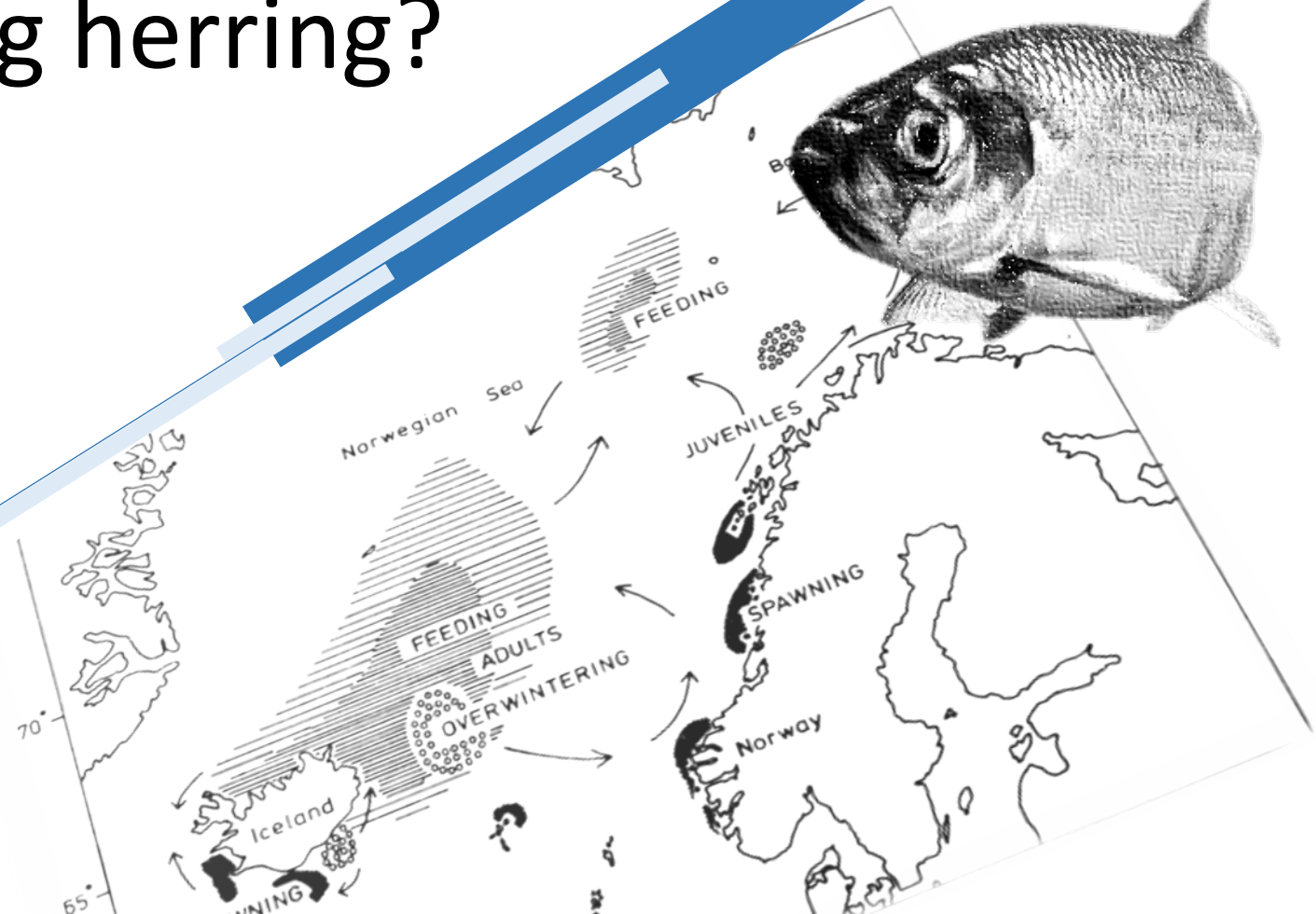
Is fishing driving energy acquisition and allocation changes in the Norwegian Spring-spawning herring?

Marion Claireaux, Katja Enberg, Mikko Heino and Bruno Ernande



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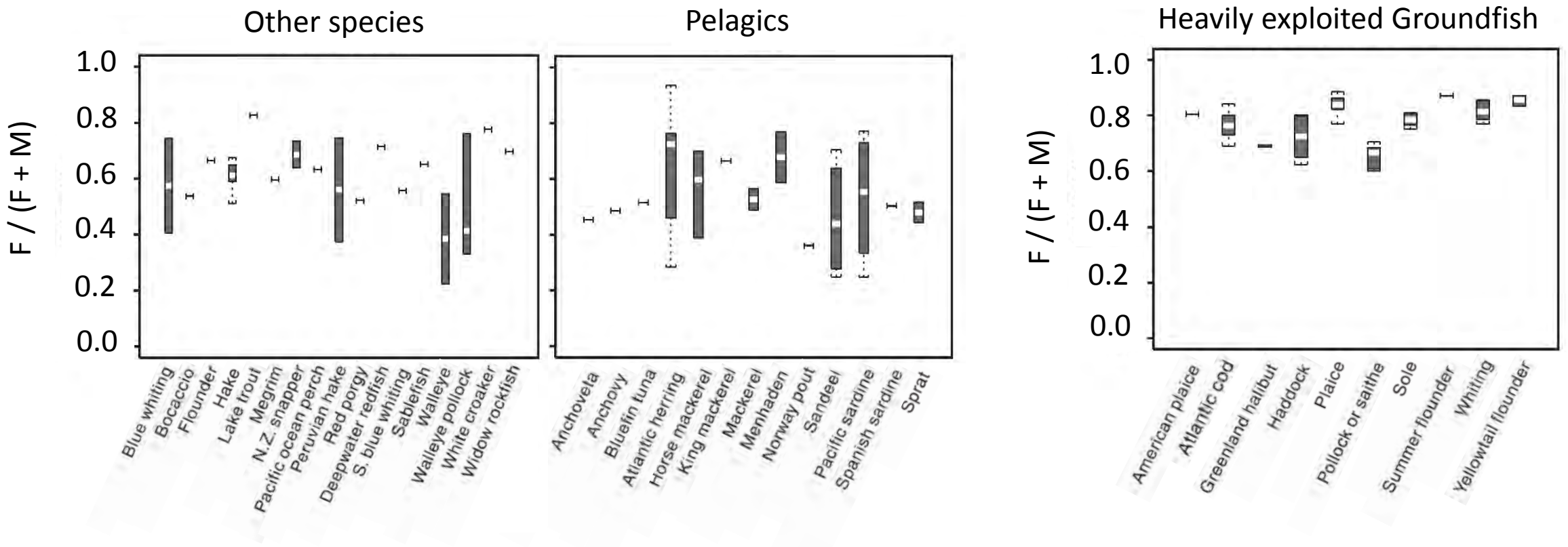
Introduction : fishing pressure

