Considerations toward choosing appropriate management procedures.

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適切な管理方式選択へ向けての考察

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Abstract

Points noted during the final testing processes were summarized. Two tuning levels 0.9 and 1.1 were considered as appropriate boundaries for management. Both levels target long-term recovery of stock but differentiate an extent of TAC reduction required and corresponding risk of stock decline. Incorporation of safe guard should be considered especially when taking aggressive policy. Plotting of catch and biomass distribution in 2022 and 2032 are found useful to compare and interpret differences among candidate MPs.

MP 最終検討の過程で気づいた点をまとめた。チューニングレベル 0.9 と 1.1 との間で管理を考えるのが妥当と思われる。両レベルとも長期的な資源回復をめざしているが、必要とされる TAC 減の程度と対応する資源が減少に向かうリスクの点で異なっている。特に積極的に漁獲を行う政策をとる場合には、安全策を導入することが必要だと思われる。2022 年、2032 年における漁獲量、資源量の分布図は、MP 候補を比較し差異を解釈する上で有効であることが明確になった。

1. Introduction:

Japan examined various types of candidate management procedures (MPs) following to the final specification agreed through the Fourth Stock Assessment Group Meeting, the Eighth Meeting of Scientific Committee, the Tenth Annual Meeting of the Commission, (Anon.; 2003a, 2003b, 2003c) and the follow-up discussions through e-mail communications. The results of this final examination were described in Butterworth and Mori (2004), Hiramatsu et al. (2004) and Takahashi et al. (2004).

This document summarizes the points noted during the final examination processes, covering both purely technical issues and our own consideration toward selecting appropriate and/or acceptable MPs. Some messages and advices for decision makers are also included.

2. Technical notes related to testing specifications:

- Random number

Table 1 shows that the random numbers generate six reference case scenarios as with intended proportions successfully for each 500 block up to 4,000 runs. However, as shown in Figure 1, behaviors of MP slightly differ depending on the number of runs. Overall levels of catch trajectory become gradually lower as increasing number of runs, with an exception for 200 runs where proportions among scenarios slightly differ from others. No substantial differences are observed in biomass trajectories, probably due to compensatory nature of MP. This may be caused by fluctuations in actual values assigned within each scenario. Although the exact causes

of this are still unknown, we are concern with a level of impacts as well as a tendency to shift toward one direction. On the other hand, this suggest that few hundreds tons difference in average catch should not be taken with too much weight when comparing MPs.

Changes of simulation periods from 30 years to 50 years will also result in differences of random numbers to be used, though the extent of impact has not been evaluated yet.

- Simulation period

Some MPs seem to behave reasonably well up to 30 years projection but indicate drastic changes afterwards (e.g. CCSBT-MP/0404/08, Appendix 3). Also, Figure 2 shows an example of two MPs showing similar behaviors up to 2032 but diversifying afterwards.

We propose to include 50 years projection at the final selection process. This is not from intention to utilize one same MP for a long period but in order to prevent selecting such MPs containing risks of sudden changes of behaviors in a long-term. Our experiences have shown us that the stock of long-lived species is quite viscous. Stock behavior of southern bluefin tuna for the next decade has already been fixed by now. We consider it critical to distinguish MP which may make the stock instable in the future.

- Tuning Level

The Eighth Scientific Committee and the Tenth Annual Meeting of Commission agreed to tune all MPs to a fixed value of B(2022)/B(2002) to make them comparable. Three tuning levels, 0.7, 1.1, and 1.5, were selected with an intention to represent cases of substantial TAC increase, sustenance around current TAC, and substantial TAC reduction, respectively, based on the results presented at the 2003 SAG/SC. After the Meetings, it was found that the projection software used for the works presented at the 2003 SAG/SC did not incorporate auto-correlation term of recruitments as intended. When this was fixed, the recruitments at the beginning of projection were substantially lowered comparing with the previous version.

