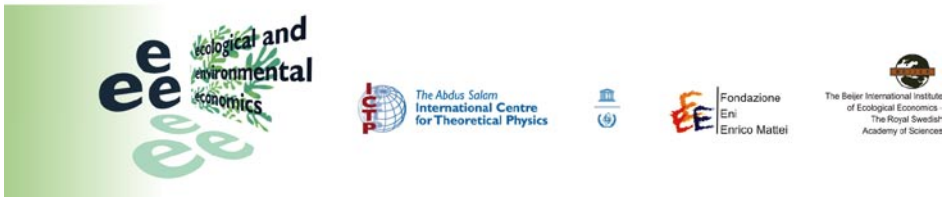

1st Teaching Workshop on Environmental Economics

for the Middle East and North Africa

December 5-16, 2005 - ICTP, Trieste, Italy

Economic valuation of coastal habitats sustaining plaice fisheries

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The Beijer International Institute of Ecological Economics

SMR 1684 - 9

Economic valuation of coastal habitats sustaining plaice fisheries

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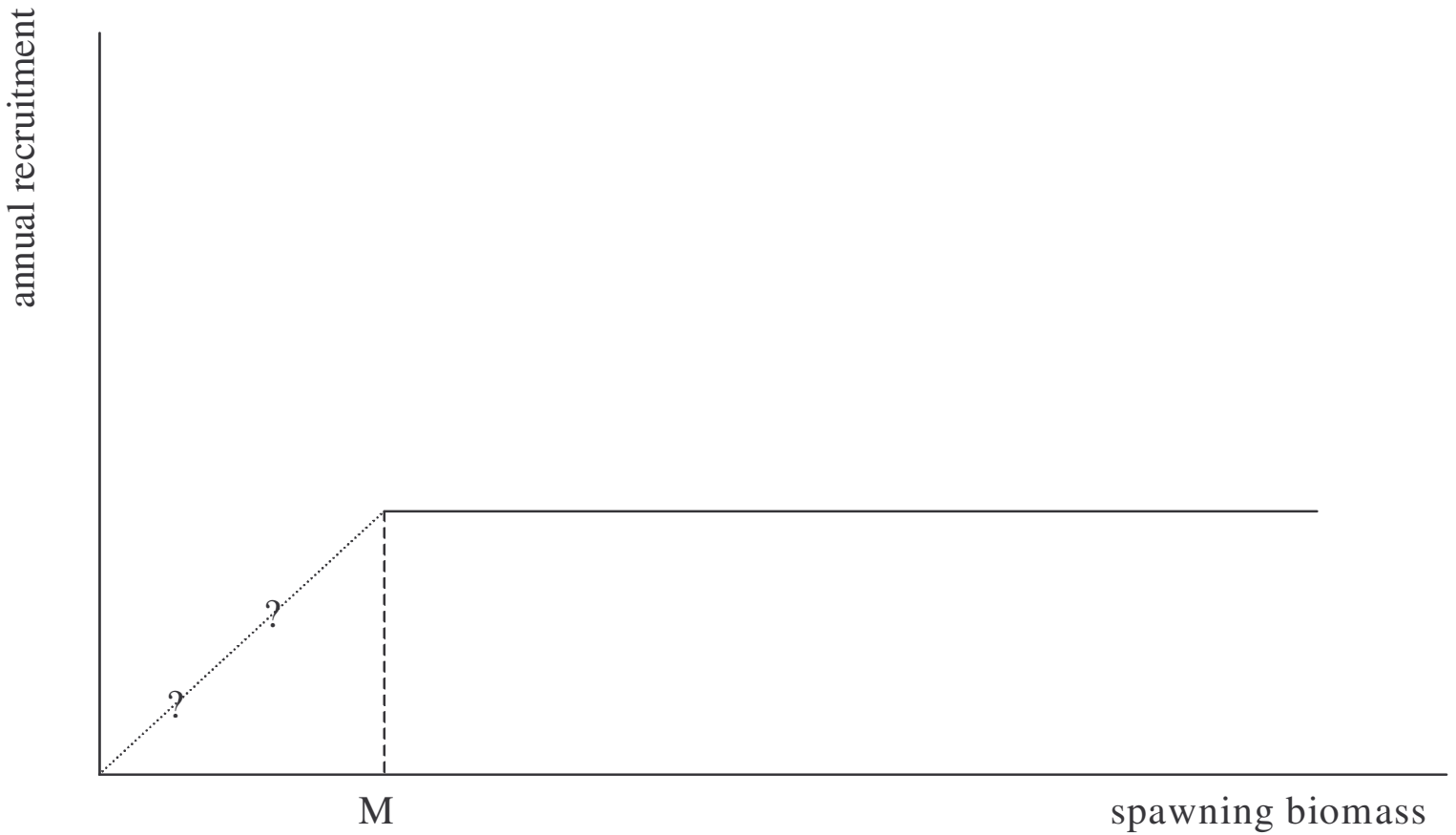
The question:

- **How do changes in the habitat (algae covering the nursery grounds in shallow soft bottom areas) affect plaice fisheries?**
- **How to value those changes?**

Plaice

- Reproduction seriously dependent on habitat and not on stock
- Spatially restricted nursery grounds in shallow soft bottom areas
- Swedish nursery grounds contribute with 77% of plaice recruitment in Kattegat and Skagerrak
- Danish commercial fisheries

Figure 5. A sketch of the relationship between spawning biomass and annual recruitment for plaice



Habitat problem

- Increasing filamentous algae coverage
- Preliminary studies show that plaice recruitment decreases in presence of algae
- How does this habitat quality problem affect plaice population and the fishery? How to value the habitat change in terms of fish production?

Population dynamics

- Plaice larvae settle during the spring on the nursery grounds in the Swedish west coast and stay in these shallow areas until the autumn, when they move into deeper waters for spending the winter. After 2 years, these 0-group juvenile fish are recruited to the adult population.

Population dynamics: how algae affect plaice recruitment?

- the recruitment of 0-group juvenile plaice is a function of the density dependent and density independent mortality rates, the size of the nursery area, the settlement density and the vegetation cover (Pihl et al.)

$$No_t = A * D(1 - V) * e^{(-M * t)}$$

The model

- **Beverton-Holt model - difficult dynamic analysis (age-stuctured population model, multiple cohorts) – no analytical solution for the general problem, even with restrictive assumptions (like costs of fishing equal to zero, etc.)**
- **application of the Beverton-Holt model using GAMS (General Algebraic Modelling System), analyzing different scenarios**

The model (cont.)

- time k in which the kth cohort enters the fishery (1970-2054)
- time t is current time (2000-2054)
- N is number of fish
- B is fish biomass
- C is cost of fishing
- Q is harvest in numbers
- H is harvest biomass

The equations

$$N(t) = N(t-1) - Q(t-1) + R$$

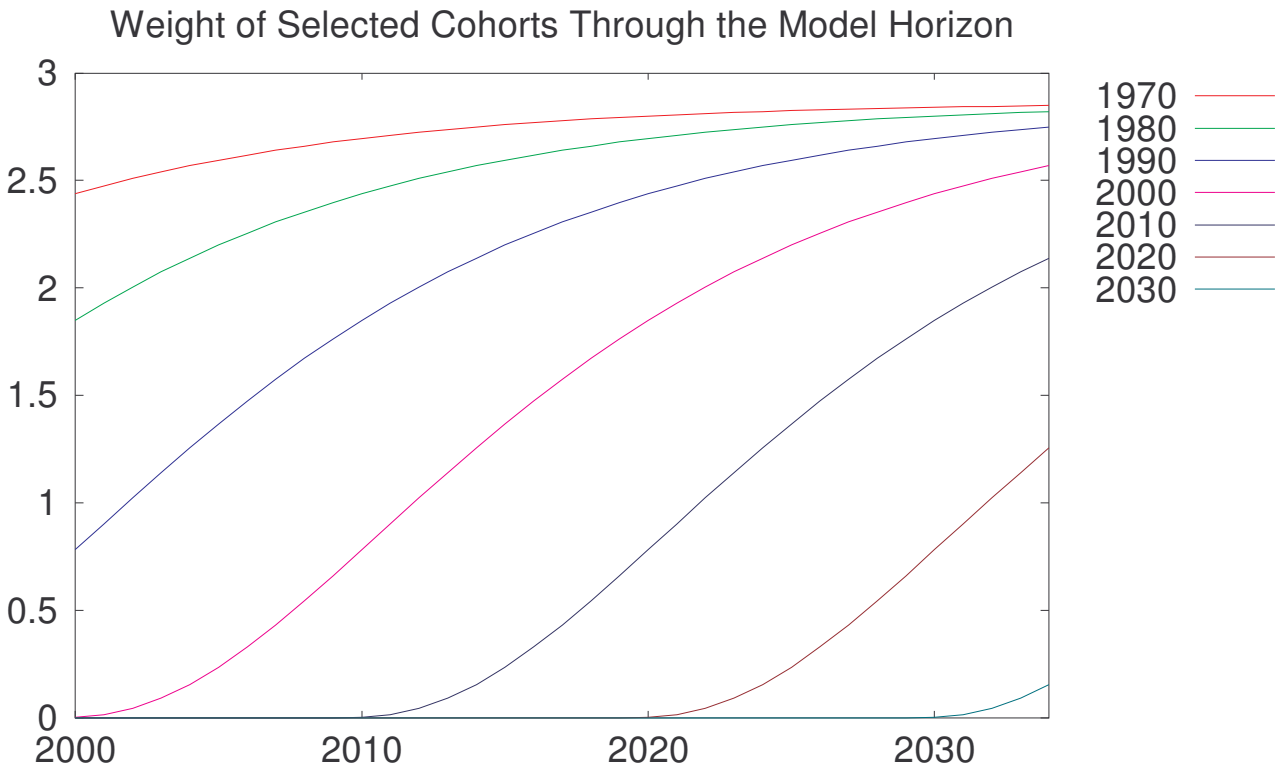
$W(k,t) = a(1-be^{-c(t-k)})^3$ von Bertalanffy weight function

