DEER HABITAT MANAGEMENT SYSTEM AND DATABASE

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Maine Department of Inland Fisheries & Wildlife
Wildlife Resource Assessment Section
Cervid Project
and
Regional Wildlife Management Section

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PART I. – DEER HABITAT MANAGEMENT SYSTEM

INTRODUCTION

This is the system currently being used by Maine Department of Inland Fisheries and Wildlife (MDIFW) to manage white-tailed deer habitat. Goals and objectives that drive these efforts are tied to the goals and objectives set forth in the current Deer Population Management System and Data Base (DPMS; MDIFW 1989). Included here are processes to identify and protect important deer habitat and techniques for enhancing this habitat.

Currently, MDIFW deer habitat management efforts are primarily directed toward protecting and enhancing deer wintering habitat. For the purpose of this document, deer wintering habitat is any area used by deer when the Winter Severity Index (WSI) $\geq$ 60 (See Appendix VI of DPMS). Any area in Maine occupied by one or mote deer under these conditions is usually called a deer wintering area (DWA). Typically, this habitat includes mature softwood shelter forest stands and peripheral areas which provide forage. However, recent forest cuttings and south facing slopes with a relatively open canopy may also be used. In this document, wintering habitat may also be referred to as winter range or deer yard (these are terms found in the literature).

When more stringent criteria are applied to define the DWA, a conditional name will be used, e.g., Land Use Regulation commission defined deer wintering areas will be referred to as LURC DWAs. A LURC DWA only encompasses the shelter portion of a deer wintering area.

REGULATORY AUTHORITY

Inland Fisheries and Wildlife Laws (12 MRSA, Part 10, Chapter 703, 7037) provide authority for the Commissioner to establish criteria for the identification of deer wintering areas in the state. In addition, documented wintering areas are to be reported to landowners and local officials.

Land Use Regulation Commission protection of LURC DWAs is provided under Chapter 10 of LURC regulations (10.16, C describes Fish and Wildlife Protection Districts). Department of Environmental Protection (DEP) protects high or moderate value deer wintering areas (DEP DWAS), as defined and identified by MDIFW, as significant wildlife habitat under Title 38 Chapter 2 Article 5-A. Under proposed DEP Permit-by Rule Standards, Chapter 305, all activities located in LURC territory and subject to Natural Resource Protection Act (NRPA), including DWAS, may proceed without licensing by or notification to DEP.

Based on Comprehensive Planning and Land Use Regulations Act (Title 30, 4312, 4326, 4341) and DECD Regulations (Chapter ____, deer wintering habitat (as defined in the NRPA) is being identified by MDIFW for the Department of Economic and Community Development (DECD) and provided to towns by DECD for planning purposes.

Copies of laws/regulations related to deer wintering habitat protection are provided in Appendix I.

WINTER HABITAT MANAGEMENT GOALS AND OBJECTIVES

Goals and objectives for deer habitat protection and enhancement are based on providing adequate winter habitat to achieve and maintain desired deer populations (see DPMS in MDIFW 1989). DPMS goals and objectives were developed during the most recent (1986) MDIFW strategic planning process (Lavigne 1986). This process included:

1. Updating the deer assessment to evaluate habitat availability, current population levels, human use and demand, etc.
2. Public participation in the form of a working group to review the assessment and develop preliminary deer population goals and objectives. The public working group included a mix of interest group and geographical representatives.
3. Final review and adoption by the Commissioner and his Advisory Council.

The following habitat goals and objectives are based on 1985 projected deer population levels (50-60% of estimated maximum supportable population - K) which could be maintained during winters of mild to moderate severity (i.e., mean severity of 1980-89 winters). Current deer population objectives were developed by a public working group during the 1985 assessment and species planning process. During that process, total available deer habitat was not anticipated to change over the 1986-1991 period. However, 2 of the concerns the Public Working Group expressed were:

1. Changes in habitat due to budworm and the addition of biomass harvesting; and,

2. No control over land use on winter habitat in organized towns.

Problems related to reduction of traditional deer wintering habitat by spruce budworm defoliation, logging, and human development were specifically discussed. Strategies for addressing these problems were also developed. These strategies included:

Strategy 1: Delineate locations of critical wintering areas in all towns of the State.

Strategy 2: Determine the effects of the distribution, area, cutting treatment, and stand composition of deer wintering habitat on herd abundance and survival.

Strategy 3: Develop improved guidelines for documenting deer wintering area use for LURC zoning in unorganized towns.

Strategy 4: Develop a program which enables regional biologists to more effectively maintain or mitigate loss of important deer wintering habitat from harmful land use practices.

Strategy 5: Encourage large landowners to actively manage the wood resource which comprises deer wintering habitat for sustained benefits to deer and landowners.

Strategy 6: Quantify the effects of winter logging operations on long-term regional abundance and survival of deer.

Deer population goals and objectives may be revised during future assessments with public input.

Habitat Management Goals

Provide protection (by identification and land-use zoning) of deer wintering habitat throughout Maine to achieve current (1985) deer population objectives. Improve the age-class diversity of existing deer wintering habitat by fostering sound silvicultural practices within deer wintering areas.

Habitat Management Objectives

Increase acreage of deer wintering habitat to meet population objectives under mild and moderate winters in Deer Management Districts (DMDS) and facilitate recovery of populations after severe winters. Wintering habitat objectives, expressed as % of total deer habitat, are presented by DMD in Table 1. Total deer habitat excludes open water and human development (Lavigne 1986).

Assumptions

Deer winter habitat management goals and objectives are based on several assumptions:

1. Long-term or prevailing winter severity varies in intensity within the state, with relative severity increasing with distance from the coast.

Table 1. Wintering habitat required to achieve and sustain current (1986-91) objective deer populations, by Deer Management District.

DMD	1980-89 Mean Yarding Period (Days)	DWA Required[a]				
		Acres	Mi^2	% of Total Deer Habitat[b]	$Deer/Mi^2$ DWA	DWA Acres/ Deer
1	95	140,388	219.4	6.1	102	6.3
2	95	124,415	194.4	7.3	104	6.2
3	95	80,502	125.8	5.5	103	6.2
4	95	181,056	282.9	8.1	101	6.3
5	95	122,031	190.7	10.7	103	6.2
6	95	131,968	206.2	8.1	103	6.6
7	68	61,440	96.0	11.5	144	4.4
8	68	77,312	120.8	12.2	141	4.5
9	68	76,736	119.9	6.6	144	4.4
10	68	84,288	131.7	8.4	142	4.5
11	68	44,672	69.8	9.0	144	4.5
12	68	164,288	256.7	13.7	143	4.5
13	36	35,648	55.7	5.6	272	2.4
14	36	26,048	40.7	6.0	270	2.4
15	36	32,896	51.4	4.8	265	2.4
16	36	23,616	36.9	4.7	260	2.5
17	36	27,584	43.1	2.5	249	2.6
Statewide	-	1,434,888	2,242	7.6	133	4.8

[a]Calculated as acreage required to support 10,000 deer-days use per mi^2 of DWA at objective population levels, given various levels of winter severity.

[b]Total deer habitat excludes open water and human development.

2. An adequate supply of deer wintering habitat providing both shelter and food improves deer survival when moderate to severe wintering conditions exist. Conversely, an inadequate quantity of wintering habitat will result in deer losses greater than normally expected during moderate to severe winters.

3. Approximately 5-15% of the land base must be wintering habitat capable of supporting deer populations at prevailing (mean 1980-89) winter severity. This range (5-15%) depends upon winter severity and deer density within DMDs (Appendix II).

4. Approximately 2/3 of identified deer wintering habitat in LURC jurisdiction (unorganized towns) can be protected by LURC zoning.

5. A portion (10-25%) deer wintering habitat in organized towns may be protected indirectly by wetland regulations and shoreland zoning.

6. DWA protection implies that regulated (silviculturally) timber management is permitted, and should be encouraged within certain guidelines.

7. Substantial acreage of deer wintering habitat in central and northern Maine will become available within 25-30 years, when former wintering

areas altered by logging or spruce-budworm damage (over past 15-20 years) regenerate and mature into age classes which provide shelter for deer. Some areas managed on short rotation (< 40 years) may be logged before LURC DWA criteria are met.

8. In southern Maine, additional development will reduce the total acreage of deer habitat (and DWAS) available.

9. Although many developed areas support deer populations, typically these areas are inaccessible to deer hunters (and thus deer management) because of firearm discharge restrictions. Since many of these areas are already carrying socially unacceptable numbers of deer, protection of DWAs may be undesirable.

10. Attainment of DMD-specific quantity objectives will result in maximum achievable interspersion of deer wintering habitat at the DMD level. Deer use will determine location of DWAS, and in some cases, the proportion of DWAs at town/local levels may exceed DMD objectives.

WINTER HABITAT IDENTIFICATION AND PROTECTION PROCESS

Habitat identification and protection decisions relate primarily to the objective of providing enough softwood shelter to permit the achievement and maintenance of desired deer population levels. The following sections describe the process by which MDIFW identifies deer wintering habitat and makes recommendations for DWA protection by zoning (LURC) or designation (DEP). PART II details the Procedures for identifying and documenting deer wintering habitats.

Criteria for Decision Making

Inputs to the decision process (Figure 1) include: deer population goals; acreage and location of documented deer winter habitat; amount of land area available for deer habitat; LURC and DEP regulations; and, acreage of DWA currently protected by LURC Zoning.

The general objective is based on a maximum average stocking level of 10,000 deer days/mi2 of wintering habitat in a given winter, when deer are confined during average wintering conditions with the deer population at 1985 target density (see DPMS). [Note: 1 deer day = 1 deer in a DWA for one day.]. This stocking level would result in acreage of deer wintering habitat between 3 to 14% of available deer habitat, depending on winter severity and 1985 deer population goals (Table 1). This wintering density (10,000 deer dayS/Mi2 of DWA per winter) is near the upper limit allowable for deer stocking rates in DWAS. Past records of DWA locations and habitat types within DWAs suggest that protection of 5-15% (shelter plus peripheral areas) of total deer

FIGURE 1A. DWA PROTECTION DECISION PROCESS.

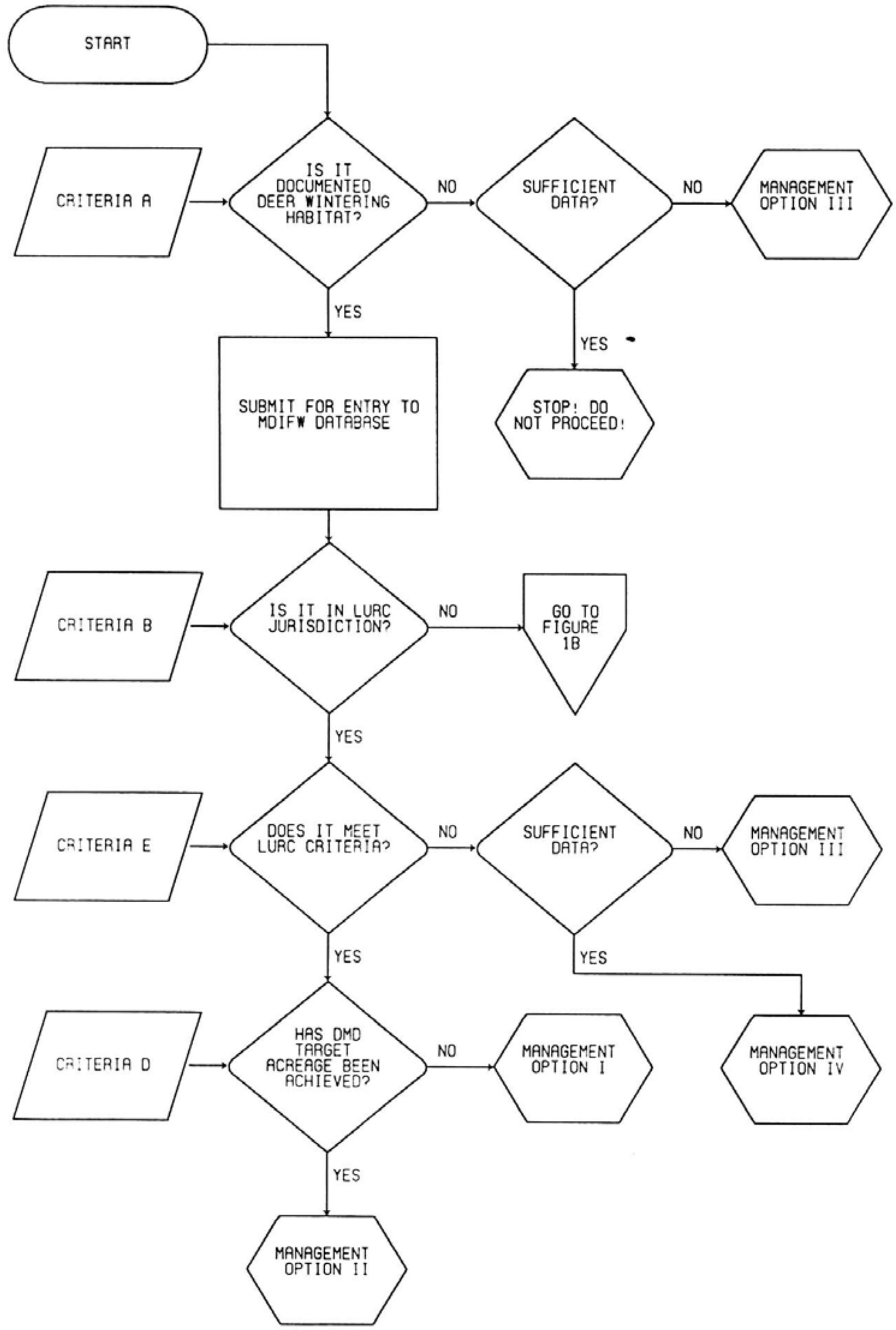
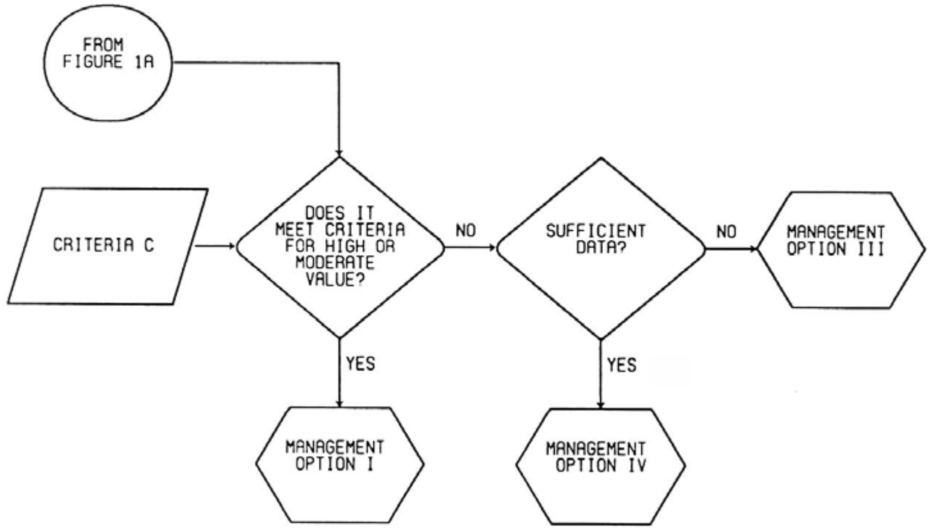


FIGURE 1B. DWA PROTECTION DECISION PROCESS.



range would provide an adequate acreage of winter habitat to overwinter 1985 target deer populations.

Criteria A

Has area being submitted been documented recently or historically as deer wintering habitat based on the following criteria:

- snow depth in open and hardwood cover types $\geq$ 12 in, and
- one or more deer present, or
- deer tracks, beds, browsing, pellets, or other sign observed.

Criteria B

This input is list of towns currently under LURC jurisdiction.

Criteria C

This input based on DEP criteria for classification as significant wildlife habitat (See Part II). Under proposed permit-by-rule, any DWA activity regulated by LURC will not require licensing by or notification to DEP.

Criteria D

See Table 1 for DMD deer wintering habitat objectives.

