On sensible harvest rate

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Overview of the presentation

- A riddle
- Characteristics of fisheries data
- The illusive maximum sustainable yield

Will use the Icelandic cod data and analysis as a illustrative case:

- Review of the pattern in fisheries data
- Glimpse into how we do HCR evaluations and the principal pattern observed

A riddle

The catch equation:

- $Catch = Harvest\ rate * Biomass$

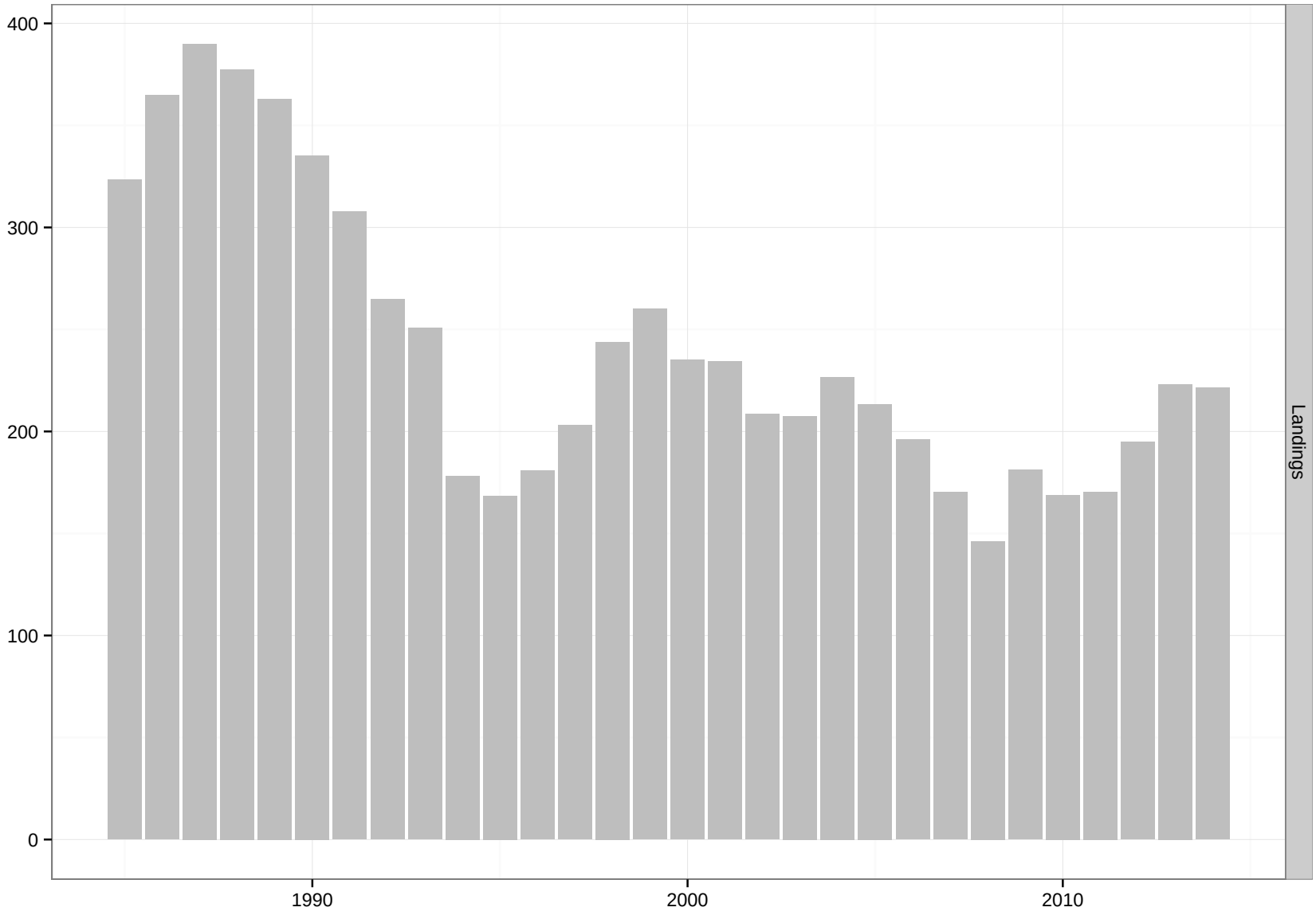
Only two options provided for managers:

- A 500 kt biomass and a harvest rate of 0.4
- A 1000 kt biomass and a harvest rate of 0.2

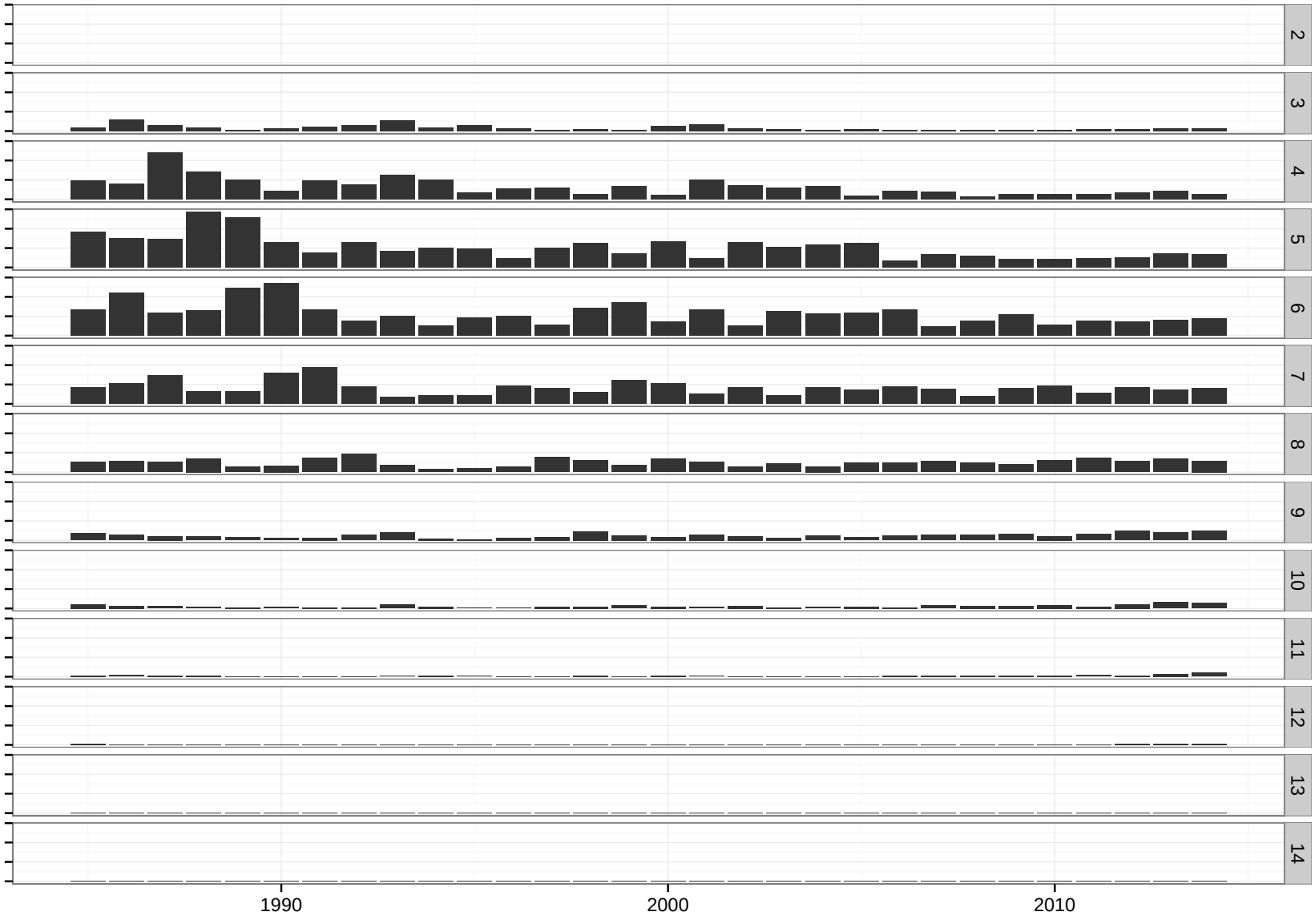
Which scenario would or should one pick?

