

Reconciling mixed demersal fisheries in the North Sea with precautionary conservation needs through adaptive management strategies

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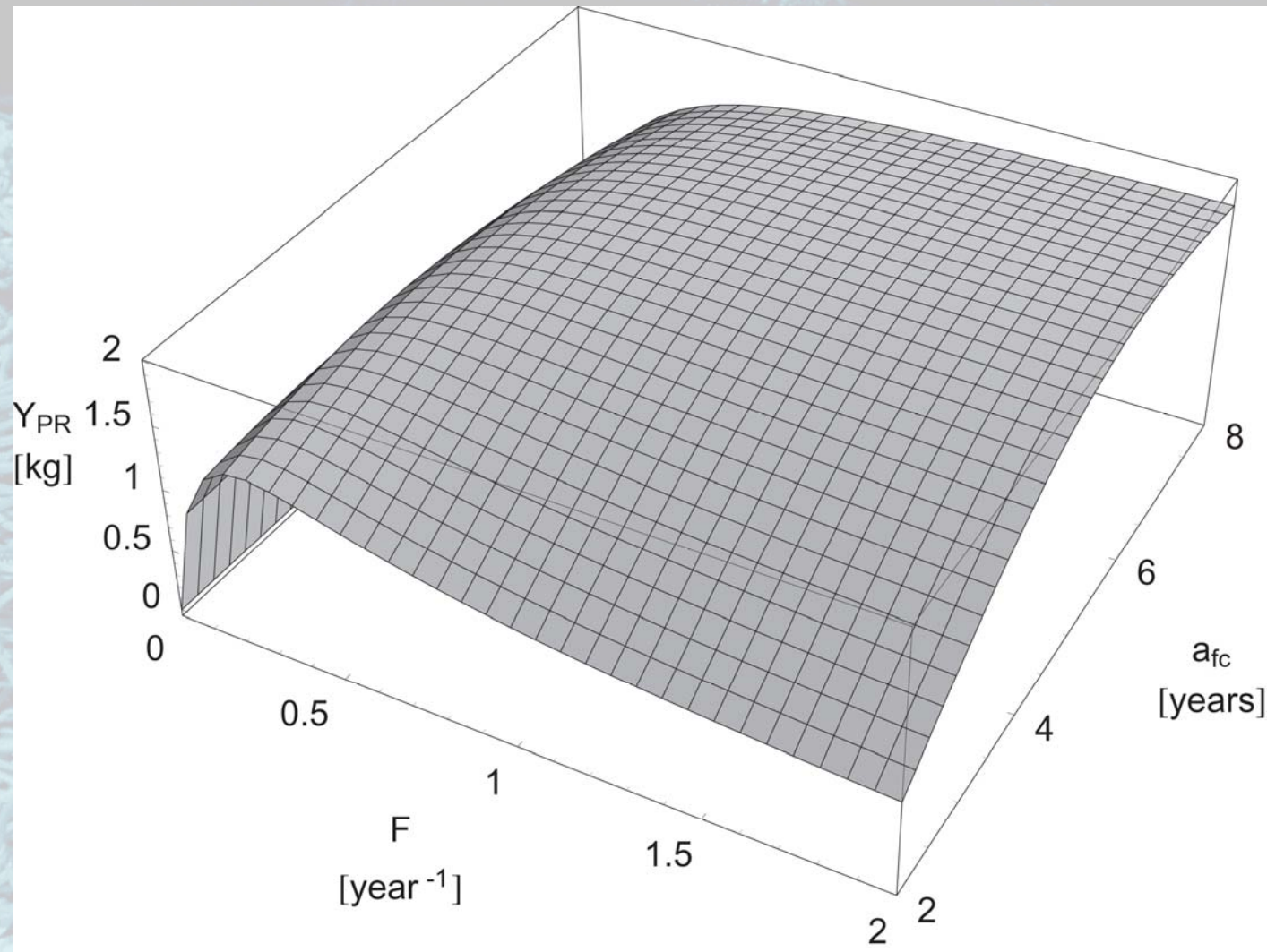
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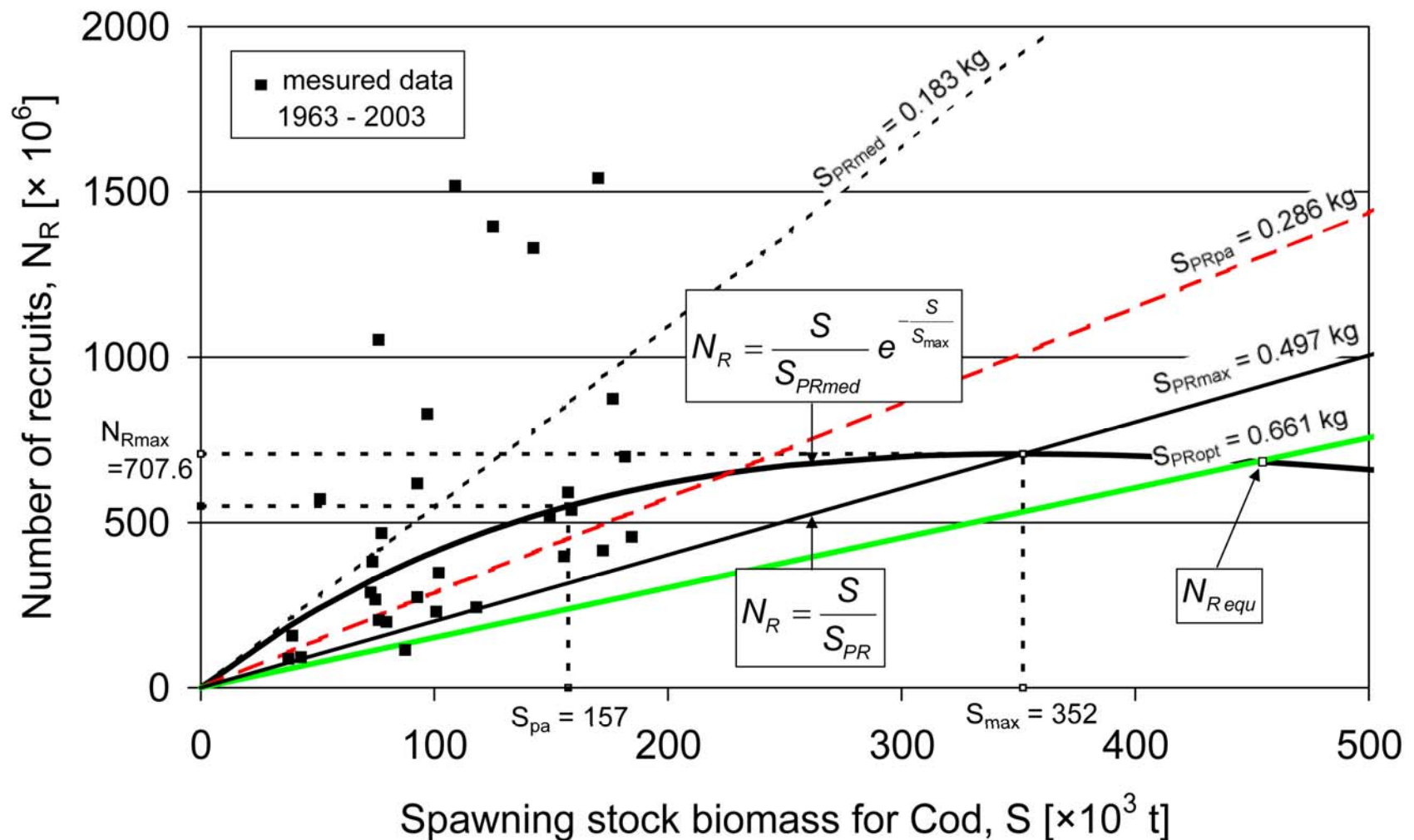
Symbol	Initial parameter
l_{∞}	Asymptotical fish length
m_{∞}	Asymptotical fish mass
N_R	Mean number of recruits per year
k	Growth constant (BLGF)
M	Natural mortality
a_M	Mean spawning age (50 % maturity)
S_{PRmed}	Minimum spawning biomass per recruit
S_{max}	Max. spawning biomass of the sea
F_P	Mean fishing mortality
S_L	Selection factor
a_{fc}	Mean age at first capture
a_R	Recruitment age
p_C	Present part of effort costs of the total costs
V	Value of fish per mass unit

