Minor Changes on Bristol Bay Red King Crab Stock Assessments, Spring 2017

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Purpose

A. Update BSFRF 2016 data and Groundfish fishery bycatches during 2009-2015

B. Address the CPT and SSC requests

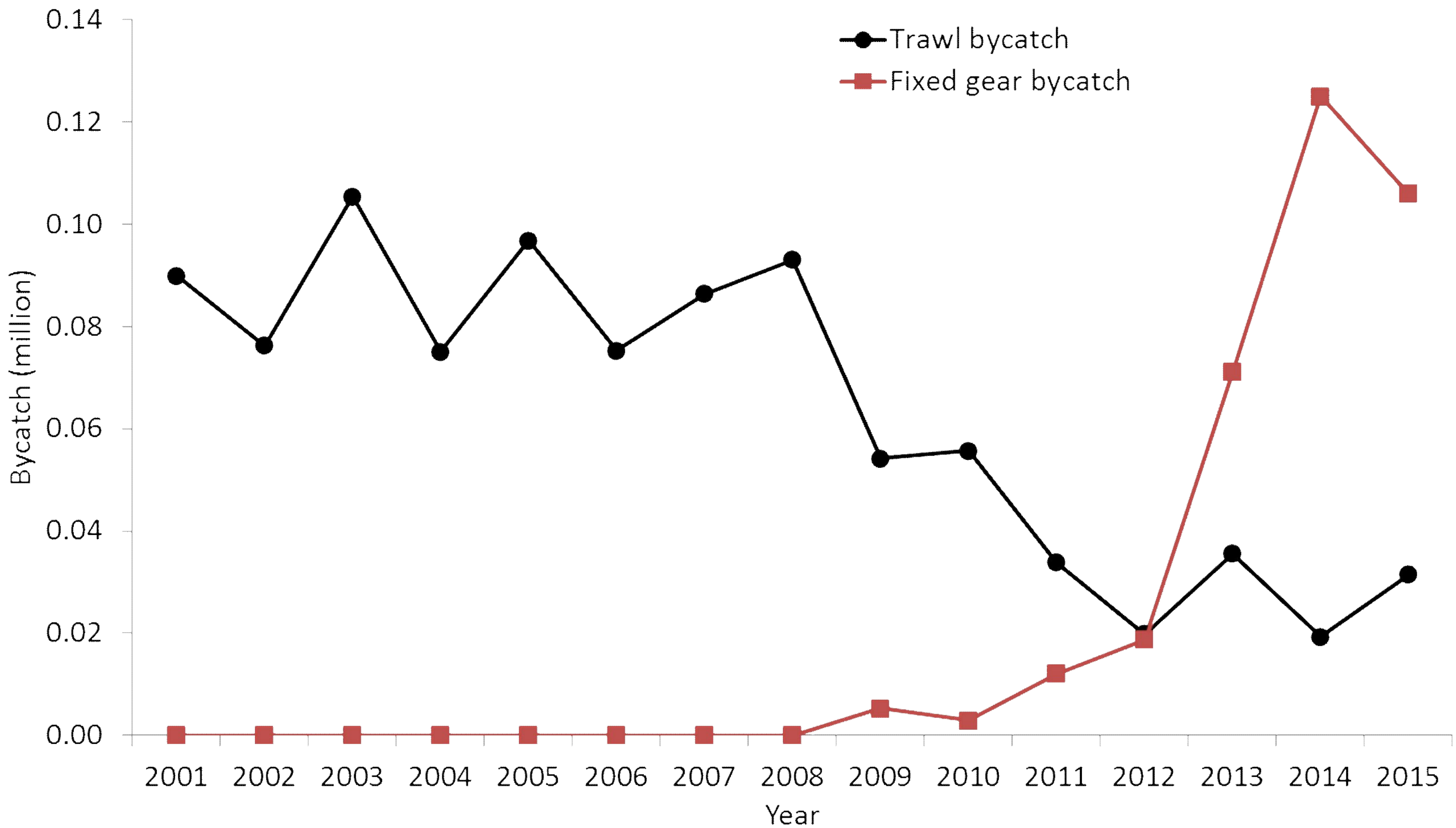
1. Compare five model scenarios (different data, with and without Q prior, and with a logit transformation of survey catchability parameter so that it is less than 1.0).

2. Conduct a recruitment breakpoint analysis, similar to the analysis for Tanner crab in 2013 (Appendix B).

Summary of New Data

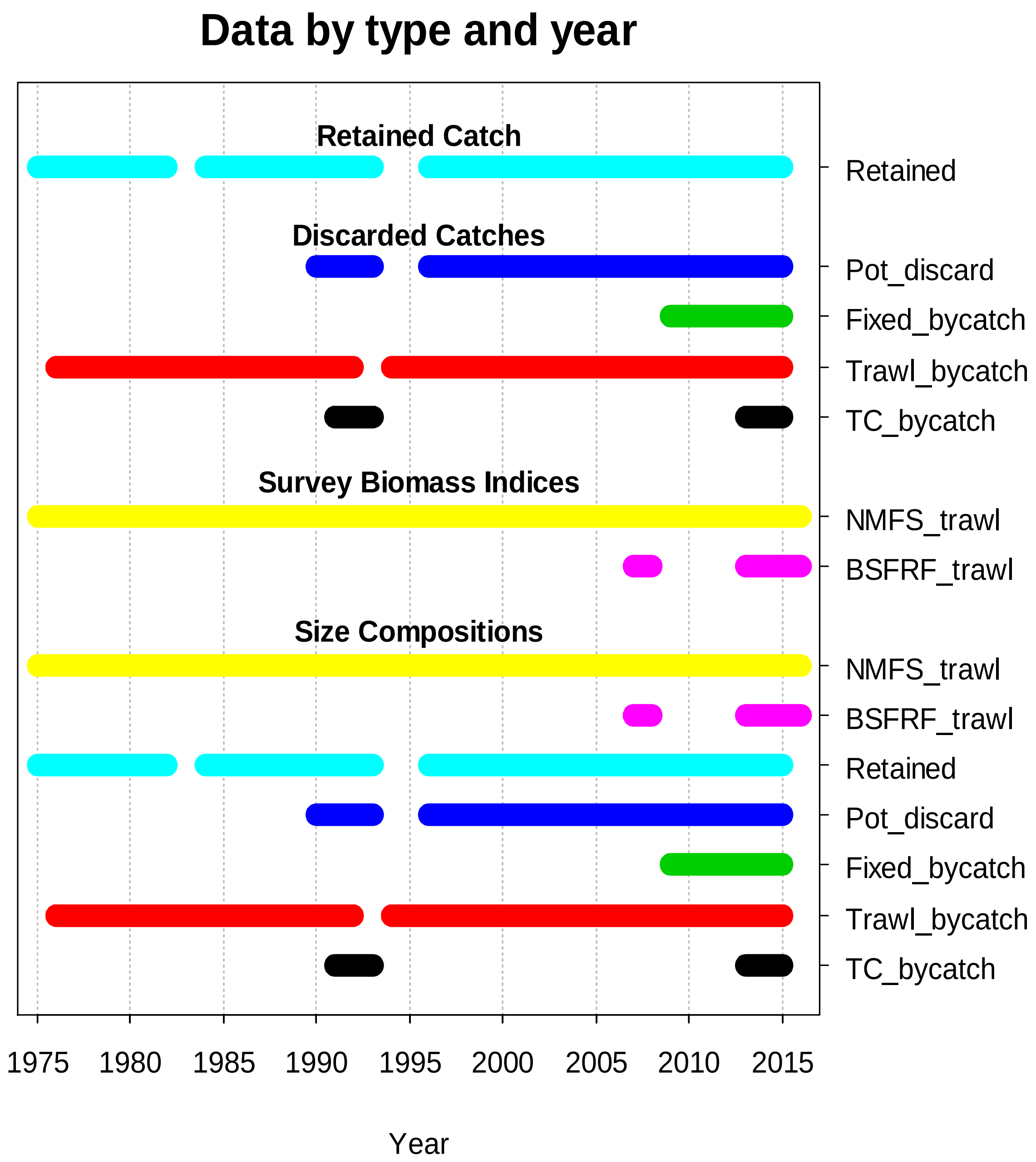
1. Update BSFRF side-by-side trawl survey data in 2016
2. Update groundfish fishery bycatch data during 2009-2015 and separate them into trawl bycatch and fixed gear (pot and line) bycatch

Groundfish Fisheries Bycatches



Groundfish fisheries fishing timing

- Assumed to be the same as the directed pot fishery in the current model (scenario 2) for simple computation due to very low groundfish fisheries bycatch relative to retained catch.
- Propose to move to the mid-point of crab year to more accurately reflect the actual fishing timing.


Data by type and year
Retained Catch
Discarded Catches
Survey Biomass Indices
Size Compositions
Retained
Pot_discard
Fixed_bycatch
Trawl_bycatch
TC_bycatch
NMFS_trawl
BSFRF_trawl
NMFS_trawl
BSFRF_trawl
Retained
Pot_discard
Fixed_bycatch
Trawl_bycatch
TC_bycatch
1975
1980
1985
1990
1995
2000
2005
2010
2015
Year

Model Scenarios

2. The base scenario in September 2016 with the same data. BSFRF survey capture probabilities are assumed to be 1.0 for all length groups.

2a. The same as scenario 2 except with the updated BSFRF side-by-side data in 2016 and changing the fishing time of the groundfish fisheries bycatch to mid-point of crab year to more accurately reflect the fishing timing. All fishing mortalities for the terminal year are not estimated during parameter estimation since the fisheries have not occurred in the model.

2b. The same as scenario 2a except with updated groundfish fisheries bycatch data during 2009-2015 and separating groundfish fisheries bycatch by trawl fisheries and fixed gear fisheries.

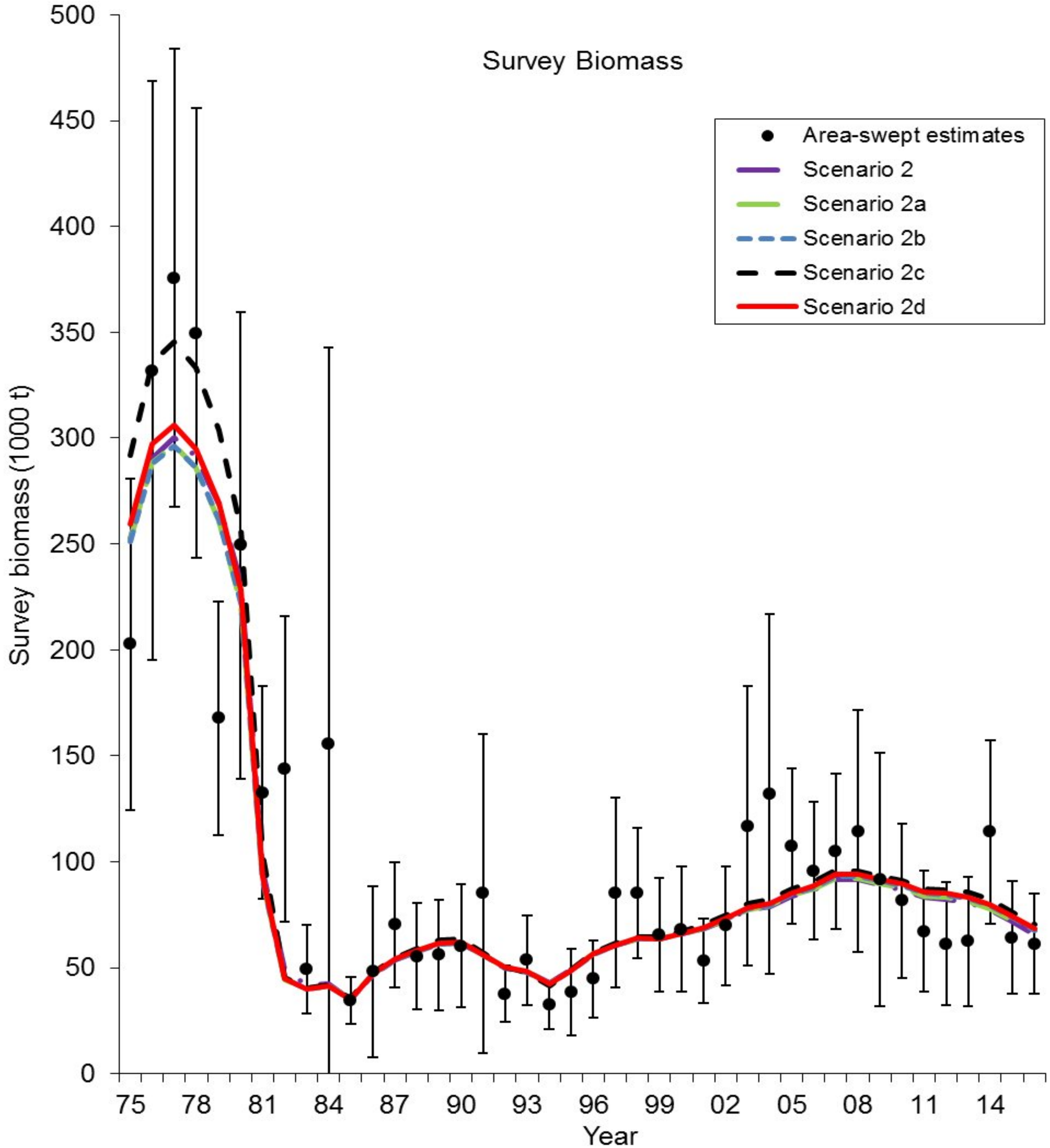
Model Scenarios

2c. The same as scenario 2b except without trawl survey catchability prior from the double-bag experiment.

