PROGRESS REPORT (WINTER 2009): EXPERIMENTAL EXCLOSURES AND THE REGENERATION OF FOREST VEGETATION IN RESPONSE TO MOOSE AND DEER BROWSING



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INTRODUCTION

Over the past 200 years as Massachusetts has become increasingly populated, human distribution, land cover, and wildlife habitats have become more heterogeneous. As a consequence of historical changes in land use, land cover, and human attitudes, there has been a remarkable change in the abundance and distribution of wildlife within the state including the re-appearance of moose (*Alces alces*), a species extirpated from the state in the early 1700s. The increase in the Massachusetts moose population in recent decades has lead to interest and concern about the interaction between forestry and moose. Moose can have landscape level effects on vegetation and it is unclear what their impact will be on forest dynamics (i.e., composition, structure, and regeneration) and timber assets in Massachusetts. We are conducting an experimental study to investigate moose ecology and forest dynamics in southern New England. In 2007, we constructed 6 20x20m exclosures with adjacent control plots (Please see Moose Exclosure Proposal and Field Protocol for details of construction and plot design which can be found online at www.umass.edu/moose). Exclosures were established in upland white pine (*Pinus strobus*), oak (*Quercus* spp.), and mixed hardwood stands that had been logged within 3-4 months before construction. The fencing on 3 "full" exclosures abuts the ground, preventing white-tailed deer (*Odocoileus virginianus*) and moose from entering, while the fencing on three "partial" exclosures starts 0.6 m off the ground, allowing access for deer but not moose. We began measuring vegetation and browse activity and monitoring some plots with remote cameras in 2007. Future exclosures may be constructed in Vermont, New Hampshire, Connecticut, and elsewhere in Massachusetts. The overall goal is to determine how moose use the landscape and their potential long-term influence on the structure and species composition of southern New England forests.

The results of this report represent preliminary data and are the property of the USGS Massachusetts Cooperative Fish and Wildlife Research Unit, the Massachusetts Department of Conservation and Recreation, and the Massachusetts Division of Fisheries and Wildlife. The report can be cited as: Compton, J. A., and S. DeStefano. 2009. Experimental exclosures and the regeneration of forest vegetation in response to moose and deer browsing. Unpublished report, USGS Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts, Amherst, MA.

GOALS AND OBJECTIVES

Our primary objectives are to (1) quantify the composition, structure, and regeneration success of woody browse in harvested plots that are (a) protected from all browsing by moose and deer, (b) protected from moose browsing but subjected to deer browsing, and (c) subjected to all browsing from moose and deer; (2) document the amount of browsing on twigs and buds and estimate bud "survival" in all plot types, and (3) improve our understanding of moose browsing and its importance for the management of forest stands.

STUDY AREAS

The Quabbin and Ware River Watershed forests in the Central Uplands of Massachusetts were selected for investigation for several reasons: they support high moose densities (as estimated in annual deer-hunter surveys), they support active forest harvesting, Quabbin has fine-scale deer density information, and current research on moose movements and landscape use is underway in these locations.

Quabbin Watershed Forest

Quabbin Reservation is the largest tract of conservation land in southern New England, forming the core of the 22,000 ha Quabbin Watershed Forest and enveloping the 10,000 ha

Quabbin Reservoir (Kittredge et al. 2003). Forests are predominantly oak-pine with lesser amounts of hemlock (*Tsuga canadensis*), sugar maple-ash (*Acer saccharum, Fraxinus* spp.), forested wetlands, and conifer plantations (MDCR 2007). Quabbin Reservation is closed to public vehicles and development; however, there is an extensive network of paved and unpaved logging roads. It is believed that moose colonized the Quabbin watershed at least 15-20 years ago and the current population is estimated at 100 animals. Deer numbers have been maintained at approximately 2-7 km^2 during the period of moose colonization (MDCR 2007), but as recently as the late 1980s were substantially higher (10-17 km^2) (Healy 1997), which led to the initiation of an annual deer hunt in 1991.