Criteria E

This input is based on LURC criteria for classification as DWA. LURC DWAs are defined by the Maine Department of Conservation Land Use Regulation Commission (LURC) as areas:

1. Documentation of use by deer during winter in at least two of the past ten years;
2. With wintering deer population > 20 deer/ sq. mi.; and,
3. Forested with > 50% conifer stems, conifer crown closure of > 50%, and predominant tree heights of > 35 ft.

See Part II for detailed description of LURC Zoning process.

Management Options

Based on the decision process outlined in Figure 1, four options are available.

Management option I Submit subject area for zoning.

Management Option II Do not submit subject DWA for zoning. May replace existing DWA, if DMD goals have been achieved. Criteria for exchanging/replacing have not been developed.

Management Option II Insufficient data available to make final determination. Continue to monitor deer use/vegetation conditions to collect additional data.

Management Option IV For whatever reason, the subject area doesn't meet the criteria based on sufficient data availability. Monitor periodically over time to determine if area meets criteria for protection at a future date (e.g., forest regeneration and recovery from budworm damage and/or logging).

PART II. – DEER WINTERING HABITAT

APPENDICES

I. Laws relating to deer wintering habitat protection.

II. Deer wintering habitat requirements.

III. Deer wintering habitat management procedures, instructions and forms.

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Introduction

Maine is divided into 17 mainland, and one coastal island-based Deer Management Districts (DMDs). Deer population management decisions are based primarily at the DMD level (MDIFW 1989). Estimation of deer wintering area (DWA) requirements of deer in each of these DMDs requires consideration of three interrelated factors: the number of deer requiring wintering habitat, duration of the yarding season, and carrying capacity or maximum allowable stocking level of the winter habitat.

During winter, Maine may be divided into 3 distinct climate zones (NOAA 1990). Distribution of DMDs within these winter climatic zones is illustrated in Figure 1. Severity of winter weather (snow accumulation and cold temperatures) generally intensifies from coastal DMDs northward. Although DMDs were aggregated by climate zone (Figure 1) for winter severity calculations, winter habitat requirements have been estimated for individual DMDS.

The following sections describe the methodology and rationale used in formulating the winter habitat objectives outlined in the Deer Habitat Management System (DHMS) main text (pp. 8-10). Figure I and Tables 1-4 (pp. II-9 to II-13) document the procedure used to estimate winter habitat requirements. A summary of winter habitat requirements of white-tailed deer in Maine is provided in Table 5 (p. II-14).

Although deer wintering habitats are commonly referred to as deer wintering areas in Maine, the terns deer wintering area, wintering habitat, winter range, and deer yard are used interchangeably in this appendix. Habitat types comprising deer wintering habitat are described in more detail on pp. II-16-17. Typically, this habitat includes mature softwood shelter forest stands, and peripheral stands which provide forage. A more specific use of the term DWA is used to denote wintering habitat which conforms to Land Use Regulation Commission (LURC) standards (LURC 1989) for inclusion of wintering habitat into P-4 or P-FW protection districts. These types of deer wintering habitats, which are basically mature coniferous shelter stands, will be designated as "LURC DWAS". [When standards under the Natural Resource Protection Act (NRPA) are established, wintering habitat protection zones regulated by Department of Environmental Protection (DEP) will be designated as "DEP DWAs".)

Deer Population Objectives

The number of deer expected to use available wintering habitat is dependent on population objectives established for each DMD, as outlined in the Deer Assessment and Strategic Plan (Lavigne 1986), and the Deer Population Management System (MDIFW 1989). Deer population objectives (based on 55% of KCC) for northern, central and coastal DMDs are presented in Table 1. Note that objective population densities are highest (9.5 to 19.5 deer/Mi2) in DMDs 7-12 (which contain Maine's best deer habitat), are intermediate (6.2 to 16.2) in coastal DMDS, and are lowest (5.7 to 11.0 deer/mi^2) in northern DMDS. Note also that these are the target densities of deer we hope to achieve through implementation of the Deer Population Management System. When achieved, target populations listed in Table 1 will be the wintering herd, for which an adequate quantity of wintering habitat must be available when yarding conditions occur.

Duration of the Yarding Season

To quantify regional differences in the need for wintering habitat, an estimate of the mean number of days in which deer utilize DWAs was determined from Winter Severity Index (WSI) values (MDIFW 1989; Appendix VI) for the 1980s (Table 2). WSI values range from 0 to 150, and reflect progressively increasing severity for deer. Values >85 denote severe wintering conditions which, if prolonged, will result in greater winter losses than normally expected during mild to moderate winters.

Deer tend to utilize their winter range when the WSI > 60. Regional WSI values differ considerably (Table 2), with WSI values increasing from coastal to northern DMDS. For the 1980s (which averaged milder in severity than the previous decade), total winter WSI values were $\geq$ 60 nearly 8 of 10 years in northern DMDS, 5 of 10 years in the central zone and 2 of 10 in coastal DMDS. Within-winter differences are also evident. WSI values $\geq$ 60 occurred an average of 3.2 months/winter in the north, 2.3 months in central DMDS, and 1.2 months/winter in coastal DMDs during the 1980s. Assuming a 30-day month, deer experienced an average yarding period of 95, 68 and 36 days in DMDs 1-6, 7-12 and 13-17, respectively, during the 1980s (Table 2). Clearly, northern deer experience yarding conditions more often (per decade), and for a longer duration (per winter), than do deer inhabiting other DMDS. DMDs 1-6 encompass most of Maine's unorganized townships which are under LURC jurisdiction.

Maximum Allowable Stocking Level

The number of deer which a given unit of wintering habitat will support depends not only on the density of deer using the habitat, but also on the number of days the herd occupies the site. In terms of maximum stocking rate, it matters little if 2 deer occupy a site for 50 days or 100 deer use the site for 1 day. In both cases, the habitat experienced 100 deer-days of use.

As detailed later, maximum stocking level for deer wintering habitat in Maine is assumed to be 10,000 deer-days/mi2 of DWA per year. Maintaining average stocking levels significantly higher than 10,000 deer-days/mi^2 of DWA per yarding season would likely result in over-browsing of winter forages during mild to moderate winters. This situation, in turn, would lead to a reduction in long-term carrying capacity of deer winter range.

<u>Winter Habitat Requirement</u>

Population objectives, mean duration of the yarding period, and maximum allowable stocking levels were assessed through the following procedure to estimate the quantity of winter range required for northern, coastal, and central DMDS. Deer populations at objective levels were first constrained into 2, 5, 7, 10 or 15 percent of the total deer habitat base (excludes water and human development) to project potential deer densities while on winter range (Table 1). These densities were then multiplied by the mean days yarded during the 1980s (from Table 2). The result (Table 3) is the potential stocking level (deerdays per mi^2 of DWA) in 2-15% of total deer habitat. A final step (Table 4) determines which percentage of wintering habitat would yield no more than 10,000 deer-days/Mi2 of DWA for each DMD. Note that wintering habitat requirements are highest, 6.6 to 13.7% of total deer habitat, for central DMDs primarily because of high population objectives (Table 1) in a region of moderate winter severity (Table 2). Northern DMDs require 5.5 to 10.7% of the habitat base as wintering habitat, reflecting rigorous winters of long duration, but relatively low population objectives. The least amount of wintering habitat (2.5 to 6.0% of the habitat base) is required in coastal DMDs where severe winters are infrequent and of limited duration, and population objectives are moderate.

Expressed as deer density in wintering areas at the recommended stocking rate, a mean density of approximately 100, 150, and 270 deer per mi^2 of winter range would be indicated for northern, central and coastal DMD'S, respectively. These figures are consistent with the fact that deer density should be lower in those DMDs which require the longest duration of use of wintering habitat. Similarly, winter range acreage allocated per deer (roughly 6.3 acres/deer in the north, 4.5 central, 2.5 coastal) are greatest where need for this important habitat will be the greatest (Table 4).

Thus, acreage required to support projected deer populations, given winters similar to those experienced during the 1980s, approximates 780,000 acres fo@ northern DMDS, 509,000 acres in central DMDs and 146,000 acres in coastal DMDs (Table 5). Statewide, this totals 1.43 million acres or 7.6% of Maine's total deer habitat.

We recognize that not all of this acreage requirement may be suitable for zoning or protection by LURC or DEP. Some acreage, because of past timber harvests and/or spruce-budworm defoliation, does not (and may never) meet standards for zoning or protection. Peripheral sections of deeryards which do not meet cover standards may qualify for protective status under other regulations (e.g., wetland habitat which is also

DWA). Thus, components of deer wintering areas which are important to W-inter nutrition for deer may receive protection, and possibly management. Additional acreage occurs around winter cutting operations which may attract deer within their home range during one or more winters. While of value to deer for that particular time, cutting operations can never be expected to permanently replace traditional deer wintering areas, unless small-scale annual woods operations occur within the home range of a population of deer for an entire timber rotation. Therefore, the area within active logging operations will not be counted toward attainment of wintering habitat objectives.

Failure to provide adequate wintering habitat (whether quantity or quality) will result in a deterioration of physical condition among wintering deer whenever deer must yard. Deer in poorer condition suffer higher losses to malnutrition and predation. In addition, fawns born to malnourished does suffer greater neonatal losses than fawns born to adequately nourished does. Above-average losses occurring among deer inhabiting -marginal wintering habitat must be compensated by a reduction in legal harvest, if target populations are to be achieved and maintained. Failure to provide a sufficient compensatory reduction in deer losses through restrictive hunting would lead to deer population reductions, and consequently, inability of MDIFW to achieve and maintain its deer population objectives.

Interspersion of DWAs

A uniform distribution of DWAs within each of the townships comprising a DMD would be ideal. However, deer wintering habitat is not currently, and probably never will be, distributed uniformly. Some towns contain little or no wintering habitat, while others contain large quantities of wintering habitat which may serve not only deer in the township in which it occurs, but also subpopulations which summer in several surrounding towns.

While from an administrative perspective, it would be desirable to allocate protected winter acreage uniformly across DMDS, towns and land ownerships, the deer themselves will ultimately determine the pattern of winter use. We assume that as deer repopulate under-utilized habitat, and as former DWAs which were altered by timber harvest and/or spruce-budworm defoliation again regenerate into winter shelter stands, a more optimal distribution of deer wintering habitat will be available for protection and management. Specificilly, achievement of habitat objectives at the DMD level should simultaneously produce an adequate distribution of protected DWAS.

LITERATURE CITED

Lavigne, G. R. 1986. Deer assessment - 1985. Pp.245-321 in: Planning for Maine's inland fish and wildlife, Vol. I, Part 1-3 Species assessments and strategic plans. ME Dept. Inland Fisheries and Wildl., Augusta.

LURC. 1989. LURC regulation of deer wintering areas. Land Use Regulation Commission, Maine Dept. of Conserv., Augusta. 9pp. mimeo.

MDIFW. 1989. Deer population management system and database. Maine Dept.of Inland Fisheries and Wildl., Augusta. 351pp.

NOAA. 1990. New England climate - January 1990. N.E Regional Climate Center Publl. 90(l):2.

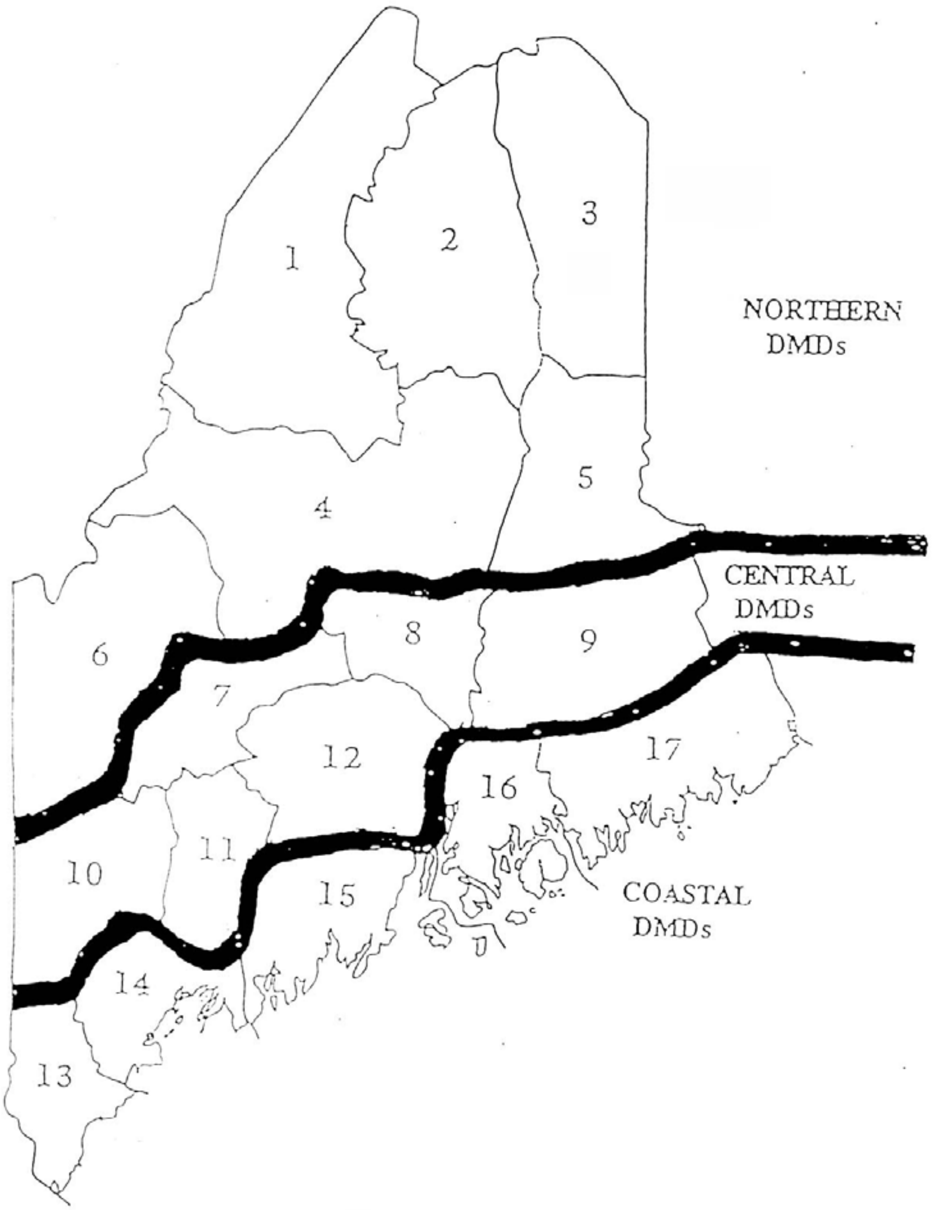

Figure 1. Maine's mainland deer management districts (DMDs) divided along winter climatic zones (after NOAA 1990).

Table 1. Deer density per mi² of winter range, given varying quantities of DWA and current (1986-91) objective population levels, by Deer Management District.

DMD	Total Deer Habitat[a] (Mi²)	Objective Population (55%K) Total	Objective Population (55%K) Per Mi²	Percent DWA 2	5	7	10	15
				(Deer per Mi²)				
1	3,596	22,349	6.2	311	124	89	62	41
2	2,663	20,213	7.6	380	152	108	76	51
3	2,287	12,956	5.7	283	113	81	57	38
4	3,493	28,625	8.2	410	164	117	82	55
5	1,782	19,602	11.0	550	220	157	110	73
6	2,546	21,146	8.3	415	166	119	83	55
7	835	13,869	16.6	830	332	237	166	111
8	990	17,043	17.2	861	344	246	172	115
9	1,816	17,279	9.5	480	190	136	95	63
10	1,568	18,714	11.9	597	239	170	119	80
11	775	10,017	12.9	646	259	185	129	86
12	1,874	36,590	19.5	976	391	279	195	130
13	995	15,159	15.2	762	305	218	152	102
14	679	10,980	16.2	809	323	231	162	108
15	1,071	13,607	12.7	635	254	181	127	85
16	786	9,597	12.2	610	244	174	122	81
17	1,725	10,721	6.2	311	124	89	62	41

[a]Total deer habitat excludes water and human development.

