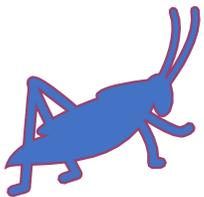


The effect of Japanese Stiltgrass
(*Microstegium vimineum*) and White-
tailed deer (*Odocoileus virginianus*) on
the ground insect community

By Elena Nattes



Fragmentation of Hardwood Forests

- Humans disturb natural ecosystems
- Change in biodiversity due to habitat destruction
- Creates smaller forests
- Unprotected environment at the forest edge



White-tailed Deer

- Behavioral plasticity
- Increase group size to make up lack of cover from predators
- Shift from one habitat to another
- Increase of white-tailed deer due to fragmentation and edge effect

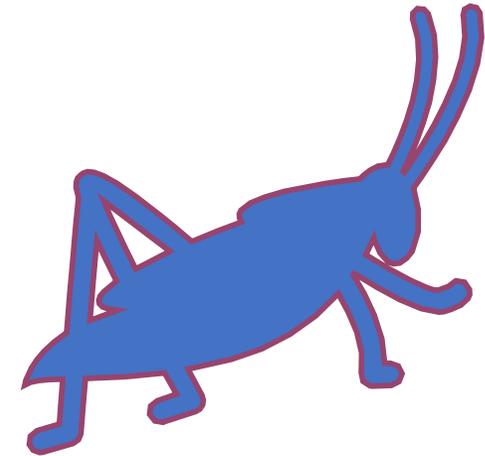


Microstegium viminuem

- Invasive warm season annual grass
- Originated in Asia
- Shade tolerance- thrive in both high and low levels of light
- Competitive with native species

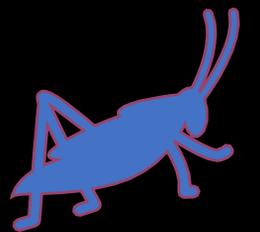


Question: How does this affect the ground insect community?



Insect Ground Community

- Some invasive plants can affect arthropod communities
- Lack of shared evolutionary history
- Change spatial and temporal dynamics
- Change behavior due to lack of shelter and plant material



Hypothesis

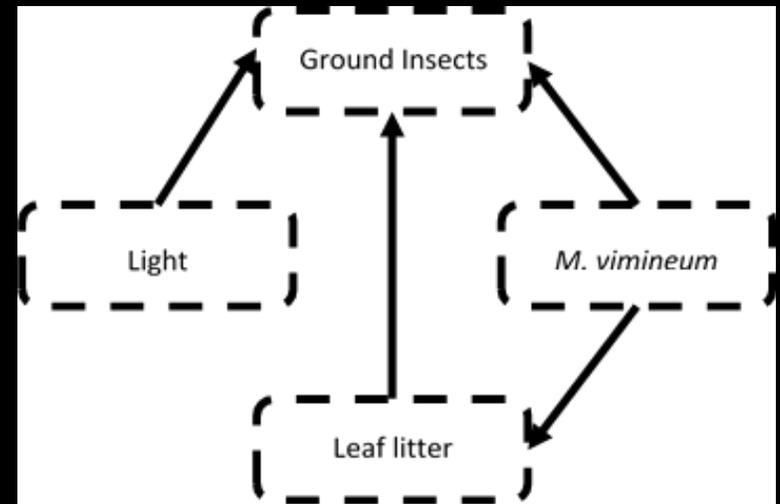
- The presence of *M. viminuem* results in a decrease of genus richness, abundance, and diversity of the ground insect community.
- Using the structural equation meta-model as a system-wide hypothesis, light and *M. vimineum* will have a negative effect on the insect ground community.

