Behaviors of the HK5 management procedure under the updated operating models.

Hiroyuki Kurota
National Research Institute of Far Seas Fisheries,
Shizuoka, Japan

アップデートされたオペレーティングモデルにおける管理方策 HK5 の挙動

黒田啓行（遠洋水産研究所）

Abstract: The HK5 management procedure, which was selected as one of the final candidates at the MPWS3, is tuned to the updated operating models (PANEL_tag and PANEL_notag) that the Panel members proposed. Behaviors of the HK5 in the PANEL_tag scenario are different from those in the PANEL_notag and the previous reference case used for the MPWS3.

要旨: 第 3 回管理方策ワークショップで最終候補の 1 つに選ばれた管理方策 HK5 をアップデートされたオペレーティングモデル(PANEL_tag と PANEL_notag)にチューニングする。このオペレーティングモデルはパネルによって提案されたものである。PANEL_tag における HK5 の挙動は、PANEL_notag や第 3 回ワークショップで使われたリファレンスケースにおける挙動と異なっている。

Introduction

Mechanical update to the Operating Model (OM) for Management Procedure (MP) development was conducted in July 2004 by the Panel members and the Consultant (Advisory Panel, 2004). However, it became apparent that there were a number of problems with the mechanical update. After the meeting held in Seattle, the Panel members proposed two new reference sets for tuning management procedures (Advisory Panel, 2004). This paper represents tuning results of the HK5 management procedure, which is selected as one of the four final candidates at the third Management Procedure Workshop (MPWS3) held in Busan in April 2004 (Anon, 2004).

Specification of tuning trials

The HK5 sets TAC as a minimum of TAC value specified using CPUE level of age 4 or CPUE slope of age 4+ (Hiramatsu et al., 2004). Detail description was shown in the next section. The constant catch rule (CON) was also tuned for comparative purpose. Simulation trials were conducted under the following specifications, which were agreed except OM scenarios at the MPWS3.

OM scenarios: PANEL_tag, PANEL_notag
Tuning level (TL=median B2022/B2004): 0.9, 1.1, 1.3
Projection time horizon: 28 years
The number of simulations: 2000
First TAC change and frequency of TAC change:
- Option-a: 2006, every 3 year
- Option-b: 2008, every 3 years
- Option-c: 2008, every 5 years

This paper presents results of following trials indicated by "*".

	TL=0.9	TL=1.1	TL=1.3
Option-a	n/a	*	n/a
Option-b	*	*	*
Option-c	n/a	*	n/a

Description of the HK5 MP

Southern bluefin tuna are long-lived fish and fisheries target fish of different age ranges by different fleets. It might be better to use plenty of information of stock condition covering different age ranges to determine TAC robustly. The HK5 is a hybrid MP of the "HK1-dfl v2" and the "HK4-ag4 v1" (Tsuji et al., 2003). TAC is set as a minimum of CPUE trend of age 4+ and CPUE level (absolute value) of age 4 over 10 years.

CPUE of age 4 in numbers ($CPUE_{age4}$) is assumed to be an index of recruitment out of information available in the projection. Nominal CPUE of age 4 of Japanese longline is used as past data before 2003 (Fig. 1) and $CPUE_{age4}$ is calculated from CPUE of age 4+ and age-composition data of LL1 provided in the file "sbtOMdata" in the projection:

$$CPUE_{age4} = \frac{catch_{age4}}{catch_{age4+}} \times CPUE_{age4+} \quad (1)$$

It is also chief characteristics of this MP to adopt the lower of TACs determined by the two different methods. TAC is specified by:

$$TAC_{y+1} = \begin{cases} TAC_y + max_{up} & if \quad TAC_{y+1} - TAC_y > max_{up} \\ \min\left(TAC_{y+1}^{trend\,4+},\ TAC_{y+1}^{level\,4}\right) & if \quad max_{down} < TAC_{y+1} - TAC_y < max_{up} \\ TAC_y - max_{down} & if \quad TAC_{y+1} - TAC_y < max_{down} \end{cases} \tag{2}$$

$$TAC_{y+1}^{trend\,4+} = TAC_y \times \left(1 + k\lambda\right) \tag{3}$$

where

λ: the slope of regression of ln($CPUE_{age4+}$) over 10 years (from y - 10 to y - 1),

k: control parameter

$$TAC_{y+1}^{level\,4} = TAC_y \times f\,(CPUE_{age4,\ y-1}) \tag{4}$$

$$f\,(CPUE_{age4,\ y-1}) = \begin{cases} m_{\max} & if \quad CPUE_{age4,\ y-1} > l_{\max} \\ a \times CPUE_{age4,\ y-1} + b & if \quad l_{\min} \le CPUE_{age4,\ y-1} \le l_{\max} \\ m_{\min} & if \quad CPUE_{age4,\ y-1} < l_{\min} \end{cases} \tag{5}$$

where

$CPUE_{age4,y-1}$: average CPUE of age 4 over 10 years (from y – 10 to y – 1),

m_{max}, m_{min}, l_{max}, l_{min}, a, b: control parameters

Fig. 2 shows a relationship between $CPUE_{age4}$ and TAC change in the PANEL_tag and PANEL_notag scenarios, when the tuning level is 1.1 and TAC change option is “B” (“1.1optB”).

Results and Discussion

The HK5 was tuned so as to prevent stock collapse and keep low catch variability, which had trade-off relationship to some extent. Several parameters were changed to tune to the PANEL_tag scenario, but only one parameter was enough for the PANEL_notag (Table 1). Note that different parameter sets achieved the same tuning level, although I did not explore a wide range of parameter space due to time constraints. The following is a brief summery of the results:

- In constant catch rules for the PANEL_tag scenario, catch levels tuned to 0.9 and 1.1 were higher than the current level (Fig. 3). This scenario seems to be optimistic. On the other hand, catch levels were lower than the current catch in the PANEL_notag, even when the tuning level was 0.9 (Fig. 4). Some extinctions were often observed in both scenarios regardless of the tuning level. I therefore consider that constant catch strategies are unsatisfactory.

