A VEGETATION MONITORING PROGRAM
FOR ASSESSING DEER DAMAGE
ON ILLINOIS DEPARTMENT OF CONSERVATION PROPERTIES

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January 8, 1990

INTRODUCTION

Because of the dramatic changes in vegetation at Busse Woods and Edward L. Ryerson Nature Preserves due to browsing by high density white-tailed deer populations, there has been an increased awareness and concern about the impacts of deer in forested natural areas. Consequently, a cooperative investigation of this problem was initiated by the Illinois Natural History Survey (INHS), Illinois Department of Conservation (IDOC), Cook County Forest Preserve District (CCFPD), and Lake County Forest Preserve District (LCFPD).

Overbrowsing can destroy the understory of forests and vegetation recovery within deer exclosures at Busse Woods Nature Preserve has been alarmingly slow (Witham & Jones, 1987). In an effort to provide an early warning system of such potential damage, the Department of Conservation has adopted methods for monitoring vegetation characteristics which are sensitive to the effects of deer foraging within state-owned or managed areas .

GOALS OF THE MONITORING PROGRAM

The monitoring program has four goals. (1) The program will provide a measure of the vegetation condition of the area in question. Vegetation condition refers to the structure and composition of the community or those parts of the community of concern, an evaluation of forage available to deer, and a measure of the current use of the vegetation by deer. (2) The program will provide a temporal record of deer foraging on the area. (3) The program will provide a temporal record and measure of changes in vegetation characteristics which are sensitive to the impacts of deer on the community.

(4) The program provides the specification of a threshold above which further damage to the vegetation is not acceptable. When damage levels meet or exceed these levels as determined by the data collected, control measures will be implemented.

BACKGROUND INFORMATION

Several factors affect the establishment of a damage threshold. Forest type, community structure, species composition, species sensitivity and response to browsing, rate of understory development and regeneration, and recruitment of seedlings and saplings into the mid- and upper canopy are all involved. Consequently, such threshold could become site specific. However, the initiation of control measures must be based on objective interpretation of monitoring data and an understanding of the structure and function of the forested area in question as well as the surrounding landscape. Additionally, browse levels and vegetation parameters should be analyzed and interpreted with respect to local weather, mast production, deer-vehicle collisions, deer damage reports, and waste grain availability.

In general, deer browsing on woody vegetation is readily distinguishable from browsing and clipping due to other Illinois mammals. Squirrels, beavers, and rabbits, having upper and lower incisors, leave behind a clean cut, usually at an angle to the twig or stem. Deer, having only lower incisors, rip or tear the twigs off, resulting in a ragged cut. Deer may feed anywhere from ground level to the limits of their reach which can exceed 2m when raising themselves on their hind legs.

MONITORING OBJECTIVES AND PARAMETER SPECIFICATION

In order to achieve the goals outlined above, the monitoring program has three objectives. (1) Record the species composition, density, and population structure for herbaceous and woody vegetation for initial evaluation and establishment of baseline conditions. (2) Measure current use of the vegetation by deer and evaluate the browse condition based on palatability to deer. (3) Measure the impacts of deer on natural succession and changes in species composition, especially in the development and recruitment of woody species. By conducting the field studies on an annual basis, a temporal record for the site will be developed. In order to observe and record changes in vegetation, measurement should be done periodically on permanent plots (Kroll, et al., 1986).

For the purposes of this program, herbaceous vegetation refers to any non-woody vegetation whose above ground growth typically, though not always, dies back each year and includes spring ephemerals, grasses, and ferns. Woody vegetation, whose above ground growth persists through the dormant season, includes shrub, vine, and tree species. Woody vegetation will be categorized into seedlings (plants < 50cm tall), shrubs (plants > 50cm and < 1m tall), and sapling (plants > 1m tall) classes. A similar scheme was used by Strole (1988) in central Illinois woodlots.

Observations in grazed woodlots have shown them to be lacking in woody reproduction, while the growth rate of established plants is thought to be lessened. Grazing often favors agressive tree species (Stoddart, et al., 1975). Changes in a hardwood stands due to heavy deer browsing included a change in diameter size distribution of the stand, particularly a gap in

smaller size classes of most species (Whitney, 1984). Seedling and sapling removal caused a lack of recruitment in eastern hemlock in Wisconsin (Curtis, 1959). Hartvigsen (1987) also observed seedling establishment and survival in Connecticut forests. Therefore, in attempting to evaluate the impacts of deer on a vegetation community, information regarding recruitment and survival of woody species may be the most sensitive indicator of species compositional changes (e.g. Frelich & Lorimer, 1985).

Based on these observations, recruitment of woody vegetation between 0-2m is the primary target parameter. This is not only an indicator of vegetational change but also is a feature which is exclusively used by deer or, at least, identified as such.

A second target parameter will be the observed densities and browsing levels on woodland forbs, particularly spring ephemerals. These have been a major concern at Ryerson Nature Preserve (Brouillard, pers. comm.) and often can be more apparent to the lay observer than lack of woody recruitment. As such, they can be a more emotional issue with the general public; certainly one more easily visualized and understood.

