Complex assessments or simple management procedures for efficient fisheries management: a comparative study

Helena Geromont and Doug Butterworth

MARAM (Marine Resource Assessment and Management)
Department of Mathematics and Applied Mathematics
University of Cape Town, Rondebosch 7701, South Africa

Fisheries management

Key management questions:

Where are we?

Stock assessment

Where do we go?

Policy decision

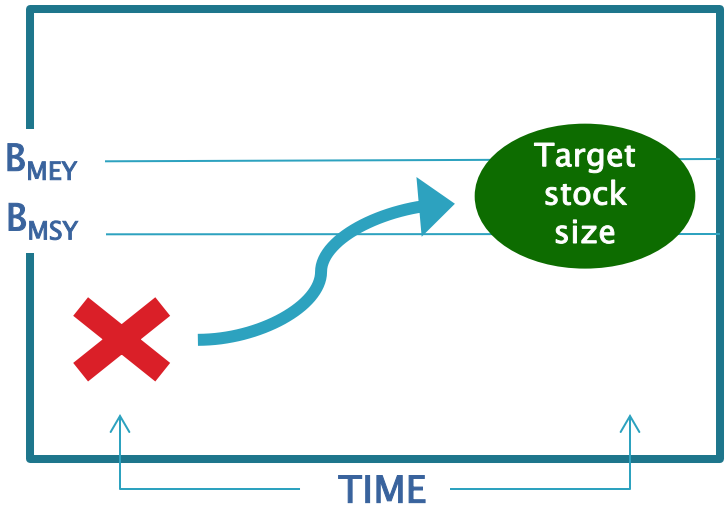
How do we get there?

Complex annual assessments

or

Empirical Management Procedures

(simple harvest control rules)



Why?

Catch advice is currently based on complex annual assessments: Virtual Population Analysis (VPA)

Require regular surveys and large ageing programmes

Costly

Need simpler and cheaper alternatives

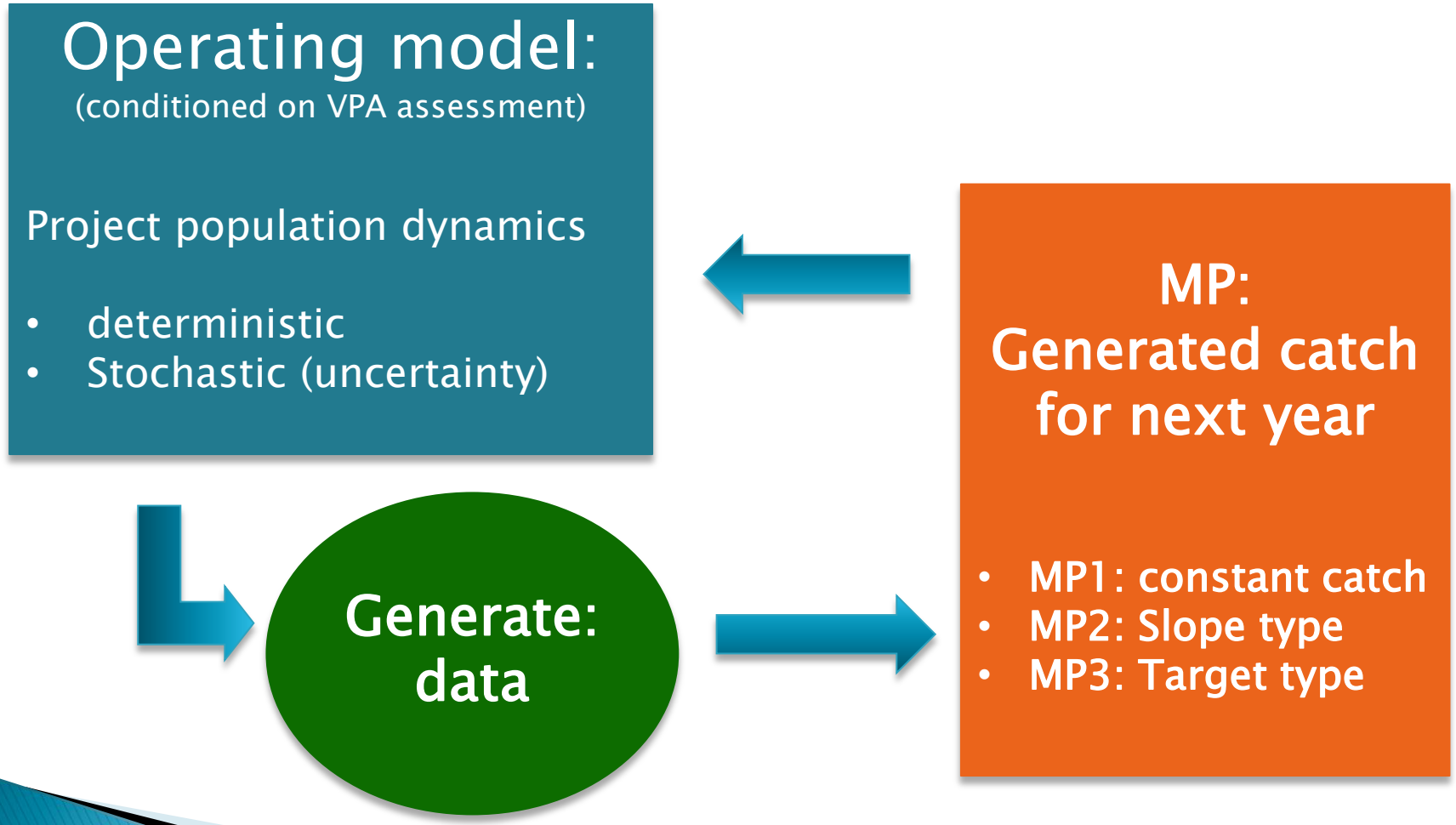
Examples: North Sea Sole and

Gulf of Maine Witch Flounder

Basic approach to comparison

- Retrospective analyses: go back 20 years.
- Project forward from 1990 with a simple empirical MP.
- For a common basis for comparison, tune the MP to achieve (at some %-ile) the same final spawning biomass at the end of projection period.
- Compare performance (catches, variability, etc.) to what was achieved in practice based on annual assessments.

