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Guidelines for Aspen Restoration on the National Forests in Utah

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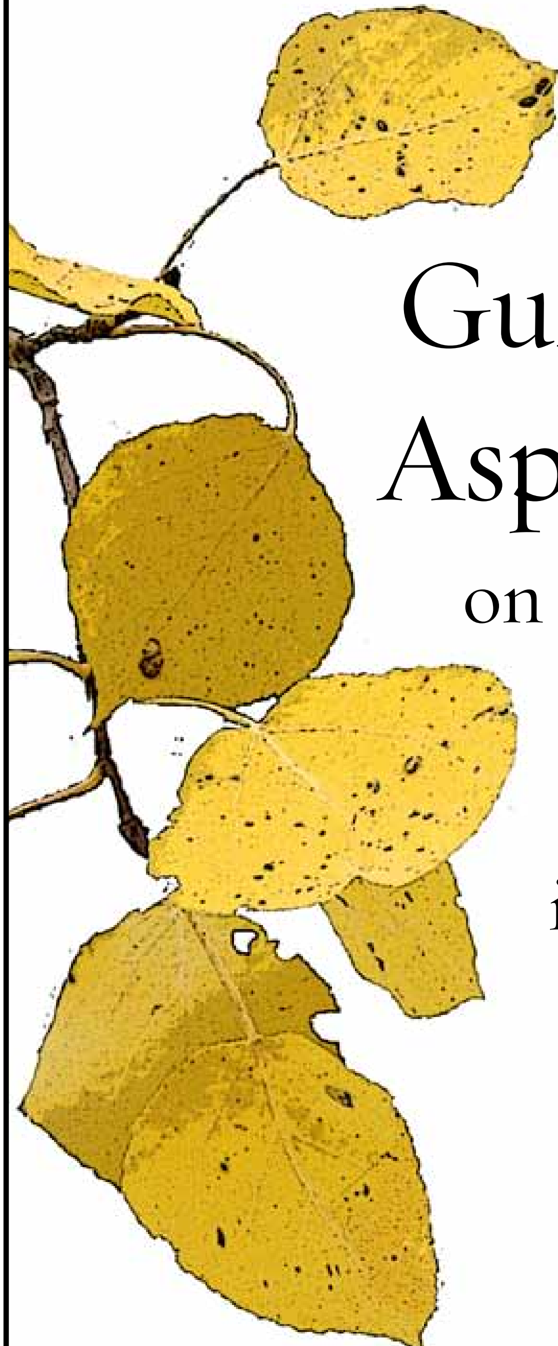

Guidelines for Aspen Restoration on the National Forests in Utah

Utah Forest Restoration Working Group

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Riparian aspen overtopped by conifer, Brumley Creek, Utah

Foreword

Guidelines for Aspen Restoration on the National Forests in Utah was produced is the first major project of the Utah Forest Restoration Working Group (UFRWG). The UFRWG is a collaborative group formed for the purpose of reaching consensus on critical forest issues primarily affecting National Forest lands in Utah. As a consensus-based entity, UFRWG is comprised of a wide variety of interest group representatives: U.S. Forest Service, State Agriculture and Natural Resources, county government, private citizens, and non-governmental organizations (environmental, resource utilization, and industry). A complete list of UFRWG participants, members of the Ecology Committee is in Appendix A.

The UFRWG - Ecology Committee (formed in April 2009) was given approximately one year to compile this set of guidelines and recommendations for aspen management in a form agreeable to all parties. During this period the Ecology Committee gained input from managers around the state working directly with aspen.

A December 2009 draft was circulated among a group of scientists who have both conducted aspen research and observed aspen conditions in Utah and the West (Appendix B). References to "personal communication" in the guidelines refers to statements made by these scientists during the review process.

We believe these guidelines incorporate the most current aspen science in a manner which allows the diverse interests represented here to move forward on a range of aspen-related restoration projects and issues affecting National Forests in Utah. The process of writing these guidelines involved considerable compromise by all parties.

The UFRWG is under no illusion that this document will solve all our aspen problems, or that we won't learn more about the needs of aspen in the future. However, the guidelines present a progressive range of alternatives, prior considerations, and monitoring elements that we believe will greatly aid forest managers in making difficult land use decisions regarding aspen communities in Utah.

Managers of National Forest system lands should be able to use the guidelines in conjunction with the forest plans, as a road map to identify, design, and implement projects to restore aspen forests. This management response for aspen should follow the pattern of: first, assessing the condition of aspen; second, using site specific data to determine the causal factors that contribute to current aspen condition; third, selecting from the range of response options to address the causes of the current condition; last, monitoring the results to learn more about aspen management in general, and to determine if different treatments are warranted to achieve success.

These guidelines are a working document and will be tested within the Utah National Forests on different aspen types.

I. ASPEN IN UTAH:
PRIOR CONSIDERATIONS

Due to its high productivity and structural diversity, aspen is capable of supporting the broadest array of plant and animal species of any forest type in the West, and is considered second only to riparian areas in its support of biodiversity (Chong, et al. 2001). Aspen can support diverse grass, forb, and shrub species and, therefore, habitat for a wide variety of bird, mammal, and arthropod species (Mueggler 1985).

However, aspen has decreased throughout the Intermountain West during the 20th century, and aspen-dominated acreage within the five national forests of Utah has declined by 50% or more in recent decades (e.g., see Fig. 1 in Kay and Bartos 2000). This decline is of special concern, as aspen does not commonly reproduce from seed and thus loss of an aspen clone may be the loss of a long-standing aspen presence not easily recovered.

Because aspen management decisions on national forests in Utah are ecologically, socially, and economically consequential (and often of uncertain outcome), aspen management guidelines developed on the basis of available scientific research and observations are desirable. Such research and observations encourage consideration of landscape-scale aspen conditions, as well as agents active in a given stand, when making management decisions regarding disturbance and protection.

Conifers are overtopping aspen in this Fishlake National Forest stand

At the landscape scale, aspen declines are variable, depending on site characteristics, fire and succession, extreme climatic events, biotic agents, and human influence. For instance, much of the loss of aspen-dominated acreage is attributable to encroachment and overtopping by conifer. It has often been presumed that this encroachment i.e., the natural succession process for seral stands, is the result of fire suppression. For much of the central Rockies, however, climate patterns of the 20th century (predominantly moist) encouraged shade-tolerant tree species (Rogers et al., 2011). Fire suppression may have had little effect on higher elevation aspen-conifer sites in terms of altering fire regimes (Baker 2009). In large pure aspen communities, wildfire has had little effect in determining present conditions due to the inherent lack of flammability and long fire-return intervals of these forests. Native American ignitions, on the other hand, may have maintained relatively short fire-return intervals in some locations.

