Landscape Heterogeneity of Aspen Ecosystems and Their Sustainable Management for Multiple Stakeholders

The Heller School for Social Policy and Management

BRANDEIS UNIVERSITY

Landscape Heterogeneity of Aspen Ecosystems and Their Sustainable Management for Multiple Stakeholders

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Acknowledgments

No piece of work happens in a vacuum. Places and people leave an indelible mark on ones work and soul. This study could not have been completed without the help of many people, and to whom this researcher is eternally grateful.

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Introduction

In the rural western United States, much of the land is under management by various federal agencies, including the United States Department of Agriculture Forest Service (Forest Service), Bureau of Land Management (BLM), and National Park Service. Since the National Environmental Policy Act (NEPA) was passed in 1969 (42 U.S.C. §4321, 1969), all development and land management decisions have been required to take the health and welfare of the natural environment into consideration. Historically, these land management decisions were made by a local level agency supervisor, and had focused on resource use and/or extraction with little regard towards conservation at least in the first 100 years of the BLM and Forest Service. Additionally, the Forest Service and BLM were required under the Multiple-Use Sustained-Yield Act (16 U.S.C. §528, 1960) to "be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes".

Similarly, the U.S. Supreme Court decided in *Geer v. Connecticut* (161 U.S. 519, 1896) that the states own the game and fish species found within their borders, and that it is their right and responsibility to regulate and preserve such game for the common benefit of the people. At the time, game was considered a valuable food supply, much more so than today. However, certain big game species, such as Rocky Mountain elk (*Cervus elaphus*), are quite popular among recreational hunting enthusiasts and as such, many are willing to pay a much higher price for the opportunity of hunting a trophy-sized animal, especially if they believed that they can be nearly guaranteed a successful hunt. However, there are other factors that influence a hunters satisfaction from the hunt.

With the controversy around filling the Grand Canyon for water storage and hydroelectric generation, the modern environmental movement was born. In the 1980s, environmental groups became much more vocal and active. In an effort to force federal agencies to comply with the requirements of the various conservation laws, these groups have utilized litigation as an important enforcement tool to force all federal agencies into complying with the Endangered Species Act (16 U.S.C. 1531, 1973) and NEPA, among others. Some federal lands in the West have been fortunate and have not yet been sued. Surprisingly, state game and fish agencies have not been sued as frequently.

While serving as an intern with such a state agency, I questioned a state legislator about why he would not support a certain bill. I was told that such a bill would make his job as a litigator for an environmental group much more difficult, and that it is usually much more difficult to sue a state agency than a federal one. Though anecdotal, I think this situation may be common.

In an effort to avoid litigation, some agencies have come to realize that land management decisions should be made by incorporating the voices and needs of the many stakeholders in the area, which also happens to comply with NEPA. One such local agency is the Fishlake National Forest (NF), located in south-central Utah. Fishlake NF came together with ten other agencies and interest groups to cooperatively manage the Monroe Mountain Ecosystem, which is located within Fishlake NF lands (Mrowka & Campbell 1996) and is also called the Monroe Mountain "Seeking Common Ground" Initiative.

They chose to use quaking aspen (*Populus tremuloides*), the keystone species of the aspen ecosystem type, as it relates to the concept of “properly functioning condition” and towards managing the lands of the Fishlake NF. A 1997 USDA Forest Service definition (Campbell & Bartos 2001) states that a “properly functioning condition exists when soil and water are conserved, and plants and animals can grow and reproduce and respond favorably to periodic disturbances."

According to Bartos and Campbell (1998) and others (Mueggler 1985, White et. al. 1998, White 2001), quaking aspen have been steadily declining over the last 100 years. Aspen ecosystems have been found to be the most biologically diverse ecosystems in the Intermountain West, with the exception of riparian areas (Bartos 1998, Campbell & Bartos 1998, White et. al 1998). As aspen dominated landscapes get converted to other cover types, such as mixed-conifer or sagebrush-grasslands, tremendous biodiversity is lost (Bartos & Amacher 1998; Bartos & Campbell 1998; Campbell & Bartos 2001). Such losses include vascular and non-vascular plants, vertebrate animals and invertebrate organisms. Thus, measures taken to sustain aspen ecosystems will also help to maintain regional biodiversity. Gifford et. al. (1984) noted that for every 1,000 acres converted from aspen to mixed-conifer, 250 to 500 acre feet of water is lost by transpiration into the atmosphere and not into streamflow. Additionally, Mrowka & Campbell (1996) project 500 to 1000 tons of understory biomass production would be lost annually, along with a loss in plant and animal diversity.

"It is commonly recognized that aspen ecosystems in the West produce numerous products and benefits, some of which include: (1) favored wildlife habitat for big-game and non-game species, (2) forage for livestock, (3) water for downstream users, (4) watershed protection, (5) esthetics, (6) sites for recreational opportunities, (7) wood fiber, and (8) landscape diversity (Bartos 1998)."

Even though controversy exists regarding the absolute cause of aspen loss to the landscape, Bartos (1998), Chappell (1997), Jones & DeByle (1985a), and White et. al. (1998), to name a few, recognize that fire played an important role in the historical perpetuation of aspen on the landscape prior to European settlement. Jones & DeByle (1985a) reported that the rate of fire rejuvenation of aspen in the West has greatly decreased. On Monroe Mountain, Chappell (1997) determined that pre-settlement fire intervals ranged from 17 to 66 years, but the study underestimates the number of historic fires, due to the nature of fire temperatures and the resultant fire scar. She goes on to say that most fires on Monroe Mountain were likely lightning ignited, and not anthropogenic, because in an earlier study, fire scars had been found on aspen, which don't burn as well during summer months when lightning strikes are highest.

According to Rawley and Rawley (1967) and Utah DWR (1994), elk had been all but extirpated from Utah by the late 1800s, due to unregulated hunting. Elk were exported from the Jackson Hole and northern Yellowstone herds, and released into six localities from 1912 to 1915, one of which was near Fish Lake in 1912. Monroe Mountain's elk herd is "a new elk unit" (Davis 1998), with the first elk hunt being held in 1982. This researcher was not able to find any information regarding historical predator populations, but throughout the West it was common for ranchers to hunt or trap wolves (*Canis lupis*), mountain lions (*Felis concolor*), coyotes (*Canis latrans*) and bears (*Ursus sp.*) that they viewed to be a threat to their livestock. So it may be safe to assume that predator numbers were high enough on Monroe Mountain, to have kept native ungulate populations in balance prior to European settlement, especially, if the Mountain was not important to native peoples.

The Monroe Mountain "Seeking Common Ground" Initiative was part of a national demonstration initiative, that used (Mrowka & Campbell 1996) "partnerships in an ecological approach to management as the vehicle for obtaining consensus on how to achieve integrated natural resources management." The Demonstration began in 1993. A Steering Committee composed of the principle state and federal land managing agencies, private landowners, and sportsman's groups, worked to identify and develop solutions to problems that they held in common, by formulating programs of work and funding for the projects from within agencies and from outside grants.

One of the stated goals in the Monroe Mountain Common Ground Initiative Charter for 1993-1998 was to "support efforts to successfully manage the area as a quality elk management unit for both hunting and viewing trophy class bulls." Another stated objective was to "see a significant progress toward improvement of food to cover ratios, a significant increase in grass and forb production and improved aspen reproduction". Since the beginning of the agreement, wildlife numbers have been increasing, and aspen restoration projects have been conducted, but to what effect?

Monroe Mountain became an important focus of this study, because restoration work done there hadn't been assessed, and the mountain is important summer range, at 9000 feet elevation, for the deer and trophy bull elk herd found there. Additionally, the Richfield Ranger District has divided the mountain into twelve grazing allotments, which are important for local livestock growers.

The purpose of this study was to assess sustainability and landscape heterogeneity of aspen ecosystems and their management by the Fishlake NF, which is part of a multi-agency, land-management cooperative association. The USDA Forest Service (Forest Service) is required under federal law to manage their lands for multiple uses, which is often called the Multiple-Use Mandate (16 U.S.C. §528, 1960). Under this mandate, the Forest Service and BLM are required to incorporate the needs of people and ecosystem health for the sustainable use of these lands. This work will assess the effectiveness of this multi-agency approach.

The sampling method that I used was adapted from Shepperd and Fairweather (1994) and from personal communication with Wayne D. Shepperd, Research Forester, Rocky Mountain Research Station, USDA Forest Service. The primary difference is that in his study he varied plot size with aspen densities (i.e. if aspen are sparsely distributed, make the plot radius larger), whereas I limited all my sample plots to 0.001 acre plots, because in most cases young, regenerating aspen stands are dense. My variances were likely wider, but I felt that sampling would be quicker per plot, and that it more closely resembled the actual conditions observed on the ground. In most cases, I tried to survey/tally 20 plots per treatment area. On occasion, that number was reduced, if the units were small or if weather conditions forced us out of the mountains.

The remainder of this study will be divided into logical sections. First, I will detail the procedures used in sampling the units, then I will describe the most recent treatment histories for each of the larger treatment areas. Next, the results of the study will be stated, followed that a discussion of the reasons for what was observed in the results, along with a deeper analysis of the larger issues contributing to those patterns. Lastly, I will make recommendations regarding the next steps and strategies that could be utilized to better support ecosystem health in the context of aspen restoration efforts.

Methods - Sampling

During the summer of 2001, eight treatment areas were sampled with a total of thirty-three sites sampled on three subsections (see Figures 1 & 2: GIS Maps) of the Fishlake National Forest. Treatments ranged in age from one to seven years old. Two areas (ten sites) had regeneration that resulted from lightning-ignited wildfires, four areas (thirteen sites) were clearcut or logged for aspen restoration and then the remaining slash was piled and burned, one area (two sites) was logged and the remaining slash left as natural exclosures, and one area (two sites) was clearcut and then burned a year later to remove the remaining subalpine fir (see Table 1). Sampling was completed during July through October 2001. The number of mil-acre plots sampled in each site ranged from nine to twenty-one and totaled 473 plots.

Figure 1 - Fishlake National Forest Subsections and Vicinity

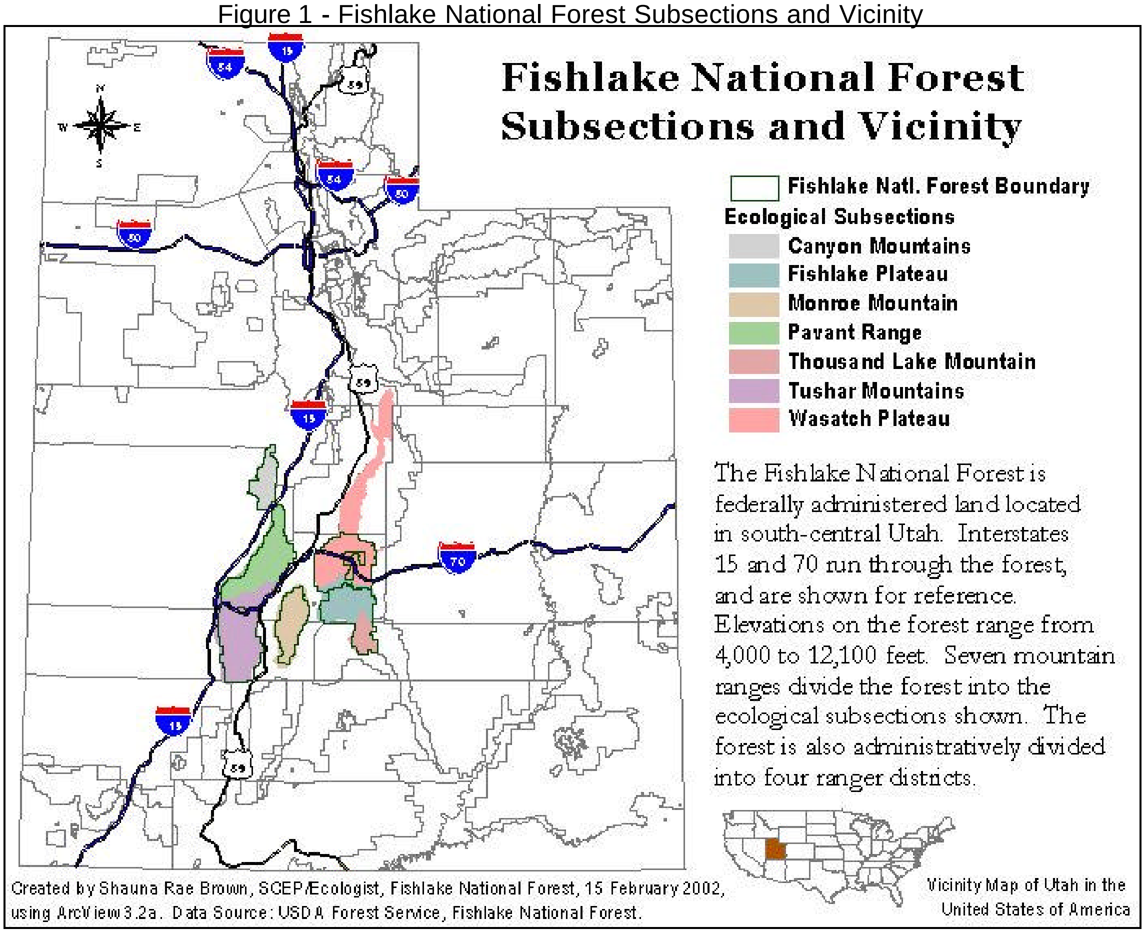


Figure 2 - Aspen Regeneration Sites Sampled

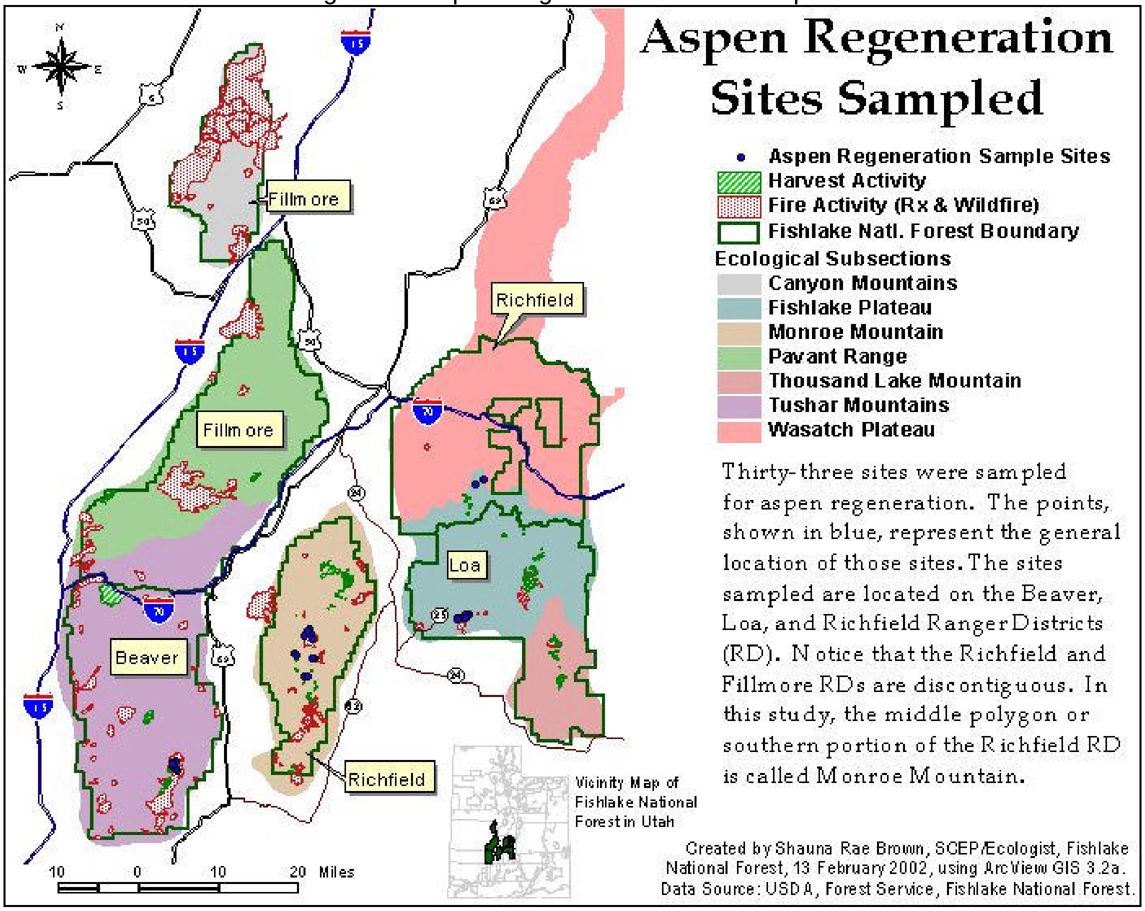


Table 1 - Treatment Area Descriptions

Treatment Area	Area ID	Forest Subsection	Treatment	Sites Sampled
Briggs Hollow	BH	Fishlake Plateau	Clearcut with slash piled, then burned	8
Burnt Flat	BF	Monroe Mountain	Aspen harvest (clearcut)	3
Dry Creek	DC	Monroe Mountain	Clearcut with slash left in piles	2
Farnsworth	F	Fishlake Plateau	Aspen harvest with slash piled, then burned	2
Oldroyd Fire	OF	Monroe Mountain	Wildfire	6
Oldroyd Private Property	OPP	Monroe Mountain		
• Conifer Harvest			Selective Conifer Harvest	1
• Aspen Harvest			Clearcut Aspen Harvest	1
Pole Creek Fire		Tushar Mountains		
• Grindstone Flat	GF		Wildfire and wildlife & cattle exclosures	3
• Rigger Park	RP		Wildfire only	1
• Rigger Park Harvest	RPH		Wildfire and salvage harvest	4
White Ledge	WL	Monroe Mountain	Clearcut and entire site burned	2

For each treatment area or site, an initial randomly determined starting point was located by throwing a large nine-inch nail tied with flagging (plot selector) into the treatment area. To randomly determine the transect's direction, a watch with a secondhand was looked at and whatever direction the needle pointed became the direction of travel for the remainder of plots in that site. To help in maintaining a generally linear direction of travel, a landmark in the distance that matched the direction of the watch's secondhand was used for sighting the direction of throws.

The plot selector was thrown with the thrower's back to the landmark so that the next plot could not be chosen, thus maintaining random plot selection. This was done for each plot. In the meantime, the remaining team members watched where the plot selector landed, to ease in finding it. In situations where one person sampled the site, the thrower sighted on the chosen landmark, closed their eyes, threw the nail as hard as possible, and then opened their eyes when the nail was released so that the location of the nail would be known.

At the point of the plot-selector, a survey pin was pushed into the ground to mark the plot's center. The plot's contents of ramets (suckers) were sampled using a 5-foot (152.4 cm) length of ¾-inch (1.9 cm) PVC pipe marked with a radius of 113.5 cm (approx. 3 ft. 9 in.) to mark a 0.001-acre circular plot. All ramets falling within the circle were counted and tallied according to combinations of size class and damage code (see Tables 2 and 3). Ramets that fell on the line of the radius were not counted as being in the plot. Only ramets whose base was fully in the plot were tallied.

Table 2 - Size class descriptions

Size Class	**Measurement**
1	0-46 cm (0-1.5 ft.) tall
2	46-137 cm (1.5 - 4.5 ft.) tall
3	137 cm (4.5 ft.) tall - 2.5 cm (1.0") d.b.h.
4	d.b.h. > 2.5 cm (1.0 inch)

d.b.h.= diameter at breast height (4.5 feet off the ground on the uphill side of the tree.

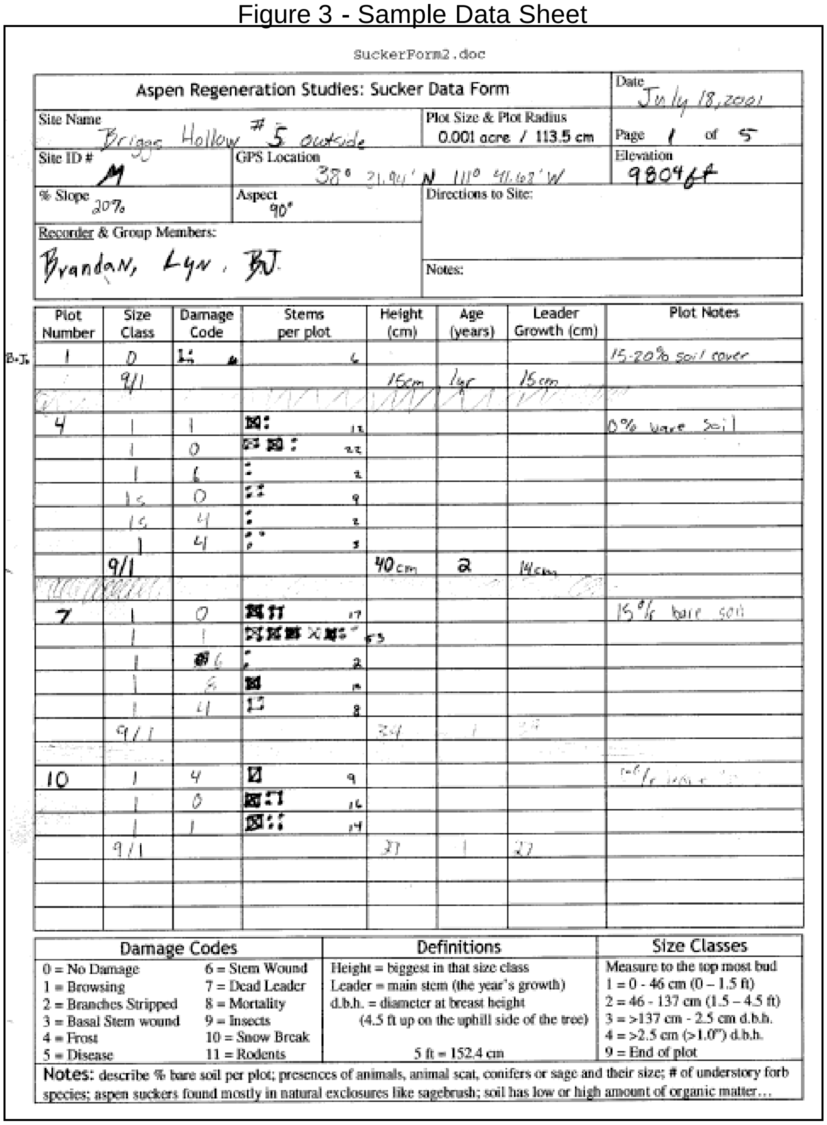
Table 3 - Damage code descriptions

0 - No Damage	6 - Stem Wound
1 - Browsing	7 - Dead Leader
2 - Branches Stripped	8 - Mortality
3 - Basal Stem Wound	9 - Insects
4 - Frost	10 - Snow Break
5 - Disease	11 - Rodents

See Appendix B for descriptions and photographs of the various damage types encountered during data collection.

To easily place ramets in their appropriate size class, the measuring pole was also marked for the heights of size classes 1, 2 and 3. Team members would then call out a series of numbers in a set order so that data could be easily recorded. For example, 1-1-3 would be understood to mean three ramets in size class one with browsing damage, and three dots would be placed on the line for size-class 1 with damage-code 1 (see Figure 3). Upon tallying the last ramet for the plot, the tallest ramet in each size class was measured for height and leader growth and then aged by counting growth rings along the main stem and/or branches of ramets. Also, some additional plot observations were made, including the presence of animal sign (scat or tracks), sagebrush or conifers, and visual estimates of percent bare soil in each plot.

Figure 3 - Sample Data Sheet



SuckerForm2.doc

Aspen Regeneration Studies: Sucker Data Form

Date: July 18, 2001
Site Name: Briggs Hollow #5 outside
Plot Size & Plot Radius: 0.001 acre / 113.5 cm
Page 1 of 5
Site ID #: M
GPS Location: 38° 21.94' N 111° 41.62' W
Elevation: 9804 ft
% Slope: 20%
Aspect: 90°
Directions to Site:
Recorder & Group Members: Brandan, Lyn, BJ.
Notes:

Plot Number	Size Class	Damage Code	Stems per plot	Height (cm)	Age (years)	Leader Growth (cm)	Plot Notes
1	0	1	6				15-20% soil cover
	9/1			15cm	1yr	15cm	
4	1	1	12				0% bare soil
	1	0	22				
	1	6	2				
	1s	0	9				
	1s	4	2				
	1	4	3				
	9/1			40cm	2	14cm	
7	1	0	17				15% bare soil
	1	1	53				
	1	6	2				
	1	8	10				
	1	4	8				
	9/1			34	1	34	
10	1	4	9				[illegible] bare soil
	1	0	16				
	1	1	14				
	9/1			37	1	37	

Damage Codes		Definitions	Size Classes
0 = No Damage	6 = Stem Wound	Height = biggest in that size class	Measure to the top most bud
1 = Browsing	7 = Dead Leader	Leader = main stem (the year's growth)	1 = 0 - 46 cm (0 – 1.5 ft)
2 = Branches Stripped	8 = Mortality	d.b.h. = diameter at breast height	2 = 46 - 137 cm (1.5 – 4.5 ft)
3 = Basal Stem wound	9 = Insects	(4.5 ft up on the uphill side of the tree)	3 = >137 cm - 2.5 cm d.b.h.
4 = Frost	10 = Snow Break		4 = >2.5 cm (>1.0") d.b.h.
5 = Disease	11 = Rodents	5 ft = 152.4 cm	9 = End of plot

Notes: describe % bare soil per plot; presences of animals, animal scat, conifers or sage and their size; # of understory forb species; aspen suckers found mostly in natural exclosures like sagebrush; soil has low or high amount of organic matter…

See Appendix A for a blank data sheet.

For each site, GPS (global positioning system) location, elevation, percent slope and aspect data were collected. These data would later be used to plot the points on a GIS-generated map. Since plot selection was randomized, GPS coordinates serve only as a general location of the areas sampled. Fishlake National Forest maintains a GIS database containing orthographic (topographic) overlays, soil-type polygons, polygons showing some of the Forest's aspen treatment areas, wildland fire boundaries, and grazing allotment boundaries. These data would later be used in the analysis and display of the aspen regeneration data collected.

All collected data were input into a commercially available computer spreadsheet (MS Excel) to facilitate various calculations such as average number of stems per acre (both overall and divided into size classes), mean and median ages of stems per site, mean height of the tallest stems, percent no-damage, and percent animal damage.

The number of stems per acre was calculated using the following formula: ((total live stems per site)/(number of plots sampled per site))*(the reciprocal of the plot size), or

$$\frac{\text{total live stems per site}}{\text{number of plots sampled per site}} \quad \text{X} \quad \text{the reciprocal of the plot size}$$

For example, one site might yield 38,200 live stems per acre = (764 stems/20 plots) x (1/0.001 acre plot). Only live stems (all damage codes except #8, mortality) were used to calculate stems per acre.

Percent no-damage for a site was determined by totaling the number of stems with frost damage or no damage, dividing that number by the total number of stems in that site, then multiplying that fraction by 100. Similarly, the percentage of animal damage on a site involved summing the number of stems with damage codes 1, 2, and 3, then dividing by the total number of stems in that site, and multiplying by 100. These two percentages usually accounted for the majority of damage codes noted in a site.

Methods - Description of Treatment Areas

The following descriptions briefly describe the number of acres treated, month and year of the treatment, the type of treatment utilized, purpose and/or need for the treatment, and the agency responsible for the treatment. Generally, each area was given a name that was derived from a map location, but not always.

The site identifications (site IDs) used in this study are noted in parentheses, and were the sites sampled during July, August, September and October of 2000. Site IDs were given to quickly give the location of the site, which unit was sampled, whether the unit was fenced and with what type/height of fence, whether the sample was taken inside or outside of the fence and a hyphenated letter, which was assigned alphabetically (A-Z, then AA-AG) in the field at the time of sampling as a quick way of keeping the tally sheets organized. Once back in the office, GPS locations gathered in the field were mapped and associated with a particular harvest unit or treatment area.

