Can ultrasound measurements be effectively used to assign body condition scores in beef cattle?

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Abstract

Relationships among body conditions score (BCS), animal age, body weight (BW, lb) and rump (RUMP) and rib (RIB) fat thickness (cm) were examined from data collected at the Dickinson Research Extension Center from November 2001 to March 2002. A total of 823 observations were taken from 416 cows (ages range from <1 year - 13 years old). Rump fat and rib fat thicknesses were estimated using ultrasonography (GE VFI-Impact, GE Medical Systems, equipped with a 6.0 mHz linear probe). Initially, cattle were classified into 5 age categories (AGE). Levels of AGE included less than two (A1), two (A2), three (A3), four to seven (A4-7) and greater than eight (A8+) years of age. BW and BCS were positively related ($P < .005$) within AGE, with the exception of A2 ($P=.22$). A unit increase in BCS resulted in a live weight increase of 34, -13, 54, 102 and 65 lb for A1, A2, A3, A4-7 and A8+, respectively. RUMP and RIB measurements increased with increasing BCS ($P < .0001$ and .07) and BW ($P < .0001$ and .001) in A1, A4-7 and A8+, but not in A2 and A3. Cattle were then reclassified into 3 new age categories (NAGE) by combining A2 and A3 (NA2-3) and A4-7 and A8+ (NA4+). Cattle less than two years of age remained in a separate level of NAGE (NA1). BCS was significantly affected by BW and RUMP in NA1 ($P < .0001$, $R^2 = .35$, SD = .60) and by BW, RUMP and RIB NA4+ ($P < .0001$, $R^2 = .54$, SD = .58). In NA2-3, BCS was only significantly affected by RUMP ($P < .001$, $R^2 = .10$, SD = .52) when BW, RUMP and RIB were considered simultaneously. When all data were combined, BCS could be predicted ($P < .0001$, $R^2 = .70$, SD = .58) using RUMP and RIB and BW within NAGE. Subjective BCS can be assigned objectively in beef cows using age, BW, RUMP and RIB. This type of procedure could prove useful in research and teaching environments where an objective assignment of a body condition score is desired.

Introduction

Most reproductive failures (Boyles et al., 1992; Herd and Sprott, 1986) and losses in overall productivity (Herd and Sprott, 1986) in beef cows can be attributed to improper nutrition that results in thin body condition at key times in the production cycle. Conversely, excessive fatness can also reduce reproductive success and overall profitability in beef operations (Boyles et al., 1992). A subjective body condition scoring system can be used to suggest relative fatness or body composition of beef cattle (Boyles et al., 1992; Herd and Sprott, 1986; Momont and Pruitt, 1988; Encinias and Lardy, 2000). This type of scoring system have been used to successfully monitor and management beef herds and is currently recommended by most beef cow consultants. The subjectiveness of these systems, however, can result in significant variation among scorers when evaluating similar animals (Herd and Sprott, 1986). The development of an objective mechanism for assigning body condition scores could prove useful in research and teaching situations were consistency in the scoring criteria is important.

Objective

To assess the relationship between body condition score and body weight and rump and rib fat measurements in female beef cattle and to determine if these factors would be useful in the development of an objective means of assigning body condition scores in beef cows.

Materials and Methods

From November 2001 to March 2002, beef cows (ages range from <1 to 13 years; Table 1) at the Dickinson Research Extension Center of North Dakota State University were used to provide data to assess relationships among body condition score (BCS) and animal age, body weight (BW, lb) and rump (RUMP) and rib (RIB) fat thicknesses (cm). Most of the data were collected during routine measurements of cattle maintained in ongoing research studies. A total of 823 observations were collected from 416 individuals (155, 115 and 146 animals had one, two or three individual observations, respectively contained in the database). Multiple measurements on any animal were made at least 28 days apart and each measurement was treated as an independent observation. As cattle were weighed during a specific trial, ultrasound (GE VFI-Impact, GE Medical Systems, equipped with a 6.0 mHz linear probe) estimates of RUMP and RIB were recorded. RUMP measurements were taken by placing the transducer approximately midway between the aitch or rump and hip bones (ischium and ilium, respectively). RIB measurements were taken by placing the transducer transversely across the 12th and 13th ribs

approximately one-half the distance between the chine and feather bones (transverse and spinous processes, respectively). Body condition scores (Encinias and Lardy, 2000) were assigned to each animal as it exited the scale. Body condition scores could range from 1 (very thin) to 9 (obese). The animal's identification number was also recorded at the time of weighing. The identification numbering system used at the Center specifies the year of birth of an animal. This information was used to assign an age in years to each animal. Thus, cattle born in 1990, 1995, 2000 and 2001 were assigned an age of 12, 7, 2 and 1 year-old, respectively.