Sampling of woody vegetation should take place in late winter/early spring before 'bud swell', mid-February to March depending on latitude and weather. Due to increases in deer metabolic rates at this time (Verme & Ullrey, 1984) and low levels of other resources, especially mast and waste grain, use of browse and spring forbs can be best measured at this time. Sampling of impacts on spring forbs should take place in mid-spring, late April to Mid-May.

PRELIMINARY DATA COLLECTION AND RECONNAISSANCE

Prior to field work, appropriate sampling sites must be located which are of an upland habitat, fairly homogenous vegetation structure, and of sufficient size or appropriate landscape pattern to serve as wintering sites for deer (e.g. Nixon, 1989). This can be done with the aid of soil maps, recent aerial photographs, and topographic maps but is most effectively done by aerial surveys during mid-January to mid-February. Depending on the investigators familiarity with the site, a field check may be necessary. One or more habitat blocks are then selected for analysis. Within a 2000 acre region, 1-2 sampling sites per community of interest will be appropriate. Number of study sites is a compromise of collecting sufficient data and the limits of the investigator but the above numbers should provide adequate coverage.

Any information on past land use should be obtained where possible. This is particularly true in areas which may have pastured in the past. With respect to vegetation destruction by browsing, goats have greater impacts than sheep which have greater impacts than cattle (Stoddart, et al., 1975). This information can help interpret current vegetation structure determined from field surveys.

Several investigators (e.g. Graham, 1954; Nixon, pers. comm. to J. M. ver Steeg; Strole, pers. obs.) have observed damage to be greater along edges, roads, and deer trails. As these act as funnels for deer activity, they may overstate the damage occurring on an area in general and, therefore, should be avoided in assessing impacts at the community level. However, as our knowledge of deer-vegetation interactions grows, these areas could act to fine tune our predictive abilities.

SAMPLING SCHEME

A. Transects

Permanent strip transects are established in each selected upland community type. Strip transects are easy to establish in the field, avoid problems of clumped distributions (common in vegetation studies), and are superior to point or plotless methods (Schemnitz, 1980). Further, permanent transects are the best method of monitoring vegetation change over time on a study site (Mueller-Dombois & Ellenberg, 1974).

Each transect is 50m long and 2m wide. At the start of each transect and at intervals of 10m thereafter, a pair of nested quadrats is established. The smaller is 0.5m long and runs the entire 2m width of the transect; the larger is 2m long by 2m wide (Fig. 1).

All saplings (see definitions above) rooted within the 50m transect and with browsable vegetation below 2.0m are included in the sample. For multistemmed species (e.g. dogwood, gooseberry), the entire clone is considered one individual and included in the sample if any of its rooted stems occur in the transect. Plants with canopies extending into the transects but rooted outside of it are not counted. Each individual in the sample is identified to genus and species (or noted as dead) and the presence or absence of browsing is recorded. A similar strategy is used for shrubs (>50cm and <1m) in the 2m x 2m quadrat and seedlings (<50cm) and herbaceous species are recorded in the 0.5m x 2m plot.

Finally, the occurrence and frequency of any plants within the 50m transect showing the following impacts should be recorded - 'hedged' plants, bark stripping (regardless of the size of individual), browsing of twigs

greater than 0.5cm in diameter, and browsing of stems over 2.0m from the ground. The presence of a browse line should also be noted and photographed.

When sampling vegetation, each seedling and shrub plot should be recorded before the saplings are tallied to prevent damage to these lower layers by trampling of investigators. Similar precautions should be observed when sampling herbaceous species.

These transects will be visited annually. Permanent records of exact locations, both in the files and in the field are required. A metal post or conduit at both ends of the transect and bearing from a notable witness object, coupled with documentation and a 'pirate' map should be sufficient. A photo station will be established at each end of the transect for understory plants and a photo of each shrub and herbaceous/seedling plot is required. Color slides are mandatory.

An trained biologist could perform 2-4 transects per day depending on complexity and remoteness. Materials are minimal and include standardized data forms (Appendix 2), field maps, plot markers, compass, and measuring tapes.

B. Exclosures

The best method for measuring and illustrating the impacts of deer on vegetation is to entirely exclude deer from areas within the tract (Owen, 1971; Mueller-Dombois & Ellenberg, 1974; Myers & Shelton, 1980). Other mammals should continue to have unrestricted access. Exclosures can be particularly useful where detailed investigations of the herbaceous layer are warranted, where contrasting photo stations are helpful in demonstrating impacts, and as a tool for demonstration and public education. The state of Minnesota

established a program of 47 exclosures scattered throughout the state embracing the full spectrum of habitats (Owen, 1971).

