

**1996
EMERGENCY DEER FEEDING PROGRAM
EVALUATION**

PRELIMINARY REPORT

**PUBLIC
REVIEW
DRAFT**

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

Section of Wildlife

February 3, 1997

Table of Contents

	Page
Executive Summary.....	4
 Introduction	
Chronology of the Emergency Feeding Issue.....	7
Legislative Requirement and Evaluation Process.....	7
 Summary of 1989 Feeding Evaluation and Emergency Deer Feeding Policy.....	 9
 Deer Feeding Issues	
Deer Feeding Programs and Policies of Other States and Provinces.....	10
Scientific Literature of Deer Feeding.....	10
 Logistics of the 1996 Emergency Deer Feeding Program	
Deer Monitoring and Winter Severity Assessment.....	12
Emergency Feeding Program Procedures.....	12
Funding and Expenditures.....	15
Impacts to Other Programs.....	17
Volunteer Effort.....	17
 Biology and Economics of the 1996 Emergency Deer Feeding Program	
Deer Population Analysis.....	18
Analysis of Feed Distribution.....	20
Analysis of Deer Fed.....	21
Cost Analysis.....	26
A Comparison of 1989 and 1996 Feeding Programs.....	28
 Summary and Conclusions.....	 29
 Recommendations	
Research.....	34
Policy.....	34
Information and Education.....	35
 Appendix	
Appendix 1. Summary of Deer Feeding Roundtables.....	A-1
Appendix 2. DNR Deer Feeding Guidelines.....	A-2
Appendix 3. The Status of Knowledge of Artificial Feeding of Deer During Winter.....	A-5
Appendix 4. Feed Distribution by Permit Area and Deer Management Unit.....	A-11
Appendix 5. Amount and Duration of Feeding by Permit Area and DMU.....	A-14
Appendix 6. Deer Population Data and Estimated Deer Fed by Permit Area and DMU...	A-17
Appendix 7. Reported Deer Fed by Permit Area and DMU.....	A-20
Appendix 8. Feeding Costs by Permit Area and Deer Management Unit.....	A-23
Appendix 9. Cost Per Deer Fed by Permit Area and Deer Management Unit.....	A-26

Figures and Tables

Figure 1. 1996 Deer Feeding Area and Feed Distribution Sites.....	16
Figure 2. 1996 Deer Management Units and Permit Areas.....	19
Figure 3. Distribution of Feed by Week.....	22
Figure 4. Feed Distribution and 1/4 Mile Road Buffers-Rainy River DMU.....	25
Table 1. 1995-96 Winter Severity Index Values.....	13
Table 2. Summary of 1996 Deer Feeding Expenditures.....	15
Table 3. Calculated Deer Populations Available to be Fed by DMU.....	18
Table 4. Proportion of Feeding Sites on Public Lands.....	20
Table 5. Amount and Duration of Feeding by DMU.....	21
Table 6. Estimated Deer Fed by DMU.....	23
Table 7. Reported Deer Fed by DMU.....	24
Table 8. Costs For Feed and Associated Activities by DMU.....	27
Table 9. Costs Per Estimated and Reported Deer Fed.....	27
Table 10. Comparison of 1989 and 1996 Feeding Programs.....	28

RECEIVED
FEB 12 1997
LEGISLATIVE REFERENCE LIBRARY
STATE OFFICE BUILDING
ST. PAUL, MN 55155

EXECUTIVE SUMMARY

In response to one of the most severe winters ever recorded across much of northern Minnesota, an emergency deer feeding program was conducted during the winter of 1995-96. The program was funded by a \$260,000 biennial appropriation to the Department of Natural Resources (DNR), and an additional \$750,000 emergency appropriation from the 1996 state legislature. Pelleted deer feed was purchased by DNR wildlife managers and distributed to the public at 57 distribution sites. The following is a summary of the 1996 program, and a comparison to a similar program conducted in 1989:

	<u>1989</u>	<u>1996</u>
Feed Costs	\$744,536	\$975,713
Total Game and Fish Fund Costs	\$1,071,492	\$1,176,922
Amount of Feed Purchased	3,955 Tons	5,115 Tons
Size of Feeding Area (Square Miles)	46,000 mi ²	38,000 mi ²
Estimated Maximum Number of Deer Fed	72,332	92,223
Cost/Deer Fed	\$14.69	\$12.76
Section of Wildlife Staff Hours	13,754	8,381

Almost all feed was provided to the public from feed distribution sites established by the department and staffed by both DNR staff and volunteers. A total of 8,277 individuals obtained feed from the program.

Based on the Recommended Daily Amount (RDA) of 2.5 pounds of feed/deer/day, a maximum of 92,223 deer could have been adequately fed by the program at a cost of \$12.76/deer. The deer that could have been potentially fed the RDA by Deer Management Unit (DMU) is as follows (with comparisons to 1989 totals):

Maximum % of Deer Potentially Fed By DMU Based on RDA of 2.5 pounds of feed/deer/day

	<u>1989</u>	<u>1996</u>
Red River DMU	36.4%	30.0%
Agassiz DMU	25.8%	41.9%
<u>Big Woods DMU</u>	<u>9.5%</u>	<u>25.8%</u>
Farmland DMU Total	22.3%	36.9%
 Rainy River DMU	 4.4%	 10.8%
Itasca DMU	10.1%	24.3%
Superior DMU	12.9%	22.9%
<u>Mille Lacs DMU</u>	<u>10.1%</u>	<u>22.9%</u>
Forest DMU Total	9.3%	21.4%
 Total	 11.0%	 23.3%

Based on the observations from volunteers, 50.7% of deer were reportedly reached by the program (86.4% in farmland units and 45.4% in forest areas) Based on these reports, deer were fed an average of 1.1 pounds of feed/day, significantly less than the RDA. Preliminary deer harvest information from the 1996 hunting season indicates that deer populations declined in all areas where feed was provided. Additional analysis of harvest data and modeling is necessary before any final conclusions can be reached regarding any benefit that feeding had to deer survival throughout the feeding area. However, analysis of two antlerless permit areas in the northwest (where feeding was very intensive) indicated that over-winter mortality and spring fawning losses were similar to what would have been projected if no feeding had taken place. Some deer

were undoubtedly saved by the emergency feeding program, but many consumed an inadequate feed ration and died, many were not reached by feed, and many likely perished in spite of ready access to artificial food. This analysis, and the evaluation of the 1989 feeding program, provide information on where feeding may be more or less efficient and effective in mitigating severe winter weather, but these findings indicate that for the most severe winters, publicly-funded emergency feeding will yield limited benefits to populations.

Summary and Conclusions: The evaluation concluded the following:

- 1) No other states or provinces have engaged in a publicly funded feeding program similar to that adopted by Minnesota in 1989 and 1996. Canadian provinces, where local populations of deer may experience winter losses of 25%-40% in many years, do not consider feeding to be a viable management.
- 2) Past studies of deer feeding have found benefits to be localized (often to individual deer), and thus feeding has not been demonstrated to be an effective tool to offset the impacts of severe winters across DMU-sized (and even permit area-sized) areas. In fact, deer populations may be negatively affected by feeding. Because deer concentrate at feeding sites, there is increased potential for disease and parasite transmission, adverse impacts to natural vegetation at feeding sites, concentration of predators, and changes to deer movements and habitat use.
- 3) There is a lack of understanding by the public regarding how the DNR uses indices, such as the Winter Severity Index, and other measures of winter severity and deer condition to determine if and when a feeding program should start.
- 4) The effectiveness of future feeding programs may be improved by targeting feed to specific, high-priority sites; providing additional flexibility for preparing feed rations; and attempting to get state-purchased feed to deer that have not had access to privately funded feeding programs. There is a need to reduce waste during future deer feeding programs, and a need to re-consider whether state feed should be used in areas where high deer populations exceed desired levels. There is some interest from the public to start state feeding programs earlier in an effort to prevent all deer losses during severe winters, despite a corresponding increase in cost.
- 5) Deer feeding programs are expensive and planning for and funding such programs is difficult because severe winters can not be predicted and can occur during several consecutive years. A new, dedicated account has been established to fund feeding programs and to re-pay the Game and Fish Fund for the \$750,000 emergency appropriation for the 1996 program. This dedicated account will generate approximately \$225,000 annually for deer feeding purposes, but will adversely impact deer and bear management activities that were previously funded from this account. Since work on deer feeding is not eligible for reimbursement by federal aid funds, reimbursements may be affected if significant DNR staff time is required for future feeding programs. This would result in reduced money available for other state wildlife programs.
- 6) More than 8,300 hours of DNR staff time (valued at \$186,000) was required to administer the 1996 program. As a result, many high-priority wildlife programs suffered. These programs are generally long-term and provide benefits to many other wildlife species, whereas deer feeding is short-term and provides limited, if any benefits to other species.
- 7) The extensive volunteer response to the 1996 program provided important social benefits to individuals and communities. The evaluation documented that private, recreational deer feeding is widespread across the north, and likely contributed to the increased volunteer interest. Approximately 66% of volunteers reported

that they had been feeding deer prior to obtaining state feed. In addition, 22.5% of feeding sites were established by individuals who obtained state feed only once, and consequently these sites are examples of locations where an insufficient ration was provided to deer. The report also found that 70% of feed was used on private lands, which comprised about 58% of the land base in the feeding area.

8) Of the estimated 396,000 deer present in the feeding area at the start of winter, over 100,000 deer were estimated to have died by the spring of 1996. Declines were greatest in the forested areas and the northwest farmland where reductions of 30% to 40% were projected to have occurred in many locales. Units in the remaining farmland and transition areas experienced losses of 5%-10%. Additional analysis is necessary to determine the precise impact that feeding may have had on these losses.

9) Feeding took place for 38 days in most forest areas, and 51 days in northwest farmland. Over 300,000 pounds (3%) of the approximately 9.5 million pounds of feed was distributed outside the designated feeding area into areas where winter severity was lower and the need for a feeding program was not as great. Access was one factor limiting the distribution of the remaining feed; 96% of the feeding sites were within 1 mile of a maintained road and 57% were within one-quarter mile of a road. This resulted in large, inaccessible areas where little or no feed was distributed. Assuming each feeding site would influence deer within one-half mile (which is probably high), feed was available on only 11% of the landscape.

10) There were significant differences in the number of deer potentially fed the RDA among deer management units. Some of this was due to differences in accessibility of deer and availability of volunteer assistance, but much of the difference was also due to the fact that feed had to be rationed in most forest areas because funding was insufficient to meet demands from volunteers. It is not possible to formulate conclusions regarding the potential number of deer that could be reached by an emergency feeding program in most deer management units, because a program has never been funded sufficiently to determine the maximum volunteer effort and amount of feed that could be mobilized and distributed, respectively.

11) If additional dollars, manpower (both volunteer and DNR staff), and access were available to double 1996 feeding efforts, 50% of the deer population could be fully fed for the same length of time as in 1996 at a cost of between \$2.3 and \$3 million. However, because more inaccessible areas would have to be reached with an expanded feeding program, there would likely be a greater increase in costs to provide access.

Recommendations: The report recommends research to address important questions raised by the 1989 and 1996 feeding programs and evaluation processes, including: 1) an assessment of private deer feeding efforts; 2) assessments of public support for feeding programs; 3) additional study of measures of winter severity and deer condition during winter; and 4) a study of the population impact of deer feeding.

The report also recommends that policy be developed to determine the long-term role of emergency deer feeding in Minnesota's deer management program. This will require involvement of the public and legislature. The process should identify whether state-funded feeding should be conducted, and if so, the goal of future emergency feeding programs and the most appropriate strategies to meet the goal. Strategic options that should be investigated include: 1) privatizing deer feeding and eliminating state agency involvement; 2) establishing a block grant program to administer deer feeding funds; and 3) targeting deer feeding to specific sites rather than distributing to the general public.

Finally, the report points out the need for improving information and education efforts on aspects of deer ecology and adaptation to winter, the DNR's deer management approach and philosophy, and the role of long-term habitat protection and improvement.

INTRODUCTION

Chronology of the Emergency Feeding Issue

The winter of 1995-96 was one of the most severe ever recorded in much of the northern part of the state. Snow arrived early and remained late, with many areas of the north having snow on the ground by early November which persisted into May. Snow depths exceeded 40" in many areas for much of the winter. Very cold temperatures also persisted throughout much of the winter, and temperatures of minus 40 degrees F were common.

In December, concern for the welfare of deer increased. A news release was issued by the DNR on December 29 announcing stepped up monitoring of northern deer herds. By January, pressure to begin a deer feeding program was building. Several sportsman's organizations began organized feeding programs in January, and on January 29 the state House of Representatives passed a resolution requesting the DNR begin a deer feeding program immediately, across a large portion of Minnesota. The next day, a bill was introduced to appropriate funds to the DNR for an emergency deer feeding program.

A feeding program using an existing DNR biennial appropriation of \$260,000 was initiated by the DNR on February 10 in the northwestern farmland. On February 27, a \$750,000 appropriation from the Game and Fish Fund "for emergency deer feeding in areas of the state affected by severe weather" was given final legislative approval and was signed into law by the Governor on March 1. Feed distribution from these funds was primarily restricted to northern forest areas and began on March 9.

Legislative Requirement and Evaluation Process

The \$750,000 emergency appropriation included the following provision: "The commissioner, in consultation with the citizen oversight committee appointed under Minnesota Statutes, section 97A.055, subdivision 4a, paragraph (b), clause (3), shall study the costs associated with emergency deer feeding and shall include the effect that the feeding project has on the deer population."

In response, the Section of Wildlife appointed a steering committee to oversee development of the evaluation. This committee communicated extensively with the chair of the citizens oversight committee referenced in the legislation. A representative of the Minnesota Deer Hunters Association (MDHA) attended all committee meetings to coordinate with that group and the oversight committee throughout the process.

The committee held three public roundtables in Thief River Falls, Hibbing, and Park Rapids to obtain input from more than 100 advocates of deer feeding on what analyses they wanted included in the evaluation. A summary of those meetings is found in Appendix 1, and analyses suggested at roundtable meetings have been incorporated into this evaluation.

In this report, most of the data used in the analysis was provided by the volunteer feeders. All assumptions used to generate estimates relating to the effectiveness of feed distribution derived from this data have maximized the benefits of an emergency feeding program. For example, it was assumed that all feed was distributed in the field and consumed by deer; that all deer (adults and fawns) had equal access to feed at feeding sites; that deer consumed no more than the RDA of 2.5 pounds per day; and that the number of deer reported by volunteers was accurate and no double-counting or inflation occurred. It is likely that an unknown portion of feed was placed in areas without deer, fed to other animals, or destroyed by weather; that many deer did not receive an adequate ration (especially fawns, which would benefit most from feed but

are often excluded from feed by stronger deer); and that only a fraction of the number of deer that were reported to have been fed were actually fed, often because of duplication (neighboring volunteers reporting the same deer). For example, it was found that some one-square mile sections had as many as 12 different volunteers providing feed, and 29% of sections had more than one feeding site in them.

It should also be noted that the analysis includes only state-purchased feed. There were extensive private feeding efforts before, during, and after the state feeding program, and this evaluation is not intended to reflect the total feeding effort in the state during the 1995-96 winter. The committee has considered the need to assess the extent of private feeding, and this has been included as a recommendation in this report.

SUMMARY OF 1989 FEEDING EVALUATION AND EMERGENCY DEER FEEDING POLICY

Prior to 1996, the last large-scale emergency feeding program conducted in the state occurred in the winter of 1988-89. An extensive evaluation of that feeding program found that \$1,071,492 was spent by the DNR to purchase and distribute 3,955 tons of pelleted deer feed across 46,000 square miles of northern Minnesota. The program required 17,000 hours of DNR staff time to implement, and an estimated 8,000 volunteers contributed 230,000 hours to support the feeding program.

To estimate the benefit to deer populations, the 1989 evaluation projected the maximum number of deer fed in each Deer Management Unit (DMU). DMUs are large areas with relatively uniform land-use and habitats, and are the basis for much of the DNR's population modeling and management programs. The number of deer fed was calculated by determining the amount of feed distributed in each DMU per week, and by assuming that each deer reached consumed 2.5 pounds of feed per day (this was based on research that shows a deer requires between 2 and 3 pounds of feed each day to maintain good physical condition). For reasons discussed earlier, the actual number of deer that consumed an adequate ration of feed was probably much lower.

This analysis found that a maximum of 54,038 deer in forest DMUs (9.3% of the forest population), and 18,294 deer in farmland DMUs (22.3% of the farmland population), were reached by the feeding program. The cost per deer fed averaged \$.235 per deer per day or \$14.69 for the duration of the program. Computer simulation models were then used to evaluate how feeding benefited deer populations. These models assumed that deer without access to feed had lower survival and produced fewer fawns the following spring. Results indicated that deer populations declined in both farmland and forest areas in spite of the feeding program. There were a maximum of 3.1% more deer available in forest DMUs the following fall than if no feeding had taken place, and a maximum of 7.2% more deer available in farmland DMUs.

The DNR developed deer feeding guidelines based on the results of this evaluation (Appendix 2). These guidelines restricted future state-funded feeding programs to farmland areas where a higher proportion of deer could be reached. The DNR would provide technical assistance for feeding efforts in forested areas by individuals or groups interested in feeding local populations of deer. State funds would not be used to purchase feed because significant benefits to deer populations across the forest could not be realized.

DEER FEEDING ISSUES

Deer Feeding Policies and Programs of Other States and Provinces

Minnesota is unique in its use of emergency feeding as a winter deer management program. No other state or province in the range of white-tailed deer has used public funds and wildlife agency staff to artificially feed deer for the purposes of preventing winter mortality.

Emergency feeding should not be confused with supplemental or recreational feed programs. Recent efforts by private conservationists to supplementally feed deer have led agencies to offer guidelines for feeding deer and for managing food plots and forest openings. Supplemental feeding has been growing in popularity and generally begins in late fall or early winter, after the end of the deer hunting seasons. Feeding commonly continues through winter and often extends into late spring or summer. In most of the northeastern states, the Great Lakes states and the central and eastern Canadian provinces, privately-funded supplemental feeding is common where access is not limiting and where second homes or recreational properties exist.

Michigan and Wisconsin report widespread, privately-funded supplemental feeding. Both states have classified emergency feeding as a high-cost, short-term deer management activity where the high costs far exceed the long-term benefits. While neither state uses public funds for emergency feeding, they do not discourage supplemental or emergency feeding if efforts are privately funded and used in conjunction with habitat and harvest management programs. Ontario has also not used public funds for emergency feeding.

