HORSE MACKEREL PROJECTIONS UNDER VARIOUS MANAGEMENT OPTIONS AND RESOURCE SCENARIOS

S.J. Johnston and D.S. Butterworth

MARAM

SUMMARY

If only a TAC control is to be imposed on the midwater trawl fishery for horse mackerel, a substantial reduction in the current allocation to this fishery will be required to allow for the possibility that the recent reduction in CPUE mainly reflects a decrease in abundance. However, the imposition of an effort limit in this fishery at the level of the average effort over recent years would avoid necessity for this reduction, and would allow for the possibility of high midwater catches if this CPUE drop is primarily the consequence of a downward fluctuation in catchability.

INTRODUCTION

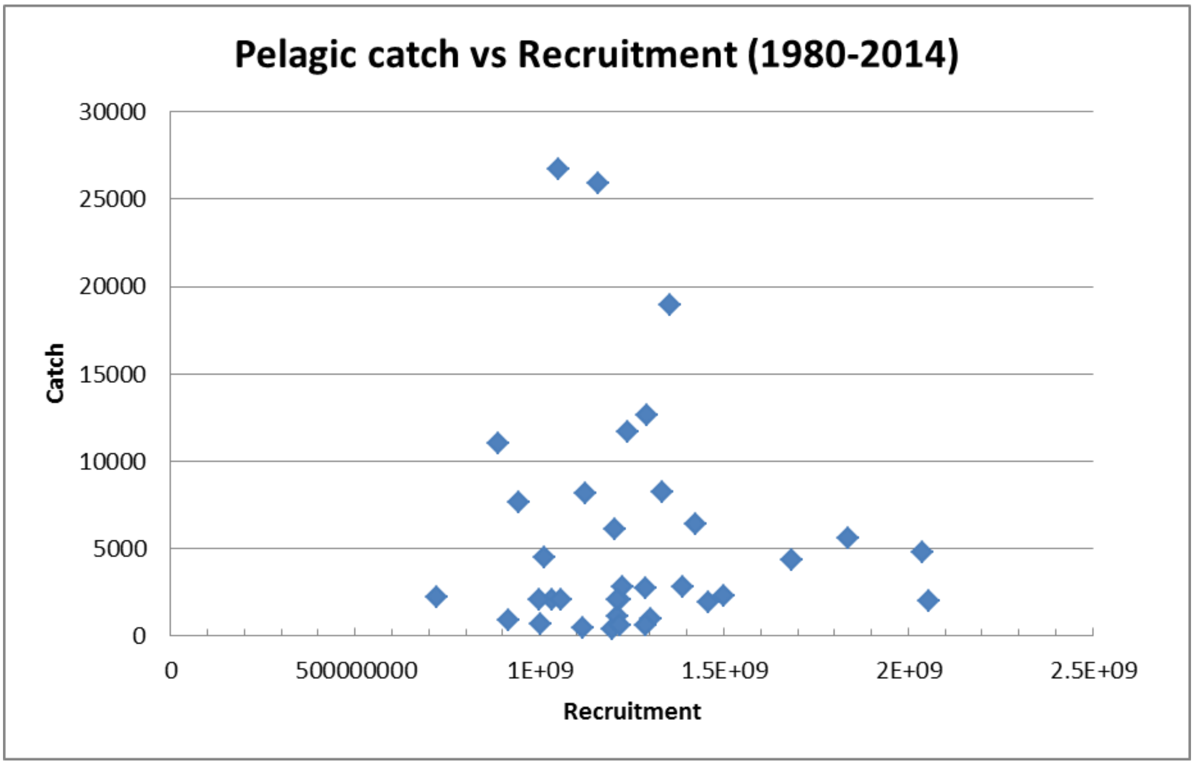
This document reports the results of horse mackerel projections under the alternative management options (termed OMPs) that were specified at the DWG meeting of 20 October for scenarios (Operating Models – OMs) reflecting the range of uncertainties about whether the recent downturn in the midwater CPUE reflects a catchability reduction or a one-off additional mortality [FISHERIES/2015/OCT/SWG-DEM/44]. In some cases those options were modified where results indicated that those modifications would provide a more informed basis to select amongst them in the light of projected catch and resource trend projections.

METHODS

The rules to compute future catches under various management approaches are set out below.

Catch Rules:

1) **Pelagic Catches** – Variable with a cap of 5000 (or 3000)



No clear relationship between Pelagic catches and recruitment.

Set pelagic catches at random from the set of pelagic catches taken from 2000-2014.

