Aleutian Islands Golden King Crab Model Discussions and Scenarios for May 2018 Assessment

Draft report for the September 2017 CPT Meeting

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Aleutian Islands GKC Stock Status: "Overfishing" did not occur in 2016/17.
Total removal 6.236 mlb < OFL 12.53 mlb

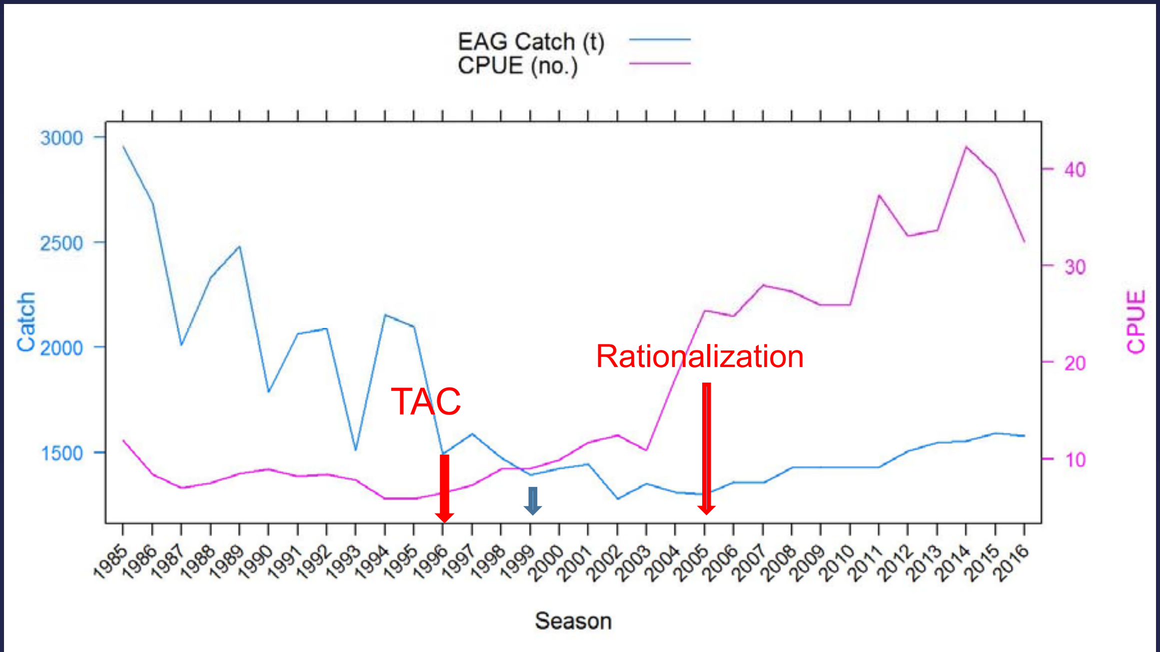
Status and catch specifications (million lb)

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch[a]	OFL	ABC[b]
2013/14	N/A	N/A	6.290	6.38	7.04	12.54	11.28
2014/15	N/A	N/A	6.290	6.11	6.79	12.53	9.40
2015/16	N/A	N/A	6.290	6.016	6.775	12.53	9.40
2016/17	N/A	N/A	5.545	5.716	6.236	12.53	9.40
2017/18	13.325	31.315				13.333	10.000

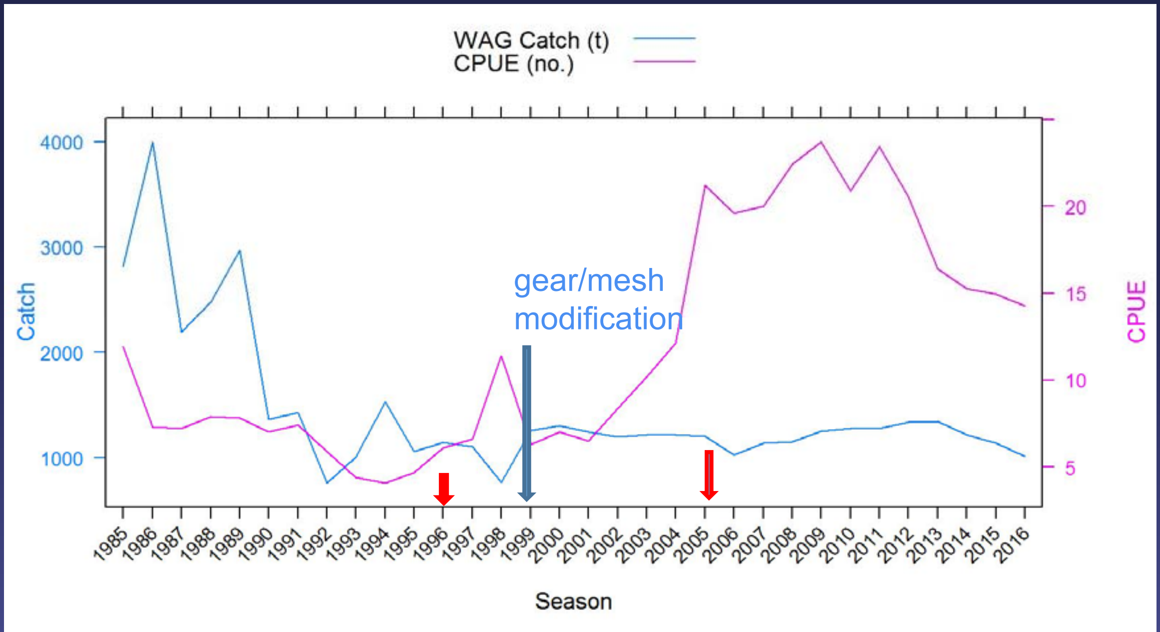
a. Total retained catch plus estimated bycatch mortality of discarded bycatch during crab fisheries and groundfish fisheries.
b. 25% buffer was applied to total catch OFL to determine ABC.

Catch (t) and CPUE (number of crab per pot lift) in 1985/86–2016/17

EAG

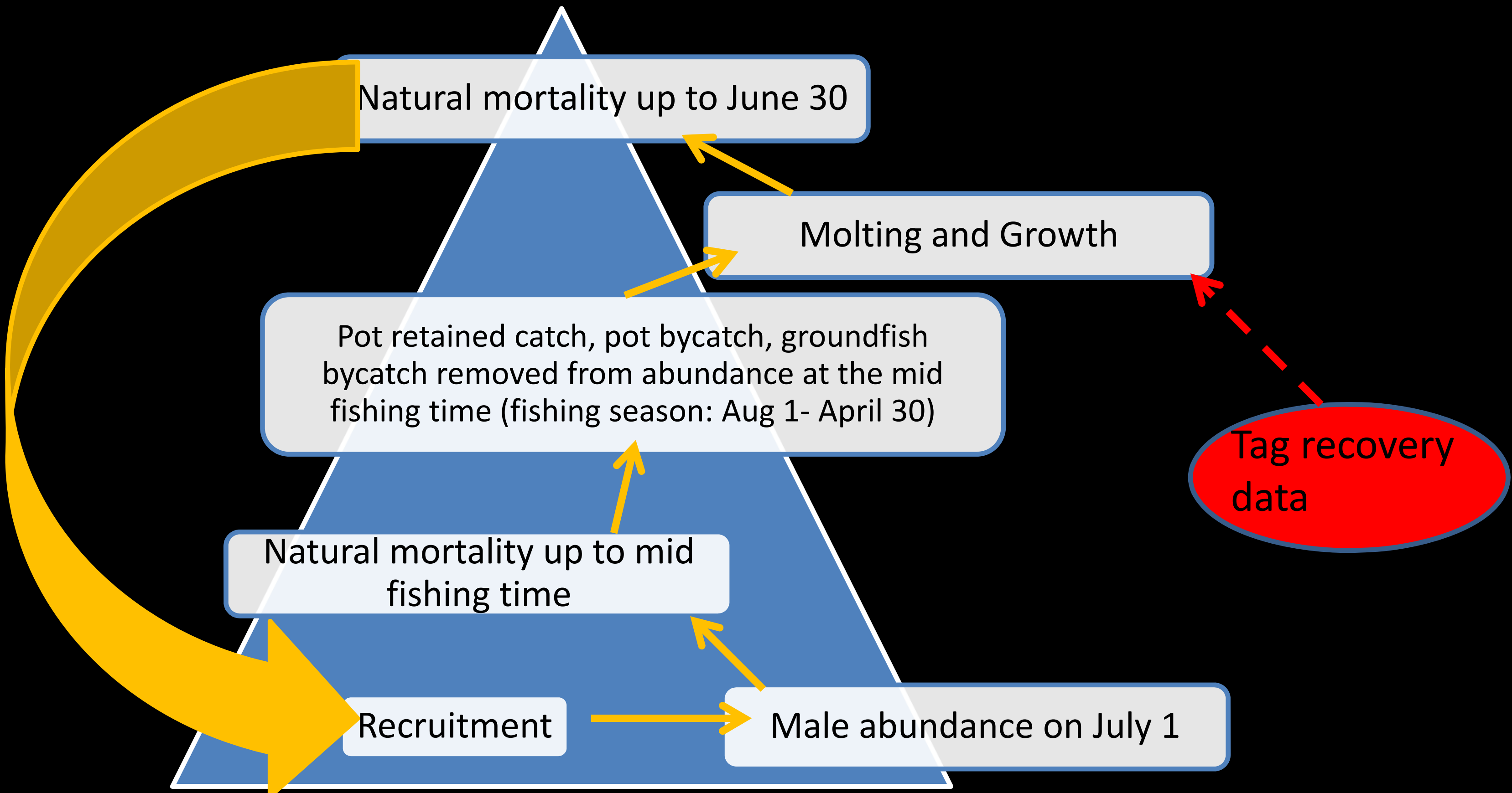


WAG



Topics

- Responses to May 2017 CPT and June 2017 SSC comments
- Scenario results
- Tier 3 OFL and ABC (preliminary)


Natural mortality up to June 30
Molting and Growth
Pot retained catch, pot bycatch, groundfish bycatch removed from abundance at the mid fishing time (fishing season: Aug 1- April 30)
Tag recovery data
Natural mortality up to mid fishing time
Recruitment
Male abundance on July 1

Length based modeling approach

- An integrated length based model. This is the only FMP crab stock modelled with fishery dependent catch and CPUE data without survey information.
- *M* estimated in the model.
- Projected the abundance from unfished equilibrium or from non-equilibrium in 1960 to initialize the 1985 abundance.
- Six pairs of scenarios (each pair consists of equilibrium and non-equilibrium initialization of the model) for EAG and WAG.
- Knife edge maturity used for MMB calculation outside the model parameter optimization in most scenarios.
- Francis re-weighting method is used for Stage-2 effective sample sizes calculation for most scenarios. One pair of scenarios used McAllister and Ianelli method for Stage-2 calculation.

May 2017 CPT (major) comments

- **Comment 1: Sensitivity analyses on values of *M* have been evaluated in the past for some stock assessments and could be included for the author’s selected model annually.**

Response:

M based on the combined EAG and WAG data. Figures 2 and 3 depict the likelihood profiles of M under equilibrium and non-equilibrium initial conditions without M penalty, respectively.

The overall total (black line), the total for EAG (dark green line), and the total for WAG (light green line) indicate that the data were informative for M calculation when all data were considered.

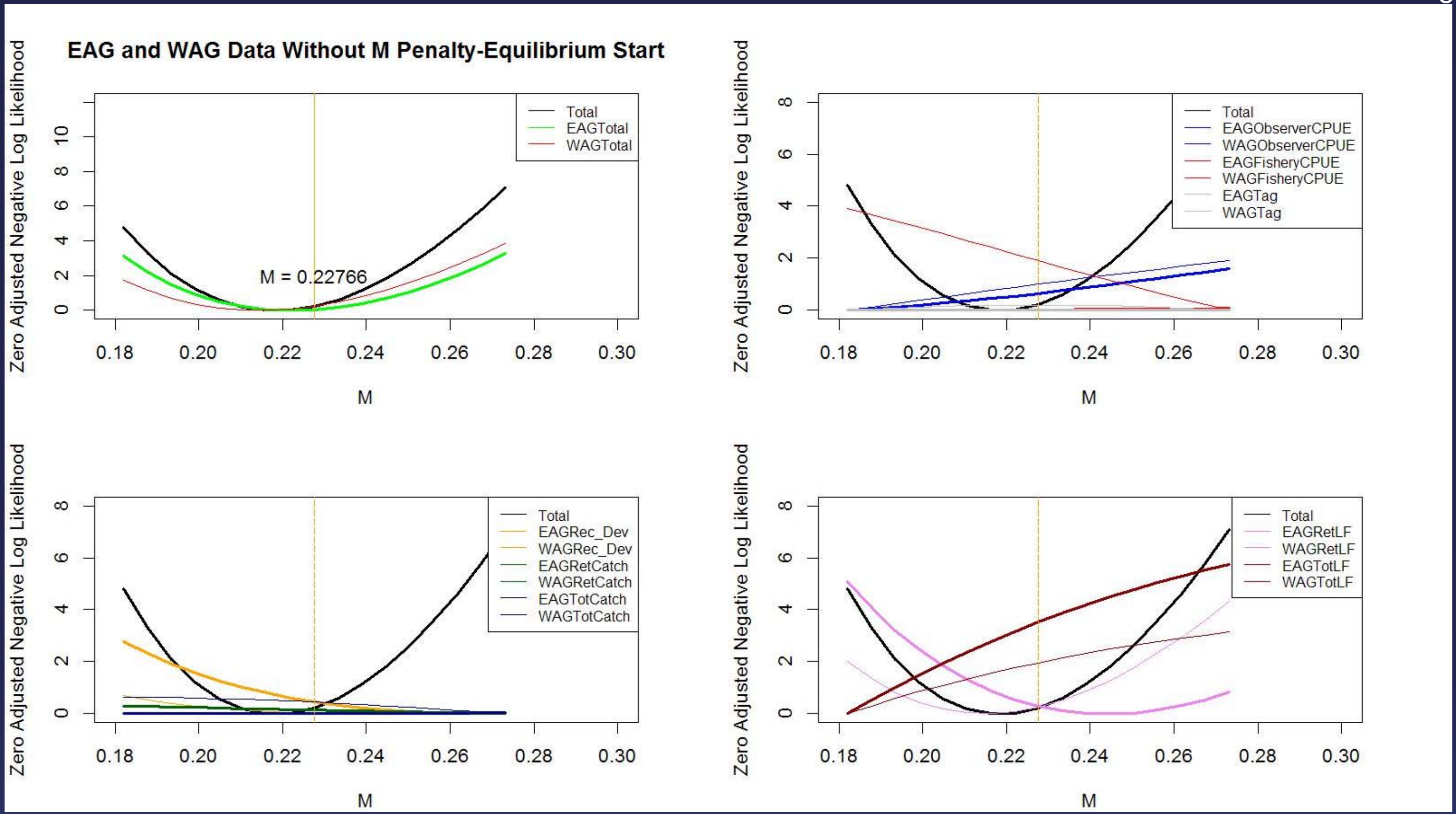


Figure 2. Total and components negative log-likelihoods vs. *M* for scenario 17Ab0D17 model fit without *M* penalty for EAG and WAG combined data. The initial abundance was determined by the equilibrium condition. The *M* estimate was 0.22766 yr^{-1} ($\pm$0.02033 yr^{-1}). The negative log likelihood values were zero adjusted.

