Consideration of risk limits for fisheries management with limited data

CEP PhD symposium 2021

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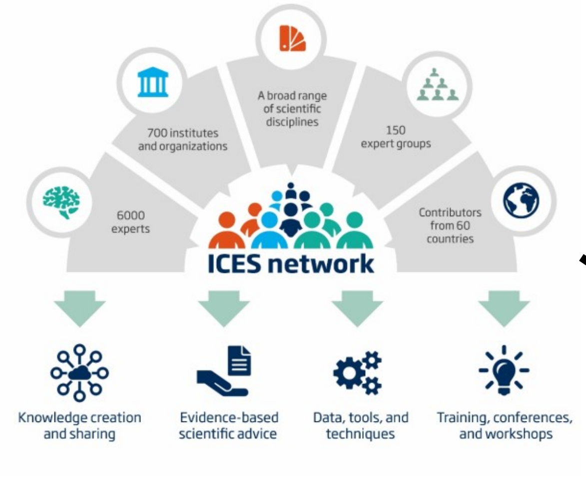
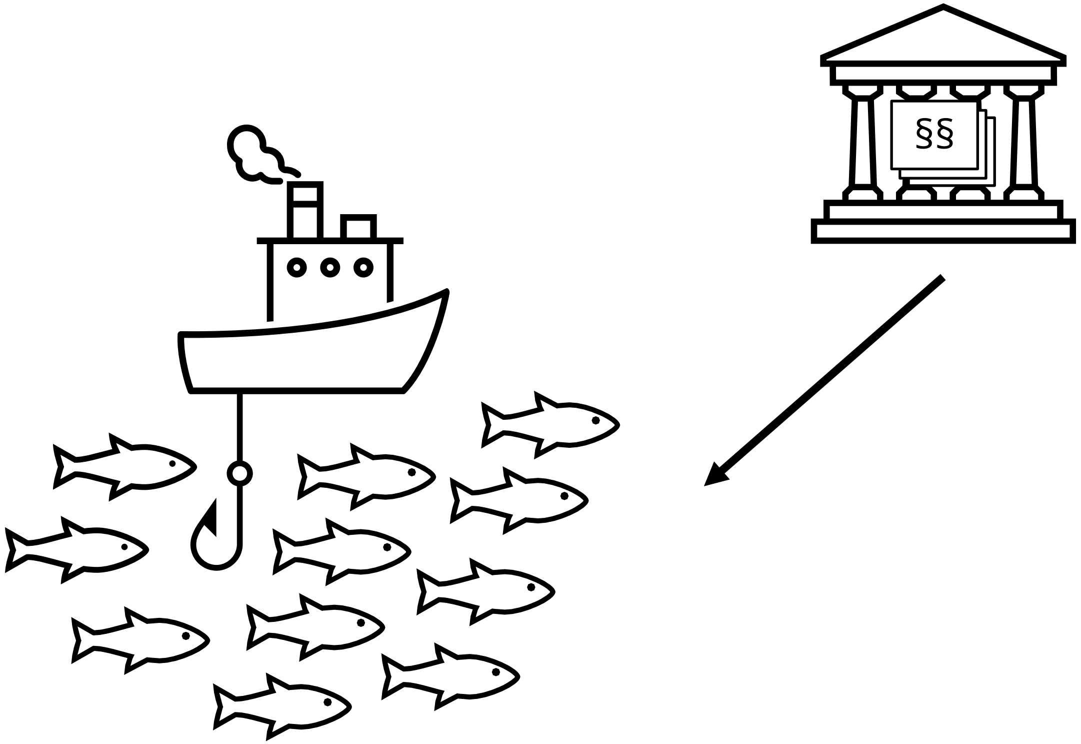
Fisheries management

- management of fisheries
- data → assessment → advice → quotas
- International Council for the Exploration of the Sea (ICES)
  - provides scientific advice to EU, UK, Norway, …
- majority of stocks data-limited
  - e.g. bycatch, less valuable species, less data, …
  - no complex assessment
- how to derive management advice?
  - model-free (empirical) control rules
  - follow trends





Data-limited control rule

- new: “rfb” rule
  - adapt catch, with:
  - r: biomass **r**atio (survey trend)
  - f: **f**ishing proxy (length data, target)
  - b: **b**iomass safeguard