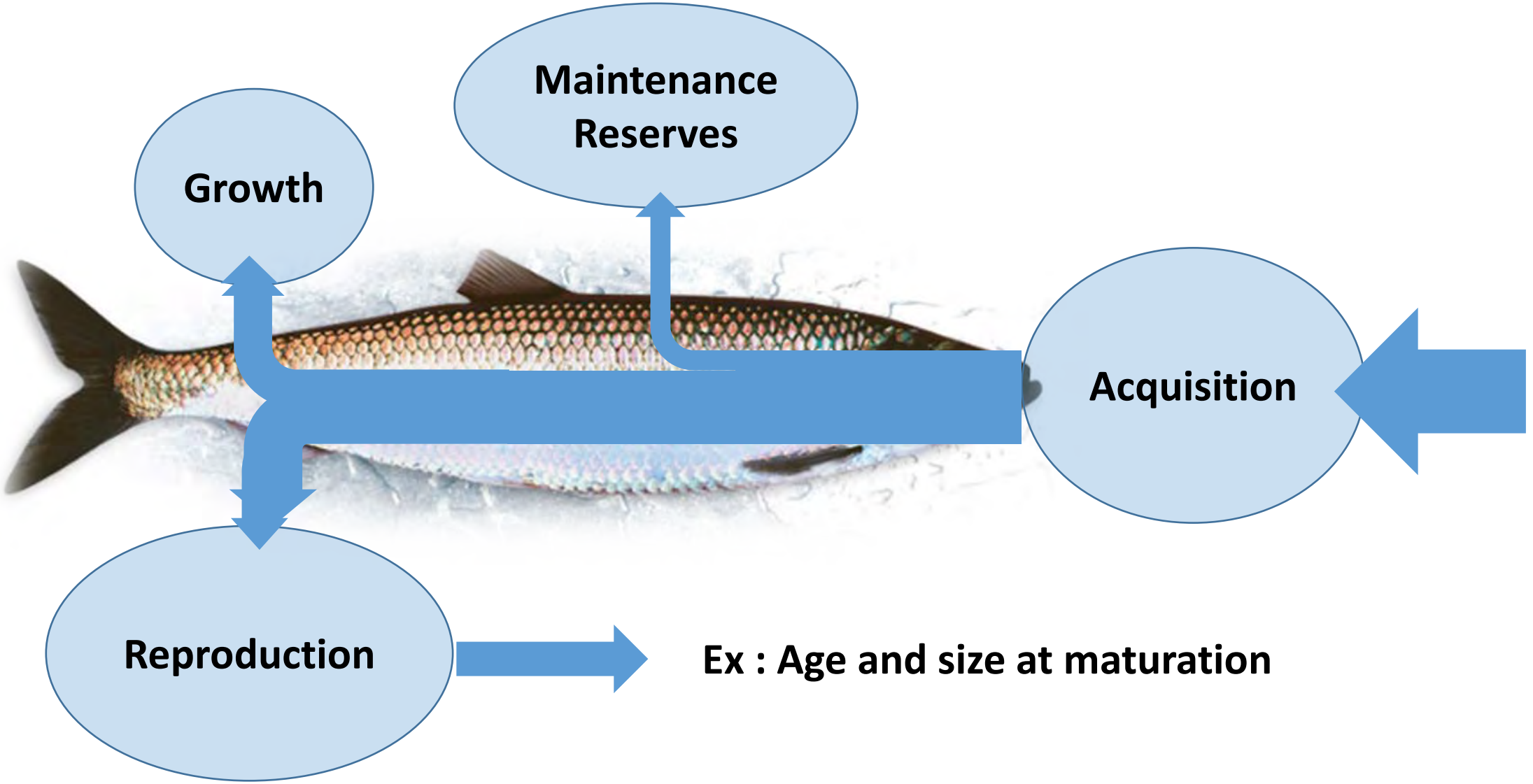
Fishing mortality

Around 60% of the total mortality : Up to 80%:



From Mertz & Myers, 1998

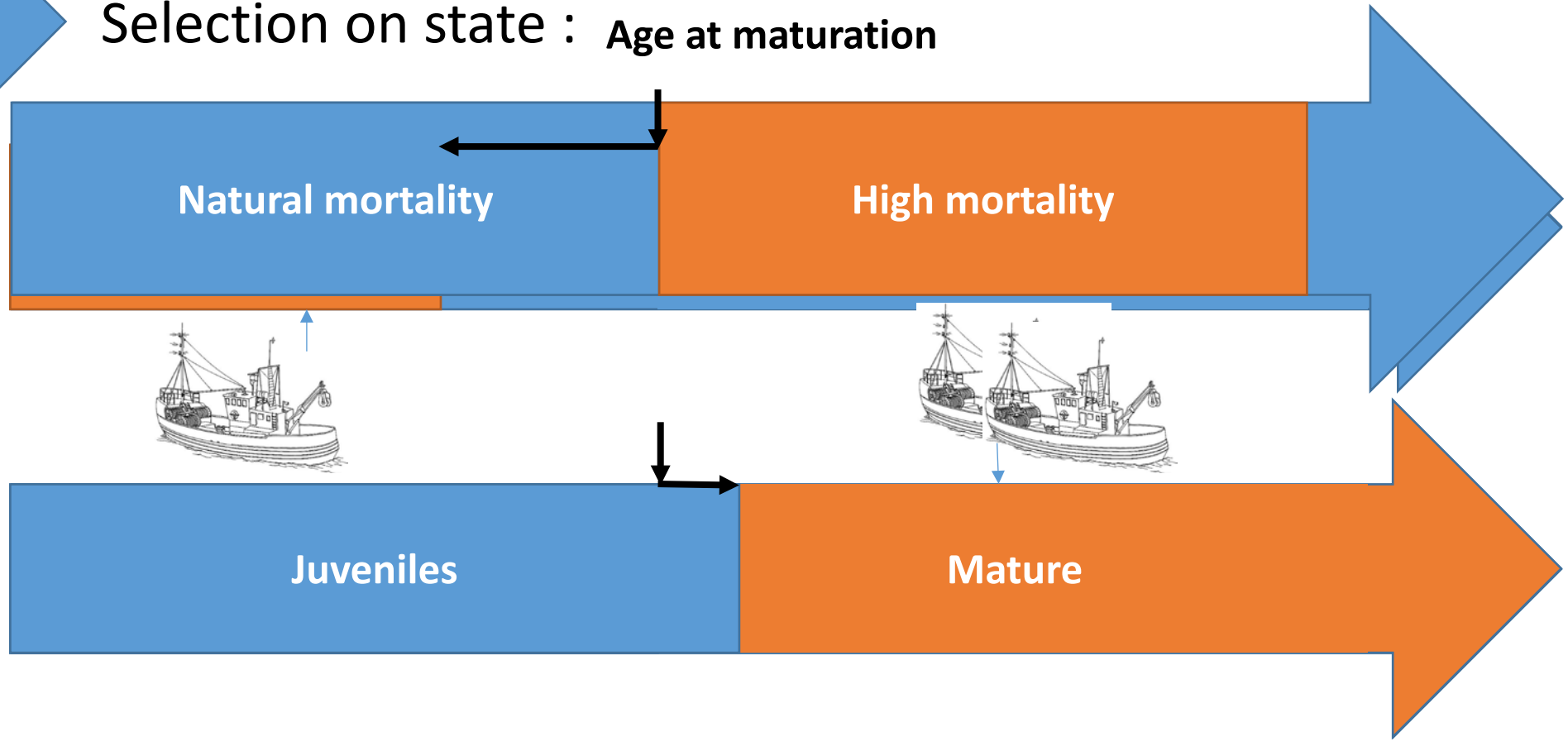
Introduction : effects of overall mortality increase



Introduction : effects of selectivity

Selectivity High relevance for the potential of evolutionary change

Example Selection on state : **Age at maturation**



Introduction : evidence for FIE

Fishing pressure is driving changes in maturation age in a wide number of stocks

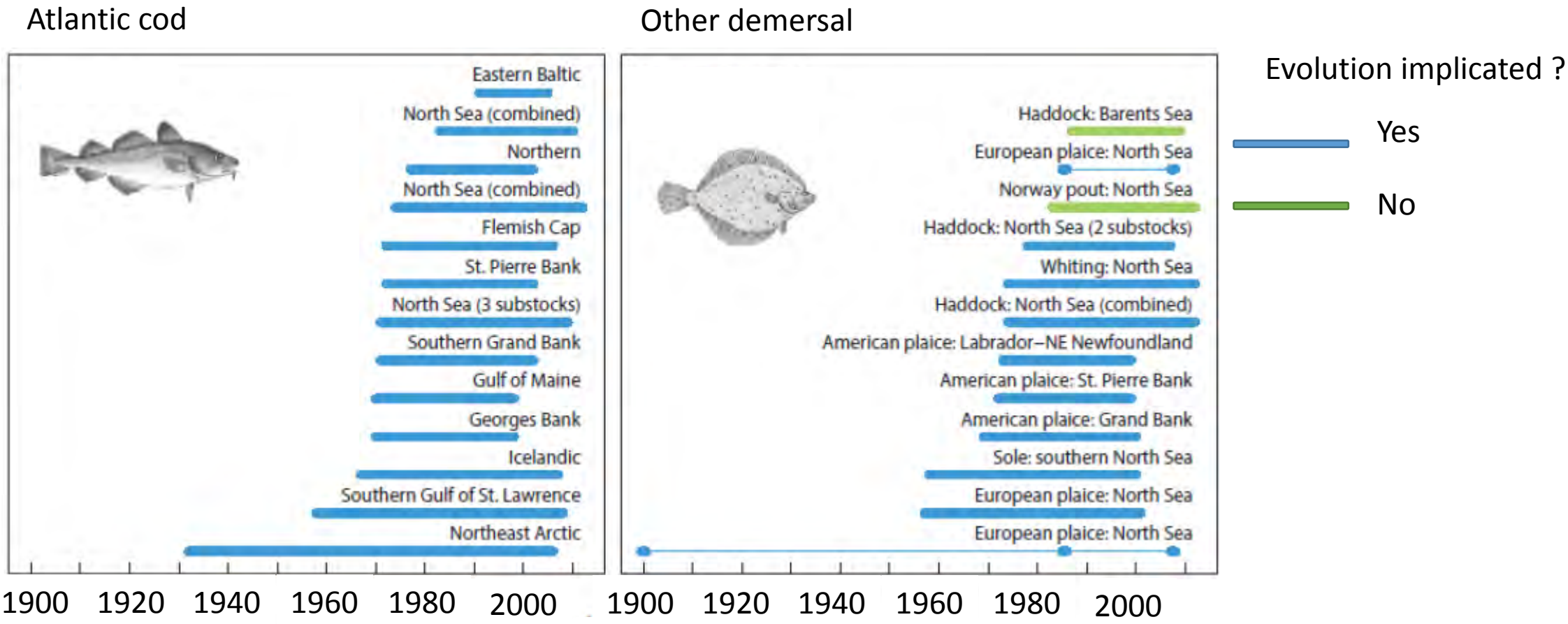


Figure: Evidence for FIE from maturation traits, Heino et al. (2015)

Introduction : evidence for FIE ?

