

# Response to the general comments



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1. What are the expectations or requirements for estimates of uncertainty to be provided for estimated quantities from the stock assessment model fitting? For most estimated quantities such as fishing mortality rates, and stock biomass by year reported in the stock assessment documents, point estimates are provided for quantities estimated from each fitted stock assessment model.

For example, in the summary for Japanese anchovy: " The spawning stock biomass (SSB) showed a downward trend from 93,000 tons in 1983 to 11,000 tons in 1992. Subsequently, the SSB showed an increasing trend, and in 2023 it was 59,000 tons. " No confidence intervals are provided within this document or any of the other three stock assessment documents for estimated historical quantities such as SSB or fishing mortality rates on fully recruited age groups. Confidence intervals are provided for relatively few reported estimated quantities (e.g., 90% intervals are reported for the stock-recruit function for splendid alfonsino) and also for future projected quantities (e.g., F, SSB, catch, etc. for splendid alfonsino). It is conventional in stock assessment elsewhere for confidence intervals or probability intervals to be provided for estimated stock assessment quantities, such as fishing mortality rates and stock biomass by year. This has commonly been done for different types of stock assessment models including VPA. Methods to generate confidence intervals that have been applied include bootstrapping (e.g., with ICCAT's VPA 2 Box method (e.g., <https://doi.org/10.1111/j.1939-7445.2011.00113.x>)) and in some instances, Bayesian VPA algorithms (<https://doi.org/10.1111/j.1939-7445.2011.00113.x>).

Is there an intention to extend the VPA methods applied, so that confidence intervals could be provided for estimated quantities also such as historical estimates of fishing mortality rates, annual recruitment, and stock biomass? If not, why not?

Lack of confidence intervals for estimated SSB and F

Exceptions (confidence intervals provided)  
- VPA-based estimates (e.g. alfonsino)  
- Future projections (all stocks)

It is conventional to provide Cis even for VPA  
- Some advanced methods are available

Direction for future?  
- extending the VPA method?

Q1

# Lack of confidence intervals for estimated SSB and F

In our stock assessment guidelines, it is not mandatory to present confidence intervals together with stock assessment results, because ...

→ VPA-based assessments make appropriate estimation of confidence intervals difficult and potentially misleading

- Bootstrap of abundance indices can provide CIs in tuned VPA (e.g. Splendid Alfonsino) → this approach does not account for uncertainty in catch at age, and cannot be applied to untuned VPA
- Advanced methods (that can consider uncertainty in catch at age) require information on catch-at-age uncertainty (CVs of aging error), which is unavailable for most stocks (needs to be improved)

Mandating confidence intervals would create the misleading impression that untuned VPA has no uncertainty, while tuned VPA does.

In addition, confidence intervals are not explicitly used in current harvest management

# How we mitigate the lack of confidence intervals

1. **Management:** our HCR guideline recommends a harvest control strategy that uniformly applies a precautionary factor (0.8) to  $F_{msy}$  as the upper limit of target fishing mortality rates (Restrepo et al. 1998, Okamura et al 2020)
2. **Model diagnostics appendix:** our model diagnostics guideline recommends to include CIs calculated by bootstrapping abundance indices in the appendix (not in the main text) if available
3. **Assessment model (future direction):** we provide CIs when they can be appropriately estimated in the main text, for example using state-space models, and we are making efforts on transition from VPA to these more advanced assessment models
4. **Data improvement (ongoing):** as pointed out, if uncertainty in catch at age can be properly evaluated, more advanced methods could be applied within VPA. Improving the data and evaluating these uncertainties is currently ongoing

2. The hockey stick stock-recruit model was adopted and fitted for all four fish stocks. However, experts in the field, e.g., Professor **Carl Walters**, have criticized this stock-recruit function, because it does not incorporate population compensation, whereby under commonly observed conditions for fish population dynamics in where stock-recruit data are available, it has been observed that as SSB decreases, the long-term average expected recruits per spawner increases monotonically.

