

# Biological reference points

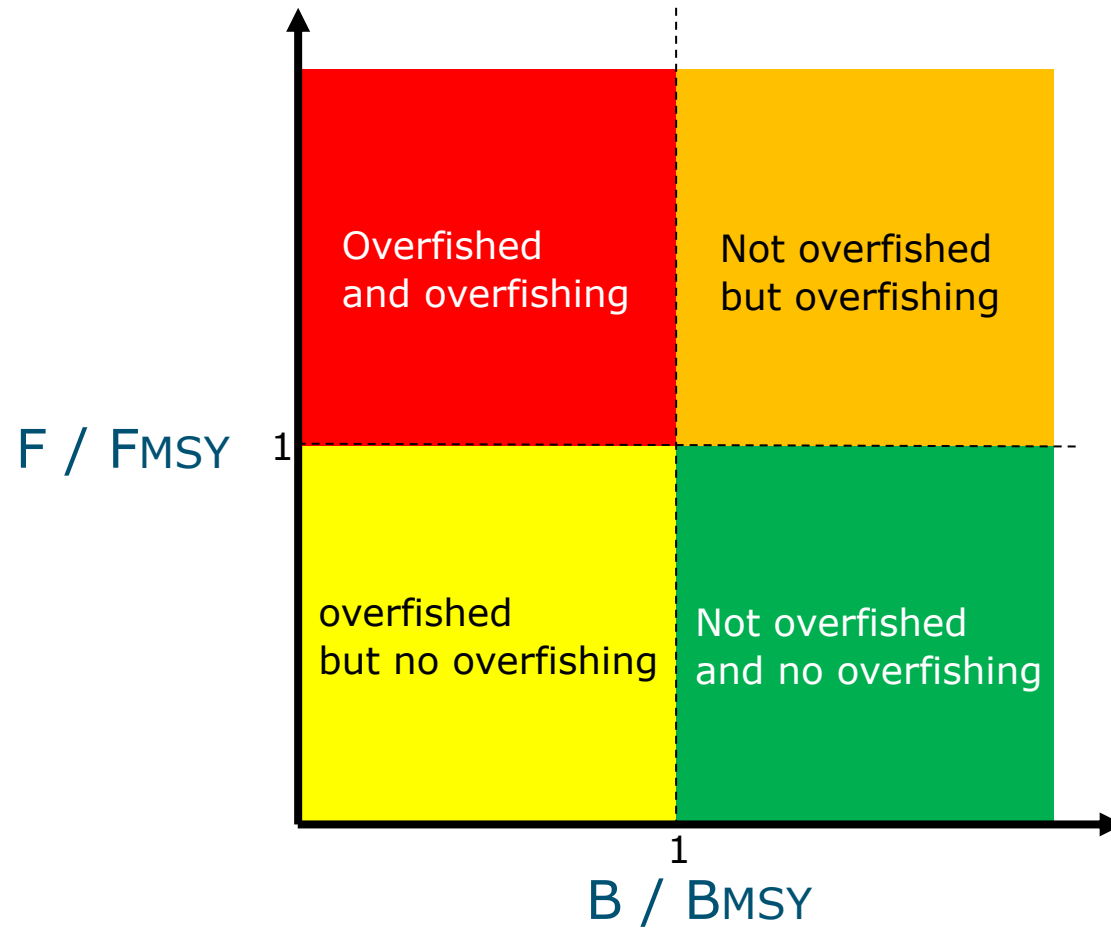
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## BlackSea4Fish Presentation Series

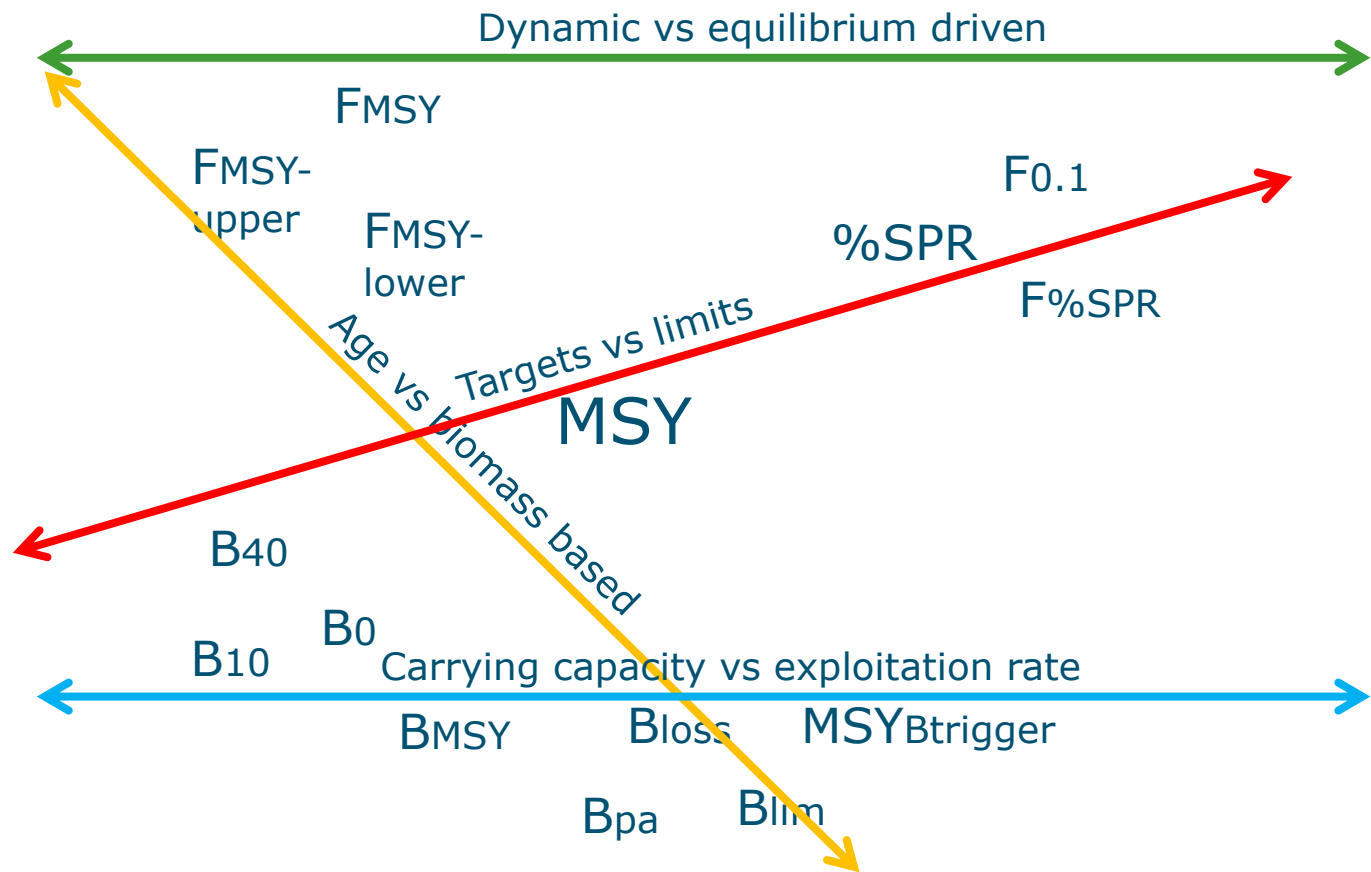
8 December 2020, Niels Hintzen



# Why do we need reference points?



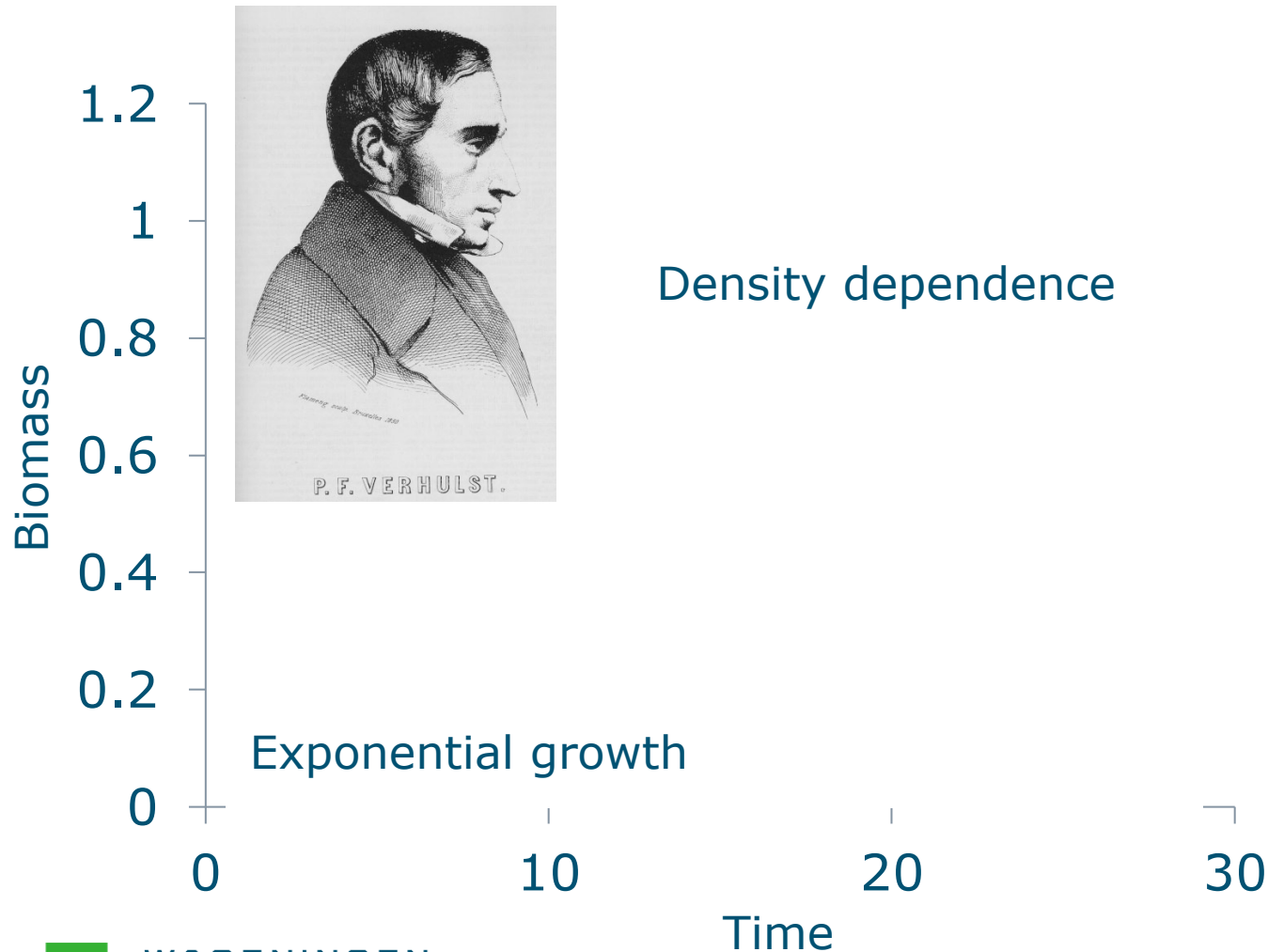
# Biological reference points in the world



