

## Results of “Future work” identified at previous SWG meeting and further projections

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### Summary

At the previous West Coast rock lobster SWG meeting it was reported that further analyses pertaining to three specific questions would be undertaken. The outcomes from these analyses are reported here, along with some further computations. Results of projections under a range of constant catches (including some phase down options) are presented for four poaching scenarios.

**Key words:** West Coast rock lobster, resource projections, poaching

### 1. Questions answered

**Q1: What if the updated A8+ assessment is fit assuming exactly the same poaching trend as used in 2019 (the LS=700mt version).**

The resource was projected forwards under CC=837mt assuming that the old 2019 LS=700mt trend applies (to both past and future).

A further projection was computed assuming 2019 poaching trend for pre-2020, but changing 700mt to 850mt for 2020+. This change was made given the advice from DFFE compliance that the overall amount of poaching seemed not to have changed – consequently the 150mt reduction in the TRAFFIC figure would have been distributed instead to sales on the local market.

Results are shown in Tables 1a and b and Figures 1a and b. It is evident that:

- a) Assuming the 2019 poaching trend does not reproduce the recruitment trend estimated in 2019 (i.e. it is not the poaching trend that is causing the different recent recruitment estimates being lower than those estimated in 2019).
- b) Projections are hardly affected if the 2019 poaching trend is assumed.

**Q2: What if a A8+ FIMS result was available and had been twice the size of the 2020 value? Does this much effect the fit and key associated results?**

The results are shown in Figure 1b. The availability of an A8+ FIMS value (even if very high) for 2020 would not have impacted results to any meaningful extent.

**Q3: What has caused the lower R2007 (and R2010) estimate (compared to 2019).**

*Obtaining a fully converged MLE (maximum likelihood estimate) for A8+ assessment*

R 2007 is related to the recent average  $\bar{x}$  (over 1970 to 2010 period) by the following equation:

$$x_y = \bar{x} e^{\varepsilon_y - \sigma_R^2/2} \text{ where } x_y \text{ is the recruitment level relative to pristine 1910 value.}$$

A likelihood profile for R2007 was constructed for A8+ in order to help identify the R2007 value giving a global minimum for  $-\ln L$ . The associated  $\varepsilon_{2007}$  value was found to be  $-0.304$ . A similar method was used to find the best R2010 value. Minimising using these values of R2007 and R2010 as the starting values then provided the new converged MLE for A8+.

In order to try to determine what components the new data were preventing a higher estimate of R2007, the R2007  $\varepsilon_{2007}$  value was fixed at  $0.4$  with the other parameters then re-estimated (note that the 2019 estimate of  $\varepsilon_{2007}$  was higher still at  $0.65$ ).

*Results*

See Table 2 for  $-\ln L$  comparisons to the original MLE (BC) model, which incorporates the assumption that  $LS=850\text{mt}$ . Figure 2a compares estimated recruitment values between the original BC model and the new MLE, and Figure 2b compares their estimated B75m values.

Projections were run assuming  $837\text{mt}$  ( $LS\ 850\text{mt}$ ) with the new MLE. See Tables 3a and b (last column). Results are more pessimistic for the new converged MLE (due to the lower R2007 and R2010 values).

*Discussion*

Table 2 shows that it is the further trap and hoopnet CPUE and male CAL data forthcoming over the last two years for A8+ that are primarily responsible for these results being more pessimistic than in 2019 (their effect outweighs that from the FIMS data which tends to impact in the reverse direction).

**2. Further Projections****Poaching trends**

Four poaching trends for each super-area have been developed which correspond to total illegal local sales in 2020 of either  $200$ ,  $400$ ,  $700$  or  $850\text{mt}$ . Figures 3a and b show plots of these poaching trends for the North (super-areas 3-4, 5-6 and 7) and South (A8+).

## Updated Assessments

All super-area assessments have been conducted assuming (in turn) four poaching scenarios (shown in Figures 1a and b) that correspond to total illegal local sales in 2020 of either 200, 400, 700 or 850mt.

Note however that since the last meeting, considerable time has been spent in trying to understand what components of the A8+ data are the causes of more pessimistic results than in 2019. This has resulted in a new MLE fit (the previous fit had not fully converged to the global minimum of the negative log likelihood), which is unfortunately yet more pessimistic than the previous fit reported at the beginning of August. The reasons for this are identified above, and in particular result in a much lower estimate for recruitment in 2007 in A8+ than was the case in 2019 (Figure 2a).

It has also been realised that future TACs will affect only the seasons from 2021 onwards. This is because the assessment gives biomass results to the start of the 2020 season, and subsequent to that the catch for the 2020 season has already been taken. It is therefore more appropriate to refer the “current” biomass level as being that at the start (October) of 2021 season (rather than the 2020 season). (Remember that the 2021 season refers to the split year season from October 2021 until September (effectively July) 2022.) This adjustment has now been made in the summary statistics presented.

## Projections

For the projections reported here, it is assumed (as has been customary) that future poaching will continue at the current level.

Projections have been run for a range of future constant catches (CC) and some phase-down options:

- 1) CC= 0
- 2) CC= 837mt (current TAC)
- 3) CC= 700mt
- 4) CC= 600mt
- 5) CC= 500mt
- 6) 600mt in 2021 then 400mt thereafter.
- 7) 500mt in 2021 then 300mt thereafter.
- 8) 700 (2021), 550 (2022) then 400 thereafter.

Table 4 reports the super-area TAC breakdowns for a range of total CC scenario that correspond to the averages over the 2017 to 2020 seasons of the proportional allocations assumed by the SWG in making its recommendations.

Results are reported in Tables 5a (biomass relative to 2006) and 5b (biomass relative to 2021), and Figures 4, 5 and 6.

### **Super-area projections**

Figure 7 shows the biomass projections for each super-area for future CC=700mt and for LS=850mt (top panel) and LS=200mt (bottom panel). Figure 8 compares the A7 TAC and commercial catch since 2015.

Comments:

- The super-area A7 commercial catch needs to be reduced more than the other super-areas, given the worse recent abundance trends for that super-area.
- There is also a need to ensure that sufficient commercial catch is taken in each super-area to enable continued reliable monitoring of abundance trends by means of CPUE data – this may require a greater proportional reduction in A8+?

### **Implications if future poaching were to be reduced substantially**

Biomass projections for A8+ (assuming LS+700mt scenario) and a future CC=553mt (current TAC) are compared assuming either poaching remains at the current level into the future, or that it halves. Figure 5 reports the B75m projections. The bottom plot shows that if poaching is reduced, the CC catch that would provide the same B25/21 level could be increased to 875mt.

This implies that if A8+ poaching (735mt) were to be reduced by half (to 368mt), this would allow an extra 322 (875=553) mt legal catch only. Thus the “exchange rate” of poached to legally taken lobster biomass seems close to 1, but this estimate may be impacted here by transient dynamics effects.

Table 1a: B75m(2025/**2006**) for a CC=**837**mt for two options for A8+ poaching trends.

	L(2020)=850mt New poaching trend	L(2020)=850 mt <b>Old 2019</b> poaching trend for past only	L(2020)=700 mt <b>Old 2019</b> poaching trend for past and future
A8	0.58	0.59	0.61
<b>T</b>	<b>0.68</b>	<b>0.68</b>	<b>0.69</b>

Table 1b: B75m(2025/**2020**) for a CC=837mt for two options for A8+ poaching trends.