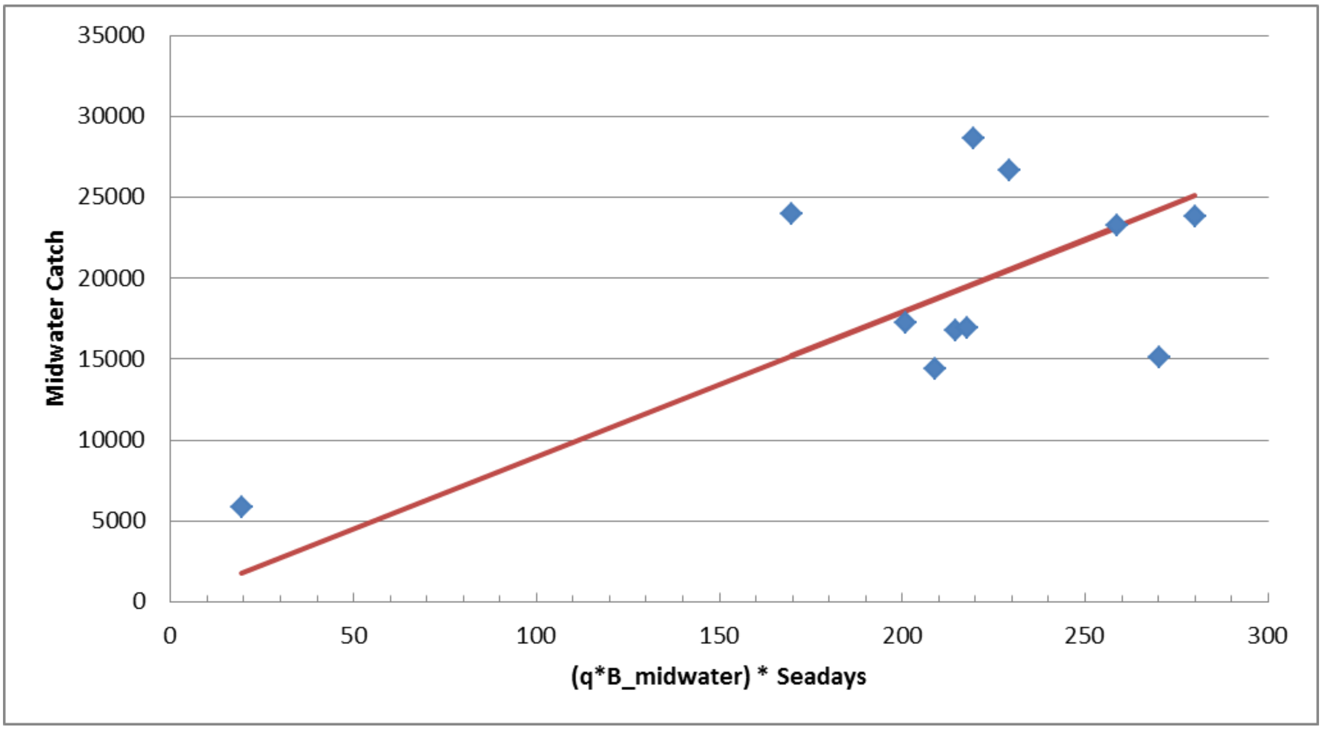
Upper cap of 5000 (sensitivity to 3000)

2) **Incidental trawl/Demersal catches** – constant proportion of HM biomass

The average over last 5 years of 12500/Bexp = 0.07697 = $\bar{F}_{trawl}$

Future demersal catches = $\bar{F}_{trawl} * B_{exp}^{dem}$

3) Midwater directed catches – use both catch and effort limitation



Initial catch (C_1) set at [38658, 31500 or 18 000].

The above plot shows the observed (diamonds) midwater catches plotted against $q * B_{exp}^{mid} * Seadays\_used$. [data provided by Larvika Singh, DAFF)].

A linear regression was fitted to these data, such that

$$C = k.(q * B_{exp}^{mid} * Seadays_{used})$$

This results in a $k = 89.555$.

The standard deviation of the residuals about the regression line, , is 5474 t.

Secondary catch calculated such that

$$C_2 = k\left(q * B_{exp}^{mid} * Seaday_{limit}\right) + error$$

where $error \sim N(0, \sigma^2)$,

and where $q * B_{exp}^{mid}$ will be the future midwater CPUE values, and $Seaday_{limit}$ value is fixed at [150, 200 or 250].

The final catch is the **lesser** of C_1 or C_2.

A minimum lower bound on midwater catch of 2000 is imposed.

Operating Models (underlying assessments)

These reflect the assessment alternatives presented in [FISHERIES/2015/OCT/SWG-DEM/44].