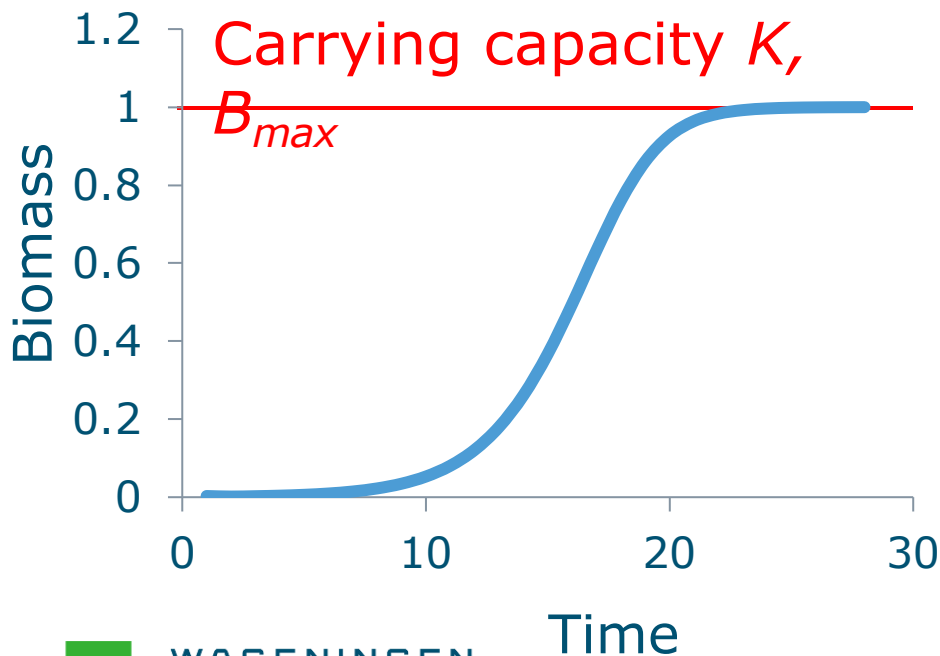
# The basics of MSY

## Unstructured models

# General population model

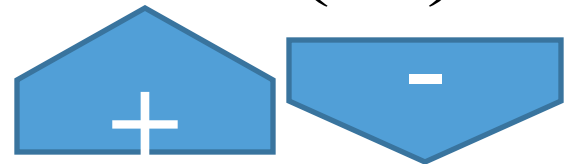


# General population model



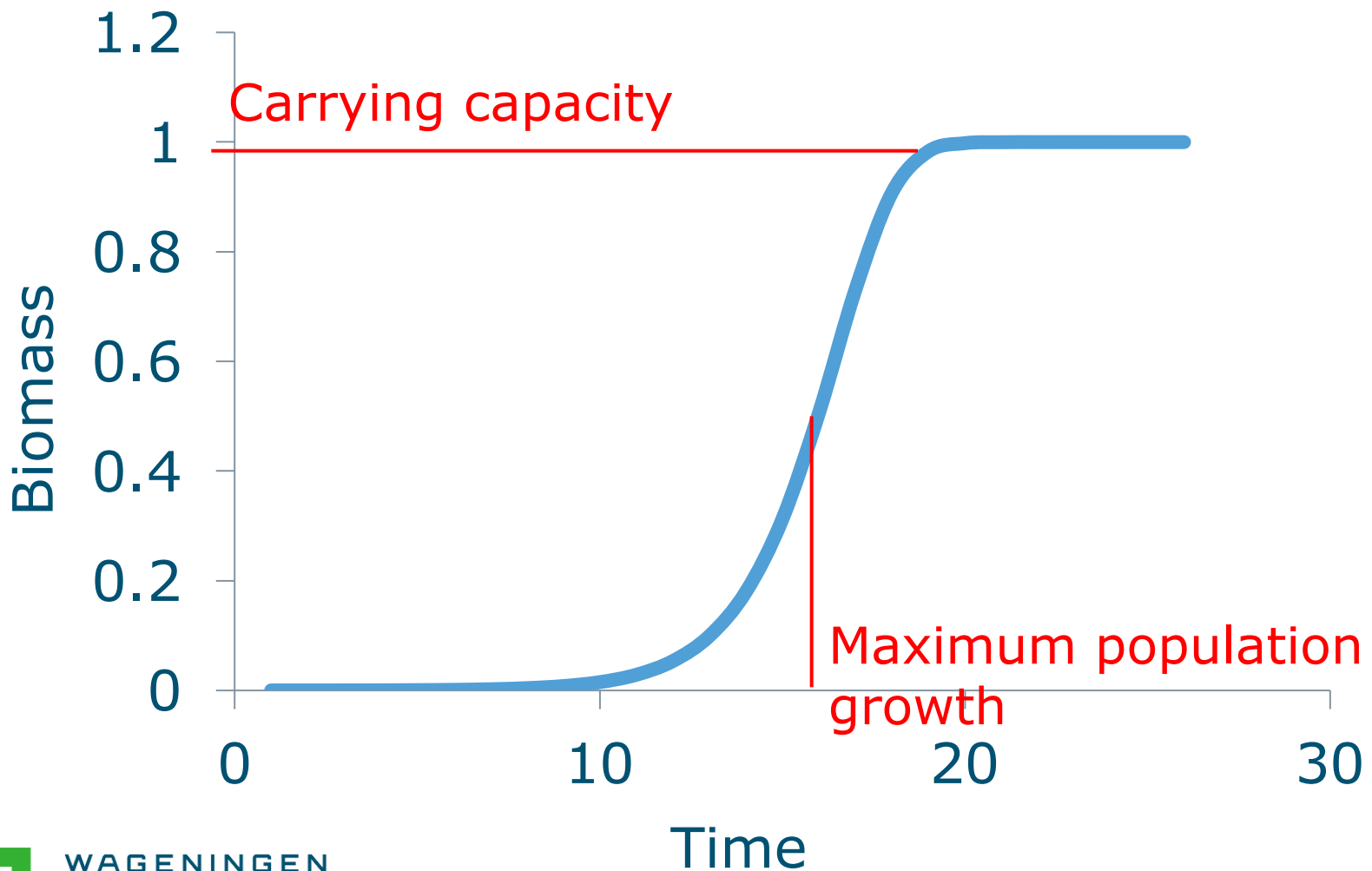
$$\frac{dB}{dt} = rB \left( 1 - \frac{B}{K} \right)$$

$$\frac{dB}{dt} = rB - \left( \frac{r}{K} \right) B^2$$

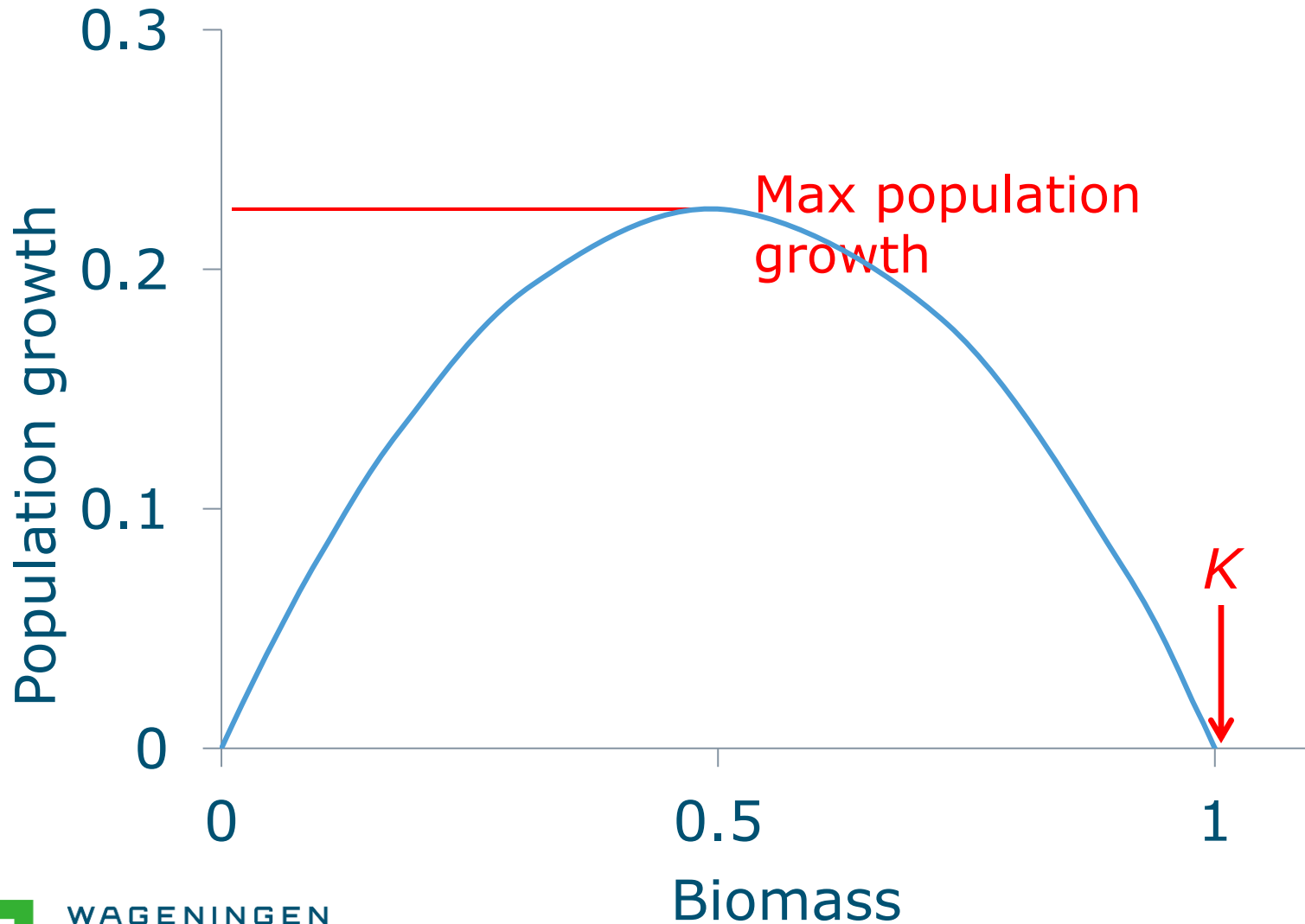


$B$  = population biomass  
 $t$  = time  
 $r$  = intrinsic population growth rate  
 $K$  = carrying capacity

# General population model



# General population model

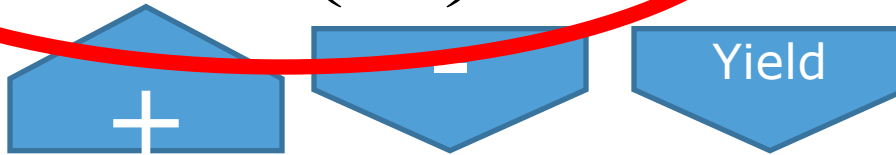




# From max population growth to surplus

$$\frac{dB}{dt} = rB - \left(\frac{r}{K}\right)B^2 - Y$$

Schaeffer model



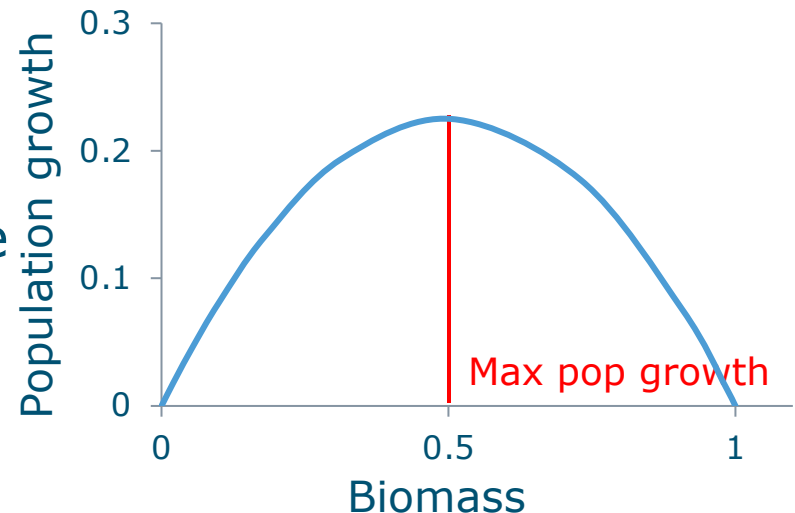
$B$  = population biomass

$t$  = time

$r$  = intrinsic population growth rate

$K$  = carrying capacity

$Y$  = Yield (also called catches)

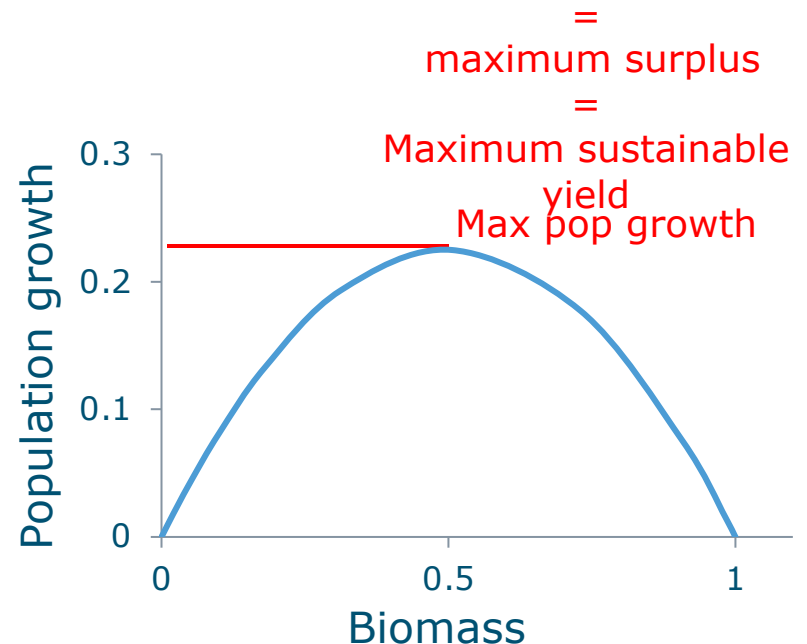


# Population in equilibrium if yield = growth

$$\frac{dB}{dt} = rB - \left(\frac{r}{K}\right)B^2 - Y$$

$$0 = rB - \left(\frac{r}{K}\right)B^2 - Y$$

$$Y = rB - \left(\frac{r}{K}\right)B^2$$



# Fitting data to estimate population size

Research survey:  
keeps track of changes in biomass from year to year

$$\frac{dB}{dt} = rB - \left( \frac{r}{K} \right) B^2 - Y$$

Variable in time

Fixed in time

Fixed in time

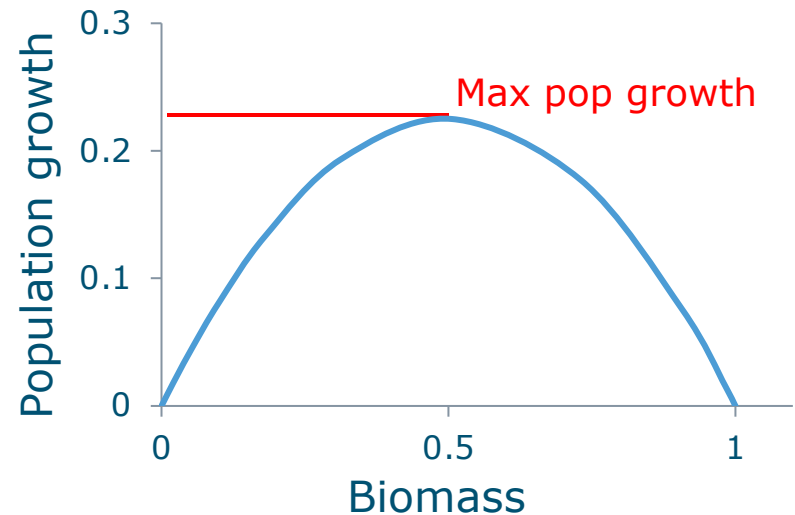
Market sampling:  
know what is landed every year