Exclosures can effectively keep deer out of monitoring areas. The exclosure should be tall enough to prevent deer from jumping over it and made of mesh wire material that will prevent deer from entering through or under the fence. The exclosures will be 20m x 10m, $200m^2$. Although other deer exclosures used in northeastern Illinois were larger ($1000m^2$), it is felt that smaller exclosures are just as effective in demonstrating impacts of deer on vegetation (Brouillard, pers. comm.; Whitham, pers. comm.). Recommendations on exclosure size are not standardized and a $200m^2$ exclosure will allow for the necessary sampling yet keep the cost and disturbance to a minimum. There may be some instances where a larger exclosure will be necessary to adequately sample a community (e.g. dry upland woods), while smaller exclosures could be used if the investigation is limited to herbaceous or seedling impacts.

Although deer will usually not jump over a 6' fence for food (Yoakum, et al., 1980), an 8' fence is recommended for added assurance and is convenient as most mesh wire fencing material comes in 4' heights. The mesh wire will cover the full height of the fence. Woven mesh wire of at least 12.5 gauge will be used (Yoakum, et al., 1980). The vertical stays and line wires will not be over 6" apart. Six inches is preferred to allow access by other animals such as rabbits. The woven mesh wire will extend to the ground. Woven mesh wire will be used since it will conform to ground contours better than welded wire. The 12' wooden posts are spaced at 3.3m and put 3' into the ground. Five inch diameter posts should be used. Because of the small nature of exclosures, bracing should not be necessary. For larger exclosures, bracing at the corners may be required and can consist of U-shaped metal fence braces or wood cross

braces. If 10'-12' T-posts can be acquired, these can be used, but wood posts must be used on the corners.

A gate should be cut into the fence, approximately 3' x 4' to allow access. The gate should have the cut ends reinforced to provide rigidity. The gate should not allow access to unauthorized personnel or deer and should be chained and padlocked.

The approximate cost of a 10m x 20m fence, excluding labor, is:

18 5" x 12' wood posts at $12.00	$216.00
2 330' rolls 6" x 6" wire mesh at $112.00	$224.00
staples, rings, misc. hardware	$ 25.00
TOTAL	**$465.00**

A per meter estimate of cost is $7.75 excluding labor.

One exclosure per forested community type is recommended. Vegetation within the exclosure can be compared to that outside and available to deer. However, since the exclosure is not long and narrow, the placement of the sampling quadrats should be slightly modified. If the original 50m x 2m transect is thought of as a series of five 10m x 2m quadrats, then sampling within the exclosure can be visualized by establishment of 5 permanent 10m x 2m quadrats regularly arranged in a pattern similar to the 5 side of dice - 4 corners and a center (Figure 2). All should be at least 2m from the fencing. Sampling intensity in both sites is identical and results are comparable. The results will be indicative of the total impact of deer on vegetation as the technique eliminates 'normal' browsing pressure as well as any potential overbrowsing.

DATA ANALYSIS AND INTERPRETATION

The information recorded from each transect includes the density of woody individuals available, the number and percentage (total and for each species) which are browsed, and the densities of herbaceous vegetation and woody seedlings. With this information, one can characterize the total level of browsing, evaluate the vegetation condition as it relates to community dynamics and deer forage (see Appendix 1), and document instances of obvious damage (e.g. bark stripping).

As noted above, several variables influence the use of browse by deer, including mast production and availability, winter severity, and availability of waste grain. Where possible, these variables should be recorded during the browse survey in either a quantitative or qualitative manner (e.g. low, medium, high). The addition of information on deer-vehicle collisions and deer damage reports available from the Department of Transportation and the Division of Wildlife Resources, IDOC is desirable.

As data is collected over time, information on general browse preferences, impacts to sensitive species, switches to less preferred foods, and understory vegetation dynamics are obtained. Potential indicator species may be identified. Detailed demographic studies of individual species may be carried out following techniques developed and in use by the Division of Natural Heritage (Schwegman, 1987).

Initiation of deer control measures should begin under any of the following conditions:

a) The presence of a browse line

b) The occurrence of bark stripping

c) The occurrence of 'hedged' plants (sensu Stoddart, et al., 1975)

d) The recording of more than one individual per transect browsed at heights greater than 2.0m

e) The recording of more than one instance per transect of twigs greater than 0.5cm being browsed (except for species whose twigs and new growth are greater than 0.5cm (e.g. Ohio buckeye)).

The qualifications in scenarios d) and e) arise from the fact that deer are constantly sampling foods available in the environment and an isolated occurrence of browse above 2.0m or of twigs greater than 0.5cm, without additional evidence, may be indicative of this behavior. Additionally, hedged plants are sometimes found at trail entrances from fields and may not be indicative of overuse without other signs (Strole, pers. obs.).

All these results indicate there are more deer than the area can support, regardless of vegetation condition (Hosley, 1956; Stoddart, et al., 1975; Rue III, 1978). Control measures should be implemented quickly and as over a short a time frame as possible as major damage to the community and deer forage has already been done. Further sampling or exclosure studies are, biologically, unnecessary.