It has become well-established in the field of fisheries stock assessment that other relatively simple stock-recruit functions such as the Beverton-Holt and Ricker stock-recruit functions provide accurate representations of stock-recruit dynamical processes for exploited fish stocks.

**Why has the hockey-stick model** which has been largely replaced by the Beverton-Holt and Ricker stock-recruit functions **still been retained in these four stock assessments?**

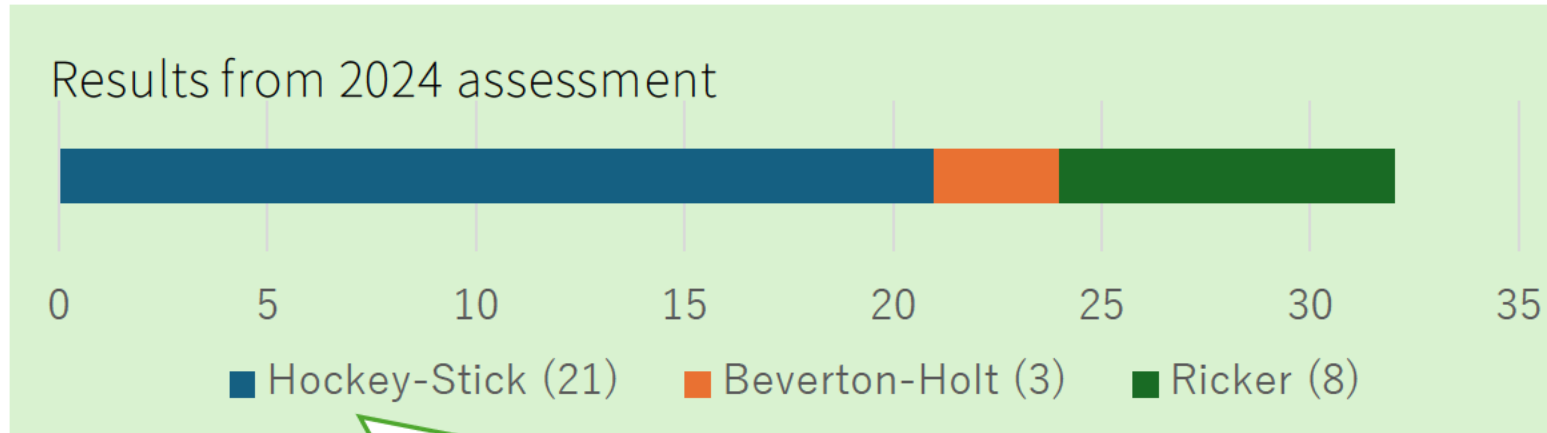
HS does not incorporate population compensation

Why HS is used for all four stocks?

Q2

# HS is not applied by default

- Stock recruitment relationships are selected on a case by case basis, following [the guideline for selecting stock-recruitment relationships](https://abchan.fra.go.jp/references_list/FRA-SA2025-ABCWG02-05.pdf) ([https://abchan.fra.go.jp/references\\_list/FRA-SA2025-ABCWG02-05.pdf](https://abchan.fra.go.jp/references_list/FRA-SA2025-ABCWG02-05.pdf))
- Note: Stock recruitment relationships (and MSY reference points) are generally reviewed on a five year cycle



For the four assessments reviewed, HS happened to be selected for all stocks based on the guideline criteria

