

Including older fish in fisheries management – a new age-based indicator (ABI_{MSY}) for exploited stocks

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General themes

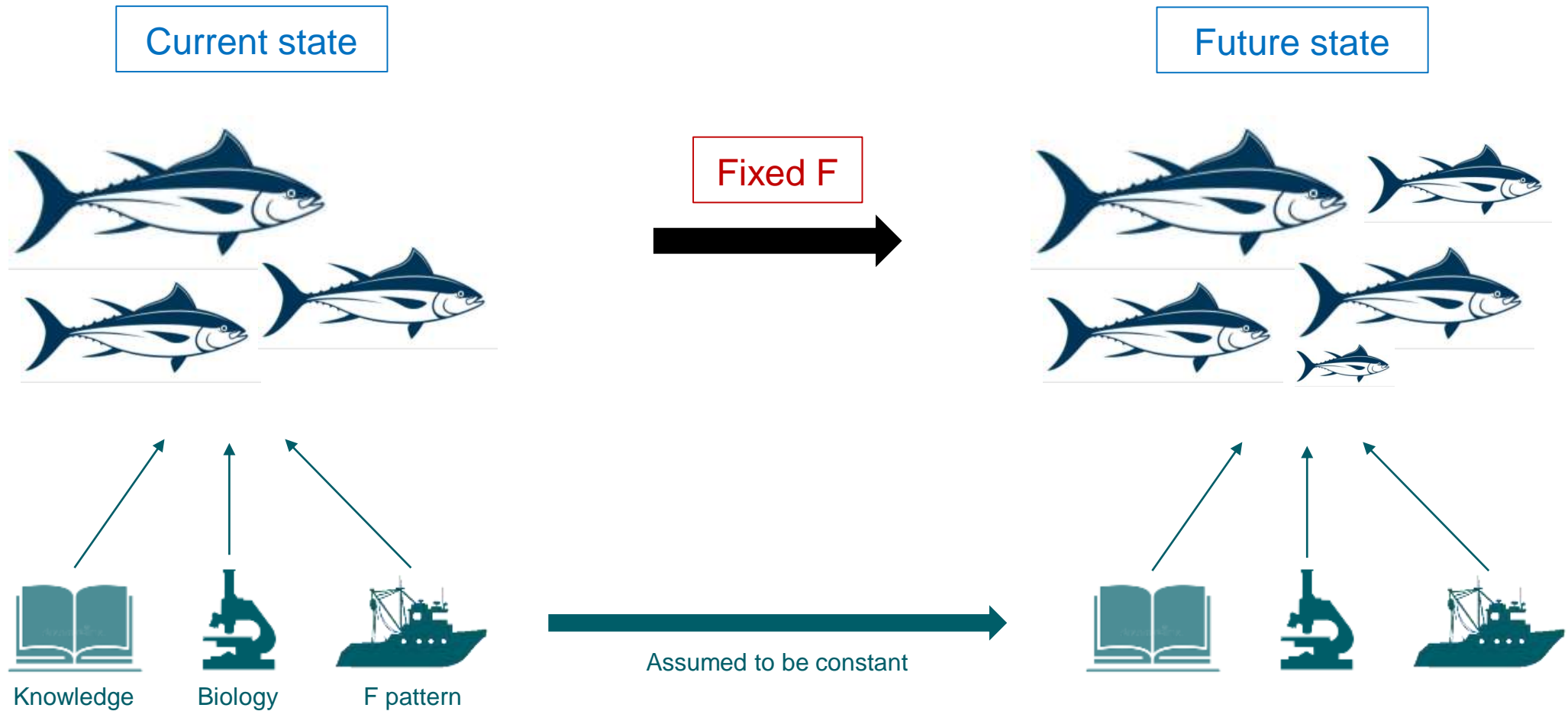
1. Age-structure (ABI_{MSY})
 - a) MSFD Descriptor 3 Criteria 3 of GES – ‘age and size distribution that is indicative of a healthy stock’
 - b) General needs on sustainability, resilience and recovery

2. Can we fish differently?
 - a) Shift in management targets/more precautionary
 - b) What will reductions in F mean for long term yields?

Case studies and tools for fisheries management

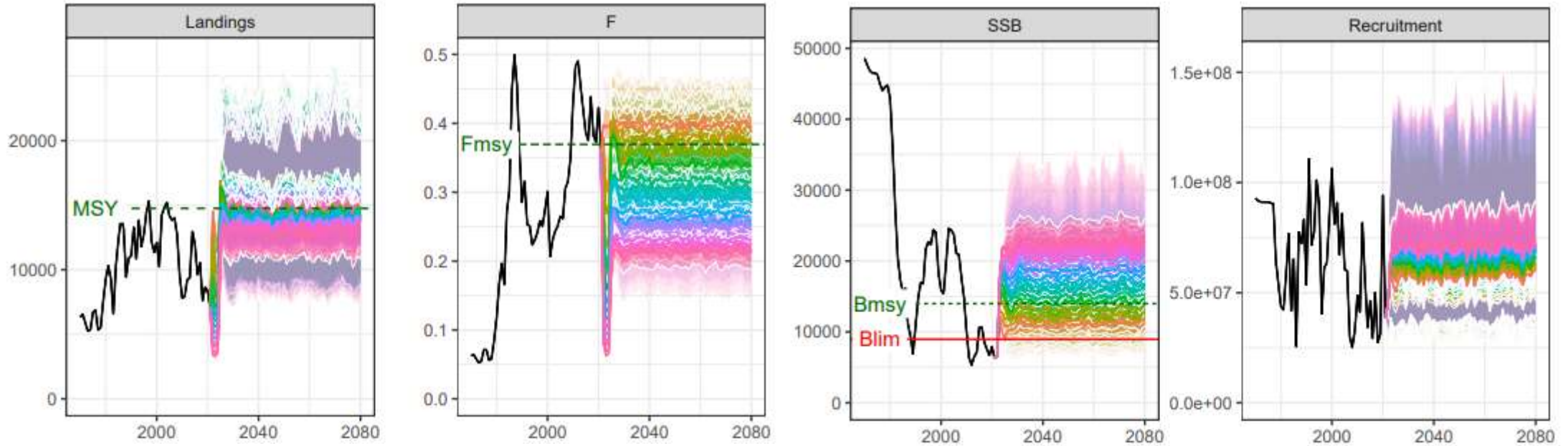
Management Strategy Evaluations (MSEs)

