SAINT MATTHEW BLUE KING CRAB STOCK STATUS & REBUILDING PROJECTIONS, PROGRESS, AND PLANS

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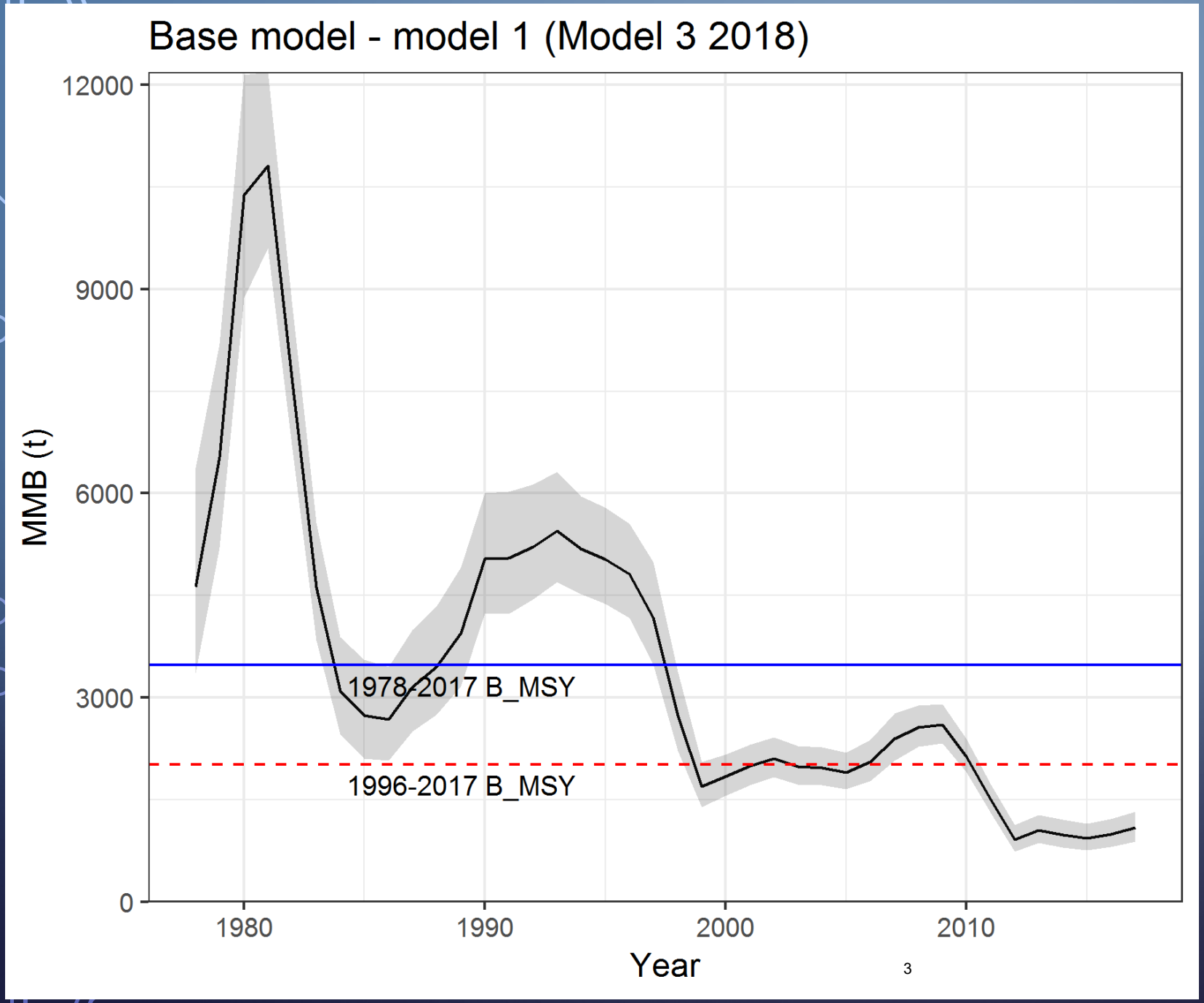
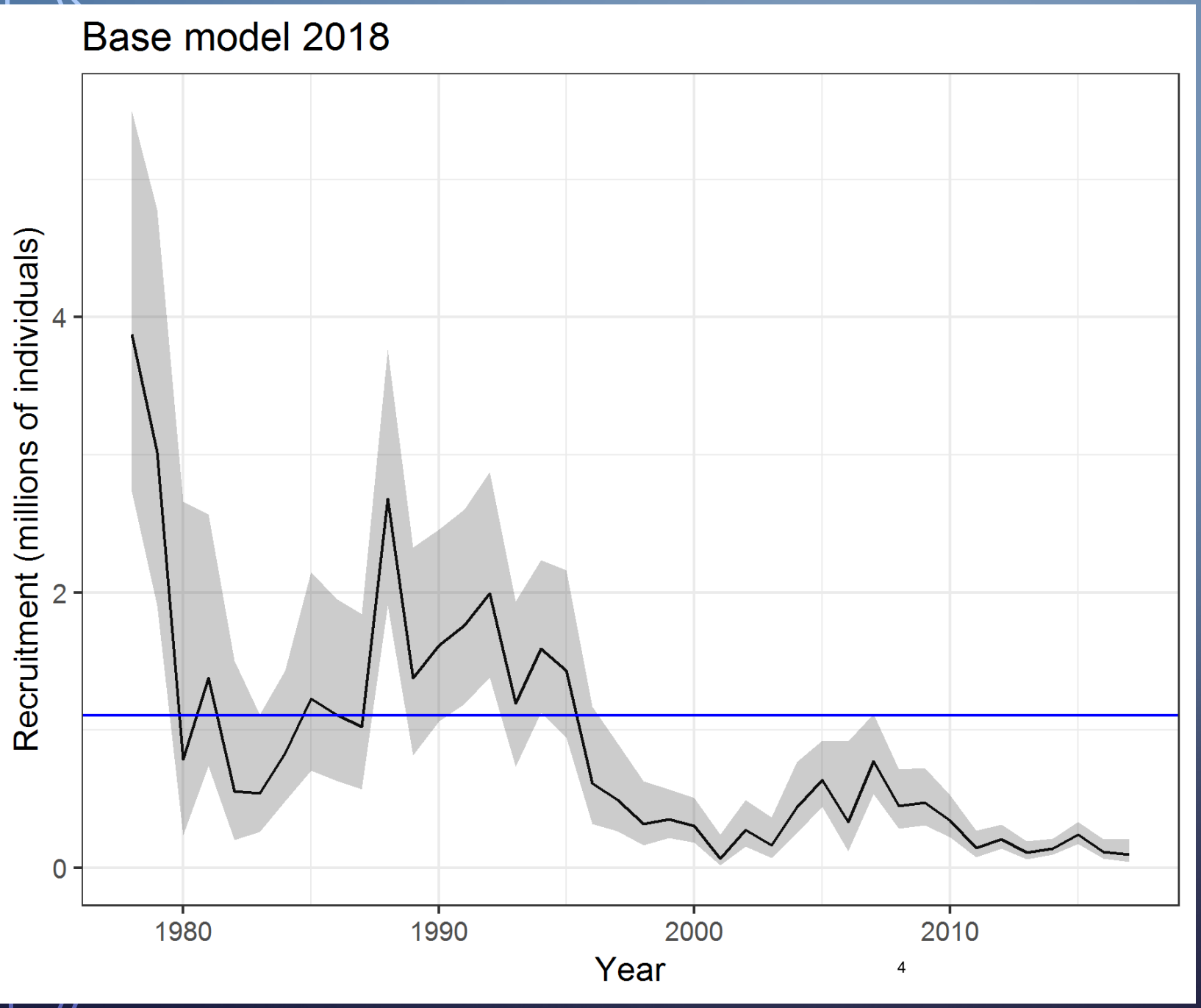
OVERVIEW

- Stock status – Fall 2018
  - Overfished but not overfishing
  - Poor recruitment in recent years (model)
  - Sept 2019 models – Base, 2019 data, “fit survey”, and VAST (?)
  - Recruitment breakpoint analysis results
- Rebuilding progress/plans
  - Projections
    - assumptions and methods – RECUITMENT
    - Results - T_{min} and T_{max} ?
  - Other considerations
    - Bycatch
    - State harvest strategy

