BODY CONDITION SCORING IN CHEETAH (*ACINONYX JUBATUS*): ADVANCEMENTS IN METHODOLOGY AND VISUAL TOOLS FOR ASSESSMENT

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INTRODUCTION

Body condition scoring (BCS) is the use of a standardized, non-invasive, cost-free tool for evaluating the degree of external adiposity of an individual (Bray, 2001). With proper validation, BCS can be applied to any species and utilizes a scale or spectrum of 1 to 5 or 1 to 9 to describe degree of fatness. BCS allows for identification of under- and overweight animals, for which interventions might be implemented to attain a desired body condition. BCS systems are well established for several species of livestock and companion animals (NRC, 1996; Edmundson, 1989; Henneke, 1983; Thatcher, 2000), and have been correlated to health outcomes such as longevity, reproduction, and performance (Scarlett, 1998; Lund, 2006). These provide a foundation for development of similar systems for exotic animal captive management. A standardized BCS system was developed for the cheetah (*Acinonyx jubatus*), including descriptors and illustrations based on observations of cheetahs and the BCS system for domestic cats (Dierenfeld, 2007). This paper contributes new data and methods for advancing and validating BCS systems in captive zoo animals.

METHODS

Standardized photo sets (n=45) of captive cheetahs from the Fort Worth Zoo (n=5 cheetah) and Fossil Rim Wildlife Center (n=21 cheetah) (Figure 1) and diverse images of free-ranging and captive cheetahs from the Internet (n=108) were collected. Photos were ranked in terms of appearance from most skeletal (least external fat) to most rounded/bulging (most external fat). Longitudinal photosets (5 cheetah, 5-7 photosets each) were also matched with corresponding weights (n=x), palpations, and ultrasounds to provide known degree of fatness and calibrate the scale. Based on these observations, photos and images were assigned to one of nine BCS categories (extreme low (1), very low (2), low (3), moderate-low (4), moderate (5), moderate-high (6), high (7), very high (8), and extreme high (9)), and accurate descriptions of each category were established by assessing the differences in appearance of specific anatomical areas most reflective of the relative degree of fatness in the cheetah.

RESULTS

Visual BCS Scale

The primary anatomical areas associated with visual BCS classification were the torso (including ribs and shape from shoulder to hip) and hindquarter area (including hindleg, point of hip, hip angle, point of buttocks, and tail head) (Figure 2). Secondary physical features which were often but not consistently identifiers of BCS include the forequarter area (neck, foreleg, shoulder, and peak of shoulder) and abdomen/flank (which may be confounded by pregnancy, gut fill, and

hydration). Four photos from each BCS category that best depicted those categories were assembled into small photo sets, and were combined with physical descriptors for each category into a 9-point BCS visual tool (Figure 3).

Validation of BCS Tool with Longitudinal BCS and Body Weight Change Data
Fairly linear relationships were obtained between BCS and weight for three of the five animals for which multiple BCS-body weight data points were available (ISIS numbers 200150, 200152, 200154) (Figure 4). These three animals were adults (fully grown), and all experienced significant changes in body condition and weight during the year leading up to this study. The linear trends found for these animals allowed for calculation of the percent change in body weight corresponding to each change in BCS. These values were determined to be 4.0% (2.5kg/BCS unit), 6.2% (2.7kg/BCS unit), and 7.1% (3.4kg/BCS unit) for animals 200150, 200154, and 200152, respectively. Animals 206681 and 206682, which were younger and still-growing, did not demonstrate a linear relationship between BCS and weight changes.

DISCUSSION

This system is intended to be an objective description of the degree of fatness, rather than a valuation of optimal condition, which requires further illumination. As such, value terms such as 'good' or 'ideal' were avoided in favor of objective terms such as 'low,' 'moderate,' and 'high' to describe the degree of external adiposity. The large collection of diverse individual photos utilized in this project was studied to minimize the influence of confounding factors such as markings, lighting, non-standardized pose, gut fill, pregnancy, and individual variation. This study attempted to calibrate the proposed BCS system with the use of palpation, ultrasound and longitudinal weight data.