New York, the New England states, Quebec and the Maritime provinces have all determined that winter feeding of deer is not a solution to winter food shortage problems. Currently, populations are above the carrying capacity of winter deer yards or agricultural wintering areas in many portions of these states, and thus, mortality is expected and works to align winter deer numbers with the amount and distribution of food and cover. In many agricultural situations, shooting permits are issued to allow local farmers/land managers to reduce deer concentrations that are causing depredation. Supplemental feeding of deer and the use of food plots and forest openings on private lands has been increasing in these states, creating significant pressure on hunting programs to control populations.

Several states (North Dakota, South Dakota, Nebraska, Montana and Wyoming) and provinces (Saskatchewan, Ontario, and Manitoba) commonly use winter feeding of deer, but only as a program to reduce or eliminate deer depredation on stored forage and crops. This practice, called "short-stopping", is characterized by Wildlife agency staff placing quantities of grain (usually corn and/or oats) and hay (usually alfalfa) in a location where winter concentrations of deer will consume the supplemental feed instead of devouring stored grain, hay or silage belonging to a private landowner. These programs often are considered the only means of maintaining local deer herds in agricultural areas from being reduced. Without short-stopping, local herds would be reduced by the use of depredation shooting permits. In addition, short-stopping in combination with permanent barrier fencing, is the only means for farmer/ranchers to protect feed intended for livestock herds confined in winter.

Scientific Literature of Deer Feeding

A summary of previous studies of deer feeding and deer behavior and adaptations to winter weather is found in Appendix 3. This summary indicates that previous studies have found that emergency feeding can reduce winter mortality and improve fawn production in small, localized areas, but that benefits to deer populations

across larger areas have not been demonstrated. It also describes some of the adverse impacts that have been documented at feeding sites. These include:

- 1) possible over-browsing and diminished natural carrying capacity because of deer over-browsing at feeding sites;
- 2) increased potential for transmission of disease and parasites (Michigan has documented bovine tuberculosis in deer herds in areas where winter feeding and baiting during the hunting season are common. Because of the mode of transmission of this disease, it is thought that this feeding is contributing to the spread of this important wildlife and livestock disease); and
- 3) creation of "predator traps" (it has been observed that deer concentrated at feeding sites are more vulnerable to wolf predation, and that feeding may provide opportunities for surplus killing by wolves).

The summary also points out potential long-term consequences of artificial feeding on deer movements and use of habitat, impacts on natural vegetation, and the overall health of deer.

LOGISTICS OF THE 1996 EMERGENCY DEER FEEDING PROGRAM

Deer Monitoring and Winter Severity Assessment

The status of deer populations in northern Minnesota is monitored each winter with a staged process. Initially, the Winter Severity Index (WSI) is calculated, which measure the cumulative sum of days with snow depths of at least 15" and the number of days with a temperature below 0 degrees F. While the WSI is not a reflection of deer condition, it is a measure of the conditions faced by deer and is used to determine whether more intensive monitoring is necessary. In general, year-end totals over 140 are considered severe and in 1996 the WSI exceeded 140 at eight stations by March 1. By the end of winter, the WSI was 190 or higher at 10 of the 15 stations (Table 1).

If the WSI indicates that the winter may be severe, the DNR initiates the second stage that includes a variety of measures to monitor deer condition. In late December, the DNR increased monitoring of deer condition across the northern part of the state. Funds were made available for managers to conduct aerial surveys to locate deer concentrations and to observe deer use of cover, deer mobility, and physical condition. In January, a sample of deer were shot and necropsied by DNR staff in parts of northwestern Minnesota to assess deer condition (i.e., fat reserves), and managers across the north were asked to inspect as many dead deer as possible. Managers solicited observations of deer and deer behavior from foresters, loggers, and others spending time in the woods.

Some of the best information available for forest deer came from an ongoing deer research project that was being conducted by the DNR in north-central Minnesota. Detailed information was available from this study concerning winter severity, deer movements and habitat use, and condition and mortality compared to previous years of the study.

Emergency Feeding Program Procedures

The chronology of emergency feeding differed between the northwest farmland and northern forest areas, and are discussed separately.

Northwest Farmland Areas: A single bid package, by county of delivery, was prepared in mid-January for the northwest feeding area, which initially included Kittson, Pennington, and parts of Roseau, Marshall and Lake of the Woods counties. The bid specified the standard DNR deer feed ration, with a bid deadline of January 31. Supersweet Feeds of Glencoe, Minnesota was the successful bidder in all counties.

The feeding area (Figure 1) was delineated based on winter severity indices and deer condition assessments. The feeding area was eventually expanded to include small parts of Polk, Red Lake, Clearwater, and Beltrami counties, as well as large portions of Roseau and Lake of the Woods counties. In addition, there were considerable efforts to adhere to the DNR's deer feeding guidelines that recommended against distribution of feed to antlerless permit areas that were above goal and to forest deer management units. However, strong public demand to feed in these areas eventually resulted in their inclusion for feed distribution.

Twelve feed distribution depots were established, most of them at sites that were already distributing feed from local MDHA or other privately-funded feeding efforts. Distribution centers were operated primarily by volunteers, and would have been impossible or prohibitively expensive to operate without the volunteer effort. Area wildlife managers coordinated feed ordering and delivery, identified priority feeding sites with

Table 1. Minnesota Winter Severity Index (WSI) Values, 1995-96.

Week Ending	Aitkin			Brainerd			Bemidji			Cloquet			Ely		
	Temp	Snow	Total	Temp	Snow	Total	Temp	Snow	Total	Temp	Snow	Total	Temp	Snow	Total
12-Nov-95	0	0	0	0	0	0	1	0	1	0	0	0	3	0	3
26-Nov-95	0	0	0	1	0	1	2	0	3	1	0	1	5	0	8
10-Dec-95	5	0	5	7	0	8	9	2	14	8	0	9	11	0	19
24-Dec-95	2	0	7	5	0	13	5	14	33	6	12	27	7	12	38
31-Dec-95	1	0	8	2	0	15	0	7	40	2	7	36	0	7	45
07-Jan-96	6	0	14	6	0	21	7	7	54	6	7	49	6	7	58
14-Jan-96	1	0	15	1	0	22	1	7	62	3	7	59	2	7	67
21-Jan-96	5	4	24	5	4	31	6	7	75	5	7	71	5	7	79
28-Jan-96	7	7	38	7	7	45	7	7	89	7	7	85	7	7	93
04-Feb-96	7	7	52	7	7	59	7	7	103	7	7	99	7	7	107
11-Feb-96	2	7	61	1	7	67	1	7	111	2	7	108	2	7	116
18-Feb-96	2	7	70	4	7	78	4	7	122	3	7	118	3	7	126
25-Feb-96	0	7	77	1	7	86	1	7	130	0	7	125	2	7	135
03-Mar-96	4	7	88	5	7	98	6	7	143	5	7	137	6	7	148
10-Mar-96	6	7	101	6	7	111	6	7	156	6	7	150	5	7	160
17-Mar-96	0	7	108	0	7	118	0	7	163	0	7	157	0	7	167
24-Mar-96	0	7	115	0	5	123	1	7	171	0	7	164	1	7	175
31-Mar-96	1	7	123	2	5	130	2	7	180	2	7	173	2	7	184
07-Apr-96	0	7	130	0	0	130	0	7	187	0	7	180	0	7	191
14-Apr-96	0	1	131	0	0	130	0	7	194	0	7	187	0	7	198
21-Apr-96	0	0	131	0	0	130	0	3	197	0	3	190	0	4	202
28-Apr-96	0	0	131	0	0	130	0	0	197	0	0	190	0	0	202

Week Ending	Eveleth			Grand Marais			Grand Rapids			Hinckley			Internat'l Falls		
	Temp	Snow	Total	Temp	Snow	Total	Temp	Snow	Total	Temp	Snow	Total	Temp	Snow	Total
12-Nov-95	2	0	2	0	0	0	1	0	1	0	0	0	2	0	2
26-Nov-95	3	0	5	1	0	1	2	0	3	0	0	0	4	0	6
10-Dec-95	10	0	15	4	0	5	5	0	8	6	0	6	10	7	23
24-Dec-95	7	12	34	5	11	21	9	14	31	5	0	11	7	14	44
31-Dec-95	3	7	44	1	7	29	3	7	41	3	0	14	2	7	53
07-Jan-96	6	7	57	5	7	41	6	7	54	5	0	19	7	7	67
14-Jan-96	2	7	66	1	7	49	3	7	64	1	5	25	3	7	77
21-Jan-96	5	7	78	4	7	60	6	7	77	5	7	37	6	7	90
28-Jan-96	7	7	92	6	7	73	7	7	91	6	7	50	7	7	104
04-Feb-96	7	7	106	7	7	87	7	7	105	7	7	64	7	7	118
11-Feb-96	2	7	115	1	7	95	2	7	114	2	7	73	1	7	126
18-Feb-96	4	7	126	2	7	104	3	7	124	2	7	82	4	7	137
25-Feb-96	1	7	134	0	7	111	1	7	132	0	7	89	3	7	147
03-Mar-96	7	7	148	2	7	120	6	7	145	5	7	101	6	7	160
10-Mar-96	6	7	161	4	7	131	7	7	159	7	7	115	6	7	173
17-Mar-96	0	7	168	0	7	138	0	7	166	0	7	122	0	7	180
24-Mar-96	0	7	175	0	7	145	0	7	173	0	2	124	0	7	187
31-Mar-96	1	7	183	1	7	153	2	7	182	2	5	131	3	7	197
07-Apr-96	0	7	190	0	7	160	0	7	189	0	0	131	0	7	204
14-Apr-96	0	7	197	0	7	167	0	7	196	0	0	131	0	7	211
21-Apr-96	0	6	203	0	3	170	0	0	196	0	0	131	0	5	216
28-Apr-96	0	0	203	0	0	170	0	0	196	0	0	131	0	0	216

Week Ending	Mille Lacs WMA			Park Rapids			Red Lake WMA			Roseau WMA			Thief Lake		
	Temp	Snow	Total	Temp	Snow	Total	Temp	Snow	Total	Temp	Snow	Total	Temp	Snow	Total
12-Nov-95	0	0	0	2	0	2	3	0	3	4	0	4	2	0	2
26-Nov-95	1	0	1	1	0	3	2	0	5	3	0	7	1	0	3
10-Dec-95	8	0	9	8	3	14	10	13	28	13	3	23	9	3	15
24-Dec-95	4	5	18	2	14	30	8	14	50	8	14	45	5	13	33
31-Dec-95	2	0	20	1	7	38	1	7	58	4	7	56	1	7	41
07-Jan-96	6	0	26	6	7	51	6	7	71	6	7	69	6	7	54
14-Jan-96	2	0	28	2	7	60	1	7	79	2	7	78	1	7	62
21-Jan-96	5	4	37	4	7	71	6	7	92	7	7	92	7	7	76
28-Jan-96	7	7	51	7	7	85	7	7	106	7	7	106	7	7	90
04-Feb-96	7	7	65	7	7	99	7	7	120	7	7	120	7	7	104
11-Feb-96	2	7	74	1	7	107	1	7	128	2	7	129	2	7	113
18-Feb-96	4	7	85	3	7	117	4	7	139	4	7	140	3	7	123
25-Feb-96	0	7	92	0	7	124	4	7	150	4	7	151	3	7	133
03-Mar-96	6	7	105	5	7	136	7	7	164	7	7	165	7	7	147
10-Mar-96	6	7	118	6	7	149	6	7	177	7	7	179	7	7	161
17-Mar-96	0	4	122	0	7	156	0	7	184	0	7	186	0	7	168
24-Mar-96	0	0	122	0	7	163	0	7	191	0	7	193	0	7	175
31-Mar-96	3	5	130	2	7	172	3	7	201	5	7	205	2	7	184
07-Apr-96	0	0	130	0	7	179	1	7	209	1	7	213	0	7	191
14-Apr-96	0	0	130	0	7	186	0	7	216	0	7	220	0	7	198
21-Apr-96	0	0	130	0	4	190	0	4	220	0	0	220	0	2	200
28-Apr-96	0	0	130	0	0	190	0	3	223	0	0	220	0	0	200

31 Jan-97

large concentrations of deer, and attempted to direct feed to those sites whenever possible.

The amount of deer feed provided to each person was based on the reported number of deer being fed each week (three, 50 pound bags for every 10 deer up to a maximum of 20 bags per person unless rationing was needed to insure that all volunteers were able to obtain feed). Individuals experiencing deer depredation on stored farm crops were given additional feed if it was available after other volunteers had obtained their feed.

The DNR began distributing feed on February 10, 1996. Due to a shortage of funds for feed, distribution was reduced or terminated from west to east and from south to north beginning in early March. The Crookston wildlife office received their last shipment on March 9, Karlstad office on March 16, Thief Lake WMA and Thief River Falls wildlife offices on March 23, Roseau River WMA on March 30, and the Baudette wildlife office on April 6 (some re-distribution of feed between depots may have occurred after the indicated last shipment date).

The feeding in the northwestern farmland was funded by a \$260,000 appropriation from the Deer/Bear dedicated account (funded by a \$1 surcharge on most resident deer and bear licenses-see below), except for \$45,000 (242 tons of feed) from the \$750,000 emergency appropriation.

Northern Forest Areas: After the emergency appropriation was passed to expand the feeding effort, two bids were prepared for feeding in northern forest areas--one for DNR Region 2 (northeast) and a separate bid for forested portions of DNR Regions 1 (northwest) and 3 (central). The standard DNR deer ration was used for the bid, except that Region 2 chose to allow vendors to bid based on either a pelleted or non-pelleted feed in an effort to allow some smaller, local mills to compete for the bid. The same vendor (Supersweet Feeds) was awarded both bids.

A feeding area (Figure 1) was delineated using the WSI, and 45 feed distribution sites were identified. Distribution sites were generally at non-DNR facilities. Managers identified feed distribution sites, and most facilities donated their services. Sites were staffed by both DNR staff and volunteers, and each distribution site had DNR staff present for most distribution times. Some managers had deer feeders sign up for feed prior to distribution in an effort to speed-up the distribution process. This resulted in thousands of phone calls to DNR offices, disrupting DNR business at these offices for several weeks. Some volunteer help was solicited to help with this sign-up process, but it still consumed much DNR staff time.

The bill providing the emergency appropriation was signed by the Governor on March 1. The first delivery occurred on March 9, and continued on a weekly basis through April 6 (5 deliveries). However, feed distribution sites were shut down from south to north starting on March 30 in an attempt to feed longer in northern areas with deeper, more extensive snow cover. An effort was made to direct the distribution of some of the feed to priority sites. Although managers identified significant deer concentration areas, there was little response to a request for volunteers to feed in these areas.

Guidelines were established that called for individual feeders to receive one bag of feed (50 pounds) for each 3 deer per week, with a limit of 10 bags per individual. However, generally, there was insufficient feed to meet demand, and feed quantities were limited even further in an effort to provide feed to as many individuals as possible. For example, most offices in DNR Region 2 restricted feed as follows: 1-5 deer, one 50-pound bag/week; 6-10 deer, 2 bags/week; 11-15 deer, 3 bags/week; etc. In some cases, individuals who were feeding larger numbers of deer were given priority for feed.

Funding And Expenditures

For the 1996-97 biennium, the department was appropriated \$130,000 each year for deer and bear management to include emergency deer feeding. If the appropriation for either year was insufficient for deer feeding purposes, the appropriation for the other year was available (this account has been referred to as the Deer/Bear/Computerized Licensing Account and is generated by a \$1 surcharge on each resident deer license. It is also used to pay for the computerized antlerless deer and bear quota drawings, and other deer and bear management). The Emergency Feeding Guidelines, referenced earlier and included in Appendix 2, recommended use of these funds only in farmland areas. Since the winter of 1995-96 occurred during the first year of the biennium, a total of \$260,000 was available for purchase of feed and related activities. A summary of expenditures from this account and the \$750,000 emergency appropriation provided by the legislature for feeding is shown in Table 2. All Deer/Bear Account funds were used in the northwestern agricultural areas, with the exception of \$5,000, which was allocated to forested areas for aerial deer surveys to locate and observe wintering deer, while most of the emergency appropriation was used in northeast forest areas.

Table 2. Summary of Expenditures for Emergency Deer Feeding Appropriations, 1995-96.

Activity	Deer/Bear Account Expenditures	Leg. Appropriation Expenditures*	Total Expenditures
Feed Purchase, Storage	\$244,268	\$731,445	\$975,713
Feed Storage	\$2,855	\$2,831	\$5,686
Deer Surveys	\$8,566	\$3,866	\$12,432
Communication, Travel	\$3,313	--	\$3,313
Feed Testing	\$172	\$49	\$221
Equipment	\$405	\$107	\$512
Total	\$259,579	\$738,298	\$997,877

* Remaining funds from this \$750,000 appropriation were used to fund development of this report.

The feed purchase and delivery expenditures include approximately \$60,000 in state sales tax that state agencies are required to pay.

In addition to the direct expenditures for deer feeding listed in Table 2, a total of 8,381 hours of DNR Section of Wildlife staff time was used to support the feeding program. The cost of this staff time was \$185,901. Total expenditures (including fleet costs and other expenditures) from the Game and Fish Fund were \$1,176,922 (note that the Deer/Bear/Computerized Licensing Account is a dedicated portion of the Game and Fish Fund). A total of 5,115 tons of pelleted deer feed was purchased and distributed across a 38,000 square mile area of the state in the 1996 program. This compares to 3,955 tons of feed distributed across a 46,000 square mile area in 1989. Feeding occurred during a 9-week period in both years.

