The Role of Deer in Determining the Abundance and Diversity of Native Plants in Oak Forests of Southwestern, CT (2007-2009)

A Proposal to Sample Vegetation on Lands Owned by William Hill, the Connecticut Department of Environmental Protection, Aquarion Water Company, the Towns of Redding, Wilton, Ridgefield, and Bethel, and the Nature Conservancy

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SUMMARY

Although the impacts of white-tailed deer to forest structure and composition are well-documented in some regions, research is comparatively scarce on the effects of this herbivore to oak forests of southern New England. Evidence of open understories, browse lines, and declining herbaceous plant diversity in this region is largely anecdotal instead of empirical. Due to its high deer densities, relatively uniform environment, extent of permanently protected land, and its recent commitment to reduce the deer population, Redding and its seven abutting towns present an ideal location within southern New England to investigate the impacts of white-tailed deer to forests. In the summer of 2007, we propose to initiate a long-term study of forest regeneration in response to different hunting pressures in mature oak forests of this region. We will compare tree seedling and herb regeneration in exclosure vs. control plots at Highstead, on hunted vs. unhunted properties across 8 towns in southwestern, CT, and on properties where hunting has just commenced to monitor forest understory changes over time. With these data and permanently marked plots, it will be possible to quantify the impacts of deer and different deer management histories on forest vegetation and to follow the vegetation response through time as a major forest disturbance is reduced.

Measurements proposed for Highstead and other properties:

- Herb and tree seedling composition, density, height, and browse pressure
- shrub and tree composition, density, and cover
- Tree diameter (provides basal area and biomass estimates)
- Antler scrape damage to small trees
- Deer pellet counts
- Landscape position and characteristics (e.g., slope, aspect, orientation)
- Soils (chemistry, moisture holding capacity, profile description, structure)
- Other natural and human disturbance

Note:

- If permitted, each plot will be marked discretely with a short <24" pipe with brass engraved cap. These permanent markers will make it possible to locate these points in the future for additional studies or monitoring (Future monitoring would occur every 1-5 years). These markers are currently being installed at Highstead.
- There will be no destructive sampling of vegetation and no permanent indication that the sampling has been performed.
- Maps of all proposed areas and plot locations will be made available to the landowners. All data collected will be made available to the respective landowners, along with a report on the results of the study.

Introduction

White-tailed deer have increased dramatically throughout the world's temperate forest region in recent decades due to reduced human and natural predators, increased forest harvesting and forest fragmentation, and milder winters (Cote 2004). In eastern North America, impacts of high deer densities to forest structure, composition, and small animal communities have been well documented (Cote et al. 2004), although the impacts are often more serious at smaller scales of investigation (Mladenoff and Stearns 1993). Nonetheless, most of these studies have been restricted to 3 geographic areas and one ecosystem type: the white pine-hemlock-northern hardwood forests of Pennsylvania, the Upper Midwest, and the Adirondacks (Russell et al. 2001). In the oak forests of southern New England, the impacts of deer browsing to forests are generally accepted among the scientific community and the general public; however, the evidence is largely anecdotal and derived from these other regions, as only a few published

studies have examined the long-term effects of deer browsing on native plants in this region (Healy 1997). In Southwestern, CT where deer numbers are among the highest of the region, a broad-scale quantitative examination of the impacts of deer to native plants is warranted.

In 2007, we will initiate an experiment both at Highstead and across Redding and its seven surrounding townships by constructing a seven foot tall fence at Highstead to exclude deer from 1800m² (although 576-625m² is sufficient for additional exclosures) of oak forest, while an adjacent, unfenced area will serve as a control area that deer can freely browse. In addition, we will establish long-term observational plots in properties across 8 towns with different deer management histories. We will sample properties that range from unhunted to hunted for 30+ years and compare tree seedling and herb abundance and diversity among these parcels. We will attempt to control as much landscape variation that could influence forest regeneration as possible by sampling in the same (1) forest type (oak); (2) land use type (historically forested) (3) physiographic type: non-calcareous metamorphic bedrock and glacial till surficial material, and (4) soil type (the Charlton-Chatfield complex). This soil complex is very common in the study area and is the soil type on which the proposed Highstead exclosure experiment will be established. Other variables that could influence forest regeneration such as canopy coverage, shrub density, soil nutrients, coarse woody debris. and rock cover will be recorded and analyzed afterwards.

