Aleutian Islands Golden King Crab Model-Based Stock Assessment May 2018 CRAB SAFE DRAFT

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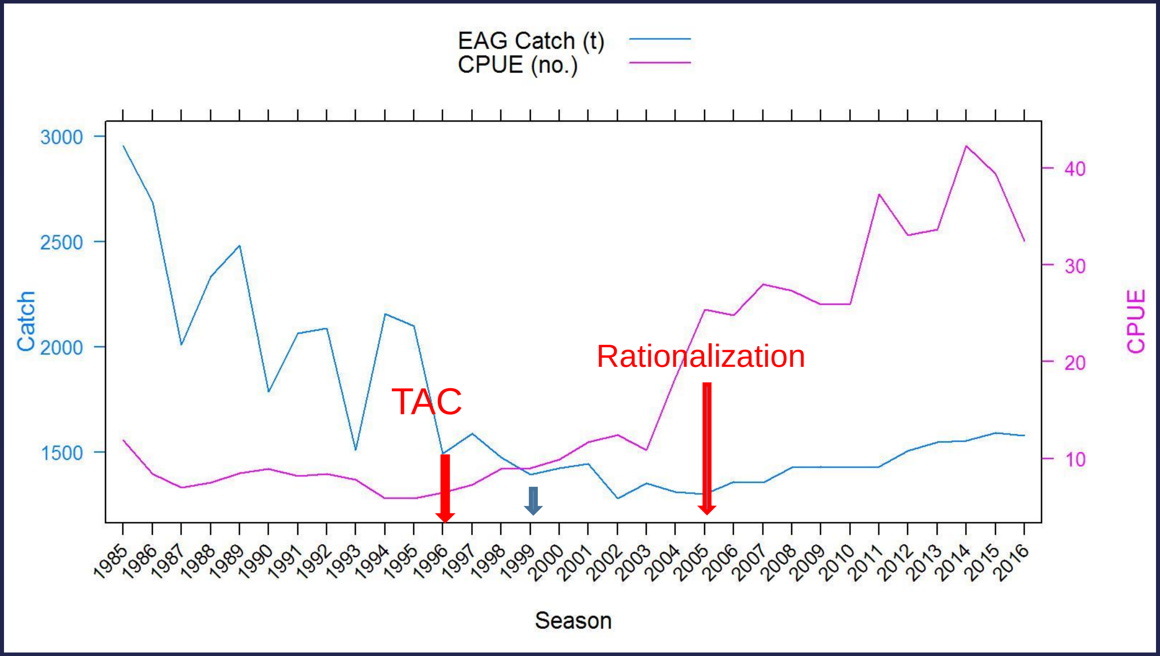
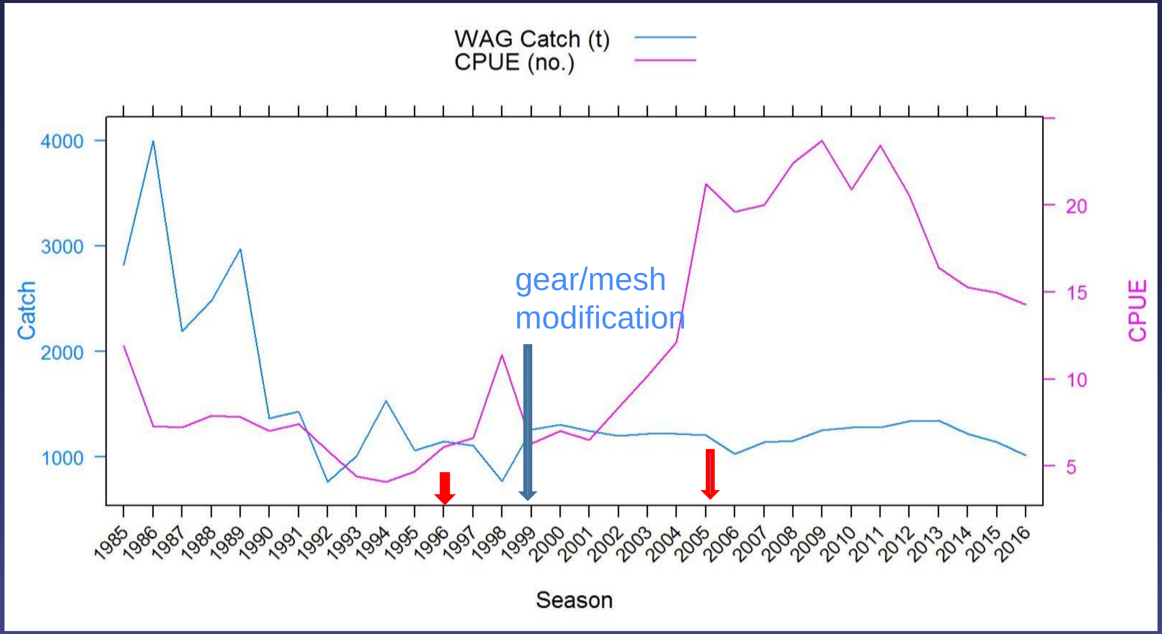
May 8, 2018, Hilton, Anchorage

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

EAG



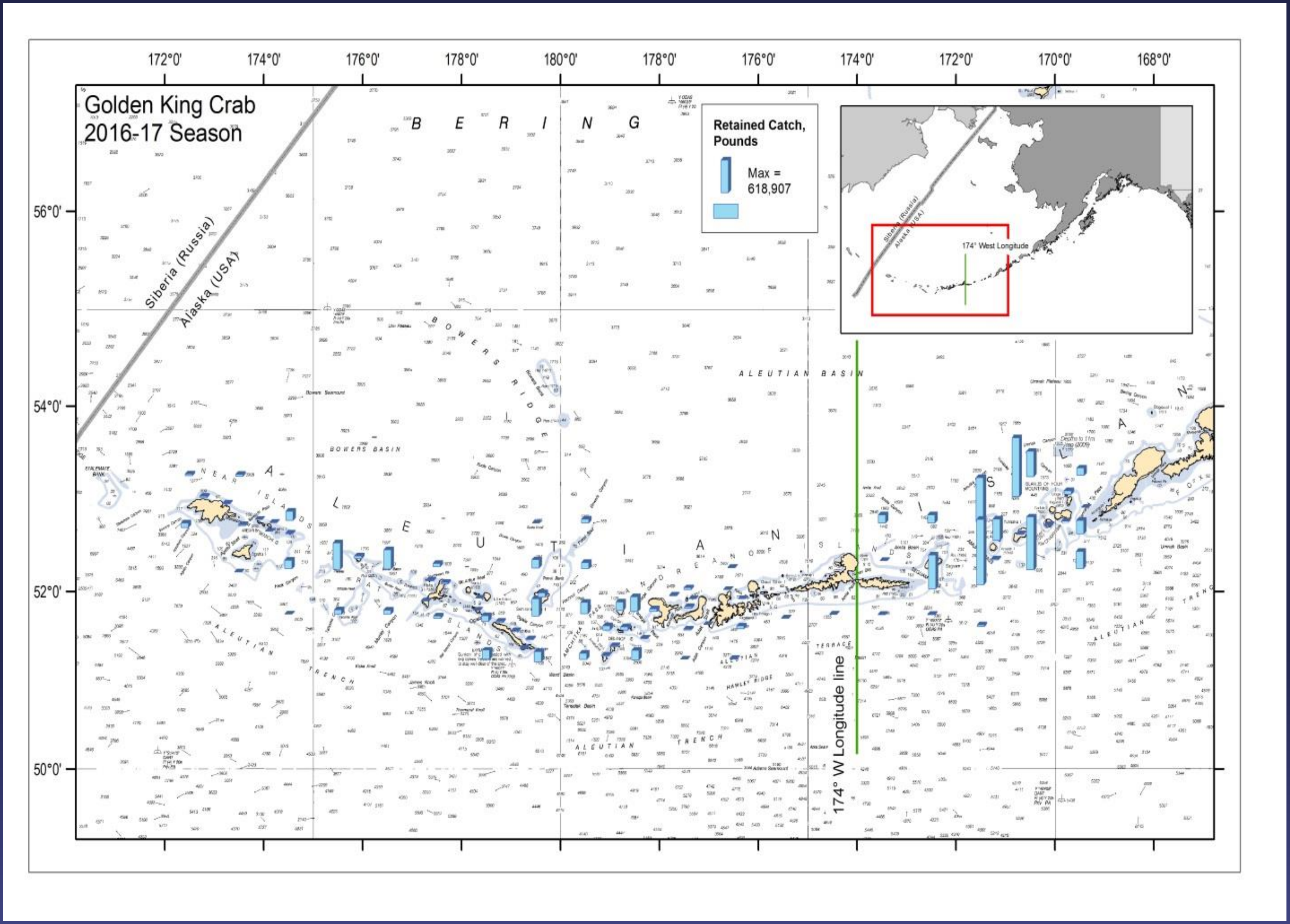
WAG



TACs approved by BOF in 2012 :
(1) EAG: 3.31 million pounds; and
(2) WAG: 2.98 million pounds;

BOF in March 2018 decided to amend the phrase "may reduce to "may modify" from the maximum TAC approved in 2012.

Figure 9. Catch distribution by statistical area.in 2016/17.



Topics

- Responses to September 2017 CPT and October 2017 SSC comments
- Scenario results
- Tier 3 OFL and ABC

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 in 1960 to initialize the 1985 abundance.
- 7 Scenarios for EAG (additional scenario for including the independent pot survey CPUE indices) and 6 Sc. for WAG.
- Knife edge maturity used for MMB calculation.
- Francis re-weighting method for Stage-2 effective sample sizes calculation for most scenarios. One scenario used McAllister and Ianelli re-weighting method for Stage-2 calculation.

September 2017 CPT (major) comments

- **Comment 1: The CPT recommended moving forward with the modeling convention adopted by the Groundfish Plan Teams.**

Response:

- *Followed this naming convention: 17_0 refers to the model established in 2017 and carried forward to 2018; no major changes occurred in 2018 and remain at the 0-level. 17_0a refers to a minor change to 17_0;*

for example, CPUE indices were determined by spatio-temporal delta generalized linear mixed model (deltaGLMM) instead of GLM in this case.

September 2017 CPT (major) comments continued

- **Comment 2: a) Reconsider what crabs are mature vs immature via breakpoint analysis; b) Repeat the breakpoint analysis using log (CH/CL) vs CL, rather than the logCH vs. logCL; c) Because it was based on an inappropriate analysis, there is no need to show models with a logistic maturity curve, unless an improved approach can be found.**

Response:

We used the log(CH/CL) vs. CL plot to get a better delineation of points for breakpoint analysis (see Appendix C figures). We used the breakpoint 50% maturity length for maturity determination in all scenarios. Sizes ≥ 111 mm CL were treated as mature and below this breakpoint immature.

- **Comment 3: It is appropriate to use only the equilibrium abundance as a starting point.**

Response:

Done.

September 2017 CPT (major) comments continued

- **Comment 4: Moving forward, do not look at the core data.**

Response:

- *We are not using the core data, but we have analyzed the independent pot survey data to estimate CPUE indices and incorporated them in a separate model scenario (17_0f). In the future we intend to use a spatio-temporal model to analyze the independent pot survey data.*

- **Comment 5: Continue analysis of spatio-temporal variation of the fishery using a program like VAST.**

Response:

- *We did a preliminary analysis of observer data using a spatio-temporal deltaGLMM (VAST) and estimated an additional set of CPUE indices (see Appendix B) for scenario 17_0a. VAST requires spatially explicit catch data and some measure of 'area fished'. This type of information is available from the observer data, which include soak time, lat. and long., and depth. These types of data are not available from dock side sampling; therefore, observer data are more suitable for VAST type of analysis.*
- *However, unlike the open West Coast Sea or Bering Sea, the Aleutian Islands areas provide additional constraints for spatial analysis due to the edge effects from the many islands. More work is needed for improvement of spatial analysis.*

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September 2017 CPT (major) comments continued

- **Comment 6: Show a scenario with the McAllister and Ianelli re-weighting for comparison when choosing preferred model.**

Response:

- *Scenario 17_0e (see Appendix D).*

- **Comment 7: Consider interaction terms, specifically area x year interaction for CPUE standardization.**

Response:

We standardized the CPUE considering the Year: Area interaction (see Appendix B). The problem with this interaction analysis on a large data set is that a lot of NAs occurred for many missing factor levels over the years. Anyway, we used the resulting CPUE indices in scenario 17_0c.

Comment 8: Consider scenarios with catchability and/or total selectivity breaking at a third point in 2010 (or a better year).

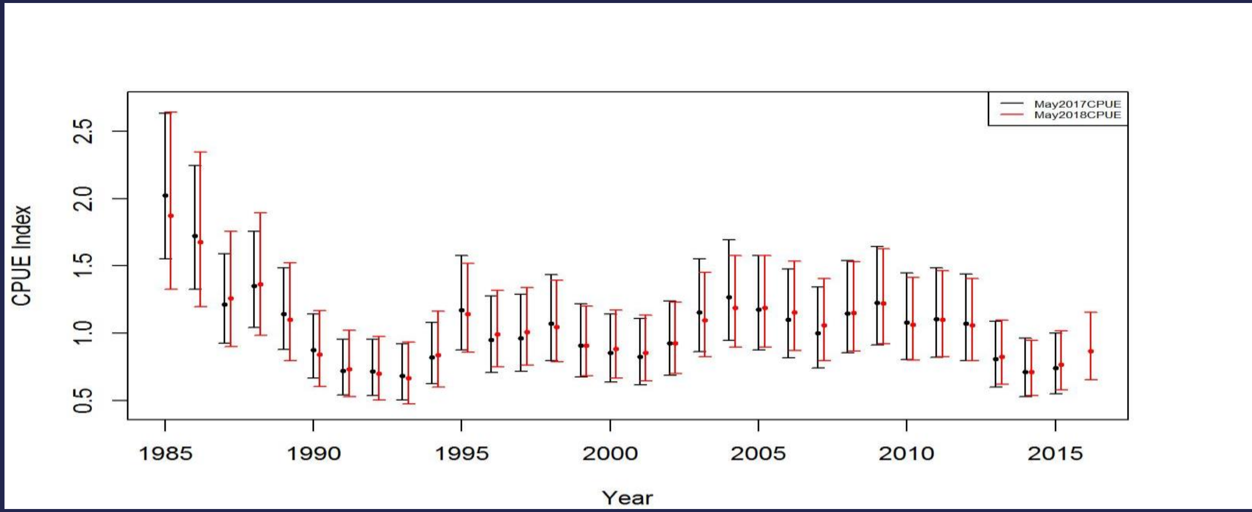
Response:
We considered scenario 17_0d with different sets of catchability and total selectivity for 1985/86–2004/05; 2005/06–2012/13; and 2013/14–2016/17.

September 2017 CPT (major) comments continued

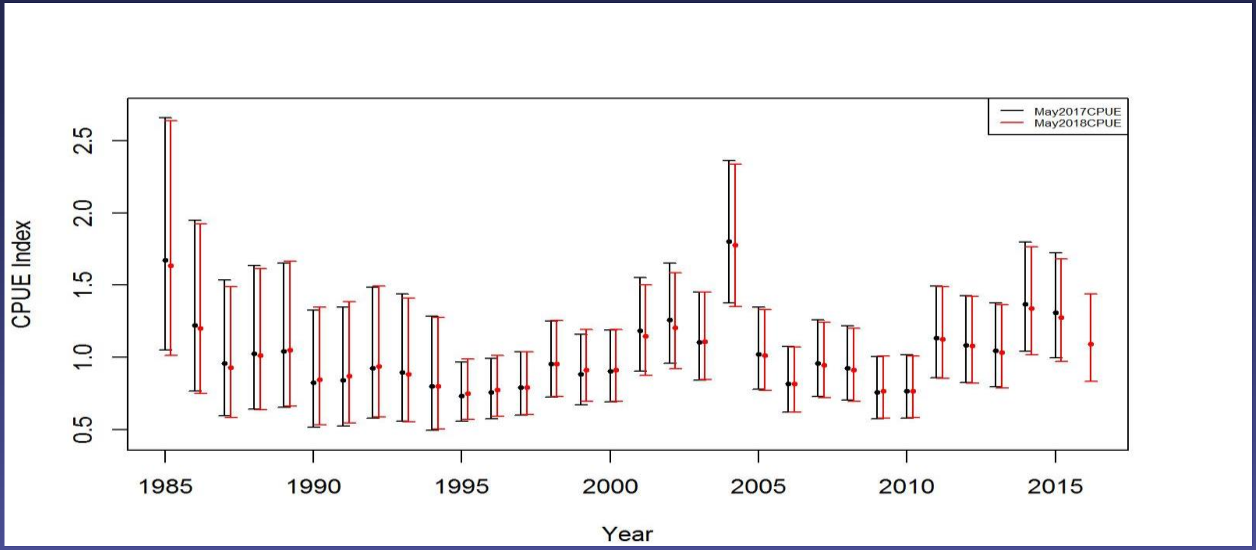
- **Comment 9: Provide a comparison between the previous CPUE standardization (May 2017) and any new standardization (May 2018) methods that are applied.**

Response:

WAG



EAG



September 2017 CPT (major) comments continued

- **Comment 10: Include last year’s model as a scenario for consideration.**

Response:

- *We have included last year’s model as scenario May17Sc9 to reflect scenario 9 with knife-edge maturity selectivity, which was accepted last year.*

- **Comment 11: Overall model recommendation for May 2018: base model from last year (equilibrium initial abundance, knife edge maturity, both CPUE analyses with any significant interaction terms).**

Response:

Done.