Feed Depots 1996 Deer Feeding Project

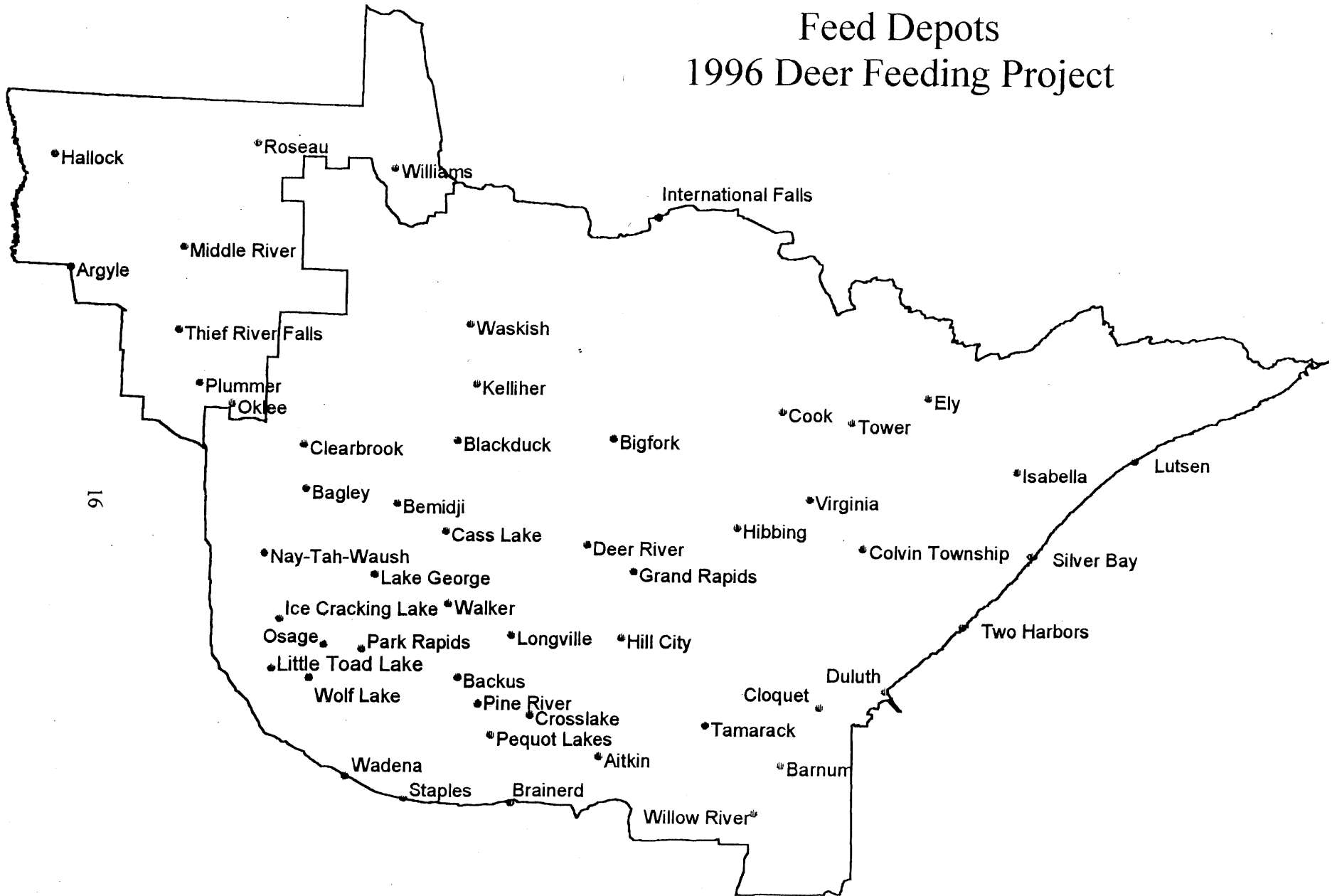


Figure 1. 1996 Deer Feeding Area and Feed Distribution Sites.

Impacts to Other Programs

The deer feeding program completely consumed staff time for DNR wildlife managers during the winter, preventing them from working on other priority wildlife habitat and population projects and initiatives. While this is difficult to quantify, work associated with the emergency feeding program exhausted over three months (24%) of time that wildlife managers in this area had available for other important activities. For example, the time spent on deer feeding exceeded the time spent on other deer management activities throughout the rest of the year in these work areas, including wildlife surveys for all species (5,258 hours), big game season preparation and analysis (4,610 hours), coordination on forestry activities (6,943 hours), and providing public information and assistance (5,273 hours).

In addition, the DNR was notified that any expenditures for emergency deer feeding were not reimbursable with federal aid funds. These funds, which are derived from federal surcharges on sales of arms and ammunition, are allocated to state wildlife agencies based on the number of licensed hunters in the state. Activities that can be funded by federal aid monies are defined by the U.S. Fish and Wildlife Service, and are determined based on a lengthy and exhaustive environmental. Based on this assessment, the cost of feed and the staff time spent by the DNR were not reimbursable by federal funds, and additional activities had to be found for the state to qualify for its maximum share of these funds. There is concern that in future years, the DNR will have difficulty qualifying for the maximum share of federal funds, and expenditures for emergency feeding programs could result in a loss of federal dollars to the state.

Volunteer Effort

A total of 8,277 volunteers picked up feed at least one time in 1996 and placed it on 8,988 sites. In addition, most managers in forested areas indicated that other volunteers were turned away because insufficient quantities were available to meet demand. Additional volunteers also provided help with feeder sign-up and feed distribution.

In 1989, there was no formal sign-up process, but managers estimated 8,000 volunteers participated in the feeding program. Volunteer effort declined during the later weeks of the 1989 feeding program. This was not the case in 1996, as demand for feed remained high throughout the program. The 1989 report also indicated that volunteer availability, along with the difficulty of finding and accessing deer, limited the potential effectiveness of a feeding program in most forested areas. The 1996 feeding program demonstrated that more volunteer effort was available than in 1989. Managers believe that this may be due, in part, to the increase in supplemental deer feeding that many of them have observed in recent years. In 1996, 66% of individuals who obtained state feed reported that they had previously been feeding deer, an indication of the tremendous amount of private feeding that was taking place. Since feed supplies were not able to meet demand, it is unknown how much potential volunteer effort could be expected for future feeding programs.

BIOLOGY AND ECONOMICS OF THE 1996 EMERGENCY DEER FEEDING PROGRAM

The following are analyses of deer population data and information reported by volunteers for the 1996 feeding program. Summary tables in the text include information at the Deer Management Unit (DMU) level, and appendices include this same information at the Permit Area level.

Deer Population Analysis

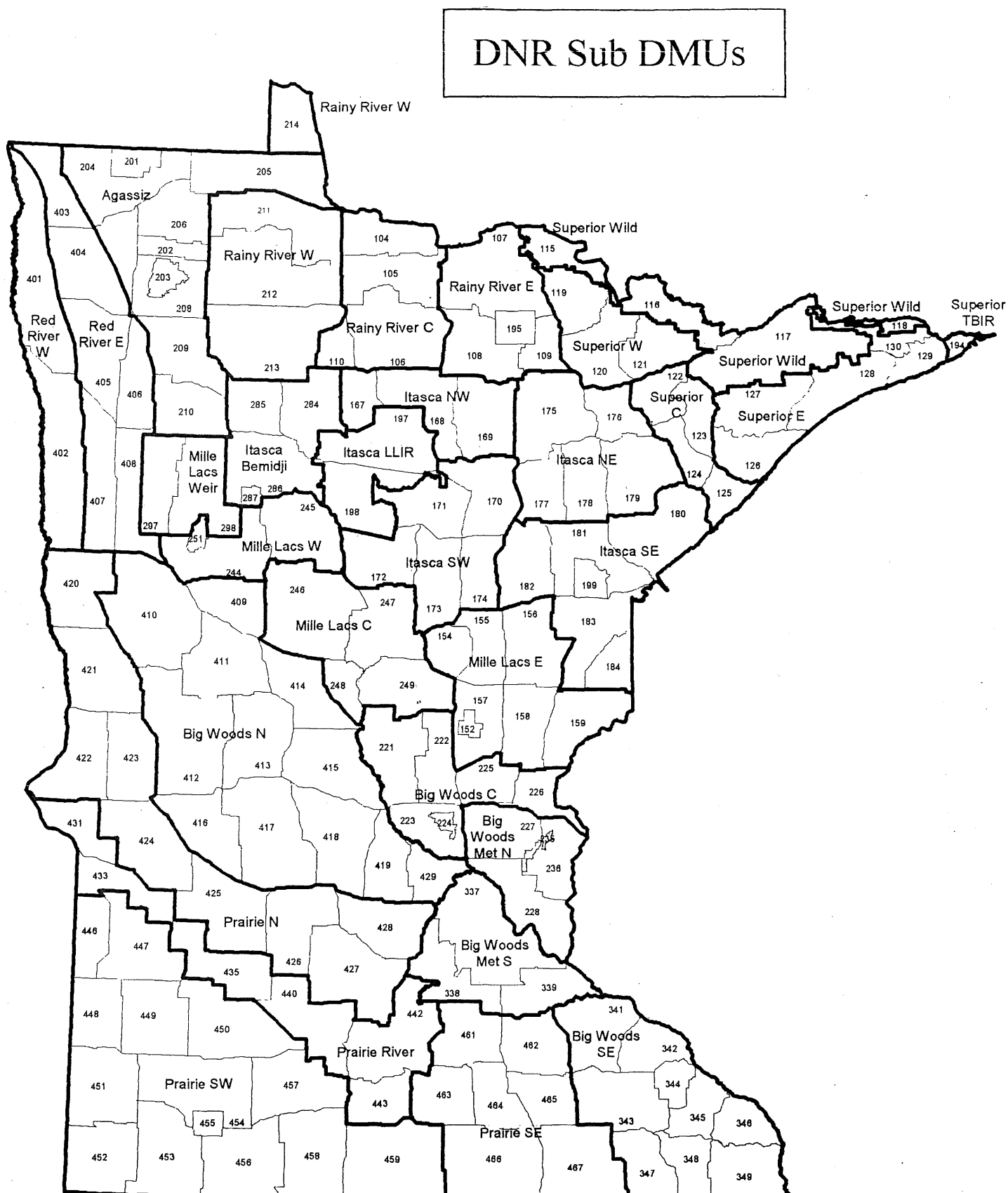
Methods: The number of deer available to be fed in each permit area was considered to be the 1995 post-hunt deer population. Estimates of the 1995 post-hunt deer population were calculated using the deer population models developed for the farmland and forest portions of the state. Preliminary projections of the 1996 prefawn deer populations were also calculated using the model, however the final estimates will not be available until after the 1996 harvest data are compiled in late winter 1997.

Results: As the winter of 1996 began, there were an estimated 396,000 deer in the northern area of the state where feed was distributed (Figure 1, Table 3, Appendix 4). About 13% of these deer (51,802) were located in the northwest farmland while the remaining 344,198 (87%) were in the forested area of the state. Deer densities ranged from 1.9 to 15.8 deer per square mile in the northwest farmland, and from 1.2 to 25.6 deer per square mile in the forest.

Table 3. Summary of the calculated deer populations after the 1995 hunting season and prior to fawning in spring 1996. Population density goals for each DMU are listed. For detailed information on permit areas within each DMU, see Appendix 4.

Deer Management Unit	Non-water area (mi ²)	1995 Post-hunt		1996 Prefawn		Deer population goal range (deer/mi ²)
		Calculated deer density (deer/mi ²)	Calculated total deer	Calculated deer density (deer/mi ²)	Calculated total deer	
Red River	5,264	4.4	20,475	4.1	19,070	1-4
Agassiz	3,986	8.2	28,325	7.2	25,372	2-17
Rainy River	6,004	12.5	63,962	7.8	37,772	10-20
Superior	5,714	7.0	45,195	5.1	28,183	3-20
Itasca	11,671	18.7	170,063	14.8	119,693	18-27
Mille Lacs	4,955	15.3	64,978	13.4	58,661	10-30
Big Woods North	417	7.2	3,002	7.0	2,919	6-7
Farmland Total	9,667	6.6	51,802	5.9	47,361	1-17
Forest Total	28,344	13.1	344,198	10.2	244,309	3-30
GRAND TOTAL	38,011	10.6	396,000	9.0	291,670	1-30

Figure 2. 1996 Deer Management Units and Permit Areas.



Projections indicate that more than 100,000 deer died in the feeding area during the 1995-96 winter (Table 3). In northern forest DMUs, this represented a 29% population decline (Table 3). The northwest farmland DMUs experienced a projected 9% decline over the same period. In the northwest farmland 14 of 18 (78%) permit areas had projected deer densities at or above density goals (Appendix 4) and only 4 permit areas had projected densities that fell below the goal levels. Alternatively, 17 of 22 (77%) of the forest permit areas where population projections were calculated were below the density goal.

Analysis of Feed Distribution

Methods: Data regarding the distribution of feed and location of feeding sites was collected at all distribution depots. Information included name, address, and telephone number of the feeder; number of bags distributed to each individual; amount of previous supplemental feeding; number of deer being fed; and the location of the feeding site to the nearest section or to the nearest forty acre parcel. A Geographic Information System (GIS) was used to plot township, range, section and permit area information. GIS points were located at the center of the smallest unit area given in the feeding site description. For example, if the smallest descriptive parcel consisted of township and range, the program placed a point in the center of the township. If, however, the description was to the nearest forty acre parcel, the point would be placed in the center of the forty acre parcel.

Results: Data were recorded for 9,146 feeding sites. Of this total, 1.5% (n=136 records) contained incorrect or incomplete site information. As a result, information on 2,183 reported deer fed and 1,641 bags (82,050 pounds) of feed distributed, could not be included in this analysis. Of the remaining 9,010 records, 2.5% (N=226) contained feed site locations outside the designated feeding zones. This further reduced the number of reported deer fed in the designated area by 7,916 and the bags of feed not distributed by 4,395 (219,750 pounds). These adjustments left a total of 8,784 usable records, resulting in a total of 200,946 reported deer fed by feeders and 188,902 bags or 9,445,100 lbs of feed distributed. Of the 8,784 usable records, 8.5% (n=751) did not contain the number of deer being fed. Finally, no feeding took place in permit areas 118, 130, and 402.

Table 4. Proportion of feeding sites on public lands compared to public land base, by DMU.

Deer Management Units	% Feed Sites on Public Land	% Public Land in DMU
Red River	3%	2%
Agassiz	22%	18%
Rainy River	57%	57%
Superior	36%	79%
Itasca	35%	49%
Mille Lacs	20%	25%
Farmland Total	16%	9%
Forest Total	32%	51%
GRAND TOTAL	30%	42%

The analysis found that 23% of the 8,784 sites received food only once. Food going to these sites totaled 228 tons of feed. Since most (1,675) of these sites received 6 bags or less of feed, it is very likely that deer at these sites did not benefit significantly from the additional food.

Because of the reliance on volunteers to distribute feed, there was concern that much of the feed would go to private, rather than public lands. Thirty percent of feed was distributed on public lands across the feeding area, while public lands comprised 42% of the land area (Table 4). This trend was most pronounced in the forest SDMUs which contain a higher proportion of public land.

Table 5. Summary of the amount and duration of feeding by DMU in the feeding area. For detailed information about each permit area within each DMU see Appendix 5.

Deer Management Units	Bags of feed	Pounds of feed distributed	Days of feed availability	Pounds of feed available per day
Red River	14,239	711,950	43	15,371
Agassiz	34,823	1,741,150	57	29,652
Rainy River	20,391	1,019,550	46	17,295
Superior	19,269	963,450	37	25,930
Itasca	73,775	3,688,750	35	103,216
Mille Lacs	25,048	1,252,400	33	37,159
Big Woods North	1,357	67,850	35	1,939
Farmland Total	50,419	2,520,950	51	46,962
Forest Total	138,483	6,924,150	38	183,600
GRAND TOTAL	188,902	9,445,100	43	230,562

The feeding program was conducted for 38 days in the majority of the forest zone and for 51 days in the farmland areas (Table 5). Deer were fed in most farmland areas for 6-8 weeks and 4-5 weeks in forest areas. The number of days feed was available varied from a low of 14 in permit area 214 to a high of 77 in permit area of 211-212 (Appendix 5).

Analysis of Deer Fed

Methods: The maximum number of deer fed the RDA in each permit area was calculated from the amount of feed distributed during the feeding period. This calculation was based on each deer consuming the RDA of feed during each day of the feeding period. For reasons discussed earlier, the actual number of deer that consumed the RDA was probably much. Data were collected on the number of deer fed as reported by the volunteers distributing feed. There was no field verification of the numbers of reported deer fed so these values appear as they were given to the DNR field staff. For this report we have assumed that no deer

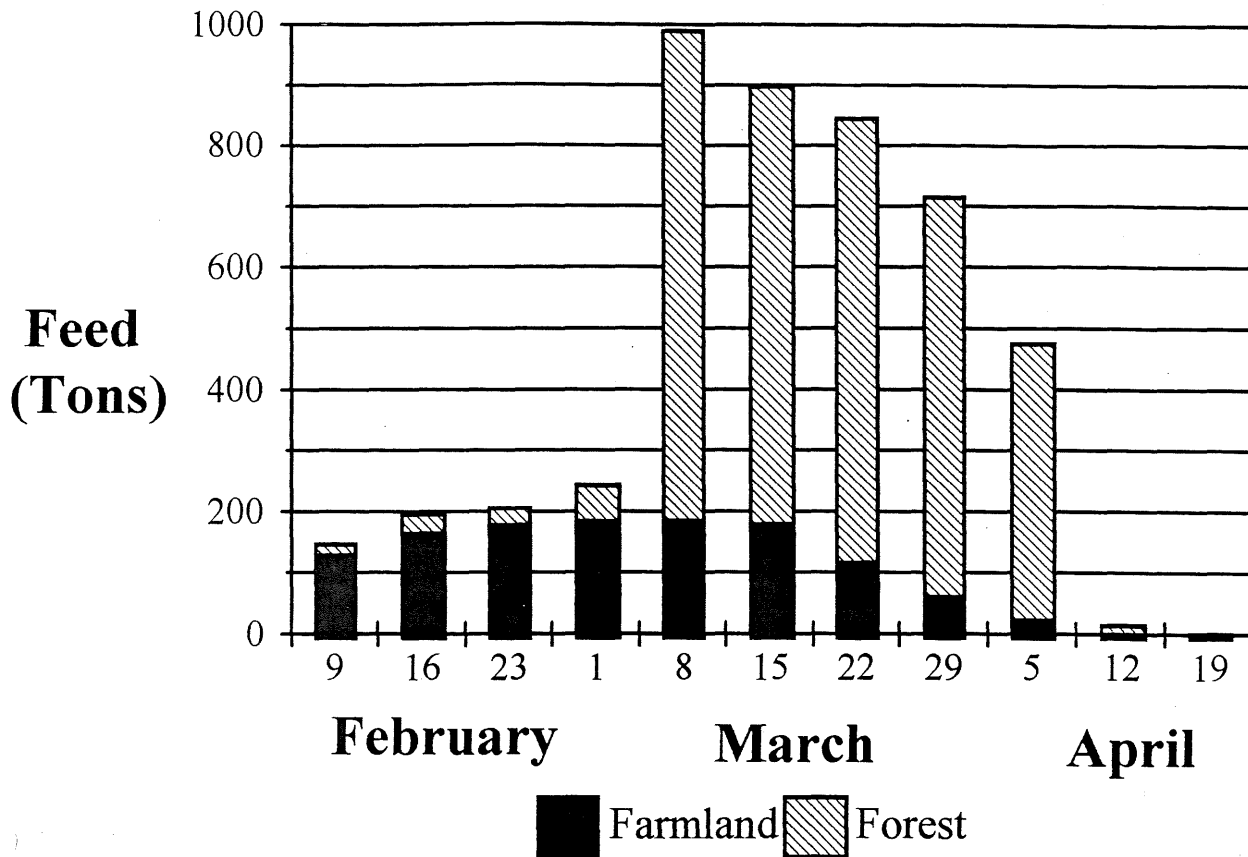


Figure 3. Distribution of feed in farmland and forest areas in tons per week.

reported by volunteers visited more than 1 feeding site and that the number of deer reported feeding at each site consumed an equal portion of the feed available over the feeding period. Typically, adult and fawn deer do not have equal access to feed.

