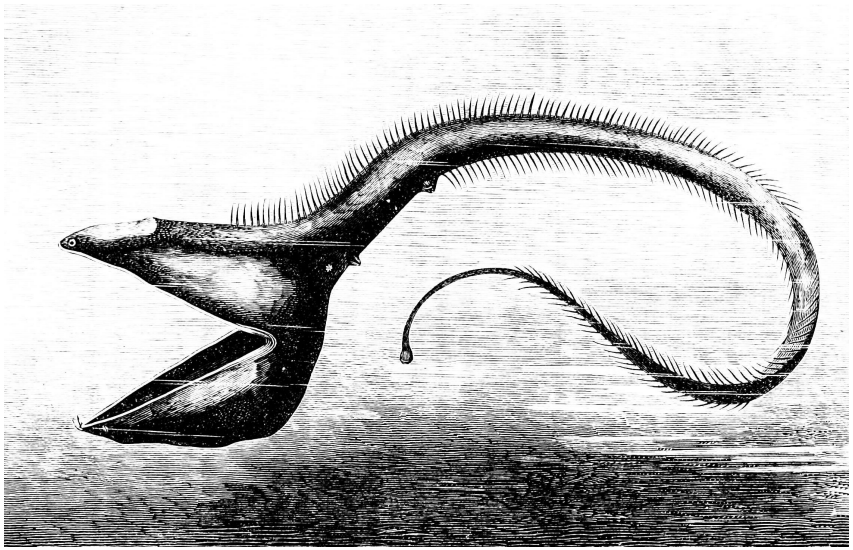
Operationalizing model ensembles to provide scientific advice for fisheries management.

CAPAM WK on the creation of frameworks for the next generation general stock assessment models

4-8 November 2019, Wellington, NZ



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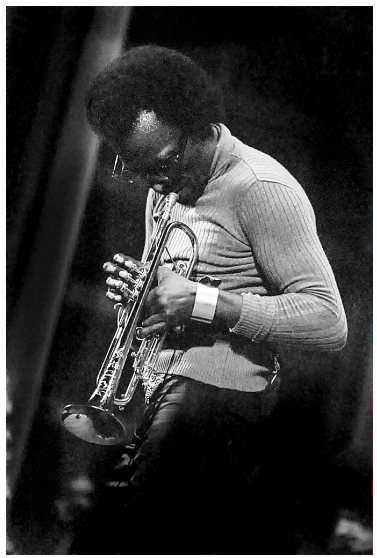
- GMIT, Ireland
- ICES
- IMR, Norway
- IPMA, Portugal
- JRC, EU
- NOAA, US
- SFO, Canada

Fact

Providing scientific advice to fisheries managers is a risky activity!

It's not uncommon that a model which was performing well suddenly fails to properly fit an additional year of data [...].

So what !?



How to deal with it ?

Our proposal to deal with the potential instability and lack of robustness of fisheries advice, is to **expand the assessment modeling basis** to integrate structural uncertainty using ensemble models.

What is an ensemble model

Ensemble models combine several individual models' predictions into quantities of interest (QoI) using specific methods to combine models' estimates.

The set of models in the ensemble, its members, encompass the candidate descriptions or working hypotheses about alternative states of nature.

Utility of ensembles.

- Include structural uncertainty across different models of the same system,
  - include model selection uncertainty,
  - uber model doesn't exist, mix of simpler models may cover processes better,
- Integrate across
  - initial conditions in projections
  - sensitivity tests runs.

Utility of ensembles.

- Estimating stock status
- Setting future fishing opportunities
- Building operating models

Weighting metrics

- Bayesian,
- information-theory based,
- tactical.

- Time varying weights !

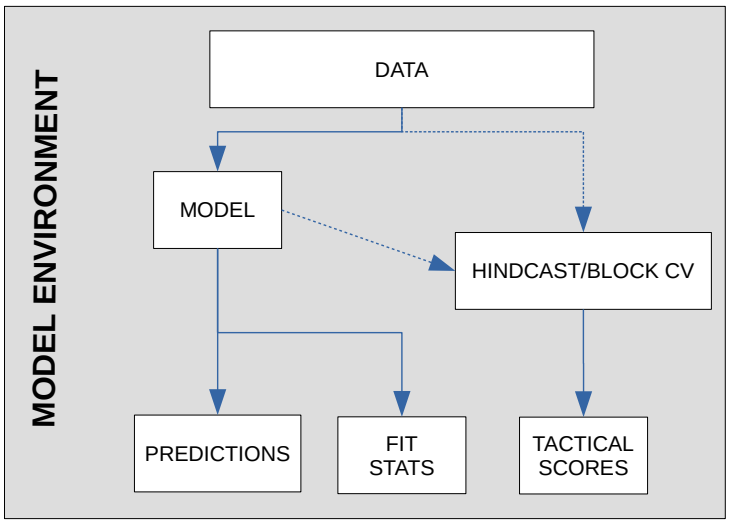
Model space or ensemble composition

If ensembles are used as a way to **integrate across structural uncertainty**, one should try to **capture** the several possible, although not necessarily equally likely, **states of nature**.

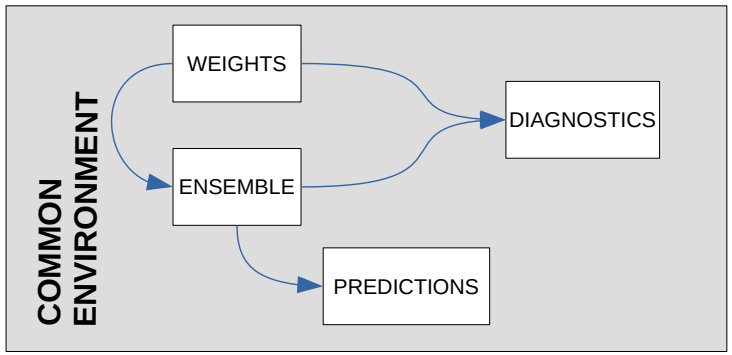
Model space solutions ??

- Model clustering and a two step combination procedure.
- Model expansion to build a discrete model space (Draper, 1995).