# Maximum sustainable yield

$$Y = rB - \left(\frac{r}{K}\right)B^2$$

$$Y_{MSY} = \frac{rK}{4}$$

$$B_{MSY} = 0.5K$$



# Fishing effort

$$\frac{dB}{dt} = rB - \left(\frac{r}{K}\right)B^2 - Y$$

$$\frac{dB}{dt} = rB - \left(\frac{r}{K}\right)B^2 - qEB$$

$B$  = population biomass

$t$  = time

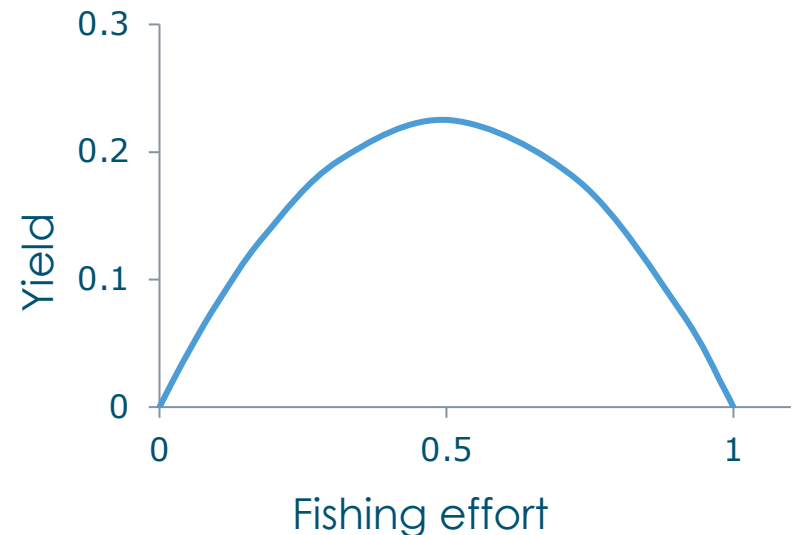
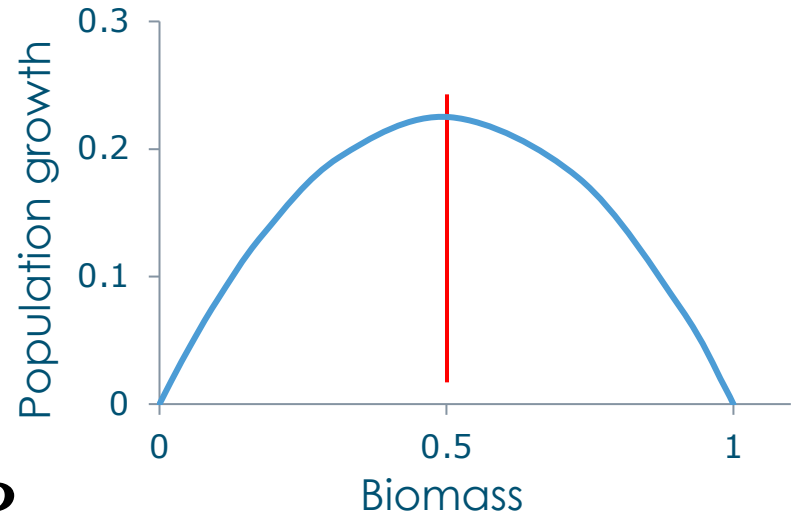
$r$  = intrinsic population growth rate

$K$  = carrying capacity

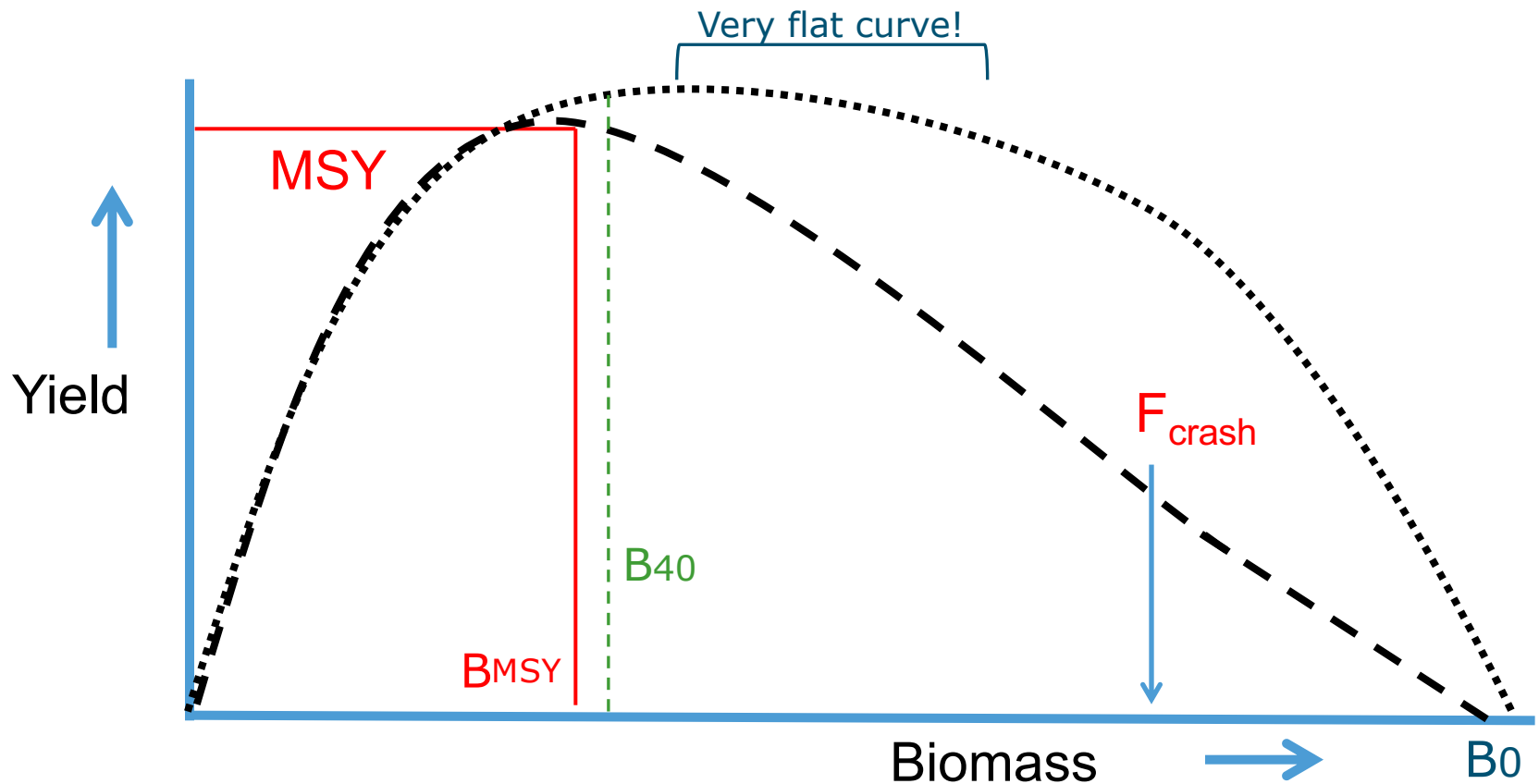
$Y$  = Yield (also called catches)

