Outdoor Facts

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THE RELATION OF THREE PHYSICAL CONDITION INDICES OF MULE DEER [a]

Several procedures and techniques have been developed to estimate the physical condition of wild ungulates. These methods range from gross estimates based on the general appearance of live animals (Riney 1960) to field and laboratory procedures used by Anderson et al. (1972) that utilize various measurements of carcass fat including weights of the carcass. Some of the most commonly used indices of carcass fat are: rump fat measurement (RF) as described by Riney (1955), the kidney fat index (KFI) originated by Riney (1955) and modified by Anderson and Medin (1965), and percentage of femur marrow fat (FMF) using the ether extraction-gravimetric method or the reagent-dry assay method described by Neiland (1970) and modified by Verme and Holland (1973). The visual method of estimating FMF described by Cheatum (1949) has been widely used, but for FMF content other than extemely low or extremely high values this method results in incorrect estimates in nearly 50 percent of the cases (Verme and Holland 1973, Table 1).

Table 1. Comparison of visual estimates vs. the ether extract method of determining femur marrow fat content.

Ether Extract Percent Fat	No. of Deer	Visual Estimates Percent Fat[a] 1-10	11-25	26-50	51-70	71-90	91+
1-10	9	.533[b]	.400	.067			
11-25	5	.102	.408	.428	.061		
26-50	8	.050	.188	.550	.188	.025	
51-70	13		.062	.385	.354	.200	
71-90	14			.164	.386	.450	
91+	1					.600	.400

[a]Based on 10 biologists examining 50 samples of femur marrow using the color drawings of Cheatum (1949).

[b]The underlined values indicate the proportion of correct answers.

Harris (1945), referring to mule deer *(Odocoileus hemionus)* and white-tailed deer *(Odocoileus virginianus)*, and Riney (1955) referring to red deer *(Cervus elaphus)* speculated that fat reserves were mobilized in the following order as an animal declines in physical condition: subcutaneous fat, visceral fat, and femur marrow fat. If this is true, estimation of any one of the above fat deposits by itself would not give a true picture of the overall condition of the animal.

METHODS

Samples were obtained from 49 male and 107 female mule deer killed by vehicles from a 20-mile segment of Highway 28 between Glenwood Springs and Basalt, Colorado, and a 20-mile segment of Highway 13 south of Meeker, Colorado. Collections began in November, 1968, and were terminated in November, 1971. The summer months, when road kills were at a minimum, are sparsely represented in the data (Table 2).

The technique described by Anderson and Medin (1965) was used to obtain the KFI, the procedure for measuring rump fat was taken from Riney (1955) and the percent FMF was obtained by using the ether extraction-gravimetric method. The femurs were frozen until analysis by the Colorado Division of Wildlife Research Laboratory at Fort Collins.

Individual animals were assigned to one of three age classes on the basis of tooth replacement. Animals less than 12 months old were considered fawns, animals 12 months to 23 months old were considered yearlings, and animals judged to be 24 months or older were assigned to the mature age class.

Examination of scatter diagrams of KFI versus FMF by sex, age, and season revealed overlapping patterns from one season to the next. This suggests that the year-long pattern is a continuous function and that each season represents a segment of that function. Therefore, data from four seasons are combined in Figures 1 through 4. The data from both sexes were combined because examination of the plotted points by sex did not provide evidence that the relationships of the indices were different by sex.

The KFI versus FMF relationship of the fawn age class was the only comparison that showed a visual difference from yearlings and matures and, therefore, was analyzed separately.

[a] Contribution from Federal Aid Project W-38-R

Table 2. The seasonal sample size by sex and age for each physical condition index obtained from mule deer killed by vehicles.

Index	Age Class	Season[a]	Sample Size Males	Females
KFI	Fawns	Autumn	15	11
		Winter	6	9
		Spring	5	4
		Summer	1	1
	Yearlings	Autumn	6	9
		Winter	2	3
		Spring	0	6
		Summer	2	5
	Matures	Autumn	1	14
		Winter	1	16
		Spring	1	7
		Summer	0	1
FMF	Fawns	Autumn	15	14
		Winter	7	11
		Spring	5	5
		Summer	1	2
	Yearlings	Autumn	8	10
		Winter	5	6
		Spring	2	6
		Summer	2	5
	Matures	Autumn	2	16
		Winter	1	21
		Spring	1	9
		Summer	0	1
RF	Fawns	Autumn	2	7
		Winter	6	8
		Spring	1	2
		Summer	0	0
	Yearlings	Autumn	4	15
		Winter	3	2
		Spring	2	1
		Summer	1	2
	Matures	Autumn	1	9
		Winter	0	9
		Spring	0	6
		Summer	0	0

[a]Within equinox and solstice dates: autumn = Sept. 23-Dec. 22; winter = Dec. 23-Mar. 21; spring = Mar. 22-June 21; summer = June 22-Sept. 22.