There was a strong linear relationship (R^2 >0.85) between BCS and weight for the three adult animals. The younger two animals did not demonstrate linear relationships between BCS and weight. This illustrates the importance of BCS in evaluating animals for which weights are not indicative of fatness (growth and pregnancy). Regression analysis of the linear BCS-weight relationships allowed for calculation of the percent body weight change represented by a 1-unit change in BCS, which ranged from 4-7% for the three animals. Compared to the human BMI which notes overweight and underweight as approximately 15% above or below the middle of the normal range, animals in study making the same move (2 BSC units) might experience a 8-15% weight change.

BCS is a valuable tool because it is cheap, accessible and facilitates consistency across all animal staff (keepers, managers, veterinarians, nutritionists, etc.). It must be user friendly requiring minimal training to incorporate into daily management. Several methods can be used to assemble photographs and descriptions, and multiple forms of visual presentation are included to illustrate BCS principles and categories. By utilizing this tool with health studies, ideal body condition can be determined for improved management.

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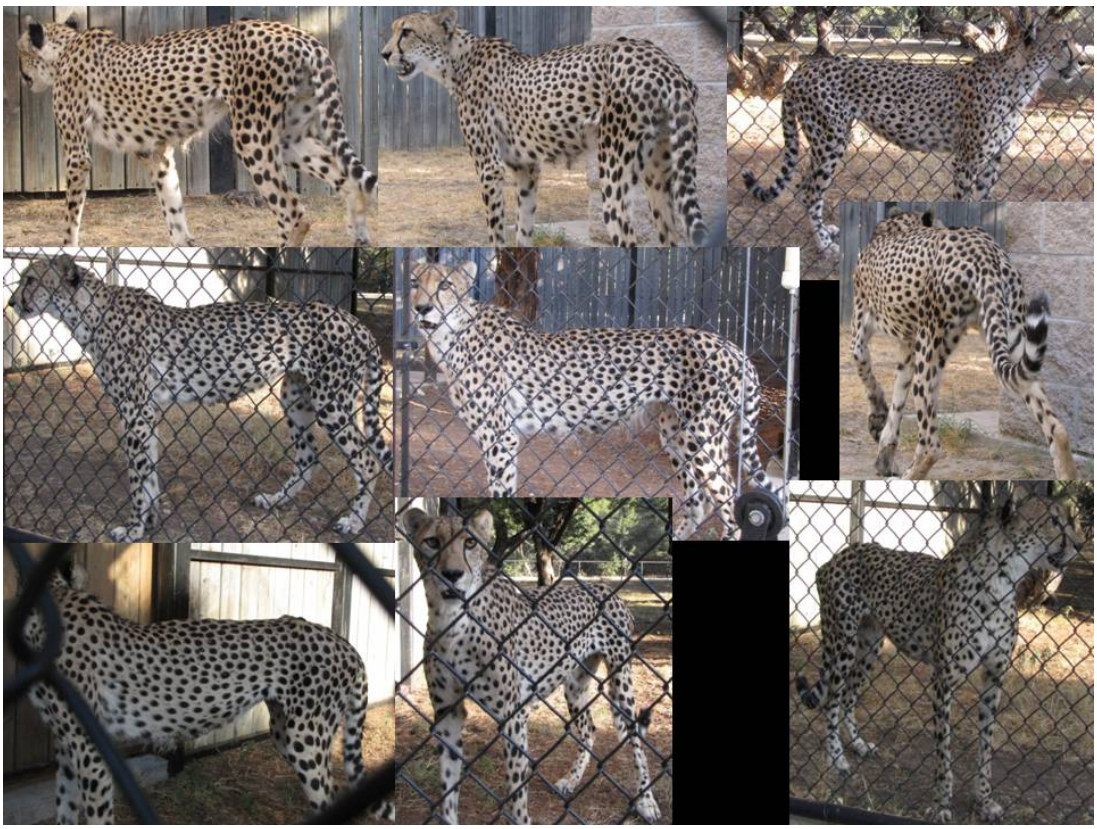


Figure 1. Example standardized photoset of captive cheetah from Fossil Rim Wildlife Center.

