Assessing aspen regeneration in East-Central Arizona

[1]Chris Hayes, [1]Tom DeGomez, [2]MaryLou Fairweather, and [3]Brian Geils
[1]Univ. of Arizona, [2]USDA Forest Service, Reg. 3 Forest Health Protection, [3]Rocky Mtn. Res. Stn.

Introduction

Quaking aspen (Populus tremuloides) is not regenerating sufficiently after disturbance across most of Arizona and elk (Cervus elaphus) herbivory has been implicated as a major cause for the failure. Ripple et al. (2001). hypothesized that the presence of wolves may impact elk feeding behavior enough to reduce negative impacts elk have on regenerating aspen. In 1998, Mexican Gray Wolves (Canis lupus baileyi) were reintroduced into Arizona, and in 2003 and 2004, a series of wildfires burned ≈ 33,275 acres in mixed conifer stands within the wolf reintroduction area. This presented an opportunity to monitor aspen regeneration in this area and test Ripple's hypothesis. In high severity burned aspen stands, high and low-wolf-use areas were identified, and aspen regeneration was measured. The objectives of this study were to determine (1) if aspen stands in high wolf-use areas had more growth than aspen stands in low wolf-use area and (2) to monitor aspen growth in regenerating aspen stands in high wolf-use areas.

(A) Aspen sucker growing with no sign of herbivory and (B) aspen that died due to herbivory

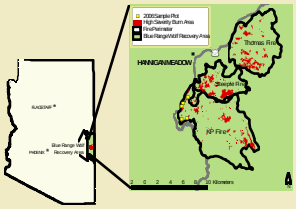
Methods

Objective one

- Areas burned in two adjacent fires, the Steeple and Thomas fires (both burned in 2003), were stratified into areas of high and low wolf-use.
- Annual wolf home-range maps created by US Fish and Game were used determine wolf-use delineations
- High-severity burned aspen stands from the high and low wolf-use areas were randomly selected and sampled (n=9).
- Response variables were measured on 16 randomly placed 1 m^2 plots and included suckers per hectare, mean sucker height, and forks per sucker.
- Estimate of biomass (tonnes ha^{-1}) were obtained by transforming height data with a power curve (adj. R^2 = 0.95) based on data obtained from Hall et al. 1996.

Objective two

- Four stands in the high-wolf-use area (KP fire) were randomly selected and sampled in two consecutive years.
- Response variables, suckers per hectare and mean sucker height, were measured on 16 randomly placed 1 m^2 plots.
- Height measurements were transformed into biomass and analysis was done with paired (before and after) t-tests



Study site

Will wolves alter the feeding patterns of elk?

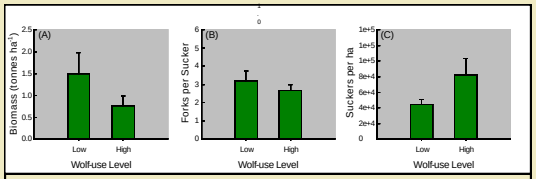


Figure 1. Comparison of (A) aspen biomass (estimate of dry weight), (B) forks per sucker, and (C) suckers per hectare in areas of low and high wolf-use areas in east-central Arizona in 2007. Bars represent mean ± standard error.

Table 1. Biomass measurements and net biomass gain for regenerating aspen stands in high-wolf-use areas east central Arizona.

		Dry weight (tonnes ha^{-1})		
Stand No.	Stand Age*	2006	2007	Net Gain[a]
1	3	1.0	3.1	+2.1
2	3	0.3	0.8	+0.5
3	3	0.4	1.4	+1.0
4	3	0.6	1.7	+1.1

* Years between fires and 2007 measurements.
[a] Biomass change between 2006 to 2007 measurements.

Results

- Aspen in low wolf-use areas had more biomass (n =9, T = -1.4, P = 0.18) and forks per sucker (n = 9, T = 0.8, P = 0.40), but fewer suckers per hectare (n = 9, T = -1.7, P = 0.10) than aspen in high wolf-use areas (Figure 1A,B,C), although these relationships were not significant.
- Aspen biomass increased between summer 2006 and summer 2007 in the high wolf-use area within the KP fire (Paired t-test; df = 3, T = -3.4, P = 0.04)(see Table 1).
- Average sucker height increased between 2006 and 2007 in the high wolf-use area within the KP fire (mean; 2006 = 96.7 cm, 2007 = 164.2 cm, Paired t-test; df = 3, T = -6.9, P < 0.01).
- There were fewer suckers per ha in 2007 (50,156/ha) than in 2006 (75,000/ha) but the difference was not statistically significant (df = 3, T = 1.4, P = 0.26).

Discussion

- Sucker densities found were high (~50,000/ha) and similar to high sucker densities found in clearcut stands in the west (see Crouch 1983, Bartos and Mueggler 1982).
- Average height in our study area after three years of growth was 1.6 m and many suckers exceeded two meters. Young aspen trees typically grow 0.9 to 1.8 m the first two years and from 2.7 to 4.5 m in five years (Shepperd 1993, Miller 1996).
- It appears that in these recently disturbed areas aspen is growing well. However, since elk browsing pressure is continuous, further monitoring is essential to determine the success or failure of a given area over time.
- Because of high variation in growth among aspen stands, we were not able to detect any difference in aspen growth due to the presence of Mexican Gray Wolves and their impact on elk foraging behavior.
- Spatial analysis could be conducted to help better understand what factors may be important in aspen regeneration in this area. Monitoring elk activity with radial collars, however, may be required to assess wolf-elk interactions.

References

Bartos, D.L., and W.F. Mueggler. 1982. Early succession following clearcutting of aspen communities in northern Utah. Journal of Range Management, 35: 764-768.

Crouch, G.L. 1983. Aspen regeneration after commercial clearcutting in southwestern Colorado. Journal of Forestry, 83: 316-319

Hall, F.G., K.F. Huemmrich, D.E. Strebel, S.J. Goetz, J.E. Nickeson, and K.D. Woods. 1996. Biomass of Sacrificed Spruce/Aspen (SNF). [Biomass of Sacrificed Spruce/Aspen (Superior National Forest)]. Data set. Available on-line [http://www.daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. Based on F. G. Hall, K. F. Huemmrich, D. E. Strebel, S. J. Goetz, J. E. Nickeson, and K. D. Woods, Biophysical, Morphological, Canopy Optical Property, and Productivity Data from the Superior National Forest, NASA Technical Memorandum 104568, National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Maryland, U.S.A., 1992.

Miller, B. 1996. Aspen management: a literature review. NEST Tech. Rep. TR-028. Ontario, Canada: Queen's Printer for Ontario. 94 p.

Ripple, W.J., E.J. Larsen, R.A. Renkin, and D.W. Smith. 2001. Trophic cascades among wolves, elk, and aspen on Yellowstone National Park's northern range. Biological Conservation, 102: 227-234.

Sheppard, W.D. 1993. Initial growth, development, and clonal dynamics of regenerating aspen in the Rocky Mountains. Res. Pap. RM-RP-312. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 8 p.

Acknowledgements

We thank Kevin Barrett, John Hockersmith, Mayra Moreno and Laine Smith for assisting in data collection. Funding provided by USDA Region 3 Forest Health, Detection Monitoring in a cooperative agreement with the University of Arizona. Other cooperators include U.S. Fish and Wildlife Service. Wolf photograph courtesy of U.S. Fish and Wildlife Mexican Gray Wolf Recovery Program

Presented at 2008 Forest Health Monitoring Conference, San Antonio, TX, 2/11 to 2/14/2007.