COASTAL Biogas

Cluster **O**n **A**naerobic digestion, environmental **S**ervices and Nu**T**rients remov**AL**

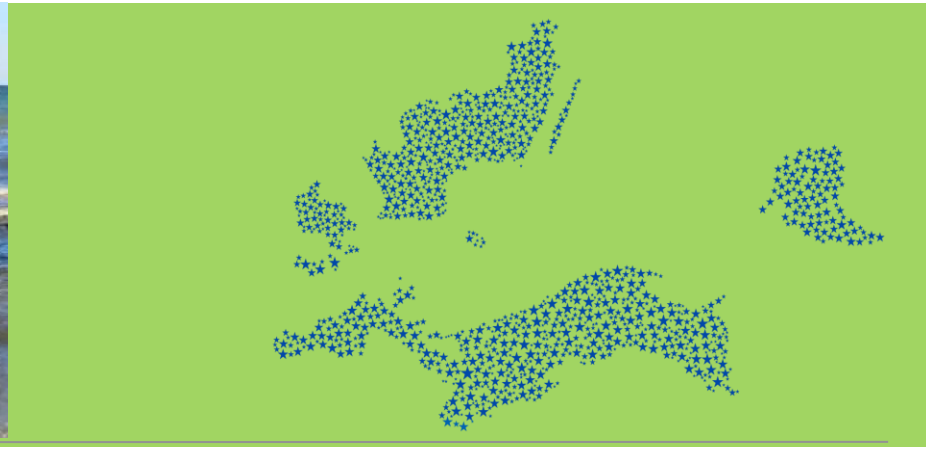
The final conference

9 December 2021

Environmental aspects and economy

Tyge Kjær

Roskilde University



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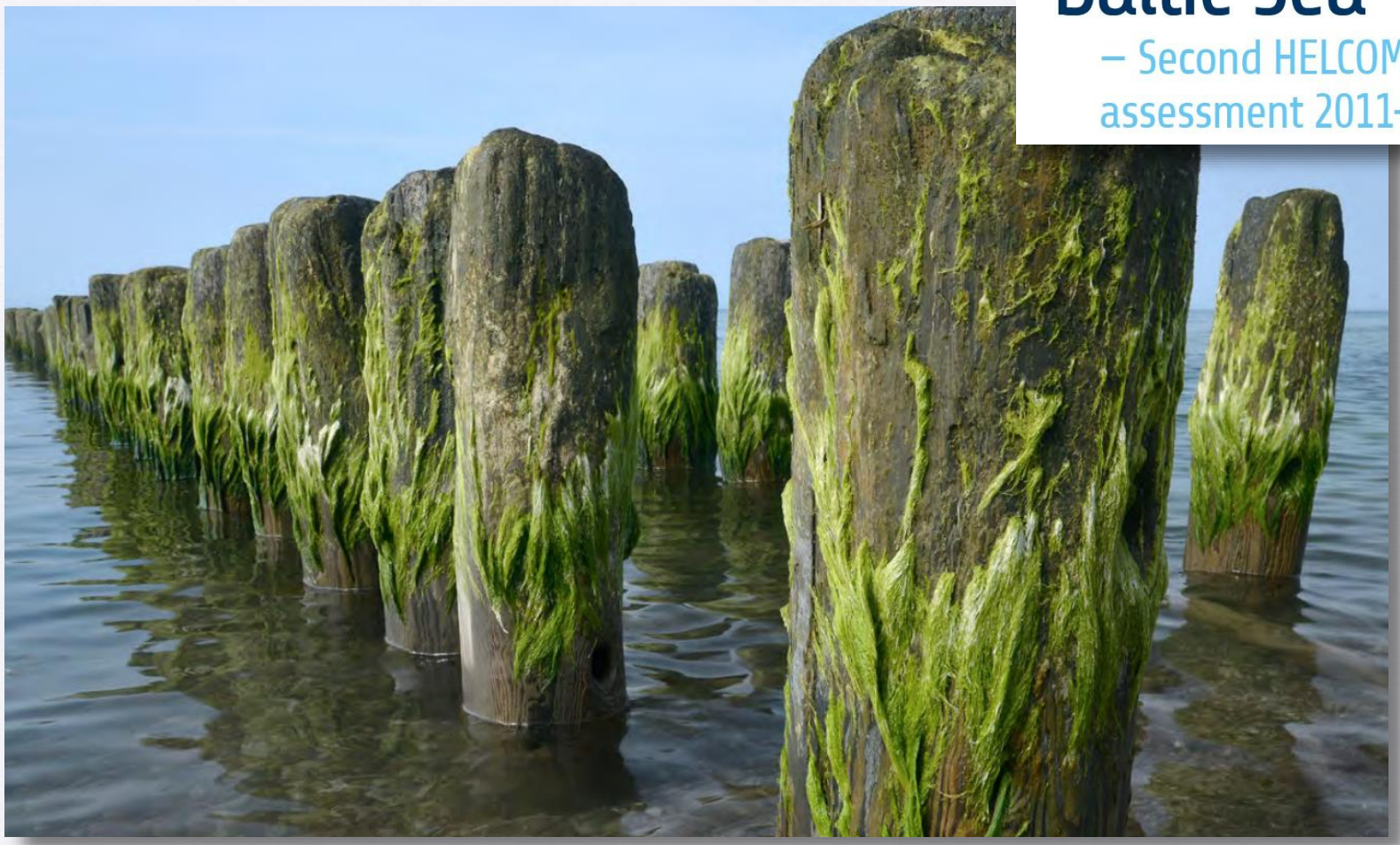
HELCOM

