Bristol Bay Red King Crab Assessment in Fall 2015

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ADF&G, Juneau

Outline

5. Projections and future outlook

4. Alternative baselines for B35% and ABC setting

3. Assessment results

2. New data and model scenarios

1. Responses to CPT and SSC Review Comments

Response to CPT Comments

"1. Use new survey data for all runs."

Done.

"2. Do runs with stepwise changes from scenario 1 to 2, with one change for each scenario."

Due to lack of female juvenile growth data, we will not include scenario 2 in this report. Scenario 2 will be evaluated in future.

"3. Run a scenario with a temperature relationship to survey q. Use a method that allows variability in the index such as the "data method" described in Schirippa et al (2009)."

Scenario 1a is the "data method" to estimate annual trawl survey catchabilities with bottom temperature data. As a comparison, scenario 1b is the "model method" to estimate annual survey catchabilities based on Wilderbuer et al. (2013).

"4. Use egg code data in the survey to separate immature and mature females and input as data to the model as an alternative for tracking changes in maturity over time. Fit immature and mature females separately in the model."

Will follow this recommendation in future when working with scenario 2.

"5. Label x axis on length composition plots with actual length in millimeters."

Done.

Response to SSC Comments

1. No comments in June 2015.

Summary of Major Changes in 2015

1. Changes to the input data:
   a. Newly re-estimated trawl survey results provided by NMFS in 2015 were used.
   b. Catch and bycatch data were updated with 2015 data.
   c. Trawl bycatch length frequency data during 2010-2014 and trawl bycatch abundance data during 2009-2014 were revised based on the new data provided by NMFS in 2015.
   d. Bottom temperature data collected during the NMFS summer trawl surveys were used to estimate trawl survey catchability.

Summary of Major Changes in 2015

2. Changes to the assessment methodology:

Three model scenarios are evaluated in this report:

Scenario1: Renamed from scenario 4nb in the SAFE report in September 2014 for simplicity with the new time series of the NMFS trawl survey data.

Scenario 1a: the same as scenario 1 except using the bottom temperature data to estimate annual trawl catchability with the "data method" described in Schirippa et al. (2009):

$T_t = \beta\, \varepsilon_t$,

where β is a parameter, $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$, the process error deviation for year t & T_t is the estimated bottom temperature deviation for year t. Annual survey Q_t are

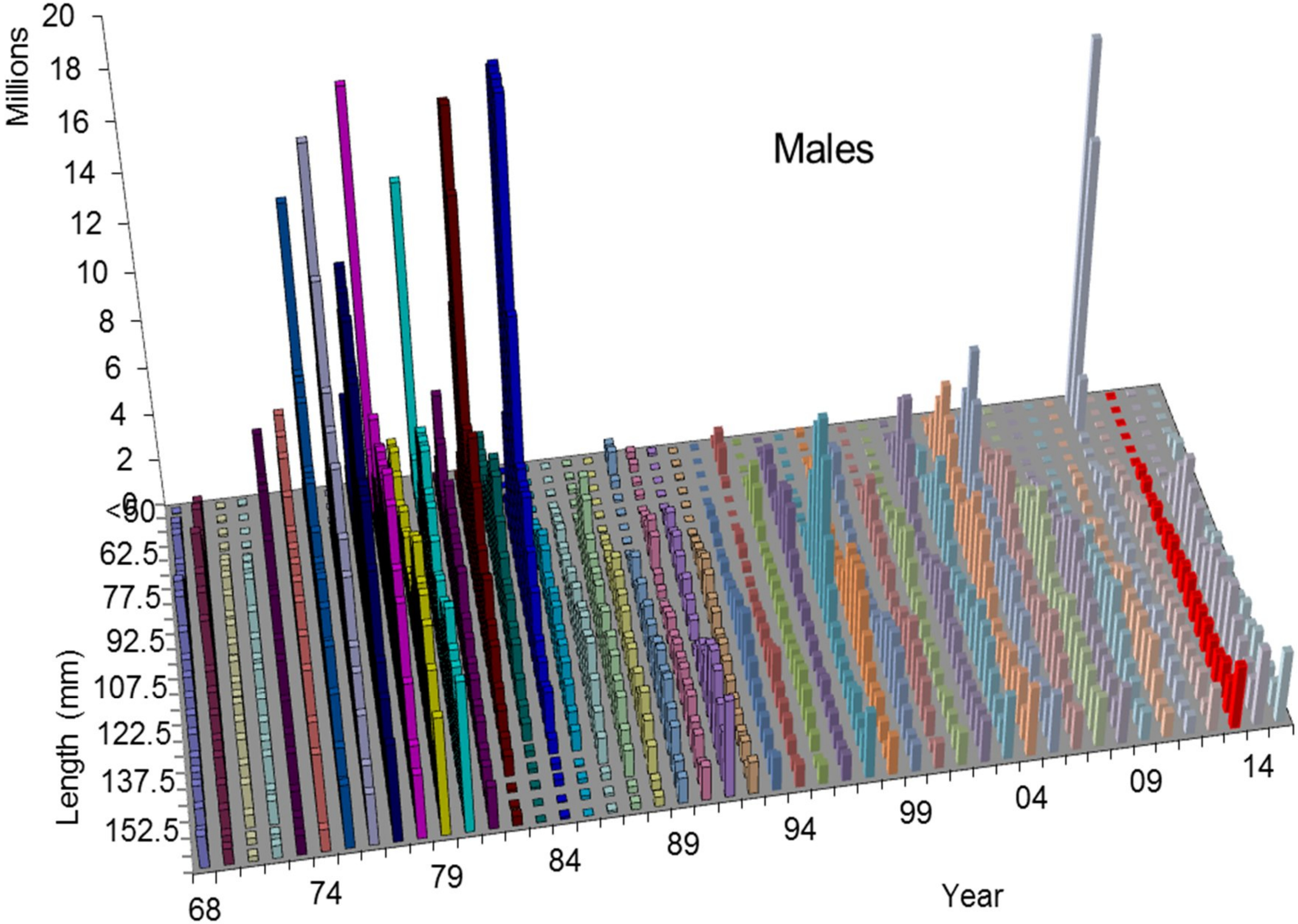
$Q_t = Q \exp(\varepsilon_t)$,

where Q is a parameter. The negative log likelihood value is

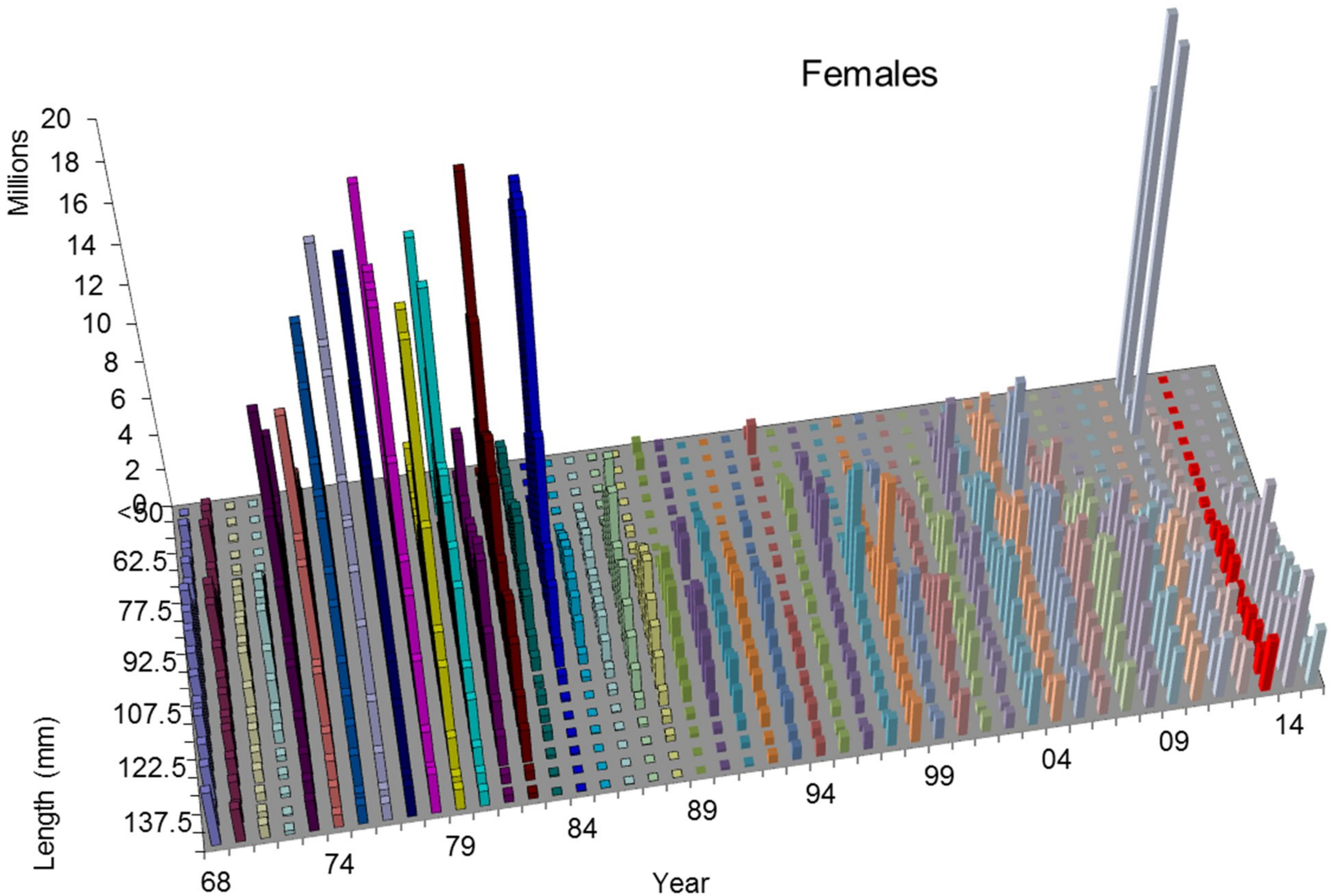
$$L = \sum [\ln(\sigma_T^2\, \beta^2)^{0.5} + (T_t^{obs} - T_t)^2 / (2\sigma_T^2\, \beta^2)]$$

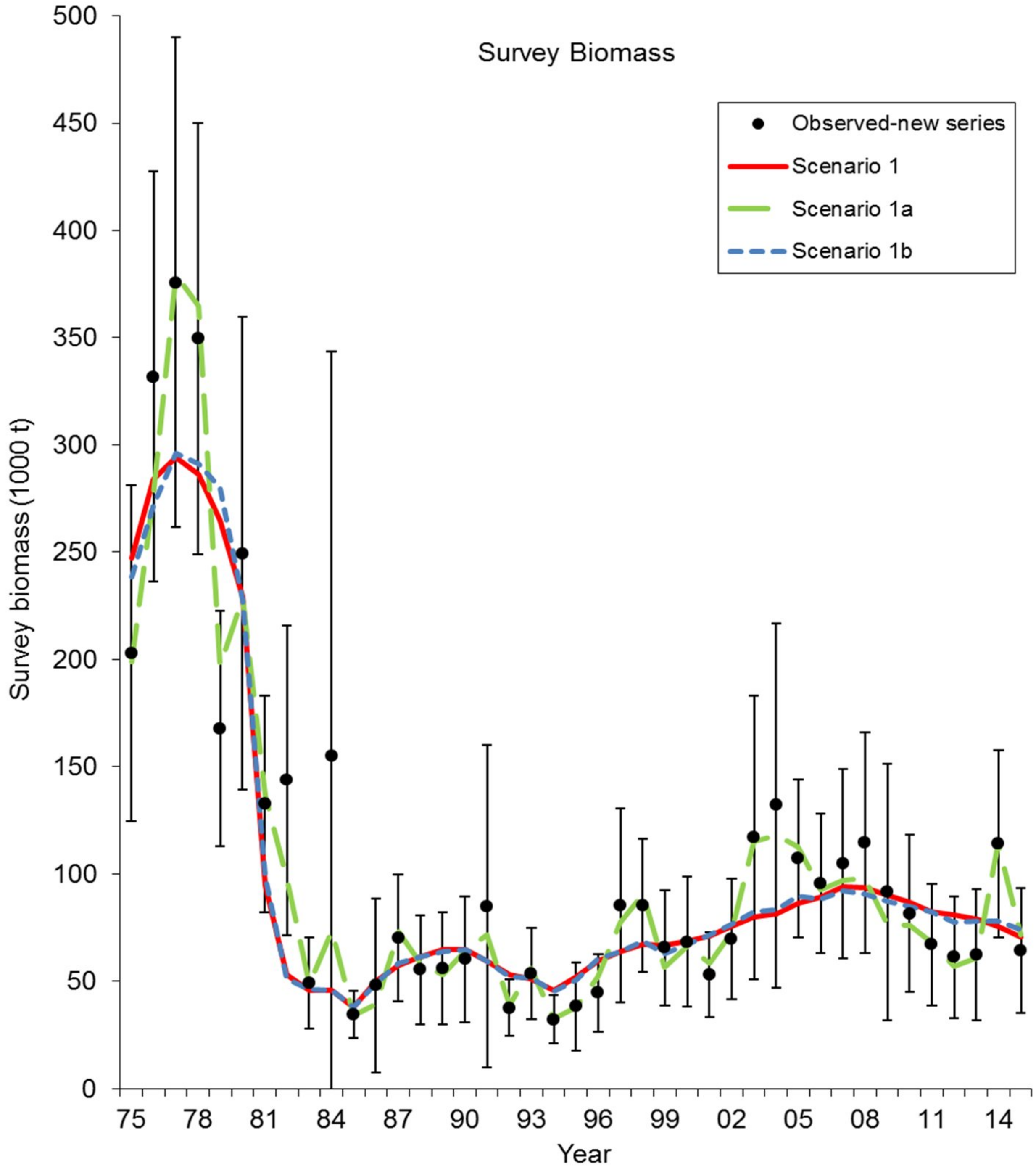
Scenario 1b: the same as scenario 1 except using the bottom temperature data to estimate annual trawl survey catchability with the "model method" based on Wilderbuer et al. (2013):

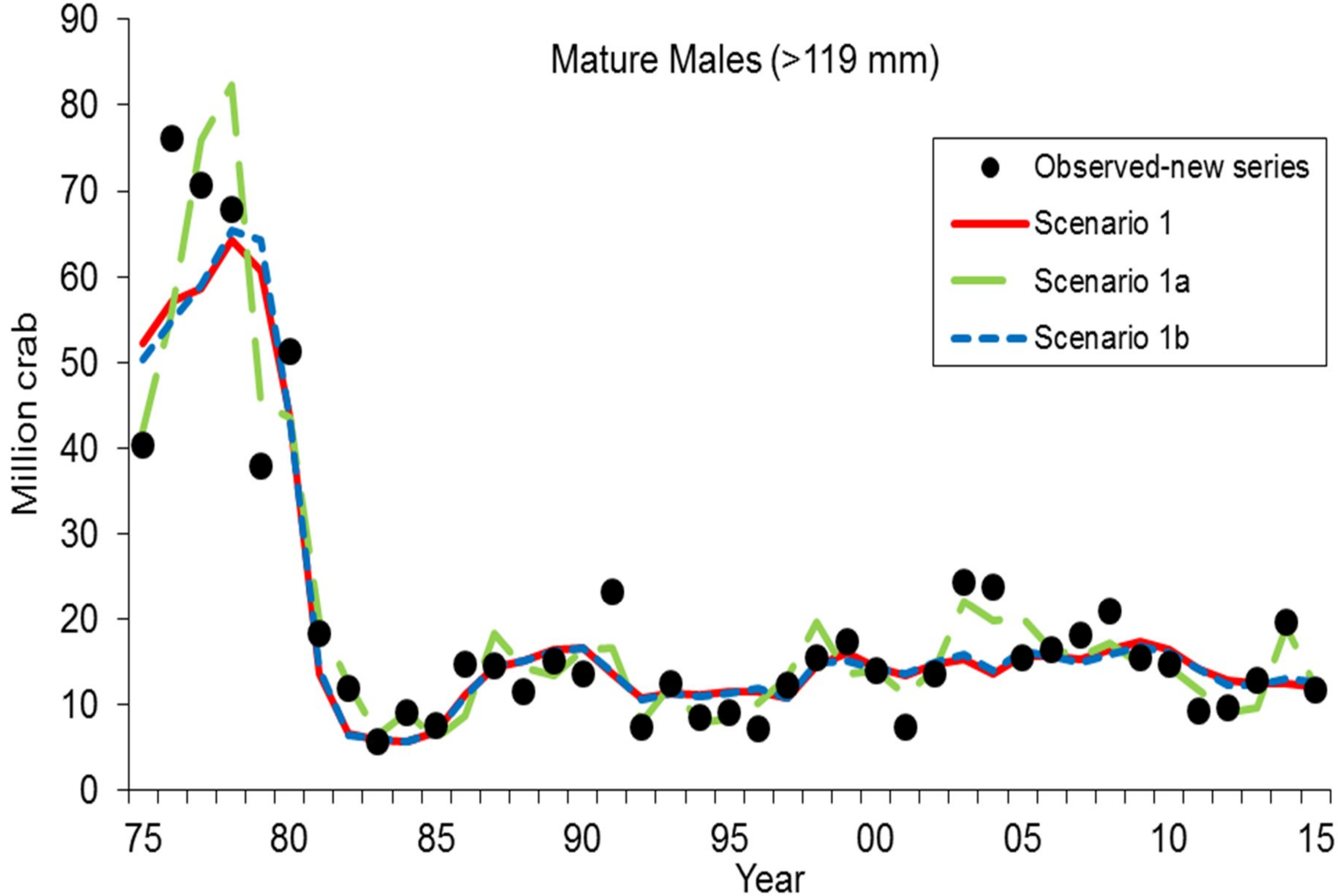
$Q_t = Q \exp(b * T_t^{obs})$, where Q and b are parameters.

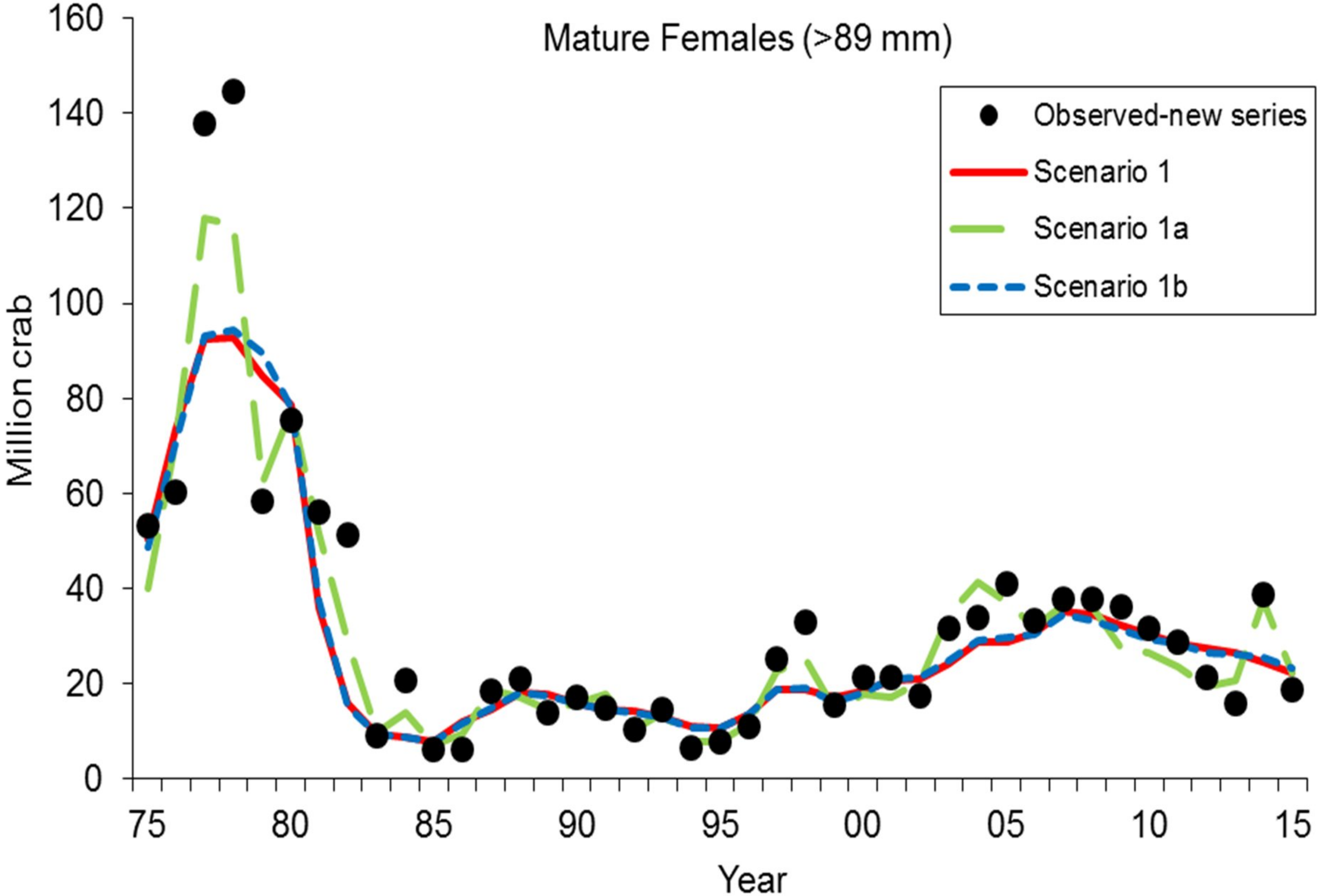


Males
Millions
20
18
16
14
12
10
8
6
4
2
0
<50
62.5
77.5
92.5
107.5
122.5
137.5
152.5
Length (mm)
68
74
79
84
89
94
99
04
09
14
Year