Simulation testing:



Three steps in projections

1. Deterministic projections

Tune control rule to reach same final spawning stock biomass as would be achieved under actual catches

Operating model: key assumptions

- Same selectivity and weight-at-age vectors
- Same S/R residuals
- Same index of abundance residuals

as assessment

Three steps in projections

1. Deterministic "hindsight" projections:

2. **Stochastic "forecast" projections:**

Tune control rule so that lower 2.5%-ile reaches the same final biomass

Operating model: incorporate uncertainty

- Selectivity and weight-at-age vectors: re-sample from past
- Stock-recruitment lognormal residuals (σ^R=0.8 for sole)
- Survey lognormal residuals (σ^i=0.2 for sole)

Three steps in projections

1. Deterministic "hindsight" projections:
2. Stochastic "forecast" projections:
3. **Deterministic projection of "forecast" MPs:**

Project with the best performing control rule obtained in Step 2 (now tuned to be robust to uncertainty)

Operating model: deterministic

- Same selectivity-at-age vectors
- Same S/R residuals
- Same survey index of abundance residuals

as assessment

Management Procedures

(I = index of abundance available annually)

Constant catch MP

$$TAC_{y+1} = TAC^{target}$$

Survey slope based MP:

$$TAC_{y+1} = TAC_y(1 + \lambda s_y) \quad s_y = \text{trend in } I$$

Target based MP:

$$TAC_{y+1} = TAC^{target}\left[w + (1-w)\left\{\frac{I^{recent} - I^0}{I^{target} - I^0}\right\}\right]$$

MARAM

Objectives and trade-offs

Biological objectives:

Maximise sustainable biological yield (MSY)

Minimise risk of resource depletion

Ecomomic objectives:

Maximise sustainable economic yield (MEY)

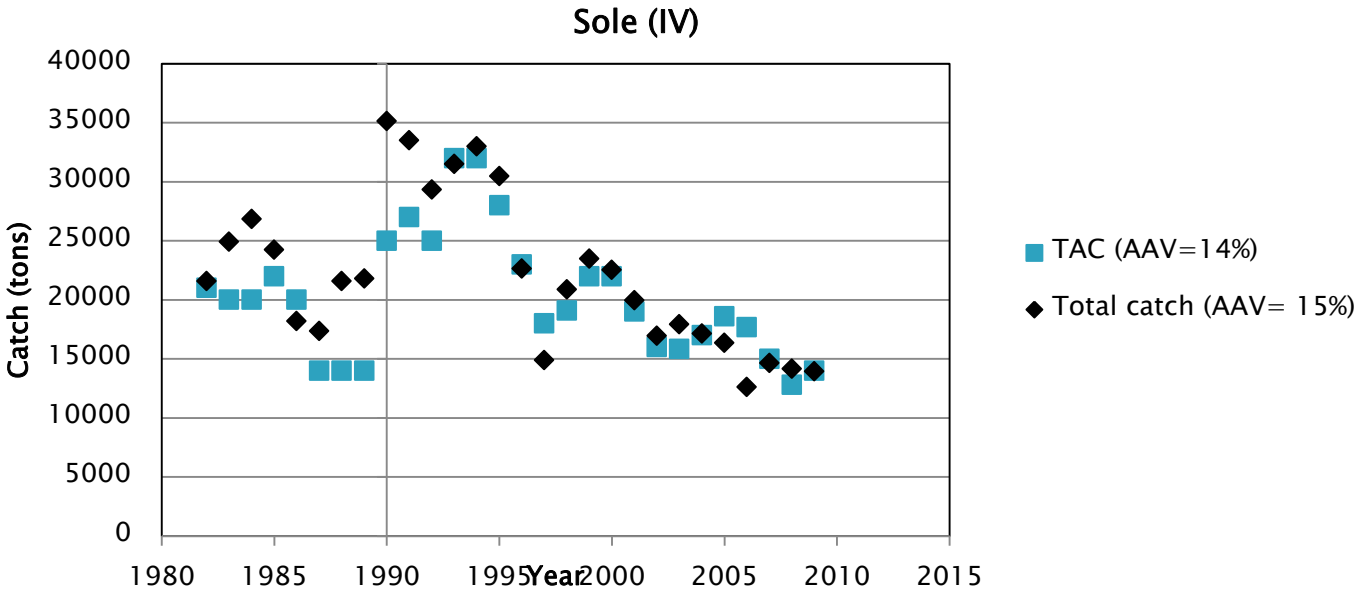
Minimise disruptions, maximise stability

Need: Management Procedures (harvest control rules):

- ✓ Robust to uncertainty
- ✓ Have feedback to adjust catch up/down with biomass trend
- ✓ Minimise fluctuations in catch advice
- ✓ Achieve biological and economic targets (here $B_{TARGET}=B_{VPA}$)

North Sea Sole (Subarea IV)

VPA-based TAC advice:

