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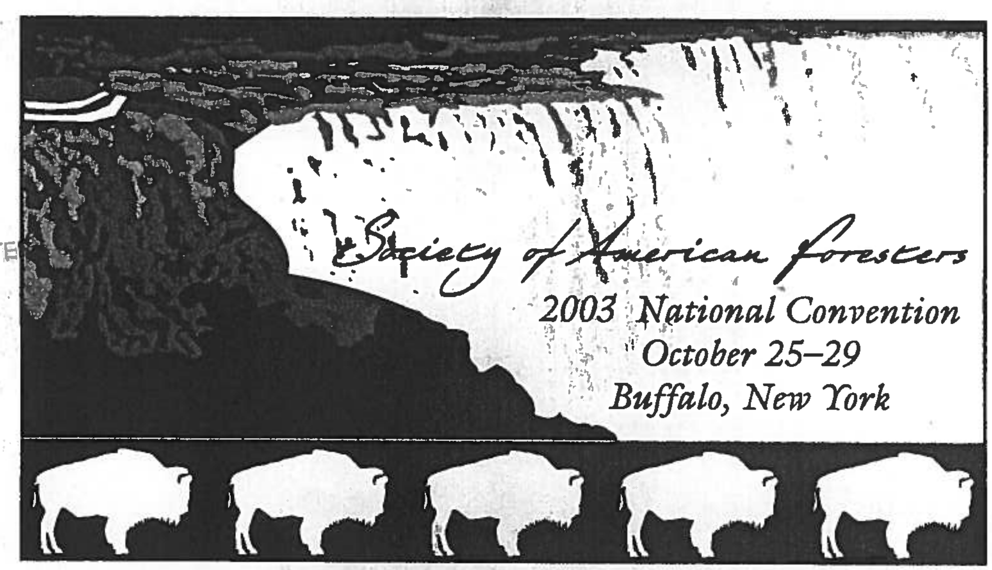

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USE OF COMPARISON AREAS RATHER THAN CONTROLS IN A STUDY OF FUELS IN INVADED FORESTS OF THE NORTHEAST AND MID-ATLANTIC STATES

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ABSTRACT. In paired studies where the comparison is between a treated and untreated forest area, the unmanipulated stand is often called a control. The two areas might not be consistent in forest cover type, understory plant communities, disturbance history, soils, slope, and aspect. To enhance rigor in forest research, the reference stand should receive more scrutiny and, unless it matches the treated area well, can be regarded as a comparison area rather than a control. For example, in a new study of interactions between fire and invasive plants, we sought paired areas – one that was heavily invaded by exotic plants, and a nearby or contiguous uninvaded area. Among our 13 pairs at 12 sites, we found a few stands that were completely free of exotic plants, but most of our comparison areas were compromised by one or more small, patchy populations of invasive species. This might not matter, as we found significant differences between invaded and uninvaded conditions, especially in fine fuels. Invasive plants alter the fuel bed in pitch pine stands where invasion by black locust leads to substantial reduction in fine fuels. Fire return interval and fire intensity are expected to decrease in such situations. Where invasive grasses such as Japanese stiltgrass or wood blue-grass are present, grass fuels are much more abundant in invaded forests. This could lead to rapid spread of wildfire in a dry year. Though we lacked ideal controls, the mostly uninvaded comparison areas provided an opportunity to understand how fuel loads differ when invasive plants are present.

KEYWORDS. Control, reference conditions, wildland urban interface, fire, fuels, invasive plants

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Introduction

To promote rigor in forest research, we need to reexamine the premise that a "control" is truly comparable to the treatment in its pre-treated condition. Even if we could return to forest conditions of presettlement times, we would likely find that many centuries of fires associated with native North Americans influenced forest composition. Thus silvicultural experiments and forest ecology studies cannot employ a bona fide control against which treatments can be assessed. Controls might not be needed if the data can be presented as a case study, and/or when the results are unequivocal. Among the ways one can adjust for inadequate controls when setting up a study design are to: (1) contrast the treatment with multiple untreated areas that share cover type, (2) capture a gradient of conditions, (3) measure the response to the treatment in one or a few species rather than by an overall feature such as basal area, and (4) call the reference conditions a *comparison* rather than a control.

I and my co-researchers used the latter option in an investigation of the interactions between fire and invasive plants in eastern forests. We undertook the study because in our region, fuels in the wildland urban interface (WUI -- the proximity of human populations to fuels that could be consumed by a wildfire) have not been fully characterized. Today, houses and businesses are near or within the forests of the Northeastern and Mid-Atlantic states. In wetter years, fire is of little concern, but sporadic droughts have created conditions leading to catastrophic wildfires in the Eastern United States. In October 1947 in Maine, nearly 213,000 acres burned; 35 towns were affected, 851 year round residences were destroyed, and 397 seasonal cottages were lost. The largest single fire that year consumed about 165,000 acres (estimates ranged from 150,000-180,000 ac) in southern Maine. The blaze stopped only when it reached the Atlantic Ocean. During April 1963, there were 4,861 forest fires in Massachusetts. In 1995, two of the largest fires in the East were the nearly 20,000-acre Greenwood Fire in New Jersey and the 5,000-acre Rocky Point Fire on Long Island, New York. Sources for this information include newspaper articles.