October 2017 SSC (major) comments

- **Comment 1: The SSC appreciates the CPT's consideration of model number convention and their recommendation to move forward with the modelling convention adopted by the Groundfish Plan Teams.**

Response:

- *Done*

- **Comment 2: Although the use of chela height-carapace size regression lines has been validated for *Chionoecetes* crabs (snow, Tanner), the SSC expressed concern that the use of this approach to determine maturity may not be appropriate for lithodid (king) crabs. The SSC recommends that efforts be made to verify this relationship in lab or field experiments, as well as to review the available literature and application of this approach for other non-*Chionoecetes* species.**

Response:

- *After analyzing a number of lithodid (king) crab stocks for size at maturity, Somerton and Otto (1986) observed that golden king crab provided a better separation of chela height growth at the onset of maturity than either red or blue king crabs (see Appendix C). We have also provided a literature review on king crab maturity determination in Appendix C, which supports the breakpoint type of analysis for male 50% maturity determination.*

October 2017 SSC comments continued

- **Comment 3: The SSC supports the exploration of the VAST geospatial model for investigation of fishery catch rate data, but cautions that the nonrandom nature of fisheries data adds an additional challenge to the standard assumptions of independence between the underlying density and the process of observation beyond that of standard statistically-designed survey programs.**

Response:

- *We did a preliminary run of VAST for observer CPUE standardization and described its advantage and limitation (see response to CPT comment 5).*

Comment 4: The SSC encourages the author to explore observer data and to discuss with the participants in the fishery potential changes in fisher behavior that may influence the relationship between fishery catch rates and crab abundance.

Response:

This is an ongoing process. We continue to explore this with the industry input and external experts.

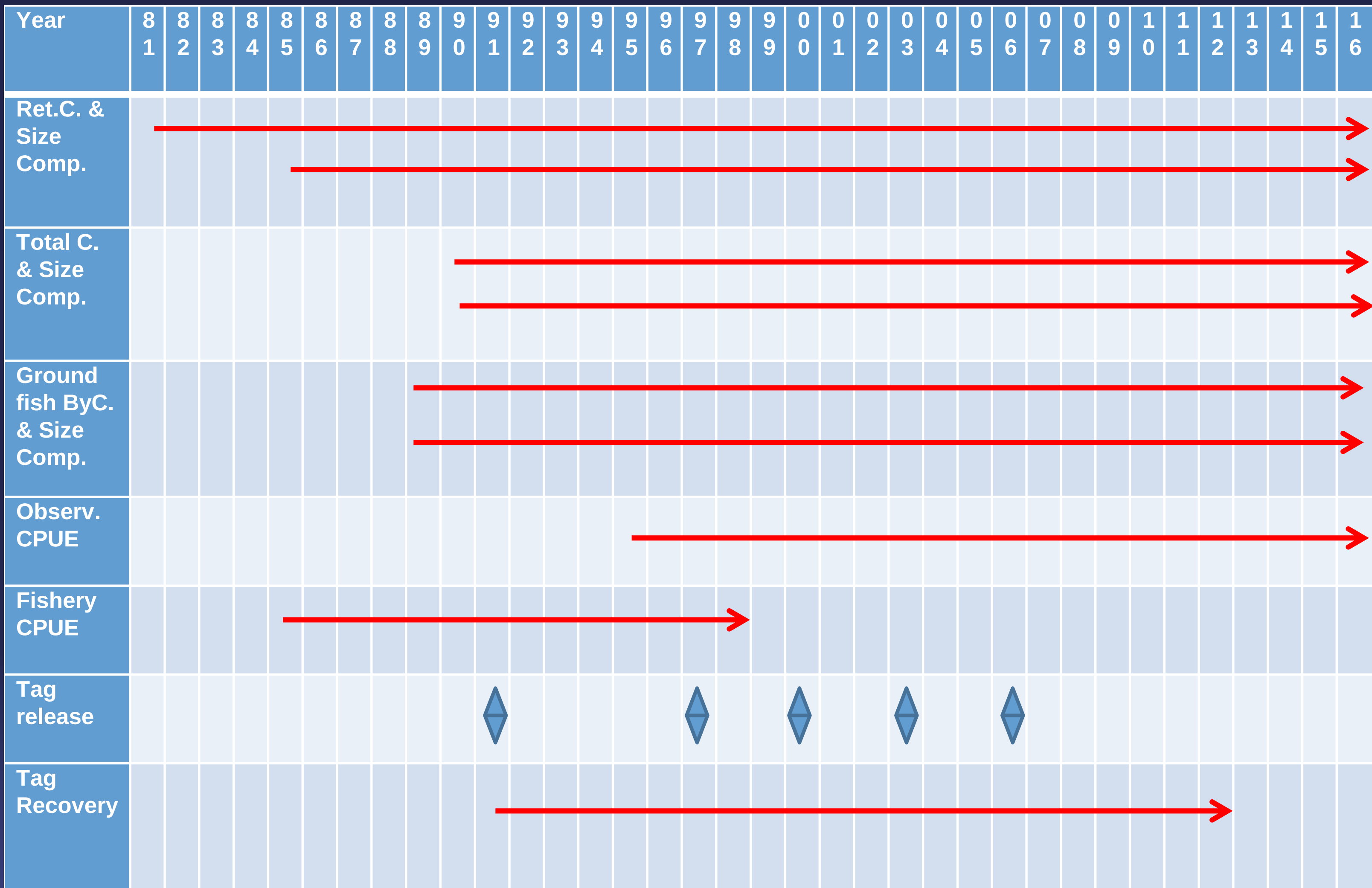
October 2017 SSC (major) comments

- **Comment 5: The SSC reiterates previous concerns that this stock assessment relies solely on fishery data, and therefore carries a higher degree of uncertainty than other model-based assessments for crab stocks. The SSC encourages recent and future efforts by the industry to include survey pots in their fishing activity in order to generate additional data to inform this analysis. The SSC extends its appreciation to the industry for their generous cooperative research efforts on this important crab stock.**

Response:

- *We recognized the higher degree of uncertainty in the assessment and therefore set the ABC using 25% buffer level. For the first time, we used the independent pot survey data in the model even though the time series is too short (2015 to 2017).*

EAG and WAG Data



EAG and WAG model scenarios

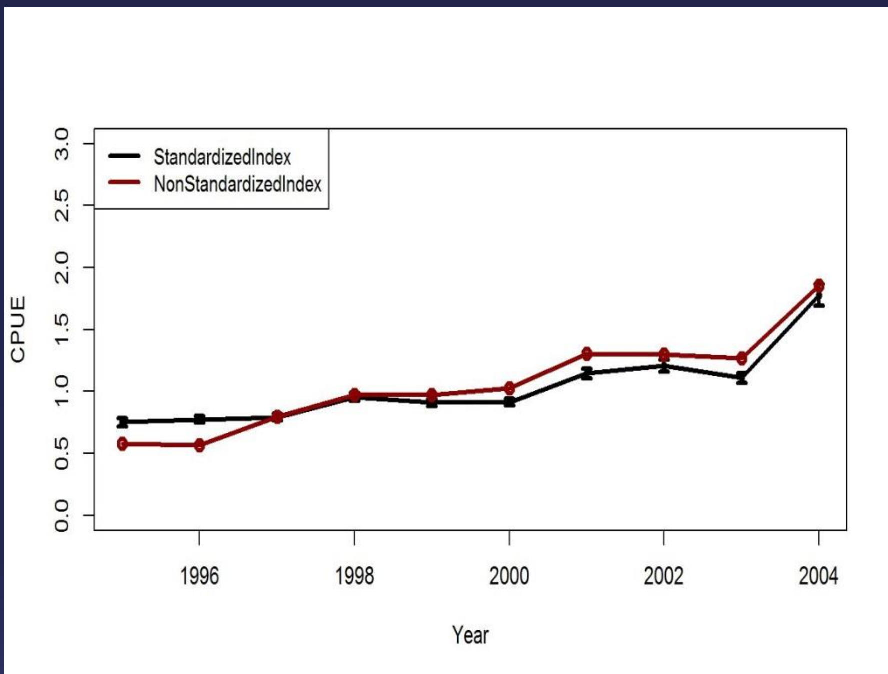
Sc.	Size-comp. weighting	Catchability and logistic total selectivity sets	Maturity	Standardized CPUE data type	Treatment of *M* an proxy MMB_{MSY}	*M* yr^{-1}
0b	Stage-1:Number of boat_days/trips Stage-2: Francis method	2	Knife-edge, 111 mm CL	Observer from 1995/96–2016/17 & Fish Ticket from 1985/86–1998/99; GLM variable selection by R square criteria	Estimate a common *M* using the combined EAG and WAG data without an *M* prior	0.2254; Individual component's estimate: EAG: 0.2142 WAG: 0.2142
17_0	Stage-1:Number of boat_days/trips Stage-2: Francis method	2	Knife-edge, 111 mm CL	Observer from 1995/96–2016/17 & Fish Ticket from 1985/86–1998/99; GLM variable selection by R square criteria	Single *M* from combined EAG and WAG data; Tier 3 MMB_{MSY} reference points based on average recruitment from 1987–2012	0.21
17_0a	Stage-1:Number of boat_days/trips Stage-2: Francis method	2	Knife-edge, 111 mm CL	Observer CPUE by VAST & Fish Ticket CPUE by GLM; GLM variable selection by R square criteria	Single *M* from combined EAG and WAG data; Tier 3 MMB_{MSY} reference points based on average recruitment from 1987–2012	0.21
17_0b	Stage-1:Number of boat_days/trips Stage-2: Francis method	2	Knife-edge, 111 mm CL	Observer & Fish Ticket CPUE by GLM; GLM variable selection by AIC	Single *M* from combined EAG and WAG data; Tier 3 MMB_{MSY} reference points based on average recruitment from 1987–2012	0.21

EAG and WAG scenarios continued

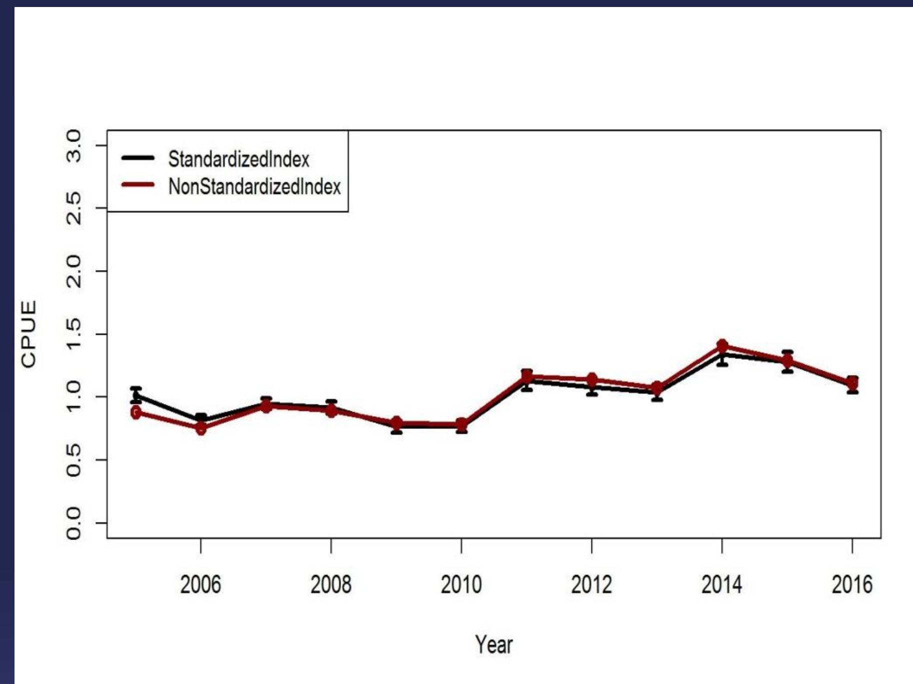
Sc.	Size-comp. weighting	Catchability and logistic total selectivity sets	Maturity	Standardized CPUE data type	Treatment of *M* an proxy MMB_{MSY}	*M* yr^{-1}
17_0c	Stage-1:Number of boat_days/trips Stage-2: Francis method	2	Knife-edge, 111 mm CL	Observer & Fish Ticket CPUE standardization considering Year:Area interaction; GLM variable selection by R square criteria	Single *M* from combined EAG and WAG data; Tier 3 MMB_{MSY} reference points based on average recruitment from 1987–2012	0.21
17_0d	Stage-1:Number of boat_days/trips Stage-2: Francis method	3	Knife-edge, 111 mm CL	Observer & Fish ticket; GLM variable selection by R square criteria	Three different total selectivity curves and catchability coefficients for 1985–2004, 2005–2012, and 2013–2016; single *M* from combined EAG and WAG data; Tier 3 MMB_{MSY} reference points based on average recruitment from 1987–2012	0.21
17_0e	Stage-1:Number of boat_days/trips Stage-2: McAllister and Ianelli method	2	Knife-edge, 111 mm CL	Observer & Fish ticket; GLM variable selection by R square criteria	Single *M* from combined EAG and WAG data; Tier 3 MMB_{MSY} reference points based on average recruitment from 1987–2012	0.21
17_0f (only for EAG)	Stage-1:Number of boat_days/trips Stage-2: Francis method	2	Knife-edge, 111 mm CL	Observer, Fish ticket, & fishery independent pot survey (2015–2016) in EAG; GLM variable selection by R square criteria	Fishery independent pot survey standardized CPUE are considered as a separate likelihood component for EAG; single *M* from combined EAG and WAG data; Tier 3 MMB_{MSY} reference points based on average recruitment from 1987–2012	0.21

Fig. B.1. Trends in non-standardized and standardized CPUE indices with +/- 2 SE by GLM for EAG. Standardized indices: black line and non-standardized indices: red line. Variables selected by R square criteria.

1995/96 – 2004/05



2005/06 – 2016/17

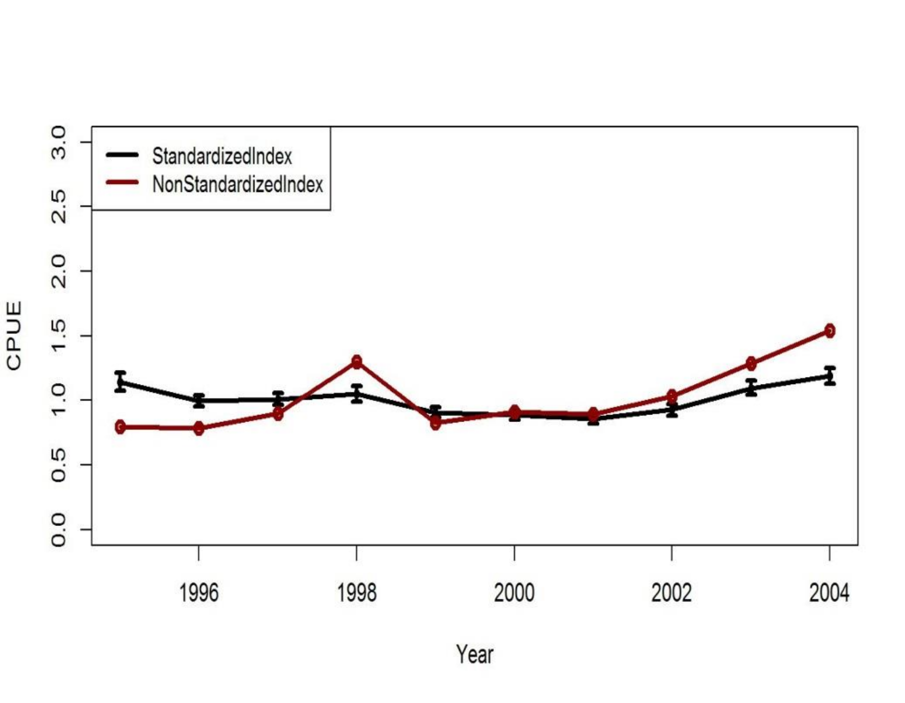


Ln(CPUE) = Year + Gear + Captain + Area + ns(Soak, df=4),
family = negative binomial (theta = 1.37)

Ln(CPUE) = Year + Captain + Gear + ns(Soak, df=11),
family = negative binomial (theta = 2.30)

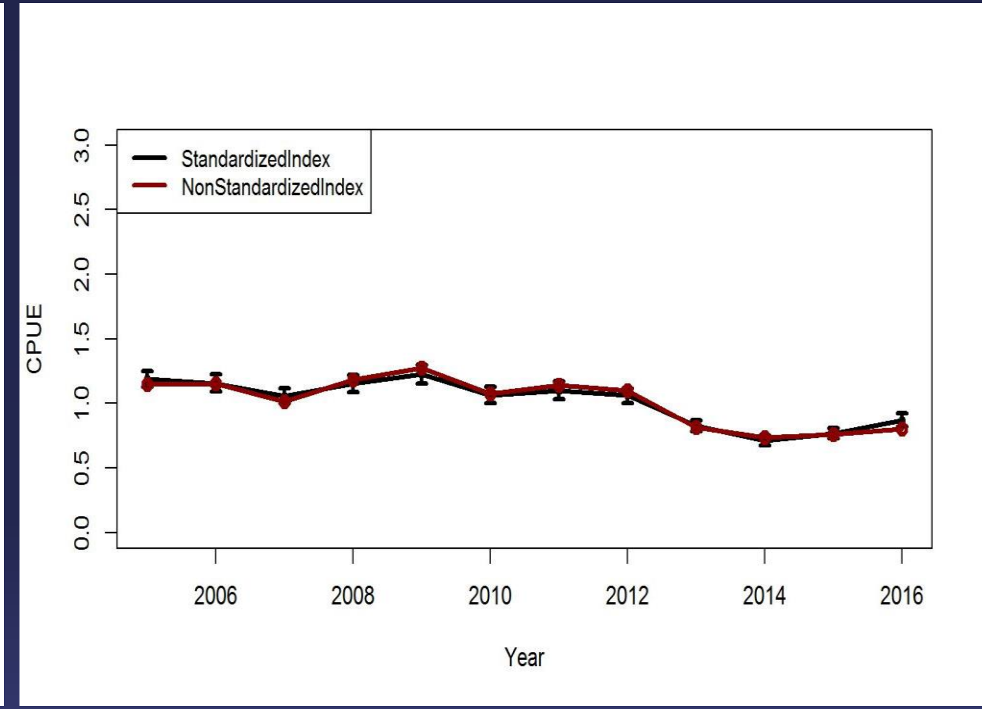
Fig. B.3. Trends in non-standardized and standardized CPUE indices with +/- 2 SE by GLM for WAG. Standardized indices: black line and non-standardized indices: red line. Variables selected by R^2 criteria.