# Guidelines for selecting stock-recruitment relationships

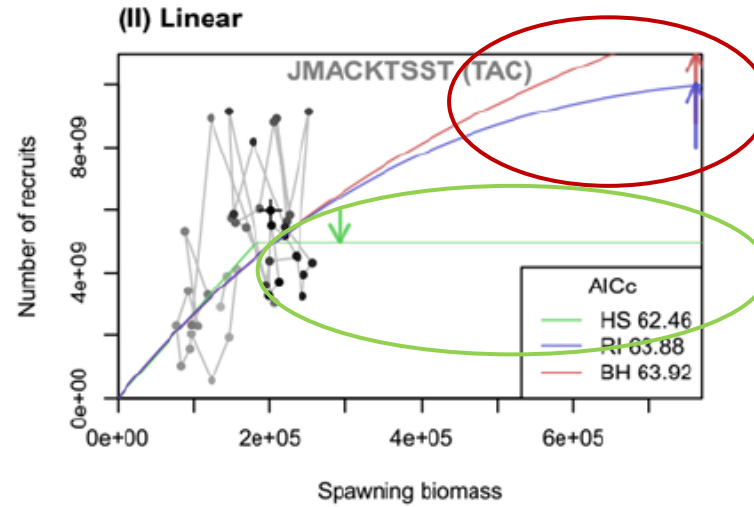
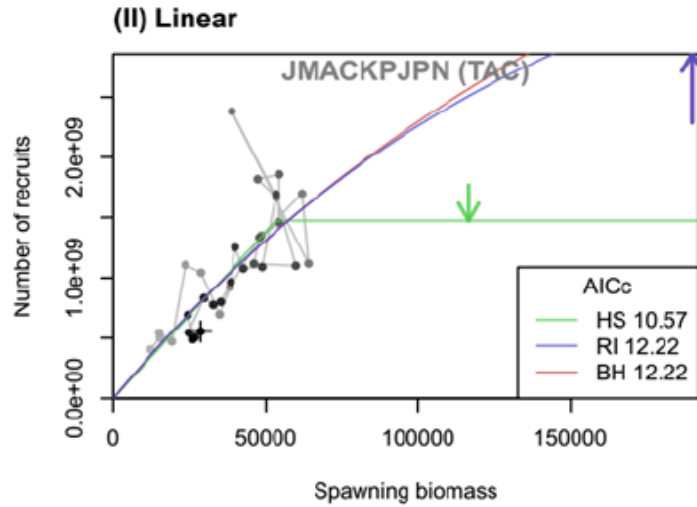
**Purpose:** Stock recruitment relationships strongly influence future projections and MSY reference points, but their parameters are among the most difficult to estimate reliably. Therefore, the guidelines aim to support informed selection of stock-recruitment relationships

Selection is based on **multiple criteria**, including:

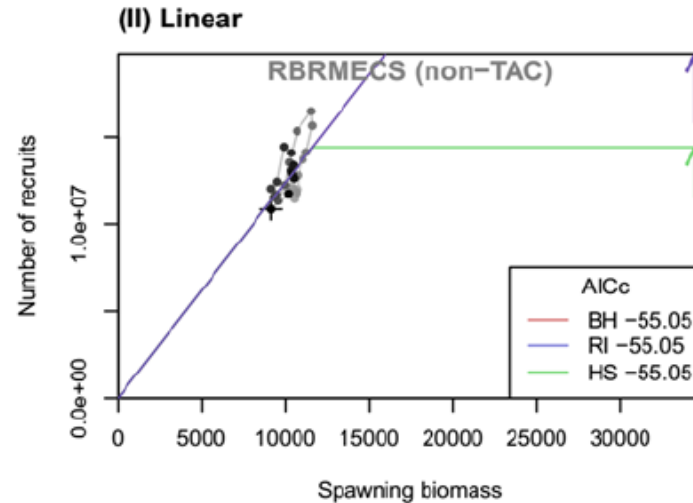
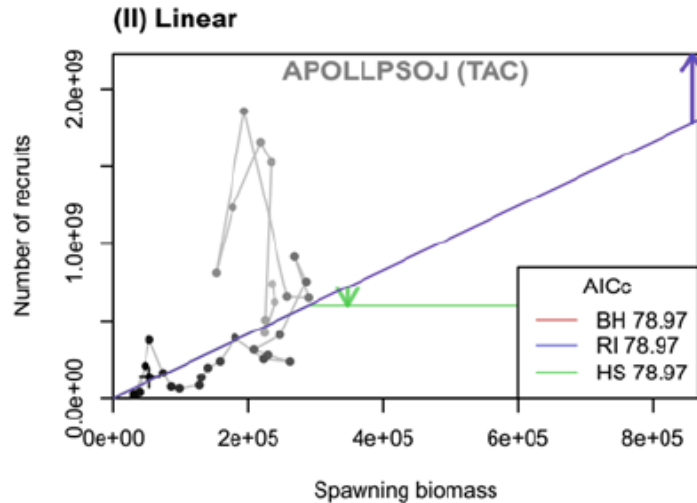
- a. AIC
- b. Biological plausibility (e.g. is steepness within a reasonable range?)
- c. Robustness to outliers
- d. Avoidance of extrapolated recruitment beyond historically observed levels
- e. Avoidance of excessive compensation below the historical minimum SSB
- f. Robustness of reference points
- g. Risk considerations
- h. auto correlation
- i. Robustness in management