Table 2. Frequency of winters of sufficient severity (WSI ≥ 60) to induce deer yarding behavior during 1980-89 for various combinations of Deer Management Districts.

DMD	Mean WSI	Years WSI ≥ 60	Mean Frequency of Winter Months/Winter WSI ≥ 60 (MAX = 5)	Mean Days Yarded[a]		
				Mean	Min	Max
1-6	75	7.7	3.2	95	30	140
7-12	59	5.0	2.3	68	0	120
13-17	50	2.3	1.2	36	0	100

[a]Assumes a 30 - day month

Table 3. Relative stocking levels (deer-days per mi²) in deer winter range given varying quantities of DWA and different levels of winter severity, by Deer Management District.

DMD	1980-89 Mean Yarding Period[a] (Days)	Percent DWA 2	5	7	10	15
		Deer-Days per Mi² DWA[b]				
1	95	29,545	11,780	8,455	5,890	3,895
2	95	36,100	14,440	10,260	7,220	4,845
3	95	26,885	10,735	7,695	5,415	3,610
4	95	38,950	15,580	11,115	7,790	5,225
5	95	52,250	20,900	14,915	10,450	6,935
6	95	39,425	15,770	11,305	7,885	5,225
7	68	56,440	22,576	16,116	11,288	7,548
8	68	58,548	23,392	16,728	11,696	7,820
9	68	32,640	12,920	9,248	6,460	4,284
10	68	40,596	16,252	11,560	8,092	5,440
11	68	43,928	17,612	12,580	8,772	5,848
12	68	66,368	26,588	18,972	13,260	8,840
13	36	27,432	10,980	7,848	5,472	3,672
14	36	29,124	11,628	8,316	5,832	3,888
15	36	22,860	9,144	6,516	4,572	3,060
16	36	21,960	8,784	6,264	4,392	2,916
17	36	11,196	4,464	3,204	2,232	1,476

[a]See Table 2 for derivation of these values.

[b]Calculated as: [mean days yarded] x [deer per mi² from Table 1].

Table 4. Wintering habitat required to achieve and sustain current (1986-91) objective deer populations, by Deer Management District.

DMD	1980-89 Mean Yarding Period (Days)	DWA Required[a] Acres				
		Acres	Mi^2	% of Total Deer Habitat[b]	Deer/Mi^2 DWA	DWA Acres/ Deer
1	95	140,388	219.4	6.1	102	6.3
2	95	124,415	194.4	7.3	104	6.2
3	95	80,502	125.8	5.5	103	6.2
4	95	181,056	282.9	8.1	101	6.3
5	95	122,031	190.7	10.7	103	6.2
6	95	131,968	206.2	8.1	103	6.6
7	68	61,440	96.0	11.5	144	4.4
8	68	77,312	120.8	12.2	141	4.5
9	68	76,736	119.9	6.6	144	4.4
10	68	84,288	131.7	8.4	142	4.5
11	68	44,672	69.8	9.0	144	4.5
12	68	164,288	256.7	13.7	143	4.5
13	36	35,648	55.7	5.6	272	2.4
14	36	26,048	40.7	6.0	270	2.4
15	36	32,896	51.4	4.8	265	2.4
16	36	23,616	36.9	4.7	260	2.5
17	36	27,584	43.1	2.5	249	2.6
Statewide	-	1,434,888	2,242	7.6	133	4.8

[a]Calculated as acreage required to support 10,000 deer-days use per mi^2 of DWA at objective population levels, given various levels of winter severity.

[b]Total deer habitat excludes open water and human development.

Table 5. Summary of winter habitat requirements of white-tailed deer in Maine, by Deer Management Districts.

	North DMDs 1-6	Central DMDs 7-12	Coastal DMDs 13-17
Deer population objectives (deer/mi² total habitat)	8.4 (5.7-11.0)[a]	14.4 (9.5-19.5)	11.4 (6.2-16.2)
Duration of yarding season - mean days WSI $\geq$ 60[b]	95 (30-140)	68 (0-130)	36 (0-100)
Maximum stocking level (deer-days/mi² DWA)	10,000	10,000	10,000
DWA requirements (% of total deer habitat to yield ≤ 10,000 deer-days)	7.2% (5.5-10.7)	9.2% (6.6-13.7)	4.6% (2.5-6.0)
Deer density in winter habitat at recommended stocking level (deer/mi²)	103 (101-104)	143 (141-144)	263 (249-272)
Necessary winter range (acres)	780,000	509,000	146,000
DWA acres/deer	6.3 (6.2-6.6)	4.5 (4.4-4.5)	2.5 (2.4-2.6)

[a]Values are weighted means for DMDs grouped by climate zone, except for necessary winter range, which is the sum. Range of values for individual DMDs are in parentheses.

[b]Snow depths in openings and hardwood cover types $\geq$ 12"; mean temperatures < 32°F. Data are for the 1980-89 period.

BACKGROUND AND SUPPORTING DATA FOR WINTER HABITAT REQUIREMENTS

Introduction

In this section, several key assumptions implicit in deriving winter range requirements are explored in more detail, based on a review of literature and unpublished data on various aspects of winter deer ecology. The scope of the review was largely restricted to white-tailed deer at the northern limit of it's range. Studies of mule deer and black-tailed deer winter ecology were included, if they contributed to overall knowledge of deer winter habitat use, nutrition, or energetics relationships. The most complete literature review was conducted for deer in Maine and the northeast. Data which support recommended winter range acreages are presented in Figure 2 and Tables 6-20.

Objective Population

Derivation of deer population objectives for each DMD is summarized in Table 6. Estimated populations at the midpoint (55%) of objective population size (50-60% of estimated maximum supportable population, i.e., KCC) were summed for DMDs within northern, central and coastal groupings and presented in Table 5 of the preceding section.

The use of yearling antler beam diameter as an index to current status of DMD populations to KCC is described by Chilelli (1988), Lavigne (1989) and Chilelli and Lavigne (1990).

Deer Wintering Habitat

Many habitat types comprise deer wintering habitat (Table 7). They may be divided into two categories: those which are used where deep (> 12 in) snow accumulates, and those used in regions of low or intermittent snow cover. The first 7 types listed in Table 7 are dominated by mature, deep-crowned coniferous species, and are the types selected by deer in regions with heavy, persistent snow accumulations-, and/or extreme low temperatures. Deer utilizing these winter habitat types frequently must subsist on limited quantities of poorly digested forages (Ullrey et al. 1971, Mautz 1978). Poor mobility in deep snow (Severinghaus 1947), and low diet quality make deer use of coniferous cover obligatory for energy conservation (Moen 1976), avoidance of predators (Hoskinson and Mech 1976), and survival (Cheatum 1951).

In Maine, most DWAs consist of the spruce-fir dominated types (Gill 1957, Gill 1964). Lesser quantities of white pinehemlock and cedar swamp types are utilized in winter, although pine-hemlock types are predominant in southern DMDs (Figure 1). All other coniferous wintering habitat types occur west of Maine. Limited use of steep south slope wintering areas (SSLOPE) and agriculture-based wintering concentrations (e.g. AGRHWD; Table 7) may occur in this state, but their distributions, and the conditions under which they are occupied, are poorly documented.

Those wintering habitat types not dominated by coniferous species (all types after OGR on Table 7) tend to be utilized as much for security cover (Zagata and Haugen 1973, Nixon et al. 1988), as for thermal shelter. In addition, they are always associated with limited snow cover (< 12 in), typically of limited duration before melting. Hence deer mobility in these areas is rarely restricted. A further characteristic is that, while in these habitat types, deer are able to utilize relatively nutritious forages such as agricultural pasturage, grain waste, native herbaceous forages, and mast, all'of which provide wintering deer with an abundant source of energy and protein (Short 1970, Short and Reagor 1970).

Initiation of Yarding

A major assumption in estimating winter range requirements was that deer are utilizing (but are not necessarily confined to) winter range when the winter severity index (WSI) $\geq$ 60. A detailed description of Maine's WSI monitoring program may be found in MDIFW 1989 (Appendix VI).

Analysis of monthly WSIs during the past 15 years suggested deer tended to yard at varying degrees when the WSI was 60 or greater. Below that WSI level, snow cover was light or nonexistent. Further analysis revealed WSI values of 60 were associated with snow depths of 10-12 in. (Figure 2). The literature review resulted in a number of studies (Table 8) which suggested that deer congregated in winter habitat and initiated yarding behavior at snow depths between 5 and 14 in., but most commonly at 10-12 in. Two studies of deer energetics (Mattfeld 1974 and Parker et al. 1984) proved that energy expenditure in snow becomes increasingly costly (exponential increases) when deer sink in snow at or above the knee joint. That joint, well below the brisket, averages 10-12 in. in white-tailed and black-tailed deer. This supports a physiological cause (excessive energy expenditure) for initiation of yarding by deer.

Diet quality also declines at these ranges (5-14 in.) of snow depth, as deer must switch from highly nutritious herbaceous forages and mast, to less well digested woody browses and litterfall (McCullough 1984, Banasiak 1961, Crawford 1982, Potvin and Huot 1983 and others). Concurrent with declines in diet quality, deer congregate on winter range, which contains habitat types that facilitate energy conservation and enhance mobility in snow (Banasiak 1961, Verme 1965).

<u>Maximum Allowable Stocking Rate</u>

Carrying capacity in northern DWAs is highly variable and dependent on forest stand type, age, crown closure, and most importantly - snow depth. Potvin and Huot (1983) determined that carrying capacity of DWAs may approach 0 when snow > 24 in. persists in DWAs for much of the winter. Few studies were found which actually describe carrying capacity of DWAs in terms of deer-days/mi^2. Potvin and Huot's (1983) data suggests that white pine-hemlock DWAs could support > 7,000 deer-days/mi^2, given a yarding period of 95 days and WSI ratings typical of northern Maine DMDS. However, their model did not include litterfall, which may be abundant in certain habitat types (Day 1963, Potvin 1980, Stevenson and Rochelle 1984), and hence should increase carrying capacity. Hanley and Rogers (1989) projected a carrying capacity of 11,000 deer-days/n i2 in old growth forests, given moderate wintering conditions (B wks with snow depth 20-24 in.). However, old growth stands are superior (more forage, better mobility) to the large pole stage DWAs which predominate in Maine.

Although carrying capacity studies are generally lacking for northern deer ranges, we may gain some understanding of relative carrying capacity from studies documenting actual deer density in existing wintering habitat. In Maine, deer densities in two deer yards in north-central Franklin and Somerset counties are presented in

Tables 9 and 10. Based on pellet-group surveys, the Coplin Plantation DWA supported 10,000 to 28,000 deer-days/Mi2 use during 1984-1990 (Table 9). These densities reflect only the shelter portion of the yard, along with a minor amount of regenerating patch cuts from spruce-budworm salvage operations conducted in 1986. Addition of peripheral (feeding) areas of this yard would likely lower mean pellet-group density and deerdays use estimates. Grand Falls DWA data (Table 10) reveal much lower deer-day use estimates. The deer population using this Mi2 study area (part of the 2,000 acre Hayden Bk. DWA) was much lower than that for Coplin Plt., and in fact, had been declining for > 10 years (Hugie 1973, Lavigne 1976). All deer-day use estimates were < 10,000 deer-days/mi2 at Grand Falls, which remained uncut, but spruce budworm-damaged, throughout the study period. Whether this DWA can support higher deer populations in its current condition is conjectural.

A number of studies reported deer density in various DWAS, but not the duration of the yarding period (Table 11). Mean densities of deer/Mi2 of wintering habitat tend to be < 100 except for cedar swamp deer yards, a type and composition of which is rare or non-existent in Maine. Assuming a yarding period of 90 days, deer-day use estimates generated for most of these studies would be in the range of 10,000 deer-dayS/Mi2. One further exception is the situation in which deer were artificially fed in winter (Kabat et al. 1953). These habitats contained high deer densities, but native browse supplies generally were depleted, and the stocking rate of deer greatly exceeded the natural carrying capacity of the winter range.

Given our current state of knowledge regarding actual and allowable stocking rates in DWAS, use of 10,000 deer-dayS/Mi2 appears reasonable and justifiable as an upper level.

Winter Range Estimates

In contrast to estimates of carrying capacity, a considerable volume of information exists regarding the proportion of total deer habitat which is utilized as winter range. Data for Maine presented in Tables 12-15, were derived primarily from aerial surveys conducted when deer were largely confined to coniferous shelter (snow depths $\geq$ 18 in.) from the 1950s to the present.

Data for northern, western and eastern Maine suggest that deer winter range approximated at least 10% of the landbase from the 1950s to the raid 1970s. Currently, less than 20% of that historical wintering habitat has been zoned as LURC DWAs in LURC towns. During the past 30 years, both the number and size of individual deer wintering areas has declined significantly (Table 12). causes of this decline are speculative, but likely include elimination of DWAs by timber harvesting prior to LURC zoning (DWA does not meet LURC standards for forest type and cotnposition), or subsequent alteration of shelter quality below LURC standards by spruce-budworm defoliation. As of 1990, DWAs were not protected as DEP DWAs (high and moderate values) in organized towns in northern, eastern and western Maine. Consequently, wintering habitat in Maine's organized towns could be cut at will.

Winter range estimates have been compiled from surveys conducted during the past 10 or 15 years in the largely settled portions of central, southern and coastal Maine

(Tables 13-15). Most of these aerial surveys were conducted under restrictive (> 15 in. snow depth) yarding conditions. Resulting winter range use estimates generally approximate 10-30% of the landbase. They tend to be higher currently in central Maine towns (e.g. DMD 12) where deer populations are thriving. However, estimates of winter range use were much lower (averaging 5%) in south coastal DMD 14 (Table 14, Figure 1). Since deer populations in DMD 14 are only slightly lower than populations in DMD 12 towns, reasons for the differences in winter range use are not readily apparent. Clearly, given current and historical patterns of known use of winter range in Maine, the recommendation that 7, 9 and 5 percent of the landbase in Maine's 3 climate zones (Table 5) be protected and/or managed under LURC or DEP regulations appears conservative.

Winter range use by deer in locations outside of Maine is documented in Table 16. Few studies hav4: documented winter range use of < 5% of the landbase. Some of those that do occur where (e.g., Quebec) the quantity of wintering habitat is limited and is hampering deer population recovery (Potvin 1984).

Proportion of Winter Range Which Meets LURC Cover Standards

Few studies are available which document deer wintering habitat composition in terms which allow evaluation of what proportion of a given yard would meet LURC standards for zoning as a P-FW subdistrict. Forest type standards for P-FWs are: ≥ 50% coniferous species; ≥ 50% crown closure and, ≥ 35 ft. average height (LURC 1989).

Maine studies related to this topic occurred in northcentral DMDs under severe wintering conditions (Table 17). Approximately 50-80% of the acreage within these yards appeared to meet LURC standards. It is noteworthy that the long-term (40 yrs) trend for the Hayden Brook DWA is for a gradual reduction in shelter quality, and in the proportion of the type and composition of forest stands which would meet LURC standards. Reasons for the decline in cover quality clearly include timber harvests and spruce-budworm damage (the former occurring prior to zoning as a P-FW). Elsewhere, coniferous shelter meeting LURC DWA standards generally ranged from 50-80% of the wintering area, except for deer yards where spruce-budworm damage has occurred. The trend in cover reduction (from 66 to 30%) for the deer yard cited by Potvin (1980) is probably typical of spruce-fir dominated wintering areas existing in the northern 2/3 of Maine today.

<u>Interspersion, Deeryard Size, and Deer Behavioral Considerations</u>

Locations of favorable wintering habitat do not occur uniformly across the landscape. Deeryards vary in size from just a few acres to many square miles, even exceeding township size in a few instances (Tables 13-16). The larger wintering areas tend to have a long history of continuous use, which may span a century or more (Table 18). Smaller yards may be more ephemeral in use by deer (Germaine et al. 1986), sometimes being abandoned if the cover is destroyed (Huot 1975) or when snow depths become excessive (Jackson and Sarbello 1980, Banasiak 1961, Krefting and Phillips 1970). There is considerable evidence that DWAs < 250 acres (pocket yards) render wintering deer more vulnerable to malnutrition (Goodreault 1975), and predation losses

(Vanballenberge and Hanley 1984, Mech and Nelson 1981, Messier and Barrette 1983, Kolenosky 1972). In addition, these pocket DWAs present fewer opportunities to conduct intensive forest management (e.g. stand age diversification, thinning, sustained yield harvesting) because of unfavorable cost-benefit factors (Germaine et al. 1986, Verme and Johnston 1986, Krefting and Phillips 1970).