Used methods and models:

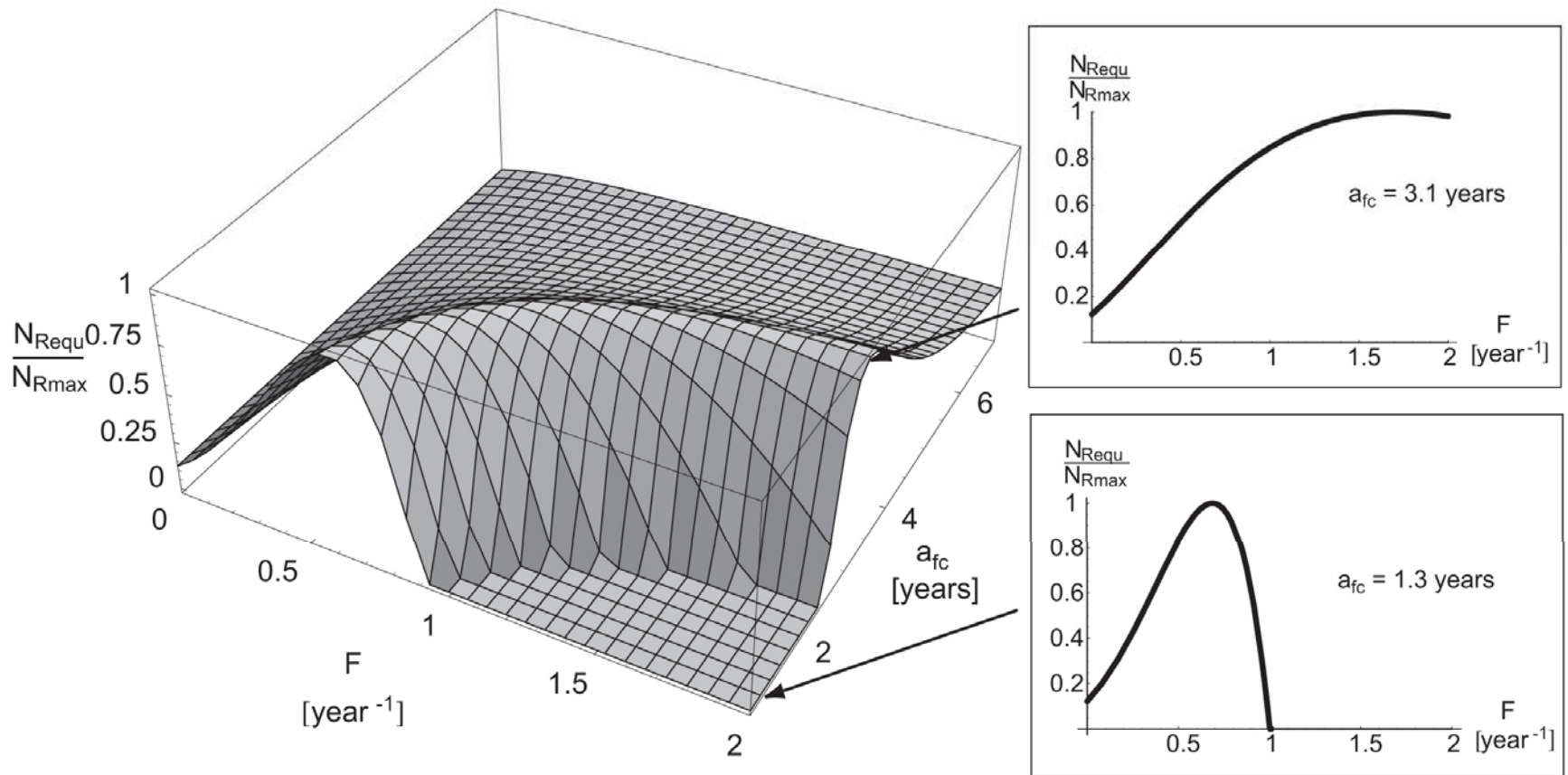
- VPA equations
- von Bertalanffy – growth model
- Knife edge – selection function
- Beverton und Holt – yield model
- Maturity model (logistic function)
- Spawner – recruit relation according to Ricker
- Sustainable yield curves, model according to Shepherd
- Linear relationship between fishing mortality and fishing effort
- Linear cost model for the fishing effort



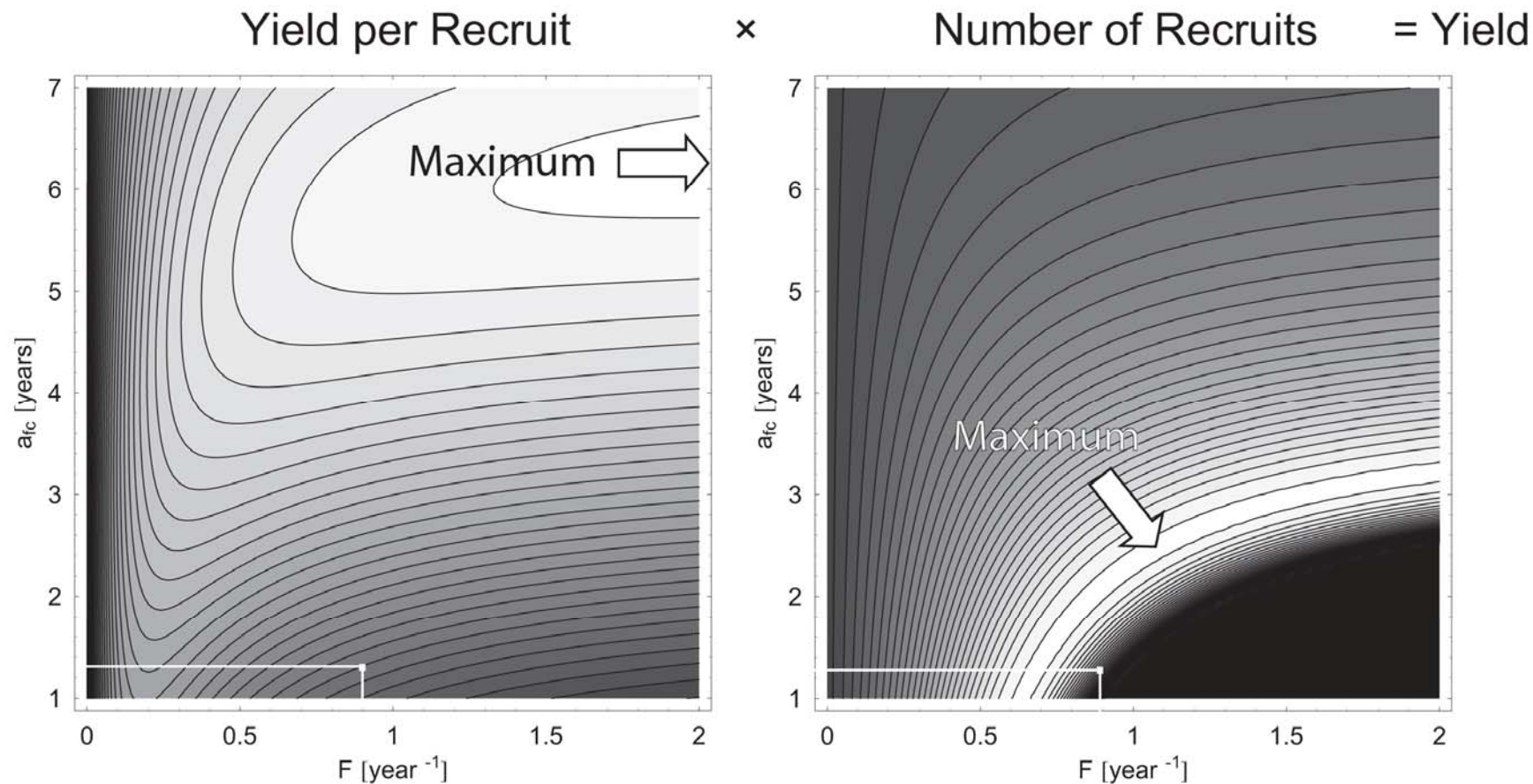
Yield per recruit for cod as a function of age at first capture and fishing mortality (Beverton and Holt, 1957).