Initially, cattle were classified into 5 age categories (AGE; Table 1). Levels of AGE included less than two (A1), two (A2), three (A3), four to seven (A4-7) and greater than eight (A8+) years of age. There were 240, 64, 99, 241 and 179 cattle in each category, respectively. Distribution of animals into AGE and BCS categories are shown in table 2. Effects of AGE and BCS on BW, RUMP and RIB were determined. Subsequently, data within AGE were sorted into six weight ranges (BWCLASS; <800, 800-1000, 1000-1200, 1200-1400, 1400-1600 and >1600 lb). Distribution of animals into AGE and BWCLASS categories are shown in table 3. Effects of AGE and BWCLASS on BCS, RUMP and RIB were determined. Similarities in the results from these two analyses were used to justify the pooling of A2 and A3 and A4-7 and A8+, creating three new age categories for further analysis (NAGE; NA1, NA2-3 and NA4+). Regression equations relating BW, RUMP and RIB to BCS were calculated within each level of NAGE. Finally, an unifying equation which included separate BW relationships within each level of NAGE and overall of effects of RUMP and RIB was calculated. Standard deviation of regression (SD), coefficient of determination (R^2) and statistical significance of model parameters were used to determine the adequacy of individual regression equations.

Conclusions

AGE effects

- BW ($P < .005$; Tables 4 and 7), RUMP ($P < .0001$; Table 5) and RIB ($P < .0001$; Table 6) increased with increasing BCS in all AGE, with the exception of N2. The magnitude of the BW increase was greatest for mature cows (A4-7 and A8+), intermediate for A3 and lowest for A1. The magnitude of RUMP and RIB were greatest for mature cows compared to younger cows (A1, A2 and A3).
- Unit increases in BCS increased BW by 34, -13, 54, 102 and 65 lb for A1, A2, A3, A4-7 and A8+, respectively.
- RUMP ($P < .07$; Table 8) and RIB ($P < .001$; Table 9) also increased with increasing BW in A1, A4-7 and A8+, but not in A2 and A3.

NAGE effects

- In NA1 ($P < .0001$) and NA4+ ($P < .0001$), BCS was quantitatively related to BW, RUMP and RIB (Table 10); however in NA2-3 ($P < .01$), BCS was only quantitatively related to RUMP and RIB.
- When BW, RUMP and RIB were considered simultaneously within NAGE, BCS was quantitatively related to BW and RUMP in NA1 ($P < .0001$), RUMP in NA2-3 ($P < .001$) and BW, RUMP and RIB in NA4+ ($P < .0001$).
- When entire data set was combined (Figure 1), BCS was quantitatively related to RUMP, RIB and BW within NAGE ($P < .0001$; Table 10). This relationship explained 70% of the total variation (Figures 2 and 3) in BCS with a SD of .58 (Table 10).

Summary

Body weight and body condition score were related in an age-dependent manner in all cows, with the exception of 2 year-old cows. In general, a unit increase in body condition score increased body weight 34, 54 and 84 lb in cows less than two, three and greater than 4 years of age, respectively. Rump and rib fat measurements increased with increasing body condition score and body weight in younger and mature cows, but not in two and three year-old cows. The differential responses of the younger cows (particularly 2 year-olds) observed in this analysis requires additional study. Body condition scores can be objectively assigned to beef cows using cow age, body weight and rump and rib fat measurements.

Implication

Subjective BCS can be assigned objectively in beef cows using age, BW, RUMP and RIB. This type of procedure could prove useful in research and teaching environments where an objective assignment of a body condition score is desired.

