**Final Report**

# Isotopic assessment between foraging strategies of adult female northern elephant seals (*Mirounga angustirostris*) and fasting stress of their offspring

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The colonies of the northern elephant seal (*Mirounga angustirostris*; NES) in Mexico, such as the San Benito Archipelago (SBA), have been declining over the recent decades, due to the increase in air temperature that may induce physiological stress (hyperthermia) on the animals. Pups are the most vulnerable age class to environmental oscillations, which can be mostly affected during the fasting period they go through once they are weaned, conditioning their survival during the first year of life. A critical factor to achieve this survival is the lactation process, which depends on the foraging success of their mothers during their post-molting migrations. The aim of this project was to determine the foraging strategies of female NES in their last months of post-molting migration, through chronological isotopic changes ($\delta^{15}N$ and $\delta^{13}C$) along the pups' vibrissae, as well as the relationship that these strategies may have on the physiological stress of pups during their post-weaning fasting.

A total of 37 pups (one month old) were sampled during the 2023 breeding season in the SBA. Two vibrissae were extracted per pup: one in February (recently weaned) and a second one in March (after one month of fasting). Through the equidistant segmentation of the February vibrissae, isotopic profiles and maternal specialization indices were obtained. This index was related to the increase in $\delta^{15}N$ (in follicles of vibrissae) between sampling months (March relative to February) as a measure of post-weaning fasting stress in pups.

## Project results

The isotopic profiles (n=15; Fig. 1) showed an approximate isotopic window of 5 months (~173 days) according to the linear growth rate calculated for NES (0.44 mm/day; Aurioles-Gamboa et al. 2019). These results allowed us to observe the behavior of females during their last months of the post-molting migration due to the variation of both isotope ratios (Newsome et al. 2007), which

was associated with the return from their distant feeding areas towards the SBA (August-December); as well as the lactation period, which lasts ~ 28 days (January-February).

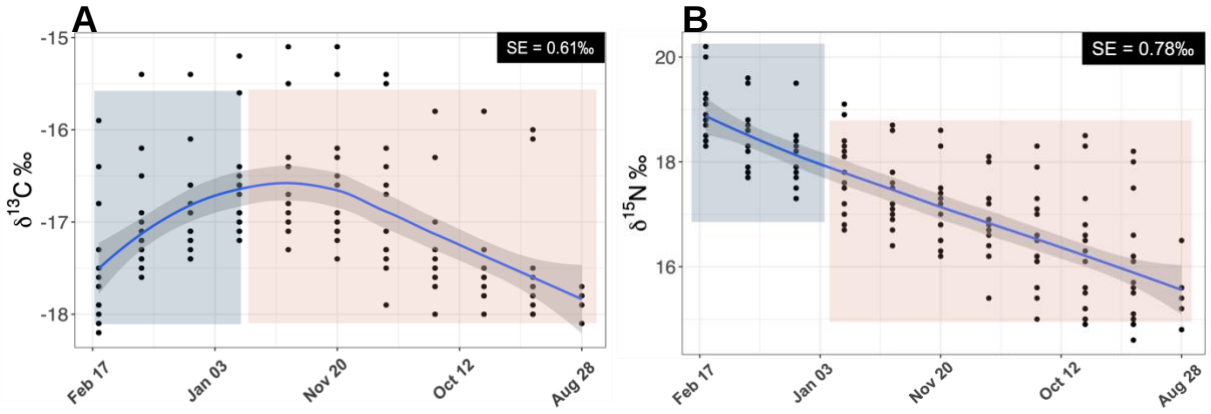


**Figure 1.** Isotopic profiles (n=15) of northern elephant seal pups (*Mirounga angustirostris*) from the San Benito Archipelago during the 2023 breeding season. A) $\delta^{13}C$ profile; B) $\delta^{15}N$ profile. The orange area represents the post-molting migration information. The blue area represents the lactation process.

Considering the results of the isotopic profiles, the specialization index (*S*) was calculated (n=15). 60% of the females were generalists in the area used (S>0.5), using more than 50% of the available habitat during their foraging trip (Hückstädt et al. 2011), while the remaining 40% corresponded to specialist females.

Regarding the stress in pups due to post-weaning fasting (n=37), a variable $^{15}N$-enrichment between 0.2 to 1‰ was observed in March relative to February (n= Fig. 2). These results were significant ($p<0.05$), showing a mean enrichment of 0.6‰ in the $\delta^{15}N$, indicating the presence of protein catabolism due to fasting (Hertz et al., 2015). However, no linear relationship was found between specialization index and $^{15}N$-enrichment ($R^2= 0.007$); thus, a Loess regression was performed to find a trend in the data. The highest enrichment values were present in pups from females NES with an intermediate index (S~0.5).

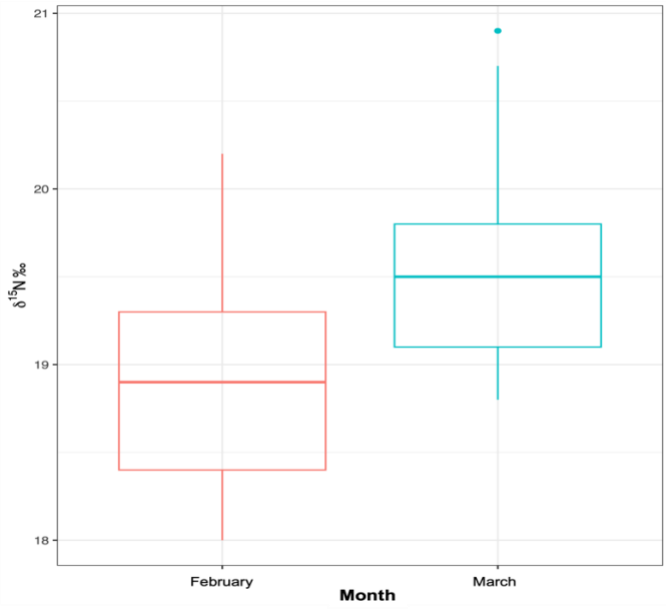


**Figure 2.** $^{15}N$ enrichment related to one month of post-weaning fasting on northern elephant seal pups during the 2023 breeding season.

## Final comments

I would like to thank to the Society for Marine Mammalogy for the financial support given through the Small Grants in Aid of Research 2022. A manuscript will be submitted with the results obtained, once the analyses are completed. This will include acknowledgements to the Society for Marine Mammalogy.

## References

Aurioles-Gamboa D, Newsome SD, Hassrick JL, Acosta-Pachón T, Aurioles-Rodríguez F, Costa DP. 2019. Use of 15N-enriched glycine to estimate vibrissa growth in free-ranging northern elephant seals Mirounga angustirostris. Mar Ecol Prog Ser 614: 199-207.

Hertz E, Trudel M, Cox MK, Mazumder A. 2015. Effects of fasting and nutritional restriction on the isotopic ratios of nitrogen and carbon: a meta-analysis. Ecology and Evolution 5(21): 4829-4839.

Hückstädt LA, Koch PL, McDonald BI, Goebel ME, Crocker DE, Costa DP. 2011. Stable isotope analyses reveal individual variability in the trophic ecology of a top marine predator, the southern elephant seal. Oecologia.

Newsome SD, Martínez del Rio C, Bearhop S, Phillips DL. 2007. A niche for isotopic ecology. Frontiers in Ecology and the Environment, 5(8): 429-436.