DETERMINING THE AVERAGE SIZE AND COMPOSITION OF BEAVER FAMILIES

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Abstract: A formula for determining the number of beavers (*Castor canadensis*), by age groups, in an average family is discussed. The formula is based on the assumptions that a colony has a dominant breeding pair, 1.5 years or older, as its basic unit and that the observed age distribution is a true representation of the actual population. Records on number of colonies trapped are not required.

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It is important to know the mean number of individual beavers, by age groups, in a colony so that optimum numbers can be trapped and past harvests evaluated. In addition, differences in mean colony size, which could be a result of different productivity rates, may reflect the general abundance and nutritional suitability of existing food supplies (Huey 1956, Hay 1958, Yeager and Rutherford 1957, Rutherford 1964, Longley and Moyle 1963) and possibly the social well being of individuals within the colonies.

Bradt (1938), Hay (1955), Safonov (1966) and Aleksiuk (1968) stated that a family of beavers consists of a pair of adults plus 1 or 2 litters of young. Schramm (1968) and Hodgdon (1971) each studied intensively 1 colony and found this to be true. However this important point has not been demonstrated adequately on a large scale because the techniques for aging and evaluating the reproductive condition were not available to the earlier investigators or the trapped sample was inadequate.

Shelton (1966), using live-trapped animals, attempted to arrive at total population estimates by the formula:

$$\frac{\text{Adults Present}}{\text{Adults Caught}} = \frac{\text{Total Present}}{\text{Total Caught}}.$$

He had to know the number of colonies trapped and assume there there were only 2 beavers 2.5 years and older in a colony and that only these beavers bred.

The objective of this paper is to examine a trapped sample of beavers and to develop a formula for calculating the mean size and composition of the average family during the trapping season.

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METHODS

Beavers were dead-trapped at North Bay, Ontario, by a single trapper between 22 October 1970 and 30 March 1971. The registered trapline (NB 164) lies immediately southeast of the city of North Bay. They were captured in leg-hold traps, snares, and Conibear traps. Most were taken under ice and in close proximity to an active lodge. Trembling aspen (*Populus tremuloides*) was frequently used as bait. The head and reproductive organs of each beaver were collected by the trapper along with date and location. Ages were determined by root closure and cementum layering (van Nostrand and Stephenson 1964). Ovaries and uterine horns were stored frozen and then examined for corpora lutea, corpora albicantia, uterine scars, embryos, and color and shape as evidence of previous or oncoming estrous (Provost 1958, 1962).

RESULTS AND DISCUSSION

Capture data for 341 of the 348 beavers trapped were summarized by colony. Data for the remaining 7 were lost or incomplete. No beavers were captured in 19 active colonies. Capture rate for the remaining 106 colonies varied from 1 to 10 and averaged 3.22. Kits, yearlings, and adults comprised 65, 10, and 25 percent, respectively, of the 341 beavers. Only 9 percent were older than 4.5 and maximum age was 16.5 years. Kits, yearlings, and adults were captured in 71, 28, and 61 percent of the 106 colonies.

There was no evidence that a particular age or sex class was captured more or less frequently. Furthermore, this area is rather heavily trapped, harvesting up to half of the entire population, so even if captures were non-random, we may catch more of a particular age class at first, but as that group decreases in number the other age categories would become predominant and the number of their captures would increase. Therefore I believe that the observed age distribution of our sample was a true representation of that of the actual population. Gunson (1970:72) arrived at the same conclusion in his Saskatchewan beaver study, as did Leege and Williams (1967) in Idaho. Henry and Bookhout (1969) in Ohio stated that trapping probably does not provide a true random sample. However in calculating the net rate of population increase these authors assumed that their sample was representative of the actual population.

There was no evidence for more than 1 female per family being in estrous. No case was recorded where the number of kits in a family exceeded the number of corpora albicantia or placental scars, or both. Wilsson (1971) also found that for European beavers (*Castor fiber*) only 1 female came into estrous in a colony. One colony at North Bay produced 2 females with placental scars and corpora albicantia. One observation of 2 females with placental scars and corpora albicantia was recorded in 344 colonies in other parts of Ontario. However, in neither case was there any evidence to suggest that 2 litters were produced in the same colony. The probable explanation (apart from recording error) is that traps were set away from the lodge and close to another active colony. The extra female could have come from the adjacent colony.