As a result, tuning level of 1.5 can be realized only when reducing TAC with almost a maximum rate regardless MPs. At the same time, tuning level of 0.7 requires increase of TAC when stock declining from the current level, which leads to further stock decline and collapse, again regardless MPs. (Note: All of Appendices in CCSBT-MP/0404/08 contain comparison among different tuning level.) We consider neither levels as realistic.

We noted that the tuning level of 1.1 also requires substantial TAC reduction at least at the first year of TAC change. Industries and managers have repeatedly pointed the importance of stable TAC, and difficulty to reduce TAC drastically. Then, in order to cover the case corresponding to relatively mild changes of TAC from the current level, we decided to include the tuning to 0.9 for all MPs testing in addition to three agreed levels.

The MPs presented at 2003 SAG/SC (Tsuji *et. al*, 2003) were selected without constraint with tuning. This means that the behaviors of those MPs are preferable ones from our standard. Corresponding tuning levels of those MP realizations were around 0.8 to 0.85. The tuning level of 0.9 was selected as a point closer to those corresponding to MP realizations presented in 2003,

and as a middle point between two agreed levels. All candidate MPs presented in 2004 by Japan realized higher median biomass in 2032 than B(2002). It should be noted that the tuning levels 0.9 are also targeting a long-term recovery of stock. Since we think both 1.5 and 0.7 tuning levels as inappropriate, our analyses are mostly concentrated to 0.9 and 1.1 levels.

3. General features of MP behaviors:

- Constant TAC

Behaviors of constant TAC rules are provided in Appendix 1 of CCSBT-MP/0404/08. When maintaining the current TAC, median biomass trajectories will stop declining or slightly increase, though substantial proportion of runs indicate stock collapse. In the other words, the operating model suggests a certain risk of stock collapse under the current catch level. If TAC will be fixed after reducing to the levels corresponding to tuning levels, cases tuned to 1.1 and 0.9 indicate gradual stock recovery after 2010. The corresponding average catches for 20 years are around 12,000 t for 1.1 and 14,100 t for 0.9. These levels are comparable or even higher than those realized by most MPs.

- General features of candidate MPs

We found that various types of decision rules could obtain the similar effects. This is the same observation made in Tsuji *et al.* (2003). MPs incorporated in the summarization figures of CCSBT-MP/0404/08 are the ones satisfying our judgment criteria. All of those show quite similar behaviors, even using different inputs and decision mechanisms.

Our qualitative judgment criteria are high long-term catch, biomass level in 2032 relative to 2002, and consistency in direction of TAC changes and biomass changes. Stability of both stock and TAC behaviors are another important factor. Those are the same principle used in Tsuji *et al.* (2003).

Several general features are noted during the final MP testing. Generally, MPs using indicators of both stock level and stock trends tend to succeed in corresponding smoothly to stock changes of all reference scenarios. MPs based on stock trend only are sensitive when stock changing to one direction, either increase or decrease, but have difficulties to detect timing of turn-around of stock change direction. This generally leads to overshoot in TAC control, i.e. increasing or decreasing TAC too much. On the other hand, MPs with stock-level indicator only are insensitive to the signals for short-term stock changes from its definition. Also, the MPs of non-symmetrical rules for increase and decrease of TAC often troubled to stabilize stock behaviors when stock moving toward the direction with a looser rule.

Several general trade-offs are also noted. Long-term (30 years) catches vs. median biomass in 2032 have inverse relationship. Similarly, a narrower range of long-term average catches directly connects to a wider range in 2032 biomass. Here, it should be noted that narrow range of catches indicates MPs as less sensitive to differences in scenarios. An extent of TAC reduction at the first TAC change partially dictates overall behaviors of TAC and stock for 30 years. Large reduction at first will stop a stock decline in earlier years, then stop a decline in

TAC too, and lead to higher recovery. Gradual reduction will require continuous reduction of TAC for long-term.

