How to cope(pod) with a multistressor environment?

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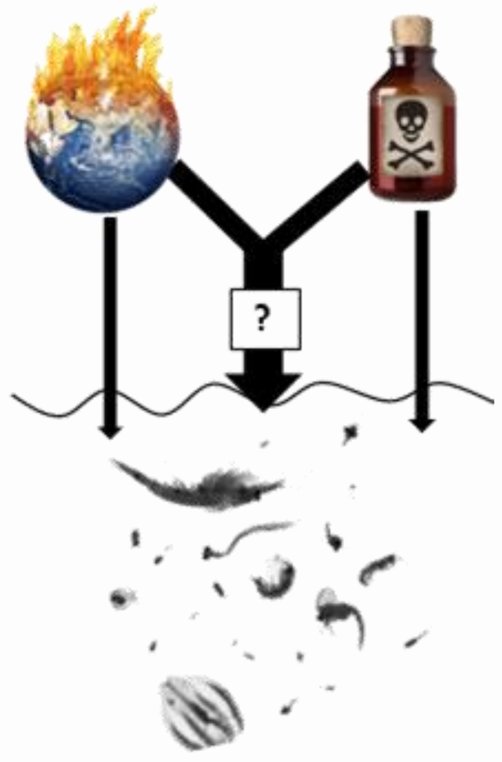
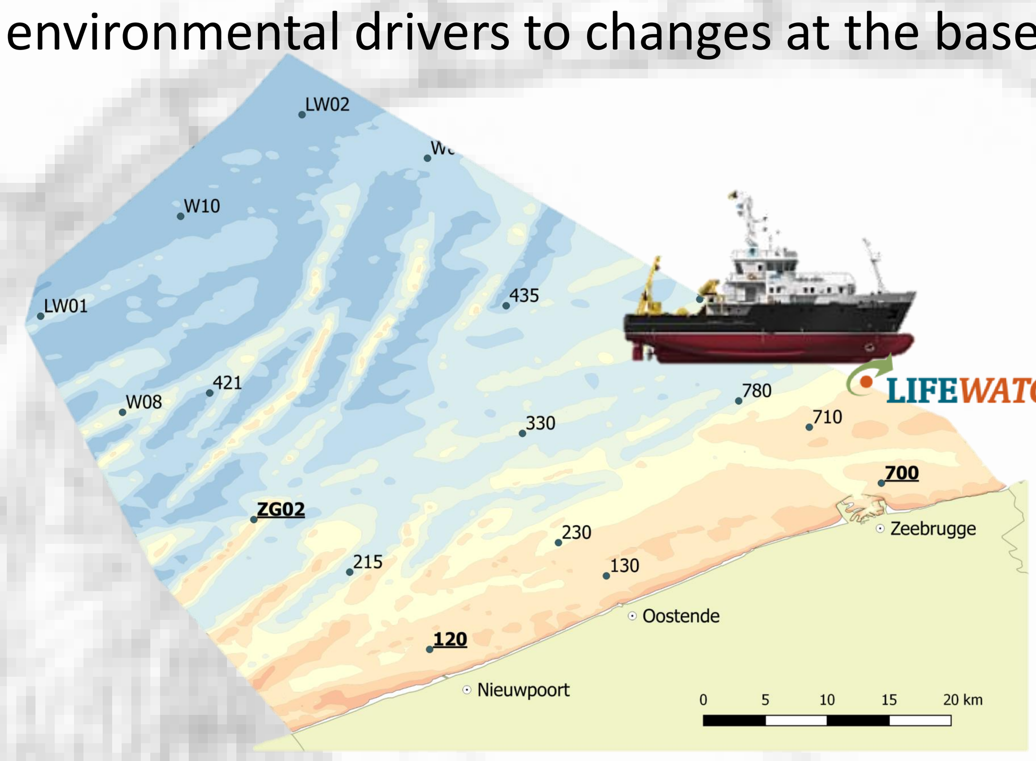
Objectives



There is still a lack of quantitative data and understanding on how stressors resulting from climate change and stressors due to pollution interact in marine ecosystems[1,2]. Our study aims to get better insight in the relative contribution of various environmental drivers to changes at the base of the pelagic food web in the Belgian Part of the North Sea (BPNS).