Methods

- Rosedale Park in Mercer County, NJ
- Deer exclosure experiment with *M. viminuem* introduced in half
- Each plot had pitfall traps with an aluminum barrier linking them together
- Cups filled with diluted Super Tech RV & Marine Antifreezes (1 antifreeze: 2 water)
- Insects collected in June and September over a five-day period
- Structural equation modeling used to analyze relationships between variables

Structural Equation Modeling

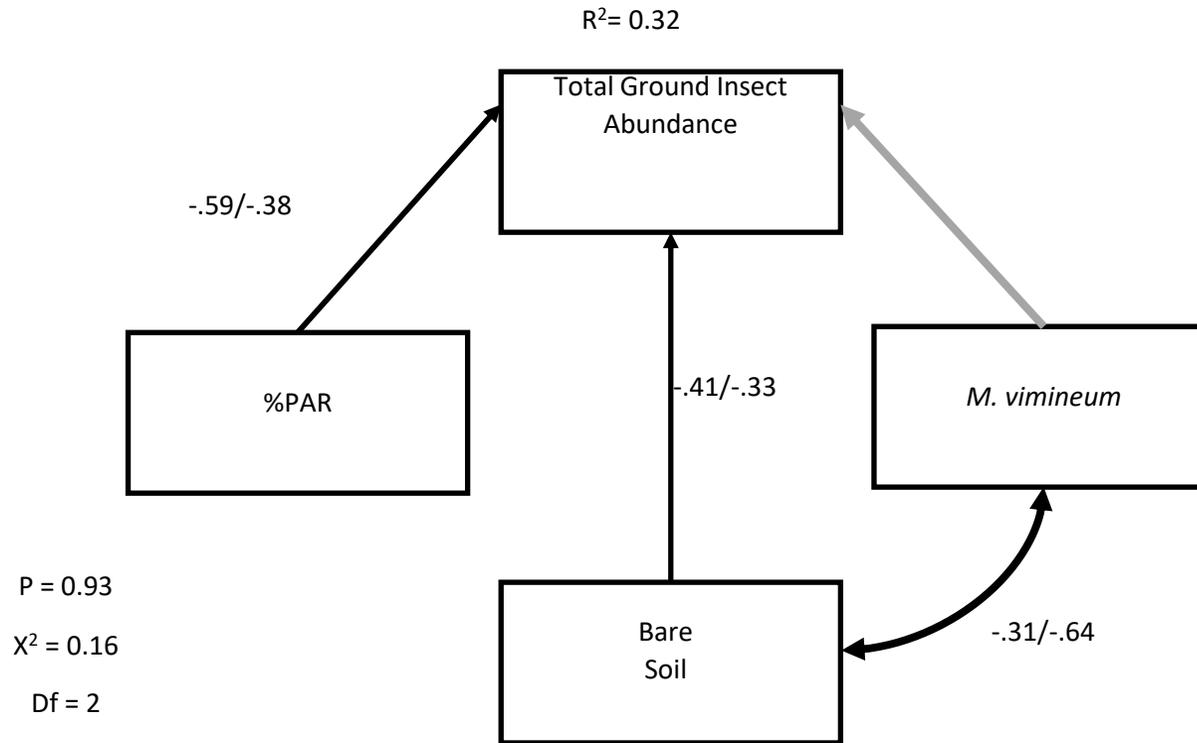
- Three collection groups: September, June, Total
- Used genus richness, abundance, Shannon-Weiner diversity index
- Variables:
 - Light
 - Leaf litter percent cover
 - *M. vimineum* percent cover
- Meta-model based on data from initial analysis
 - Fencing not considered



