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## A COMPARISON OF FISHER REPRODUCTIVE ESTIMATES

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**Abstract:** Information on placental scars (PS) in fishers (*Martes pennanti*) is limited. We obtained data from female fishers trapped during the December fur seasons in New Hampshire (1987) and Vermont (1988). The percent of females with PS, corpora lutea (CL), and blastocysts (BC) was compared to an average natal denning rate of 60% ( $n = 25$  fisher-breeding-seasons) observed in adult ( $\geq 2$  yrs old) radio-collared females in Maine, 1984-89. Also, mean litter sizes calculated from females with CL, BC, and PS were compared to a mean of 2.8 young per observed litter ( $n = 60$ ) reported in the literature. The percent of females with PS (58%,  $n = 132$ ) more closely corresponded to the 60% of radio-collared females raising offspring than data from either CL (97%,  $n = 369$ ) or BC (83%,  $n = 355$ ). Mean litter size per pregnant female based on PS (2.7,  $n = 26$ ) also more closely corresponded to the mean from the literature (2.8) than either CL (3.7,  $n = 107$ ) or BC (3.1,  $n = 94$ ) counts. PS may be a more reliable estimate of recruitment than either CL or BC, but direct testing is needed.

**Key words:** blastocysts, corpora lutea, delayed implantation, fisher, *Martes pennanti*, placental scars.

Wright and Coulter (1967:75) reported fewer placental scars (PS) than corpora lutea (CL) in reproductive tracts of fishers and suggested this disparity was because of poor tract preservation. Payne (1982) reported that PS are not always distinct in furbearers with delayed implantation, and Douglas and Strickland (1987:515) noted that PS in fishers apparently do not always persist from spring until the following trapping season. Since 1967, studies of fisher reproduction have reported mainly the mean number and percent occurrence of CL, some information on BC, and no data on PS (e.g., Shea et al. 1985, Douglas and Strickland 1987). Shea et al. (1985) reported a 95% ( $n = 141$ ) occurrence (= pregnancy rate) of CL in female fishers from Maine, and Douglas and Strickland (1987) found a 97% ( $n = 1,173$ ) occurrence in Ontario. In contrast, telemetry studies in Maine from 1984-1989 determined that on average, only 60% (range: 0-100%) of females  $\geq 2$  yrs old denned and raised young ( $n = 12$  females over 25 fisher-breeding-seasons) (Paragi 1990, Arthur and Krohn 1991).

The number of offspring produced annually (recruitment rate) is a function of pregnancy rate and litter size (Payne 1982). Both of these variables have been estimated from ovarian data and used to model fisher populations (e.g., Douglas and Strickland 1987:524-525). Because of the disparity between pregnancy rate based on CL versus the natal denning rate from telemetry, the objective of this paper was to compare the percent of females with CL, BC, and PS to the rate measured by telemetry. In addition, we compared mean litter sizes from CL, BC, and PS counts to a mean reported in the literature based on observed litters. Based on these comparisons, we recommend specific re-search.

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## METHODS

The New Hampshire Fish and Game Department provided carcasses of female fishers collected during the trapping season in December 1987. Frozen juvenile ( $\leq 0.8$  yrs of age) females were identified from the extent of coalescence of skull muscles (Wright and Coulter 1967:82) and excluded. We examined radiographs of lower canine teeth (Jenks et al. 1984) and discarded additional juveniles, leaving a sample of 19 yearling (1.8 yrs) and 31 adult ( $\geq 2.8$  yrs) females. New Hampshire fishers were stored frozen for 13-14 months and thawed at room temperature for 16 to 22 hours prior to examination of reproductive tracts.

The Vermont Department of Fish and Wildlife provided the reproductive tracts from 9 yearlings and 51 adult female fishers taken during their December 1988 season; juveniles were identified on the basis of skull musculature and excluded from the sample. Vermont fishers were frozen for about 4 months, thawed, and reproductive tracts were removed and refrozen until thawed again for about 15 minutes prior to our examination.

Ages of fishers not excluded by skull characters or radiographs were determined from counts of cementum annuli of the first upper premolars (Strickland et al. 1982). A MDIFW employee prepared and determined the ages of females from New Hampshire; the Vermont sample was prepared by a commercial vendor and ages determined by several employees of the Vermont Department of Fish and Wildlife.

