

TARGETED REGULATION OF AGRICULTURAL N LOAD TO DANISH MARINE WATERS

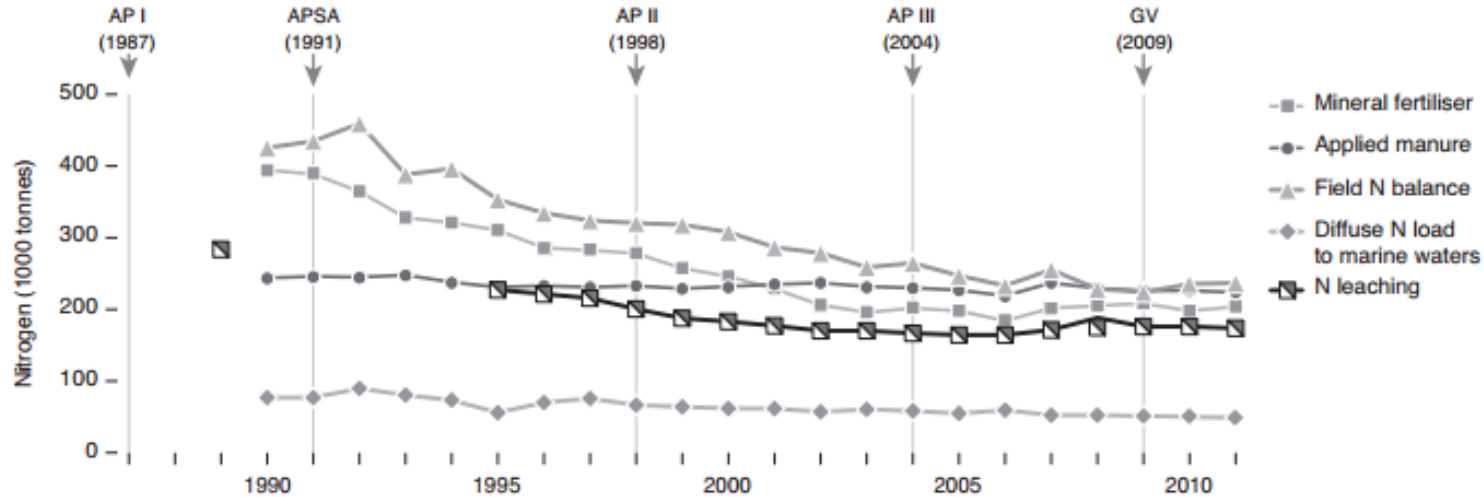
Casestudy for testing two model prototypes for differentiated regulation

Jonas Rolighed, Gitte Blicher-Mathiesen *Aarhus University, Department of Bioscience*

Nikolaj Ludvigsen, Hans Kjær *Environmental Protection Agency, Danish Ministry of the Environment*

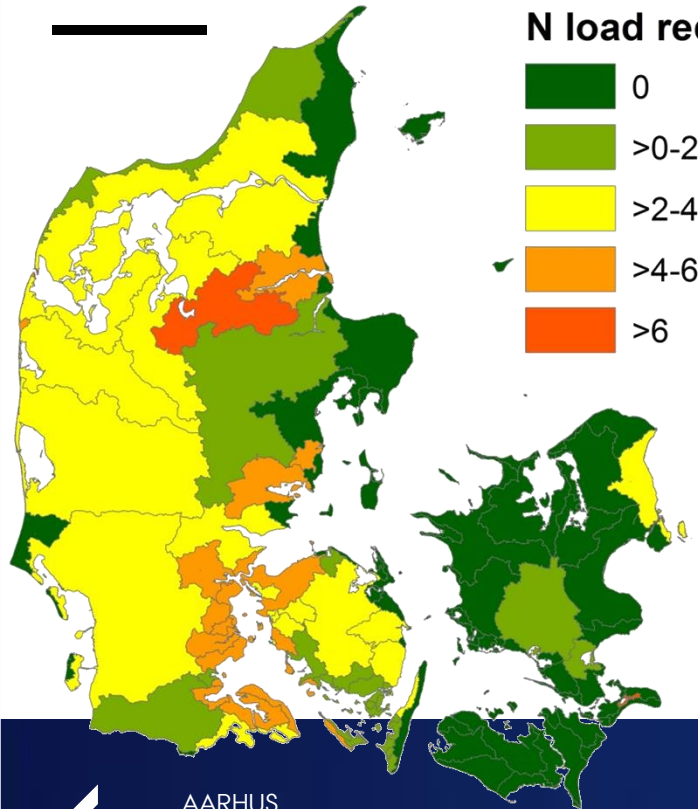
Carl Åge Pedersen, Søren Kolind Hvid, Irene Asta Wiborg, *SEGES*