$q$  = catchability

$E$  = fishing effort



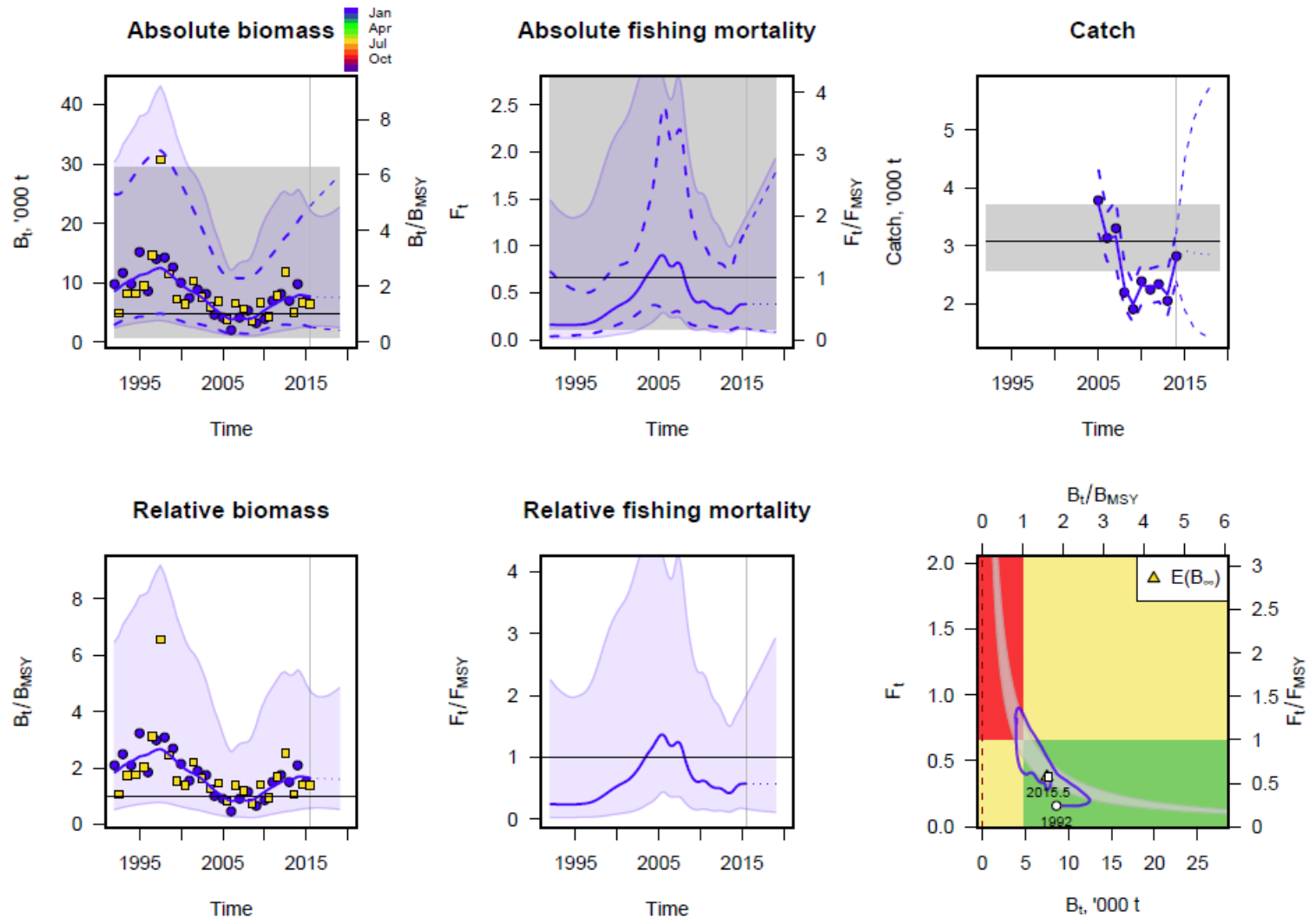
# B0 - Virgin biomass



# Unstructured models

## Time-varying

# SPICT





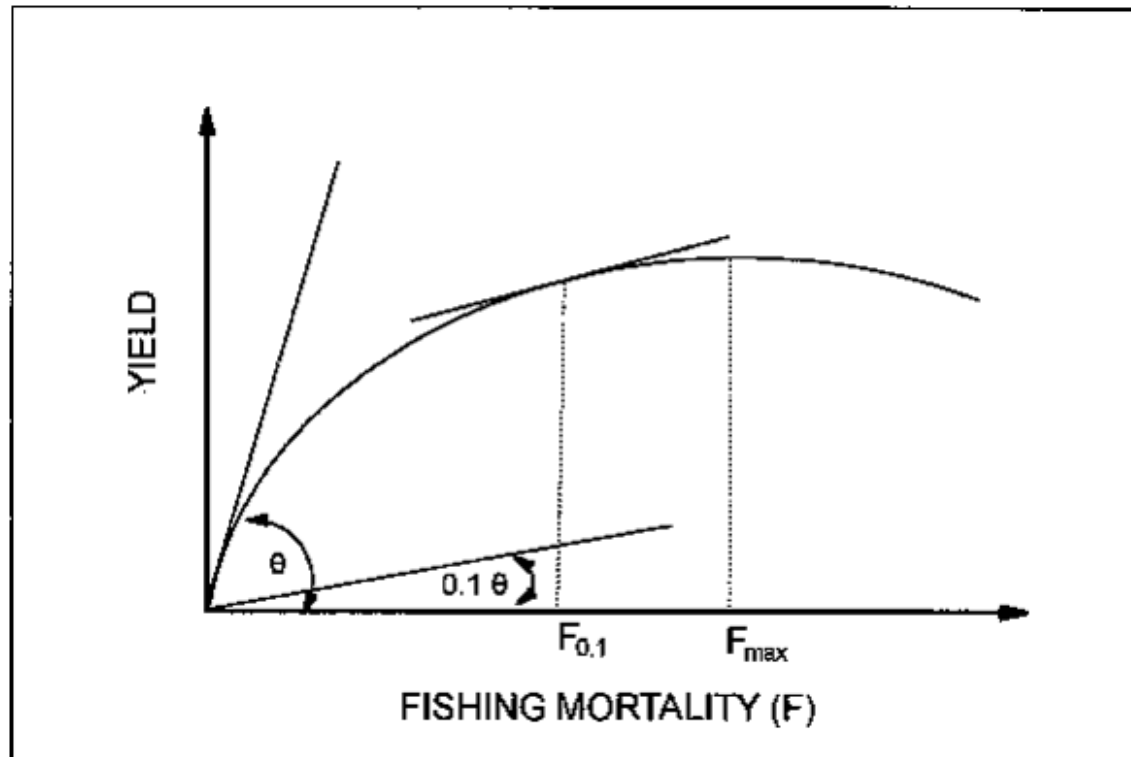
# (Age/Length) Structured models

In equilibrium

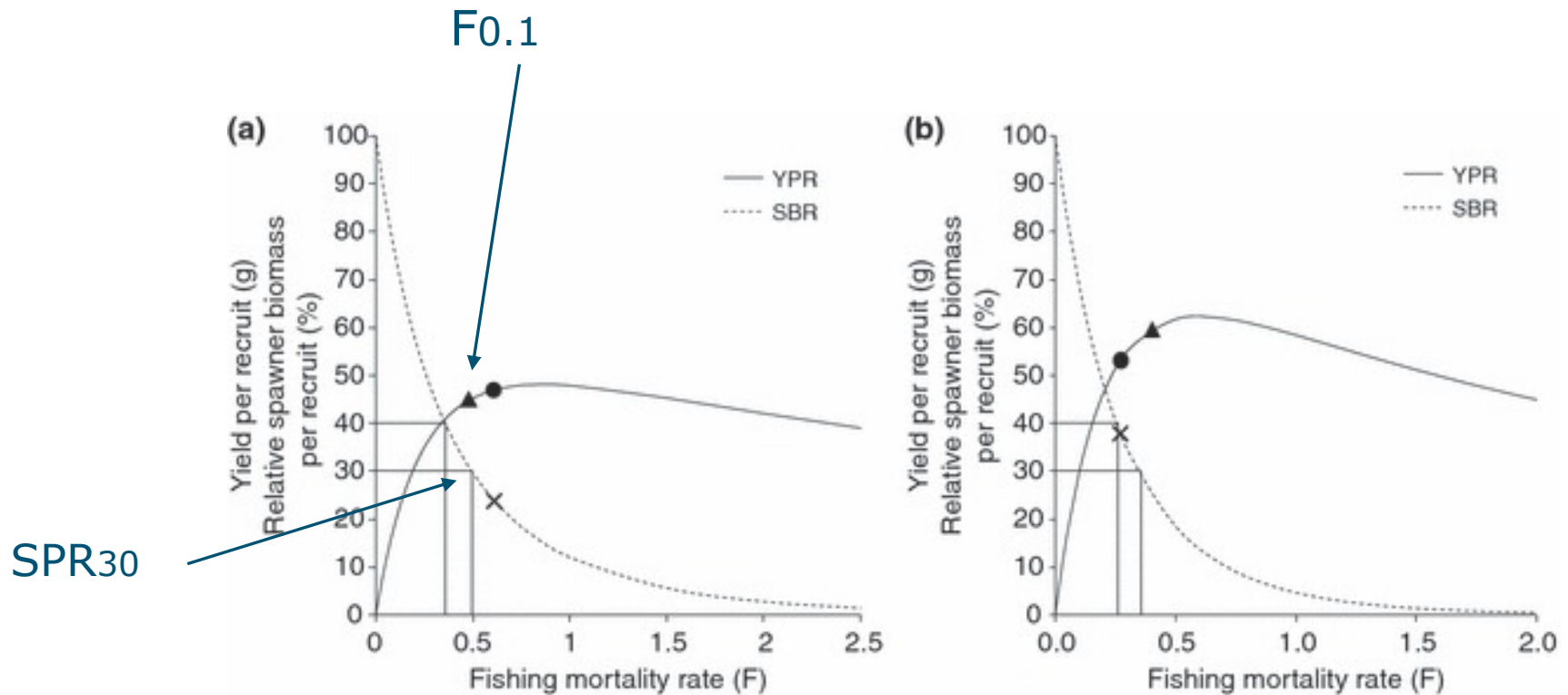
# Yield per recruit

- Age based model
- Calculate Yield over a range of fishing mortality values
- While considering a stock-recruitment relationship

$F_{0.1}$   
 $F_{max}$



# Spawner per recruit

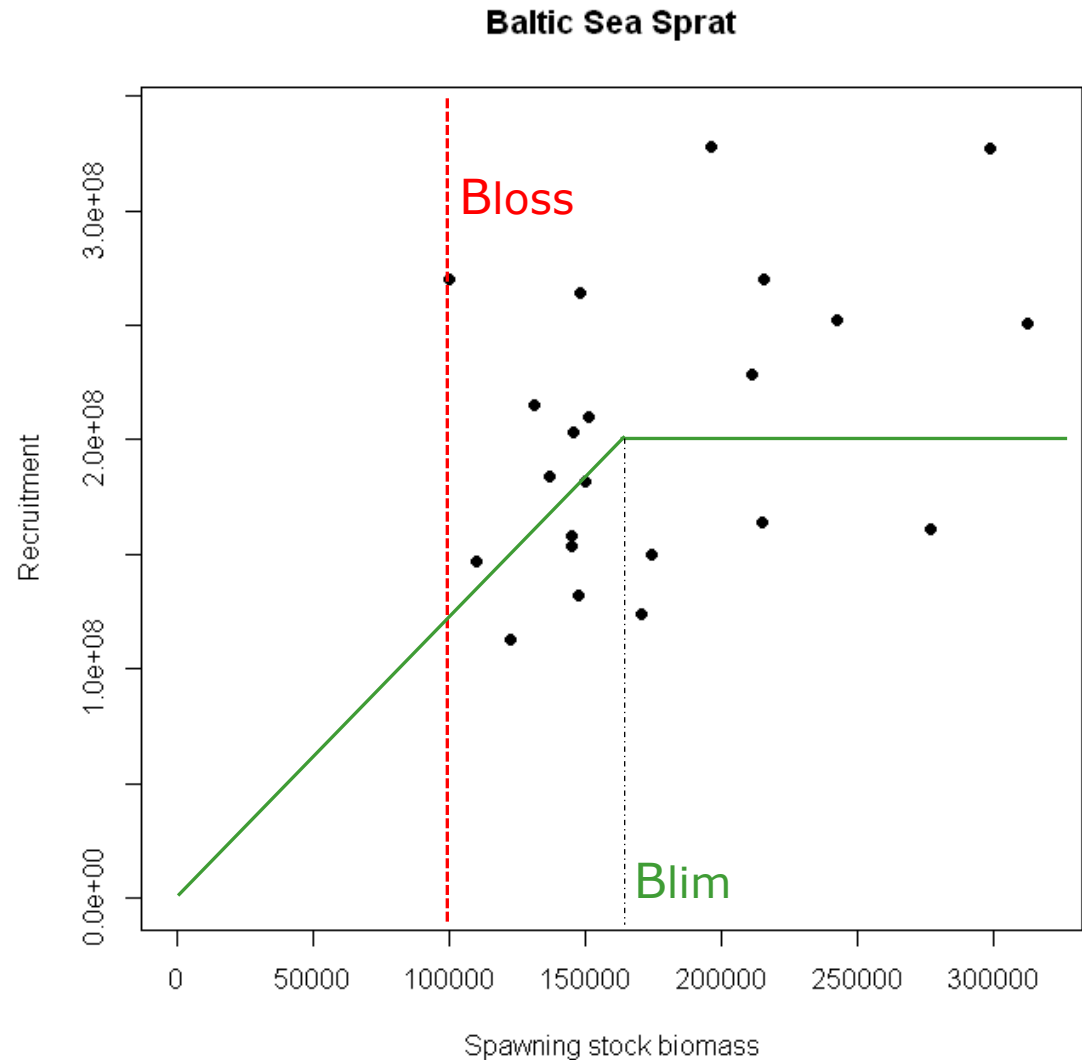


# (Age/Length) Structured models

## Time-varying

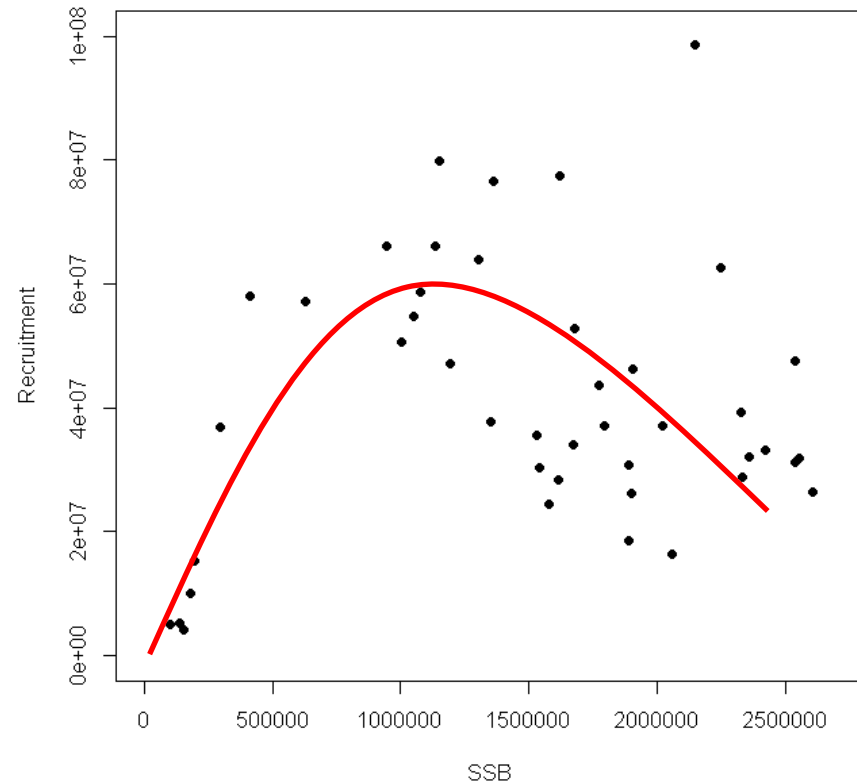
# Stock Recruit-derived reference points

Blim:  
Lower reproduction because  
SSB has dropped below a  
certain 'threshold point'

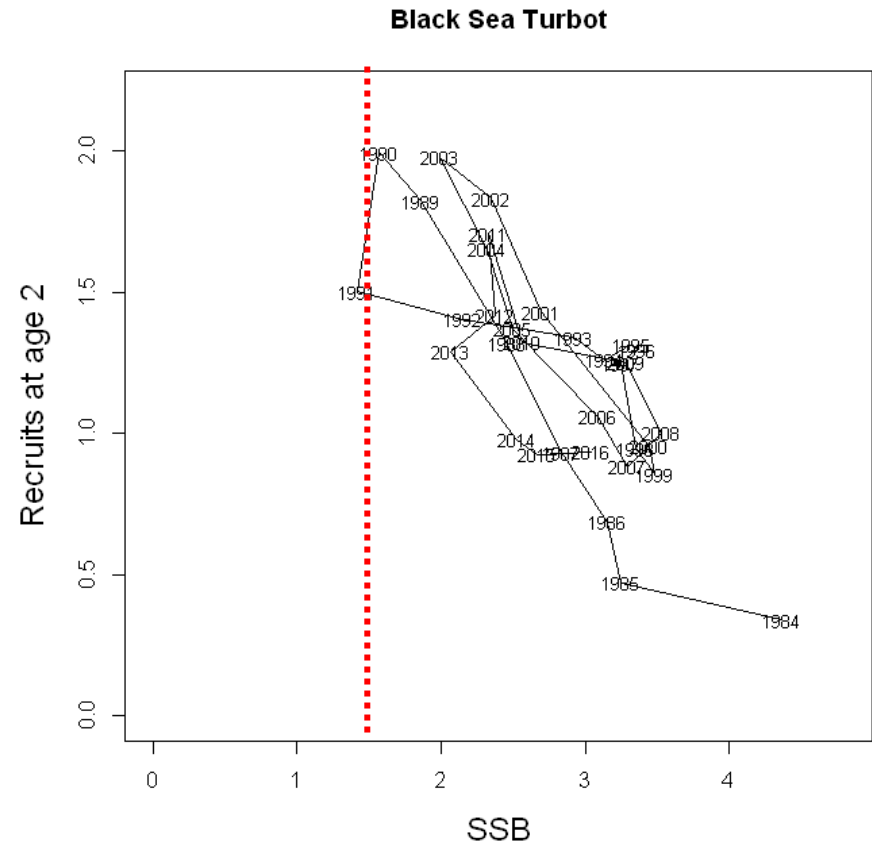


# Reasonably well defined curve

Blim:  
Lower reproduction because  
SSB has dropped below a  
certain 'threshold point'

