MSAB Meeting, May 5-6, 2014

IPHC MSAB Operating Model Update

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Outline

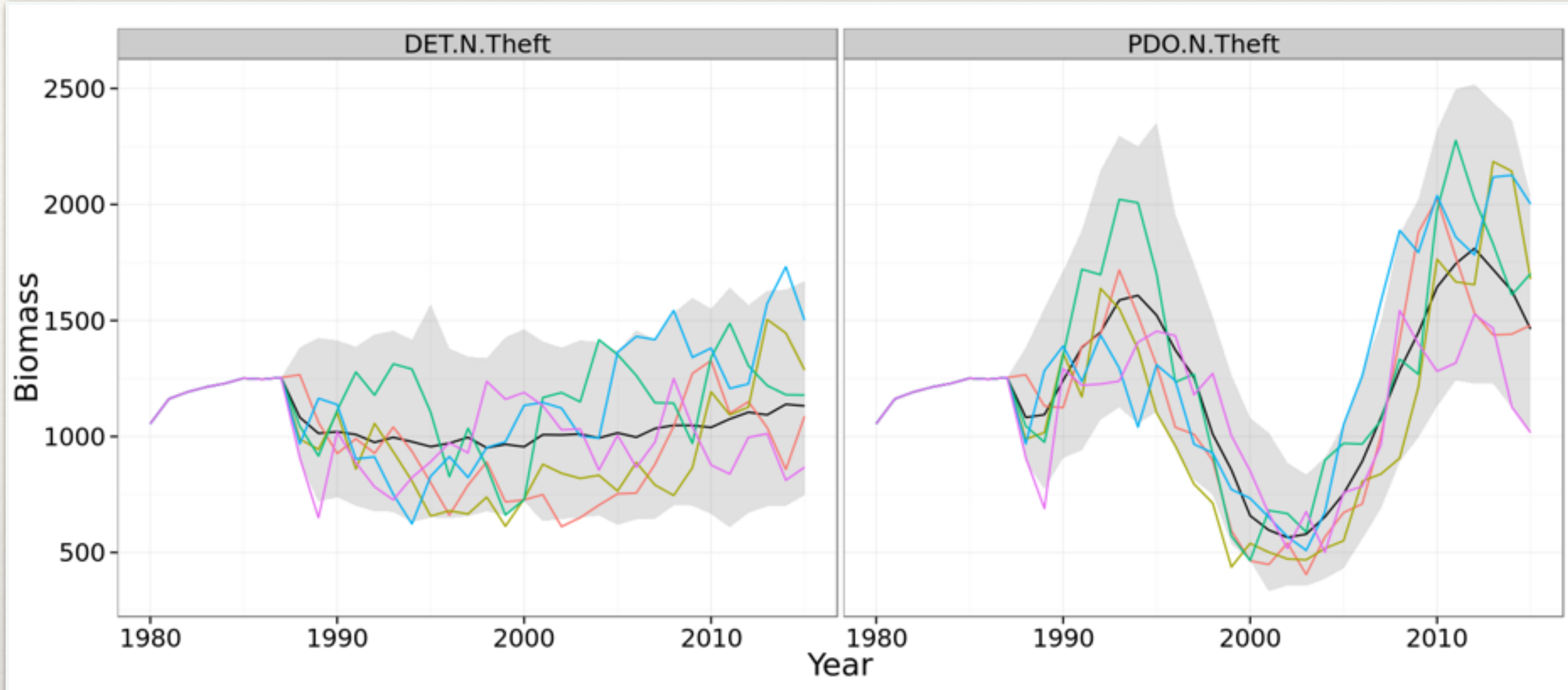
- Review MSE–process & Operating Model
- Introduction to iSCAM–Milka
- Conditioning operating model
- Simple example:
    - Implications of size-limits.
- The todo list:
- Discussion

MSE process

- Assess the consequences of the status quo and alternative management procedures and expose the tradeoffs across the range of management objectives:
  - biological sustainability, fisheries sustainability, assurance of access, minimize bycatch, serve consumer needs.

What is an Operating Model?

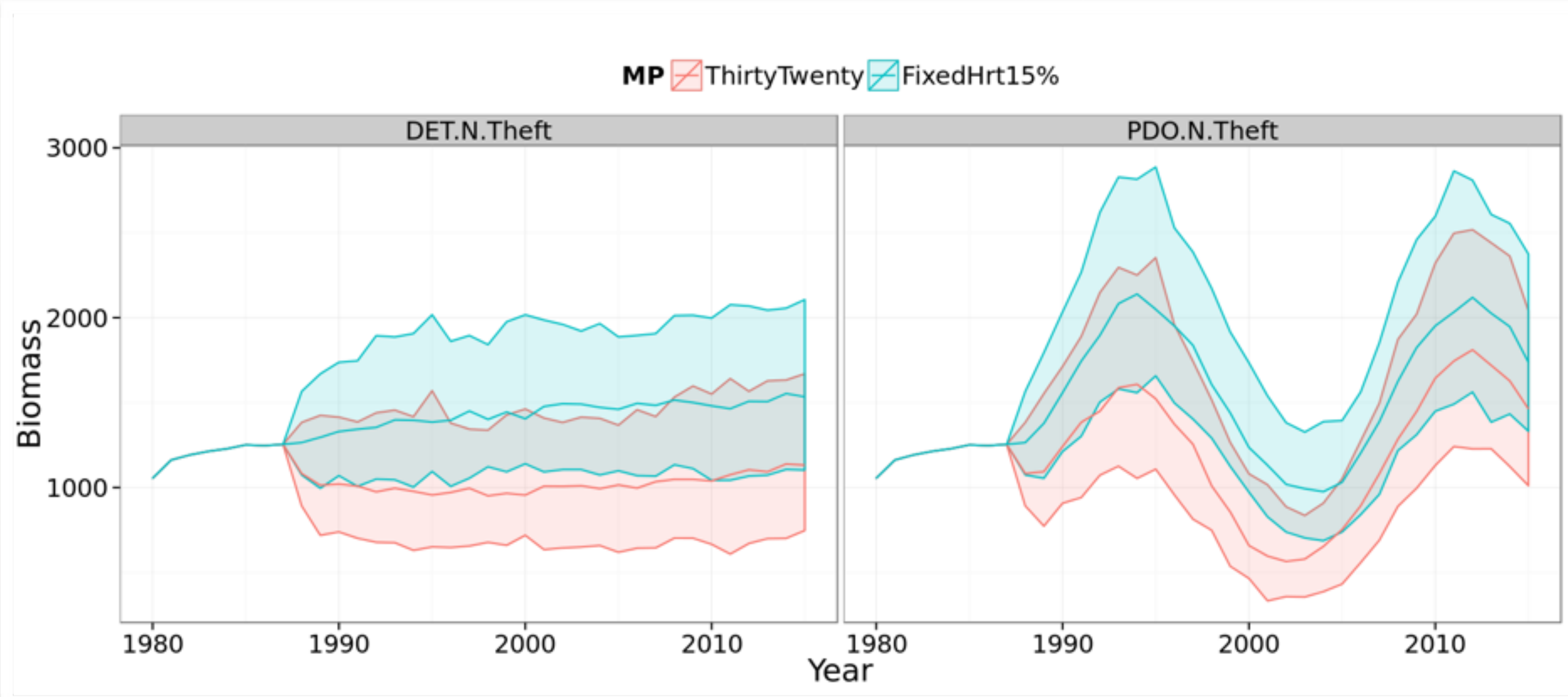
- A mathematical–statistical model used to describe the actual resource dynamics in *simulation trials* and to generate data & responses to management procedures when projecting into the future.