BACKGROUND – PRESENT REGULATION

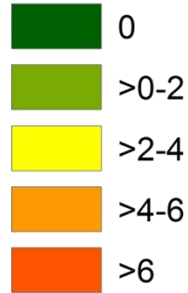


Blicher-Mathiesen et al., 2014

BACKGROUND – TARGETS OF MARINE RECIPIENTS

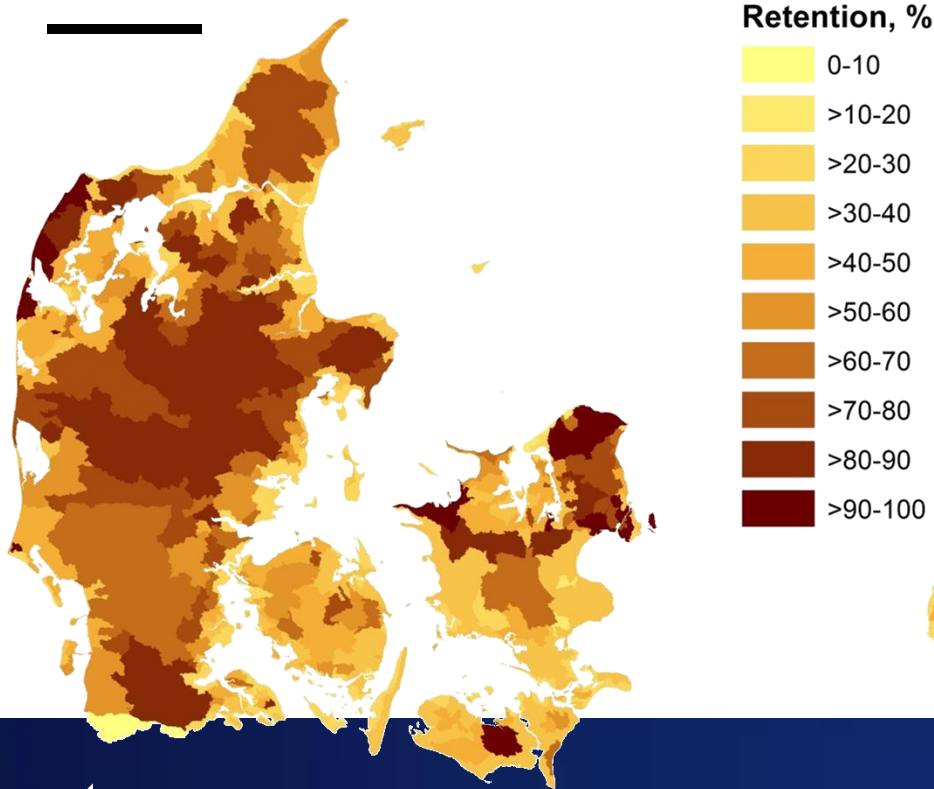


N load reduction (kg N ha⁻¹)



- Varying vulnerability towards N-loading
- Certain estuaries may be particularly vulnerable
- Work in progress, no final map yet

BACKGROUND – N RETENTION PROPERTIES



- Share of applied N that is transported to the recipient
- Map in the project is now outdated
- New N-retention map with 3000 catchments

DEVELOPING TWO NEW MODELS – QUOTA MODEL

- Total N-load of the catchment must reach set targets
 - Base Quota (15 % of catchment quota is distributed evenly among farms – rest is differentiated)
 - 160 kg N ha⁻¹
 - Adjustment for catchment retention properties
 - - 3 kg N ha⁻¹
 - Adjustment for catchment N-load targets
 - - 10 kg N ha⁻¹
 - ▶ = Adjusted base Quota
 - 147 kg N ha⁻¹
 - + Adjustment due to mitigation measures
 - 25 kg N ha⁻¹
 - = Final N-Quota
 - 172 kg N ha⁻¹

