

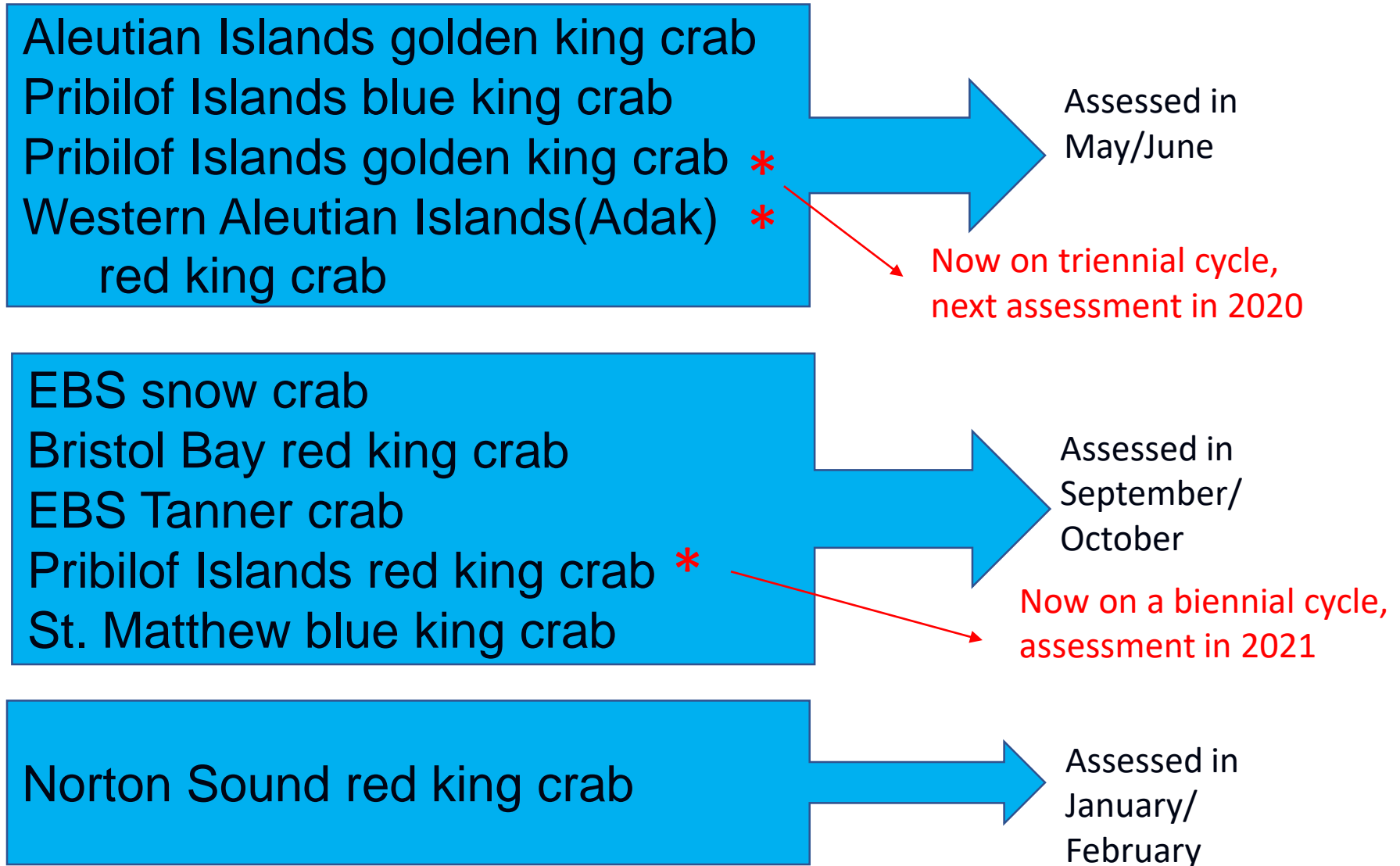
Crab Plan Team Report

Jan 14-17, 2020

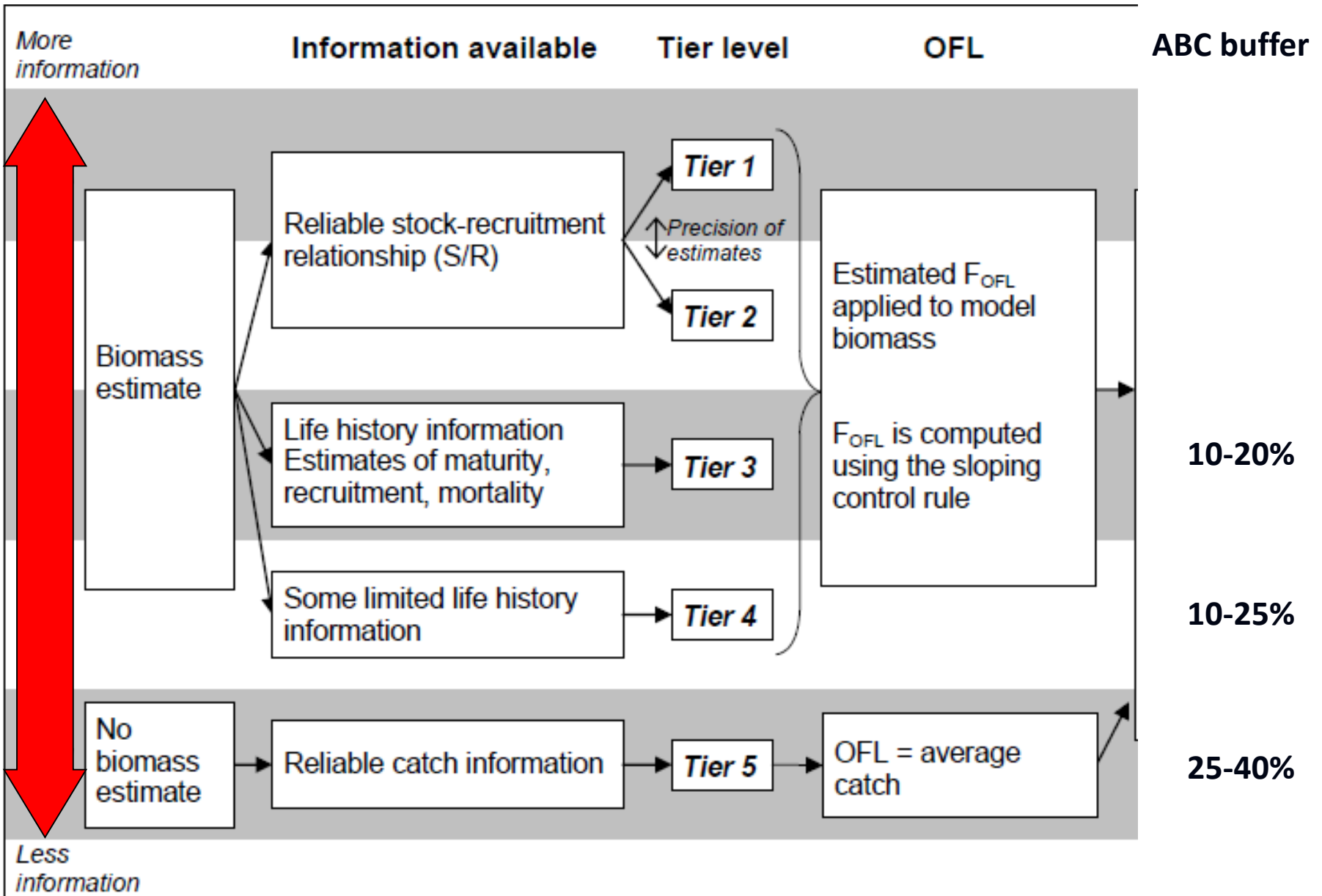
Kodiak, AK



BSAI Crab Stocks Management Timing



BSAI Crab Stocks Management



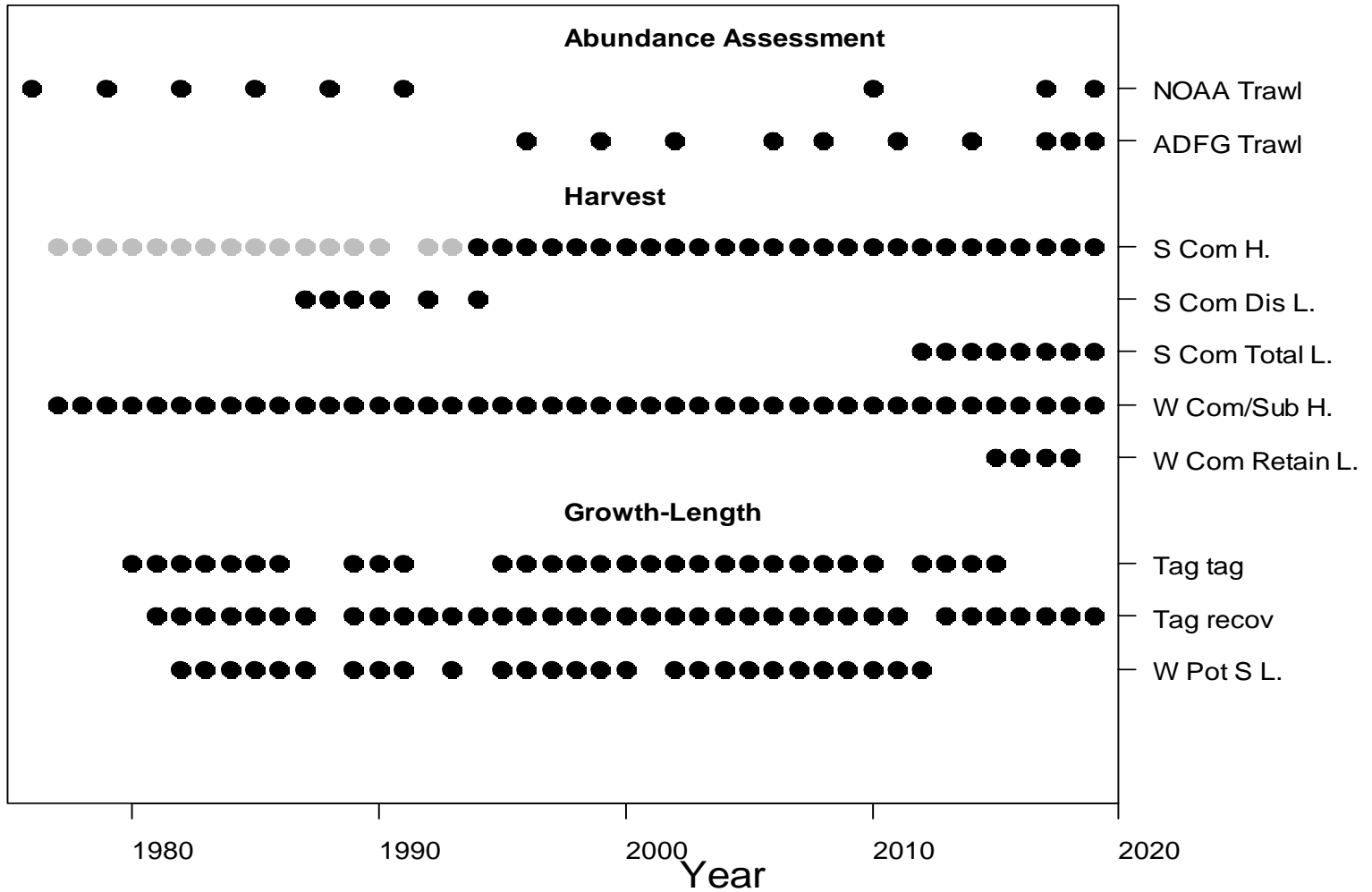
CPT Agenda for January

- Norton Sound RKC - final assessment, OFL and ABC
- AIGKC - model runs for May
- Fishery update
- ESP planning
- St. Matthew Is. BKC rebuilding
- Bering Sea FEP
- Snow crab spatial model
- Economic SAFE
- ADF&G crab observer program
- Research priorities
- Kodiak crab research overview
- Gmacs workshop



