MICHIGAN DEPARTMENT OF CONSERVATION
Game Division

Report No. 2164
December 30, 1957
Copy Number 11

Combined Deer Population Estimates

Attached are copies of 17 rough charts used to outline a possible new approach to measuring deer population levels. The charts were used in a preliminary discussion held in Lansing on December 20 which was attended by a number of people from the Lansing office and Messrs Black, Blouch, Boyce, McBeath, and Ryel. Mr. Ruhl has asked that the charts, and a brief discussion, be duplicated and made available to those concerned for further study. There will probably be a further discussion of this subject at the forthcoming Game Division "School" in January.

I would like to emphasize the point that the figures and methods used here are preliminary and will undoubtedly be revised considerably in the near future. There are several statistical problems which must be solved before we can thoroughly appraise the value of this method. In order to avoid confusion in the future, we are numbering each copy of this report and will try to recover all of the originals when a more detailed report is prepared.

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Charts Used For Game Division Staff Meeting---December 20, 1957

Chart 1

PROBLEM

Develop reliable deer population figures subject to these conditions:

(1) Reasonable cost
(2) Must apply to small areas; but state-wide also.
(3) Must be current; i.e., should apply to populations at time regulations are set.
(4) Must be reasonably reliable.

USES OF ESTIMATES

Present
(1) Public relations and regulations
(2) Research on other factors (weather, range, etc.)

Future
Basis for optimum harvest of deer herd.

Chart 2

OBJECTIVES

1. Use most of available data to produce unified picture of deer herd.
2. Evaluate reliability of this system.
3. Improve existing sources of information and/or add new sources without increasing overall costs (man-power).

SOURCES OF DATA

Checking stations	Highway kills	Roadside counts
Mail surveys	Pellet-group surveys	Mortality surveys

Chart 3

PELLET GROUP COUNTS

1. Satisfactory from sampling standpoint.
2. Can be tested on areas of known population.
3. Flexible; can be used state-wide or on small areas.
4. Can be used by limited number of skilled people---does not need to depend on inexperienced or biased observers.
5. Potential for improvement.

THUS MEET SOME OF REQUIREMENTS FOR A GOOD METHOD BUT:

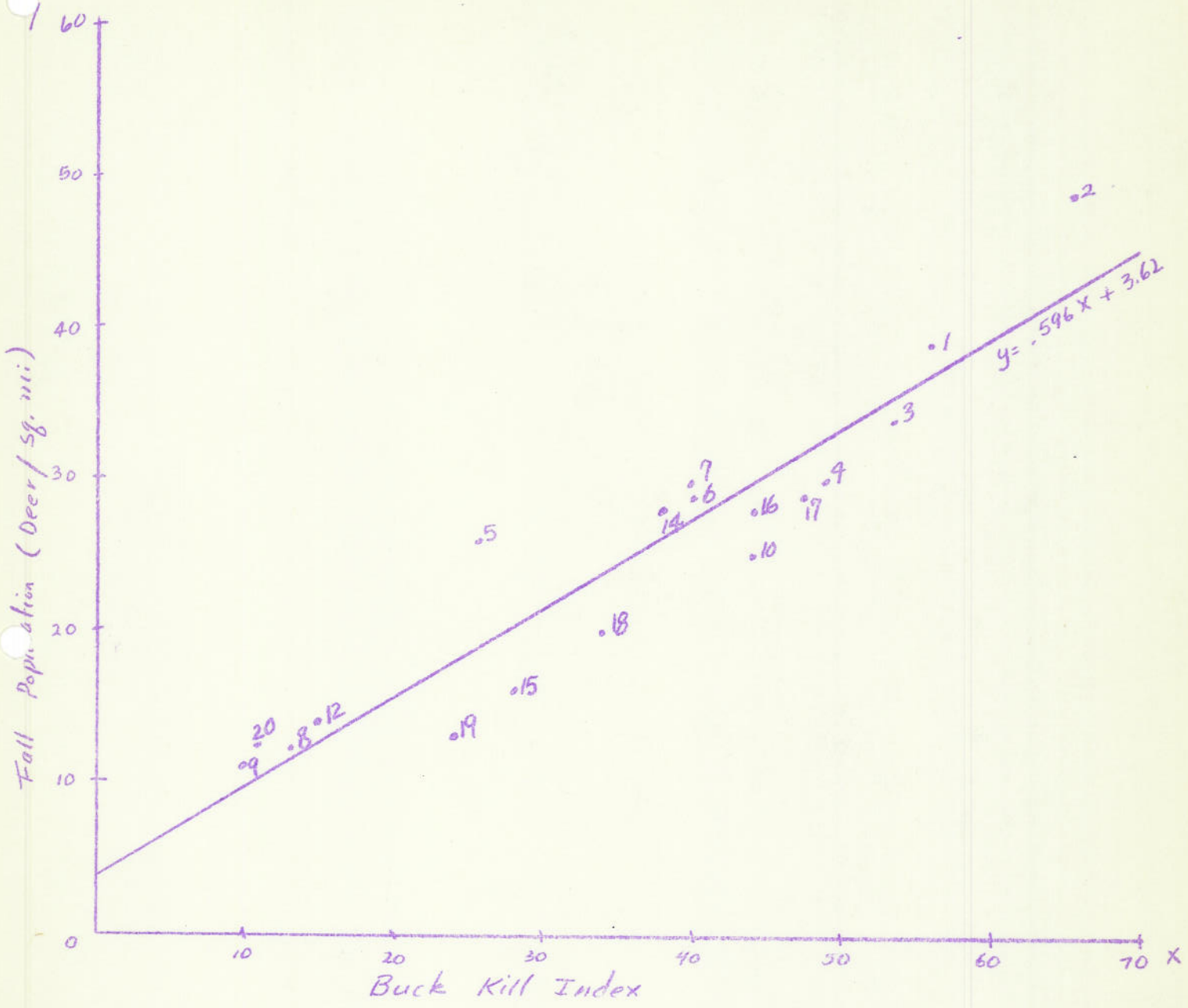
1. They are expensive.
2. They are not current (in August).