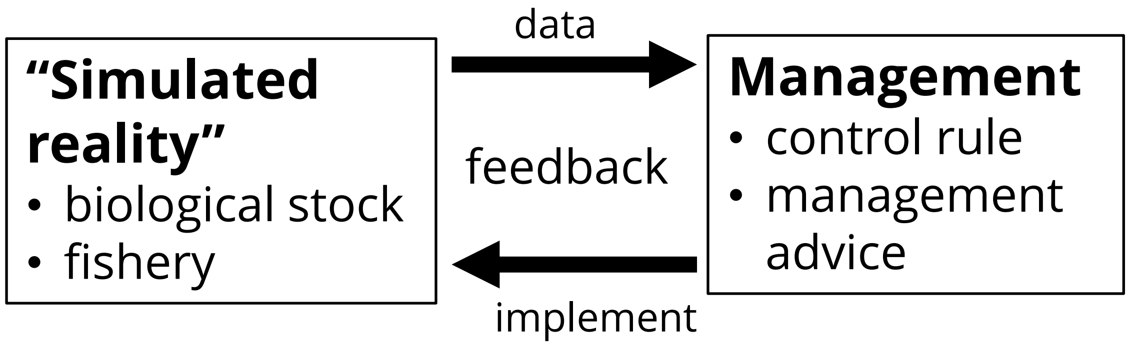
$$C_{y+1} = C_{y-1}\; r\; f\; b$$

- some more tuning parameters…

$$C_{y+v} = C_{y-1}\left(\frac{\sum_{i=y-n_0-n_1+1}^{y-n_0}(I_i/n_1)}{\sum_{i=y-n_0-n_1-n_2+1}^{y-n_0-n_1}(I_i/n_2)}\right)^{e_r}\left(\frac{\bar{L}_{y-1}}{L_{F=M}}\right)^{e_f}\left(\min\left\{1, \frac{I_{y-n_0}}{I_{\text{trigger}}}\right\}\right)^{e_b} x$$

