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Chapter 14

Development of a body condition scoring tool for the spotted eagle ray, *Aetobatus narinari*

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Abstract: In an effort to advance the care of spotted eagle rays, *Aetobatus narinari* (Euphrasén, 1790), the husbandry team at Disney's The Seas (Orlando, Florida, USA) developed a standardized scoring tool to objectively assess specimen body condition. Through an iterative process, a five point body condition score (BCS) was determined to provide the best compromise between detection of meaningful changes in body condition and minimizing inter-category ambiguity. When tested on ten reviewers, average inter-observer BCS agreement was 90% for all viewing aspects, with the lowest inter-observer agreement of 87% for the ventral aspect and highest inter-observer agreement of 93% for the lateral aspect. The BCS tool was implemented at Disney's The Seas and became invaluable for assessing the well-being of *A. narinari*, providing an early warning detection system for potential health challenges.

INTRODUCTION

As the aquarium industry has grown so has the desire to improve animal welfare, encouraging staff to expand upon traditional husbandry methods to better manage and benefit the animals within their care. One way to assess animal welfare is through the use of body scoring tools. One of the earliest methods of body scoring was the body mass index (BMI) for humans, developed by Adolph Quetelet in 1832. Still in use today, BMI compares the height and weight of a person and is used as an index of general health (Eknoyan, 2008). BMI does not translate well for use with non-human animals, due to a high variability in animal size, body mass and morphology. As an alternative, body condition scores (BCS) have been developed for a number of different animal species, especially livestock (www1).

Animal BCS systems have been used by small and large veterinary practices to assess companion animals, while agricultural workers have used BCS systems to manage their livestock. These systems provide an easy way to evaluate body condition, which can be an indicator of general health (Clingerman and Summers, 2012). An objective scoring rubric minimizes subjective opinion and imprecise assessments (e.g., statements that an animal is "too thin" or "obese"), and decreases the introduction of personal biases into management decisions. Since BCS tools rely on a process of non-invasive observation, animals under managed care can be monitored from a distance without disturbance. This absence of physical manipulation reduces potential stressors, which can lead to adverse physiological responses, particularly in elasmobranchs (Piiper and Baumgarten, 1969; Piiper et al., 1972; Cliff and Thurman, 1984; Smith, 1992; Smith et al., 2004; Stevens, 1994; Mandelman and Skomal, 2009; Hyatt et al., 2011).

Spotted eagle rays, *Aetobatus narinari* (Euphrasén, 1790), are a highly charismatic species and are becoming increasingly common in public aquaria. Despite growth of husbandry and medical management information for the species, there is no information about assessment of *A. narinari* body condition. As a pelagic species, with a finely balanced energy budget, it is not always easy or prudent to regularly capture *A. narinari* to measure body mass (BM). As an alternative, descriptors of body condition, such as "good" or "poor", are vague and allow for inconsistencies in assessment, especially if more than one observer is involved. The inherent risk is that personal biases and a lack of measurable data can lead to husbandry personnel overlooking subtle shifts in BM and/or body condition, which can be an early indicator of a serious health challenge. Early detection of these changes provides a necessary tool for assessing the current status, and future needs, of an animal.

A detailed body condition scoring tool can be used routinely, in conjunction with behavioral observations and food intake, to provide an indirect but powerful indication of the health status of an animal. BCS systems are based on a set of standardized images (diagrams, drawings, photos, etc.) and employ a numerical scoring system to quantify animal status. A score of "1" typically represents an extremely thin or emaciated body condition, with the scale increasing over multiple numerals to represent the entire spectrum of body conditions (Henneke et al., 1983; Clingerman and Summers, 2012). The optimum BCS for a species generally falls in the midrange of the numerical sequence (Clingerman and Summers, 2012). Hereafter we describe a system for assessing body condition of *A. narinari* using a BCS developed at Disney's The Seas (Orlando, Florida, USA).

