APPENDIX XI

DETERMINATION OF SAMPLE SIZES FOR CLASSIFICATIONS OF BIG GAME HERDS

Adequate sample sizes for populations of various sizes may be determined from Fig. 1. The approximate confidence intervals associated with these curves are given in Table 1.

The 2 examples that follow illustrate the use of these data to determine necessary sample sizes.

Example 1:

Biologists desire to estimate the pre-season fawn:doe ratio in a mule deer herd. Current estimates suggest approximately 3,000 does and fawns are present in the population.

Based on curve A (Fig. 1), the number of does and fawn required for the sample is 520. If the final fawn:doe ratio is approximately 70 fawns per 100 does, the 90 percent confidence interval is ±9:100, i.e., 70 ± 9 fawns per 100 does.

Assuming the sample procedure is random and unbiased, there is a 90 percent chance that the true fawn:doe ratio of the herd lies between 61 fawns per 100 does and 79 fawns per 100 does. If one desires a smaller confidence interval, then curve B or C from Fig. 1 should be selected. The sample size would be larger in both cases.

Example 2:

Biologists desire to estimate the postseason bull:cow ratio in an elk herd. Current estimates suggest there are approximately 5,000 bulls and cows in the herd.

Based on curve A (Fig. 1), the minimum recommended sample size is 560. If 560 bulls and cows are classified and the bull:cow ratio approximates 20:100, then the 90 percent confidence level from Table 1 would be 20 ±4:100. As in the previous example, “tighter” confidence intervals would require larger sample sizes refer to curves B and C (Fig. 1) and to Table 1.

Fig. 1. Recommended number of animals to be classified for estimating herd ratios at various population sizes.

