AN IMPLEMENTATION MONITORING PROTOCOL FOR ASPEN

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ABSTRACT: In California, the United States Forest Service and the Bureau of Land Management have standards and guidelines limiting woody stem vegetation browsing to 20% of leader growth. This paper presents a utilization monitoring protocol for establishing the percentage browse of aspen, *Populus tremuloides*, a species that is part of a key habitat found on rangelands.

Key words: Aspen, *Populus tremuloides*, browse identification, utilization monitoring, implementation monitoring, monitoring protocol, rangeland

TRANSACTIONS OF THE WESTERN SECTION OF THE WILDLIFE SOCIETY 40:61-67

In California, the U.S. Forest Service and the Bureau of Land Management (BLM) have instituted policies (USDA 2004b, USDI 1999c, USDI 1999d) that direct range managers and permittees to determine if the age class, structural diversity, composition, and cover of riparian vegetation are within the range of natural variability for the vegetative community, and if these factors fall outside the range of natural variability, to implement restoration actions that will result in an upward trend. Additionally, both federal agencies have standards and guidelines limiting browsing to no more than 20% of the annual leader growth of mature riparian woody stemmed vegetation (USDA 2O04b, USDI 1999c, USDI 1999d), and the Forest Service's Sierra Nevada Forest Plan Amendment (SNFPA) (USDA 2O04b) calls for removal of livestock from any area of an allotment when browsing indicates a change in livestock preference from grazing herbaceous vegetation to browsing of woody stemmed vegetation. This paper presents a utilization monitoring protocol that Forest Service and BLM range management staff and permittees can use to establish the current utilization of aspen regeneration in allotments on rangeland in California. It is believed that the protocol presented here is applicable for use on all rangelands in the West where aspen habitats are managed because of their unique biodiversity. The protocol was developed and field-tested by resource managers from the Forest Service and the Bureau of Land Management, and the protocol and its supporting field form will be published by the U.S Forest Service, Pacific Southwest Region in 2004 (USDA 2004c).

In the West, aspen reproduction is almost entirely vegetative—i.e., clones generating suckers off lateral roots (Shepperd and Smith 1993). Therefore, for aspen, the key to the range of natural variability called for by SNFPA and BLM policies is successful regeneration of aspen clones. Successful aspen regeneration is characterized by suckers and saplings growing to a tree stature of 5 feet or better. It is at 5 feet that the aspen terminal leader will be above the browse zone of cattle, sheep, and deer (Mueggler and Bartos 1977). A height of 6 feet or more and a dbh of 2 inches may be the necessary indicator of successful regeneration if elk are present (D. Bartos and W. Shepperd, RMRS, personal communications).

The utilization standard of no more than 20% found in the federal agencies' standards and guidelines has been established to protect regeneration and to implement successful regeneration. Therefore, a principal goal of all management objectives and practices is to maintain or move aspen stands toward the desired condition—fully functional and structurally diverse stands. The key to reaching this desired condition lies in understanding the relationships between natural processes, historic influences, current management practices, and knowledge gained through monitoring and adaptive management.

On a landscape scale, the viability of a structurally diverse and fully functional aspen ecosystem does not express itself in any single, simple form. Over the broad range of aspen habitats, a percentage of viable aspen stands may be older but structurally viable even-aged stands, uneven-aged stands with two or more age cohorts, or stands consisting of one or more young-age cohorts that have been established after a major disturbance such as a fire.

Research has shown that this diverse ecosystem of structures and age cohorts plays an important role in the viability of flora and fauna species dependent on the habitat (Flack 1976, Severson 1982). For example, the size and condition of a given age cohort can provide hiding and thermal cover as well as feeding and nesting locations for a range of native fauna (Loft et al. 1987). It has been documented that 4 principal historic influences have affected the natural viability of aspen habitats: (1) prolonged fire suppression, (2) poor livestock management, (3) unnatural wildlife stocking numbers, or (4) combinations of any of the above (Loope and Gruell 1973). Any one of these 4 factors can play a significant role in limiting the

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amount of successful regeneration (Shepperd 1990). Thus, in time, these factors can lead not only to decreasing stand size and significance but to the actual demise of a stand.

