Updated 2020 assessments and deterministic projections for west coast rock lobster

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Summary

The 2019 assessments and deterministic projections for the five super-areas for the west coast rock lobster resource are updated to 2020, using basically the same approach as in 2019. The update takes account of a further year's catch, resource monitoring and somatic growth data, and incorporates revisions made in 2020 of estimates of past poaching levels. Deterministic projections are calculated on an identical basis to that used in 2019. Four levels of future (legal) total CC TAC are considered for projections: these are either zero, 549t, the DEFF's final TAC selection of 837t, as well as 1084t. Updated total biomass trends are more pessimistic than those estimated in 2019.

KEY WORDS: West Coast rock lobster; *Jasus lalandii*; stock assessment

Background

Updated 2020 assessment results for west coast rock lobster, *Jasus lalandii*, for each super-area are reported here. These assessments use the 2019 assessment methodology, and updated CPUE, FIMS, somatic growth and poaching data. The 2019 assessments used data up to and including 2019, whereas the 2020 assessments have one further year of data. For A8+, results are reported for two different poaching scenarios. These scenarios assume illegal local sales of either 400 or 700 MT in 2019. For super-areas A34, A56 and A7 there is negligible difference between the LS=400 and 700 MT scenarios, so that only the LS=700 MT scenario results are shown for these super-areas. Johnston and Butterworth (2021) provides details of the updated poaching scenarios. Note that the current and projected poaching trends for the 2020 assessment are higher than those assumed for the 2019 assessment.

For each assessment a value for σ_R = 1.0 is assumed for recruitment estimation. For A7 the 2009-2019 TRAP CPUE data are up-weighted by a factor of 10 in the likelihood to provide better fits to these data.

Projections

Deterministic projections are reported for constant future annual legal catches (CC) by all sectors for the 2020+ period. Results are provided for a future CC=0, CC=549 MT, CC=837 MT (the final 2020 TAC decision by DEFF) and CC=1084 MT (the previous season's TAC). These projections are deterministic, with the aim of determining the impact of updating the assessments on projections when compared to the 2019 deterministic projections. Later, future projections will be provided under a more comprehensive stochastic simulation framework.

Results

Assessment results

Detailed updated assessment results are reported in Tables 1a-e and Figures 1-4. Figures 1-4 show recruitment estimates, model fits to data and model estimates of biomass for each of the five super-areas. Table 2a compares the 2019 and 2020 assessments estimates of total current biomass. Table 2b compares the total and super-area estimates of 2018 B75m between the 2019 and 2020 assessments.

Deterministic Projection results

Table 3a compares projection results for the 2019 and 2020 assessments, showing the recovery of B75m for the total resource by 2025 relative to 2006, for a range of future CC scenarios.

Table 3b compares projection results at a super-area level for the 2019 and 2020 assessments for a total future CC=837 MT, showing the recovery of B75m by 2025 relative to 2006.

Table 3c compares projection results at a super-area level for the updated 2020 assessments for a range of total future CC values.

Figure 5a plots the projected B75m for each super-area for a range of future CC levels. Figure 5b is a similar plot but for the resource as a whole. Figure 5c compares plots of total B75m for a CC=837 MT for the 2019 and 2020 assessments, with Figure 5d showing these comparisons both at a super-area level and for the total resource.

Discussion

Updated 2020 assessments

The 2020 updated assessments show similar fits to the data and parameter estimates as the 2019 assessments (Tables 1a-e, Figures 1-4). It is notable, however, that the estimates of recent abundance (B75m(2018)) are lower for super-areas A34-A8+, but somewhat higher for A12. The overall 2020 estimate of total B75m is 13 664 MT compared with the 2019 estimate of 15 029. This is also reflected in the B75m(2018) values relative to 2006, where the combined biomass for the 2020 is 0.61 compared with 0.69 for the 2019 assessment. A major contributing factor to this difference is that in only three of the four cases is an abundance index for 2019 higher than it was for 2018.

Deterministic projection results

Deterministic projections for a range of future CC values for the updated 2020 assessments are about 20% less than when estimated using the 2019 assessment models (as was done in 2020 when providing scientific advice on alternative TAC options for setting the 2020/21 TAC) – see Table 3a. Table 3b provides further details of the 2019 compared to 2020 projections for a CC=837 MT (DEFF's final selected TAC) at a super-area level. Super-areas A7 and A8+ appear to be the main super-areas contributing to this more pessimistic appraisal for these projections (when compared to the 2019 assessment) – with the combined 2020 B75m(2025/2006) 26% less than that estimated by the 2019 assessment. The 2019 assessments predicted an 8% increase in biomass by 2025 under continuation of the current TAC of 837 MT, whereas the 2020 assessments now predict a 10% decrease (Table 3a, and Figures 5c and d). It is also important to note that the 2020 assessments assume higher future poaching levels than the 2019 assessment, which will clearly be a partial cause of these more pessimistic results.

Reference

Johnston, S.J. and Butterworth, D.S. 2021. Updated 2020 poaching time series for use in west coast rock lobster population models. FISHERIES/2021/MAY/WCRL/03.

Table 1a: **A8+** results for the two different poaching scenarios. The values in parentheses next to the –lnL values are the associated σ values for the fit to those data. The comparative 2019 assessment results are also provided (shaded columns). Note that here and in the tables that follow, -lnL values are not comparable between 2019 and 2020 because the 2020 data set is larger including data from an extra year.

	2019		**2020**	
	LS 400	**LS 700**	**LS 400**	**LS 700**
-lnL total (T=D+R)	-55.017	-58.958	-51.539	-53.592
-lnL from data (D)	-58.576	-62.289	-54.539	-56.274
R penalties (R)	3.559	3.331	2.768	2.681
Trap CPUE –lnL (σ)	-37.640 (0.194)	-38.528 (0.189)	-40.312 (0.185)	-40.377 (0.185)
Hoop CPUE –lnL (σ)	-38.357 (0.183)	-39.525 (0.176)	-41.401 (0.173)	-41.737 (0.171)
FIMS CPUE –lnL (σ)	-11.998 (0.382)	-13.273 (0.364)	-13.402 (0.376)	-15.173 (0.353)
R_2004	0.339	0.447	0.454	0.541
R_2007	0.651	0.685	0.491	0.578
R_2010	0.351	0.386	0.410	0.441
$\bar{x}$	0.520	0.542	0.534	0.544
B75m(2006) (B75m(2006)/K)	9586 (0.041)	9275 (0.041)	9272 (0.041)	9460 (0.043)
B75m(2018) (B75m(2018)/K)	4995 (0.021)	4822 (0.021)	4215 (0.187)	4253 (0.019)
B75m(2019) (B75m(2019)/K)	-	-	5503 (0.025)	5571 (0.025)
Median B75m(2025)/B75m(2006) CC=1084	-	0.834*	0.758	0.668
Median B75m(2025)/B75m(2006) CC=837	-	-		0.743
Median B75m(2025)/B75m(2006) CC=549	-	-	0.925	0.832
Median B75m(2025)/B75m(2006) CC=0	1.324	1.110	1.100	1.002
	nn.for 8v1.res	nn.for 8v2.res	nn.for a820b.res	nn.for a820.res

*A corresponding value for LS 400 was not computed in 2019.

Table 1b: **A7** results for the LS=700 poaching scenario. The values in parentheses next to the –lnL values are the associated σ values for the fit to those data. The comparative 2019 assessment results are also provided (shaded column).

	2019	**2020**
-lnL total (T=D+R)	121.623	148.715
-lnL from data (D)	117.632	143.7144
R penalties (R)	3.992	4.777
Trap CPUE –lnL (σ)	16.015 (0.689)	24.824 (1.028)
Hoop CPUE –lnL (σ)	-	-
FIMS CPUE –lnL (σ)	5.782 (0.764)	6.388 (0.775)
R_2004	0.017	0.019
R_2007	0.013	0.018
R_2010	0.025	0.027
$\bar{x}$	0.045	0.049
B75m(2006) (B75m(2006)/K)	5147 (0.017)	6507 (0.026)
B75m(2018) (B75m(2018)/K)	3101 (0.011)	2991 (0.021)
B75m(2019) (B75m(2019)/K)	-	2930 (0.018)
Median B75m(2025)/B75m(2006) CC=1084	1.271	0.665
Median B75m(2025)/B75m(2006) CC=837	-	0.681
Median B75m(2025)/B75m(2006) CC=549	-	0.706
Median B75m(2025)/B75m(2006) CC=0	1.403	0.748
	N7.for n7v2.res	N7.for A720.res

Table 1c: **A56** results for the LS=700 poaching scenario. The values in parentheses next to the –lnL values are the associated σ values for the fit to those data. The comparative 2019 assessment results are also provided (shaded column).

	2019	**2020**
-lnL total (T=D+R)	105.533	141.992
-lnL from data (D)	103.868	140.260
R penalties (R)	1.665	1.703
Trap CPUE –lnL (σ)	-	-
Hoop CPUE –lnL (σ)	-17.066 (0.332)	6.204 (0.736)
FIMS CPUE –lnL (σ)	14.896 (1.101)	11.036 (1.002)
R_2004	0.046	0.051
R_2007	0.048	0.056
R_2010	0.069	0.055
$\bar{x}$	0.055	0.054
B75m(2006) (B75m(2006)/K)	1913 (0.007)	1750 (0.007)
B75m(2018) (B75m(2018)/K)	2803 (0.011)	2575 (0.010)
B75m(2019) (B75m(2019)/K)	-	2820 (0.011)
Median B75m(2025)/B75m(2006) CC=1084 MT	1.893	2.008
Median B75m(2025)/B75m(2006) CC=837 MT	-	2.054
Median B75m(2025)/B75m(2006) CC=549 MT	-	2.114
Median B75m(2025)/B75m(2006) CC=0	2.126	2.225
	nn.for 56v2.res	nn.for a5620.res

Table 1d: **A34** results for the LS=700 poaching scenario. The values in parentheses next to the –lnL values are the associated σ values for the fit to those data. The comparative 2019 assessment results are also provided (shaded column).