Reference

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Encinias, A.M and G. Lardy, 2000. Body Condition Scoring I: Managing Your Cow Herd Through Body Condition Scoring. NDSU Extension Publ. AS-1026. http://www.ext.nodak.edu/extpubs/ansci/beef/as1026w.htm

Herd, D.B. and L.R. Sprott. 1986. Body condition, nutrition and reproduction of beef cows. TAMU Extension Publ. B-1526. http://agpublications.tamu.edu/catalog/query.cgi?id=59

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Table 1. Range in body condition score (BCS), body weight (BW) and rump and rib fat within age classifications (AGE).

AGE	Mean	SD	Minimum	Maximum
A1 (N=240)				
BCS	7.2	.73	6	9
BW, lb	810.2	59.8	656	948
Rump, cm	.68	.21	.28	1.31
Rib, cm	.56	.19	.21	1.12
Age, yr	1.0	-	-	-
A2 (N=64)				
BCS	5.5	.66	4	7
BW, lb	1116.6	56.3	1016	1265
Rump, cm	.46	.17	.13	1.04
Rib, cm	.36	.10	.14	.76
Age, yr	2.0	-	-	-
A3 (N=99)				
BCS	5.2	.43	4	6
BW, lb	1190.7	80.8	994	1425
Rump, cm	.39	.15	.14	.79
Rib, cm	.33	.12	.16	.74
Age, yr	3.0			
A4-7 (N=241)				
BCS	5.7	.93	4	9
BW, lb	1373.2	142.4	1036	1830
Rump, cm	.78	.54	.09	2.86
Rib, cm	.60	.36	.11	2.50
Age, yr	4.8	.95	4	7
A8+ (N=179)				
BCS	6.0	.71	5	8
BW, lb	1441.6	113.7	1124	1760
Rump, cm	.91	.52	.20	3.11
Rib, cm	.65	.35	.14	1.84
Age, yr	9.2	1.34	8	13

Table 2. Frequency of cattle in body condition and age classes (AGE) for body weight and rump and rib fat measurements.

	AGE				
BCS	A1	A2	A3	A4-7	A8+
4		2	1	7	
5		34	77[a]	113	42
6	40	24	21	84	105
7	113	4		22	27[b]
8	83			13	5
9	4			2	

[a] One animal per group was missing a rib fat measurement.

Table 3. Frequency of cattle in body weight class (BWCLASS, lb) and age classes (AGE) for body condition score and rump and rib fat measurements.

	AGE				
BWCLASS	A1	A2	A3	A4-7	A8+
<800	109				
800-1000	131		1		
1000-1200		58	50	26	2
1200-1400		6	46[a]	113	59
1400-1600			2	87	104
>1600				15	14[a]

[a] One animal per group was missing a rib fat measurement.

Table 4. Effect of body condition score (BCS) and age classifications (AGE) on body weight (lb)[a].

	AGE				
BCS	A1	A2	A3	A4-7	A8+
4		1107	1130$^{.vw}$	1195$^{.v}$	
5		1126$^{.l}$	1179$^{.m,v}$	1299$^{.n,w}$	1372$^{.o,v}$
6	773$^{.l,v}$	1105$^{.m}$	1233$^{.n,w}$	1409$^{.o,x}$	1448$^{.p,w}$
7	800$^{.l,vw}$	1102$^{.m}$		1509$^{.n,y}$	1494$^{.n,x}$
8	838$^{.l,x}$			1596$^{.m,z}$	1586$^{.m,y}$
9	877$^{.l,wx}$			1700$^{.m,z}$	

[a] Effects of BCS and age classification and their interaction were statistically significant (P.01).

^{l,m,n,o,p} Means within a row with differing superscripts differ (P < .05).

^{v,w,x,y,z} Means within a column with differing superscripts differ (P < .05).

