Saint Matthew Blue King Crab rebuilding progress, plans and associated assessment planning

C-1

February Council meeting

Notification and implications

- Council notified October 22, 2018 that the Saint Matthew blue king crab stock was overfished.
- MSA requires that a rebuilding plan be prepared and implemented within 2 years
  - Must specify a time frame to rebuild
  - Time frame not to exceed ten years (unless this cannot be accomplished in the absence of all fishing mortality)

First steps for rebuilding plan= T_{min} and T_{max}

- Need to specify T_{min}
  - T_{min} = the amount of time the stock or stock complex is expected to take to rebuild to its MSY biomass level in the absence of any fishing mortality (with at least 50% probability)
- Need to specify T_{max} (maximum time for rebuilding)
- If T_{min} for the stock or stock complex is 10 years or less, then T_{max} is 10 years.
- If T_{min} for the stock or stock complex exceeds 10 years, then one of the following methods can be used to determine T_{max}:
  1. T_{min} plus the length of time associated with one generation time for that stock or stock complex. "Generation time" is the average length of time between when an individual is born and the birth of its offspring,
  2. The amount of time the stock or stock complex is expected to take to rebuild to B_{msy} if fished at 75 percent of MFMT, or
  3. T_{min} multiplied by two.
  - *2 or 3 may be appropriate if given data availability and the life history characteristics of the stock, there is high uncertainty in the estimate of generation time, or if generation time does not accurately reflect the productivity of the stock.*
- In situations where T_{min} exceeds 10 years, T_{max} establishes a maximum time for rebuilding that is linked to the biology of the stock.

What are other (secondary) considerations for the rebuilding plan?

- Potential revisions to the State harvest strategy?
- Are there reasons to consider additional groundfish fishery measures to increase likelihood of rebuilding (habitat or other area closures?
- Recommendations on ‘rebuilt’, 1 vs 2 years > B_{MSY}

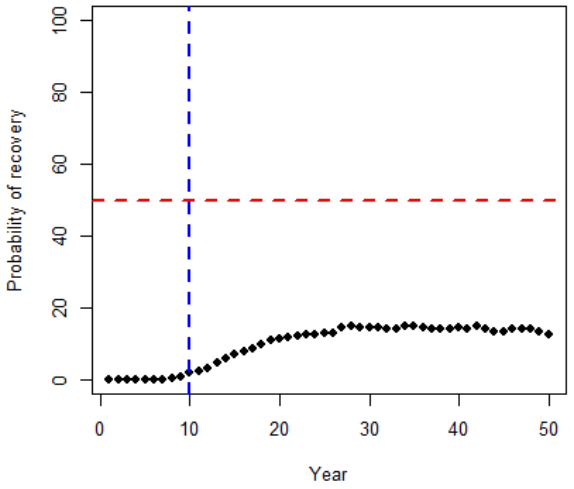
January 2019 CPT discussion and recommendations

- GMACs code corrected for SMBKC assessment and updated code to be used for 2019 assessment; also coded to allow for projections
- Need SSC input/considerations on what is the most realistic estimate for recruitment for purposes of the rebuilding plan projections
- Implications for B_{MSY} time frame

Progress/projections to Date

- Initial projections:
  - Recruitment
    - Use random draws from historical model estimates?
      - Full time series
      - Previous “rebuilding” time frame, 1999-2008
      - Most recent “stanza”, 1995-2016
    - Stock-recruit relationship
  - Bycatch mortality
    - No significant role in rebuilding probability (see next slide)
- Mean generation time

All projections performed in GMACS by Dr. André Punt



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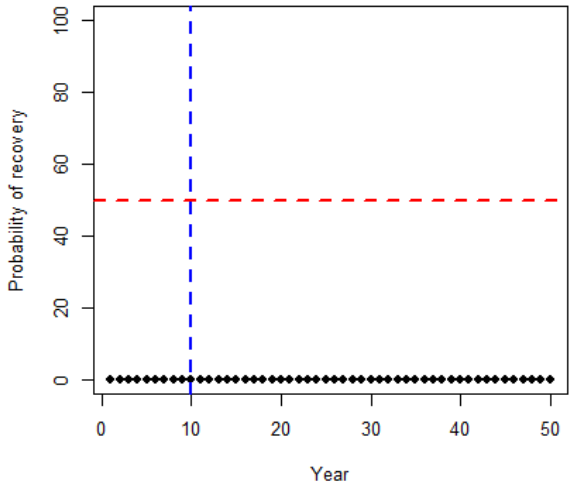

