



## North Pacific Fishery Management Council

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### SCIENTIFIC AND STATISTICAL COMMITTEE FINAL REPORT TO THE NORTH PACIFIC FISHERY MANAGEMENT COUNCIL October 3rd – 5th, 2022

The SSC met from October 3<sup>rd</sup> – 5<sup>th</sup>, 2022 in Anchorage, AK. Members present in Anchorage were:

Franz Mueter, Co-Chair  
*of Alaska Fairbanks*

Sherri Dressel, Co-Chair  
*Alaska Dept. of Fish and Game*

Alison Whitman, Vice Chair  
*Oregon Dept. of Fish and  
 Wildlife*

Chris Anderson  
*University of Washington*

Amy Bishop  
*University of Alaska Anchorage*

Curry Cunningham  
*University of Alaska Fairbanks*

Mike Downs  
*Wislow Research*

George Hunt  
*University of Washington*

Robert Foy  
*NOAA Fisheries—AFSC*

Dana Hanselman  
*NOAA Fisheries—AFSC*

Brad Harris  
*Alaska Pacific University*

Kailin Kroetz  
*Arizona State University*

Kathryn Meyer  
*Washington Dept. of Fish and  
 Wildlife*

Chris Siddon  
*Alaska Dept. of Fish and Game*

Ian Stewart  
*Intl. Pacific Halibut  
 Commission*

Patrick Sullivan  
*Cornell University*

Members absent were:

Jason Gasper  
*NOAA Fisheries—Alaska  
 Regional Office*

Andrew Munro  
*Alaska Dept. of Fish and Game*

## SSC Administrative Discussion

The SSC received administrative updates from Diana Evans (NPFMC). Ms. Evans provided a brief overview of the 7th National SSC meeting (SCS7) that was hosted by NPFMC in August and noted a report should be available in spring. Ms. Evans also noted that planning for the February 2023 SSC workshop continues. A detailed agenda and guiding questions will be distributed at the December meeting. Finally, Ms. Evans provided an update on the Council Processes and Ideas for Change. There will be no changes to the meeting timing or harvest specifications process this year, but Ms. Evans noted that there are multiple incremental efforts underway to address concerns about author, Plan Team, and SSC workload. The Council also committed to February meetings in 2023 and 2024. Finally, Nicole Schmidt (NPFMC) reminded the

SSC of the Council's travel policies and Maria Davis (NPFMC) demonstrated the new searchable eAgenda on the Council's new website. The SSC thanks NPFMC staff for these updates and reminders and commends staff for the much improved website.

## **B1 Plan Team Nominations**

The SSC reviewed the nominations of Dr. Cecilia O'Leary and Dr. Ben Williams to the Gulf of Alaska (GOA) Groundfish Plan Team (GPT). The SSC finds these nominees to be well-qualified and recommends the Council approve their nominations.

## **C1 BSAI Crab**

The SSC received a detailed report on the September 2022 Crab Plan Team (CPT) meeting from Sarah Rheinsmith (NPFMC) and the CPT co-chairs, Mike Litzow (NOAA-AFSC) and Katie Palof (ADF&G). Cody Szuwalski (NOAA-AFSC) presented the Eastern Bering Sea (EBS) snow crab assessment and rebuilding plan projections. The SSC appreciates the CPT's efforts to streamline their presentation to the SSC. Not all CPT agenda items were presented to the SSC, though they were detailed in the CPT report. Items on which the SSC provided comments are below.