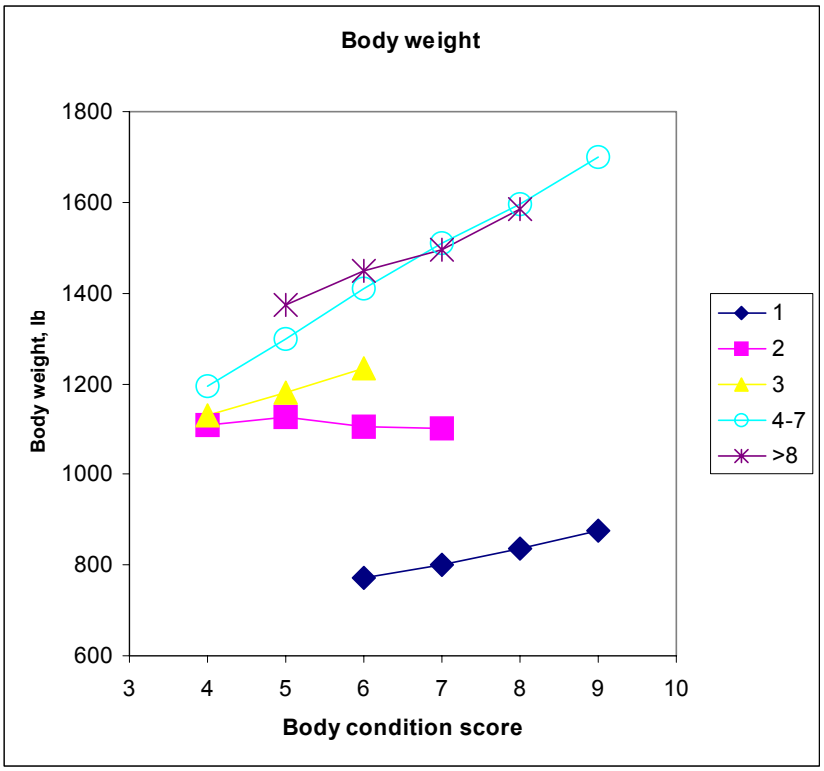

Table 5. Effect of body condition score (BCS) and age classifications (AGE) on rump fat (cm)[a].

	AGE				
BCS	A1	A2	A3	A4-7	A8+
4		.38	.38	.32^{v}	
5		.42^{l}	.37^{l}	.54^{m,v}	.63^{m,v}
6	.46^{l,v}	.48^{l}	.45^{l}	.84^{m,w}	.86^{m,w}
7	.64^{l,w}	.67^{l}		1.38^{m,x}	1.3^{m,x}
8	.78^{l,x}			1.65^{m,y}	2.23^{n,y}
9	.87^{l,wx}			2.57^{m,z}	

[a] Effects of BCS and age classification and their interaction were statistically significant (P.01).

^{l,m,n,o,p} Means within a row with differing superscripts differ (P < .05).

^{v,w,x,y,z} Means within a column with differing superscripts differ (P < .05).

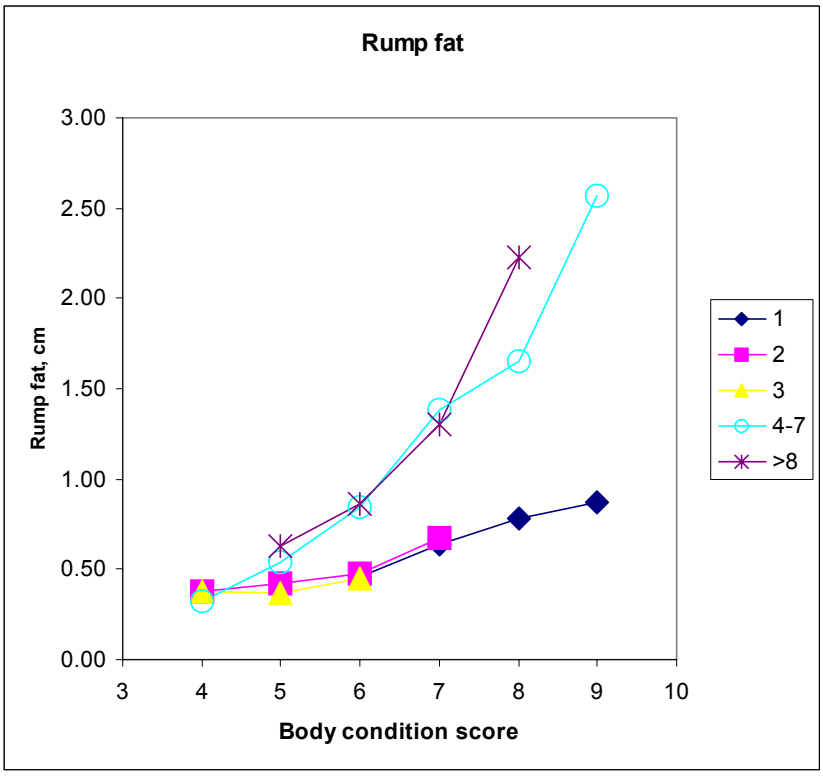

Table 6. Effect of body condition score (BCS) and age classifications (AGE) on rib fat (cm)[a].

