# Aspen Regeneration

**Johnston, B.C. 2001. Multiple Factors Affect Aspen Regeneration on the Uncompahgre Plateau, West-Central Colorado. USDA Forest Service Proceedings RMRS-P-18. 2001.**

Method: In 1996, I inventoried over 90 aspen stands in 12 timber sales that had been clearcut more than three years ago.

Observations:

1. Units that regenerated adequately were larger with higher slope angles, and soils with a thick Mollic surface layer.
2. Units that regenerated inadequately often contained plant species that indicated high water tables.
3. The factors associated with inadequate regeneration were high water tables, heavy browsing, soils with a thin Mollic surface layer, and logging practices that compact large portions of the unit.
4. One of these factors alone often does not lead to inadequate aspen sprouting.
5. Most often, inadequately regenerated aspen stands have two or more negative factors, so the factors act as cumulative stressors on aspen.

Conclusions: It is important for managers to know soils, landforms, history, and behavior of animal populations in the area.

## Aspen Fails to Regenerate in YNP After Wolf Re-introduction

**Kauffman, M.J. J.F. Brodie and E. S. Jules. 2010. Are wolves saving Yellowstone's aspen? A landscape-level test of a behaviorally mediated trophic cascade. Ecology 91: 2742–2755.**

Introduction: Reintroducing wolves to Yellowstone NP may lead to aspen recovery by reducing elk foraging in risky areas. Although this hypothesis is generally accepted, it has never been adequately tested.

Objective: We assessed whether wolves influenced aspen recruitment over 3 years.

Methods:

1. We gathered detailed demographic data on aspen stands using tree ring cores.
2. We also monitored browsing levels in experimental elk exclosures with different risks of predation.

Results:

1. The historical failure of aspen to regenerate varied widely among stands (last recruitment year ranged from 1892 to 1956).
2. The data do not indicate an abrupt end to aspen recruitment.
3. Recruitment failure appears more consistent with a gradual increase in elk numbers rather than a rapid shift in elk foraging behavior after wolf removal.
4. Relative survivorship of young aspen ramets indicate they are not currently recovering in Yellowstone, even with a large wolf population.
5. Impacts of elk browsing on aspen were not reduced in areas where elk are at higher risk of predation by wolves.

Conclusions: Wolves may increase plant biodiversity, especially in areas with too many ungulates. Past studies found that recovery of vegetation was due primarily to reducing prey density, and not changing prey behavior. After wolves were reintroduced into the park, elk populations were reduced by 10,000 or 40% compared to pre-wolf levels (based on winter counts: 6,738 in 2007 vs. 16,791 in 1995). The extent to which Yellowstone aspen decline is caused by elk browsing, fire suppression, or drought is debatable. While conifer encroachment (due to lack of fire) and drought certainly influence aspen regeneration, our work indicates that elk browsing is the single factor controlling the regeneration of Northern Range aspen. When elk browsing is reduced or excluded, aspen stands successfully regenerate

**Kimble, D.S., D.B. Tyers, J. Robison-Cox, and B.F. Sowell. 2011. Aspen recovery since wolf reintroduction on the northern Yellowstone winter range. Rangeland Ecol. Manage. 64:119–130.**

Objective 1: To observe if aspen stands have improved from 1991 to 2006.

Methods: Aspen recruitment and overstory stem densities were sampled in 315 clones in 1991 and 2006 on 140,000 acres of the Northern Yellowstone winter range. Recruitment stems (defined as greater than 6.5 ft tall and diameter at breast height less than 2 inches) represent recent growth of aspen sprouts above elk browsing height. Overstory stems (all stems greater than 6.5 ft ) represent the cohort of stems, which will insure the sustainability of the clone.

Results:

1. Overstory stem densities declined by 12% on the landscape scale from 1991 to 2006 using paired t-tests.
2. Overstory stems declined in 58% of individual clones and in 63% of the 24 drainages in the study area.
3. No differences were found in recruitment stems.

