



Bering Sea / Aleutian Islands Crab Plan Team

REPORT

September 16 - 20, 2019
Alaska Fisheries Science Center
Seattle, WA

Members in attendance:

Martin Dorn, Co-Chair (AFSC-Seattle)	Krista Milani (NMFS-AKRO-Dutch Harbor)
Katie Palof, Co-Chair (ADF&G-Juneau)	Shareef Siddeek (ADF&G-Juneau)
Jim Armstrong, Coordinator (NPFMC)	William Stockhausen (AFSC-Seattle)
William Bechtol (UAF-Homer)	Diana Stram (NPFMC)
Ben Daly (ADF&G-Kodiak)	Cody Szuwalski (AFSC-Seattle)
Ginny Eckert (UAF/CFOS-Juneau)	Miranda Westphal (ADF&G-Dutch Harbor)
Brian Garber-Yonts (AFSC-Seattle)	Jie Zheng (ADF&G-Juneau)

Members absent: André Punt (Univ. of Washington)

Others in attendance:

Julie Ayres (ADFG Dutch Harbor), Lewis Barnett, Jen Bell (ADFG Nome), Karla Bush (ADFG), Erin Fedewa (NMFS Kodiak)*, Jamie Goen (ABSC), Scott Goodman (NRCC)*, Toshihide Hamazaki (ADFG Anchorage)*, Leonard Herzog, TKendall Henry (ADFG Juneau), John Hilsiger, Scott Kent (NSEDC), Linda Kozak, Sarah LaBelle (NPFMC), Craig Lowenberg (AKCHC), James Murphy (Cascadia Sciences)*, Landry Price (YDFDA), Jon Richar (NMFS Kodiak), Madison Shipley (NRCC)*, Chris Siddon (ADFG Juneau)*, Laura Slater (ADFG Kodiak)*, Mark Stichert (ADFG Kodiak), Gary Stauffer (BSFRF), Diana Stram (NPFMC), Leah Zacher (NMFS)

Attended remotely via WebEx: Rachel Baker (ADFG), Louis Forristall, Tyler Jackson (ADFG), Andy Nault (ADFG), Ethan Nichols (ADFG), Nikolai Silverstol, Calista Songstad, George Steers, Jon Warrenchuk

* *Presented to CPT*

Although the meeting week began on Monday Sept 16 at 1pm with a joint meeting of the Crab Plan Team and the BSAI and GOA Groundfish Plan Teams, a separate report has been prepared for that meeting. The report below covers the meeting that took place from Tuesday Sept 17 to Friday Sept 20, 2019.

1. Administrative

The Crab Plan Team (CPT) meeting began at 9:05 a.m. September 17, 2019 with review of Team member assignments and logistics for the meeting including finalizing the SAFE Introduction and this CPT Meeting Report. WebEx/Teleconference broadcast of the meeting was provided throughout the meeting, and connection information was posted to the [CPT meeting agenda page](#). Draft 2019 SAFE chapters and all meeting presentations were also made publicly available throughout the meeting week via the agenda. Martin Dorn and Katie Palof are CPT Co-Chairs and chaired the meeting on alternate days.

2. EBS trawl survey

Jon Richar (AFSC-Kodiak) summarized results from the 2019 NMFS survey. The 2019 survey was conducted from June 3 through July 28, covering the 375 standard stations, and included nine special

projects. They observed continuation of the recent warming period in the eastern Bering Sea, with both surface and bottom temperatures near record levels, particularly in Bristol Bay. The cold pool was small and confined to the northwest. Total combined biomass of mature males for all FMP crab stocks continues to decline, with the 2019 value being the lowest since the record low in 1985.

Individual crab stocks showed different trends, with only BBRKC, and Tanner crab mature male biomass declining relative to 2018. The decline in Tanner crab was the most severe, with a decline of 42% and 59% for mature male biomass for the eastern and western stock components, respectively. However, the mature male biomass of PIRKC, PIBKC, SMBKC, and snow crab all increased, with SMBKC showing the strongest increase (87%). The increases for PIBKC and SMBKC were not substantial enough to affect their overfished status.

There were increases in pre-recruits for both PIRKC and BBRKC, perhaps indicating favorable conditions for the early life history survival of red king crab, though the increase for BBRKC is small relative to historical patterns. In addition, there was an increase in Tanner crab juveniles, suggesting that the decline in mature crab may slow or reverse in the near future.

Changes in distribution were noted for several crab stocks. Mature male and female BBRKC shifted to the northwest in distribution, continuing a nearly decade-long pattern. Mature male and female snow crab were also distributed more to the northwest than the long-term average, though the distribution in 2019 was similar to the previous three years.

Indicators of female reproductive success were reported for snow crab and BBRKC. Egg clutch fullness for snow crab was mostly $\frac{3}{4}$ to full, and the percent of “eyed” eggs was low, indicating most females produced healthy new clutches in 2019. More than 99% of mature BBRKC females produced new clutches in 2019. This suggests no male limitation in either of these populations at present.

Northern Bering Sea Survey

Jon also briefly reviewed preliminary results from the Northern Bering Sea survey, which included Norton Sound in 2019. The standard survey grid of 144 sampled stations was used this year in contrast to the abbreviated 2018 survey. Snow crab were broadly distributed in the surveyed area, and were mostly immature crab, suggesting that this may be a nursery area for snow crab in the Bering or Chukchi Seas. Red king crab numbers, primarily in Norton Sound, decreased for mature males but increased for both immature males and females.

3. Crab Fishery overview

Ben Daly (ADF&G Kodiak) presented fishery data from the 2018/19 Bering Sea-Aleutian Islands crab fisheries, and Krista Milani presented data on incidental crab catch in the groundfish fisheries. Catch in the Bristol Bay red king crab fishery was concentrated further west in Bristol Bay than the previous season. Catch of western area Tanner crab was distributed similarly to last season - northwest and southeast of the Pribilofs. Snow crab harvest was distributed more northerly and west of Saint Matthew Island.

Bristol Bay red king crab

The 2018/19 season total allowable catch (TAC) was 1,954 t; the lowest TAC set since the 1996 TAC of 2,268 t. CPUE (number of legal males per pot lift) in the last two seasons was lower than the long-term average. Red king crab catch was concentrated in two statistical areas north and northwest of Amak Island. Over 60% of the harvest occurred in the first week and the TAC was nearly achieved within the first three weeks of the fishery.

Average weights in the retained catch have increased over the last three seasons with a 2018/19 average weight of 7.1 pounds. Captains have communicated that they are fishing the same group of crab from last season with general concerns on the increased average weight of the crab. Fishermen reported seeing

large masses of female crab retained in pots causing captains to relocate fishing efforts. Discard mortality increased over last season and is estimated to be approximately 454 t. The rate of bycatch mortality per pounds of retained catch increased substantially over last season to approximately 20%. This could be due to a high proportion of old shell legal males in the population, or due to an increase in sub-legal males in the population.

Bering Sea snow crab

The TAC for the 2018/19 season was 12,510 t which is low for this stock but is an increase over the 2017/18 TAC. CPUE for this fishery has declined overall since 2007 but was up slightly this season. Harvest was distributed over a larger area than in the previous season with the majority of harvest occurring west of Saint Matthew Island. Similar to previous seasons, harvest began in January and lasted through April. Sea ice did not impact the fishery this season.

Average weight of retained crab in the fishery increased slightly to 1.31 pounds for legal male crab. Many fishermen reported moving north, away from typical fishing grounds, where CPUE was higher and there was an abundance of new shell crab. Captains reported having to move gear around more than usual to find clean shell crab. Fishermen west and north west of the Pribilof Islands reported an abundance of juveniles mixed with old shell crab, resulting in a lot of deck sorting. Discard mortality this season was estimated at 2,268 t.

Bering Sea Tanner crab

This fishery was closed in the eastern area and the TAC was 1,106 t in the western area (west of 166 deg. W. long.); low for this fishery but similar to the previous season. All directed harvest occurred to the west and southeast of the Pribilof Islands closure box. CPUE decreased dramatically from last season but is higher than the 2005 to 2017 average. Fishing began mid-October with 50% of the catch harvested before January.

Fishery average weight decreased from last season along with average carapace width, indicating smaller crab retained in the fishery. CPUE ranged from 9 to 92 legal males per pot with fishing improving in February and March. Fishermen reported that fishing was spotty compared to last year.

Aleutian Islands golden king crab

TACs for the 2018/19 season were set using the new harvest strategy. The TACs increased this season; 1,749 t in the east (east of 174 deg. W. long.) and 1,1134 t in the west (west of 174 deg. W. long.). In the recent history of this fishery, the west CPUE has been approximately half of the east CPUE, but the CPUE in each area increased slightly this season. The spatial distribution of harvest in the east was similar to previous seasons. Harvest in the west was spread west past Attu Island, similar to last season but further west than most other recent seasons. The TACs in both fisheries were achieved shortly after the new year.

In the east, all vessels reported good fishing throughout the season. Some fishermen expressed concerns over the small average weight (4.08 pounds). In the west, fishermen reported good fishing over the course of the season but fishing activities were limited by severe weather in the western Aleutian Islands. Bycatch mortality increased for the fifth season in the east to nearly 280 t. In the west, bycatch mortality increased slightly to approximately 160 t.

Pribilof Islands golden king crab

This a calendar-year fishery with a set guideline harvest level of 59 t. The GHL has been achieved in two of the past three seasons; harvest is confidential. From 1992 to 2019, 95% of observer pot locations occurred in the Pribilof canyon with 70% of historical harvest occurring in one statistical area. Approximately 5% of pots were observed during recent years of the fishery.

