Size composition of mesozooplankton as a valuable indicator of energy transfer in the pelagic food-web of Algoa Bay

SAMSS Vision 2022

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Introduction

Algoa Bay: A highly dynamic bay

Algoa Bay had a marked variability over scales of kilometres and days in oceanographic parameters, due to its position in the transition zone between the northeast Agulhas Current region and the Agulhas Bank shelf, and to the effect of multiple coastal features inside the bay.

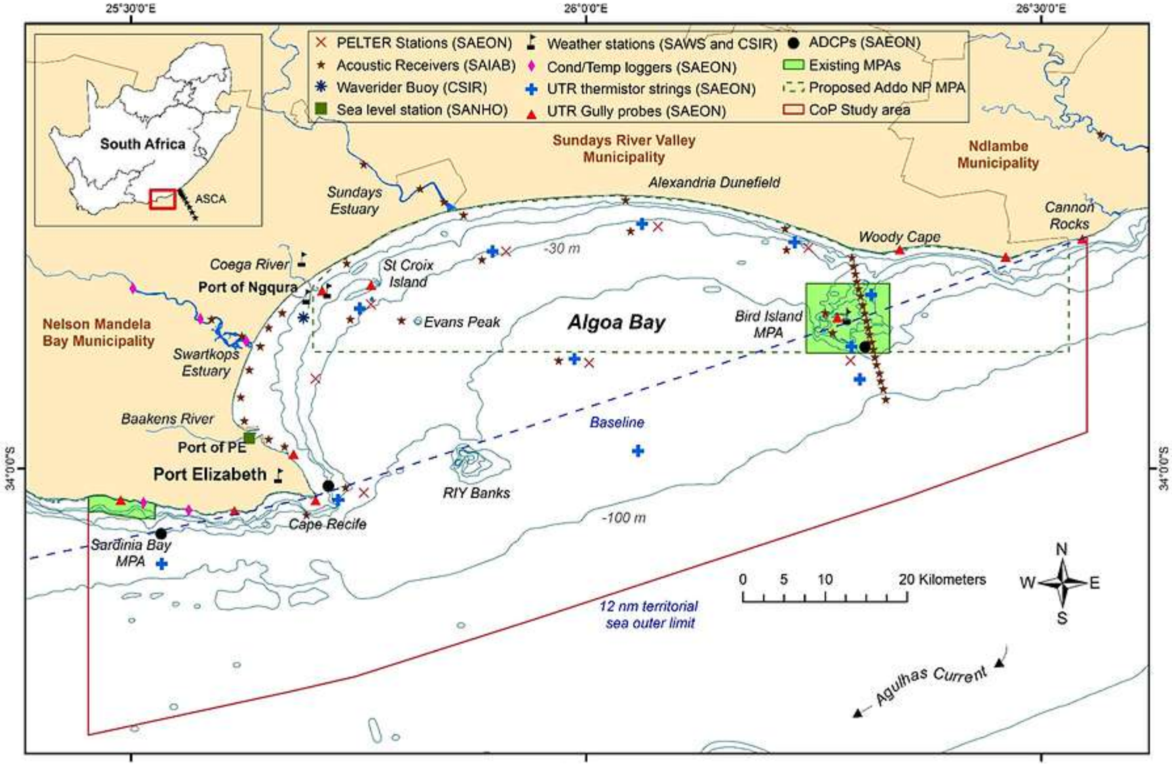

Fig. 1. Map of Algoa Bay and the multiples research activities in the area (Source Algoa Bay Project).