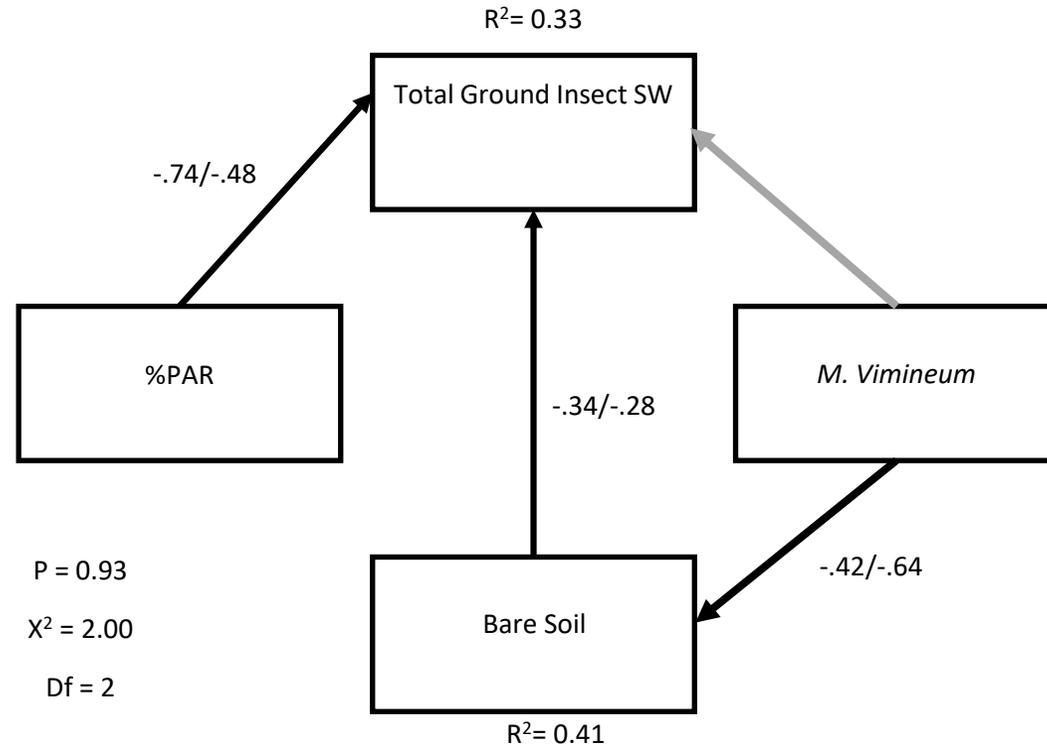
Results

- Light and bare soil had a negative effect on the ground insect community
- *M. viminuem* had no effect on the ground insect community
 - Negative effect on bare soil
- Replacing *M. viminuem* with total plant cover
 - Had positive effect on ground insect community