OM1: Once off low catchability in 2014 (then return to normal)

OM2: Once off mortality event in 2014

OM4: Combination of 1) and 2) i.e. both effects (catchability and increased mortality) in 2014 but half what they would be in isolation.

OMPs explored

RC OMP: Midwater initial catch C_1 = 38658

$Seaday_{limit}$ = 250

Pelagic catch cap 5000

Midwater catch lower bound 2000

VAR1: Pelagic catch cap 3000

VAR2: $Seaday_{limit}$ = 150

Newvar: Replace the Pelagic catch cap of 5000 with a PUCL rule as follows:

$$PUCL_y = 10\ 000 - C_{y-1}^{Pelagic} - C_{y-2}^{Pelagic}$$

VAR3a: No seaday restriction, midwater C_1 = 38658

VAR3b: No seaday restriction, midwater C_1 = 20000

VAR3c: No seaday restriction, midwater C_1 = 10000

VAR3d: No seaday restriction, midwater C_1 = 0

[Note lower midwater catch bound of 2000 still applies].

RESULTS

The results for the various OM/OMP combinations are shown in plots arranged as follows:

OM1 – see Figures 1a and b.

OM2 – see Figures 2a and b.

OM4 – see Figures 3a and b.

DISCUSSION

Under the worst resource scenario considered (OM2 – the CPUE drop is entirely a reflection of an additional mortality in the population), Figure 2b shows that in median terms (except perhaps in the very short term) midwater fishery control based only on a TAC set at 20000 t is unacceptable, and a decrease to perhaps as low as 10000 t would be needed, based upon spawning biomass projections. If the lower 5^{th}-%ile for spawning biomass is considered, the situation is worse still. However if effort control in terms of *Seadays* is introduced as well, Figure 2a shows that in most cases a limit of 250 such days would see a slow recovery of the spawning biomass.

Under a more optimistic scenario (OM4 – only half the CPUE drop has been caused by an additional mortality), Figure 3b shows that a midwater TAC only control could at most be set at 20000 t. However if a 250 *Seadays* limit was imposed in addition, midwater catches would be somewhat higher than under OM2, increasing over time to 15000 t in median terms (see Figure 3a).

Finally under the most optimistic scenario considered (OM1 – the CPUE drop is entirely a temporary downward fluctuation in catchability), Figure 1b indicates that at least for a few years, control based on a midwater TAC alone at the level suggested by the current OMP of 38658 t could be retained. Under a *Seaday* limit of 250 in addition, the median midwater trawl catch expectation over the 2015-2023 period would be about 16000 t (Figure 1c). However if the 90% probability envelope is considered (Figure 1c), the upper bound on such catches increases to well above 30 000 t.

Throughout, performance is virtually unaffected over the range of pelagic bycatch limitations suggested.

In summary, if the midwater fishery is to be under TAC control only, a substantial (well over 50%) reduction in the current allocation will need to be considered to allow for the possibility that the recent CPUE reduction was caused mainly by some additional mortality in the stock. However the imposition of an effort limitation as well in this fishery (e.g. of 250 *Seadays*) or more broadly speaking in the vicinity of the average level over recent years would avoid the necessity for a TAC reduction (of substantial magnitude), and would allow for the possibility of high midwater catches if the recent CPUE drop is primarily the consequence of a downward fluctuation in catchability.

Figure 1a: OM1 - C_1 = 38658 (RC, VAR1, VAR2 and newvar)