The Baltic Sea - Østersøen

Impacts and developments

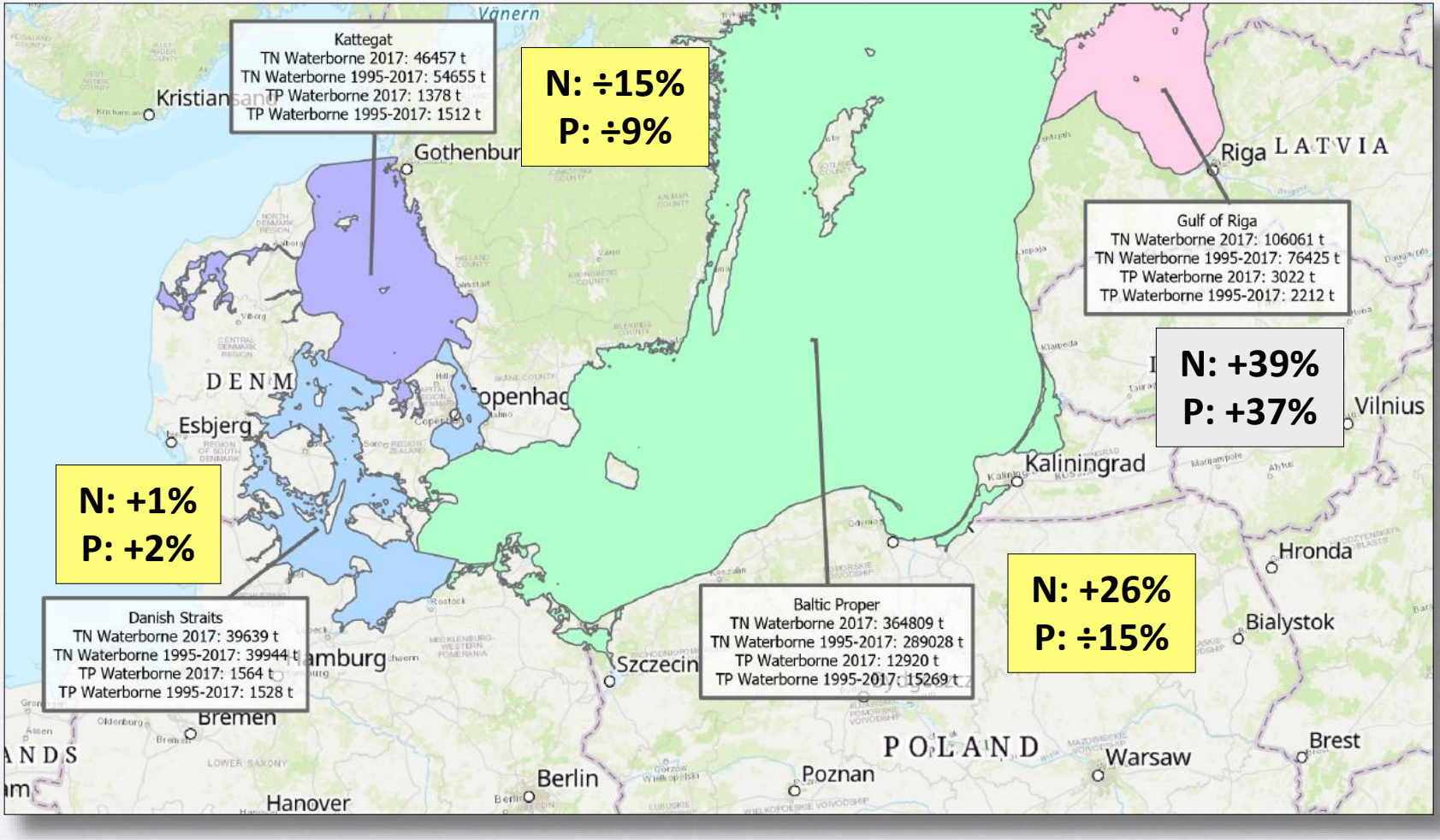
State of the Baltic Sea
– Second HELCOM holistic assessment 2011-2016



