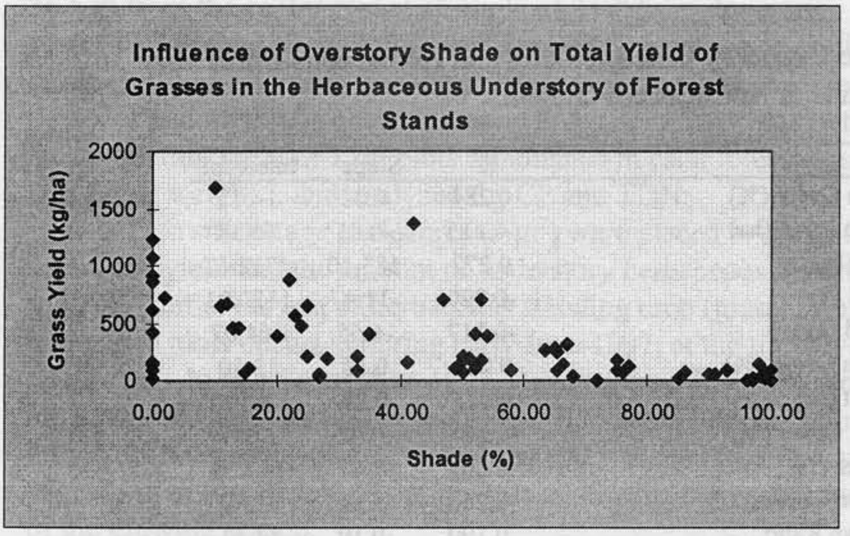

Figure 1. Scatter diagram illustrating the relationship between overstory shade (%) and grass yield (kg/ha) in a forest stand.

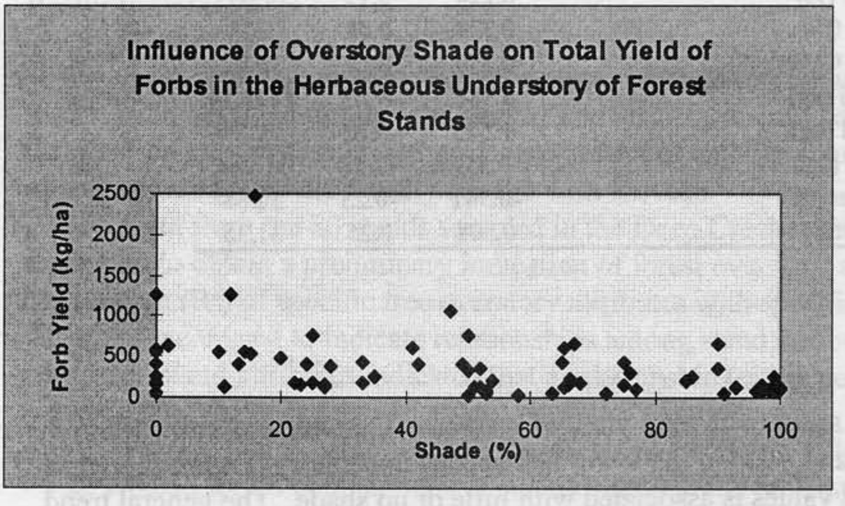

Figure 2. Scatter diagram illustrating the relationship between overstory shade (%) and forb yield (kg/ha) in a forest stand.

Industrial forests provide habitat for a large number of wildlife species as well as seasonal forage for livestock. Both the Deep Creek and Minam study areas are grazed seasonally by cattle and by Rocky Mountain elk (*Cervus elaphus nelsoni*), mule deer (*Odocoileus hemionus hemionus*), and whitetail deer (*Odocoileus virginianus*). Small cage structures were erected on 30 of the sampled forest stands to determine availability of forage in forest understory. Forage growth samples were obtained from herbaceous understory of stands in June, prior to cattle entering the study areas, and again at the end of the growing season. Yield samples were obtained by harvesting plots. Yield from plots that allowed herbivore grazing were compared with yield from plots that did not allow herbivore grazing (Figure 3 and Figure 4).