Expected warming and drying conditions in our region may promote very different disturbance patterns than we have seen in the recent past. While we cannot predict the future with precision, we can encourage adaptive management strategies that provide options for future generations. In aspen communities, for example, this may mean assuming management practices which anticipate more frequent fires for suckering – as opposed to actively thinning conifer regrowth for short-term aspen promotion.

The variable presence of ungulates, wild and domestic, browsing and grazing within aspen throughout Utah is another major consideration. While aspen tend to sprout prolifically after overstory mortality, ungulates have the potential to browse or trample aspen suckers, possibly reducing chances of successful regeneration, especially when combined with other factors.

Variable herbivory pressures, in combination with changes in fire regimes, logging practices, and even genetic variance among clones can alter expected outcomes. Thus, management decisions on different sites should attempt to account for these factors to the extent possible.

In sum, no guidelines for aspen management can anticipate all situations. The intent here is to promote holistic thinking in management decisions. If we act before understanding either the larger ecological context or agents operating on aspen in specific sites, the probability of irrevocable damage increases. If we are uncertain of management outcomes, pre- and post- decision monitoring is critical. Documentation of restoration failures, as well as successes, is an important component of management.

UFRWG members discuss aspen restoration at a clearfell site within the Dixie National Forest

There are three general aspen "types": (1) upland pure aspen (i.e., aspen stands in which conifers are largely absent); (2) upland aspen mixed with conifer; and (3) riparian aspen. While other aspen types exist (e.g., lithic aspen or snowpocket aspen stands), the three types are the major ones for which management or restoration decisions are repeatedly being made on the national forests in Utah. The guidelines in this document focus on upland pure aspen and upland aspen mixed with conifer. These two different types typically experience different factors that influence the conditions of the stands. Likewise, the management response will likely need to be different between these two general types of aspen. In the future, guidelines for riparian aspen restoration may be usefully added to these guidelines.

Finally, these guidelines focus on restoration of aspen *forests*, but maintaining healthy aspen *communities* is of equal importance to restoration as a management focus.

Pure aspen stand

Upland aspen mixed with conifer

Riparian aspen

Summary of Significant Aspen Challenges

1. In many areas in Utah, particularly in seral aspen forests, conifers have overtopped aspen due to a variety of causes, such as:
   a) a very moist 20th century,
   b) fire suppression, more prominently at lower elevations, and
   c) management.

In pure aspen forests, wildfire plays a much smaller role, while browsing and grazing pressure, combined with periodic drought, appear to have caused local declines. There are many causes of the decline, with wide variation in the decline across the State.

2. There are budget, social, administrative, economic, and potentially ecological limits to response options available to the National Forests to address this decline.

3. Aspen restoration options may be limited by available technical information.

4. There is varying public support or understanding about the importance of aspen, the decline of aspen, and why any given response would be chosen, and there are varying levels of support for aspen treatment and/or management.

5. Competing resource uses may limit restoration efforts in aspen. For example, wood fiber production, wildlife management, livestock grazing, and fire suppression may not – in combination or separately – be compatible with intrinsic or ecosystem service values of aspen.

II. Key Terminology

Aspen Community: Synonymous to an ecosystem: the biotic (e.g., grasses, forbs, aspen stems, wildlife) and abiotic (e.g., climate, groundwater) components of an aspen stand and their interactions.

Best Available Science: Scientific data that are available at the time of a decision or action and which are determined to be the most accurate, reliable, and relevant for use in that decision or action. Reliable scientific information is objective and repeatable. Multi-party monitoring, collaborative review of methods and/or data, and independent review are recommended means of assessing best available science.

Clearfell-coppice harvest: Complete removal of all live trees. This may *look* like a clearcut harvest to observers, but "clearfell-coppice" is used here to clearly articulate that regeneration via root suckering is planned, and not by seeding or planting as in typical clearcuts.

Genet: The technical name for one genetically identical clone. An aspen stem originating from seed is a unique genet.

Isolated pure aspen stand: Refers to small or moderately-small pure aspen stands that are scattered across the landscape and visibly appear as individual units. These may represent fragments of a larger, formerly connected stand surrounded by non-forest vegetation types.

Ramet: Any individual stem of a larger aspen clone (whether juvenile or mature). A ramet has the same genotypic make-up as all other stems from that clone.

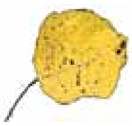
Regeneration (of aspen): The rate of new aspen suckers that grow in an area. Aspen regeneration (recent suckering, or starts from lateral roots) is a good indicator of root stock health. Less than 500 stems/acre is often considered an unsustainable level, although this is not known with certainty.

Restoration – active: Activities such as logging, burning, seeding, tree girdling, root ripping, or active reintroduction of a native species in order to restore a condition considered ecologically desirable in a particular area.

Restoration - passive: Restoring a condition considered ecologically desirable by removal of particular management activities. Examples include letting ecosystem processes such as lightning-ignited fire run their course rather than suppressing the fire; or by relieving the affected area of current pressures (e.g., changes in grazing/browsing management) that have been preventing ecologically desirable conditions.

Suckering: The growth of aspen starts from lateral roots of a clone.

Wildland Urban Interface (WUI): The Wildland-Urban Interface (WUI) is composed of both interface and intermix communities of houses and wildland vegetation. Intermix communities are places where housing and vegetation intermingle. Interface communities are areas with housing within 1.5 miles of >50% wildland vegetation. With regard to aspen, the WUI may be more actively managed to promote aspen communities as a firebreak. Generally, the higher the composition of aspen trees as opposed to conifers, the less flammable the landscape will be.



III. General Recommendations for Aspen Restoration

1. Aspen reference sites (areas and exclosures)

Identify/establish a representative set of reference aspen community sites. Reference condition stands include aspen stands not used for dispersed camping or livestock grazing, and not being heavily browsed by wild ungulates. As reference sites are of different types and are thus able to answer different questions, few criteria beyond minimal human management impacts and large size, whenever possible, are required.