Crab bycatch in groundfish fisheries

Krista Milani (NMFS Dutch Harbor) presented incidental crab catch in the groundfish fisheries. The North Pacific Observer Program is considering changing from measuring commercially important crab species to the nearest 5 mm to the nearest 1 mm. The CPT does not expect this change to cause any problems with input data for stock assessment.

Krista detailed observer coverage levels for all federal and state groundfish fisheries; vessels that are not required to carry an onboard observer (including vessels in the state-waters fisheries) have bycatch rates applied to fishing activities based on rates derived by observed vessels. Nearly all trawl vessels are observed. Fixed gear vessels eligible for partial coverage can elect for electronic monitoring instead of onboard observers at a 30% selection rate. Next year, it will be legal to fish halibut with pot gear which may impact crab incidental catch.

The following bycatch estimates are extrapolated observer data and do not have mortality applied. It should be noted that groundfish fisheries occur during a calendar year while most crab fisheries apply a crab year from July 1 to June 30; except Pribilof Islands golden king crab which is a calendar year fishery. Bycatch estimates for the 2018/19 season are preliminary and may change due to ongoing 2019 groundfish fisheries.

Annual harvest data for Norton Sound red king crab are confidential. Pooled bycatch from 2014/15 through 2018/19 totaled 19 kg of red king crab. There has been interest from vessels to fish for pot cod in the Norton Sound area which could increase bycatch levels of red king crab in the future. Pribilof Islands golden king crab bycatch mainly occurs in the rock sole trawl fishery with a small amount attributed to hook-and-line gear. Golden king crab bycatch for 2018/19 was 1,973 kg. Bycatch of Aleutian Islands red king crab usually occurs in the Atka mackerel trawl fishery during most years. For the 2018/19, bycatch of red king crab was 171 kg.

Bycatch of Pribilof Islands blue king crab fishery is mostly attributed to the yellowfin sole trawl fishery with a small amount attributed to hook-and-line fisheries. Incidental catch of blue king crab for 2018/19 was 536 kg. This stock is currently overfished and bycatch data are reported weekly on the NMFS website to safeguard against overfishing. Saint Matthew Island blue king crab bycatch mainly occurs in fixed gear fisheries. Bycatch for 2018/19 was 2,553 kg. This stock is currently overfished and bycatch data are reported weekly on the NMFS website to safeguard against overfishing (<https://www.fisheries.noaa.gov/alaska/commercial-fishing/fisheries-catch-and-landings-reports#bsai-prohibited-species>).

Bycatch of western Aleutian Islands golden king crab mainly occurs in the Atka mackerel and other Amendment 80 trawl fisheries although some bycatch occurs in hook-and-line and pot fisheries. Incidental catch of western Aleutian Islands golden king crab was 3,784 kg for the 2018/19 season. For eastern Aleutian Islands golden king crab, most bycatch occurs in fixed gear fisheries. Incidental catch of golden king crab was 15,124 kg for the 2018/19 season. Even though little federal fishing occurs in the eastern Aleutian Islands golden king crab fishery, bycatch rates are extrapolated to the state-waters Pacific cod fisheries and the state-waters sablefish fishery.

Bering Sea Tanner crab incidental catch occurs in both trawl and fixed gear fisheries. In the Tanner crab fishery, most bycatch occurs in pot fisheries. Incidental catch for 2018/19 was 140,406 kg. In the western Bering Sea Tanner crab fishery, bycatch mainly occurs in the yellowfin sole trawl fishery although other Amendment 80 and trawl cod fisheries also contribute. Incidental catch in 2018/19 was 50,545 kg. Most of the incidental crab catch in the yellowfin sole trawl fishery comes from snow crab and Pribilof Islands red king crab. Small amounts of incidental catch in both stocks is attributed to fixed gear fisheries. For 2018/19, total incidental bycatch of snow crab is 233,079 kg, and for Pribilof Islands red king crab a total of 6,288 kg. The bycatch for 2018/19 was a large increase from the previous season due to yellowfin trawl fisheries in September of 2018 north of the Pribilof Islands.

Bycatch of Bristol Bay red king crab mainly occurs in Pacific cod pot fisheries, although incidental catch also occurs on rock sole and yellowfin trawl fisheries. There was a dip in bycatch in 2016/17 generally driven by low 2017 observer rates for catcher vessels and fewer catcher processor pot vessels fishing Pacific cod in Bristol Bay. Total bycatch of Bristol Bay red king crab for 2018/19 was 318,552 kg. Much of the bycatch occurs north and east of Amak Island, although observed vessel rates are extrapolated to vessels fishing in “cod alley” and in the state-waters fishery. There has been an increase in effort north of Port Moller, which overlaps with the red king crab directed fishing grounds. Currently 23 pot vessels are fishing Pacific cod in this area, compared to 10 vessels last season.

Typically hook-and-line CP Pacific cod vessels are able to fish throughout the entire Bering Sea because they are quite mobile with their gear, are in cooperatives, and can stay on the grounds for up to two months. Pot vessels typically have a smaller range because pot gear is more cumbersome, and the fisheries are derby-style so it is beneficial for vessels to fish closer to ports where they can deliver and get back to the grounds quickly. However, there has been more interest recently from pot cod vessels to fish further north in the Bering Sea. A floating processor has the ability to move closer to the fishing grounds in the north and bring along a fleet of pot cod catcher vessels. Should this occur the distribution and amount of crab bycatch in the Bering Sea could change in future years.

The CPT is concerned that the increasing trend of red king crab bycatch in the fixed gear Pacific cod fishery is due to the changing distribution of Pacific cod in the Bering Sea and the consequent changing distribution of fishing effort. Since this is a rapidly evolving situation, there is a potential for rapid changes bycatch and increased impacts on crab stocks. For this reason, observer coverage in the federal Pacific cod pot fisheries should be adequate to provide reliable estimates of spatial patterns in bycatch, which may require an increase in coverage levels.

The CPT requests that updates to both the fishing and bycatch report be provided to the CPT each year. The CPT also requests that future presentations provide estimates of bycatch mortality, which would involve applying handling mortality rates to the total bycatch estimates, so that the CPT can better understand groundfish fishery impacts.

4. BSFRF research

Scott Goodman from the Bering Sea Fisheries Research Foundation (BSFRF) provided an update on their research activities related to crab growth, movement, and survey selectivity.

The BSFRF has contributed to growth studies for both snow and Tanner crabs over the past nine years. In April 2019, BSFRF collected 464 pre-molt Tanner and snow crabs in their Nephrops trawl in the Eastern Bering Sea and delivered the crabs to Kodiak, where NMFS is tracking molting in the lab. Crabs are held individually in crab condos and measured before and after molting. Next year, BSFRF plans to shift the timing of collections earlier in the spring.

The BSFRF is also studying crab movement in conjunction with NMFS. A total of 148 male red king crab (3 immatures, 40 sublegal and 105 legal size crabs) from Bristol Bay were tagged in June 2019 with acoustic tags and 2 tags placed in fixed locations. Similar tags have been applied in studies of Dungeness crab off Oregon using fixed receivers. Battery life on small tags last approximately 1 year and on larger tags up to 3 years. The tags will be tracked with two saildrones, which are autonomous vessels with AIS, GPS, cameras, sensors, and an acoustic receiver, should provide a cost effective tool to track tagged crabs. The saildrones will each be deployed for 15 days in October 2019 and again in March-April 2020. This technology has been used for fish and in Arctic regions. After launching the saildrones, researchers can change their search paths remotely as needed. The drones will follow a set track, within a search grid, to locate tagged crabs. When a tagged crab is located, the saildrones will conduct a more intensive search in that area. BSFRF will be able to login through a web portal to see where the saildrones are currently located, if they have received any successful measurements, and if there are any issues with the drones.

The BSFRF has also conducted index sampling for Tanner crab with the goal of informing NMFS trawl selectivity for use in the Tanner crab stock assessment model. In 2017 and 2018, BSFRF conducted side-by-side comparisons with the NMFS survey. In 2019, BSFRF sampled a smaller area with only one vessel with an intent to focus more on Tanner crab, and the 2019 survey sampled given stations about 7-10 days earlier than the NMFS survey. The BSFRF survey is of a higher resolution and their net catches smaller crabs, and in 2019 they made 115 tows in an area near Unimak canyon and SE of Pribilofs with four quadrants sampled within a target 20 nm x 20 nm survey station vs. one tow/station by the NMFS survey.

The BSFRF welcomed input for future research projects and is flexible to new opportunities with a broad scope. The Board of Directors has monthly meetings, and those with a survey ideas should approach Scott Goodman or any member of the Board of Directors. They have a new area of study to reduce crab bycatch in cod and halibut pot gear through gear modifications. Discussions for the project just started, and their first meeting was September 16.

5. BBRKC - Final 2019 Assessment

Jie Zheng (ADF&G Juneau) presented the Bristol Bay red king crab (BBRKC) stock assessment models and recommendations for 2019. The model options presented for this year's assessment focused on transitioning this assessment to the general model for assessing crab stocks (Gmacs) framework. During this assessment cycle much work has been done to bridge between the current assessment model framework and that of Gmacs. The authors have attempted to CPT and SSC concerns and comments from initial model runs in Gmacs that were presented in May 2019. The authors reiterated the need to improve documentation for the Gmacs framework.

Differences between the current model framework and Gmacs include discrepancies in likelihood values between the two models, which are largely due to the presence or absence of constant terms, and extra penalties used in the Gmacs model. Jie showed, through sensitivity analyses, that many of these weightings, penalties, and prior densities had little to no impact on model results. The authors raised some concerns on how the B35% reference point was being estimated in Gmacs, but this was addressed during the meeting with the help of Jim Ianelli and Andre Punt.

