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A COTTONTAIL RABBIT LENS GROWTH CURVE FROM ALABAMA [1]

By EDWARD P. HILL III

INTRODUCTION

Use of the eye lens in aging cottontail rabbits (*Sylvilagus floridanus*) was first reported by Lord (1959). Numerous other investigations have dealt with the application of this technique. Curves, more or less refined than those for the cottontail, have been used by Dudzinski and Mykytowycz (1961) working with rabbits (*Oryctolagus Cuniculus*) in Australia, Kolenosky and Miller (1962) working with pronghorn antelope (*Antilocapra americana*), Bauer et al. (1964) working with the fur seal (*Callorhinus ursinus*), Beale (1962) working with the fox squirrel (*Sciurus niger*), Montgomery (1963) and Sanderson (1961) working with raccoons (*Procyon lotor*) and Friend and Severinghaus (1966) working with white tailed deer (*Odocoileus virginianus*). Friend (1965) made a thorough investigation of factors causing variation in the technique.

More recently, Rongstad (1966) presented a growth curve with confidence limits for cottontails of Southern Wisconsin. On finding Wisconsin cottontail lenses heavier than those reported by Lord (1959)

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from Illinois, he suggested that there is perhaps a North-South lens weight gradient in cottontails. Others, Barkalow (1962) and Hill (1965), have shown the need for comparing specific areas of cottontail biology at northern and southern latitude extremes.

The purpose of the work herein reported was to evaluate the applicability, in Alabama, of aging techniques developed in the northern portion of cottontail range.

I wish to acknowledge advice and assistance from Professor Don W. Hayne and Mr. Robert E. Mason of the Southeastern Cooperative Fish and Game Statistics Project at North Carolina State University, Institute of Statistics, and Dr. Richard M. Paterson of the Research Data Analysis Laboratory at Auburn University, in handling statistical problems. My thanks to Mr. Wayne Colin and Dr. Maurice F. Baker for critically reading the manuscript.

METHODS

Eighty-four of eighty-nine cottontails used in this study were obtained as nestlings during studies of cottontail reproduction in 50′ x 50′ covered pens during 1963-1966. When 11 or 12 days of age, nestlings were tagged in each ear with a ⅝″ reflective disk attached with a No. 3 self piercing monel tag. Juvenile rabbits were caught and moved to holding pens when 20 to 30 days of age. They were usually transferred to rabbit enclosures after 40 to 60 days of age, but in some cases were transferred directly to enclosures from breeding pens.

Ages of the five oldest cottontails used in this study were estimated. Since the summer of their birth was known, a birth date of May 15, the mid-point of the breeding season, was arbitrarily assigned. The maximum possible error of this estimate is, plus or minus, three months, which is minimal when their total age is considered.

Enclosures in which known age rabbits were released varied in size from one to 12 acres. Nineteen (19) of the youngest rabbits were recovered while still in the 50′ x 50′ breeding pens. The remaining 70 were recovered from other areas in the following proportions: six from rearing pens, 25 from one-acre enclosures, 18 from a 1.6-acre enclosure, 13 from a six-acre enclosure, six from a 12-acre enclosure, and two were recovered outside but near fenced enclosures. The known age rabbits were sacrificed intermittently. Most were shot at night with the aid of a spotlight, but others were shot during daylight.

Both eyes were removed and fixed in 10 percent formalin. After 10 to 14 days in formalin, lenses were removed from the eyes and placed in two-inch, numbered, straight-walled bottles where they were held until they could be dried.

Lenses from known age and unknown age rabbits were dried in groups of approximately 100. Bottle caps and bottles containing lenses were placed in wire mesh baskets. They were dried at 80 degrees centigrade for six days in a gravity convection oven.

A series of lenses from wild cottontails of unknown age was used to determine the time needed for drying rabbit lenses. Fifty wet lenses weighing less than 300 mg. and 50 wet lenses weighing more than 300 mg. were dried and weighed at 3, 6, 7, 8, 9, and 12-day intervals.