Operationalize



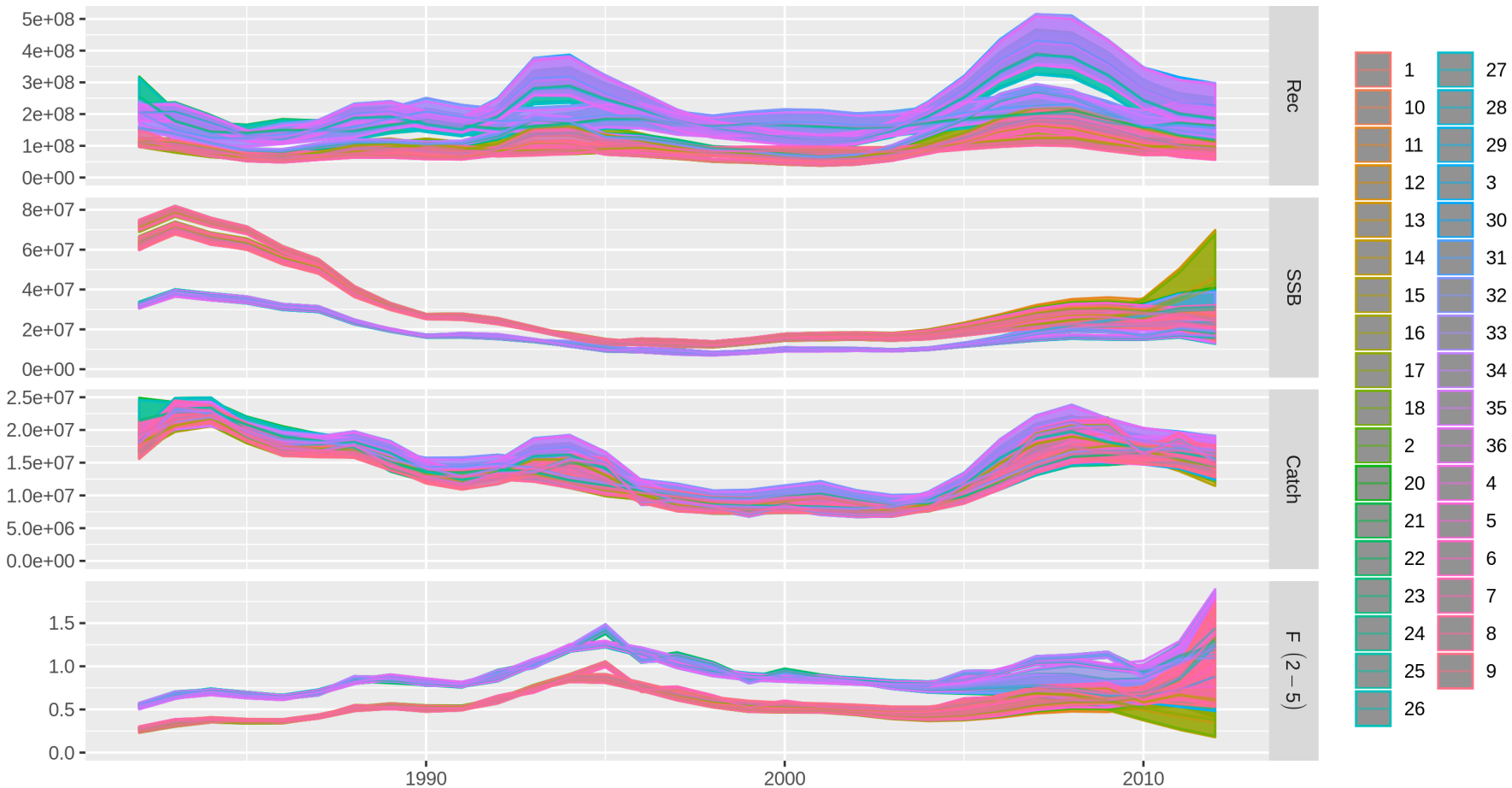
IMPORT /CONVERT



Iberian hake example: model setups (X 2 Ms)

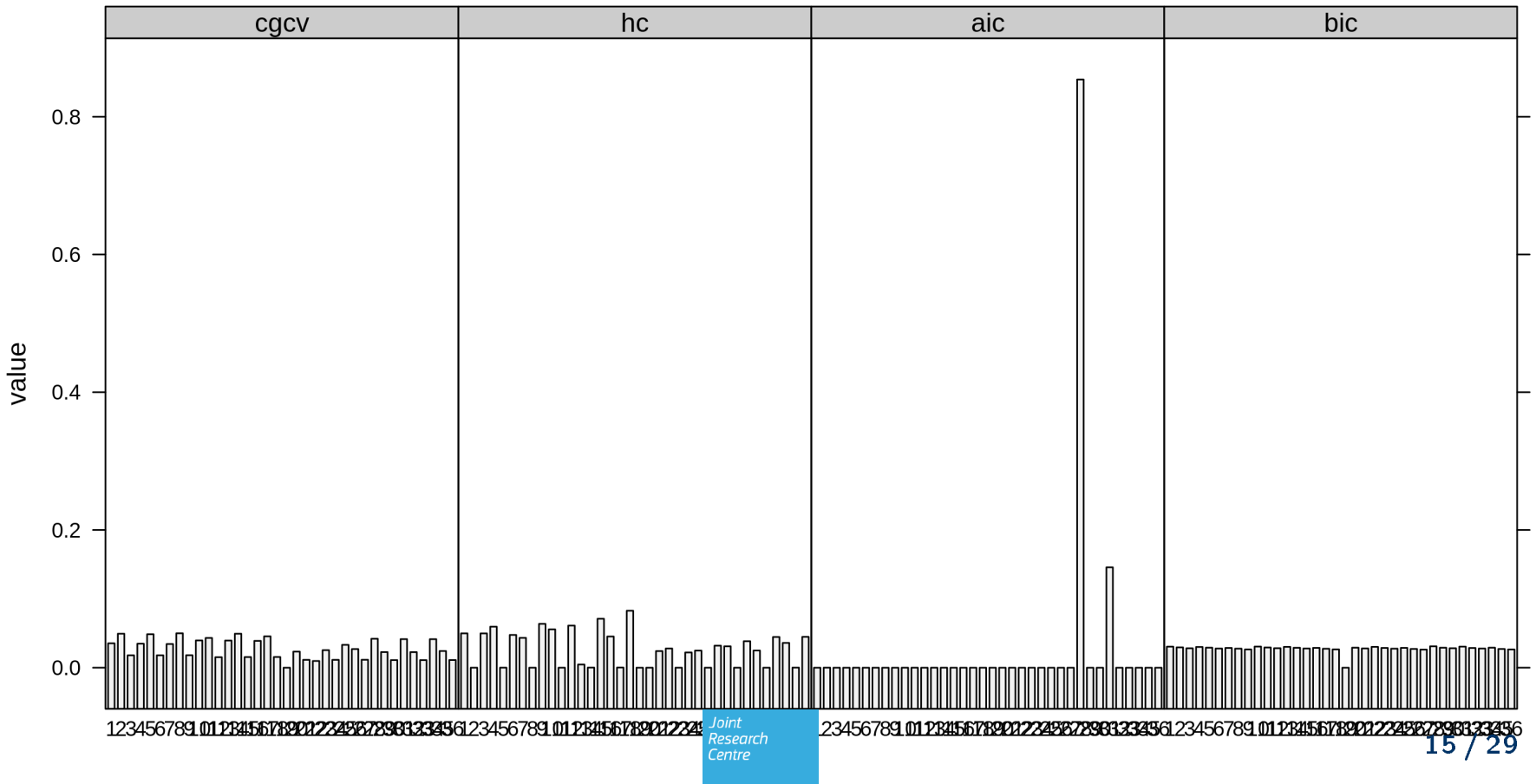
SA model	fmodel	qmodel	rmodel
1	age and year factors	age smoother	year smoother
2	spline on age and year	age smoother	year smoother
3	logistic with year smoother	age smoother	year smoother
4	age and year factors	age and year smoothers	year smoother
5	spline on age and year	age and year smoothers	year smoother
6	logistic with year smoother	age and year smoothers	year smoother
7	age and year factors	logistic with year smoother	year smoother
8	spline on age and year	logistic with year smoother	year smoother
9	logistic with year smoother	logistic with year smoother	year smoother
10	age and year factors	age smoother	Ricker
11	spline on age and year	age smoother	Ricker
12	logistic with year smoother	age smoother	Ricker
13	age and year factors	age and year smoothers	Ricker
14	spline on age and year	age and year smoothers	Ricker
15	logistic with year smoother	age and year smoothers	Ricker
16	age and year factors	logistic with year smoother	Ricker
17	spline on age and year	logistic with year smoother	Ricker
18	logistic with year smoother	logistic with year smoother	Ricker