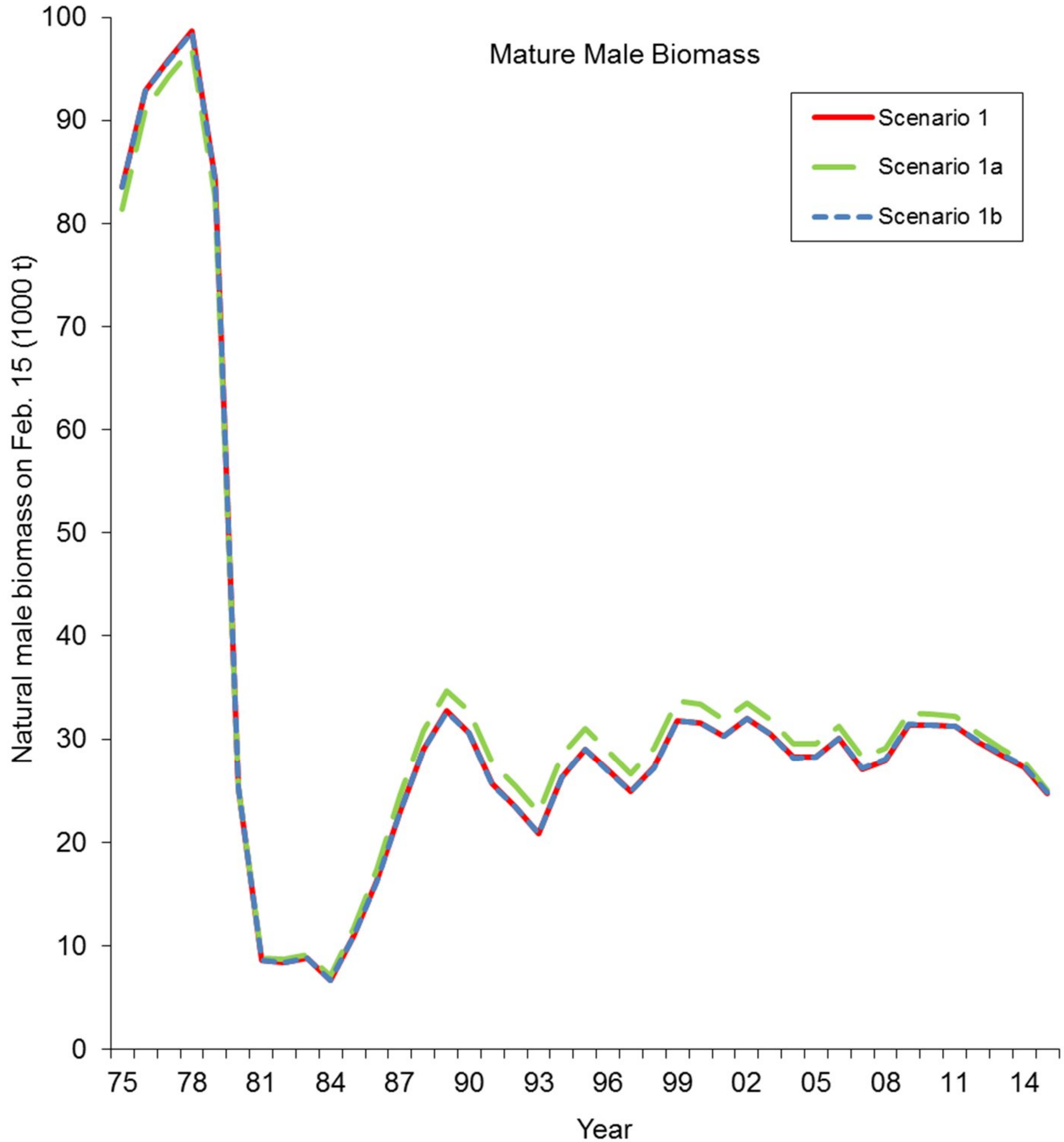

Females
Millions
20
18
16
14
12
10
8
6
4
2
0
<50
62.5
77.5
92.5
107.5
122.5
137.5
Length (mm)
68
74
79
84
89
94
99
04
09
14
Year

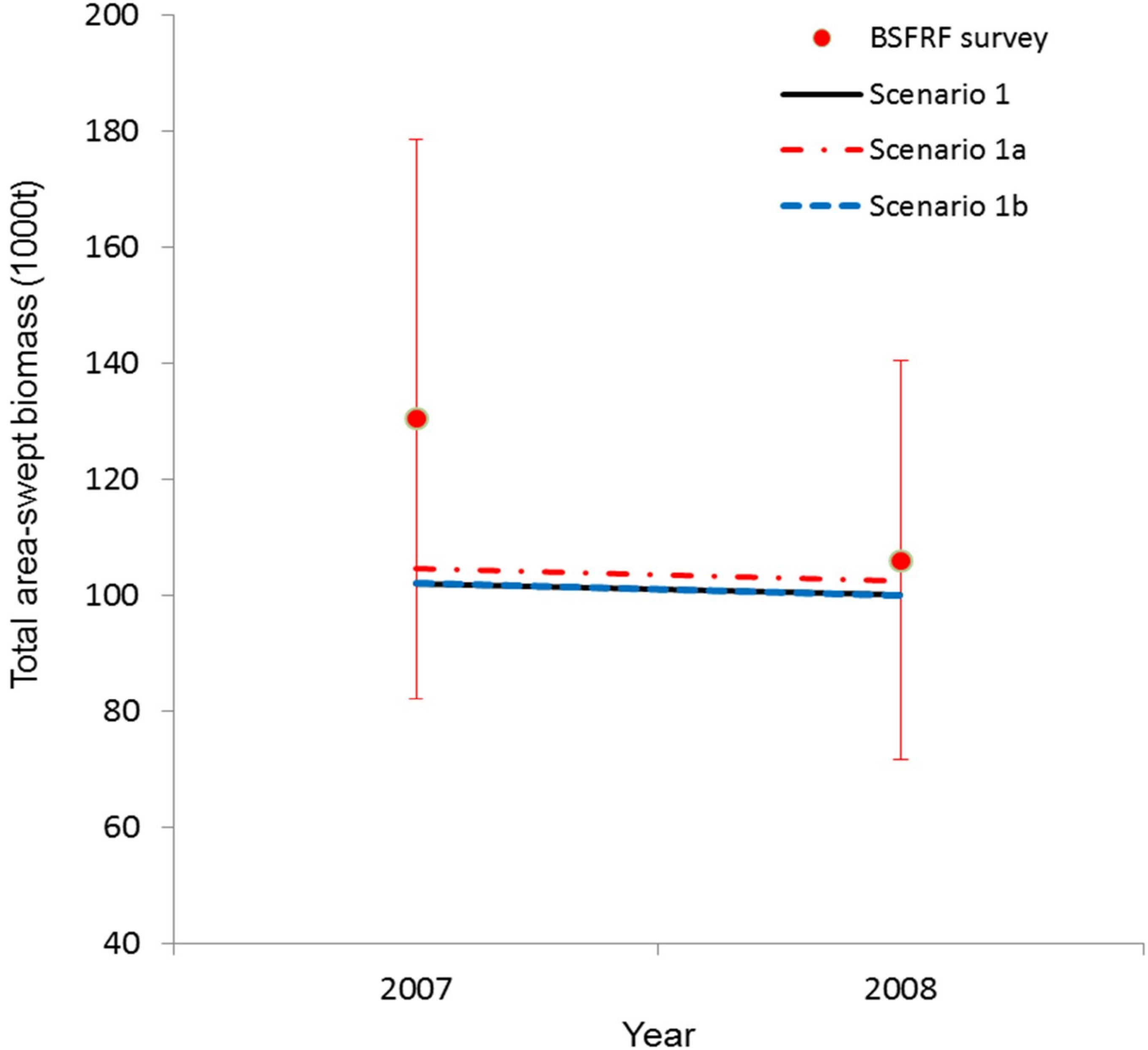

Survey Biomass
Observed-new series
Scenario 1
Scenario 1a
Scenario 1b
Survey biomass (1000 t)
Year
0
50
100
150
200
250
300
350
400
450
500
75
78
81
84
87
90
93
96
99
02
05
08
11
14


Mature Males (>119 mm)
Observed-new series
Scenario 1
Scenario 1a
Scenario 1b
Million crab
Year
0
10
20
30
40
50
60
70
80
90
75
80
85
90
95
00
05
10
15



Mature Females (>89 mm)
Observed-new series
Scenario 1
Scenario 1a
Scenario 1b
Million crab
Year
0
20
40
60
80
100
120
140
160
75
80
85
90
95
00
05
10
15


Mature Male Biomass
Scenario 1
Scenario 1a
Scenario 1b
Natural male biomass on Feb. 15 (1000 t)
100
90
80
70
60
50
40
30
20
10
0
75
78
81
84
87
90
93
96
99
02
05
08
11
14
Year



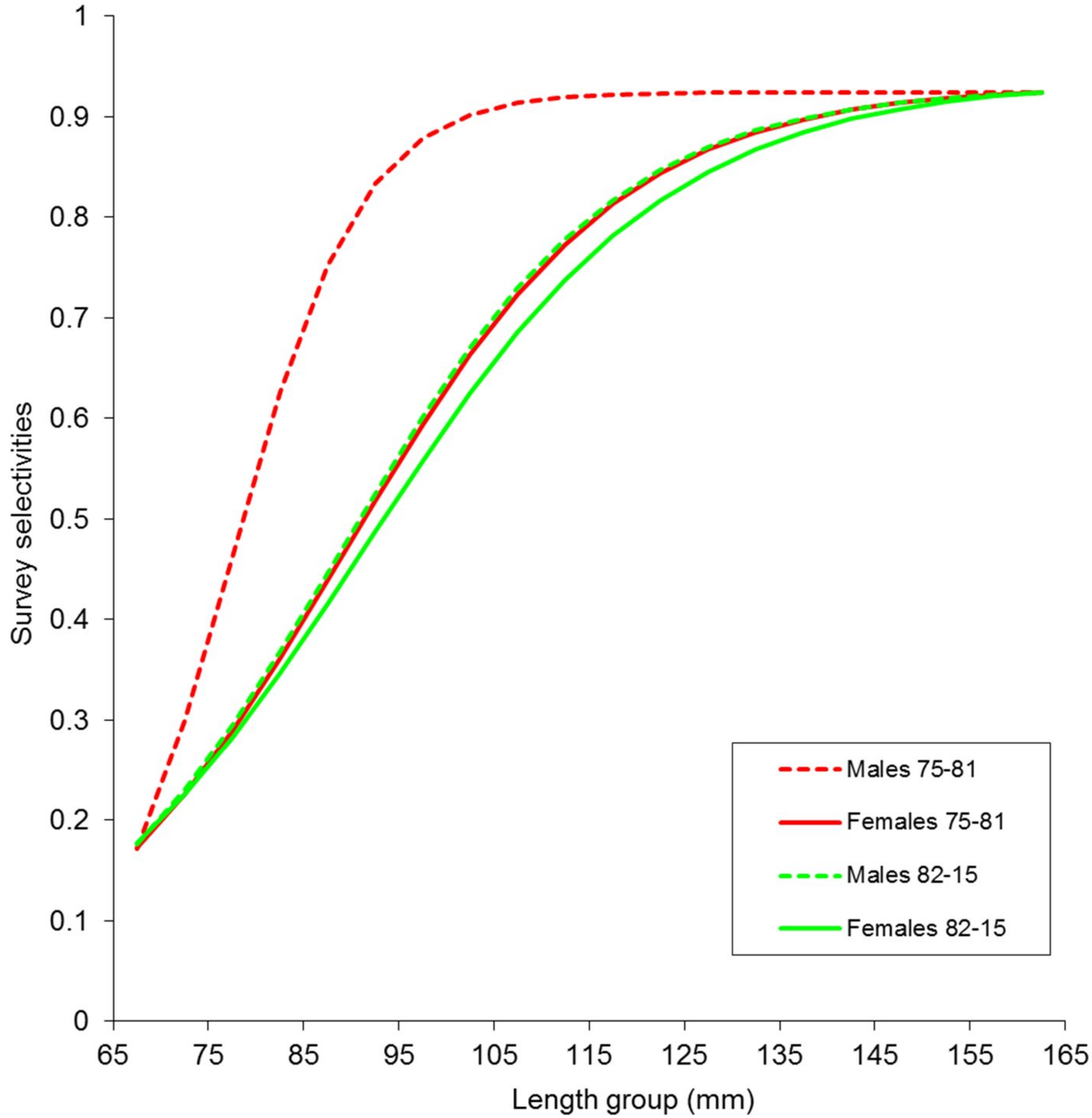
200
180
160
140
120
100
80
60
40
Total area-swept biomass (1000t)
BSFRF survey
Scenario 1
Scenario 1a
Scenario 1b
2007
2008
Year

			Scenario			
Negative log likelihood	1	1a	1b	1 – 1a	1 - 1b	1a – 1b
R-variation	80.61	78.40	80.09	2.21	0.52	-1.69
Length-like-retained	-979.49	-979.04	-979.53	-0.45	0.04	0.49
Length-like-discmale	-998.27	-999.01	-998.23	0.74	-0.04	-0.78
Length-like-discfemale	-2334.30	-2336.26	-2333.88	1.96	-0.42	-2.38
Length-like-survey	-46200.10	-46198.50	-46200.40	-1.60	0.30	1.90
Length-like-disctrawl	-2027.93	-2027.24	-2027.70	-0.69	-0.23	0.46
Length-like-discTanner	-398.41	-397.76	-398.49	-0.65	0.08	0.74
Length-like-bsfrfsurvey	-237.78	-237.57	-237.86	-0.21	0.08	0.29
Catchbio_retained	47.31	47.22	47.44	0.10	-0.13	-0.23
Catchbio_discmale	219.50	219.35	219.57	0.15	-0.06	-0.22
Catchbio-discfemale	0.13	0.10	0.12	0.03	0.00	-0.02
Catchbio-disctrawl	0.90	0.90	0.90	0.00	0.00	0.00
Catchbio-discTanner	0.13	0.12	0.13	0.01	-0.01	-0.02
Biomass-trawl survey	95.08	27.81	94.44	67.27	0.64	-66.64
Biomass-bsfrfsurvey	-4.95	-5.40	-4.96	0.45	0.01	-0.44
Q-trawl survey	0.64	0.22	0.64	0.43	0.01	-0.42
Temperature deviation		24.70				
Others	20.82	20.86	20.70	-0.04	0.12	0.16
Total	-52716.10	-52761.10	-52717.00	45.00	0.90	-44.10
Free parameters	272	314	273	-42	-1	41

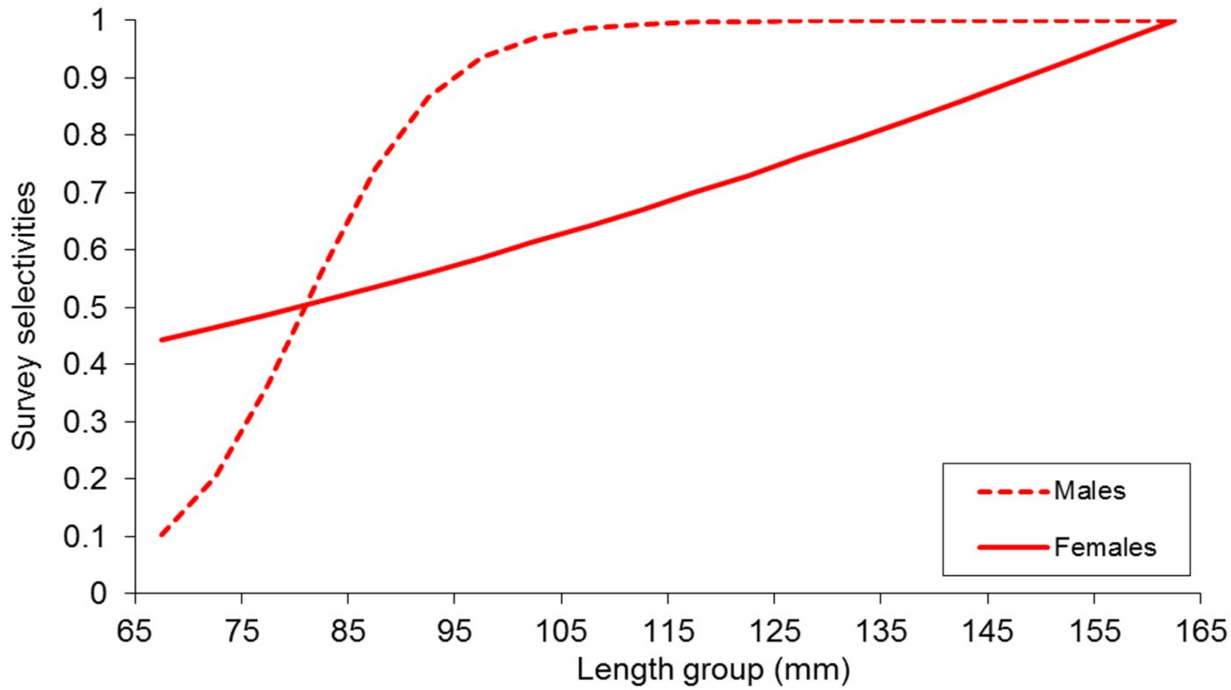
- ✓ The area-swept abundance estimates from the survey in 2015 are generally as expected, based on the survey data from the previous several years.
  (Not sure why crab would not stand up for the high temperatures in 2015???)

- ✓ Model estimated relative survey biomasses are very similar between scenarios 1 and 1b and fluctuate a lot more for scenario 1a, primarily due to a much better fit of total survey biomass. The absolute population biomass estimates are slightly higher for scenario 1a than for scenarios 1 and 1b due to a slightly lower estimate of trawl survey catchability for scenario 1a.

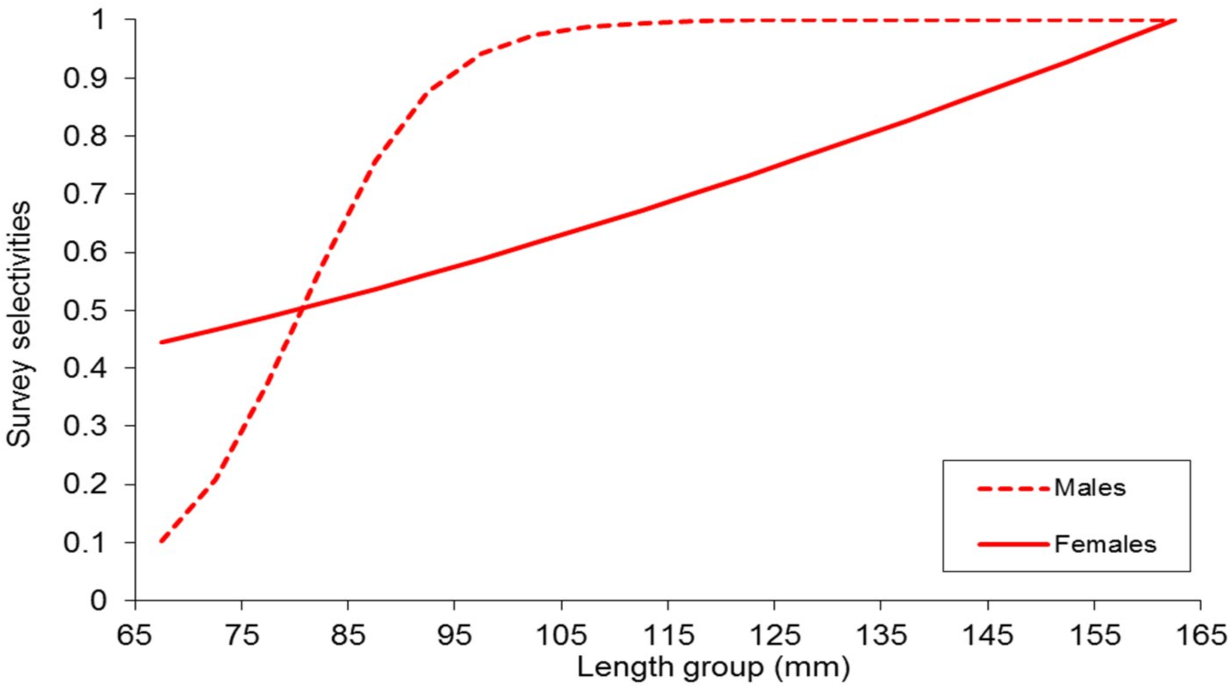
- ✓ Scenario 1 is recommended for overfishing determination this year. The full results for scenarios 1 and 1a are presented in this report.