To determine the number of BC present, each uterine horn was flushed twice with 10 ml of water from a hypodermic needle inserted into the junction of the Fallopian tube and the uterus (Hamilton and Cook 1955). The water was collected in a petri dish and inspected for BC with the aid of a dissection microscope. Ovaries were hardened in 10% formalin for  $\geq 2$  weeks and then sectioned with a scalpel along the longest axis into about 5 to 8 sections (Wright and Coulter 1967). Transverse sections were made through CL that may have abutted in a section to see the division. CL were counted under a dissection microscope. PS were identified as dark areas on the exterior of the uterus and by longitudinally splitting the tract and viewing the interior with a dissection microscope. Unflushed BC also were identified at this time (2 were recovered). Although we use the term "placental scar," we did not histologically examine these apparent hemorrhage sites. Because fishers delay implantation, breeding in the spring and giving birth almost a year later (Hamilton and Cook 1955, Wright and Coulter 1967), reproductive tracts of autumn- or winter-caught fishers contain information on 2 reproductive sequences.

Three fishers aged as 0 yr by annuli were revised to 1.8 yrs because they had CL and BC; 6 fishers aged as 1.8 yrs were revised to 2.8 due to the presence of PS. This represents 6.7% of the Vermont and 10.0% of the New Hampshire sample. These revisions assume that fishers do not mate until  $\geq 1$  year old (Wright and Coulter 1967, Shea et al. 1985, Douglas and Strickland 1987).

We recorded postmortem degeneration of the reproductive tracts. Color (light or grey, or dark), degree of desiccation, and stretching of the tract from water pressure during BC flushing were used as indicators of the amount of tissue degeneration. Reproductive tracts were classified as either good (dark, little or no desiccation or stretching) or poor (light or grey, desiccated or stretched) condition. Tracts of very poor condition (light or grey and dried or stretched out) were discarded.

We used the Mann-Whitney U (Wilkinson 1989:600) to test — by state — differences in counts of each of the reproductive measures in good versus poor condition reproductive tracts. A nonparametric test was chosen because our data were not normally distributed and had unequal variances (Zar 1984). Because nonparametric tests were used, medians and modes are presented (Tacha et al. 1982). Means ( $\bar{X}$ ) and standard deviations (SD) are presented to facilitate comparison with previous studies, and because means are the statistics generally used in population models (e.g., Douglas and Strickland 1987:525). We also tested for age-class differences in counts of the three reproductive measures. We could not reliably distinguish ages past 3.8 yrs (unpub. data) so only 3 age classes were considered (i.e., 1.8 yr, 2.8 yrs, and  $\geq 3.8$  yrs). To standardize comparisons among measures, we tested differences in 1.8 yr versus  $\geq 2.8$  yrs for counts of CL and BC, and 2.8 yrs versus  $\geq 3.8$  yrs for PS counts (i.e., CL and BC at age 1 relate to PS at age 2 given that tracts contained data on 2 reproductive years).

## RESULTS

Samples of reproductive tracts in good versus poor conditions from New Hampshire did not differ in counts of CL ( $U = 288$ , 1 df,  $P = 0.82$ ), BC ( $U = 316$ , 1 df,  $P = 0.71$ ), or PS ( $U = 110$ , 1 df,  $P = 0.91$ ). Similarly, good and poor condition tracts from Vermont fishers did not differ in counts of CL ( $U = 334$ , 1 df,  $P = 0.95$ ), BC ( $U = 260$ , 1 df,  $P = 0.17$ ), or PS ( $U = 254$ , 1 df,  $P = 0.85$ ). Thus, data from tracts in good and poor condition were pooled within states.

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CL counts of yearlings (1.8 yrs) differed from adults ( $\geq 2.8$  yrs) in New Hampshire ( $U = 146$ , 1 df,  $P = 0.01$ ) but not Vermont ( $U = 156$ , 1 df,  $P = 0.11$ ) (Table 1). BC counts also differed in yearlings versus adults in New Hampshire ( $U = 172$ , 1 df,  $P = 0.02$ ) but not Vermont ( $U = 191$ , 1 df,  $P = 0.41$ ). Mean counts of CL and BC were higher in adults than yearlings from both states. In contrast, samples of PS did not differ in 2.8 yr olds versus  $\geq 3.8$  yr olds in either New Hampshire ( $U = 135$ , 1 df,  $P = 0.33$ ) or Vermont ( $U = 355$ , 1 df,  $P = 0.29$ ) (Table 1).

Modes and medians, respectively, of the three measures in pregnant females (i.e., females with at least one of the respective measures) in New Hampshire and Vermont were consistent between states: 4 and 4 for CL, 3 and 3 for BC, and 3 to 4 and 3 for PS (Table 2). When all females were considered, however, modes and medians for CL and BC data remained unchanged, but went to 0 for PS because only 48% ( $n = 31$ ) and 22% ( $n = 51$ ) of females from New Hampshire and Vermont, respectively, had PS (Tables 2 and 3). Percent of females in New Hampshire and Vermont with CL were 100 and 95 and with BC were 90 and 83, respectively (Table 3).

