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WILDLIFE MANAGEMENT PROGRAM ON
THE MID FOREST LODGE.

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FRONTISPIECE

Forest openings along the club's roads provide opportunities to see deer at all seasons.

(Cons. Dept. photo, by Harrington)

THE RESPONSE OF DEER TO A FOREST-WILDLIFE
MANAGEMENT PROGRAM ON THE
MID FOREST LODGE

by

Ralph Irving Blouch

A dissertation submitted in partial fulfillment
of the requirements for the degree
of Doctor of Philosophy in
The University of Michigan
1963

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PREFACE

Opportunities for intensive study of a deer population are not common. Michigan is fortunate in having two fenced-in herds which provide ideal situations for such studies, but on a fairly small scale, one or two square miles. Recently a unique additional opportunity arose for a population study on 28-square-mile Mid Forest Lodge. This private club, though not having a captive herd, does provide a completely controlled situation for checking hunters and kill, and it is located conveniently near a Conservation Department research facility, the Houghton Lake Wildlife Experiment Station. The study that was undertaken and that is reported in this dissertation was primarily aimed at assessing the effects of forest management upon deer. Other aspects of the study have produced useful information on population structure, hunting mechanics, and winter mortality. An important by-product has been the development and testing of several population survey methods adapted from statewide extensive surveys.

The study was carried out as a joint effort of The University of Michigan and the Game Division of the Michigan Department of Conservation. The author, an employee of the latter agency, has pursued this investigation for a doctoral research project in the Wildlife Management Department of the University's School of Natural Resources. The several surveys which provided much of the data essential to the study were developed under Job A-2 of the Game Divisions Federal Aid to Wildlife Restoration Project W-95-R. Use of the area for this study was granted by the Board of Directors of the Mid Forest Lodge Club. The officers and many of

the members of this organization have given fullest cooperation and much valuable assistance throughout the period of the study.

The extended nature of this project and the diversity of activities which it has included have necessarily involved many people. To all who have helped in their many ways I extend my sincerest thanks. I am particularly grateful to H. D. Ruhl, Chief, and R. A. MacMullan, Assistant Chief, of the Game Division for the opportunity to carry out this research and for their continuing encouragement throughout the rather protracted period it covered.

To Warren W. Chase, chairman of my doctoral committee, I am particularly indebted for guidance and counsel and for the idea from which this study was conceived. The late S. C. Whitlock, a member of the committee, contributed valuable suggestions and sound advice on numerous phases of the work.

I am most grateful to those who have assisted in various field surveys and particularly wish to thank Casey E. Westell, Jr., and Nels I. Johnson of the Packaging Corporation of America.

For her fine work in preparation of the manuscript I extend special thanks to Mildred I. DeWitt. I am indebted to Dean Armstrong for excellent drafting and to William G. Youatt and Joan P. Carter for other phases of work on the manuscript.

Photographs other than the author's are credited individually.

TABLE OF CONTENTS

	Page
PREFACE	ii
LIST OF TABLES	vii
LIST OF FIGURES	x
 PERSPECTIVE -- MICHIGAN'S DEER PROBLEM	 1
Michigan A Leading Deer State	1
History of Michigan Deer	3
Two Phases to the Problem	13
Overpopulation	13
Forest Succession	19
Two Solutions to the Problem	21
Harvesting the Deer	21
Harvesting the Forest	26
Applying the Solutions	34
 THE MID FOREST LODGE HUNTING CLUB	 36
Deer Hunting Clubs	36
Description of the Mid Forest Lodge Area	39
Location	39
Physiography and Soils	41
Climate and Weather	45
Temperature and Precipitation	45
Snowfall	46
Severity of Winters	48
Vegetation	49
Original Forest Cover	50
Present Cover	50
Oak Type	53
Aspen Type	56
Openings	57
Coniferous Swamps	58
Other Lowland Types	58
Effects of Deer on Vegetation	60
History of the Area	67
The Land	67
The Club	68
The Deer Herd	70
The Club's Forest and Deer Management Program	74
Aspen Cutting	74
Antlerless Deer Hunting	83
Supplemental Feeding	85

	Page
HUNTING SEASONS AS A SOURCE OF INFORMATION ON THE CLUB'S DEER HERD .	89
Methods	90
Registration of Hunters at Gates	90
Biological Data from Examination of the Kill	96
Checking System	96
Weighing	98
Aging	99
Antler Size	99
Hind Foot Measurement	100
Results	100
Data from Gate Registrations	102
Yearly Kill and Hunter Records	102
Distribution of the Kill Through the Season	104
Distribution of Hunting Through the Season	108
Location of Kills	109
Antler Points	115
Biological Data	119
Age Classification	119
Weights	122
Antler Size	122
Hind Foot Length	125
Yearling Buck Data	127
CENSUS BY PELLET-GROUP COUNTS	131
Methods	132
1959 Survey	134
1960 and 1961 Surveys	136
Results	139
1959 Survey	139
1960 and 1961 Surveys	142
Pellet Group Distribution in Relation to Cutting Program .	143
MORTALITY MEASUREMENT BY DEAD DEER SEARCHES	148
Method	149
Results	153
Comparisons With Other Areas	157
OBSERVATION OF DEER ON THE CLUB	160
General Observations	160
Use of Cuttings	162
Use of Food Patches and Feeding Stations	164
Exclosure Observations	169
Exclosure No. 1	170
Exclosure No. 2	170
Exclosure No. 3	172
Counts and Surveys	175
Roadside Counts	175
Winter Track Counts	180

	Page
POPULATION DYNAMICS	184
Estimation of Numbers	184
Estimates from Buck Ages and Preseason Composition	185
Indices to Population	188
Life Equation	189
COMPARISON WITH OTHER AREAS	197
Description of Other Areas	198
Location and Source of Data	198
Region II	198
Northeast Food Shortage Area	199
District 7	199
Roscommon County	199
Rifle River Area	200
Bois Blanc Island	200
Beaver Island	201
Canada Creek Ranch	201
Lost Lake Woods	201
Hiawatha Sportsman's Club	202
Comparison of Deer Populations	202
Buck Kill	203
Biological Data	206
Pellet Counts	209
Supplementary Hunting Season Information	212
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	223
Summary of the Study	223
Conclusions	226
Management Recommendations	229
For Mid Forest Lodge	229
General	230
REFERENCES CITED	231

LIST OF TABLES

Table	Page
1. Antlerless deer kill and deer starvation losses in Michigan, 1956-1962	25
2. Soils of Mid Forest Lodge	43
3. Mean monthly temperature and precipitation. 1952-1961, Houghton Lake Heights, Michigan	46
4. Cover types on Mid Forest Lodge	51
5. Aspen harvested on Mid Forest Lodge by cutting blocks 1956-1962	76
6. Number of deer hunters and holders of antlerless permits on Mid Forest Lodge, 1958 to 1962	86
7. Winter feeding operations on the Mid Forest Lodge	87
8. Proportion of the deer kill aged and weighed on Mid Forest Lodge, 1958-1962	98
9. Mid Forest Lodge deer kill and hunting pressure during gun seasons, 1946-1962	103
10. Bucks and antlerless deer killed each day of the hunting season on Mid Forest Lodge, 1959 to 1962	107
11. Daily hunting pressure on Mid Forest Lodge, 1962 deer season	110
12. Mid Forest Lodge buck kill and hunting pressure, 1962	111
13. Mid Forest Lodge reported deer kill in each section, 1958-1962	112
14. Mid Forest Lodge, number of antler points on bucks of all age classes, 1955-1962	116
15. Deer aged during hunting seasons on Mid Forest Lodge, 1958-1962	120
16. Dressed weights of deer by age class, Mid Forest Lodge, 1958-1962 hunting seasons	123
17. Antler size by age class, Mid Forest Lodge, 1958-1962 hunting seasons	124
18. Length of hind foot by age class, Mid Forest Lodge, 1960-1962 hunting seasons	126
19. Mid Forest Lodge deer pellet group survey. Summary of data and statistical analysis - 1959	140

20. Mid Forest Lodge deer pellet group survey. Summary of data and statistical analysis - 1960 and 1961	141
21. Pellet group counts and deer population estimates, Mid Forest Lodge, 1958 to 1961	142
22. Summary of findings on dead deer surveys, Mid Forest Lodge and Turtle Lake Club, 1959, 1960 and 1962	154
23. Sex and age of starved deer found on sample plots, Mid Forest Lodge dead deer surveys, 1959 to 1962	155
24. Sex and age of starved deer found on sample plots, Turtle Lake Club dead deer surveys, 1959 to 1960	156
25. Roadside count summary. Deer sighted during car travel. . .	177
26. Deer track counts on Mid Forest Lodge made during four winters, 1958 to 1962	182
27. Mid Forest Lodge, reconstruction of buck population from ages of bucks killed, 1958-1962	186
28. Estimated deer population on Mid Forest Lodge, 1958-1962 . .	188
29. Life equation table for Mid Forest Lodge deer herd during four-year period of study	191
30. Region II deer kill and hunting pressure, 1952-1961	213
31. Roscommon Co., Michigan, deer kill and hunting pressure, 1952-1961	213
32. Rifle River Area deer kill and hunting pressure, 1946-1962 .	214
33. Bois Blanc Island deer kill and hunting season data. Gun season, 1941-1962	215
34. Beaver Island deer kill and hunting pressure, 1946-1962 . .	216
35. Canada Creek Ranch deer kill, 1937-1961	217
36. Hiawatha Sportsman's Club deer kill and hunting pressure, 1948-1962	218
37. Lost Lake Woods Club deer kill and hunting pressure, 1931-1962	219
38. Percentage of yearlings in the total buck kill	220
39. Weight of yearling bucks	220

Table

Page

40. Antler beam diameter of yearling bucks	221
41. Antler points on yearling bucks	221
42. Length of hind foot of yearling bucks	222

LIST OF FIGURES

Figure	Page
1. Hartwick Pines State Park	7
2. Big-toothed aspen, 40 years old	7
3. Number of deer killed statewide in gun hunting season . . .	11
4. Deer sighted by Conservation Department field personnel . .	11
5. Deer browse line in a cedar swamp	17
6. Starvation weakened deer	17
7. Change in stand-size classes, 1935-1955, commercial forest area in Michigan	22
8. Annual aspen pulpwood harvest in Michigan	22
9. Pulpwood load. Trucks hauling aspen to the mill	30
10. A dense growth of aspen suckers in cutover area	30
11. Percentage of forest land area in major cover types	32
12. Percentage of forest land area by stand-size class	32
13. Sign marking entrance to Mid Forest Lodge	37
14. Open spots remaining on club land	37
15. Geographical locations of areas included in the study . . .	40
16. Generalized soils map of Mid Forest Lodge	44
17. Climatograph, Houghton Lake, Michigan	47
18. Indices of winter severity, Houghton Lake, Michigan	47
19. Generalized cover types	52
20. Young stand of oak, following an extensive fire	55
21. Good site of pure aspen, second to oak in total acreage . .	55
22. Browse line on conifer swamp	61
23. Deer browse line on hardwoods	61
24. A pure stand of red and white oak	63
25. Heavy browsing on red pine and balsam fir	63

Figure	Page
26. Overbrowsed witchhazel	65
27. Browsing deformity on red oak	65
28. Aspen cutting blocks	75
29. Cumulative area and percentage of total area cutover on Mid Forest Lodge	77
30. Annual volume of aspen pulpwood cut on Mid Forest Lodge	77
31. Decked aspen pulpwood near Doyle Lake	80
32. Cutover areas starting regeneration immediately	80
33. Two-year old aspen suckers heavily browsed by deer	82
34. Five year old aspen suckers seriously damaged by hungry deer	82
35. Main gate of Mid Forest Lodge	94
36. Weighing and examining deer at clubhouse	94
37. Calipering antler beam diameter	101
38. Calipering length of hind foot	101
39. Annual deer kill on Mid Forest Lodge, 1946-1962	105
40. Number of deer hunters and their success rate	105
41. Daily kill of bucks and antlerless deer on Mid Forest	106
42. Total number of deer reported killed in each section	114
43. Average number of antler points on bucks of all age classes, Mid Forest Lodge, 1955-1962	117
44. Frequency distribution, average antler points on bucks of all age classes	117
45. Data from yearling bucks examined during hunting seasons	128
46. Deer pellet group	133
47. Deer pellet count transects, 1959 survey	135
48. Deer pellet count courses, 1960 and 1961 surveys	138
49. Deer population estimates based on pellet group counts	144

Figure	Page
50. Pellet groups per plot in relation to distance from cuttings	146
51. A fawn found dead on search course in early May	147
52. Plan for dead deer survey search strip and location	150
53. Location of sampling units and dead deer found on Mid Forest Lodge	151
54. Location of sampling units and dead deer found on Turtle Lake Club	152
55. Winter mortality estimates from dead deer surveys	159
56. Region II winter mortality estimates	159
57. Small rye patch in natural opening	166
58. A winter supplemental feeding location	166
59. Autopsy of fawns found dead near feeding locations	168
60. Exclosure No. 1 showing aspen suckers after two growing seasons	171
61. Exclosure No. 1 after four growing seasons	171
62. Exclosure No. 3 with suckers about two months old	174
63. Exclosure No. 3 after three growing seasons	174
64. Winter deer track counts on Mid Forest Lodge	183
65. Comparisons of two independent estimates of deer population	183
66. Four indices to deer population on Mid Forest Lodge	190
67. Fluctuations in deer numbers on Mid Forest Lodge	190
68. Trends in buck kill compared with eight other areas	205
69. Data from yearling bucks examined in hunting seasons, compared with four other areas	208
70. Deer population estimates based on pellet group surveys . .	210

PERSPECTIVE -- MICHIGAN'S DEER PROBLEM

Michigan A Leading Deer State

A strange and compelling malaise seizes a large portion of the male population of the United States each fall. Breaking out in the West as early as September it quickly spreads eastward and northward across the continent. November is its peak, and by year's end it has run its course through every section of the country and has laid its grip upon at least six million Americans. Few who have succumbed to it will deny that deer hunting is a fever, psychological if not organic, which can be abated only by engaging in some form of direct action aimed at bagging a deer. Successful or not, the hunt itself is the therapy, and in most cases the hunter will be restored to normalcy mainly through the doing rather than the getting.

The agent ultimately responsible for this seasonal affliction of so many Americans is, of course, the deer itself. American deer, the genus Odocoileus, are of two species, each with numerous subspecies. Mule deer (Odocoileus hemionus) are restricted to the western half of the continent and are outnumbered by the white-tailed deer (Odocoileus virginianus) which are continent-wide in distribution. Current estimates compiled by the Fish and Wildlife Service (U.S.F. & W.S., 1962) place the 1961 kill of deer in the 50 states at 1,841,000, of which about 868,000 were whitetails and 973,000 were mule deer. (While the report

distinguishes between mule deer, 815,000, and blacktails, 150,000, they are here lumped as one species.) The greater harvest of the less abundant mule deer reflects the generally more liberal and flexible hunting regulations prevailing in the western states and effectively points up the most persistent problem in the management of deer over much of their range: under-utilization.

In the eastern half of the country where whitetails are the only big game they occur in greatest numbers in the northeastern states. And it is here, where people too are most prevalent, that hunting fever reaches its greatest pitch. The five states, Pennsylvania, New York, Michigan, Wisconsin, and Minnesota in 1961 contained 2,220,000 whitetails. In these states that year 321,000 deer were killed by 2,000,000 hunters. The three Great Lakes states, Michigan, Minnesota, and Wisconsin together reported a total whitetail population of over 1,525,000 and a total kill of 206,000. Their combined hunting army probably exceeded 1,000,000. Among the three, Michigan's rank was highest both in deer numbers, 625,000 and in hunters, 420,000; but its total kill of 59,800 was far below Minnesota's healthy harvest of 106,500 animals. (These were taken from a herd of 400,000 deer by about 250,000 hunters.) Over the rest of the country Michigan's whitetail herd ranks second only to Texas' fabulous estimate of 2,000,000 animals. And, while eight other western states harvested mule and black-tailed deer in greater numbers, only one of these, California, exceeded Michigan in total deer population.

Michigan, therefore, can be considered unquestionably as one of the nation's leading deer states. And each year when the hunting contagion sweeps over the land it would be hard to deny that nowhere does the fever burn hotter than it does here, nowhere is a greater army

of hunters mobilized and moved into the field more rapidly, and nowhere are more dollars spent in a shorter time in the pursuit of a single game animal.

With the foregoing to bring into focus the position of Michigan in the nationwide deer picture it will now be appropriate to look at in some detail the history of the state's deer population and to define the several problems which have impeded successful management of this important resource. This in turn will bring into finer focus the intent of the present study which is to examine a local application of the most logical solution to the problems and assess its effectiveness on a study area.

The following account will review the essentials of Michigan's deer situation. The sources I have drawn upon are largely facts and information accumulated by the Michigan Department of Conservation, both published and unpublished. It is a story told and retold in many ways by the Department in its continuing effort to acquaint the public with the situation. Wherever possible published sources will be cited. In some cases, however, information that is public knowledge or that is in circulation through various educational channels cannot be cited as formally published material, and must be presented without cited authority.

History of Michigan Deer

The white-tailed deer in its far-flung occurrence across North America has developed many geographic races. Kellogg (1956) recognizes 30 distinct subspecies. Burt (1946) places Michigan's white-tails in the northeastern group, O. virginianus borealis, probably the widest ranging and the largest in size of all of them.

All parts of the state are presently occupied by deer, and although this was certainly true in pre-settlement times there was a period following the nearly complete removal of wild woodlands from the southern farming zone when some counties were probably completely without them. In recent years they have returned to these areas and are now firmly resident in all counties. Numerically, however, they are much more abundant in the northern two-thirds of the state than in the southern third. This disparity is strictly a reflection of land use. Deer are essentially forest animals, and forests predominate in our northern area. Southern Michigan lands are about 17 per cent forested, northern lands 80 per cent (Findell et al., 1960).

It was not always this way. In fact, it is quite likely that in pre-settlement times the numerical distribution of deer in Michigan was just the reverse of the present situation. Northern areas were probably much less hospitable to whitetails and supported only sparse and scattered populations, whereas in the southern part of the state a more favorable environment supported appreciably greater numbers of the species. This environmental difference is quite distinct, dividing the state, approximately along the 43° parallel, into two discrete ecologic associations. The classification by Dice (1943) separates the Canadian and Carolinian biotic provinces along this general line.

The Canadian (northern) biotic province has a hardwood forest climax but includes some important coniferous subclimaxes. In the lake states this is particularly true, and here, before the lumbering era, a vast forest of white and red pine dominated much of the land. In northern Michigan the virgin pine stands were extensive, covering almost unbroken blocks for miles on end. The trees themselves were large and

close together. Their tops formed a closed canopy shading the forest floor and permitting only a sparse undergrowth.

Only a few tiny remnants of this vast pinery have been left for present generations to view (Figure 1). But the millions of stumps that still persist across the northland are adequate testimony to the breadth and the density of its growth. Deer could not have easily fulfilled their needs of food and cover in that kind of forest. And though there were undoubtedly scattered openings where fire or blowdown had disturbed succession and created better habitat, whitetail numbers must have been low to the point of scarcity throughout the pine lands in general.¹

At the same time in the zone to the south, while forest cover still predominated, types and sizes of trees were more diversified, more varieties of food and cover plants were present, and a milder climate made lesser demands on wintering whitetails. Deer were probably much more abundant throughout southern Michigan than in the northern pine country. Bersing (1956), relating the history of Wisconsin deer, concludes that in the early 1800's deer were abundant in southern Wisconsin and may have had densities of over 25 per square mile. Dahlberg and Guettinger (1956) thought the figure might have been as high as 20 to 50 per square mile. Accounts of early settlers and fur traders consistently pointed out the widespread utilization of deer by the Indians, and it seems likely that their tribal economy was quite dependant upon this resource.

¹Dahlberg and Guettinger (1956) estimate that in northwestern Wisconsin prior to 1800 deer density was fewer than 10 per square mile. However, Habeck and Curtis (1959), drawing upon historical accounts, feel that dense virgin forests were not as widespread in that area as commonly believed and that deer may have been more abundant than that figure.

Figure 1. Hartwick Pines State Park, a carefully preserved remnant of the great pine forest that was completely cut from the land.

Figure 2. Large-toothed aspen, 40 years old, on a good site. A new forest has regrown on much of the cutover pine land.



Figure 1

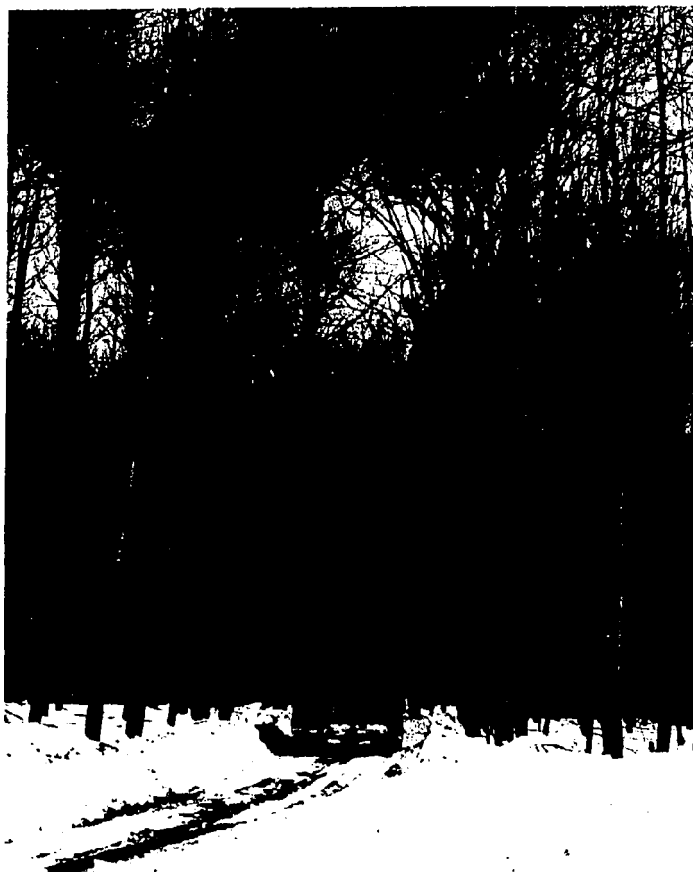


Figure 2

Rapid settlement and clearing in the southern parts of both states soon changed the picture. Year round killing by the settlers and replacement of woodlands by agriculture practically eliminated deer from the region by 1850. This date also marked the beginning of the lumbering era in the pine lands to the north. Here, as the trees were cut they were not immediately followed by the plow as in the south. Instead, a regenerating second growth forest quickly sprang up in the cuttings--an abundant low growth of young trees and shrubs. This was ideal food and cover for deer and they increased rapidly. By 1870 deer were scarce in the south and numerous in the north, a complete reversal of the original situation. But this, too, did not last. Abundance brought in exploitation, and commercial killing soon harvested extraordinary numbers. Bartlett (1950) cites railway express records indicating that over 100,000 deer carcasses were shipped out of northern Michigan in 1880. And then came the fires. Vast acreages burned repeatedly, destroying young second growth and soil fertility all across the newly cutover northland. Deer plummeted downward, and by early 1900's they were scarce throughout the state.

Public concern awakened for both deer and forests and steps were soon taken to protect them both. Restrictive laws on deer killing successively outlawed pits and traps, dogs, artificial lights, and market hunting. Open seasons shrank from five months to one month; bag limits were cut from five deer to one deer. Forest fire control efforts progressively reduced the acreage burned until by 1920 it was one-tenth of what it had been 25 years earlier.

At this point deer in northern Michigan began an upward climb, soon to be followed by another boost. In 1921 came the "buck law" limiting the hunter's bag to one male deer with antlers at least three

inches above the skull. Many counties were closed to hunting completely. With this drastic protection and with the cutover and burned over land now permitted to start forest regrowth unimpeded, the foundation was laid for development of Michigan's record size whitetail herd.

The principle involved here, so dramatically illustrated by the events described above and those that were soon to follow, is the obvious one that white-tailed deer require early stages of forest succession for optimum fulfillment of their needs. The primeval, virgin forest (climax or sub-climax stages of succession) provided almost none of the close-to-the-ground food and shelter that are the essential ingredients of deer habitat. Widespread, unbroken areas of such growth were quite certainly deer deserts.

Leopold (1950), in his paper "Deer in Relation to Plant Succession", points out that, historically, both mule deer and whitetails have greatly increased in abundance across the continent as the activities of man have disturbed climaxes and stimulated browse growth. In the west deer range has been improved and created not only by opening up the forest but also by grazing and burning grassland climaxes. In many instances these influences have brought about shrub invasions which are highly beneficial to deer. Leopold summarizes this relationship stating that,

. . . deer seem to achieve maximum densities in areas of disturbed vegetation which produce palatable shrubs or tree reproduction as secondary stages in plant succession. Logging, fire and grazing are the three principal influences which in the past have created, or at least improved, most of our present deer ranges. In excess, of course, the same influences can destroy deer range.

The virtual eruption of Michigan's deer herd in this new era was also due, in part, to man's earlier elimination of the whitetail's

only important predator, the timber wolf (Canis lupus). Thus, nature's balance being thoroughly upset at this level (superabundance of food and cover, removal of natural enemies, severe restriction of hunting), the inevitable increase in deer numbers which resulted had to be checked at a later time, at another level, and by other forces. Two factors have brought about this control: food shortage and forest succession. The first has operated erratically and at times drastically. It has effected deer numbers directly through starvation, and indirectly by lowering reproduction. The second, with gradual but increasing effectiveness, is shrinking carrying capacity as forest growth and successional changes take place.

The effects of these forces can be detected in the line graphs of Figures 3 and 4. Figure 3 shows the statewide deer kill during gun hunting seasons, 1935 to 1962. The buck kill is of most significance here, as it reflects population changes rather closely. The size of the antlerless kill is largely a function of varying types of special seasons. The ups and downs in the buck kill line show the rather severe fluctuations that have occurred repeatedly during the 28 year period. The pattern of buildup and drop is largely a reflection of the succession of periodic starvation years -- winters with long lasting deep snow (Bartlett, 1949) -- followed by years with lighter winter losses. The overall trend is upward through the 1930's and until the mid-1940's. The trend from there on is gradually downward.

Figure 4 presents data from a different source but the pattern is the same. The figures here are rates of deer seen per 100 hours of patrolling. These averages are obtained annually and represent the combined observations of all field personnel of the Michigan Department of Conservation in deer country. Records of sightings are routinely kept

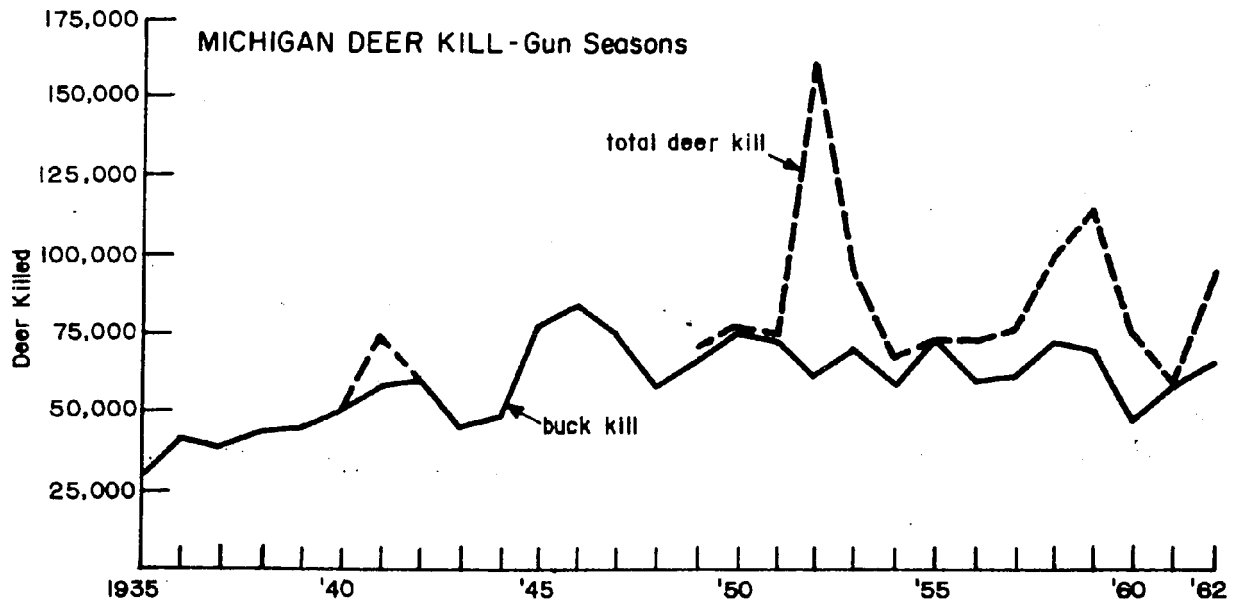


Figure 3. Number of deer killed in the state in gun hunting seasons.

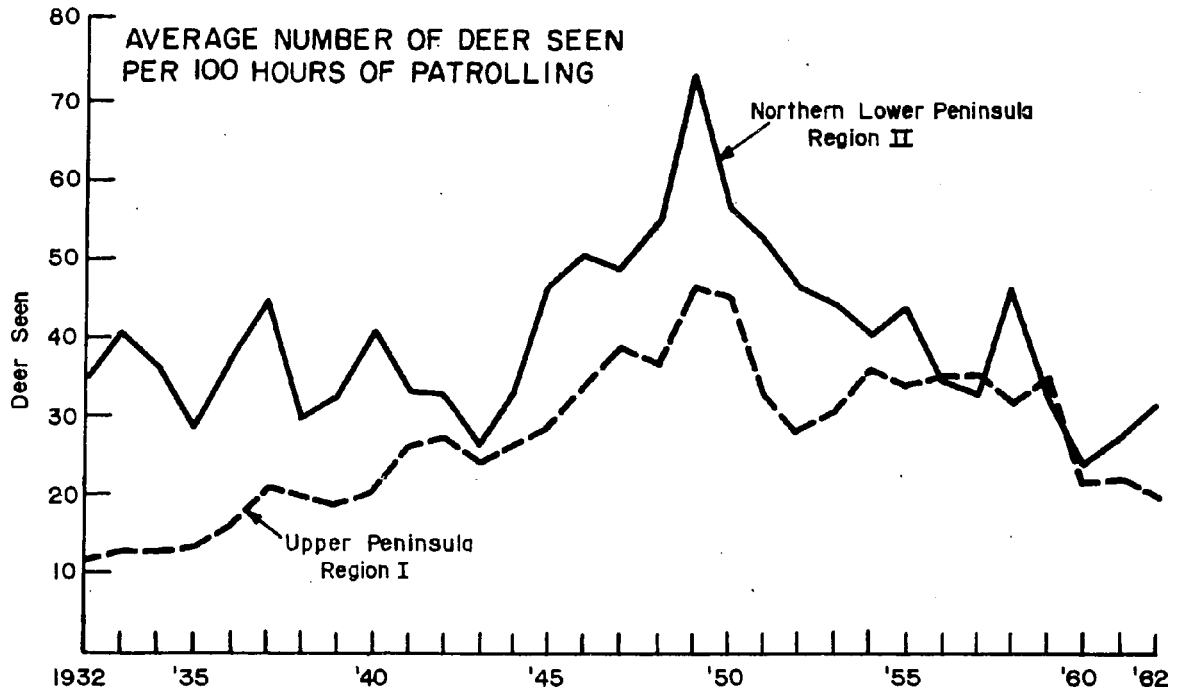


Figure 4. Deer sighted by Conservation Department field personnel, July through October, 1932 to 1962.

by officers and other field employees during the months of July through October. Their observations, over this long period again show the periodic fluctuations superimposed upon a long buildup to peak proportions in the late 1940's and a distinct falling off during the past 12 years.

The separate lines in Figure 4 for Region I, the Upper Peninsula, and Region II, the northern Lower Peninsula, illustrate that basic differences exist between the two portions of the state's deer range. It also shows that general trends have been similar. (The geographic relationship of the two regions is shown in Figure 15.) Bartlett in 1950 reported that by that date starvation losses were still not serious in Region I, whereas in Region II up to one-third of the winter range had food shortages and starvation. This situation has changed since that time, and in recent years starvation losses in Region I at times exceed those in Region II (Ryel and Bennett, 1962). Differences in climate, forest types, time of logging and other factors have caused the deer herds in the two regions to be dissimilar. In the Lower Peninsula deer in general have been more abundant and have exceeded carrying capacity earlier. In the Upper Peninsula the sequence of environmental disturbances by man lagged behind by ten to twenty years; winters are longer and more severe; and probably other range conditions are somewhat less favorable to deer. These things apparently combined to lessen and delay the herd's buildup over most of the region, but a peak was finally reached at about the same time as below the Straits, and the ensuing decline in both regions has been roughly parallel. Because of the inherent regional differences this report, for the most part, will consider the two herds as distinct and will relate to the Lower Peninsula when comparison or analogies with

regional conditions are necessary. However, in the following discussion of basic problems no distinction will be made and reference will be to the herd and the range of the state in its entirety.

Two Phases to the Problem

Overpopulation

The dominant and overriding influence upon Michigan's deer herd during the past 30 years has been overpopulation and overbrowsing of the range. Starvation losses, which are the inevitable result of an erupting population and a dwindling food supply, have piled up to enormous totals. Department of Conservation surveys in recent years have provided good estimates of these totals, based on sound biometrical design. In five of the winters from 1955 to 1962 the records show that about 150,000 deer died of starvation (Ryel and Bennett, 1962). Totals for single winters ranged from 6,000 to 50,000. In earlier years before the present method of survey was developed other types of estimates also placed losses as high as 50,000 in severe winters (Bartlett, 1950).

Michigan's record of deer overpopulation and deer starvation is dismal enough, but much more appalling is the fact that similar wasteful losses have occurred over and over again throughout much of this nation's deer range. Probably no other kind of animal has demonstrated so widely and so dramatically the fundamental biological fact of an organism being limited by its food supply. After a comprehensive survey in 1945 Leopold, Sows, and Spencer (1947) reported that 30 of the 47 states with deer herds had histories of some degree of overpopulation.

and 20 of them at that time were, or had been, afflicted with starvation die-offs. In the intervening years since then attempts have been made to bring many of these herds under control. Some are now contained within carrying capacity, some are still precariously balanced on the edge of starvation, others continue to suffer frequent losses. Westell (1955) surveyed the nine U.S. Forest Service regions 10 years after the Leopold report to determine the current status of deer on federal areas. Eight of the regions replied and all reported that deer exceeded carrying capacities. Seven of them declared that important tree species were being excessively browsed. The conclusion was that, on federal forests at least, there was essentially little change in the 10 years since the other survey.

Range damage, food shortage, and starvation are principally wintertime occurrences in northern deer areas. Leaf fall and winter dormancy restrict deer to a diet of a limited variety of twigs and evergreen foliage. Deep snow hampers movement, and cold weather imposes greatest demands on animal systems. In northern Michigan as winter sets in deer seek shelter in coniferous swamps. Most frequently these are predominantly second growth white cedar stands, swamplands that will vary in size from small pockets or stream margins up to vast tracts of many thousand acres. While these are well distributed throughout the deer range they occupy only 8 to 10 per cent of the total area (Bartlett, 1950). When deer move into these yards from all the summer range it means a tenfold concentration. A moderate or mild winter with light snow imposes no great hardship, for deer can then range out into upland areas for food, utilizing the yards as bases of operation and shelter to return to when weather turns bad. But when winters are severe and snow accumulates to depths which make travel difficult deer simply stay in the

swamps and restrict their movements to the well trodden runways which soon develop. Yarding conditions of this sort often last for 70 to 90 days. When heavy deer concentrations develop the good foods are soon consumed and subsistence for most of the period must be derived from medium to poor quality browse. Cedar foliage is the first to go, and once gone it does not grow back readily. Its conspicuous absence in the zone within the reach of deer creates the telltale browse line now so common in most of our swamps (Figure 5).

Deer yards not subjected to heavy browsing can maintain a high carrying capacity. Controlled studies have shown that better types of yards will sustain as many as three deer per acre, and if deer numbers can be held at reasonable levels continued browsing will help to maintain maximum food production (Davenport et al., 1953). But if over-browsing develops carrying capacity falls to one deer per acre or less and will not soon recover.

It is the habit of deer to return to the yard year after year, even though good foods are scarce or gone completely. Even in normal winters the small fawns in browsed out yards will weaken and verge on starvation before being released by spring thaws (Figure 6). But when a real "old fashioned" winter comes along and snow lies deep for week on week the death toll becomes great. Usually 80 to 90 per cent of the losses are fawns, and the remainder are adult does. At times even adult bucks succumb.

The actual death of the doomed animals usually occurs at the end of the yarding period, just as spring breakup and release are at hand. Prolonged malnutrition has by then drained all reserves of stored fat from body and tissues. Any foods still obtainable furnish so little

Figure 5. Deer browse line in a cedar swamp in northeastern Roscommon Co. A growing deer herd soon eliminated all the good food in winter concentration areas. The balsam fir, left foreground, is less preferred, but it too may soon be browsed. (See Figures 22 and 23).

Figure 6. Starvation weakened deer. In a bad winter after long confinement in a browsed out yard, many deer use up all reserves, and death can come with the next storm. (Cons. Dept. photo, by Harrington).



Figure 5



Figure 6

energy that they are useless except to fill space in a demanding stomach. At this extremity pneumonia or the sudden stress of a late winter storm can quickly bring the end. Those that manage to survive this crucial stage may shortly escape the yards and begin the recovery process if better foods are near at hand. At best this is a long process, for nourishment in plants is at a low ebb until spring growth commences. And even when survival and complete recovery are assured the long ordeal will leave its mark on survivors in terms of lowered productivity, poor antler growth, and perhaps other systemic weaknesses.

The browsed out deeryard with its frequent record of starvation and high mortality is of common occurrence in most of Michigan's deer range today. Ryel and Fay (1962) delineate two large segments of Region II deer range, totaling 5,300 square miles, as critical winter food shortage area, and Jenkins (1962) classifies a major part of Region I in a similar category. This serious deterioration of winter yards has spread relentlessly across the north country during the past 30 years. Starvation in the yards was recognized and reported as early as 1930 in Alpena County of Region II. Bartlett (1950) estimated that the range affected by winter food shortage at that time was about 100 square miles. He relates that this area enlarged rapidly as the expanding herd consumed food in the young cedar swamps. By 1936 it covered 500 square miles and in 1949 the starvation shadow had spread across 4,000 square miles. In Region I some yards were known to be browsed out before 1930, but the condition spread more slowly at first, and only recently have starvation losses reached as large a scale as in the Lower Peninsula.

Forest Succession

Overpopulation and starvation, the spectacular, the quick acting controls of nature, have firmly checked the erupting deer herds of both regions and turned them back to lower levels. An erratic and uneasy balance might possibly be the new order, holding numbers at a fluctuating but roughly constant level. But the second force, succession, is now unmistakably making its presence known, and this, in the long run, may clamp a tighter and lower lid on our deer herd. Overpopulation in most cases has operated primarily on the carrying capacity of winter range. Only in limited, extremely overcrowded localities has there been serious overbrowsing of summer range. But tree growth and successional change affect winter and summer range alike. As second growth forests mature and pass on to older age classes and eventually into later stages of succession deer habitat just as surely deteriorates. Grange (1949), in applying his theory that game cycles are functions of plant succession, states:

The present abundance of Deer in Wisconsin, . . . , stems directly from the logging and fires of one and two decades ago, and from the more recent forest protection program which has permitted successful regeneration more or less universally in the wooded counties. Just as certainly, in the absence of purposeful forest succession management, (best integrated with forest harvest and thinning programs), and the absence of fire, the Wisconsin forests will grow farther and farther out of the Deer home range pattern, with the result that the Deer herd will inevitably decline.

As these forces of population and succession have developed in our deer ranges it has become obvious that they are interrelated and interacting. Grange (1949) points out that deer overabundance will disturb and alter succession, for example, by preventing the seeding in

of a pine understory on aspen sites. Thus a subclimax stage, which would in general be reasonably favorable to deer, will be eliminated by them and the less favorable hardwood climax hastened. Graham (1954) cites detailed studies in Michigan's Upper Peninsula that show how selective browsing by deer will eliminate desirable elements from the hardwood climax mixture and lead to a pure hard maple stand, a most barren future environment for deer. The effects of deer on the forests and their succession are usually direct, rapid, easy to measure, and often easy to see. The effects of growth and succession on the deer are gradual, often subtle, and not quickly measureable. We can reason with assurance, however, from what we know of deer habits and requirements, that as a forest stand inevitably progresses upward through seedling, sapling, poletimber, to sawtimber size classes, it just as surely grows away from usefulness to deer for food or shelter. And as successional stages proceed toward climax types shading intensifies and progressively eliminates variety and abundance of ground cover and understory.

Much of our present northern Michigan forest can be considered a vast even aged stand having its beginning roughly in the decade of 1920 to 1930 which saw the end of large scale fires. Its progression in age and size has now put much of it in the poletimber size class, broadly speaking from 5 inches to 11 inches, d.b.h. Forests of this size and larger (sawtimber) are by inference poor deer habitat. The younger classes, seedlings and saplings (trees below 5 inches d.b.h.), and nonstocked areas (forest lands with less than 10 per cent stocking, or brush and grassland) also by inference can be considered good deer range. The proportion of Michigan's forest area in these classes in 1935 and in 1955 is shown in Figure 7.

A striking change has taken place in the 20 years between the two bars in this figure. While the seedling-sapling class dominated the forests in 1935, by 1955 poletimber area had increased by 40 per cent and was about equal to the younger class which had shrunk by 22 per cent. In other words growth far exceeded harvest and replacement. Looking at it another way, good deer range (nonstocked plus seedling and sapling stands) occupied two-thirds of the area in 1935, and the remaining third was poor range (sawtimber and poletimber). Twenty years of growth transposed this to half good and half poor. A continuation of this trend could further change the deer range to one-third good and two-thirds poor.

There are no comparable figures available later than 1955, but it is clear, in the light of subsequent events which will be discussed below, that this trend has been altered, and that the outlook for deer may not be as bleak as the past changes portended. However, the era of range deterioration through growth and succession is still with us, and the effects of this force must be considered as a primary limiting factor on deer and rated equally with overpopulation as a reducer of carrying capacity.

Two Solutions to the Problem

Harvesting the Deer

As I have pointed out Michigan's deer problem is a two-pronged one--overpopulation and forest succession. The first, it would seem, ought to be easier to solve. If there are too many deer, harvest more of them. We increased restrictions years ago when there were too few

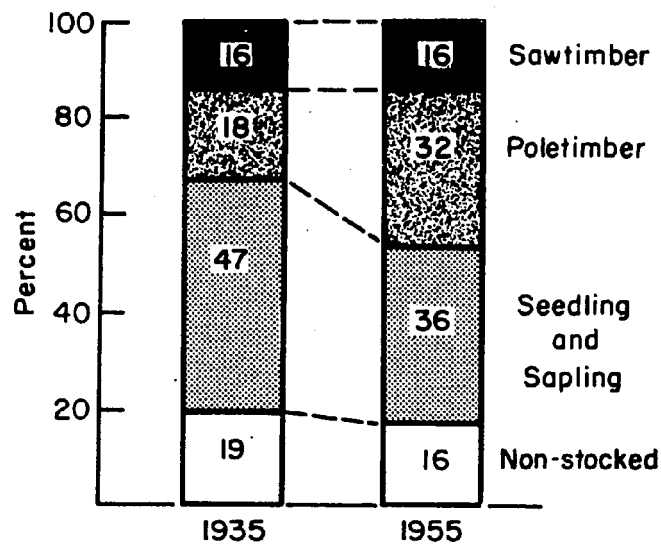


Figure 7. Change in stand-size classes, 1935-1955, commercial forest area of Michigan (Findell et al. 1960).

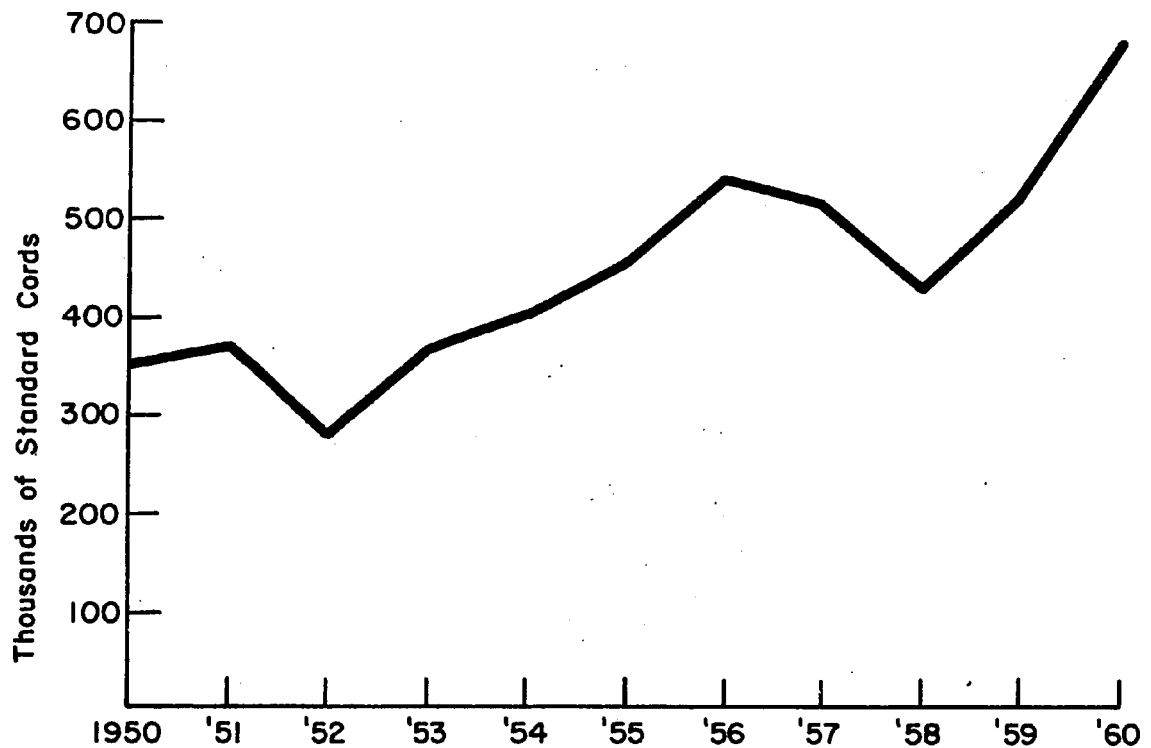


Figure 8. Annual aspen pulpwood harvest in Michigan (Pfeifer, 1961).

deer, now with too many, restrictions should be relaxed. To a limited extent this has been done, but it was too long in coming and it has not gone far enough. The barrier here, of course, has been the public with its great attachment to the buck law, its reluctance to see the facts, and its failure to recognize the importance of herd control.