- In the HK5 tuned to the PANEL_tag scenario, catch trend was similar to biomass trend (Fig. 5). Catch increased in most runs when the TAC was set first. Extinction hardly occurred when the tuning level was 1.1 and 1.3. However, it was difficult to control catch without stock collapse, when the tuning level was 0.9.

- In the HK5 for the PANEL_notag scenario, catch continued to decrease in many cases even when the tuning level was 0.9 (Fig. 6). Behaviors of the HK5 were different from those for the PANEL_tag scenario. Stock collapse was hardly found due to appropriate catch control by the HK5.

- Difference of catch among different tuning levels was small in the PANEL_tag scenario (TL=0.9 16249t, TL=1.3 13602t; Table 1) and slight change of catch influenced on stock biomass significantly. These results were different from those for the PANEL_notag and the Reference Case used for the MPWS3. This is because estimated stock biomass is much smaller for the PANEL_tag scenario.

- Each run trajectory of catch and biomass might give us different impression from the medium trajectory (Figs. 7 and 8). It is important to check each run to compare alternative management procedures (Tsuji et al., 2004).

- The HK5 tuned to the Reference Case for the MPWS3 decreased the TAC severely in most cases, when the TAC was set first (Fig. 9). This difference in MP behaviors in the near future is likely to result from difference of the biomass trend. The biomass showed a downward trend in the near future in the Reference Case for the MPWS3. However, it increased for several years in both the PANEL_tag and PANEL_notag scenarios, although it turned downward due to low recruitment after 2000.

- Comparison between "1.1optB" and "1.1optC" showed that as TAC change was less frequent, catch change had to be bigger to achieve the same tuning level. This point was also noted in the MPWS3 (Anon, 2004).

References

Advisory Panel, 2004. Report from Panel Meeting Held at NOAA Alaska Fisheries Laboratory, Seattle, 20-23 July 2004. CCSBT-ESC/0309/42.

Anon. 2004. Report of the third meeting of the management procedure workshop, 19-24 April 2004, Busan, Republic of Korea.

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

Tsuji, S., Hiramatsu, K., Kurota, H., Takahashi, N., Shono, H. 2004. Considerations toward choosing appropriate management procedures. CCSBT-MP/0404/10.

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

Table 1. Parameter values, realized tuning level in 2022 and average catch over 20 years for each scenario and option.

(a) PANEL_tag scenario

	k	l_{max}	l_{min}	m_{max}	m_{min}	max_{up}	max_{down}	TL	C20yrs
1.1optB	3.5	0.1	0.05	1.5	0.9	5000	3500	1.098	14701
0.9optB	3.5	0.1	0.05	1.5	0.9	5000	950	0.897	16249
1.3optB	2.5	0.1	0.05	1.2	0.8	5000	5000	1.296	13602
1.1optA	3.5	0.1	0.05	1.5	0.85	5000	3500	1.095	14670
1.1optC	5.0	0.1	0.05	1.5	0.75	7750	7750	1.104	14412

(b) PANEL_notag scenario

	k	l_{max}	l_{min}	m_{max}	m_{min}	max_{up}	max_{down}	TL	C20yrs
1.1optB	3.0	0.2	0.05	1.5	0.82	5000	5000	1.096	11666
0.9optB	3.0	0.2	0.05	1.5	0.95	5000	5000	0.899	13607
1.3optB	3.0	0.2	0.05	1.5	0.71	5000	5000	1.302	9632
1.1optA	3.0	0.2	0.05	1.5	0.783	5000	5000	1.101	11400
1.1optC	3.0	0.2	0.05	1.5	0.75	5000	5000	1.101	11706

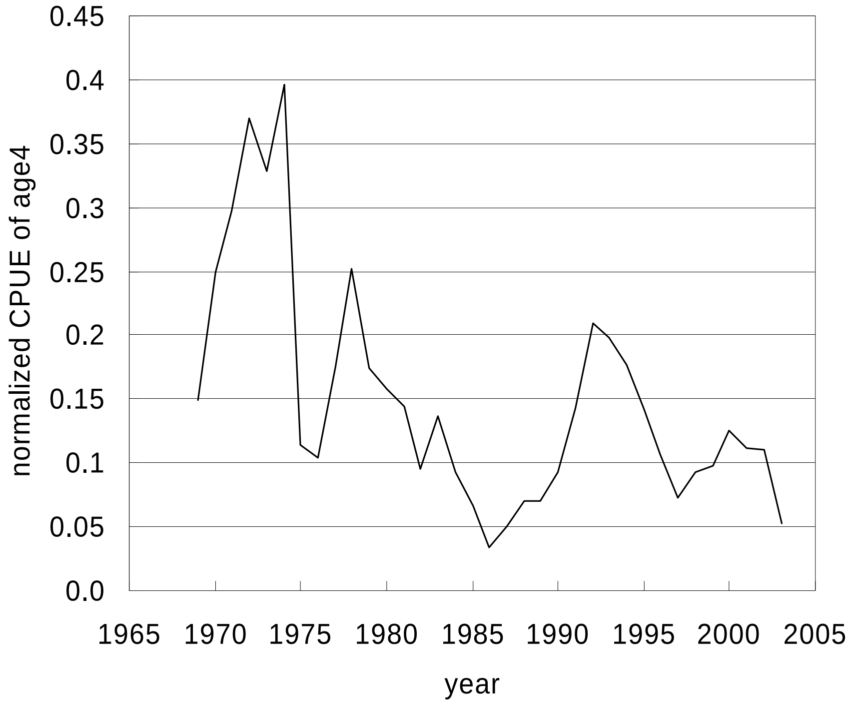


Fig. 1. Normalized CPUE of age 4 fish of Japanese longline used as recruitment information.