Estimation of reference points (management targets)



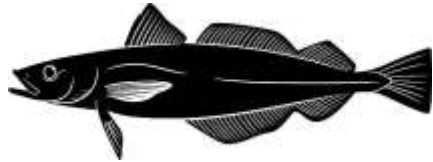
Management Strategy Evaluations (MSEs)

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Calculating ABI_{MSY}

Stock - hke.27.3a46-8abd



Older fish

$A_{MSY} = 90^{th}$ percentile

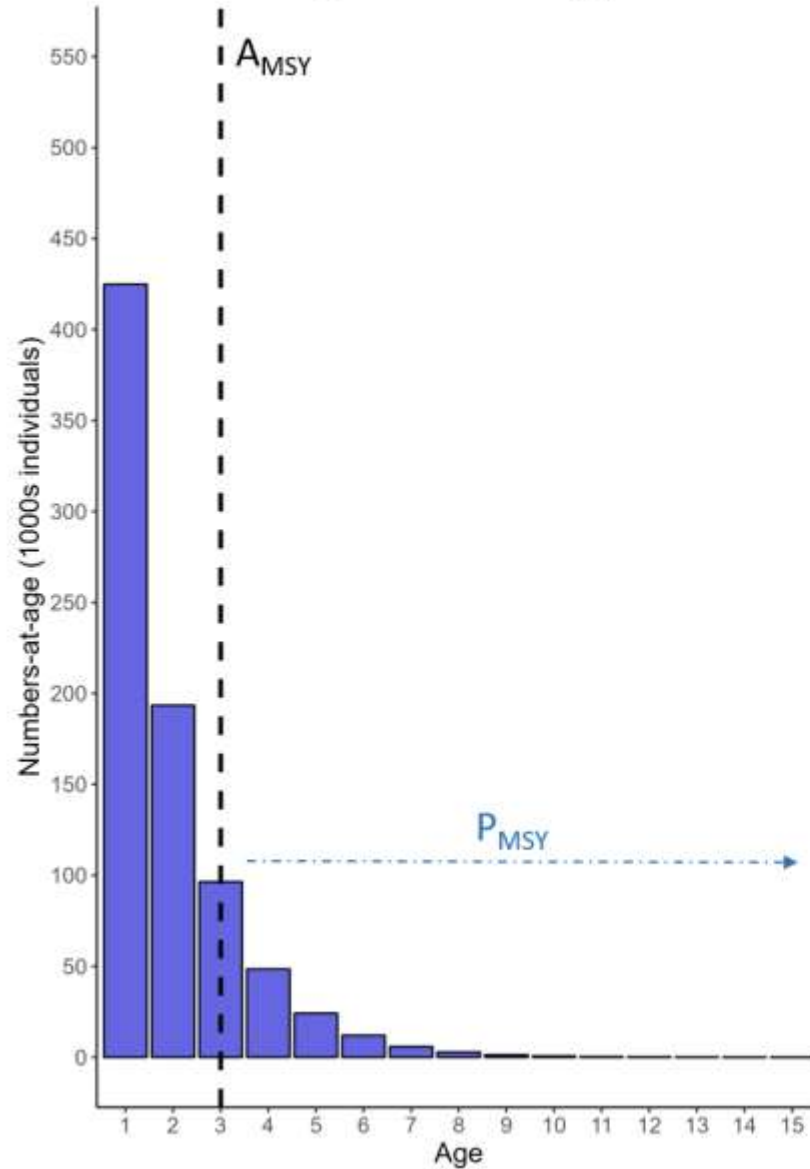
Spawning
success

Resilience

Communication
on space use

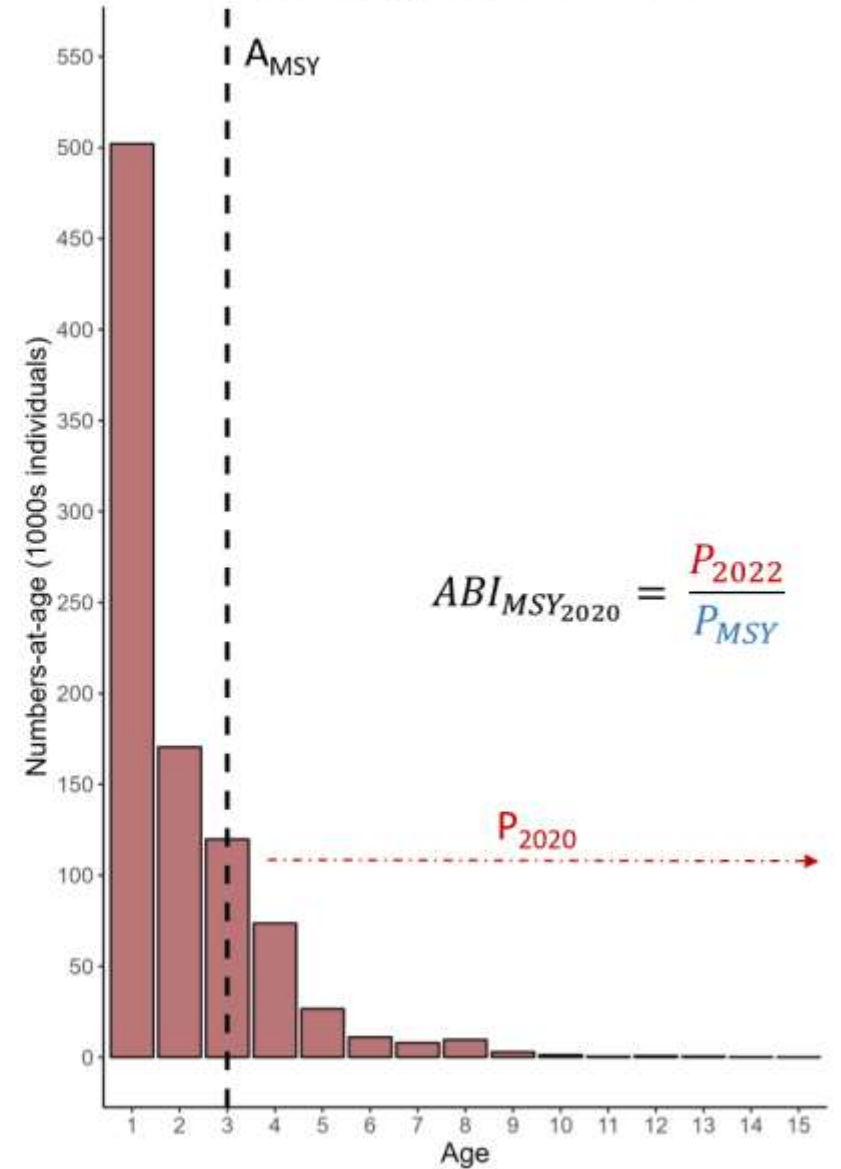
A

Age structure at F_{MSY}



B

Observed age structure in 2020



$$ABI_{MSY_{2020}} = \frac{P_{2020}}{P_{MSY}}$$