# Representative examples of cases where HS is selected

d. Avoidance of extrapolated recruitment beyond historically observed levels

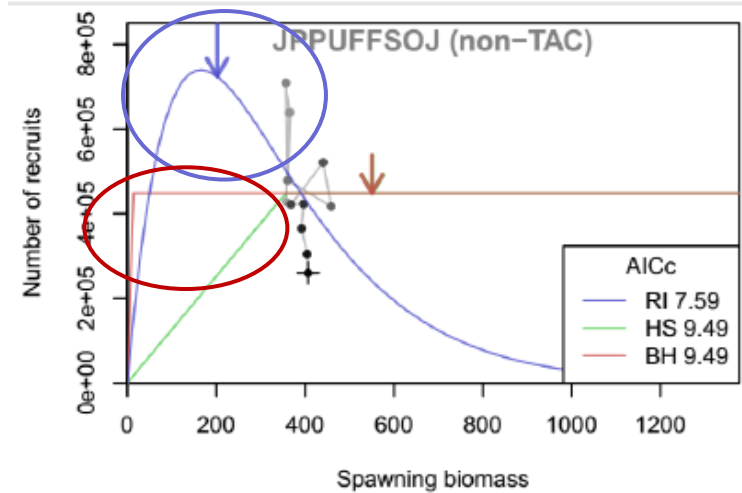


When BH or RI is applied, the estimated SB<sub>MSY</sub> is based on extremely extrapolated high recruitment



# Representative examples of cases when HS is selected

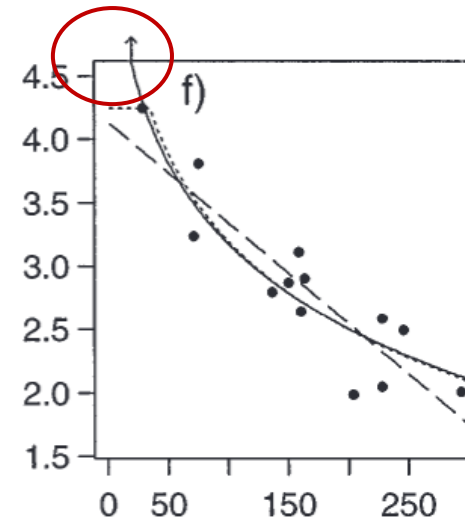
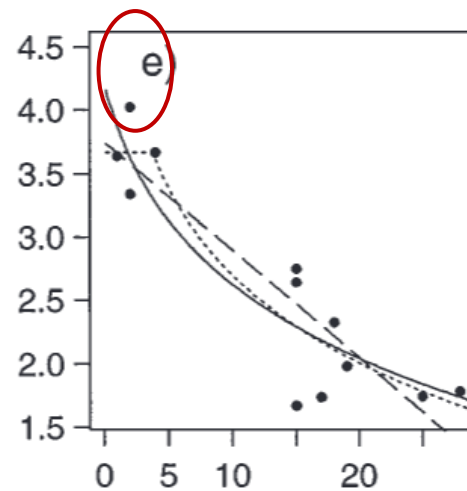
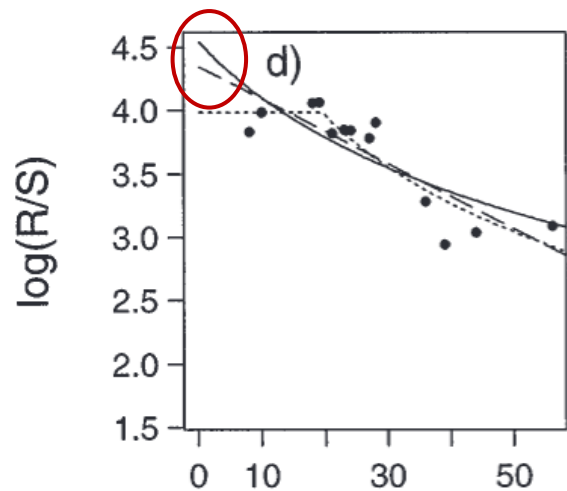
e. Avoidance of excessive compensation below the historical minimum SSB