Iberian hake example: fits

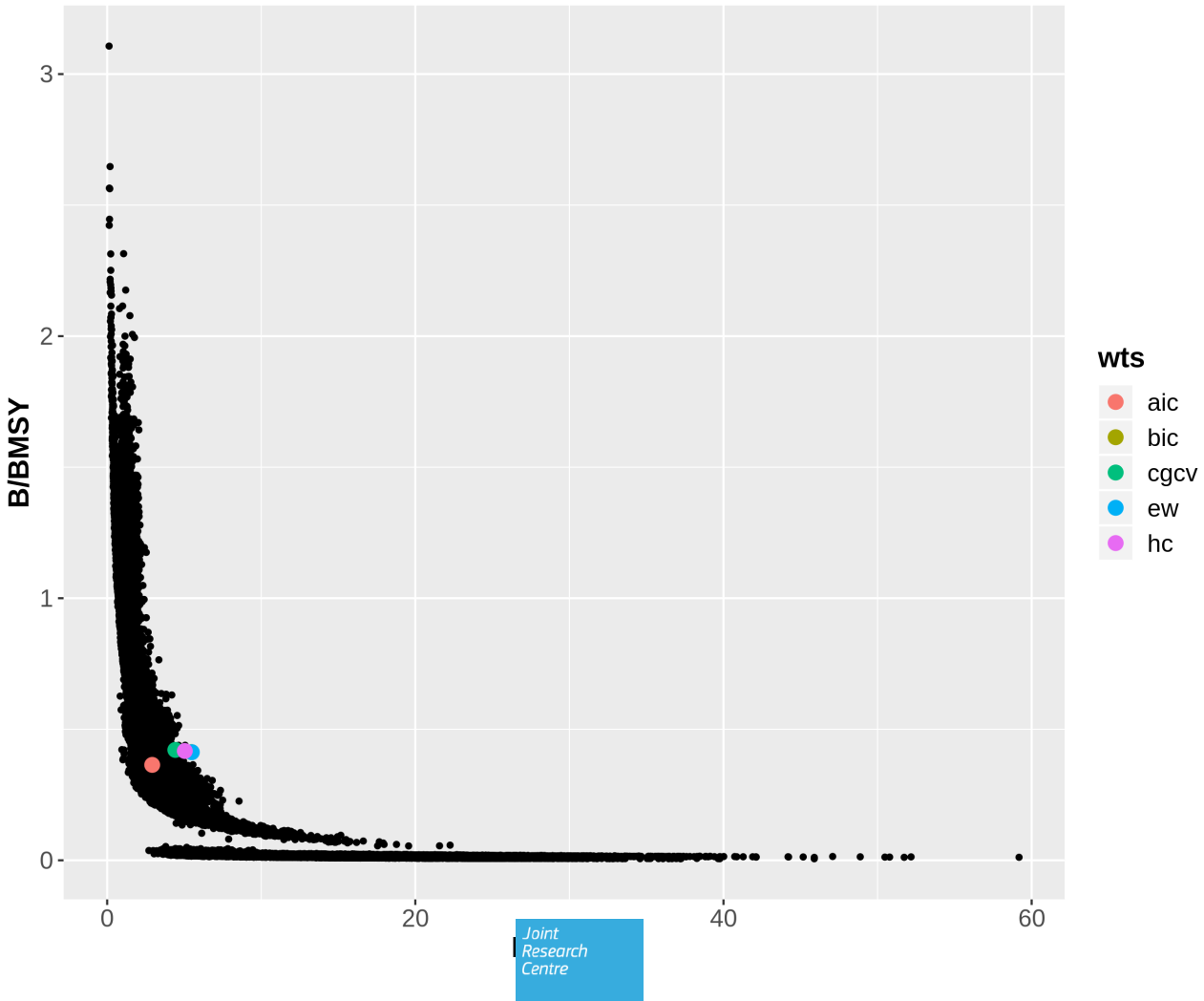


Iberian hake example: metrics

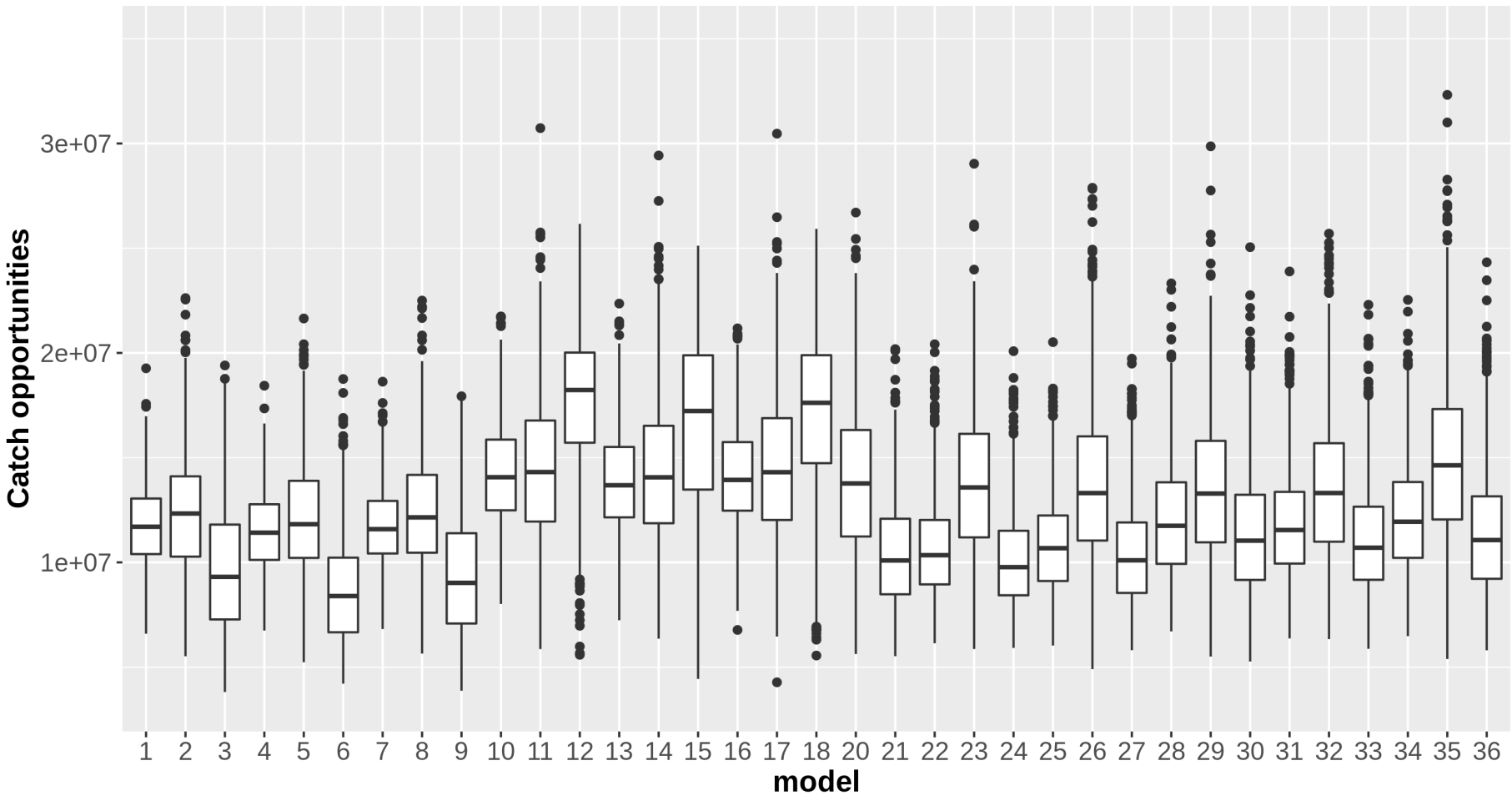
Cohort Cross Validation, Hindcast, AIC, BIC.