### DISCUSSION

Mean number of CL and BC were both 15 to 30% higher in adults ( $\geq 2$  yrs) than yearlings within each state. Similar age-related effects have been reported for CL counts by Shea et al. (1985) and Douglas and Strickland (1987). More significant to this study, however, is that mean CL and BC counts per all females were 107 to 580% greater than PS counts per all females within states (Table 2). This indicates that age-related effects have a minor impact relative to the measure used to estimate recruitment. Thus, the key issue is whether or not PS counts are a more reliable estimator of recruitment than CL or BC. To be useful in population modelling, a recruitment estimate must reliably measure both birth rate and mean litter size.

Paragi (1990:52-54) reported no evidence that radio-collaring affected denning rates, and thus we believe 60% to be a reasonable mean estimate of percent of females  $\geq 2$  yrs old giving birth (assumes negligible post-parturition mortality). Fifty-eight percent ( $n = 132$ ) of adult females from New Hampshire, Maine, and Ontario (Vermont excluded; see last footnote, Table 3) had PS; this percentage more closely corresponded to the 60% denning rate observed in radio-collared fishers than did either the percent of females with CL (97%) or BC (83%) (Table 3).

Douglas and Strickland (1987) summarized the literature and reported a mean litter size based on observations of the number of young born of 2.8 ( $n = 60$ ). Mean litter size based on PS per pregnant female in New Hampshire ( $\bar{X} = 2.8$ ,  $n = 15$ ; Table 2), Vermont ( $\bar{X} = 2.5$ ,  $n = 11$ ; Table 2), and Maine ( $\bar{X} = 2.5$ ,  $n = 15$ ; Paragi 1990:69) closely corresponded to the observed mean. In contrast, mean number of CL per pregnant female was considerably higher, and BC slightly higher, in both states (Table 2) than the observed litter size of 2.8 reported by Douglas and Strickland (1987).

Thus PS appear to more accurately estimate the percent of females giving birth and litter size than either CL or BC. These findings, along with our conclusion that tissue deterioration is not a significant factor in causing low PS counts (excluding tracts of very poor condition or those exposed to multiple freezings), suggests that PS data may better estimate recruitment than data from either CL or BC. This has significant management implications because our estimate of mean litter size per all females (recruitment rate) based on PS (0.5-1.4) is much lower than traditional estimates used in population models based on CL (3.4-3.7) or BC (2.5-2.9) (Table 2).

Ideally, CL and BC counts should be compared to PS counts in the same bioclimatic region the following year because this represents a single reproductive sequence in the same area. PS counts are relatively easy to obtain from trapped animals and may be a better estimate of both pregnancy rate and litter size in wild fishers than counts of CL or BC, but discrepancies might occur because PS can form from resorbed or aborted fetuses (Payne 1982). Further studies are needed to determine if PS data reliably measure birth rate and litter size.

Scar formation and persistence should be studied in fishers with known litter sizes. Laparotomies could allow periodic viewing of implantation sites and development of young (Jonkel and Weckwerth 1963, Sanderson and Nalbandov 1973), including nulliparous adults for controls (Conaway 1955) and marking of implantation sites for later scrutiny (Larson 1967). Data are also needed on the effects of multiple freezings on PS persistence.

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**TABLE 1. MEAN ( $\pm$ SD) REPRODUCTIVE INDICES (N) BY AGE FOR FEMALE FISHERS TRAPPED IN NEW HAMPSHIRE (1987) AND VERMONT (1988).**

| Age                                          | Corpora Lutea         |                       | Blasto-cysts          |                       | Age        | Placental Scars       |                       |
|----------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------|-----------------------|-----------------------|
|                                              | NH                    | VT                    | NH                    | VT                    |            | NH                    | VT*                   |
| 1.8                                          | 3.2 $\pm$ 0.9<br>(19) | 2.9 $\pm$ 1.2<br>(9)  | 2.3 $\pm$ 1.3<br>(19) | 2.2 $\pm$ 1.5<br>(9)  | 2.8        | 1.7 $\pm$ 1.9<br>(15) | 0.8 $\pm$ 1.4<br>(21) |
| $\geq 2.8$                                   | 4.0 $\pm$ 0.6<br>(31) | 3.5 $\pm$ 1.4<br>(51) | 3.2 $\pm$ 1.1<br>(30) | 2.6 $\pm$ 1.4<br>(51) | $\geq 3.8$ | 1.2 $\pm$ 1.6<br>(15) | 0.4 $\pm$ 1.1<br>(30) |
| <i>P</i> values from<br>Mann-Whitney<br>test | .01                   | .11                   | .02                   | .41                   |            | .33                   | .29                   |

\* - Due to possible effects on PS of multiple freezing and thawing of reproductive tracts (see Methods), these data are suspect.

