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– PESCA SUSTENTÁVEL –
SARDINHA·2030

Marine Stewardship Council

MAR 2030

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Cofinanciado pela União Europeia

Incorporating time-varying natural mortality into MSE framework for the EBFM of the Iberian Sardine

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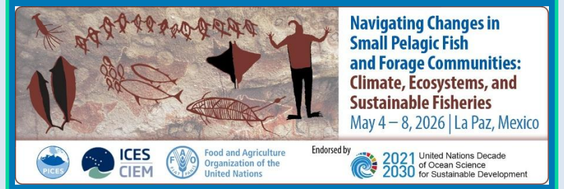
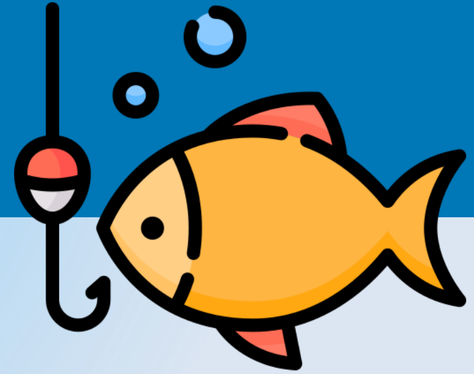
Supervisors: José Costa · Dorota Szalaj · Maria Torres
Collaborators: Laura Wise · Xavier Corrales · Susana Garrido · Alexandra A. Silva

ICES/PICES/FAO SPF and Forage Fish Symposium, La Paz, Mexico, May 2026



Overview



01 Introduction & Context

02 Objective

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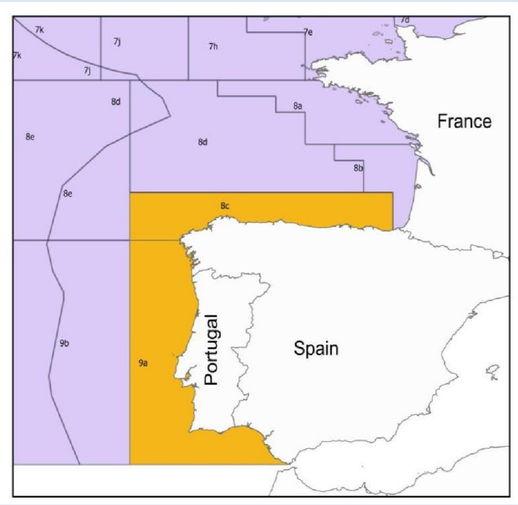
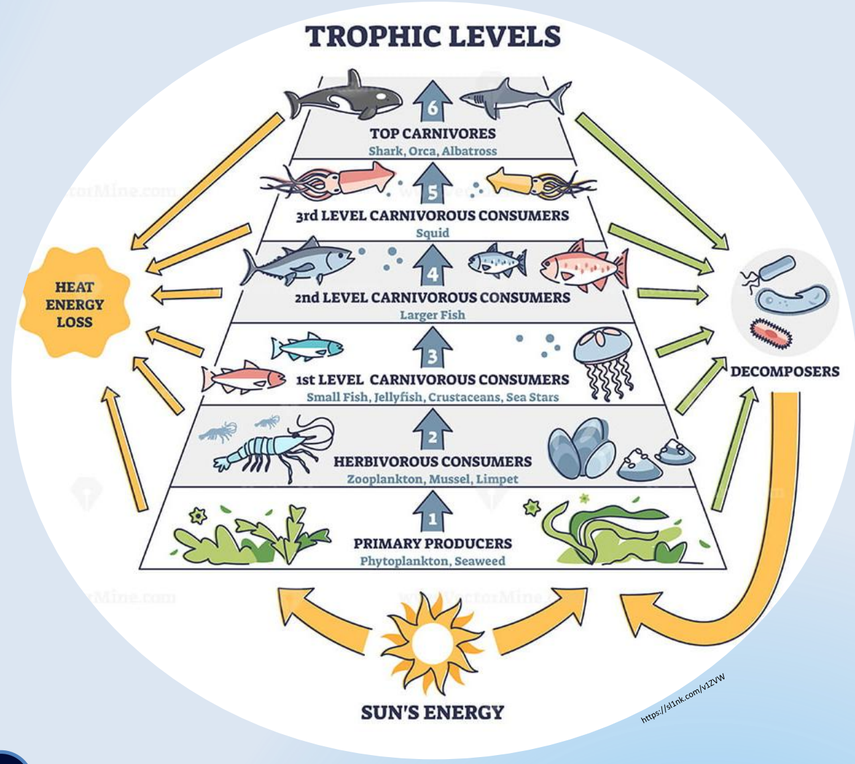
Introduction & Context

Iberian sardine (*Sardina pilchardus*) is a key low-trophic level species in the NE Atlantic and supports large fisheries in Portugal & Spain

Under Marine Stewardship Council (MSC) certification since July 2025



Management must account for ecological interactions & ecosystem variability



Objective 🎯

Integrate ecosystem-derived information into a MSE framework to test the robustness of harvest strategies for the sustainable management of the Iberian sardine fishery

Methods

Natural Mortality (M): Initial M estimates calculated from empirical equations: Gislason (2010) & Charnov (2013)

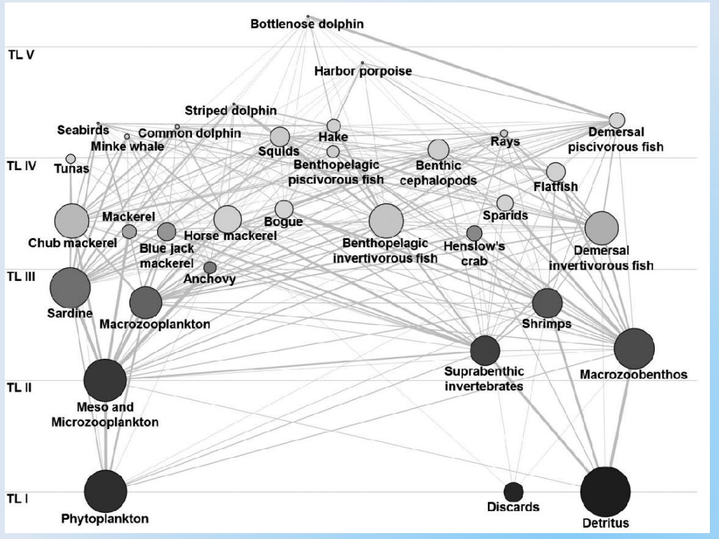
- Gislason M
- Charnov M
- 0.7*Gislason M
- M currently in use (SS3 original – time constant & age variant)