1995/96 – 2004/05



Ln(CPUE) = Year + Captain + Gear + ns(Soak, df=10) + Area,
family = negative binomial (theta = 1.0)

2005/06 – 2016/17



Ln(CPUE) = Year + Area + Gear +ns(Soak, df=5) , Soak forced in
family = negative binomial (theta = 1.17)

Year: Area interaction, GLM variable selected by R^2 criteria

EAG: $\ln(\text{CPUE}) = \text{Year} + \text{Gear} + \text{Captain} + \text{Area} + \text{Year:Area} + \text{ns}(\text{Soak}, 4)$ (B.13)

for 1995/96–2004/05 [θ=1.37, $R^2 = 0.27$, with $\text{ns}(\text{Soak}, 4)$ forced in] . Number of NAs

$\ln(\text{CPUE}) = \text{Year} + \text{Captain} + \text{Gear} + \text{ns}(\text{Soak}, 11)$ (B.14)

for 2005/06–2016/17 [$\theta = 2.30$, $R^2 = 0.12$]. Year:Area not selected.

Year: Area interaction continued

- WAG: $\ln(\text{CPUE}) = \text{Year} + \text{Captain} + \text{Gear} + \text{ns}(\text{Soak}, 10) + \text{Area}$ (B.15)

for 1995/96–2004/05 [θ=1.00, $\text{R}^2 = 0.2$]

. Year:Area not selected.

- $\ln(\text{CPUE}) = \text{Year} + \text{Area} + \text{Year:Area} + \text{ns}(\text{Soak}, 5)$ (B.16)

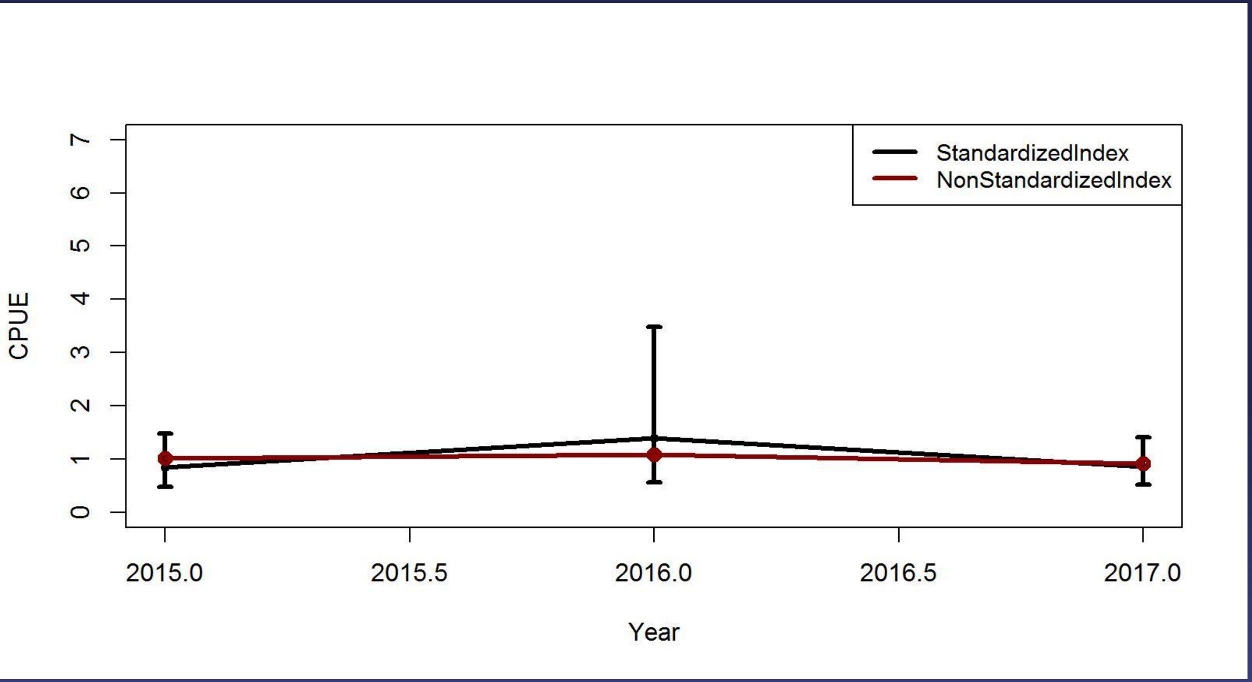
- for 2005/06–2016/17 [θ=1.17, $\text{R}^2 = 0.14$ with $\text{ns}(\text{Soak}, 5)$ forced in]

Number of NAs.

CPUE index by GLM for independent pot survey data

Figure B.5. Trends in non-standardized and standardized CPUE indices with +/- 2 SE for independent survey data from EAG during 2015–2017. Standardized indices: black line and non-standardized indices: red line. Variables selected by R^2 criteria. Only 2015 and 2016 indices were used in scenario EAG17_0f because catch and size composition data were available up to 2016/17

2015/16 – 2017/18



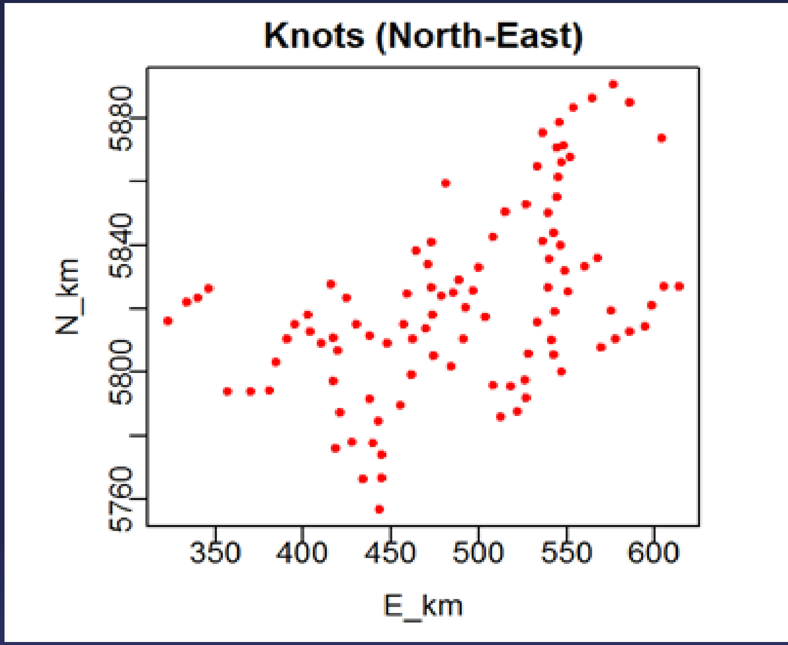
$$\ln(\text{CPUE}) = \text{Year} + \text{VesStringpotIDDatein} + \text{VesStringDatein} + \text{ns}(\text{Soak}, 11)$$

family = NB (theta = 1.37) (B.19)

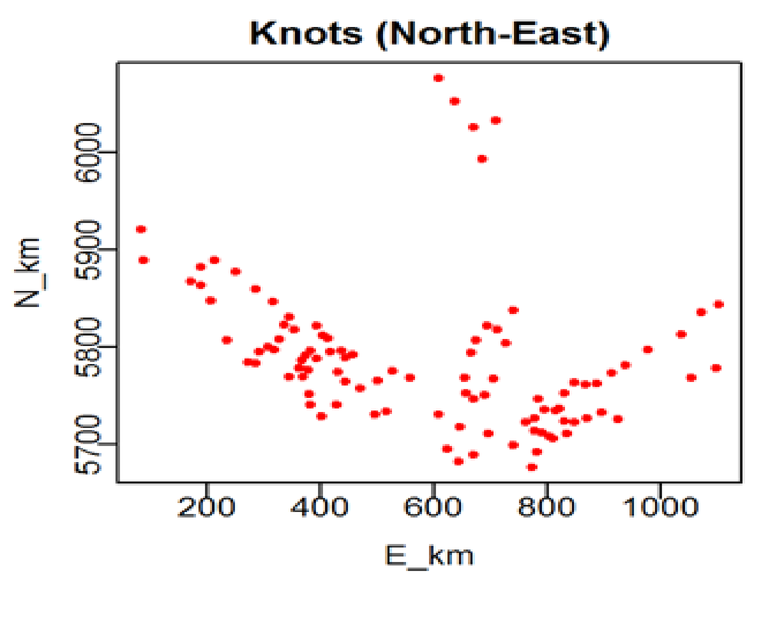
Observer CPUE by VAST

Figure B6. One hundred knots selected each for EAG (left panel) and WAG (right panel) for spatio-temporal deltaGLMM model fitting for CPUE indices estimation.

EAG



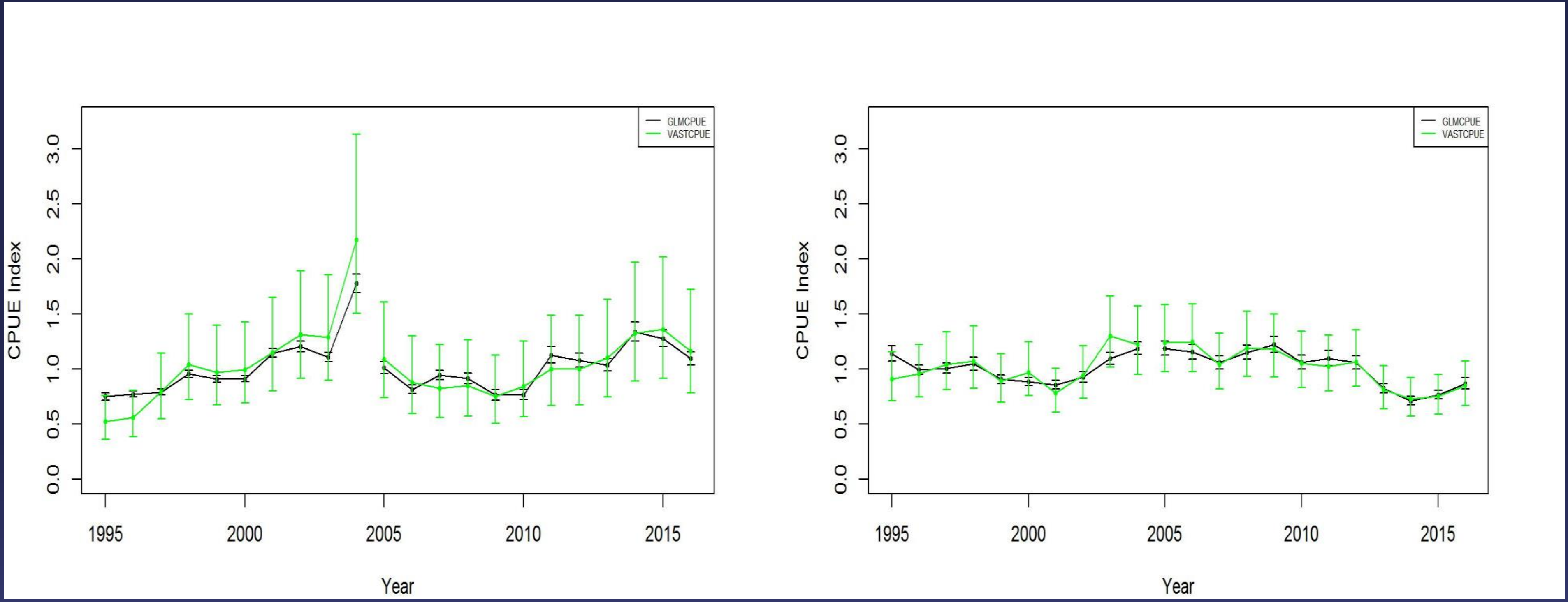
WAG



Observer CPUE by VAST

Figure B.7. Comparison of GLM (black) and VAST (green) estimated CPUE indices with +/- 2 SE for Aleutian Islands golden king crab in EAG (left panel) and WAG (right panel) for 1995/96–2016/17. GLM variables selected by R^2 criteria.

EAG WAG



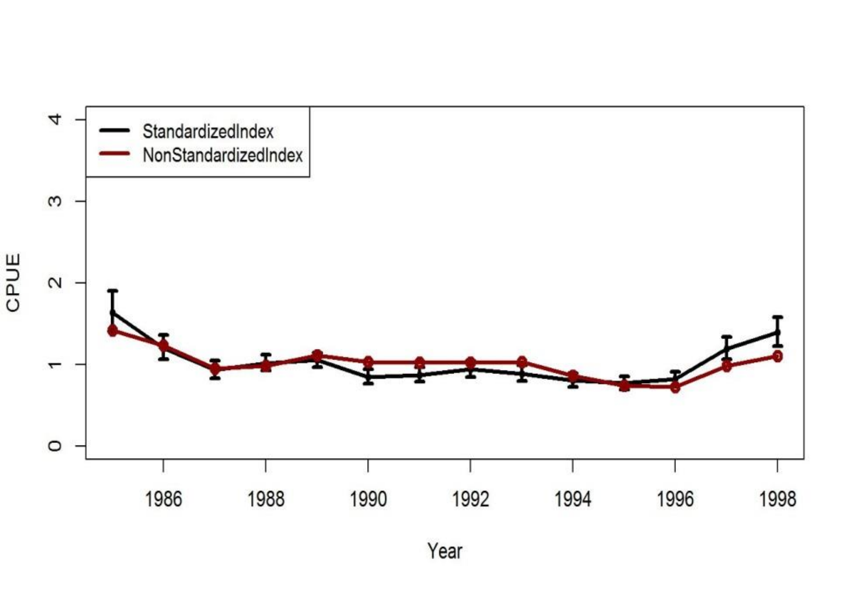
$$P_i = logit^{-1}\left[d^{(p)}_{T(i)} + r^{(p)}_{v_i} + \omega^{(p)}_{J(i)} + \varepsilon^{(p)}_{J(i),T(i)}\right] \quad \text{(B.20) VAST}$$

$$\lambda_i = w_i exp\left[d^{(\lambda)}_{T(i)} + r^{(\lambda)}_{v_i} + \omega^{(\lambda)}_{J(i)} + \varepsilon^{(\lambda)}_{J(i),T(i)}\right] \quad \text{(B.21) VAST}$$

Fish Ticket CPUE by GLM

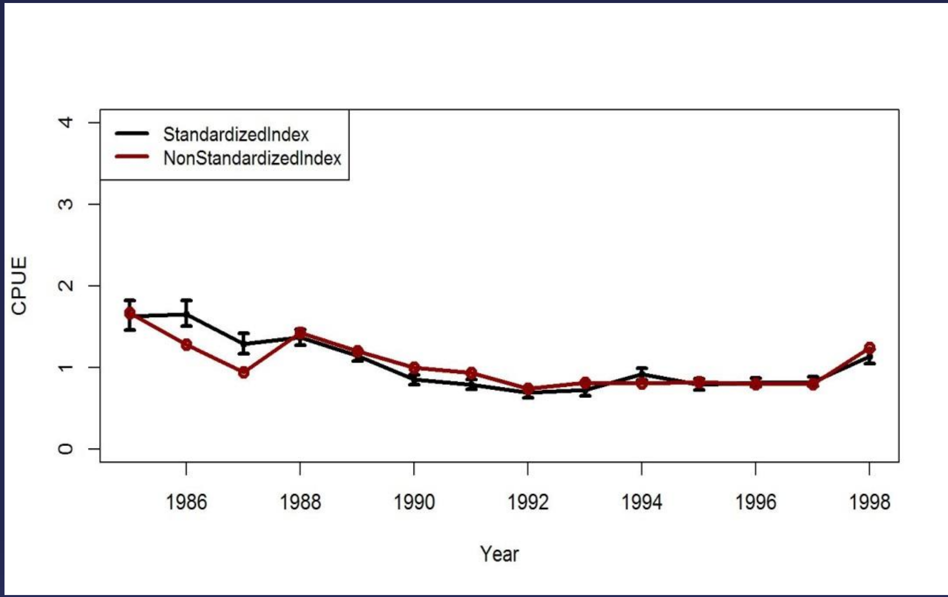
Figures B.8 and B.9. Trends in non-standardized and standardized (lognormal GLM) CPUE indices with +/- 2 SE for EAG (left panel) and WAG (right panel). The 1985/86–1998/99 fish ticket data set was used. Standardized indices: black line and non-standardized indices: red line. variable selection by R square criteria.

