Norton Sound Red King Crab SAFE2017

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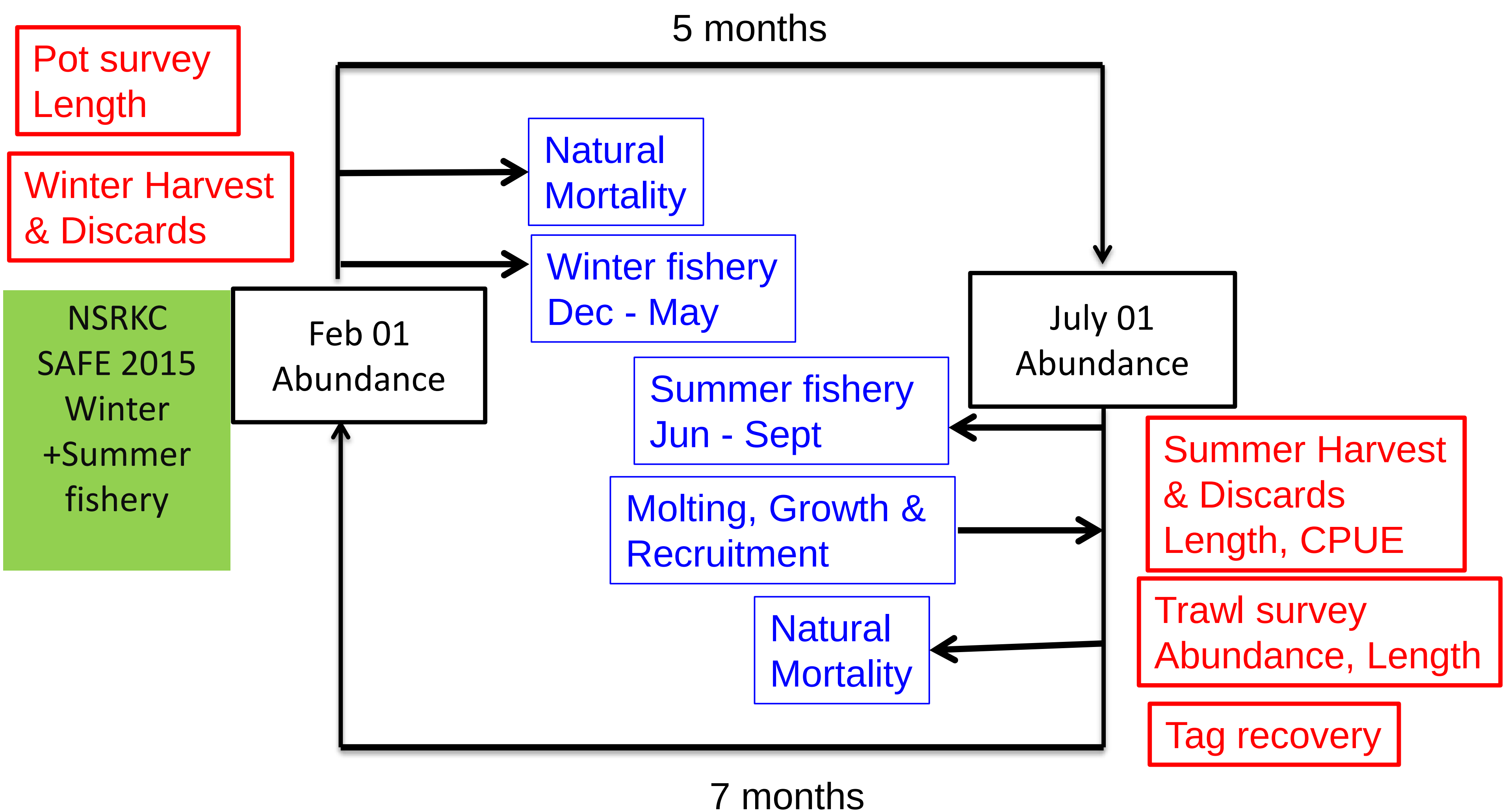
NSRKC Stock Assessment Model

