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SOME SOURCES OF ERROR IN USING PELLET-GROUP COUNTS FOR CENSUSING DEER[1, 2]

ROBERT C. VAN ETTEN, U. S. Fish and Wildlife Service, Trenton, New Jersey

CARL L. BENNETT, JR., Michigan Department of Conservation, Research and Development Section, Lansing

Abstract: The validity of the assumption that all pellet groups within sample plots are found and aged correctly was tested by checking two game biologists' ability to find and age pellet groups in the field. The biologists differed significantly in their ability to make accurate counts, but both made errors of missing groups and calling *new* groups *old.* Observations on the persistence of pellet groups deposited at different times of the year and in different cover types for 5 years, 1953–57, indicated that some pellet groups can persist at least 5 years, with a few appearing similar to new groups even 2 years after being deposited.

Sample counts of deer pellet groups are being used in several states to obtain information about deer populations. The Michigan Department of Conservation uses such data from large-scale pellet surveys (Eberhardt 1957) to estimate the average overwintering population of white-tailed deer (*Odocoileus virginianus*).

Observations in Michigan and elsewhere on both white-tailed and mule (*Odocoileus hemionus*) deer have shown that deer defecate about 13 groups of pellets daily (Rasmussen and Doman 1943:376, McCain 1948:439, Eberhardt and Van Etten 1956: 74). If the number of deer pellet groups in representative sample areas and if the period of time when the pellet groups were deposited can be determined accurately, then it is possible to compute the average population of deer on the area during the defined period. Eberhardt and Van Etten (1956) reviewed this method by comparing estimates of the size of deer herds, as computed from pellet-group counts, with the known number of deer in two Michigan deer enclosures for 3 years.

This paper attempts to evaluate the assumption of Eberhardt and Van Etten (1956) that observers locate and correctly identify all pellet groups. Large errors in estimates of deer populations could result if (1) all pellet groups upon the sample plots are not recorded, or (2) if observers fail to determine accurately those pellet groups dropped during the deposition period. This study tested the method under usual field conditions, examining specifically (1) the types and frequency of errors made by observers, and (2) the persistence of pellets in different habitats.

[1] A contribution from Pittman–Robertson Projects Michigan W-70-R and W-96-R.

[2] The senior author initiated and conducted this study. The junior author did the statistical portion and aided in preparation of the manuscript.

THE STUDY AREA

This study was conducted in the Upper Peninsula of Michigan at the Cusino Wildlife Experiment Station near Shingleton, in a mile-square deer enclosure described by Eberhardt and Van Etten (1956). Briefly, the enclosure is surrounded by a deer-proof fence and contains a fairly representative sample of Upper Peninsula deer range—hardwoods (68 percent), mixed conifers (9 percent), and grassland (23 percent). The conifer swamps form the nucleus of the winter yarding area, but deer use the entire area throughout the fall, early winter, and spring.

METHODS

Accuracy of Pellet-group Counts

Sample areas were 1/50-acre circular plot, similar to those used at that time by the Michigan Department of Conservation for wide-scale deer pellet-group censuses; 306 of these plots were located systematically in clusters of two, 100 feet apart, every 5 chains along a system of grid lines. Rows of plots were 10 chains apart and covered the entire enclosure. The time period used in Michigan to determine overwintering populations is from the average date of deciduous leaf fall in the autumn to the date of the survey early the following spring, shortly after the snow melts. In 1955, prior to leaf fall and the first snow, the senior author searched each circular plot several times and located and described each pellet group by compass angle and distance from the plot center, making every effort to retain the natural aspects of the group. Checks were spaced to cover the leaf fall period until the leaf mat was well established.

The following spring (1956), two experienced game biologists not connected with the previous fall's survey counted all pellet groups found on 293 (88 and 205 plots, respectively) of these permanent plots (13 plots were under deep water). Located groups were classified as *old* (pre-leaf fall) or *new* (post-leaf fall) from appearance, and the groups were so marked by different colored metal disks. The location of each group was also recorded on a form designed for that purpose.

The senior author and an aide immediately began a second search of each 1/50-acre plot to locate any groups that had been overlooked on the first spring survey. He then compared the recorded groups with the information collected the previous fall to determine the accuracy of pellet-group aging by the two game biologists.

