


Upscaling aquaculture operations in offshore environments - challenges and possibilities in Europe

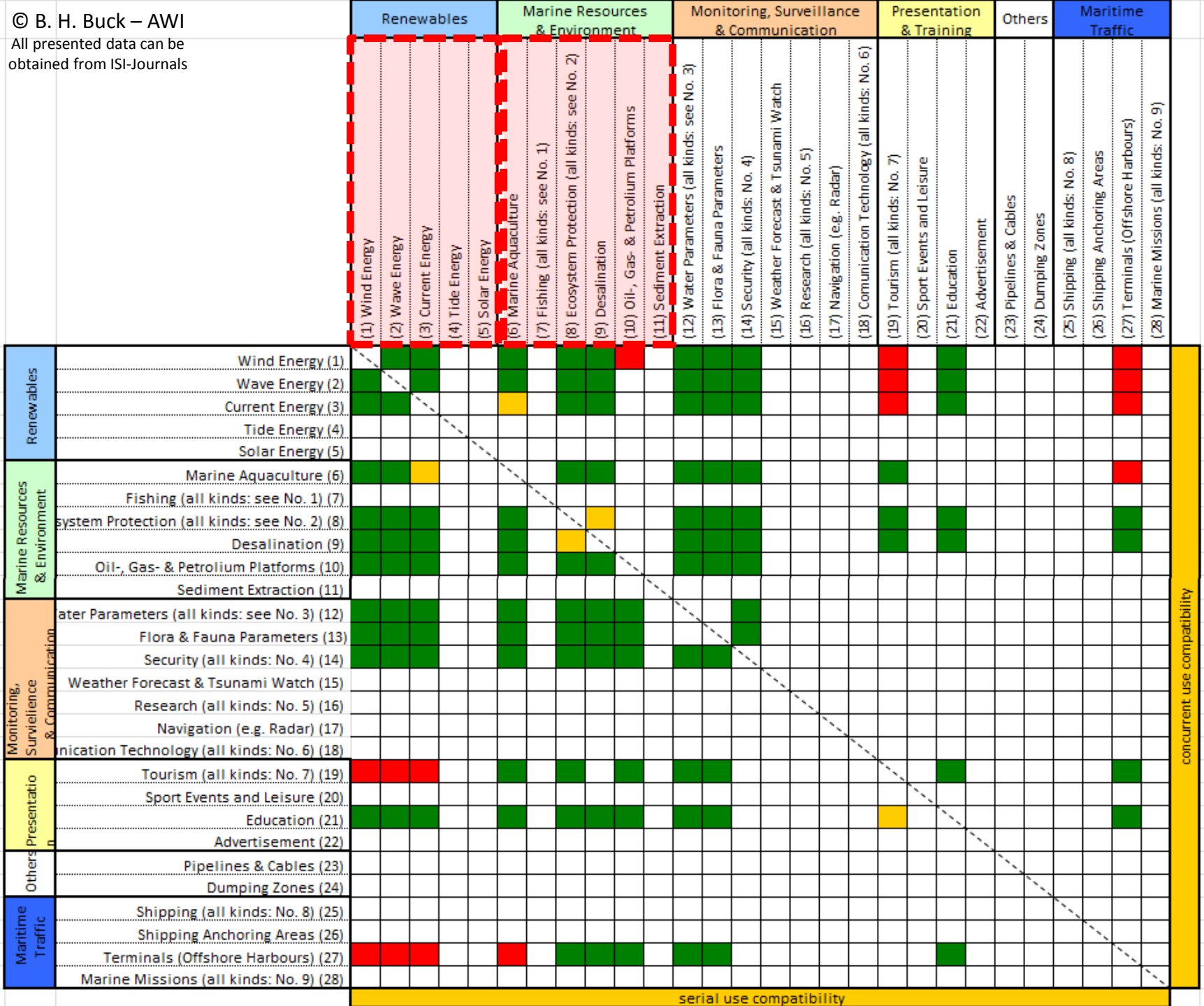
Bela H. Buck et al.

SUBMARINER Conference - Gdańsk, Poland

Offshore Aquaculture in North Europe

→ The Multi-Use Approach

All presented data can be obtained from ISI-Journals



Multi-use ideas to maximize the benefit of an offshore area:

multifunctional use

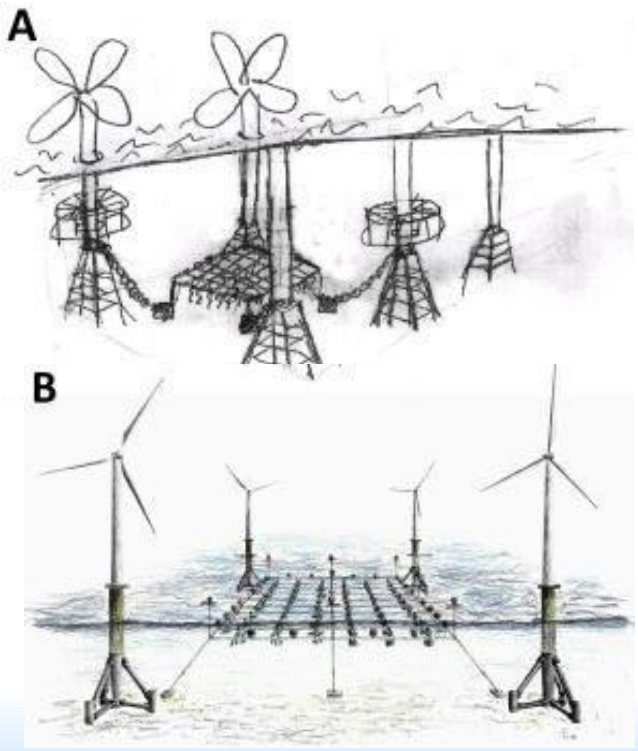
secondary use

additional use

co-use

Leatherman et al.

Multi-use ideas to maximize the benefit of an offshore area:



1. Ecology
   - Creating MPA's (nursery, sustainable fisheries…)
   - Set-up artificial reefs
2. Tourism
3. Additional energy resources
4. Offshore Aquaculture
5. Bio-Remediation / Bio-Extraction
6. Use of fouling organisms

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Construction of the *Alpha Ventus* wind farm in the EEZ 60 km off the coast of Germany.

5 MW class turbines:

65 MWh·day^{-1}·windmill^{-1}

8,000 €·day^{-1}·windmill^{-1}

70% of companies SME

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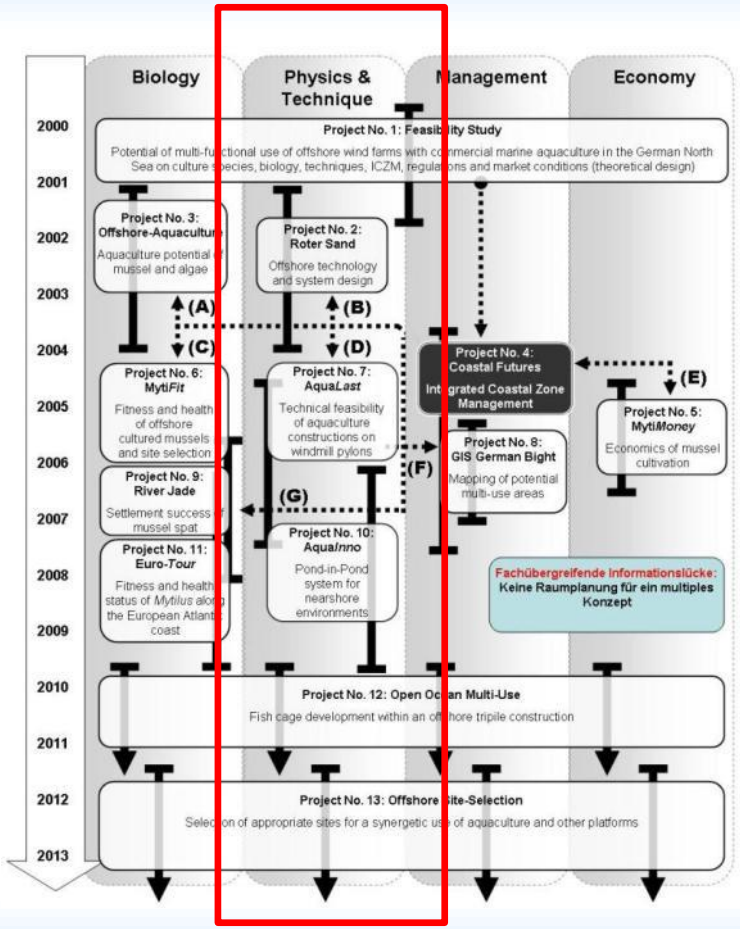
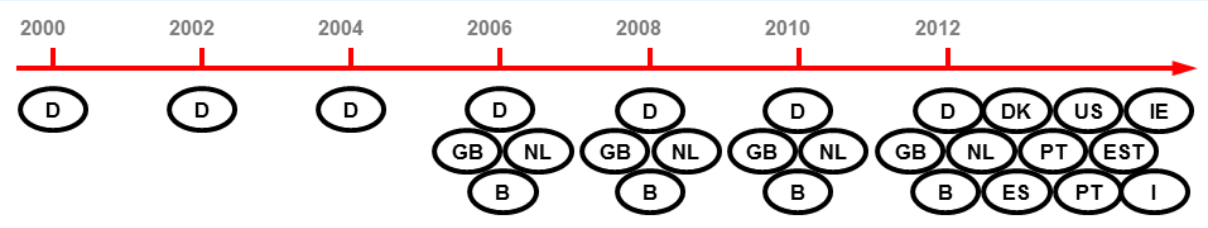