45 stocks: $ABl_{MSY} < 1$ (62%)

27 stocks: $ABl_{MSY} > 1$ (38%)

22 stocks: $ABl_{MSY} < 0.5$ (31%)



79%

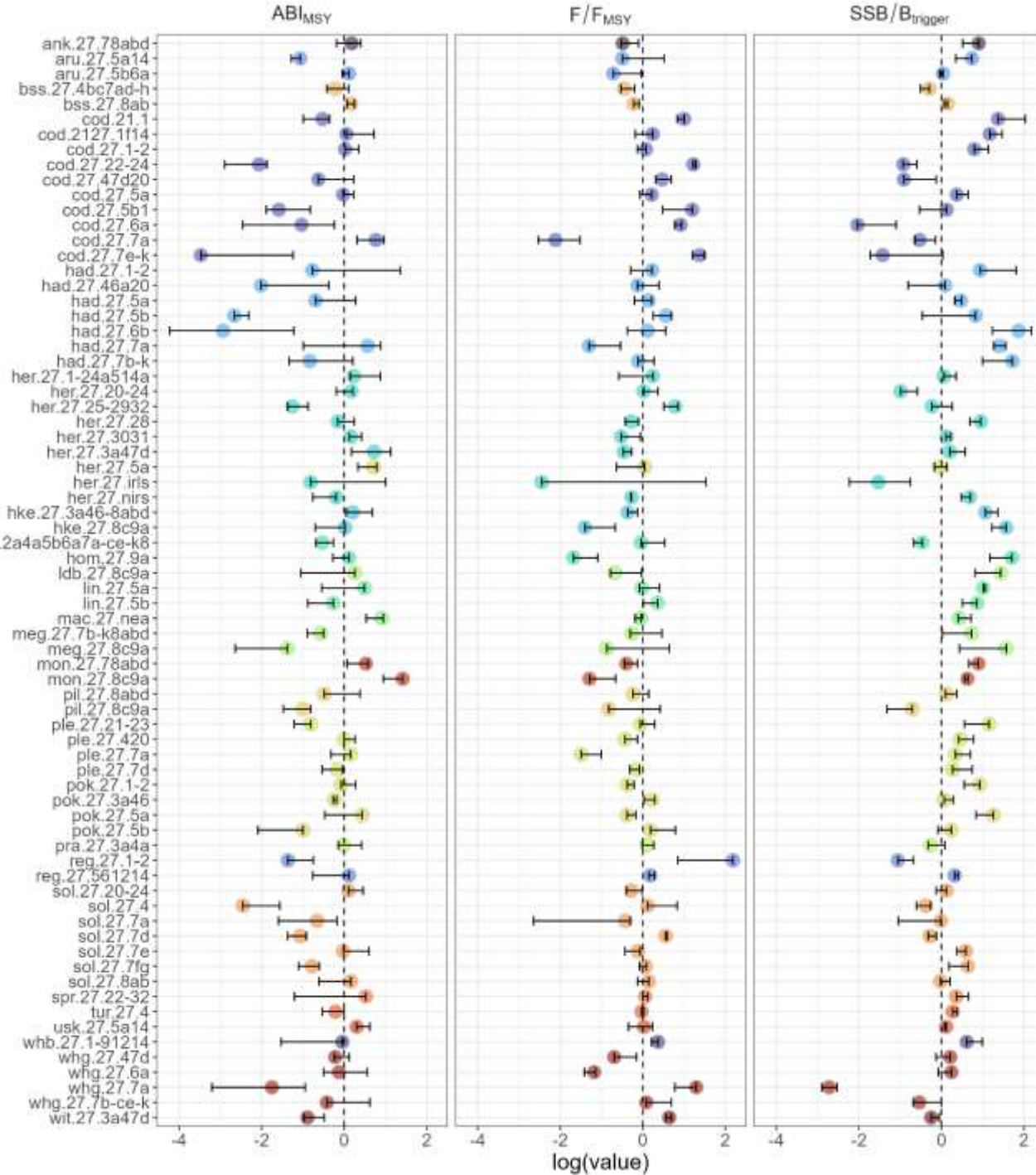
$ABl_{MSY} < 1$



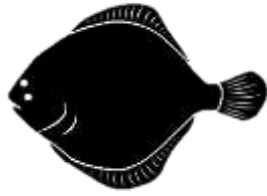
50%

$ABl_{MSY} < 1$

Stock ID



- Species
- Black-bellied anglerfish
 - Blue whiting
 - Cod
 - Golden redfish
 - Greater silver smelt
 - Haddock
 - Hake
 - Herring
 - Horse mackerel
 - Ling
 - Mackerel
 - Megrim
 - Northern shrimp
 - Plaice
 - Saithe
 - Sardine
 - Sea bass
 - Sole
 - Sprat
 - Turbot
 - Tusk
 - White anglerfish
 - Whiting
 - Witch