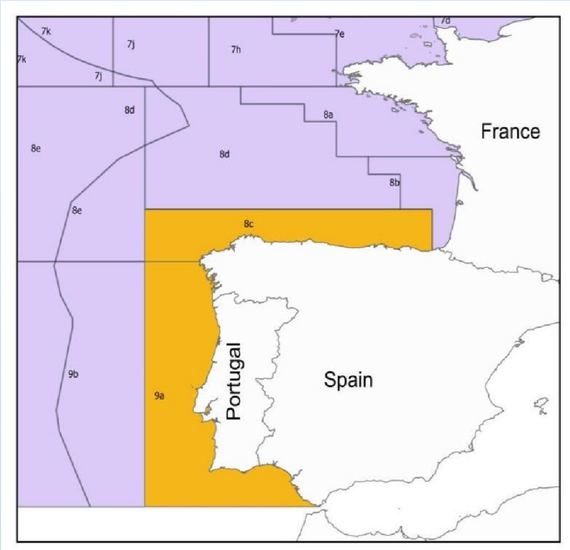
Methods

Natural Mortality (M): Initial M estimates calculated from empirical equations: Gislason (2010) & Charnov (2013)

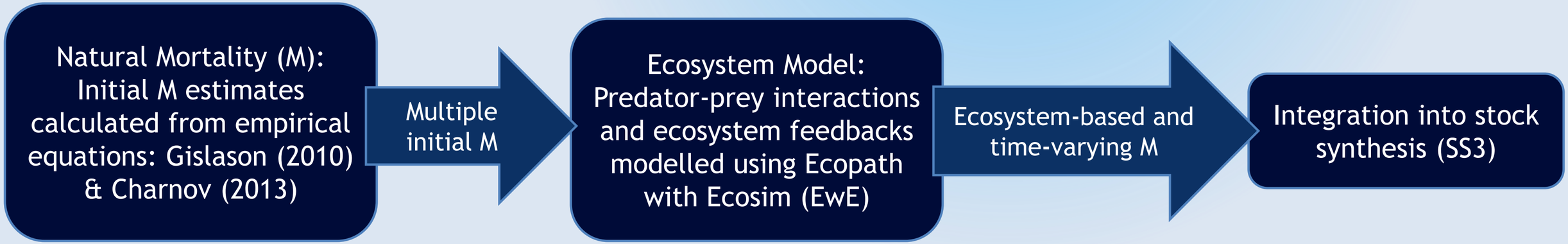
Multiple initial M

Ecosystem Model: Predator-prey interactions and ecosystem feedbacks modelled using Ecopath with Ecosim (EwE)





Methods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Multiple initial M
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Ecosystem-based and time-varying M
Integration into stock synthesis (SS3)

Methods

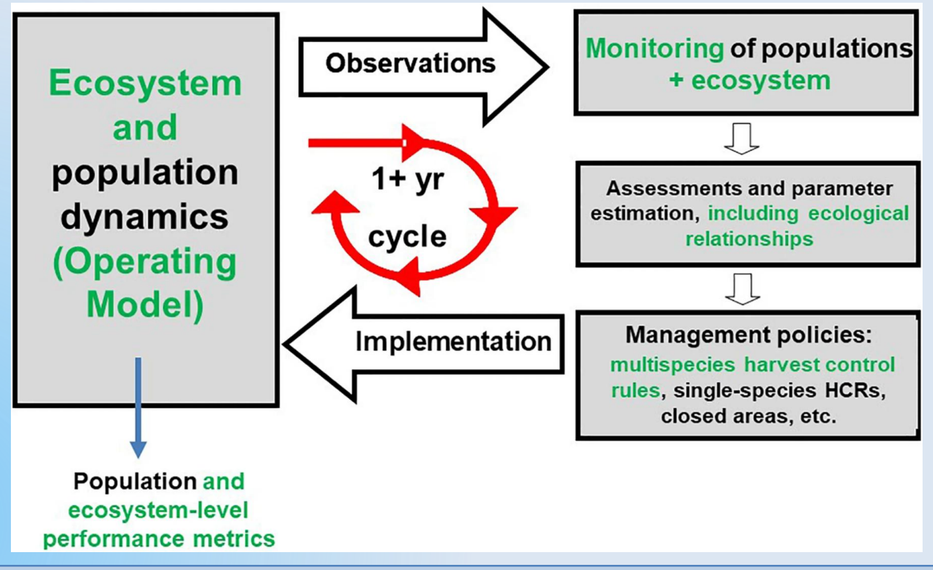
Natural Mortality (M): Initial M estimates calculated from empirical equations: Gislason (2010) & Charnov (2013)

Multiple initial M

Ecosystem Model: Predator-prey interactions and ecosystem feedbacks modelled using Ecopath with Ecosim (EwE)

Ecosystem-based and time-varying M

Integration into stock synthesis (SS3)

