Norton Sound Red King Crab SAFE2017

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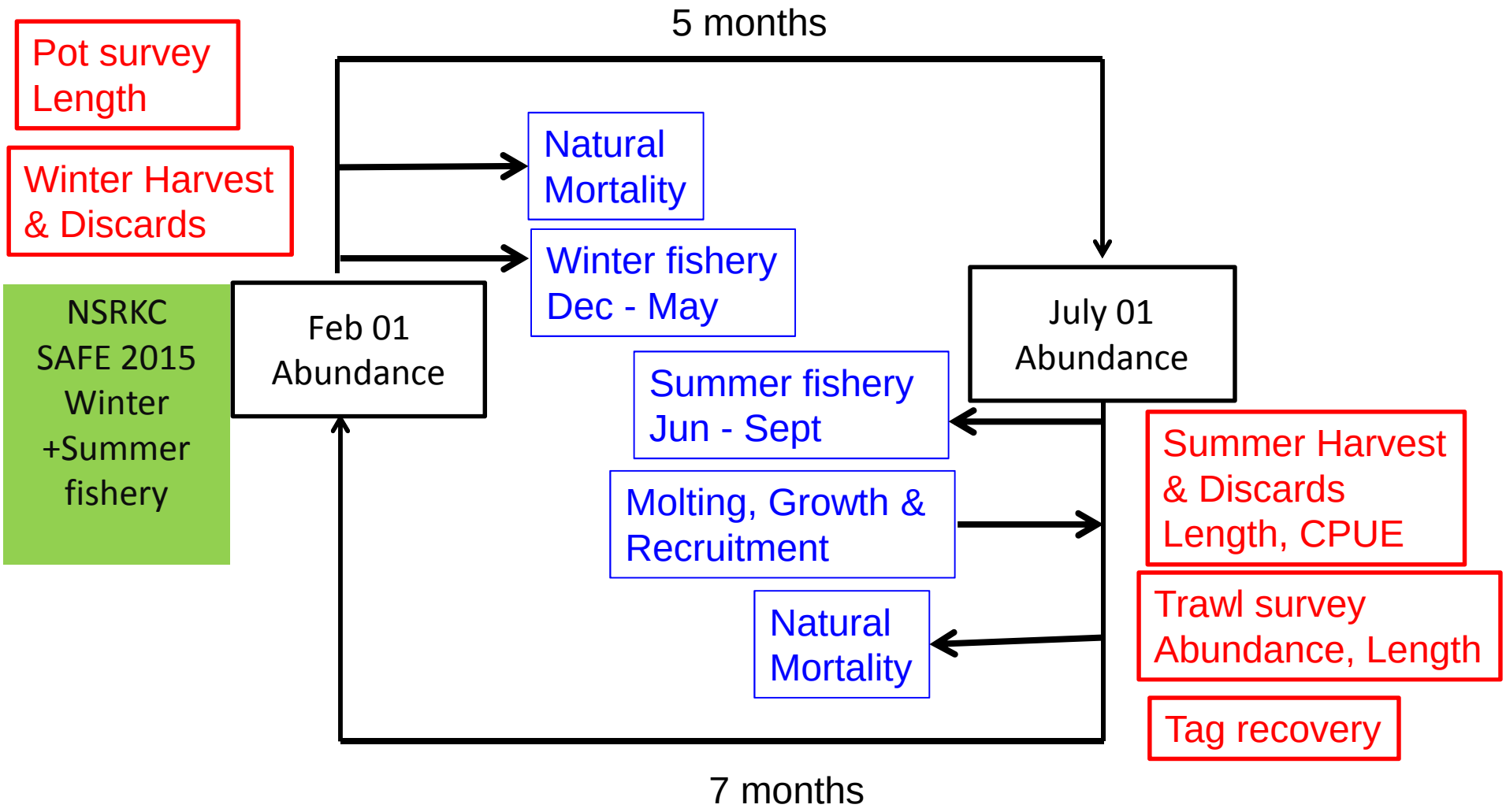
NSRKC Stock Assessment Model