Yield of grass as a component of herbaceous understory yield on grazed plots was lower than either forbs or shrubs in June, and at the end of the growing season in September. Forb yield on grazing-allowed plots was slightly higher than shrub yield in June and September. While forb and shrub yield declined in relative amount between June and September, grass yield increased in relative amounts during the same period. Comparison of yield in the ungrazed plots with yield in the grazed plots that grass yield was proportionally higher than shrub yield but lower than forb yield. Overall, total yield was highest in the grazing-allowed plot in June (which was sampled prior to entry of livestock onto the allotment), lowest in the grazing-allowed plot in September, and moderate in the ungrazed plot in September. Comparison of yield in the grazing allowed and grazing not allowed plots in September indicates that grazing of herbaceous understory by all herbivores is occurring. However, some of the decrease in understory herbage may be caused by other factors, such as losses of standing crop to litter.

Comparison of yield obtained from grazed and ungrazed plots in the herbaceous understory of forest stands of the Minam Allotment indicate a pattern similar to the Deep Creek Allotment. An exception to this pattern is the relative amount of grass present on grazed plots in June and total yield on grazed plots in September. Grass yield is higher than shrub yield in June, and higher than forb and shrub yield in September. Total yield of herbaceous understory increases in relative amounts on grazed plots between June and September. The higher yield of grass and the higher total yield of herbaceous understory may reflect the more open forest stands characteristic of the Minam allotment. However, in both allotments, total yield in September is higher on ungrazed plots than on grazed plots.

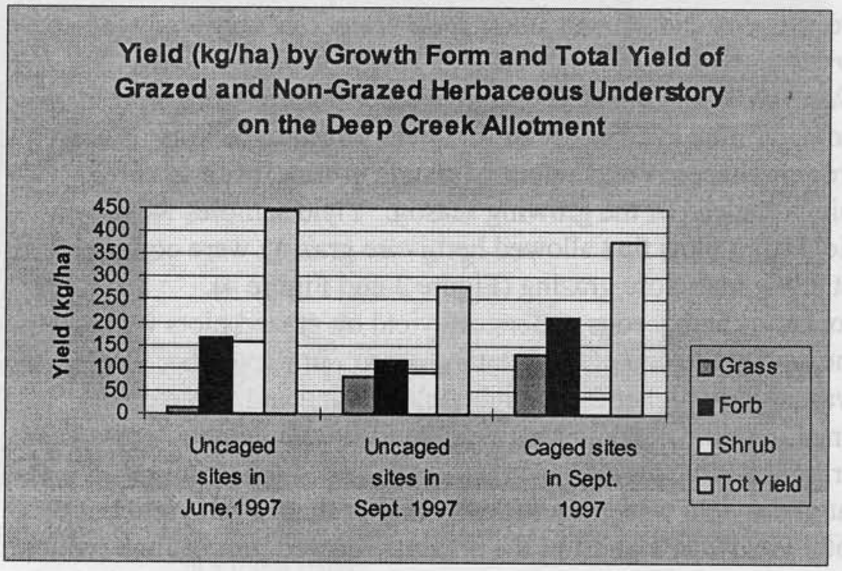

Figure 3. Yield (kg/ha) obtained from grazing allowed and grazing not allowed forest understory plots on the Deep Creek Allotment.