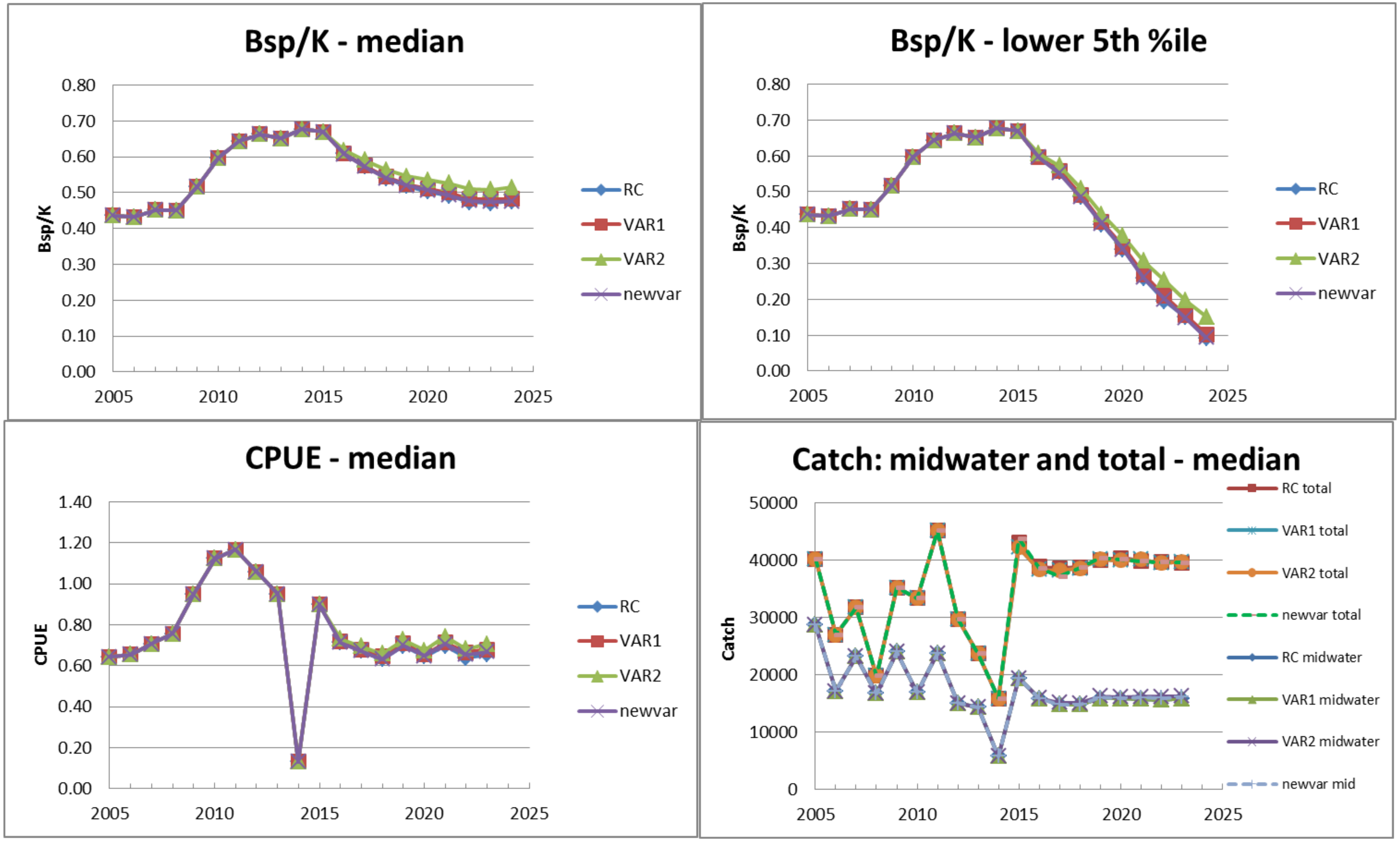


Figure 1b: OM1 – No Seaday limit, Midwater catch lower bound 2000, Pelagic catch cap 5000, C_1 = 38658 (Var3a), = 20000 (Var3b), = 10000 (Var3c) or = zero (Var3d). [Note lower midwater catch bound of 2000 still applies].