BUT

No / few changes in maturation age in heavily exploited pelagic stocks

Hypotheses

Norwegian Spring-spawning herring:

- Life style
- Changing fishing pattern
- Changes seen in growth and gonad weight

Goal

Investigate trends in traits related to energy acquisition and allocation

Relate potential changes to fishing pressure and environment

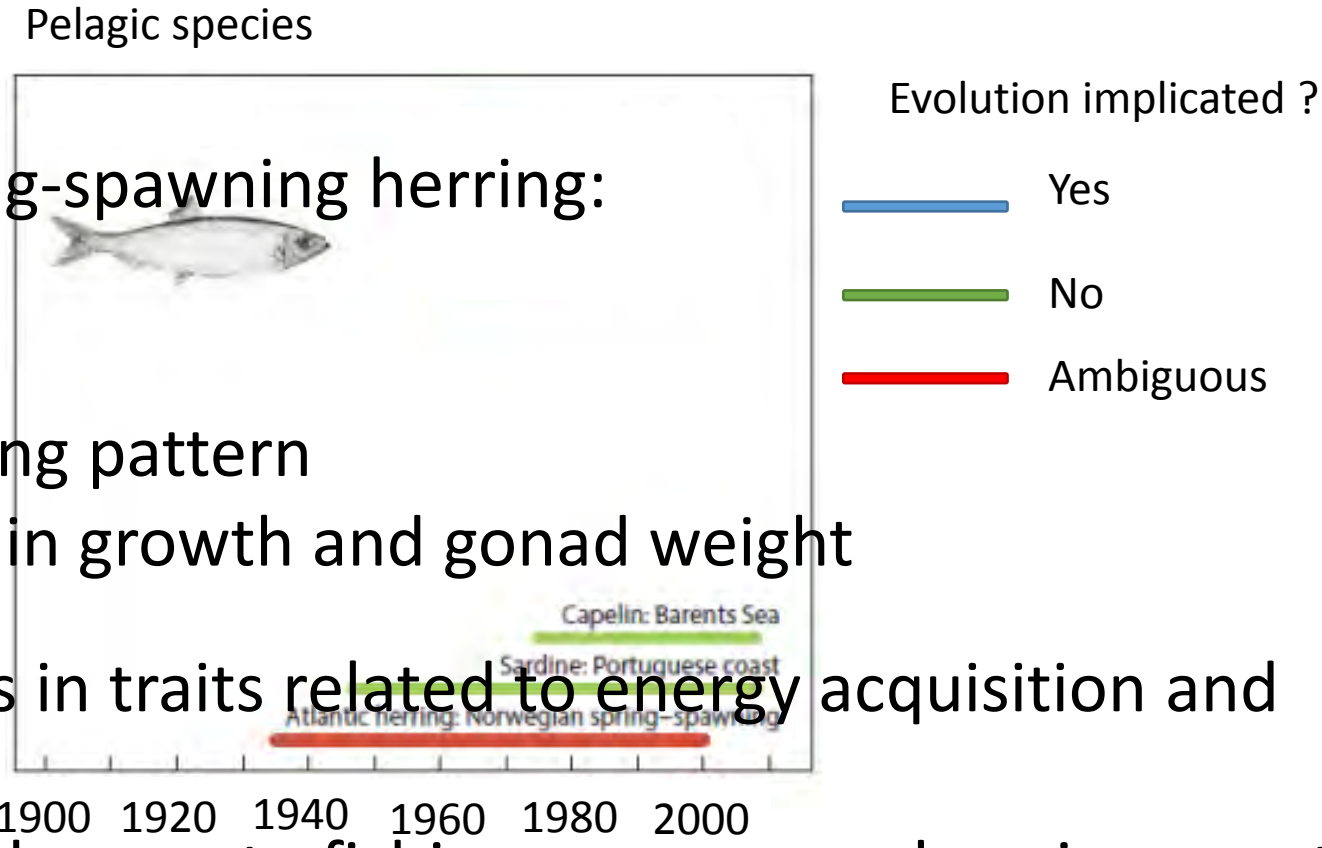


Figure: Evidence for FIE from maturation traits, Heino et al. (2015)

Material and methods : data

Original data

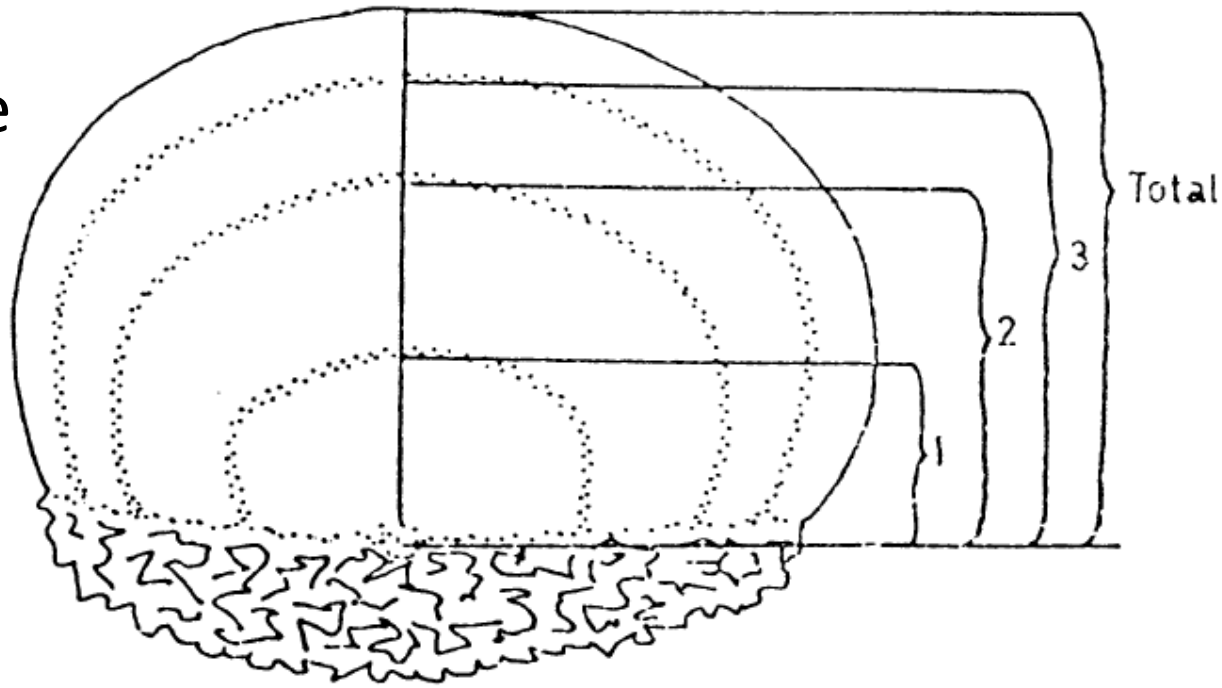
Sampled from 1935 to 2014, between October and March