Algoa Bay: Research informs better management

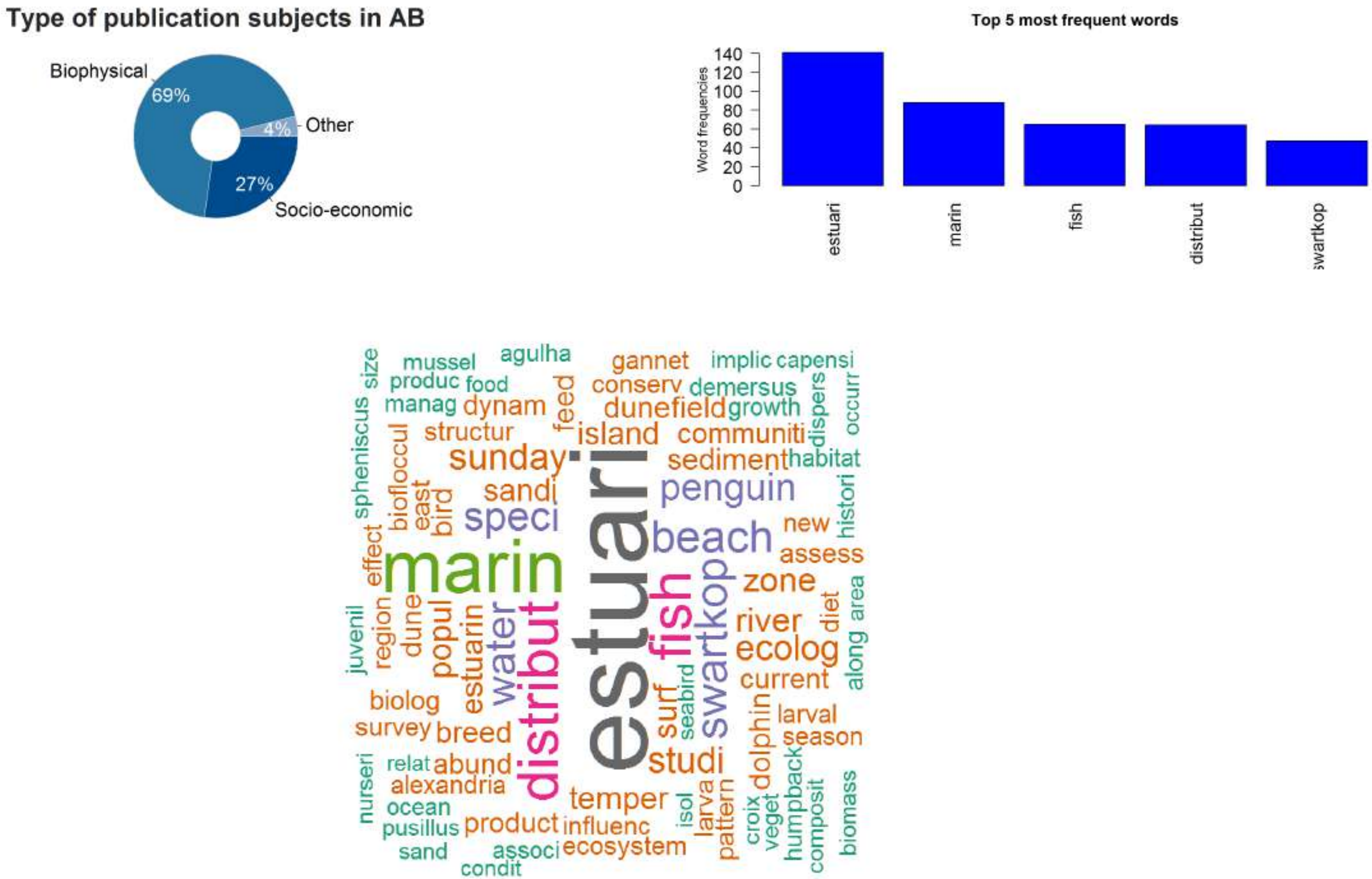

Fig. 2. Categories more studied in Algoa Bay were biophysical and socieconomic subjects. Among Biophysics, the items more explored were estuaries, marine, fish and distribution (*Prepared by the authors based on* Algoa Bay Project).