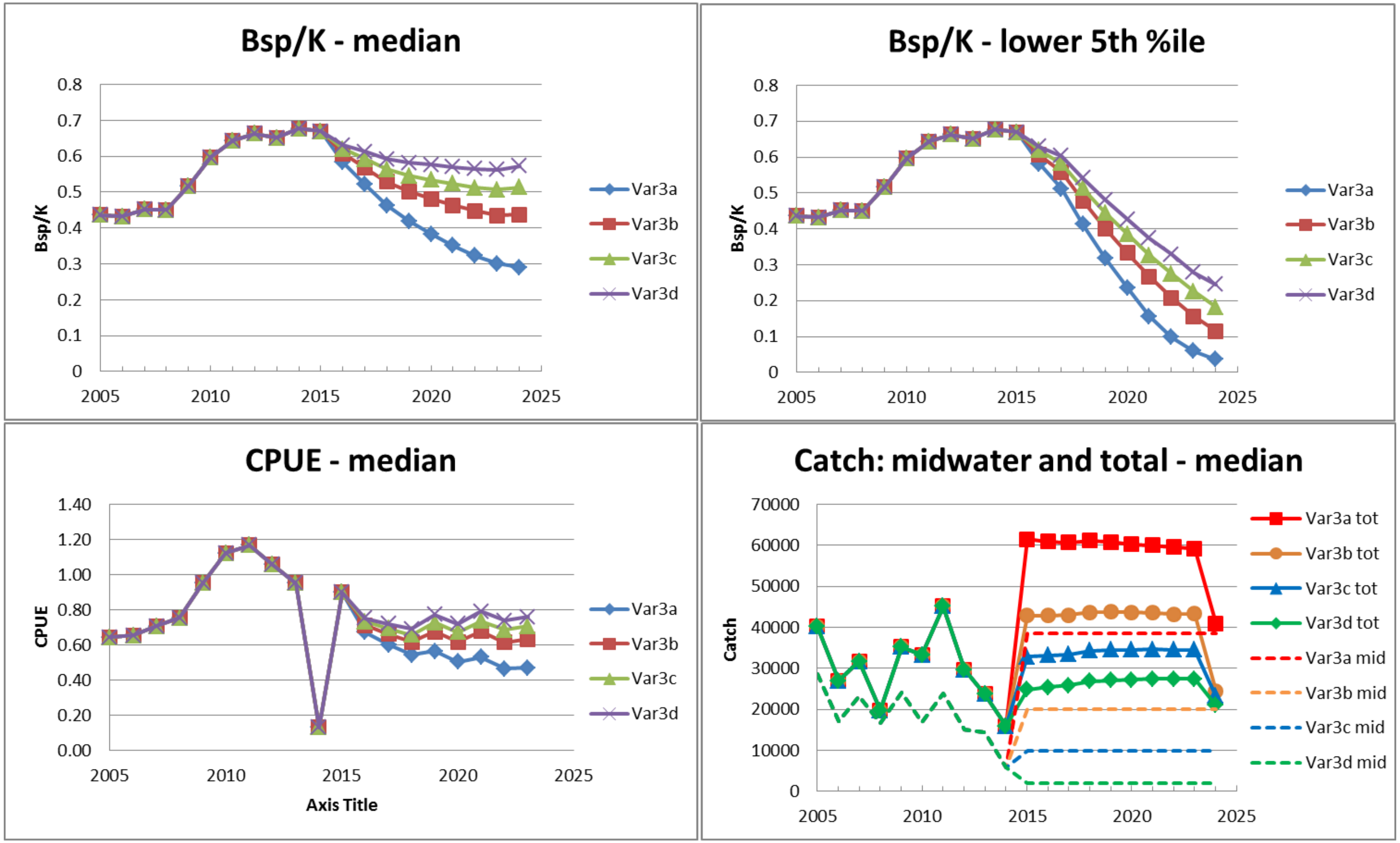


Figure 1c: OM1 - C_1 = 38658 – RC OMP. Medians and 5th and 95th percentiles are shown.