Objective 2: To determine which factors influenced changes in aspen density.

Results:

1. Winter ungulate browsing, conifer establishment, and cattle grazing all contributed to the decline in overstory stem densities.
2. In 1991, 80% of the clones were classified as having medium to high browsing levels.
3. In 2006, 65% of the clones had a similar rating, possibly due to reduced elk numbers.
4. Aspen recruitment has increased in some areas 500 to 2500 acres, but not consistently.

Conclusion: Our study found that the re-introduction of wolves has not thus far resulted in a landscape-level recovery of aspen.

From paper: Aspen recruitment density and total overstory density on the 40% of the Northern Yellowstone Winter Range (NYWR) we studied has not increased since wolf recovery. Our results do not support suppositions that aspen had begun a large-scale recovery on the NYWR by 2006. Elk numbers declined 20% in the park, but declined 45% over the same time period on our study area.

Despite the 45% reduction in elk on our study area, we believe that browsing was still too high in 2006 for aspen to respond at the landscape scale or that not enough time had passed since the decline in elk numbers for more aspen suckers to grow above 6.5 ft. Other factors not influenced by wolves also likely suppress aspen regeneration, but we believe elk browsing is the most important factor.

## Aspen Regenerates in YNP after Wolf Re-introduction

**Halofsky, J. and Ripple, W. 2008. Linkages between wolf presence and aspen recruitment in the Gallatin elk winter range of southwestern Montana, USA. Forestry 81:195-207.**

Objective: To explore evidence of a trophic cascade (wolf presence) on aspen decline.

Methods: We approximated aspen origination dates from an age – diameter relationship to examine potential correlations between wolf presence and absence, elk herbivory and aspen recruitment. A comparative analysis was also conducted between the aspen data collected on the winter range and aspen data collected within two elk exclosures.

Results:

1. Within the elk exclosures, built in 1940, aspen ramets have successfully regenerated.
2. Outside the exclosures, aspen recruitment into mature stems began to decline in the 1920s (during wolf removal), completely ceased after the 1950s and has only been observed since the 1990s (post-wolf reintroduction).

Conclusion: The correlation between aspen recruitment and historical elk browsing, coincident with the presence and absence of wolves, are consistent with a top – down trophic cascade.

**Fortin, D., H.L. Beyer, M.S. Boyce, D.W. Smith, T. Duchesne, and J.S. Mao. 2005. Wolves influence elk movements: behavior shapes a trophic cascade in Yellowstone National Park. Ecology 86:1320-1330.**

Objective: To investigate if the observed trophic cascade might have a behavioral basis by exploring environmental factors influencing the movements of 13 female elk equipped with GPS radio collars.

Methods: We developed a simple statistical approach that may unveil the influence of several environmental features on animal movements. Comparisons between observed and random steps were used to model environmental features influencing movement patterns.

Results:

1. Elk movements were influenced by multiple factors, such as the distance from roads, steep slopes, and the cover type.
2. The influence of cover type on elk movements depended on the spatial distribution of wolves.
3. In low wolf-use areas, the preference for end point locations: aspen stands > open areas > conifer forests.
4. As the risks of wolf encounter increased, the preference of elk for aspen stands gradually decreased, and selection became strongest for conifer forests.

Conclusion: The behavioral mechanisms involved in the trophic cascade of Yellowstone's wolf–elk–aspen system: elk respond to wolves on their winter range by a shift in habitat selection, which leads to local reductions in the use of aspen by elk.

**Ripple, W.J. and R.L. Beschta. 2004. Wolves and the ecology of fear: Can predation risk structure ecosystems? BioScience 54:755-766.**

Background: The removal of wolves from Yellowstone National Park in the mid-1920s and their reintroduction in 1995 provided the opportunity to examine the cascading effects of carnivore–herbivore interactions on woody browse species.

Objective: To investigate how large carnivores, herbivores, and plants may be linked to the maintenance of native species biodiversity through trophic cascades.