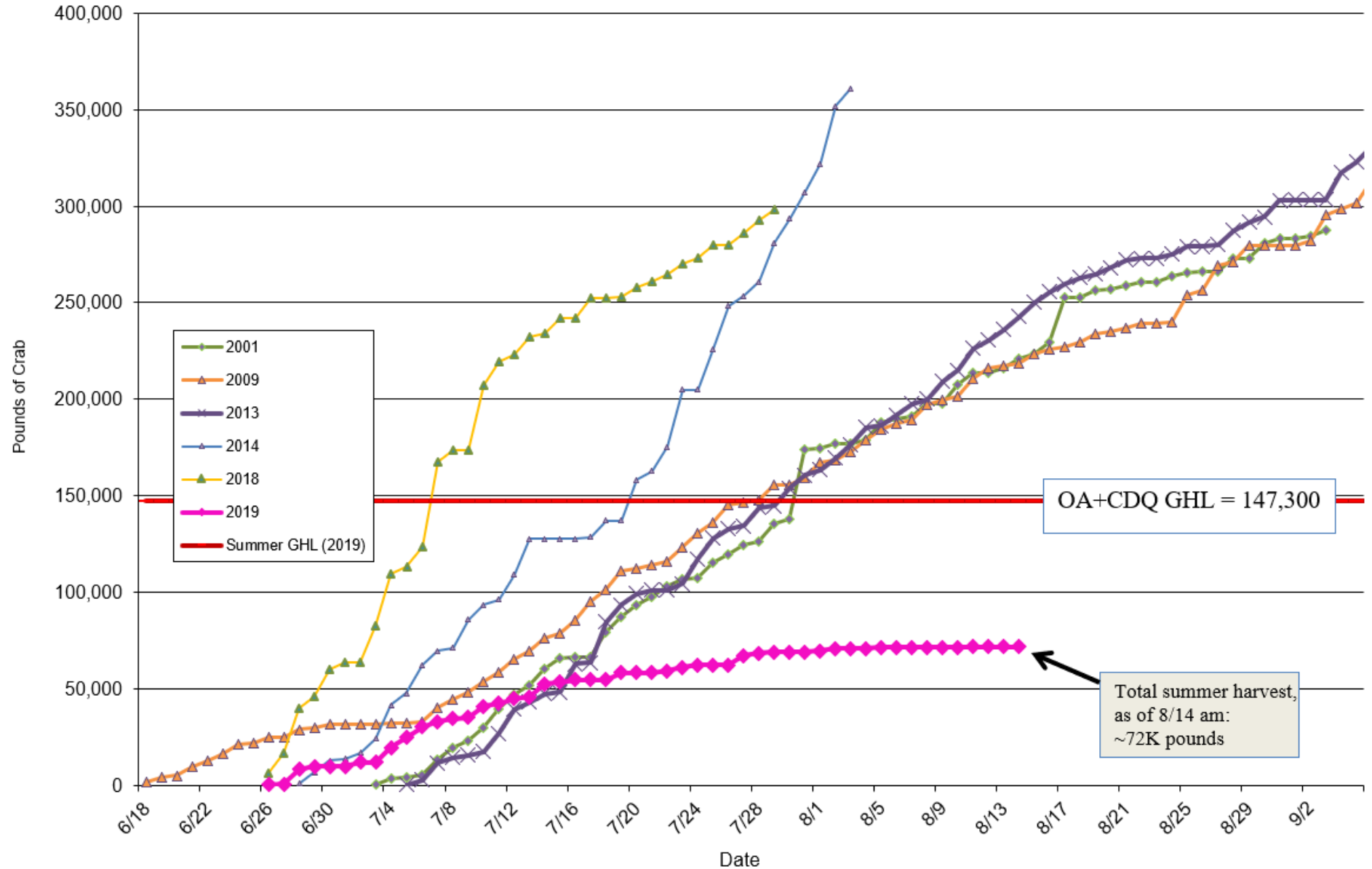
Norton Sound Red King Crab, Final assessment

Assessment data time series

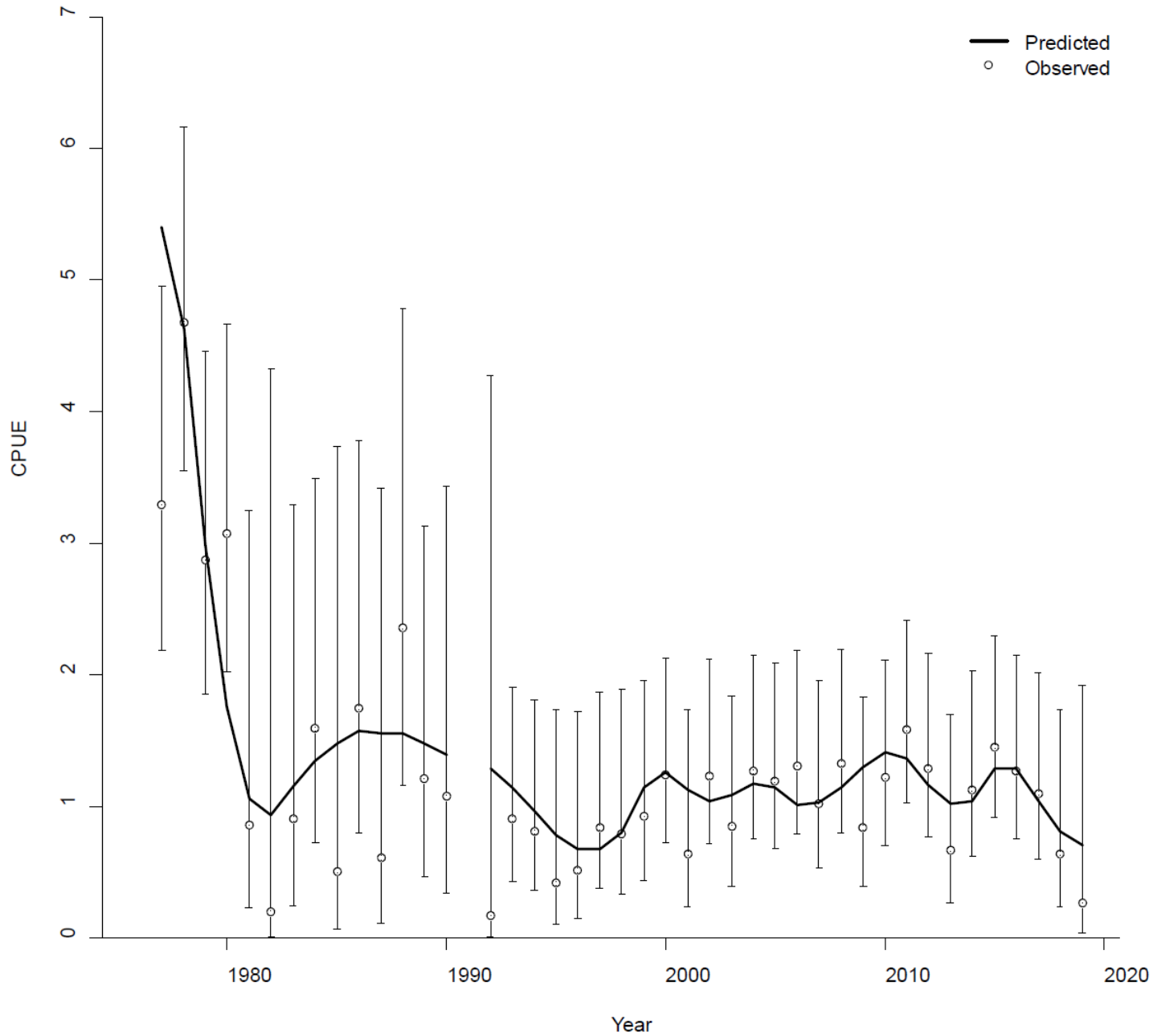


2019 summer commercial fishery

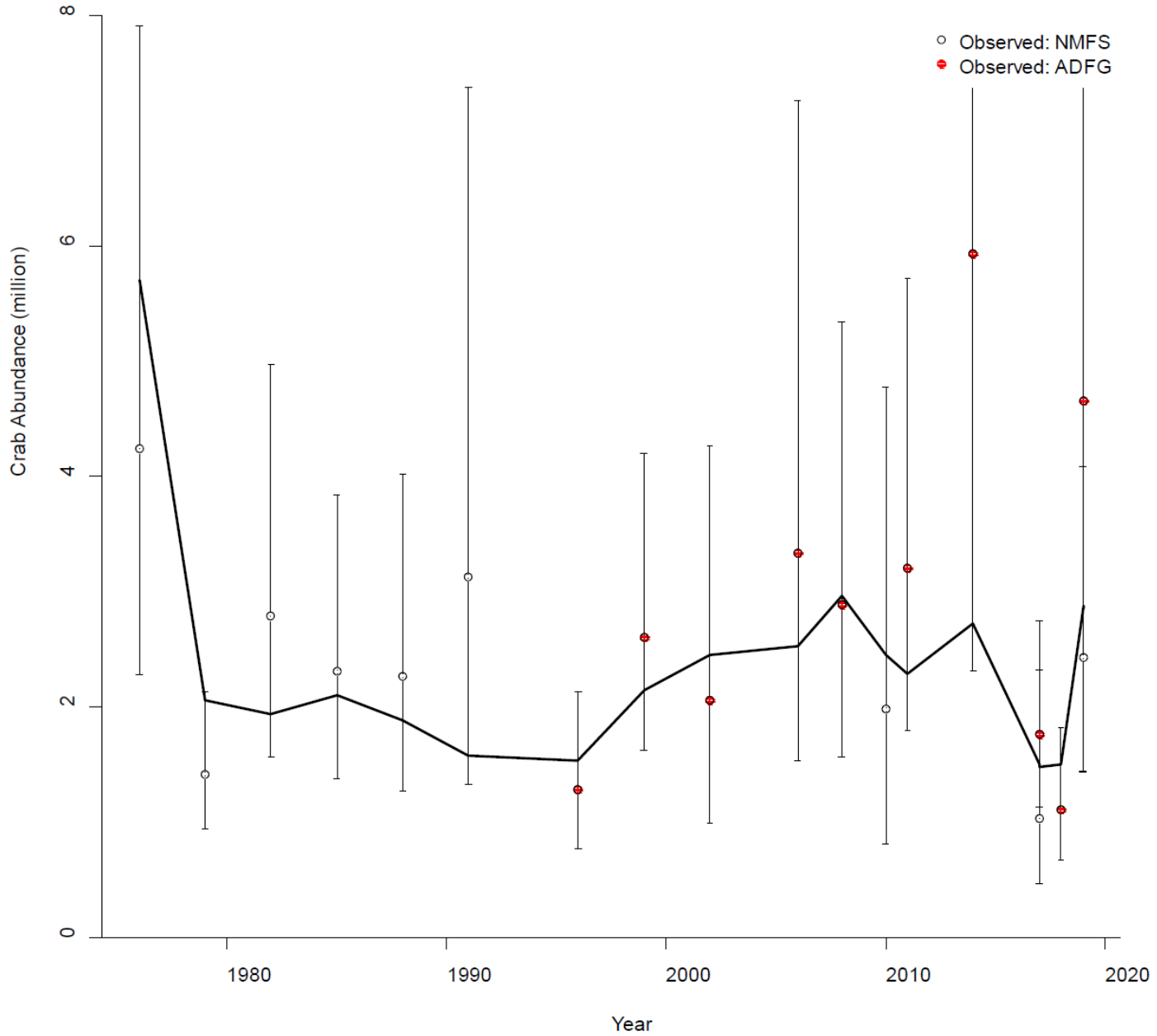
Norton Sound Summer Red King Crab Combined Fishery