AVAILABLE MEASURES – QUOTA MODEL

	Quota conversion factor (Kg N ha ⁻¹)
Catch crops	93
Undersown grass	48
Energy crops	150
Fallow	143
Bufferstrips	143
Early sowing	18.6
Fodder beets	120
Wetland, reestablished	263
Wetland, N-reduction	143
Drain connected to wetland	62

DEVELOPING TWO NEW MODELS – N-LOAD MODEL

- Total N-load of the catchment must reach set targets
 - Each farm must reach targets for N-load
 - N-retention properties and N-leaching from the rootzone determines N-load
 - N-leaching is calculated for each field
 - Crop rotation and application of fertilizer have direct effect N-leaching
 - Farmers are encouraged to place mitigation measures on fields with low N-retention and apply fertilizer on fields with high N-retention

CALCULATING N-LEACHING FROM THE ROOTZONE

$$Y = \{U + V^k\} [1 - \exp(-\delta_1 A_0)] \exp(-\delta_2 A_1) \exp(-\delta_3 H) \exp(-\delta_4 A_L) \hat{c}$$

- ▶ Empirical model NLES3
- ▶ Based on data from Danish field experiments and monitoring data (n=1299)
- ▶ Additive effects of crop rotation and applied N
- ▶ Multiplicative effect of percolation and soil attributes

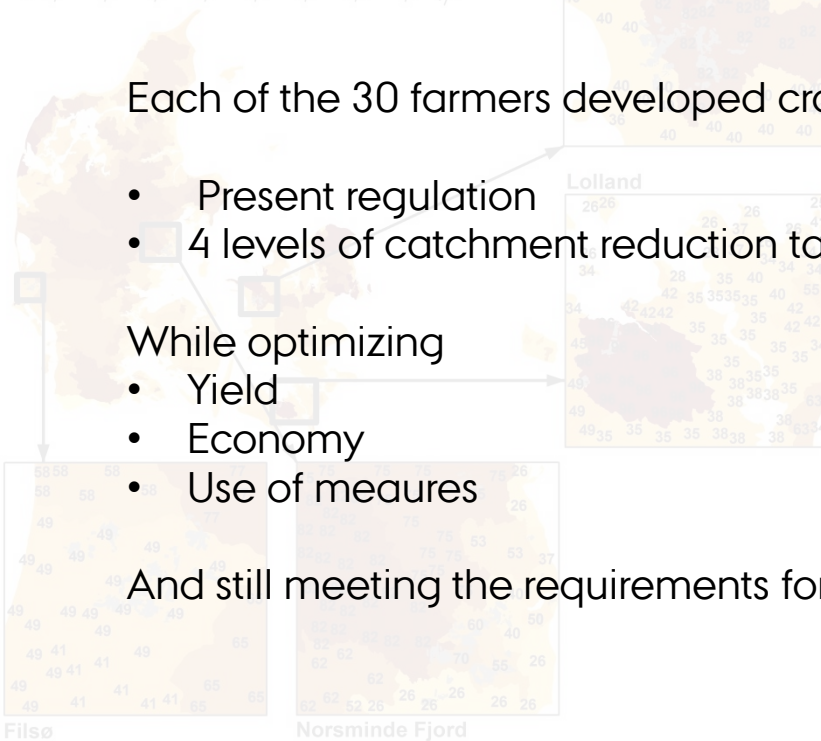
- ▶ Implemented in system for evaluating environmental impact of farm expansions

Kristensen et al., 2003

Developing two models for regulation

	Current regulation	Quota model	Load model
Regulation parameter	N-quota (applied N ha ⁻¹)	N-quota (applied N ha ⁻¹)	N-Load Quota (N ha ⁻¹)
Required measures	Catch crops	Optional	Optional
Amount of fertilizer	Suboptimal	Optimal	Optimal
Differentiation depending on reduction target of catchment	None	+	+
Differentiation of regulation parameter between farms	None	Partly	Complete
Effect of targeted measures	None	+	+

