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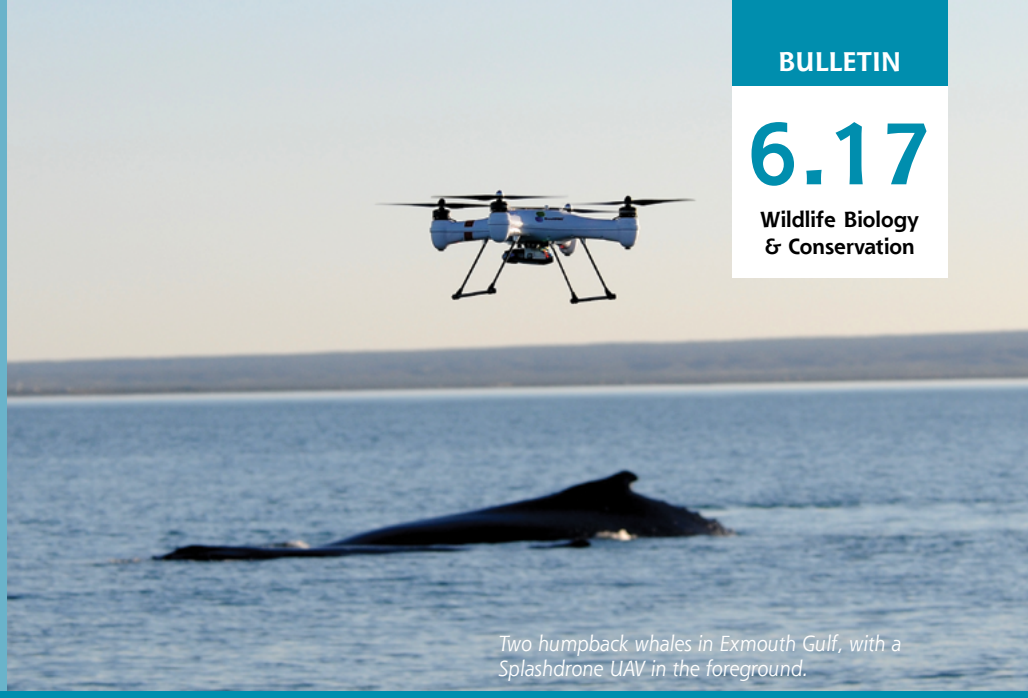
Wildlife Biology & Conservation



Two humpback whales in Exmouth Gulf, with a Splashdrone UAV in the foreground.

FREDRIK CHRISTIANSEN, ANTOINE DUJON, KATE SPROGIS, JOHN ARNOULD & LARS BEJDER

Measuring body condition of humpback whales using unmanned aerial vehicles

An animal's body condition will affect its survival and reproductive success, which in turn influences population dynamics. Despite its importance, relatively little is known about the body condition of large whales and its relationship to reproduction.

Exmouth Gulf in Western Australia serves as an important breeding and resting area for humpback whales (*Megaptera novaeangliae*) on their southwards migration returning from Camden Sound to their Antarctic feeding grounds. By investigating intra-seasonal trends in body condition of humpback whales in this area, we aimed to estimate the relative energetic costs of reproduction for different reproductive classes of whales (calves, immature, mature and lactating whales).

To understand how humpback whale body condition relates to reproduction, we also investigated the relationship between the body condition of lactating females and the growth and condition of their dependent calves.

This study (Christiansen *et al*. 2016) is the first to apply non-invasive unmanned aerial vehicle (UAV) technology to measure the body condition of free-living whales.

Methods

A small waterproof "Splashdrone" UAV, deployed from a small research vessel and flown at altitudes of 30–50m, was used to take vertical aerial photographs of humpback whales (n = 134) in Exmouth Gulf in August and September 2015 (Figure 1). The size of the research vessel was used to scale the photographs (by photographing the whales and the research vessel in the same picture). Photogrammetric methods were used to extract several morphometric measurements from the vertical close-up photographs of the whales (Figure 2). From the obtained measurements, the flat surface area of the whale was calculated and used as a proxy for body condition.

Linear models were used to investigate intra-seasonal changes in body condition of humpback whales for the four reproductive classes. We also investigated the relationship between female relative body condition (poor condition < 0 < good condition) and calf condition and growth (i.e. length).

