Other agenda items

- PIBKC WAIRKC PIGKC SAFE updates
- PIGKC assessment plan
- NSRKC models for January
- AIGKC survey operations
- BSFRF report
- Tanner crab MSE
- Chionoecetes mating dynamics
- Chionoecetes skip molting

PIBKC

- SAFE completed May 2019
  - 2018/19 fishing mortality incomplete

- Updated 2018/19 fishing mortality:
  - No directed fishery
  - Bycatch mortality in the crab fisheries: *confidential(?)*
  - Bycatch mortality in the groundfish fisheries: 0.413 t

Year	MSST	Biomass (MMB_{mating})	TAC	Retained Catch	Total Catch Mortality	OFL	ABC
2015/16	2,058 A	361 A	closed	0	1.18	1.16	0.87
2016/17	2,053 A	232 A	closed	0	0.38	1.16	0.87
2017/18	2,053 A	230 A	closed	0	0.33	1.16	0.87
2018/19	2,053 A	230 A	closed	0	0.43	1.16	0.87
2019/20	--	175 B	--	--	--	1.16	0.87

- Overfishing did not occur in 2018/19
- Stock remains overfished

WAIRKC

Overfishing did not occur in 2018/19.

The directed fishery was closed in 2018/19.

Estimated total fishery mortality in 2018/19 (0.14 t) resulted from bycatch in the AIGKC fishery (0.01 t) and bycatch in groundfish fisheries (0.14 t).

Status and catch specifications (t) of Western Aleutian Islands red king crab

Fishing Year	MSST	Biomass (MMB)	TAC	Retained Catch	Total Catch	OFL	ABC
2013/14	N/A	N/A	Closed	0	<1	56	34
2014/15	N/A	N/A	Closed	0	<1	56	34
2015/16	N/A	N/A	Closed	0	1.3	56	34
2016/17	N/A	N/A	Closed	0	<1	56	34
2017/18	N/A	N/A	Closed	0	<1	56	14
2018/19	N/A	N/A	Closed	0	<1	56	14
2019/20	N/A	N/A				56	14

PIGKC

Overfishing did not occur in 2018.

One vessel participated in the 2018 directed fishery. Estimated total fishery mortality in 2018 [redacted] resulted from retained catch [redacted], bycatch in the directed fishery [redacted] and bycatch in groundfish fisheries (1.54 t).

Management Performance Table (values in t)

Calendar Year	MSST	Biomass (MMB)	GHL[a]	Retained Catch	Total Catch[b]	OFL	ABC
2013	N/A	N/A	68	Conf.[c]	Conf.[c]	91	82
2014	N/A	N/A	68	Conf.[c]	Conf.[c]	91	82
2015	N/A	N/A	59	0	1.92	91	68
2016	N/A	N/A	59	0	0.24	91	68
2017	N/A	N/A	59	Conf.[c]	Conf.[c]	93	70
2018	N/A	N/A	59	Conf.[c]	Conf.[c]	93	70

a. Guideline harvest level, established in lb and converted to t.

b. Total retained catch plus estimated bycatch mortality of discarded catch during crab fisheries and bycatch mortality due to groundfish fisheries are included here, but not for 2013, 2014, 2017, and 2018 because the directed fishery is confidential.

c. Confidential under Sec. 16.05.815 (SOA statute).

Pribilof Island golden king crab Assessment: Review of Tier status and future directions

Benjamin Daly

Crab Plan Team Meeting

Seattle, Sept 16-20, 2019

- Fishery data
  - 100% observer coverage
  - 100% dockside sampled
- Commissioner's Permit fishery
  - Ability to design survey style fishery
    - Sample design, specific areas
- Increased interest
  - Decline in other BSAI crab fisheries
  - Increased inquiries and participation
- Requests for increased GHLs (currently 130,000 lb)
  - Reevaluate stock assessment

Pribilof District golden king crab commercial fishery harvest data, 1981/82 - 2019.

				Number of				Average		
Season	GHL[b]	Harvest[a,c]	Deadloss[c]	Vessels	Landings	Crab[a]	Pots lifted	CPUE[d]	Weight[c]	Length[e]
1981/82	-	CF	CF	2	3	CF	CF	CF	CF	CF
1982/83	-	69,970	570	10	19	15,330	5,252	3	4.6	151
1983/84	-	856,475	20,041	50	115	253,162	26,035	10	3.4	127
1984	-	No Commercial Fishing Effort								
1985	-	CF	CF	1	1	CF	CF	CF	CF	CF
1986	-	No Commercial Fishing Effort								
1987	-	CF	CF	2	2	CF	CF	CF	CF	CF
1988	-	CF	CF	1	2	CF	CF	CF	CF	CF
1989	-	CF	CF	2	4	CF	CF	CF	CF	CF
1990 - 1992	-	No Commercial Fishing Effort								
1993	-	67,458	0	5	15	17,643	15,395	1	3.8	NA
1994	-	88,985	730	3	5	21,477	1,845	12	4.1	NA
1995	-	341,908	716	7	22	82,489	9,551	9	4.1	NA
1996	-	329,009	3,570	6	32	91,947	9,952	9	3.6	NA
1997	-	179,249	5,554	7	23	43,305	4,673	9	4.1	NA
1998	-	35,722	474	3	9	9,205	1,530	6	3.9	NA
1999	200,000	177,108	319	3	9	44,098	2,995	15	4.0	NA
2000	150,000	127,217	4,599	7	19	29,145	5,450	5	4.4	NA
2001	150,000	145,876	8,227	6	14	33,723	4,262	8	4.3	143
2002	150,000	150,434	8,984	8	20	34,860	5,279	6	4.3	144
2003	150,000	CF	CF	3	6	CF	CF	CF	CF	CF
2004	150,000	CF	CF	5	8	CF	CF	CF	CF	CF
2005	150,000	CF	CF	4	8	CF	CF	CF	CF	CF
2006 - 2009	150,000	No Commercial Fishing Effort								
2010	150,000	CF	CF	1	3	CF	CF	CF	CF	CF
2011	150,000	CF	CF	2	4	CF	CF	CF	CF	CF
2012	150,000	CF	CF	1	3	CF	CF	CF	CF	CF
2013	150,000	CF	CF	1	2	CF	CF	CF	CF	CF
2014	150,000	CF	CF	1	1	CF	CF	CF	CF	CF
2015 - 2016	130,000	No Commercial Fishing Effort								
2017	130,000	CF	CF	2	6	CF	CF	CF	CF	CF
2018	130,000	CF	CF	1	3	CF	CF	CF	CF	CF
2019	130,000	CF	CF	2	5	CF	CF	CF	CF	CF

Note: CF = confidential, NA = not available.

Shaded lines indicate GHL was at least 90% harvested.

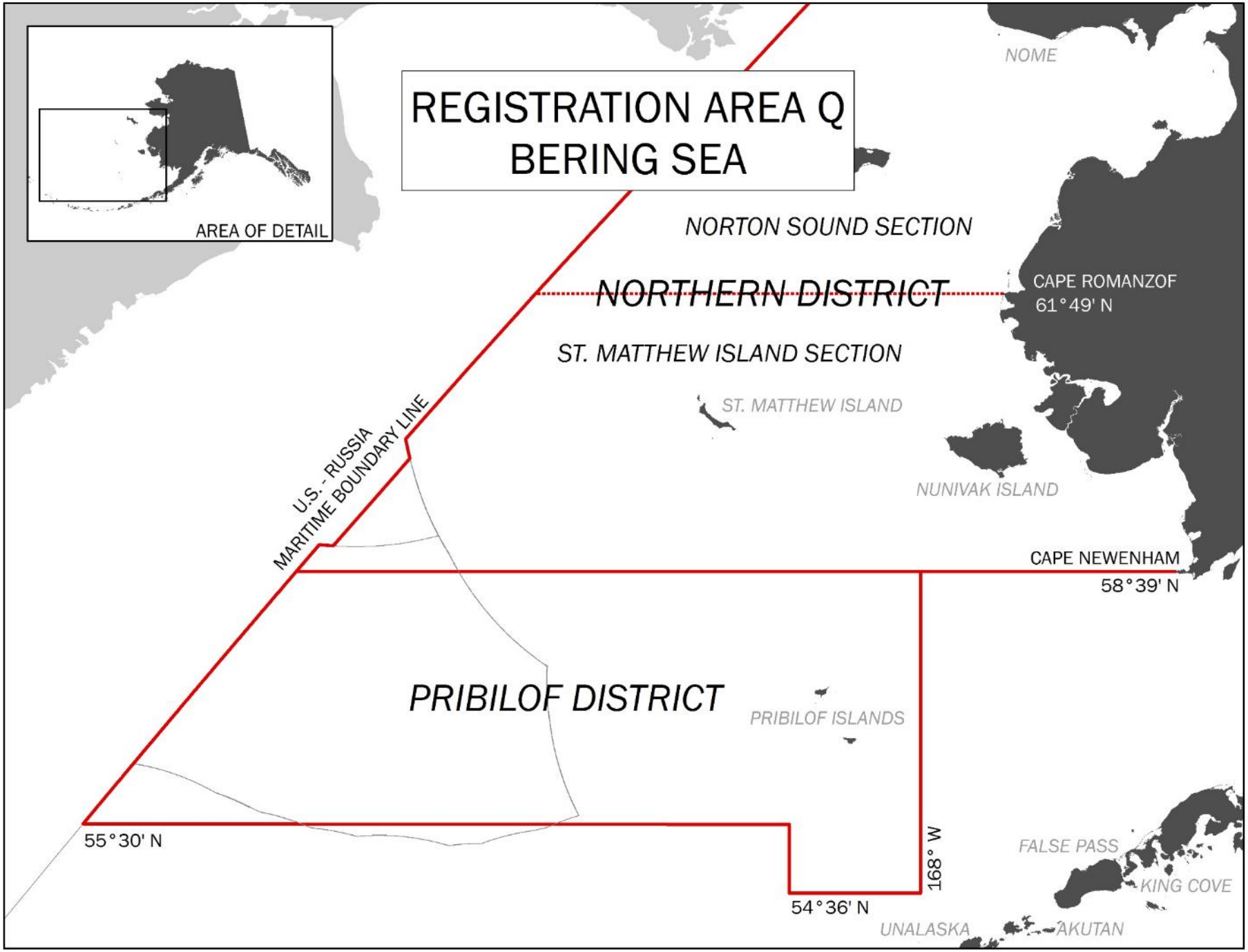
[a] Deadloss included.

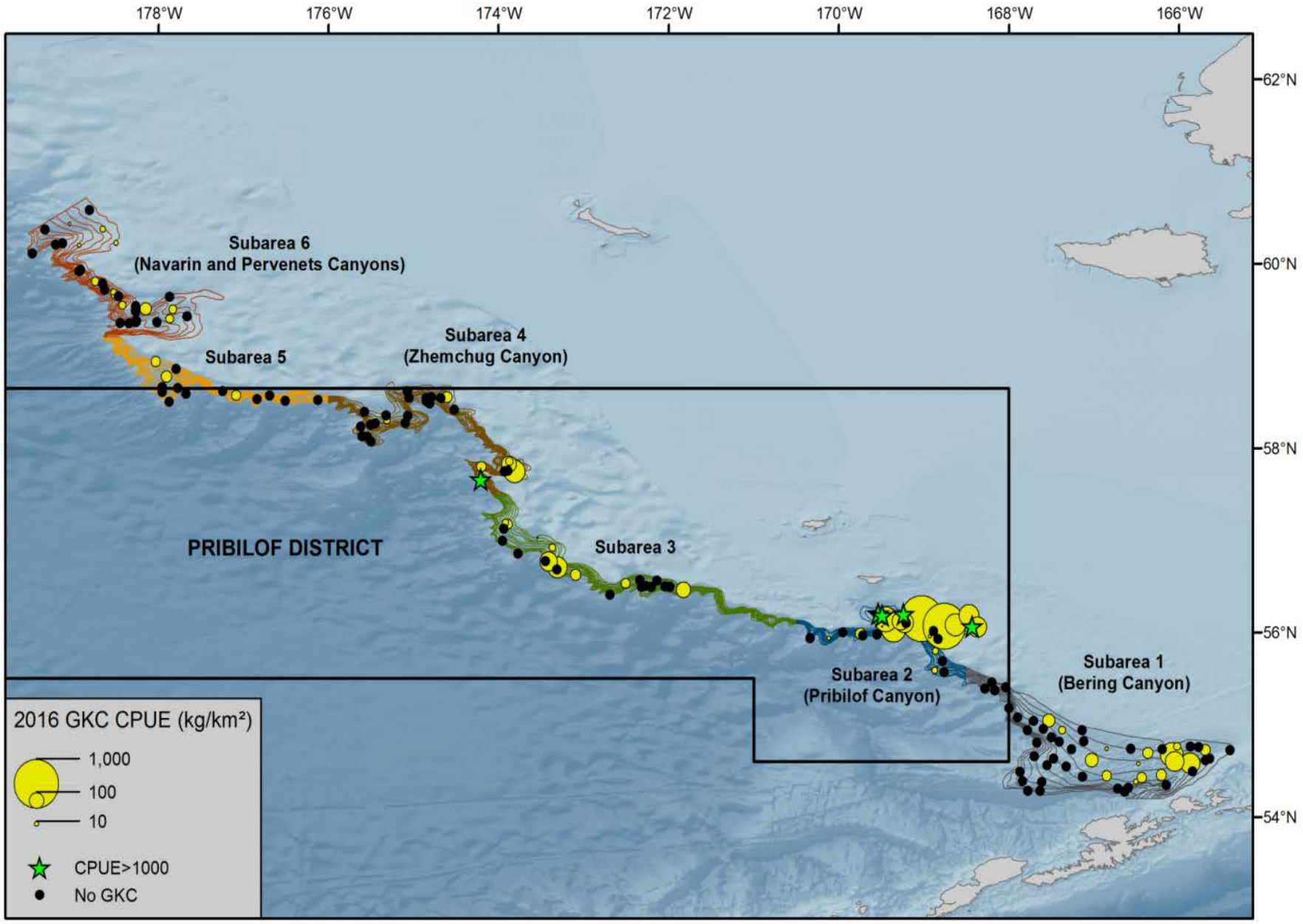
[b] Guideline harvest level (GHL) in pounds.

[c] In pounds.

[d] Number of retained crab per pot lift.

[e] Carapace length in millimeters.