Retention, %



Each of the 30 farmers developed crop rotations for

- Present regulation
- 4 levels of catchment reduction targets

While optimizing

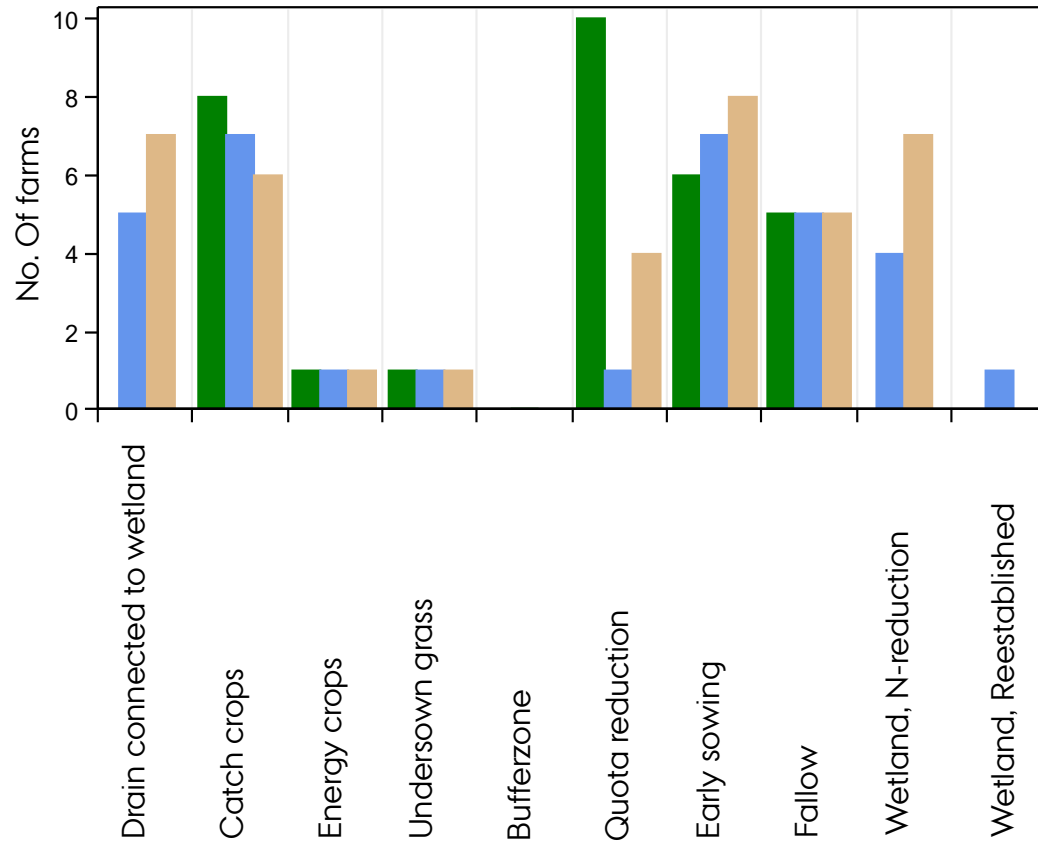
- Yield
- Economy
- Use of measures

And still meeting the requirements for the catchment N-load reduction

N - retention (%)	Catchment				ALL catchments = 30	DK
	Filsø, n=10	Lolland, n=2	Norsminde Fjord, n=10	Tisso, n=8		
		22,5	11,3		6,0	23,1
40-<60	97,3	25,0	40,5	28,7	49,8	23,2
60-<80	2,4		42,3		14,5	29,6
80-100		52,5	6,0	71,3	29,7	24,0

	Conventional				Organic		No. Of farms	Husdyr-tæthed (LU ha ⁻¹)
	Cattle	Arable with manure	Arable Without manure	Pig	Cattle	Arable with Manure		
id	(K)	(PM)	(PU)	(S)	(KØ)	(PMØ)		
Filsø	6	1		1	2		10	1,55
Norsminde Fjord	1	2		1			10	1,02
Tisso	1		3	3		1	8	0,67
Lolland			2				2	0

