Norton Sound Red King Crab SAFE2016

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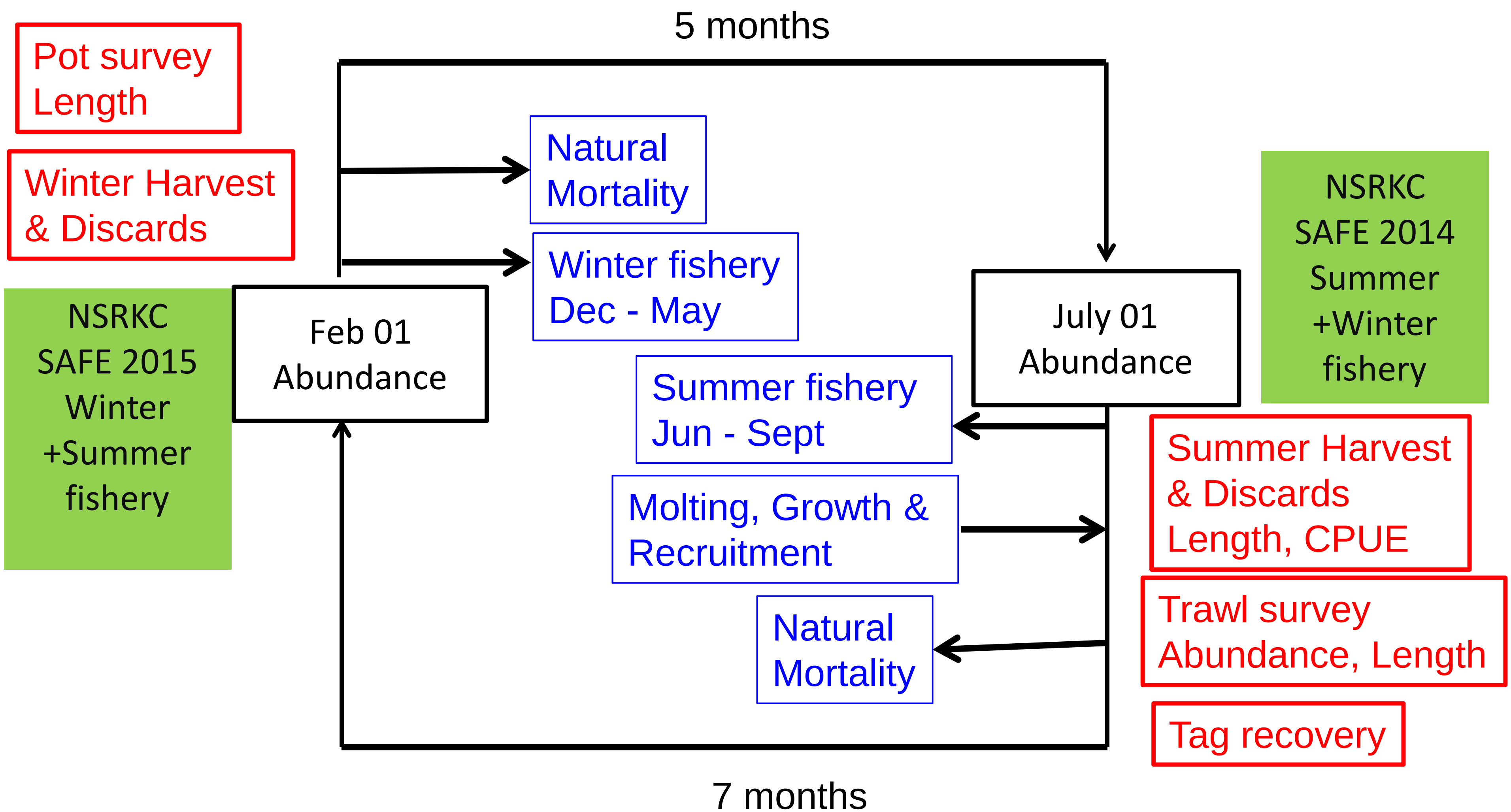
NSRKC Stock Assessment Model

Modeling process

Available Data & model fit



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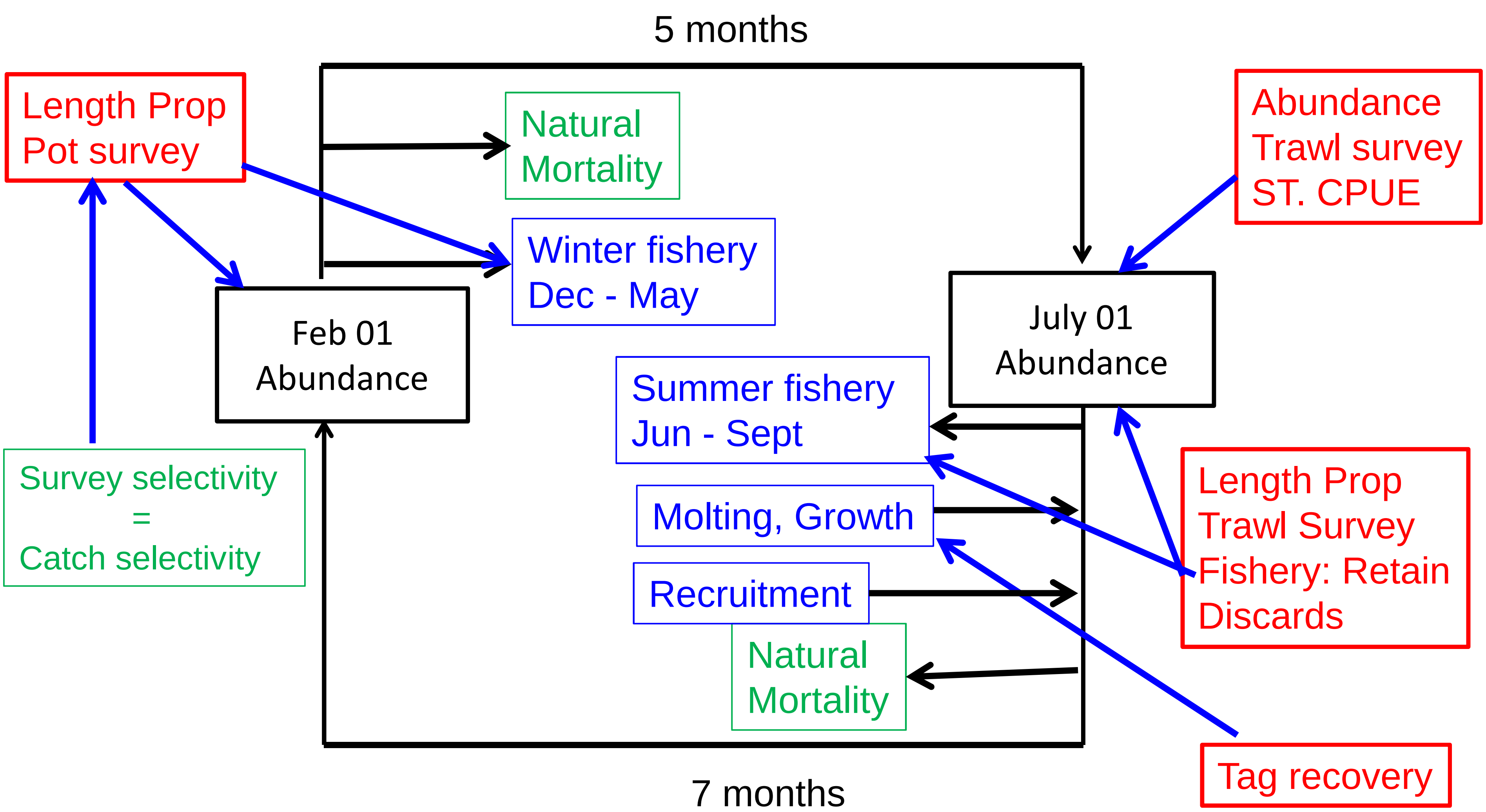
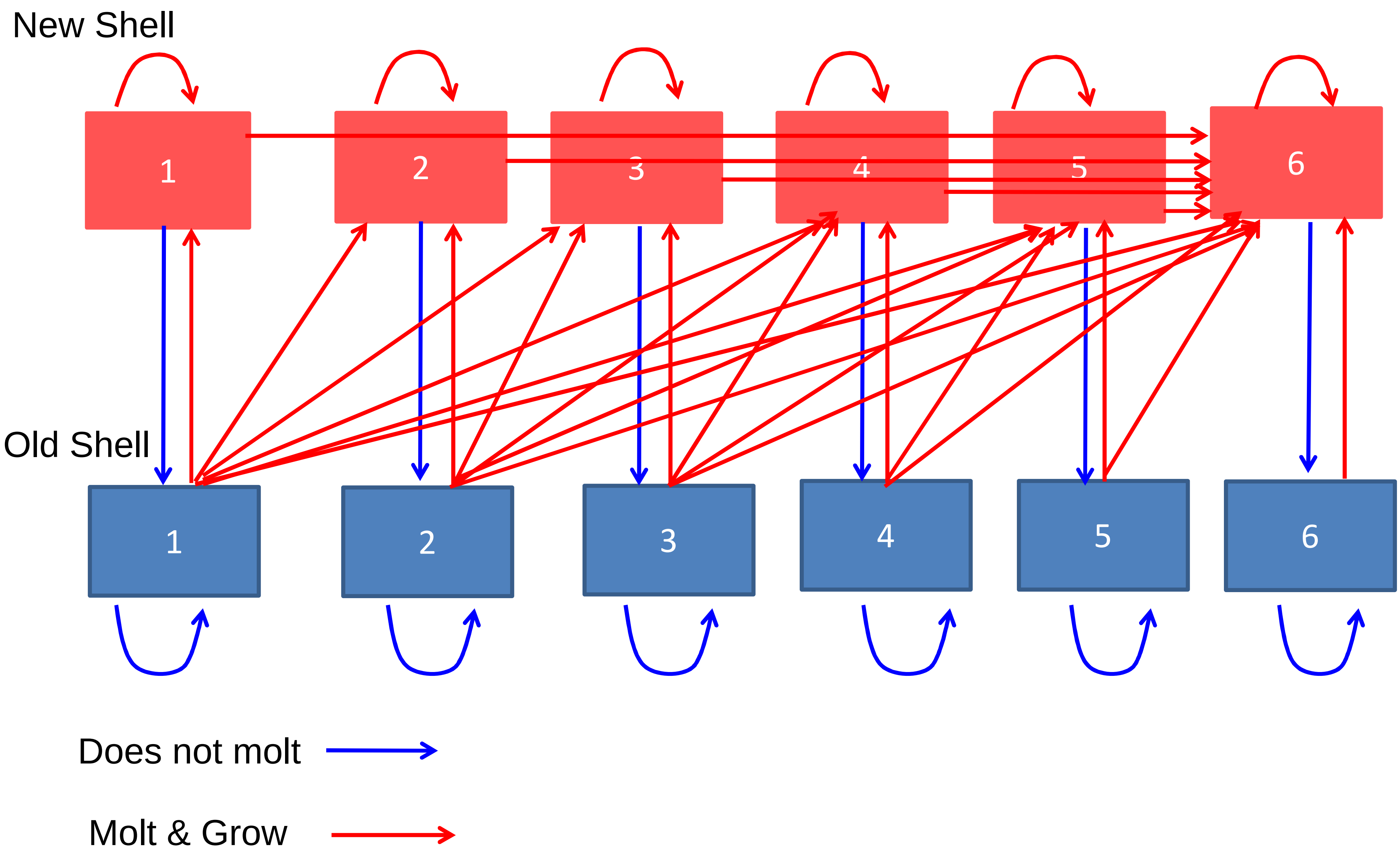
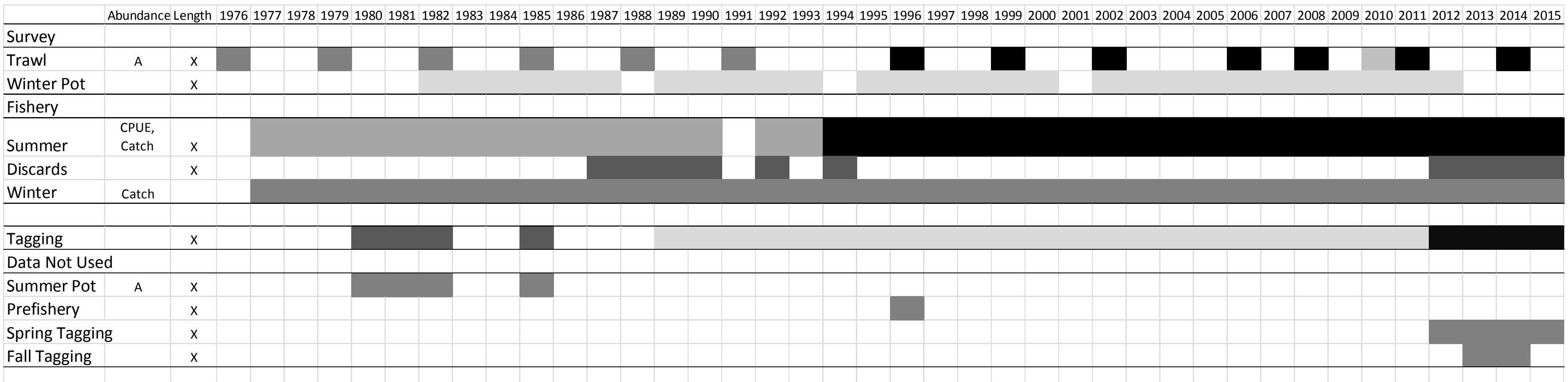