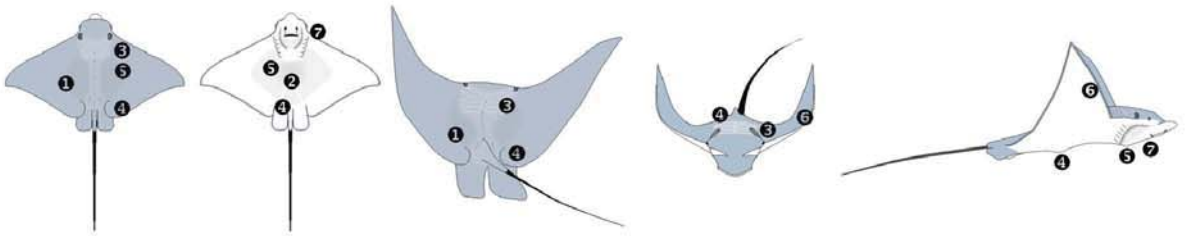
METHODS

A total of 200 photographs of *A. narinari* were evaluated to determine aspects or views that would best provide an objective assessment of animal body condition. The images represented a wide range of body shapes and sizes, taken at a variety of angles. Five different aspects of *A. narinari* were determined to provide the most robust set of views for BCS assessment: (1) dorsal; (2) ventral; (3) lateral; (4) anterior or "head-on"; and (5) posterior or "rear". Anatomical features used for the BCS were also standardized and reflected seven discrete body regions, including: (1) dorsal coelomic surface; (2) ventral coelomic surface; (3) gill arches; (4) pelvic girdle; (5) pectoral girdle; (6) wing; and (7) head (Figure 1).

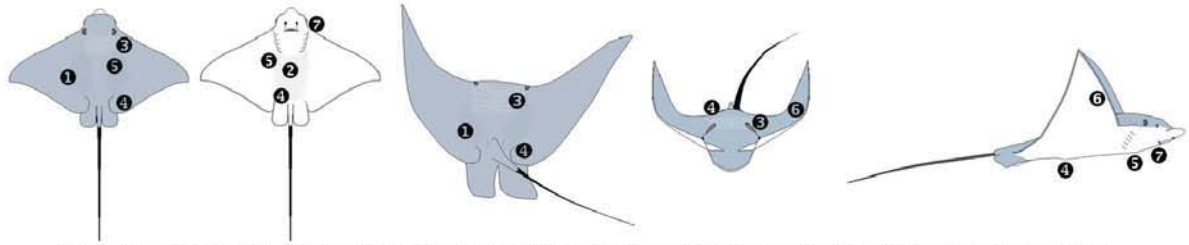
The 200 photographs were ranked into five discrete groups based on relative body condition. The groups were categorized on a sliding scale of "1 to 5", representing a spectrum from an emaciated to an obese *A. narinari*. The possibility of using a higher number of scores (e.g., 1 - 9) was abandoned as anatomical changes were deemed to be too subtle to differentiate when category granularity was increased beyond five.

Each of the seven anatomical features was then sketched and a written description generated to better define each of the five BCS categories, making objective assessment more possible. Some descriptions were binary (e.g., gill arches were categorized as "visible" or "not visible"), while other descriptions expressed a spectrum of possible states (e.g., coelomic surface was categorized on a scale from "severe concavity" through "flush with body wall" to "severe convexity") (Figure 1).

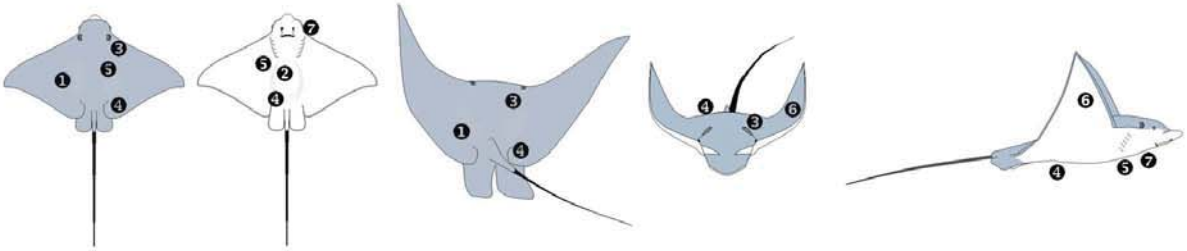
Once the model BCS tool was established, it was tested using a pool of ten observers. Each observer was shown five photographs of an individual *A. narinari*, from all five aspects, and asked to assign a BCS. Evaluated images included photographs of *A. narinari* in the wild and in aquaria. Inter-observer reliability was evaluated (using % agreement) and the results were used to