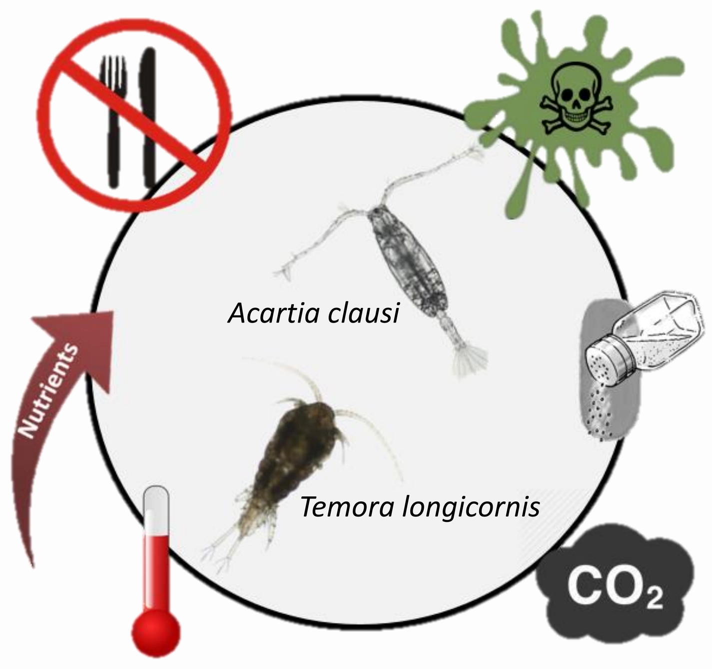
Methods



Monthly sampling campaigns were conducted at 3 stations within the BPNS (120, ZG02, 700) from February 2015 to February 2016. Zooplankton samples were collected and sea water temperature, salinity, chlorophyll a, nutrients and a selected set of priority pollutant (PCBs and PAHs) concentrations in the water were measured at each site.

Zooplankton taxa were identified to the lowest taxonomic level possible using a stereomicroscope. Calanoid copepods (Crustacea, Copepoda), being the most abundant group within the zooplankton[4] were identified to species level, sex and developmental stage.

Generalized additive modelling (GAM) in R was used[3] to determine the main drivers of abundance and distribution of the calanoid copepod species *Temora longicornis* and *Acartia clausi*. Both copepods are dominant species in the BPNS[4].



Results

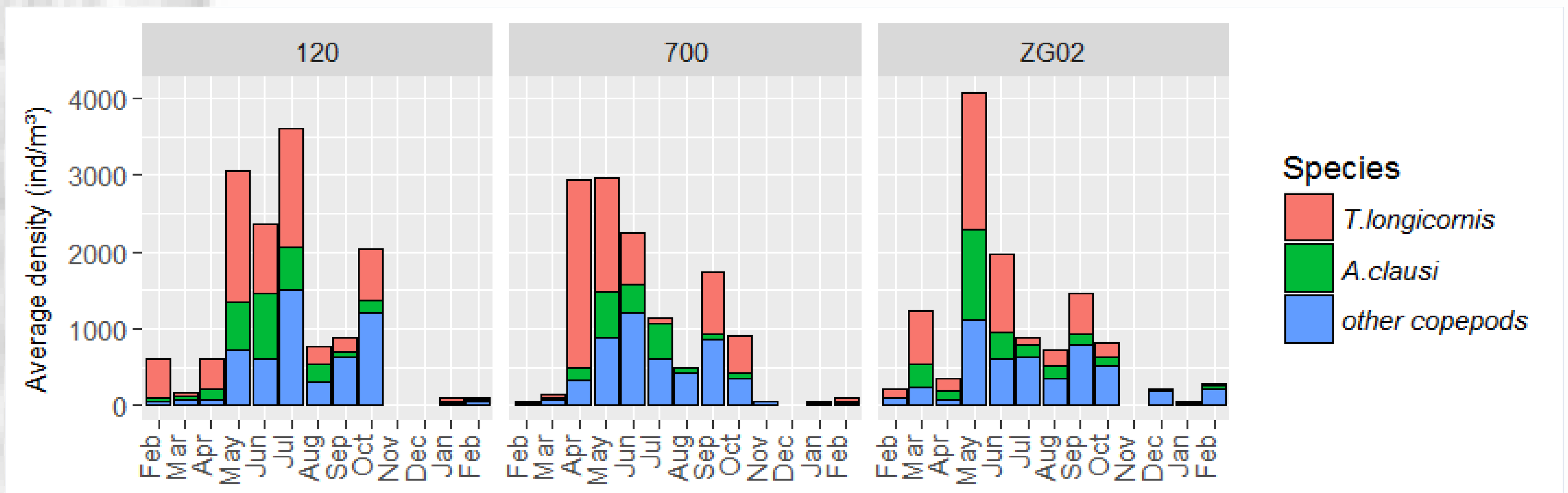


Figure 1: Average densities (ind/m³) of *T.longicornis*, *A.clausi* and other copepods at three stations within the BPNS.

The zooplankton community within the BPNS shows strong seasonal patterns with peak densities in spring followed by a smaller peak in Autumn (Figure 1).