	AGE				
BCS	A1	A2	A3	A4-7	A8+
4		.38	.36	.28^{v}	
5		.33^{l}	.32^{l}	.42^{m,tv}	.47^{m,v}
6	.42^{l,v}	.36^{l}	.36^{l}	.63^{m,w}	.63^{m,w}
7	.52^{l,w}	.49^{l}		.95^{m,x}	.9^{m,x}
8	.66^{l,x}			1.22^{m,y}	1.27^{m,y}
9	.58^{l,vwx}			1.82^{m,z}	

[a] Effects of BCS and age classification and their interaction were statistically significant (P.01).
^{l,m,n,o,p} Means within a row with differing superscripts differ (P < .05).
^{v,w,x,y,z} Means within a column with differing superscripts differ (P < .05).

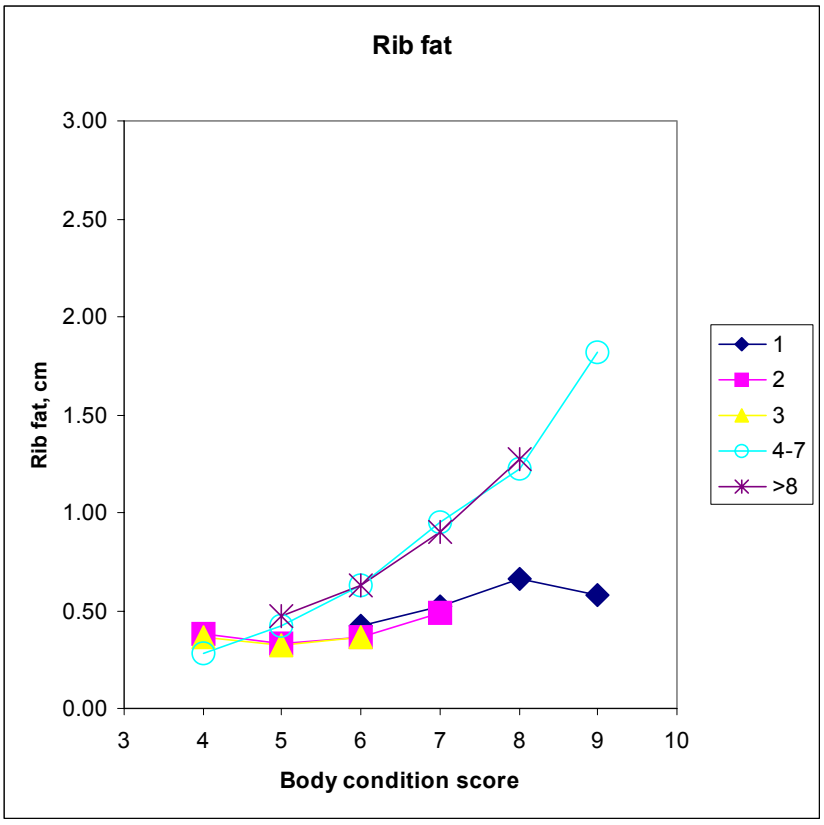

Table 7. Effect of body weight class (BWCLASS, lb) and age classifications (AGE) on body condition score[a].

	AGE				
BWCLASS	A1	A2	A3	A4-7	A8+
<800	6.92^{v}				
800-1000	7.45^{l,w}		5.00^{m}		
1000-1200		5.50^{m}	5.12^{l}	4.92^{l,v}	5.50^{lm,vw}
1200-1400		5.17^{lm}	5.28^{l}	5.35^{l,w}	5.71^{m,v}
1400-1600			5.50	6.08^{x}	6.03^{w}
>1600				7.40^{l,y}	6.70^{m,x}

[a] Effects of BW and age classification and their interaction were statistically significant (P.01).
^{l,m,n,o,p} Means within a row with differing superscripts differ (P < .05).
^{v,w,x,y,z} Means within a column with differing superscripts differ (P < .05).

Table 8. Effect of body weight class (BWCLASS, lb) and age classifications (AGE) on rump fat (cm)[a].