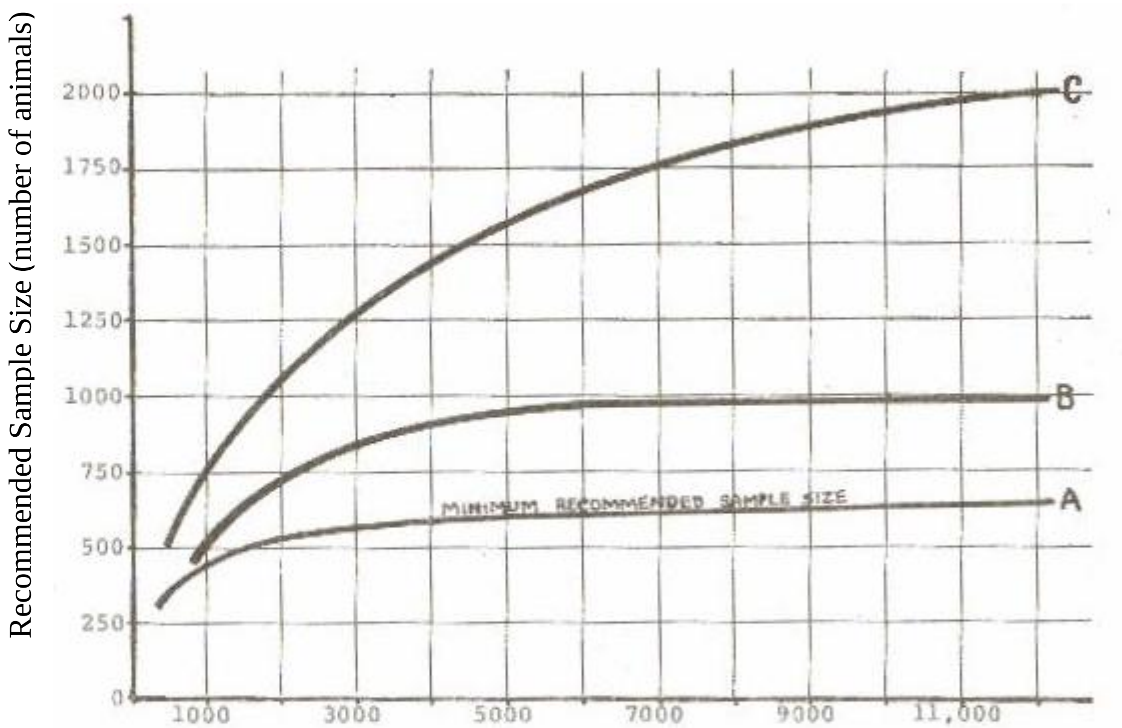

Table 1. Confidence intervals for Fig. 1 at various herd ratios at the 90% level ($\propto = 0.1$).

Curve No. from Fig. 1	20:100	40:100	50:100	70:100	100:100
A	±4:100	±6:100	±7:100	±9:100	±13:100
B	±3:100	±4:100	±5:100	±7:100	±10:100
C	±2:100	±3:100	±4:100	±5:100	±7:100

While Fig. 1 and Table 1 provide the means for determining the necessary sample size for herd classifications and allow approximation of confidence intervals, one may place a more definitive confidence interval around an estimate after the classification has been completed. The formulae needed are presented below:

$$c = t\sqrt{\frac{100a(N-n)}{(100+a)^2 Nn}} \qquad (1)$$

$$b = \frac{100c}{1 - \frac{100a}{(100+a)^2} - \frac{a}{100+a} - c^2} \qquad (2)$$

where: a = the number of animals of the first type per 100 of the second type, e.g., a = 27 if the herd ratio was determined to be 27 bucks per 100 does.

b = confidence interval size in the form a $\pm$ b:100, e.g., b = 4 and a = 27 if the confidence interval is 27 $\pm$4 bucks per 100 does.

c = confidence interval size expressed as a true proportion (calculated from equation 1).

N = estimated number of animals of the 2 classifications in the population, e.g., 2,000 bucks and does.

n = number of animals classified, e.g., 511 bucks and does.

t = value of the 2-tail t statistic for the desired probability, e.g., t = 1.645 for the 90 percent level, $\propto$ = 0.1, with n-1 degrees of freedom). If other intervals are desired, the appropriate t statistic may be found in nay statistics book.

Example:

A biologist observes 109 bucks and 502 does during an unbiased, random sample in a postseason mule deer herd classification. The herd ratio would be 109:27.1 bucks per 100 does. Therefore, a = 27.1 and n = 109 + 402 = 511. Biologists have estimated the herd is comprised of approximately 2,000 bucks and does (N = 2,000). The 90 percent confidence interval is desired; therefore, the value of t = 1.645 is used. The value of c and b are computed from equations 1 and 2 as follows:

$$c = 1.645\sqrt{\frac{(100)(27.1)(2000 - 511)}{(100+27.1)^2(2000)(511)}}$$

$$c = 1.645\sqrt{\frac{(2,710)\ (1,489)}{(16,154.41)\ (1,022,000)}}$$

$$c = 1.645\sqrt{0.0002444}$$

$c = 1.645\ (0.01563$

$c = 0.02571$

$$b = \frac{100\ (0.02571)}{1 - \frac{100((27.1)}{(100 + 27.1)^2} - \frac{27.1}{100+27.1} - (0.02571)^2}$$

$$b = \frac{2.571}{1 - \frac{2{,}710}{16{,}154.41} - \frac{27.1}{127.1} - (0.000661)}$$

$$b = \frac{2.571}{1 - 0.1678 - 0.2132 - 0.000661}$$

$$b = \frac{2.571}{0.6184}$$

$b = 4.1575$ (approximately 4.2)

Therefore, there is a 90 percent probability that the true herd ratio in this example is 27.1 $\pm$4.2 bucks per 100 does.

REFERENCES:

Czaplewski, R.L., D.M. Crowe, and L.L. McDonald. 1983. Sample sizes and confidence intervals for wildlife population ratios. Wildl. Soc. Bull. 11:121-128.