Jie presented three model options for consideration:

- Model 18.0d, which is the accepted model from 2018 updated with 2019 data, and separating the groundfish fisheries bycatch data into trawl and fixed gear during 1996-2018.
- Model 18.0e, changes the length compositions of the Tanner crab fishery bycatch in each year to sum to 1.0 for both sexes combined, thus treating this data the same as the groundfish fisheries bycatch in the model.
- Model 19.0, Gmacs model which is as close to model 18.0e as possible.

Small changes from model 18.0d to 18.0e allowed for consistency among treatment of bycatch length compositions but had little impact on model fit and outcome and therefore comparisons focused between models 18.0e and 19.0.

Some of the main differences between models 18.0e and 19.0 were the treatment of penalties and priors in Gmacs. Sensitivity analyses showed that, while they could not be mirrored in the model 18.0e framework, they had little effect on model output. Treatment of selectivity is also different between models, with model 18.0e having three parameters while model 19.0 has four for male and female logistic curves for a given period. This affects the estimation of selectivity of smaller size groups in model 19.0 and, therefore, the shape of the selectivity curves. There are also differences between models in treating the relationship between the NMFS trawl survey and the BSFRF survey. The Gmacs model fits the NMFS biomass better than the BSFRF biomass whereas model 18.0e does the opposite. Therefore, the authors recommend that

additional options be added to Gmacs to deal with different relationships of selectivities between these two survey gears.

The trawl survey biomass of BBRKC was low in 2019, similar to that in 2018. However, the model options are not fitting these lower data points, and if the survey values are accurate, then there may have been a mortality event or movement of the stock outside the survey area. Model 19.0 has slightly lower estimates of mature male biomass in recent years, which are most likely due to selectivity differences and down weighting of the BSFRF survey in recent years in the model.

Overall, the author has put in considerable work to bridge the current model with the Gmacs modeling framework, and the CPT acknowledges this and recommends adopting model 19.0. This model transitions this stock to the Gmacs modeling platform. The OFL and ABC were adopted from the Gmacs model, with a 20% buffer for ABC, consistent with last year's ABC buffer and adoptions in other crab stocks.

The CPT recommendations for the author include:

- Explore the cause of the residual pattern for female fits for the largest size class in the bottom trawl survey.
- Provide a plot of the empirical BSFRF vs. NMFS selectivity values.
- Consider a scenario with different catchabilities for males and females in the NMFS survey to address the discrepancies in the respective selectivity curves.
- Investigate the discrepancies in historical assessment, e.g., by retrospective plots, and estimation of Mohn's rho.

6. Snow Crab - Final 2019 Assessment

Cody Szuwalski (AFSC Seattle) presented the snow crab assessment and status recommendations for the 2019/20 fishery year. Mature male biomass in the NMFS EBS trawl survey was down slightly from last year, but the 2018 mature male survey biomass was the largest observed since 1998 and the value for 2019 is the second largest in that time period. This appears to be due to a large recruitment event from 2015 moving into maturity. Retained catch for 2018/19 was 12.51 kt while discard mortality was 2.90 kt, the latter mostly smaller males in the snow crab fishery itself.

The 2018 assessment model included a prior on natural mortality (M) with a median of 0.23 yr^{-1} based on assumptions of maximum age, kinked growth curves for both sexes, and sex-specific recruitment deviations with the size distribution fixed and shared among males and females. For this assessment, Cody presented six alternative assessment model scenarios, in addition to a base model using last year's accepted model updated with this year's data.

The alternative model scenarios included recommendations by the CPT and SSC to reconsider the priors on M and to consider alternative growth models (linear growth vs. "kinked" growth). Cody also presented a model that estimated sex-specific recruitment size distributions. Cody noted that the scenarios that included different priors on M also addressed concerns raised in a public comment on the assessment that recently-published work by Murphy et al. using a state space population model for snow crab with time-varying M suggested that natural mortality was quite a bit higher than that used as the prior in the base model (18.1/19.1). This was also suggested by his own analysis of the rate of decline in abundance of small, old shell males (not vulnerable to the fishery) associated with a strong cohort in the mid 1990's. However, Cody considered the estimates of mean M from the Murphy et al. study (0.36 yr^{-1} for males, 0.49 yr^{-1} for females) to be too high; the prior values he used in alternative scenarios 19.2 and 19.3 bridged the gap between the base model and those of Murphy et al.

Cody noted that the assessment model is still based on fitting discard mortality in the fisheries, although crab fishery observers are no longer classifying observed catch as "retained" or "discarded". He discussed

the use of the “subtraction” method to obtain estimates of discard mortality for males in the directed fishery from estimates of total catch and retained catch. As expected, this resulted in some negative values for discard mortality in some size bins; these were set to zero in the model. This will no longer be an issue when snow crab moves to Gmacs, because it can fit to observer estimates of total catch.

The models continued to exhibit some degree of instability in model results, as evidenced by convergence to different local minima in the objective function when jittering was done. As previously found, this was more of an issue in models that fit kinked growth curves for both sexes. Model stability was improved when a linear model was fit for one sex, but a scenario run with linear models describing growth of both sexes failed to converge. Cody noted that crab undergoing terminal molt may exhibit different growth relationships compared to immature crab, but that kinked growth curves may not be the best approach to incorporating different relationships because snow crab undergoing terminal molt overlap those continuing to grow across a fairly large range of sizes whereas a kinked growth curve models the change as occurring over a small range.

In addition, all the models exhibited generally similar retrospective patterns in MMB (with some better than others) as data from the most recent model year was “peeled away”. Models tended to overestimate MMB in the terminal year because an initially-strong recruitment event in 2010 disappeared in subsequent surveys.

After a review of fits to the data and the estimated model processes, the CPT concurred with the author’s preferred model, scenario 19.7, as the model with which to determine stock status and set the OFL for 2019/20. The basis for this recommendation was that 19.7 exhibited the best retrospective pattern among the models, it estimated male survey catchability closer to what was implied by the BSFRF side-by-side data, it incorporated one of the priors for increased M , and it used the linear growth model for males. Although 19.3 exhibited the best likelihood score, it was able to do so because it estimated the highest M ’s (0.33-0.45 yr⁻¹) and recruitment levels among the models; subsequent values for $F_{.35\%}$ and F_{OFL} (2.48yr⁻¹) were unreasonably high.

The CPT expressed some concern regarding the (still rather) high $F_{.35\%}$ (1.93 yr⁻¹) associated with the recommended model and discussed the potential value of the large mature males were to the reproductive capacity of the stock. These crab are vulnerable to this F , relative to smaller mature males that would be less subject to fishing mortality. Cody noted that the higher F_{MSY} was consistent with the higher estimated M ’s for the preferred model, but these were substantially smaller than those from 19.3.

Finally, Cody presented a prioritized list of potential topics for continued and future research, with which the CPT agreed. The CPT thus recommends the author (in order of priority):

- Move the assessment to Gmacs.
- Develop options to better utilize the BSFRF side-by-side data in the assessment.
- If possible, add maturity information to the molt increment data to better inform a more realistic growth model.
- More fully explore the impact of snow crab in the NBS on the assessment.
- Provide likelihood profiles for M .

The CPT also requested the author provide an update at the May CPT meeting on his research on the future productivity of EBS crab stocks under projected climate change.

7. SMBKC - Final 2019 Assessment

Katie Palof (ADF&G Juneau) presented the St. Matthew blue king crab assessment to the CPT. The assessment is conducted in the Gmacs framework, which was first accepted for use by the SSC in June 2016. The assessment uses the same model configuration as last year, in which the male population is divided into three length categories, and five discrete seasons are modeled with continuous natural and

fishing mortality during each season as appropriate. The model incorporates the following data: commercial catch data, bycatch data in the groundfish trawl and groundfish fixed-gear fisheries, ADF&G observer composition data, annual trawl survey data from 1978 to 2019, and ADF&G pot survey data from 1995 to 2018. New data in this year's assessment include the 2019 bottom trawl survey biomass and size composition, and updated bycatch estimates for 2010-2018. The ADF&G pot survey was not conducted in 2019.

The stock assessment examines four model configurations: Model 18.0 - the 2018 recommended model; Model 19.0 – the reference model updated with new data; Model 19.1, which gives greater weight to fitting the NMFS trawl and the ADF&G pot surveys; and Model 19.2, which estimates an additional CV for the ADF&G pot survey. A variant of model 19.0, Model 19.0a, differs only in the range of years used to calculate reference points.

The CPT discussed the various model configurations in the assessment. The addition of new data pulled the assessment model slightly upwards at the end of the modeled time period due to the increase in the NMFS survey biomass in 2019, but not enough to affect stock status. Model 19.1, which used a weighting factor of 1.5 for the bottom trawl survey and a factor of 2.0 for the pot survey, improved the fit of survey estimates only in the early part of assessment and did not change recent trends. The CPT regarded this model as a sensitivity run and not a potential base model due to the arbitrary weighting factors. Model 19.2, which estimates a parameter for additional CV for the pot survey, seemed a potentially viable base model. The effect of estimating the additional CV is essentially to remove the information content of the pot survey from the assessment, as sometimes happens when these parameters are estimated. However, the CPT was concerned about the unbalanced treatment of the two surveys, since the additional CV parameter was only estimated for the pot survey. Because of this concern, the CPT does not recommend model 19.2, but encourages further exploration of models that estimate CV terms. This is a relatively standard approach elsewhere, and it is clear that the model is sensitive to how much weight is given to the two surveys. The CPT remains concerned with generally poor fit to both the survey time series, but there appears to be no immediate way to address this problem. We do provide several recommendations below for additional modeling work.

