

Baleen archives metabolic and endocrine individual life histories of mysticete whales

William R. Cioffi¹, Jillian H. Wisse¹, Logan J. Pallin², Andrew J. Read¹.

¹University Program in Ecology, Duke University Marine Laboratory, Beaufort, NC ²Oregon State University, Department of Fisheries and Wildlife, Marine Mammal Institute, Newport, OR

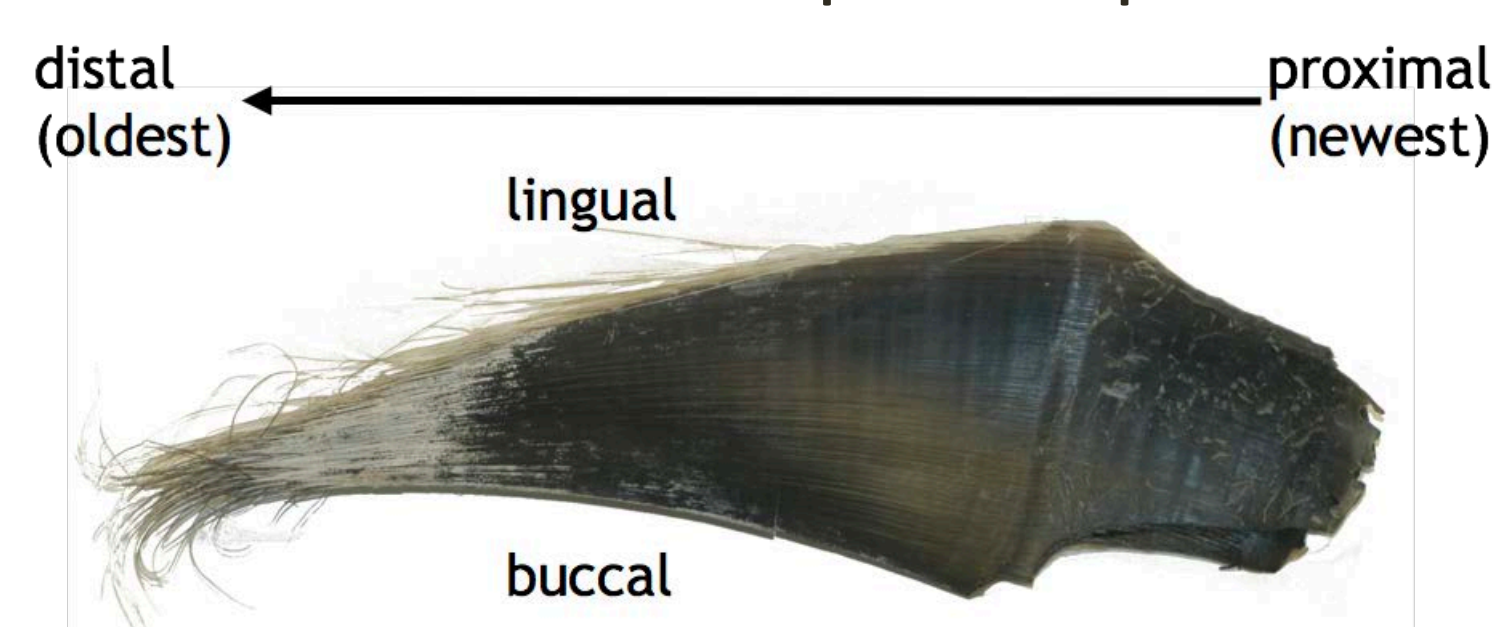
Mysticete whales are challenging study subjects because individuals spend most of their lives obscured from view, range across entire ocean basins, and require specialized equipment to locate and track. Baleen, the keratinized plates which are part of their feeding apparatus, can be used to reconstruct multi-year metabolic [1, 2] and endocrine histories [3, 4] for individual animals.

Here we present validations of stable isotope and hormone assay techniques to:

- Show **within plate variation in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$** stable isotope ratios along both the growth and non-growth axis.
- Show **between plate variation in progesterone concentration** for an animal with known pregnancy history.
- Provide a **biological validation of baleen cortisol** as an indicator of systemic stress by comparing concentrations during and after pregnancy.