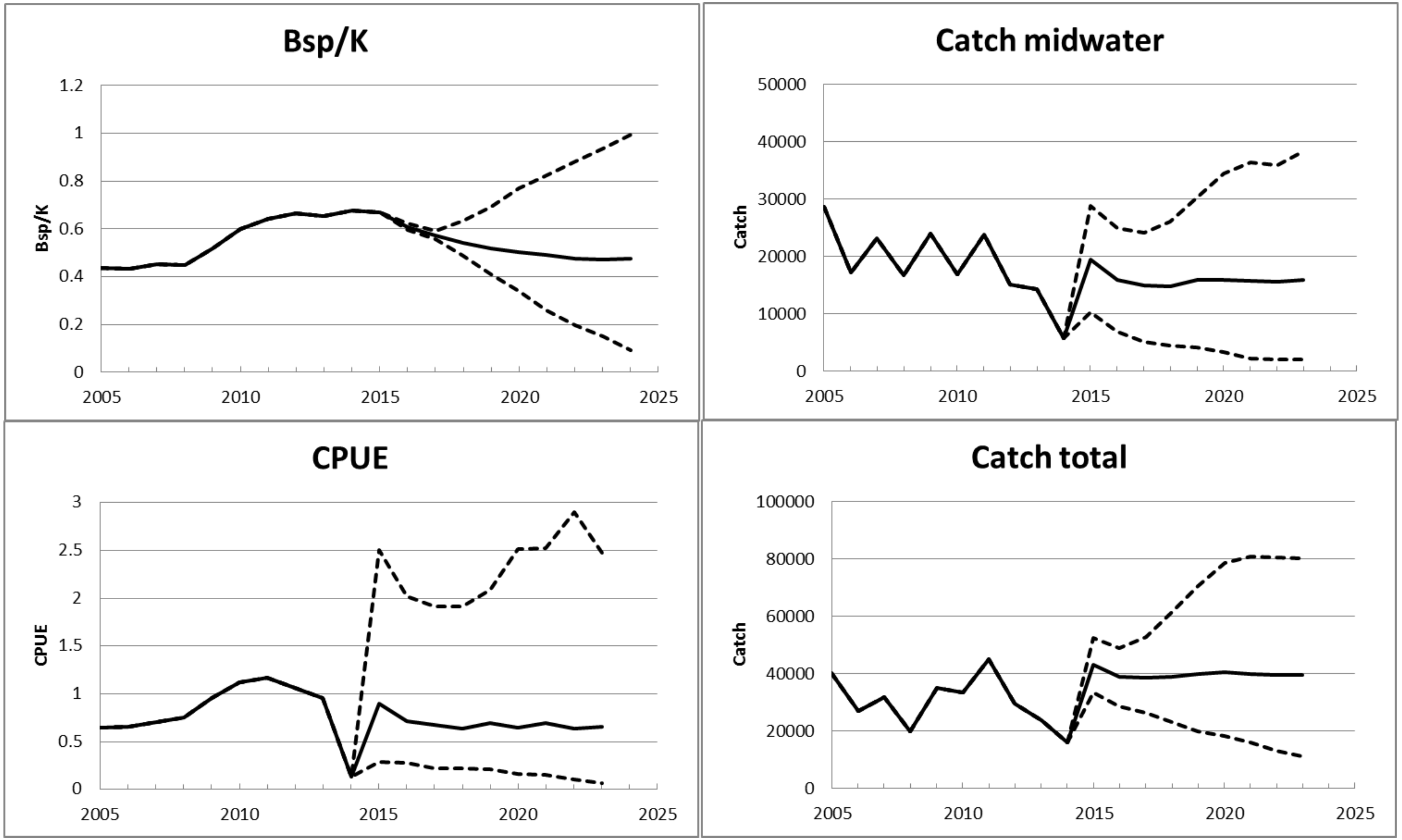


Figure 2a: OM2 - C_1 = 38658 (RC, VAR1, VAR2 and newvar)