Based on the above considerations, the CPT agrees with the author's recommendation to use the reference model 19.0 for the 2019/20 crab year. The stock classified in Tier 4c at present. The CPT recommends that the full assessment period (1978/79–2018/19) be used to define the proxy for B_{MSY} in terms of average estimated MMB . The rationale for this recommendation is provided in CPT's minutes on the rebuilding analysis of SMBKC, where different time periods for defining B_{MSY} are evaluated. The projected MMB estimated for 2019/20 under the recommended model is 1,151 t and the F_{MSY} proxy is the natural mortality rate (0.18^{-1} year) and F_{OFL} is 0.042, resulting in a mature male biomass OFL of 44 t. The MMB/B_{MSY} ratio is 0.310. The CPT also agreed with the author's recommendation of a 20% buffer on the OFL for the ABC, which is consistent with the approach used last year. The ABC based on this buffer is 35 t.

CPT Recommendations:

- Provide estimates of fishing mortality, and include a phase plane plot (i.e., a plot of fishing mortality and MMB relative to reference points).
- Explore models that estimate an additional CV parameter for both the bottom trawl and pot survey.
- Consider a model with a random walk in pot survey catchability.
- VAST remains a potentially useful approach for modeling survey data, despite current implementation issues. There is ongoing work to more appropriately model spatial correlation in the presence of islands, and these methods may soon be available for stock assessments. In addition, there is ongoing work with the VAST modeling framework to combine multiple surveys into a single synthetic time series that may be useful for reconciling the contrasting trends for the bottom trawl and pot survey indices.

- The CPT recommends the author update the SAFE document tables to reflect tons instead of thousands of tons.

8. SMBKC - 2019 Ecosystem and Socioeconomic Profile

Erin Fedewa (AFSC Kodiak) presented an update from what was presented in May 2019 based on her participation in the ESP data workshop. The ESP definition is “a standardized framework that facilitates the integration of ecosystem and socioeconomic factors within the stock assessment process and acts as a proving ground for operational use in quota setting.” The SMBKC stock was used as an example during the ESP data workshop of data-poor stock.

The Team spent considerable time on the “metric panel” slide, which highlighted a large number of ecosystem and socioeconomic vulnerabilities. Brian Garber-Yonts addressed socio-economic vulnerabilities in the metric panel noting that it is quite difficult to objectively rank many of the variables for this stock (e.g., non-catch value). Quantitative scoring are based in part on national initiatives, author input, and expert judgement. The socioeconomic aspect came from a national stock assessment prioritization initiative. Kalei Shotwell clarified information sources which included FishSource and expert opinion of assessment authors, among others. The product is an initial attempt and is valuable because it highlights the important issues and creates a foundation for future ESPs. Growth metrics were developed for fish and are not necessarily relevant for crab stocks, suggesting that crab may need to be scored separately from groundfish. This analysis highlights the vulnerability of SMBKC with respect to spatial range, temperature, fecundity, adult mobility, habitat, ocean acidification (OA) sensitivity, and predators. There was a lack of data for many critical issues.

Erin reviewed vulnerabilities by life stage: larval, juvenile, and adult, with consideration to duration in each stage. She described the development of the five ecosystem indicators which consist of 1) pre-recruit biomass, 2) bottom temperature, 3) cold pool extent, 4) benthic invertebrate biomass, and 5) benthic predator biomass. Pre-recruit biomass is often a reliable indicator of impending declines in mature male biomass and may be useful as an early indicator of stock recovery for the SMBKC rebuilding plan. In reviewing indicator trends, it was noted that the environmental regime shift in 1989 is consistent with the recruitment breakpoint in 1996 (age 7 recruits). There were bottom temperature peaks in 2018-2019, a low in cold pool extent in 2018-2019, and peaks in invertebrate biomass and predator fish in 2016. The 2016 peak in predators was dominated by Pacific cod.

It was noted that bottom temperatures in shallow areas where high abundance has historically been observed (such as NMFS station R-24) may exceed thermal optima for BBRKC, inducing movement to less favorable habitat. Erin reviewed the ecosystem “stoplight” figure that scored red lights for bottom temperature and cold pool extent, and yellow lights for the other three indicators. In summary, there are very challenging environmental conditions for SMBKC that suggest potential constraints on rebuilding.

Brian presented the socioeconomic portion of the ESP. There are nine indicators: 1) TAC utilization, 2) local quotient of SMBKC landed catch in St. Paul (dependence), 3) processors active in fishery (number of buyers, not plants), 4) SMBKC ex-vessel revenue share (average at the vessel level), 5) ex-vessel price per pound, 6) CPUE, 7) total pot lifts, 8) SMBKC male bycatch in the groundfish fishery, and 9) vessels active in the fishery. Some indicators are not statistical metrics, but instead are derived from administrative records (e.g., fish tickets that are simply landing records). The fishery started in 1977, peaked in 1983, and TAC utilization has wavered between overages and underutilization of GHL. The TAC utilization, pot lifts, and CPUE all tracked similarly with recent declines. Ex-vessel price peaked in 2013, then declined, revenue was high in 2013 and 2014 due to high prices. The SMBKC historically has been fished following Bristol Bay red king crab on an annual basis.

The number of processors declined overall as the fishery declined. The local quotient peaked at 20% in St. Paul in 2011 when the price peaked. For the socioeconomic stoplight figure, 6 of 9 are red and 3 of 9 are yellow. The fishery was not attracting effort right before the closure. For example, in 2015/2016, TAC

utilization was 26%. Brian noted that socio-economic indicators are difficult to evaluate when the fishery is closed, so most of the indices cannot be applied after the SMBKC fishery closure beginning in 2016.

In closing, Erin reviewed a need for process studies of early life history and continued development of ecological indicators. Four examples were provided including 1) larval advection/retention, 2) groundfish predation, 3) spring bottom temperature, and 4) benthic production. Brian reviewed the objectives of the socioeconomic indicators, which fall into two categories – upstream (fishery drivers, e.g., they help explain effort and catches), and downstream (effects of fishery on stakeholders/communities). There will be ongoing efforts to improve the ESP for SMBKC.

9. SMBKC - Rebuilding Analysis

Katie Palof presented a review of the progress since the May CPT meeting for the rebuilding analysis for St. Matthew blue king crab (SMBKC). In 2018, SMBKC was determined to be overfished because mature male biomass (MMB) at the time of mating was found to be less than the Minimum Stock Size Threshold (MSST, defined as $\frac{1}{2} B_{MSY}$). A rebuilding plan needs to be implemented within two years of the overfished determination. The analysis focused on evaluating rebuilding probabilities and the estimation of the minimum time to rebuild the stock (T_{min}) using the 2019 Gmacs assessment model under several different assumptions regarding SMBKC stock dynamics. Rebuilding times for several management scenarios were evaluated to address previous CPT and SSC requests.

Katie presented results from a breakpoint analysis using the “Sequential t-Test Analysis of Regime Shifts” (STARS) algorithm applied to estimated recruitment from the assessment model to address a request by the CPT. Previous analysis using both Ricker and Beverton-Holt stock-recruit models found a breakpoint corresponding to the model recruitment year of 1996, such that the stock was in a less productive state after 1996. However, recruitment is generally assumed to be independent of stock size for Bering Sea crab stocks, so this analysis was not considered conclusive evidence for a regime shift in productivity by the CPT and SSC. Whether or not such a shift did occur has substantial implications for biologically-reasonable rebuilding time frames for the stock, even under assumptions of no fishing mortality. Consequently, Katie applied the STARS algorithm to the time series of recruitment estimated by the assessment model to test whether or not it would detect a regime shift in recruitment independent of a stock-recruit relationship. As with the previous analysis, the STARS algorithm detected a regime shift in 1996, adding further support to the results of the previous analyses with the implication being that it is important to take this apparent change in productivity into account in the rebuilding analyses.

Initial rebuilding projections presented at the May 2019 CPT (June SSC) meeting looked at a suite of scenarios covering a range of combinations of assumptions regarding recruitment (Ricker or Beverton-Holt stock-recruit relationships, or recruitment independent of stock size), bycatch mortality, and implementation of the state harvest policy. The CPT and SSC recommended that further rebuilding analyses proceed with “random” recruitments (implemented by randomly resampling estimated values) using two time frames: 1978-2018 (the entire time series) and 1996-2018 (the “current” regime, as suggested by the breakpoint analyses). Katie presented results from rebuilding projections using these time frames that also took into account the state harvest policy and recent bycatch mortality levels (2014-2018 average). To address an SSC request, she also conducted a set of similar projections based on the maximum observed level of bycatch mortality (which occurred in 2007).

In general, the rebuilding times were rather insensitive as to whether or not the state harvest policy was implemented, and the level of bycatch mortality assumed. However, substantially different results were obtained depending on the time periods selected to characterize the state of the stock (the B_{MSY} proxy) and future recruitment. As per CPT/SSC recommendations from the May/June meetings, projections were run using two time frames, based on the assessment and the breakpoint analyses (either 1978-2018 or 1996-2018), to simultaneously characterize both future recruitment and to define B_{MSY} . These projections resulted in rebuilding times values between 6 and 13 years. The shortest rebuilding time occurring with

no directed fishing, assuming average bycatch, and using 1978-2018 as the years to characterize recruitment and define B_{MSY} , while the longest rebuilding time with directed fishing under the state harvest policy, maximum bycatch, and using 1996-2018 to characterize recruitment and define B_{MSY} .