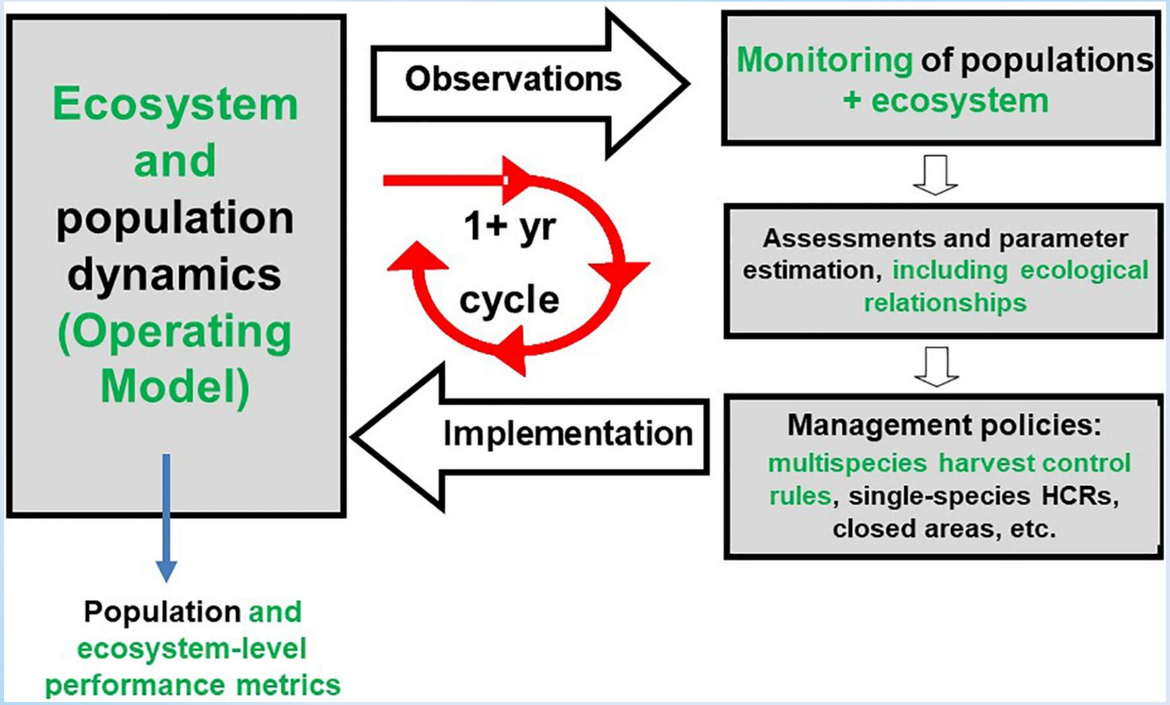


Integration of ecosystem-based stock information into MSE framework in R (**WGHANSA2024**)

Methods

64
Scenarios

1000
iterations &
50 years
projections



Methods

64 Scenarios

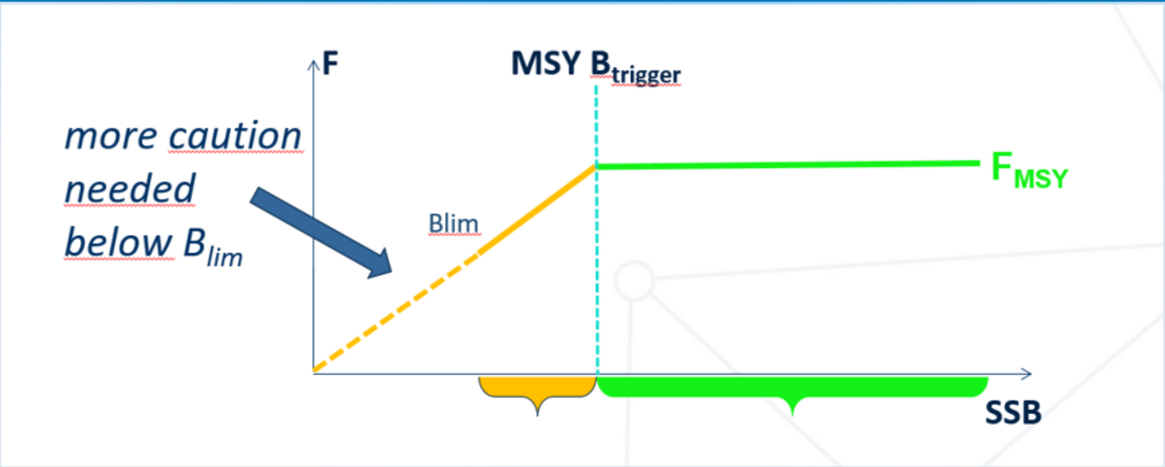
1000 iterations & 50 years projections

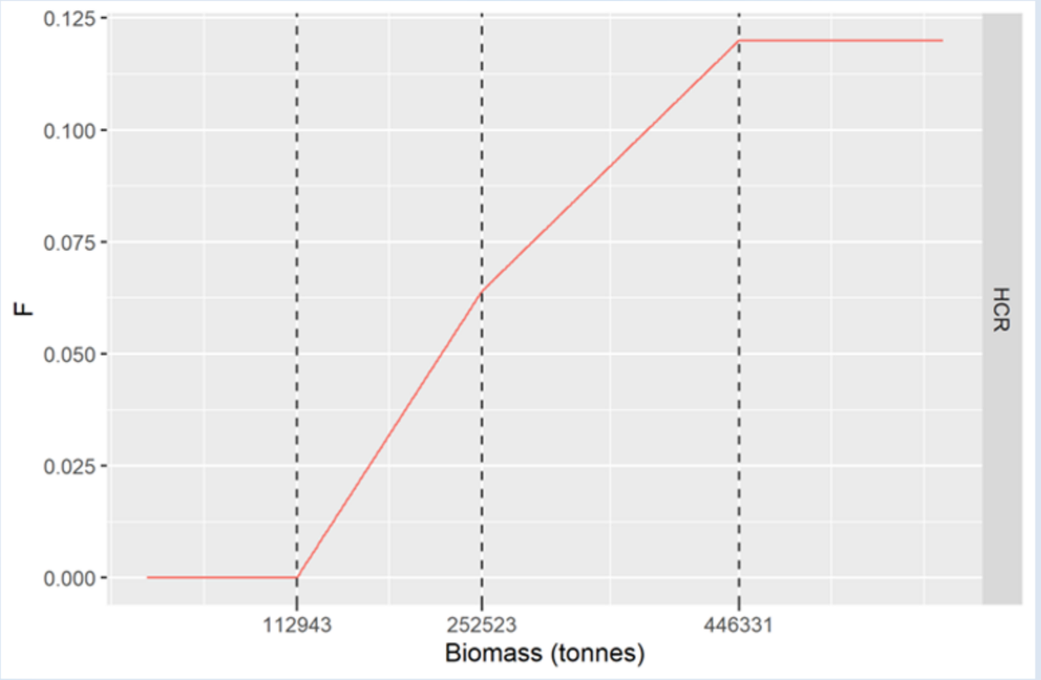
Assessment

- None

HCR

- ICES Advice Rule (ICES)
- No Fishing (No F)
- Current + 50,000t cap (50,000)
- Current + No cap (No cap)





