Evaluation of Microclimatic Advantages within White-tailed Deer Wintering Yards Located in Close Proximity to Residential Communities in the Central Adirondacks of Northern New York State

Proposal for Research

by

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B 6/4/05 7:57 AM

Comment: The research proposal is generally the first serious effort to articulate an idea for research.. It is intended to (1) persuade the reader that the objective is important and (2) that the methods to be used will accomplish the objective. To be effective in persuading the reader, the research proposal should always be written with the reader in mind. In the case of the thesis proposal, the readers are generally a committee of faculty. Sometimes the audience is also an outside group that may provide financial support. With each different group of readers, the proposal is revised to maximize communication .

When writing for your e thesis committee, the proposal serves two purposes. First, it shows that you have thought about your research to the point of having clearly defined objectives and a workable experimental design. Second, it shows that you have a good sense of the literature. The committee's role is to ensure that the question is important and that your design has a high probability of success.

The hope is that research proposal is blueprint that can be followed to the letter. The reality is that the proposal represents a first approximation. It is not cast in bronze and should be viewed as work in progress. The project will evolve dramatically as you begin work and that's fine.

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Deleted: M.S.

Sarah Wilkinson 11/23/10 8:56 PM

Deleted: Susan M. Walker

December 3, 2004

PROJECT RATIONALE AND SIGNIFICANCE

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Comment: This shows good page format. Be CERTAIN to put page numbers and your name on EVERYTHING. This should be page 1 because the title page is not numbered.

White-tailed deer (*Odocoileus virginianus*) inhabiting the northern portion of their range migrate to winter yards characterized by dense coniferous cover to alleviate the effects of extreme temperatures and deep snow (Jackson and Sarbello 1980, Tierson et al. 1985, Nelson 1998). The harsh weather imposes considerable energetic demands on deer when they are utilizing fat and protein reserves and consuming woody browse as the primary means of survival (Mautz 1978, DelGiudice et al. 1988, Underwood 1990). As snow depths increase, locomotion becomes arduous and the availability of forage is significantly reduced (Mysterud et al. 1997, Parker et al. 1984). However, winter ranges are selected primarily based on cover, and woody browse is considered to be at most a minimal contribution (poor digestibility or low nutrition) to the over-winter survival of northern white-tailed deer while occupying softwood yards (Mattfeld 1974, Moen 1976).

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Comment: Literature cited should follow Journal of Wildlife Management guidelines. This journal has an excellent set of style guidelines that are available online. The style used by this journal is widely used in scientific writing so is a good one to learn.

The thermal environments deer are exposed to during the winter under canopy cover result from a combination of variables including ambient air temperature, wind speed, canopy cover, and solar radiation. Using microclimatic variables, the operative temperatures for different environments can be determined and compared (Demarchi and Bunnell 1993). The residential environments, where the radio-collared deer reside during the winter within the Adirondacks, provide patches of multiple cover types surrounding homes and structures that may offer microclimatic advantages at different periods throughout the winter.

The community structure and the supplemental feed provided in residential areas may have contributed to the shift in wintering yards away from historical locations and closer to homes over the past three to four decades (Hurst 2004). However, a clear explanation for the shift in winter yard placement is not available. Since deer have shifted their winter yards closer to residential areas, many individuals were seen eating from feed piles in yards throughout the hamlet of Long Lake. The supplemental feed provided within this hamlet as well as many others throughout the Adirondacks may have benefited the deer nutritionally and energetically. Despite the recent enforcement of the NYSDEC's 2003 regulation prohibiting the feeding of free ranging deer populations, the deer remain in the community of Long Lake, utilizing bird feeders and ornamental shrubs for additional nutrients. The deer are seen using easily accessible, plowed roadways and paths within the residential areas that may aid in winter survival, decreasing energetic demands and improving mobility and opportunities for greater nutritional intake.

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Comment: Note the excellent paragraph structure with good topic sentences and clear sequencing of though.