RESULTS

Rump Fat vs. Kidney Fat Index

When RF is present in a measurable amount ($\geq$1 mm) the KFI is related by the function $\hat{y}$ = 23.2 + 2.01X (Fig. 1). Although the regression is significant ($P<.05$) the correlation is weak ($r = .52$). When RF is absent the KFI is low, 8.96 ± 2.28 ($\bar{X}$ ± 2 S.E.), but not depleted. In addition, when measurable RF is absent the KFI of an individual animal will be below 20.7 ($P>.95$). The 95 percent confidence interval of the RF vs. KFI regression does not overlap the 95 percent confidence interval of the mean KFI when RF $<$1 mm, indicating that while RF is depleted some visceral fat (as measured by the KFI) remains.

Rump Fat vs. Femur Marrow Fat

When RF is present ($\geq$1 mm) there is no significant regression between RF and FMF ($P>.20$) and the FMF values are relatively high 78.3 ± 3.2 ($\bar{X}$ ± 2 S.E.) (Fig. 2). It can be said ($P>.95$) that for any particular animal the FMF will be above 62 percent if measurable RF is present. When RF is absent the FMF shows high

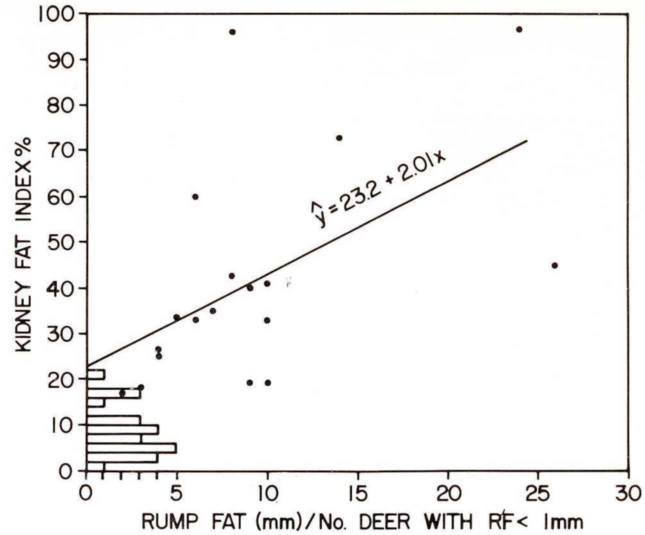

Fig. 1. Linear regression of RF measurements vs. the KFI when RF $\geq$ 1 mm and frequency distribution of KFI classes when RF $<$ 1 mm. Fawns, yearlings, and matures are included in the sample. (Graph by Graphic Arts, Colorado State University)

variability ranging from 1.7 to 84.4 percent with a mean of 42.8 ± 8.2 ($\bar{X}$ ± 2 S.E.).

From the information contained in Figure 2 it is apparent that with RF present in any amount the FMF percent is relatively constant at a high value. This shows that depth of rump fat is depleted before the percentage of fat in femur marrow.

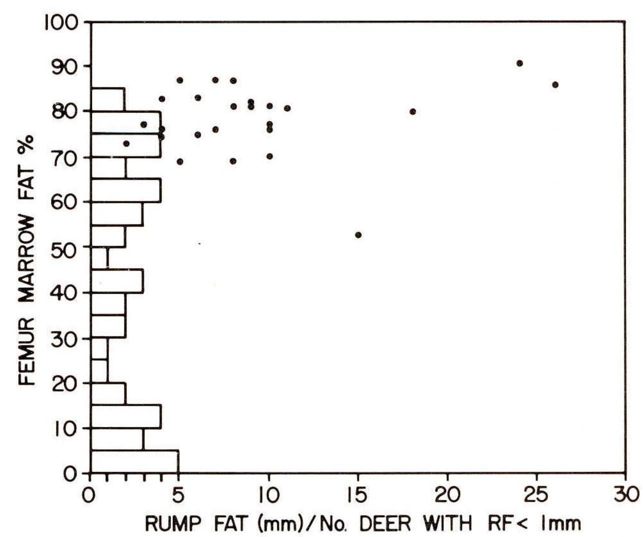

Fig. 2. Scatter diagram of RF measurements plotted against FMF percent and frequency distribution of FMF percent classes when RF $<$ 1 mm. Fawns, yearlings, and matures are included in the sample. (Graph by Graphic Arts, Colorado State University)

Femur Marrow Fat vs. Kidney Fat Index

Yearlings and matures — Figure 3 shows that when the KFI is greater than 20 the FMF is consistently high with no significant ($P>.20$) regression. The mean $\pm$ 2 S.E. is 82.8 $\pm$ 3.0 and the lower 95 percent confidence limit for individual values is 66.3, therefore, for an individual animal with KFI $>$ 20 the FMF for that animal will be 66.3 or greater ($P > .95$).