Biomass distribution & two recruitment scenarios

Operating Model Output

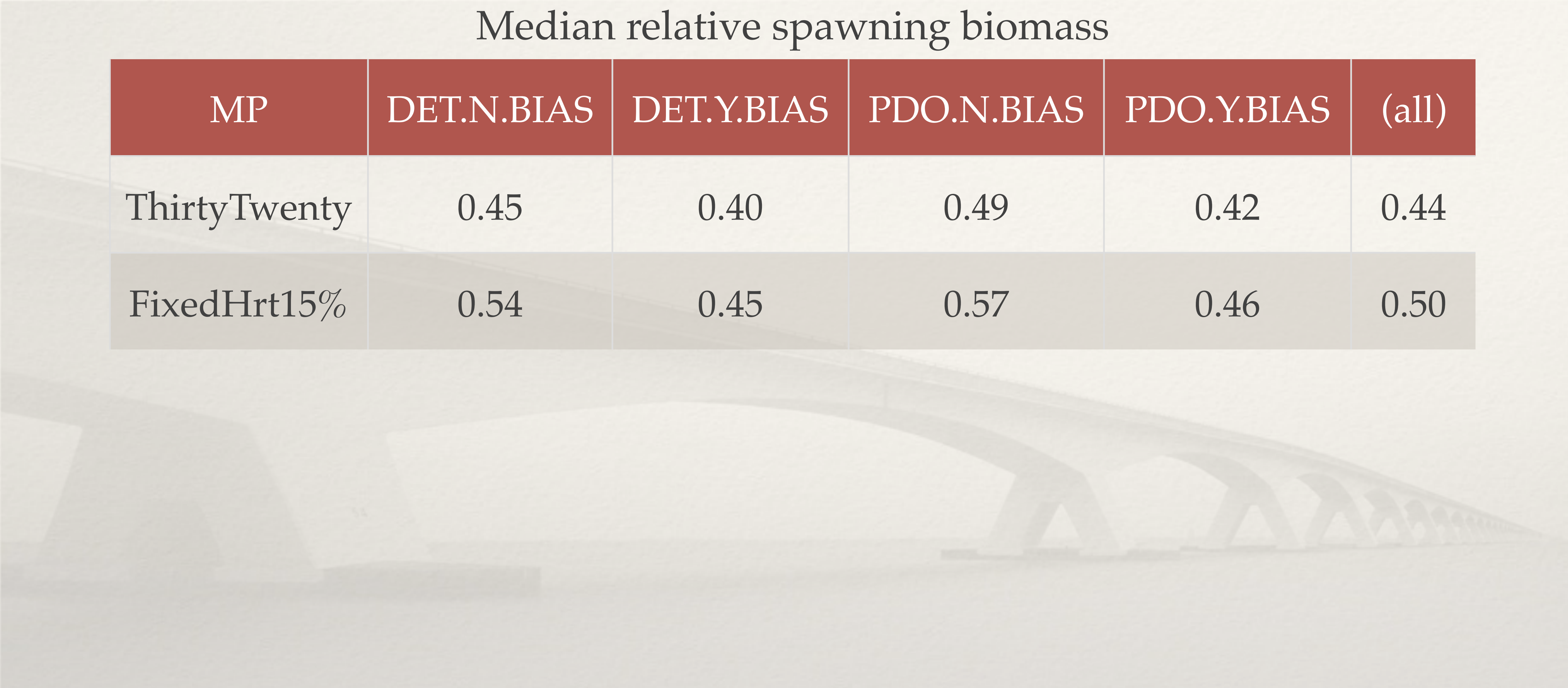
Used to calculate performance measures in which to examine the robustness of alternative management procedures.



Biomass distribution response to harvest control rule.

Alternative Management Procedures

Each alternative procedure is tested against alternative scenarios and used to compute summary performance statistics.



Median relative spawning biomass

MP	DET.N.BIAS	DET.Y.BIAS	PDO.N.BIAS	PDO.Y.BIAS	(all)
ThirtyTwenty	0.45	0.40	0.49	0.42	0.44
FixedHrt15%	0.54	0.45	0.57	0.46	0.50

Median relative spawning biomass.

Performance metrics

Integrate over Scenarios to determine which procedures are robust to variables that cannot be managed directly.

Median relative spawning biomass

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ThirtyTwenty	0.45	0.40	0.49	0.42	0.44
FixedHrt15%	0.54	0.45	0.57	0.46	0.50

Median catch between 2013 and 2020

MP	DET.N.BIAS	DET.Y.BIAS	PDO.N.BIAS	PDO.Y.BIAS	(all)
ThirtyTwenty	287.35	233.48	319.93	274.79	278.89
FixedHrt15%	183.57	159.92	198.01	174.93	179.11

Median relative spawning biomass vs median catch.

Evaluate tradeoffs

Multiple management objectives clearly expose the tradeoffs between biological sustainability & fisheries sustainability.

That was the simple model!