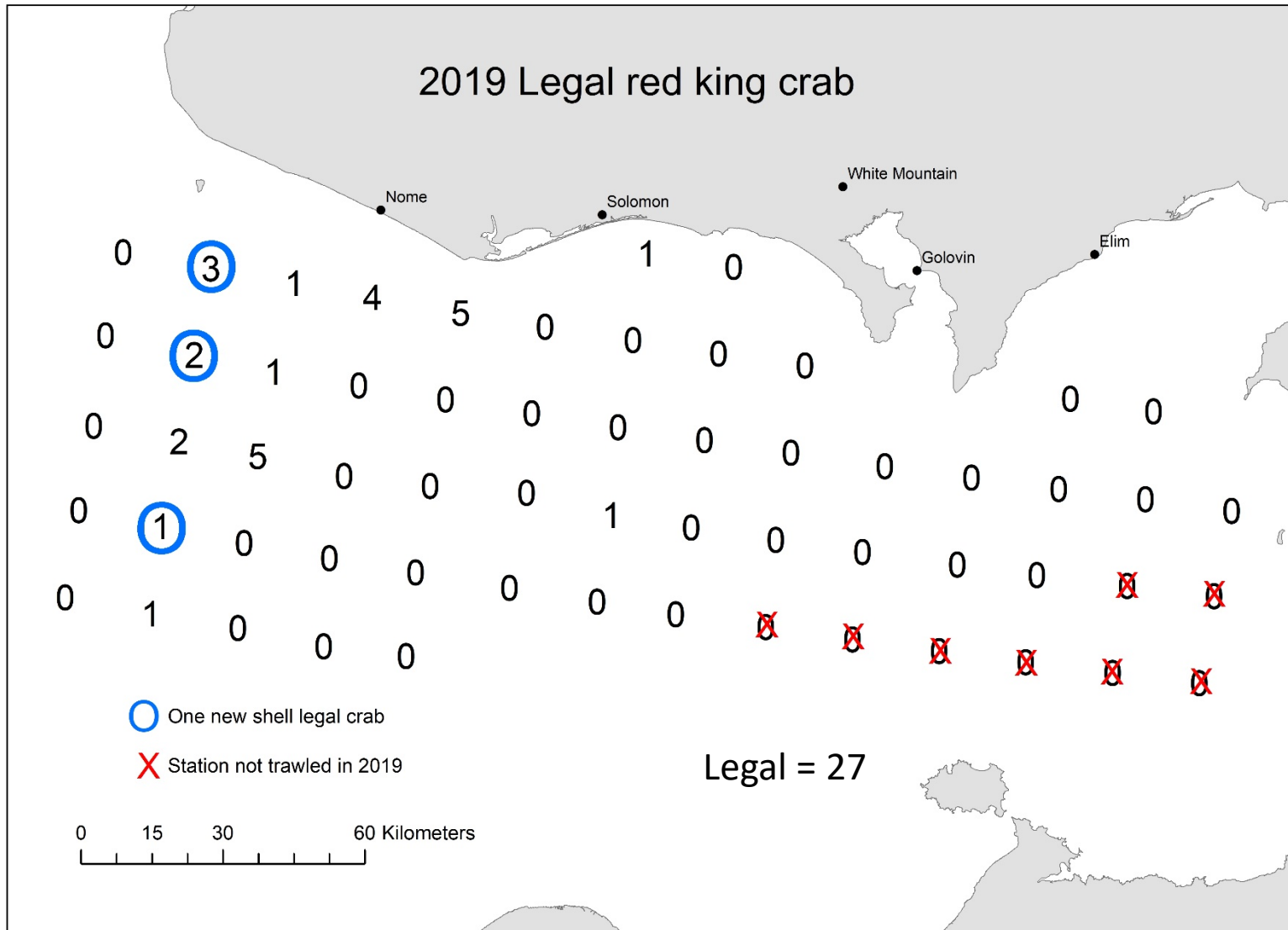
Summer commercial standardized cpue



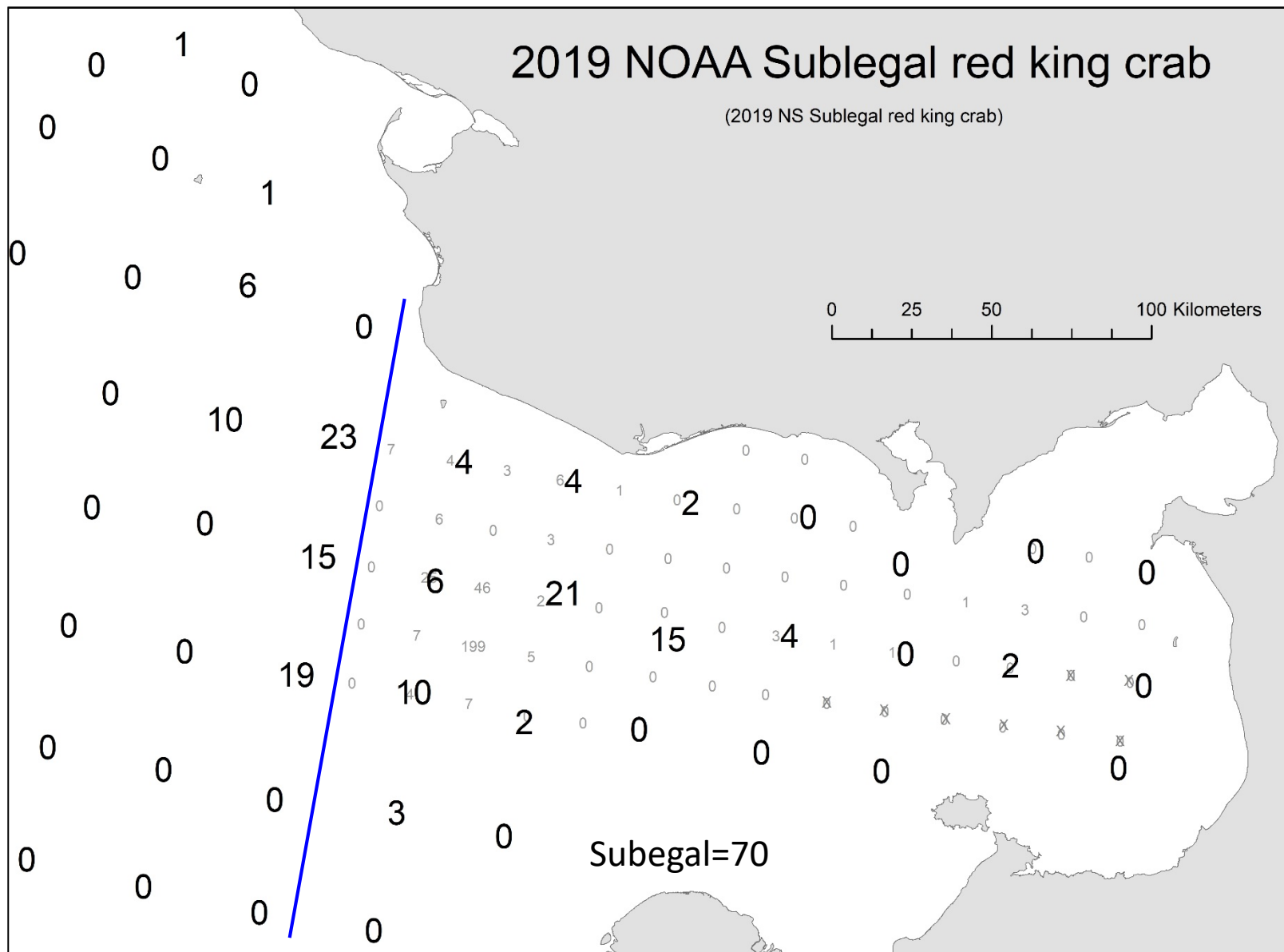
Trawl survey crab abundance



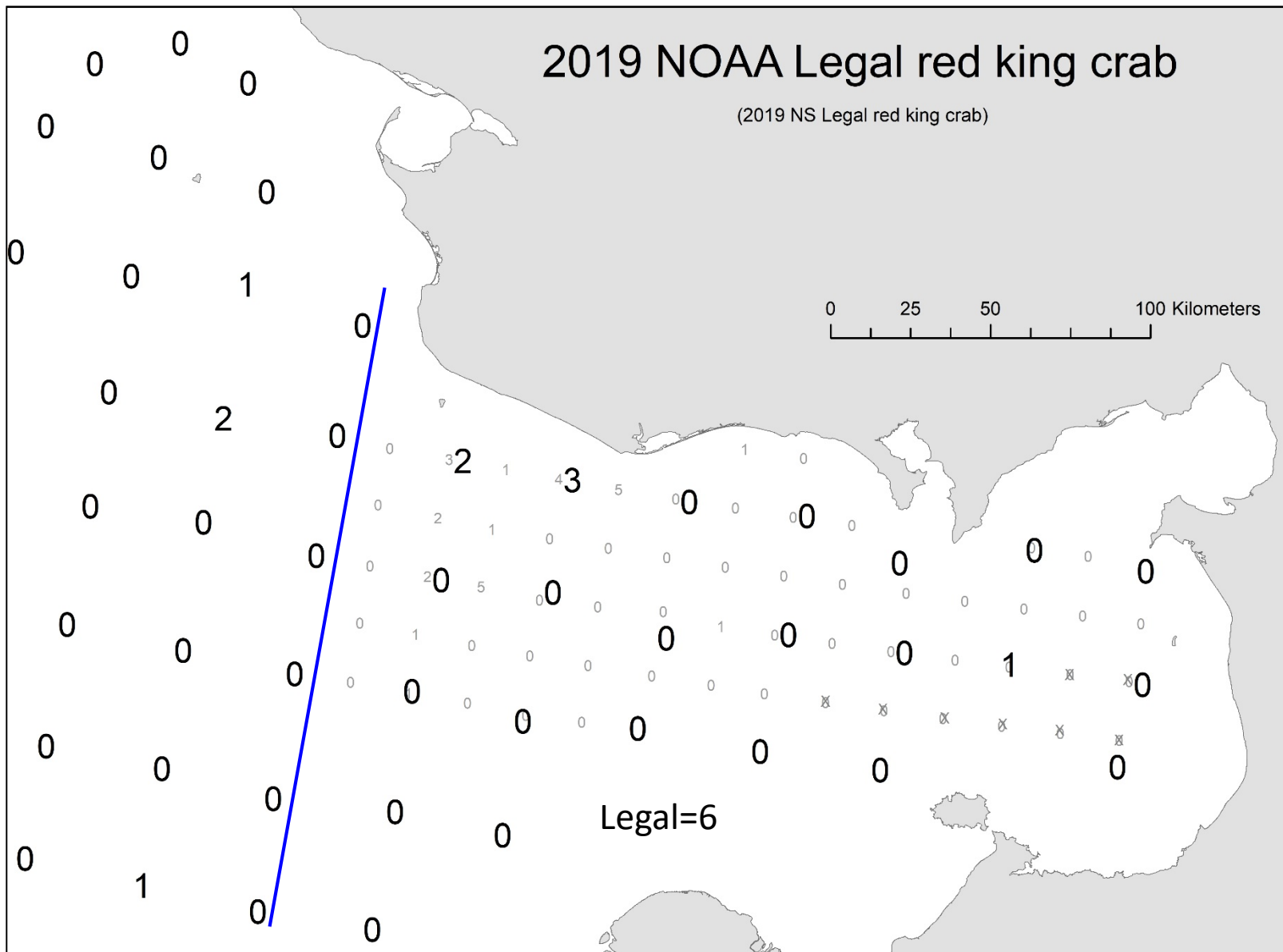
2019 Trawl Survey ADFG



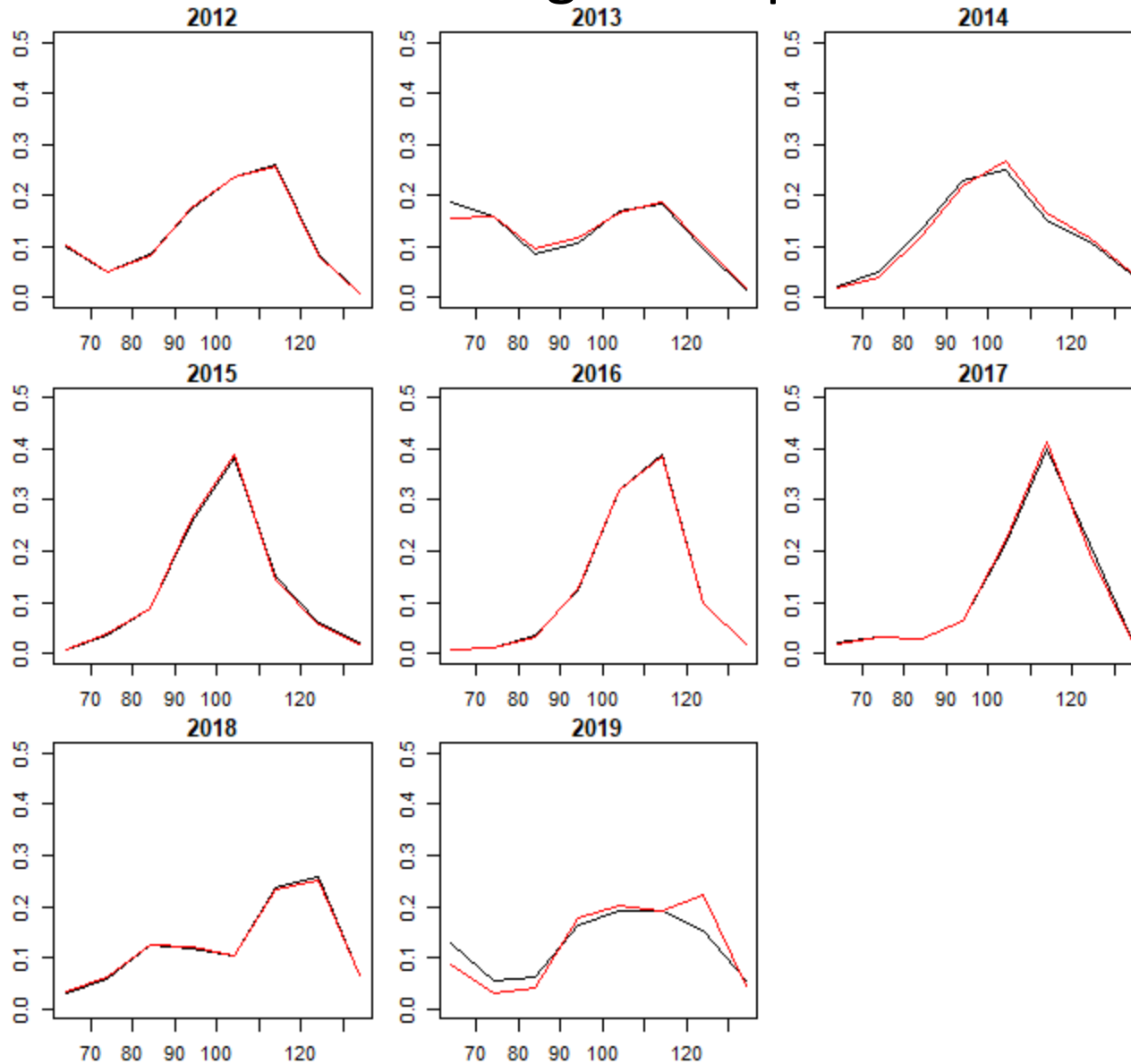
2019 Trawl Survey NMFS



2019 Trawl Survey NMFS



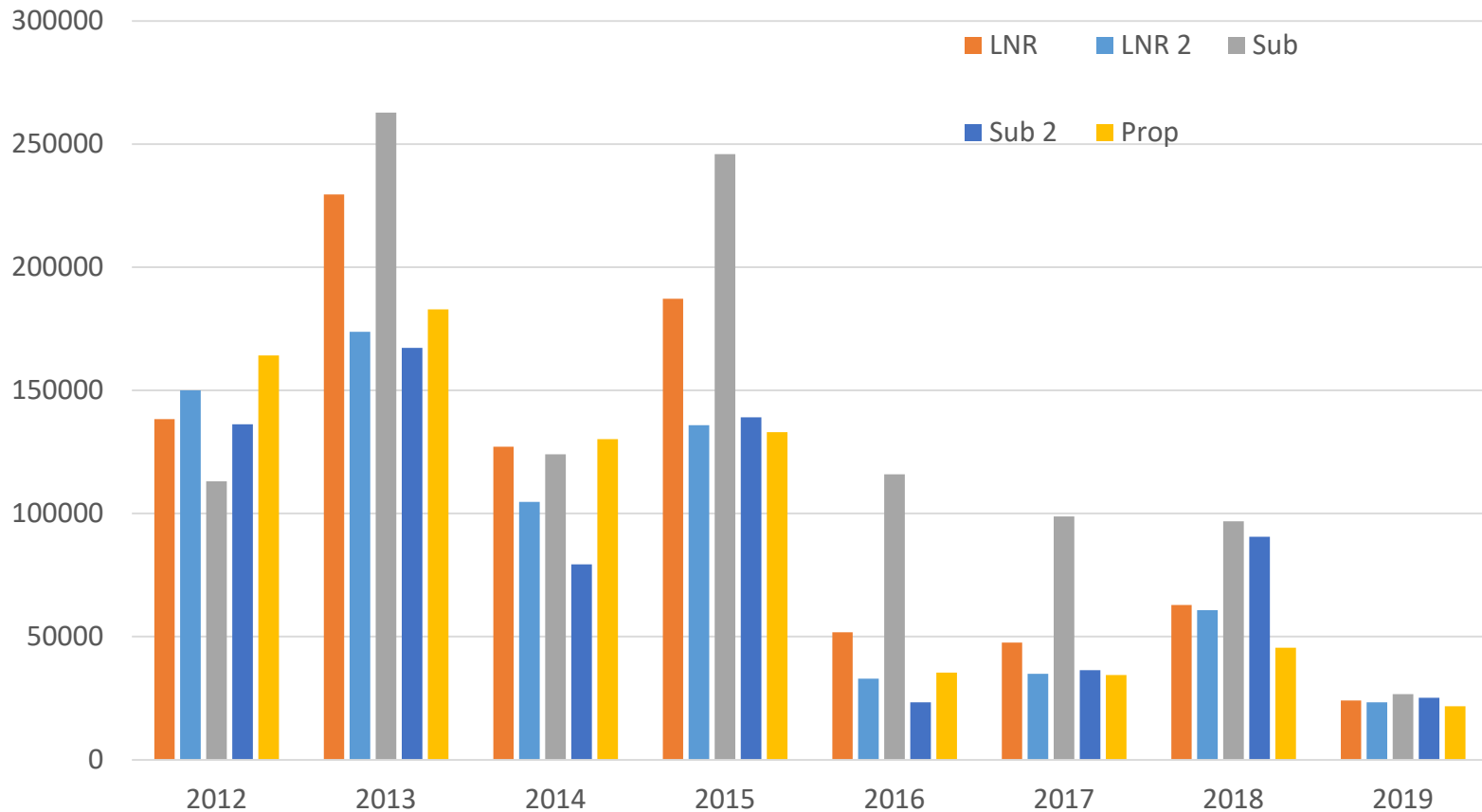
Observer length comp data



Black: Sample, Red: Spatial weighted

Discards Estimates

- CPUE based (ob CPUE = total CPUE)
 - LNR, LNR2: Directly estimate discards
 - Sub, Sub2: Discards = Total catch – total retain
- Prop based (ob p discards = total p discards) (Assessment model)
 - P: Total Discards = $(P/(1-P)) * (\text{total retain})$