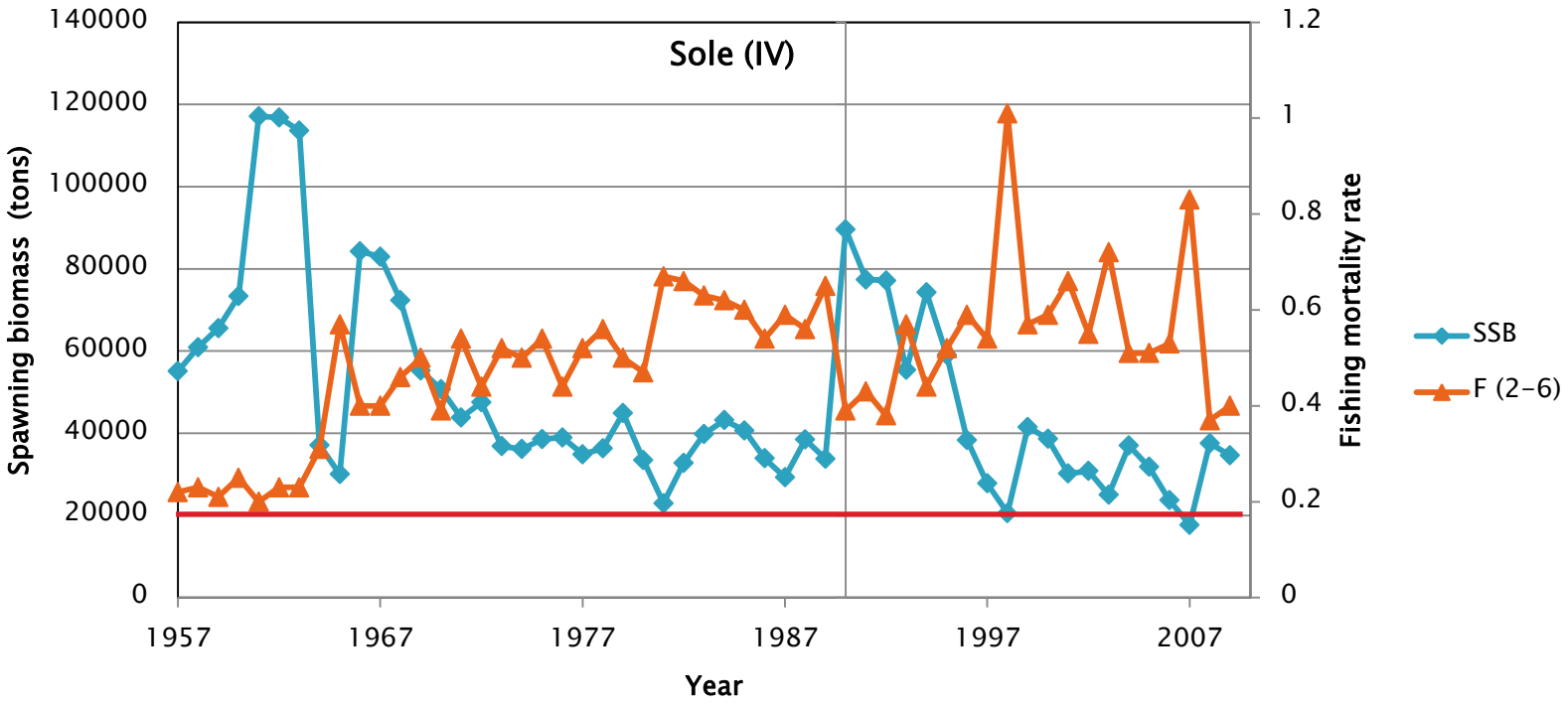


Observed average inter-annual variation in TAC: 14%

Observed average inter-annual variation in total catch: 15%

North Sea Sole (Subarea IV)

Biomass and Fishing mortality:



Observed average inter-annual variation in TAC: 14%

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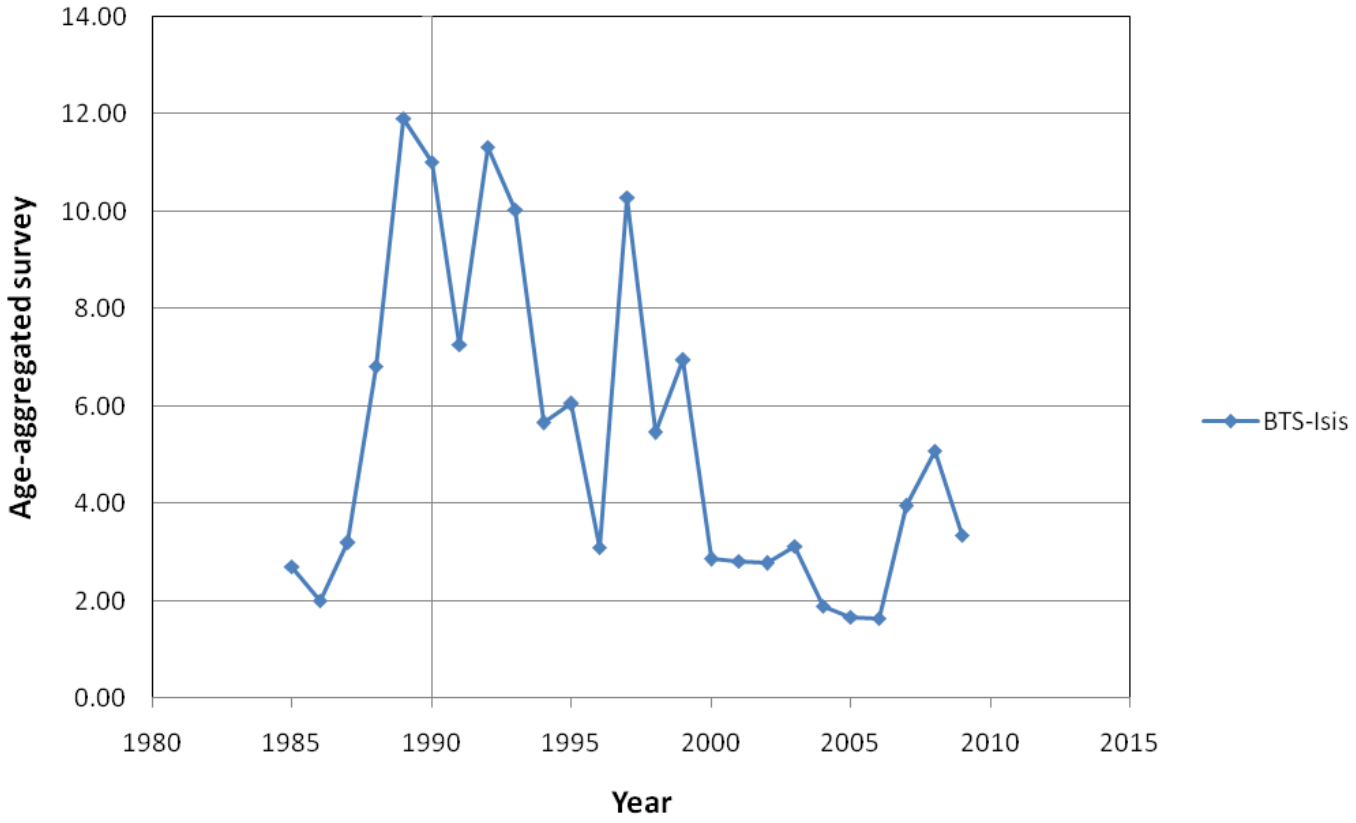
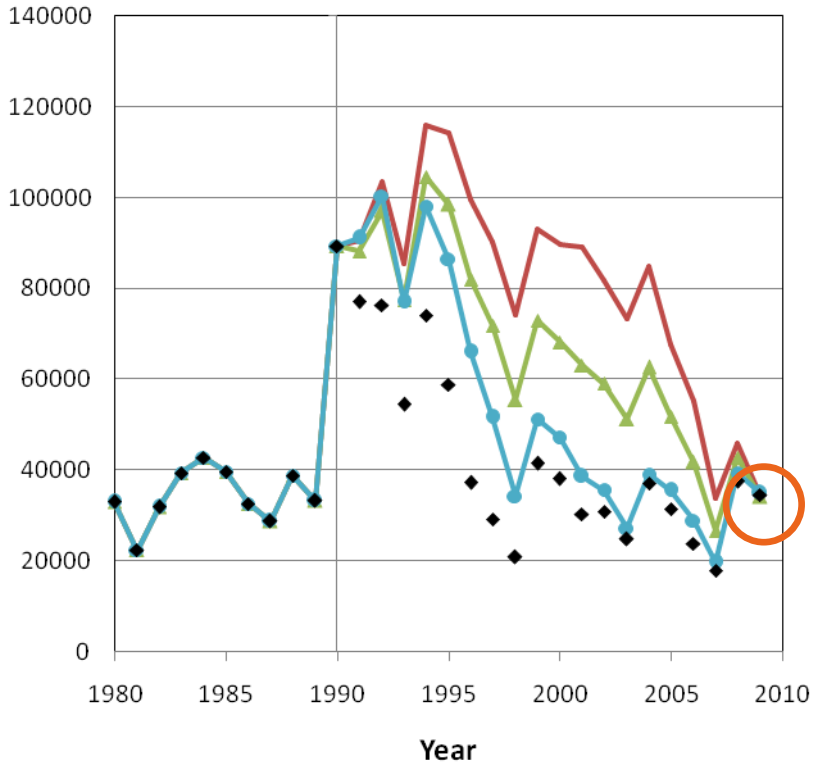
North Sea Sole (Subarea IV)