	2019	**2020**
-lnL total (T=D+R)	140.556	149.145
-lnL from data (D)	137.376	147.472
R penalties (R)	3.180	1.672
Trap CPUE –lnL (σ)	-5.533 (0.490)	-4.560 (0.512)
Hoop CPUE –lnL (σ)	-4.181 (0.534)	-6.175 (0.506)
FIMS CPUE –lnL (σ)	22.699 (1.504)	23.604 (1.504)
R_2004	0.077	0.069
R_2007	0.086	0.072
R_2010	0.111	0.123
$\bar{x}$	0.073	0.085
B75m(2006) (B75m(2006)/K)	4711 (0.026)	3593 (0.020)
B75m(2018) (B75m(2018)/K)	3564 (0.018)	2410 (0.024)
B75m(2019) (B75m(2019)/K)	-	2598 (0.034)
Median B75m(2025)/B75m(2006) CC=1084 MT	0.805	0.934
Median B75m(2025)/B75m(2006) CC=837 MT	-	0.965
Median B75m(2025)/B75m(2006) CC=549 MT	-	1.011
Median B75m(2025)/B75m(2006) CC=0	0.947	1.090
	nn.for 34v2.res	nn.for a3420.res

Table 1e: **A12** results. The values in parentheses next to the –lnL values are the associated σ values for the fit to those data. Note that the assumption made is that poaching in A12 is zero for all poaching scenarios. The comparative 2019 assessment results are also provided (shaded column).

	2019	**2020**
-lnL total (T=D+R)	-35.117	-30.891
-lnL from data (D)	-37.806	-32.361
R penalties (R)	2.689	1.470
Trap CPUE –lnL (σ)	-	-
Hoop CPUE –lnL (σ)	-48.983 (0.194)	-41.883 (0.218)
FIMS CPUE –lnL (σ)	-	-
R_2004	0.005	0.009
R_2007	0.011	0.023
R_2010	0.020	0.054
$\bar{x}$	0.014	0.035
B75m(2006) (B75m(2006)/K)	598 (0.006)	1206 (0.018)
B75m(2018) (B75m(2018)/K)	737 (0.008)	1510 (0.023)
B75m(2019) (B75m(2019)/K)		1576 (0.024)
Median B75m(2025)/B75m(2006) CC=1084 MT	1.377	1.372
Median B75m(2025)/B75m(2006) CC=549 MT	-	1.392
Median B75m(2025)/B75m(2006) CC=549 MT	-	1.415
Median B75m(2025)/B75m(2006) CC=0	1.608	1.459
	N12.for 12v1.res	N12.for A1220.res

Table 2a: Comparison of recent total biomass estimates between the 2019 and 2020 assessments.

	2019	2020
B75m(2018)	15 029t	13 664t
B75m(2018/2006)	0.694	0.607
B75m(2019)	-	15 427
B75m(2019/2006)	-	0.685

Table 2b: Comparison of super-area and total 2018 biomass estimates (MT) between the 2019 and 2020 assessments.

	2019 assessment	2020 assessment
A8+ B75m(2018)	4822	4253
A7 B75m(2018)	3101	2991
A56 B75m(2018)	2803	2575
A34 B75m(2018)	3324	2410
A12 B75m(2018)	737	1510
TOTAL B75m(2018)	14 789	13 664
A8+ B75m(2018/2006)	0.520	0.450
A7 B75m(2018/2006)	0.604	0.460
A56 B75m(2018/2006)	1.465	1.471
A34 B75m(2018/2006)	0.756	0.671
A12 B75m(2018/2006)	1.232	1.252
TOTAL B75m(2018/2006)	0.694	0.607

Table 3a: Comparative deterministic projection results for the 2019 and 2020 assessments showing the **total** recovery of B75m by 2025 relative to 2006 (A8+ is based upon LS 700 poaching scenario).

	2019 assessment	2020 assessment
Total future CC (MT)	B75m(2025/2006)	B75m(2025/2006)
0	1.277	1.062
549	1.145	0.955
837	1.076	0.898
1084	1.016	0.851

Table 3b: Comparative deterministic projection results between the 2019 and 2020 assessments for a total future **CC=837t** (the TAC selected by DEFF for the 2020 season), showing the recovery of B75m by 2025 relative to 2006 (A8+ is based upon LS 700 poaching scenario).[Note for the 2019 assessment the "future" applies to 2019+, and for the 2020 assessment it applies to 2020+].

	2019 assessment	**2020 assessment**
Total future CC (MT)	B75m(2025/2006)	B75m(2025/2006)
A8+	1.007	0.743
A7	1.021	0.681
A56	1.974	2.054
A34	0.869	0.965
A12	1.364	1.392
Total	**1.076**	**0.898**

Table 3c: Comparative deterministic projection results for the updated 2020 assessments for a range of total future (2020+) CC values.

Total future CC (MT)	**Future total CC=0t**	**Future total CC=549t**	**Future total CC=837t**	**Future total CC=1084t**
A8+	1.002	0.832	0.743	0.668
A7	0.748	0.706	0.681	0.665
A56	2.225	2.114	2.054	2.008
A34	1.090	1.011	0.965	0.934
A12	1.459	1.415	1.392	1.372
Total	**1.062**	**0.955**	**0.898**	**0.851**

Figure 1a: R estimates (relative to that in 1910) for **A8+** for two different poaching scenarios (either LS=400t or LS=700t). Values are reported for the 2019 and updated 2020 assessments. The 2019 estimates are shown as dashed lines. Xbar refers to the average R/(R(2010) value about which the 1970-2010 recruitment estimates vary.

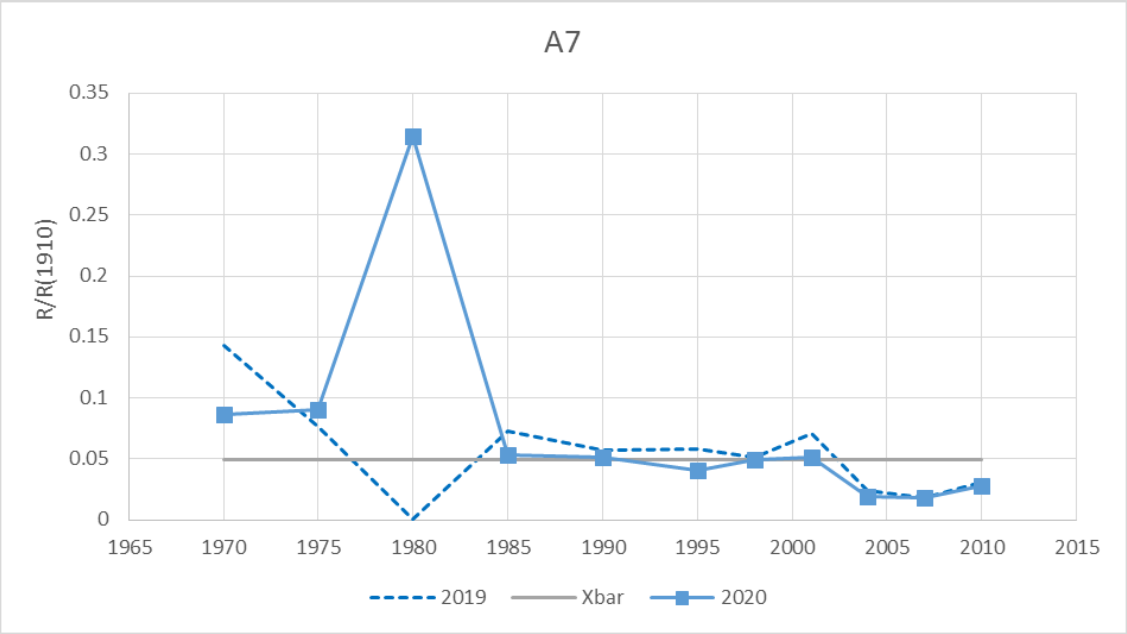


Figure 1b: R estimates (relative to that in 1910) for **A7** (assuming poaching LS=700t). Values are reported for the 2019 and updated 2020 assessments. The 2019 estimates are shown as dashed lines. Xbar refers to the average R/(R(2010) value about which the 1970-2010 recruitment estimates vary.

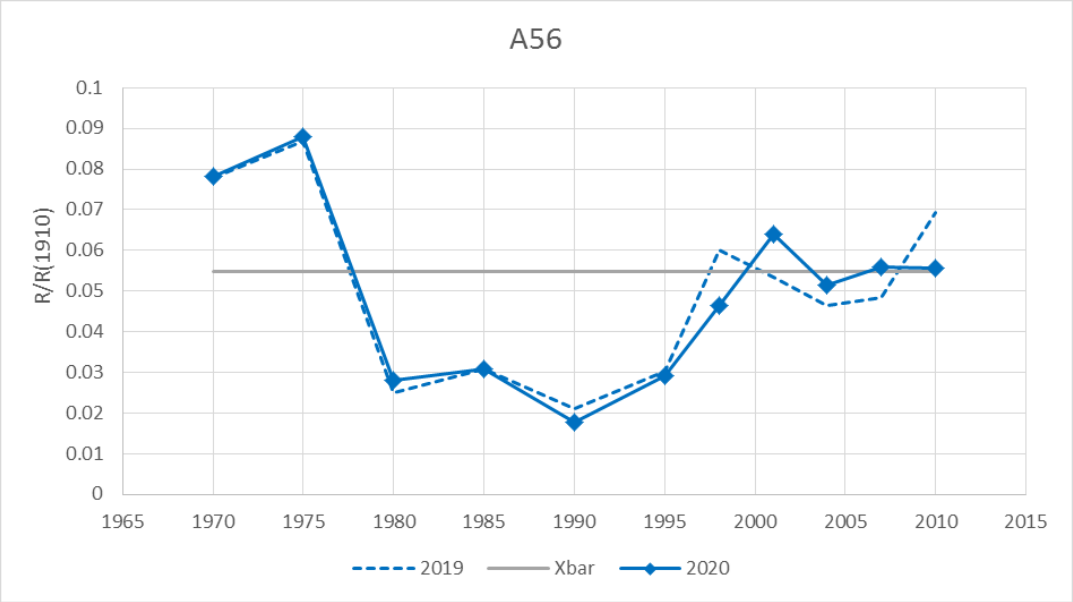


Figure 1c: R estimates (relative to that in 1910) for **A56** (assuming poaching LS=700t). Values are reported for the 2019 and updated 2020 assessments. The 2019 estimates are shown as dashed lines. Xbar refers to the average R/(R(2010) value about which the 1970-2010 recruitment estimates vary.