Modeling process

Available Data & model fit



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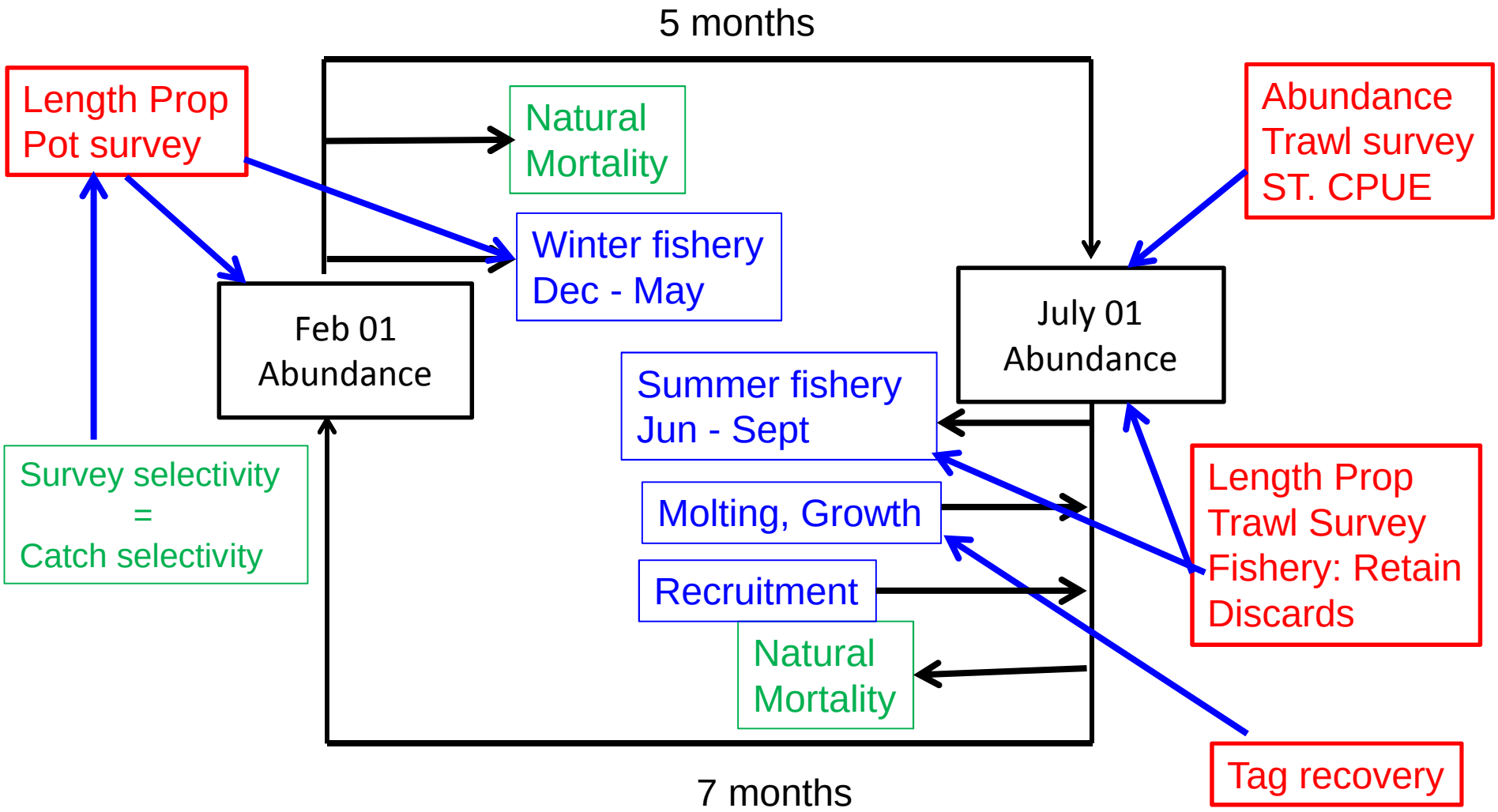


Available Data

	Abundance	Length comp	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Survey																																											
Trawl	Abundance	X																																									
Winter Pot		X																																								
Fishery																																											
Summer	CPUE, Catch	X																																									
Discards		X																																								
Winter	Catch																																										
Tagging		X																																									
Data Not Used																																											
Summer Pot	Abundance	X																																									
Prefishery		X																																									
Spring Tagging		X																																									
Fall Tagging		X																																									
Winter Commericial		X																																									

Assumptions

- M = 0.18 for length class 1-5, and 0.648 for class 6
- Same selectivity and catchability for New and Old Shells
- Discards mortality = 0.2
- Fishery harvests occur instantly:
  - Winter fishery: Feb 01: Nov – May
  - Summer fisher: July 01: Jun – Sept
- Winter catch selectivity = winter pot survey selectivity