Thus, the principal goal of current management objectives and practices, whether on a landscape scale or on a stand scale, is to protect, promote, or enhance fully functional, structurally diverse aspen habitats. Again, the key to successfully maintaining diversity on a landscape scale is to maintain or restore the natural regeneration processes of aspen. This paper addresses how utilization monitoring can be used to measure if browsing of aspen regeneration exceeds the standards and guidelines established by the Forest Service and Bureau of Land Management in the Sierra Nevada of California and Nevada. Additionally, it can be applied throughout the West where agency or private land owners are maintaining the viability of this key species.

Browse Identification

In order to establish a consistent quantitative approach to identification of browsing across allotments, it is recommended that damage to the current year's growth of the terminal leader of aspen stems within the browse range of ungulates be the method for calculating whether the management objective of no more than 20% utilization is being met (Keigley and Frisina 1998). Terminal leader damage is used as the key indicator of browse because in order for an aspen to have uninterrupted growth, the terminal leader needs to remain intact (Keigley and Frisina 1998). If the terminal bud is damaged or removed, it takes up to two years for a new primary stem to establish. The damaged primary stem must be replaced by a shoot from a lateral bud or by a subordinate lateral branch. It should be noted that defoliation can be caused by a number of other site environment factors and stressors such as drought conditions, plant vigor, available soil moisture, extensive high temperature days, insect herbivores, and pathogens. All these factors can be contributing factors to defoliation, which seldom interrupts plant growth on more than an annual basis. However, several consecutive years of defoliation can stress a plant to death.

Location of Monitoring Sites

Monitoring locations for this protocol are chosen based on key area/critical area concepts as found in the interagency technical reference: *Sampling Vegetation Attributes* (USDI 1996a) . Critical area can be defined as an area which must be treated with special consideration because of inherent site factors, size, location, condition, values, or significant potential conflicts among users (Society of Range Management 1998). Because research has demonstrated their unique or potentially unique biodiversity (Dobkin et al. 1995, Bartos and Campbell 1998), individual aspen stands shall be referenced as critical areas because they are a key indicator (Wilson 1992) of the biodiversity of the landscape. Individual stands may also be identified as key areas. An individual stand in this second situation is identified as a key area because it references what is happening in a larger number of stands as a result of on-the-ground management actions. In this case, the individual stand is a representative sample of a larger stratum, which