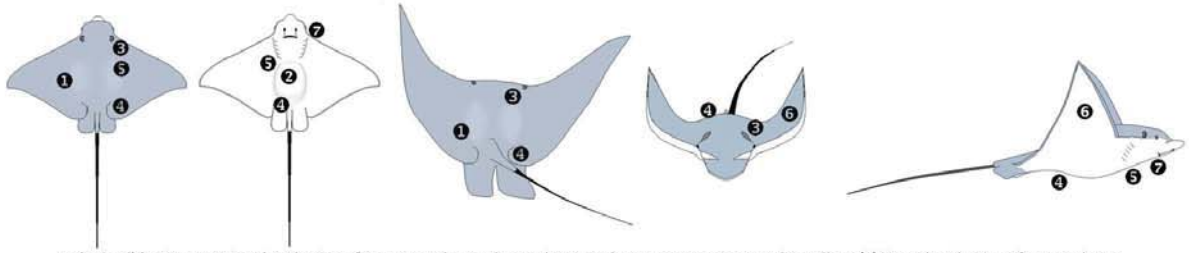
a. **Body Condition Score 1:** (1) Dorsal coelomic surface: pectoral musculature shows concavity nearest midline; (2) Ventral coelomic surface: moderate to severe concavity (sunken appearance); (3) Gill arches: visible; (4) Pelvic girdle: visible dorsally and ventrally; (5) Pectoral girdle: visible dorsally and ventrally; (6) Wing: no thickening; (7) Head: skin around eye and mouth show concavity; skin around mouth may appear stretched.



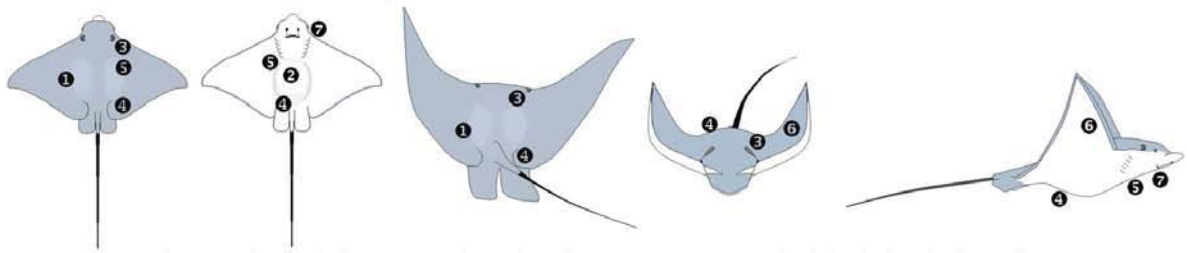
b. **Body Condition Score 2:** (1) Dorsal coelomic surface: pectoral musculature shows slight concavity or flush nearest midline; (2) Ventral coelomic surface: mild concavity or flush with body wall; (3) Gill arches: mildly visible; (4) Pelvic girdle: mildly visible dorsally and ventrally; (5) Pectoral girdle: mildly visible dorsally and ventrally; (6) Wing: thickening mild nearest the midline; (7) Head: normal (no concavity noted in skin near eyes or mouth).



c. **Body Condition Score 3:** (1) Dorsal coelomic surface: pectoral musculature shows mild convexity (distension) nearest the midline; (2) Ventral coelomic surface: no concavity; mild convexity starting past the last gill slit; (3) Gill arches: not visible; (4) Pelvic girdle: not visible; (5) Pectoral girdle: not visible; (6) Wing: thickening mild; most noticeably nearest midline; (7) Head: normal (no concavity noted in skin near eyes or mouth).



d. **Body Condition Score 4:** Dorsal coelomic surface: pectoral musculature shows moderate convexity nearest the midline; (2) Ventral coelomic surface: moderate convexity; (3) Gill arches: not visible; (4) Pelvic girdle: not visible; (5) Pectoral girdle: not visible; (6) Wing: thickening moderate; can be seen throughout the wing musculature; (7) Head: normal (no concavity noted in skin near eyes or mouth).



e. **Body Condition Score 5:** (1) Dorsal coelomic surface: pectoral musculature shows severe convexity nearest the midline; (2) Ventral coelomic surface: severe convexity; (3) Gill arches: not visible; (4) Pelvic girdle: not visible; (5) Pectoral girdle: not visible; (6) Wing: thickening severe; extreme cases may have wing thickening to the wingtips; (7) Head: normal (no concavity noted in skin near eyes or mouth).

Figure 1. Body condition scoring (BCS) tool for spotted eagle rays, *Aetobatus narinari* (Euphrasén, 1790), showing each of the five viewing aspects (i.e., dorsal; ventral; lateral; anterior or "head-on"; and posterior or "rear") and a description of the seven anatomical features for each of five discrete scoring levels.

fine-tune the BCS—i.e., the five viewing aspects, the descriptions of the seven anatomical features, and the sliding scale.

RESULTS AND DISCUSSION

Analysis of 200 photographs of *A. narinari* afforded a better understanding of the spectrum of possible animal body conditions. This process also helped determine appropriate viewing aspects to assess and score each animal. Dorsal and lateral aspects are often sufficient for assessing the body condition of terrestrial animals, however accurate assessment of *A. narinari* (and likely other pelagic rays) required three additional aspects to ensure evaluation veracity: ventral, anterior ("head-on"), and posterior ("rear"). By including all five aspects, it was possible to generate a set of standardized guidelines to accurately evaluate a ray, regardless of the position of the animal or the human evaluator.