Methods

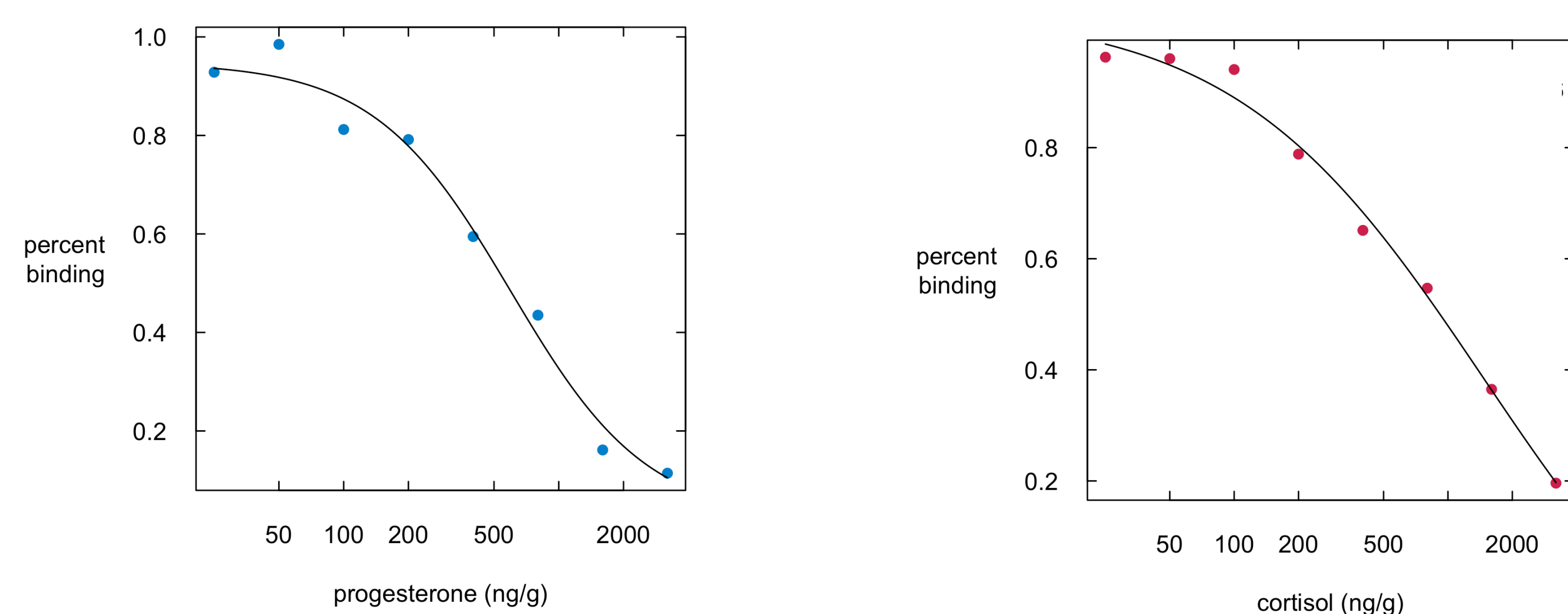
Baleen plates grow continuously from the proximal end at the gum line and erode at the distal end. One plate represents several years of growth.



We analyzed a plate collected during the necropsy of a 12.5m fin whale (*Balaenoptera physalus*) for stable isotopes and a plate collected from a 16m pregnant female North Atlantic right whale (*Eubalaena glacialis*) for progesterone and cortisol.

