

IMPACTS OF HERBIVORY  
ANNOTATED BIBLIOGRAPHY  
Katrina Strathmann

**Belsky, A. J. 1986. Does herbivory benefit plants? A review of the evidence. *American Naturalist*. 127(6):870-892.**

Belsky reviews studies of plant compensatory response, with the goal of debunking overcompensation as a widespread response to herbivory. While she enumerates flaws of studies and their conclusions that suggest overcompensation, she does not offer suggestions for future research that might convince her that overcompensatory responses exist.

**Bigger, D. S. and M. A. Marvier. 1998. How different would a world without herbivory be? *Integrative Biology*. 60-67.**

Meta-analysis of herbivory impacts data in 60 published articles to evaluate general trends. Results of meta-analysis show that among all studies: herbivory had a moderate negative impact on plant biomass (reduction in biomass), invertebrates had a greater negative impact on terrestrial plants than vertebrates, insects and molluscs had a greater and more consistent effect than other taxonomic groups of herbivores (while mammals had almost no effect), and graminoids, algae and forbs were more strongly affected by herbivory than woody plants.

**Bowers, M. A. 1993. Influence of herbivorous mammals on an old-field plant community: years 1-4 after disturbance. *Oikos*. 67(1):129-141.**

Results of the first four years of a study of herbivory by small mammals and large mammals on growth and species composition during early succession in a cleared old-field. The general conclusion is that plots with intermediate herbivory (large- or small-mammal exclosures) had higher plant richness and diversity than plots high or low herbivory (control or total exclosures).

**Bowers, M. A. 1997. Influence of deer and other factors on an old-field plant community: An eight-year exclosure study. In *The science of overabundance: Deer ecology and population management*, W. J. McShea, H. B. Underwood, and J. H. Rappole, eds. Washington: Smithsonian Institution.**

Results of 8 years of study of herbivory and succession in a cleared old-field, reporting only effects of deer herbivory. There was no significant effect of deer browse on community-level variables (diversity, species richness, total number of stems) but presence of one species (black walnut) was negatively correlated with presence of deer herbivory. The author suggests that as succession proceeds, the effects of herbivory are more difficult to detect – it is only one of many mechanisms organizing plant communities.

**Chase, J.M., M.A. Leibold, A.L. Downing, and J.B. Shurin. 2000. The effects of productivity, herbivory, and plant species turnover in grassland food webs. *Ecology*. 81(9):2485-2497.**

Meta-analysis of studies of the impact of herbivory on plant biomass and species composition across a precipitation gradient. In areas of higher precipitation, plant growth following grazing was higher than in areas of low precipitation. However, increased precipitation caused a greater difference in species composition due to grazing than areas of less precipitation.

**Crawley, M.J. 1989. The relative importance of vertebrate and invertebrate herbivores in plant population dynamics. In *Insect-Plant Interactions*, E. A. Bernays, ed. Florida: CRC Press.**

A broad review of differences in vertebrate and invertebrate herbivores that cause differential impacts on plants.

**Crawley, M. J. 1997. Plant-herbivore dynamics. In *Plant ecology*, M. J. Crawley, ed. Oxford: Blackwell Science.**

This chapter provides a thorough overview of herbivory, including herbivores, plant responses, community responses, defense and tolerance, and theoretical and mathematical models for plant responses.

**Cyr, H. and M. L. Pace. 1993. Magnitude and patterns of herbivory in aquatic and terrestrial ecosystems. *Nature*. 361:148-150.**

Meta-analysis of relationships of primary productivity, herbivore consumption and herbivore biomass in terrestrial and aquatic systems. In sites of high primary productivity, herbivory rate increases and herbivore biomass increases; these patterns were stronger in aquatic systems. The article was brief, so specifics of study methods were not reported.

**Detling, J.K., M.I. Dyer, C. Procter-Gregg, and D.T. Winn. 1980. Plant-herbivore interactions: Examination of potential effects of bison saliva on regrowth of *Bouteloua gracilis*. *Oecologia*. 45:26-31.**

The authors collected bison saliva and artificially applied it to cut plants in the greenhouse. There was no effect of bison saliva on growth (they measured blade, sheath, crown and root growth) or on C14 allocation to the roots. Unclipped plants had higher total biomass than clipped, but most of new growth in clipped plants was to new blades, not other variables.

**Frank, D.A., M. M. Kuns, and D. R. Guido. 2002. Consumer control of grassland plant production. *Ecology*. 83(3):602-606.**

Study of herbivory by large ungulates on above-ground and below-ground grassland plant productivity. The authors found that grazed plant productivity (above- and below-ground) was higher than ungrazed. Another statistical test that was reported was unclear, because measurements or calculations for the variables tested were not well-described.