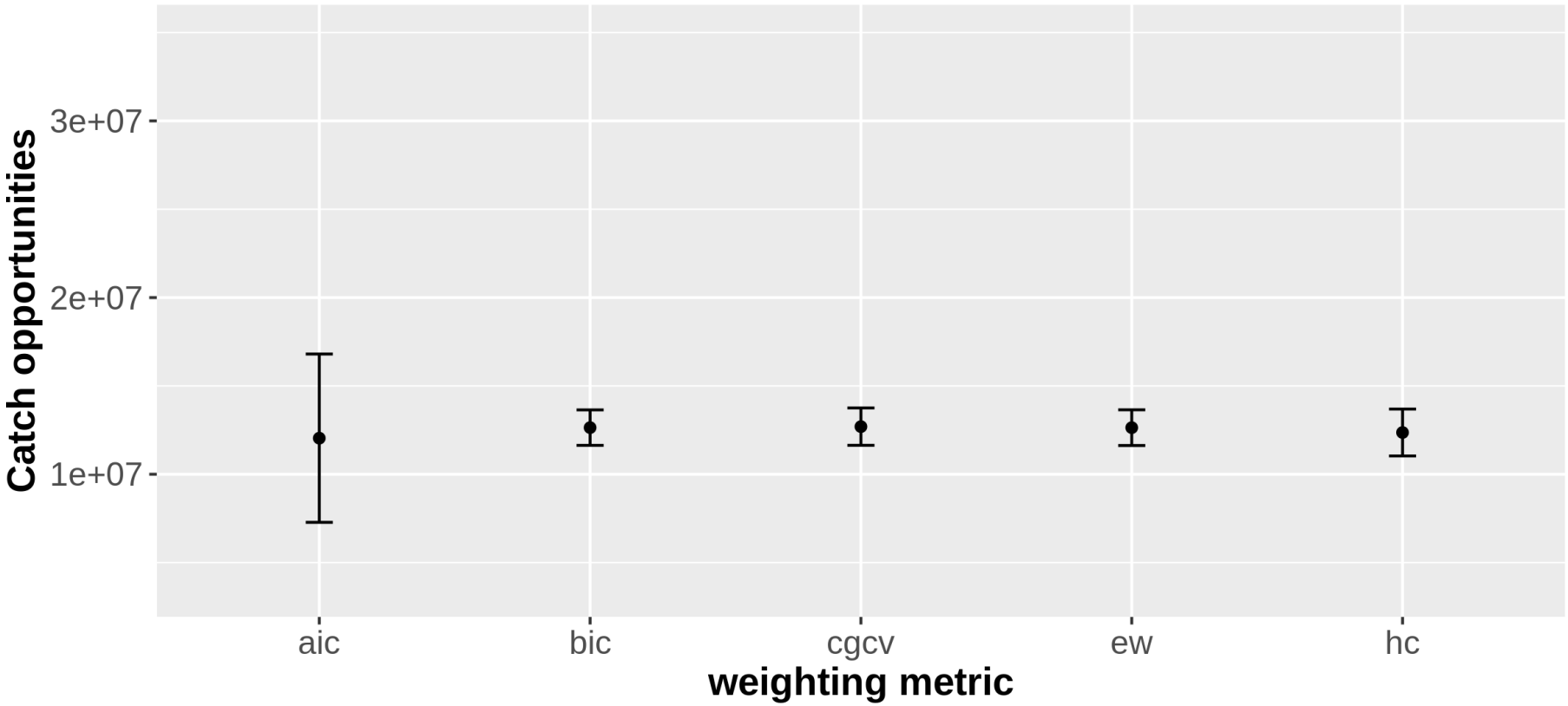
Iberian hake example: stock status



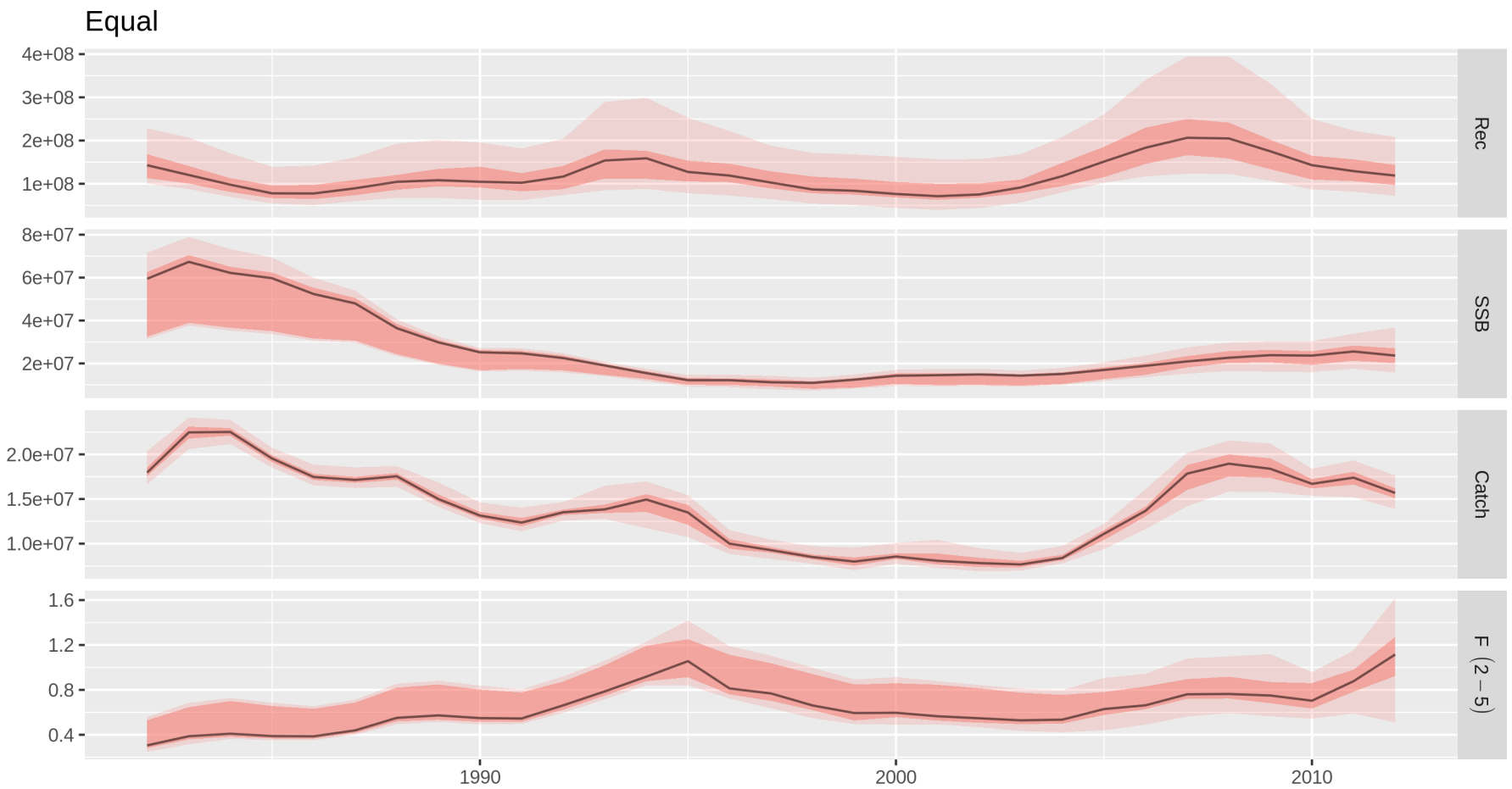