However, pocket yards may be all that is left of much larger historical deeryards which have been fragmented by timber harvest (Alexander and Garland 1984), or spruce-budworm defoliation (Potvin et al. 1981). These small pockets of deer activity may also be remnant populations which were decimated by excessive predation and hunting losses (Nelson and Mech 1976c) and/or severe winters (Potvin et al. 1977). Complete loss of these local populations is possible (Nelson and Mech 1981), and because deer are slow to colonize new territory (Tierson et al. 1985), large areas of deer habitat may remain devoid of deer following extirpation of local deer populations (Verme 1973).

White-tailed deer are highly social ungulates (Hirth 1977). They are organized in a maternal social structure in that many generations of related does, their offspring, and associated bucks form cohesive social groups or demes (Nelson and Mech 1987). These subpopulations show a high degree of annual fidelity to specific winter and summer ranges (Gill 1957, Carlsen and Farmes 1957, Westover 1971, Verme 1973, Carson 1976, Drolet 1976, Nelson 1979, Nelson and Mech 1976a, and b, Nelson and Mech 1981, Pichette and Samson 1982, Tierson et al. 1985, Nixon et al. 1988, and Beier and McCullough 1990).

The amount of summer range served by one wintering area, varies with DWA size, and overall habitat quality (Pichette and Samson 1982). In high quality habitat which contains adequate winter range, subpopulations may summer over an area of 5,000 acres or less (Tierson et al. 1985). In regions with a scarcity of winter cover, subpopulations of deer (demes) may range (at low average density) over areas exceeding 100 mi^2. In the latter situation, deer distribution may be discontinuous and irregular.

Subpopulations using a specific deer yard may all summer in one quadrant of the compass (e.g. North to East), with other subpopulations being served by other yards (Carlsen and Farmes 1957, Verme 1973, Gotie 1976, Pichette and Samson 1982, Pao et al. 1984, Tierson et al. 1985, Wood 1986, and Nelson and Mech 1987). Within their area of familiarity, entire subpopulations of deer may be short-stopped away from their traditional wintering areas by winter logging operations (Tierson et al. 1985).

Movements from summer to winter ranges vary with deme size, but tend to be shorter in high quality habitats which are well stocked with deer. Data summarizing deer movement and home range area are presented in Table 19. Annual, traditional movements on northern deer ranges may be substantial. The deer which wintered in the Armstrong deer yard in Quebec, for example, spent their summers in northern Maine, and travelled individually 2 to 59 miles between winter and summer range (Pichette and Samson 1982). This case, however, appears to be exceptional for most of Maine. Data presented by Carson (1976) and Allen (1970) are probably more representative of deer movement patterns (0-5 miles) in Maine.

Within DWAS, deer movements are more limited (Table 19). Daily home ranges appear to be less than 50 acres. During the entire winter season, deer movements up and down the watershed plus excursions outside the shelter portions of deer yards may result in seasonal home ranges of 100 to > 3,500 acres. Generally, home range size is directly related to a deer's mobility in snow (Tierson et al. 1985, Drolet 1976).

Effects of Shelter Loss

Winter mortality rate of northern deer populations is directly related to the depth and duration of snow cover and thermal stress, i.e. winter severity, (Severinghaus 1947, Verme and Ozoga 1971, Sauer and Severinghaus 1983, Crete 1976a, b, Verme 1977, Karns 1980, Telfer 1971, and Lavigne 1983). The availability of wintering habitats which ameliorate the effects of deep snow and cold are considered essential to deer survival at the northern limit of the species' range (Banasiak 1961, Telfer 1978, Potvin and Huot 1983, Mattfeld 1974). Factors which reduce the quantity and/or quality of critical winter shelter inevitably reduce carrying capacity for deer (Potvin et al. 1977, Strong 1977, Dickinson 1972).

Taken to extremes, logging of winter shelter stands can severely reduce the quality and quantity of critical wintering habitat (Gill 1957a, Strong 1977, Boer 1982, and Alexander and Garland 1984). Likewise, severe windstorms (Lanier 1982, Severinghaus 1972), fire (Lorimer 1977, Aldous and Smith 1942), defoliation and mortality from spruce budworm infestations (Potvin 1980, Strong 1984, Marston 1986), and development in deer wintering areas (Armstrong et al. 1983) may also adversely impact the quality, quantity and distribution of wintering habitat.

Unless they are able to move to more favorable habitat within their limited home ranges, deer using marginal habitat (i.e., quality or quantity is deficient) will suffer above-average losses relative to populations utilizing high quality wintering areas. The net effect of logging, fire, windthrow and development in deer shelter stands is a reduction in softwood crown closure. Stands with reduced (or no) softwood crown closure intercept snow and wind poorly (Potvin 1980, Nelson and Mech 1981), resulting in higher deer sinking depths and greater thermal stress (Moen 1968 and Tilghman 1989). Elevated sinking depths reduce deer mobility, and markedly increase energetic costs, while reducing forage availability (Mattfeld 1974, Parker et al. 1984, Potvin and Huot 1983). Unless compensated by increased fat deposition in autumn (Mautz 1978), reduction in shelter quality may contribute to more rapid depletion of endogenous energy and protein reserves (de calesta et al. 1975, Young and Scrimshaw 1971), and lead to higher losses to malnutrition (Cheatum 1951, Case and McCullough 1987, Lavigne 1983), even during winters of moderate severity. Higher losses to predation in marginal wintering habitat (Messier et al. 1986, Mech and Karns 1977, Lavigne 1983) also occur, not only because deer may be in poor condition, but also because deer may have greater difficulty escaping predators in deep snow. Does which emerge from winter yards in poor physiological condition exhibit impaired fetal development (Verme 1979), and suffer higher natal losses (Verme 1977). Entire populations of deer may, over a period of time, be extirpated where critical wintering habitat was severely damaged or eliminated, and moderate to severe wintering conditions prevailed (Verme 1973, Nelson and Mech 1976c, Strong 1977, Boer 1978).

However, reduction in crown closure in coniferous shelter stands may produce positive effects on wintering deer, when snow cover remains shallow (< 12 in.) or of limited duration. Thinned stands (Shaw and Ripley 1965) or stands naturally thinned by spruce budworm (Potvin 1980) or windthrow (Anon 1964), produce an abundance of forage from felled tops, regeneration of trees and shrubs, and litterfall (Hodgman and Bowyer 1985). When deer mobility is favorable, such shelter stand alterations serve to increase carrying capacity of deer wintering areas (Potvin 1980, Potvin and Huot 1983). But when hampered by deep, unsupportive snow, stands with a low volume of mature conifers are a liability to the deer that attempt to use them.

<u>Pre-Winter Condition</u>

Northern white-tailed deer characteristically accumulate fat reserves during autumn when energy-rich forage such as fruits, mast, fungi, agricultural crops and forbs are available (Mautz 1978). Fat reserves may comprise 4-15% of a deer's whole body weight (Anderson et al. 1972), and this energy source may provide as much as 30% of the energy requirements of wintering deer (Huot 1982). Well-fattened deer may survive for >45 days upon endogenous fat and protein reserves alone (Torbit et al. 1985, de Calesta et al. 1974, 1975). In contrast, deer with limited fat reserves may more rapidly exhaust fat an(; protein reserves when forced to subsist on low-quality forage. Death due to malnutrition is common among deer that have lost >30% body weight (de Calesta et al. 1975, Severinghaus 1981). This level of under nutrition may occur in < 12-13 weeks during severe winters among deer which entered the winter in good physical condition (Karns 1980). Among deer which entered the winter with suboptimal fat levels, malnutrition losses may occur after 8 weeks or less of severe wintering conditions (Severinghaus 1947, 1972).

Fat deposition in autumn appears to be an obligatory physiological trait among white-tailed deer. Even deer subsisting in marginal quality summer-fall habitat will deposit some fat, although total fat reserves will be significantly less than those of deer on high quality autumn range (Verme and ozoga 1982 a, b). Because of the importance of fat reserves to winter survival, it is imperative that deer populations be maintained in balance with summer-autumn carrying capacity. Deer herds maintained at or near maximum sustainable levels (KCC) will likely be in poor physical condition due to depletion of the most digestible and energy-rich forage resources. Because these individuals enter the winter with inadequate fat and protein reserves, losses to malnutrition become more likely at any given level of winter severity (Case and McCullough 1987, Cheatum 1951).

Fat reserves and high quality coniferous cover must be viewed as complimentary mechanisms which enhance winter survival when snow cover limits mobility and diet quality. Neither system alone can enable deer to survive severe winters. The absence of both abundant fat reserves and quality winter shelter make it impossible for deer populations to persist in regions with characteristically severe winters (Mautz 1978, Severinghaus 1981, Karns 1980, Crete 1976a).

Defining Deer Winter Range for LURC and DEP Standards

Deer wintering area protection programs require decisions regarding which habitat types comprise critical wintering habitat for deer. The existing LURC (1989) program restricts qualifying habitat to coniferous shelter stands where softwoods comprise $\geq$ 50% of overstory stems, average height is $\geq$ 35 ft. and softwood crown closure is $\geq$ 50% (LURC 1989). Forest types which do not conform to these standards, including peripheral stands where deer forage, cannot be zoned as a LURC DWA. Forest types which conform to LURC standards may be adequate for describing important winter shelter in regions with deep snow Deeryards which occur as "islands" surrounded by large expanses of regenerating clearcuts exhibit reduced carrying capacity for deer (Strong 1977, Boer 1978).

In deep snow regions, optimal deer wintering habitat consists of mature coniferous shelter finely interspersed with small openings or other forage-producing types (Huot 1974, Miller 1974, Drolet 1976, Hepburn 1968, Weber et al. 1983, Potvin and Huot 1983). Emphasis here is placed on the high degree of patchiness where deer may move about freely in coniferous travel lanes which are interconnected and interspersed with food producing stands. Such habitat mimics the high diversity which characterizes old growth coniferous forests, where sporadic windthrow and other site disturbances creates a diverse mosaic of small openings and young stands within a generally mature forest (Lorimer 1977, Bunnell and Jones 1984, Mundinger 1984). In contrast, large stands of unbroken pole-stage coniferous forest receive little use by deer (Huot 1974, Picard and Potvin 1975, Weber et al. 1981), primarily because forage is limited. At the other extreme, large stands which lack mature coniferous shelter (hardwood, hardwood-dominated mixed wood stands and openings) cannot support deer if snow cover limits deer mobility, and woody browse from shrubs and regeneration is the only potential winter forage source (Potvin and Huot 1983, Telfer 1978, Mattfeld

1974). When snow depth limits deer mobility, the energetic cost of browsing in these habitat types exceeds the nutritive value of the forage (Mattfeld 1974, Parker et al. 1984, Mautz et al. 1976).

Habitat selection by deer in regions with more favorable mobility and snow cover conditions suggests that deer are able to routinely utilize habitats with less coniferous cover than sites described in Table 19 (Wetzel et al. 1975, Kucera 1976, Cook and Hamilton 1942, Dickinson 1983, Ransom 1967, Fuller 1990, Nixon et al. 1988). Although one would predict that deer in southern and coastal sections of Maine may utilize stands with < 50% coniferous stems, preliminary evaluation of pellet group deposition by cover type, suggests otherwise (MDIFW, unpubl. data). Based upon pellet group surveys conducted between 1976 and 1989, deer appeared to select softwood-dominated stands in greater proportion than their occurrence, while concurrently avoiding hardwood-dominated stands and openings. This trend was evident in every DMD, and it varied little with winter severity.

However, configuration of softwoods within a hardwood-dominated (HS) stand may have been extremely important, but undetected by this survey. Deer use of HS stands or openings is greatly enhanced if available softwoods occur as high-volume, inter-connected inclusions rather than as uniformly distributed softwood trees within an overall hardwood stand (Gill 1957a, Huot 1974, Euler and Thurston 1980, Armstrong et al. 1983b). While such a limited shelter distribution may be lethal for deer when deep (> 12 in.) snows persist (Potvin 1978, Potvin 1980), HS stands with interspersed small inclusions of high volume softwoods may be adequate where snow cover is limited (e.g. < 12 in.) or of limited duration. Protection of these habitats may require zoning of entire stands with < 50% softwood stems in parts of Maine where deer depend on this type of wintering habitat.

LITERATURE CITED

Aldous, S. E. and C. F. Smith. 1942. Food habits of Minnesota deer as determined by stomach analysis. Trans. N. Am. Wildl. Conf. 3:756-767.

Alexander, C. E. and L. E. Garland. 1984. Spruce budworm/deer winter range; a situation statement.. Vermont Dept. of Fish and Wildlife, Montpelier. 12pp. (mimeo).

Allen, T. J. 1970. Telemetry studies of deer movements and habitat utilization at Acadia National Park. M.S. Thesis, Univ. of Maine, Orono. 153pp.

Anderson, A. E., D. E. Medin, D. C. Bowden. 1972. Indices of carcass fat in a Colorado mule deer population. J. Wildl. Manage. 36(2):579-594.

Anon. 1964. Deer studies carried on in the vicinity of the moose river plains in Hamilton County. New York Conservation Dept., Albany. 17pp (mimeo).

Armstrong, E., D. Euler, and G. Racey. 1983a. White-tailed deer habitat and cottage development in central Ontario. J. Wildl. Manage. 47(3):605-612.

_____, _____, and _____. 1983b. Winter bed-site selection by white-tailed deer in central Ontario. J. Wildl. Manage. 47(3):880-883.

Bailey, M. E. 1977. Production and deer utilization of vegetation on small clearcuts in central Maine. M. S. Thesis, Univ. of Maine, Orono. 99pp.

Banasiak, C. F. 1961. Deer in Maine. Game Div. Bull. No. 6., Me. Dept. of Inland Fisheries and Game, Augusta. 159pp.

Bartlett, I. H. 1950. Michigan Deer. Michigan Conservation Dept., Lansing. 50pp.

Behrend, D. F. 1966. Behavior of white-tailed deer in an Adirondack forest. New York Job Compl. Rep. Proj. W-105-R7, Job. No. V-A. N.Y. Conservation Dept., Albany. 143pp.

Beier, P. and D. R. McCullough. 1990. Factors influencing white-tailed deer activity patterns and habitat use. Wildl. Monogr. No. 109. The Wildlife Society, Washington, D.C. 51pp.

Boer, A. 1978. Management of deer wintering areas in New Brunswick. Wildl. Soc. Bull. 6(2):200-205.

_____. 1982. Deer wintering area management programs in New Brunswick. Pp. 39-43 in: J. A. Bissonette, ed. Deer Winter Habitat Management. Misc. Publ. No. 679. Maine Agric. Exp. Sta., Univ. of Me., Orono.

Bookhout, T. A. 1965. Feeding coactions between snowshoe hares and white-tailed deer in northern Michigan. Trans. N. Am. Wildl. Conf. 30:321-335.

Bucaria, G. P. 1984. Graphic analysis of potential critical deer range on Montague Island, Alaska. Pp. 329-334 in: W. R. Meehan, T. R. Merrell, Jr., and T. A. Hanley (eds '), Proc. Symp. on Fish and Wildlife Relationships in Old Growth Forests, Juneau, AK.

Bunnell, F. L. and G. W. Jones. 1984. Black-tailed deer and old growth forests - a synthesis. Pp. 411-420 in: W. R. Meehan, T. R. Merrell, Jr., and T. A. Hanley (eds.), Proc. Symp. on Fish and Wildlife Relationships in Old Growth Forests, Juneau, Alaska.

Burgason, B. N. 1977. Bird and mammal use of old commercial clearcuts. M. S. Thesis, Univ. of Maine, Orono. 53pp.