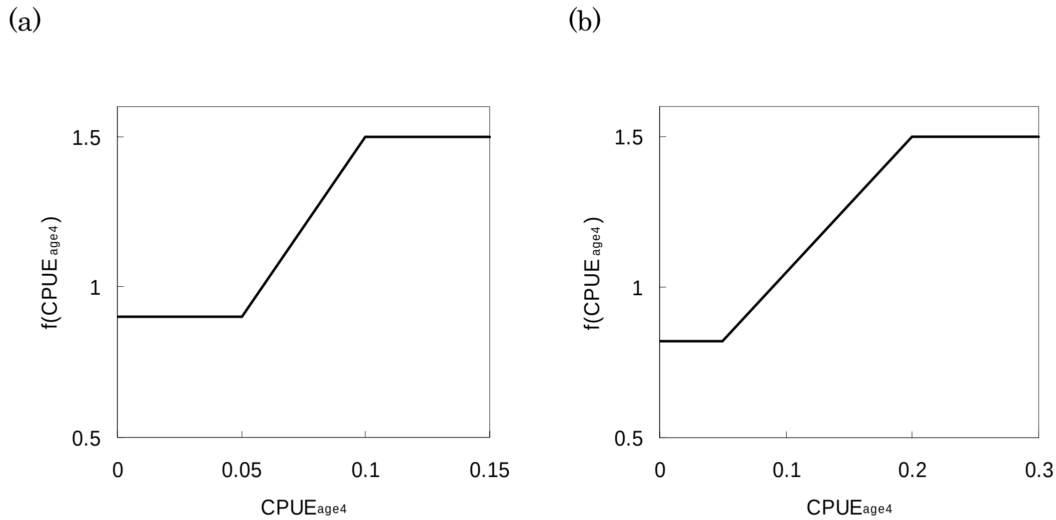


Fig. 2. Relationship between CPUE of age 4 and TAC change. (a) PANEL_tag scenario (b) PANEL_notag scenario.

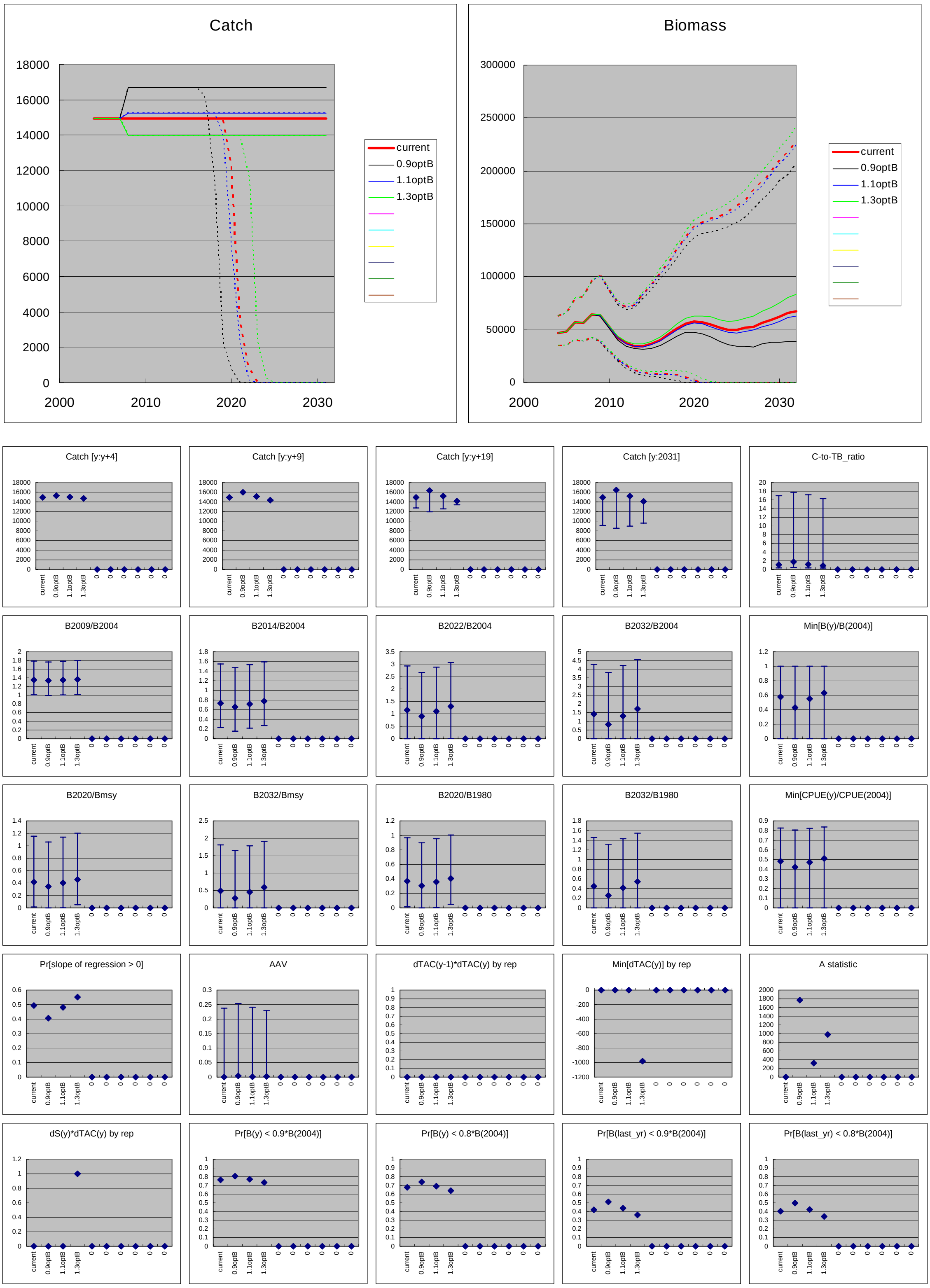


Fig. 3. Catch and biomass trajectories (Median, 10th and 90th percentile) and performance statistics of the constant catch rule (CON) for the PANEL_tag scenario.