Changes Fishery & Data

- Winter fishery 2016
  - Commercial: 29,792 (79,980 lb.) The highest ever.
  - Subsistence: 5,340 (13,350 lb.). About average.
- Summer commercial fishery 2015
  - 6/27-7/21: 138,997 (420,159 lb.)
- Total retained harvest: 168,789 (0.50 mill. lb.) < ABC (0.57 mill. lb.)
- All harvest data finalized.
- Standardized CPUE update (Appendix A2)
- Recalculation of com crab harvest during the trawl survey.
- ADMB code cleaning up underway
  - Discards estimate equation was bit wrong (changed < 10%).
- Changes in fishery regulation: None

Changes Fishery & Data

- ADMB code cleaning up underway
  - Discards estimate equation was bit wrong (changed < 10%).
  - Model description Appendix A

$$\text{Discards} = \text{Legal Catch}\ \frac{NS_f(\text{p.sub}-\text{legal})}{NS_f(\text{p.legal})}\ DM$$

ADMB code

$$\text{Discards} = \text{Legal Catch}\ \frac{NS_f(\text{p.sub}-\text{legal})}{N\ (\text{p.legal})}\ DM$$

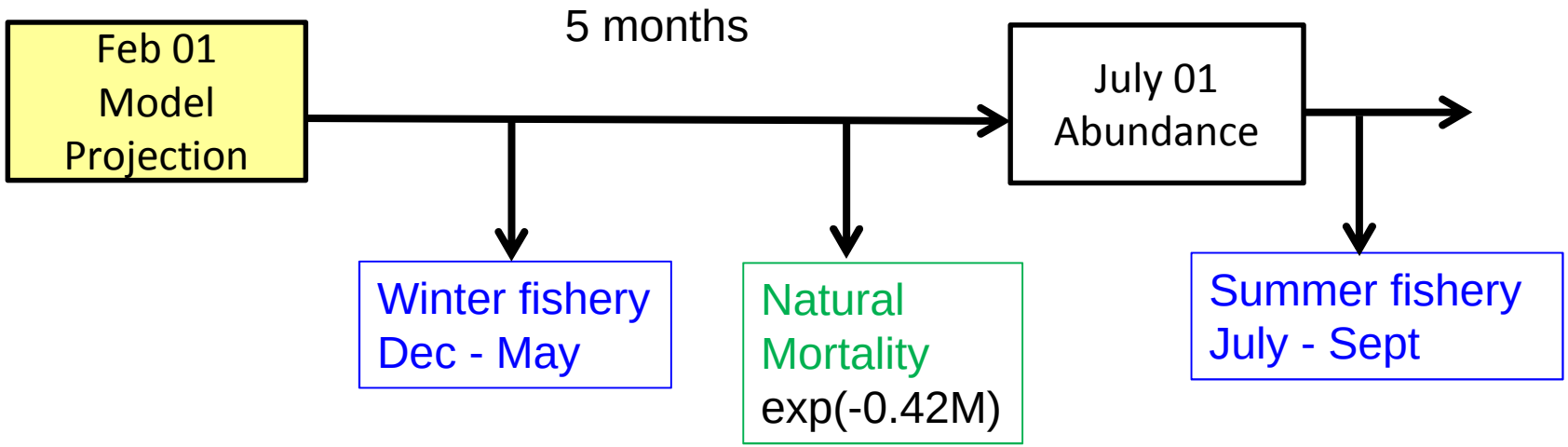
Not implemented in this progress report (just found out)
Will be implemented for Jan 2017SAFE

NSRKC Major Modeling Issues

- Under the size invariant M, the model overestimate abundance of large sized (> 123mm) crab.
  - Current Assumption: Higher M for large sized (> 123mm) crab
    - Pro: Model fits data better
    - Con: Biologically implausible
  - Alternative Assumptions
    - Large sized crab move out of fishing-survey area
      - Extended surveys did not find large crabs
      - Dome-shaped survey-commercial fishery selectivity was not supported by the model (see previous SAFE)
    - Crab does not grow large (non-linear growth)
      - Alternative model 1
    - Molting probability is not time invariant
      - Alternative model 2
    - M of only Largest (> 134mm) is high
      - Alternative model 3

NSRKC Stock Assessment Model

OFL Issue



OFL = Winter + Summer fishery

OFL = (1-exp(-F))B

How do we calculate B and OFL?