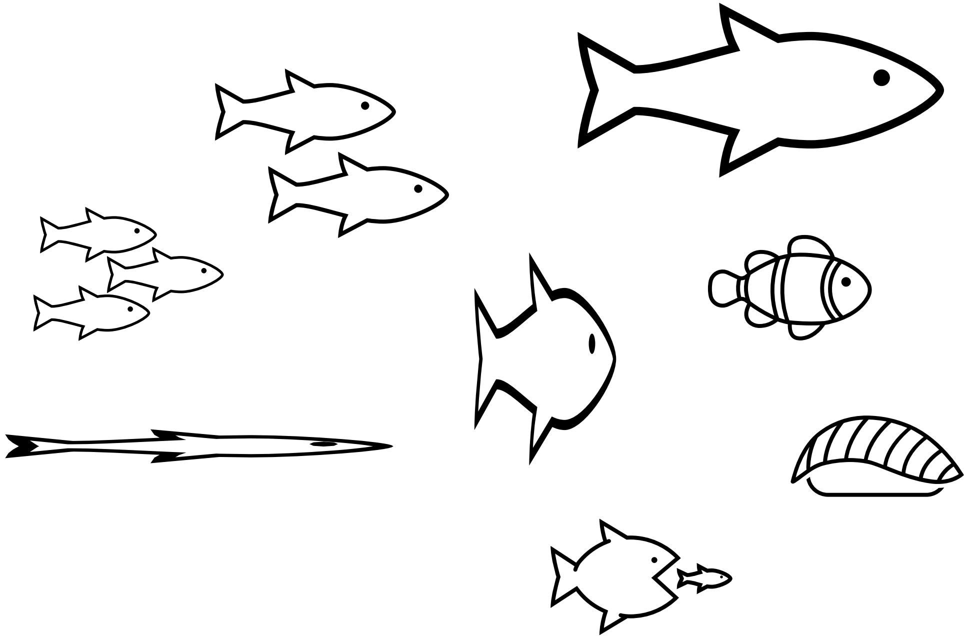
Management Strategy Evaluation

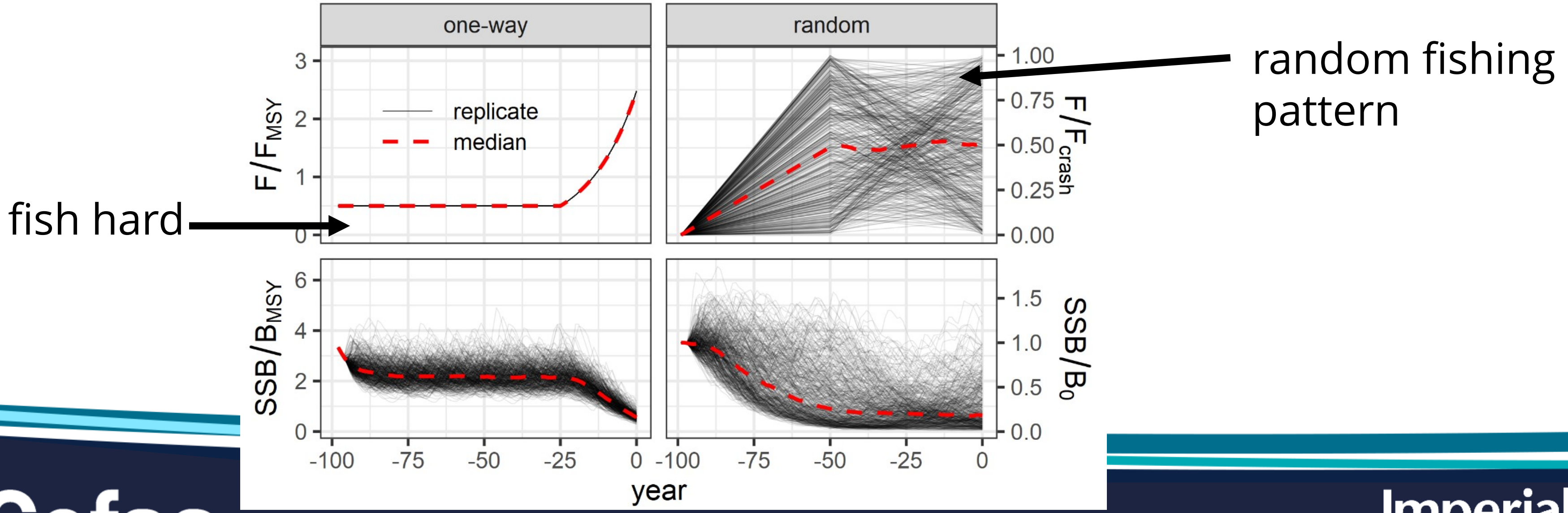
- how to test management strategies?
  - simulations
- simulate entire system
  - fish stock, fishery & management
- stochastic simulations
  - natural variability
  - uncertainty for processes, observations, etc.



Simulating fish stocks

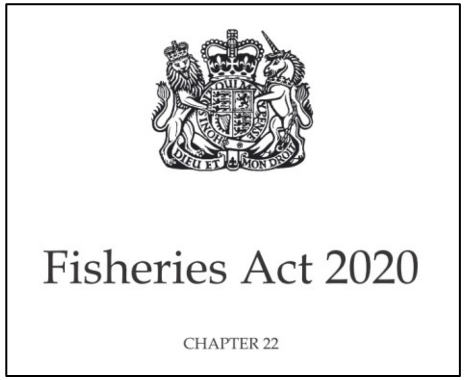
- data-limited → no population models available
- simulate based on life-history traits
  - input: life-history parameters (growth, …)
- 29 stocks, covering wide range:
  - from slow-growing and long-lived (e.g. sharks) to fast-growing short-lived (e.g. anchovy)
- artificial fishing histories