Cameron, A. W. 1958. Mammals of the islands of the Gulf of St. Lawrence. Bull. No. 154, National Museum of Canada, Ottawa, Ontario. 165pp.

Carlsen, J. C. and R. E. Farmes. 1957. Movements of white-tailed deer tagged in Minnesota. J. Wildl. Manage. 21(4):397-401.

Carson, H. S. 1976. Assessment of maintenance and seeding of commercial wood-operations landing areas, T11 R8 and T9 R8. Final Rep., P.R. Proj. No. W-77-D, Maine Dept. Inland Fisheries and Wildlife, Augusta. 72pp.

Case, D. J. and D. R. McCullough. 1987. The white-tailed deer of North Manitou Island. Hilgardia. 55(9):1-57.

Cheatum, E. L. 1951. Disease in relation to winter mortality of deer in New York. J. Wildl. Manage. 15(2):216-220.

Chilelli, M. E. 1988. Modeling the population dynamics of Maine's white-tailed deer. Ph.D. Thesis, Univ. of Maine, Orono. 192pp.

Chilelli, M. E. and G. R. Lavigne. 1990. Using antler beam diameters from yearling white-tailed deer bucks as an index to carrying capacity in Maine. Trans. N.E. Fish and Wildlife Conf. 46:1 (Abst.).

Crawford, H. S. 1982. Seasonal food selection and digestibility by tame white-tailed deer in central Maine. J. Wildl. Manage. 46(4):974-982.

Crete, M. 1976a. Estimates of winter mortality of deer in Quebec. Can. Field Nat. 90(4):397-403.

_____. 1976b. Importance of winter climate in the decline of deer harvest in Quebec. Can. Field Nat. 90(4):404-409.

Cook, D. B. and W. J. Hamilton, Jr. 1942. Winter habits of white-tailed deer in central New York. J. Wildl. Manage. 6(4):287-291.

Dahlberg, B. L., and R. C. Guettinger. 1956. The white-tailed deer in Wisconsin. Tech. Wildl. Bull. No. 14, Wisconsin Cons. Dept., Madison. 282pp.

Davenport, L. A., D. F. Switzenberg, R. C. VanEtten and W. D. Burnett. 1953. A study of deeryard carrying capacity by controlled browsing. Trans. N. Am. Wildl. Conf. 18:581595.

Day, B. W. 1963. Winter behavior of white-tailed deer in north-central Maine. M. S. Thesis, Univ. of Maine, Orono. 151pp.

de Calesta, D. S., J. G. Nagy, and J. M. Bailey. 1974. Some effects of starvation on deer rumen bacteria. J. Wildl. Manage. 38(4):815-822.

de Calesta, D. S., J. G. Nagy, and J. M. Bailey. 1975. Starving and refeeding mule deer. J. Wildl. Manage. 39(4):663-669.

Del Guidice, G. L., L. D. Mech, and U. S. Seal. 1989. Browse diversity and physiological status of white-tailed deer during winter. Trans. 54th N. Am. Wildl. and Nat. Res. Conf. 54:134-145.

Dickinson, N. R. 1972. Deer management considerations in forest management. Bull. No. Dl, Vermont Fish and Game Dept., Montpelier. 13pp.

_____. 1976a. Observations on steep-slope deer wintering areas in New York and Vermont. N.Y. Fish and Game J. 23 (1) :51-57.

_____. 1976b. Winter deer range, town of Sherburne, Vermont. Dept. of Fish and Wildlife, Barre, VT. 6pp (mimeo).

_____. 1976c. Winter deer range, Black River Project, Vermont. Dept. of Fish and Wildlife, Barre, VT. 4pp(mimeo).

_____. 1977. Vermont's winter deer habitat protection program. Trans. N. E. Deer Tech. Comm. 13:127-136.

_____. 1983. Variations in winter deer range in New York. Trans. 19th N. E. Deer Tech. Comm. Mtg., Sheffield, PA. Pp 24-26.

_____. 1987. Carrying capacity on northern ranges. Trans. 22nd N. E. Deer Tech. Comm. Mtg., Fairlee, Vermont. pp. 70-77.

_____, and C. W. Severinghaus. 1969. The 1967 deer season in the Moose River Recreation Area. N.Y. Fish and Game J. 16(l):1-18.

Dorrance, M. J., P. J. Savage, and D. E. Huff. 1975. Effects of snowmobiles on white-tailed deer. J. Wildl. Manage. 39(3):563-569.

Doucet, G. J., D. T. Brown, and P. Lamothe. 1987. Deer behavior in a powerline right-of-way located in a northern wintering yard. Pp. 7-12 in: W. R. Barnes and H. A. Holt (eds.), Proc. 4th Symp. on Environmental Concerns in Rights-of-Way Management, Purdue Univ., W. Lafayette, Indiana.

Drolet, C. A. 1976. Distribution and movements of white-tailed deer in southern New Brunswick in relation to environmental factors. Can. Field Nat. 90(2):123-136.

_____. 1978. Use of forest clearcuts by white-tailed deer in southern New Brunswick and central Nova Scotia. Can. Field. Nat. 92(3):275-282.

Dusek, G. L., J. D. Mundinger, S. J. Riley, and R. J. Mackie. 1987. The implication of body weight to reproductive strategy among young adult female white-tailed deer. Proc. 18th Congress of the Int. Union of Game Biologists, Krakow, Poland. 7pp. (Draft).

_____, R. J. Mackie, J. D. Herriges, Jr. and B. B. Compton. 1989. Population ecology of white-tailed deer along the lower Yellowstone River. Wildl. Monogr. No. 104, The Wildlife Society, Washington, D.C.

Euler, D. and L. Thurston. 1980. Characteristics of hemlock stands related to deer use in east-central Ontario. J. Appl. Ecology 17(l):1-6.

Feeney, W. S. 1943. Wisconsin deer today and tomorrow. Conservation Bull. No. 321. Wisconsin Conserve Dept., Madison. pp. 12-19.

Fritts, S. H. and L. D. Mech. 1981. Dynamics, movements and feeding ecology of a newly protected wolf population in northwestern Minnesota. Wildl. Monogr. No. 80, The Wildlife Society, Washington, D.C. 79pp.

Fuller, T. K. 1990. Dynamics of a declining white-tailed deer population in north-central Minnesota. Wildl. Monogr. No. 110. The Wildlife Society, Washington, D.C. 37pp.

Garant, V. B., and G. J. Doucet. 1986. Winter diet quality of white-tailed deer in a northern yard. Trans. N. E. Sect. Wildl. Soc. 43:57-62.

Gates, J. E. and D. M. Harmon. 1980. White-tailed deer wintering area in a hemlock-northern hardwood forest. Can. Field Nat. 94(3):259-268.

Germaine, G., C. Pichette, and F. Potvin. 1986. Guide d'amenagement des ravages de cerfs de Virginie. Ministere du Loisir, de la Chasse et de la Peche, St. Cyril, Quebec, Can. 52pp. (translation).

Gilbert, F. F. and M. C. Bateman. 1983. Some effects of winter shelter conditions on white-tailed deer, Odocoileus virginianus, fawns. Can. Field Nat. 97(4):391-400.

Gill, J. D. 1957. Review of deer yard management. Game Div. Bull. No. 5, Maine Dept. of Inland Fisheries and Game, Augusta. 61pp.

_____. 1957b. Effects of pulpwood cutting practices on deer. Proc. Soc. Am. For., Syracuse, New York. pp 137-140.

_____. 1964. Shelter preferences of deer. Job Compl. Rep., PR Proj. W-37-13-D-4. Augusta, Me. 19pp.

_____. 1966. What's a deer yard in Maine? The Northern Logger 14(8):14-15, 28.

Glasgow, L. L. 1948. A winter habitat study of deer in Maine. M. S. Thesis, Univ. of Maine, Orono. 132pp.

Gotie, R. F. 1976. Deer trap and tag, Region 6. N.Y. Dept. of Environmental Cons., Albany, N.Y. 17pp (mimeo).

Goudreault, F. 1975. Physiological response of deer to winter stress in Quebec as determined by the femur fat content. Trans. 11th N.E. Deer Study Group Mtg., Quebec, Can. pp 3756.

Habeck, J. R. 1960. A vegetational study of the central Wisconsin winter deer range. J. Wildl. Manage. 23(3):273278 .

Hamerstrom, F. N., Jr., and J. Blake. 1939. Winter movements and winter foods of white-tailed deer in central Wisconsin. J. Mammal. 20(2):206-215.

Hanley, T. A. and J. J. Rogers. 1989. Estimating carrying capacity with simultaneous nutritional constraints. USDA For. Ser. Res. Note PNW-RN-485. Pacific Northwest Res. Sta., Juneau, Alaska. 12pp.

Harestad, A. S. 1984. Seasonal movements of black-tailed deer. Pp. 403-409 in: W. R. Meehan, T. R. Merrell, Jr., and T. A. Hanley (eds.), Proc. Symp. on Fish and Wildlife Relationships in old Growth Forests, Juneau, Alaska.

Heezen, K. L. and J. R. Tester. 1967. Evaluation of radio-tracking by triangulation with special reference to deer movements. J. Wildl. Manage. 31(1):124-141.

Hepburn, R. L. 1959. Effects of snow cover on mobility and local distribution of deer in Algonquin Park. M. S. Thesis, Univ. of Toronto, Ontario, Canada. 55pp.

_____. 1968. Experimental management of mixed conifer swamps for deer and timber in eastern Ontario. Sect. Rep. (Wildl.) No. 69. Ontario Dept. of Lands and Forests, Toronto. 44pp.

Herriges, J. D. 1986. Population ecology and habitat relationships of white-tailed deer in eastern Montana. Prog. Rep. P.R. Proj. W-120-R-15-17, Job No. 3, MT. Dept. of Fish and Wildlife, Helena. 144pp.

Hirth, D. H. 1977. Social behavior of white-tailed deer in relation to habitat. Wildl. Monogr. No. 53. The Wildlife Society, Washington, D.C. 55pp.

Hodgman, T. P. and R. T. Bowyer. 1985. Winter use of arboreal lichens by white-tailed deer in Maine. Can. Field Nat. 99(3):313-316.

Hoskinson, R. L. and L. D. Mech. 1976. White-tailed deer migration and its role in wolf predation. J. Wildl. Manage. 40(3):429-431.

Hosley, N. W. and K. R. Ziebarth. 1935. Some winter relations of the white-tailed deer to the forests in north-central Massachusetts. Ecology 16(4):535-553.

Hugie, R. D. 1973. A winter mobility study of deer in west-central Maine. M. S. Thesis, Univ. of Maine, Orono. 68pp.

Huot, J. 1974. Winter habitat of white-tailed deer at Thirty-one Mile Lake, Quebec. Can. Field Nat. 88(2):293-301.

_____. 1975. The status of white-tailed deer in Quebec. Trans. 11th N. E. Deer Study Group Mtg., Quebec, Can. pp 9-24.

_____. 1982. Body condition and food resources of white-tailed deer on Anticosti Island, Quebec. Ph.D. Thesis, Univ. of Alaska, Fairbanks. 240pp.

Hutchinson, A. E. 1976. Deer wintering habitat survey of the St. John River-Dickey Lincoln Project Area. Maine Dept. of Inland Fisheries and Wildlife, Augusta. 9pp (mimeo).

_____. 1979. A deer wintering habitat survey of the St. John River (Dickey-Lincoln Project Area), 1976, 1977 and 1978. Maine Dept. of Inland Fisheries and Wildlife, Augusta. 12pp (mimeo).

Jackson, L. W. and W. Sarbello. 1980. Deer wintering areas and wintering habits of deer in the town of Malone. N.Y. Fish and Game J. 27(1):11-31.

Kabat, C., N. E. Collias, and R. C. Guettinger. 1953. Some winter habits of white-tailed deer and the development of census methods in the Flag Yard of northern Wisconsin. WI. ConsDept., Tech. Wildl. Bull. No. 7, Madison, WI. 32pp.

Karns, P. D. 1980. Winter - the grim reaper. Pp 47-53 in R. L. Hines and S. Nehls, (eds.). White-tailed Deer Population Management in the North Central States. Proc. 1979 Symp. North Cent. Wildl. Soc.

Kearney, S. R. and F. F. Gilbert. 1976. Habitat use by white-tailed deer and moose on sympatric range. J. Wildl. Manage. 40(4):645-657.

Kelsall, J. P. 1969. Structural adaptations of deer and moose for snow. J. Mammal. 50(2):302-310.

_____, and W. Prescott. 1971. Moose and deer behavior in snow in Fundy National Park, New Brunswick. Can. Wildl. Ser. Rep. Ser. No. 15. 25pp.

Kolenosky, G. B. 1972. Wolf predation on wintering deer in east-central Ontario. J. Wildl. Manage. 36(2):357-369.

Kramlich, T. A. 1985. Evaluation of seasonal habitat use by white-tailed deer in eastern South Dakota. M. S. Thesis, S. D. State Univ., Brookings. 45pp.

Krefting, L. W. and R. L. Phillips. 1970. Improving deer habitat in upper Michigan by cutting mixed conifer swamps. J. For. 68(11):701-704.

Kucera, E. 1976. Effects of winter conditions on the white-tailed deer of Delta Marsh, Manitoba. Can. J. Zool. 54(4):1307-1313.

Lanier, J. W. 1982. White Mountain National Forest Management. Pp. 51-54 in: J. A., Bissonette, (ed.). Deer Winter Habitat Management, Misc. Publ. No. 679, Maine Ag. Exp. Sta., Univ. of Me., Orono.

Lavigne, G. R. 1976. Winter response of deer to snowmobiles and selected natural factors. M. S. Thesis, Univ. of Maine, Orono. 68pp.

_____. 1983. Relationship of winter mortality, condition indices and reproductive success to winter severity in Maine. Trans. 19th N. E. Deer Tech. Comm. Mtg., Sheffield, PA. Pp. 26-28

_____. 1986. Deer assessment - 1985. Pp. 245-321 in: Planning for Maine's inland fish and wildlife, Vol. I, Part 1.3 Species assessments and strategic plans. ME Dept. Inland Fisheries and Wildl., Augusta.

_____. 1989. Maine's deer management systems. Trans. 25th N.E. Deer Tech. Comm. Mtg., Rigoud, QC, Canada. (Abst.)

Lorimer, C. G. 1977. The presettlement forest and natural disturbance cycle of northeastern Maine. Ecology 58(1):139148.

Loveless, C. M. 1962. Some relationships between wintering mule deer and the physical environment. Proc. N. Am. Wildl. Conf. 29:415-431.

_____. 1967. Ecological characteristics of a mule deer winter range. Tech. Publ. No. 20, Colorado Game, Fish, and Parks Dept., Denver. 124pp.

LURC. 1989. LURC regulation of deer wintering areas. Land Use Regulation Commission, Maine Dept. of Conserv., Augusta. 9pp (miineo).

Macfie, J. A., and E. R. Bain. 1975. Winter deer range management in the hemlock-hardwood region of east-central Ontario. Trans. 11th N. E. Deer Study Group Mtg., Quebec, Canada. pp 85-92.

Marston, D. L. 1975. Deer wintering area management in Maine a progress report. Trans. 11th N. E. Deer Study Group Mtg., Quebec, Canada. pp. 103-110.

_____. 1977. Deer winter habitat management. Maine Fish and Wildl. Magazine. 19(1):5-8.

_____. 1983. Deer wintering area management. Guidelines, problems, and needs in spruce-fir forests. Trans. 19th N.E. Deer Tech. Comm. tg, Sheffield, Pa. pp. 22-24.

_____. 1986. Guidelines for maintaining white-tailed winter habitat in the spruce-fir forest of Maine. Pp 215-235 in: J. A. Bissonette, ed. Is Good Forestry Good Wildlife Management? Misc. Publ. No. 689, Me. Agric. Exp. Sta., Univ. of Me., Orono.

Marston, M. A. 1942. Winter behavior of deer in northwestern Maine. M. S. Thesis, Univ. of Maine, Orono. 54pp.