OFL past

- 2015 OFL formula: Use projected Feb 01 biomass

  $OFL = (1-\exp(-F))B_w$

- 2016 OFL formula: Use projected summer biomass with zero winter fishery

  $OFL = (1-\exp(-F))B_s \quad B_s = (B_w)\exp(-0.42M)$

- 2017 CPT-SSC proposed OFL formula: Assume X% of OFL from winter fishery (X: 8%, or average winter harvest %)

Responses to CPT and SSC

- 2017 CPT-SSC proposed OFL formula: Assume X% of OFL from winter fishery (X: 8%, or average winter harvest %).
  - then summer OFL is (1-X)% of OFL

$(1\text{-}X)OFL = (1\text{-}\exp(\text{-}F))B_s \qquad B_s = (B_w\text{-}X \cdot OFL)\exp(\text{-}0.42M)$

Solve this:

$$OFL = \frac{B_w(1-\exp(-F))\exp(-0.42M)}{1-X+X(1-\exp(-F))\exp(-0.42M)}$$

Applying to 2016 OFL, $B_w = 4.654$, $M = F = 0.18$

OFL = 0.711 (2016 SAFE)

OFL = 0.763 (X = 0.08, 8%)

OFL = 0.822 (X = 0.16, 16%: prop winter harvest in 2016)

Responses to SSC

- Does the timing indicate that crab may go “missing” in association with the molting period?
  - Satellite tag deployed in March 2016, Bob?
- The SSC noted relatively high proportions of 134+ mm CL crab in the summer com catches 1980-1982. Investigate source data.
  - Data are probably lost. Even Doug (retired) didn’t know that ADFG Kodiak was in charge for NSRKC back in 1970-80s…
- The SSC was very interested in the conflicting observations about molt timing in Apr/May versus Aug/Sept.
  - There was no direct observation for molt timing in Apr/May
  - All observation-data suggest molt timing in Aug/Sept

Responses to CPT and SSC

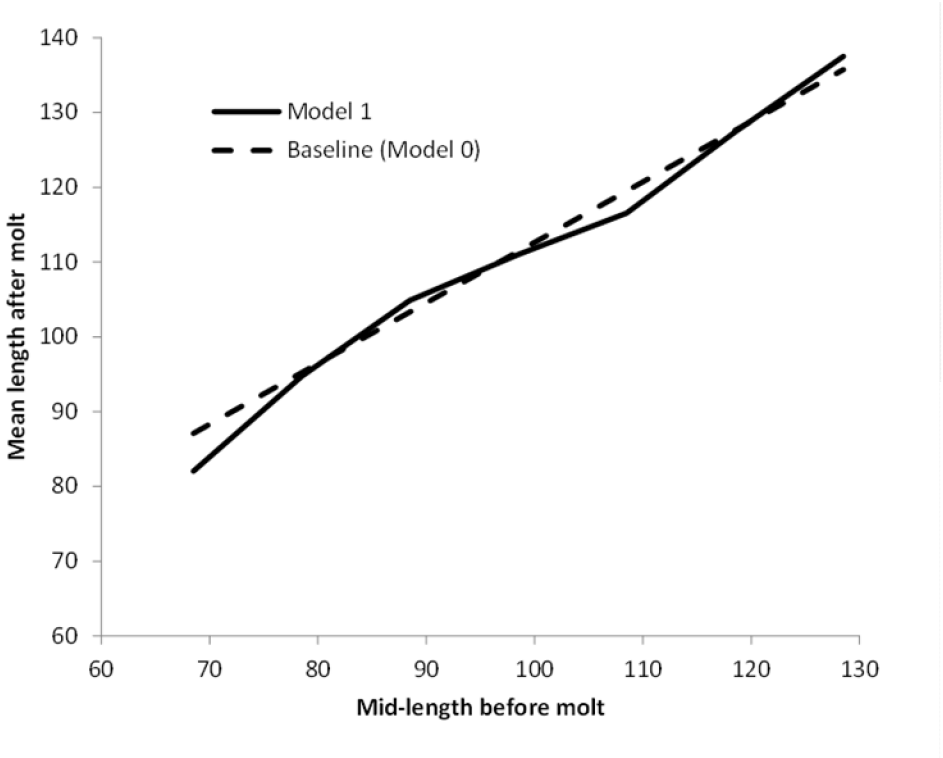
- Evaluate whether using a growth function (slow down growth).
  - Alt. Model 1
- Consider non-parametric molting probability curve with a random walk penalty.
  - Only random walk considered: Alt Model 2.
- Evaluate higher M only to 134+ mm.
  - Alt. Model 3
- Separate summer fisheries in 2 periods
  - Alt. Model 4