Modelization of energetic transfer through size composition

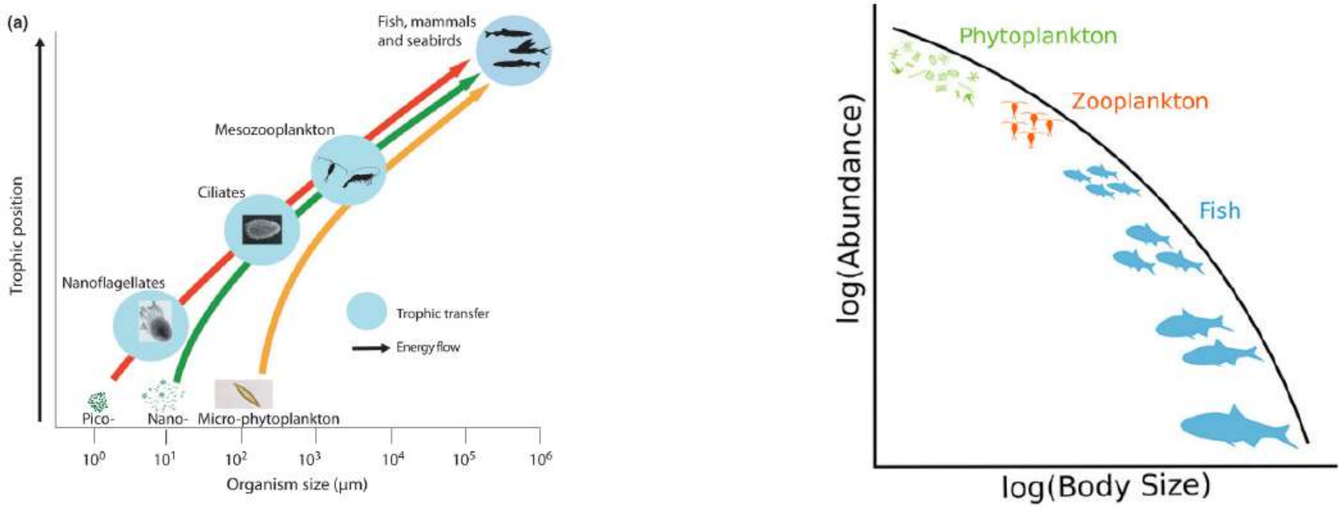

Fig. 3. In marine systems the flux from primary production to higher trophic levels is determined by size, which can be useful to estimate the efficiency on energy transfer because biomass follow a linear relation (Based on Boyce *et al.* 2015 and Everett *et al.* 2017).

Normalized Biomass Spectrum (NBSS) predicts a linear reduction of biomass with size in log–log scale (Platt and Denman, 1977, Zhou 2006), and the slopeof that linear relationship is hypothesized -1 at stable state.

$$\text{Biomass size spectrum (BSS)} = \frac{log(\text{Biomass in the size interval})}{log(\text{Size of the interval})}(m^{-3})$$

Objectives

1. Use size composition of mesozooplankton to estimate the **energy transfer** from small to big mesozooplankton in Algoa Bay, considering thT mesozooplankton IS a key component linking producers and fish in the food web.

2. Determine the **importance of environmental conditions, trophic status or predation pressure** on the configuration of the mesozooplankton size composition.

- At temporal scale : A year round from 2017 to 2018, to determine **bimonthly effect**.

- At spatial scale : 8 stations around St Croix Island, to determinate if there is an **'island mass effect'**.

Methodology

Fieldwork

- Physical parameters: Water temperature, SST, D. Oxygen, Turbidity.
- Trophic status: Nutrients (NO_xN, NH_4, PO_4, SiO_3), Chl-*a*.
- Mesozooplankton (WP2 nets 300 μm).
- Predators: Fish larvae (nets 500 μm).