When applying RI, the estimated SB<sub>MSY</sub> will be based on extremely extrapolated high recruitment (in this case, 2. Biological plausibility is also issued)

(From SR guidelines)

Barrowman and Myers (2000) also pointed out that the difficulty with both BH and RI is that at low spawner abundance, R/S is often estimated to be above the levels observed



Barrowman and Myers (2000)

# The cases for the four stocks reviewed (Alfonsino, Flounder)

## Splendid alfonsino

|            |             |            |   |            |
|------------|-------------|------------|---|------------|
| キンメダイ太平洋系群 | HS, L2, ARO | 3a, 3b, 3d | 同一の推定方法, 自己相関の考慮の有無においては, HS,BH,RI の当てはまりは同程度であった(3a).<br>BH および RI は, 推定された親魚量の極大値が過去の親魚量の範囲外に位置し, その生物学的な妥当性を検証する材料は少ないため, 便宜的に HS とした(3b, 3d). 加入量の自己相関を考慮する場合のほうが当てはまりはよいが, 自己相関係数が非常に高く推定され, 生物過程によりもたらされる加入量の自己相関の程度はそれよりもはるかに小さいと考えられるため, 自己相関なしを採用. | 亘ほか (2022) |
|------------|-------------|------------|---|------------|

d. Avoidance of extrapolated recruitment beyond historically observed levels

|               |                  |                |  |             |
|---------------|------------------|----------------|--|-------------|
| ムシガレイ日本海南西部系群 | HS, L2, AR1(二段階) | 3a, 3b, 3d, 3h | BH および RI では, 観察された親魚量の範囲では右肩上がりの直線として推定され密度効果が認められなかったため過去最大親魚量を折れ点とする HS を選択 (3b, 3d). | 八木ほか (2021) |
|---------------|------------------|----------------|--|-------------|

## Shotted Halibut

(These tables are shown in the stock recruitment guidelines)

# The cases for the four stocks reviewed (anchovy and herring)

## e. Avoidance of excessive compensation below the historical minimum SSB

|                           |                |                   |   |                |
|---------------------------|----------------|-------------------|---|----------------|
| カタクチ<br>イワシ瀬<br>戸内海系<br>群 | HS, L2,<br>AR0 | 3a, 3e, <b>3h</b> | HS, BH, RI で AICc はほぼ同じ(3a). その中で, HS では親魚量が少ない場合に RI と BH よりも予防的な加入量となっていること(3e)から HS を採用. 自己相関はみとめられなかった(3h). | 河野ほか<br>(2022) |
|---------------------------|----------------|-------------------|---|----------------|

### Japanese Anchovy

|                      |                           |                             |   |                |
|----------------------|---------------------------|-----------------------------|---|----------------|
| ウルメイ<br>ワシ対馬<br>暖流系群 | HS,<br>L2,<br>AR1(同<br>時) | 3a,<br>3h,<br><b>3g, 3i</b> | HS で自己相関の同時推定 (3h), RI で自己相関の二段階推定, BH で自己相関の二段階推定の三つのモデルの予測力に差は認められないため (3a), 不確実性に対する頑健性と, それぞれの再生産関係を誤って選択した場合のリスク(3g) を簡易 MSE で評価した (3i). | 依田ほか<br>(2021) |
|----------------------|---------------------------|-----------------------------|---|----------------|