Reference condition sites help separate climate effects (e.g., a drought) from management effects and provide indications of aspen community (overstory and understory) potential. The larger the size reference system, the better.

Three-way exclosures may draw wild ungulates to the cattle-exclosure portion as an ungrazed spot in the landscape if livestock grazing outside the exclosure is heavy. Likewise, ongoing maintenance of exclosures is required because livestock as well, can be drawn to ungrazed spots in the landscape.

High-fence exclosures (i.e., excluding both wild and domestic ungulates) do not represent the potential condition of the area's vegetation, because at least some populations of wild ungulates will graze and browse as part of the natural system. A big-game exclosure can give some insight into the consequences for the area's vegetation of current levels of wild ungulates (three-way exclosure) or the cumulative grazing of wild plus domestic ungulates (livestock exclosure).

Thus, the varying parameters of reference sites (e.g., large areas inaccessible or closed to livestock, areas minimally or not used by wild ungulates, livestock exclosures, three-way exclosures, varying elevations and locations within Utah) can yield particular types of information relevant only to particular questions.

Aspen is recruiting locally only inside this ungulate exclosure on an allotment not grazed by livestock for 8 years (Manti-La Sal NF)

The greater the diversity of aspen reference sites, the greater the potential information regarding aspen management. Examples of a variety of existing aspen reference sites include:

A. The large Cottonwood Allotment on the east side of the Tushar Range of Fishlake NF contains aspen (much of it high elevation), and has been closed to livestock for more than 30 years.

B. The small Grindstone Flat three-way aspen exclosure, on the top of the Tushar Range of Fishlake NF has been continuously maintained for 75 years and has been studied by Dale Bartos, Charles Kay, and others.[1]

C. The Cinder Cone Research Natural Area (RNA) (640 acres) in the Dixie NF exhibits aspen conditions under a conifer overstory.

D. The Butler Fork RNA (1,270 acres) in Big Cottonwood Canyon near Salt Lake City has not been grazed by livestock for more than 100 years.

E. The Vernal Municipal Watershed (6,886 acres) has been closed to livestock grazing since 1973. This area includes seral aspen/conifer communities and some stands with little conifer. Aspen is scattered over approximately half of the total area.

Grindstone Flat in the Tushar Mountains has been maintained as a three-way exclosure for more than 75 years and has been repeatedly studied

Measuring recruitment in the Butler Fork Research Natural Area near Salt Lake City provides one aspen reference area for northern Utah

1 Grindstone Flat aspen exclosure studies include Kay, Charles and Dale Bartos. 2000. Ungulate herbivory on Utah aspen: Assessment of long-term exclosures. *Journal of Range Management* 53:145-153. Also Mueggler, WF, and Dale Bartos. 1977. *Grindstone Flat and Big Flat Exclosures.* USDA Forest Service research paper INT – 195. Ogden, UT: Intermountain Forest and Range Experiment Station.

2. A central "Aspen Successes" database for National Forests in Utah

Dense aspen recruitment in a conifer opening on the Dixie NF

Even from a distance, differences in aspen stand health are evident where a green, multi-layered stand (left) contrasts with the less vibrant and open understory stand (right). A one meter fence divides these two segments

Establish a Forest Service database describing Forest/District-specific aspen restoration successes (and failures), including the actions that were taken associated with either the successes or failures at:

1. Restoring recruitment in isolated pure aspen stands
2. Increasing suckering (regeneration) in isolated pure aspen stands
3. Restoring recruitment in riparian aspen stands
4. Restoring aspen understory of native grasses, shrubs, and forbs where understory has been depleted
5. Restoring aspen in stands heavily overtopped by conifer
6. Restoring pure aspen stands that were dying
7. Restoring diseased aspen stands

The Western Aspen Alliance has offered to house this collection.

3. Establishing Monitoring Protocols Prior to Response Implementation

The "best available science" is unlikely to predict site-specific responses to management actions with a high degree of accuracy. Monitoring improves our understanding of our "field trials" of aspen restoration.

Monitoring the height/diameter structure of an aspen stand complements measures of browse intensity

4. Establish systematic and periodic monitoring of key aspen reference areas and long-term exclosures

Repeated documentation of conditions and changes within reference areas and long-term exclosures can provide understanding of aspen recruitment, disease, drought, understory development, and succession over long periods of time, shedding light on aspen dynamics. For instance, the U.S. Forest Service Rocky Mountain Research Station could take responsibility for basic, systematic monitoring of aspen exclosures.

IV. Decision Process for Aspen Restoration

The goal of an ecological aspen restoration decision process is to promote sustainable and biodiverse aspen forests.

This section describes four major steps to use in making a decision about aspen forest restoration. That is, the framework and logic flow to assess the conditions, identify the possible causal factors, and select response options and monitoring that will address the root causes, followed by a brief discussion of the rationale.

This is followed by a step-by-step process outline designed for managers to follow. Within each step there are literature citations and brief descriptions of the variation that exists across the state, intended to stimulate discussions within the group of resource specialists and others engaged in planning an aspen restoration approach. Bartos (2007) and Shepperd (2001) both describe approaches to assessing aspen conditions and making decisions on potential management actions parallel to the decision process described in more detail below.

Aspen recruitment protected by a fallen log on the Manti-La Sal NF

Four Major Steps
of the Aspen Restoration Decision Process

Step 1: Assess the condition of aspen

a) Assess the condition of aspen in the landscape/area including the determination of the aspen types

b) Assess the extent, and significance of aspen, (aspen's aerial coverage, stand structure, stand composition, overstory/understory coverage, etc.) in the project area, and the relationship of the project area to the landscape setting or watershed

Step 2: Identify problematic aspen conditions and their agents/causes

a) Identify through data collection the condition(s) considered potentially problematic

b) Identify through data collection the likely agents/causes of problematic conditions, as observed in the stand and surrounding area

Step 3: Select from among appropriate response options that address the potentially problematic conditions

Step 4: Monitor to assess aspen stand conditions and management/restoration

The implementation of these guidelines should be successful in restoring aspen forests on a small (few acre) project, and also would be effective at a landscape scale of several thousand acres. Given the apparent trend in aspen health, aspen abundance, and aspen recruitment across Utah, exclusive use of small single treatment/response units may not change the trajectory of aspen across the landscape. For this reason, large-scale aspen restoration projects (even if implemented incrementally) are recommended to truly benefit aspen forests over the long-term.