All selected CPUE-based MPs in CCSBT-MP/0404/08 and 09 correspond well to differences in recruitments, i.e. assigning higher TAC for high recruitment case and low TAC for lower recruitment case. The recruitment level alters TAC levels especially at beginning phase, then long-term average catches, but provide less impacts on the 2032 biomass. This indicates that these MPs are rather robust to recruitment fluctuation and succeed to reach the same goal.

Production model base MPs intend to reach B(msy), while CPUE-base MPs select their stock-level indicator rather arbitrarily. It was noted that these two types of MPs did not show substantial differences in B(2032)/B(msy). Thirty years may be too short for production model to contribute effectively.

- Options for fixed TAC period

It was agreed to examine the impacts of three options for fixed TAC period, 1, 3 and 5 years (e.g. option ‘a’, ‘b’, and ‘c’), from the preference to TAC stability expressed from industries and managers. All appendices in CCSBT-MP/0404/08 present comparison of these three options.

When changing TAC every year, TACs respond to stock changes promptly. These responses are sometime even so sensitive and induce instability in stock and TAC behaviors including overshoots. Options ‘b’ and ‘c’ become less sensitive to stock changes, which in turn introduce higher stability. No distinct difference is noted between TAC change options for every 3 and 5 years.

- Safe guards

Tuning level 1.1 connects to the situation of stock recovery after 2010 by reducing TAC substantially, whereas tuning level 0.9 means more gradual recovery after 2010 but less adjustment in TAC required. Higher long-term catches in tuning level 0.9 conduces to an increase of risk of stock depletion.

Under the current stock situation, it is not possible to select almost risk-free MPs without incorporating drastic TAC reduction. We explored a possibility to incorporate safe guards to prevent stock collapse under such a condition. Because of time constrain, only one example of safe guard, introduction of monitoring TAC when assigned TAC declined under a pre-fixed level, was examined. The results are shown in CCSBT-MP/0404/08, Fig. A2-23 to 25. Incorporation of safe guards seems effective especially when taking aggressive catch policy.

4. Comparison among different MPs:

Qualitative judgment criteria of our preferred MPs are high long-term catch, biomass level in 2032 relative to 2002, consistency in direction of TAC changes and biomass changes and stability of both stock and TAC behaviors. During testing process, we more or less relied on these qualitative judgments and visual impression from trajectories plots. However, when trying to quantify them using agreed performance statistics, we felt many important information

slipping away by summarizing quantitatively. This is especially true when comparing MPs with similar behaviors, like the ones already passed through the first filtering.

One of alternatives we tried was plotting frequency distributions of catch and biomass at 2022 and 2032, which are shown in Figure 3. This figure shows the comparison among major MPs developed by Japan including constant catch. It shows that the constant catch policy carry high risks of stock collapse even median biomass and catch comparable with other MPs. Median and mode are substantially different for some MPs, especially for catch. Managers may be more interested in mode since it corresponding to the most probable values. In that sense, HST_01 may not be so attractive since expecting much lower TAC to obtain the same level of biomass recovery, even with no difference in average long-term catch from other MPs.

We found these plots quite useful and easy to interpret and propose to utilize at the final selection process at the Workshop. Since this was developed at the last moment, there are still some spaces of improvement including use of relative scale such as B(2032)/B(2022) rather than absolute scale of catch and biomass.

5. Messages to decision makers:

- We consider tuning levels of 0.9 and 1.1 appropriate as a boundary. Stock will start recovering under either level. The latter (1.1) requires substantial TAC reduction at the beginning phase. The former (0.9) requires less substantial TAC adjustment but potential risk of stock depletion increases especially if something unexpected occurs. An exact point of target level should be determined based on management policy with a clear understanding on this trade-off.

- Inclusion of safe guard should be considered in order to respond in time when some unpredictable events such as low recruitments occur. This is essential when selecting aggressive MPs by accepting higher risk of stock decline.