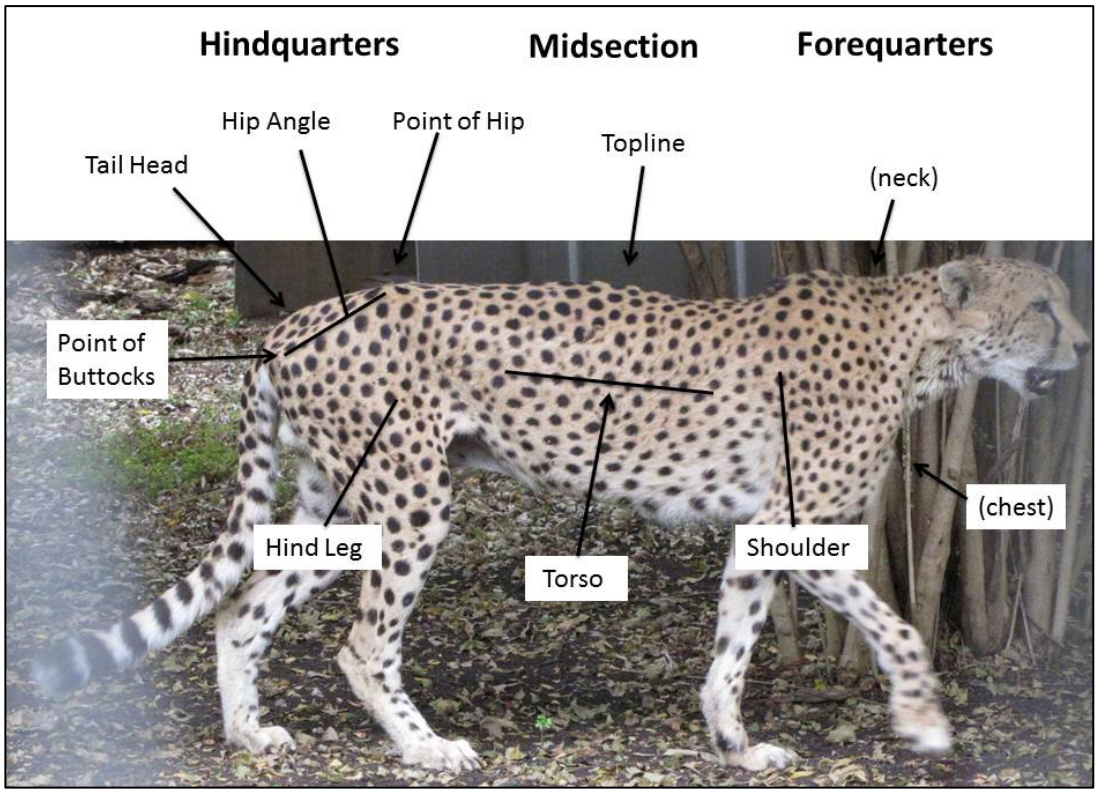
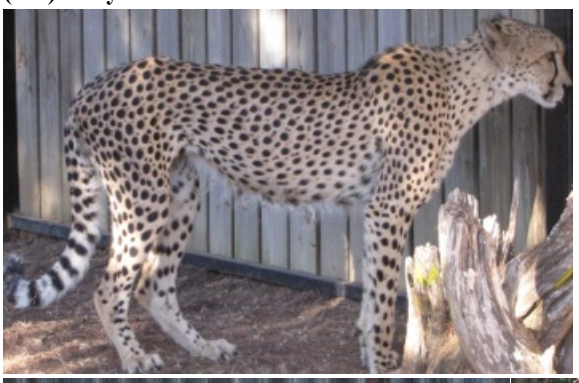
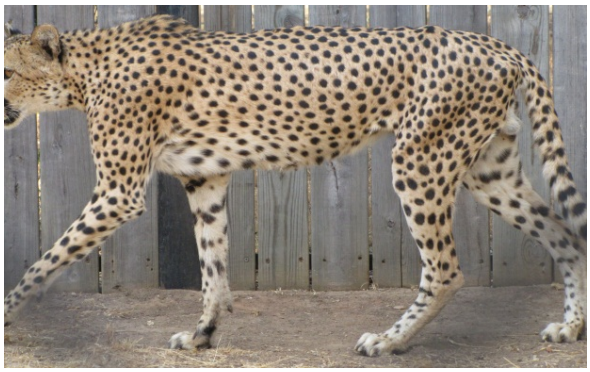


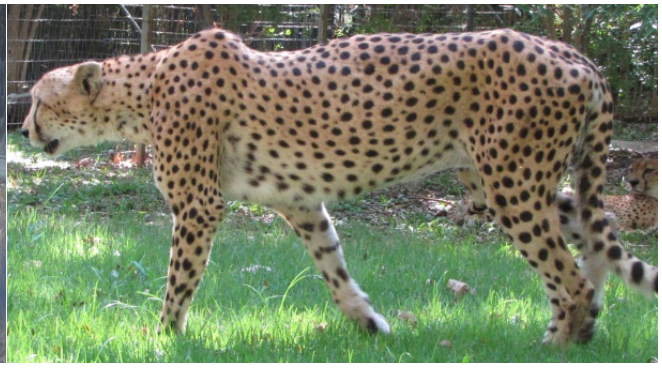
Figure 2. Illustration of anatomical focal points selected for use in determination of cheetah BCS criteria.