Chart 4

BASIS FOR PROPOSED POPULATION SURVEY METHOD

1. Use the reliable but expensive pellet-group count in conjunction with inexpensive methods which are available on a state-wide basis.
2. Use the pellet-group count to "calibrate" the other methods; i.e., convert indices to population estimates.
3. Use pellet-group counts as a basis for combining the other estimates to provide a single estimate for a given area.
4. Use pellet-group counts as a standard for improving other methods.

Chart 5.



The left hand scale on this graph is based on spring pellet-group counts. These counts have been adjusted for hunting harvest and for over-winter losses (including illegal kill in the hunting season). The horizontal scale is based on the regular season deer kill supplemented by information on antlerless deer (from summer deer counts) and age data from checking stations. There are 18 points on the chart, each representing a pellet-group count on a different area, or on the same area in different years. The line (regression line) shows the average relationship between the pellet-group counts and the "buck kill index" on these areas. Thus the regression lines might be used to convert an index value to a population estimate. Seven charts like this have been prepared for seven different indices. On each chart the fall population (pellet-group counts) will be the same but the index (horizontal scale) will be different.

Chart 6

AVAILABLE POPULATION INDICES (STATE-WIDE)

Hunting Data	Weight	r
Regular Season	7.19	.94
Special Seasons		
Subsequent	4.76	.91
Concurrent	?	?
Archery	1.54	.66
Camp	1.16	.55
Other Sources		
Summer Deer Counts	2.95	.84
Highway Kill	1.30	.64
Mail Carrier Counts (Summer)	.90	.07

The seven different indices are shown here. The column headed "weight" shows a measure of the relative value of each index for predicting deer populations. This is a measure of the deviations of the individual points away from the average line as shown on the graph on the previous page. In other words, the larger the weight the closer these points come to falling on the line. The smaller the weight the wider the scatter of these points so that a prediction based on the line would be less reliable. The column headed "r" shows the correlation coefficient. A correlation coefficient of 1 would indicate a perfect relationship or, in other words, all the points would fall on a line. There is some uncertainty about these coefficients since the pellet-group count areas were not selected at random. Probably the most useful figures shown on this chart are in the column headed "weight."

This chart shows that the regular season index is apparently the best for predicting fall populations, followed by subsequent season hunting data (which is not available state-wide as are the other figures), and then by the summer deer counts. Information from mail carrier counts is apparently worth very little.