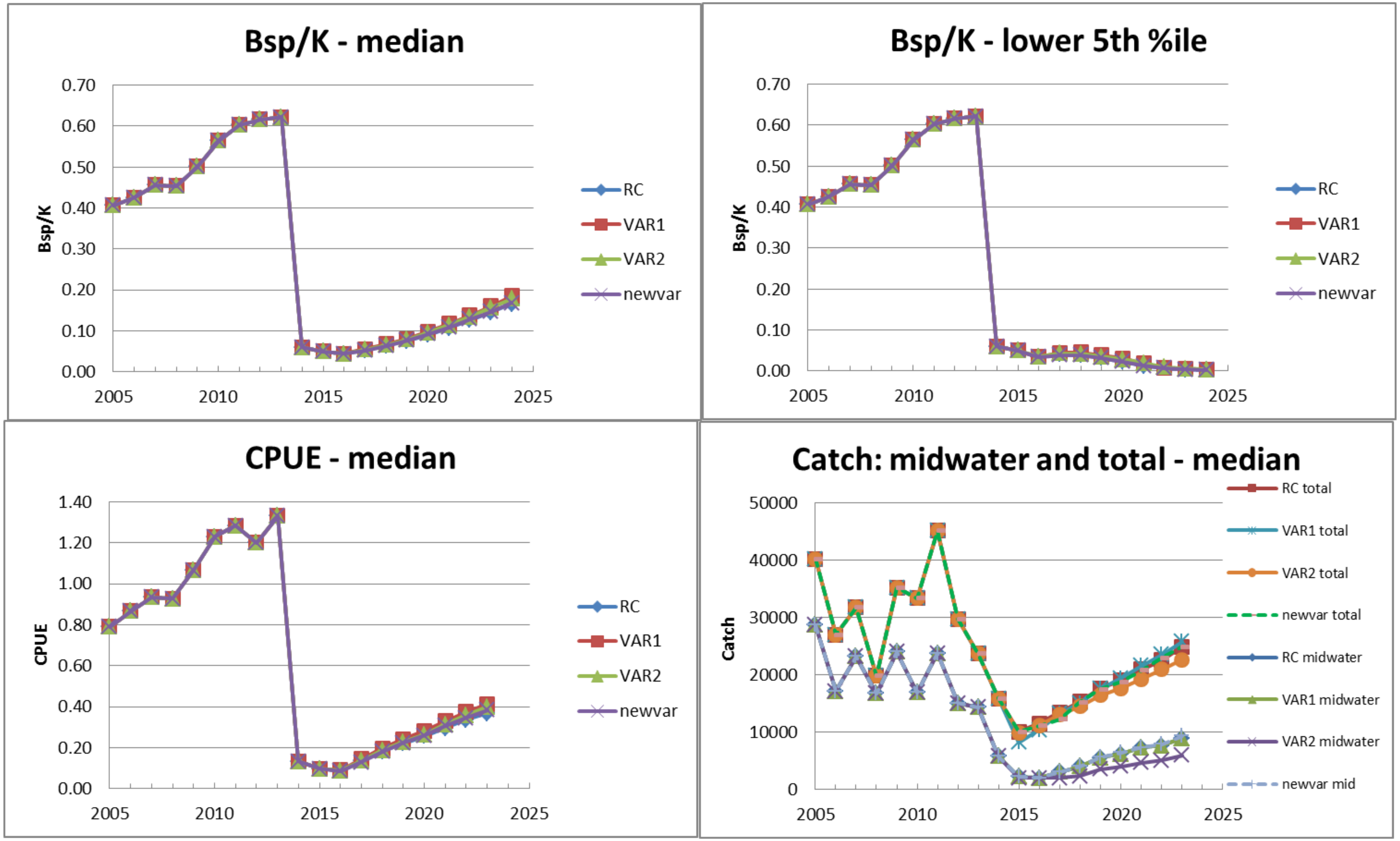


Figure 2b: OM2 – No Seaday limit, Midwater catch lower bound 2000, Pelagic catch cap 5000, C_1 = 38658 (Var3a), = 20000 (Var3b), = 10000 (Var3c) or = zero (Var3d). [Note lower midwater catch bound of 2000 still applies].

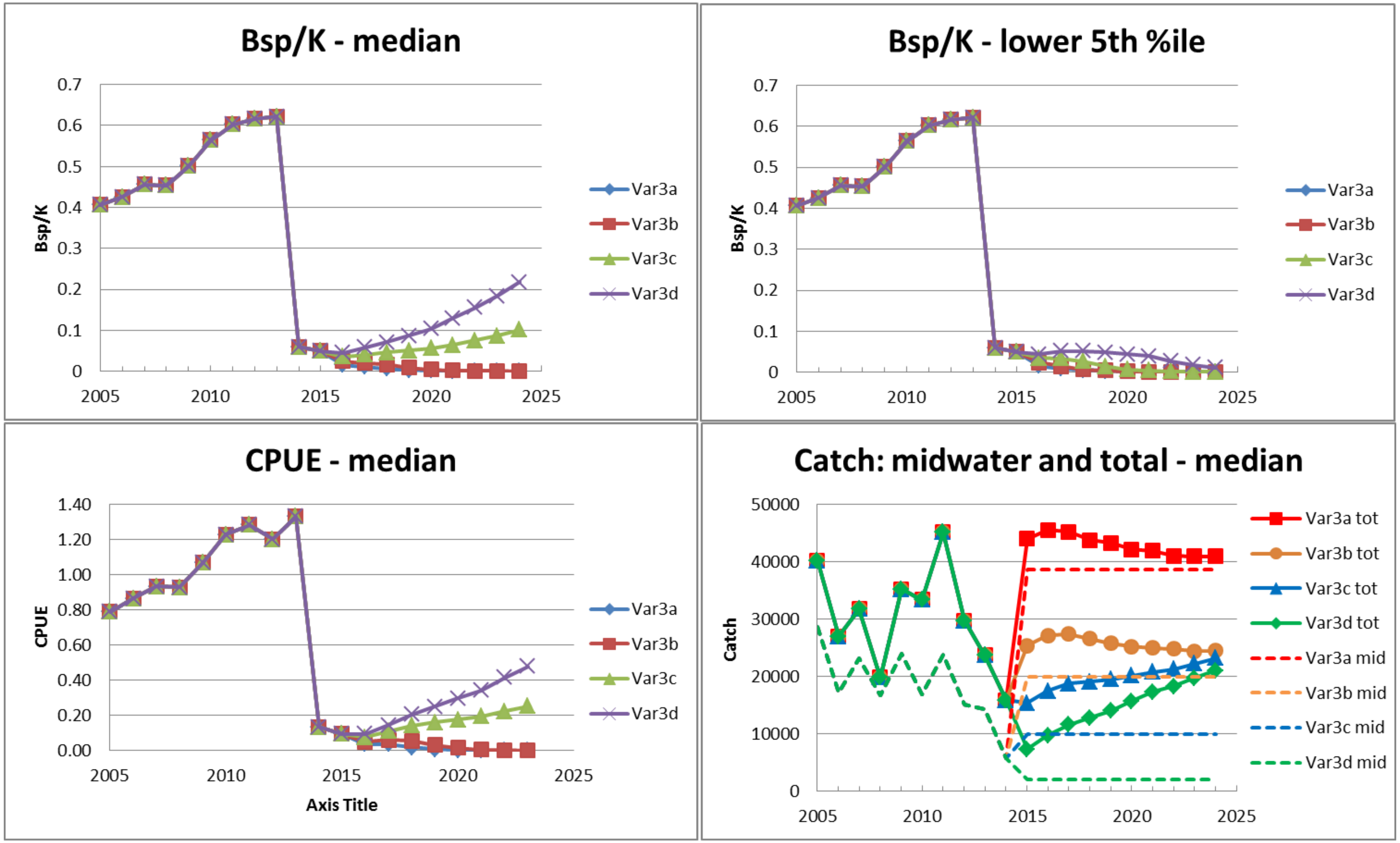


Figure 3a: OM4 - C_1 = 38658 (RC, VAR1, VAR2 and newvar)