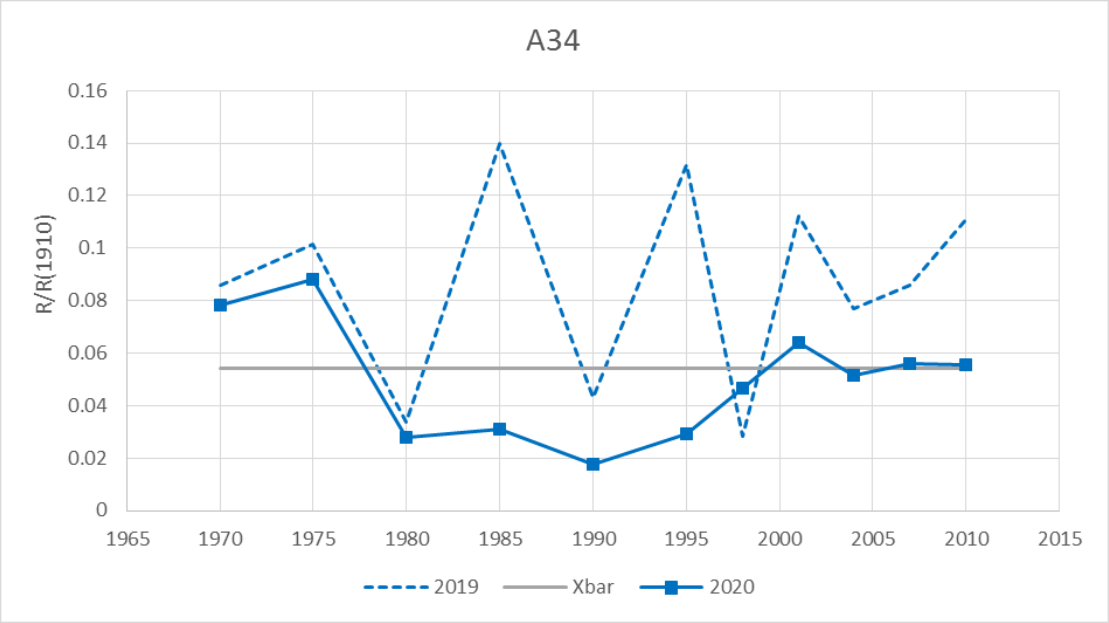


Figure 1d: R estimates (relative to that in 1910) for **A34** (assuming poaching LS=700t). Values are reported for the 2019 and updated 2020 assessments. The 2019 estimates are shown as dashed lines. Xbar refers to the average R/(R(2010) value about which the 1970-2010 recruitment estimates vary.

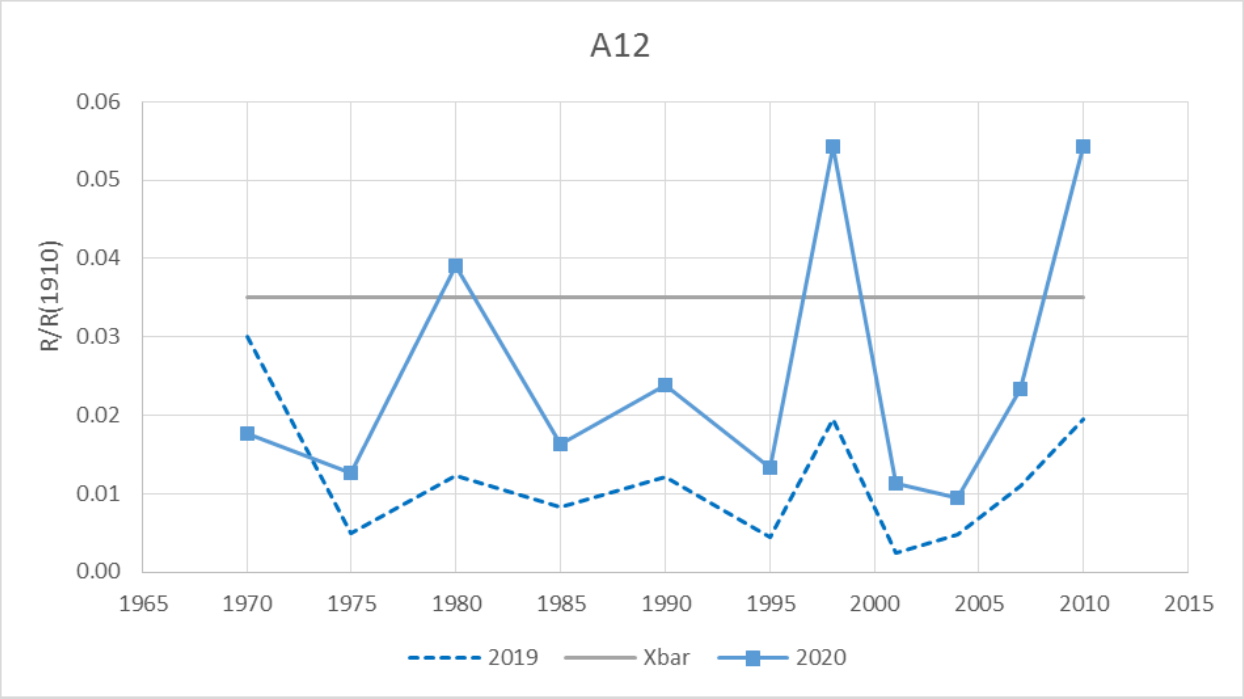


Figure 1e: R estimates (relative to that in 1910) for **A12** (no poaching is assumed to occur in A12). Values are reported for the 2019 and updated 2020 assessments. The 2019 estimates are shown as dashed lines. Xbar refers to the average R/(R(2010) value about which the 1970-2010 recruitment estimates vary.

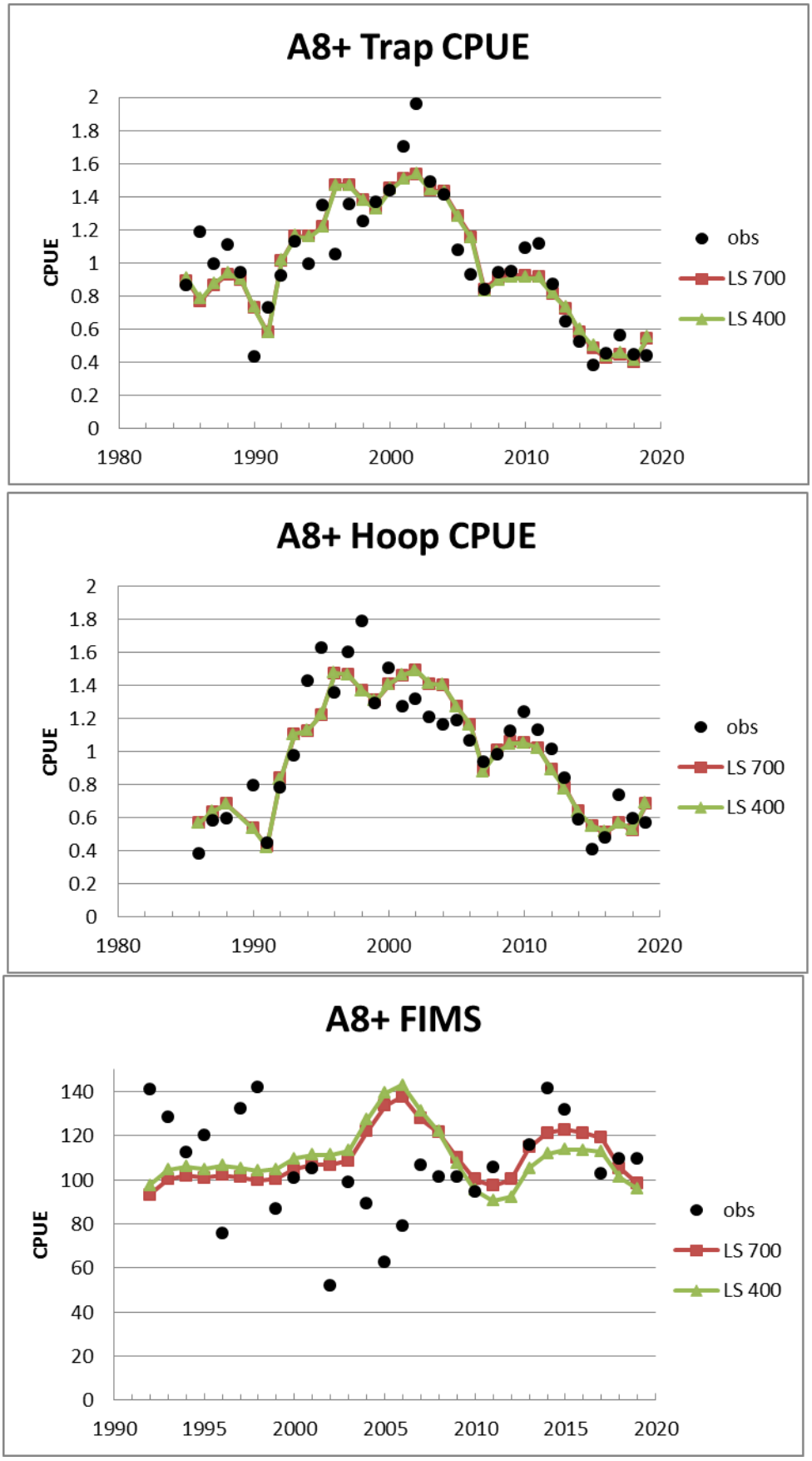


Figure 2a: Comparison of fits to **A8+** CPUE and FIMS for the different 2020 assessments.