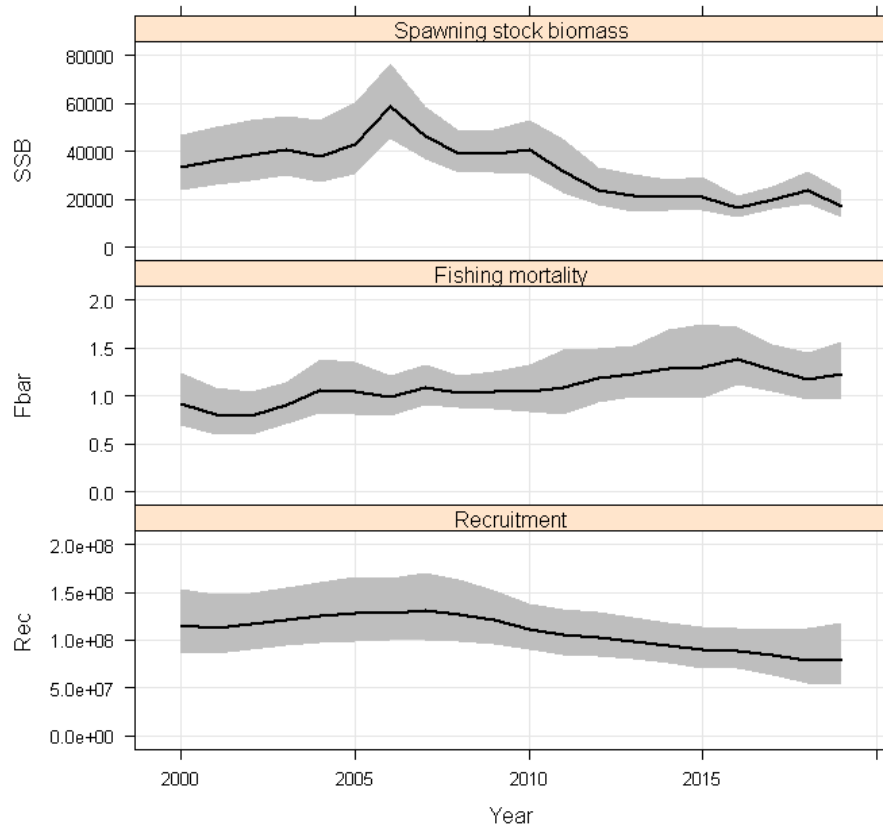


# Negative relationship with SSB

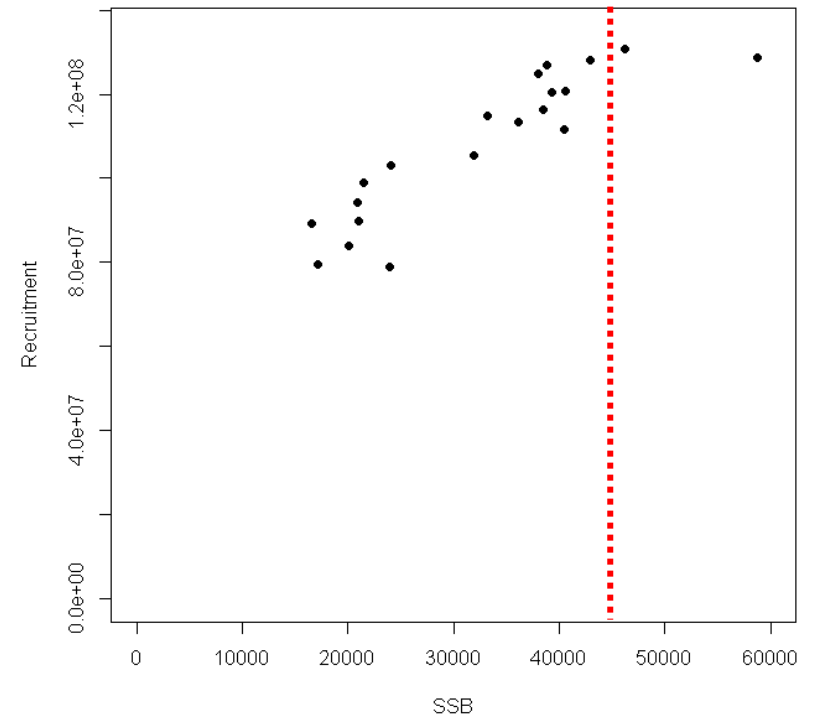


# Poorly estimated recruitment

Anchovy - Adriatic Sea - GSA 17 and 18



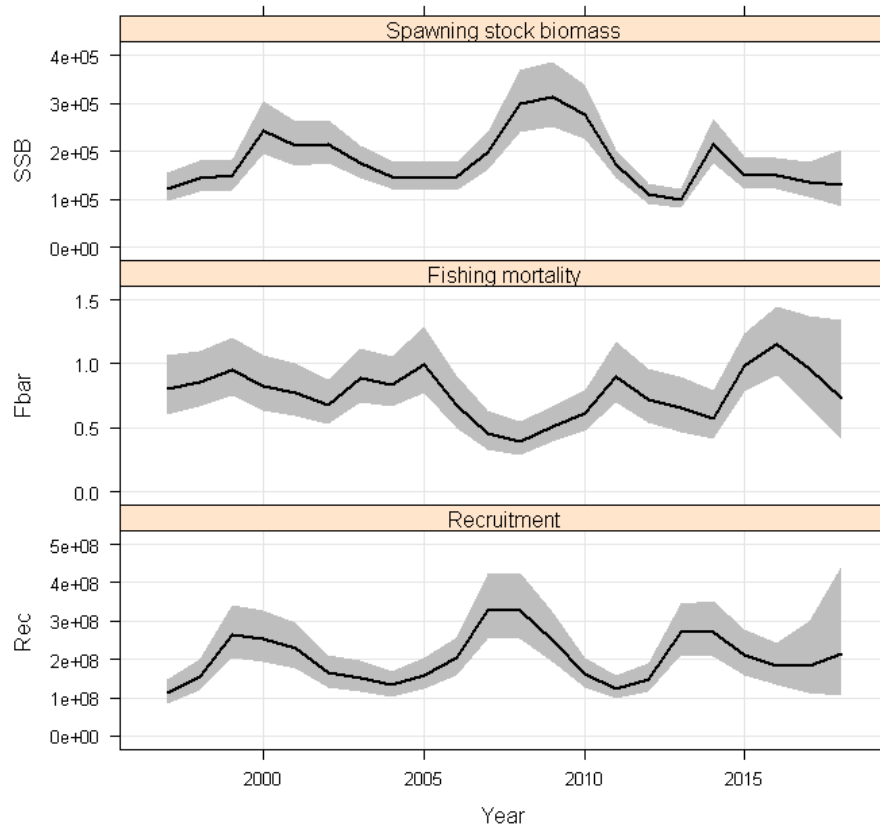
Anchovy in Adriatic



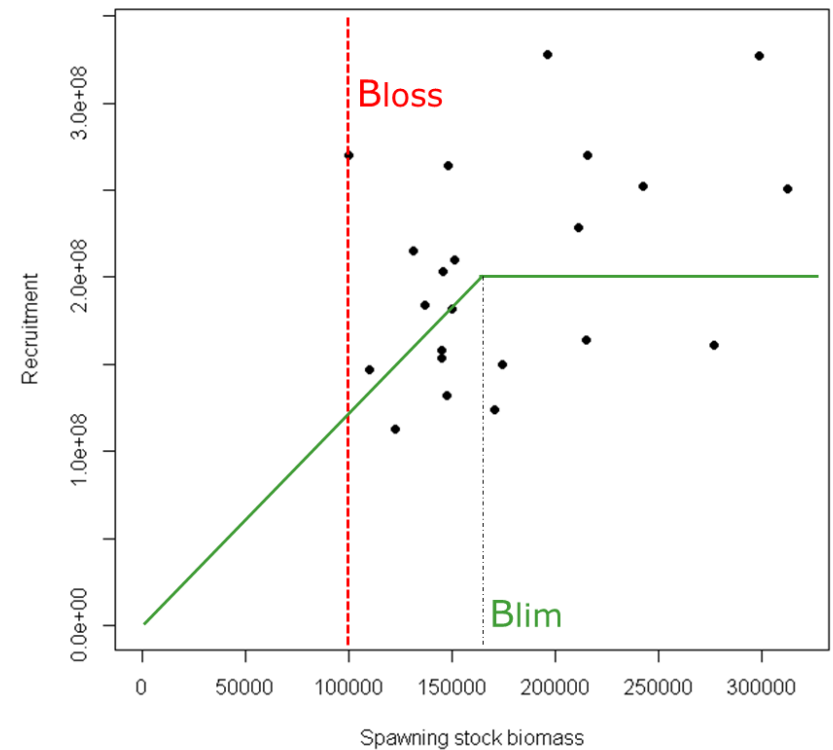


# A little better

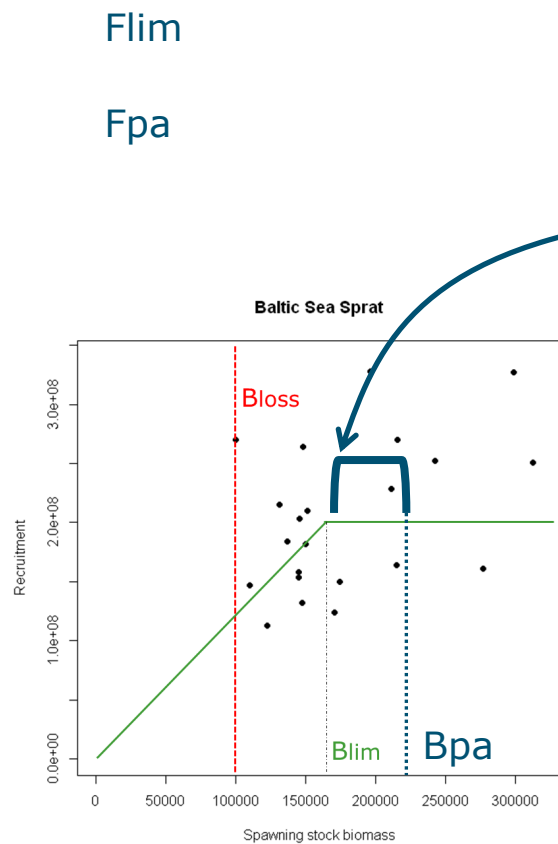