Results: Overall, the estimated percent of deer that could have been fed the RDA of food was 23.3% of the calculated 396,000 deer (Table 6). As expected, a higher proportion of deer was potentially fed the RDA in farmland (36.3%) than in the forest areas (21.3%). The maximum percent of deer potentially receiving the RDA in farmland permit areas ranged from 0.4% to 80.2% and in the forest ranged from 0.6% to 82.2% (Appendix 6).

During the winter of 1996, 9,445,100 lbs of feed were distributed into the designated northwest farmland and northern forest feeding areas (Table 5). Additional feed was distributed into permit areas not designated for feeding and thus a portion of the effort was not recorded. Slightly more than 25% of the feed was distributed into the northwest farmland area which resulted in an average of 46,962 lbs of feed available on a daily basis. Forested areas had 183,600 lbs of feed available to deer on a daily basis.

Table 6. Summary of the post-hunt deer populations by DMU and the maximum percent of deer that could have been fed the RDA. For detailed information about each permit area within each DMU, see Appendix 6.

Deer Management Unit	Pounds of feed available per day	Post-hunt deer population	Estimated number of deer fed*	Percent of post-hunt population fed 2.5 lbs. per day
Red River	15,371	20,475	6,149	30.0
Agassiz	29,652	28,325	11,860	41.9
Rainy River	17,295	63,962	6,917	10.8
Superior	25,930	45,195	10,371	22.9
Itasca	103,216	170,063	41,287	24.3
Mille Lacs	37,159	64,978	14,863	22.9
Big Woods North	1,939	3,002	776	25.8
Farmland Total	46,962	51,802	18,785	36.3
Forest Total	183,600	344,198	73,438	21.3
GRAND TOTAL	230,562	396,000	92,223	23.3

*Estimated deer fed is the number of deer that could consume 2.5 lbs (RDA) of feed each day of the feeding program.

Approximately 200 tons of feed/week was available through the first week of March (Figure 3). By the week of March 8, the amount of feed distributed increased by nearly 5 times to almost 1,000 tons as the emergency appropriation became available. From March to April feeding declined, until slightly less than 500 tons were distributed the week of April 5.

Access was one of the factors limiting the distribution of feed in all permit areas. The number of roads open for travel dictated the location of many feeding sites, and large areas of most DMUs had little or no feed available in areas that corresponded to these roadless areas. An analysis of the distance of feeding sites from maintained roads found that 96% of sites were within 1 mile of such roads, 86% within ½ mile, and 57% within 1/4 mile (Figure 4).

If it is assumed that a feeding site is available to deer residing within a ½ mile radius of the site, 11.4% of the land in the feeding area had feed available in 1996. This ½ mile radius is probably generous, but serves to illustrate the large amount of land in the designated feeding area that did not have feed available to deer.

Another analysis was done to evaluate the program based on the numbers of deer reported fed by volunteers. Overall, volunteers reported reaching 201,000 deer (50.7% of available deer) in the designated feeding area in 1996 (Table 7). In the farmland, volunteers reported feeding 44,700 deer (86.4% of available deer), while volunteers in the forest reportedly fed 156,200 deer (45.4% of available deer). These values ranged from a low of 23.8% in Rainy River DMU to 104.6% in the Agassiz DMU (feeders reported feeding more deer than were estimated to be alive in the unit after the hunting season). Wide variation was observed among permit

areas for the portion of the posthunt populations reportedly fed (Appendix 7).

Table 7. Summary of the number of deer reported fed, the amount of feed consumed per day per deer reported fed and the portion of the 1995 post-hunt deer population reported fed. These estimates assume all feed was available to deer and that no deer fed at more than 1 feeding site. For detailed information about each permit area within each DMU, see Appendix 7.

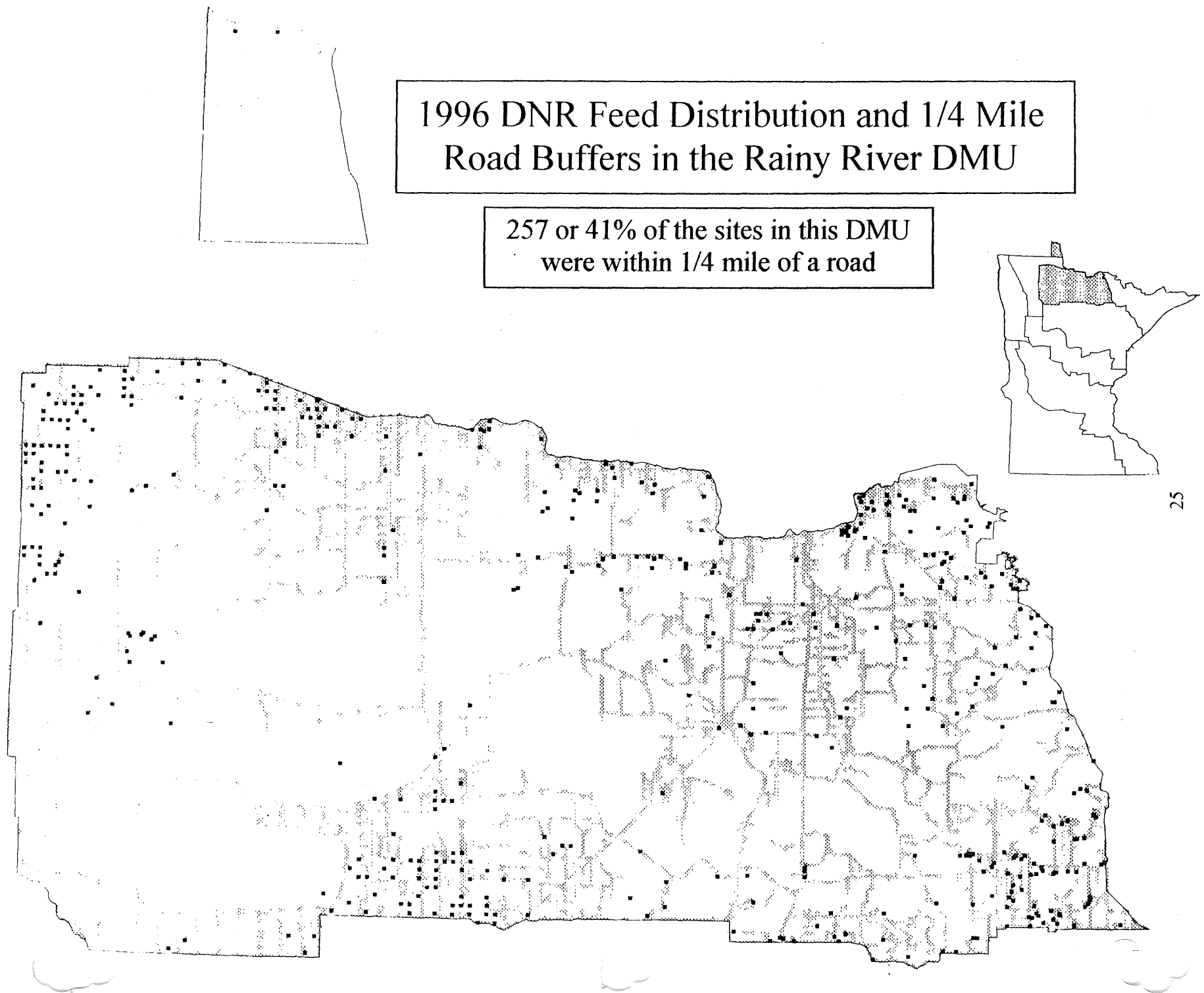
Deer Management Unit	Pounds of feed available per day	Post-hunt deer population	Reported deer fed	Pounds of feed per reported deer fed per day	Percent of post-hunt deer population reported fed
Red River	15,371	20,475	13,216	1.2	64.5
Agassiz	29,652	28,325	29,633	1.0	104.6
Rainy River	17,295	63,962	20,987	0.8	23.8
Superior	25,930	45,195	16,776	1.5	37.1
Itasca	103,216	170,063	79,699	1.3	46.9
Mille Lacs	37,159	64,978	38,732	1.0	59.6
Big Woods North	1,939	3,002	1,903	1.0	63.4
Farmland	46,962	51,802	44,752	1.0	86.4
Forest	183,600	344,198	156,194	1.2	45.4
GRAND TOTAL	230,562	396,000	200,946	1.1	50.7

Based on the reported numbers of deer fed, the average deer fed received an estimated 40% (1.0 lbs per day) to 50% (1.25 lbs per day) of the RDA required to maintain good health (Table 7, Appendix 7). The average amount of feed consumed by each deer ranged from 32% of the RDA in Rainy River DMU to 60% in the Superior DMU. Of the 82 permit areas in the feeding area, 3 reported deer had access to at least the recommended 2.5 lbs per day, while only 4 (5%) had access to at least 80% of the RDA (Appendix 7).

For permit areas 201 and 202 in the northwest, we analyzed the potential impact of feeders reaching reportedly high portions of winter deer populations, but where deer would have had available only 40% to 50% of the RDA.

Permit area 201 is the Roseau River Wildlife Management Area, and feeders reported reaching 6% more deer than were estimated to exist in the unit (note: managers report that this area serves as a wintering area for deer from surrounding areas and Canada, which may partially account for the fact that feeders here reported feeding more deer than models projected). Each deer was estimated to have received 0.9 lbs of feed per day. Analysis of sex and age data from the firearms hunting seasons from 1990 through 1996 indicated that losses of fawns during the 1996 winter were approximately 49% for males and 54% for females. While adult male and female losses were only slightly lower than normal, the reduction in fawns produced in spring 1996 was estimated to be 46%. This result was confirmed by the low numbers of fawns (particularly of female fawns) in the 1996 check station reports. While the area experienced severe flooding during the

Figure 4. Feed Distribution and 1/4 Mile Road Buffers in Rainy River DMU.



spring of 1996 which may have contributed to some of these projected losses, most are likely due to the severity of winter.

Permit area 202 is the Thief Lake Wildlife Management Area, and feeders reported reaching 85.4% of the post hunt deer population, with an estimated daily ration of 1.2 lbs of feed per day. Hunting season sex and age data from 1993 through 1996 revealed losses in the 1995 fawn group of approximately 33% for males and 10% for females. Adult losses were within the normal range of 10-15%, and a 10% reduction in the 1996 fawning rate was observed.

The pattern of events in permit areas 201 and 202 indicated that, although relatively high numbers of deer were reportedly fed at the feeding sites, mortality rates were still as high as have been observed for unfed deer in the most severe winters. This analysis suggests that given the severity of the 1995-96 winter, feeding in areas where a high percentage of the deer can be reached may contribute to increased adult deer survival, but does not reduce widespread and substantial losses of fawns born the previous year. In addition, reductions in fawns produced after the winter also were high, indicating adult females were suffering from stress that was great enough to impact the outcome of individual pregnancies and fawn survival.

Cost Analysis

Methods: Costs were recorded for the farmland and forest areas separately. Cost data included the cost of feed per 50 lb bag, the cost of all feeding operations, the cost for all staff time spent in feeding activities and the costs associated with monitoring deer winter condition.

Results: A total of 1,260 tons (50,419 bags) of feed was distributed from depots in the northwest farmland area to the feeding area, and 3,462 tons (138,483 bags) to the forest area (Table 8). Total feeding costs for the farmland were \$303,457, whereas the total feeding costs in the forest area were \$776,890. The farmland costs represented 28% of the \$1,080,346 spent to feed deer in 1996. Permit Area 180-184 reported the highest total cost to feed deer (\$98,045.97) while Permit Area 407 had the lowest feed cost (\$84.42, Appendix 8).

The cost per deer potentially fed the RDA was \$11.71, and the cost per deer reported fed by feeders was 45% of that total or \$5.38 (Table 9). The cost per deer potentially fed the RDA was slightly more than twice the cost per deer reported fed by feeders in both the farmland and forested permit areas, and the difference in all areas was due to the higher number of deer reported fed by individuals feeding deer (Appendix 9). Cost per reported deer fed varied from a high of \$14.07 in permit area 407 to a low of \$2.35 in permit area 247.

The total feeding cost of \$1,080,346.26 could have fully fed an estimated 23.3% of the posthunt deer population in the feeding zone. The costs to fully feed 50% of the posthunt deer population were estimated to be \$2,297,928.00 but were dependent on the costs to feed an additional 25% being identical to the costs to feed the first 25% of populations. In addition, feeding another 25% of the population assumed access was not limiting and that staff and feed distribution logistics could be accommodated.

A Comparison of 1989 and 1996 Feeding Programs

In 1996, over \$975,000 was spent to purchase deer feed, an increase of 31% over 1989 (Table 10). A much higher proportion of the program costs went to feed in 1996 (83%) than in 1989 (70%). This increased efficiency is a product of a smaller feeding area, a shorter feeding interval, increased volunteer help, and reduced hours by DNR staff. As a result, the 1996 program was potentially able to feed the RDA to 27% more total deer than in 1989, and the proportion of deer potentially fed increased in all DMUs except the Red River DMU. A higher proportion of deer was still reached in farmland units compared to forest DMUs in 1996, as occurred in 1989.

Table 10. Comparison of 1989 and 1996 Feeding Programs.

	<u>1989</u>	<u>1996</u>
Feed Expenditures	\$744,536	\$975,713
Total Game and Fish Fund Costs	\$1,071,492	\$1,176,922
Amount of Feed Purchased	3,955 Tons	5,115 Tons
Size of Feeding Area (Square Miles)	46,000 mi ²	38,000 mi ²
Estimated Maximum Number of Deer Fed	72,332	92,223
Cost/Deer Fed	\$14.69	\$12.76
Section of Wildlife Staff Hours	13,754	8,381
Maximum Potential % of Deer Fed By DMU Based on RDA of 2.5 pounds of feed/deer/day.		
Red River DMU	36.4%	30.0%
Agassiz DMU	25.8%	41.9%
<u>Big Woods DMU</u>	<u>9.5%</u>	<u>25.8%</u>
Farmland DMU Total	22.3%	36.9%
Rainy River DMU	4.4%	10.8%
Itasca DMU	10.1%	24.3%
Superior DMU	12.9%	22.9%
<u>Mille Lacs DMU</u>	<u>10.1%</u>	<u>22.9%</u>
Forest DMU Total	9.3%	21.4%
Total	11.0%	23.3%

Table 8. Summary of the costs for feed and associated feeding activities by DMU in the feeding zone. For detailed information about each permit area within each DMU, see Appendix 8.

Deer Management Unit	Number of bags distributed	Feed cost	Associated feeding costs*	Total feeding costs
Red River	14,239	\$53,253.86	\$32,607.31	\$85,861.17
Agassiz	34,823	\$130,238.02	\$79,744.67	\$209,982.69
Rainy River	20,391	\$82,991.37	\$31,402.14	\$114,393.51
Superior	19,269	\$78,424.83	\$29,674.26	\$108,099.09
Itasca	73,775	\$300,264.25	\$113,613.50	\$413,877.75
Mille Lacs	25,048	\$101,945.36	\$38,573.92	\$140,519.28
Big Woods North	1,357	\$5,522.99	\$2,089.78	\$7,612.77
Farmland Total	50,419	\$189,014.87	\$114,441.76	\$303,456.63
Forested Total	138,483	\$563,625.81	\$213,263.82	\$776,889.63
GRAND TOTAL	188,902	\$752,640.68	\$327,705.58	\$1,080,346.26

* Associated feeding costs include staff time, equipment, and other feeding costs.

Table 9. Summary of the cost per estimated deer fed and cost per reported deer fed by DMU in the feeding zone. For detailed information about each permit area within each DMU, see Appendix 9.

Deer Management Unit	Total feeding cost	Estimated number of deer fed*	Cost per estimated deer fed	Reported deer fed*	Cost per reported deer fed
Red River	85,861.17	6,149	13.96	13,216	6.50
Agassiz	209,982.69	11,860	17.71	29,633	7.09
Rainy River	114,393.51	6,917	16.54	20,987	5.45
Superior	108,099.09	10,371	10.42	16,776	6.44
Itasca	413,877.75	41,287	10.02	79,699	5.19
Mille Lacs	140,519.28	14,863	9.45	38,732	3.63
Big Woods North	7,612.77	776	9.81	1,903	4.00
Farmland Total	303,456.63	18,785	16.15	44,752	6.78
Forest Total	776,889.63	73,438	10.58	156,194	4.97
GRAND TOTAL	1,080,346.26	92,223	11.71	200,946	5.38

* Estimated deer fed is the number of deer that could consume the RDA. Reported deer fed is the number reported by volunteers.

SUMMARY AND CONCLUSIONS

Deer Feeding Programs and Policies of Other States and Provinces: No other state has engaged in a publicly-funded feeding program similar to that adopted by Minnesota in 1989 or 1996. Similarly, Canadian provinces, where local deer populations may experience winter losses of 25%-40%, do not consider feeding to be a viable management tool for deer.

Deer Feeding Literature: Past studies have shown that population benefits from deer feeding are localized, and neither the 1989 and 1996 evaluations of Minnesota feeding programs were able to demonstrate any widespread benefits to deer populations from feeding. In addition, because feeding concentrates deer, a number of biological issues related to emergency deer feeding have been identified, including increased potential for transmission of diseases and parasites at feeding sites, increased predation impacts, and impacts to vegetation and browse availability at feeding sites. There are also potential long-term consequences of feeding on deer movements and habitat use, natural vegetation, behavior, and the overall health of the deer herd.

Deer Monitoring and Winter Severity Assessment: Determining whether winter conditions warrant emergency deer feeding has been controversial and difficult. The WSI is widely known by the public and reported by the media. Because past experience has shown that the WSI is not always a good indicator of deer condition, managers also use observations of deer behavior, results of necropsies of dead deer, and other information to augment WSI findings. There has been interest from the public in using the WSI as a trigger to determine feed program starting dates. While the WSI may be a good index to alert managers that deer are experiencing severe conditions, research has not documented that it is useful in predicting deer condition.