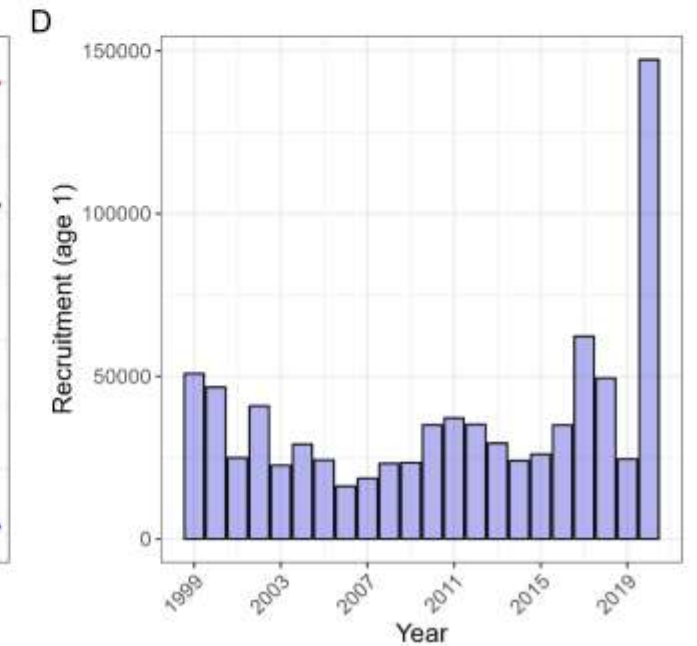
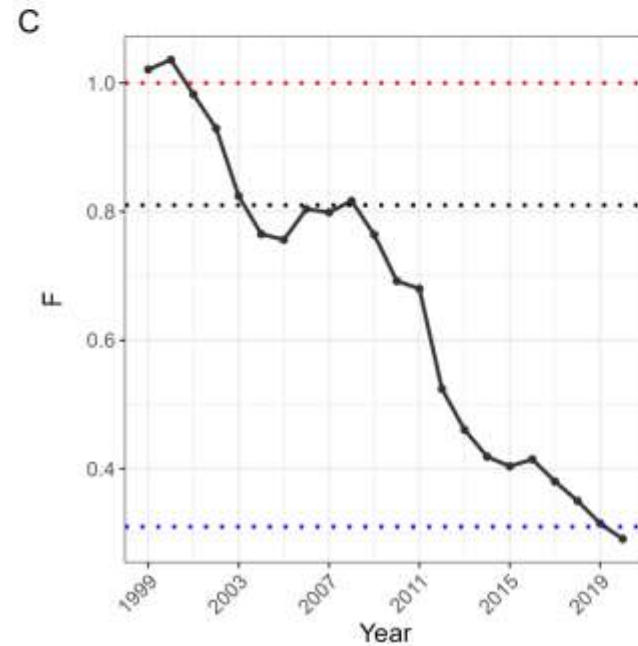
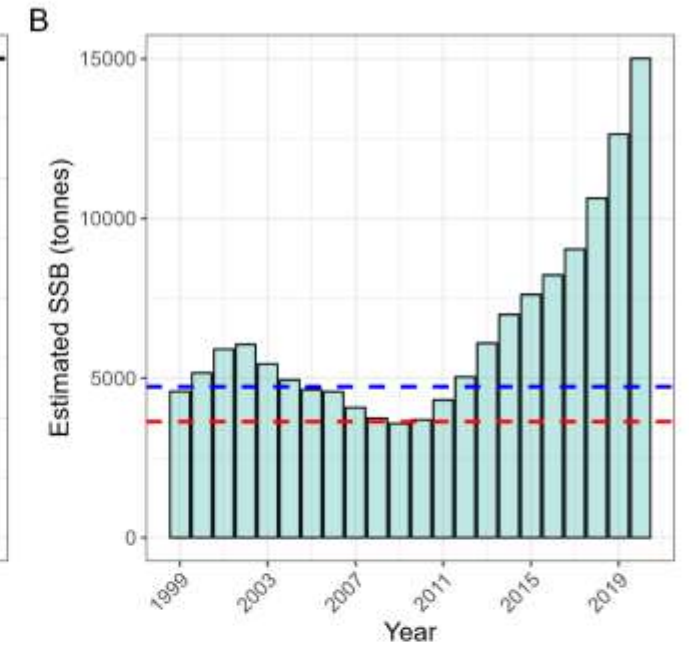
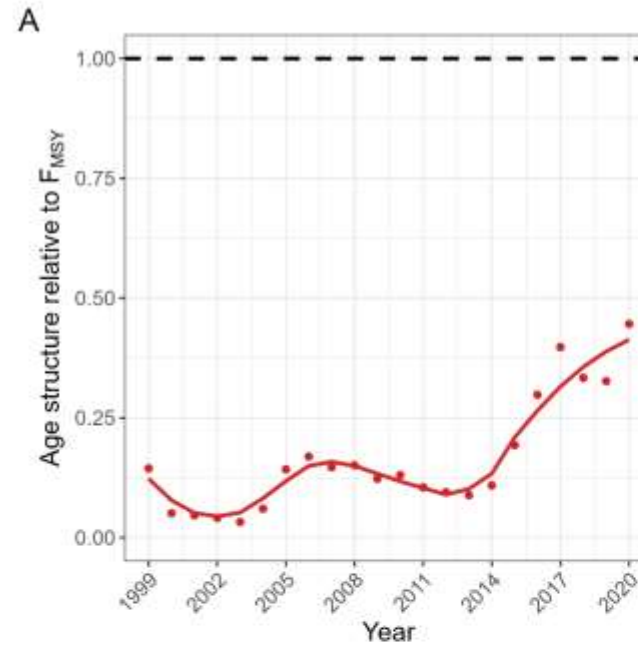
European plaice in Baltic Sea (ple.27.21-23)