Ware River Watershed Forest

The 9,600 ha Ware River Reservation forms the core of this watershed forest. Two branches of the Ware River and the Burnshirt River dissect these forest lands and merge to form the Ware River inside the Reservation. Similar to the Quabbin Reservation, the Ware Reservation is undeveloped but has a network of roads and trails; however, many of these roads are open to public vehicle access. Oak-pine forests and forested wetlands are the most common forest cover types with lesser amounts of hemlock and conifer plantations (MDCR 2007). Moose colonized the Ware River watershed during a similar time frame to that of the Quabbin,. Deer densities are estimated at 6 km^2 (MDCR 2007) and have been continuously hunted throughout the 20^{th} century.

Study Site Selection

With the aid of DCR personnel, we established and constructed 3 sets of moose exclosures within the Quabbin (Prescott and Dana) and Ware River watersheds (Please see Moose Exclosure Proposal and Field Protocol for details of construction and plot design which

can be found online at www.umass.edu/moose). Exclosures were established in upland oak-pine forest stands that had been logged within 3-4 months before construction of exclosures.

METHODS

Moose exclosures were constructed during the fall of 2007. Upon completion of exclosures, we initiated our first field season during the spring and summer of 2008. During our initial field season, we hired four undergraduate natural resource students to assist us with all aspects of data collection. We completed final construction details of exclosures and established control and surrogate (i.e., plots in the intact forest surrounding the harvest unit) plots. We also completed a coarse woody debris (CWD) survey, measured woody and herbaceous vegetation and browse, established leaf litter plots, and installed temperature sensors and wildlife monitoring cameras (Please see Moose Exclosure Proposal and Field Protocol for details sampling protocol which can be found online at www.umass.edu/moose).

PRELIMINARY RESULTS

Coarse Woody Debris

We conducted a woody detritus (slash) survey to measure coarse woody debris (CWD) that included snags, logs, and stumps (>7.5 cm in diameter). We utilized a line intercept method to measure these components (Van Wagner 1968, Harmon and Sexton 1996) (Appendix A). Minimal manipulation of woody debris took place in order to ensure plot conditions were similar among sites and previous harvesting at sites did not compound potential interactions. We calculated CWD volume per unit area by using the formula $V= 9.869* \sum (d^2/8L)$, where L is transect length (m) and d is the piece diameter (m) (Van Wagner 1968, Harmon and Sexton 1996). We will continue to monitor the change in CWD in the plots over time.

Woody Vegetation and Browse

Woody vegetation and browse sampling took place from April – August 2008 at all sites. Within each plot, 25 subplots (2.25 m diameter) were used to measure and record woody vegetation species, height, dbh, and browse (i.e., browsed or not browsed) (Appendix B and C). Browsing was recorded at all control and surrogate plots during the summer sampling period, while no browse was recorded within the full or partial exclosure. An additional sampling of woody vegetation and browse occurred in the Fall (October – November) of 2008. During the Fall sampling period browse was documented within all 3 partial exclosures, in addition to all control and surrogate plots (Appendix D).

Herbaceous Vegetation

Herbaceous vegetation sampling took place from April – August 2008 at all sites. Within each plot, 25 subplots (2.25 m diameter) were used to characterize percent ground cover and record herbaceous vegetation species (Appendix E).

Temperature Sensors

A set of three Ibuttons (Dallas Semiconductor Corporation – model DS1921G) have been placed within each plot in order to record temperature over time. Ibuttons have been placed in mesh bags and stapled to a post at 1 m (3.3') above the ground to record ambient temperature. Ibuttons have been programmed to record a temperature every 3 h and have been downloaded in October and will be downloaded again in March (Cunningham et al. 2006) (Appendix F).