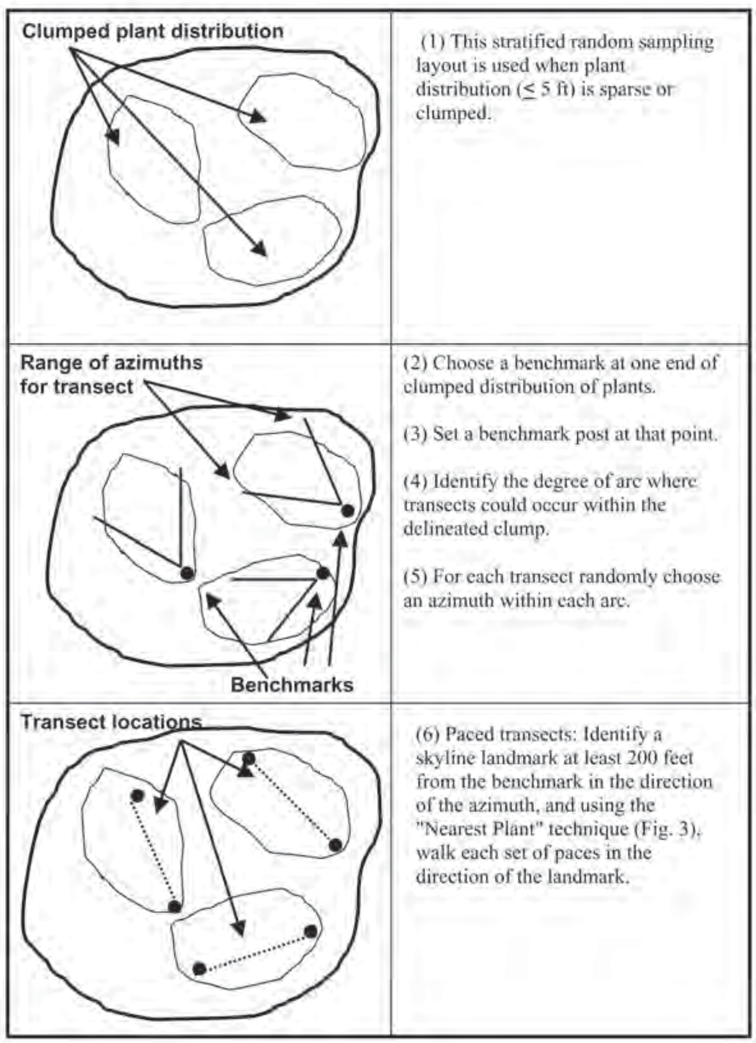

Figure 1. An illustration of the protocol using stratified random sampling. This sampling protocol is used when aspen sucker distribution is sparse or clumped.

can be defined as a collection of aspen stands, a livestock pasture, a watershed, or the entire grazing allotment.

Making monitoring sites permanent is of value because (1) the power to detect change is often much greater with permanent sampling units and (2) spatial variability is removed from analysis (Elzinga et al. 1998). How much better permanent sampling units perform depends on the degree of correlation between years of sampling units. The increase in power by using permanent sampling points outweighs the increased time cost of establishing the initial monitoring site.

Desirable sampling points will (1) quantify browsing intensity of a particular management practice at a particular time (implementation monitoring) and (2) establish whether a given management practice is moving a stand toward or away from a desired condition (effectiveness monitoring). While effectiveness monitoring is not addressed in this paper, it is closely linked to implementation monitoring. There are two important attributes that must be measured in these monitoring protocols. Implementation monitoring focuses on browse use, and effectiveness monitoring focuses on stem size changes. Thus, having young stems within browse height in the sampling area is critical to producing the data needed to evaluate management practices.

Because available browse plants in aspen stands may be either abundant or very limited in abundance and/or spatial distribution, the methods used for sampling selection are based on the distribution of the suckers (ramets). Transects should be established randomly but must intersect with aspen suckers and be spaced evenly throughout the stand. Therefore, the following guidelines should be used to determine which method is most appropriate. When large or small stands have uniform aspen stem distribution, it is recommended that restricted random sampling be used (Fig. 1); and when large stands have sparse or clumped distribution, it is recommended that stratified random sampling be used (Fig 2). Finally when small stands have clumped distribution, numbering all the clumps of aspen or areas with aspen and then randomly selecting these numbers to establish transects is recommended.