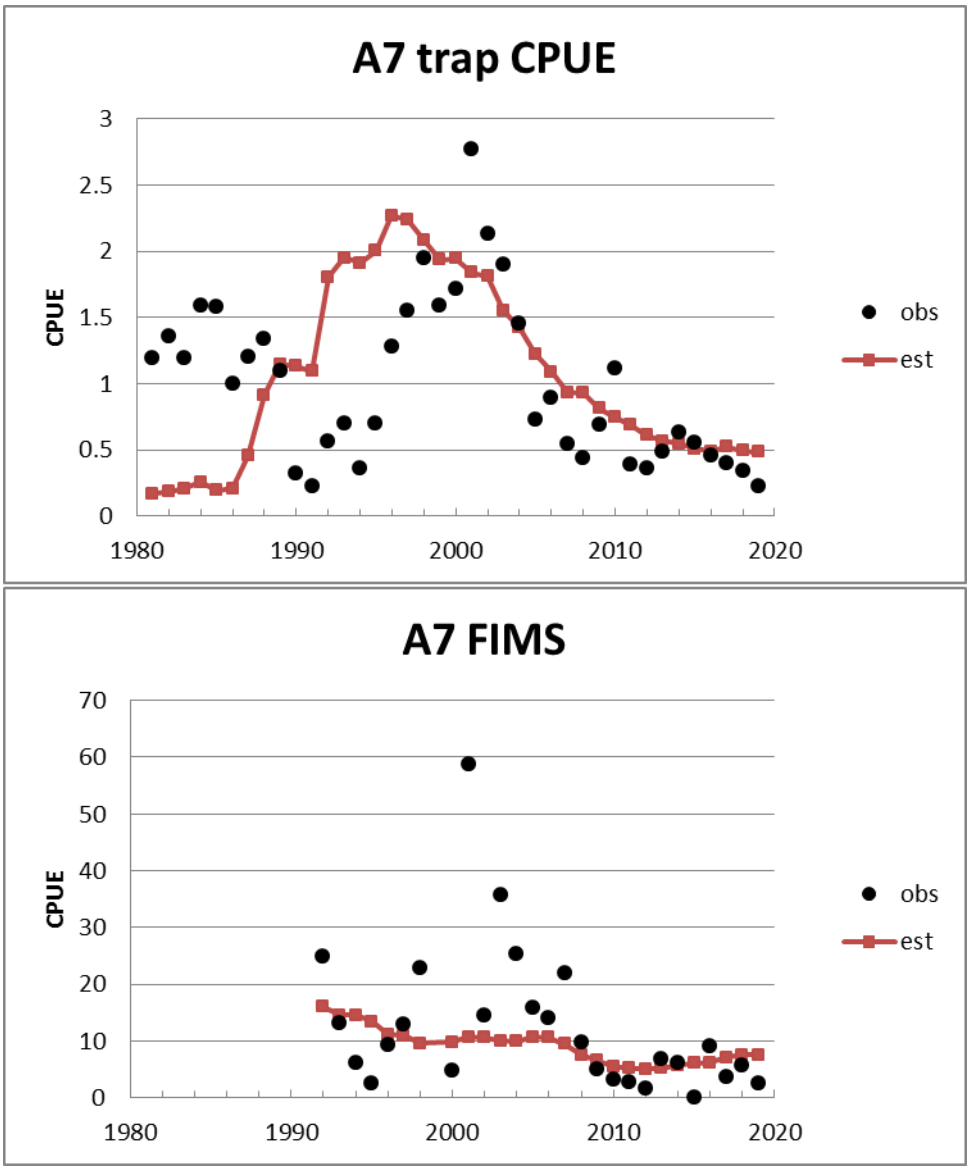


Figure 2b: Comparison of fits to **A7** CPUE and FIMS for the 2020 assessment.

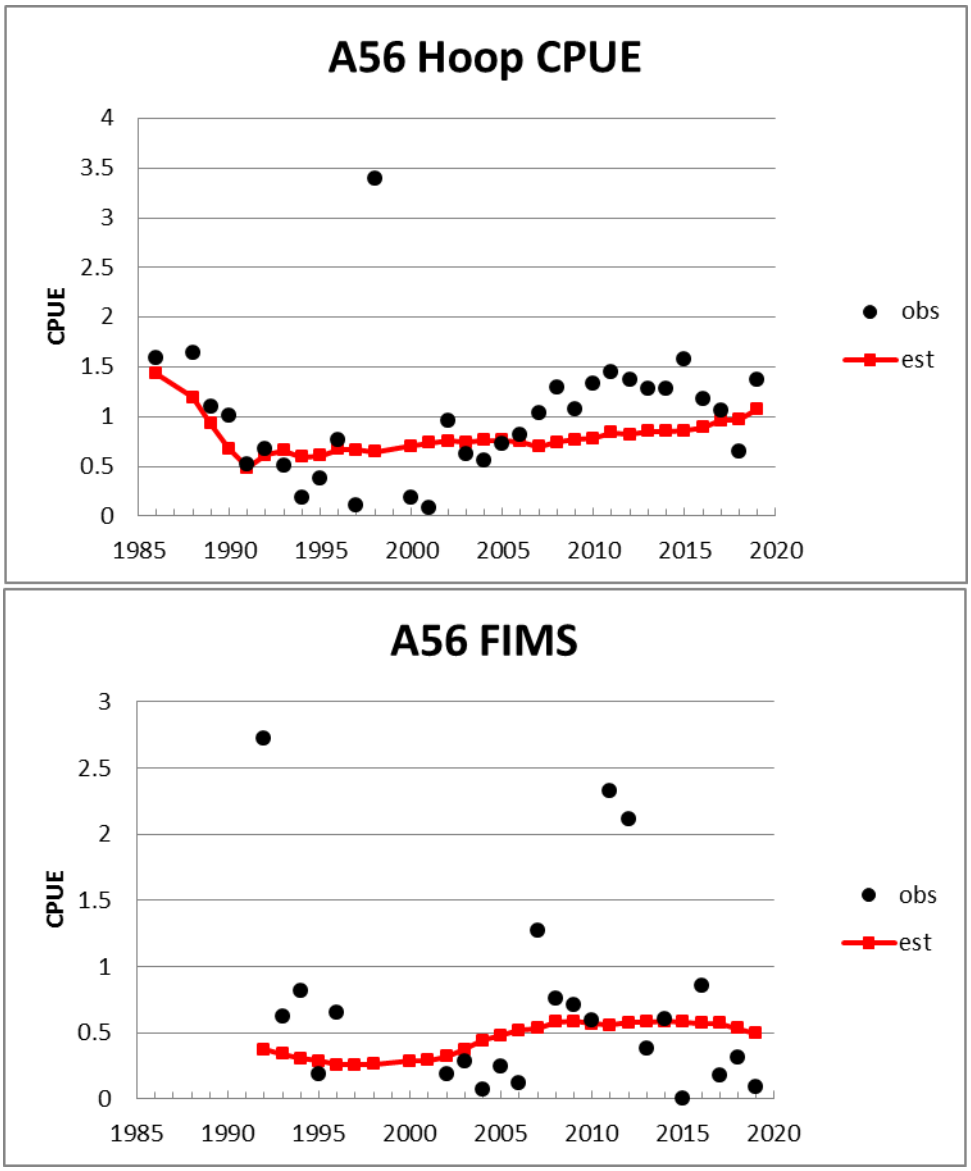


Figure 2c: Comparison of fits to **A56** CPUE and FIMS for the 2020 assessment.