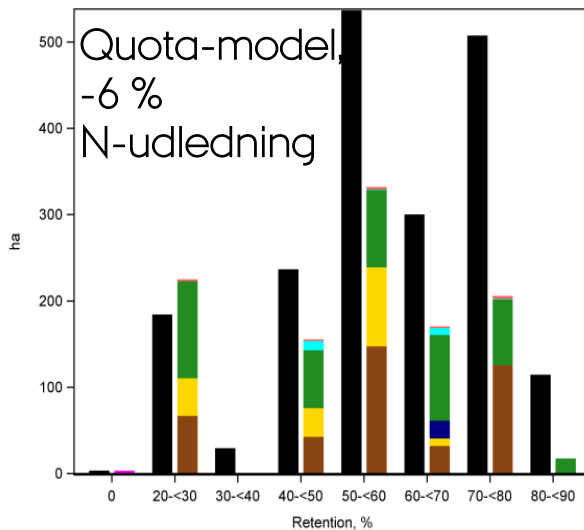
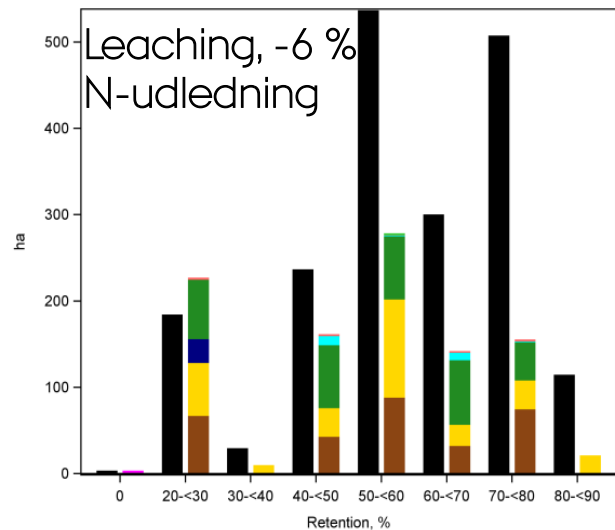
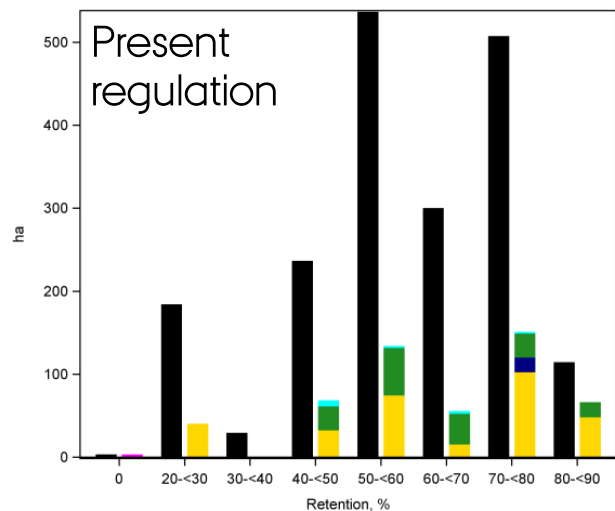
CHOICE OF MEASURES