The advantages white-tailed deer, wintering in close proximity to residential areas, gain from the microclimatic conditions where there is an interspersion of multiple cover types and buildings to provide cover and food has yet to be examined. While we know coniferous cover is a habitat characteristic of primary importance to wintering deer, we have observed a shift in winter yards from historical locations characterized by dense coniferous cover to areas that are residential in structure, possibly in response to supplemental feeding (Hurst 2004). This study proposes to examine what cover and microclimatic conditions and alternative winter food options residential environments may offer deer throughout the winter that may serve as potential survival advantages.

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Comment: This is an excellent in introduction. (1 It begins generally, and progressively focuses the reader on the specific issue of interest. (2) It provides a good justification leading to a central question.. (3) It gets to the point quickly. You need to try to get to your statement of a central question or objectives within 1 pages (if single spaced).

OBJECTIVES

I will examine deer winter yards within residential environments to determine what food and cover advantages may be available and ascertain existing differences in microclimate among varying food and cover conditions within residential winter yards and more traditional coniferous cover winter yards. My study will examine locations of radio-collared white-tailed deer on a daily basis using radio-telemetry and determine correlations between deer locations and microclimatic and snow condition data collected within the winter yards where deer currently reside. I will determine if the patchy habitat structure and homes within the residential environments may offer microclimate variation under different daily and seasonal conditions and if the daily movements and locations of the deer are reflective of these differences.

Hypothesis 1.--

Radio-collared deer will use different areas within their winter yards on a daily and seasonal basis depending on microclimate and snow conditions.

Hypothesis 2.--

Residential yards (Long Lake) will offer conditions of reduced wind speed and increased ambient temperatures and solar radiation at crucial periods throughout the winter, as compared to microclimatic conditions in traditional coniferous cover yards (Minerva/Hudson River & Hewitt Pond) and open hardwood stands located on the periphery of the hamlet of Long Lake.

Hypothesis 3.--

Residential communities provide areas of reduced snow depth that are equal to or greater than softwood stands, as compared to open hardwood stands.

Hypothesis 4.--

The presence of bird feeders and ornamental shrubs will influence the daily and seasonal movements of deer.

REASEARCH BACKGROUND

Extensive research has been conducted on Huntington Wildlife Forest (HWF) within the central Adirondacks of New York that has added to our understanding of northern white-tailed deer ecology and behavior. Social group formation of radio-collared white-tailed deer was characterized using information obtained from genetic analyses and spatial locations and movements on summer and winter range. Female deer form loosely associated matrilineal groups composed of older females and their offspring, each with overlapping home ranges (Mathews 1989, Tierson et al. 1985, Nelson and Mech 1984). The matrilineal groups are associated both on summer and winter range, with individuals

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Comment: The statement of objective is most often presented as a single declarative sentence, or a series of declarative sentences. The objective should be address WHAT you intend to address in your research.

In this case, objectives are particularly strong because they have been formulated as a series of statements of hypotheses. The preceding paragraph is fine, but would be stronger if it was focused exclusively on WHAT and did not include HOW. The first sentence is WHAT, while the following sentences are more about HOW.

As you will see in the Methods, these hypotheses are addressed through testing of a suite of predictions associated with each hypothesis

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Comment: Notice that these are not stated as the null, despite what you may have learned elsewhere. Also, note that these hypotheses are formulated so that there can be a clear yes or no answer

B 6/4/05 8:09 AM

Comment: This is an example of a hypothesis that contains more information than necessary (study sites) and language that is hard to define (“crucial periods”). It would be stronger without these elements.

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Comment: This would be a stronger hypothesis if the comparisons to be made were more clear.

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Comment: Note that these hypotheses imply a suite of important factors that are being evaluated. The reader should be aware of these factors from the Introduction, or the introductory paragraph of the Objectives section.

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Comment: This section is intended to provide more detail (literature summary) that is valuable as background to provide a foundation to the study, but not included in the Introduction. Its intent is to explain the objectives more thoroughly. A secondary intent is to provide evidence (along with the Introduction) that you have a good sense of the literature pertaining to your question.

exhibiting site fidelity from year to year and passing on knowledge of wintering areas among generations (Aycrigg 1993).

