EURO-BASIN
BASIN SCALE ANALYSIS, SYNTHESIS AND INTEGRATION

SEVENTH FRAMEWORK PROGRAMME THEME 7 Environment

Collaborative project (Large-scale Integrating Project)

Project no: 246 933

Project Acronym: EURO-BASIN

Project title: European Basin-scale Analysis, Synthesis and Integration

Deliverable 4.5 Analytic model and synthesis report on the lipid pump

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Due date of deliverable: June 2013
Actual submission date: August 2013
Organisation name of the lead contractor of this deliverable: DTU Aqua

Start date of project: 31.12.2010 Duration: 48 months
Project Coordinator: Michael St John, DTU Aqua

Project co-funded by the European Commission within the Seventh Framework Programme, Theme 6 Environment

Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission)	X
RE	Restricted to a group specified by the consortium (including the Commission)	
CO	Confidential, only for members of the consortium (including the Commission)	

Deliverable 4.5 Analytic model and synthesis report on the lipid pump
is a contribution Task 4.5 Vital Rates and Plasticity

Responsible: DTU Aqua (S.H. Jónasdóttir; A.W. Visser), SWANSEA (K.J. Flynn; A. Mitra),
Start month 1, end month 48

Executive Summary:
We define the lipid pump as the transfer of lipids from the primary producers to the other trophic levels via the copepods. Thus, the lipid pump is constituted by two aspects; (1) the acquisition of lipids by the copepods and (2) the subsequent transport of these either (i) to depth through their vertical seasonal migration or (ii) as food to higher trophic levels in the photic zone. In order to study these processes, we have developed a generic biochemical stoichiometric model of copepod describing the accumulation and fate of lipid within the individual copepod. This model is being configured and tested against data, and will subsequently be applied for hypothesis testing. Also, we provide estimates on the "deep basin seasonal lipid pump"; a mechanism to transfer surface-generated primary production to deep waters via the lipid rich copepods where a proportion of the carbon is sequestered as respired CO_2. The copepod *Calanus finmarchicus* is used as a model animal where, information on lipid content, cross basin distribution, abundance and depth in diapause, has been acquired. Estimates of diapause duration in connection with the physical environment and respiration rates during diapause are provided.

With the development of the model, and its subsequent operation, is a synthesis report.

The deliverable builds on tasks T4.2 (Trophic interactions, with associated field data collection) and T4.4 (on-ship experiments, including egg production) and is a contribution to task T4.5 Vital rates and Plasticity.

The prototype generic copepod model including biochemical stoichiometry has been developed and is currently undergoing testing and configuration prior to placement with an age-stage resolving submodel, and subsequent exploration of performance under different scenarios.

Measured lipid contents of *C. finmarchicus* stages 4-6 from the EURO-BASIN Cruise G.O. Sars in May/June 2013 will be used to validate and parameterize the model. The deep basin carbon transport has been estimated and is currently in manuscript form.

Relevance to the project & potential policy impact:
This deliverable carries indirect policy impact. It impacts on ecosystems modelling outputs and associated fisheries (WP5) and biogeochemical aspects (WP2 & 6) that may be affected by the health of the copepod populations and the operation of the lipid pump respectively.

Access to Data and/or model code (where relevant):
A schematic of the prototype model is included in this report; we aim to submit the final age-stage validated model to a peer-reviewed journal by end of summer this year so that the outputs will be included in the EURO-BASIN final report.

The model code is in beta status at this time; it is available from the originator

a.mitra@swansea.ac.uk on request, though it will change as we implement it in an age-stage structure.

The G.O.Sars cruise lipid data will be submitted to PANGEA.de in March 2014.

The data on winter lipids were collected during series of cruises spanning the period from 1993 to 2002 listed in Table 1. Information from the literature is also used. The data is owned by Sigrún Jónasdóttir, Astthor Gislason and Mike Heath and will be made available in association with the publication of the manuscript "Comparison of the overwintering lipid content of *Calanus finmarchicus* in five North Atlantic basins: the deep-basin seasonal lipid pump" by those authors." Lipids from the cruises listed in table were measured from depth integrated sampling and mostly analyzed at DTU Aqua laboratories with the same method (Iatroscan analysis). Samples owned by Heath were analyzed in FRS Aberdeen (Webster et al. 2006). Data used from the literature, were based on calibrated oil sac volume measures to lipid values (Vogedes et al 2010).

Report on Model Structure:

The structure of the prototype model, as a Forrester diagram, is given below (Fig.1). It is a development from Mitra (2006), but with an additional component that diverts a proportion of ingested C to deposition in lipid. This material is then drained during periods of (relative if not absolute) starvation or accumulated as lipids. In consequence of this addition, the copepod model becomes a variable stoichiometric description. This is in contrast with extant zooplankton models (cf. Mitra & Flynn 2007) which typically assume a fixed C:N:P (see review by Mitra et al. 2014; an output from EURO-BASIN WP4).

The diagram shows components handling the variable stoichiometry of the prey (green), prey selectivity (dark blue), variable gut transit time (grey), biomass growth (light blue), deposition of lipid (dark yellow) and respiration including consumption of the lipid (bright yellow).