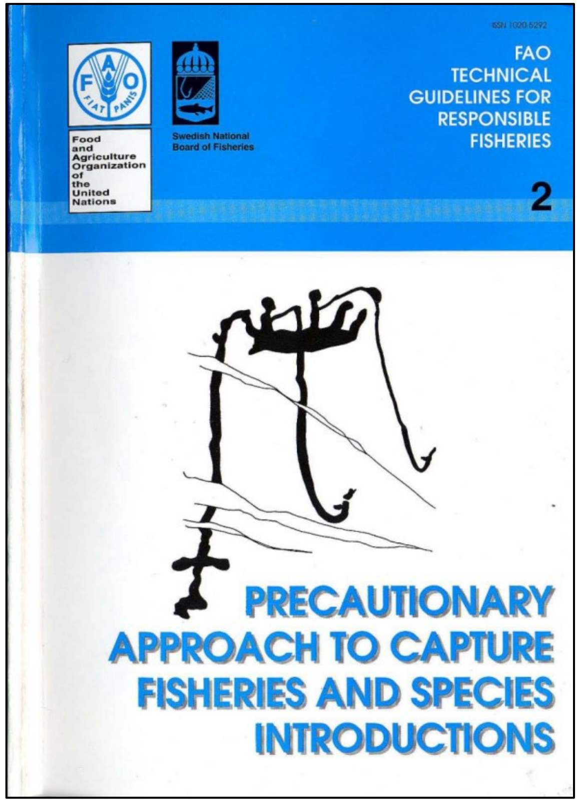
“Risk”?

- what is risk in fisheries management?
  - risk of stock falling below undesirable stock size/depletion
- precautionary approach (FAO)
  - reduce risk
- ICES: 5% risk limit
  - magic 5%
- evaluated with simulations
- risk ←→ uncertainty
  - data-limited: uncertainty uncertain