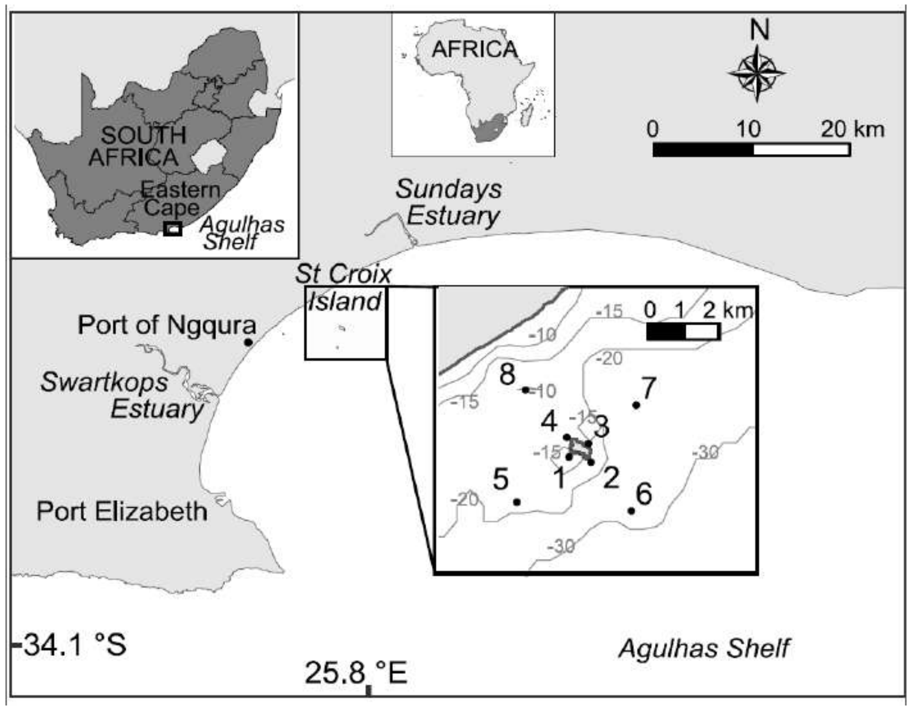

Fig. 4. Map of Algoa Bay and the 8 stations sampled during Spring (Sep-Oct), Summer (Dec-Jan), Autumn (Apr-May) and Winter (Jun-Jul) 2017-2018.

Mesozooplankton indexes

In the laboratory, mesozooplankton net samples were split to obtaining a sample of 500-2869 ind. that was scanned using a Zooscan (Vandromme *et al.* 2014). Individuals were counted and identified using Ecotaxa (Picheral M, Colin S, Irisson J). 6 indexes were estimated:

- Abundance $(ind. m^3)$
- Biovolume $(mm^3. m^3)$

- NBSS slope
- NBSS intercept
- NBSS linear fit

$$NBSS = \ a + b * log(\text{Size intervals})$$

- Size diversity

$$H = -\sum_{p=1}^{S} (p_i)(ln\ p_i)$$

Results

Monthly variability of NBSS in Algoa Bay

Significant monthly differences in the NBSS parameters and size diversity. Steeper slopes during summer and flatter slopes during winter combined with lower size diversity in summer and larger size diversity in summer.