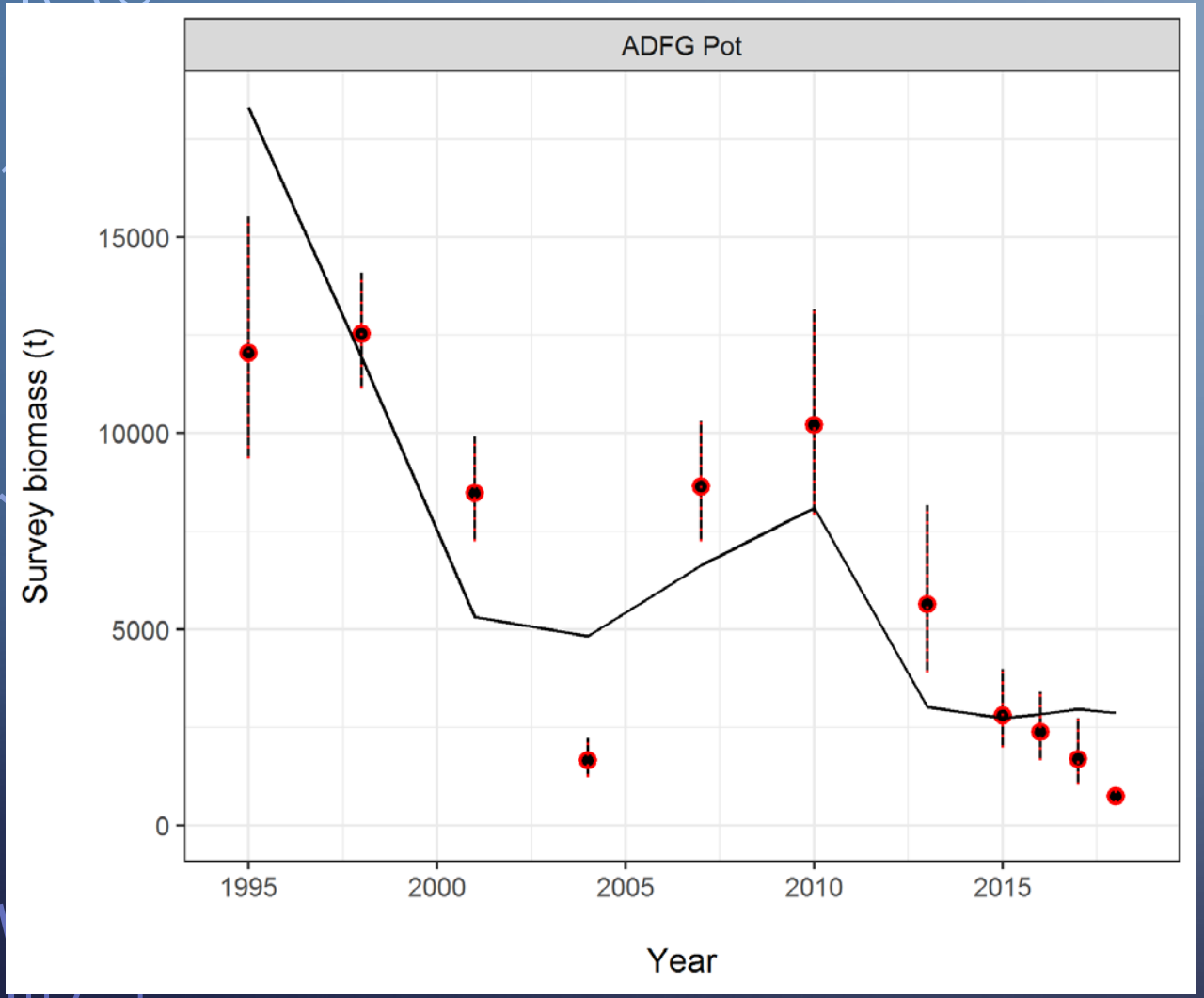


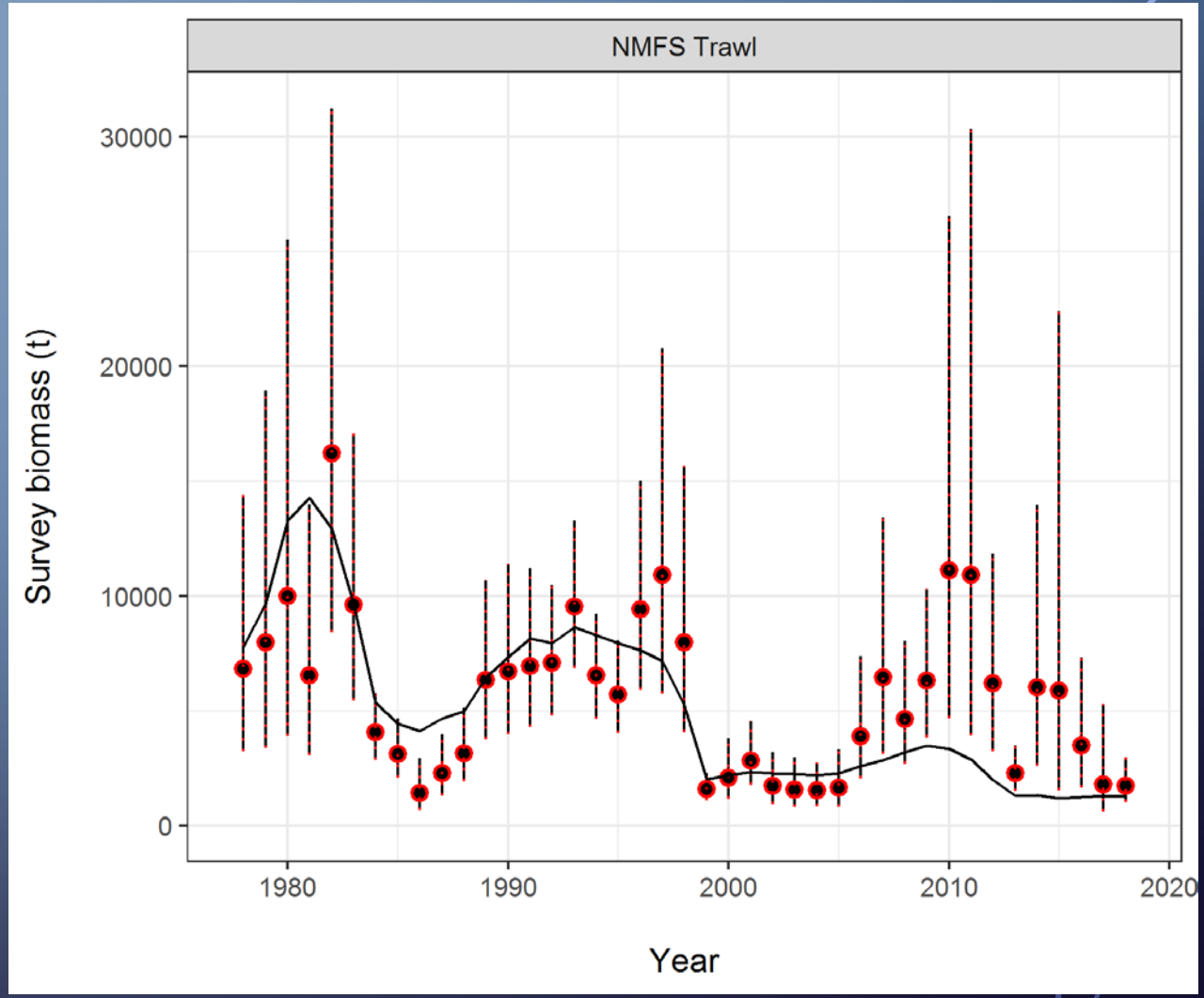
MATURE MALE BIOMASS



RECRUITMENT

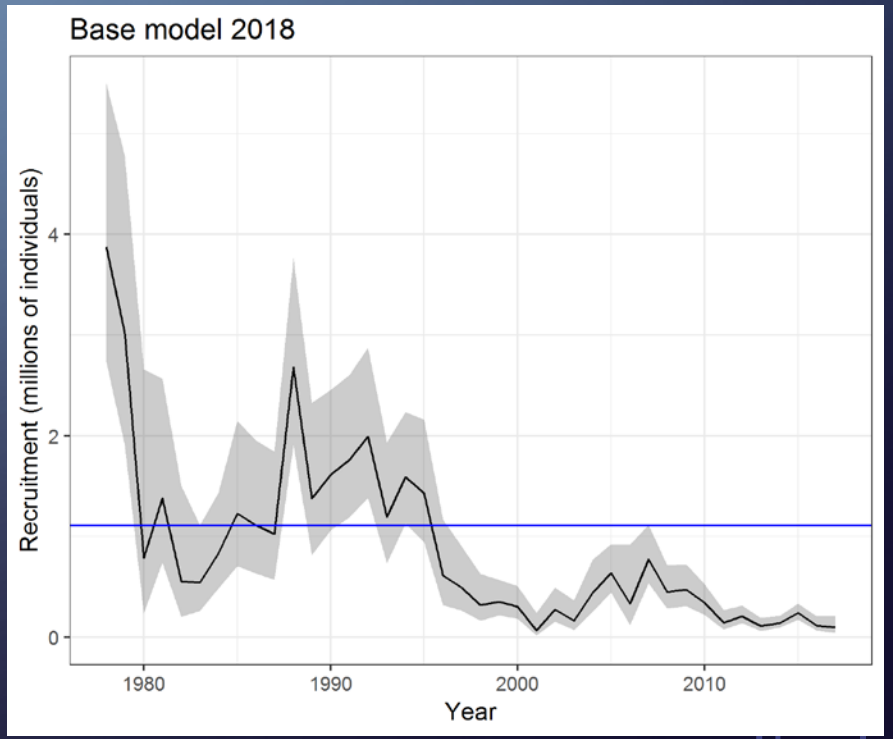
SURVEY FIT


ADFG Pot
Survey biomass (t)
15000
10000
5000
0
1995
2000
2005
2010
2015
Year

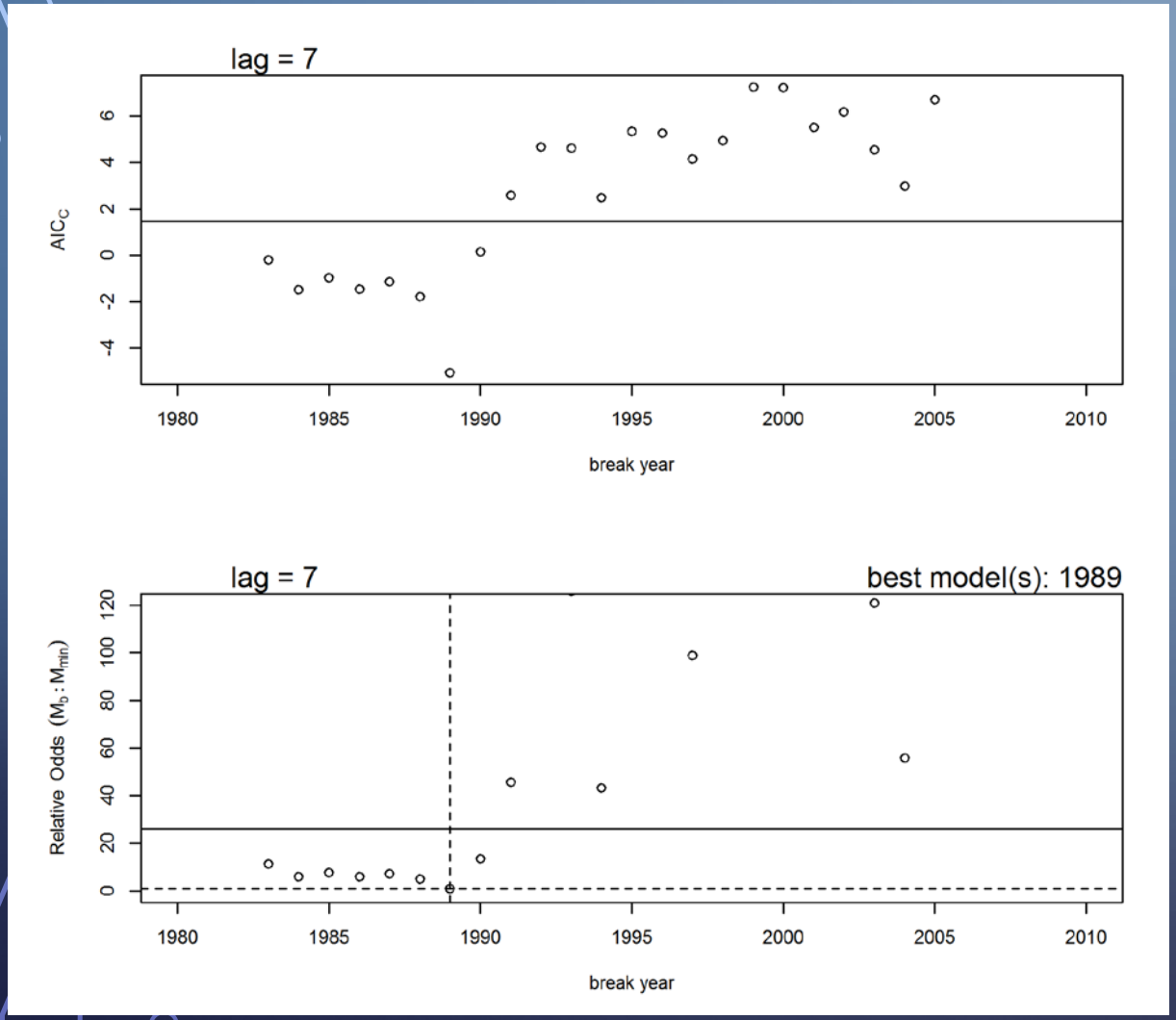

NMFS Trawl
Survey biomass (t)
30000
20000
10000
0
1980
1990
2000
2010
2020
Year

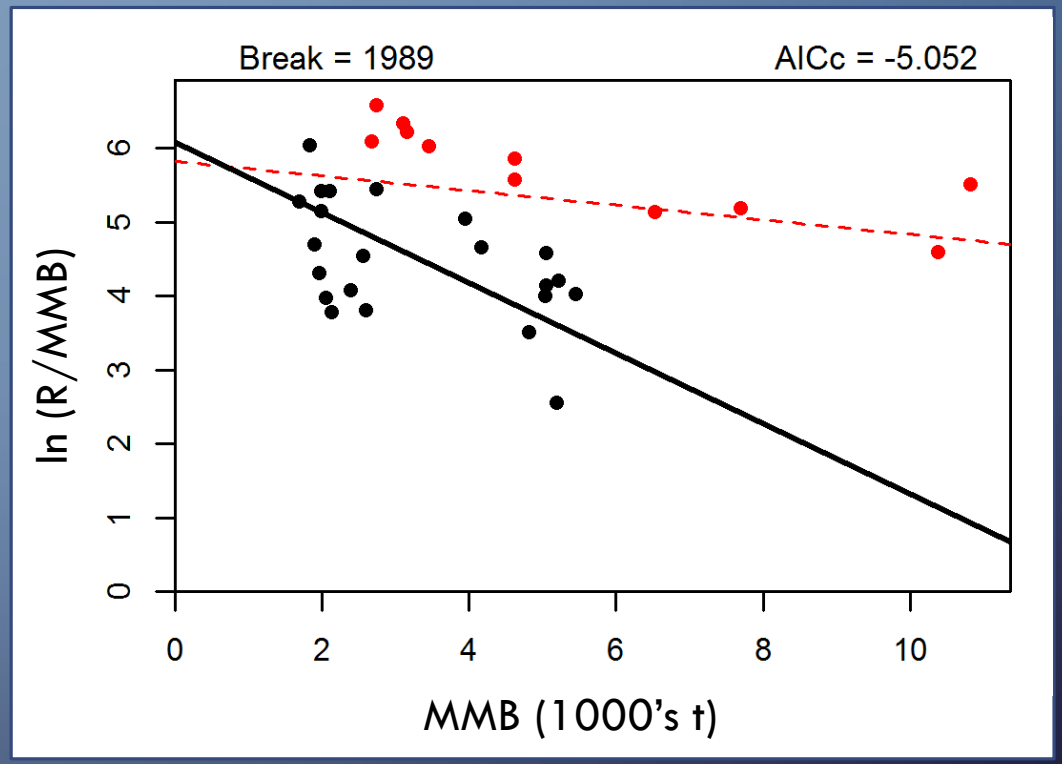
RECRUITMENT BREAKPOINT ANALYSIS

- Same approach as BBRKC and others (Punt et al. 2014)
- Use S-R relationship to look for breakpoints in productivity
- Decision points:
  - Lag of 7 years to from brood year to recruitment
  - Minimum number of years in a group - 5