The operating model

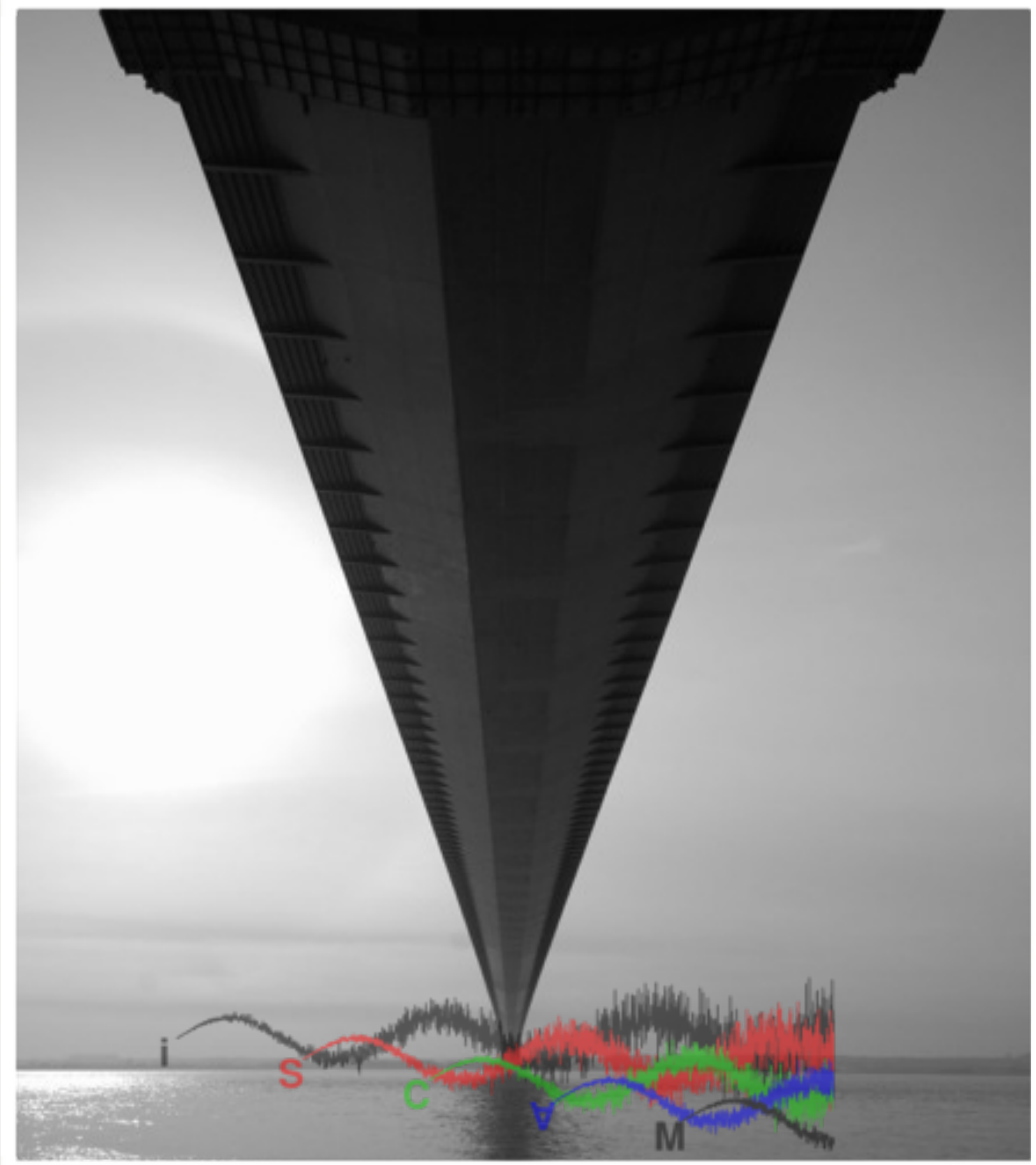
iSCAM & Milka

iSCAM – integrated Statistical Catch Age Model.

Milka – German chocolate cow & the name of our Operating Model.

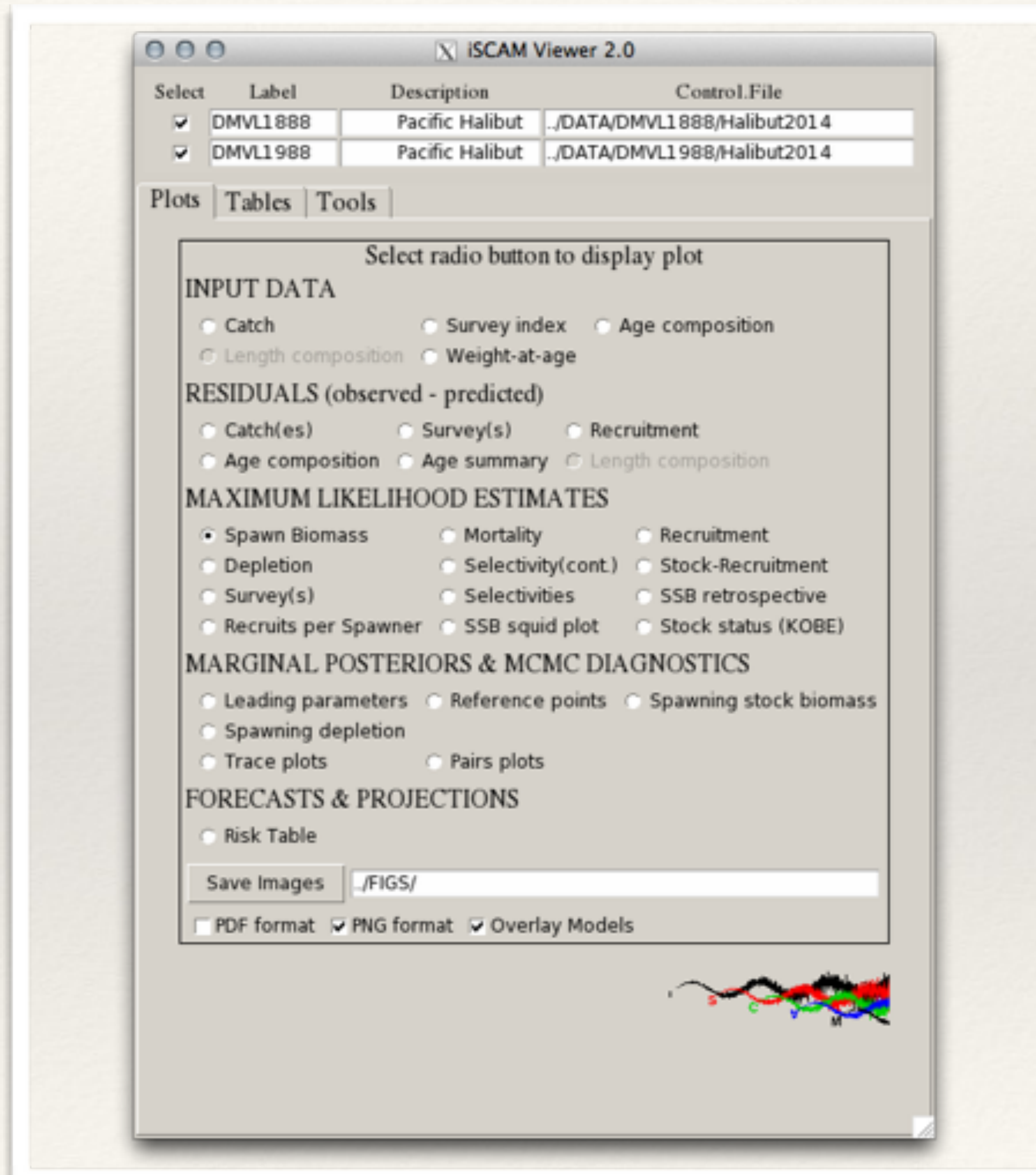
iSCAM History

- 2010 – Developed to assess BC Herring stocks.
- 2010 – Open source project.
- 2011 – DFO adapted for use with Pacific hake.
- 2011 – MSY-based reference points for multiple fisheries.
- 2012 – Best practices for estimating selectivity.
- 2013 – Two-sex, multi-fleet, multi-area & multi-stock.
- 2014 – Integrate with Milka for MSE & simulation testing.



Features of iSCAM

- Estimation of total variance.
- Self-weighting of composition data.
- Parametric & nonparametric selectivity functions.
- 1d & 2d spline interpolation.
- MSY-based reference points for multiple fleets.
- Retrospective & prospective analysis.
- Explicit spatial representation.
- Automated simulation experiments.
- Automated MSE protocols.



History of Milka

- Feb 2014 – initiated development.
- May 2014 – ~ 1000 lines of code.