Persistence of Pellets and Pellet Groups

Locations of 318 pellet groups were marked, starting during the summer of 1953 (123 groups were summer and pre-leaf fall, 195 were post-leaf fall) and re-examined at irregular intervals for varying periods up to 5 years. The pellet groups were permanently located soon after deposition, using numbered stakes. At each site the nature of the surroundings was noted, including ground moisture, ground cover, degree of shading, and the nature of the overstory. The marked pellet groups were examined each spring or early summer, and a record was made at every examination of each group of the date, shape, color, and size of pellets; the state of decomposition; the number of pellets in each group; and the age as judged from appearance. Groups deposited in summer were observed closely during their first year to determine the initial phases of decomposition. Observations were discontinued on most groups as soon as they became completely covered by leaves or other vegetation.

RESULTS

The first spring check of the 293 plots resulted in a total of 682 pellet groups, while the recheck using the previous fall's records indicated a total pellet-group deposition of 869 pellet groups for the study period from leaf fall to the first spring survey.

Table 1 shows the number and kind of mistakes made by the two biologists in their survey. The number of pellet groups missed, new groups called old minus old groups called new, and miscellaneous errors produced a composite reduction in total groups equal to 22 percent of the total number of new groups actually present. The lapsed time between the first spring survey and the resurvey was generally less than 1 percent of the total deposition period, eliminating the presence of any significant number of new groups in the interim.

Forty-three percent of the mistakes in the first spring check involved missed pellet groups, and most of these groups were considered visible and valid by the senior author. An additional 45 percent of the mistakes were calling groups old which actually had been deposited after leaf fall and should have been tallied as new. Many of these misidentifications were caused by a number of rapidly deteriorating late autumn pellet groups consisting largely of the coarse remains of black cherries (*Prunus serotina*). This food changed the general composition of such pellets from what is normally expected. It is our opinion that if observers relied strictly on the position of a pellet group in relation to the leaf litter, instead of upon the general appearance of the pellet group, many such mistakes would not be made.

Minor sources of errors resulted from calling old groups new and failing to separate the pellets of one group from those of another. Some errors of this type must be expected, especially on trails or in deer-yards where many pellet groups are present in small areas.

A small percentage (6.5) of the pellet groups were difficult to identify or had disappeared from the plots at the time of the first spring survey and the recheck. These groups were completely covered or in such poor condition that they did not appear to have been deposited since leaf fall.

The errors fell into two classes: those tending to reduce the total count of the survey (negative errors) and those tending to increase the total count of the survey (positive errors). The negative errors, groups missed plus new groups called old, were much more frequent, making the resulting survey an underestimate.

Table 1. Mistakes in the determination of age and number of deer pellet groups during the 1956 spring survey in Michigan as determined by the recheck, based on total pellet groups examined.

TYPES OF ERRORS	PERCENTAGE OF TOTAL ERRORS	
	Subtotal	Total
New pellet groups missed		42.9
Recorded in autumn—evident but not counted in spring	7.8	
Recorded in autumn—difficult to identify or missing in spring	6.5	
Not previously recorded—evident in spring	28.6	
Pellet groups judged old when new		45.3
Recorded in autumn—evident but misidentified in spring	11.0	
Not recorded in autumn—evident in spring	34.3	
Pellet groups called new when recorded as old		6.5
Miscellaneous errors		5.3
Porcupine pellets called deer pellets	2.0	
One group called two	3.3	
Negative error		88.2
Positive error		11.8

Table 2. The number of post-leaf-fall deer pellet groups visible in the Cusino Enclosure, Michigan, 1953–57. The number of pellet groups judged new in the second spring are in parentheses.

	Springs			
	First	Second	Third	Fourth
Cover type				
Swamp	35	15(1)	7	0
Hardwoods	98	49(1)	19	8
Hardwoods and conifers	34	19(0)	11	6
Open	28	21(5)	14	4
Ground moisture condition				
Wet	26	7(1)	1	0
Moist	50	26(1)	15	4
Dry	116	76(5)	44	23
Light condition				
Abundant	31	26(3)	19	10
Some	61	31(2)	15	7
Little	90	47(3)	26	9

The two observers, when their data were tested with the Mann-Whitney *U* test (Siegel 1956:116–126), were significantly different at the 1 percent level ($Z = 5.167$) in their abilities to obtain an accurate count. It was suspected that the number of mistakes made may have been influenced by the total number of groups present on any one plot. The percent counted (some over 100 percent) per plot for all plots having new groups was calculated by dividing the biologist's count of new groups by the actual number present, and these percentages were then arrayed under columns headed in an ascending rank of numbers of new groups where the denominator of the percent and the column header were the same.