Top left: Minimum for combined data was at *M*=0.216 yr^{-1}, that for EAG component was 0.222 yr^{-1}, and that for WAG component was 0.216 yr^{-1}.

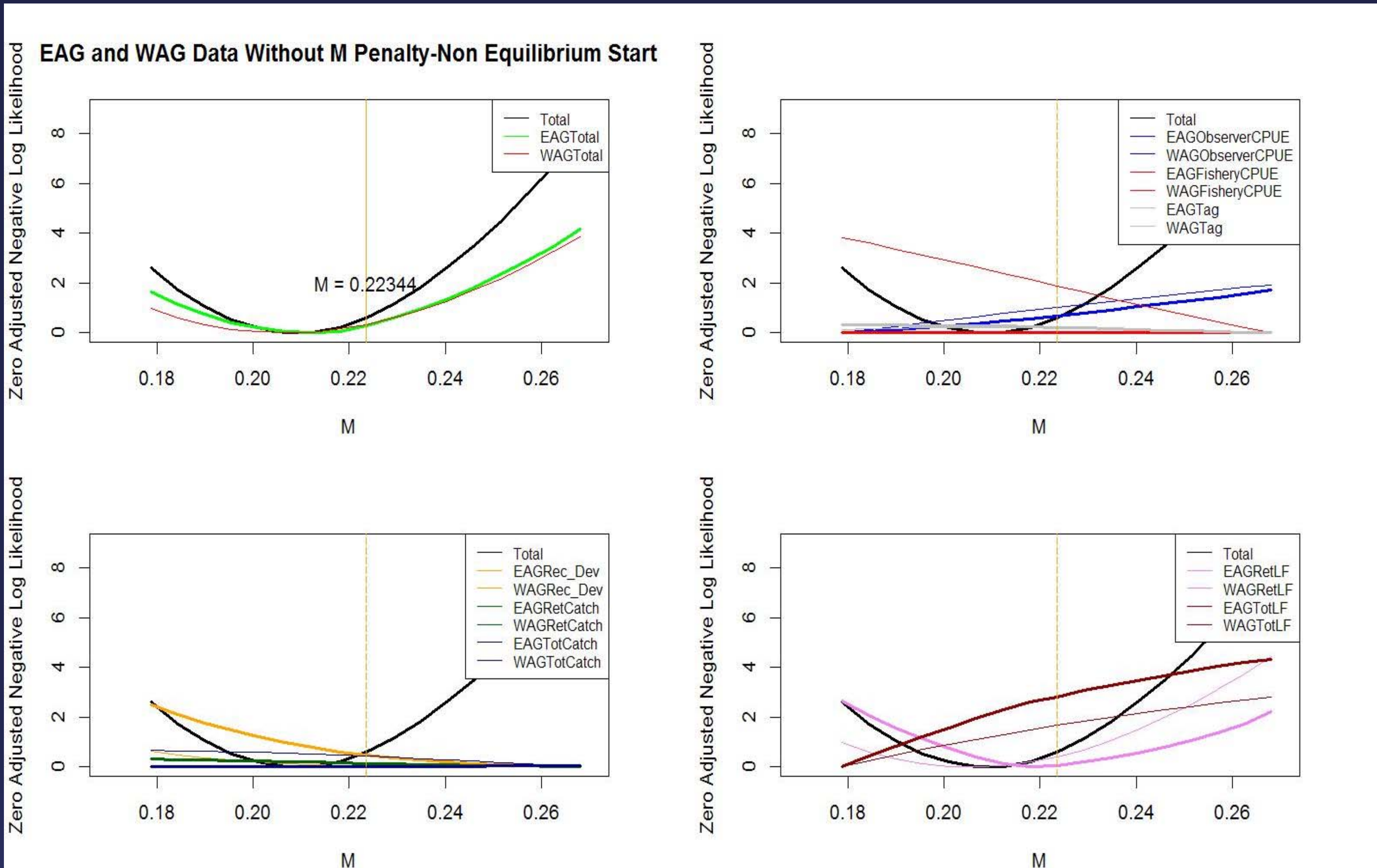


Figure 3. Total and components negative log-likelihoods vs. *M* for scenario 17Bb0D17 model fit without *M* penalty for EAG and WAG combined data. The initial abundance was determined by the non-equilibrium condition. The *M* estimate was 0.22344 yr^{-1} ($\pm$0.02268 yr^{-1}). The negative log likelihood values were zero adjusted.

Top left: Minimum for combined data was at M=0.212 yr^{-1}, that for EAG component was 0.212 yr^{-1}, and that for WAG component was 0.207 yr^{-1}.

May 2017 CPT (major) comments continued

- **Comment 2: The CPT noted that likelihood profile for current MMB was incorrect because the maturity function was estimated, which meant that different current MMB values equated to different specifications for maturity as a function of length.**

Response:

We pre-specified the maturity ogive (knife-edge or smooth curve) in all scenarios including the M estimator scenarios.

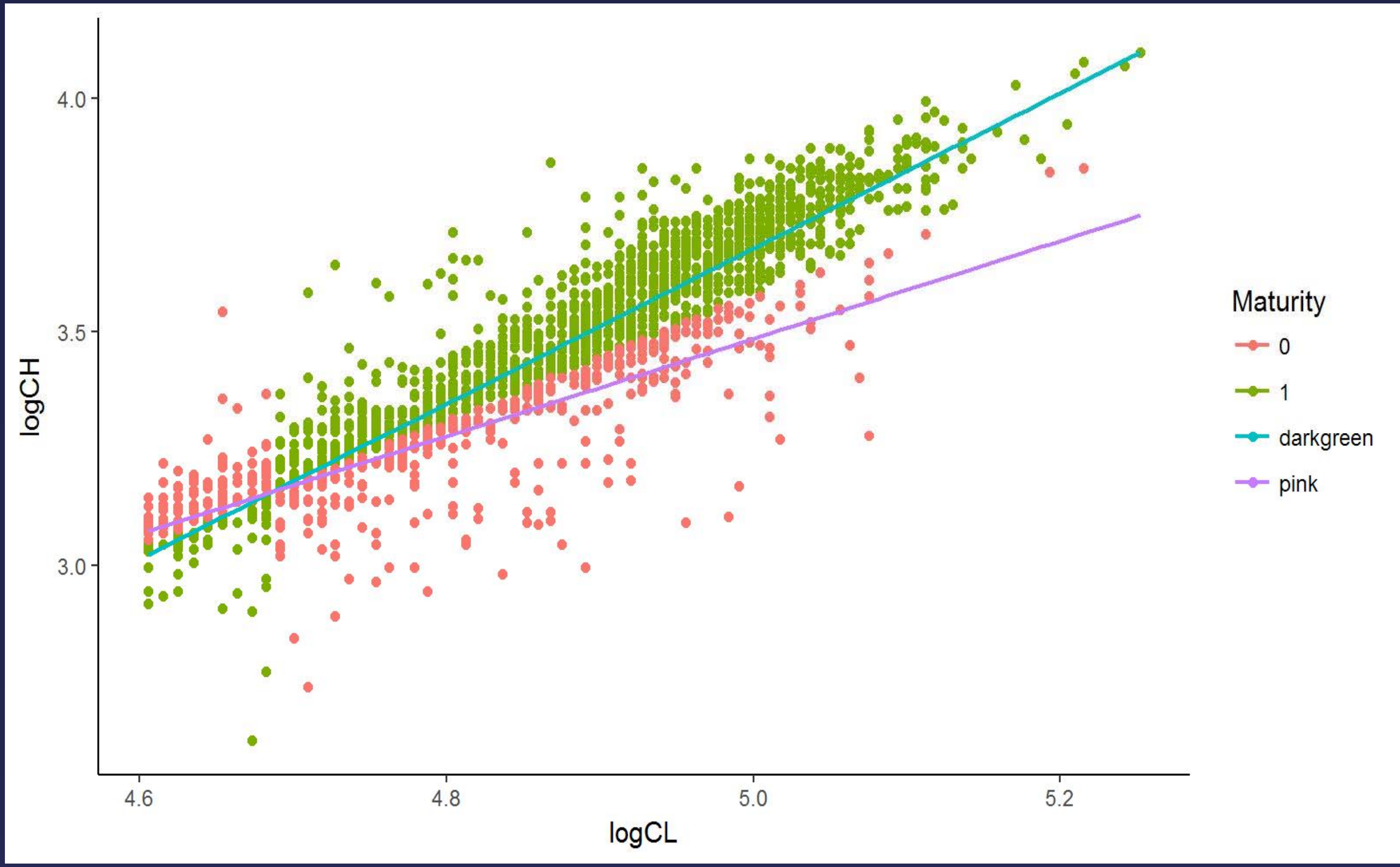


Figure 4. Segmented linear regression fit to ln(CH) vs. ln(CL) data of male golden king crab in EAG with classification of mature (code 1, dark green) and immature (code 0, red) data points. The 1991 ADF&G pot survey data.

The 50% maturity length at the bent point was 108.53 mm CL.

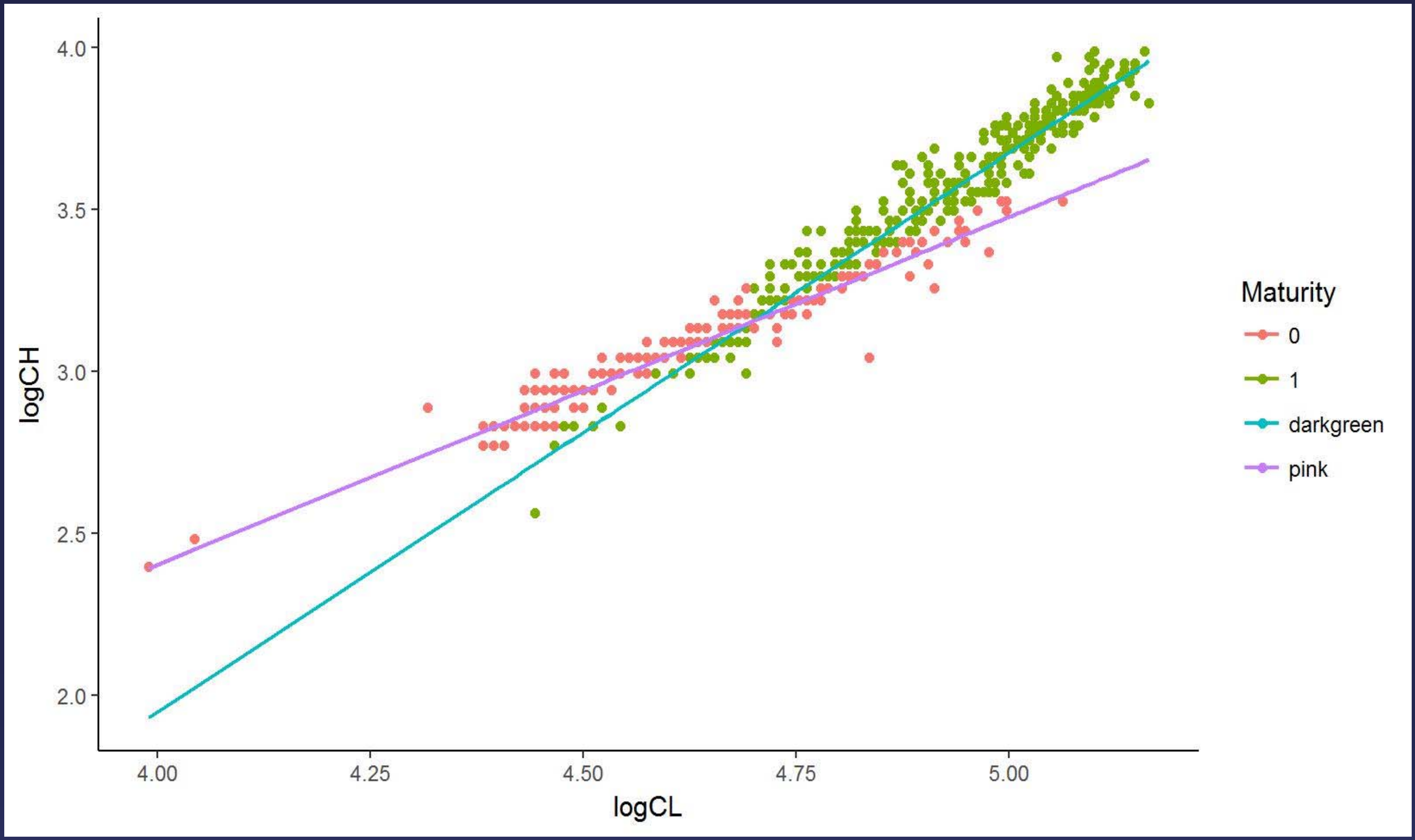


Figure 5. Segmented linear regression fit to ln(CH) vs. ln(CL) data of male golden king crab in WAG with classification of mature (code 1, dark green) and immature (code 0, red) data points. The 1984 NMFS data.

The 50% maturity length at the bent point was 109.51 mm CL.