- Although trajectories of median and 10^{th} and 90^{th} percentiles give an impression of smooth changing in both biomass and catches, actual TACs fluctuate much wildly (see examples in CCSBT-MP/0404/08, Appendices). It is important to look at worm plots at least to grasp what level of TAC fluctuation involved before making final decision.

- Option to fix TAC for three years introduces stability and seems reasonable. Option of 5 years fix TAC may be possible to apply without jeopardizing MP effectiveness too badly. In this case, an incorporation of some type of safe guards may be recommendable.

6. References:

Anon. (2003a): Report of the Fourth Meeting of the Stock Assessment Group (August 2003)

Anon. (2003b): Report of the Eighth Meeting of the Scientific Committee (September 2003)

Anon. (2003c): Report of the Tenth Annual Meeting of the Commission (October 2003)

Butterworth, D.S. and M. Mori (2003): Application of variants of a fox-model based MP to the

"Christchurch" SBT trials., CCSBT-MP/0404/06.

Hiramatsu, K., H. Kurota, H. Shono and N. Takahashi (2004): Behaviors of CPUE-based management procedures examined through the CCSBT final trial specifications., CCSBT-MP/0404/08.

Takahashi, N., M. Mori, S. Tsuji and D. Butterworth (2004): Trials of Fox-model based management procedures with TAC adjustment by recruitment information., CCSBT-MP/0404/09.

Tsuji, S., N. Takahashi, H. Shono, H. Kurota, and K. Hiramatsu (2003): Further exploration of CPUE-based management procedures., CCSBT-ESC/0309/38.

Table 1. Comparison of occurrence by scenarios depending on number of simulation runs

	Number of runs					
	200	500	1000	2000	4000	expected
S1(1/L)	7.5%	12.0%	12.0%	12.0%	12.0%	12.0%
S2(1/M)	34.5%	36.0%	36.0%	36.0%	36.0%	36.0%
S3(1/H)	13.0%	12.0%	12.0%	12.0%	12.0%	12.0%
S4(0.75/L)	10.5%	8.0%	8.0%	8.0%	8.0%	8.0%
S5(0.75/M)	27.0%	24.0%	24.0%	24.0%	24.0%	24.0%
S6(0.75/H)	7.5%	8.0%	8.0%	8.0%	8.0%	8.0%

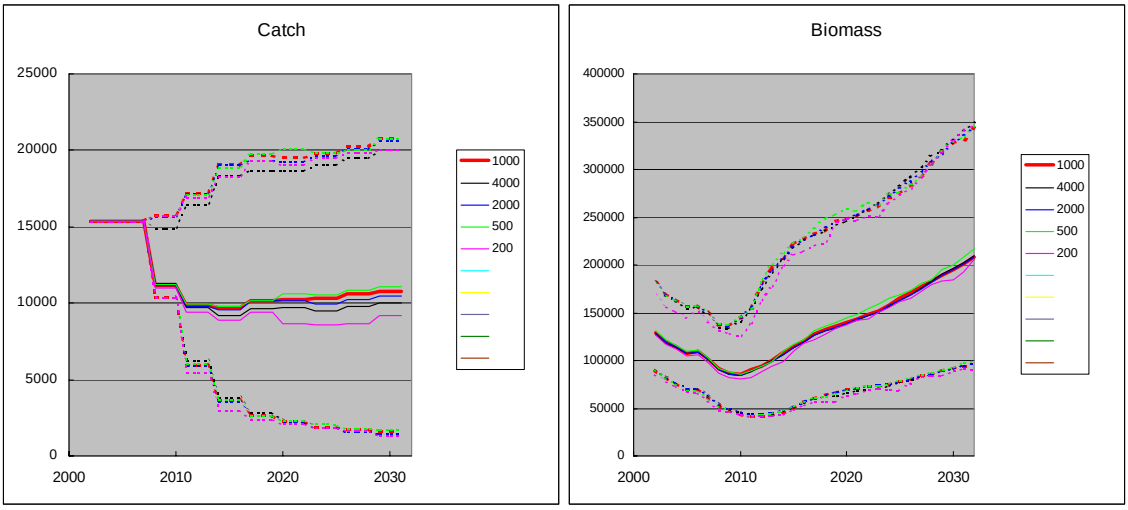

Fig.1 An example of TAC and biomass trajectories with different number of simulation runs.