White-tailed deer inhabiting the northern portion of their range annually migrate from summer to winter yards in response to changing winter climate (Severinghaus and Cheatum 1956, Verme 1973, Drolet 1976, Sabine et al. 2002). Snow depth is generally accepted as one of the principal factors driving winter migration. In the central Adirondacks, migration to winter range is initiated by snow depths exceeding 38 cm, forcing white-tailed deer to seek out coniferous forest stands for winter survival (Behrend 1966, Mattfeld 1974). However, a complex set of factors, in which snow depth is only one component, may account for this seasonal migration (Drolet 1976, Tierson et al. 1985, Sabine et al. 2002). These factors may include temperature, snow depth, and vegetation changes due to snow depth and temperature fluctuations (Verme 1973, Nelson 1998, Sabine et al. 2002).

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Comment: Once again, note the excellent writing: good topic sentences, good paragraph content that follows from the topic sentence, and good sequencing of thought from one paragraph to the next.

Snow depth, wind, and temperature can significantly influence habitat selection by white-tailed deer in the winter and together, these factors stimulate the deer to seek the shelter of softwood stands for thermal protection and increased mobility (Behrend 1966, Jackson and Sarbello 1980). Coniferous stands have been noted to serve as havens from harsh winds and low temperatures as well as to reduce radiation heat flux to the atmosphere on cold winter nights (Behrend 1966, Moen 1966, Mattfeld 1974). On winter range, white-tailed deer congregate on winter yards with dense coniferous canopy cover that intercepts snowfall to aid locomotion and offers thermal protection from inclement weather (Hamerstrom and Blake 1939, Mattfeld 1974, Moen 1976, Tierson et al. 1985, Nelson 1998). When snow depth is not a significant factor impeding movement, deer have been found to use larger winter home ranges, occupying softwood stands only in times of heavy snowfall, low temperatures, and high wind (Jackson and Sarbello 1980).

The microclimate white-tailed deer are exposed to throughout the winter can significantly impact movement and yarding behavior. This thermal environment is characterized by complex interactions under the canopy cover within the habitat of choice. The ambient air temperature, wind speed, solar radiation, canopy cover in terms of amount and distribution of foliage elements, relative humidity, as well as other abiotic and biotic features may all significantly influence the thermal quality of a winter yard (Demarchi and Bunnell 1993). The height and structure of the canopy as well as the understory contribute to the modification of wind speeds in varying habitats (Bunnell et al. 1985). Factors including location, slope, aspect, distance to an edge, and wind direction may also influence the wind speed within an environment (Demarchi and Bunnell 1993). When declining temperatures and wind interact “air chill” becomes a concern resulting in cooling through convection (Ozoga 1968, Verme 1968). White-tailed deer have been noted to seek winter cover that provides protection from inclement weather, offering a stable microclimate with considerably fewer sharp declines in ambient temperatures (Ozoga 1968). Mature conifer stands (even-aged, ≥ 40 years old) often offer optimal conditions of warmer temperatures, lessened impact of wind in areas of the densest cover, and uniform microclimate, effectively reducing the amount of heat lost due to radiation and convection (Ozoga 1968).

While, historically, white-tailed deer in the Adirondacks wintered in lowland softwood areas, increasingly deer are utilizing residential communities. Historical documentation of Adirondack white-tailed deer winter yards from over 30 years ago by the NYSDEC provided information on where social groups had historically been present. When the historical winter yards are compared to yards that were currently being used for the winters of 2003 and 2004, it is evident that several social groups have shifted their winter yard location closer to residential areas (Hurst 2004). An increasing amount of conifer harvest on private land within the Adirondack Park had been occurring over the past 3 decades and these deer shifting their yard locations likely reflect the habitat changes occurring throughout the region. Also, these deer are now found in close proximity to homes, and supplemental feeding has been thought to be one of the principal factors luring the deer away from historical winter habitat and closer to residential areas.

Supplemental feeding of white-tailed deer has been a long held tradition in many small communities within the Adirondacks. When significant snow depths persist throughout the winter, deer are confined on winter range for an extended period of time, thereby resulting in limitations on browse availability and exhaustion of fat reserves (Brown and Doucet 1991). Malnutrition and subsequent death of many deer in these areas is common and the feed provided by private landowners, recreational sporting clubs, and property managers may have aided in the over-winter survival of several deer (Page 2001, Douglass 2003).

