Ontogenetic partitioning on a key minke whale foraging ground: insights from stable isotope analysis

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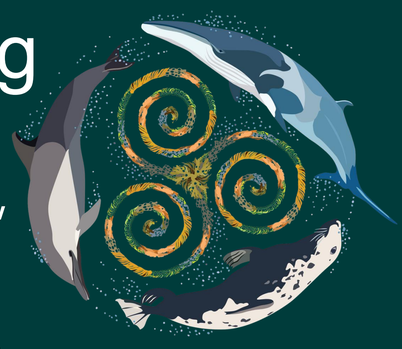

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Introduction

- Northeast Scotland offers rich foraging opportunities for minke whales (Figure 1).
- We know that they target schooling fish such as sand eel, herring, and sprat.
- Ecological partitioning between age groups has been observed in minke whales (Robinson *et al.*, 2023).

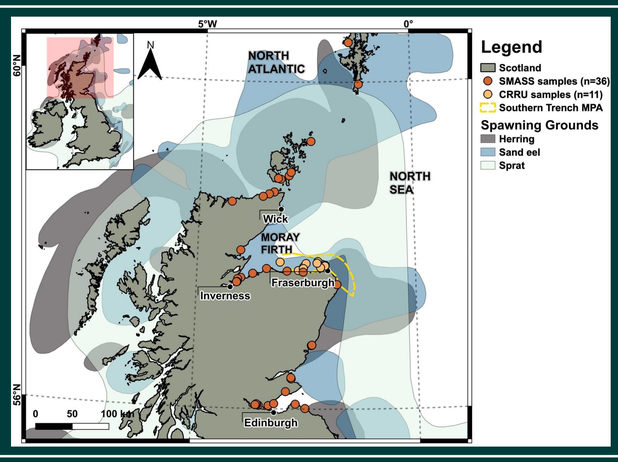


Figure 1. Northeast Scotland study area and locations of sampled minke whales.

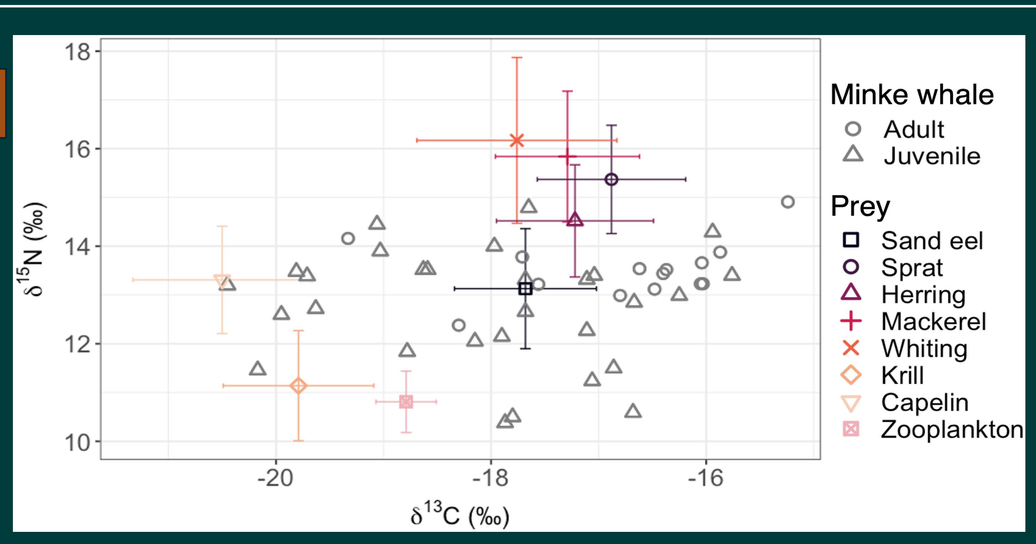


Figure 2. Mean ± SD $\delta^{13}C$ and $\delta^{15}N$ ratios of prey sources, and individual $\delta^{13}C$ and $\delta^{15}N$ isotope ratios of minke whales.

