Representing carbon-nitrogen stoichiometry in nitrogen-based ecosystem models

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OceanICU Understanding Ocean Carbon

The primary currency of many marine ecosystem models is nitrogen.

So, how can we accurately quantify carbon fluxes from such models?

Summary ①

Carbon-nitrogen data were used to identify stoichiometry patterns across marine ecosystems. Observed relationships between Carbon:Nitrogen (C:N) ratio and trophic transfers will be used to estimate carbon fluxes and carbon sequestration rates in a nitrogen-based ecosystem model: StrathE2E.

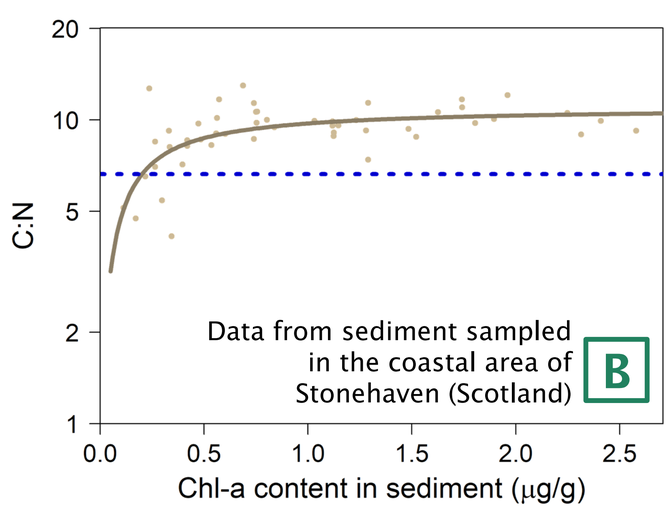
This work contributes to Ocean-ICU WP5.

Carbon:Nitrogen ratios in the food web, water and sediments ②

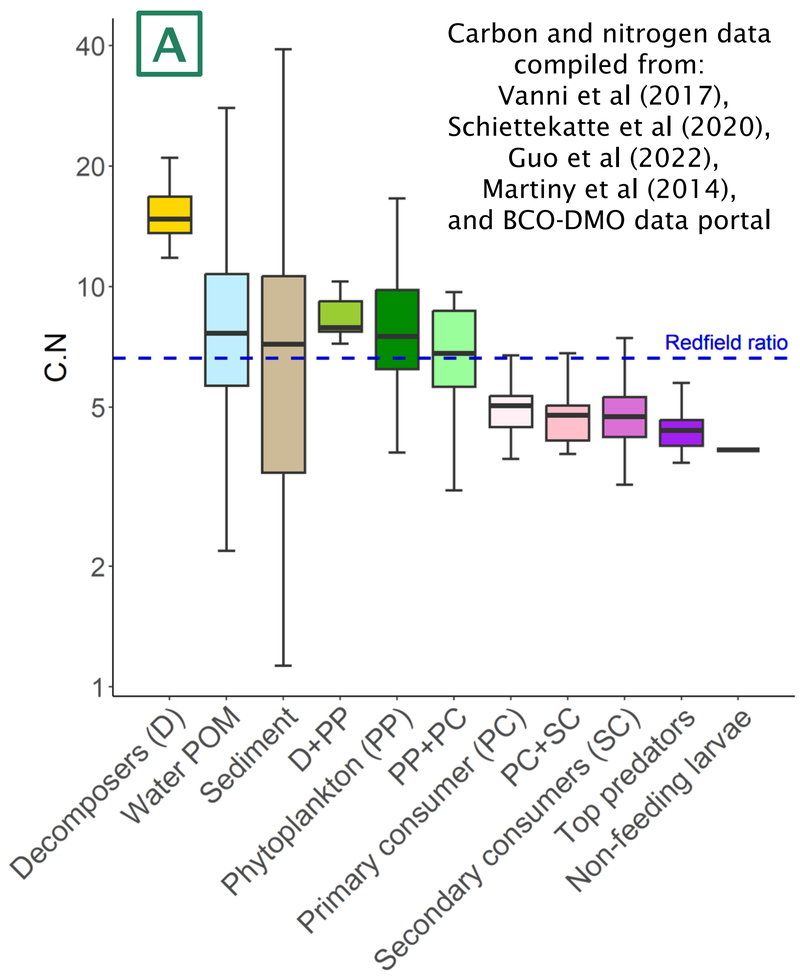
By compiling and exploring carbon-nitrogen data from different sources (papers and open-access data portals) and spanning over **all components of an ecosystem model**, we were able to visualise some key patterns of carbon-nitrogen relationships across the food web (figure A).

When **going up trophic levels** – from decomposers (*bacteria*) to primary producers (*phytoplankton*) and to top predators (*including data from pinnipeds and sperm whale*) – **C:N ratio** tends to **decrease**.

In shallow waters, a C:N ratio in sediment **under the Redfield ratio** ($C_{106}:N_{16}$) could be related to **low primary Production** (figure B).