For example, BH1win-F is shorthand for Briggs Hollow Unit 1 inside the wildlife exclosure (9-foot fence) and the F means that it was the sixth site sampled during the season. Other abbreviations used include "wout" for outside the wildlife exclosure), "cin" for inside the cattle exclosure (4-foot fence), "cout" for outside the cattle exclosure, and "ufd" for unfenced. In the case of the Oldroyd Fire, the lower case letters indicate where within the fire perimeter the sample was generally located, such as "ece" stands for east center and east of the trail, "rw" means a ridge top west of the trail, "nw" is northwest and "sc" means small creek.

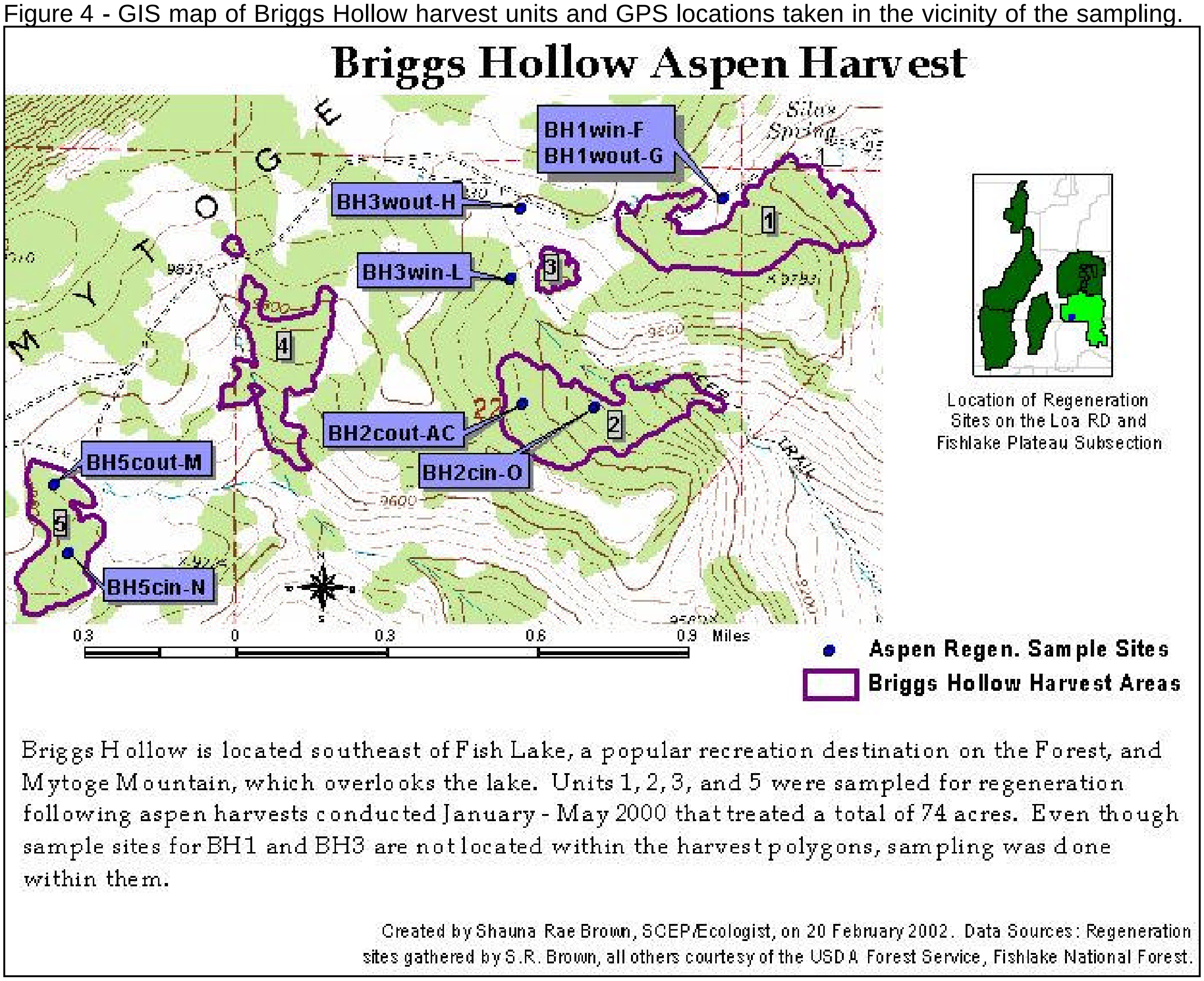
The sites sampled were located on three ecological subsections (Fishlake Plateau, Monroe Mountain, Tushar Mountains) and three forest ranger districts (Beaver, Loa, Richfield). All sites sampled were above 9,000 feet above sea level, and ranged from 9,111 to 10,039 feet.

The GPS locations noted were gathered only at the sites sampled. They are all in UTM projection, Zone 12, NAD27 datum (Wanda Bennett, personal communication).

Fishlake Plateau Subsection

Briggs Hollow

Figure 4 - GIS map of Briggs Hollow harvest units and GPS locations taken in the vicinity of the sampling.



The Briggs Hollow treatment area involved five units in which the sites were clearcut. The five units treated 74 acres. The units were cut January - May 2000 and then fenced shortly thereafter, prior to cattle being released on the allotment. Briggs Hollow lies within the Seven-Mile grazing allotment. The allotment was grazed June 1 through October 16 in 2000 and 2001, by 1,199 cattle in 2000 and 1,129 cattle in 2001. The fences installed around units 1(BH1win-F, BH1wout-G) and 3 (BH3win-L, BH3wout-H) were 9-foot wildlife exclosures, which effectively keep all large grazing mammals out, as a strategy to give relief from grazing pressure during the time when young ramets are most at risk to herbivory. Unit 2 (BH2cin-O, BH2cout-AC), 4 and 5 (BH5cin-N, BH5cout-M) were fenced with cattle exclosures, which are 4-foot fences. Units 1, 2, 3 and 5 were sampled for aspen regeneration inside and outside of the exclosures.

Table 4 - Briggs Hollow Treatment Area Summary

Unit	GPS Location	Elevation	Acres	Treated	Fenced	Fence Type
BH1	441585.97 E 4265814.79 N	9682 ft.	19	January 2000	Before mid-June 2000	Wildlife exclosure
BH2	440943.55 E 4265155.87 N	9708 ft.	26	Feb. - April 2000	Before mid-June 2000	Cattle exclosure
BH3	440909.38 E 4265557.87 N	9660 ft.	3	May 2000	Before mid-June 2000	Wildlife exclosure
BH4	not sampled	unknown	16	May 2000	Before mid-June 2000	Cattle exclosure
BH5	439451.76 E 4264902.94 N	9760 ft.	10	May 2000	Before mid-June 2000	Cattle exclosure

Farnsworth (F3cin-D, F16ufd-E): Seventeen units ranging from 1 to 4 acres were clearcut for aspen regeneration. A total of 42 acres was logged during August and September 1994. At least one unit was fenced with a cattle exclosure in September 1995 to prevent over-utilization of the young aspen suckers, because nearly all the newly sprouted suckers were utilized following a frost. The two sites sampled were above 9,000 feet above sea level (F3cin-D = 9,143 ft., and F16ufd-E = 9,420 ft.).

Figure 5 - GIS map of Farnsworth harvest units and GPS locations taken in the vicinity of the sampling.

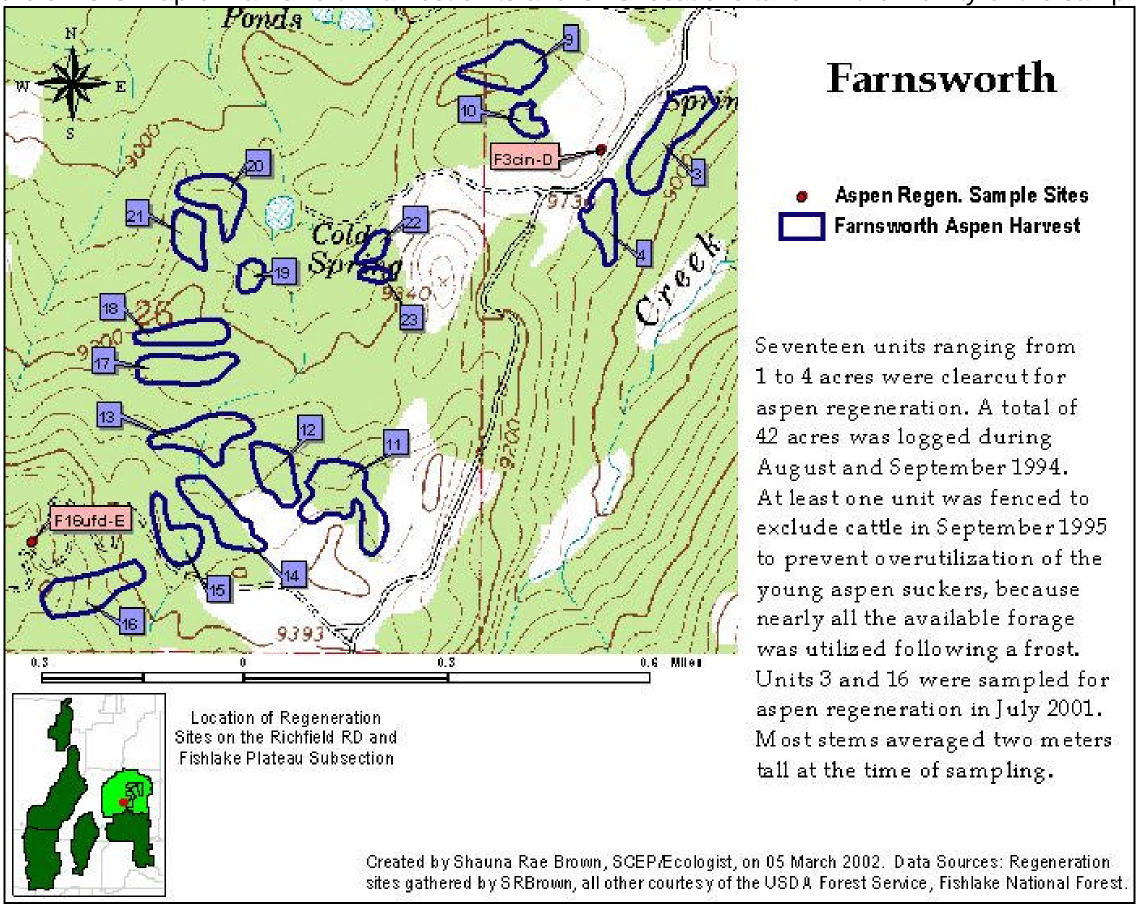


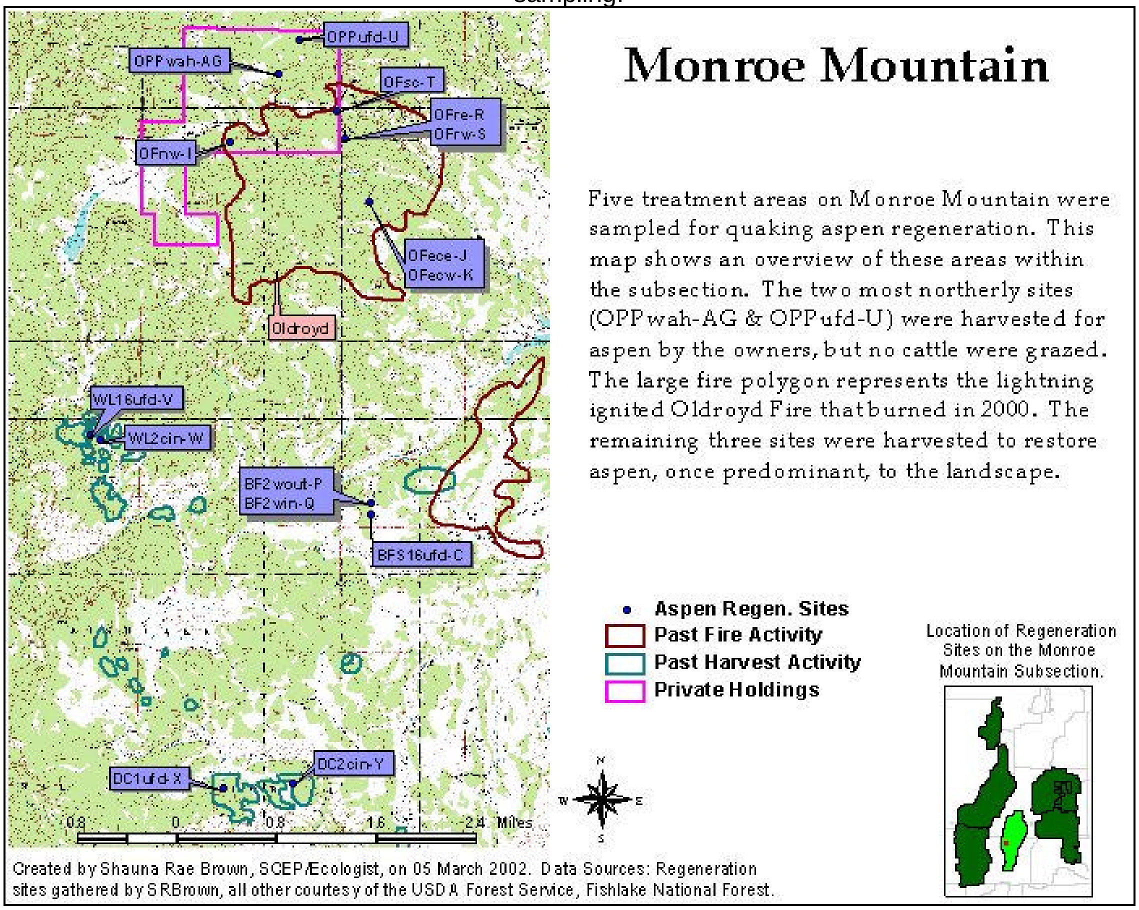
Table 5 - Farnsworth Treatment Area Summary

Unit	GPS Location	Acres	Fenced	Fence Type	Unit	GPS Location	Acres	Fenced
F3	444439.94 E 4292720.08 N	3	Sept. 1995	Cattle exclosure	F16	443086.88 E 4291786.40 N	2	no
F4	not sampled	1	no	~	F17	not sampled	3	no
F9	not sampled	4	no	~	F18	not sampled	3	no
F10	not sampled	2	no	~	F19	not sampled	1	no
F11	not sampled	5	no	~	F20	not sampled	3	no
F12	not sampled	2	no	~	F21	not sampled	1	no
F13	not sampled	4	no	~	F22	not sampled	2	no
F14	not sampled	3	no	~	F23	not sampled	1	no
F15	not sampled	2	no	~				

Monroe Mountain Subsection

According to Chappell (1997), the Monroe Mountain Subsection ranges in elevation from 5120 feet on the Sevier Valley floor to 11,227 feet on Monroe Peak. Approximately 175,000 acres of the subsection is managed by the Fishlake National Forest. Utah Division of Wildlife Resources (Utah DWR) holds an annual "limited entry bull elk hunt", and manages the herd for trophy bull elk. According to the 2001 Utah Big Game Proclamation (p. 59), there are approximately 1,800 elk and 7,500 mule deer that live within their wildlife management unit, whose boundaries generally follow the subsection's outline. The elk population has been steadily increasing since at least 1993 from around 600-800 animals. I was not able to find similar population estimates for mule deer, except as referenced in the Monroe Mountain Common Ground Initiative Charter for 1993-1998 (Appendix D), which estimated "over 5000 deer" in 1993. In 2001, Utah DWR (2001 Utah Big Game Proclamation) set the management objective to 7,500. The number of cattle grazed on the mountain have been steadily reduced since the 1930s.

Figure 6 - GIS map of the Monroe Mountain treatment areas & GPS locations taken in the vicinity of the sampling.



Burnt Flat (BF2win-Q, BF2wout-P, BFS16ufd-C): The State of Utah School and Institutional Trust Lands Administration originally managed the three sites sampled and they were responsible for the aspen timber harvest. The areas were treated by clearcutting in June and July 1997. Neither area was fenced other than a small (less than ¼ acre) temporary wildlife exclosure, which was installed just after the harvest was finished as a control for monitoring aspen regeneration and to test the fencing material's use for wildlife exclosures. Following the harvest, this section was exchanged with the Fishlake National Forest. Burnt Flat lies within the Koosharem grazing allotment. Cattle are annually released onto the allotment on June 1, and must be removed by October 15. In 1996, 665 cattle grazed the allotment. The number of cattle permitted to graze was increased to 710 in 1997 & 1998, to 810 in 1999, then down to 670 in 2000, and back up again to 735 in 2001.

Figure 7 - GIS map of the Burnt Flat area harvested by the State of Utah School and Institutional Trust Lands Administration and GPS locations taken in the vicinity of the sampling.

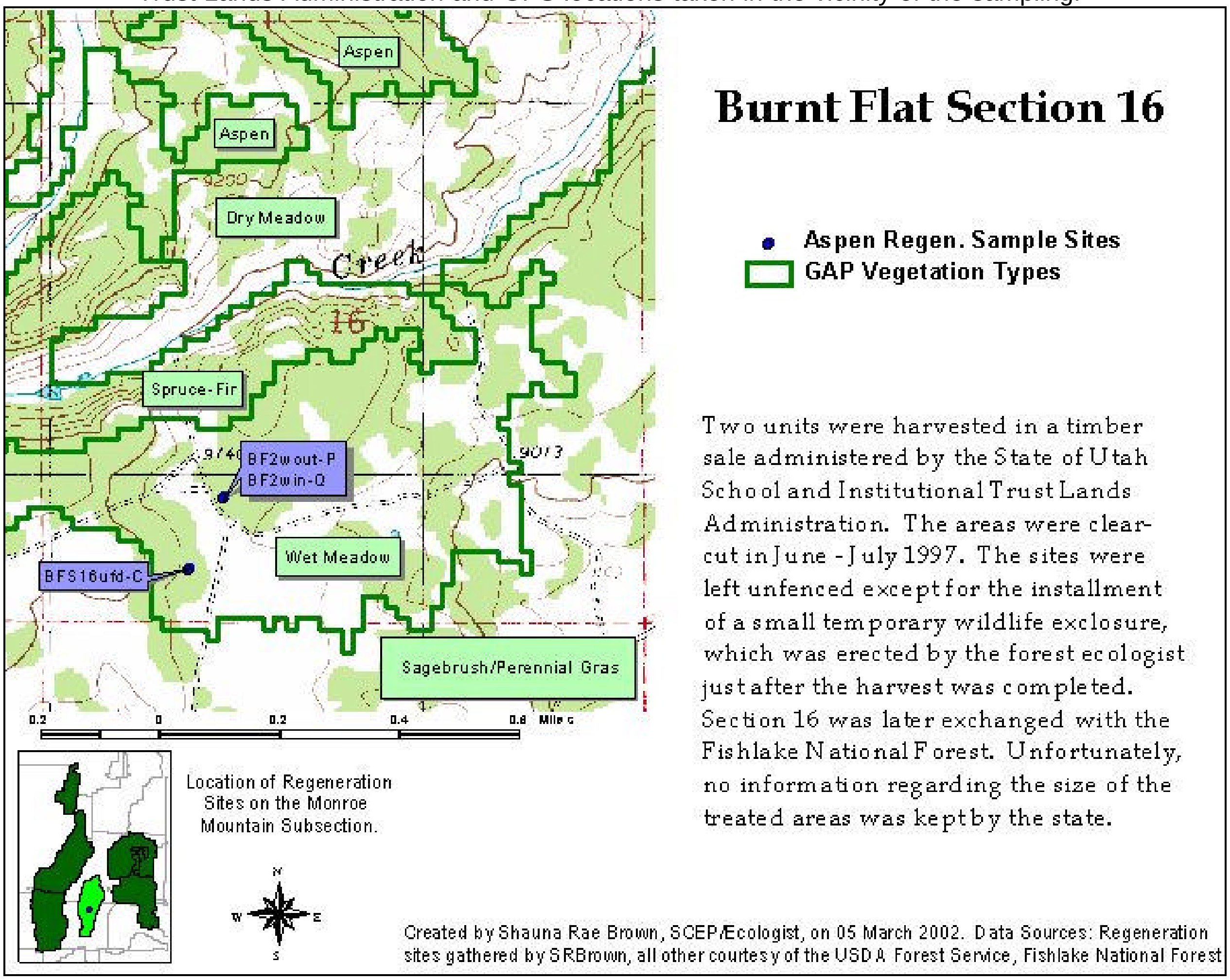


Table 6 - Burnt Flat Treatment Area Summary

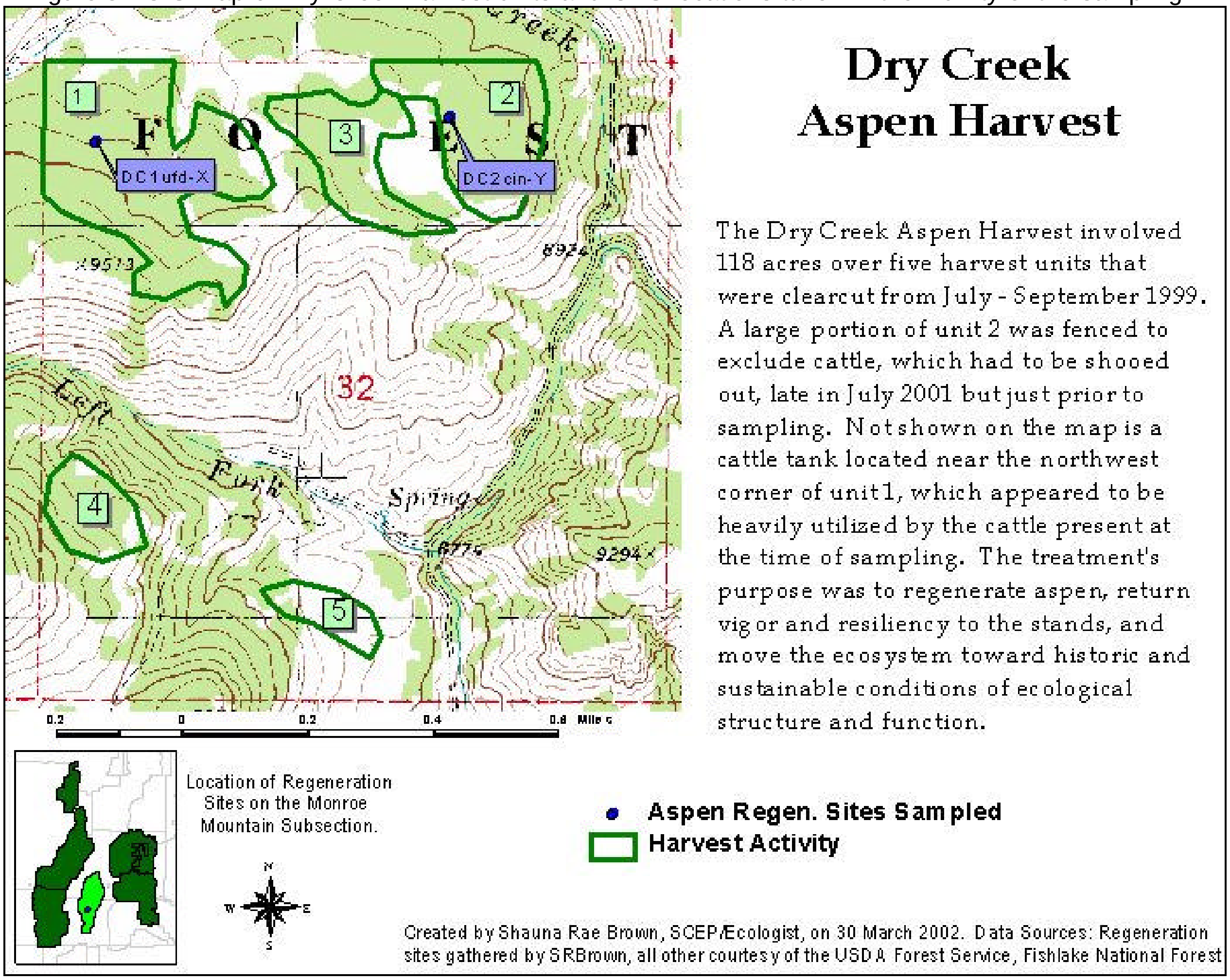
Unit	GPS Location	Elevation	Acres	Treated	Fenced	Fence Type
BFS16	410375.84 E 4256741.04 N	9111 ft.	?	1996-1997	no	~
BF2	410392.03 E 4256888.82 N	9171 ft.	?	June - July 1997	July 1997	temporary wildlife exclosure (control plot)

Dry Creek (DC2cin-Y, DC1ufd-X): The Dry Creek treatment area is located on Monroe Mountain. The purpose of the clearcut treatment was to regenerate the aspen, return vigor and resiliency to the stands, and move the ecosystem toward historic and sustainable conditions of ecological structure and function. Five units were logged from July through September 1999 totaling 118 acres. Following the harvest, the slash was left in place to allow regenerating aspen some cover from herbivory. Additionally, a cattle exclosure was put up around unit 2 late in July 2001. Units 1 & 2 were sampled for aspen regeneration in early August 2001. The Dry Creek units are located within the Rock Springs cattle allotment. In 1999 and 2000, 94 cattle grazed the allotment, and in 2001 that number increased to 155. It is also important to note that at the bottom of the hill towards the northwest corner of unit 1 (DC1ufd-X), a truck had gotten stuck in a low spot that later became a natural watering hole.

Table 7 - Dry Creek Treatment Area Summary

Unit	GPS Location	Elevation	Acres	Treated	Fenced	Fence Type
DC1	408488.53 E 4253211.05 N	9345 ft.	54	Jan., Jul.-Sep. 1999	no	~
DC2	409391.40 E 4253274.81 N	9259 ft.	27	Jan., Jul.-Sep. 1999	July 2001	Cattle exclosure
DC3	not sampled	unknown	19	Jan., Jul.-Sep. 1999	no	~
DC4	not sampled	unknown	11	May - Sept. 2000	no	~
DC5	not sampled	unknown	7	May - Sept. 2000	no	~

Figure 8 - GIS map of Dry Creek harvest units and GPS locations taken in the vicinity of the sampling.



Oldroyd Private Property (OPPufd-U, OPPah-AG): These sites were sampled for aspen regeneration in August and October 2001 respectively. The property, which is completely surrounded by the Fishlake National Forest, is privately owned and the owner conducted the timber sales. Additionally, the owner has not grazed cattle on the property since the harvests in 1996. OPPufd-U was a selective conifer harvest. OPPah-AG was an aspen/spruce/fir clearcut harvest, but it was also expected to promote aspen regeneration. Both harvests were completed during the summer of 1996.

Figure 9 - GIS map of GPS locations taken in the vicinity of the sampled locations on the Oldroyd private property.