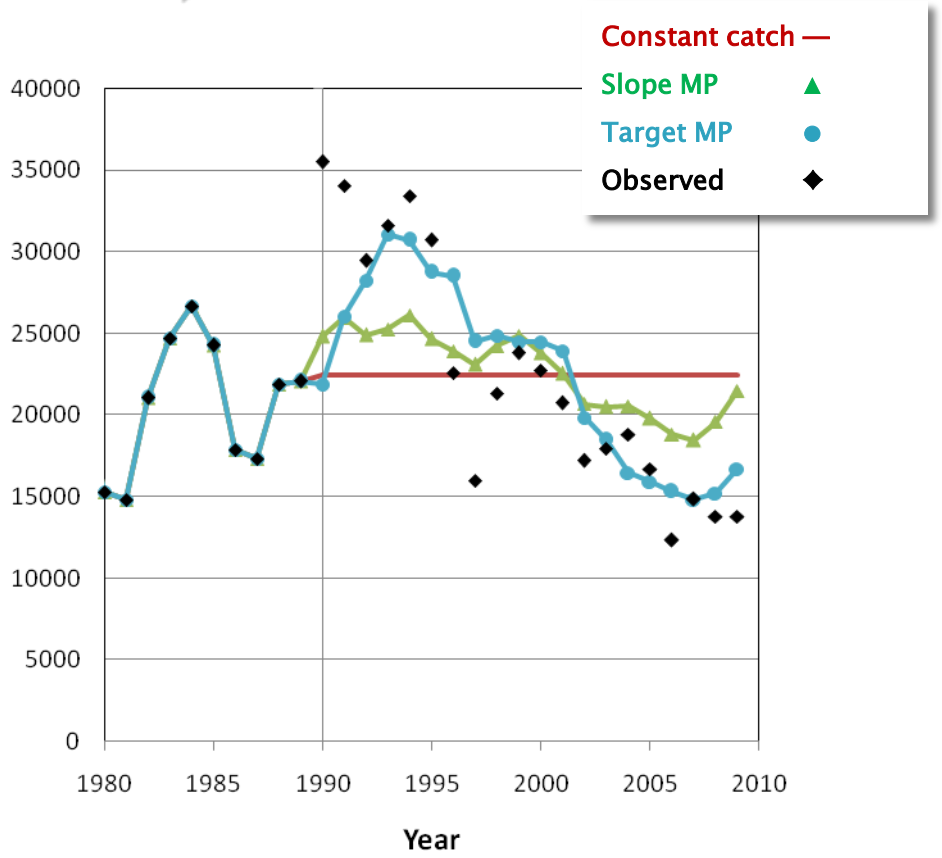
Data for MP: Index of abundance



Step 1. Deterministic hindsight projections

North Sea Sole (Subarea IV)