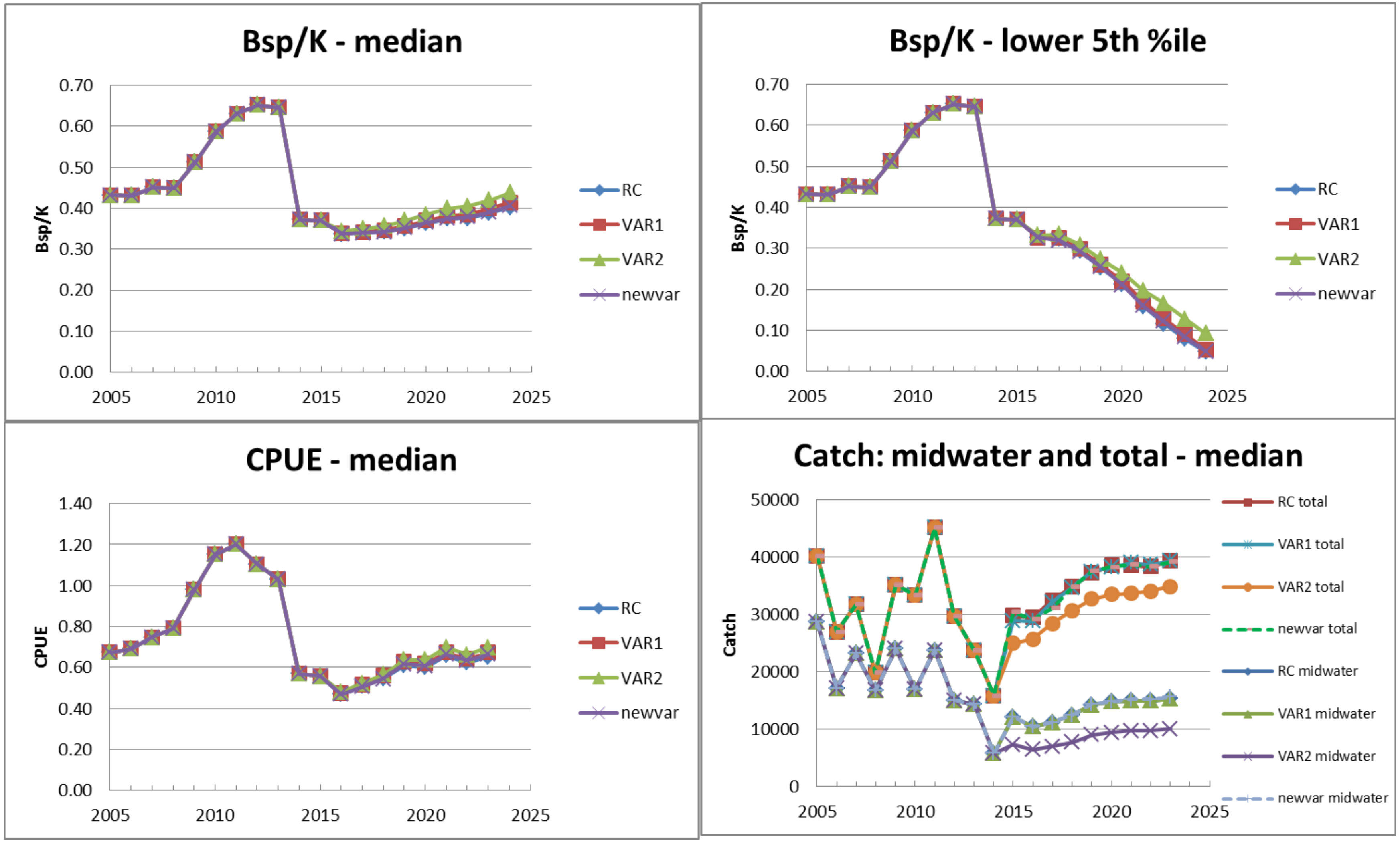


Figure 3b: OM4 – No Seaday limit, Midwater catch lower bound 2000, Pelagic catch cap 5000, C_1 = 38658 (Var3a), = 20000 (Var3b), = 10000 (Var3c) or = zero (Var3d). [Note lower midwater catch bound of 2000 still applies].