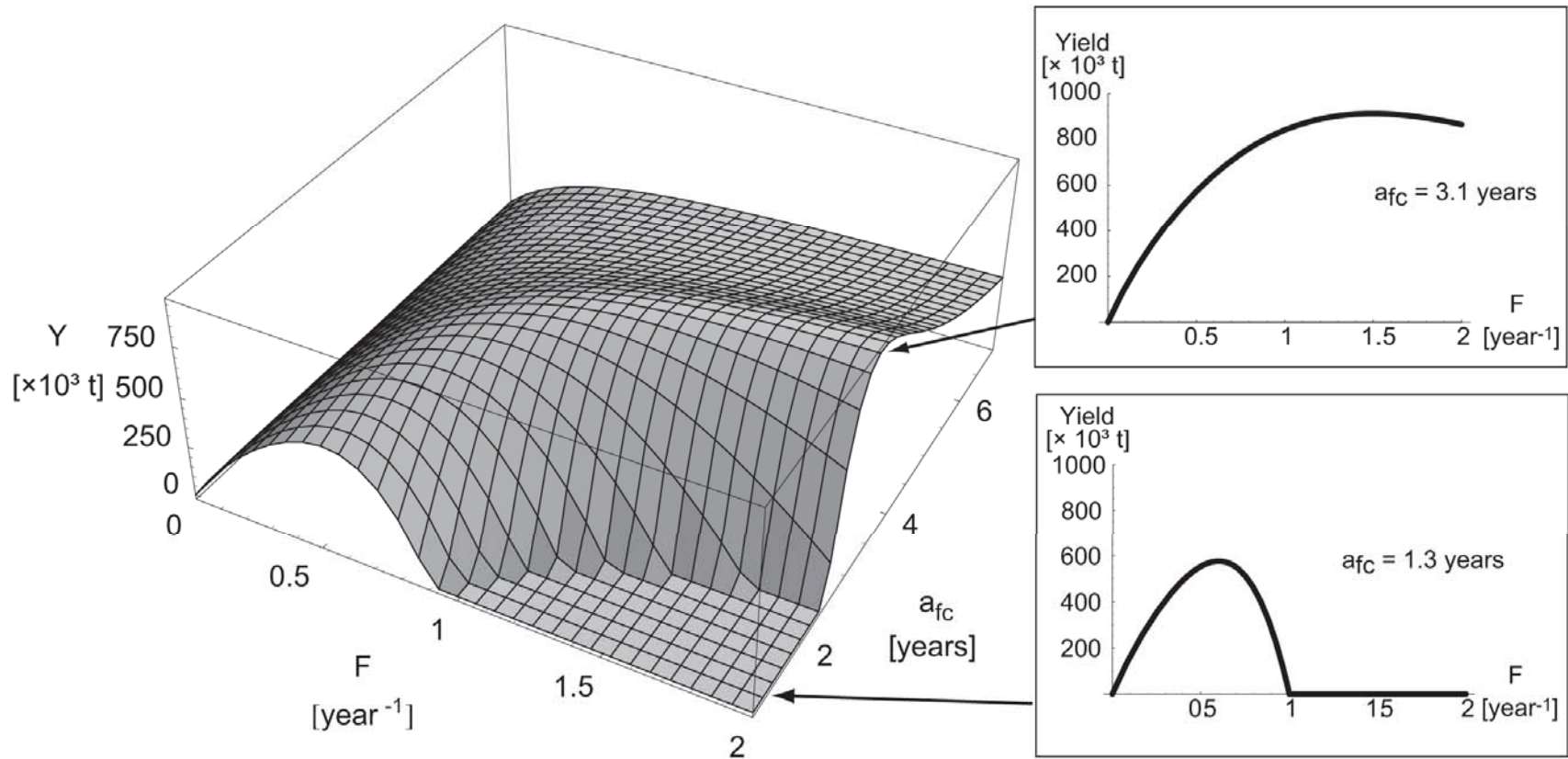
Number of recruits as a function of spawning stock biomass per recruit in the steady state – construction model of sustainable yield curves (Shepherd 1982).



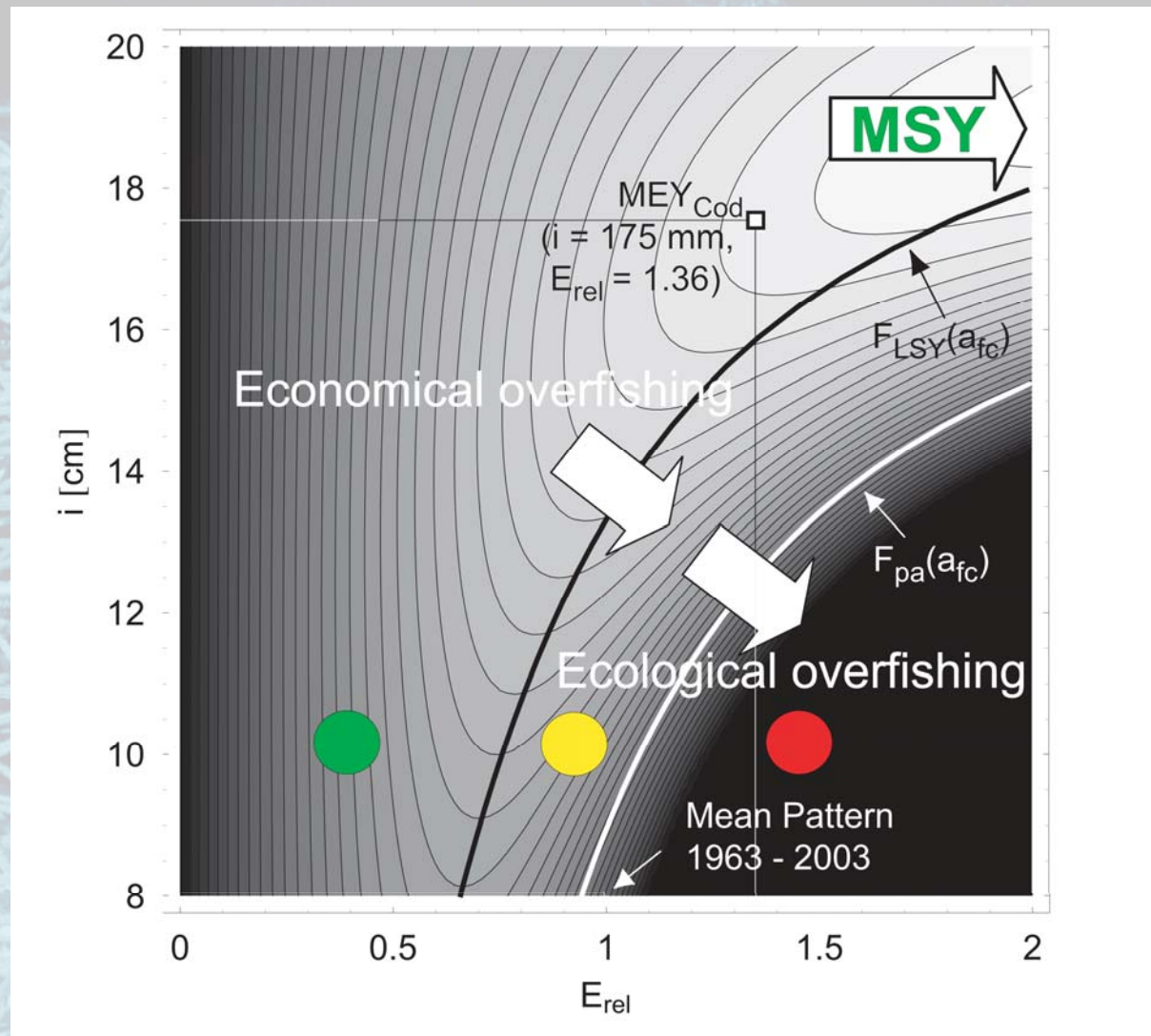
3D - Plot of normalized mean number of recruits for cod as a function of age at first capture and fishing mortality.