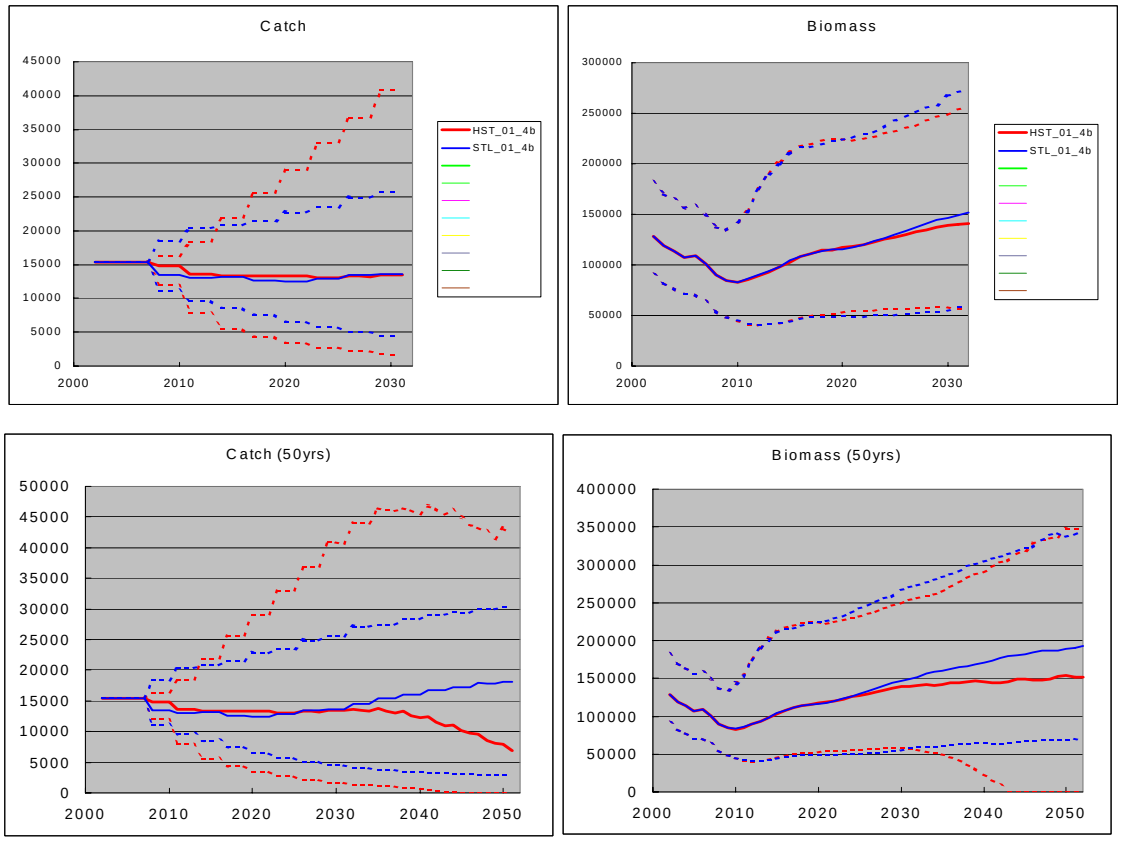

Figure 2. Comparison of two MPs showing similar behaviors for 30 years (upper panels) but differentiating afterwards (lower panels).