Conclusions: Predation risk may have profound effects on the structure of ecosystems and is an important constituent of native biodiversity. Our conclusion is based on theory involving trophic cascades, predation risk, and optimal foraging; on the research literature; and on our own recent studies in Yellowstone.

**J.S. Mao, M.S. Boyce, D.W. Smith, F.J. Singer, D.J. Vales, J.M. Vore, and E.H. Merrill. 2005. Habitat selection by elk before and after wolf reintroduction in Yellowstone National Park. J. Wildl. Manage. 69:1691-1707.**

Prey species are thought to select habitats to obtain necessary resources while also avoiding predation.

Objective: To examined whether habitat selection by elk changed following the reintroduction of wolves into Yellowstone National Park in 1995.

Methods: We compared seasonal habitat selection by elk based on weekly elk radio locations taken in 1985–1990 (without wolves) and 2000–2002 (with wolves) using regression models.

Results:

1. Fire-related habitat changes and climate likely interacted with wolf avoidance in shaping habitat selection by elk.
2. In summer, when wolf activity was centered around dens and rendezvous sites, elk apparently avoided wolves by selecting higher elevations, less open habitat, more burned forest.
3. In areas of high wolf density, elk chose steeper slopes than they had before wolf reintroduction.
4. In winter, elk did not spatially separate themselves from wolves.
5. Compared to the pre-wolf period, elk selected more open habitats in winter after wolf reintroduction, but did not change their selection of snow water equivalents or slope.

Conclusion: Elk may select habitats that allow them to avoid wolves during summer, but they may rely on other behavioral anti-predator strategies, such as grouping, in winter. This study provides evidence that wolves can alter seasonal elk distribution and habitat.

## Aspen - Conifer Forests

**Calder, W.J. and S.B. St. Clair. 2012. Facilitation drives mortality patterns along succession gradients of aspen-conifer forests. Ecosphere 3:57.**

Background: While it is well established that facilitation and competition are important in structuring plant communities, a clear understanding of the interactions between them and how they change through the life stages of plants and affect long-term plant community development is lacking.

Observation: Conifer seedlings are rarely found growing in meadows but readily establish under adjacent aspen stands, particularly at the base of aspen trees, creating the potential for competition in later life stages.

Objective: To examine these relationships and their potential consequences on forest community development, Methods: We characterized patterns of establishment, regeneration, and overstory mortality of aspen and subalpine fir along a stand composition gradient (aspen dominant to mixed aspen-conifer to conifer dominant) that develops in seral aspen forests.

Results:

We found strong stand effects on the establishment of both aspen and subalpine.

- Aspen regenerated into meadows from the forest boundary
- Aspen reached peak densities underneath aspen stands
- Aspen densities decreased in mixed and conifer dominated stands.
- Subalpine fir seedlings failed to regenerate in meadows
- Subalpine fir established readily in aspen, mixed and conifer stands.
- Subalpine fir seedlings were aggregated around mature aspen trees.
- This increased the proximity of the two species 2 to 10 fold depending on subalpine fir age class and stand type.

Both stand type and increased proximity of overstory aspen and fir trees drove mortality patterns of the two species in opposite directions.

- Overstory aspen mortality increased sharply along the stand composition gradient: aspen (7%), mixed (17%), conifer (49%)
- Subalpine fir wasn't influenced by stand type.
- Proximity of overstory aspen and subalpine fir, was associated with increased (twice) aspen death under all stand conditions.
- Increased subalpine fir survival resulted in high aspen:fir mortality ratios that likely accelerate successions toward conifer dominance.

Conclusions: Environmental conditions that promote aspen mortality may compromise the ability of aspen forests to regenerate after disturbance. Maintenance of natural disturbance (fire) regimes appears to be critical in striking an ecological balance between seral aspen and conifer stands.