	L(2020)=850mt New poaching trend	L(2020)=850 mt Old 2019 poaching trend for past only	L(2020)=700 mt Old 2019 poaching trend for past and future
A8	1.03	1.06	1.09
<b>T</b>	<b>1.01</b>	<b>1.02</b>	<b>1.04</b>

Table 2: The  $-\ln L$  contributions for the previous MLE for A8+, the new MLE and results for TRY1. The last column shows the difference compared with the new MLE where positive values reflect a worsening fit compared to the new MLE. The larger differences (magnitude above 0.5) are shown in **bold**.

	Previous MLE	new MLE ( $\varepsilon_{2007} = -0.304$ )	Try1 (fix $\varepsilon_{2007} = 0.4$ )	Try1 Diff
<b>-lnL total</b>	<b>-33.864</b>	<b>-35.632</b>	<b>-33.014</b>	2.618
Trap cpue	-33.103	-34.772	-32.504	<b>2.268</b>
Hoop cpue	-37.709	-38.299	-36.954	<b>1.345</b>
FIMS cpue	-8.933	-7.938	-9.877	-1.939
Trap F%	6.503	5.975	6.011	0.036
Hoop F%	1.851	1.821	1.815	-0.006
FIMS F%	8.504	9.126	9.187	0.061
Trap male CAL*	3.523	3.4637	4.825	<b>1.361</b>
Trap female CAL*	3.561	3.7178	3.739	0.021
Hoop male CAL*	-0.025	-0.3422	0.186	<b>0.552</b>
Hoop female CAL*	0.715	0.7031	0.717	0.014
FIMS male CAL*	11.239	11.2246	11.069	-0.156
FIMS female CAL*	6.781	6.7805	6.258	-0.552
Sublegal male*	0.584	0.3815	0.624	<b>0.224</b>
Sublegal female*	0.282	-0.3002	-0.324	-0.023

\*CAL data is down-weighted by 0.1 in the  $-\ln L$  total.

Table 3a: B75m(2025/**2006**) for a CC=837mt for the original MLE (BC) model and the new MLE (assuming L(2020)=850mt).

	Original A8+ MLE	<b>NEW A8+ MLE</b>
A8	0.58	0.38
<b>T</b>	<b>0.68</b>	<b>0.57</b>

Table 3b: B75m(2025/**2020**) for a CC=837mt for the original MLE (BC) model and the new MLE (assuming L(2020)=850mt).

	Original A8+ MLE	<b>NEW A8+ MLE</b>
A8	1.03	0.57
<b>T</b>	<b>1.01</b>	<b>0.88</b>

Table 4: The breakdown of global TAC between the five super-areas for different combined total CC. The proportions are the averages of those assumed over the 2017-2020 seasons by the SWG in making its recommendations.

	Proportion	<b>CC=837</b>	<b>CC=700</b>	<b>CC=600</b>	<b>CC=550</b>	<b>CC=500</b>	<b>CC=400</b>	<b>CC=300</b>
<b>A12</b>	0.024	20	17	14	13	12	10	7
<b>A34</b>	0.118	99	83	71	65	59	47	35
<b>A56</b>	0.079	66	55	47	43	40	32	24
<b>A7</b>	0.118	99	83	71	65	59	47	35
<b>A8</b>	0.661	553	463	397	364	331	264	198



Table 5a: B2025/**2006** and B2030/**2006** values for a range of future CC values, and for four poaching scenarios relating to level of 2020 local illegal sales (LS(2020)).

		LS(2020)= <b>200</b> mt	LS(2020)= <b>400</b> mt	LS(2020)= <b>700</b> mt	LS(2020)= <b>850</b> mt
CC=0	B25/06	0.81	0.79	0.73	0.68
	B30/06	1.06	0.99	0.90	0.84
CC=837mt	B25/06	0.67	0.65	0.59	0.55
	B30/06	0.78	0.74	0.64	0.58
CC=700mt	B25/06	0.70	0.68	0.61	0.57
	B30/06	0.83	0.78	0.68	0.62
CC=600mt	B25/06	0.72	0.69	0.63	0.59
	B30/06	0.87	0.81	0.71	0.66
CC=500mt	B25/06	0.73	0.71	0.65	0.59
	B30/06	0.90	0.84	0.75	0.67
CC=600 (2021) then 400mt	B25/06	0.74	0.72	0.65	0.61
	B30/06	0.92	0.87	0.77	0.71
CC=500 (2021) then 300mt	B25/06	0.75	0.73	0.67	0.63
	B30/06	0.95	0.90	0.80	0.75
CC=700 (2021), 550 (2022) then 400mt	B25/06	0.73	0.71	0.65	0.60
	B30/06	0.91	0.86	0.77	0.71

Table 5b: B2025/**2021** and B2030/**2021** values for a range of future CC values, and for four poaching scenarios relating to level of 2020 local illegal sales (LS(2020)).

		LS(2020)= <b>200</b> mt	LS(2020)= <b>400</b> mt	LS(2020)= <b>700</b> mt	LS(2020)= <b>850</b> mt
CC=0	B25/21	1.18	1.14	1.08	1.05
	B30/21	1.53	1.44	1.34	1.29
CC=837mt	B25/21	0.97	0.95	0.88	0.85
	B30/21	1.13	1.06	0.95	0.89
CC=700mt	B25/21	1.01	0.98	0.91	0.88
	B30/21	1.21	1.13	1.02	0.96
CC=600mt	B25/21	1.04	1.00	0.94	0.90
	B30/21	1.25	1.17	1.06	1.01
CC=500mt	B25/21	1.06	1.03	0.96	0.91
	B30/21	1.30	1.22	1.11	1.02
CC=600 (2021) then 400mt	B25/21	1.07	1.04	0.97	0.94
	B30/21	1.33	1.26	1.15	1.07
CC=500 (2021) then 300mt	B25/21	1.09	1.06	1.00	0.97
	B30/21	1.38	1.30	1.20	1.14
CC=700 (2021), 550 (2022) then 400mt	B25/21	1.05	1.02	0.96	0.93
	B30/21	1.32	1.25	1.14	1.08



Figure 1a: Comparison of recruitment estimates when fitting using the poaching values agreed in 2019 (green line). This does indicate how some of the 1970-2004 changes arises - note that green is midway between blue and red. Here and in following recruitment plots the horizontal black line indicates  $\bar{X}$ .