In the fall of 2002, the New York State Department of Environmental Conservation's began enforcing a statewide ban on supplemental feeding of wild cervid populations. Even with the ban, some degree of feeding persists in many of the residential communities throughout the Adirondack Park. In many instances, this is unintentional feeding by means of bird feeders and ornamental shrubs, but in some cases residents are still attempting to provide feed and often in meager portions. During the winter of 2003, enforcement of the ban targeted large scale feeding sites such as those provided by several sporting clubs throughout the Adirondacks. Stricter enforcement for the winter of 2004 resulted in further reduction in winter-feeding by private landholders.

While it seems likely that yard shifting may have occurred in response to supplemental feeding and surrounding habitat changes, it is unknown what microclimatic advantages these deer may be provided with through residing within these residential winter yards. Many of the residential communities within the Adirondacks provide deer with winter habitat characterized by an interspersion of multiple cover types, offering patches of conifers and deciduous cover and open areas amongst buildings and structures (Hurst 2004). These residential areas may benefit the deer in addition to providing coniferous cover as protection from inclement weather, offering openings that allow for increased foraging opportunities and radiant heat absorption from greater sun penetration, thereby increasing energy conservation (Weber 1981). Also, remaining close to homes may provide increased opportunities for energy intake through ornamental browse and bird feeders. Although we know coniferous cover is a habitat characteristic of primary importance to white-tailed deer in the winter, it is unknown what influence the patchy habitat structure within the Adirondack residential areas has on the deer and if microclimate within the multiple cover types influences use of these areas when compared to a historical yard.

STUDY SITE

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Comment: This section is written with the hope that, eventually, it can be copied verbatim into the thesis. Model it after Study Area descriptions you see in the refereed literature.

The central Adirondack region of northern New York State is dominated by northern hardwood forest (SAF Type 25) with 61% of the total forest cover being occupied by sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), and yellow birch (*Betula alleghaniensis*) (Eyre 1980, Alerich and Drake 1995). In riparian environments and at lower elevations the forest stands are dominated by red spruce (*Picea rubens*) and balsam fir (*Abies balsamea*) (SAF Type 33) (Eyre 1980) and soils are primarily Spodisols or Inceptisols on layers of glacial till (Cline and Marshall 1976). The central Adirondack region is characterized by mountainous topography with elevations reaching 1,600 m. The growing season is shortened, lasting about 90 to 150 days and the annual snowfall range is 176 to 308 cm with an average of 51 days with snow depths greater than 38 cm (Nesslage 2000).

During the late spring, summer, and fall, this study will be conducted on the Huntington Wildlife Forest, a 60-km ^{2} forested research property (74 15′ N, 44°00′ W) (McNulty 1995). During the winter and early spring all research will primarily be focused within the northern softwood and mixed forest stands surrounding and within the residential areas in the hamlet of Long Lake, Hamilton County and the hamlet of Minerva, Essex County. Forest stands consist of 72% secondary growth northern hardwoods, 18% coniferous-hardwood mixed, and 10% coniferous (Hurst 2004). The typical winter yards occupied by deer throughout the winter are located in lowland riparian environments and drainages dominated by red spruce and balsam fir (SAF Type 33) (Eyre 1980).

The hamlet of Long Lake provides an interspersion of multiple cover types among homes, buildings, and plowed road systems. Lowland coniferous stands, coniferous-hardwood mixed stands, and ornamental shrubs and bird feeders are utilized by deer in Long Lake. The deer winter yards located near Hewitt Pond and the Hudson River tributaries in Minerva offers more traditional conditions comprised of dense coniferous canopy with very few if any homes or buildings.

Radio-telemetry stations will be located throughout the hamlet of Long Lake based on previous winter yard locations determined from radio-telemetry in the winter of 2003 and 2004. However, station positions will be dependent on the movements of the radio-collared deer during the winter of 2004 and 2005.

METHODOLOGY

White-tailed Deer Behavior and Movements

Hypothesis 1.--

Radio-collared deer will use different areas within their winter yards on a daily and seasonal basis depending on microclimate and snow conditions.