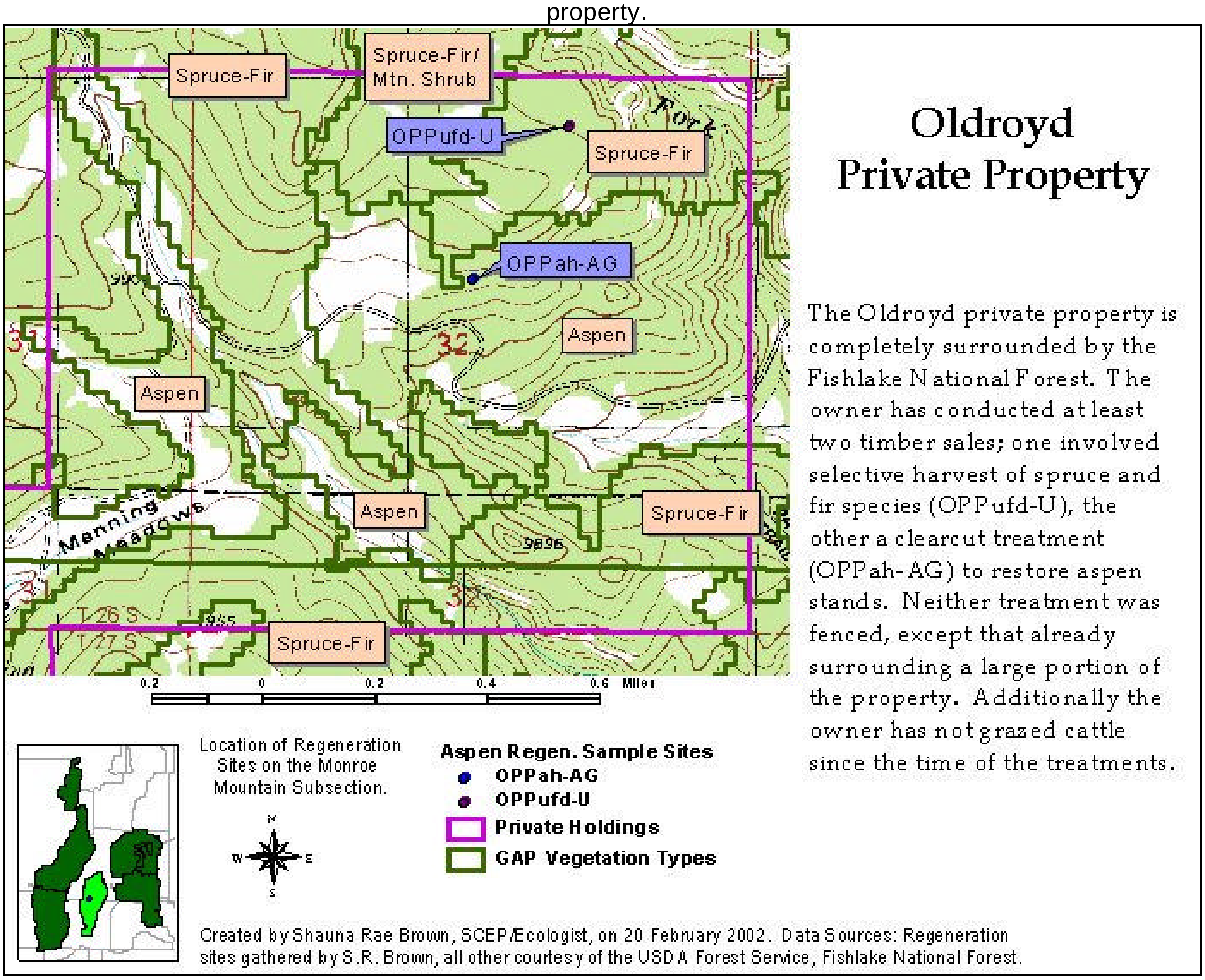


Table 8 - Oldroyd Private Property Treatment Summary

Site ID	GPS Location	Elevation	Harvest Type	Harvested
OPPufd-U	409470.39 E 4262861.03 N	10029 ft.	Selective Conifer	Summer 1996
OPPah-AG	409346.95 E 4262393.29 N	9930 ft.	Aspen/Spruce/Fir Clearcut	Summer 1996

White Ledge (WL2cin-W, WL16ufd-V): The White Ledge treatment area is located on Monroe Mountain. The purpose of the clearcut treatments were to regenerate the aspen, return vigor and resiliency to the stands, and move the ecosystem toward historic and sustainable conditions of ecological structure and function. Fourteen units ranging in size from 1 to 28 acres were clearcut with 111 total acres treated. The harvest or clearcut portion of the treatment began in 1996 and was completed in August 1999. The treatment area, except unit 12, was burned following the harvest in October 1999 to remove the remaining conifer saplings and logging residuals, and promote aspen regeneration. Only one of the units, Unit 2, was fenced with a cattle exclosure to reduce herbivory on the regenerating suckers, but it still allows wildlife access. It was also believed that by treating such a large area that the animals would be distributed over the treatment area thus moderating utilization. Units 2 and 16 were sampled 02 August 2001, are located adjacent to each other and are 9481 & 9538 ft. above sea level respectively. The White Ledge treatments are located within the Manning Creek allotment, and 142 cattle were grazed annually from June 15 through September 30 in 1996 through 2001.

Figure 10 - GIS map of White Ledge harvest units and GPS locations taken in the vicinity of the sampling.

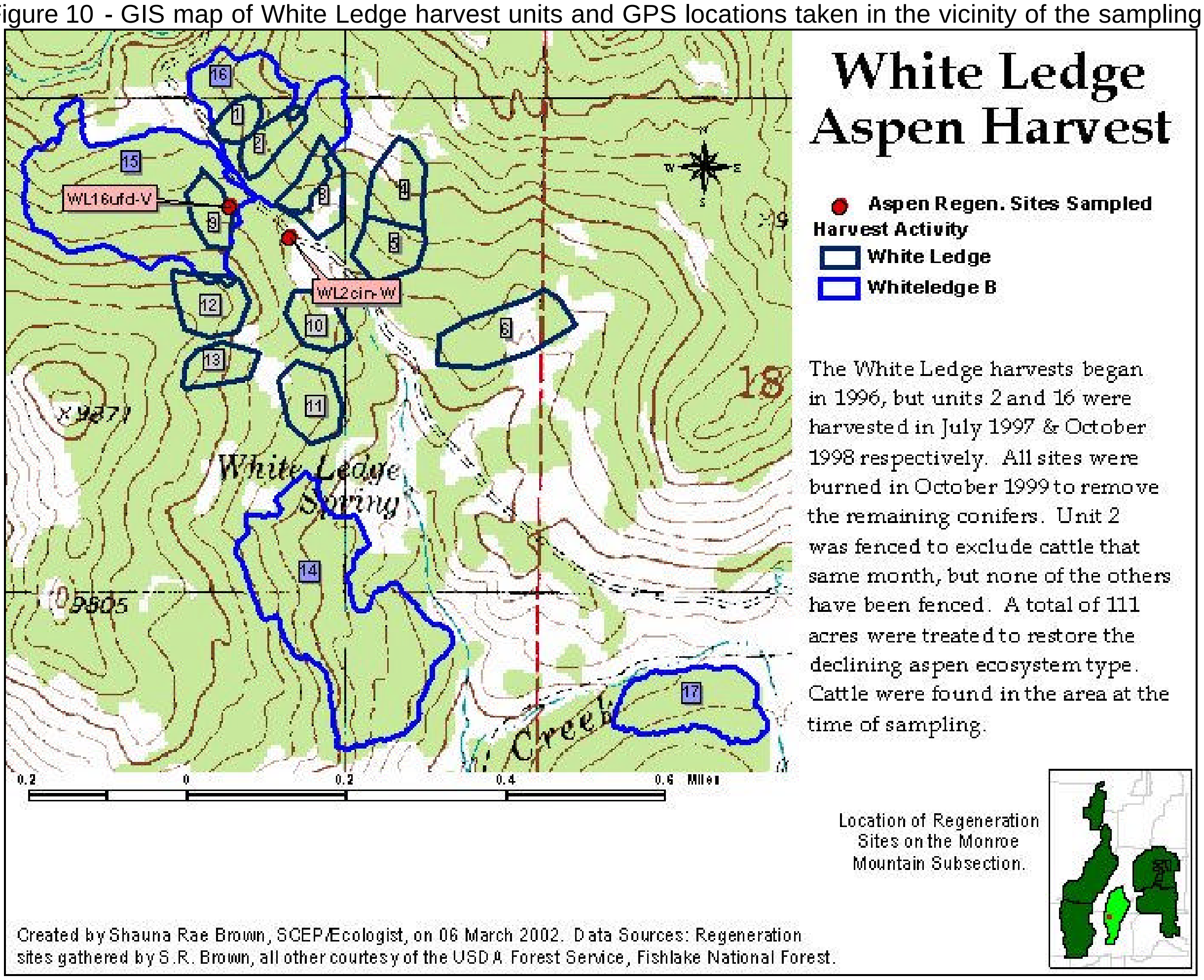


Table 9 - White Ledge Treatment Area Summary

Unit	GPS Location	Acres	Harvest	Burned	Fenced	Fence Type
WL2	406891.58 E 4257711.56 N	2	July 1997	October 1999	October 1999	Cattle Exclosure
WL3	not sampled	4	1996	October 1999	no	~
WL4	not sampled	5	1996	October 1999	no	~
WL5	not sampled	3	1996	October 1999	no	~
WL6	not sampled	5	1998	October 1999	no	~
WL9	not sampled	4	1996	October 1999	no	~
WL10	not sampled	3	1996	October 1999	no	~
WL11	not sampled	4	1996	October 1999	no	~
WL12	not sampled	6	1998	not burned	no	~
WL14	not sampled	28	August 1999	October 1999	no	~
WL15	not sampled	24	July 1999	October 1999	no	~
WL16	406771.02 E 4257774.74 N	12	October 1998	October 1999	no	~
WL17	not sampled	8	October 1998	October 1999	no	~

Oldroyd Fire (OFece-J, OFecw-K, OFnw-I, OFre-R, OFrw-S, OFsc-T): The Oldroyd Fire burned 1329 acres July 27 through August 7, 2000. It was classified as an Unwanted Wildland Fire. Following the fire Burned Area Emergency Rehabilitation work was done, which included mapping high, medium and low intensity burn polygons, installing temporary cattle excluding fence, laying straw wattles, contour felling, and broadcast seeding selected high intensity burn areas. In mid- to late-July 2001, six areas were sampled to monitor aspen regeneration. Of the six areas sampled, two areas received moderate intense burns (OFece-J, OFecw-K), two areas received moderate to high intense burns (OFre-R, OFrw-S), one area received low to moderate burn intensity (OFnw-I) and one area received low burn intensity (OFsc-T).

Figure 11 - GIS map of The Oldroyd Fire and GPS locations taken in the vicinity of the sampling.

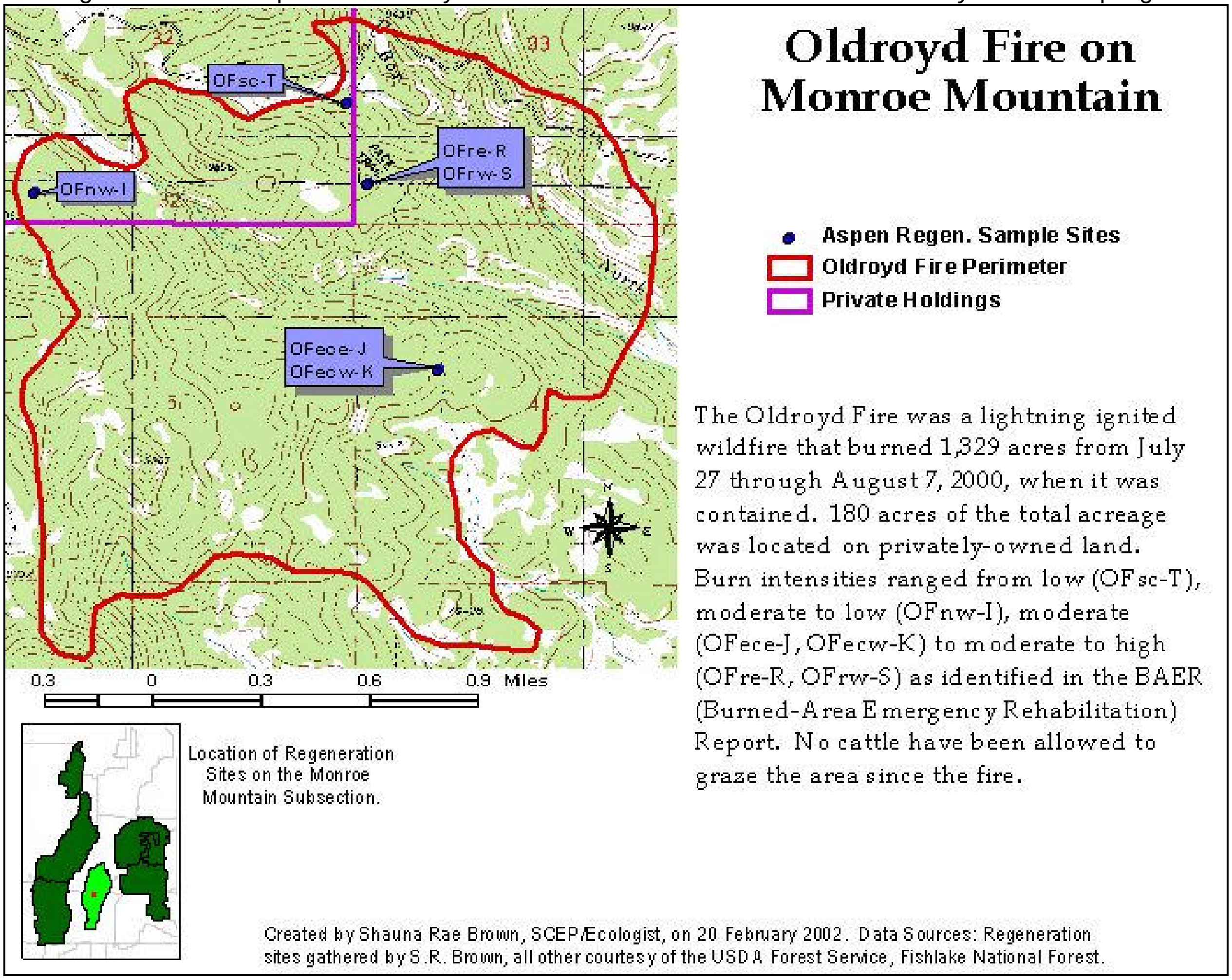


Table 10 - Oldroyd Fire Summary

Site ID	GPS Location	Elevation	Burn Intensity
OFece-J	410365.00 E - 4260767.00 N	9450 ft.	Moderate
OFecw-K	410365.00 E - 4260767.00 N	9450 ft.	Moderate
OFnw-I	408568.92 E - 4261551.91 N	9925 ft.	Low - Moderate
OFre-R	410052.01 E - 4261590.64 N	9651 ft.	Moderate - High
OFrw-S	410052.01 E - 4261590.64 N	9651 ft.	Moderate - High
OFsc-T	409954.22 E - 4261943.17 N	9479 ft.	Low

Tushar Mountains Subsection

Pole Creek Fire (GSwin-Z, GScin-A, GSout-AA, RPufd-B, RPH1ufd-AB, RHP2ufd-AF, RPH3ufd-AD, RPH4ufd-AE): The Pole Creek Fire was a lightning ignited wildfire that started in June 1996. It burned 7,916 acres before it was contained and out in late-July 1996. It was originally treated as a “containment fire” until high winds caused it to jump the fire-lines, after which it was determined that if the fire was allowed to burn it would likely burn for several months. As a result, it was decided that the fire should be put out using helicopters to drop water on it, before it reached the nearby City Creek drainage.

Part of the Pole Creek Fire burned an area called Grindstone Flat (GF), where study plots were established in 1934. The study plots are fenced plots that have been closed to all grazing (both wildlife and cattle) from one plot and cattle from an adjacent plot. The exclosures were rebuilt in 1997. The area outside the fence is grazed by both wildlife and livestock. Cattle have been grazed annually from June 1 through October 15 in every year since and including the fire (1996-2001). Generally, 359 cattle were run on this, the Circleville, allotment, which encompasses the entire Pole Creek Fire polygon; however, in 1998 and 1999 only 348 cattle grazed the allotment.

Following the fire, certain areas have been opened up for salvage harvest, in which standing dead logs are logged for timber. The Rigger Park (RPH) area is one such area. Adjacent to Rigger Park is the Baker Spring area, as you can see on the map. Located adjacent to the Baker Spring 2 harvest is RPufd-B, which is outside the harvest area on a steep slope (50%) and allows it to be used as a control site, due to its proximity to the other sites.

Figure 12 - GIS map of the Rigger Park and Baker Spring salvage harvest units, located within the Pole Creek Fire polygon, and GPS locations taken in the vicinity of the sampling.

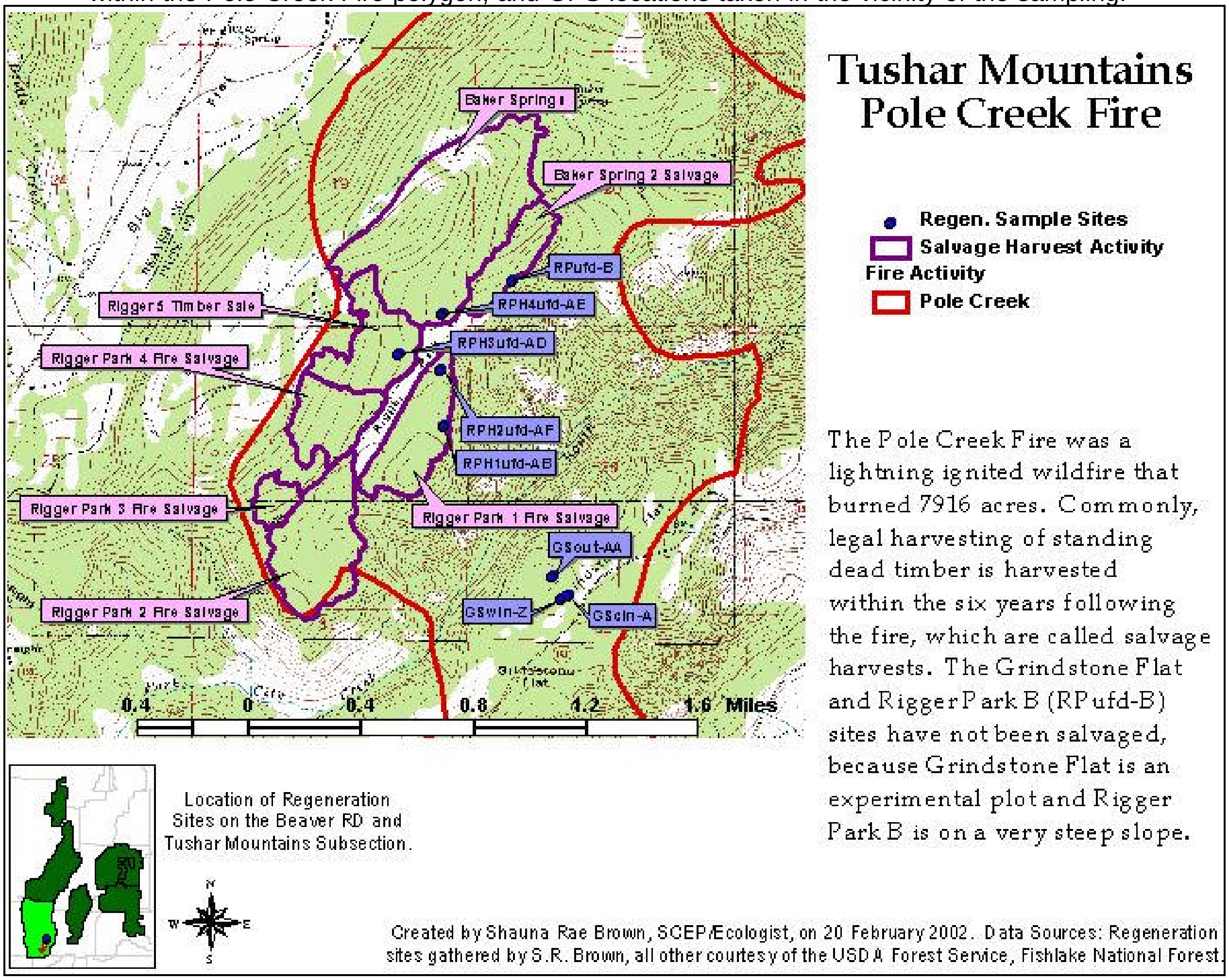


Table 11 - Pole Creek Fire Summary

Unit	Site ID	GPS Location	Elevation	Fenced	Salvaged
none	GSwin-Z	383017.52 E 4234438.96 N	9281 ft.	1997	no
none	GScin-A	410507.95 E 4256850.54 N	9268 ft.	1997	no
none	GSout-AA	382970.74 E 4234563.03 N	9310 ft.	outside exclosures	no
none	RPufd-B	382738.29 E 4236257.63 N	~ 9600 ft.	no	no
Rigger Park 1	RPH1ufd-AB	382347.31 E 4235426.67 N	~ 9760 ft.	no	1 Oct 1998 - 1 Nov 1998
Rigger Park 1	RPH2ufd-AF	382329.59 E 4235746.36 N	~ 9720 ft.	no	1 Oct 1998 - 1 Nov 1998
Rigger Park 2	not sampled	~	unknown	no	1 Aug 1999 - 30 Sept 2000
Rigger Park 3	not sampled	~	unknown	no	20 Oct 1998 - 30 Nov 1998
Rigger Park 4	not sampled	~	unknown	no	20 Oct 1998 - 30 Nov 1998
Rigger Park 5	RPH3ufd-AD	382091.84 E 4235841.39 N	~ 9760 ft.	no	15 Sept 1999 - 30 Oct 2000
Baker Spring 1	RPH4ufd-AE	382334.25 E 4236065.13 N	~ 9710 ft.	no	30 Oct 2000 - 30 Sept 2002
Baker Spring 2	not sampled	~	unknown	no	1 Aug 2001 - 30 Sept 2002

Table 12 - Treatment Area Summary

Treatment Area	Acres Treated	Year Cut	Year Burned	Year Fenced
Briggs Hollow 1 (wildlife exclos.)	19	Jan. 2000	~	mid-June 2000
Briggs Hollow 2 (cattle exclos.)	26	Feb.-Apr. 2000	~	mid-June 2000
Briggs Hollow 3 (wildlife exclos.)	3	May 2000	~	mid-June 2000
Briggs Hollow 5 (cattle exclos.)	10	May 2000	~	mid-June 2000
White Ledge 2 (cattle exclosure)	2	July 1997 - Sept. 1998	October 1999	October 1999
White Ledge 16 (unfenced)	12	July 1997 - Sept. 1998	October 1999	~
Dry Creek 1 (unfenced)	54	Jan., July - Sept. 1999	~	August 2001
Dry Creek 2 (cattle exclosure)	27	Jan., July - Sept. 1999	~	~
Farnsworth 3 (cattle exclos.)	3	Aug. - Sept. 1994	~	September 1995
Farnsworth 16 (unfenced)	2	Aug. - Sept. 1994	~	~
Oldroyd Fire	1,329	~	July - Aug. 2000	~
Pole Creek Fire (Grindstone Flat & Rigger Park)	7,916	1998-2001 Rigger Park Salvage only	1996	1997 Grindstone Flat only
Oldroyd Private Property Conifer Harvest (OPPufd-U)	?	Several different years	~	~
Oldroyd Private Property Aspen Harvest (OPPah-AG)	?	1999 or 2000	~	~
Burnt Flat (BFS16ufd-C)	?	1996-1997	~	~
Burnt Flat (BF2)	?	June - July 1997	~	July 1997

Results

Campbell and Bartos (2001) recommended that actions for aspen ecosystem restoration should be large to help disperse ungulate pressures regardless of species. Generally, the hypothesis is that if herbivory is a significant problem, then sites with wildlife exclosures would reflect the potential number of stems per acre that a site could produce, and that those stems would likely be taller than unfenced or cattle excluded sites adjacent to the exclude-everything (control) sites, since they would not have been browsed down. Additionally, cattle excluded areas would reflect only herbivory from wildlife. Further, if wildlife utilization is too high or dense over an area, then unfenced areas would be at highest risk, because the stems found there would be subject to herbivory from wildlife and cattle.

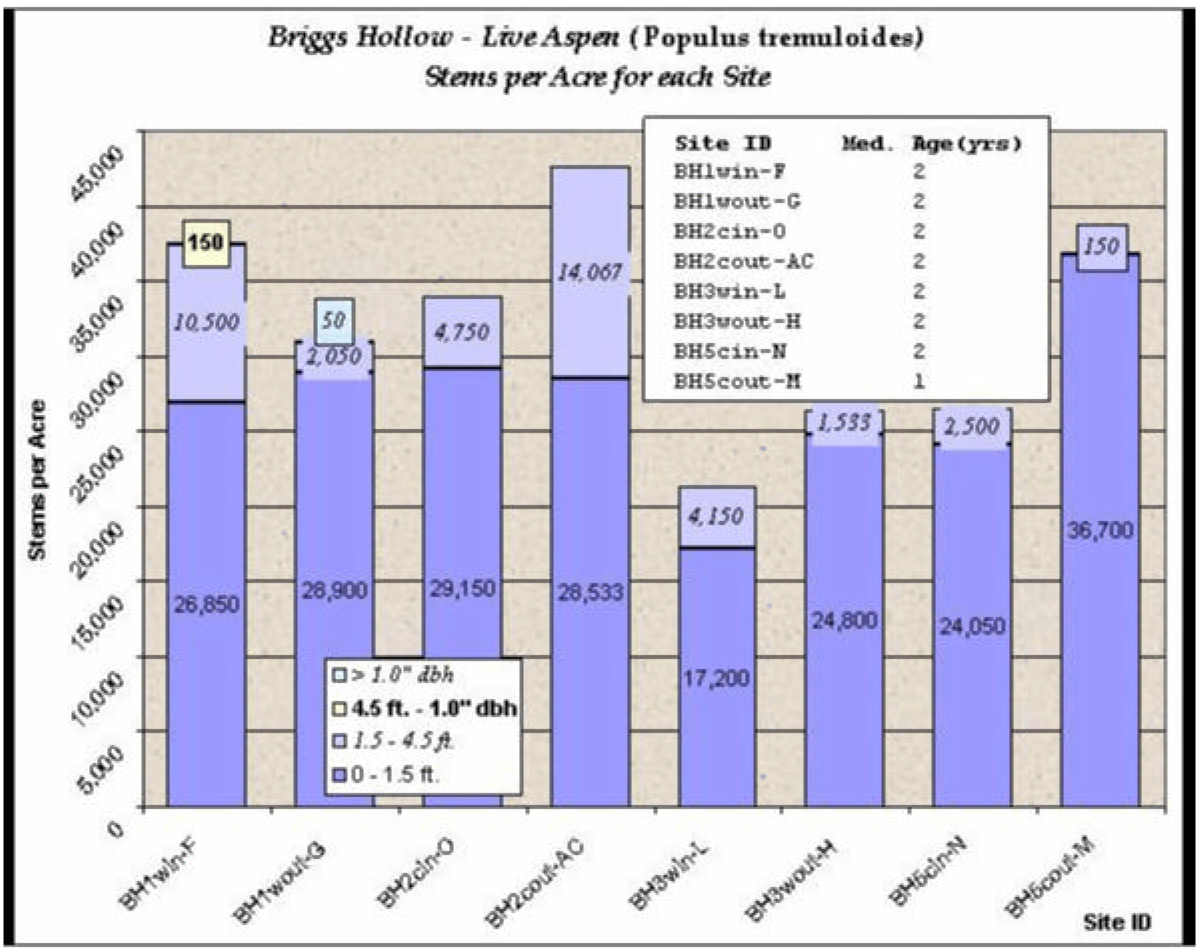
The mean number of stems per acre, percent damage by type, and the mean height of the dominant (tallest) stem per plot were calculated for each site using a commercially available spreadsheet, and then the results were graphed. Next, a variety of additional statistics were calculated using Systat 7.0 for Windows. These statistics include range, median, mean, standard error, standard deviation, variance, and two-sample t-tests. All t-tests reported in this text were two-sample t-tests, and will be referred to as t-tests for brevity. Prior to running the t-tests, significance was arbitrarily set at $P = 0.05$, or a 95% confidence interval. All statistical tests can be found in Appendix C.