May 2017 CPT (major) comments continued

- *Table R2. 1000 bootstrapped (on chela height and carapace length data) estimates of breakpoint , descending and ascending slopes:*

	Mean	Lower 95% Limit	Upper 95% Limit	Logistic Model L50
EAG				
Breakpoint (mm CL)	108.4673	108.4334	108.5040	109.7167
Descending slope (logCH vs.logCL)	-1.74808	-1.74931	-1.74695	
Ascending slope (logCH vs.logCL)	1.662065	1.661803	1.66235	
WAG				
Breakpoint (mm CL)	109.5525	109.5339	109.5597	112.6847
Descending slope (logCH vs.logCL)	-1.88061	-1.88108	-1.87938	
Ascending slope (logCH vs.logCL)	1.724643	1.724478	1.724706	

Knife-edge maturity of 111 mm CL was used

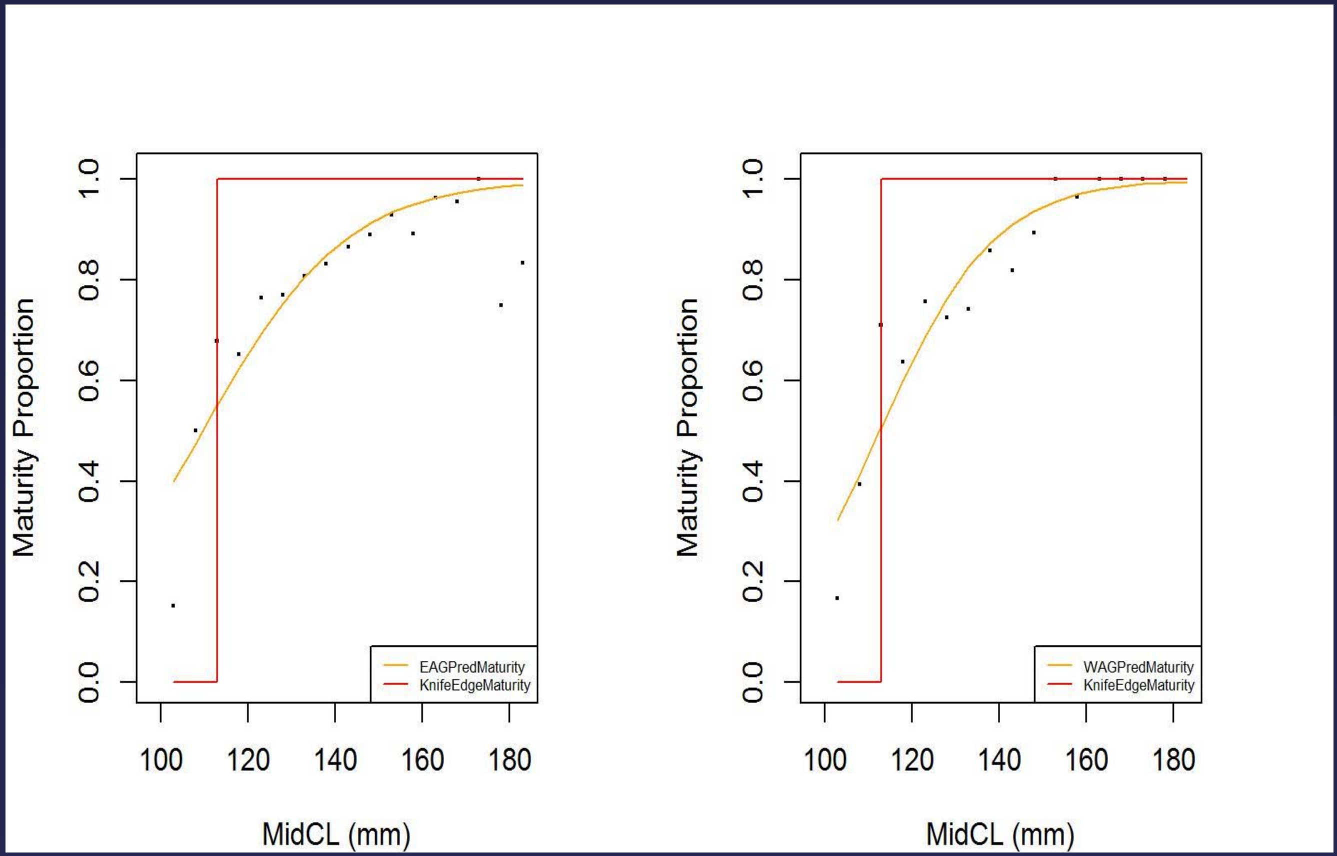


Figure 6. Logistic model fitted by GLM to observed proportion of mature male for EAG (left) and WAG (right). The estimated L50 (at 50% probability of mature) by the logistic model for EAG was 109.72 mm CL and that for WAG was 112.68 mm CL

We used the externally fitted logistic maturity curves (orange) to estimate MMB for two sets of scenarios (17AaD17a and 17BaD17a, and 17AeD17a and 17BeD17a) for EAG and WAG, respectively.

May 2017 CPT (major) comments continued

- **Comment 3: There is a weak retrospective pattern for Model 9 for the EAG (additional years of data lead to higher estimates of biomass), but not for the WAG.**

Response:

We provide the retrospective patterns of MMB for the EAG and WAG fits under equilibrium and non-equilibrium initial condition (Figures 7 and 8). The patterns for recent years are similar between the two initial conditions.

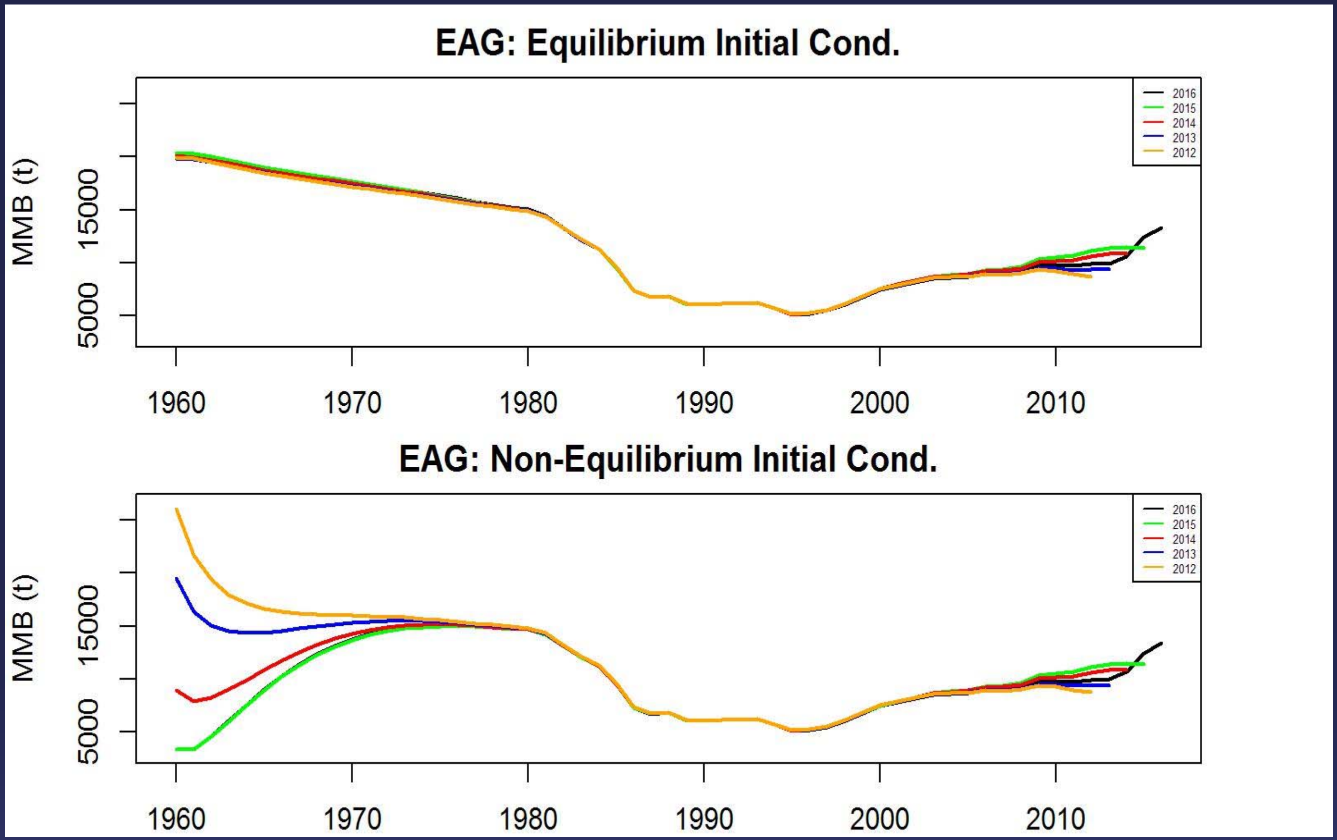


Figure 7. Retrospective fits of mature male biomass by the model when terminal year's data were systematically removed until 2012/13 for scenarios 17AD17 (equilibrium initial condition) and 17BD17 (non-equilibrium initial condition) fits for golden king crab in the EAG, 1960–2016.

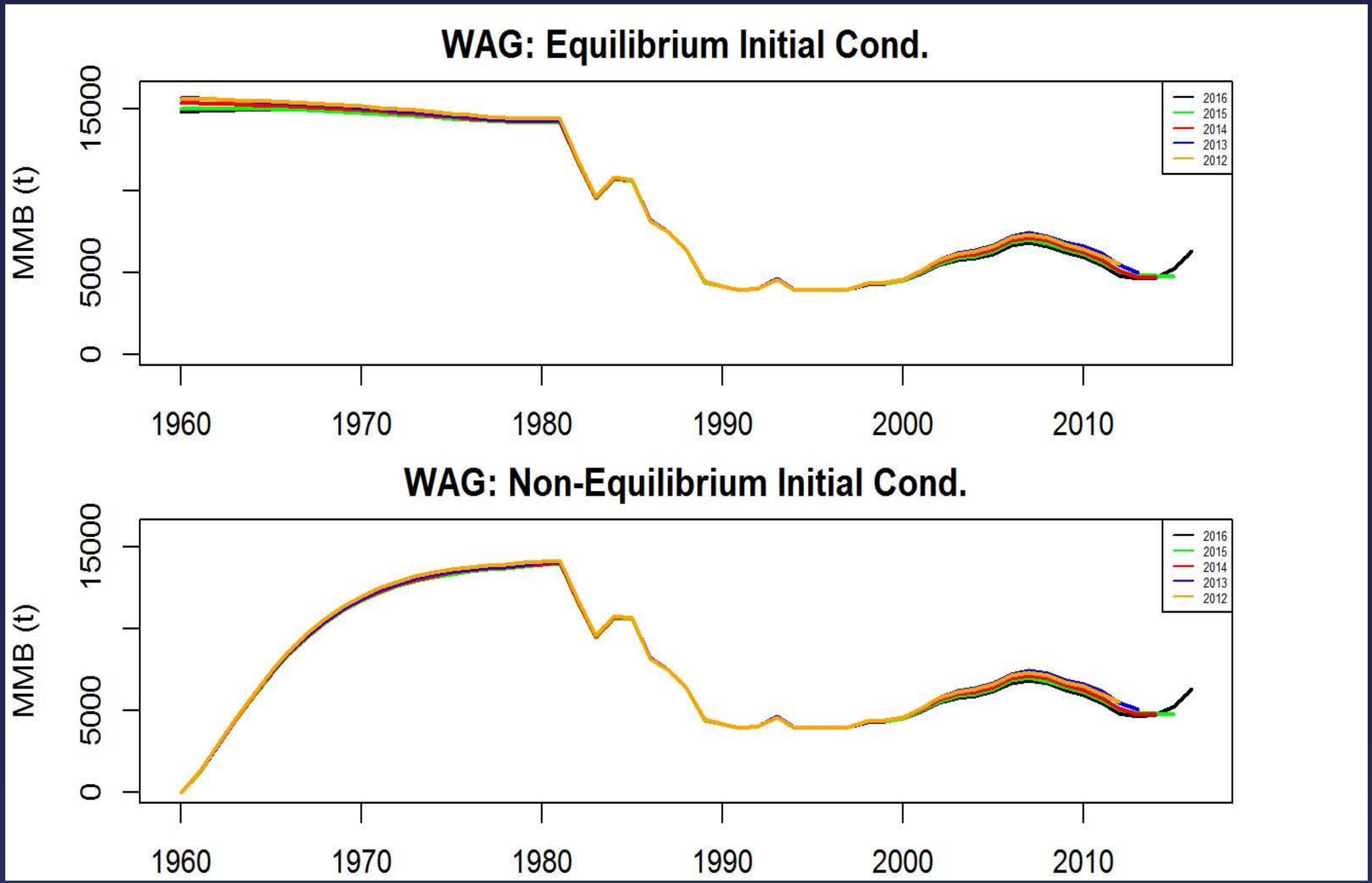


Figure 8. Retrospective fits of mature male biomass by the model when terminal year's data were systematically removed until 2012/13 for scenarios 17AD17 (equilibrium initial condition) and 17BD17 (non-equilibrium initial condition) fits for golden king crab in the WAG, 1960–2016.

May 2017 CPT (major) comments continued

- **Comment 5: Consider estimating rather the pre-specifying the 1960 recruitment, which would then be used to calculate *MMB_{MSY}*.**

Response:

Considered the equilibrium (denoted by A) and non-equilibrium (i.e., not pre specifying the 1960 recruitment, denoted by B) initial abundance estimates for 1960. The recent years estimates of management parameters are similar for the two types of initial conditions. However, non-equilibrium initial abundance estimates for 1960 hit the lower bound in some cases.