SPRAT BLACK SEA 1997-2018



Baltic Sea Sprat

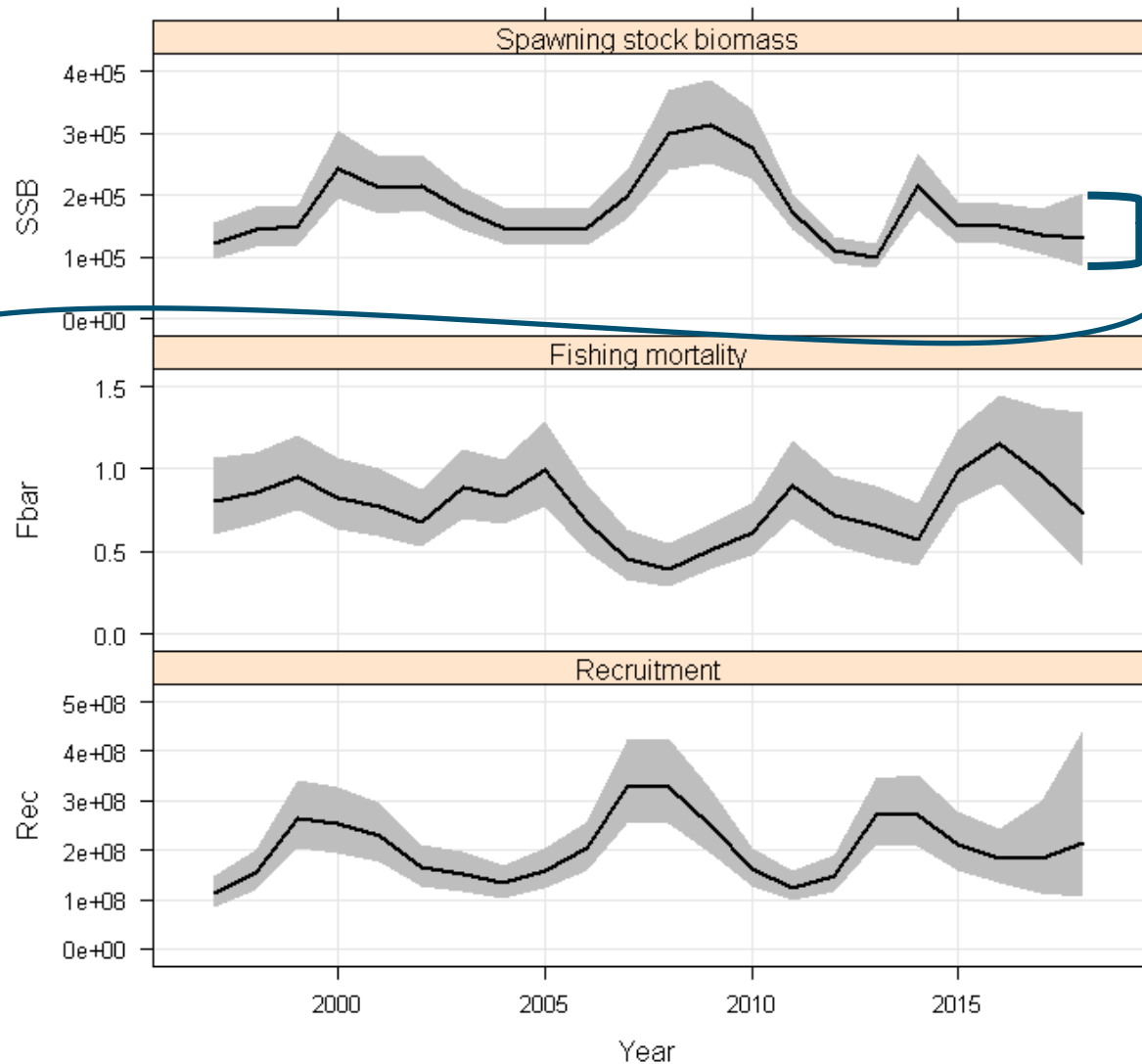


# Stock Recruit-derived reference points



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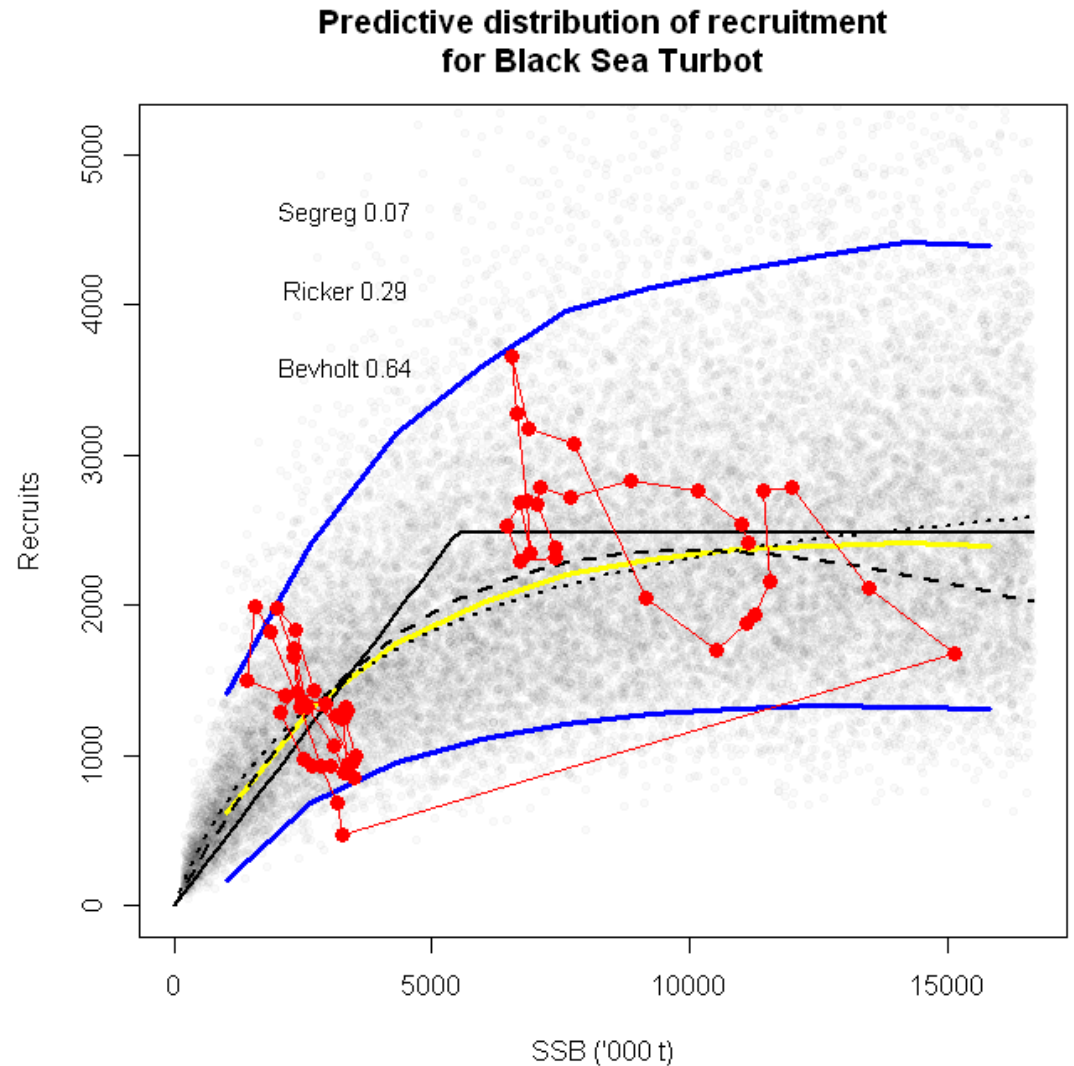
SPRAT BLACK SEA 1997-2018



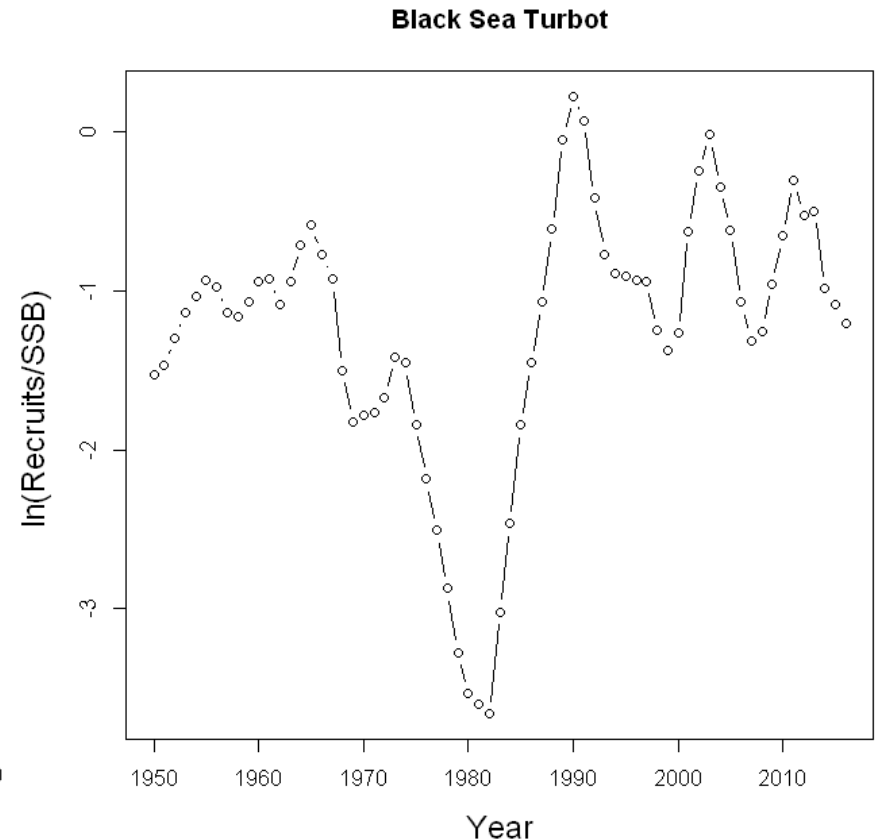
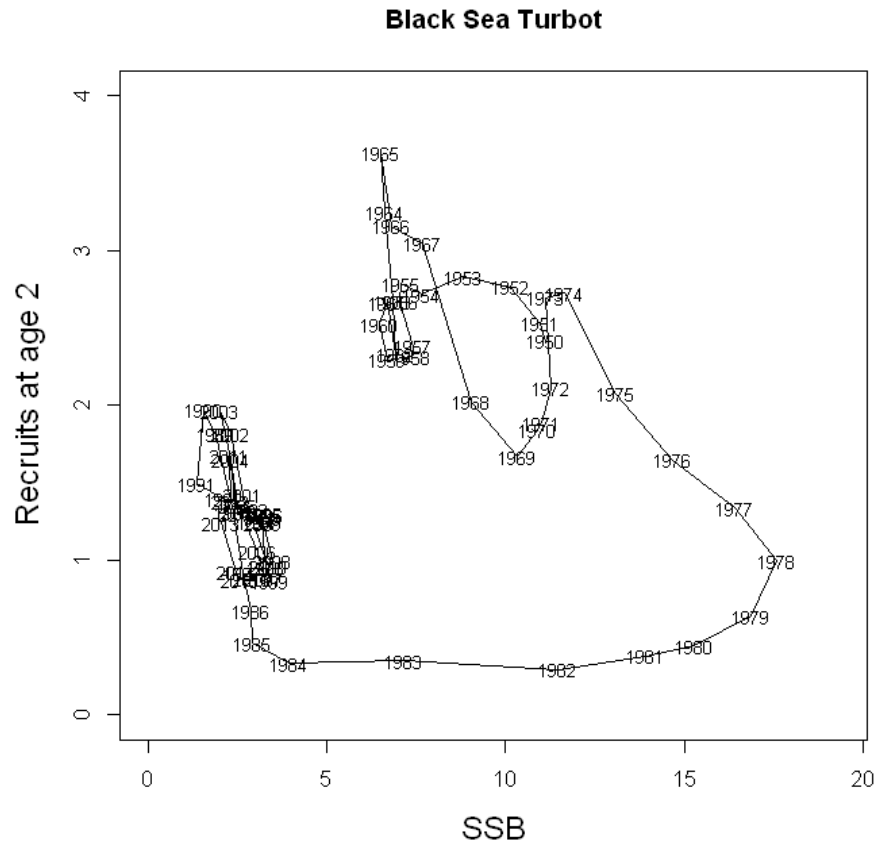
# Uncertainty