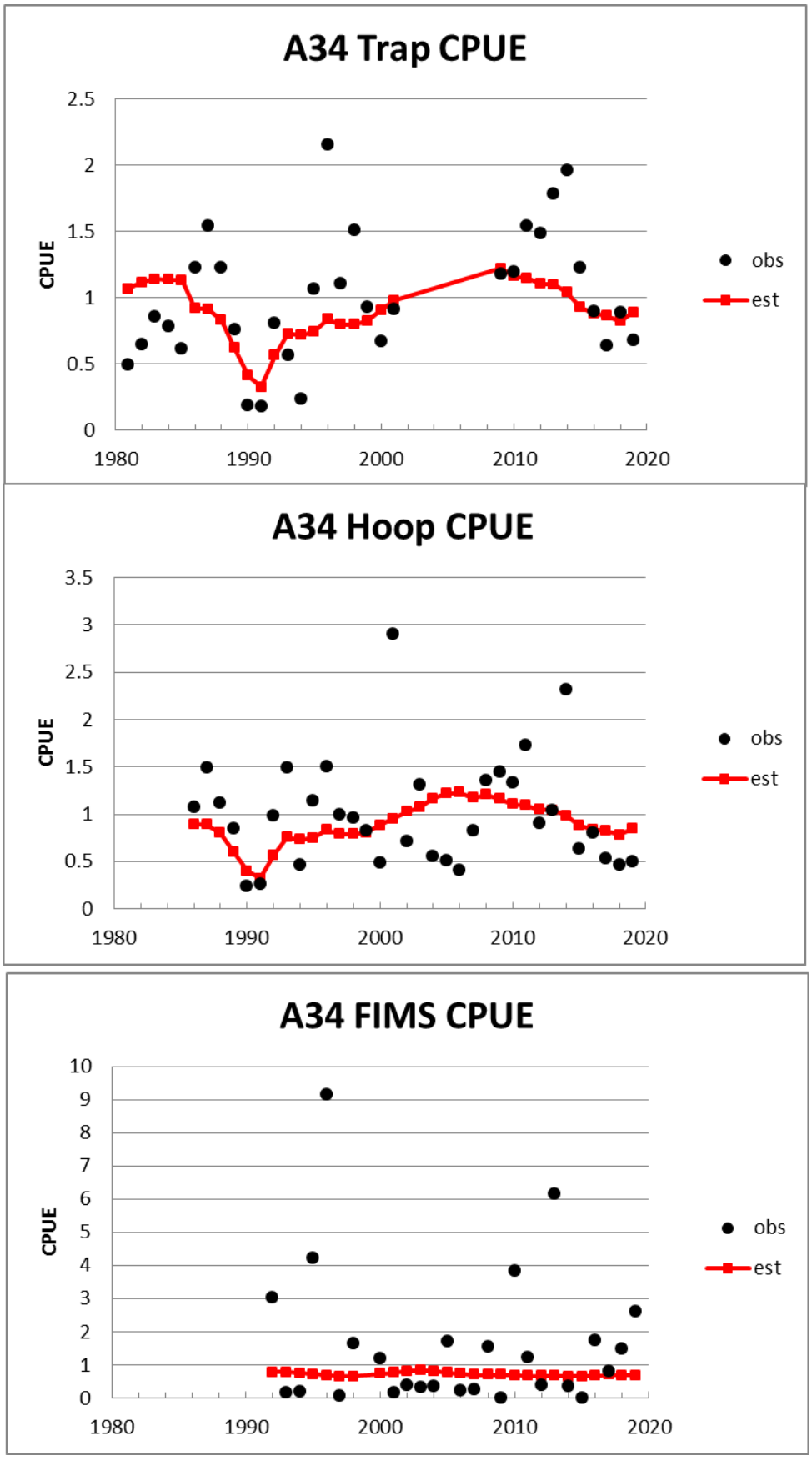


Figure 2d: Comparison of fits to **A34** CPUE and FIMS for the 2020 assessment.

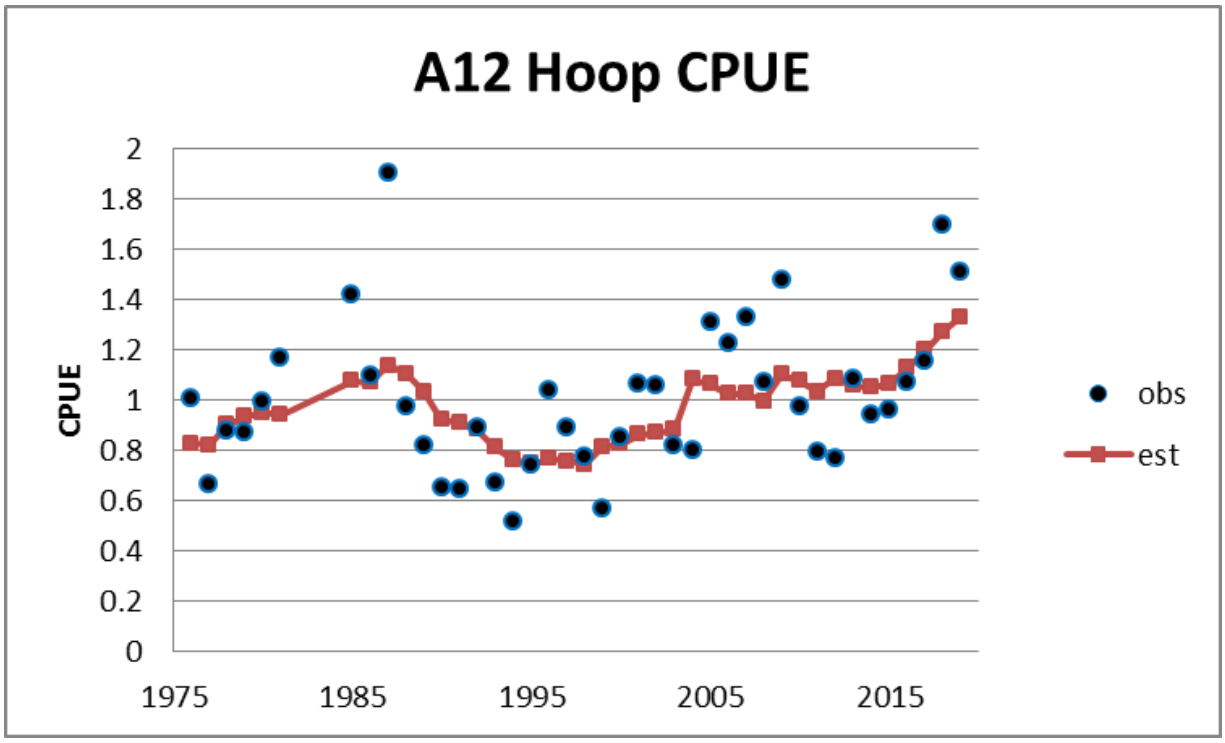


Figure 2e: Comparison of fits to **A12** CPUE for the 2020 assessment.

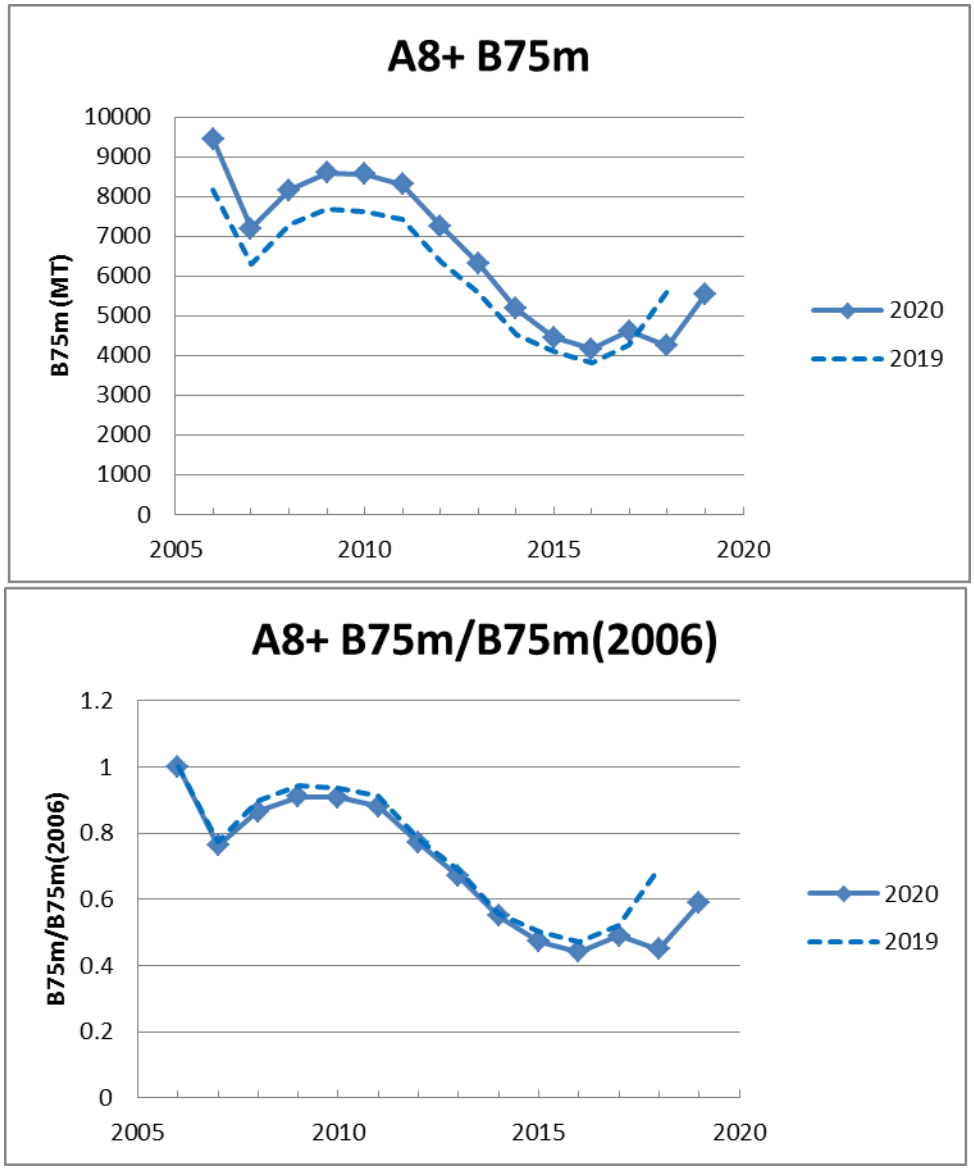


Figure 3a: Comparison between the 2020 assessment **A8+** B75m trajectories (for the LS=700t poaching scenario). The 2019 estimated trends are shown as dashed lines. The top plot shows absolute values with the bottom plot showing biomass relative to the 2006 levels.