Small areas can be very useful for learning more about response options in specific locations and should not be ruled out if they are to be used as part of an adaptive management approach. Small response areas can also be critical in taking actions when the existing aspen clones are naturally small in size in the specific geo-physical setting.

To make the most positive change on the trajectory of aspen in a watershed, multiple small stands may need to be considered.

Two Pando clone exclosures with different aspen conditions. Left, clearcut and protected; right, enclosed but not successfully protected from deer

Step 1: Assess the condition of aspen in the landscape/area including, the determination of the aspen types and significance of aspen in the project area.

Aspen ramets generally produce suckers with reduced vigor (i.e. fewer suckers produced) as they age (greater than 100 years old).

The relative amounts of these aspen types in the landscape should be described. What is the current trajectory for the amounts of these aspen types if no changes in management/actions are pursued? At the landscape scale, managers should assess the mix between enhancing and sustaining existing pure aspen forests, and restoring aspen communities that may be impacted by conifer encroachment or some other influence that is leading to their reduction on the landscape.

Landscape Assessment Decision Tree Questions

1) Is aspen a significant part of the diversity, composition, and function of the landscape or watershed in question?

a) Yes – some management changes/actions may be warranted and continue through the decision tree, moving to question 2.

b) No – management changes/actions may not be warranted at this time.

2) Is the trajectory for aspen without treatment to move outside of the sustainable conditions at the landscape level? (For example, consider aspen's aerial cover, stand structure, stand composition, overstory/understory cover, etc.)

a) Yes – some management changes/actions may be warranted. Continue with additional site specific data collection and analysis

.

b) No – management changes/actions may not be warranted at this time.

Forest Service pathologist John Guyon and entomologist Liz Hebertson examine the complex of diseases and insects which are affecting the Pando aspen clone on the Fishlake National Forest

Given the apparent downward trend in aspen health, aspen abundance, and aspen regeneration (and recruitment) in a given area as described by Bartos (2007), small single treatment/response units may not change the trajectory of aspen across the landscape. Consequently, large-scale/multi-phase treatments or management changes are generally recommended.

Although the focus should be at the landscape level, it is important to recognize that there are small stands of pure aspen that are biologically significant and threatened by climate changes or existing management practices. These small pure aspen stands may need manipulation and/or management changes.

The following aspen types and problematic conditions have been suggested as relevant to the national forests in Utah.

- **Pure Upland Aspen**
  1. **Extensive, large**
  2. **Isolated, small**

- **Upland Aspen/Conifer ("seral")**
  3. **Conifer subdominant**
  4. **Conifer dominant**

- **Riparian Aspen** [not focused on in these guidelines]

Upland aspen/conifer, Manti-La Sal National Forest

A problem may exist when an aspen stand is not recruiting suckers into the overstory for long-term maintenance of the stand, as an aspen stem generally does not live more than 150 years. Very low or nonexistent recruitment and regeneration is nearly always a cause for further investigation.

The following encompasses major forms of depleted recruitment observed in aspen stands in the national forests:

1. Overstory aspen (mature aspen) with regeneration (suckering), but depleted recruitment
2. Overstory aspen, but little regeneration
3. Dying mature aspen with regeneration, but depleted recruitment
4. Dying mature aspen, but little regeneration

Aspen understory is lacking in this Parker Mountain stand

In addition, understory (forbs, grasses, and/or shrubs), a major source of aspen community diversity, may be depleted relative to potential. For instance, smooth brome (*Bromus inermis*), an exotic, perennial, rhizomatous grass, may affect aspen suckering (Stanley Kitchen, personal communication). Reduction of understory vegetation due to grazing/browsing may reduce or prevent the occurrence of low severity/high frequency fires (Bob Beschta, personal communication).

The aspen clone may exhibit significant levels of disease.

Starting with Mueggler (1989), a series of publications, when linked together, provides one logic path to determine the need, if any, to restore landscapes that were once dominated by aspen stands, i.e., the reasons for the actions to be taken.

Mueggler (1989) provides a flow chart (Fig. 1 from that publication, p. 17) that may be helpful for managers in asking key questions. Mueggler's diagram is included to help conceptualize key steps in the process, but these guidelines do not support all of Mueggler's suggested response options.

Bartos and Campbell (1998) discuss risk factors associated with aspen dominated landscapes that may indicate a need for change in management. The risk factors are one way for managers to prioritize stands for consideration.

Any of the following risk factors or signs of potential problematic conditions may warrant further investigation and potentially a response:

- Conifer understory and overstory cover are greater than 25%
- Aspen stems 5–15 feet tall are less than 500/acre
- Aspen canopy cover is less than 40%
- Dominant aspen trees are greater than 100 years old
- Sagebrush cover is greater than 10%

These numbers should be considered as minimum indicators. There is some disagreement within the community of scientists that study aspen what the exact numbers may be; however, the numbers described by Bartos and Campbell (1998) are a reasonable starting point that could be adjusted based on site specific data.

Portions of the 106-acre Pando clone on the Fishlake National Forest are undergoing 50-75% mortality in the autumn of 2010

For instance, Dale Bartos (personal communication) suggests that 50% overstory cover by conifers (not 25%) may be a useful indicator of conifer dominance. Note that dominance is a measure that the site may have already changed away from aspen. The presence of 25% conifer may be an indicator of trend away from aspen dominance and a trend toward conifer dominance.

Aspen sprouts which are repeatedly browsed have multiple stems and a "bushy" appearance

Both regeneration and recruitment are important indicators of aspen stand conditions. The following chart outlines three levels of regeneration and one level of recruitment as per acre/hectare measures. If either regeneration (suckers) or recruitment (saplings/midstory) are below 500/stems per acre, it is likely that a stand is not "self-replacing" (Mueggler 1989, Campbell & Bartos 2001, Kurzel et al. 2007, Rogers et al. 2010).

Regarding aspen canopy cover, aspen inside the high-fenced exclosure part of the Hancock exclosure on Fishlake NF (Kay and Bartos 2000) and Cinder Cone Research Natural Area on Dixie NF (DeRose and Long 2010) in Utah have successfully recruited despite 60-70% conifer canopy cover. This is evidence that aspen can successfully recruit new stems at conifer canopy coverage over 40%. At the same time, given the shade-intolerant nature of aspen, it is unlikely a stand with a 60–70% conifer canopy coverage will ever become aspen-dominated without a natural disturbance or some manipulation of the existing conifers.