(1) Extreme Low


- Animal emaciated, skeletal, with noticeable muscle wasting and no visible fat covering.
- Torso expected to have no visible covering; ribs may be visible.
- Individual lumbar vertebrae are sharply apparent.
- Transitions between shoulder, torso, and hip are sharply exaggerated.
- Femur, point of hip, point of buttocks and tail head are sharply apparent.
- Bones of tail may be visible.

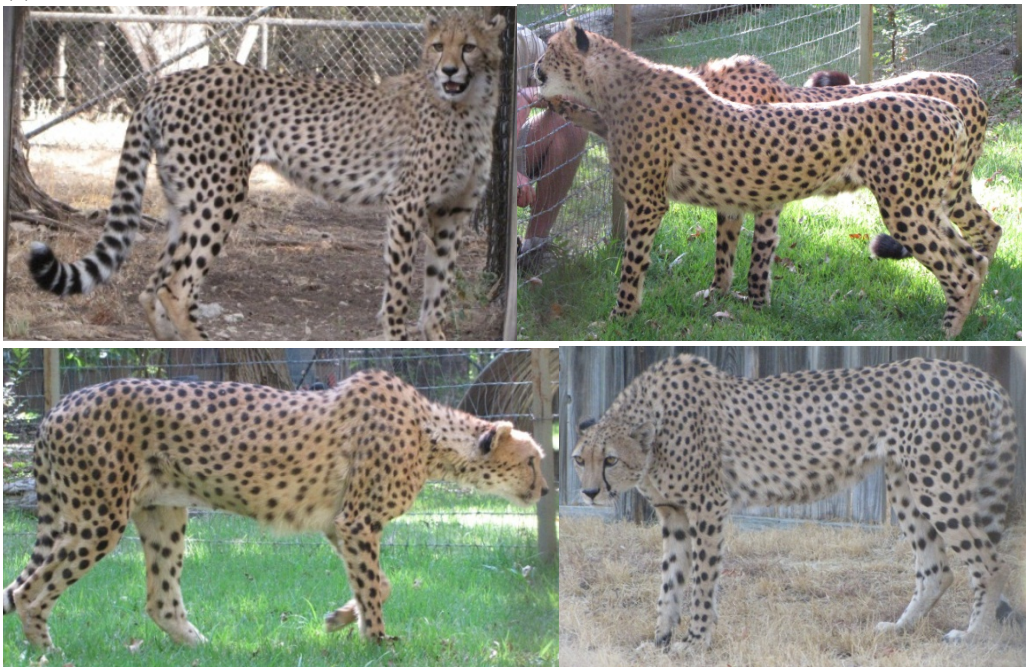
(2-3) Very Low/Low



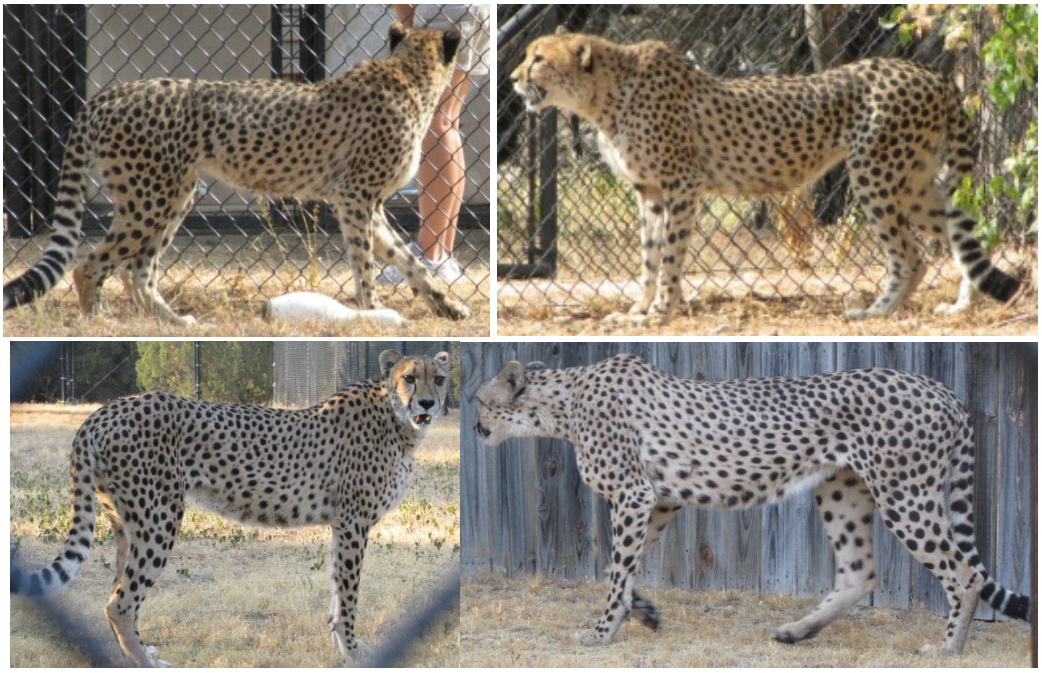
- Minimal fat cover visible.
- Torso slightly covered, has flattened appearance. Ribs not visible.
- Topline lumbar vertebrae visible (2) or barely covered (3).
- Shoulder and hindleg do not flow smoothly into torso.
- Femur (hip angle), point of hip, and point of buttocks sharply prominent, but with slight covering.
- Tail head visible, protrudes fully above hip and buttocks.