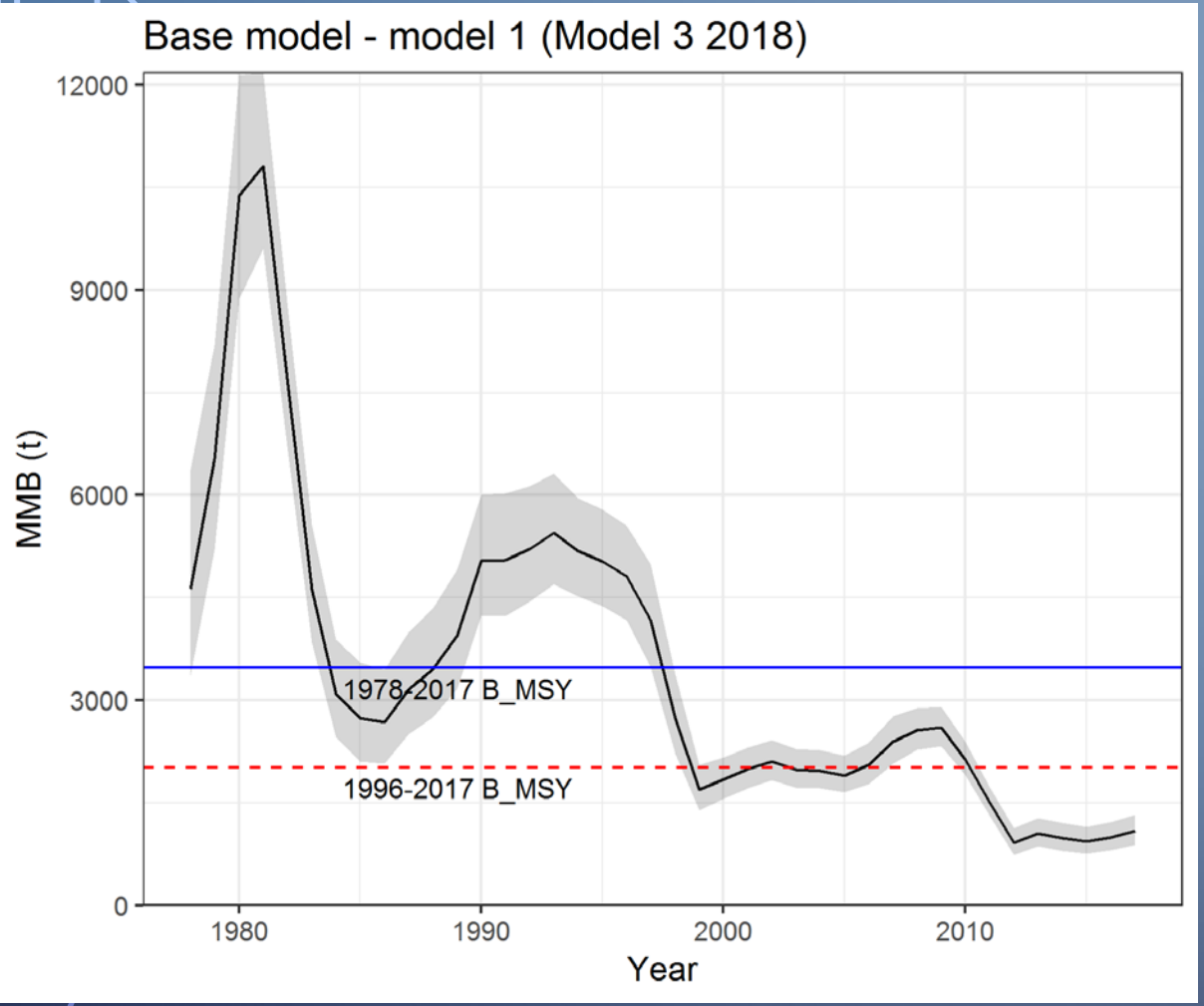


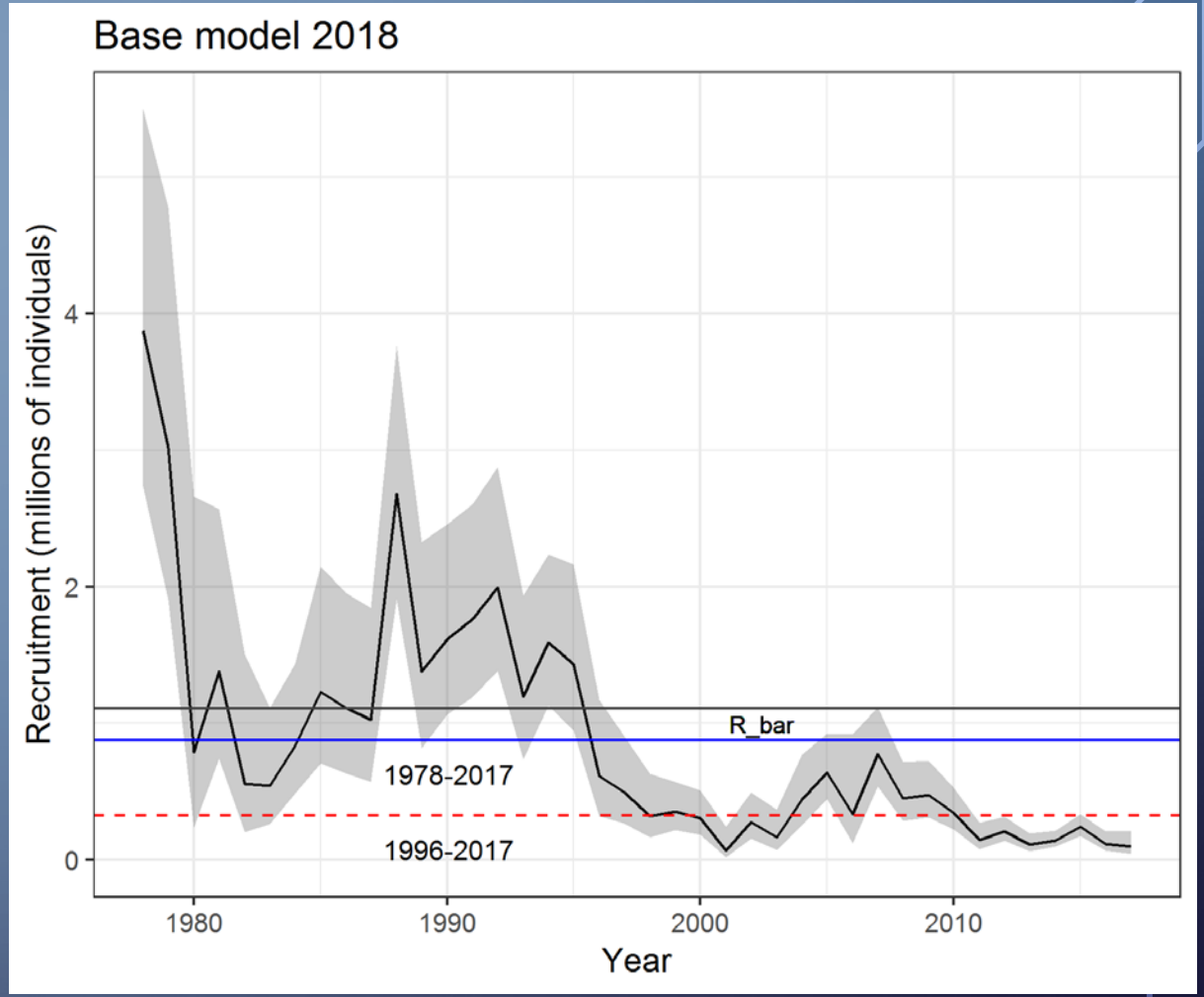
RECRUITMENT BREAKPOINT / PRODUCTIVITY





1989 brood year – 1996 recruitment





Year	Basis for B_{MSY}	B_{MSY} proxy	MSST	Biomass (MMB_{mating})	B/B_{MSY}
2018/19	1978-2017	3.48	1.74	1.09	0.31
2018/19	1996-2017	2.03	1.015	1.09	0.53

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} = time the stock or stock complex to rebuild to its MSY biomass level in the absence of any fishing mortality (≥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} + one generation time. "Generation time" = average length of time between when an individual is born and the birth of its offspring,
  2. Time to rebuild to B_{msy} if fished at 75 percent of MFMT, or
  3. T_{min} multiplied by two.
- 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.

REBUILDING PROJECTIONS

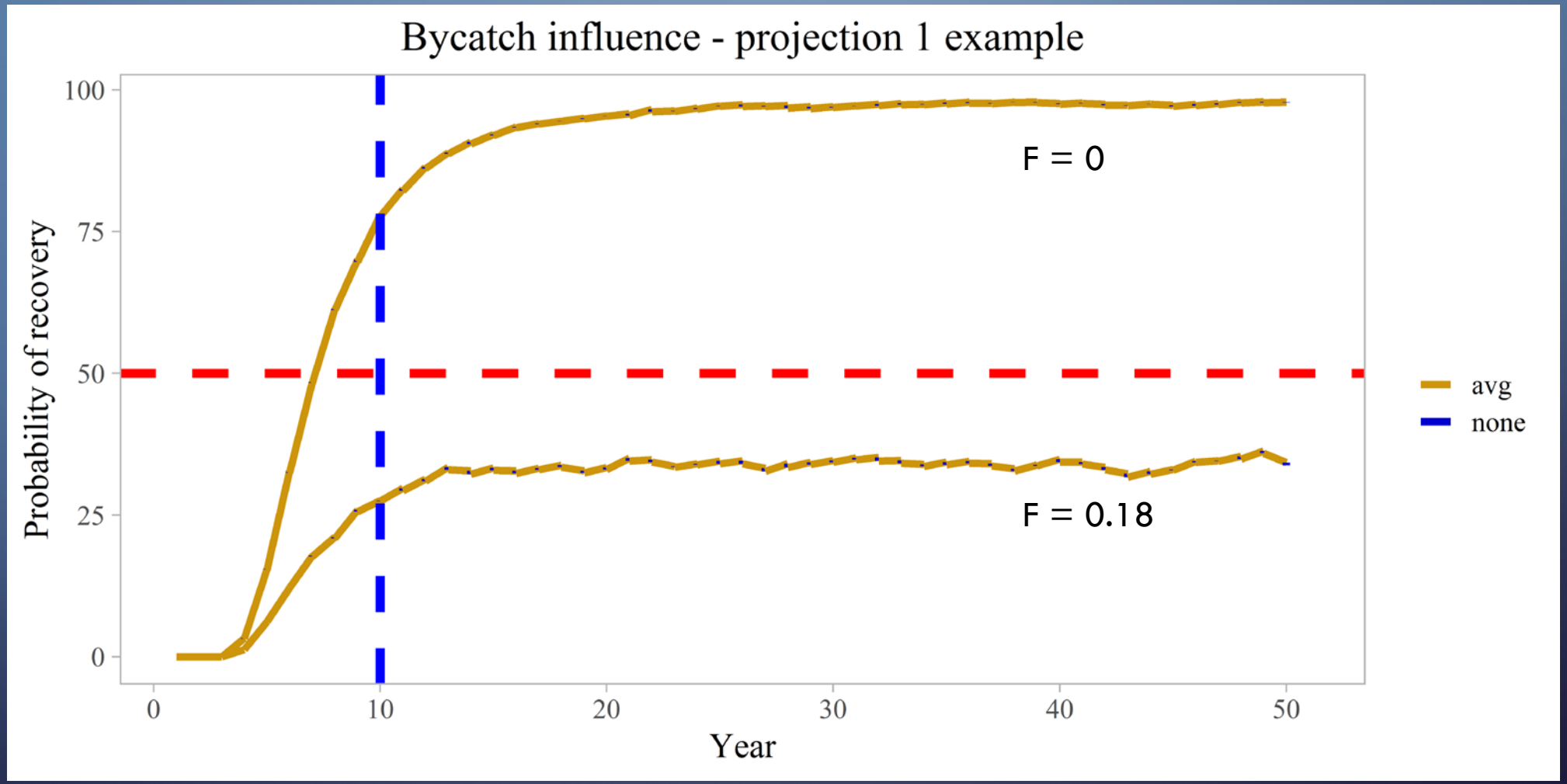
- Gmacs projection module developed in Jan – uses mcmc output (.psv file)
- Assumptions:
  - Bycatch (does not influence rebuilding time)
  - State harvest policy
  - Future recruitment – KEY ASSUMPTION
    - S-R (A. Punt) – Ricker or B-H
    - “mean” recruitment or “random” recruitment draws