There was concern regarding the use of the same time frames to characterize recruitment and define B_{MSY} for the rebuilding analyses. For B_{MSY} , the concern was with regard to “shifting baselines” when using the shorter time frame to define B_{MSY} , since this seemed to guarantee that the stock would be declared rebuilt at population sizes much smaller than those seen in the 1990s. Conversely, it was felt that it was unreasonable to expect that recruitment in the near future could approach levels seen prior to 1996 (the evidence for some sort of shift in recruitment in the mid-1990s being fairly convincing), as could easily result if the projections sampled from the full recruitment time series. The CPT suggested that modeling recruitment as an ARIMA process, in place of a stock-recruit relationship, would allow larger recruitments to occur further into the rebuilding time frame, but this is not possible within the current Gmacs framework.

In light of these concerns, the CPT reversed its recommendation from May to use the same time frame for B_{MSY} and recruitment, and instead recommends that mature male biomass during 1978-2018 be used to define B_{MSY} for stock status while recruitments during 1996-2018 be used to characterize future recruitment in rebuilding projections. Projections with similar time frames presented at the May CPT meeting would suggest that under these criteria and conditions T_{min} maybe much greater than 10 years. In the (likely) event that the recommended rebuilding analyses find that the stock cannot be rebuilt within 10 years, the CPT recommends that the rebuilding plan use T_{max} to be calculated as T_{min} plus a generation time as provided for in the National Standard 1 Guidelines. Previous work suggests the generation time is ~14 years for this stock.

10. Tanner Crab - Final 2019 Assessment

William (Buck) Stockhausen (AFSC Seattle) presented the Tanner crab stock assessment and recommendations for the 2019/2020 fishery. Tanner crab mature male and female biomasses are down relative to last year, but the stock did not experience overfishing and is not overfished. The overall decline in mature female biomass is largely driven by declines east of 166°W long. The model scenarios focused on the use of revised or new data streams, including revised fisheries catch time series, the use of chela height data for estimating male maturity, and the use of Bering Sea Fisheries Research Foundation data from the experimental side-by-side surveys to inform the catchability/selectivity of the NMFS summer trawl gear. The following model scenarios were considered:

- M19F00: the 2018 assessment model (18AM17)
- M19F00a: M19F00 with revised ADFG data for crab fisheries
- M19F01: M19F00a updated for 2018/19 (base model for 2019)
- M19F02: M19F01 plus the observed male maturity data
- M19F03: M19F02 but male maturity characterized by Rugolo/Turnock maturity ogive dropped from the model
- M19F04: M19F01 plus the 2013-2017 BSFRF/NMFS side-by-side data
- M19F05: M19F03 plus the 2013-2017 BSFRF/NMFS side-by-side data

There was considerable discussion of the scenarios. In general, the CPT supported the use of the revised historical catch data (which have been presented at previous CPT meetings) and were receptive to the idea of incorporating the chela height and BSFRF survey data into the assessment. The revised fishery data have undergone more scrutiny than the previous time series and are likely a better representation of true total catches. Most bycatch historically occurred in the snow crab and yellowfin sole and pollock trawl fisheries, but bycatch in the groundfish fisheries is mainly due to fixed gear in recent years; notable is the catch of large Tanner crab in RKC pots, which is related to ontogenetic movement SE toward Bristol Bay as Tanner crab grow.

Additional growth data (~50 data points) were provided for EBS Tanner crab from collaborative efforts by the NMFS Kodiak lab, ADFG and BSFRF. Visually, there is some suggestion that the data that could support separate relationships between size and growth increment for immature crab and crab undergoing terminal molt. The CPT asked that the author plot the data and color them by maturity state. If there appears to be separation by maturity state, fitting models to determine if the differences are significant could be useful to inform how growth is modeled in future assessments. A recurring issue with Tanner crab is the over-prediction of crab in the largest length bins for the directed fishery, which is potentially related to the fits to the growth data and other size composition data. It was noted that the estimated molt increments in the model are biased high for males at larger sizes. It might also be useful to fit the growth data outside of the model and specify the growth parameters within the assessment to explore the impact of fits to length composition data. Natural mortality was noted as another potential process to examine in relation to the over-prediction of large male abundance. Immature crab appear widely dispersed with males and females exhibiting similar distribution patterns suggesting 50:50 ratio. Variability in survey abundance for small (<40 mm) crab may have an inverse relationship with the size of the cold pool, but this needs to be explored more fully.

The CPT appreciated the description and derivation of empirical selectivity and availability that accompanied the presentation of the BSFRF data. Adding the BSFRF data to the models resulted in many more estimated parameters and much poorer stability under jittering. Examining the correlation matrices produced from fitting these models may indicate which parameters the BSFRF data are confounded with and suggest a direction towards improving model stability. For future scenarios incorporating the BSFRF data, it would be useful to know how the prior on catchability from the Somerton under bag experiment and the BSFRF data interact. One method for doing this would be to compare their contribution to the objective function; another might be likelihood profiles. Finally, empirical and model estimated availability do not line up well, so it may be useful to fix the availability to empirical estimates to understand how this assumption affects model output. The CPT agreed with the assessment author's conclusion that models incorporating the BSFRF data were not yet ready to be used for harvest recommendations.

The CPT had some concern about the effects of the new total catch data on survey catchability and the resulting rescaling of the population. The "observed" selectivity/catchability of the NMFS gear, as implied by comparison with the BSFRF data outside the model, is ~0.6 for males. In comparison, the author's preferred model has the lowest catchability, which was ~0.4 for males. Ultimately the CPT agreed with the author's preferred model, M19F03, which adopted the revised fisheries data and added chela height data but did not include the BSFRF survey data.

CPT recommendations:

- Explore appropriate values for catchability. For example, runs that fit to the BSFRF data and fix availability to empirical estimates to contrast the outcomes with runs in which availability is estimated could be informative for what is driving the small estimates of catchability in the author-preferred model.
- Explore the relationship between natural mortality, growth, and overestimates of large crab. For example, estimate growth outside the model to attempt to address the overestimates of large crab.
- Explore maturity states for growth increment data and make recommendations for directions for growth model development.
- Include the data to which the models are fit for the survey biomass figures in presentation.
- If 'catchability' is to be used for something similar to 'fully-selected fishing mortality', perhaps translate it to a 0-1 scale and distinguish it from survey catchability so that it is clear that there is mortality associated with it.
- The figure showing fits to NMFS male survey biomass is not actually showing the data being fit; future assessments should display the actual data being fit.
- Explore ways to provide a retrospective analysis of the assessment model.

11. Tanner Crab MSE

The CPT received an overview and update from Madison Shipley (NRCC, UW) on the Bering Sea Tanner crab (BST) Management Strategy Evaluation (MSE) project that she is doing for her MS thesis (with funding from BSFRF and thesis advisor André Punt). The project focuses on evaluating the alternative Harvest Control Rule (HCR) specifications and has benefited from substantial and ongoing contributions from Buck Stockhausen and Ben Daly. Madi started with a schematic overview of the MSE model process, which includes full-feedback parameter estimation at each time step of a model run, and outlined 13 HCR scenarios that are included in the MSE, nine of which are viable alternatives for potential adoption by the State of Alaska in an updated Harvest Strategy for the stock, and four included for sensitivity testing. Under all scenarios, the TAC is constrained not to exceed 50% of estimated Effective Legal Males (ELM) but is not constrained by the ABC because occurrences of TAC exceeding ABC is a potential outcome of the HCR specifications that the MSE tests for. Viable scenarios include HCRs based on: mature female biomass only; mature male biomass only; a combination of male and female biomass (i.e., where the slope of the ramp portion of the HCR is conditional on MFB); and three alternative HCRs based on ELM. Sensitivity testing scenarios include a 'TAC=ABC' rule, and a scenario intended to represent the status quo HCR for Tanner crab. The CPT discussed the details of the status quo scenario, which includes an element (not included in the other scenarios) that reduces the TAC by 50% in the first open season after a closure. It was noted that the State's HCR for Tanner crab is substantially more complicated than those for other crab stocks, and the status quo scenario is a simplification intended to capture the key elements of the HCR as currently implemented by ADFG.

Madi reviewed the results of test runs of each scenario. Given the complexity and cost of supercomputer time of full implementation of the MSE, test runs were limited to three simulation runs of ten years each (full implementation will employ 100 simulations of 100 years each). The performance metric file includes 14 metrics, and the CPT discussed whether other metrics should be included in the output, but Madi clarified that other metrics can be calculated in post-processing. Plots of performance metrics (e.g., TAC, ELMB, MMB, MFB) were presented for each scenario, showing the 10-year projections (model average and spread) and historical pattern (1982-2017) shown for comparison.

The CPT discussed the marked differences in output variability between scenarios, particularly the sensitivity scenarios that alternate between model and survey estimates as simulation inputs, and it was noted that the limited number of runs (3 each) were insufficient to allow the simulations to smooth out the model fits, and preliminary results were not meaningful indicators of variability between the scenarios at this point. It was also noted that the outputs are overly precise during the initial years of the simulations because stochasticity in recruitment does not enter into the model for the initial years of the run.

The CPT discussed the issue of HCRs potentially resulting in TAC exceeding ABC or OFL in some years (as in the results Madi presented for the TAC = 50% ELMB scenario), and the projects strategy for identifying potentially viable alternatives or dropping non-viable scenarios from the MSE. It was explained that ADFG is using and interpreting the MSE to investigate the tradeoffs between conservation and economic objectives, and that capping TAC in MSE scenarios by ABC or OFL has the disadvantage of masking the performance of a candidate HCR scenario that might be worth considering.

