

Energy from Offshore Kelp Farms: Technologies and Production of *Laminarian* Species

Prof. Dr. Bela H. Buck

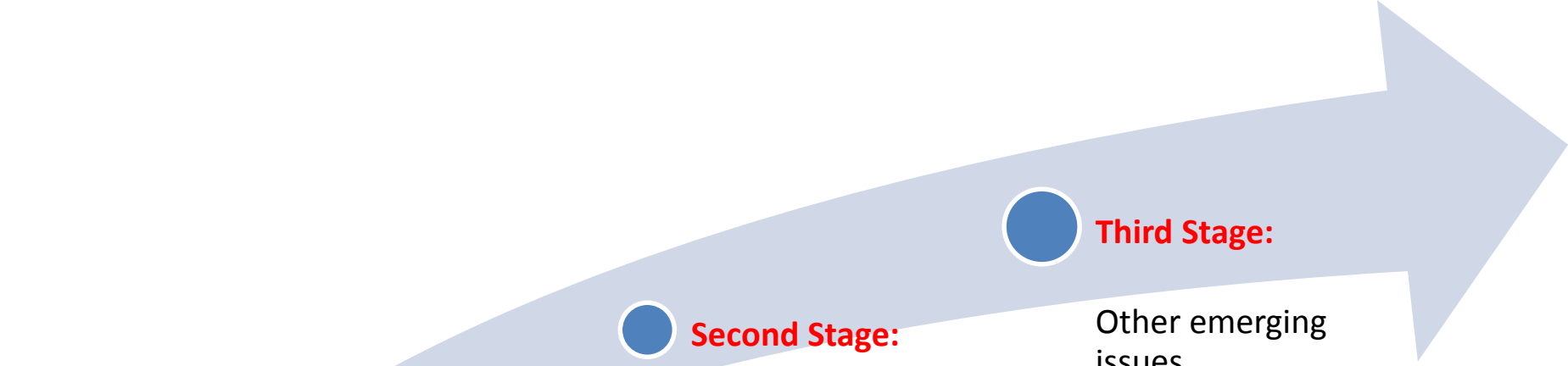


Marine Offshore Biorefinery Workshop in Israel - Tel Aviv-Jaffa 24th May 2017

Production of seaweed offshore

1. What are the drivers?
2. Is there an withstanding technique and how can we avoid failures?
3. How is the economic potential depending on target product?
4. Is experienced personal available?
5. Who is willing to conduct this enterprise?





First Stage:
Gather advance information

Second Stage:
Environmental baseline, assessment and monitoring

Third Stage:
Other emerging issues

Information of the potential sites:

- Data availability (GIS, satellite)
- Maps with geologic/geographic/bathymetric/topographic/navigational and hydrographic data (!)
- Previous usages, future plans by the local community
- Other stakeholders
- Jurisdiction and regulations (current/future use) (!)

Information of the local area (land-based):

- Accessibility from land (roads, harbour, electricity, phone cables, land-based facilities, etc.) (!)
- Experiences/educated workers available (!)
- Equipment available (spare parts, farm harness) (!)
- Subcontractors available (deployment at sea, security, harvest vessels, further processing, transport, etc.)
- proximity to processing plants, airport, other ports, markets
- Community related support: Permit, taxation and co-finance (!)

Site-specific and oceanographic parameter:

- Current velocity, wave height, and direction (!)
- Year-round climate conditions (wind exposure, fetch, storm conditions, ice drift, etc.) (!)
- Depth and seafloor conditions (!)
- Distance from shore and tides (!)

Water quality parameter:

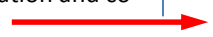
- Temperature, pH and salinity regime
- Oxygen/nutrient concentrations (!)
- Turbidity and attenuation
- Effects of river run-offs
- Red tides and plankton blooms
- Predators

Other important requirements:

- Potential of expansion
- Technical feasibility (!)
- Economic feasibility (!)