Fishlake Plateau Subsection

Briggs Hollow

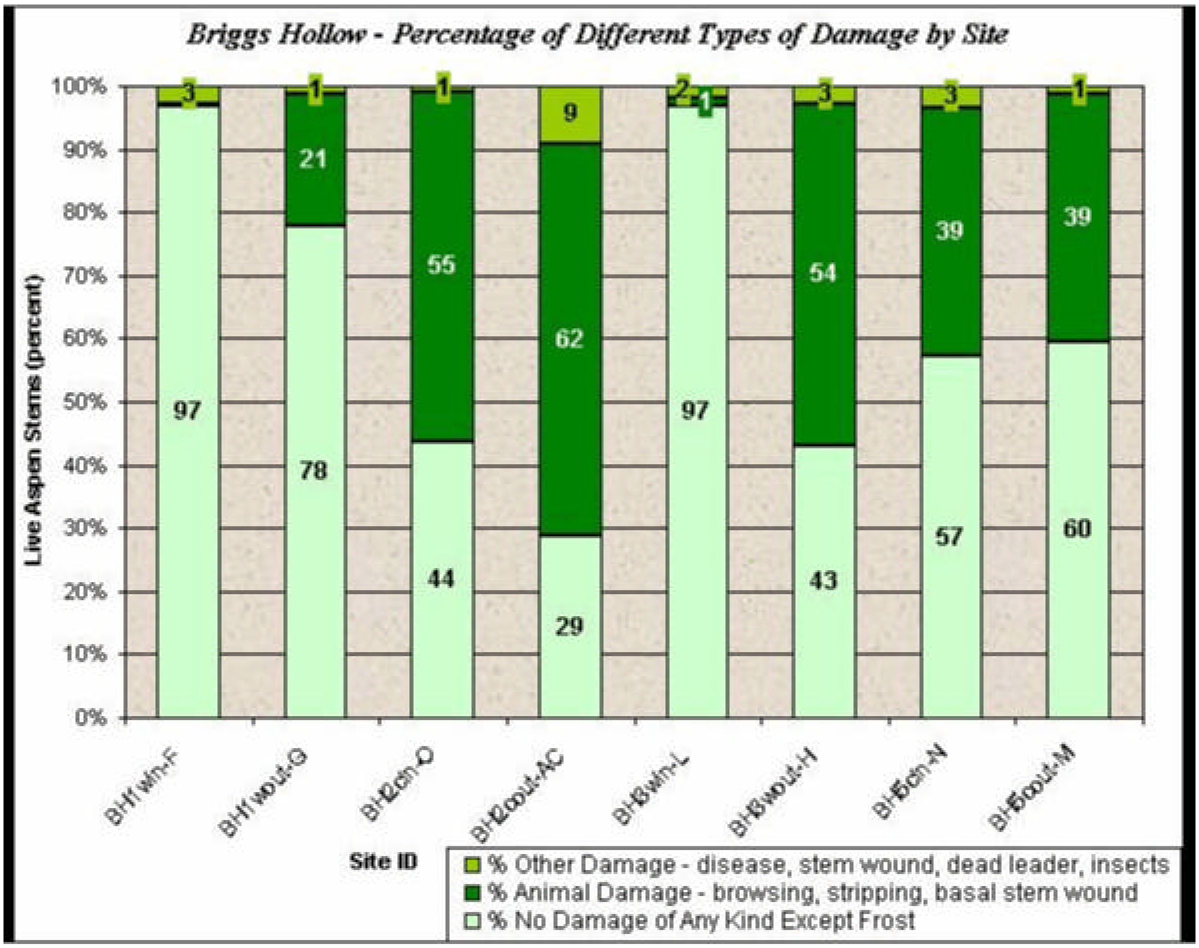
The four Briggs Hollow units sampled produced between 21,350 (BH3win-L) and 42,600 (BH2cout-AC) stems per acre. Since all units were treated in the winter through spring of 2000, all units had median ages of two years except, Briggs Hollow unit 5 (BH5cout-M). As can be seen in Figure 13, all sites had the largest number of stems in the smallest size class (0 to 1.5 ft or 45 cm). Additionally, the number of stems per acre did not follow what one would expect, if herbivory were impacting the regeneration. Only one unit, Briggs Hollow unit 1 (BH1win-F, BH1wout-G), shows what would be expected. However, when t-tests were run for each of the paired (inside/outside) sample sites, none of them was found to have significantly more stems inside the exclosures than outside.

Figure 13 - Briggs Hollow - Live Aspen Stems Per Acre



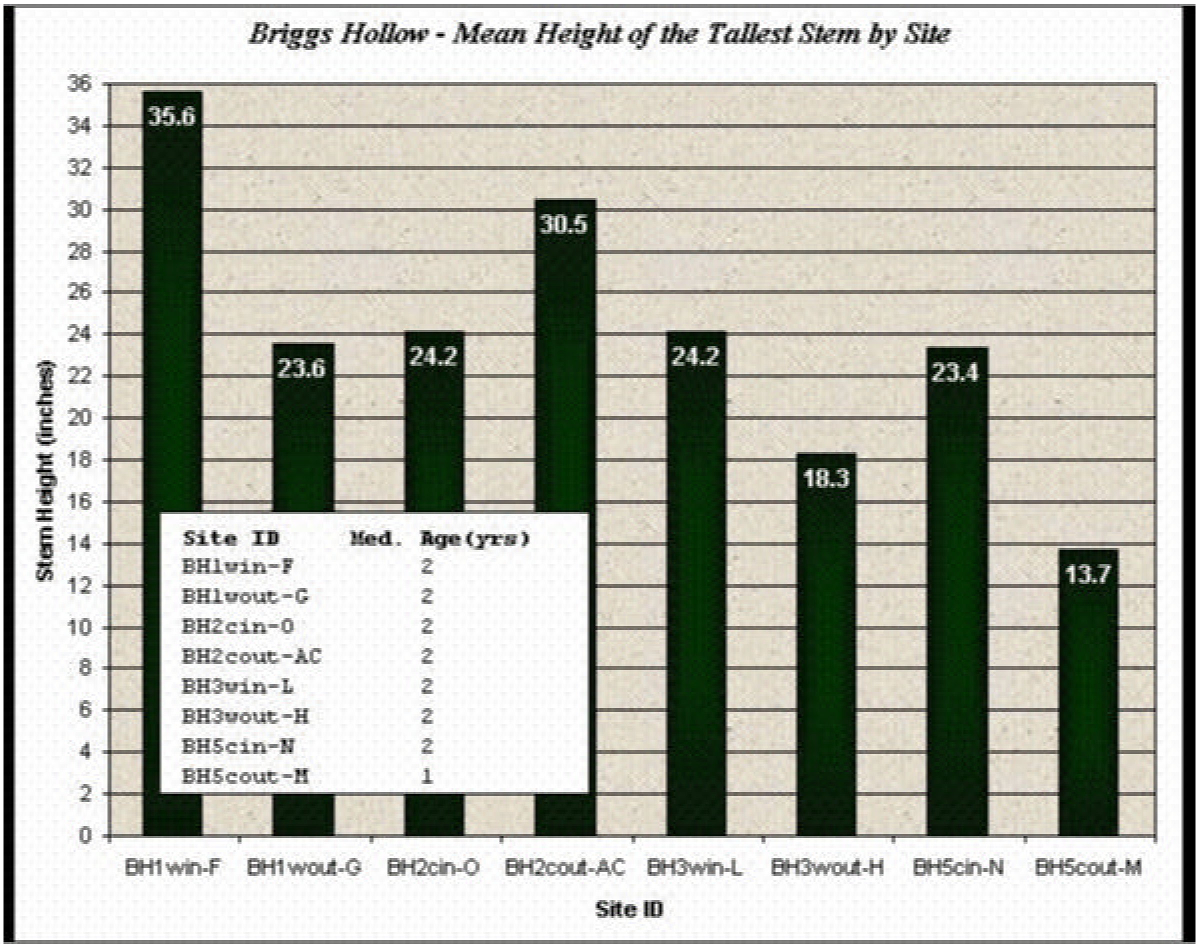
According to Figure 14, the percentages of the three damage classes do follow what one would expect, with the exception of Briggs Hollow unit 5 (BH5cin-N, BH5cout-M), which doesn't show much difference.

Figure 14 - Briggs Hollow - Damage Class Percentages



For each site means of the tallest (dominant) aspen stem found in each plot were calculated, then t-tests were used to compare inside and outside the exclosures for each harvest unit. With the exception of Briggs Hollow unit 2 (BH2cin-O, BH2cout-AC), all stems located inside exclosures were significantly taller than those outside. However all t-tests showed that there were significant differences in mean dominant stem heights between inside and outside the exclosures (P<0.0228).

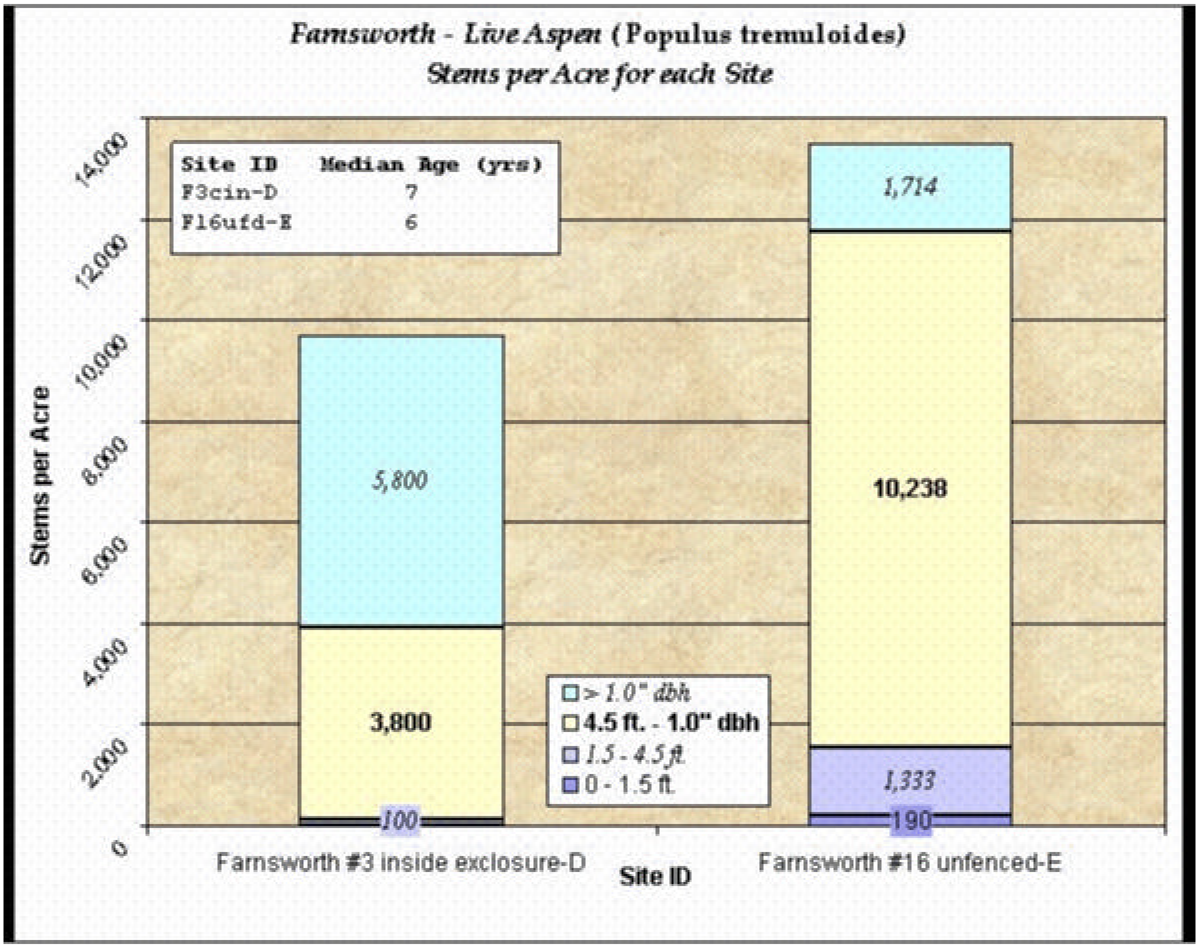
Figure 15 - Briggs Hollow - Mean Stem Height of the Dominant Aspen Stem in Each Plot



Farnsworth

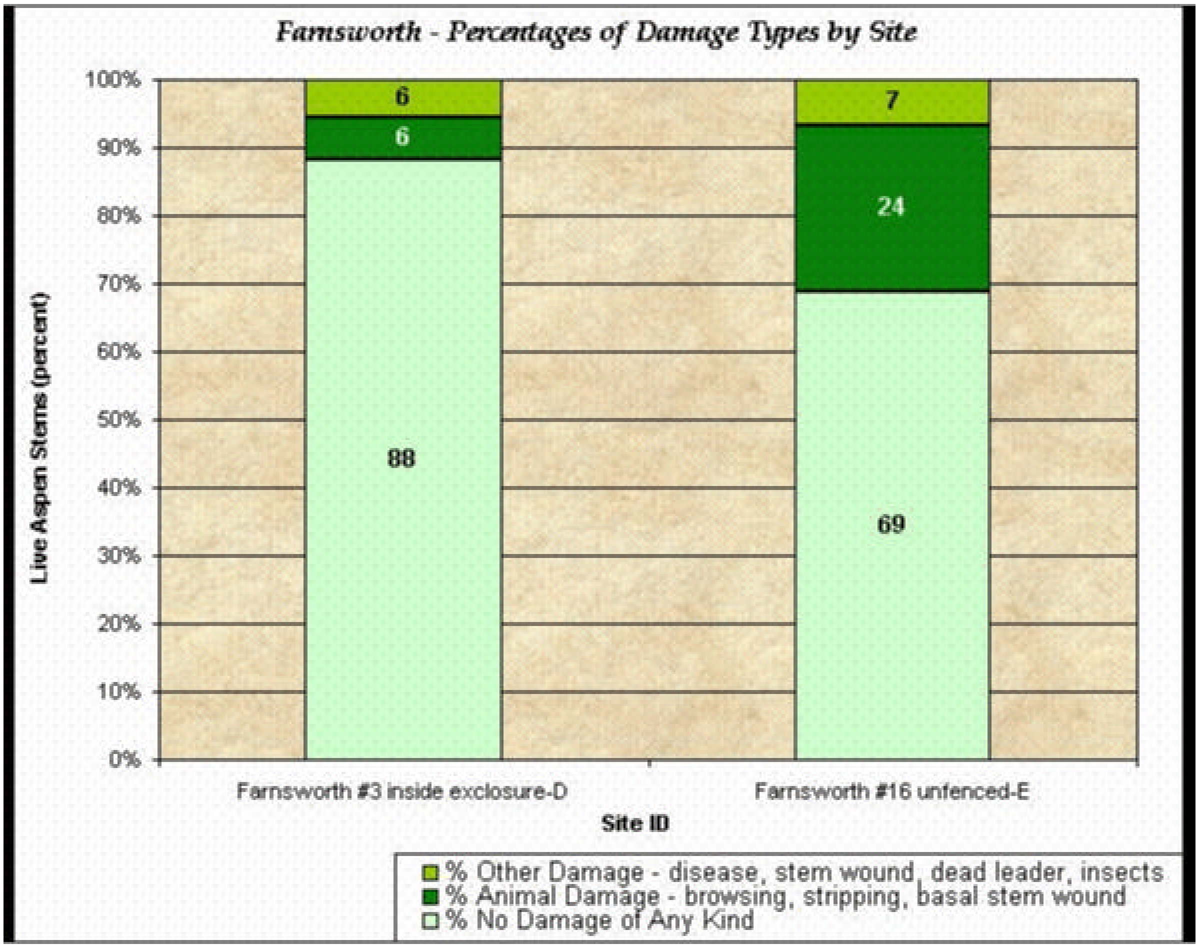
As can be seen in Figure 16, Farnsworth unit 16 produced more stems per acre than Farnsworth unit 3 at 13,475 and 9,700 stems respectively. When two-sample t-tests were calculated comparing the mean number of stems per plot, no significance was found. The graph also shows that size classes 3 and 4 (see Table 2) represented the bulk of the regenerated stems.

Figure 16 - Farnsworth - Live Aspen Stems Per Acre



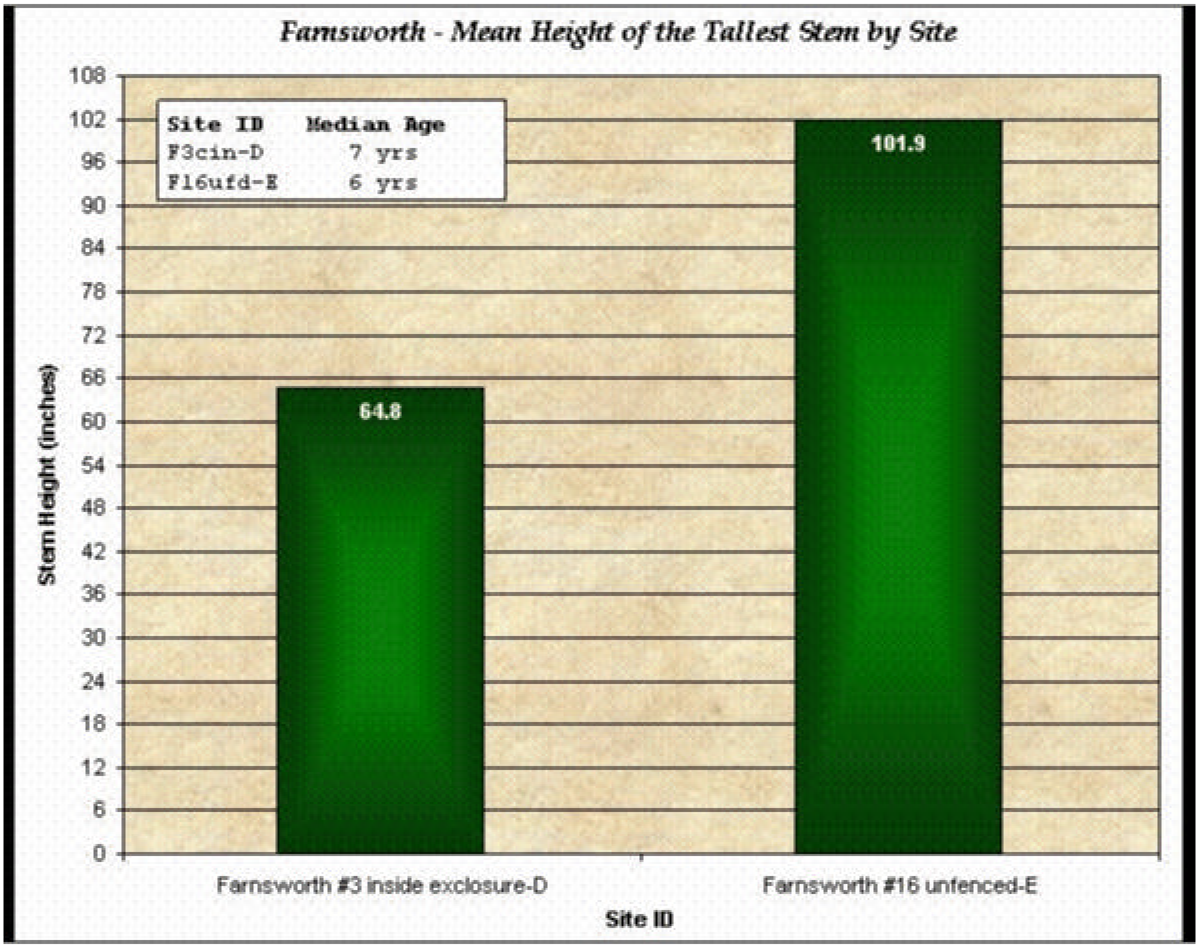
Like Briggs Hollow, the Farnsworth unit inside the cattle exclosure (#3) also received less animal damage than the unfenced unit (#16), though both units had fewer than half of their stems damaged by animals.

Figure 17 - Farnsworth - Damage Class Percentages



When the mean heights of the tallest stems were calculated and graphed (Figure 18), Farnsworth unit 16 was found to have taller dominant stems, and when a two-sample t-test was completed, they were found to be significantly different. This result was not originally expected.

Figure 18 - Farnsworth - Mean Stem Height of the Dominant Aspen Stem in Each Plot



Monroe Mountain Subsection

On Monroe Mountain, fenced units produced more stems per acre than unfenced units and the fenced ones sustained less animal damage. Additionally, fenced units produced taller ramets than unfenced units on a site by site basis.

In this discussion of the Monroe Mountain Subsection, the Oldroyd Fire will be covered separately, because its treatments are the different fire intensities, and the herbivory effects are all due to wildlife, since cattle had not been released on the site since the fire.

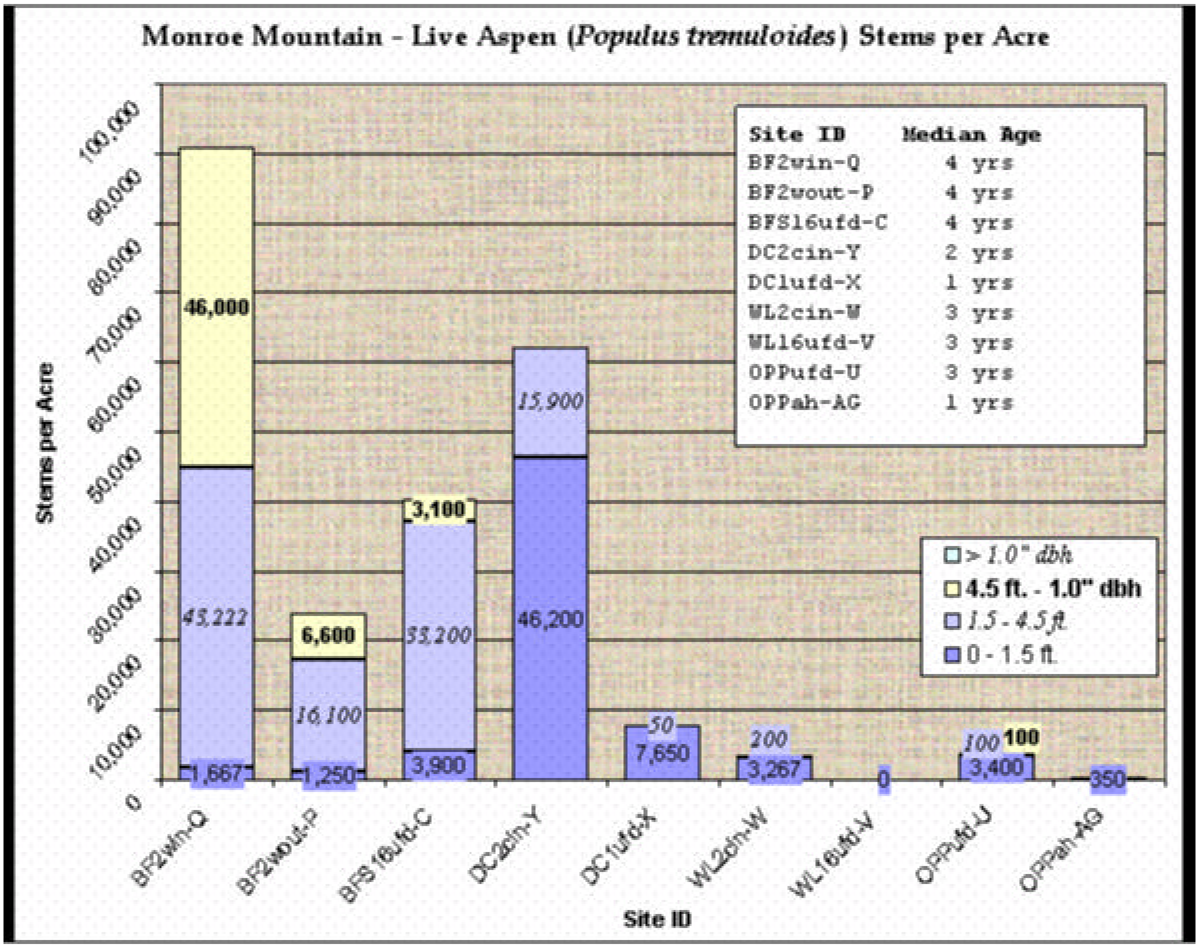
Burnt Flat was sampled in three areas, one of which was a small-area wildlife exclosure (BF2win-Q) located within a larger unfenced aspen harvest unit (BF2wout-P). T-tests showed that the fenced site produced significantly more stems per acre that either of the unfenced units ($P < 0.0012$). Additionally, when the two unfenced units were pooled, there still remained a significant difference ($P = 0.0004$).

Even though Dry Creek Unit 2 was fenced a couple of weeks prior to being sampled, this site produced significantly more stems per acre ($P = 0.0001$). There are several reasons for this, which will be covered in the discussion section of this paper.

It is important to note that in early June, prior to sampling the unfenced White Ledge unit (WL16ufd-V), a few stems had been found on the site, but the sampling was done about a month after that visit. The graph shows that the site was devoid of aspen suckers at the time of sampling. However, the adjacent cattle excluded site did produce a few stems (about 3,467 stems/acre). Since the unfenced unit produced no suckers, Systat could not calculate significance for the t-test, however, it is apparent to this researcher that fencing had an affect.

The two Oldroyd private property units (OPPufd-U & OPPah-AG) have not been grazed by cattle during the time following the harvest, thus the only animal damage they received would be from wildlife, which was in the area (spotted by the researcher) at the time of sampling. OPPufd-U produced significantly more ($P = 0.0312$) stems than OPPah-AG.

Figure 19 - Monroe Mountain - Live Aspen Stems Per Acre



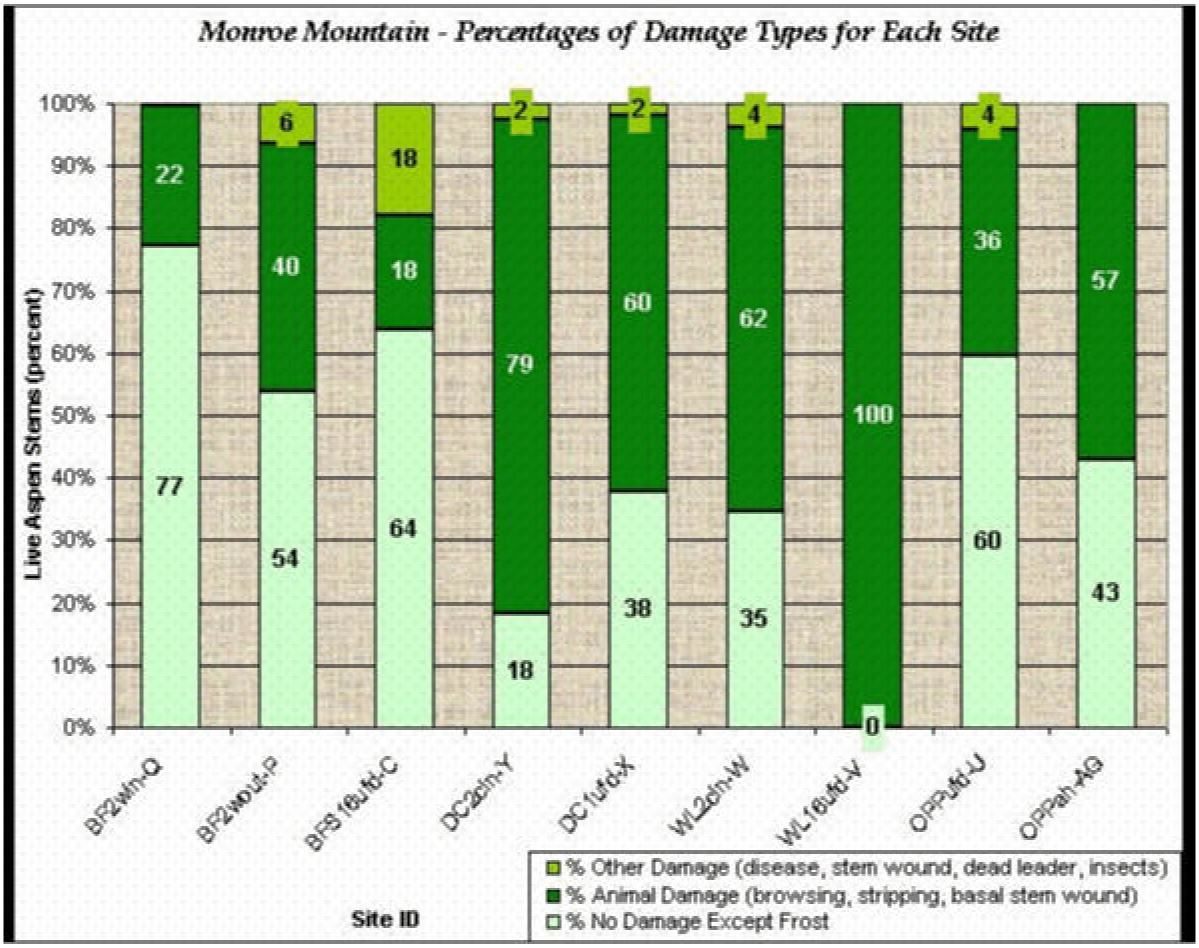
Burnt Flat's three sites all had greater than 50% no damage, but BF2wout-P had the highest amount of animal damage at 40%. It appears that between inside and outside the adjacent units (BF2win-Q, BF2wout-P), this difference may be significant. However, the difference between BF2win-Q and BFS16ufd-C is probably not significant.