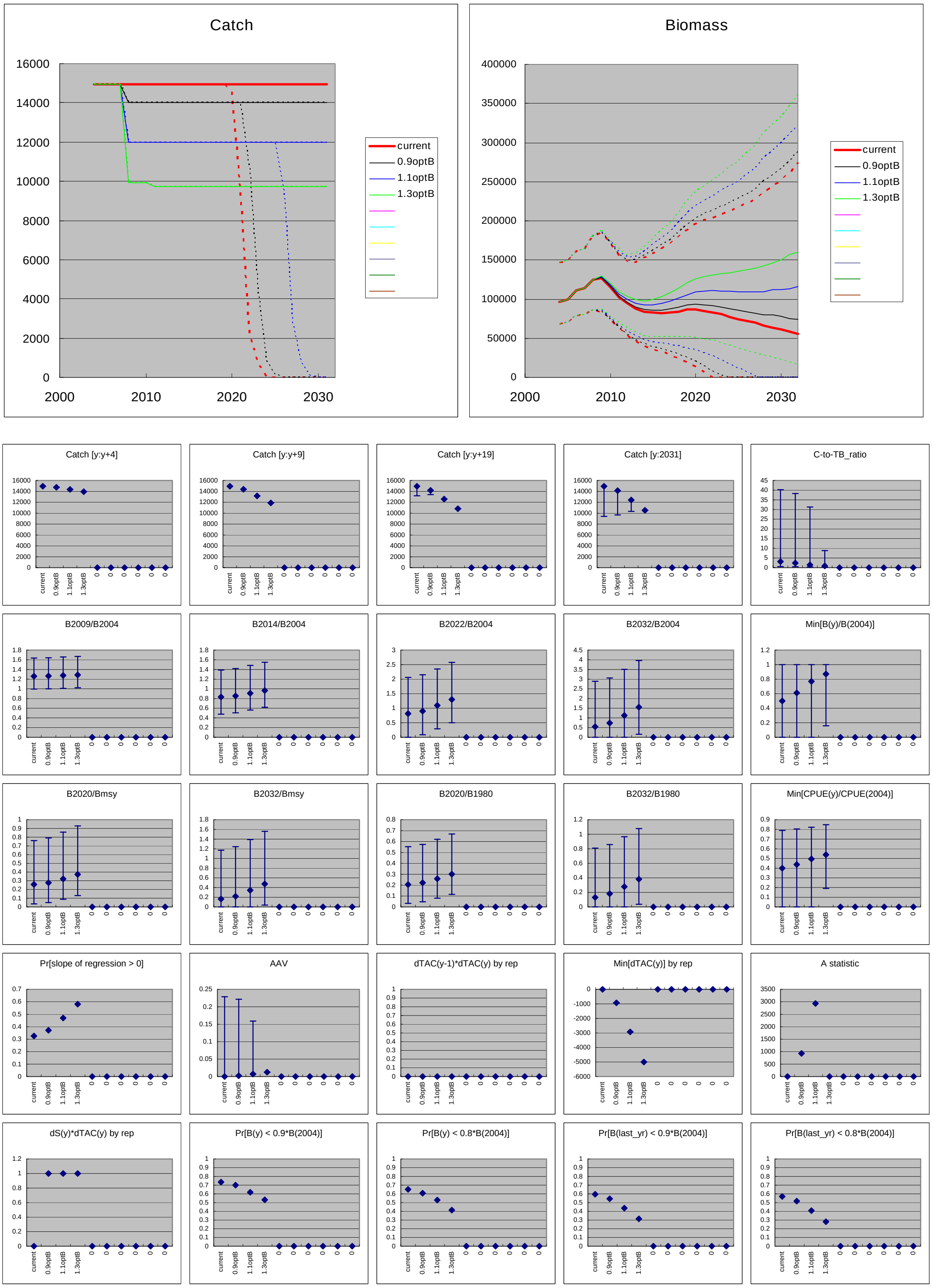


Fig. 4. Catch and biomass trajectories (Median, 10th and 90th percentile) and performance statistics of the constant catch rule (CON) for the PANEL_notag scenario.