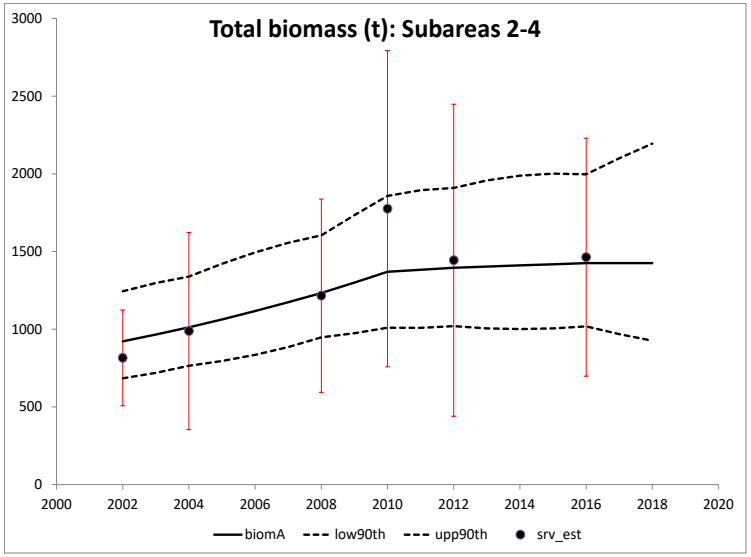

AREA OF DETAIL
REGISTRATION AREA Q
BERING SEA
NOME
NORTON SOUND SECTION
NORTHERN DISTRICT
CAPE ROMANZOF
61°49' N
ST. MATTHEW ISLAND SECTION
ST. MATTHEW ISLAND
NUNIVAK ISLAND
U.S. - RUSSIA
MARITIME BOUNDARY LINE
CAPE NEWENHAM
58°39' N
PRIBILOF DISTRICT
PRIBILOF ISLANDS
55°30' N
168° W
54°36' N
FALSE PASS
KING COVE
UNALASKA
AKUTAN

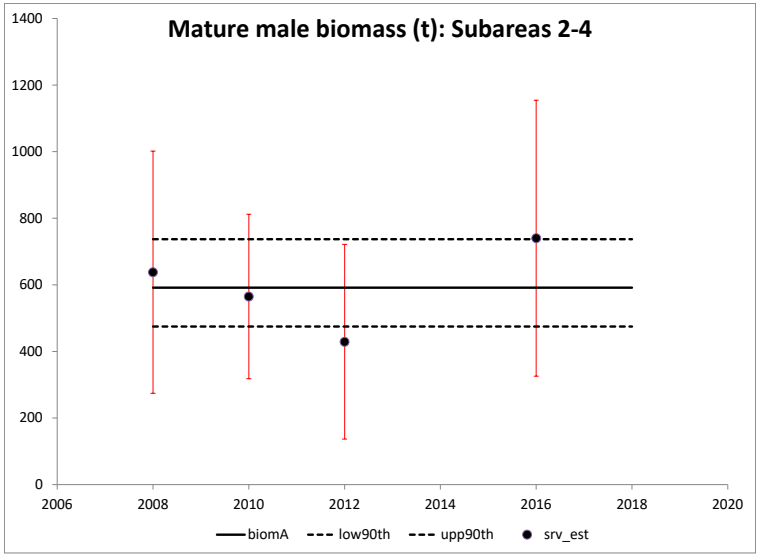

178°W
176°W
174°W
172°W
170°W
168°W
166°W
62°N
60°N
58°N
56°N
54°N
Subarea 6
(Navarin and Pervenets Canyons)
Subarea 5
Subarea 4
(Zhemchug Canyon)
PRIBILOF DISTRICT
Subarea 3
Subarea 2
(Pribilof Canyon)
Subarea 1
(Bering Canyon)
2016 GKC CPUE (kg/km²)
1,000
100
10
CPUE>1000
No GKC

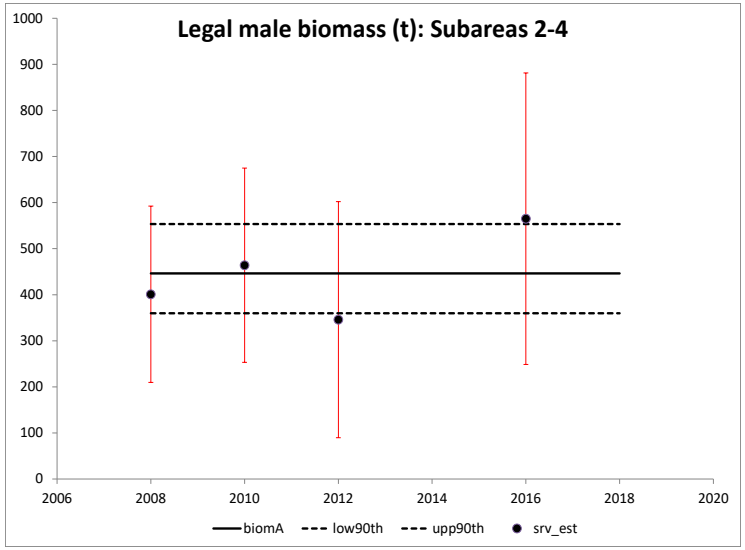
Random Effects Model: Program "re.exe"

- Considers the process errors as "random effects" (i.e., drawn from an underlying distribution) and integrated out of the likelihood.
- Developed by the NPFMC groundfish plan team's survey averaging working group as a smoothing technique similar to the Kalman Filter
  - Provides more flexibility with non-linear processes and non-normal error structures.

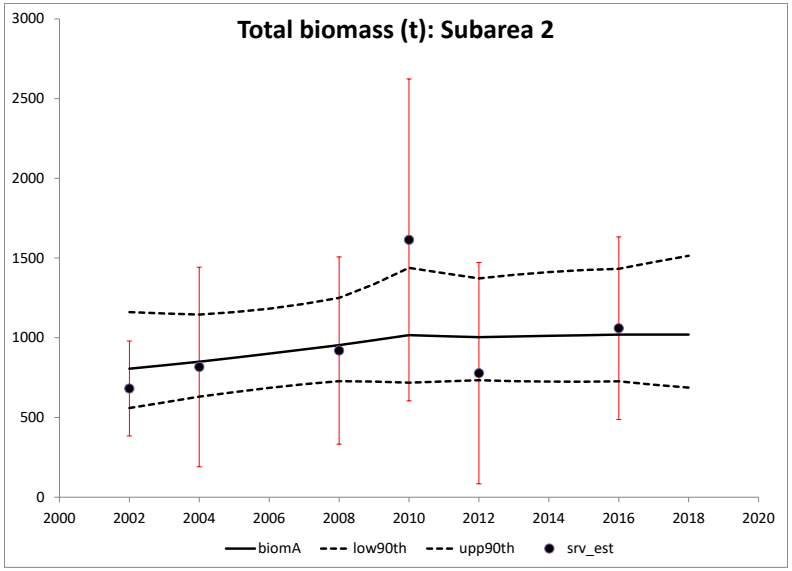
Model results

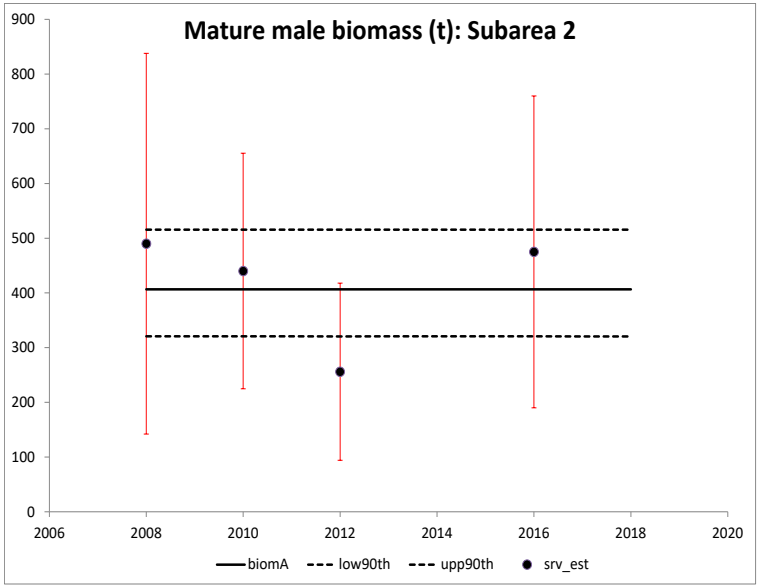


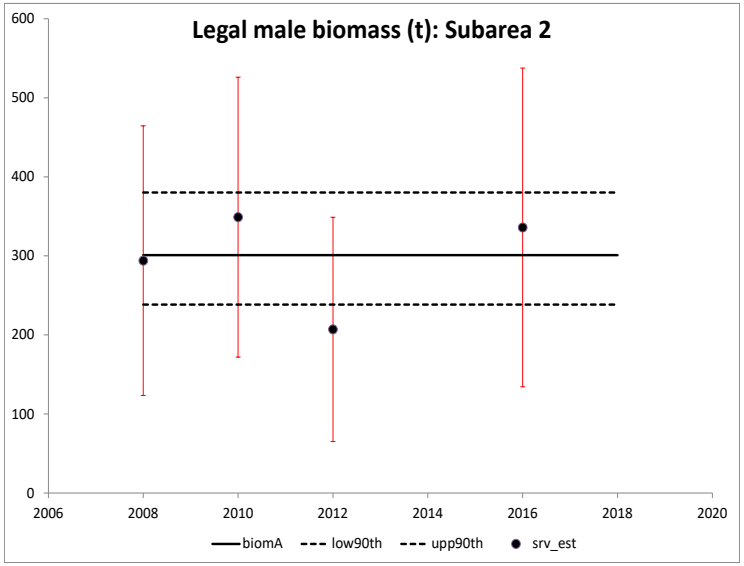




Model Results







Regarding Tier 4….

- The CPT agreed with the author's recommendation of keeping PIGKC at Tier 5 until the model improves.
- It is also noted that the model does run through the point estimate error bars. Ben Daly, Martin Dorn, and Jack Turnock discussed process error at the [May 2017] meeting break, and investigated the "par" files, which showed that the model did converge and estimated zero process error. As such, *an argument could be made that the model did perform adequately and could be used to estimate mature and legal male biomass.*

Update for May 2020 assessment

- Tier 5 (currently) or Tier 4 (random effects model)
- Random effects model – Bering Sea Slope survey
  - Only post 2000 data
  - Total biomass for 2002(not separated by male and female)
  - Male biomass available for 2008, 2010, 2012, 2016
  - Working on 2004 size frequency data restoration
  - Concern over the fit of this model in the past
- Future of NOAA trawl survey uncertain (cancelled in recent years)
- Cooperative survey with industry option?

CPT Feedback?

- Short-term: For May 2020
  - Re-run model with 2004 survey size data
  - Reconsider model performance?
  - Include more recent catch data in Tier 5 calculation
    - this will likely decrease OFL/ABC…recent catch lower than reference years mean
- Long-term: next ~5+ years
  - Expand survey data
    - Future NOAA slope surveys is uncertain
      - *Very little chance of 2020 slope survey (J.Hoff, pers. comm.)*
    - New ADF&G pot survey?
  - Work on model performance
  - Try in GMACS?

Norton Sound Red King Crab SAFE 2020

Sept 19 2019

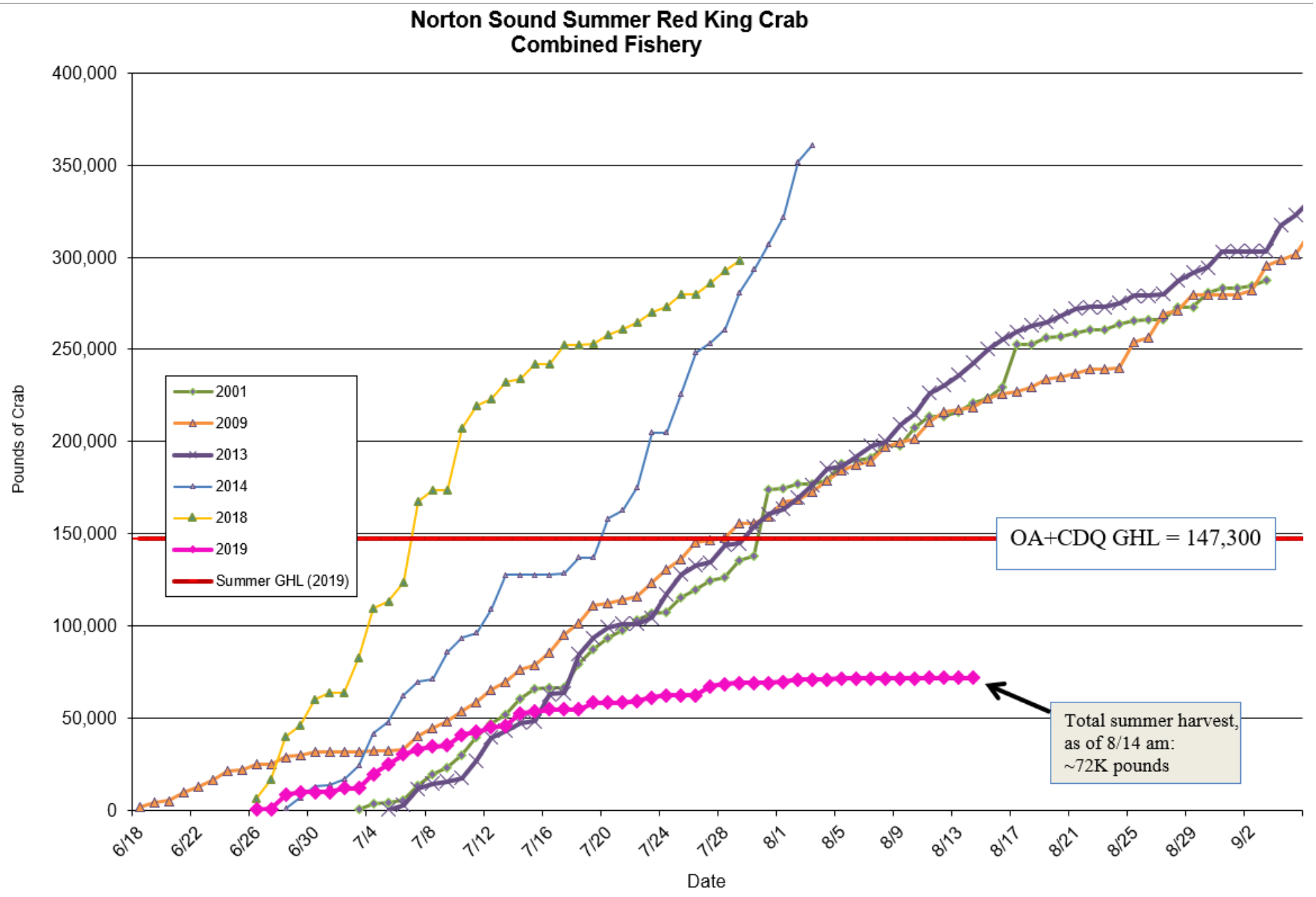
Crab Plan Team Seattle WA

Toshihide “Hamachan” Hamazaki,
Jie Zheng
Alaska Department of Fish & Game
Division of Commercial Fisheries