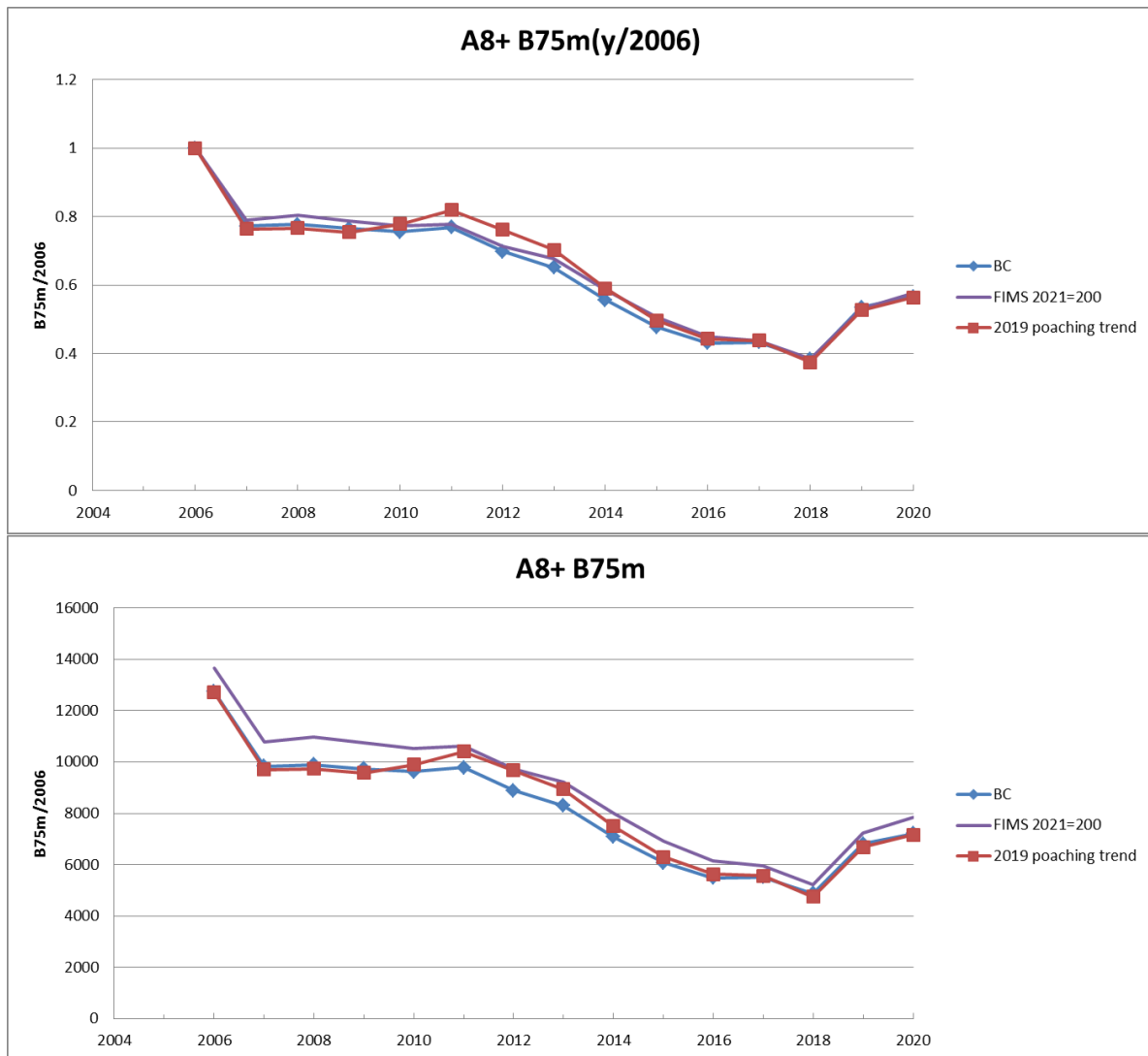


Figure 1b: Biomass estimates for the BC and alternative scenarios. LS is 850mt throughout.

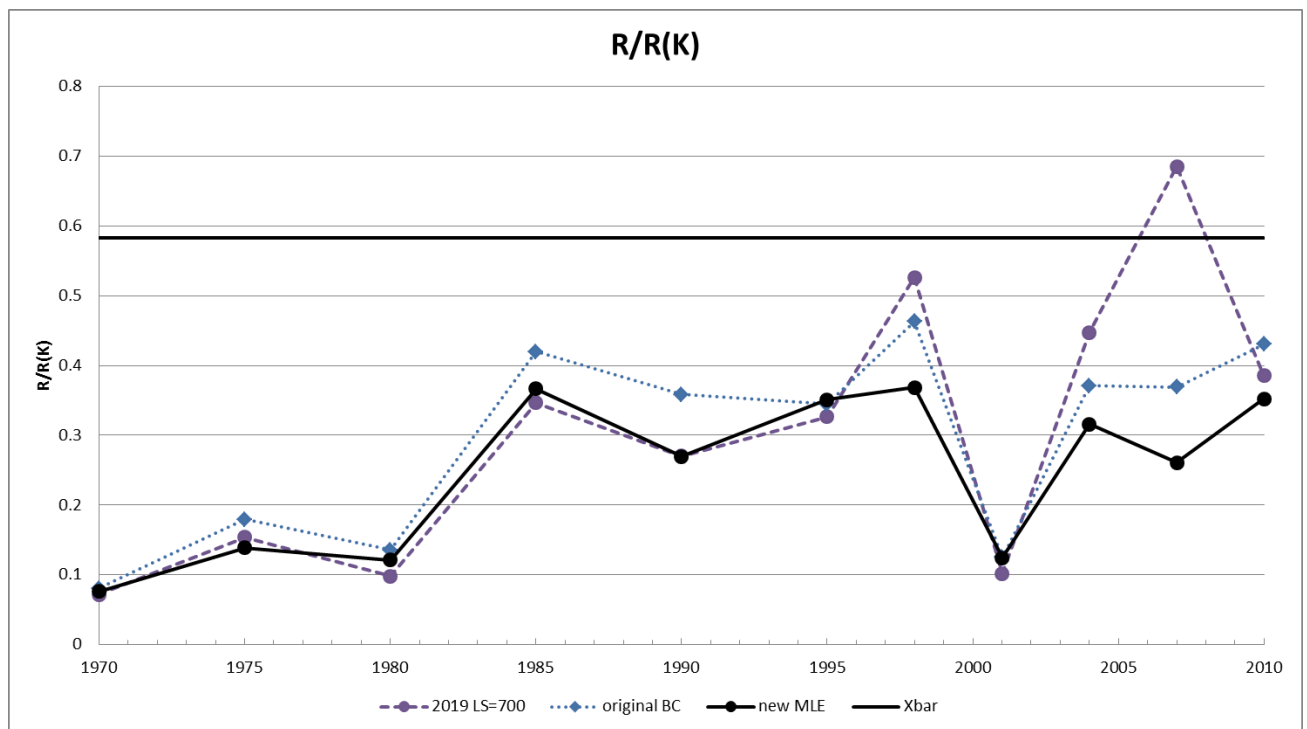


Figure 2a: A8+ comparison of recruitment estimates between the original BC MLE and the new MLE for both of which LS=850mt.