	AGE				
BWCLASS	A1	A2	A3	A4-7	A8+
<800	.58^{v}				
800-1000	.73^{w}		.27		
1000-1200		.46	.36	.35^{v}	.38^{v}
1200-1400		.43^{lm}	.42^{l}	.66^{mn,w}	.74^{n,v}
1400-1600			.55	1.01^{x}	.97^{w}
>1600				1.35^{y}	1.26^{x}

[a] Effects of BW and age classification and their interaction were statistically significant (P.01).

^{l,m,n,o,p} Means within a row with differing superscripts differ (P < .05).

^{v,w,x,y,z} Means within a column with differing superscripts differ (P < .05).

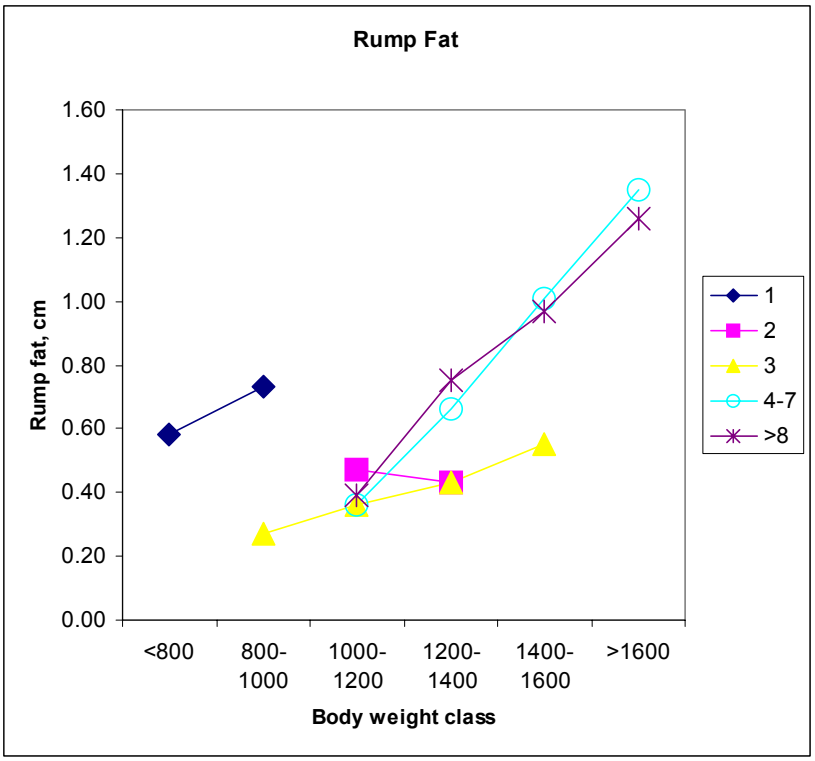

Table 9. Effect of body weight class (BWCLASS) and age classifications (AGE) on rib fat (cm)[a].

	AGE				
BWCLASS	A1	A2	A3	A4-7	A8+
<800	.48^{v}				
800-1000	.61^{w}		.28		
1000-1200		.36	.32	.30^{v}	.28^{v}
1200-1400		.28^{l}	.34^{l}	.51^{m,w}	.57^{m,vw}
1400-1600			.32^{l}	.73^{m,x}	.70^{m,x}
>1600				.76^{l,m}	.69^{m,wx}

[a] Effects of BW and age classification and their interaction were statistically significant (P.01).

^{l,m,n,o,p} Means within a row with differing superscripts differ (P < .05).

^{v,w,x,y,z} Means within a column with differing superscripts differ (P < .05).