Methods

64 Scenarios

1000 iterations & 50 years projections

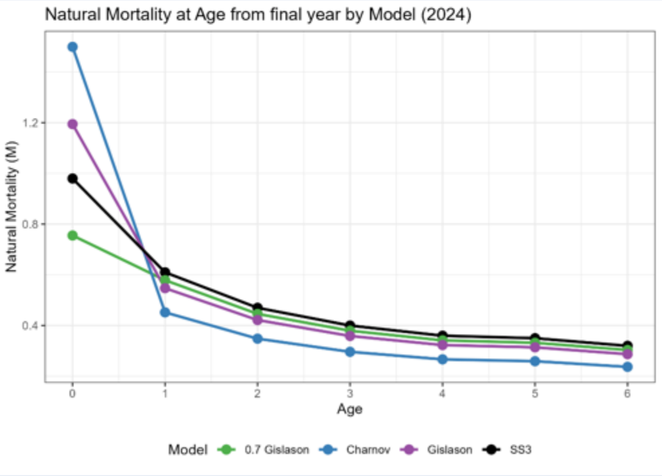
Assessment
- None

HCR
- ICES Advice Rule (ICES)
- No Fishing (No F)
- Current + 50,000t cap (50,000)
- Current + No cap (No cap)

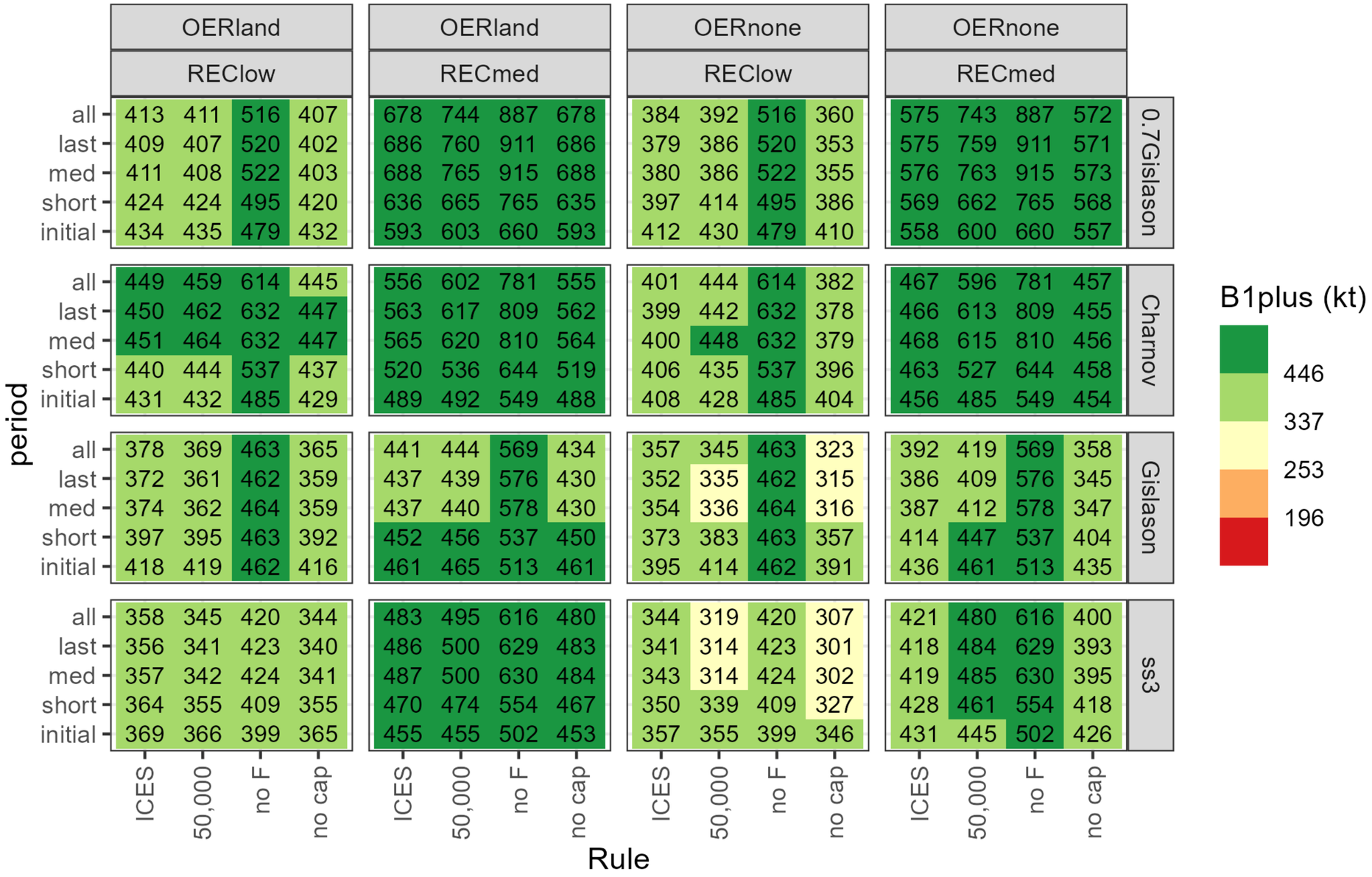
Recruitment
- Low
- Medium

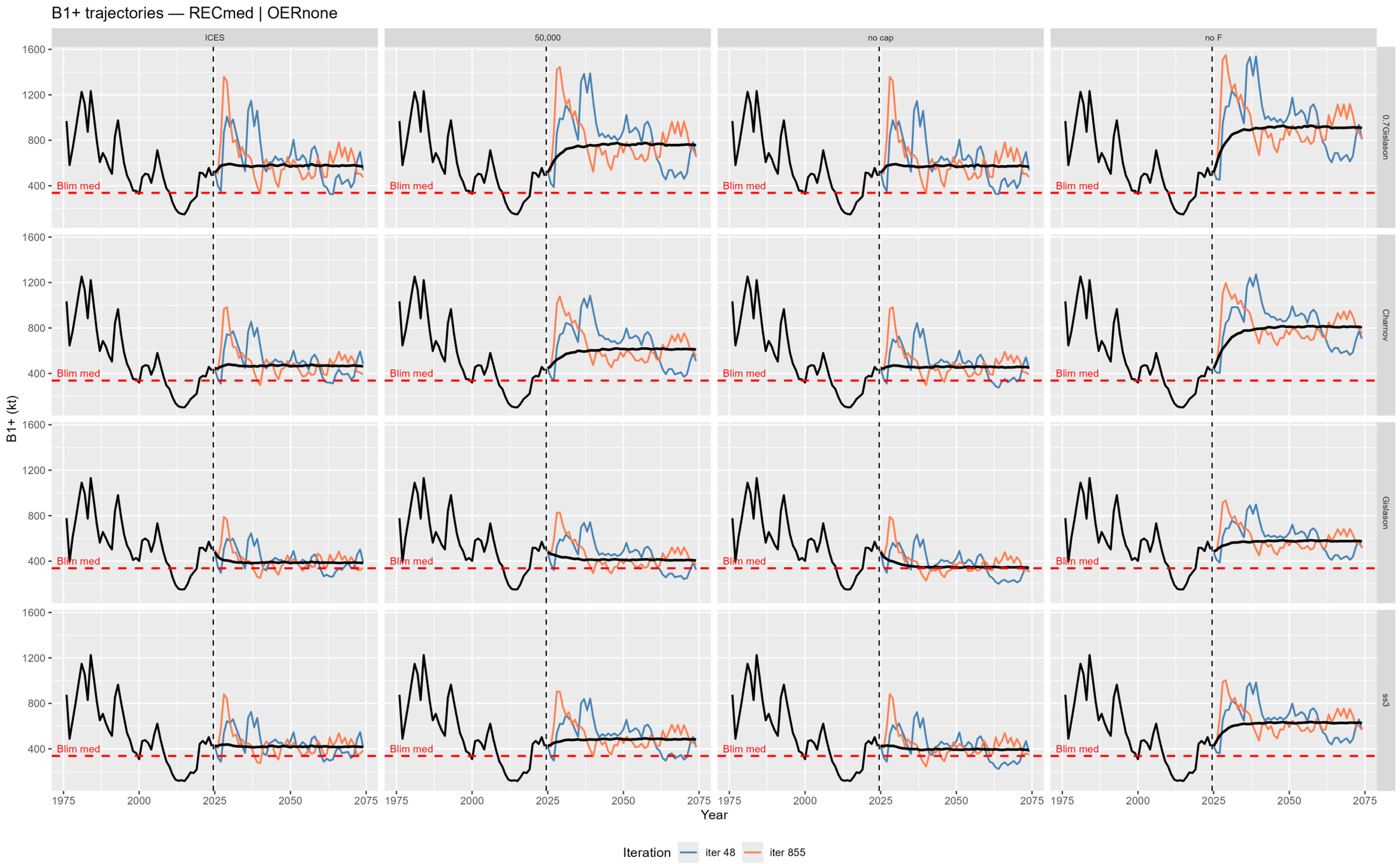
Implementation/ Observation errors
- None (OERnone)
- Landings (OERland - multiplicative lognormal errors in catch n-at-age and stock n-at-age)

Mortality (M)
- SS3 (currently in use - time constant)
- Gislason (time-varying)
- 0.7*Gislason (time-varying)
- Charnov (time-varying)