NMFS survey:
Scenario 1

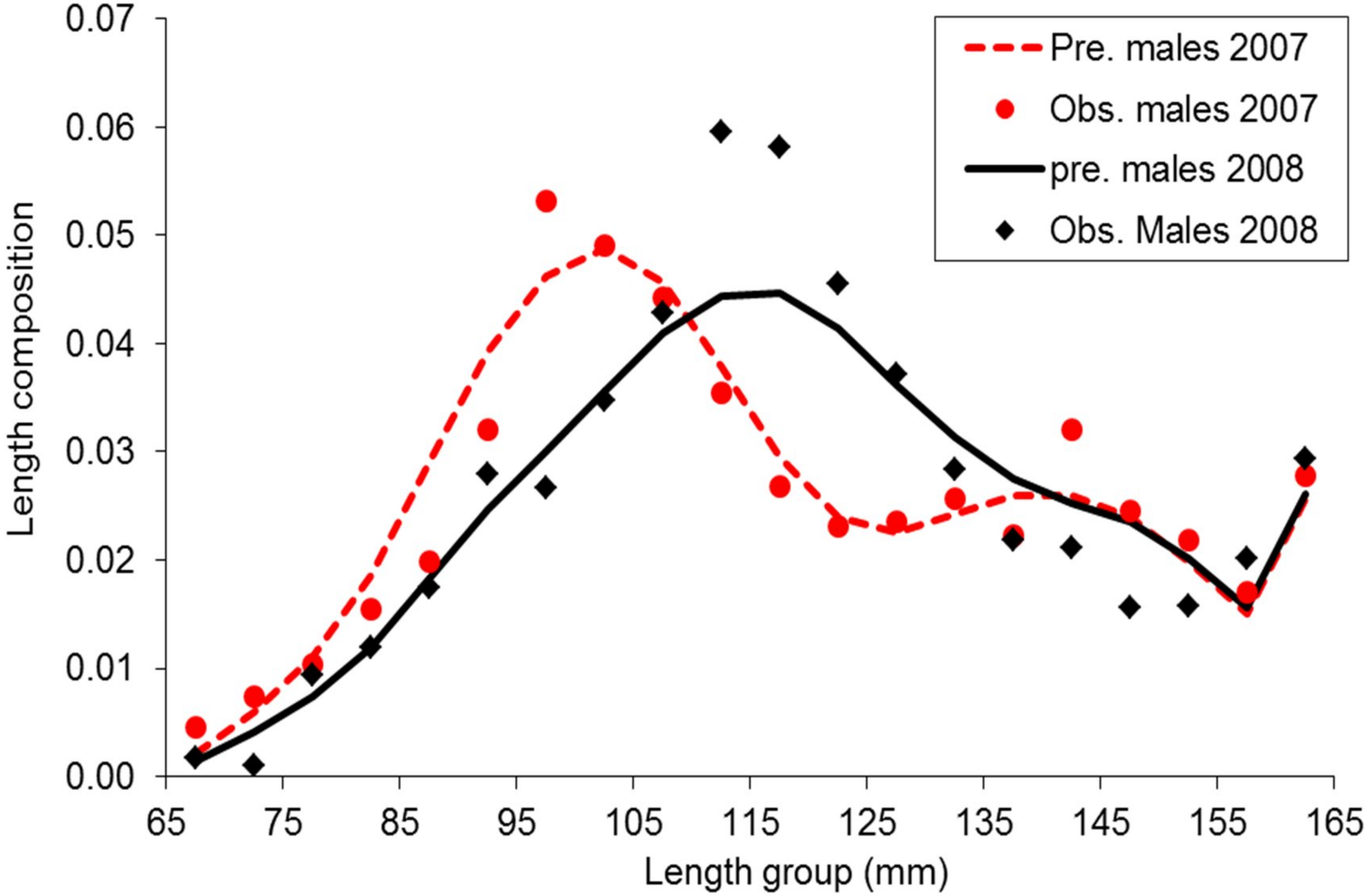


BSFRF survey:
Scenario 1

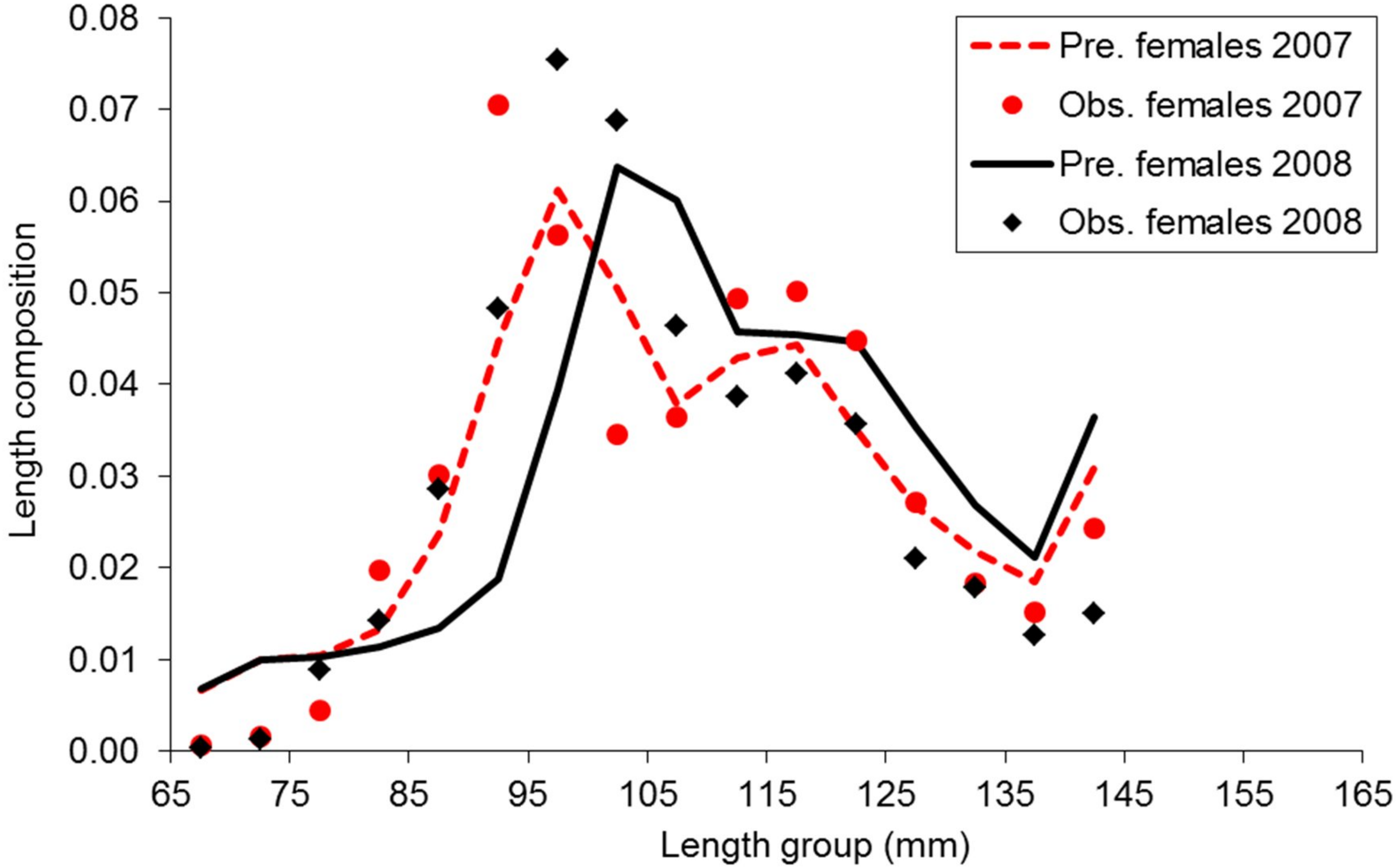


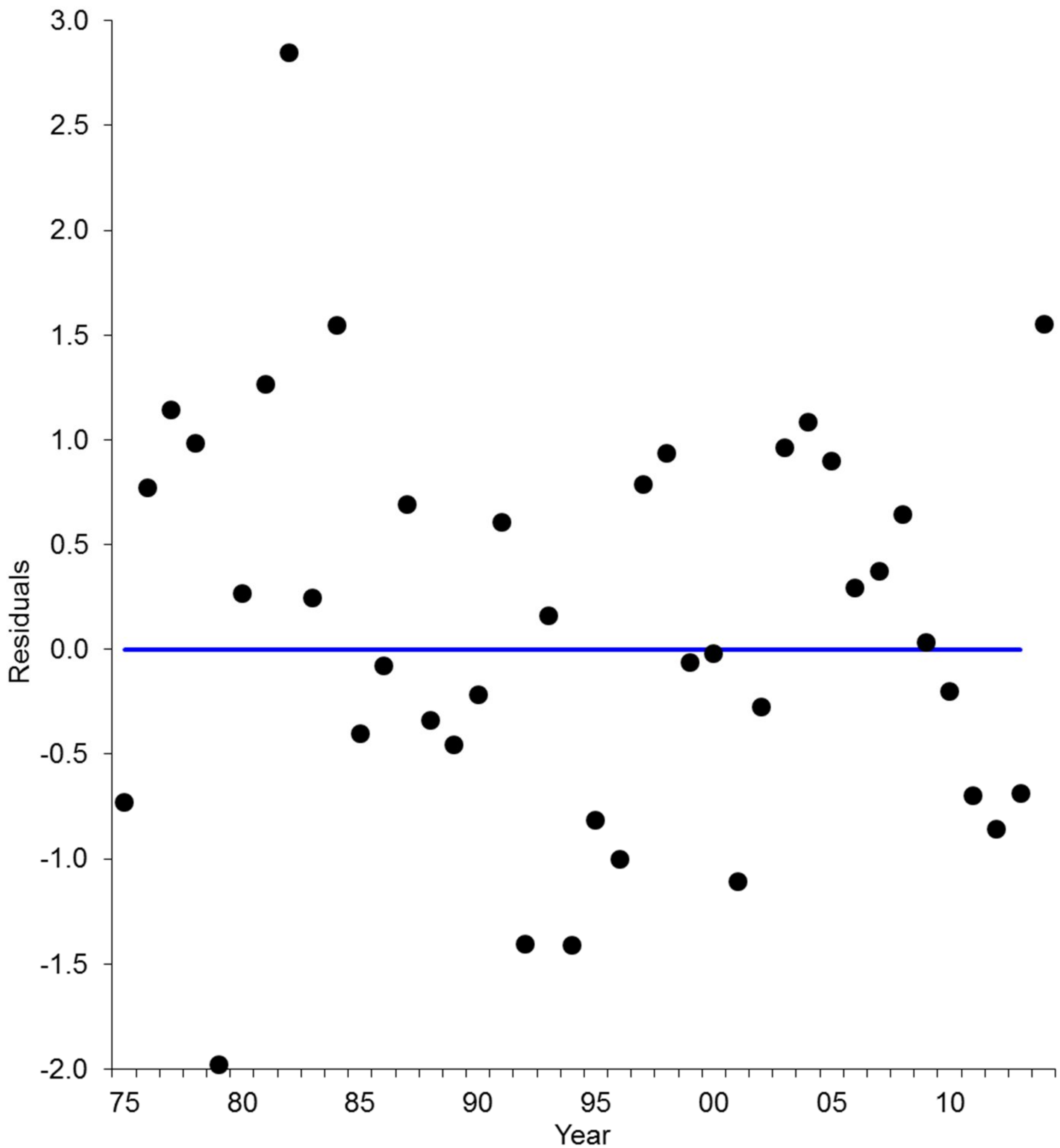
BSFRF survey:
Scenario 1a

BSFRF survey length frequency (scenario 1)



BSFRF survey length frequency (scenario 1)

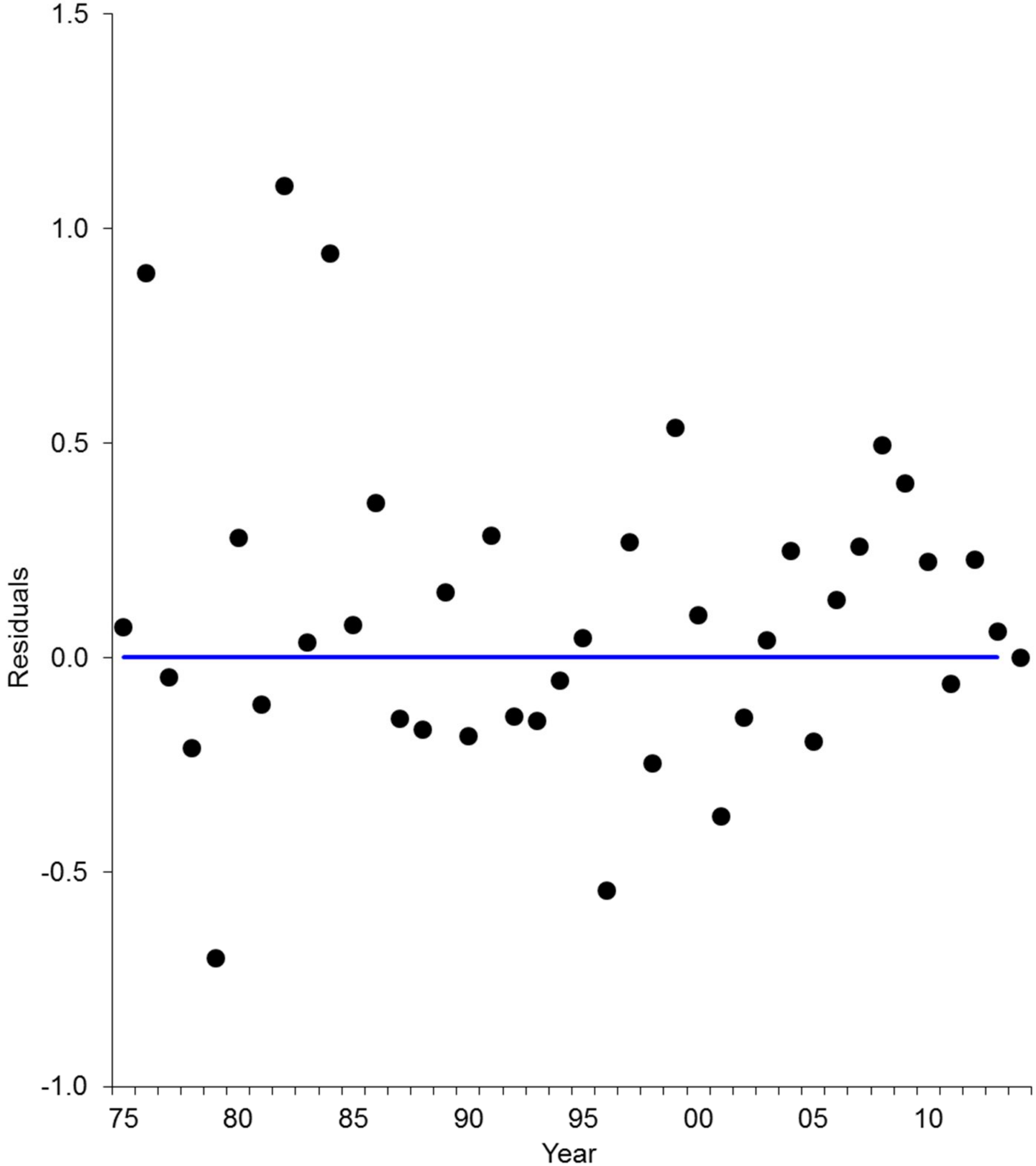


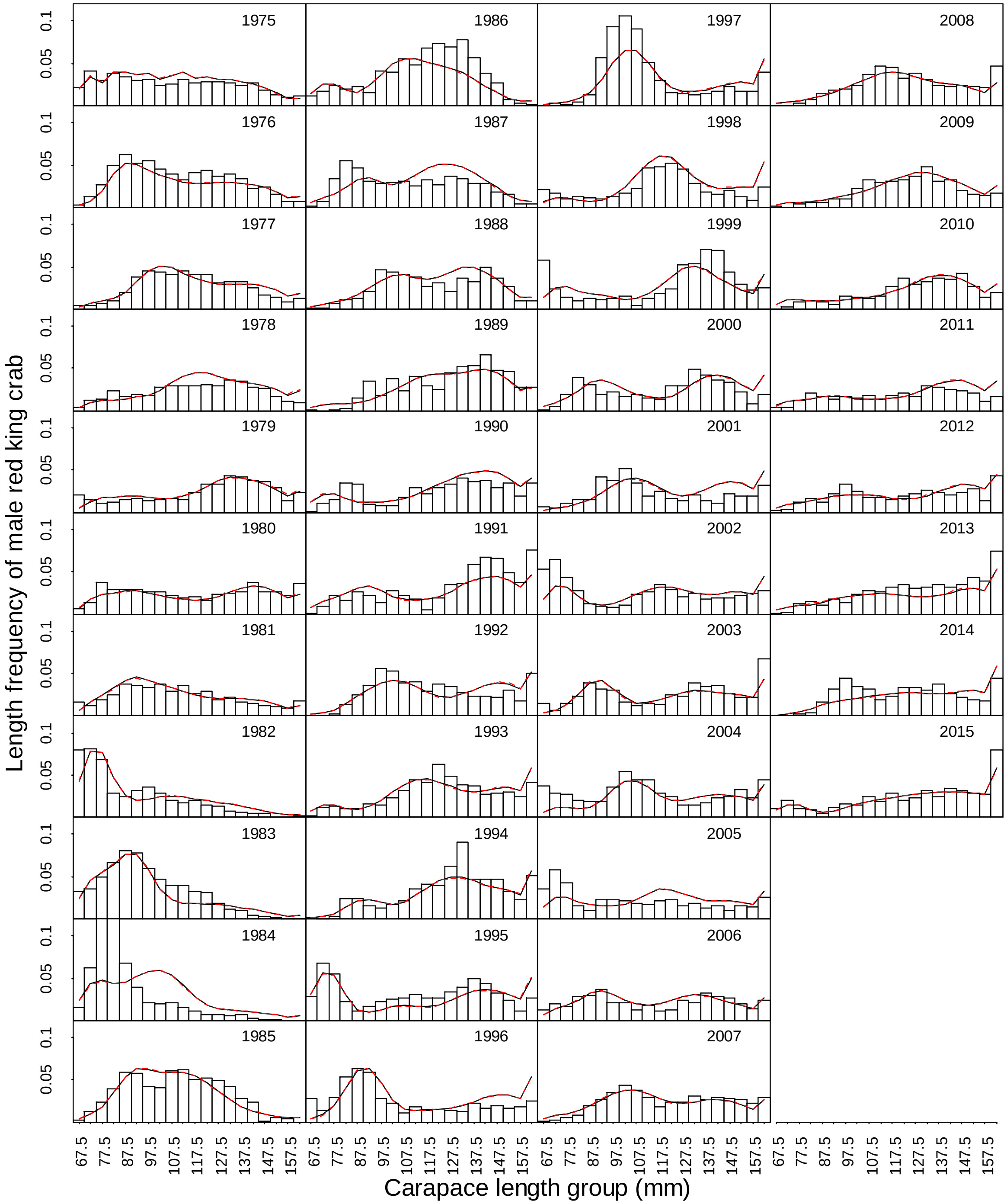


Residuals
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
75
80
85
90
95
00
05
10
Year