Both of the Dry Creek sites received the majority of their damage from animals, and less than half of the stems were without damage. These sites were not adjacent to each other, but were less than a half mile apart. There appears to be an interaction between the number of stems produced and the percentage of damage from animals.

White Ledge is an unusual site in that the unfenced unit produced no stems, so there was no absolute way of assessing damage. However, since the site should have produced stems, as can be evidenced by the adjacent cattle excluded site having produced stems, all damages were assigned to have been caused by animals. This was also given because at the time of sampling, there was almost no plant life in any of the White Ledge treatment areas. Additionally, thirteen of the twenty plots sampled contained some type of animal sign, such as prints, burrowing activity or most commonly animal droppings. It is important to note that following the cutting treatment, the forest ecologist noted that the site produced over 10,000 stems per acre.

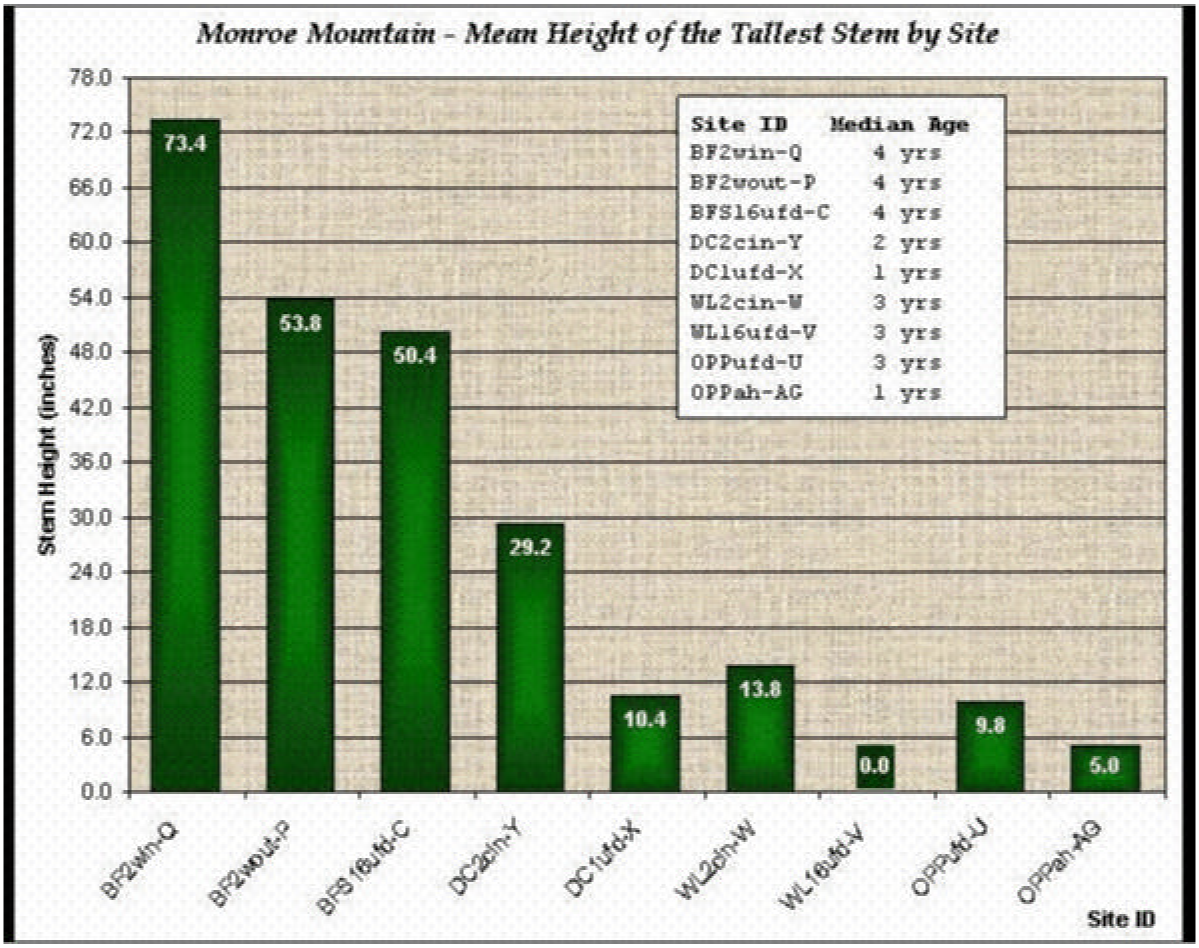
The two Oldroyd private property sites received differing amounts of damage. Specifically, the selective harvest (OPPufd-U) aspen stems received about 36% of their damage from animals, but this site was generally more densely vegetated with immature conifers acting as natural exclosures for the young aspen suckers. The aspen harvest (OPPah-AG) was clearcut leaving no protection for the few stems found there. Fifty-seven percent of those found had shown signs of animal damage. Additionally, only two of the twenty plots sampled didn't contain any wildlife sign (typically pellet mounds).

Figure 20 - Monroe Mountain - Damage Class Percentages



Burnt Flat's two unfenced sites (BF2wout-P, BFS16ufd-C) both produced significantly shorter aspen stems than the wildlife excluded site ($P < 0.0013$). The same was also true for Dry Creek ($P < 0.0001$). White Ledge's significance could not be calculated, because there weren't any stems in the unfenced unit to compare against the fenced one. Still, it appears to be significant if only intuitively. Oldroyd private property's two treatments, in spite of their differences in median age, were not significantly different in height ($P = 0.2874$), however, both sites were harvested in the summer of 1996.

Figure 21 - Monroe Mountain - Mean Stem Height of the Dominant Aspen Stem in Each Plot



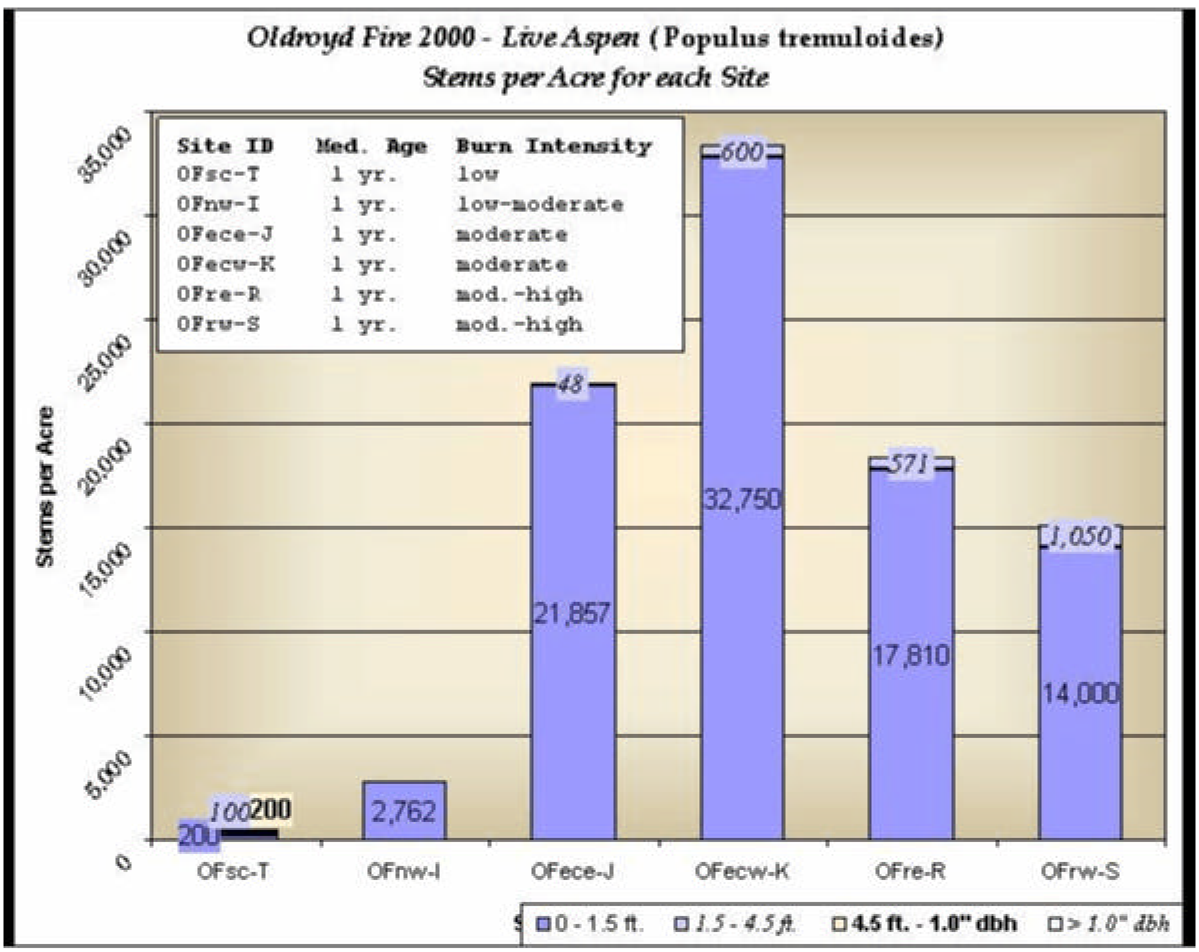
Oldroyd Fire

As noted earlier in the "Treatments" section of this paper, burn intensities varied from low (OFsc-T), low to moderate (OFnw-I), moderate (OFece-J, OFecw-K), and moderate to high (OFre-R, OFrw-S). Burn intensities were determined by the BAER report (Fishlake National Forest 2000).

I ran an ANOVA (analysis of variance), to study the effects of burn intensity on the number of stems per acre. I did this because when simple means were graphed, I noticed that there might be a correlation. I also wondered if moderate burn intensity produced similar amounts of suckering (number of live stems per acre) as clearcutting, since the moderate intensity burn areas produced the most suckers.

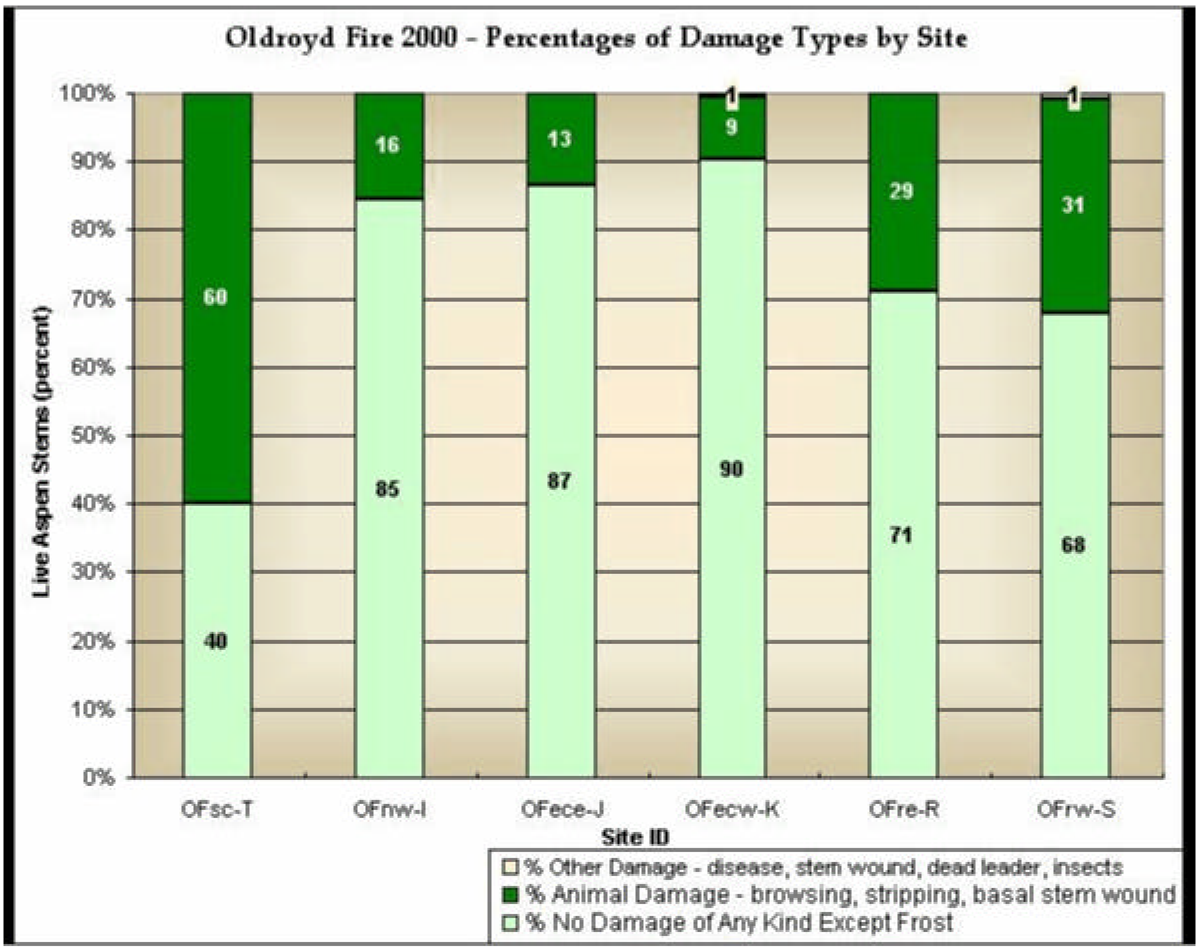
According to the ANOVA results, burn intensity may have (P = 0.0538) a significant affect on the number of stems produced initially following a fire. I also ran t-tests comparing low to low-moderate, low-moderate to moderate, and moderate to moderate-high on number of live stems per acre. I found no significant differences between low and low-moderate, nor between moderate and moderate-high. There was only a difference between low-moderate and moderate (P=0.0073). I did not compare low to moderate or moderate-high, because I was only interested in determining if there were subtle differences between the burn intensity types, rather than obvious ones.

Figure 22 - Oldroyd Fire - Live Aspen Stems Per Acre



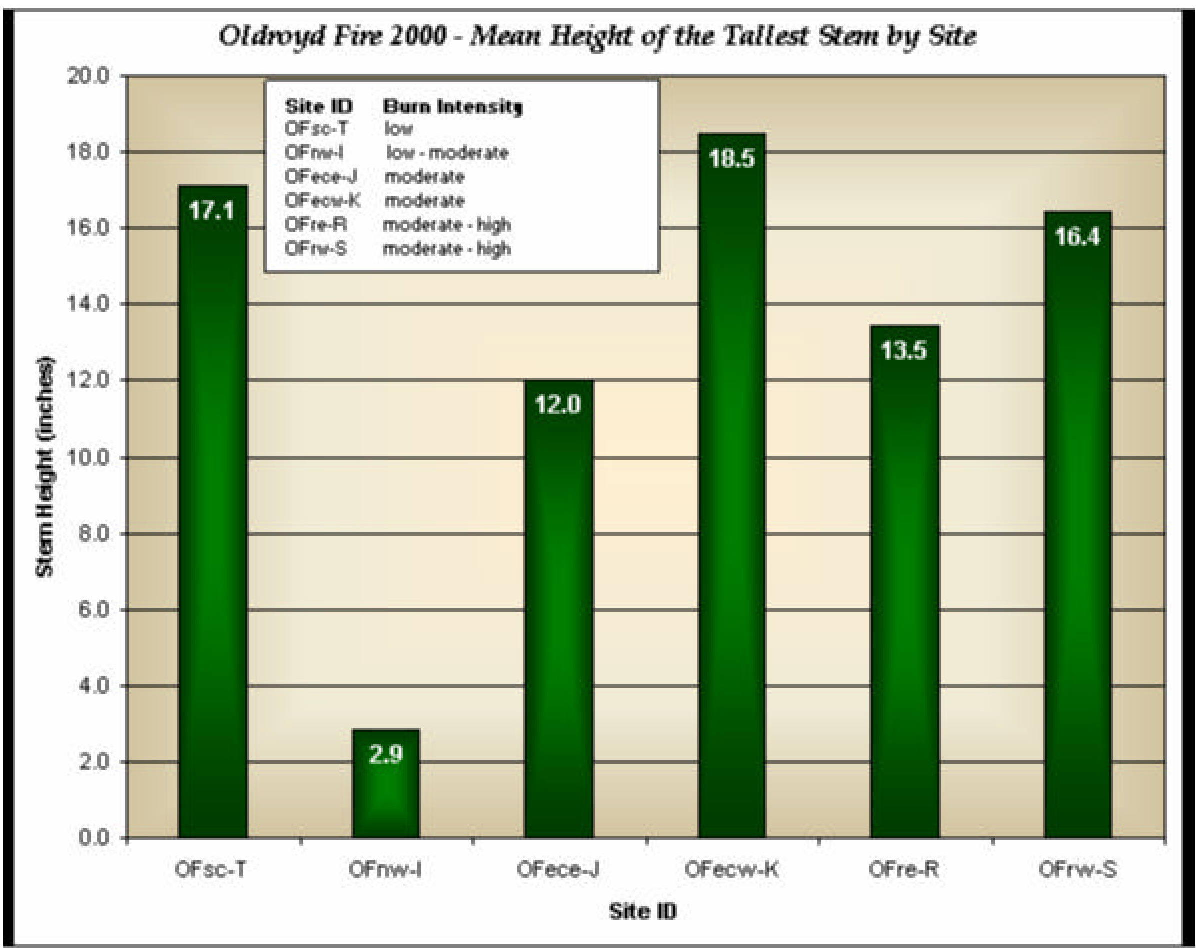
As far as damage goes, only the low intensity burn area (OFsc-T) had greater than 50% of its damage from animals, though there were a lot fewer stems to be sampled in that site, so the small sample site may have magnified the impact of animal browsing. The remaining sites all showed higher percentages of healthy, undamaged stems. However, damage accumulates as stems grow, and these stems were only in their first year of growth. When in the field, I observed that it was common to see stems that had been pulled completely out of the ground by foraging wildlife. In most cases, the animal sign found in the area was from elk.

Figure 23 - Oldroyd Fire - Damage Class Percentages



When OFsc-T was sampled, most of the stems found there were advance regeneration, meaning that the stems were there before the fire. This has the result of confounding the impact of fire intensity on stem heights. Also, since the fire didn't burn as hot, the stems found there didn't die, even though there was fire scaring on trees within the plots. I also ran an ANOVA to study the effects of burn intensity on the height of the dominant stem in each plot. According to the ANOVA results, fire intensity had a significant ($P < 0.0001$) affect on stem heights. When I ran t-tests to compare low to low-moderate, low-moderate to moderate, and moderate to moderate-high, I found that stems in the moderate and moderate-high intensity areas were not significantly different ($P = 0.8419$); however, there was significant difference ($P < 0.0001$) between low and low-moderate stem heights, and low-moderate and moderate stem heights.

Figure 24 - Oldroyd Fire - Mean Stem Height of the Dominant Aspen Stem in Each Plot



As mentioned above, I had noticed that the moderate burn intensity areas had produced the most suckers and that these sites produced about the same amount of suckers as areas that had been clearcut. Of the areas sampled for regeneration, only the Briggs Hollow and Dry Creek aspen clearcuts were treated in the same year as the Oldroyd Fire. Of the clearcut areas on the Monroe Mountain Subsection, only the cattle exclosure of Dry Creek was not so heavily browsed that the regeneration was almost gone, but only 10 sample plots were surveyed. The only other sites clearcut in 2000 that had been fenced were the Briggs Hollow units. Even though Briggs Hollow is on the Fishlake Plateau Subsection, I pooled the fenced Briggs Hollow and Dry Creek sites to make the clearcut treatment sample set.

To assess the differences between clearcutting and the moderate and moderate-high burn intensities on the number suckers produced, I ran t-tests comparing the fenced clearcut units to the Oldroyd Fire moderate and then moderate-high burn intensity sites. I hypothesized that there shouldn't be any significant difference ($P > 0.05$) between clearcutting and moderate intensity burn sites, but that there should be ($P < 0.05$) with the moderate-high intensity burn sites. The t-test confirmed the hypothesis ($P = 0.5363$) that there is no significant difference between the two treatments. Additionally, when the moderate-high burn plots were compared with the clearcut plots, significant difference ($P = 0.0018$) was noted.

Tushar Mountains Subsection

In spite of the fact that the Grindstone Flat exclosures were installed the year following the Pole Creek Fire, there was no statistical difference found between any of the three sites sampled on the number of live stems produced, nor in the heights of the dominant stems. The three sites (wildlife excluded, cattle excluded, grazed by all) received progressively more animal damage, but the damage didn't seem to be enough to impact the number of stems produced nor the height of the dominant stems.

Rigger Park, on the other hand, did show some significant difference between the sites sampled. This was determined by setting RPufd-B, the unsalvaged and sloped site, as the control for the area, since all the Rigger Park and Baker Springs sites were located within walking distance of each other. All of the Rigger Park sites, except unit 5 (RPH3ufd-AD), received 3 - 6% of their damage from animals and over half of their stems were healthy. Of the three salvage units sampled, only units 1 (when RPH1ufd-AB and RPH2ufd-AF were pooled) and 5 (RPH3ufd-AD) produced significantly ($P < 0.0533$) fewer live stems per acre than RPufd-B. Additionally, all sample sites except the Baker Spring unit (RPH4ufd-AE) had significantly ($P<0.0139$) shorter dominant stems than the control (RPufd-B) site.

Figure 25 - Pole Creek Fire - Live Aspen Stems Per Acre

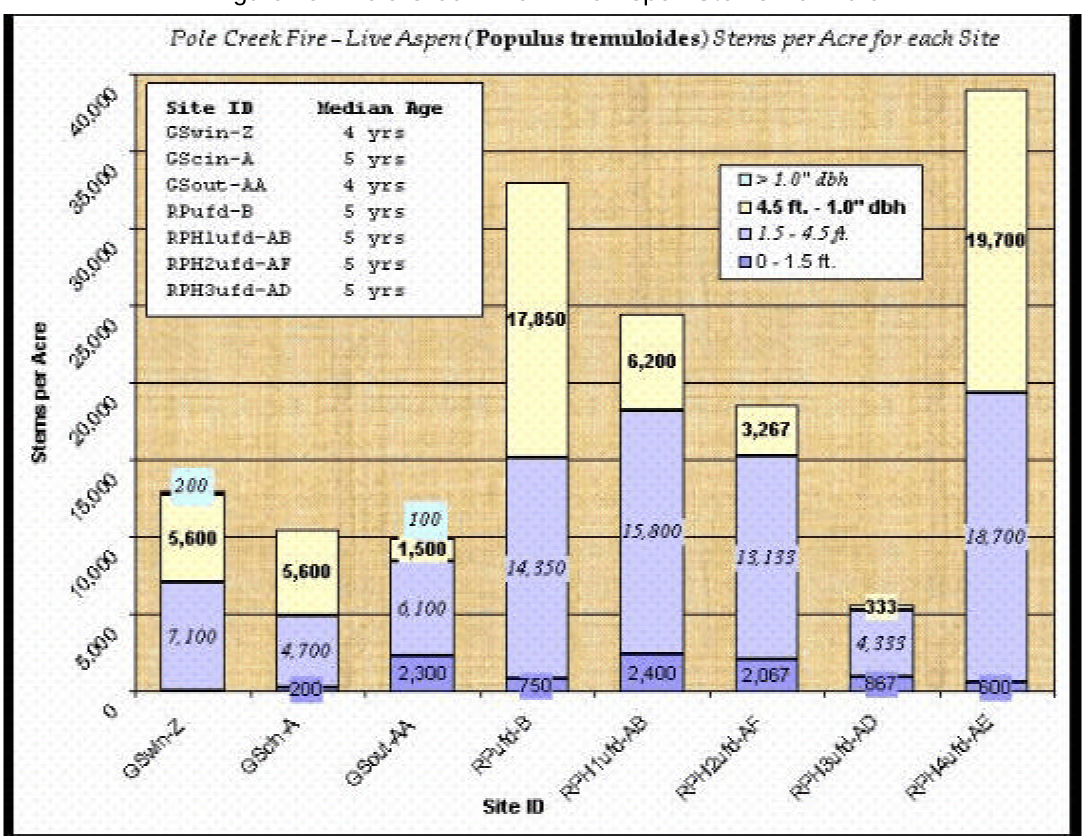


Figure 26 - Pole Creek Fire - Damage Class Percentages

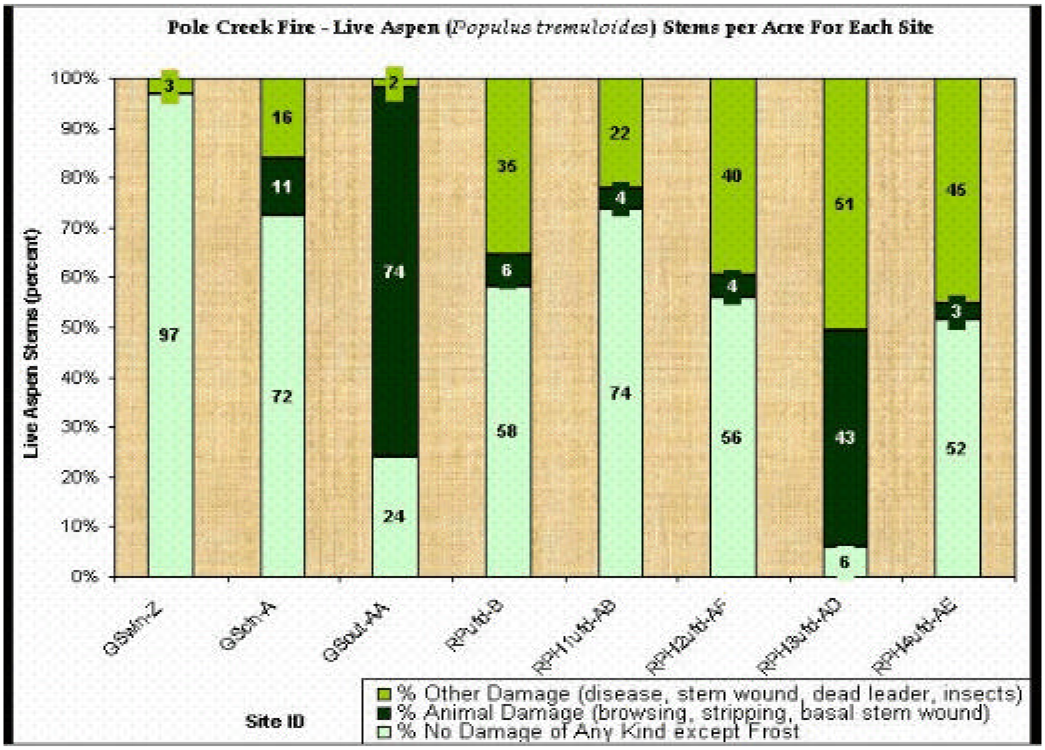
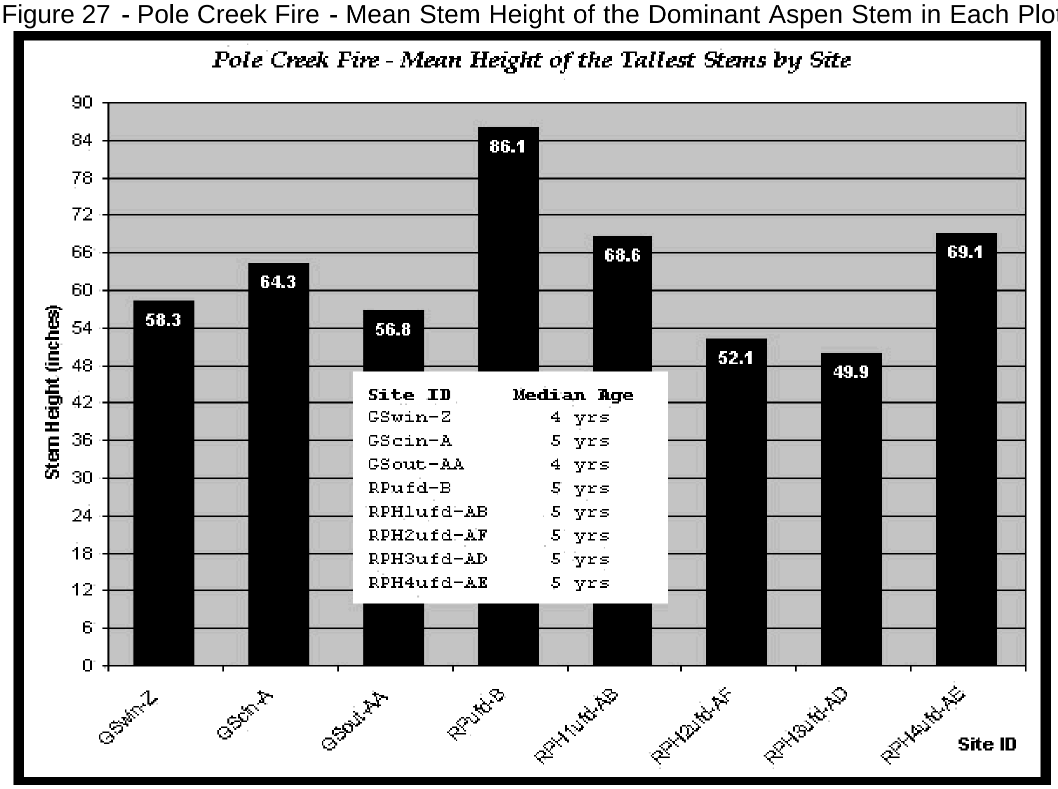


Figure 27 - Pole Creek Fire - Mean Stem Height of the Dominant Aspen Stem in Each Plot



Discussion

Initially, I will discuss the results on a treatment area by treatment area basis: suggesting the reasons for what was observed. Next, I will discuss the patterns observed along with land management issues that could be contributing to the observed patterns..