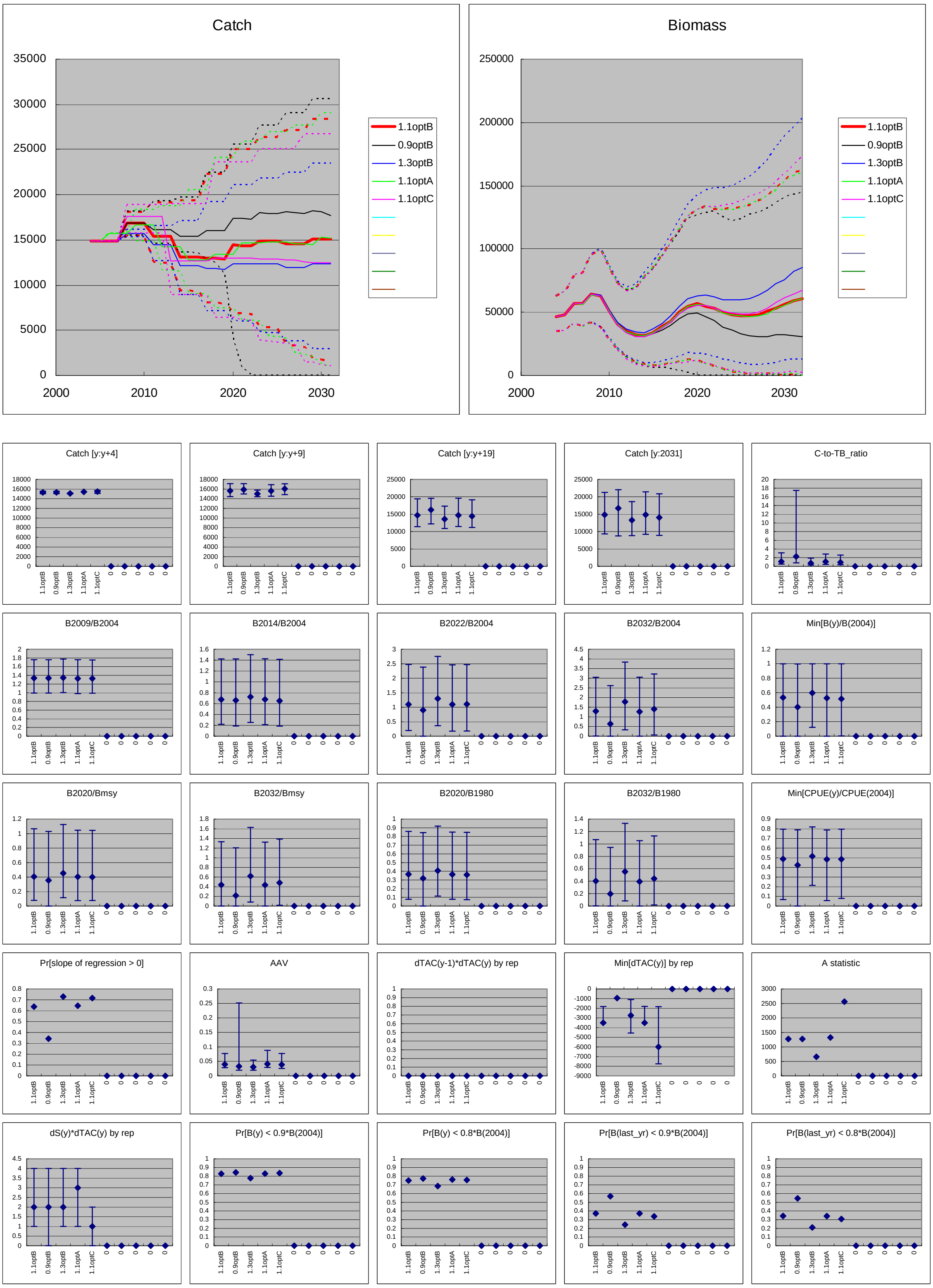


Fig. 5. Catch and biomass trajectories (Median, 10th and 90th percentile) and performance statistics of the HK5 for the PANEL_tag scenario.

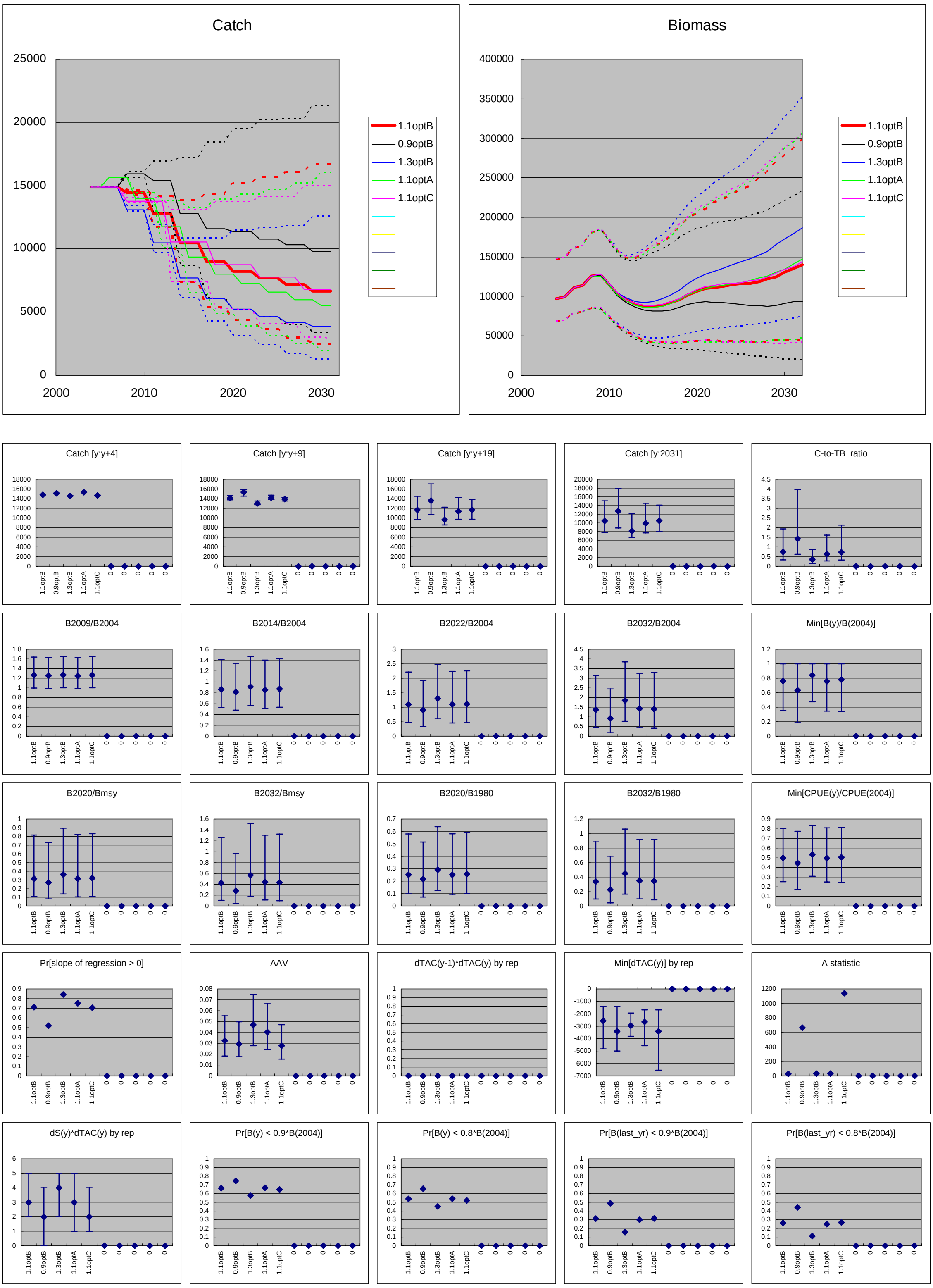
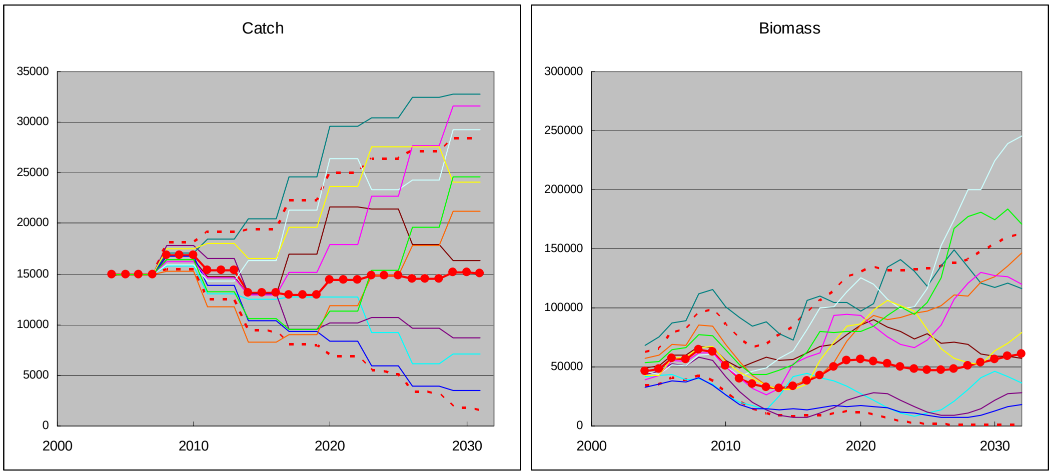
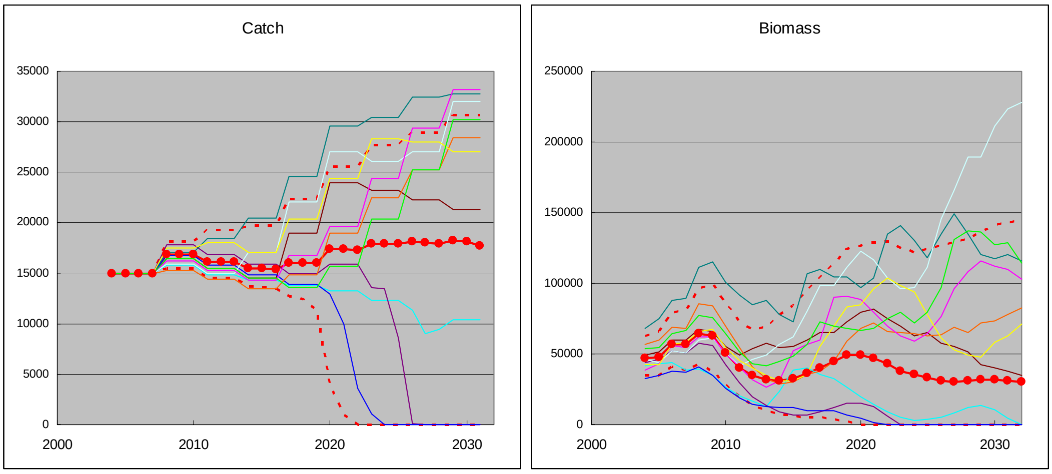