Characteristics of fisheries dynamics

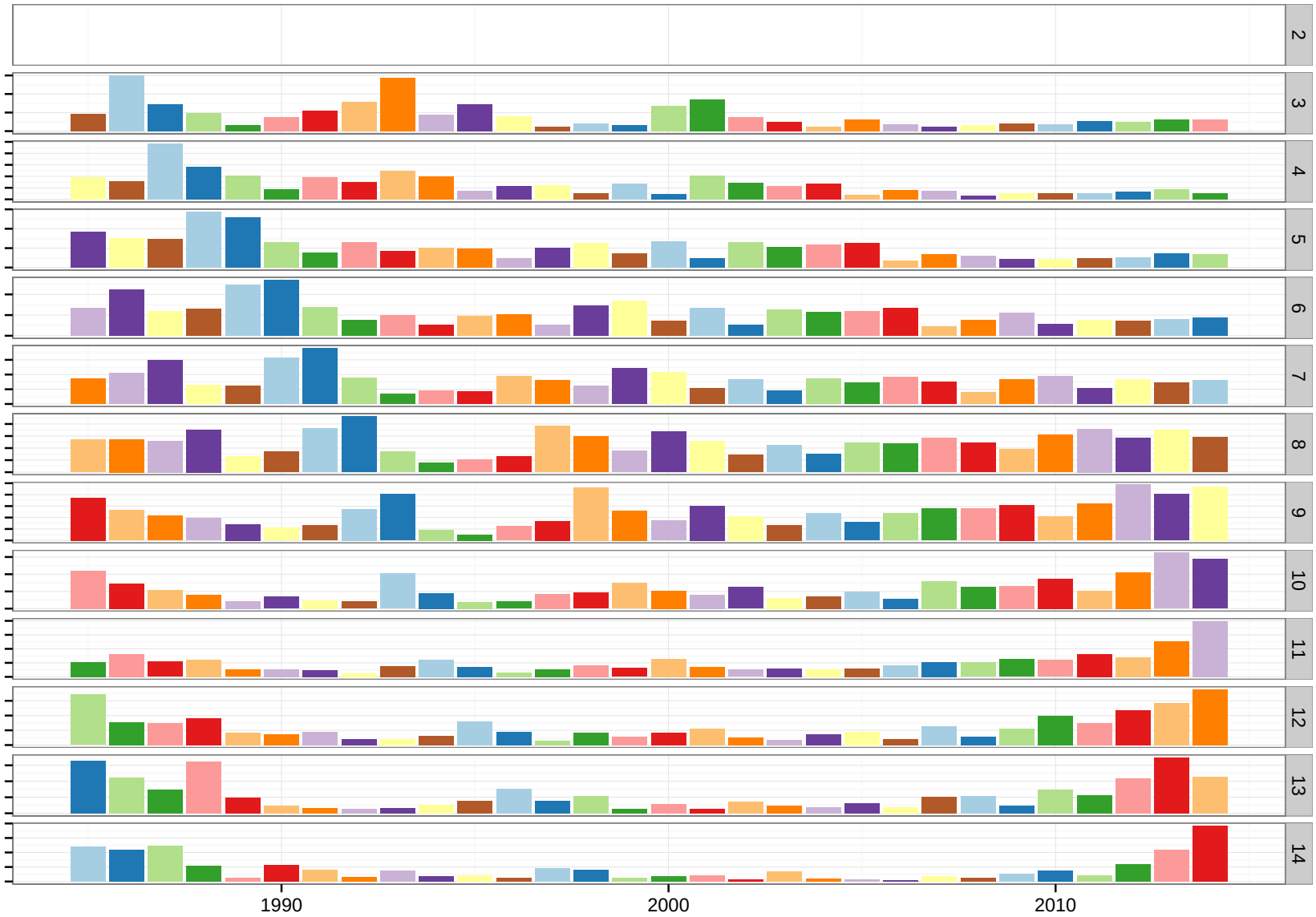
Landings



Landings by age

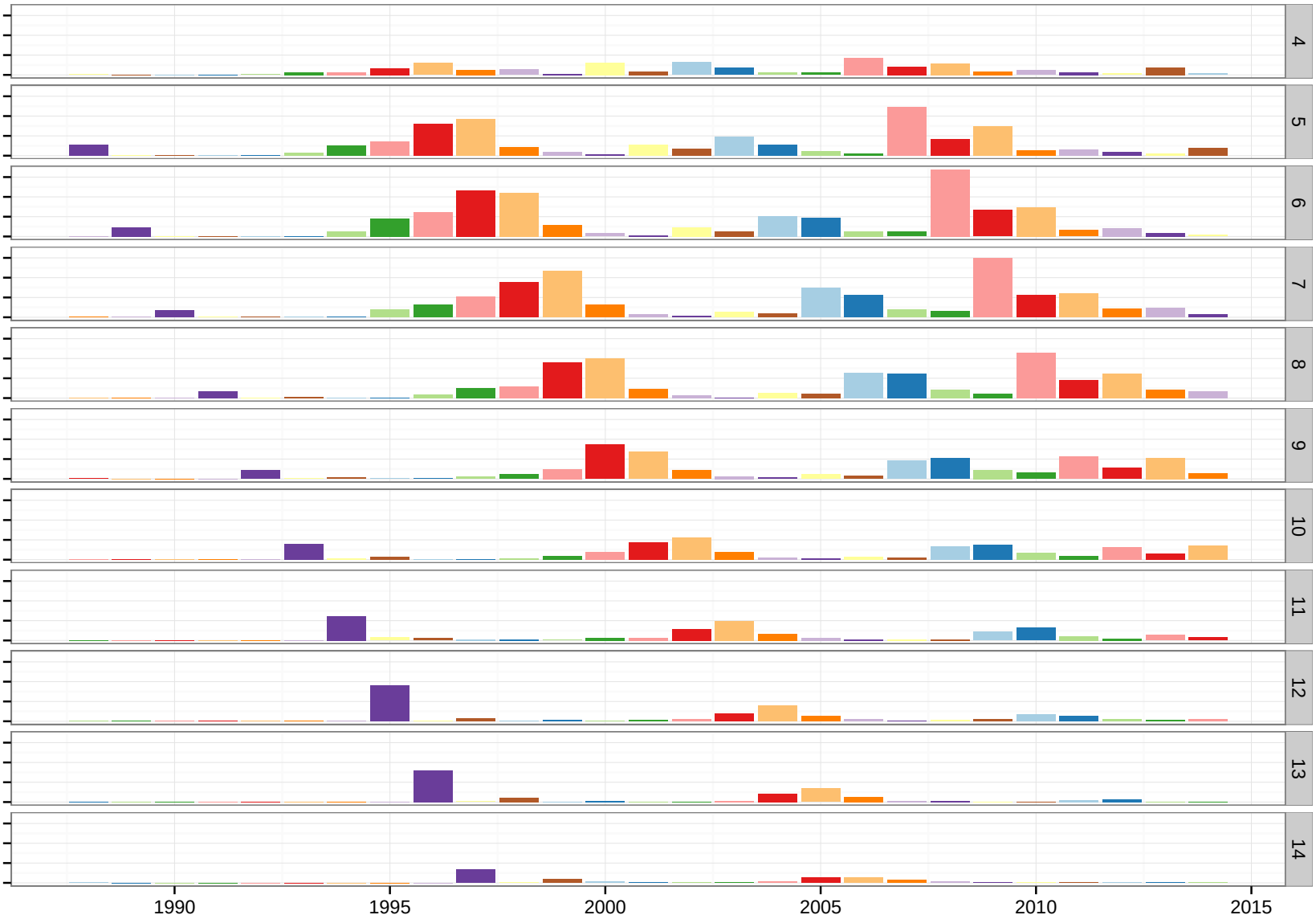


Landings by age and year classes



Survey indices

Landings by age and year classes (Herring)