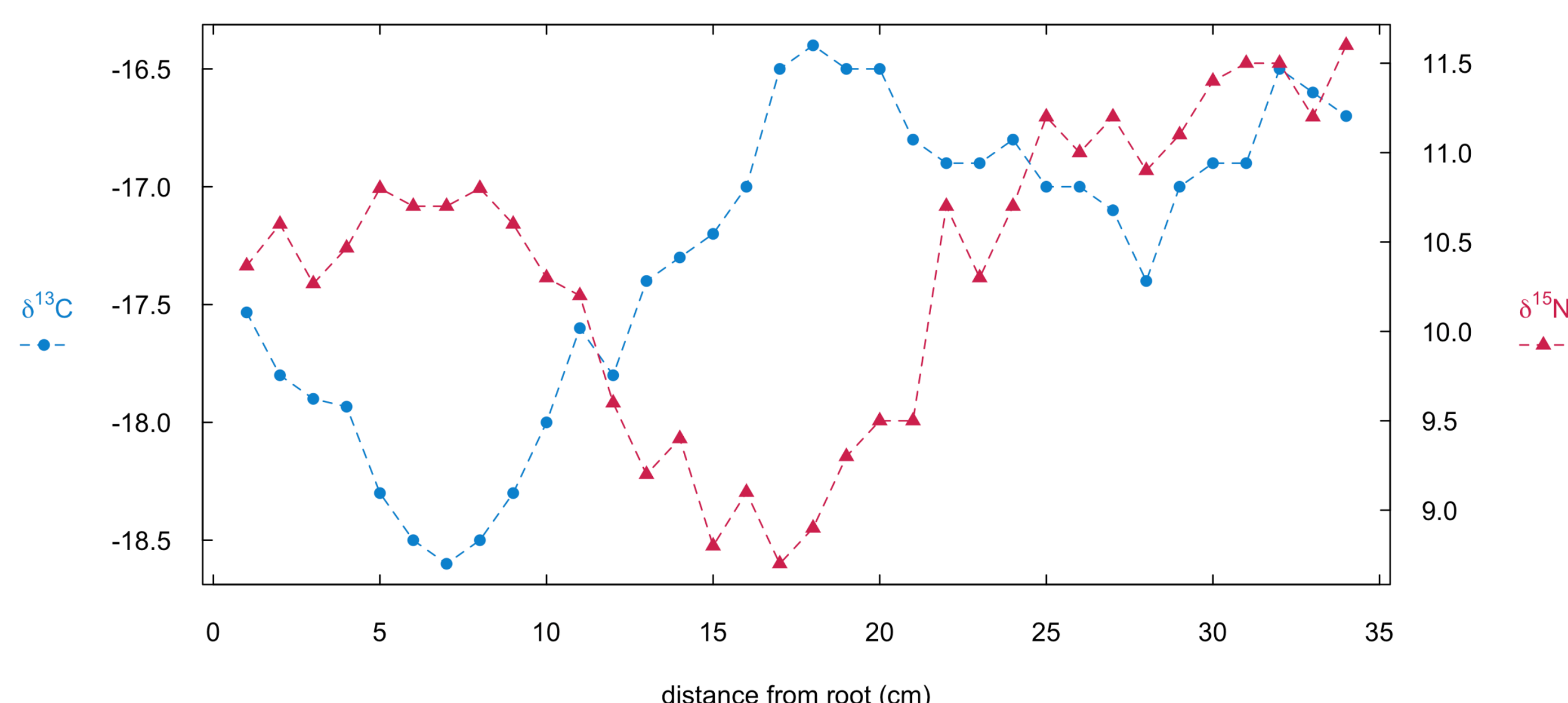
right whale (*Eubalaena glacialis*) for progesterone and cortisol.

Stable isotope analysis was carried out at the Duke Environmental Stable Isotope Laboratory. Hormone assays were performed using Arbor Assays EIA kits (K025, K003) following methanol extraction based on [3].



Steroid hormone concentrations were determined from 4 parameter logistic standard curve fits calculated in R package *nplr* [5].

$\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ provide an internal clock from seasonal cycles along the growth axis.