Nutrients

Estimated nitrogen and phosphorus emissions

Data from Helcom



Estimated nitrogen and phosphorus emissions

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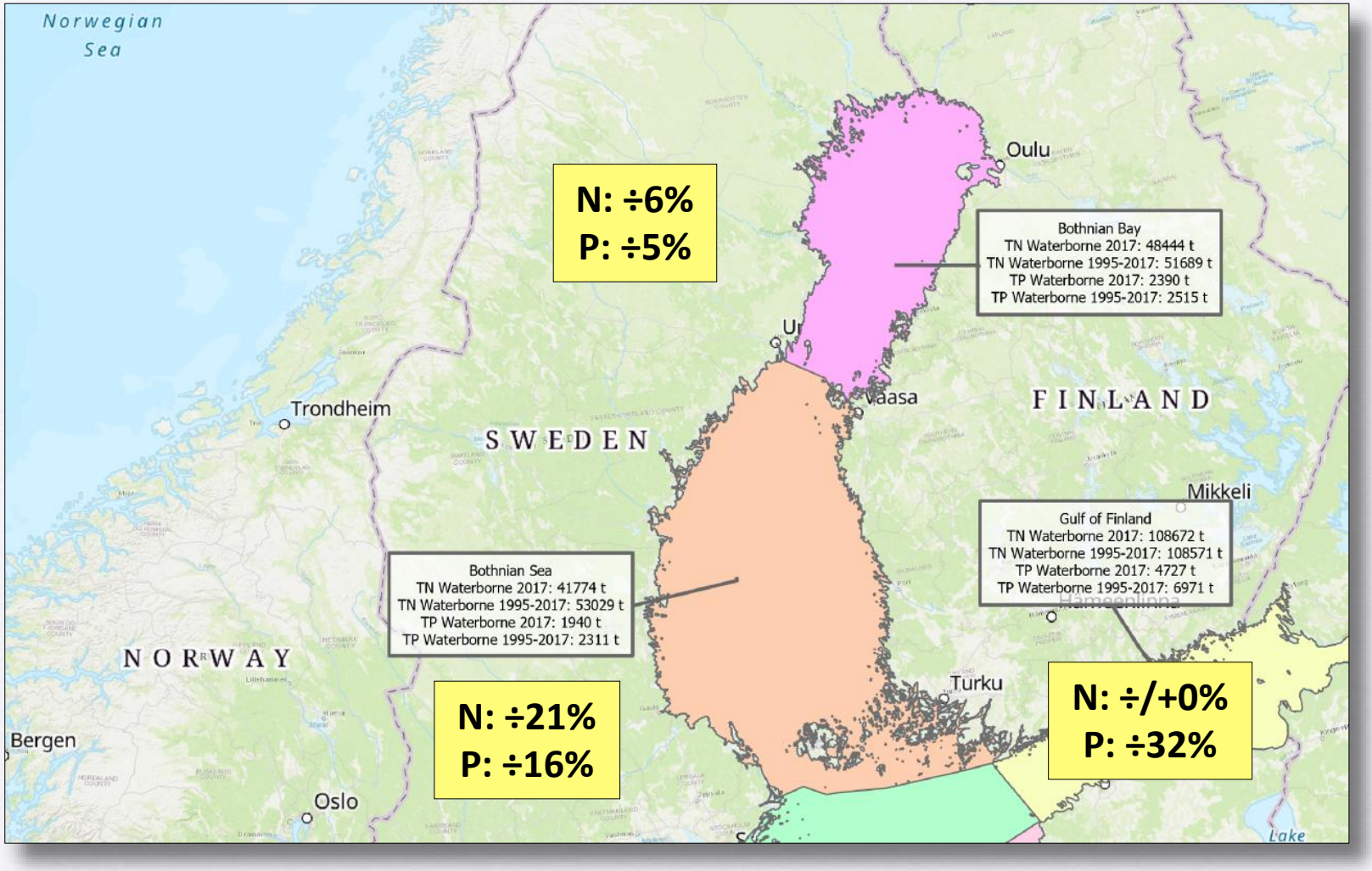

Dead Areas: Nutrients and Global Warming

Global warming = less oxygen; global warming = increased oxygen consumption; increased nitrogen emissions = increased plant growth

