UMEÅ UNIVERSITET

Importance of bacterial maintenance respiration and baseline respiration for development of coastal hypoxia

Kevin Vikström

Akademisk avhandling

som med vederbörligt tillstånd av Rektor vid Umeå universitet för avläggande av filosofie doktorsexamen framläggs till offentligt försvar i Sal N440, Naturvetarhuset
fredagen den 9e November, kl. 09:00
Avhandlingen kommer att försvaras på engelska

Fakultetsopponent: Professor, Josep M. Gasol, Departament de Biologia Marina i Oceanografia, Institut de Ciències del Mar—CSIC.

Department of Ecology and Environmental Science

Organization
Umeå University
Department of Ecology
and Environmental Science

Document type
Doctoral thesis

Date of publication
19th of October 2018

Author
Kevin Vikström

Title
Importance of bacterial maintenance respiration and baseline respiration for development of coastal hypoxia.

Abstract
Reduced oxygen concentrations and increasing hypoxic zones have become more common in the sea due to climate change and eutrophication. The main cause of oxygen loss in oxygenated environments is respiration. Respiration rates can be estimated using optode methodologies which utilize dynamic luminescence quenching to estimate the oxygen concentration declines in dark incubations. A published optode methodology was improved by using optodes with titanium housing instead of plastic housing plausibly trapping oxygen. Drift was highly reduced by the titanium casings leading to a higher precision and lower detection limit of 0.97 mmol O_2 m^{-3} d^{-1}. 28% of measurements were shown to have non-linear oxygen concentration declines. The rate of oxygen change was derived with a 2nd degree polynomial at 1 hour from the incubation start. The majority of non-linear declines were concave and due to carbon substrate limitation. Analyzing non-linear trends linearly, a common practice, leads to an underestimation of respiration by up to 64%.

Bacterial maintenance respiration (R_m) was studied using an ecophysiological model unverified in natural environments. The model was applicable at high productivities but a quadratic model was demonstrated to give a better fit. R_m was found to represent a significant part in the sub-arctic estuary contributing to 58% of the annual specific bacterial respiration. Therefore, R_m may be more important in nature than previously recognized. The ecophysiological model is driven solely by the bacterial specific growth rate (μ) where the relative influence of R_m is elevated as μ decreases. As a consequence, I hypothesize that a reduction in nutrients may not decrease the oxygen consumption but rather shift bacterial growth based respiration to R_m as μ approaches zero.

Baseline respiration (R_{bl}), defined as ecosystem respiration disconnected from contemporary primary produced carbon, was also studied. R_{bl} was shown to be largely supplied by allochthonous carbon in a coastal ecosystem and had a contribution of 50% to the annual plankton community respiration in the sub-arctic estuary studied. I claim that R_{bl} and R_m are crucial to include for understanding and managing development of aquatic hypoxia in an effective and economic manner

Keywords
Respiration, hypoxia, bacteria, marine ecology, Oxygen, DOC, primary production, pelagic production, environmental management, allochthonous organic carbon

Language
English

ISBN
978-91-7601-927-6

Number of pages
46 + 4 papers