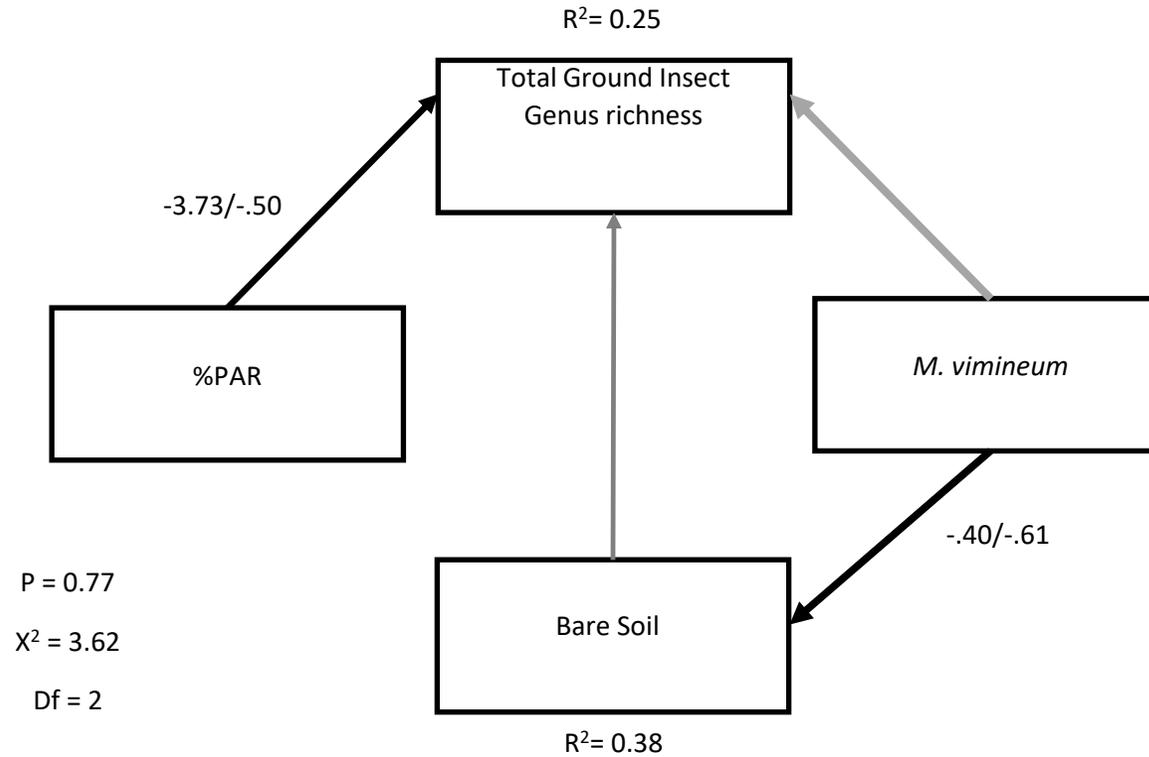
Total Ground Insect Abundance



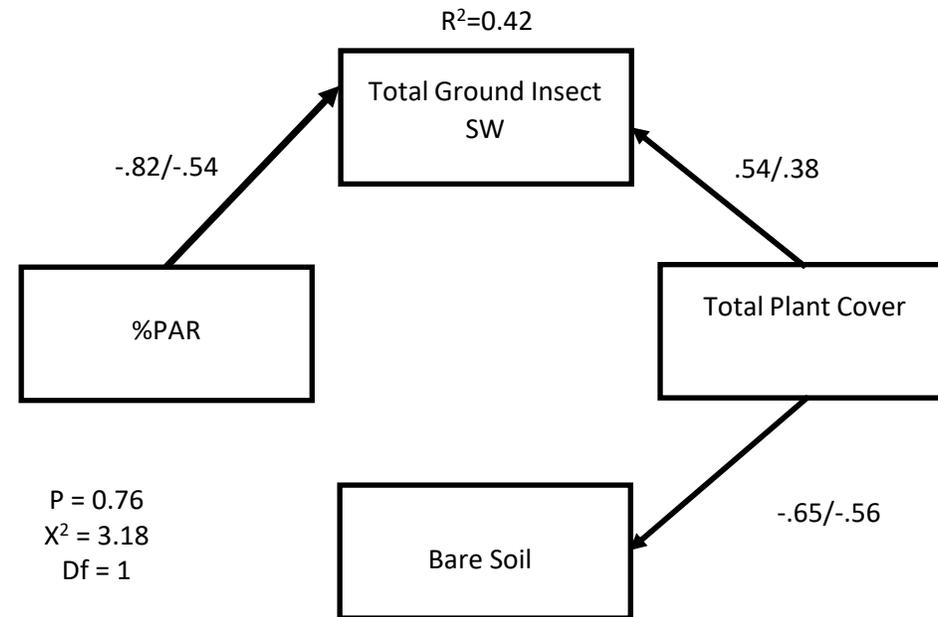
Total Ground Insect Shannon-Weiner Diversity Index



Total Ground Insect Genus Richness



Total Ground Insect Diversity with Total Plant Cover



Discussion

- *M. viminuem* indirectly affects the insect ground community
 - Indirect positive relationship with total abundance
 - Cover provided more important than invasive itself
 - Humidity, temperature, light exposure
- Overall herbaceous cover more influential

Acknowledgements

- I want to thank Dr. Morrison, Elizabeth Nemec, Daniela Nattes, and the Morrison Lab
- I want to thank my parents

Literature Cited

- Abbas F., N. Morellet, A. J. M. Hewison, J. Merlet, B. Cargnelutti, B. Lourtet, J. M. Angibault, T. Daufresne, S. Aulagnier, and H. Verheyden. 2010. Landscape fragmentation generates spatial variation of diet composition and quality in generalist herbivore. *Oecologia* 167:401-411.
- Anderson, A. N. 1995. Measuring more of biodiversity: Genus richness as a surrogate for species richness in Australian ant faunas. *Biological Conservation* 73:39-43.
- Aronson, M. F. J. and S. N. Handel. 2011. Deer and invasive plant species suppress forest herbaceous communities and canopy tree regeneration. *Natural Areas Journal* 31:400-407.
- Averill, K. M., D. A. Mortensen, E. A. H. Smithwick, and E. Post. 2016. Deer feeding selectivity for invasive plants. *Biological Invasions* 18:1247-1263.
- Averill, K. M., D. A. Mortensen, E. A. H. Smithwick, S. Kalisz, W. J. McShea, N. A. Bourg, J. D. Parker, A. A. Royo, M. D. Abrams, D. K. Apsley, B. Blossey, D. H. Boucher, K. L. Caraher, A. DiTommaso, S. E. Johnson, R. Masson, and V. A. Nuzzo. 2018. A regional assessment of white-tailed deer effects on plant invasion. *AoB Plants* 10(1):1-22.
- Barbara, J. D. 1981. *Simon & Schuster's guide to insects*. Radius-Verlag, Stuttgart.
- Barden, L. S. 1987. Invasion of *Microstegium vimineum* (Poaceae), an exotic, annual, shade-tolerant, C4 grass, into a North Carolina floodplain. *American Midland Naturalist* 118:40-45.
- Bartomeus, I., M. Vila, and L. Santamaría. 2008. Contrasting effects of invasive plants in plant-pollinator networks. *Oecologia* 155:761-770.
- Batary, P., A. Baldi, G. Szel, A. Podlussany, I. Rozner, and S. Erdos. 2007. Responses of grassland specialist and generalist beetles to management and landscape complexity. *Diversity and Distributions* 13:196-202.
- Beguin, J., J. Tremblay, N. Thiffault, D. Pothier, and S. D. Cote. 2016. Management of forest regeneration in boreal and temperate deer–forest systems: challenges, guidelines, and research gaps. *Ecosphere* 7:1-16.