Features of Milka

- Inherits data structures from estimation model (iSCAM).
- Stock dynamics: explicit rules for sex, area, stock/group, recruitment, advection–migration.
- Fishery dynamics: explicit rules for fleets, areas, selectivity/availability, size-limits.
- Scientific data: sex-specific data on catch, age-composition, size-composition, weight-at-age sampling.
- Stochastic variability: recruitment deviations, size/age sampling, relative abundance indices, implementation error.

Fishing Fleet OM controls

Fleet	Size-limit	Discard Mortality	Sex Info	Area 2A	Area 2B	…	Area 4CDE
Commercial	82+	0.16	Yes	Open	Open	Open	Open
Bycatch	NA	0.8	No	Open	Open	Open	Open
Charter	111-193+	0.16	No	Open	Open	Closed	Open
….	NA	0.16	No	Open	Open	Open	Open
Setline Survey	NA	0.16	Yes	Open	Open	Open	Open

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* STATUS LEGEND
*     : not implemented yet.
*  - : partially implemented
*  + : implemented & testing
*   : Good to go!
* ——————————————————————————————————————————————— *
* runScenario:                                STATUS
*      |- readMSEcontrols                       [+]
*      |- initParameters                        [+]
*          |- surveyQ                           [ ]
*          |- stock-recruitment parameters      [ ]
*      |- initMemberVariables                   [-]
*      |- conditionReferenceModel               [+]
*      |- setRandomVariables                    [+]
*      |- | getReferencePointsAndStockStatus    [-]
*         | calculateTAC                        [-]
*         | allocateTAC                         [-]
*         | implementFisheries                  [-]
*              |- calcSelectivity               [ ]
*              |- calcRetentionDiscards         [ ]
*              |- calcTotalMortality            [-]
*         | calcRelativeAbundance               [-]
*         | calcCompositionData                 [-]
*         | calcEmpiricalWeightAtAge            [-]
*         | updateReferenceModel                [-]
*         | writeDataFile                       [-]
*         | runStockAssessment                  [-]
*      |- |
*      |- writeSimulationVariables              [-]
*      |- calculatePerformanceMetrics           [ ]
* ——————————————————————————————————————————————— *
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More on the features of Milka

- **Inherits data structures from estimation model (iSCAM).**
- Stock dynamics: explicit rules for sex, area, stock/group, recruitment, advection–migration.
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Inheritance: data structures

- Operating model -> huge time investment & is conditioned on the results of an assessment.
- So what happens if the assessment model changes?
  - traditionally: re-write the operating model code.
  - inheritance: operating model automatically inherits new data structures.

Stock dynamics

- **explicit rules for sex, area, stock/group, recruitment, advection–migration**
- These explicit rules will allow us to address the following questions:
  - does sexing the commercial catch improve estimates of abundance?
  - how do area-specific regulations impact the status of halibut (e.g., area-specific size limits)?
  - implications of advection-migration on directed fisheries yield?

Features of Milka

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Fishery dynamics

- **explicit rules for fleets, areas, selectivity/availability, size-limits.**
    - how do area-specific bycatch caps impact harvest policy?
    - how sensitive is the U32 selectivity assumption for the commercial fishery for estimating wastage?
    - what are the benefits of having an upper size-limit in the directed fishery?

Features of Milka

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- Fishery dynamics: explicit rules for fleets, areas, selectivity/availability, size-limits.
- **Scientific data: sex-specific data on catch, age-composition, size-composition, weight-at-age sampling.**
- Stochastic variability: recruitment deviations, size/age sampling, relative abundance indices, implementation error.

Scientific data:

- **sex-specific data on catch, age-composition, size-composition, weight-at-age sampling**
- We would now have the capability to quantify the value of new & existing research programs on the utility of those programs for better decision making.
    - eg. juvenile surveys,
    - sex-specific commercial catch data,
    - real-time migration rate estimates from high-tech Geo-Mag tags deployed as part of the annual survey,
    - direct measures of fishing mortality rates via CWT & port-sampling.

Features of Milka

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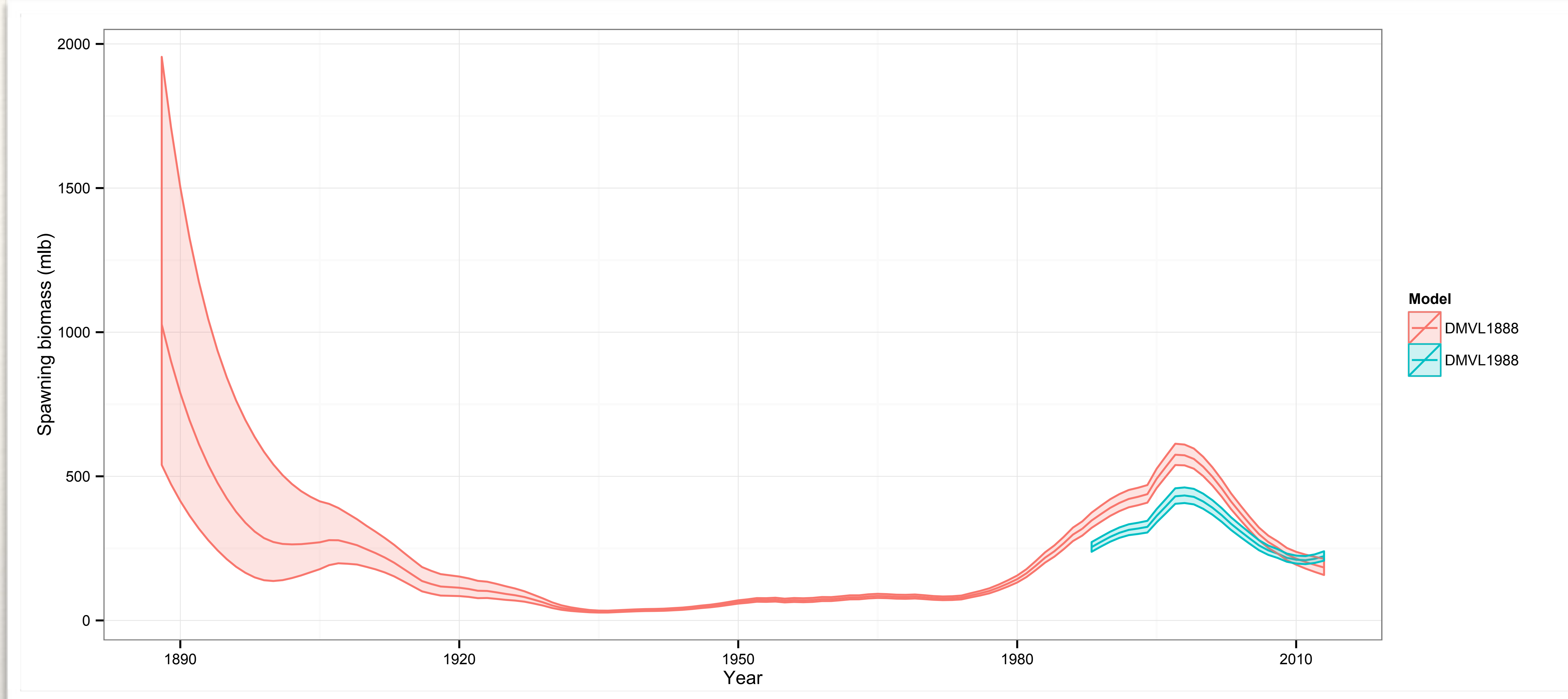
- Scientific data: sex-specific data on catch, age-composition, size-composition, weight-at-age sampling.
- **Stochastic variability: recruitment deviations, size/age sampling, relative abundance indices, implementation error.**

Stochastic events

- **recruitment deviations, size/age sampling, relative abundance indices, implementation error.**
- It is possible to address questions related to bias in assumptions about error distributions & the potential impacts of these biases on the decision framework.
    - e.g., observer programs & the observer effect?
    - how robust are the procedures to biases in estimates of bycatch?