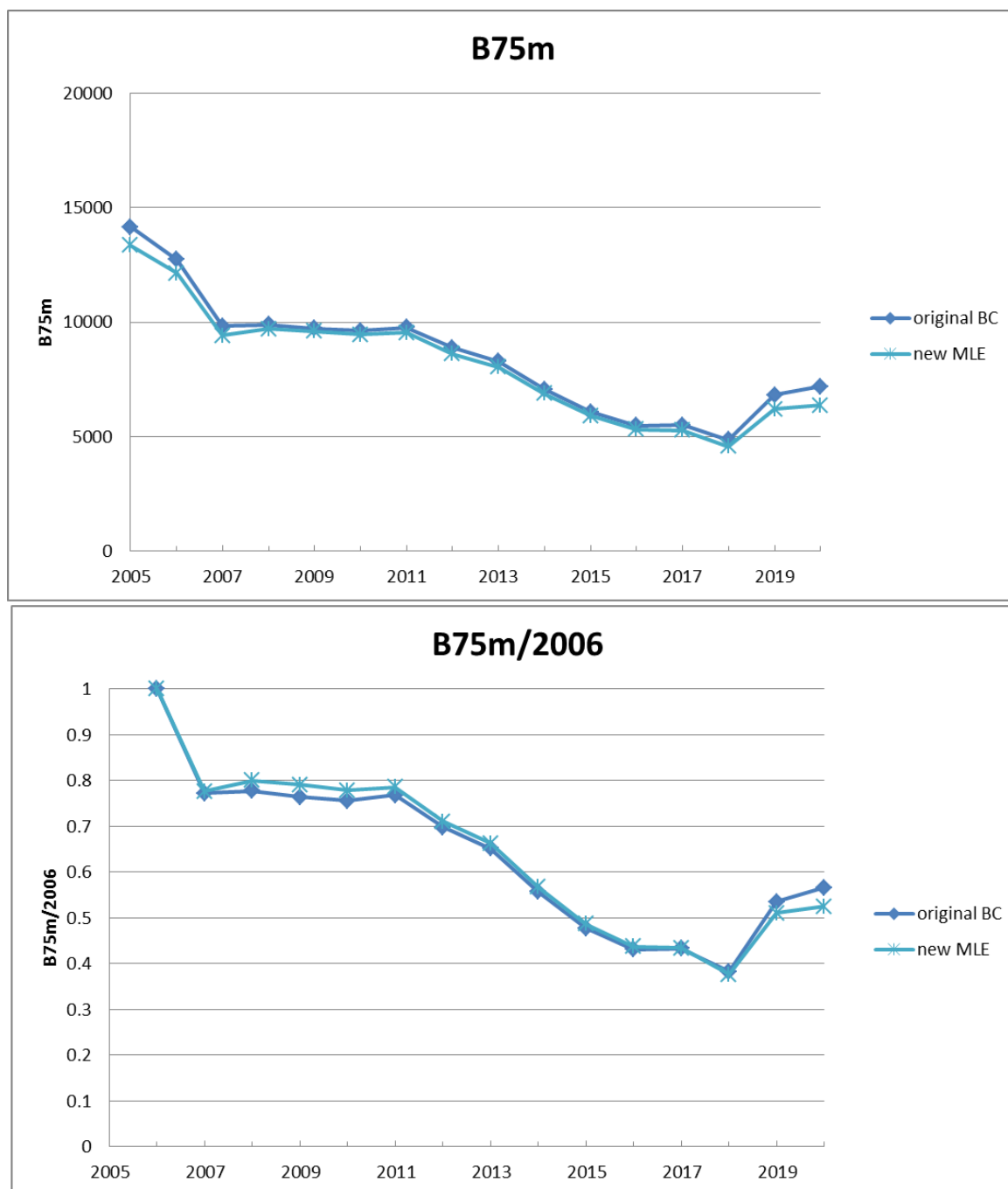


Figure 2b: A8+ B75m trajectories as estimated by the original BC model and the new MLE (LS is 850mt for both).

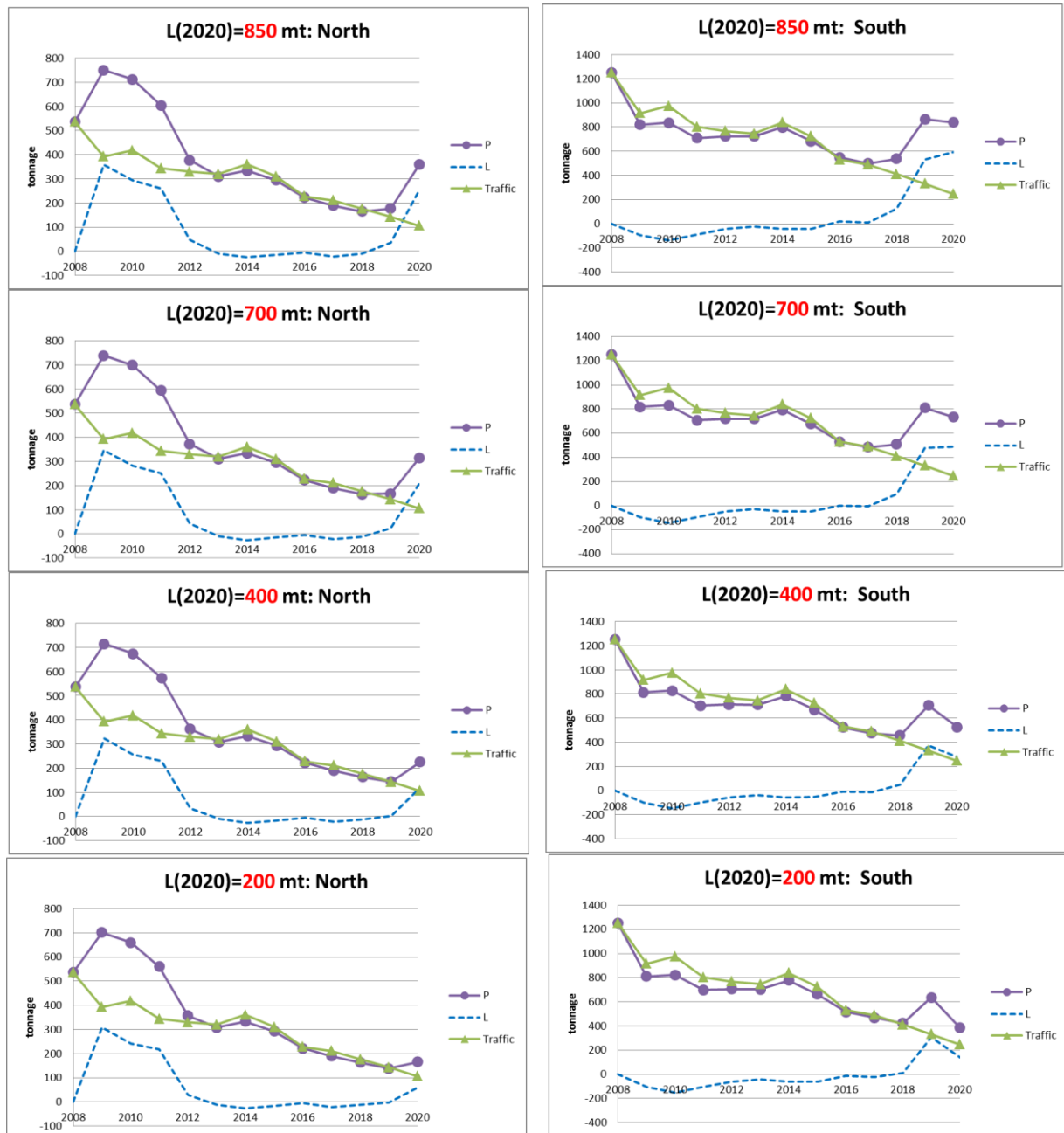


Figure 3a: Poaching trends for four possible scenarios for recent local sales (200mt, 400mt, 700mt and 850mt). Results on the left are for the Northern super-areas, with the results on the right for the South (i.e. A8+). “P” refers to the total poaching, and “L” refers to the implied local sales (P less Traffic).