Table 4: Projections performed with associated recruitment assumptions

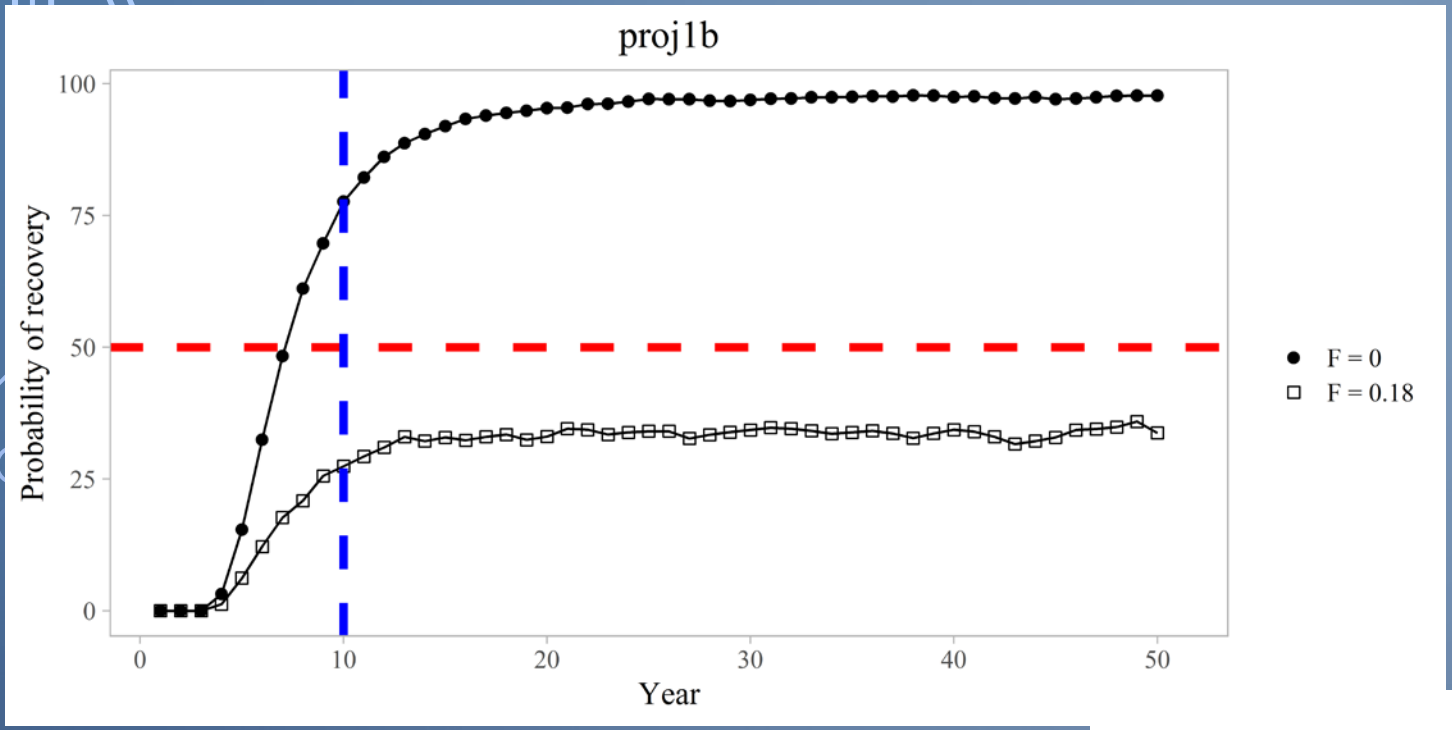
Projection	recruitment	B_{MSY} proxy	recruitment years
1	random	1978-2017	1978-2017
2	Ricker	1978-2017	
3	Beverton-Holt	1978-2017	
4	random	1978-2017	1996-2017
5	random	1996-2017	1996-2017
6	random	1978-2017	1999-2008
7	random	1978-2017	1989-2017

Table 5: Versions for each of the projections in Table 4.

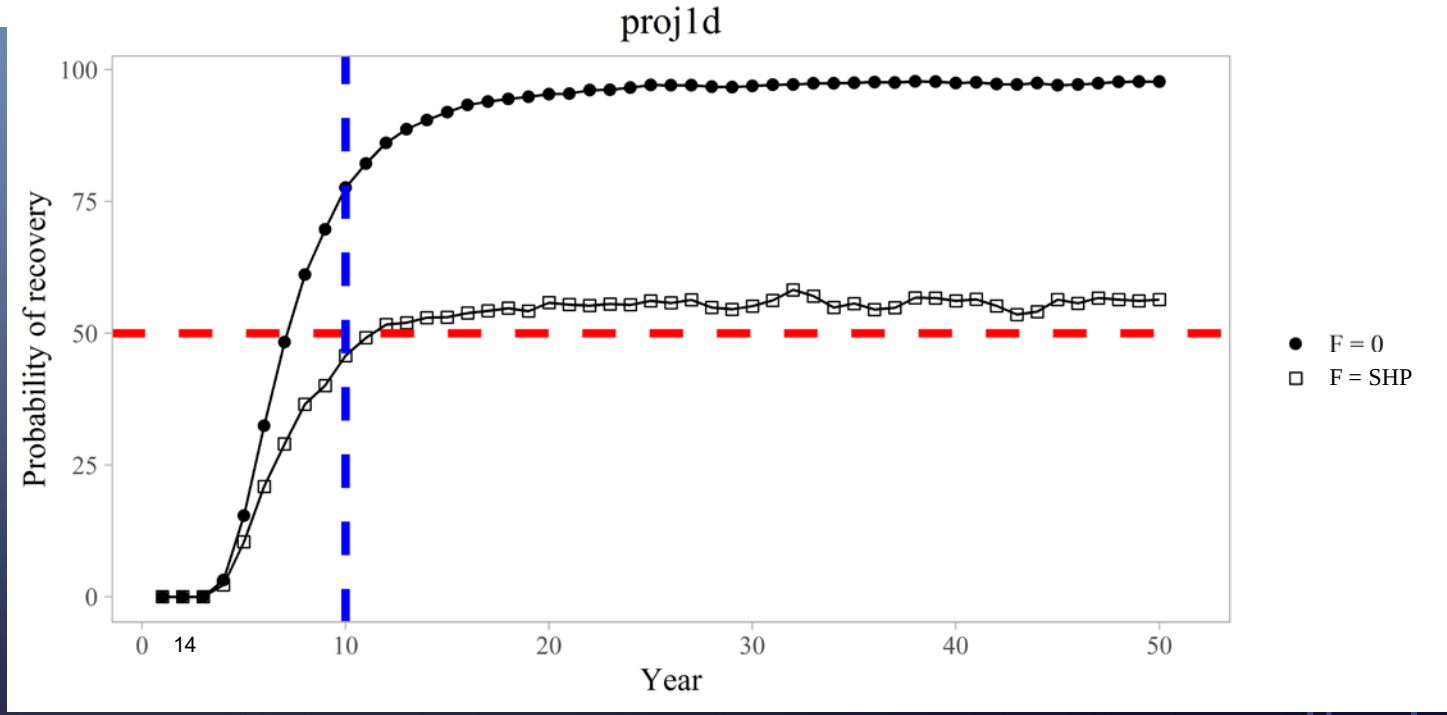
Version	Bycatch mortality	SOA harvest policy (SHP)
a	0	no
b	present (2013-2017)	no
c	0	yes
d	present (2013-2017)	yes


Bycatch influence - projection 1 example
Probability of recovery
100
75
50
25
0
0
10
20
30
40
50
Year
F = 0
F = 0.18
avg
none