Wildlife Monitoring Cameras

Trail cameras (model: Reconyx RapidFire™ RM45 IR Game Camera) have been placed in partial exclosure and control plots to aid in the detection of site use by target and non-target species. Cameras placed within all three partial exclosures have documented white-tailed deer

(*Odocoileus virginianus*) (bucks and does) browsing inside the fenced area. Cameras also have documented moose and white-tailed deer use within all control plots. In addition, cameras have documented the use of partial exclosure plots by a number of wildlife species (Appendix G).

RESEARCH ACTIVITY FOR 2009

The spring of 2009 will represent our second field season of vegetation and browse sampling. Sampling will begin in April and continue throughout the summer, with a focus on measuring woody vegetation regeneration and woody browse. We will periodically download images from remote cameras and download temperature data from sensors placed within each plot. In addition, we are exploring opportunities to construct additional exclosures in the White Mountain National Forest of New Hampshire and the Green Mountain National Forest of Vermont. Finally, we hope to make significant progress with the analysis of existing data and preparation of manuscripts.

LITERATURE CITED

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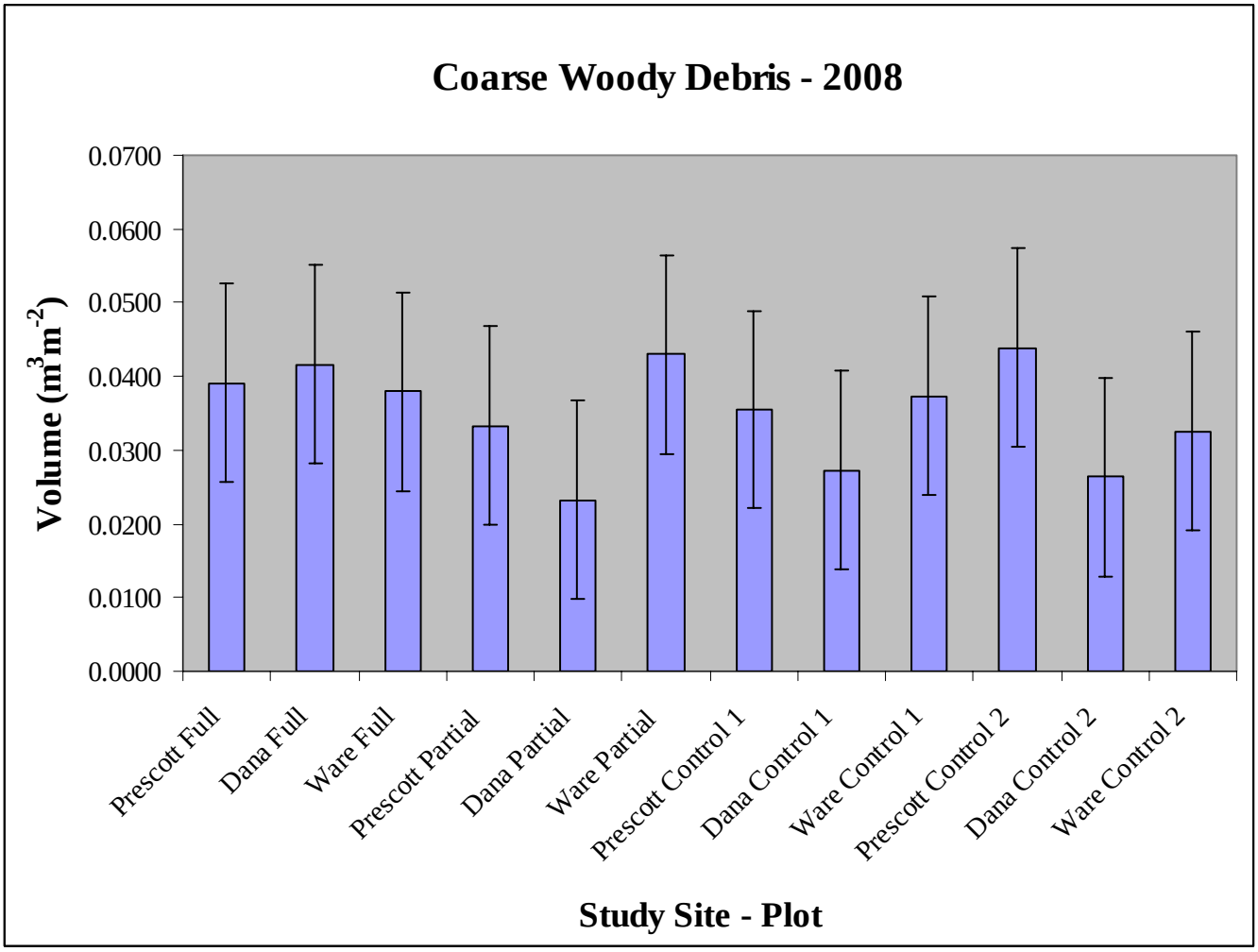
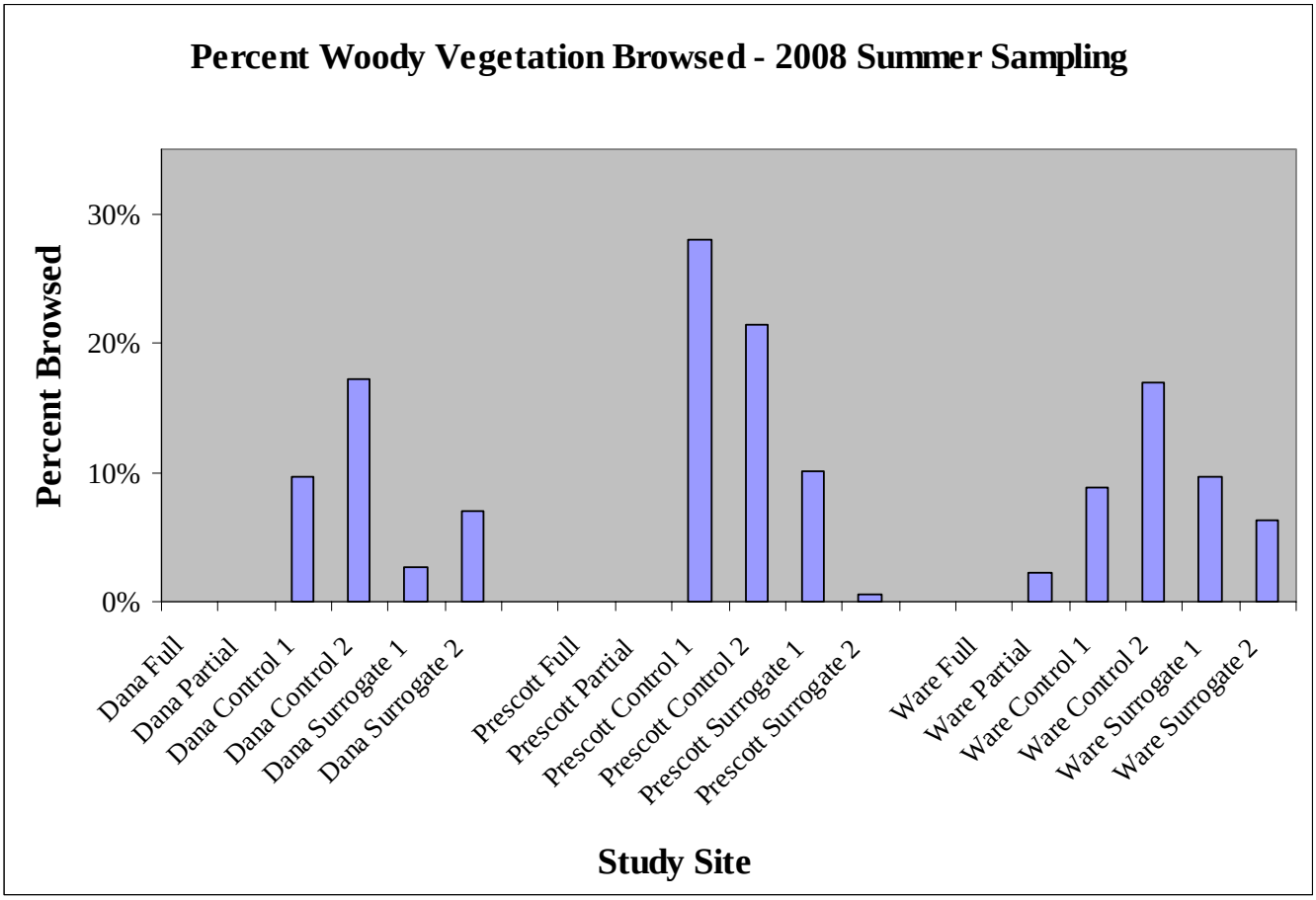
APPENDIX A: COARSE WOODY DEBRIS SURVEY - 2008