Mattfeld, G. F. 1974. The energetics of winter foraging by white-tailed deer. A perspective on winter concentration. Ph.D. Thesis. State Univ. of New York, Syracuse. 306pp.

Mautz, W. W. 1978. Sledding on a brushy hillside: the fat cycle in deer. Wildl. Soc. Bull. 6(2):88-90.

_____, H. Silver, J. B. Holter, H. H. Hayes and W. E. Urban, Jr. 1976. Digestibility and related nutritional data for seven northern deer browse species. J. Wildl. Manage. 40(4):630-638.

McCullough, D. R. 1985. Variables influencing food habits of white-tailed deer on the George Reserve. J. Mammal. 66(4):682-692.

MDIFW. 1989. Deer population management system and database. Maine Dept. of Inland Fisheries and Wildl., Augusta. 351pp.

Mech, L. D. and P. D. Karns. 1977. Role of the wolf in a deer decline in the Superior National Forest. USDA For. Ser., N. Cen. For. Exp. Sta., Res. Pap. NC-148, St. Paul, Minnesota. 23pp.

Messier, F. and C. Barrette. 1985. The efficiency of yarding behavior by white-tailed deer as an anti-predator strategy. Can. J. Zool. 63(4):785-789.

_____, _____, and J. Huot. 1986. Coyote predation on a white-tailed deer population in southern Quebec. Can. J. Zool. 64:1134-1136.

Miller, F. L. 1974. Distribution and numbers of white-tailed deer wintering in Gatineau Park, Quebec. Can. Field Nat. 88(l):41-45.

Moen, A. N. 1968. Energy exchange of white-tailed deer in western Minnesota. Ecology 49(4):676-682.

_____. 1976. Energy conservation by white-tailed deer in the winter. Ecology 57(1):192-198.

Monthey, R. W. 1978. Relative abundance of mammals in commercially harvested forests of Maine. Ph.D. Thesis, Univ. of Maine, Orono. 64pp.

Mooty, J. J., P. D. Karns, and T. K. Fuller. 1987. Habitat use and seasonal range size of white-tailed deer in north-central Minnesota. J. Wildl. Manage. 51(3):644-648.

Mundinger, J. G. 1981. White-tailed deer reproductive biology in the Swan Valley, Montana. J. Wildl. Manage. 45(1):132139.

_____. 1984. Biology of the white-tailed deer in the coniferous forests of northwestern Montana. Pp. 275-284 in: W. R. Meehan, T. R. Merrell, Jr. and T. A. Hanley (eds.), Proc. Symp. on Fish and Wildlife Relationships in old Growth Forests, Juneau, Alaska.

Nelson, M. E. 1979. Home range location of white-tailed deer Res. Pap. No. NC-173. USDA For. Ser., N.C. For. Exp. Sta., St. Paul, Mn.

_____ and L. D. Mech. 1981. Deer social organization and wolf predation in northeastern Minnesota. Wildl. Monogr. No. 77, The Wildlife Society, Washington, D.C. 53pp.

_____ and _____. 1986a. Relationship between snow depth and gray wolf predation on white-tailed deer. J. Wildl. Manage. 50(3):471-474.

_____ and _____. 1986b. Mortality of white-tailed deer in northeastern Minnesota. J. Wildl. Manage. 50(4):691698.

_____ and _____. 1986c. Deer population in the central Superior National Forest, 1967-1985. USDA For. Ser., N. Cen. For. Exp. Sta., Res. Pap. NC-271. 9pp.

_____ and _____. 1987. Demes within a northeastern Minnesota deer population. Pp. 27-40 in B. D. Chepko-Sade and Z. Halpin (eds.). Mammalian Dispersal Patterns. Univ. of Chicago Press, Chicago, Il. 342pp.

Nixon, C. M., L. P. Hansen and P. A. Brewer. 1988. Characteristics of winter habitats used by deer in Illinois. J. Wildl. Manage. 52(3):552-555.

NOAA. 1990. New England Climate - January 1990. N.E. Regional Climate Center Publ. 90(1):2.

Norberg, E. R. 1954. Deer population study at the Cedar Creek Forest. M. S. Thesis, Univ. of Minnesota, St. Paul. 77pp.

Ozoga, J. J. 1968. Variations in microclimate in a conifer swamp deeryard in northern Michigan. J. Wildl. Manage. 32(3):574-585.

_____. 1972. Aggressive behavior of white-tailed deer at winter cuttings. J. Wildl. Manage. 36(3):861-868.

_____ and E. M. Harger. 1966. Winter activities and feeding habits of northern Michigan coyotes. J. Wildl. Manage. 30(4):809-818.

Pac, D. F., R. J. Mackie, and H. E. Jorgensen. 1984. Relationships between mule deer and forest in southwestern Montana - some precautionary observations. Pp. 321-328 in W. R. Meehan, T. R. Merrell, and T. A. Hanley (eds.). Proc. symposium on Fish and Wildlife Relationships in Old Growth Forests, Juneau, Alaska.

Parent, R. 1978. Population et habitat du ravage de cerf de Virginie du mont Rigaud, hiver 1977-78. Min. Tourisme, Chasse et Peche. Serv. Faune Quebec. Rapp. Tech. 28pp.

Parker, K. L., C. T. Robbins, and T. A. Hanley. 1984. Energy expenditures for locomotion by mule deer and elk. J. Wildl. Manage. 48(2):474-488.

Picard, J. and F. Potvin. 1975. A review of deer habitat management in Quebec. Trans. 11th N. E. Deer Study Group Mtg., Quebec, Canada. pp. 79-84.

Pichette, C. and N. Samson. 1982. Dispersion et. deplacements du cerf de Virginie du ravage d'Armstrong. Ministere du Loisir, de la Chasse et. de la Peche, Quebec, Can. 47pp.

Potvin, F. 1978. Deer and browse distribution by cover type in the Cherry River wintering area, Quebec. Le Naturaliste Canadien 105(6):437-444.

_____. 1980. Short-term impact of a spruce budworm outbreak on a deer wintering area. Can. J. For. Res. 10(4):559-563.

_____. 1982. Deer management programs in Quebec. Pp 44-47 in: J. A. Bissonette, ed., Deer Winter Habitat Management. Misc. Publ. No. 679, Maine Ag. Exp. Sta., Univ. of Me., Orono.

_____. 1984. Influence of spruce budworm infestation on deer wintering areas in Quebec. Trans. 20th N. E. Deer Tech. Comm. Mtg., Greenville, Me. pp 69-77.

_____. and J. Huot. 1983. Estimating carrying capacity of a white-tailed deer wintering area in Quebec. J. Wildl. Manage. 47(2):463-475.

_____, _____, and F. Duchesneau. 1981. Deer mortality in the Pohenegamook wintering area, Quebec. Can. Field Nat. 95(1):80-84.

_____, M. Belanger, and S. Georges. 1977. Quebec deer decline and deer harvest strategies at the northern limit. Trans. 13th N.E. Deer Study Group Mtg., Ft. Pickett, Va. pp 100-106.

_____, H. Jolicoeur, and J. Huot. 1988. Wolf diet and prey selectivity during two periods for deer in Quebec: decline vs. expansion. Can. J. Zool. 66:1274-1279.

Ransom, A. B. 1967. Reproductive biology of white-tailed deer in Manitoba. J. Wildl. Manage. 31(1):114-123.

Reay, R. S. 1986. Compatibility of timber management and wintering deer in hemlock stands. Pp. 205-214 in: J. A. Bissonette, ed., Is Good Forestry Good Wildlife Management? Misc. Publ. No. 689, Maine Agr. Exp. Sta., Univ. of Maine, Orono.

Rongstad, O. J. and J. R. Tester. 1969. Movements and habitat use of white-tailed deer in Minnesota. J. Wildl. Manage. 33(2):366-379.

Rose, C. L. 1984. Response of deer to forest succession on Annette Island, southeastern Alaska. Pp. 285-290 in: W. R. Meehan, T. R. Merrell, Jr., and T. A. Hanley (eds.), Proc. Symp. on Fish and Wildlife Relationships in old Growth Forests, Juneau, AK.

SAF. 1967. Forest cover types of North America. Society of Am. Foresters, Washington, D.C. pp 4-19

Sanford, R. M. 1976. Characteristics and use of deer habitat in south-central Maine. M. S. Thesis, Univ. of Maine, Orono. 45pp.

Sauer, P. R. and C. W. Severinghaus. 1983. Relationship of degree and composition of winter mortality of deer, as indicated by strip surveys, to severity of the winter. N.Y. Fish and Game J. 30(2):173-181.

Severinghaus, C. W. 1947. Relationship of weather to winter mortality and population levels among deer in the Adirondack region of New York. Trans. N. Am. Wildl. Conf. 12:212-223.

_____. 1953. Springtime in New York - another angle. What goes on in our Adirondack deer yards. N.Y. State Conservationist 7(5):2-5.

_____. 1972. Weather and the deer population. N.Y.S. Conservationist 27(2):28-31.

_____. 1981. Overwinter weight loss in white-tailed deer in New York. N.Y. Fish and Game J. 28(l):61-67.

Shaw, S. P. and T. H. Ripley. 1965. Managing the forest for sustained yield of woody browse for deer. Proc. Soc. Am. For., Detroit, MI. pp. 229-233.

Short, H. L. 1971. Forage digestibility and diet of deer on southern upland range. J. Wildl. Manage. 35(4):698-706.

_____ and J. C. Reagor. 1970. Cell wall digestibility affects forage value of woody twigs. J. Wildl. Manage. 34(4)964-967.

Sparrowe, R. D., and P. F. Springer. 1970. Seasonal activity patterns of white-tailed deer in eastern South Dakota. J. Wildl Manage. 34(2):420-431.

Stevenson, S. K. and J. A. Rochelle. 1984. Lichen litterfall - its availability and utilization by black-tailed deer. Pp. 391-396 in W. R. Meehan, T. R. Merrell and T. A. Hanley (eds.)., Proc. Symposium on Fish and Wildlife Relationships in old Growth Forests, Juneau, Alaska.

Stocker, M. and F. F. Gilbert. 1977. Vegetation and deer habitat relations in southern Ontario: application of habitat classification to white-tailed deer. J. Appl. Ecol. 14:433-444.

Strong, K. F. 1977. Evaluative review Of deer yard management in New Hampshire and Maine. N.H. Fish and Game Dept., Concord. 117pp.

_____. 1984. Deer wintering area - budworm relationships in New Hampshire. Trans. 20th N.E. Deer Tech Comm. Mtg., Greenville, Maine. pp. 78-79.

Telfer, E. S. 1965. Some factors in the ecology of moose and white-tailed deer in Nova Scotia. Trans. 22nd N. E. Fish and Wildl. Conf., Harrisburg, Pa. 16pp.

_____. 1967. Comparison of moose and deer winter range in Nova Scotia. J. Wildl. Manage. 31(3):418-425.

_____. 1968. Distribution and association of moose and deer in central New Brunswick. Trans. 25th N. E. Fish and Wildl. Conf., Bedford, N.H. pp 41-69.

_____. 1971. Changes in carrying capacity of deer range in western Nova Scotia. Can. Field Nat. 85(3):231-234.

_____. 1978. Silviculture in eastern deer yards. For. Chron. 54(4):203-208.

Tierson, W. C., G. F. Mattfeld, R. W. Sage, Jr., and D. E. Behrend. 1985. Seasonal movements and home range of white-tailed deer in the Adirondacks. J. Wildl. Manage. 49(3):760-769.

Tilghman, N. G. 1989. Impacts of white-tailed deer on forest regeneration in Pennsylvania. J. Wildl. Manage. 53(3):524-532 .

Torbit, S. C., L. H. Carpenter, D. M. Swift, and A. W. Alldredge. 1985. Differential loss of fat and protein by mule deer during winter. J. Wildl. Manage. 49(l):80-85.

Ullrey, D. E., W. G. Youatt, H. E. Johnson, L. D. Fay, D. B. Purser, B. L. Schoepke and W. T. Magee. 1971. Limitations of winter aspen browse for the white-tailed deer. J. Wildl. Manage. 35(4):732-743.

Van Ballenberghe, V. and T. A. Hanley. 1984. Predation on deer in relation to old growth forest management in southeastern Alaska. pp. 291-296 in. W. R. Meehan, T. R. Merrell and T. A. Hanley (eds). Proc., Symposium on Fish and Wildlife Relationships in Old Growth Forests, Juneau, Alaska.

Verme, L. J. 1965. Swamp conifer deeryards in northern Michigan, their ecology and management. J. For. 63(7):52352 9 .

_____. 1973. Movements of white-tailed deer in upper Michigan. J. Wildl. Manage. 37(4):545-552.

_____. 1977. Assessment of natal mortality in upper Michigan. J. Wildl. Manage. 41(4):700-708.

_____. 1979. Influence of nutrition on fetal organ development in deer. J. Wildl. Manage. 43(3):791-796.

_____ and J. J. Ozoga. 1971. Influence of winter weather on white-tailed deer in upper Michigan. Pp. 16-28 in: A. O. Haugen (ed.). Proc. Symp. Snow and Ice in Relation to wildlife and Recreation, Iowa State Univ., Ames.

_____ and W. F. Johnston. 1986. Regeneration of northern white-cedar deeryards in upper Michigan. J. Wildl. Manage. 50(2):307-313.

Verme, L. J. and J. J. Ozoga. 1982a. Influence of protein-energy intake on deer fawns in autumn. J. Wildl. Manage. 44(2):305-314.

_____. 1982b. Effects of diet on growth and lipogenesis in deer fawns. J. Wildl. Manage. 44(2):315-324.

Wallmo, O. C., and R. B. Gill. 1971. Snow, winter distribution, and population dynamics of mule deer in the central Rocky Mountains. Pp 1-15 in A. 0. Haugen, (ed.), Proc. Symp. Snow and Ice in Relation to Wildlife and Recreation, Iowa State, Univ., Ames.

Webb, W. L. 1948. Environmental analysis of a winter deer range. Trans. N. Am. Wildl. Conf. 13:442-450.

_____, R. T. King, and E. F. Patric. 1956. Effect of white-tailed deer on a mature northern hardwood forest. J. For. 54(6):391-398.

Weber, S. J., W. W. Mautz, J. W. Lanier, and J. E. Wiley, III. 1983. Predictive equations for deer yards in northern New Hampshire. Wildl. Soc. Bull. 11(4):331-338.

Westover, A. J. 1971. The use of a hemlock-hardwood winter yard by white-tailed deer in northern Michigan. Occ. Pap. No. 1., Huron Mountain Wildlife Foundation, Marquette, MI. 59pp.

Wetzel, J. F., J. R. Wambaugh, and J. M. Peek. 1975. Appraisal of white-tailed deer winter habitats in northern Minnesota. J. Wildl. Manage. 39(l):59-66.

Wiley, J. E., III. 1988. Wildlife Guidelines for the public reserved lands of Maine. Me. Dept. of Cons., Bur. Publ. Lands., Augusta. 70pp.

Wood, A. K. 1986. Population ecology and habitat relationships of mule deer in prairie-agricultural habitat. (Ecology of a prairie mule deer population.) Prog. Rep. Proj. No. W-120-R-7-11, 14-17. Montana Dept. of Fish, Wildlife and Parks, Helena. 224pp.

Young, V. R. and N. S. Scrimshaw. 1971. The physiology of starvation. Sci. Am. 225(4):14-21.

Zagata, M. D. and A. O. Haugen. 1973. Winter movement and home range of white-tailed deer at Pilot Knob State Park, Iowa. Iowa Acad. Sci. Proc. 79(2):74-78.