(4) Moderate-Low



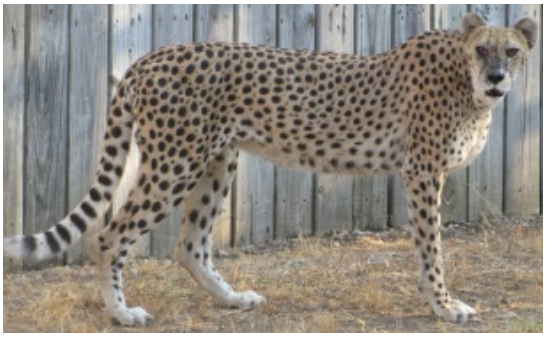
- Torso mildly covered; distinct but smoother transition from shoulder and hip into torso. Ribs not visible.
- Topline mildly covered; some lumbar vertebrae may be barely visible.
- Hip angle, points of hip and buttocks remain visible, but have some covering; points smooth/rounded.
- Tail head visible but blending more smoothly into hip at tail base.

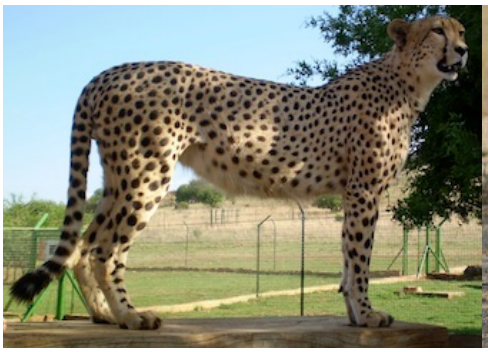
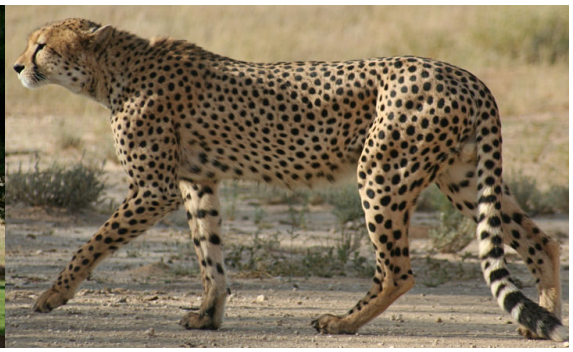
(5) Moderate



- Shape of torso just apparent, becoming more round. Shoulder and hind legs flow smoothly into torso.
- Topline moderately covered, flatter in appearance; lumbar vertebrae not visible
- Hip angle, point of hip, and point of buttocks are slightly visible or beginning to round.
- Tail head may be slightly visible but is becoming rounded in appearance.