Modeling process

Available Data & model fit



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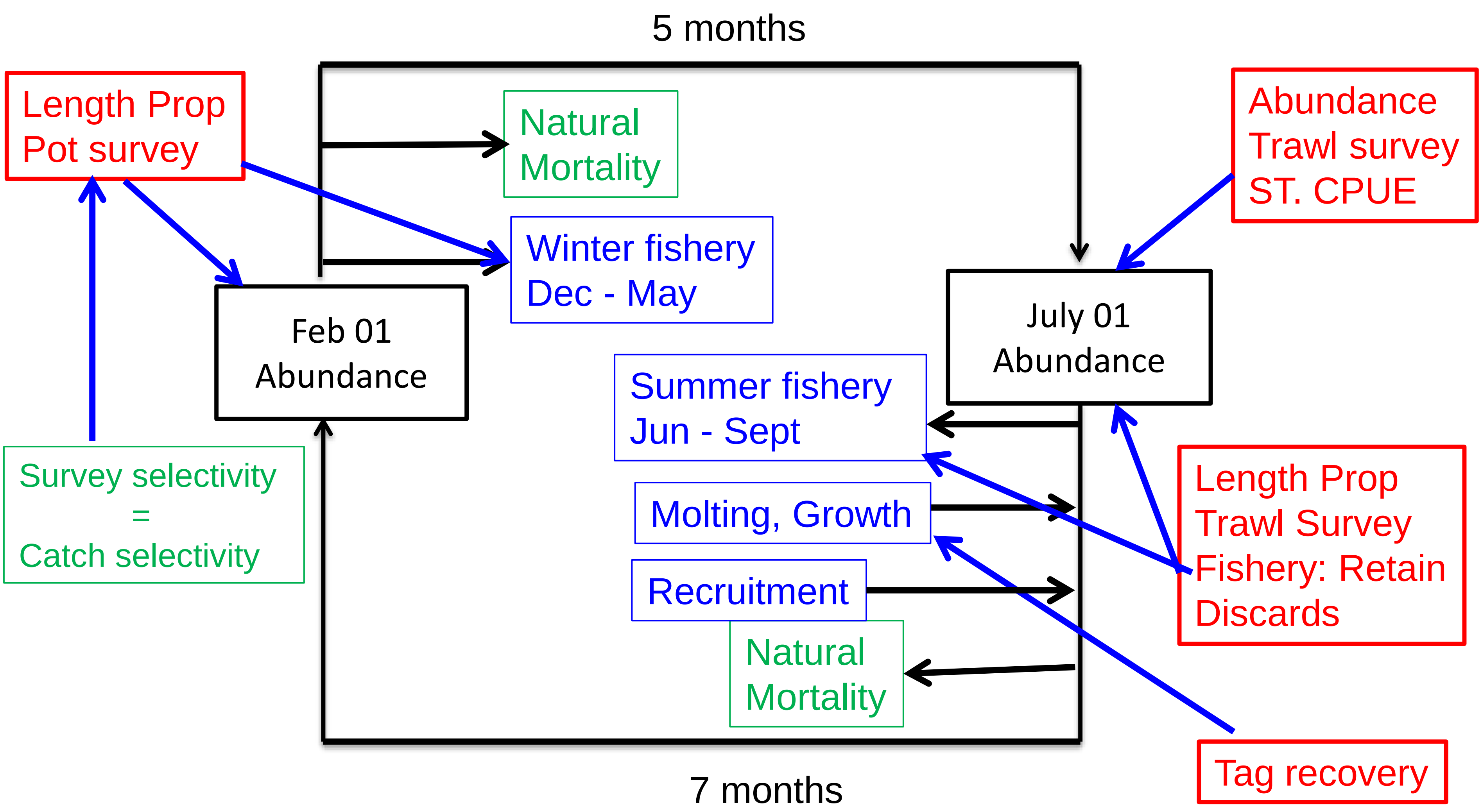
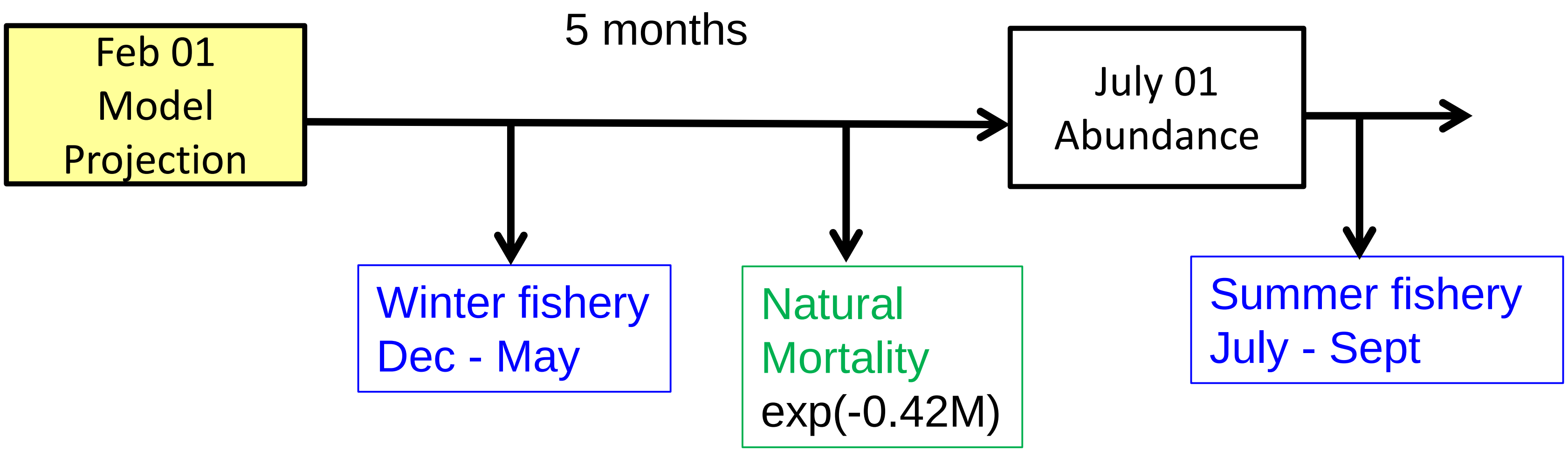