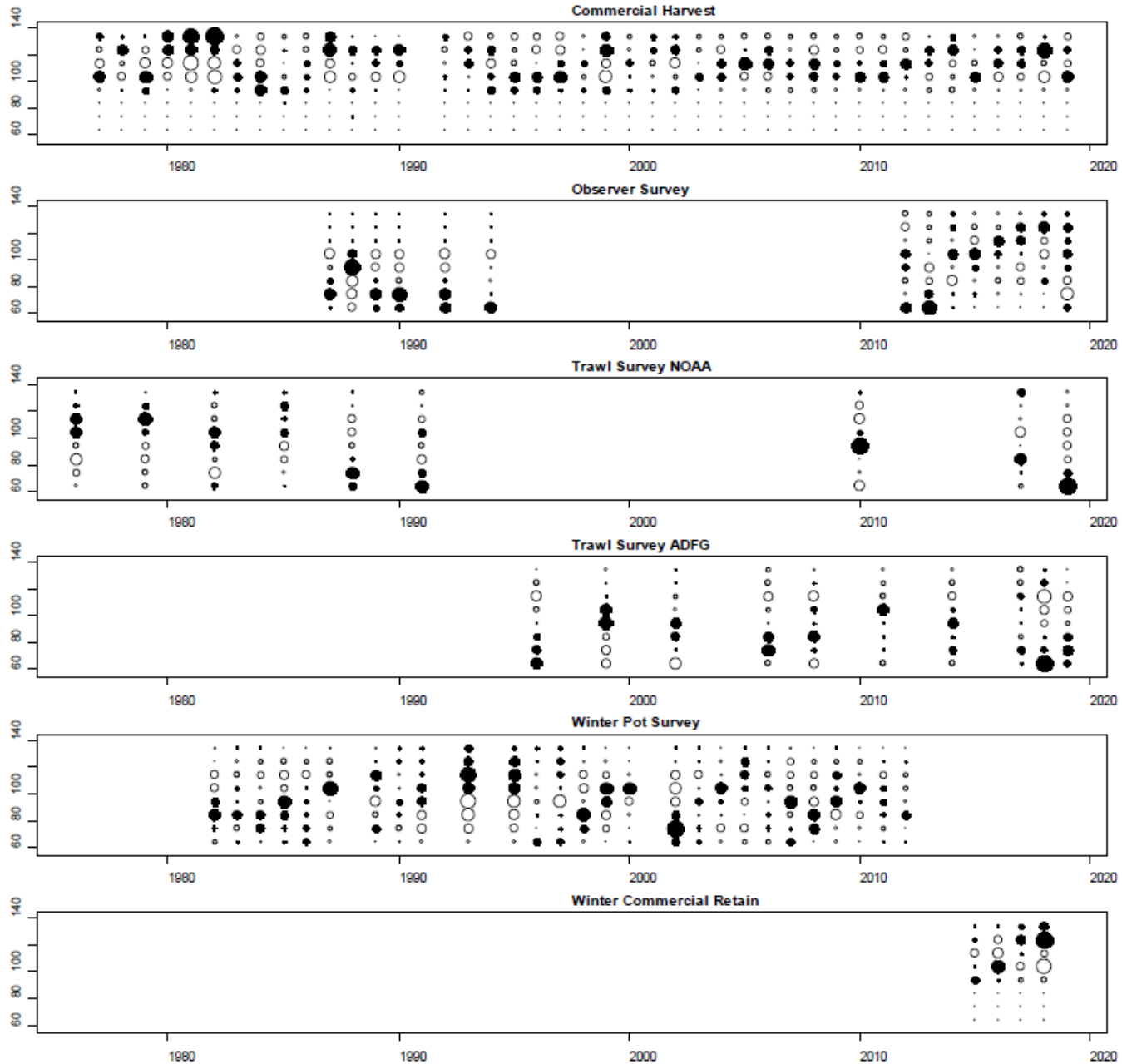
Model assumptions

- Male-only size structured model
- ADF&G survey q assumed 1.0, NMFS survey estimated < 1.0
- $M = 0.18$ for size class 1-6, estimated higher mortality for size classes 7 and 8
- Same selectivity and catchability for new and old shell crab
- Discard mortality = 0.2
- Fishery harvests occur instantaneously:
 - Winter fishery: Feb 01: Nov – May
 - Summer fisher: July 01: Jun – Sept
- Winter catch selectivity = winter pot survey selectivity

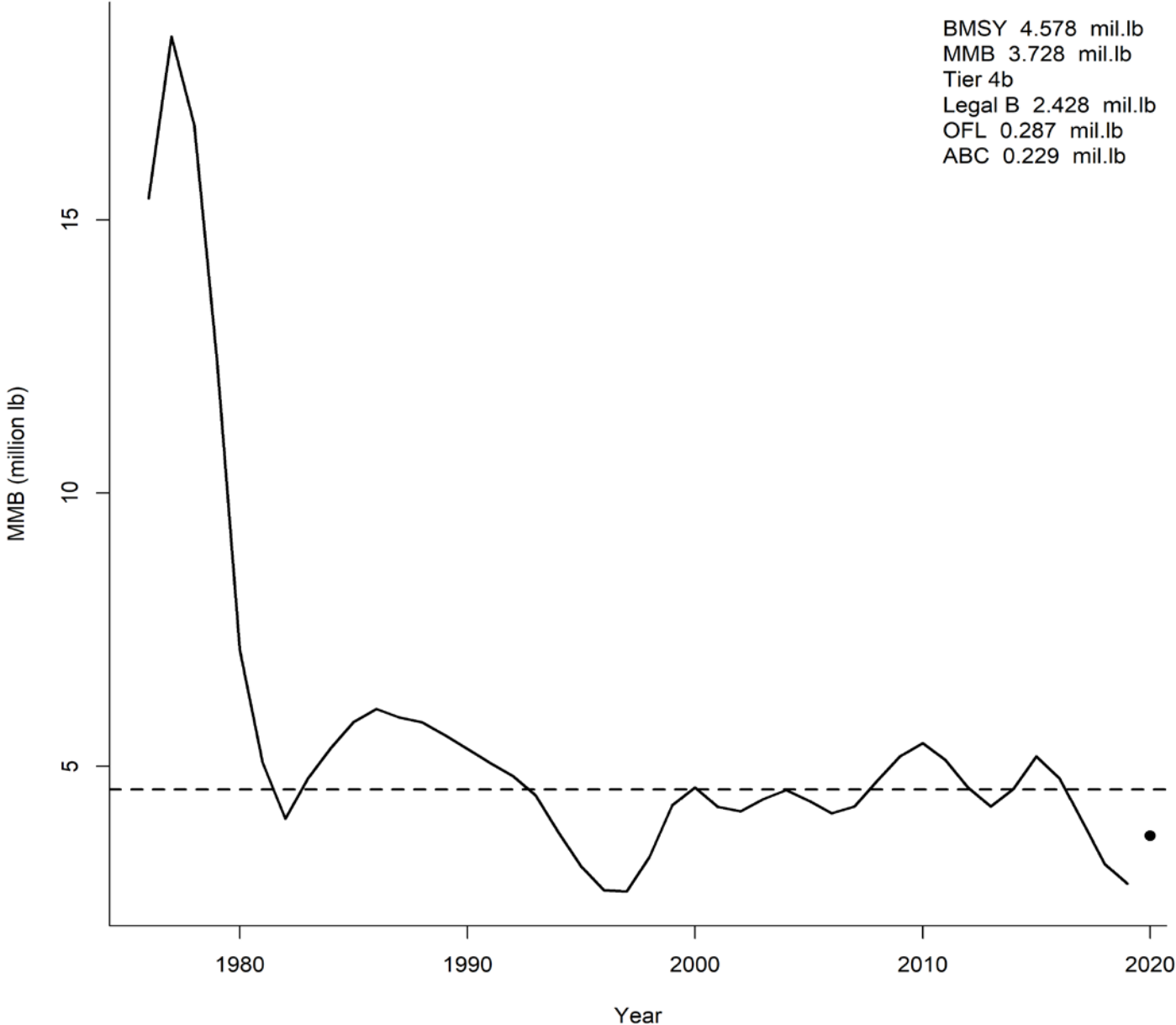
Final Changes: Fishery catch & Data

- Winter fishery 2019
 - Commercial: 1,050
 - Subsistence: 1,545
- Summer commercial fishery 2018
 - 6/25-9/03: 24,506
- Total retained harvest: 0.03 mill. lb. < ABC (0.19 mill. lb.)
- All harvest and observer data **FINALIZED**
- Standardized CPUE updated (Appendix B)
- ADF&G 2019 Summer trawl survey
 - 7/17-7/29: 4660.8 k, CV =0.60
- NOAA 2019 Summer trawl survey (NS portion)
 - 8/04-8/07: 2532.4 k, CV =0.30
- NOAA 1976-1991 Summer trawl survey
 - Abundance data updated: method reviewed
- Winter Commercial Retained length-shell **Not collected**
- Tag recovery: Completed.
- Changes in fishery regulation: None

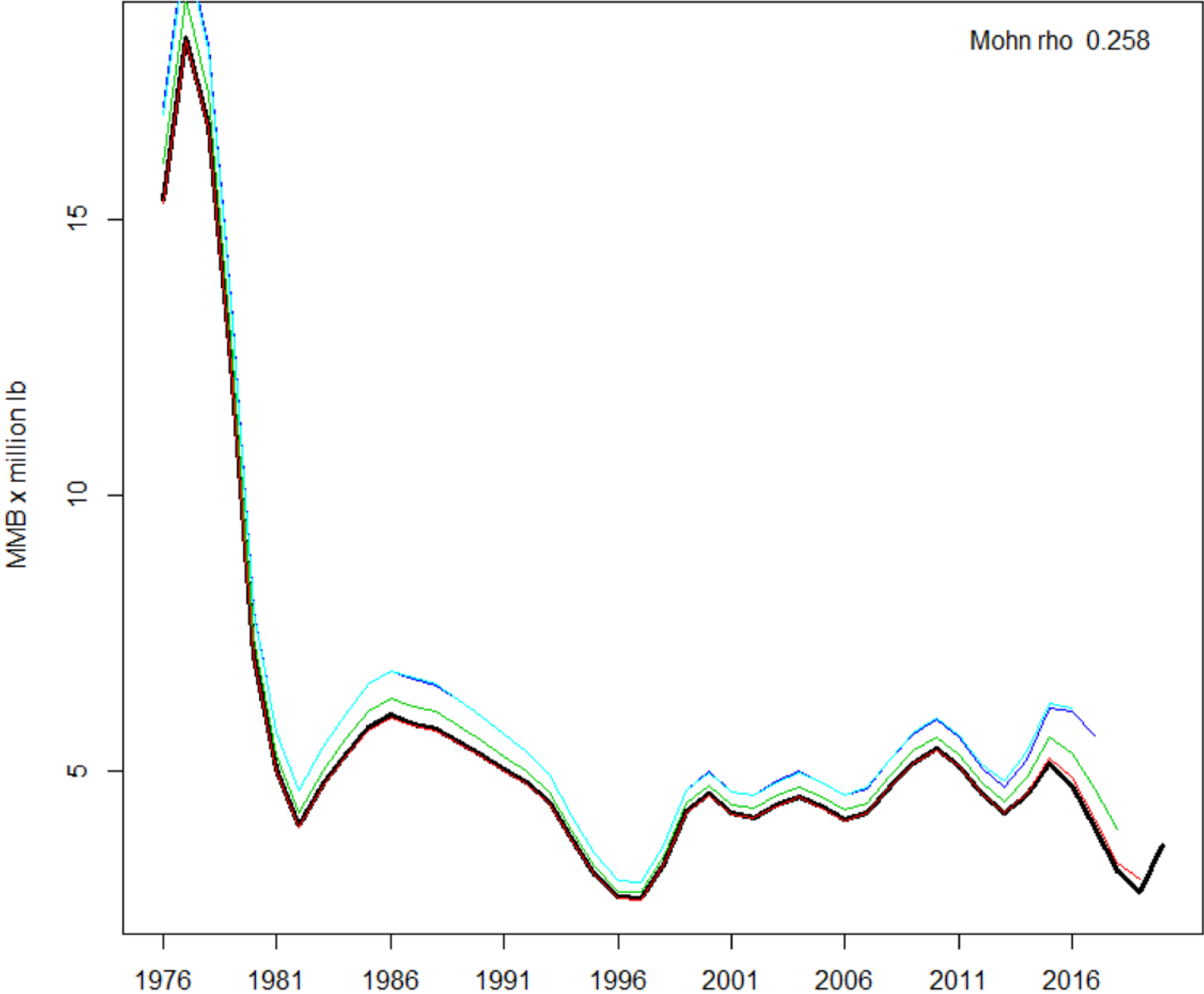
Length composition residuals



Model 19.0 MMB trend



Model 19.0 retrospective analysis



CPT recommendations

- The CPT recommends the status quo model 19.0 for calculating the OFL.
 - The CPT recommends that the SSC increase the buffer to obtain the ABC from 20% to 25% for two reasons: 1) the sharp decline in CPUE and poor fishery performance, 2) the preponderance of large crab in the catch suggesting a lack of recruitment to the fishery.
 - There is an apparent recruitment event but these crab will not recruit to the fishery until 2-3 years.
- Model is fit to new shell and old shell data length data separately: try a model run that combines these data.
 - The goal would be to address whether the estimates of high terminal M is being driven by inaccurate shell condition
- We need to move forward on a decision on the best way to estimate discards.
 - Provide a recommendation to the CPT
 - Document methods, define terms.
 - Compare to model estimates.