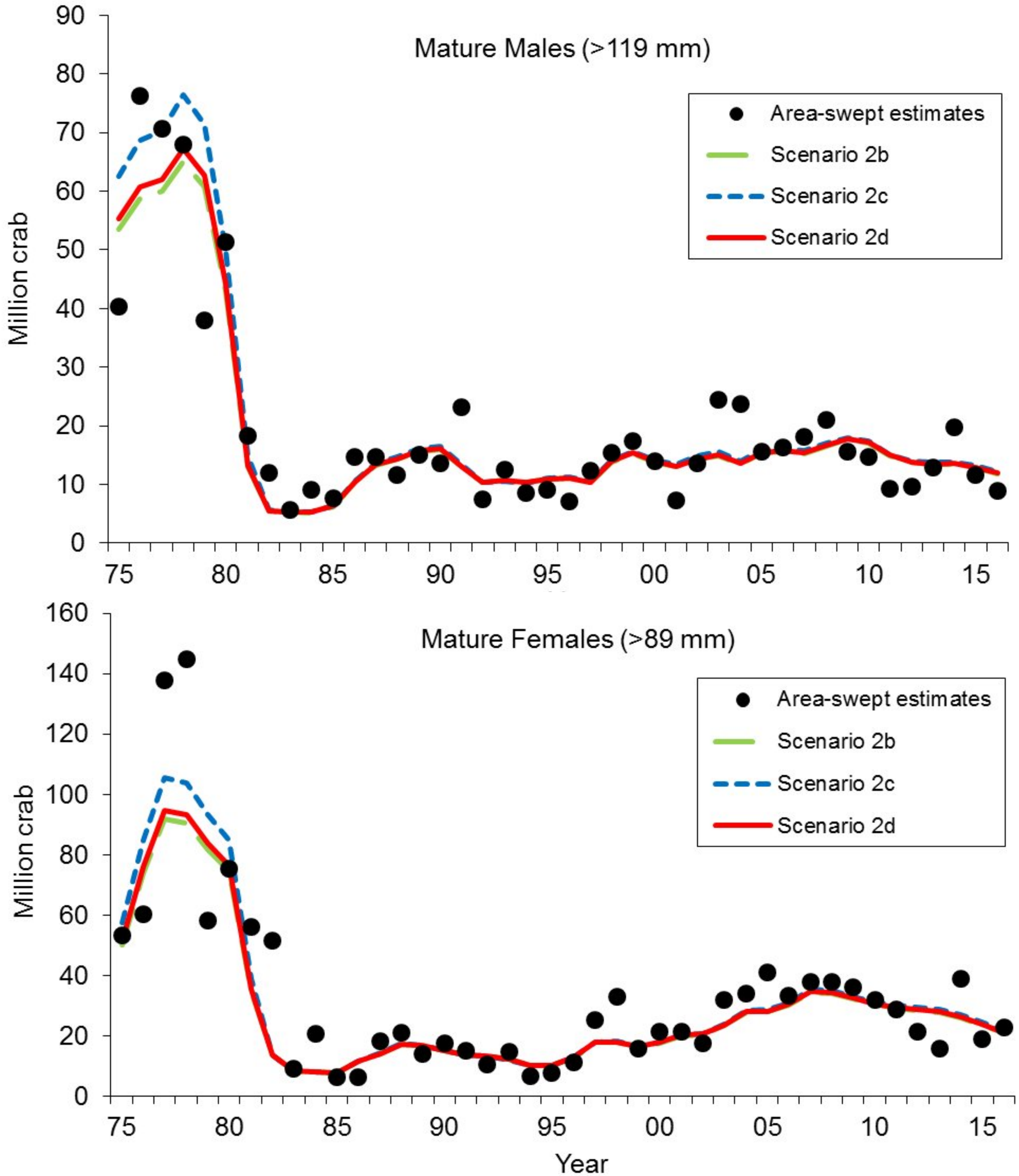
2d. The same as scenario 2c except using a logit transformation to make sure trawl survey catchability be <1.0:

$$Q = \exp(x)/(1+\exp(x)),$$

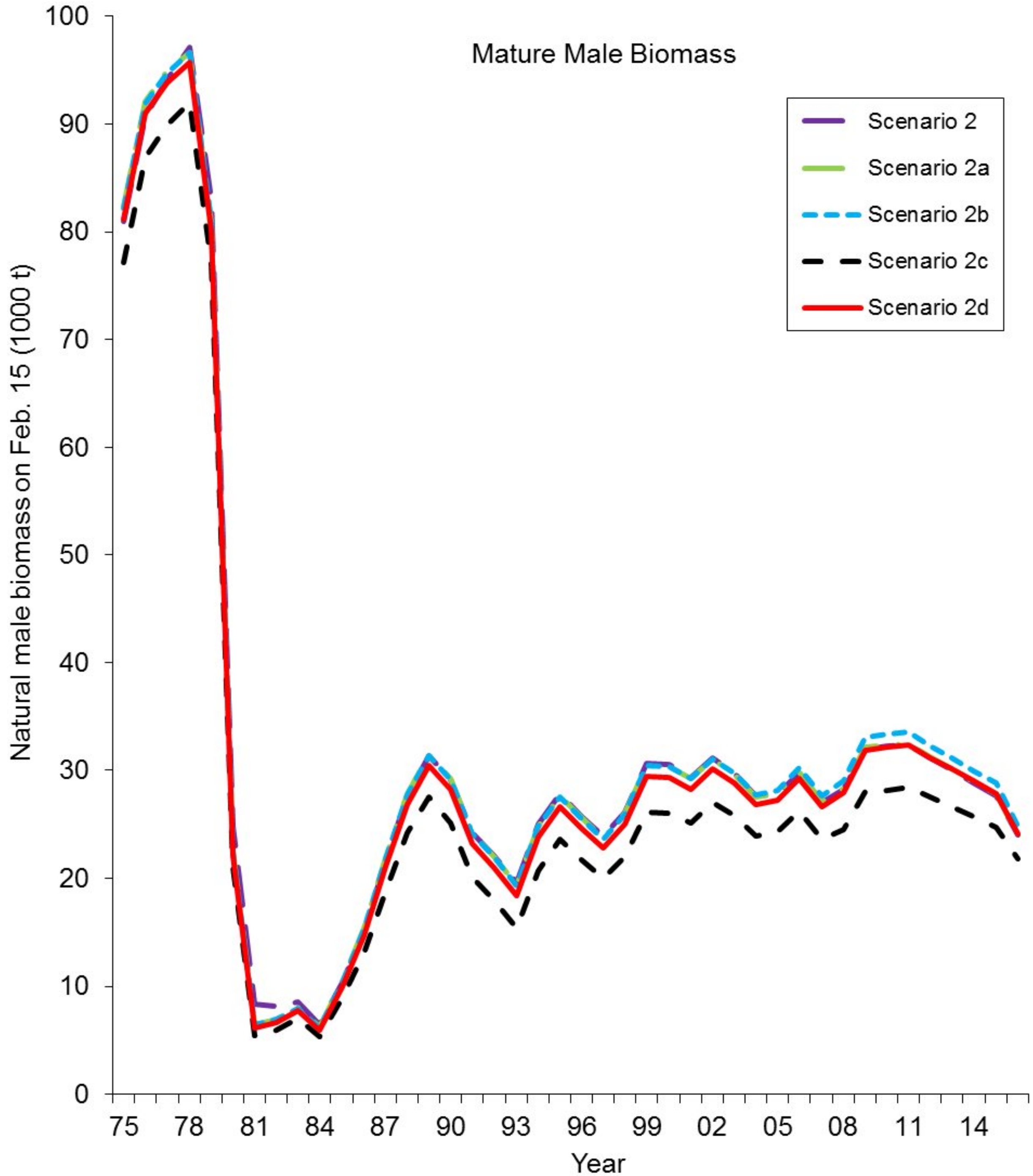
where *x* is estimated as a parameter.



Comparisons of area-swept estimates of total NMFS survey biomass and model prediction for model estimates in 2016 under scenarios 2, 2a, 2b, 2c and 2d. The error bars are plus and minus 2 standard deviations.



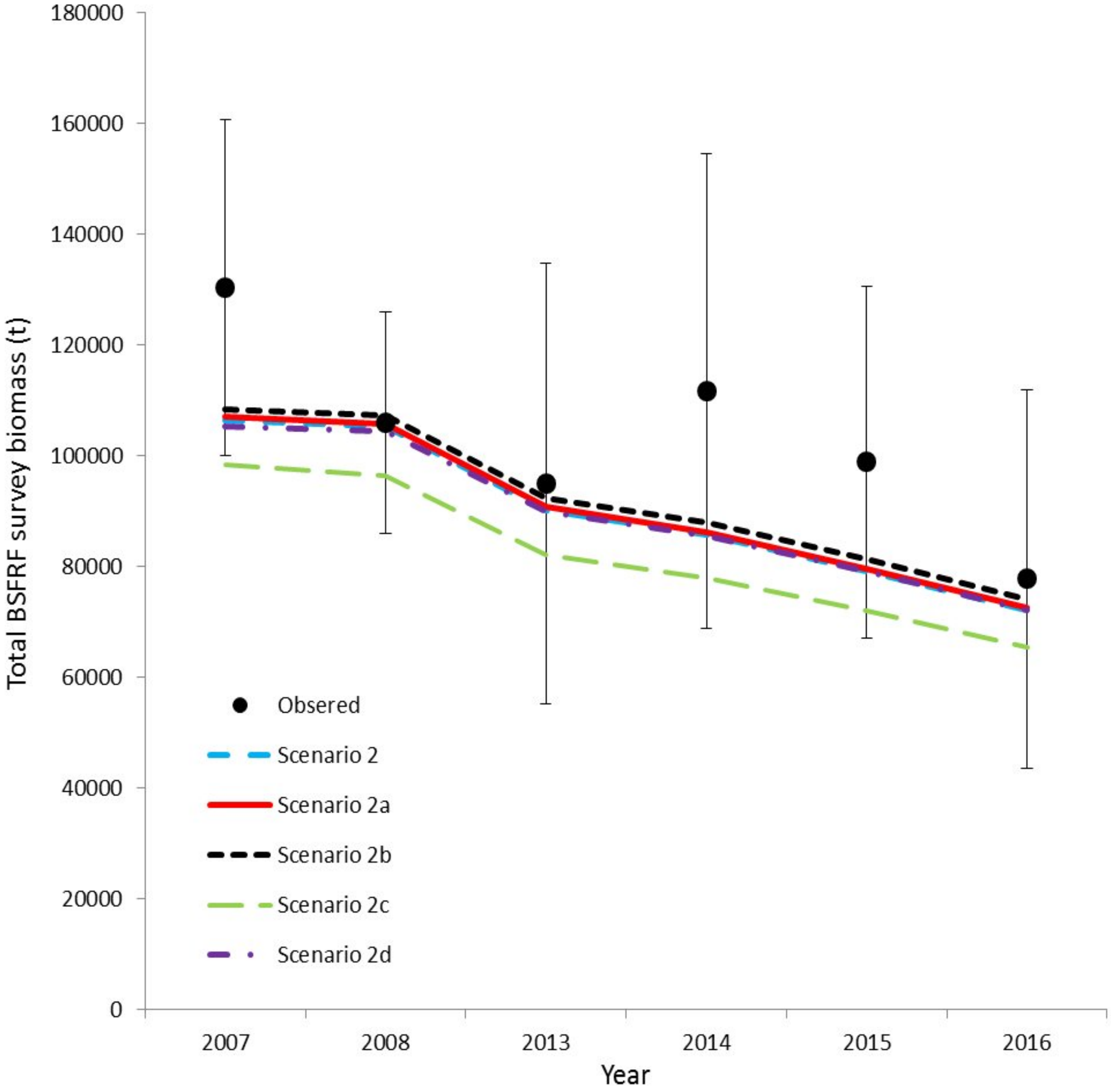
Comparisons of NMFS survey area-swept estimates of male (>119 mm) and female (>89 mm) abundance and model prediction for model estimates in 2016 under scenarios 2b, 2c and 2d