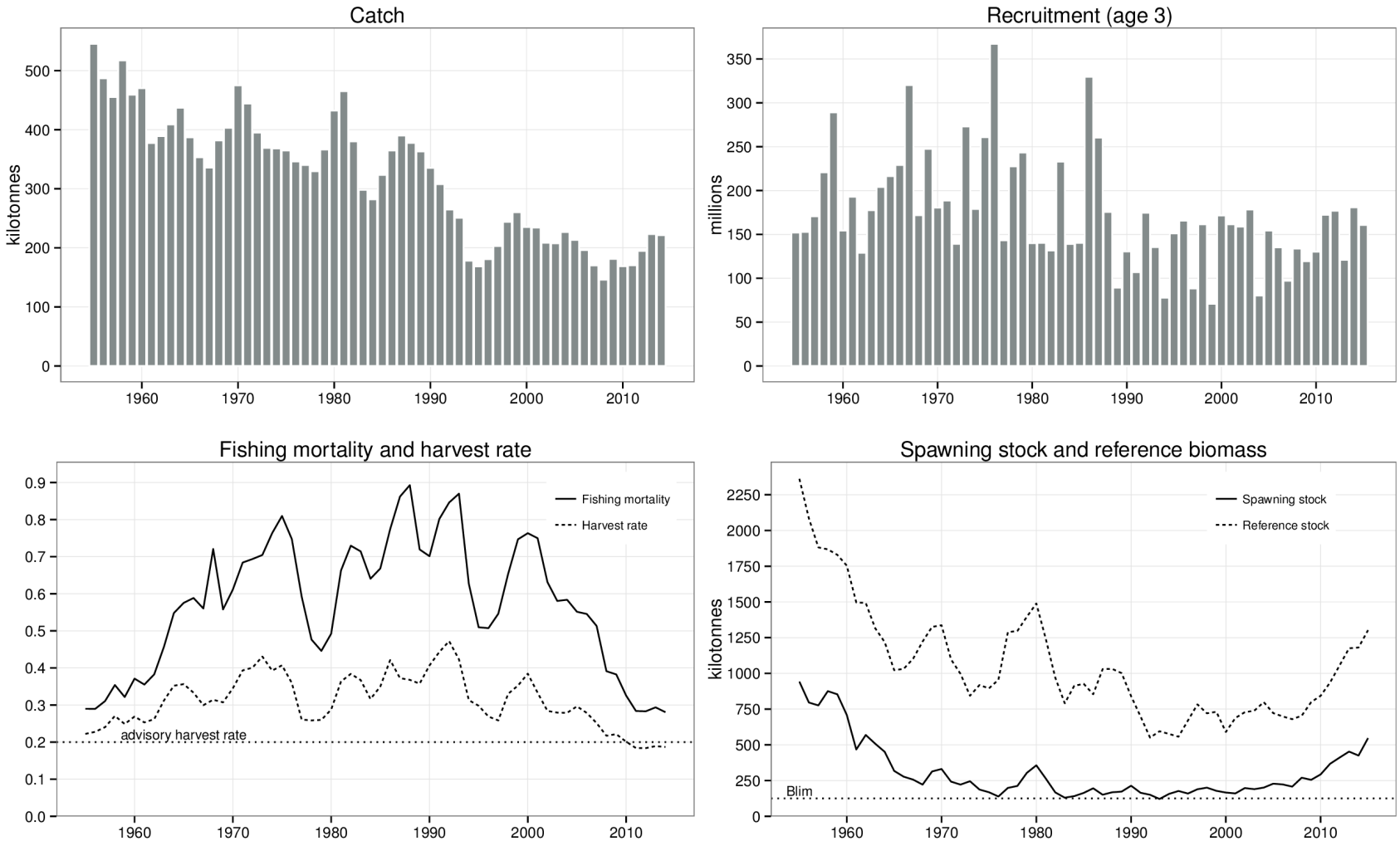
Dynamics

The signal in the data becomes apparent when following year classes

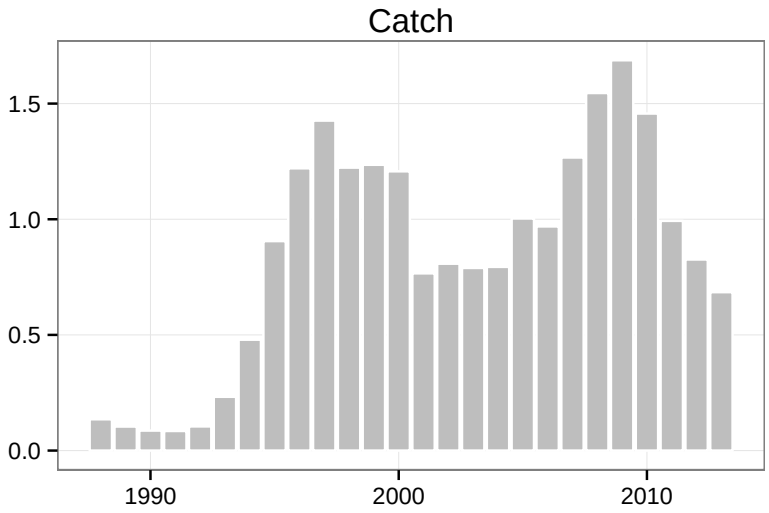
General characteristic of catch (fisheries) and survey data:

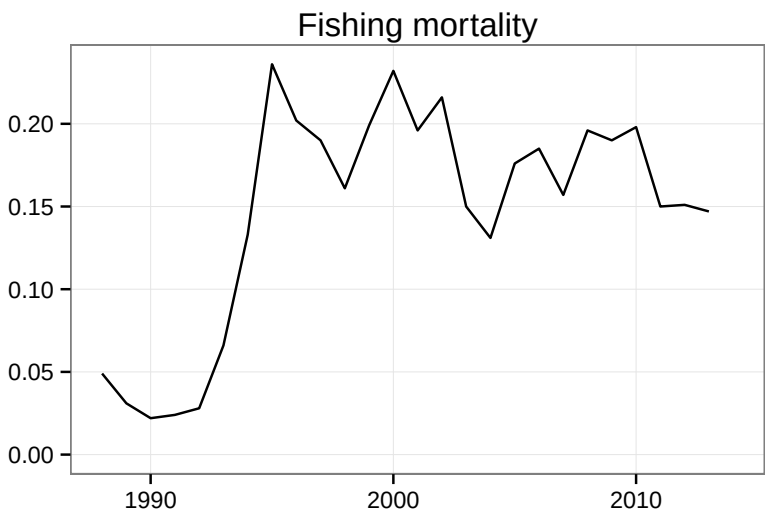
- Year class size is generally determined at a young age
- Year class sizes can be highly variable between consecutive years
- A year class contributes to the total catches over a number of years
- How quickly year classes declines is a measure of fishing pressure

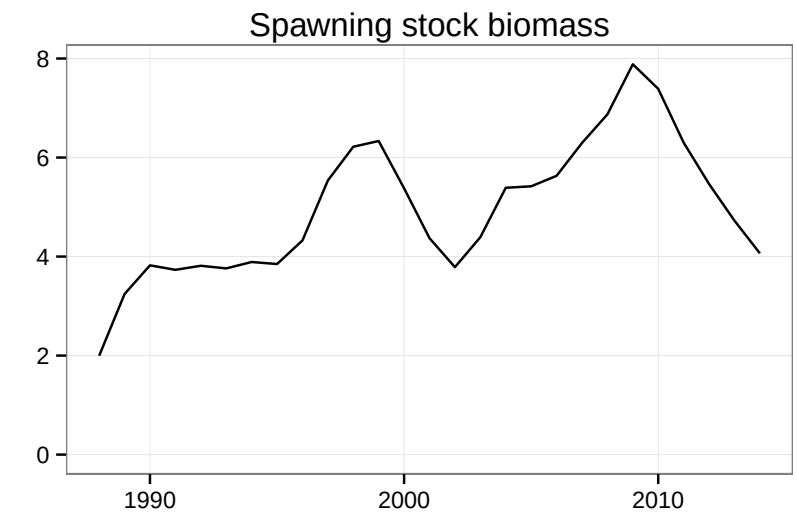
Stock assessment (Cod)



Stock assessment (Herring)







HCR evaluations and the illusive maximum sustainable yield

Question

Taking into account:

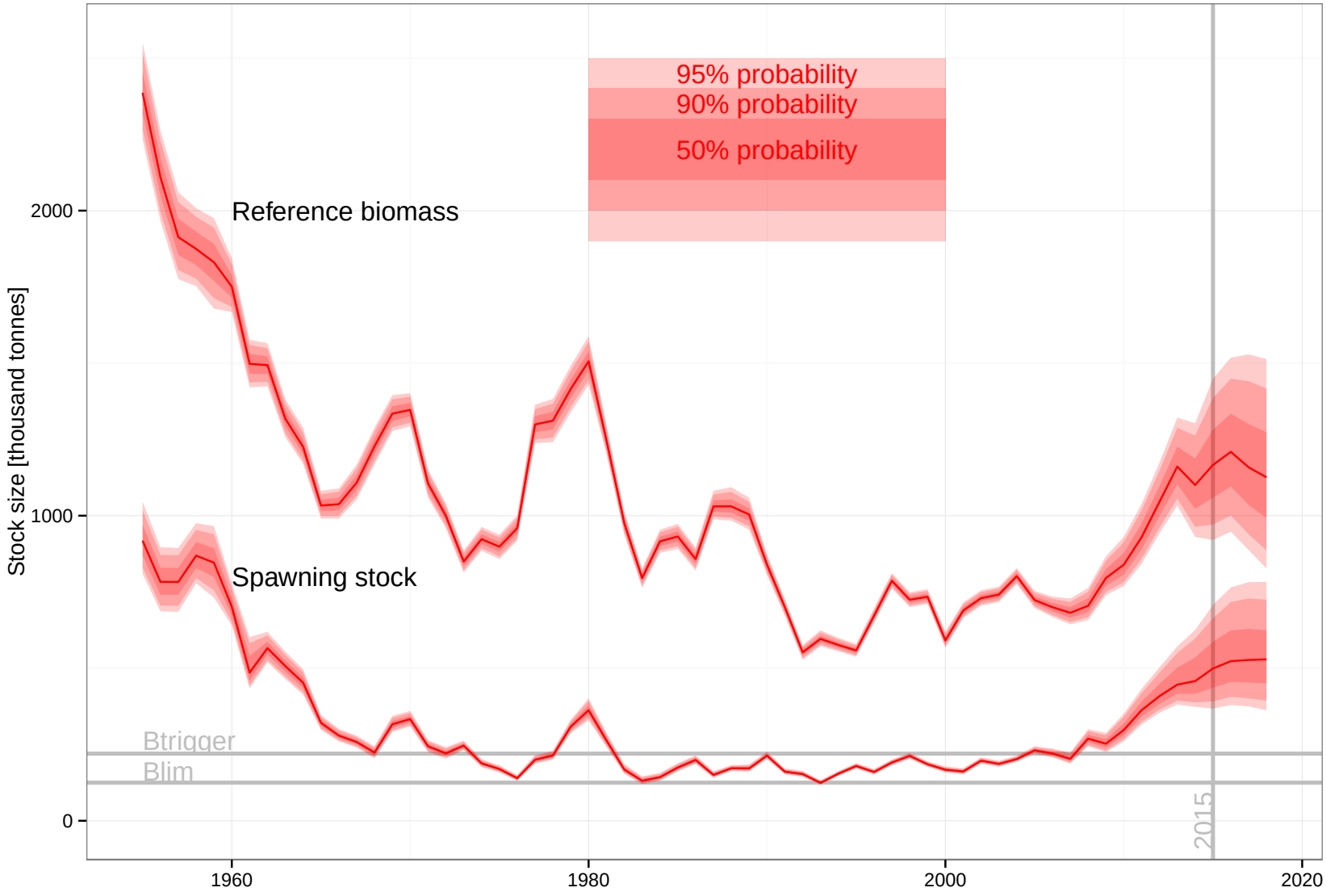
- Assessment error
- Growth
- Stock-recruitment dynamics
- Long term concerns/view

what is the most sensible harvest rate (fishing mortality) when making decision on next years catch?:

$$TAC = Harvest\ rate * Biomass$$

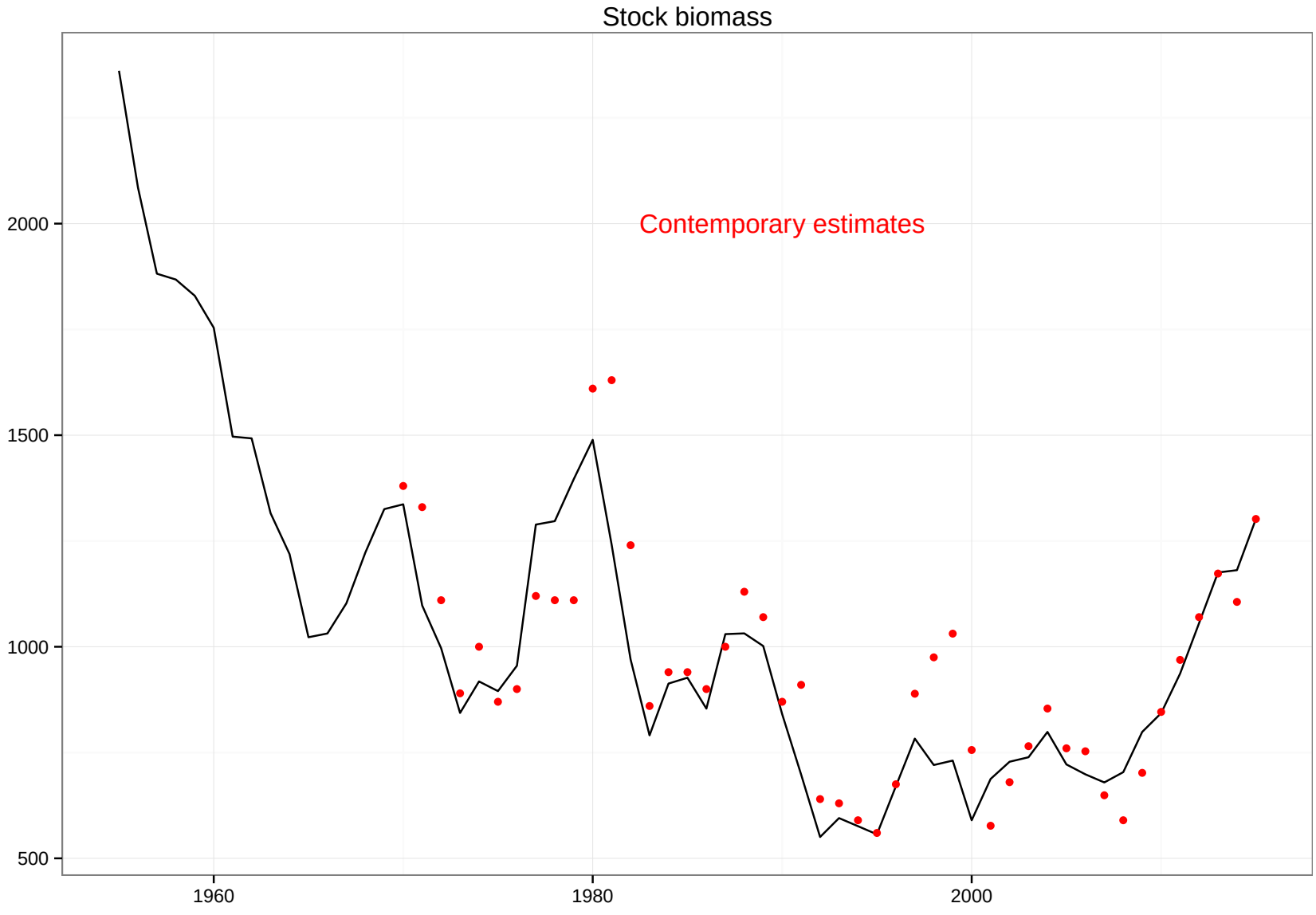
To solve the riddle we currently use a HCR simulation framework

Stock assessment and uncertainty (Cod)