- Berthon, K., F. Thomas, and S. Bekessy. 2020. The role of 'nativeness' in urban greening to support animal biodiversity. *Landscape and Urban Planning* 205.
- Bezemer, T. M., J. A. Harvey, and J. T. Cronin. 2014. Response of native communities to invasive plants. *Annual Review of Entomology* 59:119-141
- Boetzi, F. A., E. Ries., G. Schneider, and J. Krauss. 2018. It's a matter of design—how pitfall trap design affects trap samples and possible predictions. *PeerJ* 6:e5078.
- Bultman, T. L. and DeWitt, D. J. 2008. Effect of an invasive ground cover plant on the abundance and diversity of a forest floor spider assemblage. *Biological Invasions* 10:749–756.
- Burghardt, K. T., D. W. Tallamy, and W. G. Shriver. 2009. Impact of native plants on bird and butterfly biodiversity in suburban landscapes. *Conservation Biology* 23: 219-224.
- Christopher, C. C., S. F. Matter, and G. N. Cameron. 2014. Individual and interactive effects of Amur honeysuckle (*Lonicera maackii*) and white-tailed deer (*Odocoileus virginianus*) on herbs in a deciduous forest in the eastern United States. *Biological Invasions* 16:2247-2261.
- Cote, S. D., T. P. Rooney, J. P. Tremblay, C. Dussault, and D. M. Waller. 2004. Ecological impacts of deer overabundance. *Annual Review of Ecology, Evolution, and Systematics* 35:113-147.
- Derraik, K. J. M. D., J. G. B. Derraik, C. G. Rufaut, and G. P. Closs. 2005. Ground invertebrate fauna associated with native shrubs and exotic pasture in a modified rural landscape, Otago, New Zealand. *New Zealand Journal of Ecology* 29:129-135.
- Dickson, T. L., J. L. Hopwood, and B. Wilsey. 2012. Do priority effects benefit invasive plants more than native plants? An experiment with six grassland species. *Biological Invasions* 14:2617-2624.
- Dillon, M. and E. S. Dillon. 1972. *A manual of common beetles of eastern North America*. Row, Peterson, and Company.
- Dutra, H. P., K. Barnett, J. R. Reinhardt, R. J. Marquis, and J. L. Orrock. 2011. Invasive plant species alters consumer behavior by providing refuge from predation. *Oecologia* 166:649-657.
- Eaton, E. R., R. Bowers, and K. Kaufman. *Field guide to insects of North America*. Houghton Mifflin, New York.
- Eisenhauer, N., M. A. Bowker, J. B. Grace, and J. R. Powell. 2015. From patterns to causal understanding: Structural equation modeling (SEM) in soil ecology. *Pedobiologia* 58:65-72.
- Faeth, S. H., P. S. Warren, E. Shochat, and A. Marussich. 2005. Trophic dynamics in urban communities. *BioScience* 55:399-407.
- Ferro, M. L., M. K. Thayer, A. F. Newton Jr., and J. S. Park. 2015. Key to North American Staphylinidae subfamilies. Lucidcentral.