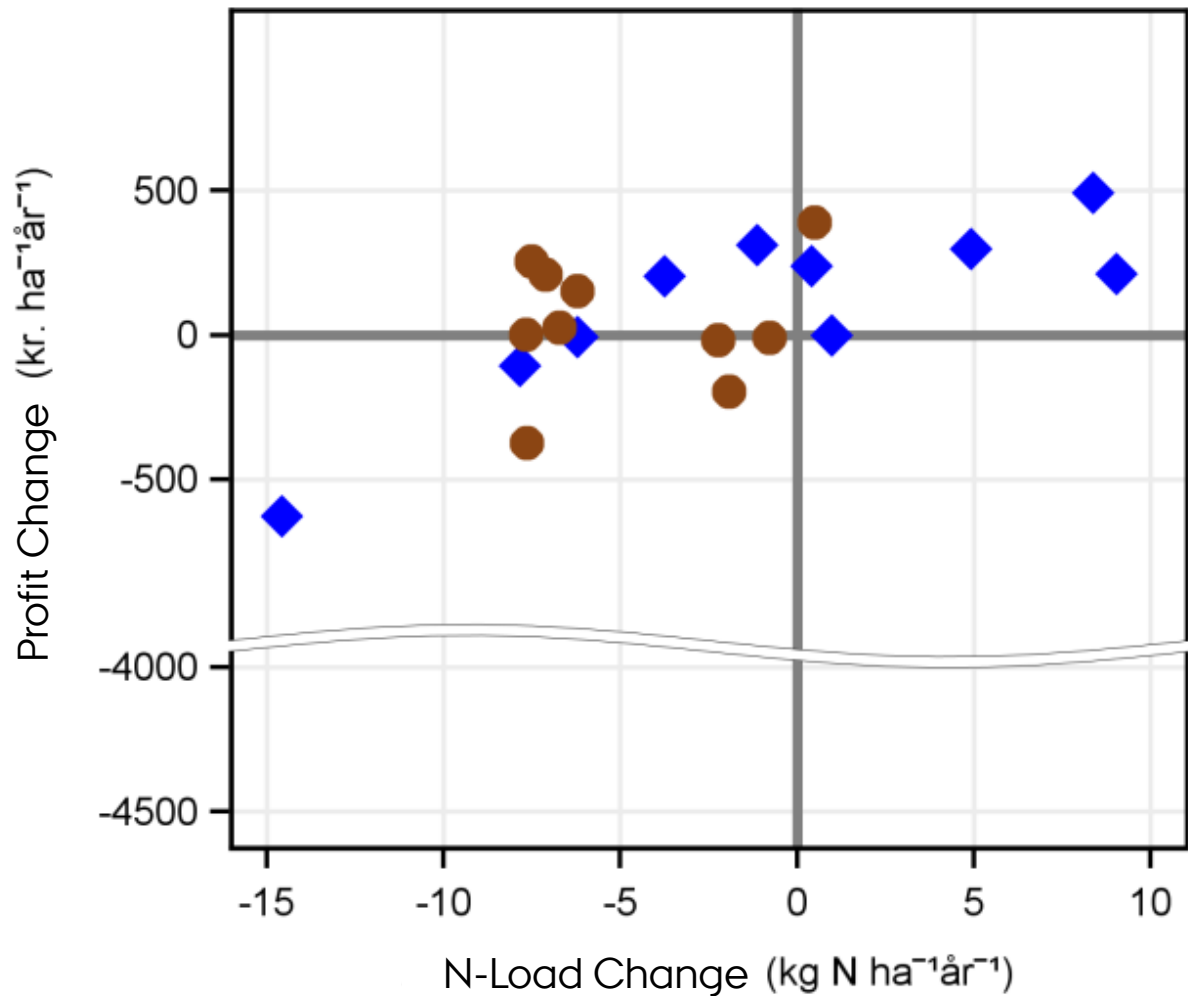


- Norsminde, Present Regulation
- Norsminde, N-Load Model -6% N-load
- Norsminde, Quota Model -6% N-load

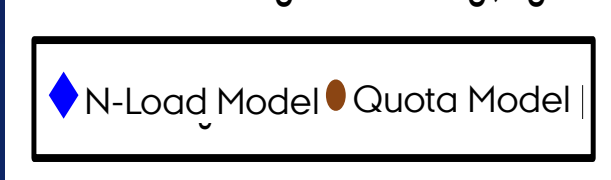
LOCATION AND CHOICE OF MEASURES IN NORSMINDE