Prediction 1.--

At night as well as during periods of high wind and extreme low ambient temperatures, the deer will utilize available coniferous stands to provide protection from inclement weather and reduce cooling through convection and radiation heat flux to the atmosphere (Behrend 1966, Moen 1966, Mattfeld 1974, Ozoga 1968, Verme 1968). During the day and during periods of high light availability, the deer will utilize open areas including residential yards and areas near homes which allow for increased foraging opportunities and radiant heat absorption, thereby increasing energy conservation (Weber 1981). Homes will serve as sources of residual heat and deer will bed down close to buildings. Residential areas surrounding homes will offer greater solar radiation penetration, and deer will utilize these areas mainly during daylight hours.

Field Methodology.--

I will trap 20-30 adult and yearling white-tailed deer on HWF property using Stephenson box traps, baited with rock salt during May and June in 2004 and 2005. I will lead a team of 4-5 individuals to immobilize trapped deer using a tangle net and an intramuscular injection of a sedative mixture of ketamine hydrochloride and xylazine hydrochloride. A 1mg:1mg dosage will be prepared based on the estimated weight of the deer. I will use Yohimbine (antagonist) to reverse the sedative ketaset mixture. Using the replacement and wear technique I will estimate age (Severinghaus 1949). I will determine the sex of the deer, and fit females with a 550 g radio collar (Advanced Telemetry Systems, Isanti, MN 55040). I will fit male and female deer with numbered steel and plastic ear tags for visual identification. Trapping and handling procedures will follow the approved SUNY-ESF 2004 protocol for humane use of live vertebrates.

I will use a 2-band scanning receiver and a 4-element hand-held yagi antenna mounted on a tripod to conduct radio-telemetry. I will identify signal strength based on a 1-5 scale, with 1 being the strongest and activity/inactivity will be based on audible signal fluctuations. Using the loudest signal method, I will determine azimuths of the radio signals. I will take compass bearings for each azimuth and the location of a deer will be determined by triangulation of 2 – 3 azimuths. I will determine telemetry error using beacon radio-transmitters placed randomly in known locations throughout the study area. I will determine beacon azimuths following procedures similar to those used for collared deer.

I will monitor the collared deer on summer range 3-4 times weekly in July through November 2004. As the collared deer shift to the winter range, I will continue

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Comment: It is wise to repeat the objective so that the reader does not have to flip back.

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Comment: The hypothesis prediction approach is valuable because if forces you to think carefully about what you're going to measure and how those measurements will provide a clear inference of yes or no. Ideally, the prediction should be a crisp statement of the test that will allow rejection or support of the hypothesis. Explanation of how this will be accomplished is then described in sections on field methods and analytical methods.

There is a strong tendency to attempt to persuade the reader that your methods are sound. Thus, Methods sections often contain a lot of rationale. They should not. At most, rationale should be limited to portions of sentences. The statement here would be stronger if it omitted explanation of rationale

Methods should be a restatement of the WHAT followed by HOW, but not WHY.

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Comment: Active voice, as used here, is strongly preferred.

monitoring the deer daily from December 2004 to April 2005. I will collect telemetry relocations at various times of the day and night.

The tagged and collared deer typically migrate off HWF during the winter, with some individuals relocating near the hamlet of Long Lake and others wintering within the lowland forest located along the upper Hudson River and tributaries in the hamlet of Minerva. I will examine the winter home ranges of individual females and these females' movements with respect to microclimate measurements, canopy cover, snow depth, and snow surface condition.

The methods indicated for the hypotheses and predictions that follow these methods will be conducted in order to collect ambient temperature, wind speed, solar radiation, snow depth, and snow surface condition data.