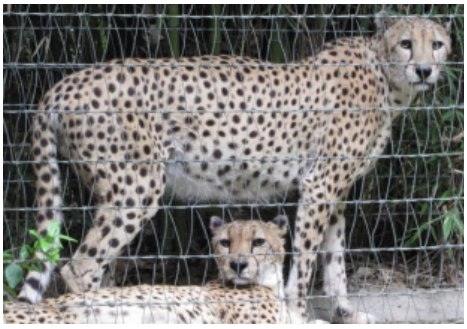
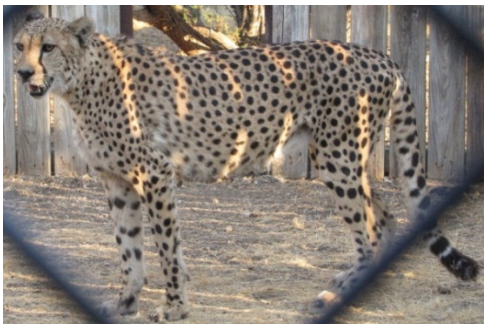
(6) Moderate-High

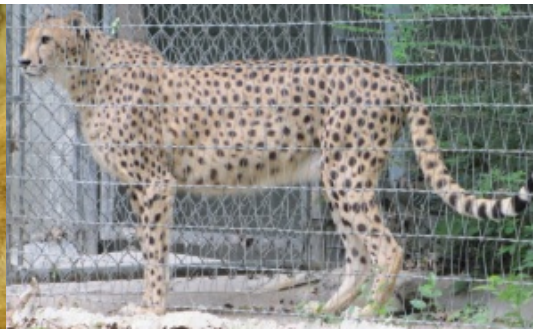


- Shape of torso disappearing; almost smooth transition between shoulder and torso, and torso and hip.
- Topline smooth, rounded, and moderately covered, almost flat in appearance.
- Shape of rump almost hidden by moderate fat covering; point, angle of hip rounded, barely or not visible.
- Tail head barely visible, blends smoothly into rump.