Status and catch specification table for NSRKC—Crab SAFE introduction

Status and catch specifications (kt). Shaded values are new estimates or projections based on the current assessment. Other table entries are based on historical assessments and are not updated except for total and retained catch.

Year	MSST	Biomass (MMB)	GHL	Retained Commercial Catch	Total Retained Catch	Retained OFL	Retained ABC
2016	1.03	2.66	0.24	0.23	0.24	0.32	0.26
2017	1.05	2.33	0.23	0.22	0.24	0.30	0.24
2018	1.09	1.85	0.13	0.14	0.15	0.20	0.16
2019	1.03	1.41	0.07	0.04	0.04	0.11	0.09
2020	1.04	1.66	TBD	TBD	TBD	0.13	0.10

Status and catch specifications (million lb.) Shaded values are new estimates or projections based on the current assessment. Other table entries are based on historical assessments and are not updated except for total and retained catch.

AIGKC - model discussion for May 2020



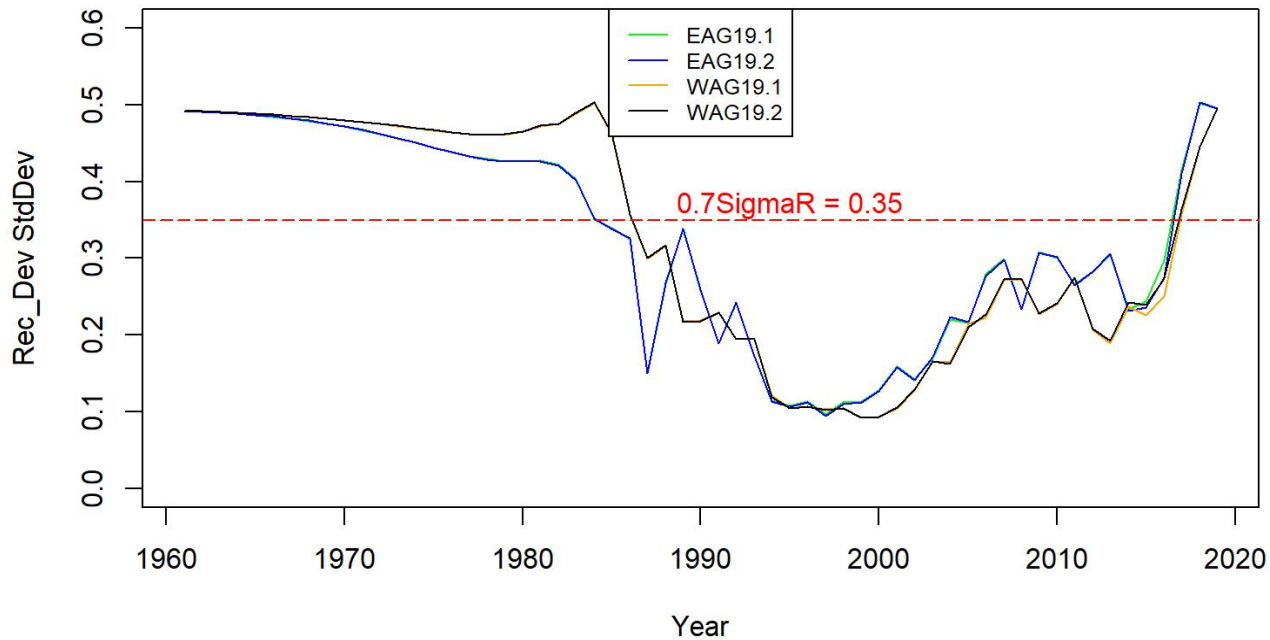
AIGKC model configuration

- Integrated male-only length-based model fitted to fishery dependent catch and CPUE data.
- Constant M of 0.21yr^{-1} .
- Projected the abundance from unfished equilibrium in 1960 to initialize the 1985 abundance.
- Separate models **EAG** and **WAG**.
- Model fit to standardized fishery CPUE as primary index.
- Francis re-weighting method for Stage-2 effective sample sizes calculation for all scenarios.

Major topics addressed by the CPT

- Revised approach to select mean recruitment for BMSY calculation.
- Revised approach for standardizing the fishery catch-rate data for 1985/86-1998/99.
- Estimating year-area interactions for fishery observer catch-rate data for 1995/96 – 2018/19.
- Analysis of the cooperative survey data.
- Improved maturity ogive.
- Models for June.

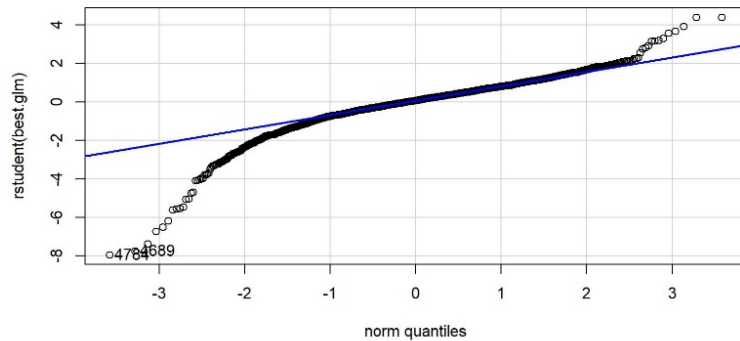
Time period for BMSY calculation



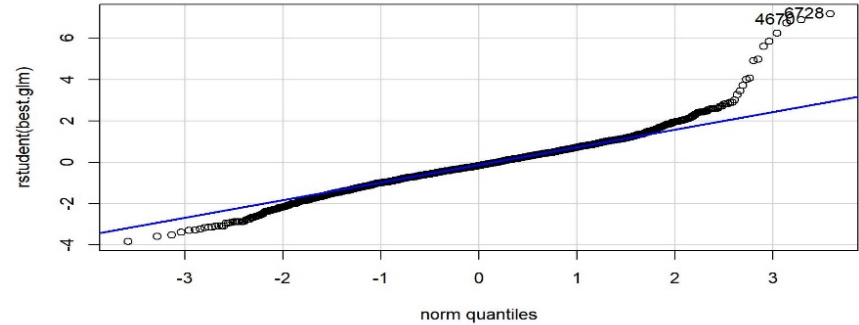
The CPT agrees with the general approach, and requests that the authors include the basis for the 70% in the next report. The choice of 70% is the lowest percentage at which a contiguous set of years would be selected.

Pre-observer CPUE standardization 1985/86–1998/99 fish ticket data set)

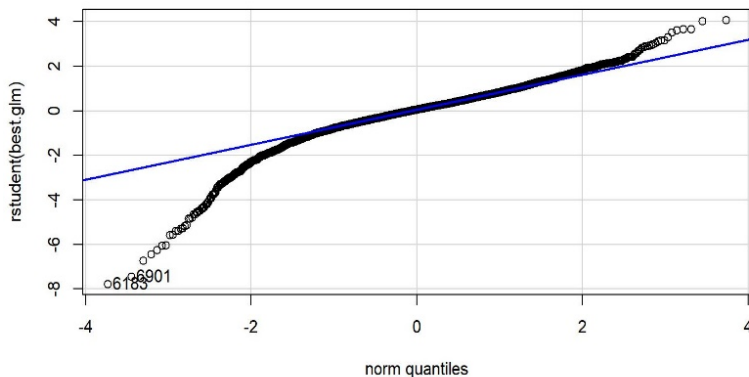
Log Normal Fit, EAG 1985/86-1998/99



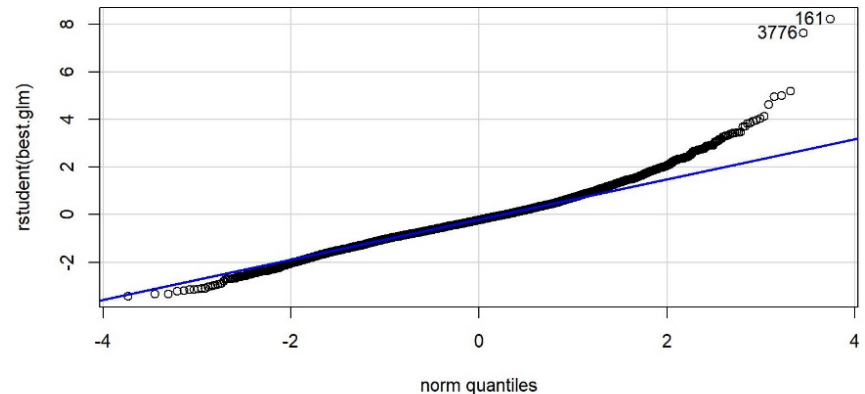
NB Fit, EAG 1985/86-1998/99



Log Normal Fit, WAG 1985/86-1998/99

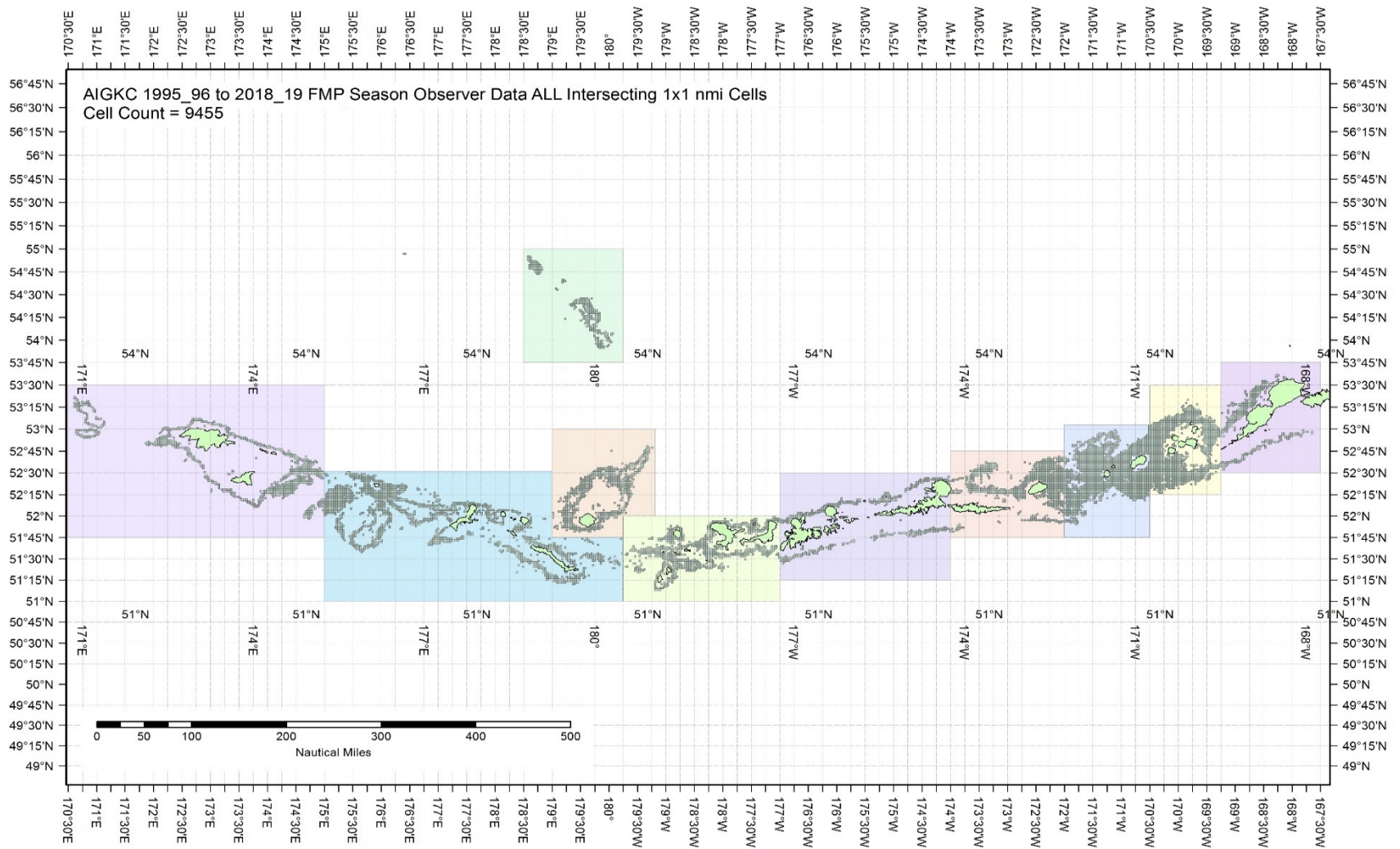


NB Fit, WAG 1985/86-1998/99



The negative binomial distribution leads to much better q-q plots; the CPT supports the change from log normal to negative binomial.