NSRKC Major Modeling Issues

- **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

  $OFL = (1\text{-}\exp(\text{-}F))B_w$

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

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

- 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

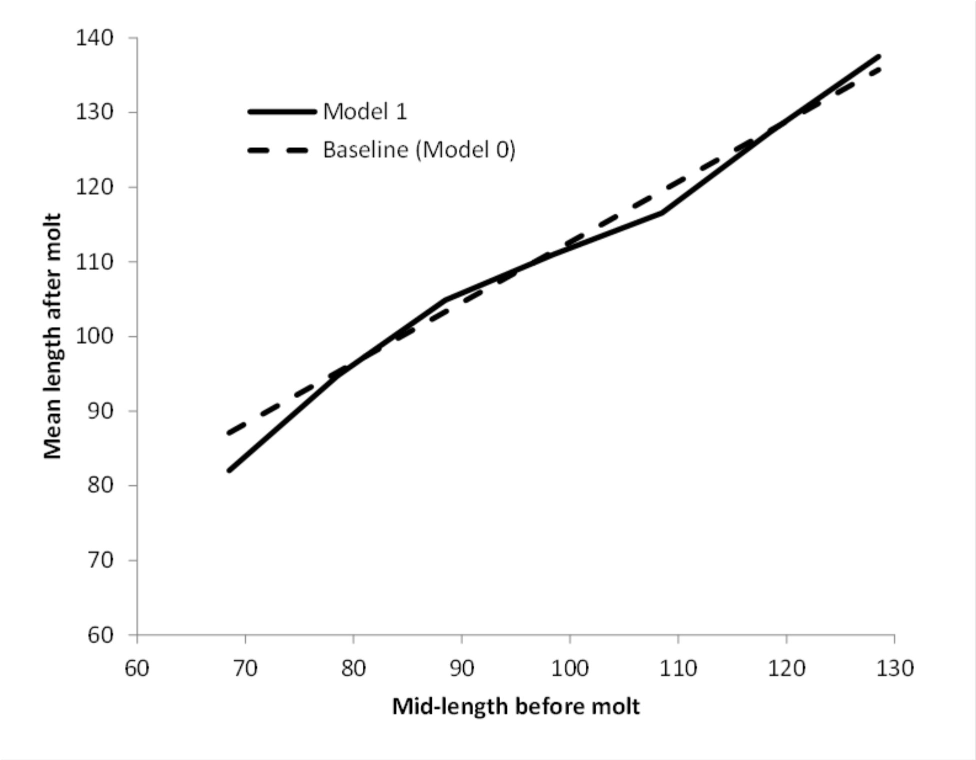
- Evaluate whether using a growth function (slow down growth).
  - Alt. Model 1
- Consider non-parametric molting probability curve with a random walk penalty.
  - Only random walk considered: Alt Model 2.
- Evaluate higher M only to 134+ mm.
  - Alt. Model 3
- Separate summer fisheries in 2 periods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