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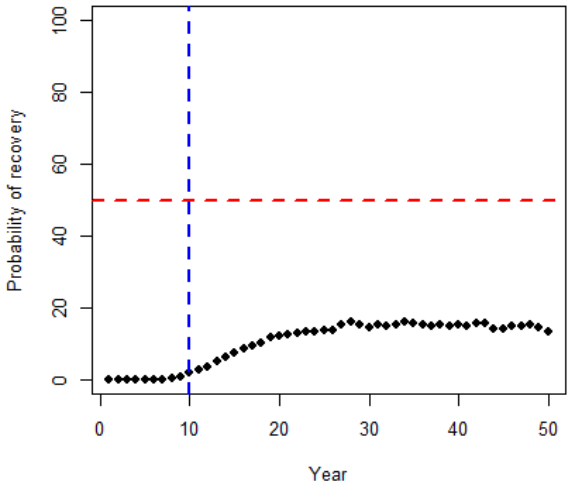
Recruitment 1999-2008; with future bycatch mortality; 2 year recovery



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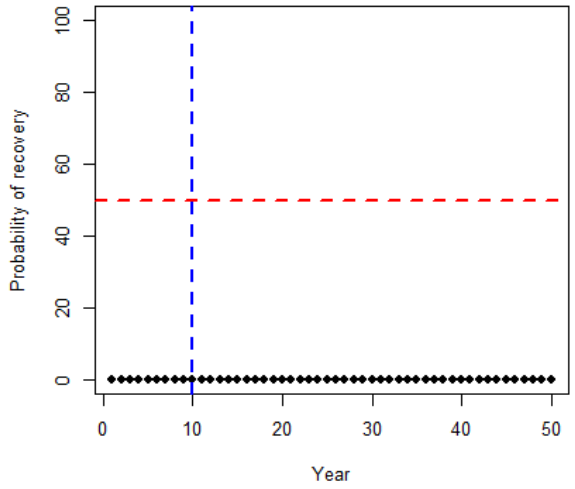

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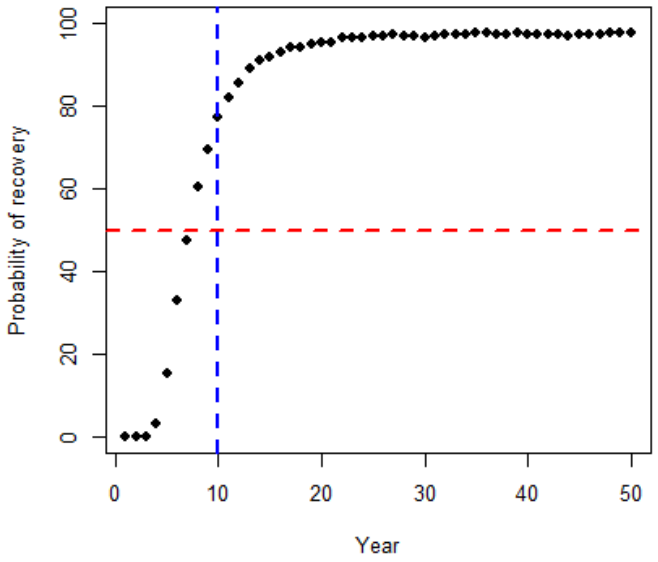