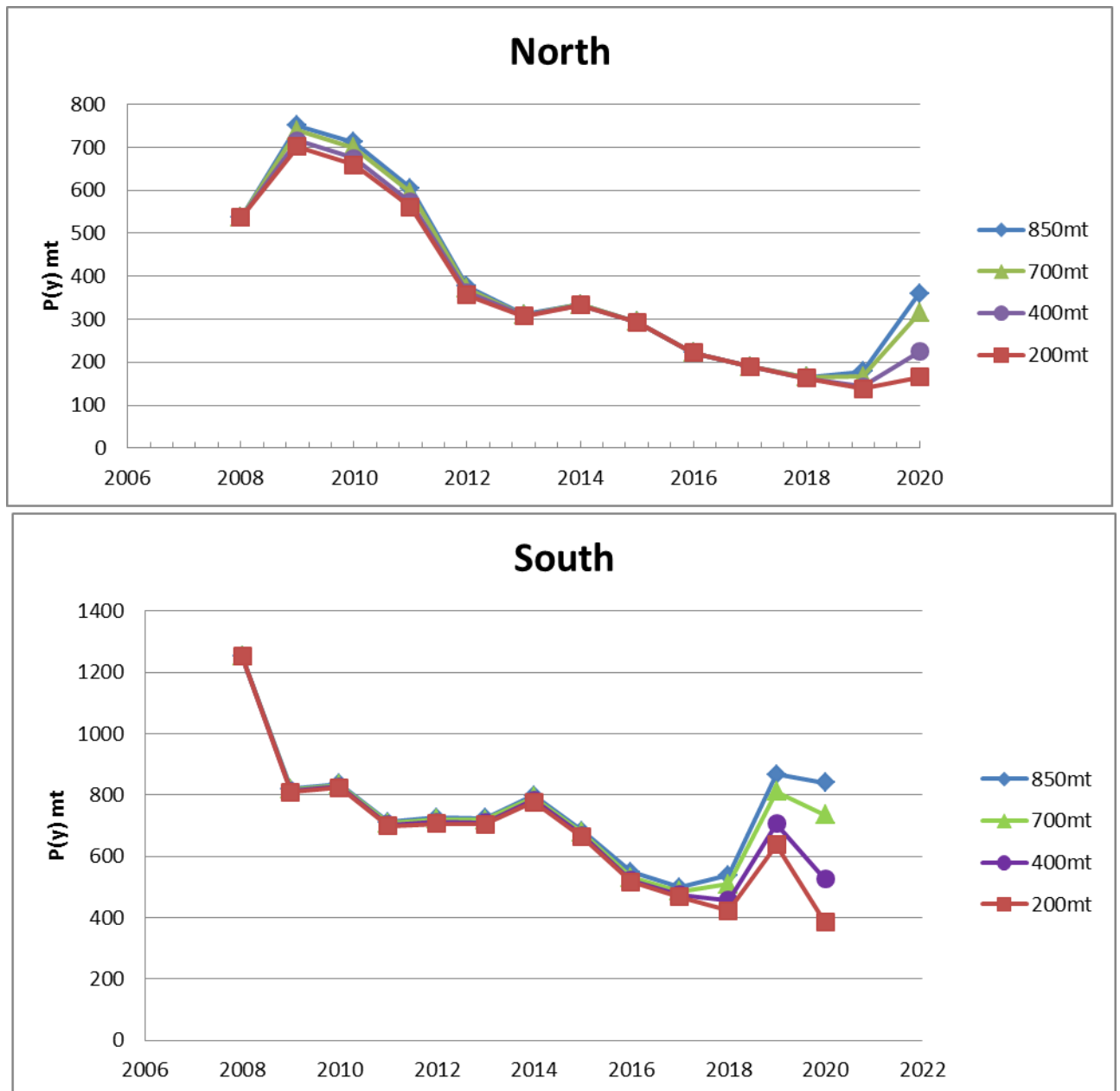


Figure 3b: Poaching trends for four possible scenarios of recent local sales (200mt, 400mt, 700mt and 850mt). Results in the top plot are for the Northern super-areas, with the results in the bottom are for the South (i.e. A8+).

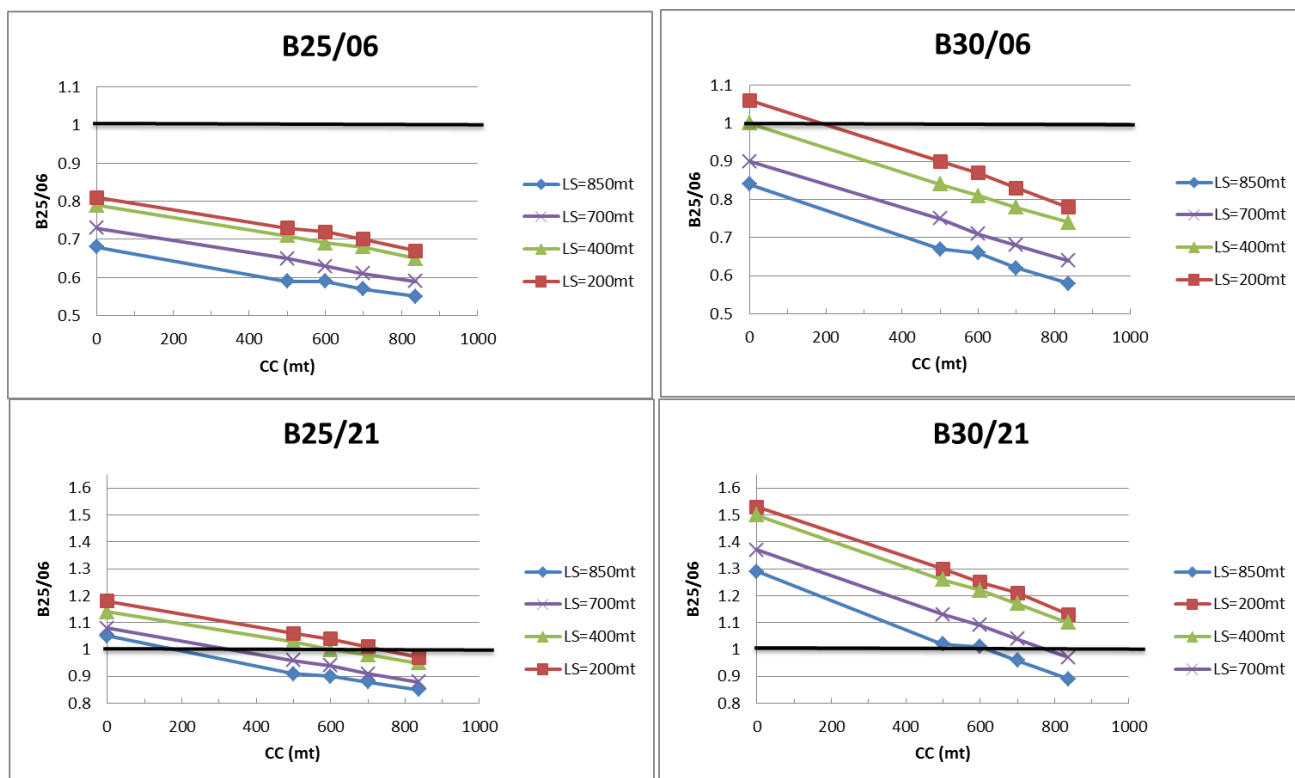


Figure 4: B25/06, B30/06, B25/21 and B30/21 statistics for the total resource under different future CC levels. Results are shown for four levels of recent 2020 local illegal sales (200, 400, 700 and 850mt).