Modeling discussion for Jan 2017 SAFE

- Alternative Models:
- Model 0: Default 2016 SAFE model
- Model 1: Non linear growth, M = equal for all lengths
- Model 2: Random walk molting prob
- Model 3: High M only for 134+ mm length group
- Model 4: Separate fishery selectivity

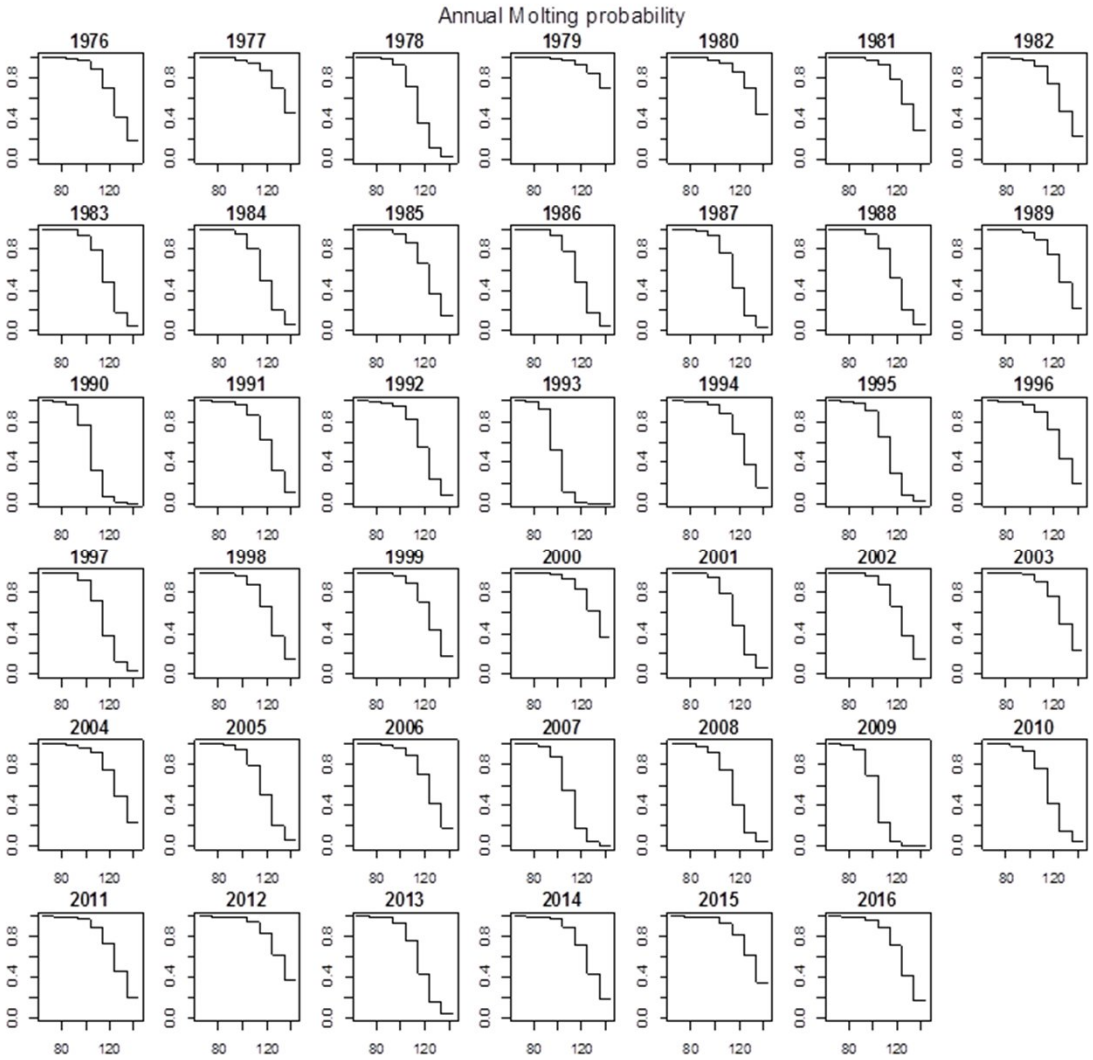
Modeling discussion for Jan 2017 SAFE

- Model 1: Non linear growth, M = equal for all lengths
  - Little evidence of “slow” growth