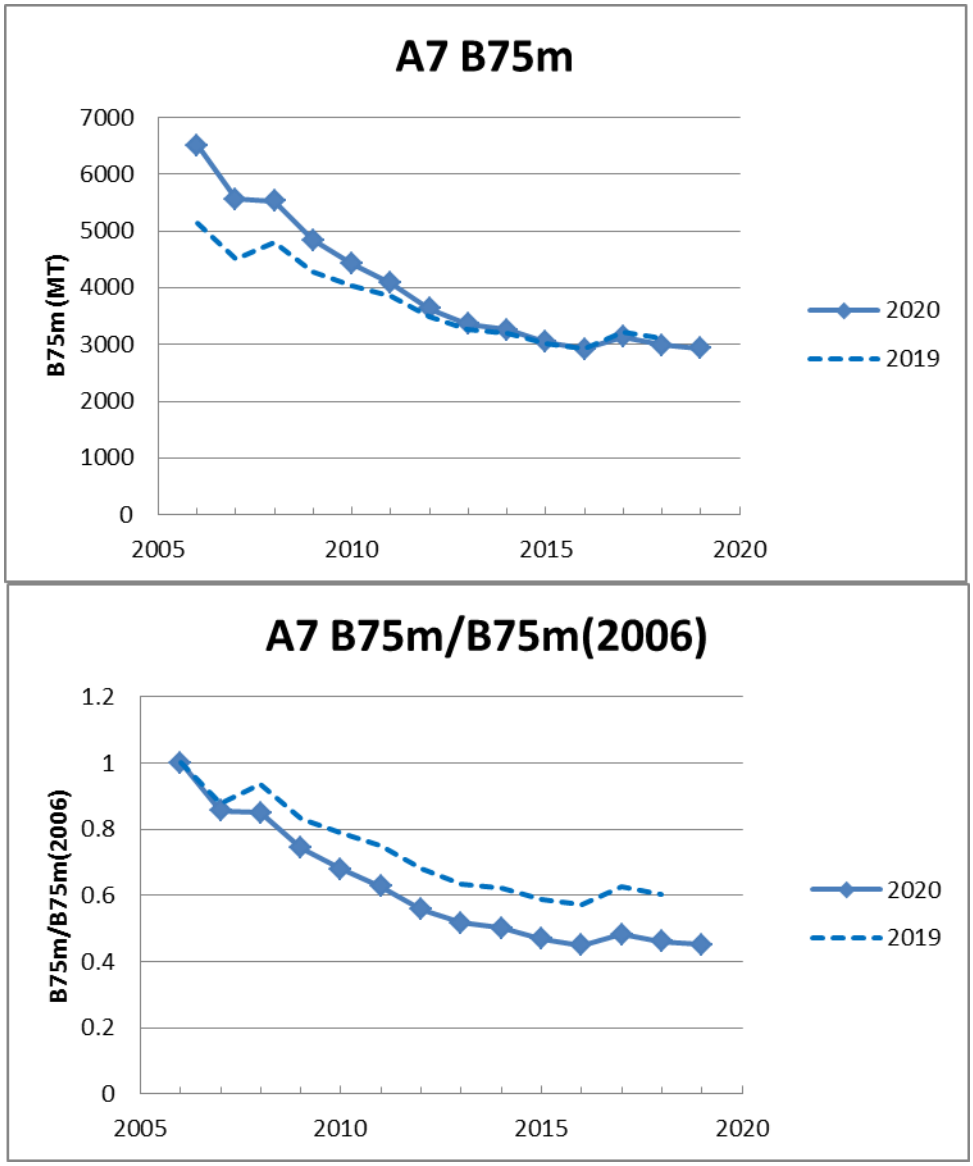


Figure 3b: The 2020 assessment **A7** B75m trajectory The 2019 estimated trend is shown as a dashed line. The top plot shows absolute values with the bottom plot showing biomass relative to the 2006 levels.

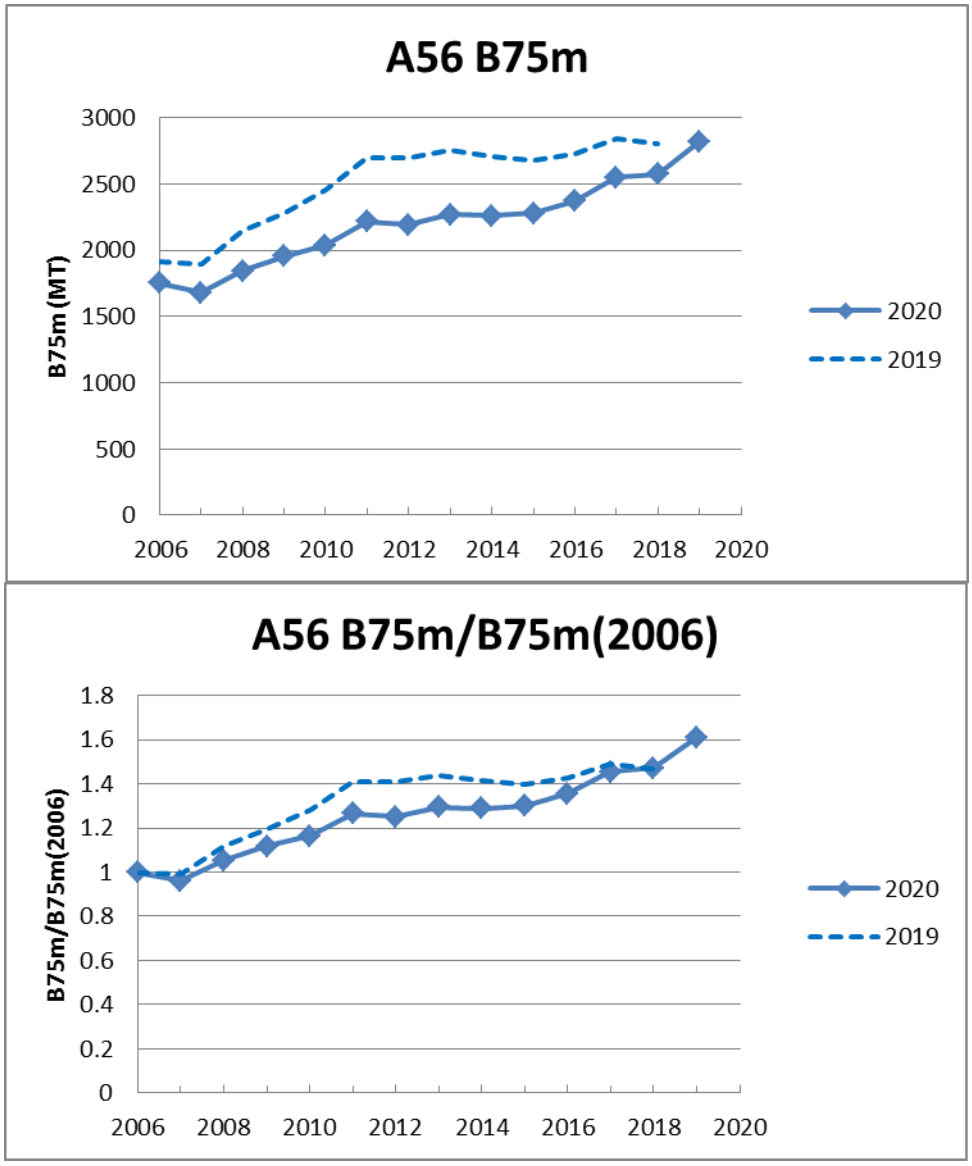


Figure 3c: The 2020 assessment **A56** B75m trajectory. The 2019 estimated trend is shown as a dashed line. The top plot shows absolute values with the bottom plot showing biomass relative to the 2006 levels.

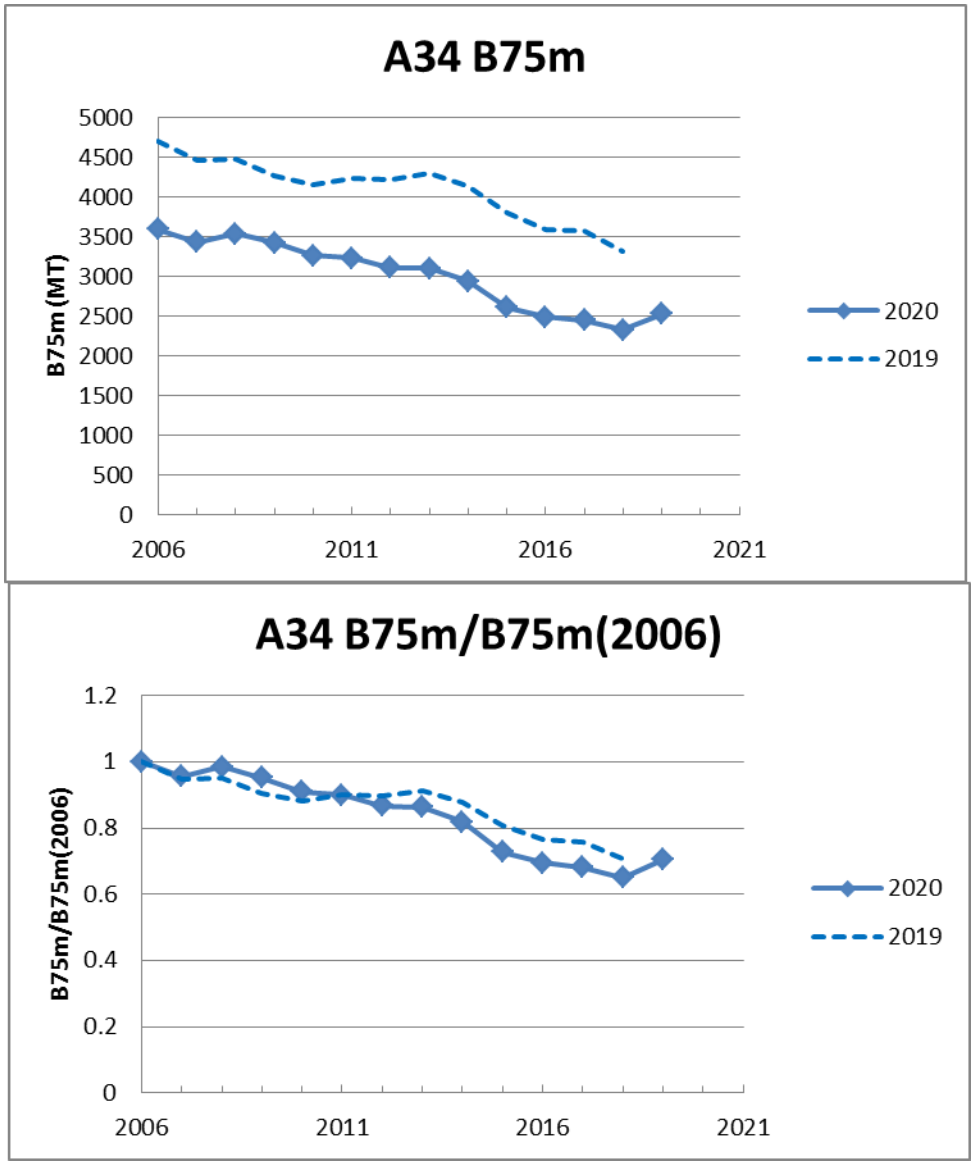


Figure 3d: The 2020 assessment **A34** B75m trajectory. The 2019 estimated trend is shown as a dashed line. The top plot shows absolute values with the bottom plot showing biomass relative to the 2006 levels.