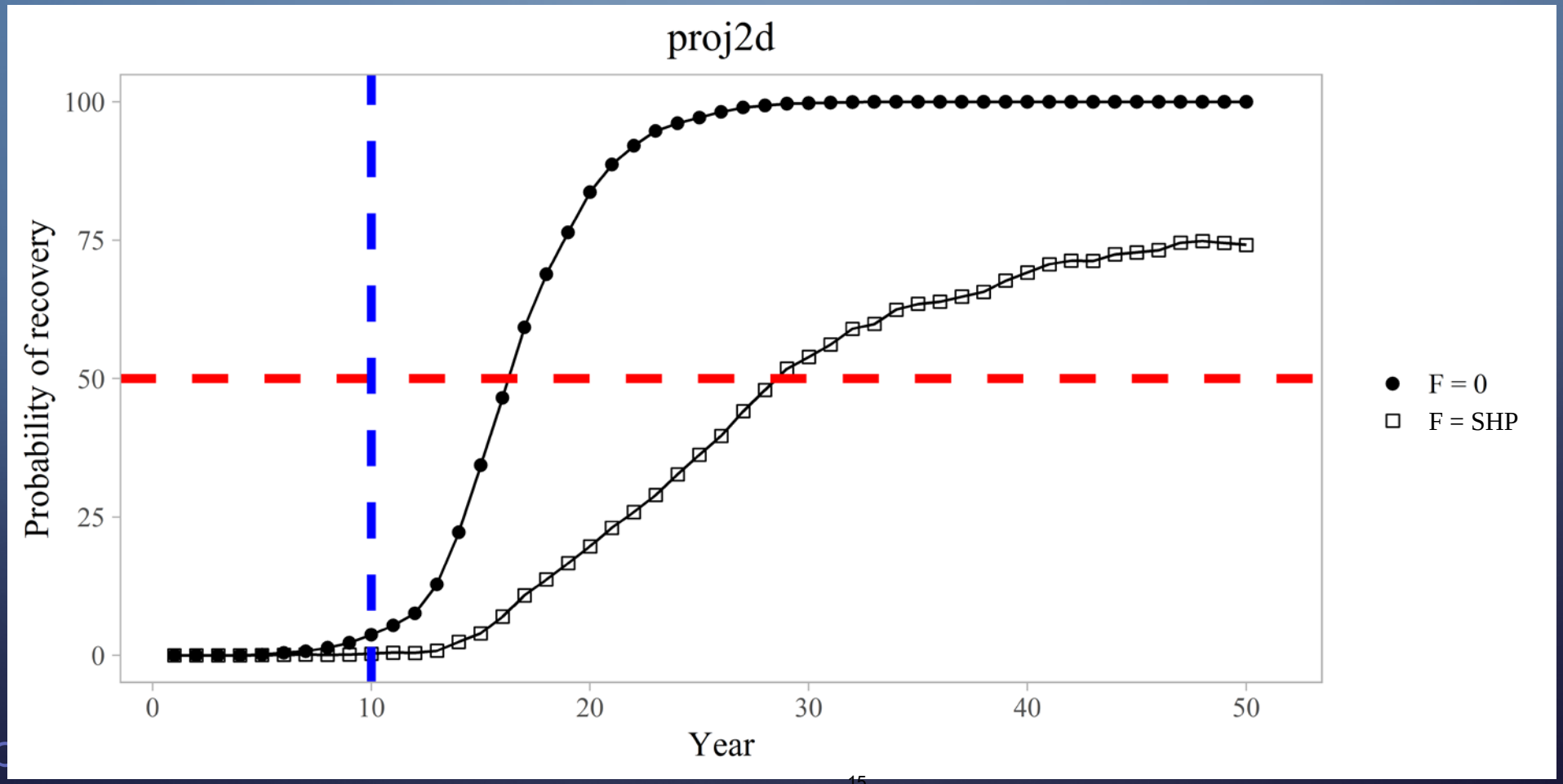
STATE HARVEST POLICY



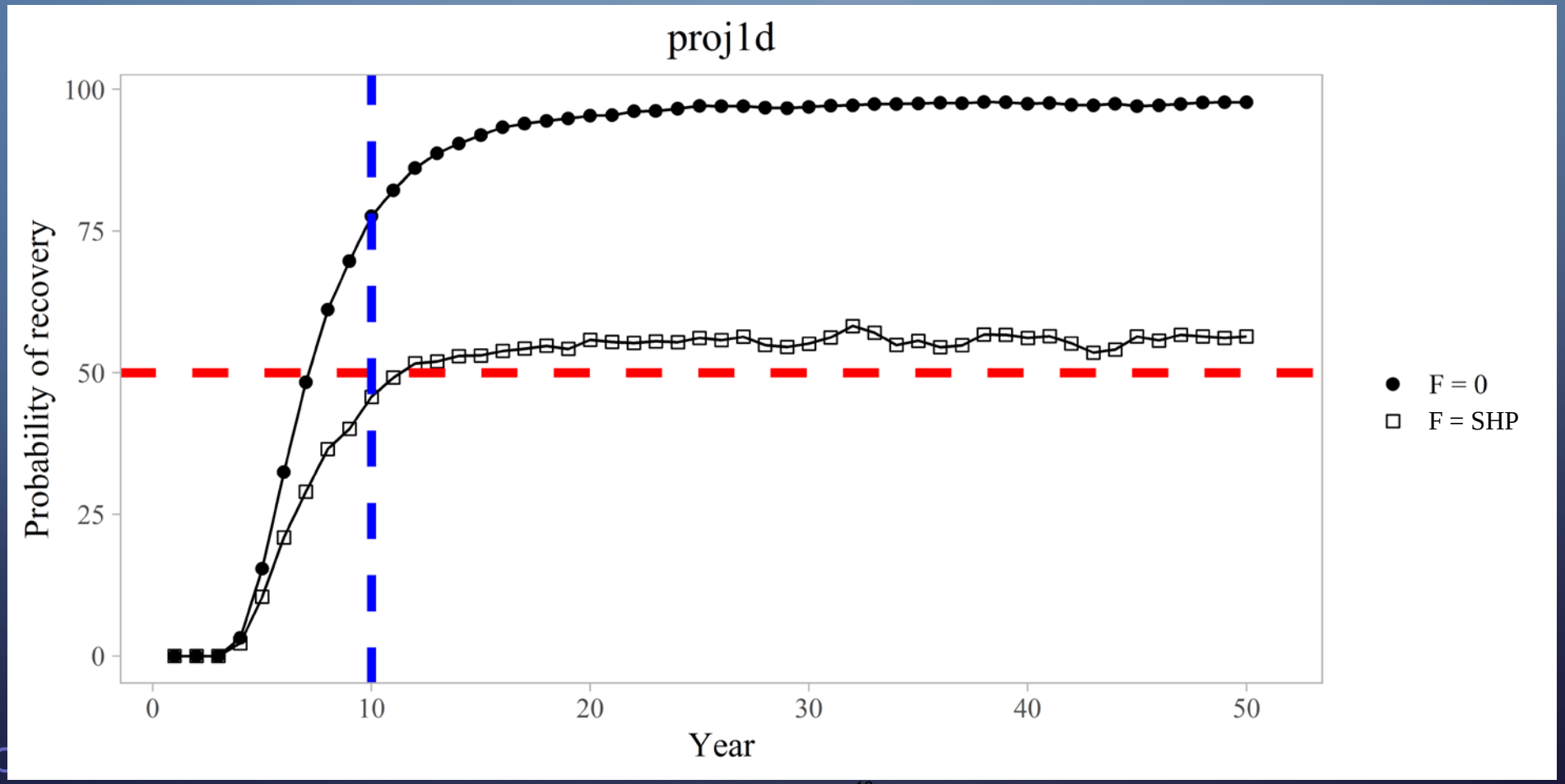
b – off
d - on



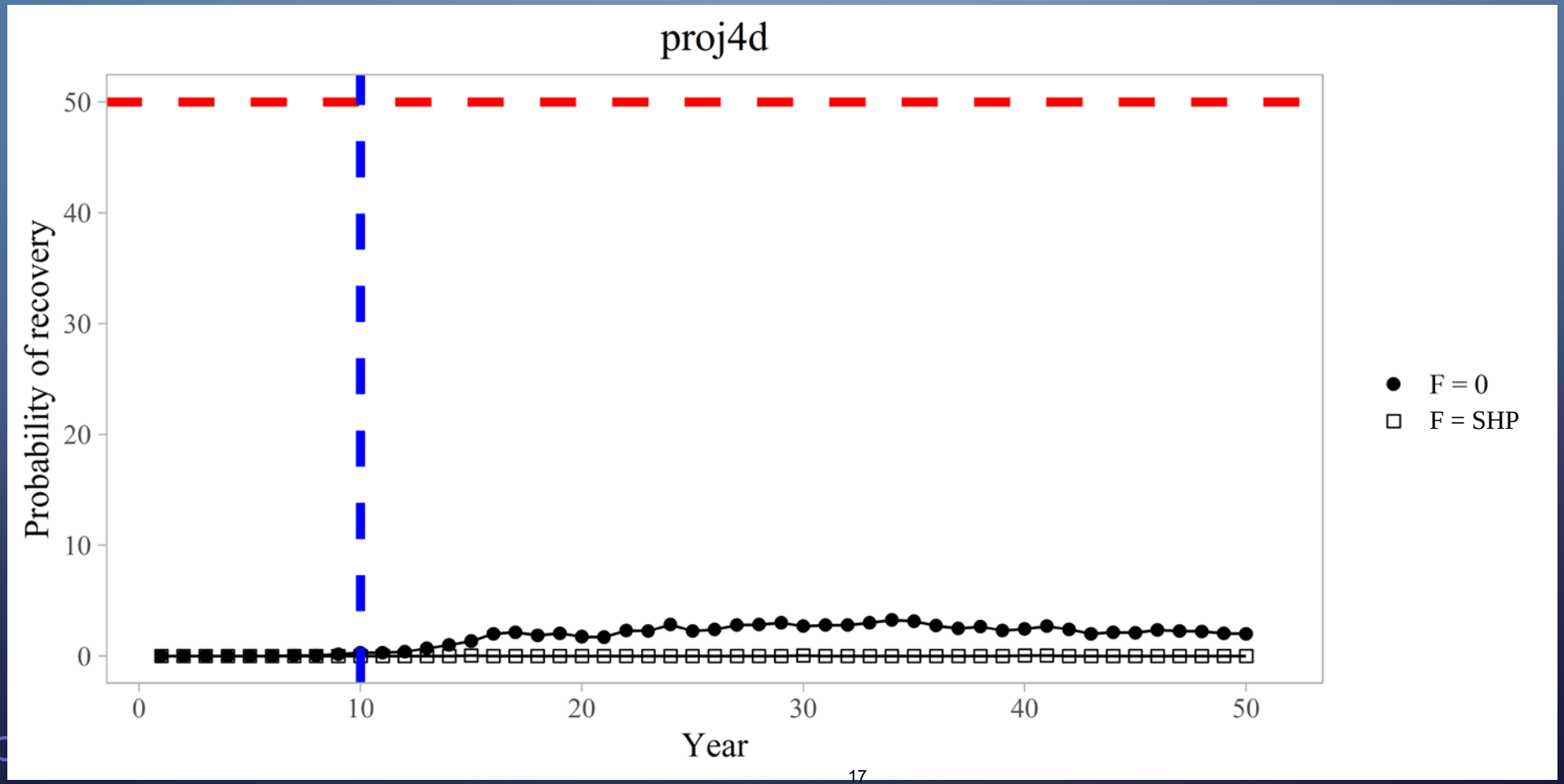
RICKER S-R RELATIONSHIP



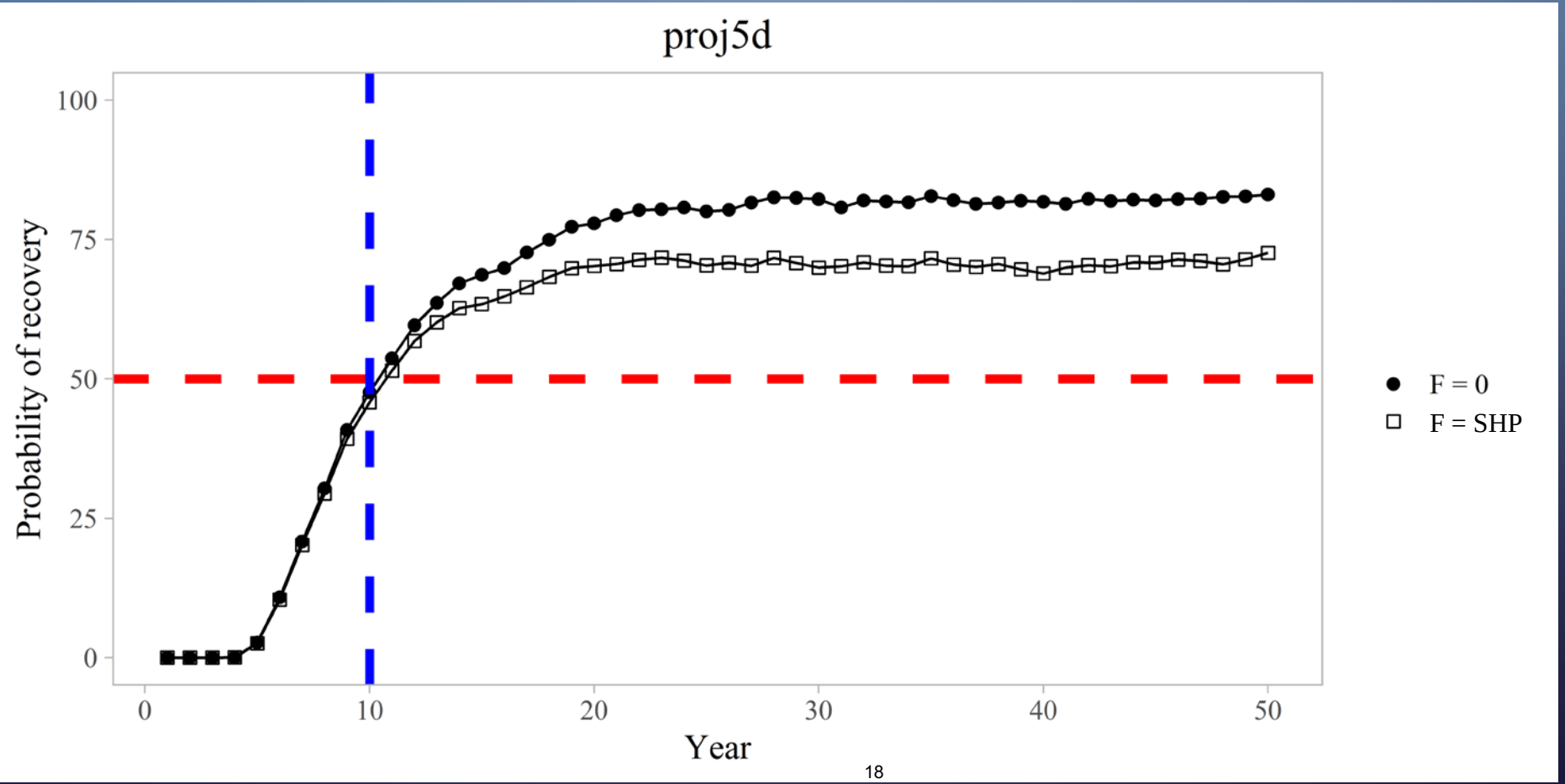
RANDOM RECRUITMENT (1978-2017)



RANDOM RECRUITMENT (1996-2017)



RANDOM RECRUITMENT (1996-2017) AND B_{MSY} PROXY (1996-2017)



CPT recommendation on recruitment and Bmsy relative to Tmin

Table 7: T_{min} for each projection version d with no directed fishing (F=0).				
Projection	**recruitment**	**B_{MSY} proxy**	**recruitment years**	**T_{min}**
1	random	1978-2017	1978-2017	7.5 years
2	Ricker	1978-2017		16.5 years
3	Beverton-Holt	1978-2017		14.5 years
4	random	1978-2017	1996-2017	100+ years
5	random	1996-2017	1996-2017	10.5 years
6	random	1978-2017	1999-2008	100+ years
7	random	1978-2017	1989-2017	10 years

DECISION POINTS

- Most probably assumption on recruitment?
- Change B_{MSY} proxy years? Evidence for this?
- T_{MIN} based on these choices
- Weighed combinations of projections?

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}

Previous SMBKC rebuilding plan

harvest strategy

1. SQ 20% Mature male abundance
2. **New harvest strategy:**
   a. **min stock threshold**
   b. **min GHL**
   c. **threshold on harvest rates**
   d. **cap on legal males**

bycatch controls

1. SQ
2. **BOF gear mod measures and area closure**

habitat protection

1. SQ
2. **EFH**
3. **BOF state waters habitat protection areas**

Other considerations

No fishing until the stock is rebuilt

Additional habitat protection measures (not part of RBP)

St. Matthew Island Habitat Conservation Area

Amd 89 to FMP implemented 2008

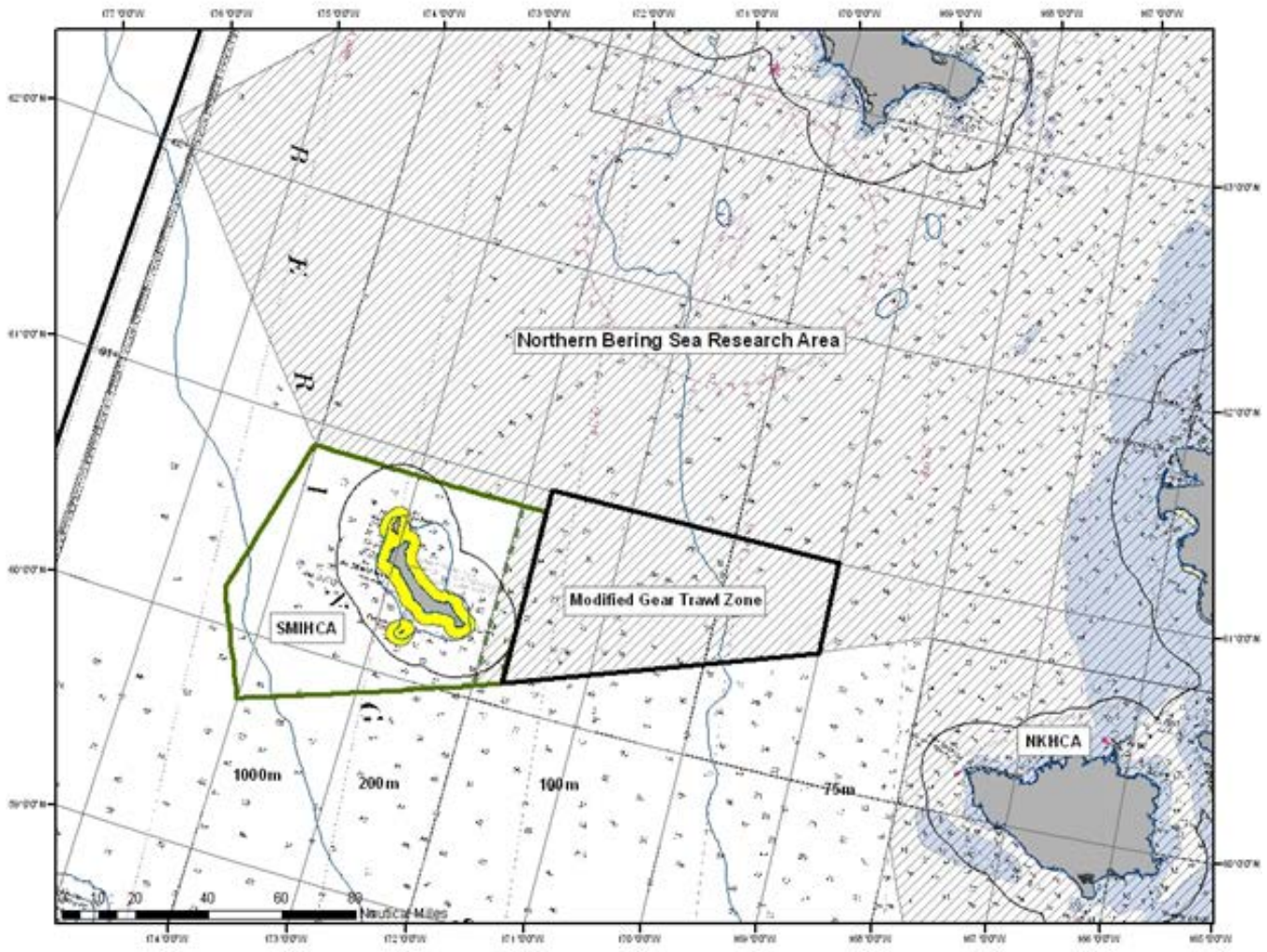
- primary goal to protect BKC habitat
- done in conjunction with much broader analysis of non-pelagic closures