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- *We computed the non-equilibrium initial condition (t=1960) using the following equation:*
-
- $N_{1960,i} = \widehat{N}_{1960} \frac{e^{\varepsilon_i}}{\sum_j e^{\varepsilon_j}}$ (1)

May 2017 CPT (major) comments continued

Core Data Analysis:

- **Comment 8: The CPT suggested that a run in which just the observer CPUE indices were replaced by the CPUE indices for the core area might be informative.**

Response:

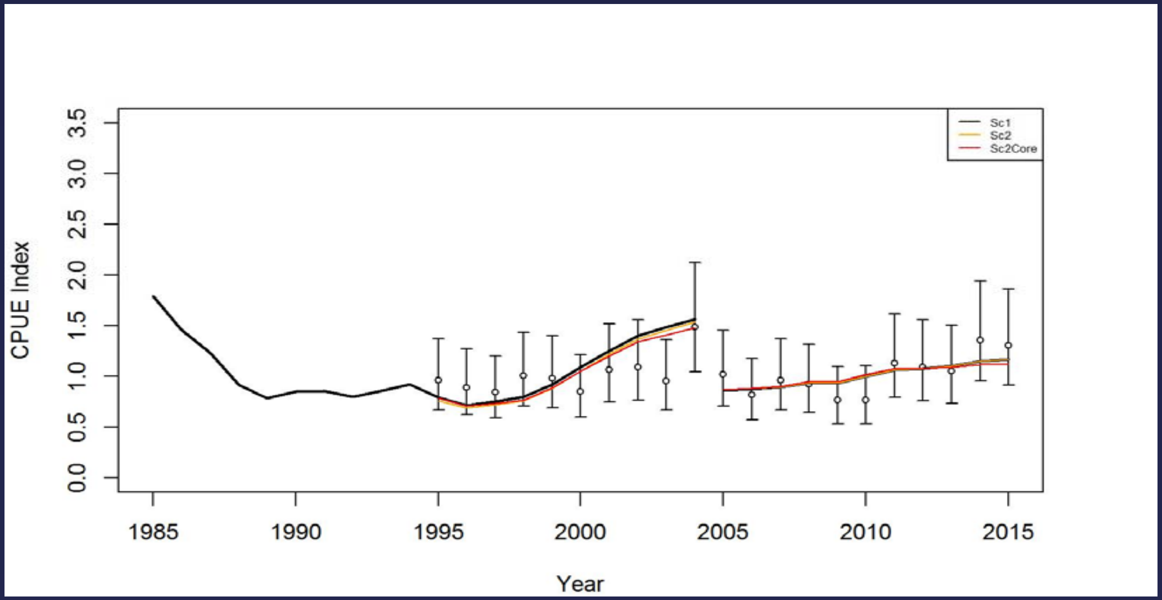
We compared the CPUE indices and MMB trends between the whole area and core area CPUE input indices. Scenarios 1 and 2 were the base and fish ticket CPUE likelihood removed models, respectively as presented at the May 2017 CPT and June 2017 SSC meetings. The differences were minor.

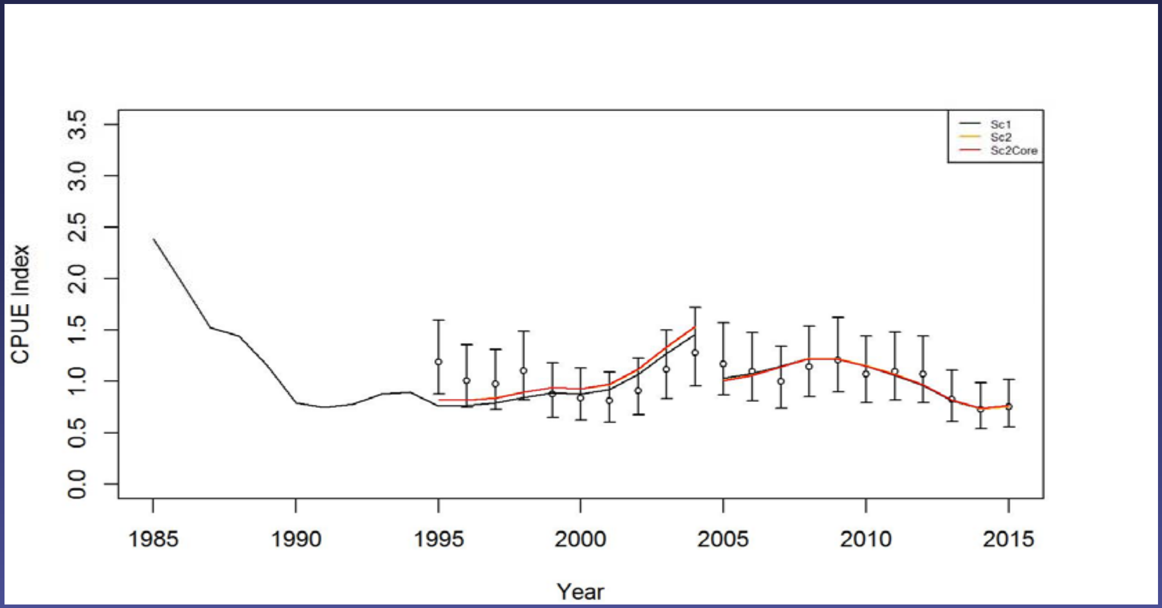
Note:

1. In the current model runs, we used a finer resolution of area code (ADF&G code) to standardize the observer and fish ticket CPUE data.

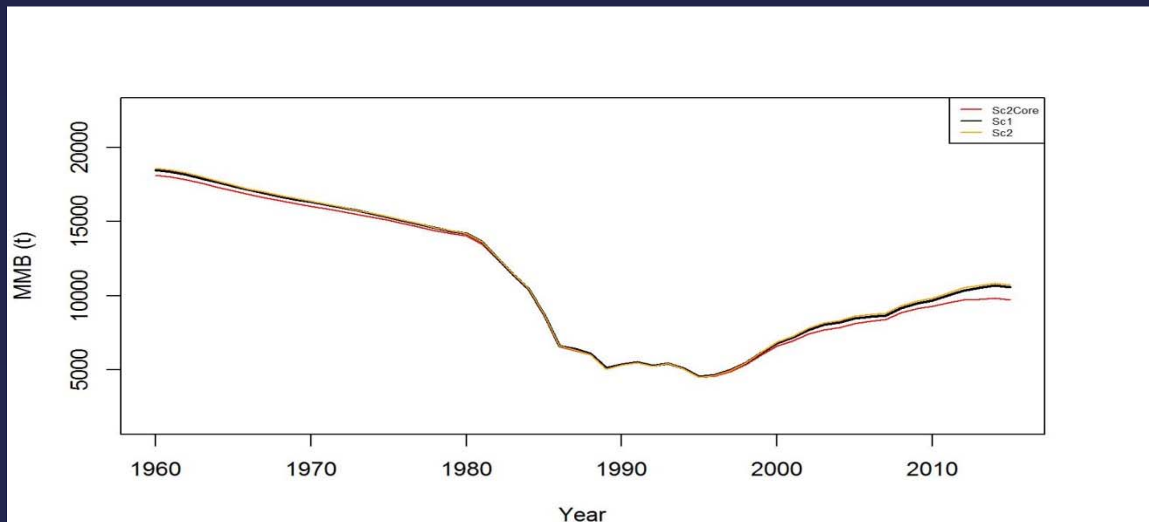
2. Further work on the effect of spatio-temporal variation of the fishery on CPUE index is continuing (we are exploring the feasibility of using VAST to determine an alternative index).

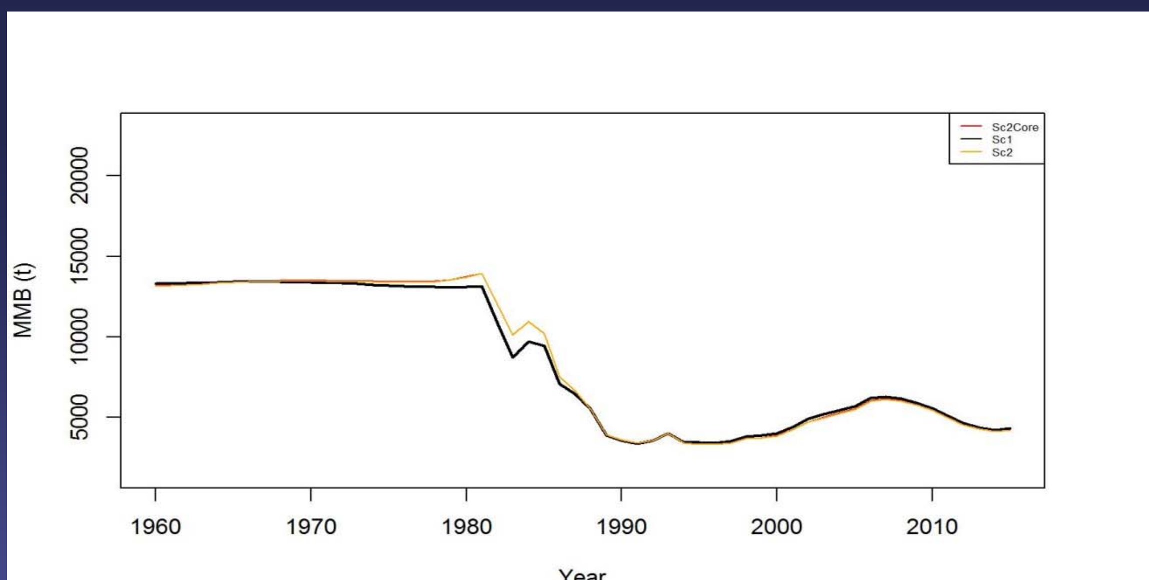
Figures 9 and 10. Comparison of input CPUE indices (open circles with +/- 2 SE) with predicted CPUE indices (colored solid lines) for scenarios 1, 2, and 2Core for (top) EAG and (bottom) WAG golden king crab data, 1985/86–2015/16.





Figures 11 and 12. Comparison of MMB for scenarios 1, 2, and 2Core for EAG (top) and WAG (bottom) golden king crab data, 1985/86–2015/16.





June 2017 SSC (major) comments

- **Comment 1: Data Weighting: The SSC encourages stock assessment authors and the CPT to continue to consider alternative approaches, as data weighting is not a ‘one-size-fits-all’ problem.**

Response:

- *All scenarios considered data weighting.*
- *Most scenarios used the Francis method for data weighing.*
- *One set of scenarios used the McAllister and Ianelli method (17AcD17 and 17BcD17) for data weighting. The management parameters in recent years were not much different between Francis and McAllister and Ianelli methods.*

June 2017 SSC comments continued

- **Comment 4: The SSC appreciates the efforts to investigate the spatial dynamics of the fishery data. Analysis of a subset 'core area' of spatial data indicated similar trends to those estimated for the standardized CPUE series using all of the data. However, this approach is not the same as predicting the CPUE in unfished areas; this type of spatial extrapolation has been the subject of considerable fisheries literature, and incomplete spatial analysis remains a fundamental problem in the interpretation of CPUE data.**

Response:

1. In the current model runs, we used a finer resolution of area code (ADF&G code) to standardize the observer and fish ticket CPUE data.

2. Further work on the effect of spatio-temporal variation of the fishery on CPUE index is continuing (e.g., an alternative index by VAST).

Comment 5: The assessment authors examine potential causes of the retrospective pattern for Model 9 for the EAG whereby additional years of data lead to higher estimates of biomass. The possibility that this feature is a function of population trend should be explored.

Response: Initial abundance decline patterns between EAG and WAG were different. Also see our response to CPT comment 3.

June 2017 SSC (major) comments

- **Comment 6: To address the issues concerning model fits to maturity data, the CPT recommended that, for the next assessment, the maturity ogive should be estimated outside the model rather than inside the model along with other model parameters. The SSC feels that the veracity of the approach to estimate mature versus immature crab in this assessment needs to be evaluated.**

Response:

In the current analysis, in scenarios 17AaD17a, 17 BaD17a, 17AeD17a, and 17BeD17a, we estimated the maturity ogive outside the model. For other scenarios, we used the knife-edge maturity outside the model.

EAG and WAG scenarios

Scenario	Size-comp. weighting	Catchability and logistic total selectivity sets	Maturity	CPUE data type	Initial Abundance and Treatment of M	M yr^{-1}
17Aa0D17	Stage-1: Number of days/trips Stage-2: Francis method	2	Knife-edge 111 mmCL	Observer from 1995/96–2016/17 & Fish Ticket from 1985/86–1998/99	Equilibrium initial condition, estimate *M* using the combined EAG and WAG data with an *M* prior	0.2258
17Ab0D17	Stage-2: Francis method	2	Knife-edge 111 mmCL	Observer & Fish Ticket	Equilibrium initial condition, estimate *M* using the combined EAG and WAG data without an *M* prior	0.2277
17Bb0D17	Stage-2: Francis method	2	Knife-edge 111 mmCL	Observer & Fish Ticket	Non-equilibrium initial condition, estimate *M* using the combined EAG and WAG data without an *M* prior	0.2234
17AD17 base	Stage-2: Francis method	2	Knife-edge 111 mmCL	Observer & Fish Ticket	Equilibrium initial condition, single *M*	0.21
17BD17 base	Stage-2: Francis method	2	Knife-edge 111 mmCL	Observer & Fish Ticket	Non-equilibrium initial condition, single *M*	0.21
17AaD17a	Stage-2: Francis method	2	Logistic curve	Observer & Fish Ticket	Equilibrium initial condition, single *M*	0.21

EAG and WAG scenarios continued

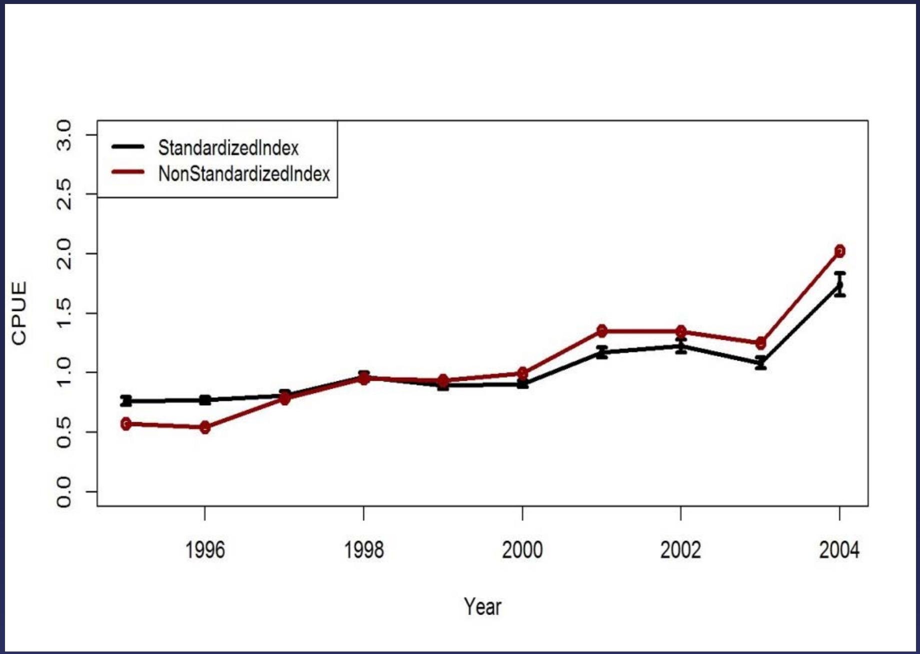
Scenario	Size-comp. weighting	Catchability and logistic total selectivity sets	Maturity	CPUE data type	Initial Abundance and Treatment of M	M yr^{-1}
17BaD17a	Stage-2: Francis method	2	Logistic curve	Observer & Fish Ticket	Non-equilibrium initial condition, single *M*	0.21
17AbD17	Stage-2: Francis method	2	Knife-edge 111 mmCL	Omit CPUE likelihoods	Equilibrium initial condition, single *M*	0.21
17BbD17	Stage-2: Francis method	2	Knife-edge 111 mmCL	Omit CPUE likelihoods	Non-equilibrium initial condition, single *M*	0.21
17AcD17	Stage-2: McAllister & Ianelli method	2	Knife-edge 111 mmCL	Observer & Fish Ticket	Equilibrium initial condition, single *M*	0.21
17BcD17	Stage-2: McAllister & Ianelli method	2	Knife-edge 111 mmCL	Observer & Fish Ticket	Non-equilibrium initial condition, single *M*	0.21
17AdD17	Stage-2: Francis method	2	Knife-edge 111 mmCL	Observer & Fish Ticket	Equilibrium initial condition starts in 1975, single *M*	0.21