Total lenght at capture

Total weight at capture

Scale measurements

Age at capture

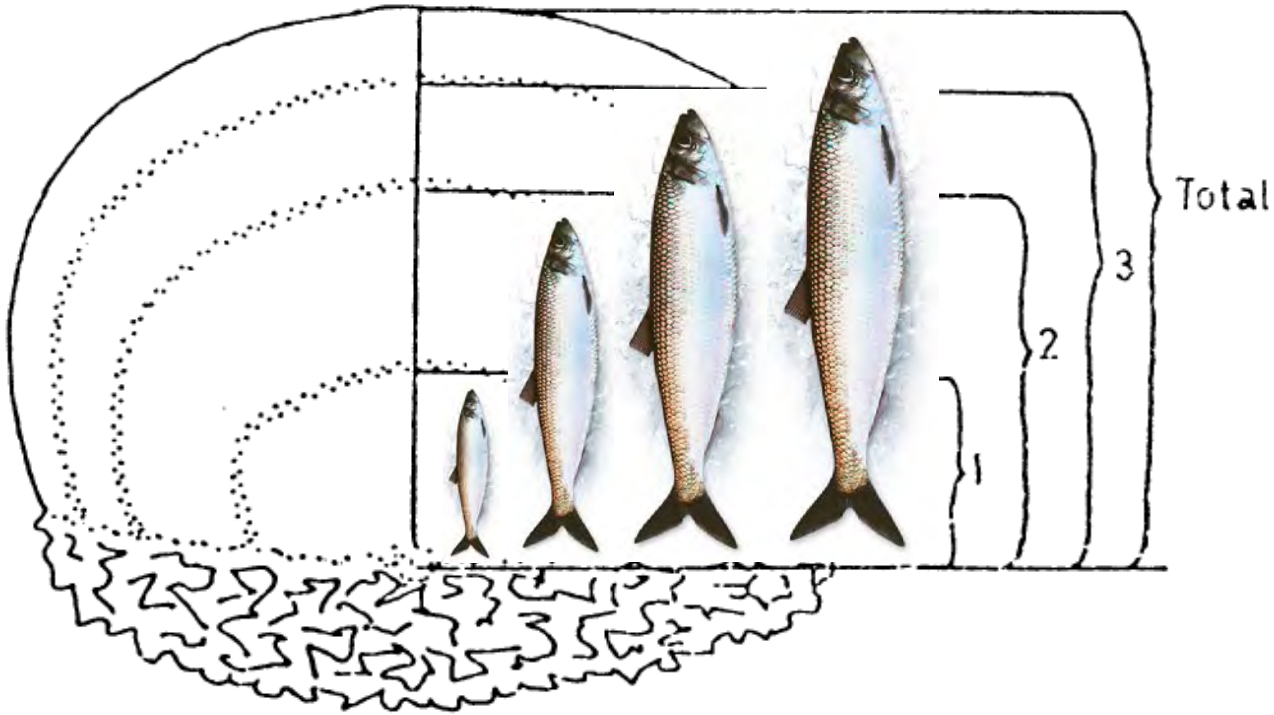


Material and methods : data

Data at age

Length-at-age up to age 9 obtained from back-calculation

Weight-at-age obtained from length-weigth relationship



Materials and methods : model

$$dW/dt = a \cdot W^{\alpha} \qquad dW/dt = a \cdot W^{\alpha} - c \cdot W$$

Materials and methods : model

$$dW/dt = \begin{cases} a \cdot W^{\alpha} & \text{for juveniles (t < tmat)} \\ a \cdot W^{\alpha} - c \cdot W & \text{for adults (t > tmat)} \end{cases}$$