Highest uncertainty in the terminal (decision) year

Assessment error



Assessment error - ratio

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## Joining by: "year"
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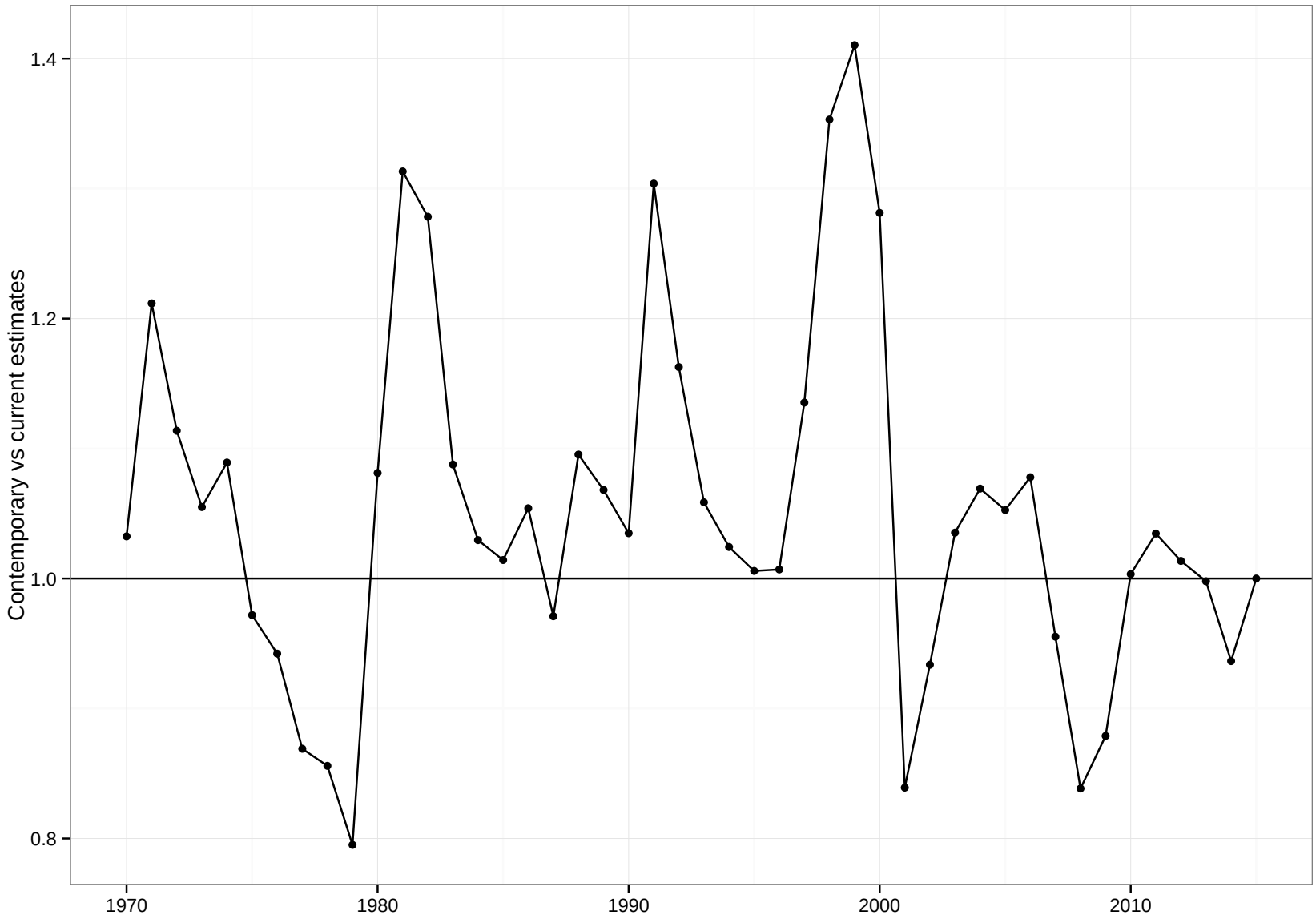
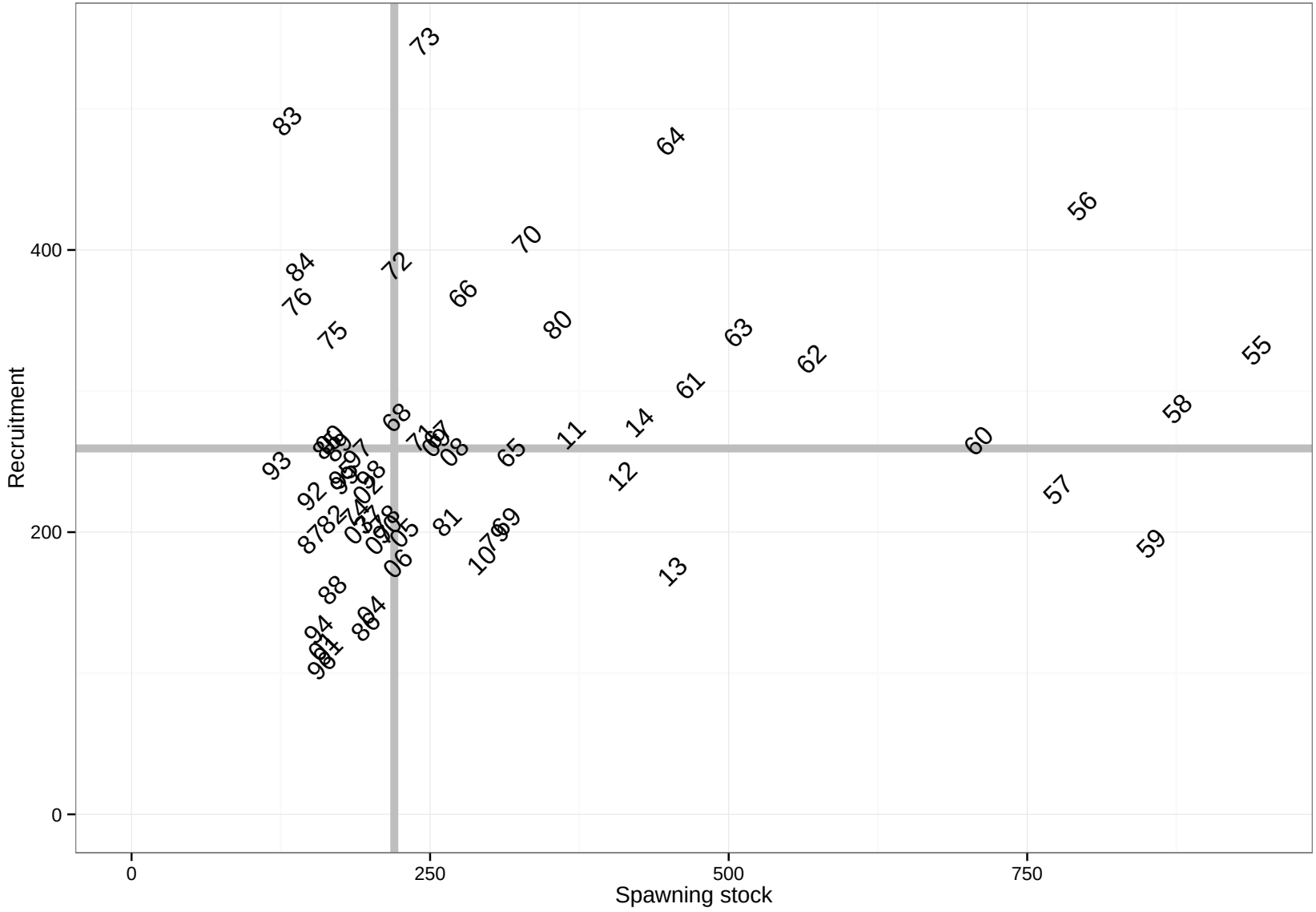
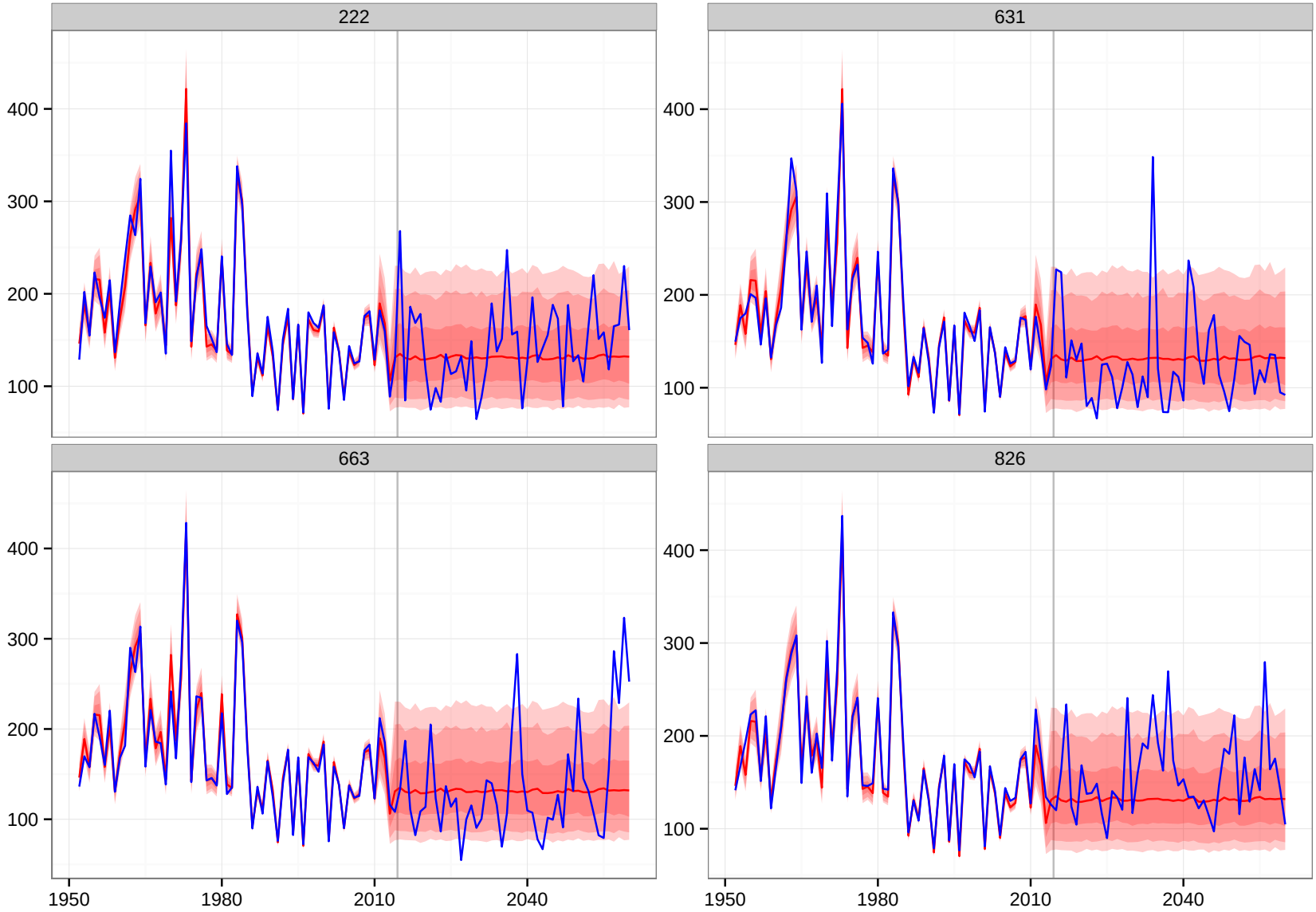