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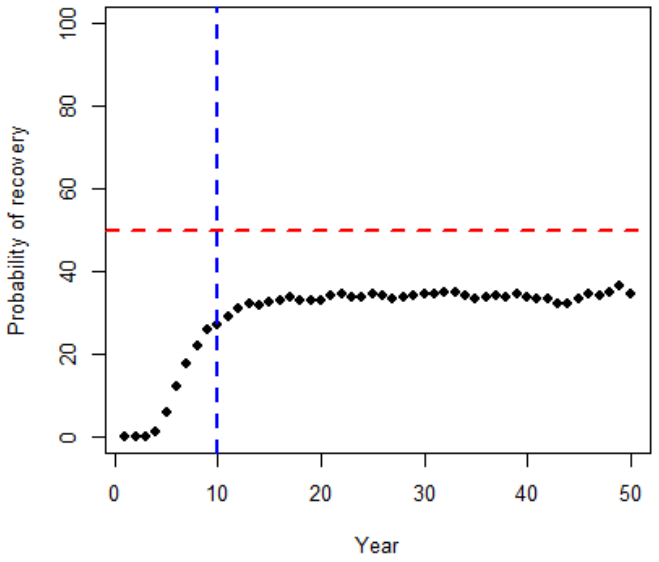


F=0.18

Recruitment 1978-2017; with future bycatch mortality; 2 year recovery

Conclusion – recruitment matters (a lot)

Stock-recruitment relationship

If this is of interest (sigh), it could be parameterized so that F_{MSY} equals the F_{MSY} proxy and B_{MSY} equals the B_{MSY} proxy, i.e. first solving for "steepness" such as that:

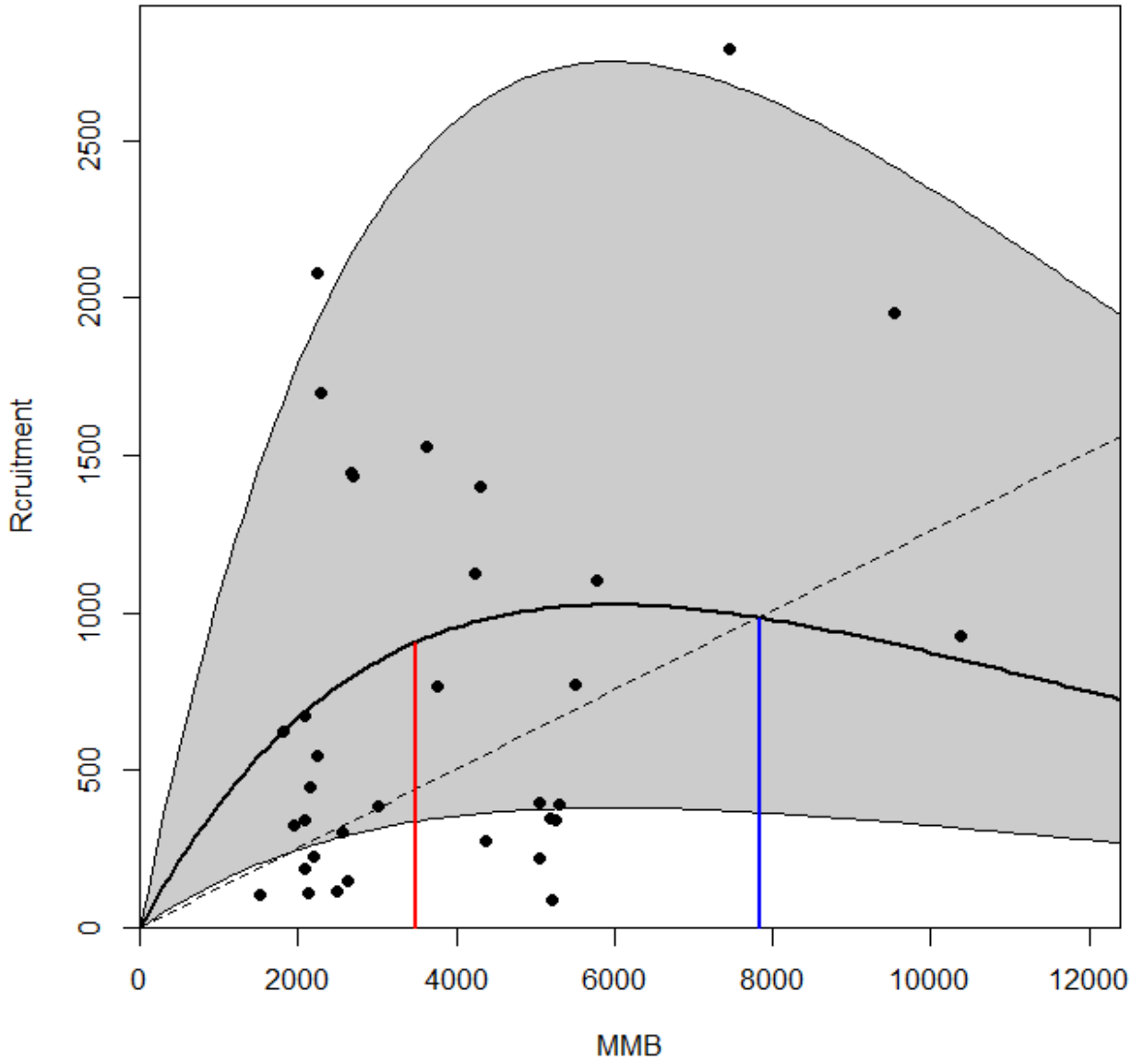
$$\left.\frac{dY(F)}{dF}\right|_{F=F_{MSY\text{-prox}}} = \left.\frac{d\tilde{Y}(F)R(F)}{dF}\right|_{F=F_{MSY\text{-prox}}} = 0$$