The department's approach to winter deer monitoring has been a multi-staged approach. The first stage is monitoring WSI values. If WSI indicates the potential for a more serious winter, additional monitoring such as field observations of deer behavior, mobility, and use of food resources, as well as inspection of dead deer is implemented. The final stage includes shooting and necropsy of deer in selected areas to determine physical condition. In addition, results and observations of deer from ongoing deer research studies is used throughout the monitoring process to augment other monitoring findings.

There is a need to improve public understanding of the WSI and other deer monitoring activities. There is also a need to assess the value of the WSI and other measures as an indicator of deer condition in farmland areas of the state, as is currently being done as part of an ongoing DNR deer research study in north-central Minnesota. Finally, there is interest from the public in an easily understood "trigger" for determining the need for (and starting dates of) future feeding programs if dedicated funds for deer feeding continue to be provided. This may not be possible to develop because of complex variations in year-to-year deer condition, severity and timing of winter, and other factors.

Emergency Feeding Program Procedures: Participants in the deer feeding roundtables urged the DNR to improve planning for future deer feeding programs to enhance their effectiveness. Some specific suggestions included: 1) targeting feed to priority deer concentration areas; 2) providing more flexibility in feed ration specifications to obtain feed at a cheaper cost; and 3) generally attempting to get state-funded feed to deer that are not being fed with private funds. However, there was not total agreement on these points, and additional discussions with stakeholders are necessary before a long-term strategy for administering dedicated deer feeding funds is developed.

As in 1989, wildlife managers reported instances of waste associated with the emergency deer feeding

program. Documented examples included: feed distributed along roads or in areas not being used by deer; feed stored for future winters; feed provided to deer that were also being fed by individuals on neighboring properties; and feed provided to deer outside of the designated deer feeding zone. Increased monitoring of feeding sites and additional restrictions or direction concerning who may obtain feed and where feed may be distributed would be necessary to limit these types of problems in the future.

Although DNR feeding guidelines recommended that emergency deer feeding not be conducted in antlerless permit areas that were above goal levels, there was little public support for this approach. Some individuals from forested areas questioned why deer were being fed in areas where the DNR was attempting to reduce deer populations, but there was very little local support for withholding deer feed from these areas to help achieve population management objectives. The DNR was accused of using "starvation as a management tool", when in fact, the restriction on use of state funds to feed deer in these areas was an attempt to direct deer feed into those permit areas where feeding could be used for attaining population objectives. Additional discussion with stakeholders is necessary on this aspect of feeding policy.

In 1996, the DNR was generally criticized for starting the state feeding program too late. Most organized private feeding programs started much earlier than state-funded programs, and as these private programs ran low on funds there was increasing pressure to initiate state feeding. Reports and observations of dead deer, mostly smaller fawns, also brought pressure to feed earlier than the department's monitoring indicated was necessary. The DNR's approach has been to use winter feeding as an emergency measure, with the primary intent of maintaining the condition of adult does, which is important to helping deer herds recover from winter losses. Since adult does enter winter in better condition than either fawns or adult bucks, feeding programs have started later than they would if the intent was to save fawns. There is not a good understanding of this approach by the public, and at roundtable meetings interest was expressed in designing state feeding programs to prevent mortality in all segments of the deer herd. This would require a much earlier start date and significantly more money.

Funding and Expenditures: Deer feeding is a very expensive management technique. Despite complaints that the state feeding program started too late, ended too early, was not available in a large enough area of the state, and did not provide adequate feed to meet demand, nearly \$1 million of state funds was expended for feed purchase, and total state expenditures exceeded \$1.175 million. Thus, the potential costs of an expanded feeding program that would meet all expectations of deer feeders are extremely high. Based on past history, the frequency of severe winters can not be predicted and it is possible that such an expenditure might be necessary for several consecutive years. For these reasons, it is difficult to plan and develop deer management program budgets that include emergency feeding programs as a component.

There was a widely held misconception that a portion of the \$1 Deer/Bear/Computerized Licensing surcharge was dedicated exclusively to emergency deer feeding. This was not the case, and the State Legislative Auditor's Office determined that the DNR has administered this account properly. The 1996 emergency appropriation bill did also establish a dedicated feeding account for the first time. Starting on July 1, 1997, \$.50 from each deer license will be deposited in an account that can only be used for deer feeding. The funds in the account are available immediately, and any unused funds carry over to succeeding years. (Note: When or if the balance of this dedicated feeding account reaches \$750,000, the entire \$750,000 transfers over to the Game and Fish Fund to re-pay the Fund for the 1996 feeding program, and the account will again begin accruing funds for deer feeding, but at a rate of \$.25 per deer license.) It is expected that this account will generate approximately \$200,000-\$250,000 annually for deer feeding programs until the \$750,000 emergency appropriation is repaid.

This new dedication of deer feeding funds will result in a corresponding decrease in funds available to the Section of Wildlife for other deer and bear management programs. Previously, the funds were set-aside for deer feeding, but if they were not used for that purpose they could be used for other deer and bear management activities. Important deer and bear research and management programs that have long-term benefits to these and other species will be cut back as a result.

Impacts to Other Programs: Section of Wildlife staff in the feeding area devoted almost all available time to deer feeding during much of the winter in those areas that fed deer. The more than 8,300 hours of staff time (valued at \$186,000) for emergency feeding is equivalent to 4 full-time positions for one year. Much of this time was spent on activities that would not require professional wildlife expertise such as ordering feed, monitoring feed sign-up processes, mobilizing volunteers, and answering public inquiries about the feeding program. Important work did not get accomplished due to the feeding program, including many activities that would provide long-term benefits to deer and other wildlife.

Publicly-funded deer feeding programs are short-term, and the benefits rarely extend beyond one or two years. In addition, feeding benefits a very small group of species (deer and perhaps some predators that rely on deer as prey). Most wildlife management programs have evolved to employ a more comprehensive approach that focuses on managing landscapes to address the needs of all species and to focus on long-term habitat management programs that provide benefits for a number of years. Important programs that provide these multiple species, long-term benefits were compromised as a result of the time that professional staff spent on the deer feeding program, and as a result of the diversion of funds from other management activities that occurred in 1995-96. This also will occur in future years as deer license fees are dedicated to deer feeding. The success of the state's deer management program over the past 20 years was a direct result of focusing on long-term activities.

The possible future impact on federal aid reimbursement as a result of time spent on deer feeding is also cause for concern. Federal aid funds are returns of federal excise taxes on hunting equipment and ammunition, but they can be provided only for qualifying wildlife management activities. Because the U.S. Fish and Wildlife Service has determined that feeding is not a reimbursable activity, the Section could have difficulty in qualifying for the maximum allowed payments if significant time is spent on feeding programs in the future. The net result would be reduced federal funds into the Game and Fish Fund for wildlife management programs in the state.

Volunteer Effort: There was very strong demand and support for emergency feeding across the northern part of the state, and the feeding program allowed interested individuals to get involved and participate in a wildlife program. The response by volunteers to the feeding emergency was tremendous. Individuals and conservation organizations assisted with depot selection, feeder sign-up, and feed distribution. This increased reliance on volunteers reduced the amount of time spent by wildlife staff on the feeding program compared to 1989, and reduced the total cost per deer reached.

There were more than 8,277 individuals that picked up and provided feed in the field and many additional individuals who had to be turned away from the program because of insufficient funds. Both the 1989 and 1996 evaluations have demonstrated that without a strong volunteer interest and involvement, emergency feeding programs would be impossible. The fact that such a high proportion of volunteers distributed feed only once (23% of sites) is problematic, and indicates that feed distributed by these individuals may have provided very little benefit to deer.

Interest in deer feeding increased in 1996, likely a result of the high numbers of recreational feeders.

Approximately 66% of volunteer feeders in 1996 reported that they had previously been feeding deer. It appeared that state funds were used in many cases to offset costs for individuals that feed deer every winter for recreation or personal enjoyment. Some local feed mills reported that the state feeding program negatively impacted sales of their deer feed.

Reliance on volunteer feeders also makes it difficult to direct feed to priority sites. In 1996, 70% of feed went to private lands even though public lands comprised 42% of the land base. Managers reported that there was generally little interest from volunteers to feed in areas identified by managers, especially on public lands, and most feeders wished to feed deer in the most accessible areas of specific interest to them (near homes, cabins, hunting sites, etc.).

Deer Population Analysis: Of the estimated 396,000 deer in the feeding area at the start of the 1995-96 winter, 104,000 were estimated to have died during the winter. Declines were greatest in forested and northwest farmland areas where reductions of 30% to 40% were projected to have occurred in many locales. Areas in the rest of the farmland and transition areas experienced losses of 5%-10%. Additional analysis of harvest information via population models is necessary before any conclusions can be made regarding the impact that the feeding program had in preventing deer losses.

Analysis of Feed Distribution: Feed was placed at more than 9,000 sites during a 38-day feeding period in most forest areas, and a 51-day period in northwestern agricultural areas. Access was the major limiting factor in the distribution of the feed. A total of 96% of the feeding sites were within 1 mile of a maintained road, and 57% were within one-quarter mile of a road. This resulted in large, inaccessible areas where little or no feed was distributed. Also, about 300,000 pounds of the approximately 9.5 million pounds of feed was distributed outside the feeding area.

Analysis of Deer Fed: Based on the recommended daily ration of 2.5 pounds/deer, 23% of deer in the feeding area (36% in farmland units and 21% in forest areas) could have adequately been fed. Based on reports of volunteers, nearly 51% of deer (86% of farmland and 45% of forest deer) were fed an average of about 1.1 pounds of feed/day. However, since some feeders feeding in close proximity likely counted the same deer, and because managers reported that some feeders over-estimated the number of deer being fed in an effort to obtain additional feed, the reported deer numbers reached by the program were biased high, and it is not possible to determine the number of deer that were reached.

There were significant differences in the estimated number of deer reached with feed between deer management units. Some of this was due to differences in accessibility of deer and availability of volunteer assistance, but much of the difference was also due to the fact that feed had to be rationed in most forest areas because funding was insufficient to meet demands from volunteers. It is not possible to make any conclusions regarding the potential maximum number of deer that can be reached by an emergency feeding program in most deer management units, because a program has never been funded sufficiently to determine the maximum volunteer effort and feed that could be distributed. It is likely, however, that costs to feed added deer through an expanded program will increase significantly as deer in more inaccessible areas are provided feed.

Preliminary analysis indicates deer populations declined everywhere feeding occurred. Additional analysis is necessary, but in some northwestern areas, over-winter losses (especially of fawns), and reductions in fawn recruitment the following year, were significant in spite of extensive feeding and, given the severity of the winter, similar to what would have been expected even if no feeding had occurred. Although some adult deer were undoubtedly saved by feeding, many fawns consumed feed and still died, many did not have access to

feed, many were provided an inadequate ration to survive, and many likely perished in spite of ready access to artificial food. This analysis, and the evaluation of the 1989 feeding program, provide information on where feeding may be more or less efficient and effective in mitigating severe winter weather, but these findings indicate that for the most severe winters (like the winter of 1995-96), publicly-funded emergency feeding will yield limited benefits to populations. There may be some winter conditions where feeding benefits would be more pronounced.

Participants in the deer feeding roundtables indicated that the concern of many feeders is with individual deer or deer populations in small areas near where the feeders live or recreate. While deer are certainly not uniformly distributed in winter, the fact that feed was available to deer on less than 11% of the landscape indicates that there were large areas (many on public lands) where no feed was available to deer. Other areas (often near lakes and larger communities) had very intensive feeding and it is likely that some of these areas saw reduced winter deer losses because of the intensity of feeding (both private and state-funded). This evaluation is not able to assess the feeding program effects at this reduced spatial scale, and instead focused the analysis on larger Permit Areas and DMUs that are the basis of the DNR's deer management program.

Cost Analysis: If there were additional dollars and manpower (both volunteer and DNR staff), it would cost in excess of \$2.5 to \$3 million to feed 50% of the deer the RDA. This assumes that the number of volunteers could be doubled, substantially more DNR staff time could be diverted, and that volunteers could access this increased proportion of deer. Analyses indicate that while some volunteers (especially in the forest) were turned away because of insufficient food, their numbers were only a fraction of those that did distribute food. Diversion of additional DNR staff would only exacerbate problems and would likely reduce funds available from federal aid. Finally, because most feeding occurs within 1 mile of a road, it is highly unlikely that volunteers would have access to significantly more deer.

A Comparison of 1989 and 1996 Feeding Programs: Generally, the 1996 program was more efficient than the 1989 program. The additional amount of state funds available to purchase feed in 1996 and the smaller feeding area resulted in more feed available for distribution, and the increased volunteer response assured that manpower was available to distribute the additional feed. Consequently, a higher proportion of deer was reached in almost all Deer Management Units. As in 1989, a higher proportion of deer were reached in farmland vs. forest DMUs.

RECOMMENDATIONS

Research

The department's experience during the 1989 and 1996 deer feeding programs and evaluations of each of these efforts have pointed out the need for additional research if publicly funded feeding programs are to continue in the future. The following are some examples:

Assessment of Private Feeding: Circumstantial information indicates that private feeding has increased across the northern deer range. Research is needed to determine the extent of private feeding during both "normal" and severe winters. In addition, the degree to which private feeding may influence deer hunting opportunities, deer winter movements, deer health, and behavior need to be investigated.

Deer Feeder Profiles: Surveys would be useful to determine demographic and economic profiles of deer feeders. There is also a need to determine support for deer feeding among various sectors of the public, especially of hunters who have provided most funds for past deer feeding efforts.

Deer Condition/Winter Severity Assessment: Ongoing research being conducted by the DNR will provide useful information in correlating various measurements of winter severity with deer condition and survival in forest areas. Similar research is necessary in farmland and transition areas. The DNR also needs to assess current techniques used to assess deer condition and develop improved assessment techniques that are easily used by management staff, inexpensive to implement across large geographic areas, and that allow wildlife managers to track the progression of winter effects on local deer populations.

Population Impact of Emergency Deer Feeding: The impact of previous emergency feeding programs on deer populations has been estimated through modeling and evaluation of harvests in following years. Research is needed to assess the impact that feeding has on deer populations in several local areas that vary in the degree of access for feeding, habitat available to deer for winter, and the factors affecting deer populations on a routine basis. Extrapolation of the impact of feeding across large geographic areas will require study sites in several locations in agricultural and transition areas where there has never been research information developed. In addition, forest research sites would need to continue to produce data, with added focus on examination of the feeding issue.

Policy Development

Long-term policies are needed regarding the role that emergency feeding will have in future deer management programs in the state. The legislation that provided the \$750,000 Game and Fish Fund appropriation for deer feeding in 1996 also created a dedicated deer feeding account. The presence of this new account makes long-term policy development very necessary, as it will require that the DNR determine when and where funds will be allocated for deer feeding, and how these programs will be administered and applied. Development of these policies will require the active involvement of deer feeders and other members of the public with an interest in the state deer management program. It will also require coordination with legislators and conservation organizations.

The process should determine whether state funds should be used for deer feeding, and if so, what the goals of future feeding programs are and strategies for meeting those goals. The following represent some alternative strategies, based on discussions at the deer feeding roundtables and the department's deer feeding evaluation committee:

alternative strategies, based on discussions at the deer feeding roundtables and the department's deer feeding evaluation committee:

Privatization Option: Although private deer feeding is very common in other Great Lakes states, state funds are not used for feeding deer. Individuals and conservation organizations in these states have taken on the responsibility to feed deer that they have a personal interest in, allowing state wildlife managers to focus their efforts and limited funds on research and long-term habitat and population management programs. There is certainly strong interest in privately funded deer feeding in Minnesota, as evidenced by the high number of individuals involved in private recreational feeding in recent years and the very substantial efforts by MDHA chapters and other organizations to raise and use funds for deer feeding in 1996. While the new dedicated account that has been created for deer feeding will ensure that there will be at least a limited amount of state funds available for deer feeding each winter, it establishes deer hunters as the sole contributors to future state feeding efforts. It also requires deer hunters from southern areas to pay for deer feeding programs that will likely never be necessary in their part of the state. A privately funded feeding program would allow those individuals with an interest in feeding to contribute their money and feed deer that they have a direct interest in, without the involvement of the state as a "pass-through" for deer feeding funds.

Grant Program: Under this option, the department would provide block grants from dedicated deer feeding funds to organizations with an interest in deer feeding. Each organization would then be responsible for all aspects of feeding including feed ordering, distribution, and monitoring. The department would continue to provide technical assistance, assess winter severity and deer condition, determine where and when feeding funds can be used, and administer the feeding account. A matching requirement on the part of organization receiving feed could help increase feeding efforts by stretching limited state funds dedicated towards feeding. An important benefit of this approach would be to reduce the direct involvement and time commitment towards deer feeding by state wildlife managers. It would also allow organizations to tailor feed distribution strategies to their area.

Directed Program: Under this option, state-purchased feed would be used only at deer concentration areas identified by area wildlife managers, and general distribution of feed to the public would not occur. Managers would identify large deer concentrations and attempt to receive commitments from individuals or organizations to feed deer at these sites. Feed would only be provided to these approved feeders for use at the priority sites. This option could help to ensure that state funds are used to feed deer that are not already being fed with private funds, and could increase the effectiveness of future feeding programs. However, there may not be sufficient wildlife staff or willing volunteers available to support and monitor this approach.

Information and Education

There is a need for long-term efforts to educate the general public on aspects of the winter ecology of deer, including physiological and behavioral adaptations of deer to winter weather, the importance of natural selection in long-term health of deer populations, mortality of deer under various winter severity conditions, and other aspects of deer and winter. There is poor understanding of the department's overall deer management philosophy, deer goal-setting and modeling processes, and roles and activities of wildlife managers and researchers at area, region, and St. Paul levels. There is also a need to explain the importance of long-term habitat protection and improvement in mitigating the effects of winter. These education efforts need to be focused, continuous, and aimed at changing strongly-held, long-time beliefs.

APPENDIX

Appendix 1. Summary of Deer Feeding Evaluation Roundtables

Thief River Falls (July 31): About 50 people attended from Baudette, Thief Lake, Thief River, Karlstad, and Crookston work areas. Since the DNR agreed to use state funds to feed deer in most of this area, the discussion centered more on how to feed (when to start, what to use for feed, etc.) rather than whether to feed. However, there was a concern with the department's desire to not feed where deer populations were significantly above goal levels. Participants felt that high deer numbers should be addressed by changes in season frameworks, and that winter starvation should not be a management tool. When asked what their objective for a feeding program was, several stated that they desired to prevent any deer from dying. There was not a lot of interest in helping shape the evaluation--the process used in 1989 seemed to meet their needs. Participants suggested that feeding sites should be pre-determined, and that feed should go where it will reach the greatest number of deer. They also suggested that additional or better-managed food plots would reduce the need to feed in this area of the state.