Contour plot of yield per recruit and number of recruits as a function of age at first capture and fishing mortality for cod.

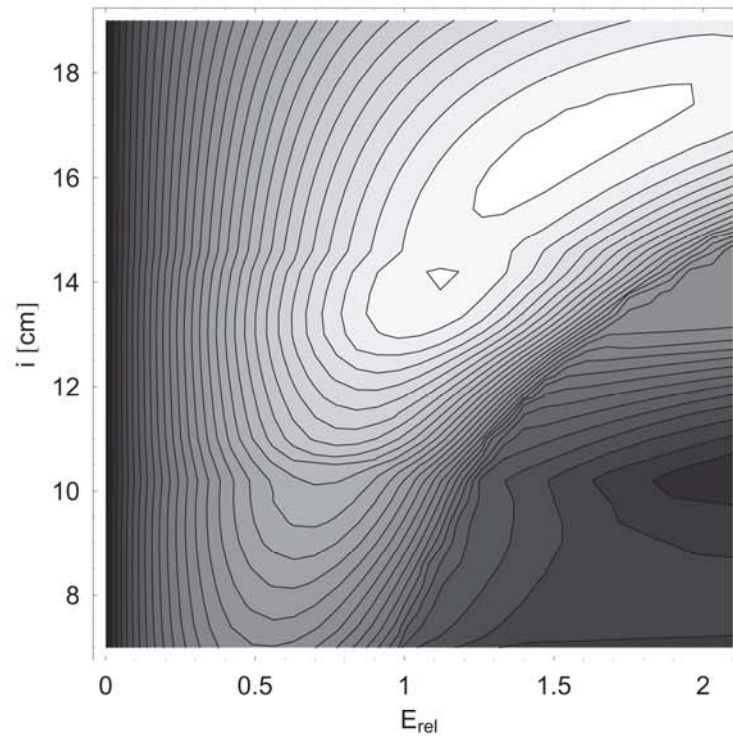


3D - Plot of sustainable long-term yield as a function of age at first capture and fishing mortality for cod in the North Sea.



Contour plot of the mean long-term yield for cod as a function of mesh size (age at first capture) and relative effort (fishing mortality).