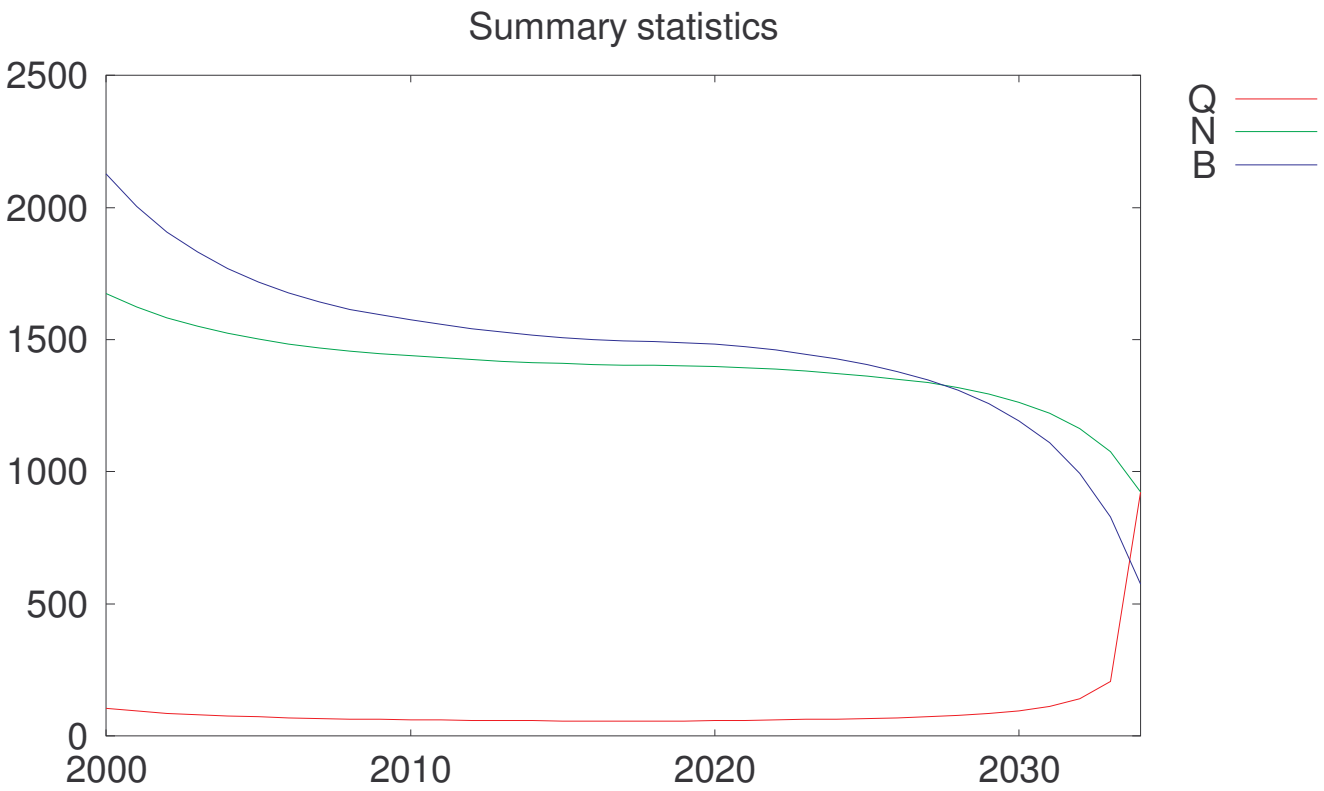
$$NB(t) = \sum_{t=2000}^{2034} \frac{1}{(1+r)^{t-2000}}(p.H(t) - C(t))$$ flow of net benefits from the fishery