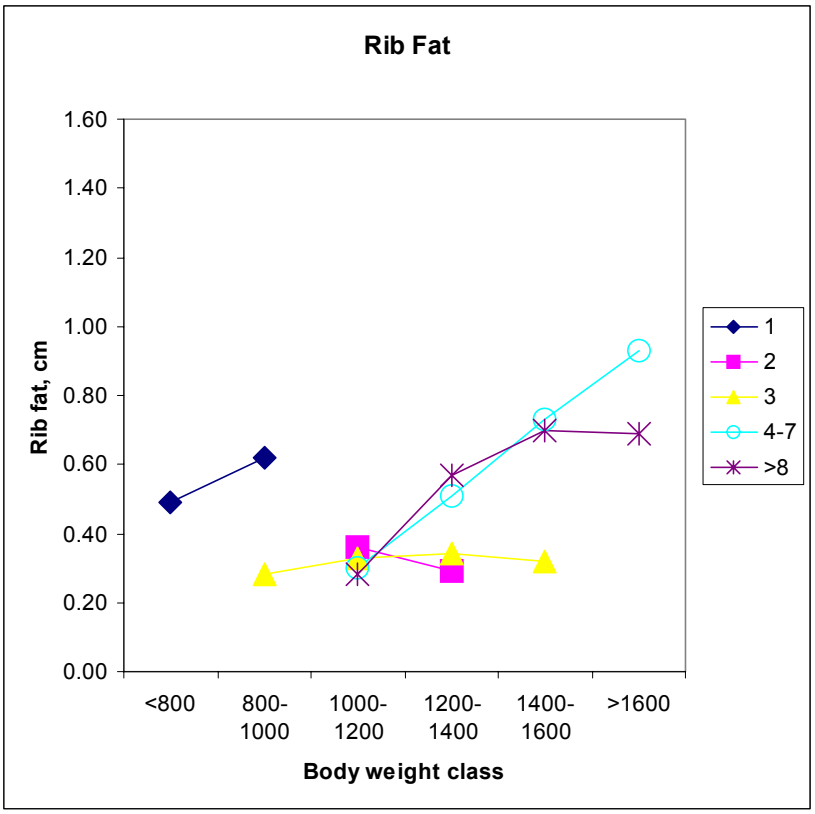

Table 10. Body condition score (BCS) regressed on body weight (BW, lb) and rump and rib fat (cm) within age categories (NAGE).

	Regression coefficients					
NAGE	Intercept	BW	Rump	Rib	SD	R^2
NA1						
BW	3.10	.00507	-	-	.68	.17
Rump	5.99	-	1.84	-	.62	.28
Rib	6.28	-	-	1.67	.66	.19
Combined	3.67	.00304	1.32	.35*	.59	.35
NA2-3						
BW	5.48	-.00015*	-	-	.55	.00*
Rump	4.87	-	1.04	-	.52	.10
Rib	4.95	-	-	1.05	.54	.05
Combined	5.20	-.00035*	.93	.36*	.52	.10
NA4+						
BW	.43	.00384	-	-	.68	.36
Rump	4.96	-	1.00	-	.67	.39
Rib	4.91	-	-	1.45	.68	.37
Combined	1.77	.00236	.40	.63	.58	.54
All data	-	-	.51	.59	.58	.70
NA1	3.48	.00378	-	-		
NA2-3	5.20	-.00027	-	-		
NA4+	1.93	.00220	-	-		

* Coefficient or statistic is not different from 0 (P>.05).

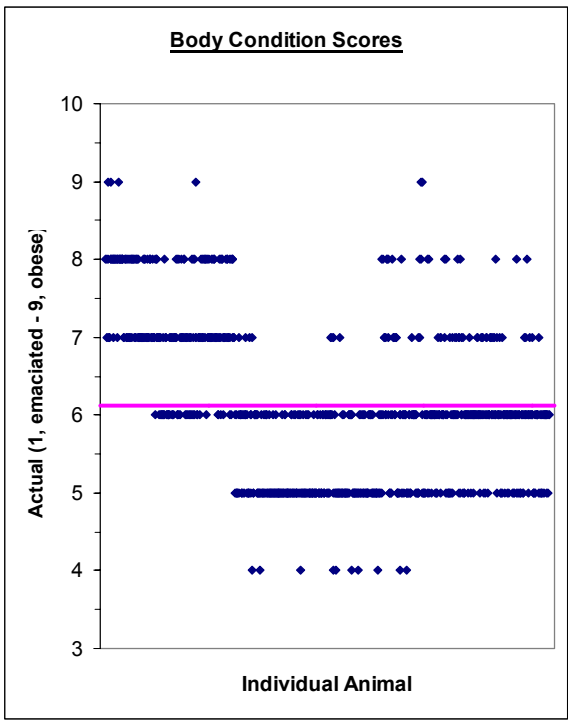

Figure 1. Scatter plot of actual body condition scores (BCS) amongst individual animals.