Spawning biomass 1888-2013: 1988-2013

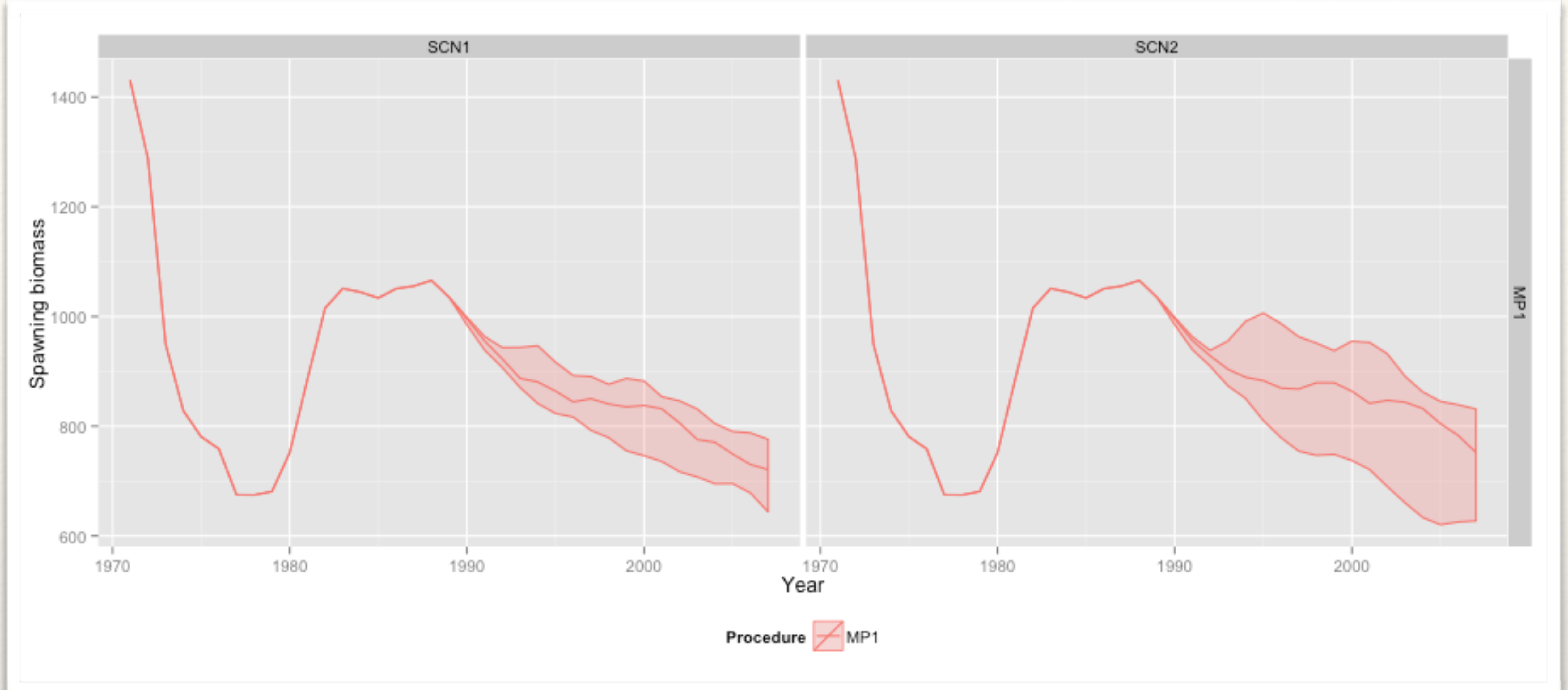
Conditioning the Operating Model

First step: use the stock assessment model to parameterize the operating model.

Spatial–explicit.

Simple example using Size limits:

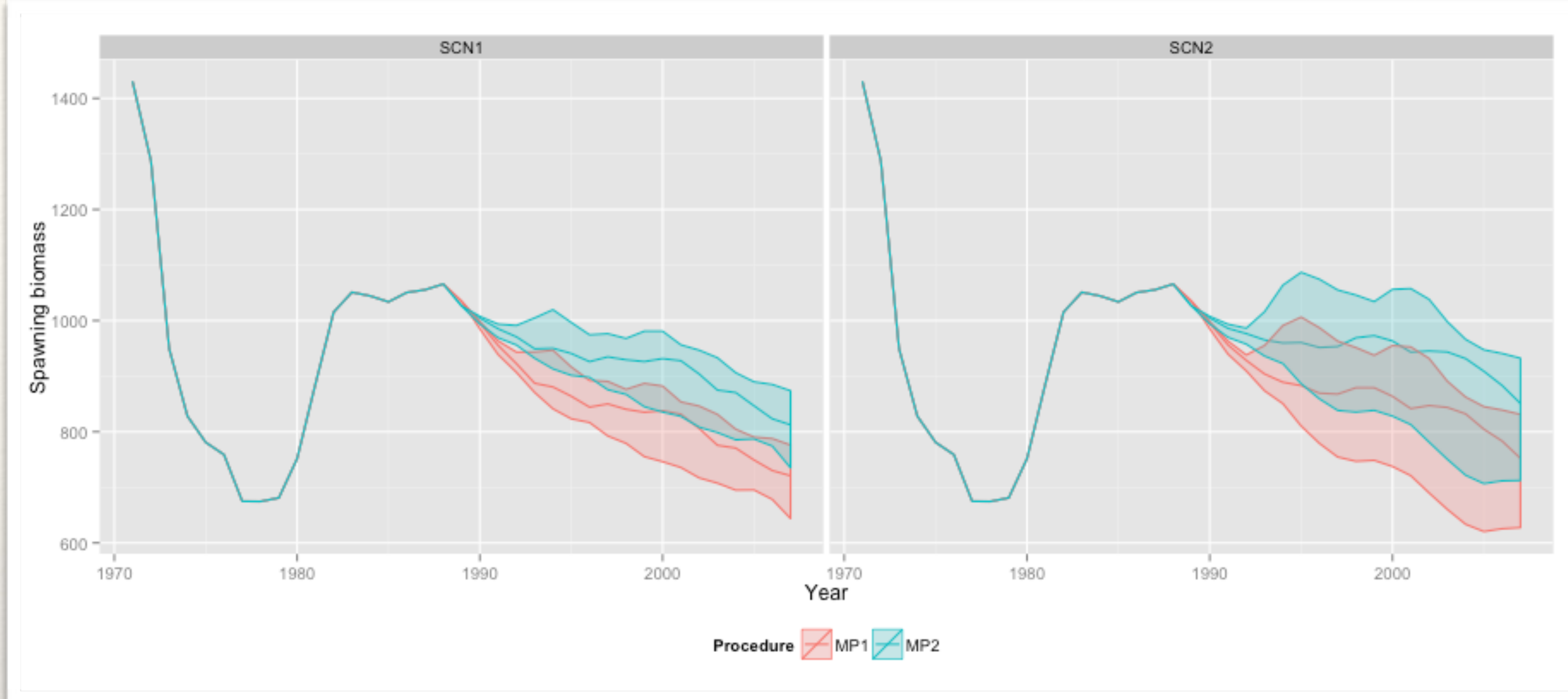
- Generic age-structured model (1 fishery–halibut like fish).
- Scenarios:
  - (SCN1) independent recruitment,
  - (SCN2) environmentally forced recruitment
- Procedures:
  - (MP1) no size limits, fixed harvest rate
  - (MP2) 82 cm min size limit, fixed harvest rate
  - (MP3) 82-108 cm slot limit, fixed harvest rate
  - (MP4) 82 cm min size limit, 30:20 harvest control rule.