Other, less obvious, conditions also indicate overuse of vegetation by deer. These include vegetation dominated by a few species, usually agressive species, the prevalence of primarily low preference foods (Appendix 1), and the presence of a high percentage of annual plants in the herbaceous layer (Stoddart et al., 1975). When integrated with information on past land use (esp. grazing), and expected species composition in typical, less disturbed communities of the same type, the importance of the present deer population in creating the observed pattern can be determined. If deer are found to be the primary cause of the conditions or are instrumental in maintaining such a condition, control measures should be implemented. Compared to browse lines

and bark stripping, slightly less but very significant damage to the vegetation has already occurred.

Finally, deer impacts on plant communities can be expressed as an unnatural shift in species composition or lack of recruitment of young (small) individuals into older (larger) age (size) classes. For example, Stoeckeler, et al. (1957) found that woody growth greater than 5.4' tall increased dramatically in deer exclosures. Matschke, et al. (1984) noted that in areas with heavy populations of deer, 25-75% of individual woody plants were heavily browsed, making it difficult to practice good forestry. Hosley (19??) noted a Wisconsin browse survey which recorded <25% mortality on saplings of preferred browse species in an area with a balanced herd.

Over time, recruitment can be observed by changes in the number of seedling, shrub, and understory classes for any combination of species but particularly for those which 1) are high preference foods (Appendix 1) and 2) would be expected to persist into larger size classes (e.g. trees) or through time (e.g. Vaccinium).

Based on these observations, it is proposed that damage begins to accrue to the vegetation when deer related mortality exceeds 50% of herbs, seedlings, and/or shrubs in any one year. Deer related mortality of less than 25% is considered normal and acceptable. Between 25% and 50% is a buffer zone which indicates potential, but not certain, change. For example, an area with less than 25% mortality may exceed this limit in years of stress but then return to previous levels when normal conditions return. Alternatively, increases above 25% could be due to increasing pressure on the vegetation. In this case, one would expect to see a general upward trend until the 50% threshold level is reached. These declines in vegetation recruitment can be observed in trend analysis of data from transects and quadrats over 2 or more years or,

especially with herbaceous vegetation, can be obtained by direct comparison to exclosures plots.

REFERENCES

Curtis, J.T. 1959. The Vegetation of Wisconsin. Univ. Wisc. Press, Madison. 657pp.

Frelich, L.E. and C.G. Lorimer. 1985. Current and predicted long term effects of deer browsing in hemlock forests in Michigan, USA. Biol. Conserv. 34:99-120.

Graham, S.A. 1954. Changes in northern Michigan forests from browsing by deer. Trans. N. Am. Wildl. Conf. 19:526-533.

Gysel, L.W. and L.J. Lyon. 1980. Habitat analysis and evaluation. pp. 305-327 in Schemnitz, S.D. (ed.) Wildlife Management Techniques Manual. The Wildlife Society, Washington, D.C. 686pp.

Hartvigsen, G. 1987. The effects of deer browse on the growth of trees. Conn. Woodlands 52(4):16-17.

Hosley, N.W. 1956. Management of the white-tailed deer in its environment. pp. 187-259 in Taylor, W.P. (ed.) The Deer of North America. The Stackpole Company, Harrisburg, PA.

Kroll, J.C., W.D. Goodrum and P.J. Behrmen. 1986. Twenty-seven years of overbrowsing: implications to white-tailed deer management on wilderness areas. pp. 294-303 in Kulhavy, D.L. and R.N. Conner (eds.) Wilderness and

Natural Areas in the Eastern United States: A Management Challenge. Stephen F. Austin St. Univ., Nacogdoches, TX.

Matschke, G.E., K.A. Fagerstone, R.F. Harlow, F.A.Hays, V.F. Nettles, W. Parker and D.O. Trainer. 1984. Population influences. pp. 169-188 in Halls, L.K. (ed.) White-tailed Deer. Stackpole Books, Harrisburg, PA. 870pp.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and Methods of Vegetation Ecology. J. Wiley & Sons, NY. 547pp.

Myers, W.L. and R.L. Shelton. 1980. Survey Methods for Ecosystem Management. J. Wiley & Sons, NY. 403pp.

Nixon, C.M. 198?. Winter refuges - the key to survival for farmland deer. IL Nat. His. Sur. Reports no. ???:3-4.

Owen, O.S. 1971. Natural Resource Conservation: An Ecological Approach. Macmillan & Co., NY. 593pp.

Rue III, L.L. 1978. The Deer of North America. Crown Publ., NY. 463pp.

Schwegman, J.E. 1987. Prodedures for census, demographic monitoring, compiling life history information, and development of management guidelines for special plants. IDOC, Springfield, IL. 21+pp.

Stoddart, L.A., A.D. Smith and T.W. Box. 1975. Range Management. McGraw-Hill Book Co., NY. 532pp.

Stoeckeler, J.H., R.O. Strothmann and L.W. Krefting. 1957. Effects of deer browsing on reproduction in the northern hardwood -hemlock type in northeastern Wisconsin. J. Wildl. Manage. 21:75-80.

Strole, T. 1988. Influence of white-tailed deer browsing on successional patterns and woody species composition in central Illinois upland forests. MS Thesis, Illinois St. Univ., Normal. 44pp.