This array was then tested using the Kruskal–Wallis one-way analysis of variance (Siegel 1956:184–194) with the null hypothesis that the K samples came from the same population; that is, they were tested to find if the proportion of groups counted to total groups present remained constant. If no difference was found between the different categories, then either all counts were 100 percent or the number of mistakes made was dependent on the number of groups present.

If a difference was found, then the proportion was not constant, and therefore, the number of mistakes made was independent of the number of groups present. The resulting *H* values (4.467 and 101.438) suggested that one observer had been so influenced while the other had not been. Another Kruskal–Wallis test was applied to the data of the observer whose count had not been influenced by the number of groups present on a plot to ascertain if the number of mistakes made differed between cover types. The *H* value (7.718) was important, though not significant. A similar test could not be run for the first observer because the number of pellet groups present on a plot depended upon the cover type; the greatest numbers of groups found per plot were in cedar swamps.

Because of the field techniques involved, further statistical tests on these data did not seem appropriate, and no valid index values could be calculated owing to the large differences between observers.

Persistence of Post-leaf-fall Pellet Groups

Deer pellet groups persist for varying periods of time under different conditions of overstory, degree of wetness of the site, and probably the amount of light falling upon the pellet group. The influence of these three factors is felt through their effects on the rates of deterioration and bacterial decay of pellet groups.

The number of pellet groups visible in each of four springs following their original discovery and recording is listed in Table 2 with regard to cover type, ground moisture, and light conditions. Because of a recording error, the number of pellet groups listed as visible in the first spring in the ground moisture and light condition categories

does not add up to 195, and cross-referencing of the number of pellet groups visible in particular springs between cover type, moisture, and light conditions is not exact. Definitions of the terms describing the subgroups within cover, moisture, and light condition categories are as follows:

Cover type

- Hardwoods—deciduous trees, usually a leafy mat on the ground.
- Swamp—moist conditions, usually in cedar, spruce, balsam, or alder swamps.
- Hardwoods and conifer—mixed woodland, sometimes having quantities of balsam, hemlock, and pine, with ground cover different from that normally found under hardwoods.
- Open—areas having few or no trees or shrubby overstory.

Ground moisture

- Wet—extremely moist conditions, as found in most swamp types.
- Moist—some ground moisture, as under dense hardwood, and lowland areas having layers of humus.
- Dry—little ground moisture, as found in open, semiopen, and many sandy upland hardwood areas.

Light condition

- Abundant—little or no tree or shrub overstory.
- Some—a partially open canopy.
- Little—a closed canopy with little direct sunlight reaching the ground.

During the second spring after deposition, 53 percent of all *winter* groups were still visible, and the senior author judged that 7 percent would have been considered new by qualified personnel. During the third spring, 26 percent of the groups studied were visible; however, the senior author judged that none would have been considered new. Ninety pellet groups, of which 20 percent were still uncovered, were observed for a fourth year. A small number of pellet groups under heavy cover remained solid after 5 years.

Winter pellet groups in swamps and deciduous hardwoods tended to disappear more quickly than in mixed hardwood–conifers or the open. Forty-three percent of the pellet groups in swamps and 50 percent under deciduous conditions were visible the second spring. In contrast, 56 percent of the groups in mixed hardwood–conifers and 75 percent of those in open places were visible the second spring. Generally, groups in wet areas were covered more quickly or deteriorated more rapidly than those on dry sites, 27 versus 66 percent. On dry sites where the vegetation was generally less dense, pellets often appeared hard and impervious to water and persisted for many years in a relatively unchanged condition. Pellet groups in open areas and exposed to light were more evident in the second spring than were those located in the shade.

Ground cover was an important factor in the length of time deer pellet groups remained evident. Since pellet groups deposited in the winter persisted for a number of years, ground cover and litter were important in distinguishing old groups from new. Table 3 characterizes 184 new pellet groups as to the type of litter on which they were found. At least 58 percent of all pellet groups found on grass, bracken fern and grasses, coniferous needles, and mosses and herbs were evident the second spring while less than 52 percent deposited on leaves or leaves and herbs were evident the second spring. Presumably, this is simply related to the amount of dead vegetation added to the surface litter each year. Patric and Bernhardt (1960) came to the same conclusion from their study in New York.

Different species of mosses tended to cover pellet groups at different rates. Groups deposited on *Sphagnum* sp. disappeared by midsummer of the first year when the moss grew over the groups. Pellet groups deposited on slow-growing mosses in dry, open sites, however, often persisted unchanged for a number of years.