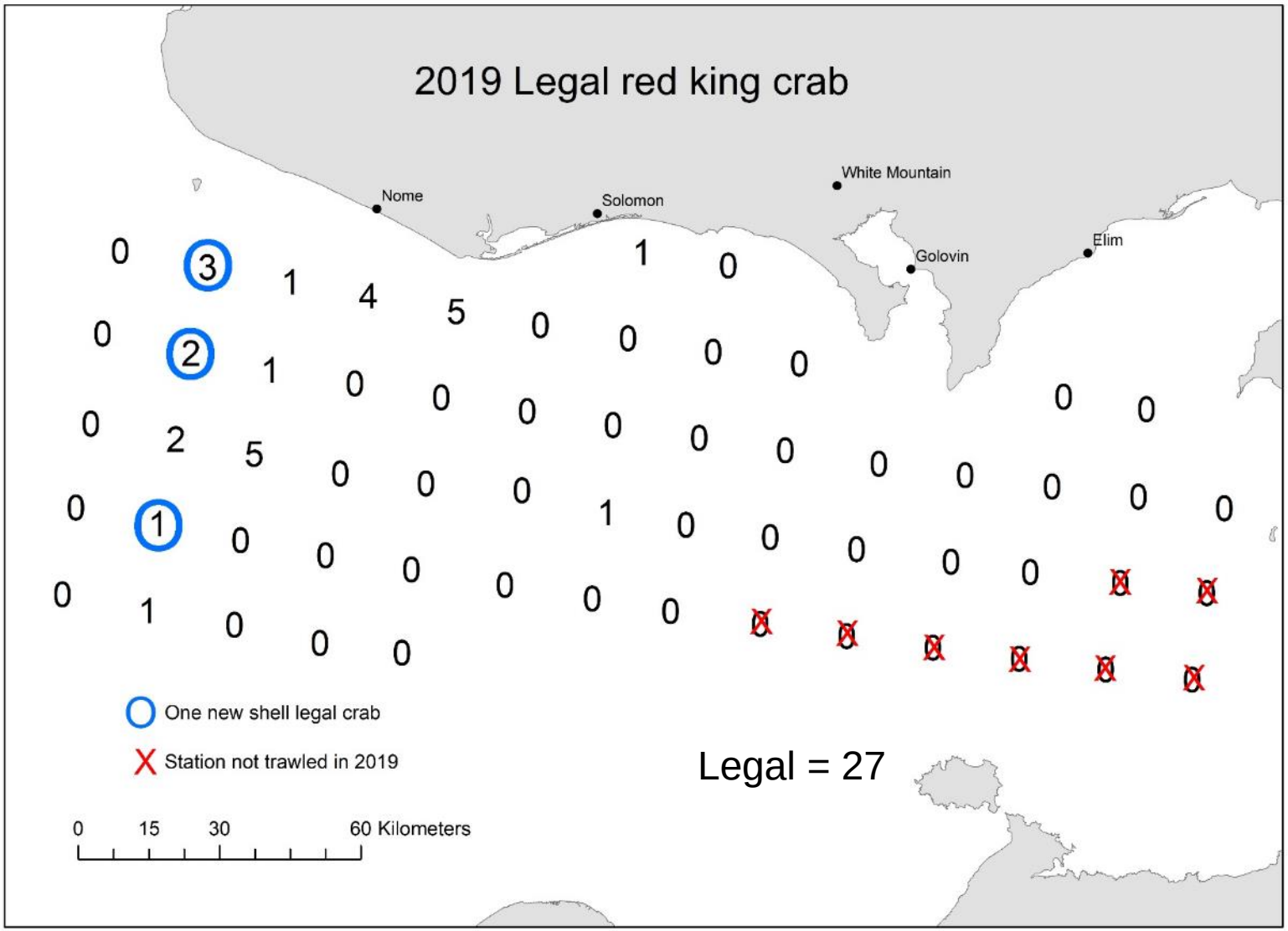
Changes Fishery & Data

- Winter fishery 2019
  - Commercial: 1,050 89% down from 2018 (9,180)
  - Subsistence: 1,545 65% down from 2018 (4,424)
- Summer commercial fishery 2018
  - 6/25-9/03: 24,506 73% down from 2018 (89,613)
- Total retained harvest: 0.03 mill. lb. < ABC (0.19 mill. lb.)
- All harvest and observer data NOT FINALIZED
- Standardized CPUE update preliminary (Appendix B)
  - 60% down from 2018
- ADF&G 2019 Summer trawl survey
  - 7/17-7/29: 4660.8 k, CV =0.60 420% up from 2018 (1,108.9)
- NOAA 2019 Summer trawl survey
  - 7/28-8/30: Waiting for Haul data
- NOAA 1976-1991 Summer trawl survey
  - Abundance data updated
- Winter Commercial Retained length-shell Not collected
- Tag recovery: waiting (but may not need them).
- Changes in fishery regulation: None