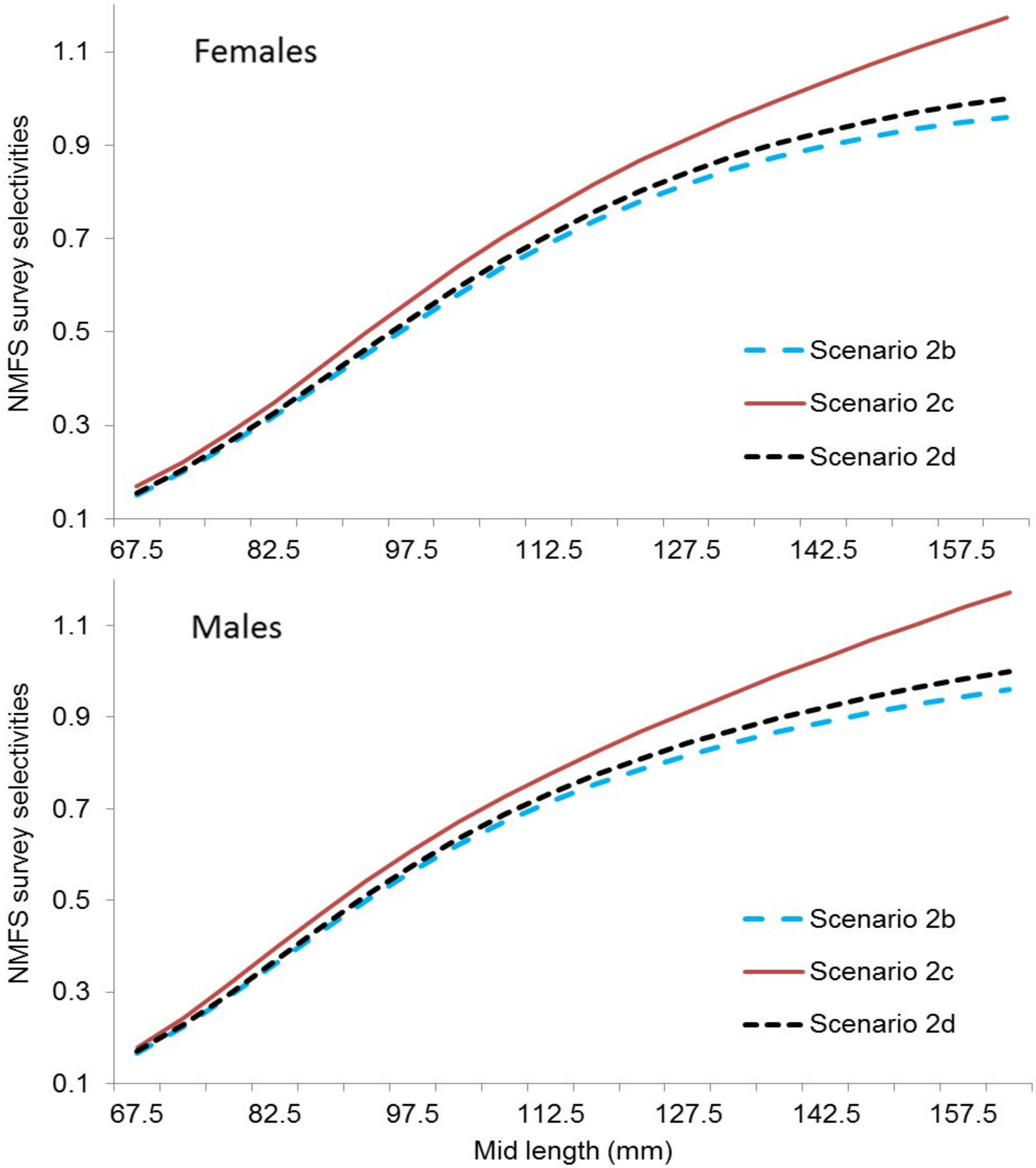
Comparisons of mature male biomass on Feb. 15 under scenarios 2, 2a, 2b, 2c and 2d

Estimated trawl survey catchabilities:

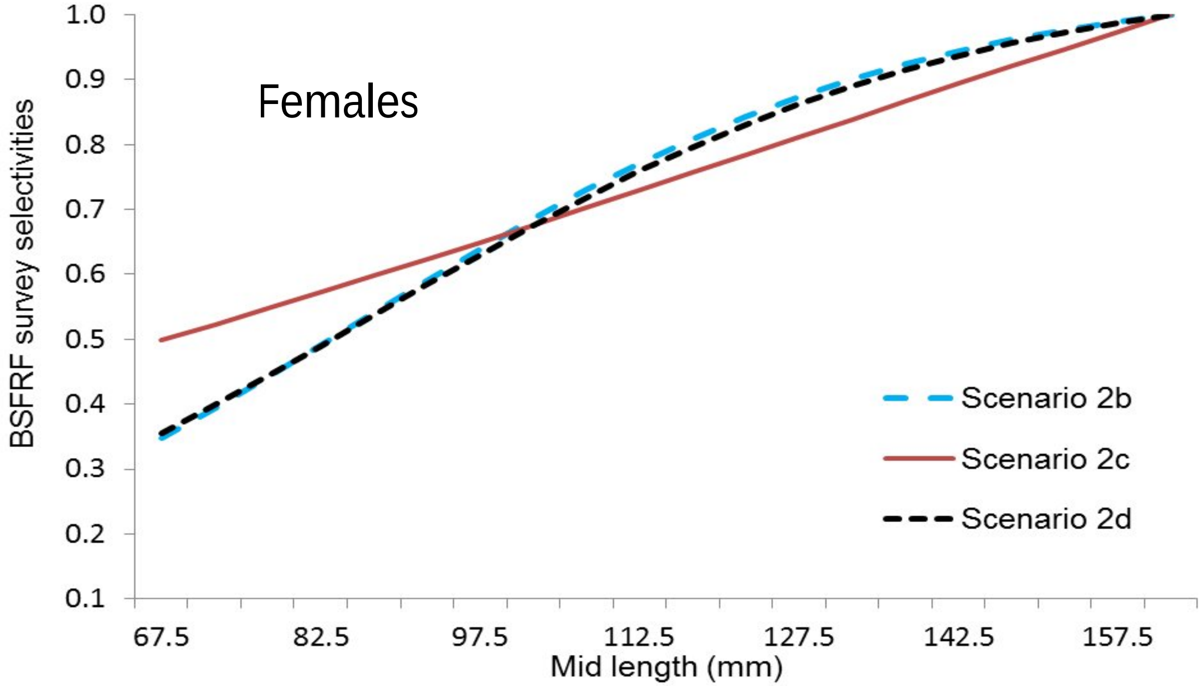
Scenario	Q
2	0.955
2a	0.963
2b	0.960
2c	1.173
2d	1.000

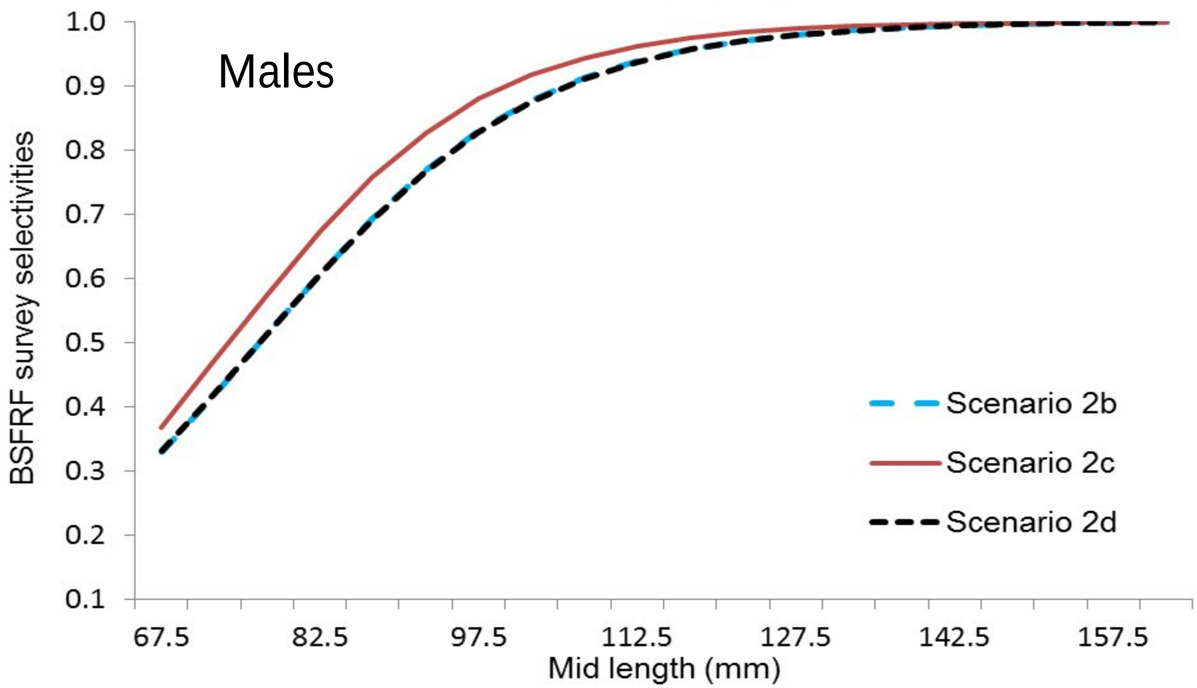


Comparisons of total survey biomass estimates by the BSFRF survey and the model for model estimates in 2016 (scenarios 2, 2a, 2b, 2c & 2d). The error bars are plus and minus 2 standard deviations of scenario 2d.



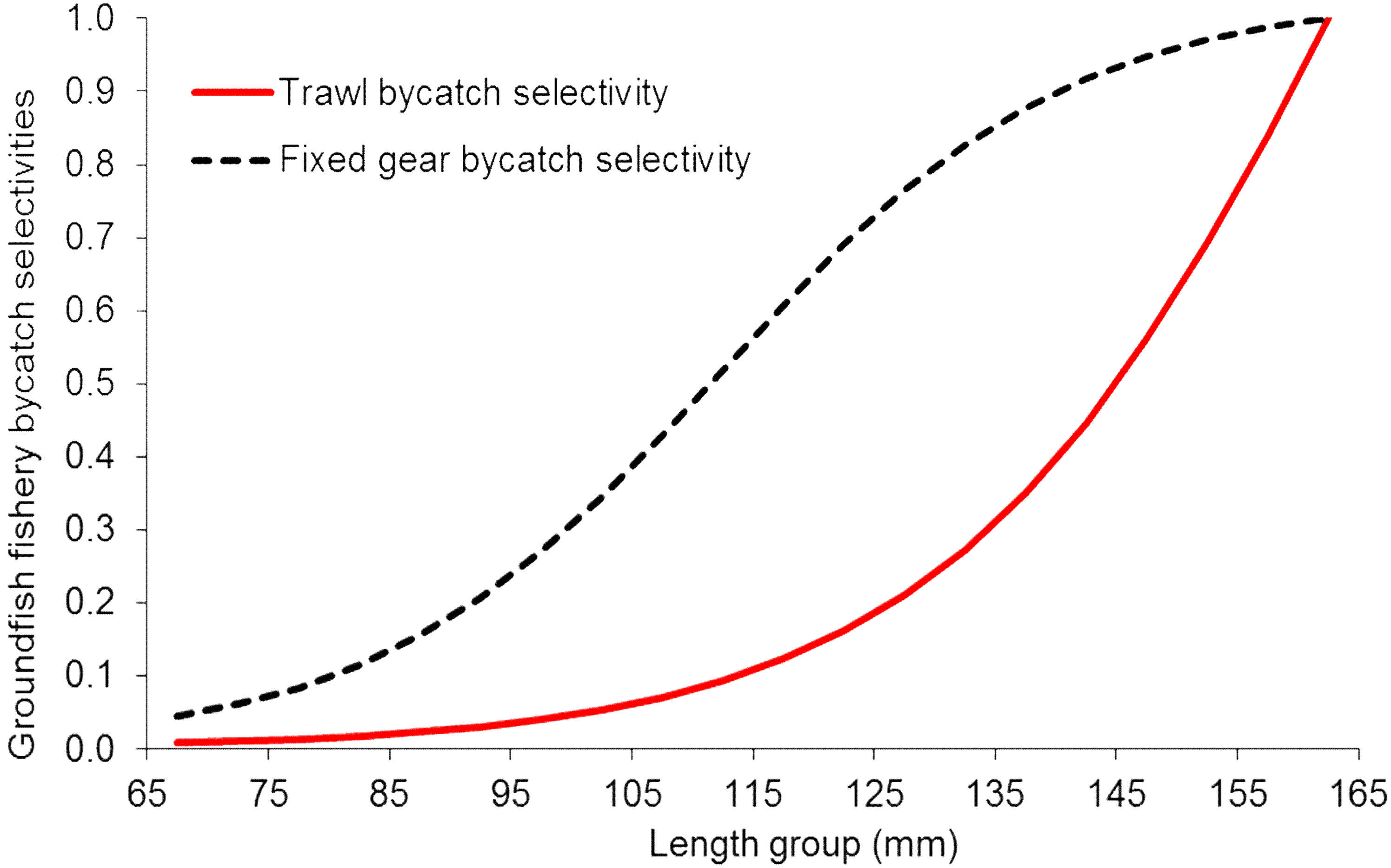
Estimated selectivities of NMFS trawl survey during 1982-2016 with different dataset of BSFRF survey data and three scenarios