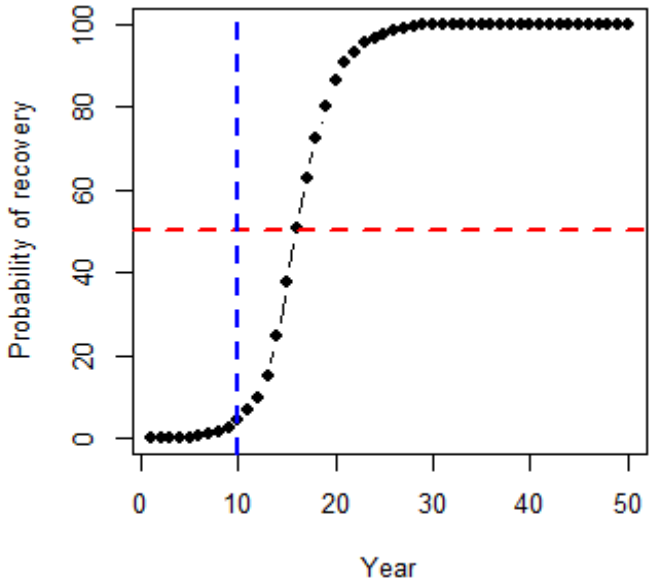
Then finding equilibrium recruitment such that:

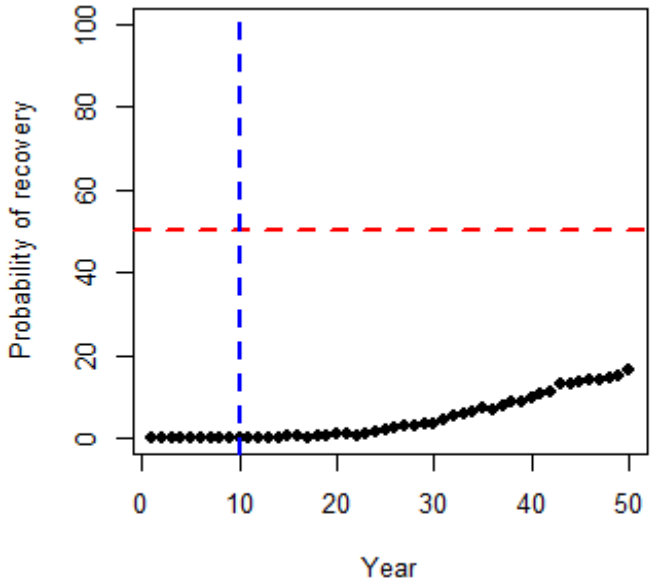
$$MMB(F_{MSY\text{-prox}}) = \tilde{M}MB(F_{MSY\text{-prox}})R(F_{MSY\text{-prox}})$$