EAG



$$\ln(\text{CPUE}) = \text{Year} + \text{Captain} + \text{Area} + \text{Vessel} + \text{Month},\ R^2 = 0.504$$

WAG

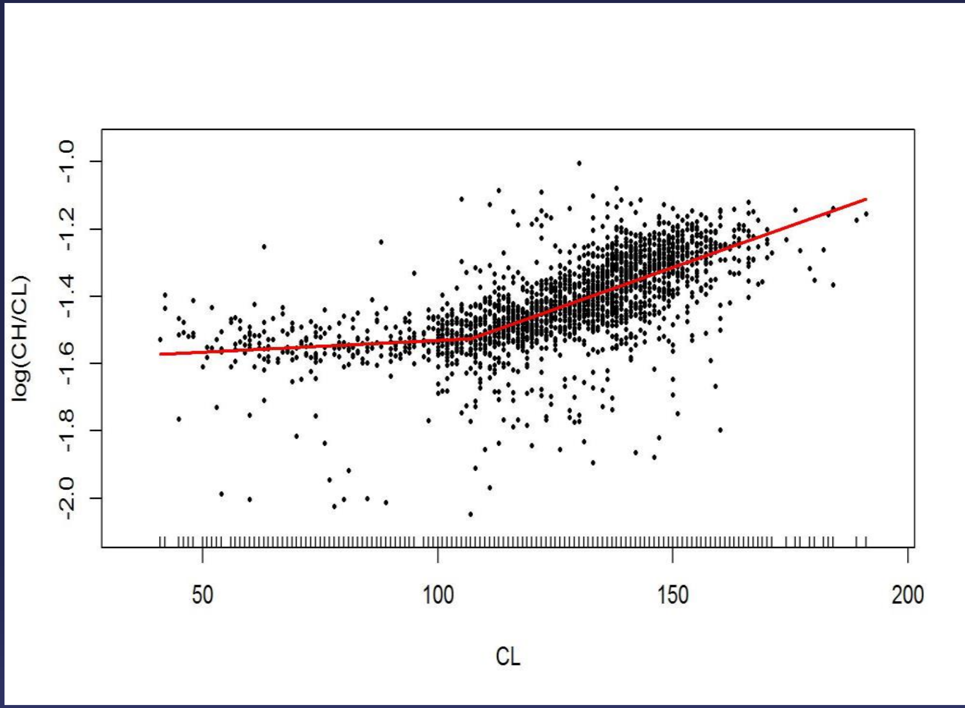


$$\ln(\text{CPUE}) = \text{Year} + \text{Captain} + \text{Vessel} + \text{Area},\ R^2 = 0.497$$

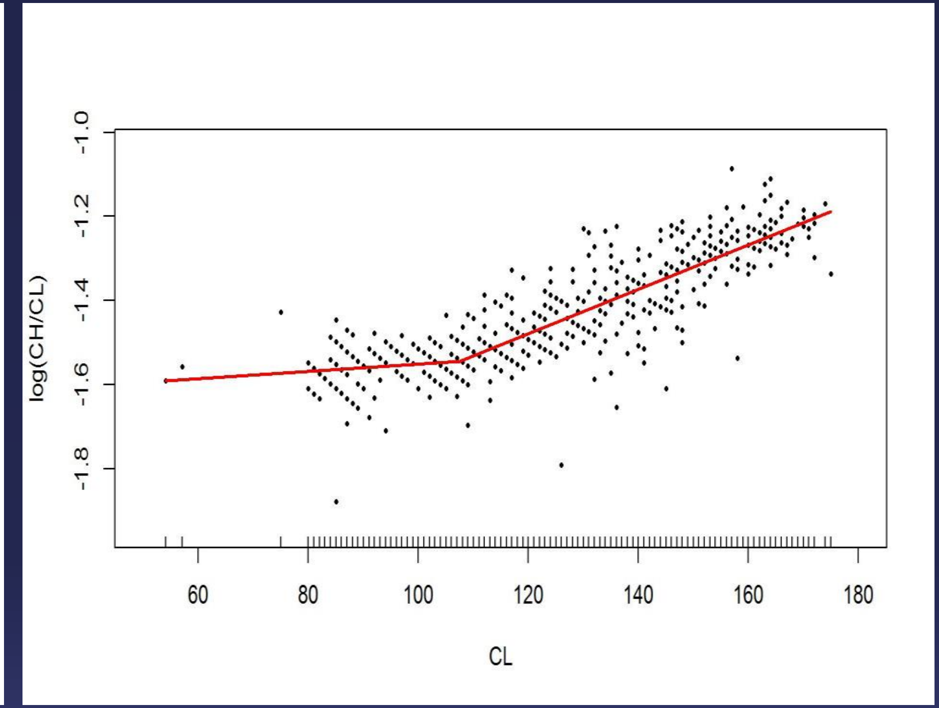
Knife-edge maturity by Breakpoint analysis

Figures C.1 and C.2. Segmented linear regression fit to ln(CH/CL) vs. CL data of males in EAG (left) and WAG (right).

EAG



WAG



ADFG is planning to collect more chela height and carapace length measurements from observer and market samples during the coming fishing season(s)

Bootstrap estimate of 50% maturity size breakpoint with 95% confidence limits:

Males	Median	Lower 95% Limit	Upper 95% Limit
EAG			
Maturity Breakpoint (mm CL)	107.02	85.12	111.02
WAG			
Maturity Breakpoint (mm CL)	107.85	103.46	126.03

Figure 1. Total and components negative log-likelihoods vs. *M* for **scenario 0b** model fit for EAG and WAG combined data. The *M* estimate was 0.2254 yr^{-1} (± 0.0199 yr^{-1}). The *M* profile indicates an *M* of 0.2142 yr^{-1} at the minima of negative total likelihood for combined data as well as individual date sets. Hence an *M* of 0.21 yr^{-1} was used in all scenarios.

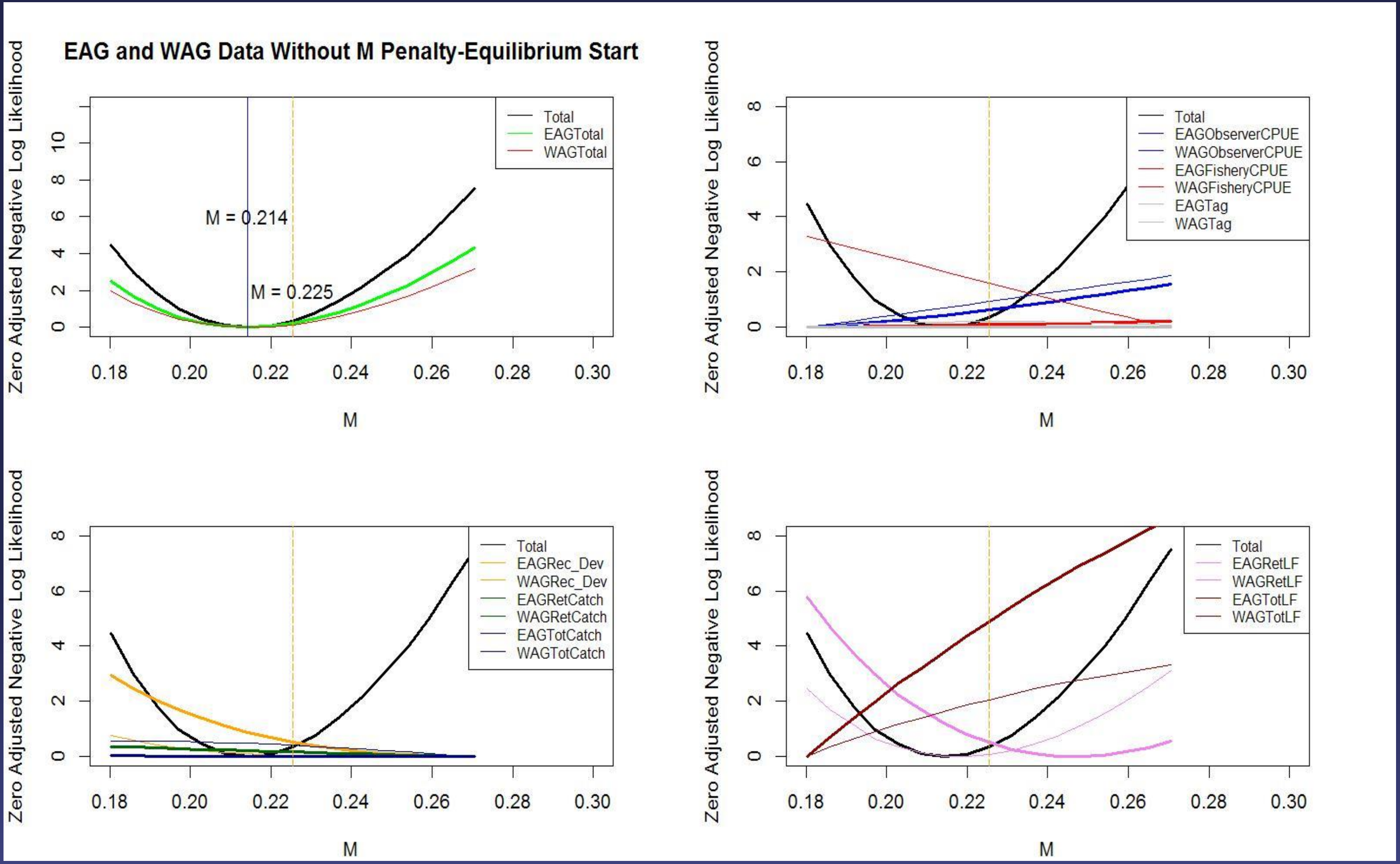


Figure 11. Predicted (line) vs. observed (bar) retained catch relative length frequency distributions under scenarios 17_0 (black line), 17_0a (orange line), 17_0b (red line), 17_0c (blue line), 17_0d (violet line), 17_0e (dark green line), and 17_0f (green line) for golden king crab in the EAG, 1985/86 to 2016/17. This color scheme is used in all other graphs.

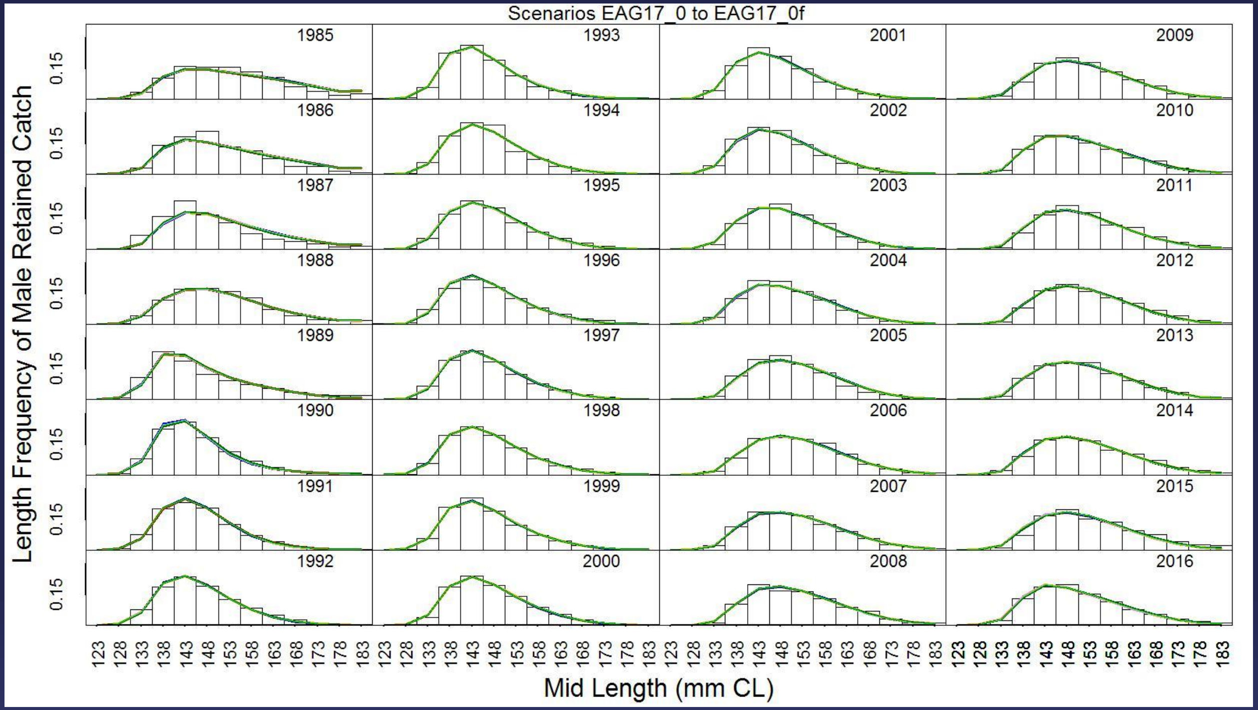


Figure 12. Predicted (line) vs. observed (bar) total catch relative length frequency distributions under scenarios 17_0 to 17_0f for golden king crab in the EAG, 1990/91 to 2016/17.

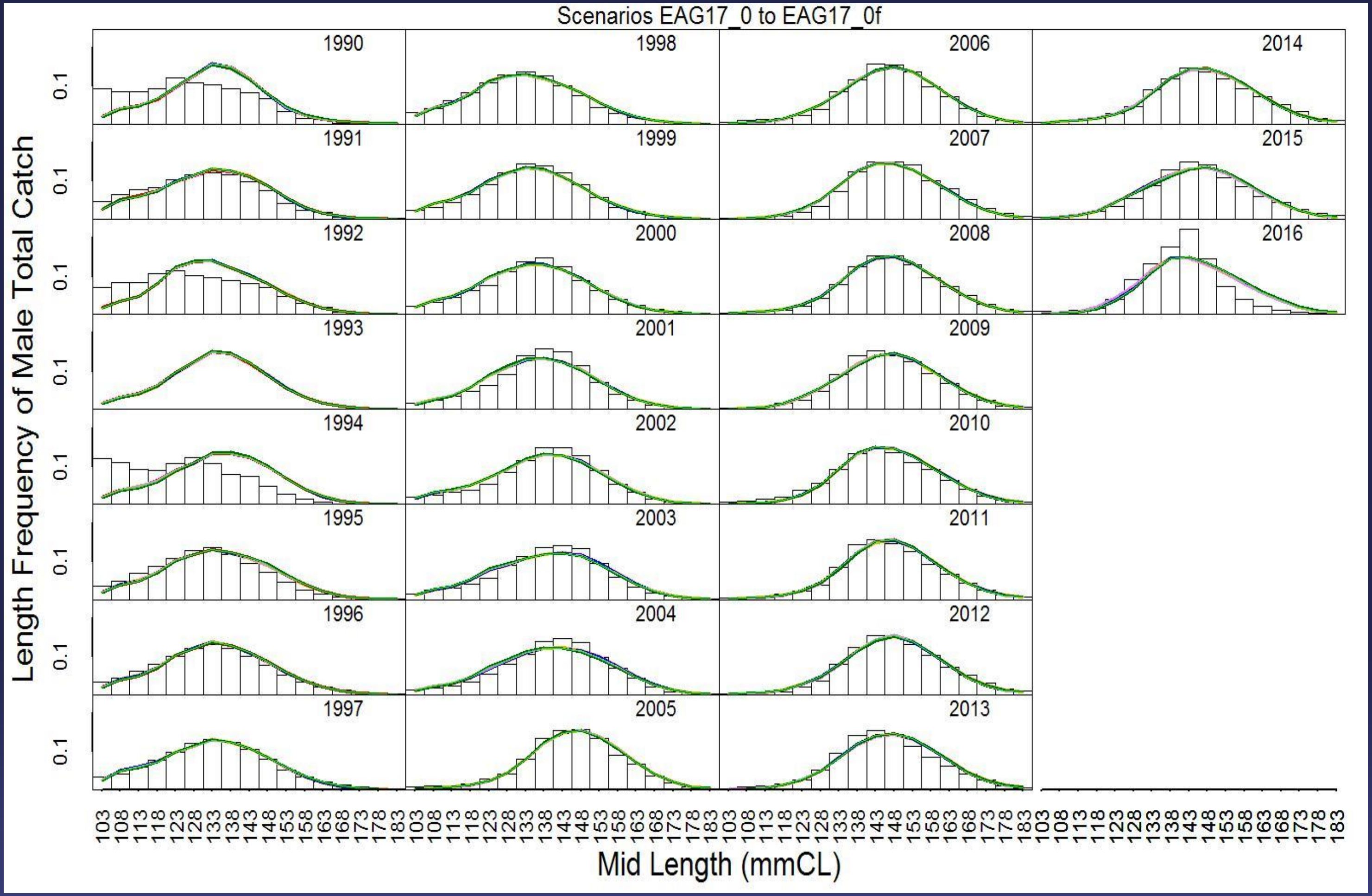


Figure 13. Predicted (line) vs. observed (bar) groundfish (or trawl) discarded bycatch relative length frequency distributions under scenarios 17_0 to 17_0f for golden king crab in the EAG, 1989/90 to 2016/17. Note that this data set was not used in the model fitting.

