

## **Proactive Coevolution: Staying Ahead of Invasive Species in the Face of Climate Change and Uncertainty**

By Dave Ellum

The next generation of foresters, silviculturists and forest managers will have to be far more imaginative in predicting management outcomes than we've had to be up to this point. Until recently, our profession as had the luxury of basing management prescriptions on the ecological response of well-defined forest communities under relatively stable regional climates. With climate change, predicting the outcomes of long-term management prescriptions will be far more elusive than it was for our predecessors. A warmer, drier climate in the southeastern United States could have profound effects on the forest communities under management. As plant species ranges shift north or contract<sup>1</sup>, competition dynamics could become fundamentally altered and standard regeneration methods could produce limited success. Shifts in species ranges could also provide opportunities for unique species mixtures leading to the development of novel forest communities unseen during recent times<sup>2</sup>. The uncertainties brought about by climate change are especially relevant to managing future threats of invasive plant species to our native forest ecosystems. To meet this challenge, we will have to develop proactive approaches that focus on identifying future invasive species, promote management strategies that reduce the opportunity for invasion and prioritize our efforts in combating these species.

Currently known invasive species such as multiflora rose (*Rosa multiflora*), Oriental bittersweet (*Celastrus scandens*), privet (*Ligustrum sinense*) and autumn olive (*Elaeagnus umbellata*) may be the least of our future management worries in the face of climate change. With climate change, we could conceivably see niche contraction of some of these species and subsequent declines in populations. It is far more likely that we will have to deal with a whole new set of invasive species; species that are completely new to our forest ecosystems, or background species that do not currently cause problems but will become invasive due to climatic release. In Great Smoky Mountain National Park, there are 380 exotic species currently documented with only 35 of these considered invasive<sup>3</sup>. Changing climate could release many of these species from environmental or competitive constraints, providing a whole new suite of invasive species needing

management. In addition, we could find some native species becoming more aggressive and taking over sites leading to regeneration failure and damage to current stands. We may already be seeing this in the southeast with the increased growth of woody vines such as poison ivy (*Rhus radicans*) and grape (*Vitis sp.*)<sup>4</sup>. These scenarios require that we shift some of our attention and resources away from fighting well established species and focus on a proactive approach of predicting and managing what lies ahead.

Plant ecologists have done much of the work determining which life history traits make a species a successful invader. These traits include early sexual maturity, many light and widely dispersed seeds, rapid growth, extended growing periods, high photosynthetic rates and the ability to rapidly colonize disturbed sites<sup>5</sup>. As forestry professionals, our job is to assess the variety of management prescriptions at our disposal for their tendency to either promote or limit the invasion of managed sites by exotic species. While intermediate treatments merit attention, the need for a better understanding of these mechanisms is especially important for regeneration treatments that can result in highly disturbed site conditions.

Conditions that could facilitate invasion during the course of management include exposed mineral soil, high light environments resulting from complete canopy removal, fragmentation of stands, permanent roads into forest interiors and short rotation lengths. These conditions not only promote the colonization of exotic invasive species, they also limit the ability of native, forest interior plant communities to maintain viable populations due to physiological stress, low reproductive rates and physical damage<sup>6</sup>. With this in mind, the best management practices will not only limit the probability of invasion, but also provide a competitive advantage to native forest species. These would include irregularly shaped harvest gaps that are oriented so that viable populations of native species remain along gap edges, and reducing the area/perimeter ratio of gaps to limit the extent of high light gap centers which favor early successional colonizing species<sup>7,8</sup>. It may also be necessary to rely on advance regeneration whenever possible and to limit road systems to reduce the amount of bare mineral soil exposed during operations, along with shelterwood or group selection systems that maintain canopy structure during regeneration.

While we can implement management practices that limit the negative effects of invasive species, in most cases it is not reasonable to use the words elimination or eradication in our invasive species management plans. Many of these species can not be realistically removed completely and prevented from returning long-term unless intense resources are expended. When those resources included repeated herbicide treatments, the potential for negative side effects could outweigh the management goal. This is especially true in forest stands that are surrounded by non-forested landscapes, or forest blocks that are small and isolated.