Most people, it seems, will not believe that there can be "too many deer." To the hunter, who measures deer abundance in terms of how many shots he gets and how many years he is successful, the more deer the better. To the vacationer and his family, driving the back roads after supper, the enjoyment of the trip is likely to be directly proportionate to the number of deer glimpsed. And to the resort operator having lots of deer around keeps the clients happy and is just good business. So, how can there be too many deer!

Shortage of food and damage to the range are not easily detected by the untrained eye, and most people never have an opportunity of seeing deer country in the winter when these things are most conspicuous. The buck law seems to be such a safe and sensible conservation measure. Killing the young ones and the producing females seems so risky and unnecessary, and above all, so unsportsmanlike. Yet it is exactly this which must be done if the herd is to be controlled. Game managers of the Conservation Department began advocating antlerless harvest in the 1930's when range damage and starvation began to spread. Resistance was massive and resolute. Emotions, sentiment, economics, and politics all joined forces to oppose such heresy. The department could not act without permissive legislation, and the lawmakers were hard to convince. Education was obviously needed, and the job was started. It was a long, slow process, and is in fact still under way, spearheaded largely by the

game managers themselves who soon found out that the most effective and indisputable way to spread the gospel was to take people right into the winter yards to show them browse lines and dead deer.

Progress has been discouragingly slow, and results a long time in coming. But the sacred buck law was eventually dethroned. Jenkins and Bartlett (1959) chronicle the steps, beginning in 1941 with the short-lived antlerless camp deer law, proceeding through the special orchard seasons, the three-day any deer season of 1952, and finally the antlerless deer law of 1956 which has prevailed to the present time. This act authorizes the Conservation Department to open special antlerless seasons in addition to the regular buck season in areas where food shortage or crop damage occur, with the kill regulated by a quota system. Under this authority antlerless deer have been harvested each year since 1956. One year, 1961, was virtually closed except for a single small area where orchard damage had been serious and a few antlerless deer were taken. In the other six years numerous special areas were established in both Upper and Lower Peninsulas and varying quotas of permits were issued.

The actual number of antlerless deer killed in Michigan, except for the seasons 1952 and 1959, has been too small to have had any real control of the overpopulation problem (see Figure 3). Quotas have been kept well below levels that would have actually removed the surplus. The continuing starvation die-off figures attest to this. Conservation Department records of deer kill and starvation losses for several recent years are shown below in Table 1.

Table 1. Antlerless deer kill and deer starvation losses in Michigan, 1956-1962

	Antlerless kill	Starvation
1956	12,530	50,650
1957	14,924	*
1958	25,792	*
1959	46,970	21,050
1960	28,370	38,650
1961	48	*
1962	32,510	31,040
Total	161,144	141,390

* Light losses, no survey made.

This conservative harvest of antlerless deer is largely a reflection of the doubts and fears that still dominate much of the public's attitude toward herd control. The loudly expressed opposition from certain groups and individuals tends to amplify this and perhaps weight it too heavily. The result has been that special season quotas are set well below actual needed harvest levels, apparently on the theory that it is better to take some antlerless deer rather than none at all.

The fact remains, however, that overpopulations still persist on much of our deer range. Buck hunting alone is not controlling the herd, and the antlerless kills, while taking some of the surplus, still need to go much further. Deer that are not removed from overcrowded range by hunting stay on until starvation removes them, but in the meantime they are consuming the limited food supplies and forcing the already low carrying capacity even lower. Effective management of this important

Michigan resource hinges fundamentally on an adequate harvest. To date, though we have taken important steps toward that goal, we are still falling short. There are hopeful signs that this will improve. Repeated antlerless seasons are conditioning people to the fact that shooting does and fawns will not destroy the herd. Opposition is fading and support by responsible organizations is growing. It seems likely that more realistic harvests will be possible in the very near future.

Harvesting the Forest

Stated in its simplest form, the solution to the first part of the deer problem is, kill more deer. The second part has a solution which can be phrased just as simply, cut more trees. A maturing forest, advancing in successional changes, can be set back and started over again quickly by removing (cutting off) the old growth and letting nature proceed with revegetation. This, when done improvidently and on a massive scale, as we once witnessed in the logging off of the pineries, can waste and destroy values that may never be regained. On the other hand, done with foresight and guided by scientific principles, the harvesting of trees is salutary and desirable. It is, in fact, the essential basis of good forest management.

Obviously, we will never again subject our forests to wholesale exploitive clearing. Scientific forestry with its management technology is well established on public and private lands. But without the wholesale cutting which was really the basis for originally creating so much good deer range, have we any hope of re-creating it on the now grown up range? Where once (1889) Michigan's forests were producing 5 1/2 billion board feet of lumber, present day production is about 400.

million board feet, one-fourteenth as much (Findell et al., 1960), and the trend is downward. This is certainly not an encouraging picture for deer, but, it is fortunately not the complete picture. Sawtimber is no longer the primary forest product; in recent years it has been greatly overshadowed by another--pulpwood. Michigan's harvest of trees for pulpwood has increased from around 200,000 cords in 1900 (Findell et al., 1960) to 1,248,318 cords in 1960 (Pfeifer, 1961). This trend is continuing upward, and it can go considerably higher. In 1954 the allowable cut of pulpwood species was about 50 per cent higher than the actual cut, which means that from a forest management standpoint it would be highly desirable to increase the annual harvest.

Markets, of course, are the big controlling factor in harvesting forest products. New uses of pulpwood and new industrial processes have greatly increased the demand for this raw material in Michigan. It has been particularly true for one species, aspen. And this, more than any other, may be the factor which will solve the second part of Michigan's deer problem.

The aspen type (forest land dominantly one or both of two species, Populus tremuloides,² trembling aspen, or P. grandidentata, large-toothed aspen) is the commonest forest type in northern Michigan. It occupies about 27 per cent of the total commercial forest area in both Upper and Lower Peninsulas (Findell et al., 1960). Quick growing, intolerant of the shade of other trees, aspen is one of the earliest tree stages in plant succession. In much of northern Michigan's cutover land following the great fires, it seeded in quickly and became the first stage of a

²Plant names, common and scientific, are according to Fernald (1950).

regrowing forest. Most of the stands, since they started at about the same time, are roughly even-aged and are now poletimber size. Since aspen grows rapidly and has a short life span much of it has become mature in Michigan during the past 20 years and in many cases it is going into over-maturity.

The market for aspen was very limited until recently. It is not a desirable lumber or veneer species and its pulpwood potential was not at all outstanding. In 1945 foresters estimated that the annual harvest of aspen in the Lake States was only 25 per cent of its annual cubic volume growth (Zehngraff, 1949). The situation was not an encouraging one from either a forester's or a game manager's standpoint. The tree that covered more forest land and more deer range than any other seemed to have little chance of ever being harvested on a wide scale. Maturing aspen stands, already of little value as deer habitat, would soon start to decline in volume growth and timber quality. Yet without an active and expanding market for the species there was little that could be done to improve the situation.

Beginning about 1949 the market for aspen began to expand (Westell, 1960). This was largely due to new pulp processes and new mills which began to utilize aspen on a large scale in the manufacture of corrugating board and paperboard. By 1954 four of such mills were in production, and between 1956 and 1958 three new mills were operating. One of these was designed to produce bleached kraft paperboard utilizing pine as well as aspen (Findell et al., 1960). Thus was a new era ushered into the forest products industry in Michigan, and the future for the state's aspen stands suddenly became brighter.

Aspen harvest has increased by leaps and bounds (Figure 8). Where only 30,000 cords were cut in 1936, by 1950 the statewide cut was 350,000 cords and in 1960 it had climbed to 680,000 cords (Pfeifer, 1961). This very welcome expansion to cutting on a large scale has affected Region II forests more than those of Region I. Logging for both saw-timber and pulpwood had centered largely in the Upper Peninsula before the aspen boom with very little of either being done in the Lower Peninsula. The new program now meant that large scale cutting operations were being carried on in the region for the first time in many years. Suddenly the loaded pulpwood truck became a common sight on Lower Peninsula highways (Figure 9), and soon dense stands of aspen regeneration began to spring up on the newly cutover areas (Figure 10).

Aspen, in common with other poplars, produces a widespread and shallow root system. Cutting or otherwise destroying the parent stem of an aspen will, if conditions are right, stimulate adventitious buds on the roots to produce sprouts. Large numbers of these root suckers spring up quickly and grow rapidly after cutting, providing a very efficient asexual reproductive mechanism in this forest type. Since sunlight is essential in this process complete removal of the canopy through clear-cutting is the recommended silvicultural practice to assure a future stand of the same type (Zehngraff, 1949). Here then was just the answer to the second part of the deer problem, a quick and thorough setting back of forest succession to a stage of young second growth.

But how beneficial would this be to the deer herd? Would this regrowth be utilized by deer, will it affect overall carrying capacity of the range, and can it be sustained long enough to be significant? These important questions have not been completely answered, but there are good indications that deer are benefiting and that, if their numbers



Figure 9. Pulpwood load. Trucks hauling aspen to the mill are a common sight on northern Lower Peninsula highways.



Figure 10. A dense growth of aspen suckers blankets the cutover area one season after pulpwood harvest.

can be kept in reasonable bounds, the expanding acreage of new second growth will mean improved habitat and an upturn in carrying capacity. The comprehensive study of aspen and its ecology recently undertaken by the University of Michigan School of Natural Resources (Phoenix Project No. 29) included an investigation of deer-aspen relationships. Westell (1960), who pursued this study and reported it in a doctoral dissertation, found that deer are heavily utilizing the sucker growth in commercially cutover aspen stands in the Lower Peninsula. He concludes that aspen logging can provide a continuing large supply of good quality food for deer but cautions that populations of deer must be controlled to prevent destruction of future stands.

An important consideration in evaluating the potential influence of the aspen harvest on the deer herd is the fact that such a large proportion (27%) of the state's over-all range is in the aspen type, and furthermore the portion of the deer range that has been most seriously overbrowsed for such a long time has an even greater supply of aspen. An examination of recent timber inventory figures will document this and provide some indications of the potential future cut.

The Michigan cooperative forest survey has published timber resource information by groups of counties. The report on the Mio Block (Quinney et al., 1957) includes five counties, Alcona, Crawford, Ogemaw, Oscoda, and Roscommon. This block coincides rather closely with the northeast deer food shortage area delineated by the Conservation Department (Ryel and Fay, 1962) and shown on the map in Figure 15. Conditions in these counties represent the heart of Lower Peninsula deer range and the nucleus of Michigan's deer problem. Figure 11 shows the percentages of the principal forest types in the five counties, and Figure 12 illustrates the proportions of the various size classes of the combined types.

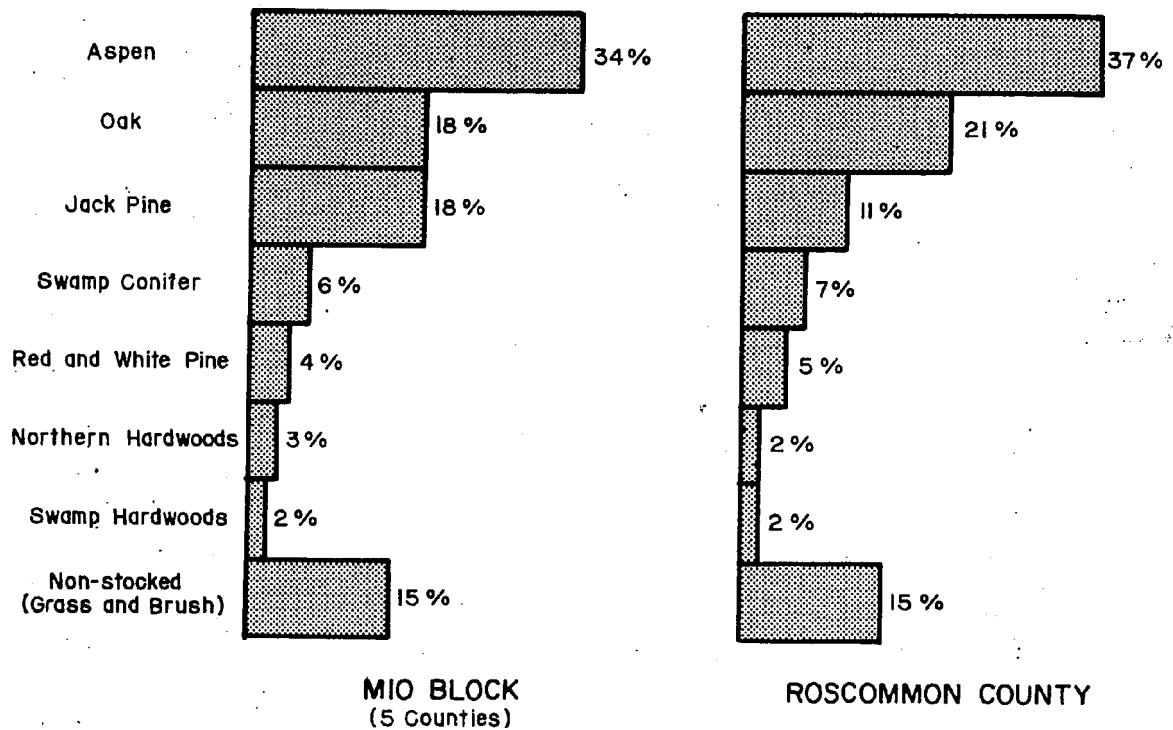


Figure 11. Percentage of forest land area in major cover types (Quinney et al. 1957).

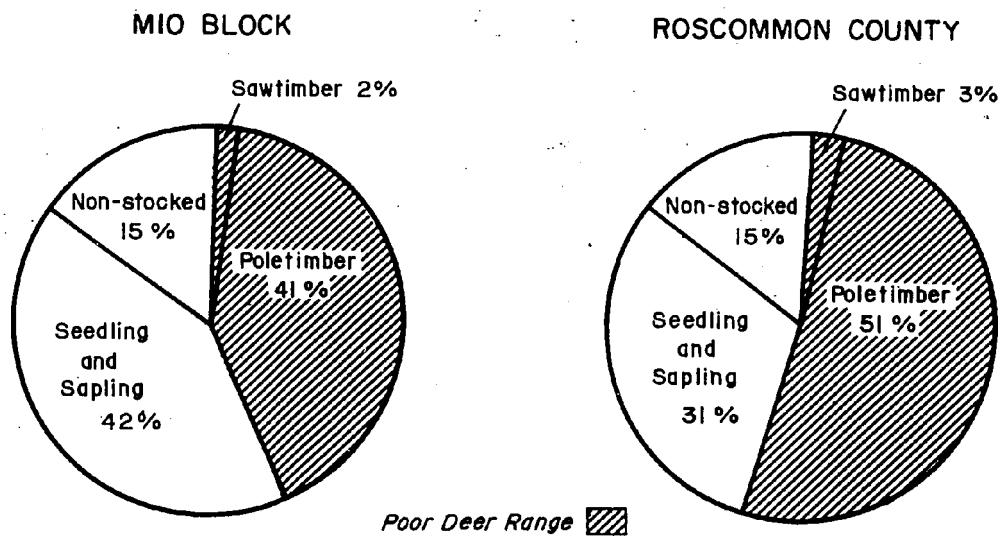


Figure 12. Percentage of forest land area by stand-size class (Quinney et al. 1957).

(Also presented in the figures are similar graphs for a single county of the block, Roscommon. This is the location of Mid Forest Lodge, the area with which this study is concerned, and the comparison shows that this county is typical of, and perhaps epitomizes, the points which will be discussed below).

Aspen dominates the forest here, occupying over one-third of the block and nearly equaling the combined area of the other two important types, oak and jack pine. These three types are characteristic of the lighter, poorer soils which are so common in this section of the state. Northern hardwoods, reflecting better soils, occupy only a very small portion of the block. In other sections of the deer range, particularly the Upper Peninsula, the hardwoods assume a greater role, usually to the detriment of deer range quality since they represent successional climax. Swamp conifers, the vital winter range for deer, and non-stocked types with scattered trees, brush and grassy openings, together occupy a significant portion of the total and contribute essential environmental ingredients.

These types, occurring as they do in good inter-mixture, once provided almost ideal habitat for deer when they were in earlier stages of second growth. Presently, as Figure 12 shows, they are to a large extent growing into the poletimber stage which must be classed as poor range. Most of the poletimber aspen stands, however, are the proper size for pulpwood harvesting, and the cutting they now sustain is beginning to convert an appreciable amount of this size class back to the earlier stage, seedlings and saplings. Inventory figures for 1960 show the annual pulpwood aspen cut in the five counties to be 75,000 cords (Horn, 1962), which was 21 per cent of the total for Region II. The

timber resource report estimates that the net annual growth of the aspen type in this block for 1955 was 154,800 cords, and the annual allowable cut for the years 1954 to 1963 is 144,500 cords. Thus the 1960 cut was 48 per cent of what was actually grown and 52 per cent of what could be harvested. Aspen logging in this vital deer area is certainly not overly exploiting or exhausting the resource. It can be safely sustained at present or expanded levels as a continuing program into the future.

Applying the Solutions

It appears, then, that solutions to the two parts of the deer problem are at hand. Furthermore, they are being applied on a statewide scale, though with limitations. Is the problem now in fact being solved? Can we at this point find any evidence that management of herd and range are taking affect? For the deer range as a whole I believe it is too early to answer these questions. Responses are not rapid and are not easily measurable. Time will be required to build up the series of data which will significantly reflect trends. Smaller areas that permit more intensive study should provide answers earlier. Such an area is the Mid Forest Lodge, the subject of this dissertation.

On this private club both of the essential deer management measures have been undertaken. An aspen cutting program was begun in 1956, and antlerless deer hunting under state regulations has been permitted in five of the past eleven years. Further, an enlightened club leadership, in the interest of obtaining vital statistics on their deer, have established hunting season checking procedures which provide a degree of accuracy in harvest data unique in the state. For these reasons,

and also because of its location conveniently nearby the Houghton Lake Wildlife Experiment Station, this club was selected for the intensive study herein reported.

It seems evident that this area should provide some early indications of the effectiveness of a large scale cutting program combined with a degree of herd control. How do the deer themselves respond? How have their numbers, movements, behavior, physical well-being, and productivity been affected? How has the vegetation responded, and how have deer affected this response? Answers to these questions on an area of this size should give some hint of what the future holds on a statewide scale.

My investigation was planned as an approach to the first aspect: a study of the deer and their responses. (A second, and corollary study, to be carried out by another worker, would have dealt with the questions on vegetation, but to date this study has not been made.) In order to include a broad enough series of observations to measure trends I found it necessary to extend the study over a four year period, applying generally the same methods of population surveys as used by the Game Division in its statewide investigations. These included hunting season bag checks and examination of deer killed, pellet counts, dead deer surveys, roadside counts, and track counts. In most cases I have modified the methods somewhat to adapt them to the special requirements of an intensive study. The following chapters describe the study area and the methods used; facts obtained on the Mid Forest herd are presented and analyzed; comparisons are made with similar data from other areas, and conclusions are drawn as to the effectiveness of the management program.

THE MID FOREST LODGE HUNTING CLUB

Deer Hunting Clubs

One of the singular outgrowths of the frenetic sport of deer hunting in Michigan is the private deer hunting club (Figure 13). While it is undoubtedly true that the vast amount of public lands in the state have been largely responsible for making the sport so popular, paradoxically its great popularity has driven many of the participants to seek private hunting opportunities. Since few could afford as individuals to own or lease tracts large enough to provide the degree of privacy they sought, group ownership became the logical alternative. Hunting clubs in large numbers were formed in the 1930's, acquiring their holdings for the most part in the tax delinquent cutover lands (Figure 14) where the deer herd was burgeoning. While some are scattered throughout most of the deer range a large proportion of them are concentrated in a block of about 400 square miles in the northeastern Lower Peninsula. This large area is known as the "club country" and is devoted almost exclusively to deer hunting. Clubs may have from 5 to 500 members and range from 1 to 50 square miles in area. Westell (1956) estimates that at least 20,000 deer hunters are club members.

Centered as they are in the heart of the deer range the clubs have long been afflicted with the deer problem. It was, in fact, in the vicinity of one of the oldest and largest clubs that browsed out

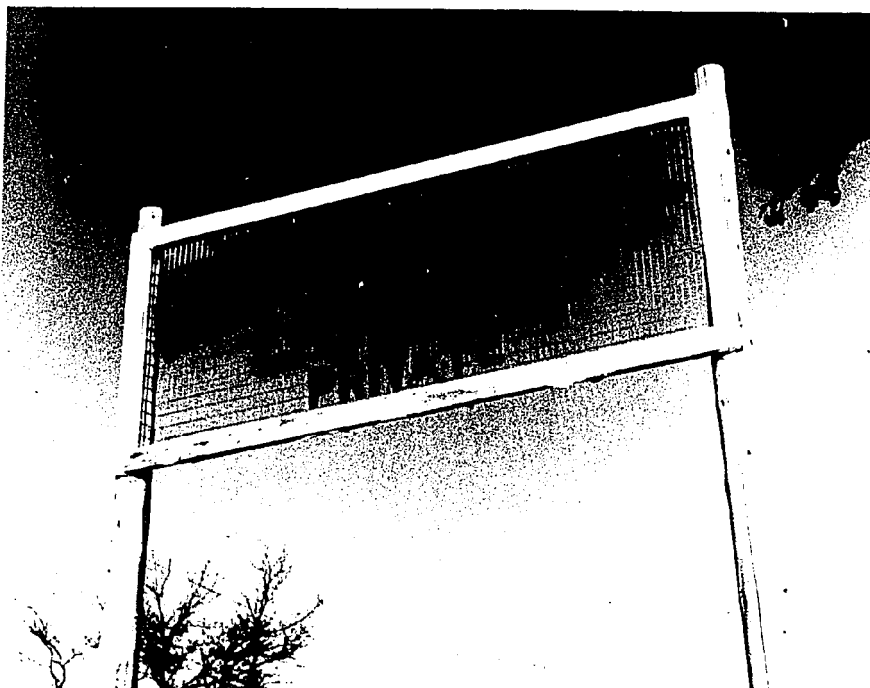


Figure 13. Members of this large, fenced club are proud of their property and mark it with an attractive sign.



Figure 14. Most of the club was pine land, cut and burned. A forest has regrown on much of it, but some spots remain open.

yards and winter starvation were first noted in the Lower Peninsula (Bartlett, 1938). The limited hunting, which clubs by their nature have provided, has aggravated overpopulation. Poletimber second growth, blanketing most of the holdings, has steadily become poorer deer habitat. The deer clubs for some time have been outstanding examples of the deer problem at its worst. Recently, however, a chance for improvement has come their way. The expanding pulpwood industry, seeking stability in its future sources of raw material, recognized that it shared with the clubs and their large acreages of maturing aspen a concomitance of interest in sustained yield forest management. An aspen harvest program which would assure continuing future crops of pulpwood for the industry would also provide continuing improvement of deer range for the clubs. At least two of the larger pulp-paper producers have acted on this and for several years have been enrolling numerous deer clubs in forest-game management programs. The companies in return for stumpage options provide participating clubs with technical assistance, forest resources inventories, and detailed forest and wildlife management plans (Westell, 1956). Cutting is contracted with local operators and is supervised by company foresters. The income from stumpage fees realized by the clubs often assumes a major role in their financial affairs.

Mid Forest Lodge is a hunting club that has availed itself of such an arrangement. Its agreement with Packaging Corporation of America was one of the earliest in the program, and extensive portions of its lands are now under sustained yield forest management. This large and progressive club is an outstanding example of the opportunity that Michigan's club country now has to do something about the plight of its deer range.

Description of the Mid Forest Lodge Area

Location

The Mid Forest Lodge club is located in the heart of Michigan's most populous deer range. Figure 15 shows its location and its geographic relationship to other areas discussed in this study. Its size is 18,080 acres, or 28.25 square miles, roughly 80 per cent of a 36 square mile township. Due to the rather uneven boundary on its east side it is not exactly rectangular. Its long dimension, north and south, is six miles; its width at one point in the center is six miles. However most of the north half is five miles wide and the south half four miles. The main entrance road leading west from the Main Gate connects with Highway M-18 seven miles south of the village of Prudenville, Michigan. Access on the club's east side is through the East Gate located on Roscommon County Road 500 seven miles south of its junction with M-55. Gladwin, Michigan is 17 miles south from this access point.

The boundary of the club, which for the most part follows section or quarter-section lines, is fenced entirely with four-foot high woven wire. Signs posted at frequent intervals, identify the club and caution against hunting or other trespassing. In addition to the Main and East gates two other gates permit entrance on the west side. All four are padlocked. Members are furnished keys and may use any gate they wish except during deer season when only the guarded Main and East gates may be used.

There are about 50 miles of drivable roads and trails on the club. The main roads are kept in good repair and the secondary trails

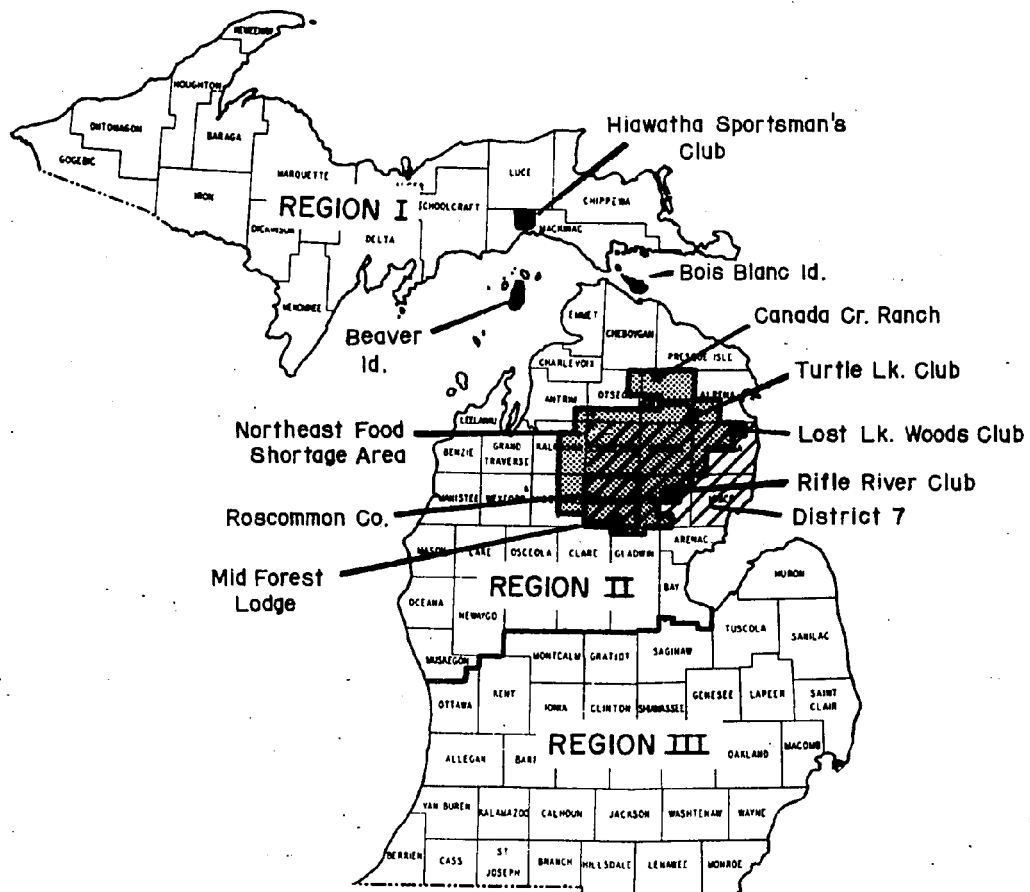


Figure 15. Geographical locations of areas included in the study.

are normally passable except in winter. Usually in the winter only the entrance road is plowed open from the Main Gate to the clubhouse and caretaker's residence. The road network covers the area quite thoroughly giving access to at least some portion of every section in the club.

Physiography and Soils

The topography of the area ranges from gently rolling flats to moderately high, irregular rounded hills. All features are constructional and glacial in origin. While some of the level areas are parts of outwash plains, most of the more irregular surface is morainic in character and is shown by Martin (1955) to be part of the West Branch moraine of the Saginaw Lobe. Numerous small lakes and ponds occupy depressions in both moraine and outwash surfaces.

Elevations range from 1,100 to 1,300 feet above sea level. Relief is greatest in the southeastern quarter of the area where some of the steeper slopes rise 100 to 150 feet.

Surface drainage is mainly northwestward through Denton Creek to Houghton Lake and the Muskegon River watershed to Lake Michigan. A small portion of the southeastern part of the area drains to the southeast into the Tittabawassee watershed to Saginaw Bay. Watercourses are small and intermittent except for the Denton Creek headwaters, a small, slow outlet from Ryan Lake flowing northward through marshland for about a mile before leaving the area.

There are 10 lakes on the club varying in size from 10 to 80 acres. These plus about 20 smaller ponds, potholes, and beaver floodings occupy a total of 228 acres, or 1.3 per cent of the club's total

acreage. About five per cent of the land area is wet swamp or marshland and another five per cent is poorly drained and semiswampy in character.

Eleven soil types are present within the boundaries of the club according to Veatch et al., (1924). I have grouped these into four generalized categories in Table 2. Areas of each type were planimetered from Veatch's map. Figure 16 shows the locations of these soil groupings on an outline map of the property.

The deep, dry sands of the Roselawn, Rubicon, and Grayling series predominate here as they do in much of the county. These soils, droughty and inherently low in fertility because of the near absence of a clay component, under the virgin pine forests had managed to accumulate a fair amount of humus in their upper horizon. This, their one redeeming quality, they lost almost completely in the repeated great burns of the early post-logging era. They have virtually no agricultural potential.

Only slightly better are the other dry sands that have some clay at varying depths beneath them. They are distinguished here primarily by their slightly better site quality and the occasional appearance of other hardwood species in the type mixture. In some situations soils of these types have had moderate agricultural or horticultural development, but abandonment has been the rule. A large apple orchard on Roselawn gravelly sandy loam adjacent to the northeastern boundary of the club has been abandoned for many years.

The poorly drained sands and the wet organic soils support a diversity of swamp forest, brush, and marshland types and supply moderate amounts of a much needed component: winter cover.

None of the soils on the club have any but a very low degree of agricultural desirability. Their best use is clearly forestry and recreation. In this respect they are typical of a large part of the principal deer problem area.

Table 2. Soils of Mid Forest Lodge

Soil type	Per cent of total land acreage
Dry sands, deep, low fertility, acidity high	
Roselawn sand	55.7
Rubicon sand	12.7
Grayling sand	<u>5.3</u>
	73.7%
Well drained loamy sands, moderately acid, some clay in deeper layers, moderately fertile	
Roselawn gravelly sandy loam	7.7
Ottawa loamy sand	5.3
Roselawn sandy loam	<u>1.6</u>
	14.6%
Poorly drained sand loams, high acidity, low fertility	
Saugatuck sand	5.2
Newton loamy sand	2.4
Bergland clay loam	<u>.2</u>
	7.8%
Organic soils, peats of heath bogs or conifer swamps	
Rifle peat	2.7
Greenwood peat	<u>1.2</u>
	3.9%
	<u><u>100.0%</u></u>

Climate and Weather

Weather data presented here were recorded at the Houghton Lake Wildlife Experiment Station, also in Roscommon County. This location is approximately 14 miles northwest of the center of Mid Forest Lodge, and weather differs but little between the two. The station participates in the cooperative observer system of the U.S. Weather Bureau. All measurements were made by means of standard instruments furnished by the bureau.

The climate of the study area can be classified as cool and dry, principally continental in character, although alternating at times with a semimarine type due to the Great Lakes influence. Precipitation in the summer period occurs largely as thunder showers and in the winter it occurs mostly as snow.

Temperature and Precipitation

The monthly and annual mean temperatures and precipitation for the 10-year period of operation of the Houghton Lake weather station are shown in Table 3. The annual mean temperature is 44.4°F. February is the coldest month, averaging one-half degree below January, and July is the hottest. The frost-free period averages 124 days and has varied from 139 days in 1952 to 98 days in 1956. First frosts normally occur in mid-September, last ones in mid-May.

Annual precipitation averages 28.14 inches. It is fairly well distributed, ranging from 1.33 inches in December to 3.19 in June.

A climatograph constructed from these data is shown in Figure 17. This graphic form of depicting climatic conditions is often useful in pointing up significant weather factors. In this case the proximity of

Table 3. Mean monthly temperature and precipitation. 1952-1961,
Houghton Lake Heights, Michigan

Month	Monthly Temp. °F.	10-yr. means Precipitation inches	12-year mean total snowfall inches
January	21.1	1.53	15.1
February	20.6	1.33	11.5
March	28.4	1.73	9.2
April	42.4	2.20	1.3
May	54.7	2.82	
June	64.4	3.19	
July	68.3	2.61	
August	66.4	2.64	
September	58.6	3.02	
October	48.5	3.06	
November	35.1	2.24	5.8
December	24.6	1.77	12.3
Annual	44.4	28.14	55.2

the point for March to the three preceding winter months is a good illustration of the rather prolonged winter season that is normal for the present deer range in Michigan.

Snowfall

Measurable amounts of snow usually occur during six months of the year (Table 3). Total snowfall averaged 55.2 inches for the period of record, ranging from 1.3 inches in April to 15.1 in January. The range in annual totals during the period was rather great, 28.3 inches in 1952-1953 and 76.4 in 1959-1960 (Figure 18).

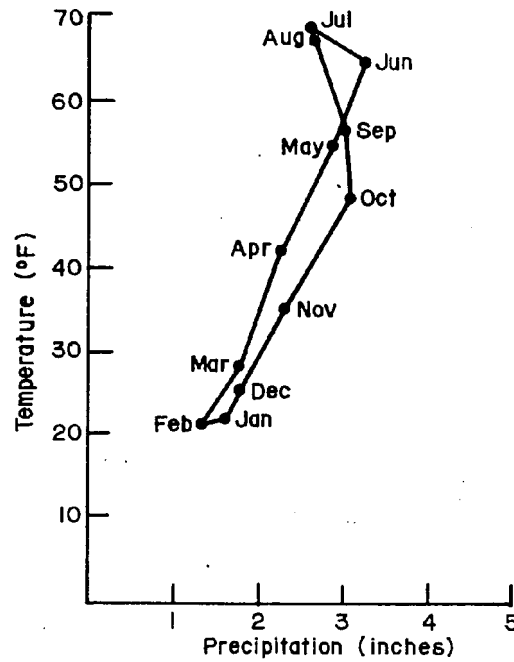


Figure 17. Climatograph, Houghton Lake, Michigan. 1952-1961.*

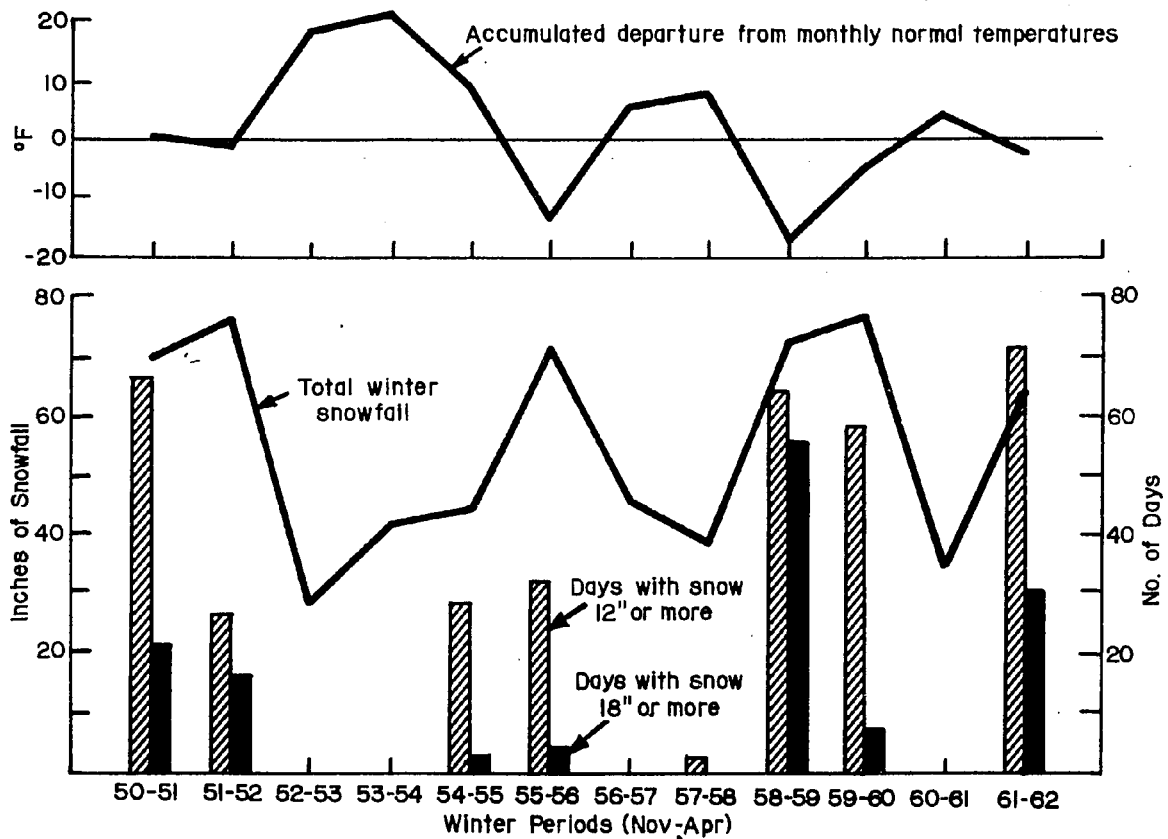


Figure 18. Indices of winter severity, Houghton Lake, Michigan.*

*Data from Houghton Lake cooperative weather observer station, U.S. Weather Bureau.

In most years the ground is snow covered throughout the winter. Snow begins to accumulate in late November or early December and, though it may settle or thaw some between storms, it usually increases in depth for many weeks. Seldom are there thaws which lay bare the ground once December arrives. Depths of 12 to 18 inches are common, having occurred in 8 of the past 12 winters, and 24-inch depths were recorded in 4 of those.

Severity of Winters

Severe winters for deer are those with prolonged deep snows that confine the herds in the yards for many weeks. As a means of obtaining an index to severity the Conservation Department has established 32 snow depth gauges, scattered throughout the deer range. Weekly readings of the depth of snow on the ground at each of these gauges are averaged and the figure obtained for the entire period, November through April, serves as a rating of the winter. These records extend back to 1937. Bartlett (1949) in analyzing this information and relating it to the observed starvation losses concluded that a winter average of .4 foot was the minimum critical depth in Region II, and that all winters with heavy losses had depths of .4 foot or more. There were, however, some years with snow of those depths which did not have serious starvation, so the index is not a consistent reflection of winter severity on deer.

In seeking a better expression of this factor for my study area I have reviewed the 12 years of weather observations at the Houghton Lake station and have extracted data for total snowfall and for the number of days each winter that snow depth reached or exceeded 12 inches and also 18 inches. In addition, since colder weather makes greater energy demands, and an index of relative temperatures seemed desirable,

I computed for each year an accumulated departure from normal. This was obtained by calculating the difference each month between the monthly mean temperature and the normal or long term mean for the month. These departures, expressed as plus or minus, when added for the season gave a total accumulated departure from normal and should indicate the relative warmth or coldness of each winter.

The three measurements of winter severity are shown graphically in Figure 18. It appears from their data that five of the past twelve winters have been mild, and that the seven harder winters have varied in severity, with the 1958-1959 season being the worst of all. Four other winters may have approached this one: 1950-1951, 1955-1956, 1959-1960, and 1961-1962. Department of Conservation records show that these were the five years of heaviest starvation losses throughout the state (Jenkins and Bartlett, 1959; Ryel and Bennett, 1962). Data on winter mortality presented later in this report will indicate the extreme rigors of the very bad winter of 1958-1959.

Vegetation

Northern Michigan lies within the Canadian Biotic Province of Dice (1943). The climatic climax in this zone is northern hardwood forest with sugar maple (Acer saccharum) dominant. However, Mid Forest Lodge is located within an important subclimax found on poor, sandy soils in the Great Lakes area. This is a mixed pine type, largely white pine (Pinus Strobus) and red pine (Pinus resinosa). Shantz and Zon (1924) term this the northeastern pine forest. Successional stages resulting from logging and fires are usually aspen, jack pine (Pinus Banksiana), paper birch (Betula papyrifera), and oaks.

Original Forest Cover

Wherever one looks over all the lands enclosed by this club pine stumps meet the eye (Figure 14). There can be no doubt that this area 100 years ago was almost a solid block of towering pines. Yet this forest was by no means purely pine. The general Land Office Survey field notes and map (1837 and 1850) for this township, while making continual reference to "White and Yellow Pine" also frequently mention "Beech, Maple, Hemlock, White and Black Oak, Aspen, and Spruce." On the map along the western boundary of the township is noted a stand of "Pitch Pine." It is interesting to see that at present this same location is still occupied by a block of pure jack pine.

Veatch (1959) in his map of presettlement forests shows this township to consist mostly of a type he classified as white, red, and jack pine; oaks, aspen, and red maple. Wet sites were two types: spruce, cedar, tamarack, fir; and elm, ash, red maple, aspen, yellow birch, and white birch.

Present Cover

It is hard to visualize a change in vegetation so drastic and complete as that which swept away the Michigan pineries. No better example of it can be found than on the lands of this club. With the stumps on every hand a constant reminder of what once grew here, one can search in vain over many square miles for a living remnant of that original splendid forest. Except for here and there a few scattered, tall-stemmed relics the red and white pines are virtually non-existent. The lumberjacks were thorough, but the fires that followed, in the slash and later in the young second growth, were even more so. No vestige of

the pine forest escaped them here. And the land, struggling to renew a forest cover on its almost sterile sandy wastes, was forced to start over again at the bottom of the scale with a much less noble generation.

Cover on the Mid Forest Lodge today consists of six major forest types. These have been identified and mapped by foresters of the Packaging Corporation of America in their development of a management plan for this club (Westell, 1958). These and five other land and water types found on the area are listed in Table 4.

Table 4. Cover types on Mid Forest Lodge

Type	Acres	Percentage of total
Oak	7781	43.0
Aspen	7139	39.5
Openings	1876	10.4
Mixed coniferous swamp	278	1.5
Lakes	228	1.3
Lowland brush	227	1.3
Swamp hardwoods	207	1.1
Muskeg	197	1.1
Northern hardwoods	62	0.3
Jack pine	50	0.3
Marsh	35	0.2
Total	18,080	100.0

A generalized map showing the locations of principal cover types is presented in Figure 19. As will be seen, the pattern and distribution of these types is varied and intermixed. Roughly, oak

MID FOREST LODGE CLUB

ROSCOMMON COUNTY, MICHIGAN

T 21 N , R 2 W

Scale in Miles



Club Area: 16,080 acres - 23 1/4 sq. miles

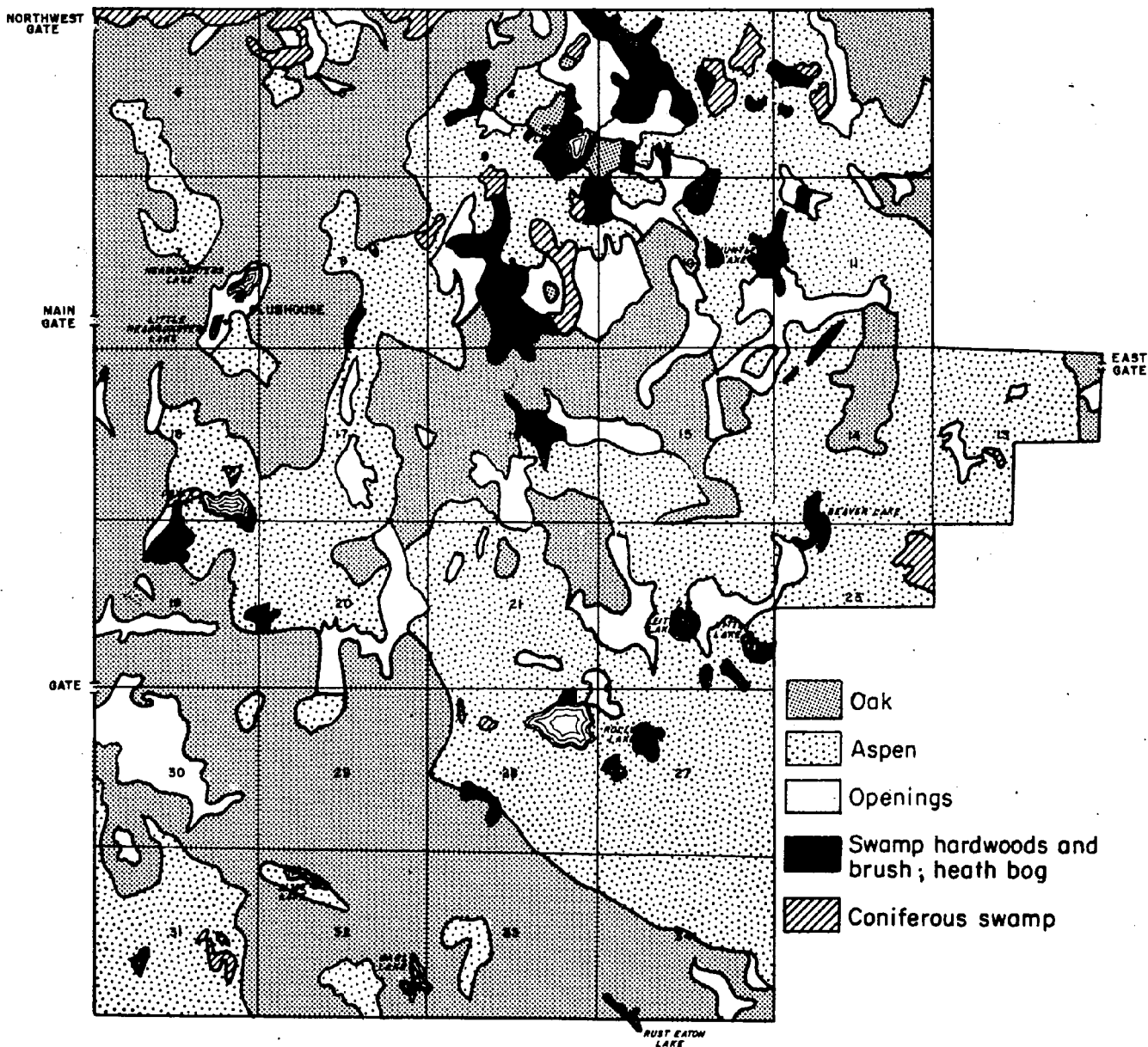


Figure 19. Generalized cover types.

dominates the western half of the club and aspen the eastern half. Irregular openings of fairly large size are scattered throughout, but are more frequent in central and northeastern sections. Swamps do not occupy a very large portion of the area, and they are most common in the northern third.