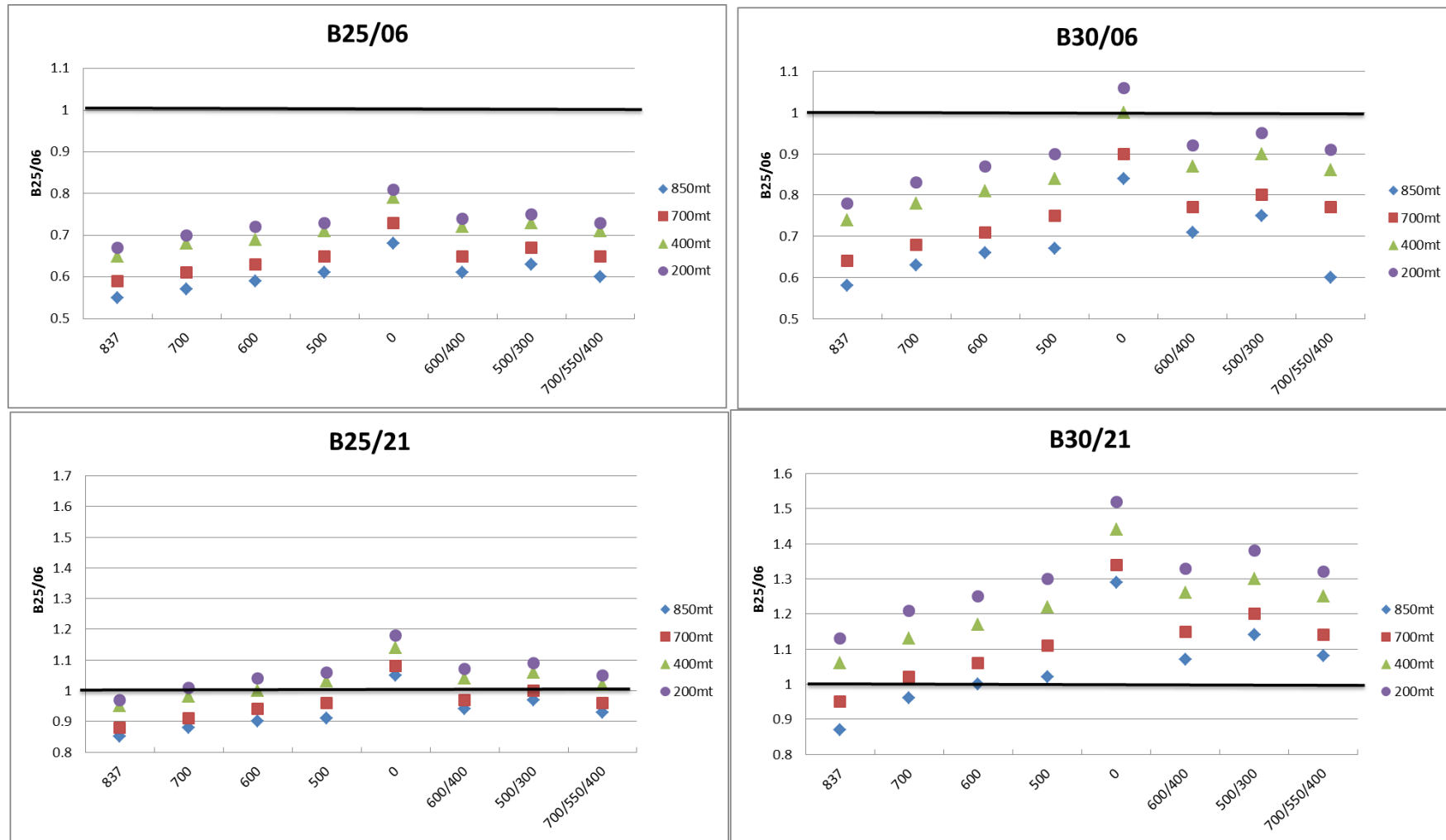
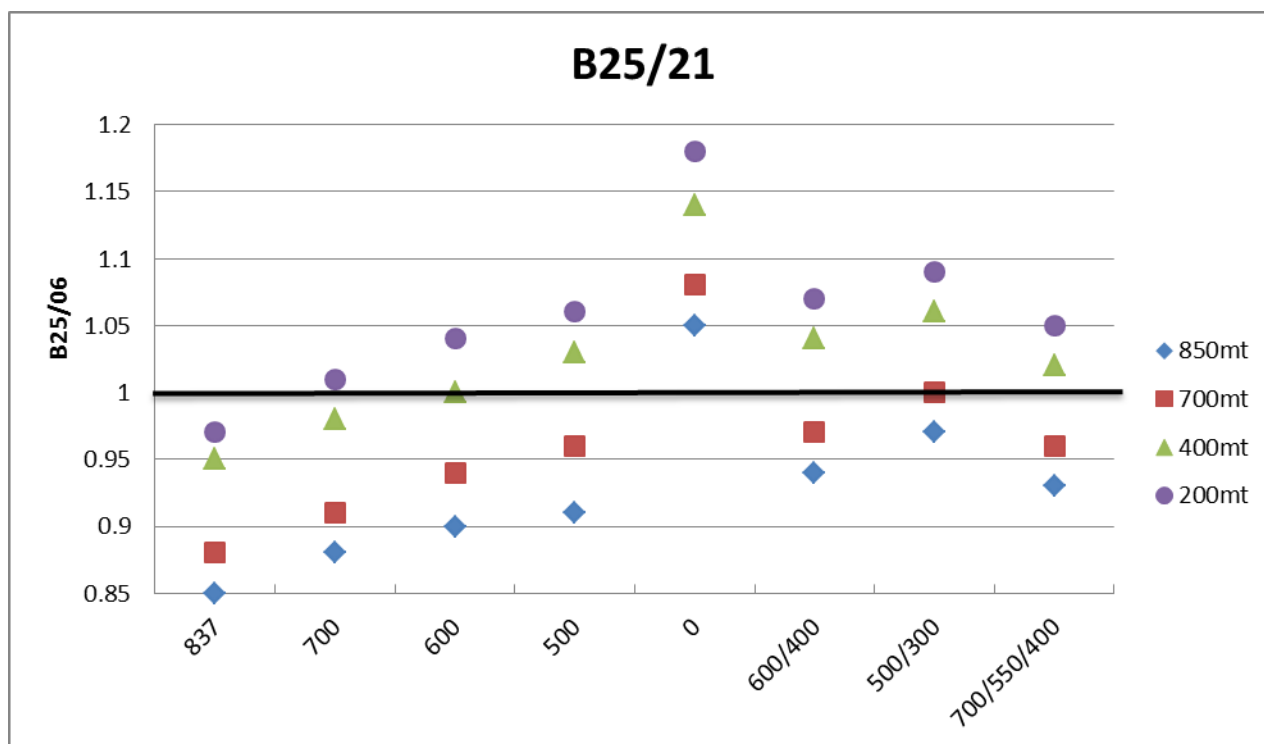
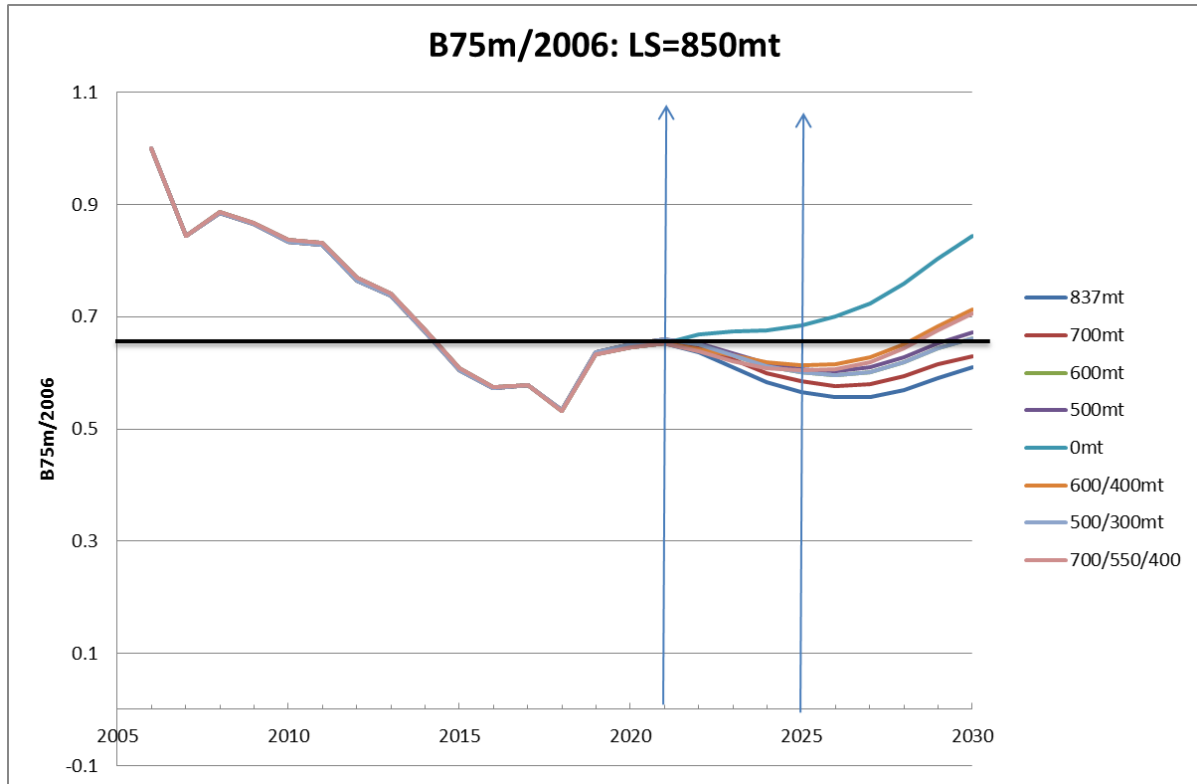