Marine Facilities Ordinance

OSS-Project forces wind farm operators to investigate in co-uses concepts



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Main biological results:

- grow faster
- no parasites
- adapt to and withstand conditions
- resist detachment
- settlement is lower

Main biological results:

- low diversification
- only a few resist exposed conditions
- need an IMTA concept
- problems to submerge all fish

Technical Realisation

→ Co-Use in High Energy Environments

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Consideration of mechanical loads on grounding constructions of windmills by aquaculture devices

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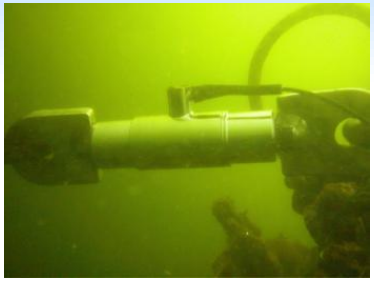
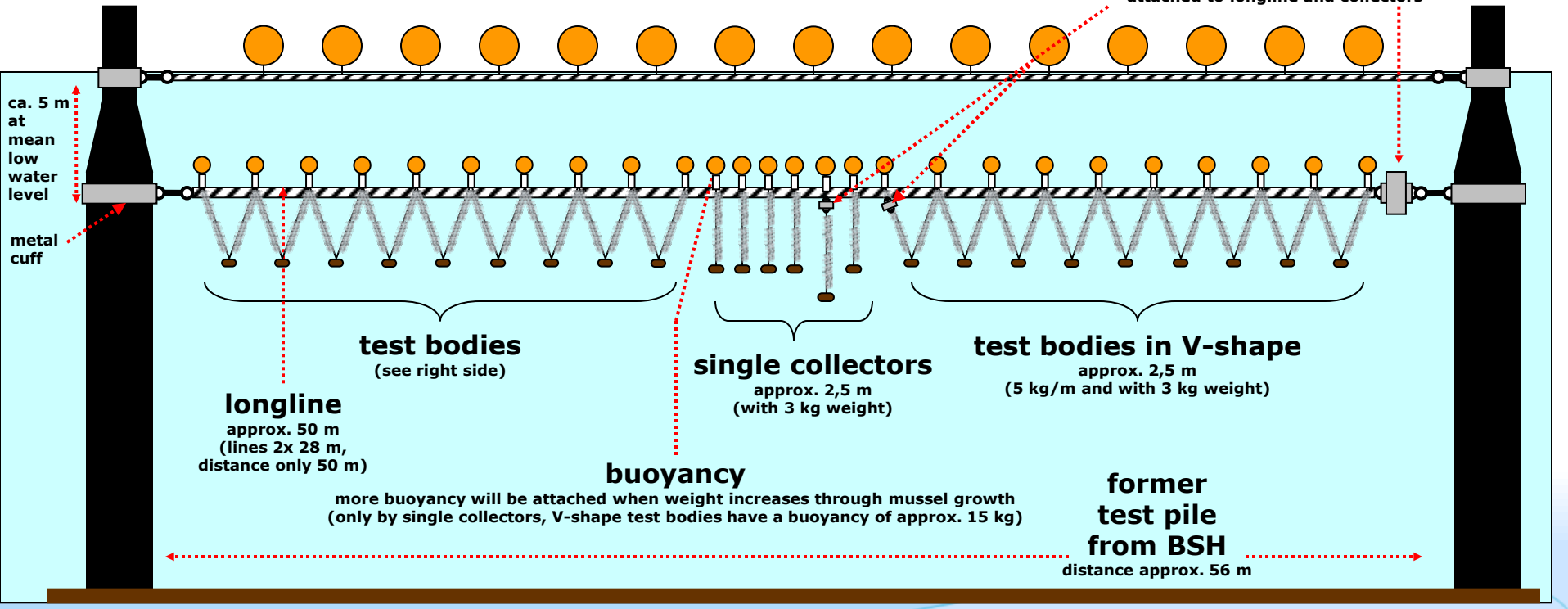
test bodies

collector ropes



force sensor



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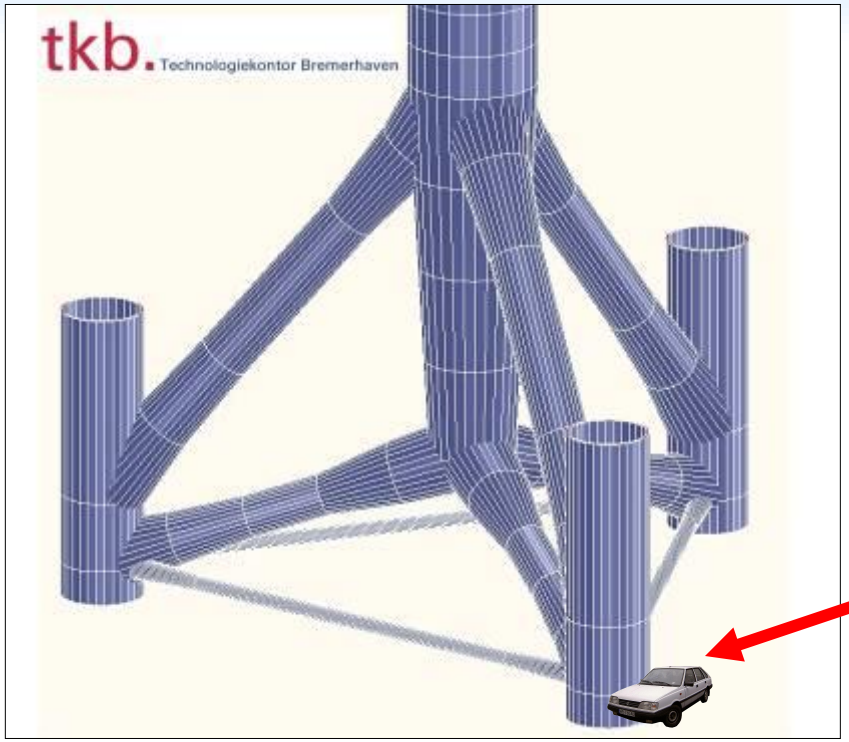

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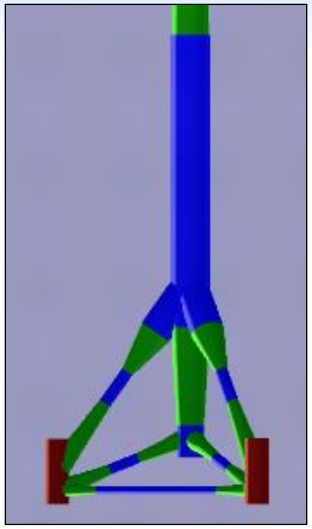

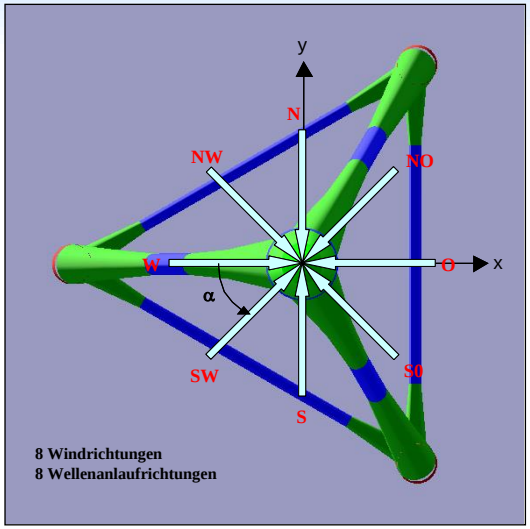

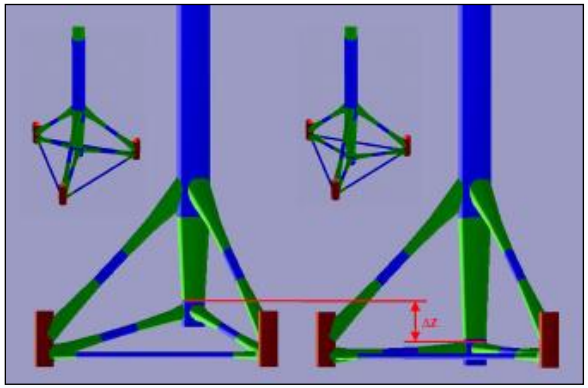

Development of static models
(for 3-5 MW turbine class)