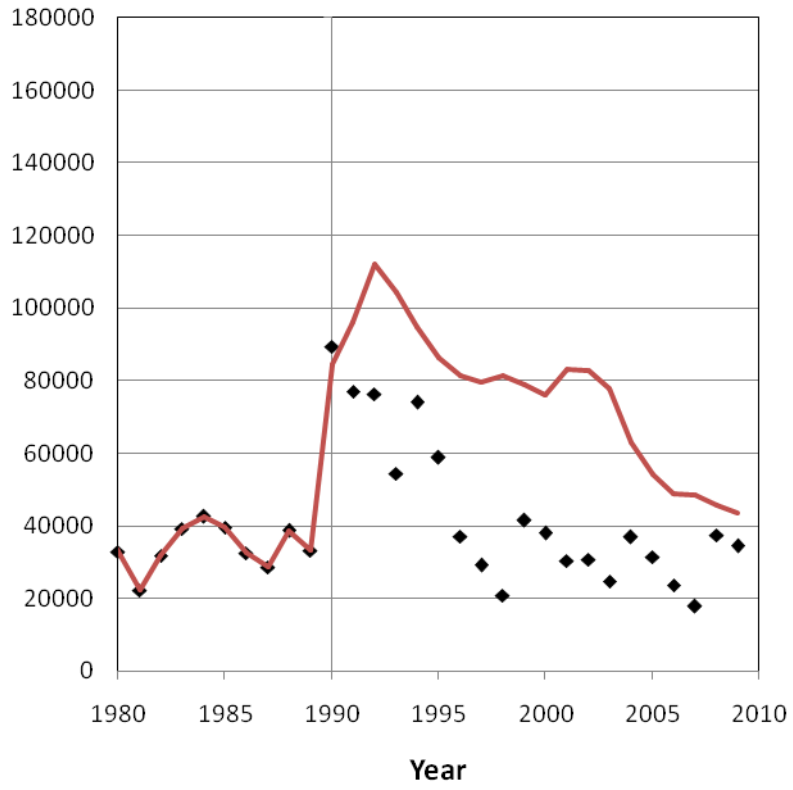


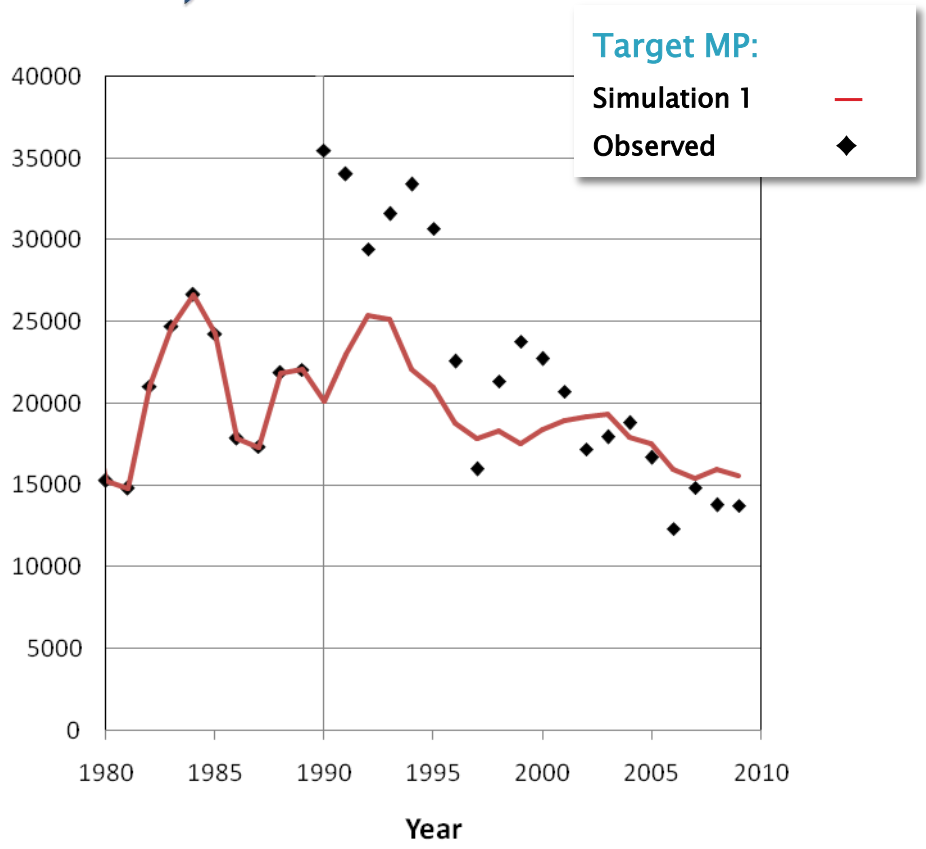


Spawning biomass (tons)

Annual catch (tons)

Step 2. Stochastic forecast projections: North Sea Sole (Subarea IV)

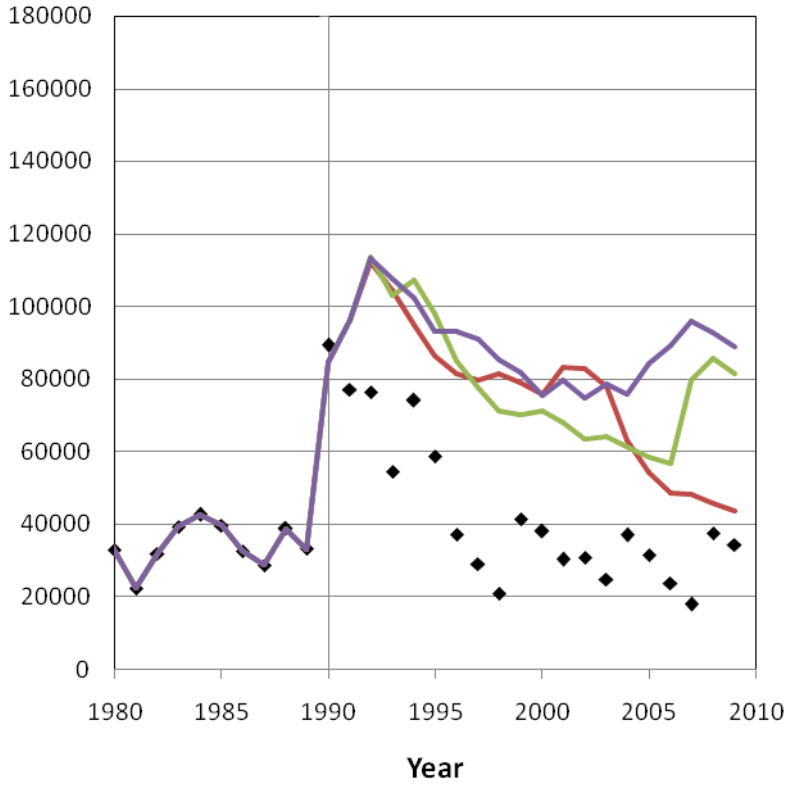




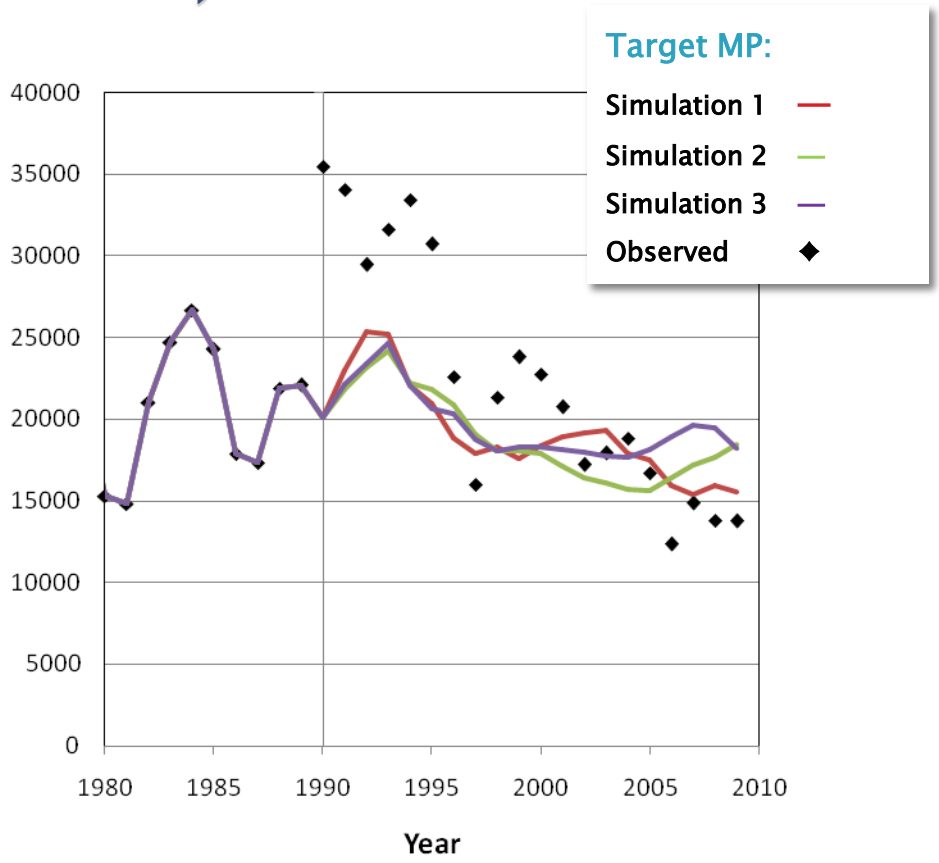
Spawning biomass (tons)

Annual catch (tons)

Step 2. Stochastic forecast projections: North Sea Sole (Subarea IV)