Total revenue = sum of revenue of the species



Cod

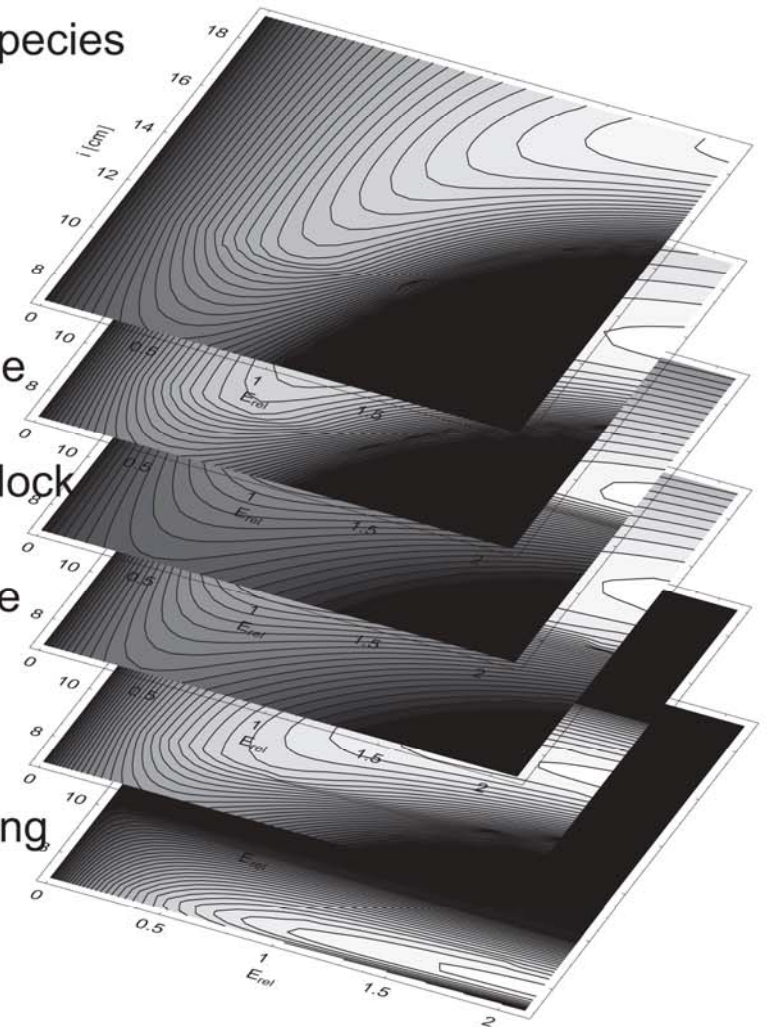
Saithe

Haddock

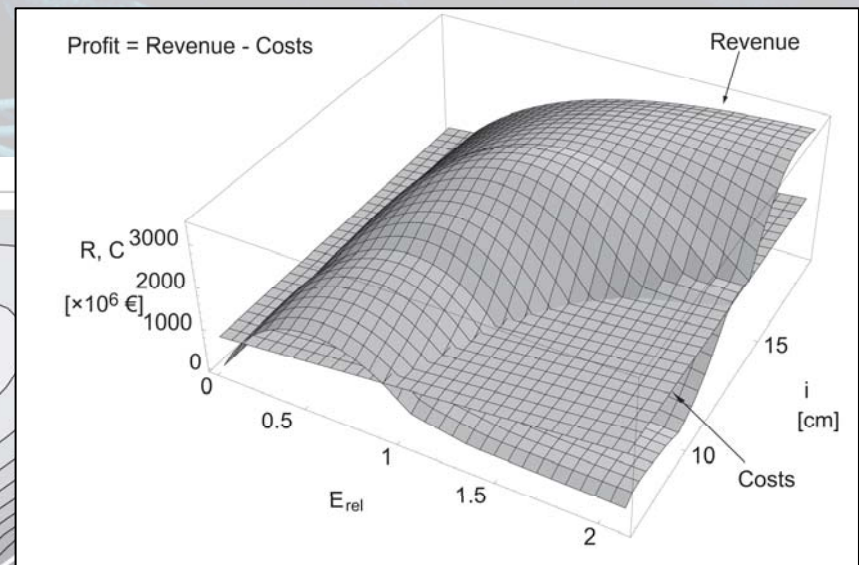
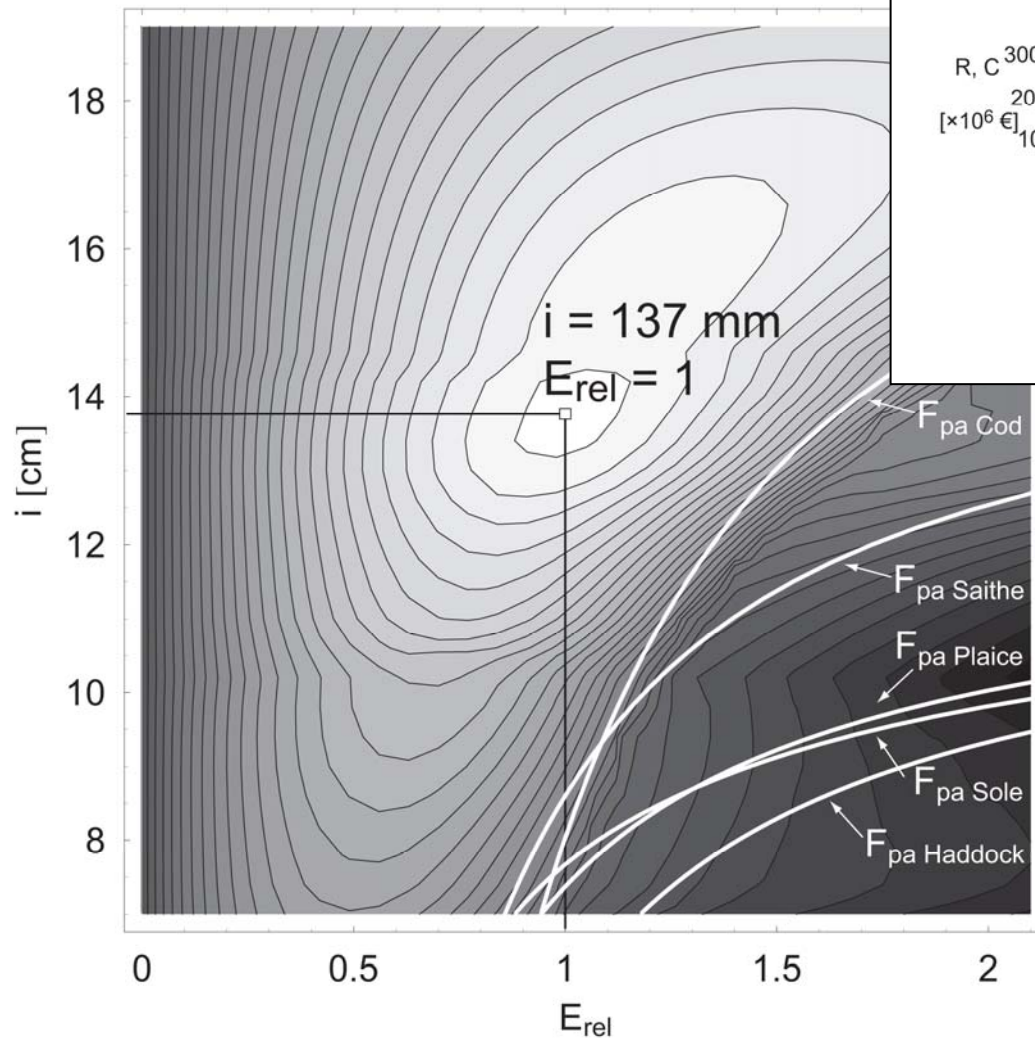
Plaice

Sole

Whiting

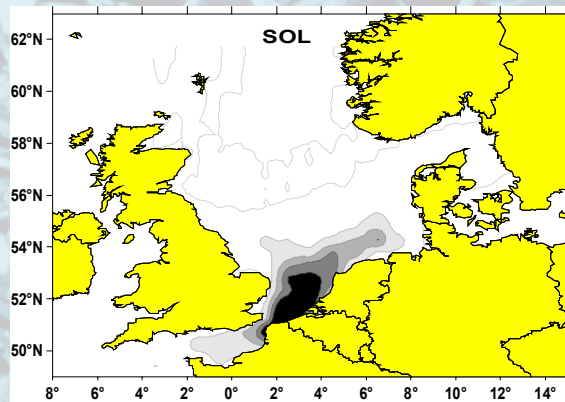
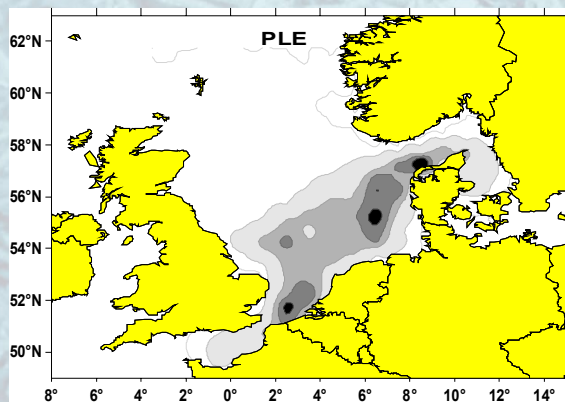
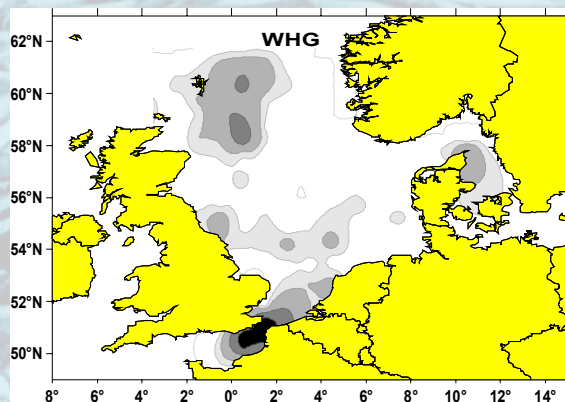
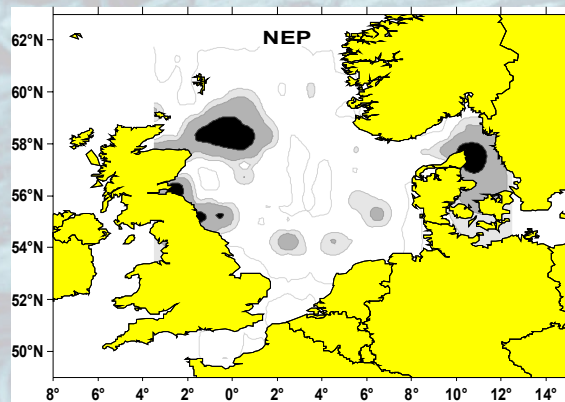
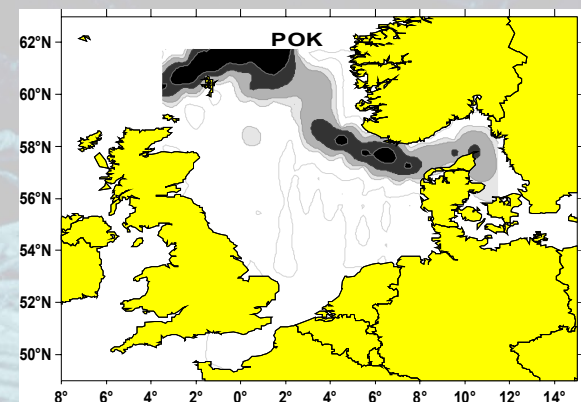
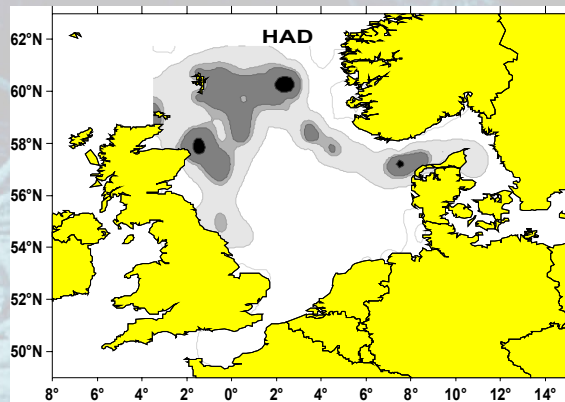
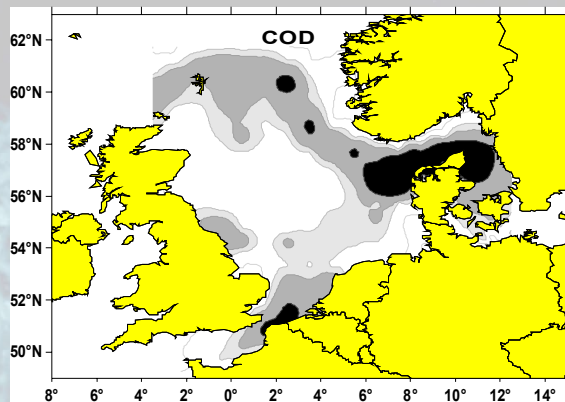


Contour plot of the total mean long-term revenue as a function of mesh size and relative effort.