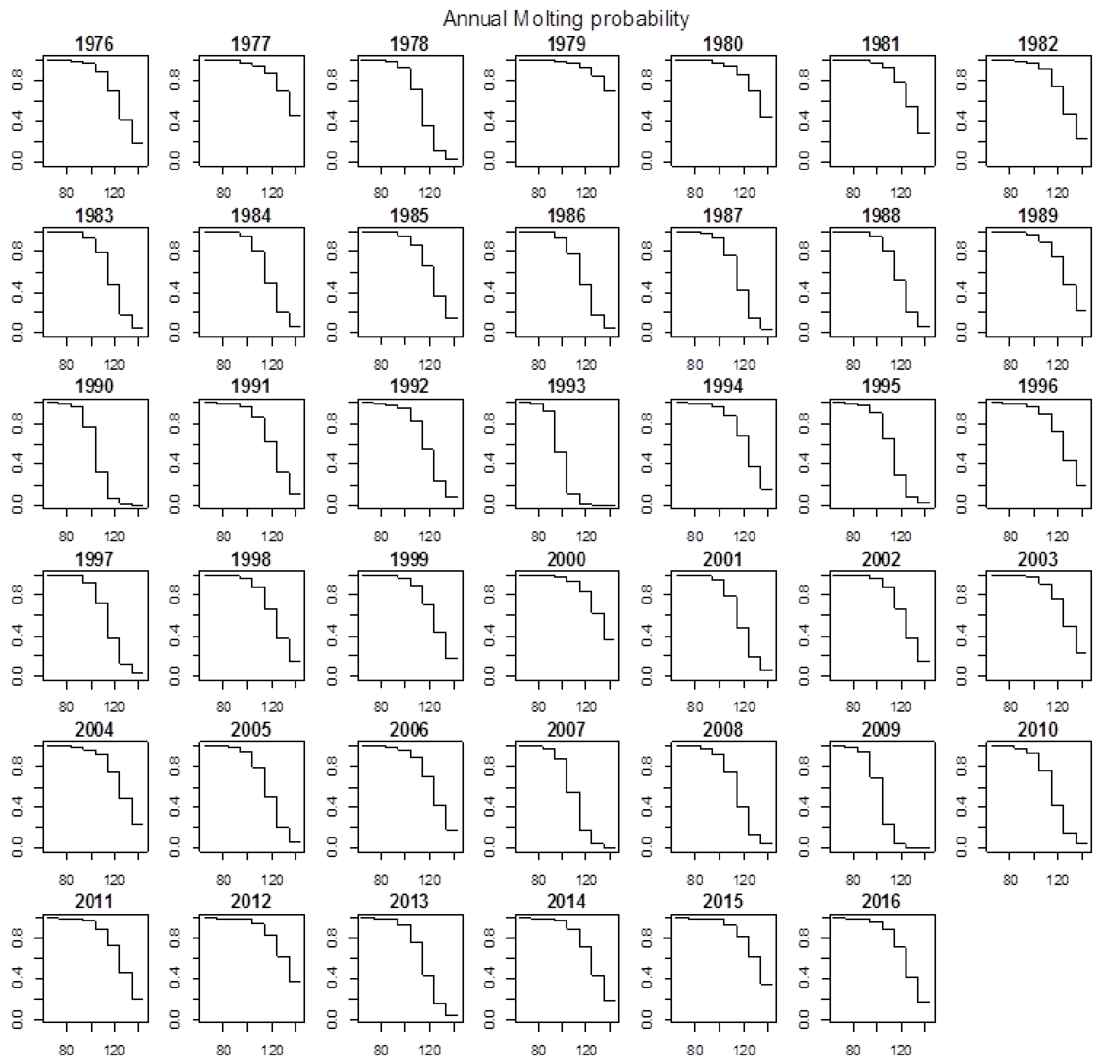
Modeling discussion for Jan 2017 SAFE

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



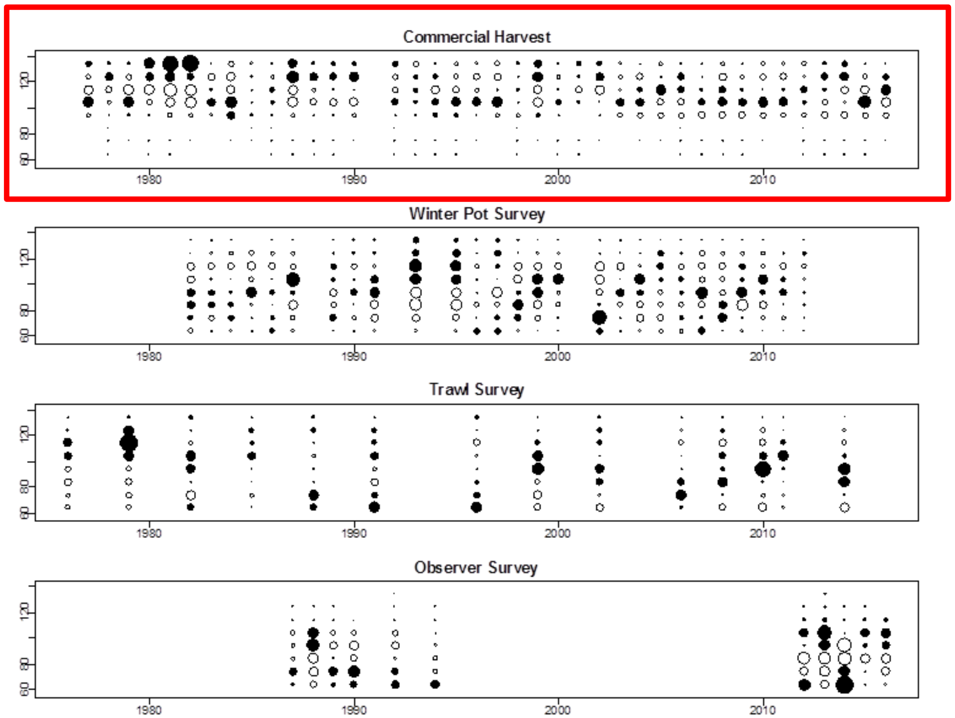