Verme, L.J. and D.E. Ullrey. 1984. Physiology and nutrition. pp.91-118 in Halls, L.K. (ed.) White-tailed Deer. Stackpole Books, Harrisburg, PA. 870pp.

Whitney, G.A. 1984. Fifty years of change in the arboreal vegetation of Heart's Content, an old growth hemlock-white pine-northern hardwood stand. Ecol. 65:403-408.

Witham, J.H. and J.M. Jones. 1981. Chicago urban deer study. IL Nat. His. Sur. Reports no. 265. 4pp.

Yoakum, J., W.P. Dasmann, H.R. Sanderson, C.M. Nixon and H.S. Crawford. 1980. Habitat Improvement Techniques. pp. 329-403 in Schemnitz, S.D. (ed.) Wildlife Management Techniques Manual. The Wildlife Society, Wasington D.C. 686pp.

Figure 1. Schematic of vegetation sampling plot (not to scale).

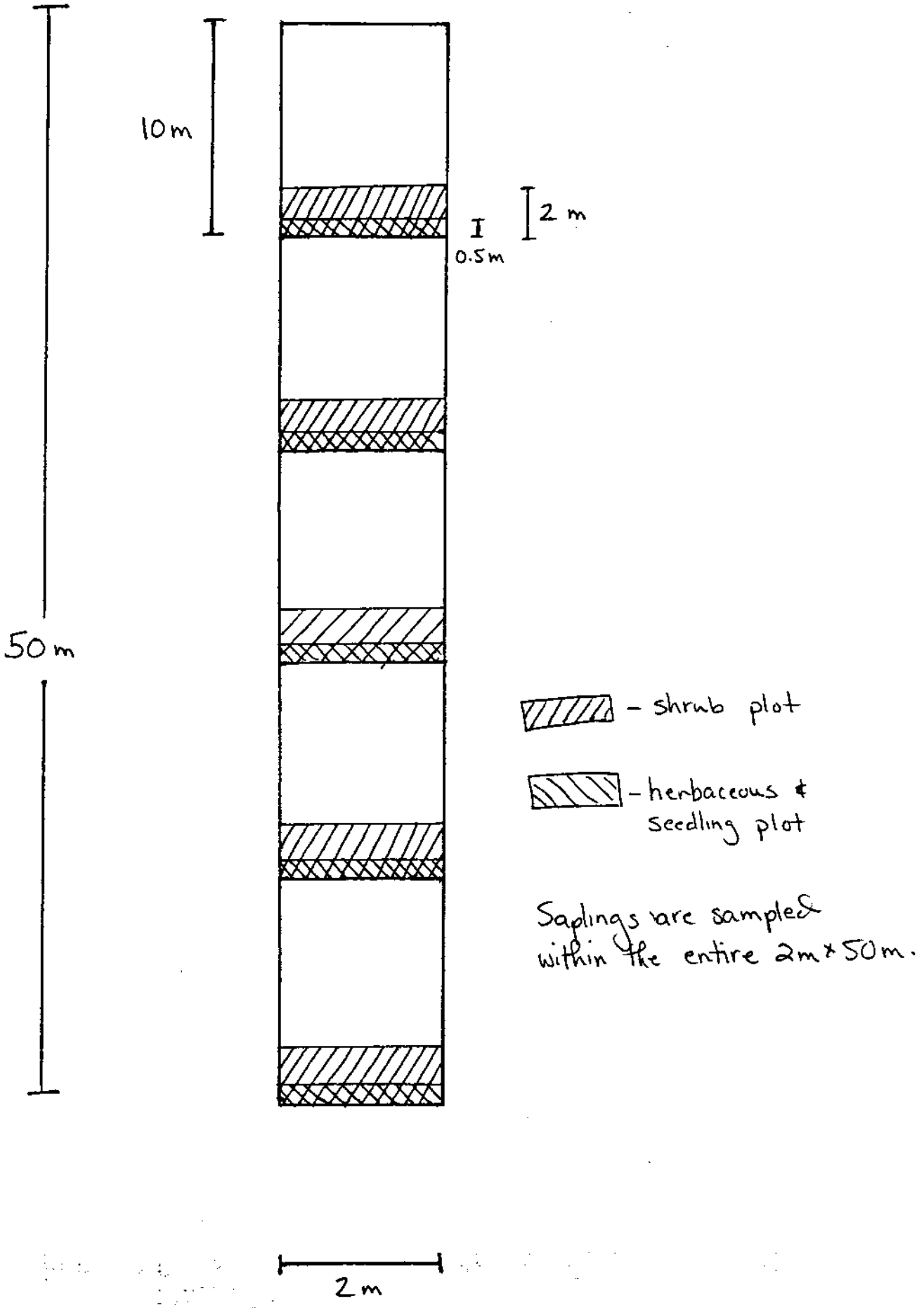
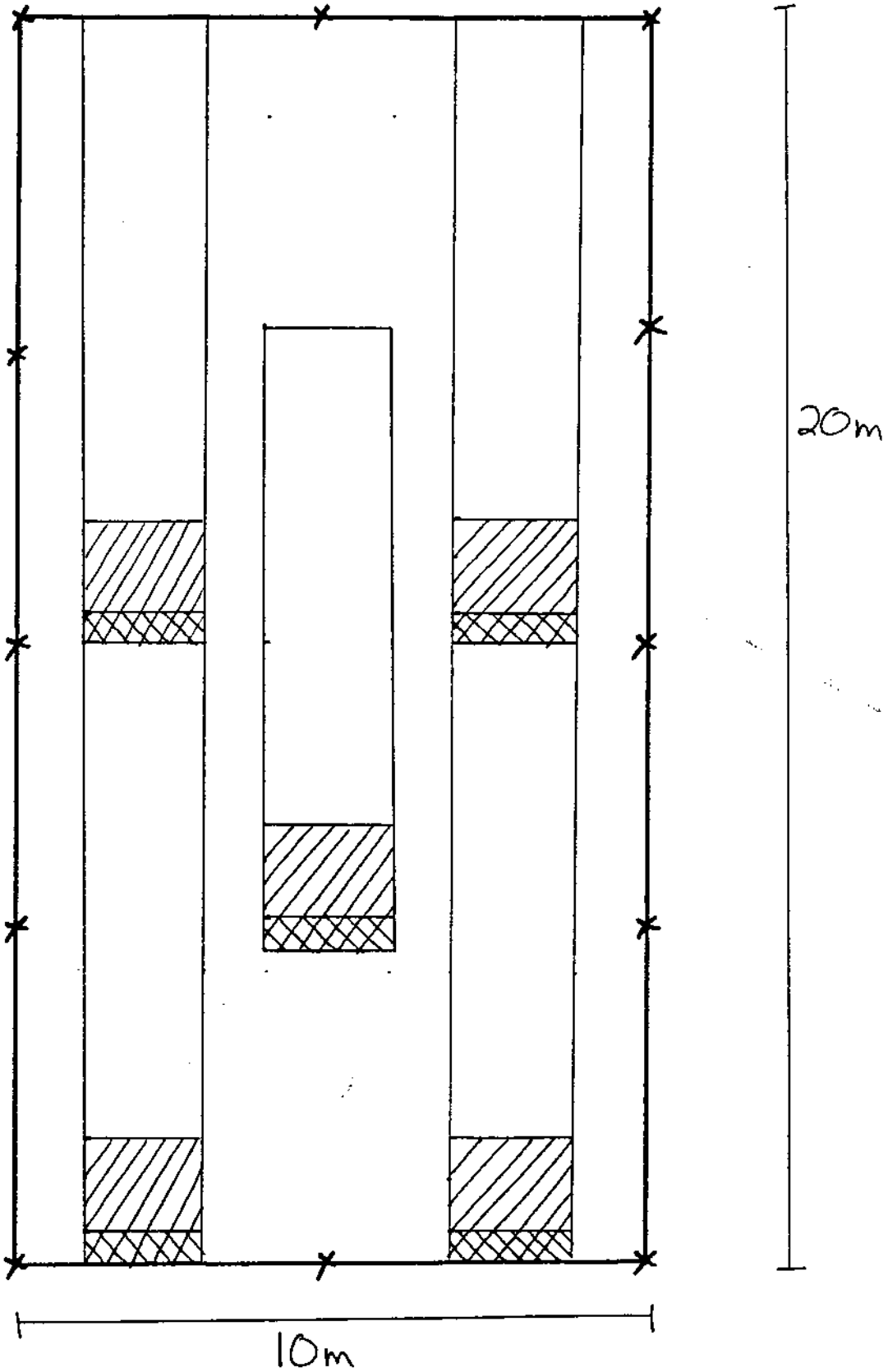