We will also take advantage of the 2006 initiatives in Redding, Wilton, and Ridgefield to begin hunting selected town and state properties. Permanent plots will be established on these properties, and changes in understory growth will be monitored over time as hunting pressure increases and browsing pressures are presumably reduced. Highstead's exclosure plot will

simulate a forest in which deer have been completely eliminated by hunting and will thus serve as a control to this study.

Detailed Methods

A systematic sampling scheme will be used to quantify the density and diversity of tree seedlings and herbaceous plants at Highstead's exclosure plots and unenclosed observation plots across the study area. Vegetation data from the observation plots will be analyzed in relation to four independent estimates of relative deer densities including hunting history of property, deer pellet counts, and proportion of tree seedling stems browsed and tree saplings antler scraped. Other potential drivers of regeneration such as soil chemistry, moisture holding capacity, and physical properties; overstory vigor and composition, shrub density, and coarse woody debris will be compared among plots as well. Plots will be selected randomly (stratified by property and soil type) using ArcGIS software and will be positioned at least 50 meters from a property boundary. Coordinates will be entered into a GPS receiver to locate the plot in the field.

To determine the abundance and diversity of native herbs and tree seedlings at each site, we will census 20 x 20 m plots for vegetation and environmental characteristics.

Tree Seedlings

In each 20x20m treatment, four contiguous 10x10m subplots will be established to tally, identify, and measure the height of all tree seedlings ≥30cm DBH <2.5cm DBH. The seedlings will be recorded in 3 size classes (30-99cm, 100-200cm, >200cm). For sprout clumps, stems that share a common base above the stump will be characterized as a single stem, whereas stems that

individually attach to the stump will be counted as separate. Data from the subplots will be summed for each 20x20m plot

Herbaceous Vegetation

In each 20x20 m treatment, a 5 x 5 matrix of subplots will be laid out in the center of the plot (4m from edges and 3m from each other). Each circular subplot will be 2.25 m in diameter (100 m2 total sampling area per plot) (Risenhoover and Maas 1987). The center of each subplot will be marked with a permanent stake. At each subplot, each herbaceous species will be tallied as present, and reproductive status (fruit, flower, nothing) will be noted. Five of these subplots will then be randomly selected, and the maximum height of each species will be recorded in each subplot.

Tall Shrubs, Overstory Trees

To provide overstory tree density, basal area, and approximate age structure, all trees >2.5cm DBH will be measured for DBH and identified. Tall shrub (>1 meter) % cover will be estimated visually, and the number of tall shrub stems will be counted and identified in the 20x20 meter plot

Browsing, Antler Scrapes, and Pellet Counts

In four contiguous 10x10m subplots of the 20x20 m plots, deer pellet piles will be counted. Counts will be summed across the 4 subplots to provide relative use by deer of each plot. In addition, tree seedlings with available twigs <200 cm in height will be recorded as being browsed or not by the presence of torn or bluntly nipped twigs (Rooney et al. 2000). For each

tree sapling (2.5-9.9 cm DBH), the presence/absence of (antler) bark scrapes will be recorded. The proportion of the tree's circumference damaged will be measured and the status of the wound will be noted (open = <90% healed; healed = ≥90% closed over). (Miquelle and Van Ballenberghe 1989).

Coarse Woody Debris

Two diagonal transects will run from corner to corner of the 20x20m plot, and two transects will bisect the plot in a N-S direction and E-W direction. To survey CWD we will measure the diameter of every piece of wood that intersects the line-transect (>7.5 cm in diameter). In addition, we also will be recording decay class as defined by Pyle and Brown (1998).