NSRKC Stock Assessment Model
Molting and Growth Transition



Data Sets



Tagging: 1980s: Legal Crabs only, 1990s: mostly sublegal (winter pot), 2012: legal, sublegal

Model Assumptions

- Length classes: 74 – 123 mm above 10 mm interval, 6 length classes
- New and Old Shells: Constant and identical selectivity, catchability, and molting probability
- M: 0.18 for length classes 1-5, and 0.648 for class 6
- Discards mortality = 0.2
- Fishery harvests occur instantly:
  - Winter fishery: Feb 01: Nov – May
  - Summer fisher: July 01: Jun – Sept
- Trawl survey selectivity: constant and identical for NMFS (1976-1991) and ADFG (1996-2015)
- Winter catch selectivity: winter pot survey selectivity constant and identical
- Commercial catch selectivity: constant and identical from 1977-2015

Responses to CPT and SSC

- No model modification-improvement requests
- Incorporate results from data-weighting workshop.
  - Waiting for CPT's guidelines.
- Provide retrospective estimates of spawning stock biomass and the appropriate statistics (e.g., Mohns' rho).
  - Calculated Mohn's rho. Guidelines needed.

Major changes in assessment model

- Alternative Models Considered

1. Jan. 2015 crab assessment model with updated data
2. Estimate M multiplier (ms) for > 123mm
3. Estimate M equal for all length classes
4. Estimate M for ≤ 123 mm and ms for > 123mm
5. Expand length classes 64 – 134 mm (from 6 to 8 classes)
6. Reduce length class interval from 10 to 5 mmm
7. All combinations above = 15 alternative models

Major changes in assessment model

Scenario	Length Range	Length Interval	M	ms (> 123mm)
0 (Default)	74-124	10	0.18	3.6
1			0.18	Est
2			Est	1.0
3			Est	Est
4	64-134	10	0.18	3.6
5			0.18	Est
6			Est	1.0
7			Est	Est
8	74-124	5	0.18	3.6
9			0.18	Est
10			Est	1.0
11			Est	Est
12	64-134	5	0.18	3.6
13			0.18	Est
14			Est	1.0
15			Est	Est

Summary of Alternative Model Scenarios

Model	Number of Parameters	Total	TSA	St. CPUE	TLP	WLP	CLP	OBS	REC	TAG
0	59	**310.9**	**9.7**	**-21.7**	**124.5**	**44.6**	**59.7**	**33.5**	**12.0**	**48.6**
1	60	-0.1	-0.1	0.0	-0.3	0.0	0.4	0.0	0.1	-0.2
2	60	13.3	-0.4	0.5	-4.4	0.3	12.5	0.9	-0.8	4.7
3	61	-0.2	-0.1	0.0	-0.9	-0.2	0.8	0.1	-0.1	0.1
4	61	-18.0	0.3	0.6	-22.5	-2.3	-1.6	-3.6	0.3	10.8
5	62	-18.0	0.3	0.6	-22.5	-2.3	-1.5	-3.6	0.3	10.8
6	62	3.1	0.2	0.7	-21.2	0.6	10.0	-2.1	-0.6	15.5
7	63	-18.3	0.2	0.6	-21.9	-2.4	-1.8	-3.9	0.4	10.6
8	60	42.3	0.1	-0.4	-5.1	-0.9	3.7	-3.0	-0.4	48.1
9	61	42.2	0.1	-0.4	-5.4	-1.0	4.1	-3.0	-0.4	48.2
10	61	55.4	-0.2	0.0	-7.8	1.7	11.5	-1.4	-1.0	52.6
11	62	41.9	0.1	-0.4	-6.2	-0.8	4.0	-2.7	-0.5	48.4
12	64	43.9	0.6	0.4	-22.6	0.2	2.9	-5.5	0.3	67.7
13	65	43.9	0.6	0.4	-22.6	0.2	2.9	-5.5	0.3	67.7
14	65	67.5	0.5	0.5	-19.9	4.4	13.7	-3.7	-0.4	72.3
15	66	43.4	0.5	0.3	-22.4	-0.3	3.2	-5.9	0.3	67.5

Summary of Alternative Model Scenarios

Model	*M*	*ms*	MMB(2016)	OFL
0	0.18	3.6	5.99	0.85
1	0.18	**3.42**	5.78	0.82
2	**0.42**	1	6.15	1.74
3	**0.21**	**2.96**	6.03	0.78
4	0.18	3.6	5.88	0.77
5	0.18	**3.56**	5.87	0.77
6	**0.4**	1	5.81	1.42
7	**0.14**	**4.61**	6.54	0.81
8	0.18	3.6	6.50	0.86
9	0.18	**3.45**	6.46	0.85
10	**0.41**	1	6.63	1.64
11	**0.22**	**2.78**	6.54	1.02
12	0.18	3.6	6.17	0.76
13	0.18	**3.60**	6.17	0.76
14	**0.39**	1	6.16	1.33
15	**0.14**	**4.82**	6.05	0.59

Alternative model summary

1. Estimate M for > 123mm
   Little change in model fit (current assumption works)
2. Estimate M equal for all length classes
   Lower model fit (Higher M)
3. Estimate M for ≤ 123 mm and ms for > 123mm
   Little change in model fit: Model estimates of M and ms are similar to current assumption.
4. Expand length classes 64 – 134 mm (from 6 to 8 classes)
   Better model fit. (less model fit to tag recovery data)
5. Reduce length interval from 10 to 5 mmm
   Less model fit. (less model fit to tag recovery data)
6. All combinations above = 15 alternative models
   MMB estimates are similar among all models. (5.87-6.63)