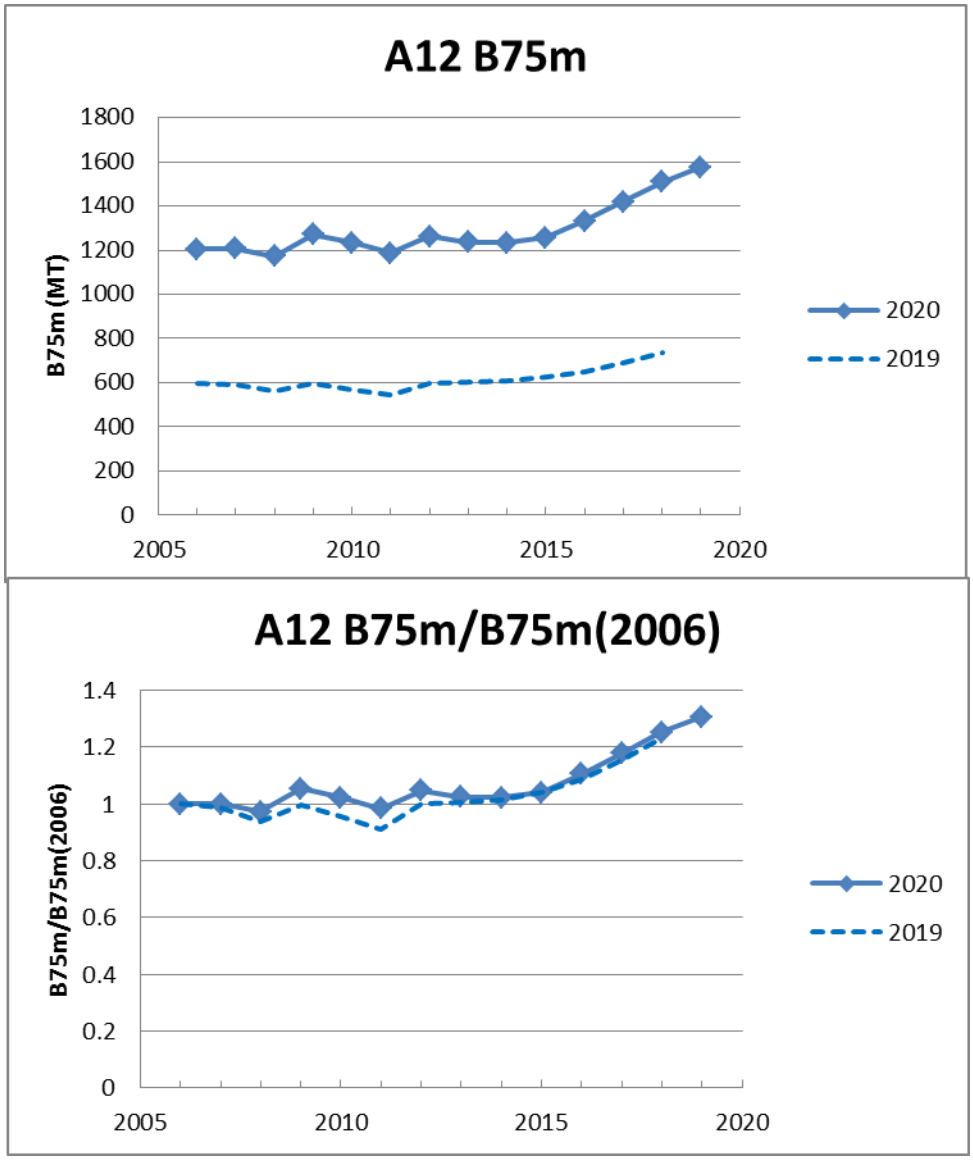


Figure 3e: The 2020 assessment **A12** B75m trajectory. The 2019 estimated trend is shown as a dashed line. The top plot shows absolute values with the bottom plot showing biomass relative to the 2006 levels.

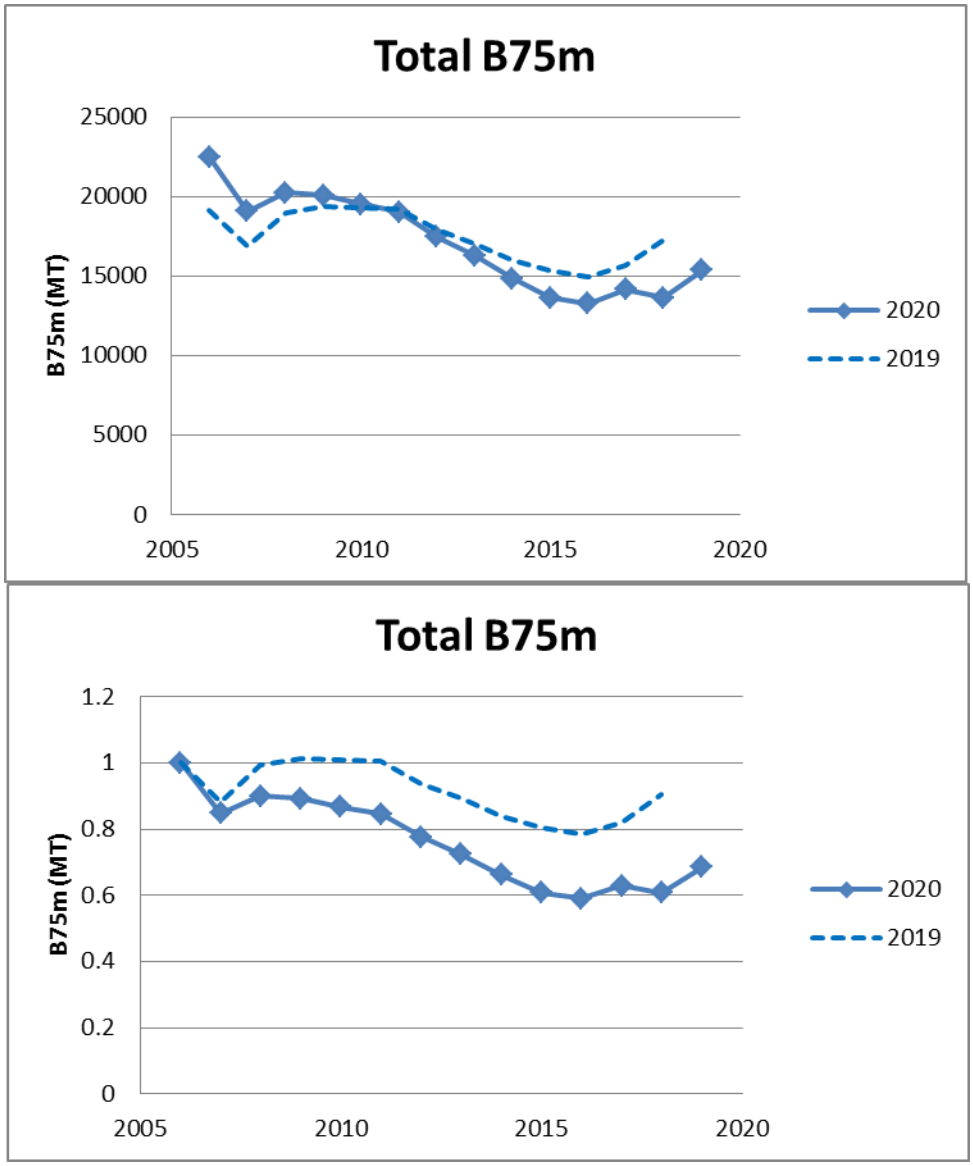
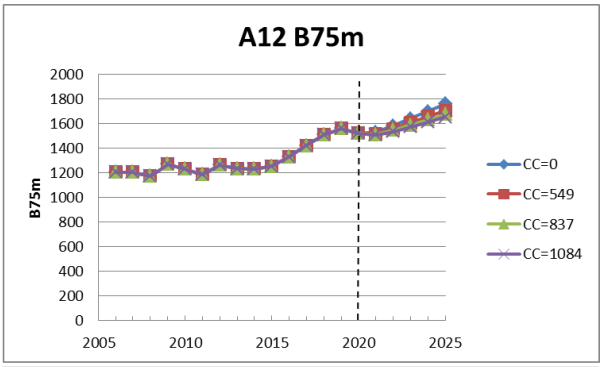
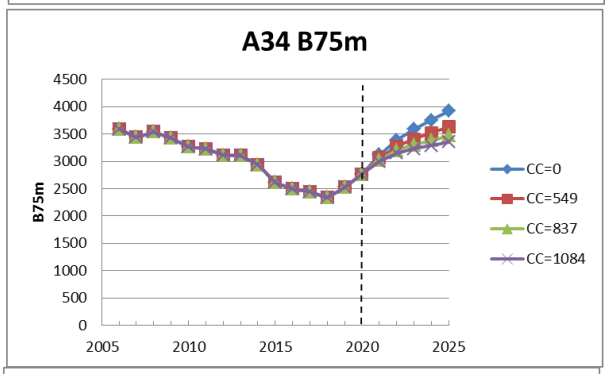
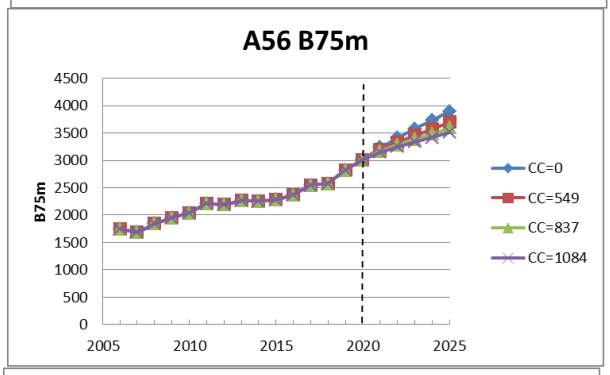
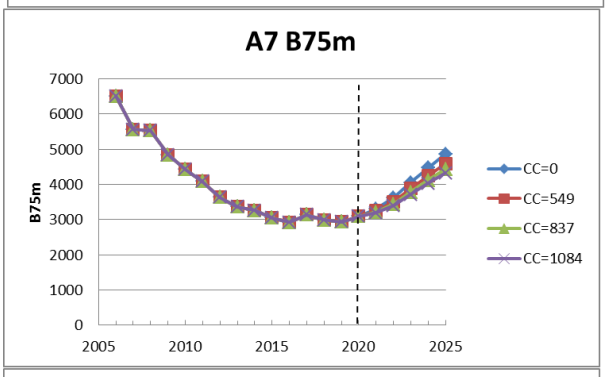