Buck & Grote (submitted)
Springer

First sites selected



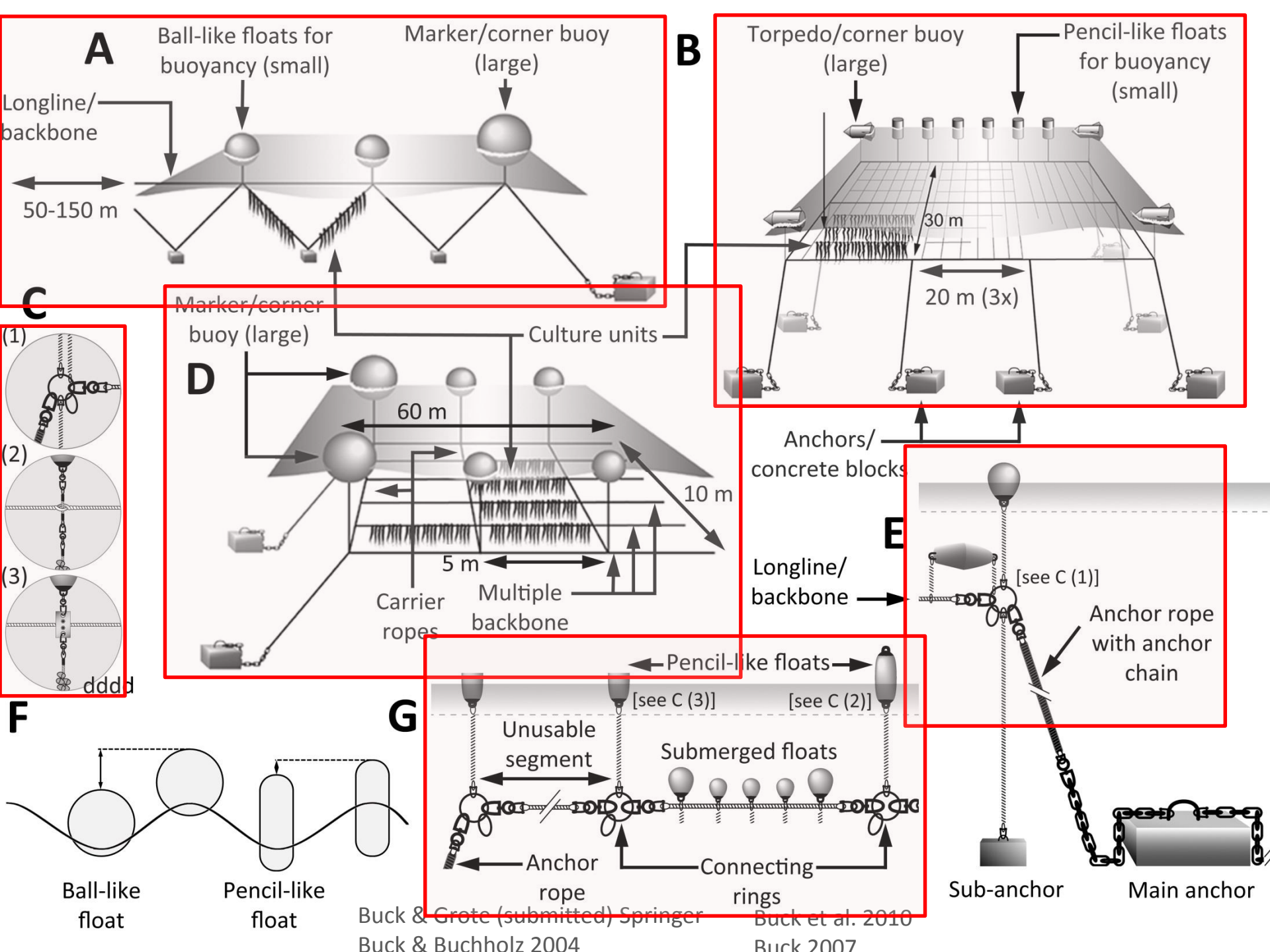
Selected sites reduced

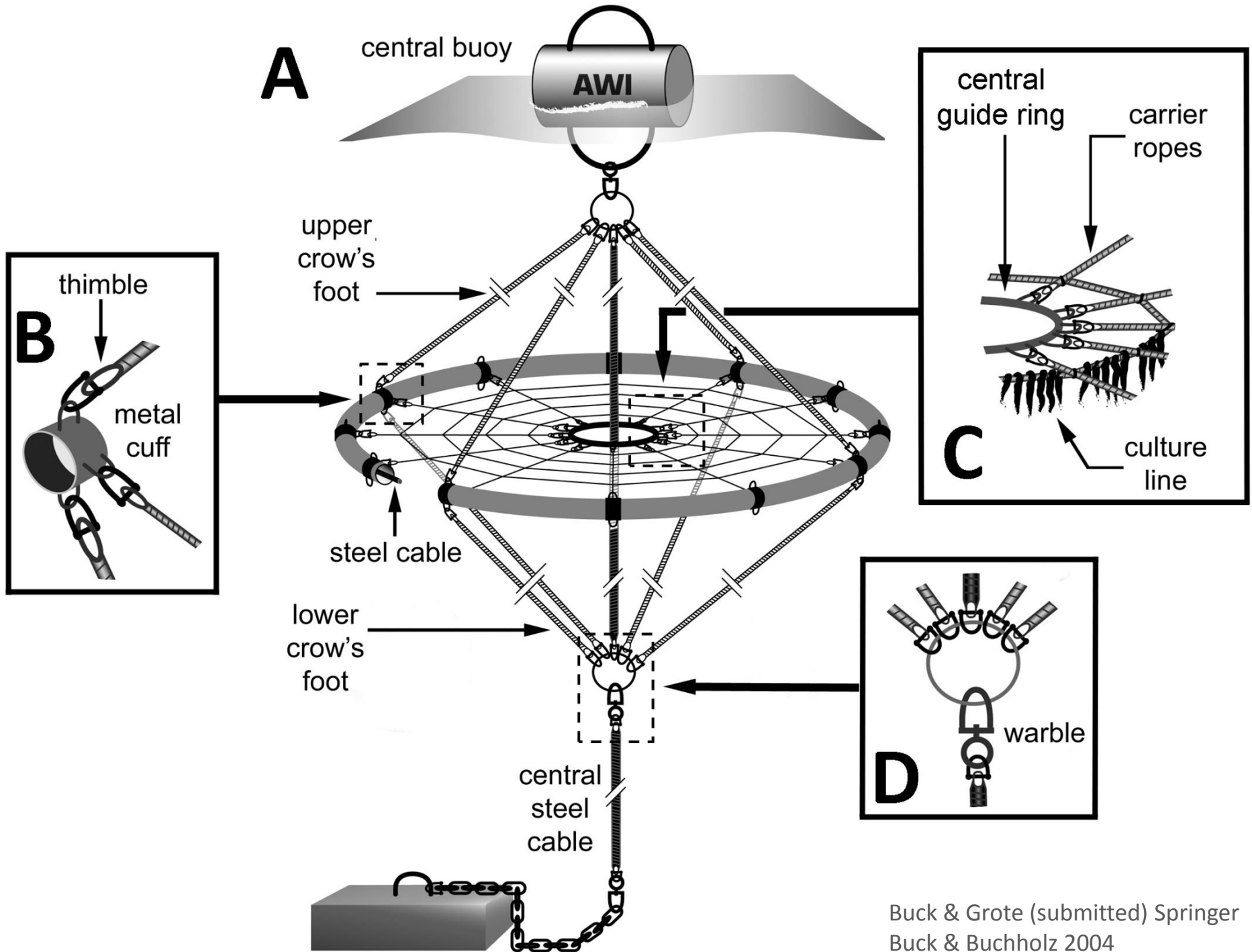


Final site selected

Technology and System Design

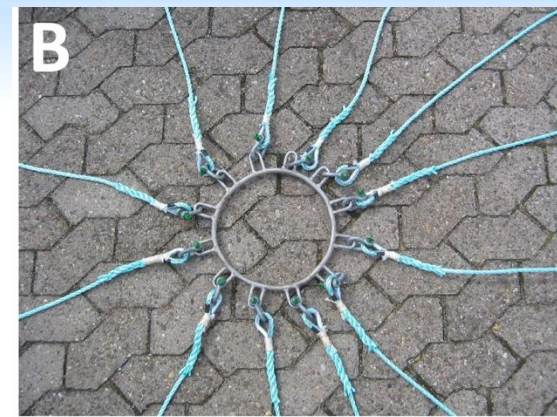
→ Offshore Resistant Techniques







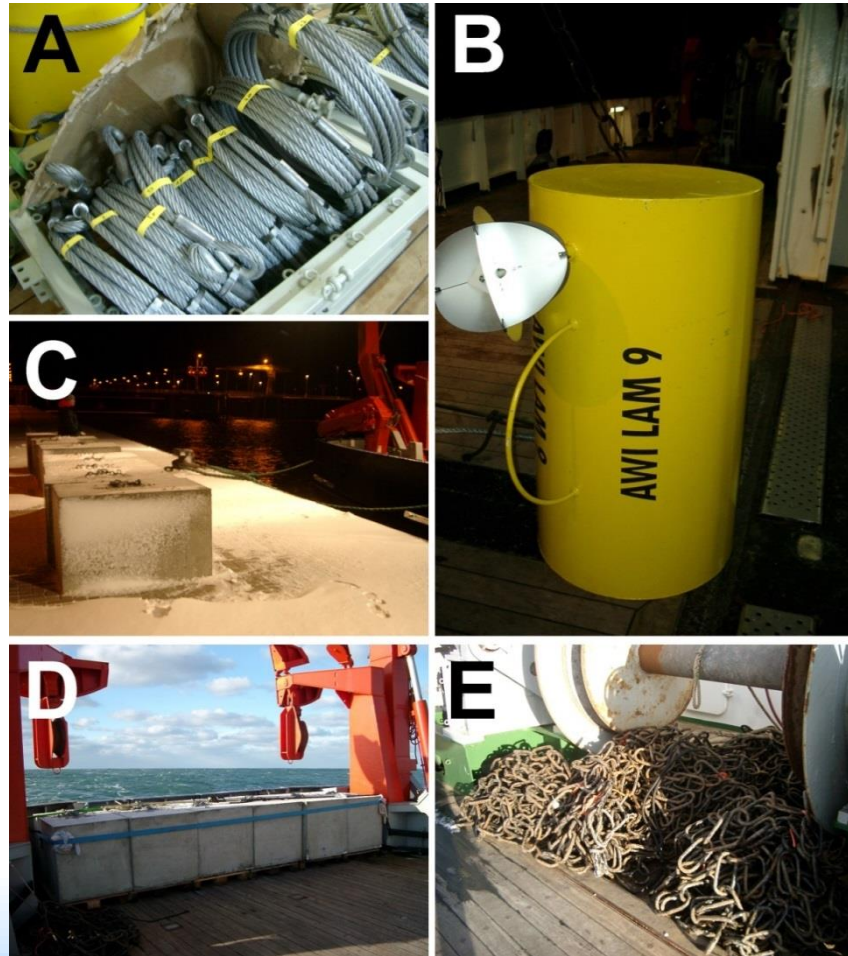
First version from
1994-1997



Modified version from
2001-2006



Resistant equipment:



Preparation at sea:



A



B



C

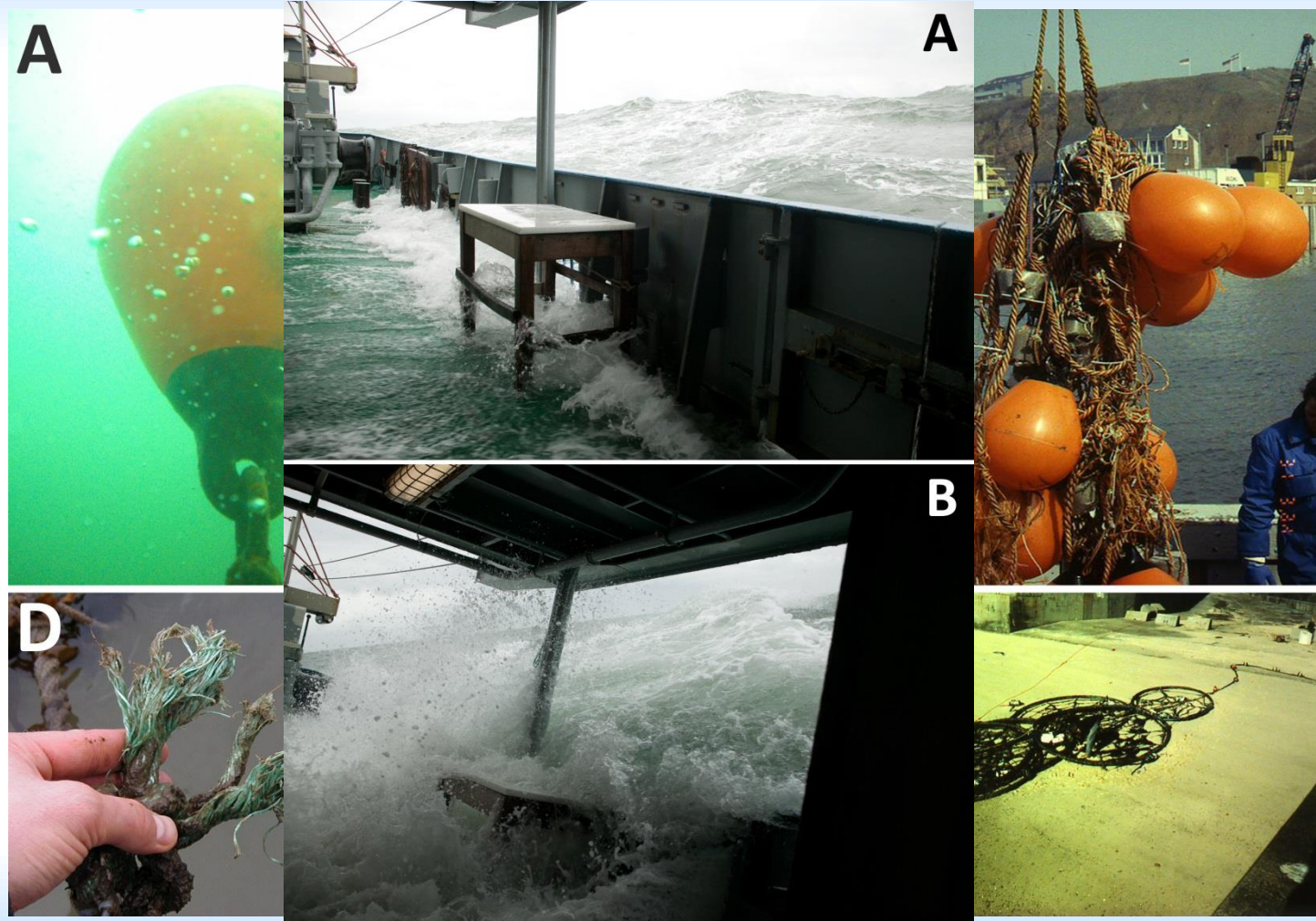


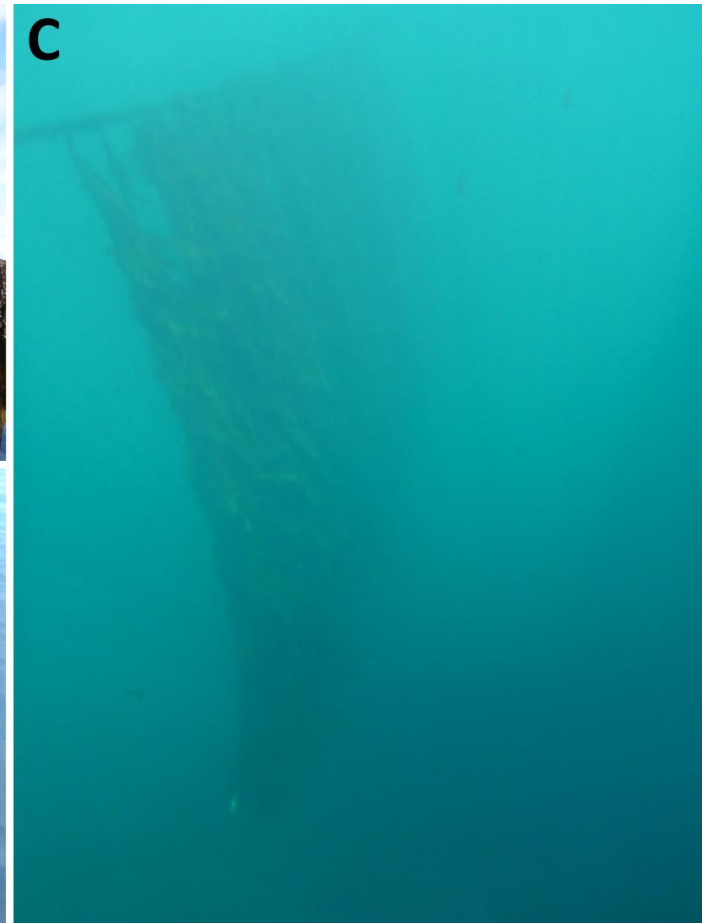
D



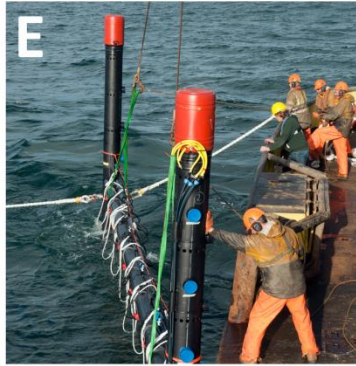
Buck et al 2017a/b
Buck & Grote (submitted) Springer

Wrong Calculations and failures:





Curtain system from Sweden



H-frame from the Netherlands

Data Collection on *Saccharina latissima* Cultivation: other costs

Other cost data

1	License costs, only paid one time [€]	1.000
2	motor overhaul (every 10 years) [€]	0
3	labour costs	
4	fuel	72.000

Labour:	Boss (owner and captain)	1x
	employee	2x

Working days at sea:

120 days	deployment of longlines	30 days	full staff
	harvest of longlines	30 days	full staff
	maintenance	60 days	full staff

Working days on land:

100 days	lab work	40 days	employee only
	store/handle of biomass	20 days	full staff
	other work	40 days	boss only

fuel costs:

one day price [€]	600	120 days price [€]	72.000
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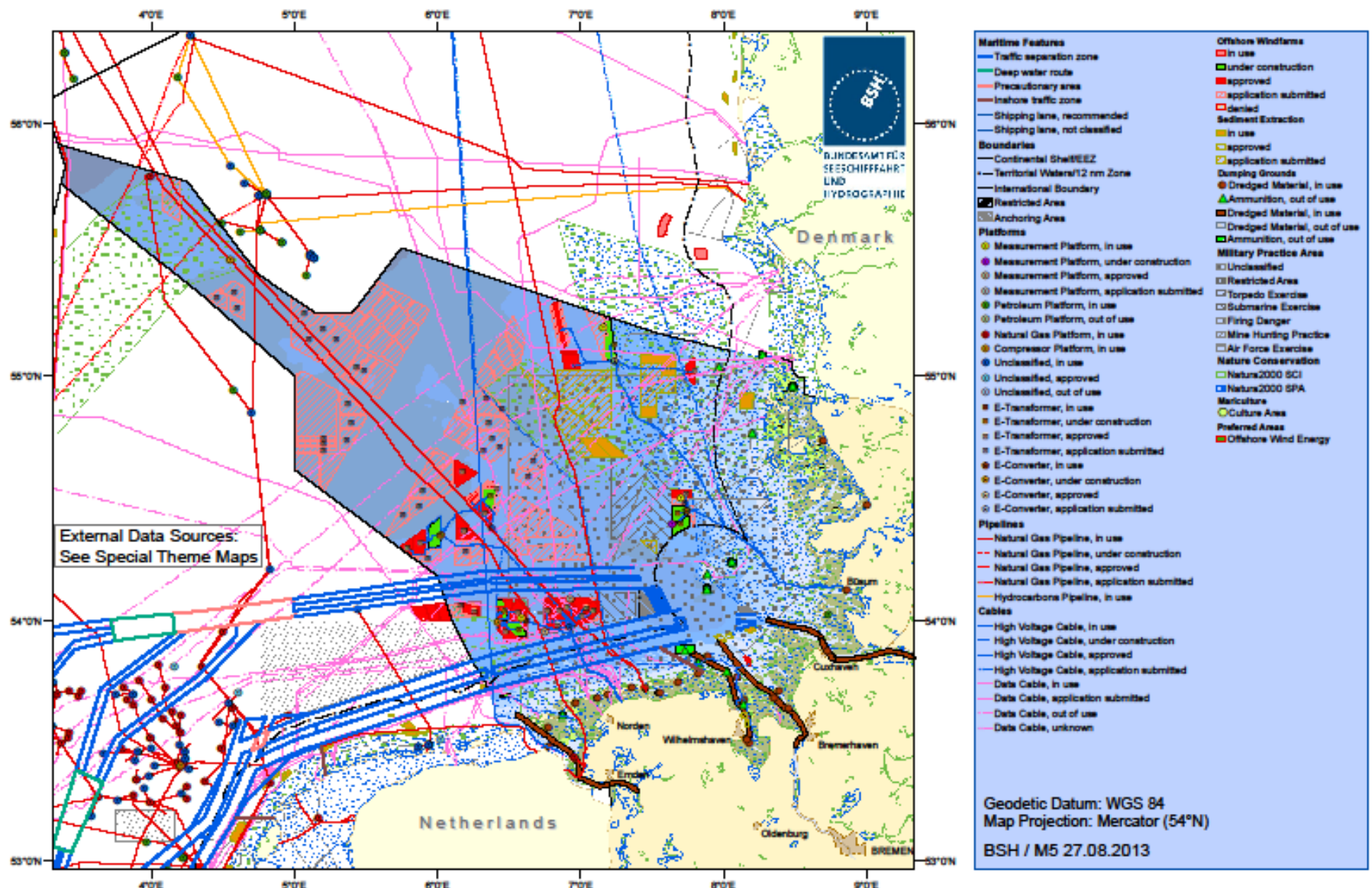
b	(triangle)
4,33	→ 5 m ring
18,75	
4,47	→ 8 m ring
20	

years of useful life)