Candidate Models

Model	Number of Parameters	Total	TSA	St. CPUE	TLP	WLP	CLP	OBS	REC	TAG
0	59	**310.9**	**9.7**	**-21.7**	**124.5**	**44.6**	**59.7**	**33.5**	**12.0**	**48.6**
1	60	-0.1	-0.1	0.0	-0.3	0.0	0.4	0.0	0.1	-0.2
2	60	13.3	-0.4	0.5	-4.4	0.3	12.5	0.9	-0.8	4.7
3	61	-0.2	-0.1	0.0	-0.9	-0.2	0.8	0.1	-0.1	0.1
4	61	-18.0	0.3	0.6	-22.5	-2.3	-1.6	-3.6	0.3	10.8
5	62	-18.0	0.3	0.6	-22.5	-2.3	-1.5	-3.6	0.3	10.8
6	62	3.1	0.2	0.7	-21.2	0.6	10.0	-2.1	-0.6	15.5
7	63	-18.3	0.2	0.6	-21.9	-2.4	-1.8	-3.9	0.4	10.6
8	60	42.3	0.1	-0.4	-5.1	-0.9	3.7	-3.0	-0.4	48.1
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Author Preferred Candidate Models

Models 0, 1, 5, 13

- Better model fit:
  - Trawl, Discards, Winter pot survey length comp
  - But, worsen tag recovery

Retrospective Mohn's rho

Model 0: -0.482 : Appendix C1

Model 1: -0.556 : Appendix C2

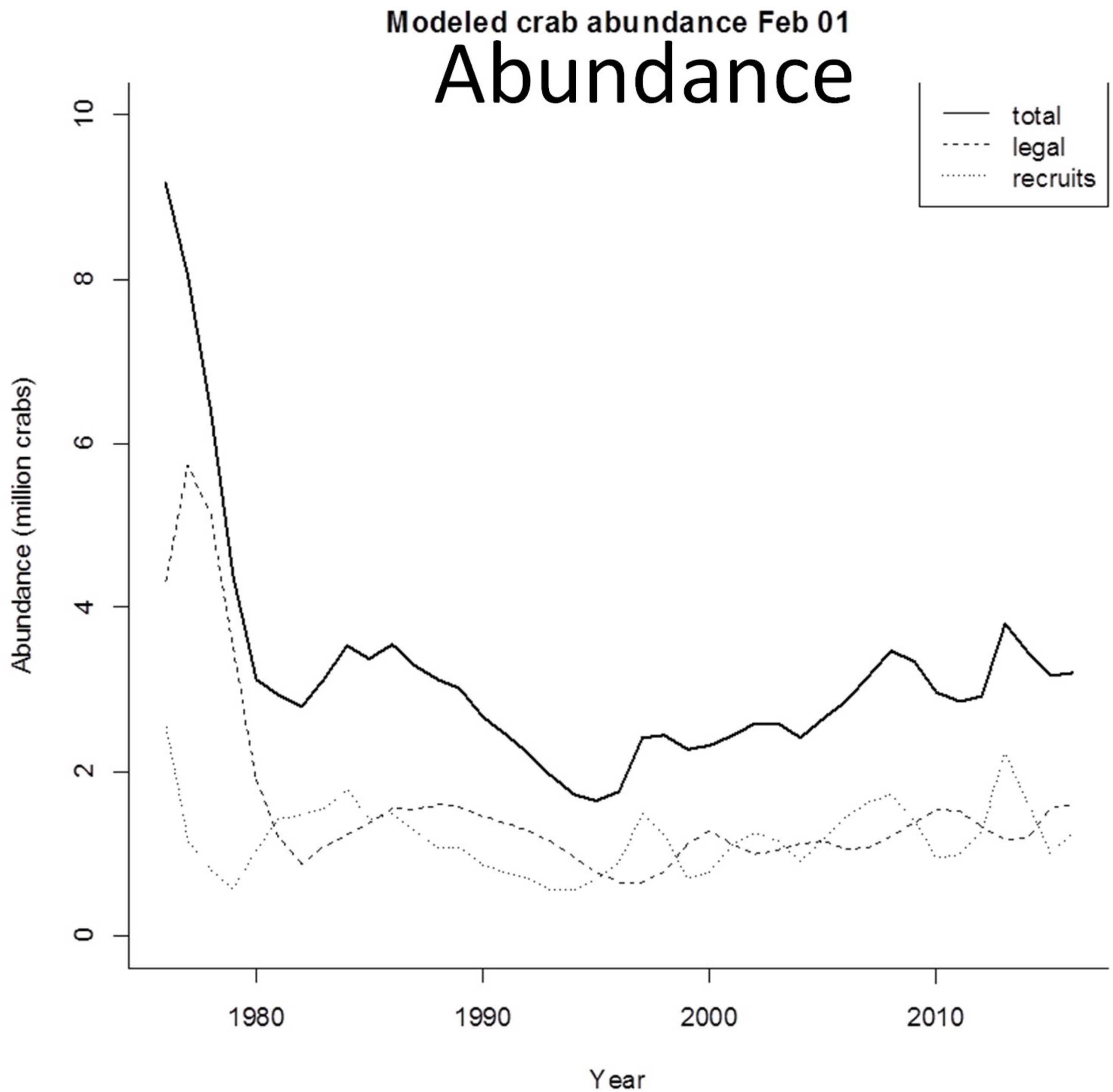
Model 5: 0.115 : Figure 17

Model 13: 0.926 : Figure 18

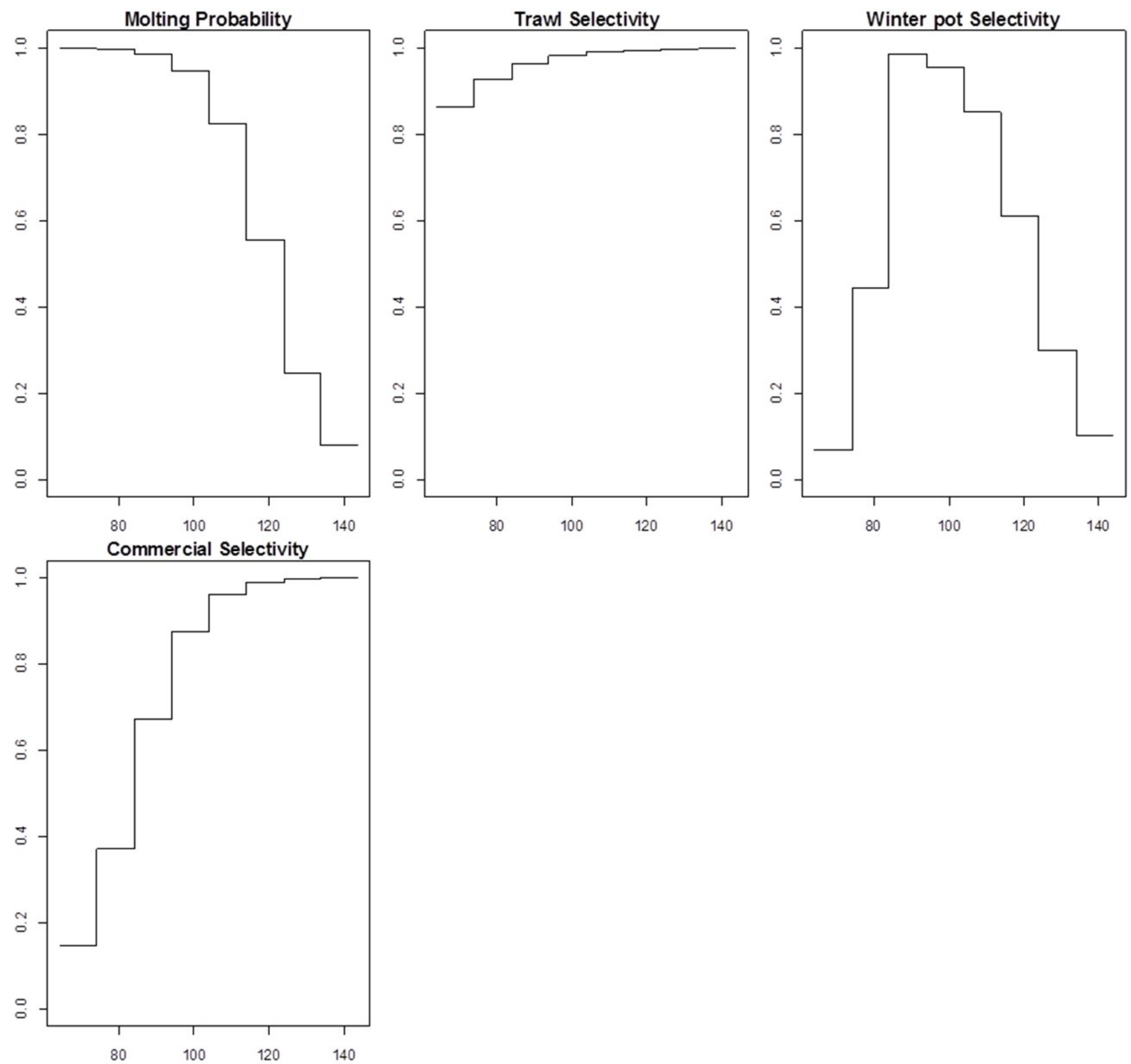
Author recommended Model:

Model 5: the lowest Mohn's rho

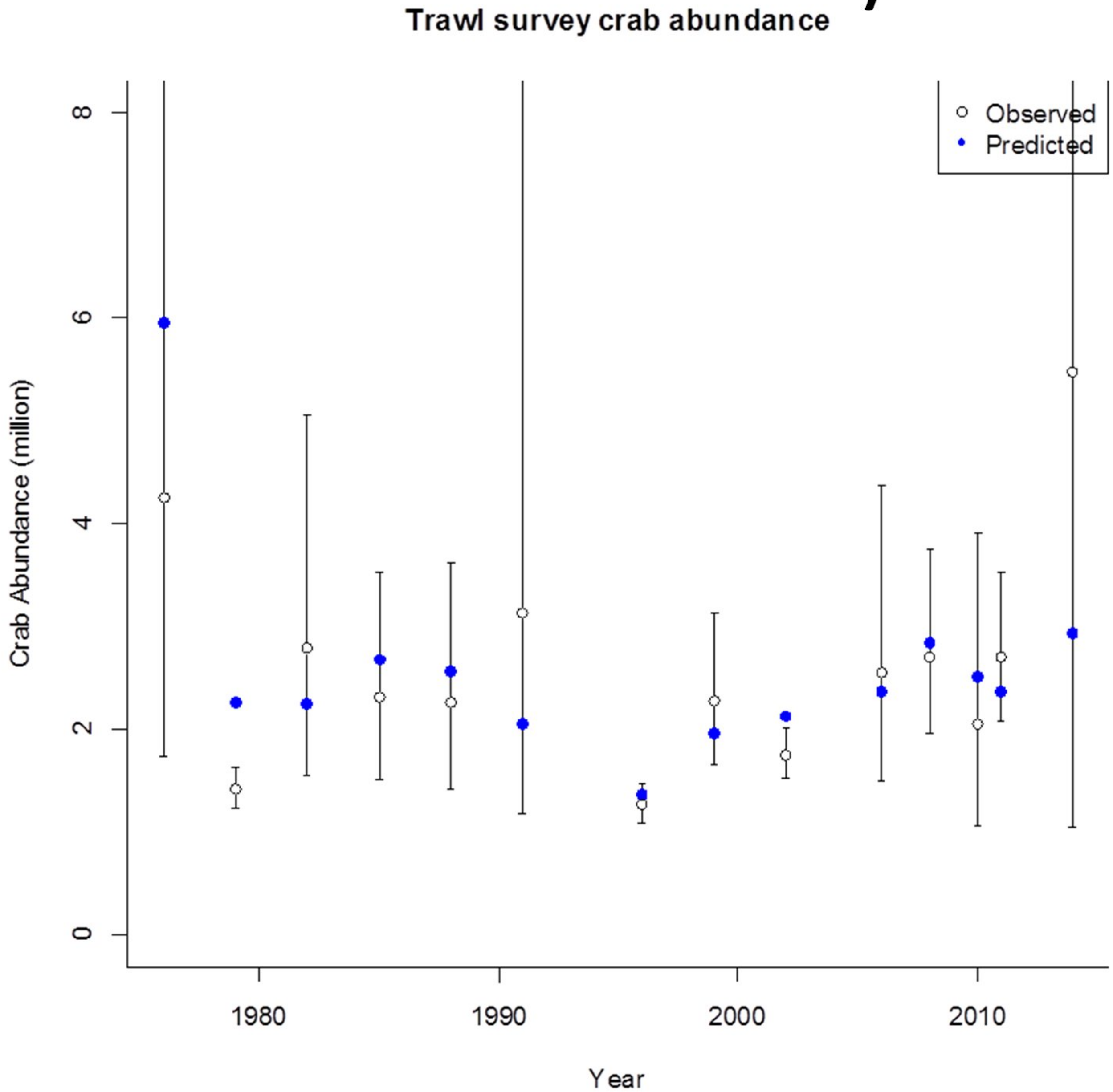
Abundance


Modeled crab abundance Feb 01
total
legal
recruits
Abundance (million crabs)
0
2
4
6
8
10
1980
1990
2000
2010
Year