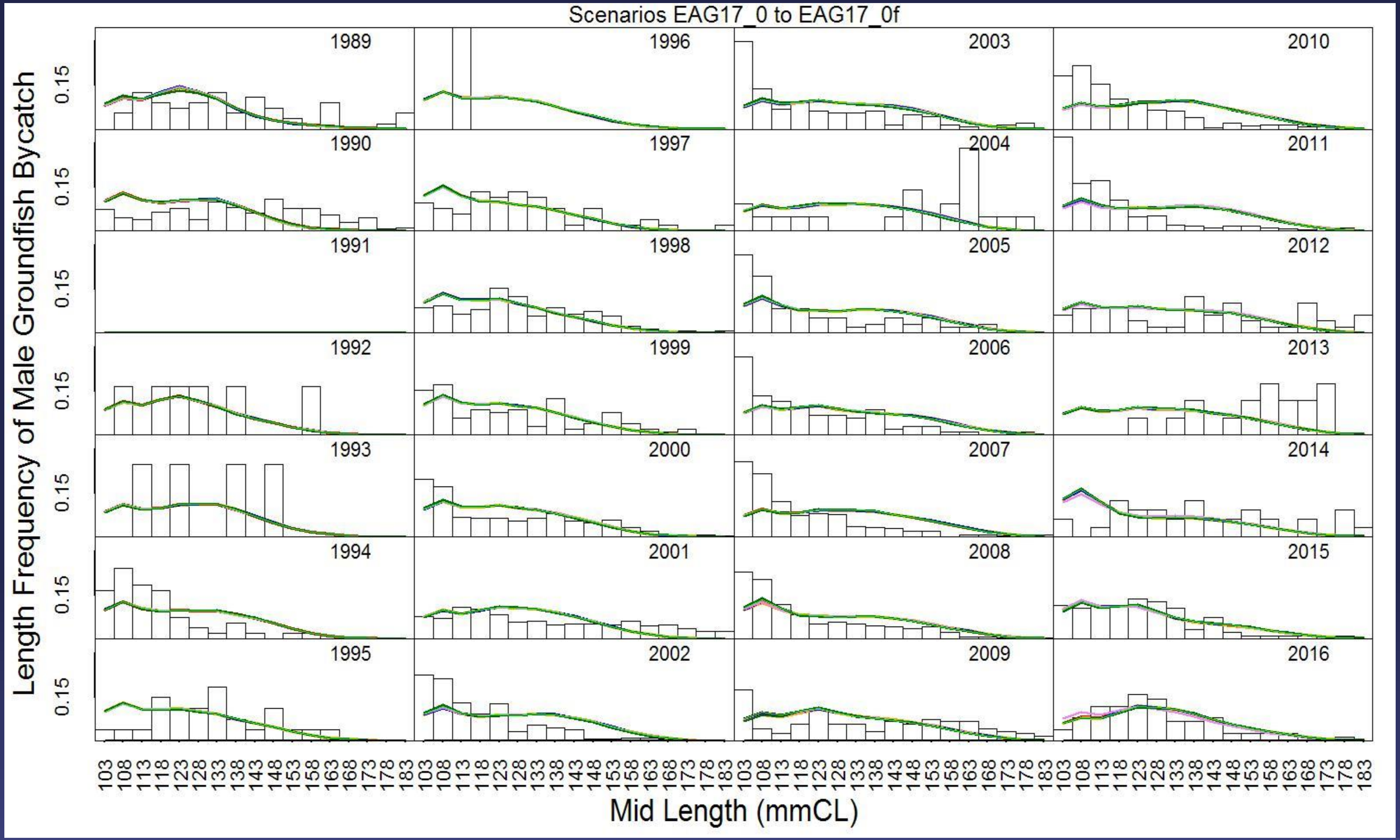
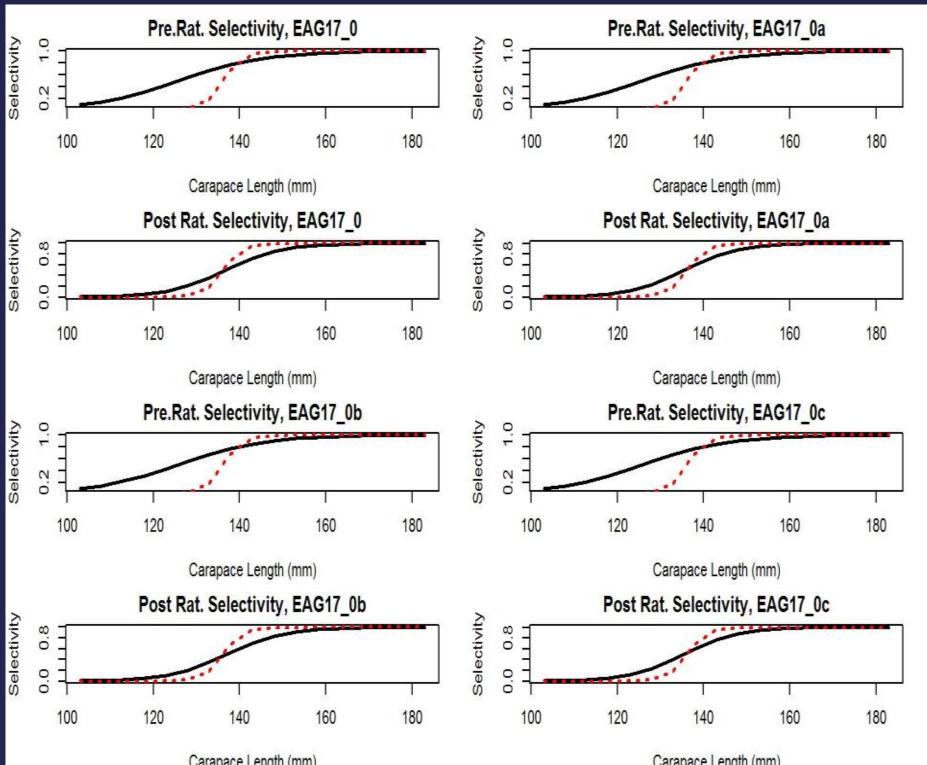
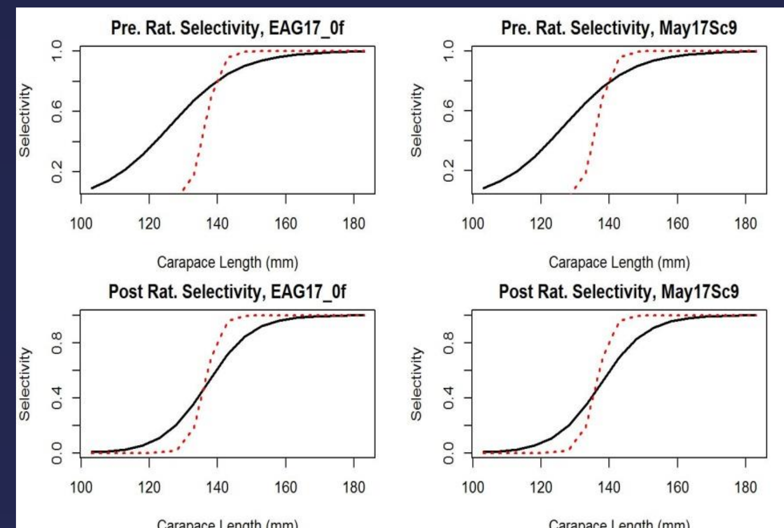


Figure 14. Estimated total (black solid line) and retained selectivity (red dotted line) for pre- and post- rationalization periods under scenarios 17_0 to May 2017 Sc9 model fits to golden king crab data in the EAG.





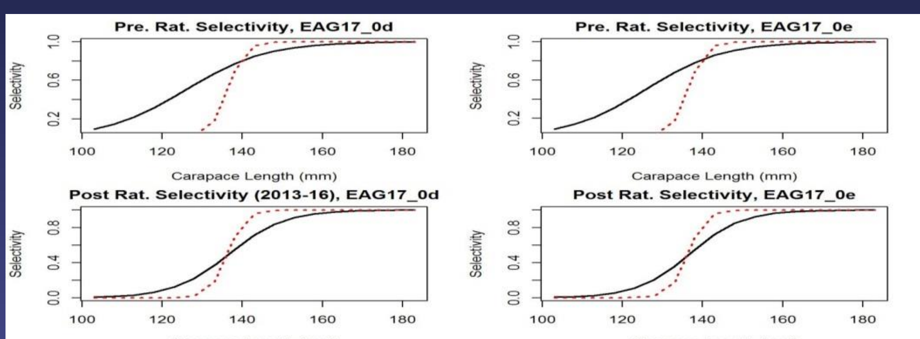


Fig. 26. Comparison of input CPUE indices (open circles with +/- 2 SE) with predicted CPUE indices (colored solid lines) for EAG, 1985/86 – 2016/17
.
Top left: 17_0 vs. 17_0a, Top right: 17_0b vs. 17_0c,
Bottom left: 17_0d vs. 17_0e, and bottom right: 17_0f vs. May17Sc9.

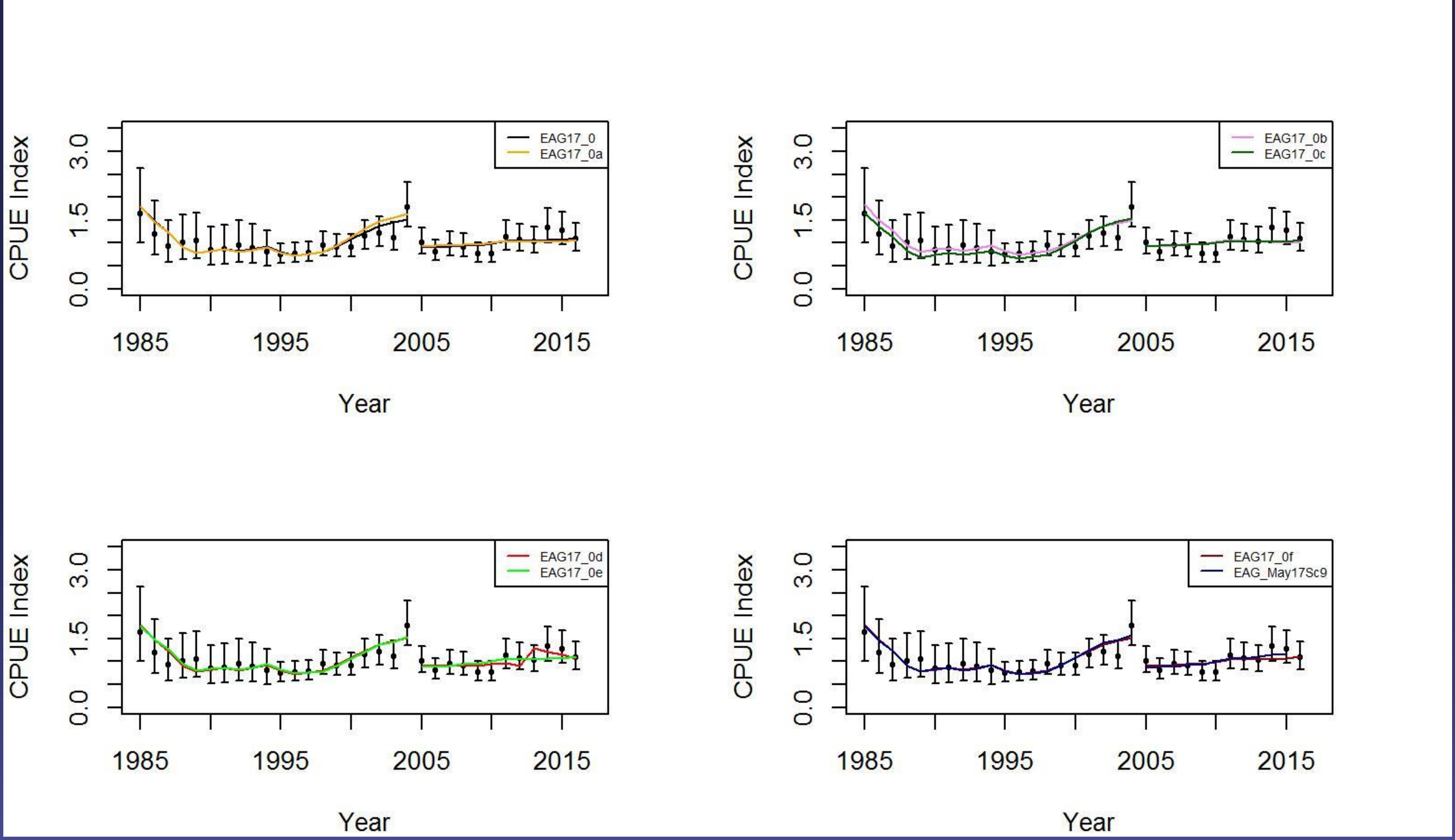
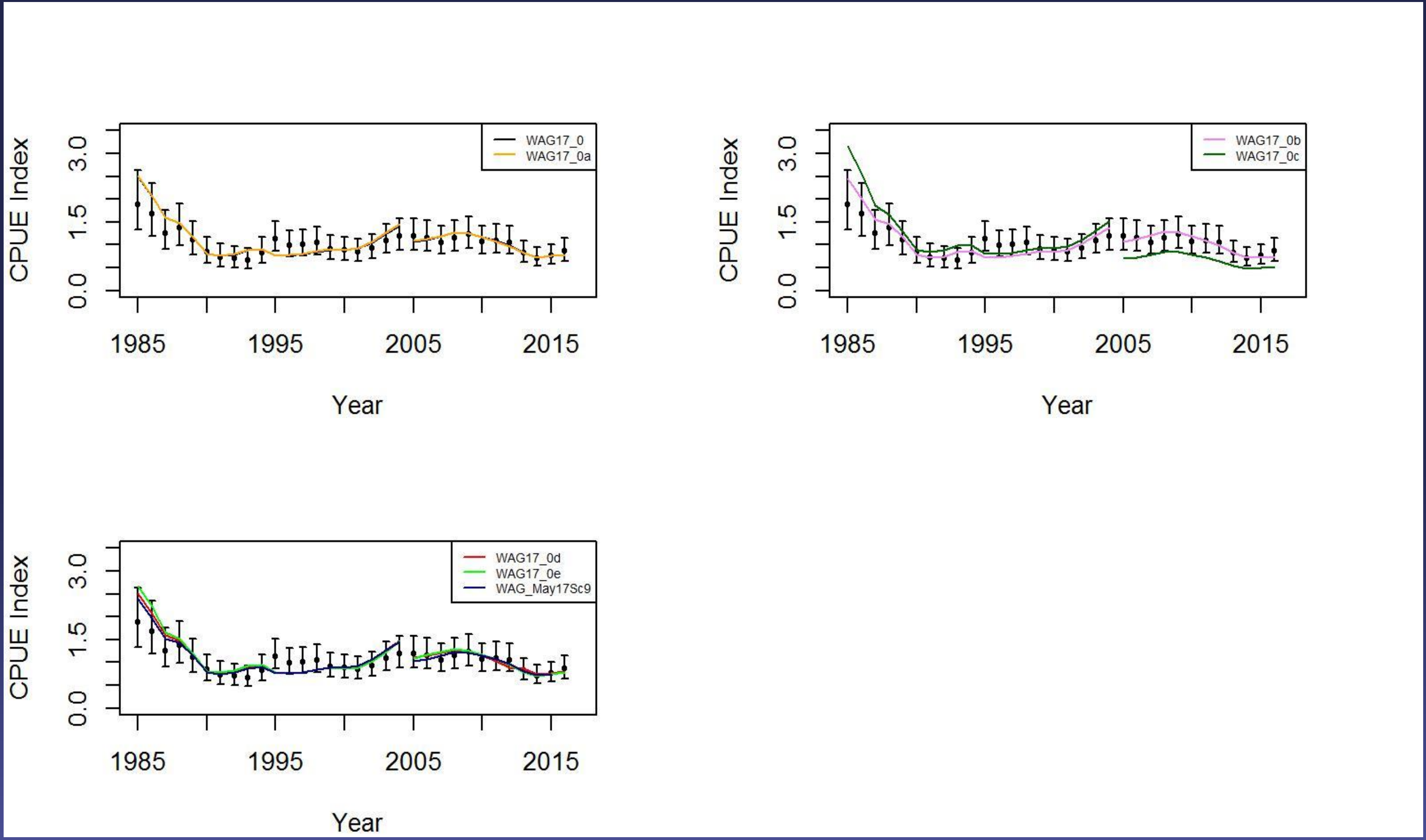
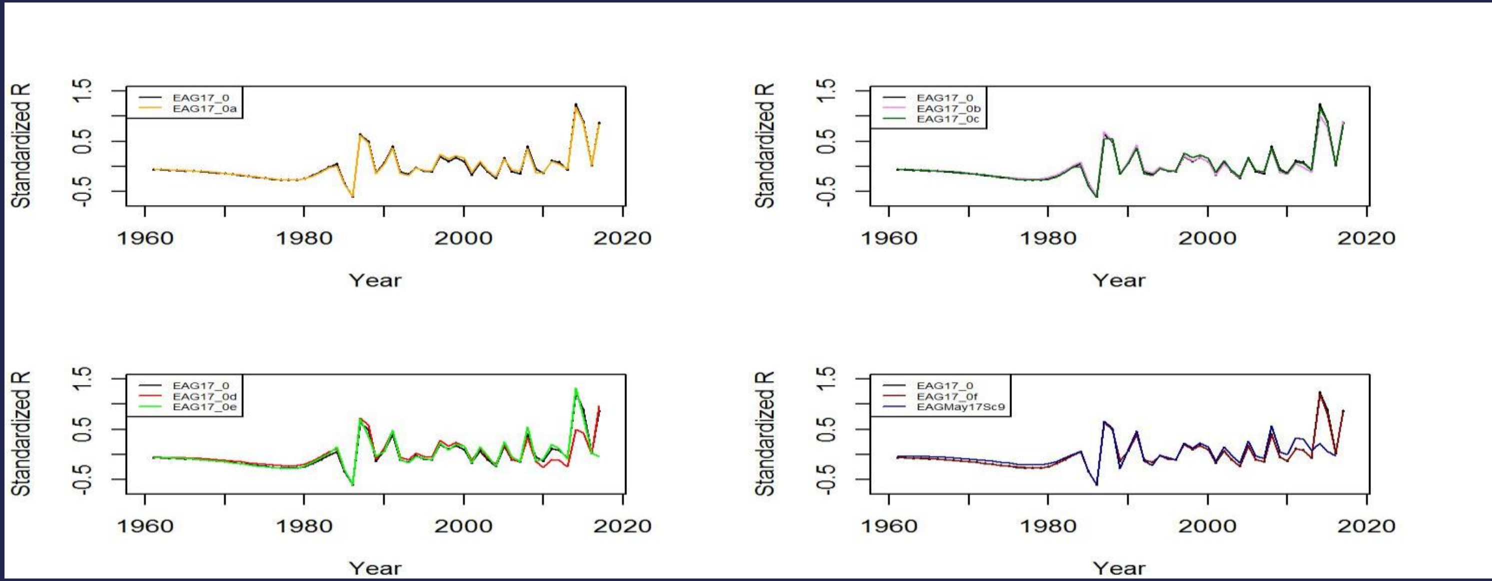


Fig. 44. Comparison of input CPUE indices (open circles with +/- 2 SE) with predicted CPUE indices (colored solid lines) for WAG, 1985/86 – 2016/17
.
Top left: 17_0 vs. 17_0a, Top right: 17_0b vs. 17_0c,
Bottom left: 17_0d vs. 17_0e, vs.May17Sc9.



Figs. 16 and 34. Number of male recruits for scenarios (Sc) 17_0 to May17Sc9 fits to EAG (top) and WAG (bottom) data, 1961 – 2017. The numbers were mean adjusted for comparison.