High SSB

Low F and declining

Low proportion of older fish

Indications of stock recovery but
increasing F could lead to growth
overfishing

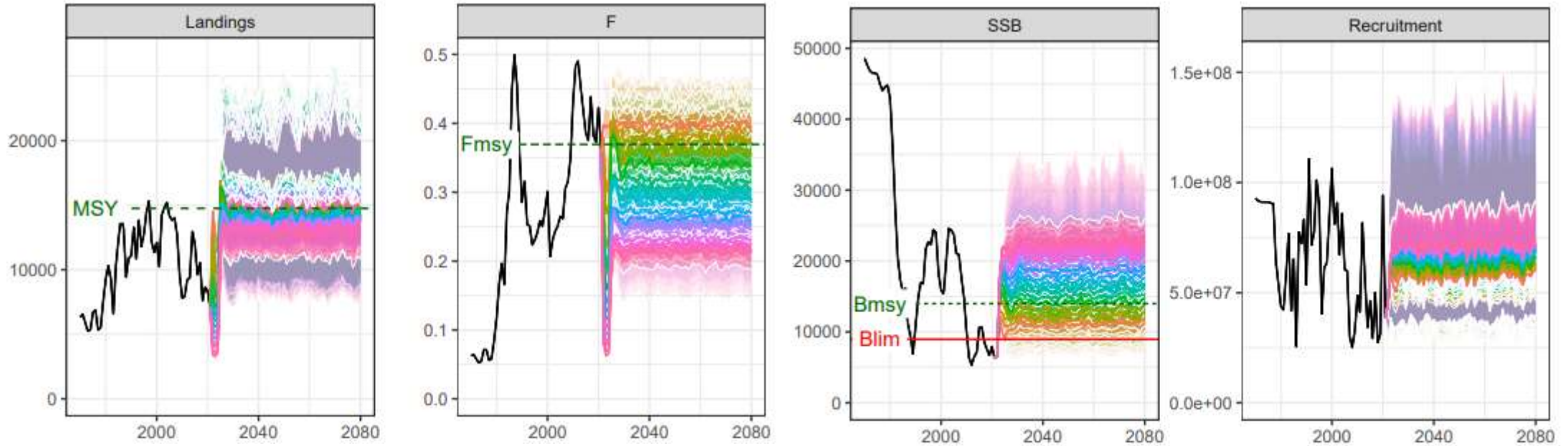


Conclusions #1

- A. ABl_{MSY} provides information on the age structure of exploited stocks that aligns well with current ICES stock assessments and advice
- B. Meets the recommendations of the EU Commission and those described in the scientific literature for the MSFDs D3C3 of GES
- C. Has established reference points (age structure at F_{MSY}) that match policy objectives
- D. Is perfectly placed to address two general needs in fisheries management:
 - Does a stock have the age structure it needs to sustain an advised level of catch?
 - Does a stock have enough older fish to recover as expected from fishing?

Management Strategy Evaluations (MSEs)

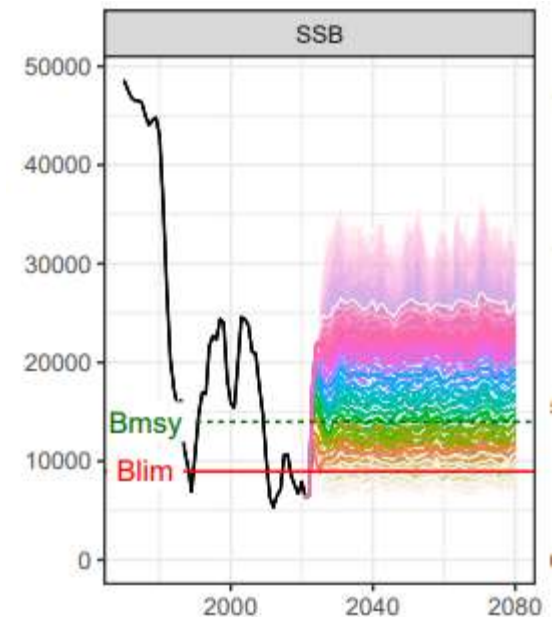
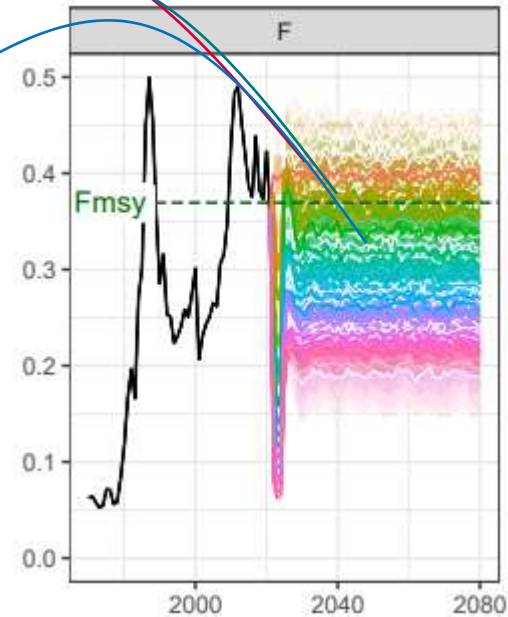
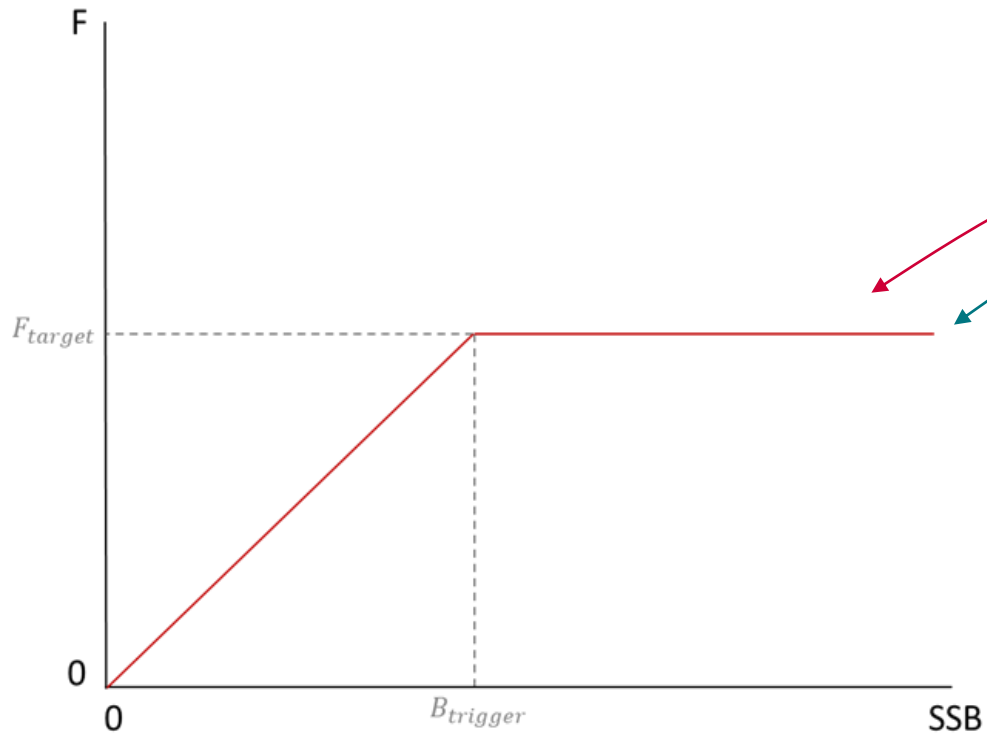
Estimation of reference points (management targets)