Six-days of drying were sufficient to remove more than 99 percent of the moisture in both groups of lenses. The weight lost by six additional days of drying was .00468 percent for the larger lenses and .00623 percent for the smaller lenses.

Bottles were removed from the oven individually, the caps screwed on, and the bottles and lenses allowed to cool. Lenses were then weighed on a Mettler H4 Electronic Balance. Paired lenses were weighed separately and unless one lens was eroded or otherwise damaged, the average weight of the two lenses was used to plot the growth curve.

Methods employed by Dudzinski and Mykytowycz (1961) were used to express the lens weight data in usuable graphs and tables. These authors proposed use of the following relationship:

$$y = (c)\ 10^{\frac{b}{A+K}}$$

where: y = lens weight in mg.
c,K,b = constants fitted to data (see below)
A = age.

For the practical purpose of fitting this relationship to the observed data, this relationship is made linear by the following transformation:

$$\log_{10}(y) = a + bx$$

where: y = lens weight in mg.
a = log c (above)
b = slope
$x = \frac{1}{A+K}$
where: A = age
K = constant fitted by trial and error to minimize variance of observations about the line.

In the present study, setting the constant K equal to 36 was found through trail and error to produce the minimum deviation from linear regression. After determining values for a and b, the following prediction equation was derived:

$$y = (292.3)\ \frac{-59.885}{A + 36}$$

where: y = lens weight in mg.
A = age in days.

RESULTS AND DISCUSSION

In Figure 1 the dry weight of the eye-lenses of 89 cottontails is plotted against their age. The curve was fitted by the prediction equation mentioned earlier.

When the data plots from this curve are superimposed on Rongstad's (1966) plot of his and Lord's (1959) data, the lens weight differences for corresponding ages appear to corraborate the north to south lens weight gradient suggested by Rongstad (op. cit). There appears to be less of a gradient (differences in lens weight) from Illinois to Alabama than from Illinois to Wisconsin. The statistical validity of these apparent differences has not been tested.

The transformation of values of lens weights y into $\log_{10}$ of y and of ages x into 1/(x+36) provided the straight line shown in Figure 2. The line is of the form y=a + bx in which a and b are constants established by trial and error to give linearity.

Perhaps the most frequent use that can be made of the type information being reported is availed through an age prediction table. That is, given the weight of a dried lens, an age bracket is provided in which 95 percent of the specimens sampled can be expected to fall. Table 1 shows estimated ages and confidence intervals at the 90 and 95 percent level for lens weights at five milligram intervals based on the data used in this study.

The average breeding season for cottontails in Alabama usually extends from February 15 through August 15. The spread of litters precludes the grouping of lens weights that would otherwise occur if littering was a one time event. This in effect, widens the confidence interval used in aging rabbits born early in the breeding season.

The time of the year that collections are made influences the reliability of the technique when attempting to distinguish between young of the year and older age groups. The sooner after the end of the breeding