Madi presented tables and figures of aggregate metrics for comparison across scenarios, including limits (e.g., average and CV of OFL over the simulation, average, CV, minimum and maximum TAC) and biometrics (average and CV of MMB, MFB, ELMB, and recruitment). Preliminary results for most metrics were consistent within expected ranges across scenarios, but Madi expressed some concern that results for catch (average ELMC and MMCB) and discard metrics were excessively variable and may reflect a coding error. Madi reviewed troubleshooting considerations to resolve before attempting full simulations, including the variability in catch and discard projections and occasional model failure due to negative growth estimates (coding issues to be followed up later).

Major work remaining to be addressed include refinement of output figures and results tables for scenarios as well as comparison of operating and estimation models, running full scenarios, and outputting probability reference point estimates. Full runs are expected in the near future and will be run on Amazon Webservices supercomputers and are expected to take 16 full days to complete allowing for extra time to deal with errors that stop any runs. Madi will consult with collaborators to finalize all code and scenario specifications prior to initiating full runs.

There was some discussion by the CPT and members of the public regarding Tanner crab harvest strategy considerations related to shell condition and marketability, and it was noted that such questions could be investigated after work for Madi's thesis is completed.

There were concerns that some HCR scenarios are conditional on female biomass, but the MSE does not model the contribution of females to recruitment success. Therefore any benefit of higher female abundance would not be captured by the simulation. The CPT recommended that summary statistics omit at least one generation time after the simulation is initiated so that that initial conditions do not influence simulation results. ADFG expects that the MSE results will be completed and incorporated into a white paper for the Board of Fisheries over the next few months, and that the Board of Fisheries will make a decision on a new Tanner crab harvest strategy in early 2020. The CPT requested a presentation on the outcome of that process for the May 2020 meeting.

12. AIGKC cooperative survey

Chris Siddon (ADF&G Juneau) presented an overview of the Aleutian Islands golden king crab (AIGKC) industry cooperative survey design and updated the CPT on survey progress. The survey is a stratified 2-stage random sampling design, with a spatial footprint that covers 95% of the historical fishing area. We now have 5 years of data in the EAG, and Shareef Siddeek will begin incorporating survey data into the assessment model. Throughout the design of the survey, the goal has been to get feedback early and often from the CPT. Chris encouraged CPT feedback and emphasized that improvements can still be incorporated into the survey design.

The AIGKC fishery was conducted east and west of 174° W. long. (EAG and WAG respectively) by 5 vessels. Commercial pots used in the fishery have large mesh and vary in size but generally range from 5.5 x 5.5 ft to 7 x 7 ft. Pots are longlined with 30-40 pots per string, each string approximately 4 nmi. long. Fishery CPUE is currently used in the assessment model to monitor population trends, but there are potential biases such as hyperstability that could result in CPUE trends that do not reflect true population abundances. Additionally, the tendency to repeatedly fish at the same locations can cause non-independence and can cause variances to be biased low.

The AIGKC cooperative survey design was described. A grid of 2 nm x 2 nm squares was placed over the historical fishing area (as defined by pooled observer pot locations from 1990 to 2012) to aggregate historical fishing data. Some areas were excluded, but the final grid covered 95% of the historical fishing area. Approximately 50% of the historical fishing grounds have not been fished since rationalization, and approximately 20% of the historical fishing ground is fished in a given year.

The goal of the survey is to improve spatial extent, reduce potential for hyperstability, provide consistent data long-term, and be cost effective. Within each 4 nm string, 5-7 pots are sampled by biologists, and individual crab are subsampled (targeting 30-40 crabs/pot) depending on the magnitude of the catch in order to keep pace with incoming pots (i.e., cannot slow down fishing operations). First and last pots (anchor pots) were never sampled as they might fish differently due to lack of other baited pots on each side and tend to be larger and heavier, which could affect how they fish. The survey grid was limited to within the 200-1,000 m bathymetric lines as crab generally occur within this depth and because of the difficulty of fishing at depths greater than 1,000 m. The grid was stratified by area (3 equal sizes) to separate stations reasonably well and 75 2 x 2 nm squares are randomly selected each year (25 squares in each strata).

The rationale for using a grid of 2 x 2 nm squares was discussed: 1 x 1 nm square was at an unnecessarily fine spatial scale and resulted in a large number of possible stations. Larger squares (e.g., 4 x 4 nm) was at a scale that was difficult to precisely define crab habitat and allowed for the potential of including non-GKC habitat in stations. The 2 x 2 nm squares were deemed the best compromise between the scale of the fishing gear, accuracy of defining habitat, and the number of possible stations.

The survey is shown to be logistically feasible, covers nearly the entire fishing area, and is cost effective (\$150,000-\$200,000 for the EAG+WAG). It was recognized that the survey does increase costs to the fleet due to the additional run time (fuel costs) and days fishing. Anecdotally, some skippers have indicated that they have observed excellent fishing in areas that they would not have fished if there was no survey and will likely fish these areas in the future. Next steps in the survey design are to explore better stratification options (e.g., skipper, habitat, effort). Some smaller mesh pots have been added to the survey to monitor recruitment, and the plan is to add more in the future.

Chris clarified that the intent of the survey is to not micromanage location of strings, but to set at least some portion of the survey string within a survey station boundary. It was acknowledged that the geometry of the habitat within a given grid can drive specific set locations. Effects of depth have not been explored, but the data is available for future analyses. Standardization of bait was discussed and could be explored by stratifying by skipper. It was also noted that skippers may be using different soak times and tunnel openings.

There was a question about whether the number of survey stations is appropriate. Chris noted that looking at the variances of the survey CPUEs will help inform if additional sampling stations are needed. There was a suggestion that the percentage of full pots (pot saturation) be investigated. It was pointed out that the gear is designed to sort on the bottom so saturating with small crab should not be an issue and that mortality in high-density holding conditions is generally low. Deploying underwater cameras on pots was suggested to give insights to crab behavior. In general, the CPT and the public emphasized that the survey is extremely valuable for gaining biological data on the stock. ADF&G is grateful for the industry's willingness to collaborate on the survey. Members of the industry were grateful for ADF&G's leadership on getting the survey up and running.

13. PIRKC - Final 2019 Assessment

Cody Szuwalski presented the 2019 assessment of Pribilof Islands red king crab (PIRKC). The directed fishery only occurred during 1993–1999 and has been closed since then mainly to protect the severely overfished, co-occurring blue king crab stock. Bycatch has been relatively constant since 2000 and is a small fraction of the OFL. Assessment of PIRKC is challenging because of small survey sample sizes (~100 crab/yr) from 4 to 14 stations since the mid-2000s. In recent years, mature male biomass in the survey peaked in 2015 and has since declined and is at low levels compared to mean biomass since 1991. The earliest survey data indicate that the red king crab were not present in the Pribilof Islands. Estimated recruitment appears to be highly episodic. Survey length composition is informative of population dynamics but has not been used in the past assessments. A relatively strong cohort has appeared in recent years. The PIRKC is on a biennial assessment cycle and was last assessed in 2017.

The author evaluated seven model scenarios:

- 19.01 - Three-year running average survey mature male biomass (MMB) weighted by the inverse of the variance.
- 19.02 - Random effects model fit to survey MMB.
- 19.1 - An integrated length-based model implemented in Gmacs, with model parameter assumptions borrowed from BBRKC.
- 19.2 – 19.1 sensitivity run with more of the population selected in the trawl bycatch.
- 19.3 – 19.1 sensitivity run with the probability of molting shifted to the left.
- 19.4 – 19.1 with increased M based on Hamel (2015).

19.5 – 19.1 with increased M based on Then et al. (2015).

Models 19.01 and 19.02 were presented in 2017. The remaining models represent the introduction in an integrated assessment model using the Gmacs framework. The integrated assessments fit to MMB, male biomass >120 mm CW (1976–2019), survey size composition (1988–2019), fishery retained catch (1993–1998), and bycatch (1991–2018). The author preferred the Gmacs models over either the running average or random effects models because Gmacs made more complete use of available data, including length composition data which showed the consistent progression of strong cohorts through the population, and provided a plausible fit to survey MMB.

The CPT questioned why the trawl selectivity curve seemed to differ from BBRKC which was the source of the curve. The author discovered that the model parameters output in the BBRKC undergo further rescaling (i.e., L_{50} is not the real L_{50}), adjusted the parameters in the PIRKC assessment to match the selectivity curve from the BBRKC assessment, and reran the suite of models. He presented the updated models on Friday morning of the CPT meeting.

One topic of comprehensive discussion the biomass peak in 2015 that is not fit by the Gmacs model. This peak is a result of a cohort that starts relatively small, and then suddenly increases in abundance only to decrease just as rapidly (the Benjamin Button cohort). This contrary to the usual dynamics of cohorts, which start large and then decline. One advantage of the integrated model is that it allowed us to diagnose this problem. The most likely explanation is that red king crab in Pribilofs is not a unit stock, and periodic influxes of adult crab occur.

The CPT agreed with the author's recommendation of using model 19.4 for OFL and ABC determination. Model 19.4 uses more of the available data, adequately fits 3 of 4 biomass pulses, and allows exploration of assumptions not possible with running average or random effects models. Model 19.4 is relatively parsimonious for an EBS crab model and borrows usefully from the BBRKC assessment. CPT thought the model struck a good balance between parsimony and complexity given the availability of assessment data. The use of the Hamel prior for natural mortality corresponds with current practice. The CPT continues to support 25% buffer on OFL for ABC estimation to be consistent with other Tier 4 stocks.