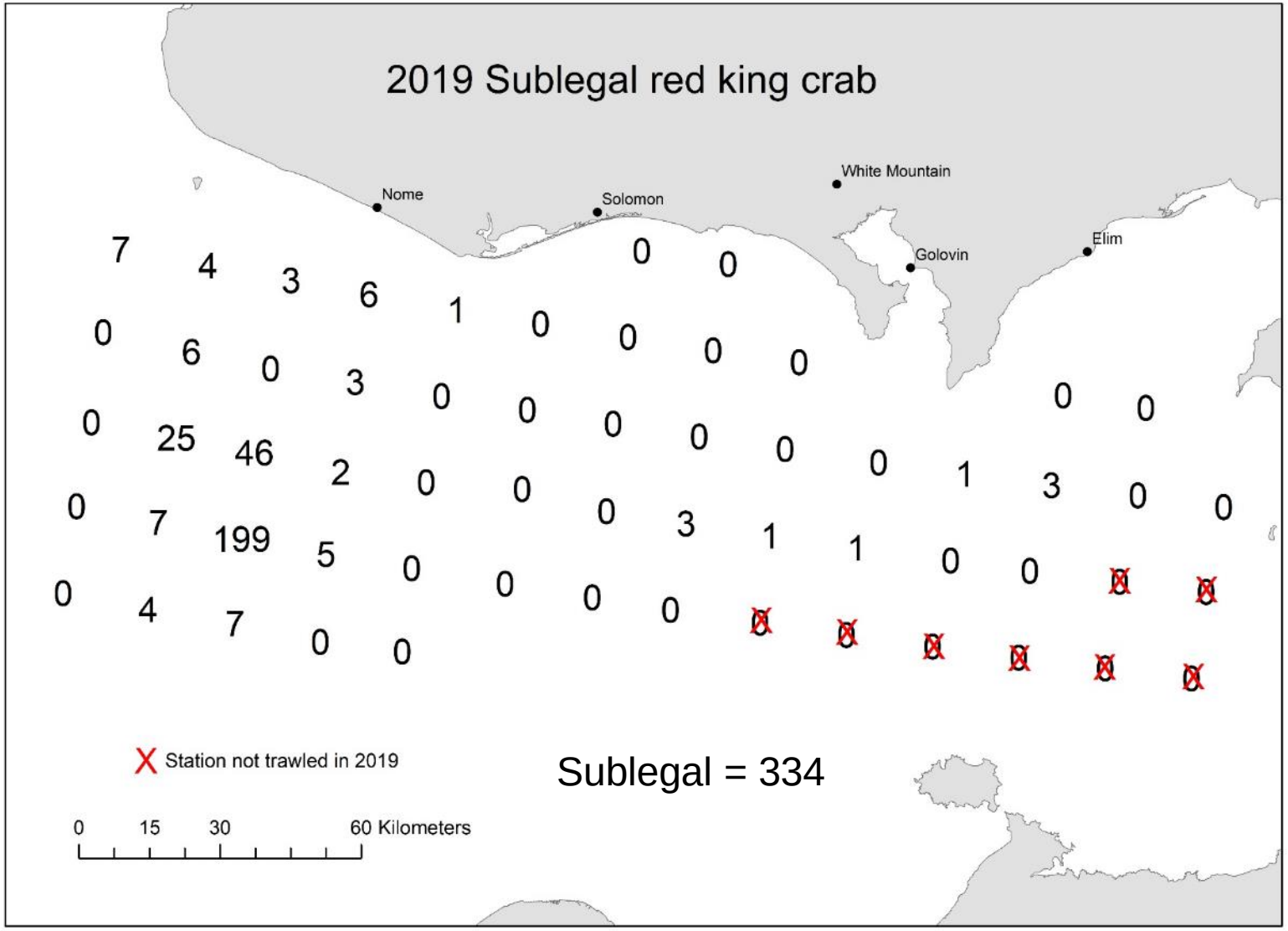
2019 Summer Commercial Fishery



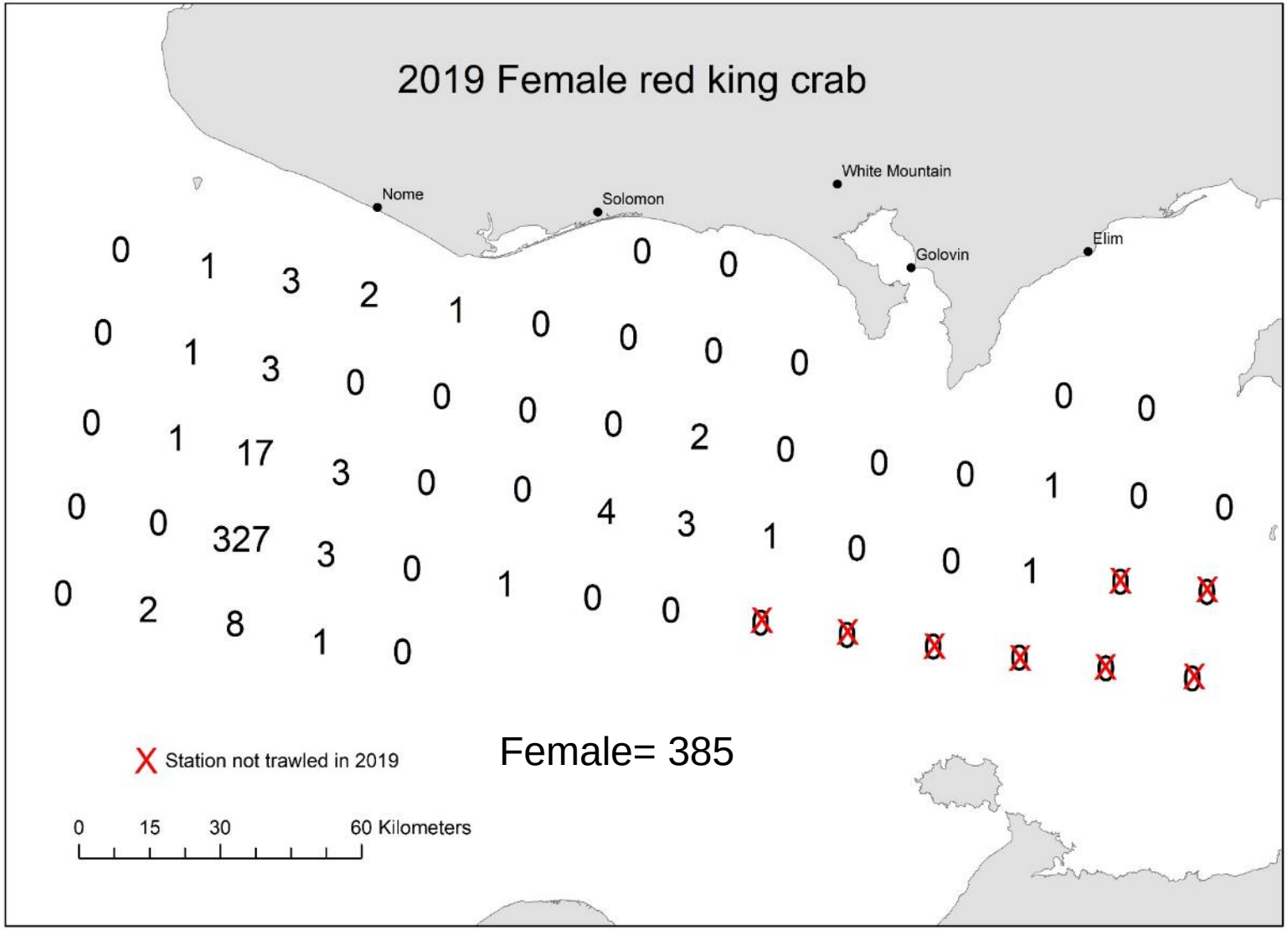
2019 Trawl Survey ADFG



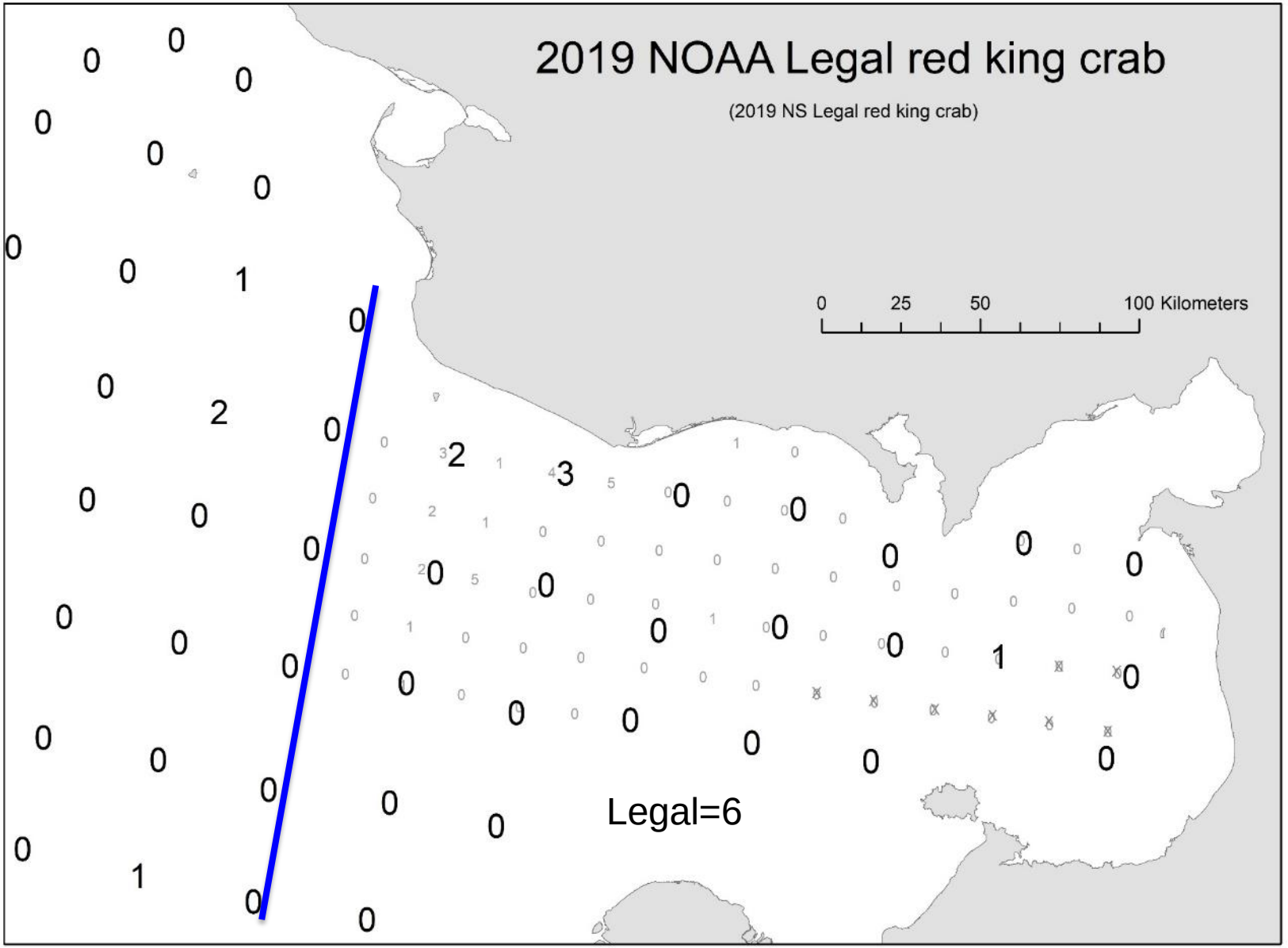
2019 Trawl Survey ADFG



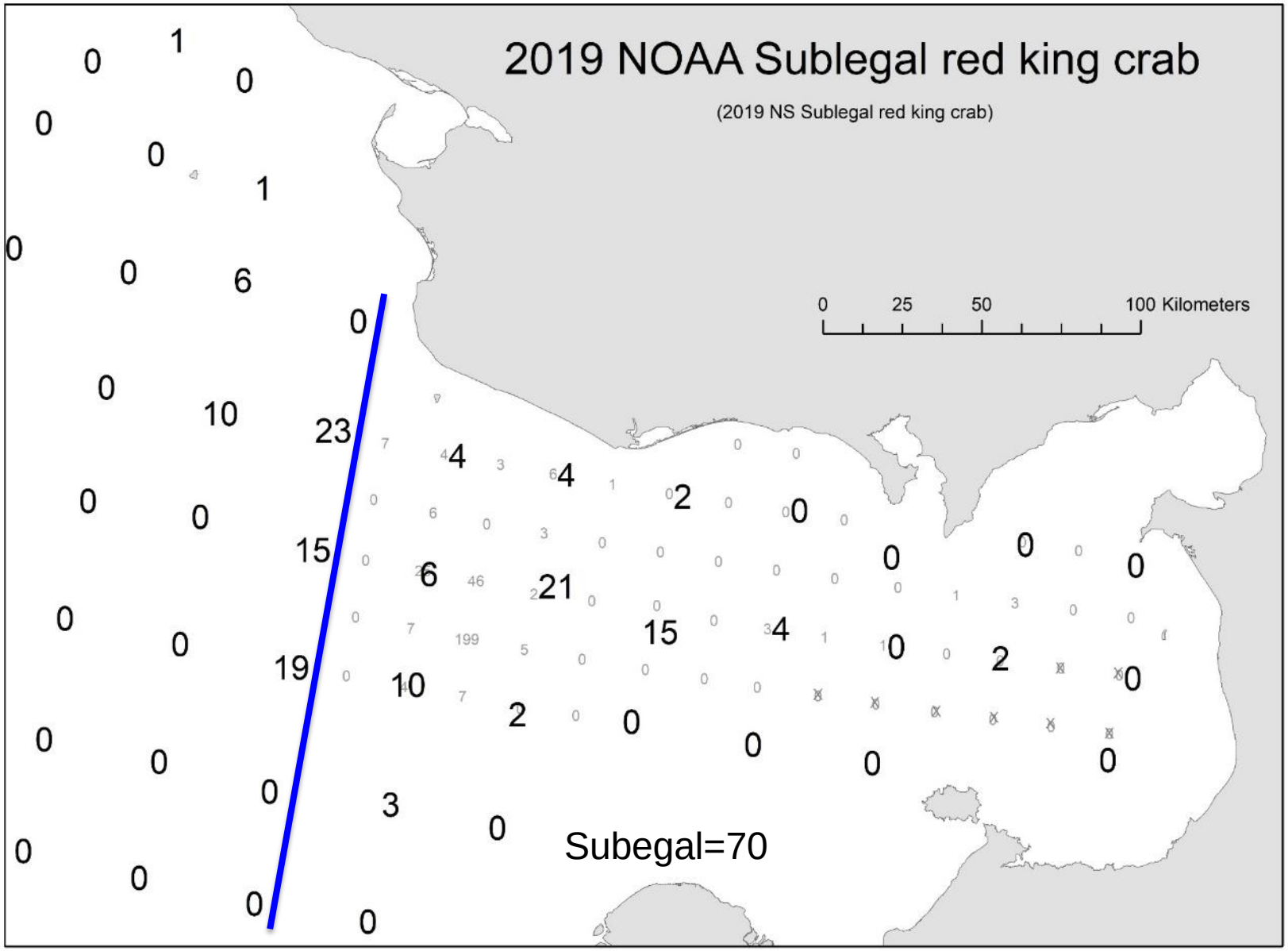
2019 Trawl Survey ADFG



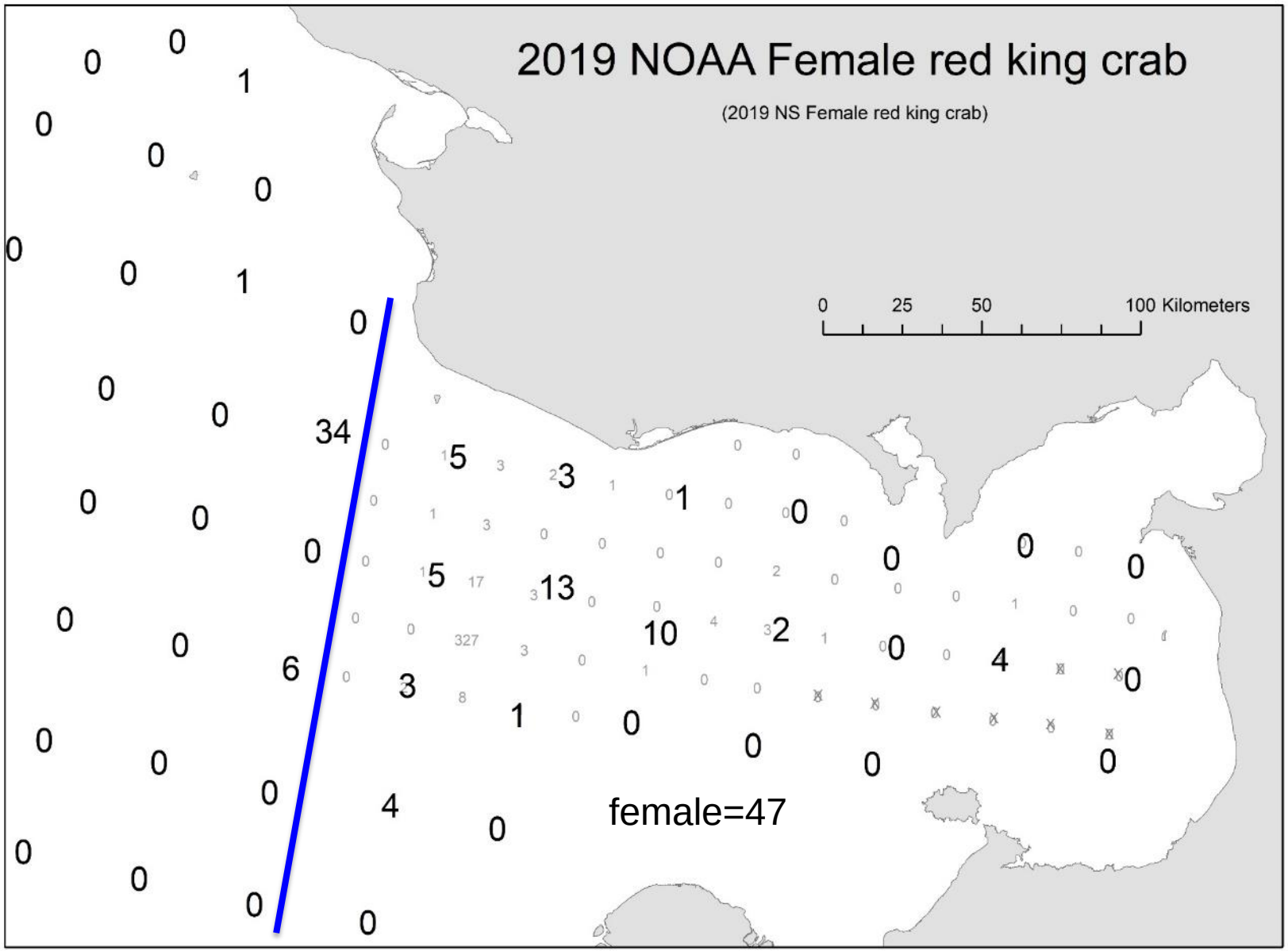
2019 Trawl Survey NMFS



2019 Trawl Survey NMFS



2019 Trawl Survey NMFS

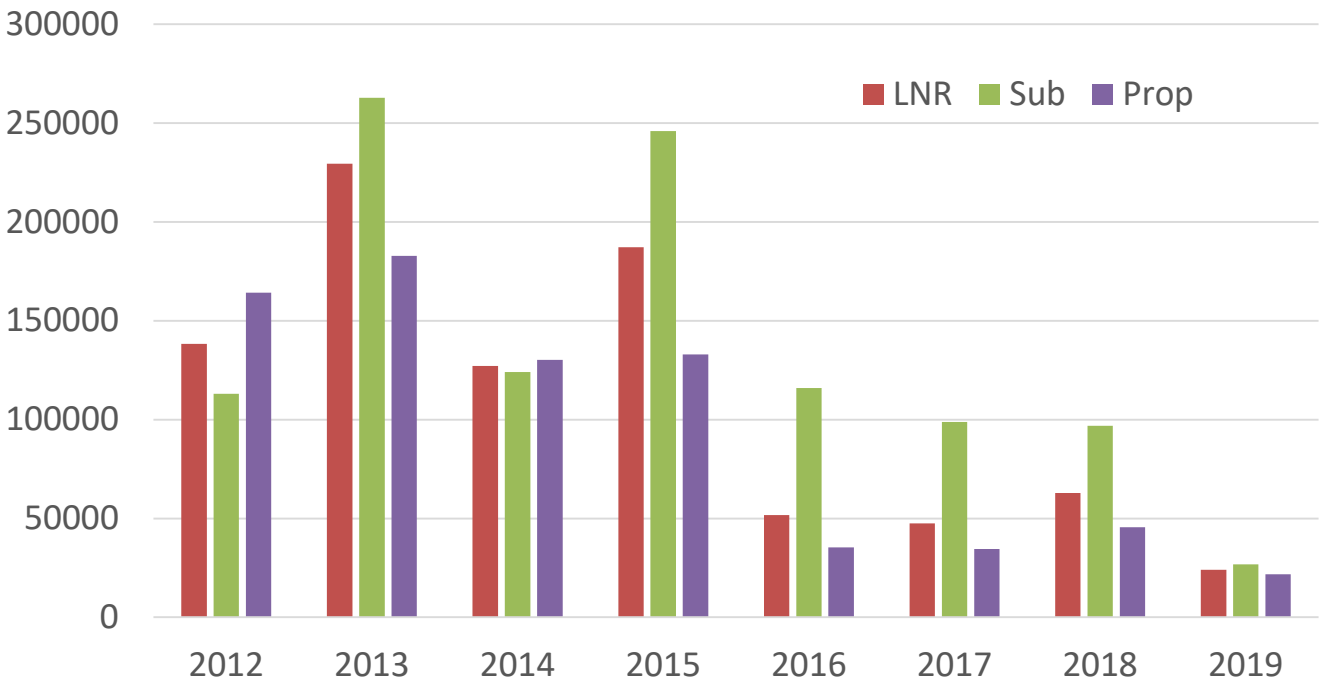


CPT / SSC comments

- Retained catch OFL/ABC due to lack of discards
  - Work to include discard estimates
- Maturity data using chela height
- CPUE standardization

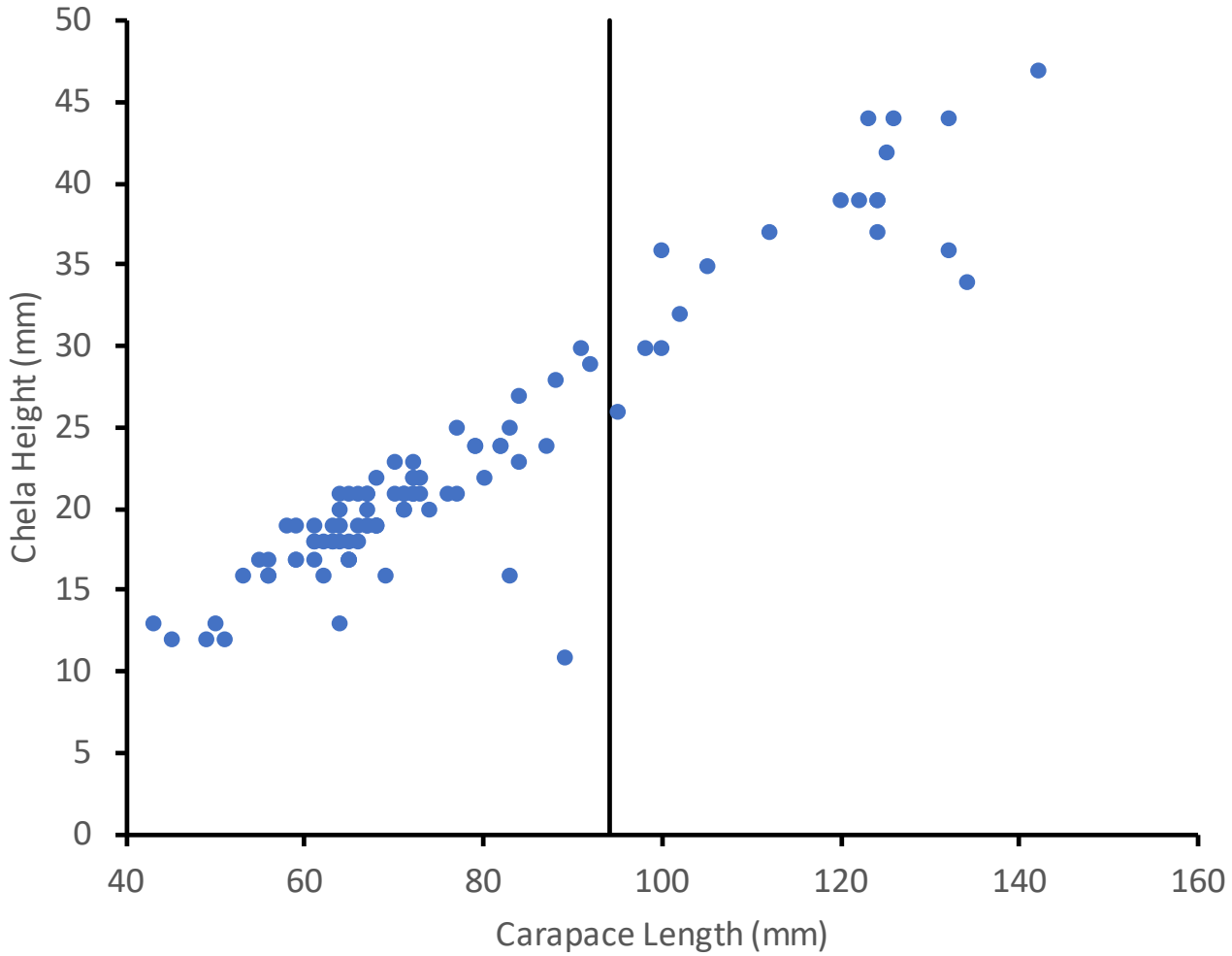
Discards Estimates

- CPUE based (ob CPUE = total CPUE)
  - LNR: Total Discards = (ob discards)*(total pot lifts)/(ob pot lifts)
  - Sub: Total Discards = (ob total catch)*(total pot lifts)/(ob pot lifts) – total retain
- Prop based (ob p discards = total p discards) (Assessment model)
  - P: Total Discards = (ob discards)*(total retain)/(ob retain)