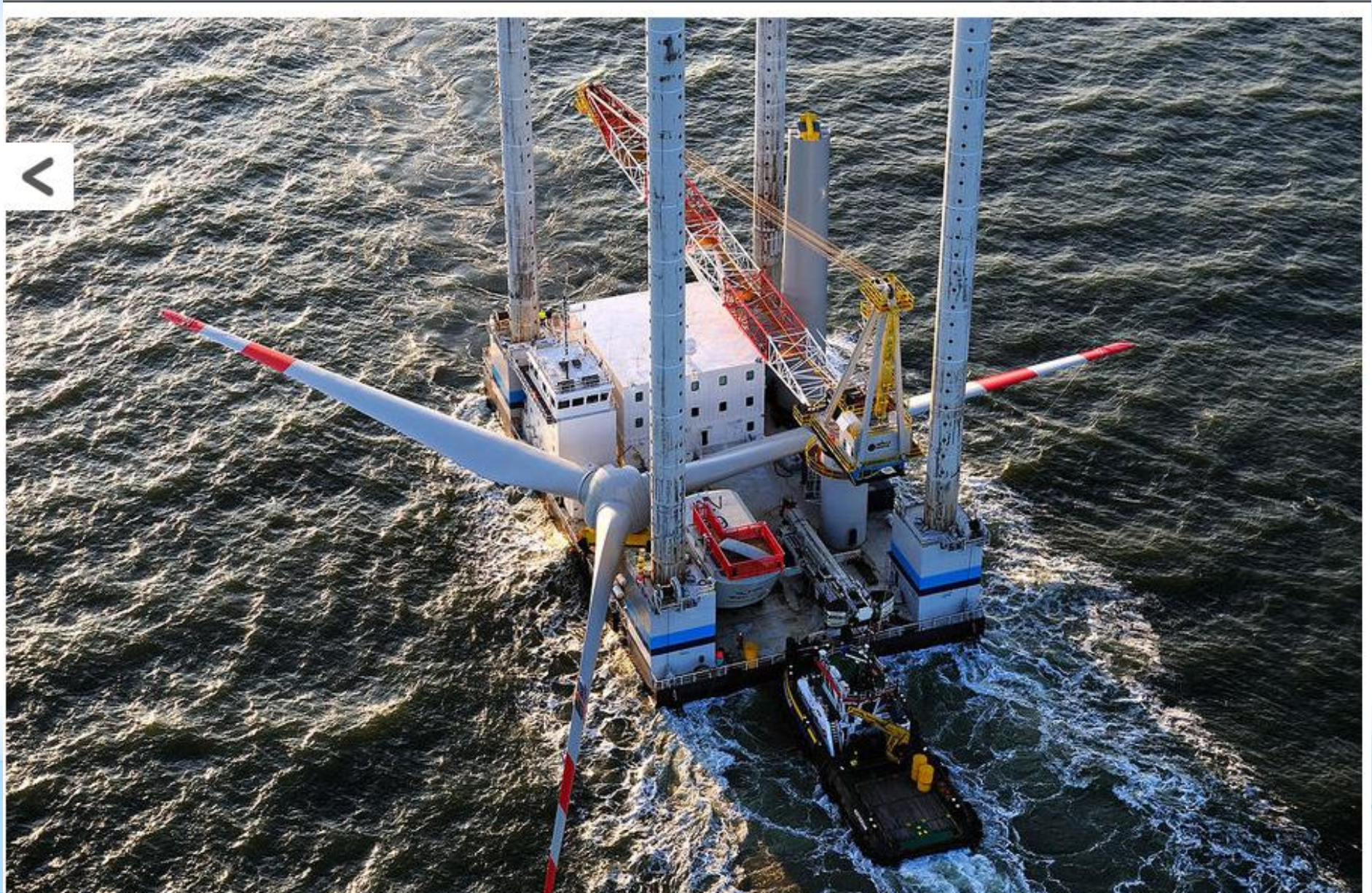
Special Case

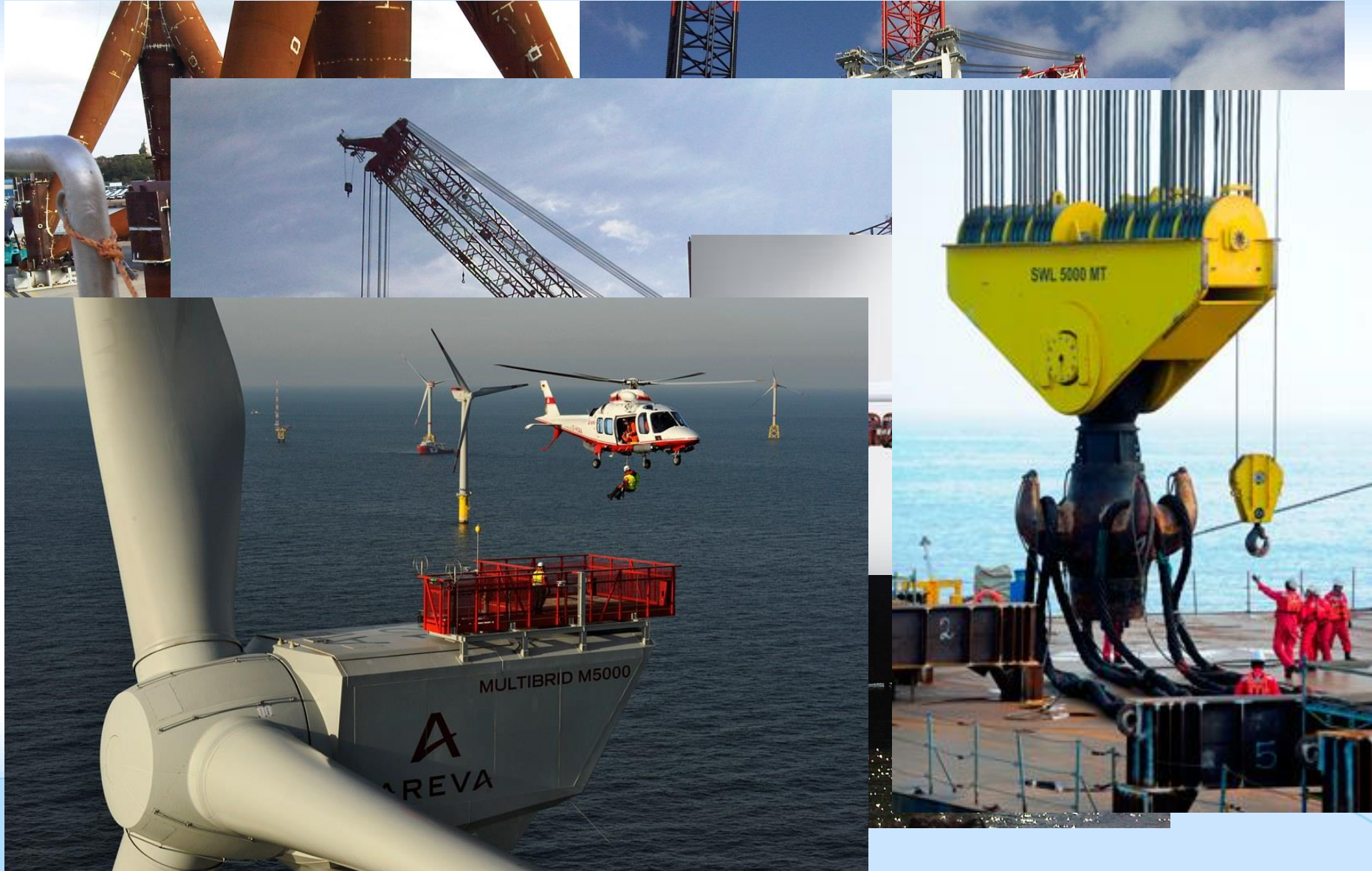
→ Multi-use as Solution

North Sea: Existing and Perspective Uses and Nature Conservation

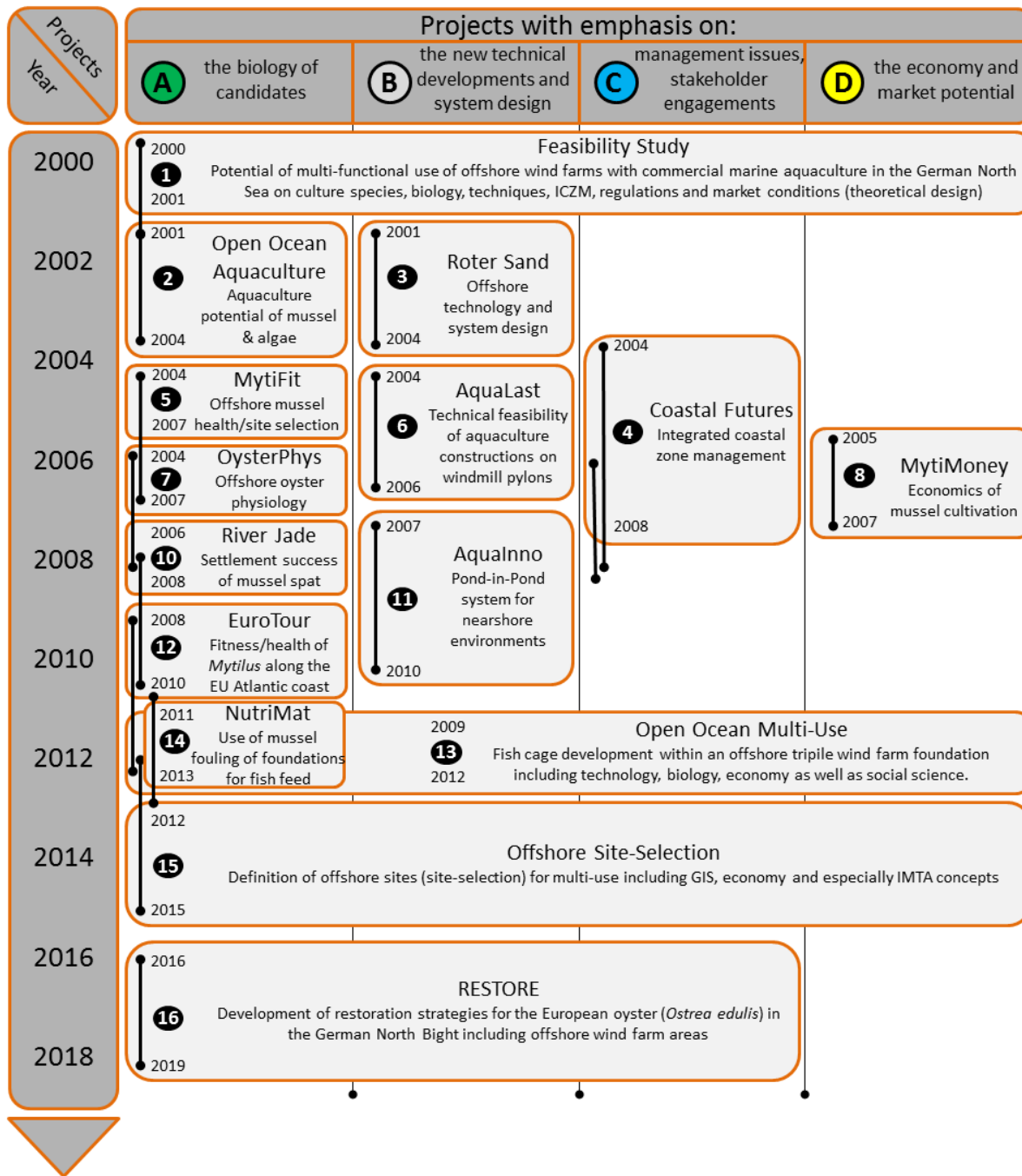


http://www.bsh.de/en/Marine_uses/Industry/CONTIS_maps/index.jsp





All presented data/information are published in ISI-Journals or can be obtained from Bela.H.Buck@awi.de