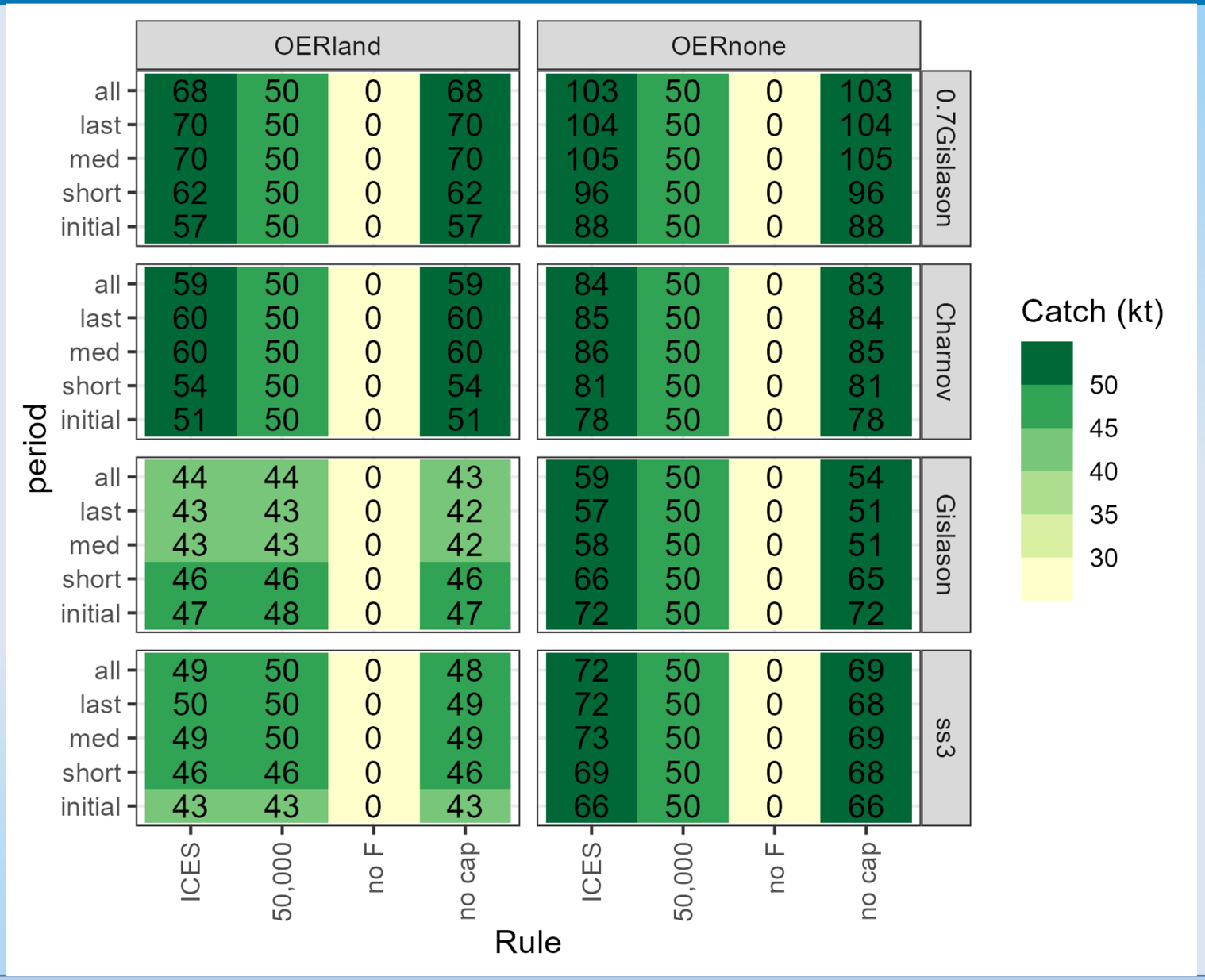
Results


OERland
RECmed
OERnone
RECmed
0.7Gislason
Charnov
Gislason
ss3
period
all
last
med
short
initial
ICES
50,000
no F
no cap
Rule
B1plus (kt)
446
337
253
196


B1+ trajectories — RECmed | OERnone
ICES
50,000
no cap
no F
0.7Gislason
Charnov
Gislason
ss3
B1+ (kt)
Blim med
1600
1200
800
400
1975
2000
2025
2050
2075
Year
Iteration
iter 48
iter 855