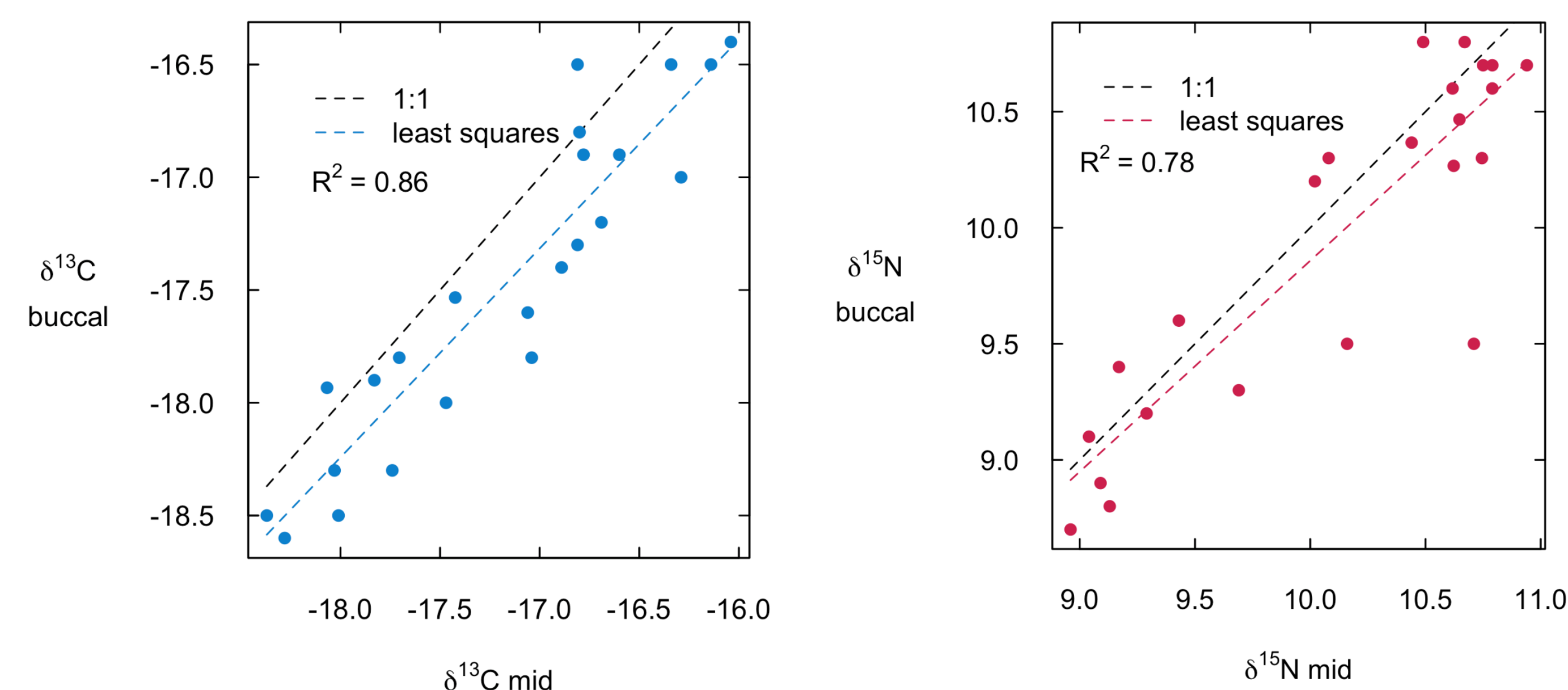
Stable isotope ratios are shown here for a single fin whale plate sampled along the growth axis. $\delta^{13}\text{C}$ ratios generally reflect prey identity. $\delta^{15}\text{N}$ ratios are used as a proxy for trophic level. Cycles in both represent seasonal patterns of migration and foraging.