### **General Crab Comments**

The SSC received considerable oral public testimony on BSAI crab harvest specifications under multiple stocks. These include: Frank Kelty (City of Unalaska), Edward Poulsen, Craig Rose (FishNext Research), Heather McCarty (Central Bering Sea Fishermen's Association; CBSFA), Mateo Paz-Soldan (City of Saint Paul Island), Craig Lowenberg, Joshua Songstad (F/V Handler), Cory Lescher and Jamie Goen (Alaska Bering Sea Crabbers; ABSC), Scott Goodman (Bering Sea Fisheries Research Foundation; BSFRF), Gretar Gudmundsson, Lenny Herzog (Homer Crab Cooperative), Keith Colburn, and Siri Dammarell. Additional written testimony was provided by Scott Goodman (BSFRF), Cooper Curtis (Highmark Marine LLC), Scott Campbell (F/V Seabrooke, F/V Lady Alaska), Clint Moudy (Kodiak Hydraulics Inc), Calista Songstad (Compass Rose Fisheries LLC), Heather McCarty (CBSFA), Gabriel Prout (F/V Silver Spray), Mikal Mathisen (F/V Karin Lynn), Jamie Goen (ABSC), Gary Painter (F/V Trailblazer), David Wilson (F/V Keta), Mike Shelford (Shelford's Boat Ltd.), Ty Warnock, Joshua Songstad (F/V Handler), Dennis Scates, Craig Rose (FishNext Research), Oystein Lone (Lone Larsen LLC, Lone Shelton LLC, F/V Pacific Sounder, F/V Confidence), Neal Hillstrand (F/V Time Bandit), Jonathan Hillstrand (F/V Time Bandit), and Andrew Hillstrand (F/V Time Bandit).

The SSC appreciates the extensive public testimony on BSAI crab agenda items that reiterated the unprecedented and difficult situation before the NPFMC and the State of Alaska (Alaska Department of Fish and Game; ADF&G). Public testimony is characterized under the specific BSAI crab sections below. The SSC recognizes that the severe economic consequences of the potential closures of Bristol Bay red king crab (BBRKC) and EBS snow crab stocks and reduced catch limits for other stocks would be devastating to fishermen, small businesses and communities that strongly rely on crab fisheries. While the SSC is charged with setting harvest specifications based on the best available science, it also acknowledged the impacts that these specifications will have. Although the EBS appears to be returning to cooler environmental conditions in 2021/22, the SSC noted that crab stocks face increased uncertainty in a changing climate.

The SSC noted that federal OFL and ABC determinations for crab are generally based on mature male biomass, but in cases like BBRKC, State management also accounts for the need to maintain female biomass (threshold for female biomass). This creates a disconnect between the population assumptions and biological considerations in the model and in the State harvest control rule (HCR; see also BBRKC section

below). **The SSC recognizes the need to protect female crab and their habitat and supports collaborative approaches between federal and State agencies to fully account for the reproductive potential of crab stocks in stock assessment models**, while recognizing that management is primarily for mature male crab. The SSC also supports collaboration to make crab assessment models as informative as possible for State management.

The SSC supports the CPT plans to discuss appropriate model start dates as well as reference periods for  $B_{MSY}$  (e.g., SMBKC and PIRKC) at their January 2023 meeting to provide guidance to stock assessment authors. The SSC recommends that the CPT explore a consistent approach across all EBS stocks to use trawl survey data after 1982 when gear and sampling designs were more standardized.

With regards to the timing of crab assessments, the SSC appreciates the discussion at the CPT to explore shifting harvest specifications for EBS snow crab to December and supports this exploration. In addition to the possibility of shifting harvest specifications to December, **the SSC encourages crab authors to continue to move as much of the research and model development as possible to earlier in the year**, as this would streamline reviews in the fall and facilitate the use of VAST models and inclusion of Northern Bering Sea (NBS) survey data into crab assessments.

The SSC encourages further considerations or ideas on potential cooperative pot surveys for different crab stocks, as suggested in public testimony.

Crab models have become increasingly complex over time, and model parsimony is a key goal for assessments. It is difficult to balance this with the need to account for the complex dynamics of crab populations. For multiple crab stocks, the SSC suggests that fitting a range of simpler models and data limited approaches, such as the Tier 4 calculation, can also provide insight into the differences between raw survey observations and integrated assessment model output. This would highlight the information available on natural mortality, which demographic components of the biomass are most important, which years are representative of MSY, and how catchability affects the scaling of the model estimates. **The SSC recommends a working group to address the use of simpler models for at least snow crab, Tanner crab and BBRKC**. This effort is intended to fundamentally support the use of Tier 3 size structured models such as GMACS, not replace them, and may help inform pathways toward greater model parsimony and stability. The move to GMACS that has been implemented or recommended for many crab stocks should give authors an opportunity to start from a simpler base model and add features, rather than continuing to replicate legacy model complexities in GMACS. The SSC further recommends that the working group include State scientists, in an effort to explore whether any inconsistent approaches between Federal assessments and State harvest control rules or TAC-setting considerations are based on scientific considerations that could be reconciled.