The CPT recognized the basic inconsistency pointed out by the author of using a time period during which there was no fishing to estimate B_{MSY} . Two B_{MSY} estimation methods were presented: a) average MMB for 1991–present (status quo), and b) 35% of average MMB for 2000–present. The proposed method recommended by the author recognizes there has been no fishery since 1998, bycatch was very small, and therefore the average MMB should approximate to MMB_0 during the current regime, so 35% of average MMB should approximate to B_{MSY} . The CPT considered any approach to estimating B_{MSY} to be somewhat problematic, given the non-stationarity of the population dynamics, but eventually agreed that the author's approach was the most acceptable alternative.

The CPT recommended the following for consideration in the future assessment:

- Examine the weighting of the length compositions and other data components used in the integrated model.
- A potentially better estimate B_{MSY} would be replay the stock dynamics using the integrated model under the assumption of $F=0$ (i.e., dynamic B_0). B_{MSY} could then be estimated by taking 35% of the average biomass for full period.
- Explore using ADF&G pot survey data for 2003, 2005, 2008, and 2011 in the assessment model.
- Evaluate the survey or fishery catches adjacent to the defined stock area to see they are indicative of movement into the Pribilof Islands area.

14. Chionoecetes mating dynamics

Laura Slater (ADF&G and UAF) summarized some of her graduate work exploring aspects of male and female reproductive potential that can improve our understanding of stock productivity in snow and Tanner crab. In theory, polyandry and polygyny, plus sperm storage by females, may provide a buffer against limited male availability in some years. However, several publications caution about the risks of sex-specific harvests such as sperm depletion and reduced fertilization rates under intense harvest, and the impacts of changes to male size composition on reproductive success. Laura's research collected samples during the 2007–2018 NOAA EBS trawl surveys to investigate aspects of population productivity related to fecundity and sperm reserves, including genetics of mating dynamics. Additional data collected by NOAA and BSFRF are being used to develop indices of sex ratios, predictions of male maturity, and population expansion weights incorporating survey selectivity.

Mating dynamics differ between a female's first mating season at terminal molt (male mate selection) and subsequent mating seasons (female mate selection). Shell condition can serve as an imperfect proxy to distinguish between primiparous and multiparous females for snow crab. Temperature can trigger changes to duration of embryo development with an annual snow crab spawning tempo for temperature $>1^{\circ}\text{C}$ and biennial for $<1^{\circ}\text{C}$ (not evident for Tanner crab). Canadian data show that annual sex ratios vary as females recruiting from a given brood year mature earlier than males, and spermathecal load of primiparous crab varies with the male proportion. Crab in the EBS exhibit ontogenetic migration with primiparous females more in the middle domain and multiparous females moving SW to SE toward the shelf break. Spermathecal load also varies by shell condition and area, doubling from new shell to old shell, and also doubling from NW to SE areas. Because a lack of unfertilized eggs across the population suggests there is no evidence of sperm limitation, and there is minimal embryo loss during brooding, clutch fullness is good index of fertilized egg production. Spermathecal load increases with female size, but only when aggregated across the population and not when examined at the station level, suggesting variation is due to spatial patterns in size for both male and female crab.

Work in progress includes examining measures of spermathecal load in the context of available sperm cells, number of mates (using genetic methods), relationship to qualitative measures of spermathecal fullness, and presence of fresh ejaculate (recent mating indicator) and developing indices of crab participating in mating examined separately for primiparous and multiparous females (ideally including the proportion of females that may be in a biennial spawning tempo), and males by size and shell condition (while considering the size and maturity composition of males by area). The definition of male maturity is critical when determining sex ratios. Male size at morphometric maturity (based on chela height) occurs over a wide size range and varies spatially. However, males may undergo physiological maturity at a relatively small size (~38 mm CW) and these adolescent males can mate in the absence of competitive exclusion by larger or adult males. Laura will explore patterns between sex ratio indices and spermathecal load at a spatial scale reasonable for reflecting available mating pairs (likely using six EBS regions (inner and outer bathymetric domains for the NW, C, and SE areas based on female ontogenetic migration patterns). Annual measures of mean spermathecal load and sex ratio will be examined over the available study time series (2007-2016) for each spatial region.

Regarding monitoring of female reproductive potential in the EBS, Laura noted that tracking an egg production index and accounting for the portion of the population in a biennial spawning tempo, is needed to allow detection of changes in reproductive output over time. Due to persistent spatial patterns in snow crab reproductive potential, and the shifting nature of the spatial distribution of the population and fishing pressure (both highly influenced by sea ice extent), examination of abundance and removals at a finer spatial scale than the entire survey grid would allow detection of trends that are likely important to population renewal. A qualitative assessment (low/med/high) of spermathecal load in the field could be used as a basic monitoring index.

Laura thinks environmental conditions are having big impacts on reproductive dynamics in general, with recruitment fluctuations likely impacted by mechanisms after larval release (e.g., circulation patterns transporting larvae, suitable temperature for early survival). Female location at larval release ties into these factors and therefore influences the fate of offspring, which provides another incentive to examine temporal changes in mature female distribution. The snow crab assessment author noted that it may be difficult to incorporate female reproductive dynamics into some assessment models, particularly since many models focus on fine-tuning estimates for males with females receiving less attention. Laura's goal is to have a synthesized story as part of her PhD dissertation and make recommendations about considering measures of sperm reserves in management.

15. *Chionoecetes* skip molting

James Murphy (Cascadia presented information from his recently published study on skip molting for EBS snow and Tanner crab males and the implications for population assessment. James conducted research on EBS snow crab for his PhD and has continued to analyze crab data. He has two additional manuscripts on crab growth and population dynamics to be submitted with anticipated publication in 2020.

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. Incorrect assumptions about molting frequency in assessment models could potentially result in incorrect growth dynamics. Research on this topic has been largely based on snow crab stocks in Atlantic Canada and Japan, where skip molting has been documented. Juveniles molt more than once per year, adolescents molt up to once per year, and adult *Chionoecetes* do not molt. Molting frequency is influenced by maturity status, sex, temperature, and likely other factors such as food supply. Adolescents can molt to another adolescent stage, molt to maturity, or skip molt. They may skip a molt if they are energetically limited. If there is more skip molting, 1) there are fewer large males, 2) males terminally molt at smaller sizes, and 3) crab that skip molt may have lower survival.

James used chela height data to estimate the frequency of skip molting frequency. The skip molt proportion is the ratio of old shell immature crab to total immature crab by size bin. The proportion skip molting was corrected for oversampling of old shell individuals in past surveys. The proportion of skip molting increases with size, and there is a higher proportion for Tanner crab than snow crab; for both species it approaches 40% in crabs above 105 mm CW.

A simple simulation model was used to evaluate the impact of skip molting on mature male biomass relative to a population without skip molting. The simulation evaluated the effect of changes in survival associated with skip molting, where survival was assumed be 0.68 (no change due to skip molting), 0.61, 0.54, and 0.48. Molting probabilities in the simulation were adjusted to match the observed proportions of skip molting. The simulation results showed a reduction of large mature males as a result of skipped molting and decreased survival, with a greater degree of reduction for Tanner crab rather than snow crab. James noted a number of caveats to the study, including that shell condition is likely to be underestimated, and may be unreliable for males, and that non-random sampling for chela height data requires post-hoc weighting.

James suggested additional research that could help to better understand skip molting, including aquaria-based studies (skip-molt survival), shell structure analysis (microscopy, histology), durometer measurements, crab condition data – digestive gland, muscle size, etc., and, finally, better collaboration and communication with crab researchers from Atlantic Canada and Japan. An additional issue discussed by the CPT concerns the potential relationship between skip molting and adolescent reproduction. Bernard St. Marie found that when immature crabs mate then they might be more likely to skip molt because of reduced energy for growth. The spatial pattern of skip molting could be examined to address

this question, and this could be looked at along with crab condition. Larger adolescents are in warmer water and these are more likely to skip molt than the adolescents in more northern areas.

CPT recommends that there be further evaluation of the impacts on stock assessment of skip molting. Two approaches could be explored: the first approach would be to modify the assessment model to model skip molting, and the second approach would be to conduct a simulation of crab population dynamics to further evaluate the potential impact of skip molting. This research has higher priority for Tanner crab than snow crab due to the higher proportion of skipped molting seen in Tanner crab. CPT also recommended exploration of ways to improve shell condition data, such as further investigations using durometer measurements that focus on immature crabs.

16. PIBKC, WAIRKC, and PIGKC - Overfishing status determination

Buck Stockhausen provided an overview of the catch in relation to the overfishing limit for the 2018/19 PIBKC fishery. Overfishing did not occur on this stock. The PIBKC stock is overfished and the status has not changed since 2002. This stock is on a biennial assessment cycle and was last assessed at the May 2019 CPT meeting. However, at that time the fishing year (July 1 to June 30) had not yet been completed, and evaluation of overfishing status, taking into account the bycatch in other crab and groundfish fisheries, could not be determined until the September 2019 CPT meeting. The OFL and ABC for this stock will remain in effect until the next assessment in 2021.

Ben Daly provided an overview of total fishery mortality in relation to overfishing limits for WAIRKC (2018/19) and PIGKC (2018 calendar year). Overfishing did not occur the previous season for either stock. Updated summaries for these stocks are contained in the introduction to the final SAFE report. However, total catch in the PIGKC fishery is considered confidential due to a limited number of participants and is not displayed in the SAFE report. Assessments for both stocks are on a triennial assessment cycle and were last completed in May 2017. The OFL and ABC for both stocks will remain in effect until the next assessment in May 2020.