EAG and WAG scenarios continued

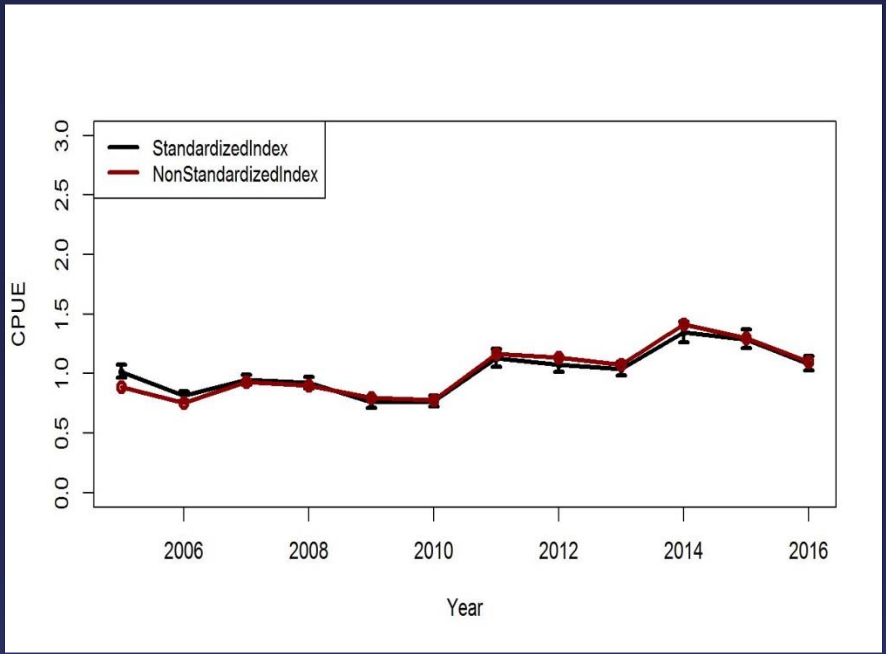
Scenario	Size-comp. weighting	Catchability and logistic total selectivity sets	Maturity	CPUE data type	Initial Abundance and Treatment of M	M yr^{-1}
17BdD17	Stage-2: Francis method	2	Knife-edge 111 mmCL	Observer & Fish Ticket	Non-equilibrium initial condition starts in 1975, single *M*	0.21
17AeD17a	Stage-2: Francis method	2	Logistic curve	Observer & Fish Ticket	Equilibrium initial condition starts in 1975, single *M*	0.21
17BeD17a	Stage-2: Francis method	2	Logistic curve	Observer & Fish Ticket	Non-equilibrium initial condition starts in 1975, single *M*	0.21

Trends in non-standardized and standardized CPUE indices with +/- 2 SE for EAG. Standardized indices: black line and non-standardized indices: red line.

1995/96 – 2004/05



2005/06 – 2016/17

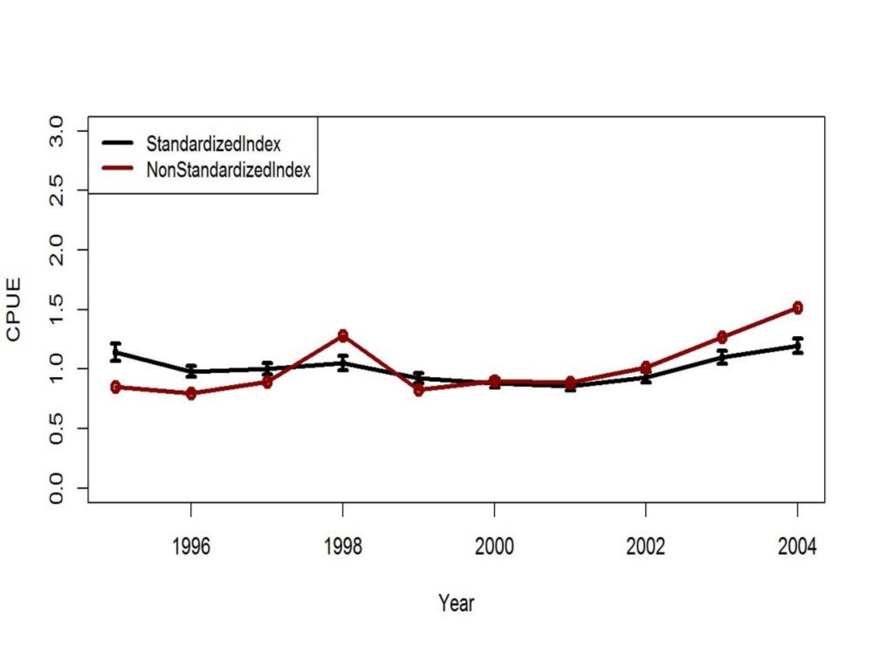


Ln(CPUE) = Year + Gear + Captain + Area + ns(Soak, df=3),
family = negative binomial (theta = 1.33)

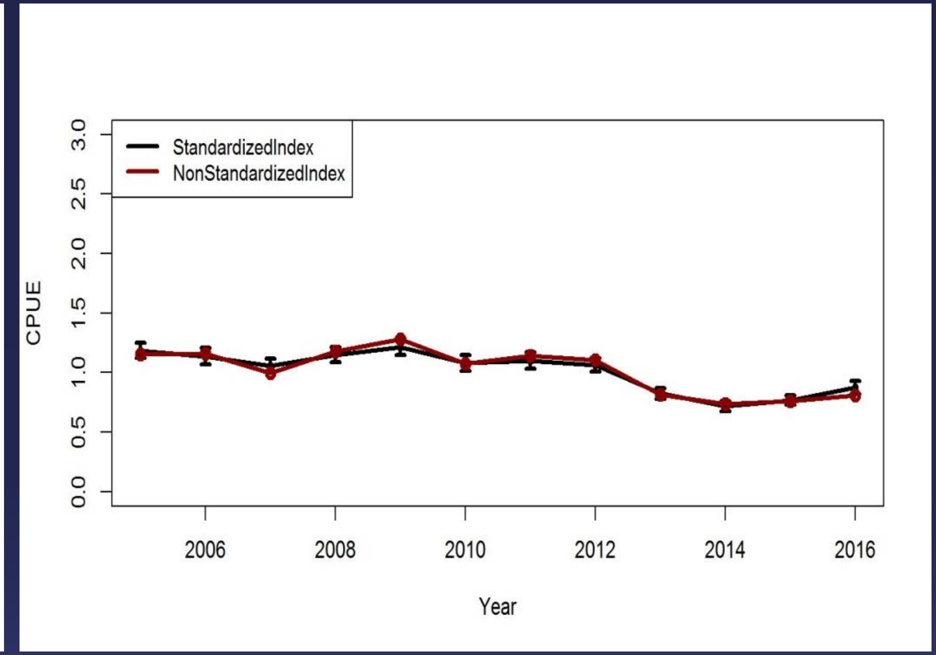
Ln(CPUE) = Year + Captain + Gear + ns(Soak, df=16),
family = negative binomial (theta = 2.32)

Trends in non-standardized and standardized CPUE indices with +/- 2 SE for WAG. Standardized indices: black line and non-standardized indices: red line.

1995/96 – 2004/05



2005/06 – 2016/17



Ln(CPUE) = Year + Captain + Gear + ns(Soak, df=8) + Area,
family = negative binomial (theta = 0.98)

Ln(CPUE) = Year + Area + Gear +ns(Soak, df=17) ,
family = negative binomial (theta = 1.12)

Table D. Results from 100 jitter runs for scenario 17AD17 for WAG. Jitter run 0 corresponds to the original optimized estimates. NA= not converged.

Jitter Run	Objective Function	Maximum Gradient	$MMB_{35\%}$ (t)	OFL (t)	Current MMB (t)
0	192.0466	0.00071560	5149.51	1597.38	6460.90
1	192.0466	0.00030374	5149.51	1597.38	6460.90
2	192.0466	0.00007064	5149.51	1597.38	6460.90
3	192.0466	0.00005073	5149.51	1597.38	6460.90
4	192.0466	0.00021277	5149.51	1597.38	6460.90
5	192.0466	0.00026881	5149.51	1597.38	6460.90
6	192.0466	0.00024244	5149.51	1597.38	6460.90
7	192.0466	0.00001517	5149.51	1597.38	6460.90
8	193.0027	0.00011287	5652.62	1717.97	6838.37
9	NA	NA	NA	NA	NA
10	192.0466	0.00011472	5149.51	1597.38	6460.90
11	192.0466	0.00004718	5149.51	1597.38	6460.90
12	192.0466	0.00014885	5149.51	1597.38	6460.90
13	………………………				

Table 4. Iteration process for stage-2 effective sample size determination by Francis and McAllister and Ianelli methods

Sc	Iter. #	Retained Size Comp Effective Sample Multiplier (W)	Total Size Comp Effective Sample Multiplier (W)	Groundfish Discard Size Comp Effective Sample Multiplier (W)	Terminal MMB (t)
17AD17		Francis Method			
EAG	1	0.85787	0.47883	0.450625	13,337
	2	0.85784	0.47886	0.45062	13,337
	3	0.85785	0.47886	0.45062	13,337
WAG	1	0.51723	0.46880	0.75856	6,322
	2	0.51724	0.46880	0.75861	6,322
	3	0.51724	0.46880	0.75858	6,322
17AcD17		**McAllister & Ianelli Method**			
EAG	1	1.05721	0.97710	1.00146	13,253
	2	1.00801	0.99737	0.99998	13,253
	3	1.00117	0.99966	0.99998	13,253
WAG	1	1.01120	0.97999	0.99983	6,410
	2	1.00311	0.99316	0.99980	6,418
	3	1.00087	0.99980	0.99979	6,418

Fig. 21. Comparison of input CPUE indices (open circles with +/- 2 SE) with predicted CPUE indices (colored solid lines) for EAG, 1985/86 – 2016/17
.
Top left: 17AD17 vs. 17BD17, Top right: 17AaD17a vs. 17BaD17a,
Bottom left: 17AbD17 vs. 17BbD17, and bottom right: 17AcD17 vs. 17BcD17.

