Effectiveness and efficiency of alternative fishery management approaches

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IIFET 2016
Baltic cod catch stock year biomass [1000 tons]

minimum landing size since 1940 in Denmark
mesh size regulation since 1950 in Denmark
Baltic cod

total allowable catches

biomass [1000 tons]

year

minimum landing size since 1940 in Denmark
mesh size regulation since 1950 in Denmark
Baltic cod catch stock

Total allowable catches


Minimum landing size since 1940 in Denmark
Mesh size regulation since 1950 in Denmark

Biomass [1000 tons]
Baltic cod

total allowable catches

minimum landing size since 1940 in Denmark

mesh size regulation since 1950 in Denmark
Baltic cod

**Baltic cod catch stock year**

- Biomass [1000 tons]
- Total allowable catches

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**Minimum landing size since 1940 in Denmark**

**Mesh size regulation since 1950 in Denmark**
Baltic cod

- Baltic cod catch stock
- Biomass [1000 tons]
- Total allowable catches
- Minimum landing size since 1940 in Denmark
- Mesh size regulation since 1950 in Denmark
Baltic cod

**Baltic cod catch stock** year biom [1000 tons] Bacoma 120mm; 35cm min. landing size

**Total Allowable Catches**

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- Minimum landing size since 1940 in Denmark
- Mesh size regulation since 1950 in Denmark
Baltic cod catch stock year biomass [1000 tons] Bacoma 110mm; 38cm min. landing size.

Minimum landing size since 1940 in Denmark
Mesh size regulation since 1950 in Denmark
Baltic cod

Total allowable catches

- 2010
- 2005
- 2000
- 1995
- 1990
- 1985
- 1980

Minimum landing size since 1940 in Denmark

Mesh size regulation since 1950 in Denmark
Baltic cod

total allowable catches

biomass [1000 tons]

minimum landing size since 1940 in Denmark

mesh size regulation since 1950 in Denmark
Baltic cod

landings

biomass [1000 tons]

year

Baltic cod fishery case study

- Mesh size regulation has been an important management instrument in the past, besides TACs, which often have not been binding.
- Long-term management plan introduced in 2007 aims at maximum sustainable yield (MSY).
Baltic cod fishery case study

- Mesh size regulation has been an important management instrument in the past, besides TACs, which often have not been binding.

- Long-term management plan introduced in 2007 aims at maximum sustainable yield (MSY).

- How does MSY objective perform in an age-structured fishery, when both mesh-size and total catches can be optimized?
Baltic cod biomass model

Tahvonen/Quaas/Voss (2016). What difference does it make? Age structure, gear selectivity, stochastic recruitment, and economic vs. MSY objectives in the Baltic cod fishery
- age-structured population model based on Tahvonen (JEEM, 2009), quantified using stock assessment data from ICES
- concept of *efficient biomass*

\[ B_t = \sum_{s=1}^{n} w_s q_s(\sigma_t) x_{st} \]

\( w_s \): weight at age \( s \); \( x_{st} \): stock numbers in year \( t \)
\( q_s(\sigma_t) \): catchability at age, depending on mesh size \( \sigma_t \)
an age-structured population model based on Tahvonen (JEEM, 2009), quantified using stock assessment data from ICES

- concept of efficient biomass

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- objectives

  maximum yield \( \max_{H_t,\sigma_t} \sum_{t=0}^{\infty} H_t \)

- “ultimate sustainable yield”: assume perfect selectivity
- “gear-constrained maximum yield”: maximize yield with available gear
- “maximum sustainable yield”: max. equilibrium yield with available gear
age-structured population model based on Tahvonen (JEEM, 2009), quantified using stock assessment data from ICES

- concept of *efficient biomass*

\[
B_t = \sum_{s=1}^{n} w_s q_s(\sigma_t) x_{st}
\]

- \(w_s\): weight at age \(s\);
- \(x_{st}\): stock numbers in year \(t\)
- \(q_s(\sigma_t)\): catchability at age, depending on mesh size \(\sigma_t\)

- objectives

**maximum yield** \[
\max_{H_t, \sigma_t} \sum_{t=0}^{\infty} H_t
\]

**economic objective** \[
\max_{H_t, \sigma_t} \sum_{t=0}^{\infty} \left( \frac{\bar{P}}{1 - \eta} H_t^{1-\eta} - c B_t^{-\chi} H_t \right) b^t
\]

- utility from catch: \(\bar{P} = 27, \eta = 0.65\) estimated using time series of prices from Danish fishery accounts
- cost function: \(c = 6.6, \chi = 0.43\), est. assuming regulated open access
- discount factor \(b = 1/(1 + r), r \geq 0\) varied
selectivity of trawl gear parametrized using experimental data

max. equilibrium annual economic surplus, given total biomass
max. equilibrium annual economic surplus, given total biomass

max. equilibrium yield with available gear, given total biomass
age-structured optimization model for Baltic cod fishery

- total catch and mesh size as optimized variables

- MSY and economic management approaches make big difference

- maximum of equilibrium annual economic surplus is obtained at smaller stock size than MSY

- in the past, mesh size has been set higher than optimal, while catches have not been restricted enough

Tahvonen/Quaas/Voss (2016). What difference does it make? Age structure, gear selectivity, stochastic recruitment, and economic vs. MSY objectives in the Baltic cod fishery
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