EAG



WAG

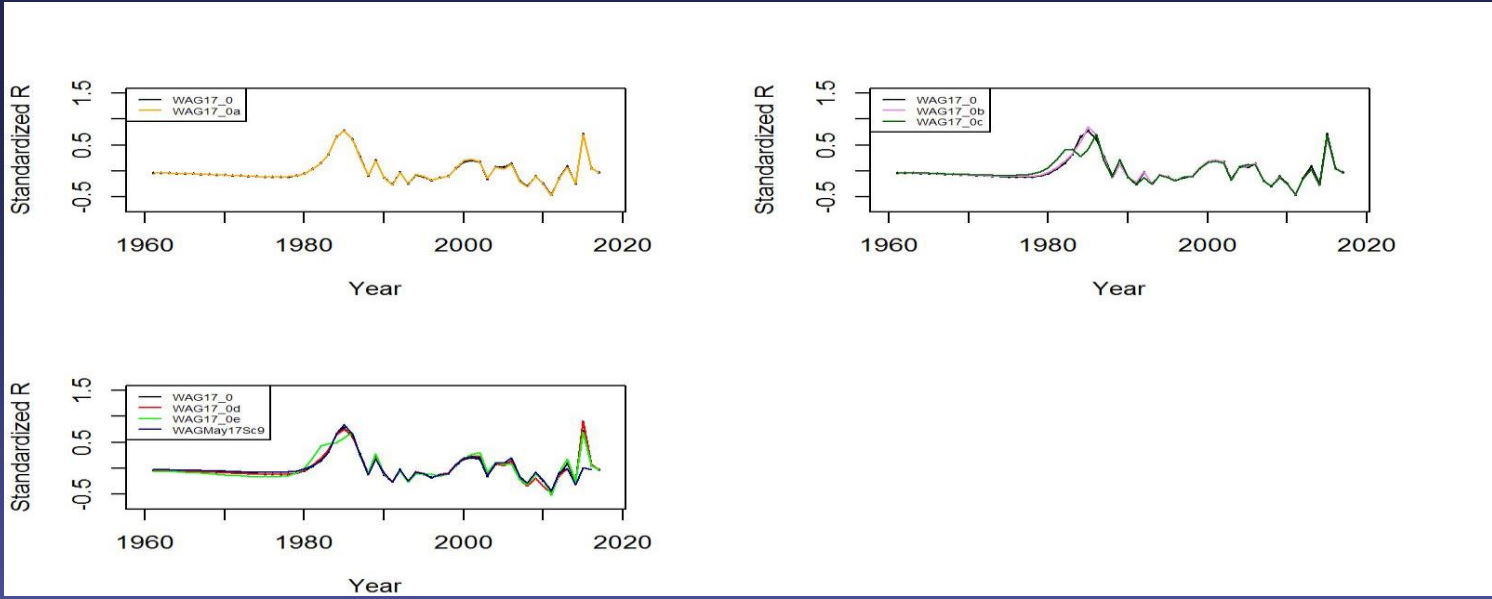


Figure 19. Observed (open circle) vs. predicted (solid line) retained catch (top left in each scenario set), total catch (top right in each scenario set), and groundfish bycatch (bottom left in each scenario set) of golden king crab for scenarios (Sc) 17_0 to May 2017Sc9, in EAG, 1981/82–2016/17.

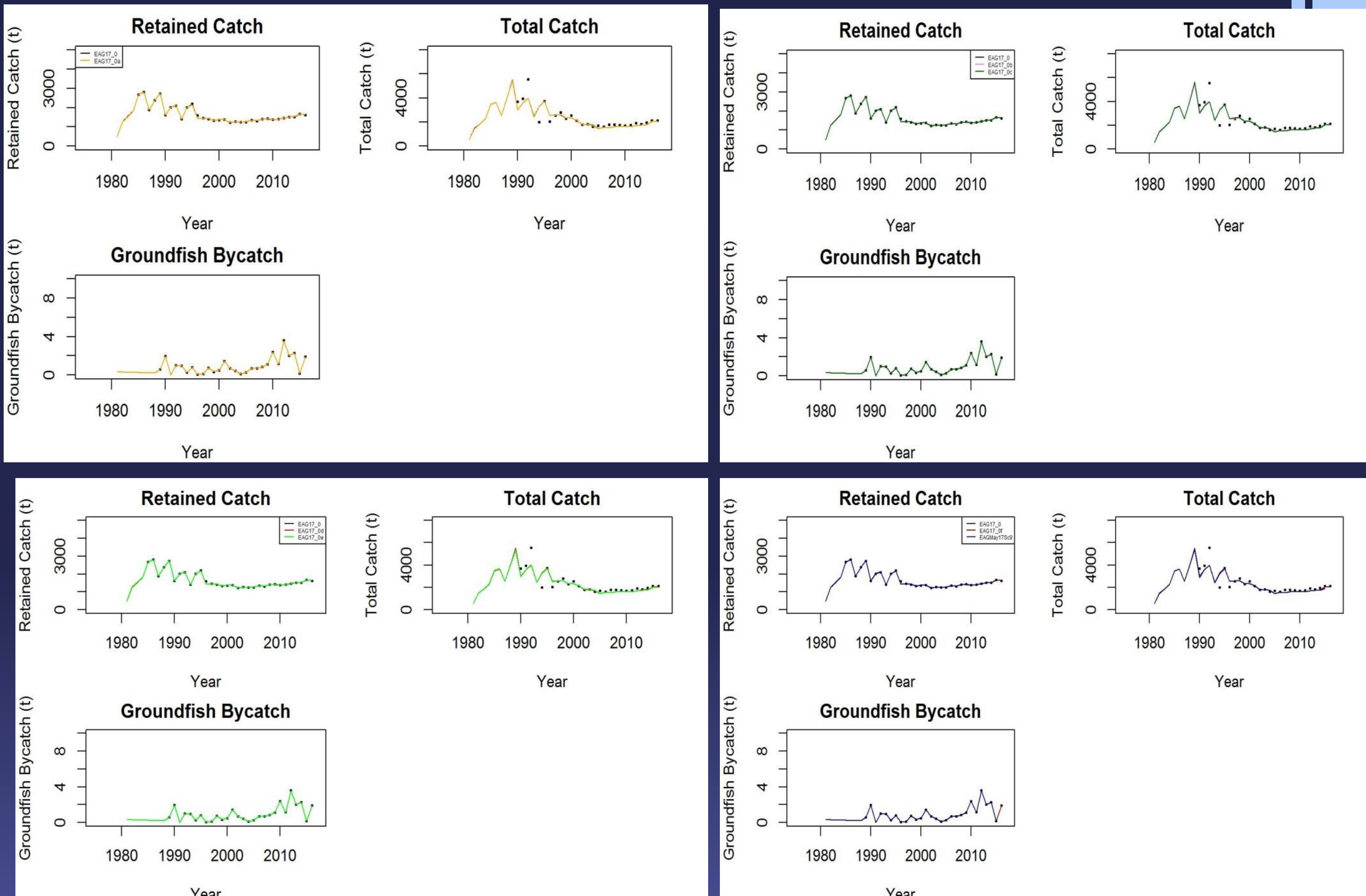
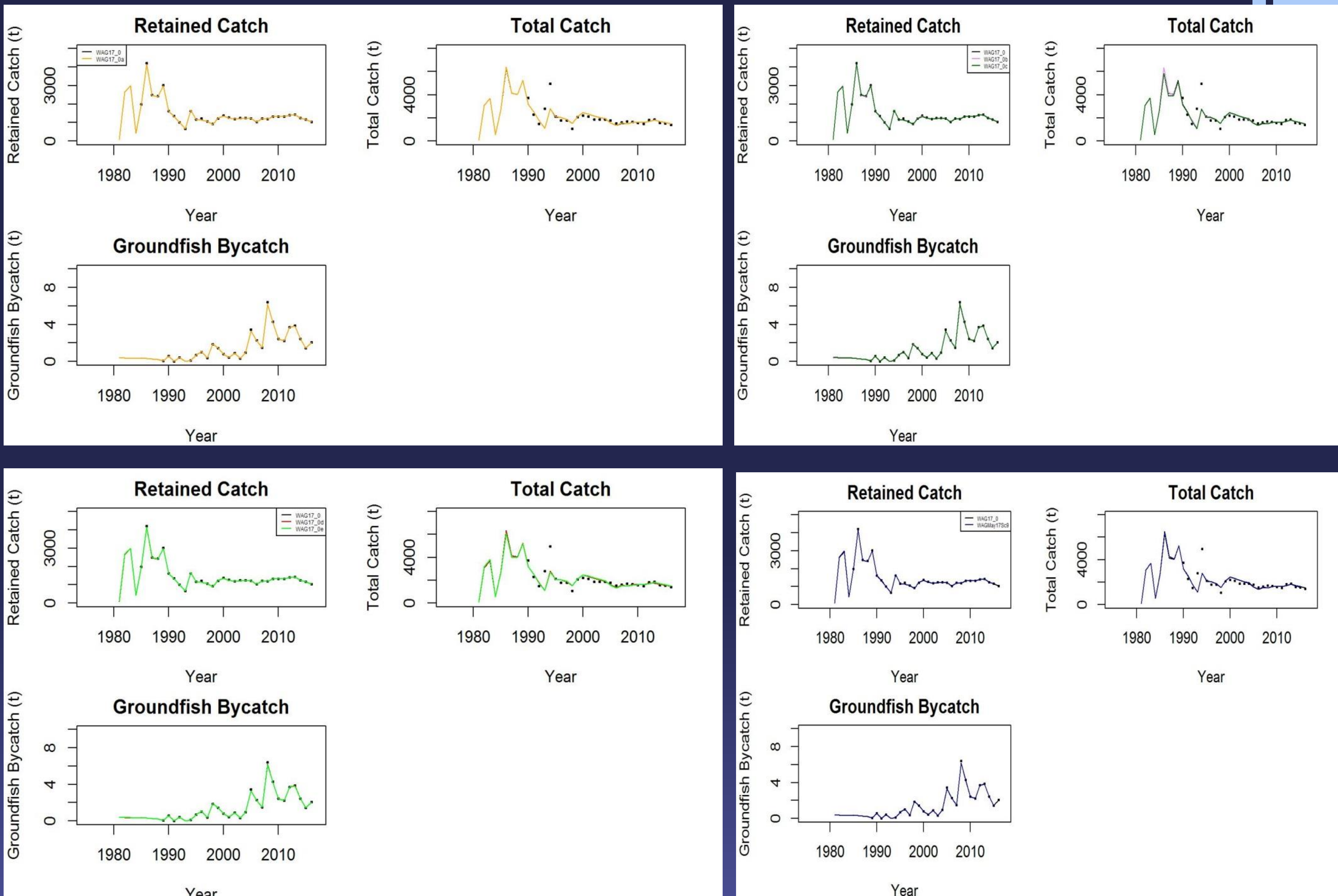
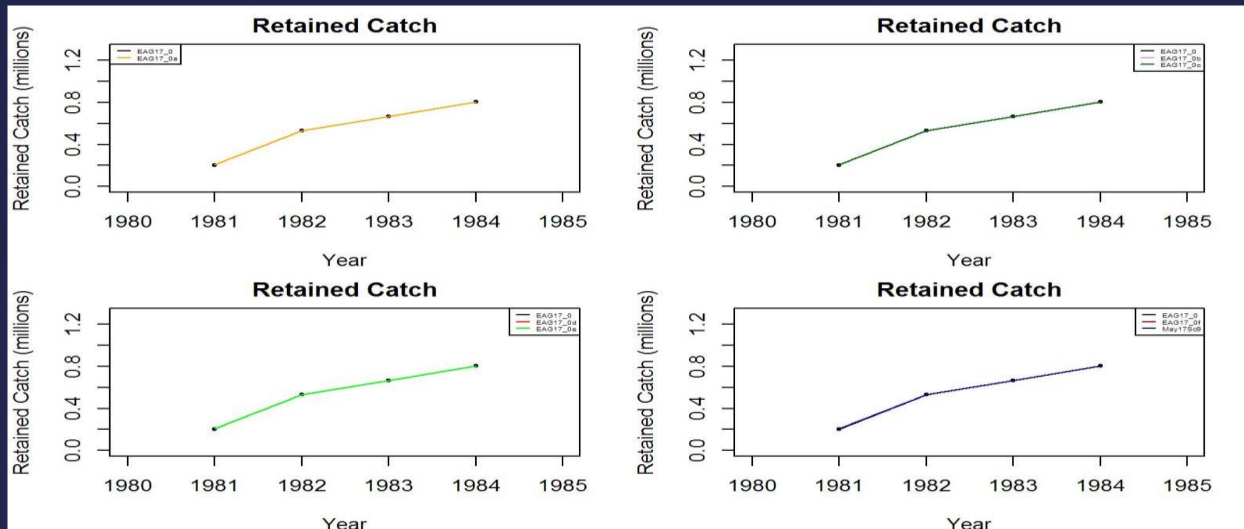


Figure 37. Observed (open circle) vs. predicted (solid line) retained catch (top left in each scenario set), total catch (top right in each scenario set), and groundfish bycatch (bottom left in each scenario set) of golden king crab for scenarios (Sc) 17_0 to May 2017 Sc9 fits in the WAG, 1981/82–2016/17.



Figures 20 and 38. Observed (open circle) vs. predicted (solid line) retained catch for (Sc) 17_0 to May 2017 Sc9 fits in the EAG (top) and WAG (bottom).1981/82–1984/85.

EAG



WAG

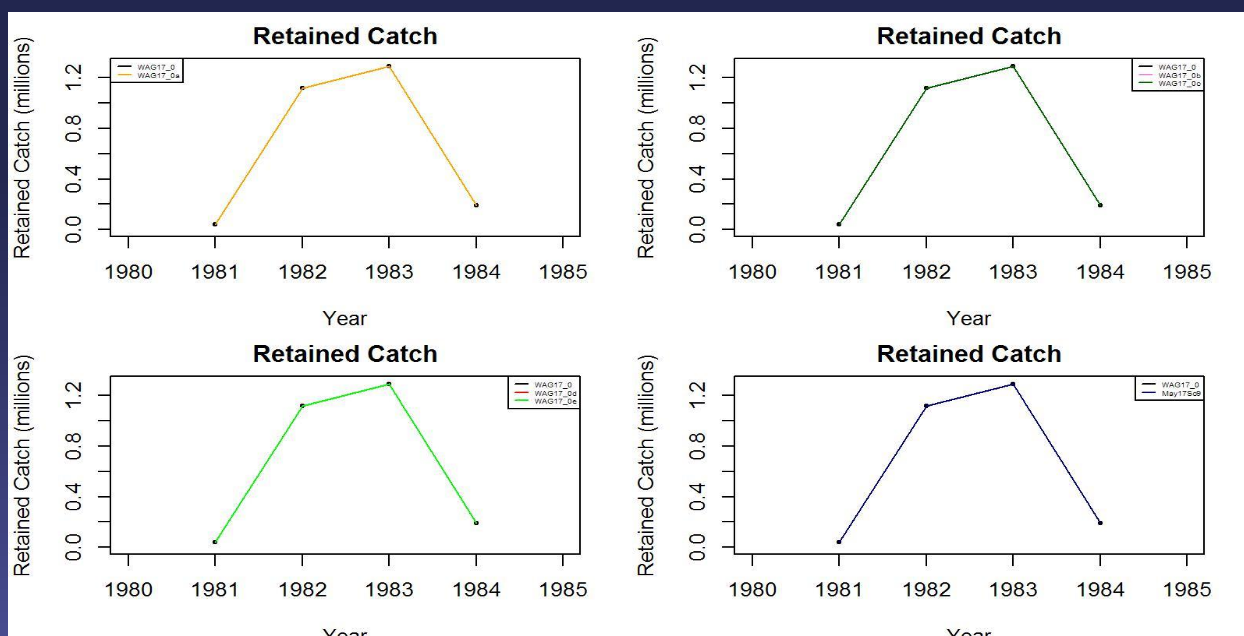
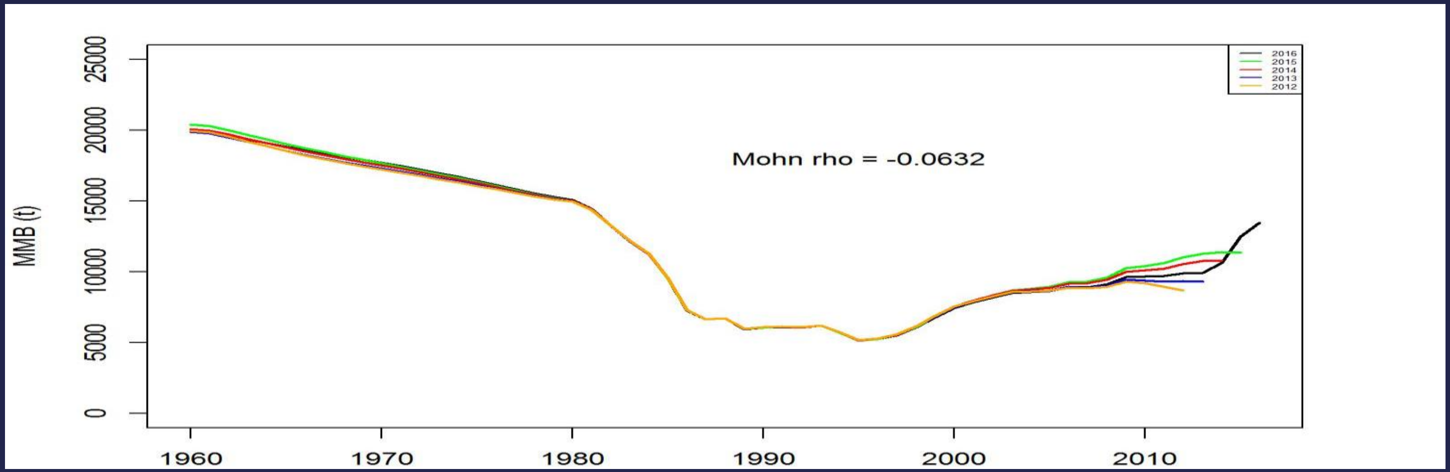


Figure 25. Retrospective fits of MMB by the model following removal of terminal year data under scenarios (Sc) 17_0 (top) and 17_0d (bottom) for EAG, 1960/61–2016/17.



$$Mohn\ \rho = \frac{\sum_{n=1}^{x} \frac{\left[\widehat{MMB}_{y=T-n,T-n} - \widehat{MMB}_{y=T-n,T}\right]}{\widehat{MMB}_{y=T-n,T}}}{x}$$