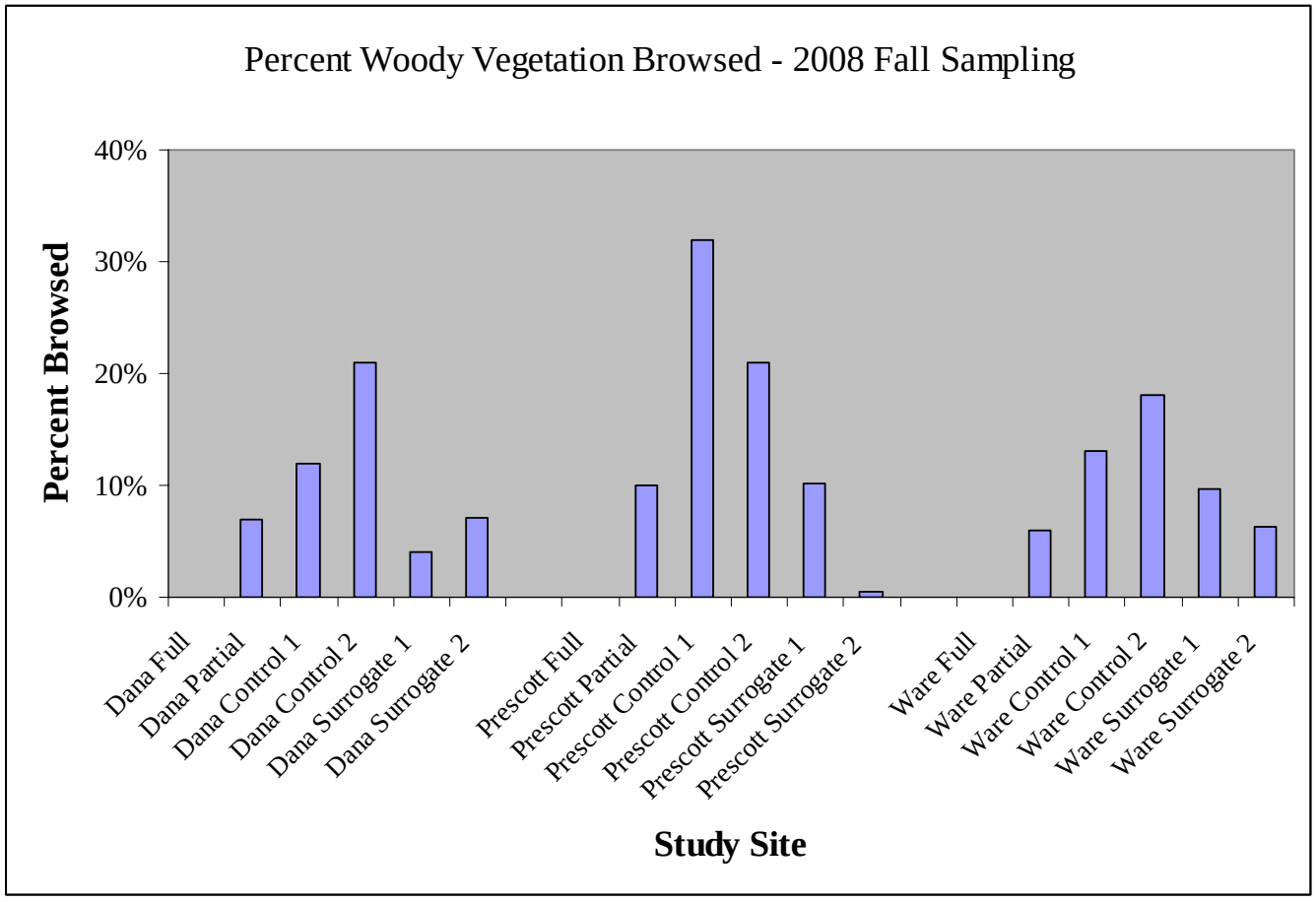
APPENDIX B: WOODY VEGETATION IDENTIFIED AT SITES