The desire to eliminate or eradicate invasive species can in part be attributed to our desire to return our forests to their historic conditions. However, the combination of a century of intensive management combined with changing climate most likely makes historic conditions unattainable<sup>9</sup>. The more appropriate approach to invasive species control would be to manage these species at “acceptable levels”. What constitutes an acceptable level should shift on a case by case basis depending on site and the desired management outcome. Forests of unique conservation or social value or high economic value should merit lower acceptable levels than more widely represented forest types or non-production forests. The species we choose to manage against should also be prioritized by the probability of success, as well as the amount of damage they can inflict on the forest system. What this means is that some exotic invasive species might have to be accepted as part of our “natural” forest systems so that other more detrimental species, or species that are more reasonably considered controllable, can be given increased attention. Unfortunately, many of our worst invasive species threats might still be on the horizon and very difficult to predict, let alone prioritize.

Using the place-based knowledge that comes along with sound ecological forestry will be an important tool in identifying potential problem plants before they become full scale invaders. This work can not be left to researchers alone. It must also be a task for the practitioner in the field who can use his or her intimate knowledge of a forested landscape to identify and bring attention to subtle changes in forest structure and composition. One priority will be to identify and document any plant species, exotic or native, that are in early stages of population growth that could indicate the beginning stages of invasion. This would include new species that suddenly occur or background

species that become more common in abundance or diversify the habitats types where they can be found. Another important task will be the identification of landscape features that could become future refugia where native plant communities could persist in spite of invasive species and climate change due to their ability to compete in temporally stable conditions<sup>10</sup>. As with our management practices, it will be as important to identify and protect the attributes of forest systems that provide resiliency against invasion as it is to control invasive species once they have arrived.

My mentor is fond of saying that good silviculture does not come from a cookbook. Now, with climate change and the probability of novel forest community types, this may be truer than ever. We could be entering a time when the path to desired outcomes is less clear than it has been in the past, and most management becomes experimentation. In these times, we can not rely solely on a reactionary approach of controlling invasive species that are already well established. A truly proactive approach must focus not only on management practices that control invasive species but also those that promote them, identify the components of forest ecosystems that provide resilience to invasion and be able to predict future invasive species before they become regional problems. Perhaps most difficult of all, this approach must be realistic enough to prioritize our efforts, and always aware of the uncertainty that lies ahead. This will take forestry professionals who have intimate knowledge of the forests they manage, and are willing and imaginative enough to integrate the current body of knowledge with future predictions on forest ecosystem trajectories to develop management practices that are flexible enough to adapt to a moving target of unknown size and shape. These goals are obtainable, and uncertainty should not lead to inaction. While I realize that I may not be right in some of these predictions, I know that I am wrong if I do not ask the questions.

<sup>1</sup>Prasad, A. M., L. R. Iverson, S. Matthews, M. Peters. Climate Change Tree Atlas (A Spatial Database of 134 Tree Species of the Eastern USA). NRS-4151, USDA Forest Service, Northern Research Station, Delaware, Ohio.

<sup>2</sup>Williams, J. W., S. T. Jackson. 2007. Novel climates, no-analog communities, and ecological surprises. *Frontiers in Ecology and the Environment*. 5(9): 475-482.

<sup>3</sup>Langdon, K. USNPS, GSMNP All Taxa Biodiversity Project. Personal communication.

<sup>4</sup>The Forestry Source. 2007. Increase in vine density may alter composition, structure of southeast's bottomland hardwood forests. *Society of American Foresters*. 12(9).

<sup>5</sup>Bazzaz, F. A. 1986. Life history of colonizing plants: some demographic, genetic and physiological features. In: Mooney, H. A. and Drake, J. A. (Eds). *Ecology of biological invasions of North America and Hawaii*. Springer-Verlag. New York, NY.

<sup>6</sup>Meier, A.J., S. Bratton, D. Duffy. 1995. Possible ecological mechanisms for loss of vernal-herb diversity in logged eastern deciduous forests. *Ecological Applications*. 5(4):935-946.

<sup>7</sup>Aikens, M. L., D. Ellum, J. McKenna, M. Kelty, M. Ashton. 2007. The effects of disturbance intensity on temporal and spatial patterns of herb colonization in a southern New England mixed-oak forest. *Forest Ecology and Management*. 252: 144-158.

<sup>8</sup>Ellum, D.S. 2007. Demographic patterns and disturbance responses of understory vegetation in a managed forest of southern New England. PhD Dissertation. Yale University School of Forestry and Environmental Studies.

<sup>9</sup>Seastedt, T.R., R. Hobbs, K. Suding. 2008. Management of novel ecosystems: are novel approaches required? *Frontiers in Ecology and the Environment*. 10(6): 547-553.

<sup>10</sup>Loarie, S.R., B. Carter, K. Hayhoe, S. McMahon, R. Moe, C. Knight, D. Ackerly. 2008. Climate change and the future of California's endemic flora. *PLOS One*. 3(6): 1-10.