Leibniz Institute For Baltic Sea Research Warnemünde

Trophic diversity of smelt, pikeperch and terns in the Elbe Estuary in 2021

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BluEs

Bundesministerium für Bildung und Forschung

Introduction

Is the collapse of terns and smelt in the Elbe estuary related to changes in their position in the energy pyramid? In the BluEs project, changes in functional biodiversity of food webs, namely changes in the trophic position of it's key species smelt (*Osmerus esperlanus*), pikeperch (*Sander lucioperca*), and arctic and common terns (*Sterna paradisaea* and *S. hirundo*), are directly measured and related to stressors to answer this question. ■

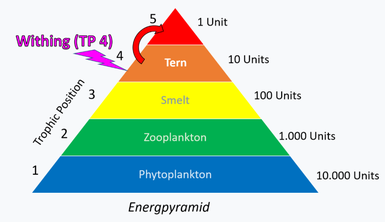


Figure 1: Energy loss within every step in a food web[1].

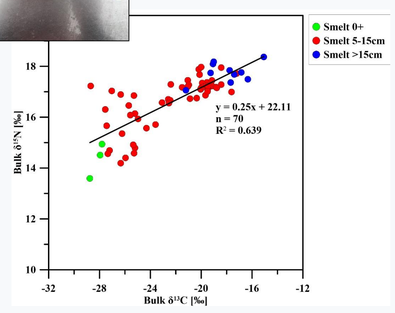


Figure 2: Bulk $\delta^{15}N$ and bulk $\delta^{13}C$ values of smelt of different size classes sampled within the three stations of the Elbe estuary in June, August and November 2021.

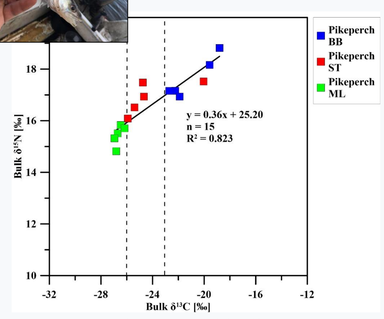
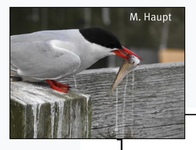


Figure 3: Bulk $\delta^{15}N$ and bulk $\delta^{13}C$ values of pikeperch (10-20cm) sampled in Mühlenberger Loch (ML), Schwarztonnensand (ST) and Brunsbüttel (BB) in August 2021.



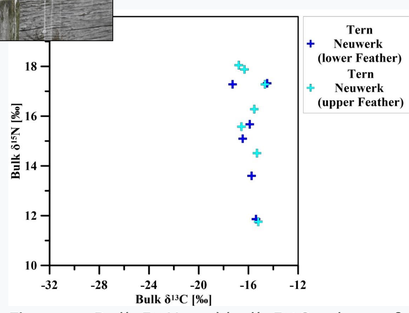


Figure 4: Bulk $\delta^{15}N$ and bulk $\delta^{13}C$ values of upper and lower feather sample parts of arctic terns collected on the island of Neuwerk in June 2021.

Results and Discussion

Terns in the Elbe estuary occupy higher trophic positions than expected, possibly caused by preying on whiting instead of smelt. That leads to a drastic reduction of mass and energy supply within 50% of the tern stock of the estuary. ■

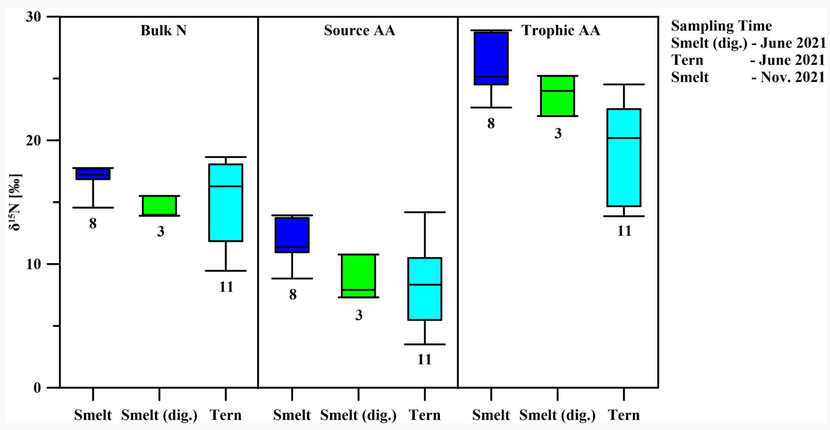


Figure 5: Box plot of the pooled bulk $\delta^{15}N$, $\delta^{15}N$ source AA and $\delta^{15}N$ trophic AA values of tern feathers and smelt out of tern stomach content (smelt dig.) sampled in June and smelt sampled within the estuary within November 2021.