Soils and Other Variables

Soil properties will be characterized by taking two soil cores along a diagonal axis through each quadrant of the plot (8 total samples) The top 15 cm of soil (excluding the leaf litter) will be sampled and pooled into one sample; samples will be air dried, sieved (<2mm), and analyzed for texture and extractable nutrients (calcium, magnesium, nitrogen, phosphorus and potassium concentrations, percentage of organic matter, and pH (1:1 in water) by Brookside Labs, Inc. (New Knoxville, OH, USA). Lastly, landscape position and characteristics (e.g., slope, aspect, orientation, rock cover), and other natural and human disturbances will be noted.

Literature Cited

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.

Healy, W.M. 1997. Influence of deer on the structure and composition of oak forests in central Massachusetts. Pages 249-266. In *The Science of Overabundance*. (edited by W.J. McShea, H.B.Underwood, and J.H. Rappole). Smithsonian Books, Washington DC.

Miquelle, DG and V Van Ballenberghe. 1989. Impact of bark stripping by moose on aspen-spruce communities. *Journal of Wildlife Management* **53:** 577-586.

Mladenoff, D.J. and F. Stearns. 1993. Eastern hemlock regeneration and deer browsing in the Northern Great Lakes Region: a reexamination and model simulation. *Conservation Biology* **7**: 889-900.

Pyle, C. and M. M. Brown. 1998. A Rapid System of Decay Classification for Hardwood Logs of the Eastern Deciduous Forest Floor. Journal of the Torrey Botanical Society 125:237-245.

Risenhoover, K.L., S.L. Maas, 1987. The influence of moose on the composition and structure of Isle Royale forests. Canadian Journal of Forest Research 17, 357-366

Rooney TP, RJ McCormick, SL Solheim and DM Waller. 2000. Regional variation in recruitment of hemlock seedlings and saplings in the upper Great Lakes, USA. *Ecological Applications* 10: 1119-1132

Russell, F. L., D. B. Zippin, and N. L. Fowler. 2001. Effects of white-tailed deer on plants, plant populations, and communities: A review. *American Midland Naturalist* **146**: 1-26.

Sampling Intensity Proposed on Different Properties

2007 (estimates)
Highstead*:* (exclosure and control): 2 plots
CT DEP (Bennet Pond, Trout Brook Valley, Paugusset State Forest, Wooster Mountain, Warner Pond Water Access, Seth Low Pierrepont, Putnam, Huntington, Quarry Head, and Spectacle Swamp): 1 plot on each
Town of Redding (Gallows Hill, Little River, Stormfield, Kruger, Old Edwards Farm, 40 Dayton Road, and 372 Black Rock Turnpike): 1 plot on each
Town of Ridgefield (Hemlock Hills): 1 plot
Wilton Land Trust (Gregg Preserve): 1 plot
Town of Bethel (Chestnut Ridge and Terre Haute): 1 plot on each
TNC: (Senber and Devil's Den): 1 plot each
Aquarion Water Company: 15 plots on various parcels in Easton, Redding, Newtown, Trumbull, and Weston.

William Hill (Management Unit 5): 1 plot

Field Crew 2007
Edward Faison – Forest Ecologist, Highstead
Catherine Erne and Jesse Taylor-Waldman-Undergraduate Field Interns
David Foster – Director of Harvard Forest, Harvard University and Chair of Highstead's Board
William H. Moorhead -Consulting Botanist