Fisheries Act 2020

CHAPTER 22

https://www.legislation.gov.uk/ukpga/2020/22/contents/enacted/data.htm



http://www.fao.org/3/w3592e/w3592e00.htm


L 354/22 EN Official Journal of the European Union 28.12.2013

REGULATION (EU) No 1380/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

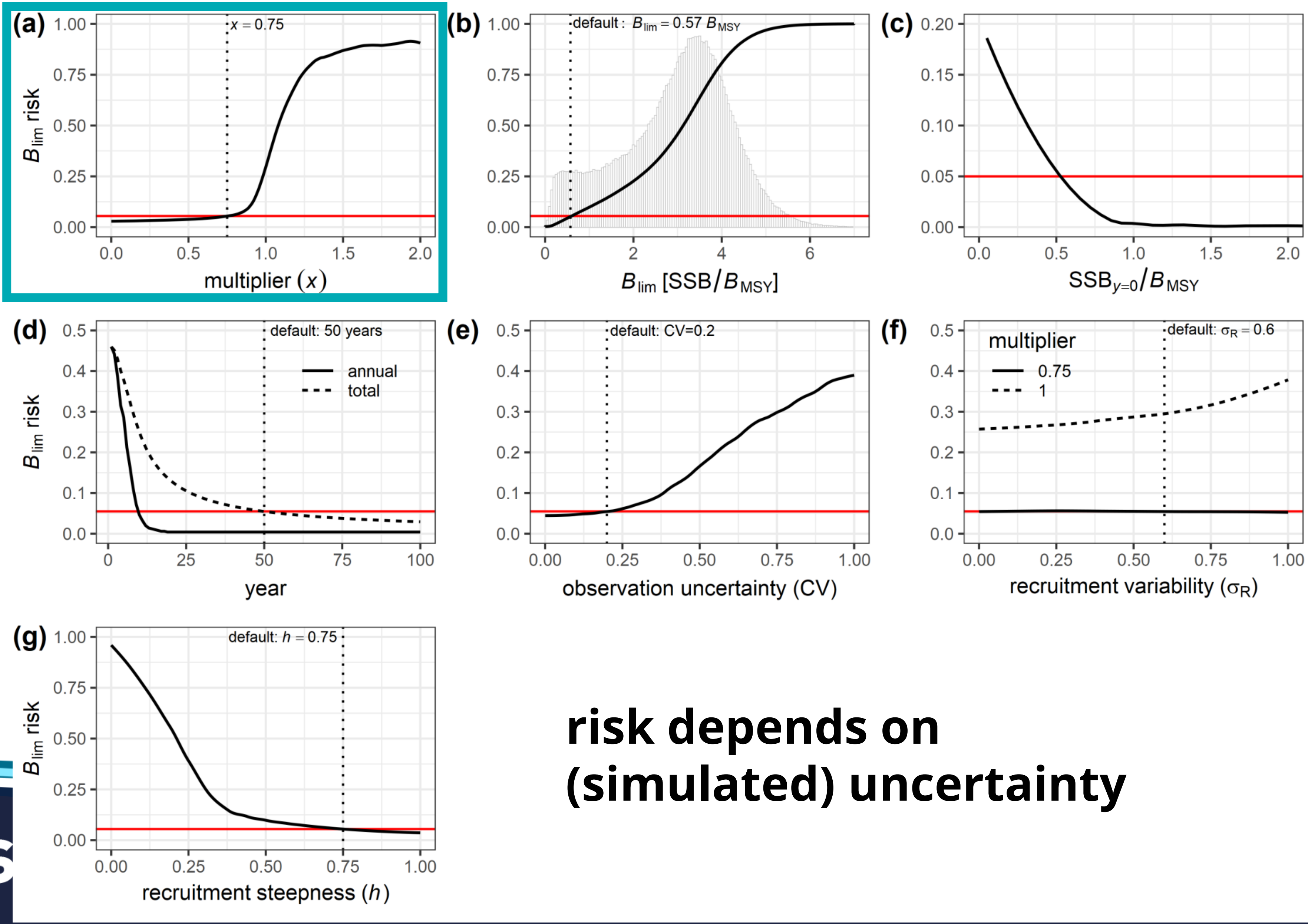
of 11 December 2013

on the Common Fisheries Policy, amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC

http://data.europa.eu/eli/reg/2013/1380/oj

Risk sensitivity

a. example: management with 5% risk
b. definition of undesirable stock size
c. starting condition of simulation
d. length of simulation
e. uncertainty of observed data
f. variability in number of young fish
g. recruitment at low stock size



risk depends on (simulated) uncertainty

Optimisation: genetic algorithm

- genetic algorithm for optimisation
- used in many scientific fields
- on top of management strategy evaluation
- management strategy (parameters) “evolve”
- fitness function defines objectives
  - stock size, catch, risk, variability