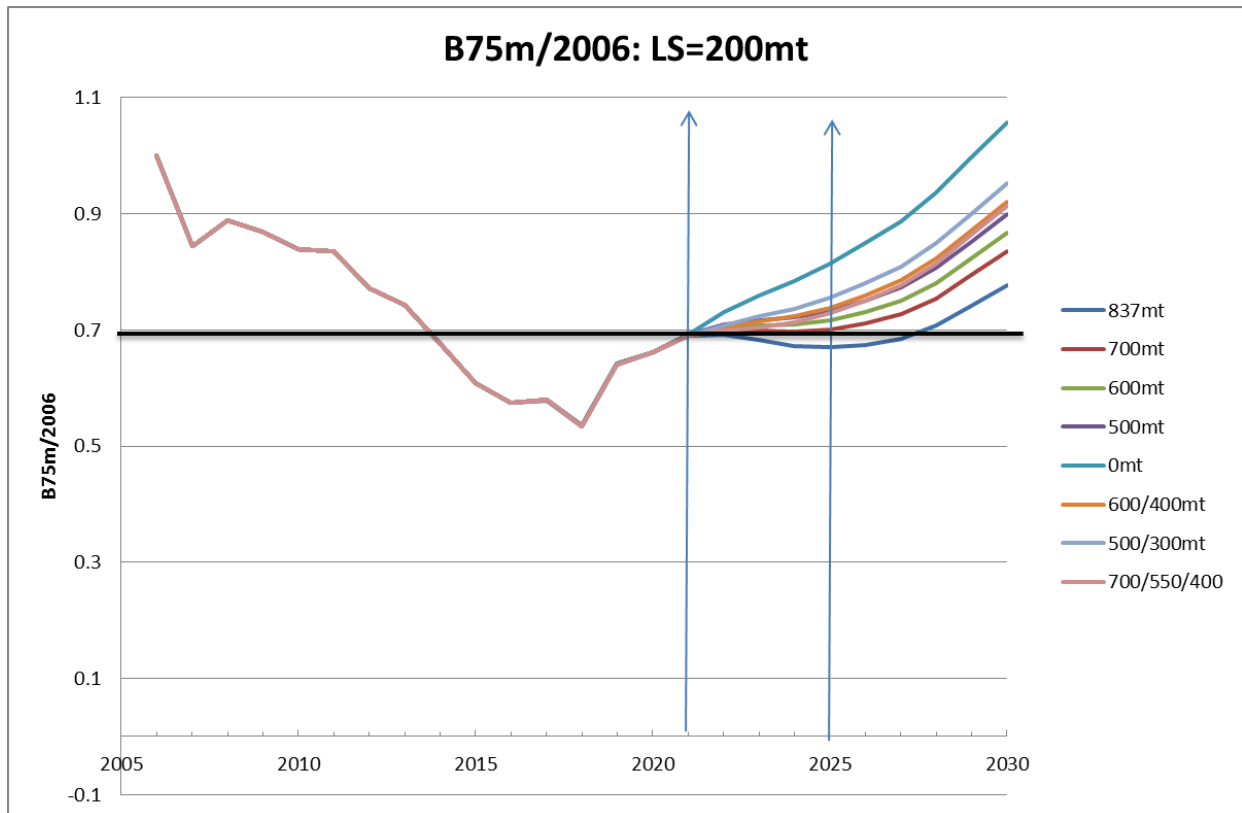
Figure 5a: B25/06, B30/06, B25/20 and B30/20 statistics for the total resource under different future CC levels, including some phase-down scenarios. Results are shown for four levels of recent 2020 local illegal sales (200, 400, 700 and 850mt).



**Figure 5b:** B25/20 statistics for the total resource under different future CC levels, including some phase-down scenarios. Results are shown for four levels of recent 2020 local illegal sales (200, 400, 700 and 850mt).