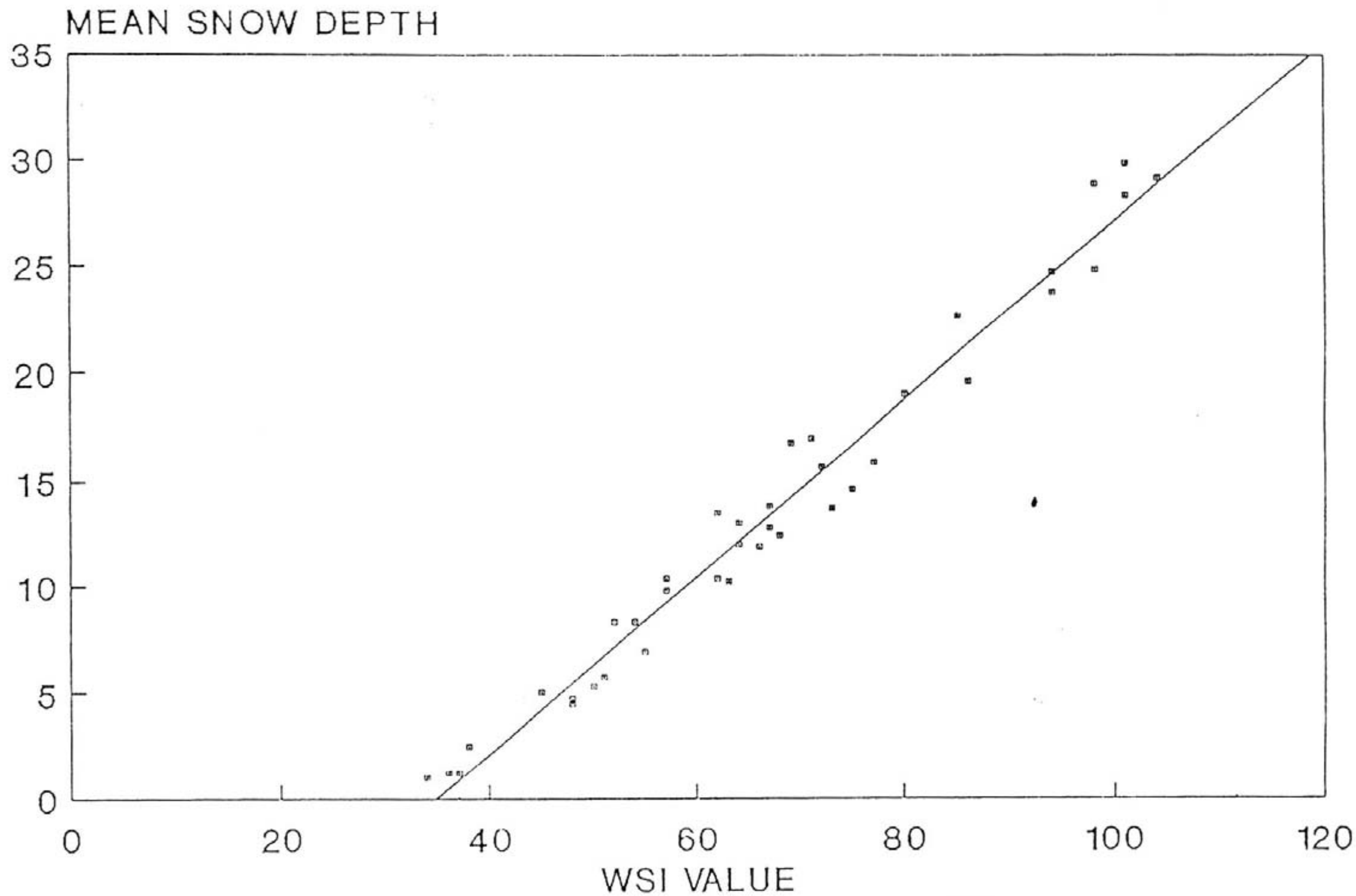

Figure 2. Mean snow depth (inches) at various Winter Severity Index (WSI) values computed from Maine WSI stations during 1973-89.

Table 6. Derivation of deer population objectives by Deer Management District (DMD) based on yearling antler beam diameters, 1988.

DMD	Area (Mi²)	YABD[1] (mm) 1988	HARPOP[2] 1988	HARPOP as % of KCC[3]	Estimated Population at 55% of KCC[4]
1	3,596	17.2	5.4	48	22,349
2	2,663	17.3	6.6	48	20,213
3	2,287	19.6	4.0	39	12,956
4	3,493	17.4	7.0	47	28,625
5	1,782	16.6	10.0	50	19,602
6	2,546	16.9	7.4	49	21,146
7	835	17.6	13.9	46	13,869
8	990	17.3	15.0	48	17,043
9	1,816	17.5	8.1	47	17,278
10	1,568	17.5	10.2	47	18,714
11	775	18.3	10.1	43	10,017
12	1,874	18.0	16.0	45	36,590
13	995	16.0	14.7	53	15,159
14	679	17.3	14.1	48	10,980
15	1,071	17.0	11.1	48	13,607
16	786	16.4	11.3	51	9,587
17	1,725	17.2	5.4	48	10,721
All DMDs	29,482				287,746

[1]Mean antler beam diameter from a sample of 30 to 250 yearling bucks per DMD from the harvest biological sample (Appendix IV; Deer Population Management System).

[2]Deer per mi² of habitat estimated from the Harvest-derived Population Model (Appendix III; Deer Population Management System).

[3]KCC defined as maximum supportable population (see Table 8, p283; Lavigne 1986). Percent of KCC derived from Chilelli 1988, Lavigne 1989, and Chilelli and Lavigne 1990.

[4]55% of KCC is the midpoint of deer population objectives (50-60% KCC) stated on p6 of the Deer Population Management System main document.

Table 7. Deer wintering area habitat types in the northern part of North American deer range.

DWA Habitat Type[1]	Description
SFC	Spruce, balsam fir, northern white-cedar; may or may not include eastern hemlock.
WPH	White-pine, eastern hemlock; sometimes with northern white-cedar and black spruce.
CED	Northern white-cedar swamp.
MIXED	White, red or jack pine associated with balsam fir, eastern hemlock and/or northern white-cedar and black spruce.
PIN	Jack or Pitch pine associated with oak, shrubs and/or marshes
OGR	Old growth sitka spruce, mountain hemlock, western red cedar.
MON	Fraser Fir, Douglas Fir, Engleman Spruce, Lodgepole Pine
AGRRIP	Cottonwood, elm, ash, along rivers interspersed with intensive agriculture.
AGRHWD	Central hardwood woodlots interspersed with intensive agriculture. S. Canadian type is intolerant hardwood.
AGRMAR	Shallow cattail marsh and meadow interspersed with intensive agriculture.
LAR	Tamarack - shrub swamp.
SAGE	Shrubs interspersed with grass-dominated meadows primarily on south-facing slopes.
SSLOPE	Very steep south or south-west oriented slopes vegetated by hardwoods, often interspersed with small stands of eastern hemlock and/or rock outcroppings.

[1]Forested DWA habitat types generally follow SAF forest type associations (SAF 1967).

Table 8. Reported influence of snow depth (inches) on various degrees of confinement of wintering deer within deer wintering areas.

		Snow depth at which deer:			
DWA Type[1]	State/Province	Initiate Yarding	Are Confined to Coniferous Shelter	Are Confined to Trails	Source
SFC	Nova Scotia	14			Telfer 1965
SFC	New Brunswick		12-20		Telfer 1968
SFC			16		Kelsall 1969
SFC		8	16		Kelsall and Prescott 1971
SFC		12	18		Drolet 1976
SFC;WPH	Maine	10			MDIFW unpubl. data
SFC		8-13	20		Marston 1942
SFC;WPH			18	24	Glasgow 1948
SFC;WPH			18	24-36	Banasiak 1961
SFC		5-10	15	24	Day 1963
SFC		5		24	Allen 1970
SFC		<12		24	Hugie 1973
SFC		10-12	18-20		Lavigne 1976
SFC		<12			Sanford 1976
WPH		12			Bailey 1977
SFC		12			Monthey 1978
SFC				>12	Gilbert and Bateman 1983
WPH	Quebec	12			Parent 1978
SFC		>5			Pichette and Samson 1982
SFC;WPH	Vermont	12			Dickinson 1976[a]
WPH	Massachusetts	<10	<24		Hosley and Ziebarth 1935

Table 8 Cont.

DWA Type[1]	State/Province	Snow depth at which deer: Initiate Yarding	Are Confined to Coniferous Shelter	Are Confined to Trails	Source
SFC	New York		20		Severinghaus 1947
SFC			20		Anon 1964
SFC			14-16		Behrend 1966
SFC			>15		Severinghaus 1972
SFC		10			Mattfeld 1974
SFC			15-20		Jackson and Sarbello 1980
SFC		<15			Tierson et al. 1985
WPH;SSLOPE		12			Dickinson 1987
WPH	Maryland		22		Gates and Harmon 1980
SFC;WPH	Northeast	10-14	20		Telfer 1978
WPH	Ontario	10	14-18		Hepburn 1959
MIXED	Michigan	12			Bartlett 1950
CED		20			Krefting and Phillips 1970
WPH		8	15	24	Westover 1971
LAR		3-10			Beier and McCullough 1990
MIXED	Wisconsin	12			Hamerstrom and Blake 1939
MIXED			18		Kabat et al. 1953

Table 8 Cont.

DWA Type[1]	State/Province	Snow depth at which deer: Initiate Yarding	Are Confined to Coniferous Shelter	Are Confined to Trails	Source
MIXED	Minnesota	3-5			Heezen and Tester 1967
MIXED		5-10	17-22		Rongstad and Tester 1969
SFC;MIXED			18		Karns 1980
SFC		<10			Nelson and Mech 1981
MON	Montana	10			Dusek 1989
AGRRIP		4			Wood 1986
SSLOPE	Colorado[2]	10-12	20		Loveless 1962; Loveless 1967
OGR	British Columbia[3]	<12			Bunnell and Jones 1984
			15		Harestad 1984

[1]See Table 7 for DWA type descriptions.

[2]Mule deer

[3]Black-tailed deer

Table 9. Summary of deer pellet group survey data collected at the Coplin Plt. DWA survey area, 1984 to 1990.

Survey Year (spring)	Mean Pellet Groups Per[1]			Deer-Days Use Per Square Mile	Deer Per Square Mile	
	Mileacre Plot	Acre	Square Mile		Leaf-fall to Spring Count	Yarding Period (120 days)
1984	.322 ± .063	322 ± 63	206,080 ± 40,384	15,852 ± 3,106	75 ± 15 (60-90)[2]	131 ± 26 (105-157)
1985	.205 ± .058	205 ± 58	131,200 ± 37,120	10,092 ± 2,855	50 ± 14 (36-64)	84 ± 24 (60-180)
1986	.515 ± .116	515 ± 116	329,600 ± 74,240	25,354 ± 5,711	130 ± 29 (101-159)	211 ± 48 (163-259)
1987	.458 ± .160	458 ± 160	293,120 ± 102,400	22,548 ± 7,877	121 ± 42 (79-163)	186 ± 65 (121-251)
1988	.288 ± .085	288 ± 85	184,479 ± 54,421	14,191 ± 4,186	70 ± 21 (50-91)	118 ± 35 (83-153)
1989	.364 ± .079	364 ± 79	233,244 ± 51,314	17,942 ± 3,947	90 ± 20 (70-110)	150 ± 33 (117-182)
1990	.575 ± .115	575 ± 115	367,751 ± 73,550	28,289 ± 5,658	148 ± 30 (118-178)	216 ± 43 (172-260)

[1]Mean pellet groups ± 90% confidence limits.

[2]Range in parentheses represents upper and lower 90% confidence intervals.

[3]Yarding period in 1990 was considered November 20 to March 31 or 131 days.

Table 10. Summary of deer pellet survey data collected at the Grand Falls DWA survey area, 1982-1988.

Survey Year) (spring)	Mean Pellet Groups Per[1] Milacre Plot	Acre	Square Mile	Deer-Days Use Per Square Mile	Deer Per Square Mile Leaf-fall to Spring Count	Yarding Period (120 days)
1982	.180 ± .075	180 ± 75	115,200 ± 48,000	8,862 ± 3,692	43 ± 18 (25-61)[2]	74 ± 31 (43-105)
1983	.029 ± .014	29 ± 14	18,560 ± 8,960	1,428 ± 689	7 ± 4 (3-11)	12 ± 6 (6-18)
1984	.080 ± .038	80 ± 38	51,200 ± 24,320	3,938 ± 1,871	20 ± 9 (11-29)	33 ± 15 (18-48)
1985	.134 ± .033	134 ± 33	85,760 ± 21,120	6,597 ± 1,625	33 ± 8 (25-41)	55 ± 14 (41-69)
1986	.130 ± .033	130 ± 33	83,200 ± 21,120	6,400 ± 1,625	32 ± 8 (24-40)	53 ± 14 (39-67)
1987	.161 ± .046	161 ± 46	103,040 ± 29,440	7,926 ± 2,265	42 ± 12 (30-54)	66 ± 19 (47-85)
1988	.094 ± .026	94 ± 26	60,257 ± 16,872	4,635 ± 1,298	23 ± 6 (17-30)	39 ± 11 (28-49)

[1]Mean pellet groups ± 90% confidence limits.

[2]Range in parentheses represents upper and lower 90% confidence intervals.

Table 11. Deer density (per mi^2) by deer wintering area habitat type and location (primarily within the northern part of white-tailed deer range).

DWA Habitat Type[a]	State/Province	Winter Density (Deer/mi.^{2} DWA) Mean	Range	Source
SFC	Maine		6-260	MDIFW unpubl. data
			82-90	Hugie 1973
			80-180	Lavigne 1976
	Quebec	25		Crete 1976[b]
			29-44	Pichette and Samson 1982
			32-40	Potvin et al. 1981
			80-85	Huot 1974
		250		Cameron 1958
	New Hampshire		60-120	Strong 1977
	Vermont	80		Alexander and Garland 1984
	New York		65-130	Anon. 1964
			100-120	Webb 1948
			100-200	Webb et al. 1956
	Ontario	20		Kearney and Gilbert 1976
		74		Stocker and Gilbert 1977
WPH	Maryland	443		Gates and Harmon 1980
	Quebec	26		Garant and Doucet 1986
		44		Messier et al. 1986
			4-52	Potvin et al. 1988
		75		Parent 1978
		81		Potvin and Huot 1983
			20-140	Potvin 1978
			48-143	Doucet et al. 1987
	Ontario		10-15	Hepburn 1968
			24-50	Macfie and Bain 1975
CED	Minnesota	112		Rongstad and Tester 1969
	Michigan		92-206	Bookhout 1965
			100-200	Verme and Ozoga 1971
		200		Ozoga and Harger 1966
		200		Verme 1965
		253		Ozoga 1972
		>200		Ozoga 1968
		>600		Davenport et al. 1953

Table 11 Cont.

DWA Habitat Type[a]	State/Province	Winter Density (Deer/mi.² DWA) Mean	Range	Source
MIXED	Wisconsin	41	9-142	Hammerstrom and Blake 1939
			225-320	Kabat et al. 1953
	Minnesota		16-37	Del Guidice et al. 1989a
			15-42	Nelson et al. 1986
			37-108	Fuller 1990
			40-113	Nelson and Mech 1977
		100		Hoskinson and Mech 1976
			100-140	Mech and Karns 1977
AGRRIP	Montana	15		Wood 1986
			140-230	Herridges 1986
MON	Montana	100		Mundinger 1981, 1984
OGR	Alaska (black-tailed deer)	56	10-120	Rose 1984

[a]See Table 7 for DWA habitat type descriptions.

Table 12. Winter range estimates and DWA characteristics in various locations in Maine as determined by aerial inventories in winter between 1954 and 1989.