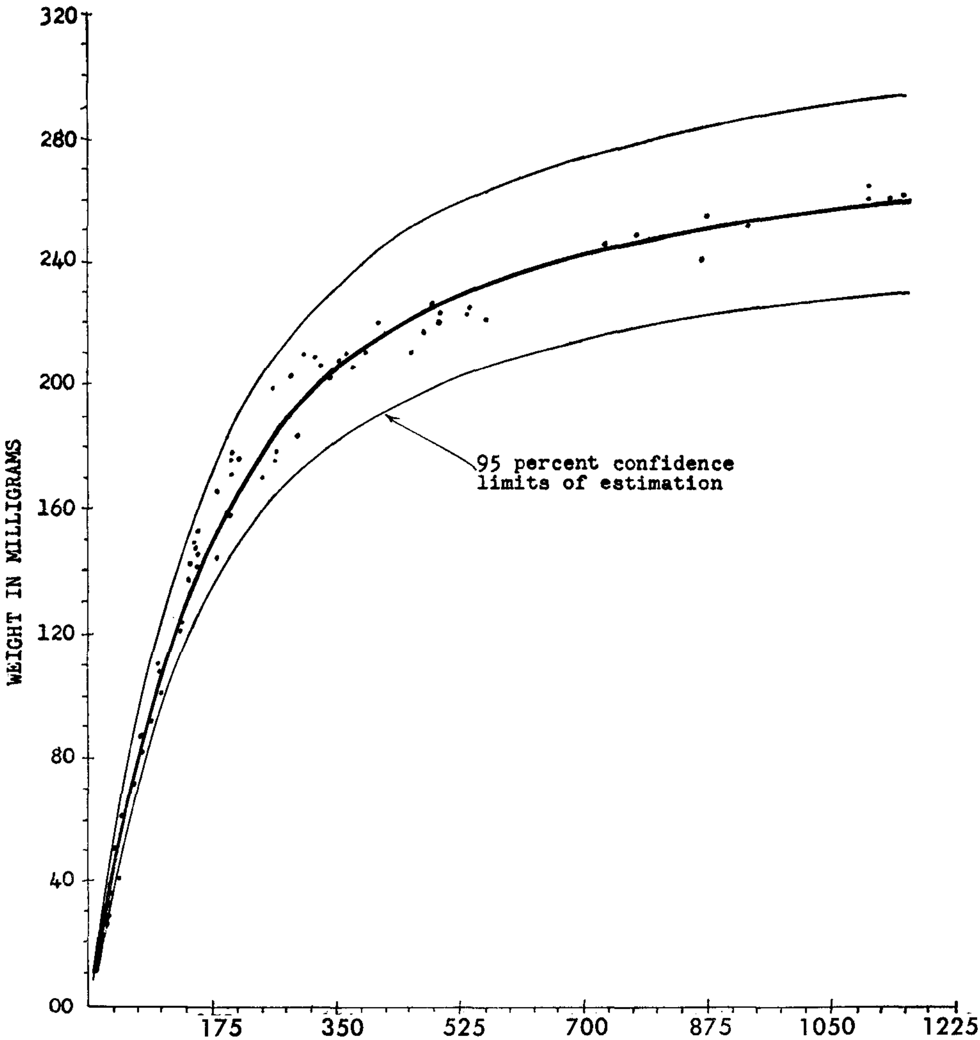

Fig. 1. Dry weight of lenses of semi-captive cottontail rabbits of known age. the heavy line is a fitted line with the equation $y = (292.3)\ 10^{-59.885/x} + 36$

season that collections can be made, the greater the reliability of the technique. Collections made November 15 would, for example, contain young of the year with a normal maximum age of eight months. The normal minimum age of rabbits in the year and half age group from the same collection would be 15 months of age. At the 90 percent confidence level there is only a small area of overlap between the year and half and young of the year age groups. Other indications of age may be used on individuals falling into the area of overlap, so that a combination of the lens technique with other aging techniques such as ossification of long bone cartilage often makes it possible to separate all young of the year from year and half age groups.

The 95 percent confidence level, usually considered standard in biological research, seems an unnecessarily high working level for some phases of wildlife research when one considers that many uncontrolled factors, any one of which may produce wide variation in population levels. Weather factors alone can influence quail and cottontail population levels as much as 20 percent from year to year. In many cases, a more usable confidence level for working with uncontrolled wildlife populations would be approximately .90 percent, and in some cases an even lower level would appear more appropriate.