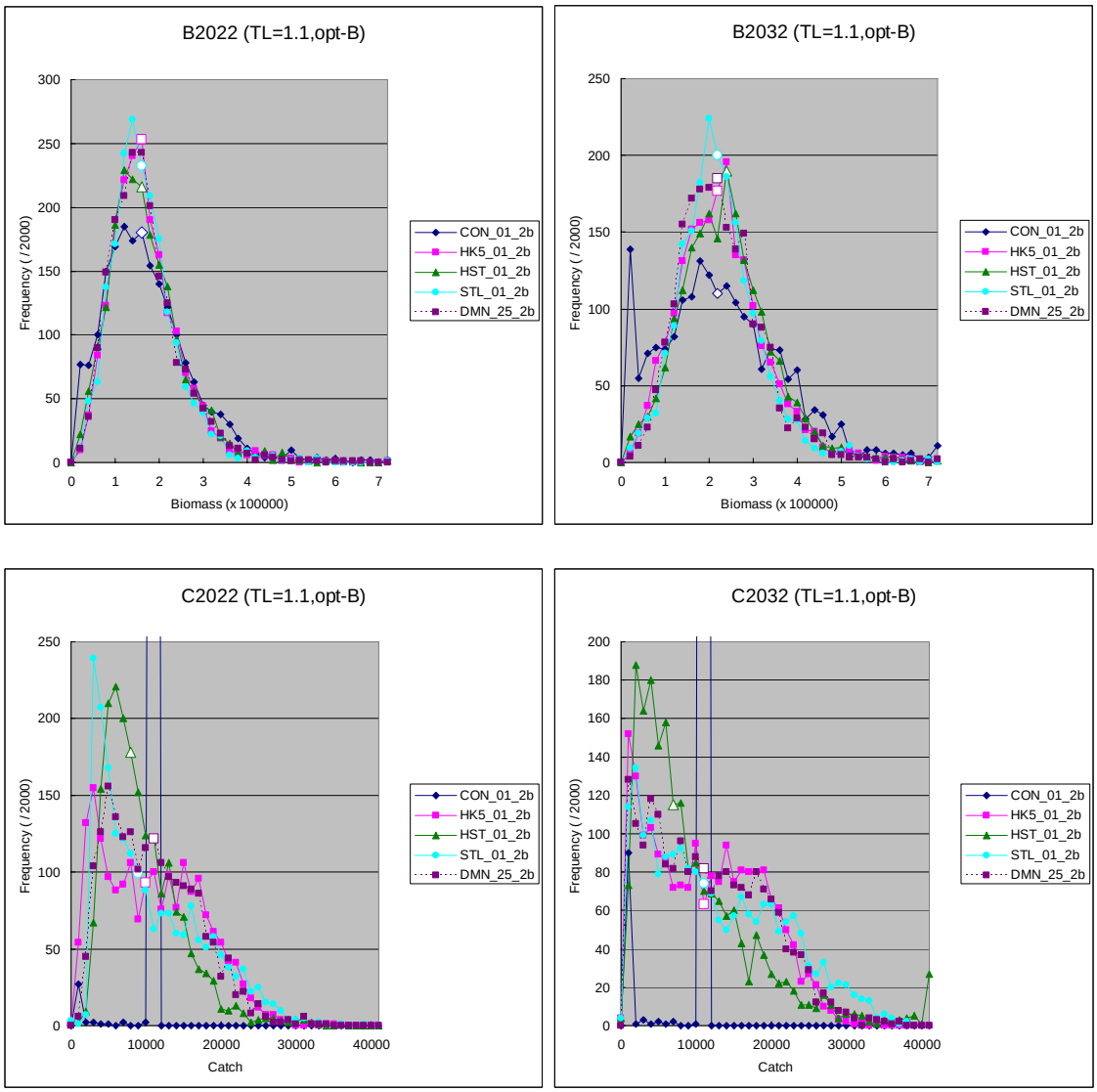

Figure 3a. Comparison among candidate MPs by distribution of catch and biomass at 2022 and 2032 (tuning level 1.1).