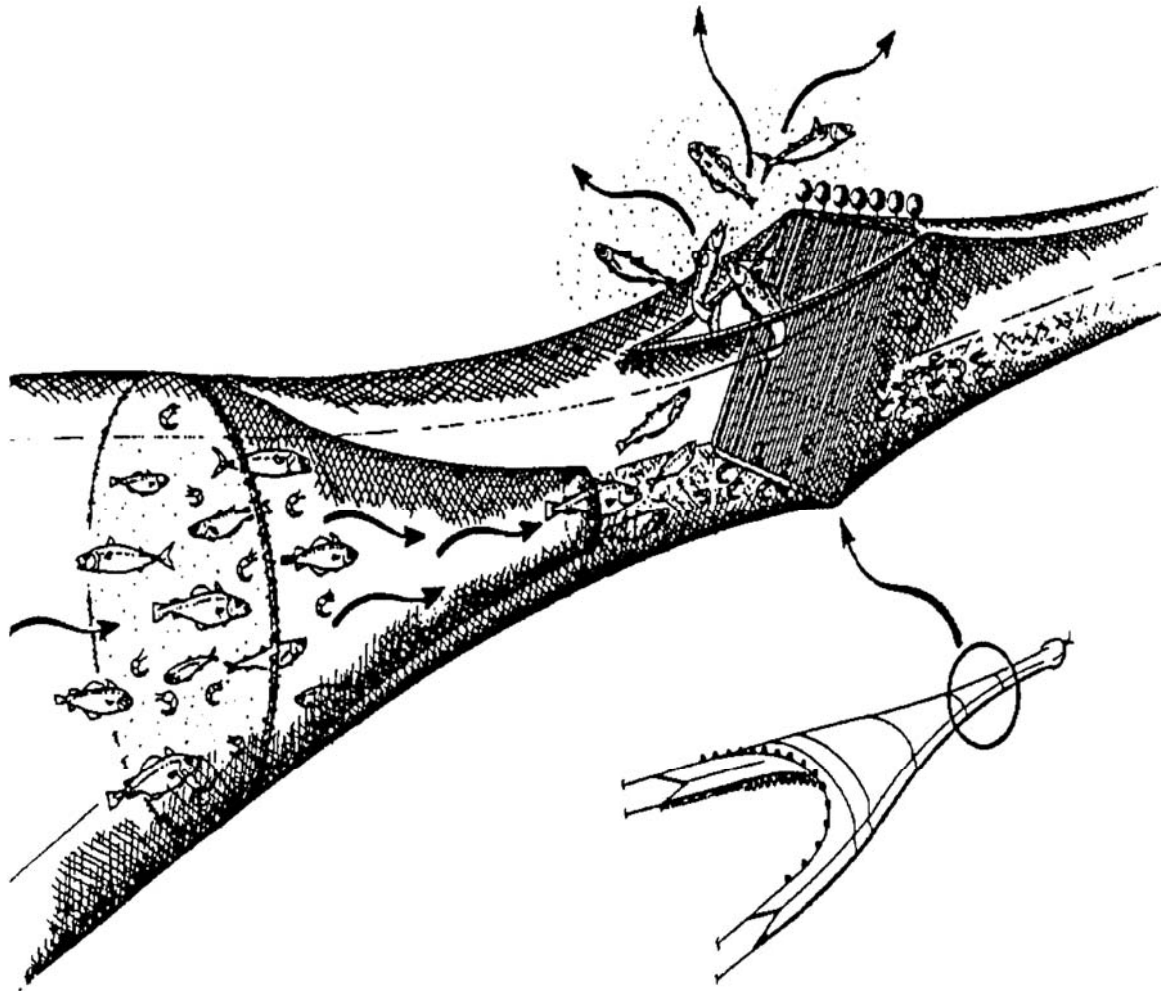


Contour plot of the mean long-term profit as a function of mesh size and relative effort.

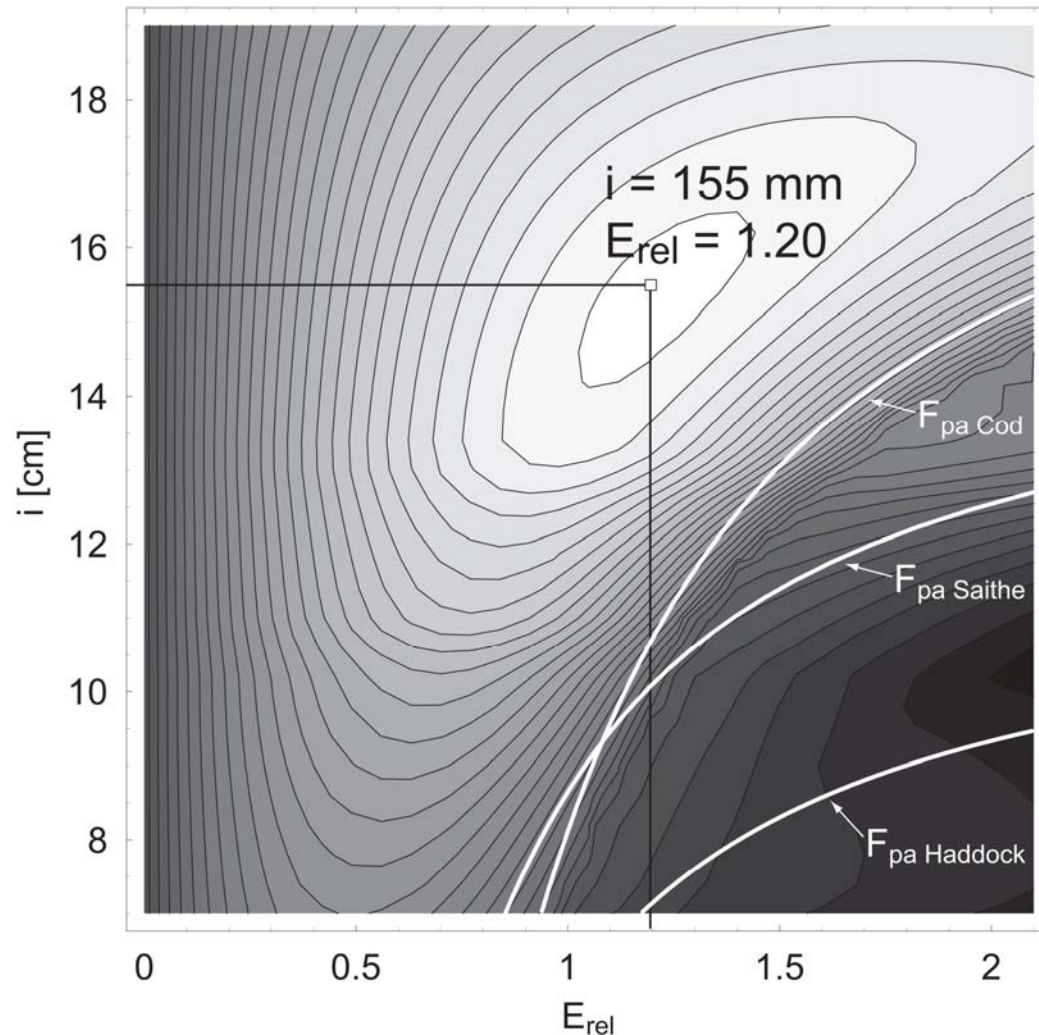
(Assumed that there is no profit for $i = 80 \text{ mm}$).