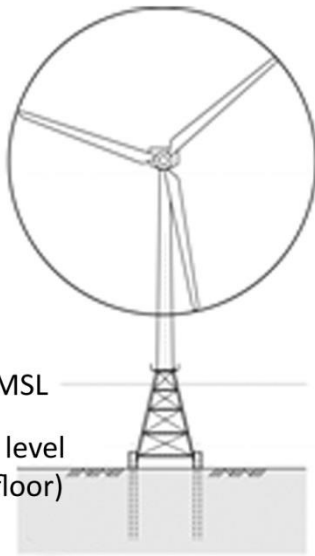
Offshore-Site-Selection

→ IMTA in OWF

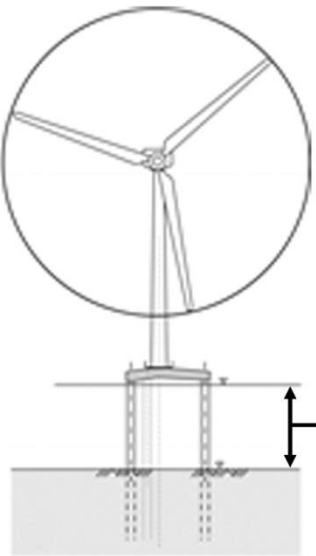
A



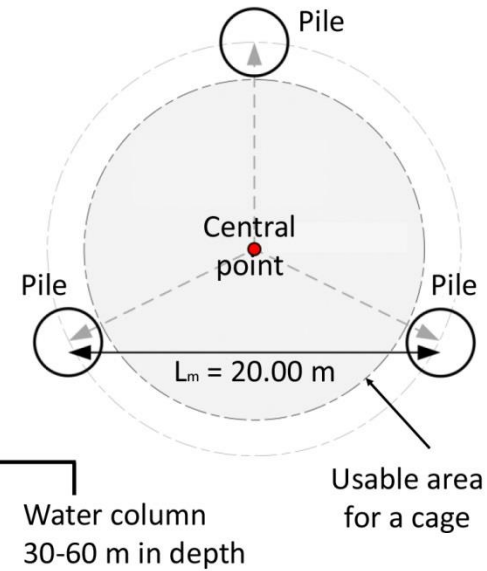
B



C



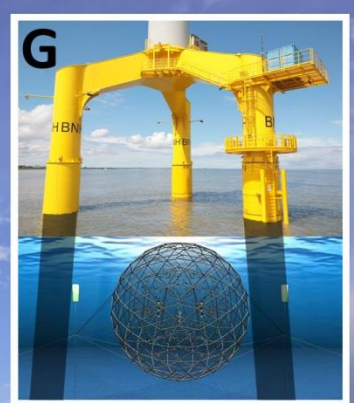
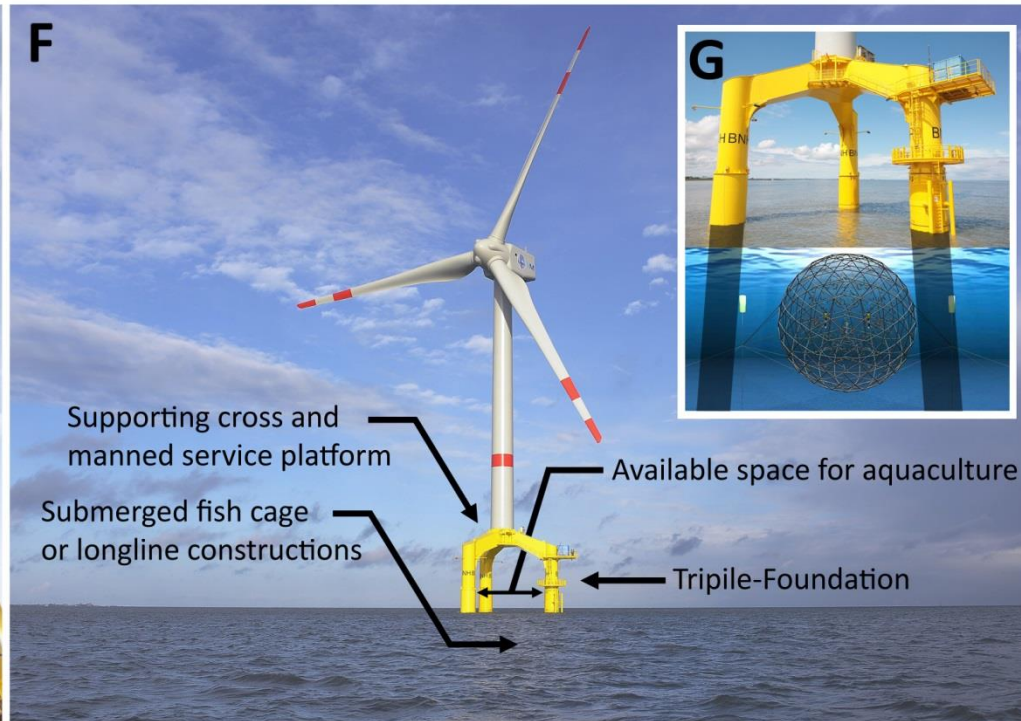
D



E

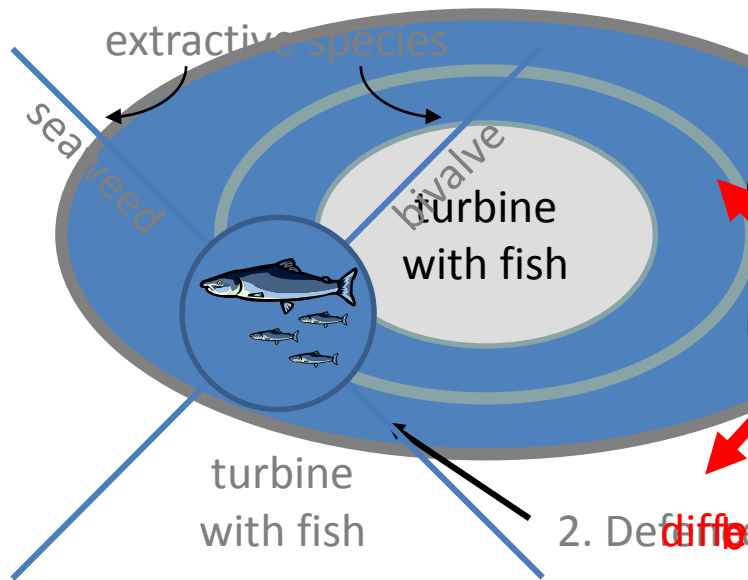


F



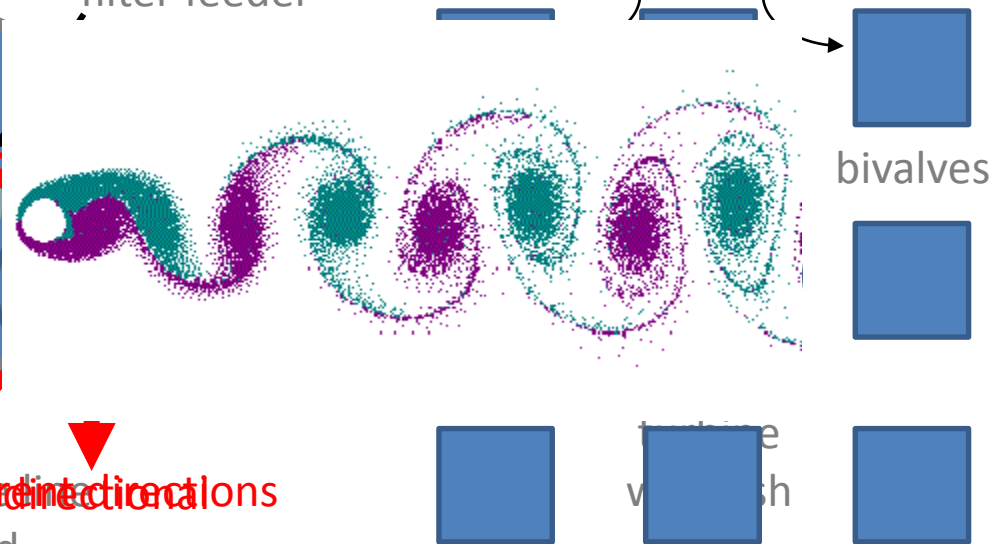
IMTA

(Integrated multi-trophic aquaculture)