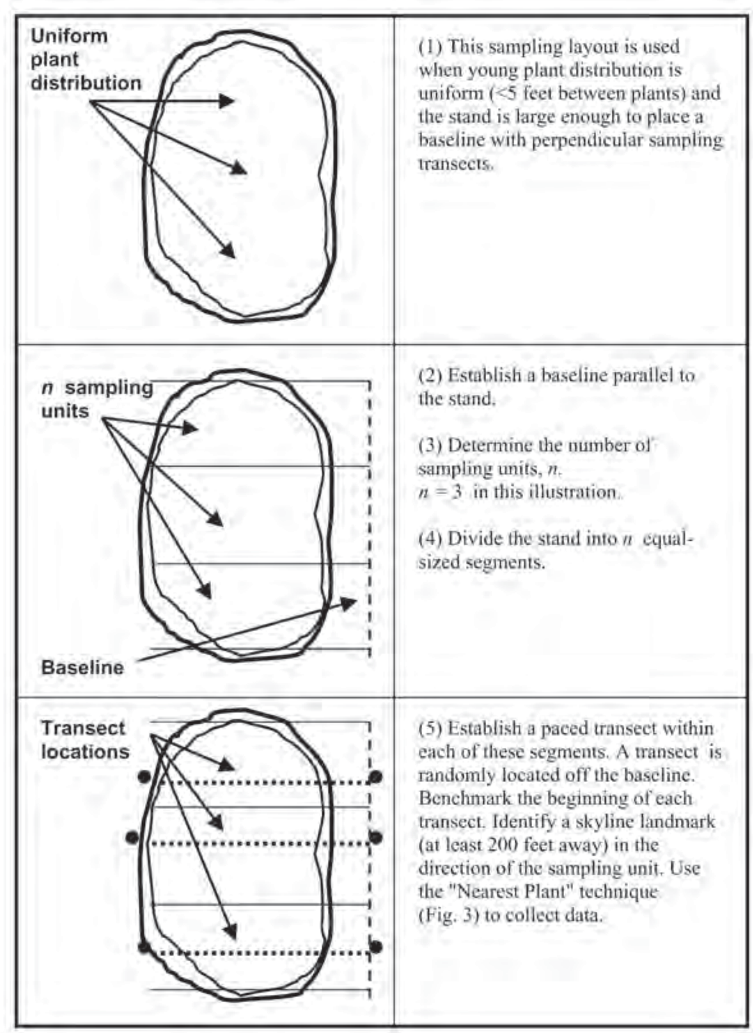

Figure 2. An illustration of the protocol using stratified random sampling. This sampling protocol is used when aspen sucker distribution is uniform.

Implementation (Utilization) Monitoring Protocol

The monitoring objective of this protocol is to establish whether the current management practice exceeds 20% utilization. This will be done by monitoring at a given point in time the percentage of utilization of aspen suckers 5 feet or less in aspen stands on grazing allotments. The main purpose of implementation monitoring is to identify the percentage of browsing that has occurred on aspen suckers at a fixed time in a fixed location. The information recorded in this protocol along with the additional data collected—such as monitoring livestock type, number of animals, class of animal, date of livestock introduction and date of livestock removal—will assist the range manager and permittee in understanding the significance of variables within the allotment.

Methodology

Aspen use will be based on percentage of plants browsed as measured on plants ≤5 feet in height. The *Browsed Plant Method for Young Quaking Aspen* developed by the Forest Service (UDSA 2004) will be used to assess level of herbivory occurring on aspen.

The *Grazed Plant Method* (Roach 1950, Hurd 1953, Gierisch 1967, USDA, 1993) is similar to the approach used on key bunch grass species. Browse use levels will be determined based upon a count of individual plants that have terminal buds of primary stems of the current year's growth, either intact or removed.

Detailed directions for the implementation monitoring protocol are as follows: using the sampling protocols identified in *Location of Monitoring Sites* and illustrated in either Fig. 1 or Fig. 2, place a linear transect through the sampling site being monitored. Mark the starting point (benchmark) with a T-post, randomly choose the azimuth of the transect, and record the azimuth of the transect line on the data entry form. Establish and record the benchmark's GPS location. To assist in relocating the monitoring unit, nail an aluminum tag with the plot number on the closest tree to the T-post and paint a yellow circle around it. If the closest tree is an aspen, use paint only and do not nail a tag to it. Nailing and even surveyor's flagging wrapped around a stem can provide an entry point for fungal damage in aspen (Wayne Shepperd, RMRS, personal communication). Marking the starting point and recording the azimuth are