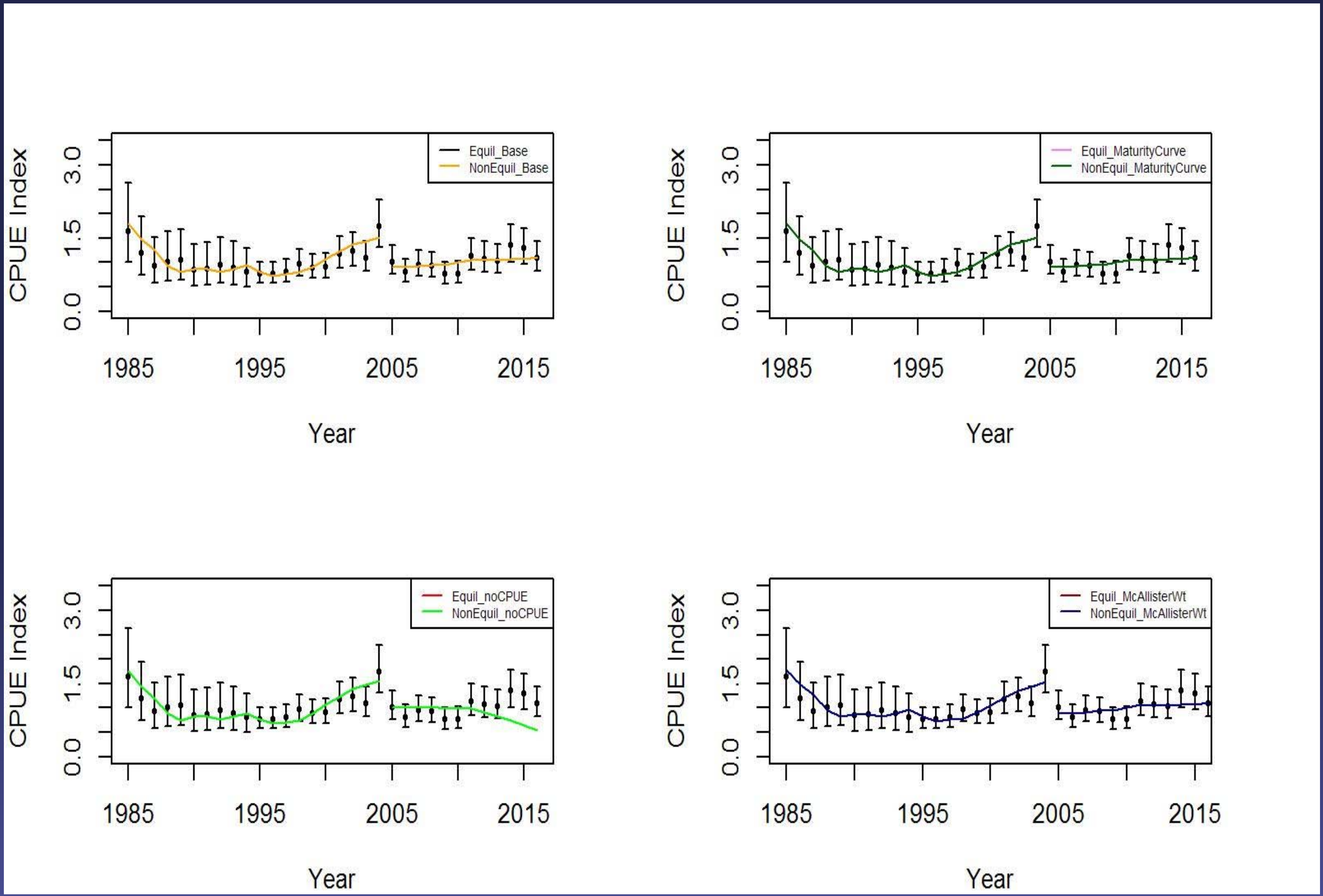
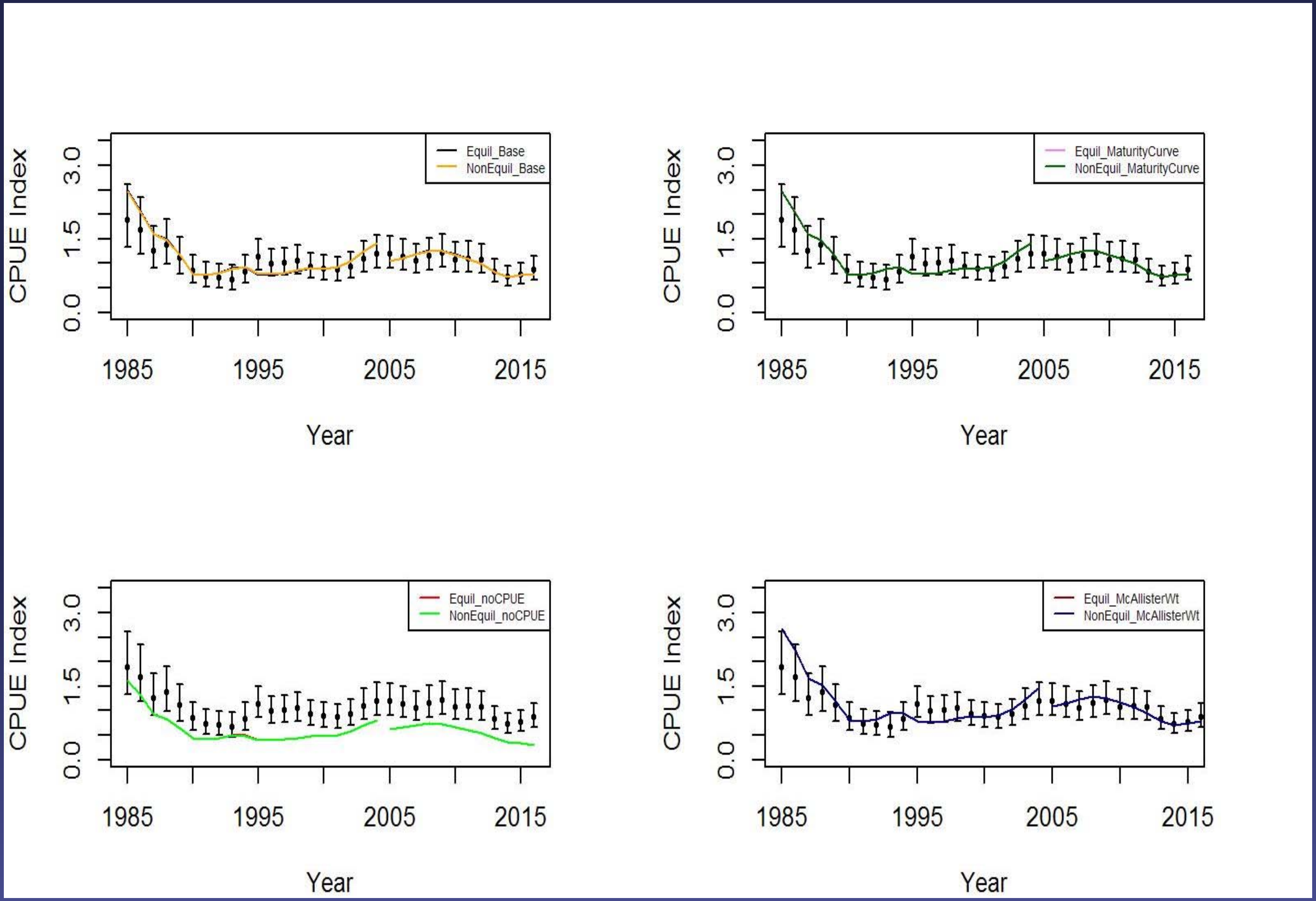
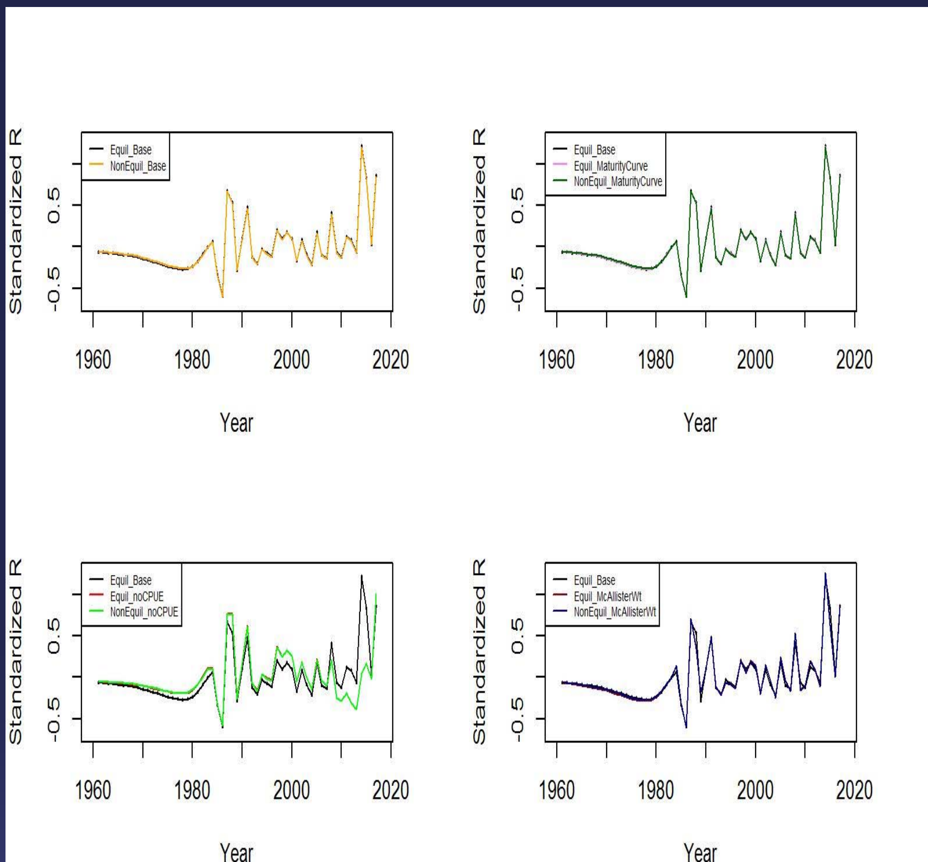


Fig. 33. Comparison of input CPUE indices (open circles with +/- 2 SE) with predicted CPUE indices (colored solid lines) for WAG, 1985/86 – 2016/17
.
Top left: 17AD17 vs. 17BD17, Top right: 17AaD17a vs. 17BaD17a,
Bottom left: 17AbD17 vs. 17BbD17, and bottom right: 17AcD17 vs. 17BcD17.



Figs. 22 and 34. Number of male recruits for scenarios (Sc) 17AD17 to 17BcD17 fits to EAG (right) and WAG (left) data, 1961 – 2017. The numbers were mean adjusted for comparison.



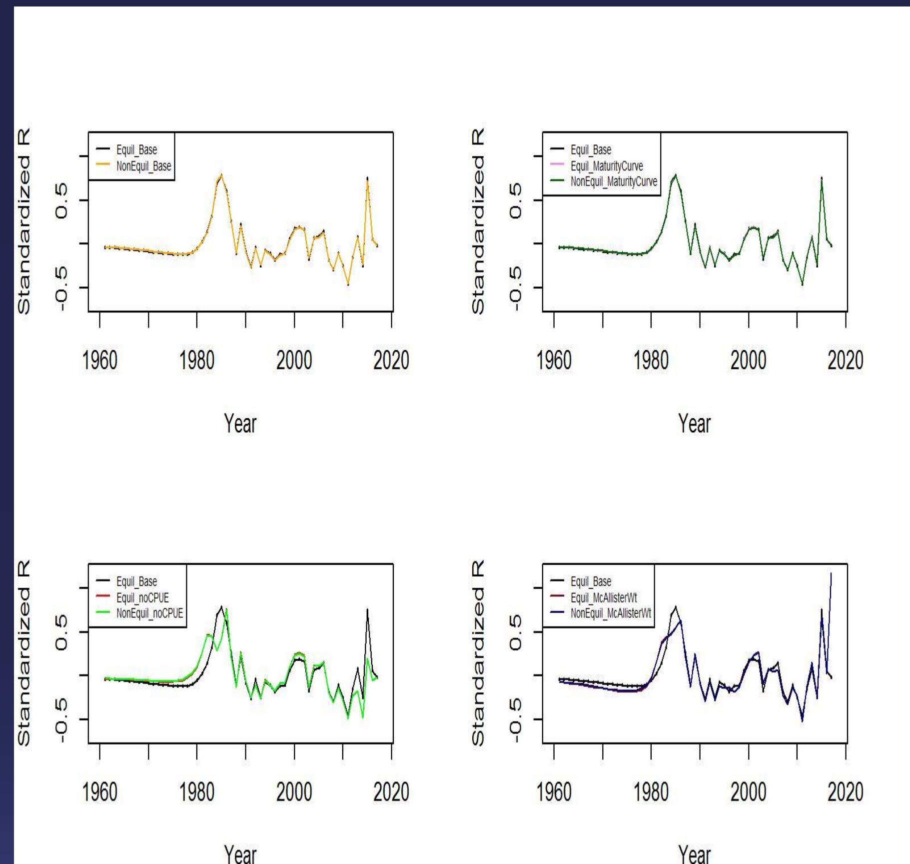


Figure 23. Observed (open circle) vs. predicted (solid line) retained catch (top left in each scenario set), total catch (top right in each scenario set), and groundfish bycatch (bottom left in each scenario set) of golden king crab for scenarios 17AD17 to 17BcD17 fits in EAG, 1981–2016.

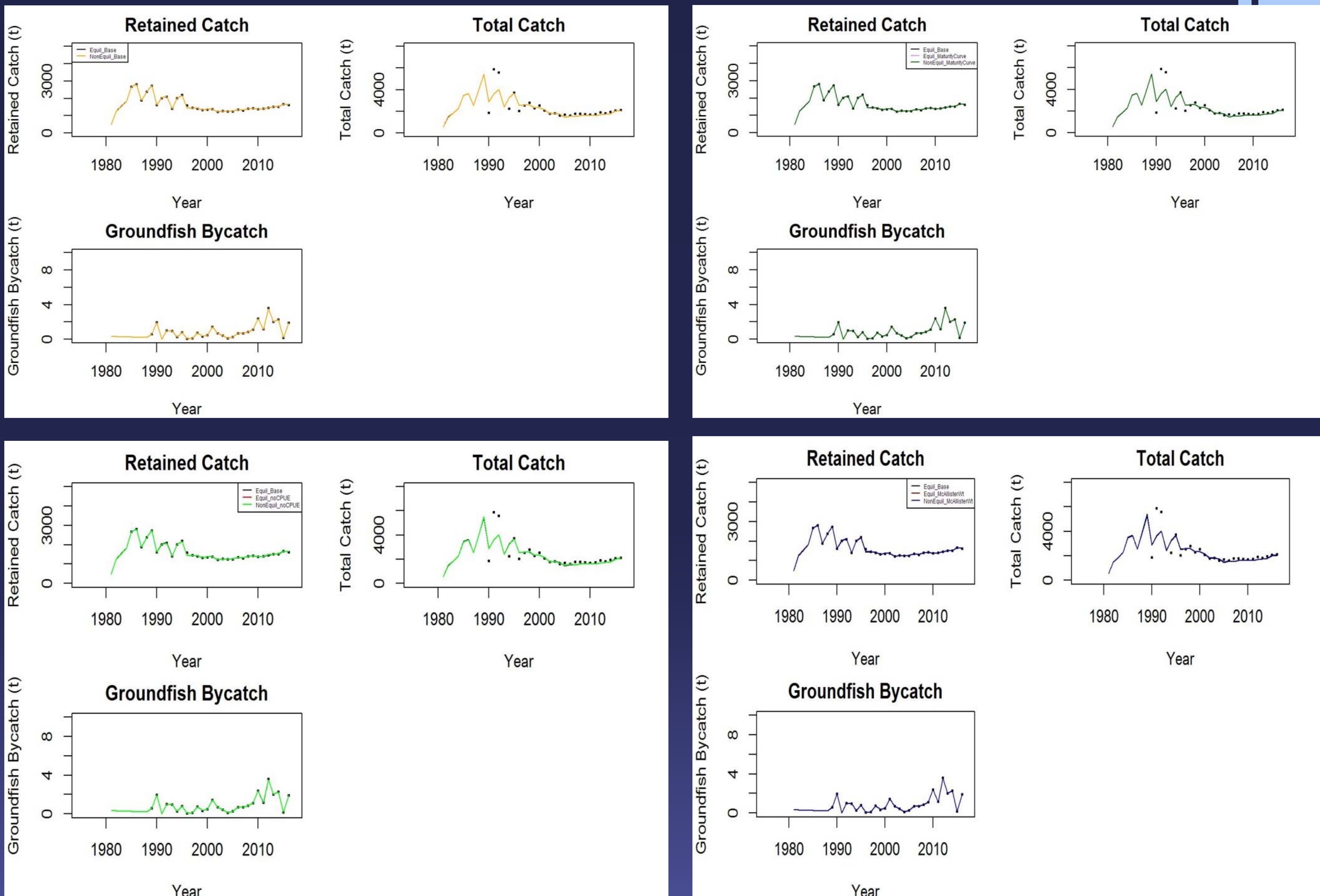


Figure 23. Observed (open circle) vs. predicted (solid line) retained catch (top left in each scenario set), total catch (top right in each scenario set), and groundfish bycatch (bottom left in each scenario set) of golden king crab for scenarios 17AD17 to 17BcD17 fits in WAG, 1981–2016.