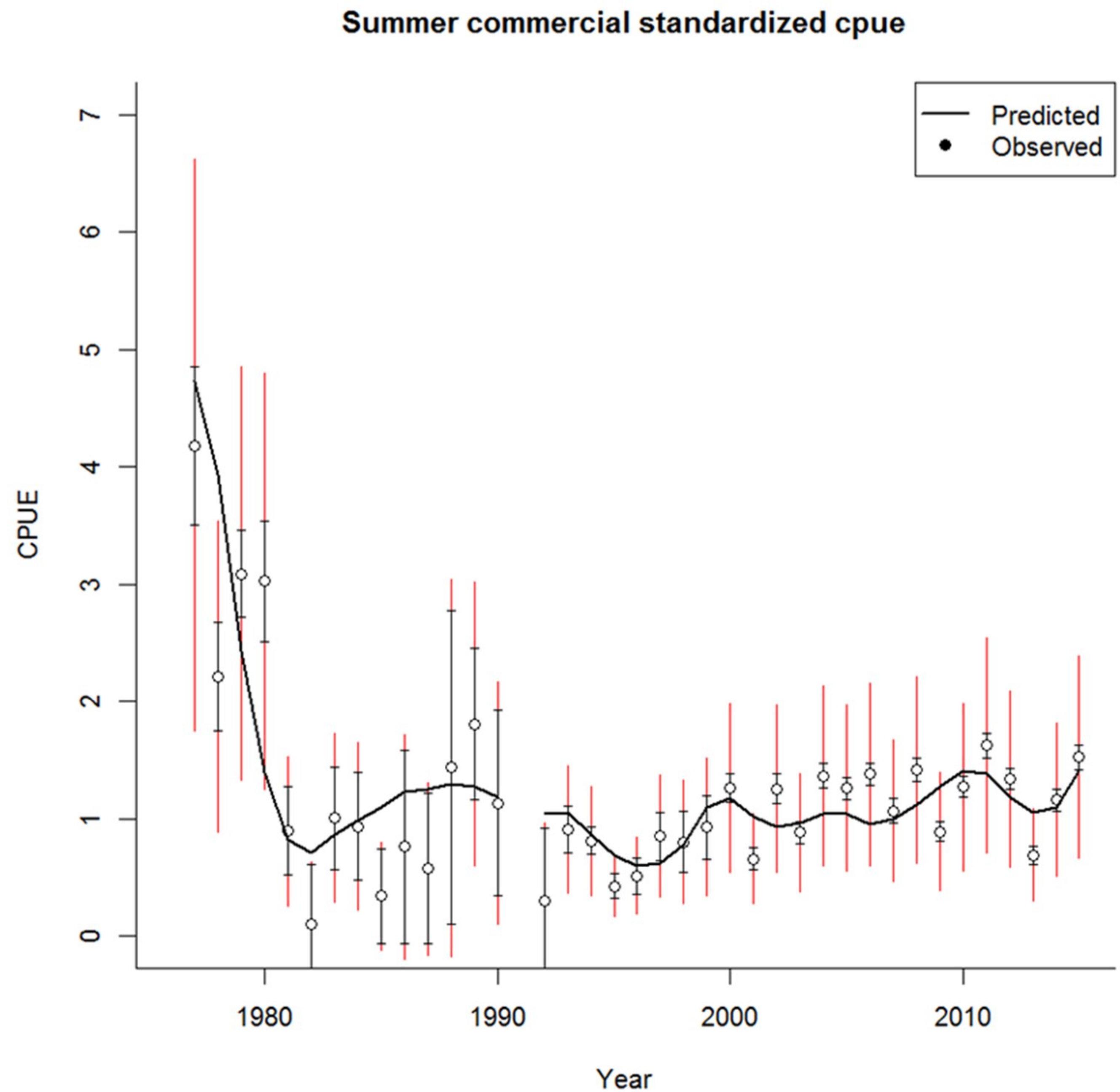
Selectivity



Fit to Trawl survey data

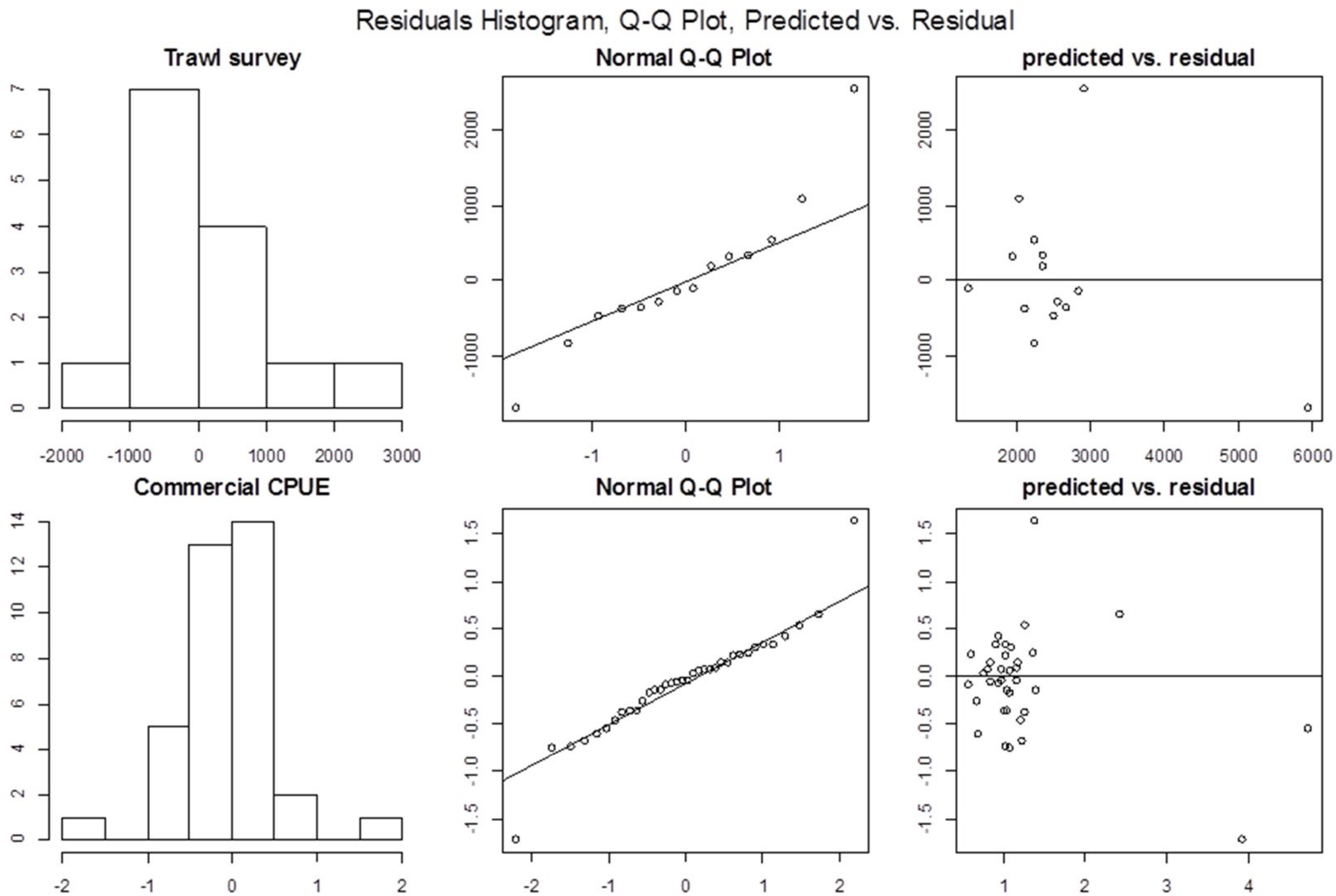


ST CPUE

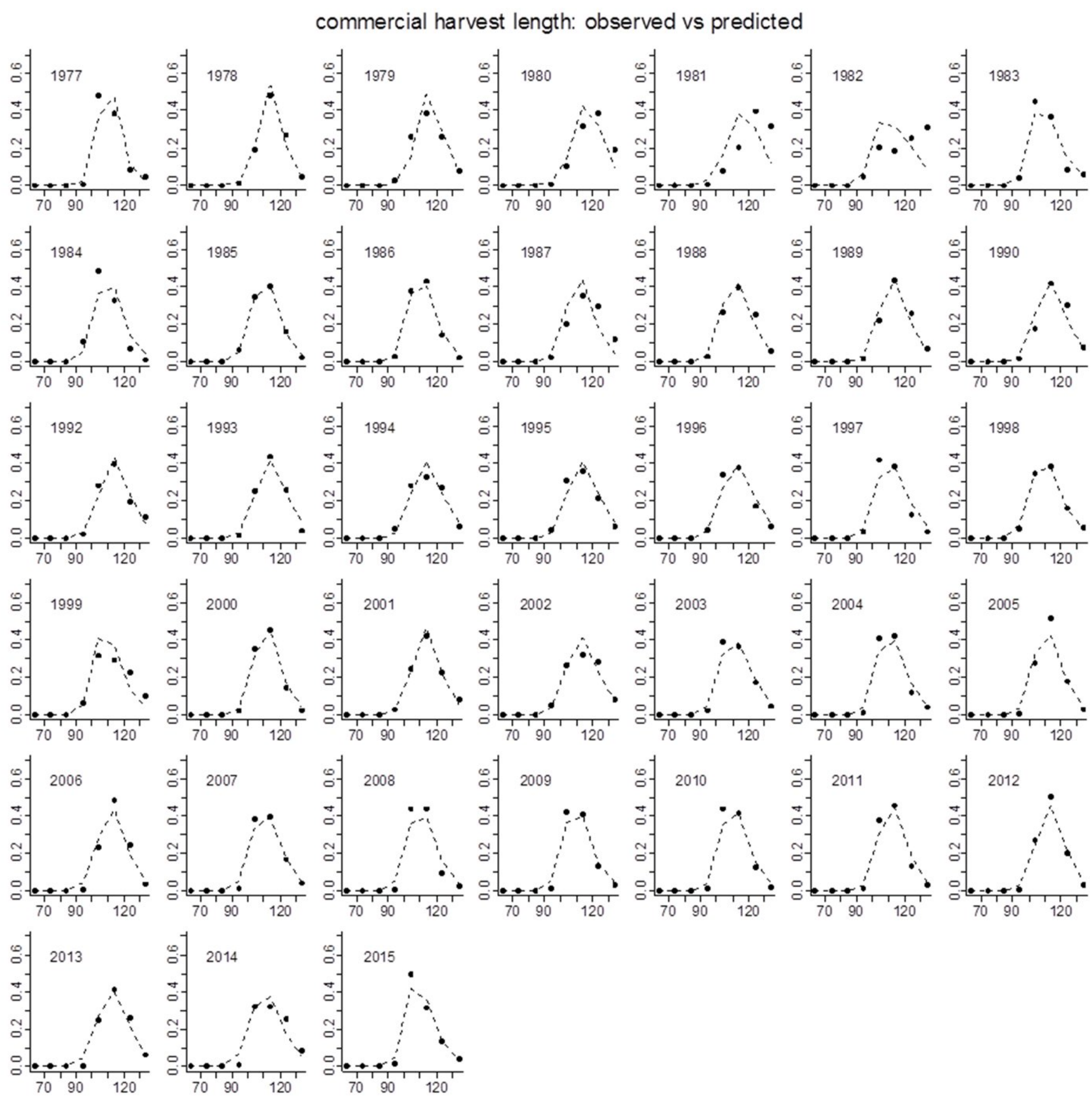


Summer commercial standardized cpue
Predicted
Observed
CPUE
0
1
2
3
4
5
6
7
1980
1990
2000
2010
Year