Expansion of SMIHCZ

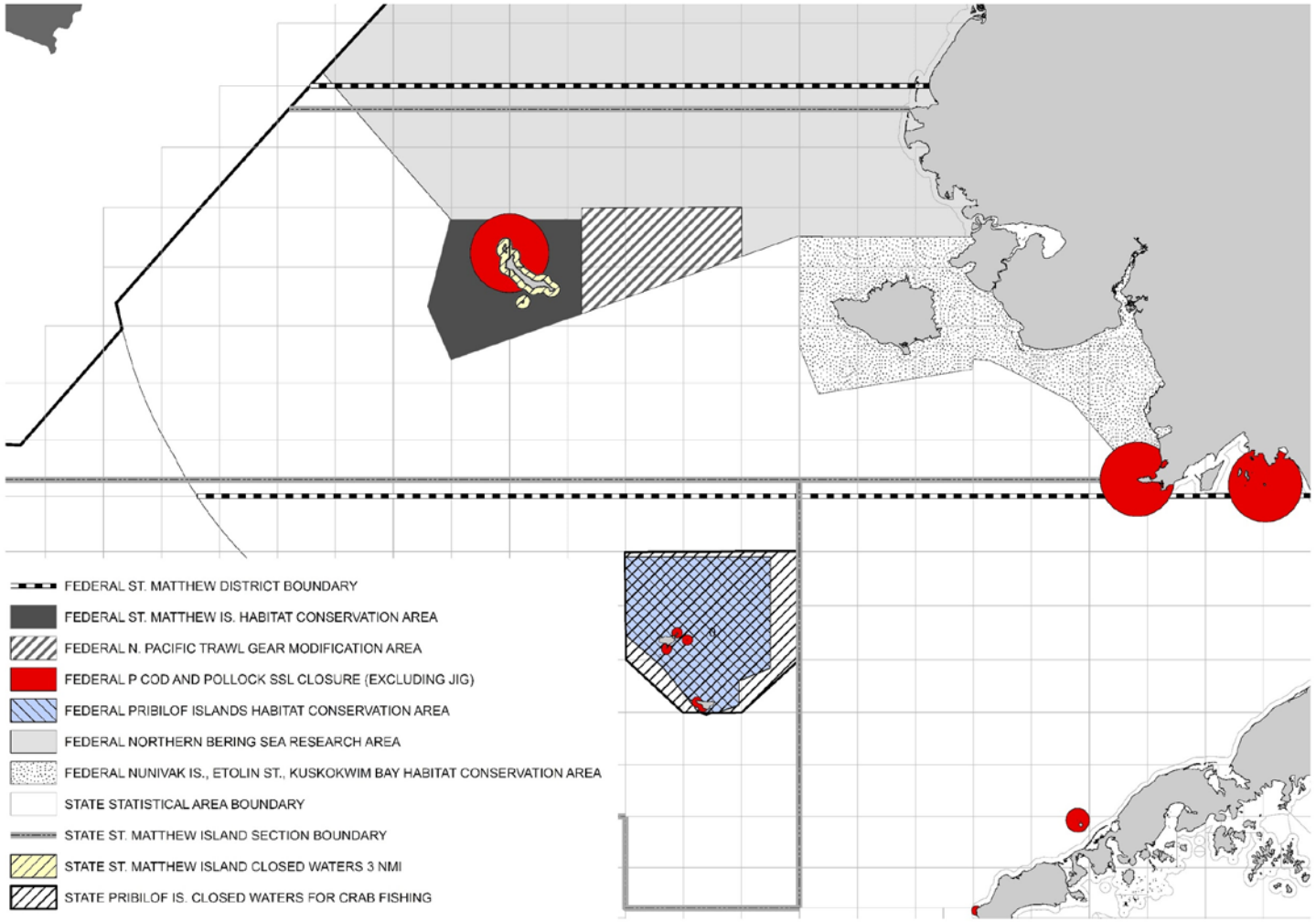
Amd 94 to FMP implemented 2010

- expanded eastern boundary of SMIHCZ

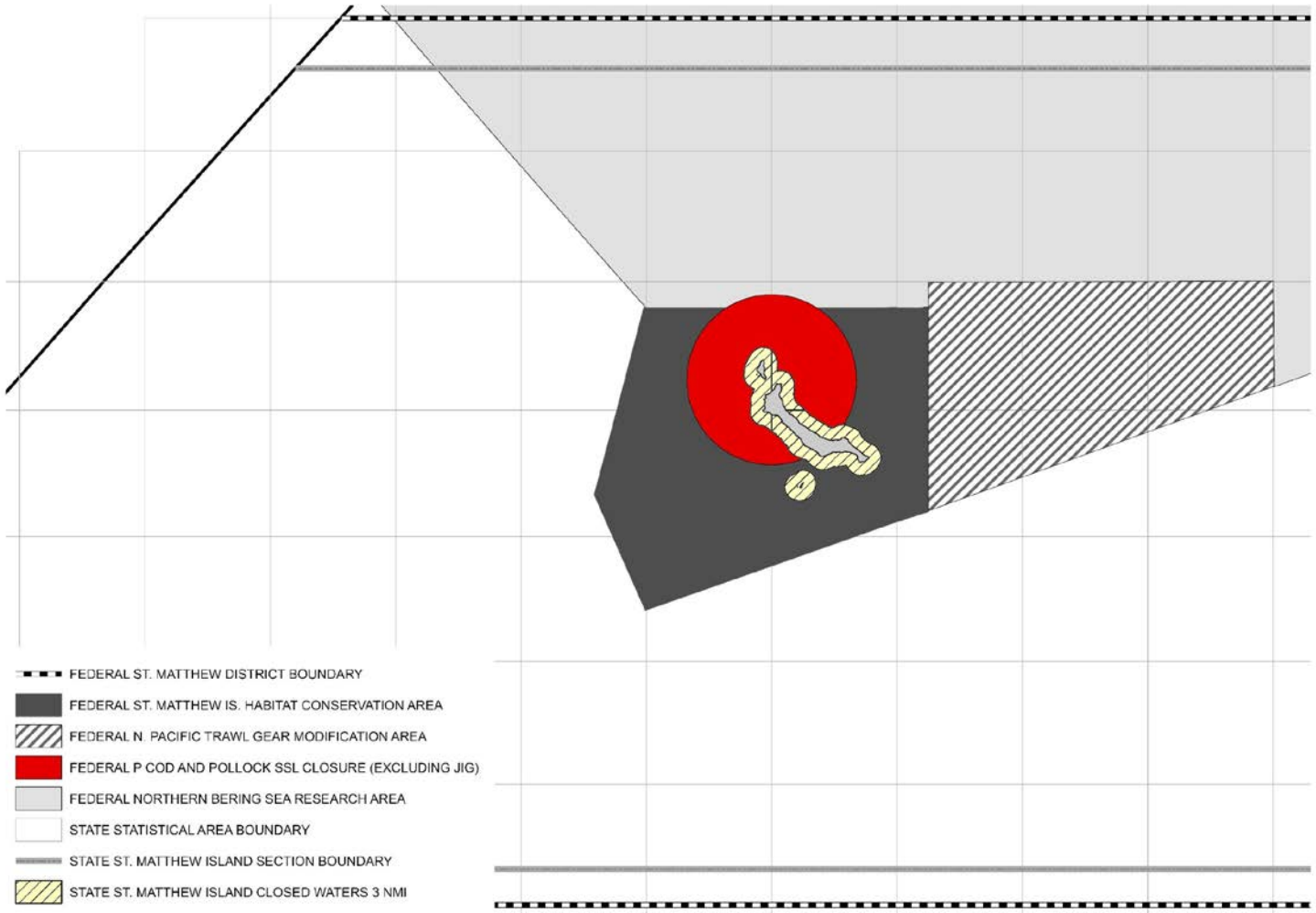
SMIHCZ including revised boundary



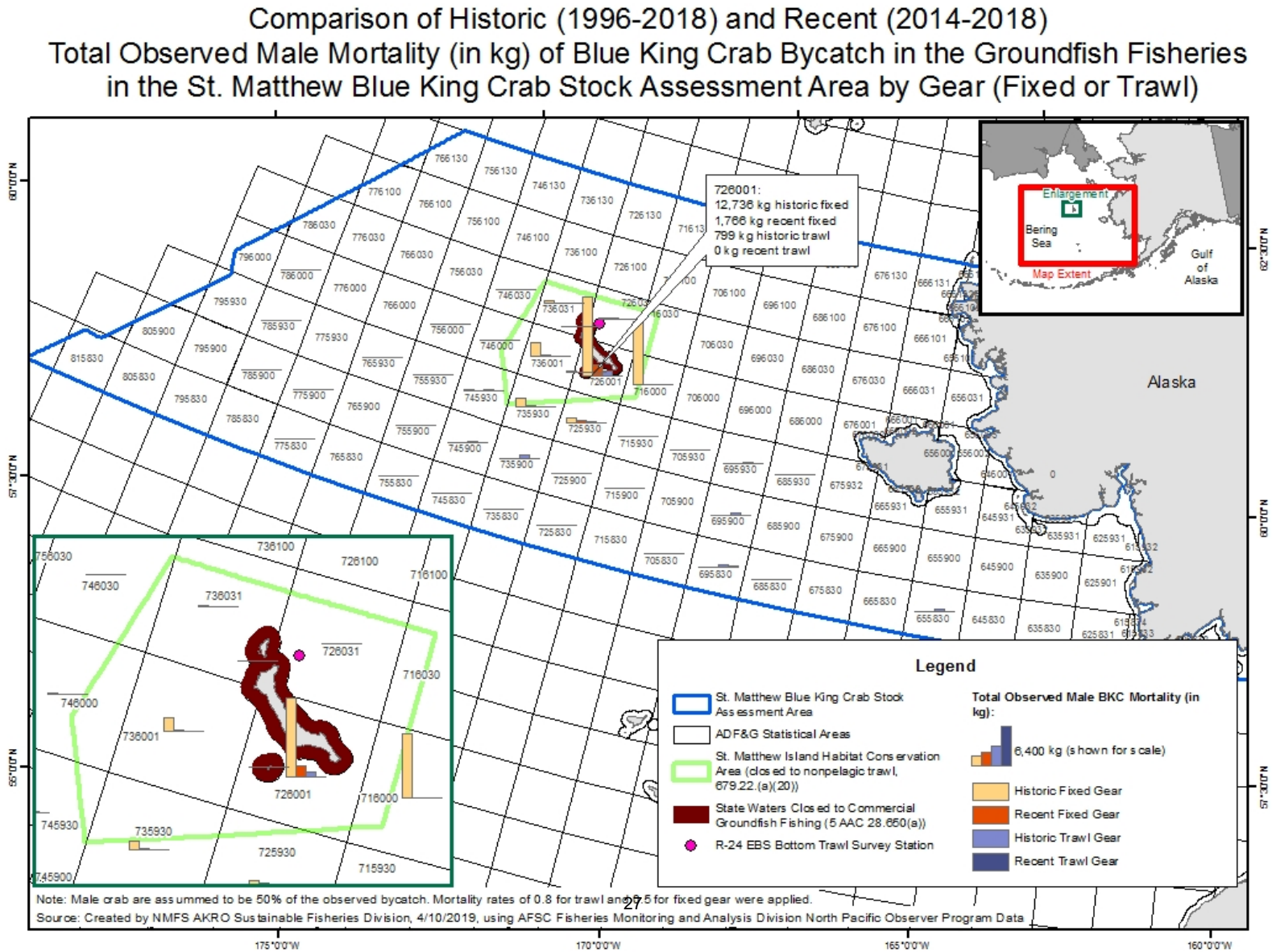
Closure Areas



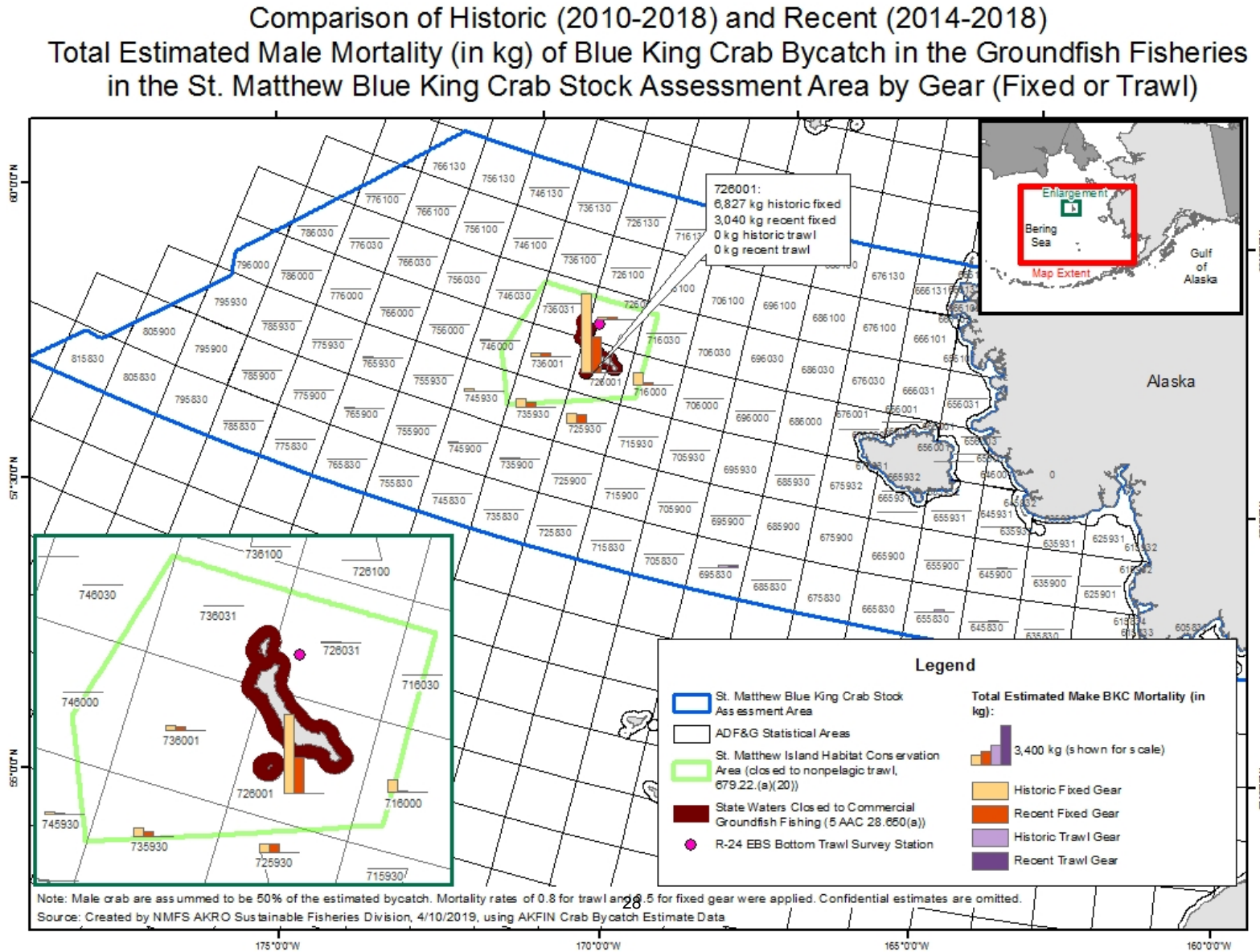
Closure Areas

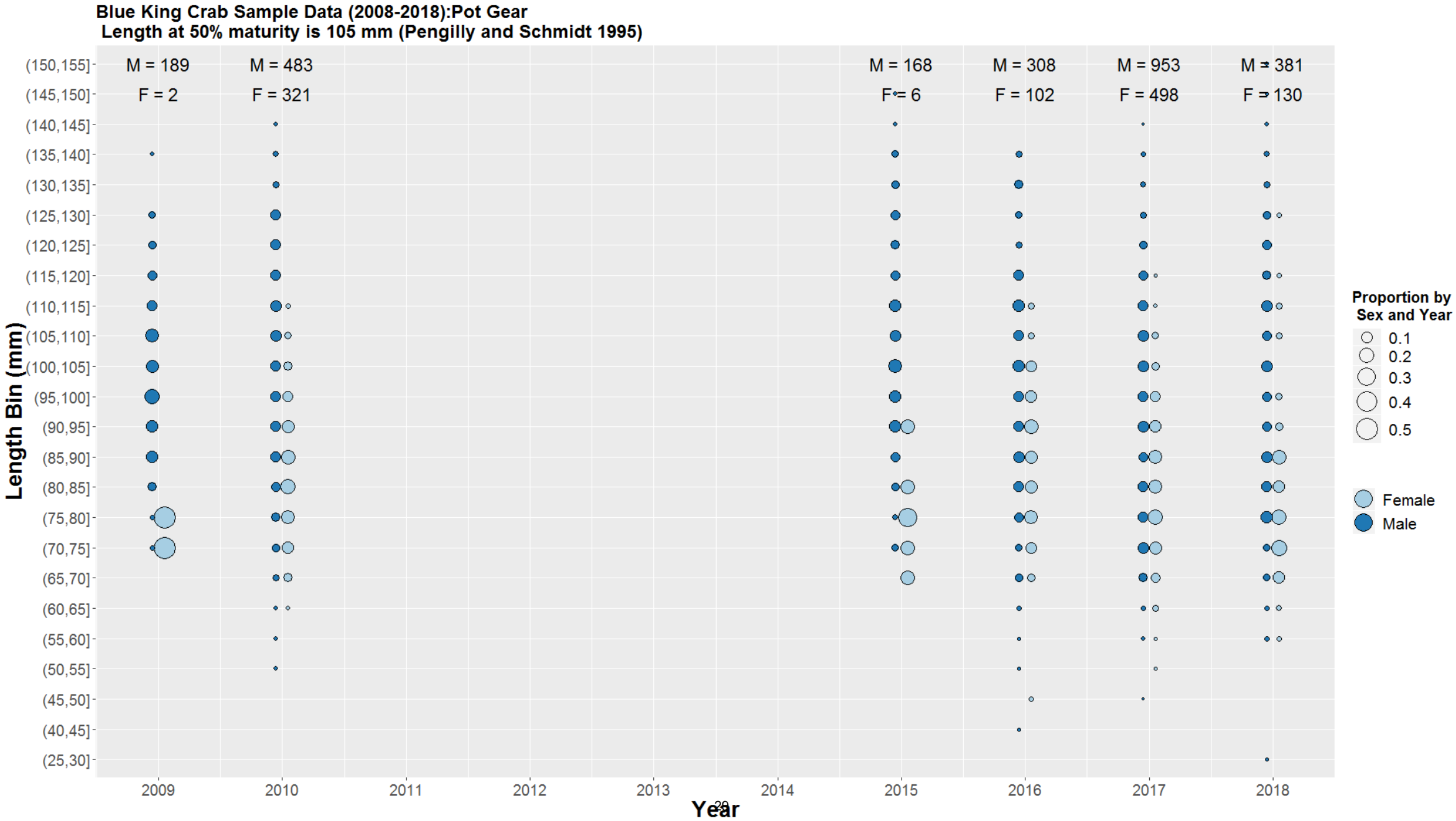


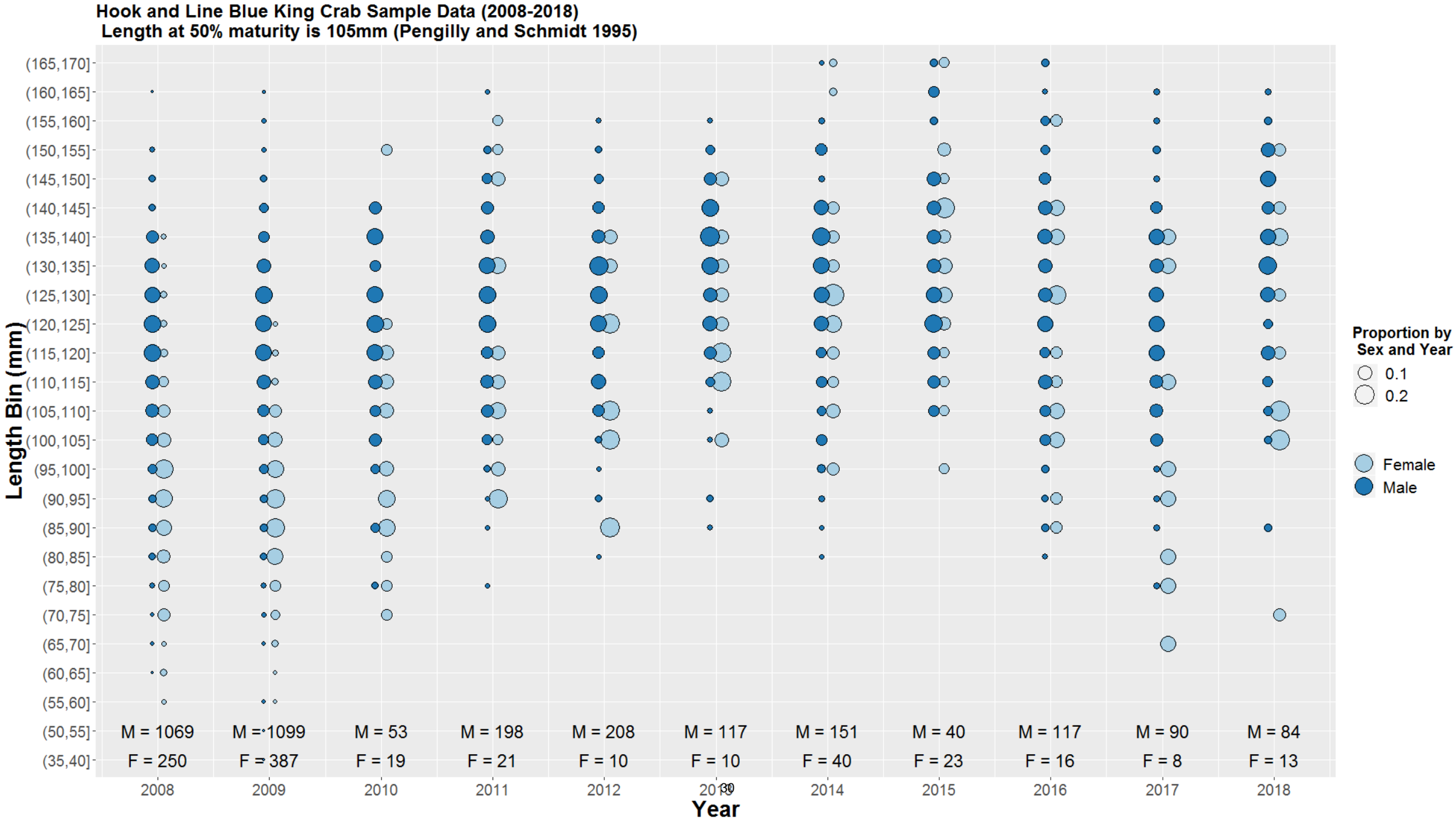
Spatial Location of Observed Groundfish Bycatch



Spatial Location of Estimated Groundfish Bycatch




Blue King Crab Sample Data (2008-2018):Pot Gear
Length at 50% maturity is 105 mm (Pengilly and Schmidt 1995)
M = 189
F = 2
M = 483
F = 321
M = 168
F = 6
M = 308
F = 102
M = 953
F = 498
M = 381
F = 130
(150,155]
(145,150]
(140,145]
(135,140]
(130,135]
(125,130]
(120,125]
(115,120]
(110,115]
(105,110]
(100,105]
(95,100]
(90,95]
(85,90]
(80,85]
(75,80]
(70,75]
(65,70]
(60,65]
(55,60]
(50,55]
(45,50]
(40,45]
(25,30]
Length Bin (mm)
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Proportion by Sex and Year
0.1
0.2
0.3
0.4
0.5
Female
Male


Hook and Line Blue King Crab Sample Data (2008-2018)
Length at 50% maturity is 105mm (Pengilly and Schmidt 1995)
Length Bin (mm)
(165,170]
(160,165]
(155,160]
(150,155]
(145,150]
(140,145]
(135,140]
(130,135]
(125,130]
(120,125]
(115,120]
(110,115]
(105,110]
(100,105]
(95,100]
(90,95]
(85,90]
(80,85]
(75,80]
(70,75]
(65,70]
(60,65]
(55,60]
(50,55]
(35,40]
M = 1069
F = 250
M = 1099
F = 387
M = 53
F = 19
M = 198
F = 21
M = 208
F = 10
M = 117
F = 10
M = 151
F = 40
M = 40
F = 23
M = 117
F = 16
M = 90
F = 8
M = 84
F = 13
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Proportion by Sex and Year
0.1
0.2
Female
Male