Harvest Control Rules

HCR performance criteria:

1. The probability of SSB falling below B_{lim} in any single year should not exceed a 5% probability
2. High long-term yields should be achieved that, ideally, should correspond to fishing at F_{MSY}



Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East (Skagerrak and Kattegat and northern North Sea in the Norwegian Deep)

ICES advice on fishing opportunities

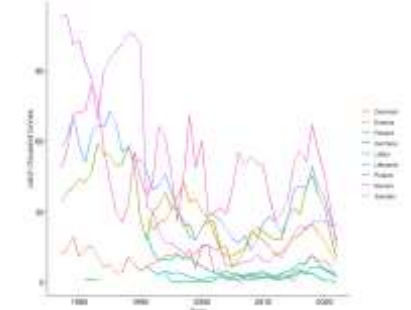
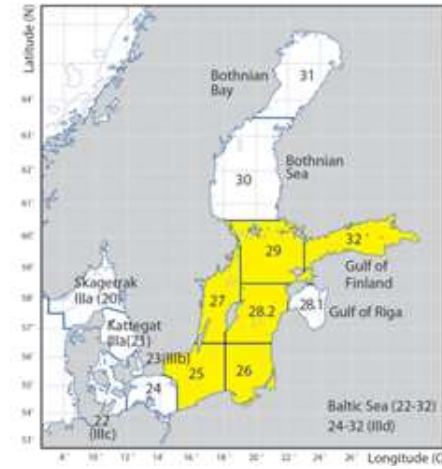
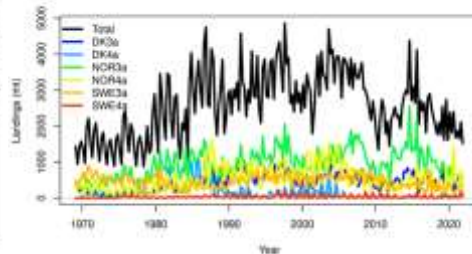
ICES advises that when the MSY approach is applied, catches should be no more than 7712 tonnes in 2022, and catches for the first six months of 2023 should be no more than 5882 tonnes.

Stock development over time

Fishing pressure on the stock is below F_{MSY} , and spawning-stock size is below MSY $B_{trigger}$ and B_{lim} but above B_{lim} .



Figure 1 Northern shrimp (*Pandalus borealis*) in divisions 3.a and 4.a East. Summary of the stock assessment. The assumed recruitment value for 2022 is shown in a lighter shade of blue. [Note: $B_{lim} = MSY B_{trigger}$]. Spawning-stock biomass (SSB) is the biomass of mature females.



Herring (*Clupea harengus*) in subdivisions 25–29 and 32, excluding the Gulf of Riga (central Baltic Sea)

ICES advice on fishing opportunities

ICES advises that when the EU multiannual plan (MAP) for the Baltic Sea is applied, catches in 2023 that correspond to the F ranges in the plan are between 70 130 and 95 643 tonnes. The current advice applies to all catches from the stock, including those taken in Subdivision 28.1.

Stock development over time

Fishing pressure on the stock is above F_{MSY} and between F_{H1} and F_{H2} and that spawning-stock size is below MSY $B_{trigger}$ and between B_{H1} and B_{H2} .

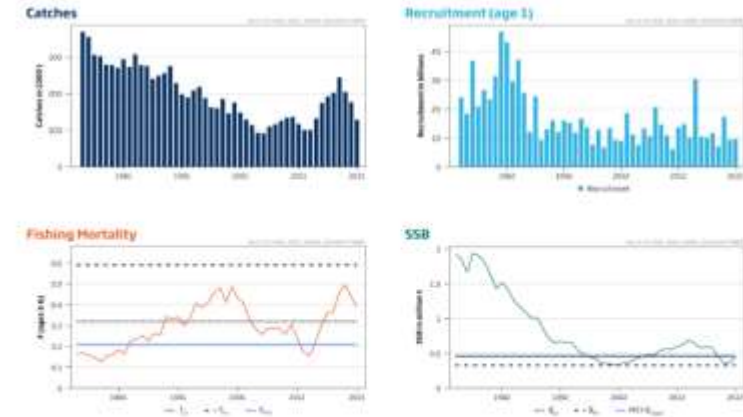


Figure 1 Herring in subdivisions 25–29 and 32, excluding the Gulf of Riga. Summary of the stock assessment. SSB at spawning time in 2022 is predicted.