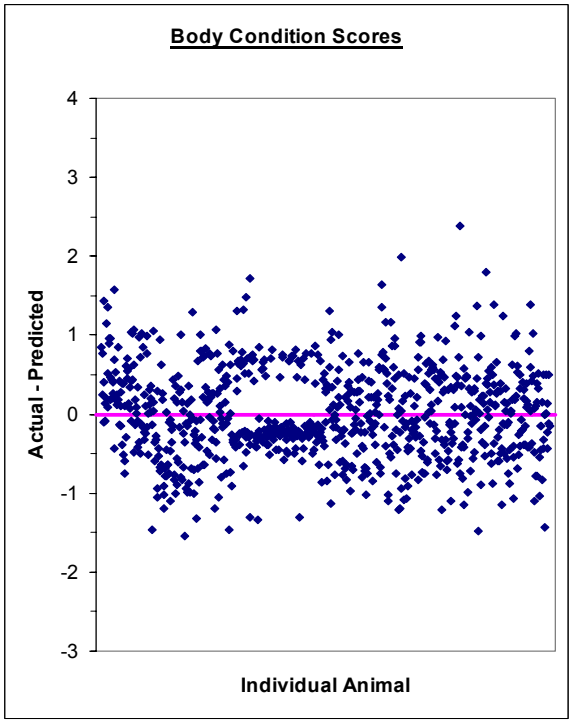

Figure 2. Scatter plot of the difference between actual and predicted body condition scores (BCS) using the overall prediction equation within age-specific body weight coefficients from Table 10 (R^2 = .70; SD = .58 units of BCS).

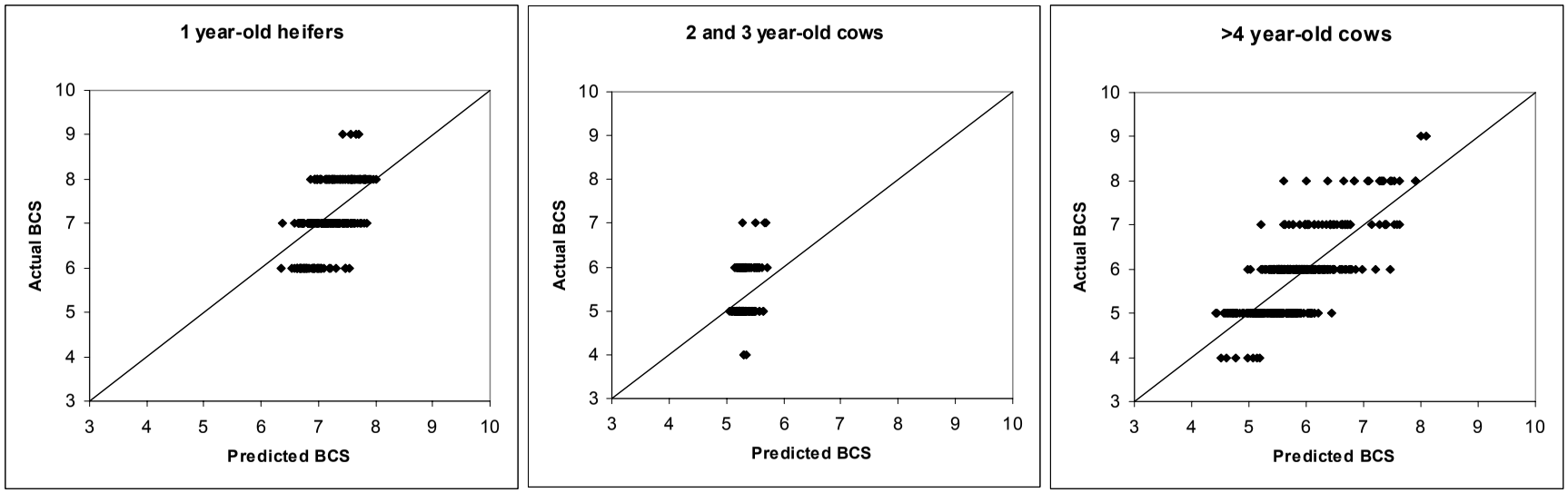

Figure 3. Scatter plot of the difference between actual and predicted body condition scores (BCS) within age classifications (NAGE) using the overall prediction equation within age-specific body weight coefficients from Table 10 (R^2 = .70; SD = .58 units of BCS).