10m
2 m
0.5m
50 m
- shrub plot
- herbaceous & seedling plot
Saplings are sampled within the entire 2m x 50m.
2m

Figure 2. Layout of samplings plots within an exclosure

(not to scale)


20m
10m

List of woody and herbaceous browse species showing preference patterns by white-tailed deer from 10 sources. L = Low preference M = Medium preference, H = High preference.

List of sources (citation followed by study area)

1. Hubbard, M. L. 1987. Unpublished thesis research data. (Crab Orchard National Wildlife Refuge, Illinois.)

2. Rue III, L. L. 1978. The deer of North America. Crown Publishers. Inc., New York. 463 pp. (Eastern United States)

3. Wetzel, J. F., J. R. Wambaugh, and J. M. Peck. 1975. Appraisal of White-tailed deer winter habitats in Northern Minnesota. J. Wildl. Manage. 39:59-66. (Northeastern Minnesota.)

4. LaGory, M. K., K. E. LaGory, and D. H. Taylor. 1985. Winter browse availability and use by white-tailed deer in Southeastern Indiana. J. Wildl. Manage. 49:120-124.

5. Nixon, C. 1988. Illinois Natural History Survey. personal communication. (Central Illinois.)

6. Strole, T. A. 1988. Influence of white-tailed deer (Odocoileus virginianus) browsing on successional patterns and woody species composition in Central Illinois Upland Forests. Illinois State University thesis. (Central Illinois)

7. Stormer, F. A. and W. A. Bauer. 1980. Summer forage use by tame deer in Northern Michigan. J. Wildl. Manage. 44:98-106. (Northern Michigan)

8. Shelford, V. E. 1963. The Ecology of North America. University of Illinois Press. Urbana, IL 610 pp. (Pisgah National Game Preserve, North Carolina)

9. Korschgen, L. J., W. R. Porath, and O. Torgerson. 1980. Spring and Summer Foods of deer in the Missouri Ozarks. J. Wildl. Manage. 44:89-97 (Southern Missouri)

10. Blair, R. M. and L. E. Brunett. 1980. Seasonal browse selection by deer in a Southern pine-hardwood habitat. (Kisatchie National Forest, Louisiana)

WOODY PLANTS

Species	Source									
	1	2	3	4	5	6	7	8	9	10
Arrowwood, Viburnum dentatum	-	-	-	-	-	-	-	-	-	H
Basswood, Tilia americana	-	-	-	-	-	H	-	-	-	-
Beaked Hazel, Corylus cornuta	-	-	-	-	-	-	H	-	-	-
Bitternut Hickory, Carya cordiformis	-	-	-	-	-	M	-	-	-	-
Black Cherry, Prunus serotina	H	H	-	-	H	H	-	-	-	-
Blackberry, Rubus spp.	M	-	-	-	-	-	H	-	-	H
Black Haw, Viburnum prunifolium	-	-	-	-	-	H	-	-	H	-
Black Oak, Quercus velutina	-	-	-	-	-	M	-	-	-	-
Black Walnut, Juglans nigra	-	-	-	-	-	H	-	-	-	-
Box Elder, Acer negundo	-	-	-	L	-	M	-	-	-	-
Choke Cherry, Prunus americana	-	-	-	-	-	H	H	-	H	-
Coralberry, Symphoricarpos orbiculatus	M	H	-	-	H	-	-	-	-	-
Dogwood, Cornus spp.	H	H	H	L	-	H	-	H	-	L
Dewberry, Rubus flagellaris	-	-	-	-	-	-	-	-	H	H
Elderberry, Sambucus canadensis	H	-	-	-	-	-	-	-	-	-
Elm, Ulmus spp.	H	-	-	L	H	M	-	-	H	-
Farkleberry, Vaccinium arboreum	-	-	-	-	-	-	-	-	H	-
Fragrant Sumac, Rhus aromatica	-	-	-	-	-	-	-	-	H	-
Gooseberry, Ribes spp.	-	-	-	-	-	L	-	-	-	-
Grape, Vitis spp.	M	-	-	-	-	-	-	H	H	-
Greenbriar, Smilax spp.	H	H	-	-	-	M	-	-	-	H
Hackberry, Celtis occidentalis	M	-	-	-	-	-	-	-	-	-
Hawthorn, Cretaegus spp.	M	-	-	-	-	L	-	-	-	H
Hazelnut, Corylus americana	-	-	-	H	-	H	-	-	-	-
Hickory, Carya spp.	-	-	-	-	L	-	-	-	-	-
Highbush Blackberry, Rubus pensilvanicus	-	-	-	-	-	-	-	-	H	-
Ironwood, Ostrya virginiana	-	-	-	-	-	M	-	-	-	-
Japanese Honeysuckle, Lonicera japonica	H	H	-	-	-	-	-	-	-	-
Juneberry, Amelanchier arborea	-	-	-	H	-	-	-	-	-	-
Lowbush Blueberry, Vaccinium vacillans	-	-	-	-	-	-	-	-	H	-
Multiflora Rose, Rosa multiflora	M	H	-	L	H	H	-	-	H	-
Oaks, Quercus spp.	-	H	-	-	L	H	-	-	-	L
Ohio Buckeye, Aesculus glabra	-	-	-	-	-	M	-	-	-	-
Persimmon, Diospyros virginiana	H	H	-	-	-	-	-	-	-	-
Poisen Ivy, Toxicodendron radicans	H	-	-	-	H	-	-	-	-	-
Post Oak, Quercus stellata	M	-	-	-	-	-	-	-	-	-
Prickley Ash, Zanthoxylem americanum	-	-	-	-	-	L	-	-	-	-
Raspberry, Rubus occidentalis	H	-	-	-	-	-	-	-	-	-
Redbud, Cercis canadensis	M	-	-	-	-	-	-	-	-	-
Red Cedar, Juniperus virginiana	-	H	-	H	-	-	-	-	-	H
Red Oak, Quercus rubra	M	-	-	-	-	H	-	-	-	-
Red Maple, Acer rubrum	H	-	H	-	-	-	H	-	-	L
Red Mulberry, Morus rubra	-	-	-	-	-	-	-	-	-	H
Russian Olive, Eleagnus umbellatum	M	-	-	-	-	-	-	-	-	-
Sassafras, Sassafras albidum	H	-	-	H	-	-	-	H	-	H
Shagbark Hickory, Carya ovata	-	-	-	-	-	H	-	-	H	-
Shingle Oak, Quercus imbricaria	M	-	-	-	-	L	-	-	-	-
Spicebush, Ilex decidai	M	-	-	-	-	-	-	-	-	-

WOODY PLANTS cont.