Mollet et al., 2013

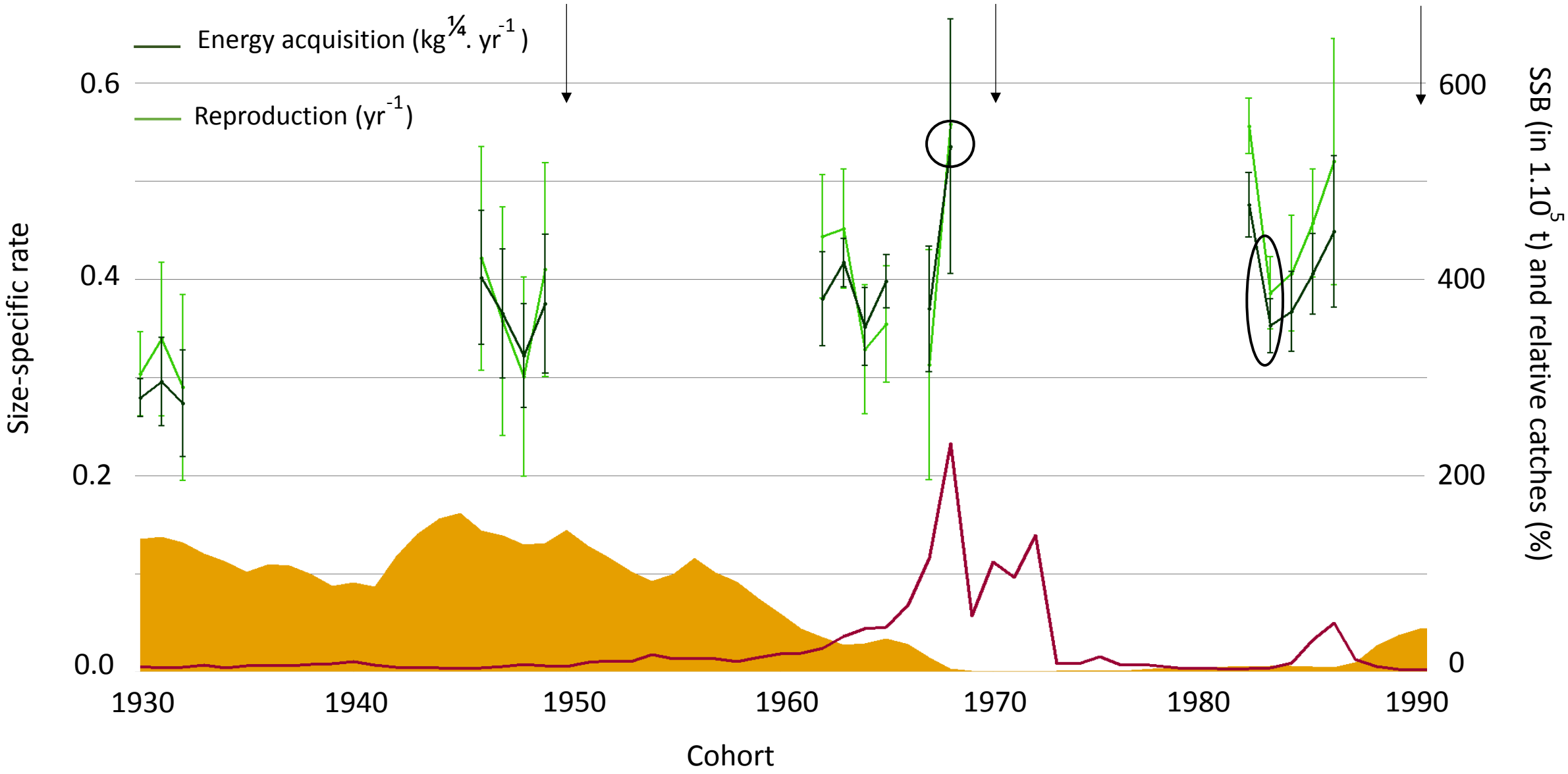
Parameters estimated:

a : rate of energy acquisition (α = ¾)

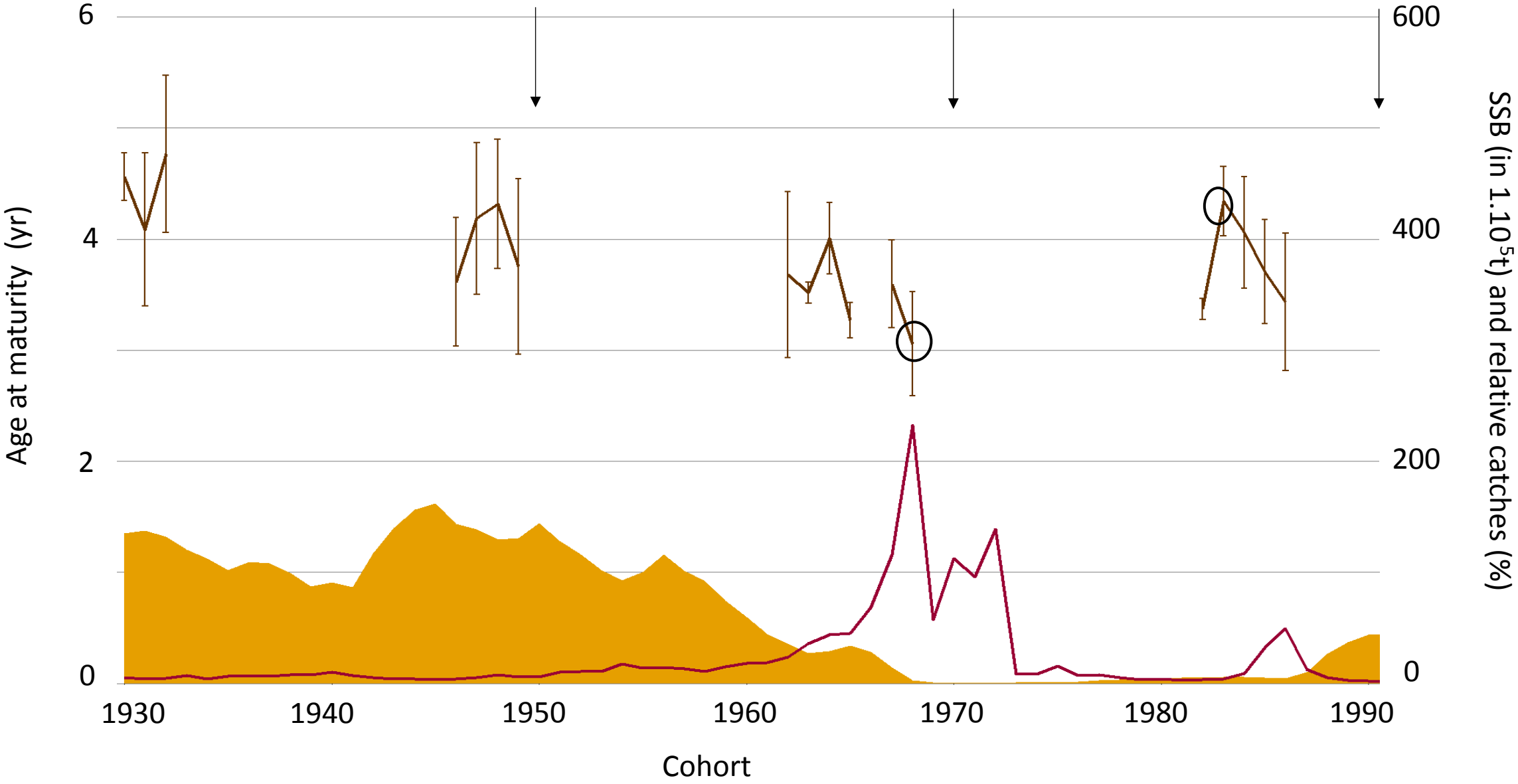
c : rate of energy allocation to reproduction (γ = 1)

tmat : age at maturity (one year before age at first spawning)