Hibbing (August 28): Over 50 people attended from the Ely, Cloquet, Eveleth, and Grand Rapids work areas. At this meeting, there were extensive questions on modeling and population estimates, the WSI, and mortality assessments. There was also a lot of concern expressed about wolf numbers and the effect that feeding has on wolf predation. There was a lot of interest in documenting the impact of feeding at local areas within deer management units or antlerless permit areas, and that these local benefits to deer were the reasons why people were feeding in the first place. There was also a request to document the social and economic benefits of the feeding program, and another suggestion to document the cost to feed additional numbers of deer (25%, 50%, and 100% was suggested). Many individuals suggested the need to plan for future feeding programs, but the desired approach varied. There were suggestions to focus feeding on major wintering areas (to reach the most number of deer with the least possible effort), to distribute feed only to those people already feeding (to ensure that feed would actually get to deer), or to distribute feed to permit areas based on the number of hunters within each area. Finally, there was interest in doing more "local" bidding and purchasing of state deer feed because of the impact our program had on local businesses in the area. In addition, a letter received from the International Falls MDHA Chapter in lieu of attendance at the meeting expressed concerns related to the lack of sufficient feed to address demand by interested feeders, payment to some distribution facilities (while others donated this service), cost of state-purchased feed, and cooperation between the department and conservation organizations.

Park Rapids (September 24): About 30 people from the Park Rapids, Detroit Lakes, Brainerd, Aitkin, and Bemidji areas attended this meeting. This crowd was very interested in discussing funding issues, and there was a lot of sentiment that the \$.50/license currently allotted for feeding (and the \$.25/license allotted once the \$750,000 is paid off) is insufficient and that additional dedication is necessary. As in Hibbing, there was a strong suggestion to address local benefits of feeding in addition to the deer management unit evaluation. Attendees agreed that feeding programs could not reach and save all deer, and there were suggestions to use future feeding programs to reach the greatest possible number of deer, to direct feed away from recreational feeders and to deer wintering areas, and to help out deer feeders that were spending more than they anticipated due to severe winter conditions. One individual pointed out the need to compare and evaluate the costs of the program to other habitat and research work, and there was support to increase the effectiveness of food plot and timber management programs to reduce future deer feeding needs. Finally, there was a great deal of concern about feeding deer in agricultural areas with high deer populations and management and intensive harvest permits available.

Appendix 2. DNR Deer Feeding Guidelines.

EMERGENCY DEER WINTER FEEDING GUIDELINES

MINNESOTA DEPARTMENT OF NATURAL RESOURCES Section of Wildlife

PURPOSE

To guide implementation of state-funded emergency deer feeding programs in Minnesota.

NEED

Emergency winter deer feeding has been controversial because of the high cost of past programs, questionable effects on deer populations, and the emotional nature of the feeding issue. Clear and objective guidelines are necessary to assure that management efforts in severe winter situations are appropriate biologically, economically, and socially.

BACKGROUND

State-funded emergency feeding programs were conducted in various areas of the state in 1969, 1975, 1978, 1982, 1984, 1986, 1989, and 1994. An analysis of the 1989 program documented, for the first time, the true costs of a large-scale feeding program, and the effects on deer populations over large areas. This analysis (see Executive Summary, Appendix I) found significant differences in costs and effects between farmland and forest areas.

In farmland areas (primarily Deer Zone 4) where deer are easily located and accessible and where sufficient volunteer help is available, a high proportion of deer can be reached by emergency feeding and benefits to the deer population may be significant. Feeding can also prevent depletion of local breeding populations in farmland areas where deer from a relatively large geographic area are concentrated and isolated from food resources. From 1975 to 1995, feeding has been necessary in one or more farmland DMUs during four winters.

In forest and transition areas (primarily Deer Zones 1, 2, and 3) where deer concentrations are more difficult to locate and access, and where volunteers cannot reach a high proportion of deer, state-funded emergency feeding programs are not effective or feasible. Feeding was also found to be only one-third as cost effective in forest areas as in farmland areas. Although private feeding efforts may benefit small forest deer populations in local hunting or viewing areas, feeding provides no general population benefit.

POLICY

State-funded emergency deer feeding programs will not be conducted except in those areas and during those winters where feeding would be effective in maintaining viable breeding populations of deer.

GUIDELINES

The following guidelines outline actions the Section of Wildlife will undertake to implement the emergency deer feeding policy.

A. POPULATION AND HABITAT MANAGEMENT-STATEWIDE

The Section will manage summer and winter deer habitat to minimize deer winter feeding needs. The Section will also establish deer population goals based on quantity and quality of habitat, landowner tolerance, public safety, and recreational demand, and will use harvest during the deer season to manage populations at or near goals.

B. MONITORING AND ASSESSMENT

The Section will annually monitor winter weather to determine severity. If funds are available, monitoring and assessment activities will be accelerated in those areas where there is the potential for significant deer losses. Activities may include aerial or ground surveys to locate deer concentrations, and collecting data related to indicators of winter severity and deer survival such as snow conditions (depths, extent, chronology, crusting), temperature, food availability, deer movements and concentrations, and deer physiology. Area wildlife managers will be responsible for assessing winter severity in their work areas.

C. EMERGENCY FEEDING- FARMLAND

Emergency deer feeding programs funded by the Section of Wildlife may be conducted in farmland areas (primarily Deer Zone 4) when the following conditions are met:

- 1) deer are isolated and unable to move from scattered winter cover;
- 2) adequate food supplies are generally unavailable to deer;
- 3) the Section determines there is potential for significant deer mortality;
- 4) feeding is necessary and would be effective in maintaining viable breeding populations; and
- 5) deer concentrations can be located and are accessible.

Final approval of any decision to feed will be made by the Section Management Team based on information provided by area and region wildlife staff. The following guidelines will be followed:

- 1) **Feeding area:** State-funded emergency feeding programs will only be implemented on aggregations of antlerless permit areas on sub-DMU sized areas or larger, and only in those areas where warranted by food, weather, and deer population conditions.
- 2) **Feed distribution:** Distribution of feed to volunteers will be coordinated by area wildlife managers. DNR staff will work with volunteers to locate deer concentrations, and to improve access if funding permits. Area staff will direct distribution of feed to known deer concentrations and priority will be given to deer on public lands.
- 3) **Feeding on State Wildlife Management Areas:** Area wildlife staff will assist with feeding deer

on State Wildlife Management Areas, but the Section will rely on volunteers to feed deer on other public and private lands.

4) **Initiation of feeding:** The date when feeding is initiated will be determined by the Section based on deer condition. Feeding will start as late in winter as possible to minimize costs of the feeding program and maintain volunteer efforts, while still ensuring that deer can utilize the feed.

5) **Urban areas, refuges, and permit areas above goal:** State-funded feed will not be provided for urban areas, refuges, and other areas where hunting or other appropriate deer population control measures are not being implemented. Feeding will also not be undertaken in those antlerless permit areas where deer populations are above goal levels, unless feeding is necessary to maintain a viable breeding population of deer.

D. EMERGENCY FEEDING-FOREST AND TRANSITION AREAS

The Section of Wildlife will not undertake state-funded emergency feeding programs in forest areas, or in transition areas where the above conditions are not met (primarily Deer Zones 1, 2, and 3). However, area wildlife staff will provide technical advice and guidance to individuals and groups interested in developing or initiating privately-funded feeding programs to benefit small, local deer populations.

The Status of Knowledge of Artificial Feeding of Deer During Winter

Background

Winter feeding of free-ranging deer may be categorized into two basic types, emergency and supplementary feeding (Voigt 1990). Emergency feeding involves providing artificial food (e.g., pellets, corn, hay, oats, or cut browse) to deer towards the end of a severe winter when availability or accessibility of natural foods are extremely low. The goal is to decrease winter losses to chronic undernutrition and to reduce losses of neonatal and post-natal fawns the following spring and summer (Voigt 1990). Pregnancy does coincide with winter, and there is a relationship between their winter nutrition and birth weights and probabilities of survival of the spring-born fawns (Verme 1962, 1967).

Supplementary feeding is characterized as the provision of artificial food to deer to supplement their natural diet; generally, it occurs throughout the winter regardless of weather conditions and the availability of natural foods. "Recreational feeding" by private citizens would be classified as supplementary feeding. Voigt (1990) has summarized information addressing the different types of feed that may be fed to deer during emergency or supplementary efforts, as well as some of the physiological and nutritional consequences of feeding inappropriate diets.

Here, we are addressing emergency feeding specifically. Before discussing the current knowledge of emergency feeding efforts for deer during winter and its potential implications, it is important to provide a brief understanding of their winter nutritional ecology and adaptive responses to winter conditions.

Nutrition is centrally related to all other aspects of deer ecology, including behavior, movements, habitat use, reproduction, and survival. Thus knowledge of their nutrition is critical to a more complete understanding of their ecology and to sound management (Robbins 1983). For northern deer, winter is the most nutritionally challenging season of the year, and for the past million years, these animals have evolved adaptations to a diminished quality, quantity, and availability of food resources, as well as to the increased energetic costs of mobility in deep snow during this season (Short et al. 1966, Moen 1976, Mautz 1978). These adaptations are morphological, behavioral, and physiological in nature. For example, with respect to morphology (i.e., physical characteristics), the deer's winter coat provides increased insulation against cold temperatures, and thus reduces the loss of heat energy (Sauer 1984; Moen 1968, 1973). Further, deer attain peak body weights and accumulate greatest fat reserves by late fall (Moen and Severinghaus 1981, DelGiudice et al. 1992). Body protein and fat serve as alternate sources of energy during the natural nutritional restriction of winter (Torbit et al. 1985, DelGiudice et al. 1990). Behaviorally, most forest deer migrate to winter ranges in late fall where food resources are more concentrated and conifer stands provide protection as thermal cover, again allowing deer to more efficiently maintain energy balance (i.e., energy intake versus energy loss), conserve energy, and consequently, slow the rate of body fat and protein depletion (Ozoga 1968; Rongstad and Tester 1969; Ozoga and Gysel 1972; Moen 1973, 1976). Most forest deer rely on a very diverse diet of browse (24 species or more) during winter as opposed to the ground forage and leaves primarily consumed during spring, summer, and fall (Wetzel et al. 1975, Rogers et al. 1981, DelGiudice et al. 1989).

On winter range, deer use smaller areas (home ranges) than on spring-summer-fall ranges and voluntarily reduce feeding activity, which lowers the energy costs associated with movement and digestion (French et al. 1955, Rongstad and Tester 1969, Moen 1973, Nelson and Mech 1981). The decrease in

feeding appears to be triggered by the shortening photoperiod of late fall-early winter sensed by the pineal gland and hormonally mediated (Brown et al. 1978, Abbott et al. 1984). Finally, associated with the winter decline in digestible energy intake is a concomitant reduction in metabolism and thyroid activity, which are physiological mechanisms facilitating energy conservation (Bahnak et al. 1981; Newsholme and Leech 1983; DelGiudice et al. 1987, 1994; Mautz et al. 1992). Body condition and survival of deer as winter progresses depends on such factors as their condition (i.e., repleteness of fat reserves) entering winter, severity of weather conditions, habitat quantity and quality, deer densities (i.e., competition for food), and predator densities.

Status of Knowledge of Artificial Feeding

From ecological and management perspectives, there are many issues that must be considered before an emergency winter feeding program is initiated for free-ranging deer. Three primary considerations are: (1) what are the deer population management goals (i.e., numbers of deer) for the area where artificial feeding is being contemplated; (2) what are the expectations of feeding in a particular area(s); and (3) what are the implications of feeding deer an artificial, high quality diet in selected areas with respect to other aspects of their ecology (e.g., reproduction, survival, movements, disease transmission). Information formulated from studies of feeding deer artificial diets during winter and of deer ecology can assist us in addressing considerations 2 and 3. The intention of this section is to provide a summary of this information, not to address the question of artificial feeding as a management practice.

Initially, the results of emergency feeding will depend on whether the deer find the artificial food provided; once discovered, whether they will consume it; and how much is available per deer and for what length of time. Clearly, deer must find the source of artificial food to have the opportunity to consume it, and this will depend on how many and where on winter ranges they are concentrating. Evidence indicates that this will be directly influenced by the severity of winter weather conditions (Ozoga and Gysel 1972; Lewis 1990; Nelson 1995; Doenier 1996; G. D. DelGiudice, unpublished data). Once aware of the food source, again, its use and the degree of consumption appear to depend on winter severity, alternate sources of natural food available in the area, the physical condition of deer at the time of discovering emergency feed, and the type of food being fed (Doman and Rasmussen 1944, Schmitz 1990, Doenier 1996, DelGiudice, unpublished data). In a detailed study, Doenier (1996) has observed deer bed next to and travel by (repeatedly) sources of high quality feed without consumption when weather conditions were mild to moderate. Further, it has been well documented that deer will continue to consume natural foods (e.g., woody browse) while making use of artificial feeders (Doman and Rasmussen 1944, Hubert et al. 1980, Schmitz 1990, Doenier 1996), and in some cases, the degree of consumption of feed, as well as the pressure on natural foods in the area, has been related to the severity of winter conditions (e.g., snow depth). There has been little study of browsing in areas where deer are artificially concentrated at high densities during emergency feeding efforts; however, it is reasonable to speculate that in such cases, the natural carrying capacity of these areas could be adversely affected (diminished) for an indefinite period of time. This issue requires further study.

Increased potential for transmitting disease and parasites among deer artificially concentrated around feeders has been reported as a concern of artificial feeding during winter. Recently, in Michigan, 16 deer were identified as infected with Mycobacterium bovis, the causative agent of bovine tuberculosis (TB) (Schmidt 1995, 1996). The disease was detected in one deer during the 1994 hunting season; during a limited followup survey, it was not detected in any additional deer. However, during the next hunting season (1995), it was detected in 15 additional deer. This is an extremely rare disease in white-tailed deer. All of these deer wintered in an area called the "Country Club," where hunting clubs have been artificially supporting a high density deer population with winter-long supplemental feed for many years. This disease requires close contact for transmission. Although emergency feeding efforts tend to be of shorter duration, the evidence described above suggests that the concern of increasing the potential for disease transmission

with artificially supported high deer concentrations should be afforded serious consideration.

Research has documented that emergency feeding will decrease winter mortality losses due to undernutrition during severe winters in local areas when deer have ready access to feed (Damon and Rasmussen 1944, Baker and Hobbs 1985). However, these studies reported that even when artificial food was provided ad libitum (unlimited supply) during most of the winter, significant losses occurred (up to 24%). In addition to the direct effect nutrition has on the survival of wintering deer and other ungulates, it also may positively influence a female's reproductive success (survivability of neonate fawns) during the subsequent spring and summer (Verme 1962, 1967; Ozoga and Verme 1982; Singer and Coughenour 1997). It would be difficult to quantify the effects of emergency feed on the reproductive success of does without conducting intensive research in areas where those deer give birth; however, it is reasonable to expect that the reproductive success of some individuals that benefited nutritionally from the emergency feed would be enhanced.

There is clear evidence that at the individual and local population or subpopulation (i.e., specific sites) levels, emergency feeding will reduce, but not eliminate, winter losses of deer due to severe, chronic undernutrition. However, as one considers applying such efforts at a larger scale, both with respect to area and to the greater numbers of deer occupying larger areas, the issues of economics and practicality require more serious consideration. A modeling study by Lenarz (1991) demonstrated that at the spacial or area-scale of a forested deer management unit (6,991 km²) in Minnesota with more than 34,000 deer, the numeric effect of emergency feeding efforts is minimal. Specifically, Lenarz (1991) estimated that if 10% of the deer population in this forested management unit received emergency feed, the population would only be 0.8% larger than normally expected just prior to the following fawning season, and the following preharvest population would only be 3.1% larger, which translates into 0.02 additional bucks or 0.13 additional deer per km². Examining a best-case-scenario, this study reported that if 30% of the deer received feed, the prefawning population would still only be 2.4% larger than if no feed were provided. It is very important to note, that wherever there was doubt regarding the accuracy of data-input for the model (e.g., quantity of feed actually provided in the field, found by deer, and consumed by deer), the maximum benefit of those doubts were levied in favor of the feeding effort. In other words, all emergency feed was provided in the field, found by deer, and consumed by deer; these assumptions were made despite field observations to the contrary. Lenarz (1991) reported that emergency feeding only began to approach cost-effectiveness if willingness-to-pay for a harvested buck was about \$1,318, approximately \$700 more than the actual willingness-to-pay.

A final note addresses the possible influence that emergency feeding may have on predator-deer interactions and other sources of mortality of deer. During the historically severe winter of 1995-96, predation rates of deer by wolves and bobcats were higher than normal, and "excessive-killing" or "surplus killing" were documented (DelGiudice 1996; G. D. DelGiudice, unpublished data). Observations of excessive and surplus killing of deer by predators was particularly apparent where deer gathered in atypical, high concentrations, including at active logging sites and where large-scale emergency feeding efforts occurred.

Clearly, ignoring the significant economic and opportunity costs, as well as the logistical constraints associated with emergency feeding, it likely has immediate, positive nutritional benefits for local deer that have frequent and ready access to a proper type of food for a sufficiently long period of time. However, inadequate study has addressed the indirect and more long-term consequences emergency feeding may have on deer movements, use of habitat, impacts on natural vegetation, predator relationships, overall health, and ultimately, on the "natural" carrying capacity of the winter ranges of deer.

LITERATURE CITED

Abbott, M. J., D. E. Ullrey, P. K. Ku, S. M. Schmitt, D. R. Romsos, and H. A. Tucker. 1984. Effect of photoperiod on growth and fat accretion in white-tailed fawns. *J. Wildl. Manage.* 48:776-787.

Bahnak, B. R., J. C. Holland, L. J. Verme, and J. J. Ozoga. 1987. Effects of winter fasting and refeeding on white-tailed deer blood profiles. *J. Wildl. Manage.* 51:865-873.

Baker, D. L., and N. T. Hobbs. 1985. Emergency feeding of mule deer during winter: tests of a supplemental ration. *J. Wildl. Manage.* 49:934-942.

Brown, R. D., R. L. Cowan, and J. F. Kavanaugh. 1978. Effect of pinealectomy on seasonal androgen titers, antler growth, and feed intake in white-tailed deer. *J. of Animal Sci.* 47:435-440.

DelGiudice, G. D. 1996. Factors associated with surplus killing of white-tailed deer in northcentral Minnesota. *J. Mammal.* Submitted.

DelGiudice, G. D., L. D. Mech, K. E. Kunkel, E. M. Gese, and U. S. Seal. 1992. Seasonal patterns of weight, hematology, and serum characteristics of free-ranging female white-tailed deer in Minnesota. *Can. J. Zool.* 70:974-983.