Oak Type

The oak stands, occupying 43 per cent of the club lands, are the largest single forest type. Three species of oak are found in the area, red oak (Quercus rubra), jack oak (Quercus ellipsoidalis), and white oak (Quercus alba). The first species is most common. It occurs in mixture with aspen on some sites, and often grows in nearly pure stands on many of the driest sites. Poletimber size predominates, although sawtimber trees are not uncommon. Some of the pure stands are sapling size and of very poor quality, having originated from stump sprouts following an extensive burn about 38 years ago (Figure 20). All of them have a very sparse ground cover and understory, and very little reproduction is occurring. The oak in mixed stands tends to be of better quality but is also unsuccessful in reproducing.

Commonest plants in the sparse undergrowth of the oak stands include sweet fern (Comptonia peregrina), bracken fern (Pteridium aquilinum), blueberry (Vaccinium spp.), witch hazel (Hamamelis virginiana), and willows (Salix spp.).

Acorns are produced by the oak stands in varying abundance from year to year. This is usual in northern Michigan where blossoming oaks are at the mercy of frequently occurring late spring frosts. Fair to good acorn crops are produced at the rate of about two years out of five

Figure 20. Oak is the commonest forest type on the club. Some of the younger stands, such as this one, originated as stump sprouts, following an extensive fire. Undergrowth is very sparse in all of the oak stands.

Figure 21. Aspen stands are a close second to oak in total acreage. This is an example of a good site, well stocked with pure aspen. The trees are about 40 years old and poletimber size; undergrowth is completely absent. Such a stand offers no attraction to deer.



Figure 20



Figure 21

(Duvendeck, 1957). In contrast to white oak acorns which germinate within a month or so after falling, those from red oaks remain dormant on the ground over winter and do not germinate until the following spring. They are therefore available as winter deer food, provided the crop is bountiful enough and is not cleaned up by the many competing mast eaters, and provided snow is not too deep or too crusted to permit deer to dig for them. Oaks, then, in the occasional year when circumstances are favorable can be a good source of winter food for deer. On Mid Forest during the five years of this study there was only one year when these circumstances were right and deer fed significantly on acorns through most of the winter. In two other years fairly good crops were available in the fall and provided additional fattening before winter set in. Management of the oak types for deer food production will be discussed in a later chapter.

Aspen Type

Only slightly below oak in overall area the aspen type covers 39.5 per cent of the club. The classification, as used here, is a rather broad one. It includes both trembling and large-toothed aspen in stands ranging from nearly pure aspen to mixtures in various amount with several common associates. In whatever type of stand aspen occurs it is usually poletimber size and 30 to 50 years old. On better sites pure stands of well stocked aspen are putting on good volume growth (Figure 21) and offer excellent management possibilities. Mixtures with other species are usual on most other sites. Red oak, red maple (Acer rubrum), white oak, paper birch (Betula papyrifera), and balsam fir (Abies balsamea) all are frequently found growing with aspen. Quality and management potential vary according to soil and moisture conditions. Wetter sites may have very poor quality aspen, often deformed or diseased and very thinly stocked.

Undergrowth in all these stands is quite sparse. Bracken fern is usually the most conspicuous species, but under completely closed canopies even this is missing. Blueberry, witch hazel, and Juneberry (Amelanchier spp.) are shrubs that are found in quite limited numbers in most of the aspen type. Wintergreen (Gaultheria procumbens) occurs as a ground cover in certain of the better sites.

Openings

Open grassy areas occupy a fairly large portion (10 per cent) of the total acreage of the club. In addition to a great many small openings of 10 acres or less, there are at least a dozen very large, irregular shaped open areas of 40 to 200 acres in area. Most of these presently treeless sites were once forested, for stumps are still much in evidence. What has kept trees from regrowing is not readily apparent. Some stump removal and limited cultivation has occurred in a few instances, but for the most part there has been almost no farming on this land. Pasturing may have been tried for a brief period in some of the other sections. There is no evidence that it ever was done on a large scale, and it certainly has not occurred since the land was in club ownership. A few of these bare spots have the appearance of frost pockets (Figure 14), there being definite zoning apparent in the vegetation on slopes surrounding the sites.

Whatever their causes, these openings would seem to be a valuable element of the deer range. They provide a large amount of edge effect and are heavily used by deer in all seasons but winter. Most game managers are in agreement that openings in forest cover are of great importance in deer habitat, although it has never been precisely demonstrated why this is so.

Coniferous Swamps

These are mostly small seepage areas supporting stands of mixed conifers, principally white cedar (Thuja occidentalis), balsam fir, and sometimes black spruce (Picea mariana) and white pine. The trees are small, mostly sapling size, and usually quite heavily stocked. The edge zone around these small pockets in some cases supports a shrubby growth of willow or speckled alder (Alnus rugosa).

The total area of these swamps is just under 300 acres, only 1.5 per cent of the club. This is a much smaller proportion of the total than is usual for Roscommon County (see Figure 11), and it represents a distinct deficiency in the club's deer habitat.

A large conifer swamp lies immediately north of the club along the drainage of Denton Creek. It covers several square miles and is the most important area of winter deer range in the locality.

Other Lowland Types

The four other wet types listed in Table 4 have been combined in the type map. Taken together they occupy about 670 acres, or 3.7 per cent of the total area. No one type is very extensive, and they usually occur as small kettleholes or seepage areas scattered throughout most parts of the club.

The swamp hardwood areas are largely American elm (Ulmus americana), red maple, black ash (Fraxinus nigra), and aspen. Swamp brush consists primarily of willow, speckled alder, and swamp-birch (Betula pumila) located along the headwaters of Denton Creek. Here, too, is located a small area of open marsh, principally sedges (Carex spp.) and meadow-sweet (Spiraea alba). Heath bogs occupy occasional small

kettleholes a few acres or less in size. They are composed in almost every instance of a solid, dense mat of leather-leaf (Chamaedaphne calyculata) and sphagnum moss (Sphagnum spp.), with small amounts of blueberry, Labrador-tea (Ledum groenlandicum), and bog-laurel (Kalmia polifolia).

The above types in their principal occurrence are all shown on the map in Figure 19. Two other forest types listed in Table 4 are too limited in size to be included. They are jack pine and northern hardwoods. A few very small stands of pure jack pine are scattered in the oak type near the western boundary. The northern hardwoods are limited to a single small stand of principally hard maple, red maple, and beech (Fagus grandifolia) located in the central part of the property. Together, these two types are less than one per cent of the total area.

Without exception all cover types on the Mid Forest Lodge are the direct results of the combined disturbance effects of logging and fire. The original forest cover of nearly solid red and white pine was cut off in a fairly short period about 80 years ago. Fires, large and small, burned uncontrolled in the slash and later in the new second growth. Many parts of the property suffered repeated burns throughout the nearly quarter century that elapsed before the era of wild fires was ended. As is so common in this region, the present patchwork pattern of vegetation has resulted chiefly from the many possible combinations of such factors as soil and moisture, number and intensity of burns, length of time between fires, season of the last fire, vegetation immediately preceding the last fire, kind and proximity of seed sources, and others.

Effects of Deer on Vegetation

There can be no doubt of the overpopulation of deer on the club in its recent past. The effects of their heavy browsing on the vegetation are evident in all cover types throughout the area. A browse line stands out starkly along the margins of all the coniferous swamps (Figure 22). This, of course, is the standard indicator of exhausted winter foods. Indeed, it is so common now in much of the northern deer range that it is difficult to find examples of swamp evergreens growing normally with foliage extending down to the ground.

Of much more significance is the browse line which can be seen in most of the upland types on the club. Though scarcely discernible in winter with the foliage gone, as summer comes, and the deciduous trees and shrubs leaf out, a sharp and distinct browsed zone becomes very evident along the edges of hardwood stands and on individual trees and large shrubs growing in openings (Figure 23). Close inspection reveals that nearly all foliage-bearing twigs within reach of deer have been repeatedly pruned away. This is summer range damage and is indicative of an extreme degree of overpopulation not often encountered in Michigan deer range. I am not aware of its occurrence on any public lands in Roscommon or neighboring counties. In fact, the only other cases I have seen of such a conspicuous upland browse line have been on some other private hunting clubs and on Bois Blanc Island in northern Lake Huron.

Browse lines are the glaring external scars of deer abundance, marking the absence of foliage from the lower parts of larger trees and shrubs. Smaller undergrowth, the shrubs and forest reproduction normally found from ground level to six feet above, may be browsed away in varying degrees; and, being gone completely, its absence is less conspicuous.



Figure 22. Browse line on conifer swamp. Deer heavily concentrated in winter yards soon eat away all evergreens within reach.



Figure 23. Deer browse line on hardwoods. When damage becomes as conspicuous as this on summer range, deer are much above carrying capacity.

This woody undergrowth is strikingly lacking in the forest stands on the Mid Forest Lodge. Its absence is most evident in the winter when leaves and herbaceous growth are gone and snow provides a contrasting background. The forest floor then is starkly barren in both aspen (Figure 21) and oak types (Figures 20 and 24). The numerous kinds of shrubs normally found in the understory are almost non-existent. Many species cannot be found at all; others that do occur are extremely limited in quantity. Tree reproduction of all species is a rarity. Oak seedlings in particular should be abundant but are actually few and far between in all oak stands. White pine reproduction is completely absent on the club despite the presence of numerous large, remnant seed trees scattered through many parts of the area. This is in contrast to a very noticeable abundance of white pine seedlings present elsewhere in Roscommon County on similar sites.

Even in the summer when herbaceous vegetation is present and shrubs are in leaf most of the stands on the club present a park-like, open appearance. Bracken fern, sweet fern, and blueberry provide a fairly abundant ground cover, but above that level there is virtually no foliage to impede the view. Smaller herbaceous growth appears to be relatively sparse, both in stocking density and in variety of species. Spring and summer wildflowers are uncommon and so, too, are fruits and berries except on higher shrubs and trees.

A poorer flora seems to be characteristic of areas with high deer populations. Westell (1960) presented evidence of this which he obtained in his quantitative studies of aspen stands. In comparing the number of plant species present in western and eastern portions of northern lower Michigan he found that aspen stands in the east had



Figure 24. A pure stand of red and white oak. Deer browsing pressure has eliminated all shrubs and tree seedlings.



Figure 25. Heavy browsing on two low-preference winter foods. Red pine, left, and balsam fir, right, are eaten only when better quality foods are gone.

38 per cent fewer species of shrubs and 44 per cent fewer herbs. He attributed this difference to a deer density twice as great in the east as in the west.

The marked preferences that deer display in their choice of foods often result, under moderately heavy browsing pressure, in contrastingly selective browse damage. Along swamp edges, for example, the greatly preferred white cedar will have a sharp browse line while the less palatable balsam fir will retain foliage down to the ground (see Figure 5). The less preferred red pine may have good survival of its seedlings while neighboring white pine seedlings, high on the palatability list, will be heavily damaged or completely eliminated. On Mid Forest Lodge balsam fir commonly has just as distinct a browse line as cedar (Figure 22), and red pine reproduction is about as rare as that of white pine. Figure 25 shows a young red pine and a balsam fir in the foreground at the edge of a cedar swamp. The browse line on both is indistinguishable from that on the cedar in the background.

The deformity of woody growth caused by repeated heavy browsing is much in evidence on the club. It occurs on all but the least palatable trees and shrubs but is most conspicuous on a few species which are resistant enough to survive many years of heavy pruning. These frequently assume a characteristic dwarfed, gnarly form as each year's growth of twigs is browsed back and internodal growth of stems is reduced to little or nothing. On Mid Forest Lodge witch-hazel commonly is deformed in this way (Figure 26) and oak seedlings, when found at all, are usually dwarfed and misshapen (Figure 27). Wild raisin (Viburnum cassinoides), a shrub regularly found around swamp edges in Roscommon County and a preferred deer food, is not often encountered within the club's boundary



Figure 26. Overbrowsed witch-hazel. Repeated heavy browsing on many shrubs results in twig deformity.



Figure 27. Browsing deformity on red oak. This 4-ft. high tree was 18 years old.

in the situations where one would expect it. In every instance where I have observed this species surviving it is so grotesquely deformed that it is almost unrecognizable. Staghorn sumac (Rhus typhina) falls in the same category. In the few openings where it can be found it is uniformly dwarfed to a height of about two feet. Other shrubs of lower palatability to deer occur where they usually would be expected and are of normal form. Most common of these are shrub willows and speckled alder.

The signs of severe overbrowsing are conspicuous on this area. They point to a very high deer population maintained for a relatively long period. Based on my several years of experience working in overpopulated deer range in this region, I believe that Mid Forest Lodge has supported a greater density of deer than any but the most severely crowded range of the "club country."

Although it is not within the scope of the present study, an assessment of range utilization, based on quantitative vegetation measurements and comparisons with other areas, is essential to a full understanding of deer and their management on this club. At the inception of this study it was planned that a paralleling vegetational phase would be carried on at the same time by another worker. This has not yet materialized, but it is hoped and strongly recommended that such an investigation can be initiated in the near future. The unique opportunity here for combined research on both the deer herd and the range should be fully exploited.

History of the Area

The Land

Very little logging era history has been recorded for this part of Michigan. Recollections of still living local residents are the best source of information on specific areas. Fortunately, a retired Conservation Officer, for 80 years a resident of Houghton Lake, clearly recalls many pertinent facts of the Mid Forest Lodge locality (White, 1963). The following account is based on his information.

The township T. 21 N., R. 2 W., 78 per cent of which is now the club's property, was logged off as a block over a period of about six years, 1880 to 1886. The operation was carried out by the Roscommon Lumber Company, and the total cut was in the neighborhood of 276 million board feet of red and white pine. The logs were hauled by rail to Prudenville where they were dumped into Houghton Lake. Then, towed 10 miles across the lake in rafts, they were floated down the Muskegon River 150 miles to the sawmills at Muskegon. Further cutting of hemlock and swamp conifers continued, off and on, for another 15 years. In 1892 a sawmill, set up in Section 9 of the township, produced lumber and shingles from some of this later cutting. By this time a railroad spur from the south had reached the area and products then went to Saginaw.

In 1904 a rather unusual enterprise was attempted in the northeastern part of the township. A Chicago firm started a plant to recover turpentine from pine stumps. Most of the stumps in Section 12 (now outside the club's boundary) were pulled before the operation was finally given up as unprofitable. The cleared land was planted to apple trees shortly afterwards, but this venture, although apparently more successful

for awhile than turpentine production, eventually languished from neglect and was finally abandoned. No other agricultural attempts were made on the lands now belonging to the club.

Fires large and small were commonplace in the township for many years following the logging. A particularly bad one in the spring of 1907 destroyed decked logs and threatened the mill in Section 9. The last, and perhaps the largest, of the big burns was in October, 1925, when an uncontrollable fire swept across the second growth of the entire township. The forest fire control efforts of the Conservation Department developed rapidly at this period, and no serious burns have occurred since. A wooden fire tower was constructed in Section 29 in 1935 but has been removed within the past few years.

Ownership of the land in this township did not revert to the state as was so common in much of the cutover pine lands. Following the logging period most of the property was acquired by a development known as the Eggleston Ranch. This was probably intended to be a livestock venture similar to several other large holdings in the county also known as "ranches." In this case, however, little or no grazing was ever done, and no other use of the land was attempted until its acquisition for a hunting club.

The Club

The Mid Forest Lodge Club was formed and incorporated in 1938. The original purchase of land from the Eggleston family amounted to 17,490 acres. Later acquisition of other parcels brought the total to 18,080 acres.

As stated in its by-laws, the club was formed as a nonprofit organization for "hunting, fishing, camping, and other recreational purposes." Membership shares are limited to 400, and shareholders' rights include use of the club lands, and the privilege of constructing cabins on designated building lots. The affairs of the organization are run by elected officers and a board of directors. A clubhouse has been constructed to provide food and lodging for members who do not have cabins on the area.

The club in its first year or two consisted of 78 members, but it grew rapidly, and it has been up to full membership for many years. The largest number of the members come from the nearer metropolitan areas of Saginaw, Flint, and Pontiac. Others are from Detroit, Lansing, and the nearby localities of Roscommon and Gladwin counties.

Construction of cabins is restricted to the subdivided areas around just two of the lakes and two limited zones along the east and west boundary fences. A trailer-park site has been designated, and two picnic areas are established in the by-laws. No other development is permitted on the property. The club's policy is to keep as much of the land as possible in a natural and undeveloped state.

Deer hunting is restricted to the members, their wives, and their minor children. Some members own plural memberships and may bring in a nonmember to hunt under this authority. No other hunting guests are permitted. All who hunt must register at either of the gates and must wear identification badges. Two gates are watched by paid gatekeepers 24 hours a day throughout the deer season, and the boundaries are patrolled by guards. Since 1954 gatekeepers have kept records of the number of hunters and the deer killed. Prior to that time this information was obtained from cards mailed to members.

The affairs of the club are generally handled by appointed committees. These include committees on fish, game, and forest management. The work of these groups in recent years is largely responsible for the enlightened program of resource management that the club has been following. In this respect Mid Forest Lodge has been a pioneer and leader among the state's many deer clubs, which, for the most part, have been slow to recognize and follow sound ecological principles in managing their lands.

The Deer Herd

The history of this area's deer and their habitat has been essentially the same as described earlier for the region in general. The pre-logging forest here was virtually a pure stand of pine and could not have supported more than a sparse deer population. The prolonged period of burning and reburning, from 1890 to 1925, undoubtedly resulted in brush and second growth at times ideally suited as deer range. This was also a period when there was little or no protection, and the year-round hunting kept deer numbers under control.

After the last big fire in 1925 the resulting second growth was accompanied by a period of tightened hunting restrictions and better enforcement. Deer increased rapidly and the area became known for its good hunting. Then, in 1938, came acquisition by the club and with it fencing, posting and patrolling against outsiders. The club's relatively small membership in its early years meant very light hunting pressure with probably very little illegal or accidental killing of antlerless deer. Even as membership and hunters grew to a maximum level in the 1940's the legal kill during buck seasons was relatively low. By

comparison public land in Roscommon County was receiving two or three times as much hunting pressure and sustaining a much greater kill of legal bucks plus a high illegal kill of antlerless deer both in and out of season.

The 10 years 1938 to 1948 were undoubtedly the period of deer eruption on the club. There are no reliable records to show this. The only kill figures obtained were mailed reports beginning in 1946, and these appear to be very spotty and incomplete. Recollections of a few of the long-time club members shed some light on this. John Campbell (1963), past president and member for 20 years, relates that bucks with large racks were common in the early 1940's, and that in the late 1940's does and spikehorns were plentiful with racks becoming scarcer. It is his impression that 1945 was the year of peak numbers of both bucks and antlerless deer. He remembers that browse scarcity began to show up in the late 1940's and that the ground became bare in the early 1950's. Don Eakle (1963), club secretary and charter member, similarly believes that overbrowsing became apparent in about 1945 and that a downward trend in the herd has been effective since about that time.

Others of the older members confirm that their best deer hunting was in the 1940's and that trophy bucks then were much more common than in the next decade. All accounts emphasize the great abundance of antlerless deer by the late 1940's. It was not unusual for individual hunters to see 50 or more deer a day in the beginning of the hunting season. By the early 1950's a decline had apparently begun, although in 1952, the first antlerless season, deer were still abundant enough to produce one of the largest buck harvests plus a high removal of does and fawns. Gate records of the kill were begun in 1954 and they show a continuing decline until 1957 (see Figure 39).

There is no evidence to indicate the fate of the deer that were obviously lost from the population during the period of decline. I believe it is safe to assume they were largely lost in heavy winter die-offs and in lowered production and survival of fawns. The starvation winters of 1947, 1951, 1952, and 1956 accounted for heavy deer mortality in much of the overpopulated range in this region. Losses must also have been high on the club in those years. That the members could be largely unaware of this is quite understandable. Finding starved deer requires special efforts to search the yards and their edges just after spring breakup. Few members ever visit the club until summer, and most do not actually get into the woods at all until hunting season. In the spring of 1959 when the first organized search for starved deer was made on the club (reported later in this study) 35 members participated in the survey. Winter mortality was high that year and many dead deer were encountered by the search teams on the sample plots. Yet it is highly unlikely that any member would ever have observed enough of the mortality to recognize its magnitude had the survey not been conducted.

What the numerical level of the Mid Forest herd was in its peak period we can only surmise. During the years of my study, 1958 to 1962, surveys indicated fall pre hunting populations of from 34 to 60 deer per square mile. Westell (1958) in his forest-wildlife management plan for the club, roughly calculated a 1957 population of about 50 per square mile. Since older members all agree that deer at their peak were appreciably more abundant than in any recent year, I believe we can assume the buildup reached a magnitude of at least 100 animals per square mile before declining. This is not an unreasonably high figure since deer drive censuses conducted by CCC workers have revealed populations of

100 or more per square mile in some areas of Wisconsin (Swift, 1946) as well as Michigan (Bartlett, 1938). Also, it certainly appears that the deer herd must have reached those proportions to have inflicted the browsing damage so apparent throughout both summer and winter range on the club.

There are no indications that a crash decline occurred in the Mid Forest deer. Impressions of the club members are that numbers fell off rather gradually over a period of around ten years. It is probable that several winter die-offs plus the heavy kill of the first antlerless season took the population from a high in 1945 or 1946 to a low in 1956. Accurate hunting season figures, beginning in 1954, show a drop in success from 1954 to 1956 and a rather sharp rise to 1958. From that year on the various surveys conducted in this study permit a much more accurate appraisal of population levels which will be presented in later sections.

Projecting back from Westell's estimate of a 1957 population at 50 per square mile and my 1958 figure of 60 it seems likely that the level of 1956 was in the range of 30 to 40 deer per square mile. This would then represent the low point to which the herd dropped. Compared to other areas such a population is not exactly low. Using estimates based on six years of statewide pellet surveys (Ryel, 1962) it would rank close to the average of District 7, the region's highest population, and well above the average for the entire region.

The Club's Forest and Deer Management Program

Aspen Cutting

An earlier section explained the pulpwood industry's interest in developing aspen cutting programs on Michigan's numerous deer club lands. Mid Forest Lodge was one of the first of the clubs to enter into a forest management agreement with the firm that pioneered this movement, Packaging Corporation of America. This agreement provides the company with an option on the club's pulpwood stumpage. The club, in addition to realizing a substantial annual income, received even greater benefits, in terms of its overall objectives, from the comprehensive resource management service provided to it by the company. The service includes, (1) a forest inventory, (2) a management plan for the forest and wildlife resources on the club lands, and (3) a pulp cutting contract set up by the company with a local operator.

The inventory of the property was made in 1957. Timber types were cruised and mapped (see Table 4 and Figure 19), and a detailed management plan was prepared and presented to the club (Westell, 1958).

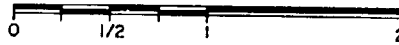
The plan's recommended cutting program was predicated upon a future sustained yield with a large enough annual cut in the aspen type to assure satisfactory reproduction and adequate habitat improvement for deer. Twenty-four aspen cutting blocks were set up and scheduled to be cut over a 23-year period. Varying in size from 90 to 400 acres they total 5,377 acres with an estimated yield of 60,600 cords. Average size and yield of the blocks is 233 acres and 2,635 cords. Figure 28 shows the location and numbers of these blocks and indicates which of them have been cut to date.

MID FOREST LODGE CLUB

ROSCOMMON COUNTY, MICHIGAN

T 21 N , R 2 W

Scale in Miles



Club Area: 18,080 acres - $28\frac{1}{4}$ sq. miles

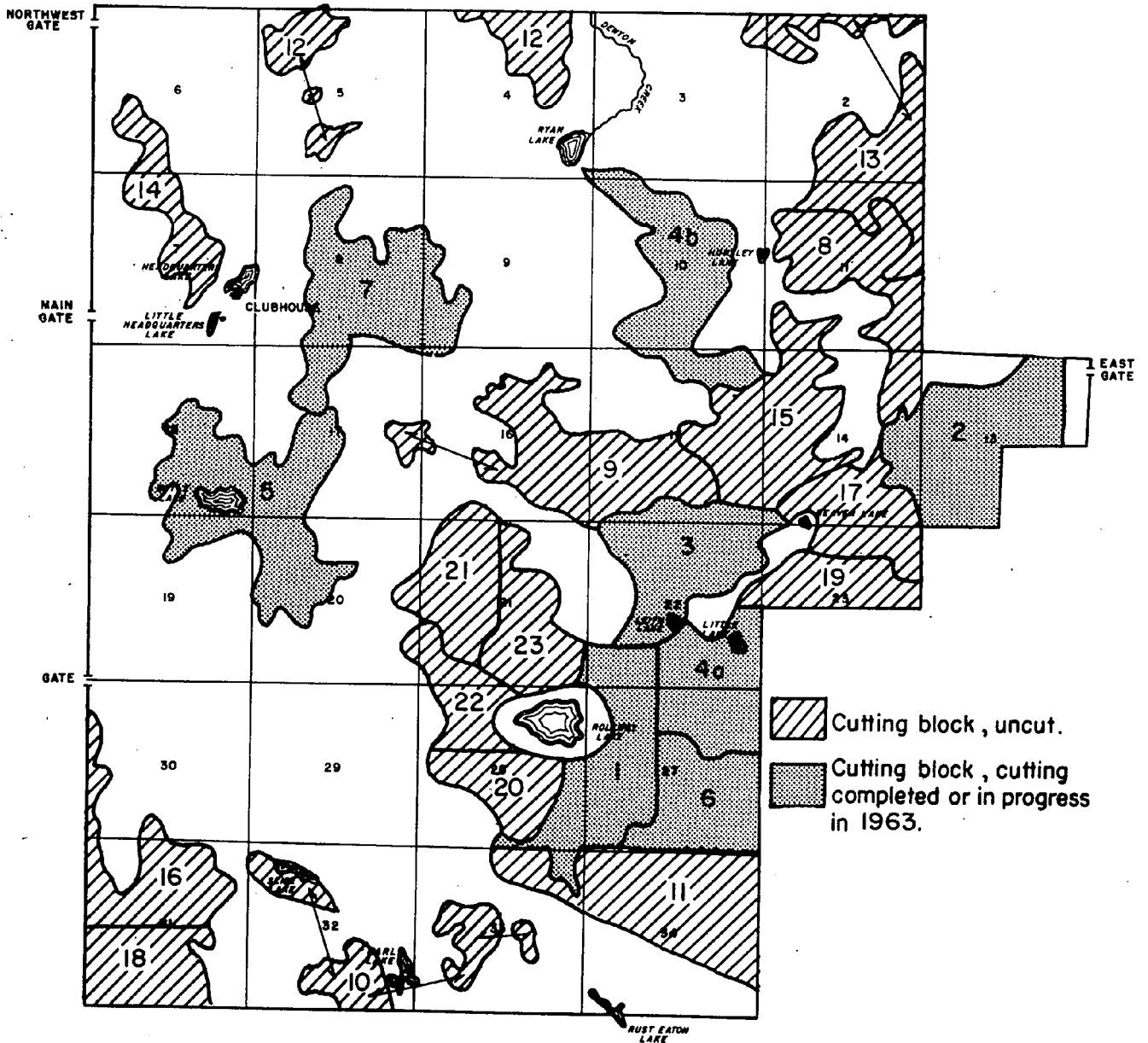


Figure 28. Aspen cutting blocks.

Cutting began in 1956. Through 1962, 7 blocks have been completed yielding a total of 25,291 cords from 2,024 acres. Table 5 summarizes the harvest on these cutting blocks.

Table 5. Aspen harvested on Mid Forest Lodge by cutting blocks, 1956-1962

Block	Year harvested	Acres cut	Cords harvested
1	1956-1957	330	4,770
2	1957-1959	403	4,823
3	1958	270	2,472
4a	1958-1961	218	2,552
4b	1959-1961	150	1,852
5	1959-1961	300	2,646
6	1961-1962	193	4,221
7	1962*	160	1,955
Totals		2,024	25,291

* Not completely harvested

The average annual cut has been 3,613 cords removed from 289 acres, a yield of about 12 cords per acre. Through 1962 cutting has been completed on 11.1 per cent of the club's total area. An average of 1.6 per cent of the property has been cutover annually. Figure 29 shows the progress of the cutting program to date in terms of cumulative acreage and percentage of total area, and Figure 30 shows the volume of aspen cut each year.

The size of the blocks and the order in which they are scheduled for cutting was governed by several considerations. The more or less even-aged character of the aspen did not permit an ideal rotation, with the

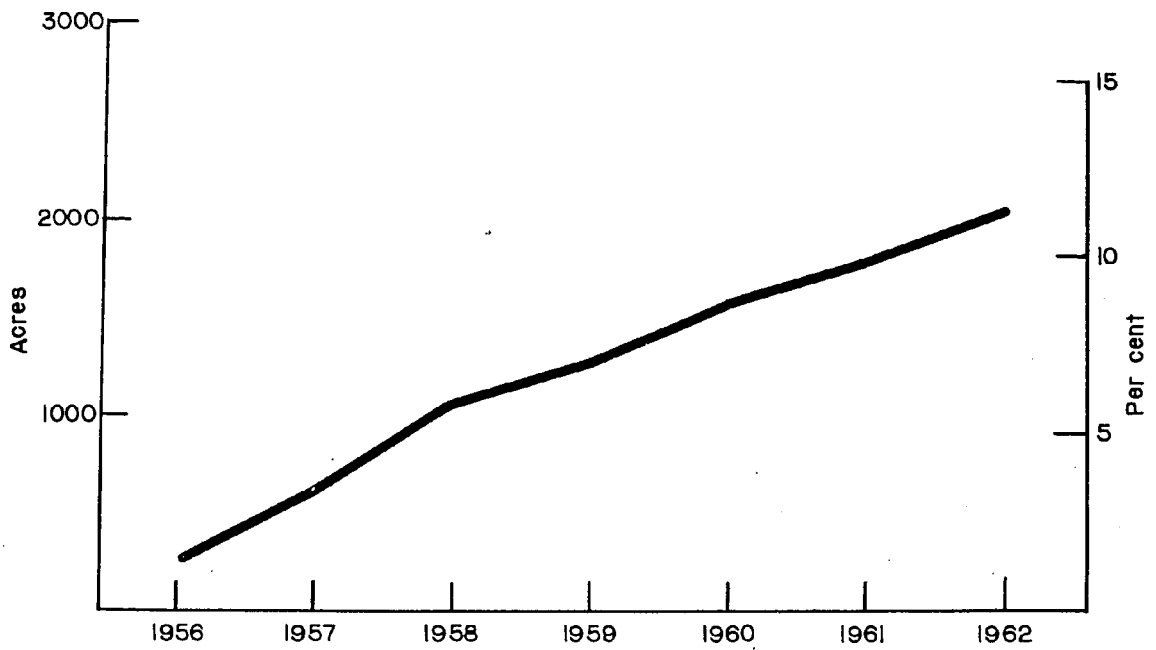


Figure 29. Cumulative area and percentage of total area cutover on Mid Forest Lodge.

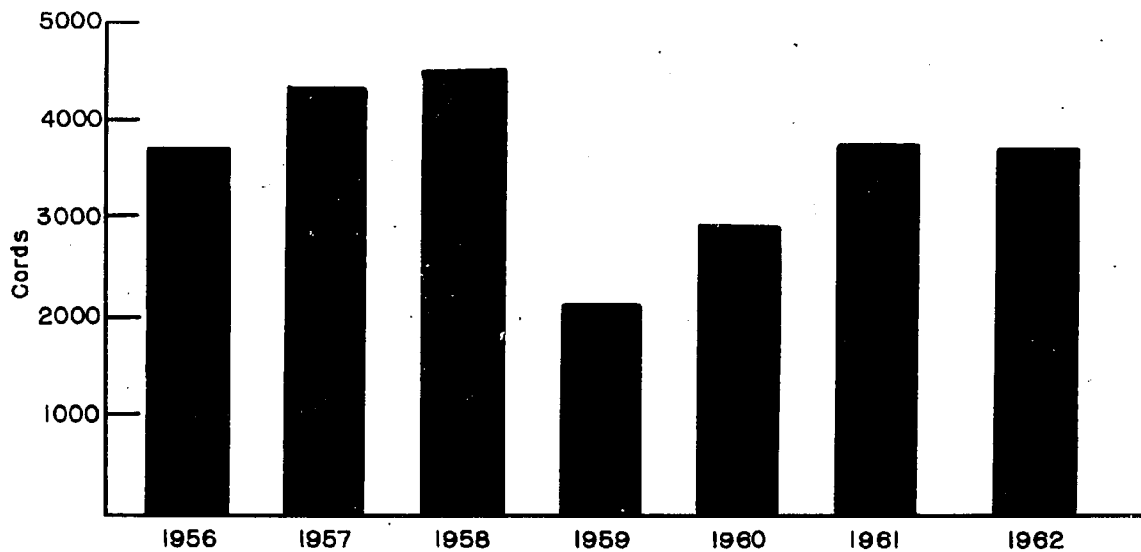


Figure 30. Annual volume of aspen pulpwood cut on Mid Forest Lodge.

cutting of only mature blocks each year throughout a 30 or 40 year period. It was felt the longest period the rotation could cover would be about 20 to 23 years. Size of the cutting blocks was an important consideration since it was apparent that if the area cut each year were too small deer browsing pressure would be more concentrated and reproduction would be jeopardized. The areas of aspen type with commercial logging possibilities are not evenly distributed over the property, being more common in the eastern than in the western half. This, plus the irregular and varied pattern of age and quality, was of great importance in planning the order of cutting, the consideration here being the need for cutting the older, poorer stands first and the need for keeping the cutting operations scattered and staggered over all parts of the area.

The cutting method recommended is the commercial clearcut which removes all aspen and associated species, on stands of at least 70 per cent aspen, taking all trees that will yield at least one stick of pulpwood. This has been largely followed, except that the club has not wanted to have any oak removed because of the strong concern of some members that all oaks should be preserved for their acorn producing potential. Until recently the question of taking or leaving oak has not been of any importance, as the company did not particularly desire this species. Now, however, technical changes are increasing the marketability of oak. From a management standpoint its removal, along with other aspen associates, is quite essential to good aspen regeneration. The plan recommends this and also suggests a future management cutting in the oak type itself.

The aspen cutting operation is carried on throughout the year, except during the deer hunting season and during occasional periods of

very severe winter weather. The harvested pulpwood is decked along hauling roads (Figure 31), the slash is left where it falls. After drying in the deck the wood is hauled to the mill in trucks. The truck roads are maintained by the company.

The commercial clearcut, for the most part, leaves only a light residual stand, and root suckering from the cutover aspen quickly follows the harvest (Figure 32). It is this prolific regrowth which is the primary benefit to the deer herd accruing from the cutting program. Of benefit, too, are the tops cut from the felled trees, but these are available only for a relatively short time, and though often heavily browsed during winter operations, their value is secondary to the sprout growth.

Westell (1960) has shown that regeneration on recently cutover aspen areas of northern Michigan is heavily utilized by deer, and he has presented good evidence that commercial pulpwood logging is contributing significantly to the ecology and management of the state's deer herd. There is no doubt of the high use made by deer of the aspen suckers produced in the cuttings on Mid Forest. The new sprouts are browsed in all seasons (Figure 33), and deer are attracted to, and remain in, the cutover areas, particularly in winter. Damage, at times, is very heavy, even on older sprouts (Figure 34), but recovery has followed in most cases. A further discussion on utilization of sprouts and some observations provided by exclosures will be included in a later section.

Other management suggestions made in the company's plan for the club include post-logging treatment to remove residual trees, treatment of unmerchantable aspen stands to stimulate regeneration, and planting of conifers. The planting program recommended emphasizes the need for dense winter cover on the club and suggests spot planting of red



Figure 31. Decked aspen pulpwood near Doyle Lake. The club's large scale management program makes this a common sight in the cutting blocks.



Figure 32. The cutover areas start regeneration immediately as sucker sprouts are sent up by the parent root systems.

Figure 33. Two-year-old aspen suckers heavily browsed by deer during both winters.

Figure 34. Five-year-old aspen suckers seriously damaged by hungry deer. Stems 10 ft. high and $3/4$ in. in diameter were broken over to make tips accessible. Some of the stems in the foreground show evidence of having recovered from similar damage in previous winters.



Figure 33



Figure 34

and white pine in the cutover blocks to fill in where aspen regeneration has failed. Also suggested is under-planting in poorer oak stands and around edges of openings and irregular clump and strip plantings in a few large openings. The value of leaving most of the openings unplanted is stressed. As yet, the club has not followed these recommendations to any extent.

Antlerless Deer Hunting

A strongly emphasized point in the Mid Forest management plan is the necessity for deer herd control. The danger of permitting overpopulation to continue on the club lands is explained, and the need for adequate harvesting stressed. It is recommended that the club start with a conservative take of antlerless deer and later extend this to take full advantage of the antlerless quotas established by the Conservation Department.

The club is to be commended on their acceptance of this principle. Many other deer clubs in Michigan have remained very reluctant to relax the "buck law" on their lands. While the antlerless take on Mid Forest has remained quite conservative, and undoubtedly a portion of the membership continues to have doubts about it, the fact nevertheless remains that extra deer are being harvested and expansion of the policy seems likely.

The graph of the club's deer kill in the following section (Figure 39) shows the years and the size of the extra deer harvests. The biggest kill, 1952, preceded the management program by several years. It occurred in the first year of the Conservation Department's discretionary deer authority when the regulations permitted any deer to be

killed during three days at the end of the regular buck season. Here, as in all parts of the state, many hunters jumped at the chance to take home a doe or fawn, and the kill was large. It was probably large enough, in fact, to accomplish some much needed thinning of the herd, though it by no means endangered it. Reaction among the members was very strong. Many were convinced their herd was wiped out, and the feeling was general that the unregulated antlerless hunting stimulated excesses of unsportsmanlike behavior. Accordingly, in the following five years when various regulated antlerless seasons were open to them, the club voted to hunt bucks only. In 1958 and 1959, heeding recommendations of the new management plan, the group changed its rules and members with permits were allowed to kill does but not fawns. This was restricted to the east half of the property where the cutting program, up to that time, had been limited. In 1960 the rules were again changed and in that year, and in 1962, holders of permits were able to use them throughout the area and on both does and fawns. In 1961 no antlerless season was held in the state.

The state regulations for special antlerless seasons provide for a permit system. Areas are established and varying quotas of permits are allotted to each. A permit holder may kill a buck, doe, or fawn in the area for which his permit is issued at any time during the regular two-week deer season. In most areas applications exceed the quotas, and permits are issued on the basis of random drawings. The proportion of Mid Forest hunters having permits is therefore governed first by how many apply, and second by the success of the applicants in receiving them. Further, the success rate of the permittees in filling their permits is affected by some other factors. Some individuals, feeling strongly opposed to harvesting does and fawns, deliberately obtain permits and

then fail to use them, hoping in this way to help hold the kill down. Many permittees are successful in bagging bucks and therefore cannot make use of their permits. And finally, others, after unsuccessfully hunting for bucks, find that does and fawns have made themselves hard to get, and they fail to bag anything.

Table 6 shows the extent to which the club members were successful in receiving and filling permits in the past four antlerless seasons. The information was obtained from questionnaires filled out by hunters at the gate checking stations. It appears that with as many as two-thirds of the hunting members applying for permits the number of antlerless deer harvested has not exceeded about 15 per cent of the total number of hunters. Even if all hunters were to apply we could expect this figure to be only about 20 per cent. Therefore, under the present system and regulations, it is not likely that the antlerless take on the club could much exceed 100 animals, and, as will be shown later, this cannot be considered an adequate harvest.

Supplemental Feeding

The aspen cutting program and the harvest of antlerless deer are measures recommended to the club in the management plan drawn up by Packaging Corporation of America. Another practice currently followed by the club is supplemental feeding. While not advocated in the plan, the feeding program is nevertheless believed by many of the members to be essential to the welfare of their deer, and a major financial outlay is allocated for it each year.

Wanting to provide supplemental food for deer is the usual and natural reaction of many people to the winter food shortage problem.

Table 6. Number of deer hunters and holders of antlerless permits on Mid Forest Lodge, 1958 to 1962

	1958	1959	1960	1961	1962
No. of people hunting	566	490	456	465	469
Percentage applying for permits	--	54%	67%	(No antlerless season)	60%
Percentage of applicants receiving permits	--	60%	51%		60%
Percentage of hunters with permits	8%	32%	33%		35%
Estimated number of permittees	46	157	151		165
No. who filled permits	29	60	64		50
Percentage of permittees filling	63%	38%	42%		30%

It seems to be such an obvious and logical solution. If deer aren't getting enough food, plant something for them or take emergency rations out to them. The latter, usually termed artificial feeding, has been the popular response to winter starvation the country over. Untold tons of hay and grain have been trucked, sledged, snowshoed, and air-dropped by individuals, committees, clubs, communities, and conservation agencies in every major deer state. And yet game biologists, almost without exception, oppose it and decry it.

The case against large-scale artificial feeding is thoroughly presented in a publication from Wisconsin, the state that for a period probably engaged in it on a larger scale than any other. Chapter 14 of Dahlberg and Guettinger (1956) details the 10-year Wisconsin experience which cost over a half-million dollars of earmarked funds. They show that an artificial feeding program is expensive, futile, deceptive, and

harmful; and they condemn it as having no place in management, except in certain limited emergency situations.

Mid Forest clings tenaciously to the feeding concept, basing it primarily on the desire to prevent starvation losses and the hope that it will relieve browsing pressure on their aspen regeneration. Compared to most artificial feeding theirs is carried on very thoroughly. Good quality food is used: corn and second cutting alfalfa hay; it is widely distributed over the club, replenished frequently, and is available throughout the winter. Listed below in Table 7 are the quantities fed during six winters. The cost of the feed runs about \$1,800 per year. Distribution costs are in addition to this but cannot be determined closely as the job is carried out by the caretaker, who resides on the property, using equipment and fuel not specifically accounted to this program.

Table 7. Winter feeding operations on the Mid Forest Lodge

Year	Tons of feed distributed			Total
	Alfalfa hay	Shelled corn	Pelleted concentrate	
1957	20	12		32
1958	20	12		32
1959	24	12	6	42
1960	30	15		45
1961	26	13		39
1962	<u>26</u>	<u>15</u>	<u> </u>	<u>41</u>
Total	146	79	6	231

The caretaker spends a large amount of time throughout the winter putting out feed. Tractor, jeep, and motor sled are employed, and only the severest weather halts the operation. From 20 to 30 feeding stations are kept supplied. Hay bales are suspended from trees to keep them above the snow, and the shelled corn is scattered on top of the snow (see Figure 58).

Deer visit these stations in varying numbers. Some are heavily used, others scarcely at all, and the degree of use may change through the winter. Often, after heavy storms, deer may fail to show up at stations where use had been heavy and may start to appear at others that had previously been little used.

In addition to the artificial feeding effort the club maintains another program primarily aimed at alleviating the food shortage. Food patches are planted in numerous openings and small clearings. These areas, for the most part, are tilled and planted to rye in late summer. The green, newly sprouted rye is grazed by deer in the fall until snow comes and again in the spring when the snow is gone. Other types of plantings have been tried in the past but rye remains the most successful. Plots are small, from 1/4 to 3 or 4 acres, and are located along roads.

The plantings, of course, contribute nothing to deer when they most need it--from mid-winter until breakup. They do provide a first green food source in early spring. But their total nutritional contribution is questionable even then, as other grasses are greening at the same time. It seems likely that the primary contribution of the food patches is their attraction of deer into openings close to roads, where club members can see them. Driving around the club, looking for deer, is one of the favorite pastimes of many families and members. The rye patches help greatly in this form of enjoyment of the club's deer resource.

HUNTING SEASONS AS A SOURCE OF INFORMATION ON THE CLUB'S DEER HERD

Game managers must rely heavily upon the hunting season for much of the population knowledge they require. The number of animals harvested and the amount of hunting effort expended are facts essential to many methods of game inventory. Very often they are the only absolute population figures available. Examining game bagged by hunters provides technicians with opportunities to determine sex and age structure and physical condition of large samples obtainable in no other way.

This has become especially true with deer since the development of quick and accurate aging methods. The voluminous data of this type accumulated by Michigan and some other states in recent years has been of great importance in furthering enlightened management of the whitetail and its range. Michigan Conservation Department biologists have examined over 100,000 deer during hunting seasons from 1951 to 1962. This has been accomplished principally at highway checking stations and locker storage plants. Data obtained annually on age distribution, weight, and antler size provide an important means for assessing range and other environmental conditions on an area basis, essential under the law prescribing antlerless deer harvests in the state.

Although hunting season data are collected in large volume in Michigan each year the sample is still relatively small and it cannot be applied with any degree of accuracy to restricted localities. There are but few opportunities to make complete checks of hunters and deer on

entire areas, or even to sample them adequately. Mid Forest Lodge has provided such an opportunity, and the information that has been gained there during the past five hunting seasons is a basic source of population data in this study.