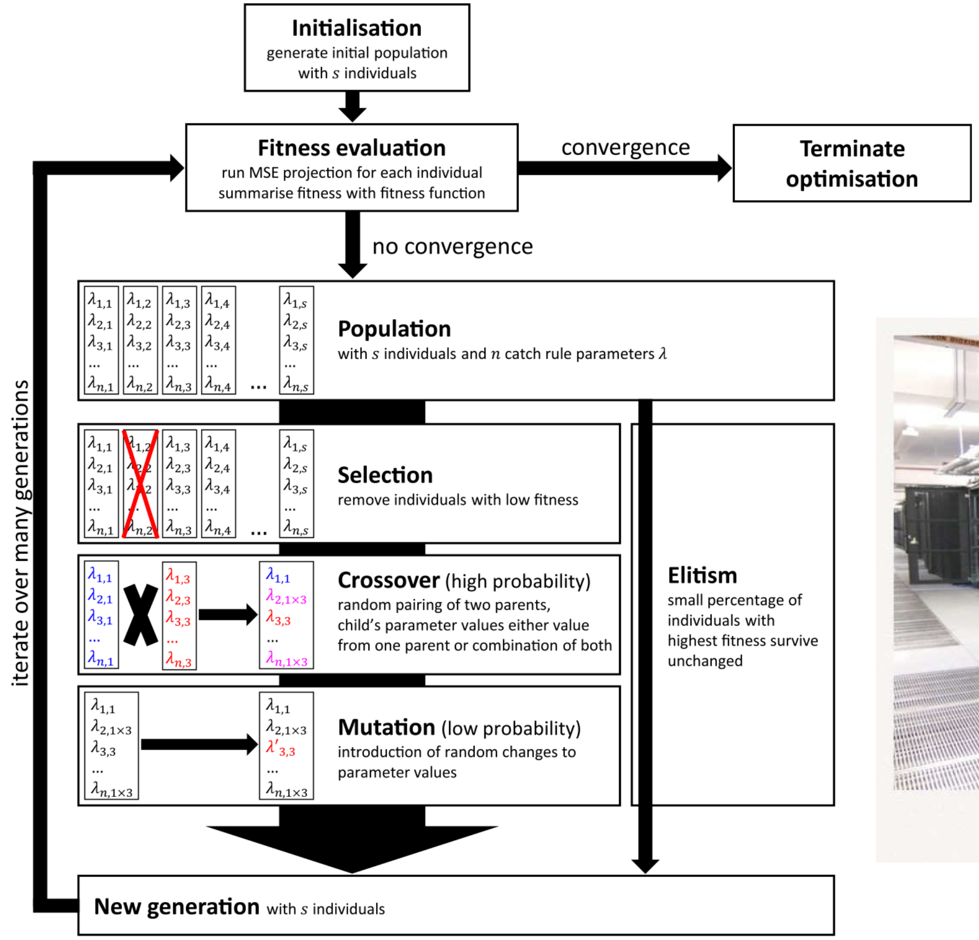
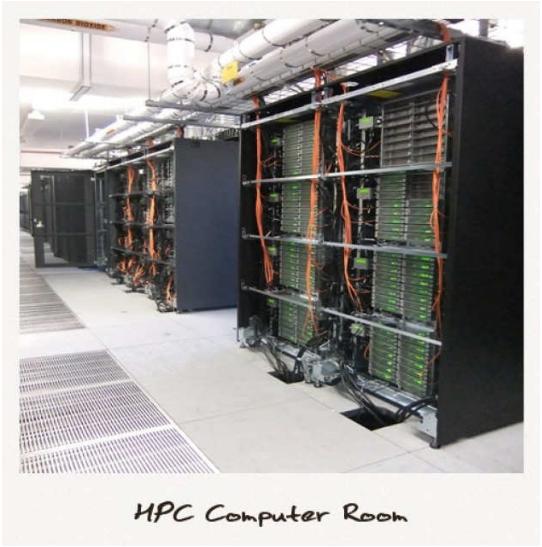
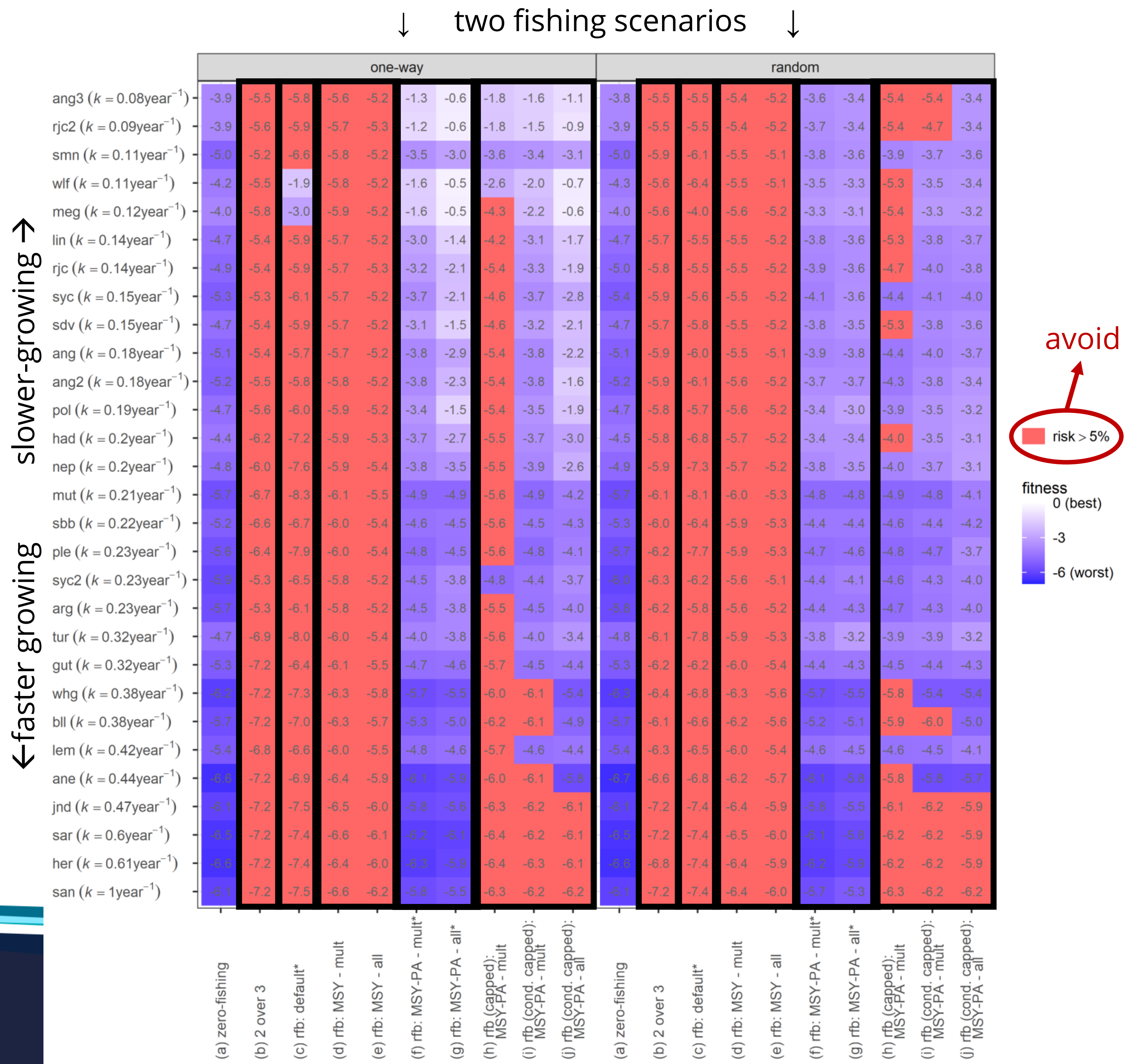