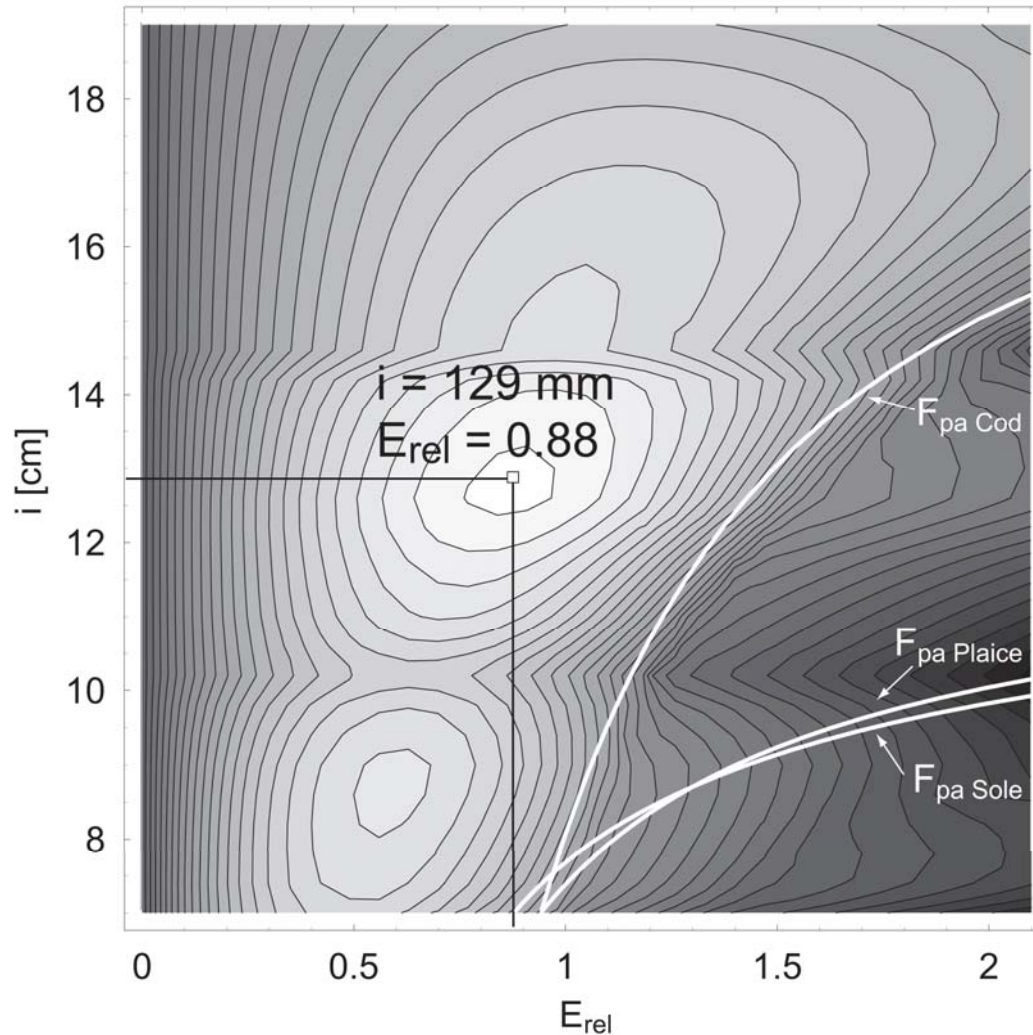
Distribution patterns of international landings of cod (COD), haddock (HAD), saithe (POK), whiting (WHG), plaice (PLE), sole (SOL) and Norway lobster (NEP) in the North Sea, Skagerrak and Eastern Channel, 2000-2004.



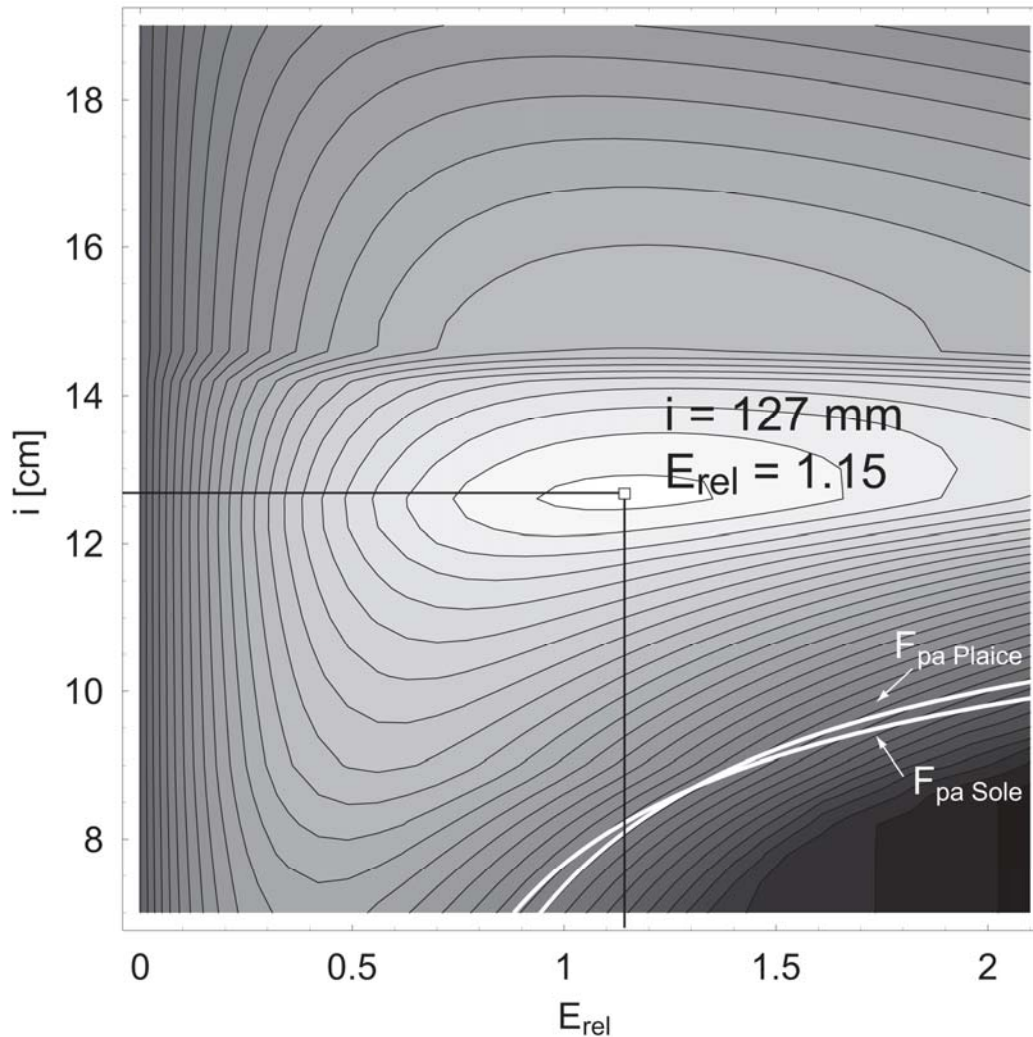
The Nordmøre Grid as a technical measure to detach the management-control variables for fish from the variables for Norway lobster.