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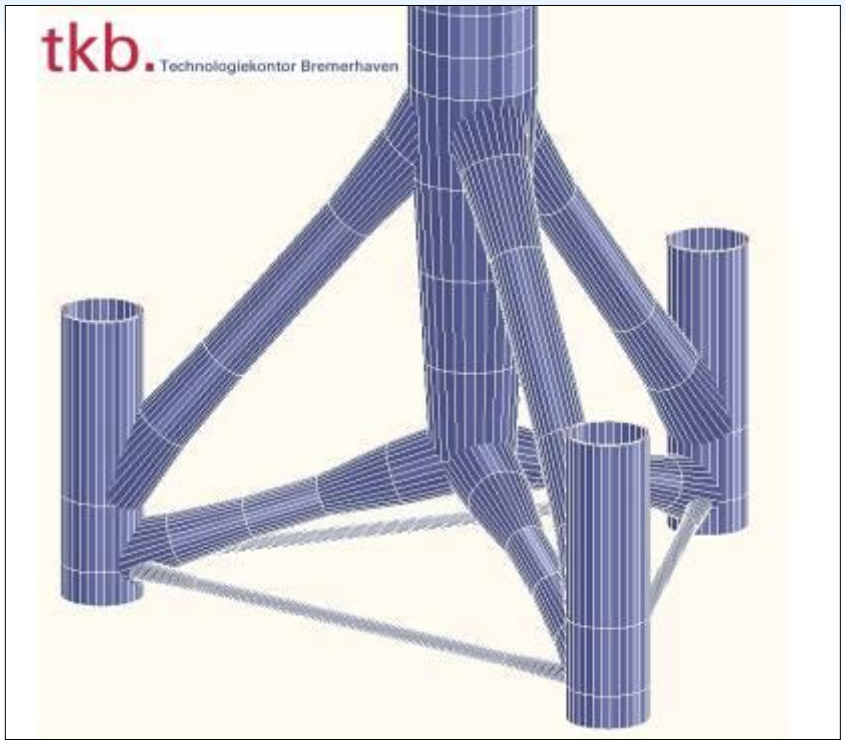

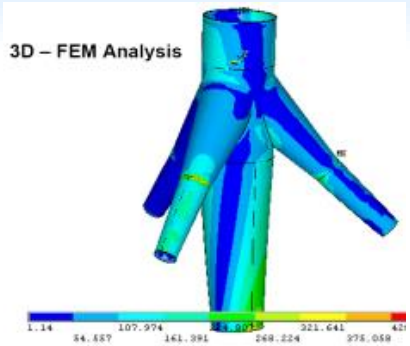

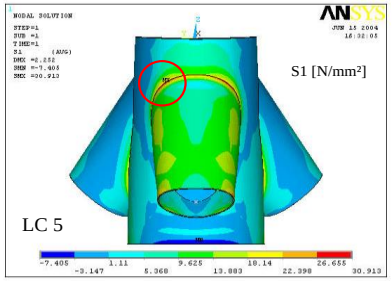

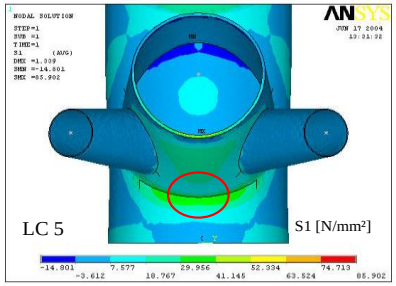

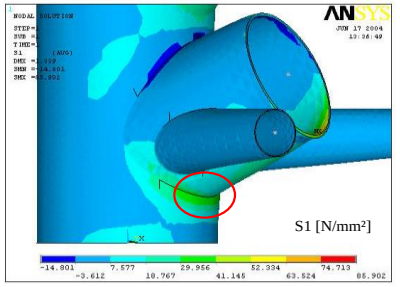

Discussion of alternative connection points of foundation structure

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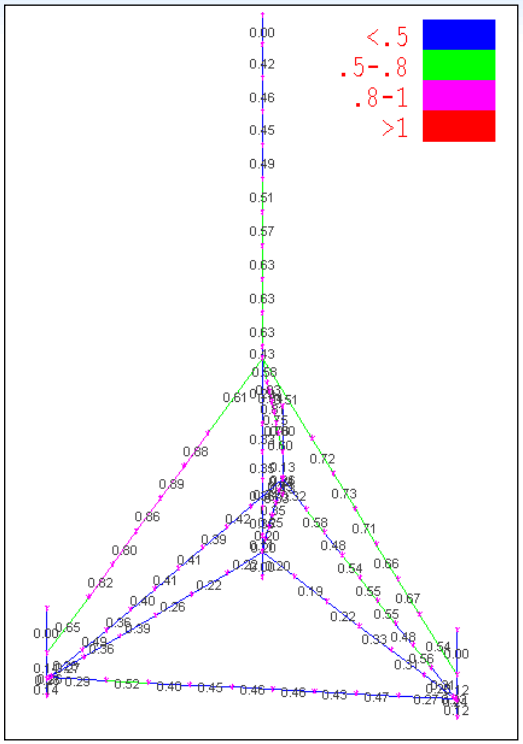
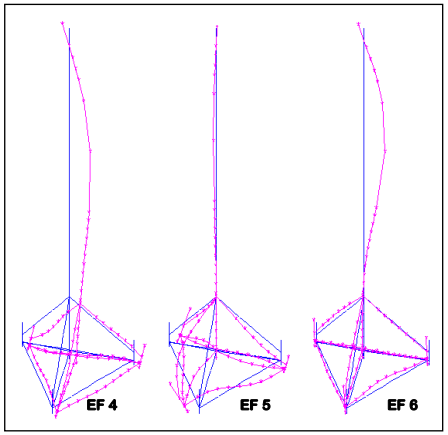
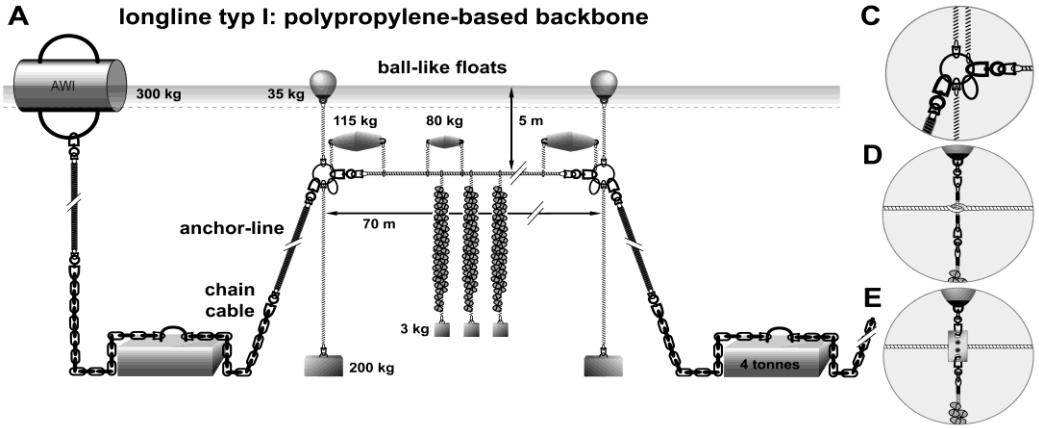
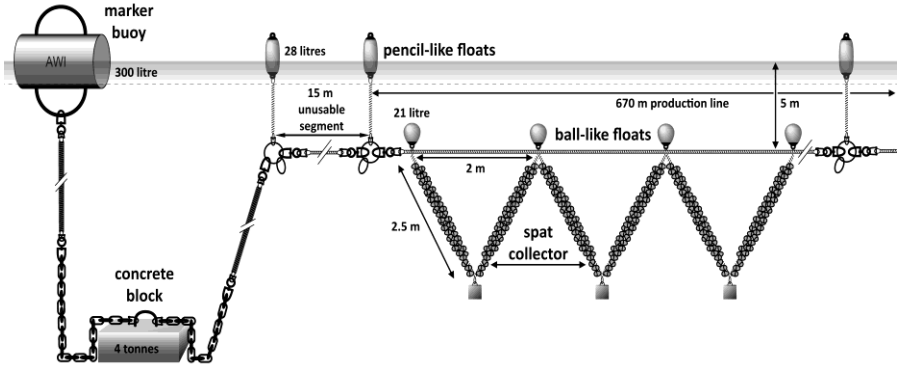