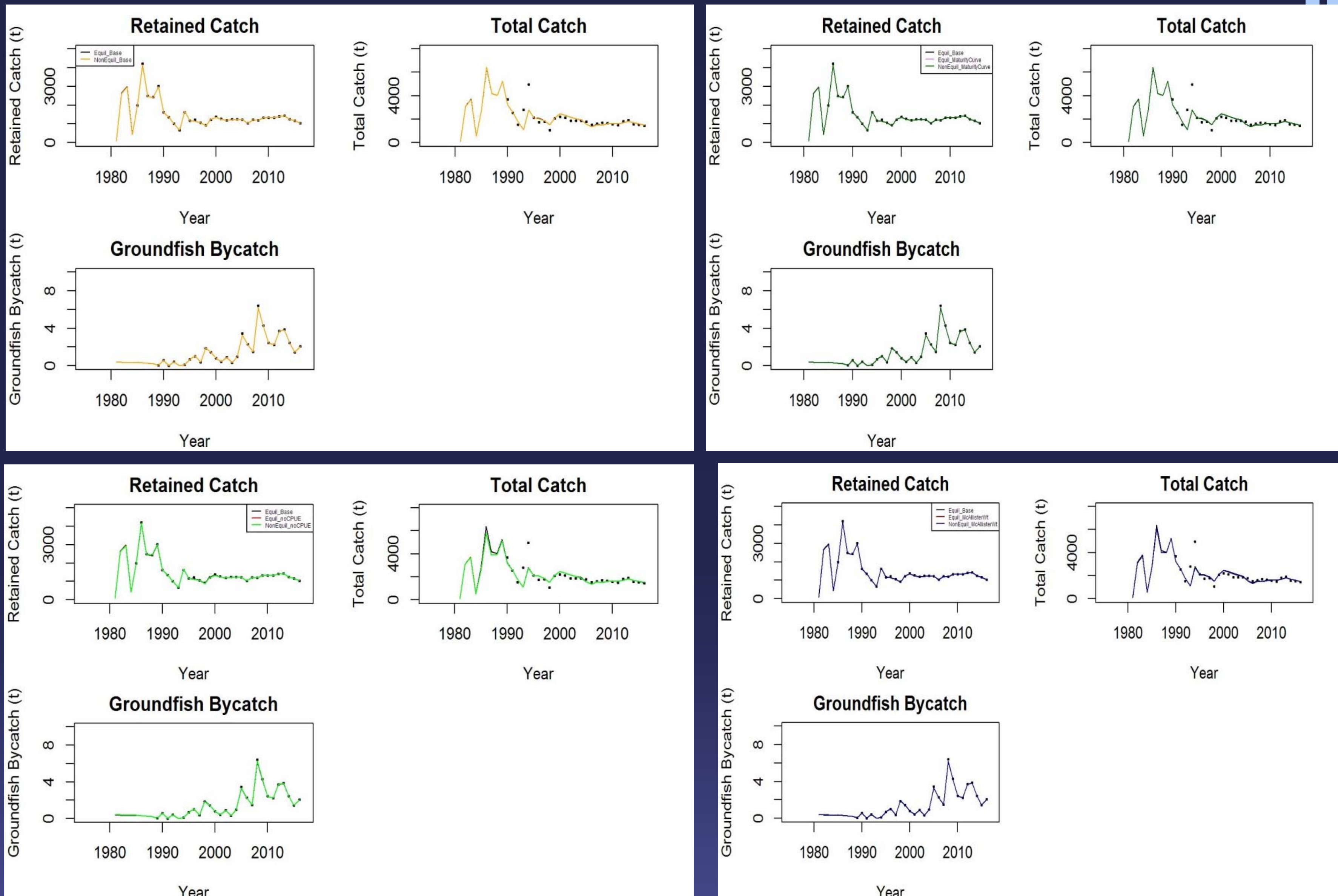


Figure 25. Trends in pot fishery full selection total fishing mortality of golden king crab for scenarios 17AD17 to 17BcD17 fits in the EAG, 1981–2016.

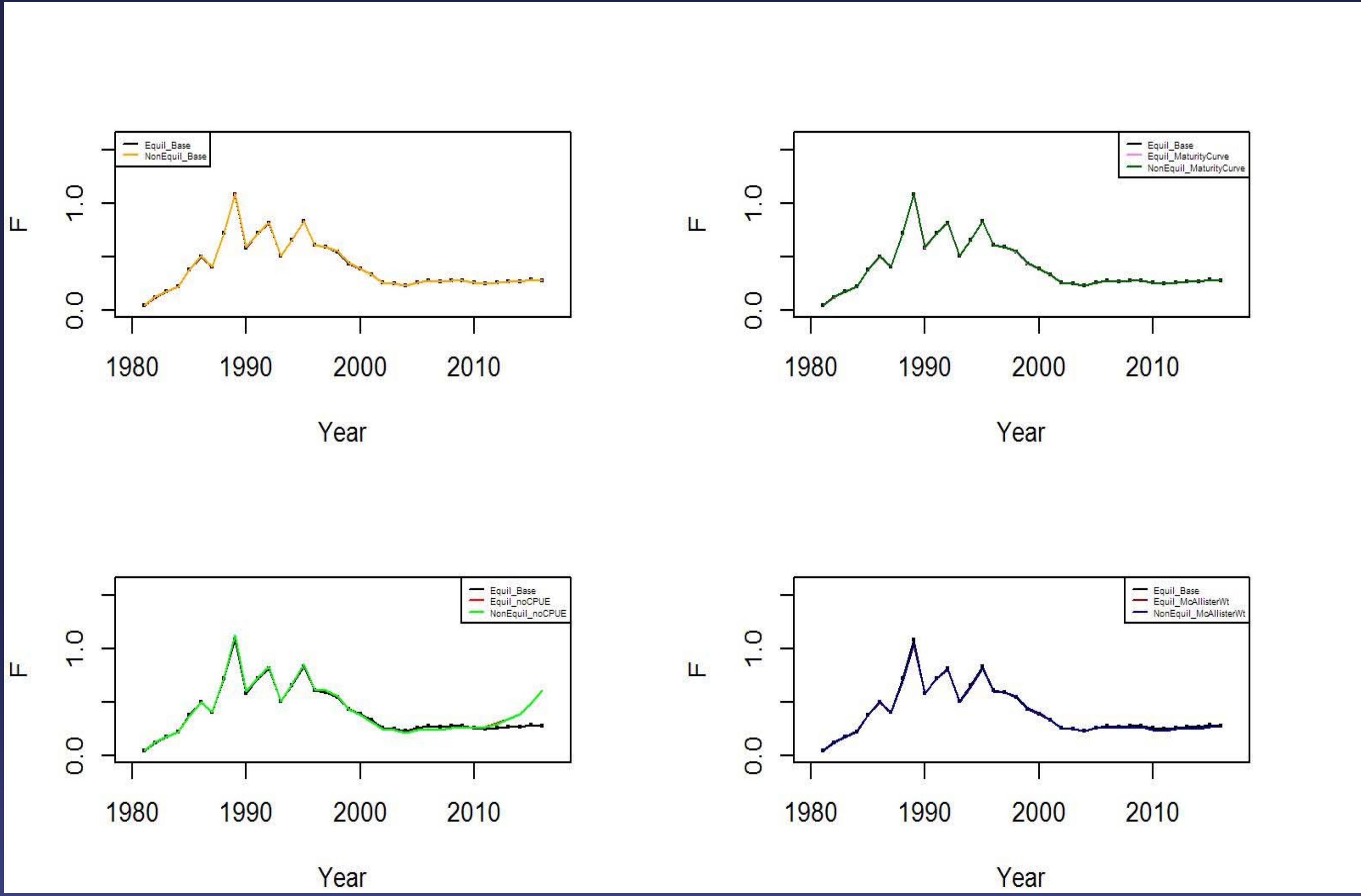


Figure 37. Trends in pot fishery full selection total fishing mortality of golden king crab for scenarios 17AD17 to 17BcD17 fits for WAG golden king crab data, 1981–2016.

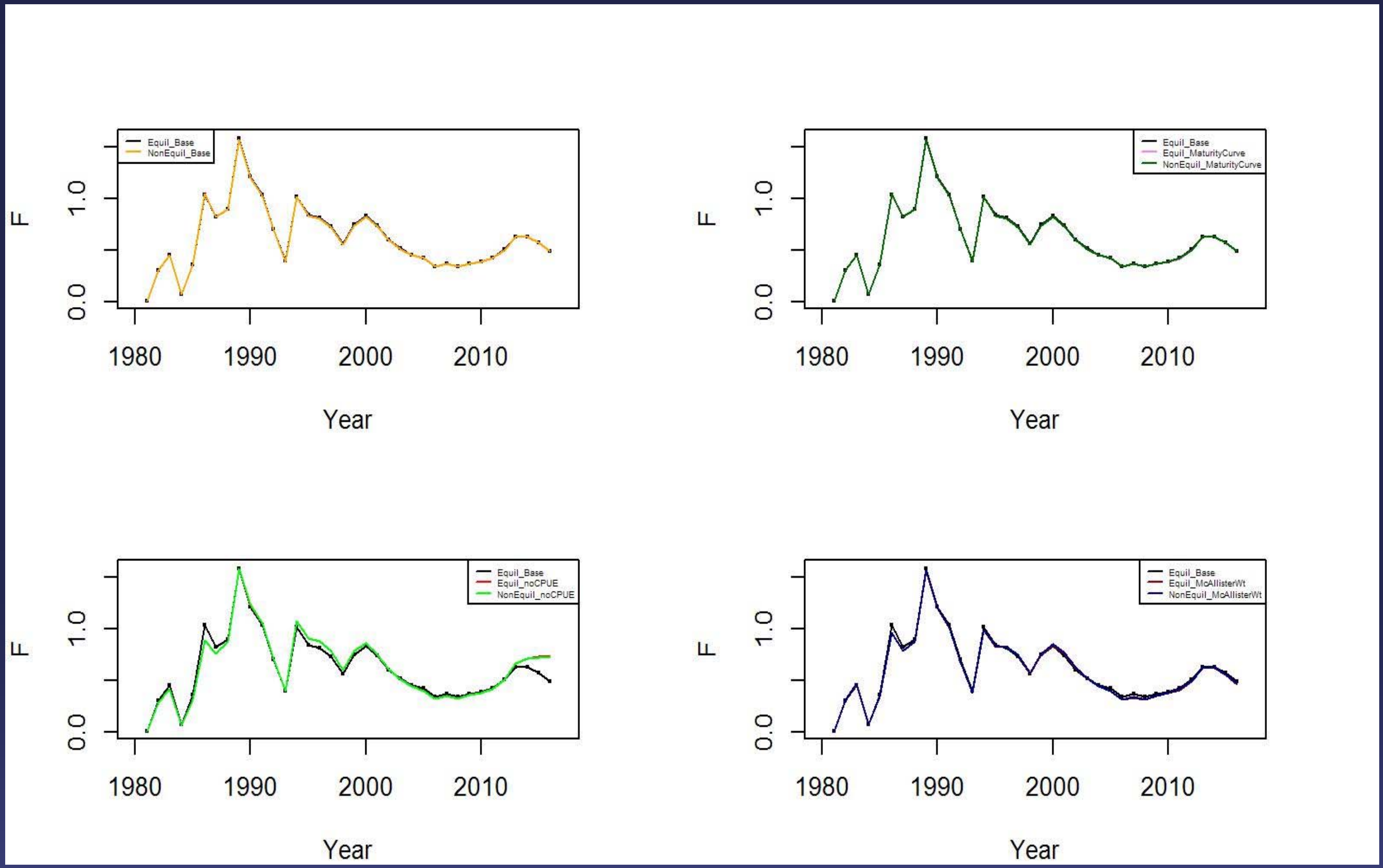


Figure 26. Trends in golden king crab mature male biomass for scenarios 17AD17 to 17BcD17 fits in the EAG, 1960/61–2016/17. Top left: Scenarios 17AD17 (Equil_Base) and 17BD17 (NonEquil_Base) estimates have two standard errors confidence limits.