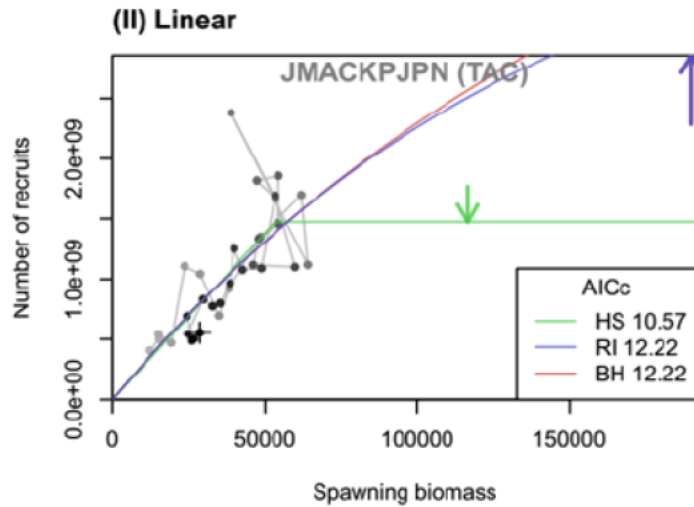
### Round herring

g. i, Risk and robustness of management

(These tables are shown in the stock recruitment guidelines)

No single decision is perfect, but the selections reflect a balanced judgement across multiple criteria, and were **agreed upon through institutional consensus in Scientific Committee.**

# Remaining concerns about limited biological realism in HS



In HS, the historically observed range of SSB determines the breakpoint (i.e. MSY reference points).

This may introduce bias in MSY reference points.

Nevertheless

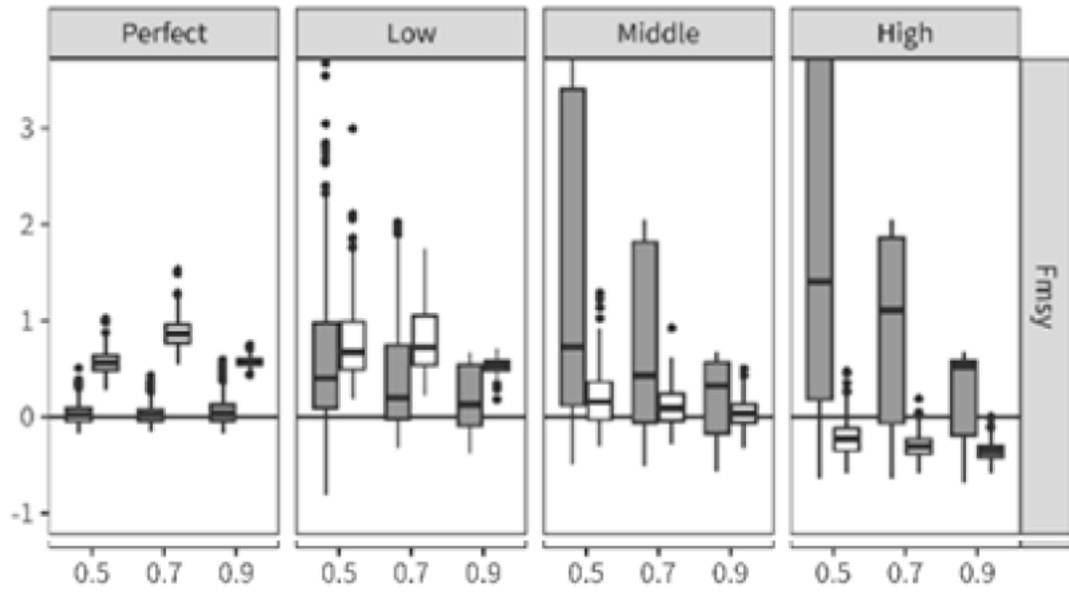
## Role of HS in management context

- HS is not intended to represent the true stock–recruitment process
- Its role is to **provide robust reference points** for management.
- As accumulating the stock recruitment data, the **true stock-recruitment is expected to be selected**