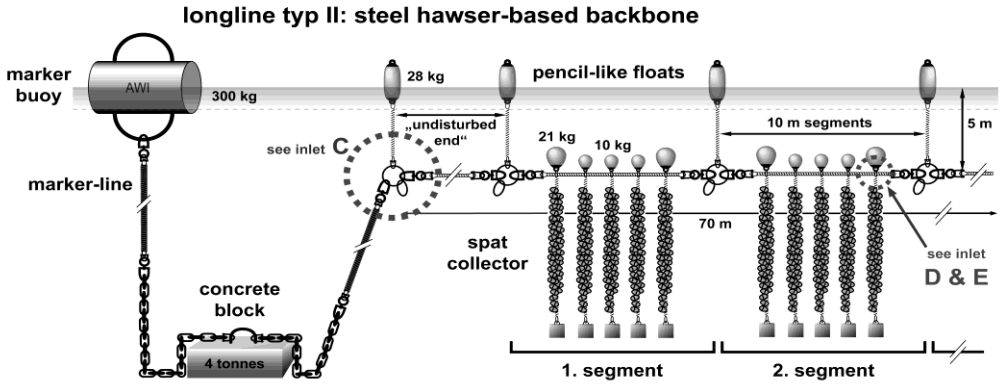


Generation of representative loads of wind energy installations

Mussel cultivation designs



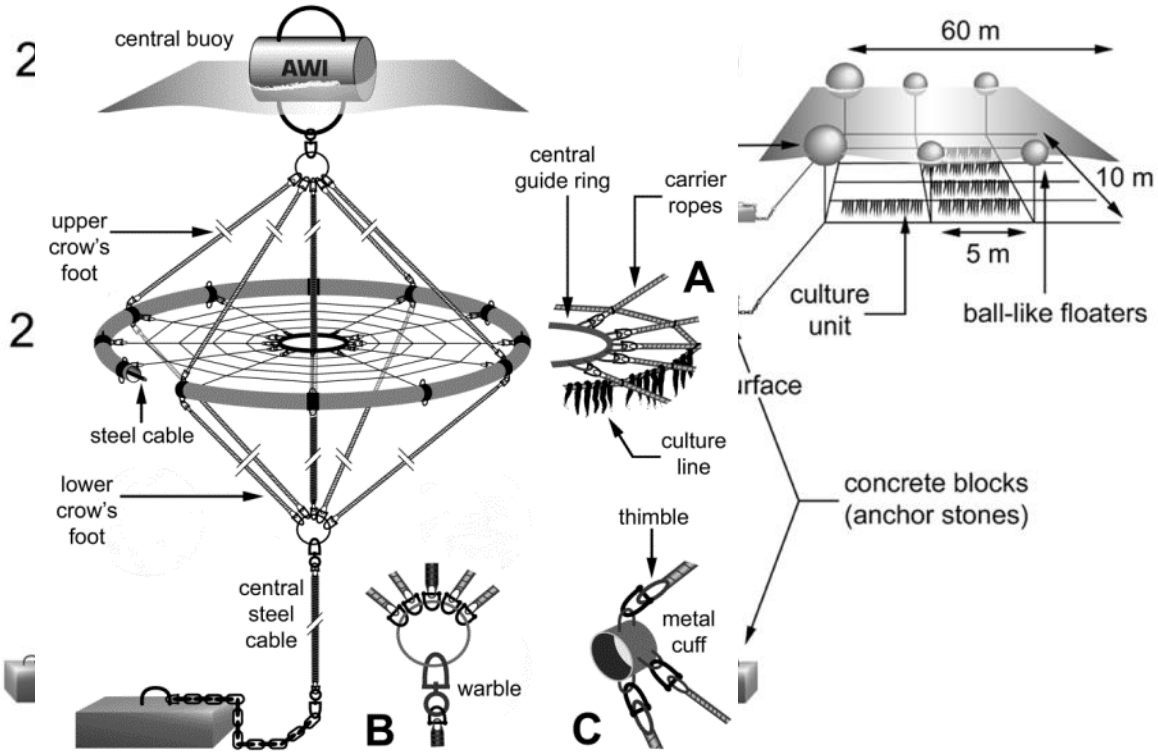




Buck (2007), Helg. Mar. Res.

Buck et al. (2010), Aquac. Econom. Management

Seaweed cultivation



- longlines
- ladder
- grid

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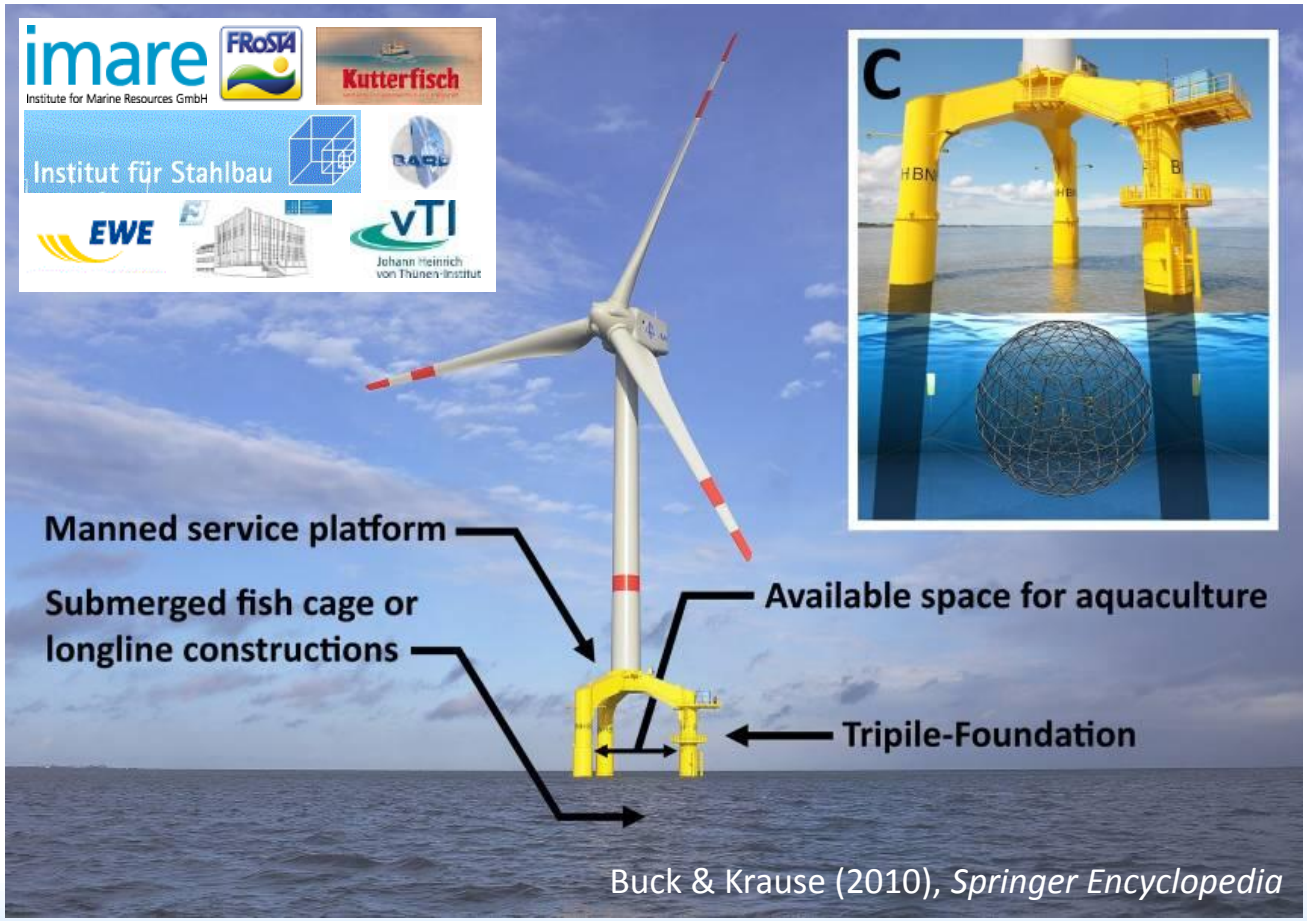

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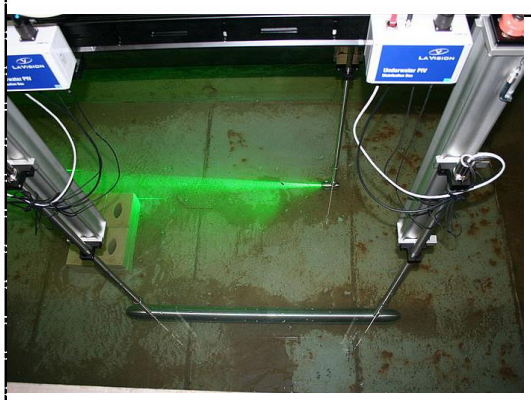
Experimental facility and probes