Figure 1. Conceptual representation of the genetic algorithm as an optimization procedure for a management procedure.



Optimisation

- 29 stock simulated
- current management strategy not precautionary!
- new rfb rule
    - default: non-precautionary
    - but can be optimised
    - optimisation without risk limit → higher catch
    - optimisation with risk limit → lower catch
    - catch stability possible



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Impact (I)

- Part of ICES workshop on data-limited methods (“WKLIFE”)
  - annual meeting
- Publications
  - Fischer et al. (2020) https://doi.org/10.1093/icesjms/fsaa054
    - initial simulation testing of rfb-rule
    - performance linked to life-history
  - Fischer et al. (2021) https://doi.org/10.1093/icesjms/fsab018
    - application of genetic algorithm
    - improve performance
  - Fischer et al. (in revision)
    - risk considerations

TENTH WORKSHOP ON THE DEVELOPMENT OF QUANTITATIVE ASSESSMENT METHODOLOGIES BASED ON LIFE-HISTORY TRAITS, EXPLOITATION CHARACTERISTICS, AND OTHER RELEVANT PARAMETERS FOR DATA-LIMITED STOCKS (WKLIFE X)

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RAPPORTS SCIENTIFIQUES DU CIEM

ICES Journal of Marine Science

ICES Journal of Marine Science (2020), 77(5), 1914–1926. doi:10.1093/icesjms/fsaa054

Original Article

Linking the performance of a data-limited empirical catch rule to life-history traits

Simon H. Fischer [1,2]*, José A. A. De Oliveira[1], and Laurence T. Kell[2]

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ICES Journal of Marine Science

ICES Journal of Marine Science (2021), doi:10.1093/icesjms/fsab018

Using a genetic algorithm to optimize a data-limited catch rule

Simon H. Fischer [1,2]*, José A. A. De Oliveira[1], John D. Mumford[2], and Laurence T. Kell [2]

Manuscripts submitted to ICES Journal of Marine Science

Application of explicit precautionary principles in data-limited fisheries management