Scenario 1&2, No size-limits, Fixed harvest rate

Spawning biomass

No size limit!

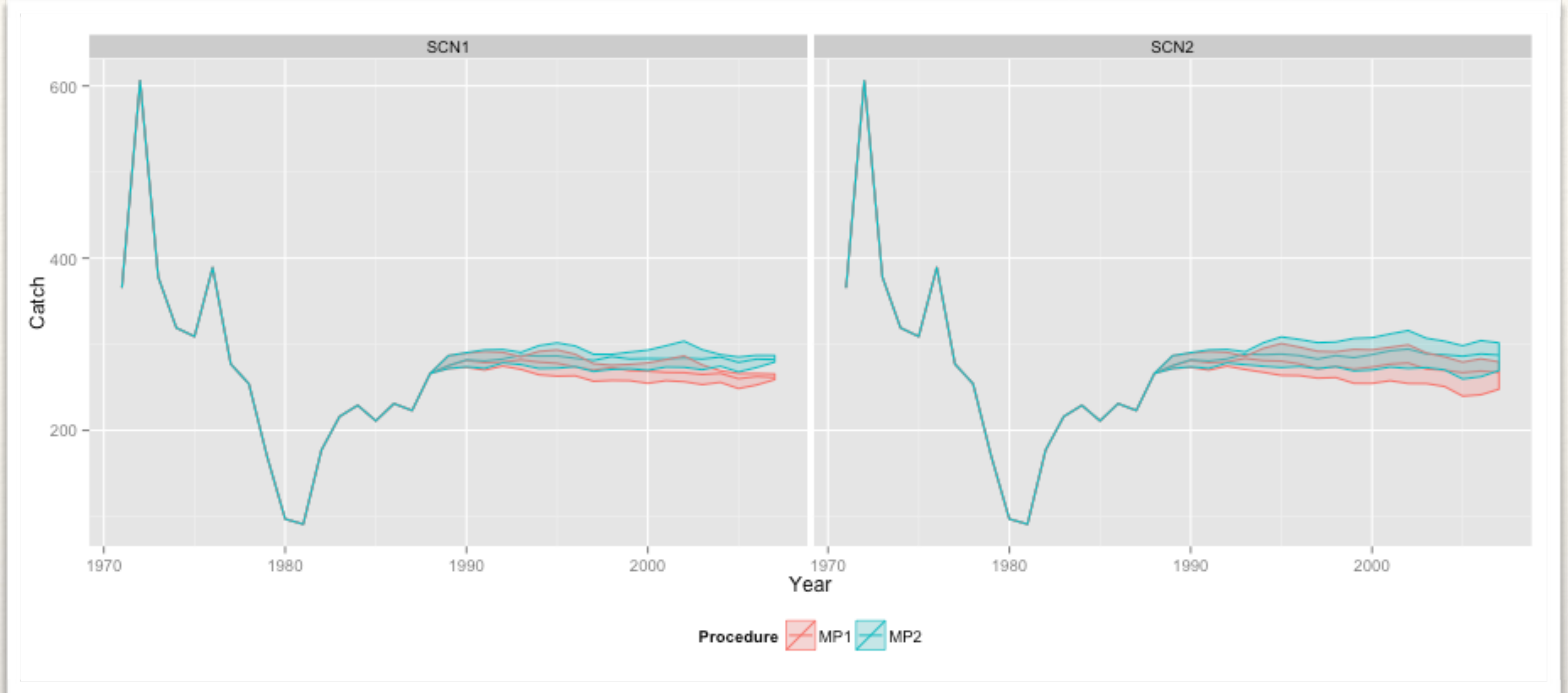


MP1=fixed HR , no SL. MP2=fixed HR, 82cm SL.

Spawning biomass

Minimum size-limt, discard mortality rate 15%

Good for spawning biomass.



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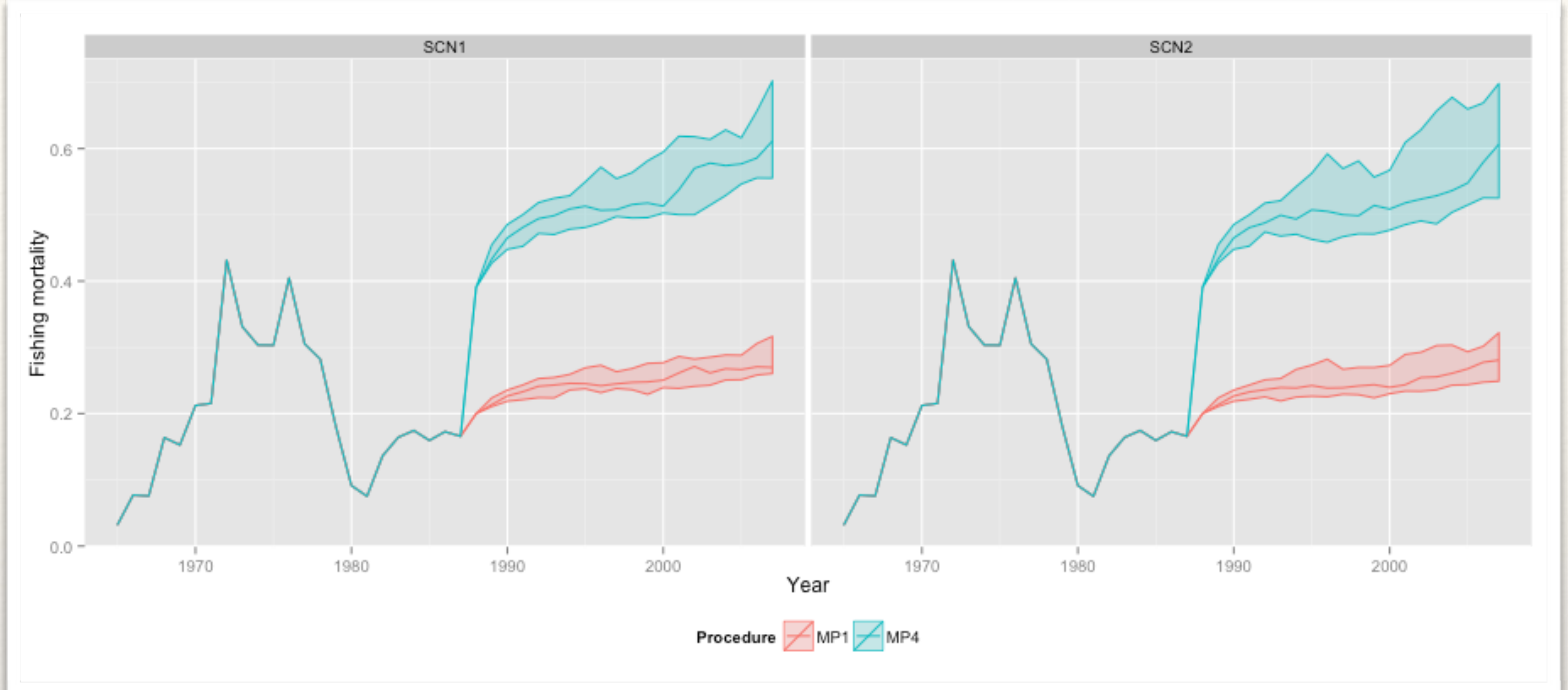
Fisheries yield