Fig. 6. Catch and biomass trajectories (Median, 10th and 90th percentile) and performance statistics of the HK5 for the PANEL_notag scenario.

(a) TL = 1.1, option B



(b) TL = 0.9, option B



(c) TL = 1.3, option B

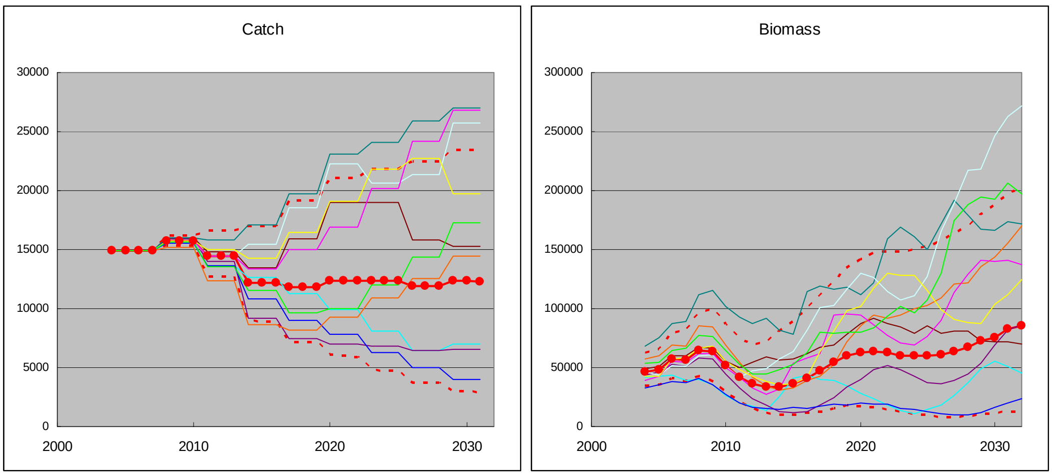
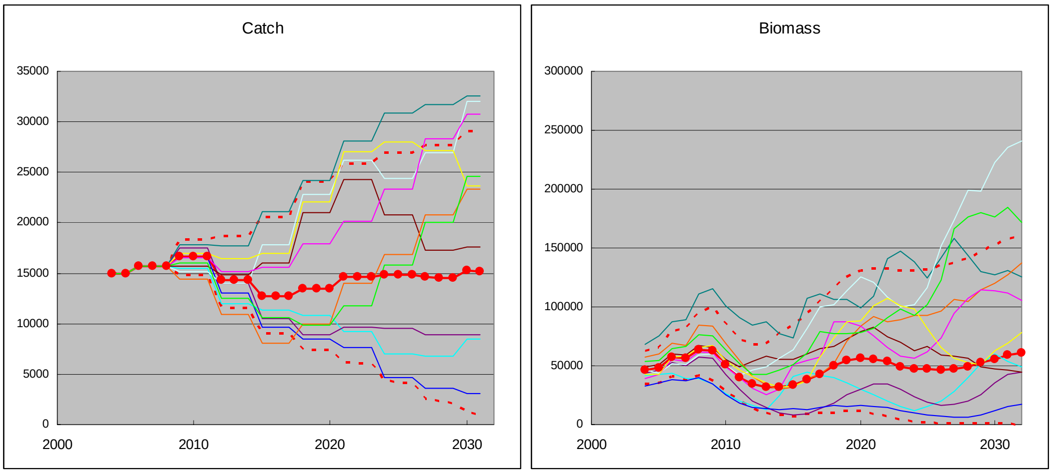


Fig. 7. Individual trajectories of catch and biomass of the HK5 for the PANEL_tag scenario. Red lines indicate Median, 10th and 90th percentile of 2000 runs.