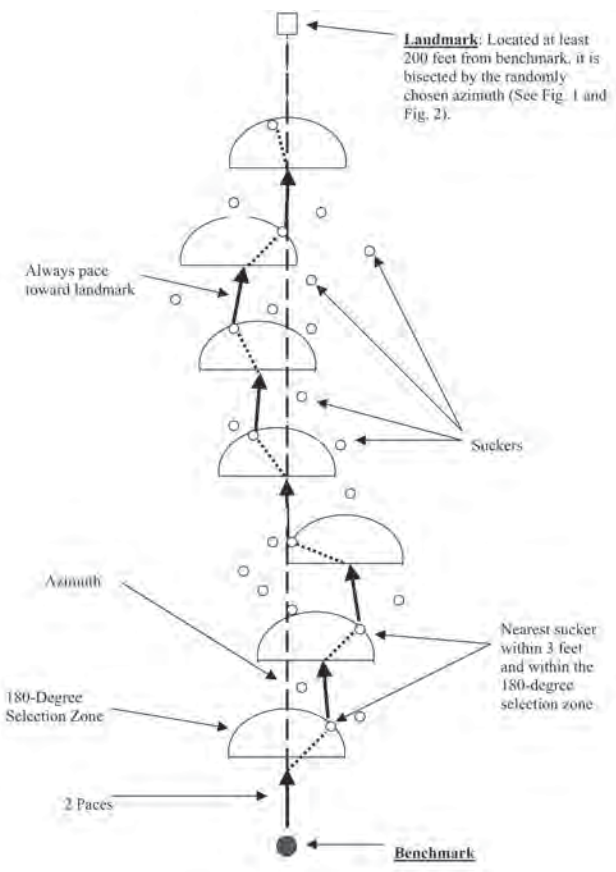

Figure 3. An illustration of the "Nearest Plant" technique for sampling young aspen that are ≤ 5 feet

key components of the integrated approach to adaptive management of aspen. Permanently marked implementation monitoring transects allow replication of implementation monitoring throughout a season or between seasons. In turn, the benchmark and azimuth should be used for establishing permanent plot locations when conducting effectiveness monitoring.

The Nearest Plant Technique (USDI 1996b) will be used to determine which individual plants to sample along the paced transect (Fig 3). Start the transect by taking 2 paces in the direction of the azimuth. At the end of each set of paces, identify and record the condition of the nearest aspen plant ≤5 feet in height that is within 3 feet and within a 180-degree arc in front of you. If the terminal leader of the primary stem has been removed, the sampled plant is counted and recorded as browsed. If the terminal leader of the primary stem is intact, the sampled plant is counted and recorded as unbrowsed. If clumped suckers are present, record the plant of the sucker stem nearest to the front of your boot. Use a 3 foot measuring pole to assist in determining the nearest stem. If no stems ≤5 feet are within the designated areas, take 2 additional paces and repeat the process. A minimum of 30 observations per transect will be made and recorded on the *Browsed Plant Method Field Form* (Fig. 4). In a small stand it may not be possible to complete transects in a straight line. If the transect is not complete when it has been determined that there are no more aspen suckers in the direction of the azimuth, make a 90 degree turn, take five paces, make a second 90 degree turn in the same direction, and then complete the transect following a line that is parallel to the initial transect. In larger stands and in stands that are being used as "key area" indicators, it recommended that 3 transects of $n = 30$ be established for a total of 90 samples in order to increase confidence levels (See Section: Statistical Analysis section). The percentage of plants browsed will equal the number of plants browsed divided by the number of plants observed, multiplied by 100. See: Statistical Analysis section to determine the most appropriate sample size.

Also, photo points should be established at each transect to assist in the interpretation of stand condition and to assist in relocating transects. Establish photo points by looking in the direction of each transect and taking one photo from the transect benchmark. Include a measuring pole with height indicators in each photo. In each photo include a note card or notebook page, held in the corner of the frame, with the site identification, transect number, bearing, and date written large enough to be read when the film is developed or downloaded from a digital camera.

Finally, the range manager and permittee should work collaboratively to record the following additional data: livestock type, number of animals, class of animal, date of livestock introduction, and date of livestock removal. All these variables are keys to understanding the intensity of browse utilization.