Data Analysis.--

Using the program DogTrack, I will calculate error ellipses for collared deer in the winter of 2004/2005 and these points will be transferred to a geographic information system (ArcGIS 9) to determine home ranges (95% polygon) and core areas (50% polygon) for each of the collared deer. ArcGIS will provide geographic locations of individual deer for every position located using radio-telemetry. Using a residential layer of Long Lake digitized from 24 inch resolution color infared orthoimagery (NYSDOP High Resolution orthoimagery 2003 of Long Lake obtained from NYS Interactive Mapping Gateway), deer locations will be compared to residential homes and buildings as well as to land cover (National Land Cover Data) and road systems (census data).
Simple and Multiple regression analysis will be used to test for correlations between parameters (type of cover used by deer, distance to homes and buildings, and habitat type of residential, hardwood, coniferous, or mixed) and daily weather data. A comparison of climatic conditions in different habitats will be tested using multiple regressions with Y representing climatic conditions, X1 the temperature, X2 the wind speed, X3 the solar radiation, X4 the snow depth, and X5 the snow load bearing capacity. To eliminate the negative numbers in the equation, 20 degrees may need to be added to the temperature means (Verme 1968).
Snow hazard will be calculated per week using the following equation:

$$\text{Snow Hazard} = \sum (\text{Snow Depth} * \text{Snow load bearing capacity}) \quad (1)$$

Winter severity will be determined for comparisons between habitat types using the following equation:

$$\text{Winter Severity} = \text{Climatic Conditions} + \text{Snow Hazard} \quad (2)$$

Simple MANOVA's will be applied to test for seasonal or daily differences in habitat use by the deer. Multvariate regression analysis will be used to relate changes in habitat use by the deer to one more independent variables such as winter severity, snow depth, or ornamental browse availability (Aebischer et al. 1993).

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Comment: This is excellent organizational structure: hypothesis, followed by prediction, then field methods and finally data analysis.

Subheading format should follow Journal of Wildlife Management guidelines.

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Comment: If single spacing, then use extra space between paragraphs.

B 6/4/05 8:25 AM
Comment: Note that the analytical design has been thought through to the point of being able to describe the dependent and independent variables. This is hard to do, but indicative of a lot of careful thought.

Look back at the hypothesis and predictions and ask yourself, do these models allow a clear test?

I will model the thermoregulatory response by deer in each study habitat (residential, coniferous, hardwood, and mixed) based on the climatic and winter severity data collected. I will use a modified equation similar to the model designed by Porter and Gates 1969:

Energy In = Energy Out

$$M + Q_{abs} = \delta\sigma T_r^4 + h_c(T_r - T_a) + E_{ex} + E_{sw} \pm C \pm W \quad (3)$$

where M is the metabolic rate, Q_{abs} is the amount of radiation absorbed by the deer's surface, h_c is the convection coefficient, C is the heat conducted to a substrate, W is the work done, E_{ex} respiratory moisture loss, E_{sw} moisture lost by sweating, T_a air temperature, T_r radiant surface temperature. Unmeasured variables will be obtained from research literature. From this model, I will determine what habitat types offer optimal conditions for the thermoregulatory processes of white-tailed deer during the winter, comparing the energy balance based on an average adult female.

Microclimate and Residential Habitat Structure

Hypothesis 2.--

Residential yards (Long Lake) will offer conditions of reduced wind speed and increased ambient temperatures and solar radiation at crucial periods throughout the winter, as compared to microclimatic conditions in traditional coniferous cover yards (Minerva/Hudson River & Hewitt Pond) and open hardwood stands located on the periphery of the hamlet of Long Lake.

Prediction 1.—

In residential yards**,** homes and buildings will block wind, providing reduced wind speeds that are less than or equal to those within coniferous forest stands and lower than those in hardwood stands.

Prediction 2.--

In residential yards**,** homes and buildings will serve as sources of residual heat, offering warmer ambient temperatures that are greater than or equal to the conditions within coniferous yards and greater than those in hardwood stands.

Prediction 3.--

Solar radiation will be greater within residential yards when compared to coniferous and hardwood stands due to the greater proportion of open areas and reduced percentage of canopy cover.

Field Methodology.--

To test the first and second predictions, I will utilize HOBO Micro Station multi-channel data loggers and sensors (Onset Computer Corporation) to measure ambient temperature and wind speed within the residential yard of Long Lake, an open hardwood stand on the periphery of the hamlet of Long Lake, and a traditional coniferous yard near Hewitt Pond and the tributaries of Hudson River in the hamlet of Minerva, Essex County.