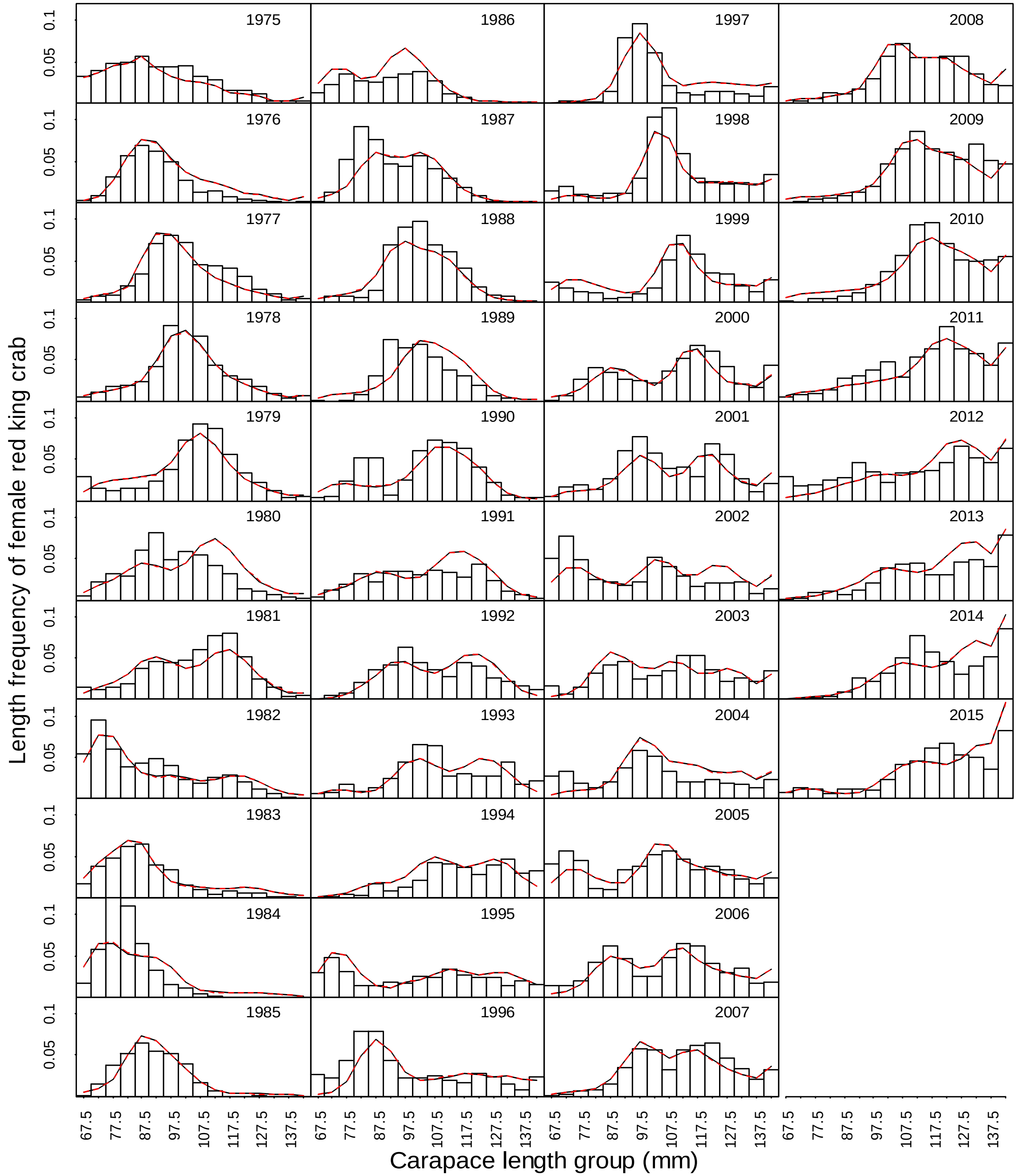
Scenario 1

Scenario 1a

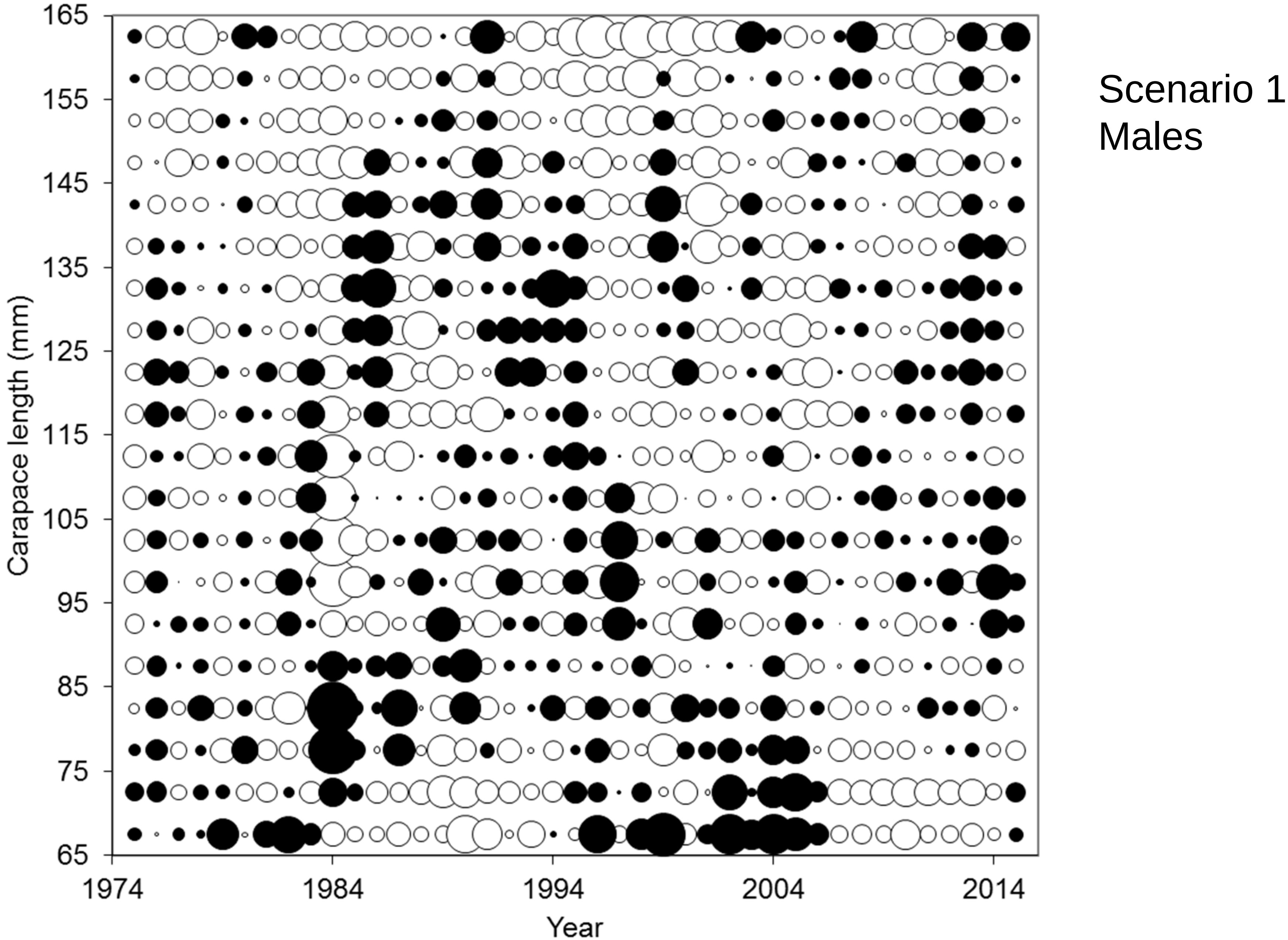


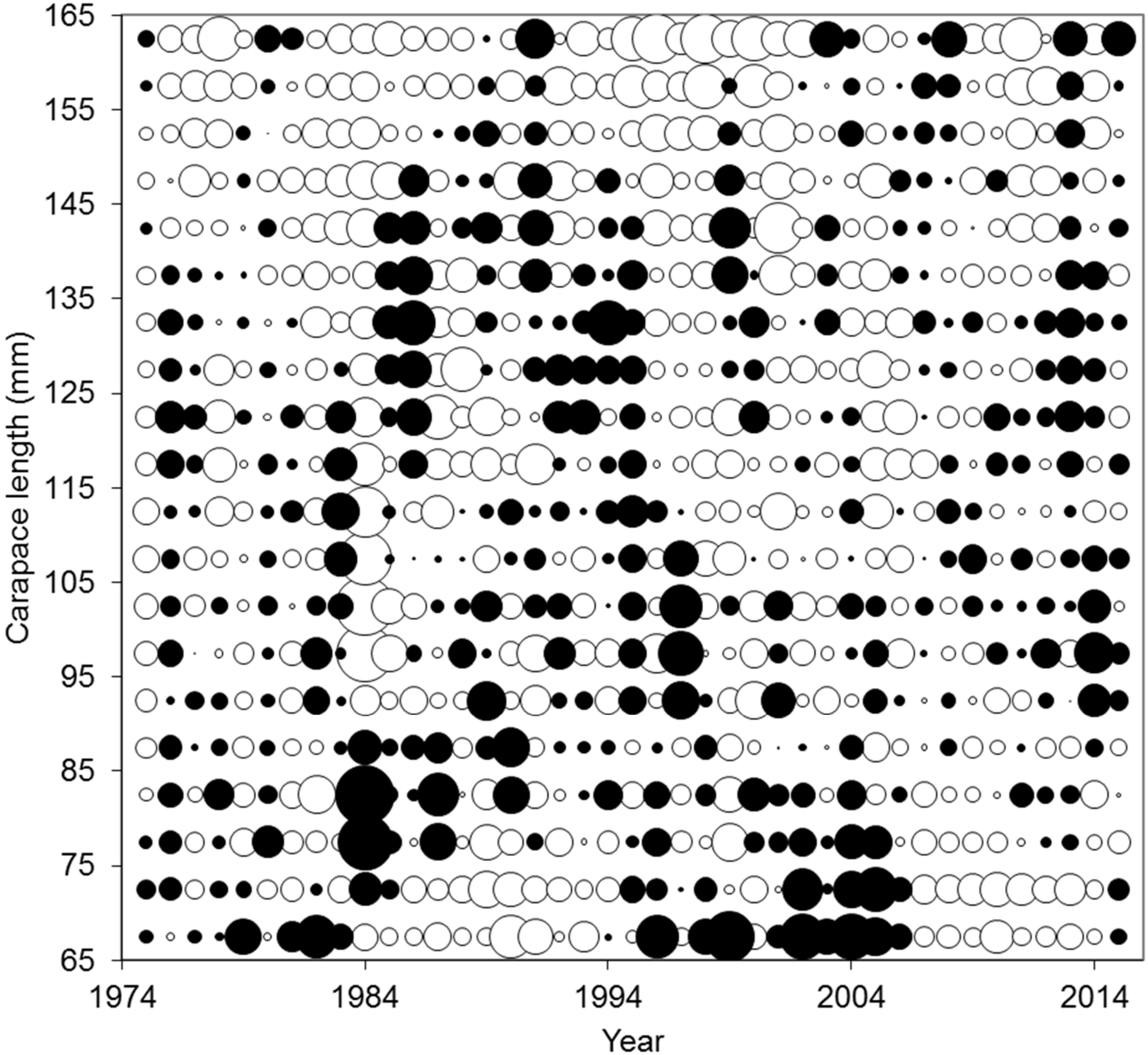


Scenarios 1(black) and 1a(red) Males

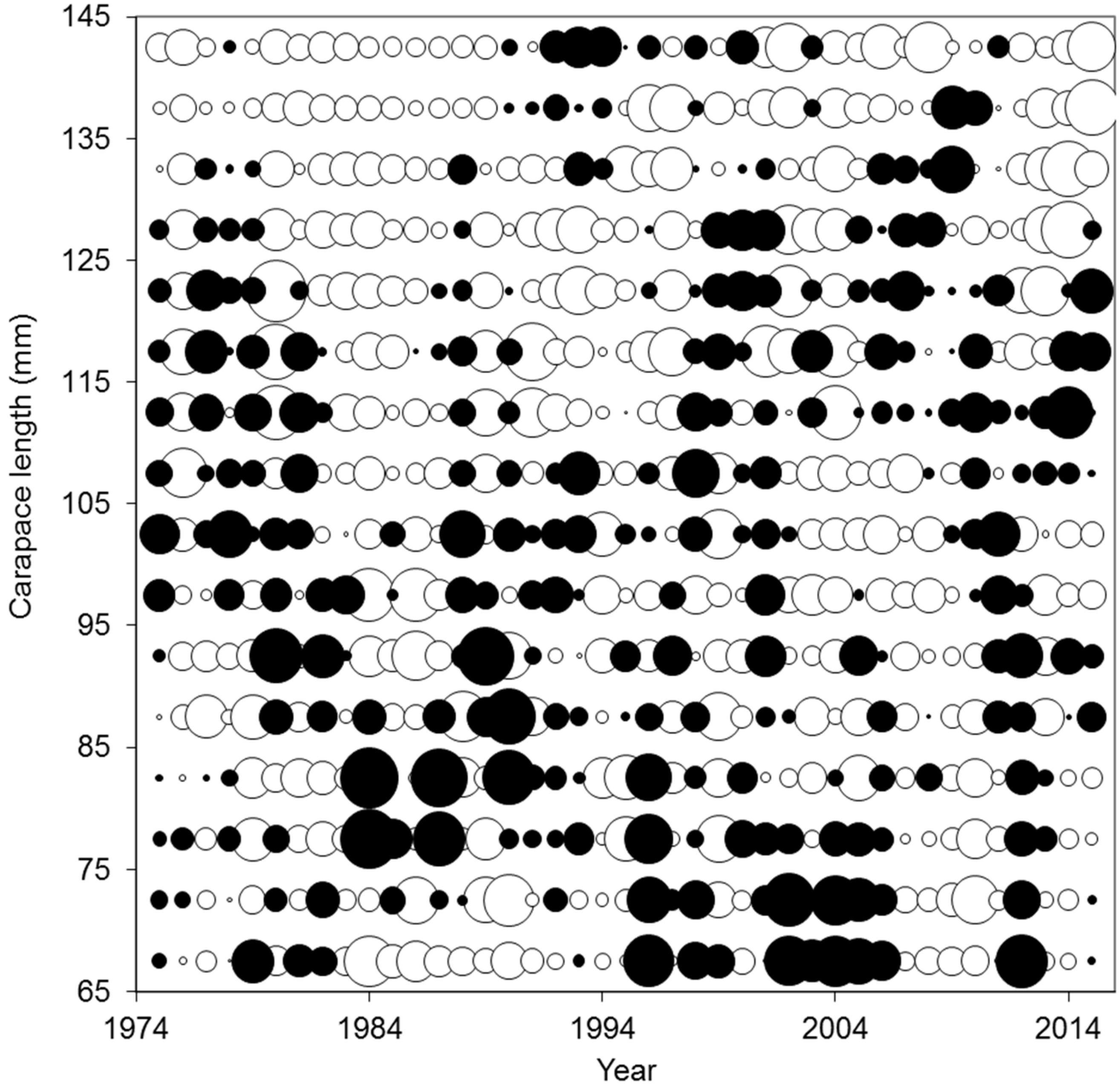


Scenarios 1(black) and 1a(red) Females

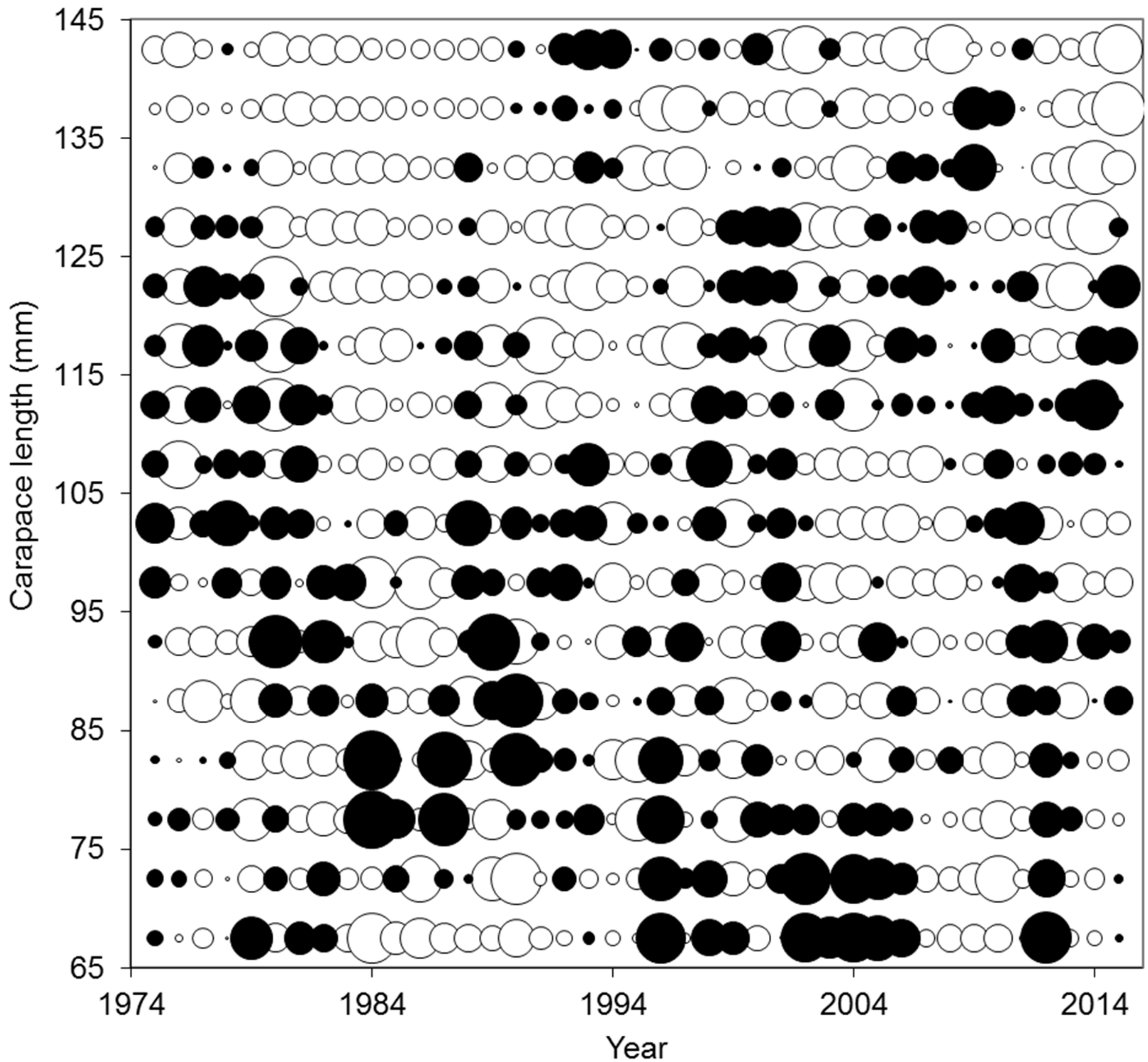

Scenario 1
Males
Carapace length (mm)
165
155
145
135
125
115
105
95
85
75
65
1974
1984
1994
2004
2014
Year