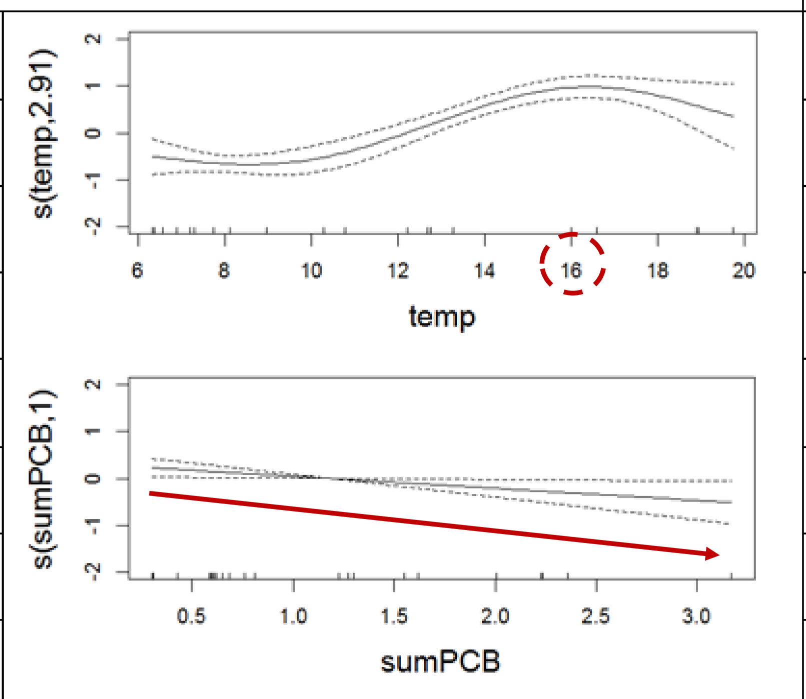
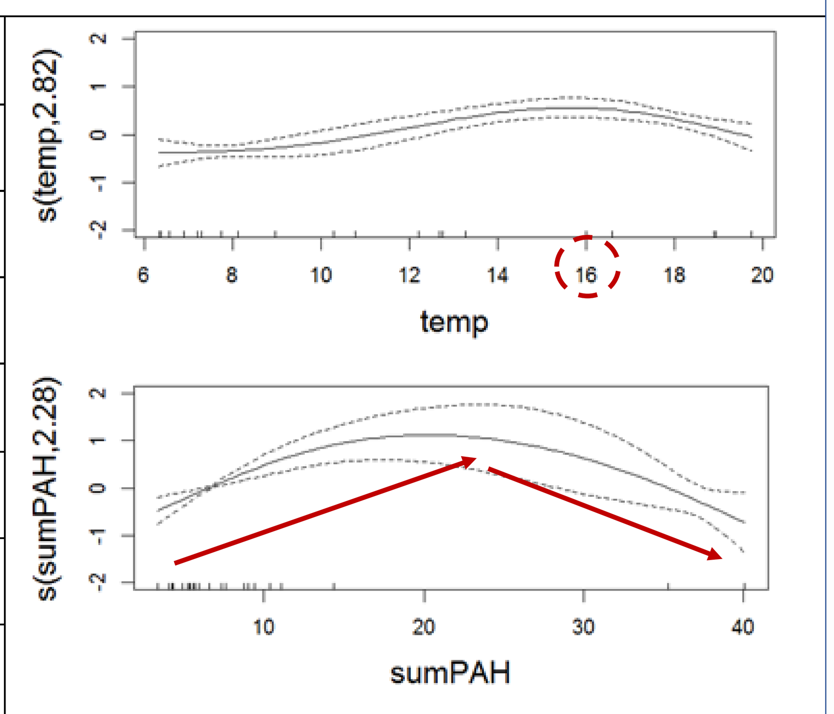
	GAM *T. longicornis*		GAM *A.clausi*	
Variable	**p-value**		**p-value**	
Temperature	p < 0.01		p < 0.01	
Chlorophyl a	p < 0.01		p < 0.01	
SiO_4	p < 0.01		p < 0.01	
∑PAH	p = 0.03		p < 0.01	
$\sum_7$PCB	p < 0.01		n.s.	
Salinity	p < 0.01		n.s.	
N/P	p < 0.01		n.s.	

Figure 2: Main environmental drivers for *Temora longicornis* and *Acartia clausi* determined by generalised additive modelling. Graphs: smooth functions of selected covariates of the *T. longicornis* and the *A. clausi* model *n.s. = not significant. $\sum_7$PCB = PCB28, PCB52, PCB101, PCB118, PCB153, PCB138, PCB 180 ∑PAH=* acenaphthylene, acenaphthene, fluorine, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, benzo(g,h,i)perylene, dibenzo(a,h)anthracene

Temperature, chlorophyll a, SiO_4, ∑PAH, $\sum_7$PCB, salinity and N/P ratio are significant predictors for *T. longicornis* abundance (deviance explained = 94.1%), while the abundance of *A. clausi* only seems to be driven by temperature, chlorophyll a a, SiO_4 and ∑PAH (deviance explained = 81.8%).

The optimal temperature for *T. longicornis* and *A. clausi* in the BPNS is 16°C. There is a negative correlation between $\sum_7$PCB concentrations and *T. longicornis* abundances, while no effect of the $\sum_7$PCB on *A. clausi* was found. Both *T. longicornis* and *A. clausi* show a positive correlation with ∑PAH at low concentrations.

Conclusions

The zooplankton community of the BPNS shows distinct seasonal and spatial trends over a one year period. *T. longicornis* and *A. clausi* show different dynamics in their spatial distributions and abundances and appear to be driven by different factors. When optimised, GAM will provide important tools to identify and quantify the relative contribution of multiple stressors on zooplankton species within the BPNS.

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