Management Strategy Evaluation outcomes for a range of Harvest Control Rules for northern shrimp in divisions 3.a and 4.a East



HCRs		Objectives		
$B_{trigger}$	F_{target}	$B < B_{lim}$	Catch/MSY	B/B_{MSY}
No trigger	F_{MSY}	0.34	1.00	0.82
60% x B_{MSY}	F_{MSY}	0.28	1.00	0.86
80% x B_{MSY}	F_{MSY}	0.22	1.01	0.92
B_{MSY}	F_{MSY}	0.14	1.01	0.99
60% x $B_{25\%}$	$F_{B25\%}$	0.22	0.97	0.98
80% x $B_{25\%}$	$F_{B25\%}$	0.17	0.97	1.05
$B_{25\%}$	$F_{B25\%}$	0.10	0.96	1.12
60% x $B_{30\%}$	$F_{B30\%}$	0.09	0.98	1.20
80% x $B_{30\%}$	$F_{B30\%}$	0.06	0.98	1.25
90% x $B_{30\%}$	$F_{B30\%}$	0.04	0.97	1.28
$B_{30\%}$	$F_{B30\%}$	0.03	0.97	1.34
60% x $B_{35\%}$	$F_{B35\%}$	0.02	0.97	1.42
80% x $B_{35\%}$	$F_{B35\%}$	0.02	0.96	1.47
90% x $B_{35\%}$	$F_{B35\%}$	0.02	0.95	1.49
$B_{35\%}$	$F_{B35\%}$	0.02	0.94	1.53
60% x $B_{40\%}$	$F_{B40\%}$	0.01	0.94	1.63
80% x $B_{40\%}$	$F_{B40\%}$	0.00	0.93	1.66
90% x $B_{40\%}$	$F_{B40\%}$	0.00	0.91	1.71
$B_{40\%}$	$F_{B40\%}$	0.00	0.90	1.76

HCR accepted – maximises catch

Precautionary HCR – higher B lower F same catch

Management Strategy Evaluations outcomes for a range of Harvest Control Rules for herring in subdivisions 25–29 and 32, excluding the Gulf of Riga.



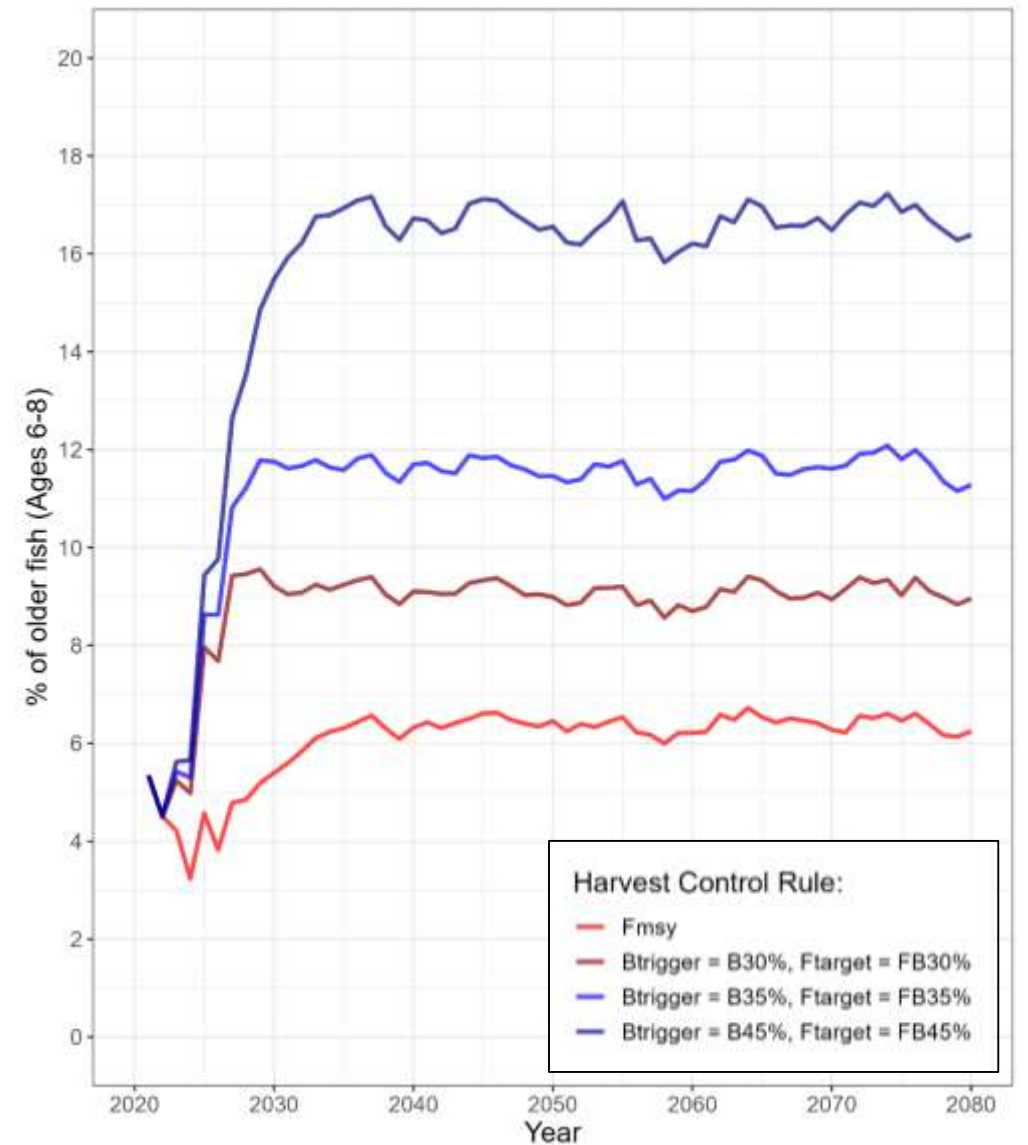
HCRs		Objectives		
$B_{trigger}$	F_{target}	$B < B_{lim}$	Catch/MSY	B/B_{MSY}
No trigger	F_{MSY}	0.07	1.00	0.81
60% x B_{MSY}	F_{MSY}	0.06	1.00	0.82
80% x B_{MSY}	F_{MSY}	0.03	1.00	0.85
B_{MSY}	F_{MSY}	0.01	1.00	0.90
60% x $B_{20\%}$	$F_{B20\%}$	0.50	0.92	0.56
80% x $B_{20\%}$	$F_{B20\%}$	0.38	0.94	0.59
$B_{20\%}$	$F_{B20\%}$	0.30	0.95	0.64
60% x $B_{25\%}$	$F_{B25\%}$	0.15	0.98	0.71
80% x $B_{25\%}$	$F_{B25\%}$	0.09	0.98	0.74
$B_{25\%}$	$F_{B25\%}$	0.04	0.99	0.79
60% x $B_{30\%}$	$F_{B30\%}$	0.02	1.01	0.86
80% x $B_{30\%}$	$F_{B30\%}$	0.01	1.01	0.90
$B_{30\%}$	$F_{B30\%}$	0.00	1.01	0.95
60% x $B_{35\%}$	$F_{B35\%}$	0.00	1.01	1.03
80% x $B_{35\%}$	$F_{B35\%}$	0.00	1.01	1.06
$B_{35\%}$	$F_{B35\%}$	0.00	1.00	1.11
60% x $B_{40\%}$	$F_{B40\%}$	0.00	1.00	1.20
80% x $B_{40\%}$	$F_{B40\%}$	0.00	0.99	1.22
90% x $B_{40\%}$	$F_{B40\%}$	0.00	0.98	1.24
$B_{40\%}$	$F_{B40\%}$	0.00	0.98	1.28
60% x $B_{45\%}$	$F_{B45\%}$	0.00	0.97	1.38
80% x $B_{45\%}$	$F_{B45\%}$	0.00	0.96	1.40
90% x $B_{45\%}$	$F_{B45\%}$	0.00	0.96	1.43
$B_{45\%}$	$F_{B45\%}$	0.00	0.95	1.46

