EXPOSE

In order to define what's, the planned work for mini project about creating and parameterizing a small ecosystem model based on specific research paper (Contrasting Controls on Microzooplankton Grazing and Viral Infection of Microbial Prey, David Ta lmy et al 2019) there are some questions to be answered and titles to be investigated.

Why we are doing this?

We want to understand the fate of biomass produced by phytoplankton through carbon cycle when we add viral infection, zooplankton grazers or investigate how do different nutrient/temperature/light levels affect plankton population.

First of all, why phytoplankton are important? because they are starting point of marine biogeochemical cycles, protistan (unicellular eukaryotic) phytoplankton have long been recognized as foundation al to fisheries and export of atmospheric CO2 to the deep ocean, (M. B. Higgins, et al 2012)(PG Falkowski - Photosynthesis research, 1994 – Springer). So, they actually play an important role in carbon cycle. Protists convert CO2 to organic carbon via photosynthesis, simultaneously altering cycles of other elements linked to carbon by the stoichiometry of cellular composition. Thus, the carbon cycle interacts with biogeochemical cycles of nitrogen, silica, and many other elements (J. P. Zehr, R. M. Kudela, Nitrogen cycle of the open ocean: From genes to ecosystems.2011). (Joseph H. Street and Adina Paytan Marine Chemistry, 2008 - Elsevier). The next question is how the plankton population are controlled? Phytoplankton populations are controlled both by bottom up (nutrient, light, temperature) and top-down mechanisms (viral infection, zooplankton grazing) which can influence the "distribution" of biomass within an ecosystem. (H.W.Harvey et al 11 may 2009) (M. R. Landry 1984).viruses (that affect phytoplankton) are also an important factor that influences the balance of phytoplankton productivity, export production and food availability for higher trophic levels. Also, addition to sea water of particles in the 0.002–0.2 µm size range, concentrated from sea water by ultrafiltration, reduced primary productivity ([^{14}C] bicarbonate incorporation) by as much as 78%. These results indicate that, in addition to grazing and nutrient limitation, infection by viruses could be a factor regulating phytoplankton community structure and primary productivity in the oceans. (CA Suttle et al - Nature, 1990) (Borsheim, K. Y., *envir. Microbiool.* 1990)(Proctor, L. M. et al -*Nature* 1989) (Ian Hewson et al 2001). We don't know the quantity of virilizes, it's really difficult to go out the wild to measure then that's why we look at it mathematically and we basically are guessing how rates effect this carbon cycle thus we need to create a small ecosystem model, parametrize it and run it inside the R software to see what happens to base food web if we change virilizes, grazing rates or if change growth rate because of light intensity. For this purpose, a variety of biological models have been developed (e.g., EvansandParslow,1985; Fasham et al,1990; SteeleandHenderson,1992; HurttandArmstrong,1999; Doney et al., 1996; Moore et al., 2001). These models differ in complexity, from simple models containing three biological state variables up to more complex ones with, presently, some thirty compartments. The nitrogen-based ecosystem model developed by Fasham et al. (1990) (hereafter named FDM-model) has become a standard model used in various studies ranging from zero-dimensional mixed-layer applications to fully three-dimensional coupled ecosystem circulation models. Nitrogen-based ecosystem model, composed of four state variables (NPZD model). (M Schartau, et al- Journal of Marine Research, 2003). Basic NPZD models can show the flow of biomass through the basic food web levels within an ecosystem. Within the mini

project, we want to add a viral component to a NPZD model and thus build a NPZD-virus model. Such a model will be the basis for i) parametrization experiments of viral lysis and grazing experiments and ii) integration into water body models of the Baltic Sea. (Garrett and Loder 1981) (Rucheng Tian et al 2015 ICES journal)

Research questions

How do different viral infection rates influence the model outcome? Simply in response to the higher viral infection rates V, D, Z after a sharp increase at first, they will decrease slowly, however, the situation is upside down for the N and P after a sharp fluctuation will remain constant.

How do different zooplankton grazing rates influence the model outcome? With the higher grazing rates same situation for previous question happen again however with lower grazing rates V will increase and remains high and Z after a sharp increase will reduce smoothly.

What are basic materials and method, relevance of the work being done?

The whole work is to build a NPZD-V model in R, parametrize it and answering to research questions. The NPZD model consists of four state variables as mentioned, the NPZD model has demonstrated its capability of simulating the basic ecosystem process at the low trophic level (Ji et al., 2008).

-can start by drawing a diagram to indicate biomass flow through the compartements

-writing equations for different components and listing the parameters needed

-building the model in R. The initial condition of parameters was specified using the December climatological data obtained through an objective analysis (The OA was done using the software developed by Bedford Institute of Oceanography (Hendry and He, 1996)). Data sources include the National Oceanographic Data Center (www.nodc.noaa.gov), the Canadian Marine Environmental Data Service (MESD, provided by Dr Pierre Clement) and the University of Maine Database (provided by Dr Dave Townsend). Numerical method was isoda.

-literature search for parameters and parametrizing the model with constant parameters. Parameter definition, units, and values were described in detail in Ji et al. (2008) and Tian et al. (2001)

-running the model in R software