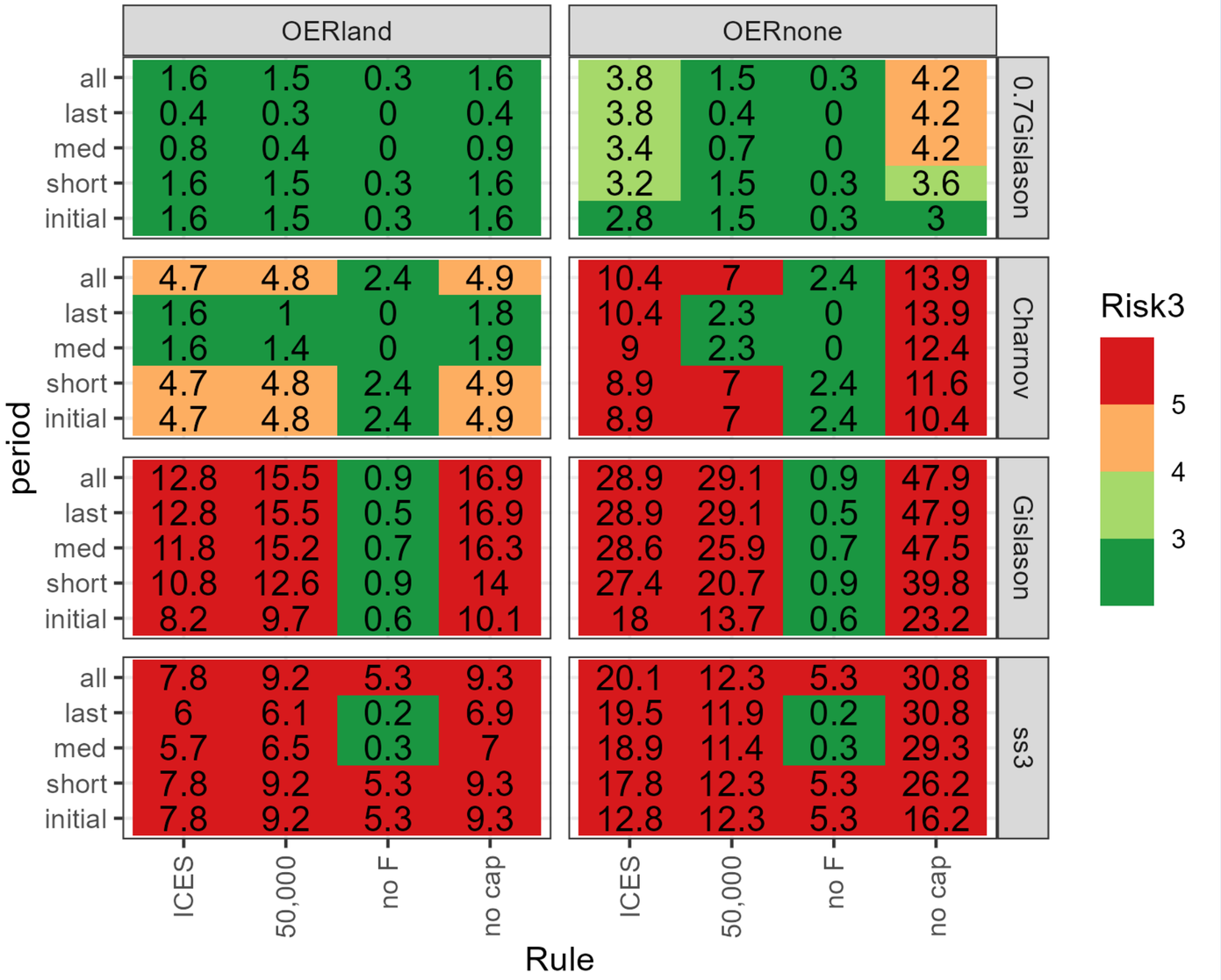
Results

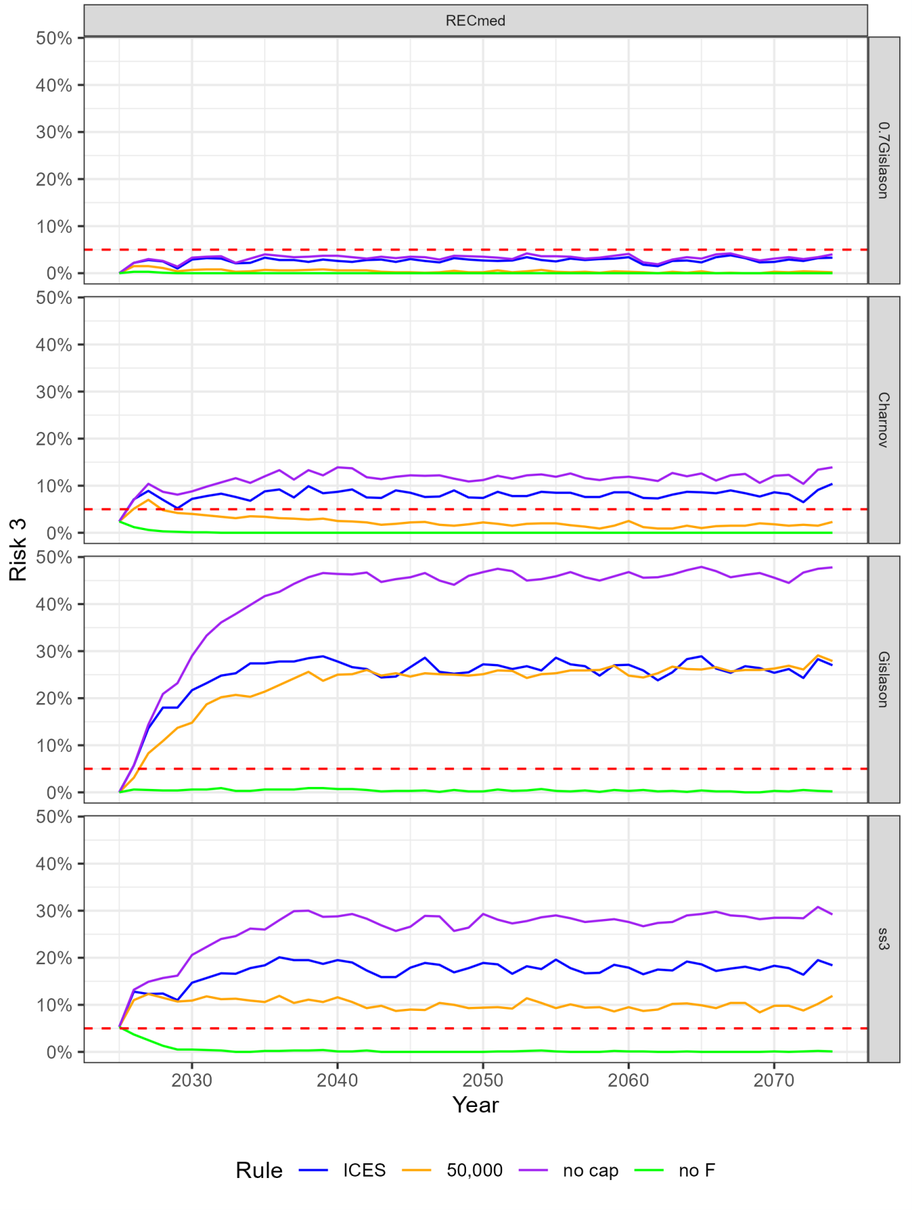
Medium productivity regime



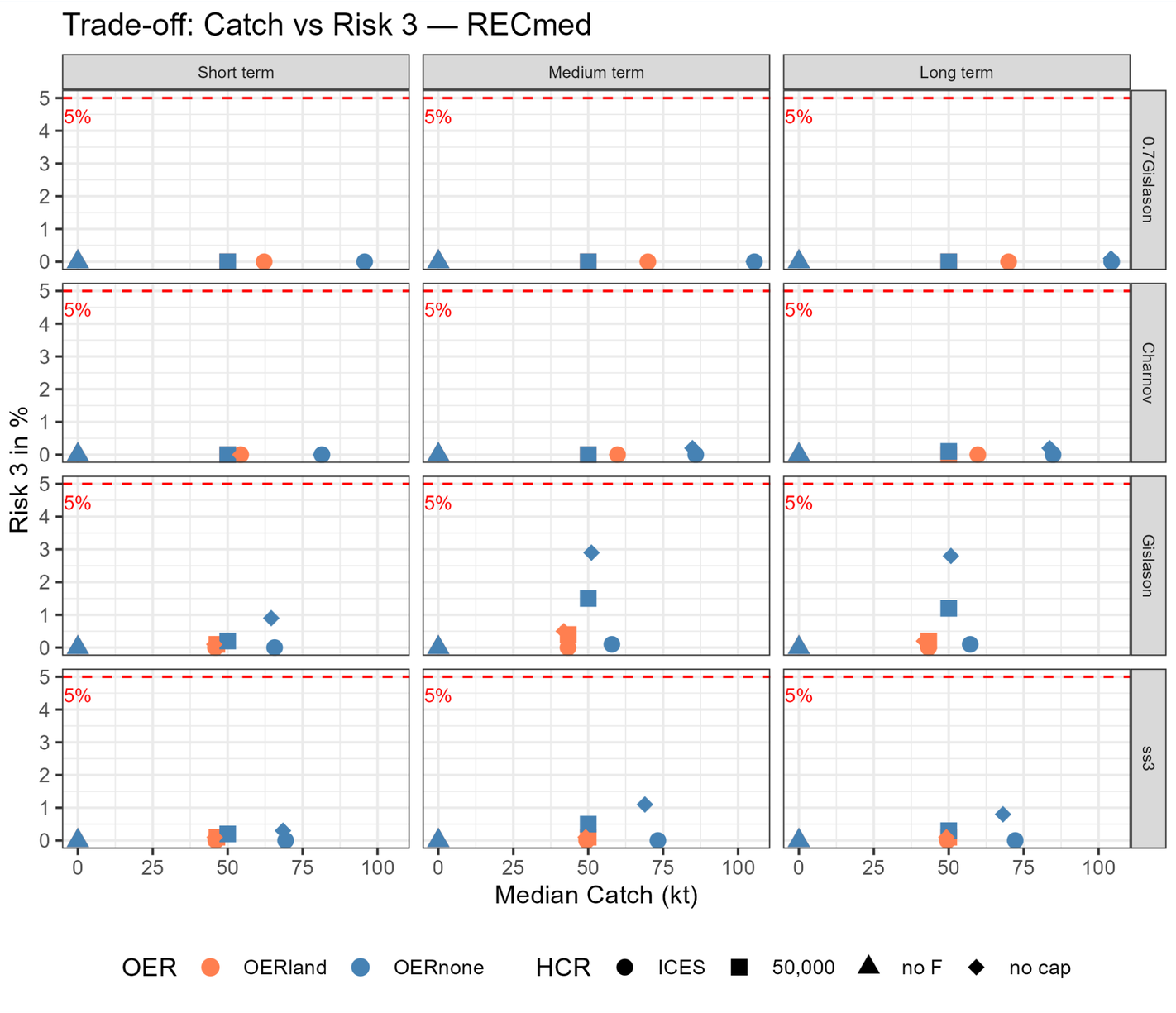
Results

Medium productivity regime

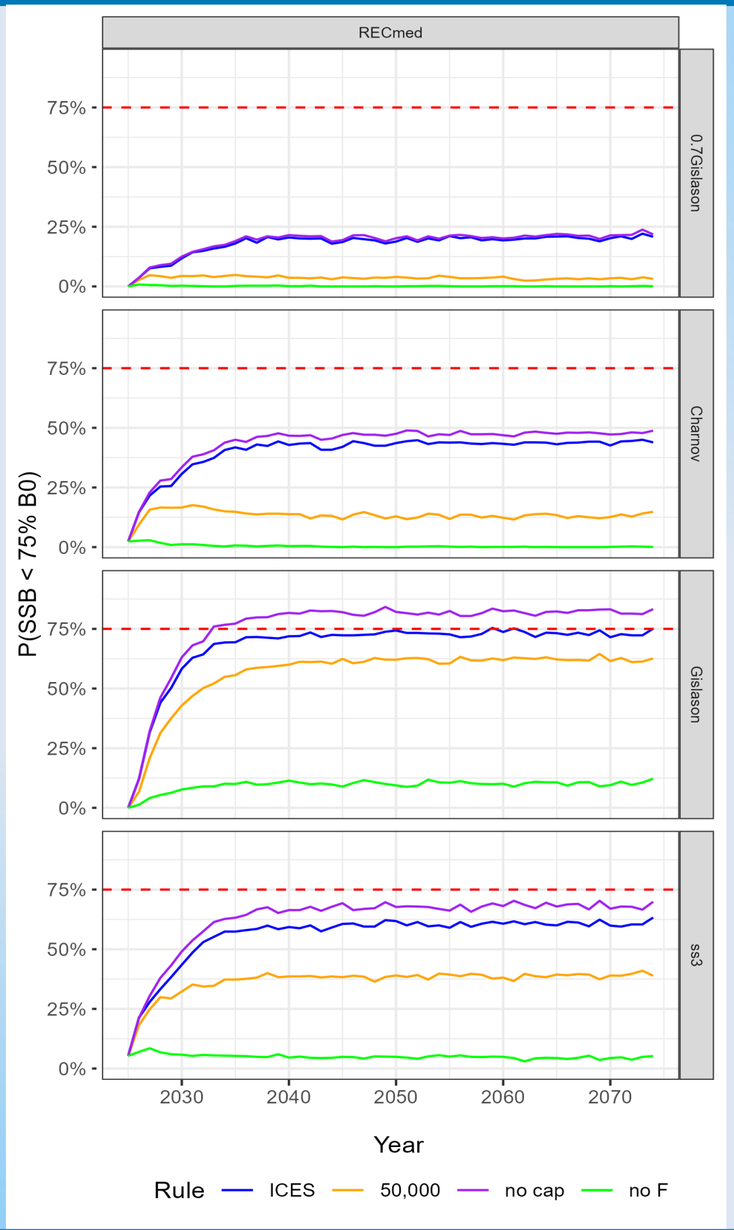




Results


Trade-off: Catch vs Risk 3 — RECmed
Short term
Medium term
Long term
0.7Gislason
Charnov
Gislason
ss3
5%
Risk 3 in %
Median Catch (kt)
0
25
50
75
100
OER
OERland
OERnone
HCR
ICES
50,000
no F
no cap

Results


RECmed
0.7Gislason
Charnov