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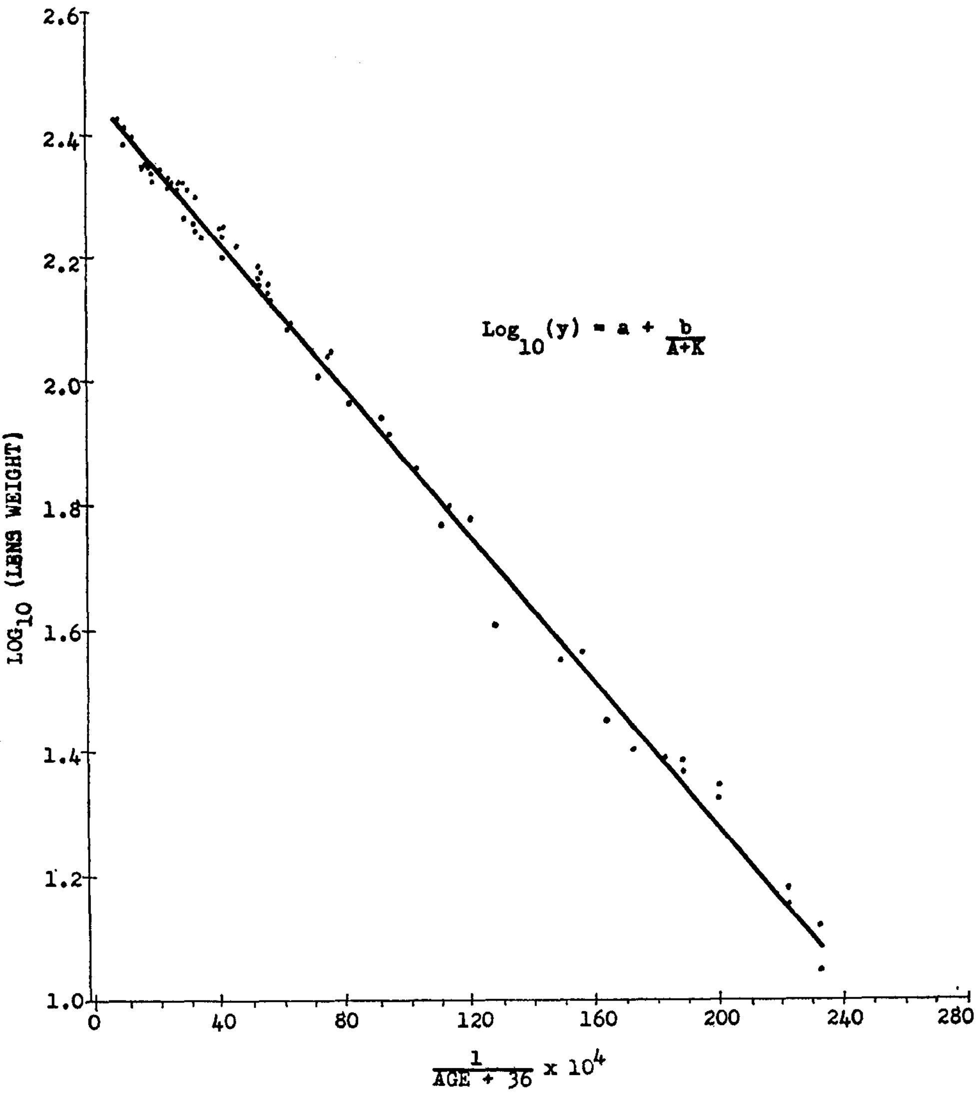

Fig. 2. Plot of $\log_{10}$ (dry weight of lens) against reciprocal of (age in days + 36).

Table 1. Estimates of age in days, 90 percent confidence limits, and 95 percent confidence limits for various lens weights based on 89 semi-captive cottontail rabbits from Alabama.