Iberian hake example: fishing opportunities



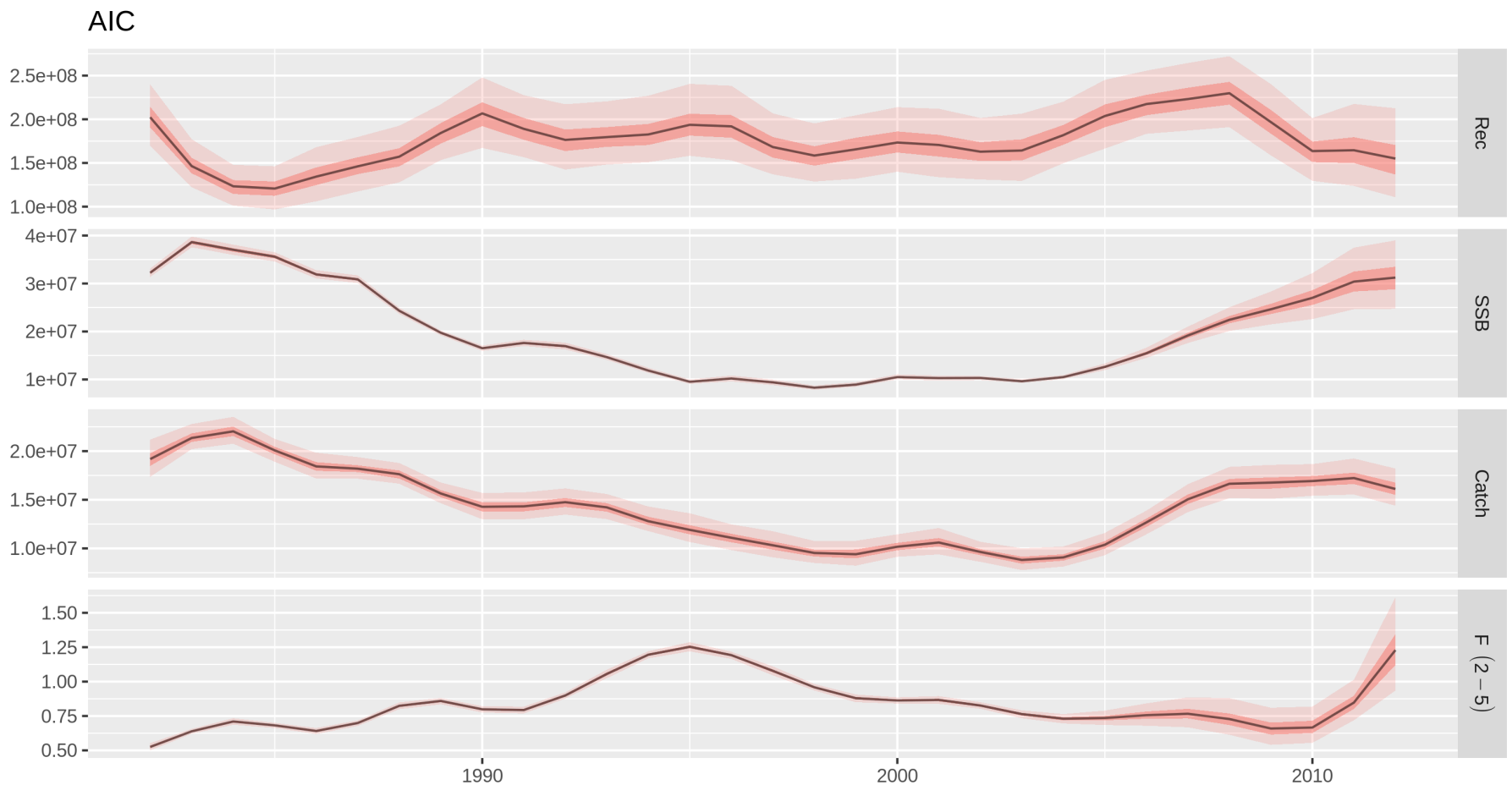
Iberian hake example: fishing opportunities