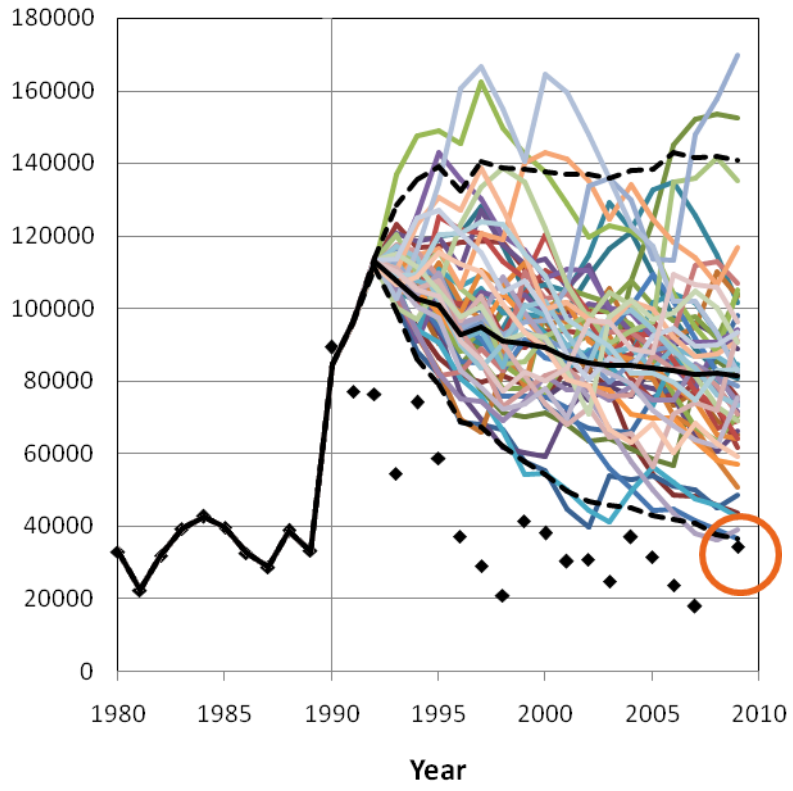


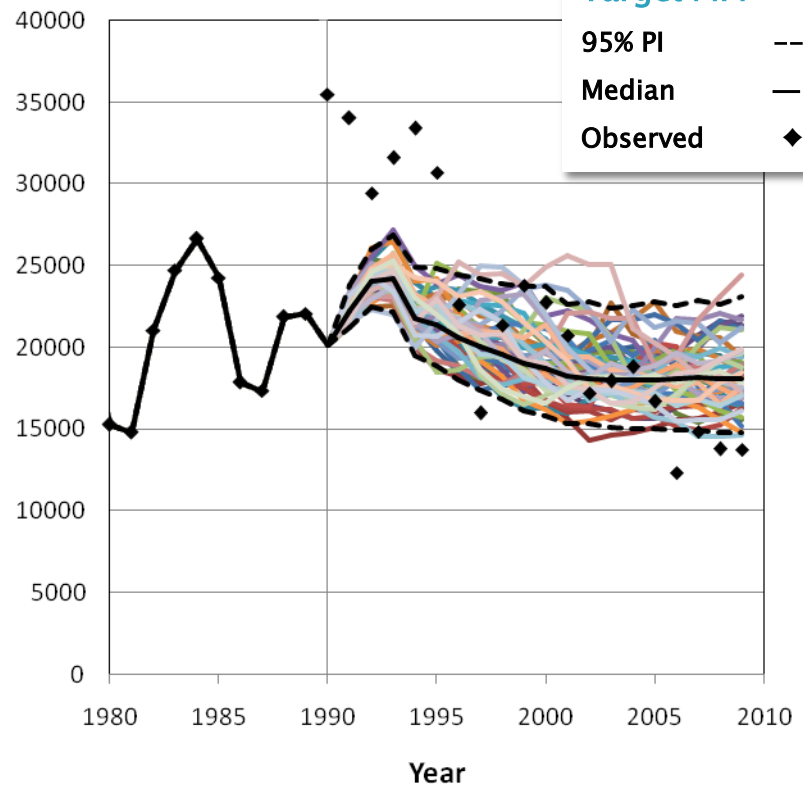
Spawning biomass (tons)



Annual catch (tons)

Step 2. Stochastic forecast projections: North Sea Sole (Subarea IV)



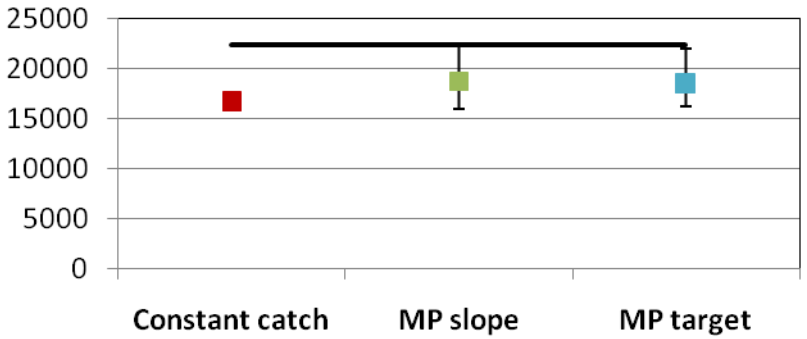


Spawning biomass (tons)

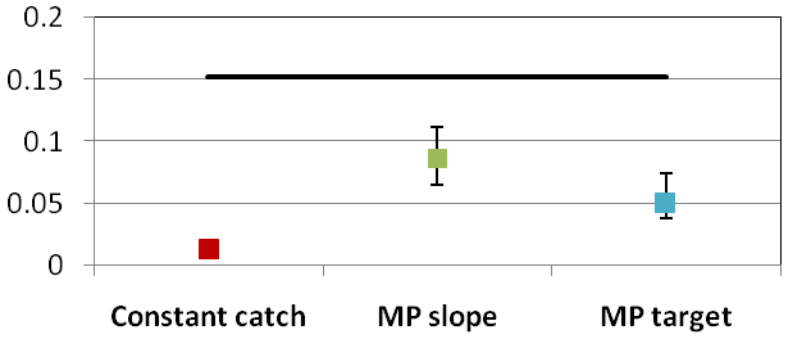
Annual catch (tons)

Step 2. Stochastic forecast results:
North Sea Sole (Subarea IV)

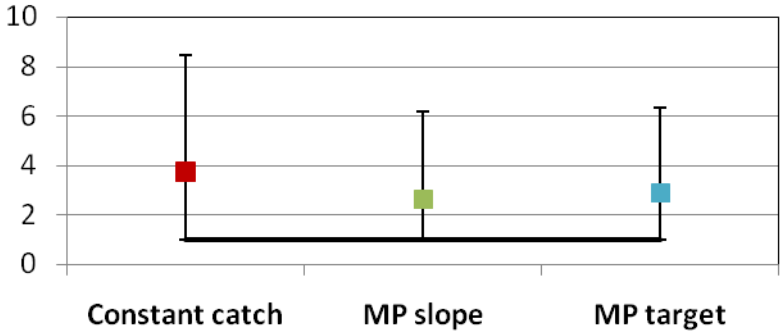
Observed —



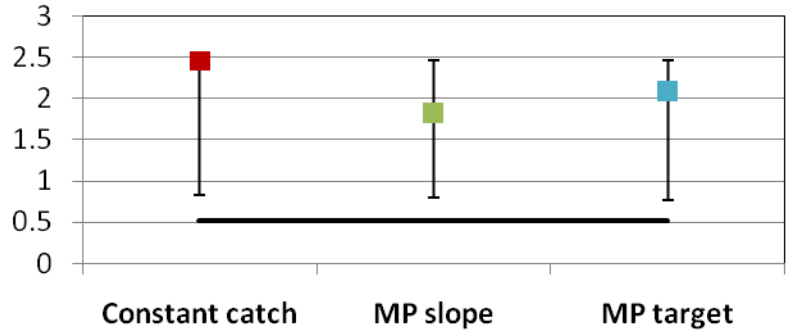
Annual average catch (tons)