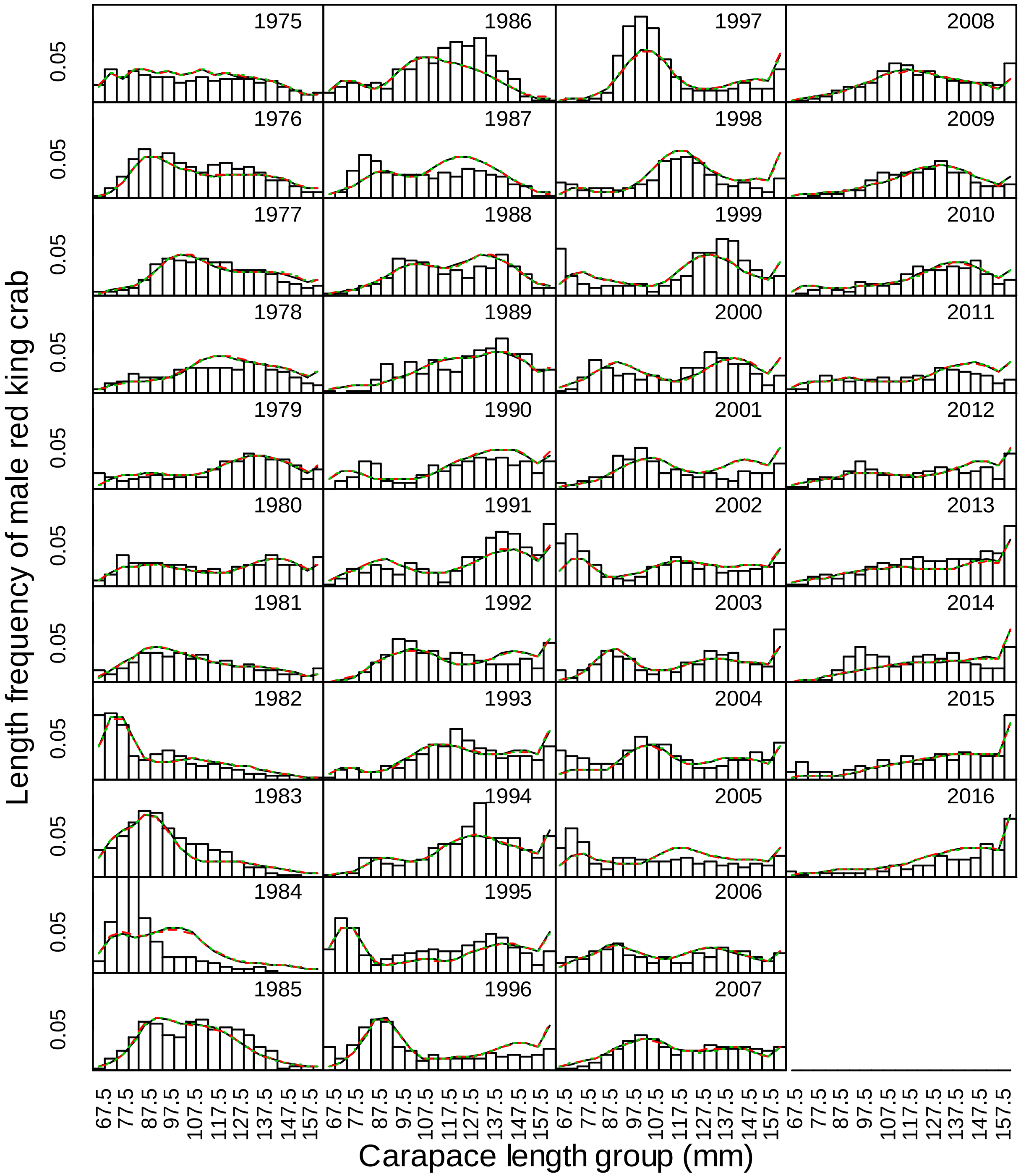




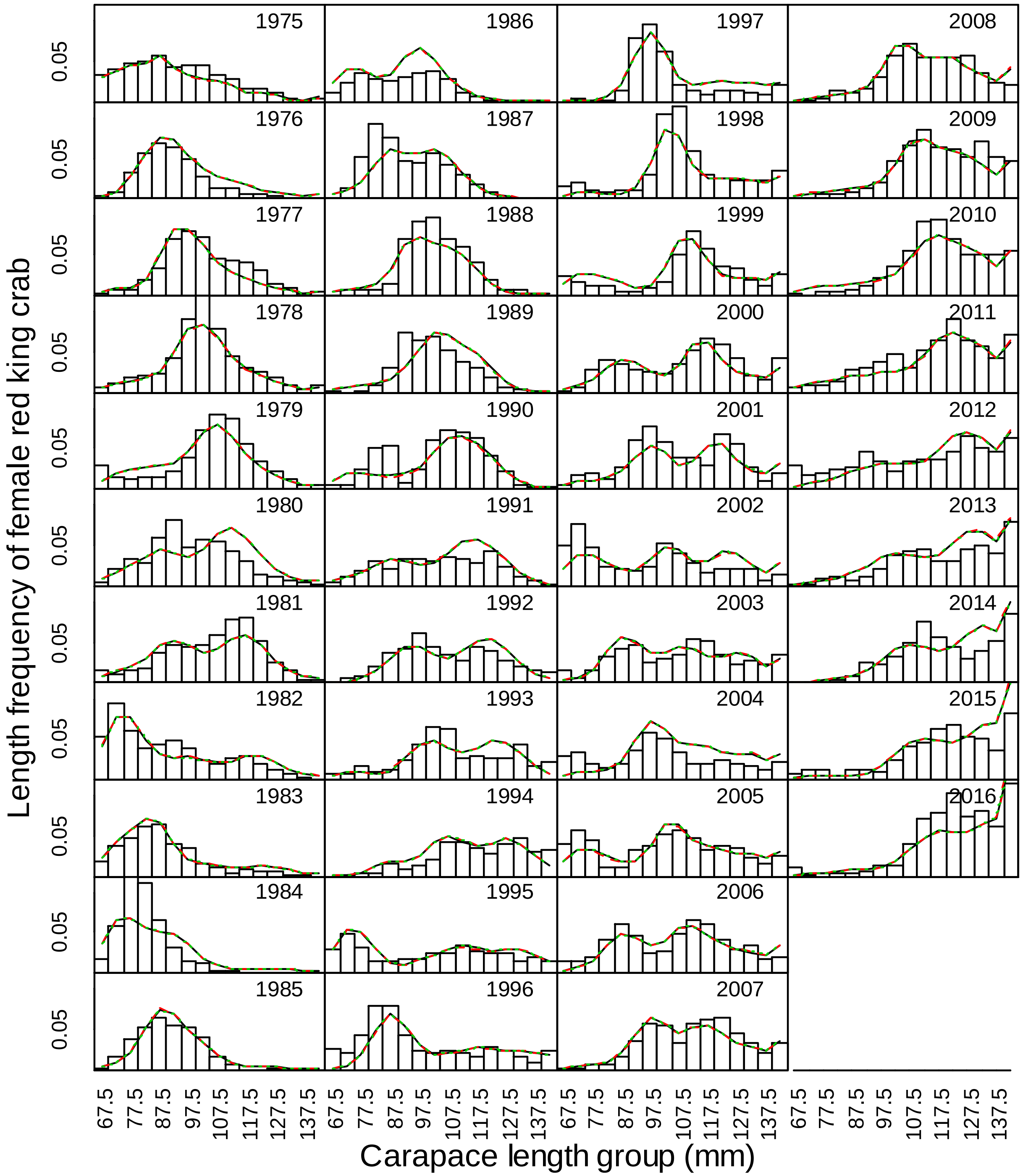
Estimated selectivities of BSFRF trawl survey during 2007-08 and 2013-2016 with three scenarios