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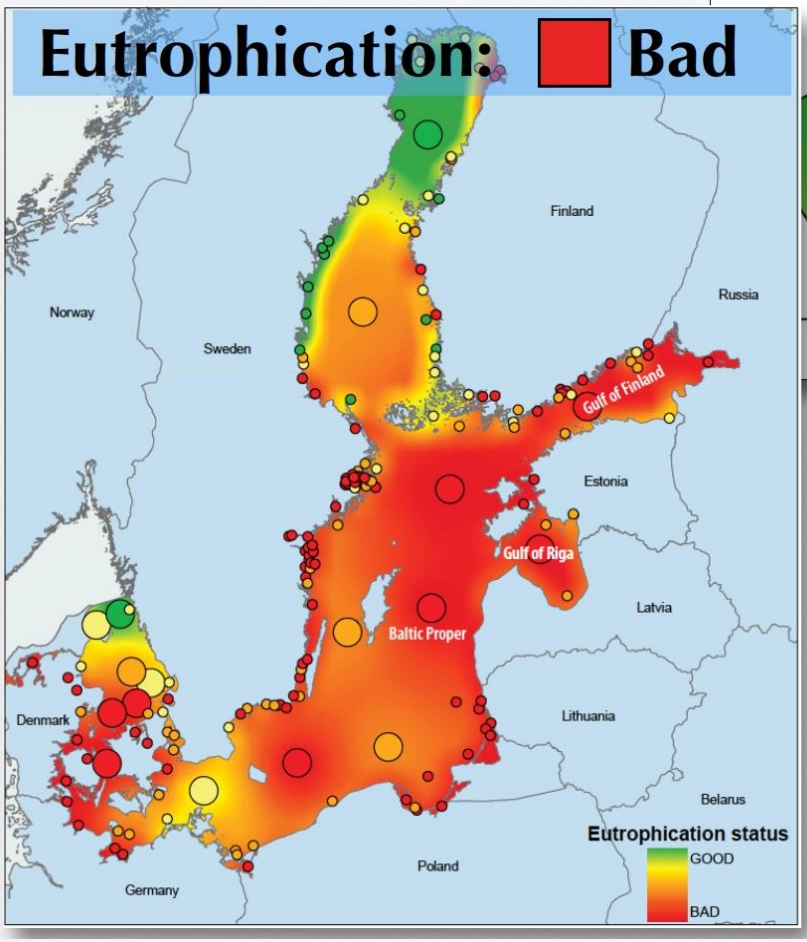
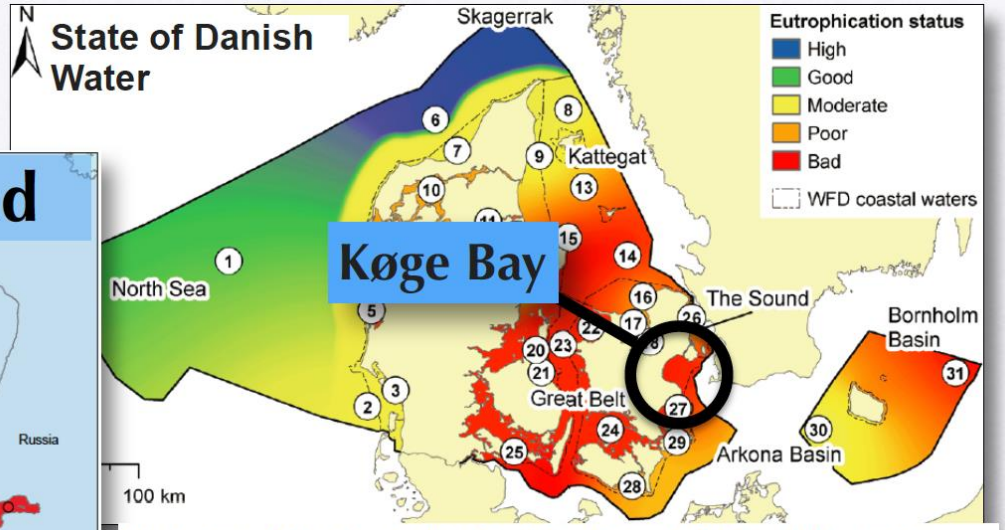
Nutrients

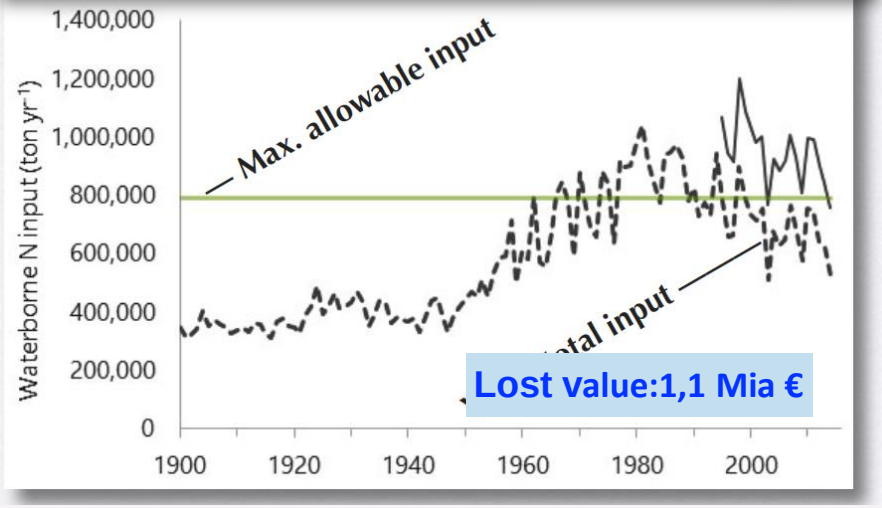
Nitrogen/Phosphorus

Helcom





Helcom, State of the Baltic Sea, 2018 - Nitrogen



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New report 2021

New goals

Baltic Sea Action Plan
2021 update

Sea-based activities goal

"Environmentally sustainable sea-based activities"