Aspen Regeneration and Recruitment Levels

Aspen regeneration levels (suckers < 6 ft. [2 m] height)

>1000/acre	>2500/ha	self-replacing
500-1000/acre	1250-2500/ha	marginal
<500/acre	<1250/ha	not self-replacing (recommend investigation)

Aspen recruitment levels (stems > 6 ft. [2 m] and < canopy height)

<500/acre	<1250/ha	not self-replacing (recommend investigation)

Step 2. Rely on site-specific data to target the underlying cause(s) of the problematic condition(s).

Gather or use locally-collected quantitative data to determine what agents are causing problematic conditions.

Major factors contributing to aspen decline in the National Forests

- Shading by and/or competition with conifers (in low elevation stands this typically may be due to the absence of fire)
- Excessive browsing of aspen suckers by ungulates at specific locations
- Multiple stressors (e.g., drought, insect/diseases, heavy browsing, compacted soils) impacting an area at the same time

Recent drought, wildlife, and domestic browsing may lead to complete die-off of aspen stands (Cedar Mountain, Utah)

Appendix C provides some methods for data collection and monitoring that could be used as starting points to collect data to help identify underlying problematic conditions.

For instance, Sam St. Clair (Calder and St. Clair in review) notes that gaps in conifer overstory may be extremely important in creating high light conditions within late successional aspen-conifer stands that allow aspen to persist with no larger disturbance. Lack of aspen recruitment could be solely but potentially inaccurately attributed to shading or competition from conifer when other major underlining causes listed above may be at play.

Stands that are near water, on gentle topography, or near domestic sheep bedding grounds are particularly accessible to ungulate herbivory (Kay 2003).

Where there is uncertainty or controversy as to which category or categories of ungulate is involved in excessive herbivory, installation of three-way exclosures is almost always a fundamental need (Robert Beschta, personal communication).

Clear-felling or otherwise removing aspen without determining the need for protection from subsequent ungulate browsing can eliminate the aspen stand (e.g., Kay and Bartos 2000; Shepperd et al. 2006), particularly if the stand is small.

Similarly, an aspen stand that has been cut by beaver for dam construction or food may require protection from ungulate browsing for 3-5 years to ensure aspen regeneration and recruitment (Kay 2003).This situation can occur outside the riparian area.

Recreational activity within an aspen clone may cause severe damage to mature trees, regeneration and understory plant communities. Damage can include: 1) cutting and carving of aspen trees, 2) trampling of community understory, and 3) soil compaction (see Table 4-3 in Shepperd et al. 2006). While a comparatively small source of impact in acreage, isolated pure aspen stands on gentle terrain or young aspen at the margin of aspen-conifer stands may be particularly vulnerable to recreational impacts.

While an aspen stand may die of disease, it may have been pre-disposed to disease by drought, human or animal activities within the stand (e.g. debarking; Hinds & Krebill 1975; DeByle 1985). Managers should endeavor to determine the relative significance of the stressors in areas of aspen decline.

Aspen cut by beaver

Dispersed camping in aspen stands often prevents stand regeneration

Step 3. Select Response Option(s) relevant to the particular stand type, problematic condition(s), underlying causes of the problematic condition(s), and landscape context.

The most critical decision step is the selection of responses to lack of aspen recruitment. As Stanley Kitchen noted to the UFRWG, "If we are serious about keeping aspen and all of its benefits then some difficult choices will have to be made and implemented."

Several general recommendations apply to selection among response options:

1. Select responses that are tied to the identified underlying cause(s) of the problematic conditions of the aspen stand(s). Some responses may be inappropriate for particular areas (e.g., roadless areas) or incapable of addressing the causes of the problematic conditions.

2. Rely upon best available science (e.g., objective, repeatable, up-to-date) to identify and select response opportunities to restore and maintain aspen recruitment.

3. Establish quantifiable, post-implementation desired conditions (overstory, understory) and monitoring schedule and methods as part of the restoration decision.

4. If controversy exists regarding the cause of a problem (e.g., lack of recruitment) or outcomes of treatment, try alternative treatments next to each other for comparison over time.

5. Include baseline and post-implementation monitoring costs in the budget for the restoration effort.

6. Select restoration options that retain potential wilderness/roadless area attributes and values that have a reasonable possibility of success within potential wilderness/roadless areas. A few likely scenarios in practice include prescribed burning over logging-related options, reliance on natural fuel breaks and/or substantially unnoticeable fuel break construction (i.e. use of masticator, flush cut stems and gradiated/feathered edges of fuel lines).

7. Establish boundaries of current aspen and desired aspen boundaries (Note: This is out of concern and observation that certain aspen stands post-treatment may be smaller than previous stand boundaries, e.g., when marginal aspen are heavily browsed).

The following response options are recommended as relevant and feasible for particular types of stands, problematic conditions, and causes of problematic conditions. Conversely, particular response options listed below may be inappropriate when protecting particular resource values.

The phrase "response options" is used rather than "treatment options," as some response options involve passive restoration; others active restoration. One or more of the response options may be appropriate for any given combination of stand type, condition(s), and causes of the condition(s).

As described in Step 1, Mueggler (1989) provides a flow chart that may be helpful for managers when asking key questions (Fig. 1, page 26). We recognize that this chart does not include all response options recommended for consideration in these guidelines, nor does it directly target root causes. Mueggler's suggestion to protect aspen with fenced exclosures will likely not be effective at a large scale and the response option of spraying, clearcutting, etc. is not recommended in these guidelines. Conifer dominance may or may not indicate a problem.