Stereo Particle Image Velocimetry (PIV): Flow field near structure



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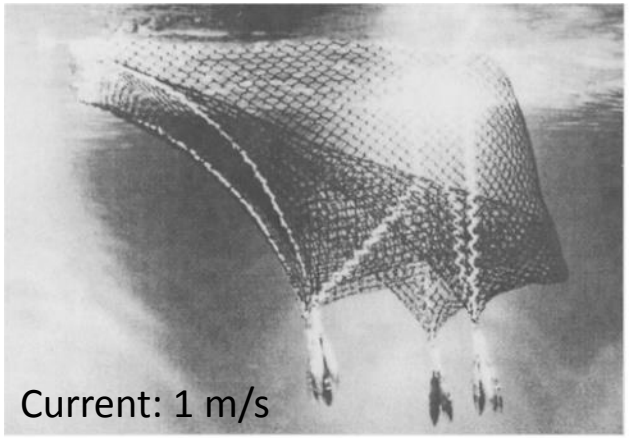
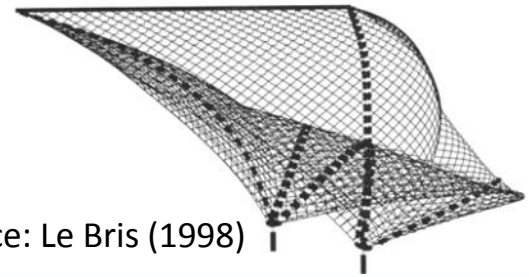
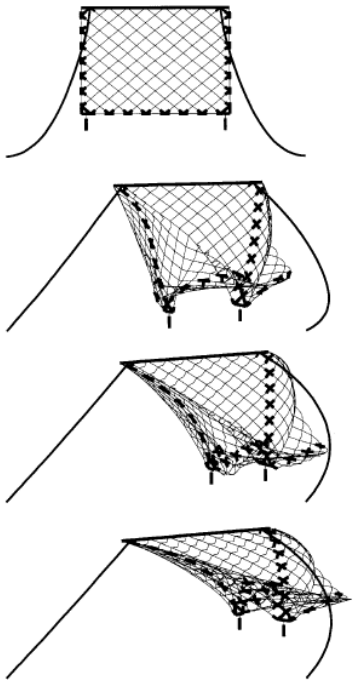
Include net loading in beam model





Source: Le Bris (1998)



Tripile + cage + net?
Experiments and numerical simulations

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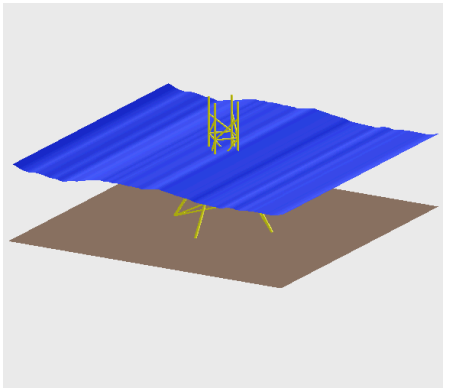
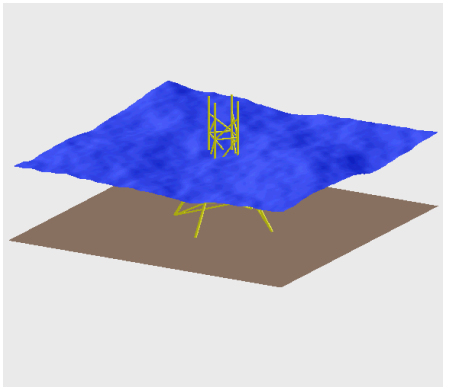
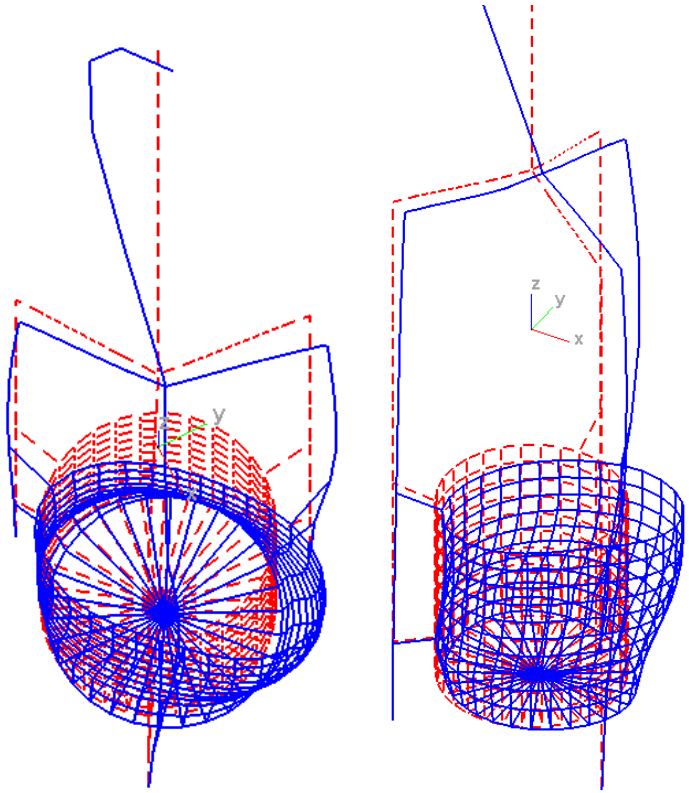
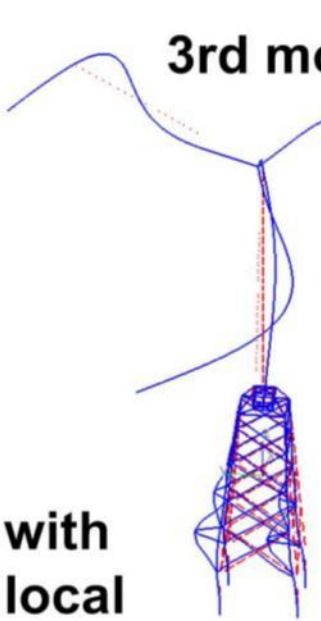




Influence on support structure dynamics





with local contribution

depends on stiffness of pile-cage connection!

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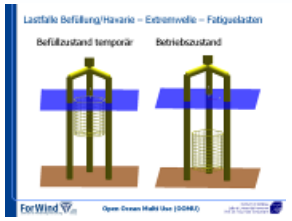
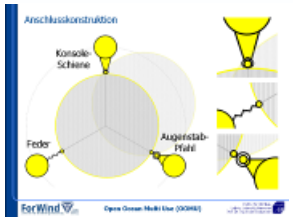
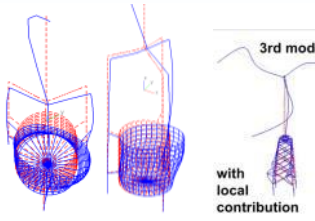
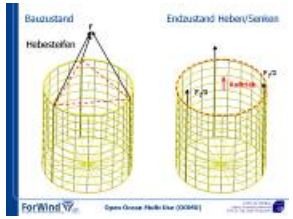
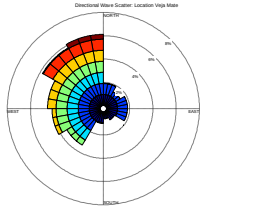
AWI SeaKult sustainable futures in the marine realm Bundesverband Aquakultur Hochschule Bremerhaven

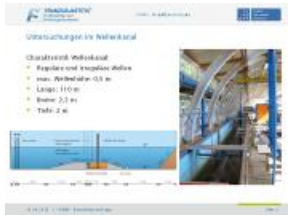


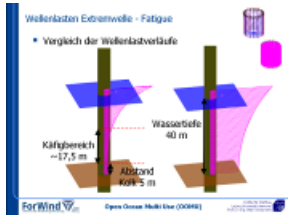


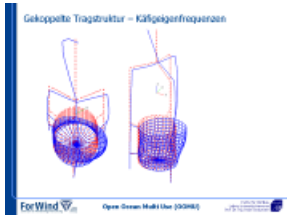


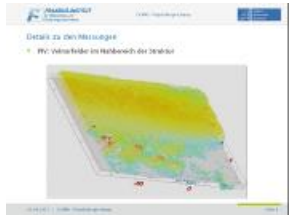


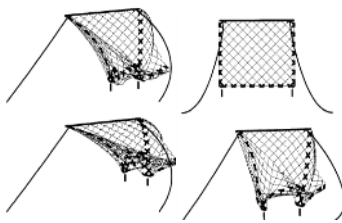


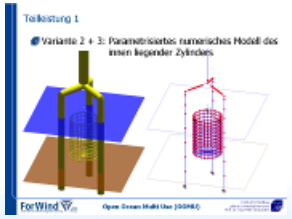


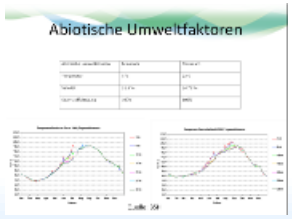


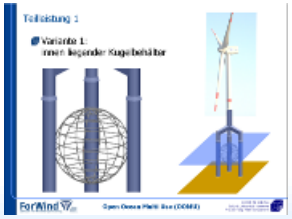


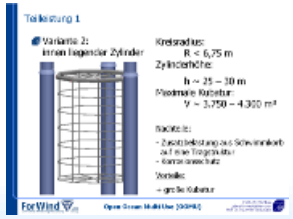


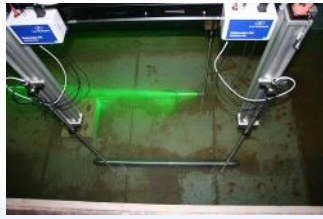












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Sustainable Production of Food