HCR accepted

Precautionary
HCRs –
higher B
lower F
comparable catch

Herring in subdivisions 25–29 and 32, excluding the Gulf of Riga.

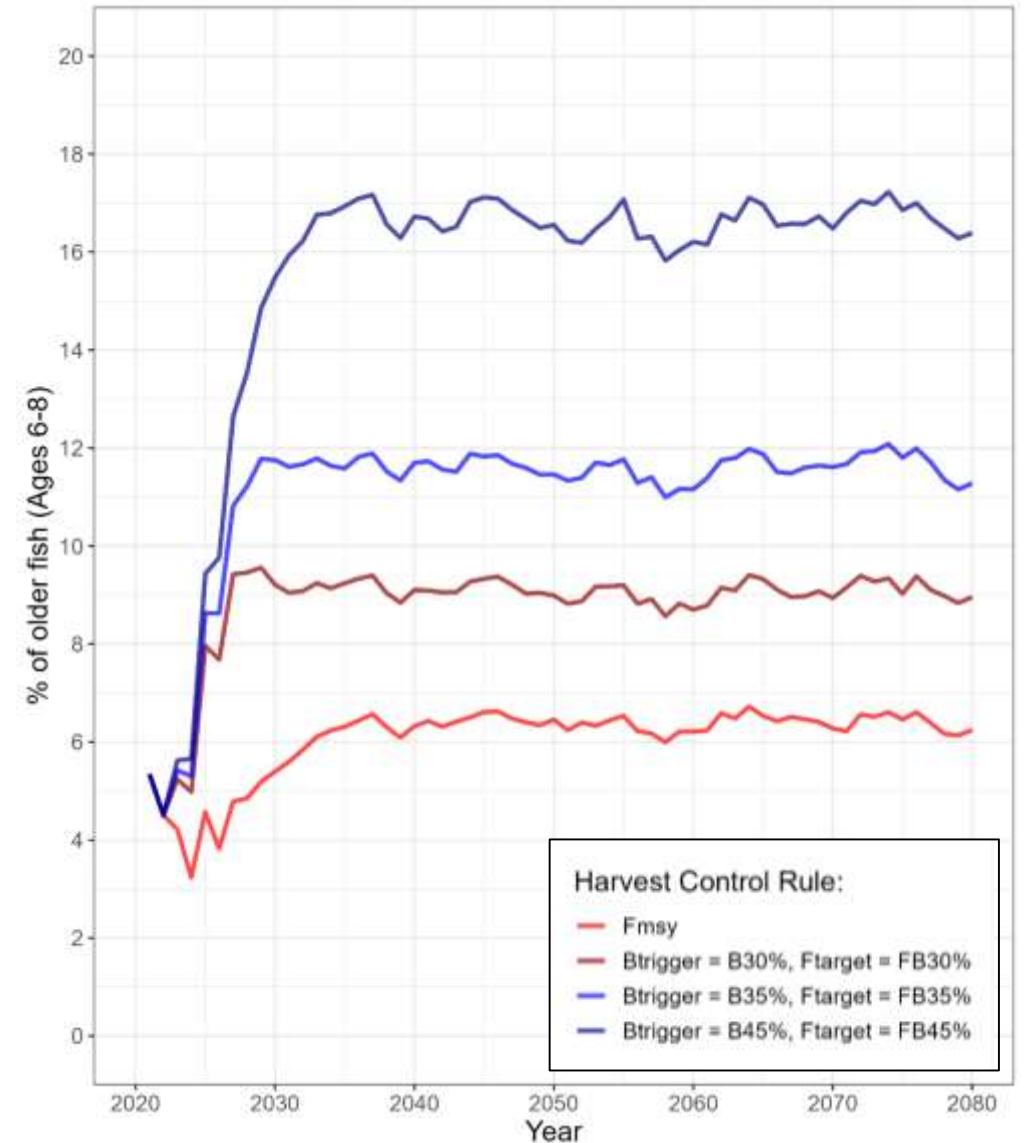
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$B_{30\%}$	$F_{B30\%}$	0.00	1.01	0.95
60% x $B_{35\%}$	$F_{B35\%}$	0.00	1.01	1.03
80% x $B_{35\%}$	$F_{B35\%}$	0.00	1.01	1.06
$B_{35\%}$	$F_{B35\%}$	0.00	1.00	1.11
60% x $B_{40\%}$	$F_{B40\%}$	0.00	1.00	1.20
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80% x $B_{45\%}$	$F_{B45\%}$	0.00	0.96	1.40
90% x $B_{45\%}$	$F_{B45\%}$	0.00	0.96	1.43
$B_{45\%}$	$F_{B45\%}$	0.00	0.95	1.46



Conclusions #2

Fishing at an **F lower** than F_{MSY} in the long term can result in:

- Increased biomass
- Increased abundance of older/larger fish
- Very limited loss in long term catch





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Questions

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