Chart 7

REGULAR SEASON KILL INDEX

A. Use of Supplemental Information:

	Weight	r
1. None	2.75	.83
2. Ratio of bucks: other deer from summer deer counts	4.67	.90
3. Ratio and hunter density	4.83	.91
4. Ratio and % 1½ yr. olds in kill	5.29	-
5. Ratio and estimate of % shot	7.19	.94

$$\text{Index} = \left(\frac{\text{Buck kill}}{\text{Proportion Shot}}\right) \times \left(\begin{array}{l}\text{Ratio all deer to}\\ \text{bucks from summer}\\ \text{deer counts (4 months)}\end{array}\right)$$

PROBLEMS:

1. Assumptions used in estimating % shot are of uncertain validity.
2. Validity of mail survey data.
3. Concurrent season deer in mail surveys.

Possible Improvements

1. Increase sample size.
2. Find better methods of estimation.
3. More efficient mail surveys.

The first part of this chart shows how various combinations of supplementary information add to the value of the regular season kill index. The buck kill alone has a smaller weight than the summer deer counts, but adding information on the ratio of antlerless deer to bucks (obtained from summer deer counts), and an estimate of the proportion of bucks shot (from age data and mortality surveys), brings the value up to more than twice the weight of the summer deer counts.

Chart 8

SPECIAL SEASON KILL INDEX

Present data are for subsequent season areas only. A number of pellet counts will be required to prepare an index for concurrent areas.

SUMMER DEER COUNTS

Combinations	Weight	r
All four months	1.06	.43
July and August	1.82	.73
July alone	2.95	.84

ARCHERY KILL

Supplemental data

None	1.54	.66
Hunter density	1.44	-

Here the "weight" values of several combinations of months in the summer deer counts show that apparently July alone is more reliable than all four months together. This might indicate that we should stop recording deer seen in the other three months, but we should investigate two things before doing this: (1) The ratio of antlerless deer to bucks used in preparing the buck kill index may require more than one month's data. (2) The variability among the four months should be studied from the many years of records available as a supplement to this information which is based just on the four years for which we have pellet counts.

Chart 9

CAMP KILL

Supplementary data

	Weight	r
None	1.08	.45
Camp permit sales	1.16	.55

HIGHWAY KILL

None	1.08	.49
Traffic Volume	1.30	.64

MAIL CARRIER COUNTS (Summer)

None	.90	.07

Possibly measurements of weather may serve for improvement (supplemental data).

Spring mail-carrier counts presently are worthless but show promise of improvement if spring break-up dates taken into account.

The camp kill weight, while small, is based on less than 200 mail survey reports. It may be advisable to increase the mail survey on camp deer, possibly to include all permits. The same goes for archery except that archers kill very few deer so that they might well contribute more information about populations if we ask them to report deer seen while hunting and test such records as an index to population level.

The highway kill index might be improved by attempting to improve the collection and recording of kill information, and by getting better data on traffic volumes.

Mail carrier counts do not show a good enough correlation with fall populations to be worth using in their present form. However, a detailed study of the routes and winter conditions may improve the correlations to the point where they are worthwhile.

Chart 10

DISTRICT 7--1956

FALL POPULATION
(in Deer/sq. Mile)

Index	Population Estimate	Weight
Buck kill	26.1	.369
Special season	27.9	.244
July count	23.8	.151
Archery kill	34.3	.079
Camp kill	26.2	.055
Highway kill	28.1	.055
Mail carrier count	26.6	.047
		1.000

Weighted average = 27.0 deer per sq. mi. in District 7.

As described above, each of the seven indices can be used to estimate fall populations in an area, but they have varying degrees of reliability. This chart shows how an average value might be obtained from the seven indices. The first column shows a population estimate for each index and the second column gives the relative weight assigned to each index on the basis of the weights obtained from the regression lines. The over-all average is a weighted average so that the less reliable indices (mail carrier counts, for example) have very little effect. Actually only the first three indices shown here contribute any worthwhile amount of information about the fall populations. Probably the only reason for using the other four is as some sort of protection against something going wrong with the first three. Also the statement that we use seven indices certainly has some public relations value. The question of just how to combine these indices will require a great deal of study before we actually use them in combined form. The close agreement of most estimates from the seven indices here is certainly encouraging.