DelGiudice, G. D., L. D. Mech, and U. S. Seal. 1989. Browse diversity and physiological status of white-tailed deer. *Trans. North Am. Wildl. and Nat. Resour. Conf.* 54:134-145.

DelGiudice, G. D., L. D. Mech, and U. S. Seal. 1990. Effects of winter undernutrition on body composition and physiological profiles of white-tailed deer. *J. Wildl. Manage.* 54:539-550.

DelGiudice, G. D., L. D. Mech, and U. S. Seal. 1994. Undernutrition and serum and urinary urea nitrogen of white-tailed deer during winter. *J. Wildl. Manage.* 58:430-436.

DelGiudice, G. D., L. D. Mech, U. S. Seal, and P. D. Karns. 1987b. Effects of winter fasting and refeeding on white-tailed deer blood profiles. *J. Wildl. Manage.* 51: 865-873.

Doenier, P. B. 1996. Effects of providing supplemental feed to wintering white-tailed deer on standing browse, foraging strategies, and chemistry profiles of deer urine in snow. M.S. Thesis. Univ. Minnesota. 132pp.

Doman, E. R., and D. I. Rasmussen. 1944. Supplemental winter feeding of mule deer in northern Utah. *J. Wildl. Manage.* 8:317-338.

French, C. E., L. C. McEwen, N. D. Magruder, R. H. Ingram, and R. W. Swift. 1955. Nutritional requirements of white-tailed deer for growth and antler development. Pennsylvania Agric. Exp. Stn. Bull. 600, University Park. 50pp.

Hubert, G. F., Jr., A. Woolf, and G. Post. 1980. Food habits of a supplementary-fed captive deer herd. *J. Wildl. Manage.* 44:740-746.

Lewis, T. L. 1990. The effects of supplemental feeding on white-tailed deer in northwestern Wisconsin. Ph.D. Dissert. Univ. Wisconsin-Madison, Madison. 79pp.

Lenarz, M. S. 1991. Simulation of the effects of emergency winter feeding of white-tailed deer. *Wildl. Soc. Bull.* 19:171-176.

Mautz, W. W. 1978. Nutrition and carrying capacity. Pages 321-348 in J. L. Schmidt and D. L. Gilbert, eds. Big game of North America: ecology and management. Stackpole Books, Harrisburg, Pa.

Mautz, W. W., J. Kanter, and P. J. Pekins. 1992. Seasonal metabolic rhythms of captive female white-tailed deer: a reexamination. J. Wildl. Manage. 56:656-661.

Moen, A. N. 1968. Surface temperatures and radiant heat loss from white-tailed deer. J. Wildl. Manage. 32:338-344.

Moen, A. N. 1973. Wildlife ecology, an analytical approach. W. H. Freeman and Company, San Francisco, Calif. 458pp.

Moen, A. N. 1976. Energy conservation by white-tailed deer in the winter. Ecology 56:192-198.

Moen, A. N., and C. W. Severinghaus. 1981. The annual weight cycle and survival of white-tailed deer in New York. N. Y. Fish and Game J. 28:162-177.

Nelson, M. E. 1995. Winter range arrival and departure of white-tailed deer in northeastern Minnesota. Can. J. Zool. 73:1069-1076.

Nelson, M. E., and L. D. Mech. 1981. Deer social organization and wolf predation in northeastern Minnesota. Wildl. Monogr. No. 77.

Newsholme, E. A., and A. R. Leech. 1983. Biochemistry for the medical sciences. John Wiley & Sons, New York, N.Y. 952pp.

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

Ozoga, J. J., and L. W. Gysel. 1972. Response of white-tailed deer to winter weather. J. Wildl. Manage. 36:892-896.

Ozoga, J. J., and L. J. Verme. 1982. Physical and reproductive characteristics of a supplementally-fed white-tailed deer herd. J. Wildl. Manage. 46:281-301.

Robbins, C. T. 1983. Wildlife feeding and nutrition. Academic Press, New York, N.Y. 343pp.

Rogers, L. L., J. J. Mooty, and D. Dawson. 1981. Foods of white-tailed deer in the Upper Great Lakes region--a review. U.S. For. Serv. Gen. Tech. Rep. NC-65. 24pp.

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

Sauer, P. R. 1984. Physical characteristics. Pages 73-90 in L. K. Halls, ed. White-tailed deer: ecology and management. Stackpole Books, Harrisburg, Pa.

- Schmidt, S. 1995. Mysterious TB case in a Michigan whitetail. Page 1 in G. L. Doster, ed. Southeastern Cooperative Wildlife Disease Study Briefs. Univ. Georgia, Athens. 11:1.
- Schmidt, S. 1996. TB in Michigan whitetails. Page 1 in G. L. Doster, ed. Southeastern Cooperative Wildlife Disease Study Briefs. Univ. Georgia, Athens. 11:1.
- Schmitz, O. J. 1990. Management implications of foraging theory: evaluating deer supplemental feeding. J. Wildl. Manage. 54:522-532.
- Short H. L., D. R. Dietz, and E. E. Remmenga. 1966. Selected nutrients in mule deer browse plants. Ecology 47:222-229.
- Singer, F. J., A. Harting, K. K. Symonds, and M. B. Coughenour. 1997. Density-dependence, compensation, and environmental effects on elk calf mortality in Yellowstone National Park. J. Wildl. Manage. 61:12-25.
- Torbit, S. C., L. H. Carpenter, D. M. Swift, and A. W. Aldredge. 1985. Differential loss of fat and protein by mule deer during winter. J. Wildl. Manage. 49:80-85.
- Van Soest, P. J. 1982. Nutritional ecology of the ruminant. O & B Books, Inc. Corvallis, Oreg. 374pp.
- Verme, L. J. 1962. Mortality of white-tailed deer fawns in relation to nutrition. Pages 15-38 in Proceedings of the First White-Tailed Deer Disease Symposium, February 13-15, 1962, University of Georgia, Athens.
- Verme, L. J. 1967. Influence of experimental diets on white-tailed deer reproduction. Trans. North Am. Wildl. Nat. Resour. Conf. 32:405-419.
- Wetzel, J. F., J. R. Wambaugh, and J. M. Peek. 1975. Appraisal of white-tailed deer winter habitats in northeastern Minnesota. J. Wildl. Manage. 39:59-66. 383pp.

ppendix 4. Summary of the amount and duration of feeding by Deer Management Permit Area in the feeding zone.

Deer Management Unit	Permit area	Bags of feed	Pounds of feed distributed	Days of feed availability	Pounds of feed available per day
Red River West	401	1,592	79,600	42	1,895
	402 ^a	0	0	0	0
	Total	1,592	79,600		1,895
Red River East	403	3,246	162,300	42	3,864
	404	6,076	303,800	49	6,200
	405	2,302	115,100	49	2,349
	406	929	46,450	49	948
	407	14	700	35	20
	408	80	4,000	42	95
	Total	12,647	632,350	44	13,476
Red River Total		14,239	711,950	43	15,371
Agassiz	201	1,237	61,850	63	982
	202	2,358	117,900	56	2,105
	203	336	16,800	49	343
	204	5,477	273,850	56	4,890
	205	9,592	479,600	70	6,851
	206	6,907	345,350	56	6,167
	207	3,176	158,800	49	3,241
	208	1,509	75,450	49	1,540
	209	2,473	123,650	63	1,963
	210	1,758	87,900	56	1,570
Agassiz Total		34,823	1,741,150	57	29,652
Rainy River West	211-212	11,370	568,500	77	7,383
	214	90	4,500	14	321
	Total	11,460	573,000	46	7,704
Rainy River Central	104-106	3,271	163,550	63	2,596
	110	1,081	54,050	35	1,544

Deer Management Unit	Permit area	Bags of feed	Pounds of feed distributed	Days of feed availability	Pounds of feed available per day
	Total	4,352	217,600	49	4,140
Rainy River East	107-109, 195	4,579	228,950	42	5,451
Rainy River Total		20,391	1,019,550	46	17,295
Superior West	119-121	6,612	330,600	42	7,871
Superior Wilderness	115	90	4,500	42	107
	116	50	2,500	35	71
	117	1,572	78,600	35	2,246
	118*	0	0	0	0
	Total	1,712	85,600	37	2,424
Superior Central	122-125	4,930	246,500	35	7,043
Grand Portage I.R.	194*	0	0	0	0
Superior East	126, 128-129	4,889	244,450	35	6,984
	127	866	43,300	35	1,237
	130	260	13,000	35	371
	Total	6,015	300,750	35	8,592
Superior Total		19,269	963,450	37	25,930
Itasca NW	167-169	9,181	459,050	42	10,930
Itasca SW	170-171	6,004	300,200	35	8,577
	172	4,224	211,200	35	6,034
	173-174	4,094	204,700	35	5,849
	Total	23,503	1,175,150	35	31,390
Itasca NE	175-179	12,706	635,300	35	18,151
Itasca SE	180-184, 199	17,477	873,850	35	24,967
Leech Lake I.R.	197, 198	3,965	198,250	35	5,664
Bemidji	284-286	16,097	804,850	35	22,996
	287	27	1,350	28	48
	Total	16,124	806,200	33	23,044
Itasca Total		73,775	3,688,750	35	103,216

Deer Management Unit	Permit area	Bags of feed	Pounds of feed distributed	Days of feed availability	Pounds of feed available per day
Mille Lacs West	244	4,732	236,600	35	6,760
	245	3,858	192,900	35	5,511
	251	227	11,350	28	405
	Total	8,817	440,850	33	12,676
Mille Lacs Central	246	5,002	250,100	35	7,146
	247	3,628	181,400	28	6,479
	Total	8,630	431,500	32	13,625
Mille Lacs East	154-156	5,150	257,500	35	7,357
White Earth I.R.	297-298	2,451	122,550	35	3,501
Mille Lacs Total		25,048	1,252,400	33	37,159
Big Woods North	409	1,357	67,850	35	1,939
Farmland Total		50,419	2,520,950	51	46,962
Forested Total		138,483	6,924,150	38	183,600
Grand Total		188,902	9,445,100	43	230,562

*No feed was distributed in this permit area.

Appendix 5. Summary of the amount and duration of feeding by Deer Management Permit Area in the feeding zone

Deer Management Unit	Permit area	Bags of feed	Pounds of feed distributed	Days of feed availability	Pounds of feed available per day
Red River West	401	1,592	79,600	42	1,895
	402 ^a	0	0	0	0
	Total	1,592	79,600		1,895
Red River East	403	3,246	162,300	42	3,864
	404	6,076	303,800	49	6,200
	405	2,302	115,100	49	2,349
	406	929	46,450	49	948
	407	14	700	35	20
	408	80	4,000	42	95
	Total	12,647	632,350	44	13,476
Red River Total		14,239	711,950	43	15,371
Agassiz	201	1,237	61,850	63	982
	202	2,358	117,900	56	2,105
	203	336	16,800	49	343
	204	5,477	273,850	56	4,890
	205	9,592	479,600	70	6,851
	206	6,907	345,350	56	6,167
	207	3,176	158,800	49	3,241
	208	1,509	75,450	49	1,540
	209	2,473	123,650	63	1,963
	210	1,758	87,900	56	1,570
Agassiz Total		34,823	1,741,150	57	29,652
Rainy River West	211-212	11,370	568,500	77	7,383
	214	90	4,500	14	321
	Total	11,460	573,000	46	7,704
Rainy River Central	104-106	3,271	163,550	63	2,596

Deer Management Unit	Permit area	Bags of feed	Pounds of feed distributed	Days of feed availability	Pounds of feed available per day
	110	1,081	54,050	35	1,544
	Total	4,352	217,600	49	4,140
Rainy River East	107-109, 195	4,579	228,950	42	5,451
Rainy River Total		20,391	1,019,550	46	17,295
Superior West	119-121	6,612	330,600	42	7,871
Superior Wilderness	115	90	4,500	42	107
	116	50	2,500	35	71
	117	1,572	78,600	35	2,246
	118 ^a	0	0	0	0
	Total	1,712	85,600	37	2,424
Superior Central	122-125	4,930	246,500	35	7,043
Grand Portage I.R.	194 ^a	0	0	0	0
Superior East	126, 128-129	4,889	244,450	35	6,984
	127	866	43,300	35	1,237
	130	260	13,000	35	371
	Total	6,015	300,750	35	8,592
Superior Total		19,269	963,450	37	25,930
Itasca NW	167-169	9,181	459,050	42	10,930
Itasca SW	170-171	6,004	300,200	35	8,577
	172	4,224	211,200	35	6,034
	173-174	4,094	204,700	35	5,849
	Total	23,503	1,175,150	35	31,390
Itasca NE	175-179	12,706	635,300	35	18,151
Itasca SE	180-184, 199	17,477	873,850	35	24,967
Leech Lake I.R.	197, 198	3,965	198,250	35	5,664
Bemidji	284-286	16,097	804,850	35	22,996
	287	27	1,350	28	48

Deer Management Unit	Permit area	Bags of feed	Pounds of feed distributed	Days of feed availability	Pounds of feed available per day
	Total	16,124	806,200	33	23,044
Itasca Total		73,775	3,688,750	35	103,216
Mille Lacs West	244	4,732	236,600	35	6,760
	245	3,858	192,900	35	5,511
	251	227	11,350	28	405
	Total	8,817	440,850	33	12,676
Mille Lacs Central	246	5,002	250,100	35	7,146
	247	3,628	181,400	28	6,479
	Total	8,630	431,500	32	13,625
Mille Lacs East	154-156	5,150	257,500	35	7,357
White Earth I.R.	297-298	2,451	122,550	35	3,501
Mille Lacs Total		25,048	1,252,400	33	37,159
Big Woods North	409	1,357	67,850	35	1,939
Farmland Total		50,419	2,520,950	51	46,962
Forested Total		138,483	6,924,150	38	183,600
GRAND TOTAL		188,902	9,445,100	43	230,562

*No feed was distributed in this permit area.

Appendix 6. Summary of the post-hunt deer populations by Deer Management Permit Area and the estimated percent of deer that could have been fed the recommended daily amount of feed (2.5 lbs.) for each day feed was available. These estimates assume all feed was available to deer and all deer had access to feed.

Deer Management Unit	Permit area	Pounds of feed available per day	Post-hunt deer population	Estimated number of deer fed	Percent of post-hunt population fed 2.5 lbs per day
Red River West	401	1,895	1,976	758	38.4
	402 ^b	0	2,558	0	0.0
	Total	1,895	4,534	758	16.7
Red River East	403	3,864	2,218	1,546	69.7
	404	6,200	3,092	2,480	80.2
	405	2,349	2,799	940	33.6
	406	948	3,098	379	12.2
	407	20	2,225	8	0.4
	408	95	2,509	38	1.5
	Total	13,476	15,940	5,391	33.8
Red River Total		15,371	20,474	6,149	30.0
Agassiz	201	982	1,008	393	39.0
	202	2,105	2,137	842	39.4
	203	343	1,675	137	8.2
	204	4,890	5,220	1,956	37.5
	205	6,851	4,574	2,740	59.9
	206	6,167	4,098	2,467	60.2
	207	3,241	2,183	1,296	59.4
	208	1,540	2,259	616	27.3
	209	1,963	2,304	785	34.1
	210	1,570	2,867	628	21.9
Agassiz Total		29,652	28,325	11,860	41.9
Rainy River West	211-212	7,383	22,740	2,953	13.0
	214 ^a	321	768	128	16.7

Deer Management Unit	Permit area	Pounds of feed available per day	Post-hunt deer population	Estimated number of deer fed	Percent of post-hunt population fed 2.5 lbs per day
	Total	7,704	23,508	3,081	13.1
Rainy River Central	104-106	2,596	8,735	1,038	11.9
	110	1,544	4,838	618	12.8
	Total	4,140	13,573	1,656	12.2
Rainy River East	107-109, 195	5,451	26,881	2,180	8.1
Rainy River Total		17,295	63,962	6,917	10.8
Superior West	119-121	7,871	20,501	3,148	15.4
Superior Wilderness	115 ^a	107	3,762	43	1.1
	116 ^a	71	5,026	28	0.6
	117 ^a	2,246	1,092	898	82.2
	118 ^{ab}	0	85	0	0.0
	Total	2,424	9,965	969	9.7
Superior Central	122-125	7,043	8,465	2,817	33.3
Grand Portage I.R.	194 ^{ab}	0	85	0	0.0
Superior East	126, 128-129	6,984	4,163	2,794	67.1
	127 ^a	1,237	1,789	495	27.7
	130 ^a	371	227	148	65.2
	Total	8,592	6,179	3,437	55.6
Superior Total		25,930	45,195	10,371	22.9
Itasca NW	167-169	10,930	21,462	4,372	20.4
Itasca SW	170-171	8,577	15,895	3,431	21.6
	172	6,034	7,081	2,414	34.1
	173-174	5,849	14,591	2,340	16.0
	Total	31,390	37,567	8,185	21.8
Itasca NE	175-179	18,151	28,139	7,260	25.8
Itasca SE	180-184, 199	24,967	34,355	9,987	29.1
Leech Lake I.R.	197, 198	5,664	8,182	2,266	27.7

Deer Management Unit	Permit area	Pounds of feed available per day	Post-hunt deer population	Estimated number of deer fed	Percent of post-hunt population fed 2.5 lbs per day
Bemidji	284-286	22,996	38,150	9,198	24.1
	287	48	2,208	19	0.9
	Total	23,044	40,358	9,217	22.8
Itasca Total		103,216	170,063	41,287	24.3
Mille Lacs West	244	6,760	13,841	2,704	19.5
	245	5,511	12,047	2,204	18.3
	251	405	1,139	162	14.2
	Total	12,676	27,027	5,070	18.8
Mille Lacs Central	246	7,146	15,105	2,858	18.9
	247	6,479	6,525	2,592	39.7
	Total	13,625	21,630	5,450	25.2
Mille Lacs East	154-156	7,357	9,873	2,943	29.8
White Earth I.R.	297-298	3,501	6,448	1,400	21.7
Mille Lacs Total		37,159	64,978	14,863	22.9
Big Woods North	409	1,930	3,002	776	25.8
Farmland Total		46,962	51,802	18,785	36.3
Forest Total		183,680	344,198	73,438	21.3
Grand Total		230,362	396,000	92,223	23.3

^aPopulation density was estimated (not modeled) for this permit area.

^bNo feed was distributed in this permit area.

Appendix 7. Summary of the number of deer reported fed, the amount of feed consumed per deer reported fed per day and the portion of the 1995 post-hunt deer population reported fed. These estimates assume all feed was available to deer and that no deer fed at more than 1 feeding site.