Statistical Analysis

The monitoring objective of this protocol is to see whether current management practice exceeds the US Forest Service and BLMs 20% utilization standard, and the sampling objective of the protocol is to obtain a 95% level of confidence such that utilization estimates are within 10%$\pm$ of the estimated true value. A sample size of $n = 90$ meets these objectives and because of the clumped distribution patterns of aspen regeneration, one could use 3 transects of $n = 30$ to reach the sampling size of $n =$

Browsed Plant Method Field Form

Sampling Date: ____________ Examiner: ____________
Allotment Name: ____________ Recorder: ____________
Key Area Name: ____________ Landmark Description: ____________
BM Coordinates T1: ____________ Azimuth T1: ____________
BM Coordinates T2: ____________ Azimuth T2: ____________
BM Coordinates T3: ____________ Azimuth T3: ____________
Animal Kind/Class: ____________ Date Animals Introduced: ____________
Number of Animals: ____________ Date Animals Removed: ____________

Transect 1				Transect 2				Transect 3			
Plot/Browse		Plot/Browse		Plot/Browse		Plot/Browse		Plot/Browse		Plot/Browse	
1		16		31		46		61		76	
2		17		32		47		62		77	
3		18		33		48		63		78	
4		19		34		49		64		79	
5		20		35		50		65		80	
6		21		36		51		66		81	
7		22		37		52		67		82	
8		23		38		53		68		83	
9		24		39		54		69		84	
10		25		40		55		70		85	
11		26		41		56		71		86	
12		27		42		57		72		87	
13		28		43		58		73		88	
14		29		44		59		74		89	
15		30		45		60		75		90	
Subtotal				Subtotal				Subtotal			

Total Browsed ______ / Total Sampled ______ X 100 = ______ % Total Browse

(Total No. Plants Browsed) / (Total No. Plants Sampled) = Total % Browse for All Sampled Plants

Notes (Use other side or another page, if necessary)

Figure 4. The field form that is used with the *Browsed Plant Method for Young Quaking Aspen*. The field form was developed by the U.S. Forest Service, Pacific Southwest Region (2004c).

90 (Fig. 1 and Fig. 2). The 95% confidence interval assumes the 20% estimate was achieved by sampling these ≤5 feet tall aspens and recording whether the terminal leader was either browsed or not browsed. This type of yes/no data is binomial in nature and allows for estimates of confidence intervals based on only the initial estimate (here 20%) and the sample size. The upper and lower 95% confidence limits for estimates of 20% can be established for different sample sizes (Table 1). These limits, developed by John Willoughby, California State Botanist, BLM, have established that with a sample size of n = 90 the lower confidence limit would be 0.123 and the upper confidence limit would be 0.298. Thus, the sample size of n = 90 would provide lower and upper confidence limits that would be within ± 10% of the true value of the estimated value of 20%. These limits were calculated using an Excel workbook that incorporates the exact method for calculating confidence intervals for a binomial distribution as described by J. H. Zar (1996).

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Table 1. This table presents the 95% confidence intervals for an estimate of 20% utilization of aspen for different sample sizes. The sample size of n=90 provides lower and upper confidence limits that are within the monitoring objective of this protocol. That objective is to be within ±10% of the estimated true value. These estimates were calculated using the exact method for calculating confidence intervals for a binomial distribution as described by Zar (1996).

Number of Sampling units (Aspen ≤5 Feet)	Lower Confidence Limit (Based on 20% Estimate)	Upper Confidence Limit (Based on 20% Estimate)
30	0.077	0.386
40	0.09	0.357
50	0.1	0.338
60	0.107	0.324
70	0.113	0.313
80	0.118	0.305
90	***0.123***	***0.298***
100	0.126	0.292
150	0.139	0.274
200	0.146	0.263
500	0.165	0.238
1000	0.175	0.227

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