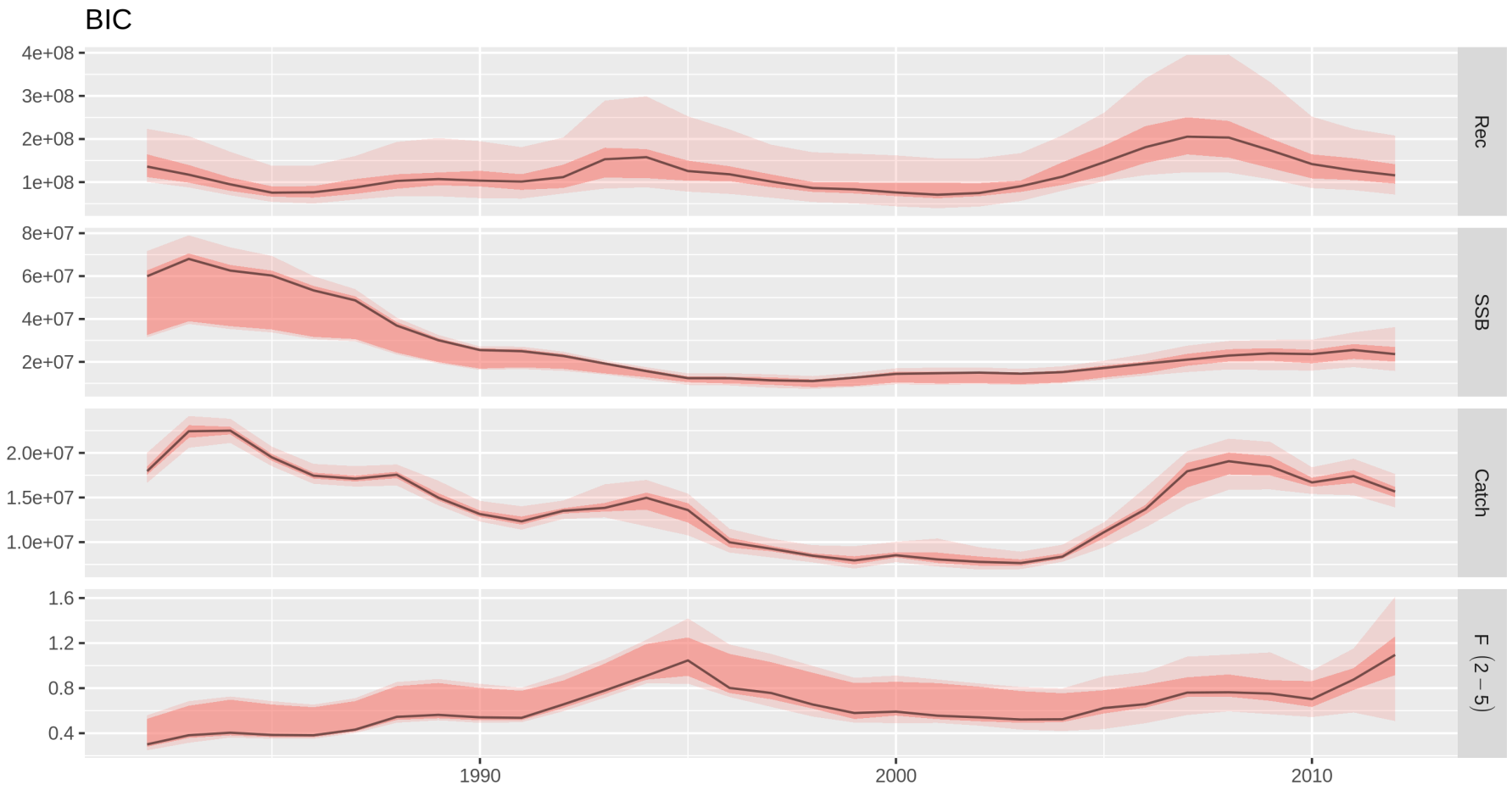
Iberian hake example: equal weights ensemble