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**TABLE 2. FREQUENCY DISTRIBUTIONS AND SUMMARY STATISTICS OF REPRODUCTIVE INDICES FOR FEMALE FISHERS TRAPPED IN NEW HAMPSHIRE (1987) AND VERMONT (1988).**

| Indicator<br>Count                           | Corpora<br>Lutea <sup>a</sup> |                 | Blasto-<br>cysts <sup>a</sup> |                 | Placental<br>Scars <sup>b</sup> |                 |
|----------------------------------------------|-------------------------------|-----------------|-------------------------------|-----------------|---------------------------------|-----------------|
|                                              | NH                            | VT              | NH                            | VT              | NH                              | VT              |
| 0                                            | 0                             | 3               | 5                             | 10              | 16                              | 40              |
| 1                                            | 0                             | 0               | 4                             | 3               | 3                               | 4               |
| 2                                            | 3                             | 4               | 4                             | 10              | 3                               | 1               |
| 3                                            | 17                            | 21              | 19                            | 21              | 4                               | 3               |
| 4                                            | 22                            | 25              | 14                            | 15              | 4                               | 3               |
| 5                                            | 8                             | 7               | 3                             | 0               | 1                               | 0               |
| 6                                            | 0                             | 0               | 0                             | 1               | 0                               | 0               |
| $\bar{X} \pm SD (n)$                         |                               |                 |                               |                 |                                 |                 |
| Per All<br>Females                           | 3.7±0.8<br>(50)               | 3.4±1.1<br>(60) | 2.9±1.4<br>(49)               | 2.5±1.4<br>(60) | 1.4±1.7<br>(31)                 | 0.5±1.2<br>(51) |
| Per Pregnant<br>Females<br>only <sup>c</sup> | 3.7±0.8<br>(50)               | 3.6±0.8<br>(57) | 3.2±1.0<br>(44)               | 3.0±1.0<br>(50) | 2.8±1.3<br>(15)                 | 2.5±1.3<br>(11) |

<sup>a</sup> - Data from females  $\geq 1.8$  yrs of age.<sup>b</sup> - Data from females  $\geq 2.8$  yrs of age.<sup>c</sup> - Females with  $\geq 1$  of the respective measure (i.e., mean for CL based on females with  $\geq 1$  CL).

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**TABLE 3. PROPORTION OF FEMALE FISHERS FROM FOUR LOCATIONS HAVING CORPORA LUTEA (CL), BLASTOCYSTS (BC), AND PLACENTAL SCARS (PS).**

| Location<br>and year(s)                      | Pregnancy rate <sup>a</sup> |                   |                    |
|----------------------------------------------|-----------------------------|-------------------|--------------------|
|                                              | CL (n)                      | BC (n)            | PS (n)             |
| <b>Algonquin Region, Ontario<sup>b</sup></b> |                             |                   |                    |
| 1975-76                                      | 0.92 (59)                   | 0.77 (53)         | 0.43 (37)          |
| 1976-77                                      | 1.00 (17)                   | 0.83 (18)         | 0.33 (6)           |
| 1977-78                                      | 1.00 (46)                   | 0.85 (41)         | 0.57 (7)           |
| 1978-79                                      | 0.97 (95)                   | 0.78 (93)         | 0.77 (31)          |
| <b>Central Maine<sup>c</sup></b>             |                             |                   |                    |
| 1988                                         | 0.94 (18)                   | 0.83 (18)         | 0.88 (8)           |
| 1989                                         | 1.00 (24)                   | 0.87 (23)         | 0.67 (12)          |
| <b>New Hampshire<sup>d</sup></b>             |                             |                   |                    |
| 1987                                         | 1.00 (50)                   | 0.90 (49)         | 0.48 (31)          |
| <b>Vermont<sup>e</sup></b>                   |                             |                   |                    |
| 1988                                         | 0.95 (60)                   | 0.83 (60)         | 0.22 (51)*         |
| <b>OVERALL MEANS</b>                         | <b>0.97 (369)</b>           | <b>0.83 (355)</b> | <b>0.58 (132)*</b> |

<sup>a</sup> Proportion examined that had CL or BC (females age  $\geq 1.5$  yr) or PS ( $\geq 2.5$  yrs), respectively.

<sup>b</sup> CL data from Douglas and Strickland (1987: Table 8); BC and PS data courtesy of M. A. Strickland, Ont. Min. of Nat. Res. (PS counted on interior of uterine horns without magnification; Strickland cautioned that PS identification was subjective and thus subject to error).

<sup>c</sup> From Paragi (1990) using same techniques as this study.

<sup>d</sup> This study.

<sup>e</sup> Vermont PS data excluded from overall mean due to possible effects on PS of multiple freezing and thawing of reproductive tracts (see Methods).

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