Methods

Registration of Hunters at Gates

In its earlier days when membership was smaller the club had no regular system of finding out how many deer were killed. As the number of hunters and the kill grew the need for such a system was recognized, and the club began an effort to learn the kill through a questionnaire mailed to members after each season. The replies to these were never complete enough to provide an accurate record of the kill or the number of hunters. The figures on annual deer kill from 1946 to 1953 are therefore of little use except that they represent a minimum. In 1954 the present system of gate registration was begun. Records from then and the following years are complete and accurate.

The gate system as it is now carried on requires every car entering or leaving the club during the two-week deer season to check in with the gatekeeper. The system was devised primarily to prevent unauthorized people from hunting on the property; however, its value in providing accurate information was also recognized and full use of it has been made in this respect.

Hunting on the club is permitted only to shareholding members, their wives, and their minor children. Members owning more than one

membership share can bring in a guest and family for each share. Guests so authorized may hunt like any other member. These are known as guest memberships and are not numerous. The entire number of membership shares is limited to 400, but the total number of possible hunters would be difficult to determine, as additional varying numbers of wives and children hunt each year. Other guests may come into the club with members and stay at their cabins, but they are not permitted to hunt or even to go out into the woods, and they must sign an affidavit agreeing to this before entering.

Upon arriving at the club for the first time on a deer hunting trip a member must stop at the gate to register. He has previously been mailed registration forms for himself and family which are supposed to be already filled out and ready to turn in. These ask the hunter for his name, address, and membership number, his hunting license number, the dates he plans to hunt, and whether he applied for and received an antlerless permit. Answers to questions on results of his hunt are to be filled out when leaving the club for the last time after his hunting is finished. These include, whether or not a deer was killed, date of kill, whether it was a buck, doe, or fawn, the section where it was killed, the number of antler points, the weight, and the age if known.

Each authorized person planning to hunt must show a paid-up receipt for annual dues and must then purchase a 25¢ numbered, metal badge. This must be displayed by the hunter at all times on the property. Once registered, the hunter can stay on the club or leave at will. But each time he leaves or re-enters he must stop at the gate to show his badge and allow the guard to check his car for deer.

Only two of the club's four entrances can be used during deer season, the Main Gate and the East Gate. These are both manned by hired

gatekeepers on duty throughout the day and night for the entire season. Usually about 90 per cent of the hunters enter and leave through the Main Gate. Comfortable, small guard buildings are provided at each gate (Figure 35). Also employed are deputized guards who patrol the club and its boundary fence against trespass.

The penalty for violating any of the club's regulations is suspension of membership privileges. For the most part compliance is extremely good and information collected at the gates is quite accurate. The only exception noted in this study was a slight laxity on the part of some gate guards in accepting registration slips incompletely filled out. Questions on antlerless permit application and on planned hunting dates were sometimes unanswered. Information on deer killed was always complete except for weight and age, which was not mandatory.

The accuracy of such information as the location of kill, whether antlerless deer were does or fawns, and the sex of the fawns may be open to some question. Hunters can be unreliable in telling where their favorite spots are (and justifiably so). However, it is not likely that many would feel that naming only the section would pinpoint their kill too closely, and I believe the location data are quite acceptable. Distinguishing the kinds of antlerless deer is another matter. In this, the identification is usually left up to the hunter with only infrequent verification by the gate guard. The possible error here is in misidentifying fawns of either sex as adult does. Honest mistakes may be expected in this, as fawns are frequently much larger than many people's conception of them and may easily pass for does. Added to this is the often encountered reluctance of hunters to admit, even to themselves, that they would shoot a fawn. For these reasons I have felt the gate record on

Figure 35. Main gate of Mid Forest Lodge; gatekeeper checking out hunters' cars. During the two-week deer season, the only access to the club is through two gates, manned 24 hours a day.

Figure 36. Most of the successful hunters brought their deer to the clubhouse for weighing. Aging and other biological examinations were often done with members and families as interested onlookers. (Cons. Dept. photo by Harrington).



Figure 35



Figure 36

does and fawns is quite cloudy and I have accepted only such identification as I have done or verified myself.

During the years this study has been in progress the gate registration forms have been turned over to me for summarizing and analysis. I feel they represent a very accurate record of the hunting done on the area and the number of legal deer killed by authorized hunters. There are undoubtedly additional deer taken out by unauthorized hunters. Stories are heard each year of members seeing "outside" hunters trespassing on the property, and there are occasional instances where evidence clearly indicates that a kill has been taken over the fence. In general though, I believe the boundary patrol keeps this to a minimum and losses from this source are insignificant.

Accidental or mistake kills are also relatively low on the club. This loss can be high at times on public lands, but hunter quality on Mid Forest is much higher, and the "shoot first, look later" attitude is not prevalent. Unrecovered kills certainly occur here as they do elsewhere. Members occasionally have reported finding dead bucks but this is not at all common. Together, I believe these losses usually do not amount to more than about 10 per cent of the recorded kill, and there is some evidence from the spring dead deer searches to support this estimate.

Information on archery deer hunting is not complete. Very little of this is done on the club. It takes place over a six-week period prior to the gun season. Gate registration is not required at this time, and although archers are supposed to register with the caretaker the degree of compliance is not known. The figures available indicate only a very light kill.

Biological Data from Examination of the Kill

Checking System

When examining hunting season kills in the field several gross determinations can be made quickly and easily. These include looking into the lower jaw for aging, counting the number of antler points, measuring the diameter of the antler beam, taking a foot measurement, and weighing the hog-dressed carcass.

On Mid Forest Lodge there was no practical way to examine very many deer at the gates. Hunters take them home at all hours of the day and night throughout the season, and almost constant attendance at two gates would have been necessary. I therefore devised a system of examining deer at the hunters' cabins and having them weighed by the hunters themselves at a centrally located weighing station. The system proved to be very satisfactory, and I was able to obtain data on a high percentage of the deer killed in five hunting seasons.

By means of information sheets passed out at the gates registering hunters were instructed how to weigh their deer and how the other checking would be done. The majority of members stay on the area for several days. These resident hunters upon bagging deer usually take them to their cabins, or to the clubhouse, where they hang them outside on "buck poles" until their departure. By periodically driving around the cabin areas during the first few days of the season I was able to find and examine a large portion of the kill hanging on the poles. Two other biologists, from Packaging Corporation of America, were present on the area some days and assisted in this.

When a deer was aged and measured the data were recorded on a wired, cardboard tag which was attached to the carcass, either on an antler or a leg. The owner of the deer was then requested to weigh it before leaving for home and to record its weight on the tag. The completed tags were removed by the gate guards as the deer left the club and were retained at the gate for later collection by me. In some instances successful hunters would stop at the clubhouse weighing station and weigh their deer before taking them to their cabins. For these occasions blank tags were provided at the scales. The hunter was requested to record the weight of his deer on the tag, attach it to the carcass, and then hang the tagged deer at his abode. After aging and measuring these weighed deer I removed the record portion of the tags at a perforation, leaving a stub still attached to the carcass. This indicated to me or to the gatekeepers that these deer had been completely checked.

Hunters who did not reside on the club and took their deer out on the same day they were shot were not too numerous. I found that I could catch some of these as they left by staying at the Main Gate for a few hours in the evening of the first day or two. I also found it profitable to be at the clubhouse, where the scales was located, around mealtime. Frequently deer were brought in for weighing then, and I was able to weigh, age, and measure them all in one operation (Figure 36).

The club's hunters, in general, were very cooperative. The majority were usually interested in learning the weight and age of their deer and quite willing to bring them around to the scales. For many this meant an extra trip to the clubhouse; for all of them it required the extra effort of the weighing process. Table 8 shows the proportions of the total kill that were aged and weighed each year of the study.

Table 8. Proportion of the deer kill aged and weighed on Mid Forest Lodge, 1958-1962

Year	No. of bucks killed	Per cent aged & weighed	No. of antlerless killed	Per cent aged & weighed	Total No. deer killed	Per cent aged & weighed
1958	155	73	29	24	184	65
1959	107	71	60	62	167	68
1960	107	78	64	61	171	71
1961	144	71	0		144	71
1962	<u>186</u>	<u>65</u>	<u>50</u>	<u>72</u>	<u>236</u>	<u>66</u>
Total	699	71	203	59	902	68

The lower percentage of antlerless deer examined is probably due to some of these hunters being a little less proud of their kill and not being too eager to bring in does and fawns to be weighed. Also, many members customarily waited until the last day of their hunting before filling antlerless permits, and this greatly reduced the opportunity for me to examine their kill.

Weighing

All weights were taken on a warehouse type, platform scales, having a 700-lb. capacity and reading to the nearest 1/2 lb. An extension frame was attached to the platform in order to accommodate the carcass of a deer laid on its side. The scales was placed on the side porch of the clubhouse, under cover of a roof and on a concrete floor. The same scales was used each year, and its accuracy was checked periodically throughout the season.

All deer were weighed field-dressed (or, as sometimes expressed, hog-dressed), that is, carcass intact with only viscera removed.

Aging

The aging method which I employed was that developed in New York and reported by Severinghaus (1949). This is based on mandibular tooth replacement and wear and is a technique that has been widely accepted and used by game biologists since its publication. Extensive use in this state, and comparisons with known-age specimens, have disclosed some differences in replacement and rate of wear between New York and Michigan deer. Recently, Ryel et al., (1961) have presented a revision of this method for Michigan deer. Some adjustments have been made in Severinghaus' criteria, particularly as regards replacement of incisors and premolars and the wear of molars in the 4 1/2-year group and older. As applied to my Mid Forest examinations I feel the revised key would have had little effect on age determination. Most of the deer that I aged were younger than 4 1/2 years and were easily classified by characters common to both methods.

Deer jaws were opened for aging examination by means of a tubular steel "jaw-bar." One or both cheeks were usually cut open to expose the posterior teeth. Club members were advised of this, and in the event that any of them wanted a head saved for mounting they would attach a note to it requesting that the cheek not be cut. (Trophy heads were seldom encountered on the club.)

Antler Size

The total number of points on both antlers was recorded for all adult bucks. Only points one inch or more in length were counted. Points were not recorded for bucks with either or both antlers broken off.

The diameter of the antler beam was measured immediately above the bur (Figure 37) using calipers measuring to the nearest millimeter.

Two measurements were normally made at this point and the average recorded for the antler. Both antlers were measured and recorded separately, and an average of the two was used as the value for each animal.

Hind Foot Measurement

A measurement which was attempted in Michigan's statewide deer checks for several years was also tried on Mid Forest Lodge. It was hoped that there might be an easily made external measurement of body size which could substitute for weight as an index to physical condition. Weights are not easy to obtain at highway checking stations and relatively few are taken. The standard, gross metatarsal length appeared to be most promising and was, accordingly, included in the routine checking station examination. The measurement is made on the hind foot, or hock, from the tip of the calcaneum to the tip of the extended hoof. On the club in 1960 this was done with a steel tape. In 1961 and 1962 a meter stick modified as a caliper was used (Figure 38). Length was taken to the nearest millimeter.

Results

A large volume of detailed information on the club's harvest of deer has been accumulated in this study during five hunting seasons and by the club itself in earlier years. Much can be learned from these data concerning the herd, its population level, its productivity, and its physical condition. This in turn should be indicative of the environmental effects attributable to the forest cutting program, the objective of the study. Ideally, data of this nature should be available

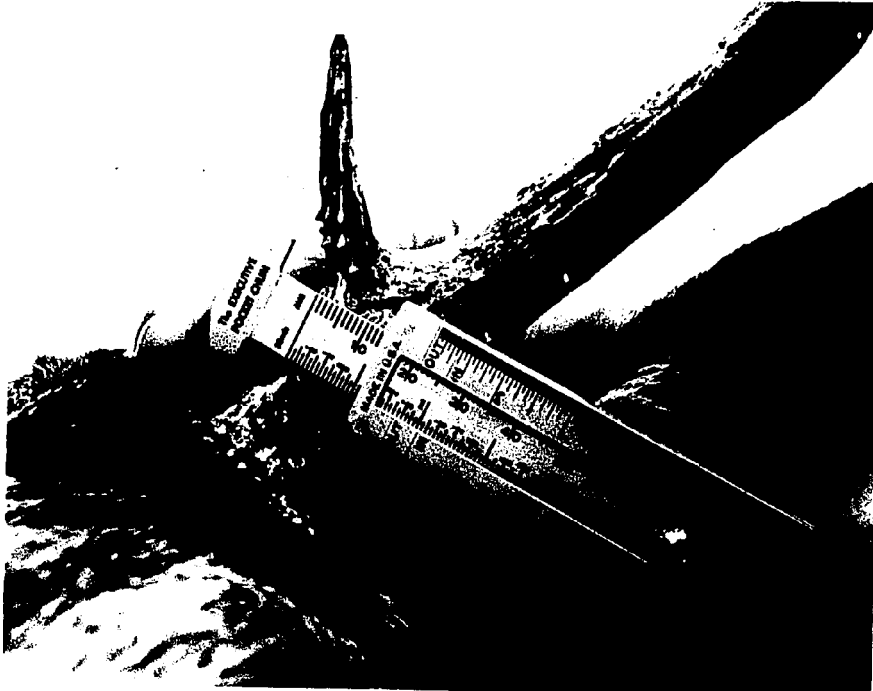


Figure 37. Calipering antler beam diameter.

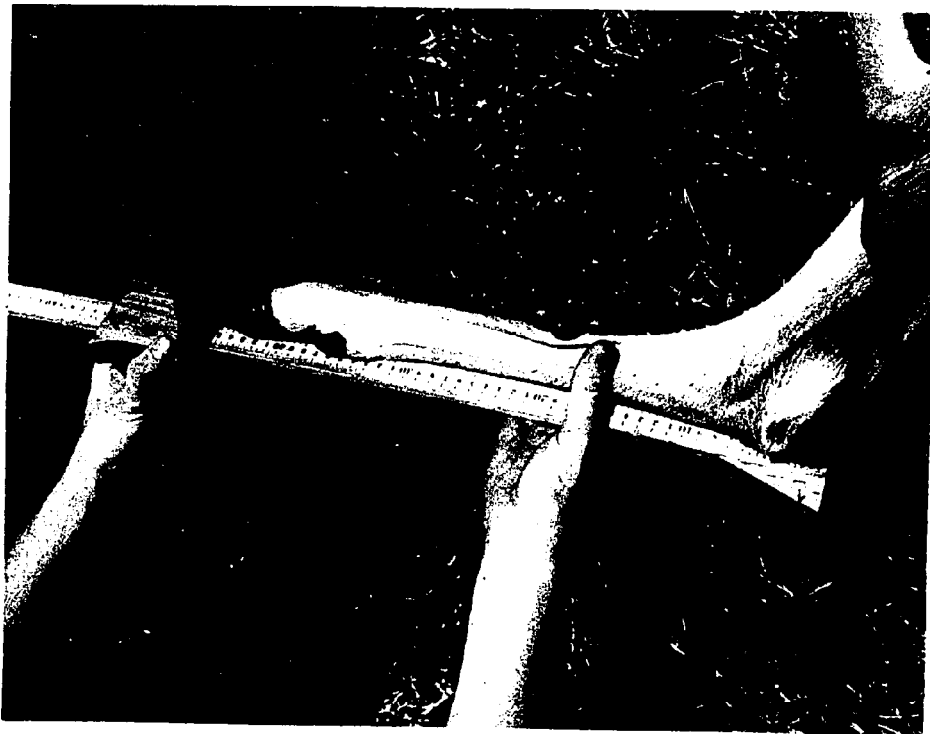


Figure 38. Calipering length of hind foot.

from a control area where conditions matched the club except for the forest harvest. Unfortunately no such matching area exists, and the comparisons which must be made in order to make the data most meaningful will be drawn from broader state surveys and from a few small area studies that are available and are somewhat comparable.

This section will present the Mid Forest data, largely in tables and graphs. Some analysis will be included, but for the most part, interpretation, comparisons, and conclusions will be presented in later sections.

Data from Gate Registrations

Yearly kill and Hunter Records

A compilation of all available club records on deer kill, number of hunters, and hunter success is given in Table 9. As pointed out in the footnote the figures from earlier than 1954 are incomplete and of little use in comparing with the later complete counts. They do indicate, however, the outstanding high kill of 1952, the year of the first antlerless season. It is no doubt true that more bucks than usual were taken that year, as the three-day any deer season attracted heavy hunting and added to the buck kill of the regular season. Also, since interest ran high that year, it is likely that many more members than usual responded to the mailed report card after the season. This would tend to approach a complete tally of the kill more nearly than usual.

The columns expressing kill and hunters per square mile convert the totals to a density rate which has become a standard expression in studying deer biology.

Table 9. Mid Forest Lodge deer kill and hunting pressure during gun seasons, 1946-1962*

Year	Bucks killed		Hunters		Bucks per hunter	Antlerless kill	
	Total	Per sq.mi.	Total	Per sq.mi.		Total	Per sq.mi.
1946	35	1.24					
1947	26	.92					
1948	--	--					
1949	103	3.65					
1950	86	3.04					
1951	79	2.80					
1952	185	6.55				98	3.47
1953	75	2.66					
1954	94	3.33	534	18.90	.176		
1955	90	3.19	552	19.54	.163		
1956	66	2.34	601	21.28	.110		
1957	134	4.74	527	18.66	.254		
1958	155	5.49	566	20.04	.278	29	1.03
1959	107	3.79	490	17.35	.218	60**	2.12
1960	107	3.79	456	16.14	.235	64	2.27
1961	144	5.10	465	16.46	.310		
1962	186	6.58	469	16.60	.397	50***	1.77
Total	1,672	59.21	4,660	164.97	2.141	301	10.66
Ave.	104.5	3.70	517.8	18.33	.238	60.20	2.13

* Prior to 1954, figures are from incomplete replies to mailed questionnaires. From that year on information was obtained from gate registration.

** Includes 5 yearling bucks with sublegal antlers.

*** Includes 2 yearling bucks with sublegal antlers.

The relatively light take of antlerless deer is very evident from this table. Except for the unusual first season in 1952 the kill has been only one or two per square mile, as compared to the buck kill, in those years, of four to seven.

The records are shown graphically in Figures 39 and 40. These illustrate the unmistakable upward trend in buck kill and hunter success since 1956 and the downward trend of hunters in the same period.

Distribution of the Kill Through the Season

The gate records for 1959 through 1962 give the dates of kill for most of the deer taken. In 1958 there were some uncertainties and discrepancies in the recording of these dates so that year was not used. Data for the four years were combined and plotted in a graph in Figure 41. The kill for each day of the season, November 15-30, is expressed as a percentage of the total kill for the four years. Table 10 presents the data for the individual years and the totals, both as number of deer and percentage, for each day.

In general the pattern of the buck kill is the same each year. The opening day of the season is the big day, with about one-half of the bucks being taken then. The kill falls off on the second day to about one-third as many and continues to drop until by the fifth day over 90 per cent of the bucks have been taken. Some variation in the opening day percentage can be noted, but this appears to be strictly a function of weather. The lower take on the first day of 1960 was due to the completely miserable rainy weather from daylight to dark that day. This condition was statewide and was believed to be an important factor in the reduced kill that year. The higher than usual kill on November 15, 1962, was probably a reflection of the ideal weather and the exceptionally large crop of yearling bucks in the herd.

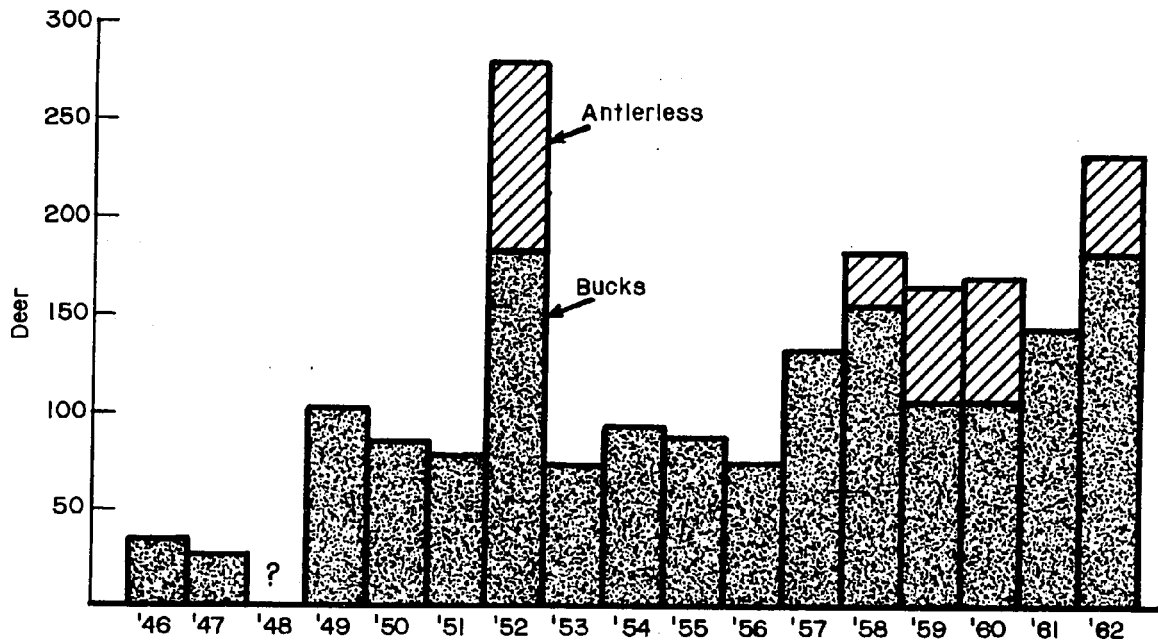


Figure 39. Annual deer kill on Mid Forest Lodge. 1946-1962.*

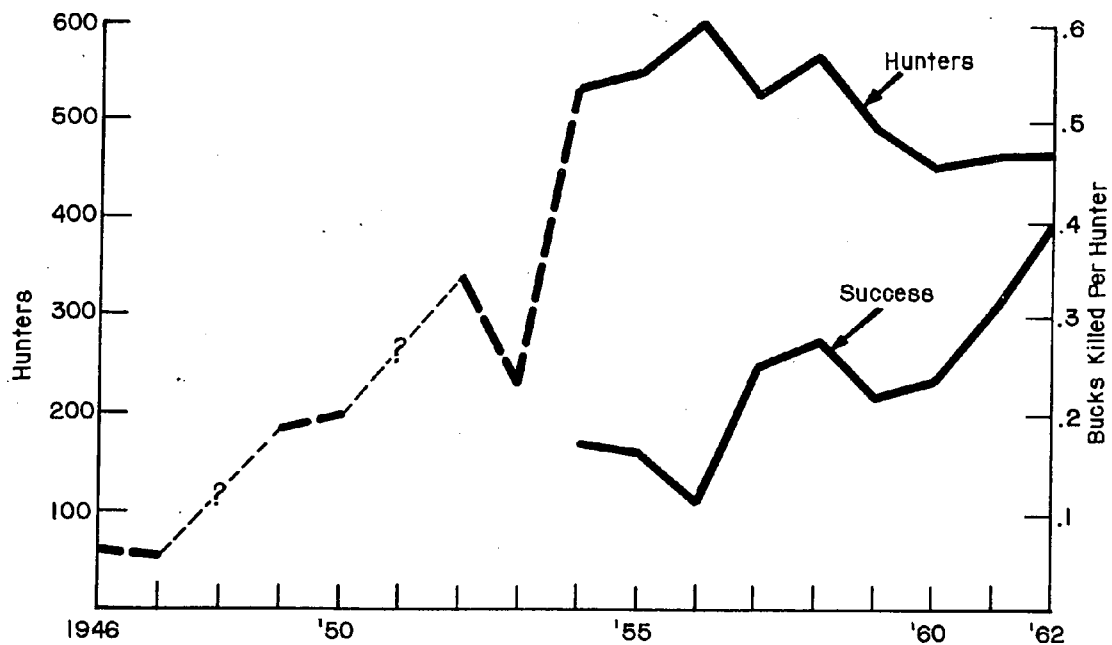


Figure 40. Number of deer hunters and their success rate in killing bucks on Mid Forest Lodge, 1940-1962.*

*Data prior to 1954 from incomplete returns of mailed report cards; 1955 and later from gate registrations.

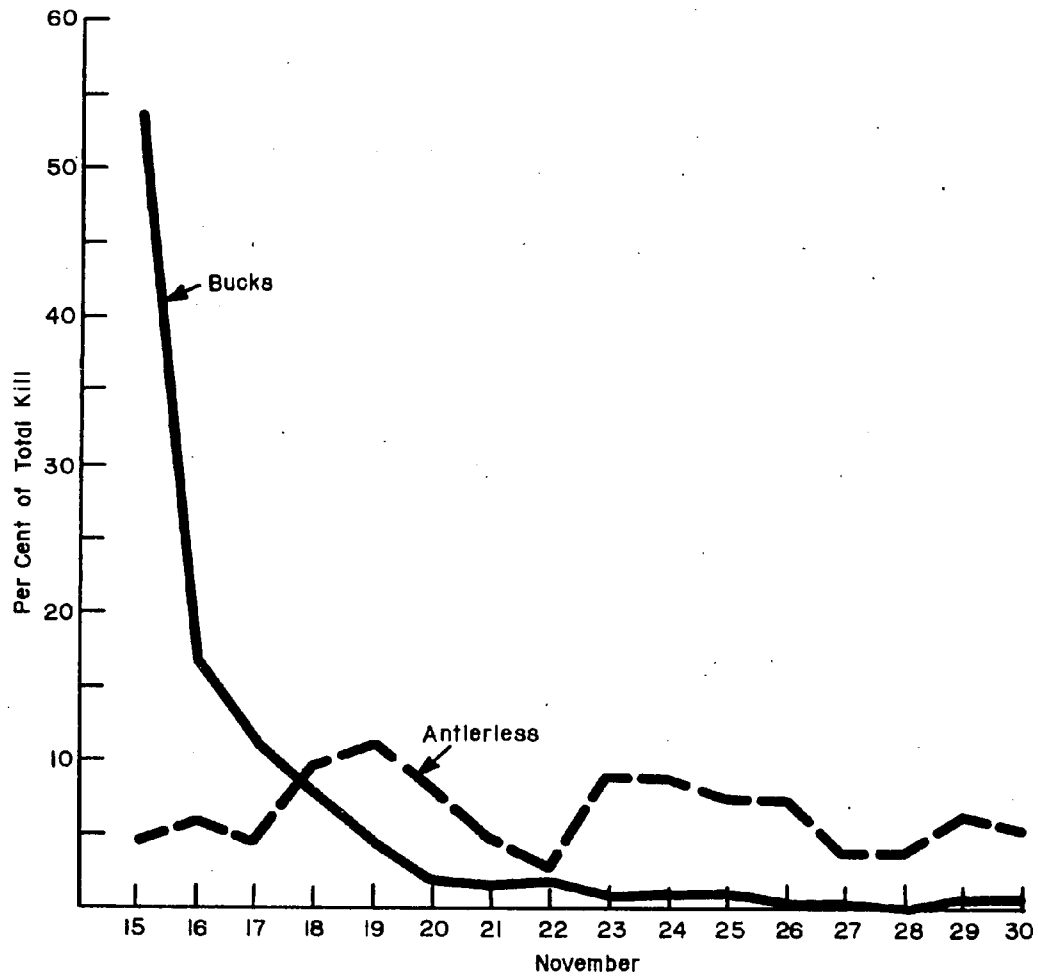


Figure 41. Daily kill of bucks and antlerless deer on Mid Forest Lodge, four years data combined, 1959 through 1962.

Table 10. Bucks and antlerless deer killed each day of the hunting season on Mid Forest Lodge, 1959 to 1962

Nov.	1959				1960				1961				1962				Total			
	Bucks		Antlerless		Bucks		Antlerless		Bucks		Antlerless		Bucks		Antlerless		Bucks		Antlerless	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
15	53	(57)	1	(3)	36	(41)	3	(6)	62	(51)	111	(60)	2	(4)	262	(53.7)	6	(4.4)		
16	16	(17)	4	(10)	18	(21)	4	(8)	16	(13)	30	(16)	0		80	(16.4)	8	(5.8)		
17	4	(5)	1	(3)	15	(17)	3	(6)	17	(14)	17	(8)	2	(4)	53	(10.9)	6	(4.4)		
18	3	(3)	2	(5)	4	(5)	7	(15)	16	(13)	13	(6)	4	(8)	36	(7.4)	13	(9.5)		
19	5	(6)	8	(21)	9	(10)	5	(11)	8	(6)	0		2	(4)	22	(4.5)	15	(10.9)		
20	1	(1)	4	(10)	3	(4)	5	(11)	0		3	(2)	2	(4)	7	(1.4)	11	(8.0)		
21	3	(3)	4	(10)	0		2	(4)	0		2	(1)	0		5	(1.1)	6	(4.4)		
22	2	(2)	1	(2)	0		0		1	(1)	3	(2)	2	(4)	6	(1.2)	3	(2.2)		
23	1	(1)	2	(5)	1	(1)	0		0		1	(1)	10	(20)	3	(0.6)	12	(8.8)		
24	0		0		0		2	(4)	1	(1)	3	(2)	10	(20)	4	(0.8)	12	(8.8)		
25	1	(1)	3	(8)	0		3	(6)	1	(1)	2	(1)	4	(8)	4	(0.8)	10	(7.3)		
26	1	(1)	1	(2)	0		8	(17)	0		0		1	(2)	1	(0.2)	10	(7.3)		
27	1	(1)	0	(0)	0		4	(8)	0		0		1	(2)	1	(0.2)	5	(3.6)		
28	0		3	(8)	0		0		0		0		2	(4)	0		5	(3.6)		
29	1	(1)	3	(8)	0		1	(2)	0		1	(1)	4	(8)	2	(0.4)	8	(5.8)		
30	1	(1)	2	(5)	1	(1)	1	(2)	0		0		4	(8)	2	(0.4)	7	(5.2)		
Total	93	(100)	39	(100)	87	(100)	48	(100)	122	(100)	186	(100)	50	(100)	488	(100.0)	137	(100.0)		

The antlerless kill is distributed throughout the season with only a light take during the first few days. This is because hunters wait for a buck and usually do not give up and start "doe hunting" until just before going home. The best kills are likely to be on the two or three weekends following the opening. These show plainly on the graph as the three higher periods of several days each.

Distribution of Hunting Through the Season

Records at the gates do not show the exact days each person hunted, which would be the most accurate way of determining the daily pattern of hunting pressure. Registering hunters are asked what days they plan to hunt, but hunters checking out are not asked what days they actually did hunt. There is a very good reason for this and it is also the reason why accurate hunting pressure data cannot be obtained. It is customary for many hunters after killing their buck not to terminate their hunting but to continue, helping their friends, or perhaps seeking to fill their spouses' antlerless permits. This is, of course, illegal, though widely done, and no one would be expected to admit to it. Therefore, when you ask a hunter the date he made his kill you cannot also ask him to list the dates he hunted and expect to get accurate information.

Some idea of the pattern of hunting pressure can be gained by taking the planned dates as reported and reconstructing from them the total planned hunter-days for each day of the season. This may be adjusted by assuming all successful hunters stop hunting and subtracting the days that followed their kill dates. I have done this for one year, 1962. This was the year with best data on planned hunting dates--62 per cent of the 469 registrants answered the question. In the earlier years

response was poorer, and I did not feel the information was reliable enough to be usable.

Table 11 shows the 1962 data with the reported hunter-days expanded to an estimated total number of hunter-days per day of season. Table 12 combines the daily hunting pressure with the kill and derives estimated daily rates of kill per hunter-day. Eberhardt (1960) develops the possible application of data on kill and effort in estimating populations. I regard my data on daily effort as having too little accuracy to be of use in this method. It may be of value, however, in comparing the general pattern of hunting on the club with that of other areas and of the region.

Location of Kills

Response was good to the check-out question on where deer were killed. During the five years, 1958 to 1962, 90 per cent of the successful hunters reported the section number of their kills. The complete accuracy of these replies, of course, may be in some doubt, as explained earlier. Table 13 lists all the sections of the club and shows how many bucks and antlerless deer were reported killed in them each year.

Annually, the range between sections is extreme. Some have had no bucks taken in a season and some as many as 20. Many sections have had no antlerless kill, even in the two years the entire club was open, and the highest antlerless kill was 15. This was in the same section that yielded 20 bucks three years later. This section (22) had the highest total kill in the five years, 90 deer.

In general, where the most deer are killed is where the most deer are, for these are the areas that attract heaviest hunting. But there is a certain amount of habit and tradition to going back each year

Table 11. Daily hunting pressure on Mid Forest Lodge, 1962 deer season

Date	Day of week	Reported hunter-days*	% of total reported hunter-days	% of total hunters who reported	Estimated daily hunter-days**
15	T	251	21.6	86.2	402
16	F	146	12.5	50.2	234
17	S	127	10.9	43.6	204
18	S	117	10.1	40.2	188
19	M	66	5.7	22.7	106
20	T	59	5.1	20.3	95
21	W	53	4.6	18.2	85
22	T	61	5.2	21.0	98
23	F	62	5.3	21.3	100
24	S	65	5.6	22.3	104
25	S	51	4.4	17.5	82
26	M	26	2.2	8.9	42
27	T	19	1.6	6.5	30
28	W	20	1.7	6.9	32
29	T	20	1.7	6.9	32
30	F	21	1.8	7.2	34
Totals:		1164	100.0		1868

* These are totals of the days that 291 hunters reported they planned to hunt when they checked in at the gate. Adjustments have been made for successful hunters who presumably stopped hunting after killing a deer. Of the 469 hunters on the club 178 did not report their hunting plans.

** These values are derived by applying the percentages in preceding column to the total number of hunters on the club (469).

Table 12. Mid Forest Lodge buck kill and hunting pressure, 1962

Date	Day of week	Hunter- days	No. of bucks killed	Kill per hunter- day
15	T	402	111	.277
16	F	234	30	.128
17	S	204	17	.083
18	S	188	13	.069
19	M	106		
20	T	95	3	.031
21	W	85	2	.024
22	T	98	3	.031
23	F	100	1	.010
24	S	104	3	.029
25	S	82	2	.024
26	M	42		
27	T	30		
28	W	32		
29	T	32	1	.031
30	F	<u>34</u>	<u> </u>	
		1868	186	

10.04 hunter-days per buck

9.96 bucks per 100 hunter-days

39.66 bucks per 100 hunters

Table 13. Mid Forest Lodge reported deer kill in each section, 1958-1962

	1958		1959		1960		1961		1962		Total bucks	Total antlerless deer	Total deer
	B*	A*	B	A	B	A	B	A	B	A			
2	10		2	1	3	2	8		10		33	3	36
3	8		7	1	8	2	5		5		33	3	36
4	8		2		3	5	3	1	6		22	6	28
5	3		2		5		5	4	10		25	4	29
6	6					1	5	2	3		14	3	17
7					1	1	2		2		4	1	5
8	3		2		5		2		8		20		20
9	10		4		3	4	9	1	5		31	5	36
10	6		5	1	4	3	7	3	8		30	7	37
11	1		7	3	5	3	15	3	9		37	9	46
13	4	6	6		2	1	1	1	2		15	14	29
14	2	3	7		3	1	3	3	9		24	7	31
15	5	3	3	3	1	1	4	1	8		21	7	28
16	10		1		7	5	5	3	9		32	8	40
17	3		4		2	2	3	3	4		16	5	21
18	5		1		3	1			2		11	1	12
19	5		1		1	1	2		3		12	1	13
20	8		2		1	1	5	3	3		19	4	23
21	7		3		1	3	2		7		20	3	23
22	14	11	13	15	5	4	3	5	20		55	35	90
23	4		1	1	1	2	1		4		11	3	14
27	7	4	2	4	5	3	6		12		32	11	43
28	4	1	1	2	2	5	3	1	5	1	15	9	24
29	1		1		3	1		1	4	1	9	2	11
30	3		1		1	1		2	1	2	6	3	9
31	1				3				2		6		6
32	1		4		7	2	4	1	7	1	23	3	26
33	7	1	3		2		2	1	2	1	16	2	18
34	9		9	6	5	1	17	1	15	1	55	8	63
Total	155	29	94	43	91	55	122	40	185	40	647	167	814

* B = Bucks A = Antlerless

to a favorite and familiar stump, and for this reason it may take a few years for an area that has had a sudden increase in deer to start attracting more hunters. I believe this has occurred to a certain extent on Mid Forest. The sections where the pulp cuttings began, in the east and southeast, were already popular hunting areas. As deer numbers built up in the cuttings the kill became heavier and the areas even more popular. But as cuttings were begun on the west side, even though deer suddenly increased there too, hunters lagged and did not immediately take advantage of it. The kill, therefore, has remained quite low in the Doyle Lake area, even though hunters there have recently reported good numbers of deer.

Total kills for the period are shown on the map (Figure 42) in various degrees of shading. In general the western sections have had consistently lower kills than central and eastern sections. This difference is undoubtedly a reflection of poorer deer range in the predominantly oak types on the west side. Also, the newly cutover areas have been concentrated on the east side and this has served to improve more range there and to accentuate the difference. The cuttings with their dense suckering have generally remained very good fall deer habitat even after six or seven years. In numerous cases heavy browsing has prolonged their attractiveness by holding back growth and keeping it low and brushy. A later section will present some evidence that winter usage may fall off faster than this.

MID FOREST LODGE CLUB

ROSCOMMON COUNTY, MICHIGAN

T 21 N , R 2 W

Scale in Miles

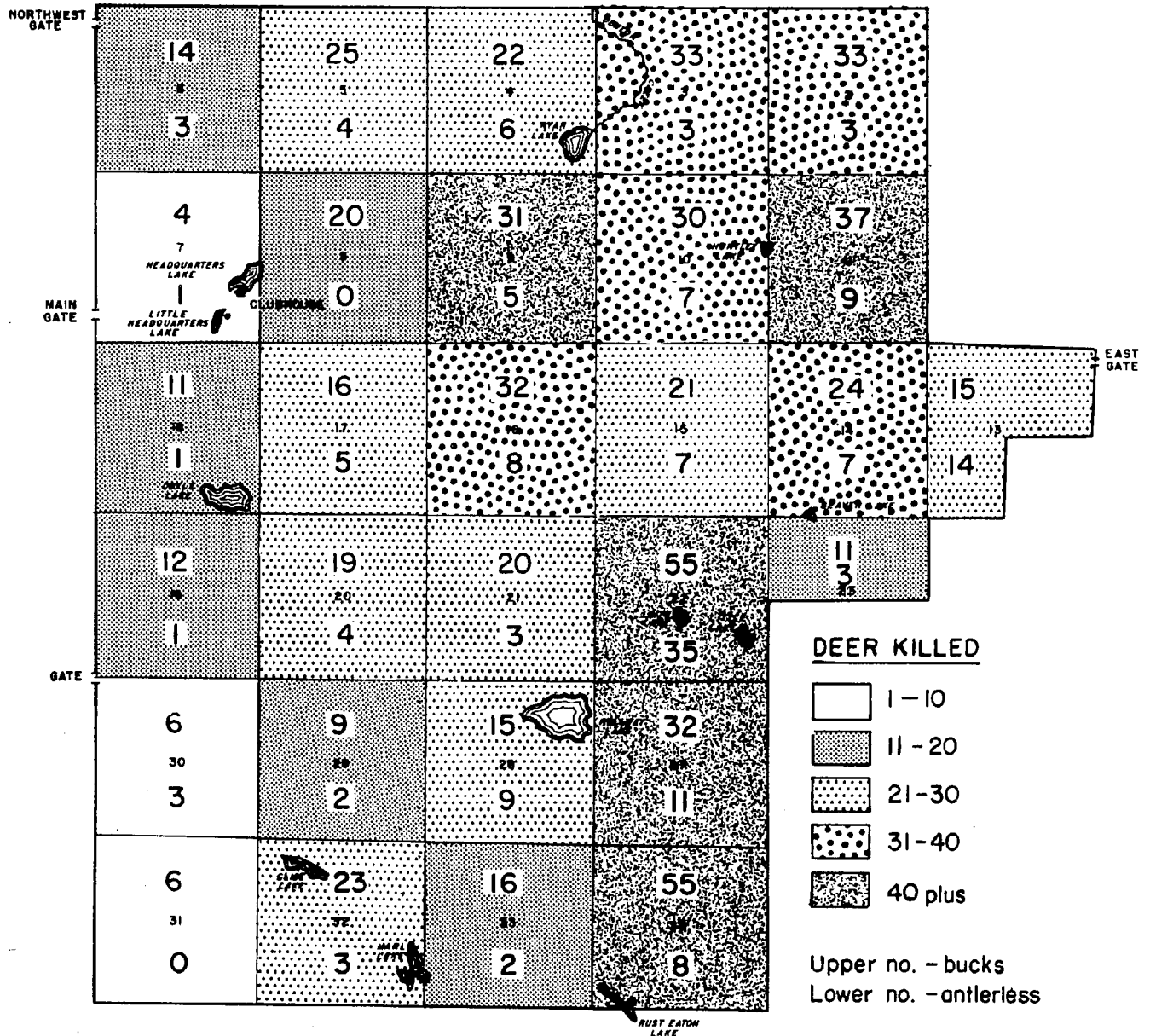
Club Area: 18,080 acres - 28 $\frac{1}{4}$ sq. miles

Figure 42. Total number of deer reported killed in each section during five hunting seasons, 1958 to 1962.

Antler Points

The pinnacle of success for any deer hunter is the moment that he finally secures his buck to the buck pole. Events leading to this have been debilitating: the uncertainties and suspense of the hunt, the exhilaration of the kill, the distasteful job of field dressing, the exhaustion of dragging. The world takes on a new complexion now, and the fruits of success can really be savored; one can stand back and see for the first time what the trophy actually looks like. Until now the size of its antlers hadn't mattered much. Spikehorn or 8-point, a buck is a buck, and the thrill is the same. Few, if any, hunters in Michigan ever lower the gun on a buck because it's only a spikehorn and not a "rocking chair." But now that it's up there on the pole the bonus thrill of a nice rack may add an inch or so of swell to a nimrod's chest, and every additional antler point will add a dash of extra flavor to the story of the hunt which must now be related to anyone within range.

Antler points are therefore a great concern to deer hunters, and keeping a record of them has been held of prime importance on Mid Forest. With only a few exceptions the number of points has been listed for every buck checked out during the past eight years. This record is summarized in Table 14. The graphs in Figures 43 and 44 illustrate the change in the average number of points from year to year and the frequency distribution of points on all bucks taken during the period.

Data on antler points without being related to age classes may be of limited biological value. The number of points is no indicator of age, but it may reflect physical condition in a general way. (In a later section I will present data collected on antler size of known-age deer and discuss its application in range evaluation.) The average

Table 14. Mid Forest Lodge, number of antler points on bucks of all age classes, 1955-1962

Year	Number of bucks of all ages											Ave. no. pts.
	2	3	4	5	6	7	8	9	10	11	Total bucks	
1955	No. 31	2	20	7	14	5	9	2	0	0	90	4.4
	% 34.4	2.2	22.2	7.8	15.6	5.6	10.0	2.2			100.0	
1956	No. 40	7	8	2	0	0	3	0	1	0	61	2.9
	% 65.6	11.5	13.1	3.3			4.9		1.6		100.0	
1957	No. 52	12	29	9	17	3	12	0	0	0	134	3.9
	% 38.8	9.0	21.6	6.7	12.7	2.2	9.0				100.0	
1958	No. 51	10	21	10	18	12	28	4	1	0	155	4.7
	% 32.9	6.5	13.5	6.5	11.6	7.7	18.1	2.6	.6		100.0	
1959	No. 44*	7	16	10	15	5	12	3	0	0	112	4.2
	% 39.3	6.2	14.3	8.9	13.4	4.5	10.7	2.7			100.0	
1960	No. 35	11	11	8	14	5	21	1	1	0	107	4.6
	% 32.7	10.3	10.3	7.5	13.1	4.7	19.6	.9	.9		100.0	
1961	No. 46	19	33	13	18	5	8	1	0	1	144	4.0
	% 31.9	13.2	22.9	9.0	12.4	3.5	5.6	.7		.7	100.0	
1962	No. 73**	33	31	16	13	10	8	2	1	1	188	3.7
	% 38.8	17.5	16.5	8.5	6.9	5.4	4.3	1.1	.5	.5	100.0	
8-yr. total	No. 372	101	169	75	109	45	101	13	4	2	991	4.1
	% 37.5	10.2	17.1	7.6	11.0	4.5	10.2	1.3	.4	.2	100.0	

* Includes 5 sublegal bucks (spikes less than 3 in.)

** " 2 " "

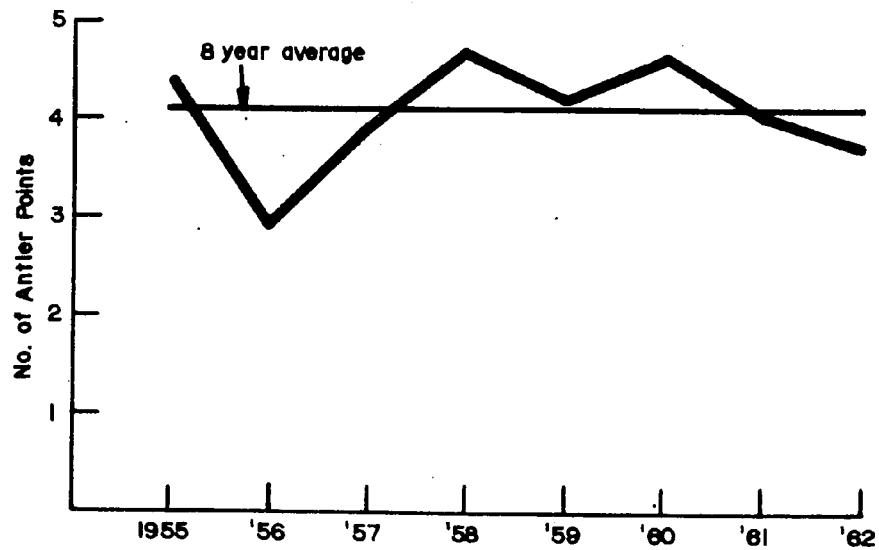


Figure 43. Average number of antler points on bucks of all age classes, Mid Forest Lodge, 1955-1962.