Average change in catch



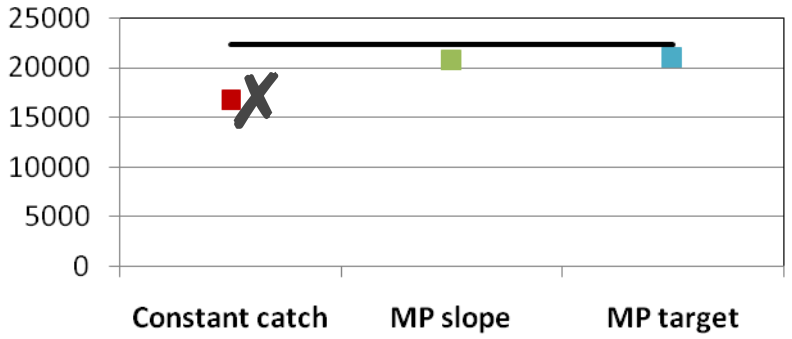
2009 SSB/SSBtarget



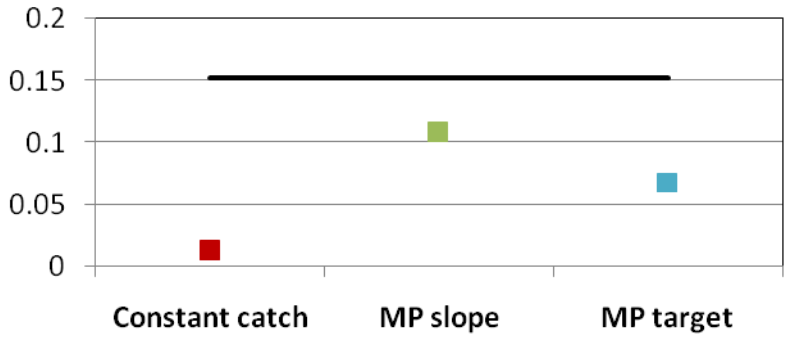
Min SSB/SSBtarget

Step 3.Hindsight projection of forecast MP
North Sea Sole (Subarea IV)

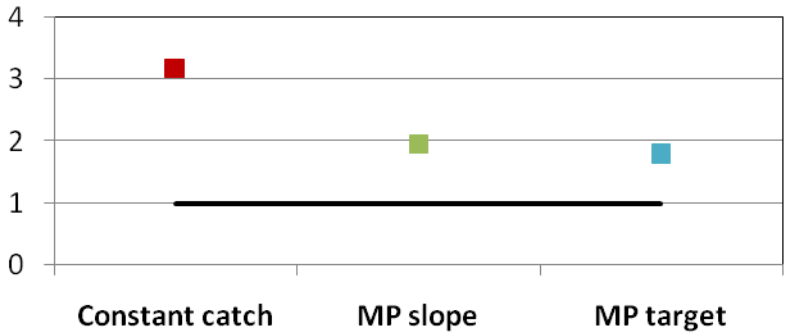
Observed —



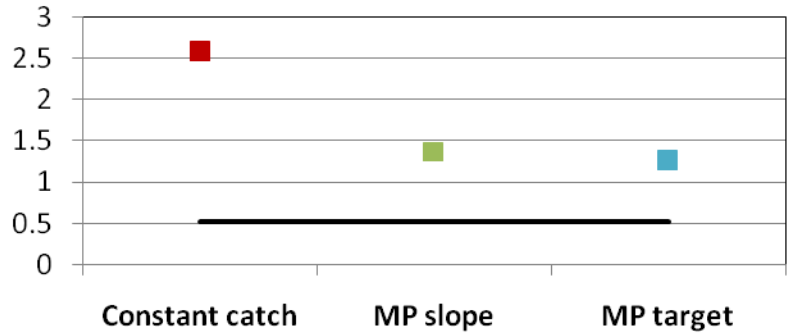
Annual average catch (tons)