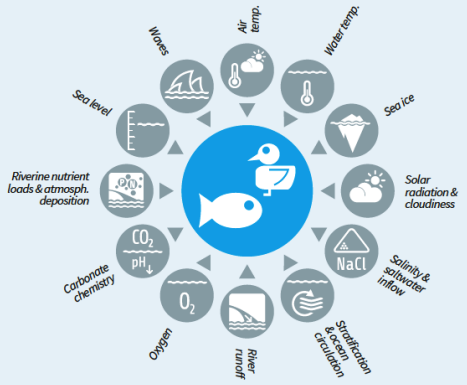
Management objectives

Ecological objectives

Biodiversity goal

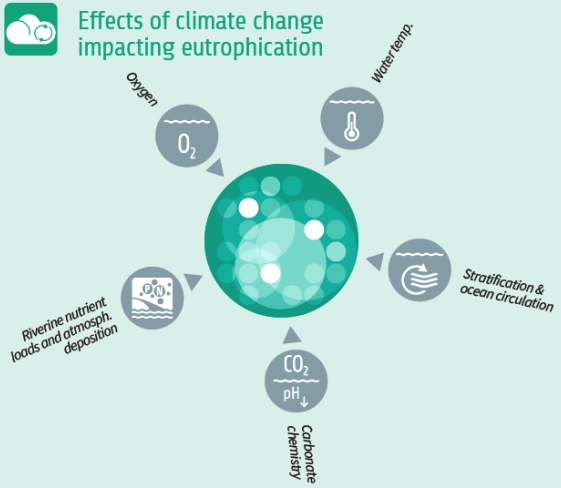
"Baltic Sea ecosystem is healthy and resilient"

Effects of climate change impacting biodiversity



"Baltic Sea unaffected by eutrophication"

Effects of climate change impacting eutrophication



Hazardous substances & litter

Hazardous substances and litter goal

"Baltic Sea unaffected by hazardous substances and litter"

HELCOM eutrophication effects

Assessment of economic effects of eutrophication

Country	Cost of degradation (M€/year, 2015 euros)
Denmark	125 – 158
Estonia	21 – 31
Finland	176 – 189
Germany	1,572 – 1,781
Latvia	8 – 9
Lithuania	19 – 22
Poland	368 – 383
Russia	1,028 – 1,129
Sweden	440 – 674
Total	3,760 – 4,380

HELCOM - efforts against eutrophication

New action plan - here are just a few examples of action plans

Theme: Nutrient recycling	
E30	Implement adequate measures, especially in agriculture and wastewater management, to achieve the objectives of the Baltic Sea Regional Nutrient Recycling Strategy by 2027.
E31	Create legal and institutional tools to advance towards introducing annual field-level fertilization planning and farm-gate nutrient balancing for nitrogen (N) and phosphorus (P) as a requirement for all farms in the Baltic Sea Region to reduce nutrient surplus on farmlands to the highest possible degree in
E32	Enhance the use of recycled nutrients in agriculture making use of best available technologies and fertilize according to crop needs.
E33	Develop by 2027 safety requirements for recycled fertilizer products and minimise the occurrence of harmful compounds in these products to comply with the requirements.
E34	Increase the knowledge and promote education and advisory services on nutrient recycling.
E35	Improve the conditions for the development of a market for recycled fertilizer products by setting incentives with the aim of making the use of such products equally attractive to farmers as the use of mineral fertilizers.
E36	Enhance cooperation and share experiences between sectors and actors to create a holistic view on sustainable food systems including nutrient recycling across sectors.