When $10 < \text{KFI} \leq 20$ the FMF decreases significantly ($P < .05$) to 73.1 $\pm$ 4.0 ($\bar{X} \pm 2$ S.E.) with the lower 95 percent confidence limit for an individual value at 52.3. As the KFI decreases to 10 or less the corresponding FMF values average 43.3 $\pm$ 10.48 ($\bar{X} \pm 2$ S.E.) which differs significantly ($P < .05$) from the FMF mean of 73.1.

The relationship between FMF and the KFI as seen in Figure 3 is very similar to that obtained by Ransom (1965) for white-tailed deer. The interpretation of Figure 3 indicates that FMF remains consistently high when the KFI is above 20 but does not drop to low values until the KFI is below 10. This is supportive evidence that visceral fat reserves (as measured by the KFI) are nearly depleted before the fat reserves of the femur marrow are mobilized to any great extent.

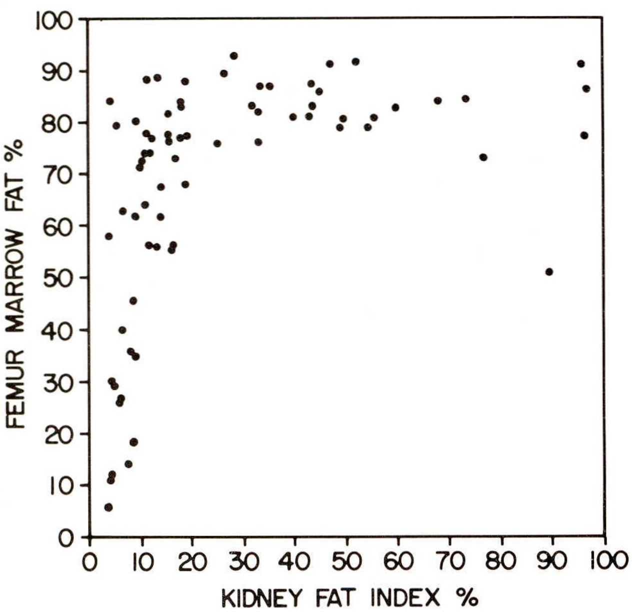

Fig. 3. Scatter diagram of KFI plotted against FMF percent of yearling and mature mule deer. (Graph by Graphic Arts, Colorado State University)

Fawns — The striking difference in the relationship between the KFI and FMF for fawns compared to yearlings and matures is that the majority of the points fall in the area below 20 and 80 on the KFI and FMF scales, respectively, (Fig. 4). For KFI values greater than 20 the FMF will exceed 43.3 percent ($P > .95$).

DISCUSSION

It appears that subcutaneous (RF) and visceral fat reserves (KFI) are mobilized concurrently but that subcutaneous fat reserves are depleted first (Fig. 1). From Figure 2 it is apparent that subcutaneous fat reserves are depleted before the FMF values begin to decline. The visceral fat reserves, as measured by the KFI, decline to a relatively low value of 20 before any noticeable decline in FMF is observed (Fig. 3). This is fairly reliable evidence that FMF is not mobilized at least until the bulk of the visceral and subcutaneous fat reserves have been utilized.

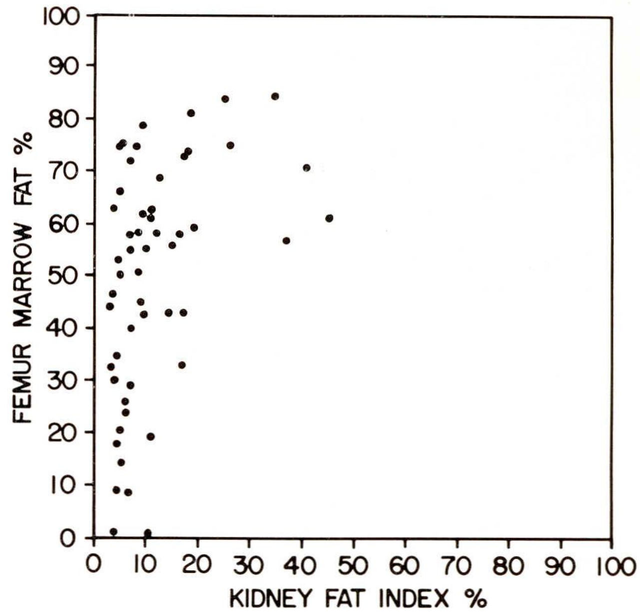

Fig. 4. Scatter diagram of KFI plotted against FMF percent of fawn mule deer. (Graph by Graphic Arts, Colorado State University)

The practical importance of the relationship of these three physical condition indices is that a true picture of the fat reserves of an animal cannot be determined by measuring only one of the indicators. If the investigator is interested only in the lower end of the physical condition scale then the FMF indicator would be most useful. The KFI would be more useful than RF measurements to monitor physical condition at the upper end of the scale mostly because it provides continuous data and lacks zero values.

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