Invasive plants can alter the fire regime by adding fuel, by changing the phenology of green-up and browning of vegetation, and eventually by altering forest composition. Not all forests in this region are invaded, and invasive plants tend to be patchy where they are present. But many invasive plant species are abundant in eastern forests (Richburg et al. 2001). Some were introduced as "conservation plantings" or garden subjects and then escaped from their original plantings, or were spread from plantings into forests by birds. Some have persisted and spread in part because white-tailed deer do not favor them as food, and because they are aggressive competitors for space, light, water, and nutrients. Invasive plants affect not only fuel loads, they affect biodiversity by occupying rare plant habitat, and they degrade wildlife habitat, constituting a different food and cover resource than native plants.

Among the most prominent invasive plants of forests in our region is black locust (*Robinia pseudoacacia*), which is native from Pennsylvania southward but not in New England. The trees are thought by some managers to be unflammable. In fire-adpated pitch pine (*Pinus rigida*) sites, black locust lengthens the fire return interval to an unsustainable level, and pitch pine eventually is shaded out along with fire-adapted understory plants. This benefits the WUI in that fire danger to nearby houses is lower. However, locust invasion impacts habitat for insects such as the federally endangered Karner blue butterfly (*Lycaeides melissa sameulis*) and its disturbance-dependent host plant, blue lupine (*Lupinus perennis*). (This blue lupine is not the same as the popular lupine of roadsides in Maine, which is native *L. polyphyllus* of Pacific Northwestern North America.) Other invasive trees here are tree-of-heaven (*Ailanthus altissima*), Norway maple (*Acer platanoides*) and exotic apple (*Malus* sp.). All of these are capable of spreading and persisting, and might crowd out native trees over time. Invasive shrubs and vines include Japanese barberry (*Berberis thunbergii*), common barberry (*B. vulgaris*), Asian honeysuckle (i.e., *Lonicera* x*bella, L. tatarica, L. xylosteum, L. maackii, L. morrowii*, and *L.* x*bella*), Japanese honeysuckle (*L. japonica*), privet (*Ligustrum* spp.), alder buckthorn (*Frangula alnus*), common buckthorn (*Rhamnus cathartica*), Asian bittersweet (*Celastrus orbiculatus*), and multiflora rose (*Rosa multiflora*). Forbs include garlic mustard (*Alliaria petiolata*), Japanese stiltgrass (*Microstegium vimineum*), wood bluegrass (*Poa nemoralis*), fine-leaved sheep fescue (*Festuca filiformis*), and sweet vernal grass (*Anthoxanthum odoratum*). We are searching the literature to find data to support our assumption that most of the invasive plants in forests are necessarily shade tolerant.

We hypothesized that invasive exotic shrubs and grasses contribute to the fuel bed by adding fine fuels. Uninvaded stands might have a sparse shrub or grass layer, but a similar nearby stand can have its understory filled with honeysuckle, multiflora rose, or barberry in an unpenetrable thicket, or it might have Japanese stiltgrass in a homogeneous sward. In dry conditions, such grasses can allow rapid spread of a wildfire so that it is larger and more intense than it might otherwise be if those grasses were not present.

During a 3-year project, we quantified the fuels in forests with invasive plants and compared results with those from nearby stands having few or no invasives. The objective was to determine whether these plants contribute to the fuelbed or increase the potential for spread of wildfire in invaded forests associated with the WUI. Analyses are in the early stages, and the final results will be published in more detail soon. You can learn more at:

http://www.fs.fed.us/ne/durham/4155/fire/dibble_1/jfsp.html.

Methods

From 2001 to 2003 we sampled woody fuels at 13 sites: Acadia National Park (Bar Harbor, ME), Albany (NY) Pine Bush (2 sites), Antietam National Battlefield Park (Sharpsburg, MD), Cape Cod National Sea Shore (Wellfleet, MA), Finger Lakes National Forest (Hector, NY), Holbrook Island Sanctuary (Brooksville, ME), Manassas (VA) National Battlefield Park, Massabesic Experimental Forest (Lyman, ME), Merck Forest and Farmland Center (Rupert, VT), Morristown (NJ) National Historical Park, Penobscot Experimental Forest (Bradley, ME), and Rachel Carson National Wildlife Refuge (Kittery, ME). Site selection was based on management priorities concerning the worst invaded conditions and most pristine forest of a similar cover type. Cover types include pitch pine-scrub oak, eastern white pine-northern red oak, balsam fir-red spruce, oak-hickory, northern hardwoods, and various mixed hardwood types. In some cases the invaded area was part of the same stand, with uninvaded sections interspersed along a single transect. At other sites, we had to compare two separate stands < 2 km apart because the invaded stands offered an insufficient area of uninvaded conditions to sample. Our criterion for "uninvaded" focused especially on woody exotic plants because the fuel sampling method concentrates on this. Topography and elevation were similar between paired areas, and cover type matched in most cases.