Adopted: Total allowed emissions of nitrogen

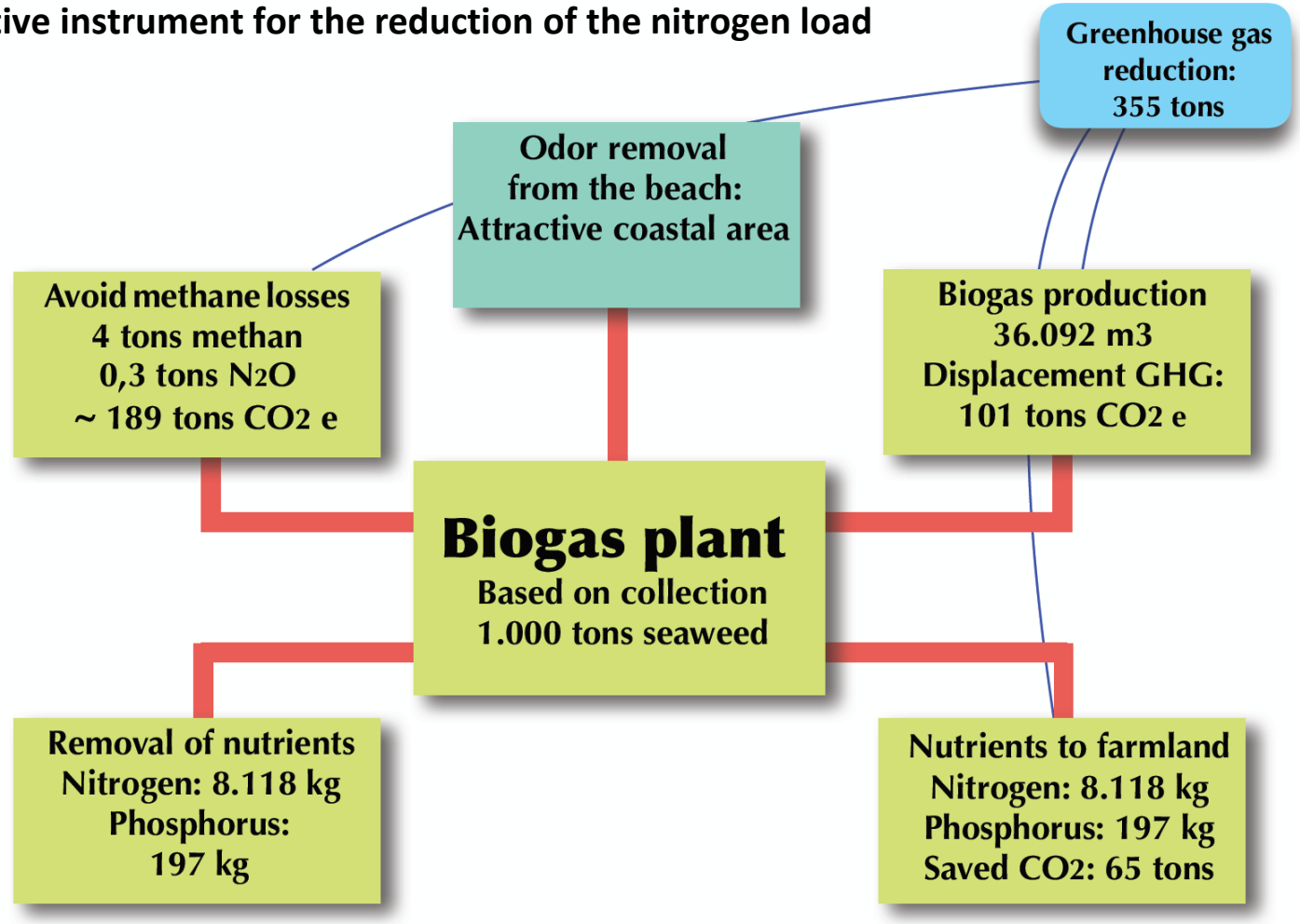
In Helcom-regi:

Total allowed: 792.209 tons/year nitrogen
Exceeded by: 47.434 tons/year nitrogen

Area	Nitrogen in tons/year	Phosphorus in tons/year
Kattegat	74,000	1,687
Danish Straits	65,998	1,601
Baltic Proper	325,000	7,360
Bothnian Sea	79,372	2,773
Bothnian Bay	57,622	2,675
Gulf of Riga	88,417	2,020
Gulf of Finland	101,800	3,600
Baltic Sea	**792,209**	**21,716**

What could the biogas plant do for the sea

Be an cost effective instrument for the reduction of the nitrogen load



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Seaweed for food

Greenhouse gas reduction: 189 tons

Odor removal from the beach: Attractive coastal area

Avoid methane losses
4 tons methan
0,3 tons N_2O
~ 189 tons CO_2 e

Farming

E.g. Sukkertang
Based on 1.000 tons
(Saccharina latissima)
2-15°C / Salitiny: 1,7%