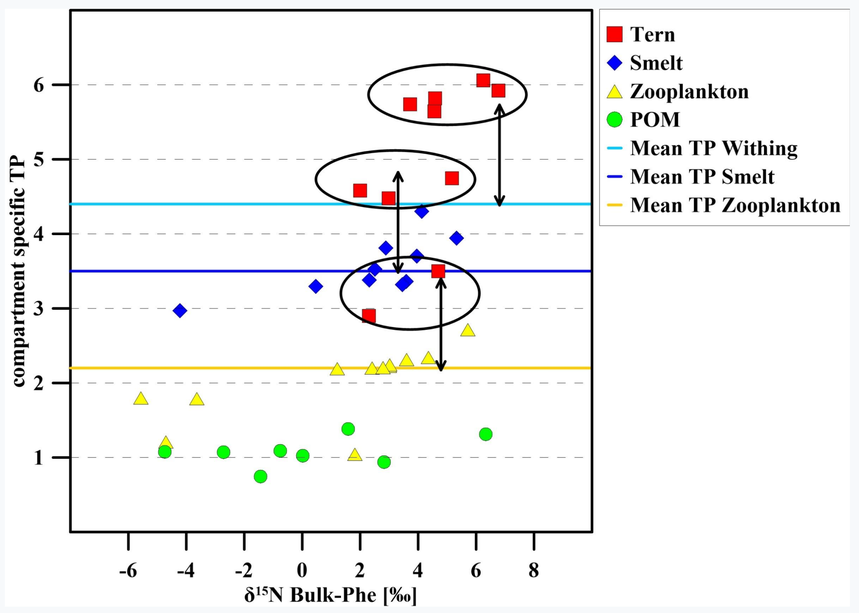


Figure 6: Plot of bulk $\delta^{15}N$ values normalised against the $\delta^{15}N$ Phe values against the TP values based on multiple equations[2,3,4] for POM, Zooplankton, Smelt and Terns. Coloured lines indicate mean TP values based on literature[5] or data of this study.

Materials and Methods

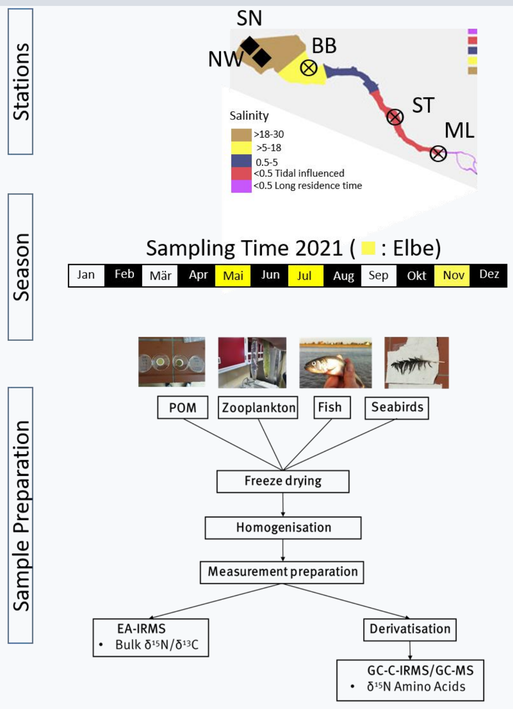


Figure 7: Sampling stations, strategy, and preparation of the pelagic food web members in the Elbe estuary for top carnivores from SN: Scharhörn, NW: Neuwerk and their food base from BB: Brunsbüttel, ST: Schwarztonnensand, ML: Mühlenberger Loch.

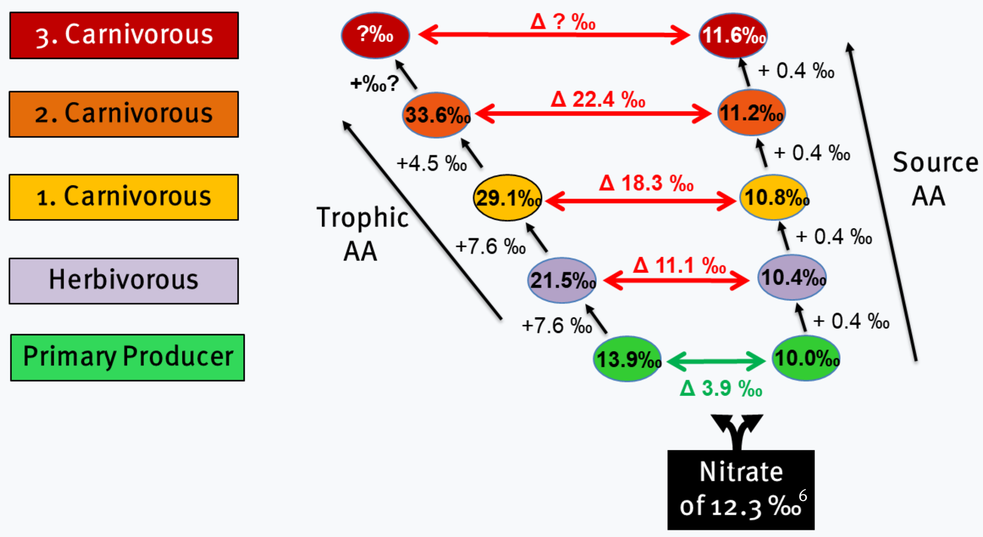


Figure 8: Changes in the $\delta^{15}N$ of so called "trophic" and "source" amino acids (in ‰) in the different samples from the pelagic food web in the Elbe estuary. This trophic cascade, these amino acid groups and the different enrichment factors over the trophic steps are the basis for trophic position calculations. Samples are derivatised into TFA-esters and analysed by means of gas chromatography-combustion-isotope ratio mass spectrometry (GC-C-IRMS) with a precision ‹1.0 ‰ from three to four runs.

Conclusions

Pikeperch functions as an indicator for stressors at different parts of the estuary due to its site-faithfulness ■

Smelt seems to perform a dietary and site shift within its ontogenesis ■

Half of the terns have increased their position in the energy pyramid from 4 to 5. This can explain why the population in the Elbe estuary has collapsed ■

References | 1 Post et al., 2000 | 2 Chikaraishi et al., 2009 | 3 Brault et al., 2019 | 4 Bradley et al., 2015 | 5 Fishbase, 2022 | 6 Russnack, personal communication

Acknowlegdements

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