Estimated Groundfish Fisheries Bycatch Selectivities for Scenario 2d

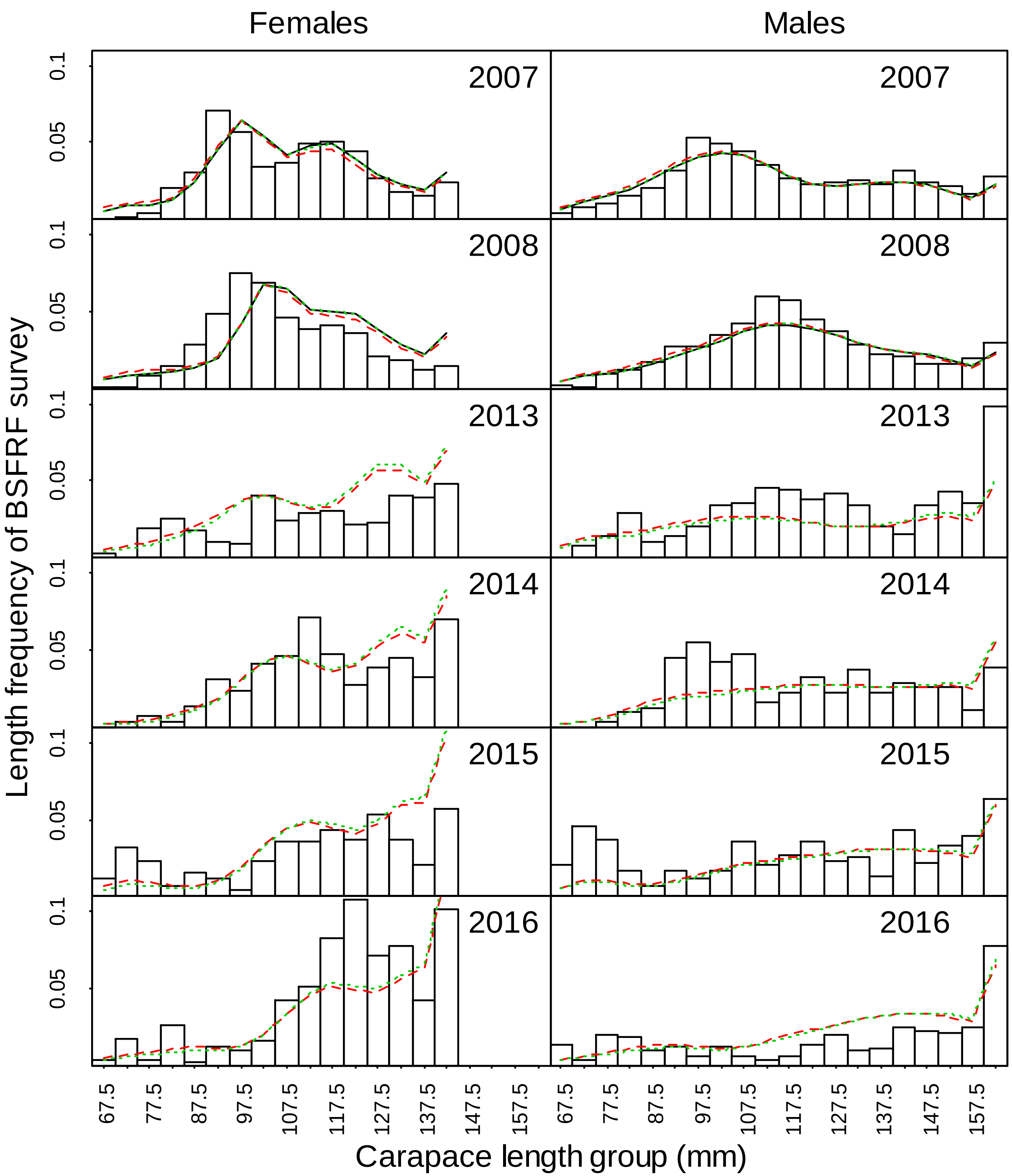




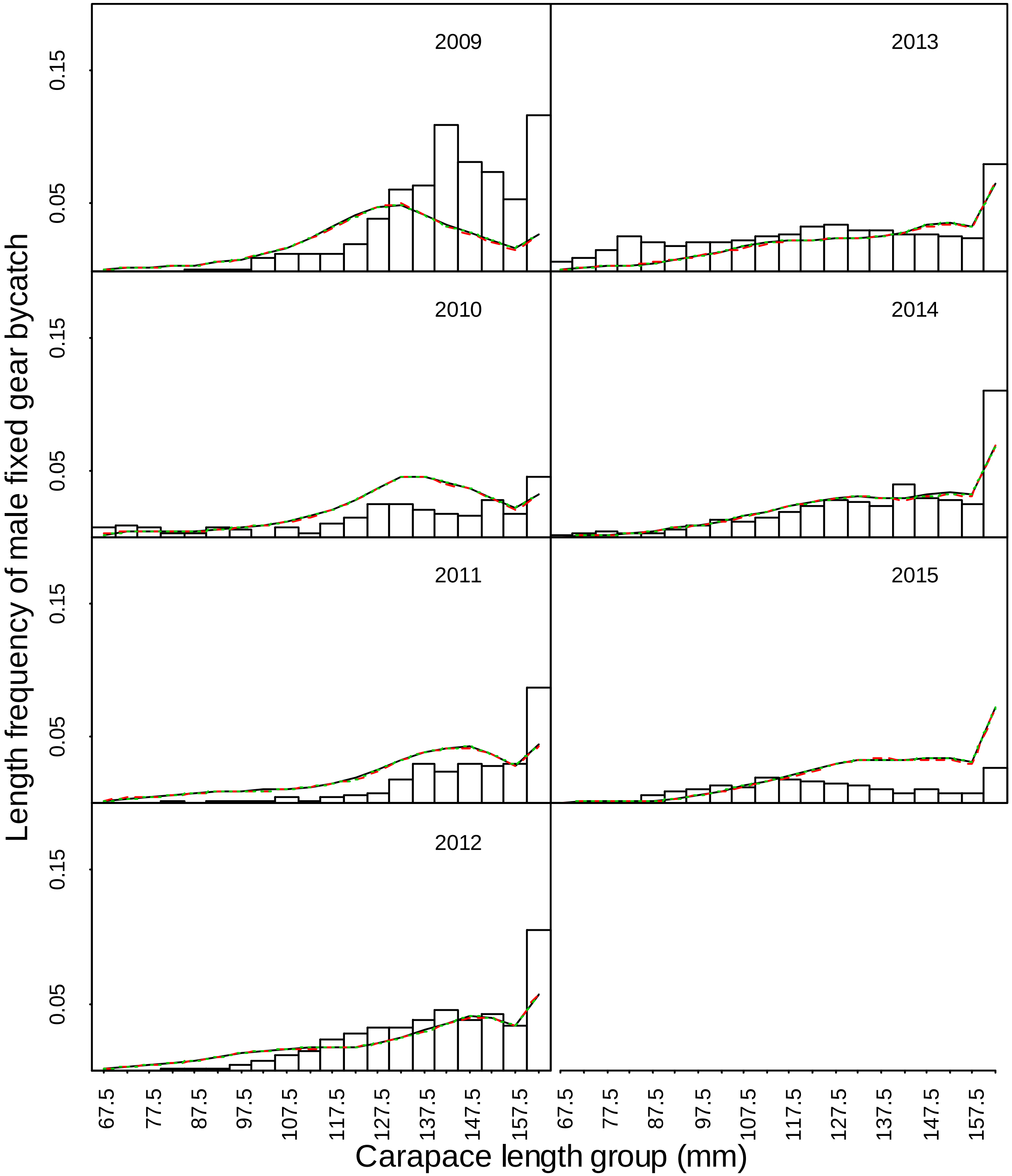
Comparison of area-swept and model estimated NMFS survey length frequencies of Bristol Bay male red king crab by year under scenarios 2b(solid black), 2c(dashed red), and 2d (green lines)



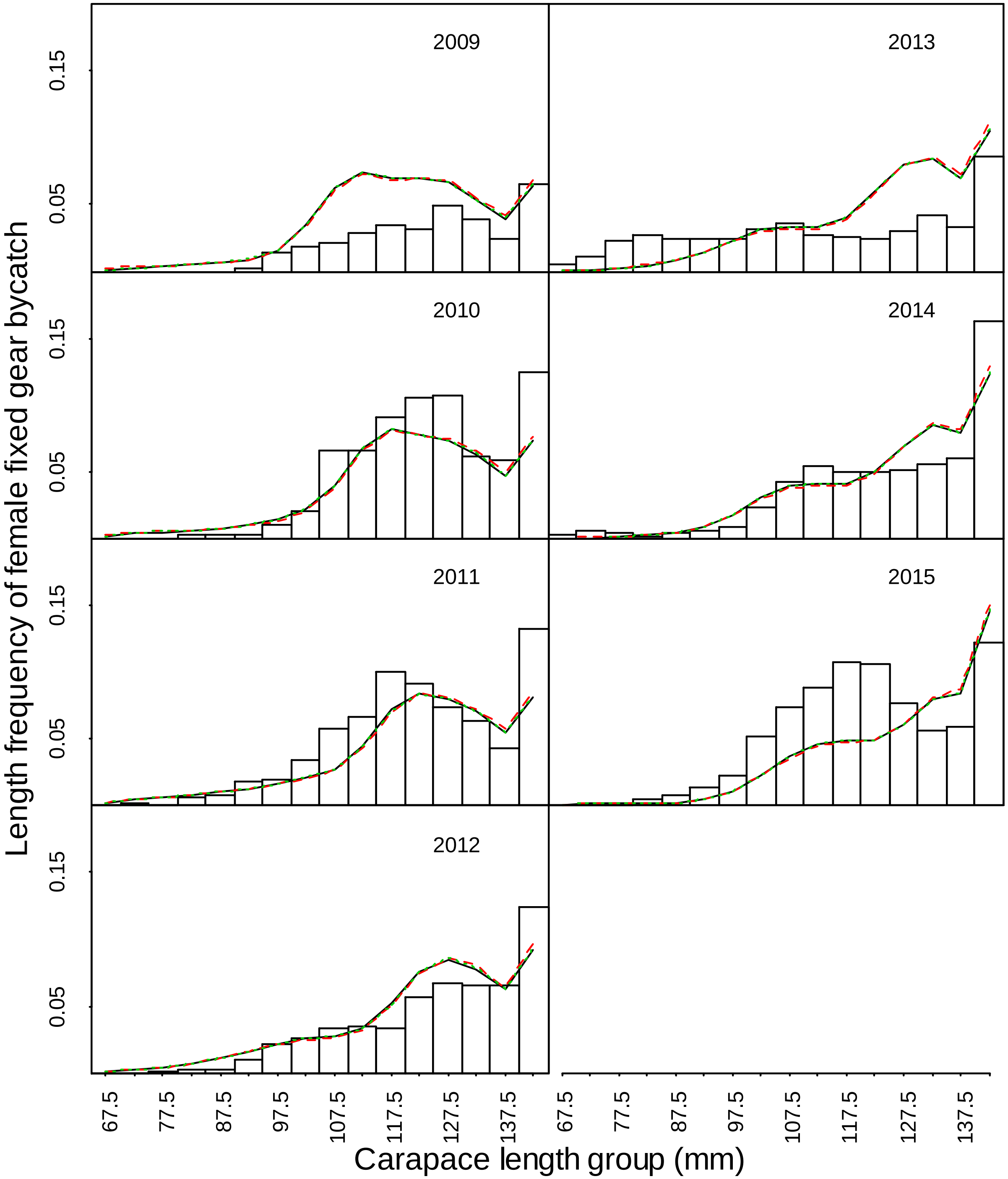
Comparison of area-swept and model estimated NMFS survey length frequencies of Bristol Bay female red king crab by year under scenarios 2b(solid black), 2c(dashed red), and 2d (green lines)



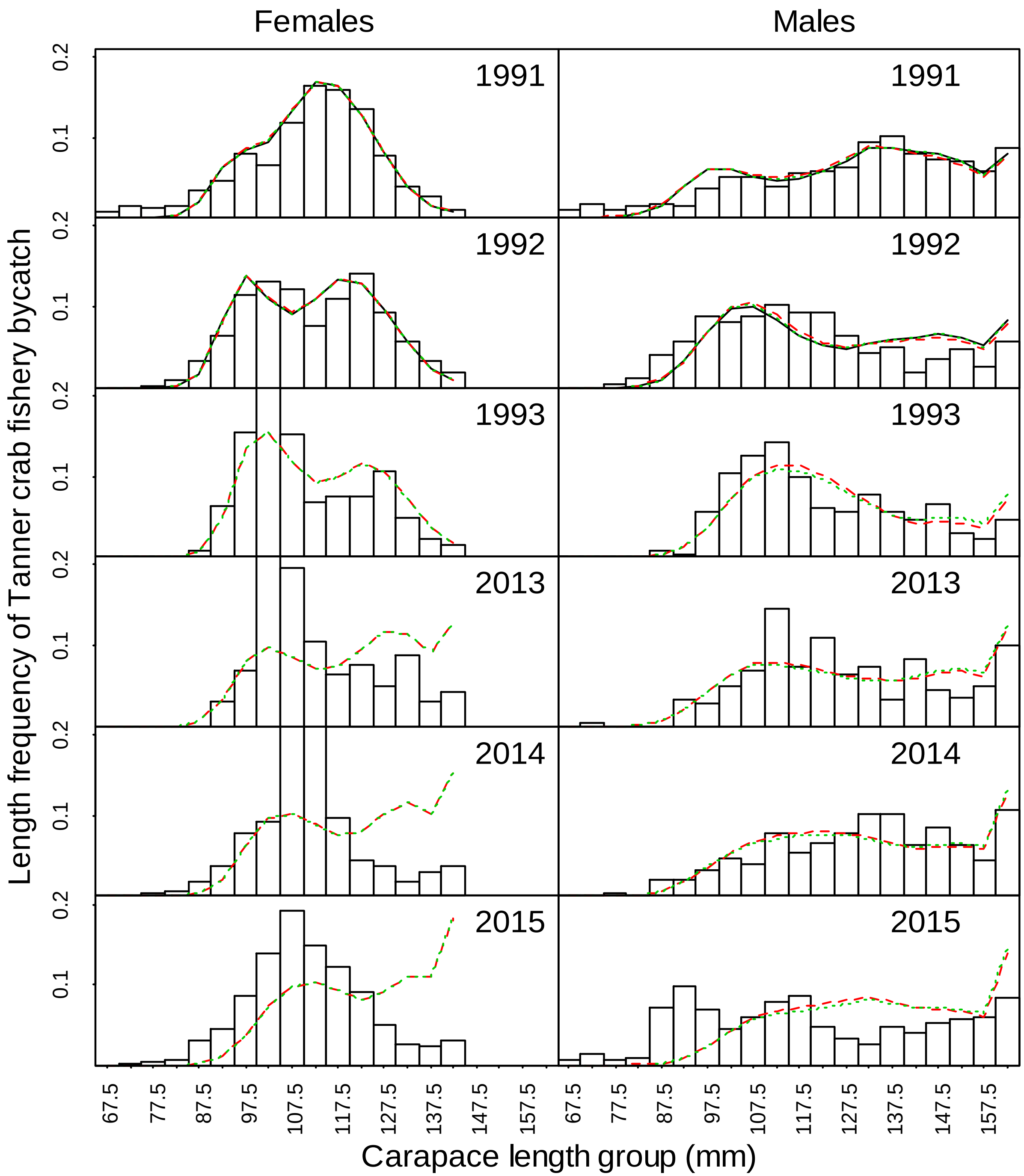
Comparison of area-swept and model fits of BSFRF survey length compositions with scenarios 2b (black lines), 2c (red lines), and 2d (green lines)



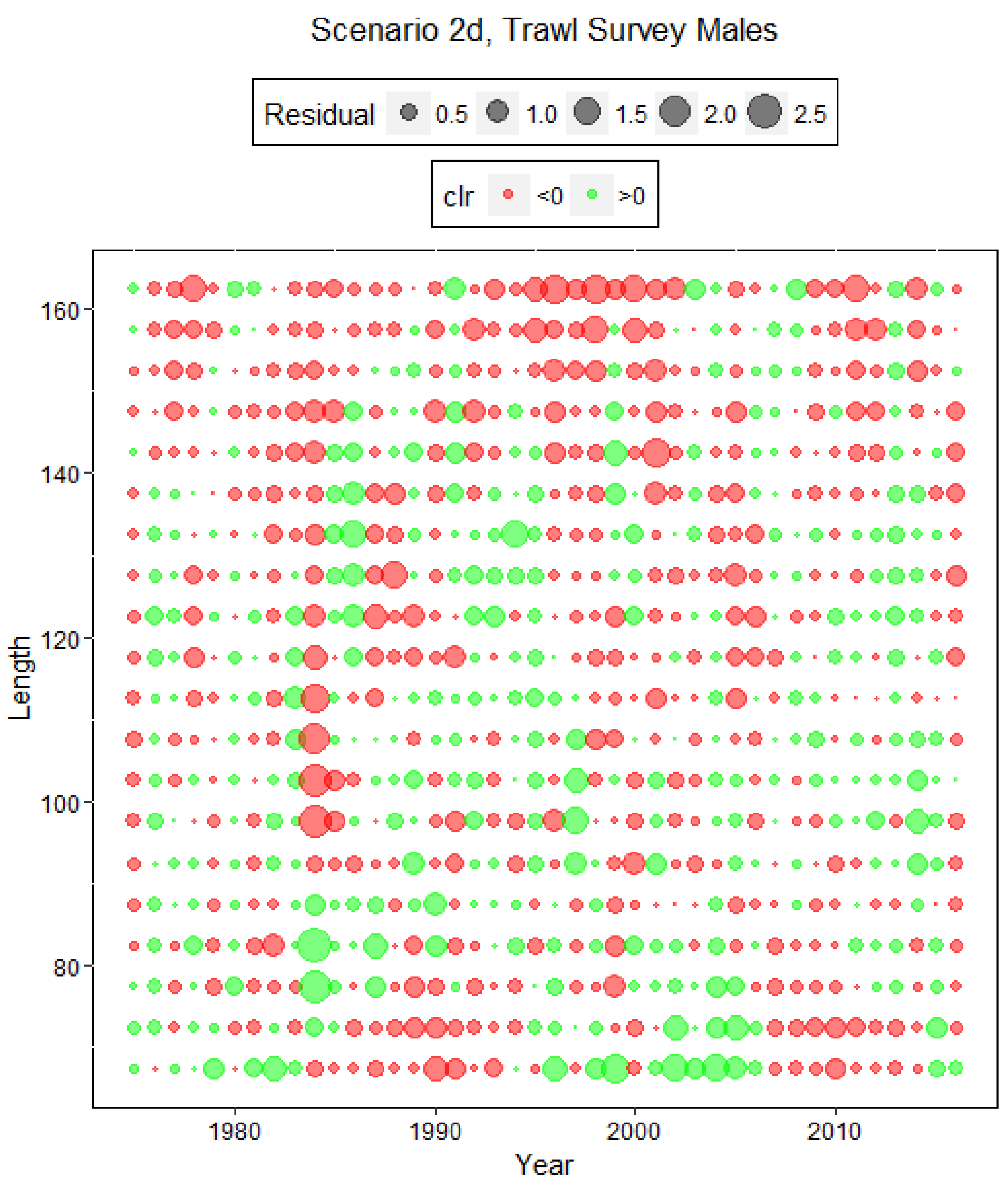
Comparison of observer and model estimated discarded length frequencies of Bristol Bay male red king crab by year in the groundfish fixed gear fisheries under scenarios 2b(solid black), 2c (dashed red), and 2d (green lines).