I will use a 3 cup anemometer sensor with Teflon bearings and hardened beryllium shaft to measure wind speed at an accuracy of ±1.1m/s (2.4 mph) or ±4% of reading. I will use a temperature sensor to measure ambient temperatures with a stainless steel sensor tip at accuracy of ±1.3°F at 77°F. These sensors will read into a data logger with data logging capabilities at intervals of 1 second to 9 hours and a user-specified interval logging option. Data loggers have a time accuracy of 0 to 2 seconds for the first data point and ±3 seconds per week at 77°F (Onset Computer Corporation).

With the permission of homeowners, I will randomly select homes throughout the hamlet of Long Lake for microclimate measurements. I will mount data loggers and sensors on steel fence posts approximately 2 meters above the ground, accounting for snow accumulation as winter progresses. I will position 1 data logger mount on each side of a study home. Throughout the winter, I will rotate data loggers between study homes. Each home will be examined for at least a 2-week period. To measure wind speed and ambient temperatures in the open residential areas surrounding study homes, I will establish 2 random sample points where calibrated steel fence posts will be placed. I will rotate 1 data logger and sensor mount between the 2 random sample points during a 2-week study home sample period. To measure wind speed and ambient temperature in the coniferous and hardwood stands, I will establish 5 transect lines, each 100-meters in length with sample points at 10 meter intervals along each transect in each forest stand. Using calibrated steel fence posts, I will mount 1 data logger with ambient temperature and wind speed sensors to a steel fence post and rotate the mount along sample points on 1 transect line, sampling a new transect line every 2 weeks.

To test the third prediction, I will measure solar radiation and canopy closure at each site through hemispherical photography of forest canopy and sky above homes within the residential areas and in forest stands using an 8 mm fisheye (hemispherical) lens. I will photograph areas sampled for microclimate and snow depth within the residential areas and forested stands in Long Lake and Minerva. All photographs taken will be digitized and using Gap Light Analyzer (GLA), imaging software used to extract gap light transmission indices and forest canopy structure from true-color hemispherical photographs (Simon Fraser University, Institute of Ecosystem Studies 1990), the extent of solar radiation and canopy structure will be determined to provide an estimate of the value of the surrounding winter habitat in terms of its thermal protecting and snow intercepting qualities.

Data Analysis.--

Using Boxcar 4.3 software (Onset Computer Corporation 2004), I will offload all microclimate data collected in the field from the data loggers. This software will be used for system launch, data analysis, graphing, and file export.

Using GLA, imaging software, I will obtain measurements of the following variables:

Canopy structure :

% sky area, % mask area, % canopy openness, % site openness, and Leaf Area Index (LAI)

Transmitted gap light:

Beam radiation tilt factor (RB), Diffuse radiation tilt factor (RD), Total Shortwave extraterrestrial radiation (Extra), the amount of direct (Above Direct), diffuse (Above Diffuse), and total (Above Total) radiation incident in the absence of topographical or canopy foliage light obstruction, the amount of transmitted direct (Above Direct Mask), and total (Above Total Mask) radiation incident in the presence of light blockage by topography or canopy, and the percentage of transmitted direct, diffuse, and total radiation incident in the presence of light obstruction.

GLA will be used to plot solar irradiance (amount of total, direct, and diffuse solar radiation incident above and below the canopy) as a function of zenith angle and calculate equal-area gap fractions to determine regions that have equal sky-area weightings. Radiation data will be modeled in GLA to provide monthly information and data over the length of a growing season using 3 site-specific parameters, cloudiness index, spectral fraction, and beam fraction obtained from the data collected at the weather station on Huntington Wildlife Forest.

Multiple and simple regressions, MANOVA, and Multivariate regressions will be applied as stated in the data analysis for the first hypothesis and predictions.

Hypothesis 3.--

Residential communities provide areas of reduced snow depth that are equal to or greater than softwood stands, as compared to open hardwood stands.

Prediction 1.--

The proportion of the area in a residential community where snow depths are less than 38 cm (Behrend 1966, Mattfeld 1974) is greater than or equal to that of softwood stands, and greater than hardwood stands.