Estimation of observer CPUE index by a Year:Area interaction model



1995/96 – 2018/19 observer pot samples enmeshed in 10 blocks.

CPT recommendations for index standardization

- The CPT supports creating blocks and using this in the standardization, basis for the specific blocks chosen should be more clearly documented.
- Weights should be the total number of 1x1 nmi. cells ever fished in a block.
- Use a linear no-interaction model with a year effect and an area effect to deal with cells with missing data.

Initial results with year-area interaction look good!

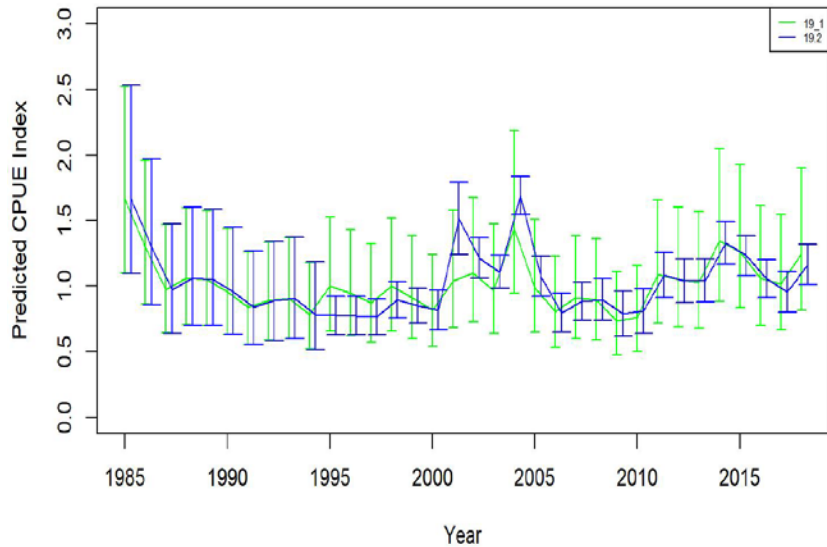


Figure A.10. Comparison of standardized (negative binomial GLM) CPUE indices with +/- 2 SE between no interaction (green line, 19.1) and Year:Area interaction (blue line, 19.2) models for **EAG**.

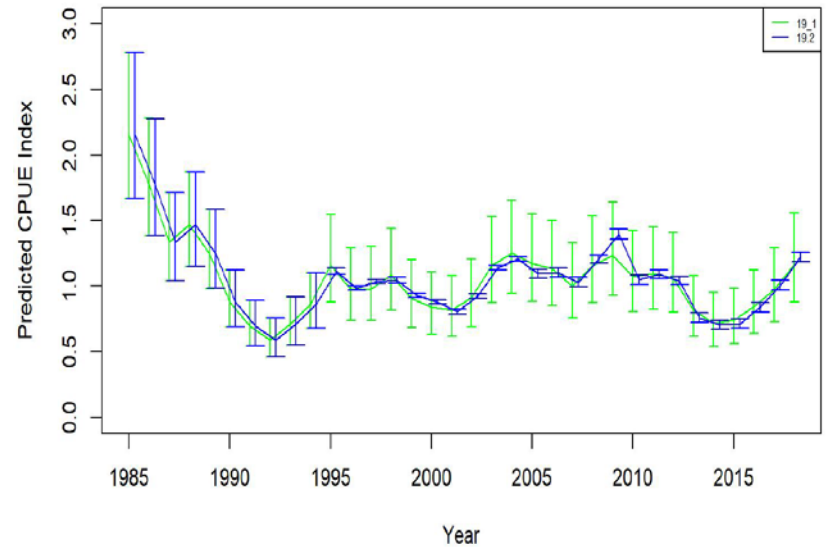


Figure A.11. Comparison of standardized (negative binomial GLM) CPUE indices with +/- 2 SE between no interaction (green line, 19.1) and Year:Area interaction (blue line, 19.2) models for **WAG**.

Analysis of the cooperative survey data

- The use of a mixed-effects model is appropriate.
- In general, the model for the analysis of the survey data should be more closely aligned with the design of the survey.
- A hierarchical structure for strings * block should be considered, such as string random within block, which is itself random.
- One possible model would be:

Sumcatch ~ Year + (1 | vessel/pot number) +
ns(soakdays, ns=9) + ns(Depth, df=6) + (1 | block/string)

Initial cooperative survey CPUE index looks promising!

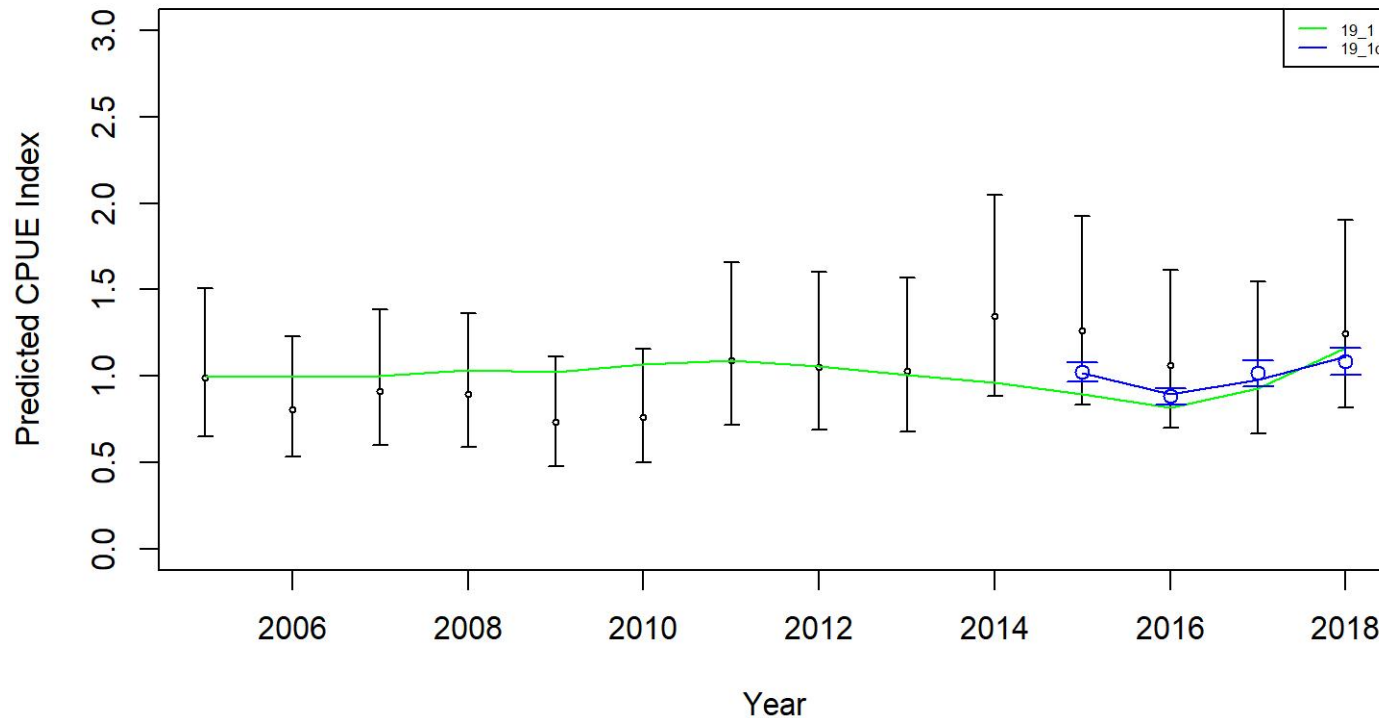
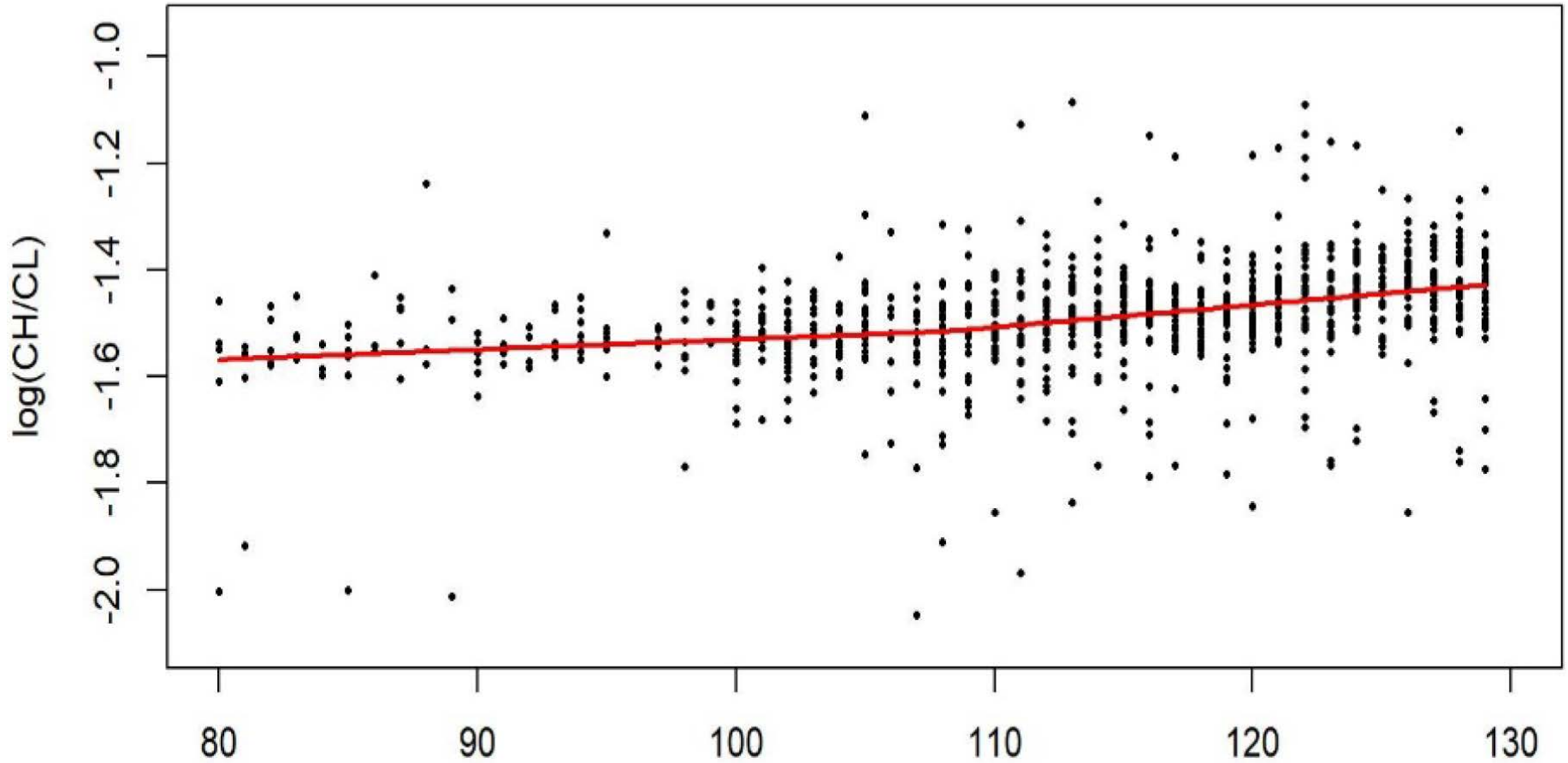
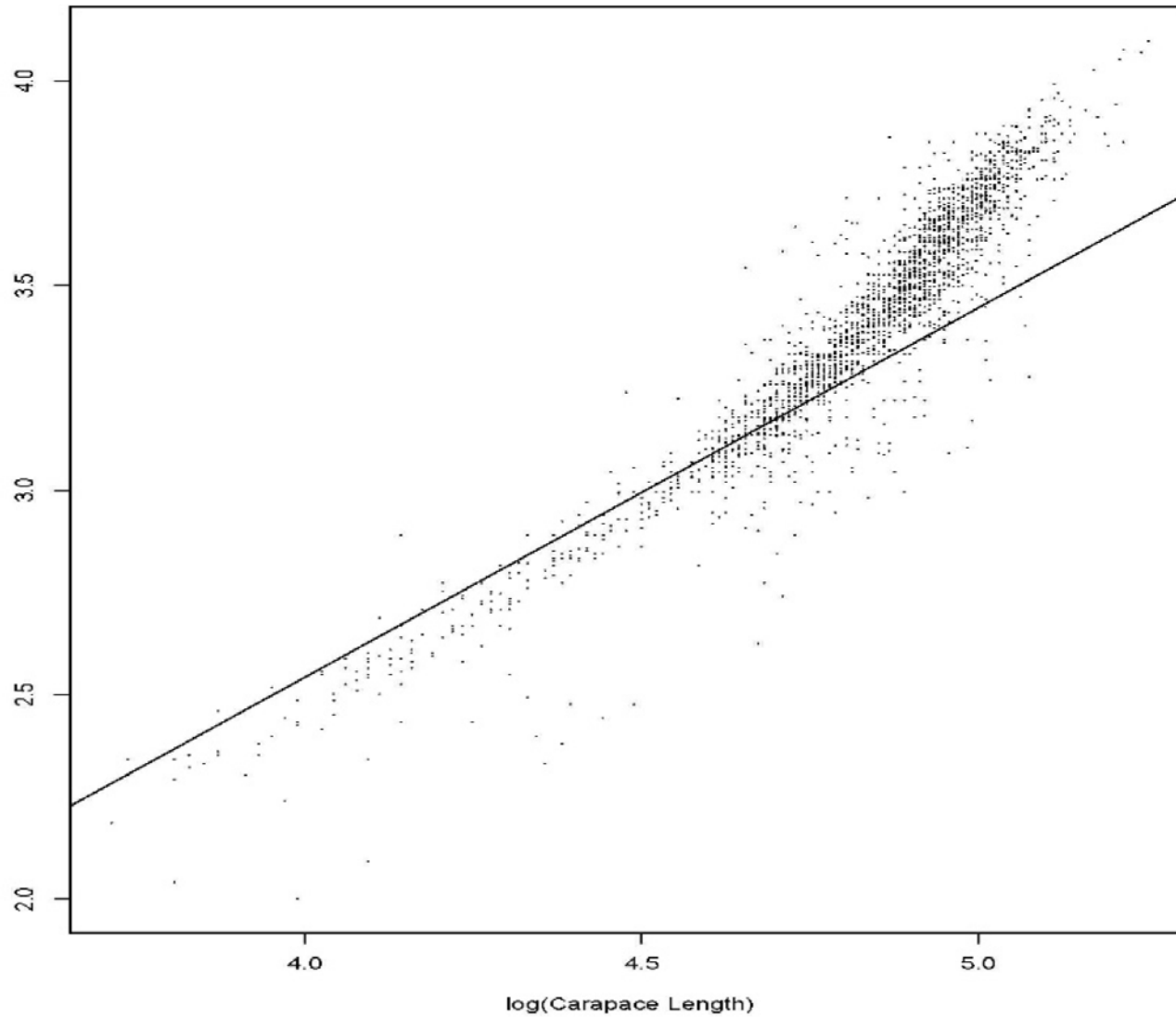