Acknowledgements and References

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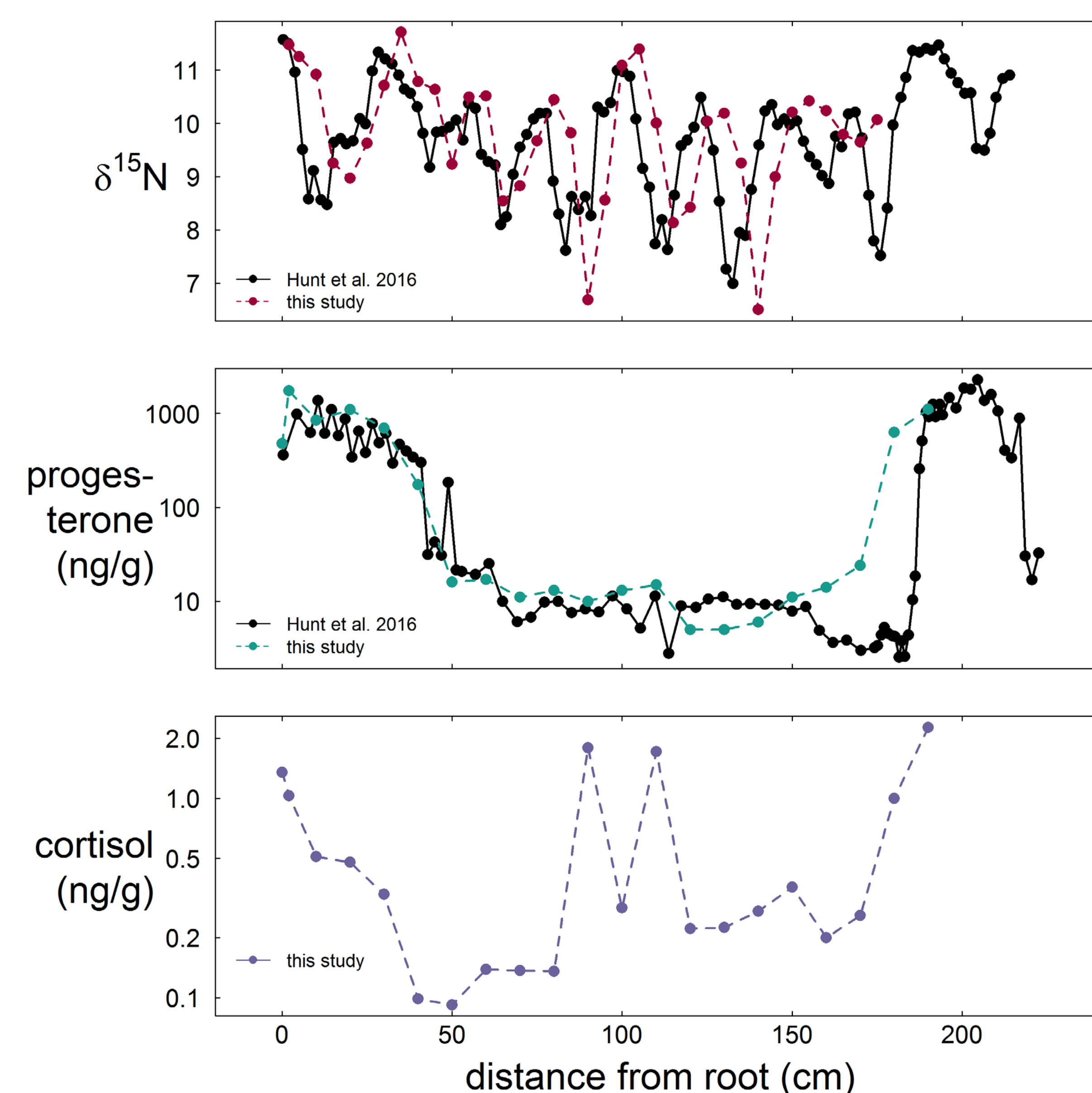
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 [4] Hunt, K. E., Lysiak, N. S., Moore, M. J., & Rolland, R. M. (2016). Longitudinal progesterone profiles in baleen from female North Atlantic right whales (*Eubalaena glacialis*) match known calving history. *Conservation Physiology*, 4(1), cow014.
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$\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values are consistent along the non-growth axis.



Stable isotope values are closely correlated along the non-growth axis in a fin whale baleen plate. There may be a slight systematic difference in $\delta^{13}\text{C}$ across the plate.

Cortisol concentration increased in baleen during pregnancy. Plates are similar in growth rate.



Progesterone concentrations in this study were similar to those presented in [4]. High progesterone levels coincides with pregnancy at the time of death in 2004 and a calf born in 1996.

Growth rates appeared similar between plates from the same individual, although there may have been some warping at the distal end.

Cortisol concentrations increased during pregnancy, providing a biological validation that baleen cortisol accurately reflect systemic concentrations.

Next steps

Quantify the relationship between baleen stable isotope ratios and steroid hormone concentrations and comparable values for soft tissues which can be collected in the field via biopsy sampling.

Calculate the rate of steroid hormone degradation over time in the keratin matrix.

Apply baleen stable isotope analysis and hormone assays together to answer questions about mysticete ecology and life history.