Aspen in fall

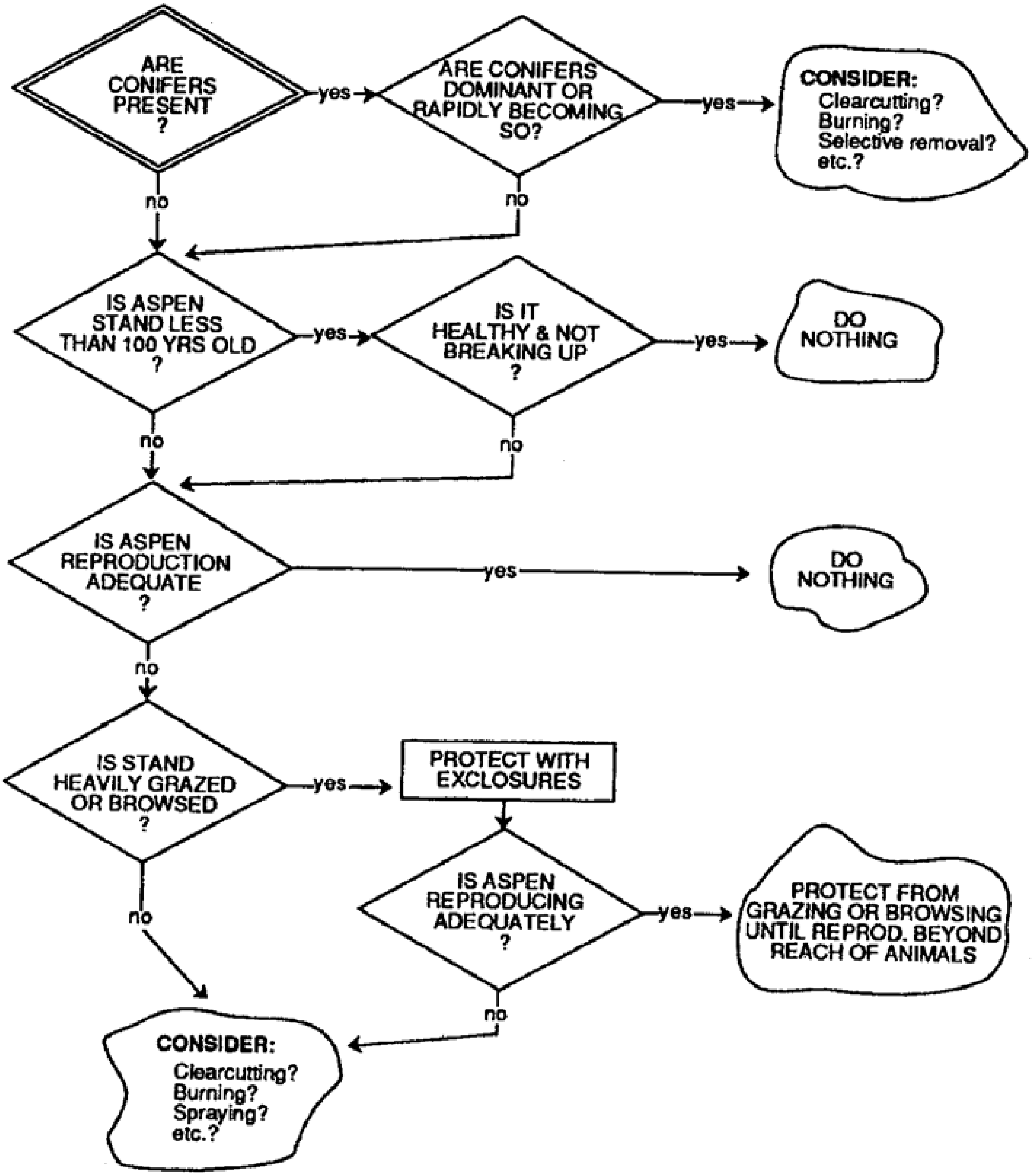


Figure 1. General decision model for maintaining aspen stands in the Intermountain Region. (Mueggler 1989)

Conifer advantage: Browsed aspen sprout (arrow) next to unbrowsed conifer sprouts

Aspen about to be overtopped by conifer, Manti-La Sal NF

A MENU OF POSSIBLE RESPONSES

Note: It is possible to combine several responses at the same time, or move to more intensive responses as monitoring indicates the need.

1. Cut subdominant conifers.
2. Clear-fell aspen and conifers.
3. Burn aspen and conifers.
4. Selectively cut overstory conifers.
5. Hinge trees as an effort to impede ungulate access (this has had variable results).
6. Girdle conifer.
7. Root separation.
8. Change livestock grazing management (e.g., length and/or timing of grazing, class of livestock, or number of livestock, placement of salt and nutritional supplements).
9. Fence/temporarily fence for livestock and/or wild ungulates, dependent on prior determination of type of ungulate pressure. In situations where the relative impact of domestic livestock versus wildlife has not been determined, a livestock exclusion fence alone (followed with monitoring) may be a reasonable first choice.
10. Rest the pasture or allotment of excessively-browsed aspen stands, when options 8 and 9 are not sufficient or feasible or when actions are needed across a landscape.

Livestock exclosure with hiking trail entrance, Manti-La Sal NF

11. Improve/increase the availability of native vegetation for wildlife nutritional opportunities outside of the aspen stands of concern.

12. Work within the existing framework for wildlife management to set specific herd objectives that match other resource conditions within the area.

13. Explore evolving technology and methods to mitigate wild ungulate impacts on aspen regeneration and recruitment. Explore the issue of scale to success ratio.

14. Prevent/reduce dispersed camping within aspen.

15. Post/sign dispersed camping in appropriate locations.

16. Restore natural fire regimes.

17. In conifer-dominant stands, create scattered canopy gaps in conifer overstory so the aspen component persists over time in later successional forest. This likely must be accompanied by close monitoring and fencing/hinging/pasture rest/jackstrawing/etc. to ensure aspen sucker recruitment reaches the 6'+ height class in those cases where browse pressure appears to be contributing to recruitment problems. [1]

18. Change annual browse utilization limits in grazing systems to ensure aspen sucker recruitment into the 6'+ height class. [2]

Different restoration responses may be more effective or feasible for extensive upland mixed conifer-aspen than for riparian aspen, which tend to be intermixed with a variety of riparian woody species; are adjacent to sensitive aquatic habitats; and are frequently relatively small in acreage.

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1 For conifer-overtopped/later successional aspen-mixed conifer types found in potential wilderness/roadless areas, canopy gap creation may be one recommended management opportunity in lieu of clear fell/regeneration harvest prescription. In these cases a number of associated mitigation measures are available to insure consistency with WUI and potential wilderness/roadless values. This includes but isn't necessarily limited to jackstrawing sawtimber-sized and/or smaller diameter tree boles to impede ungulate grazing pressure in canopy gaps (and mitigate cost of fencing), flush-cutting smaller boles even with forest floor, limiting stump heights on sawtimber-sized boles and helicopter skidding.