Figure A.13. Comparison of input CPUE indices [with ± 2 SE for model 19.1 (black small circles) and model 19.1d (cooperative survey, blue large circles)] with predicted CPUE indices (green (19.1) and blue (19.1d) solid lines) by 19.1 and 19.1d model fits for **EAG** (fishery data:2005/06–2018/19 and survey data: 2015–2018). Model estimated additional standard error was added to each input standard error.

Improved maturity ogive (break-point method, 1991 ADF&G data)



Improved maturity ogive (cut line method, 1991 ADF&G data)



CPT recommendations for maturity ogive

- The results of the cut-line and bend point approaches are not convincing. Evidence for two clusters of CH/CL are not evident.
- Additional samples of smaller animals (e.g. from small mesh pots) may rectify this, but the resulting data may still be uninformative.

CPT model recommendations June

- Model 19.1b As for model 19.1 but with revised periods of years for defining mean recruitment (EAG: 1985-2016; WAG: 1987-2016) and the fish ticket CPUE data standardized assuming a negative binomial distribution.
- Model 19.1d. As for model 19.1b except that the EAG 2015-2019 cooperative survey CPUE index is included in the assessment.
- Model 19.2. As for model 19.1b, except that the 1995/96 – 2018/19 CPUE data are standardized using year*area interactions.
- Model. 19.2b. As for model 19.1b, except that both the EAG 2015-2019 cooperative survey CPUE index and the 1995/96 – 2018/19 CPUE

Fishery Update

- Ben Daly from ADF&G gave an update on crab observer data, catch data estimation, and future assessment needs.
- Length-weight regressions NMFS EBS trawl survey are used in fishery catch estimation. CPT recommends that LW data be collected during the fishery to evaluate this practice.
- ADF&G is currently working to re-calculate the time series of total catch using standardized methods for May. The CPT recommended that the base model from last year be used to evaluate the new estimates prior to further model runs.
- Ben proposed starting the time series for observer data in 1995 to avoid some of the errors and lack of documentation that are found further back in time. The CPT agreed with the 1995 start date.

ESP planning

- Erin Fedewa presented on BSAI crab Ecosystem and Socio-economic Profiles (ESPs).
- An ESP was done last year for St. Matts. BKC. Crab-specific report cards for snow crab, Tanner crab, BBRKC were also completed.
- CPT recommends that the report cards be maintained and updated, and included in the SAFE stock assessments.
- Draft report cards should be presented and reviewed by the CPT in May to inform the assessment for the fall SAFE.
- The CPT did not see a need for a separate ecosystem status report for crab (but give thought to making the EBS ecosystem status report more relevant for crab stocks)
- The CPT recommends that Bristol Bay RKC be the next crab stock for developing an ESP, due to concerns about its continued decline.
- The CPT recommends that an ESP “team” be formed to develop the ESP.

St. Matthew Is. BKC rebuilding

- Katie Palof gave an update on the initial review draft on the St. Matthew Island blue king crab rebuilding plan.
- Final action scheduled for April 2020
- CPT recommends:
 - Document the data and the assumptions used to fit the Ricker S-R model.
 - Document the data and method to estimate the generation time.
 - Include the projection envelopes to show the uncertainties of the projections.
 - Provide more thorough analysis of socio-economic impacts for each alternative.

Bering Sea FEP

- Ben Daly (CPT and FEP Team member) briefed the CPT on FEP concepts and processes
- The CPT discussed the interaction of the FEP process with the CPT and other plan teams
- As action modules are completed the expectation is that the results would be incorporated into the Council process.
- This may create a greater need for coordination between the FEP process and the CPT and other Plan Teams directly involved in the Council management of fish and crab stocks.

Snow crab spatial model

- Maxime Olmos (UW) presented an overview of a spatial assessment model for snow crab in the EBS (Post-doc project with Punt, Szuwalski ,Thorson)
- Model embeds length- and sex-structured population dynamics within a spatial distribution model with spatial correlation (i.e., like VAST). The model uses an integrated statistical framework and was tested using simulated data in previous work (Jie Cao, Andre, Cody, and Jim)
- Goal of this project is to fit to actual snow crab data.
- CPT discussed a the potential spatial mismatch between summer survey distribution and winter fishery removals (but no simple solution was evident).
- The CPT supports this research effort (could be used to evaluate the “ratchet” hypothesis for snow crab.)

Economic SAFE

- Update on SAFE through calendar year 2018
- Future priorities:
 - Report card type metrics
 - ESP integration
 - Price forecasts & current year estimates
 - Demographics
 - Processing sector income analysis

ADF&G observer program overview (Bo Whiteside)

- Review of observer program and data collection
- Noted difficulties in collecting crab data – especially with a large proportion of new observers each year
- Discussion on trade-offs between count and measure pots.
 - CPT recommends that variance estimates for total catch be calculated so trade-offs can be evaluated.
- CPT requests a future presentation on the spatial coverage of observer sampling

Research Priorities

- Reviewed top 5 priorities from May 2018
- Discussed other high priority topics
 - Discard mortality
 - MSEs
 - Growth
 - Radiometric aging for natural mortality estimation
 - Impacts of trawling on benthic habitat

Revisit top 5 priorities:

1. 148--Spatial distribution and movement of crabs relative to life history events and fishing.
2. 225--Develop projection models to evaluate management strategies under varying climate, ecological, and economic conditions and evaluate impacts to managed resources and coastal communities.
3. 592--Maturity estimates for Bering Sea and Aleutian Island crab stocks.
4. 147/171--Acquire basic life history information (e.g., natural mortality through radiometric aging or other methods, growth, size at maturity) needed to inform the crab assessment models.
5. New research priority called “Studies on physiological responses to climate stressors”. Description: “Investigate how observed environmental changes (temperature, OA, etc.) affect physiological condition & survival of multiple life stages and reproductive output. Consider interactions among multiple stressors.”

Kodiak crab research and lab tours

- Short presentations on ongoing research by both NOAA and ADF&G researchers in Kodiak
 - Ocean acidification work (NOAA)
 - Snow crab reproductive cycle (NOAA)
 - Bristol Bay red crab sail drone tagging
 - 148 tags deployed summer, 59 detections in fall
 - More detections possible with drone this spring
 - Tanner crab satellite tagging (ADF&G)

Outreach: Kodiak lab tours



GMACS workshop

- Current status of the model
 - Much thanks to Andre Punt for his past and continued work on model development
- Discussion of improvements from current users
- To do / wishlist for future stocks
- Initial runs with both AIGKC and NSRKC
- Currently 3 stocks using GMACS, on track to add more possibly this Sept or the next.
- Good opportunity to make progress and collaborate on model improvements.