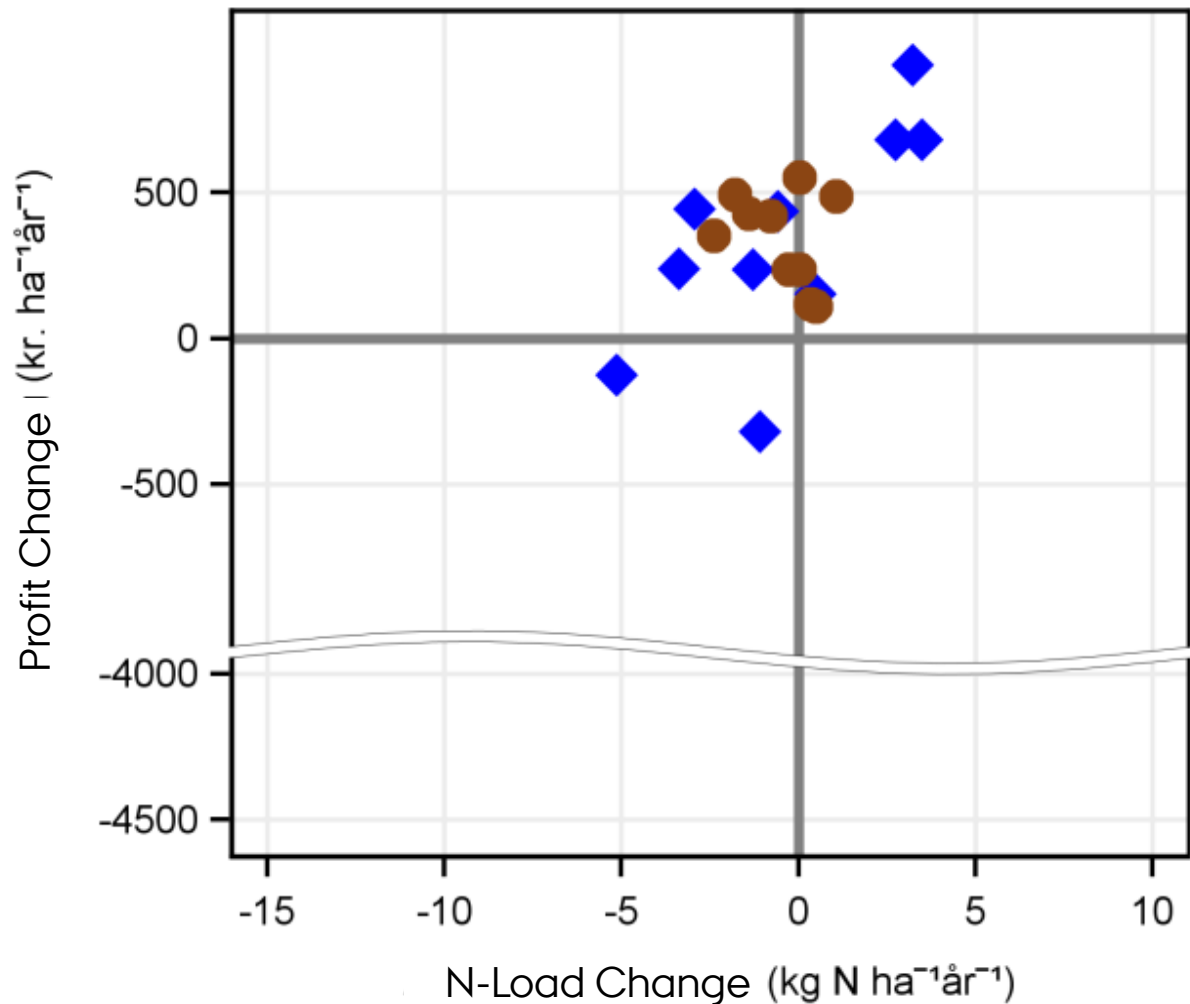
- Catch crops
- Early sowing
- Undersown grass
- Drain connected to wetland
- Fallow