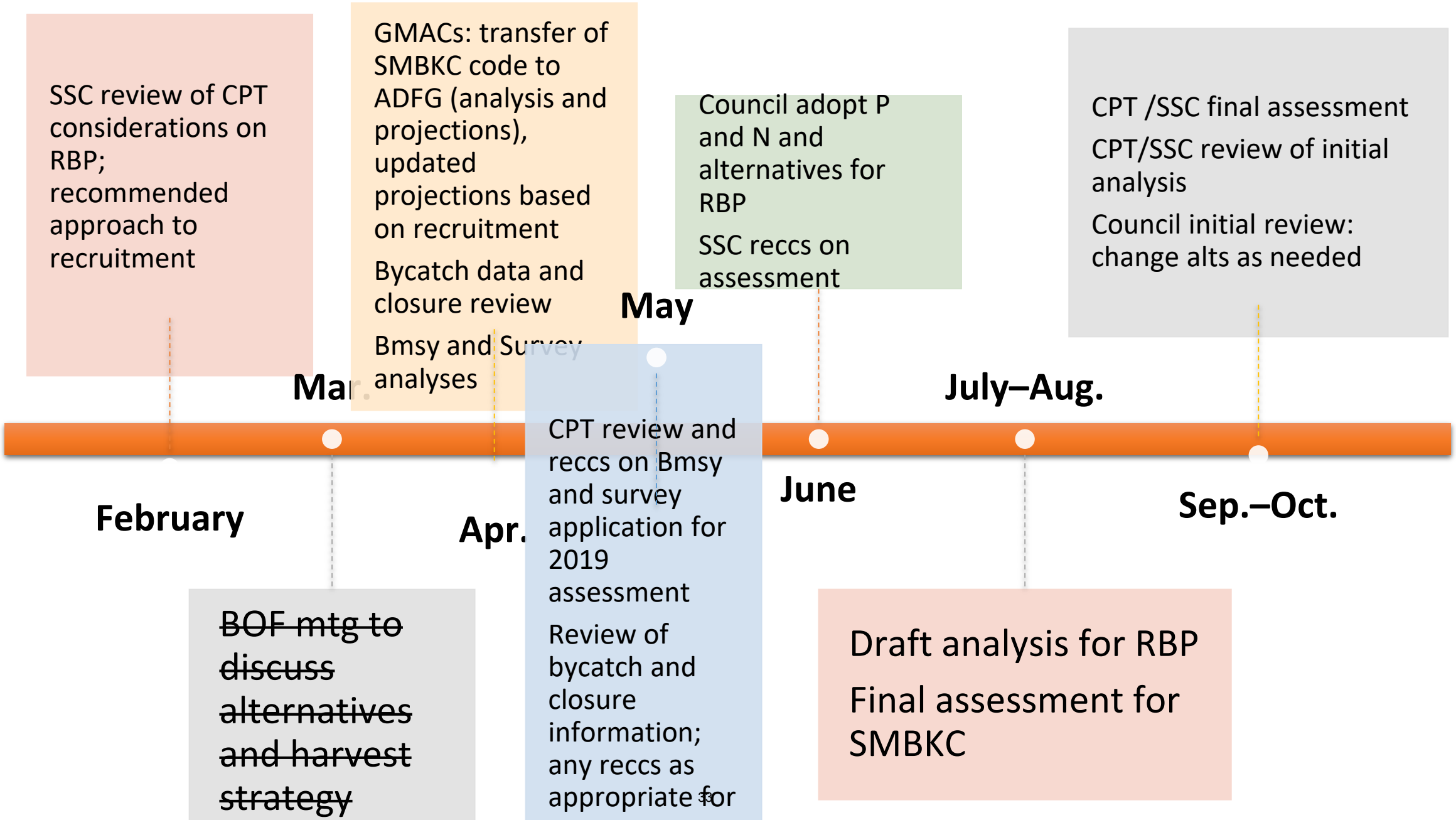
What should be considered in a range of alternatives?

Considerations:

- harvest strategy
- habitat considerations
- probability of rebuilding
- bycatch in groundfish fisheries
- other considerations?

CPT recommendations

- Scenarios with $B_{MSYPROXY}$ and recruitment defined using same time frames (Scenarios 1 and 5)
- Assessment to present alternative status determination results for Fall 2019
  - Current (1978-2017) and breakpoint (1996-2017)
- State harvest strategy as upper bound on mortality
  - Consider amending so that no directed fishing until rebuilt
- Rebuilt should be defined in plan as first year > B_{MSY}
- Rely on in-season management measures to close areas of high bycatch if OFL is approached
- Consider environmental factors which may affect rebuilding


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

Council actions 2019-2020 following initial review draft

Dec

- Council action as necessary
- Public review draft

Feb

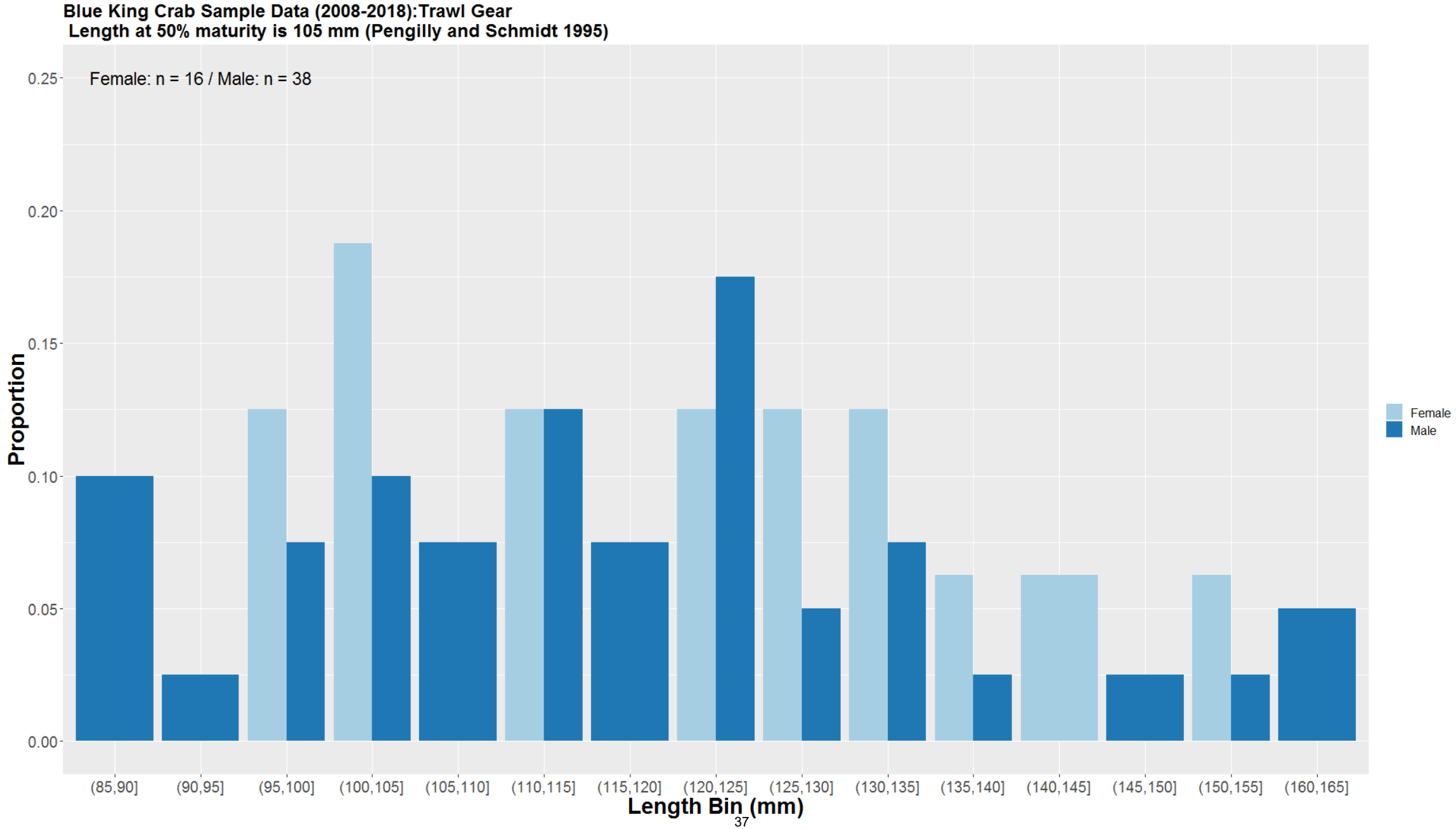
- Council Final action
- SOC final analysis

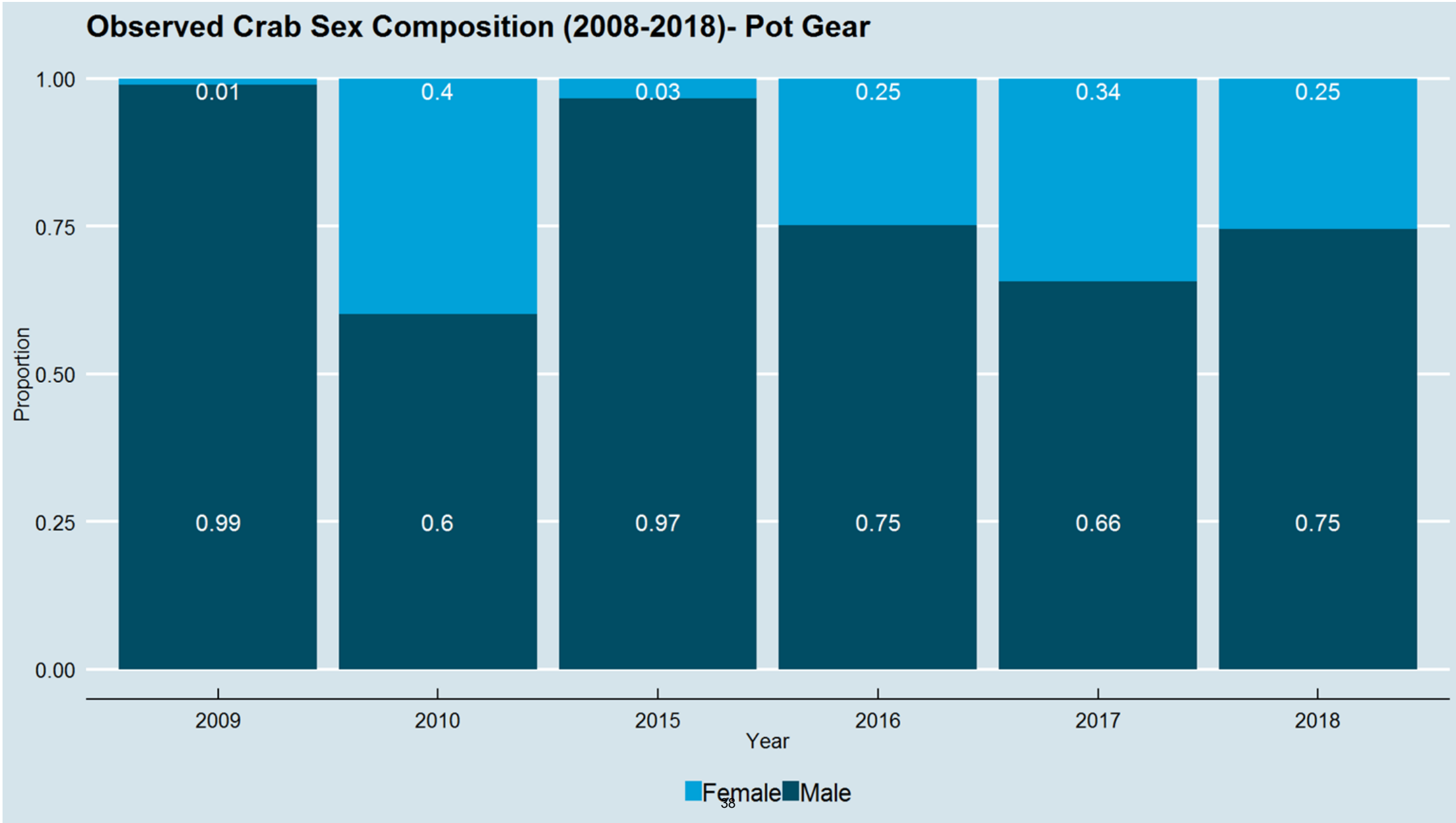
April/October

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

T_{MAX} / GENERATION TIME

- Age of recruitment – 7 : Generation time – 13.59
- Age of recruitment – 6 : Generation time – 12.59


Blue King Crab Sample Data (2008-2018):Trawl Gear
Length at 50% maturity is 105 mm (Pengilly and Schmidt 1995)
Female: n = 16 / Male: n = 38
Proportion
0.25
0.20
0.15
0.10
0.05
0.00
(85,90]
(90,95]
(95,100]
(100,105]
(105,110]
(110,115]
(115,120]
(120,125]
(125,130]
(130,135]
(135,140]
(140,145]
(145,150]
(150,155]
(160,165]
Length Bin (mm)
Female
Male


Observed Crab Sex Composition (2008-2018)- Pot Gear
1.00
0.75
0.50
0.25
0.00
Proportion
0.01
0.4
0.03
0.25
0.34
0.25
0.99
0.6
0.97
0.75
0.66
0.75
2009
2010
2015
2016
2017
2018
Year
Female
Male