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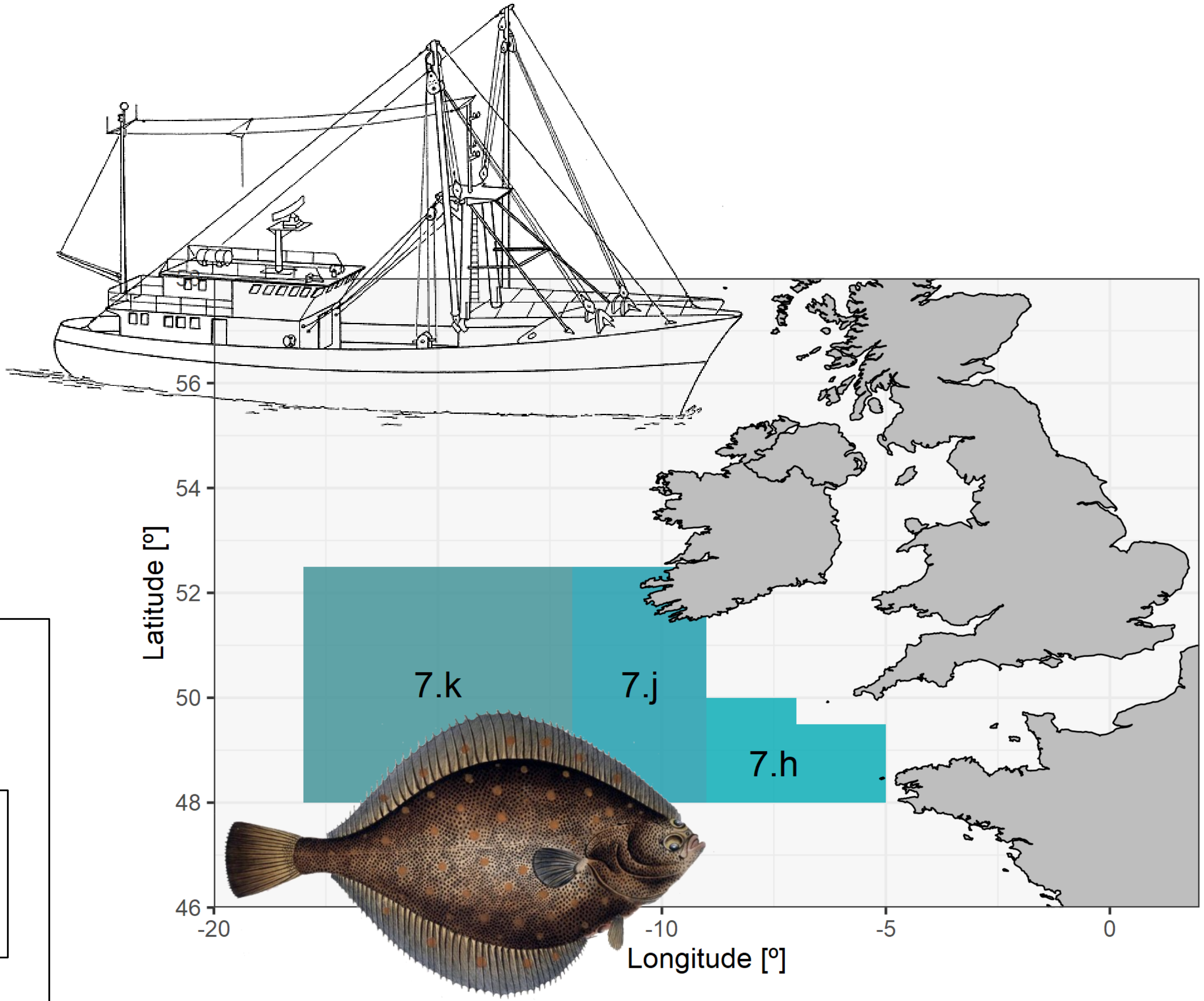
Impact (II): Policy

- ICES provides advice
- guidelines are being revised
- rfb rule applied to first stock in 2021 (plaice in division 7.h-k)
    - catch advice for 2022
    - more to follow next year



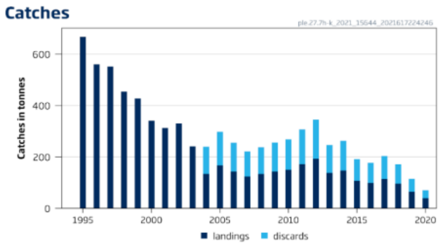
https://doi.org/10.17895/ices.advice.7824

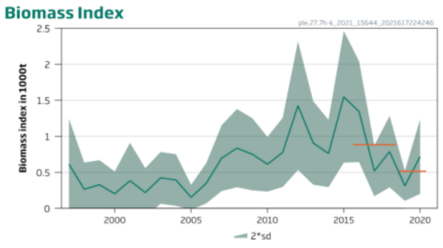
Published 30 June 2021

ICES CIEM

Plaice (*Pleuronectes platessa*) in divisions 7.h–k (Celtic Sea South, southwest of Ireland)

ICES advises that when the MSY approach is applied, catches in 2022 should be no more than 114 tonnes.





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Thank you for listening

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