The maximum number of beavers 2.5 years and older captured per colony was 3 in 2 colonies for North Bay. In addition there was indirect evidence in 3 of the 106 colonies for the presence of 3 beavers 2.5 years and older. Sixteen similar observations were made from the other 344 colonies. There was no evidence for more than 3 beavers 2.5 years and older on the North Bay trapline, although there was 1 case of 4 beavers 2.5 years of age and older in 1 of the 344 families.

Female beavers 2.5 years of age and older generally assumed the dominant breeding status, although some yearling females bred successfully. Although testes were not examined, Larson (1967) and Wilkinson (1962) reported that some yearling males may achieve sexual maturity. Reproductive behaviour of yearling males was assumed to be the same as that of yearling females.

Since the age distribution from the 341 trapped beavers represents the actual age distribution, I suggest (initially simplifying the model) that the cumulative percentage of beavers 2.5 years and older, 25 percent, can be equated to the factor 2.0, as there are 2 dominant breeding individuals in a colony.

The following empirical formula would then represent the average family.

$$\frac{\%\ \text{kits} + \%\ \text{yearlings}}{\%\ \text{adults}} = \frac{N}{2.0}.$$

N is the number of kits and yearlings and 2.0 is the number of adults. Solution of this

equation yields N = 6.02. The average family group would be 2.0 + 6.02 = 8.02.

This formula is complicated by several factors:

(1) Breeding yearlings. Because of the small sample of female yearlings and because the earliest record of corpora lutea and uterine swellings was on 22 January, females 2.5 years old had to be examined for their previous year's breeding record. Of 10 2.5 year olds, 3 bred as yearlings. It would have been preferable to use current data, because the percent breeding may vary each year.

(2) Non-breeding adults. Sometimes non-breeding individuals 2.5 years of age and older may stay attached to a colony. In this study, these individuals did not breed and were referred to as socially subordinate. Since there was evidence for 3 beavers 2.5 years of age and older occurring in each of 5 colonies, and since 40 percent of the population was captured we can assume that if the total population was captured, more than 2 beavers 2.5 years of age or older would have occurred in about 12.5 of the 106 colonies, or an average of 0.12 per family.

(3) Single occupant colonies. The 26 single capture colonies involved 2 male and 2 female kits, 1 male and 4 female yearlings, and 9 males and 8 females 2.5 years of age or older. Kits would not be living alone since they do not start dispersing till the following spring (Novak, unpublished data, Gunson 1970). Six of the 8 females 2.5 years and older were captured during the breeding season and all had bred or were going to breed, indicating that a mature male had to be present. Since the sex ratio of those 2.5 years and older was not significantly different from a 50:50 ratio, it is reasonable to assume that we would find that the males captured during the breeding season would show spermatogenesis if testes had been examined. Nothing definite can be concluded about the yearlings. Wilsson (1971) pointed out the necessity of beavers continually interacting socially with other beavers or their keeper and that single beavers held in captivity often do not do well. Although this evidence is circumstantial I do not believe that any colonies contained only a single occupant. Gunson (1970) considered that single occupant colonies did occur.

Incorporating the first 2 factors in the empirical formula and assuming no single occupant colonies, I derived the following formula:

$$\frac{\%\,\text{Kits} + \%\,\text{Yearlings} - \%\,\text{Breeding Yearlings}}{\%\,\text{Adults} + \%\,\text{Breeding Yearlings}} = \frac{\text{N}}{2.0 + \text{Non-breeding Adults}}.$$

Substituting in this formula, N = 5.47. Therefore, in the 106 colonies where beavers were captured, the average family unit was 2.12 + 5.47 = 7.59 and the total population was 805 of which 348 (43%) were captured. The average colony had 4.94 kits (mean placental scar count from 11 females was 4.82), 0.53 non-breeding yearlings, 0.23 breeding yearlings and 1.89 individuals 2.5 years and older.