Removal of nutrients
Nitrogen: 8,118 kg
Phosphorus:
197 kg

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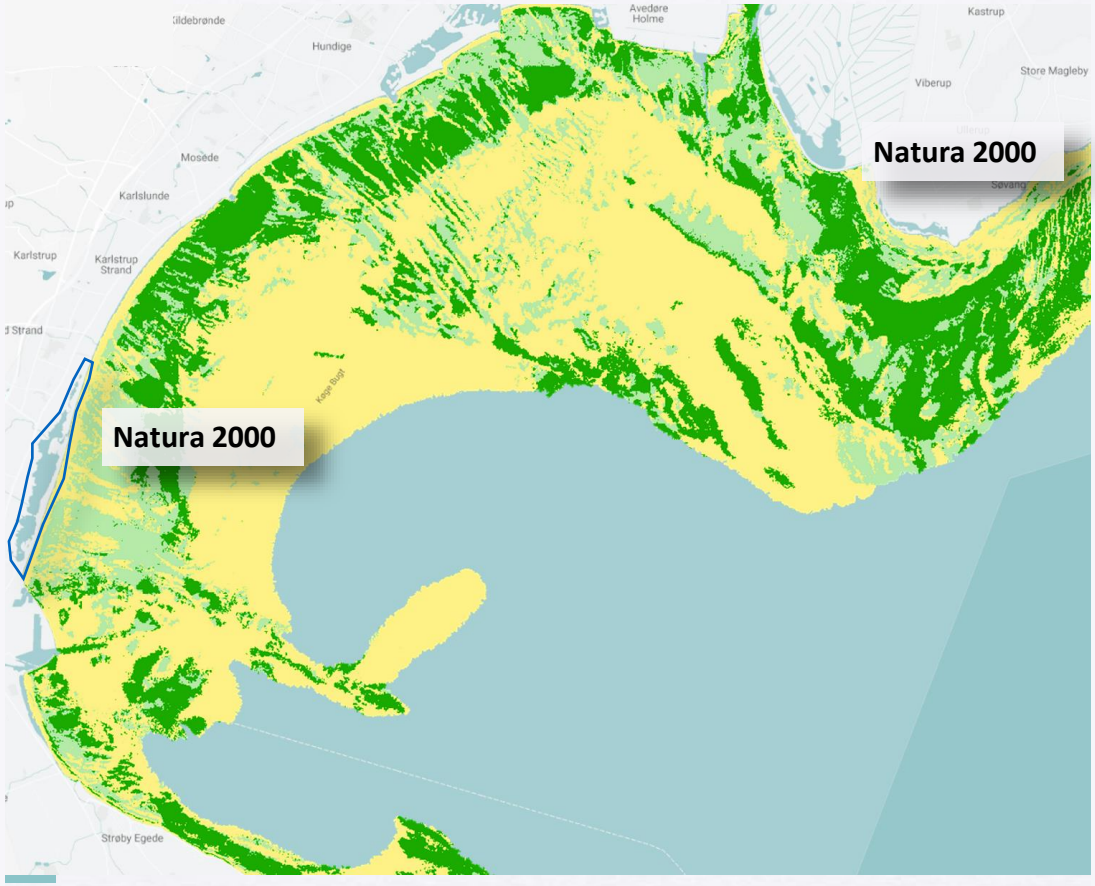
Seaweed in Zealand

Seaweed production
in the Køge Bay

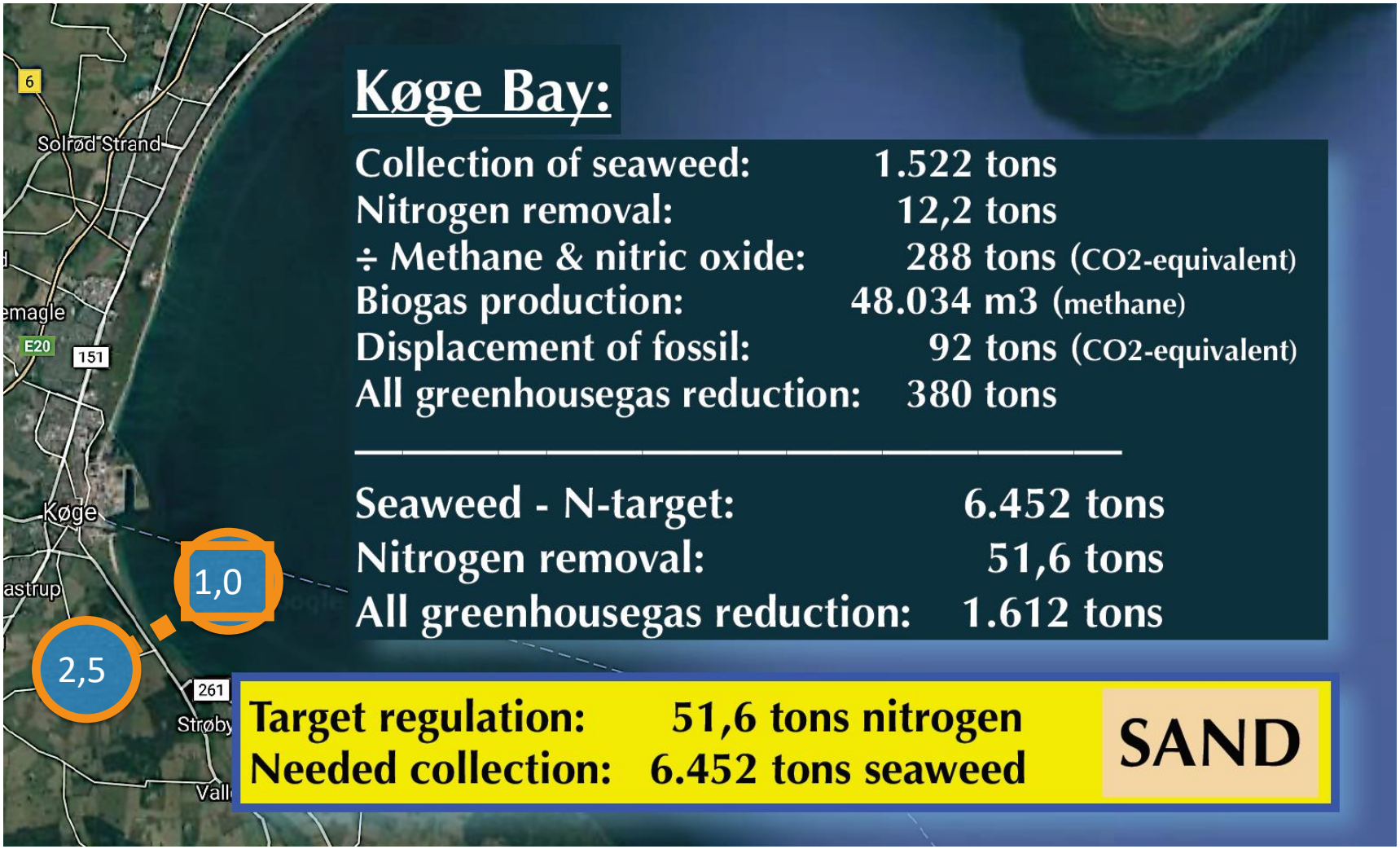
Estimated seaweed per year in Køge Bay: 30.825 tons