→ The IMTA-concept

Bioextraction

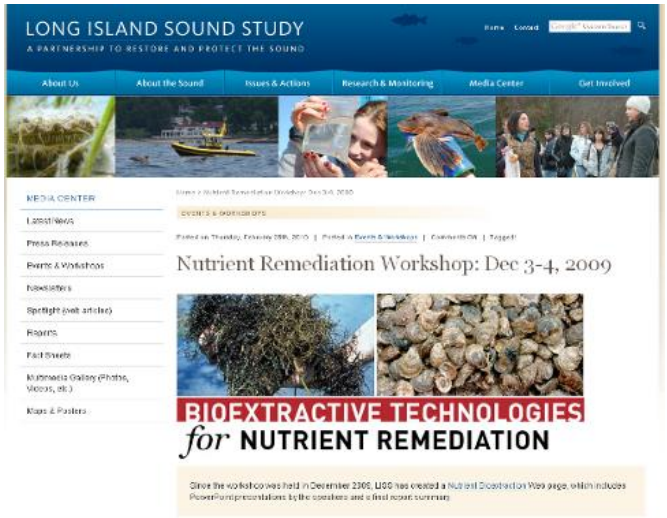
“An environmental management strategy by which nutrients are removed from an aquatic ecosystem through the harvest of enhanced biological production, including the aquaculture of suspension-feeding shellfish or algae”

Ecological Engineering

“Ecological Engineering is an emerging field that uses ecological processes within natural or constructed systems to achieve environmental goals”

Balanced Ecosystem Approach

“Fed aquaculture of finfish or shrimp with extractive organic aquaculture of shellfish and extractive inorganic aquaculture of seaweed (IMTA)”




POLICY FORUM

ECOLOGY

Controlling Eutrophication: Nitrogen and Phosphorus

Improvements in the water quality of many freshwater and most coastal marine ecosystems requires reductions in both nitrogen and phosphorus inputs.

Daniel J. Conley,[1]* Hans W. Paerl,[2] Robert W. Howarth,[3] Donald F. Boesch,[4] Sybil P. Seitzinger,[5] Karl E. Havens,[6] Christiane Lancelot,[7] Gene E. Likens[8]

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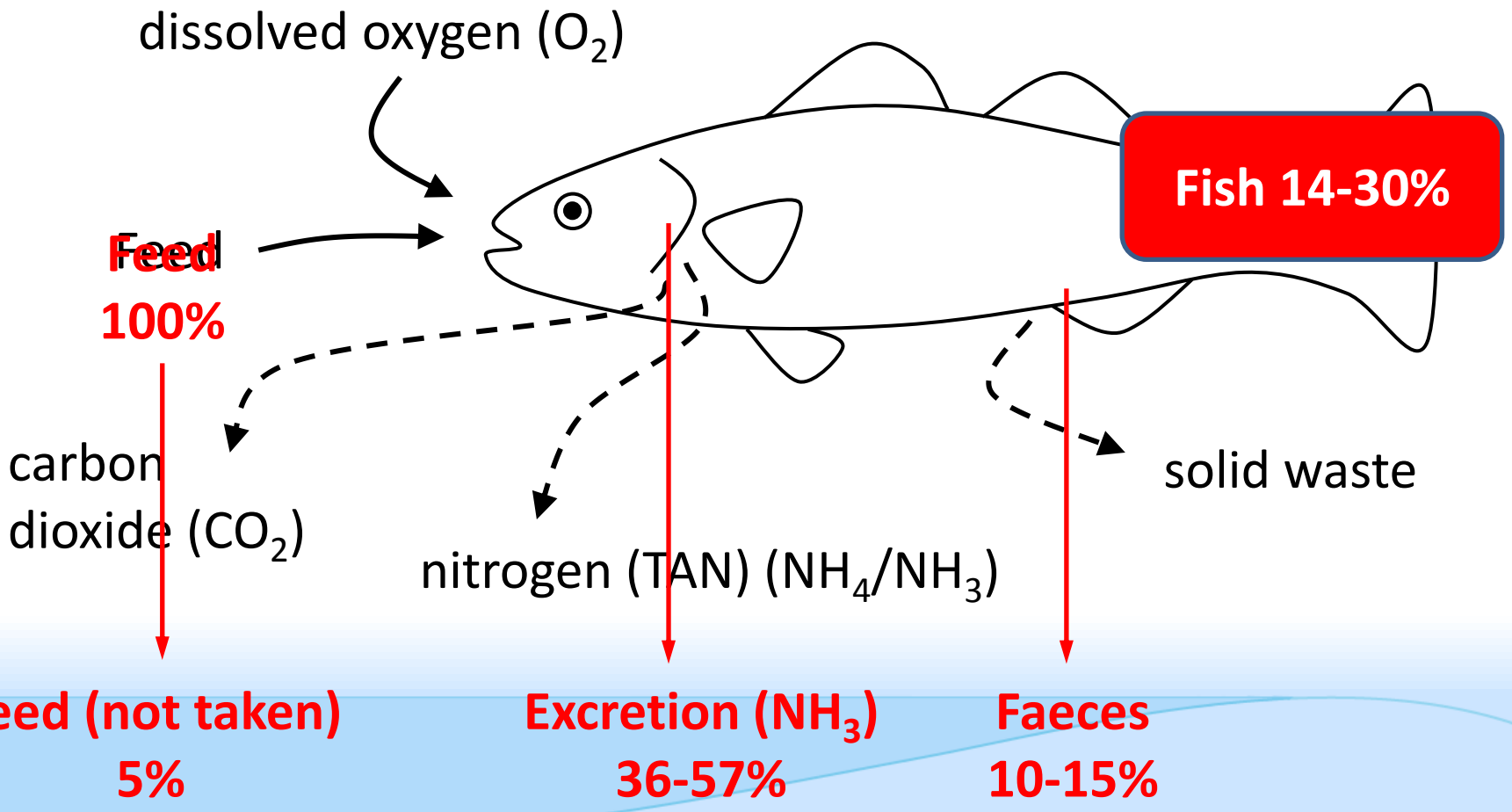
FLOWS OF MATTER (N)



MODEL FOR NITROGEN BUDGETS WITHIN IMTA-SITE

Basic Data Fish (fed AQ)
- standing stock and stocking density
- growth performance / FCR
- feed components
- biology and diet

Basic Data (extractive AQ)
- dissolved inorganic extraction (macroalgae)
- particulate organic extraction (polychaetes, bivalves)
- biology

Basic Data (environment)
- local current regime
- carrying capacity

Basic Data Origin
- data bases (ASFA, Scirrus, Web of Science, etc.)
- peer-reviewed publications as well as “grey” lit.
- own research

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MODEL FOR NITROGEN BUDGETS WITHIN IMTA-SITE

Start IMTA-Model (*Scoph. - L. sach - Mytilus*)

Data sheat 1 of 17

No.	Day	Standing Stock	Stocking Density	Growth Rate	FCR	NO_x Feed	NO_x Fish Ex.	NO_x SW	NO_x BM	biomass SW	biomass BI
1	1										
2	2										
3	3										
4	4										
5	5										
6	6										
7	7										
8	8										
9	9										
10	10										
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22	22										