This technique can be of value to the game manager in assigning harvest quotas or evaluating the effects of past harvests. Used together with reproductive data estimates can be made of kit mortality during summer, and of overall mortality other than from trapping. The limitations, as with most techniques, are in obtaining an adequate sample size, primarily of reproductive material. For some areas in Ontario harvests from several trappers may have to be combined to increase sample size. The most complicated variable is the yearling breeding component. This appears to be a func-

tion of previous trapping intensity. Further work may clarify this relationship. Additional work is required to see if single occupant colonies do occur under certain conditions before trapping commences.

It may not be necessary to collect and analyze teeth to obtain the age statistics needed for this formula. The percentage of kits in a trapper's harvest can be derived with high accuracy (Novak, unpublished manuscript) provided different pelt size criteria are used for different habitats. A good approximation of the percentage of yearlings can also be made from pelt measurements even though there is always some overlap with older beavers.

LITERATURE CITED

ALEKSIUK, M. 1968. Scent-mound communication, territoriality, and population regulation in beaver (*Castor canadensis* Kuhl). J. Mammal. 49(4):759–762.

BRADT, G. W. 1938. A study of beaver colonies in Michigan. J. Mammal. 19(2):139–162.

GUNSON, J. R. 1970. Dynamics of the beaver of Saskatchewan's northern forests. M.S. Thesis. Univ. of Alberta. 122pp.

HAY, K. G. 1955. Development of a beaver census method applicable to mountain terrain in Colorado. M.S. Thesis. Colorado State Univ. 143pp.

———. 1958. Beaver census methods in the Rocky Mountain region. J. Wildl. Manage. 22(4):395–401.

HENRY, D. B., AND T. A. BOOKHOUT. 1969. Productivity of beavers in northeastern Ohio. J. Wildl. Manage. 33(4):927–932.

HODGDON, H. E. 1971. Some sexual differences in behaviour within a marked beaver colony. M.S. Thesis. Univ. of Massachusetts. 68pp.

HUEY, W. S. 1956. New Mexico beaver management. New Mexico Dept. Game and Fish Bull. No. 4. 49pp.

LARSON, J. S. 1967. Age structure and sexual maturity within a western Maryland beaver (*Castor canadensis*) population. J. Mammal. 48(3):408–413.

LEEGE, T. A., AND R. M. WILLIAMS. 1967. Beaver productivity in Idaho. J. Wildl. Manage. 31(2):326–332.

LONGLEY, W. H., AND J. B. MOYLE. 1963. The beaver in Minnesota. Minnesota Dept. Conserv. Div. Game and Fish. Tech. Bull. No. 6. 87pp.

VAN NOSTRAND, F. C., AND A. B. STEPHENSON. 1964. Age determination for beavers by tooth development. J. Wildl. Manage. 28(3):430–434.

PROVOST, E. E. 1958. Studies on reproduction and population dynamics in beaver. M.S. Thesis. Washington State Univ. 76pp.

———. 1962. Morphological characteristics of the beaver ovary. J. Wildl. Manage. 26(3): 272–278.

RUTHERFORD, W. H. 1964. The beaver in Colorado: its biology, ecology, management and economics. Colorado Dept. Game, Fish and Parks. Tech. Bull. No. 17. 49pp.

SAFONOV, V. G. 1966. Morphological features and structure of beaver population. Translated from: Bulletin of Moscow Society of Nature Investigators, Section of Biology. 46pp.

SCHRAMM, D. L. 1968. A field study of beaver behaviour in East Barnard, Vermont. M.S. Thesis. Dartmouth College, New Hampshire. 83 + viii pp.

SHELTON, P. C. 1966. Ecological studies of beavers, wolves, and moose in Isle Royale National Park, Michigan. Ph.D. Thesis. Purdue Univ., Indiana. 284 + xvi pp.

WILKINSON, P. M. 1962. A life history study of the beaver in east-central Alabama. M.S. Thesis. Auburn Univ., Alabama. 76pp.

Wilsson, L. 1971. Observations and experiments on the ethology of the European beaver (*Castor fiber* L.). Viltrevy 8(3):115–266.

YEAGER, L. E., AND W. H. RUTHERFORD. 1957. An ecological basis for beaver management in the Rocky Mountain region. Trans. N. Am. Wildl. Conf. 22:269–300.

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