A stock recruitment scenario



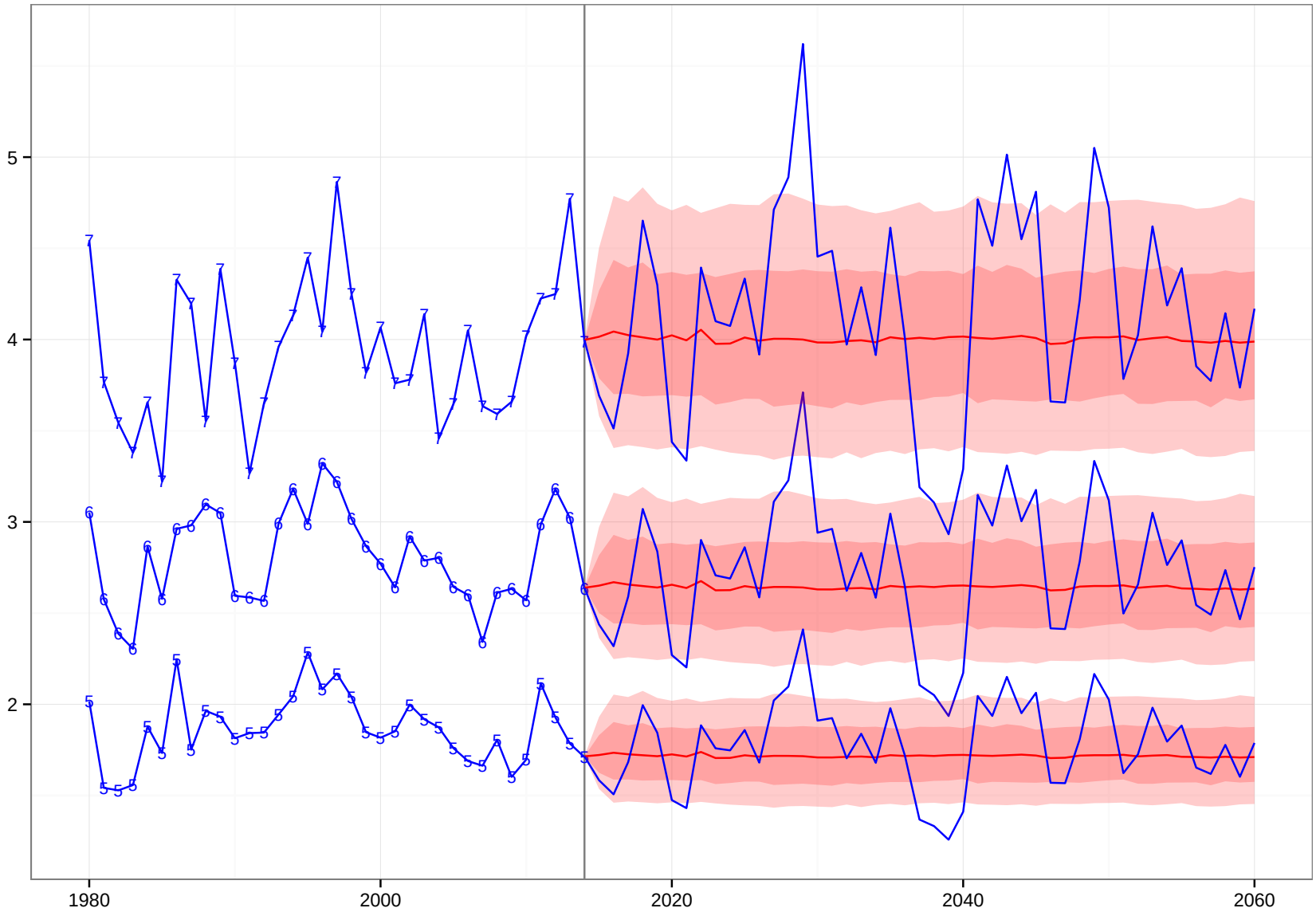
Higher frequency of poor recruitment below ~ 220 kt spawning stock