Methods

- Minke whale skin and prey muscle tissue samples attained.
- Samples lipid extracted and analysed for $\delta^{13}C$ and $\delta^{15}N$ (Figure 2).
- Applied a 'best guess' trophic discrimination factor (TDF).
- Bayesian mixing models estimated relative dietary contributions (Parnell et al., 2023) (Figure 3).
- Bayesian ellipse methods calculated isotopic niche metrics (Total area/TA, Standard Ellipse Area/SEA) of whale groups and respective overlap (Jackson *et* al., 2011) (Figure 4; Table 1).

Results

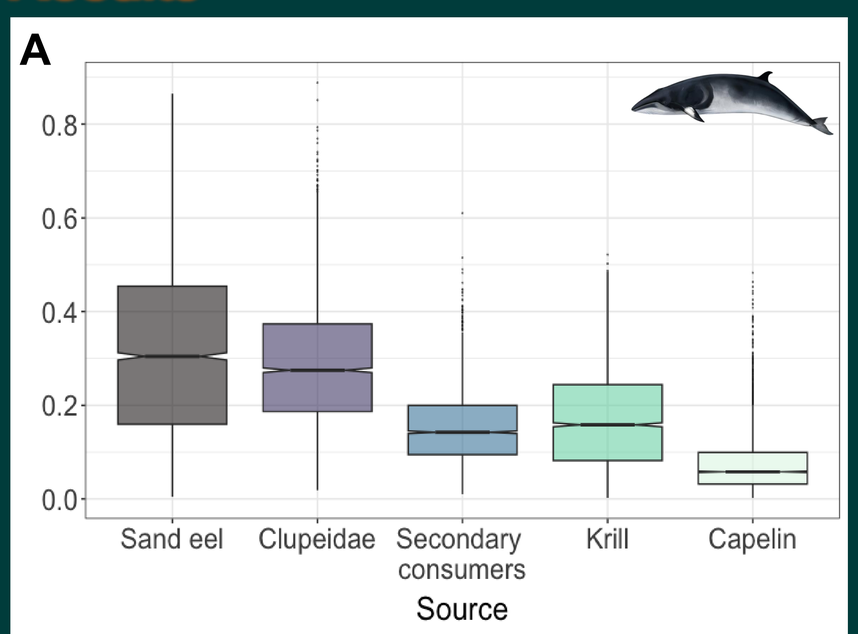


Figure 3. The proportions of putative prey to the diet of (A) adult whales, and (B) juvenile whales.

Diet

- Adults targeted sand eel (31 ± 19%) and Clupeidae (29 ± 14%).
- Juveniles targeted a sand eel (32 ± 20%) and krill (33 ± 13%).

Isotopic niche

- Juvenile whales occupy a larger isotopic niche than adults.
- The respective niche area overlap is only 11% between the two age groups.