Chart 11

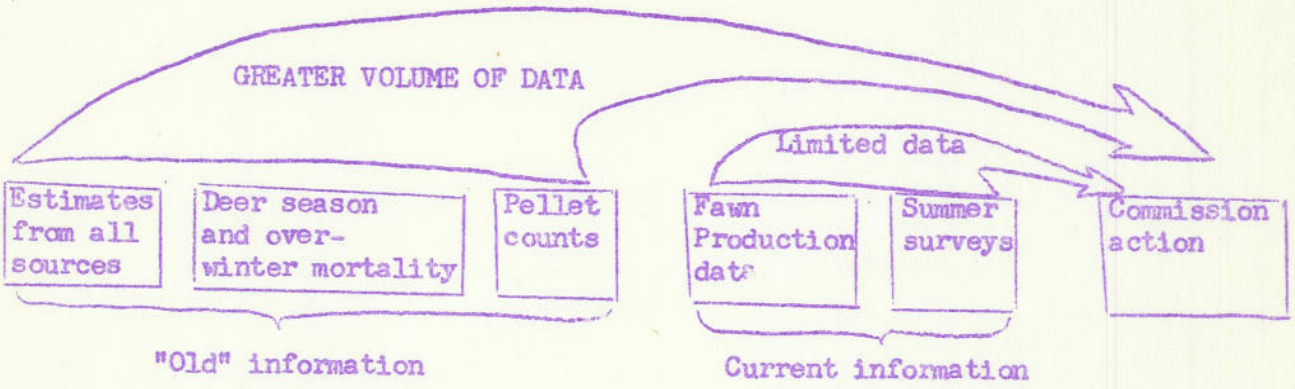
PRELIMINARY ESTIMATE OF FALL POPULATION

(Deer per square mile)

District	1955	1956
1	23	21
2	25	24
3	26	28
4	25	26
5	22	20
6	15	14
7	29	27
8	16	18
9	14	14

This chart shows fall population estimates for each game management district for 1955 and 1956. These are by no means final figures and are shown here for illustrative purposes only. Again, the close agreement is encouraging. It should be noted that population estimates can be made for each county but we need to know a great deal more about the reliability of such estimates before we make any attempt to do this.

Chart 12



This illustrates one of the most serious difficulties in using our deer population data. Most of the information we have applies mainly to the fall herd. We have very little information which might be regarded as current at the time regulations are set (August).

Chart 13

REGION II BUCK HERD

Year	Pre-Season Population	Regular Season Kill	Total Buck Kill	Prop. Shot in Regular Season	Survivors to next Year	Prop. Surviving
1952	62,950	41,200	47,000	.654	14,030	.223
1953	65,980	42,500	44,300	.644	19,080	.289
1954	61,250	32,800	33,600	.535	24,330	.397
1955	63,810	41,900	41,900	.657	19,280	.302
1956	52,300	34,200	35,300	.654	14,950	.286

r	1952 Population	
0	60,300	
.00010	61,100	
.00020	61,800	
.00030	62,600	
.00035	63,000	(Approx, value from mortality surveys)
.00040	63,500	

This chart shows results of an attempt to estimate vital statistics of the Region II buck population from hunting kill records and mortality surveys. The lower portion of the chart shows estimates of the pre-season 1952 population for various values of "non-hunting mortality." The only reason for including this chart is to indicate that there are possibilities of getting population estimates which are entirely independent from the pellet survey. While we have not done much with this possibility as yet, it should be a useful partial check on pellet survey figures.

Chart 14

FAWN PRODUCTION INDEX

	1952	1953	1954	1955	1956
Alcona	1.33	.74	.84	-	.81
Crawford	1.04	1.13	.76	-	1.04
Iosco	1.20	.97	.52	-	.54
Ogemaw	1.06	.85	.74	-	.59
Oscoda	1.14	.95	.55	-	.52
Roscommon	1.23	1.56	.79	-	.52

DOE REPLACEMENT INDEX

	1952	1953	1954	1955	1956
Alcona	.48	.51	.66	-	.15
Crawford	.43	.53	.36	-	.20
Iosco	.30	.47	.44	-	.13
Ogemaw	.33	.43	.32	-	.59
Oscoda	.26	.64	.34	-	.30
Roscommon	.36	.57	.35	-	.21

Figures shown here are based on age composition of deer shot in special seasons. Again the purpose of the chart is to illustrate data which can be used to supplement population estimates from pellet counts and the various indices.