Persistence of Pre-leaf-fall Pellet Groups

Interest in pre-leaf-fall pellet groups stems from the frequency with which they are confused with new pellet groups in the spring surveys.

During the spring of 1954, 32 percent (Table 4) of the 123 summer-deposited pellet groups were still evident, and 13 percent of these were judged sufficiently well preserved to be classified as new groups by experienced observers. Few pellet groups remained evident until the second spring, and all appeared old. In general, summer pellet groups deposited under dry, open grassy conditions persisted until spring more readily than those deposited in shady, moist, and covered conditions. These are the same factors which determined the relative durability of pellet groups deposited during the winter.

Table 3. The number of post-leaf-fall pellet groups by ground cover types visible in the Cusino Deer Enclosure, Michigan, 1952–57. The number of pellet groups judged new in the second spring are in parentheses.

Ground Cover Types	Springs			
	First	Second	Third	Fourth
Grasses	10	6(0)	3	1
Bracken fern and grasses	12	9(2)	6	3
Coniferous needles	24	17(0)	12	6
Mosses and herbs	34	20(3)	15	5
Leaves and herbs	49	25(0)	14	5
Leaves	55	23(3)	10	5

Table 4. Longevity of summer (pre-leaf-fall) deer pellet groups in the Cusino Deer Enclosure, Michigan, 1953–55. The number of pellet groups judged new in the subsequent spring are in parentheses.

	Summer Pellets	Visible		
		First Fall	First Spring	Second Spring
Cover type				
Swamp	3	3	2(1)	1
Hardwoods	99	84	25(2)	0
Hardwood–conifers	6	5	1(1)	
Open	15	13	11(1)	1
Ground moisture				
Wet	3	3	1(0)	0
Moist	26	26	8(3)	1
Dry	86	70	29(2)	2
Light condition				
Open	28	25	17(1)	1
Some	33	27	8(2)	0
Little	54	47	14(3)	2

DISCUSSION

It would appear from the evidence presented that the technique of determining deer populations through pellet-group surveys is a failure before it ever begins, but we do not believe this to be altogether true.

The two biggest errors, groups missed and new groups called old, could be reduced by using a plot shape that could be more readily searched, by using two experienced observers to check each other's findings, and by using the position of groups upon the litter as the age criterion.

Through intensive instruction which emphasizes the errors that can be made, the pellet-group survey can be a useful tool.

In Michigan we now use rectangular 1/50-acre plots, 72.6 feet long, 12 feet wide, and divided in half longitudinally. Two men search each plot by starting from opposite ends and on opposite sides. All

groups found are marked. As each man completes his assigned half-plot, he crosses over and double-checks his partner's half-plot (Bennett 1964).

From the results of this study it is also apparent that even with improved techniques, the average-use estimate would probably be conservative.

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EFFECT OF AN INTENSIVE CLEANING ON DEER-BROWSE PRODUCTION IN THE SOUTHERN APPALACHIANS

LINO DELLA-BIANCA, Southeastern Forest Experiment Station, U. S. Forest Service, Asheville, North Carolina
FRANK M. JOHNSON, U. S. Fish and Wildlife Service, Asheville, North Carolina (Deceased)

Abstract: The objective of this study was to determine the effects of an intensive cleaning on browse production. All woody stems except selected crop trees were removed from a dense, 11-year-old hardwood sapling stand which developed after a clearcut. Significantly more browse occurred in treated than in untreated stands. Treated lower slopes contained 10 times more browse than upper ones (805 to 81 pounds per acre), but untreated stands had only 3 pounds per acre on both slope positions. A high-quality, mixed hardwood stand resulted, and a significant increase in browse production occurred.

In the southern Appalachians, past cutting practices have resulted in poor reproduction of desirable hardwood species. Dense canopies and relatively undisturbed conditions also severely restrict the amount of browse produced. Under these conditions, it is difficult, if not impossible, to regenerate stands of desirable intolerant hardwoods in the presence of deer.

Research to develop management techniques which would provide desirable forest regeneration and create adequate levels of deer browse was conducted on the Pisgah National Forest by Morriss (1954) and Ripley and Campbell (1960). They concluded that a heavy harvest cut leaving an adequate number of seed trees would provide acceptable tree regeneration and sufficient browse for deer.

When these newly regenerated stands reached the sapling stage, however, browse was out of reach of deer and crop tree growth was greatly reduced. Development of management techniques which would