(d) TL = 1.1, option A



(e) TL = 1.1, option C

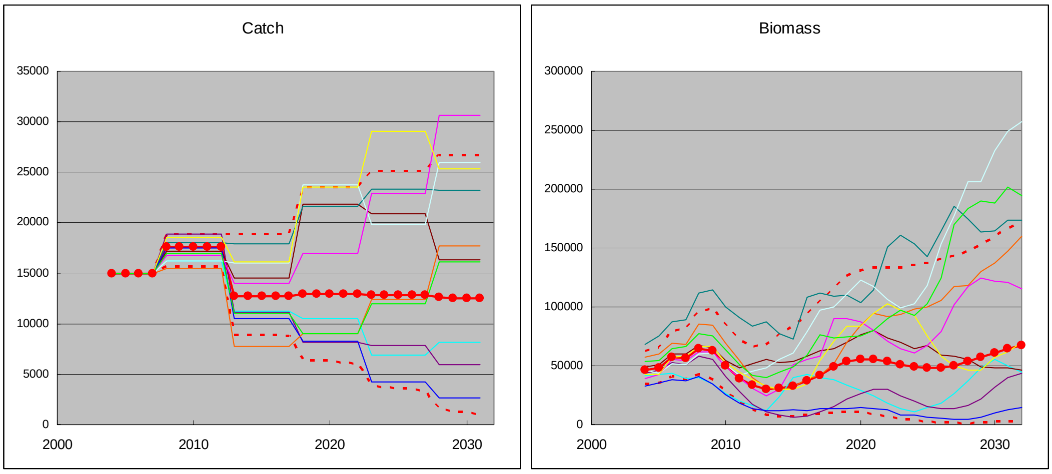
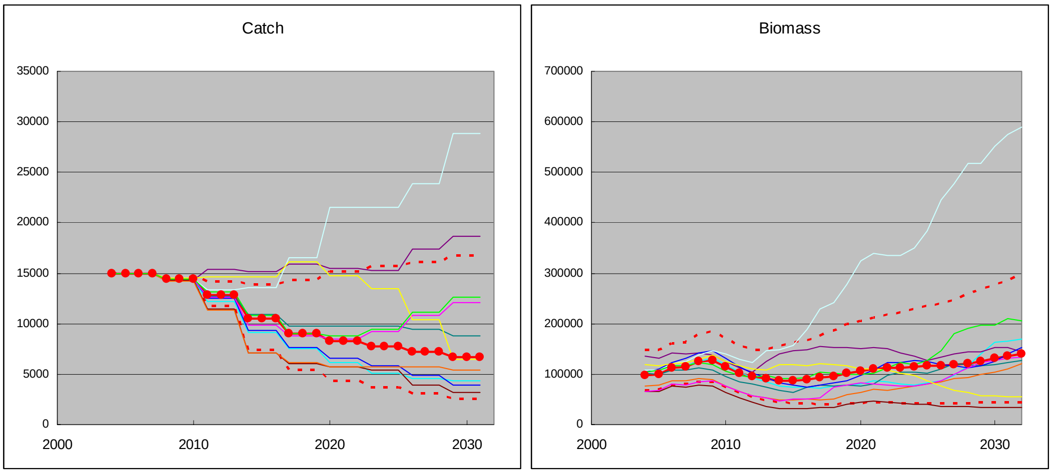
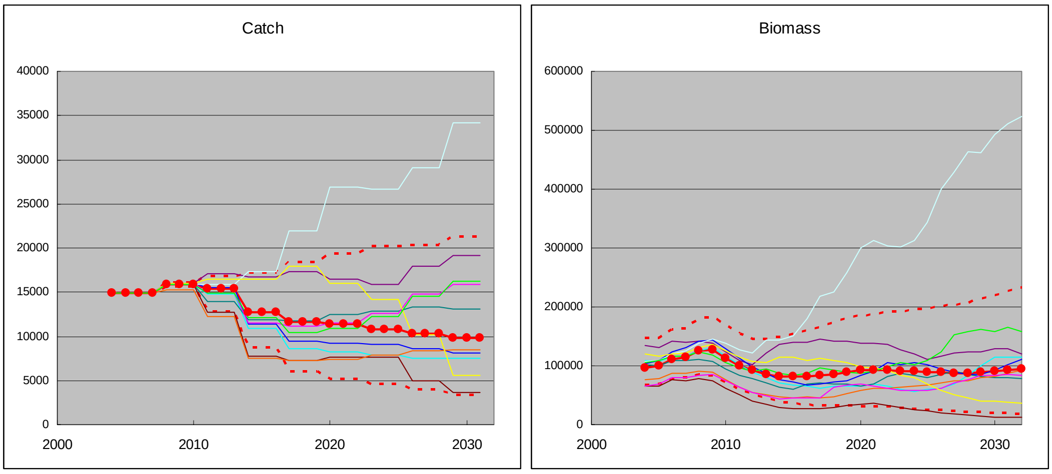


Fig. 7 (cont'd).