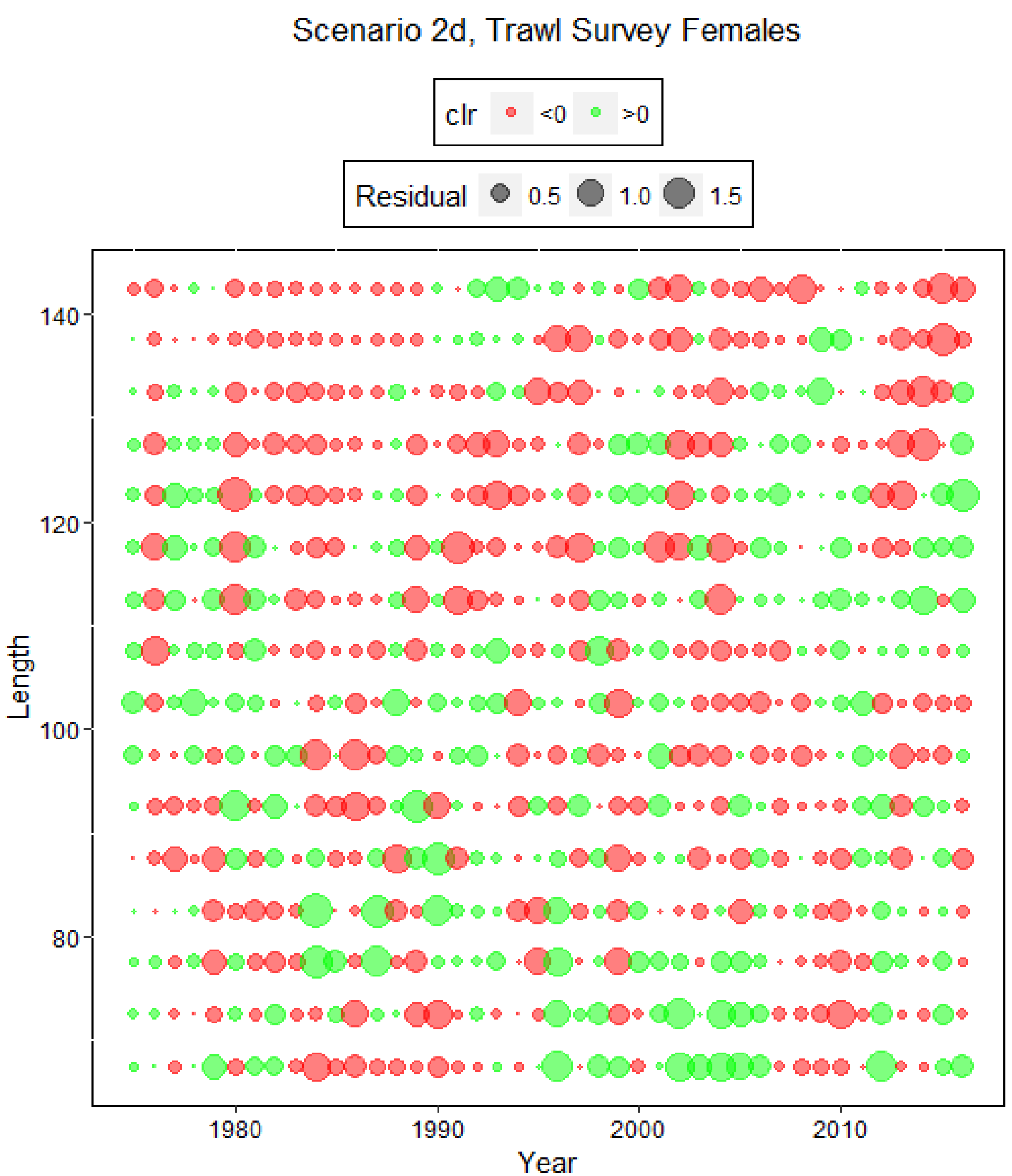


Comparison of observer and model estimated discarded length frequencies of Bristol Bay female red king crab by year in the groundfish fixed gear fisheries under scenarios 2b(solid black), 2c (dashed red), and 2d (green lines).



Comparison of observer and model estimated discarded length frequencies of Bristol Bay female red king crab by year in the Tanner crab fishery under scenarios 2b(solid black), 2c (dashed red), and 2d (green lines).


Scenario 2d, Trawl Survey Males
Residual 0.5 1.0 1.5 2.0 2.5
clr <0 >0
Length
160
140
120
100
80
1980
1990
2000
2010
Year


Scenario 2d, Trawl Survey Females
clr
<0
>0
Residual
0.5
1.0
1.5
140
120
100
80
Length
1980
1990
2000
2010
Year

Negative loglikelihood components for scenarios 2, 2a, 2b, 2c and 2d and differences in negative loglikelihood components among model scenarios

	Scenario							
Negative log likelihood	2	2a	2b	2c	2d	2b-2a	2b-2c	2b-2d
R-variation	86.87	83.79	83.85	84.45	83.77	0.05	-0.61	0.08
Length-like-retained	-1005.2	-1010.28	-1011.33	-1012.4	-1011.80	-1.05	1.05	0.47
Length-like-discmale	-1047.2	-1047.3	-1047.5	-1046.0	-1047.2	-0.23	-1.52	-0.35
Length-like-discfemale	-758.31	-757.84	-758.04	-757.49	-757.85	-0.19	-0.55	-0.19
Length-like-survey	-47410	-47411	-47411	-47420	-47413	-0.30	8.40	2.00
Length-like-disctrawl	-3726.3	-3743.9	-3684.7	-3685.0	-3684.8	59.21	0.31	0.04
Length-like-discfix	0.00	0.00	-681.94	-681.76	-681.92	-681.9	-0.18	-0.02
Length-like-discTanner	-465.88	-466.04	-466.20	-467.28	-466.53	-0.16	1.08	0.32
Length-like-bsfrfsurvey	-646.36	-645.03	-645.38	-647.24	-645.67	-0.35	1.86	0.29
Catchbio_retained	48.59	50.92	50.95	52.16	51.15	0.03	-1.21	-0.20
Catchbio_discmale	227.80	227.30	228.83	227.31	228.56	1.52	1.52	0.27
Catchbio-discfemale	0.13	0.10	0.11	0.11	0.11	0.00	-0.01	0.00
Catchbio-disctrawl	0.92	0.22	0.21	0.25	0.22	-0.01	-0.04	-0.01
Catchbio-discfix	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Catchbio-discTanner	0.12	0.13	0.13	0.17	0.14	0.00	-0.03	-0.01
Biomass-trawl survey	97.75	102.91	102.55	101.46	101.44	-0.36	1.08	1.11
Biomass-bsfrfsurvey	-8.07	-8.29	-8.45	-7.37	-8.27	-0.16	-1.08	-0.18
Q-trawl survey	2.76	3.63	3.26	0	0	-0.38	3.26	3.26
Others	21.00	16.41	17.91	17.94	18.00	1.50	-0.03	-0.09
Total	-54581	-54604	-55227	-55241	-55234	-622.8	13.30	6.80
Free parameters	279	276	286	286	286	10	0	0
Bmsy(t)	25785	25818	25930	24487	25588	112.0	1443.3	342.2
MMB2016(t)	23999	24086	24726	22027	24116	639.3	2698.3	609.2
OFL2016(t)	6637	6692	7047	5791	6771	355.5	1256.3	276.6
Fofl2016	0.268	0.268	0.275	0.258	0.271	0.007	0.017	0.017

Comparison of some estimated values of scenarios 2a, 2b, 2c, and 2d (1000 t for biomass and catch)

	Scenario 2a	Scenario 2b	Scenario 2c	Scenario 2d
Q	0.963	0.960	1.173	1.000
$B_{35\%}$	25.818	25.930	24.487	25.588
$F_{35\%}$	0.29	0.29	0.29	0.29
MMB_{2016}	24.086	24.726	22.027	24.116
OFL_{2016}	6.692	7.047	5.791	6.770
ABC_{2016}	6.022	6.342	5.212	6.093

Summary

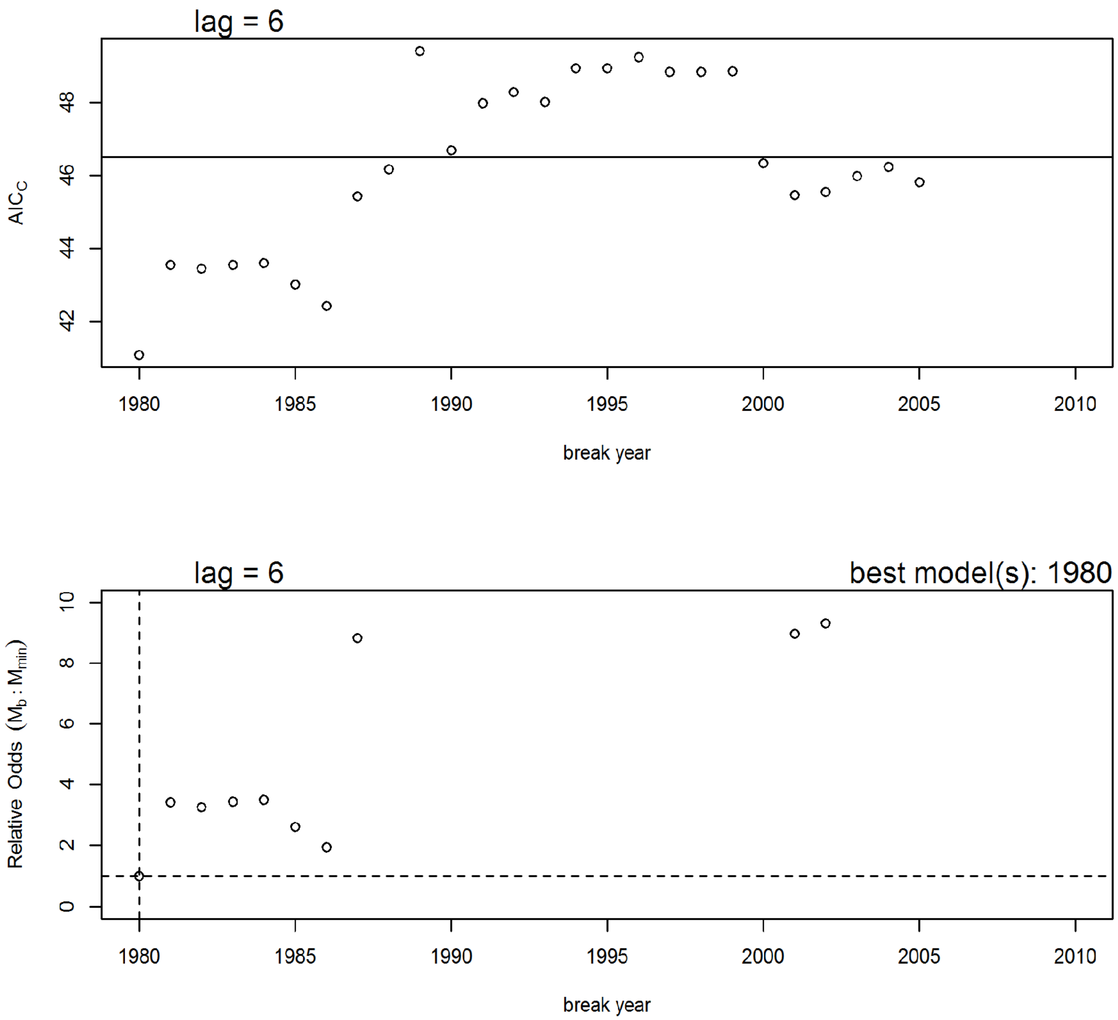
1) Updated BSFRF survey data in 2016 hardly impacts the results; scenarios 2 and 2a are almost the same.
2) Separating groundfish fisheries bycatch into trawl and fixed gear fisheries bycatches also results in similar results except for very slightly a lower NMFS survey Q estimate and higher biomass and catch estimates.
3) Changing groundfish fisheries timing to mid-point of crab year generally results in slight higher population biomass estimates in recent years.
4) Without Q prior from the double bag experiment, estimated Q values are generally higher, resulting in lower biomass and catch estimates. NMFS survey Q estimate is greater than 1 (1.17) for scenario 2c.
5) Estimated BSFRF survey selectivities for scenario 2c are somewhat different from other scenarios, and estimated BSFRF female survey selectivites for other scenarios appear more plausible than those for scenario 2c.