Field Methodology.--

To test the first prediction, I will use the random sample points within the open areas surrounding study homes and the transect lines established within the coniferous and hardwood stands (as mentioned in the previous hypotheses and predictions) to measure snow depths within the community and surrounding habitat every week. In periods of significant snow depth changes, measurements will be taken more often. Using the calibrated steel fence posts along the transect lines I will measure snow depth within the forest stands. Within the residential areas surrounding study homes, snow depth will be measured at the 2 random sample point locations from the calibrated steel fence posts. I will rotate between the 2 randomly chosen sample points weekly for snow depth measurements. Snow surface factor (snow load bearing capacity) measurements will accompany snow depth measurements, averaging of 10 measurements of penetration depth of a 1 kg weight with a surface area of 19.24 cm^2, dropped from a height of 10 cm (Mattfeld 1974).

Data Analysis.--

Multiple and simple regressions, MANOVA, and multivariate regressions will be applied as stated in the data analysis for first hypothesis and predictions. Comparisons will be made of snow depth in the habitat types using Pearson correlation coefficients.

Food Availability

Hypothesis 4.--

The presence of bird feeders and ornamental shrubs will influence the daily and seasonal movements of deer.

Prediction 1.—

Homes will serve as wind blocks and sources of residual heat and residential areas will provide areas of reduced snow depth resulting in higher usage by deer. When herbivory exclosures prevent access to ornamentals and feeders, the deer will continue utilizing the homes and surrounding areas.

B 6/3/05 7:44 AM
Comment: Note that this prediction would be stronger if it addressed the hypothesis more directly.

Field Methodology.—

To test the first prediction, I will use data gathered from the methods used to measure microclimatic variables and snow depth. In addition, I will sample ornamental shrubs, identifying what species are available for browsing by deer and the amount each plant is browsed at study homes with willing residents. I will determine the extent of deer browse on the sampled ornamental species based on visual observation, classifying by overall percentage of an individual plant that has been browsed and scaling from 1 to 3, with 1 being minimally, 2 being intermediately, and 3 being heavily browsed. Browse classification will be done in early January, late February, and late March.

Herbivory exclosures will be designed using wire mesh fencing. The body of water, Long Lake, isolates homes located in the northwest portion of the town. All ornamentals and bird feeders within this section of the hamlet will be fenced off, preventing access to feed sources.

Long Lake residents interested in aiding in data collection will voluntarily record number of deer they observe, tag number or presence of tags/radio-collar, location, date and time of observation, and the behavior of the deer such as eating, bedding, and walking. This will provide an idea of how often and when the deer within the community are actually utilizing homes, ornamental shrubs, and bird feeders. To ensure the confidentiality of the data collected, residents participating will receive an identification number for their home. This number will serve as the only source of identification associated with house location. The information gathered from the residents will be used to test both prediction 1 and 2.

Data Analysis.--

Multiple and simple regressions, MANOVA, and multivariate regressions will be applied as stated in the data analysis for first hypothesis and predictions.

PRELIMINARY TIMELINE

B 6/4/05 8:29 AM
Comment: A timeline is valuable and strongest if it contains a list of operational objectives that serve as milestones against which to evaluate progress for the project.

2004

May-June.--

Trap deer Monday-Saturday; Conduct telemetry relocations of collared deer while on summer range (HWF).

November-December.--

Follow the collared deer as they migrate to winter range.

2005

January-April.--

Conduct telemetry relocations of each collared deer at least 5 times/week; place microclimatic data loggers within field for recording data on weekly basis; assess habitat within winter yards; set up snow measurement transects; enter and analyze data.

May-June.--

Repair and maintain Stephenson box traps on HWF; trap deer

Monday-Saturday; begin writing thesis.

July-September.--

Analyze winter telemetry data and microclimatic data;

Compare with winter habitat and snow measurements; write thesis.

September.--

Defend thesis.

LITERATURE CITED

B 6/4/05 8:31 AM
Comment: Note that this is, appropriately, "Literature Cited" and not "Bibliography." Format for literature citations should follow Journal of Wildlife Management guidelines.

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