lens weight in mg.	estimated age in days	90 percent confidence interval		95 percent confidence interval		lens weight in mg.	estimated age in days	90 percent confidence interval		95 percent confidence interval	
10	4.86	3.3	5.8	3.0	6.1	140	151.42	126.8	180.2	122.9	187.4
15	10.42	8.5	11.7	8.2	12.1	145	166.80	133.8	192.9	129.7	201.0
20	15.65	13.0	17.1	12.7	17.5	150	170.79	141.3	206.7	136.8	215.8
25	20.08	17.3	22.1	16.9	22.6	155	181.33	149.2	221.7	144.2	231.9
30	24.57	21.4	26.9	20.9	27.5	160	193.00	157.5	238.1	152.1	249.7
35	28.96	25.4	31.7	24.8	32.4	165	204.67	166.3	256.2	160.4	269.4
40	33.33	29.3	36.5	28.7	37.3	170	218.52	175.6	276.1	169.2	291.2
45	37.70	33.2	41.4	32.5	42.3	175	232.88	185.6	298.2	178.5	315.6
50	42.09	37.1	46.3	36.3	47.3	180	241.37	196.2	322.9	188.5	343.1
55	46.54	41.0	51.3	40.2	52.4	185	265.44	207.5	350.8	199.0	374.3
60	51.09	45.0	56.4	44.1	57.7	190	284.31	219.6	382.4	210.3	410.1
65	55.73	49.1	61.7	48.0	63.1	195	299.13	232.7	418.5	222.4	451.4
70	60.48	53.2	67.1	52.0	68.7	200	327.71	246.7	460.3	235.4	499.9
75	65.37	57.4	72.8	56.1	74.6	205	353.34	261.9	509.2	249.3	557.3
80	70.43	61.7	78.7	60.3	80.7	210	381.81	278.4	567.3	264.4	626.7
85	75.66	66.1	84.8	64.6	87.0	215	413.52	296.4	637.2	280.8	712.1
90	81.08	70.7	91.3	69.0	93.7	220	450.08	316.0	723.3	298.6	819.9
95	86.68	75.4	98.0	73.6	100.7	225	491.11	337.6	831.7	318.0	960.3
100	92.55	80.2	105.1	78.2	108.1	230	538.99	361.5	972.5	339.4	1150.6
105	98.72	85.2	112.6	83.1	115.9	235	595.56	388.0	1162.8	362.9	1225.0
110	105.10	90.5	120.5	88.1	124.2	240	663.15	417.5	1225.0	389.0	1225.0
115	111.86	95.9	128.9	93.4	133.0	245	745.38	450.8	1225.0	418.0	1225.0
120	118.94	101.5	137.8	98.8	142.4	250	847.13	488.5	1225.0	450.6	1225.0
125	126.36	107.4	147.3	104.4	152.5	255	975.91	531.6	1225.0	487.5	1225.0
130	134.22	113.6	157.5	110.3	163.2	260	1143.53	581.2	1225.0	529.5	1225.0
135	142.50	120.0	168.4	116.5	174.8	265	1370.41	639.2	1225.0	577.8	1225.0

Confidence limits have been calculated by the Southeastern Cooperative Fish and Game Statistics Project. Age estimates were derived from the equation $y = (292.3)\ 10 - 59.885/x + 36$.

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A COMPARISON OF SOME DEER CENSUS METHODS IN TENNESSEE

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ABSTRACT

Five deer census methods are compared on the Central Peninsula deer herd in Eastern Tennessee. This insular herd is intensively managed and has several characteristics which make it worthy of population analysis. All census methods indicated similar population trends and differed only in magnitude. The Lincoln Index and Percent Kill Methods provided the most reliable estimates. The latter is the easiest to calculate,

The Sex-age Kill Method will apparently give good herd estimates, if the percent of non-hunting losses can be approximated and allowance made for other problems. It shows promise of greater accuracy when existing biases and unknowns can be omitted. For the present time the Percent Kill Method seems to be the most practical for use on the typical management area in Tennessee.

Identification of accurate and practical deer census methods continues to challenge herd managers in most of North America. A study of a confined deer herd, of known population, has not yet been possible in Tennessee. However, we have one deer herd with characteristics which make it worthy of population analysis. This herd is located in eastern Tennessee on the Central Peninsula Wildlife Management Area.

This area is a 24,831-acre peninsula located between the Clinch and Powell Rivers in the upper portion of Norris Lake. It has been in public ownership since 1934. In 1937 eleven whitetail deer were stocked there. Deer hunting began in 1950 and has always been closely regulated by the Tennessee Game and Fish Commission.

Since this deer herd is an insular population, ingress and egress of deer and humans are limited. The area manager's home is located on the