The per-recruit calculations already exist so it would be adding the numerical solution

Stock-recruit relationship

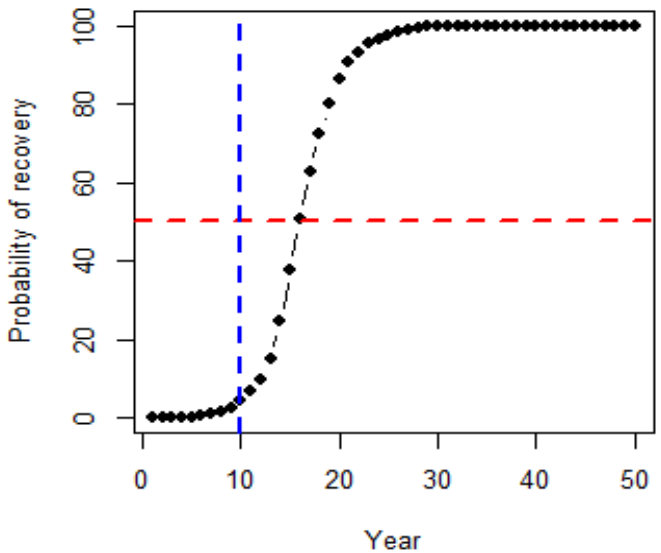


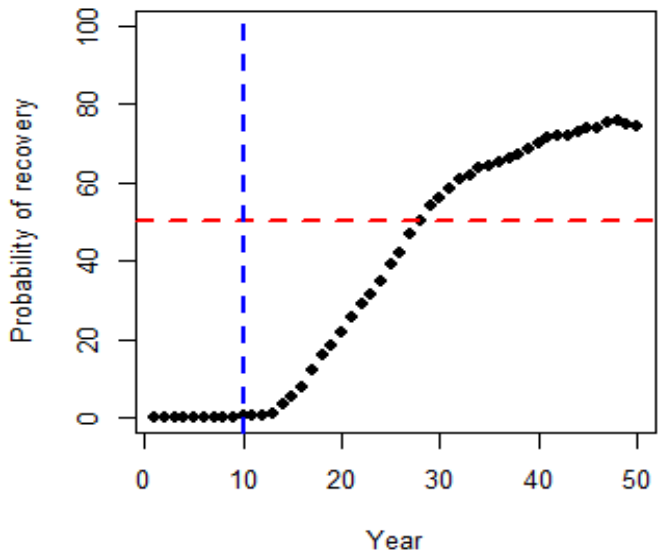




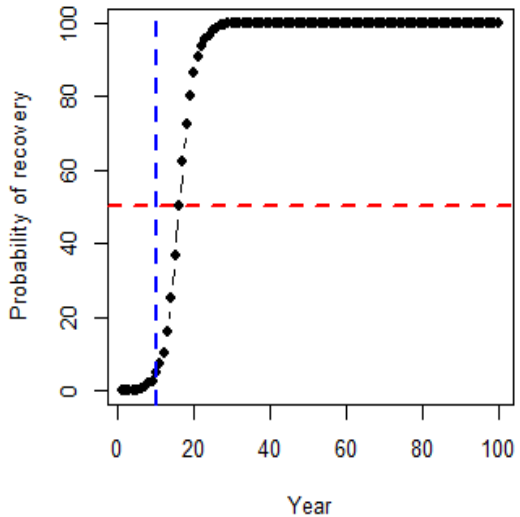
- No State HCR (Left F=0, Right F=0.18)