			All DWAs							DWAs > 250 acres[b]		
		Deer[a] Habitat	Winter Range	Percent of All Deer	Number of	DWAs Per 1,000	DWA Size (acres)			Percent of Total	Percent of All Deer	Mean Size
Location	Years	(Mi^2)	(Mi^2)	Habitat	DWAs	Mi^2	Mean	Min	Max	DWAs	Habitat	(acres)
Statewide (Source: Banasiak 1961; p 82)	1954-57	30,000			4,500	150						
Commercial Forest Region[c] (Source: Gill 1957)	1950's	20,000			3,000	150						
Commercial Forest Region[c] (Source: Banasiak 1961; p 78)	1950's	2,673[e]	276	10.3[g]	345	129	512					
LURC Towns (Source: LURC 1989)	1989	14,623	278[f]	1.9	572	39	310	4	3,078			
NW Aroostook Co.[d] (Source: Hutchinson 1976; 1979)	1968-78	1,069	92	8.6	70	65	555					
NW Aroostook Co. (Source: MDIFW unpubl. data)	1989	1,069	17[f]	1.6	35	33	315	19	1,229	37	1.2	635
Pierce Pond Twp (Source: Hugie 1973; Lavigne 1976)	1970-75				1		2,000[h]	1,500	5,000			

[a]Total area excluding open water.
[b]Cut-off value was set at 240 acres to account for potential errors in using the planimeter.
[c]Basically coincides with Maine's unorganized towns which today are regulated by LURC.
[d]The St. John river drainage above the confluence of the Allagash River encompassing 27 towns.
[e]Only a sample of towns in this region were flown.
[f]Only acreage conforming to LURC standards for mature coniferous shelter and deer density are tabulated and considered winter range.
[g]Winter range reported to vary from 5-20% depending on winter severity.
[h]Hayden Bk. DWA area used by deer varied depending on daily changes in mobility and/or thermal stress.

Table 13. Winter range estimates and DWA characteristics on selected pellet group survey areas as determined by aerial inventories in winters of 1977, 1978 and 1982.

			All DWAs							DWAs > 250 acres[b]		
Location	Year	Deer[a] Habitat (Mi^2)	Winter Range (Mi^2)	Percent of All Deer Habitat	Number of DWAs	DWAs Per 1,000 Mi^2	DWA Size (acres) Mean	Min	Max	Percent of Total DWAs	Percent of All Deer Habitat	Mean Size (acres)
Monroe	1977	109	9.0	8.3	40	367	145	31	423	18	4.3	348
Monroe	1982	135	7.6	5.6	64	474	76	15	332	5	1.0	298
Machias	1978	133	10.2	7.7	32	241	204	7	1,850	5	4.2	718
Waterboro	1978	160	24.0	15.0	21	131	730	52	5,504	55	14.0	1,191

[a]Total area excluding open water.
[b]Cut-off value was set at 240 acres to account for potential errors in using the planimeter.

Table 14. Winter range estimates and DWA characteristics for selected towns in Cumberland County as determined by aerial inventories during the winter of 1989-90.

		All DWAs							DWAs > 250 acres[b]		
Location	Deer[a] Habitat (Mi²)	Winter Range (Mi²)	Percent of All Deer Habitat	Number of DWAs	DWAs Per 1,000 Mi²	DWA Size (acres) Mean	Min	Max	Percent of Total DWAs	Percent of All Deer Habitat	Mean Size (acres)
Baldwin	32.4	2.1	6.6	5	154	273	30	949	20	4.6	949
Casco	31.3	2.0	6.5	3	96	431	102	1,061	33	5.3	1,061
Gray	46.4	6.5	14.0	5	108	829	59	3,415	40	12.6	1,878
Gorham	47.4	0.3	0.5	2	42	84	62	105	0	0	-
Harrison	34.7	0.9	2.5	5	144	329	56	871	20	1.1	240
Naples	34.5	1.5	4.1	6	174	154	74	317	33	2.5	280
New Gloucester	40.1	1.8	4.4	9	224	126	59	377	11	1.5	377
Pownal	23.1	0.4	1.8	2	86	135	71	200	0	0	-
Raymond	39.5	1.1	2.7	7	177	99	69	129	0	0	-
Sebago	34.4	0.8	2.4	3	87	173	30	378	33	1.7	378
Standish	61.0	5.1	8.4	10	164	329	56	871	70	7.5	420
Westbrook	12.2	0.5	4.2	2	164	164	67	262	50	3.4	262
Windham	44.8	1.0	2.3	5	112	132	46	248	20	< 1	248
All Towns	482	24	5.0	55[c]	114	279	60[d]	706[d]	33	3.5	609

[a]Total area excluding open water and development (which was estimated as 5% of the land area).
[b]Cut-off value was set at 240 acres to account for potential errors in using the planimeter.
[c]Because some individual DWAs extended into 2 or more towns, total number of DWAs is less than the sum of this column.
[d]Mean minimum and mean maximum for all towns.

Table 15. Winter range estimates and DWA characteristics for selected towns in Penobscot and Waldo Counties as determined by aerial inventories during the winter of 1989-90.

		All DWAs							DWAs > 250 acres[b]		
	Deer[a] Habitat	Winter Range	Percent of All Deer	Number of	DWAs Per 1,000	DWA Size (acres)			Percent of Total	Percent of All Deer	Mean Size
Location	(Mi²)	(Mi²)	Habitat	DWAs	Mi²	Mean	Min	Max	DWAs	Habitat	(acres)
Alton	37.9	1.95	5.1	1	26	1,249	-	-	100	5.1	1,249
Bradford	42.3	5.0	11.7	15	355	212	62	464	40	7.2	327
Dixmont	37.1	7.1	19.2	6	162	759	122	1,386	66	18.0	1,070
Etna	23.9	6.8	28.6	6	251	730	247	1,798	100	28.6	730
Newburgh	26.7	5.5	20.6	8	300	440	124	1,416	75	18.5	528
Plymouth	26.2	5.9	22.4	8	305	470	132	1,499	50	18.7	784
Troy	33.3	3.4	10.2	9	270	241	142	1,043	56	6.7	286
All Towns	227	36	15.9	52[c]	229	439	138[d]	1,268[d]	60	14.6	679

[a]Total area excluding open water and development (which was estimated as 3% of the land area).
[b]Cut-off value was set at 240 acres to account for potential errors in using the planimeter.
[c]Because some individual DWAs extended into 2 or more towns, total number of DWAs is less than the sum of this column.
[d]Mean minimum and mean maximum for all towns.

Table 16. Winter range estimates by deer wintering area habitat type, location and characteristics for North American deer at the northern part of their range.

DWA Type[a]	State/Province	Total Deer Habitat (Mi.^{2})	Winter Range Area (Mi^2)	Winter Range Percent of Total	Number of DWAs	DWAs per 1,000 Mi.^{2} Habitat	DWA Size (acres) Mean	DWA Size (acres) Min	DWA Size (acres) Max	Source
SFC,WPH,CED	Quebec			7						Germaine et al. 1986
		24,552	756	3				60	25,600	Morasse and Choquette 1975
				2-3				<640	64,000	Potvin 1982
				1.4	1		875			Potvin 1978
	New Hampshire	746	23.1	3.1	93	125	159	42	370	Weber et al. 1983; Lanier 1982
	Vermont			<10						Dickinson 1972
		35.4	1.63	4.6	10	282	104	33	154	Dickinson 1976b
		69.0	3.86	5.6	5	72	494	230	1,286	Dickinson 1976c
SFC	New Brunswick			8						Telfer 1968
		21,073	843	4	1,628	77	325	50	7,000	Boer 1978
	New Hampshire			<10						Strong 1977
	Vermont	210	21.1	10	19	90	711			Alexander and Garland 1984
	Quebec				1		3,100			Pichette and Samson 1982
					1			2,816	7,680	Potvin et al. 1981
	New York	8	.9	11.5	1		590			Severinghaus 1947
				30						Webb 1948
			15		1		9,600			Anon 1964
		46.4	6.9	14.9	14	304	316	64	1,280	Tierson et al. 1985
	Ontario			7.8						Stocker and Gilbert 1977
WPH	Maryland				1		78			Gates and Harmon 1980

Table 16 Cont.

DWA Type[a]	State/Province	Total Deer Habitat (Mi.²)	Winter Range Area (Mi²)	Winter Range Percent of Total	Number of DWAs	DWAs per 1,000 Mi.² Habitat	DWA Size (acres) Mean	DWA Size (acres) Min	DWA Size (acres) Max	Source
WPH	Massachusetts			13						Hosley and Ziebarth 1935
	Quebec	62.2	14.3	23	1		9,164			Messier et al. 1986
			19.2		1		12,288			Garant and Doucet 1986
	Ontario	5,800	406	7				<10	128,000	Macfie and Bain 1975
WPH;CED	Quebec		4.0		1		2,560	1,280	3,840	Doucet et al. 1987
			16.0		1		10,240			Parent 1978
			1.4		1		875			Potvin 1978
CED	Minnesota		2.4		1		1,536			Rongstad and Tester 1969
	Michigan		40		1		25,600			Bookhout 1965
					2			32	53	Krefting and Phillips 1970
MIXED	Wisconsin	158	24	15	40	253	380	50	2,600	Hamerstrom and Blake 1939
	Wisconsin (Northern)			10						Feeney 1943
MON	Montana	672	144	21.4	7	10	13,166			Pac et al. 1984
		335	58	17.3	1	3	37,120			Mundinger 1984
OGR	Alaska	319	59	18.5						Bucaria 1984
AGRRIP	Montana			28						Dusek 1989
		208	23	11.0						Wood 1986
AGRHWD	Manitoba			>75						Ransom 1967
AGRMAR	S. Dakota	36.4	4.0	11.0						Kramlich 1985
SAGE	Colorado			11.0						Walmo and Gill 1971

[a]DWA types are described in Table 7.

Table 17. Percent of deer wintering area (DWA) which would conform to LURC[1] standards for PFW designation.

DWA Type	State/Province	DWA Name	Estimated[2] Percent of DWA which would meet LURC standards	Source
SFC	Maine	Reed Stm.	>80	Day 1963
SFC		Middle Branch Pleasant R.	<50	Day 1963
SFC		Hayden Brook 1950's	>75	Lavigne 1976
SFC		Hayden Brook 1970	60	Hugie 1973
SFC		Hayden Brook 1973	<50	Lavigne 1976
SFC	Nova Scotia	Cobequid Hills	50-75	Telfer 1967
WPH	Quebec	Thirty-one Mile Lake	>80 nucleus	Huot 1974
			<60 nucleus and periphery	Huot 1974
SFC		Cherry River	20-25	Potvin 1978
SFC		Témiscouata Lk. 1972	66 pre-budworm	Potvin 1980
SFC		Témiscouata Lk. 1979	29 past-budworm	Potvin 1980
WPH		Hill Head	50	Potvin and Huot 1983
SFC		Lk. Stubbs and PL Reserve	50-60	Potvin et al. 1988
MIXED	Minnesota	Mean of 12 DWAs	66	Wetzel et al. 1975

[1]Land-Use Regulation Commission standards for a deer wintering area to be placed in a protection district (PFW) require, in part, that the DWA forest stands with ≥ 50% coniferous species with an average crown closure of coniferous species of ≥ 50% and a mean height ≥ 35'.

[2]Rounded figures are estimates derived from study area descriptions or planimeter measurements of study area maps. Other figures are those given by the respective authors.

Table 18. Years of known continuous use of DWAs by State and author.

State	Source	DWA Name	Years known to be occupied
ME	Glasgow 1948; MDIFW unpubl. data	Killick Pd.	> 50
	Glasgow 1948; MDIFW unpubl. data	Brownville Jct	> 50
	Coulter, MW, pers. comm.; MDIFW unpubl. data	Tannery Rd.	> 50
	Lavigne 1976; MDIFW unpubl. data	Hayden Bk.	> 40
	Carson 1976; MDIFW unpubl. data	Rowe Brook	> 40
NY	Severinghaus 1953	Adirondacks	> 50-100
NY	Anon 1964; Dickinson and Severinghaus 1969	Moose River Plains	> 100
MD	Gates and Harmon 1980	-	> 10
MI	Verme 1973; Verme and Johnston 1986	Petrel Grade	> 50 yrs
WI	Habeck 1960	Various	> 100 yrs
	Kabat et al. 1953; Applegate, R., pers. comm.	Flag	> 50
MN	Rongstad and Tester 1969	Cedar Creek	> 35
MN	Fritts and Mech 1981	Several	> 25

Table 19. Winter home range and distance travelled to winter ranges by white-tailed deer at the northern part of the species' range.

State/Province	Winter Home Range (acres) Daily	Winter Home Range (acres) Seasonal	Movements to Winter Range (miles) Mean	Movements to Winter Range (miles) Range	Source
Maine		171		0.4-1.7	Allen 1970
			2.0	0.1-5.3	Carson 1976
Nova Scotia	20		2.5	0-6	Telfer 1965
New Brunswick	10-42	12-164			Drolet 1976
Quebec		263-3,780		2-59	Pichette and Samson 1982
New York		350		0-12	Tierson et al. 1985
				1-48	Gotie 1976
Michigan			8.6	0-32	Verme 1973
		113-355		0-1	Beier and McCullough 1990
Wisconsin			3.5	0-12	Dahlberg and Guettinger 1956
Minnesota		65		6-23	Hoskinson and Mech 1976
		38-58	10.2	0-13	Nelson and Mech 1981
		75		<2	Mooty et al. 1987
	<40	80-650		0-19	Rongstad and Tester 1969
	20-50				Dorrance et al. 1975
			5.1	0-22 coniferous	Carlsen and Farmes 1957
			9.7	0-55 deciduous-prairie	Carlsen and Farmes 1957

Table 19 Cont.

State/Province	Winter Home Range (acres) Daily	Seasonal	Movements to Winter Range (miles) Mean	Range	Source
Minnesota	<1-6				Norberg 1954
	6-145				Heezen and Tester 1967
South Dakota		1,728			Sparrowe and Springer 1970
Montana		590			Dusek et al. 1988
		1,613		0-8	Wood 1986
	102-353	466-1,720		0-1.5	Herriges 1986
		163	19	3-43	Mundinger 1981
British Columbia				0-3.7	Harestad 1984[1]

[1]Harestad documented movements by black-tailed deer.

Table 20. Characteristics of the shelter portion of deer wintering areas, by state/province and DWA type.

State/Province	DWA Type[1]	Percent Softwood	Softwood Basal Area (ft^2/acre)	Percent Softwood Crown Closure	Stand Height (ft)	Minimum Shelter Stand Size (acres or ft.)	Shelter as Percent of DWA	Actual or Recommended[3]	Sources
Maine	SFC,WPH	> 75		≥ 41[2]	35-64	> 100' wide		Actual	Gill 1957 a,b; Gill 1966
	SFC,WPH	> 50		≥ 75	≥ 35		≥ 50	Recommended	Marston 1975, 1977, 1983, 1986
	SFC,WPH	> 50	> 80-100	≥ 70	≥ 35	> 100' wide	≥ 50	Recommended	MDIFW 1987
	SFC					60-110 ac.		Recommended	Wiley 1988
	SFC,WPH,CED	> 50		≥ 50	≥ 35			Recommended	LURC 1989
Nova Scotia	SFC	> 75	85-185	≥ 70	≥ 35			Actual	Telfer 1968
New Brunswick	SFC	> 75		≥ 70	≥ 35			Recommended	Boer 1978
Quebec	SFC,WPH	> 50		40-66	≥ 35			Actual	Huot 1974
	SFC,WPH			≥ 40				Recommended	Morasse and Choquette 1975; Germaine et al. 1986
Ontario	WPH	> 50		50-70	≥ 35			Actual	Euler and Thurston 1980
	WPH	> 75		> 66				Actual	Armstrong et al. 1983b
New Hampshire	SFC	> 75		> 70	≥ 35			Actual	Strong 1977
	SFC,WPH	> 50		67 (32-88)	≥ 35			Actual	Weber et al. 1983
Vermont	SFC,WPH	> 50	150-200	50-90	≥ 35	> 200' wide		Recommended	Dickinson 1972; Dickinson 1977, Alexander and Garland 1984
	WPH	> 75	> 100	≥ 80	≥ 35		≥ 50	Recommended	Reay 1986
Michigan	WPH	> 66	≥ 155		≥ 35			Actual	Westover 1971
	CED	> 75	≥ 100	≥ 75	≥ 35	40-160 ac.	≥ 50	Actual	Verme 1965; Krefting and Phillips 1970

[1]See Table 7 for DWA type descriptions.

[2]Minimum crown closure that was still considered winter shelter. Optimum softwood crown closure given as > 70%.

[3]Actual = shelter characteristics based upon quantified field measurements.
Recommended = shelter characteristics comprising management recommendations or land-use zoning standards, based upon previous studies and/or experience and unpublished data.