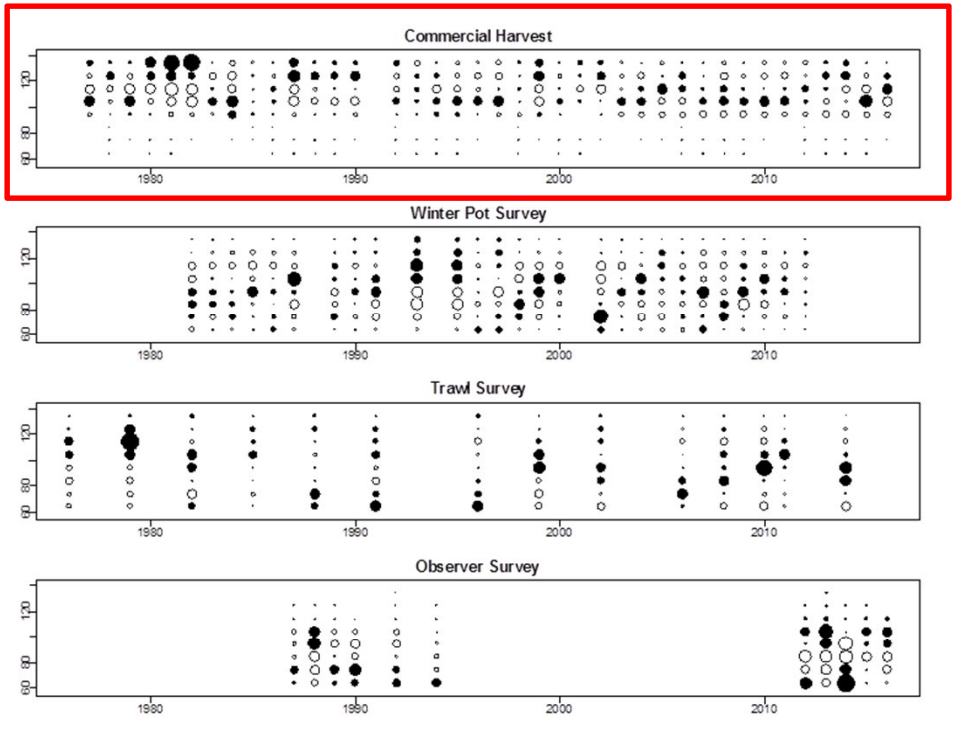
Modeling discussion for Jan 2017 SAFE

- Model 2: Random walk molting prob

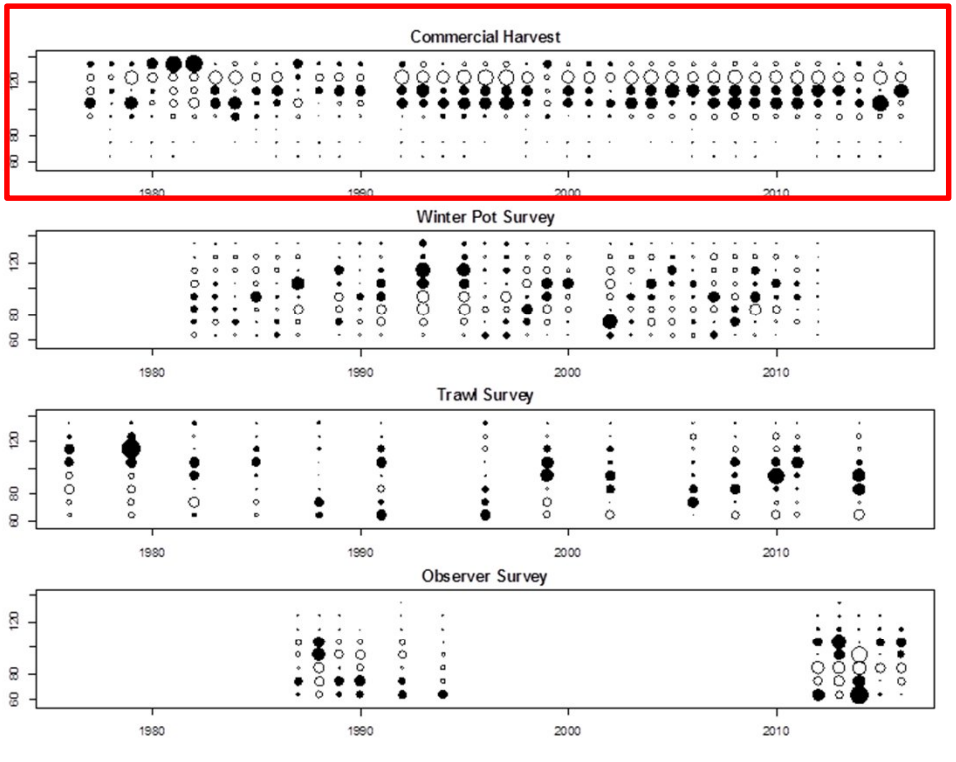


Modeling discussion for Jan 2017 SAFE

- Model 3: High M only for 134+ mm length group