Recommendations

1) Either scenario 2b or 2d for September 2017 base assessment because of corrected data and refined approach to estimation of survey catchability.

Appendix B. Recruitment Breakpoint Analysis

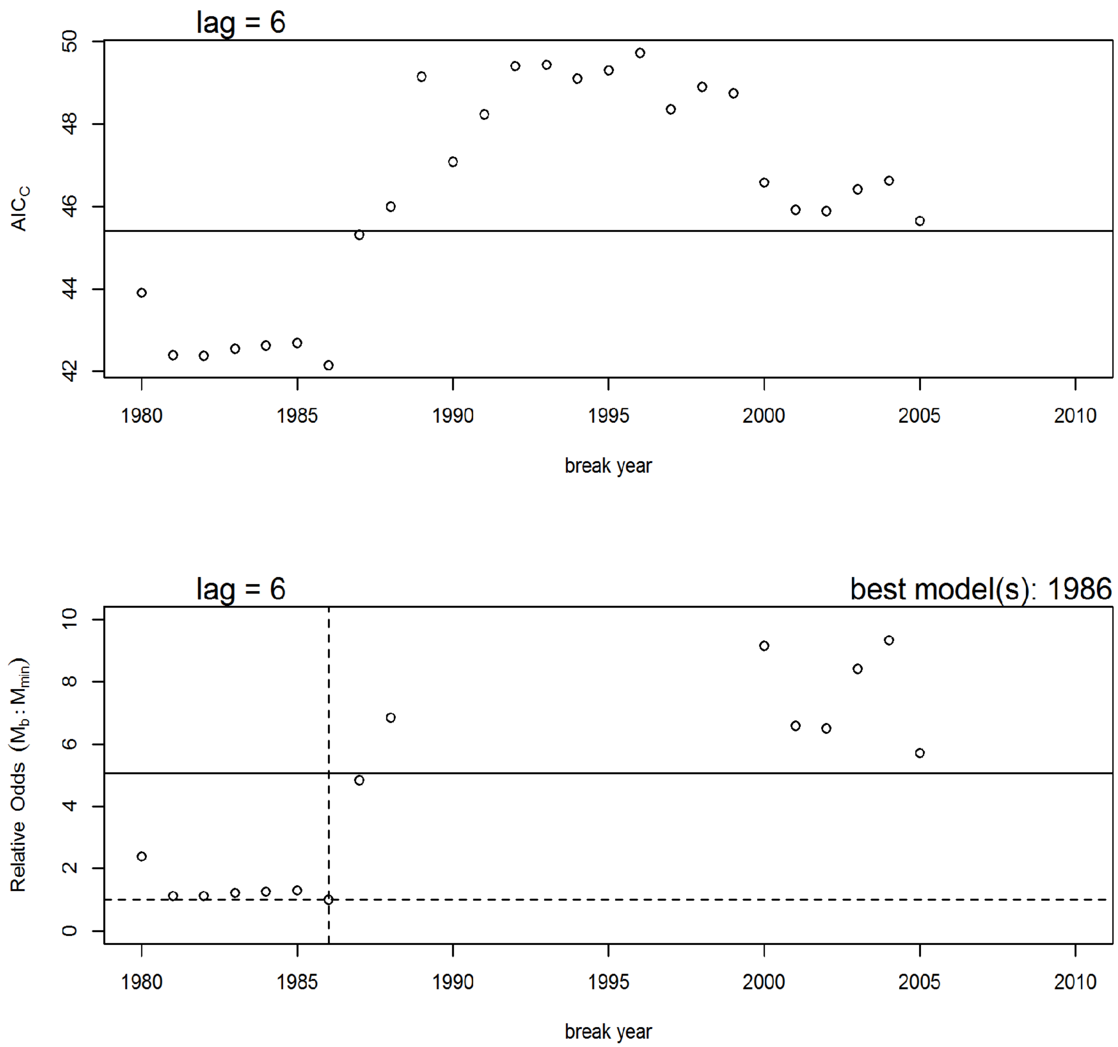
- Requested by SSC
- Same approach as Punt et al. (2014) and Stockhausen (2013) (please read appendix B if interested in the detailed method)
- Understanding the temporal change of stock productivity and the recruitment time series
- Estimating the best breakpoint year
- Results with scenario 2d



The Ricker stock-recruit breakpoint analysis

Best breakpoint brood year: 1980 without plausible estimated S-R parameters, next is 1986 => recruitment year: 1992

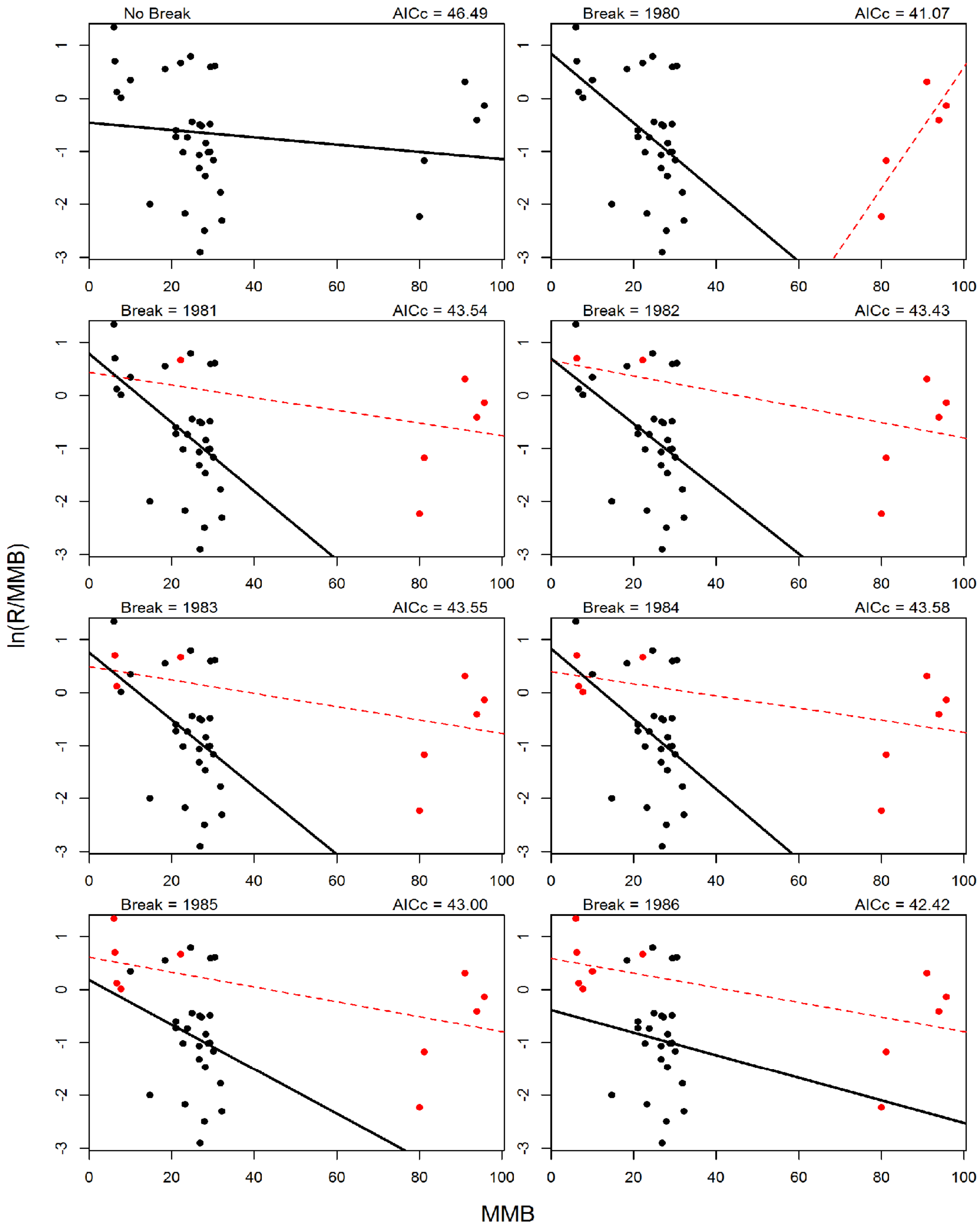
Brood years of 1981-1985 are also likely



The Beverton-Holt stock-recruit breakpoint analysis

Best breakpoint brood year: 1986
⇒ Recruitment year: 1992

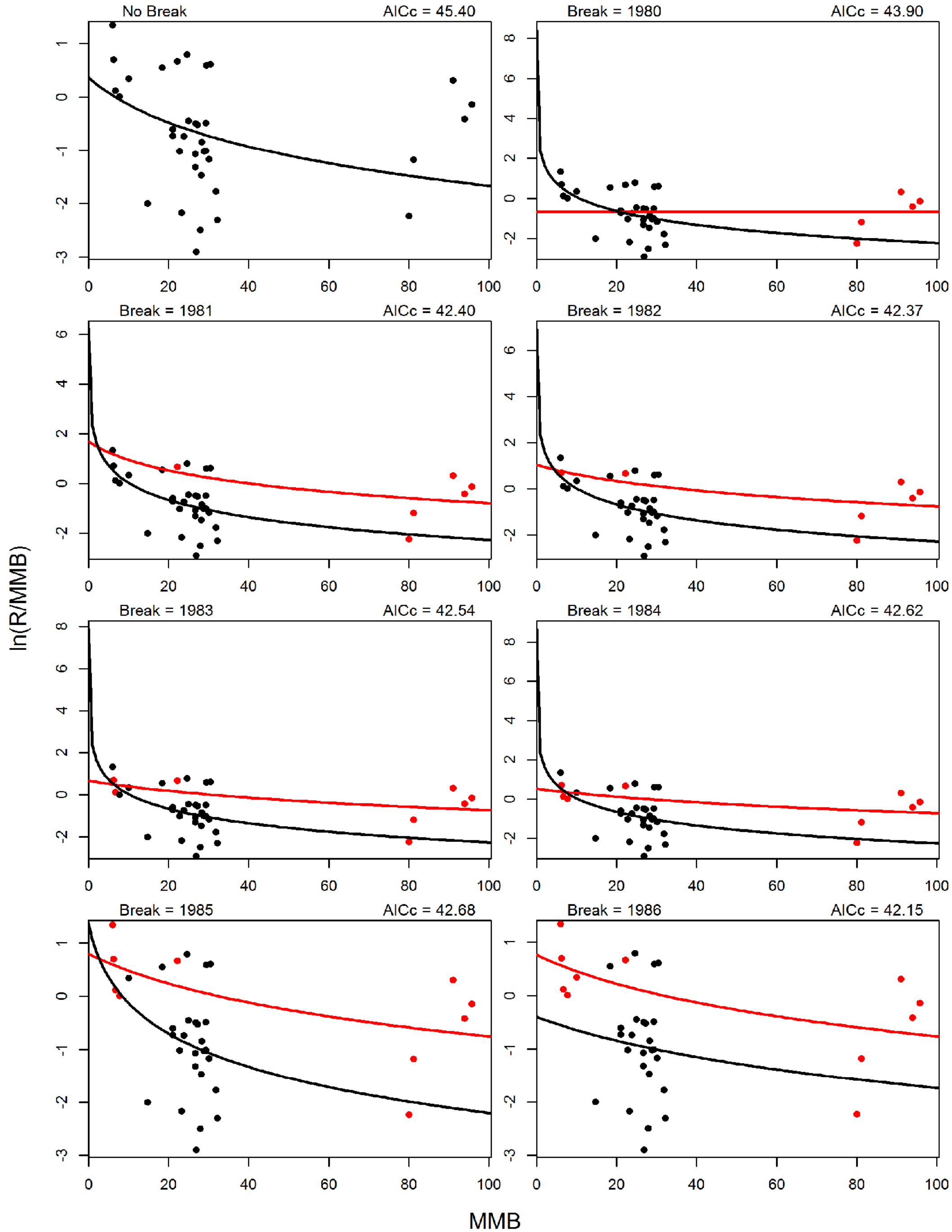
Brood years of 1980-1985 are also likely