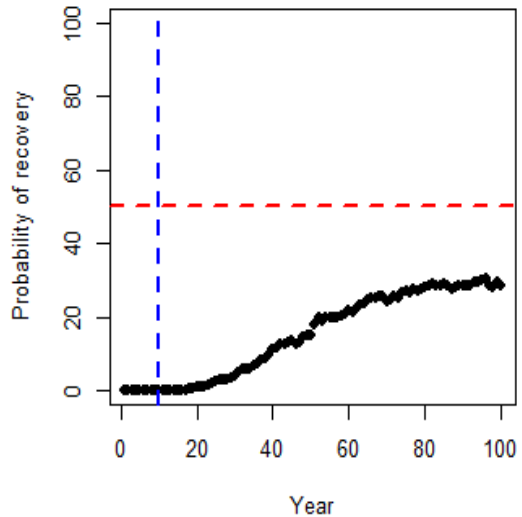
- Stock-recruit relationship (FMSY and steepness based on 100 yr projections)



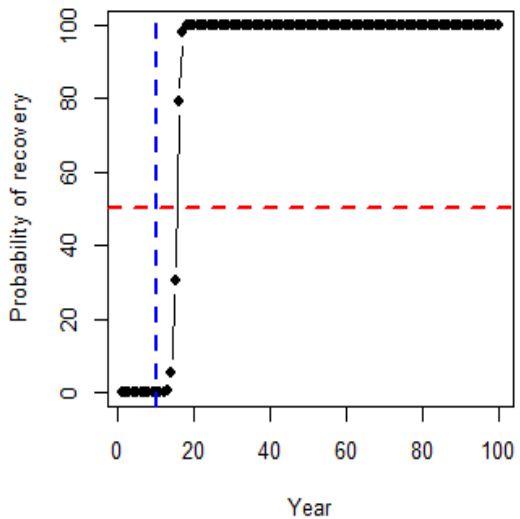


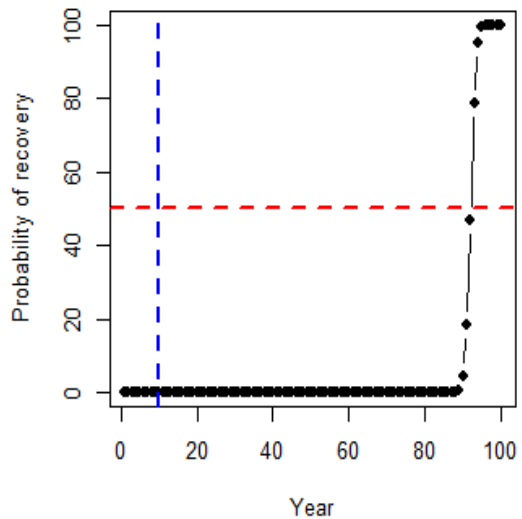
- State HCR on right hand side (not F=0.18)





- 100-yr stochastic recruitment





- 100-yr deterministic recruitment

Generation Time-I

Generation time is defined as a the average AGE of spawners in an unfished state, i.e.:”

$$G = \sum_{a=0}^{\infty} aN_a f_a \,/\, \sum_{a=0}^{\infty} N_a f_a$$

Numbers-at-age

Fecundity-at-age

$$N_a = \begin{cases} 1 & \text{if } a = \text{recruitment age} \\ N_a e^{-M} & \text{if } a > \text{recruitment age} \end{cases}$$

Generation Time-II

For crab we have some complexities (!), (a) growth is length-structured, (b) recruitment is not at age-0, and (c) spawning occurs on 15 February each year so generation time is:

$$G = age_{rec} + \sum_{a=0}^{\infty} a \sum_{l} N_{a,l} f_{a,l} S_l^{0.694} \Big/ \sum_{a=0}^{\infty} \sum_{l} N_{a,l} f_{a,l} S_l^{0.694}$$