Modeling discussion for Jan 2017 SAFE

- Model 2: Random walk molting prob

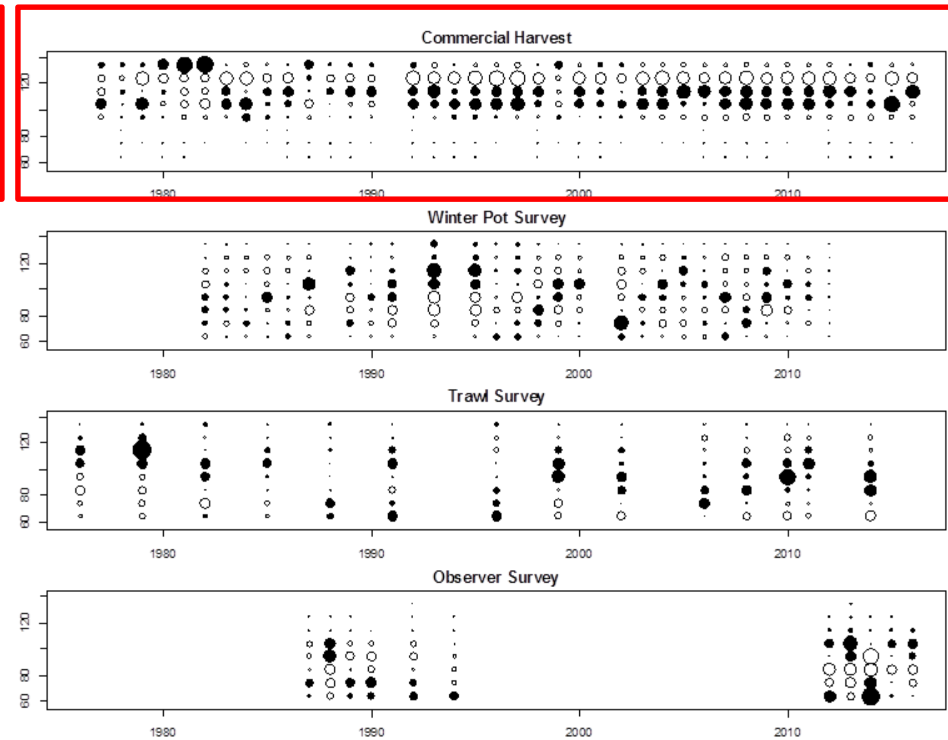


Modeling discussion for Jan 2017 SAFE