2 USFS Region 5 (California and a portion of Nevada) and California BLM, for instance, utilize a standard of 20% utilization of the current year's woody vegetation leader growth. In Utah, Fishlake NF allows 40% utilization of current year's available twigs on young woody species, and 50% on mature woody species; Dixie NF allows 50% of total annual leaders on woody species; and the Manti-La Sal NF allows 60% browse of woody vegetation in spring, 50% in summer and 40% in fall. The Ashley NF limits utilization of (unspecified) key browse species on big game winter range to 20%, does not limit browse of other upland woody species, and allows 50% use of current year's growth on riparian browse species. The Wasatch-Cache NF permits browse of 50% of the current year's growth on woody vegetation. The Uinta limits browse of willow and upland shrubs, but does not limit browse on other woody vegetation (e.g. aspen).

OTHER POSSIBLE INFLUENCES ON THE SELECTED RESPONSE

- Interagency/public (including a variety of stakeholders and interests) working groups to address complicated, site-specific problems. Use existing mechanisms as well as consider other creative options.

- Increase local outreach and education efforts on the value of aspen forests and the need for aspen management.

- The clearfell-coppice option (#2) may at times conflict with fuels reduction values in Wildland Urban Interface (WUI) locations.

- The clearfell-coppice option (#2) may conflict with potential wilderness/roadless area values.

- Leaving some number of scattered large legacy trees on the site does not seem to hinder sucker establishment.

- Jackstrawing trees when cut down in some cases has limited ungulate access thus allowing suckers to grow into the 6'+ height class.

- Root separation (option #7) has been documented as successful in some settings; typically isolated clones and maybe smaller clones where the objective is to increase the area covered by the clone, (see Sheppard et al., 2006). One value of root separation is the existing mature trees are not disturbed and would be available as a source for other management actions if root separation is not successful. At the same time, on some soil types this response may create unacceptable impacts on site productivity.

- Rest, whether provided by fences or the absence of grazing, may be needed for 3-15 years or until the aspen suckers reach at least 6' in height.

- Clearfell-coppice has been commonly used in the past to promote even-aged aspen stand regeneration. There are some concerns with this approach to aspen restoration, however. It is not a preferred aspen restoration option in practice:
    - Shading to understory and some nutrients are lost from the stand with removal of overstory trees.
    - Although clearfell-coppice harvest can introduce a new age class of aspen into cutting units, old standing and down trees that provide important ecological roles and niches are eliminated within the cutting units.
    - Recent practical experience (see Shepperd et al. 2006) supports leaving large aspen trees inside a coppice treatment, as well as down jackstrawed trees to address issues above, as well as herbivory concerns.
    - Dale Bartos suggests (personal communication) that leaving large aspen during a clearfell-coppice treatment may reduce initial regeneration, but also may help protect surviving suckers where herbivory is a threat (see also Kota 2005).
    - Retention of old-growth ("legacy") conifer trees which pre-date fire suppression activities and likely coexisted in or near the aspen stand during a more active fire regime will likely resist fire (David Burton, personal communication).

- Where excessive wild ungulate browsing has been observed as a significant cause of aspen problematic conditions (Shepperd & Fairweather, 1994; Zeigenfuss et al., 2008; DeRose & Long, 2010), it must be noted that it is difficult to focus reduction of wild ungulate numbers on a particular stand or area of aspen, because wild ungulates can be wide-ranging and their presence in a particular area can vary year to year (although, see Weisberg et al. 2002).

- Since the individual impacts of domestic livestock and wildlife may be masked in the cumulative impact, the less expensive livestock exclusion fence may be enough protection. Selection of this response would require monitoring to determine efficacy.

- Jones (2010) has found the crude protein content of aspen suckers relative to other available forage increases in the later part of the grazing season. With this relative increase, livestock may site-specifically select for aspen suckers in the fall. The avoidance of fall grazing may, therefore, offer protection for suckers.

- Exploration of landscape-scale response options may help avoid ungulate browsing complications experienced when focused on a single response option at a smaller geographic scale.

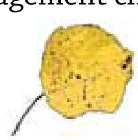
Step 4. Monitor.

Do not treat monitoring as an afterthought, or an optional activity. Monitoring should be implemented throughout the aspen restoration process. Consistent monitoring is essential.

MONITORING

1. Clearly state project objectives and post-implementation desired conditions.
2. Monitor according to the schedule and methods for attaining quantifiable desired conditions established prior to the restoration implementation.
3. Develop and test monitoring protocols (previously used methods should be centrally located for easy access, but may be modified for local conditions/issues).
   a. Monitoring protocols should be systematically- or randomly-based for objectivity and repeatability.
   b. Monitor adjacent control sites for each action.
   c. Consider the need for a three-way exclosure and annually check exclosure fences for maintenance needs.
4. Manage data so as to preserve and share the data.
5. Interpret monitoring data in reports that are shared.
6. Consider altering monitoring methods or restoration methods on the basis of monitoring results.

As discussed earlier, Shepperd and Weixelman (2003), Ferguson (2004), USDA Forest Service (2004), Jones et al. (2005), Jones et al. (2009), and Campbell and Bartos (2001) provide methods to monitor the condition of aspen regeneration following a variety of treatment or management changes.



A 2-day Utah Forest Restoration Working Group field trip examined various Dixie NF aspen conditions

Six years after the Johnson Fire on Fishlake NF, this single-tier stand is 12'-18' tall

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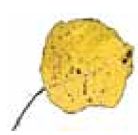

APPENDIX A

Utah Forest Restoration Working Group Membership List

(Ecology Committee members identified with *)

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Gary Hallows*
UT Cattlemen's Association

John Harja/Judy Edwards
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Bill Hopkin*
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Rob MacWhorter*
(on assignment in California 4/10 – 7/10)
Dixie National Forest

Jim Matson (co-convenor)
Rural Life Foundation Stewardship Center

Kevin Mueller*
Utah Environmental Congress

Mary O'Brien (co-convenor)*
Grand Canyon Trust

Paul Rogers*
Western Aspen Alliance

Allen Rowley
Fishlake National Forest

Ken Sizemore
Five County Association of Governments

Scott Truman
Rural Life Foundation Stewardship Center

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UT Division of Wildlife Resources

Mindy Wheeler [Implementation Committee]
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Forest Service – State & Private Forestry

Facilitators
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APPENDIX B

Science Reviewers

The following aspen scientists graciously reviewed, in December 2009, a beginning draft of the guidelines, and provided further resources.