Responses to CPT & SSC

- Male Maturity: Chela height does not seem to inform about male maturity



Responses to CPT & SSC

- Standardized CPUE: dealing with changes of fishery practice and regulation
  - Period 1: Large vessel: 1977-1993
  - Period 2: Small vessel: 1994-2004
  - Period 3: Buyer accepting large > 5.0 in CW only: 2005-2019
- Original model
  - Separate data two periods: 1977-1993, 1994-2019
- SSC: Incorporate Period 3 in the standardization
  - Option 1: Separate data into 3 periods and run separate GLM
    - 3 Fishery Qs
  - Option 2: Include PD (Period 2, 3) as separate variable and run single GLM for 1994-2019 (SSC suggestion)
    - 2 Fishery Qs (SAFE model 18.6)
  - Option 3: Include PD (Period 1,2,3) and run single GLM for 1976-2019
    - 1 Fishery Q

Responses to CPT & SSC

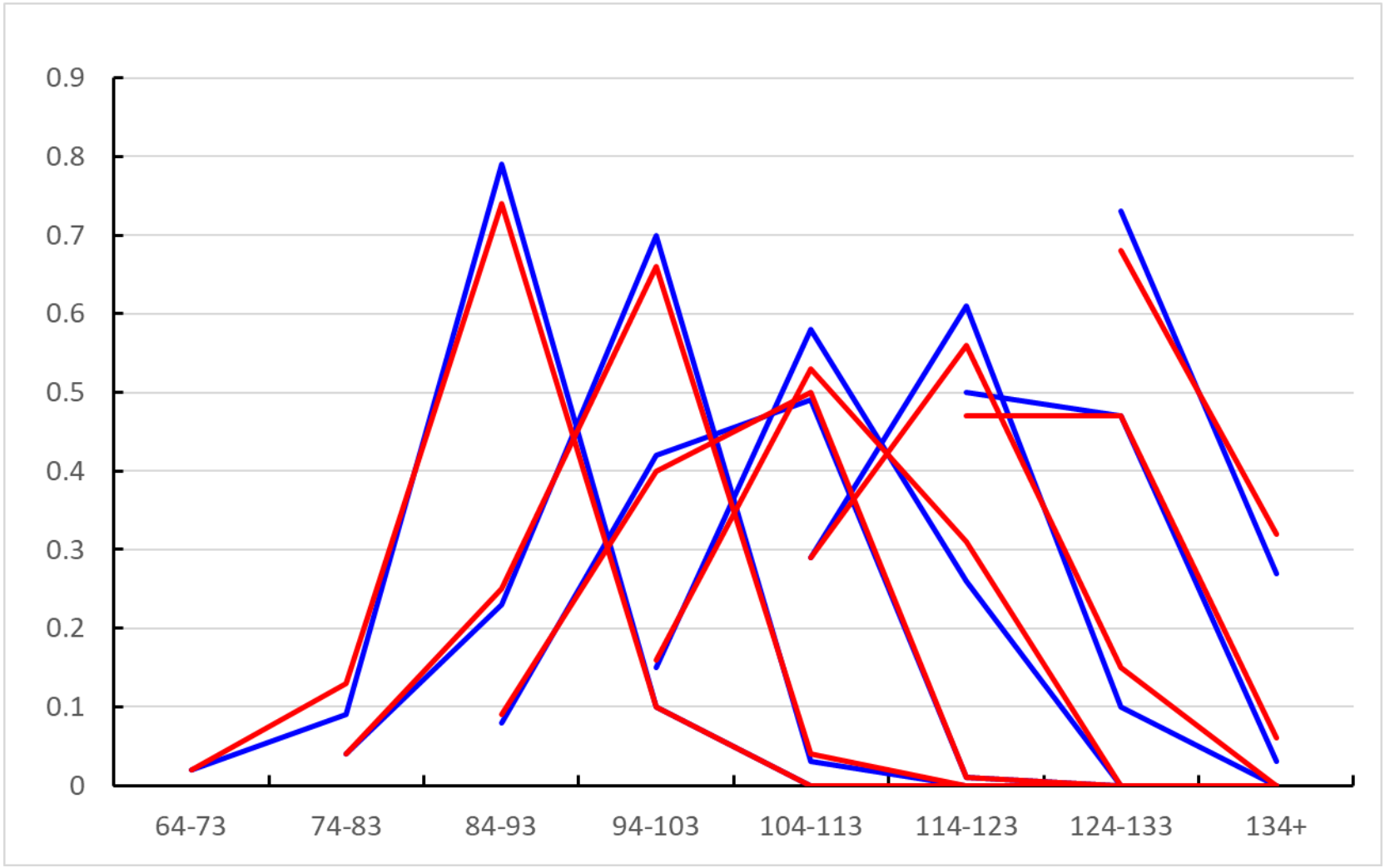
- Option 3: Include PD (Period 1,2,3) and run single GLM for 1976-2019
  - 1 Fishery Q
- Final model did not include PD
- Model CV increased ~ 0.3 for all years
  - Assessment model additional var ~ 0

Alternative model selection for 2020 SAFE

- Model 19.0: Baseline SAFE 2019 model with updated data
- Model 19.1: Fit only 1 year of tag recovery data
- Model 19.2: NMFS (1976-1991) survey Q = 1.0 and estimate ADFG (1996-2018) survey Q (ADFG survey is biased)
- Model 19.3: Estimate survey Q both NMFS, ADFG (Both surveys are biased)
- Model 19.4: Estimate single M and dome shape selectivity (Hide & Kill All option 1)
- Model 19.5: Estimate single M and dome shape selectivity (Hide & Kill All option 2)

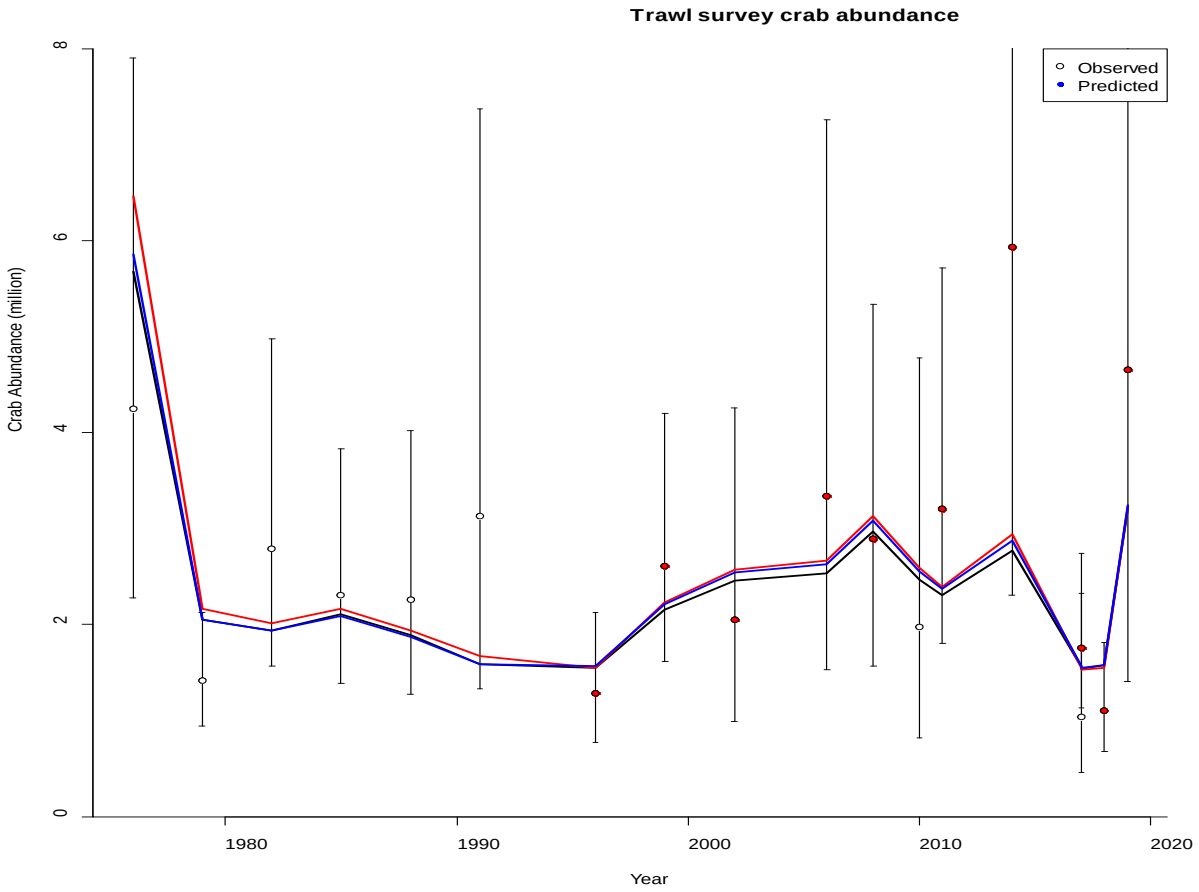
Alternative model selection for 2020 SAFE

- Model 19.0 (blue) vs. 19.1(red) : Fit only 1 year of tag recovery data



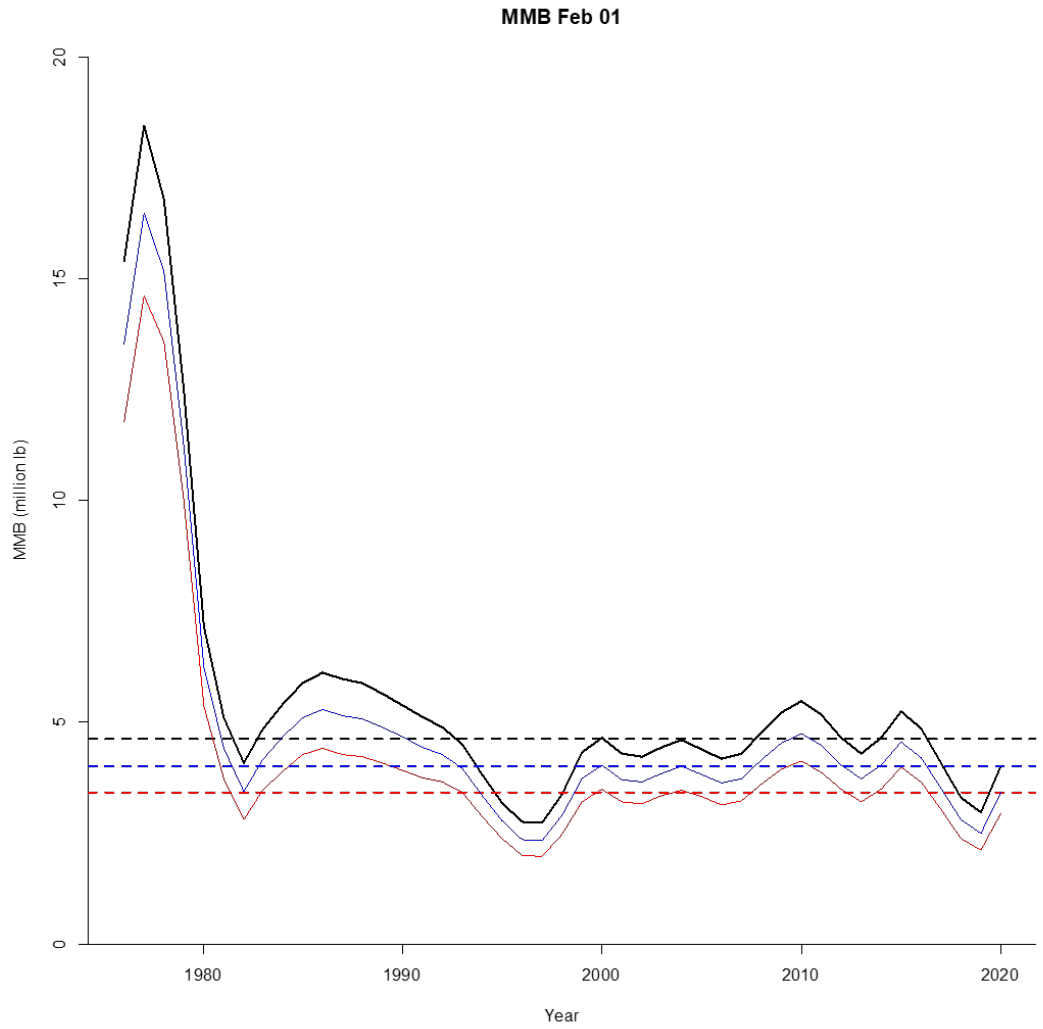
Alternative model selection for 2020 SAFE

- Model 19.2: NMFS (1976-1991) survey Q = 1.0 and estimate ADFG (1996-2018) survey Q (red)
- Model 19.3: Estimate survey Q both NMFS, ADFG (blue)
  - ADFG survey Q > 1.0, NMFS survey Q < 1.0



Alternative model selection for 2020 SAFE

- Model 19.2 (red), 19.3 (blue)
  - Q > 1.0: ADFG trawl surveys overestimate TRUE abundance