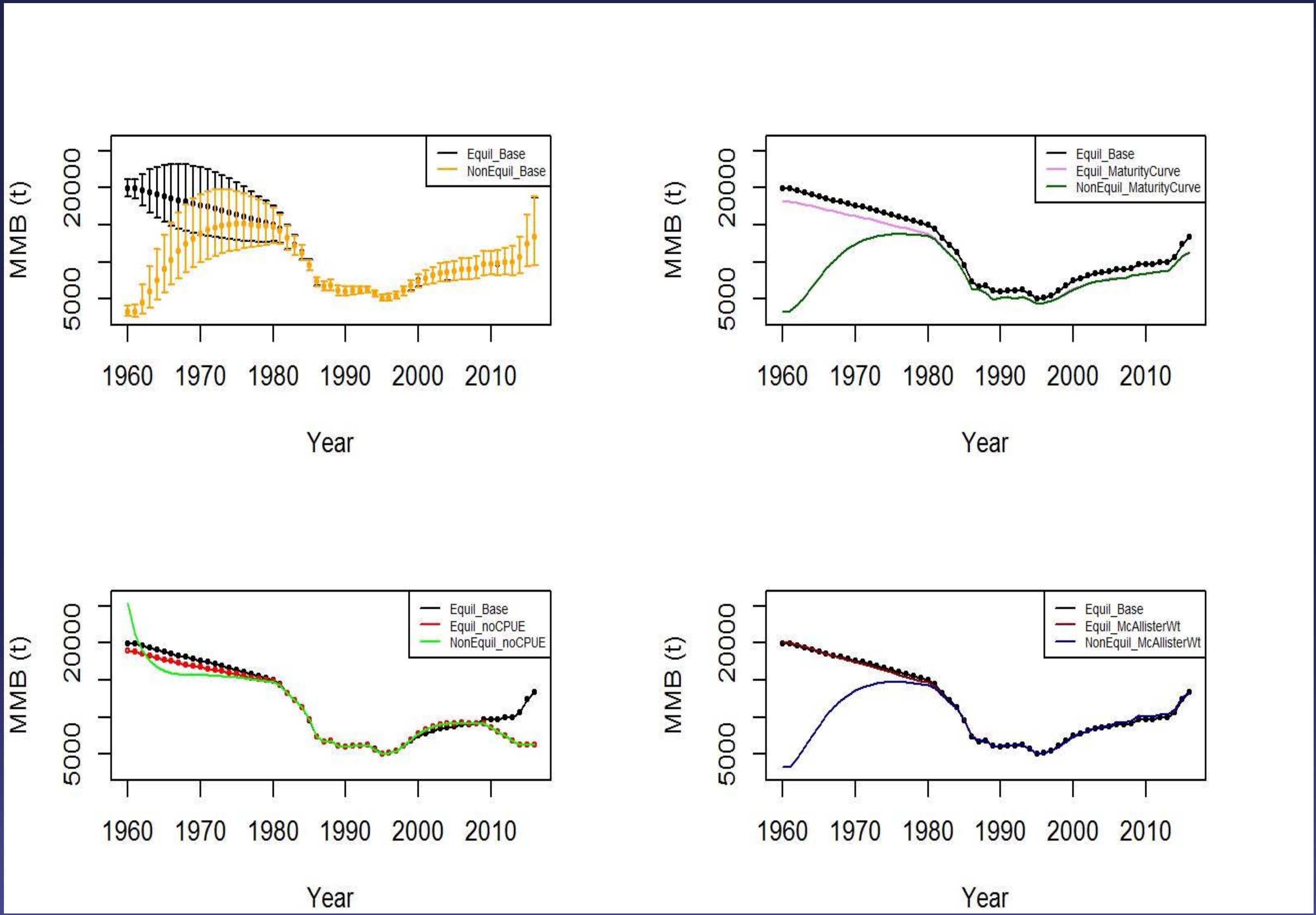


Figure 38. Trends in golden king crab mature male biomass for scenarios 17AD17 to 17BcD17 fits in the WAG, 1960/61–2016/17. Top left: Scenarios 17AD17 (Equil_Base) and 17BD17 (NonEquil_Base) estimates have two standard errors confidence limits.

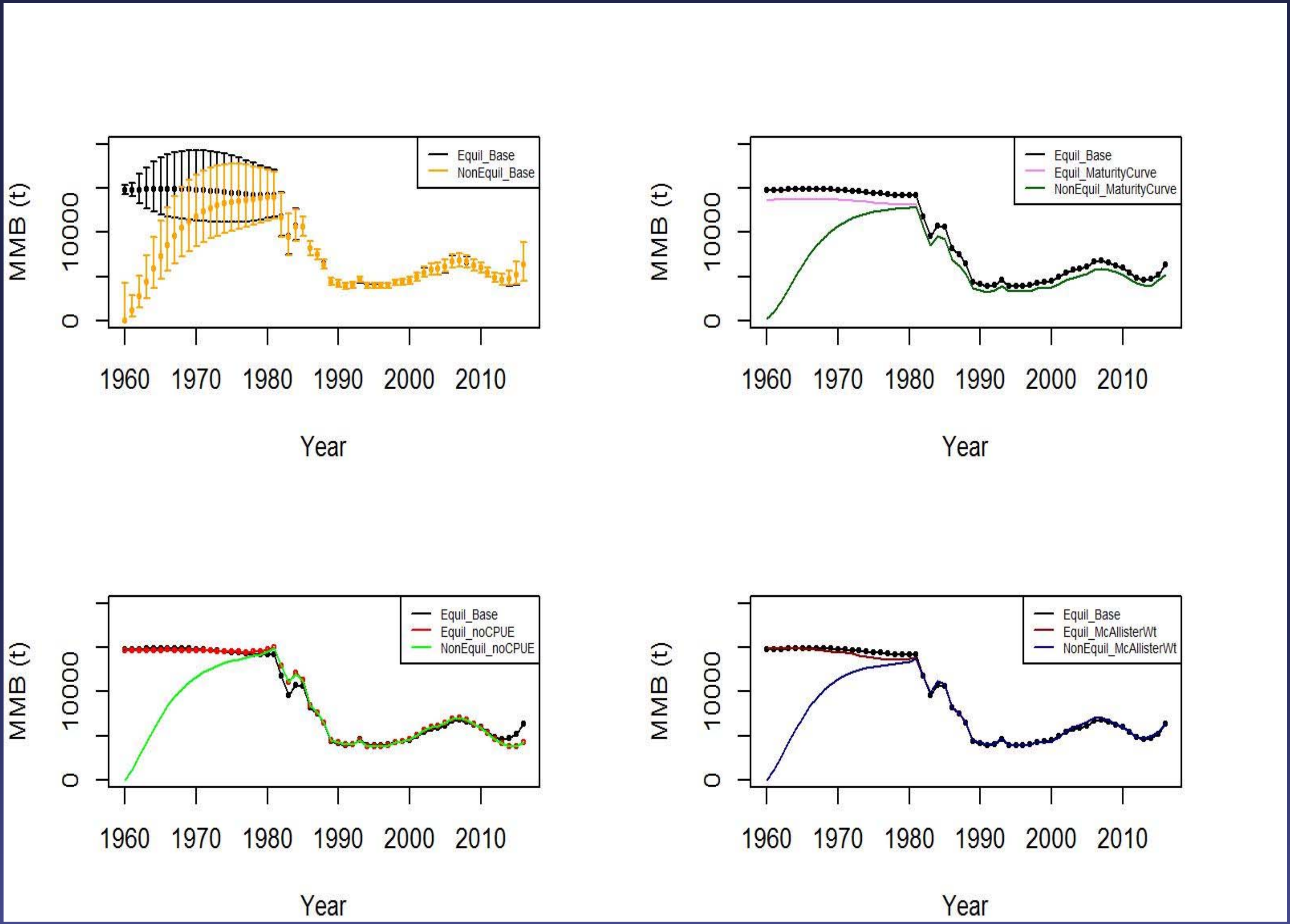
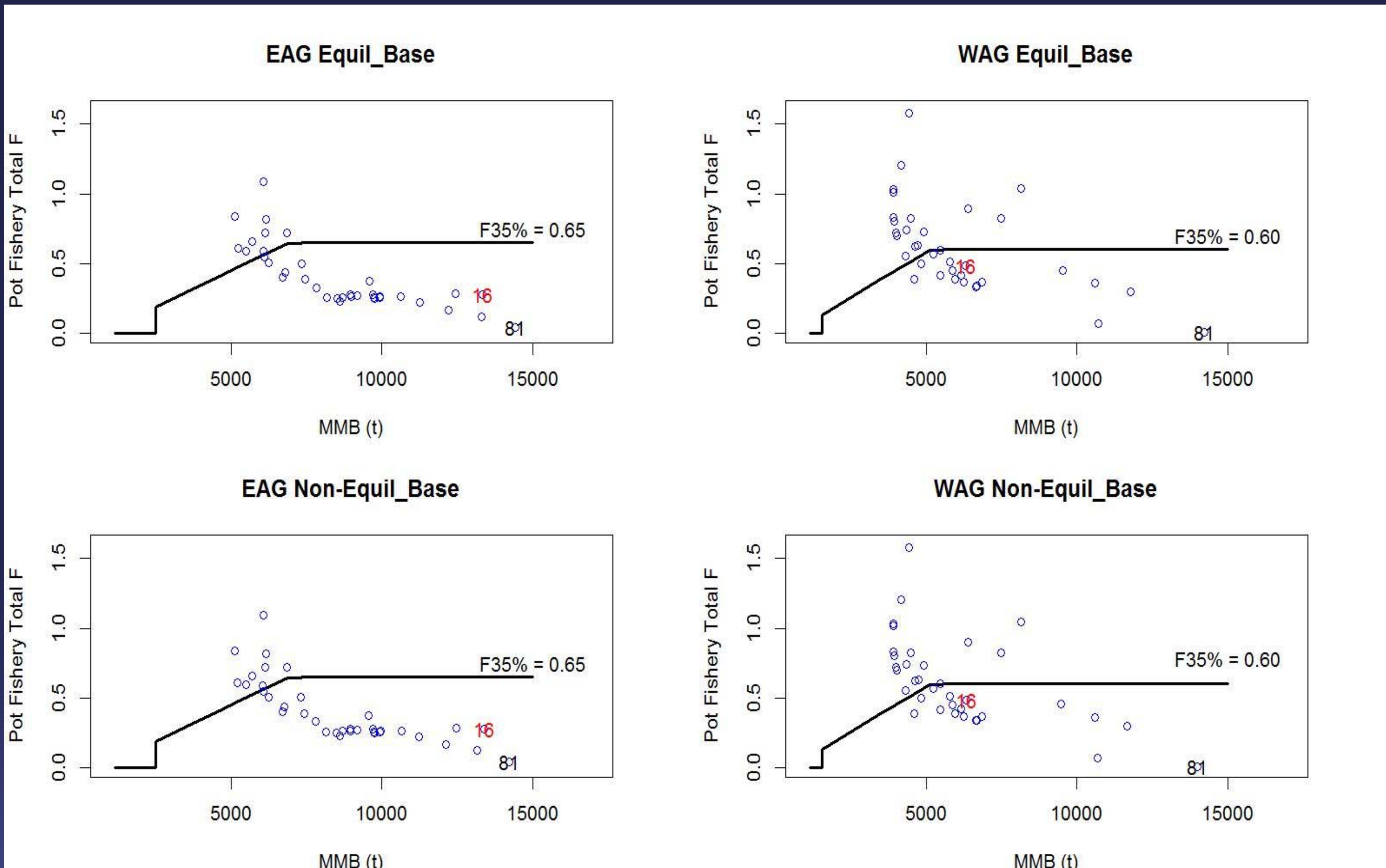


Figure 41. Relationships between full fishing mortalities and mature male biomass during 1981/82–2016/17 for base scenarios 17AD17 (Equilibrium initial abundance) and 17BD17 (Non-equilibrium initial abundance) during 1981/82–2016/17 for EAG and WAG.



Million pounds (Recruitment years to define $MMB_{35\%}$: 1987–2012)

EAG

Scenario	Tier	$MMB_{35\%}$	Current MMB	MMB/ $MMB_{35\%}$	F_{OFL}	$F_{35\%}$	OFL	ABC (P*=0.49)	ABC (0.75*OFL)
17AD17	3a	15.264	25.121	1.65	0.65	0.65	8.659	8.622	6.494
17BD17	3a	15.277	25.245	1.65	0.65	0.65	8.679	8.642	6.509
17AaD17a: Mat.Curve	3a	13.962	22.835	1.64	0.56	0.56	7.706	7.674	5.780
17BaD17a: Mat.Curve	3a	13.972	22.942	1.64	0.56	0.56	7.724	7.691	5.793
17AbD17: No CPUE	3b	14.522	13.895	0.96	0.59	0.62	3.598	3.551	2.698
17BbD17: No CPUE	3b	14.527	13.958	0.96	0.59	0.62	3.636	3.589	2.727
17AcD17: McAlister Wt	3a	15.494	24.621	1.59	0.64	0.64	8.658	8.622	6.494
17BcD17: McAlister Wt	3a	15.506	24.760	1.60	0.64	0.64	8.677	8.641	6.508
17AdD17: Starts 1975	3a	15.183	24.870	1.64	0.65	0.65	8.472	8.436	6.354
17BdD17: Starts 1975	3a	15.427	26.637	1.73	0.64	0.64	8.961	8.923	6.721
17AeD17a: Starts 1975; Mat Curve	3a	13.889	22.575	1.63	0.56	0.56	7.539	7.507	5.654
17BeD17a: Starts1975; Mat Curve	3a	14.135	24.183	1.71	0.55	0.55	7.956	7.922	5.967

WAG

Scenario	Tier	$MMB_{35\%}$	Current MMB	MMB/ $MMB_{35\%}$	F_{OFL}	$F_{35\%}$	OFL	ABC (P*=0.49)	ABC (0.75*OFL)
17AD17	3a	11.353	14.244	1.25	0.60	0.60	3.522	3.507	2.641
17BD17	3a	11.350	14.251	1.26	0.60	0.60	3.549	3.534	2.662
17AaD17a: Mat.Curve	3a	10.503	12.418	1.18	0.50	0.50	3.062	3.049	2.296
17BaD17a: Mat.Curve	3a	10.508	12.449	1.18	0.50	0.50	3.065	3.052	2.298
17AbD17: No CPUE	3b	11.184	10.349	0.93	0.55	0.60	2.142	2.115	1.606
17BbD17: No CPUE	3b	11.190	10.398	0.93	0.55	0.60	2.161	2.134	1.621
17AcD17: McAlister Wt	3a	11.476	14.289	1.25	0.59	0.59	3.586	3.571	2.690
17BcD17: McAlister Wt	3a	11.487	14.352	1.25	0.59	0.59	3.579	3.564	2.685
17AdD17: Starts 1975	3a	11.337	14.323	1.26	0.60	0.60	3.561	3.546	2.671
17BdD17: Starts 1975	3a	11.377	14.552	1.28	0.60	0.60	3.577	3.562	2.683
17AeD17a: Starts1975; Mat Curve	3a	10.496	12.507	1.19	0.50	0.50	3.074	3.062	2.306
17BeD17a: Starts 1975; Mat Curve	3a	10.529	12.688	1.21	0.5	0.50	3.091	3.078	2.318

Million pounds

AI

Entire Aleutian Islands (AI)			
Scenario	OFL	Max ABC (P*=0.49)	ABC (0.75*OFL)
17AD17	12.181	12.129	9.135
17BD17	12.228	12.176	9.171
17AaD17a: Mat.Curve	10.768	10.723	8.076
17BaD17a: Mat.Curve	10.789	10.743	8.091
17AbD17: No CPUE	5.740	5.666	4.304
17BbD17: No CPUE	5.797	5.723	4.348
17AcD17: McAlister Wt	12.244	12.193	9.184
17BcD17: McAlister Wt	12.256	12.205	9.193
17AdD17: Initial input abundance in 1975	12.033	11.982	9.025
17BdD17: Initial input abundance in 1975	12.538	12.485	9.404
17AeD17a: Initial input abundance in 1975; Mat Curve	10.613	10.569	7.960
17BeD17a: Initial input abundance in 1975; Mat Curve	11.047	11.000	8.285

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