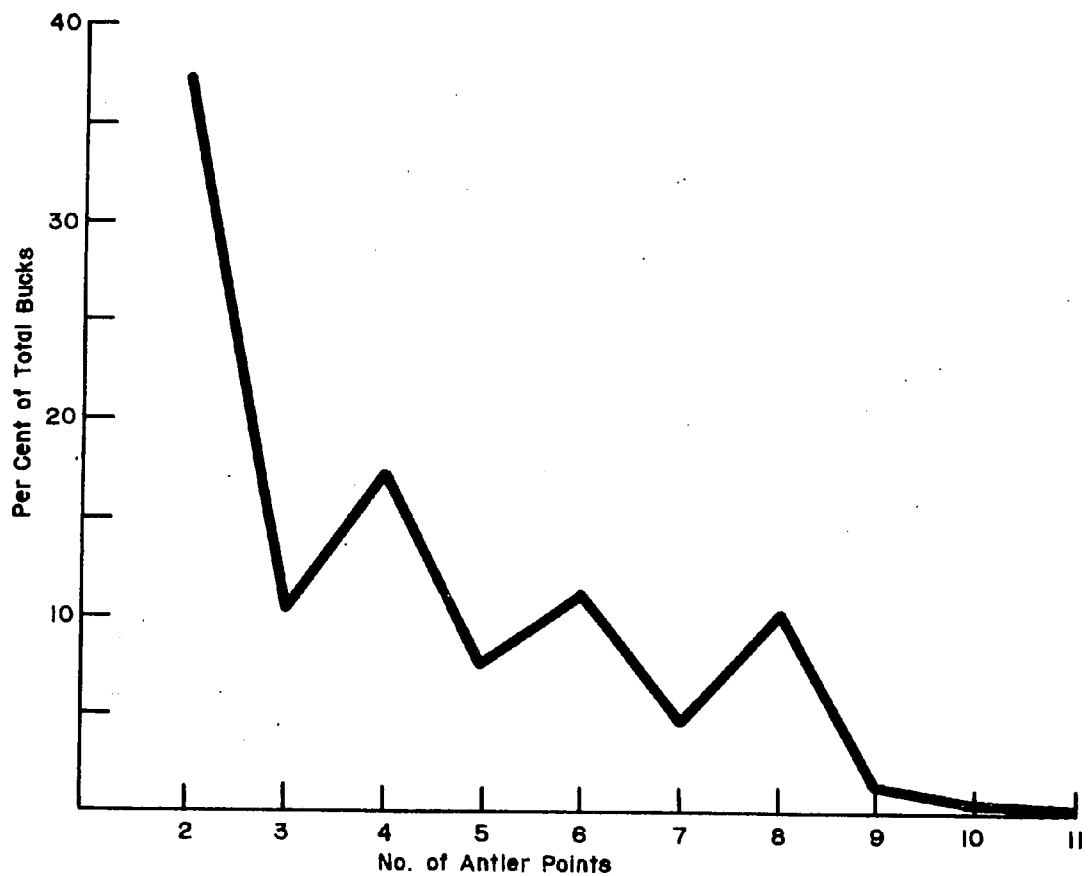


Figure 44. Frequency distribution, average antler points on bucks of all age classes, Mid Forest Lodge, 1955-1962 combined.

of points on all bucks, as shown in Table 14 and Figure 43, has remained close to four, except in 1956 when it dropped to about three. This was due to the very high proportion of spike bucks taken that year, almost two-thirds, as compared to the usual proportion of closer to one-third. The preceding winter, 1955-1956, was a severe one, and it seems quite certain that the many 1956 spikehorns were a direct reflection of the herd's condition that year. No other indicator is available, and we cannot know whether the spikes were mostly yearlings or whether two-year olds were also in the group. It may be noted that in 1959 following an even more severe winter, the average of points also dropped, but not nearly as much as before.

Many of the members hold rather distorted notions about the number of trophy heads on the club, where they may be found, and how they increase or decrease from year to year. Actually, no outstanding racks have been taken in recent years, to my knowledge. With the constant high hunting pressure no bucks can escape and live long enough to grow a real trophy set of antlers. As Table 14 shows, the largest taken are 10 and 11-pointers, and on the average only one of them a year. Analyzing the kill by section number did not reveal that any particular areas were producing disproportionately more 8 to 11 point bucks than others. The larger bucks seem to be found quite uniformly throughout the club.

Attention is called to the sublegal bucks referred to in Table 14. These are adults with spike antlers less than the 3-inch legal minimum. They can be legally taken only by antlerless permit holders and are normally classed with the antlerless kill. They are usually yearling deer that have barely survived their first winter and have not been physically capable of producing any but very stunted antlers.

(Sometimes even 2 1/2-year bucks have been found with sublegal spikes.) Again, the rigors of the 1958-1959 winter are reflected in the number of these small spikes occurring in the 1959 bag.

Biological Data

The combined observations on age, weight, antler size, and foot measurement which the Michigan Conservation Department obtains each hunting season are, for convenience, called deer biological data. This term will also be used for similar information obtained in the Mid Forest study.

Age Classification

These data are presented in Table 15. The number and percentage of bucks, does, and fawns in each age class are given for each year. A subdivision of the yearling bucks into 1 1/2 - and 1 1/2 + groups will be noted. These two classes designate 1 1/2-year-olds with one or more milk premolars still in position (1 1/2 -) or those with milk premolars completely displaced by permanent premolars (1 1/2 +). Ryel et al. (1961) discusses the analysis that has been made of Michigan's statewide data on this differing rate of displacement. The evidence is quite clear that in the Upper Peninsula a significantly higher percentage of yearlings replace their deciduous premolars at a later date than in the Lower Peninsula. Also, in both regions replacement differed between years. No good explanation has been found for the differences.

In this study I routinely distinguished between the two classes of 1 1/2-year bucks in 1960, 1961, and 1962. The distinction was easily made, and though the data at present appear to have no particular significance it is presented here along with the other age information. On

Table 15. Deer aged during hunting seasons on Mid Forest Lodge,
1958-1962; number and percentage of deer in each age class

	Age class	1958		1959		1960		1961		1962	
		No.	%	No.	%	No.	%	No.	%	No.	%
Bucks	1-1/2 -					37	69	45	60	69	69
	1-1/2+					17	31	30	40	30	30
Total 1-1/2		62	55	39	49	54	62	75	71	99	82
2-1/2		37	32	28	36	22	25	24	23	13	11
3-1/2		15	13	12	15	9	10	6	05	8	07
4-1/2		0		0		2	03	1	01	0	
Total bucks		114	100	79	100	87	100	106	100	120	100
Does	1-1/2	4	57	7	20	7	29			6	21
	2-1/2	0		12	34	3	13			9	32
	3-1/2	0		6	17	6	25			5	18
	4-1/2	1	14	6	17	2	08			4	14
	5-1/2	2	29	3	09	2	08			3	11
	6-1/2	0		1	03	4	17			1	04
Total does		7	100	35	100	24	100			28	100
Fawns	♂	1	50	3	75	11	73			6	75
	♀	1	50	1	25	4	27			2	25
Total fawns		2	100	4	100	15	100			8	100

casual examination it appears to show good correspondence to the Michigan data for the Lower Peninsula, where proportions of 1 1/2- in two years averaged around .70. Upper Peninsula figures averaged nearer .90. In the tables immediately following (Tables 16, 17, and 18) it will be seen that the club's 1 1/2 - class rather consistently weighs less, has smaller beam diameters, and few antler points than the 1 1/2+ group; and that the two show no regular difference in foot length.

I have shown earlier (Table 8) that a high proportion of the kill has been aged each year. In the case of bucks I believe this sample is also a high percentage of the total buck population. It is obvious from the age class distribution that the kill each year harvests the bucks very heavily, and therefore a very substantial proportion of the total has actually been examined. I feel, also, that the sample is relatively unbiased; in other words, that it represents the age classes as they actually were taken and is close to the proportions that existed in the population. It appears that the continual high hunting pressure regularly harvests most of the bucks on the area and that there is little difference in survival rate between age classes. This was confirmed by computing and plotting survival rates according to the method described by Hayne and Eberhardt (1952).

On the other hand, the sample of antlerless deer aged, while a high proportion of those harvested, is a relatively small number and a much smaller proportion of the total antlerless population which outnumbered bucks by six or eight to one. Survival rates determined from the age class distribution of the adult does were variable and inconsistent, indicating a too small and unrepresentative sample.

The age class distribution of the adult bucks will be utilized in a later section in the development of a method of estimating population level.

Weights

The average weights of deer for the various sex and age classes are shown in Table 16.

Weight and size of deer in a given region will vary with food quality and quantity, and are an accepted index to degree of range overpopulation (Severinghaus and Cheatum, 1956). Comparisons must be made within sex and age classes, and usually the yearlings (1 1/2-year) group is the most useful for this. Yearlings are likely to be the most abundant age group and therefore the largest sample; but of more importance, they are the best indicators of range condition for a given year. Having experienced only one winter as fawns and one season growing into adults their condition as yearlings will be a direct reflection of range quality and winter stress for that particular year. Comparison of biological data within the yearling buck age class will be discussed at the end of this chapter.

Considering briefly the weights of all age classes, as shown in Table 16, there has been a very noticeable trend upward from 1958 for all deer, bucks, does, and fawns. The sample has not been large enough for analysis within any one age group of antlerless deer or older bucks, but the change has been remarkably consistent in most groups. The increase was most pronounced in 1959.

No exceptionally heavy deer have been taken on the club during the period of study. A few of the 3 and 4-year-old bucks have weighed in the neighborhood of 150 lbs. and among these 156 lbs. has been the heaviest.

Antler Size

Table 17 presents the data on antler beam diameter and number of points for all bucks that have been aged and measured. It will be

Table 16. Dressed weights of deer by age class, Mid Forest Lodge,
1958-1962 hunting seasons

Age class		Average weight in pounds (number of deer in parentheses)				
		1958	1959	1960	1961	1962
Bucks	1-1/2 -			94.6 (35)	99.4 (42)	101.1 (69)
	1-1/2 +			98.1 (15)	102.8 (29)	103.0 (30)
Total	1-1/2	86.3 (55)	98.6 (36)	85.7 (50)	100.7 (71)	101.7 (99)
	2-1/2	108.4 (35)	112.4 (28)	118.0 (22)	117.3 (24)	122.8 (13)
	3-1/2	118.2 (12)	130.6 (12)	125.4 (9)	141.0 (6)	133.0 (8)
	4-1/2			125.0 (2)	146.0 (1)	
Total bucks		97.8 (113)	108.8 (76)	105.5 (83)	108.0 (102)	106.1 (120)
Does	1-1/2	78.5 (2)	89.3 (7)	87.4 (7)		94.7 (6)
	2-1/2		103.4 (12)	107.0 (3)		100.4 (9)
	3-1/2		102.8 (6)	102.2 (6)		97.0 (5)
	4-1/2	91.0 (1)	110.2 (4)	107.5 (2)		122.2 (4)
	5-1/2	88.5 (2)	99.0 (3)	105.5 (2)		99.0 (3)
	6-1/2		102.0 (1)	107.0 (4)		102.0 (1)
Total does		85.0 (5)	101.6 (33)	100.0 (24)		101.6 (28)
Fawns	♂	50.0 (1)	70.6 (3)	55.6 (9)		69.0 (6)
	♀	54.0 (1)	72.0 (1)	67.0 (6)		88.0 (20)
Total fawns		52.0 (2)	71.0 (4)	60.1 (15)		73.8 (8)

Table 17. Antler size (points and beam diameter) by age class,
Mid Forest Lodge, 1958-1962 hunting seasons

Age class	Antler size (number of deer in parentheses)				
	1958	1959	1960	1961	1962
<u>Ave. no. of points</u>					
1-1/2-			2.9 (36)	3.1 (45)	3.2 (69)
1-1/2+			3.9 (17)	3.7 (28)	2.8 (30)
Total 1-1/2	3.0 (62)	2.7 (39)	3.2 (53)	3.4 (73)	3.1 (99)
2-1/2	7.0 (37)	5.4 (28)	5.9 (22)	6.2 (24)	6.5 (13)
3-1/2	7.4 (13)	7.4 (12)	6.9 (9)	7.8 (6)	8.0 (8)
4-1/2			7.5 (2)	8.0 (1)	
Total bucks	4.8 (112)	4.4 (79)	4.5 (86)	4.3 (104)	3.8 (120)
<u>Ave. beam diameter in mm.</u>					
1-1/2-			16.1 (35)	17.6 (39)	17.1 (61)
1-1/2+			17.6 (17)	18.6 (22)	16.8 (25)
Total 1-1/2	15.8 (16)	15.2 (37)	16.6 (52)	17.9 (61)	17.0 (86)
2-1/2	27.7 (21)	19.8 (26)	21.4 (22)	23.4 (23)	23.0 (13)
3-1/2	25.0 (10)	25.2 (12)	24.2 (9)	26.9 (6)	27.9 (8)
4-1/2			23.5 (2)	31.0 (1)	
Total bucks	23.1 (47)	18.4 (75)	18.0 (85)	20.1 (91)	18.5 (107)

noted that there are differences in the annual totals between the two categories in this table and also between these totals and those in Tables 16 and 18. This is because all checking operations were not performed on all deer that were examined. There were some deer that had points tallied but were not measured; others were measured and aged but not weighed. The various combinations of incomplete checking has produced the varying totals within years.

Severinghaus et al. (1950) have shown direct relationship between antler beam diameter and range quality in New York deer and suggested that this measurement can be used as a condition factor for evaluating range adequacy. They also emphasize that many variables exist and that large samples are necessary. French et al. (1956), in controlled feeding experiments at Pennsylvania State University, found that weight and antler size were directly affected by food quality and quantity and that "body growth took precedence over antler development in these young growing deer." Thus antlers may be even more indicative of range conditions than weight or other physical characteristics. Statistical analysis of my data indicates a fairly wide variability (see Figure 45) in beam diameter and antler points. It shows that the sample was probably inadequate for any high degree of significance. However, upward trends conforming with those of other factors are apparent, and I feel the data contribute some substantiation of changes in range quality.

Hind Foot Length

Foot length data is summarized in Table 18. The measurement was not made routinely until 1962, and the 1959 and 1960 samples for the various age classes are therefore rather small. The figures show a distinct upward trend from 1960 to 1962 within each age class, and they

Table 18. Length of hind foot by age class, Mid Forest Lodge, 1960-1962 hunting seasons

Age class		Average length of hind foot in mm. (number of deer in parentheses)		
		1960	1961	1962
Bucks	1-1/2 -	469 (18)	476 (31)	489 (53)
	1-1/2 +	469 (7)	480 (21)	486 (20)
Total	1-1/2	469 (25)	478 (52)	488 (73)
	2-1/2	474 (8)	482 (18)	497 (11)
	3-1/2	489 (7)	490 (6)	501 (8)
	4-1/2	476 (2)	490 (1)	
Total bucks		472 (42)	481 (77)	490 (92)
Does	1-1/2			455 (4)
	2-1/2			458 (4)
	3-1/2	472 (2)		462 (1)
	4-1/2			465 (3)
	5-1/2			
	6-1/2	452 (3)		
Total does		462 (5)		459 (12)
Fawns	♂			430 (5)
	♀			431 (2)
Total fawns		422 (4)		430 (7)

indicate each year a gradation upward with increasing age. Measurements of does and fawns were too scanty to be useful except to show general size differences.

Yearling Buck Data

The biological data for one age class, the yearling bucks, is shown in the series of graphs in Figure 45. The curves are plots of the means of values for all 1 1/2-year bucks each year. Except for the first item, yearling percentages, the range of plus or minus two standard errors has been plotted as a vertical line through each mean. This will portray the variability range of the samples measured and will aid in judging the significance of the trends indicated.

The percentage of yearling bucks in the kill can be a rough index of reproductive rate. In studying the Mid Forest herd it was the only measurement available to me which expressed reproduction quantitatively; I present it here to show an indicated trend and in a later section will compare it with some other areas.

A number of factors will govern how much of the buck kill is in this age class. The proportion harvested may not be the same as the proportion actually present in the population. It might be assumed that bucks older than yearlings are warier and would be killed at a lower rate than the unwary yearlings. There is some evidence that this is not true, except perhaps on opening day. Maguire and Severinghaus (1954) arrived at this conclusion after analyzing several years' checking station data in New York. Michigan data, analyzed by Eberhardt (1960), was inconclusive. On Mid Forest, with its hunting pressure every year at a constant high level and its heavy harvest of bucks, I believe that the age classes are killed in the proportion that they are present in the herd and that this factor can be disregarded.

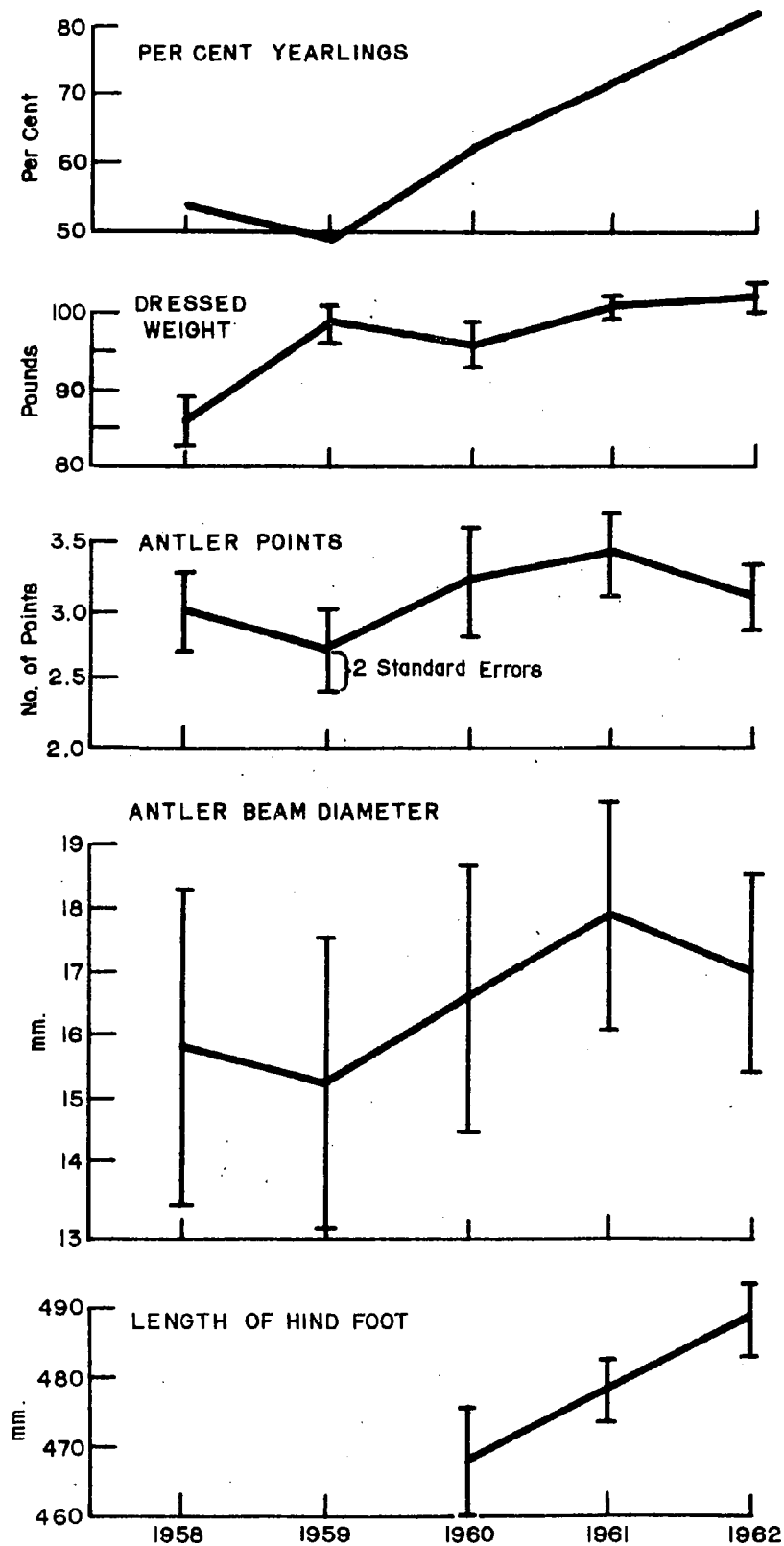


Figure 45. Data from yearling bucks (1½ yrs. old) examined during hunting seasons on Mid Forest Lodge. Values are means, vertical lines indicate limits of ± 2 standard errors.

The other factors are those of productivity and survival. The relative size of the fawn crop conceived and born, the survival of the fawns after birth, and their survival during their first winter, all combine to affect the relative abundance of the yearling group at the beginning of the hunt. The environmental forces of range quality during two winter seasons thus may impinge upon the group. Cheatum and Severinghaus (1950) established the importance of the winter range factor in controlling fertility and reproductive rate; Verme (1962) reported evidence of postnatal fawn mortality being directly affected by winter diet of does; and the effects of weather and range on the over-winter mortality of fawns is well established.

From this it will follow that changes in the proportion of yearlings in any year can signify range or weather changes in either or both of the two preceeding winters. Jenkins (1961) shows a spectacular drop in Michigan's yearling bucks in the 1960 season, and suggests that heavy fawn mortality in the 1960 winter may have caused it. It is likely, too, that an additional influence may have been felt--the equally or more severe winter of 1959.

Conversely, marked improvement in the size of the yearling class is probably a direct reflection of higher production and survival following mild winters or improved carrying capacity.

The pattern shown by the club's harvest of yearlings is shown in the upper curve of Figure 45. The distinct drop in 1959 and the successive improvement that followed, I feel, is quite significant. The drop is undoubtedly a reflection of the high fawn mortality that occurred in the winter and spring of 1959. This dieoff was observed and measured and will be reported in a later section. The increase during succeeding

years conforms to the observed lack of serious winter mortality during that period and probably also indicates repeated successful reproduction.

The curves for weight and antler size show a disparity in 1959 and again in 1962. Weight went up, antler size decreased. This could be explained, however, by the established fact pointed out earlier that body growth has precedence over antler growth. The yearlings in 1959, then, reflected the starvation winter in their small antlers but showed the abundance of a good summer food supply in their heavier body weights. The poorer antlers in 1962 probably also show some effects of the hard winter of 1961-1962, but the range by this time was considerably improved and, as will be shown later, mortality was insignificant that spring.

These condition factors of the club's yearling bucks all seem to point to a continuing improvement in range quality. They will be compared to biological data from other areas in a later section, and it will be shown then that a similar record of improvement is not evident elsewhere in the state.

CENSUS BY PELLET-GROUP COUNTS

Deer surveys based upon the principle of counting pellet groups have been tried throughout most of the continent's deer range with varying degrees of success and acceptance. In mule deer country the pellet count has been extensively studied and tested (McCain, 1948; Rogers et al., 1958) and is more often used to measure trends in population or to evaluate range use than to census deer numbers. Michigan has had good results in applying the technique to statewide censusing, and it has now become an annual survey and a key information source for population estimates (Ryel, 1962).

Development of the technique in Michigan by the Conservation Department has included frequent testing on two small areas of known population (Eberhardt and Van Etten, 1956; Ryel, 1959b). These fenced enclosures of one and two square miles have provided excellent checks on the accuracy of the method, and studies of penned deer have been repeated at intervals to improve knowledge of defecation rates. There remain, however, certain limitations and weak spots in the method, and further testing and application to larger areas are desirable.

The Mid Forest Lodge study offered an opportunity to develop and test an adaptation of the currently used pellet method on an area of township size where basic herd information would be available. This aspect of the study was accordingly incorporated into Pittman-Robertson Project W-95-R of the Houghton Lake Wildlife Experiment Station.

Population data obtained from the surveys, of course, provided information essential to the Mid Forest study. The methods used and their findings are reported below.

Methods

The pellet count techniques which I applied on Mid Forest were in general very similar to the standard statewide surveys annually used in Michigan. This method is described in detail by Ryel (1962). Different sampling procedures were required for the Mid Forest area than for the statewide survey. The first procedure, which I tried in 1959, proved unsatisfactory. A modification tried in 1960 gave good results and it was repeated in 1961.

In brief, the Michigan method counts pellet groups in the spring immediately after snow is gone. Only the groups lying on top of the previous fall's leaves (Figure 46) are considered. The basic sampling unit is a 1/50-acre rectangular plot, 12 ft. x 72.6 ft. Counts on a series of these plots yield estimates of pellet groups per square mile. These are converted to deer-days by applying the defecation rate factor of 12.7 groups per deer per day (Eberhardt and Van Etten, 1956). Deer-days convert to total number of deer by applying the known number of days from the date of average leaf fall to the date of survey. Corrections are made for the known removals of deer through hunting and winter mortality. Randomization of sampling permits calculation of statistical confidence limits.



Figure 46. Deer pellet group. The unit of count in the pellet survey census method. This group was deposited after leaf fall.

1959 Survey

A sampling system for the Mid Forest area was devised with the assistance of L. L. Eberhardt, then biometrician of the Game Division. Limitations of manpower available for the survey made it desirable to attempt a stratified random sample, as this would reduce the number of sampling units required. From what was known of the area it was estimated that deer in the winter were most numerous in the northern one-third and fewest in the southern one-third. Three strata were established: I) the northern two tiers of sections, II) the central two tiers, and III) the southern two tiers. Six transects were located randomly in the strata: three in I, two in II, and one in III. It was determined that plots systematically located at 8-chain intervals would yield about 150 total plots which would be an adequate sample for the expected group frequency and the desired degree of accuracy. Also, it would be about as many as the limited manpower could handle. The first plot on each transect was located a random number of chains (1 chain equals 66 ft., 1/80 mile) east of the west boundary but within 8 chains of it. From that plot eastward the others were spaced 8 chains apart to the end of the transect. The total number of plots amounted to 146. Figure 47 shows the approximate location of the transects and the plots.

In the field I laid out the transects by hand compass, paced distance between plots, measured length of the plots with a pre-cut plastic clothesline, and width by a 6-foot wand. The 12-foot wide plots were searched by one man walking slowly along the clothesline rope, scanning a 6-foot wide area and then returning along the other side of the rope to the beginning. All pellet groups one-half or more of which were

MID FOREST LODGE CLUB

ROSCOMMON COUNTY, MICHIGAN

T 21 N , R 2 W



Club Area: 18,080 acres - 26 $\frac{1}{4}$ sq. miles

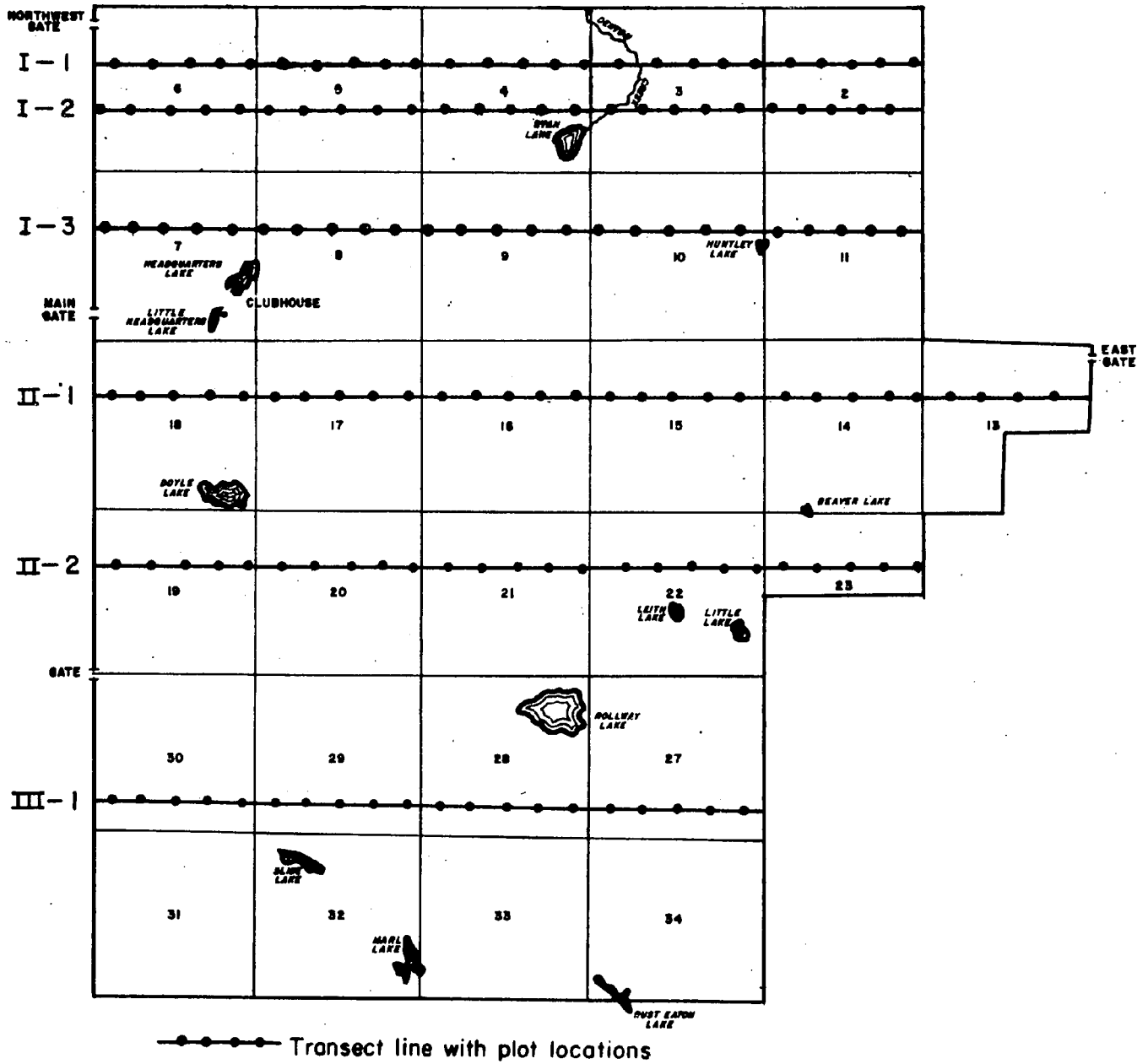


Figure 47. Deer pellet count transects, 1959 survey.

lying within the plot limits were recorded. Groups on top of leaves were classed as "new", others as "old." If leaves were not present pellet classification was based on texture, color, and other pertinent criteria developed through previous experience. On the club most plots were in or near deciduous cover, and leaves of some type were usually present.

Transects were seldom run in one continuous trip. Depending upon access and location of road crossings starting points were at various positions along the lines and return trips were frequently along adjacent lines. The author conducted most of the field work, assisted at times by two other biologists. The work was done alone, not in two-man teams as customarily done in the state survey, and no other system of rechecks was attempted. Experience has shown in the state surveys that rechecks are desirable, but time and manpower limitations precluded this in my study.

The totals of "new" groups counted on each plot were grouped in sets of three adjacent plots. The combined number for each set was then treated as a single unit representing a plot .06 acre in size ($3 \times 1/50$ acre). Means and variance were computed for each stratum and a weighted mean and variance was derived for the area.

1960 and 1961 Surveys

After the 1959 count was completed and the results analyzed it was apparent that the stratification was not realistic and that a heavier sampling rate was needed in central and southern portions of the club. Also, the transects running completely across the club were difficult to cover efficiently on foot, as they required much wasted time walking between lines or returning to the car.

Again with the assistance of L. L. Eberhardt, a new sampling system was designed. The 1/50-acre rectangular plot remained the basic sampling unit. However, instead of being distributed systematically along belt transects completely across the area they became subunits within randomly located quarter-sections which were then the primary units. In order to provide mile-long transects, the sections were quartered laterally into parallel rectangles rather than square quarters.

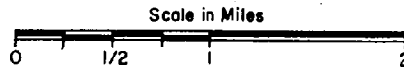
Each section in the club was divided into four lateral quarters extending east and west across the section. All of these quarter-sections were numbered serially from 1 to 113. It was determined that a minimum of 30 of these would be required for an adequate non-stratified sample. That many were then selected by drawing from a table of random numbers. Within each chosen quarter-section was located a course consisting of two randomly positioned lines running lengthwise across the quarter-section and parallel to the north and south boundaries. Along each line four of the 1/50-acre plots were spaced at 20-chain intervals, the location of the first plot being selected at random within 20 chains of the western end of the line. Thus each quarter-section sampling unit consisted of eight plots or subunits along a course of two belt transects. Figure 48 gives the location of the 30 quarter-section units.

All parts of the club are readily accessible by a good system of roads. This made it possible to go by car to a point on, or quite near to, each of the courses. The survey of each course was begun on either line, wherever it was most accessible, and proceeded in either direction around the course to all eight of the systematically spaced plot locations. The plots were searched in the same manner as in 1959.

MID FOREST LODGE CLUB

ROSCOMMON COUNTY, MICHIGAN

T 21 N, R 2 W



Club Area: 18,080 acres - $28\frac{1}{4}$ sq. miles

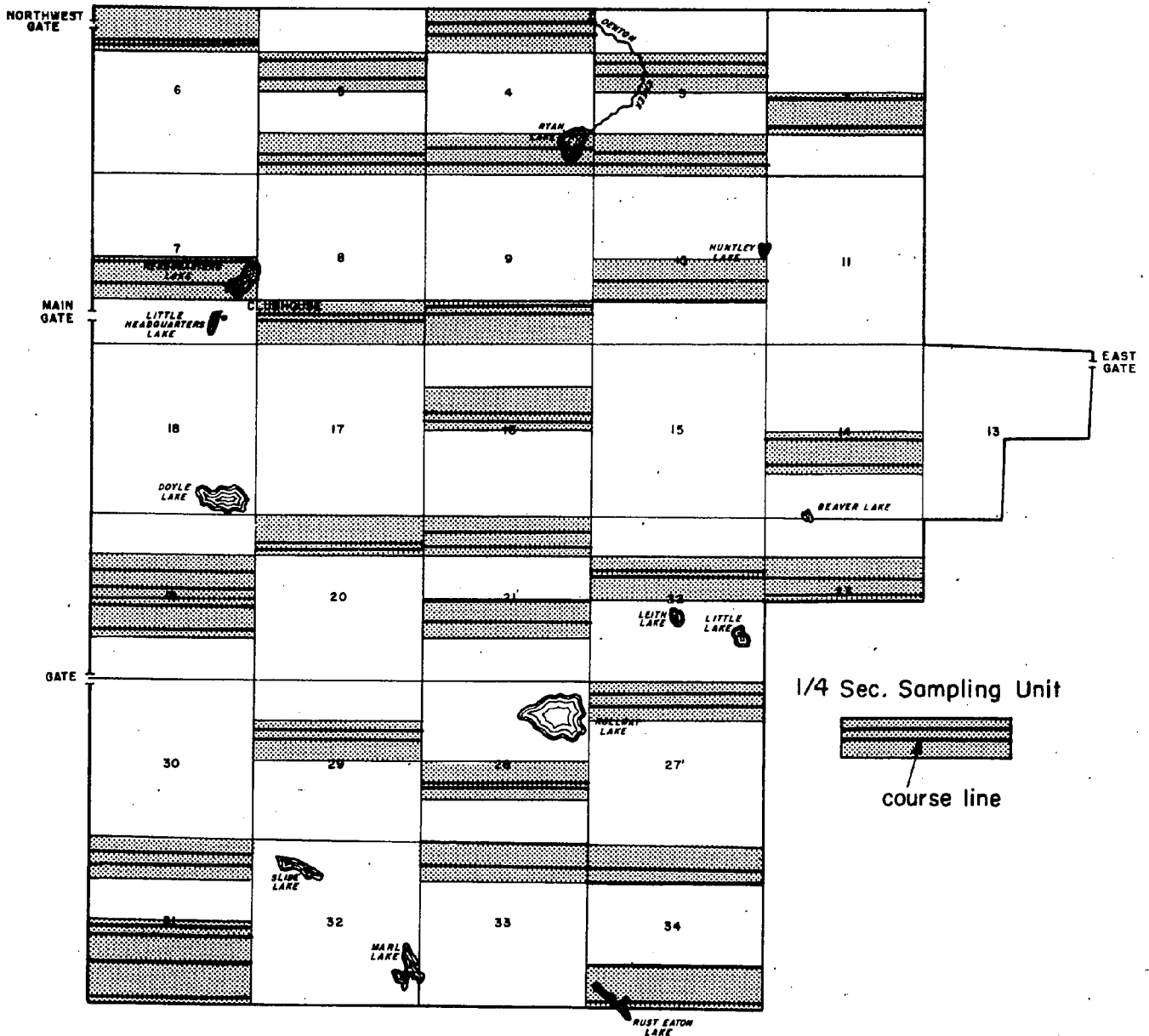


Figure 48. Deer pellet count courses, 1960 and 1961 surveys.

After pellet groups were counted on all plots the "new" groups on the eight plots for each course were added up and were thereafter considered as the total for one plot .16 acre in size ($8 \times 1/50$ acre).

The system proved to be more efficient than the previous one and it was used again in the 1961 survey, but with different plot locations. Sixty man-hours of work time were required to run the 30 courses. This did not include travel to and from, or between, courses. Thus, based on an 8-hour work day, it is likely that the average rate would be three courses per day, and 20 man-days of field time would be required to complete the survey.

Results

1959 Survey

Table 19 summarizes the statistical treatment of the 1959 data. The mean number of pellet groups per set was used to derive an estimate of the groups per acre, and from that a total population estimate for the club. A mean leaf fall date of October 18, 1958, had been determined from field observations. Hunting season removals, and fall and winter losses were obtained from other surveys made in this study. Confidence limits at the .95 level were computed to be $\pm 30.4\%$ of the mean.

In Table 21 are listed the population estimates for the spring of 1959 and the fall of 1958. The fall figure is obtained by adding the estimated removals to the spring figure.

Table 19. Mid Forest Lodge deer pellet group survey. Summary of data and statistical analysis - 1959

Stratum	Area sq.miles	Pro- portion w	Mean group/set $\bar{x}$	No. sets n	w^2	Variance s^2	$\frac{w^2 s^2}{n}$
I	10.00	.354	15.333	24	.125	195.623	1.021
II	10.25	.363	22.006	18	.132	571.232	4.176
III	<u>8.00</u>	<u>.283</u>	9.429	<u>7</u>	.080	68.286	<u>.783</u>
	28.25	1.000		49			5.980

Mean No. groups, all strata = 16.099 S.E. = $\sqrt{\frac{w^2 s^2}{n}} = \sqrt{\frac{5.980}{49}} = 2.445$

1. Mean no. pellet groups per set of 3 plots: 16.099
2. Area of each set (3 x 1/50 A): .06 A
3. Pellet groups per acre (16.099/.06): 268.317
4. Groups per square mile: 171,722.880
5. Groups per deer day (pellet deposition constant): 12.7
6. No. of days (Oct. 18 to May 14): 209
7. Correction for deer removals (per square mile)
 - (a) Hunting season kill (184/28.25): 6.51
 Days contributed (Oct. 8 to Nov. 16): 29
 Groups deposited (6.51 x 12.7 x 29): 2397.633
 - (b) Fall and early winter losses 4.17
 (.20 x 20.89):
 Days contributed (Oct. 18 to Dec. 31): 75
 Groups deposited (4.17 x 12.7 x 75): 3971.925
 - (c) Starvation loss (.80 x 20.89): 16.71
 Days contributed (Oct. 18 to Mar. 1): 135
 Groups deposited (16.71 x 12.7 x 135): 28649.295
 - (d) Total groups contributed by removals: 35018.853
8. Corrected groups per sq.mi. (from deer alive on May 14): 136,704.027
9. Spring population, deer per square mile

$P = \frac{\text{groups per sq.mi.}}{\text{days x groups/deer/day}} = \frac{136,704.027}{209 \times 12.7} = 51.503$
10. Confidence limits on estimate, 95% level

2 S.E. as per cent of mean: $\frac{2(2.445)}{16.099} = .304 \quad \pm 30.4\%$
11. Range of estimate, deer per sq.mi.: 51.5 (35.9 to 67.1)
 total deer on club: 1455 (1013 to 1897)

Table 20. Mid Forest Lodge deer pellet group survey. Summary of data and statistical analysis - 1960 and 1961

	No. plots	No. courses n	Mean groups/course $\bar{x}$	Standard error S. E.	2 S.E. $\bar{x}$
1960	240	30	22.567	4.105	.364
1961	240	30	28.233	3.673	.245

	1960	1961
1. Area of plots on each course (8 x 1/50):	.16 A	.16 A
2. Pellet groups per acre ($\bar{x}/.16$):	141.042	176.458
3. Pellet groups per sq. mile	90,266.752	112,933.184
4. Groups per deer day (pellet deposition constant):	12.7	12.7
5. No. of days, leaf fall to middle survey period:	209	205
6. Correction for deer removals (per sq.mile)		
(a) Hunting season kill		
Gate tally +10% estimated unrecovered	6.62	6.65
Days contributed	23	26
Groups deposited	1933.702	2195.830
(b) Starvation loss	0	0
7. Corrected groups per sq. mile	88,333.050	110,737.354
8. Spring population = $\frac{\text{groups/sq.mi.}}{\text{days x groups/deer/day}}$	33.279	42.534
9. Confidence limits on estimate, 95% level 2 S.E. as per cent of mean	36.4	24.5%
10. Range of estimate, deer per sq.mile	21.2 to 45.4	32.1 to 52.9
Total deer on club:	940	1200
	598 to 1282	906 to 1494

Table 21. Pellet group counts and deer population estimates,
Mid Forest Lodge, 1958 to 1961

	1958	1959		1960		1961
	Fall	Spring	Fall	Spring	Fall	Spring
Pellet groups per acre						
Uncorrected		268.3		141.0		176.5
Corrected		213.6		138.0		173.0
Deer per sq. mile	78.9	51.5	39.9	33.3	49.2	42.5
Deer on club	2229	1455	1127	940	1390	1200

1960 and 1961 Surveys

Table 20 summarizes the data and the statistical treatment for the two years in which the second method was used. The mean number of pellet groups per 8-plot course and their standard errors were computed and expanded to groups per acre. Leaf fall dates of October 24, 1960, and October 22, 1961, were used to derive the survey period. Confidence limits on the population estimates were $\pm 36.4\%$ in 1960 and $\pm 24.5\%$ in 1961.

Table 21 shows the estimates of deer populations on the club derived from all three pellet surveys. It will be noted that the fall 1959 figure, obtained by adding known deer removals to the spring 1960 pellet count figure, is lower than the spring 1959 pellet count estimate. Since this could not conceivably be possible, one or both surveys must be in error. Evidence pointed strongly to 1959. The stratification was

obviously incorrect, and the sampling appeared to cover the area incompletely. Also the good agreement between 1960 and 1961 tended to support their acceptance. Confirming evidence came later in the study when an independent method yielded population estimates conforming very close to the 1960 and 1961 pellet figures. I have, therefore, decided that the 1959 pellet count was greatly in error, beyond even the usual sampling error. In Figure 49 I have plotted the estimates derived from the three pellet counts and show by a broken line the probable position of the fall and spring herd as indicated by the unrelated method.

Pellet Group Distribution in Relation to Cutting Program

It was apparent to me as I made the pellet counts that deer had used cuttings extensively each winter and that pellet group density on plots in or near cuttings might be a means of showing quantitatively the effects of this habitat change on winter behavior. Normally the heaviest expected use in winter would be in or near the swamp conifers and the lowland brush, the usual winter yarding sites. These types are quite limited on the club, and as I was not familiar with the area before the cutting program I am not sure how much the other types of cover were frequented in winter. Probably they were not used much except in very open years. I presume that many of the club's deer left to winter in the extensive yards to the north. Now, however, it is obvious from both pellet and track signs that the cuttings are a big winter attraction and large numbers of deer are remaining on the club through even the severest weather. The track evidence will be presented in a later section.

To analyze the pellet data in this regard I set up five categories of location relative to cutover areas: the blocks that had been

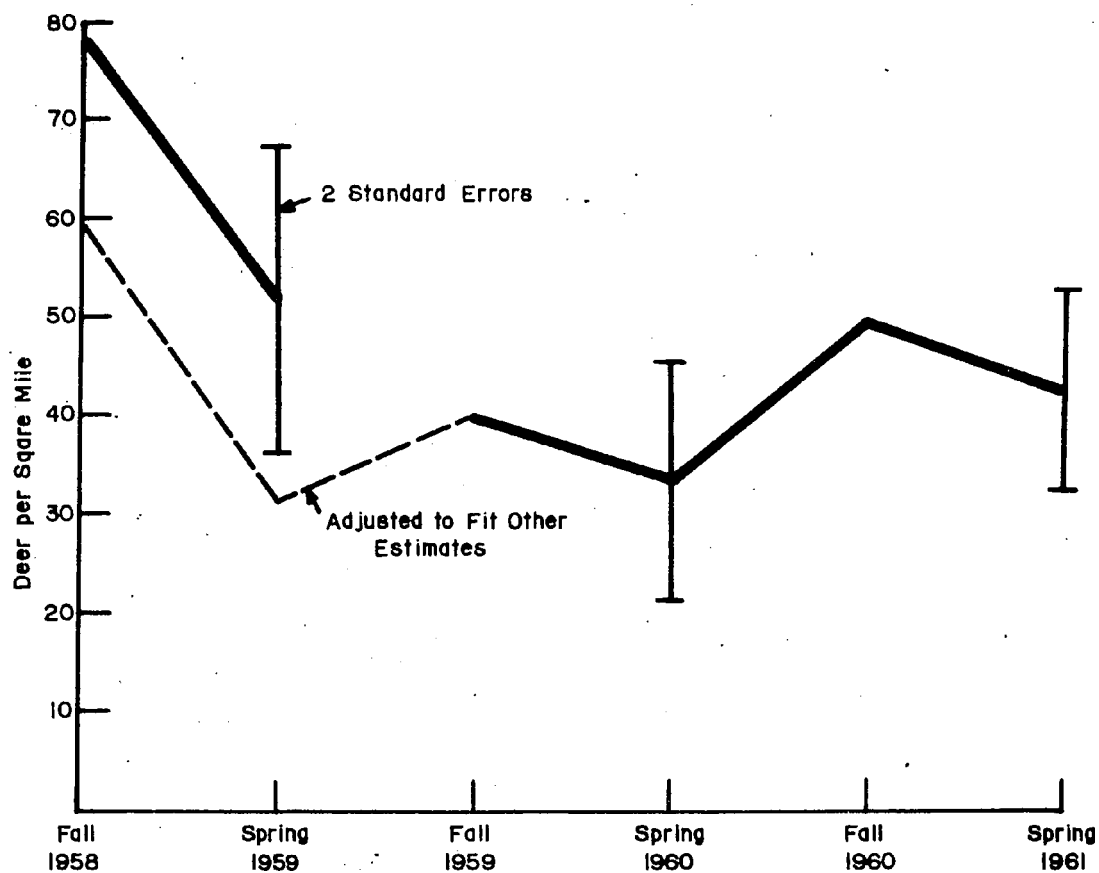


Figure 49. Deer population estimates on Mid Forest Lodge based on pellet group counts made in the spring of 1959, 1960, and 1961.

or were being cut, and four zones of distance from such blocks, 1/4 mile, 1/2 mile, 3/4 mile, and over 3/4 mile. I then combined all plots on which pellet groups had been counted during the three surveys, a total of 603. From these I removed 19 which were in or immediately adjacent to known yarding swamps. Each of the remaining plots was then classified according to location category and pellet frequency class. For the latter I used three classifications, 0-4, 5-9, and 10 or more, pellet groups per plot.