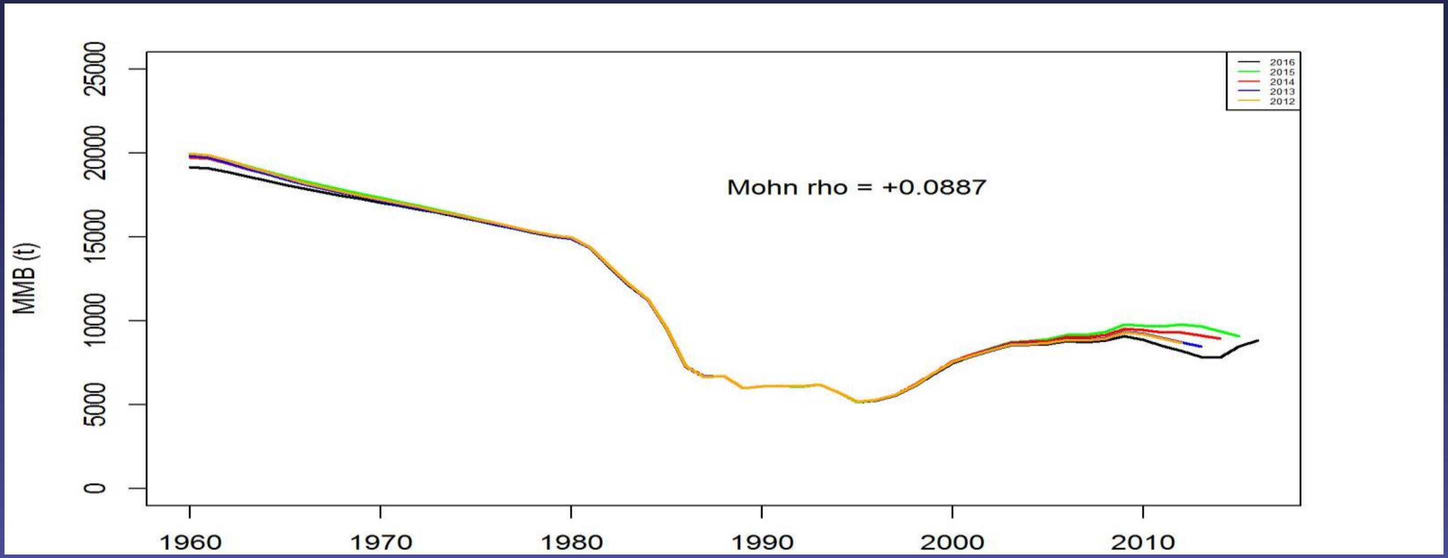
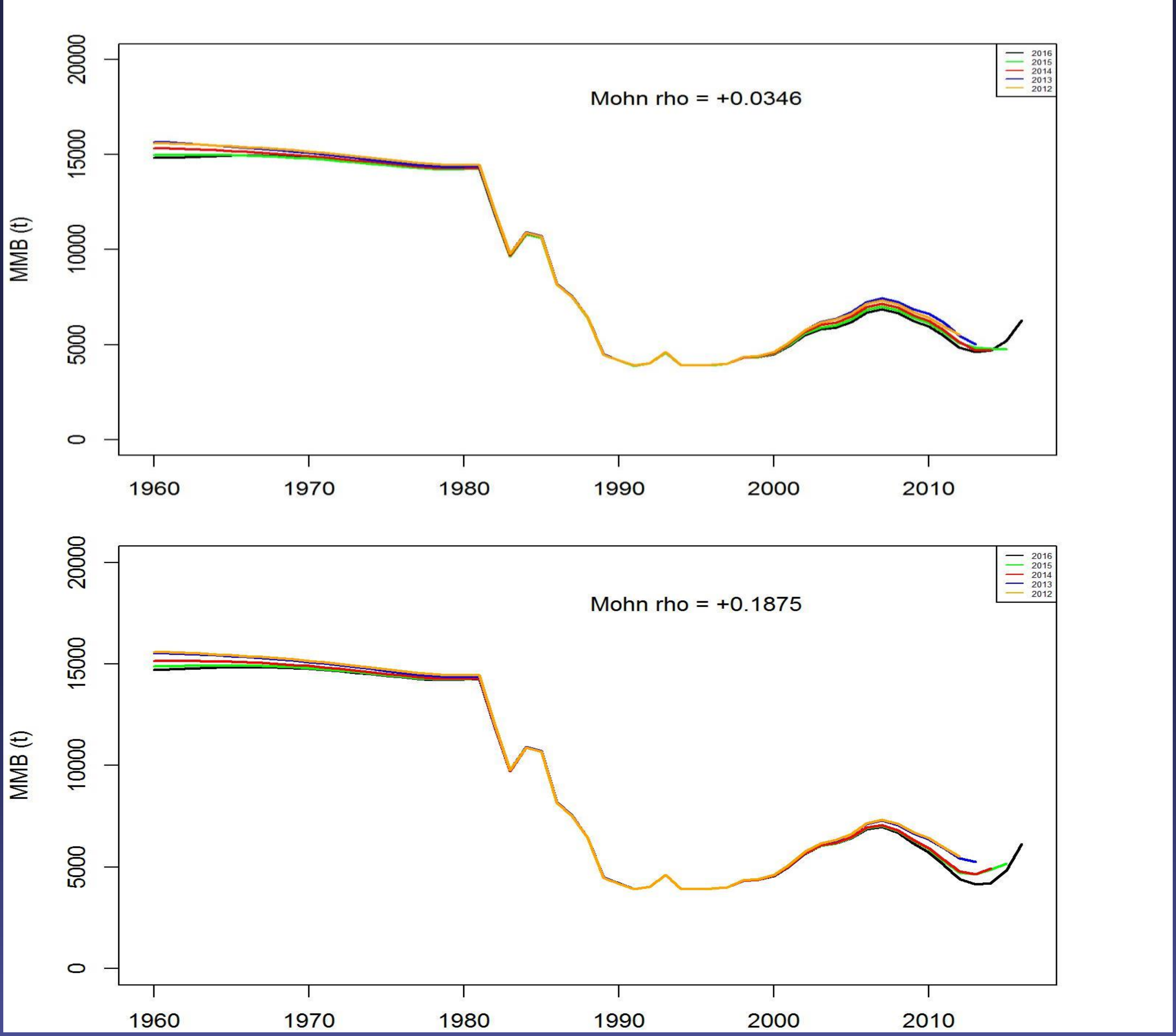
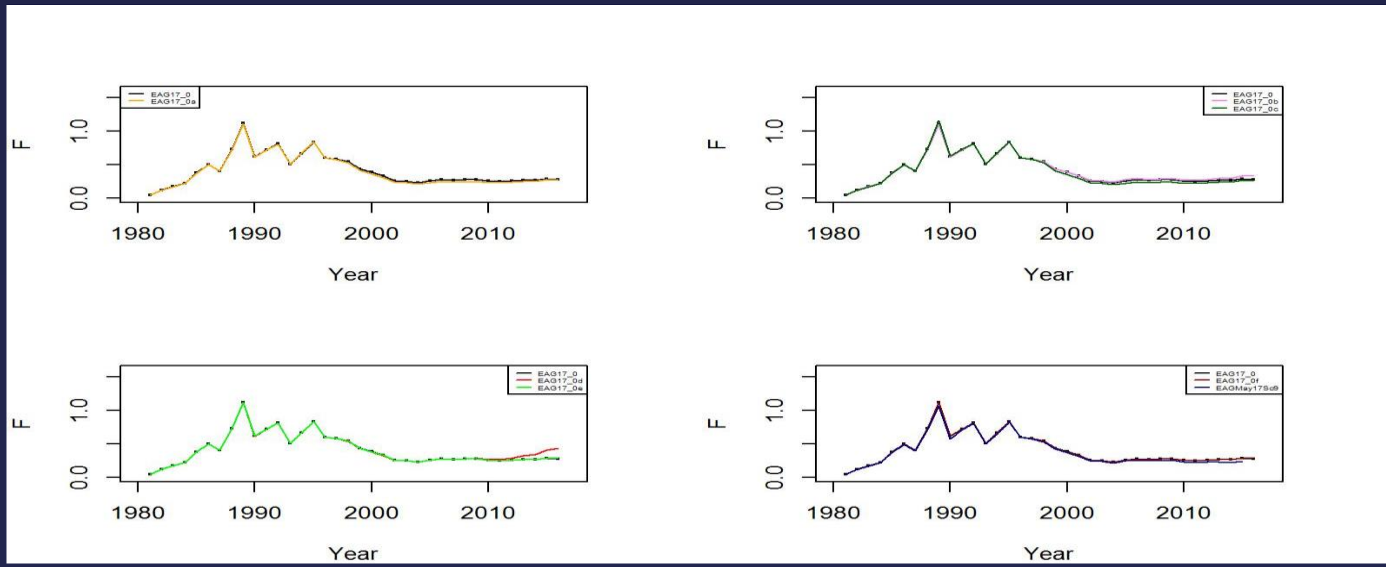


Figure 43. Retrospective fits of MMB by the model following removal of terminal year data under scenarios (Sc) 17_0 (top) and 17_0d (bottom) for WAG, 1960/61–2016/17.



Figures 27 and 45. Trends in pot fishery full selection total F for scenarios (Sc) 17_0 to May 2017 Sc9 model fits in the EAG (top) and WAG (bottom), 1981/82–2016/17.

EAG



WAG

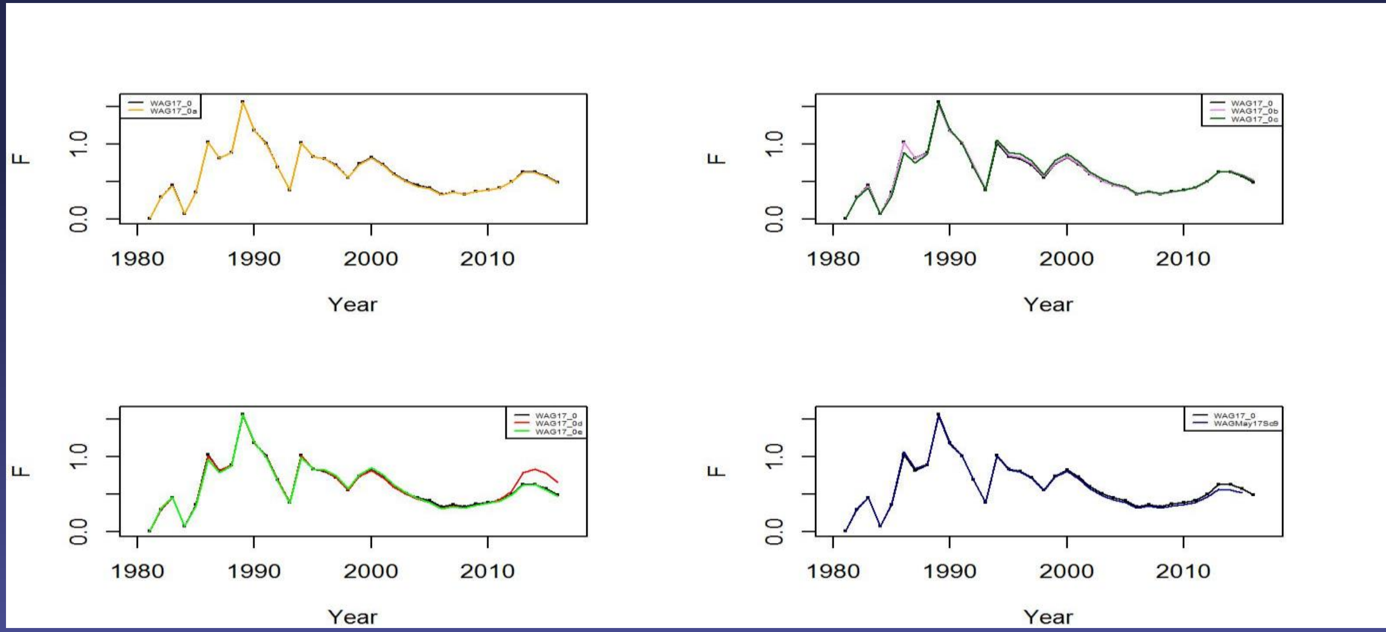


Figure 28. Trends in MMB for scenarios 17_0 to May 2017 Sc9 fits in the EAG, 1960/61–2016/17. Scenario 17_0 estimates have two standard errors confidence limits.

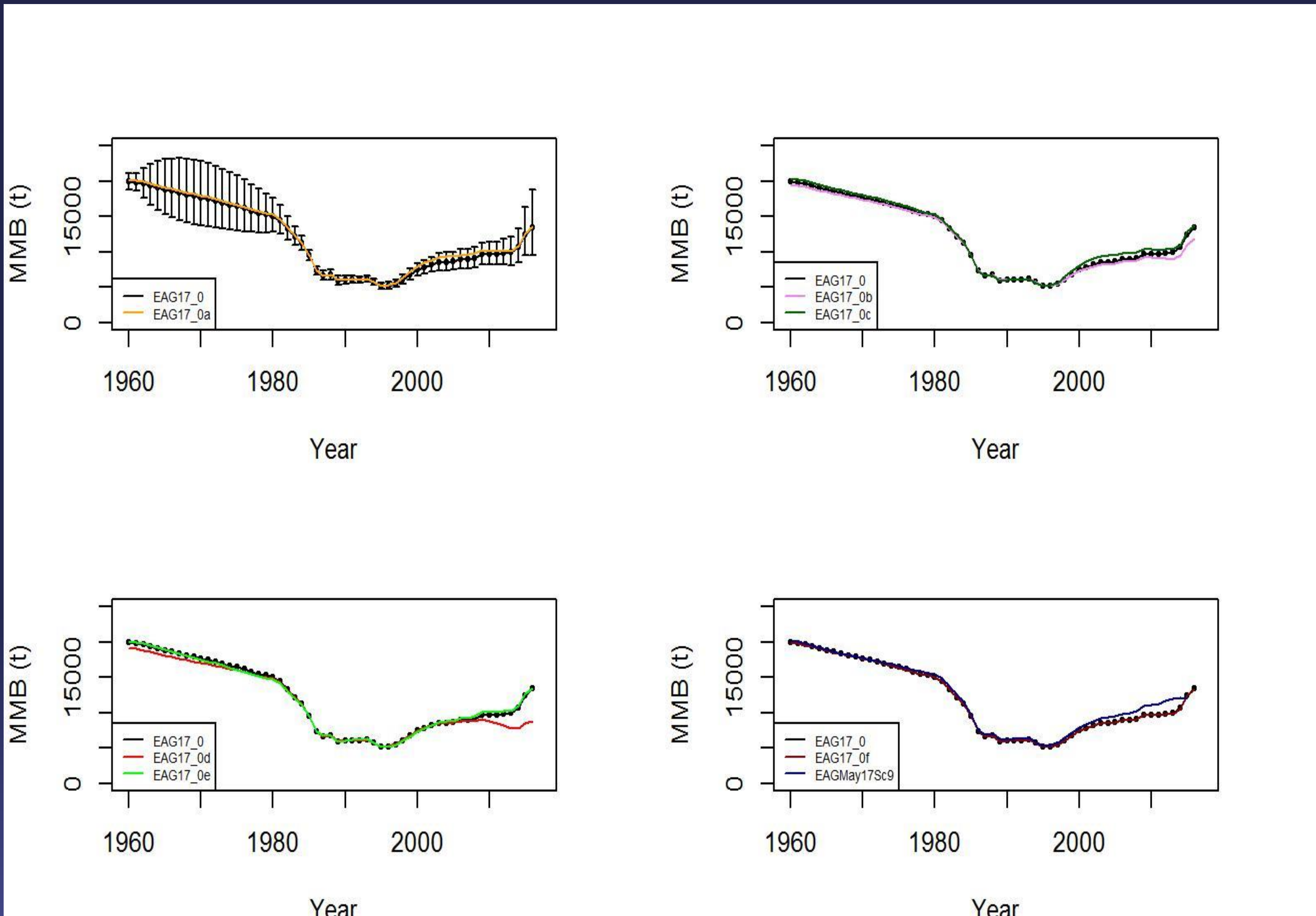


Figure 46. Trends in MMB for scenarios 17_0 to May 2017 Sc9 model fits in the WAG, 1960/61–2016/17. Scenario 17_0 estimates have two standard errors confidence limits.