Alternate-leaf Dogwood	*Cornus alternifolia*
American Hazelnut	*Corylus americana*
Beech	*Fagus grandifolia*
Black Birch	*Betula lenta*
Black Cherry	*Prunus serotina*
Chestnut	*Castanea dentata*
Hemlock	*Tsuga canadensis*
Hickory	*Carya* spp.
Larch (Tamarack)	*Larix laricina*
Red Maple	*Acer rubrum*
Red Oak	*Quercus rubra*
Red Pine	*Pinus resinosa*
Sassafras	*Sassafras albidum*
Scarlet Oak	*Quercus coccinea*
Striped Maple	*Acer pensylvanicum*
White Ash	*Fraxinus americana*
White Oak	*Quercus alba*
White Pine	*Pinus strobus*
Yellow Birch	*Betula alleghaniensis*

APPENDIX C: PERCENT WOODY VEGETATION BROWSED AT SITES - SUMMER



APPENDIX D: PERCENT WOODY VEGETATION BROWSED AT SITES – FALL

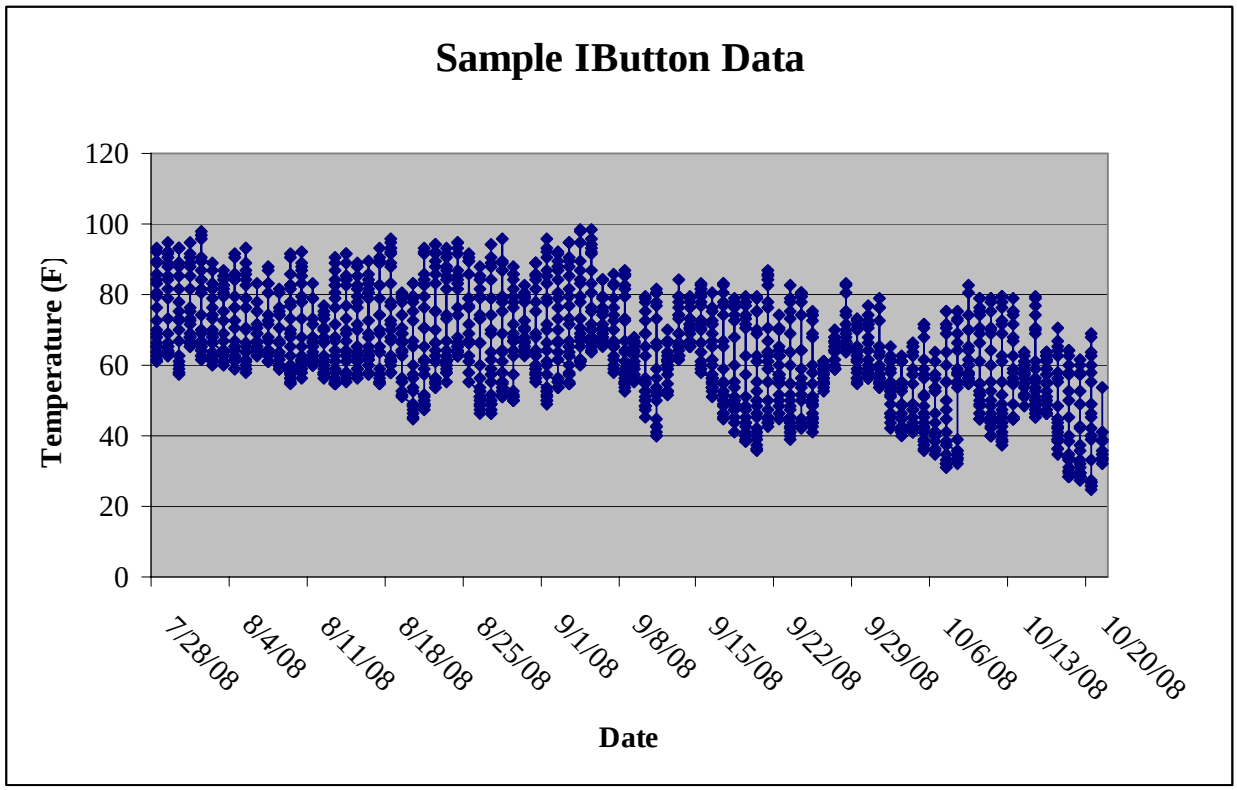


APPENDIX E: HERBACEOUS VEGETATION IDENTIFIED AT SITES

Baneberry	*Actaea* spp.
Black huckleberry	*Gaylussacia baccata*
Blackberry	*Rubus* spp.
Blue-stem goldenrod	*Solidago caesia*
Bunch berry	*Cornus canadensis*
Canada mayflower	*Maianthemum canadense*
Canadian cinquefoil	*Potentilla canadensis*
Cherry	*Aronia arbutifolia*
Choke cherry	*Prunus virginiana*
Cinnamon fern	*Osmunda cinnamomea*
Common wood sorrel	*Oxalis Montana*
Cudweed	*Gnaphalium* spp.
Enchanters nightshade	*Circaea alpine*
False nettle	*Boehmeria cylindrical*
Foam flower	*Tiarella cordifolia*