At each site we established transects (200 to 400 m long) that extended through invaded and uninvaded conditions. At random locations we established five 2m x 8m plots in stands with substantial density of invasive plants, and five plots in a nearby relatively uninvaded stand that shared the same cover type and that had potential for restoration (total, 10 plots per study area). We sampled fuels by a protocol modified from the widely-used planar-intercept fuel sampling technique for dead woody vegetation (Brown 1974). We included live shrub height as a way to capture live fuels, and five Braun-Blanquet cover classes for forbs, graminoids, shrubs, trees, and slash. We sampled nonwoody litter biomass in 40- x 40-cm subplots (one at each plot). Data analyses were conducted separately for a group of ten mixed hardwood and softwood sites, which are not fire-adapted, and another group of three study areas with fire-adapted pitch pine (two at Albany Pine Bush, one at Cape Cod National Sea Shore). Analyses to date include t-tests, multivariate techniques, and nonparametric tests such as Kruskal Wallis.

Summary of Results to Date

Few of the "uninvaded" stands were free of exotic plants, but we found wide discrepancies in the fuel loads and think the lack of true controls does not affect our interpretation of the data.

We found several patterns: (1) in three pitch pine sites, which included invasion by black locust, the invaded stands had lower nonwoody litter in tons/ac, lower biomass of 100-hr fuels (1 to 3 inches in diameter), and lower basal area; (2) at ten sites with spruce-fir, mixed hardwoods, and hardwoods, invaded stands had less nonwoody litter, more 100-hr fuels, less duff depth, more cover by graminoids and shrubs, and less basal area. Where present, exotic grasses significantly increase the continuity of fine fuels, suggesting that during an extreme drought in autumn, a wildfire could spread more easily than in a stand where such grasses are absent. Site-specific rather than general management recommendations are appropriate given that the species of invasive plants that occupy a forest in a given locale will determine what action might be effective.

Implications for Managers

A true control is practical where a single forest stand of homogeneous composition and structure is divided into blocks and treatment levels assigned at random. Otherwise, where managers wish to compare a treated area to a comparison area, it is wise to examine differences between the two areas that do not stem from the treatment itself. If these differences can be measured, they might be used as a covariate in a model. Otherwise, assume that only highly significant differences can override the inadequate match-up in conditions between the treated and untreated areas.

Based on my observations in seven states of the northeast and Mid-Atlantic, I suggest that in general, when seeking to control invasive plant populations, the manager needs to recognize the problem while populations are small, and then direct resources toward controlling the invasive plants early and often. If the populations are already dense and well-established, seek to coordinate the timing of treatments with the season of fruit dispersal. For example, if garlic mustard is to be hand-pulled, this should be undertaken before seeds ripen. If Japanese barberry is to be cut and the stumps painted with herbicide, this should be done before the berries ripen and are taken by birds.

In forests of our region, control efforts include girdling (black locust), cutting, herbiciding stumps of woody plants, hand-pulling, mowing (difficult in most forests!), and burning. To my knowledge, grazing has not been tried here much yet. Dormant season burning often has the effect of promoting regrowth of the undesirable species. Whatever treatment is selected, repeated treatments will probably be necessary, and total eradication might not be realistic. Where resources are scant, it might be possible to enlist the help of volunteers who can be trained to recognize and pull undesirable vegetation, but soil disturbance during this activity could expose seeds of other invasive species, or contribute to erosion. If there are multiple problem species over a wide area, a triage approach would involve prioritization of rare plant habitat or areas where sensitive features are a concern. Lower priority habitats initially would receive fewer resources, but if ignored completely, they could be a source for fresh invasions into new or restored areas.

To reduce hazard fuels that have accumulated with invasive grasses, flammable shrubs, or invasive trees, it might be necessary to cut, spray, graze, or burn in the invaded area. Such treatments might have to be phased in, depending on the proximity of houses or businesses. And repeat treatments are, again, likely to be necessary.

Regardless of the invasive plant species of interest and the control method selected, a manager might wish to leave an untreated comparison area because it would be useful in judging the efficacy of the treatment. However, the manager risks further spread of the invasive plants back into the treated area. In such a situation, both a true control and a comparison area would be lacking, but the overall goal of controlling invasive plants has a higher priority.

A related study, which is part of this same project, was conducted by William A. Patterson III and Julie Richburg at the University of Massachusetts (Amherst). They tested cutting and burning in the dormant and growing seasons, and investigated the timing of treatments to weaken woody clonal invasive plants by repeated disturbances. The results of that study will be available at http://www.fs.fed.us/ne/durham/4155/fire/dibble_1/jfsp.html.

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