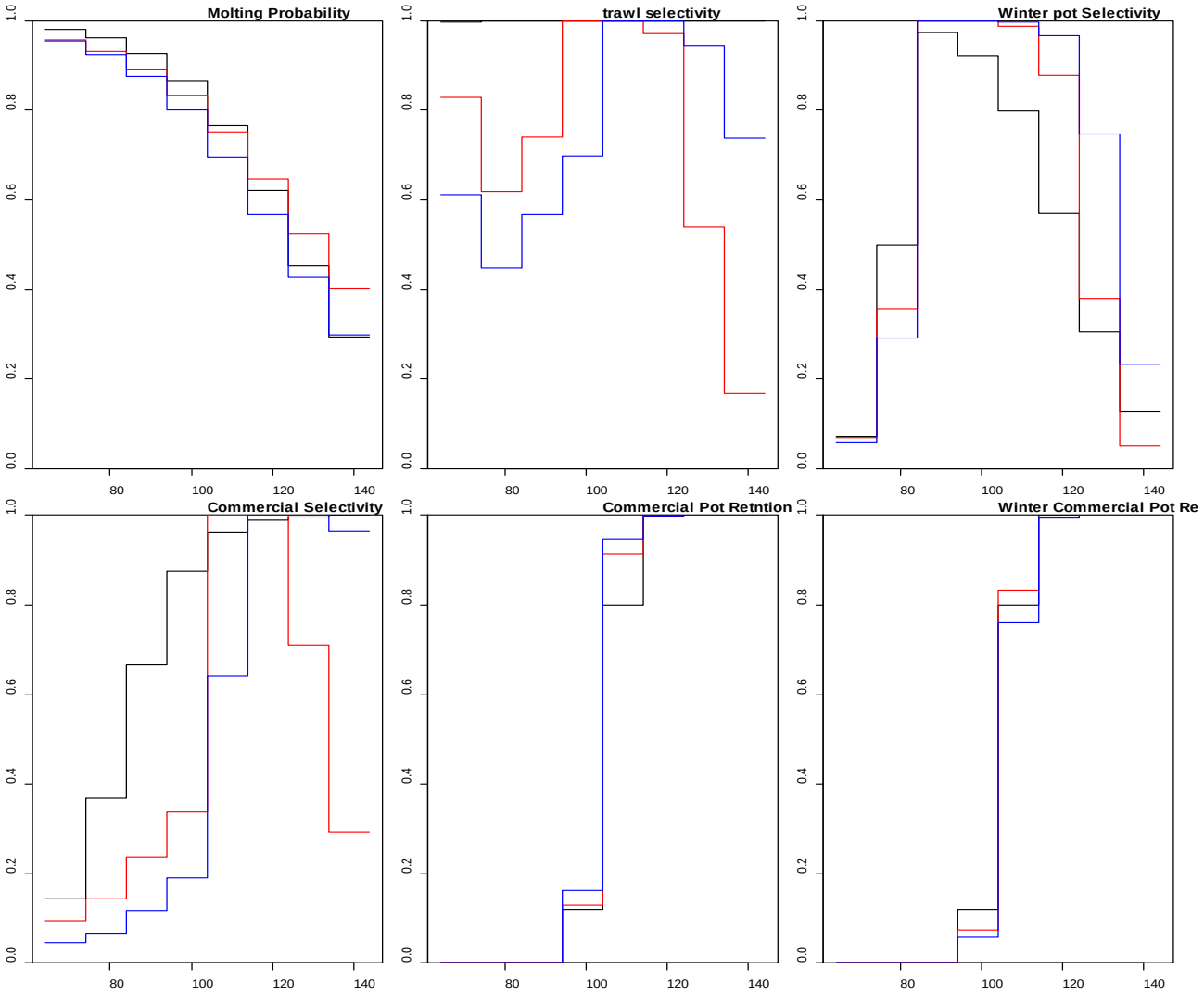


Alternative model selection for 2020 SAFE

- Model 19.4 & 19.5 : Estimate single M and dome shape selectivity for com fish and trawl (Hide & Kill All option 1,2)
- Selectivity of each length class was directly estimated ($0 < sel < 1$) (with smoothing penalty) with assumed sel= 1.0 in some length classes
- Model 19.4: max sel 94-103 for trawl, 104-113 for com
- Model 19.5: max sel 104-113 for trawl, 114-123 for com

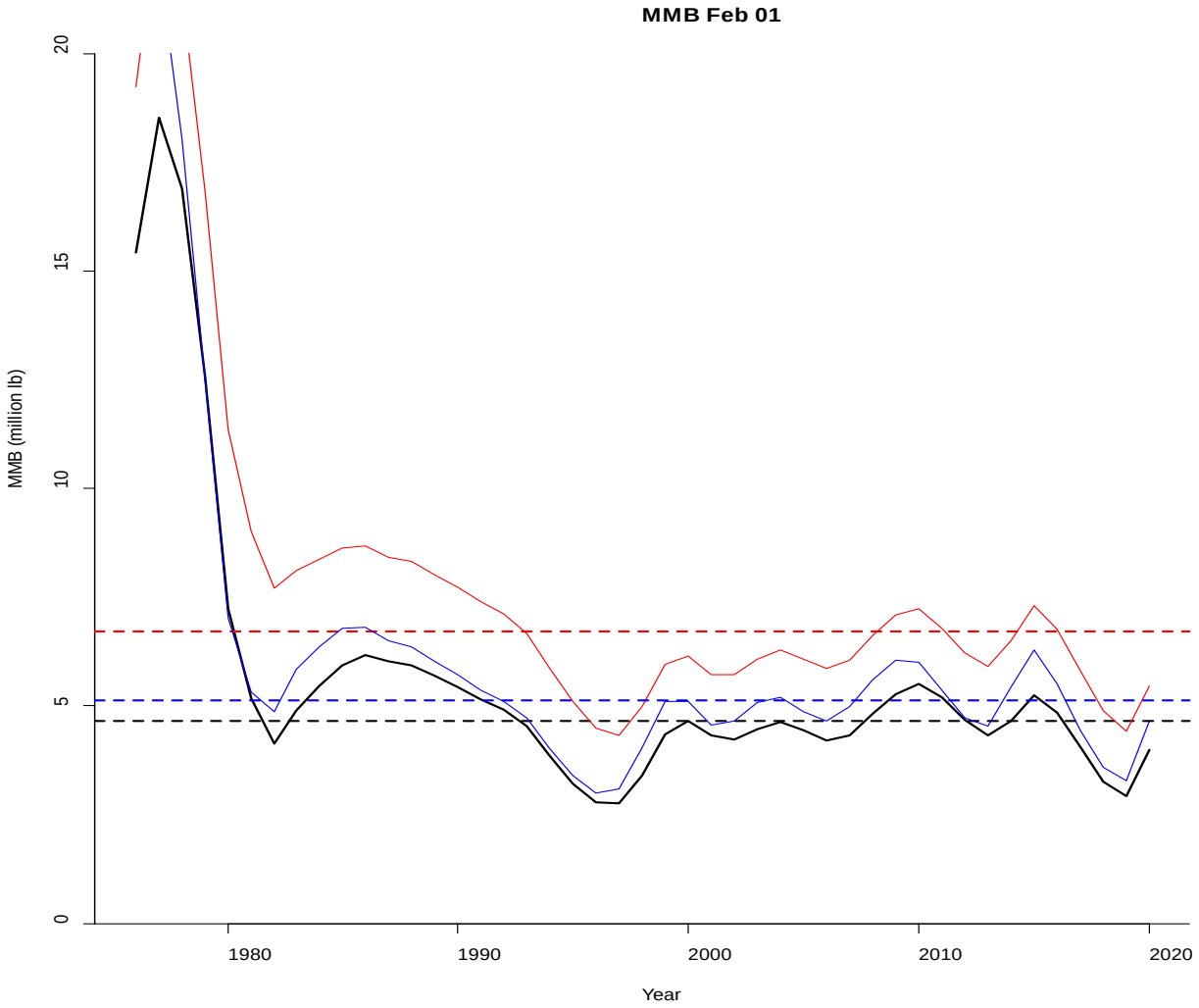
Alternative model selection for 2020 SAFE

- Model 19.4 (red), 19.5 (blue) : (Hide & Kill All option 1,2)



Alternative model selection for 2020 SAFE

- Model 19.4, 19.5: (Hide & Kill All option 1,2: Existence of crab that are never caught nor observed -> Higher MMB)



Likelihood

Model	Model 19.0	Model 19.1	Model 19.2	Model 19.3	Model 19.4	Model 19.5
BMSY(mil.lb)	4.66	4.70	3.40	4.00	6.72	5.13
MMB(mil.lb)	3.98	3.87	2.86	3.35	5.45	4.66
Legal crab Catchable (mil.lb)	2.53	2.46	1.78	2.10	2.37	2.18
OFL(mil.lb)	0.31	0.29	0.22	0.26	0.46	0.60
NOAA q	0.70	0.68	1	0.81	0.66	0.71
ADFG q	1	1	1.40	1.20	1	1
M	018/0.58	018/0.64	018/0.52	018/0.55	0.31	0.43

Due to higher M: $F_{OFL} = M$

Model Recommendation for 2020 SAFE

- Model 19.0 or 19.1: Remove or keep tag recovery data beyond 1 year at liberty
  - Marginal decline in likelihood
  - No practical difference in MMB
  - No
- Include NMFS 2019 trawl survey data
- Include Observer total catch length
- CPT requested models:
  - Model 19.0
  - Model 19.1 – 19.0 plus new discard abundance estimation method
  - Model 19.2 – 19.1 plus estimating additional selectivity multipliers for large male plus group, keep M constant

Aleutian Island GKC Cooperative Survey

Current stock assessment: Observer data

Only 50% of historic harvest area

Non-independence/hyperstability

Former Triennial Survey:

10% of harvest area

Time prohibitive (one month)

Cost prohibitive ($400K)

Lost funding

Commerical Fishing Process

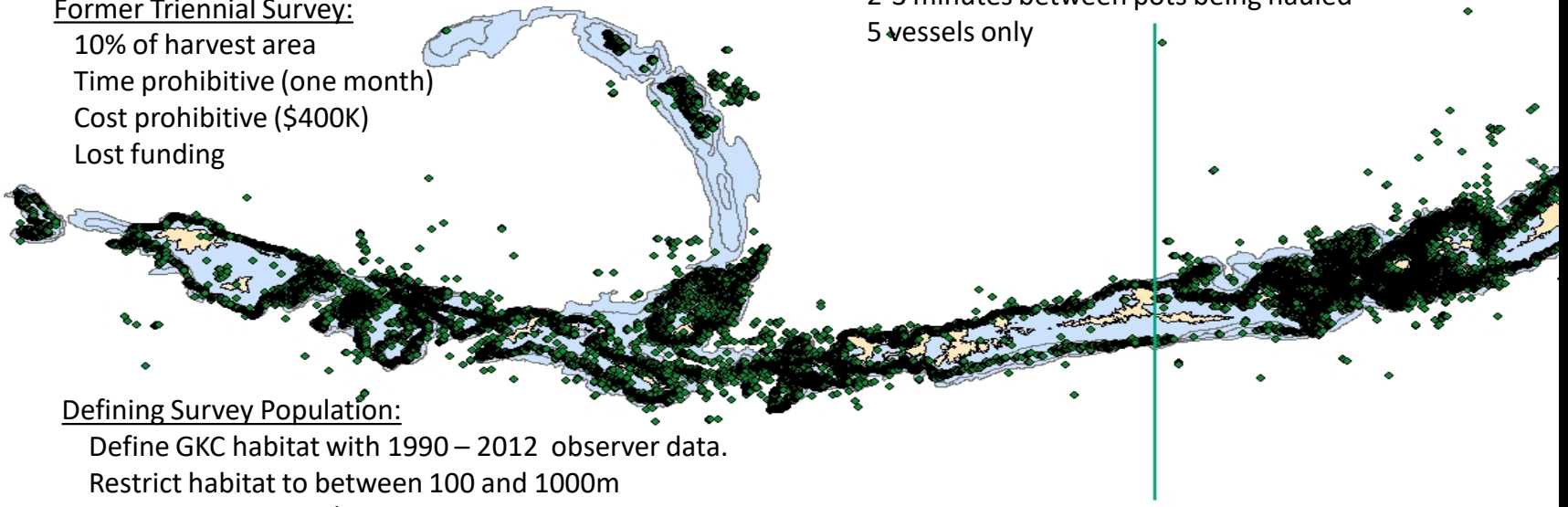
Variable pot sizes (5.5 – 7ft squares)

~35 long-lined pots/string, 200m apart

Strings ~4nm in length

2-3 minutes between pots being hauled

5 vessels only



Defining Survey Population:

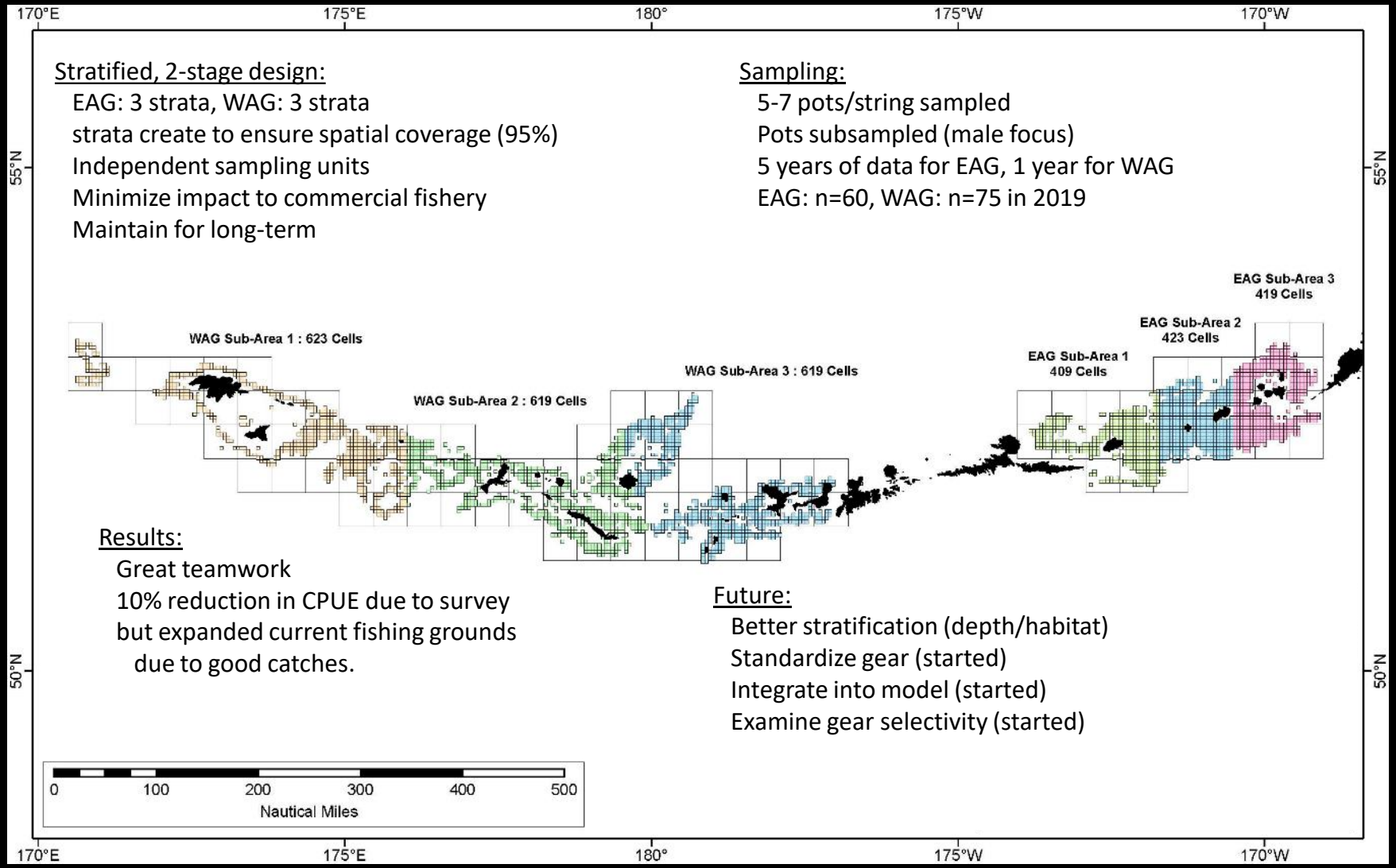
Define GKC habitat with 1990 – 2012 observer data.