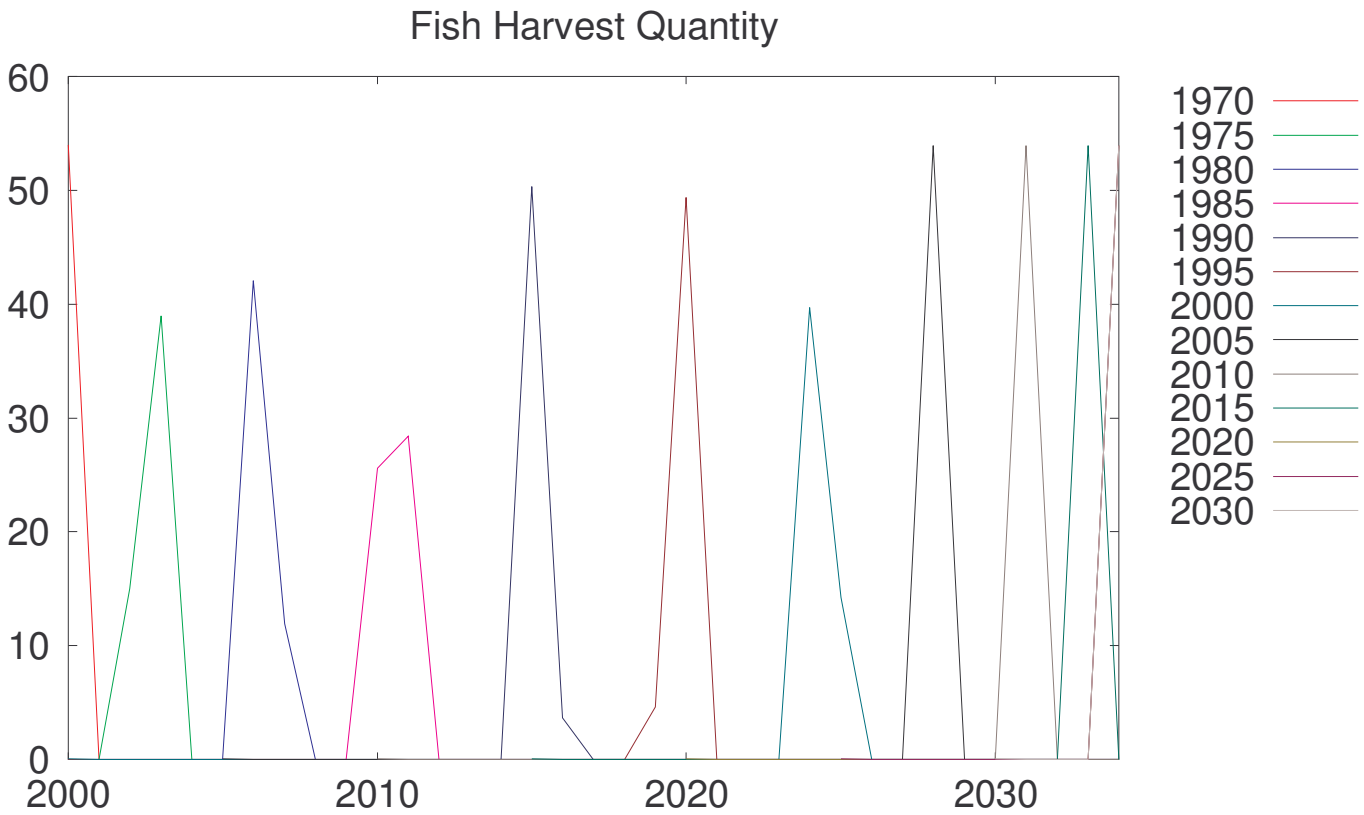
The cost function $C(t) = e^{-3,334} * H(t)^{0,9898} * TotB(t)^{-0,146}$