1. Defense line: filter feeder

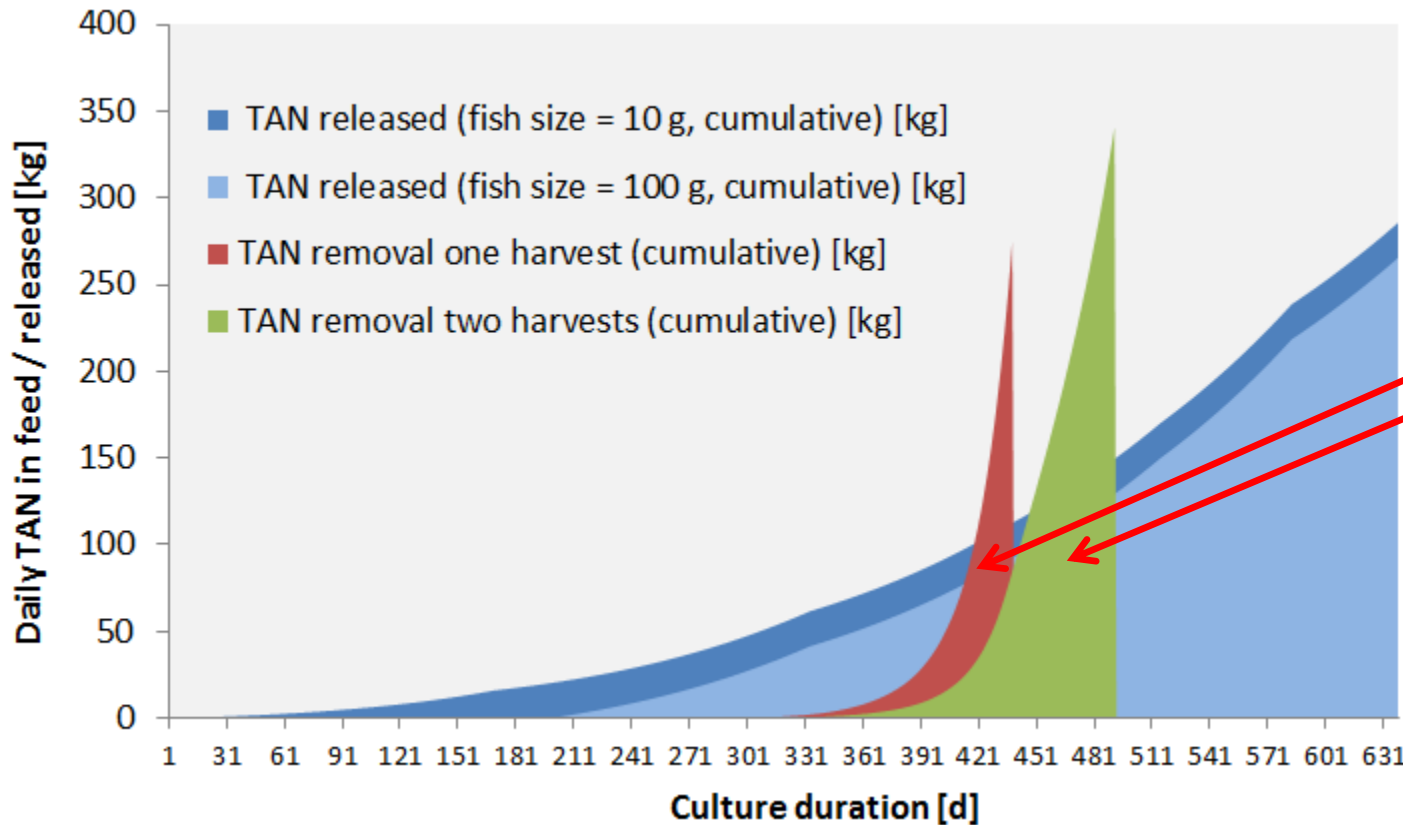
extractive species



2. Defense line: different directions seaweed

McVey & Buck (2008), WAS

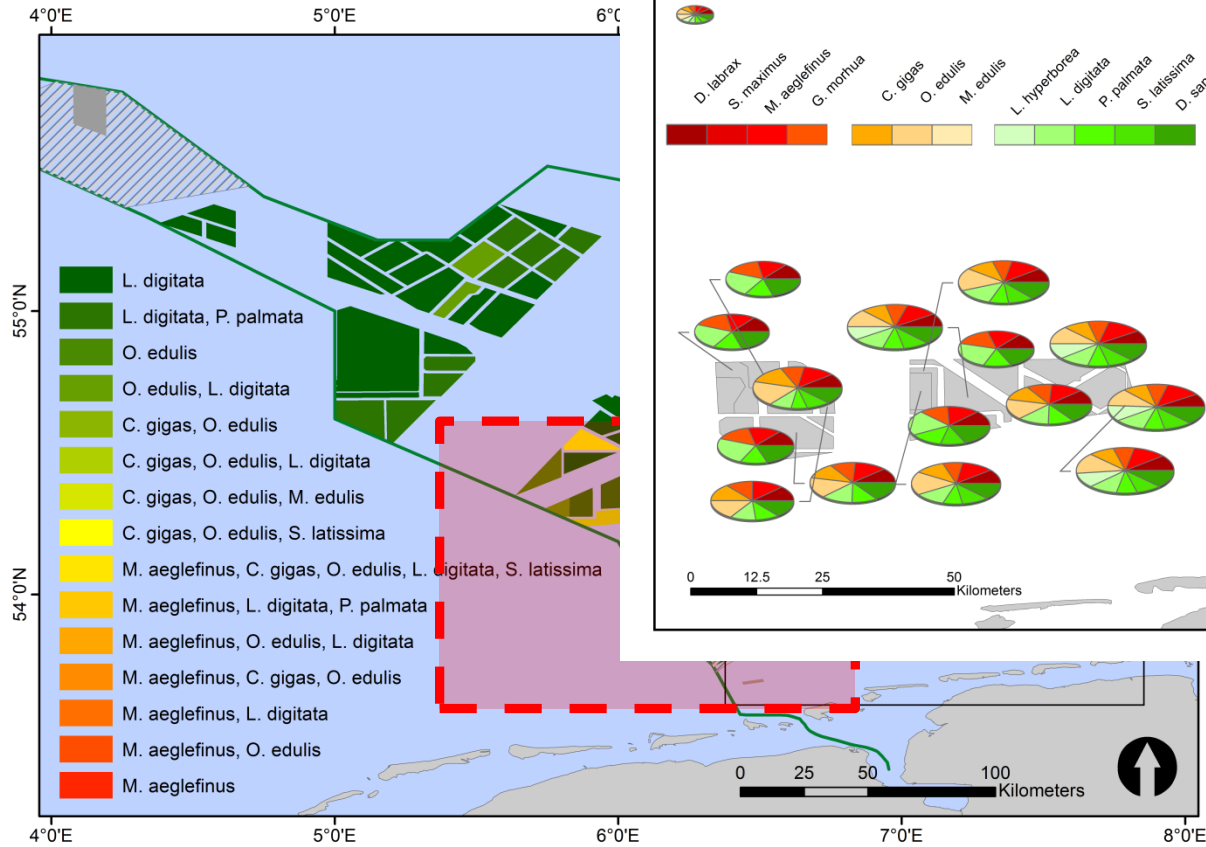
Basic Data 07: Fish & seaweed



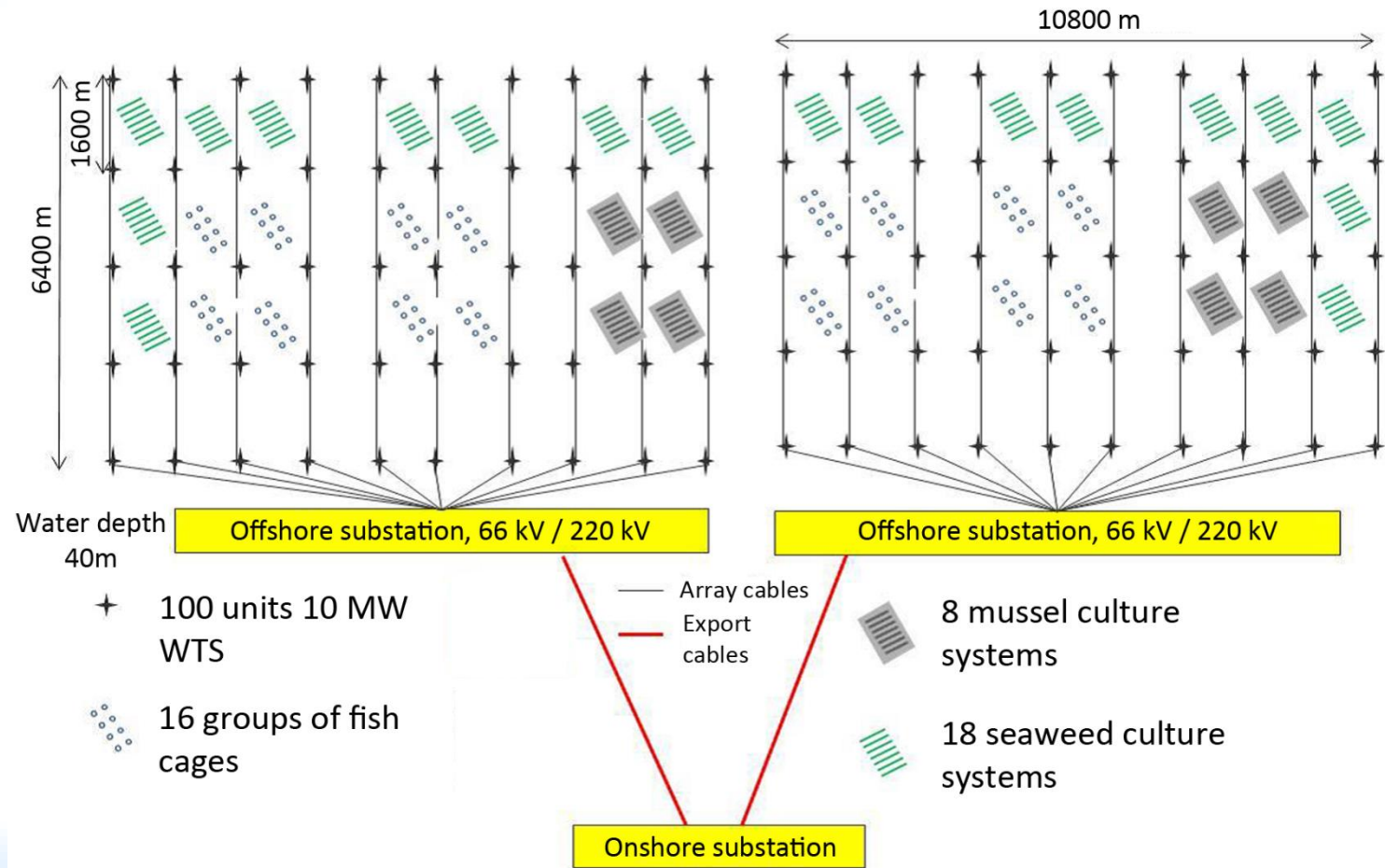
264.52 kg

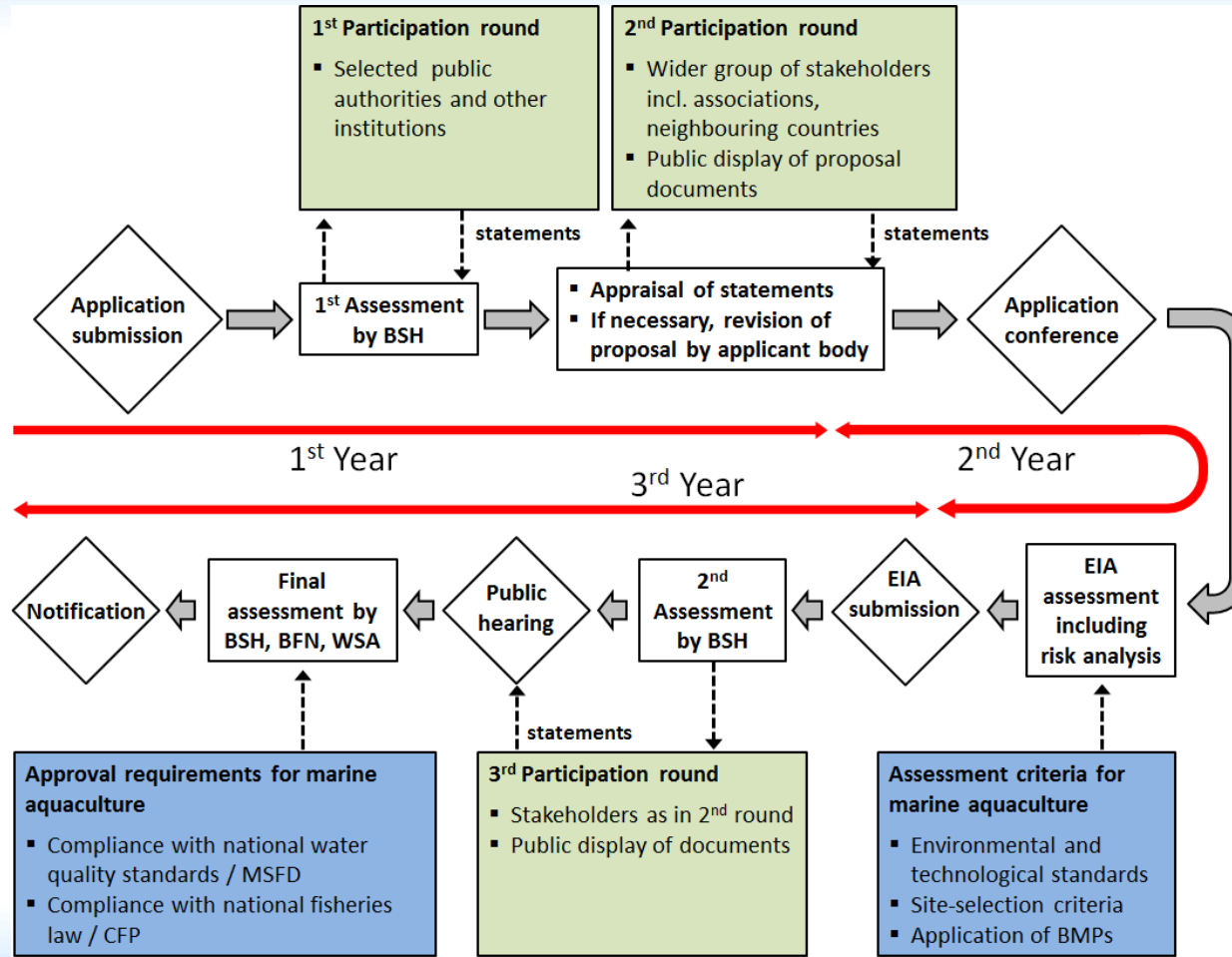
- two harvests within one year
- Enlarge seaweed farm size and reduce costs ($675 \text{ €} \cdot \text{t}^{-1}$)
- Emission concept with regard to credits/tax reduction