Average change in catch



2009 SSB/SSBtarget



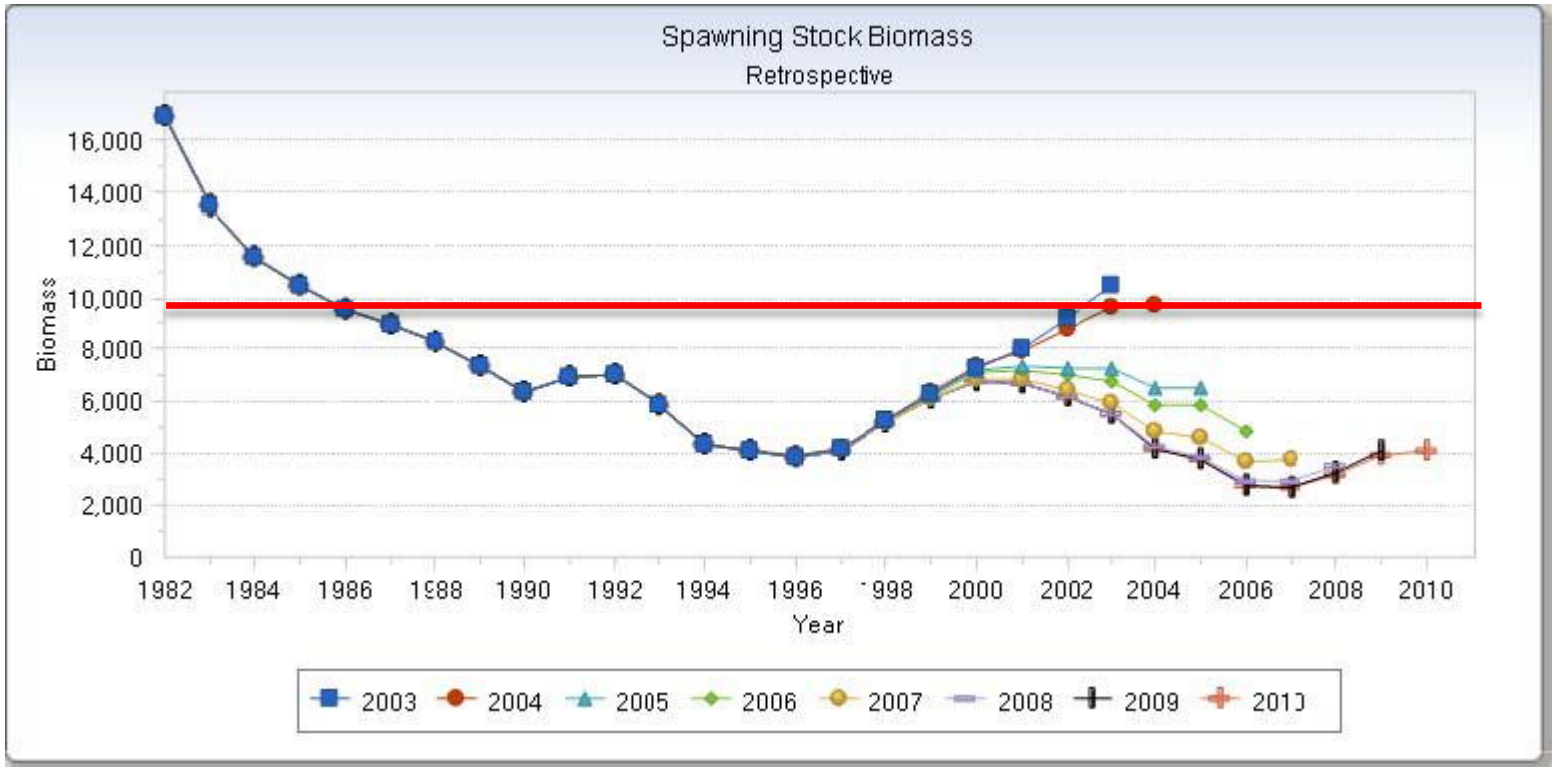
min SSB/SSB target

New England witch flounder VPA assessments, and…

Retrospective patterns!

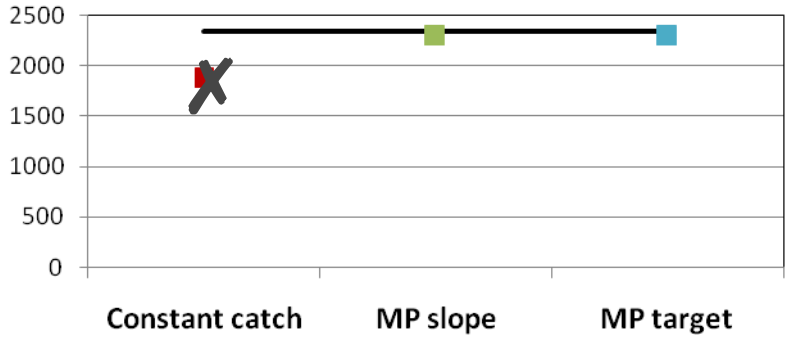
Gulf of Maine Witch Flounder:

Retrospective patterns in VPA assessments

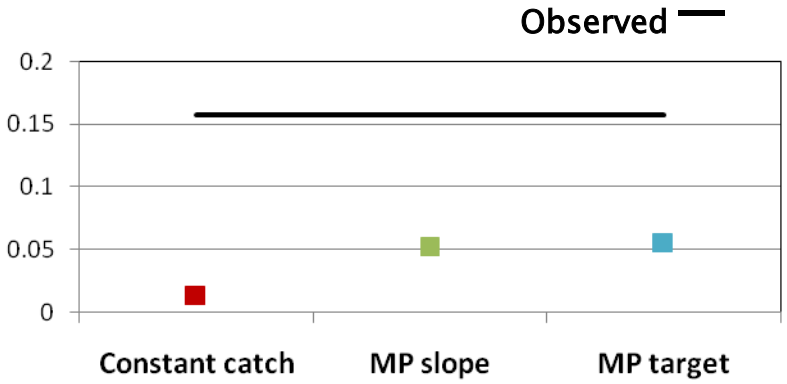


Plot copied from F. Witch Flounder by S.E. Wigley and S. Emery. February 2012

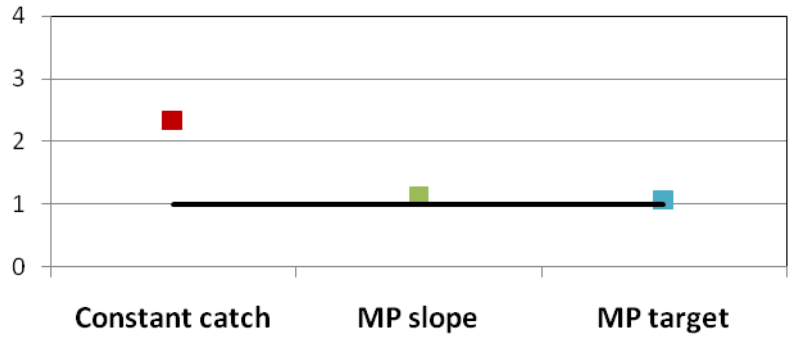
Step 3.Hindsight projection of forecast MP
Gulf of Maine Witch Flounder



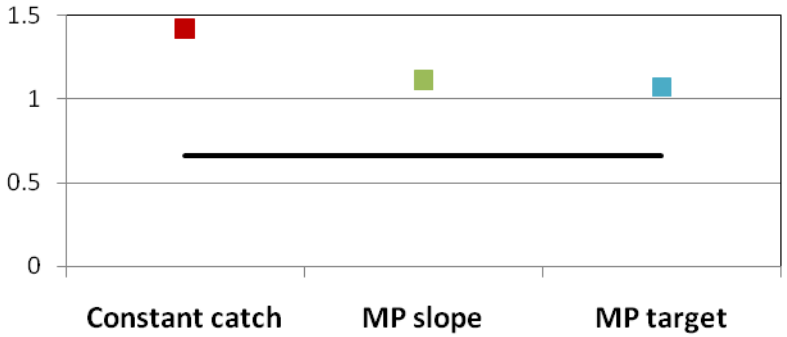
Annual average catch (tons)



Average change in catch



2010 SSB/SSBtarget



min SSB/SSB target

Initial conclusions

- Simple harvest control rules perform as well or better than assessment-based management
- TAC advice based on annual assessments add unnecessary variation to management measures without reducing resource risk
- Changed role for complex assessments: provide operating models for simulation testing of simple harvest control rules
- Savings (e.g. ageing of catch need not be annual) better spent on monitoring
- MP approach seems to be able to handle cases with relatively strong retrospective patterns

Thank you for your attention

We thank José de Oliveira, Charlie Edward and Laurie Kell, for assistance in providing the ICES assessment data we have used.

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