Deer Management Unit	Permit area	Pounds of feed available per day	Post-hunt deer population	Reported deer fed	Pounds of feed per reported deer fed per day	Percent of post-hunt deer population reported fed
Red River West	401	1,895	1,976	2,016	0.9	102.0
	402 ^b	0	2,558	0	0.0	0.0
	Total	1,895	4,534	2,016	0.9	44.5
Red River East	403	3,864	2,218	3,530	1.1	159.2
	404	6,200	3,092	5,065	1.2	163.8
	405	2,349	2,799	1,762	1.3	63.0
	406	948	3,098	725	1.3	23.4
	407	20	2,225	6	3.3	0.3
	408	95	2,509	112	0.8	4.5
	Total	13,476	15,941	11,200	1.2	70.3
Red River Total		15,371	20,475	13,216	1.2	64
Agassiz	201	982	1,008	1,072	0.9	106.3
	202	2,105	2,137	1,825	1.2	85.4
	203	343	1,675	340	1.0	20.3
	204	4,890	5,220	6,429	0.8	123.2
	205	6,851	4,574	5,105	1.3	111.6
	206	6,167	4,098	5,685	1.1	138.7
	207	3,241	2,183	2,705	1.2	123.9
	208	1,540	2,259	1,399	1.1	61.9
	209	1,963	2,304	2,927	0.7	127.0
	210	1,570	2,867	2,146	0.7	74.9
Agassiz Total		29,652	28,325	29,633	1.0	104.6
Rainy River West	211-212	7,383	22,740	10,992	0.7	48.3
	214 ^a	321	768	70	4.6	9.1

Deer Management Unit	Permit area	Pounds of feed available per day	Post-hunt deer population	Reported deer fed	Pounds of feed per reported deer fed per day	Percent of post-hunt deer population reported fed
	Total	7,704	23,508	11,062	0.7	47.1
Rainy River Central	104-106	2,596	8,735	2,996	0.9	34.3
	110	1,544	4,838	1,541	1.0	31.9
	Total	4,140	13,573	4,537	0.9	33.4
Rainy River East	107-109, 195	5,451	26,881	5,388	1.0	20.0
Rainy River Total		17,295	63,962	20,987	0.8	23.8
Superior West	119-121	7,871	20,501	6,802	1.2	33.2
Superior Wilderness	115 ^a	107	3,762	95	1.1	2.5
	116 ^a	71	5,026	30	2.4	0.6
	117 ^a	2,246	1,092	1,164	1.9	106.6
	118 ^{ab}	0	85	0	0.0	0.0
	Total	2,424	9,965	1,289	1.9	12.9
Superior Central	122-125	7,043	8,465	4,359	1.6	51.5
Grand Portage I.R.	194 ^{ab}	0	85	0	0.0	0.0
Superior East	126, 128-129	6,984	4,163	3,738	1.9	89.8
	127 ^a	1,237	1,789	368	3.4	20.6
	130 ^a	371	227	220	1.7	96.9
	Total	8,592	6,179	4,326	2.0	70.0
Superior Total		25,910	45,193	16,776	1.5	37.1
Itasca NW	167-169	10,930	21,462	7,827	1.4	36.5
Itasca SW	170-171	8,577	15,895	4,859	1.8	30.6
	172	6,034	7,081	7,204	0.8	101.7
	173-174	5,849	14,591	5,135	1.1	35.2
	Total	31,390	37,567	17,198	1.8	45.8
Itasca NE	175-179	18,151	28,139	12,046	1.5	42.8
Itasca SE	180-184, 199	24,967	34,355	16,317	1.5	47.5
Leech Lake I.R.	197, 198	5,664	8,182	4,578	1.2	56.0

Deer Management Unit	Permit area	Pounds of feed available per day	Post-hunt deer population	Reported deer fed	Pounds of feed per reported deer fed per day	Percent of post-hunt deer population reported fed
Bemidji	284-286	22,996	38,150	21,697	1.1	56.9
	287	48	2,208	36	1.3	1.6
	Total	23,044	40,358	21,733	1.1	53.9
Itasca Total		103,216	170,063	79,699	1.3	46.9
Mille Lacs West	244	6,760	13,841	4,309	1.6	31.1
	245	5,511	12,047	3,610	1.5	30.0
	251	405	1,139	350	1.2	30.7
	Total	12,676	27,027	8,269	1.5	30.6
Mille Lacs Central	246	7,146	15,105	11,175	0.6	74.0
	247	6,479	6,525	8,673	0.7	132.9
	Total	13,625	21,630	19,848	0.7	91.8
Mille Lacs East	154-156	7,357	9,873	7,076	1.0	71.
White Earth I.R.	297-298	3,501	6,448	3,539	1.0	54.
Mille Lacs Total		37,159	64,978	38,232	1.0	59.6
Big Woods North	409	1,939	3,002	1,903	1.0	63.4
Farmland Total		46,962	51,802	44,752	1.0	86.4
Forest Total		183,600	344,198	156,194	1.2	45.4
GRAND TOTAL		230,562	396,000	200,946	1.1	50.7

^aPopulation density was estimated (not modeled) for this permit area

^bNo feed was distributed in this permit area.

Appendix 8. Summary of the costs for feed and associated feeding activities by Deer Management Permit Area in the feeding zone.

Deer Management Unit	Permit area	Number of bags distributed	Feed cost per bag	Associated feeding costs	Total feeding costs	Feeding cost per bag
Red River	401	1,592	\$5,954.08	\$3,645.68	\$9,599.76	\$6.03
	402 ^a	0	\$0.00	\$0.00	\$0.00	\$0.00
	Total	1,592	\$5,954.08	\$3,645.68	\$9,599.76	\$6.03
Red River East	403	3,246	\$12,140.04	\$7,433.34	\$19,573.38	\$6.03
	404	6,076	\$22,724.24	\$13,914.04	\$36,638.28	\$6.03
	405	2,302	\$8,609.48	\$5,271.58	\$13,881.06	\$6.03
	406	929	\$3,474.46	\$2,127.41	\$5,601.87	\$6.03
	407	14	\$52.36	\$32.06	\$84.42	\$6.03
	408	80	\$299.20	\$183.20	\$482.40	\$6.03
	Total	12,647	\$47,299.78	\$28,961.63	\$76,261.41	\$6.03
Red River Total		14,239	\$53,253.86	\$32,607.31	\$85,861.17	\$6.03
Agassiz	201	1,237	\$4,626.38	\$2,832.73	\$7,459.11	\$6.03
	202	2,358	\$8,818.92	\$5,399.82	\$14,218.74	\$6.03
	203	336	\$1,256.64	\$769.44	\$2,026.08	\$6.03
	204	5,477	\$20,483.98	\$12,542.33	\$33,026.31	\$6.03
	205	9,592	\$35,874.08	\$21,965.68	\$57,839.76	\$6.03
	206	6,907	\$25,832.18	\$15,817.03	\$41,649.21	\$6.03
	207	3,176	\$11,878.24	\$7,273.04	\$19,151.28	\$6.03
	208	1,509	\$5,643.66	\$3,455.61	\$9,099.27	\$6.03
	209	2,473	\$9,249.02	\$5,663.17	\$14,912.19	\$6.03
	210	1,758	\$6,574.92	\$4,025.82	\$10,600.74	\$6.03
Agassiz Total		34,823	\$130,238.02	\$79,744.67	\$209,982.69	\$6.03
Rainy River West	211-212	11,370	\$46,275.90	\$17,509.80	\$63,785.70	\$5.61
	214	90	\$366.30	\$138.60	\$504.90	\$5.61
	Total	11,460	\$46,642.20	\$17,648.40	\$64,290.60	\$5.61
Rainy River Central	104-106	3,271	\$13,312.97	\$5,037.34	\$18,350.31	\$5.61

Deer Management Unit	Permit area	Number of bags distributed	Feed cost per bag	Associated feeding costs	Total feeding costs	Feeding cost per bag
	110	1,081	\$4,399.67	\$1,664.74	\$6,064.41	\$5.61
	Total	4,352	\$17,712.64	\$6,702.08	\$24,414.72	\$5.61
Rainy River East	107-109,195	4,579	\$18,636.53	\$7,051.66	\$25,688.19	\$5.61
Rainy River Total		20,391	\$82,991.37	\$31,402.14	\$114,393.51	\$5.61
Superior West	119-121	6,612	\$26,910.84	\$10,182.48	\$37,093.32	\$5.61
Superior Wilderness	115	90	\$366.30	\$138.60	\$504.90	\$5.61
	116	50	\$203.50	\$77.00	\$280.50	\$5.61
	117	1,572	\$6,398.04	\$2,420.88	\$8,818.92	\$5.61
	118*	0	\$0.00	\$0.00	\$0.00	\$0.00
	Total	1,712	\$6,967.84	\$2,636.48	\$9,604.32	\$5.61
Superior Central	122-125	4,930	\$20,065.10	\$7,592.20	\$27,657.30	\$5.61
Grand Portage I.R.	194*	0	\$0.00	\$0.00	\$0.00	\$0.00
Superior East	126, 128-129	4,889	\$19,898.23	\$7,529.06	\$27,427.29	\$5.61
	127	866	\$3,524.62	\$1,333.64	\$4,858.26	\$5.61
	130	260	\$1,058.20	\$400.40	\$1,458.60	\$5.61
	Total	6,015	\$24,481.05	\$9,263.10	\$33,744.15	\$5.61
Superior Total		19,269	\$78,424.83	\$29,674.26	\$108,099.09	\$5.61
Itasca NW	167-169	9,181	\$37,366.67	\$14,138.74	\$51,505.41	\$5.61
Itasca SW	170-171	6,004	\$24,436.28	\$9,246.16	\$33,682.44	\$5.61
	172	4,224	\$17,191.68	\$6,504.96	\$23,696.64	\$5.61
	173-174	4,094	\$16,662.58	\$6,304.76	\$22,967.34	\$5.61
	Total	14,322	\$58,290.54	\$22,055.88	\$80,346.42	\$5.61
Itasca NE	175-179	12,706	\$51,713.42	\$19,567.24	\$71,280.66	\$5.61
Itasca SE	180-184, 199	17,477	\$71,131.39	\$26,914.58	\$98,045.97	\$5.61
Leech Lake I.R.	197, 198	3,965	\$16,137.55	\$6,106.10	\$22,243.65	\$5.61
Bemidji	284-286	16,097	\$65,514.79	\$24,789.38	\$90,304.17	\$5.61
	287	27	\$109.89	\$41.58	\$151.47	\$5.61

Deer Management Unit	Permit area	Number of bags distributed	Feed cost per bag	Associated feeding costs	Total feeding costs	Feeding cost per bag
	Total	16,124	\$65,624.68	\$24,830.96	\$90,455.64	\$5.61
Itasca Total		73,775	\$300,264.23	\$113,613.50	\$413,877.75	\$5.61
Mille Lacs West	244	4,732	\$19,259.24	\$7,287.28	\$26,546.52	\$5.61
	245	3,858	\$15,702.06	\$5,941.32	\$21,643.38	\$5.61
	251	227	\$923.89	\$349.58	\$1,273.47	\$5.61
	Total	8,817	\$35,885.19	\$13,578.18	\$49,463.37	\$5.61
Mille Lacs Central	246	5,002	\$20,358.14	\$7,703.08	\$28,061.22	\$5.61
	247	3,628	\$14,765.96	\$5,587.12	\$20,353.08	\$5.61
	Total	8,630	\$35,124.10	\$13,290.20	\$48,414.30	\$5.61
Mille Lacs East	154-156	5,150	\$20,960.50	\$7,931.00	\$28,891.50	\$5.61
White Earth I.R.	297-298	2,451	\$9,975.57	\$3,774.54	\$13,750.11	\$5.61
Mille Lacs Total		25,048	\$101,945.36	\$38,573.92	\$140,519.28	\$5.61
Big Woods North	409	1,357	\$5,327.99	\$2,089.78	\$7,417.77	\$5.61
Farmland Total		50,419	\$189,014.87	\$114,441.76	\$303,456.63	\$6.03
Forested Total		138,483	\$561,625.81	\$213,263.82	\$776,889.63	\$5.61
GRAND TOTAL		188,902	\$752,640.68	\$327,735.58	\$1,080,376.26	\$5.72

*No feeding took place in this permit area.

Appendix 9. Summary of the cost per estimated deer fed and cost per reported deer fed by Deer Management Permit Area in the feeding zone.

Sub-DMU	Permit area	Total cost	Estimated deer fed	Cost/Estimate deer fed	Report deer fed	Cost/Report deer fed	Cost 50%estimated deer fed
Red River West	401	9,599.76	758	12.66	2,016	4.76	12508.08
	402 ^b	0.00	0	0.00	0	0.00	0.00
	Total	9,599.76	758	12.66	2,016	4.76	12,508.08
Red River East	403	19,573.38	1,546	12.66	3,530	5.54	14,039.94
	404	36,638.28	2,480	14.77	5,065	7.23	22,834.42
	405	13,881.06	940	14.77	1,762	7.88	20,670.62
	406	5,601.87	379	14.78	725	7.73	22,878.73
	407	84.42	8	10.55	6	14.07	11,736.88
	408	482.40	38	12.69	112	4.31	15,919.61
	Total	76,261.41	5,391	14.15	11,200	6.81	108,080.20
Red River Total		85,861.17	6,149	13.96	13,216	6.50	120,588.28
Agassiz	201	7,459.11	393	18.98	1,072	6.96	9,511.6
	202	14,218.74	842	16.89	1,825	7.79	18,040.97
	203	2,026.08	137	14.79	340	5.96	12,369.88
	204	33,026.31	1,956	16.88	6,429	5.14	44,056.80
	205	57,839.76	2,740	21.11	5,105	11.33	48,278.57
	206	41,649.21	2,467	16.88	5,685	7.33	34,587.12
	207	19,151.28	1,296	14.77	2,705	7.08	16,124.36
	208	9,099.27	616	14.77	1,399	6.50	1,682.72
	209	14,912.19	785	19.00	2,927	5.09	21,876.48
	210	10,600.74	628	16.88	2,146	4.94	24,197.48
Agassiz Total		209,982.69	11,860	17.71	29,633	7.09	245,791.34
Rainy River West	211-212	63,785.70	2,953	21.60	10,992	5.80	245,592.00
	214 ^a	504.90	128	3.93	70	7.21	1,509.12
	Total	64,290.60	3,081	20.87	11,062	5.81	247,101.12
Rainy River Central	104-106	18,350.31	1,038	17.68	2,996	6.12	77,173.73

DMU	Permit area	Total cost	Estimated deer fed	Cost/Estimate deer fed	Report deer fed	Cost/Report deer fed	Cost 50% estimated deer fed
	110	6,064.41	618	9.81	1,541	3.94	23,754.58
	Total	24,414.72	1,656	14.74	4,537	5.38	100,928.31
Rainy River East	107-109, 195	25,688.19	2,180	11.78	5,388	4.77	158,329.09
Rainy River Total		114,393.51	6,917	16.54	20,982	5.45	506,358.52
Superior West	119-121	37,093.32	31.48	11.78	6,802	5.45	120,750.89
Superior Wilderness	115 ^a	504.90	43	11.74	95	5.31	22,195.80
	116 ^a	280.50	28	10.02	30	9.35	24,828.44
	117 ^a	8,818.92	898	9.82	1,164	7.58	5,361.72
	118 ^{ab}	0.00	0	0.00	0	0.00	0.00
	Total	1,604.32	969	9.91	1,289	7.45	52,385.96
Superior Central	122-125	27,657.30	2,817	9.82	4,359	6.34	41,563.15
Grand Portage I.R.	194 ^{ab}	0.00	0	0.00	0	0.00	0.00
Superior East	126, 128-129	27,427.29	2794	9.82	3,738	7.34	20,440.33
	127 ^a	4,858.26	495	9.81	368	13.20	8,783.99
	130 ^a	1,458.60	148	9.86	220	6.63	1,115.71
	Total	33,744.15	3,437	9.82	4,326	7.80	30,340.03
Superior Total		108,099.09	10,371	10.42	16,776	6.44	245,040.03
Itasca NW	167-169	51,505.41	4,372	11.78	7,827	6.58	126,411.18
Itasca SW	170-171	33,682.44	3,431	9.82	4,859	6.93	78,044.45
	172	23,696.64	2,414	9.82	7,204	3.29	34,767.71
	173-174	22,967.34	2,340	9.82	5,135	4.47	7,141.81
	Total	80,346.42	8,185	9.82	17,198	4.67	184,453.97
Itasca NE	175-179	71,280.66	7,260	9.82	12,046	5.92	138,162.49
Itasca SE	180-184, 199	98,045.97	9,987	9.82	16,317	6.01	168,683.05
Leech Lake I.R.	197, 198	22,243.65	2,266	9.82	4,578	4.86	40,173.62
Bemidji	284-286	90,304.17	9,198	9.82	21,697	4.16	187,316.50
	287	151.47	19	7.97	36	4.21	8,710.56
	Total	90,455.64	9,217	9.81	21,733	4.16	196,027.06

Sub-DMU	Permit area	Total cost	Estimated deer fed	Cost/Estimate deer fed	Report deer fed	Cost/Report deer fed	Cost 50%estin deer fed
Itasca Total		413,877.75	41,287	10.02	79,699	5.19	853,911 ^a
Mille Lacs West	244	26,546.52	2,704	9.82	4,309	6.16	679,591
	245	21,643.38	2,204	9.82	3,610	6.00	59,150 ^b
	251	1,273.47	162	7.86	350	3.64	4,476 ^b
	Total	49,463.37	5,070	9.76	8,269	5.98	131,586 ^b
Mille Lacs Central	246	28,061.22	2,858	9.82	11,175	2.51	74,165 ^b
	247	20,353.08	2,592	7.85	8,673	2.35	25,610 ^b
	Total	48,414.30	5,450	8.88	19,848	2.44	99,776 ^b
Mille Lacs East	154-156	28,892.50	2,943	9.82	7,076	4.08	48,476 ^b
White Earth I.R.	297-298	13,750.11	1,400	9.82	3,539	3.89	31,659 ^b
Mille Lacs Total		140,519.28	14,863	9.45	38,732	3.63	311,498 ^a
Big Woods North	409	7,612.77	776	9.81	1,903	4.00	14,739 ^b
Farmland Total		303,456.63	18,785	16.15	44,752	6.78	381,111 ^a
Forest Total		776,889.63	73,438	10.58	156,194	4.97	1,916,808 ^a
Grand Total		1,080,346.26	92,223	11.71	200,946	5.38	2,297,928 ^a

aPopulation density was estimated (not modeled) for this permit area.

bNo feed was distributed in this permit area.