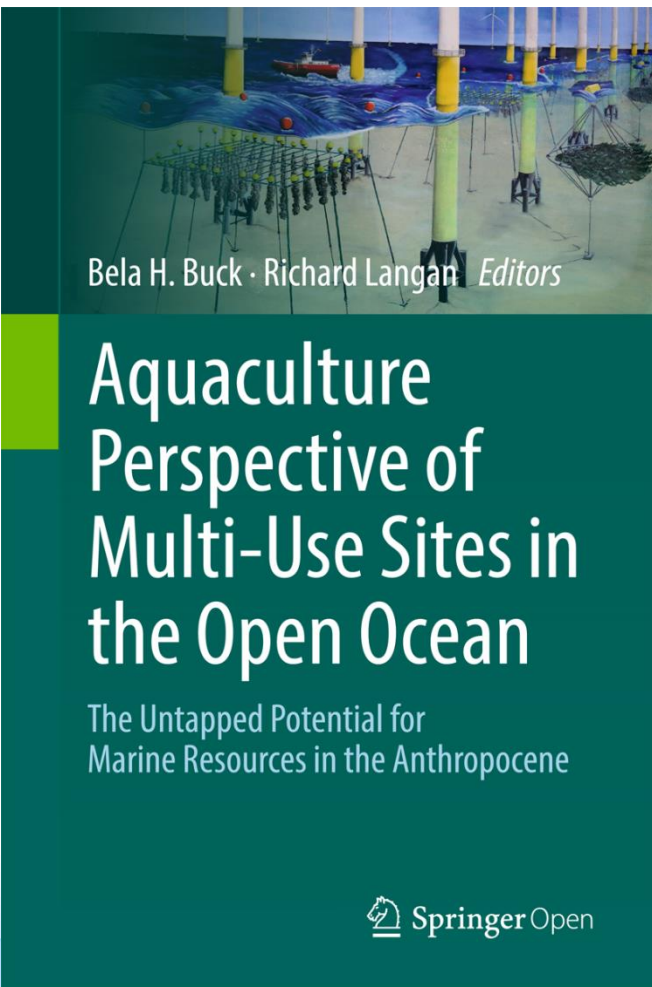
Buck & Grote, submitted



Courtesy of Vanessa Stelzenmüller – Thünen Institute Germany







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Editors: **Buck**, Bela H., **Langan**, Richard (Eds.)

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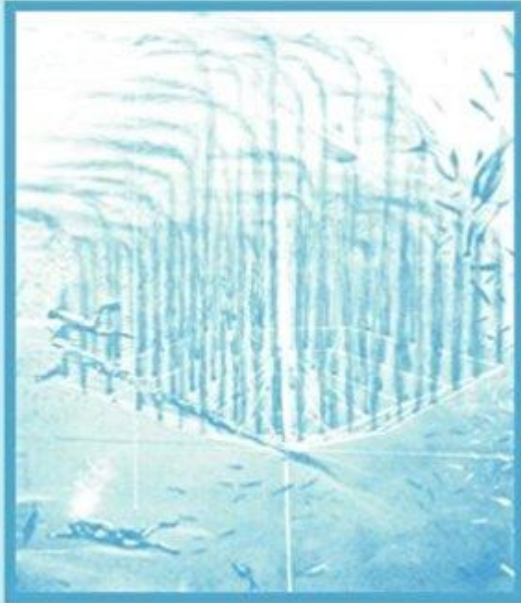
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Energy from Open Ocean Kelp Farms

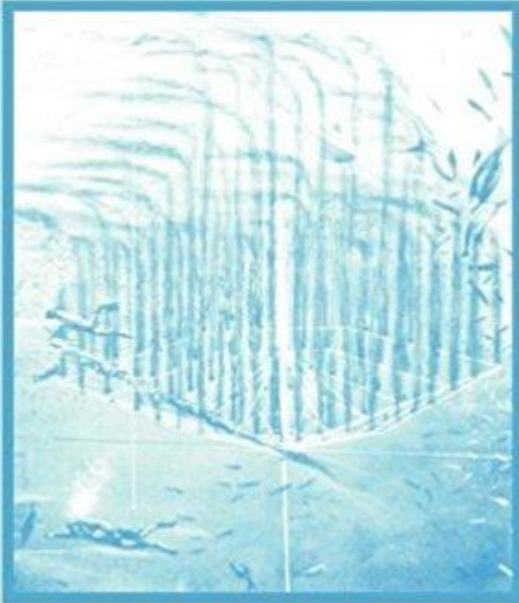
Office of Technology Assessment
United States Congress