- Model fit was worse.



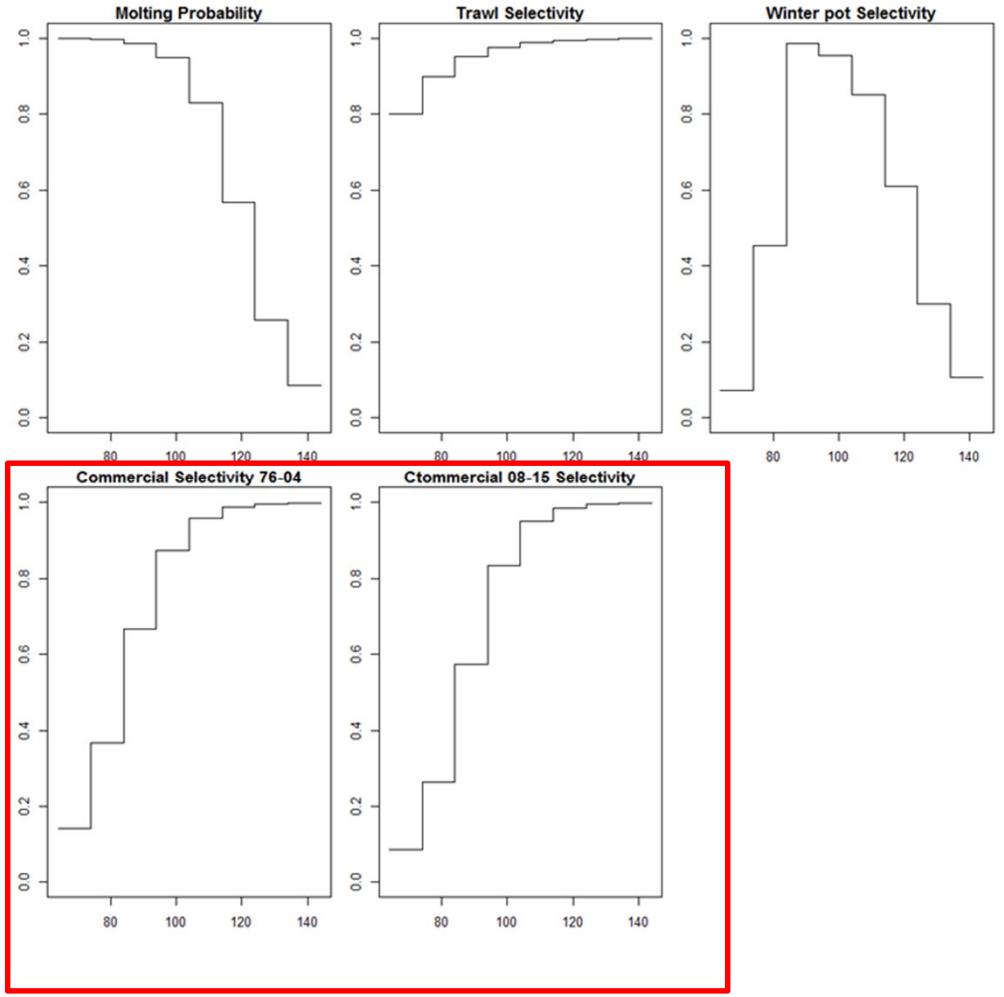
Model 0



Model 3

Modeling discussion for Jan 2017 SAFE

- Model 4: Separate fishery selectivity
- No statistical difference between the two selectivity