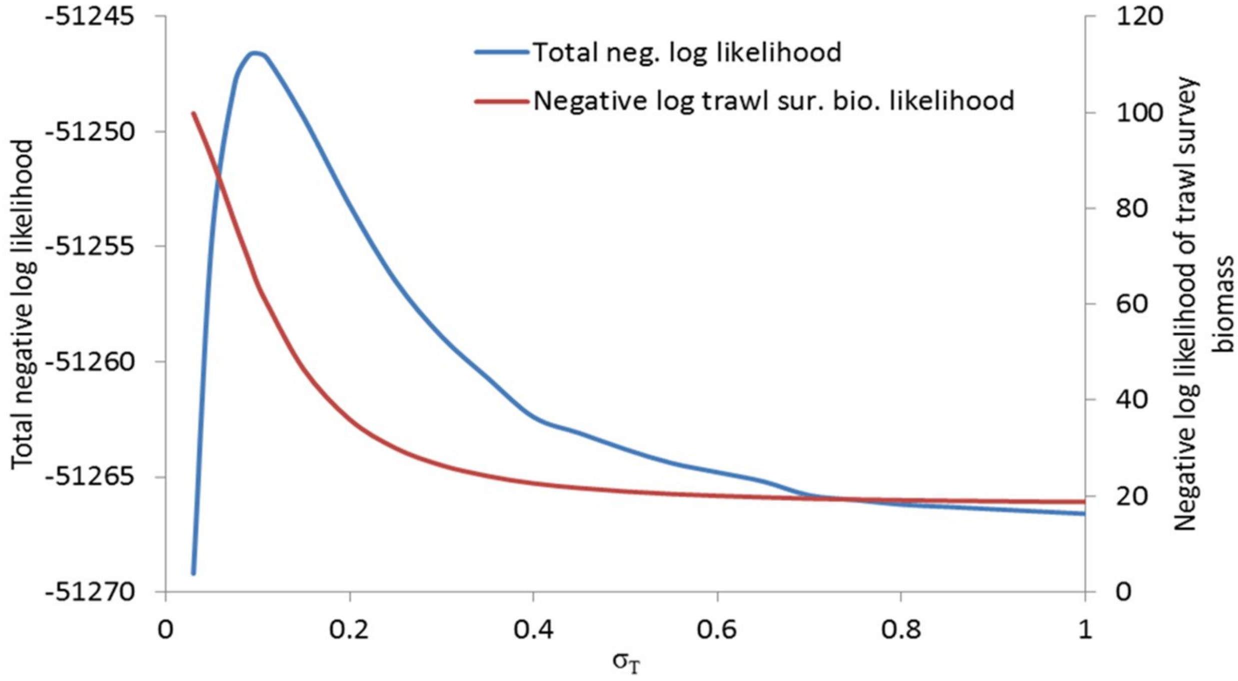
Scenario 1a
Males



Scenario 1
Females



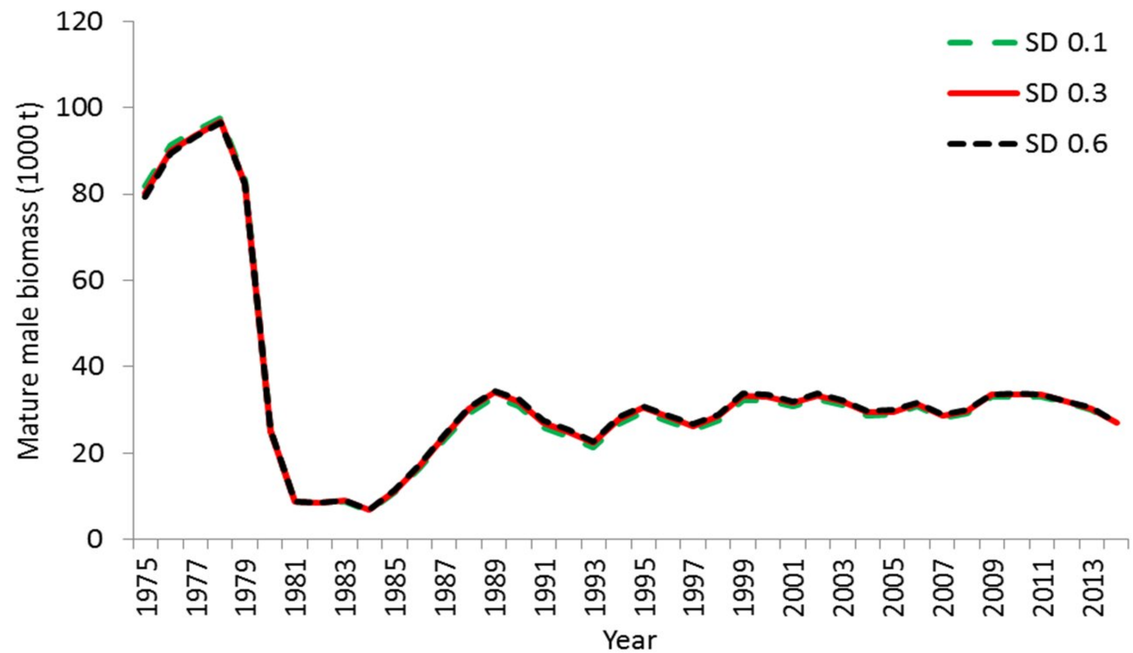
Scenario 1a
Females

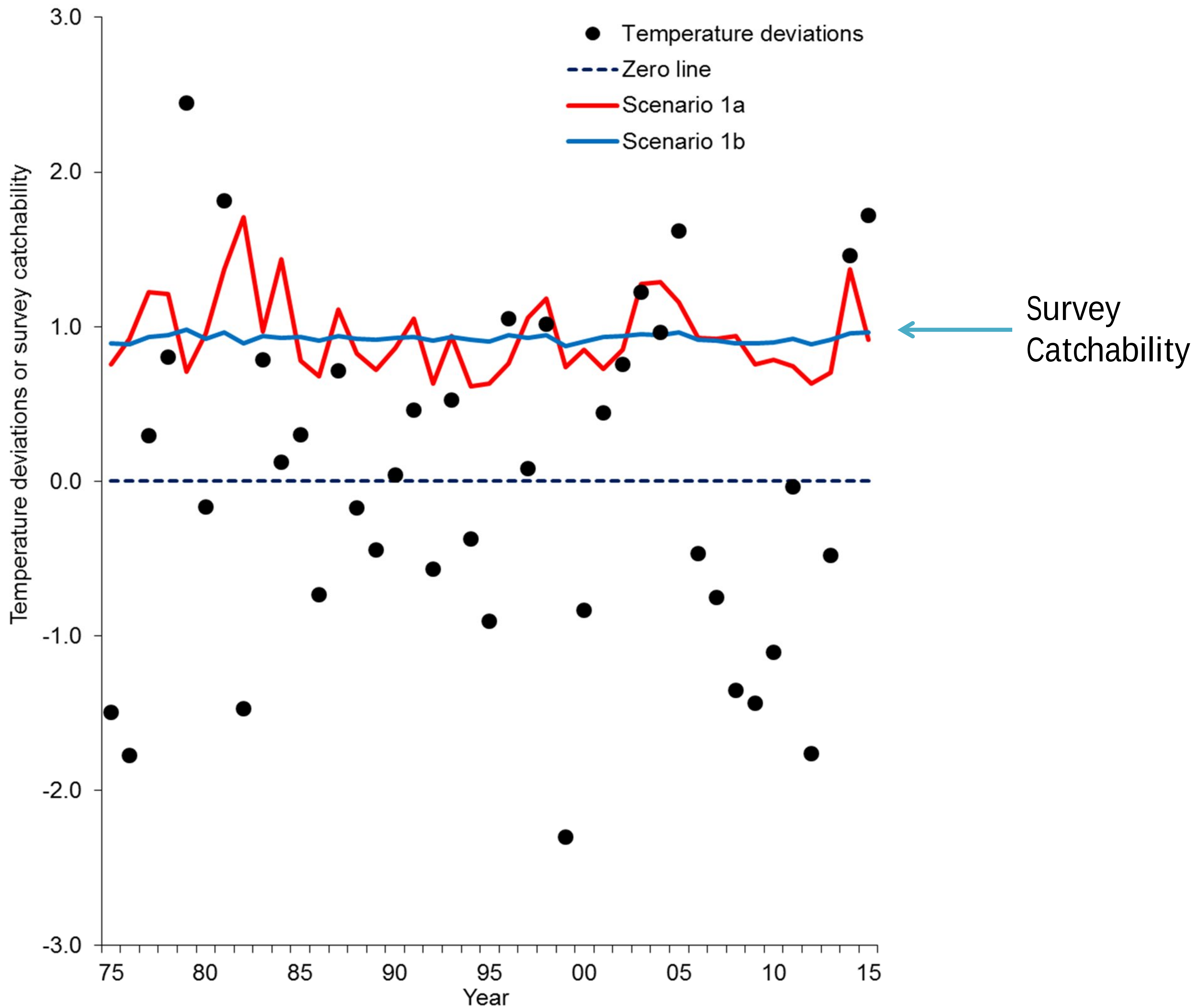


Choice of Standard Deviation

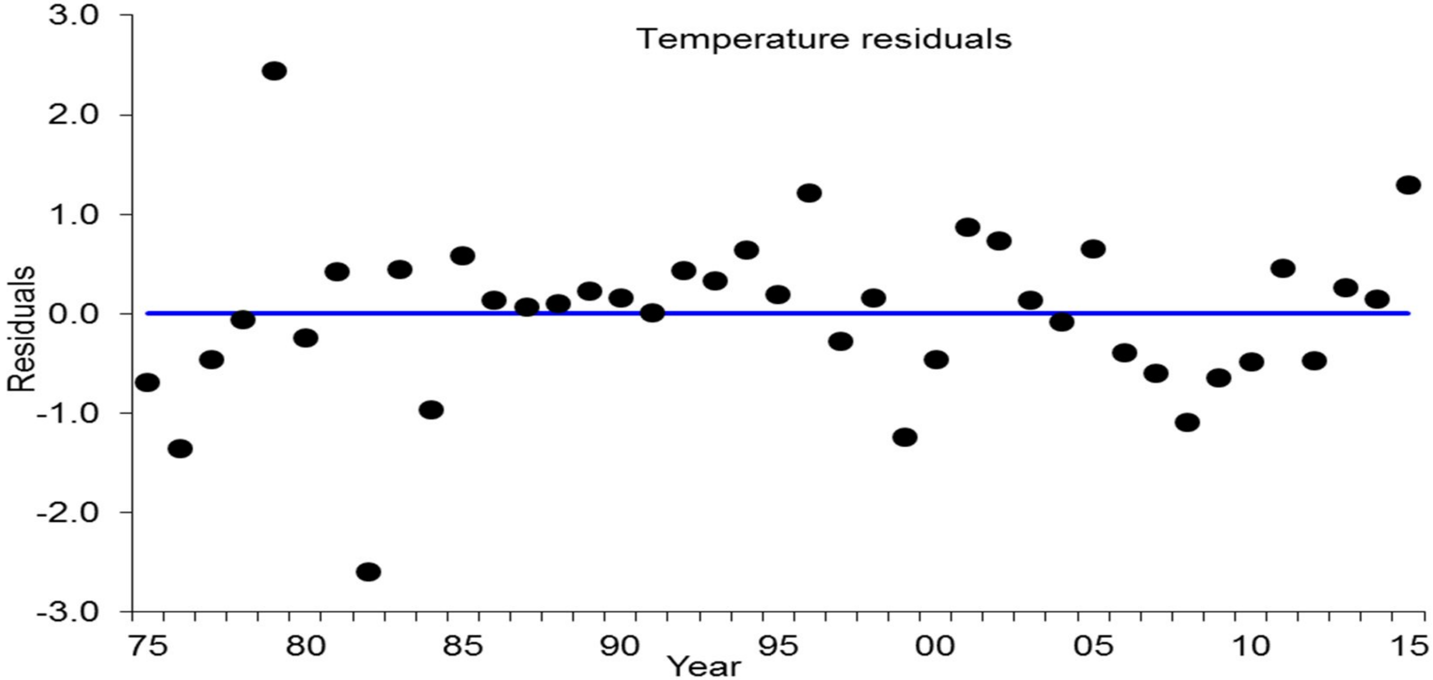
$$T_t = \beta\, \varepsilon_t,$$

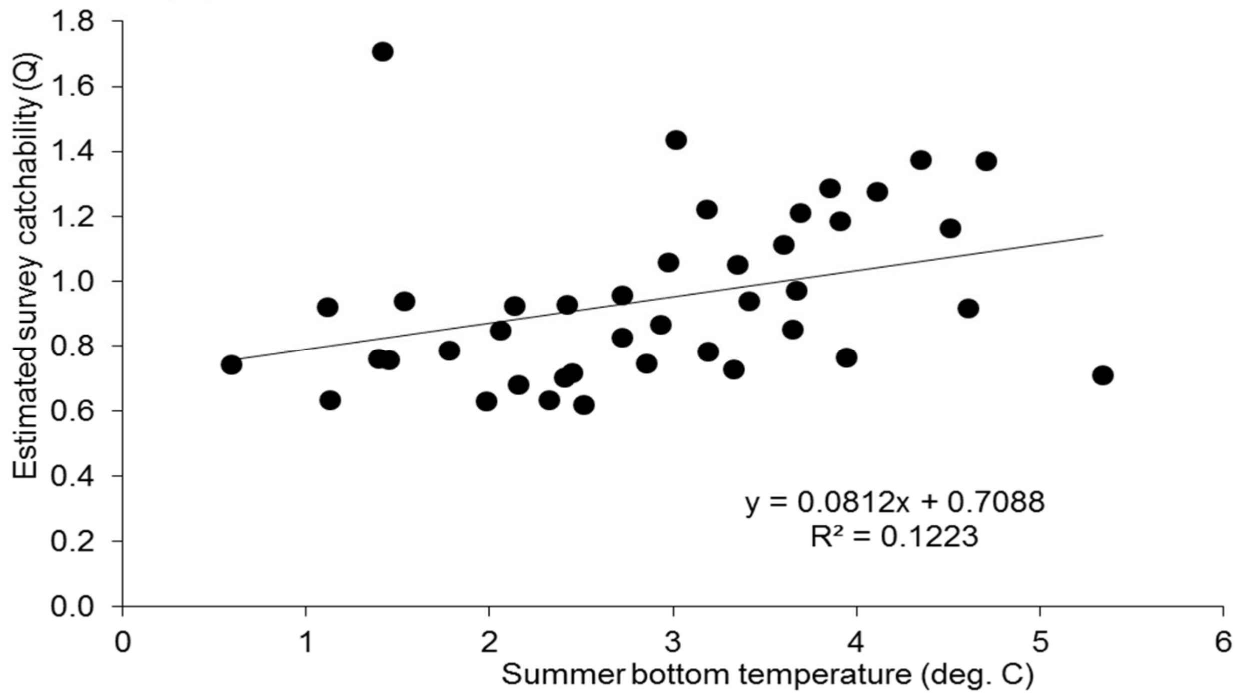
$$L = \sum [\ln(\sigma_T^2\, \beta^2)^{0.5} + (T_t^{obs} - T_t)^2 / (2\,\sigma_T^2\, \beta^2)]$$



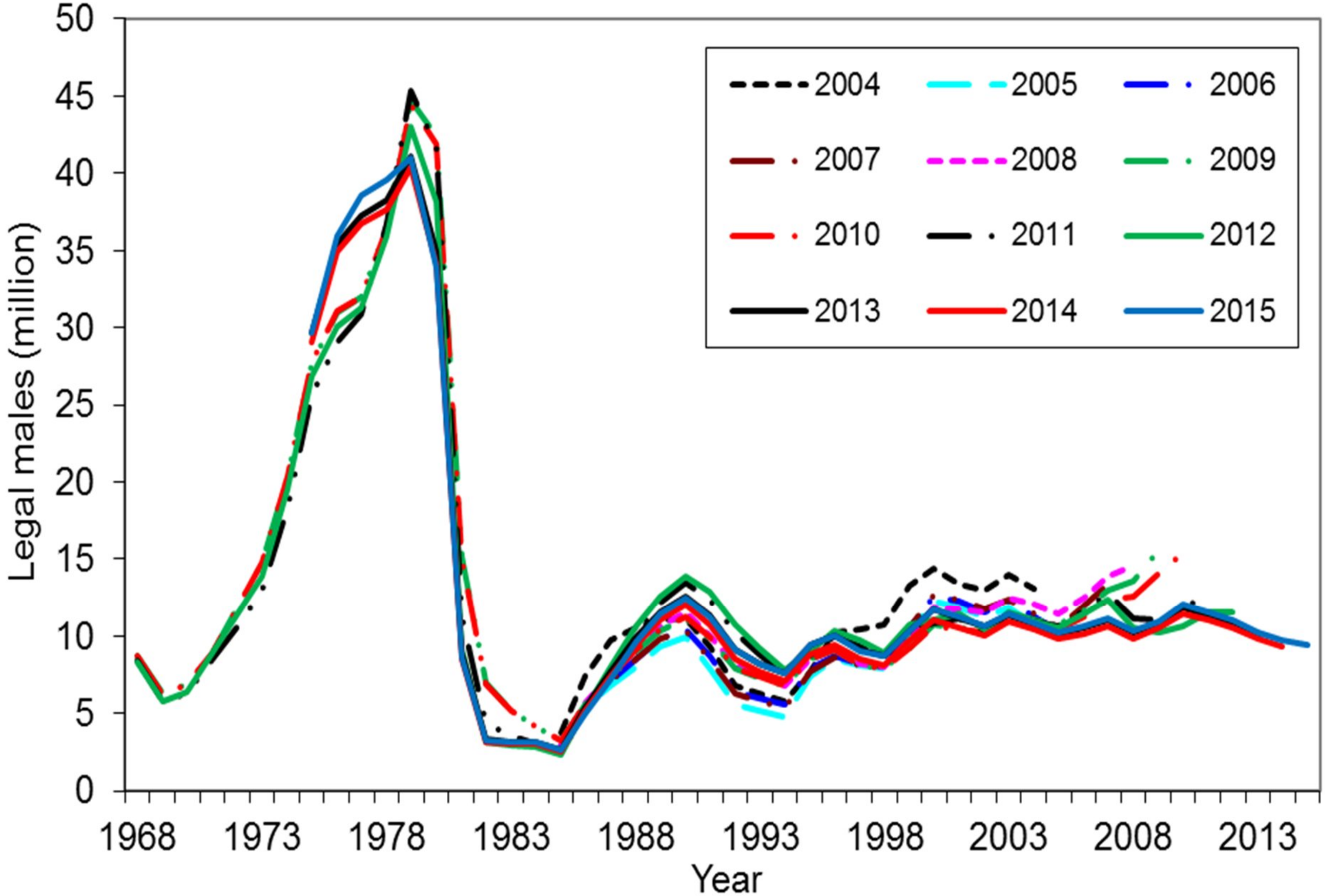


Temperature deviations
Zero line
Scenario 1a
Scenario 1b
Temperature deviations or survey catchability
Year
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
75
80
85
90
95
00
05
10
15
Survey Catchability

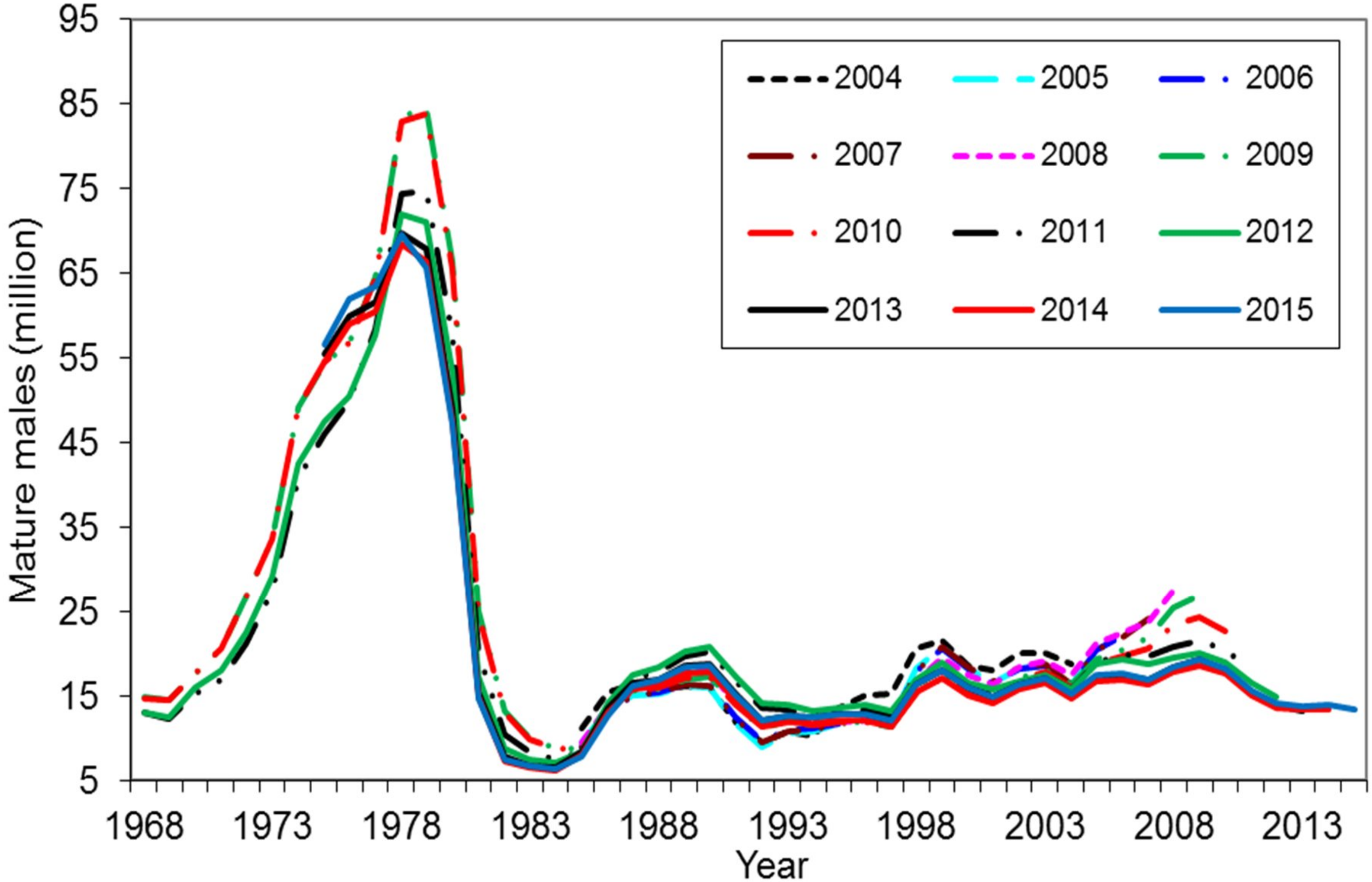

Temperature residuals
Residuals
Year
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
75
80
85
90
95
00
05
10
15


Estimated survey catchability (Q)
Summer bottom temperature (deg. C)
y = 0.0812x + 0.7088
R² = 0.1223
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
1
2
3
4
5
6