# (Appendix) Results of MSE supporting pragmatic use of HS for management

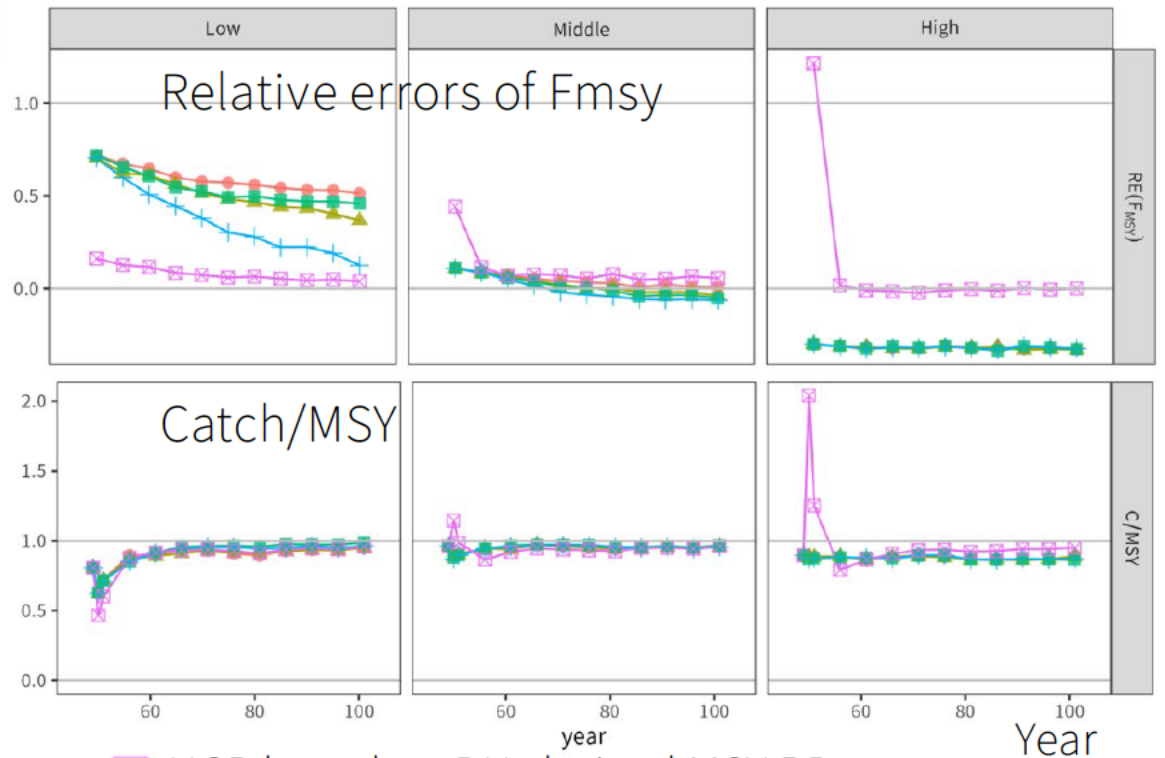
MSE: Although BH is true SR, HS is used to estimate MSY RPs in HCR (Ichinokawa and Okamra, in preparation)

Relative errors of Fmsy



BH is applied to the true BH SR function  
 HS is applied to the true BH SR function

HS shows larger bias but smaller variance in Fmsy estimation



⊠ HCR based on BH-derived MSY RPs  
● HCR based on HS-derived MSY RPs  
+ ▲ More precautionary HCR based on HS (catch capping, model selection)

Expected yield is similar, and precautionary HCRs using HS reduce bias of MSY RP estimation

MSE results suggest that the pragmatic use of HS can be acceptable for management when combined with precautionary measures