The Ricker stock-recruit model

MMB range for the recent period is too narrow

The model does not fit stock-recruitment data well



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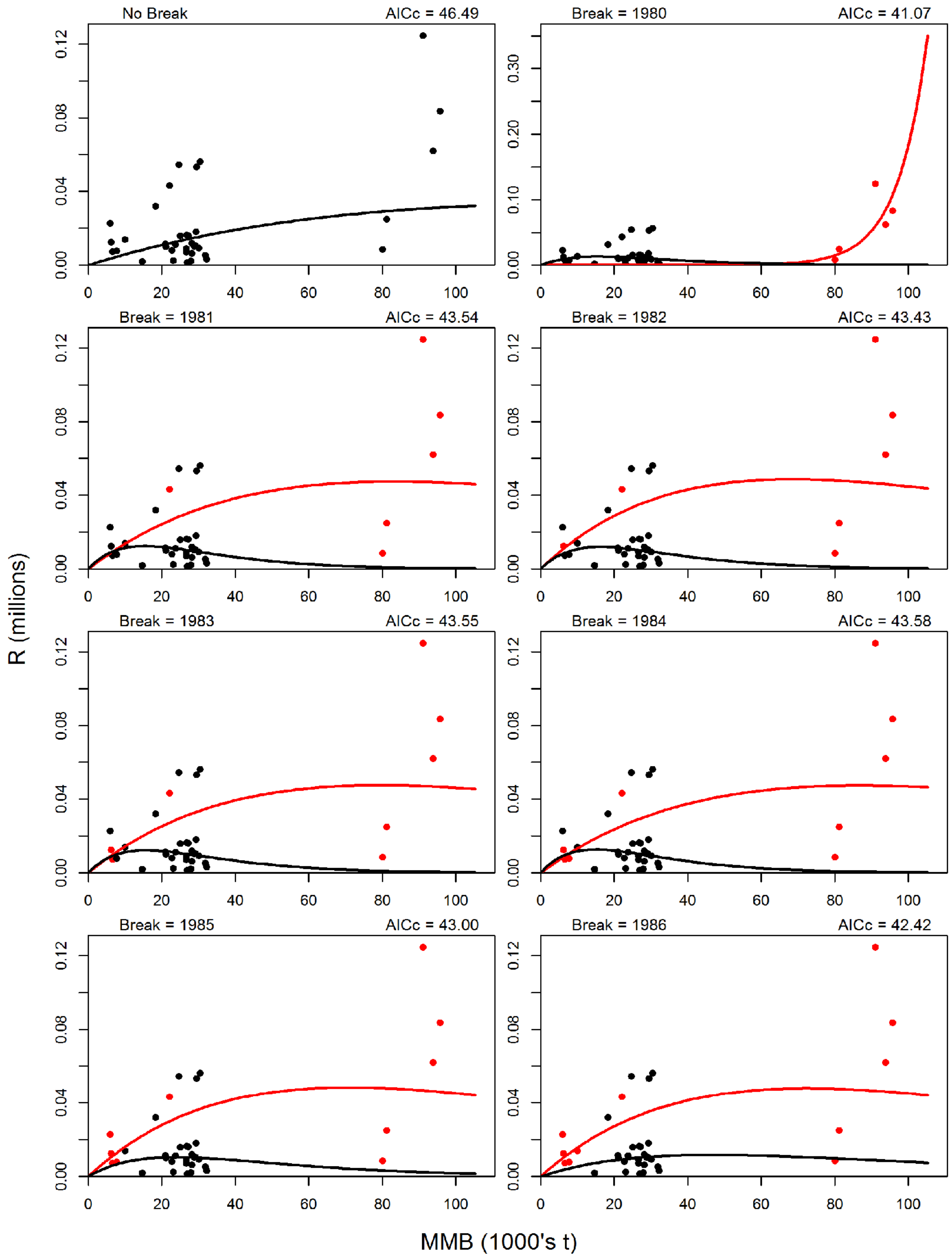

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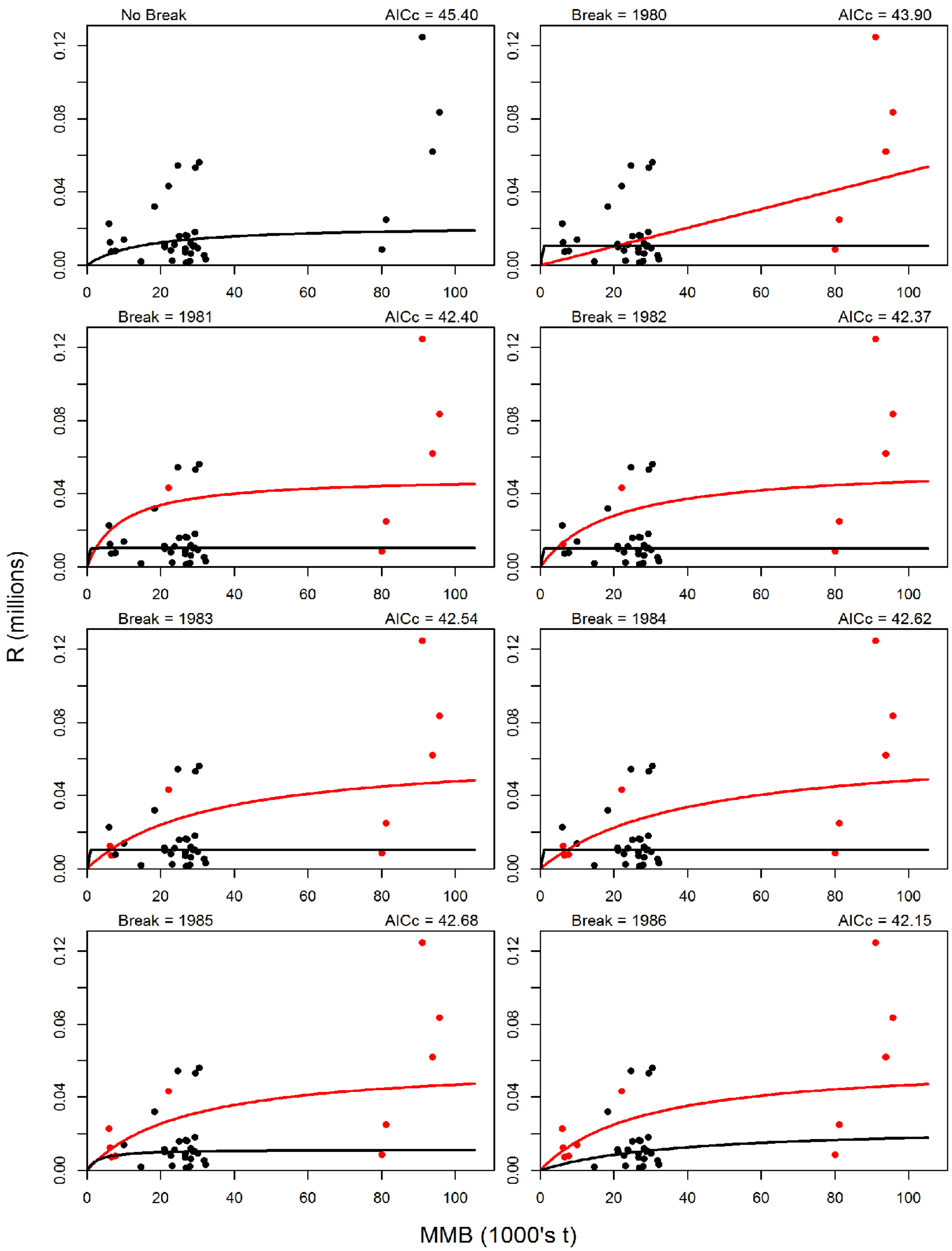


The Beverton-Holt stock-recruit model

MMB range for the recent period is too narrow

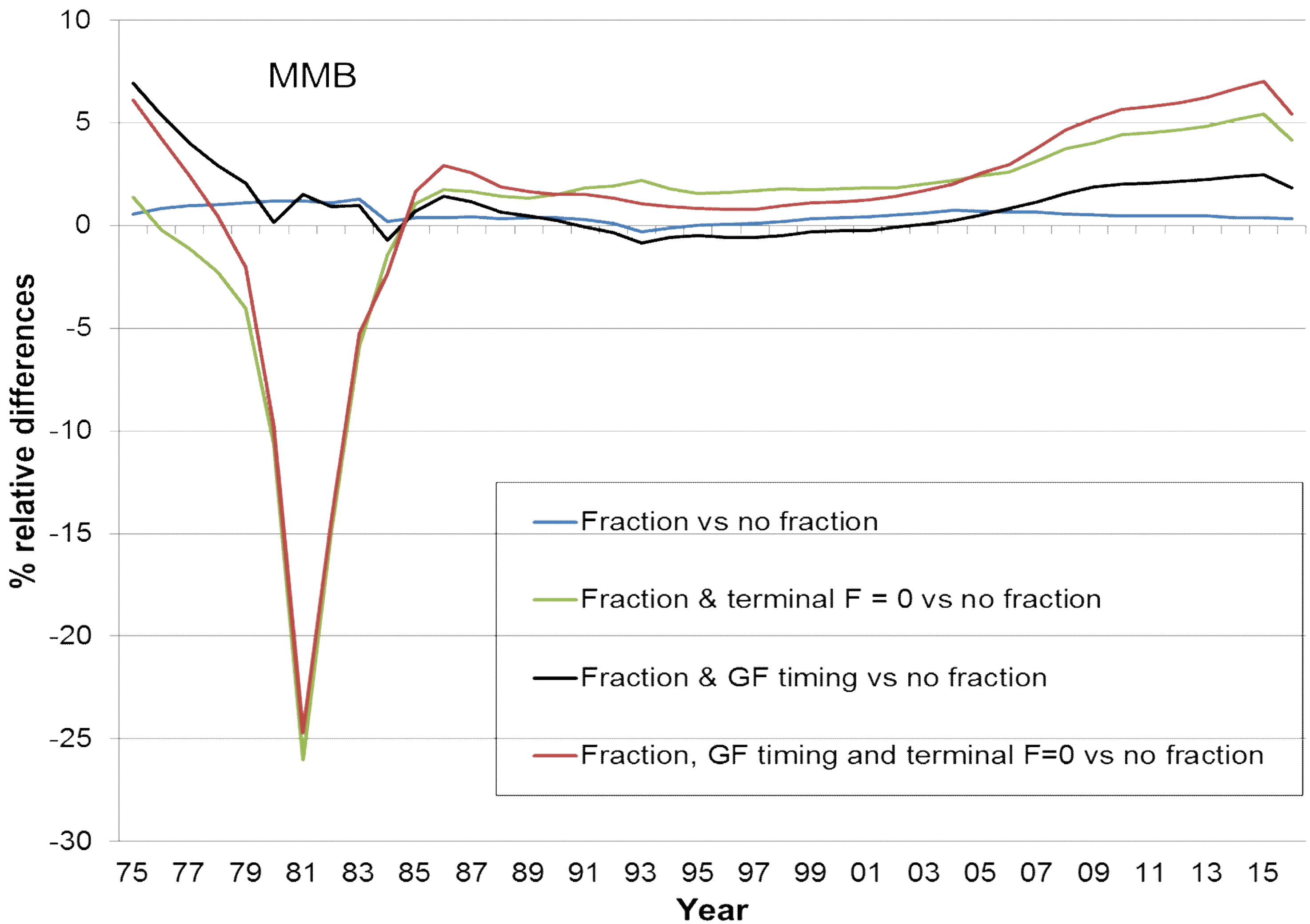
The model does not fit stock-recruitment data well

Discussion

1) Best breakpoint brood year of 1986, compared to 1984 by Punt e al. (2014), likely caused by data period difference (1975-2016 vs. 1968-2010). Brood year 1984 is also a likely breakpoint year in our results.
2) Current OFL setting uses recruitment time series of 1984-present. If using the best breakpoint year, the time series of recruitment during 1992-present should be used. For scenario 2d, period 1992-2016 has 13.0% lower mean recruitment than period 1984-2016.
3) SSC recommended that "should not be used to change the time frame used to estimate biological reference points".
4) Cannot detect the recruitment break in 2006 (brood year of 2000).

Thanks

Fraction: Fi/Ftot*(1-exp(-Ftot)) ; No fraction: (1-exp(-Fi))
GF timing: G. fisheries occur at mid-point ; No fraction: same time as directed pot f.
Terminal F=0: no estimating terminal F; No fraction: estimating terminal F



Fraction: Fi/Ftot*(1-exp(-Ftot)) ; No fraction: (1-exp(-Fi))
GF timing: G. fisheries occur at mid-point ; No fraction: same time as directed pot f.
Terminal F=0: no estimating terminal F; No fraction: estimating terminal F