

# ANNUAL CYCLE OF PELAGIC METABOLISM IN THE SCHELDT ESTUARY

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## INTRODUCTION

Estuaries are semi-enclosed zones where continental dissolved and particulate material transfer to the coastal zone. These systems are usually characterized by strong physico-chemical gradients and enhanced biological activity due to high inputs of organic matter and nutrients from rivers.

The Scheldt estuary is a turbid, eutrophic coastal plain estuary in the southwest of the Netherlands and northwest of Belgium (Fig. 1). It drains about 21,580 km<sup>2</sup> of land in one of the most densely populated and highly industrialised regions of Europe. The residence time of water in the entire estuary is approximatively 75 days.

We present results of **pelagic gross primary production (GPP)**, **community respiration (CR)** and **nitrification (Nit)**, measured by the oxygen Winkler method, from an annual study in 2003. Five stations along the estuary were monthly investigated at fixed salinities (0, 2, 10, 18 and 25; see the average position of each station in Fig. 1).

## MATERIAL & METHODS

Surface water was sampled with a Niskin bottle at sunrise and incubated on deck until sunset in 60ml glass bottles stored in a 5-compartment incubator kept at *in situ* temperature by flowing water (Fig. 2). Irradiance was controlled in each compartment by filters having a shading capacity ranging from 0 to 100%. In order to avoid sedimentation of particulate material in samples, bottles were fixed on rotative axes (1 tr/min).

Oxygen concentration was measured on board within 2 days by the **Winkler method**. The estimation of the oxygen consumption due to respiration and nitrification processes was assessed by incubating samples, in the dark compartment, with and without addition of **nitrification inhibitors** (N-serve and Chlorate). Moreover, surface partial pressure of CO<sub>2</sub> (*p*CO<sub>2</sub>) was also measured at the beginning of the incubations.

## RESULTS

### ✓ *p*CO<sub>2</sub> and O<sub>2</sub> concentrations

Very low O<sub>2</sub> concentrations and high *p*CO<sub>2</sub> were found in the inner part of the estuary (sal 0 and 2), with the lowest O<sub>2</sub> concentration found at salinity 2 (7.4%) and the highest *p*CO<sub>2</sub> measured at salinity 0 (10110 µatm) in June (Fig. 3). In the freshwater part (sal 0), a decrease of *p*CO<sub>2</sub> and an increase of O<sub>2</sub> concentrations were observed in summer well related to high GPP and positive NCP values measured in this section of the estuary during this period (see next section). In the lower part of the estuary (sal 18 and 25), O<sub>2</sub> oversaturation (highest in April; 116% at salinity 25) was found in spring; *p*CO<sub>2</sub> values measured during this period correspond to the lowest ones observed in the estuary in 2003 (lowest value in April at sal 25: 400 µatm).

### ✓ Integrated metabolic results

Oxygen-based rates were converted into carbon assuming a photosynthetic quotient of 1.3 based on simultaneous O<sub>2</sub> and DIC incubations (data not shown), a molar O<sub>2</sub>/C of 14 for Nit based on simultaneous O<sub>2</sub> and <sup>14</sup>C incubations (data not shown) and a respiration quotient of 1. NCP is the difference between organic matter production (GPP + Nit) and mineralization (CR). Highest GPP values (Fig. 4) were found in the freshwater part of the estuary in summer, reaching a maximal rate in August (230 mmol C m<sup>-2</sup> d<sup>-1</sup>). At salinity 2, two peaks were observed (June and August). Lowest GPP values were found at salinity 10. Nitrification rates were highest at salinity 2 reaching a maximal rate in May (20 mmol C m<sup>-2</sup> d<sup>-1</sup>; 50% of total primary production). CR values were highest in the inner part and presented 2 major peaks (May and October). Most of the time, the system was heterotrophic (NCP<0) excepted in April in the lower part and in summer in the freshwater and lower parts.

## DISCUSSION & CONCLUSION

This study showed the strong heterotrophic status of the turbid Scheldt estuary over an annual cycle. Annual averaged NCP values along the salinity gradient are presented in Fig. 5 and compared with a previous model-based estimate. Higher NCP values were observed but showing the same trend along the salinity gradient. Net Community Production rates measured during these campaigns are among the lowest reported in the literature, leading to elevated *p*CO<sub>2</sub> and low O<sub>2</sub> concentrations in surface waters, especially in the inner part of the estuary.

The nitrification process accounted for a significant part of the oxygen consumption (and organic matter production) especially at salinity 2 where the annual average nitrification rate represented almost 30% of total organic matter production.

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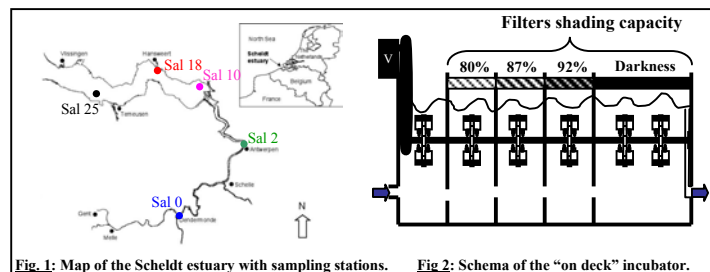


Fig. 1: Map of the Scheldt estuary with sampling stations.

Fig. 2: Schema of the "on deck" incubator.

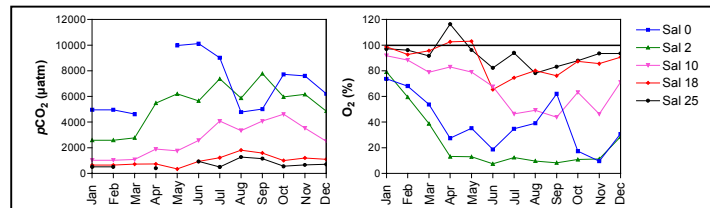


Fig. 3: Surface *p*CO<sub>2</sub> and O<sub>2</sub> (%) at each incubated station over an annual cycle.

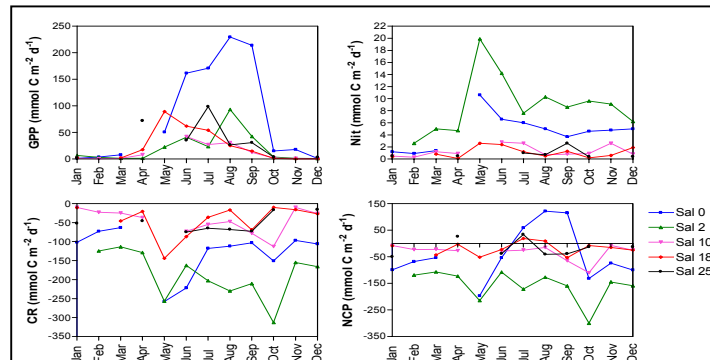


Fig. 4: Integrated gross primary production (GPP), nitrification (Nit), community respiration (CR) and net community production (NCP) values.

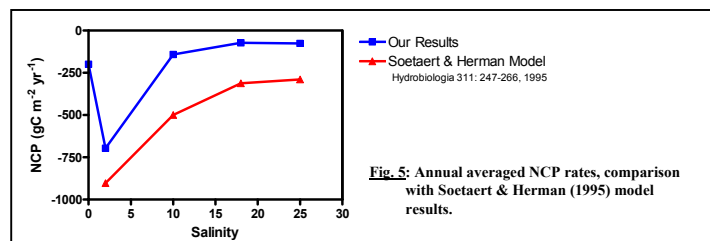


Fig. 5: Annual averaged NCP rates, comparison with Soetaert & Herman (1995) model results.



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