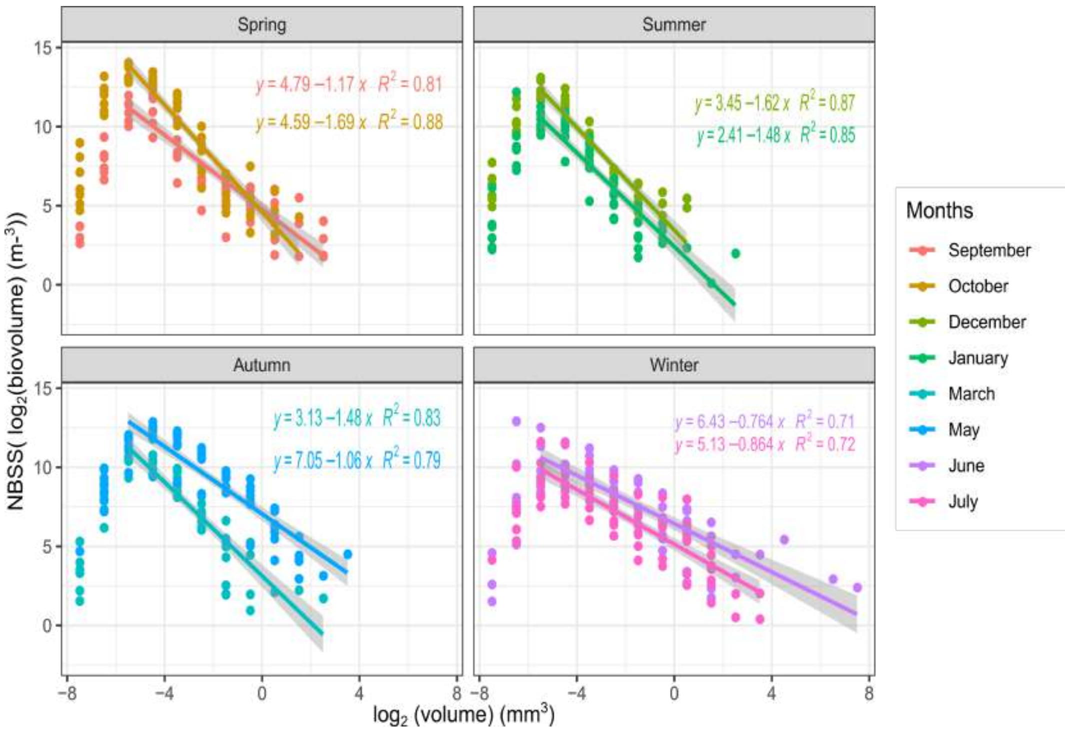

Fig. 5. NBSS regressions by month. The linear regression equations were represented with distinctive colors for each month.

Monthly variability of NBSS in Algoa Bay: by stations

The only significant differences observed were between autumn and winter months, where the shallower and closer to the coast station had flatter slopes and more size diversity.

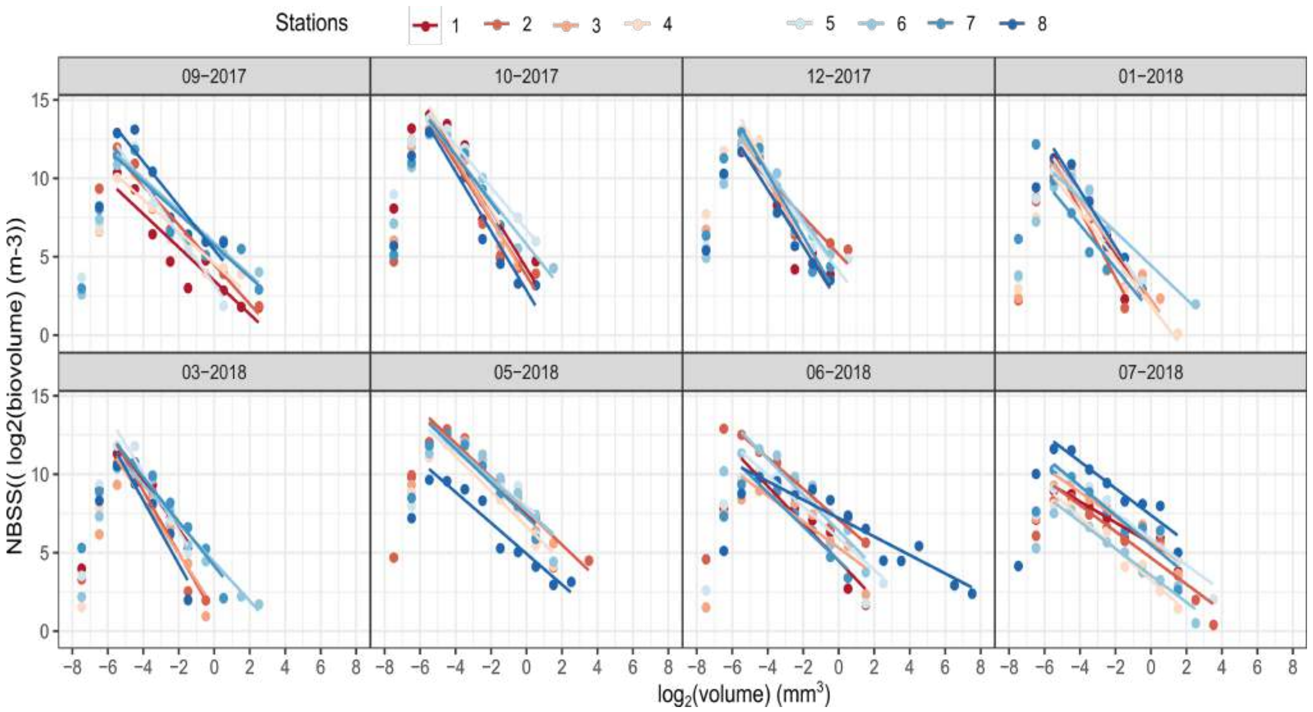

Fig. 6. NBSS regressions by month and stations. Stations from 1 to 4 (proximal to St Croix island) were represented in a range of red colors and 5 to 8 (distal to St Croix Island) were represented in blue colors.

