Shellfish farming in low nutrient environments

Øivind Strand and Tore Strohmeier
Sources of nutrients for primary production "catering" shellfish farming

FRESHWATER RUNOFF

ADVECTION

UPWELLED DEEPER WATER

[Diagram showing the relationship between total primary production, new production, regenerated production, export production (sedimentation), and the euphotic zone.]

Wassmann 1998
Water exchange patterns in fjords
Nutrients

Typical summer situation in fjords
A low seston environment

• For extended periods after the spring blooms phytopl conc (CHL $a$) is low $\sim < 1-2$ mg m$^{-3}$, due to nutrient limitation

• Resuspension is low and organic content in seston is generally high

Chl a concentrations at 5 m depth in Bjørnefjord
Bivalve feeding in low seston environment

”State of the art” before CANO

- Numerous studies on feeding physiology in meso-eutrophic environments
- Mussels apparently ceased feeding at concentrations below 0.5-0.8 mg Chl a m⁻³ (Dolmer 2000; Riisgard et al 2006; and others)
- Risk of negative net energy balance in farming environments? (green lipped mussel ~ 0.9 mg Chl a m⁻³) (Hawkins et al 1999)
- The tropical Pearl oyster increased feeding at low seston concentrations (Pouvreau et al 2000)

Feeding physiology in low seston environments poorly known.
A contradiction to observations from bivalve growth in Norway

SHELLFISH FARMING

Licenses

<table>
<thead>
<tr>
<th>Year</th>
<th>Licenses</th>
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<tbody>
<tr>
<td>2001</td>
<td>594</td>
</tr>
<tr>
<td>2003</td>
<td>750</td>
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<td>2005</td>
<td>668</td>
</tr>
<tr>
<td>2007</td>
<td>531*</td>
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<td>2009</td>
<td>352*</td>
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Carrying capacity in Norwegian Aquaculture (CANO)

Strategic Institute Project (RCN/IMR 2006-20xx)
Clearence rate at low seston concentrations

Strohmeier etal. 2009.

Fig. 5 Mean clearance rate (CR) data for *P. maximus* (a) and *M. edulis* (b) at increasing chlorophyll *a* concentrations. Each point in the figure represents the mean value of 18 individual CR measurements. All data from treatments 1 to 4 are included and equations describing the fitted curves are given in the text.
Net energy balance in a low seston environment

Strohmeier 2009

zero NEB

Pecten maximus

Mytilus edulis

0.4 µg CHL L⁻¹
Seston depletion in longline farms

Coupling DEB-growth model and waterflow reduction model

Modelling growth variation as function of stocking density and farm design

Rosland et al. 2011.
Controlled upwelling of nutrient-rich deeper water in fjords

Hydropower plant

Ascending nutrients

Pycnocline

Nutricline

Aure et al. 2007

Erga et al. 2012
Controlled upwelling in the Lysefjord
How can shellfish farming be maximized in low nutrient environments

- Provide basic eco-physiological knowledge about the bivalves in low nutrient environments
- Adapt biomass distribution/stocking density to site specific food availability
- Escape from "oligotrophy" by controlled supply of natural nutrients

 Attend the dissertation this afternoon
TAKK FOR OPPMERKSOMHETEN!!