- Fieberg, J., D. W. Kuehn, and G. D. Delgiudice. 2008. Understanding variation in autumn migration of northern white-tailed deer by long-term study. *Journal of Mammalogy* 89:1529–1539.
- Frerker, K., A. Sabo, and D. Waller. Correction: long-term regional shifts in plant community composition are largely explained by local deer impact experiments. *PLoS One* 9:1-17.
- Gibson, D. J., S. L. Collins, and R. E. Good. 1988. Ecosystem fragmentation of oak-pine forest in the New Jersey Pinelands. *Forest Ecology Management* 25:105-122.
- Grace, J. B. 2006. *Structural equation modeling and natural systems*. Cambridge University Press, Cambridge.
- Gratton, C. and R. F. Denno. 2006. Arthropod food web restoration following removal of an invasive wetland plant. *Ecological Applications* 16:22-31.
- Harvey, J. A., T. Bukovinszky, and W. H. V. Putten. 2010. Interactions between invasive plants and insect herbivores: a plea for a multitrophic perspective. *Biological Conservation* 143:2251-2259.
- Hejda, M., P. Pysek, and V. Jarosik. 2009. Impact of invasive plants on the species richness, diversity, and composition of invaded communities. *Journal of Ecology* 97:393-403.
- Janzen, D. H. 1985. Coevolution as a process: what parasites of animals and plants do not have in common. *Coevolution of Parasitic Arthropods and Mammals* 1:83-99.
- Jepsen, J. U. and C. J. Topping. 2004. Modeling roe deer in a gradient of forest fragmentation: behavioural plasticity and choice of cover. *Canadian Journal of Zoology*, 82:1528-1541.
- Jouquet P., J. Dauber, L. P. Lagerlöf, and M. Lepage. 2006. Soil invertebrates as ecosystems engineers: intended and accidental effects on soil and feedback loops. *Applied Soil Ecology* 32:153–164
- Kellogg, C. H. and S. D. Bridgham. 2004. Disturbance, herbivory, and propagule dispersal control dominance of an invasive grass. *Biological Invasions* 6:319-329.
- Klein, B. C. 1989. Effects of forest fragmentations on dung and carrion beetle communities in Central Amazonia. *Ecology* 70:1715-1725.
- Knight T. M., J. L. Dunn, L. A. Smith, J. Davis, and S. Kalisz. 2009. Deer facilitate invasive plant success in a Pennsylvania forest understory. *Natural Areas Journal* 29:110-116.
- Litt, A. R. and R. J. Steidl. 2010. Insect assemblages change along a gradient of invasion by a nonnative grass. *Biological Invasions* 12:3449-3463.
- Litt, A. R., E. E. Cord, T. E. Fulbright, G. L. Schuster. 2014. Effects of invasive plants on arthropods. *Conservation Biology* 28:1532-1549.
- Liu, H., P. Stiling, and R. W. Pemberton. 2007. Does enemy release matter for invasive plants? evidence from a comparison of insect herbivore damage among invasive, non-invasive, and native congeners. *Biological Invasions* 9:773-781.
- Mandelik, Y., T. Dayan, V. Chikatunov, and V. Kravchenko. 2007. Reliability of a higher-taxon approach to richness, rarity, and composition assessments at the local scale. *Conservation Biology* 21:1506-1515.
- Maron, J. L. and M. Marler. 2008. Effects of native species diversity and resource additions on invader impact. *American Naturalist* 172:18–33.
- Marshall, J. M. and D. S. Buckley. 2009. Influence of *Microstegium vimineum* Presence on insect abundance in hardwood forests. *Southeastern Naturalist* 8:515-526.
- Mattos, K. J. and J. L. Orrock. 2010. Behavioral consequences of plant invasion: an invasive plant alters rodent antipredator behavior. *Behavioral Ecology* 21: 556–561
- McCrary, K. W. and J. E. Willand. 2007. Effects of pitfall trap preservative on collection of carabid beetles (Coleoptera: Carabidae). *The Great Lakes Entomologist* 40:154-165.
- Nuland, M. E. V. and W. L. Whitlow. 2014. Temporal effects on biodiversity and composition of arthropod communities along an urban–rural gradient. *Urban Ecosystems* 17:1047-1060.
- Orrock, J. L., R. D. Holt, and M. L. Baskett. 2009. Refuge-mediated apparent competition in plant–consumer interactions. *Ecology Letters* 13:11-20.
- Parker, J. D. and M. E. Hay. 2005. Biotic resistance to plant invasions? Native herbivores prefer non-native plants. *Ecology Letters* 8:959–967.