Effects of environmental, trophic and predation conditions on size composition

Silicates, water temperature and Chl-a were the most important variables to explain the NBSS slope and intercept, while ammonium and turbidity was more important for size diversity. For most indexes variables used explain ~60% of their variance.

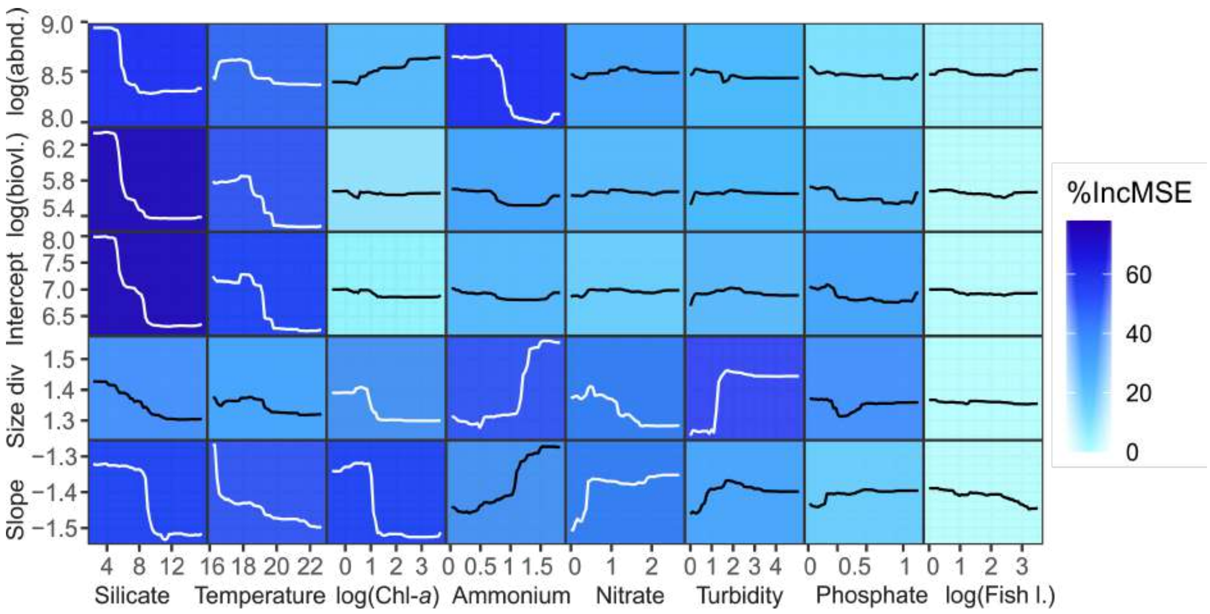

Fig. 7. Heatmap of the %IncMSE (increase in MSE of predictions). Higher values represented with deep blue indicate a higher importance of the predictor variable. Additionally partial plots are represented inside each square. For the most important predictors, the relation on partial plots were highlighted with white lines.

Discussions and Conclusions

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- The average slope **-1.36** indicated a pelagic system with relative high productivity but low trophic transfer efficiency from small to large organisms. Following the equations for energy transfer efficiency applied to the slope and assuming a system assimilation of 70% (Zhou 2006), the biomass transfer from herbivorous to carnivorous zooplankton was recycled **1.7** times in winter, but only **0.4** times in summer.

- Physical parameters and trophic status were the most important variables to explain size composition of mesozooplankton, while predation was not a significant effect.

- Among physical parameters water temperatures was sorted as one of the most important parameters controlling the size composition of mesozooplankton which has strong implications given the rise of water temperatures related to climate change.

- Our results do not support the “island mass effect” of St Croix Island on the surrounding waters.

Thanks for your attention!

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