Randomness in future recruitment - 4 iterations

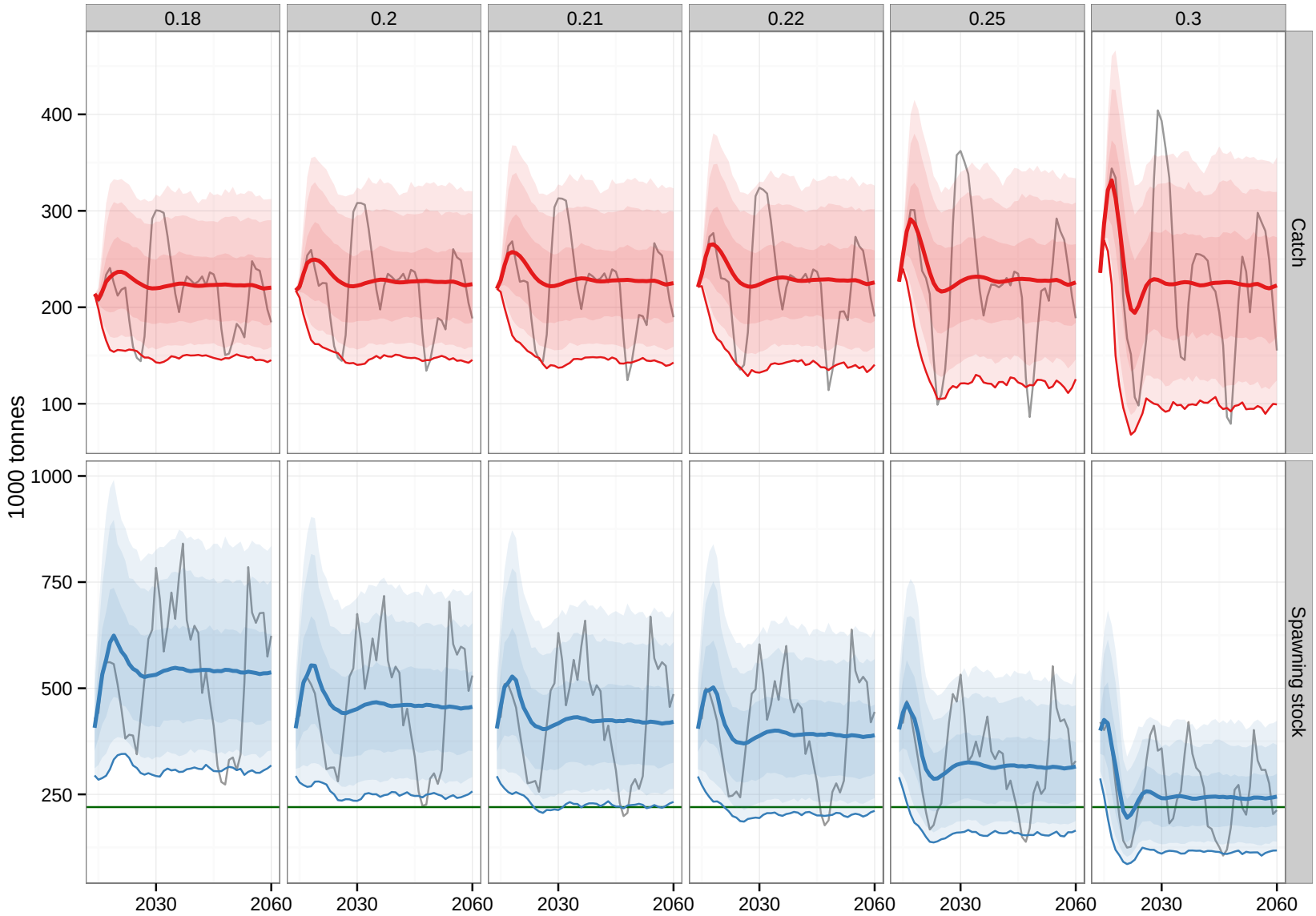


Pessimistic future recruitment scenario

Weight at age modeled as a random process



Results: Catch and stock dynamics

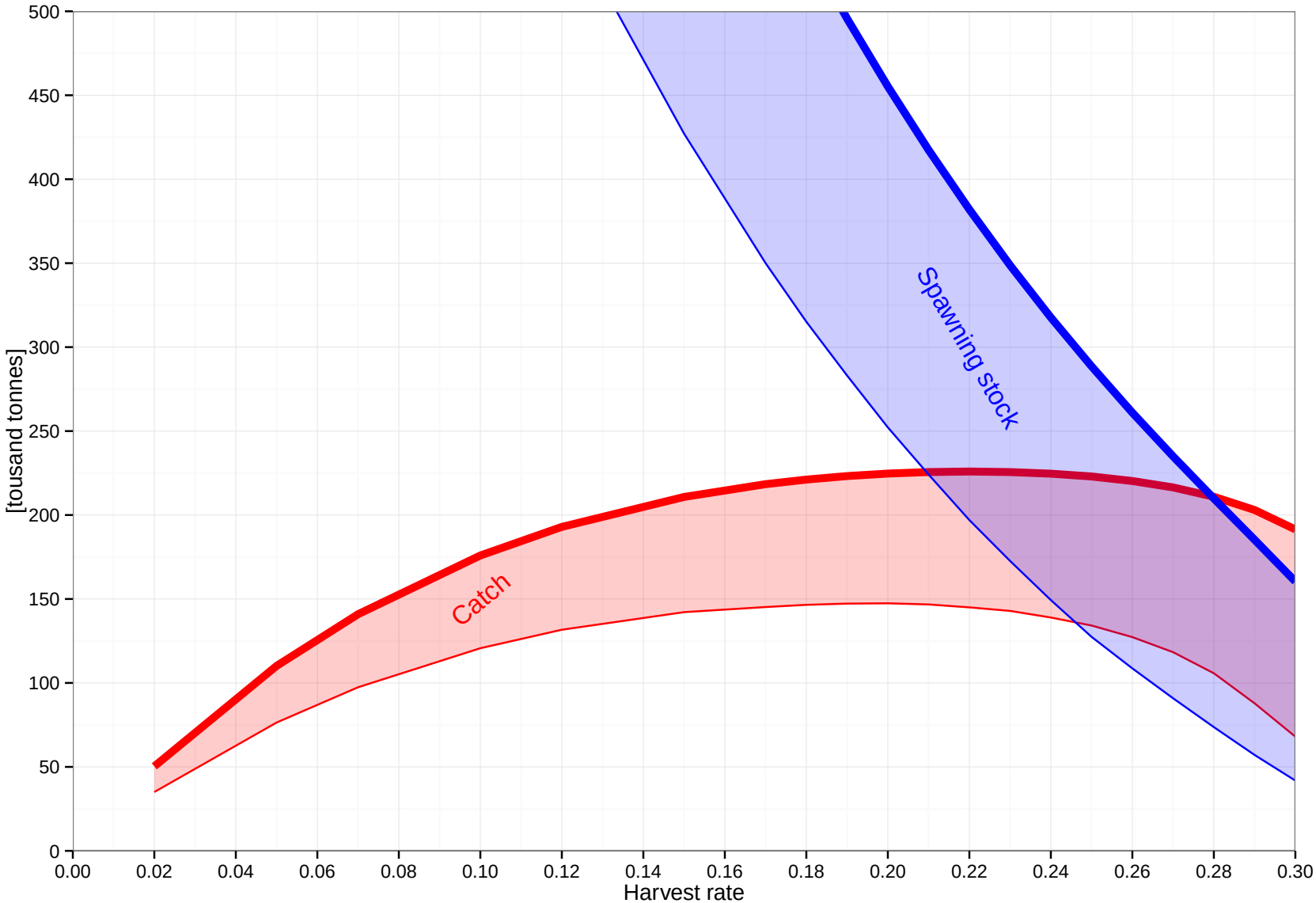


Summary of the general pattern

Within a certain range increased harvest rate in a decision rule leads to:

- Short term
  - A temporary gain in catches
- Long term considerations (sustainability)
  - Little or no gain in mean catches
  - Catches become more variable
  - Biomass decreases ($\sim$ exponentially)
  - Probability of stock size going below some undesirable size increases

Under long term considerations



Deciding on a multiplier in a HCR

- The evaluation methodology is pretty much in place
- The results are pretty much the same, irrespective of stock:
  - Over some range sensible of harvest rates the catch does not change much
  - Over this range the stock declines ($\sim$ exponentially)

Deciding on a multiplier in a HCR

What complicates things and delays actions:

- Biology:
  - Uncertain stock recruitment relationship
  - The potentiality of density-dependence
  - Single species considerations
- Complexity of the decision rule requested to be evaluated
  - Simpler rules are better
- The number of HCR options requested to explore
  - The results are more or less the same
- Frequency of "special requests"
- Managers focus/obsession on getting the maximum "squeezable" harvest rate from the fisheries scientists (the illusive F_{msy})
  - A short term focus

Thanks