Figure 50 shows the results of this analysis in terms of frequency distribution of pellets within each location category. For example, of all plots located in cuttings (there were 72 of them) 33 per cent had 0-4 groups, 26 per cent had 5 to 9, and 41 per cent had 10 or more. On the 370 plots which were 3/4 mile or farther from cuttings 86 per cent had 0-4 groups, 9 per cent had 5-9, and 5 per cent had 10 or more. The gradation between these two sets of distributions is very evident. The high use in the cuttings extends outward for about 1/2 mile, Beyond this distance use is very low.

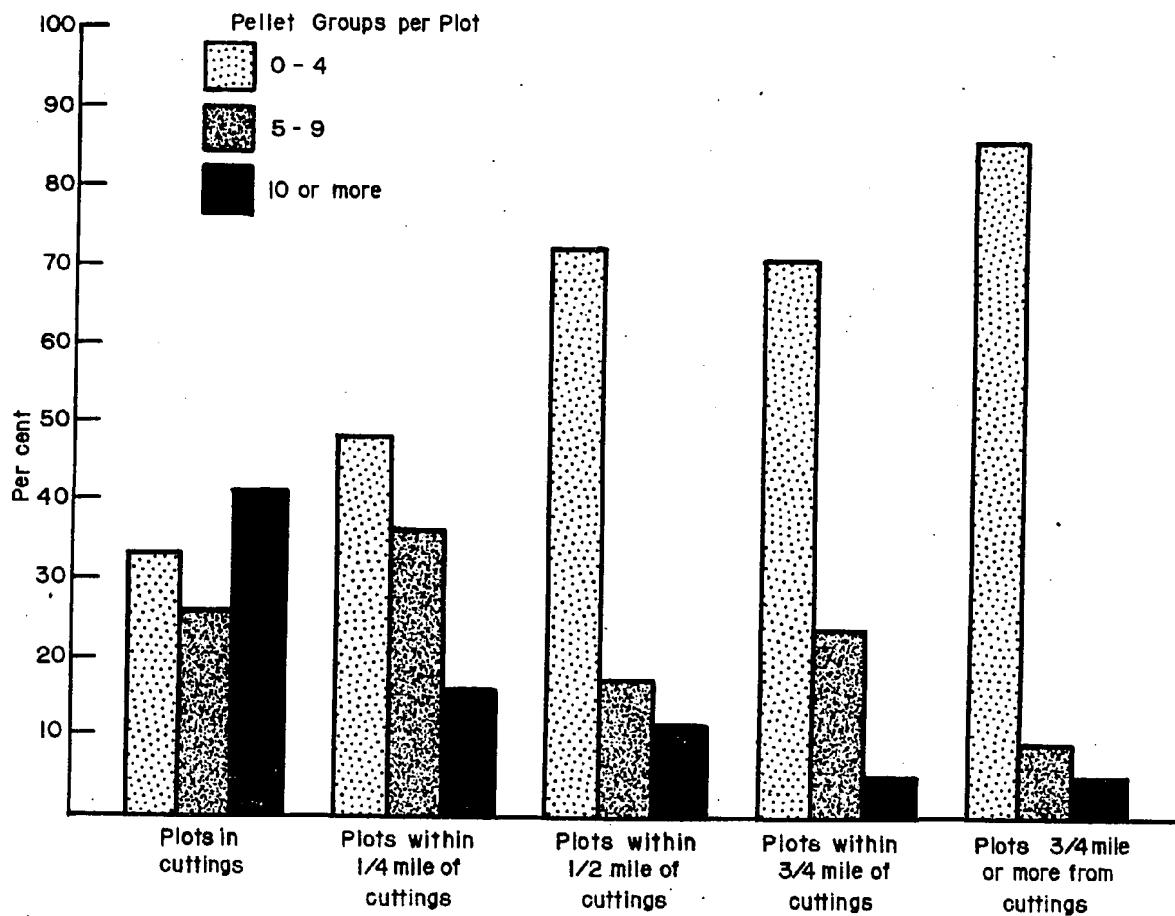


Figure 50. Pellet groups per plot in relation to distance from cuttings; 1959, 1960, and 1961 surveys combined.



Figure 51. Starvation. A fawn found dead on a search course in early May. Nothing much left but bones, however, the marrow test left little doubt as to cause of death.

MORTALITY MEASUREMENT BY DEAD DEER SEARCHES

Hunting season kills and overwinter mortality together represent the greatest annual drain on a deer herd and must be measured or estimated in some fashion if the game manager is to have any useful knowledge of population behavior. The legal harvest is, of course, measurable in obvious ways. The attendant unrecovered mortality, made up of crippling losses and accidental or illegal kills, is not so easily determined. Some sort of search for carcasses must be made after the season. In northern regions snow usually precludes this until spring. By then the often high winter losses will be added and a combined measurement can be attempted. The searching of sample areas is a feasible approach to this and several useful methods have been developed.

In Michigan a system has been worked out for sampling the state's entire deer range. Whitlock and Eberhardt (1956) have reported the sampling plan as originally conceived; Ryel (1959a) and Ryel and Bennett (1962) give details on later refinements and summarize the findings.

In the winter of 1959 it became apparent that deer on Mid Forest Lodge were in difficulty and serious starvation was impending. Plans were made for an intensive dead deer survey utilizing club members and wildlife students from The University of Michigan as the primary manpower. Technical supervision and crew leaders were game biologists from the Packaging Corporation of America, the University, and the Department of Conservation. The writer coordinated and supervised the planning and

the field operations of the project. Included in the plans was a similar survey on the Turtle Lake Club, an area also under management agreement with the pulpwood company and showing even greater starvation potential.

The surveys of the two areas were very successful, yielding important information on the deer and on the practicality of the method. It was the first time that intensive sampling of township-size areas had been attempted in the state, and the system proved to be so useful that it was applied again on the two clubs the following year and on Mid Forest for a third time in 1962. The following account will summarize the method and the findings on both areas and will compare results with Michigan statewide surveys.

Method

The survey developed and used on the two clubs, Mid Forest Lodge and Turtle Lake, is described in detail in the published Papers of the Michigan Academy of Science, Arts, and Letters (Blouch, 1961). It is essentially an adaptation of the Michigan statewide survey (Whitlock and Eberhardt, 1956) except that no stratification was attempted.

The basic sample plot was a 3-chain wide strip, 1 1/2 miles long, 36 acres in area. Strips followed a closed rectangular course systematically located within a square quarter-section (Figure 52). The quarter-section was the sampling unit, and these were randomly located in the areas. Figures 53 and 54 illustrate the manner in which the 40-unit sample was distributed on both clubs. The same samples were used each year.

We searched the sample strips with teams of at least three men walking in line abreast. A compassman set the course and measured the

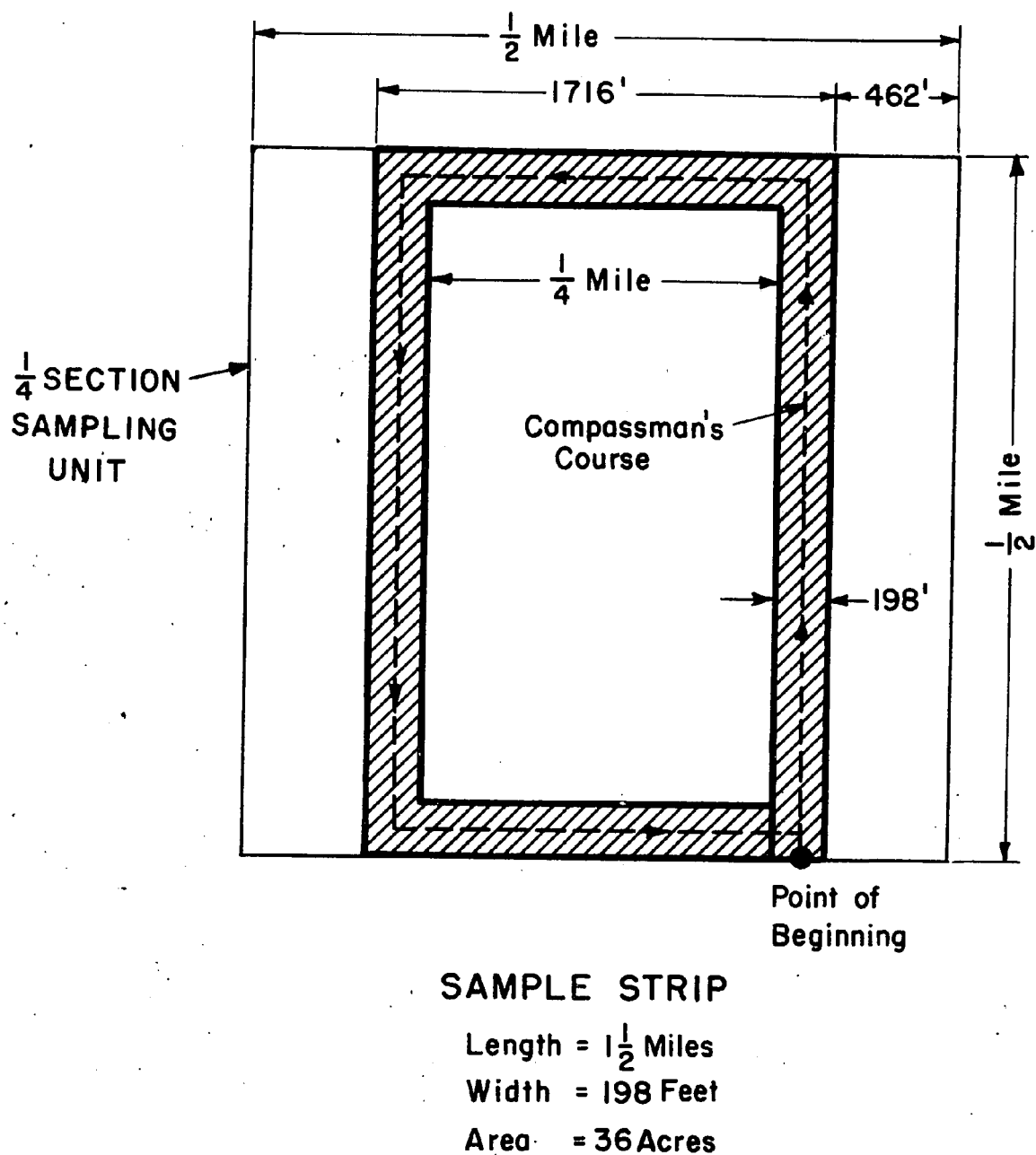


Figure 52. Plan of dead deer survey search strip and its location in the sampling unit.

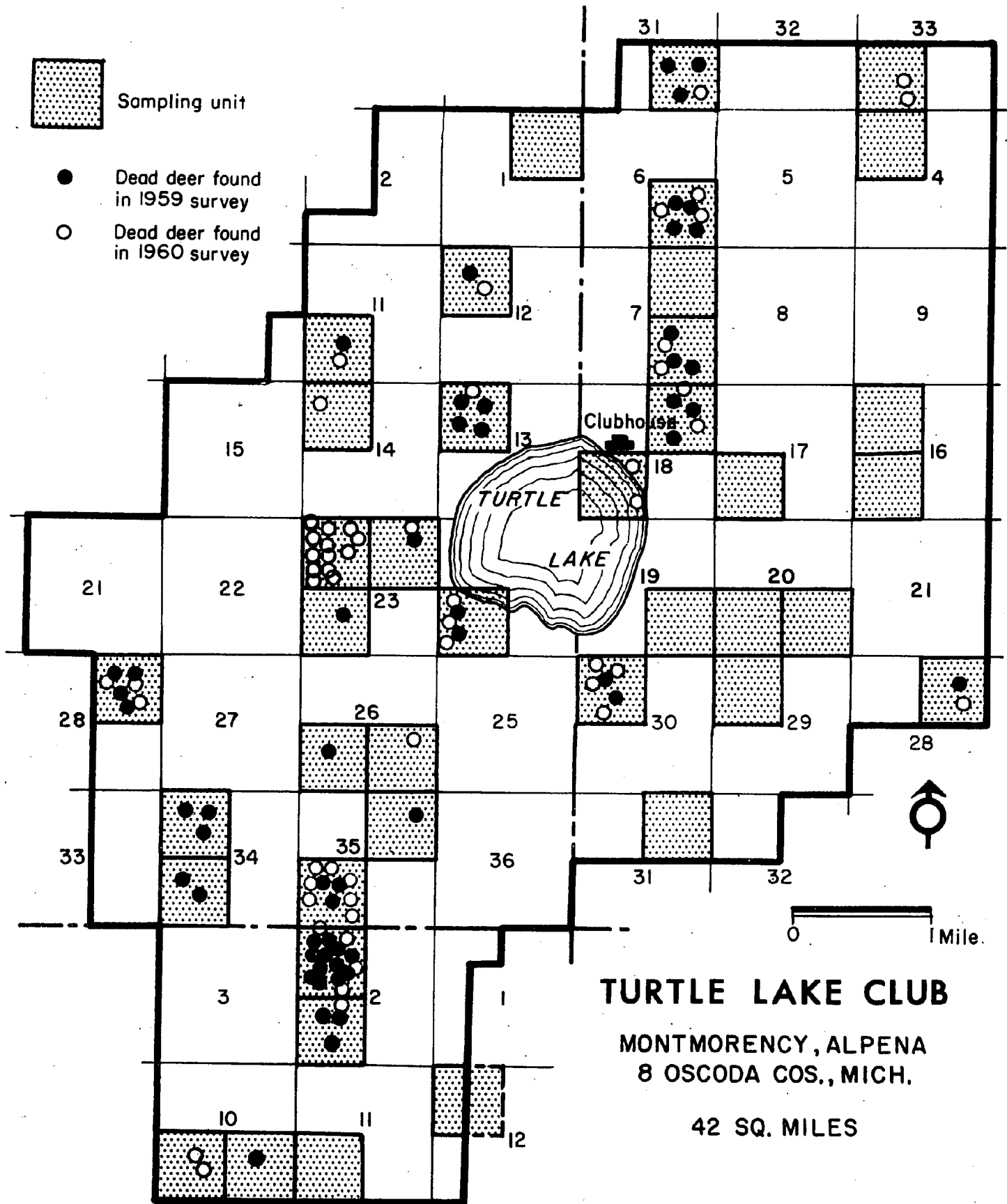


Figure 54. Location of sampling units and dead deer found in the 1959 and 1960 dead deer surveys on Turtle Lake Club.

distance using pacing and a hand compass. All dead deer found on the strips were tallied and autopsied to determine cause of death. Starvation and gunshot evidence were primarily sought, and whenever possible we used the bone marrow test of starvation (Cheatum, 1949). Occasionally little else but bones remained (Figure 51) and the cause of death could not be ascertained.

The carcasses we found were classified by sex, age, and cause of death, and the samples were expanded to estimates of the total mortality. The sampling design permitted statistical analysis, and fiducial limits of sampling error were computed.

Results

The survey findings and the estimates of mortality on the two clubs are summarized in Tables 22, 23, and 24.

Wide confidence limits on total estimates are indicated by the relatively large standard errors in three of the surveys. This is the result of the very uneven distribution of carcasses. They were grouped on relatively few strips, and the majority of strips had none (see Figures 53 and 54). Such a condition was to be expected because of the yarding habits of the animals. A stratified type of sampling was indicated here and had been originally considered. But at that time we had no knowledge of probable distribution upon which to base any workable stratification. We would now be in a better position to do this, and any future surveys on the areas should utilize stratification, both to make more efficient use of manpower and to improve accuracy.

Table 22. Summary of findings on dead deer surveys, Mid Forest Lodge and Turtle Lake Club, 1959, 1960, and 1962

	<u>Mid Forest Lodge</u>			<u>Turtle Lake Club</u>		
Area of club	18,080 acres			29,900 acres		
Number of sample strips	40			39		
Total area of sample strips	1,440 acres			1,404 acres		
Proportion of club sampled	.080			.052		
	<u>1959</u>	<u>1960</u>	<u>1962</u>	<u>1959</u>	<u>1960</u>	<u>1962</u>
Number of dead deer found	47	1	6	56		58
Mean number of dead deer per strip	1.175	--	.150	1.436		1.487
Standard error of mean (S.E.)	.324	--	--	.354		.392
Two S.E. as proportion of mean	.534	--	--	.493		.527
Average number dead deer per sq.mi.	20.9	--	2.7	25.5		26.4
Estimated mortality on club	590	--	75	1,071		1,111
Proportion starved	.808	1.0	.500	.804		.776
Proportion shot	.064	0	.333	.071		.052
Proportion cause of death undetermined	.128	0	.167	.125		.172

Table 23. Sex and age of starved deer found on sample plots,
Mid Forest Lodge dead deer surveys, 1959 and 1962

Age class	<u>1959</u>			<u>1962</u>		
	Male	Female	Total	Male	Female	Total
Fawns	11	21	32 (84%)	3	0	3 (100%)
1 year						
2 "	1	1	2			
3 "						
4 "		1	1			
5 "						
6 "						
7 "						
8 "		3	3			
Total adult	1	5	6 (16%)	0	0	0
Total deer	12	26	38 (100%)	3	0	3 (100%)

Sex ratio

Fawns 52 ♂♂ : 100 ♀♀

Adults 20 ♂♂ : 100 ♀♀

Table 24. Sex and age of starved deer found on sample plots,
Turtle Lake Club dead deer surveys, 1959 and 1960

Age class	<u>1959</u>			<u>1960</u>		
	Male	Female	Total	Male	Female	Total
Fawns	12	16	31* (69%)	11	22	36** (80%)
1 year						
2 "	1	1	2	2	1	3
3 "		1	1	1		1
4 "	1		1	1	1	2
5 "		2	2			
6 "		3	3		1	1
7 "		4	4		1	1
8 "		1	1		1	1
Total adult	2	12	14 (31%)	4	5	9 (20%)
Total deer	14	28	45 (100%)	15	27	45 (100%)

Sex ratio

Fawns 75 ♂ : 100 ♀

Adults 17 ♂ : 100 ♀

* Includes 3 fawns of unknown sex

Sex ratio

50 ♂ : 100 ♀

80 ♂ : 100 ♀

** Includes 3 fawns of unknown sex

In spite of the high variability of the sample I feel the surveys yielded very good estimates, at least in the high mortality years. In comparing the 1959 results on the two clubs the high degree of similarity in all points lends confidence to the findings. The rates of occurrence and the classifications of the carcasses correspond very well between the two areas. Also the differences indicated between the two, the higher rate on Turtle Lake along with the higher proportion of adults, conform to the known conditions, i.e. that Turtle Lake had poorer range and greater overpopulation. Likewise, the similarity between the 1959 and the 1960 counts on Turtle Lake would tend to confirm confidence, as it again corresponded to our knowledge of the sustained, serious overcrowding of that range.

On Mid Forest in 1960, in spite of another winter almost as severe as in 1959, knowledge of the herd and of range conditions led me to expect only negligible losses that spring. This was clearly confirmed by the survey. Again in 1962, although the winter was a hard one and some mortality was likely, I had expected it to be much lower than the 1959 extreme. This too was borne out by the survey.

I therefore feel these sample counts have supplied very acceptable measurements of deer mortality on the two areas and I do not hesitate to draw important conclusions from them.

Comparisons With Other Areas

The mortality rates on the two clubs in 1959 were extremely high, 21 and 26 deer per square mile. In comparing them with other reported dieoffs (Blouch, 1961) it has been pointed out that they resemble

some of the severest losses measured. Also, there is close agreement to the rate which occurred in the Michigan statewide survey that year in the high-level stratum of District 7, 25.5 deer per square mile.

In comparing the 1959 mortality on Mid Forest and Turtle Lake several points are outstanding. The rates are both high, but Turtle Lake is somewhat above Mid Forest. The proportions of dead deer that were starved, shot, or undetermined are strikingly similar. The fairly high number of gunshot deaths (assumed to be mostly accidental antlerless kills) on both clubs possibly indicates that the club member is no more careful a sportsman than the public land hunter. But between the two Mid Forest, with its much higher hunting pressure, appears to have a better record. Turtle Lake's fewer hunters should be expected also to have fewer of these mistakes; but they did not.

As shown in Figure 55 the two clubs were strikingly similar in 1959; but they were strikingly different in 1960--no losses on Mid Forest and high ones again on Turtle Lake. In Figure 56 where statewide survey findings are illustrated it will be seen that both years produced equally high mortality in the state as a whole. In 1961, with a mild winter, no surveys were deemed necessary. The 1962 winter brought significant mortality again across the state, as the bar in Figure 56 shows, but Mid Forest's losses were minor. Turtle Lake could not be surveyed in 1962, so we have no documentation, but from a few known observations the starvation toll was believed to be severe there again.

Mid Forest apparently escaped high starvation two out of three years when starvation was the rule. I believe this to be very significant evidence of an improvement in carrying capacity.

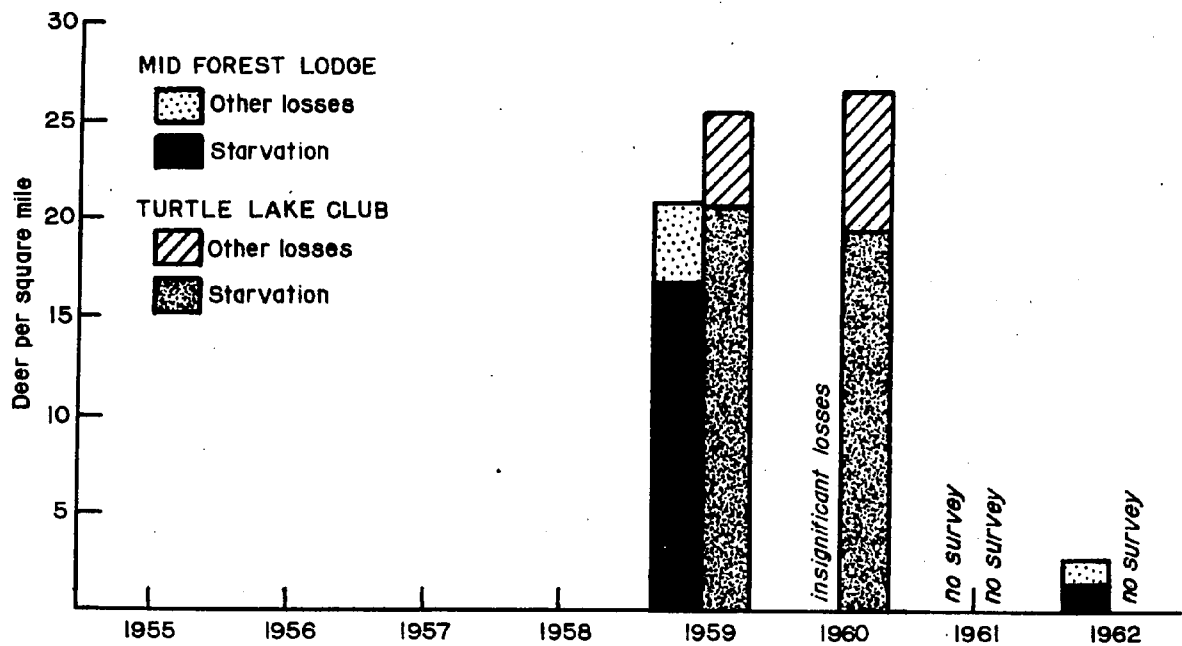


Figure 55. Winter mortality estimates from dead deer surveys, Mid Forest Lodge and Turtle Lake Club. 1959, 1960, and 1962.

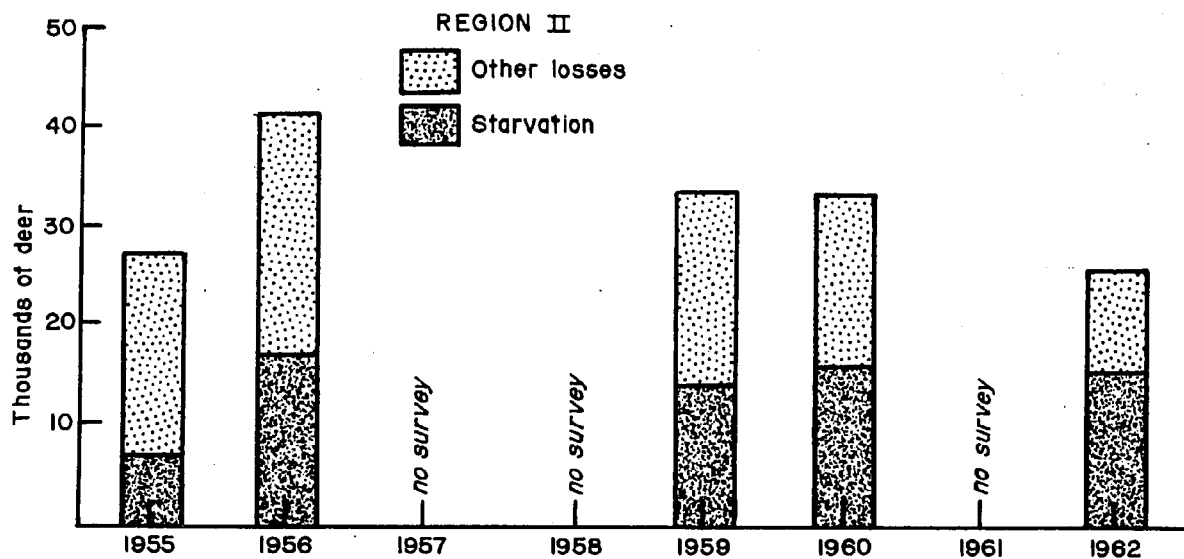


Figure 56. Region II winter mortality estimates from dead deer surveys 1955-1962.

OBSERVATION OF DEER ON THE CLUB

General Observations

During the 4 1/2 years of my field work on Mid Forest Lodge I have spent over 1,200 hours on the area. This has included about 1,000 miles of driving and 240 miles of walking. While most of this field work has been in the pursuit of specific data for objective type surveys it has also provided an opportunity for me to accumulate, through more general and subjective observations, a fairly broad knowledge of deer numbers and habits on the club. I have also obtained a great deal of useful information in this regard from the caretaker and from several members who know the club well and spend much time there. The following general account of the herd is drawn from these sources.

I have described in an earlier section the impressions of a few of the members on deer abundance prior to the period of this study. While most of the public, and at times even trained observers, greatly underestimate actual deer numbers, opinions on changes or trends in abundance can often be acceptably accurate. I believe it to be true that the club's deer had reached a peak about 1945 or 1946, and that they fell off after that rather steadily to a low in 1956. For two years after that a good increase was apparent, and by 1958, when I began working on the area, members were generally quite in agreement that the herd was building up again. My impressions of the herd level at that time was that it noticeably exceeded the population on similar range elsewhere in the country.

After the dieoff in 1959 deer were down again, probably reaching about the same point they had dropped to in 1956. Increases became noticeable in 1961, and then again in 1962. By that year even some of the most skeptical of the members were remarking that deer were showing up well again. It should be noted that opinions of the members were apt to be quite varied. Usually based on the impressions gained from a few drives around the roads, they can be influenced strongly by some good or some poor counts of deer on favorite rye patches. A night of good shining counts raises hopes and estimates high; an unprofitable shining trip lowers them and brings on doubts and fears. A few who know the club really well and spend much time there can assess the deer situation more objectively, and from these I have obtained many useful appraisals.

Deer distribution and activity on the club undergoes drastic seasonal changes. In the summer they are everywhere; though themselves not necessarily readily seen in daylight, they leave their tracks in sand trails and mud holes in all sections. Fawn tracks begin to show up in July, and by August and September nighttime shining counts frequently note the doe-fawn combinations. Bucks become conspicuous in late summer, and they often appear in small groups during September and October. A good acorn year produces noticeable October concentrations of deer in the oak uplands. Daylight observations of deer become more common throughout late summer and fall months.

With the arrival of hunting season the pattern is completely disrupted. The first few days disperse deer widely over all parts of the club. Bucks quickly seek seclusion in heavier cover, small family groups of does and fawns may travel around covering considerable distances as they are pushed from one hunter to another. In general the more open

uplands are abandoned, at least in daylight, though good acorn crops may attract nighttime visits. There seems to be no consistent pattern of deer leaving or coming into the club during open season. Hunting pressure outside the fence is at least as great as within, and deer movement occurs in both directions.

When the season ends there is often a period of considerable moving around. The more open oak areas may become attractive again, and if snow does not deepen too soon a great deal of acorn digging will occur. There is then a period of gradual concentration into loose groups. The prevalence of swamps in the northern portions of the club draws deer in that direction rather noticeably. Severe storms and very deep snows greatly reduce movements, and the yarding effect will become extreme when snow deepens to 18 inches or more or when crusting becomes a problem. With these conditions prevailing most of the oak and older aspen areas are abandoned completely throughout most of the winter. As spring thaws start to settle the snow and compact it a period arrives when deer can once again travel, and suddenly they are released. Almost overnight they disperse from the yarded concentrations and once again they may be found throughout all parts of the club.

Use of Cuttings

The attraction of the cutover blocks to deer is very noticeable. In all seasons deer and their sign are more readily encountered in the cuttings than in any other cover type. The data from pellet group surveys and winter track counts clearly show this for wintertime. General observations point plainly to it for other seasons. Fresh tracks can always be found in abundance on the hauling roads and skid trails.

Sightings of deer are consistently high in the extensive thickets of aspen suckers, although visibility is much reduced in comparison to the parklike vistas that can be scanned in all the uncut forest types.

Browsing of the suckers, though most conspicuous in the dormant period, was observable in varying amounts during growth seasons. On several occasions in late summer I have encountered local areas where new aspen sprouts had been very heavily browsed and were almost completely stripped of leaves and tips. Similar observations have been reported by Westell (1960) and described by him as being exceptional, and indicative of very poor summer range conditions.

Winter use of the cuttings varied considerably within and between blocks and also fluctuated with weather. In general, the two- and three-year-old sprout stands seemed most attractive, but some localities were used very little at any age. The more heavily browsed stands usually remained attractive longer because of the brushier, denser growth near the ground that resulted from the pruning effect. Thus, an area that was only lightly browsed for the first year or two would quickly grow up and get away from the deer and by four years of age would largely have most of its twigs above their reach. Another stand, intensively browsed during its first two years, would appear to stagnate and remain low and brushy for three or four years. This would extend its attractive period and browsing would be continued or repeated. In some cases such sustained high use would result in severe mortality of the sprouts and obvious failure of the regeneration. But more often, enough of the stems would survive to permit a canopy to develop, and by about five or six years the stand would suddenly appear to escape with adequate stocking.

Activity and movements of deer seemed to be less restricted by weather extremes in the cuttings than in other upland types. Storms and deepening snows would at times completely eliminate signs of deer activity in most parts of the club, yet tracks would remain abundant within and between the sprout thickets. During particularly severe weather there were concentrations that resembled yarding, with packed trails and deeply furrowed runways. Freshly cut tops were always particularly attractive and often were so heavily utilized that tracks and pellet groups around them resembled conditions at winter feeding stations.

Use of Food Patches and Feeding Stations

The club's efforts to provide supplemental food, described in an earlier section, were always well received by the deer. The heavy use which food patches and feeding stations obviously sustained tended to overemphasize their true importance to the herd. In the minds of most members the fact that some deer fed heavily in these spots was proof enough of their value and amply justified their costs.

Food patches were usually small fields of rye (Figure 57) planted in late summer. There were about 20 of such locations, but some were generally kept fallow for a year or two to provide a sort of rotation. The green rye in the fall was very attractive, and deer grazed this heavily. In some cases the trampling and grazing together destroyed most of the seedlings before snow cover arrived, and by spring there was little left to green up again. With the coming of snow, use of the rye fields usually stopped abruptly, there being little attempt made to paw through the snow for the plants. When snow left in the spring grazing was resumed intensively for a short period and then diminished rapidly as the rye matured.

In most of the rye patches it appeared that usage was restricted to relatively few deer, and these were individuals that habitually stayed in the immediate vicinity of the spots and spent little time elsewhere. It was often possible to recognize individual deer or groups of does and their fawns. These particular animals could be seen and identified day after day on the same fields, and while occasionally other individuals might join them, usually they remained the primary occupants.

Winter feeding began shortly after the end of deer season. The caretaker distributed hay and corn to about 25 or 30 different locations in 15 or 16 sections of the property. Hay was left in bales which were suspended in tree branches a foot or so above the snow. Corn was stored in steel drums at each station and scattered on the snow surface around the immediate vicinity of the station (Figure 58). Use of the stations varied greatly. Some would become very popular and were regularly visited by from 10 to 50 deer. Others would remain virtually unused throughout the winter. Snow around the well used stations became heavily trampled and packed down. The hay would be pulled from the bales and scattered around with coarser stems left uneaten. Corn was consumed quickly, even if covered by fresh snow. The caretaker visited each of the active stations at two or three-day intervals to replenish hay if needed and scatter more corn.

Movement and behavior of deer around the feeding stations varied considerably. At some locations deer appeared to be drawn in from a mile or more in all directions. More often it seemed that a limited number of individuals stayed in the vicinity and traveled no more than a quarter-mile to and from some convenient sheltering cover. As weather became severe the pattern of use changed noticeably. Travel distances shortened,



Figure 57. The club plants small patches of rye in several natural openings around the property.



Figure 58. A winter feeding location. Baled hay and shelled corn (a supply stored in drum) is distributed at frequent intervals throughout the winter at 20 to 30 such locations on the club.

some stations became more heavily used, others less heavily. In the very bad winters a point was usually reached when almost all stations were abandoned altogether for long periods. It seemed that at such times, when the supplemental feeding might be of greatest assistance in survival, it was least used.

With feeding starting early in the season deer that were regular visitors to the stations became conditioned to the corn and hay supplements with no apparent difficulty. There was evidence, however, that new visitors to the feed could have trouble digesting it, particularly in late winter when nutrition was at a low ebb. I have observed droppings indicative of diarrhea in several instances near feeding stations after prolonged deep snow. Late in the winter of 1962 three dead fawns were found near two feeding stations. Autopsy revealed large quantities of undigested corn in the rumens (Figure 59). Other evidence indicated extreme malnutrition; and it seemed likely that these animals, visiting the feeding stations for the first time, had fatally gorged on the corn. This is one of the serious risks in winter feeding, particularly when the food is not provided until extreme emergency conditions develop.

A thorough evaluation of the winter use of cuttings and the effects of the feeding program would require an intensive study of deer movements. This could probably be accomplished by employing a marking technique to follow the activities of individual animals. Although such an approach would be feasible on the club it was not within the scope of the present study.

In my opinion, based largely upon general observations of range and movements together with the population knowledge gained through this study, the club's artificial feeding has been of no clearcut benefit to



Figure 59. Autopsy of several fawns found dead near feeding locations revealed foundering on corn. Sporadic or improper feeding runs this risk. However, good feeding practices on this club hold such occurrences at a minimum.

the herd, the range, or the management program. It certainly did little to prevent wholesale starvation in 1959. Any deer that might be saved through feeding are probably in excess of carrying capacity and should be harvested rather than carried on. Since it appears very unlikely that the harvest will be increased appreciably it is fallacious to continue attempts to boost the carryover artificially. It did not appear evident to me that the feeding stations in any way protected the forest regeneration from damage. If anything, they were apt to promote it. In several instances it was noticeable that heavily damaged spots were close to feeding locations where concentrated animals had repeatedly overbrowsed all vegetation at the same time they were feeding regularly at the stations.

Exclosure Observations

Three deer exclosures have been erected on the club in cutover areas. They are a standard type, 40 ft. square and 8 ft. high, constructed according to recommendations given in the management plan (Westell, 1958). Their purpose is to provide the company with a means of measuring the effects of the deer herd on aspen regeneration and the club with an easily seen demonstration of the same. To date, no quantitative measurements have been made on these exclosure sites, but as demonstrations they are serving very effectively. Browsing has been conspicuous around each of them and the contrasts with unbrowsed interiors have been striking. Their locations close to roads have kept them easily in view and they have served as a continuing reminder to the club that the influence of deer can be important. My general observations on these three exclosures are summarized below.

Exclosure No. 1

Located just north of Rollway Lake in SW 1/4 SW 1/4 sec. 22, T. 21 N., R. 2 W., this was erected in the first cutting made on the club in 1956. After two growing seasons following the cut a conspicuous difference was apparent (Figure 60). Suckers inside were 8 to 10 ft. high and on the outside they averaged 3 to 4 ft. Browsing during the two winters had been very heavy, although the weather both years was relatively mild. It appeared that deer had concentrated heavily on this initial cutting, moving in from a wide area because of the moderate winter conditions. The third and fourth winters were both severe. Browsing continued but was not as concentrated or as heavy as before. Sucker growth outside the exclosure after four growing seasons remained alive but rather stunted and brushy, averaging about 4 ft. high and less than 1/2 in. in diameter. Inside, stems of up to 1 in. in diameter averaged 12 ft. high (Figure 61). During the next two years the area received little browsing, and after six growing seasons the sprouts outside began to put on good height growth. At seven years there is no longer a conspicuous difference between the protected and unprotected stems, and stocking appears more than adequate.

There are localities in this same cutting block that did not succeed as well. Where browsing was heavier during the third and fourth winters high mortality has resulted and stocking is now very poor. As pointed out earlier, this uneven pattern of success and failure within one cutting block can be expected because of the varied patterns of deer use in the cuttings.

Exclosure No. 2

This was constructed in the second of the club's cuttings which began in 1957 and continued for 1 1/2 years. It is located near the

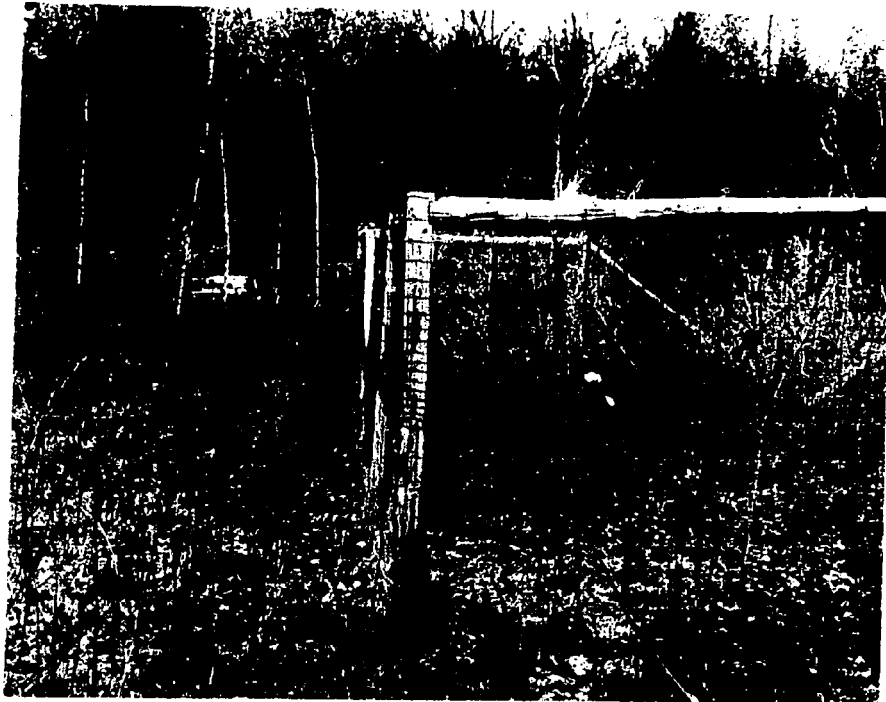


Figure 60. Exclosure No. 1, aspen suckers after two growing seasons. Growth inside was twice as high as outside.



Figure 61. Exclosure No. 1, after four growing seasons.

East Gate in NW 1/4 NE 1/4, sec. 13, T. 21 N., R. 2 W. Browsing was particularly heavy there in the hard winter of 1959 and again in 1960. Much of the good growth the suckers had put on in their first year was browsed or broken. However, recovery was very rapid and after four growing seasons there was not a conspicuous difference. During the hard winter of 1962 a heavy deer concentration again browsed this area of five-year-old growth and again damage was severe. A great deal of breakage occurred, of the type described by Westell (1960) and many of the stems that had recovered from damage two and three years earlier were rebroken. Figure 34 is a photograph of broken stems adjacent to this enclosure. There was rather good recovery following this and stocking at present appears to be adequate. Whether or not quality will be affected due to deformity or disease cannot be answered until later.

Exclosure No. 3

The location of this plot was selected to include regeneration of both large-toothed and trembling aspen. It was placed between clones of these two species after they were cut in the spring of 1960. It is in cutting block No. 5 located along Rollway Road in NW 1/4 NE 1/4, sec. 20, T. 21 N., R. 2 W.

Browsing on the growing suckers was immediately evident during the first summer in this location. Figure 62 shows the growth that was apparent inside the fence and its absence outside in July, 1960. There was little noticeable difference between species. Browsing pressure on this area remained high through its first winter, the mild season of 1960-1961. This was the first cutting to take place on the western side of the club, and deer concentrated on it heavily throughout. A feeding station within 1/4 mile of this location probably added to the pressure here. Growth was good in the second growing season and although a

difference could be seen by that fall it was not too startling. Very heavy browsing occurred again in the second winter, and during the third growing season the damaged sprouts took on a stunted, brushy appearance, particularly on the large-toothed side. Browsing and breakage was the rule again in the third winter and by spring the contrast between the protected and unprotected stems was extreme (Figure 63). As the growing season got underway it was apparent that there was high mortality in the damaged growth outside the fence, and that it was much more noticeable in the large-toothed sprouts than in those of the trembling aspen. Three seasons of sustained heavy browsing here have brought severe damage and probably greatly reduced successful regeneration in this locality.

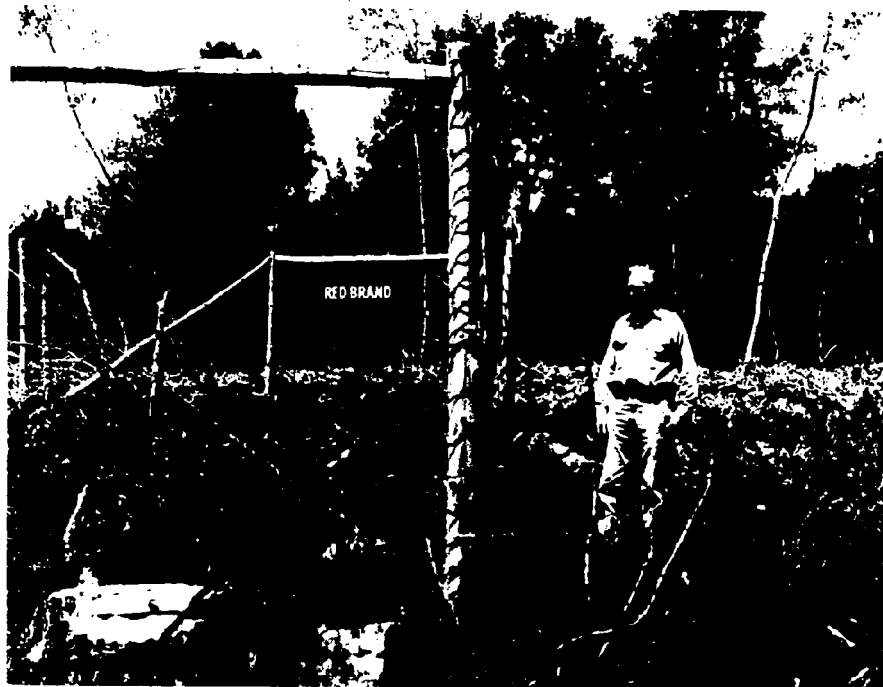


Figure 62. Exclosure No. 3, newly constructed. Suckers about two months old. Outside already showing browsing.



Figure 63. Exclosure No. 3, after three growing seasons. Suckers inside of fence about four times as high as the heavily browsed growth outside.

Counts and Surveys

Roadside Counts

Deer are easy to see from a car on Mid Forest Lodge. A drive of a few miles on any of the roads or trails is almost certain to provide several sightings. The many openings, small and large, and the numerous rye patches attract deer close to roads quite consistently. Driving to see deer is a favorite pastime of the members. The deer have become accustomed to cars traveling around on the trails and are not frightened very much by them particularly since they are never shot at from cars as they are in much of the public land.

During the four years of my work on the area I customarily recorded the mileage of all my driving on club roads and tallied all deer seen during this travel. Identifiable deer were recorded as bucks, does, or fawns; those unidentified were so recorded. Several nights each summer and fall I made special visits to the club for the purpose of shining deer from a car with a spotlight to obtain preseason sex and age counts. Other than these shining counts I made no special trips to census deer by car. I was not able to spend enough time after the hunting seasons to make any worthwhile postseason sex and age counts. This might have been desirable in order to attempt a calculation of total population based on the kill and the sex-age ratios before and after hunting season. The few counts which were made in the early winter are of no use in this respect as no bucks were observed on any of them.