Modeling discussion for Jan 2017 SAFE

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Negative log-likelihood

Model	Number of Parameters	Total	TSA	St. CPUE	TLP	WLP	CLP	OBS	REC	TAG	Dev. molt
0	65	315.0	9.0	-22.1	104.5	42.5	59.5	36.0	11.6	74.7	
1	69	349.9	15.1	-21.8	112.4	45.3	91.4	34.3	14.5	61.8	
2	104	265.2	9.3	-21.8	71.4	40.9	48.6	27.6	12.3	71.7	5.2
3	65	352.3	9.5	-22.3	117.1	45.3	79.6	36.3	12.5	74.3	
4	66	328.4	9.0	-22.3	104.6	42.5	59.5	35.5	11.7	88.1	

Modeling discussion for Jan 2017 SAFE

- Model 0: Default 2016 SAFE model
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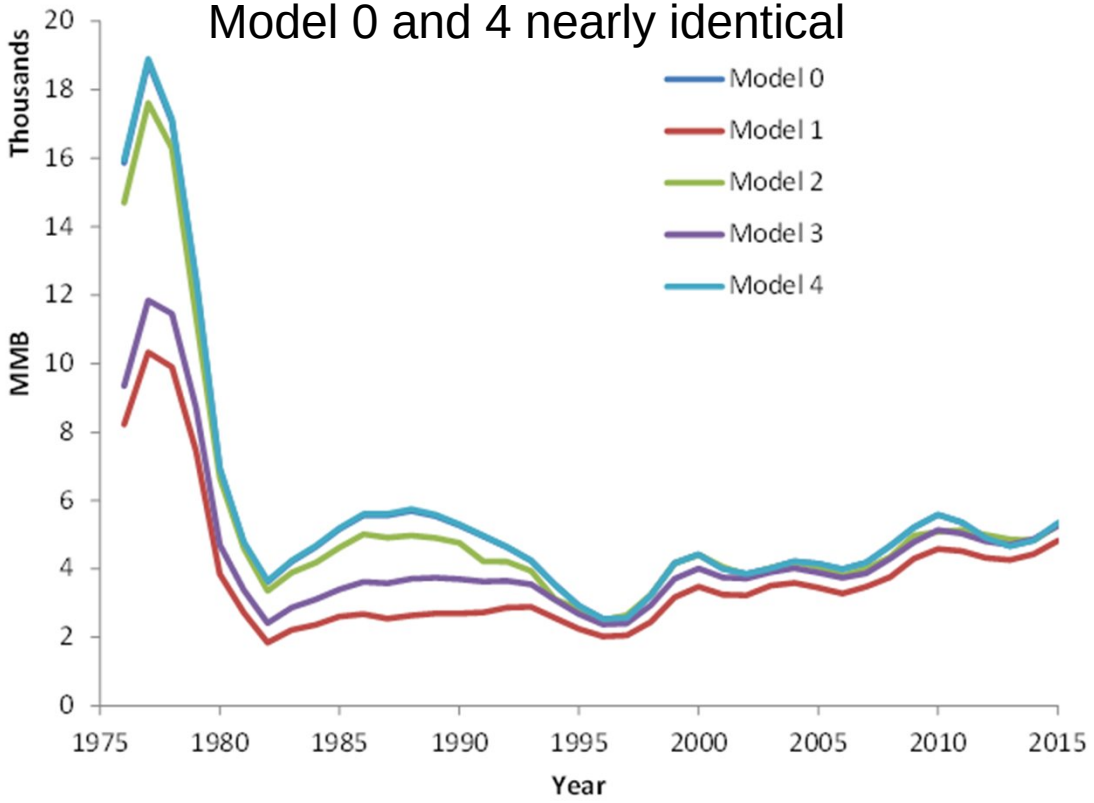
MMB time series:
Model 0 and 4 nearly identical



Modeling discussion for Jan 2017 SAFE

- Model 0 seems to be sufficient for 2017 Assessment.
- CPT-SSC finalize OFL formula.

Modeling discussion for Jan 2017 SAFE

- Model 4: Separate fishery selectivity: Tagging data issue
  - All tagged crabs are recaptured by fisheries.
  - Observed length frequencies of recaptured crab are function of
    - Molting probability
    - Growth transition increments
    - Fishery size selective recapture probability
  - Tag recovery data must be separated by each fishery selectivity periods.
  - The more fishery selectivity separation, the less recovery data for each fishery period.