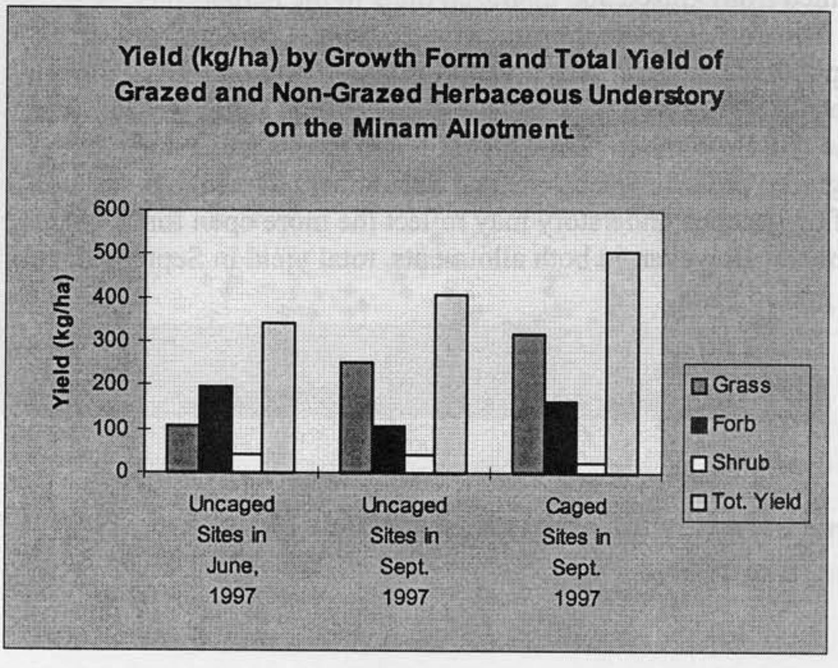

Figure 4. Yield (kg/ha) obtained from grazing allowed and grazing not allowed forest understory plots on the Minam Allotment.

DISCUSSION

Correlation analysis indicates tree overstory attributes influence herbaceous understory attributes. Overall, the shrub layer of herbaceous understory is positively influenced by higher levels of shade and larger diameter trees. This relationship indicates that shrubs which commonly occur in a forest environment are shade tolerant and respond positively to overstory characteristics that create more shade. However, the relatively low positive R^2 values indicate a weak relationship between tree-overstory attributes and shrub attributes. High crown closure and/or tree density may begin to negatively affect shrubs in the understory.

The grass and forb herbaceous layer is negatively affected by attributes characterizing tree overstory. Yield and cover of grasses in the understory is negatively affected by increasing levels of tree-crown closure or tree density. Increased competition for light may be the major limiting factor yield and cover of plant growth forms in the herbaceous understory. If competition for light is a major factor limiting yield of grasses, the positive relationship between tree and shrub layers would be a significant factor in eliminating grass and forbs from the herbaceous layer relatively early as succession occurs following harvest of trees.

Large herbivores apparently graze herbaceous understory in forest stands. Although further analysis of the data will be needed to determine the nature of large herbivore grazing relative to different overstory cover or forest communities, the importance of herbaceous understory as herbivore forage is apparent. Comparison of understory herbage produced on the two allotments indicates that more open-forest stands produce more understory herbage. However, further analysis of the data is needed to determine if forage is desirable to the different herbivore grazers using the allotments. Further analysis is also needed to determine the impact of tree harvest and the overstory/understory relationship to other wildlife.

A major focus of the study was to relate the relationship between forest overstory and understory vegetation to suitability of habitat for livestock and wildlife. Although determination of habitat suitability from the perspective of animal users is difficult, many of the site variables examined in this study appear to relate to habitat quality. Variables that relate to forest-overstory stand characteristics are important in providing animal-hiding cover and thermal regulation. The understory component of this habitat, while it provides cover and thermal regulation for many different animals, is a major source of food. Large and small herbivores, especially grazers, concentrate feeding activities in the shrub and herbaceous plant layers.

Species composition, yield, protein, and digestible nutrients are important determinants of habitat food quality if palatability of this combination of plant factors to potential users are known. Indices to habitat suitability and forage suitability for large herbivore users were developed for stand classifications comprising the two allotments.

An index of habitat suitability is being developed by assigning a palatability rating to each shrub and herbaceous species in the understory for eight kinds of potential animal users. Potential animal users were cattle, sheep, elk, mule deer, whitetail deer, upland game birds, waterfowl, small non-game birds, and small mammals (Dittberner and Olson 1983). The index of forage suitability for large herbivore grazers is developed by adjusting total yield, total CP yield, and TDN of each plant species present in the understory to the palatability rating of each species for the five large herbivores.

Information obtained from the study of overstory and understory relationships characterizing different forest stands is also useful in developing databases needed to support use of Decision Support Systems (DSS). The Grazing Land Applications DSS, which has application to managing and planning herbivore grazing on forested grazing allotments, will use information derived from measurement of overstory cover and associated understory plant communities, to establish large herbivore stocking rates.

Grazing Land Applications establishes stocking rates based either on plant yield available to meet forage intake requirements of grazing animals over the grazing season, or by determining the availability of critical nutrients to meet herbivore metabolic needs over the grazing season. Forage yield of plant communities in different forest stands is indexed to specific overstory-crown closure and habitat suitability to determine herbivore stocking rates based on the availability of plant biomass. Adjusted forage yield, CP, TDN, and weather factors during the grazing season were used to establish a potential metabolic stocking rate for large herbivores using forested stands of the two allotments.

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