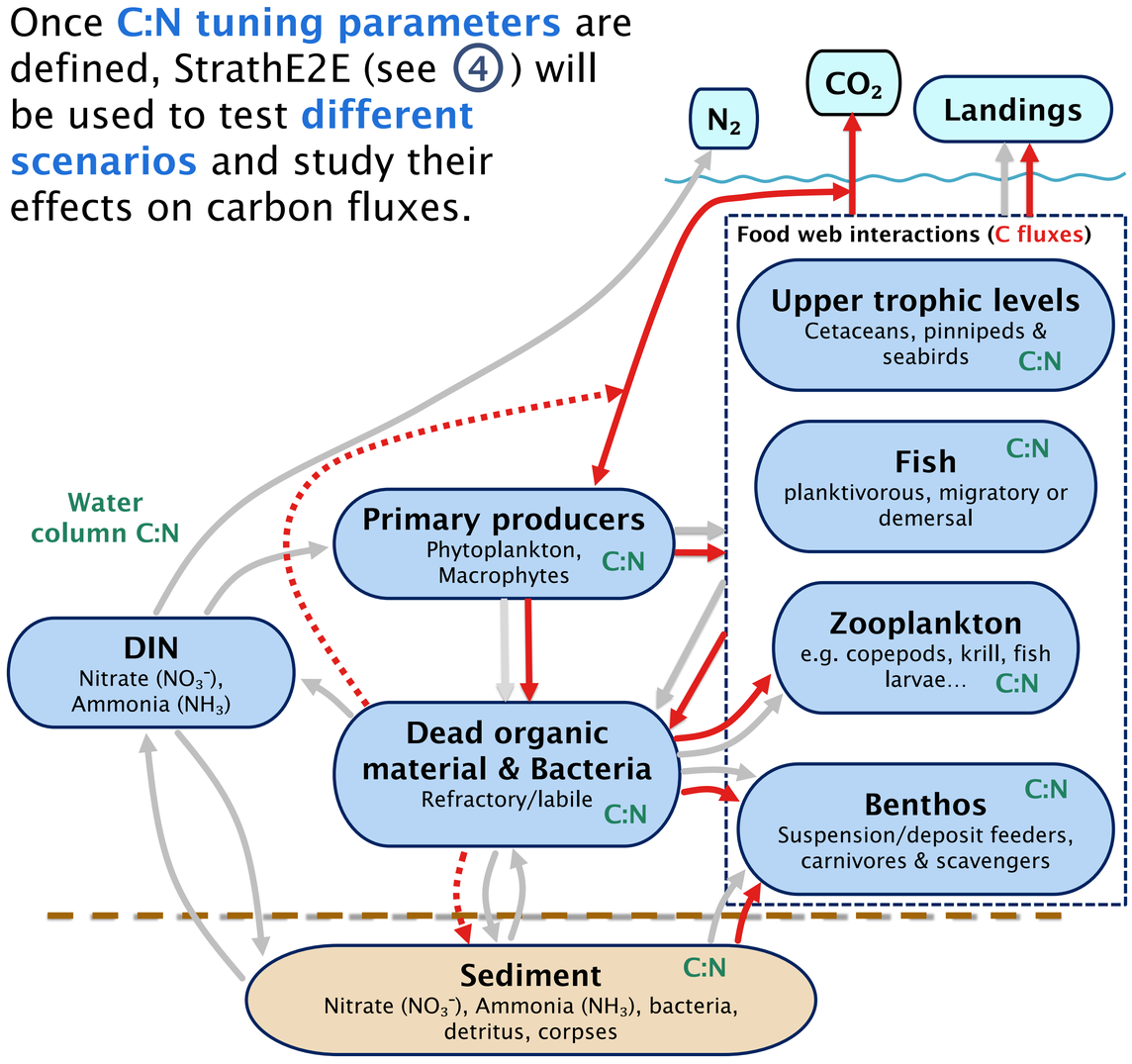
Observed **variation in C:N** in particulate organic matter (**POM**) is likely caused by the **shift** in **environmental conditions** and both **physical** and **ecological processes** taking place across the water column [1][2].



The Carbon Challenge ③

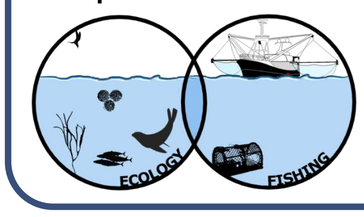
In an ecosystem model where fluxes are expressed in nitrogen – such as StrathE2E – what are the equivalent carbon fluxes? In the schema below, the **nitrogen fluxes** are shown as grey lines. The **carbon fluxes** that need to be estimated so as to generate the trophic patterns in C:N ratios (see ②) are shown in red.

Once **C:N tuning parameters** are defined, StrathE2E (see ④) will be used to test **different scenarios** and study their effects on carbon fluxes.



The StrathE2E Model ④

StrathE2E is an **end-to-end ecosystem model**, describing the entire food web within **shelf regions**, from inorganic nutrients to megafauna, including bacterial degradation. It uses climate model outputs, and combined with a fishing fleet model, StrathE2E allows for the study of both **climate** and **fishing** effects on nutrient cycling and trophic interactions [3][4][5].



StrathE2E App

First conclusions and future work ⑤

- C:N ratios in marine ecosystems are not equal to the Redfield ratio and vary with trophic levels and other environmental factors.
- Observed patterns of C:N will be used to estimate carbon fluxes from nitrogen fluxes (StrathE2E outputs).
- StrathE2E will then be used to study the effect of climate and fishing on carbon sequestration in different geographical areas.

References

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