Gislason
ss3
75%
50%
25%
0%
P(SSB < 75% B0)
2030
2040
2050
2060
2070
Year
Rule
ICES
50,000
no cap
no F

Important take aways

M scenarios (mostly at age 0) influence stock's biomass along HCR and time → importance of recruits

B1+: No F > 50,000 > ICES > No cap
Trade-off with risk3, catch, 75%B0: 50,000 > ICES > No F/No cap

50,000t cap provides the best catch-risk trade-off

Future work

Refine and update EwE parameterisation with updated diet, stanzas and biomass data and for all the stock's distribution

Expand uncertainty scenarios & add yearly assessment into MSE

Test our framework under climate-driven ecosystem change

Engage stakeholders in co-designing performance statistics

Include reference points based on ecosystem information from EwE model into MSE

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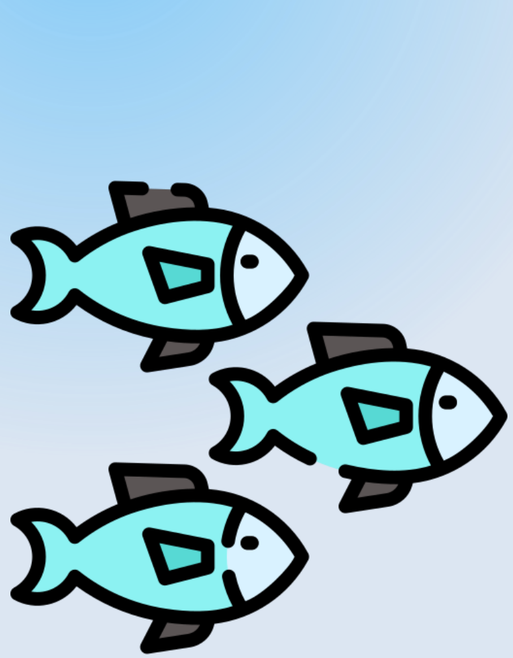
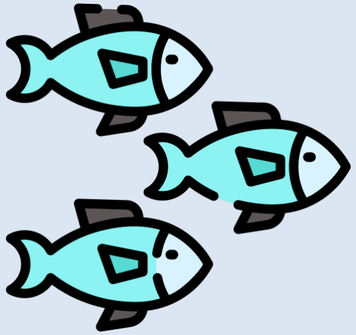


Questions?

THANK YOU!



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