Average yield increase.

Size-structure rebuilds after a few years & hence increased SSB.

Size-limits

- Pro’s: increased SSB, roughly similar average yields after age-structure has stabilized.
- So what are the cons?



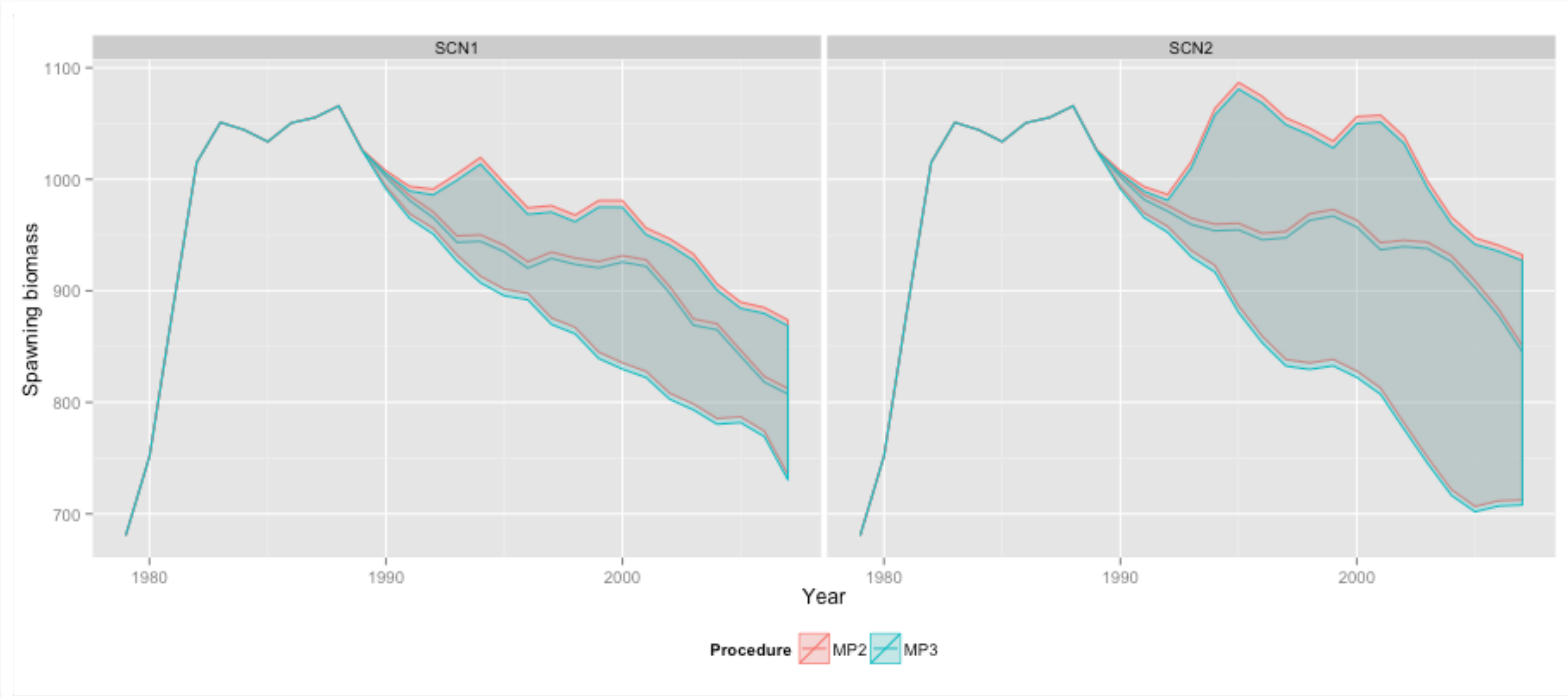
MP1=fixed HR , no SL. MP2=fixed HR, 82cm SL.

Fishing mortality

You need to fish a lot harder–smarter to catch the same amount of fish (by weight).

Size-limits

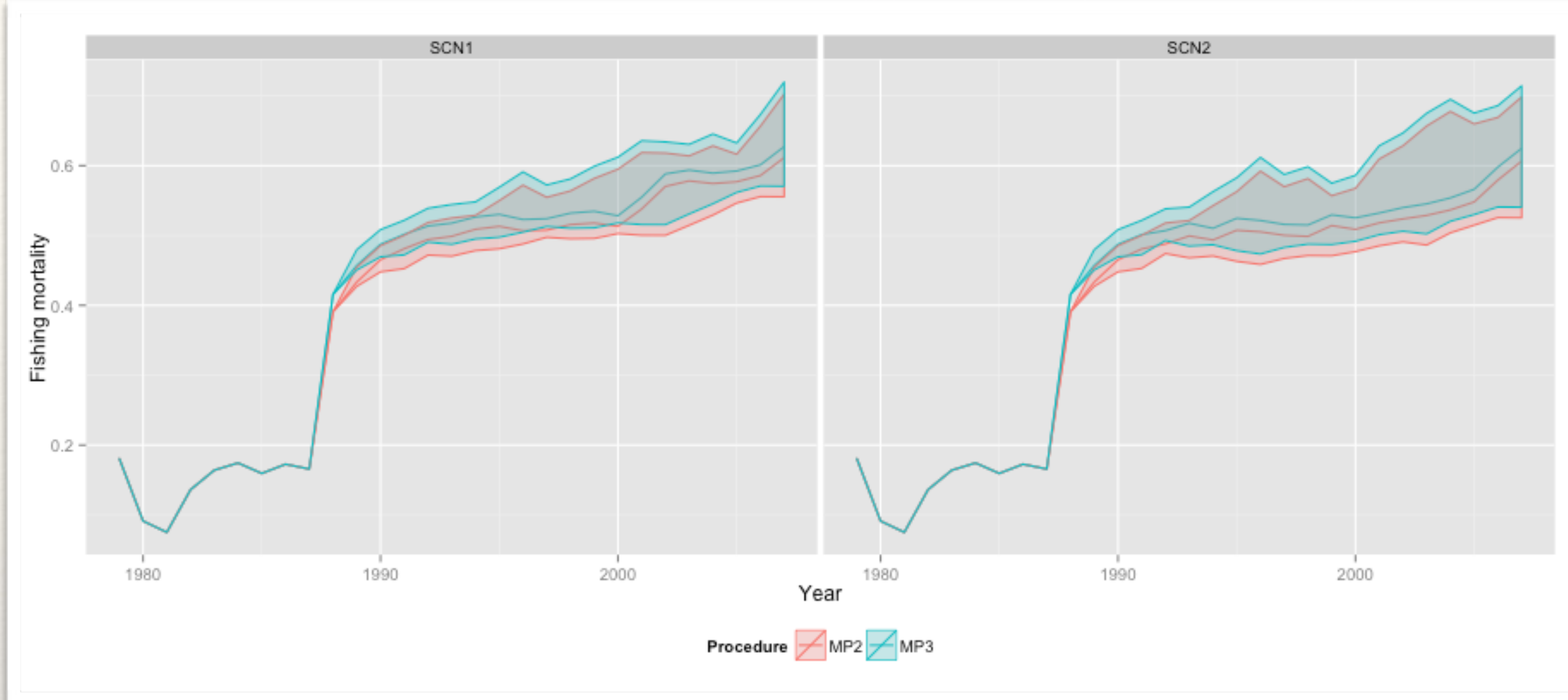
- What about protecting the big fish?
  - Use slot limit (82cm - 108cm)