Charts 15, 16, and 17

SOME PROBLEMS IN USING THE POPULATION INDICES

A. Overall considerations

1. How reliable are the predictions of population size? This, of course, is one of the major problems in the use of these indices. We can consider two sources of error; bias, and sampling or "chance" errors. If the bias errors are constant from year to year they may not cause us any serious trouble. That is, we might operate very successfully without actually knowing true deer populations. The matter of sampling error is one that can, in many cases, be handled by increasing sample sizes. However, we do not as yet, have the necessary statistical theory for determing the sampling errors. Two procedures for measuring sampling error need to be considered. They are:

   (a) Measure the intemel variability from the data at hand.

   (b) Test reliability of actual predictions of the deer kill in future years.

2. We need to develop better methods of converting the indices to population estimates. For example the straight line shown on the graph quite possibly should be a curve. Development of better methods of estimation will require considerable statistical analysis.

3. Eighteen pellet count areas have been used so far on this study, but actually 20 areas were available, two of which do not seem to fit in with the other 18 so they were left out in preliminary work. Before any direct applications of this study can be made it will be necessary to find out why these two areas differ from the other 18. Other wise, we take the serious risk of running into the same situation in the future. This error could occur in predicting the population on an area where we do not have a pellet count so that the prediction could be very bad without our knowledge.

4. We need to relate cost of the various sources of information on deer populations to their value in predicting populations. We may find it advisable to drop some of these indices and put more effort into others.

5. It seems certain that we will need to continue to make pellet counts to strengthen the basis for converting indices to population estimates. We do not, as yet, know how large an area the pellet counts should cover, nor what sampling rate should be used.

6. We possibly should consider developing other population indices. These might include track and shining counts, aerial counts, records of deer seen while hunting (obtained by mail surveys) and some way of relating drive counts to the pellet counts.

7. Possibly the most important over-all problem is to maintain some sort of "quality control" on the entire process. If we put all of the available information into some system which will provide a single, unified picture of the deer herd, this will necessarily be a very complex process. A mistake any place in the system could jam up the whole works.

B. Pellet Counts

1. Possible Biases. There are a number of possibilities for biased estimates from pellet counts. We need to maintain repeated checks on areas of known populations and continue to study such factors as "aging" pellets found in areas of scanty leaf-fall.

2. Errors in Counting. We have found that even the most experienced people tend to miss pellet groups. A system of rechecks has been necessary and will probably have to be continued.

3. Allocation of Effort. Most effective use of counts on sample plots requires some system to decide how many plots to take at one location as contrasted to the number of locations visited. There are good ways of doing this but their application is complicated by the necessity for rechecks.

4. Improved Stratification. We probably can get better results from the pellet counts if we look for ways of doing a better job of stratification. This might include using cover maps, aerial photos, etc.

5. Change in Method. The introduction of the system of rechecking sample plots in 1956 means that the basic data for this study were obtained from two different methods. It will be necessary to study the data on our 20 units to determine how important this change in method is, that is, how much of the overall variability is due to the change.

6. Corrections for Deer Removal. We need to study the possibilities for improving these corrections, since they also probably contribute to the variability from the regression lines.

C. Mail Surveys

1. Sample Size. We need to know how much of a reduction in sampling errors will result from increasing the size of our mail surveys.

2. Validity. There is a possibility that some hunters may report falsely on their hunting success. If this varies from area to area or year to year it will also effect the reliability of our predictions. There is good evidence that many hunters do not properly report the kind of deer they shot. This poses a serious problem, especially in using concurrent season data.

3. Sampling Methods. It is quite possible that we can reduce our over-all cost of mail surveys through more effective sampling methods.

D. Summer Deer Counts

1. We have noted several instances where changes in personnel in certain counties have resulted in sharp variations in the number of deer seen.

2. Choice of Months. This has been discussed above, that is, can we use July alone for summer deer counts?

3. Improved collection of records may make the summer counts more useful, that is, we might keep the records on smaller areas and by shorter time intervals.

4. Weather conditions may have an effect on the counts so that we probably should make an attempt to see whether adjustments for temperature, rainfall, etc. might reduce the variability of the counts.