17. PIGKC assessment and management issues

Ben Daly presented an overview of the Pribilof Islands golden king crab fishery with a review of tier status, assessment, and available fisheries data. The Pribilof Islands golden king crab stock is covered under the FMP but was not rationalized. The fishery is prosecuted on a calendar year through an ADF&G Commissioner's Permit and has 100% observer coverage with 100% dockside sampled. Approximately 70% of the harvest is concentrated in one ADF&G statistical area in Pribilof Canyon. With reduced fishing opportunities in other Bering Sea fisheries, there is increased interest and increased participation in this fishery. Fishermen have also inquired about the possibility of an increase in GH. Therefore it is timely to reevaluate the assessment and potentially the tier status for this stock, especially since the next assessment for this stock will be in May 2020.

This stock is currently classified as Tier 5 and is on a 3-year assessment cycle. In May 2010, the CPT established a total-catch OFL computed as a function of the average retained catch during 1993–1998, a ratio-based estimate of the bycatch mortality during the directed fishery of that period, and an estimate of the “background” bycatch mortality due to other fisheries. Other time periods have been considered by the CPT, but they were ultimately rejected by the CPT and SSC. The same data and estimates have been used for the 2013 to 2019 OFLs.

Ben and the CPT discussed the options for updating the assessment. Updating the average retained catch using recent data will only lower the Tier 5 OFL because recent catches are constrained by the OFL. This was not considered a viable option. In May 2017, the CPT discussed moving to a Tier 4 assessment using random effects model with NMFS slope survey data, but at the time only four data points were available from the survey for mature male biomass (MMB) and legal male biomass (LMB). The CPT eventually decided not to use the random effect model due to concerns about model convergence, and kept the stock

at Tier 5, applying a 25% buffer on the OFL for the ABC. However assessment author noted that the model does run through the point estimate error bars and the par files showed convergence but estimated zero process error. This may be a reasonable result, given that a lightly exploited golden king crab stock may be very stable. A preliminary run of the Tier 4 calculations using model estimated biomass and M of 0.18 doubled the current Tier 5 OFL.

The NMFS slope survey provides area-swept biomass estimates for MMB and LMB available starting in 2008, while total biomass is available starting in 2002. Biomass is regarded as a minimum estimate due to the affinity of golden king crab for rocky substrate. The survey occurs in a narrow band along the slope and is divided up into six sub-areas with sub-areas 2 through 4 coinciding with the Pribilof District. Only post-2000 data is used due to a difference in sampling gear, design, methodology, and species identification prior to 2000. In the most recent 2016 survey, the majority of biomass was in Pribilof and Zhemchug Canyons. The slope survey in 2006, 2014, and 2018 was cancelled, and the 2020 survey will also likely be cancelled.

Biomass is estimated using an established length-weight regression and assumes a size at maturity of 107 mm carapace length and a legal size of 124 mm carapace length. Total biomass for 2002 and 2004 does not include size composition data so it is not possible to parse out legal and mature males for those years.

The CPT previously suggested investigating whether size frequency data are available for the 2002 and 2004 surveys. Size frequency data has been discovered for the 2004 survey and biomass estimates of mature and legal-size males will be incorporated into the model for the May 2020 meeting. Initial reviews of sex ratios for 2008-2016 survey data show a mean ratio of 1.1, although there is high variation between years. A model run could apply the mean ratio in other surveys to infer the MMB in the 2002, thereby adding another point to the time series, albeit with greater uncertainty.

The future of the NMFS slope survey is uncertain. The CPT indicated that NOAA may be more eager to conduct future slope surveys if the data will be used for crab assessment. Since this fishery is prosecuted by Commissioner's Permit, the CPT discussed the possibility of creating an industry cooperative survey, similar to Aleutian Islands golden king crab. There would be benefit to timing future cooperative survey efforts to coincide with potential slope trawl surveys, however this may not be possible due to the derby style of this fishery with fishermen prosecuting this fishery shortly following the January 1 opening. CPT also discussed the possibility of using Gmacs for assessing this stock. Since assessment data are very limited, an approach similar to Simple Stock Synthesis (SSS) could be tried, in which Gmacs is configured to estimate a few basic parameters but is otherwise constrained.

The CPT recommended the following for consideration in the May 2020 assessment:

- Continue the work using the random effects model by incorporating 2004 NMFS slope survey data point and possibly the 2002 data point in model runs. If needed, consider setting a lower bound on process error, although it was noted that this approach did not work for Pribilof Islands red king crab.
- Explore the feasibility of a simplified Gmacs model to assess the stock.
- Consider initiating an industry cooperative survey to assess abundance trends

18. NSRKC - Model discussion for January 2020

Hamachan overviewed the subsistence, winter and summer NSRKC commercial fisheries in 2019, which all performed very poorly. Relative to the 2018 fisheries, in 2019, the subsistence catch declined 65%, the winter commercial fishery catch declined 89%, and the summer commercial fishery catch dropped 73%. The preliminary standardized summer commercial fishery CPUE in 2019 also decreased sharply and is 60% lower than in 2018. The preliminary total catch is about 0.082 million lbs, much less than the

ABC of 0.19 million lbs. Reasons for the poor fishery performance in 2019 are not clear. Fishing pots in 2019 were mostly filled with sublegal males.

Both ADF&G and NMFS conducted a summer trawl survey on NSRKC in 2019. The ADF&G survey resulted in the second highest estimated abundance (after the highest one in 2014), up 420% from the survey in 2018. Large numbers of sublegal males and females were caught in the survey, but most of these crab were in one tow. The haul data from the 2019 NMFS survey are not yet available yet, but a considerable number of crab were caught outside of ADF&G trawl survey area.

Hamachan also compared two methods to estimate bycatch abundance: CPUE-based and proportion-based. The CPUE-based method generally results in higher total bycatch estimates than the proportion-based method. CPT suggested an approach to estimate bycatch:

$$\text{Number of discards} = \frac{\text{FT_unobserved_CPUE}}{\text{FT_observed_CPUE}} \times \text{At_sea_observed_CPUE} \times \text{total_fishery_effort}$$

This would be applied to each discard category (female, sublegal male, and LNR), and then combined for total discards. A way of adjusting the discard estimates (using the subtraction method) could be by down-weighting the at-sea CPUE by the ratio of unobserved:observed_CPUE taken from the retained catch (i.e., fish ticket):

$$\text{Number of discards} = \left(\frac{\text{FT_unobserved_CPUE}}{\text{FT_observed_CPUE}} \times \text{At_sea_observed_CPUE} \times \text{total_fishery_effort} \right) - \text{retained_catch}$$

The CPT suggested evaluating the above approaches to estimate bycatch.

Hamachan presented and evaluated six alternative model scenarios to address the CPT and SSC comments and for January 2020 model runs:

- Model 19.0: Baseline: Model 18.2b in January 2019.
- Model 19.1: Model 19.0 + tag recovery data just for 1 year.
- Model 19.2: Model 19.0 + NMFS trawl survey catchability =1.0 and estimating ADFG survey catchability.
- Model 19.3: Model 19.0 + estimating survey catchabilities for both NMFS and ADF&G.
- Model 19.4: Model 19.0 + estimating M equal for all lengths + dome shape selectivity for trawl and summer commercial (max sel 94-103 for trawl, 104-113 for commercial).
- Model 19.5: Model 19.0 + estimating M equal for all lengths + dome shape selectivity for trawl and summer commercial (max sel 94-103 for trawl, 104-113 for commercial).

Model scenarios 19.0 and 19.1 have almost the same results. Scenarios 19.2 and 19.3 result in lower mature male biomass and OFL estimates than scenarios 19.0 and 19.1 while scenarios 19.4 and 19.5 result higher mature male biomass and OFL estimates. The authors recommend either scenario 19.0 or 19.1 for January 2020 model runs. The parameter estimates and overall assumptions of models 19.2, 19.3, 19.4, and 19.5 did not appear realistic for the stock, and therefore the CPT did not recommend exploring them further.

Based on the results and performance of six alternative model scenarios, the CPT recommends the following model scenarios for the NSRKC assessment for the January 2020 CPT meeting:

- Model 19.0.
- Model 19.1: Model 19.0 plus the new discard abundance estimation method.
- Model 19.2: Model 19.1 plus estimating additional selectivity multipliers for the large male plus group for trawl surveys and the summer commercial fishery, plus keeping M (0.18) constant for all length groups.

19. New Business

The CPT discussed future meetings for 2020. The January CPT meeting will be held in Kodiak at the Kodiak Fisheries Research Center during January 14-17. Proposed agenda items include:

- NSRKC final SAFE
- AIGKC models for May
- Research Priorities
- Economic SAFE
- BSFEP update (Ben Daly)
- ADF&G crab observer program overview
- Updated time series for catch and bycatch in crab fisheries
- Development of crab ESPs, including indicators specific to crab (Erin Fedewa)
- Overview of crab research at the NMFS Kodiak lab and ADF&G (field trip for touring lab facilities)
- Gmacs workshop (additional agenda planning needed). Possible topics include Gmacs upkeep, stepping through the code, implementation of terminal molt, fitting maturity data, preliminary snow crab model, preliminary NSRKC model, fitting to tagging data.

The May CPT meeting will be held in Juneau with proposed dates May 4-8. Suggested agenda items for the May meeting include:

- Update on snow crab IBM research
- VAST model estimates and evaluation in crab stock assessments
- Proposed model runs for September
- Final AIGKC SAFE
- Tier 5 OFL/ABC for PIGKC and WAIRKC
- PIGKC - potential tier 4 assessment
- Alaska Board of Fisheries update including Tanner crab harvest strategy

The next September CPT meeting will be held in Seattle and has been tentatively set for September 14-18, 2020.