**Figure 6a:** B75m/2006 trajectories for the LS=850mt scenario, for a range of future catch scenarios.



**Figure 6b:** B75m/2006 trajectories for the LS=200mt scenario, for a range of future catch scenarios.

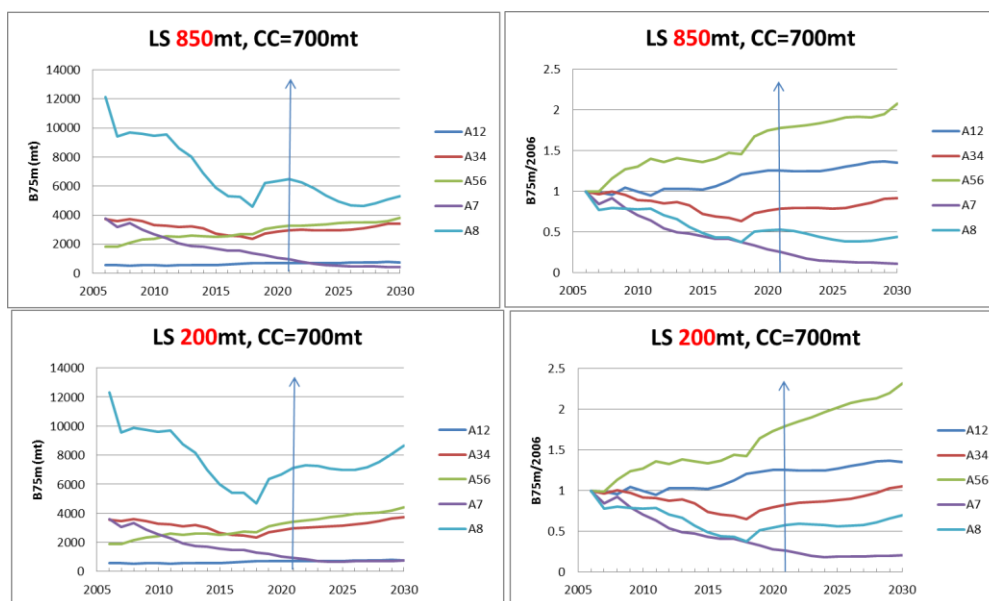


Figure 7: Biomass projections for each super-area for future CC=700mt and for LS=850mt (top) and LS=200mt (bottom).

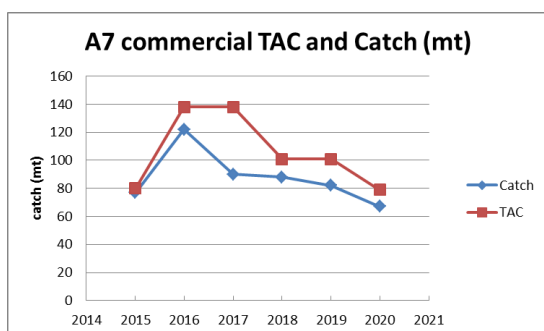


Figure 8: Comparison of the A7 TAC and commercial catch since 2015.

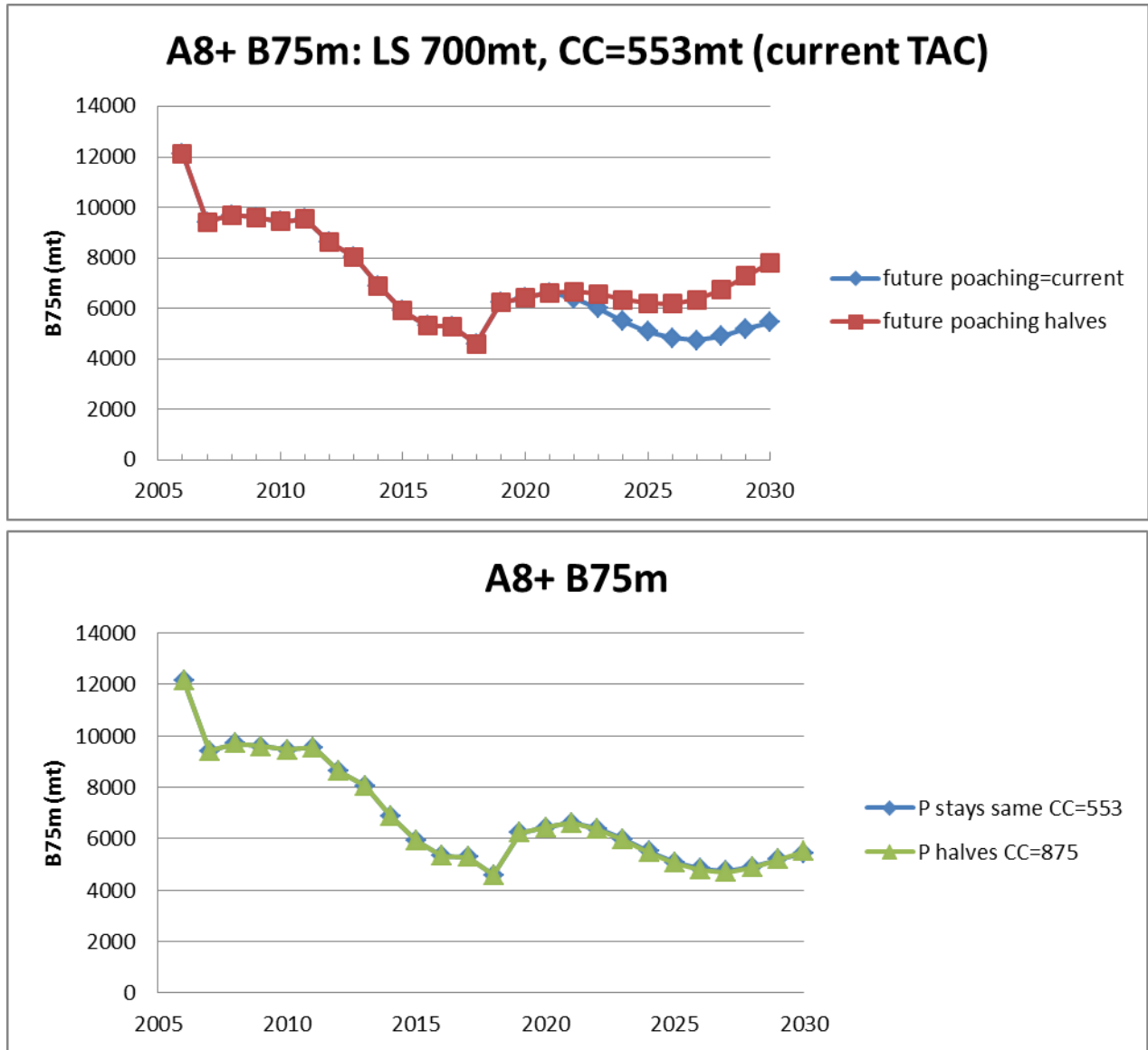


Figure 5: Biomass projections for A8+ (assuming LS=700mt scenario) and a future CC=553mt (current TAC in A8+). Results in the top plot assume either that the current level of poaching continues into the future, or that it halves. The bottom plot shows the trajectory, if poaching is reduced in this way, for the CC catch (875mt) that would provide the same B25/21 level.