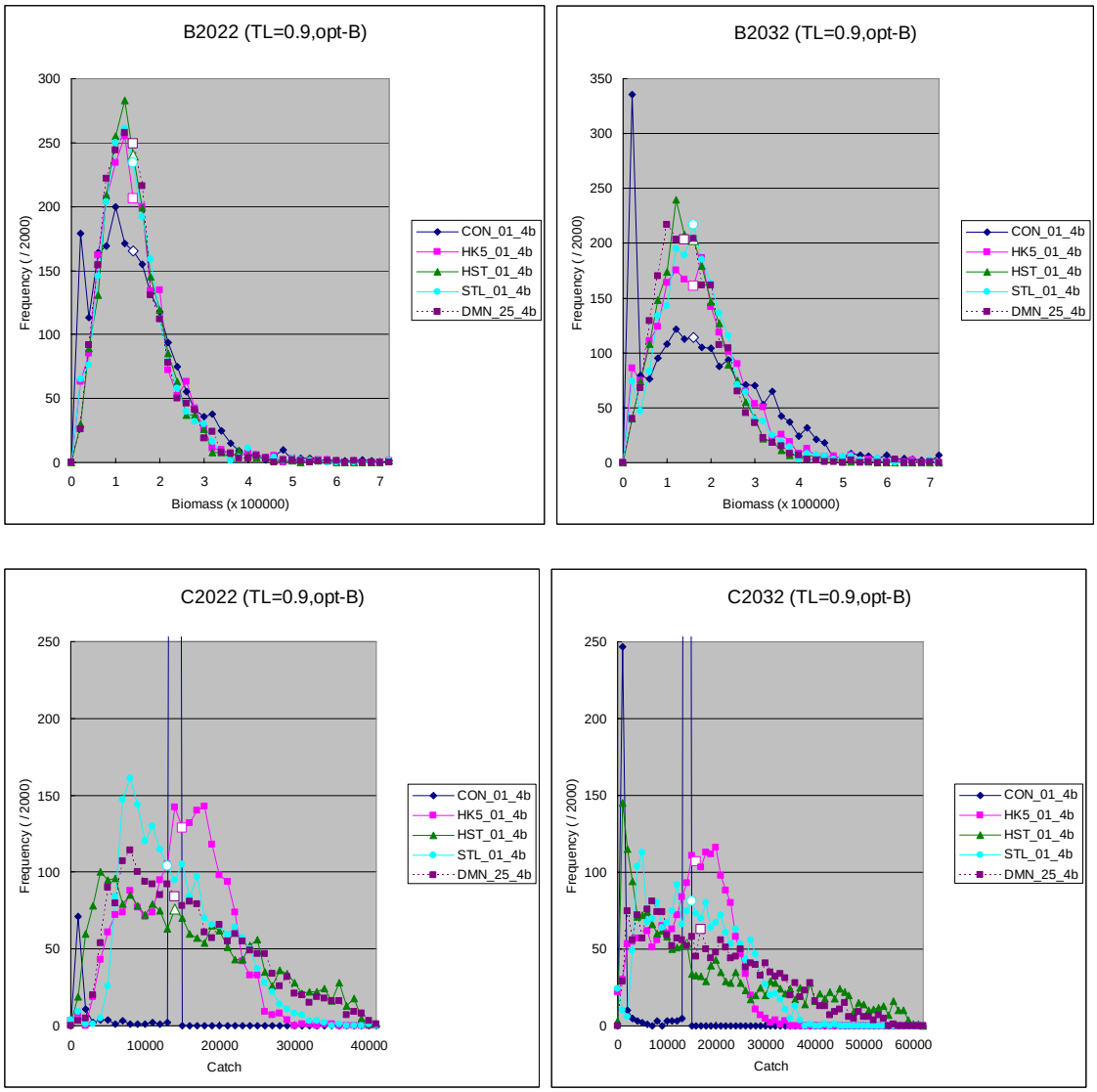

Figure 3b. Comparison among candidate MPs by distribution of catch and biomass at 2022 and 2032 (tuning level 0.9).