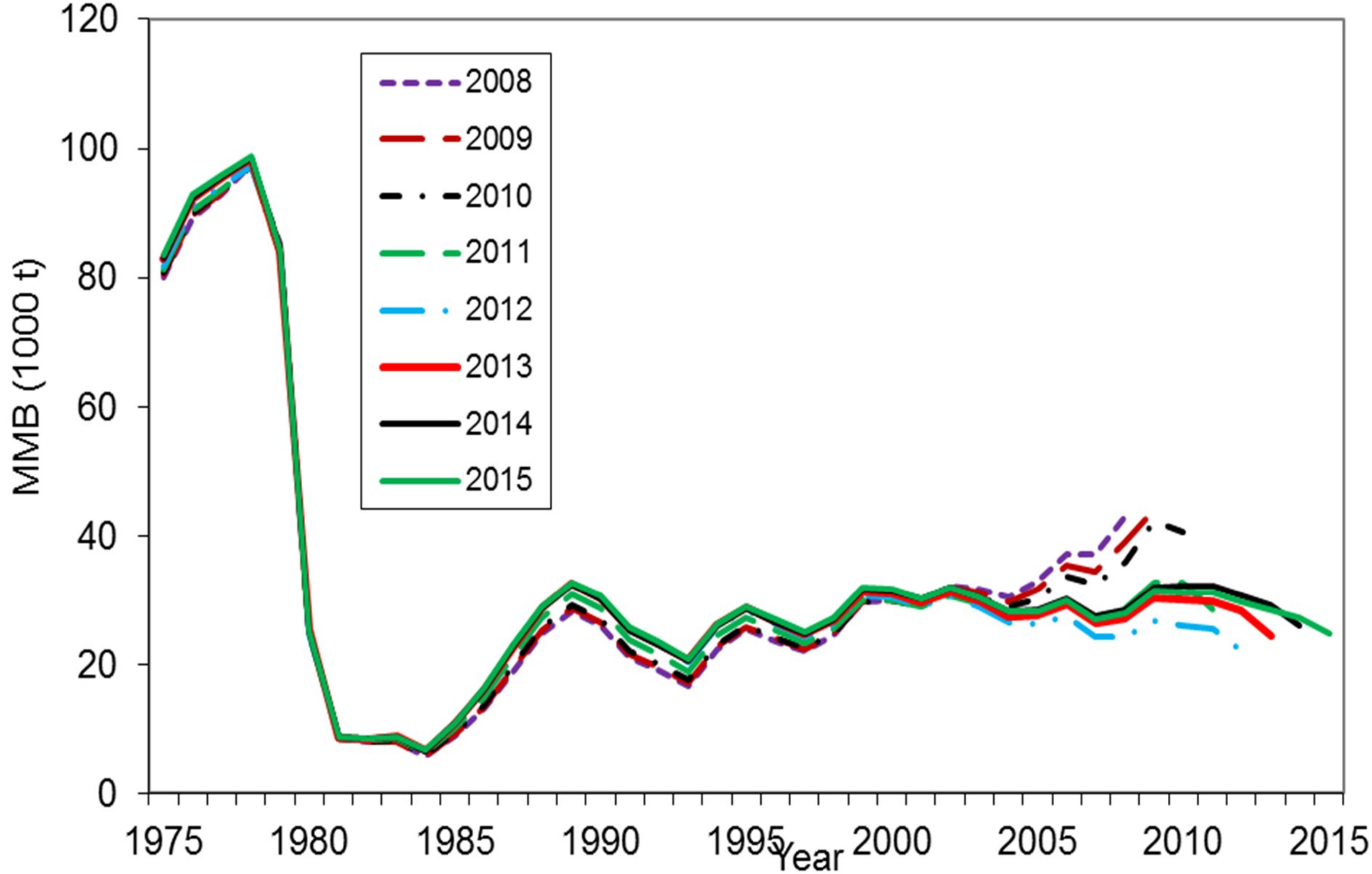
Scenario 1, historical results



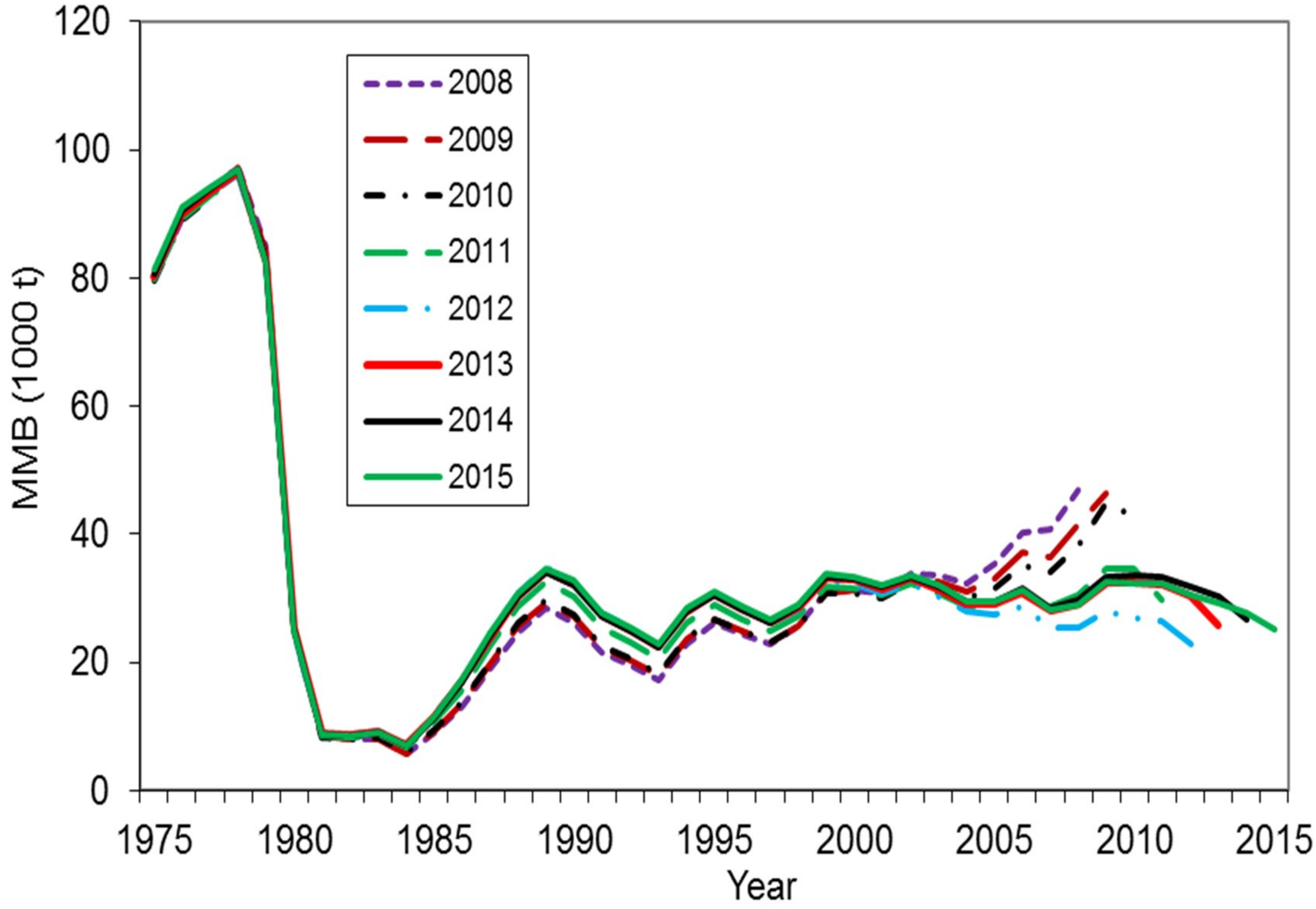
Scenario 1, historical results



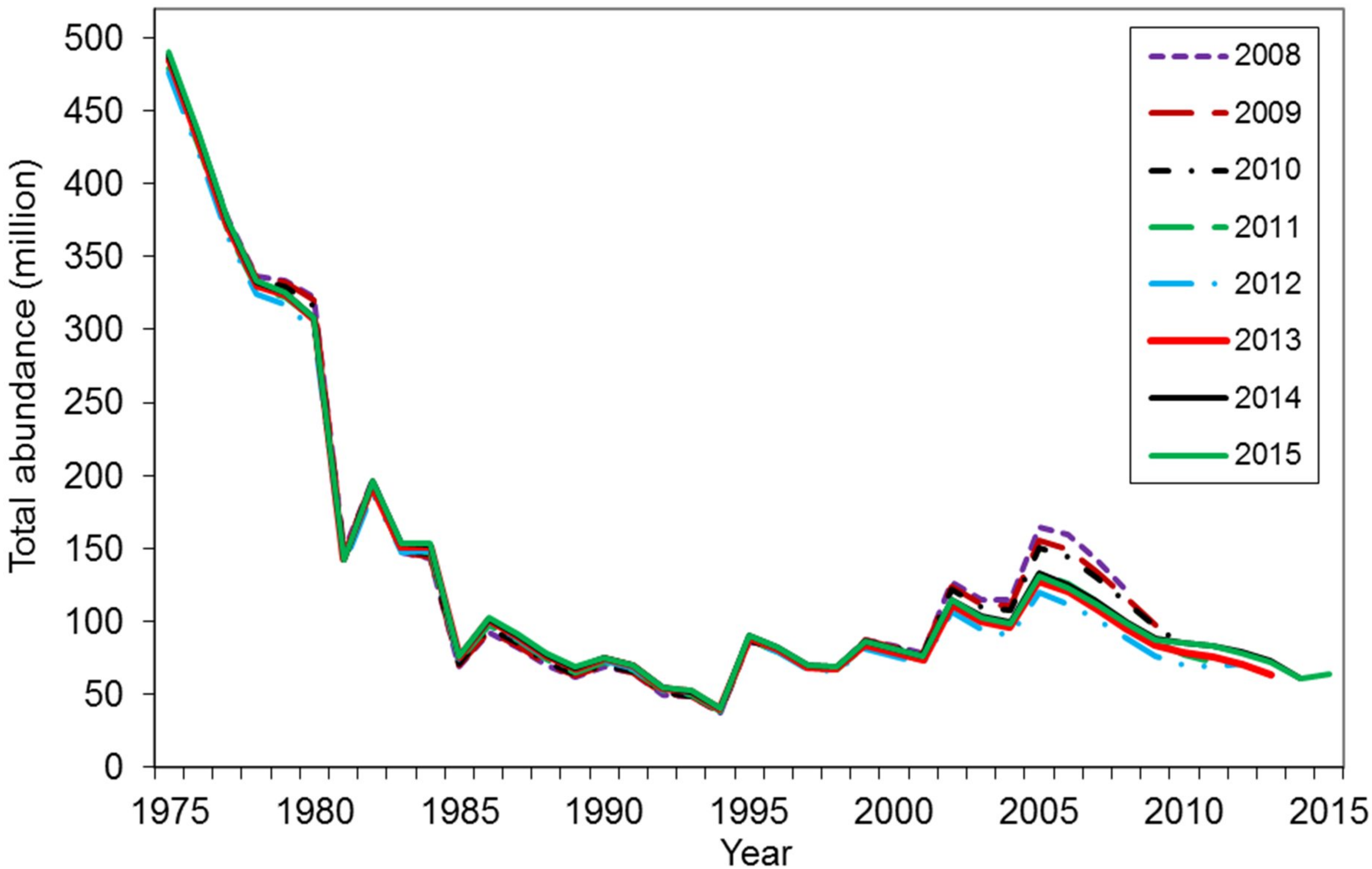
Scenario 1, 2015 model results



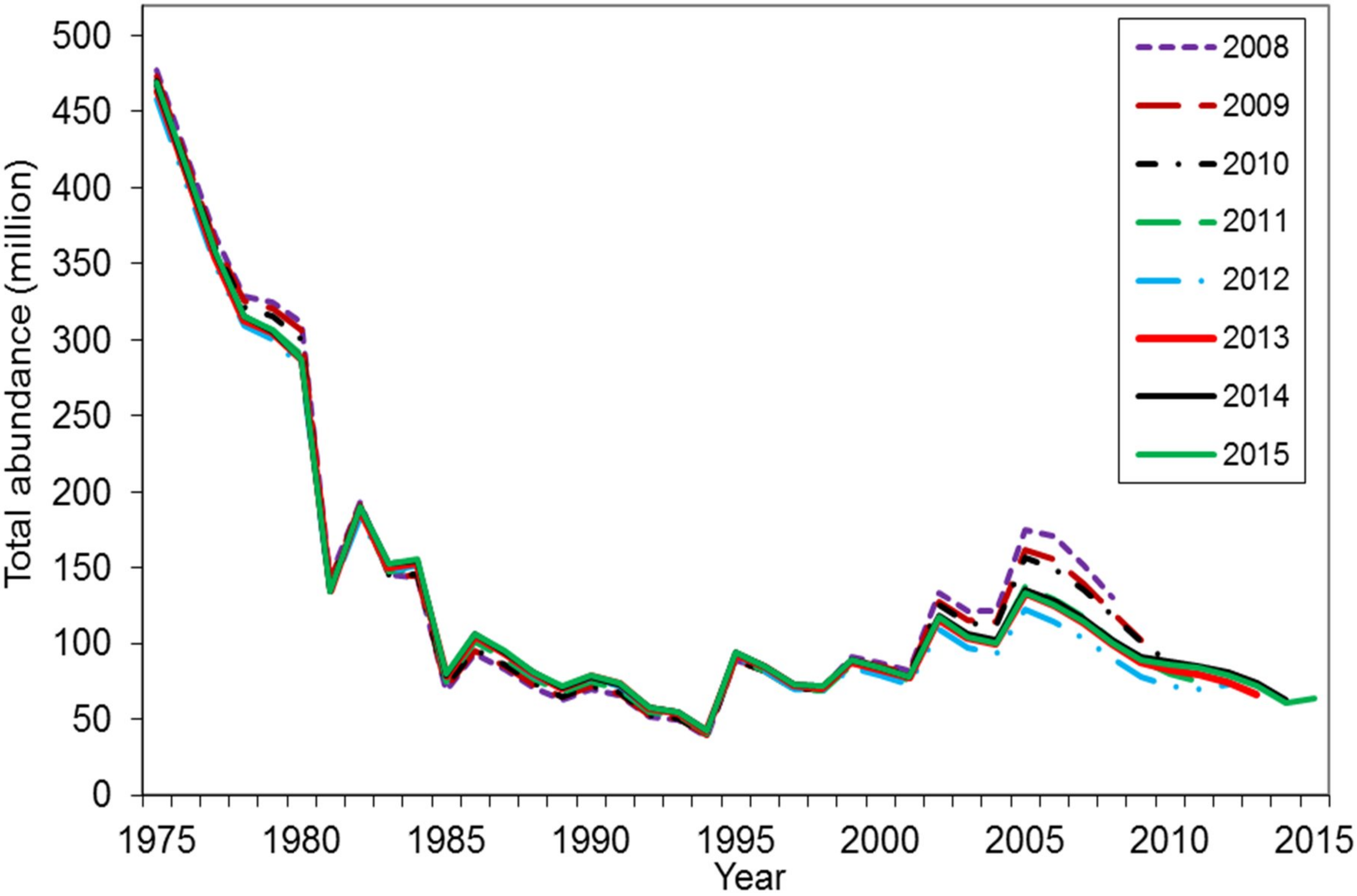
Scenario 1a, 2015 model results



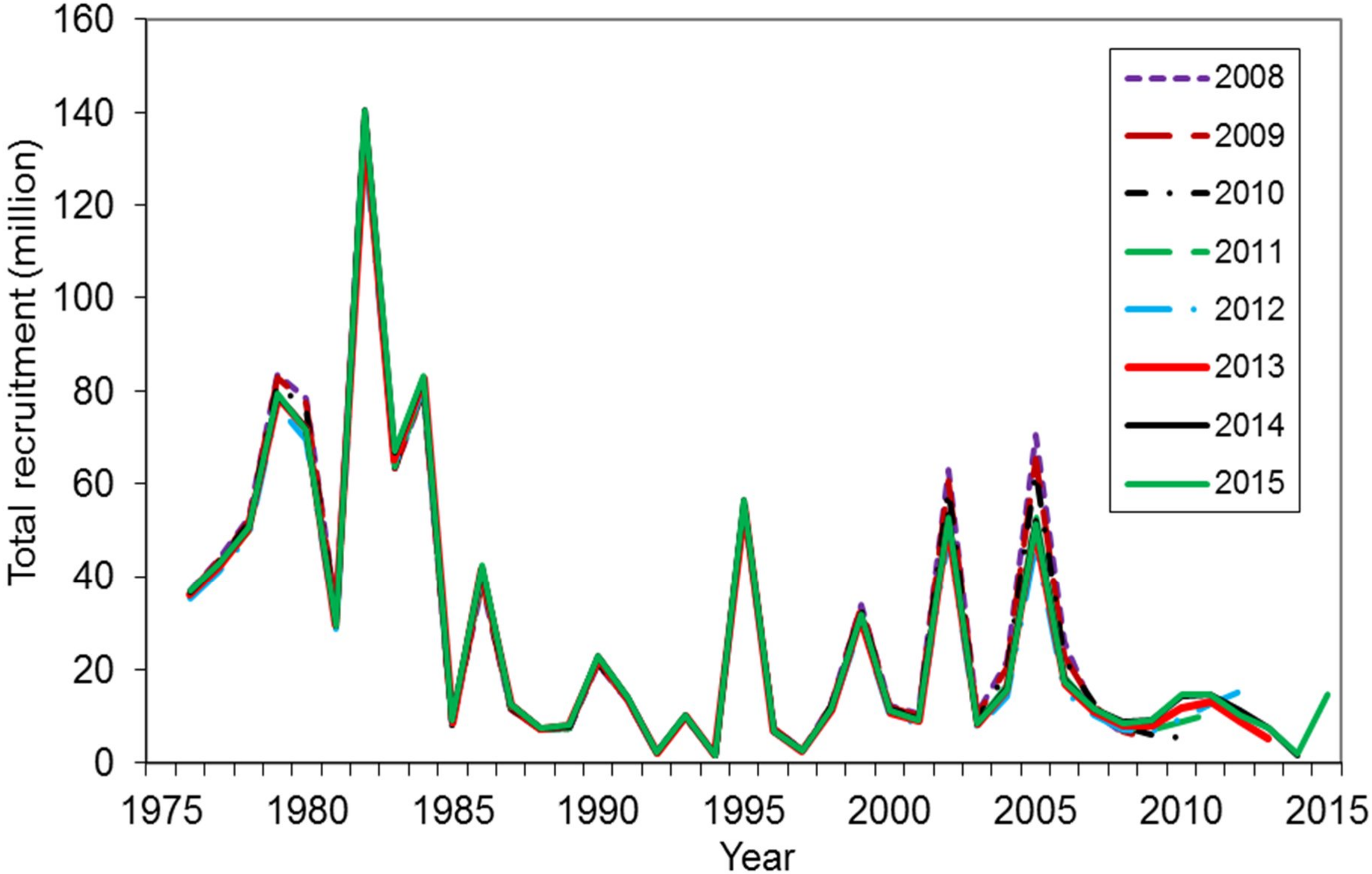
Scenario 1, 2015 model results



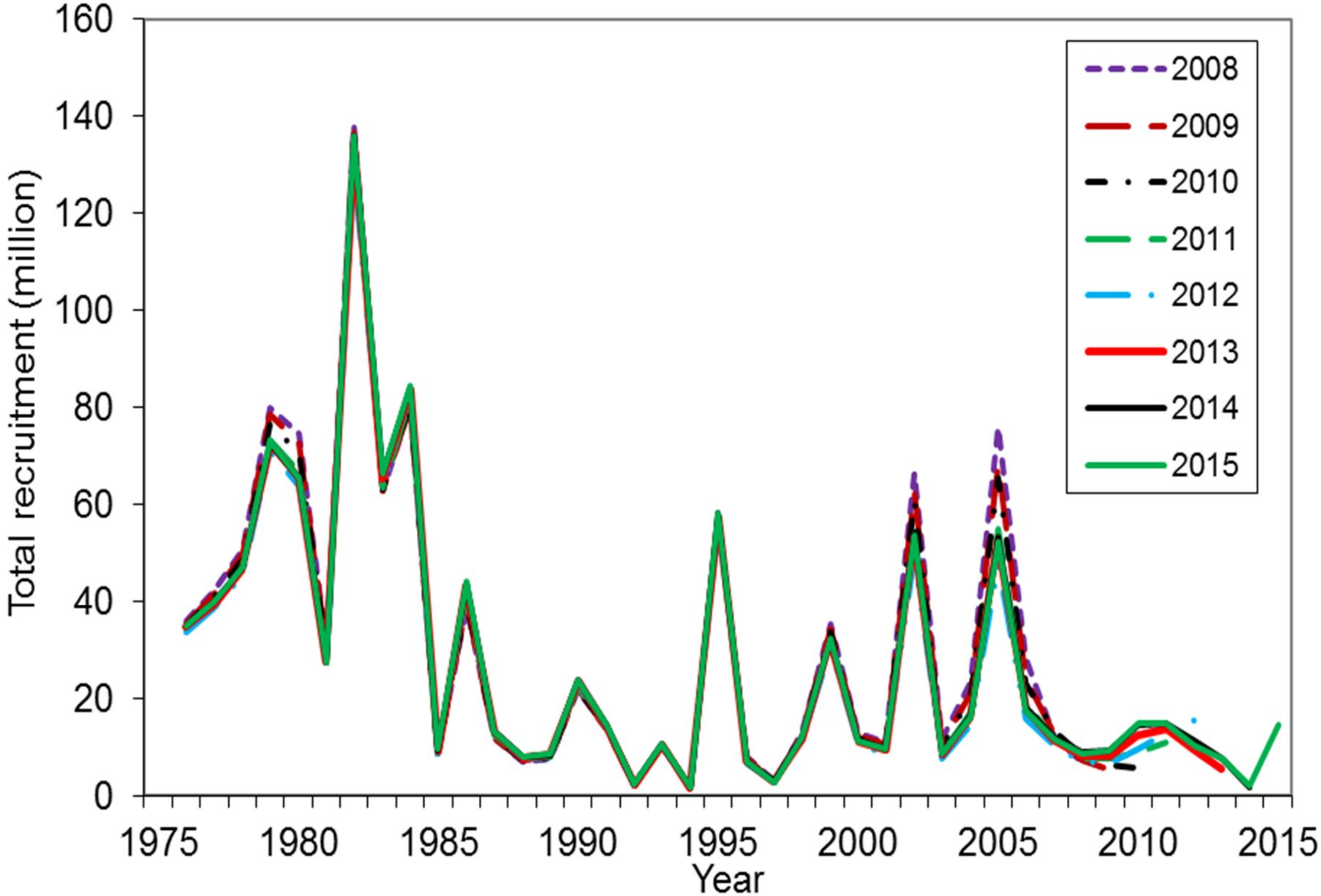
Scenario 1a, 2015 model results



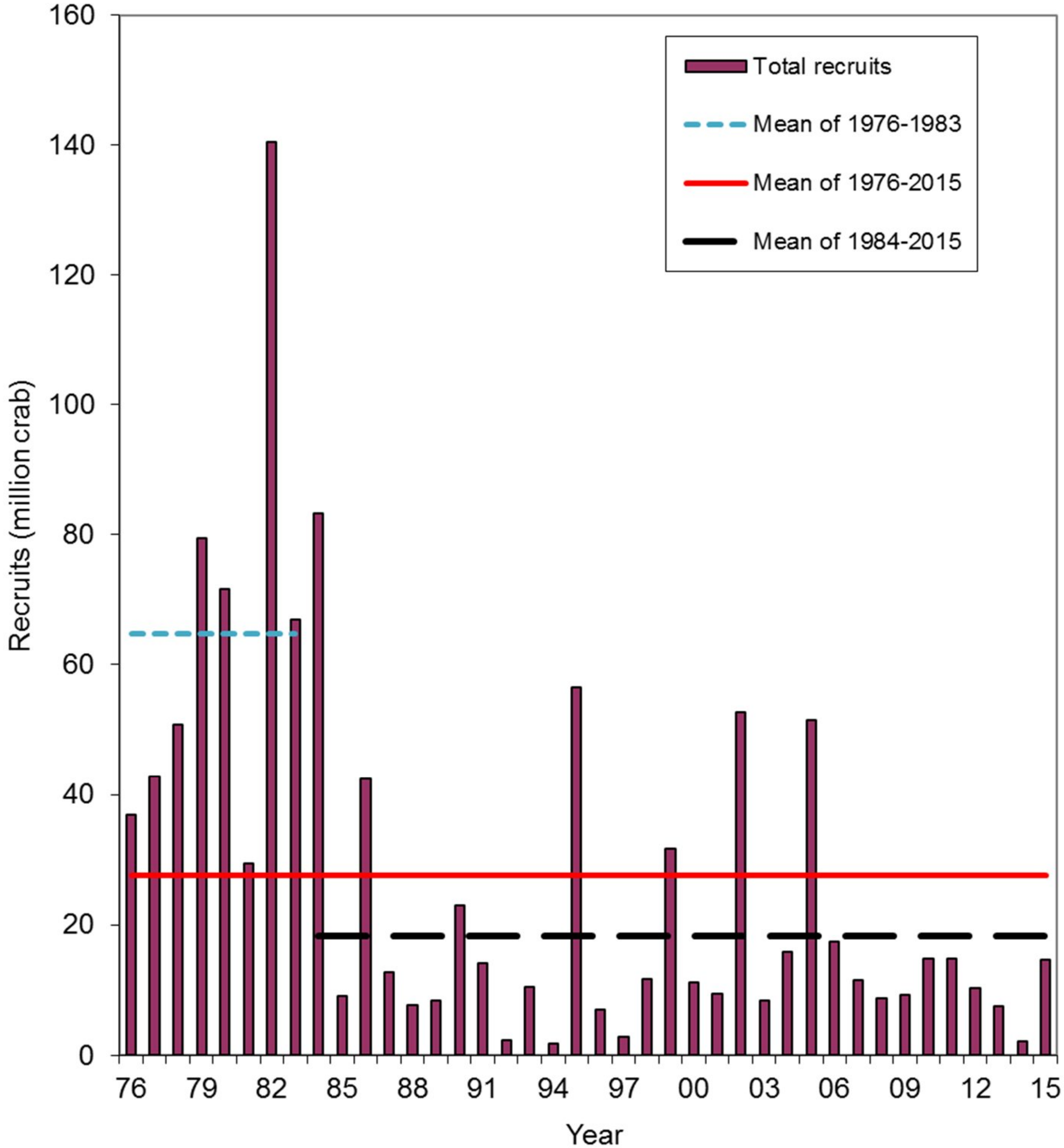
Total recruitment, scenario 1, 2015 model results