**Gomez, J. M. and Zamora, R. 2000. Differential impact of vertebrate and invertebrate herbivores on the reproductive output of *Hormathophylla spinosa*. *Ecoscience*. 7(3):299-306.**

This study examined the individual impacts of multiple herbivores on *Hormathophylla spinosa*, a shrub found in the Sierra Nevada of Spain. The authors documented impacts of insects and birds observationally, and ungulates through enclosures. Reproductive output was estimated based on floral buds at the beginning of the season. Ungulates were found to have consumed 50% of the total reproductive output compared to less than 12% for all other herbivores combined.

**Gurevitch, J., J. A. Morrison, and L.V. Hedges. 2000. The interaction between competition and predation: A meta-analysis of field experiments. *American Naturalist*. 155(4):435-453.**

Meta-analysis of studies comparing competition and predation effects. Studies were drawn from an odd mix, primarily anuran (lentic organisms) manipulation studies with some studies of plants-herbivores and other organisms. As such, this study doesn't seem useful to draw conclusions about terrestrial interactions.

**Halaj, J. and D. H. Wise. 2001. Terrestrial trophic cascades: How much do they trickle? *American Naturalist*. 157(3):262-281.**

Meta-analysis examining trophic cascades: the effects of predator removal on herbivore density, plant damage and plant biomass. Regarding impacts of herbivory on plants, results were consistent with other meta-analysis where removing predators (combined for all predators across studies) had the effect of increased herbivore density and plant damage, and decreased growth after herbivory.

**Haukioja, E. and J. Koricheva. 2000. Tolerance to herbivory in woody vs. herbaceous plants. *Evolutionary Ecology*. 14:551-562.**

A review of plant structural differences in woody and herbaceous plants that contribute to responses to herbivory. The authors conclude with a caution to consider plant structure in studies of herbivory impacts.

**Hawkes, C.V. and J. J. Sullivan. 2001. The impact of herbivory on plants in different resource conditions: A meta-analysis. *Ecology* 82(7):2045-2058.**

Meta-analyses of studies of herbivory impacts under different resource (nutrients, water, light) conditions. Of interest, the authors reported responses for plant functional groups (herbaceous monocot, herbaceous dicot, and woody species), that seemed to be explained by general plant structure of each group.

**Hulme, P.E. 1994. Seedling herbivory in grassland: relative impact of vertebrate and invertebrate herbivores. *Journal of Ecology*. 82:873-880.**

A field study of level and proportion of damage by small mammal, above-ground insects, and molluscs to grassland seedlings. The study did not examine impacts on growth or fitness of the seedlings.

**Jaremo, J. and E. Palmquist. 2001. Plant compensatory growth: a conquering strategy in plant-herbivore interactions? *Evolutionary Ecology*. 15:91-102.**

This mathematical model tests the interactions of plant type (ordinary and compensating) and herbivory. For the model, the authors assume that "ordinary"

plants are most effective in the absence of herbivory and “compensating” plants in the presence of herbivory. Of interest, the propose increased competition, or invasion, of the overcompensating plant in the presence of herbivory. While their model does not include the complexity of real-world conditions, such as resource availability or timing of herbivory, it presents a hypothesis for community composition change mediated by herbivores.

**Kotanan, P.M. and J.P. Rosenthal. 2001. Tolerating herbivory: does the plant care if the herbivore has a backbone? *Evolutionary Ecology*. 14:537-549.**

The authors review differences in vertebrate and invertebrate herbivores that affect plant response, such as size and feeding behaviour. They suggest plants that tolerate specialist herbivores (more often insects) are less able to “cross-tolerate” various types of herbivory.

**Lennartson, T., J. Tuomi and P. Nilsson. 1997. Evidence for an evolutionary history of overcompensation in the grassland biennial *Gentianella campestris* (*Gentianaceae*). *The American Naturalist*. 149(6):1147-1155.**

A study of the evolutionary basis of overcompensation in a field gentian due to grazing history. Only late-flowering plants overcompensated in their greenhouse experiments, and this trait was found to be heritable.

**Low, C. and E. F. Connor. 2002. The guild-specific impact of avian predators on a community of willow insects. Master’s thesis, Dept. of Biology, SFSU.**

This study evaluates the effects by bird predators on insect herbivores, using enclosure nets to manipulate predation.

**Maschinski, J. and T. G. Whitham. 1989. The continuum of plant responses to herbivory: The influence of plant association, nutrient availability and timing. *American Naturalist*. 134(1):1-19.**

The authors examined the interactions of competition, nutrient availability and timing on relative fitness on the response of *Ipomopsis arizonica* to herbivory.