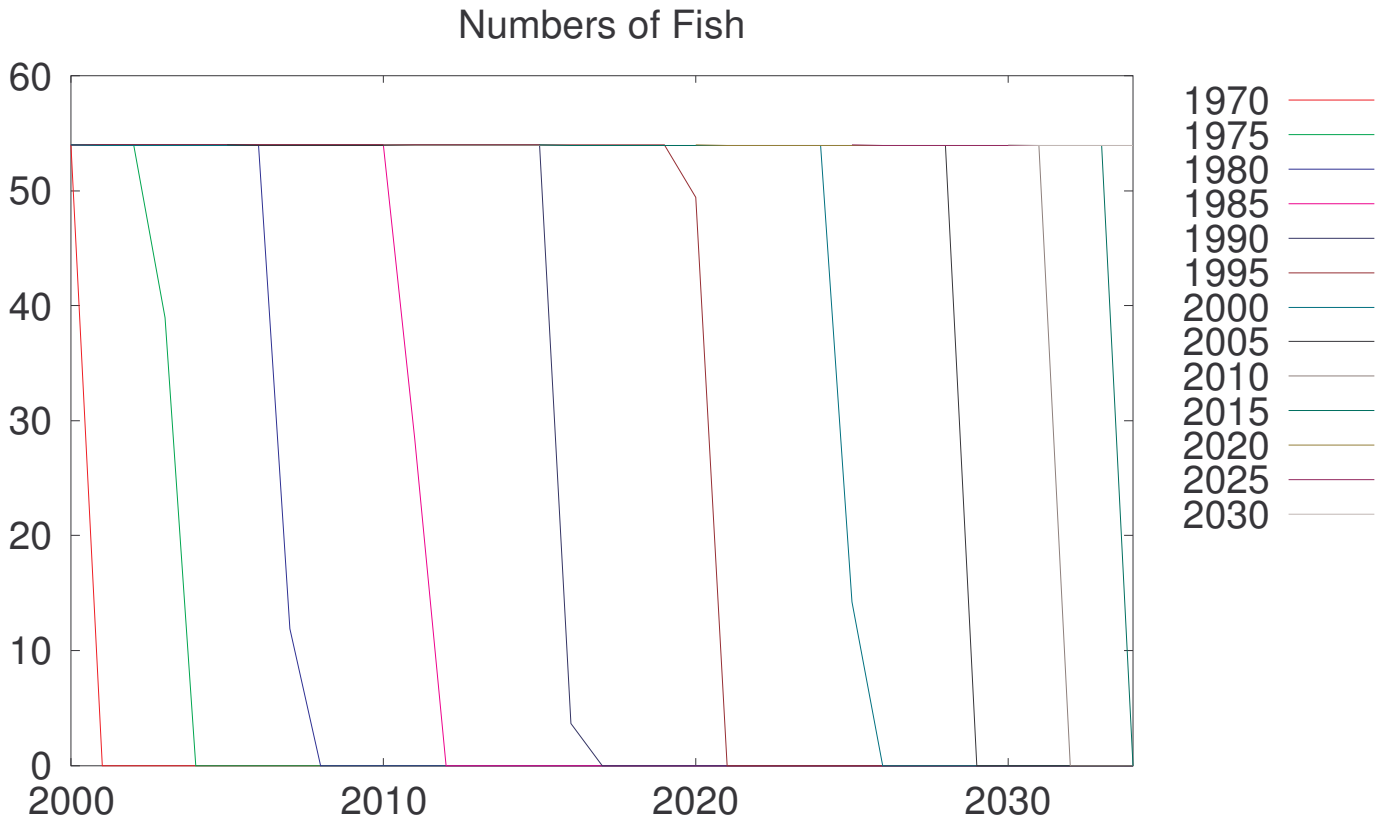
Results

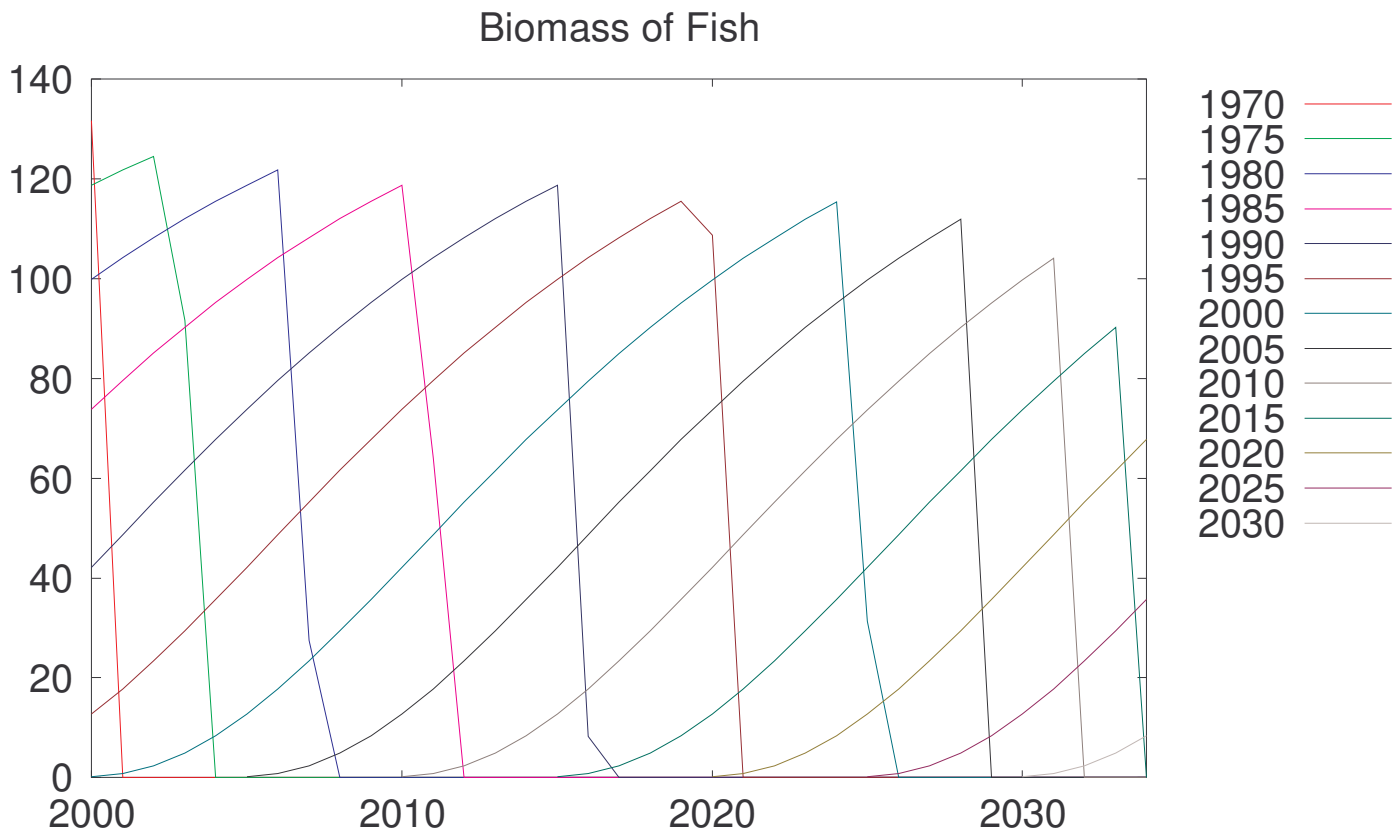
- the cost function used has been empirically estimated with the data available


Weight of Selected Cohorts Through the Model Horizon
3
2.5
2
1.5
1
0.5
0
2000
2010
2020
2030
1970
1980
1990
2000
2010
2020
2030


Summary statistics
2500
2000
1500
1000
500
0
2000
2010
2020
2030
Q
N
B


Fish Harvest Quantity
60
50
40
30
20
10
0
2000
2010
2020
2030
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030


Numbers of Fish
60
50
40
30
20
10
0
2000
2010
2020
2030
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030


Biomass of Fish
140
120
100
80
60
40
20
0
2000
2010
2020
2030
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030

Remaining aspects (to be discussed)

- restrictions built into the model
  - total selectivity of fishing gear
  - perfect selection of fish to harvest
  - pulse fishing
  - harvesting every individual cohort at its optimal age
  - harvesting only one cohort at a time