Figure 4: Comparison of the **total** estimated resource biomass in absolute terms (top plot) and relative to 2006 (bottom plot) for the 2020 and 2019 assessments (where the poaching scenario assumed for all areas is LS=700).









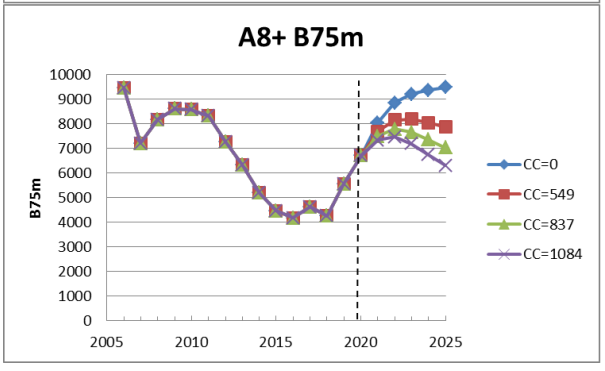


Figure 5a: Plots of projected B75m for each super-area for a range of future (2020+ CC) values.

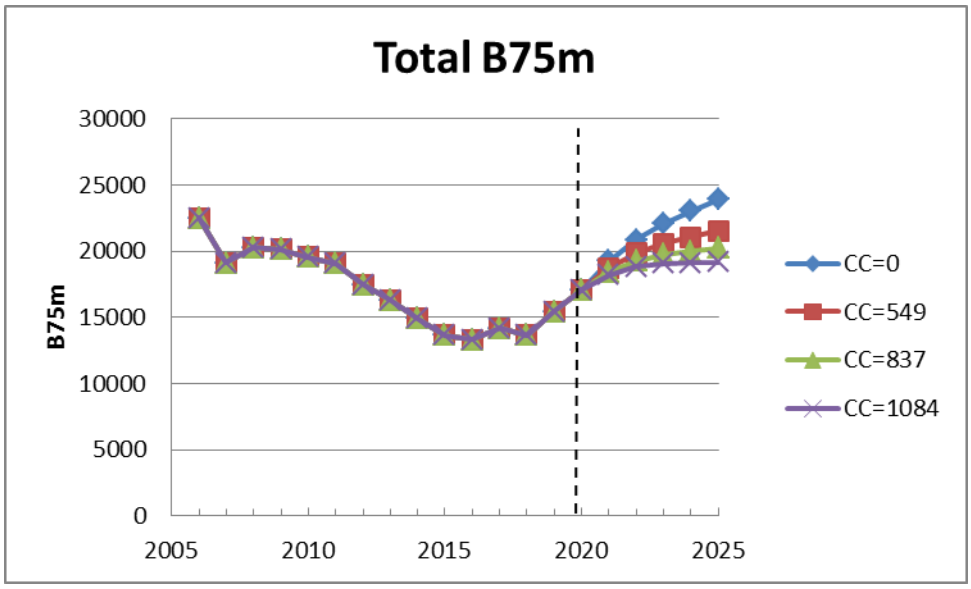


Figure 5b: Plots from 2006 of projected B75m (2020 assessment) for the resource as a whole for a range of future (2020+ CC) values.

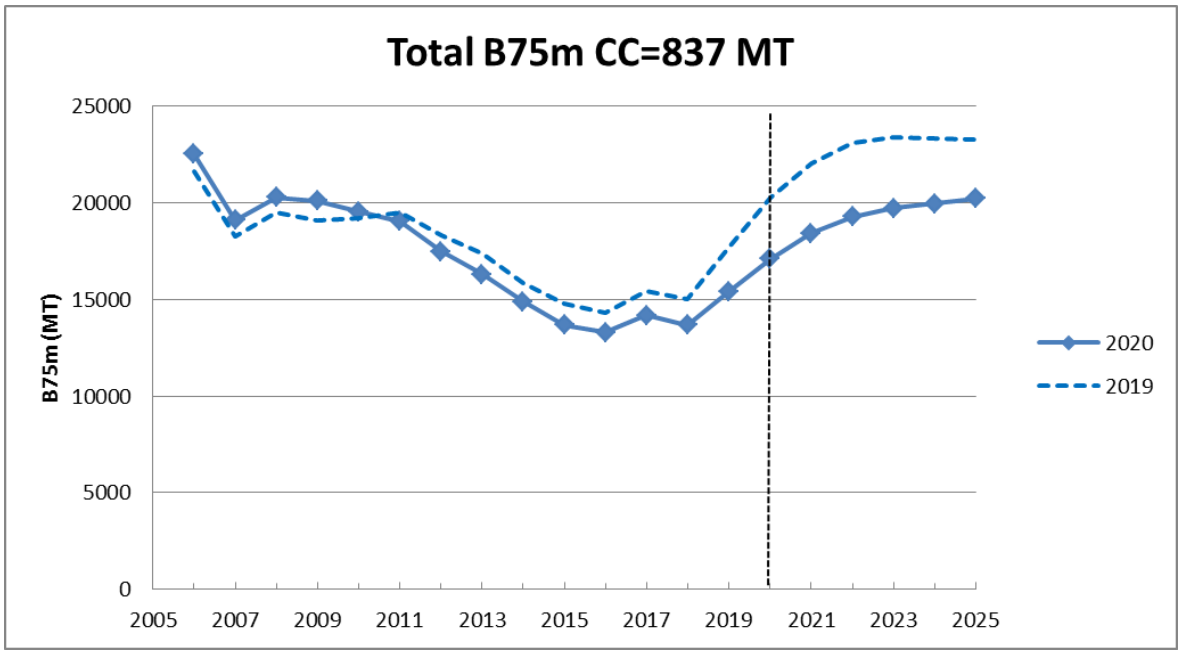


Figure 5c: Comparative plot from 2006 of projected B75m between the 2019 and 2020 assessment for the resource as a whole for a CC=837t.

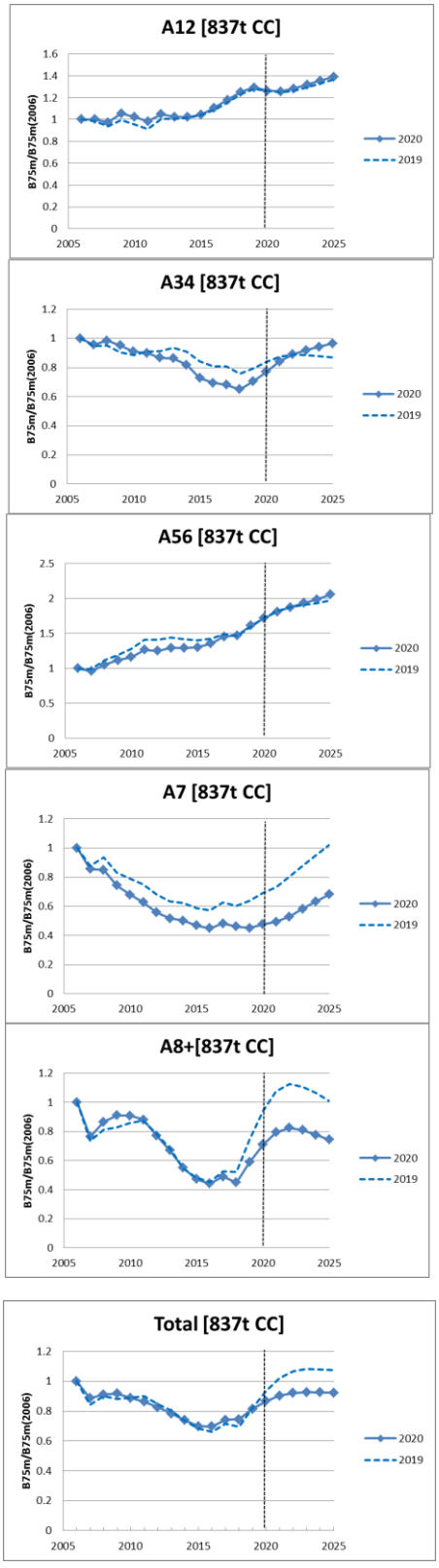


Figure 5d: B75m relative to 2006 values between the 2019 and 2020 assessments for a future total CC of 837 MT.