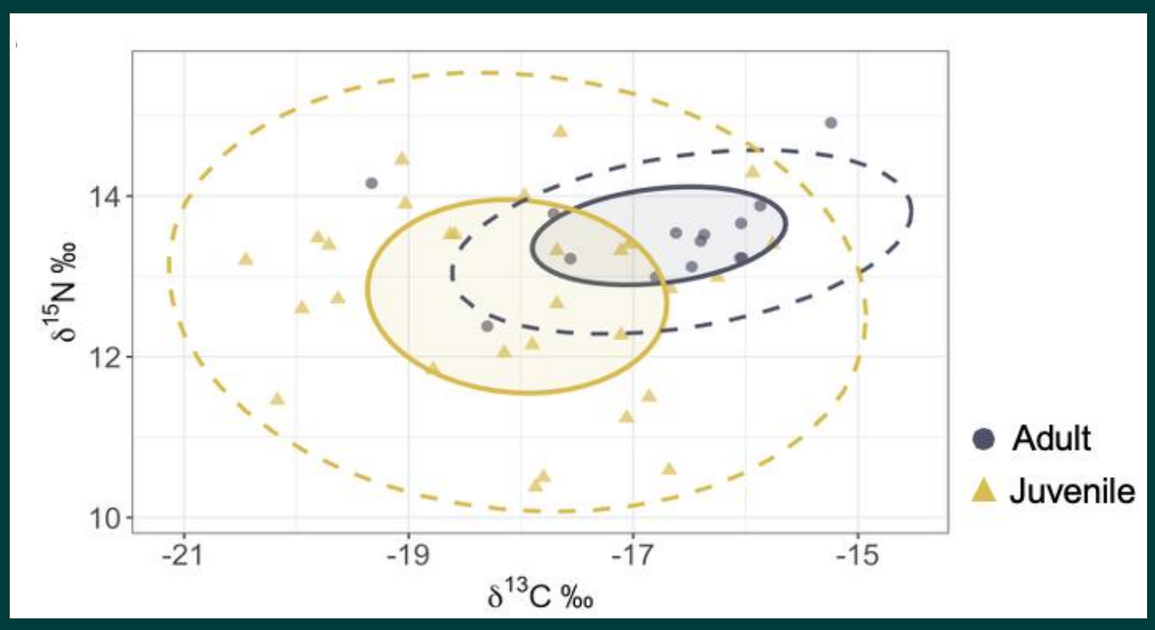
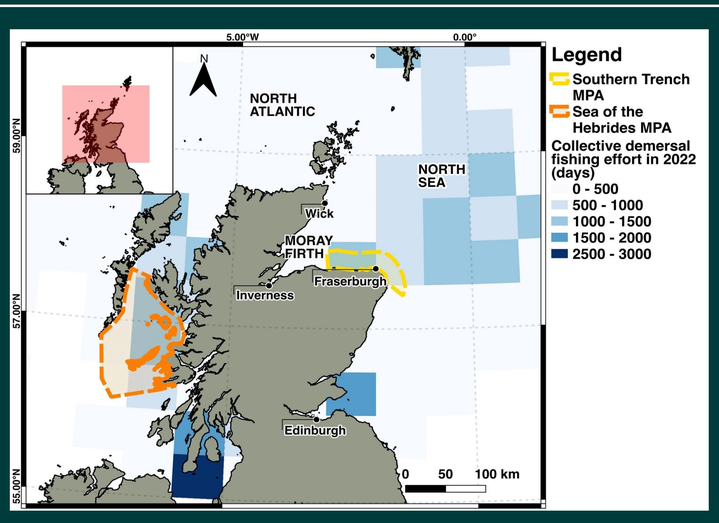


Figure 4. Isotopic niche areas of adult and juvenile whales, and their overlap.

Figure 6. Demersal fishing effort in two minke whale MPAs.



Discussion

- Inclusion of krill and capelin suggests possible movement between higher latitude foraging grounds.
- Experienced adults may have greater success targeting more evasive, higher energy fish, of commercial significance.
- Juveniles demonstrate greater dietary plasticity; an adaptive advantage in areas of patchy prey availability.
- Key considerations for MPA and fisheries management.

References

Robinson, MacDougall, D. A. I., Bamford, C. C. G., Brown, W. J., Culloch, R. M., Dolan, C. J., Hall, R., Russell, G., Sidiropoulos, T., Spinou, E., Sim, T. M. C., Stroud, E., Williams, G. and Haskins, G. N. 2023. Ecological habitat partitioning and feeding specialisations of coastal minke whales (Balaenoptera acutorostrata) using a designated MPA in northeast Scotland. *PLOSOne*. 18(7). doi:10.1371/journal.pone.0246617.

Parnell, Inger, Bearhop and Jackson. 2023. simmr: A stable isotope mixing model. Rpackage version 0.5. PLoS ONE. doi:10.1371/JOURNAL.PONE.0009672.

Jackson, Inger, R., Parnell, A. C. and Bearhop, S. 2011. Comparing isotopic niche widths among and within communities: SIBER – Stable Isotope Bayesian Ellipses in R. Journal of Animal Ecology. 80(3). pp.595–602. doi:10.1111/J.1365-2656.2011.01806.X.