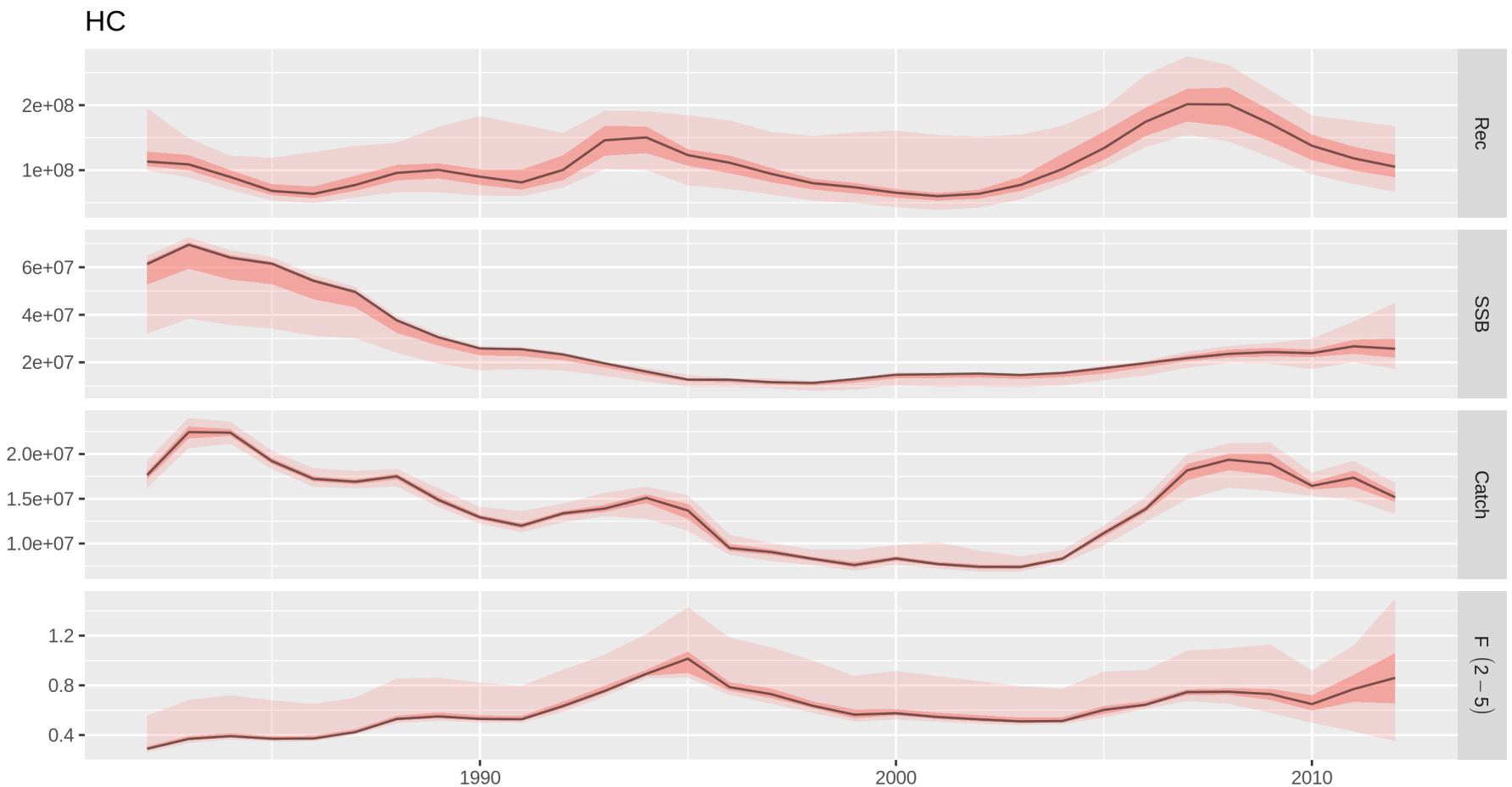
Iberian hake example: AIC ensemble



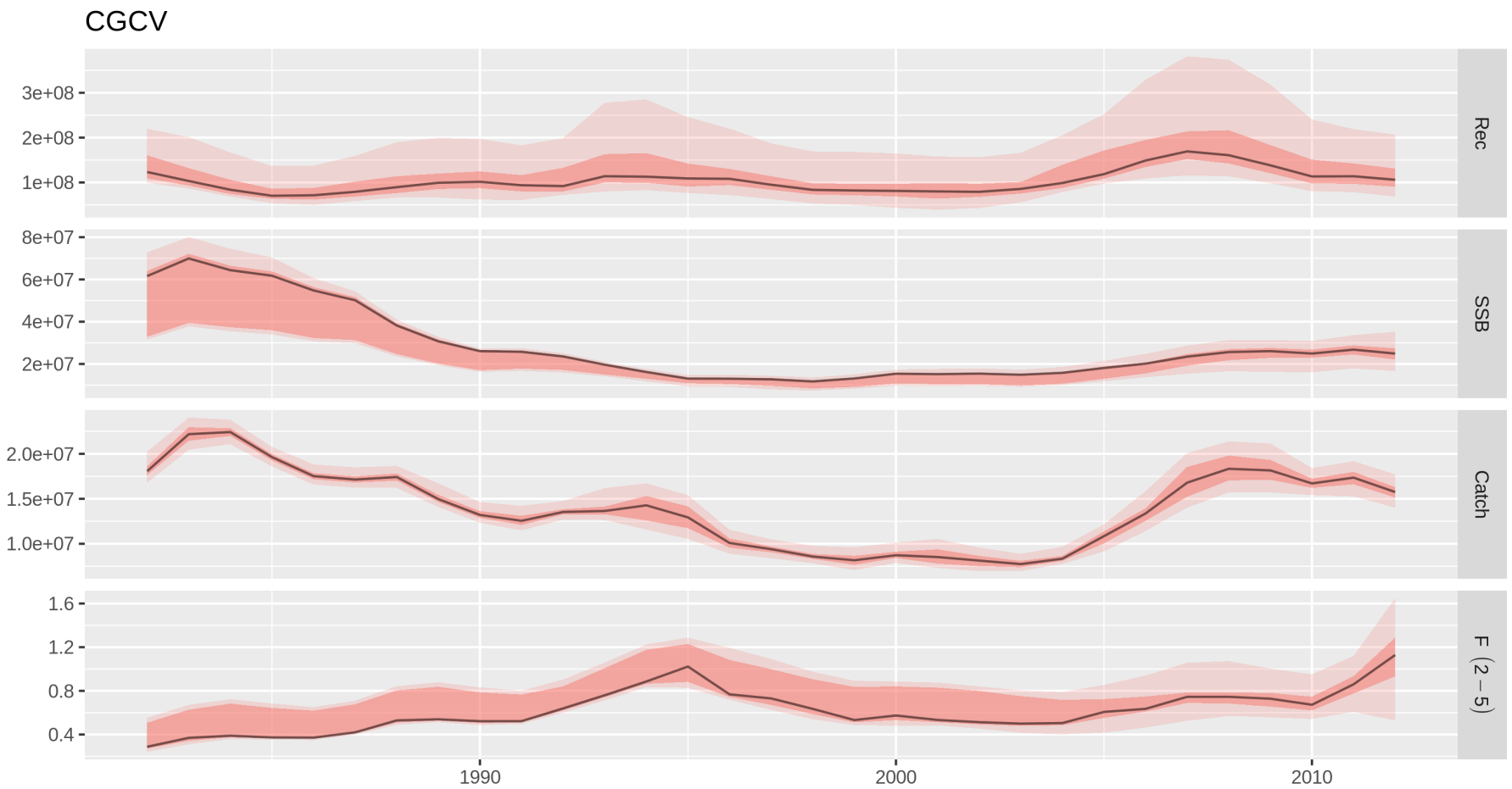
Iberian hake example: BIC ensemble



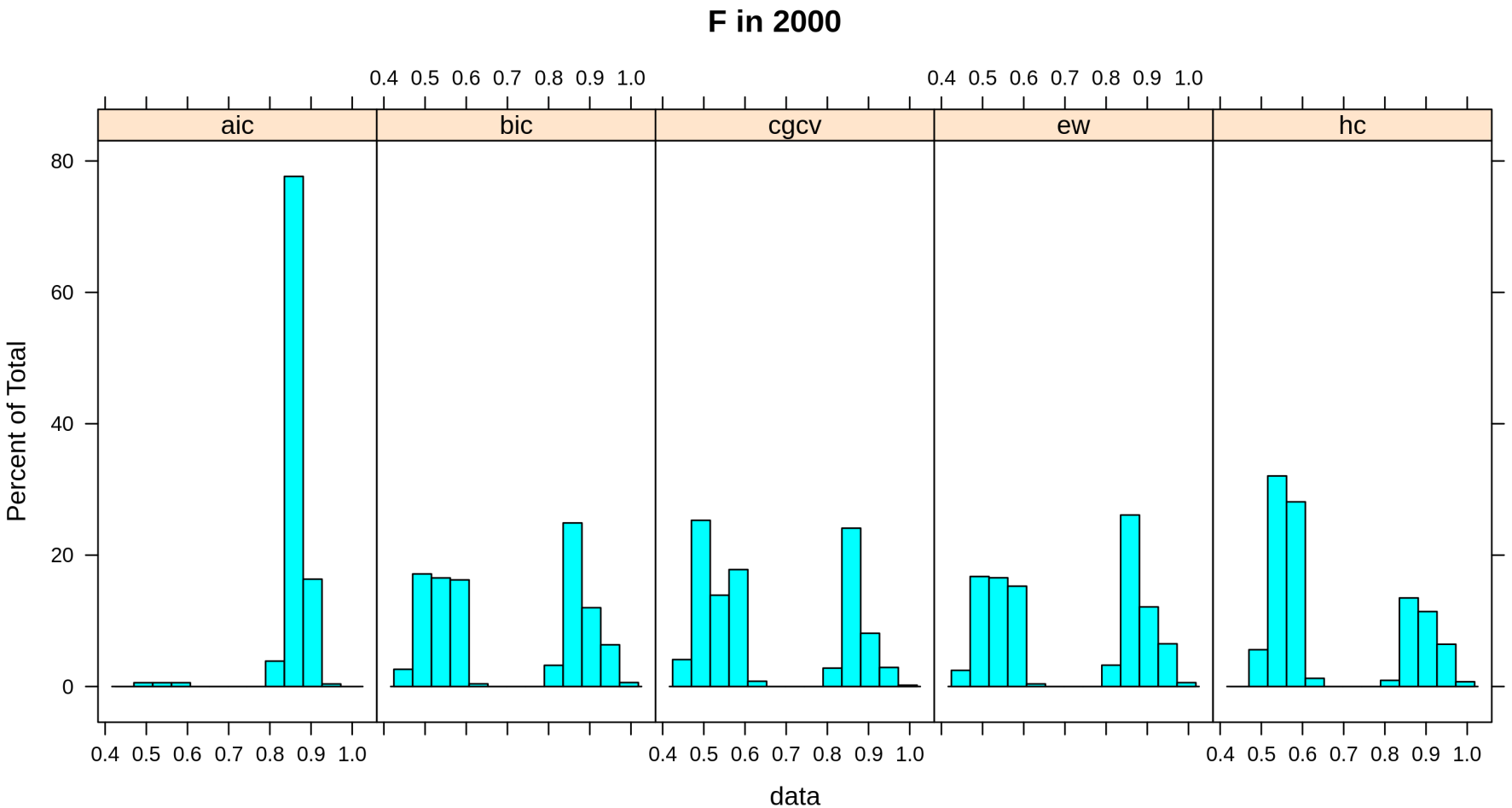
Iberian hake example: Hindcast ensemble



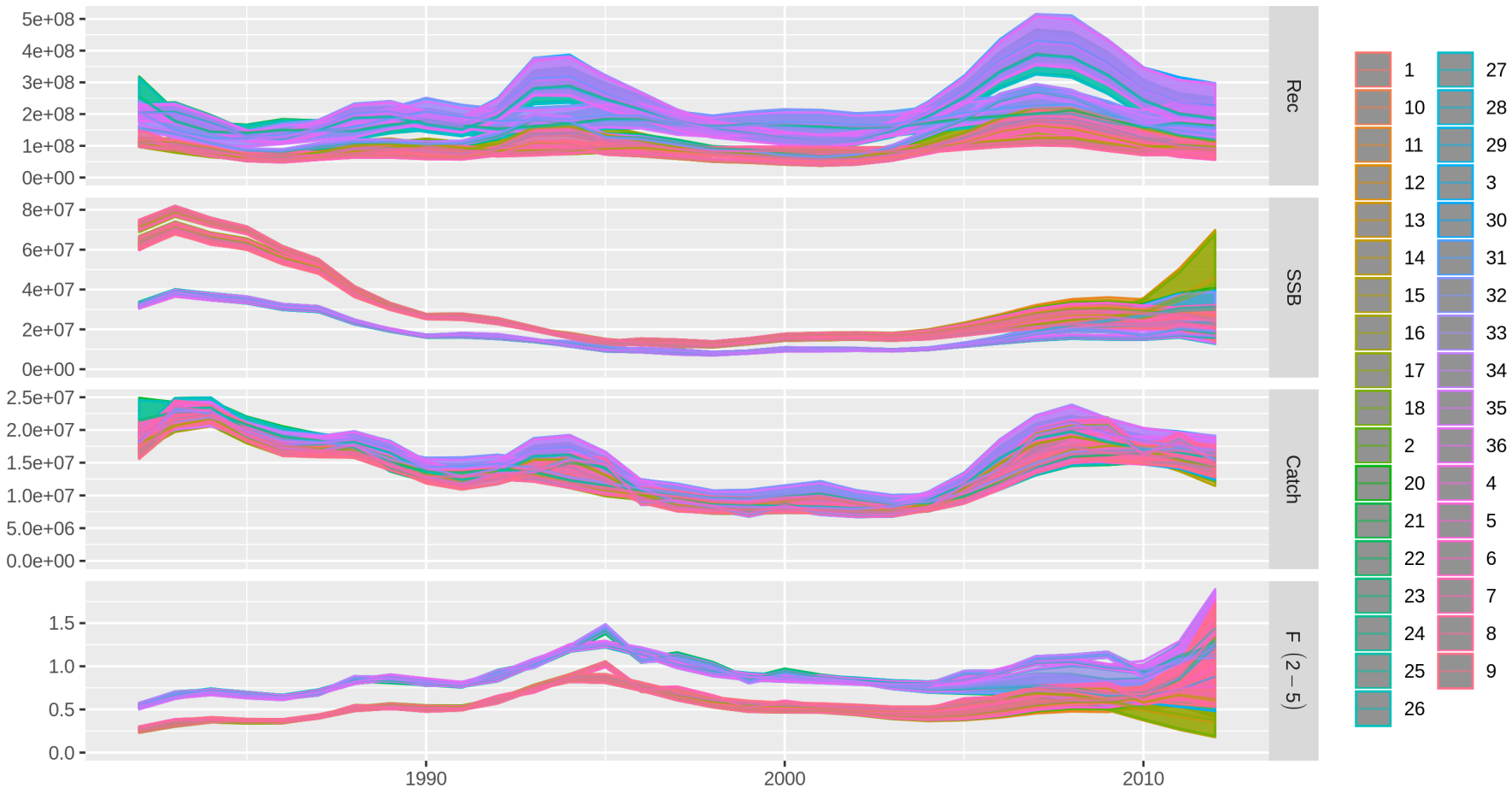
Iberian hake example: Cohort GCV ensemble



Iberian hake example: bimodality



Iberian hake example: fits



uber super duper ensembles

Super-ensembles ?

Current stock assessments

We're already doing large part of the work needed !

but

We assign a probability of 1 to a single model fit (the 'best' model) and zero for all the others ...

Final comments

Ensemble models can help to:

- include structural uncertainty across different models of the same system,
- integrate across initial conditions in projections or sensitivity tests runs.

and improve

- estimation of stock status
- estimation of future fishing opportunities
- building operating models

Thank you !

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