A comparison of BCSs from ten test observers examining photographs of *A. narinari,* from each of the five viewing aspects, yielded an average inter-observer agreement of 90%. The lowest and highest inter-observer agreement was 87% for the ventral aspect and 93% for the lateral aspect, respectively. These results indicated a high degree of inter-observer reliability, as well as the utility of the BCS tool to aid husbandry decision-making. Ground-truthing the BCS tool at Disney's The Seas enabled fine-tuning of the descriptions of the seven anatomical features, as well as the "1" to "5" rating scale. The rating scale was determined to be sufficiently fine to detect meaningful changes in *A. narinari* body condition, yet sufficiently quantized to minimize ambiguity between individual BCS scores.

Once established, a BCS of "3", the middle score, was deemed ideal for *A. narinari* in aquaria. However, it should be noted that many wild *A. narinari* scored a BCS of "2". This difference is reflective of *A. narinari* in aquaria having access to a regular and highly nutritional diet, and being generally more robust than conspecifics in the wild. A BCS of "2" in an aquarium setting would indicate that an *A. narinari* was underweight. In general, animals with a slightly elevated BCS have a better ability to tolerate modest shifts in BM and better withstand environmental challenges (e.g., water quality shifts, inter- and intra-specific competition, etc.), as well as offering a health advantage when the animal is challenged by an active disease state (Henneke et al., 1983).

Once established, and in routine use, the BCS tool became invaluable for assessing the well-being of *A. narinari* maintained at Disney's The Seas. Each ray was evaluated weekly using the BCS tool. A database of assessed BCSs was established and individual animal body condition tracked over time, providing an early detection system for potential health challenges.

An example of BCS tool utility was demonstrated by tracking a female *A. narinari* that had been introduced into the exhibit at Disney's The Seas. Regular BCS assessments highlighted a dramatic decline in body condition (from a score of "3" to "1") within three months of introduction to the aquarium. Declining condition was coupled with an increased pallor. As a consequence of the observed trend intervention was deemed appropriate. The *A. narinari* was given a series of anthelmintic immersion treatments using praziquantel, as there had been a history of other animals suffering infestation with the parasitic flatworm *Decacotyle floridana*. As suspected, analysis of treatment water revealed the presence of the parasite. In addition to treatment with praziquantel, the diet of the *A. narinari* was augmented to accelerate improvement of specimen body condition. Within two months of intervention the body condition of the *A. narinari* had recovered to a BCS of "2" and continued to improve thereafter.

The BCS tool was also used to monitor potential pregnancies in *A. narinari*. Once baseline BCSs were established for each ray, increasing scores, in the absence of dietary changes, indicated a possible pregnancy. When this phenomenon was observed and marked, ultrasound imaging was prescribed for confirmation of pregnancy.

The von Bertalanffey and Gompertz equations allow calculation of BM or disc width (DW) when only one of the values is known—e.g., in cownose rays, *Rhinoptera bonasus* (Mitchill, 1815), (Neer and Thompson, 2005). However, obtaining weight or morphometric information typically requires capture and handling of the animal, which can be stressful (Piiper and Baumgarten, 1969; Piiper et al., 1972; Mazeaud et al., 1977; Cliff and Thurman, 1984; Wood, 1991; Smith, 1992; Stevens, 1994; Mandelman and Skomal, 2009; Hyatt et al., 2011), and may not be possible for wild specimens. The described BCS tool may be further developed to yield an estimate of BM, DW and/or age, without

direct physical manipulation or measurement of the animal. Preliminary results from application of the BCS as an estimate tool, using six *A. narinari* at Disney's The Seas, yielded promising results, representing an area for future study.

Ideally, a BCS tool would cater to other species of pelagic or free-swimming rays with similar body forms to *A. narinari*, such as R*. bonasus* and bat eagle rays, *Myliobatis californica* (Gill, 1865). However, the usefulness of the BCS tool must be validated for each species before implementation. Although mobulids (e.g., giant manta, *Manta birostris* (Walbaum, 1792) are considered pelagic, like myliobatids, differences in overall body shape between the two families would necessitate modification of BCS criteria before the tool could be employed to assess the body condition of mobulids.

The BCS concept described above provides a valuable framework for the development of improved husbandry tools, aiding the growing aquarium industry in advancing best practices for the management of the animals in their care.

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INTERNET RESOURCES

www1 http://www.staywell.co.uk/Intl/UK/You-and-Your-Pet/Recommendations/BMI-or-Condition-Score