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



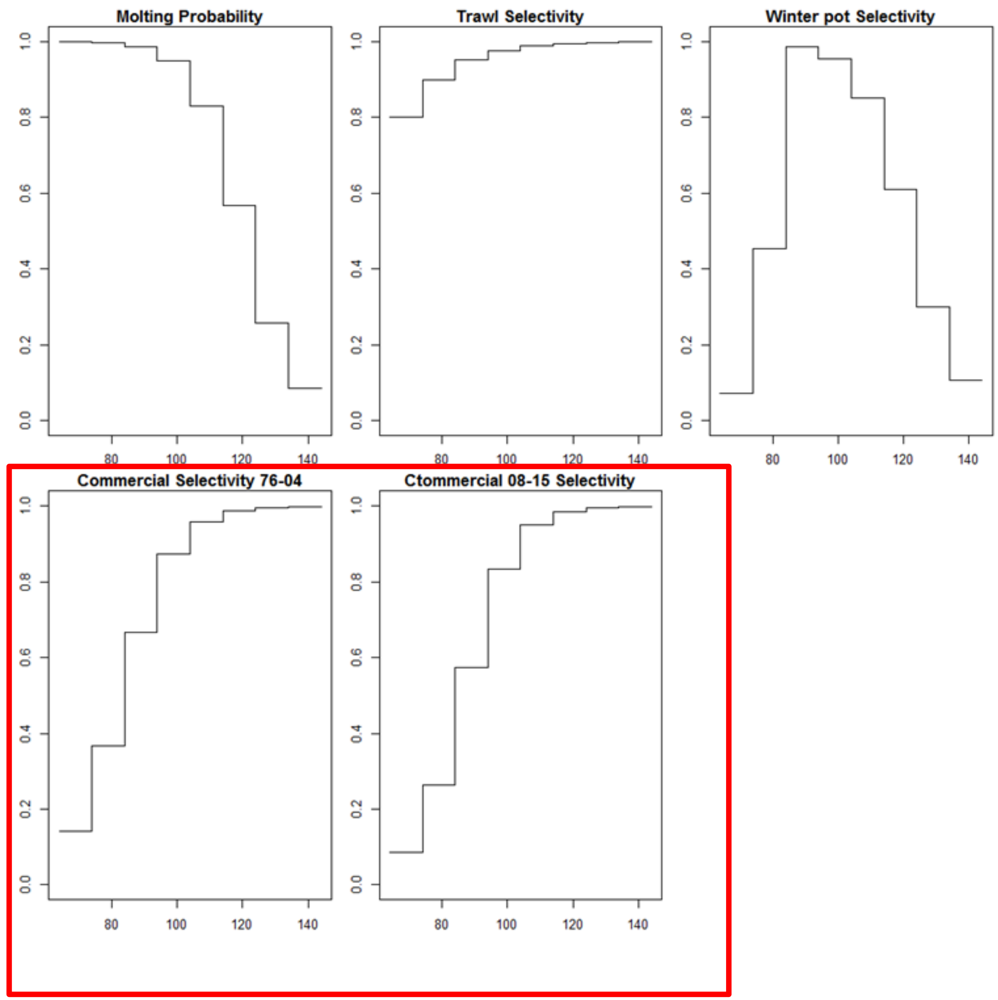
Model 0



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