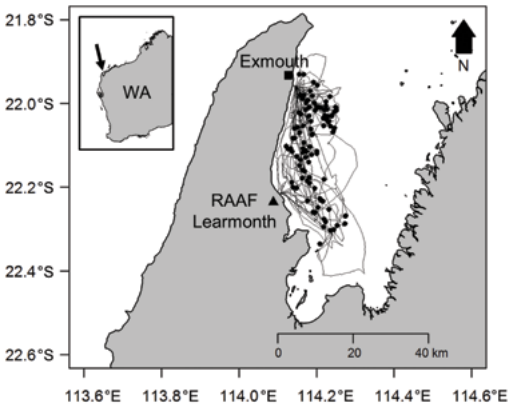


FIGURE 1 Map of the Exmouth Gulf study area in Western Australia, displaying the survey track lines (solid lines) and the positions of the sightings (black circles)

Results and discussion

The key findings from this research included:

1. The body condition of mature and lactating whales decreased during the study period, while calves and immature whales did not change in condition (Figure 3);
2. The rate of decline in body condition was higher for lactating females (0.032m^2 per day) compared to mature whales (0.027m^2 per day);
3. Female body condition had a positive linear effect on calf condition (Figure 4) but did not affect the growth (i.e. length) of calves.

Mature and lactating whales carry the costs of reproduction (i.e. lactation and finding a mate) and thus their body condition reduced significantly. In contrast, immature whales and calves do not carry the added energetic costs of reproduction, and hence did not show intra-seasonal variation in condition.

The positive relationship between female body condition and the condition of their calves suggests that female humpback whales with insufficient energy reserves reduce their energetic investment into

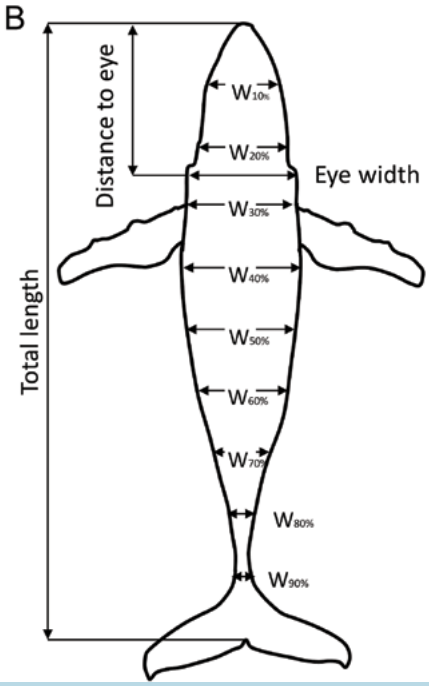


FIGURE 2 (A) Aerial photograph of humpback whales captured by the UAV. (B) Position of measurement sites of humpback whales recorded in this study

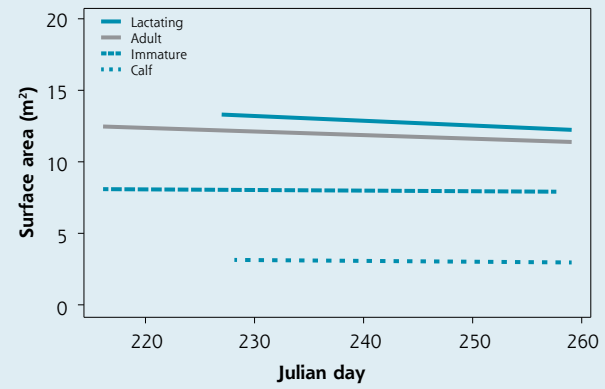


FIGURE 3 Intra-seasonal changes in body condition (i.e. surface area) for different reproductive classes of humpback whales (see legend)

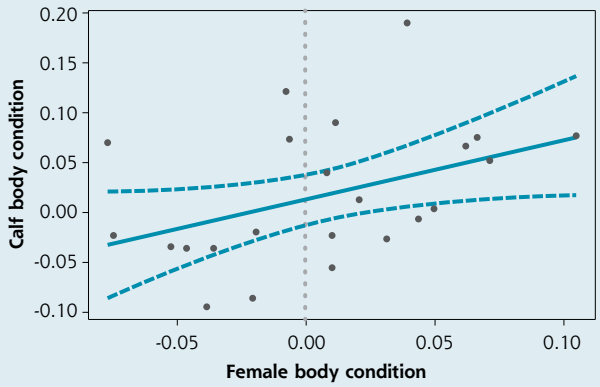


FIGURE 4 Calf body condition as a function of female body condition for humpback whales. The dashed lines represent 95% confidence intervals. The dotted vertical line crossing the x-axis at zero represents the average female body condition (FBC = 0)

their offspring, by producing poorer conditioned calves, in order to maintain their survival. That calf growth (i.e. length) was not affected by maternal condition suggests that the best strategy for calves to reduce heat loss might be to invest their excess energy into growth (i.e. length) rather than fat reserves, so that they can become larger overall and reduce their surface to volume area.

This study demonstrates how photogrammetry can be used to assess the body condition of humpback whales from aerial photographs recorded using UAV technology. This non-invasive approach provides a valuable tool to monitor the health of baleen whale populations globally. ■

More information

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References

1 Christiansen, F., Dujon, A.M., Sprogis, K.R., Arnould, J.P.Y. and Bejder, L. (2016). Non-invasive unmanned aerial vehicle provides estimates of the energetic cost of reproduction in humpback whales. *Ecosphere* Doi:e0146810.1002/ecs2.1468.

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