# Uncertainty in type of SR relationship

Uncertainty in type of SR relationship

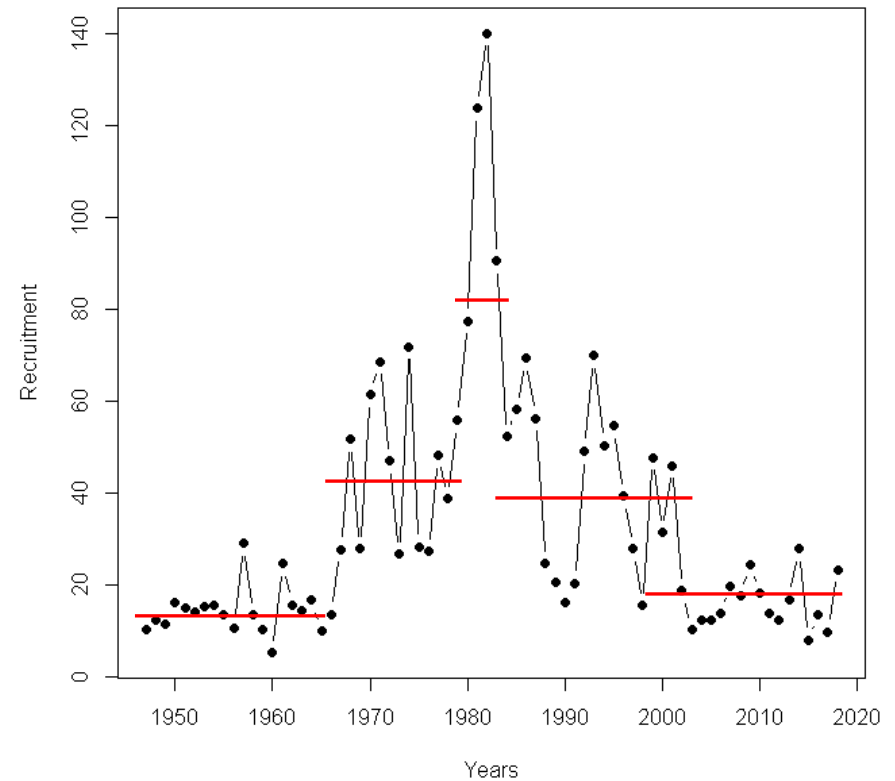


# Uncertainty in section of time-series



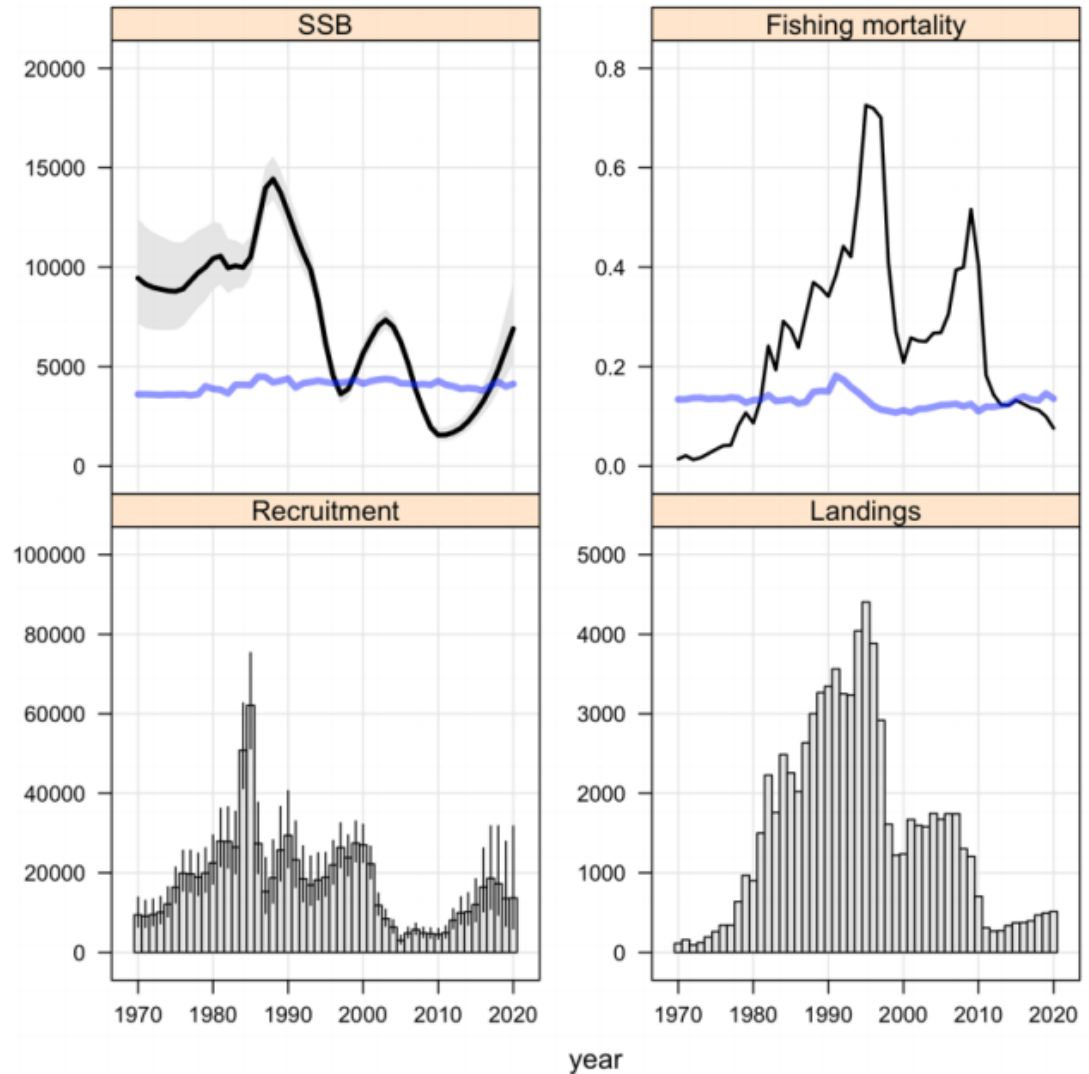
Uncertainty in length of time-series to use  
due to changes in productivity?

# Uncertainty in section of time-series



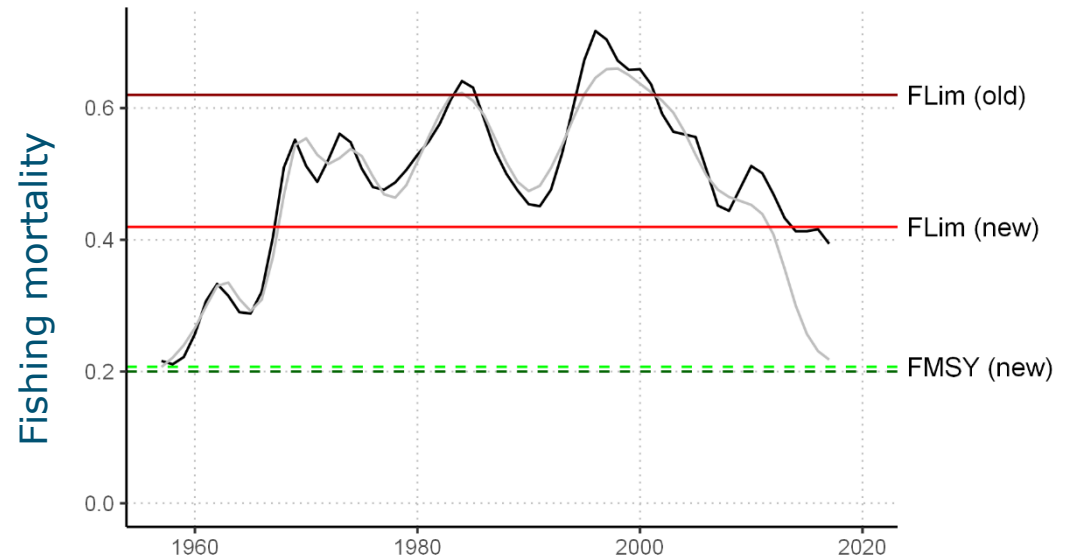
# Uncertainty in stock assessments

Uncertainty due to changes in selectivity



# Uncertainty in stock assessments

Retrospective impact on  
reference points





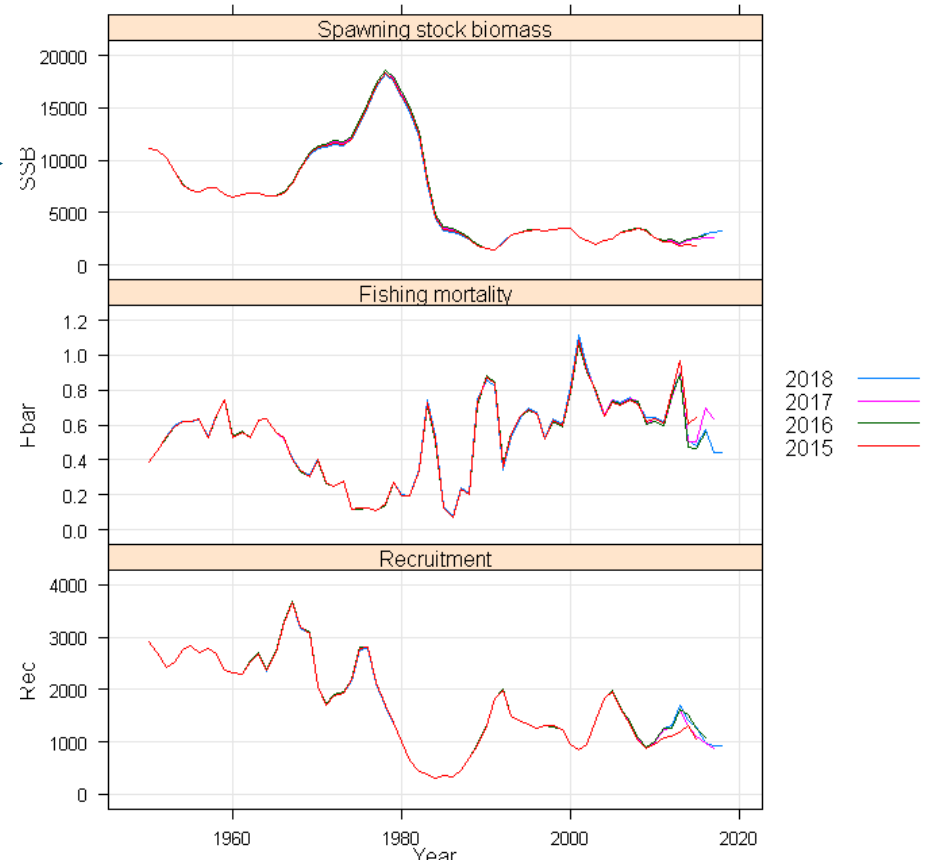
# Uncertainty in stock assessments

Blim not so different



Fmsy variable!  
From 0.17 -> 0.13

## Black sea Turbot



# Eqsim – Rlibrary msy on CRAN

eqsim\_run(

fit = stock recruitment sets -> go for biologically informed

bio.years = biological years of m, mat, weights etc -> recent period but not too short

bio.const = keep year vector constant or not -> FALSE please

sel.years = selection pattern years -> recent period

sel.const = keep year vector constant or not -> FALSE please

Fscan = scan over certain range of Fbar values -> depends on your stock

Fcv = assessment error in the final year, -> from your final assessment (NOT TOO SMALL)

Fphi = autocorrelation in assessment error (usually) -> default 0.423

SSBcv = assessment error in the final Year -> from your final assessment (NOT TOO SMALL)

rhologRec = autocorrelation in recruitment -> best = TRUE,

Blim = limit reference point,

Bpa = precautionary reference point,

recruitment.trim = trimmer outliers

Btrigger = ICES advice rule,

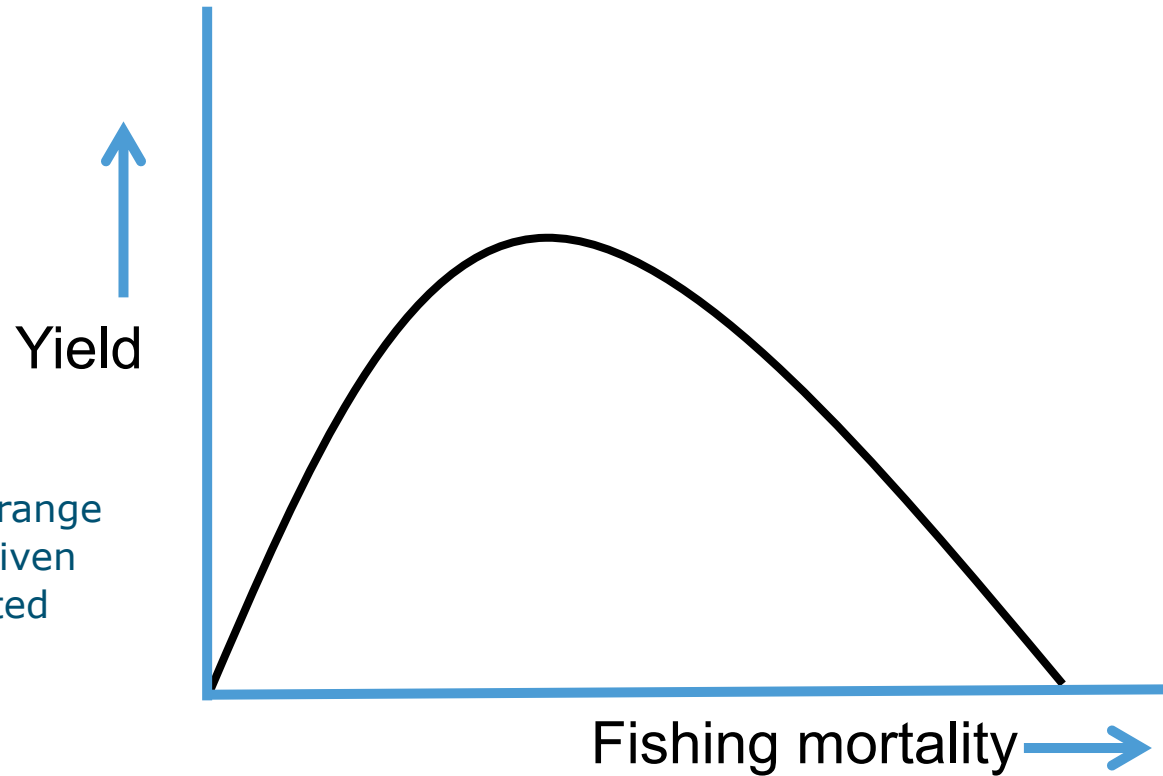
Nrun = number of runs,

process.error = include observation error in recruitment,

)