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APPENDIX C

Comparison of Key Attributes of Forest Service Monitoring Methods for Aspen Ecosystems; and method used by Grand Canyon Trust

Method / Attribute	USDA FS Pacific Southwest Region (2004)	Shepperd and Weixelman (2010)	Jones et al. (2005)	Ferguson (2003) (R4 Silviculture White paper)	Campbell and Bartos (2001)	O'Brien (2009, unpublished, Grand Canyon Trust)
Flexibility of Installation (can be adapted to specific situations)	Easy	Moderate	Involved	---	Easy	Easy
Permanent/Temporary	Temporary	Typically temporary; can be permanent	Permanent	---	Temporary	Temporary
Plot Shape	Roughly linear transect	Typically circular; can be any shape	Belt transect; shape can be modified	---	Typically circular	Belt transect; shape can be modified
Plot Size (area)	Indeterminate length; typically 90 hits of sprouts or young aspen	Variable; typically 1/1,000 or 1/300 ac; can accommodate any size desired	600 sq ft (6 x 100 ft); Other sizes can be used (e.g. 2 x 30 m)	---	Typically 0.1 ac	600 sq ft (6 x 100 ft); Other sizes can be used (e.g. 2 x 30 m)
Ease of Implementation	Rapid assessment	Robust; can be streamlined and simplified.	Robust / involved	---	Rapid assessment	Rapid assessment
Timing of Monitoring Relative to Possible Treatment	Typically after	Before and/or after	Before and/or after	Suggestions for both before and after	Typically before	Before/after livestock when trying to separate browse pressure; or after livestock if simply measuring season's browse
Elements Monitored	% of stems with terminal leader's current-year growth browsed. Method measures the primary stems of aspen sprouts and young trees, less than or equal to 5 ft in height.	% of stems with terminal leader's current-year growth browsed. Comprehensive and can monitor up to 12 more factors including several stem damage codes, all within 4 size classes.	% of stems with terminal leader's current-year growth browsed. Trend for aspen regeneration density in 4 size classes.	Density of aspen stems in stand at various heights (6 ft tall and 10-15 ft tall) after treatment. Trend is demonstrated.	% Conifer Cover; % Aspen Cover; % Sagebrush Cover; Estimate age of dominant aspen; # aspen stems 5-15 feet tall (lack of stems at least 5 ft tall often indicates trend of heavy utilization)	% leader browsed (or frost, or fine) – doesn't distinguish between current year and previous years' leaders as it is often subjective; but could attempt the distinction % subleaders w'in 6 vertical inches of terminal leader browsed Height distribution in 1' increments (generally

						collapsed to 4 height classes) "Bushiness" – as indicated by # of subleaders w/in 6 vertical inches of terminal leader
Quantities/Thresholds for Elements Monitored	Yes	No	Yes	Yes	Yes	Yes
Ease of Conversion of Results	Easy	Moderate	Moderate	---	Easy	Easy
Data Analysis	Tabular data sheet	Excellent software package with statistical evaluation and charts available.	Tabular data sheet	---	Tabular data sheet	Tabular data sheet
Ease of Interpretation	Easy	Moderate	Moderate	Easy	Easy	Easy
Complexity	Simple	Moderate to Complex	Moderate	Moderate	Simple	Simple
Provides Response Recommendations	No	No	Yes	Yes	Yes	

Summary of the Methods

USDA – 2004
Simple and quick method designed to determine the percent of aspen sprouts and young stems, less than or equal to 5 feet tall, with the terminal leader browsed.

Shepperd and Weixelman – 2010
(Method has been used for more than a decade, but this web-based version is current in 2010.)
Robust method can be scaled from simple to involved to measure multiple aspects of the health and condition of aspen regeneration for up to 4 size classes. Can be used before and after management treatments. Does provide an excellent data analysis software package.

Jones – 2005
Robust and involved method designed to measure percent of regenerating aspen plants with terminal leaders utilized and the trend in density for 4 size classes. Can be used before and after management treatments.

Ferguson – 2003
Does not use a set method but provides recommendations for expected response of given stand metrics collected from other methods. Can be used before and after management treatments.

Campbell and Bartos – 2001
Walk through rapid assessment of aspen stand health and condition. Quantitative data that would be meaningful before and after a project are typically not collected.

Mary O'Brien, unpublished method used 2008-present by Grand Canyon Trust
Walk through rapid assessment of aspen stand health and condition has been used by the Trust primarily for pure aspen stands that have not been treated recently – i.e., to assess condition of pure aspen stands before and/or after livestock presence during the season. The same method is used for cottonwood and willow (all subleaders within 6 vertical inches and 6 horizontal inches, so as to limit the number of subleaders). Lends itself to narrow riparian stands – e.g., five 6' wide belt transects at equal distance perpendicular to a stream bank).

APPENDIX D

Additional References to Literature Relevant to Aspen in Utah

Other literature that was not specifically cited and contains information about aspen, some very specific to Utah, that will be useful for managers to review includes:

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UTAH FOREST RESTORATION WORKING GROUP MEMBERS

Five County Association of Governments

Grand Canyon Trust

United States Forest Service:
Ashley, Dixie and Fishlake National Forests

Rocky Mountain Elk Foundation

Rural Life Foundation Stewardship Center

Trout Unlimited, UT Council

Utah Cattlemen's Association

Utah Department of Agriculture and Food

Utah Division of Forests, Fire and State Lands

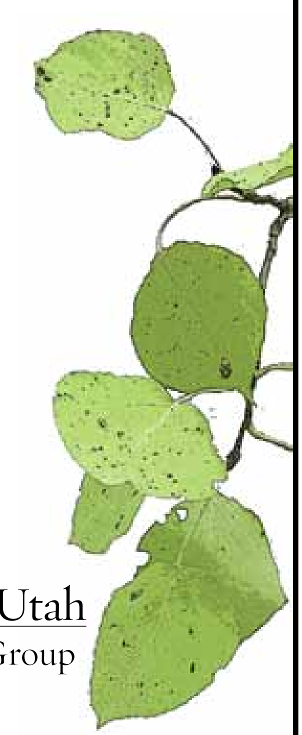
Utah Division of Wildlife Resources

Utah Environmental Congress

Utah Public Lands Policy Coordination Office

Western Aspen Alliance

Facilitated by the National Forest Foundation



Guidelines for Aspen Restoration on the National Forests in Utah

Utah Forest Restoration Working Group