- Pimentel, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52: 273-288.
- Potapov, E., A. Bedford, F. Bryntesson, and S. Cooper. 2014. White-tailed deer (*Odocoileus virginianus*) suburban habitat use along disturbance gradients. *American Midland Naturalist* 17:128-138.
- Rawinski, J. T. 2008. Impacts of white-tailed deer overabundance in forest ecosystems: an overview. *Northeastern Area State and Private Forestry*.
- Rooney, T. and D. M. Waller. 2003. Direct and indirect effects of white-tailed deer in forest ecosystems. *Forest Ecology Management* 181:165-17.
- Rossell, C. R., S. Patch, and S. Salmons. 2007. Effects of deer browsing on native and non-native vegetation in a mixed oak-beech forest on the Atlantic coastal plain. *Northeastern Naturalist* 14:61-72.
- Rutberg, A. T., R. E. Naugle, L. A. Thiele, and I. K. M. Liu. 2004. Effects of immunocontraception on a suburban population of white-tailed deer *Odocoileus virginianus*. *Biological Control* 116:243-250.
- Schmit, J. P., E. R. Matthews, and A. Brolis. 2020. Effects of culling white-tailed deer on tree regeneration and *Microstegium vimineum*, an invasive grass. *Forest Ecology and Management* 463.
- Seastedt, T. R. and D. A. Crossley. 1984. The influence of arthropods on ecosystems. *BioScience* 34:157-161.
- Snyder, W. E. 2019. Give predators a complement: Conserving natural enemy biodiversity to improve biocontrol. *Biological Control* 135:73-82.
- Spafford, R. D., C. J. Lortie, and B. J. Butterfield. 2013. A systematic review of arthropod community diversity in association with invasive plants. *NeoBiota* 16:81-102.
- Stephan, J. G., F. Pourazari, K. Tattersdill, T. Kobayashi, K. Nishizawa, and J. R. DeLong. 2017. Long-term deer enclosure alters soil properties, plant traits, understory plant community and insect herbivory, but not the functional relationships among them. *Oecologia*, 184:685–699.
- Stromayer, K. A. K. and R. J. Warren. 1997. Are overabundant deer herds in the Eastern United States creating alternate stable states in forest plant communities? *Wildlife Society Bulletin* 25:227-234.
- Tallamy, D. W. 2004. Do alien plants reduce insect biomass? *Conservation Biology* 18:1689-1692
- Thomas, D. B. 2008. A safe and effective propylene glycol-based capture liquid for fruit fly (Diptera: Tephritidae) traps baited with synthetic lures. *Florida Entomologist* 91:210-213.
- Thomas, Donald B. 2008. Nontoxic antifreeze for insect traps. *Entomologist News* 119: 361-356.
- Vilà, M., J. L. Espinar, M. Hejda, P. E. Hulme, V. Jarošík, J. L. Maron, J. Pergl, U. Schaffner, Y. Sun, and P. Pyšek. 2011. Ecological impacts of invasive alien plants: a meta-analysis of their effects on species, communities, and ecosystems. *Ecology Letters* 14: 702-708.
- Werner, S. M. and K. Raffa. 1999. Effects of forest management practices on the diversity of ground-occurring beetles in mixed northern hardwood forests of the Great Lakes Region. *Forest Ecology and Management* 139:135-155.
- White, R. E. 1998. *A field guide to the beetles of North America*. Houghton Mifflin, Boston.
- Williams, S. C. and J. S. Ward. 2006. Exotic seed dispersal by white-tailed deer in Southern Connecticut. *Natural Areas Journal* 26:383-390.
- Williams, S. C., J. S. Ward, and U. Ramakrishnan. 2008. Endozoochory by white-tailed deer (*Odocoileus virginianus*) across a suburban/woodland interface. *Forest Ecology and Management* 255:940-947.