Grass-leaved goldenrod	*Euthamia graminifolia*
Green milkweed	*Asclepius exaltata*
Ground ivy	*Glechoma hederacea*
Hay-scented fern	*Dennstaedtia punctilobula*
Japanese bittersweet	*Celastrus orbiculatus*
Lance-leaved wild licorice	*Galium lanceolatum*
Low-bush blueberry	*Vaccinium angustifolium*

Maleberry	*Lyonia ligustrina*
Nannyberry	*Viburnum lentago*
Partridge berry	*Mitchella repens*
Red baneberry	*Actaea rubra*
Rock polypody	*Polypodium virginianum*
Rue anemone	*Anemonella thalictroides*
Sedge	*Carex* spp.
Sheep festcue	*Festuca ovina*
Soft rush	*Juncus effuses*
Spreading dogbane	*Apocynum androsaemifolium*
Stoneroot	*Collinsonia Canadensis*
Tall meadow rue	*Thalictrum polygamum*
Trailing evergreen	*Diphasiastrum digitatum*
White wood aster	*Aster divaricatus*
Whorled aster	*Aster acuminatus*
Whorled loosestrife	*Lysimachia quadrifolia*
Wild lettuce	*Lactuca canadensis*
Wild sarsaparilla	*Aralia nudicaulis*
Winterberry	*Ilex verticillata*
Wood anemone	*Anemone quinquefolia*

APPENDIX F: SAMPLE IBUTTON TEMPERATURE DATA (July – October)



APPENDIX G: WILDLIFE PHOTOGRAPHED WITHIN PARTIAL EXCLOSURES

Black Bear	*Ursus americanus*
Bobcat	*Lynx rufus*
Coyote	*Canis latrans*
Eastern Cottontail	*Sylvilagus floridanus*
Red Fox	*Vulpes vulpes*
Turkey	*Meleagris gallopavo*
White-tailed deer	*Odocoileus virginianus*