Results : parameters for each cohort



Results : parameters for each cohort



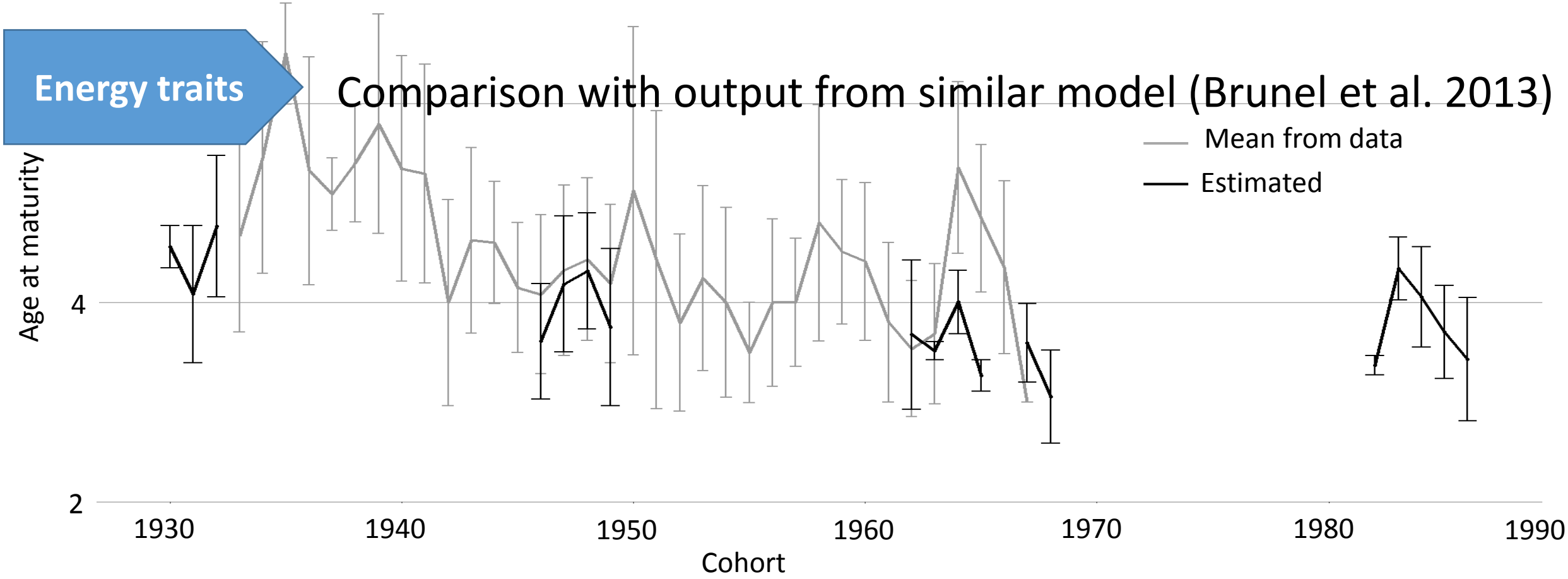
Discussion : model fit

Age at maturity

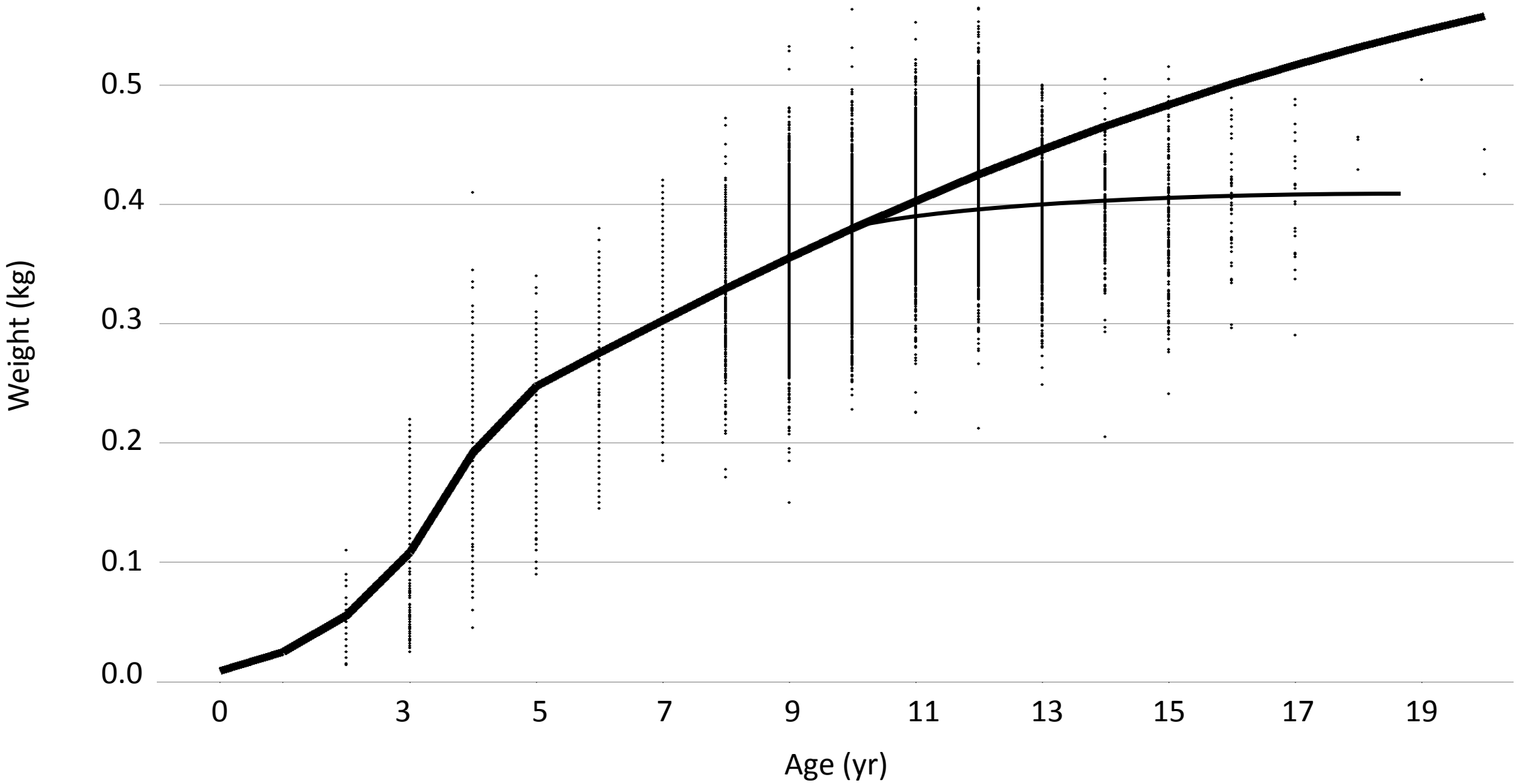
Comparison with available data

Energy traits

Comparison with output from similar model (Brunel et al. 2013)



Discussion : model misfit



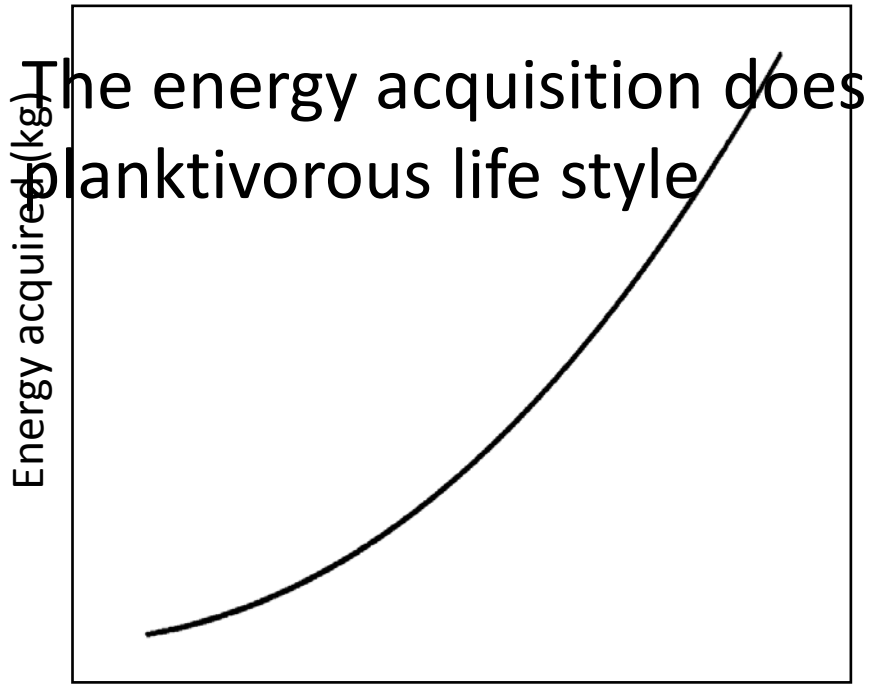
Discussion : model misfit

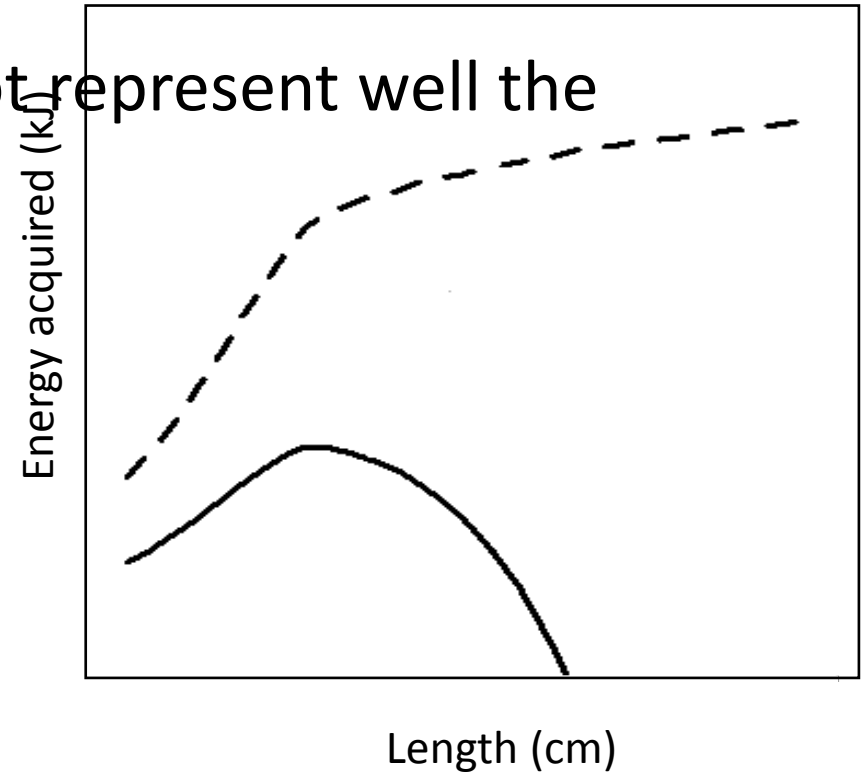
Length data

Back-calculated data available up to 9 year old
Inclusion of weight at age of capture ?

Reformulation

The energy acquisition does not represent well the planktivorous life style





Baulier (Unpublished)

Conclusion

The model

Satisfactory enough for a first overview
Still needs improvement

Points of interest

Interesting fishery pattern with herring
Correlation between traits

Next steps

Compute results for the whole time series
Analyse the trends
Improve the model to one more fit to planktivorous life style ?

Acknowledgments

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