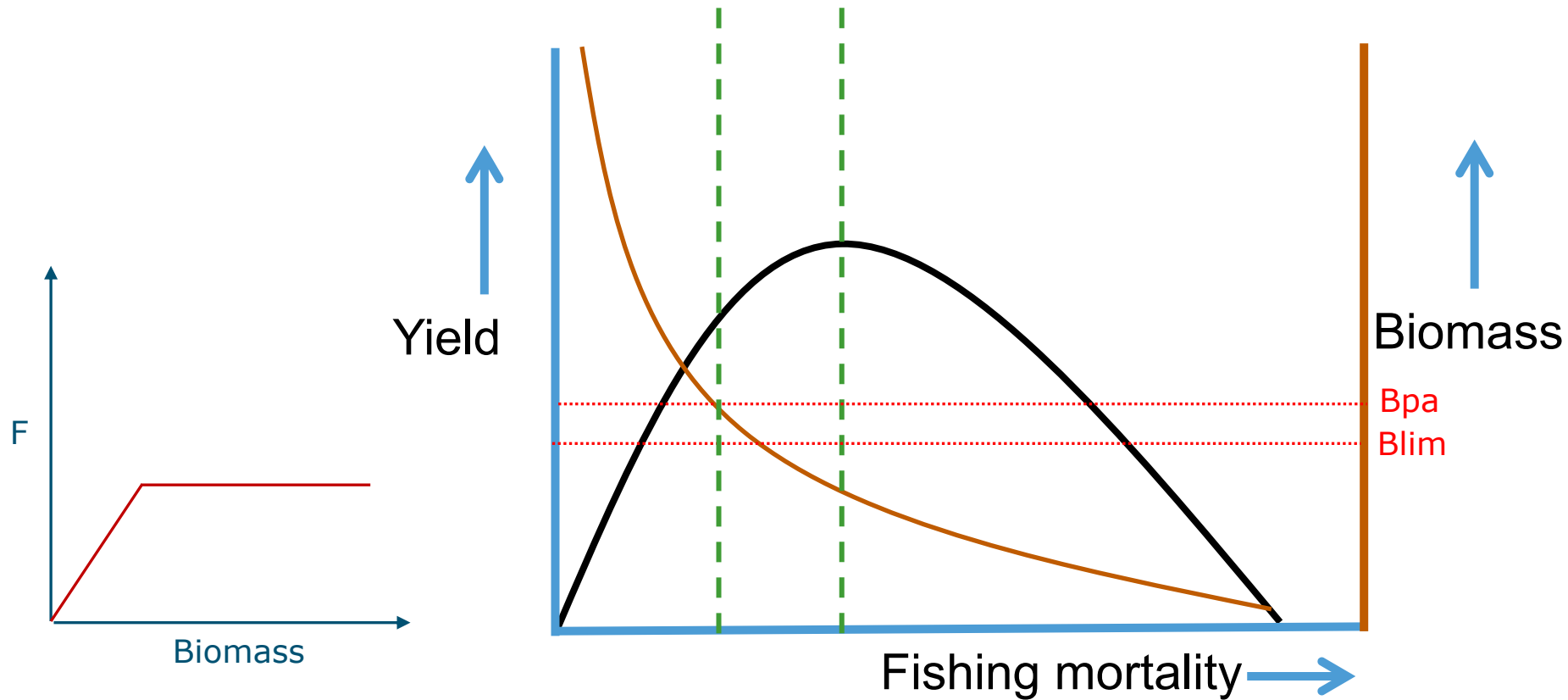


# Eqsim – Estimation of $F_{msy}$

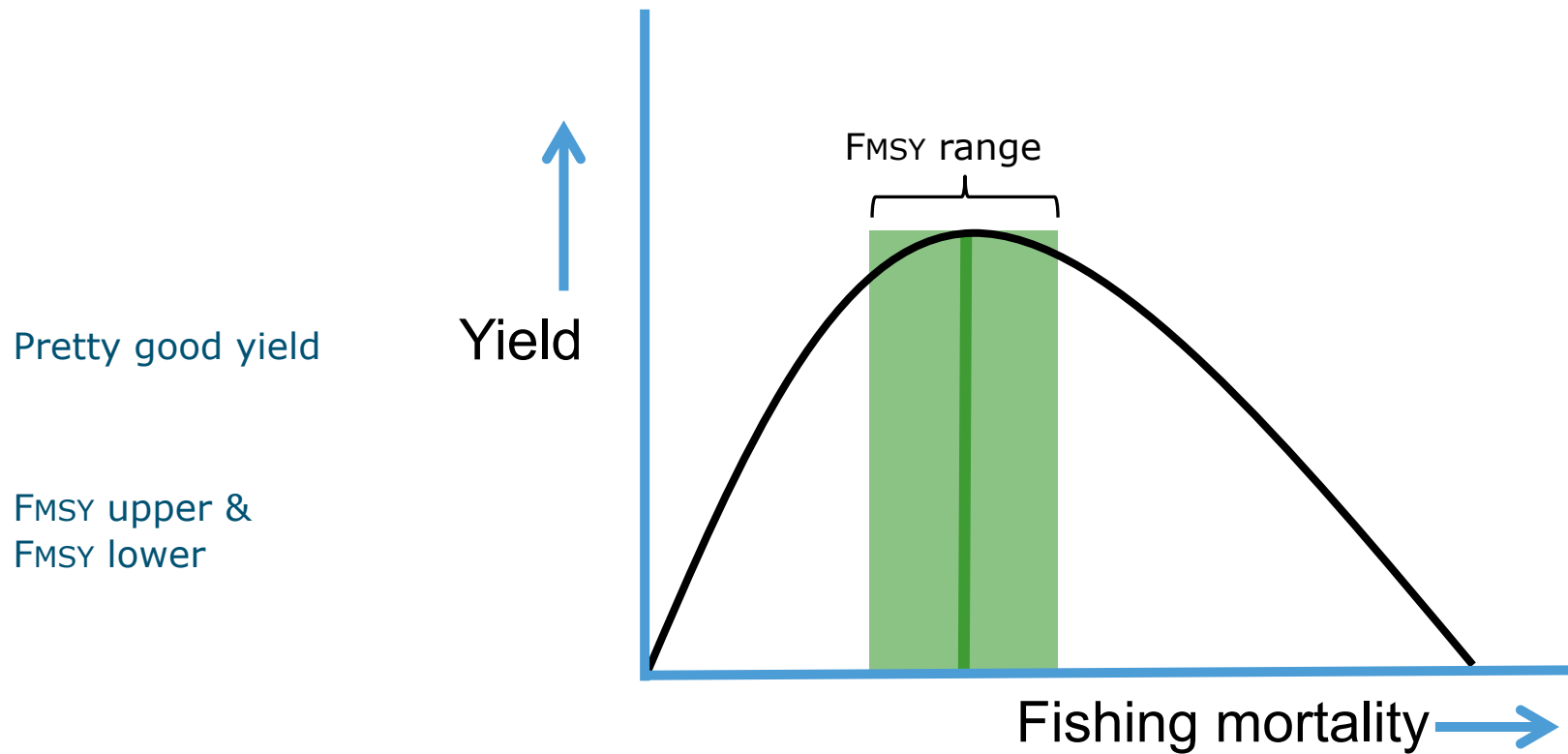


Eqsim scans over a large range of  $F$  values to find  $F_{msy}$  given the uncertainty incorporated

# Eqsim – Constrained estimation of $F_{msy}$

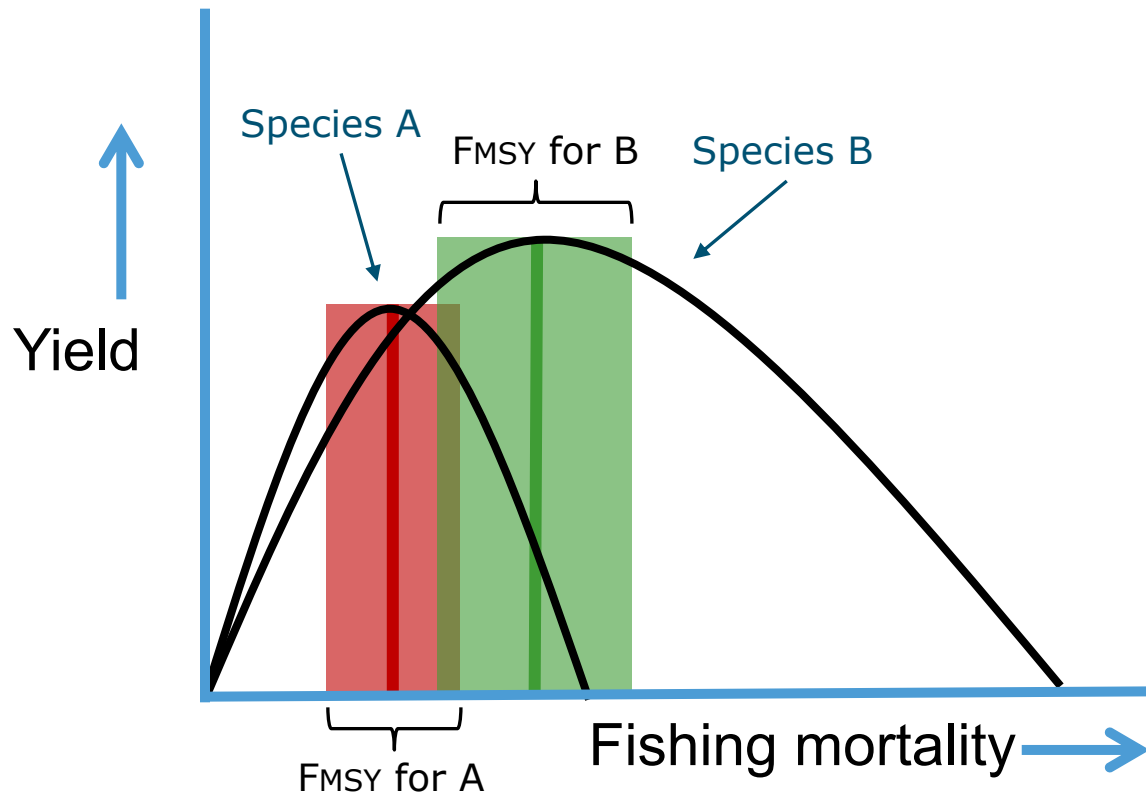


# Uncertainty in stock assessments

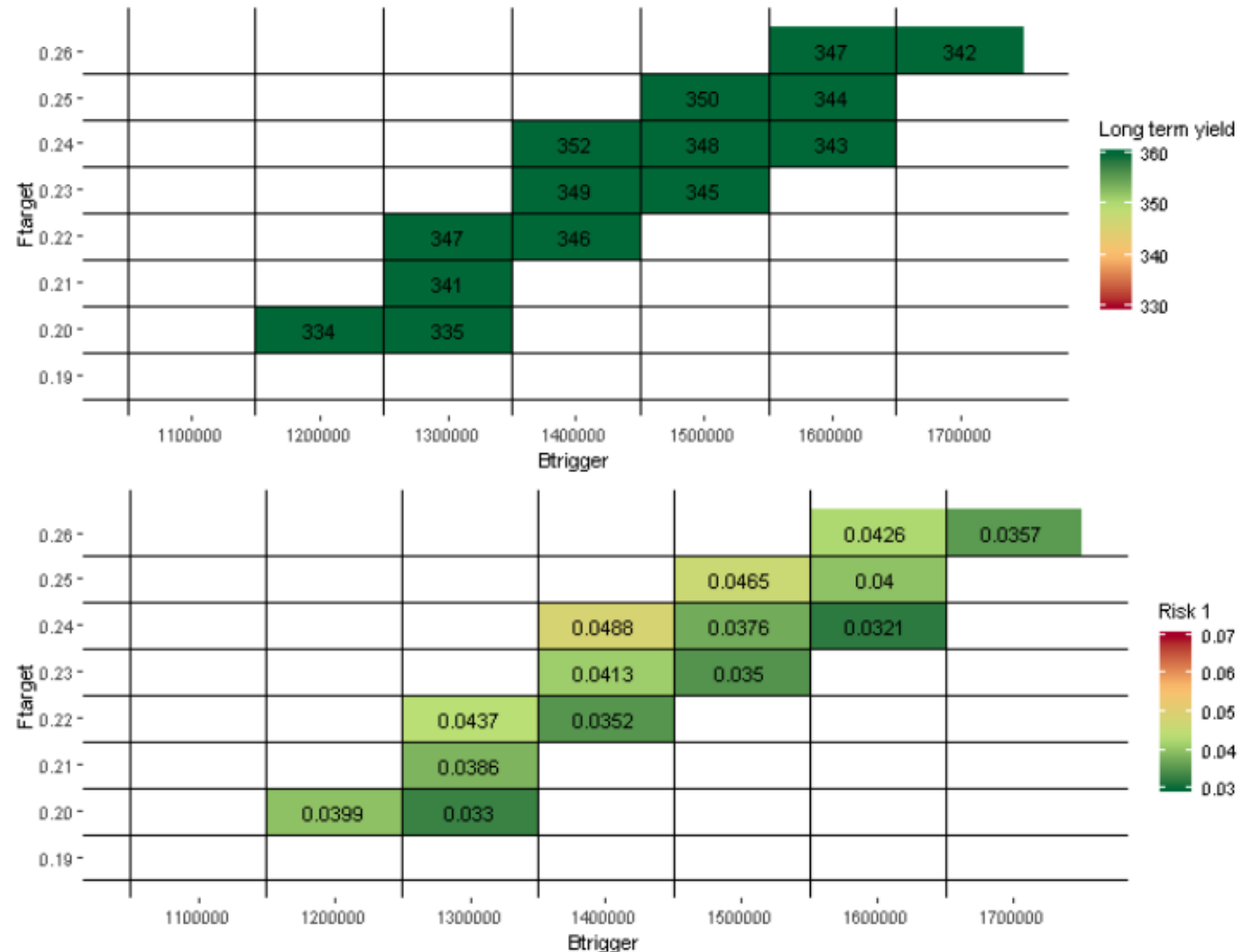
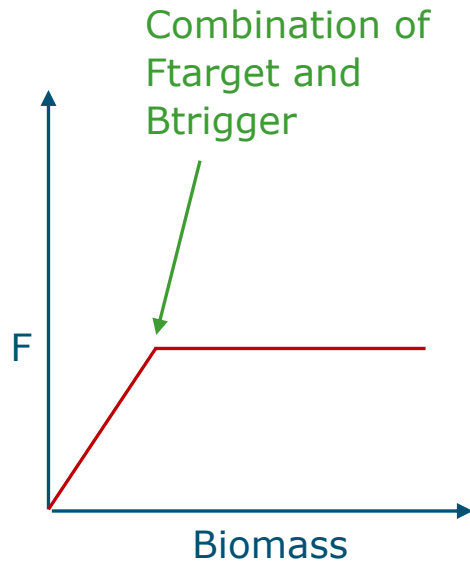


## Other things to keep in mind

# Mixed fisheries



# Role of MSE in reference points





# Take home message

A lot has been written on reference points

A lot of manuals are available

Do not re-invent the wheel but keep an open mind  
and use **common sense!**

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# Thank you for your attention

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