Inter-specific overlap in foraging habitat use and diet but segregation in utilization of winds in Antarctic fulmarine petrels

Nina Dehnhard[1]

[1] *Norwegian Institute for Nature Research (NINA), Trondheim, Norway*

Antarctic fulmarine petrels, as all procellariform seabirds, rely heavily on wind for their energy-efficient, gust-soaring flight. According to physics, flight speeds and thus commuting costs are highly dependent on wind speeds and wind direction, and differences in wing loading (mass per surface area) between species may further affect flight behaviour. With global climate change, wind patterns in the Southern Hemisphere are predicted to change, as is the amount and distribution of sea ice, which is an important foraging habitat for these species. Identifying the currently utilized foraging habitats and diets and how wind conditions affect the travel to and from foraging sites is essential to understand the species' biology and help make predictions about how future changes will affect the species. I will here present data that have been previously published (see Dehnhard et al. 2020, 2021) and discuss the results in the context of ecological niche theory and climate change.

In 2015/16 the foraging behaviour and diet of southern fulmars (*Fulmarus glacialoides*), Antarctic petrels (*Thalassoica antarctica*) and cape petrels (*Daption capense*) breeding sympatrically on Hop Island (68.82°S, 77.68°E) in the Prydz Bay region (East Antarctica) was investigated. The three species show a gradient in mass and wing loading, with southern fulmars being approximately twice as heavy as cape petrels, but Antarctic petrels having the highest wing loading. Using lightweight GPS loggers, a total of 270 foraging trips were recorded, covering the entire 2015/16 breeding season from incubation to late chick-rearing in all three species, including multiple foraging trips made by several individuals. Blood, feathers and egg membranes were collected from the same species.

GPS data were intersected with environmental data from remote sensing (e.g. bathymetry, sea ice concentration, wind speed and wind direction). Foraging locations were identified using wet/dry data recorded by the GPS loggers and Expectation-Maximization binary Clustering (EMbC). Generalized Additve Models (GAMs) were used to identify habitat characteristics associated with foraging locations, and kernel analyses to assess inter-specific overlap in spatial habitat use. Stable isotopes were used to explore the dietary overlap between the three seabird species using isotopic niche parameterisation and estimates of resource use through mixing models. The commuting sections (outbound and inbound legs) of foraging trips during the chick-rearing period were used to investigate the relationship between wind speed and wind direction and the birds' flight speed over ground as well as trip distances.

All three species showed a high overlap in utilized foraging areas and isotopic niches as well as timing of foraging. There was also no indication for individual specialisation in foraging behaviour or habitat characteristics. Wind direction relative to flight direction (and thus whether birds were encountering head- or tailwinds) did not affect how far away from the colony birds were feeding. However, wind speeds and wind direction had distinct effects on flight speeds of the three species, with Antarctic petrels reaching higher flight speeds than the other two species. All three species reached higher flight speeds under tailwinds, especially on return trips from foraging, when wing loading was increased since birds carried food for their chicks.

The high overlap in space use and diet among the three study species is likely a result of high food availability in the sea ice zone during the Antarctic summer and may further be driven by high spatial mobility of prey swarms. This allowed the three sympatrically breeding species to coexist despite feeding on the same resources within the same spatial area. The only inter-specific differences in foraging behaviour were linked to flight speeds and utilizing winds, likely caused by the morphological differences among the three species. These results highlight the importance of winds for the long commutes to their foraging locations. Changes in sea ice and resulting prey availability as well as changes in wind patterns that affect the ability to fly at low cost may have significant implications for this species group in the future.

References

Dehnhard, N., Achurch, H., Clarke, J., Michel, L., Southwell, C., Eens, M. and L. Emmerson, High inter- and intraspecific niche overlap among three sympatrically breeding, closely-related seabird species: Generalist foraging as an adaptation to a highly variable environment? Journal of Animal Ecology 89: 104-119, 2020.

Dehnhard, N., Klekociuk, A.R. and L. Emmerson, Interactive effects of body mass changes and species-specific morphology on flight behavior of chick-rearing Antarctic fulmarine petrels under diurnal wind patterns, Ecology and Evolution 11: 4972–4991, 2021.