Species	Source									
	1	2	3	4	5	6	7	8	9	10
Sugar Maple, Acer saccharum	H	-	-	-	-	L	-	-	-	-
Sumac, Rhus glabra	-	H	-	-	H	-	-	-	-	-
Sweetgum, Liquidambar styraciflua	L	-	-	-	-	-	-	-	-	-
Trumpet Creeper, Campsis radicans	M	-	-	-	-	-	H	-	-	-
Virginia Creeper, Parthenccissus quinquefolia	H	-	-	-	H	-	-	-	H	-
White Ash, Fraxinus americana	H	-	-	L	L	L	-	-	-	M
Willow, Salix Spp.	-	-	-	-	-	-	H	-	-	-
Winged Elm, Ulmus alata	H	-	-	-	-	-	-	-	-	M
Winged Sumac, Rhus copallina	H	-	-	-	-	-	-	-	-	-

HERBACEOUS SPECIES

Species	Source									
	1	2	3	4	5	6	7	8	9	10
Annual Blue Grass, Poa annua	-	-	-	-	-	-	-	-	H	-
Aster, Aster Spp.	-	-	-	-	-	-	P	-	-	-
Bracken Fern, Pteridium aquilinum	-	-	-	-	-	-	L	-	-	-
Cinquefoil, Potentilla simplex	-	-	-	-	-	-	-	-	H	-
Dandelion, Taraxacum officinale	-	-	-	-	-	-	H	-	-	-
Fall Panic Grass, Panicum dichotomiflorum	-	-	-	-	-	-	-	-	H	-
False Solomon'sSeal, Smilacina racemosa	-	-	-	-	-	-	-	-	H	-
Goldenrod, Solidago	H	H	-	-	-	-	H	-	H	-
Grass, -	-	-	-	-	-	-	L	-	-	-
Jewelweed, Impatiens biflora	H	-	-	-	-	-	-	-	-	-
Orchard Grass, Dactylis glomerata	-	-	-	-	-	-	-	-	H	-
Pansy Violet, Viola pedata	-	-	-	-	-	-	-	-	H	-
Prickly lettuce, Lactuca Scariola	-	-	-	-	-	-	-	-	H	-
Pokeweed, Phytolacca americana	-	-	-	-	-	-	-	-	H	-
Painted Leaf Spurge, Euphorbia heterophylla	-	-	-	-	-	-	-	-	H	-
Snakeroot, Sanicula spp.	M	-	-	-	-	-	-	-	-	-
Star of Bethleham, Ornithogalum umbellatum	-	-	-	-	-	-	-	-	H	-
Solomon's Seal, Polygonatum commutatum	-	-	-	-	-	-	-	-	H	-
Smooth yellow violet, Viola pensylvanica	-	-	-	-	-	-	-	-	H	-
Strawberry, Fragaria virginiana	-	-	-	-	-	-	H	-	-	-
Tick Trefoil, Desmodium spp.	-	-	-	-	-	-	-	-	H	-
White Dogtooth Violet, Erythronium albidum	-	-	-	-	-	-	-	-	H	-

Species showing low use in the region as a whole are:

Alder
Bayberry
Blackberry
Bluebeech
Blueberry, deerberry
  lowbush
Butternut
Cane
Clematis
Elms, *Ulmus* sp.
  American
  cork
  slippery
Goldenrod
Hickory, *Carya* sp.
  shagbark
  mockernut
Holly, inkberry
Honey locust
Hop hornbeam
Lespedeza
Lily
Partridge berry
Persimmon
Pipsissewa
Plum
Poison ivy
Raspberry
Sedges and rushes
Self heal
Sourwood
Spicebush
St. Andrew's Cross
Sweet bay
Viburnum, black haw
Walnut, black
Willow, black
  sandbar
Witch hazel, eastern
  Ozark

The region referred to is the 'central states forest' region of Hosley (1956).

APPENDIX 2.

BROWSE SURVEY - SAPLING
(> 1.0m tall)

Site:
Transect:
Page __ of __

Date:
Community:
Investigators:

Species	Unbrowsed	Browsed

NOTES:

Bark Stripping:
Hedged Plants:
Browsing above 2.0m:
Browsed twigs > 0.5cm:

BROWSE SURVEY - SHRUB
(>50cm & <1.0m tall)

Site:
Transect:
Page __ of __

Date:
Community:
Investigators:

Plot	Species	Unbrowsed	Browsed

BROWSE SURVEY - SEEDLING
(<50cm tall)

Site:
Transect:
Page __ of __

Date:
Community:
Investigators:

Plot	Species	Unbrowsed	Browsed