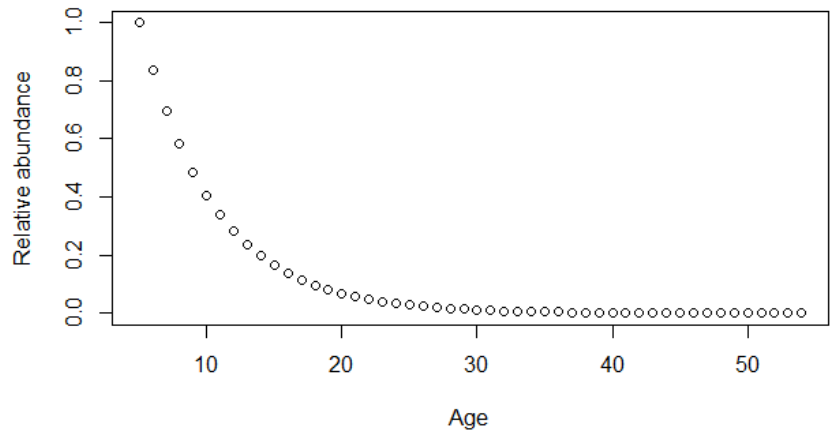
Lets us assume that (a) recruitment is for one cohort (age at Y) and (b) all recruitment is to size-class 1, i.e.:

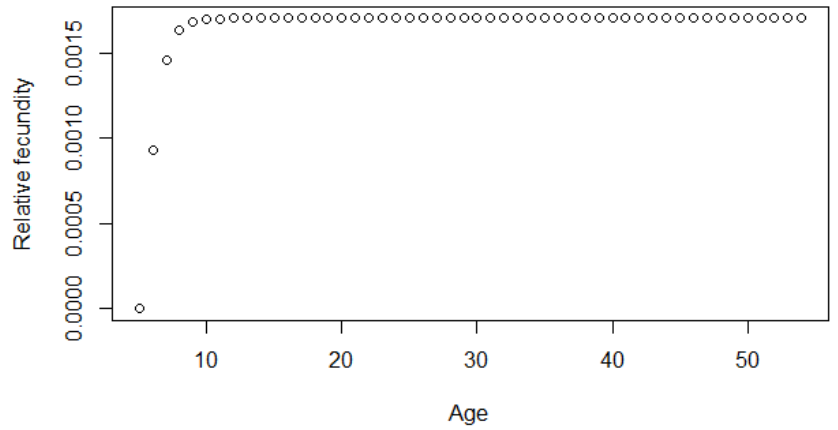
$$N_{age_{rec}} = c(1,0,0)$$

$$N_{a+1} = \mathbf{X}\mathbf{S}\, N_a$$

Generation Time-III

For St Matthews Blue king crab, the average generation time is 11.59 years assuming an age-at-recruitment if 5