Overcompensation was present only when nutrients were added. The authors agree with Belsky (1986) that overcompensation is most likely where resources are abundant and competition is low, although they suggest that late-season herbivory is not likely to result in overcompensation under any conditions. (See Lennartson above for a different result.)

**McIntire, E. J. B. and D. S. Hik. 2002. Grazing history vs. current grazing: leaf demography and compensatory growth of three alpine plants in response to a native herbivore (*Ochotona collaris*). *Journal of Ecology*. 90:348-359.**

Authors examine the long-term effects of herbivory on three species of alpine cushion plants by pikas. The assumption on which the study is hinged is that plants located away from talus fields (pika habitat) have been ungrazed historically and those that are located in talus have been grazed. Shrub species differed in response to herbivory, and grazing history had a greater effect on growth parameters than current herbivory.

**McNaughton, S. J., M. Oesterheld, D. A. Frank, and K. J. Williams. 1989. Ecosystem-level patterns of primary productivity and herbivory in terrestrial habitats. *Nature*. 341:142-144.**

Meta-analysis of the relationship of herbivore consumption and biomass to plant primary productivity in terrestrial. Variables were positively related to plant primary productivity, suggesting that primary productivity both influences and is affected by level of herbivory. A very brief article that does not provide details about the methods used.

**Milchunas, D.G. and Lauenroth, W.K. 1993. Quantitative effects of grazing on vegetation and soils over a global range of environments. *Ecological Monographs*. 63(4):327-366.**

Meta-analysis of the effects of grazing by large ungulates in different plant communities, environmental conditions and grazing intensities and frequencies. Environmental variables such as temperature, latitude, and precipitation (or related ANPP) are much more important than grazing variables such as consumption or duration. While the authors' stated goal is a reevaluation of current range management methods for the benefit of managers, their presentation of a rather complicated analysis may prevent the information from being accessible and useful to the managers for whom it was intended.

**Noy-Meir, I. 1993. Compensating growth of grazed plants and its relevance to the use of rangelands. *Ecological Applications*. 3(1):32-34.**

A brief review of mechanisms for under- or overcompensation, followed by an appeal for alternatives for grazing management besides no-grazing or overgrazing (as implied by the different factions of the overcompensation debate) to reconcile economic and conservation goals.

**Painter, E.L. and Belsky, J. A. 1993. Application of herviore optimization theory to rangelands of the Western United States. *Ecological Applications*. 3(1):2-9.**

By reviewing studies claiming overcompensation in grassland species, the authors refute the generality of the phenomenon and suggest that equal compensation is more likely the norm. As such, they scold ecologists to more clearly communicate their ideas to the public and land managers (and that the latter not take concepts out of context), so that overcompensation is abandoned as justification for overgrazing.

**Proulx, M. and A. Mazumder. 1998. Reversal of grazing impact on plant species richness in nutrient-poor vs. nutrient-rich ecosystems. *Ecology*. 79(8): 2581-2592.**

Meta-analysis of herbivory impacts and resource availability on species richness. The authors visually compared impacts of high vs. low herbivory intensity on species richness in high and low resource systems. In sites of high resources, species richness increased in nearly all studies with increased grazing intensity; in sites of low resources, species richness decreased in all studies. These results do not appear to be consistent with those of Chase et al 2000.

**Simons, A. M. and M. O. Johnston. 1999. The cost of compensation. *American Naturalist*. 153(6):683-687.**

An example of the oddity of the bet-hedging hypothesis as an explanation of overcompensation.

**Strauss, S.Y. and Agrawal, A. A. 1999. The ecology and evolution of plant tolerance to herbivory. *Trends in Ecology and Evolution*. 14(5):179-185.**

A review of the genotypic basis of plant tolerance, including summaries of typical methods used and recent studies (see Lennartsson et al 1997 above). We're left with their question: Why don't all plants develop heritable tolerance to herbivory?

**Warner, P.J. and J. H. Cushman. 2002. Influence of herbivores on a perennial plant: variation with life history stage and herbivore species. *Oecologia*. 132:77-85.**

A study of the impacts of deer and mollusc herbivory on seedling and mature *Lupinus chamissonis*.

**Whitam, T. G., J. Maschinski, K. C. Larson, and K. N. Paige. 1991. Plant responses to herbivory: The continuum from negative to positive and underlying physiological mechanisms. In *Plant-Animal Interactions: Evolutionary Ecology in Tropical and Temperate Regions*. P. W. Price et al (Eds.). John Wiley & Sons, Inc. 227-257.**

An overview of the overcompensation debate. While arguing for a "continuum of compensation" model, the authors allocate more space to proving the existence of overcompensation.