Restrict habitat to between 100 and 1000m

Eliminate low catch/effort areas (Bowers Ridge, Amlia to Adak, and Umnak)

Overlay 2 x 2nm areas on remaining observer data as basic sampling unit.

(best trade-off between scale of fishing gear and defining habitat accurately; other sized areas were examined).



Stratified, 2-stage design:

EAG: 3 strata, WAG: 3 strata
strata create to ensure spatial coverage (95%)
Independent sampling units
Minimize impact to commercial fishery
Maintain for long-term

Sampling:

5-7 pots/string sampled
Pots subsampled (male focus)
5 years of data for EAG, 1 year for WAG
EAG: n=60, WAG: n=75 in 2019

Results:

Great teamwork
10% reduction in CPUE due to survey
but expanded current fishing grounds
due to good catches.

Future:

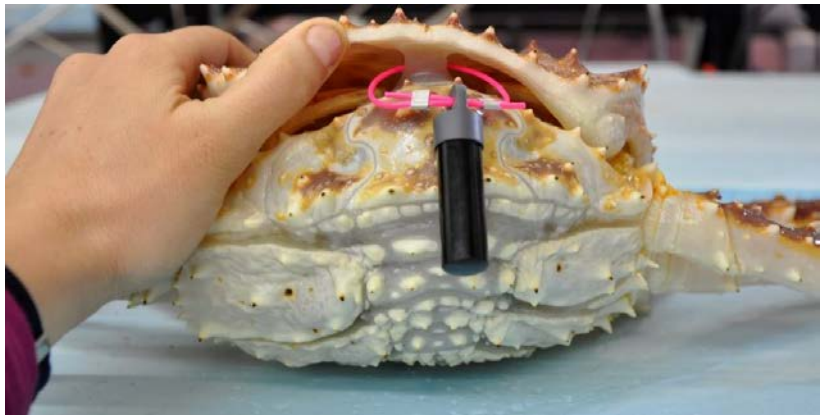
Better stratification (depth/habitat)
Standardize gear (started)
Integrate into model (started)
Examine gear selectivity (started)

BSFRF research report

- Growth studies for both snow and Tanner crabs

  April 2019, 464 pre-molt Tanner and snow crabs were collected using a Nephrops trawl in the Eastern Bering Sea and delivered to Kodiak.

- Crab movement study in conjunction with NMFS

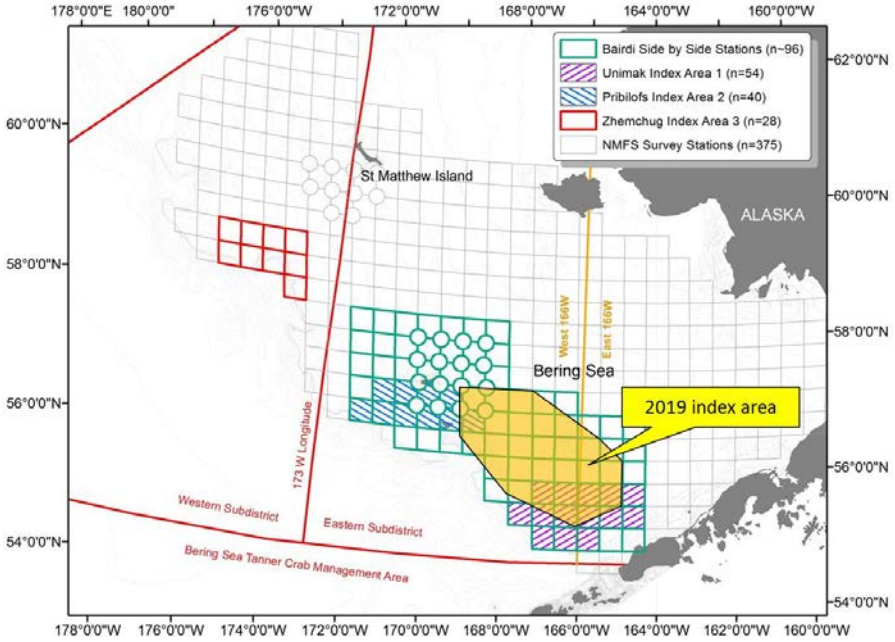


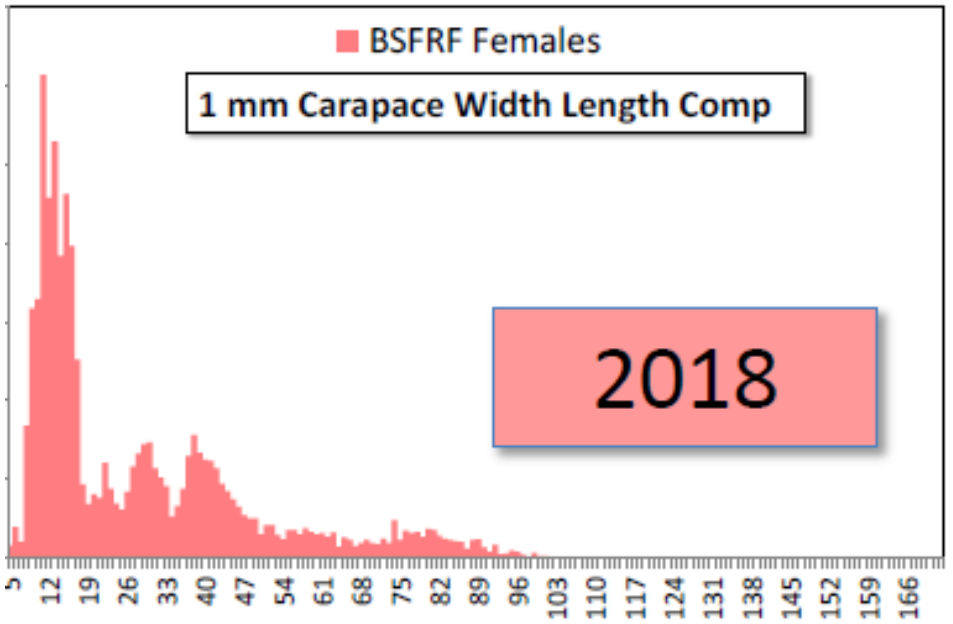
148 red king crab tagged with acoustic tags in June

Two 30 day saildrone deployments October, 2019 and March-April 2020 to re-find tagged crab

BSFRF research report

- 2019 Index sampling for Tanner crab





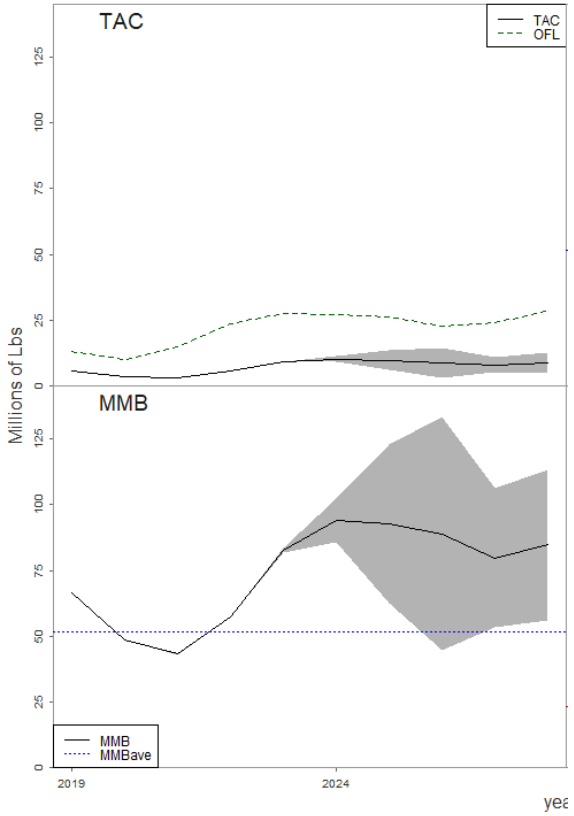
- Tanner crab MSE (separate agenda item)
- Beginning a new project to evaluate gear modifications to reduce crab bycatch in cod and halibut pot gear

Tanner Crab MSE

- Madison Shipley presented preliminary results from MSE for Tanner Crab (MS thesis at SAFS)
- Collaborators: André Punt (advisor), Buck Stockhausen, Ben Daly.

- This is a full feedback MSE designed to evaluate existing and proposed harvest control rules used by the State to set the TAC.

- SSC reviewed this project in June.



Tanner Crab MSE Timeline:

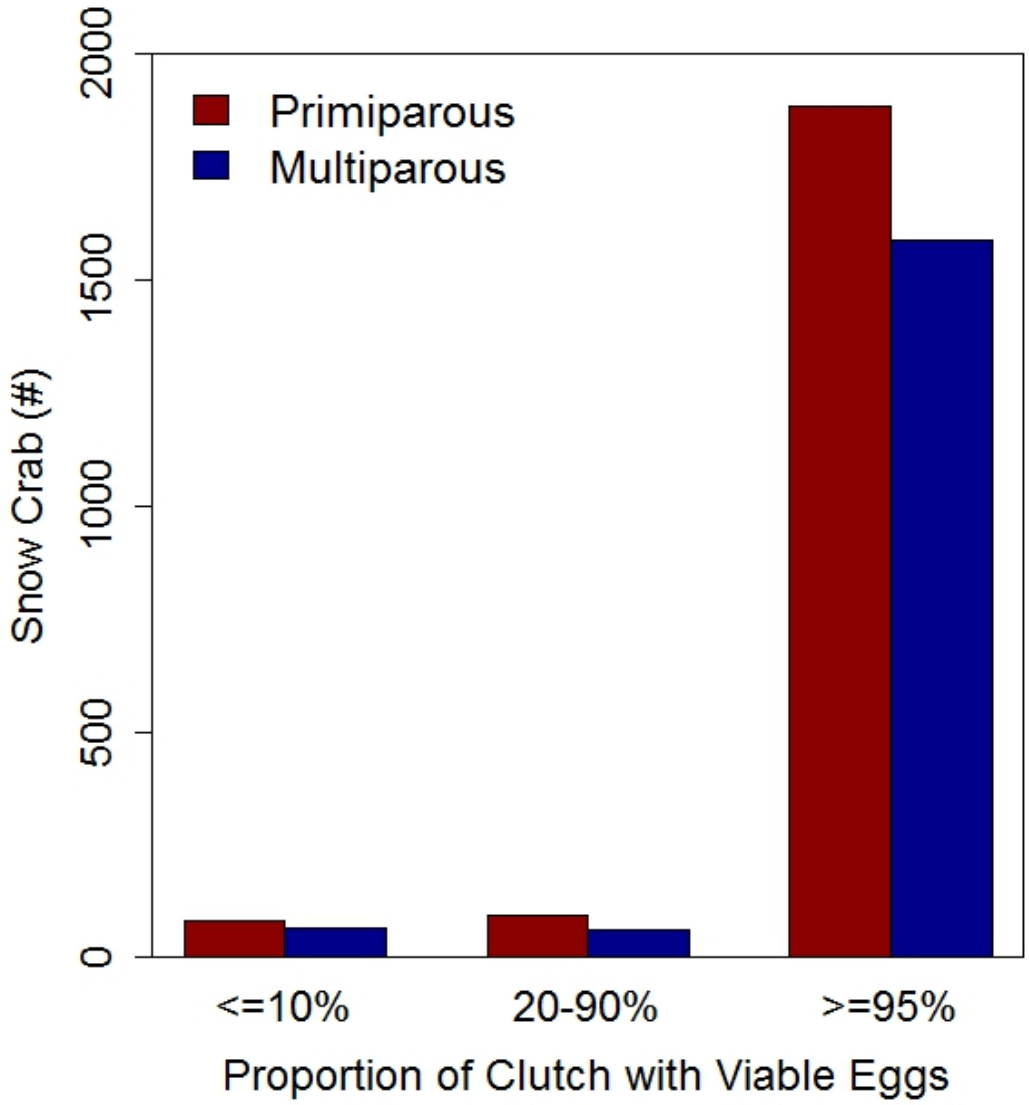
- Full runs are expected in the near future and will be run on Amazon Web services supercomputers (100 iterations of 100 years for each alternative).
- Run are expected to take 16 full days to complete.
- Results will be incorporated into a white paper for the Board of Fisheries
- Board of Fisheries will make a decision on a new Tanner crab harvest strategy in early 2020.

Chionoecetes mating dynamics

- Laura Slater (ADF&G and UAF) summarized her ongoing graduate work exploring aspects of male and female reproductive potential
- Samples collected during the 2007–2018 NOAA EBS trawl surveys to investigate fecundity and sperm reserves
- Laura is exploring patterns between sex ratio indices and spermathecal load using six EBS regions based on female ontogenetic migration patterns to develop spatial estimates of reproductive output.