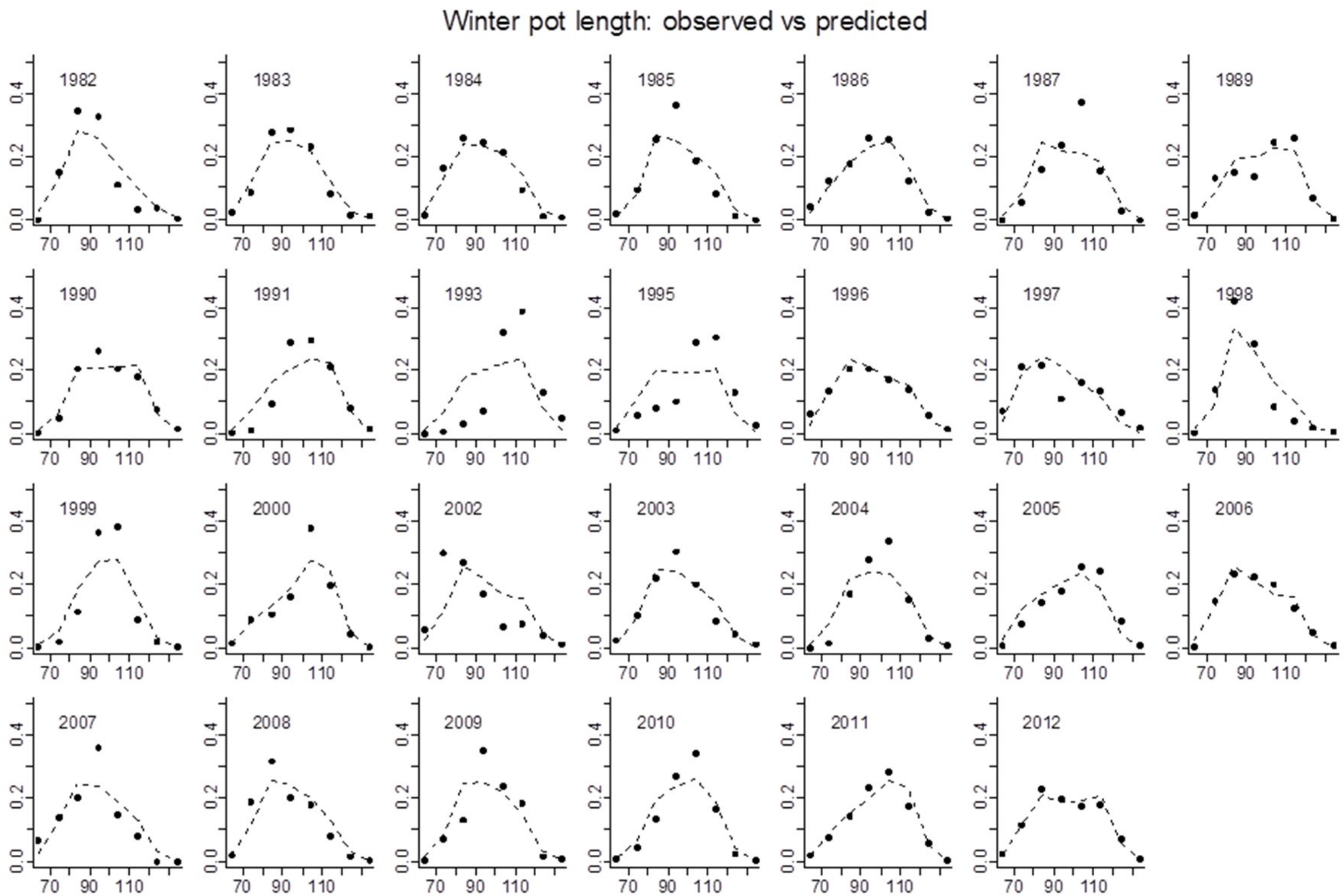
Residual Analyses



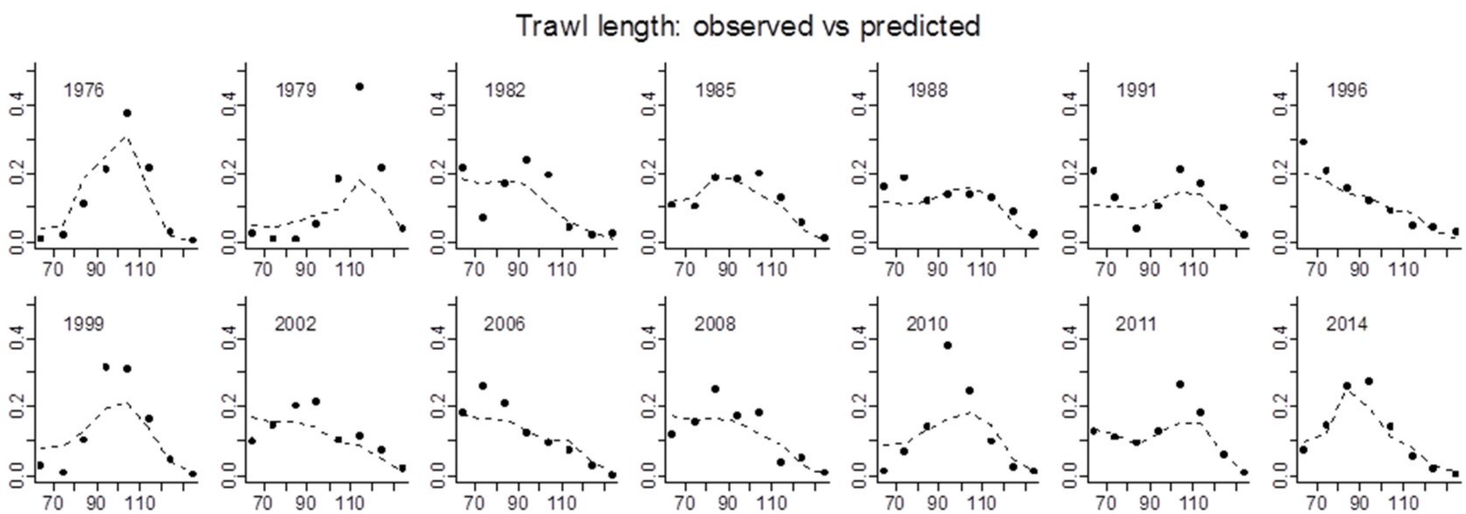
Com Harvest Length Composition

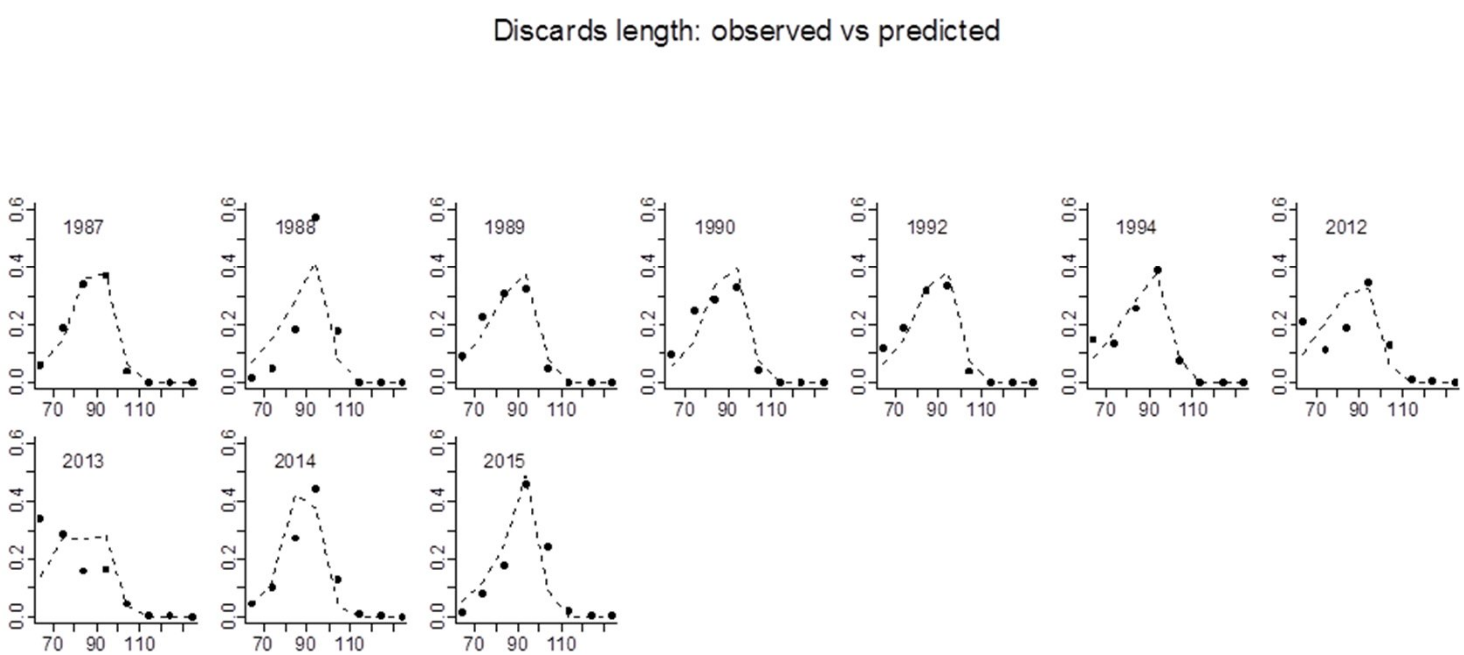


Winter Pot Length Composition

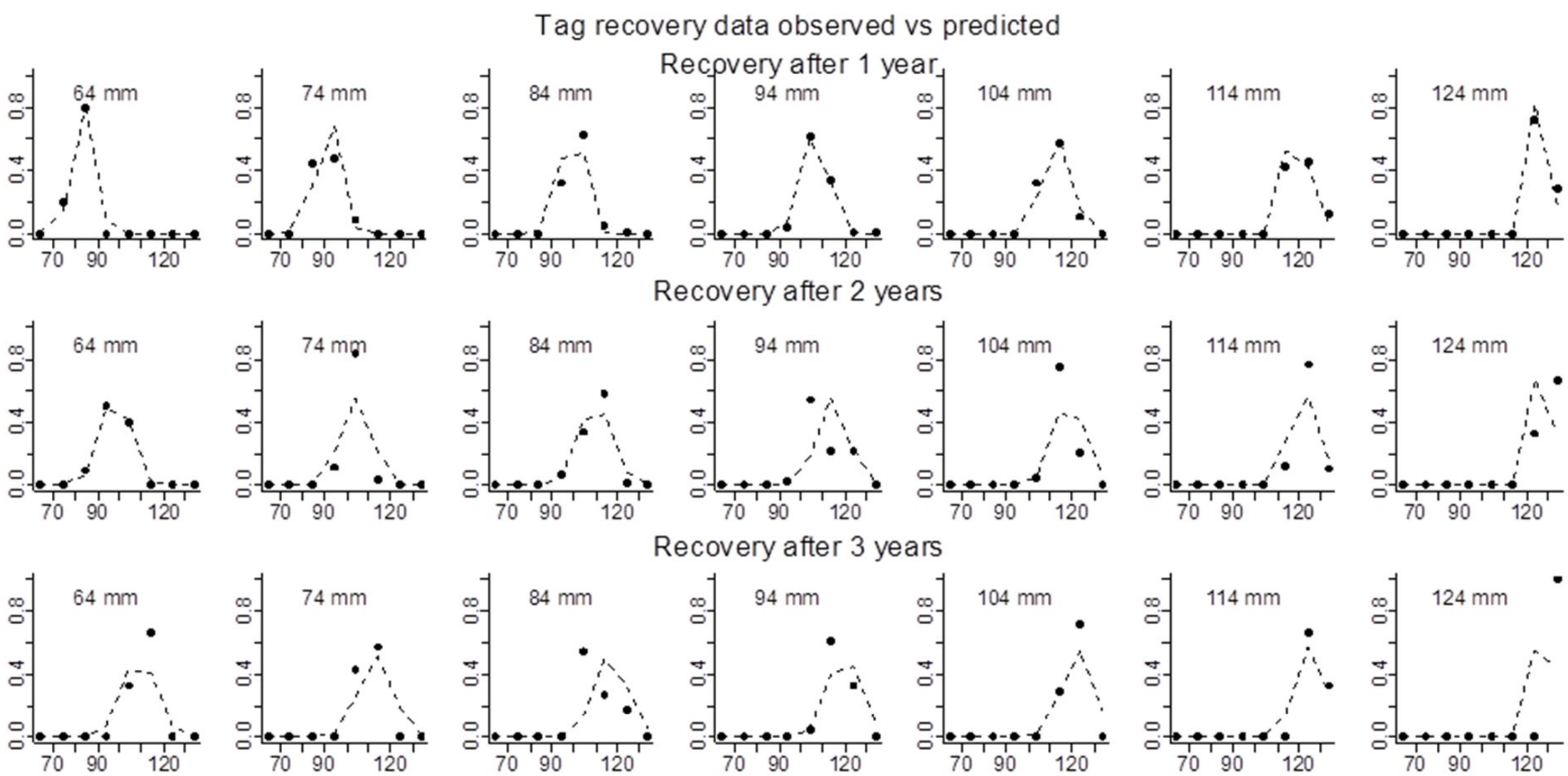


Trawl, Discards Length Composition

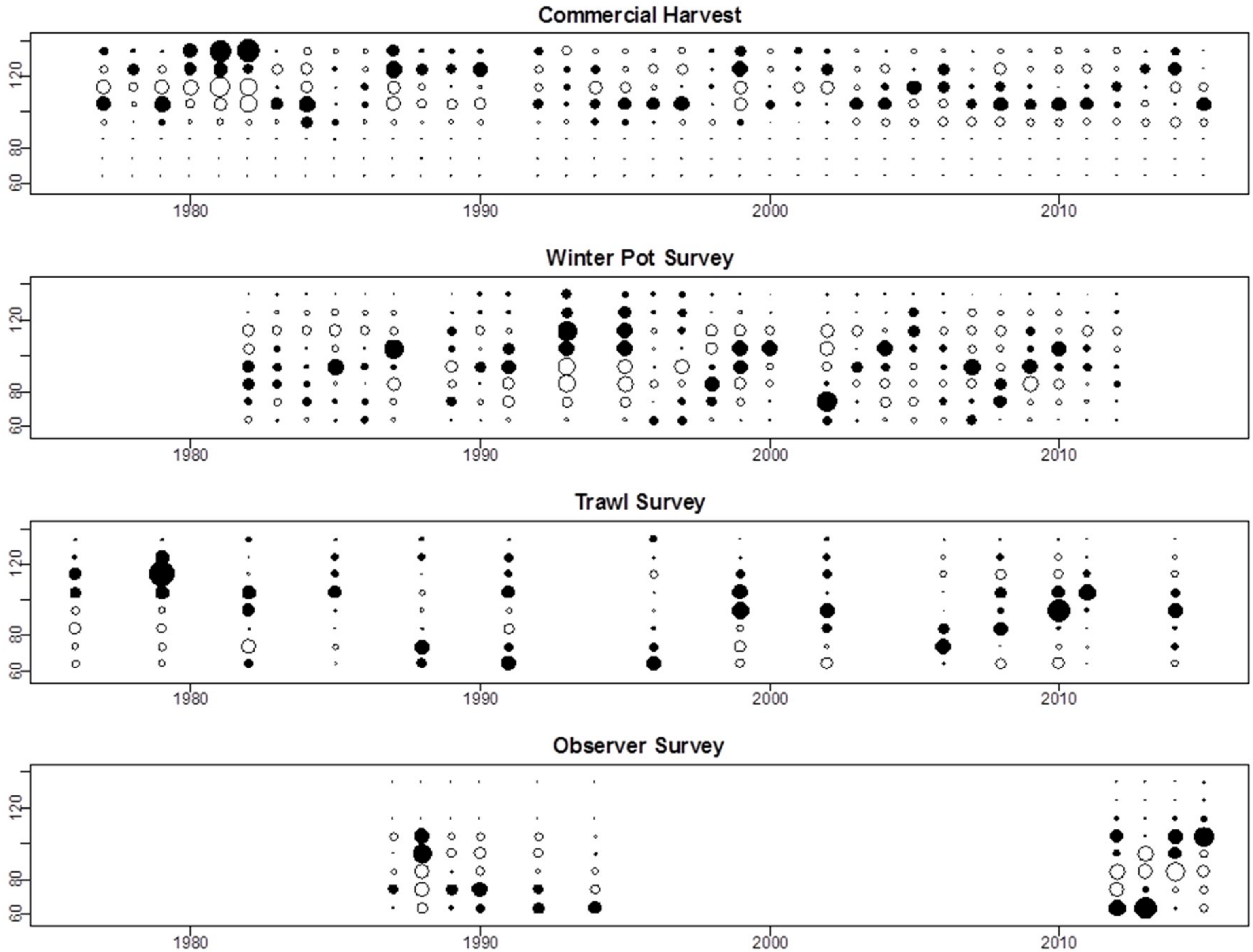




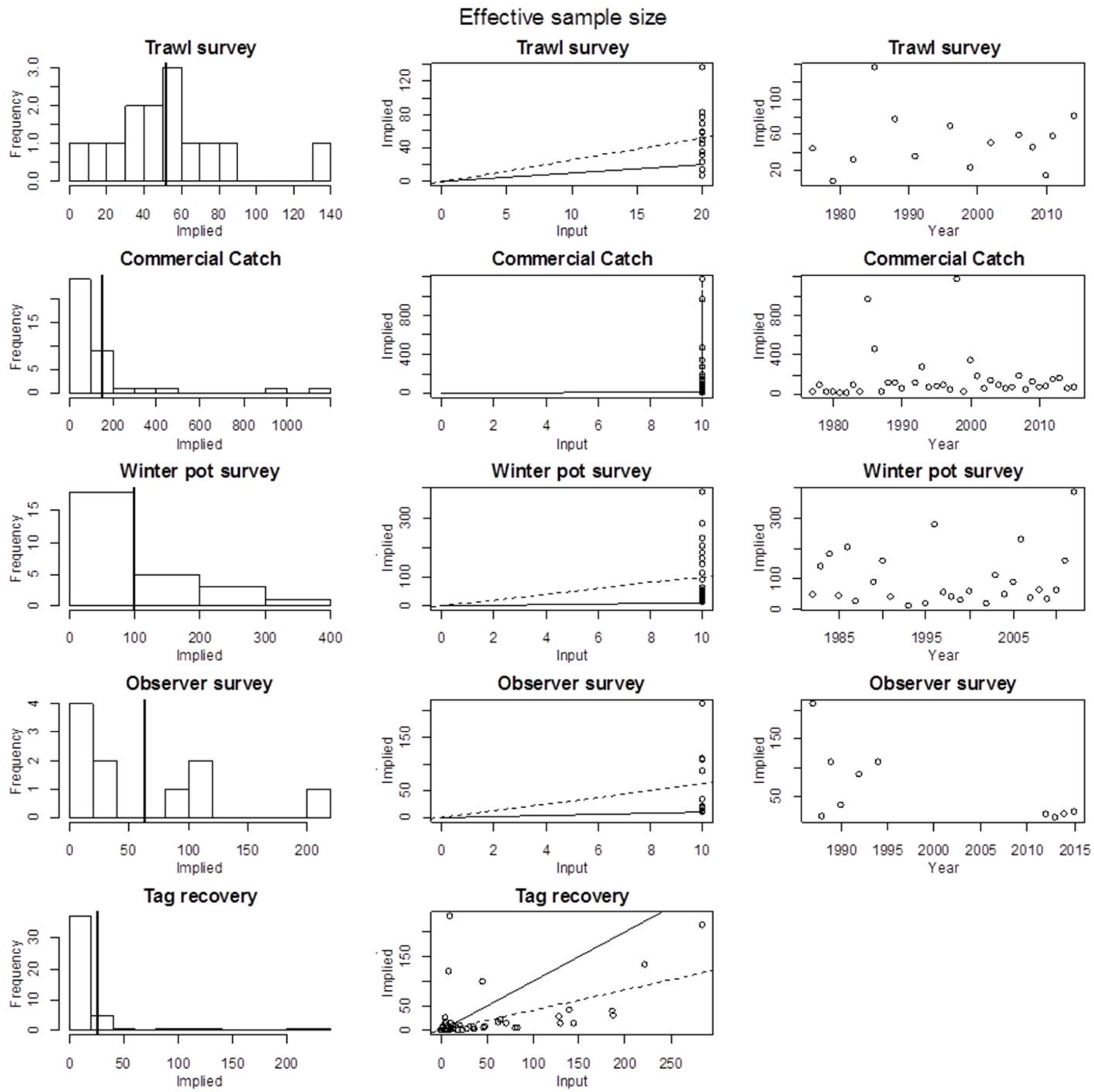
Tag recovery composition

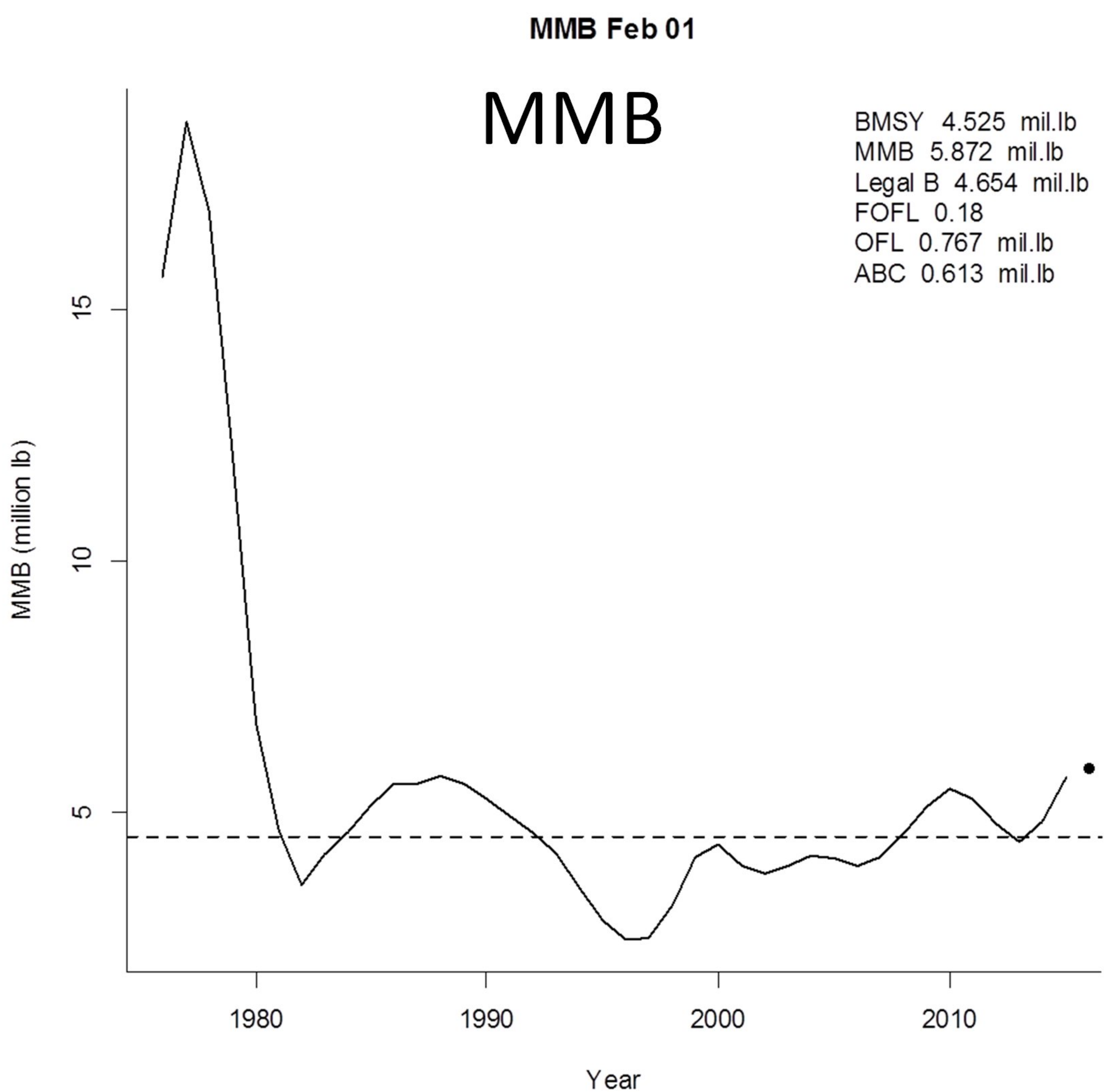