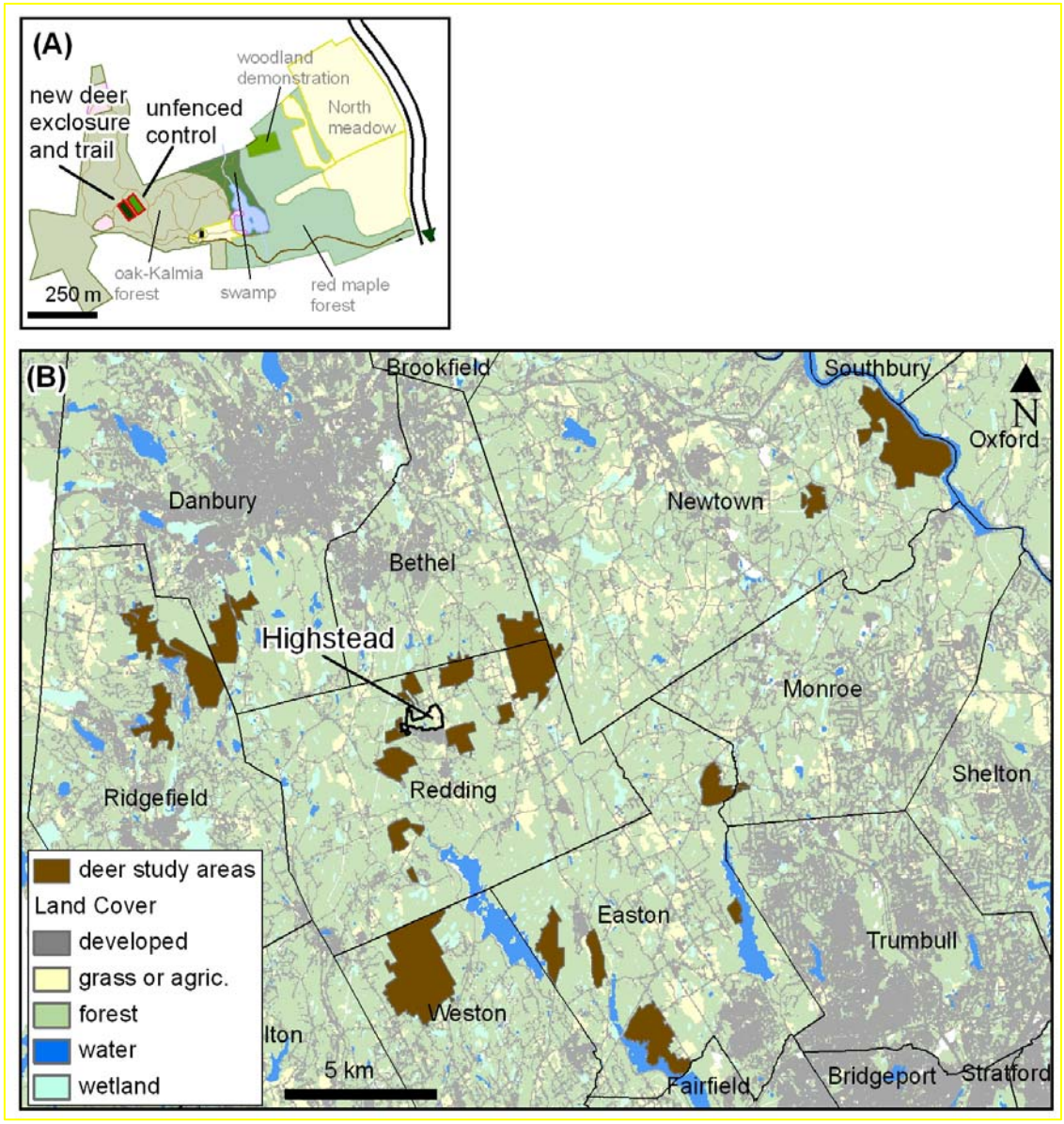

Fig. 1. Study Area for the 2007 deer-forest regeneration study including (A) Highstead's landscape with the existing deer exclosure experiment in red maple forest and the new exclosure site in the oak forest. Map B shows many of the proposed study sites of the broader comparative study of forest regeneration in hunted and unhunted properties of Redding and surrounding towns. Proposed vegetation sampling would occur on Connecticut DEP, Aquarion Water Company, Municipal, and Private Lands.