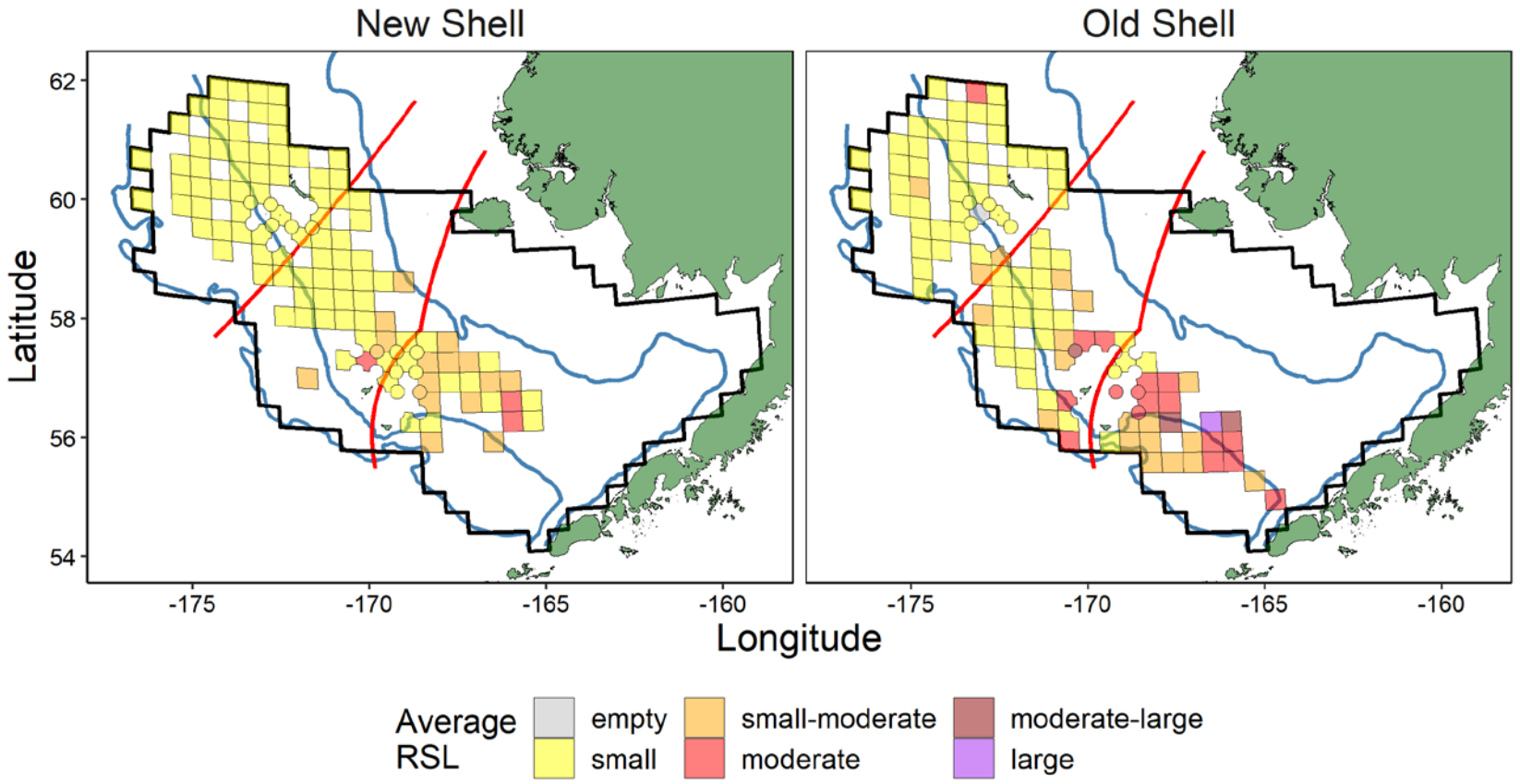
Chionoecetes mating dynamics: results

- No evidence of sperm limitation via unfertilized eggs
- Embryo loss during brooding minimal (Webb et al. 2016)
- Clutch fullness provides a good indication of fertilized egg production (Webb et al. 2016)



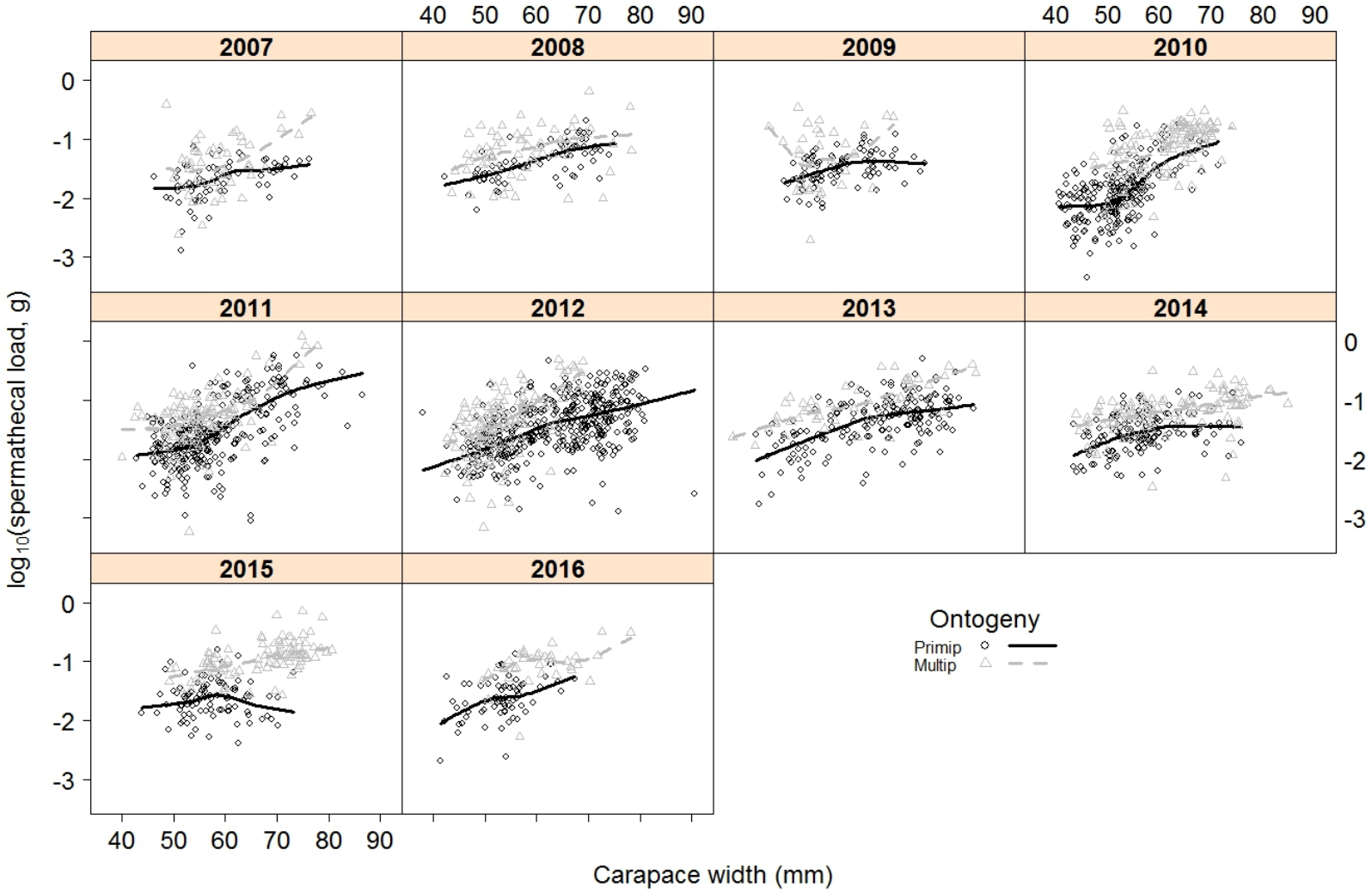
Chionoecetes mating dynamics: results

- Variability in spermathecal load reserves exists by shell condition groups and areas
- Re-mating to fertilize subsequent clutches is often necessary & usually occurs



Chionoecetes mating dynamics

SL increases with female size



Chionoecetes mating dynamics

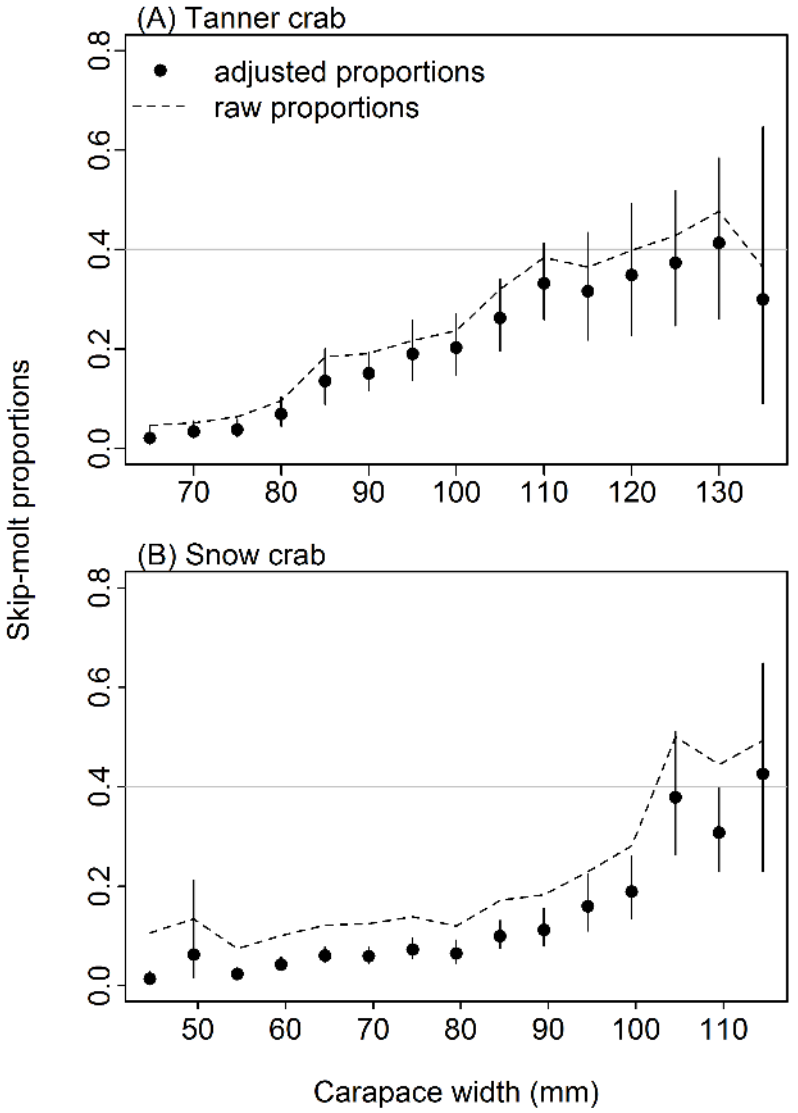
- What has been learned?
- Sperm storage in EBS provides little buffer (re-mating is necessary).
- No evidence of sperm limitation
- Variability in SL with female size likely reflects size composition and maturity status of available males, which varies across EBS.
- Interspecies mating is unimportant.

Chionoecetes skip molting

- James Murphy (Cascadia) presented his recently published study on skip molting for EBS snow and Tanner crab males
- Molting frequency plus molt increments determine the growth rate for crab.
- Molting increments at size are not considered to be very variable for *Chionoecetes* crab, so molting frequency is most important to the growth rate.
- Juveniles molt more than once per year, adolescents molt up to once per year, and adult *Chionoecetes* do not molt.

Chionoecetes skip molting

- Skip molt proportion is the ratio of old shell immature crab to total immature crab by size bin.
- Proportion skip molting was corrected for oversampling of old shell individuals in past surveys.

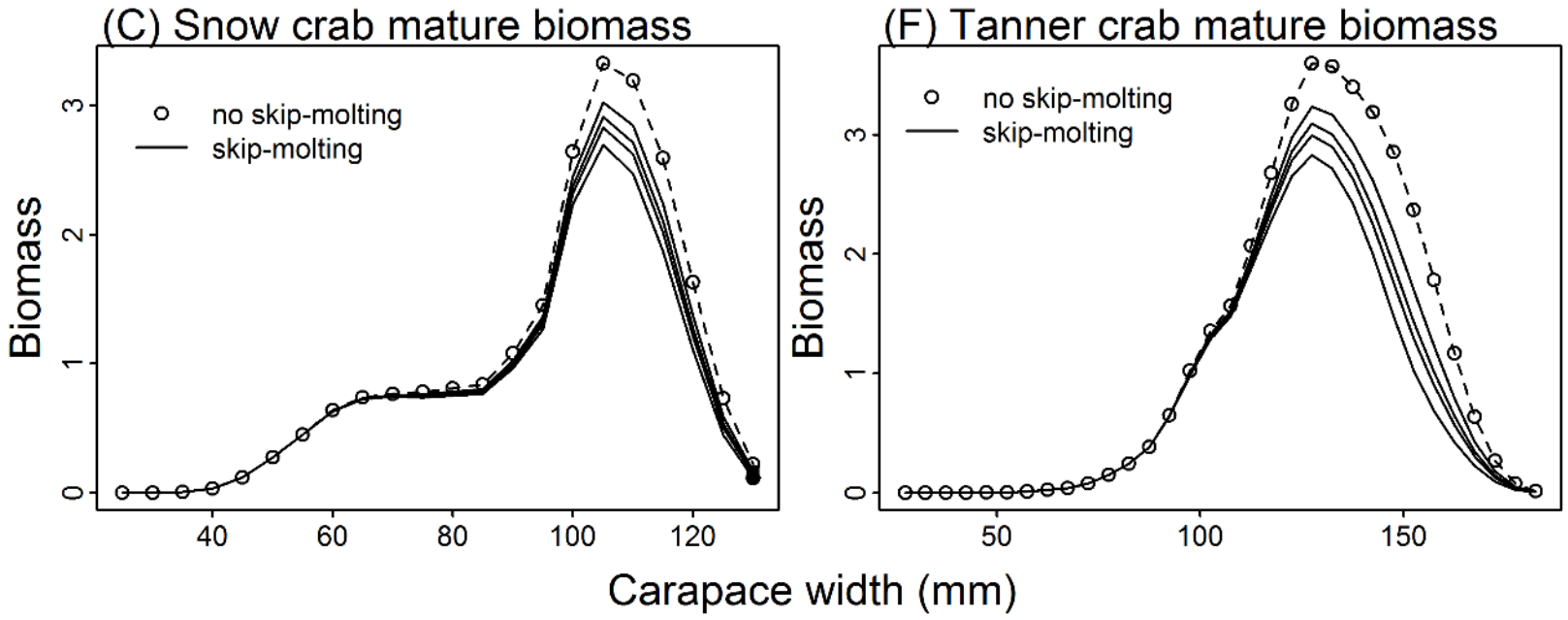


Chionoecetes skip molting

- Simple population simulation
- Skip-molt annual survival: 0.68 (no change due to skip-molting), 0.61, 0.54, 0.48
- Reduction in large mature males:

  Snow crab: 12% - 24 %

  Tanner crab: 23% - 47%



Chionoecetes skip molting: CPT recommendations

- Recommend further evaluation of the impacts of skip molting on stock assessments
- Two approaches could be explored:
  - Modify the assessment model to model skip molting
  - To conduct a simulation of crab population dynamics to further evaluate the potential impact of skip molting.
- Priority for Tanner crab than snow crab due to the higher proportion of skipped molting seen in Tanner crab (and chronic over prediction of large crab).