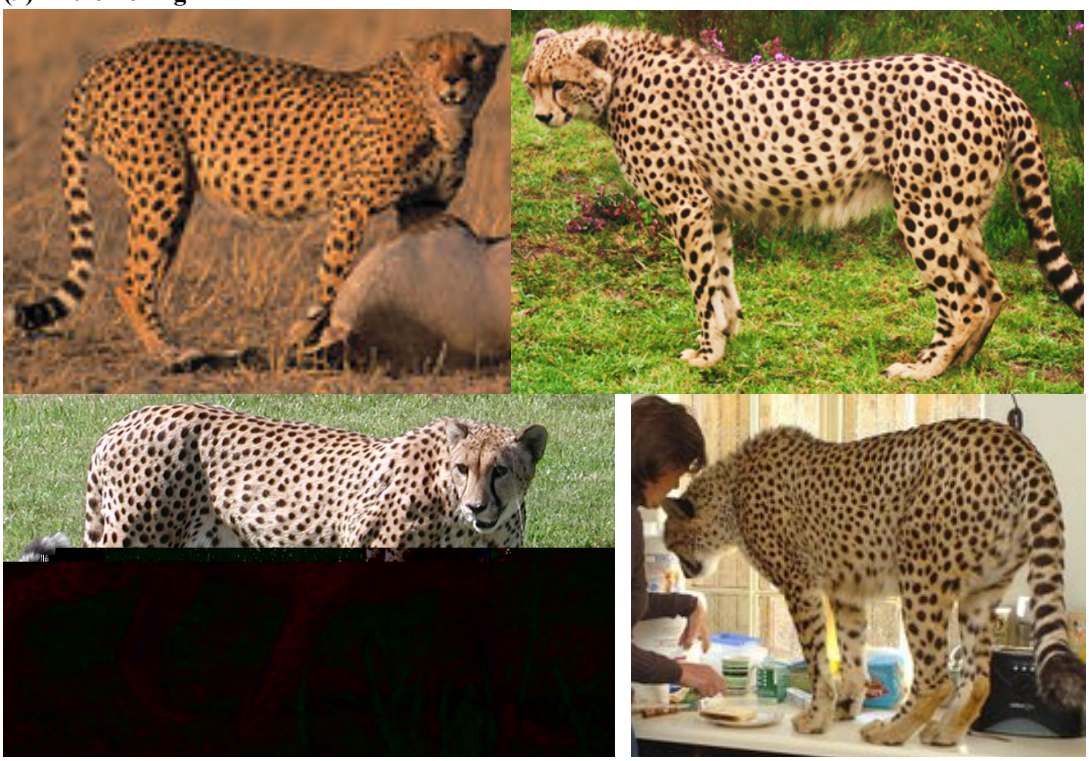
(7-8) High/Very High



- Topline is smooth, flat in appearance.
- Torso rounded in appearance, with filling/bulging behind shoulder. Shoulder-torso-hip nearly continuous.
- Consistent full appearance of abdomen (may be confounded by pregnancy or recent large food intake).
- Points of hip and buttocks rounded and filled-in; peaks not visible.
- Tail head not visible; blends continuously with hip. Tail base beginning to thicken.

(9) Extreme High



- Chest is full, bulging in appearance.
- Neck rounded and filled-in, blending into shoulder.
- Shoulders bulging behind and on top, barely discernable from topline.
- Topline has flat, wide, table-like appearance; continuous with neck, shoulders and hip.
- Torso completely bulging; no distinction between torso and shoulder, torso and hip.
- Abdomen rounded, bulging in appearance, with full, pendulous fat between hind legs (may be confounded by pregnancy or recent food intake).
- Hip, hind legs, and rump completely rounded, bulging in appearance.
- Tail head rounded, blends continuously with hip. Tail base thickened.

Figure 3. 9-point visual BCS scale with accompanying descriptors for each category.

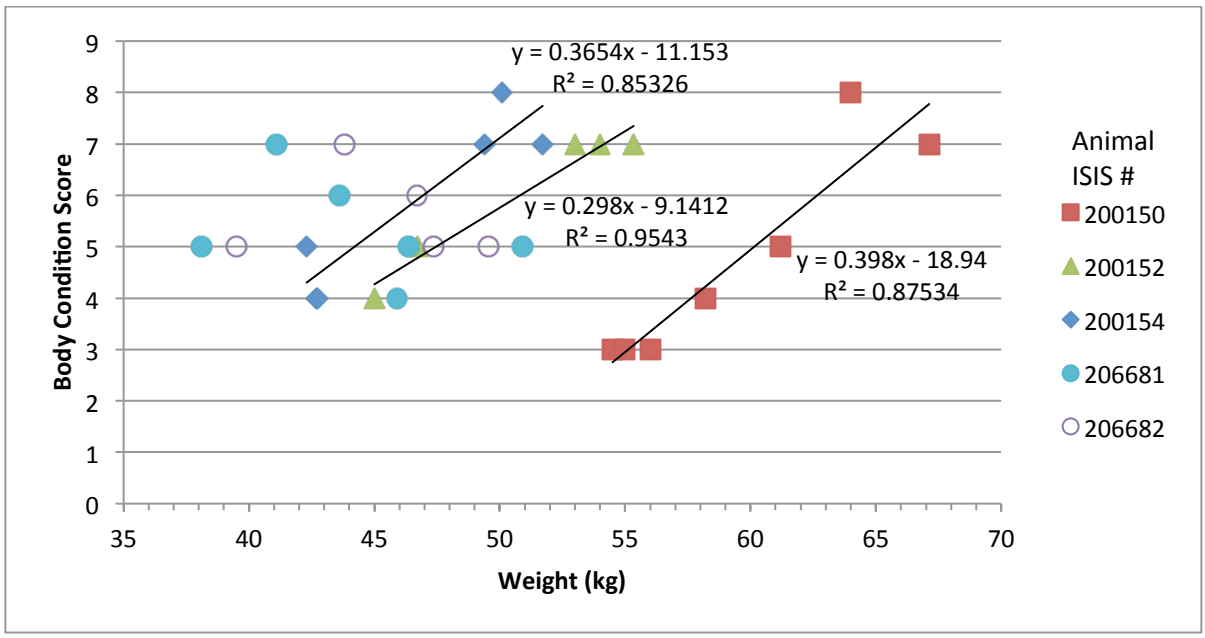


Figure 4. Relationship between body weight and BCS changes longitudinally for five cheetah at Fort Worth Zoo.