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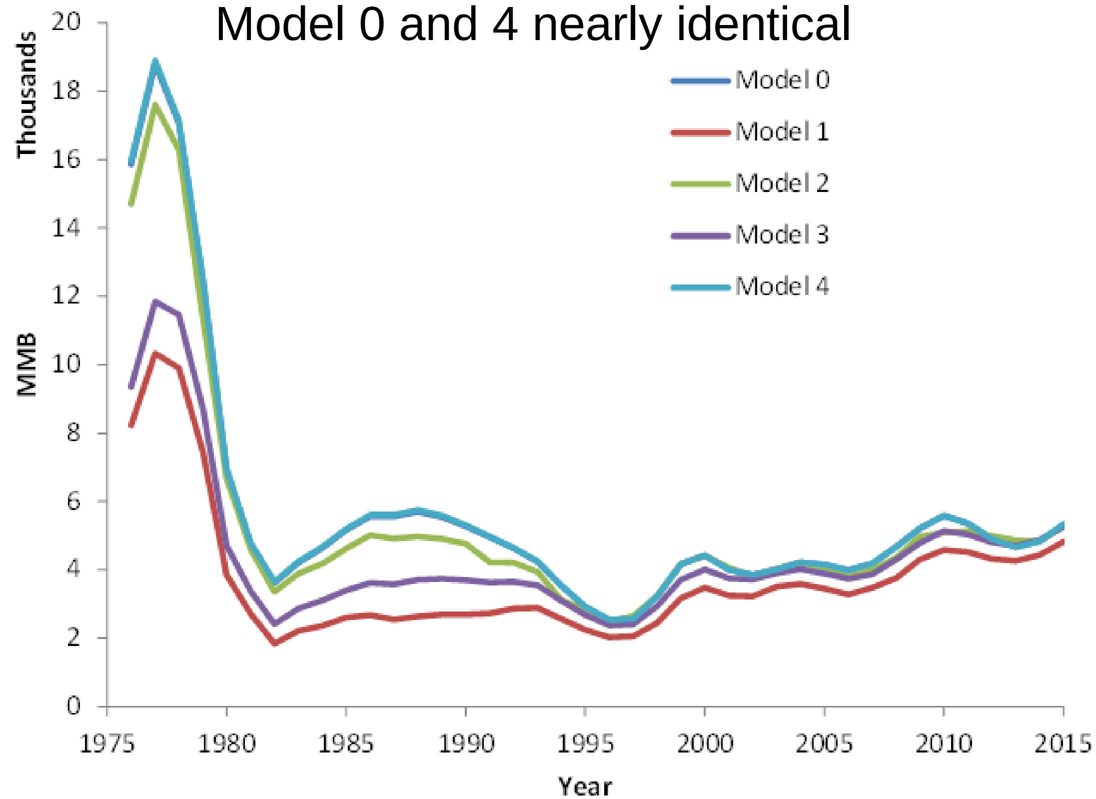
MMB time series:
Model 0 and 4 nearly identical



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.