- Dense vegetation
- Sparse vegetation
- No vegetation



The actual situation of Köge Bay - Water Framework

Reduction of discharge to the runoff area to Køge Bay - Direct nitrogen removal



Affordable pre-treatment

Cost efficiency N-reduction

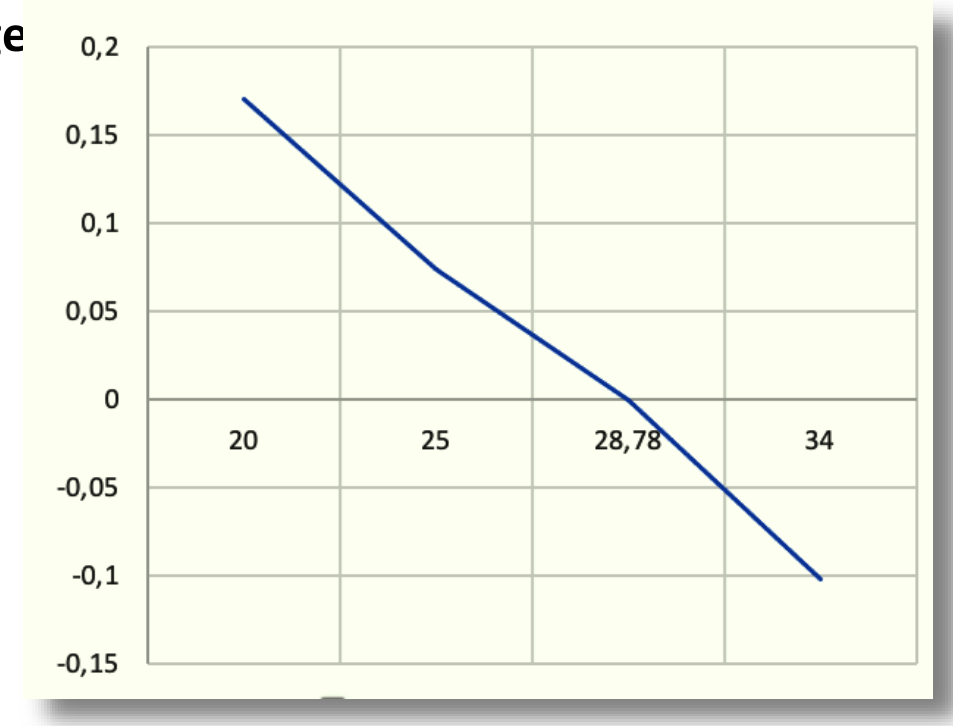
Collection of seaweed is a cost-effective method of reducing the nitroge load.

However, the collection cost level is a critical factor.

If the cost of collection, transport and pre-treatment is higher than 28-29 € per **tons, the biogas use of seaweed will no longer be a cost-effective methods**

Calculation of cost efficiency

(Cost structure Solrød Biogas)



Cost and price structure

	Cattle manure		Pig manure		Straw		Seaweed		Seaweed	
Income										
Gas (metan) pr tons:	11,4	m3	12,8	m3	193,8	m3	120,0	m3	54,0	m3
Income pr. tons + subsidy	74,64	kr	83,54	kr	1.268,53	kr	785,65	kr	353,54	kr
Proces costs										
Feedstock pr. tons	0	kr	0	kr	550	kr	0	kr	0	kr
Collection + pretreatment pr. tons:	0	kr	0		120	kr	280	kr	280	kr
Operation costs pr. tons RV:	23,13	kr	23,13	kr	23,13	kr	23,13	kr	23,13	kr
Transport pr. tons:	11,4	km	13,1	km	30	km	8	km	8	km
Transport (tur/retur):	23,99	kr	24,87	kr	57,00	kr	15,20	kr	15,20	kr
Cost storage, etc.	45,00	kr	45,00	kr	45,00	kr	45,00	kr	45,00	kr
Brutto income										
In total pr. tons fedstock:	-17,48	kr	-9,46	kr	473,40	kr	422,32	kr	-9,79	kr

Thank you!

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