Total recruitment, scenario 1a, 2015 model results

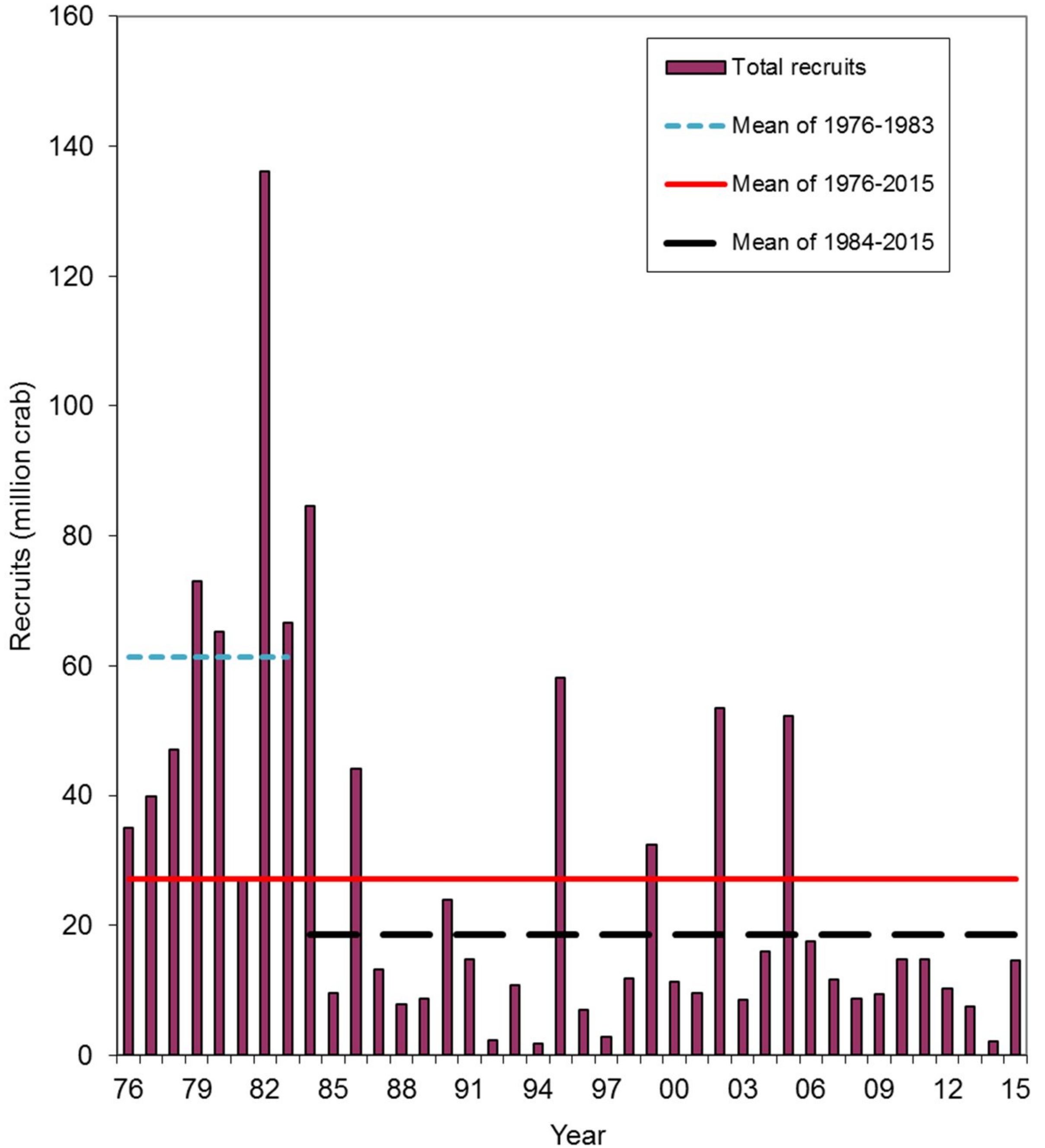


Scenario 1

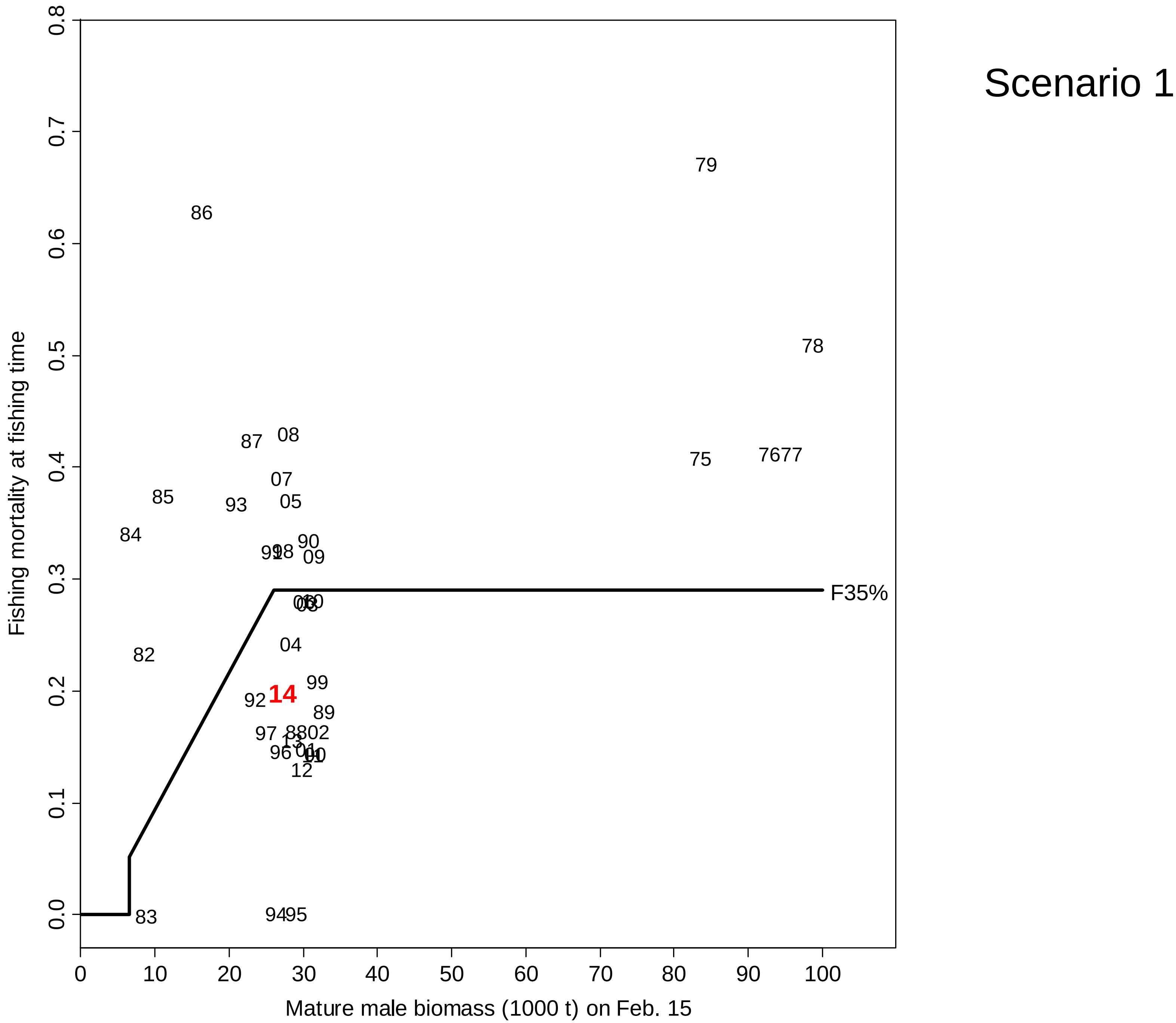


Total recruits
Mean of 1976-1983
Mean of 1976-2015
Mean of 1984-2015
Recruits (million crab)
Year
0
20
40
60
80
100
120
140
160
76
79
82
85
88
91
94
97
00
03
06
09
12
15

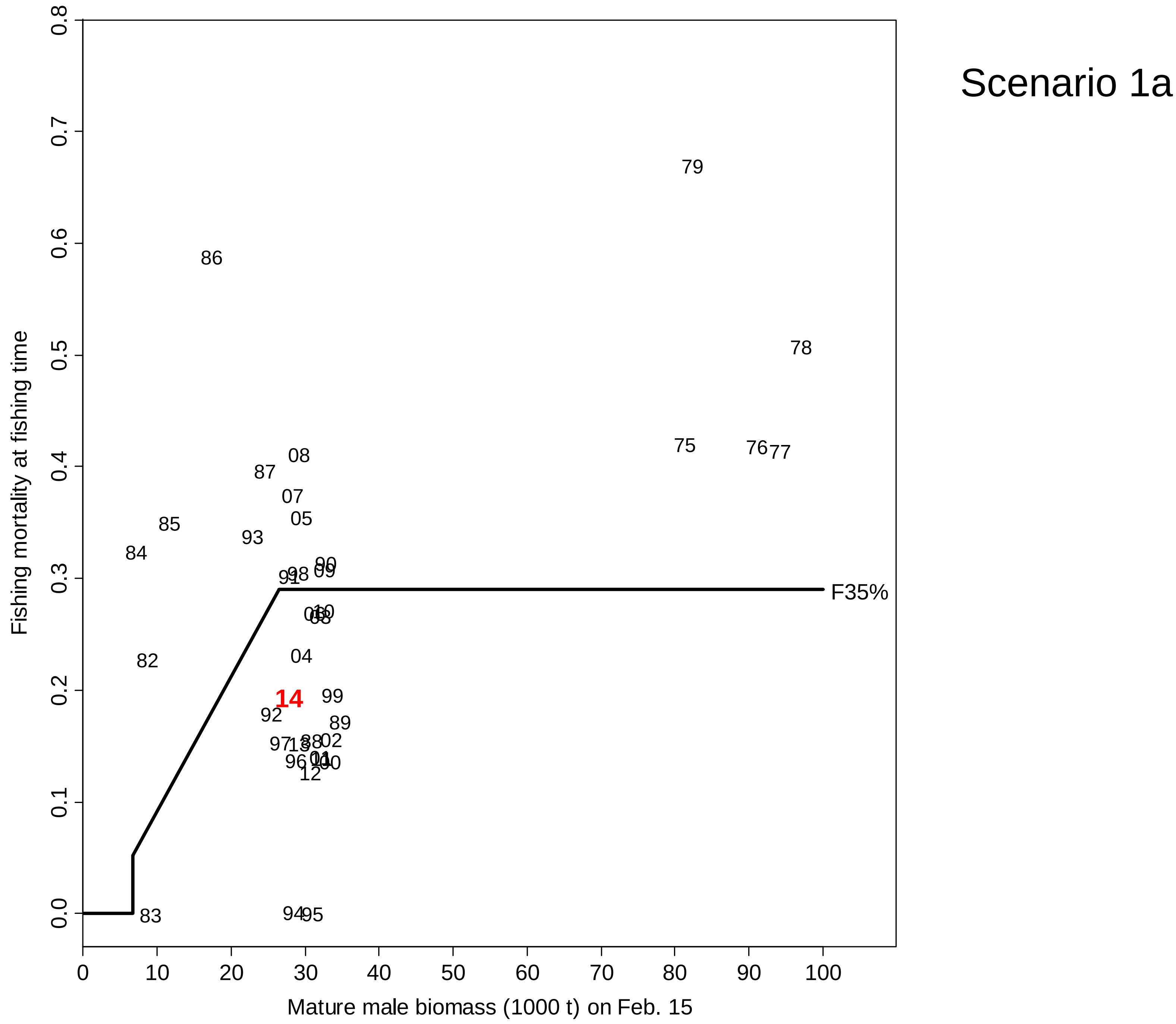
Scenario 1a



Total recruits
Mean of 1976-1983
Mean of 1976-2015
Mean of 1984-2015
Recruits (million crab)
Year
0
20
40
60
80
100
120
140
160
76
79
82
85
88
91
94
97
00
03
06
09
12
15



Scenario 1
Fishing mortality at fishing time
Mature male biomass (1000 t) on Feb. 15
F35%
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
10
20
30
40
50
60
70
80
90
100
79
86
78
87
08
75
7677
07
85
93
05
84
90
09
82
04
99
14
92
89
97
12
83



Scenario 1a
Fishing mortality at fishing time
Mature male biomass (1000 t) on Feb. 15
F35%
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
10
20
30
40
50
60
70
80
90
100
79
86
78
75
76
77
08
87
07
05
85
93
84
91
98
90
09
82
04
14
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92
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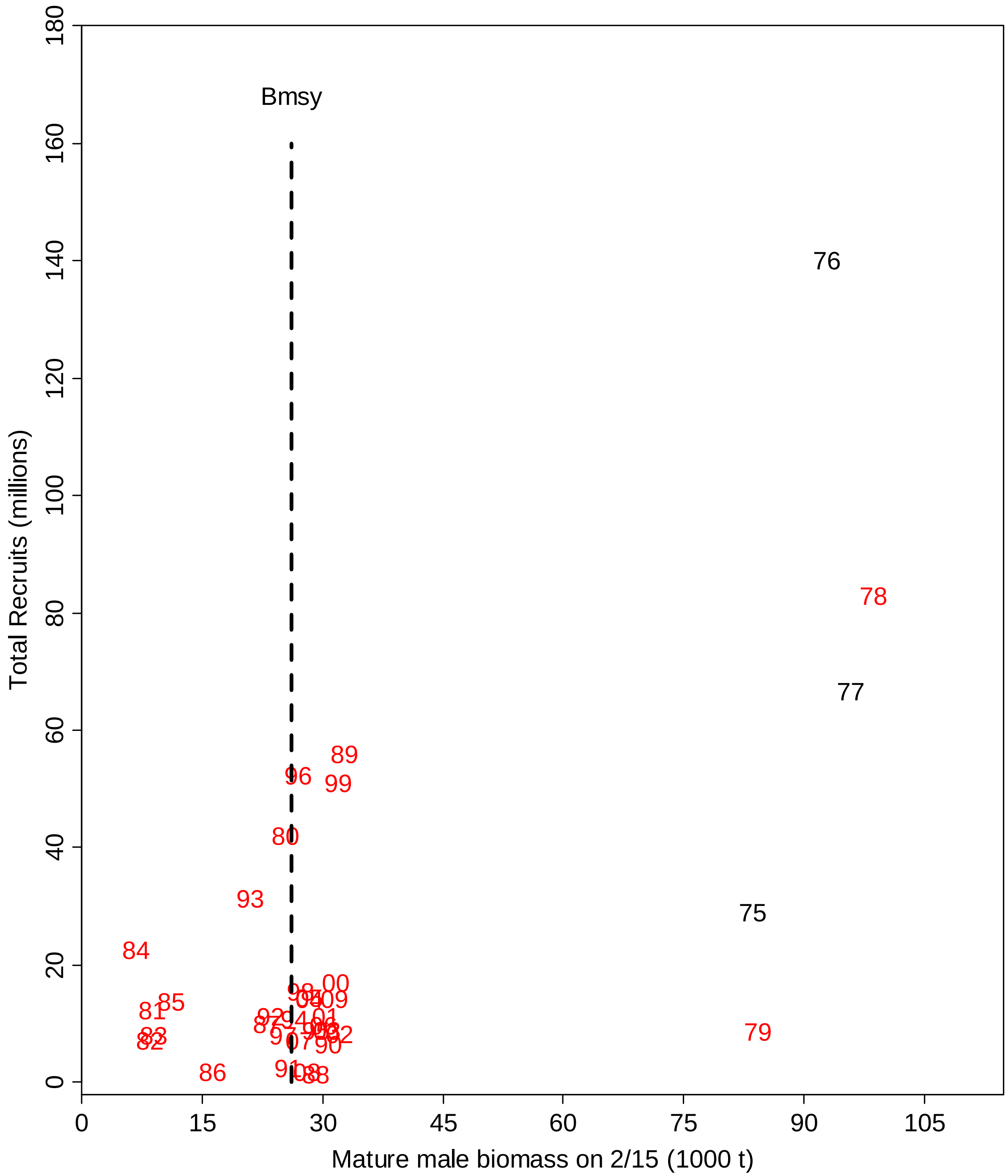
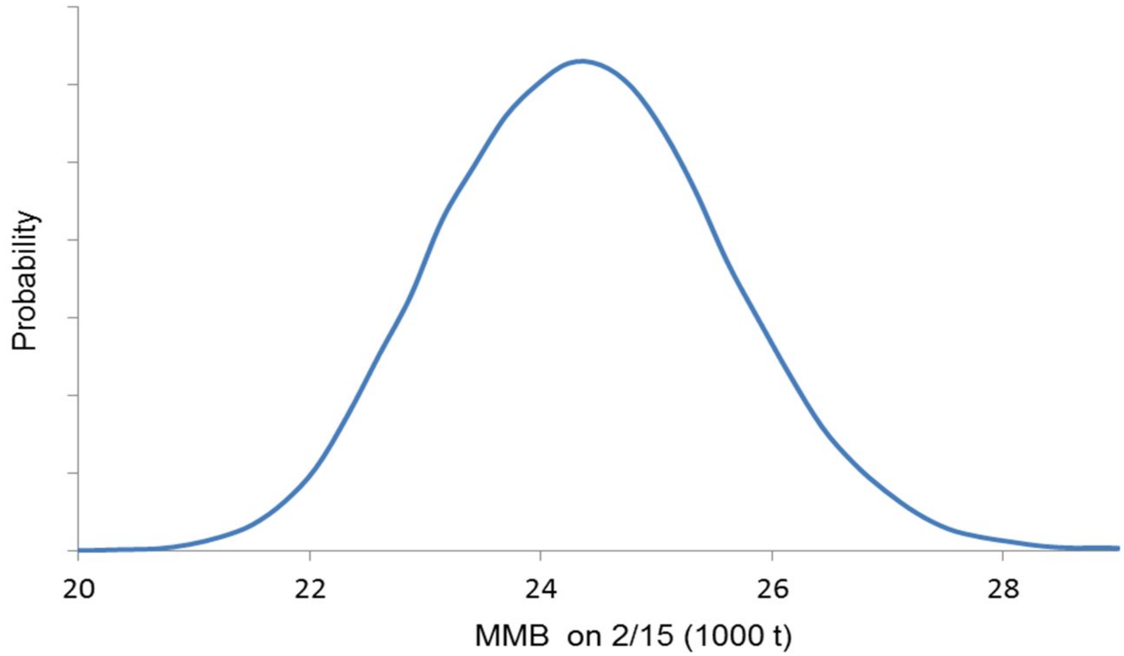
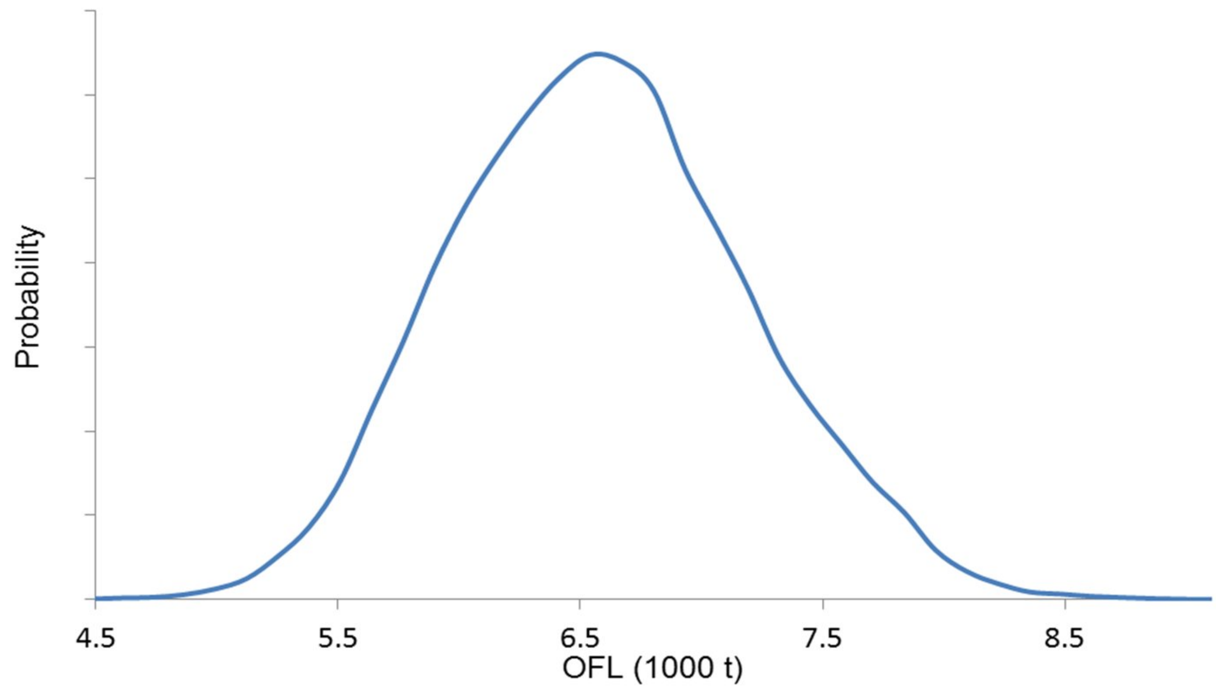
97
13
88
02
96
01
00
12
83
94
95