Fit to Length Composition

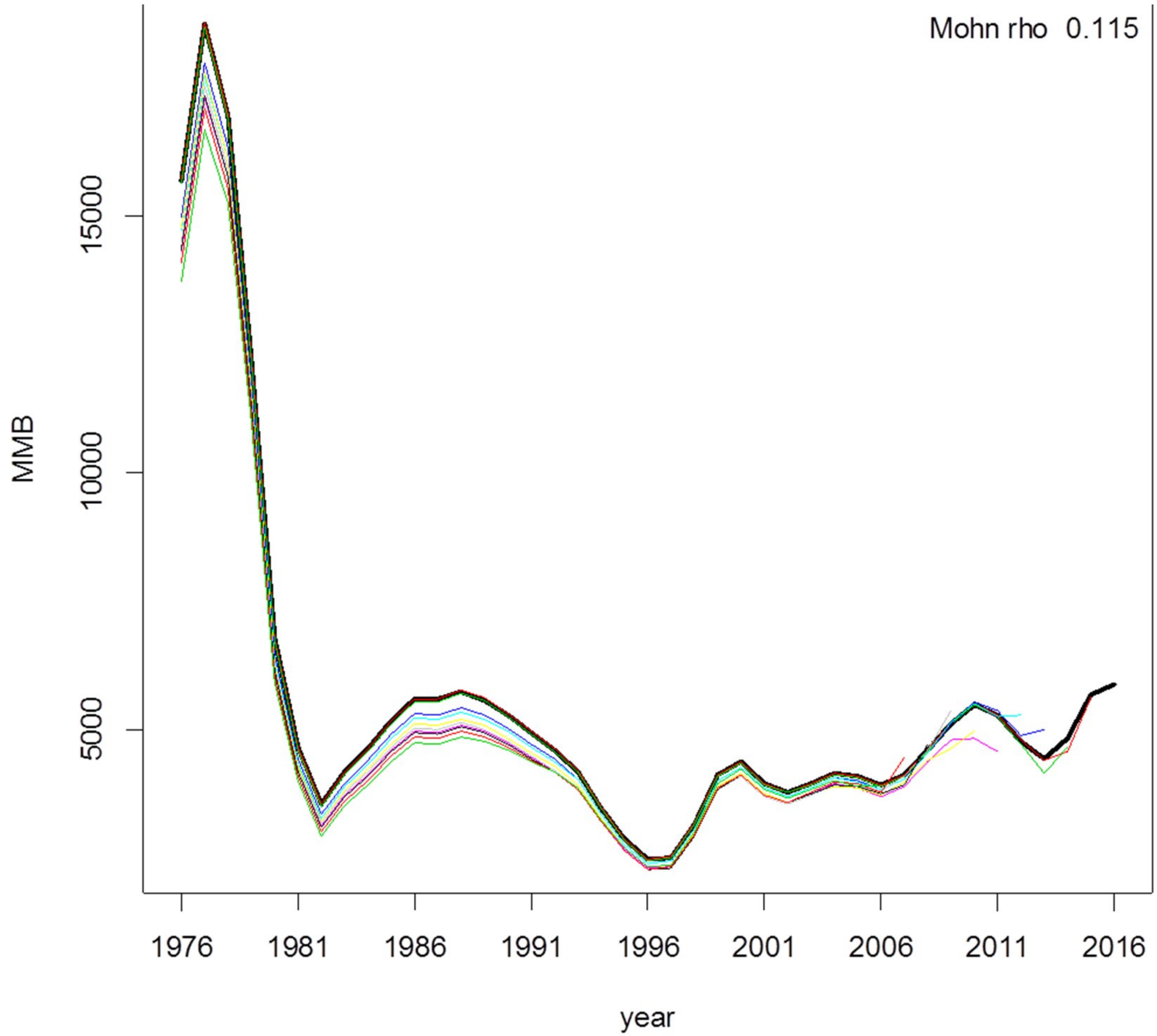


Effective Sample size

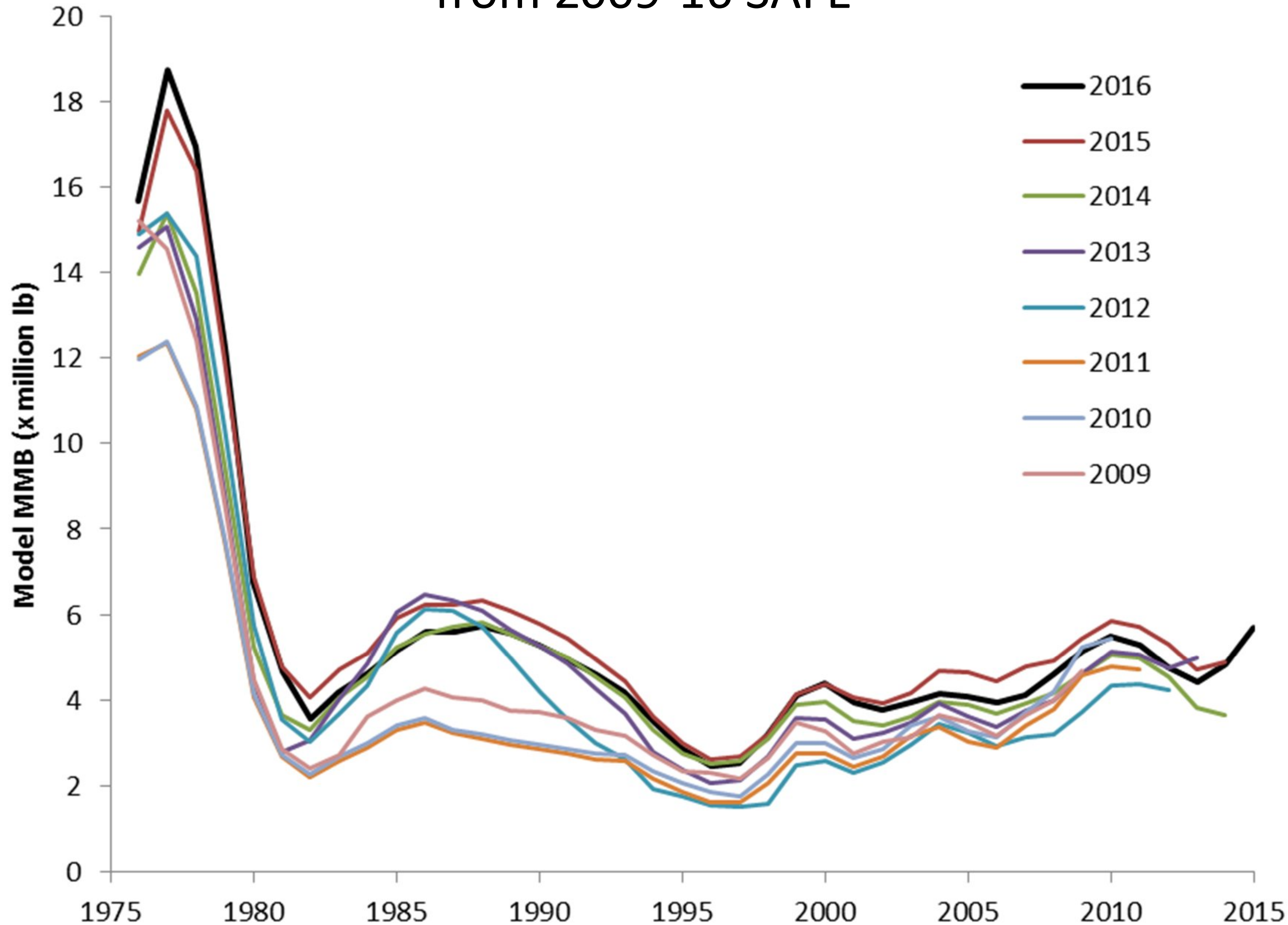



MMB Feb 01
MMB
BMSY 4.525 mil.lb
MMB 5.872 mil.lb
Legal B 4.654 mil.lb
FOFL 0.18
OFL 0.767 mil.lb
ABC 0.613 mil.lb
MMB (million lb)
5
10
15
1980
1990
2000
2010
Year

Retrospective Analyses



Andre's Retrospective Analyses of CPT adopted model MMB from 2009-16 SAFE



OFL & ABC

- $B_{MSY\ Proxy}$
  - Average MMB from 1980-2016 = 4.53 million lb
- MMB
  - MMB (2016) = 5.87 (SD 1.12) million lb

- MMB > $B_{MSY\ Proxy}$: Tier 4a

- $F_{OFL} = M = 0.18$

- OFL_r (Retained Legal: Summer 2016)
  = (1-exp(-F_{OFL}))Legal Biomass (July 01 2016)

- Legal Male Biomass (Feb 01, 2016) : 4.65 (SD 0.89)
- Legal Male Biomass (July 01, 2016) = 4.65*exp(-0.42M) = 4.31

- OFL_r = 4.31*(1-exp(-0.18))= 0.710 million lb
- ABC = 0.8OFL_r = 0.568 million lb = 0.26 Metric ton