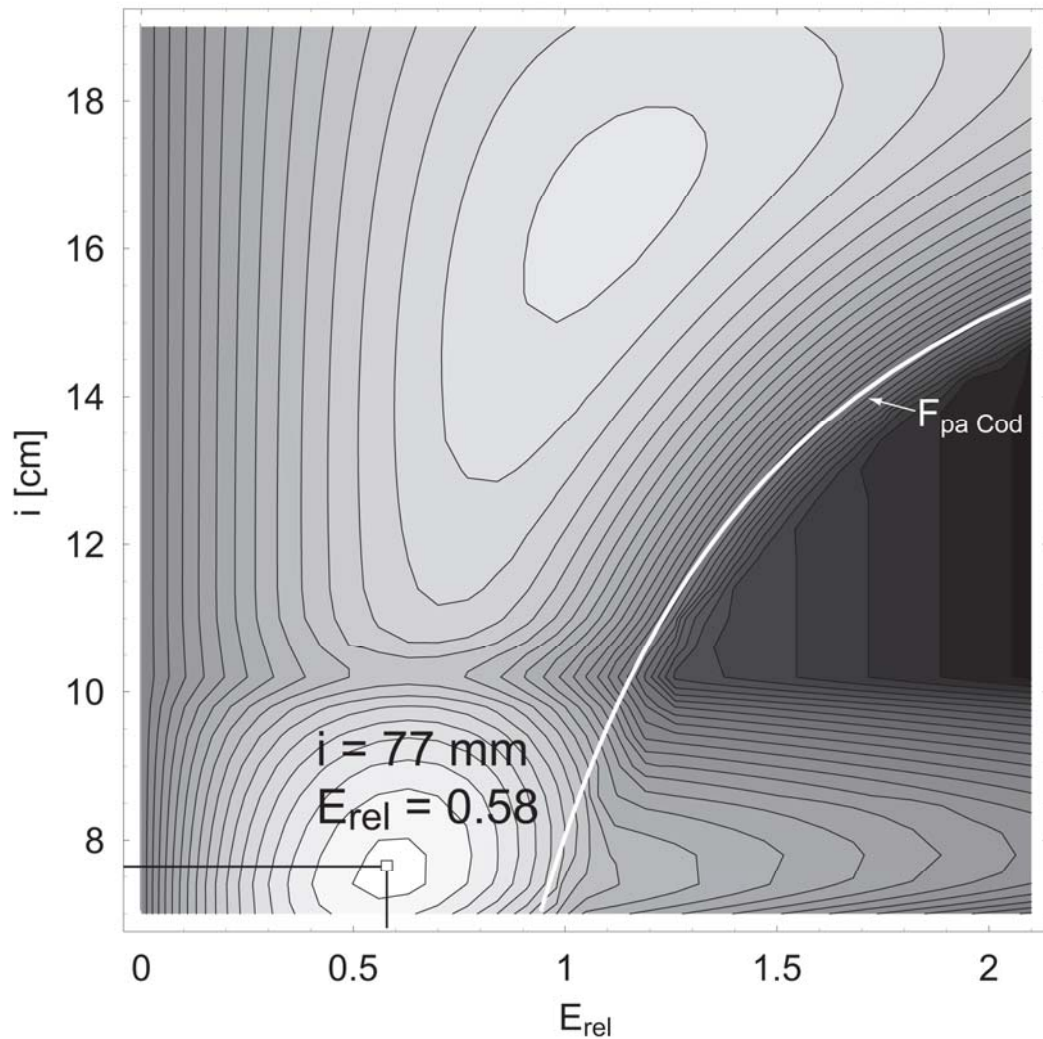
Contour plot of the profit in the northern area as a function of mesh size and relative effort. (Assumed that there is no profit for $i = 80$ mm).



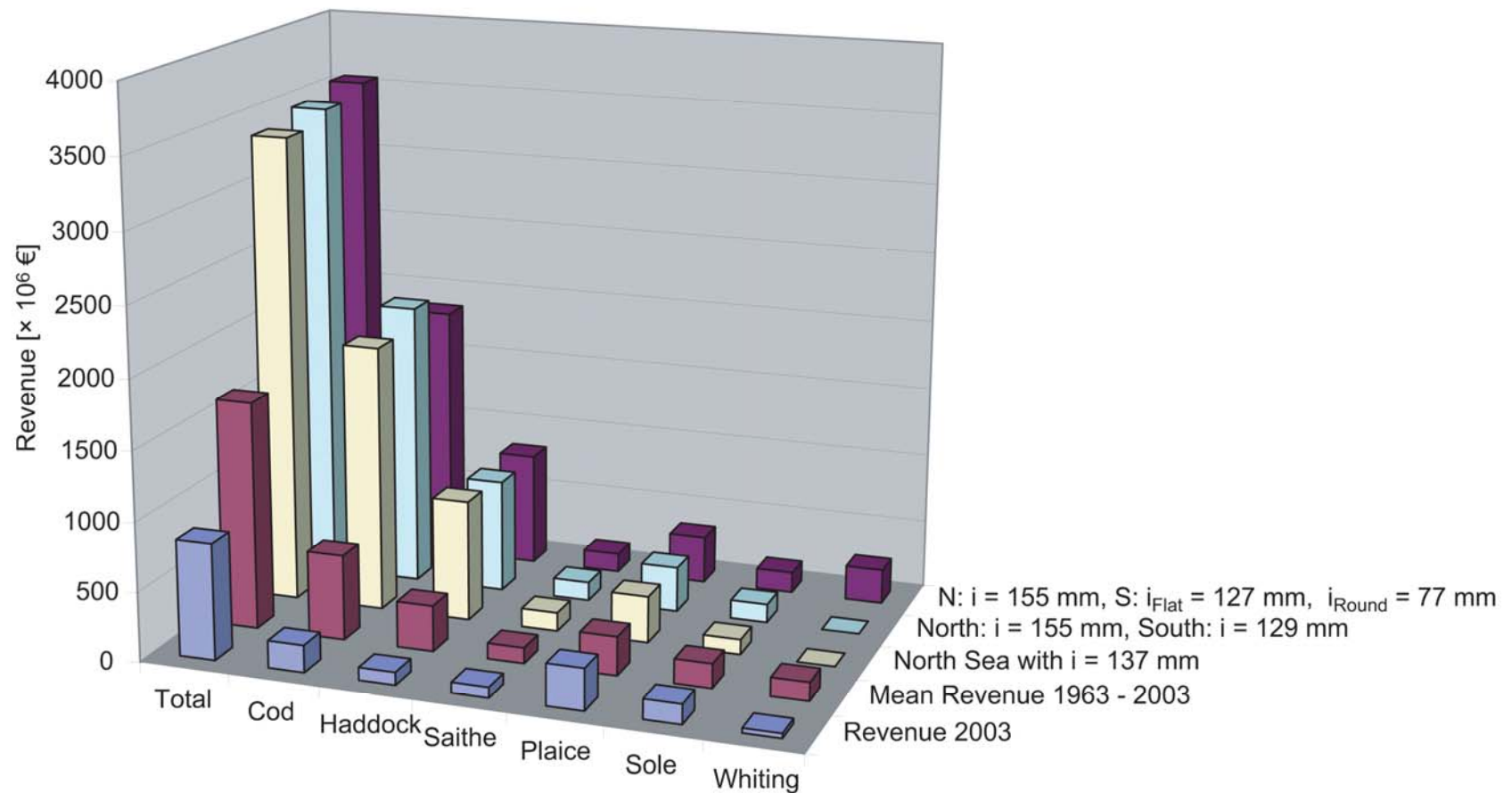
Contour plot of the profit in the southern area as a function of mesh size and relative effort. (Assumed that there is no profit for $i = 80$ mm).



Contour plot of the profit for the fishery with flat-fish trawls in the southern area as a function of mesh size and relative effort.



Contour plot of the profit for the fishery with cod trawls in the southern area as a function of mesh size and relative effort.



3D Plot of the revenue depending on the harvesting strategy applied in the North Sea.



Thank you!