During the summer and early fall when fawns were easily identifiable and closely associated with their mothers, my sighting records

included an additional category for family size. This was to determine the relative numbers of single, twin, or triplet fawns for does that were seen accompanied by their young. I had hoped that some index of productivity could be developed from this, as no other direct measurement of it seemed likely. Also, there appeared to be some possibility of obtaining records of fawn sightings from club members. A few who visited the club regularly in the summer were interested in keeping records, and I felt that the most useful and easily kept data would be the single-twin-triplet sightings. Although this outside assistance was never developed I continued to keep my fawn sighting records in this manner throughout the study, and they appear to be of some significance.

Table 25 presents a summary of my deer sighting records. They begin in the late summer of 1958 and extend through the fall of 1961. The data for each year is grouped into two periods: summer-fall, which begins in June when fawns start to appear and extends to the deer hunting season, November 15; and winter-spring, beginning after deer season, December 1, and extending to the end of May. The latter period is of doubtful value. Deer sightings are much less frequent and sex-age ratios virtually meaningless. This is due to the limited amount of winter travel on any but a few main roads and the high mileage in the spring when bucks are very hard to identify.

The rate of deer sighted per 100 miles of travel is useful to the extent that it reflects relative deer abundance with any consistency. Such an index may have reasonable accuracy when it is based on very large volumes of travel and sightings, for example, those kept by Michigan Conservation Officers on patrol. Many years of these records have shown general trends quite well (Figure 4). The Mid Forest sightings, while

Table 25. Roadside count summary. Deer sighted during car travel on Mid Forest Lodge, September, 1958 to November, 1961

Period	Miles driven	Deer seen	Deer per 100 mi.	Deer identified		Fawns accompanying does			
				No.	Bucks:Does:Fawns	Singles No. (%)	Twins No. (%)	Triplets No. (%)	Fawns No. (%) per doe
<u>1958</u>									
Summer-Fall	62	163	263	112	1 : 3.8:	2.2	9 (41)	11 (50)	1 (9) 1.61
<u>1959</u>									
Winter-Spring	134	77	57	51	1 : 9.0:	2.8			
Summer-Fall	109	142	130	112	1 : 3.6:	2.4	16 (62)	10 (38)	0 (0) 1.38
<u>1960</u>									
Winter-Spring	140	122	87	71	1 : 43:	27			
Summer-Fall	166	200	120	149	1 : 3.7:	2.8	8 (33)	15 (63)	1 (4) 1.71
<u>1961</u>									
Winter-Spring	140	120	86	42	1 : 25:	16			
Summer-Fall	121	229	190	179	1 : 4.4:	3.6	3 (9)	22 (69)	7 (22) 2.12
Totals	872	1053		716					

limited in volume and influenced by factors which draw deer near to roads, are nevertheless repeated observations under fairly similar conditions on the same area; and they show rather close correspondence to some other measurements. In Figure 66 a curve representing deer seen per 100 miles is superimposed on three other population indices. It follows the trends of pellet counts and buck kill rather consistently and should serve to reinforce the indicated trend.

The data from these counts which proved to be of most value to the study were the ratios of bucks, does, and fawns seen prior to the hunting season. Only deer that were positively identified were included in computing these ratios; they amounted to about 75 per cent of the total. The middle columns in Table 25 list these preseason ratios along with the less useful ones from the winter-spring periods. They are expressed as numbers of does and fawns per adult buck. Their principal use, explained in the following chapter, was in deriving total population estimates from reconstructed, preseason buck populations. The figures so derived were quite acceptable each year and thus lend credence to my observed ratios.

The columns on the right in Table 25 give the single-twin-triplet distribution of the fawn sightings and include rates of fawns per doe each year. I believe these figures reflect relative reproductive success quite distinctly. However, they are not an accurate measure of true productivity rate for they do not include the portion of does with no fawns. The high proportion of single fawns in 1959 plainly shows that year's very poor productivity; the increase in twins in 1960 and the jump in triplets in 1961 obviously indicate a two-year improvement in production.

The 1961 crop of triplets appeared to be very unusual. Several of the club members commented to me that they had noticed more does with

three fawns that year than they could remember ever seeing before. This was also the year that the captive deer at the Houghton Lake Wildlife Experiment Station's deer pens produced a record number of triplets, six sets out of 24 does fawning. This was three times as many triplets as ever produced there before. There are no clear reasons for this record production. However, it seems likely that the exceptionally mild and open winter of 1960-1961 could have been an important factor.

Another fact confirming the apparent high productivity on the club in 1961 is the exceptionally large proportion of yearling bucks (82 per cent) in the 1962 kill (see Table 15 and Figure 45). This was the highest percentage recorded on the club during five years of study, and it was higher than any other reported for the region (see Figure 71). As was pointed out in an earlier discussion on the yearling age class such a high representation of yearlings must reflect both good fawn production in 1961 plus good survival over winter in 1962.

Winter Track Counts

It is tempting to make use of deer tracks in some way for censusing or measuring activity. They are such tangible, easily countable evidence of deer presence. Numerous track counting techniques have been developed and tried by deer managers with varying degrees of success. Certain of them were considered for use on this study but none appeared to be practicable under existing circumstances. However, during the first winter of the study, while snowshoeing on different parts of the club, I was impressed by the conspicuous difference in abundance of deer tracks between cutover areas and other sections. In the hope that track counting might provide some useful measure of relative deer use in the cuttings I began keeping records of tracks seen. The figures seemed to give promising results and I therefore continued the practice each winter, making numerous trips to various parts of the club for this particular purpose.

On each trip I tallied all deer tracks that I crossed on my route of travel. I made no attempt to eliminate recrossings by individual deer. When tracks were heavily grouped I made as good a judgment as possible on the number of complete crossings. At times this required following tracks in both directions to unravel the tangled trails. I attempted to count only fresh tracks, and for this reason usually made the trips within a day or so of new snowfall. The route traveled was plotted on a map as I went, along with the approximate locations of the tracks crossed. I also plotted the locations of cutting boundaries as they were encountered.

The general location of each trip was planned beforehand, but the exact route was not predetermined. I traveled generally in a

wandering course determined mainly by locations of the various cover types which I wished to examine, the lay of the land, and the amount of time available. Usually the route was a wide circuit beginning and ending at the point where I was able to park my car. The general locations were selected to include cuttings of different ages and uncut areas in all parts of the club. In all but one trip the travel was on foot, and in most cases snowshoes were required. The lengths of trips varied from two to four miles and averaged 3.2 miles. The exception was a trip made on a Polaris Sno-Traveler, a track-driven motor sled, when a total of 12 miles was covered one forenoon in February, 1960. Altogether 25 of these track-counting trips were made during five winters and they covered a total of 90 miles.

In analyzing the data it was decided that location with respect to cuttings and age of cuttings were the two most important factors affecting track frequency. Accordingly the distance traveled and the number of tracks counted were organized in two categories of location and four of age. The resulting classification is shown in Table 26. Routes that were $1/2$ mile or more from any area of previous cutting were all grouped together. Routes in cuttings or within $1/2$ mile of them were grouped in a second category. Cuttings were classified according to age groups of less than 1 year, 1-2 years, 3-4 years, and 5-6 years.

The bottom line of the table shows the average rates of tracks per mile for each category. Figure 64 portrays these rates graphically. We can conclude from these data that winter deer activity is much greater in or near cuttings than away from them; that cuttings one to two years old are most attractive, but newer ones or older ones up to six years are all relatively heavily used by deer in winter.

Table 26. Deer track counts on Mid Forest Lodge made during four winters, 1958 to 1962

Date	Routes run 1/2 mile or more from any cutting		Routes run in, or within 1/2 mile of, cuttings		Cuttings less than 1 year old		Cuttings 1-2 years old		Cuttings 3-4 years old		Cuttings 5-6 years old		All cuttings	
	Miles Tracks		Miles Tracks		Miles Tracks		Miles Tracks		Miles Tracks		Miles Tracks		Miles Tracks	
Dec. 9, 1958	2.9	16												
Jan. 8, 1959	3.8	6												
Jan. 28							3.6	249					3.6	249
Feb. 19			3.0	104									3.0	104
Mar. 2	2.6	8												
Dec. 24	3.0*	28												
Jan. 11, 1960			3.3	36										
Jan. 17	3.4	7											3.3	36
Feb. 15														
Feb. 23	5.0	26	4.6	62			2.5	75					2.5	75
Mar. 1	3.7	6					2.5	38					7.1	100
Mar. 4			1.2	43			.5	12					2.4	98
Mar. 18	3.2	6												
Dec. 30			2.8	135									2.8	135
Jan. 11, 1961	3.6	11												
Jan. 27	3.4*	47												
Feb. 17							1.5	49	2.0	51			3.5	100
Feb. 21	2.5	14												
Dec. 18							3.9	105					3.9	105
Jan. 4, 1962			1.2	25			1.3	98			.7	14	3.2	137
Jan. 18	1.7	2					2.4	72					2.4	72
Feb. 6	2.3	5	2.4	12									2.4	12
Feb. 21											2.5	46	2.5	46
Feb. 27	3.9	6												
Mar. 8	2.0	10												
Total:	47.0	198	18.5	417	9.5	511	11.4	281	3.2	60	42.6	1269		
Tracks per mile		4.2	22.5	52.8		24.6		18.7				29.8		

* Routes were within 1/2 mile of conifer swamp yarding area on northern boundary of the club.

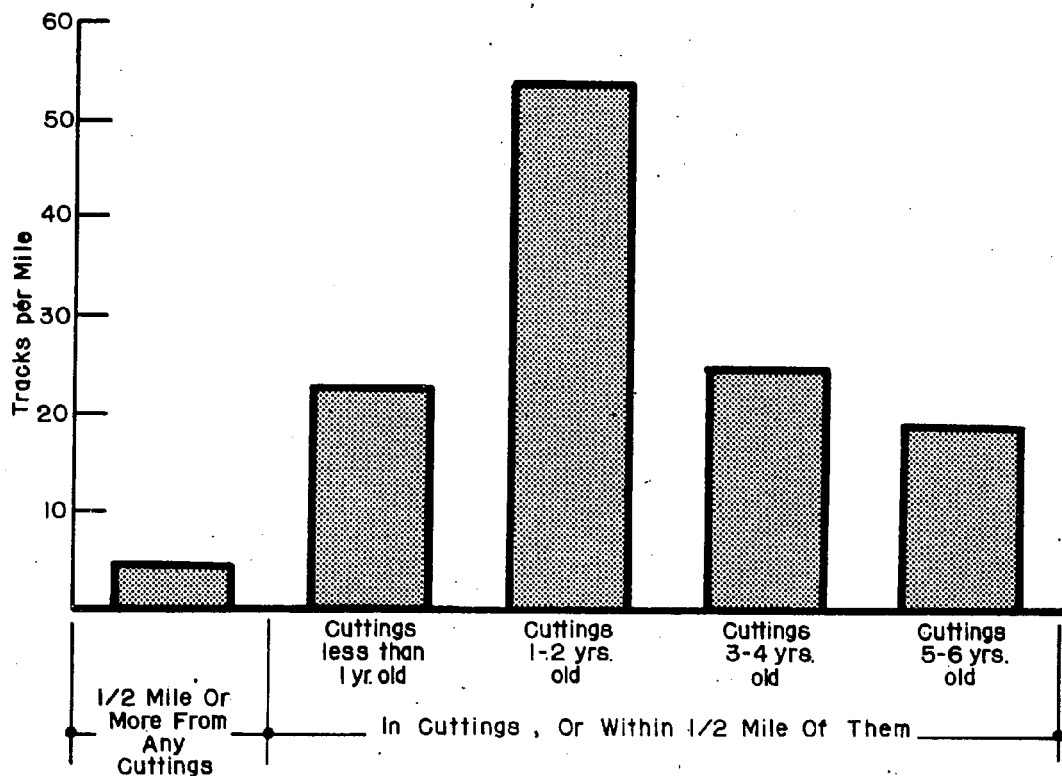


Figure 64. Winter deer track counts on Mid Forest Lodge.

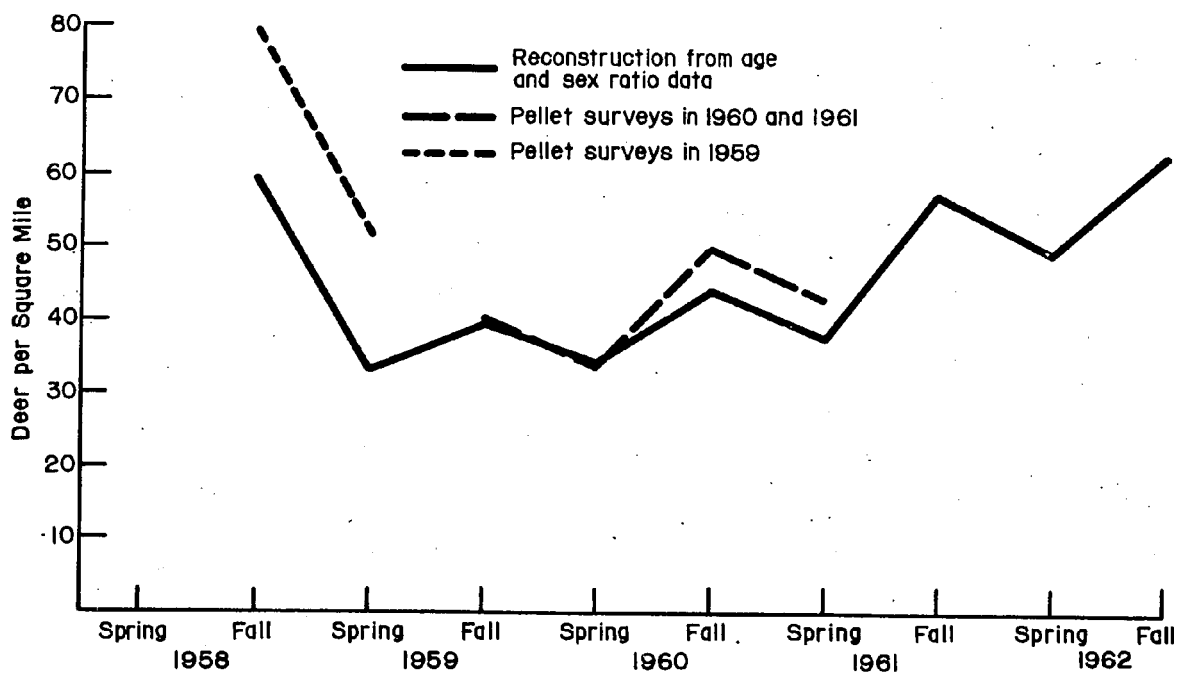


Figure 65. Comparisons of two independent estimates of deer population on Mid Forest Lodge; one based on pellet surveys, the other on ages of bucks killed and observed sex-age ratios.

POPULATION DYNAMICS

Estimation of Numbers

The question of "how many deer?" is the basic one which must be answered before any logical analysis of population changes or projection of future management can be pursued. Census methods, at best, on an area the size of Mid Forest Lodge must be approximations based on sampling. Numerous approaches to the estimation of deer numbers are available, yet few of them were feasible in this study because of severe manpower limitations. One of the more widely used methods in recent years, the pellet count, proved to be adaptable to my needs. I have described my procedures in applying this method and the results in a previous chapter.

Because of the pellet count's rather wide confidence limits from sampling error I felt it was necessary to check these estimates against some other completely independent method, for example one based on kill figures. In this way Leopold et al., (1951) in the Jawbone herd study compared their pellet count estimates with those derived from kill plus herd composition. The latter method is essentially that described by Lauckhart (1950) and requires, in addition to kill estimates, buck:doe:fawn ratios observed before and after the hunting season. This had to be ruled out because of my inability to get adequate data on postseason ratios. Likewise, two of the approaches developed by Eberhardt (1960), the sex-age-kill method, and the kill-effort method were both not applicable to my data because of the lack of sufficient information on antlerless deer and daily hunting effort.

A method that did prove to be feasible, however, was one that made use of my series of hunting season buck ages plus my preseason herd composition figures. From these elements I was able to derive a second set of population estimates to check against those from pellet counts. The method is described below and its results are compared with those of the pellet counts.

Estimates from Buck Ages and Preseason Composition

The aging of a large portion of the buck kill, which has been done for five years on the club, provided a series of good estimates of buck age structure each year. Hunting season losses and winter mortality, when occurring, have been measured. All other mortality is assumed to be negligible. Therefore, it was possible from these data to project backward the known numbers of bucks in each age class and reconstruct for any one year the number of bucks that must have been alive before hunting season.

Table 27 shows this reconstruction in the form of a modified life table. For every year the number of bucks killed in each age class is listed along with the additional bucks that were alive that year but killed in a later year. This yields a total of adult bucks that were alive preseason each year. For example, in 1958 before the hunting season the following adult bucks were present on the area: 155 that were killed later that year, 38 yearlings and 16, 2 1/2-year-olds that were killed in 1959; 11 yearlings and 3, 2 1/2-year-olds killed in 1960; and 2 yearlings eventually killed in 1961. In addition there were 12 of unknown ages that died in the heavy winter loss that occurred that year. These add up to a total of 237 adult bucks which must have been there in 1958.

Table 27. Mid Forest Lodge, reconstruction of buck population from ages of bucks killed, 1958-1962

Year	Bucks killed		Yr. killed	No. of bucks alive preseason, by age class					Total adult bucks
	Age	No.		1/2	1-1/2	2-1/2	3-1/2	4-1/2	
1958	1/2	2	1958	2 (+155)*	84	50	21		
	1-1/2	84	1959	58	38	16			
	2-1/2	50	1960	27	11	3			
	3-1/2	21	1961	8	2				
	Total	157		95 (+155)*	135	69	21	(+12)**	237
1959	1/2	4	1959	4	58	38	16		
	1-1/2	58	1960	66	27	11	3		
	2-1/2	38	1961	33	8	2			
	3-1/2	16	1962	13					
	Total	116		116	93	51	19		163
1960	1/2	18	1960	18	66	27	11	3	
	1-1/2	66	1961	101	33	8	2		
	2-1/2	27	1962	20	13				
	3-1/2	11							
	4-1/2	3							
	Total	125		139	112	35	13	3	163
1961	1/2	0	1961	0	101	33	8	2	
	1-1/2	101	1962	155	20	13			
	2-1/2	33							
	3-1/2	8							
	4-1/2	2							
	Total	144		155	121	46	8	2	177
1962	1/2	8	1962	8	155	20	13		
	1-1/2	155							
	2-1/2	20							
	3-1/2	13							
	Total	196		8	155	20	13		196

* Estimated winter mortality of buck fawns

** Estimated winter mortality of adult bucks of various ages

These totals are most accurate through 1960. The data for 1961 and 1962 are incomplete for they do not include the animals that will probably be killed in 1963, 1964, and 1965. An adjustment for these years can be estimated, based on average kill and age distribution of previous years. This would raise the 1961 and 1962 figures by about 7 per cent and 25 per cent respectively.

It should be emphasized again that these totals of adult bucks are minimums, based on all known mortality, assuming only negligible additional mortality and no appreciable gains or losses through movement in or out of the area.

With estimates of adult buck numbers established they can then be applied to the buck:doe:fawn ratios observed during the summer car counts and expanded to estimates of total fall population. These in turn become spring population when hunting removals and winter losses are deducted. For example, 237 bucks were present in 1958; the buck:doe:fawn ratio was 1 : 3.8 : 2.2; therefore there were 237 : 900 : 521 deer on the area, a total of 1,658 for the fall 1958 population estimate. When 184, the 1958 harvest, and 590, the winter losses, are deducted, a spring total of 884 is obtained.

In Table 28 the computed total population estimates are listed for each year. Also included in the table for comparison are the estimates of total population derived from pellet counts; this is the data which was presented earlier in Table 21. The estimates as derived from the two independent methods are also compared graphically in Figure 65.

The two methods show very close similarity in estimated deer numbers provided the 1959 pellet count is disregarded. I have discussed this earlier in the pellet survey chapter and shown why the method used

Table 28. Estimated deer population on Mid Forest Lodge, 1958-1962.
Comparison of two independent methods

Season	Year	<u>Population reconstruction</u>		<u>Pellet counts</u>	
		Total deer	Deer per sq. mile	Total deer	Deer per sq. mile
Fall	1958	1658	58.7	2229	78.9
Spring	1959	884	31.3	1455	51.5
Fall	1959	1141	38.9	1127	39.9
Spring	1960	957	33.9	940	33.3
Fall	1960	1222	43.3	1390	49.2
Spring	1961	1040	36.8	1200	42.5
Fall	1961	1593	56.4		
Spring	1962	1360	48.1		
Fall	1962	1750	61.9		

that year was faulty. The pellet count technique used in 1960 and 1961, I believe, has given the best population estimates for the area. The figures derived from the other method will tend to underestimate the number of deer on the club, but in the absence of pellet survey data, as in 1962, these estimates should be acceptably accurate.

Indices to Population

The two separate series of estimates of deer population presented above both show a trend pattern: a decrease from 1958 to 1959, no change from 1959 to 1960, and a steady increase from 1960 to 1962. It is very significant, I believe, that this same trend is shown quite clearly by data from three other sources, each independent of the others. These are, deer seen per 100 miles of driving, fawns seen per doe, and hunting season buck kill.

These three indices, together with the pellet count estimates, are shown superimposed graphically in Figure 66. The data and the methods for each of these have all been presented and discussed in preceding chapters. I am portraying them together here to show the general similarities in their trends and to emphasize the very definite changes in the club's population which they reflect.

Life Equation

The analysis of year to year changes in a population is often clarified by the use of some sort of life equation table. This is usually in the form of a balance sheet which shows the gains and losses and the sex-age structure for a single year. Known values are used wherever possible and unknowns may be interpolated. An accounting of this type is essential to the game manager seeking to identify and evaluate the factors acting upon a population.

I have constructed a form of life equation for the Mid Forest deer herd covering the four years 1958 to 1962. It is presented in Table 29. Each year begins with the fall, pre hunting population and ends at the same point the following year. Fall sex-age structures are based on observed ratios from car counts; hunting removals and winter losses are known from survey data; rates of change in population are derived from population estimates as listed in Table 28; spring sex-age structures are computed from known removals. In estimating the potential production the average in utero productivity rate of 1.4 was used each year. This is a 12-year average rate for the state's northeast food shortage area. It was determined by Conservation Department autopsies of does accidentally killed during the gestation period (Ryel and Fay, 1962). It applies to adult does only; does under one year in this area have a negligible rate, .08.

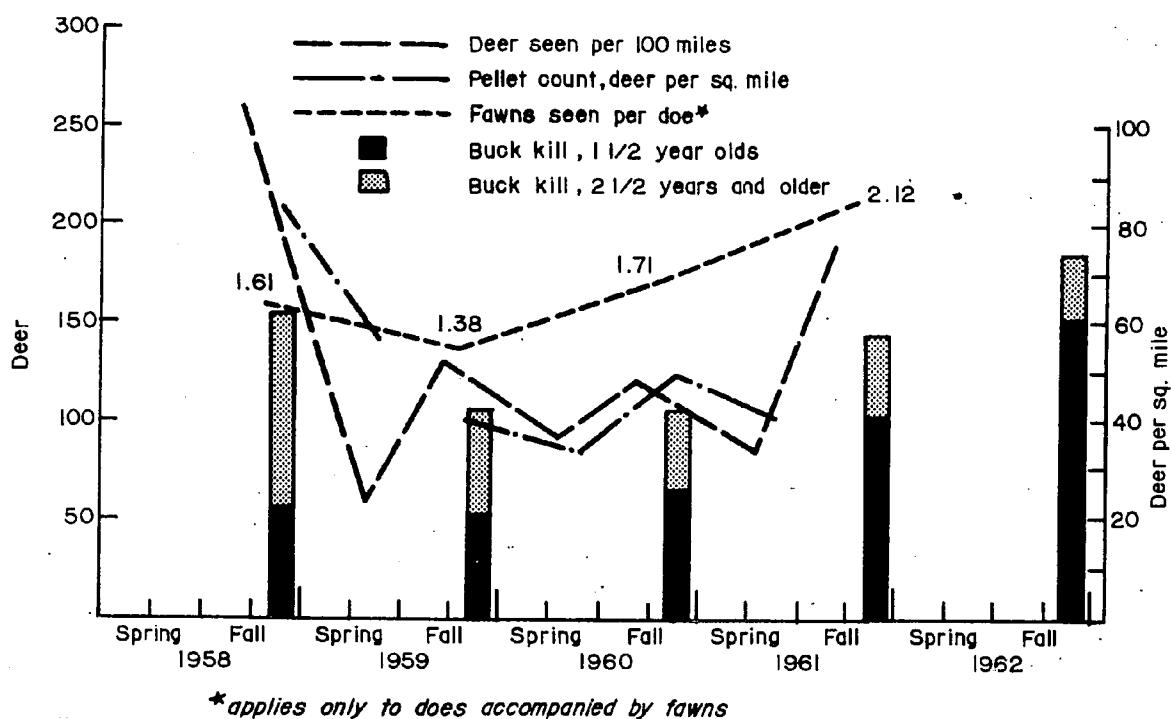


Figure 66. Four indices to deer population on Mid Forest Lodge.

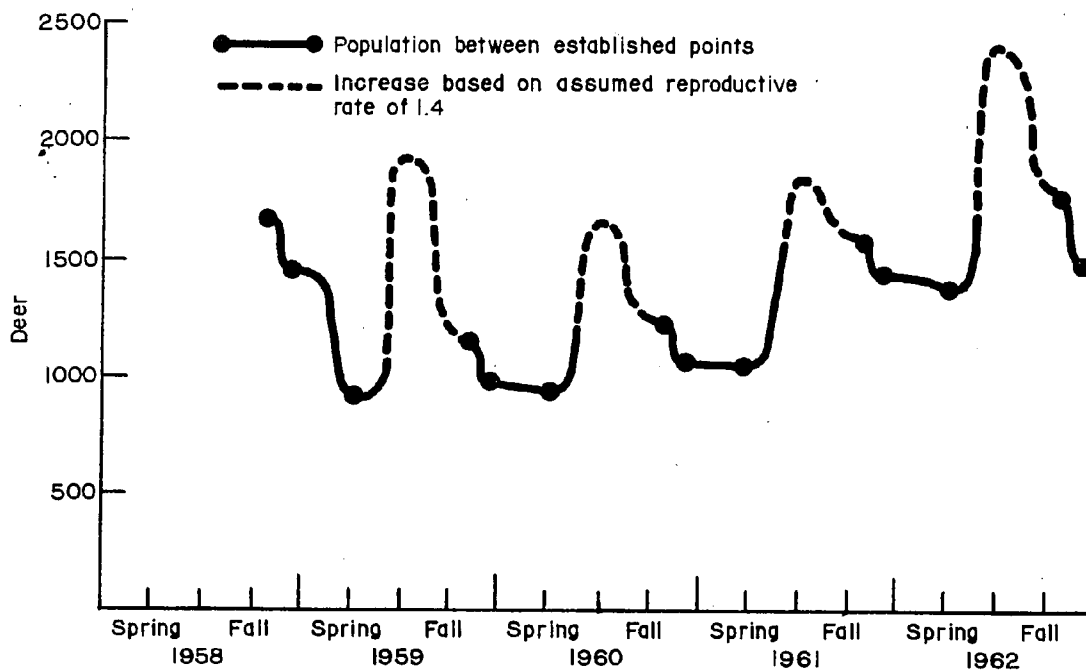


Figure 67. Fluctuations in deer numbers on Mid Forest Lodge during four year period of study.

Table 29. Life equation table for Mid Forest Lodge deer herd during four-year period of study

	Annual periods, beginning and ending pre-hunting season			
	1958-1959	1959-1960	1960-1961	1961-1962
Fall buck:doe:fawn ratio, observed	26:100:58	28:100:67	27:100:76	23:100:82
Per cent of fall herd removed by hunting*	13	17	15	10
Composition:				
bucks, per cent	77	64	65	100
does, " "	16	32	26	0
fawns, " "	7	4	9	0
Per cent yearling bucks bagged	54	49	62	71
Per cent of fall herd lost over winter **	32	3	0	5
Spring buck:doe:fawn ratio, calculated	10:100:24	9:100:70	8:100:79	4:100:81
Potential increase from fawn crop, per cent***	105	78	75	76
Actual net increase over spring population, per cent	26	32	53	29
Fawns produced per doe	.58	.88	1.14	.74
Net annual population change, pre-hunting, per cent	-32	+7	+30	+10

* Includes crippling loss, assumed 10% of bag

** Includes starvation and all other losses

*** Assumed productivity rate of 1.40 fawns per adult doe

The salient points brought out by this table are listed and discussed below.

1) The hunting harvest has averaged around 14 per cent of the fall herd. It was 10 per cent in the bucks-only season of 1961, and in the other three seasons, when an antlerless harvest was included, it ranged from 13 to 17 per cent.

2) During seasons with antlerless harvests the buck kill was two to three times as great as the antlerless kill.

3) The heavy dieoff in 1959 removed nearly one-third of the 1958 pre hunting herd.

4) Population structure in the spring is normally around 55 per cent adult does and 5 per cent bucks. In 1959 following the heavy loss of fawns it was 75 per cent does and 7 per cent bucks.

5) With the fairly low reproductive potential of 1.4 common to this part of the region the potential increase in the breeding herd is at least 75 per cent. Following the high fawn losses in the spring of 1959, with the herd heavy to adult does, the potential increase was over 100 per cent.

6) The actual increase in the 1959 season was the lowest of all, only 26 per cent; greatest was 53 per cent in 1961. Average increase for the four years was 35 per cent.

7) Actual productivity was highest in 1961 with a rate of 1.14 fawns per doe, poorest in 1959 with .58. The average was .81 fawns per doe.

From this balance sheet of increases and decreases in population it will be seen that the greatest annual loss to the herd is the one represented by the apparent difference between potential and actual

productivity. How much of this is a paper loss or to what extent actual mortality is occurring cannot be measured or estimated from my present knowledge. There was no practicable way for me to determine the in utero productivity rate of Mid Forest deer. However, I see no reason to believe it would differ greatly from the average rate determined in the hundreds of autopsies of deer in this general problem area. In which case we must assume that a large number of the deer conceived each year do not survive.

A graphic portrayal of the fluctuations implied by this difference between productivity rates is shown in Figure 67. Points that are known from valid estimates are connected with generalized curves shown as solid lines. The broken line curves extend to a height each year determined by the estimate of potential production based on the 1.4 rate. This type of generalized population curve was constructed for the Jawbone herd in California by Leopold et al. (1951), and I have borrowed the design of it from them. The similarity in the patterns is striking. While it is not clear from their discussion how they derived the peaks to which they draw their fawning curve, I presume they have selected a theoretical reproductive potential. It is interesting that my data, based on a measured potential for this part of Michigan, yield the same form of curve.

The implication from this assumed drastic, annual fluctuation is that there is a high fawn mortality, either prenatal or postnatal, or both. This inferred mortality was greatest in the spring of 1959 following the winter of the heavy dieoff, but it appeared to be almost as great in 1960 and again in 1962. Both of these seasons followed winters that were very severe, but they were winters when the club had

little or no starvation loss. The year in which actual production came closest to the potential increase was 1961. This followed an exceptionally mild winter and was the season when observed doe:fawn ratios were high and triplet fawns were conspicuous.

Losses in potential fawn production can be computed as follows: 75 per cent in 1959, 59 per cent in 1960, 29 per cent in 1961, and 62 per cent in 1962.

The disparity between potential and actual population increase is encountered in most deer population studies. It represents frequently the greatest single loss in the annual turnover, and yet it is a mortality that is extremely difficult to observe or measure. Stillbirths, or fawns dying shortly after birth, are almost impossible to find in the field or to count in any way. An experimental approach has been tried in Michigan with captive deer. Verme (1962), reporting on this, showed that both prenatal and postnatal deaths occurred, with the latter most frequent. Most of the mortality was within 48 hours after parturition. The rate was directly affected by the dietary plane of the pregnant does. Severe dietary stress induced 50 to 90 per cent mortality, and a loss of 10 to 20 per cent appeared to be normal even under good food conditions. Also in Michigan, Eberhardt (1960) has used age ratios and embryo counts from state surveys to estimate fawn mortality rates in this part of Region II. His data indicate an average 30 per cent mortality for fawns up to six months of age.

It is obvious from this that range deficiencies, whether brought about by overstocking, or severe weather, or both, cannot be judged solely on the degree of winter starvation. The slightly delayed, and much harder to detect, fawn mortality is likely to exact an even greater toll than starvation, and may be serious even when winter survival is good.

Some inferences regarding carrying capacity of the club's range can be drawn from the data summarized in the life equations and the population curves. Obviously, in 1958-1959 the wintering herd of approximately 1,500 deer (50 per square mile) was larger than the habitat could support. The dieoff in the 1959 winter took them down to 900 (32 per square mile), and fawn production was very poor that summer. In the following winter, also a hard one, the herd remained at this lower level and came through without further heavy losses. We know, however, that browse utilization was severe and that productivity was again much reduced. This rather clearly indicates that, while carrying capacity was higher than the year before, the herd still exceeded it.

The next winter, 1961, was mild and no real test of carrying capacity. The population level was about 35 per square mile. There was no starvation and fawn production was high. The herd, much enlarged, went into the severe 1962 winter at the level of about 50 per square mile, just as in 1959. Continuing improvement in the range permitted this large herd to survive without an appreciable dieoff; but, as in 1960, reproduction was sharply curtailed and utilization of winter food was very heavy. Although 48 animals per square mile were carried through it would be wrong to assume that the range could safely sustain that level.

Carrying capacity of deer range, as it is usually understood by game managers, is the maximum number of animals that can regularly be maintained over winter without deterioration of the animals' physical condition or productivity. There is no exact way, as yet, of measuring deer carrying capacity. The manager must rely upon empirical procedure--observing results of known population levels and adjusting future levels accordingly. In this case, four years' data are scarcely enough to build

on, particularly in the absence of any quantitative measurement of browse availability and utilization. However, guided by present knowledge of the herd and the range, I feel that a fair appraisal of the club's carrying capacity can be made. I believe that the range now will support through the winter about 25 deer per square mile, and, while its capacity has been improved significantly in the past six years, it is not likely to be further increased. I think the herd can be safely held at this level only if forest management is continued. Although this may be too high a level to permit quick recovery or reappearance of high preference food plants, I believe that the quantity of sustenance browse produced by the cutting program will not be impaired and that this will adequately support a herd of this size. Such a herd could be expected to reproduce at the rate of about 40 per cent; it would yield a fall population of 35 per square mile and a harvestable surplus of about 300 deer on the club.

COMPARISON WITH OTHER AREAS

Much has been learned about the deer on Mid Forest Lodge. To evaluate properly the things that have happened to the herd there and to seek relationships with habitat changes comparisons should be made with other deer herds and with places where the habitat has not been altered. Ideally, there should be a control area, matching in size and in general range conditions, and capable of providing comparable data on its deer population. Unfortunately, no such area was known which would qualify in all respects as a suitable control. The very few areas on which complete hunter and bag checks could be made were either too small, too distant, or too dissimilar in habitat to be considered for intensive study. The Rifle River area is a good example. A complete and detailed hunting season check is made there at a single entry gate. Its deer range is very similar to Mid Forest, it is reasonably close to it and could be worked on conveniently, and it has had no cutting program (until very recently). However, being only 6.7 square miles in area it was much too small to provide reliable population data. There is good evidence of a considerable movement of deer on and off the area, and I felt it unlikely that data collected there would truly reflect conditions on the property.

The Turtle Lake Club was considered initially as another area suitable for detailed study. It did not qualify as a control, for it was also undergoing an aspen cutting program, and it provided no means of checking hunting or kill completely. However, its herd was extremely underharvested and its range heavily damaged. There appeared to be a

possibility of examining herd response to a cutting program that was not accompanied by any effective amount of herd control. Field work on this area proceeded only as far as making two dead deer searches when, for reasons unrelated to the merits of the property as a study area, it was discontinued.

Lacking a true control situation comparisons have had to be made with whatever data were available. For the most part these have been hunting season records from six different areas in the state where a check of some type has been made over a period of years. Also, applicable data on a county, district, and regional scale are available from the Conservation Department's various statewide surveys. The several areas and surveys used are briefly described below, followed by the comparisons with Mid Forest population data and a discussion of their significance.

Description of Other Areas

Location and Source of Data

The locations of all areas described below are shown on the map in Figure 15.

Region II

The northern 34 counties of Lower Michigan, this is an administrative region of the Department of Conservation. Statewide deer hunter numbers and deer kill figures are obtained each year by the department from a postcard poll of licensees. The sample polled normally amounts to about 10,000 out of 450,000 hunters. Information on where licensees

hunted, their success, and what they killed is most accurate when applied on a regional basis. Estimates for smaller areas, such as districts or counties, are much less exact because of the reduced sample size. Biological data on deer killed are obtained by examining deer at highway checking stations and in locker plants. Locations of kill are recorded by township. This information is normally summarized on a regional basis; however in Region II an internal subdivision is separated. It is the following area.

Northeast Food Shortage Area

This is a subdivision of Region II that includes Crawford, Oscoda, and Roscommon Counties and parts of eight others totaling 4,000 square miles. It has had the longest history of overpopulation and range damage in the state. This is the smallest area that the deer biological data from statewide surveys can be related to.

District 7

The administrative district of the Department of Conservation that includes the six counties Crawford, Oscoda, Alcona, Roscommon, Ogemaw, and Iosco, a total area of about 3,600 square miles. It is the smallest area into which the statewide pellet count estimates of population size can be divided.

Roscommon County

Mid Forest Lodge is located in this county. Normally none of the statewide surveys can be broken down into as small an area as a county. However, data on buck kill and hunting pressure are available on a county basis and are deemed accurate enough for the purpose of portraying trends in buck kill.

Sources of data for the above four geographic areas: Ryel, 1961, 1962; Ryel and Fay, 1962; and unpublished Game Division records..

Rifle River Area

A state-owned area of 6.7 square miles in Ogemaw County, it is approximately 30 miles northeast of Mid Forest Lodge. Deer range and history of the herd is very similar to Mid Forest. The area has been administered as a fisheries research project and is now in the state parks system. Aspen cutting was begun in 1962. All hunters and fishermen must register in and out through a single gate daily. All deer taken are weighed, aged, and examined.

Sources of data: Ruch, 1962; and Game Division unpublished records.

Bois Blanc Island

This is an island of 33 square miles located in Lake Huron immediately east of the Straits of Mackinac. The habitat is principally northern hardwoods and conifer swamps. Most of it is mature second growth, with very little being harvested. The deer herd, introduced about 50 years ago, built up rather slowly and not until about 1958 had it overbrowsed much of the range. Antlerless deer have been killed since 1956. The physical condition of the animals has deteriorated rapidly since overbrowsing and is now the poorest of any area in the state. A checking station on the island determines number of hunters and number of deer killed; a large portion of the kill is weighed, aged, and examined.

Source of data: Johnson et al., 1963; and unpublished Game Division records.

Beaver Island

This island of 55 square miles is located in northern Lake Michigan. Deer were introduced in 1927, have never built up to serious overcrowding levels. There is no serious winter food problem though in the past few years browse lines are appearing. The range is mixed hardwoods and conifer swamps with much abandoned farmland. It is maturing second growth with virtually no cutting in recent years. Antlerless deer have been hunted since 1957. A checking station on the island counts hunters and deer and examines a large portion of the kill.

Sources of data: Johnson et al., 1962; and unpublished Game Division records.

Canada Creek Ranch

This is a private deer hunting club of 20 square miles, located in Montmorency County about 70 miles north of Mid Forest. Membership is 1,600; deer hunters number about 500. The range is largely second growth aspen and aspen-oak, with a diversity of other forest types and openings. Its history and that of the deer herd is quite similar to Mid Forest's. An aspen cutting program was begun in 1959 with an annual cut of about 1.5 per cent of the area. Antlerless deer have been hunted during four seasons. Kill records are compiled from volunteered hunter reports; no exact figures are available on number of hunters and no checking of deer is done.

Source of information: unpublished club records.

Lost Lake Woods

A private deer hunting club, this is an area of about 14 square miles in Alcona County, 70 miles northeast of Mid Forest Lodge. Hunting

pressure averages about 500 hunters each year. The range is second growth forest, dominantly aspen, with oak, swamp conifers and various other types intermixed. An aspen cutting program, very similar to Mid Forest's, has been under way since 1956. About 3.5 per cent of the area is cut annually. Some antlerless deer have been taken for seven years. The club does not make a complete check of hunters or kill; records are based on voluntary reports. This area, its deer herd, and its management resembles Mid Forest Lodge more closely than any of the others listed.

Sources of information: records of club and of Packaging Corporation of America.

Hiawatha Sportsman's Club

This private deer club, covering about 56 square miles, is the largest in the state. It is located in Mackinac County of the Upper Peninsula about 40 miles northwest of the Straits. Average hunting pressure is about 350 hunters. The cover is maturing second growth, principally aspen, mixed hardwoods, and conifer swamp. No timber has been harvested for many years. The deer herd increased rather slowly to a peak in about 1955. Numbers have noticeably declined since then. The area is very conspicuously overbrowsed, both winter and summer range. There has never been any harvest of antlerless deer. Hunting records are from the members' voluntary reports.

Source of information: club records.

Comparison of Deer Populations

Although in general more is known about the deer on the assorted areas being considered here than on any other localities in the state,

there is not good uniformity among them in the types of facts known or the methods of obtaining them. Kill figures, while available for all of these units, are based on complete counts on only a few and are estimated in various ways on the others. Hunting pressure and success figures likewise vary among them. Biological facts from deer examinations are available from only four of the localities, but with no consistency in sampling. Pellet count data are limited to the two larger geographic areas.

Upon analyzing the assembled facts I have decided that the most useful comparisons can be made from three types of data: annual buck kill, biological measurements, and pellet count surveys. These data have been extracted and are compared to similar data from Mid Forest Lodge in the following sections. Because of its possible value for other comparisons and for future reference I have summarized all of the hunting season information that has been assembled from the various areas and am including it in a series of tables appended to the end of this chapter. See Tables 30-42, pp. 213-222.

Buck Kill

The one measurement common to all of the areas considered is the annual buck kill. The harvest of bucks is not necessarily a consistent reflection of total deer population. It is influenced by hunting pressure, by weather, and, of course, by the proportion of the herd that is made up of the adult buck segment. Nevertheless, if hunting pressure is assumed to be reasonably consistent from year to year, changes in buck kill will usually reflect population changes on an area with enough

precision to show general trends. To a certain extent, also, the size of a population will be indicated by the buck kill, provided that the relative level of the hunting pressure is also considered.

Primarily for the purpose of comparing population trends I have made comparisons of the Mid Forest buck kill with that of eight other areas. These are presented as a series of curves in Figure 68. In order to show the trends more clearly I have smoothed the curves by plotting 3-year moving averages. This has removed much of the sharp, year to year fluctuations and emphasizes trends over longer periods.

The most significant feature brought out by these curves, I believe, is the sustained upward trend of Mid Forest since about 1955. None of the other areas show this. Four of the units having very similar past histories--falling carrying capacity caused by the combined factors of overpopulation and forest maturity--are Rifle River, Roscommon County, Canada Creek, and Lost Lake Woods. Their curve patterns are also very similar: rather drastic ups and downs but with an overriding decline from the late 1940's. Mid Forest, too, should have conformed to this pattern. Its apparent nonconformity during the past six or seven years indicates, I believe, an improvement in carrying capacity which none of the other areas can show.

Areas with relatively different deer histories have curves of different patterns. Bois Blanc Island has had a later, but steady, buildup of deer until overbrowsing culminated suddenly in the late 1950's. This has been accompanied by a continuing increase in hunting pressure which probably amplified the rising buck kill. The Hiawatha Club also had a later but steady deer buildup with a sudden development of overbrowsing. Light hunting pressure there has undoubtedly attenuated

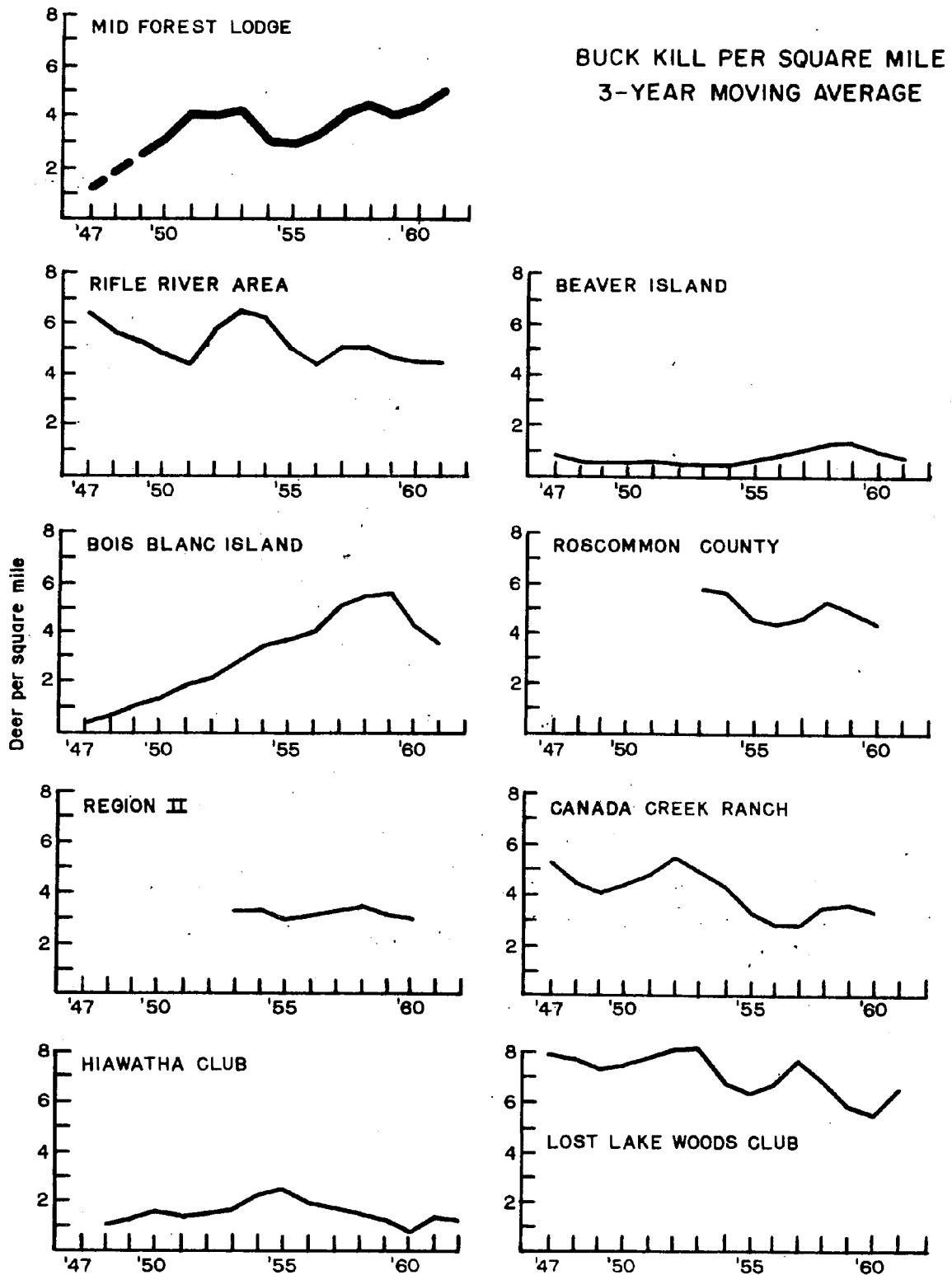


Figure 68. Trends in buck kill on Mid Forest Lodge compared with eight other areas, 1947-1962.

the rise and fall of the buck kill trend. Beaver Island deer have never built up to an overbrowsing level. Hunters have increased in recent years, and this has caused the moderate increase in buck kill. The Region II kill reflects many factors and seems to indicate a fairly stable population. Its present level, however, is lower than it was in the 1940's. The current method of obtaining kill figures does not go back far enough to show the drop that occurred late in that period.