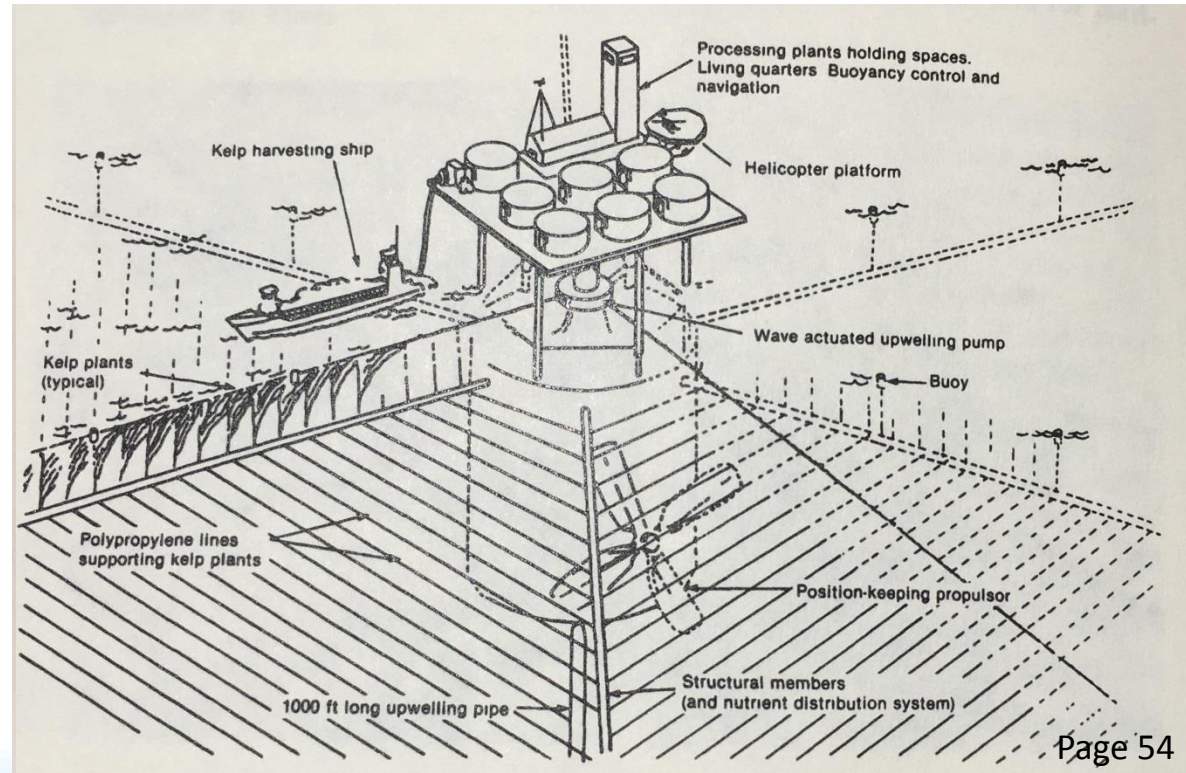
Large ocean energy farms may one day prove to be an alternative source of synthetic natural gas for homes and businesses. Research into new ocean biomass energy systems has been reviewed here by the Office of Technology Assessment of the United States Congress, with the assistance of specialists in the research and development aspects of ocean farming. This report presents the status of ocean energy farm developments and evaluates their potential. While ocean energy farms are now in the early stages of development and much research remains to be done, the prospects are encouraging. This book contains descriptive and analytic material concerning ocean biomass resources; potential for future ocean farms; technologies of ocean farming; existing government and private efforts; energy and economic data; environmental effects and legal aspects; and future research needs.

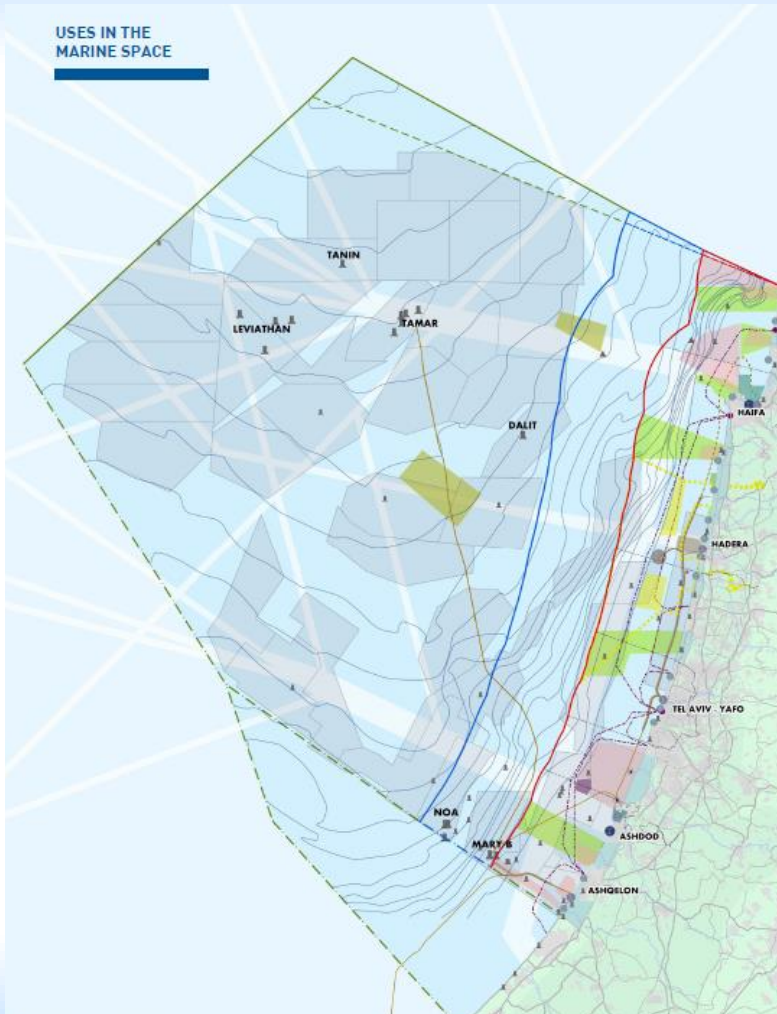
Energy from Open Ocean Kelp Farms

Office of Technology Assessment
United States Congress



Examples: Farm Designs





LEGEND

- Maritime borders**
 - Border of coastal waters
 - Border of Contiguous zone
 - Border of EEZ
- Statutory borders**
 - District border
 - Closed areas – Order 100
 - Coastal texture – NOP 35
- Marine reserves-Status of proposal**
 - Approved
 - Declared
 - Proposed
- Marine transportation**
 - Shipping routes
- Ports and anchorages**
 - Ports
 - Energy anchorages
 - Anchorages
- Port areas**
 - Commercial port
 - Energy port
- Gas and petroleum infrastructures**
 - ▲ Petroleum and gas wells
 - NOP 37/a/2
 - Drilling rights
 - NOP 37/h – plan border
 - NOP 37/h – offshore complex
- Gas transmission pipeline infrastructure**
 - Existing pipeline infrastructure
 - Planned [NOP 37/a/2 amendment 4]
- Other infrastructures**
 - Fishing cages
 - Desalination plant
 - Discharge areas (acidic sewage/earth)
 - ▲ Discharge of excavation matter
- Communication**
 - Communication switchboards
 - Communication cables
- Land infrastructures**
 - Roads
 - Towns
 - Rivers

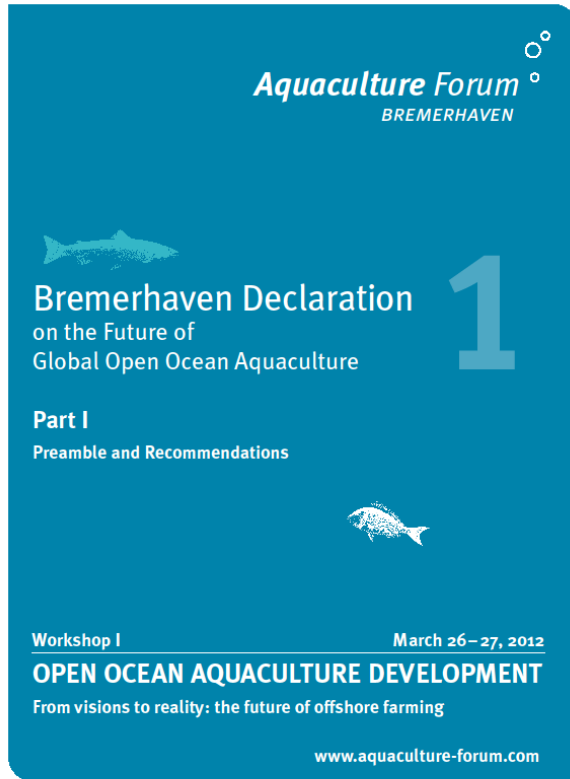
*NOP – National Outline Plan

First challenge: find an appropriate space in the marine real,



Future Production of Food from the Oceans:

- Do not reinvent the wheel
- Follow guidelines defined by the FAO
- Foster cooperation with experts within the EU + X
- Develop innovative technologies to allow co-use concepts
- Set-up an inter. offshore test facility



Bremerhaven Declaration

on the Future of Global Open Ocean Aquaculture

Authors:

Buck
Krause
Rosenthal
Shpigel
Cost-Pierce
Langan
Fredheim
and others...



Thank you for your attention!