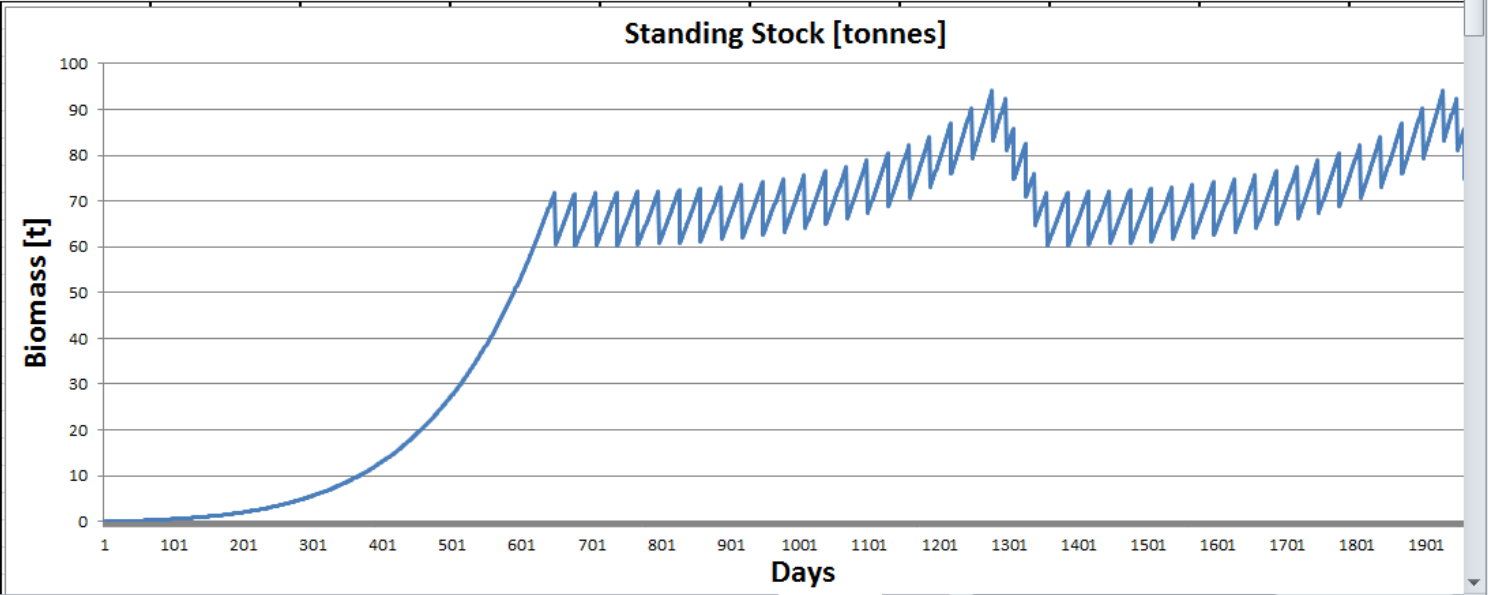
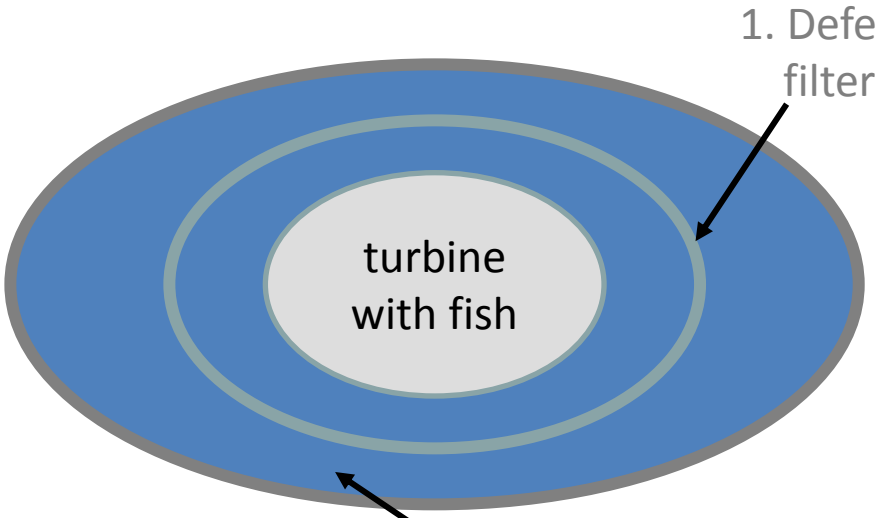


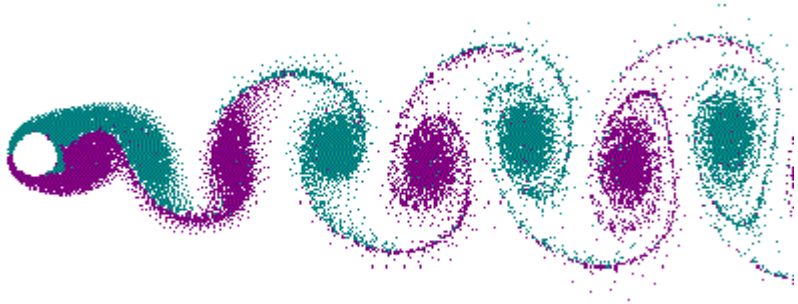
Tabelle1 | Wachstumskurve II | Futterberechnung | Pelletgrößen | Flächenberechnung II | Besatzplan II | Flächenplan II | Tabelle2

IMTA

(Integrated multi-trophic aquaculture)



McVey & Buck (2008), WAS



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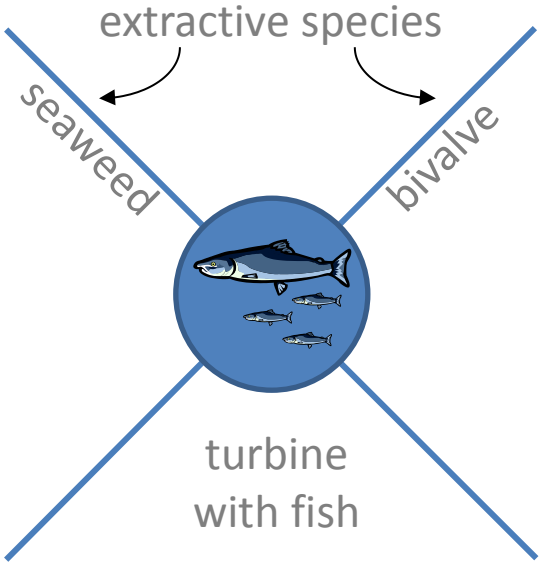
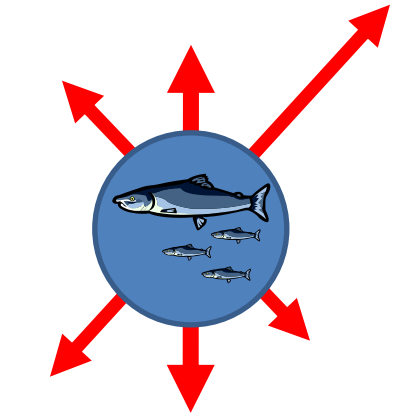
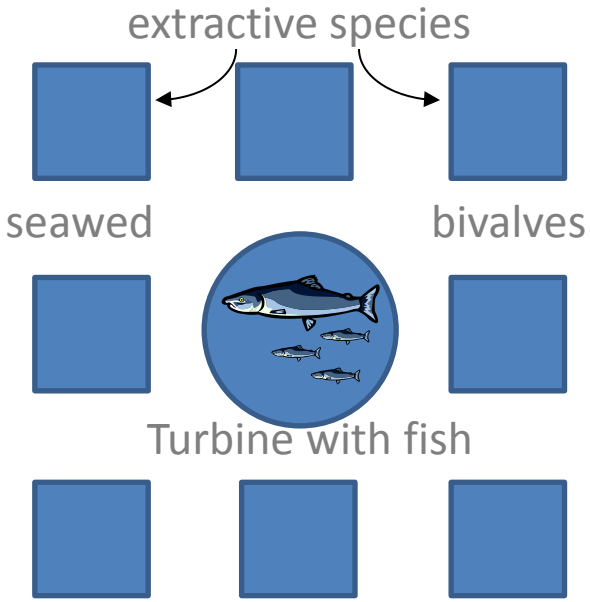
IMTA

(Integrated multi-trophic aquaculture)







Combination with other Infrastructure

→ RAS ⇔ OOA

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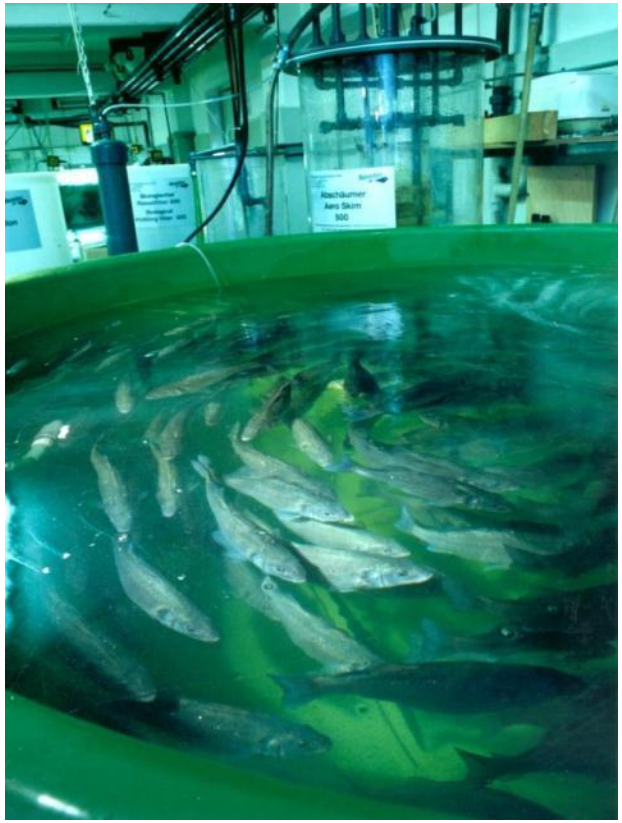