Fishlake Plateau Subsection

Briggs Hollow

According to my hypothesis, there should have been significant differences in the number of aspen suckers produced inside the fenced sites versus outside the sites, however that was not what happened. It is important to note that all sites were sampled early in the grazing season (July 16-18, 2001), except outside the cattle exclosure on unit 2 (BH2cout-AC), which was sampled at the end of the grazing season (October 11, 2001). BH2cout-AC also received the highest percentage of animal damage. Additionally, all the other sites had more wildlife sign (pellet groups or scat) in them than cow sign (cow paddies). Thus, the most probable explanation is that the cattle had not yet reached the sites by the time we sampled them, except for BH2cout-AC.

Even though the number of stems produced did not vary statistically, herbivory was impacting stem height in all the units that had been sampled in July. The most likely reason for stems outside unit 2 to be taller than inside the cattle exclosure would be the time lag in sampling, since inside the exclosure was sampled in July, outside the exclosure in October, giving those stems more time to grow.

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Farnsworth

Similar to Briggs Hollow, there was no significant difference in the production of aspen stems between the fenced and unfenced Farnsworth units, but they did vary in their stem heights. Unexpectedly, the unfenced unit's stems were taller. The stand that was one year younger was the taller of the two. There are two possible reasons for this. One, there is clonal variation being observed, since the sites were separated by almost 0.9 miles. The other, there are physical differences between the sites.

When the unfenced unit was sampled, we noted that it had a 20% slope and there were boulders as large as 1.5 meters (~ 5 feet) in diameter throughout the site, whereas the fenced unit was quite flat with very thick undergrowth and it was much wetter. In spite of the greater percentage of damage attributable to animals on the steeper site, it had no deer, elk or cow sign, whereas the flat, fenced site did have either moose or elk sign. The steep, stony site was more difficult to move around in, with footing being much more treacherous, and it didn't have the same thick, grassy undergrowth that the fenced unit had. It is likely that instead of browsing on the aspen, wildlife were grazing the grasses.

Monroe Mountain Subsection

Burnt Flat

As mentioned earlier, the wildlife excluded site produced significantly more stems per acre than either of the two unfenced sites. The same was true of stem height. It is interesting to note that BFS16ufd-C received about the same amount of animal damage as the tall-fenced unit (BF2win-Q); however, BF2wout-P received more animal damage than the other two. As mentioned, the fenced unit was quite small, and the plastic fencing material was quite pliable.

These qualities made the fencing easy for cattle and wildlife to push into and still browse the perimeter of the stems inside the fence, but it was strong enough to limit browsing damage to the periphery. The plot had originally been fenced with the plastic netting to test the utility of the material for protective exclosures. There was one section of the fence that had been torn leaving a hole large enough for an animal's head. In this area, as well as all along the fence, sample plots had been surveyed, which explains the amount of animal damage noted.

Dry Creek

The two Dry Creek units sampled were about 0.6 miles apart. The unfenced unit was sloped 17%, was nearest to the road and there was a depression were water collected or seeped. The other unit (fenced) had not been fenced until late-July, only about two weeks prior to sampling, so the data should be interpreted as if it weren't fenced. In any event, the units were statistically different in the number of stems produced and in dominant stem heights, with the fenced unit producing more and taller stems. The fenced unit had also received more animal damage. According to the forester who had initiated the fencing, cattle had to be driven or shooed out of the fenced area, which was much flatter with only a 5% slope. In spite of the greater percentage of animal damage that the fenced unit received, the stems there were a year older and taller than the unfenced sloped unit nearer the water source. In all likelihood, the water source tended to congregate animals at a less desirable foraging site, which had been very nearly browsed clean. The animals probably didn't move to the flatter site until the nearby sloped site, nearer to water had been utilized to the point of no longer being worth the effort.

Oldroyd Private Property

On the Oldroyd private property units, harvests were conducted in 1996. The selective harvest's (OPPufd-U) median stem age was three years, and the clearcut aspen harvest's was one year. Quaking aspen is not a shade tolerant tree (Jones & DeByle 1985b), thus by selectively removing the shade tolerant spruce and fir species, thereby opening up the canopy, aspen was able to regenerate on the site, even though the mature aspen were left. The remaining cover on OPPufd-U probably gave the aspen suckers protection from foraging wildlife. However, both sites produced very few stems, with the aspen harvest (OPPah-AG) site producing only 350 stems per acre. The clearcut aspen harvest looked very much like the unfenced White Ledge unit, but the acreage clearcut on the Oldroyd property was much smaller. When the aspen clearcut (OPPah-AG) was sampled, we noted that 18 of the 20 plots contained elk sign, in comparison to the selective harvest unit (OPPufd-U), with 3 of the 20 having elk sign. These sites demonstrate that treatment type can have an important impact on the success of aspen restoration projects.

White Ledge

When comparing the cattle excluded (WL2cin-W) and unfenced (WL16ufd-V) units of the White Ledge treatment area, one can see that over-utilization is a very real problem. There are just too many animals foraging in this treatment. At the time of sampling, some cattle were seen in the area, but only four plots contained cow sign. In contrast, only eight of the twenty plots surveyed were without animal sign, with elk sign, in half of the plots, being most common. Clearly, elk have as much or more impact on the treatment area as cattle. Sadly, unless something is done immediately to protect this site from further herbivory, the treatment will have failed in its purpose to restore the aspen.

Oldroyd Fire

When the number of stems per acre of the moderate burn intensity areas was compared to the fenced Dry Creek and Briggs Hollow units, there was only a possible statistical significance found (P = 0.0538). However, the bulk of the fenced samples were from the Briggs Hollow units (n=80, vs. n=10 from DC2cin-Y). Briggs Hollow is located on the Fishlake Plateau, and the site was much drier, with much of the surrounding vegetation being a sagebrush (*Artemisia sp.*) type. In contrast, the moderate burn sites were in a mixed conifer/aspen type. Additionally, since aspen is a clonal species, there could also be differences related to clonal variation that are confounding the results. So, had it been possible to compare the moderate intensity sites with nearby successfully regenerating sites, then the significance would probably have been stronger.

It would be useful to compare a wide variety of clearcut sites with a wide variety of moderate burn sites, so that site characteristics and clonal variation could be masked. That said, there was an effect of fire intensity on stem heights (P = 0.0018), since the moderate burn sites weren't statistically different from the clearcut sites. Thus, with the almost significant number of stems produced and the significance of stem height noted, clearcutting a site has about the same restorative use or value as a moderate burn intensity. Schier et. al. (1985) noted that the greatest number of suckers was produced following clearcutting versus partial cutting.

Since, fire is such an important component of Rocky Mountain forests, and many researchers (Bartos & Campbell 1988b, Campbell & Bartos 2001, Clark & Sampson 1995, Chappell 1997, Gifford et. al. 1984, Malespin & Kingston 1986, Mueggler 1985, White et. al. 1998 and White 2001) note that changes in fire intervals are causing a conversion from an aspen to mixed conifer ecotype and a build up of forest fuels. Clearcutting aspen to restore the ecosystem type could be a useful tool in situations where burning is unsafe or otherwise problematic. Burning is an inexpensive and effective way to naturally regenerate aspen forests (Schier et. al. 1985), making it an important management tool for its efficiency. My data showed that if fire intensities can be kept in the moderate range, then aspen could be economically restored to the landscape. But as Chappell (1997) determined Monroe Mountain's fire intervals are more than 100 years overdue. The accumulation of forest fuels over that long of a time frame means that fire intensities will tend toward the high end, rather than the pre-settlement trend of frequent, low-intensity fires.

Tushar Mountains Subsection

Grindstone Flat

As noted earlier, there was no significant difference found on the number of stems produced, nor on the heights of the stems between the three treatments (wildlife exclosure, cattle exclosure, outside the exclosures). This was not what was expected. Clearly, animals were differentially impacting the three treatments, as can be seen by the very different percentages of animal damage noted (GSwin-Z = 0%, GScin-A = 11%, GSout-AA = 74%), but herbivory must not be having a significant impact on the area. This is also interesting, since the area is quite flat; only about 7% slope. However, the area of the Grindstone exclosures is quite small in relation to the surrounding flat, which was also burned in the 1996 fire. As mentioned by (Campbell & Bartos 2001), if treatments are large, herbivory may be effectively distributed across the treated landscape.

Rigger Park

The only post-fire salvage treatment was found in the Rigger Park area. For the most part, the area is bowl shaped and gently slopes (10-26%) towards the bowl. The salvaged sites had statistically fewer stems than the unharvested, sloped site. Additionally, salvaging overall had statistical impact on stem height to the detriment of the salvaged units. Thus, salvaging areas that have regenerating aspen following a fire appears to adversely impact the young aspen stems. How salvaging impacts the long-term health and possible restoration of aspen to these sites still needs to be studied. But many of the stems found in the salvaged units had oozing, diseased wounds, which cannot bode well for those infected stems.

Patterns and Management Issues

Overall, restoring aspen to the landscape on Monroe Mountain appears to be the most challenging subsection of the three studied. Aspen restoration treatments on the Fishlake Plateau and Tushar Mountain Ecological Subsections appear to be regenerating without much impact from herbivory, as was seen by the lack of significance noted on the number of stems produced in combination with the significance noted on the stem height of regenerating aspen. By comparison, Monroe Mountain treatments are receiving enough herbivory impact to not just inhibit stem height, but to also reduce the number of stems produced following treatments.

This study also determined that clearcut treatments appear to mimic the effects of moderate burn intensity. It is disturbing, however, that efforts to restore aspen on Monroe Mountain are having limited to unacceptable success, since only the Burnt Flat units appear to be successful. Without knowing the movement patterns of elk, deer and cattle on and near this area, one cannot accurately determine what is happening here; whether the physical characteristics are unsatisfactory, the area is relatively isolated, the clones are unpalatable, or some other reason that reduces the density of animals on that part of the mountain.

Jones & DeByle (1985a) observed that "moderate intensity fire that kills most or all the overstory will stimulate very adequate suckering and will have the least effect on subsequent sucker growth. From 12,100 to 60,700 suckers per acre were produced after burning several sites in western Wyoming (Bartos 1979), certainly enough to adequately regenerate aspen to those sites." The Briggs Hollow, Farnsworth, Burnt Flat, Dry Creek fenced unit, Oldroyd Fire moderate and moderate-high burn intensities, Grindstone Flat, and all but one Rigger Park unit produced between 10,000 and 90,000 stems per acre. The sites that didn't were either experiencing setbacks from herbivory pressure or mechanical damage from salvaging operations. Clearly, the most extreme cases of unsuccessful aspen restoration were found at White Ledge, Dry Creek near the water source, and the Oldroyd Private Property aspen harvest, which were all due to over-utilization.

White (2001) pointed out that, "Disturbance reduces tree cover, the more open cover conditions favour increased elk use, and elk browse off all young aspen suckers before reaching sapling size (2-4 m tall)." White et. al. (1998) used <1 elk per square kilometer (Km^2) as a low elk density, but then revised that in 2001 (White 2001) to <2 elk / Km^2. In either case, elk density within Utah DWR's Monroe Mountain Wildlife Management Unit (WMU), which completely encompasses the Fishlake NF boundary of Monroe Mountain, is considered low (1800 elk / 443,629 acres (1795.27 Km^2) = 1.00 elk / Km^2). Moderate elk density would be 2 to 4 elk / Km^2, and high elk density would be >4 elk / Km^2 (White 2001). In White's study, cattle grazing was not a factor, since his work was limited to Canadian and United States National Parks found in the Rocky Mountains, which have not permitted cattle grazing since the parks were established. In 1999 through 2001, the Fishlake NF grazed 906 to 1046 cattle within three of the twelve grazing allotments on Monroe Mountain. In 1996, Mrowka & Campbell reported that 3500 domestic cattle and 5000 sheep grazed the mountain. According to DeByle (1985), "Cattle and elk compete because they both graze and both prefer grasses when succulent forbs are not available. The summer ranges of cattle and elk overlap, although the elk commonly retreat to steeper, higher, and more inaccessible areas." DeByle (1985) goes on to say that generally, this is a problem on winter ranges when cattle are grazed in the summer where elk will congregate in the winter.

The Fishlake NF is unique however, because cattle, elk and deer all utilize the same summer range on Monroe Mountain with winter ranges being used only by wildlife. Monroe Mountain's top is relatively flat (Davis 1998) and weather conditions observed were quite mild during the summer, which makes cattle grazing possible at elevations above 9000 feet. This is also true of the Tushar Mountains and Fishlake Plateau Ecological Subsections. Davis (1998) also states that, "winter range is still considered the limiting factor for the unit's elk and deer herds", and as a result Utah DWR only monitors range trends on the winter ranges. However, without having range trend data for the summer range, which lies fully within Forest Service boundaries, no assessment can be made as to the validity of this statement. This is important, because, if cattle are utilizing the same amount of forage as the elk, then their density on the mountain could be comparable, and the number of animals on the mountain would fall into the moderate or high density range, even without figuring in the approximately 7500 deer that are utilizing the same summer range. Further, Monroe Mountain's elk population is managed by the Utah DWR as a trophy bull elk unit. According to DeBloois (2001b), Utah DWR's Beaver (Pole Creek Fire) and Plateau (Briggs Hollow) WMUs are larger (4656.23 Km2, 8534.22 Km^2 respectively), but their wildlife management objectives set elk densities much lower (0.2 elk / Km^2, and 0.003 elk / Km^2 respectively) than Monroe Mountain's 1.00 elk / Km^2. Similarly, Monroe Mountain's deer density (4.18 deer / Km^2) is much higher that either the Beaver (2.36 deer / Km^2) or Plateau (2.93 deer / Km^2) WMUs.

Other researchers have found that elk or deer alone can effectively prevent aspen regeneration in untreated areas as well as following prescribed fires (Krebill 1972, DeByle 1985, White et. al. 1998, White 2001). So it is safe to assume that a combination of low cattle, elk, and deer densities may produce enough cumulative herbivory to effectively undermine aspen restoration efforts. Thus, aspen restoration efforts on Monroe Mountain may be doomed to failure, if relief from herbivory cannot be guaranteed. As can be seen by comparing the Oldroyd Private Property aspen harvest (wildlife only), and the unfenced White Ledge unit (cattle and wildlife), wildlife herbivory on Monroe Mountain, may be enough to keep aspen suckers cropped to the ground, thereby starving the underlying root system of nutrients derived from photosynthesis, which would ultimately kill the clone itself. Unfortunately, no studies could be found that studied the combinations of cattle, deer and elk densities that would be low enough to regenerate aspen without relief from herbivory.

White (2001) studied the functional response of elk herbivory to aspen sapling (2 - 4 m tall) density, and determined that elk density in the Canadian Rockies was probably kept low through predation by wolves (*Canis lupis*), mountain lions (*Felis concolor*), bears (*Ursus sp.*)), and native peoples. Further, he found that, "Increasing elk herbivory results in a relatively rapid transition from a regenerating aspen state to a declining state, where few stems survive beyond the sapling age class. In this state, high herbivory levels combined with disturbances such as fire will not create increased densities of young aspen, and may even kill long-lived aspen clones (Kay and Wagner 1996, White et. al. 1998a)." Monroe Mountain has few bears or mountain lions, and no wolves. According to the Fishlake NF (2000a), Monroe Mountain received limited use by prehistoric people. As a result, one would hypothesize that if native elk did occur on

Monroe Mountain prior to European settlement, then elk densities were probably kept low, by higher densities of predators than there are now.

Presently, Utah DWR administers annual limited entry bull elk, general buck deer and general antlerless (does or yearling deer) deer hunts on Monroe Mountain. Elk populations have increased from about 600 in 1992 to about 1800 in 2001. Over that time, an average of 20 bull elk per year have been harvested from an average of 23 permits. Antlerless (cow elk or yearling elk) elk hunts are not held annually, but when held are considered control hunts. In 2000, Utah DWR sold 200 of these control hunt permits, with 157 antlerless animals being harvested, and in 2001 DWR sold another 200 control permits, but data regarding the harvest are not yet available. Prior to the 2000 and 2001 control hunts, antlerless elk hunts were held in 1993 yielding 23, in 1994 yielding 15, and in 1996 when 50 were removed. It remains to be studied, whether removing 157 to 357 antlerless elk over two years will bring elk numbers down low enough to permit aspen regeneration on treated areas without providing relief from herbivory; however it is doubtful that harvesting 16 to 27 bull elk will have much, if any effect on elk densities or herbivory impacts.

Recommendations

Jones and Schier (1985) reported that it generally takes between two and five years for aspen stems to reach breast height (4.5 feet (1.37 m)), but dieback, browsing or competition from shrubs or herbs can mean that stems take more than five years to reach breast height. Shepperd & Fairweather (1994) determined that even though aspen stems are taller than 1.37 meters (4.5 feet) and have breast height diameters > 2.5 cm (1 inch), these stems still received enough elk damage to impact their health and vigor following removal of fencing after an area was treated five years before. They go on to recommend that stems may require ten to fifteen years of fencing to protect them from elk breaking stems while foliage browsing. Rolf (2001) and Kay (2001) also reported on the effectiveness of protectively fencing treatments from wildlife pressure.

Realizing that the Forest Service must work to manage the health of the ecosystems found within their administrative boundaries, the only management tools that are available to them are to remove cattle from affected grazing allotments for between five and ten years (the time required for aspen to mature past the sapling stage), fence treated areas with exclude-everything or cattle excluding fences, or utilize a combination of the fencing and allotment manipulations. It may also be useful to locate treatment areas away from readily available water, where cattle prefer to congregate. Negative conditioning techniques may be also be useful, such as percussion charges to frighten animals away from treatment areas.

Future Monroe Mountain aspen restoration treatments should at least be fenced with 8-foot exclosures for at least ten years. Determining elk and deer movement patterns could be useful in predicting which areas may only need cattle exclosures, since Burnt Flat is the only site that produced enough aspen stems to potentially restore the ecosystem to properly functioning condition.

Following wildfires, it would be impossible to completely fence out wildlife, not to mention the cost involved in erecting miles of permanent tall-fencing. Keeping cattle out for as long as it takes for stems to reach size class 4 (d.b.h. > 2.5 cm (1.0")) would be the minimum. Fencing areas known to be wildlife corridors may also be necessary. Additionally, areas where elk act as disease vectors (Sheppard & Fairweather 1994, Hart & Hart 2001) may also need to be fenced, since disease can dramatically affect the vigor of regenerating aspen stems.

In contrast, Utah DWR's primary focus lies not with ecosystem health, but with managing the state's wildlife populations for its citizens. This means that they alone determine how many animals are too many, and they can set management objective populations without regard for ecosystem health. However, hunting and other recreation on the Forest are very important to the local economy through revenue generated from these activities by visitors. According to Rolf (2001), "The expense and visual impact of establishing and maintaining over 20 miles of fence along with continued damage to aspen greater than 3.0 inches d.b.h. outside the fenced areas have resulted in the Arizona Game and Fish Department increasing the elk hunting permits by 400%, in an effort to reduce the elk herd in the area of the San Francisco Peaks." Similarly, certain alternatives may not be acceptable to all stakeholders, so different strategies would need to be negotiated. It is also important to note that Utah DWR’s funding comes primarily from the sale of hunting and fishing licences, and this funding source must be maximized.

Another alternative for managing the wildlife on Monroe Mountain would be to reintroduce predators, such as wolves. However, this option may not be an acceptable one for political reasons. When the U.S. Fish and Wildlife Service attempted to reintroduce the Mexican gray wolf (*Canis lupus baileyi*) onto the Gila National Forest in eastern Arizona, local residents eventually managed to kill enough of the released wolves to force the U.S. Fish and Wildlife Service to retrieve the remaining survivors and move them across the border into a more isolated area of the Forest, in New Mexico (personal recollection).

Originally, one of the stated goals of the Monroe Mountain Common Ground Initiative (see Appendix D), was to "improve management of livestock and wildlife on all lands, regardless of ownership". Unfortunately, my study shows that the cooperative was anything but. Utah DWR managed the wildlife to increase elk herds to unprecedented levels, even though complaints were expressed regarding the condition of summer and winter ranges. Another of the expressed goals of the Initiative was to manage the existing breeding elk herd to 1000 - 1200 mature animals. As of 2001, Monroe Mountain's elk herd had exceeded that number by as many as 600 animals, and the deer population has increased from 5000 in 1993 to 7500 in 2001. Utah DWR should re-think its commitment to maintaining a large trophy elk herd in combination with a large deer population on Monroe Mountain. At the very least Utah DWR should reduce its deer populations to those found in the nearby Beaver and Plateau WMUs (< 0.2 deer / Km^2), because this study shows that the summer range, previously thought to be adequate, may not be able to support the densities of deer, elk and cattle currently present without changing the existing habitats and losing potentially ancient aspen clones.

Presently, the two goals of maintaining wildlife densities noted and aspen ecosystem restoration may not be compatible, since more elk need more forage, and aspen regeneration projects offer that forage to the detriment of the restoration treatments. The Initiative had hoped to "contribute to an economically viable livestock grazing program". Additionally, the Forest Service must abide by the Multiple-Use, Sustained-Yield Act, which states that lands "shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes". Thus, removing cattle from the mountain may not be a legally viable alternative, and was counter to the Initiatives stated goal. However, a more liberal interpretation of the mandate would allow short-term cattle removal or manipulation of allotments, which would still allow for managing the Forest for long-term sustainability, thereby balancing multiple interests.

I still believe that cooperatively managing ecosystems on Forest Service land is possible, but stated goals can only be reached if the steps towards reaching those goals are clearly defined and measurable. In the case of reversing processes that took 100 years to create, time scales must be realistic and included in the planning process. The Monroe Mountain Initiative failed to reach many of its goals, because its objectives were actually subsets of goals with no clear pathways or sets of steps needed to reach those goals or objectives. Forest Service and Utah DWR personnel needed to work more closely to monitor and feedback information that would be useful to the other, so that adjustments could have been made when and where needed. The cooperative concept will only work if all involved parties are willing to respect all needs and viewpoints, put forward the effort needed, and to plan the processes needed to attain those goals, but more importantly to trust one another. Only when the parties trust each other can the other three be achieved.

As a final closing note, this study sampled a large number of treatment types and locations, which made analysis challenging. However, the treatment areas sampled were ones that the Forest had completed prior to my arrival, so study design was outside of my control. That said, I would have preferred to control some of the many variables. For example, I would have liked to conduct a single study of same-aged burned areas in which thirty, 1-acre or larger side-by-side wildlife and cattle exclosures that had been erected within a month after the fire.

This type of study would have produced more easily interpreted data sets that could be used for long-term monitoring purposes. Additionally, during my literature review, I found many references to elk's impact on aspen suckers, saplings and trees, but only one reference to deer's impact and no studies of strictly cattle impacts. These are issues that if studied, could be useful to both wildlife and land managers.

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Appendix A - Ramet Tally Form

This was the data sheet used to tally the number of aspen stems (ramets) found in each mil-acre plot. This form was created using Microsoft Word XP document. This form was created generally following Wayne Sheppard's example (of the Rocky Mountain Research Station, Fort Collins, Colorado), but I made various modifications and clarifications to make data collection easier for the YCC crew that helped me and myself.

Blank Data Sheet

SuckerForm.doc

Aspen Regeneration Studies: Ramet Tally Form

Date

Site Name		Plot Size & Plot Radius 0.001 acre / 113.5 cm	Page of
Site ID #	GPS Location		Elevation
% Slope	Aspect	For each sucker tallied, code the damage (if any) most likely to affect the future vigor of the tree. For example, if a sucker has an uninfected stem wound and the terminal leader is browsed, code it as browsed. If the wound is infected, code the stem wound instead.	
Recorder & Group Members:		Notes:	

Plot Number	Size Class	Damage Code	Stems per plot	Height (cm)	Age (years)	Leader Growth (cm)	Plot Notes

Damage Codes		Definitions	Size Classes
0 = No Damage	6 = Stem Wound	Height = tallest in that size class	Measure to the top most bud
1 = Browsing	7 = Dead Leader	Leader = main stem (the year's growth)	1 = 0 - 46 cm (0 – 1.5 ft)
2 = Branches Stripped	8 = Mortality	d.b.h. = diameter at breast height	2 = 46 - 137 cm (1.5 – 4.5 ft)
3 = Basal Stem wound	9 = Insects	(4.5 ft up on the uphill side of the tree)	3 = >137 cm - 2.5 cm d.b.h.
4 = Frost	10 = Snow Break		4 = >2.5 cm (>1.0") d.b.h.
5 = Disease	11 = Rodents	5 ft = 152.4 cm	9 = End of plot

Notes: describe % bare soil per plot; presences of animals, animal scat, conifers or sage and their size; # of understory forb species; aspen suckers found mostly in natural exclosures like sagebrush; soil has low or high amount of organic matter…

Appendix B - Damage Codes

Suckers were tallied based on the damage (if any) that was most likely to affect the future vigor of the tree. For example, if a sucker has an uninfected stem wound (damage 6) and the terminal leader is browsed (damage 1), then code the stem as browsed (damage 1). If the wound is infected, code the stem wound instead (damage 6).