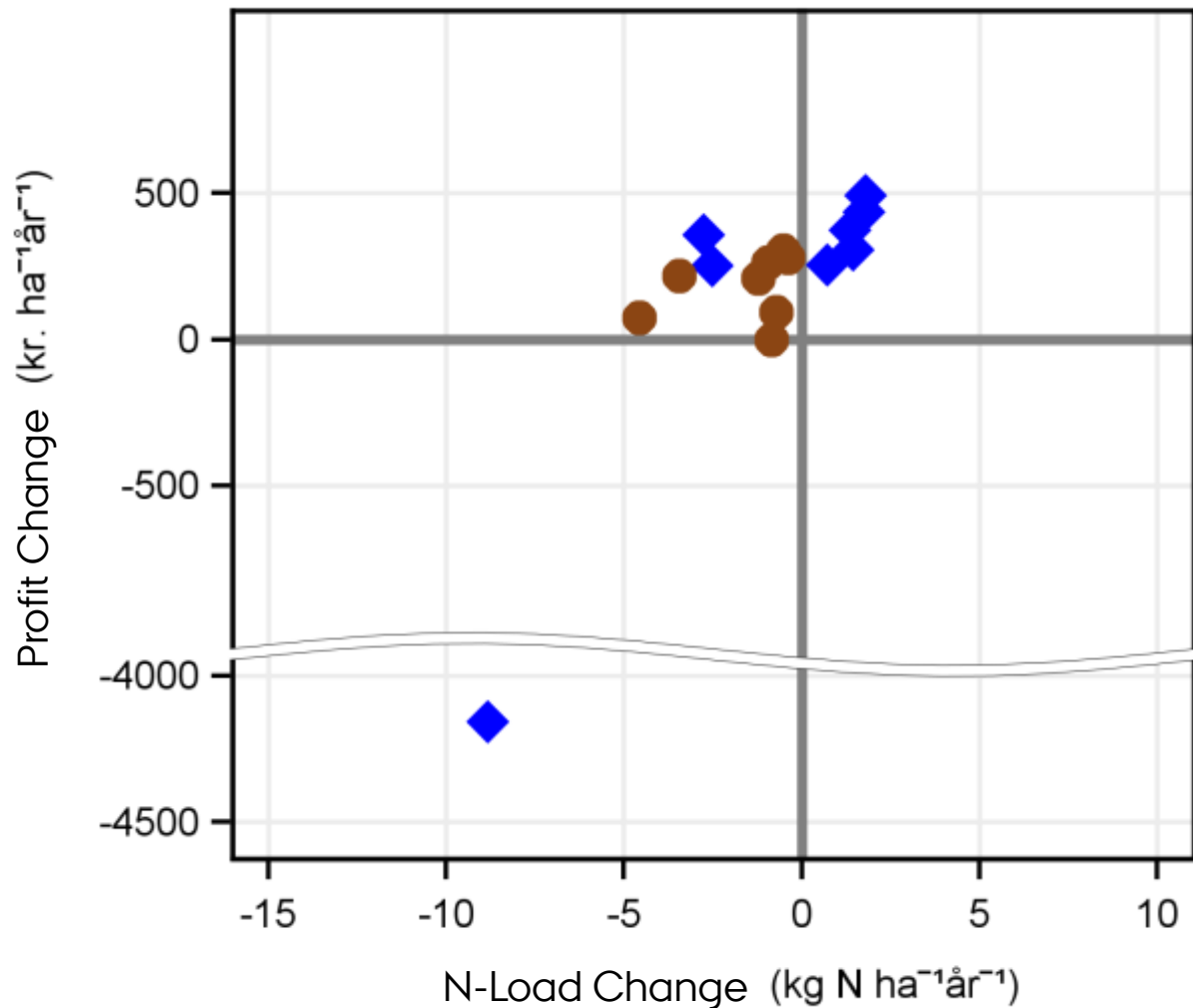
- Economy
- Filsø, -11% N-Load





- Economy
- Norsminde, -11% N-Loas





- Economy
- Tjøssø, -9 % N-load

◆ N-Load Model ● Quota Model

References

Blicher-Mathiesen, G., Andersen, H.E., Carstensen, J., Børgesen, C.D., Hasler, B., Windolf, J. (2014). Mapping of nitrogen risk areas. *Agriculture, Ecosystems and Environment* 195 (2014) 149–160.

Kristensen, K., Jørgensen, U. & Grant, R. (2003) Genberegning af modellen N-LES. Baggrundsnotat til VMPII-slutevaluering. Danmarks Jordbrugs-Forskning og Danmarks Miljøundersøgelser.

Conclusions from testing two model prototypes

- Differentiated N-load reduction effort can be targeted to the marine recipients
- 50-90% of the farms reduces N-load and increases profit
- All types of measures are used. Catch crops are most preferred
- Wetlands are used in Norsminde that has tile drainage
- Distribution of the N-load reduction effort between farms has potentially great consequences – not all are winners
- The current project does not convert well to national scale

Thank you