Open Ocean Aquaculture (**OOA**)

Land-Based Recirc.-System (**RAS**)

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small

Marked size

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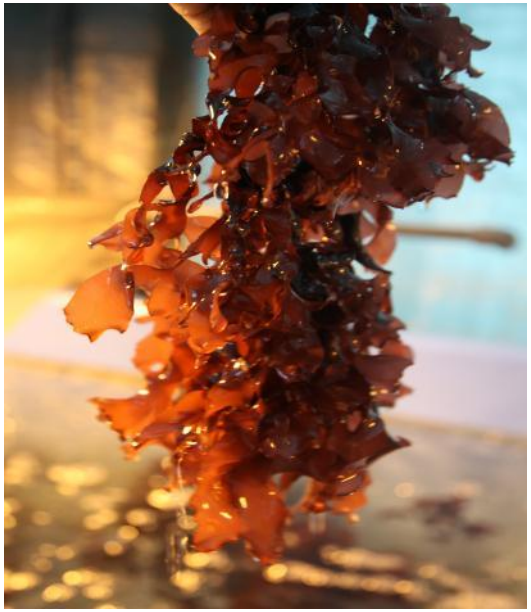
AWI SeaKult sustainable futures in the marine realm Bundesverband Aquakultur Hochschule Bremerhaven

Integrated Multi-Trophic *Multi-Loop* Aquaculture



Scophthalmus maximus

Nereis diversicolor

Mytilus edulis

Palmaria palmata

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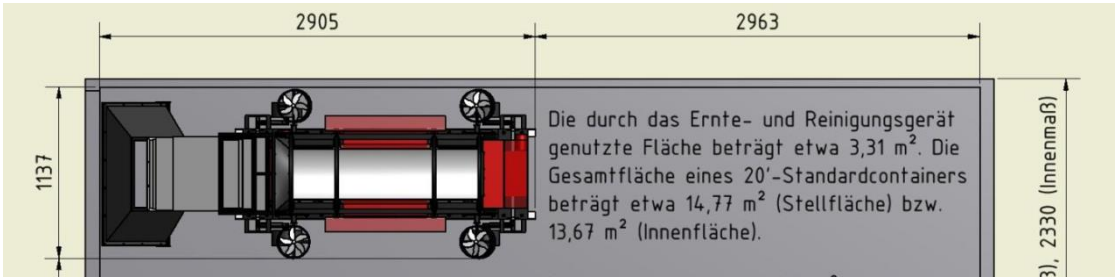
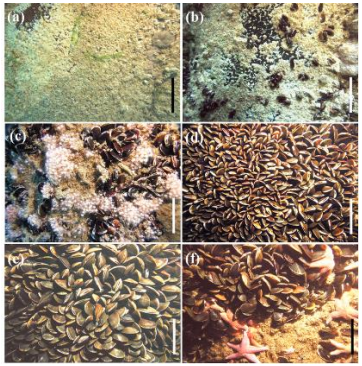
imare GmbH





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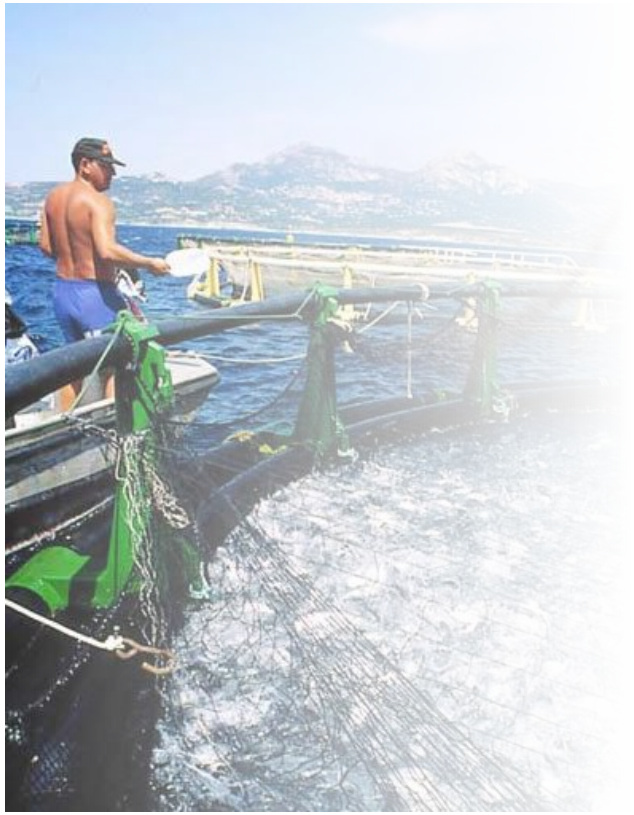

Future Production of Food from the Oceans:

- Follow guidelines defined by the FAO
- Foster cooperation with experts within the EU
- Develop innovative technologies to allow co-use concepts
- Set-up an inter. offshore test facility

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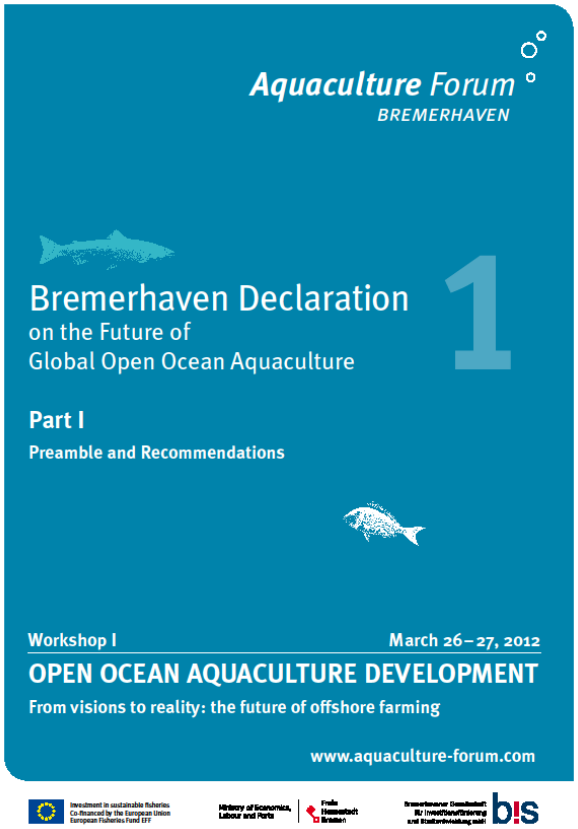

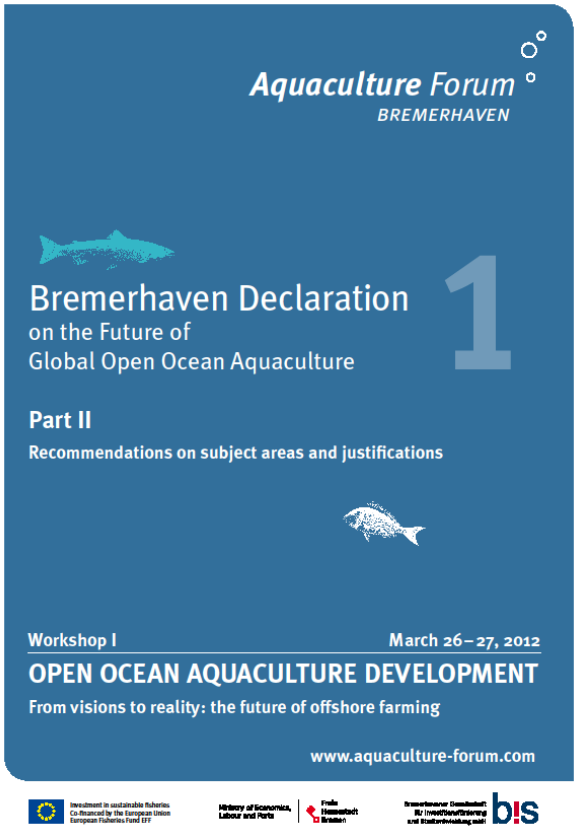

Bremerhaven Declaration

on the Future of Global Open Ocean Aquaculture

Key Issues:

1. Upscaling aquaculture requires a move offshore.
2. IMTA concepts should form the basis for new enterprises to fulfill criteria of sustainability and environmental friendly techniques => acceptance
3. Multi-use will have a better acceptance for both stakeholders and would save costs/have economic benefits
   - quick procedure
   - combined EIA
   - shared vessels/personal
   - training
   - additional biomass

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