The wide differences in hunting pressure between areas makes comparison of population levels difficult. Probably the greatest amount of hunting is done on the Rifle River Area where 60 or 70 people per square mile may be hunting on opening day. Roscommon County is a close second with an average for the season of about 45 hunters per square mile. Lost Lake Woods is next in rank with 35 per square mile, followed by Canada Creek with about 25. The Region II average is around 20 hunters per square mile; Mid Forest and Bois Blanc are similar with about 18; Beaver Island and the Hiawatha Club have the lightest pressure, averaging from 4 to 6. The significance of this is that Mid Forest, with moderate hunting pressure, is now harvesting bucks at the same rate as the areas with very heavy hunting, and the trend is upward. Since the buck kills on all of them each year are probably very close to potential, it appears that potentials are falling off in other areas but rising on Mid Forest.

Biological Data

There was very little choice in selecting areas with which to compare the biological data of Mid Forest yearling bucks. Measurements from the statewide checking station surveys provided a comparison with both the northeast food shortage area and with the balance of the region.

These might be considered respectively as normals of poor and moderately good range. The complete bag check on the Rifle River Area gave data from a nearby range, fairly similar, but with a past history of somewhat less overcrowding. Bois Blanc Island figures represented an area which had recently displayed an extremely low standard of physical condition in its deer.

The measurements that are considered here are those for yearling bucks. They include: the percentage of the total buck kill that this age class comprises, weight, antler beam diameter, antler points, and length of hind foot. The comparisons are shown in the graphs in Figure 69.

The relation of the Mid Forest data to that of the other areas is quite clear in these superimposed curves. In 1958, when I began the measurements, Mid Forest ranked low in all characteristics. In the following four years it has improved very consistently in all of them. Average weight has risen from the lowest to a very respectable rank close to the top. The other areas did not approach this degree of improvement. Antler size on the club, both beam and points, similarly changed rank and are now close to the average for the main zone of the deer problem area.

In foot length, the limited data show Mid Forest having an increase matching the others. It is interesting to note here that the difference between areas is small in contrast to the differences shown by the body weight comparisons. Thus the heavier deer may not be proportionately larger in frame than the lighter ones, and the weight differences are likely to be due to variations in body fat storage. This could be viewed as supporting the use of body weight as a condition factor reflecting quality of the range.

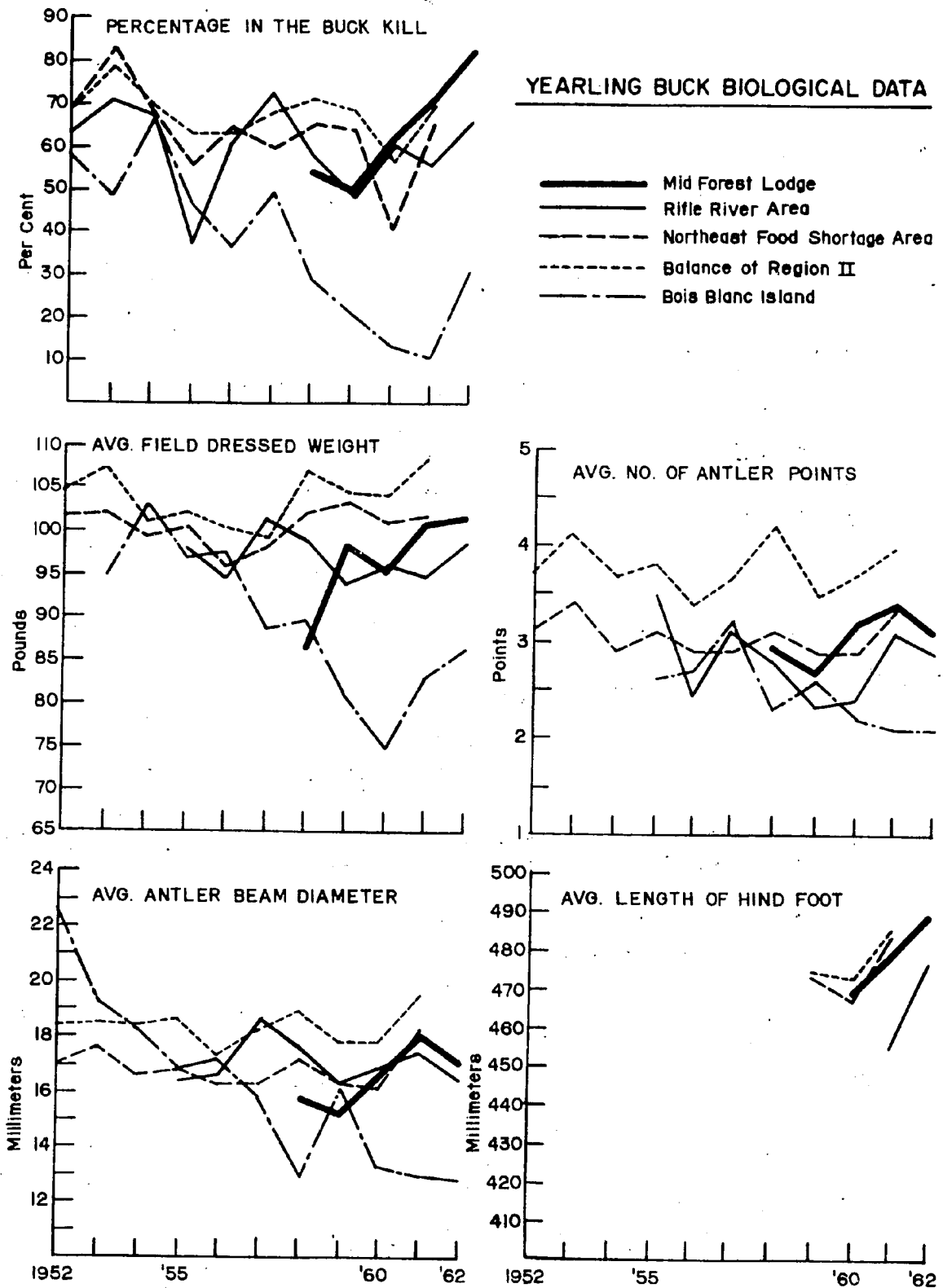


Figure 69. Data from yearling bucks examined in hunting seasons, Mid Forest Lodge compared with four other areas.

The percentage of yearlings in the buck kill, as pointed out in an earlier section, is largely a factor of productivity and winter survival, and in both cases reflects range quality. This factor on Mid Forest has shown a rather spectacular increase since its drop in 1959. In contrast the records from three other sources all show a severe drop in 1960 as well as 1959, and Rifle River, though it rose in 1960, declined again in 1961. It is quite evident that the severity of the 1960 winter was not as damaging to productivity and survival on Mid Forest as it was elsewhere in the region. Also apparent is the fact that improving production on the club has carried it from below average to as high a level as any the region has had for 10 years.

Pellet Counts

The Mid Forest pellet count data can be compared with no other area of similar size in the state. In the Conservation Department's survey the region is sampled on a district basis, and this is the smallest unit for which population estimates are available. A comparison of the club with District 7 and with Region II is shown in Figure 70.

The Mid Forest deer population is shown to be over twice as high as the average for the region. In general, the region's deer herd appears to be steadily declining, while on this club a distinct increase has nearly restored the population to the high level of 1958.

In District 7 deer are nearly twice as abundant as the region-wide average. (They are also higher than in any of the four other districts in the region). For two years the population dropped very

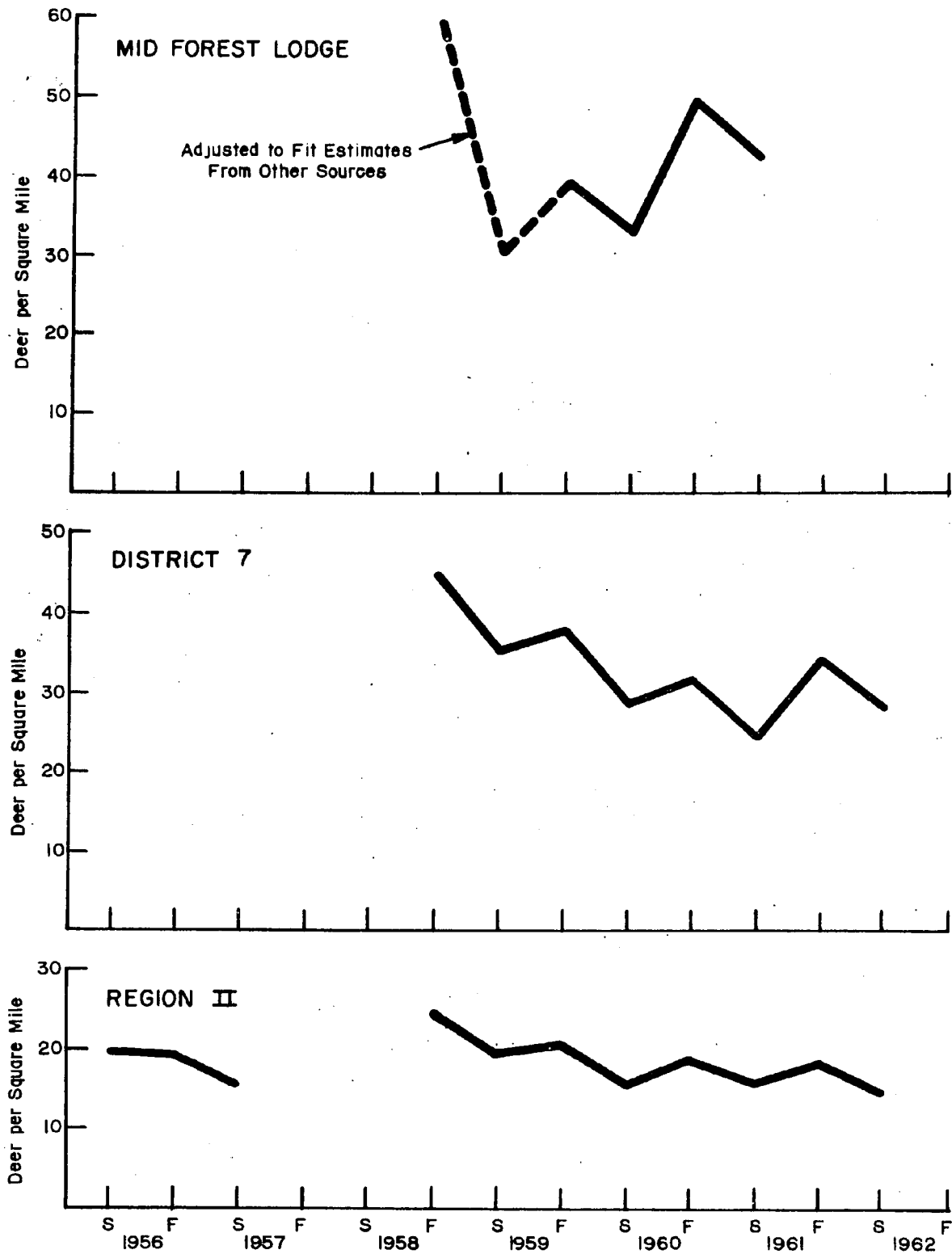


Figure 70. Deer population estimates based on pellet group surveys.

noticeably, no doubt in response to the successive severe winters of 1959 and 1960. Recovery in 1961 followed that winter's respite and a leveling off is indicated in 1962.

Mid Forest deer, though they dropped steeply in 1959, resisted the rigors of the following winter and recovered very well by the next season. Since the club is a part of District 7 and conforms to the general pattern of the district in its past history the contrast here, I feel, is highly significant.

All of the above comparisons consistently point to an improving situation for the deer on Mid Forest Lodge during a period when improvement was definitely not the rule for other places in the Region. A population increasing from better production and survival at a time when other herds were falling off because of lowering productivity and repeated mortality; animals improving in physical condition, climbing from below normal to at least as good condition as others in the region: all of these enhancements clearly set apart this area and denote a basic improvement in the habitat. Obviously something good has been happening to deer range on Mid Forest Lodge in the past five years.

Tables 30 to 42

The following tables are appended to this chapter as supplemental information. They are compilations of hunting season data for the 13 areas discussed in the chapter and are presented here because of their possible value for future reference and comparison.

Table 30. Region II deer kill and hunting pressure, 1952-1961

Year	Bucks killed		Hunters		Bucks per Hunter	Antlerless kill	
	Total	Per sq.mi.	Total	Per sq.mi.		Total	Per sq.mi.
1952	41,200	2.9	305,860	21.8	.135	100,520	7.2
1953	42,520	3.0	309,660	22.1	.137	26,620	1.9
1954	32,820	2.3	285,160	20.4	.115	8,330	.6
1955	41,930	3.0	275,080	19.6	.152		
1956	34,240	2.4	296,120	21.1	.116	11,580	.8
1957	38,200	2.7	281,435	20.1	.136	13,360	1.0
1958	46,910	3.3	313,320	22.4	.150	18,908	1.4
1959	41,440	3.0	317,920	22.7	.130	31,160	2.2
1960	29,040	2.1	297,840	21.3	.098	18,640	1.3
1961	37,700	2.7	269,470	19.2	.14	50	--
Tot.	386,000	27.4	2,951,865	210.7		229,168	16.4
Ave.	38,600	2.7	295,186	21.1	.130	25,463	1.6

Table 31. Roscommon Co., Michigan, deer kill and hunting pressure, 1952-1961

Year	Bucks killed		Hunters		Bucks per Hunter	Antlerless kill	
	Total	Per sq.mi.	Total	Per sq.mi.		Total	Per sq.mi.
1952	2,800	5.3	29,065	54.9	.096		20.6
1953	3,330	6.3	30,070	58.0	.111		5.0
1954	2,138	4.0	24,701	46.7	.087		1.1
1955	2,540	4.8	22,364	42.3	.114		--
1956	1,491	2.8	23,570	44.5	.063		1.5
1957	2,045	3.9	21,954	41.5	.093		.9
1958	2,707	5.1	23,757	44.9	.114		1.9
1959	2,623	5.0	25,486	48.2	.103		3.7
1960	1,656	3.1	21,805	41.2	.076		2.5
1961	1,755	3.2	20,279	38.0	.087		--
Totl	21,330	43.5					37.2
Ave.	2,133	4.4		46.0	.10		3.7

Table 32. Rifle River Area deer kill and hunting pressure, 1946-1962

Year	Bucks killed		Hunter-days		Bucks per 100 Hunter-days	Antlerless kill		Illegal kill
	Total	Per sq.mi.	Total	Per sq.mi.		Total	Per sq.mi.	
1946	51	7.5	2,159	317.4	1.61			9
1947	48	7.1	1,921	282.4	2.50			8
1948	32	4.7	1,784	262.2	1.79			
1949	36	5.3	1,535	225.6	2.34			8
1950	40	5.9	1,519	223.3	2.63			8
1951	22	3.2	1,226	180.2	1.79			12
1952	30	4.5	1,527	224.5	1.96	46		2
1953	66	9.7	4,445	653.4	1.48	75		38
1954	37	5.4	2,708	398.1	1.37	36		9
1955	27	4.0	2,001	294.1	1.35			10
1956	38	5.7	2,350	345.4	1.62	24		10
1957	26	3.9	1,845	271.2	1.41	12		13
1958	38	5.7	2,265	333.0	1.68	20		11
1959	37	5.4	2,209	324.7	1.67	53		14
1960	21	3.1	1,868	274.6	1.12	22		5
1961	34	5.0	2,080	305.8	1.63			12
1962	39	5.7	2,541	373.5	1.53	53		4
Total	622	91.8	35,983	5,289.4		341		173
Ave.	36.6	5.4	2,117	311.1	1.73	37.9		10.8

Area: 4,318 acres or 6.8 square miles.

Table 33.. Bois Blanc Island deer kill and hunting season data. Gun season, 1941-1962

Year	No. hunters	% success		Deer killed		Kill per sq.mi.		Yearling bucks		
		bucks	deer	bucks	antler-	bucks	antler-	No. % of total examined bucks	lbs.	pts.
			all	less	less					
1941	19	5.3		1		.03				
1942	41	17.1		7		.21				
1943	30	33.3		10		.30				
1944	48	27.1		13		.39				
1945	36	22.2		8		.24				
1946	76	14.5		11		.33				
1947	40	20.0		8		.24				
1948	43	51.2		22		.67				
1949	98	31.6		31		.94				
1950	132	37.9		50		1.52				
1951	191	31.9		61		1.85				
1952	232	29.7		69		2.09				
1953	276	33.3		92		2.79				
1954	380	27.1		103		3.12				
1955	442	28.9		128		3.88				
1956	414	29.7	34.3	123	19	3.73	.58	11	58	121.3
1957	494	33.5	34.6	146	45	4.42	1.36	11	48	94.9
1958	416	35.0	50.8	224	101	6.79	3.06	36	67	102.9
1959	659	24.7	50.9	163	207	4.94	6.27	18	46	97.0
1960	818	19.9	37.2	163	147	4.94	4.45	32	36	97.6
1961	577	15.8		91		2.76		45	49	88.5
1962	624	14.6	37.5	91	143	2.76	4.33	33	29	89.5
Total	6086			1615	662	2277	20.05	26	21	81.0
Ave.	277	26.5	37.4	73.4	110.3	103.5	3.34	17	13	75.0
								8	11	83.3
								25	30.5	85.7
								252	1016.7	24.7
								24	37.2	92.4
										2.7
										16.2

Area: 21,120 acres or 33 square miles.

Table 34. Beaver Island deer kill and hunting pressure, 1946-1962

Year	Bucks killed		Hunters		Bucks per Hunter	Antlerless kill	
	Total	Per sq.mi.	Total	Per sq.mi.		Total	Per sq.mi.
1946	75	1.4	278	4.5	.270		
1947	43	.8	280	5.1	.154		
1948	33	.6	200	3.6	.165		
1949	27	.5	160	2.9	.169		
1950	40	.7	162	2.9	.247		
1951	26	.5	165	3.0	.158		
1952	35	.6	130	2.4	.269		
1953	30	.5	138	2.5	.217		
1954	29	.5	132	2.4	.221		
1955	34	.6	189	3.4	.181		
1956	45	.8	186	3.4	.242		
1957	62	1.1	262	4.8	.237	44	.8
1958	79	1.4	300	5.4	.263	71	1.2
1959	80	1.4	425	7.7	.188	105	1.9
1960	56	1.0	475	8.6	.118	77	1.4
1961	22	.4	233	4.2	.094		
1962	61	1.1	260	4.7	.234	58	1.1
Total	777	13.9	3,975	71.5		355	6.4
Ave.	45.7	.8	233.8	4.2	.195	59.2	1.1

Area: 35,500 acres or 55 square miles.

Table 35. Canada Creek Ranch deer kill, 1937-1961

Year	Bucks killed		Antlerless kill		Archery kill	
	Total	Per sq.mi.	Total	Per sq.mi.	Bucks	Antlerless
1937	78	3.8				
1938	83	4.1				
1939	88	4.3				
1940	91	4.5				
1941	109	5.4				
1942	98	4.8				
1943	--	--				
1944	71	3.5				
1945	93	4.6				
1946	129	6.4				
1947	96	4.7				
1948	94	4.6				
1949	82	4.0				
1950	68	3.3				
1951	112	5.5				
1952	107	5.3	289	14.2		
1953	107	5.3	50	2.5		
1954	77	3.8				
1955	74	3.6				10
1956	46	2.3				7
1957	51	2.5				7
1958	82	4.0				10
1959	76	3.7	23	1.1		9
1960	59	2.9	11	.5	1	8
1961	61	3.0				13
Total	2,032		373		1	64
Ave.	84.7	4.2				9.1

Area of club: 13,000 acres or 20.3 square miles.

Table 36. Hiawatha Sportsman's Club deer kill and hunting pressure, 1948-1962

Year	Bucks killed		Hunters		Bucks per hunter
	total	per sq.mi.	Total	per sq.mi.	
1948	56	1.0	--		
1949	68	1.2	231	4.1	.29
1950	76	1.4	--		
1951	75	1.3	297	5.3	.25
1952	78	1.4	309	5.5	.25
1953	86	1.5	320	5.7	.27
1954	115	2.1	332	5.9	.35
1955	135	2.4	354	6.3	.38
1956	107	1.9	402	7.2	.27
1957	96	1.7	422	7.5	.23
1958	85	1.5	443	7.9	.19
1959	70	1.2	360	6.4	.19
1960	40	.7	326	5.8	.12
1961	65	1.2	300	5.3	.22
1962	61	1.1	300	5.3	.20
Total	1213		4396		
Average	80.9	1.4	338	6.0	.28

Area of club: 35,800 acres or 56 square miles.

Table 37. Lost Lake Woods Club deer kill and hunting pressure, 1931-1962

Year	Bucks killed		Hunters		Bucks per hunter	Antlerless kill		Total kill	
	Total	per sq.mi.	total	per sq.mi.		total	per sq.mi.	total	per sq.mi.
1931	26	2.0							
1932	33	2.5							
1933	39	3.0							
1934	40	3.1							
1935	54	4.2							
1936	72	5.5							
1937	68	5.2							
1938	70	5.4							
1939	101	7.8							
1940	103	7.9							
1941	109	8.4							
1942	112	8.6							
1943	93	7.2							
1944	100	7.7							
1945	120	9.2	493	37.9	.243				
1946	112	8.6	523	40.2	.214				
1947	107	8.2	465	35.8	.230				
1948	89	6.8	472	36.3	.189				
1949	105	8.1	459	35.3	.229				
1950	92	7.1	519	39.9	.177				
1951	93	7.2	529	40.7	.176				
1952	114	8.8	515	39.6	.221	108	8.3	222	17.2
1953	109	8.4							
1954	94	7.2				19	1.5	113	8.7
1955	58	4.5							
1956	98	7.5				6	.5	104	8.0
1957	103	7.9				20	1.5	123	9.4
1958	97	7.5				34	2.6	131	10.1
1959	66	5.1				70	5.4	136	10.5
1960	67	5.2				49	3.8	116	9.0
1961	81	6.2							
1962	101	7.8							
Tot.	2726	209.8				307	23.6		233.4
Ave.	85.2	6.6			.210		3.4		7.3

Area of club: 8,850 acres or 13.8 square miles.

Table 38. Percentage of yearlings in the total buck kill

Year	Mid Forest %	Roscommon County %	Balance of Region II %	Rifle River %	Bois Blanc %
1952		69	69	63	58
1953		82	79	71	48
1954		69	69	67	67
1955		56	63	37	46
1956		64	63	61	36
1957		60	67	73	49
1958	54	65	71	58	29
1959	49	64	69	48	21
1960	62	41	57	62	13
1961	71	66	70	56	11
1962	82			67	31

Table 39. Weight of yearling bucks

Year	Mid Forest lbs.	S.E.*	NE food shortage area lbs.	Balance of Region II lbs.	Rifle River lbs.	Bois Blanc lbs.
1952			101.7	104.7		
1953			101.8	107.3		94.9
1954			99.6	101.0		102.9
1955			101.3	102.0	97.9	97.0
1956			95.8	100.3	94.8	97.6
1957			97.8	101.3	101.3	88.5
1958	86.3	1.5	101.8	106.8	99.0	89.5
1959	98.6	1.4	103.0	104.6	94.0	81.0
1960	95.7	1.5	101.0	104.4	96.0	75.0
1961	100.7	.8	101.7	108.0	95.0	83.0
1962	101.7	.9			98.5	86.2

* Standard error of the mean

Table 40. Antler beam diameter of yearling bucks

Year	Mid Forest		NE food shortage area	Balance of Region II	Rifle River	Bois Blanc
	mm.	S.E.*	mm.	mm.	mm.	mm.
1952			17.0	18.4		22.6
1953			17.6	18.5		19.3
1954			16.6	18.4		18.3
1955			16.9	18.6	16.5	16.9
1956			16.4	17.4	16.7	17.2
1957			16.5	18.2	18.6	15.9
1958	15.8	± 1.3	17.3	19.0	17.7	13.0
1959	15.2	± 1.2	16.4	17.9	16.4	16.2
1960	16.6	± 1.1	16.2	17.9	16.9	13.3
1961	18.1	$\pm .9$	18.3	19.6	17.5	13.0
1962	17.0	$\pm .8$			16.5	12.9

* Standard error of the mean

Table 41. Antler points on yearling bucks

Year	Mid Forest		NE food shortage area	Balance of Region II	Rifle River	Bois Blanc
	no.	S.E.*				
1952			3.1	3.7		4.9
1953			3.4	4.1		--
1954			2.9	3.7		--
1955			3.1	3.8	3.50	2.6
1956			2.9	3.4	2.47	2.7
1957			2.9	3.7	3.10	3.2
1958	2.95	$\pm .17$	3.1	4.2	2.82	2/3
1959	2.72	$\pm .16$	2.9	3.5	2.33	2.6
1960	3.21	$\pm .21$	2.9	3.7	2.43	2.2
1961	3.38	$\pm .15$	3.3	4.0	3.10	2.1
1962	3.10	$\pm .13$			2.88	2.1

* Standard error of the mean

Table 42. Length of hind foot of yearling bucks

Year	Mid Forest		NE food shortage area	Balance of Reg. II	Rifle River
	mm.	S.E.*	mm.	mm.	mm.
1959			472.2	472.9	
1960	468.8	± 3.8	467.1	472.6	
1961	478.1	± 2.1	482.8	484.7	454.8
1962	488.3	± 2.1			477.1

* Standard error of the mean

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary of the Study

1. Deer are an important recreational resource in the United States, and Michigan ranks among the highest in deer numbers and in recreation provided.
2. Michigan has a twofold deer problem, compounded from (1) a long-standing overabundance of the animals and (2) a gradual maturing of forest stands. Both factors cause deterioration of deer range.
3. A solution to the first part of the problem is attainable through closer harvesting of the deer, though public sentiment continues to prevent the fullest application of this means.
4. A greater harvest of the maturing forest would solve the second part, but market capacity has limited this. A recently expanding pulpwood market now brightens the prospects for improving deer habitat. Aspen, a most important forest type, is being cut at a rapidly expanding rate.
5. Mid Forest Lodge, a large, private hunting club, began a forest-wildlife management program in 1956 and is now sustaining an aspen cut on about 2 per cent of its area annually. Over 11 per cent of the property had been cut by 1962. Club members in recent years have begun to shoot antlerless deer in addition to bucks.
6. This study was undertaken to see if management effort was producing any measureable effects on the club's deer herd.

7. Mid Forest Lodge typifies the state's deer problem. It has suffered severe overpopulation and its second growth forest is maturing beyond optimum usefulness to deer.
8. Winters in this locality are periodically severe. In recent years the winter of 1958-1959 was the extreme, with 1959-1960, and 1961-1962 approaching it in severity.
9. The club maintains a unique system of registering and checking hunters at two gates. This, together with a biological examination of a large segment of the kill, has provided detailed information on the deer herd.
10. Buck kill and hunter success in general have increased since 1956. The trend had been downward before that. Antlerless kill has been relatively light with some members showing reluctance to get permits and others failing to fill them.
11. More deer are killed in aspen than in oak types, and cutover areas consistently have largest kills.
12. Biological data from the kill shows a drop in production and in physical condition in 1959 but a continuing improvement in both during the three years following.
13. A method of censusing deer by pellet-group counts gave very good results in two successive years. The population density was about 40 per square mile in the fall of 1959 and 49 per square mile a year later.
14. Distribution of pellet groups indicated a high wintertime use of cuttings with deer being drawn in from a wide area. Deer confined most of their winter activity to within 1/2 mile of cutover areas.

15. Dead deer counts, cooperative efforts of club members with biologists from three agencies, successfully surveyed winter mortality. The club sustained a loss of 21 deer per square mile in 1958-1959, but had negligible mortality in two other hard winters that followed. Other areas had severe starvation in all three years.
16. Observations of deer, their activities, and their tracks showed that cuttings are attractive to deer throughout the year, that they are most attractive at two or three years of age, and that heavy browsing can extend their period of high use to four or five years.
17. Aspen sucker stands generally survived heavy browsing even after three or four successive years and appeared eventually to escape. Some areas seemed permanently damaged by two or three years of browsing.
18. Supplemental winter feeding, though carried on efficiently, did not effectively disperse deer throughout the area, relieve browsing on cuttings, or assist survival when need was greatest. It may have aggravated damage by concentrating animals in small areas.
19. Car counts of deer gave a rough indication of population trends and yielded good summer-fall ratios of sex and age.
20. Estimates of deer population were derived from buck ages and fall sex-age ratios. They correspond very well with the entirely independent pellet count estimates. The data showed that the club's herd had dropped sharply in 1959 but climbed steadily since then and by 1962 was at the former high level of 1958. Other population indices conformed to this same pattern.
21. A life equation, constructed for four years, showed these important features:

- a) The average hunting removal was 14 per cent of the fall herd; the buck kill normally removed 10 per cent of the herd, and the antlerless kill took 3 to 7 per cent more.
- b) The average annual increase in the herd was 35 per cent. The lowest, 26 per cent in 1959; the highest, 53 per cent in 1961.
- c) Average productivity was 0.81 fawns per doe, with a range from .58 to 1.14, in 1959 and 1961 respectively.
- d) A heavy mortality of fawns was indicated each year, ranging from 29 per cent to 75 per cent of the potential, annual fawn crop.

22. There was no control area available. However, comparable information from various other areas showed the Mid Forest deer herd to be consistently different in important factors.
23. While deer on Mid Forest improved steadily in numbers and in physical condition after the drop in 1959, in other areas they fell off on both points for two successive years and failed to show good recovery after that. The population in the region in general appears to be declining, while on this club it is improving.

Conclusions

There can be no doubt of the impact that forest management has had on the club's deer herd and their habitat. Before the aspen harvest began the population was high but declining; the range, long overbrowsed and overmatured, was carrying many more deer than it could safely support. Range improvement brought by the cutting program had not advanced far enough to stave off the grim losses of a starvation winter in 1958-1959. Only 5 per cent of the club was cutover by that season, and the cutting

was still limited to the eastern side of the area. A herd of 1,500 dropped to 900. By the following year 7 per cent of the club had been cut, and the range now proved capable of carrying over the thinned down herd as the second severe winter struck. There was little margin of safety however, and even as the cutover lands of the range expanded to 10 per cent by 1962 the deer increased proportionately. Again the improved range carried deer safely through the hard winter, but again the margin was narrow. Most of the cuttings remained effective as winter range even after six years, and shifting operations to the western half of the club helped to disperse the herd and relieve pressure on the east side.

Annual cuttings of 200 to 300 acres are a bare minimum in size for this area. Deer utilize them fully and repeatedly, and the risk of permanent damage to regeneration is high. The lack of coniferous winter cover is very apparent. Although the deer seem to get along without very much of this type, more of it would bring about a more stable and dispersed pattern of winter usage which is very desirable. Cutting in the oak areas would contribute greatly to this need and is also essential to the unified management of the forest.

In general the results of this study have confirmed the soundness of the forest management plan now in progress on this club. The design of the cutting program, the number, size, location, and scheduling of the compartments have thus far proven to be well suited to the area's special problems of deer range and abundance. The management of the range is proceeding well; management of the herd is lagging.

The range has been carrying too many deer each year throughout the study. The lowest overwinter population level was about 32 deer per

square mile, the highest observed was about 50. Indications are that, although carrying capacity of the range has been improved, the club should not be wintering more than about 25 per square mile. Such a herd would attain an annual fall population of about 35 per square mile.

The harvest of deer on the club has been inadequate and must be increased if the herd is to be brought in line with carrying capacity and kept reasonably close to it. A 14 per cent kill and a 35 per cent increase can only result in a building herd. The animals will not stockpile for long, and inevitably a dieoff will cut them down again. The improved range now may permit them temporarily to build to a higher level than in 1958, but the crash will come just as surely as it did then. And in the meantime only harm can come from the mounting browsing pressure. The gains in carrying capacity that accrue from the cutting program are fixed in amount, and the cut cannot be stepped up to accommodate an overcrowding deer herd. A population much above the present level will jeopardize the regenerating future pulpwood crop which, after all, is the basic reason for the program's pursuance.

With the present imbalance in the herd, caused by the long continued killing of bucks only, it is not possible to step up the harvest rate of adult bucks appreciably. It will remain close to 10 or 15 per cent. More antlerless deer will have to be taken. More could be killed by the members under the present antlerless quotas of the state, but only up to a certain point, and that point is probably not quite high enough for an adequate harvest.

For the management program to succeed and for the fullest realization of the club's aims in maintaining a good harvest of healthy deer, the herd must be hunted heavily enough to reduce it to the level

of the carrying capacity and then to hold it there. This will obviously require a greater effort than the club now makes to kill antlerless deer, and may require some special measures not at present available to them.

Management Recommendations

For Mid Forest Lodge

1. The aspen cutting program should be continued according to the existing management plan.
2. Management of the oak areas as called for in the plan should be started as soon as possible.
3. A planting program should begin immediately, following the methods suggested in the management plan. This should be aimed at establishing coniferous cover in some of the larger openings and underplanting in oak.
4. The antlerless kill must be increased. The immediate goal should be high harvests, 300 antlerless plus 150 bucks, to lower the herd in line with carrying capacity. Thereafter, a total annual kill of 300 deer should be aimed for, half bucks and half antlerless. This would be approximately the annual harvestable surplus of an overwintering herd of 25 deer per square mile.
5. The present system of registering and checking hunters at the gates should be continued. A scales for weighing deer should be provided at the clubhouse so that a check may be made on physical condition.

Also, antler points data should be analyzed each year to determine the percentage of the bucks that are spikehorns. This will give a rough index to productivity and condition.

6. The winter feeding program should be discontinued. Rye patches can be maintained, as at present, to facilitate the seeing of deer by the members.

General

For adequate deer range benefit aspen harvest on township-size units with a high deer herd, 40 to 60 per square mile, should aim to keep 7 per cent to 10 per cent of the range in effective regrowth. This will require a cut of about 1.5 per cent to 2.5 per cent of the total area per year. Where the deer population is half as high the amount of the annual cut could be reduced considerably, possibly to 1 per cent of the area.

In the block of counties that include most of the large deer problem area in this region, the allowable cut of aspen would probably be just about 0.8 per cent of the area per year. This would require a cut nearly twice as great as at present. Probably anything less than this will not adequately improve or sustain deer range carrying capacity. This must also be accompanied by an antlerless take approximately equal to the annual buck kill, or the gain in carrying capacity will be forfeited.

REFERENCES CITED

- Bartlett, I. H. 1938. Whitetails, presenting Michigan's deer problem.
Mich. Dept. Conserv., Game Div., Lansing. 64 pp.
- _____. 1949. Deer and snow. Mich. Conserv. 18(1):3-5, 23-25.
- _____. 1950. Michigan deer. Mich. Dept. Conserv., Game Div.,
Lansing. 50 pp.
- Bersing, O. 1956. A century of Wisconsin deer. Wisc. Conserv. Dept.,
Madison. 184 pp.
- Blouch, R. I. 1961. Winter deer mortality on two private hunting clubs.
Papers Mich. Acad. Sci. 46:277-287.
- Burt, W. H. 1946. The mammals of Michigan. Univ. Mich. Press,
Ann Arbor. 288 pp.
- Campbell, J. G. 1963. Personal correspondence, April 15.
- Cheatum, E. L. 1949. Bone marrow as an index of malnutrition in deer.
N. Y. State Conservationist. 3(5):19-22.
- _____ and C. W. Severinghaus. 1950. Variations in fertility of white-
tailed deer related to range conditions. Trans. N. Am. Wildl. Conf.
15:170-189.
- Dahlberg, B. L. and R. C. Guettinger. 1956. The white-tailed deer in
Wisconsin. Wisc. Conserv. Dept., Tech. Wildl. Bull. No. 14. 282 pp.

- Davenport, L. A., D. F. Switzenberg, R. C. Van Etten and W. D. Burnett.
1953. A study of deeryard carrying capacity by controlled browsing.
Trans. N. Am. Wildl. Conf. 18:581-596.
- Dice, L. R. 1943. The biotic provinces of North America. Univ. Mich.
Press, Ann Arbor. 78 pp.
- Duvendeck, J. P. 1957. Oak management and acorn crop forecast for deer
in Michigan's Lower Peninsula. Mich. Dept. Conserv., Game Div.,
Rept. No. 2156. 5 pp. mimeo.
- Eakle, D. 1963. Personal correspondence, May 20.
- Eberhardt, L. 1960. Estimation of vital characteristics of Michigan
deer herds. Mich. Dept. Conserv., Game Div., Rept. No. 2282.
192 pp. mimeo.
- _____ and R. C. Van Etten. 1956. Evaluation of the pellet group count
as a deer census method. J. Wildl. Mgmt. 20(1):70-74.
- Fernald, M. L. 1950. Gray's manual of botany. 8th ed. American Book
Co., New York. 1632 pp.
- Findell, V. E., R. E. Pfeifer, A. G. Horn, and C. H. Tubbs. 1960.
Michigan's forest resources. U. S. Forest Serv., Lake States Forest
Expt. Sta., Paper 82. 46 pp.
- French, C. E., L. C. McEwen, N. D. Magruder, R. H. Ingram, and R. W. Swift.
1956. Nutrient requirements for growth and antler development in
the white-tailed deer. J. Wildl. Mgmt. 29(3):221-232.

- Graham, S. A. 1954. Changes in northern Michigan forests from browsing by deer. Trans. N. Am. Wildl. Conf. 19:526-533.
- Grange, W. B. 1949. The way to game abundance. Chas. Scribner's Sons, New York. 365 pp.
- Habeck, J. R. and J. T. Curtis. 1959. Forest cover and deer population densities in early northern Wisconsin. Trans. Wisc. Acad. Sci. 48:49-56.
- Hayne, D. W. and L. Eberhardt. 1952. Notes on the estimation of survival rates from age distributions of deer. Mich. Dept. Conserv., Game Div. 11 pp. mimeo.
- Horn, A. G. 1962. Pulpwood production in Lake States counties, 1960. U. S. Forest Serv., Lake States Forest Expt. Sta., Paper 84. 28 pp.
- Jenkins, D. H. 1961. Deer in 1961. Mich. Dept. Conserv., Game Div., Info. Circ. 125. 14 pp. mimeo.
- _____. 1962. Deer in 1962. Mich. Dept. Conserv., Game Div., Info. Circ. 127. 15 pp. mimeo.
- _____ and I. H. Bartlett. 1959. Michigan whitetails. Mich. Dept. Conserv., Game Div., Lansing. 80 pp.
- Johnson, H. E., R. D. Curtis, and R. I. Blouch. 1963. Island deer studies. Mich. Dept. Conserv., Game Div., Job Completion Report D-1, Pittman-Robertson Project W-95-R-6. 13 pp. mimeo.

Kellogg, R. 1956. What and where are the whitetails?, pp. 31-55.

In Taylor, W. P. The deer of North America. Stackpole Co.,
Harrisburg. 668 pp.

Lauckhart, J. B. 1950. Determining the big-game population from the
kill. Trans. N. Am. Wildl. Conf. 15:644-650.

Leopold, A., L. K. Sows, and D. Spencer. 1947. A survey of over-
populated deer ranges in the United States. J. Wildl. Mgmt.
11(2):162-177.

Leopold, A. S. 1950. Deer in relation to plant succession. Trans. N.
Am. Wildl. Conf. 59:571-578.

_____, T. Riney, R. McCain, and L. Tevis, Jr. 1951. The Jawbone deer
herd. Calif. Dept. Nat. Res., Div. of Fish and Game, Game Bull.
No. 4. 139 pp.

Maguire, H. F. and C. W. Severinghaus. 1954. Wariness as an influence
on age composition of white-tailed deer killed by hunters. N. Y.
Fish and Game J. 1(1):98-109.

Martin, H. M. 1955. Map of the surface formations of the southern
peninsula of Michigan. Mich. Dept. Conserv., Geol. Surv. Div.,
Publ. 49.

McCain, R. 1948. A method for measuring deer range use. Trans. N. Am.
Wildl. Conf. 13:431-441.

Pfeifer, R. E. 1961. Michigan pulpwood production-1960. Mich. Dept.
Conserv., Forestry Div., Rept. 4/61. 11 pp. mimeo.

- Quinney, D. N., C. Chase, and A. G. Horn. 1957. Timber resources, Mio block, Lower Peninsula, Michigan. Mich. Timber Resources Reports, Coop. Forest Survey, Mich. Dept. Conserv., Lansing. 48 pp.
- Rogers, G., O. Julander, and W. L. Robinette. 1958. Pellet-group counts for deer census and range use index. J. Wildl. Mgmt. 22(2):193-199.
- Ruch, L. C. 1962. Rifle River Area deer season 1962. Mich. Dept. Conserv., Game Div., Rept. No. 2406. 12 pp. mimeo.
- Ryel, L. A. 1959a. Technical report on the 1959 dead deer searches. Mich. Dept. Conserv., Game Div., Rept. No. 2242. 49 pp. mimeo.
- _____. 1959b. Deer pellet group surveys on an area of known herd size. Mich. Dept. Conserv., Game Div., Rept. No. 2252. 25 pp. mimeo.
- _____. 1961. 1960 regular season deer kill estimates. Mich. Dept. Conserv., Game Div., Rept. No. 2335. 2 pp. mimeo.
- _____. 1962. Technical data on the 1962 deer pellet group surveys. Mich. Dept. Conserv., Game Div., Rept. No. 2397. 64 pp. mimeo.
- _____ and L. D. Fay. 1962. Deer biological data, 1961-1962. Mich. Dept. Conserv., Game Div., Rept. No. 2387. 26 pp. mimeo.
- _____ and C. L. Bennett, Jr. 1962. Results of 1962 dead deer surveys. Mich. Dept. Conserv., Game Div., Rept. No. 2379. 4 pp. mimeo.
- _____, L. D. Fay, and R. C. Van Etten. 1961. Validity of age determination in Michigan deer. Papers Mich. Acad. Sci. 46:289-316.

Severinghaus, C. W. 1949. Tooth development and wear as criteria of age in white-tailed deer. J. Wildl. Mgmt. 13(2):195-216.

_____, H. F. Maguire, R. A. Cookingham, and J. E. Tanck. 1950.

Variations by age class in the antler beam diameters of white-tailed deer related to range conditions. Trans. N. Am. Wildl. Conf. 15:551-568.

_____ and E. L. Cheatum. 1956. Life and times of the white-tailed deer, p. 57-186. In Taylor, W. P. The deer of North America, Stackpole Co., Harrisburg. 668 pp.

Shantz, H. L. and R. Zon. 1924. Natural vegetation. U.S.D.A. Atlas of Am. Agr. 29 pp.

Swift, E. 1946. A history of Wisconsin deer. Wisc. Conserv. Dept., Publ. 323. 96 pp.

Taylor, W. P. 1956. The deer of North America. Stackpole Co., Harrisburg. 668 pp.

U. S. Fish and Wildlife Service. 1962. Big game inventory for 1961. U.S.D.I., Bur. Sports Fish. and Wildl., Wildl. Leaflet 446. 4 pp.

Veatch, J. O., L. R. Schoenmann, and J. W. Moon. 1924. Soil survey of Roscommon Co., Michigan. U.S.D.A., Bur. Chem. and Soils. Soil Surv. Rept., No. 27. 27 pp., map.

_____. 1959. Presettlement forest in Michigan (map). Mich. State Univ., Dept. Resource Develop., E. Lansing.

- Verme, L. J. 1962. Mortality of white-tailed deer fawns in relation to nutrition. Proc. 1st Deer Disease Symposium, Univ. Georgia, Athens. 1:15-32.
- Westell, C. E., Jr. 1955. Ecological relationship between deer and forests in lower Michigan. Proc. Soc. Am. Foresters Ann. Meet. 130-132.
- _____. 1956. Deer, club country, and industry. Mich. Conserv. 25(6):12-15.
- _____. 1958. A forest and wildlife management plan for the Mid Forest Lodge Club. Unpublished report, Packaging Corp. of Am., Am. Boxboard Div., Filer City, Mich. 67 pp. mimeo.
- _____. 1960. The ecology of deer and aspen in lower Michigan. Univ. Mich. Unpublished Ph. D. thesis.
- White, T. 1963. Interview, Houghton Lake, Mich., August 29.
- Whitlock, S. C. and L. Eberhardt. 1956. Large-scale dead deer surveys: methods, results and management implications. Trans. N. Am. Wildl. Conf. 21:555-566.
- Zehngraff, P. J. 1949. Aspen as a forest crop in the Lake States. J. Forestry. 47:555-565.