Trophic structure and resource use in SW Greenland fjord communities: A stable isotope approach

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Arctic regions are undergoing significant changes due to global warming, driving ice sheet and glacier melt. Marine-terminating glaciers (MTGs) are retreating rapidly, with many having already transitioned or currently in the process of transitioning into land-terminating glaciers (LTGs). This shift in glacier type fundamentally alters Arctic fjord ecosystems. MTGs enhance pelagic productivity by releasing subsurface meltwater that drives nutrient upwelling, supporting diatom-based primary production and large zooplankton. In contrast, LTG-influenced fjords, fed by meltwater rivers, are more stratified and nutrient-depleted at the surface, resulting in less productive, picoplankton-dominated communities. These fundamental differences at the base of the fjord food web are expected to cascade through higher trophic levels, influencing both pelagic and benthic compartments and potentially reshaping the structure and functioning of the entire food web. However, these impacts remain poorly understood.
This study investigates how glacier type (MTG vs. LTG) influences resource use and trophic structure in Arctic fjord communities. Using stable isotopes ($\delta^{15}N$ and $\delta^{13}C$), we characterize the isotopic niches of species communities across two fjord types in SW Greenland: a fjord influenced purely by LTGs (LTG fjord) and one under mixed influence of MTGs and LTGs (mixed fjord). Sampling focused on the outer fjord region and the more glacier-influenced inner fjord region to capture environmental variability within each fjord type. Our analysis builds on unique stable isotope data comprehensively covering the food web—from benthic (meio- and macrobenthos, demersal fish) to pelagic (zooplankton)—collected during the RV Belgica campaign in summer 2023 (Belspo project CANOE). This represents the first integrated benthic-pelagic food web study in Greenlandic fjords.

Our results revealed that, at the whole-community level (including benthic and pelagic), communities from all sampling locations occupy similar isotopic niche dimensions (i.e., similar $\delta^{15}N$ and $\delta^{13}C$ ranges and high niche overlap), despite significant differences in taxonomic composition between and within fjord types. However, the number of distinct feeding clusters—groups of organisms with similar $\delta^{15}N$ and $\delta^{13}C$ values—increases toward the inner regions of both fjord types, indicating higher trophic diversity in these areas. Greenland cod (*Gadus ogac*) and sea star *Ctenodiscus crispatus* are the top consumers (highest $\delta^{15}N$) at all locations. Basal consumers (lowest $\delta^{15}N$) include Decapod Zoea larvae in the pelagic zone, and meiofauna (harpacticoid copepods, kinorhynchs) in the benthic zone, except at the inner station of the LTG fjord, where the polychaete family Maldanidae also occupies the lowest trophic level.

Differences between fjord types become evident when focusing only on the macrobenthic community. In the inner, glacier-influenced region of the mixed fjord, macrobenthos occupy a narrower isotopic niche compared to macrobenthic communities in the LTG fjord. This may reflect greater specialization or reduced resource availability in the mixed fjord, possibly indicating lower resilience of macrobenthos to environmental change. However, fully understanding how glacier type influences these patterns requires investigation across the full gradient of fjord types, including fjords solely influenced by MTGs (MTG fjord). This will become possible with additional stable isotope data from a purely MTG fjord, to be collected in 2025.

Keywords
Arctic Fjords; Glacier Retreat; Food Webs; Stable Isotopes