Calder, W.J., Calder, W. John, K.J. Horn, K.J. Horn, and S.B. St Clair. 2011. Conifer Expansion Reduces the Competitive Ability and Herbivore Defense of Aspen by Modifying Light Environment and Soil Chemistry. Tree Physiology 31:582-91.

Objective: To determine in a field and greenhouse study how photosynthesis, growth and defense of quaking aspen and subalpine fir regeneration are affected under light reductions and shifts in soil chemistry that occur as conifer numbers increase.

Results:

1. Aspen regeneration was much more sensitive to reductions in light and changes in soil chemistry than fir.
2. In aspen seedlings light reductions and/or shifts in soil chemistry limited height growth, biomass gain, photosynthesis and production of phenolic glycosides and condensed tannins.
3. Fir seedlings were more tolerant of low light conditions and showed no sensitivity to changes in soil chemistry.
4. Unlike aspen, subalpine fir increased its root to shoot ratio on conifer soils, which may partially explain its ability to grow and produce defensive chemicals.

Conclusions: The results suggest that increasing dominance of conifers in subalpine forests alters light conditions and soil chemistry in a way that places greater physiological and growth constraints on aspen than subalpine fir, which will likely increase recruitment of conifers and reduce aspen cover.

**D.J. Shinneman, W.L. Baker, P.C. Rogers , and D. Kulakowski. 2013. Fire regimes of quaking aspen in the Mountain West. Forest Ecology and Management 299:22–34.**

Background: Many aspen stands regenerates prolifically after fire. Aspen is often thought to be dependent upon disturbance for persistence. In many areas, historical evidence for post-fire aspen establishment is clear. When fire is absent, these stands decline often lacking adequate regeneration and they may succeed to conifers. However, other aspen stands are relatively stable that contain little or no evidence past fire disturbance. Thus, aspen woodlands can range from highly fire-dependent to relatively stable, self-replacing stands that do not require fire for persistence.

Rational: Given the broad distribution of aspen in the Mountain West, the history of fire in these forests likely varies with location, community composition, environment, land use, and climate. However, few studies have focused on these variables in time and space.

Objective: To review the literature to summarize aspen fire regimes in the western US.

Results:

1. Only about a quarter of the 46 research papers we reviewed for this study were fire history studies (mean fire intervals were calculated), and all but one of these were based on data from fire-scarred conifers.
2. Nearly half of the studies reported at least some evidence of persistent aspen in the absence of fire.
3. We also found that large portions of the Mountain West have little or no aspen fire history research.

We put forth a classification framework for aspen that is defined by fire regime (fire severity and probability of fire), and that reflects underlying biophysical settings and aspen functional types. We propose the following aspen fire regime types: (1) fire-independent, stable aspen; (2) fire-influenced, stable aspen; (3) fire-dependent, seral, conifer-aspen mix; (4) fire-dependent, seral, montane aspen-conifer; and (5) fire.dependent, seral, subalpine aspen-conifer. We hope to develop site-appropriate disturbance ecology characteristics, to aid efforts in managing and restoring aspen communities and to diagnose key factors contributing to changes in aspen.

Sue Macmeeken, former Bitterroot Silviculturist, expressed:

“The Bitterroot is not known for having a lot of aspen. Before the 2000 fires we saw it sporadically across the landscape in draws, openings, and a few other areas - mostly as individual trees and once in awhile as a small grove. After the fires, it came up all over the place and in fairly large numbers. It seemed impossible that it could be due to sprouting alone although no one spent a lot of time digging them to check their origin. It was not everywhere but it was so  common that no one took notice anymore.There is so much of itt hat it appears that there’s plenty fort he deer & elk to munch on and we really didn’t notice it disappearing anywhere.”

Jack Cornelisse, Bitterroot National Forest Silviculture and GIS Specialist, mapped (Appendix 1) the majority, 96%, where an aspen component of seedlings and saplings are found on approximately 25,740 acres and 653 stands. These sites vary primarily from 200 to 400 stems/acre from generated data.

## On This Page