(a) TL = 1.1, option B



(b) TL = 0.9, option B



(c) TL = 1.3, option B

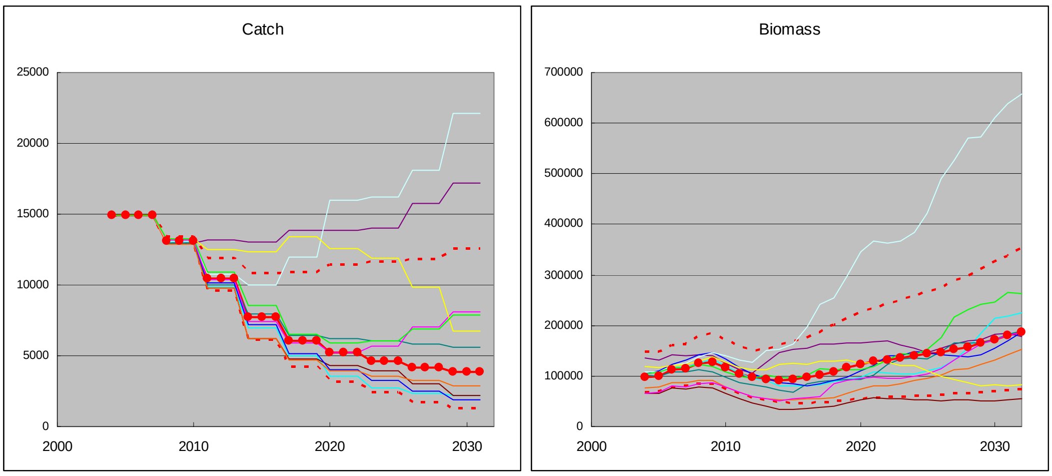
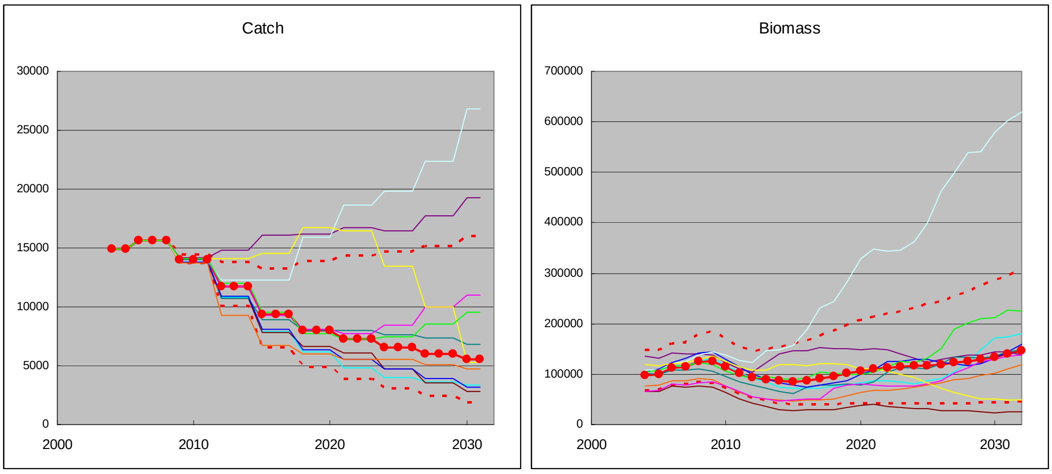


Fig. 8. Individual trajectories of catch and biomass of the HK5 for the PANEL_notag scenario. Red lines indicate Median, 10th and 90th percentile of 2000 runs.

(d) TL = 1.1, option A



(e) TL = 1.1, option C

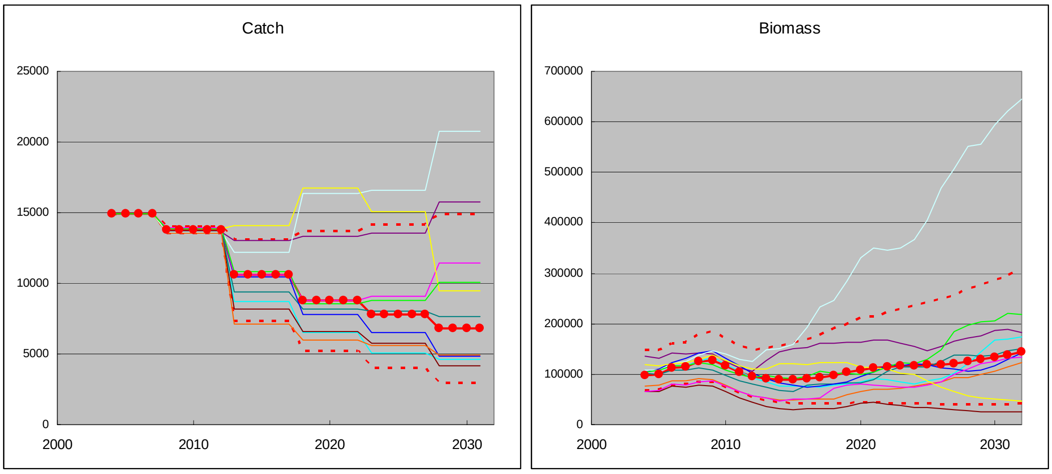


Fig. 8 (cont'd).

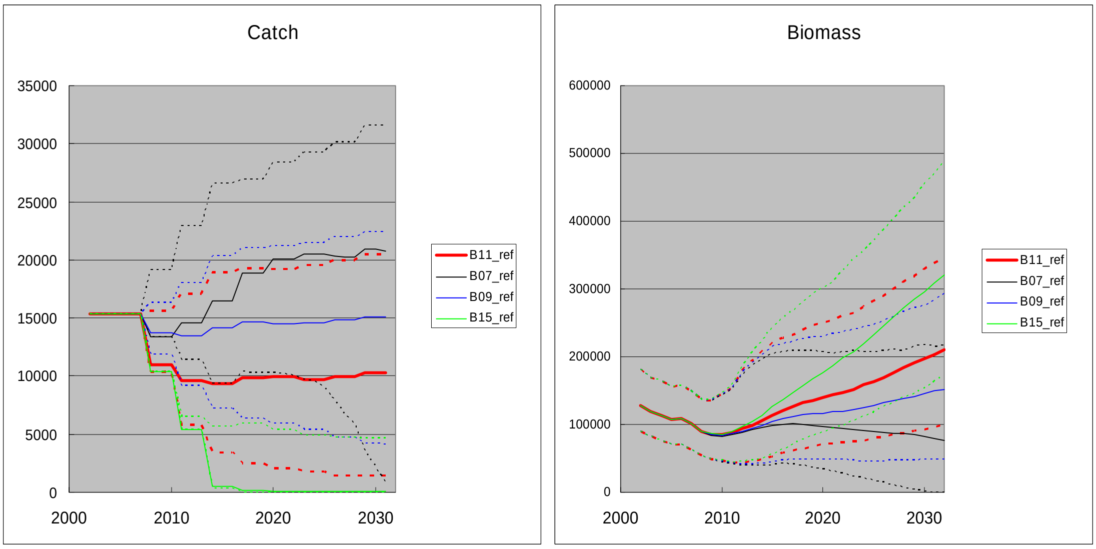


Fig. 9. Catch and biomass trajectories (Median, 10th and 90th percentile) for the Reference Case for the MPWS3 with four tuning levels (TL=1.1, 0.7, 0.9, 1.5) with Option-b (Hiramatsu et al., 2004). The MPs are HK5.