Bmsy
Total Recruits (millions)
0
20
40
60
80
100
120
140
160
180
Mature male biomass on 2/15 (1000 t)
0
15
30
45
60
75
90
105
76
78
77
89
96
99
80
93
75
84
00
85
81
79
86

Scenario 1

Scenario 1
2015





Based on the $B_{35\%}$ estimated from the average male recruitment during 1984-2015, the biological reference points and OFL:
(based on the 10% rule used last year, ABC = 0.9*OFL)

	Scenario 1		Scenario 1a		Scenario 1b	
	1000t	Million lbs	1000t	Million lbs	1000t	Million lbs
$B_{35\%}$	26.064	57.462	26.467	58.350	26.075	57.486
$F_{35\%}$	0.29		0.29		0.29	
MMB_{2015}	24.691	54.433	25.019	55.156	24.778	54.626
OFL_{2015}	6.732	14.841	6.824	15.044	6.783	14.954
ABC_{2015}	6.059	13.357	6.141	13.539	6.105	13.459

Status and catch specifications (1000 t):

Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2011/12	13.77[A]	30.88[A]	3.55	3.61	4.09	8.80	7.92
2012/13	13.19[B]	29.05[B]	3.56	3.62	3.90	7.96	7.17
2013/14	12.85[C]	27.12[C]	3.90	3.99	4.56	7.07	6.36
2014/15[1]	13.03[D]	27.25[D]	4.49	4.54	5.44	6.82	6.14
2015/16[1]		24.69[D]				6.73	6.06
2014/15[1a]	13.23[D]	27.80[D]	4.49	4.54	5.44	6.82	6.14
2015/16[1a]		25.02[D]				6.82	6.14

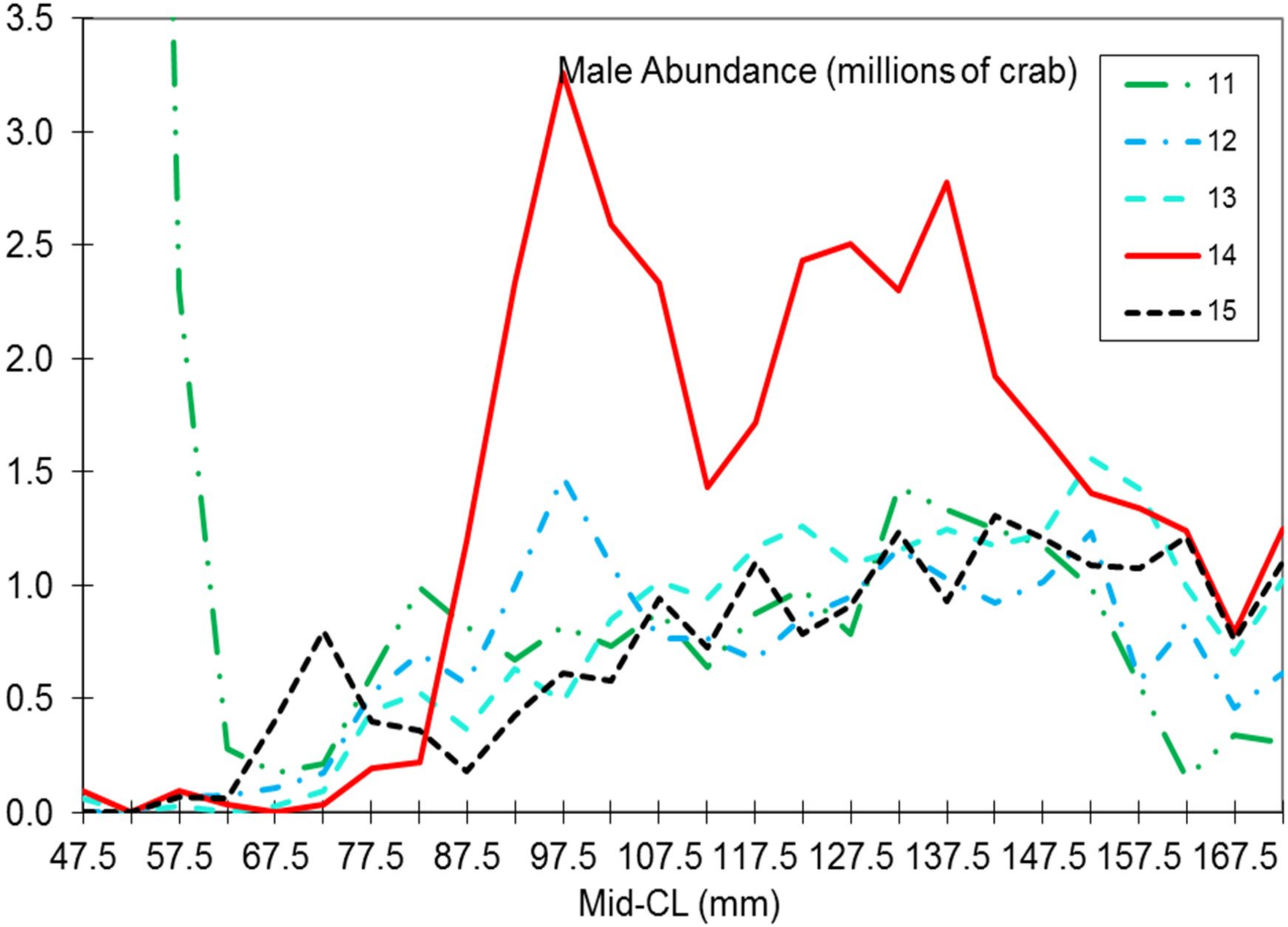
1---Scenario 1, 1a---Scenario 1a

Basis for the OFL: All table values are in 1000 t:

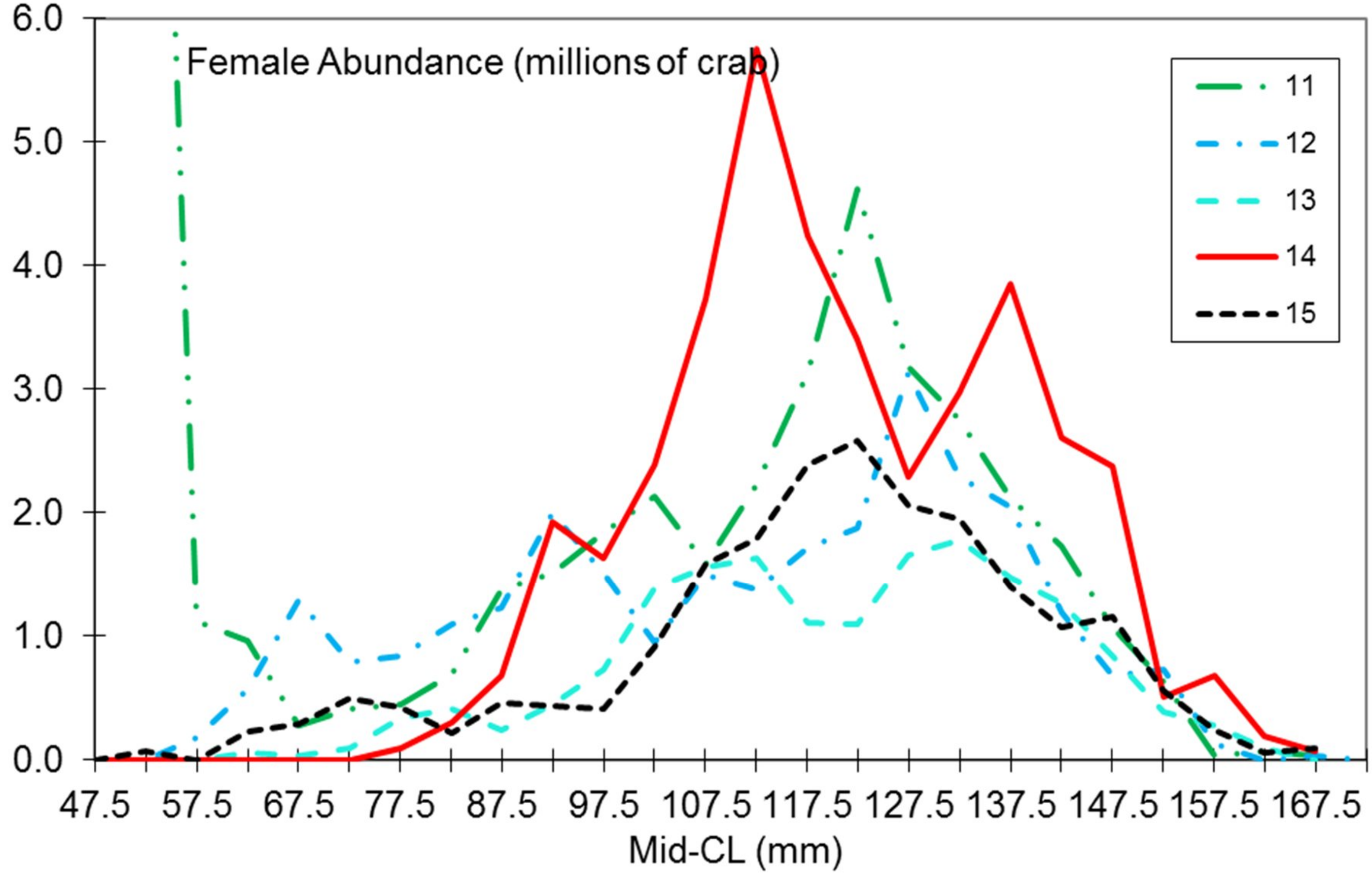
Year	Tier	B_{MSY}	Current MMB	B/B_{MSY} (MMB)	F_{OFL}	Years to define B_{MSY}	Natural Mortality
2011/12	3a	27.3	29.8	1.09	0.32	1984-2011	0.18
2012/13	3b	27.5	26.3	0.96	0.31	1984-2012	0.18
2013/14	3b	26.4	25.0	0.95	0.27	1984-2013	0.18
2014/15	3b	25.7	24.7	0.96	0.28	1984-2014	0.18
2015/16[1]	3b	26.1	24.7	0.95	0.27	1984-2015	0.18
2015/16[1a]	3b	26.5	25.0	0.95	0.27	1984-2015	0.18

1---Scenario 1, 1a---Scenario 1a

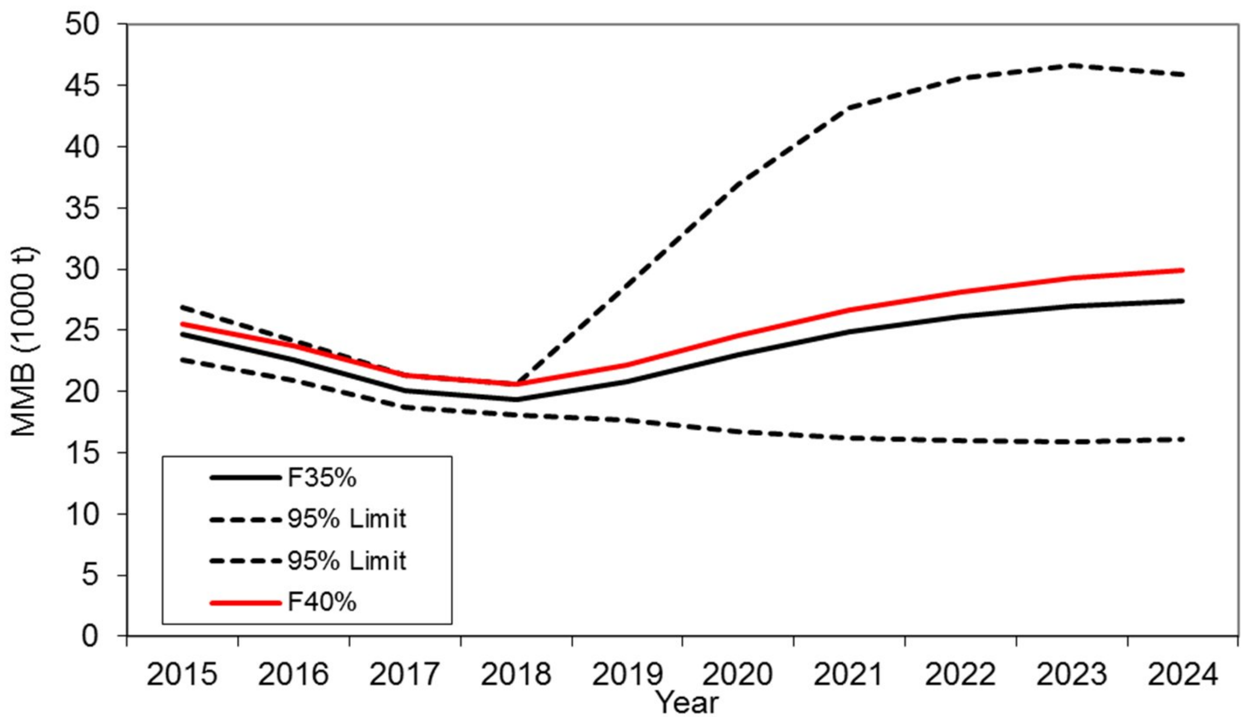
Male area-swept abundance during 2011-2015



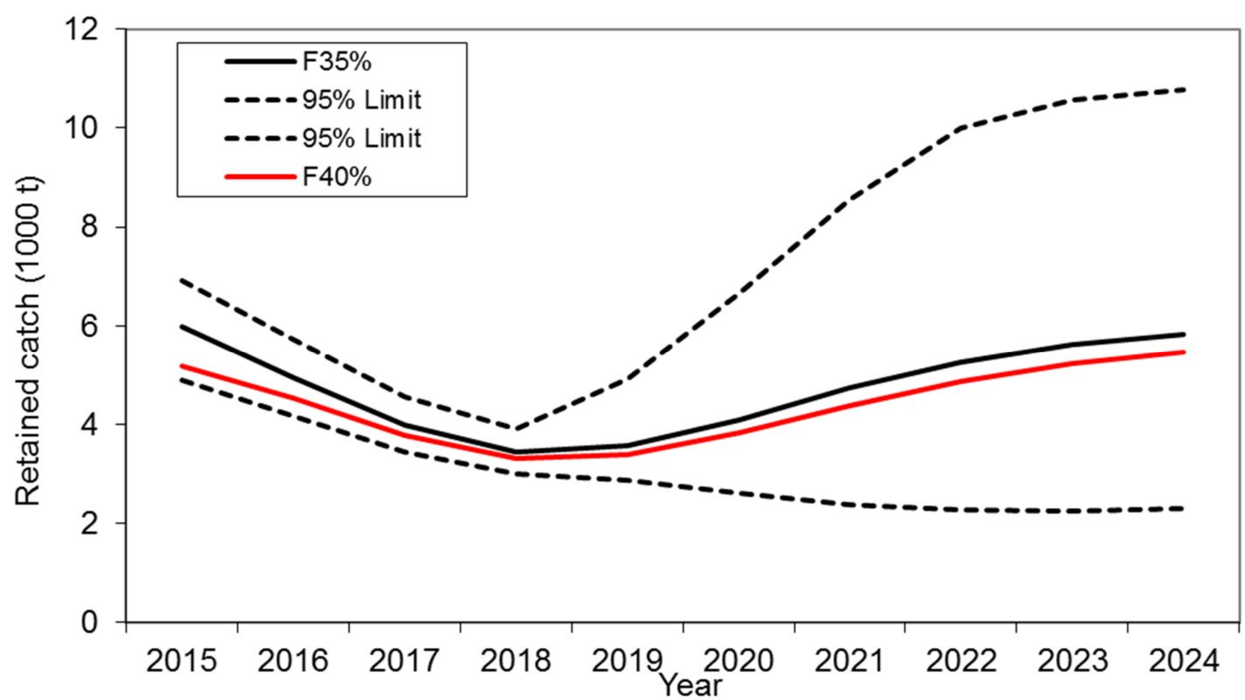
Female area-swept abundance during 2011-2015



Scenario 1

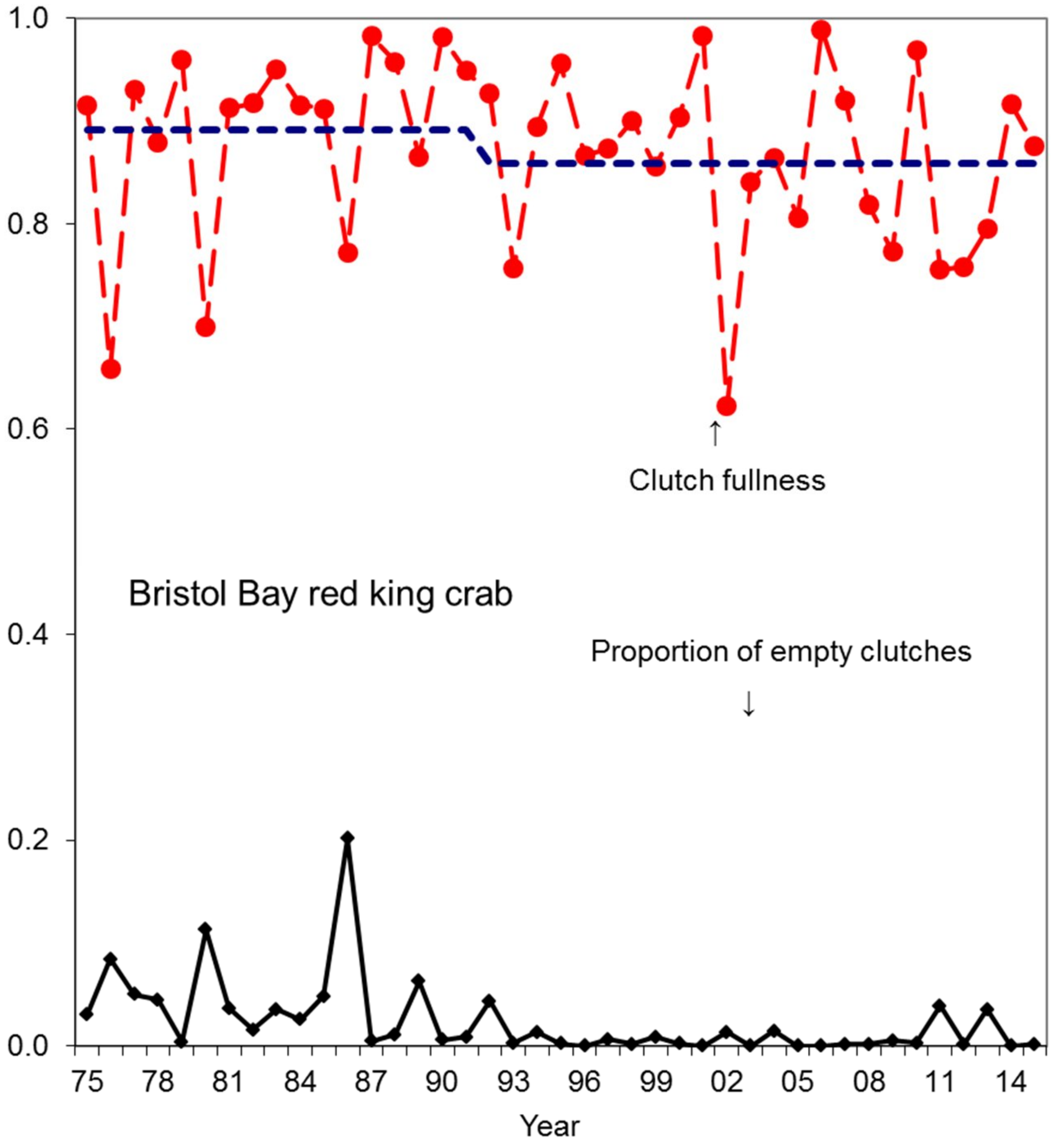


MMB (1000 t)
50
45
40
35
30
25
20
15
10
5
0
F35%
95% Limit
95% Limit
F40%
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Year



Retained catch (1000 t)
12
10
8
6
4
2
0
F35%
95% Limit
95% Limit
F40%
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
Year

Thanks



Clutch fullness did not change much over time.