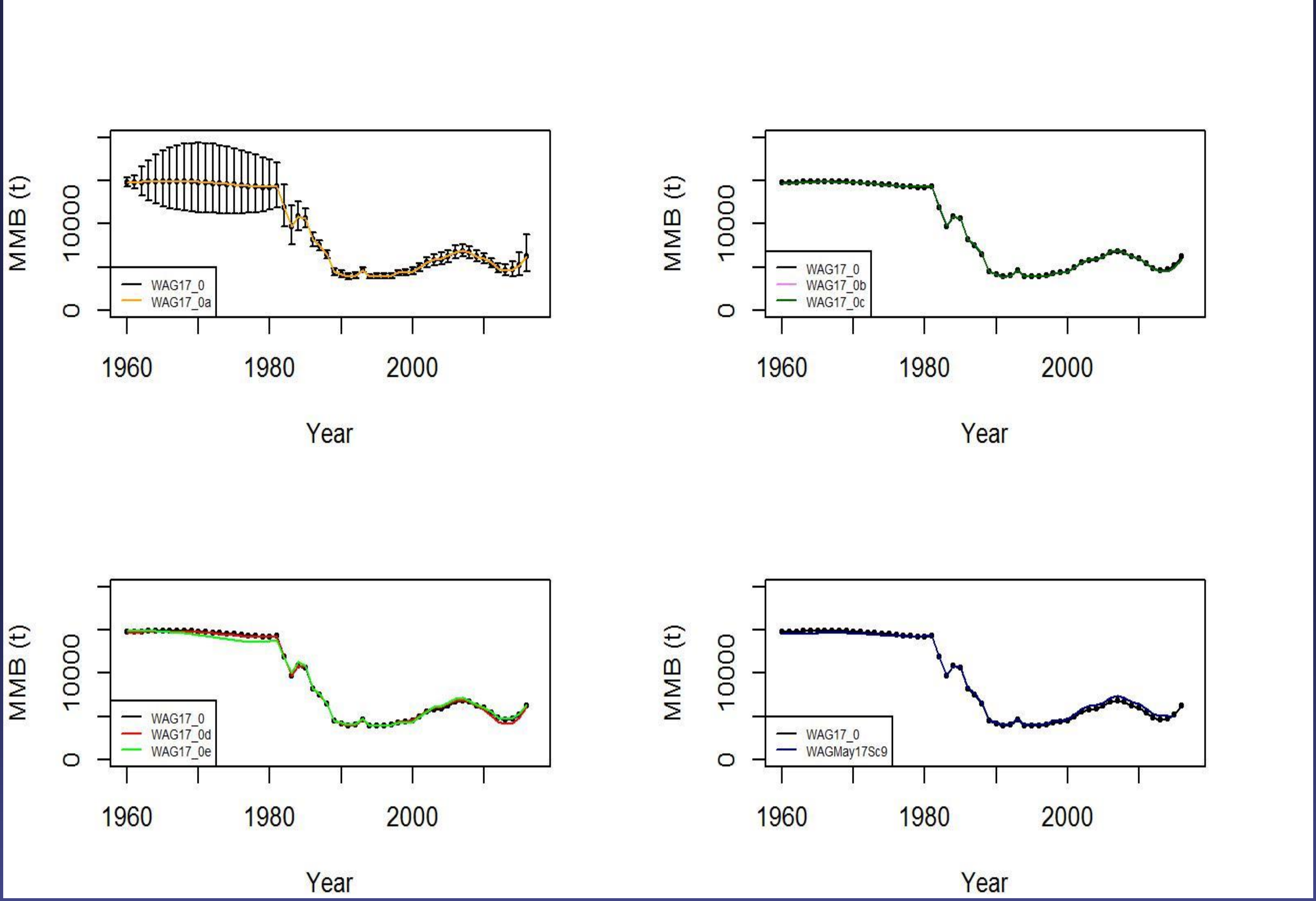


Figure H.1. Estimated B0 (t) (dark green curve) and MMB (t) with fishing (black curve with +/- 2SE) (top panel); and MMB/B0 ratio (bottom panel) from 1960 to 2016 for scenario 17_0 in EAG (left) and WAG (right). (Note: 2016 MMB= MMB estimated on 15 February 2017).

EAG WAG

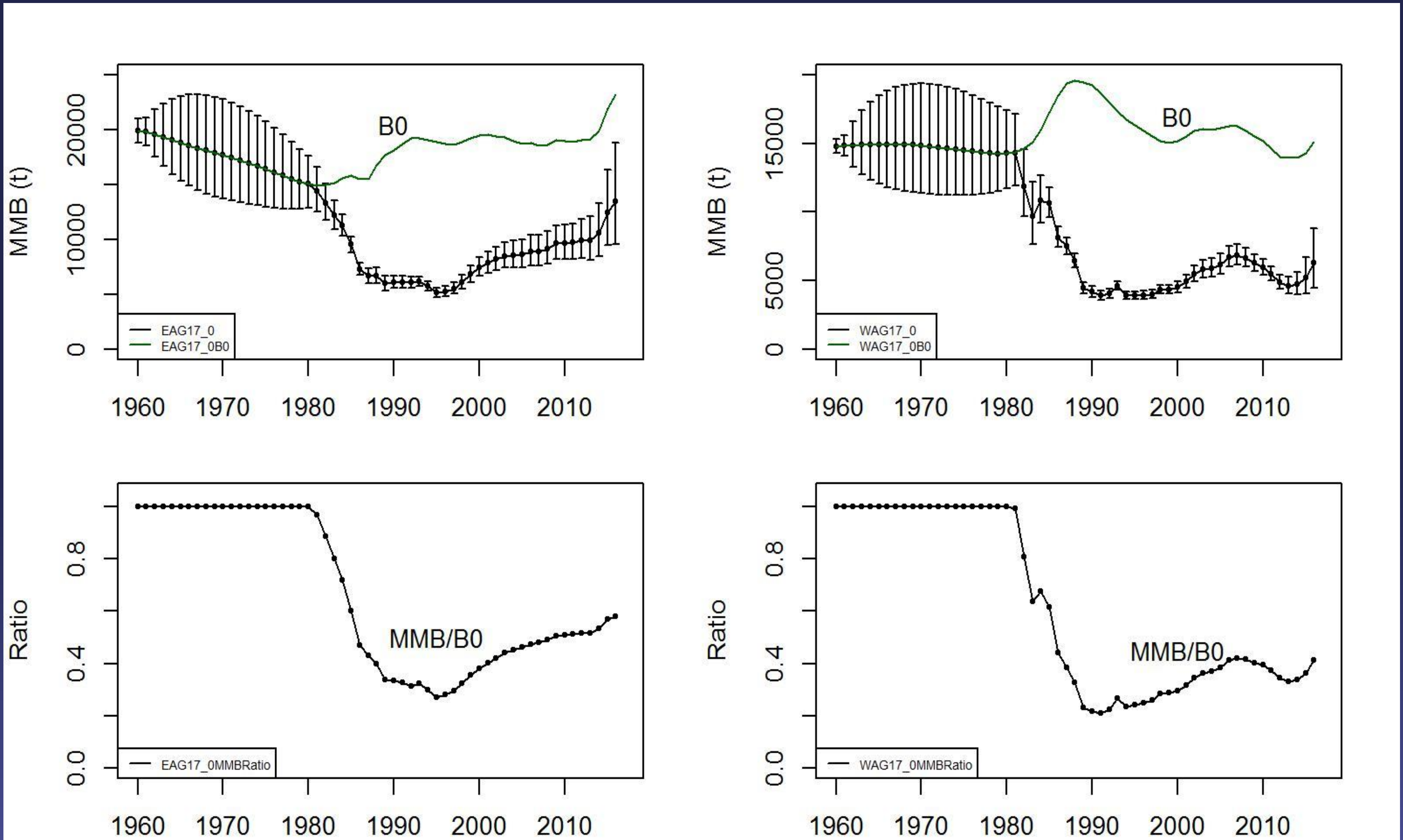


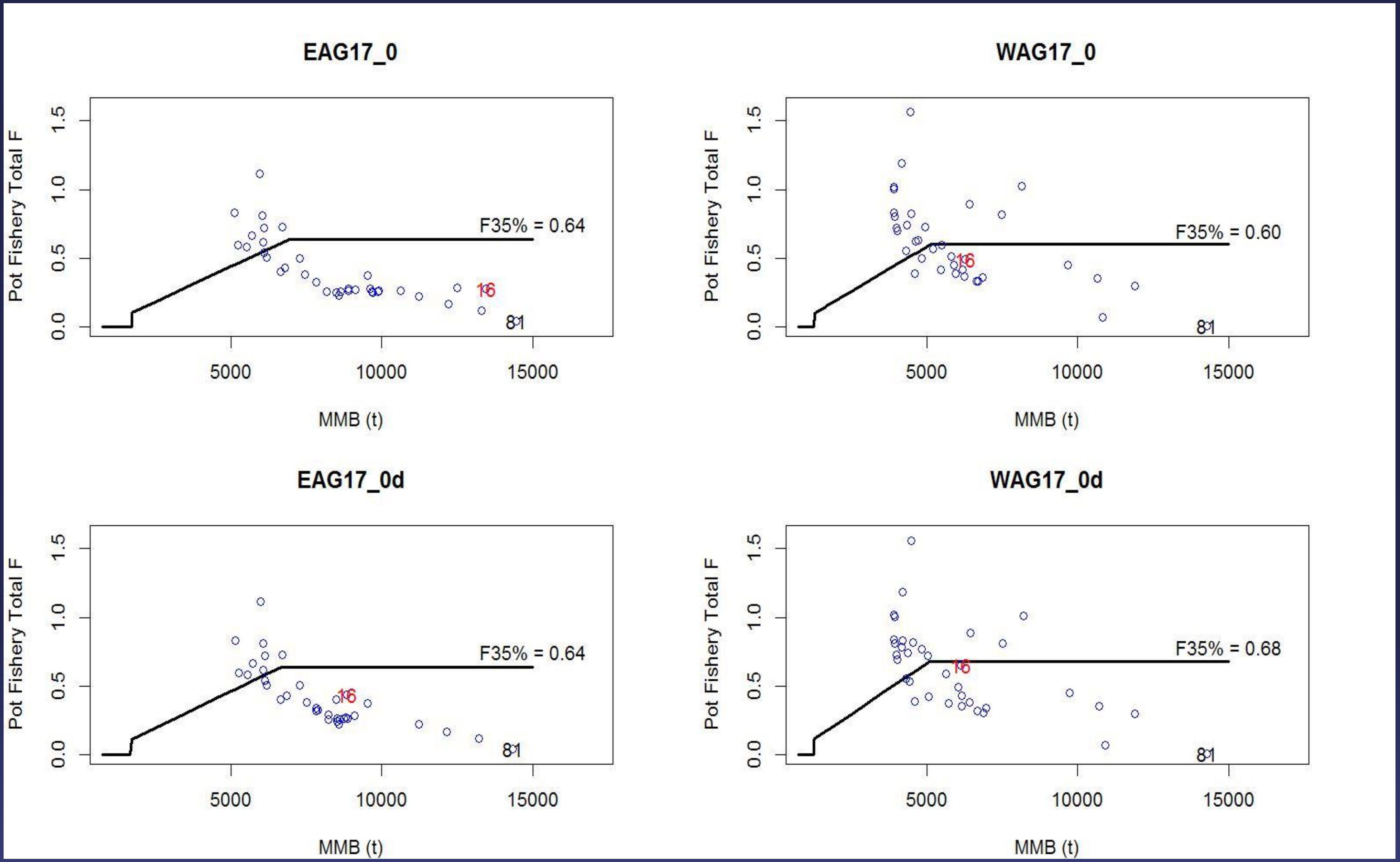
Table 21. Comparison of negative log likelihood values for EAG

Likelihood Component	Sc 17_0	Sc 17_0a	Sc 17_0b	Sc 17_0c	Sc 17_0d	Sc 17_0e	Sc 17_0f	Sc17_0a– Sc 17_0	Sc 17_0b – Sc 17_0	Sc 17_0c – Sc 17_0	Sc 17_0e – Sc 17_0
Number of free parameters	140	140	140	140	143	140	141				
Data	Base	Base	Base	Base	Base	Base					
Retlencomp	-1177.540	-1177.110	-1178.030	-1174.470	-1180.060	-1235.080	-1177.740	0.43	-0.490	3.070	-57.540
Totallencomp	-1249.120	-1260.300	-1248.190	-1261.890	-1258.200	-1192.770	-1249.490	-11.18	0.930	-12.770	56.350
Observer cpue	-12.551	-5.466	-6.545	-3.945	-12.776	-12.429	-12.364	7.085	6.006	8.606	0.122
RetdcatchB	7.502	8.109	7.283	8.009	7.581	7.034	7.501	0.607	-0.219	0.507	-0.468
TotalcatchB	18.260	18.609	18.199	18.611	18.419	17.723	18.267	0.349	-0.061	0.351	-0.537
GdiscdcatchB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0	0	0	0
Rec_dev	7.571	7.435	6.880	7.804	5.937	7.966	7.552	-0.136	-0.691	0.233	0.395
Pot F_dev	0.013	0.014	0.013	0.015	0.013	0.013	0.013	0.001	0	0.002	0
Gbyc_F_dev	0.026	0.026	0.026	0.026	0.028	0.026	0.026	0	0	0	0
Tag	2692.200	2691.860	2692.350	2691.730	2692.220	2692.450	2692.200	-0.34	0.150	-0.470	0.250
Fishery cpue	-0.460	-0.565	-2.206	10.74300	-0.461	-0.347	-0.463	-0.105	-1.745	11.203	0.113
RetcatchN	0.007999	0.007584	0.007019	0.007569	0.005034	0.010917	0.0079	-0.00042	-0.00098	-0.00043	0.002918
Total	285.910	282.618	289.789	296.634	272.703	284.602	285.765	-3.292	3.879	10.724	-1.308

Table 37. Comparison of negative log likelihood values for WAG

Likelihood Component	Sc 17_0	Sc 17_0a	Sc 17_0b	Sc 17_0c	Sc 17_0d	Sc 17_0e	Sc17_0a– Sc 17_0	Sc 17_0b – Sc 17_0	Sc 17_0c – Sc 17_0	Sc 17_0e – Sc 17_0
Number of free parameters	140	140	140	140	143	140				
Data	Base	Base	Base	Base	Base	Base				
Retlencomp	-1146.700	-1147.140	-1143.350	-1142.310	-1161.250	-1243.980	-0.440	3.350	4.390	-97.280
Totallencomp	-1389.720	-1389.680	-1395.850	-1396.210	-1396.220	-1370.230	0.040	-6.130	-6.490	19.490
Observer cpue	-11.773	-14.747	-0.680	15.078	-10.040	-11.199	-2.974	11.093	26.851	0.574
RetdcatchB	4.721	4.854	4.853	5.858	4.846	4.956	0.133	0.132	1.137	0.235
TotalcatchB	43.783	43.745	43.936	44.348	43.849	47.086	-0.038	0.153	0.565	3.303
GdiscdcatchB	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000
Rec_dev	5.243	5.248	5.254	4.797	6.091	6.103	0.005	0.011	-0.446	0.860
Pot F_dev	0.026	0.026	0.026	0.027	0.027	0.026	0.000	0.000	0.001	0.000
Gbyc_F_dev	0.037	0.037	0.037	0.037	0.038	0.037	0.000	0.000	0.000	0.000
Tag	2693.630	2693.450	2693.710	2693.780	2693.910	2695.840	-0.180	0.080	0.150	2.210
Fishery cpue	-5.155	-5.207	-9.456	17.685	-5.004	-2.783	-0.052	-4.301	22.840	2.371
RetcatchN	0.002129	0.002068	0.001757	0.000874	0.002098	0.005553	-0.000061	-0.000372	-0.001255	0.003424
Total	194.090	190.591	198.490	243.086	176.255	125.863	-3.499	4.400	48.996	-68.227

Figure 47. Relationships between full F for the directed pot fishery and MMB during 1985/86–2016/17 under scenarios 17_0 and 17_0d for EAG and WAG.



Tier level, $MMB_{35\%}$, current MMB (on 15Feb 2018) , F_{OFL}, $F_{35\%}$, OFL, and ABC for all scenarios (in million pounds)

EAG

Scenario	Tier	$MMB_{35\%}$	Current MMB	MMB/ $MMB_{35\%}$	F_{OFL}	Recruitment Years to define $MMB_{35\%}$	$F_{35\%}$	OFL	ABC (P*=0.49)	ABC (0.75*OFL)
EAG17_0	3a	15.332	25.474	1.66	0.64	1987–2012	0.64	8.637	8.601	6.478
EAG17_0a	3a	15.590	25.611	1.64	0.62	1987–2012	0.62	8.780	8.732	6.585
EAG17_0b	3a	14.979	22.949	1.53	0.65	1987–2012	0.65	7.529	7.492	5.646
EAG17_0c	3a	15.633	25.869	1.65	0.62	1987–2012	0.62	8.920	8.872	6.690
EAG17_0d	3a	14.745	17.986	1.22	0.64	1987–2012	0.64	5.469	5.435	4.102
EAG17_0e	3a	15.462	25.045	1.62	0.64	1987–2012	0.64	8.761	8.725	6.570
EAG17_0f	3a	15.312	25.340	1.65	0.64	1987–2012	0.64	8.581	8.545	6.436
May2017Sc9	3a	15.539	20.515	1.32	0.75	1987–2012	0.75	9.890	9.852	7.417

WAG

Scenario	Tier	$MMB_{35\%}$	Current MMB	MMB/ MMB35 %	F_{OFL}	Recruitment Years to Define $MMB_{35\%}$	$F_{35\%}$	OFL	ABC (P*=0.49)	ABC (0.75*OFL)
WAG17_0	3a	11.327	14.103	1.25	0.60	1987–2012	0.60	3.520	3.505	2.640
WAG17_0a	3a	11.354	14.702	1.29	0.60	1987–2012	0.60	3.716	3.699	2.787
WAG17_0b	3a	11.252	13.391	1.19	0.60	1987–2012	0.60	3.289	3.270	2.466
WAG17_0c	3a	11.294	13.947	1.23	0.60	1987–2012	0.60	3.418	3.395	2.564
WAG17_0d	3a	11.260	14.345	1.27	0.68	1987–2012	0.68	3.268	3.248	2.451
WAG17_0e	3a	11.466	14.182	1.24	0.59	1987–2012	0.59	3.544	3.529	2.658
May2017Sc9	3a	9.937	10.800	1.09	0.68	1993–1997	0.68	3.443	3.428	2.582

OFL and ABC for the whole Aleutian Islands (million pounds)

AI

Aleutian Islands (AI) **Total OFL, maxABC, and ABC for the next fishing season in millions of pounds.**			
Scenario	OFL	maxABC (P*=0.49)	ABC (0.75*OFL)
17_0	12.157	12.106	9.118
17_0a	12.496	12.431	9.372
17_0b	10.818	10.762	8.112
17_0c	12.338	12.267	9.254
17_0d	8.737	8.683	6.553
17_0e	12.305	12.254	9.228

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

We will update with the 2017/18 completed fishery at the September 2018 CPT meeting.

Status and catch specifications (million lb)

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch[a]	OFL	ABC[b]
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	5.545			13.333	10.000
2018/19c	13.329	39.577				12.157	9.118
2018/19d	13.002	32.331				8.737	6.553
2018/19e	13.464	39.227				12.305	9.228

a. Total Catch = retained catch + estimated bycatch mortality of discarded bycatch from all sources.
b. 25% buffer applied to total catch OFL to determine ABC.
c. 17_0 base scenario with Francis method of re-weighting
d. 17_0d three catchability and total selectivity with Francis method of re-weighting
e. 17_0e McAllister and Ianelli method of re-weighting

Thank you

Acknowledgement

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