Damage Code 0 - No Damage

This would be a healthy, undamaged stem, which was just emerging in early summer (June 2001) following the Oldroyd Fire that burned the area in July and August 2000.

Damage Code 1 - Browsing

Stems lack a terminal bud and end bluntly. Notice also that the bark is frayed at the wound.

Damage Code 2 - Branches Stripped

Notice that all of the leaves are missing and that there aren't any leaves on the ground. If this had been fall, there would have been many yellow, gold or reddish leaves on the ground. The ruler in the picture shows that most of the stems were nearly 3 feet tall.

Damage Code 3 - Basal Stem Wound, and Damage Code 6 - Stem Wound

This stem wound was actually a damage code 6 stem wound, damage code 6. Notice that this wound has scarred over to nearly cover the place where the damage occurred. Basal stem wounds usually occur as a result of animals stepping on the stem and scraping the stem's thin bark.

Damage Code 4 - Frost

Notice how most of the leaves are brown, but the stem is predominately green. This frost damage was due to an unseasonable snowstorm that occurred in early July 2001.

Damage Code 5 - Disease

The orange-ish colored region along the stem is disease. If you look on the tip of the little-finger, you can see a dot of orange, which wiped of as I was trying to handle the stem. Although it is difficult to see, the wound was actively weeping the orange-ish discharge.

Damage Code 7 - Dead Leader

Notice that the top ends, or leaders, of these stems are brown. All of the dead leaders also showed browsing signs on their tips. This photo was taken in late October 2001 in the middle of the Oldroyd Fire scar. These stems had regenerated from the dead aspens' root system, which is why they are called suckers.

Damage Code 8 - Mortality

This stem was dead when I found it. Most stems coded "8" are found standing and usually lack leaves. This one probably died from the July 2001 snowstorm that blanketed Monroe Mountain and much of the rest of the Fishlake National Forest.

Damage Code 9 - Insects

Notice that some of the leaves have holes in them. There were lots of grasshoppers jumping and flying around this site, so the damage was probably due to them.

Damage Codes 10 - Snow Break, and 11 - Rodents

I didn't see either of these two damage types. Presumably, snow break would break the main stem, or leader, of the aspen. Rodent damage would probably be partially identifiable by a nearby animal hole, or lifted up/disturbed soil under the stem.

Photo Credits:

Damage0.jpg, damage1.jpg, damage3.jpg, damage4.jpg, damage8.jpg, and damage9.jpg, were taken by the author. Damage2.jpg was taken by Ronald Sanden, Silviculturist, Fishlake National Forest. Damage5.jpg and damage7.jpg were taken by Robert B. Campbell, Forest Ecologist, Fishlake National Forest.

Appendix C - Statistical Summaries

All statistical tests were computed with Systat 7.0 for Windows. Significance was arbitrarily set at 95% confidence intervals or $P = 0.05$.

Fishlake Plateau Subsection

Briggs Hollow

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group       N     Mean      SD
BH1win-F   20   37.5000   20.2991
BH1wout-G  20   31.0000   23.1699

Separate Variance t = 0.9437, df = 37.4, Prob = 0.3514
Difference in Means = 6.5000, 95.00% CI = -7.4520 to 20.4520
Pooled Variance t = 0.9437, df = 38, Prob = 0.3513
Difference in Means = 6.5000, 95.00% CI = -7.4441 to 20.4441


Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group        N     Mean      SD
BH2cin-O    20   33.9000   19.1995
BH2cout-AC  15   42.6000   24.0737

Separate Variance t = -1.1517, df = 26.2, Prob = 0.2599
Difference in Means = -8.7000, 95.00% CI = -24.2235 to 6.8235
Pooled Variance t = -1.1900, df = 33, Prob = 0.2425
Difference in Means = -8.7000, 95.00% CI = -23.5736 to 6.1736


Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group       N     Mean    SD
BH3win-L   20  21.3500   9.9381
BH3wout-H  15  26.3333  12.8044

Separate Variance t = -1.2510, df = 25.7, Prob = 0.2222
Difference in Means = -4.9833, 95.00% CI = -13.1770 to 3.2104
Pooled Variance t = -1.2976, df = 33, Prob = 0.2034
Difference in Means = -4.9833, 95.00% CI = -12.7968 to 2.8301


Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group       N     Mean      SD
BH5cin-N   20   26.5500   15.0245
BH5cout-M  20   36.8500   27.0424

Separate Variance t = -1.4890, df = 29.7, Prob = 0.1470
Difference in Means = -10.3000, 95.00% CI = -24.4331 to 3.8331
Pooled Variance t = -1.4890, df = 38, Prob = 0.1447
Difference in Means = -10.3000, 95.00% CI = -24.3037 to 3.7037
```

```
Two-sample t test on LIVESTEMSPP grouped by TREATMENT$
Group          N     Mean      SD
outside excl  35   29.0000   19.3132
wildlf exclo  40   29.4250   17.7690

Separate Variance t = -0.0987 df = 69.7 Prob = 0.9217
Difference in Means = -0.4250 95.00% CI = -9.0158 to 8.1658
Pooled Variance t = -0.0992 df = 73 Prob = 0.9212
Difference in Means = -0.4250 95.00% CI = -8.9608 to 8.1108


Two-sample t test on LIVESTEMSPP grouped by TREATMENT$
Group          N     Mean      SD
cow exclosur  40   30.2250   17.4187
outside       35   39.3143   25.6053

Separate Variance t = -1.7718 df = 58.7 Prob = 0.0816
Difference in Means = -9.0893 95.00% CI = -19.3556 to 1.1770
Pooled Variance t = -1.8163 df = 73 Prob = 0.0734
Difference in Means = -9.0893 95.00% CI = -19.0627 to 0.8842


Two-sample t test on HEIGHTCM grouped by SITEID$
Group       N     Mean      SD
BH1win-F   20   90.5000   33.7288
BH1wout-G  20   60.1500   29.4963

Separate Variance t = 3.0292, df = 37.3, Prob = 0.0044
Difference in Means = 30.3500, 95.00% CI = 10.0555 to 50.6445
Pooled Variance t = 3.0292, df = 38, Prob = 0.0044
Difference in Means = 30.3500, 95.00% CI = 10.0673 to 50.6327


Two-sample t test on HEIGHTCM grouped by SITEID$
Group        N     Mean      SD
BH2cin-O    20   61.3500   16.3265
BH2cout-AC  15   77.3333   21.2558

Separate Variance t = -2.4248, df = 25.5, Prob = 0.0227
Difference in Means = -15.9833, 95.00% CI = -29.5465 to -2.4202
Pooled Variance t = -2.5188, df = 33, Prob = 0.0168
Difference in Means = -15.9833, 95.00% CI = -28.8937 to -3.0730


Two-sample t test on HEIGHTCM grouped by SITEID$
Group       N     Mean      SD
BH3win-L   20   61.3500   15.6853
BH3wout-H  15   46.4000   12.2870

Separate Variance t = 3.1611, df = 32.9, Prob = 0.0034
Difference in Means = 14.9500, 95.00% CI = 5.3272 to 24.5728
Pooled Variance t = 3.0518, df = 33, Prob = 0.0045
Difference in Means = 14.9500, 95.00% CI = 4.9833 to 24.9167
```

```
Two-sample t test on HEIGHTCM grouped by SITEID$
Group       N     Mean      SD
BH5cin-N   20   59.3500   21.5218
BH5cout-M  20   34.7500    9.9730

Separate Variance t = 4.6380, df = 26.8, Prob = 0.0001
Difference in Means = 24.6000, 95.00% CI = 13.7133 to 35.4867
Pooled Variance t = 4.6380, df = 38, Prob = 0.0000
Difference in Means = 24.6000, 95.00% CI = 13.8626 to 35.3374
```

```
Two-sample t test on HEIGHTCM grouped by TREATMENT$
Group           N     Mean      SD
outside excl   35   54.2571   24.4135
wildlf exclo   40   75.9250   29.8658

Separate Variance t = -3.4551, df = 72.7, Prob = 0.0009
Difference in Means = -21.6679, 95.00% CI = -34.1673 to -9.1684
Pooled Variance t = -3.4090, df = 73, Prob = 0.0011
Difference in Means = -21.6679, 95.00% CI = -34.3355 to -9.0002
```

```
Two-sample t test on HEIGHTCM grouped by TREATMENT$
Group          N     Mean      SD
cow exclosur  40   60.4500   18.8203
outside       35   53.0000   26.4342

Separate Variance t = 1.3877, df = 60.5, Prob = 0.1703
Difference in Means = 7.4500, 95.00% CI = -3.2867 to 18.1867
Pooled Variance t = 1.4188 df = 73, Prob = 0.1602
Difference in Means = 7.4500, 95.00% CI = -3.0151 to 17.9151
```

Farnsworth

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group       N     Mean     SD
F16ufd-E   21   13.4762   7.6917
F3cin-D    20   11.3500   7.9952

Separate Variance t = 0.8670, df = 38.7, Prob = 0.3913
Difference in Means = 2.1262, 95.00% CI = -2.8352 to 7.0875
Pooled Variance t = 0.8679, df = 39, Prob = 0.3908
Difference in Means = 2.1262, 95.00% CI = -2.8291 to 7.0815
```

```
Two-sample t test on HEIGHTCM grouped by SITEID$
Group       N     Mean       SD
F16ufd-E   20  147.2900   144.4306
F3cin-D    18   21.7111    51.9599

Separate Variance t = 3.6358, df = 24.3, Prob = 0.0013
Difference in Means = 125.5789, 95.00% CI = 54.3381 to 196.8197
Pooled Variance t = 3.4874, df = 36, Prob = 0.0013
Difference in Means = 125.5789, 95.00% CI = 52.5480 to 198.6098
```

Monroe Mountain Subsection

Burnt Flat

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group        N     Mean      SD
BF2win-Q     9   92.1111   32.7698
BF2wout-P   20   23.9500   22.8507

Separate Variance t = 5.6522, df = 11.6, Prob = 0.0001
Difference in Means = 68.1611, 95.00% CI = 41.7982 to 94.5240
Pooled Variance t = 6.4853, df = 27, Prob = 0.0000
Difference in Means = 68.1611, 95.00% CI = 46.5962 to 89.7260


Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group        N     Mean      SD
BF2win-Q     9   92.1111   32.7698
BFS16ufd-C  20   40.2000   29.7226

Separate Variance t = 4.0599, df = 14.2, Prob = 0.0011
Difference in Means = 51.9111, 95.00% CI = 24.5234 to 79.2988
Pooled Variance t = 4.2186, df = 27, Prob = 0.0002
Difference in Means = 51.9111, 95.00% CI = 26.6627 to 77.1596


Two-sample t test on LIVESTEMSPP grouped by TREATMENT$
Group         N     Mean    SD
unfenced     40  32.0750  27.4314
wildlf exclo  9  92.1111  32.7698

Separate Variance t = -5.1082, df = 10.7, Prob = 0.0004
Difference in Means = -60.0361, 95.00% CI = -86.0028 to -34.0694
Pooled Variance t = -5.7277, df = 47, Prob = 0.0000
Difference in Means = -60.0361, 95.00% CI = -81.1226 to -38.9496


Two-sample t test on HEIGHTCM grouped by SITEID$
Group        N     Mean       SD
BF2win-Q     9   186.3333   23.5478
BF2wout-P   20   140.5000   40.9692

Separate Variance t = 3.7993, df = 25.1, Prob = 0.0008
Difference in Means = 45.8333, 95.00% CI = 20.9905 to 70.6761
Pooled Variance t = 3.1130, df = 27, Prob = 0.0043
Difference in Means = 45.8333, 95.00% CI = 15.6243 to 76.0424


Two-sample t test on HEIGHTCM grouped by SITEID$
Group        N     Mean       SD
BF2win-Q     9   186.3333   23.5478
BFS16ufd-C  18   142.1111   38.4477

Separate Variance t = 3.6886, df = 23.7, Prob = 0.0012
Difference in Means = 44.2222, 95.00% CI = 19.4625 to 68.9820
Pooled Variance t = 3.1499, df = 25, Prob = 0.0042
Difference in Means = 44.2222, 95.00% CI = 15.3075 to 73.1369
```

```
Two-sample t test on HEIGHTCM grouped by TREATMENT$
Group         N     Mean     SD
unfenced     38  141.2632  39.2653
wildlf exclo  9  186.3333  23.5478

Separate Variance t = -4.4586, df = 20.1, Prob = 0.0002
Difference in Means = -45.0702, 95.00% CI = -66.1483 to -23.9920
Pooled Variance t = -3.2892, df = 45, Prob = 0.0020
Difference in Means = -45.0702, 95.00% CI = -72.6685 to -17.4718
```

Dry Creek

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group       N    Mean      SD
DC1ufd-X   20   7.7000   12.9538
DC2cin-Y   10  62.1000   26.9174

Separate Variance t = -6.0503, df = 11.1, Prob = 0.0001
Difference in Means = -54.4000, 95.00% CI = -74.1608 to -34.6392
Pooled Variance t = -7.5430, df = 28, Prob = 0.0000
Difference in Means = -54.4000, 95.00% CI = -69.1731 to -39.6269
```

```
Two-sample t test on HEIGHTCM grouped by SITEID$
Group       N    Mean      SD
DC1ufd-X   14  26.5000   11.9341
DC2cin-Y   10  74.2000   15.9011

Separate Variance t = -8.0106, df = 15.9, Prob = 0.0000
Difference in Means = -47.7000, 95.00% CI = -60.3287 to -35.0713
Pooled Variance t = -8.4113, df = 22, Prob = 0.0000
Difference in Means = -47.7000, 95.00% CI = -59.4607 to -35.9393
```

White Ledge

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group       N   Mean     SD
WL16ufd-V  20   0.0       .
WL2cin-W   15   3.4667  8.7901
Insufficient data for test.
```

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group      N    Mean      SD
WL16ufd-V 20    0.0        .
WL2cin-W   4   35.0000  12.8323
Insufficient data for test.
```

Oldroyd Private Property

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group       N    Mean     SD
OPPah-AG   20   0.3500   0.9881
OPPufd-U   20   3.6000   6.1934

Separate Variance t = -2.3175, df = 20.0, Prob = 0.0312
Difference in Means = -3.2500, 95.00% CI = -6.1757 to -0.3243
Pooled Variance t = -2.3175, df = 38, Prob = 0.0260
Difference in Means = -3.2500, 95.00% CI = -6.0890 to -0.4110


Two-sample t test on HEIGHTCM grouped by SITEID$
Group       N     Mean      SD
OPPah-AG    3   12.6667   17.6163
OPPufd-U   10   27.6000   20.8870

Separate Variance t = -1.2314, df = 3.9, Prob = 0.2874
Difference in Means = -14.9333, 95.00% CI = -48.9866 to 19.1199
Pooled Variance t = -1.1158, df = 11, Prob = 0.2883
Difference in Means = -14.9333, 95.00% CI = -44.3909 to 14.5243
```

Oldroyd Fire

ANOVA comparing burn intensity (TREATMENT$) and number of live stems per plot (LIVESTEMSPP)

```
Effects coding used for categorical variables in model.
Categorical values encountered during processing are:
TREATMENT$ (4 levels) low, low-moderate, moderat-high, moderate
2 case(s) deleted due to missing data.

Dep Var: LIVESTEMSPP, N: 111, Multiple R: 0.2621, Squared multiple R: 0.0687

                            Analysis of Variance

Source     Sum-of-Squares   df   Mean-Square   F-ratio   P
TREATMENT$    11313.6100     3   3771.2033     2.6305   0.0538
Error        153401.7594   107   1433.6613

*** WARNING ***
Case 32 is an outlier (Studentized Residual = 6.5761)
Case 59 is an outlier (Studentized Residual = 7.3238)

Durbin-Watson D Statistic 1.896
First Order Autocorrelation 0.052
----------------------------------------------------------------
COL/
ROW TREATMENT$
1 low
2 low-moderate
3 moderat-high
4 moderate
Using least squares means.
Post Hoc test of LIVESTEMSPP
----------------------------------------------------------------
```

```
Using model MSE of 1433.661 with 107 df.
Matrix of pairwise mean differences:

      1         2        3        4
1    0.0
2    1.6508    0.0
3   17.1389   15.4881   0.0
4   26.6450   24.9942   9.5061   0.0

Tukey HSD Multiple Comparisons.
Matrix of pairwise comparison probabilities:

     1        2        3        4
1   1.0000
2   0.9995   1.0000
3   0.6112   0.4304   1.0000
4   0.2293   0.0723   0.6721   1.0000
================================================================

ANOVA comparing burn intensity (TREATMENT$) and height of the dominant stem
per plot (HEIGHTCM)

Effects coding used for categorical variables in model.

Categorical values encountered during processing are:
TREATMENT$ (4 levels) low, low-moderate, moderat-high, moderate
40 case(s) deleted due to missing data.

Dep Var: HEIGHTCM, N: 73, Multiple R: 0.6406, Squared multiple R: 0.4104

                            Analysis of Variance

Source     Sum-of-Squares   df   Mean-Square   F-ratio    P
TREATMENT$    9078.1880      3    3026.0627    16.0107   0.0000
Error        13041.1818     69     189.0026
----------------------------------------------------------------

*** WARNING ***
Case 68 is an outlier (Studentized Residual = 3.4362)

Durbin-Watson D Statistic 1.487
First Order Autocorrelation 0.257
COL/
ROW TREATMENT$
1 low
2 low-moderate
3 moderat-high
4 moderate
Using least squares means.
Post Hoc test of HEIGHTCM
----------------------------------------------------------------
```

```
Using model MSE of 189.003 with 69 df.
Matrix of pairwise mean differences:

      1         2        3        4
1    0.0
2  -27.7273    0.0
3    3.1667   30.8939   0.0
4    4.0000   31.7273   0.8333   0.0

Tukey HSD Multiple Comparisons.
Matrix of pairwise comparison probabilities:

     1        2        3        4
1   1.0000
2   0.0511   1.0000
3   0.9889   0.0000   1.0000
4   0.9789   0.0000   0.9957   1.0000
================================================================

Two-sample t test on LIVESTEMSPP grouped by TREATMENT$
Group           N    Mean     SD
low             9   1.1111   1.2693
low-moderate   21   2.7619   4.5487

Separate Variance t = -1.5299, df = 25.8, Prob = 0.1382
Difference in Means = -1.6508, 95.00% CI = -3.8696 to 0.5680
Pooled Variance t = -1.0614, df = 28, Prob = 0.2976
Difference in Means = -1.6508, 95.00% CI = -4.8367 to 1.5351


Two-sample t test on HEIGHTCM grouped by TREATMENT$
Group           N    Mean     SD
low             2  35.0000   1.4142
low-moderate   11   7.2727   4.1735

Separate Variance t = 17.2506, df = 5.3, Prob = 0.0000
Difference in Means = 27.7273, 95.00% CI = 23.6726 to 31.7819
Pooled Variance t = 9.0129, df = 11, Prob = 0.0000
Difference in Means = 27.7273, 95.00% CI = 20.9561 to 34.4984


Two-sample t test on LIVESTEMSPP grouped by TREATMENT$
Group           N    Mean     SD
low-moderate   21   2.7619   4.5487
moderate       41  27.7561  56.3178

Separate Variance t = -2.8238, df = 41.0, Prob = 0.0073
Difference in Means = -24.9942, 95.00% CI = -42.8694 to -7.1190
Pooled Variance t = -2.0223, df = 60, Prob = 0.0476
Difference in Means = -24.9942, 95.00% CI = -49.7169 to -0.2715
```

```
Two-sample t test on HEIGHTCM grouped by TREATMENT$
Group            N    Mean     SD
low-moderate    11   7.2727   4.1735
moderate        24  39.0000  17.3180

Separate Variance t = -8.4554, df = 28.2, Prob = 0.0000
Difference in Means = -31.7273, 95.00% CI = -39.4116 to -24.0430
Pooled Variance t = -5.9522, df = 33, Prob = 0.0000
Difference in Means = -31.7273, 95.00% CI = -42.5719 to -20.8827
```

```
Two-sample t test on LIVESTEMSPP grouped by TREATMENT$
Group            N     Mean      SD
moderate        41   27.7561   56.3178
moderat-high    40   18.2500   25.8732

Separate Variance t = -0.9800, df = 56.5, Prob = 0.3313
Difference in Means = -9.5061, 95.00% CI = -28.9344 to 9.9222
Pooled Variance t = -0.9720, df = 79, Prob = 0.3340
Difference in Means = -9.5061, 95.00% CI = -28.9717 to 9.9595
```

```
Two-sample t test on HEIGHTCM grouped by TREATMENT$
Group            N     Mean      SD
moderate        24   39.0000   17.3180
moderat-high    36   38.1667   13.0570

Separate Variance t = -0.2007, df = 40.0, Prob = 0.8419
Difference in Means = -0.8333, 95.00% CI = -9.2234 to 7.5567
Pooled Variance t = -0.2123, df = 58, Prob = 0.8326
Difference in Means = -0.8333, 95.00% CI = -8.6895 to 7.0229
```

Of the areas sampled for regeneration, only the Briggs Hollow, Dry Creek and the Oldroyd Private Property aspen harvest were treated in the same year as the Oldroyd Fire. Of the clearcut areas on Monroe Mountain, only the cattle exclosure of Dry Creek was not so heavily browsed as that the regeneration was almost gone, but only 10 sample plots were surveyed. Also, the only sites clearcut in 2000 that had been fenced were the Briggs Hollow units. Even though Briggs Hollow is on the Fishlake Plateau Subsection, I pooled the fenced Briggs Hollow and Dry Creek sites to make the clearcut treatment sample set.

To assess the differences between clearcutting and the moderate and moderate-high burn intensities on the number suckers produced, I ran two-sample t-tests comparing the fenced clearcut units to the Oldroyd Fire moderate and then moderate-high burn intensity sites. I hypothesized that there shouldn't be any significant difference ($P > 0.05$) between clearcutting and moderate intensity burn sites, but that there should be ($P < 0.05$) with the moderate-high intensity burn sites.

```
Testing moderate-high intensity burn sites against all fenced sites (BH and
DC).
Two-sample t test on LIVESTEMSPP grouped by TREATMENT$
Group             N     Mean      SD
clearcut (all)   90   33.4111   21.1840
mod.-high burn   40   18.2500   25.8732

Separate Variance t =3.2530, df = 63.2, Prob = 0.0018
Difference in Means =15.1611, 95.00% CI = 5.8482 to 24.4740
Pooled Variance t =3.5123, df = 128, Prob = 0.0006
Difference in Means =15.1611, 95.00% CI = 6.6200 to 23.7023
```

```
Testing only moderate intensity burn sites against all fenced sites (BH and
DC).
Two-sample t test on LIVESTEMSPP grouped by TREATMENT$
Group            N     Mean      SD
clearcut (all)  90   33.4111   21.1840
moderate burn   41   27.7561   56.3178

Separate Variance t = 0.6232, df = 45.2, Prob = 0.5363
Difference in Means = 5.6550, 95.00% CI = -12.6191 to 23.9291
Pooled Variance t = 0.8346, df = 129, Prob = 0.4055
Difference in Means = 5.6550, 95.00% CI = -7.7503 to 19.0603
```

Tushar Mountains Subsection (Pole Creek Fire)

Grindstone Flat

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group      N     Mean      SD
GScin-A   10   11.5000   12.5985
GSwin-Z   10   12.9000   10.9082

Separate Variance t = -0.2657, df = 17.6, Prob = 0.7936
Difference in Means = -1.4000, 95.00% CI = -12.4878 to 9.6878
Pooled Variance t = -0.2657, df = 18, Prob = 0.7935
Difference in Means = -1.4000, 95.00% CI = -12.4715 to 9.6715
```

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group       N     Mean      SD
GSout-AA   10   10.0000    8.1786
GSwin-Z    10   12.9000   10.9082

Separate Variance t = -0.6726, df = 16.7, Prob = 0.5104
Difference in Means = -2.9000, 95.00% CI = -12.0091 to 6.2091
Pooled Variance t = -0.6726, df = 18, Prob = 0.5097
Difference in Means = -2.9000, 95.00% CI = -11.9578 to 6.1578


Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group       N     Mean      SD
GScin-A    10   11.5000   12.5985
GSout-AA   10   10.0000    8.1786

Separate Variance t = 0.3158, df = 15.4, Prob = 0.7564
Difference in Means = 1.5000, 95.00% CI = -8.5989 to 11.5989
Pooled Variance t = 0.3158, df = 18, Prob = 0.7558
Difference in Means = 1.5000, 95.00% CI = -8.4791 to 11.4791


Two-sample t test on HEIGHTCM grouped by SITEID$
Group     N     Mean       SD
GScin-A   9   153.8889   63.3057
GSwin-Z   9   148.1000   80.2439

Separate Variance t = 0.1699, df = 15.2, Prob = 0.8673
Difference in Means = 5.7889, 95.00% CI = -66.7549 to 78.3327
Pooled Variance t = 0.1699, df = 16, Prob = 0.8672
Difference in Means = 5.7889, 95.00% CI = -66.4356 to 78.0134


Two-sample t test on HEIGHTCM grouped by SITEID$
Group       N     Mean       SD
GSout-AA    9   132.2222   71.2158
GSwin-Z     9   148.1000   80.2439

Separate Variance t = -0.4440, df = 15.8, Prob = 0.6631
Difference in Means = -15.8778, 95.00% CI = -91.7785 to 60.0229
Pooled Variance t = -0.4440, df = 16, Prob = 0.6630
Difference in Means = -15.8778, 95.00% CI = -91.6914 to 59.9359


Two-sample t test on HEIGHTCM grouped by SITEID$
Group      N     Mean       SD
GScin-A    9   153.8889   63.3057
GSout-AA   9   132.2222   71.2158

Separate Variance t = 0.6822, df = 15.8, Prob = 0.5050
Difference in Means = 21.6667, 95.00% CI = -45.7406 to 89.0739
Pooled Variance t = 0.6822, df = 16, Prob = 0.5049
Difference in Means = 21.6667, 95.00% CI = -45.6653 to 88.9987
```

Rigger Park

```
Two-sample t test on LIVESTEMSPP grouped by TREATMENT$
(fire only = RPufd-B on slope; salvaged = RPH1ufd-AB & RPH2ufd-AF)
Group        N    Mean       SD
fire only  20   32.9500   11.3345
salvaged   25   20.8400   23.6778

Separate Variance t = 2.2546, df = 36.0, Prob = 0.0303
Difference in Means = 12.1100, 95.00% CI = 1.2167 to 23.0033
Pooled Variance t = 2.0995, df = 43, Prob = 0.0417
Difference in Means = 12.1100, 95.00% CI = 0.4775 to 23.7425
```

These two sites (RPH1ufd-AB, RPH2ufd-AF) were part of the same harvest unit (Rigger Park 1 Fire Salvage), but they had slightly different aspects. They had also received about the same amount of animal damage, but very different amounts of salvage/equipment caused damage (RPH1ufd-AB=22%; RPH2ufd-AF=40%).

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group         N     Mean      SD
RPH1ufd-AB  10   24.4000   21.8337
RPH2ufd-AF  15   18.4667   25.2894

Separate Variance t = 0.6244, df = 21.3, Prob = 0.5390
Difference in Means = 5.9333, 95.00% CI = -13.8108 to 25.6774
Pooled Variance t = 0.6057, df = 23, Prob = 0.5507
Difference in Means = 5.9333, 95.00% CI = -14.3323 to 26.1990
```

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group         N     Mean      SD
RPufd-B     20   32.9500   11.3345
RPH1ufd-AB  10   24.4000   21.8337

Separate Variance t = -1.1625, df = 11.5, Prob = 0.2686
Difference in Means = -8.5500, 95.00% CI = -24.6542 to 7.5542
Pooled Variance t = -1.4238, df = 28, Prob = 0.1656
Difference in Means = -8.5500, 95.00% CI = -20.8508 to 3.7508
```

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group         N     Mean      SD
RPufd-B     20   32.9500   11.3345
RPH2ufd-AF  15   18.4667   25.2894

Separate Variance t = -2.0678, df = 18.2, Prob = 0.0532
Difference in Means = -14.4833, 95.00% CI = -29.1855 to 0.2188
Pooled Variance t = -2.2819, df = 33, Prob = 0.0291
Difference in Means = -14.4833, 95.00% CI = -27.3964 to -1.5703
```

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group        N     Mean      SD
RPufd-B     20   32.9500   11.3345
RPH3ufd-AD  15    5.5333    7.5296

Separate Variance t = -8.5831, df = 32.6, Prob = 0.0000
Difference in Means = -27.4167, 95.00% CI = -33.9183 to -20.9150
Pooled Variance t = -8.1074, df = 33, Prob = 0.0000
Difference in Means = -27.4167, 95.00% CI = -34.2967 to -20.5366
```

```
Two-sample t test on LIVESTEMSPP grouped by SITEID$
Group         N     Mean      SD
RPufd-B      20   32.9500   11.3345
RPH4ufd-AE   10   39.0000   29.0708

Separate Variance t = 0.6344, df = 10.4, Prob = 0.5395
Difference in Means = 6.0500, 95.00% CI = -15.0894 to 27.1894
Pooled Variance t = 0.8247, df = 28, Prob = 0.4165
Difference in Means = 6.0500, 95.00% CI = -8.9780 to 21.0780
```

```
Two-sample t test on HEIGHTCM grouped by TREATMENT$
(fire only = RPufd-B on slope; salvaged = RPH1ufd-AB & RPH2ufd-AF)
Group       N     Mean       SD
fire only  20   218.6500   41.5404
salvaged   20   149.1000   40.7262

Separate Variance t = 5.3467, df = 38.0, Prob = 0.0000
Difference in Means = 69.5500, 95.00% CI = 43.2161 to 95.8839
Pooled Variance t = 5.3467, df = 38, Prob = 0.0000
Difference in Means = 69.5500, 95.00% CI = 43.2164 to 95.8836
```

These two sites (RPH1ufd-AB, RPH2ufd-AF) were part of the same harvest unit (Rigger Park 1 Fire Salvage), but they had slightly different aspects. They had also received about the same amount of animal damage, but very different amounts of salvage/equipment caused damage (RPH1ufd-AB=22%; RPH2ufd-AF=40%).