MP2=fixed HR , 82cm SL. MP3=fixed HR, 82-108cm SL. Discard mortality rate = 0.15

Spawning biomass

You get less spawning biomass. This is counter-intuitive, any ideas what is going on here?



MP2=fixed HR , 82cm SL. MP3=fixed HR, 82-108cm SL. Discard mortality rate = 0.15

Fishing Mortality

You have to fish harder to attain the TAC when required to release large halibut that contribute proportionally more to the TAC.

Outline

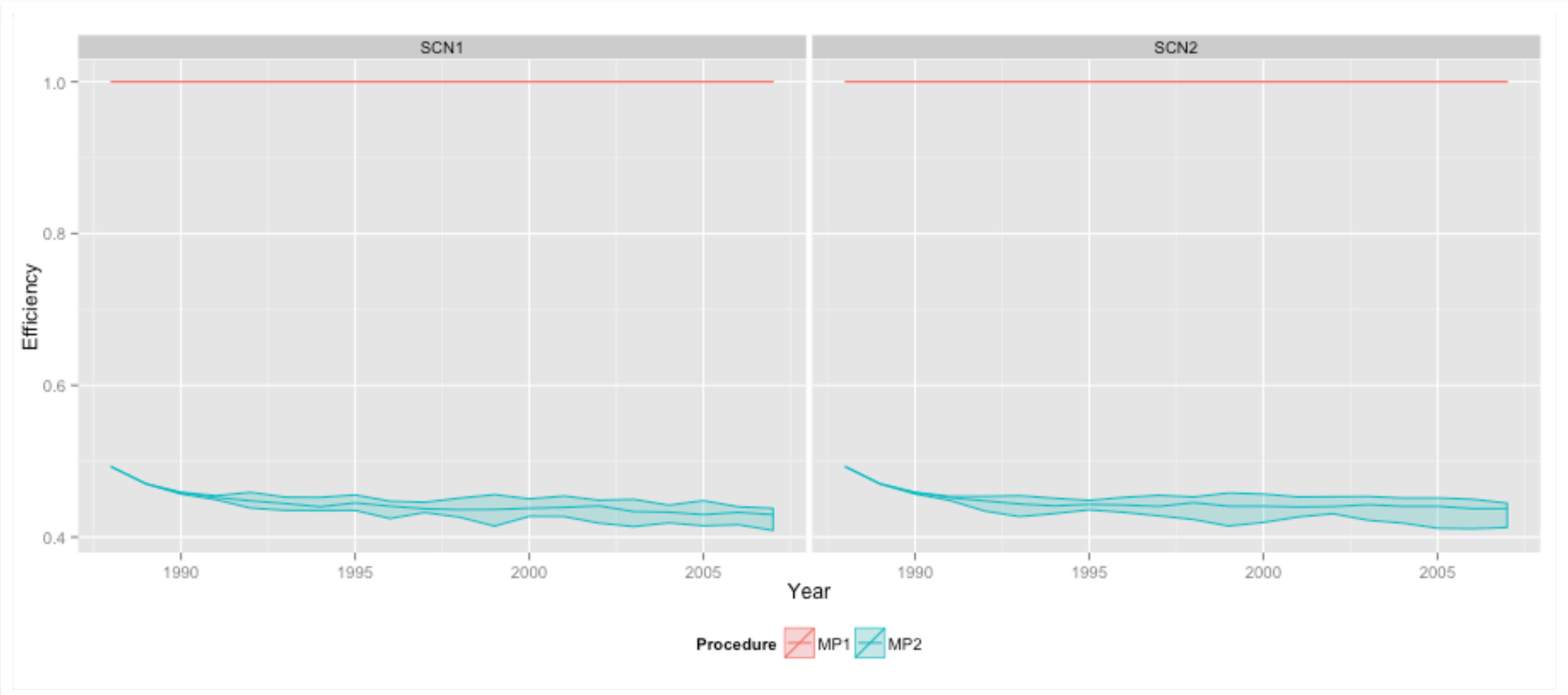
- Review MSE–process & Operating Model
- Introduction to iSCAM–Milka
- Conditioning operating model
- Simple example:
    - Implications of size-limits.
- **The todo list:**
- **Discussion**

To Do List

- Continue developing & test the operating model.
- Implement migration and recruitment advection for spatially explicit-models.
- Develop simple spatially explicit cases.
- Modify may-based reference point algorithms to explicitly account for size-limits and bycatch caps.
- Fit coast-wide iSCAM model to available data.
- Implement coast-wide MSE & explore performance of current management procedures vs. perfect information.
- Explore alternative harvest control rules.
- Data structures for spatially resolved model.
- Focus on performance measures & how these relate to stated objectives.

Discussion

- The simple size-limit example highlights some counterintuitive results.
  - Handling fish & careful release practices are extremely important.
  - Fisheries efficiency (ratio of landed catch: total catch).



MP1=fixed HR , no SL. MP2=fixed HR, 82cm SL.

Efficiency

Efficiency = Landed Catch/ (Landed + Released)

Discussion

- The simple size-limit example highlights some counterintuitive results.
  - Handling fish & careful release practices are extremely important.
  - Fisheries efficiency (ratio of landed catch: total catch)
    - there are already economic incentives to fish in areas with bigger fish or use gear that is less likely to capture sub-legal fish (cost per unit effort & price premiums).
    - other incentives? (e.g., less wastage would equate to larger TAC).
- What performance metric would capture efficiency (esp. in cases where halibut are jointly landed with sablefish).
- How should we integrate PSC caps into the MSE process.
  - Accounting for total mortality (accountability & management).