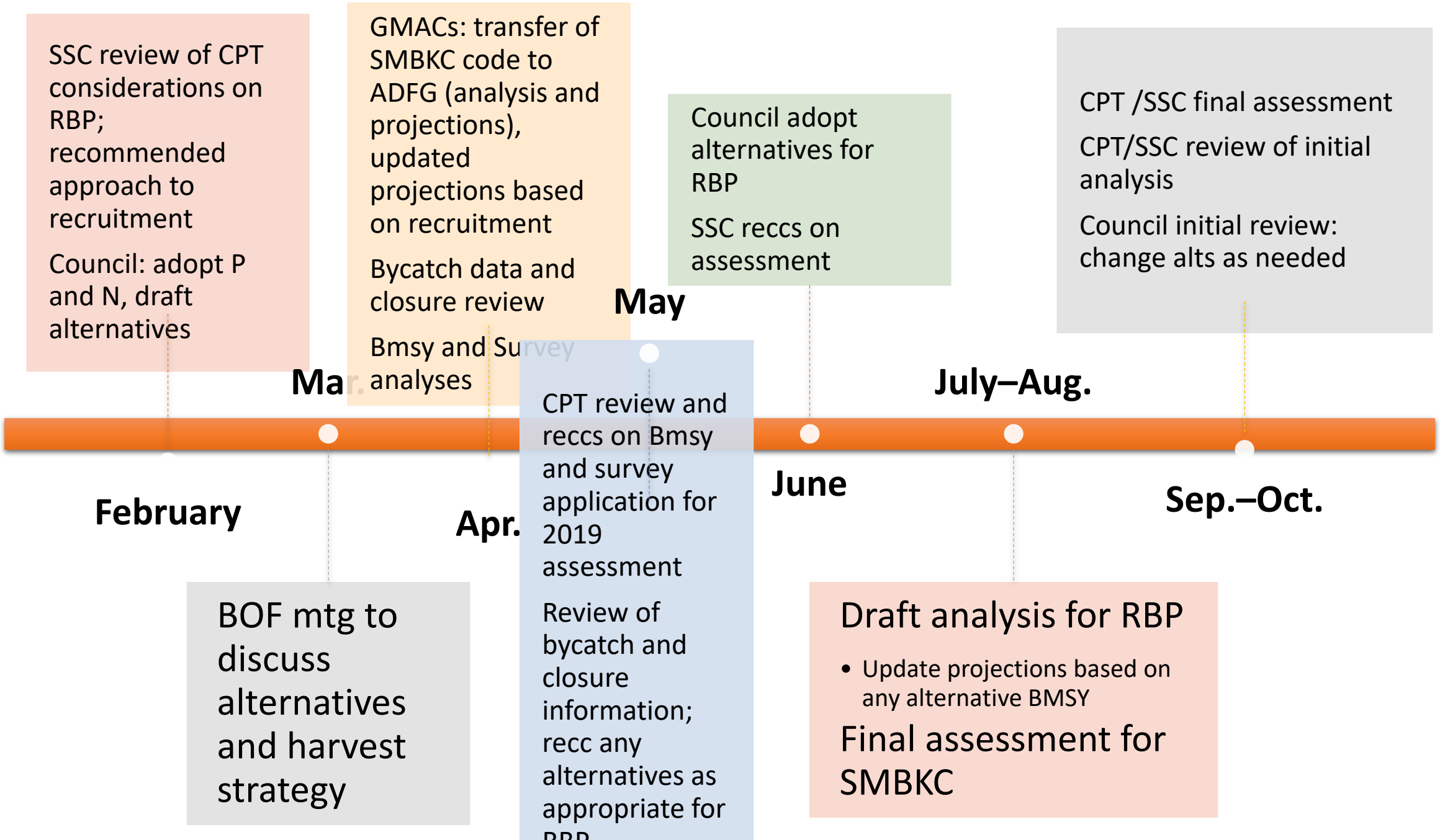
Analyses and Plans for Winter/Spring 2019

Assessment

- Transfer assessment and projection code to ADFG [late Feb - Andre/ADFG]
- B_{MSY} time frame [ADFG]
  - Log Recruit per spawner analysis to evaluate changes in productivity over time (similar to Jie's BBRKC examination)
  - Proposed changes to BMSY time frame: alternatives for inclusion in September final assessment
- Survey data review [ADFG]
  - Review of State and NMFS survey data, implications of offshore movement
  - VAST application to survey data

Rebuilding Plan

- Revised projections [Andre/ADFG/Diana]
  - Updated projections following Feb SSC; revised alternative projections consistent with proposed B_{MSY} alternatives
- Review of previous rebuilding plans [Diana]
  - Changes to assessment methodology and reference points since then
- Bycatch data review [Diana/NMFS]
  - Spatial locations of groundfish bycatch
  - Overlay existing area closures and review of rationale for closures
  - Size and sex composition of groundfish fishery bycatch


SSC review of CPT considerations on RBP; recommended approach to recruitment
Council: adopt P and N, draft alternatives
GMACs: transfer of SMBKC code to ADFG (analysis and projections), updated projections based on recruitment
Bycatch data and closure review
Bmsy and Survey analyses
Council adopt alternatives for RBP
SSC reccs on assessment
CPT /SSC final assessment
CPT/SSC review of initial analysis
Council initial review: change alts as needed
February
Mar.
Apr.
May
June
July–Aug.
Sep.–Oct.
BOF mtg to discuss alternatives and harvest strategy
CPT review and reccs on Bmsy and survey application for 2019 assessment
Review of bycatch and closure information; recc any alternatives as appropriate for
Draft analysis for RBP
• Update projections based on any alternative BMSY
Final assessment for SMBKC

Council actions 2019-2020 following initial review draft

Dec

- Council action as necessary
- Public review draft

Feb

- Council Final action
- SOC final analysis

April/October

- NMFS approval and regulations as needed
- Implementation prior to October 2020