```
Two-sample t test on HEIGHTCM grouped by SITEID$
Group        N     Mean       SD
RPH1ufd-AB   8   174.1250   28.3369
RPH2ufd-AF  12   132.4167   39.9351

Separate Variance t = 2.7308, df = 17.9, Prob = 0.0138
Difference in Means = 41.7083, 95.00% CI = 9.6037 to 73.8129
Pooled Variance t = 2.5473, df = 18, Prob = 0.0202
Difference in Means = 41.7083, 95.00% CI = 7.3084 to 76.1083
```

```
Two-sample t test on HEIGHTCM grouped by SITEID$
Group        N     Mean       SD
RPufd-B     20   218.6500   41.5404
RPH1ufd-AB   8   174.1250   28.3369

Separate Variance t = -3.2590, df = 19.0, Prob = 0.0041
Difference in Means = -44.5250, 95.00% CI = -73.1174 to -15.9326
Pooled Variance t = -2.7693, df = 26, Prob = 0.0102
Difference in Means = -44.5250, 95.00% CI = -77.5744 to -11.4756
```

```
Two-sample t test on HEIGHTCM grouped by SITEID$
Group        N     Mean       SD
RPufd-B     20   218.6500   41.5404
RPH2ufd-AF  12   132.4167   39.9351

Separate Variance t = -5.8247, df = 24.1, Prob = 0.0000
Difference in Means = -86.2333, 95.00% CI = -116.7855 to -55.6812
Pooled Variance t = -5.7657, df = 30, Prob = 0.0000
Difference in Means = -86.2333, 95.00% CI = -116.7779 to -55.6888
```

```
Two-sample t test on HEIGHTCM grouped by SITEID$
Group        N     Mean       SD
RPufd-B     20   218.6500   41.5404
RPH3ufd-AD   7   126.7143   37.5886

Separate Variance t = -5.4162, df = 11.6, Prob = 0.0002
Difference in Means = -91.9357, 95.00% CI = -129.0765 to -54.7949
Pooled Variance t = -5.1529, df = 25, Prob = 0.0000
Difference in Means = -91.9357, 95.00% CI = -128.6811 to -55.1903
```

```
Two-sample t test on HEIGHTCM grouped by SITEID$
Group        N     Mean       SD
RPufd-B     20   218.6500   41.5404
RPH4ufd-AE   9   175.5556   58.5899

Separate Variance t = -1.9927, df = 11.8, Prob = 0.0700
Difference in Means = -43.0944, 95.00% CI = -90.3143 to 4.1254
Pooled Variance t = -2.2728, df = 27, Prob = 0.0312
Difference in Means = -43.0944, 95.00% CI = -81.9986 to -4.1902
```

In these last two t-tests, I pooled all the data from the salvaged sites and compared it against the sloped, unsalvaged Rigger Park (RPufd-B/ control) site.

```
Two-sample t test on LIVESTEMSPP grouped by TREATMENT$
Group       N     Mean      SD
fire only  20   32.9500   11.3345
salvaged   50   19.8800   24.1683

Separate Variance t = 3.0716, df = 66.1, Prob = 0.0031
Difference in Means = 13.0700, 95.00% CI = 4.5748 to 21.5652
Pooled Variance t = 2.3113, df = 68, Prob = 0.0239
Difference in Means = 13.0700, 95.00% CI = 1.7862 to 24.3538
```

```
Two-sample t test on HEIGHTCM grouped by TREATMENT$
Group       N     Mean       SD
fire only  20   218.6500   41.5404
salvaged   36   151.3611   46.9274

Separate Variance t = 5.5414, df = 43.6, Prob = 0.0000
Difference in Means = 67.2889, 95.00% CI = 42.8099 to 91.7679
Pooled Variance t = 5.3492, df = 54, Prob = 0.0000
Difference in Means = 67.2889, 95.00% CI = 42.0689 to 92.5089
```

MONROE MOUNTAIN COMMON GROUND INITIATIVE CHARTER FOR 1993-1998

CHARTER AGREEMENT

We, the undersigned, support the Monroe Mountain Common Ground Initiative and its goals to improve management of livestock and wildlife on all lands, regardless of ownership, in the Monroe Mountain Area of South Central Utah. The initiative illustrates our commitment to deal with wildlife habitat and livestock grazing issues through partnerships that rely on natural resource professionals, concerned citizens, and groups. This five year charter describes goals, issues, and strategies for managing the Monroe Mountain ecosystems in partnership under this initiative.

The primary goal of this initiative is to more effectively manage the area using an ecosystems management philosophy as applied to projects and field activities. Innovation and cooperation will be key to our success. We will move forward in an open, active, and creative manner to accomplish our goals.

This agreement does not change the legal mandates or decision-making authority or processes of participants. Rather, it enables participants to more effectively share costs, staffing, labor, and other resources to implement projects and activities for mutual benefit.

This initiative reflects the importance of developing a common ground to meet the needs of the ecosystem as well as the expectations of those dependent on the area. Of equal importance is our collective recognition that wildlife can have an effect on landowners, industries, recreationists, and other users of the area. As such, management of all species, domestic and wild, requires close and open communications and coordination between all interests. This is another step in our efforts to manage these resources wisely for present and future generations. Participants include, but are not limited to the signatories that follow:

MONROE MOUNTAIN COMMON GROUND INITIATIVE STEERING COMMITTEE

GARTH BAGLEY, Livestock Permittee
Representing Utah Farm Bureau/Landowners
Garth O. Bagley

NORM BOWDEN, Wildlife Biologist
Representing Division Wildlife Resources
Utah Department of Natural Resources
Norm Bowden

BRAD WILLIAMS, Forester
Representing Division of State Lands & Forestry - Utah Department of Natural Resources

KAY KIMBALL, President
Sevier Wildlife Federation
Representing Sportsmen
Kay Kimball

SAM ROWLEY, Assistant District Manager - Richfield District - BLM
Samuel R Rowley

RICHARD FARRAR, Branch Chief, RW&WS
~~Fishlake~~ National Forest
2/8/94

GERALD CANNON
Representing Monroe Mountain Trophy Elk Association
Gerald Cannon

AREA DESCRIPTION

The project area is located southeast of Richfield, Utah. The area includes 318,000 acres, with 65 percent administered by the Fishlake National Forest, 26 percent by the Richfield District of the Bureau of Land Management, 7 percent by the Utah Division of State Lands and Forestry as State School Trust Lands, and the remainder is owned by the Utah Division of Wildlife Resources, the Piute Indians, and private landowners.

The project is located in Piute and Sevier Counties. The area is a somewhat isolated mountain range of the Wasatch Plateau. The proposed boundaries encompass a unique ecological management unit that lends itself to demonstration of ecosystem management principles.

The unit includes a complete spectrum of summer and winter range for both livestock and big game. Approximately 3,500 cattle and 5,000 sheep will be affected by the project. In addition, there are 600-800 elk and over 5,000 deer.

INITIATIVE STRATEGY

Key aspects to selecting Monroe Mountain and vicinity as a demonstration area ties to strong community awareness of the area and community commitment to development of a management strategy that meets the needs and interest of as many people as possible. In addition, the area is somewhat isolated from surrounding geography allowing better focus on the interests and individuals that need to be involved.

This program will be initiated by establishment of a steering committee of the principal land managers and those with special interests in the area, including private landowners. The steering committee will develop a management strategy for the area and coordinate efforts at developing solutions to problems.

An advisory committee will be established, made up of representative of all interested parties. This will include Research Stations, wildlife, livestock, sportsmen's groups, environmentalists, local government, etc. The advisory committee's role will be to provide recommendations to the steering committee regarding management of the area. They will also provide recommendations for public participation in the management process.

Partners and volunteers will join the project effort as endorsees' of a Stewardship Management Program for the area. All partners will sign a Stewardship Management Agreement that outlines the contributions and responsibilities of the partner.

Annually, a report on management progress will be produced and distributed to interested parties.

GOALS - THE PURPOSES FOR THIS INITIATIVE ARE SEVERAL

1. Resolve many of the issues, real or perceived, that have developed between livestock interests and big game interests within the project area.
2. Improve overall cooperation between the various land management and private land management entities.
3. Apply management practices to the ground that result in improved management of the resource, both on public and private land.
4. Develop solutions to livestock/big game interactions that can be exported to other areas.
5. Support efforts to successfully manage the area as a quality elk management unit for both hunting and viewing trophy class bulls.
6. Contribute to an economically viable livestock grazing program in the area.

OBJECTIVES

1. Identify sufficient sources of funding to get this project under way by March 1, 1993.
2. Initiate designation of steering team and clear a charter for their operation by August 1, 1993.
3. Implement the various objectives of the affected Allotment Management Plans.
4. Within five years, see a significant progress toward improvement of food to cover ratios, a significant increase in grass and forb production and improved aspen reproduction.
5. Within ten years, reduce the amount of sagebrush in key meadow areas by 50 percent.
6. Selectively remove trees around meadows to enhance edge effects and expand the size of meadows.
7. Reduce pinyon/juniper invasions in key winter range.
8. Improve the quality of winter and spring forage at the DWR's Elbow Ranch and other key wintering areas.
9. Within 10 years, reduce big game depredation to private crops to acceptable levels.
10. Increase forage production for livestock.
11. Manage the existing elk herd to maintain a bull/cow ratio above 35 percent and determine an acceptable breeding herd size.

ISSUES TO BE RESOLVED

Big game/livestock competition.

Fear that increasing elk populations will drive down livestock permit numbers or eliminate livestock from the range entirely.

Encroachment of high mountain meadows by trees and brush reducing forage areas for big game and livestock.

Encroachment of conifers into aspen stands and decline in number of aspen stands.

Age of existing aspen stands, lack of diverse age classes in aspen, and anticipated decline in aspen health.

Overgrazing by both livestock and big game.

PJ encroachment into winter range.

Increasing elk population is causing competition on spring range.

Increasing beaver activity changing riparian areas into ponds.

Depredation of private croplands by big game species.

Demand by sportsmen to improve the deer herd in the project area.

Need for coordinated livestock/big game grazing systems in Allotment Management Plans.

Demand by sportsmen and wildlife watchers to manage the area for trophy elk, placing strict limits on harvests of both bulls and cows. At the same time, livestock interests want strict limits placed on elk numbers in the project area.

Water users are demanding more control of beaver populations, including removal of dams.

Landowners are increasingly posting their lands to public access.

Recreation use, especially wildlife viewing and ATV use of the Paiute ATV trail are increasing rapidly.

RESOURCES IN NEED OF IMPROVEMENT

Summer Range:

Vegetative manipulation, especially regeneration of decadent aspen stands and meadow encroachment are essential to maintaining adequate summer range for both big game and livestock. Use of prescribed fire has successfully improved forage conditions. Past projects are in need of maintenance to improve lost productivity and to retain the investment already made in improved forage production. More areas are in need of treatment.

Natural high elevation meadows are shrinking as a result of sagebrush and spruce encroachment. Aspen stands are generally mature or overmature. The demands for summer forage have increased with the increased elk populations.

Winter Range:

Much of the winter range, especially on the west side of the project area is in need of extensive rehabilitation. Chainings have been very successful in the past at improving forage production. Many of these areas were opened up 20 years ago and are now being re-invaded by juniper. They are in desperate need of treatment to retain previous investments in productivity. Improved winter range conditions will greatly reduce depredation on private land crops.

Riparian Zones:

Many riparian areas are in need of improved beaver management and improved grazing management. There is need for some protective fencing, log barriers, and other structures to protect riparian habitat.

Timber Areas:

Timbered areas are in need of some selective and group selection cutting to improve forest health, maintain or expand meadows, and regenerate aspen. Spruce and fir beetle infestations are an increasing problem.

Watchable Wildlife:

This area has been designated a "watchable wildlife" area and will develop national recognition over time as "the place" to see and photograph trophy class elk. Much can be done to enhance and interpret the recreational experience associated with this area. Informational brochures on the demonstration and construction of viewing platforms and blinds will greatly compliment this effort. Big deer and other wildlife are also attractions in the area.

Roads:

Improvement of several of the main arterial roads will be necessary to enhance the "watchable wildlife" opportunities. Since this area is being managed for trophy class elk, it will attract many visitors looking for an opportunity to see and photograph such animals. Some roads in the are in need of closure, also.

Water Developments:

Water developments in the project area need maintenance. Additional developments are needed to better disperse livestock on the summer range. Elk wallows can be improved to better disperse summer elk use.

Range Improvements:

Some fences could be removed and new ones developed under a totally new allotment management strategy. The strategy will focus on using livestock to accomplish ecosystem management objectives. A more open less traditional program will be developed. Some new fencing will be necessary to reduce depredation to crops.

Recreation:

Improvement of picnic and sanitation facilities, dispersed recreation sites, roads and recreation trails will be necessary to accommodate increasing recreation use. Scenic driving and "watchable wildlife" activities will be capturing regional and national attention.

MONITORING

Funding levels have not been adequate to provide the desired level of monitoring. With adequate funding, an ecologist/botanist will be hired to work with existing personnel and partners to develop a monitoring plan and establish baseline data for the first five years of the project. Partners, including Forest Service Research, and volunteers will be used to assist in data collection.

The information and subsequent data collections will be stored in a database compatible to electronic data files used by the various land management agencies involved. A GIS compatible system is preferable.

The steering committee will oversee these efforts and monitor results. Radio telemetry systems will be used to facilitate studies of game and livestock movement. This information could be combined with existing date for elk in the area and help establish a database on interrelationships and interactions.

An accomplishment and monitoring report will be produced annually and shared with stakeholders in the project.

Seeking Common Ground

A Livestock/Big Game Demonstration Area Proposal

1. Name of Project:

The Monroe Mountain Livestock/Big Game Demonstration Project
Fishlake National Forest
R-4

Seeking Common Ground

A Livestock/Big Game Demonstration Area Proposal

2. Description of project location:
(Include type of land ownership, geographic location, and size.)

The project area is located in south central Utah within the Sevier River drainage of the Great Basin. The boundary includes 318,000 acres, with 65 percent administered by the Fishlake National Forest, 26 percent by the Richfield District of the Bureau of Land Management, 7% by the Utah Division of State Lands and Forestry as State School Trust Lands, and the remainder is owned by the Utah Division of Wildlife Resources, the Piute Indians, and private landowners.

The project is located in Piute and Sevier Counties. The area is a somewhat isolated mountain range of the Wasatch Plateau. The proposed boundaries encompass a unique ecological management unit that lends itself to demonstration of ecosystem management principles.

The unit includes a complete spectrum of summer and winter range for both livestock and big game. Approximately 3500 cattle and 5000 sheep would be affected by the project. In addition, there are 600-800 elk and over 5000 deer.

There are also numerous opportunities to incorporate other wildlife interactions into the project, especially those related to beaver, game birds, and fisheries. The area includes known habitat for the goshawk and eagles. The Utah Division of Wildlife Resources owns the water rights in several reservoirs and is managing Manning Meadow Reservoir for the Bonneville Cutthroat trout, a sensitive species.

The geology of the area is basically mixed volcanics. Soil inventories and mapping have been completed at the 1:24,000 scale. The elevation ranges from 11,227 feet on Monroe Peak to 5,200 feet at Rocky Ford Reservoir at the northern tip of the project area. Drainage is into the Sevier River system of the Great Basin.

Habitat classification was completed during the soils survey. Sagebrush/grass/pinyon-juniper dominate the lower elevation grading into oak and other mountain brush at mid-elevations. These areas constitute the primary winter and intermediate range for big game and livestock. The upper elevations are dominated by mixed alpine fir/spruce/aspen stands interspersed with meadows or riparian areas. This is the primary summer range.

There are numerous types of riparian areas within the project area. A growing population of beaver has many of them in a state of flux. The livestock interests and water users are increasingly concerned about the increased beaver activity.

Vegetation in the area also is showing signs of increased stress, the direct effect of a 5-7 year drought combined with heavy grazing by both wildlife and livestock. Spruce and fir are increasingly being affected by beetles as a result of the stressed conditions.

Access to the project area is excellent. Interstate 70 runs along the northwestern boundary. Paved state highways, 24, 62, and 89 constitute the remainder of the boundary. Improved dirt roads branch off the paved road providing seasonal access to the higher elevations. Most of the roads and trails at mid and higher elevations are closed in the winter. Even with good access, there are several large portions of the area that remain roadless. There is adequate rugged terrain to provide excellent escape cover for deer and elk, even within the roaded areas. The popular Paiute ATV trail traverses the area also.

The entire project area is within State Big Game Herd Unit 48 - Monroe Mountain.

Seeking Common Ground

A Livestock/Big Game Demonstration Area Proposal

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3. List project strategy, goals, and objectives:

Strategy:

Key aspects to selecting Monroe Mountain and vicinity as a demonstration area ties to strong community awareness of the area and community commitment to development of a management strategy that meets the needs and interest of as many people as possible. In addition, the area is somewhat isolated from surrounding geography allowing better focus on the interests and individuals that need to be involved.

This program would be initiated by establishment of a steering committee of the principal land managers and those with special interests in the area, including private landowners. The steering committee would develop a management strategy for the area and coordinate efforts at developing solutions to problems.

An advisory committee would be established, made up of representative of all interested parties. This would include Research Stations, wildlife, livestock, sportsmen's groups, environmentalists, local government, etc. The advisory committee's role would be to provide recommendations to the steering committee regarding management of the area. They would also provide recommendations for public participation in the management process.

Partners and volunteers would join the project effort as endorsees' of a Stewardship Management Program for the area. All partners would sign a Stewardship Management Agreement that outlined the contributions and responsibilities of the partner.

Annually, a report on management progress would be produced and distributed to interested parties.

Goals:

The purposes for this demonstration project are several:

1. Resolve many of the issues, real or perceived, that have developed between livestock interests and big game interests within the project area.

2. Improve overall cooperation between the various land management and private land management entities.

3. Apply management practices to the ground that result in improved management of the resource, both on public and private land.

4. Develop solutions to livestock/big game interactions that can be exported to other areas.

5. Support efforts to successfully manage the area as a quality elk management unit for both hunting and viewing trophy class bulls.

6. Contribute to an economically viable livestock grazing program in the area.

Objectives:

1. Identify sufficient sources of funding to get this project under way by March 1, 1993.

2. Initiate designation of steering team and clear a charter for their operation by March 1, 1993.

3. Implement the various objectives of the affected Allotment Management Plans.

3. Within five years, see a significant improvement in food to cover ratios; a significant increase in grass and forb production and improved aspen reproduction.

4. Within five years, reduce the amount of sagebrush in key meadow areas by 50 percent.

5. Selectively remove trees around meadows to enhance edge effects and expand the size of meadows.

6. Reduce pinyon/juniper invasions in key winter range.

7. Improve the quality of winter and spring forage at the DWR's Elbow Ranch and other key wintering areas.

8. Within 10 years, reduce big game depredation to private crops by 80 percent.

9. Increase forage production for livestock.

10. Manage the existing elk herd to maintain a bull/cow ratio above 35 percent and a breeding herd size of 1000-1200 mature animals.

Seeking Common Ground

A Livestock/Big Game Demonstration Area Proposal

4. What are the conflicts/problems in the project area?

Major problems include:

Big game/livestock competition.

Fear that increasing elk populations will drive down livestock permit numbers or eliminate livestock from the range entirely.

Encroachment of high mountain meadows by trees and brush reducing forage areas for big game and livestock.

Encroachment of conifers into aspen stands and decline in number of aspen stands.

Age of existing aspen stands, lack of diverse age classes in aspen, and anticipated decline in aspen health.

Overgrazing by both livestock and big game.

PJ encroachment into winter range.

Increasing elk population is causing competition on spring range.

Increasing beaver activity changing riparian areas into ponds.

Depredation of private croplands by big game species.

Demand by sportsmen to improve the deer herd in the project area.

Need for coordinated livestock/big game grazing systems in Allotment Management Plans.

Demand by sportsmen and wildlife watchers to manage the area for trophy elk, placing strict limits on harvests of both bulls and cows. At the same time, livestock interests want strict limits placed on elk numbers in the project area.

Water users are demanding more control of beaver populations, including removal of dams.

Landowners are increasingly posting their lands to public access.

Recreation use, especially wildlife viewing and ATV use of the Paiute ATV trail are increasing rapidly.

History:

Efforts to resolve conflicts and problems have been severely limited by shortages in both funding and people in the land management agencies. In addition, local partners and permittees are financially strained. The area is economically depressed and in need of revitalization.

There has been some use of prescribed fire and cutting to regenerate aspen, chainings in the pinyon/juniper, and several small timber sales. The results have been very good. The prescribed burns have increased forage, the number of ecotones between brush and new grass and forbs, and opened up dense stands of conifers and aspen. Chainings, especially those in Box Creek, are excellent examples of how chainings can be planned and conducted to blend existing environments, maximize ecotones and esthetics, as well as increase forage for deer, elk, and livestock. There is a market for spruce in the area, but markets are limited for subalpine fir and aspen. Consequently, fire is often the most practical tool for vegetative manipulation in the forested areas. The small aspen management projects conducted in the area demonstrate that aspen regeneration is possible and that forage production and stimulation of aspen regeneration can be done in unison.

The Forest Service and the Utah Division of Wildlife Resources have cooperated on a beaver management policy that allows for removal of beaver in irrigation structures or when their activities impede direct flow of water for irrigation.

There have been some changes in elk and deer herd management for the unit through the interagency process. Since the 1990 Nevada Livestock/Big Game Symposium there have more efforts to get livestock owners and sportsmen together to resolve conflicts. These efforts have been effective this year in development of the annual predator control program, and development of the Lion, Bear Hunting Proclamation.

Local county committees of livestockmen, county agents, agency representatives, and sportsmen have been formed to discuss issues and problems. The UDWR recently purchased the Elbow Ranch in the project area, a critical big game winter range. They also acquired water rights to two reservoirs flowing into the ranch. They intend to manage the area for winter range.

The area was cooperatively flown to collect baseline population data.

Seeking Common Ground

A Livestock/Big Game Demonstration Area Proposal

5. What resources are in need of improvement?

Summer Range:

Vegetative manipulation, especially regeneration of decadent aspen stands and meadow encroachment are essential to maintaining adequate summer range for both big game and livestock. Use of prescribed fire has successfully improved forage conditions. Past projects are in need of maintenance to improve lost productivity and to retain the investment already made in improved forage production. More areas are in need of treatment.

Natural high elevation meadows are shrinking as a result of sagebrush and spruce encroachment. Aspen stands are generally mature or overmature. The demands for summer forage have increased with the increased elk populations.

Winter Range:

Much of the winter range, especially on the west side of the project area is in need of extensive rehabilitation. Chainings have been very successful in the past at improving forage production. Many of these areas were opened up 20 years ago and are now being re-invaded by juniper. They are in desperate need of treatment to retain previous investments in productivity. Improved winter range conditions would greatly reduce depredation on private land crops.

Riparian Zones:

Many riparian areas are in need of improved beaver management and improved grazing management. There is need for some protective fencing, log barriers, and other structures to protect riparian habitat.

Timber Areas:

Timbered areas are in need of some selective and group selection cutting to improve forest health, maintain or expand meadows, and regenerate aspen. Spruce and fir beetle infestations are an increasing problem.

Watchable Wildlife:

This area has been designated a "watchable wildlife" area and will develop national recognition over time as "the place" to see and photograph trophy class elk. Much can be done to enhance and interpret the recreational experience associated with this area. Informational brochures on the demonstration and construction of viewing platforms and blinds would greatly compliment this effort. Big deer and other wildlife are also attractions in the area.

Roads:

Improvement of several of the main arterial roads would be necessary to enhance the "watchable wildlife" opportunities. Since this area is being managed for trophy class elk, it will attract many visitors looking for an opportunity to see and photograph such animals. Some roads in the are in need of closure, also.

Water Developments:

Water developments in the project area need maintenance. Additional developments are needed to better disperse livestock on the summer range. Elk wallows can be improved to better disperse summer elk use.

Range Improvements:

Some fences could be removed and new ones developed under a totally new allotment management strategy. The strategy would focus on using livestock to accomplish ecosystem management objectives. A more open less traditional program would be developed. Some new fencing would be necessary to reduce depredation to crops.

Recreation:

Improvement of picnic and sanitation facilities, dispersed recreation sites, roads and recreation trails would be necessary to accommodate increasing recreation use. Scenic driving and "watchable wildlife" activities will be capturing regional and national attention.

Seeking Common Ground

A Livestock/Big Game Demonstration Area Proposal

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6. How will the success of the project be monitored?

Funding levels have not been adequate to provide the desired level of monitoring. With adequate funding, an ecologist/botanist would be hired to work with existing personnel and partners to develop a monitoring plan and establish baseline data for the first five years of the project. Partners, including Forest Service Research, and volunteers would be used to assist in data collection.

The information and subsequent data collections would be stored in a database compatible to electronic data files used by the various land management agencies involved. A GIS compatible system is preferable.

The steering committee would oversee these efforts and monitor results. Radio telemetry systems would be used to facilitate studies of game and livestock movement. This information could be combined with existing date for elk in the area and help establish a database on interrelationships and interactions.

An accomplishment and monitoring report would be produced annually and shared with stakeholders in the project.