**The SSC recommends the formation of a working group to develop a framework for how to estimate the magnitude of unobserved mortality for crab stocks and how these estimations may be utilized in BSAI crab stock assessments.** The SSC acknowledges that there are studies informing some of the inputs needed for this analysis, but that a framework for the calculations should be very explicit about each of the data sources and assumptions needed. There may be multiple approaches, perhaps including the spatial overlap of stocks and various fisheries, the mortality rate of interactions and/or the ratio of unobserved to observed encounters.

The SSC recommends that all crab authors plot length compositions over years with the most recent year at the bottom of the plot.

### **Ecosystem Status Report Preview**

The SSC received remote presentations from Elizabeth Siddon (NOAA-AFSC), Ivonne Ortiz (UW-CICOES), and Bridget Ferriss (NOAA-AFSC). There was no public testimony. The SSC thanks the

presenters for their efforts in providing excellent, targeted information related to crab stock assessments. In particular, the SSC greatly appreciates the presentation of slides with the “big picture” summary at the top, and then supporting information provided below in highly condensed form. The new format resulted in a smooth, clear, efficient presentation.

**In general, there were no new major environmental concerns reported to date in 2022.** The major climate indices were in the normal range, with indications that the marine heatwaves were of less concern in the GOA and EBS but continued in the Aleutian Islands (AI).

### *Eastern Bering Sea*

The authors provided a highly condensed discussion of ecosystem aspects that have the potential to influence crab stocks in the EBS marine ecosystem. Although the Arctic Oscillation has been positive since spring 2021, 2021–2022 exhibited near-normal sea surface temperatures (SST). Marine heatwaves were infrequent and brief. Winds in winter 2022 were more northerly than the long-term average, with rapid sea ice growth in November 2022 and rapid loss in April 2022. Sea ice was thinner than in 2021. The cold pool was average in extent when compared to other cool years.

For 2022, pH was relatively low over the outer and middle shelf of the EBS, and near the Bering Strait, decreasing at a rate comparable to the global oceans due to ocean acidification. **These conditions have been shown experimentally to negatively impact the growth and survival of red king crab and Tanner crab.**

Prey resources for crab in the EBS marine ecosystem appear to have been near the long-term mean. Chlorophyll-a biomass was near the long-term mean, as was bloom timing. A coccolithophore bloom was recorded, the implications of which may include longer trophic chains and reduced foraging success for visual predators. In spring 2022, copepods were more abundant than in 2021, especially small copepods. Visual inspection of collection vials suggested that *Calanus* spp. were low in lipids.

Competitors for benthic crab remained high or increased in 2022 (brittle/sea stars and other echinoderms, epibenthic fish), as did competitors for pelagic crab. Both pelagic (pollock and herring) and benthic predators of crab (Pacific cod and arrowtooth flounder) increased in 2022, and 2022 was the largest Bristol Bay sockeye run on record (>78 million). Pacific cod condition was average for the EBS survey area and was improved from the below-average condition in 2021.

Finally, the authors noted two issues of general concern in the EBS: 1) the continued failures of some salmon runs in western Alaska that impact a number of fisheries and communities, and 2) impacts from Typhoon Merbok. Typhoon Merbok circulated in western Alaska in September 2022 and caused considerable damage to coastal communities, especially hunting and fishing camps and subsistence harvests. The impacts on benthic and pelagic communities have not been investigated.

**The SSC concluded that none of these physical or biological elements presented unusually problematic conditions for EBS crab stocks.**

### *Gulf of Alaska*

Based on the data available to date, there were no emerging concerns related to groundfish that need to be considered at this point in the GOA. The multi-year recovery from the marine heatwave of 2016–2018 continues, as seen with a shift to a negative Pacific Decadal Oscillation (PDO) and average summer SST warming. Lower trophic-level productivity may have been above average, while there were mixed signals concerning upper trophic-level productivity. One area of concern was the first identified presence of invasive green crab in SE Alaska, though the implications for species of concern to the NPFMC remain unclear.

## *Aleutian Islands*

Sea surface temperatures remained high in 2022 throughout the AI, with temperatures above the 1985–2014 mean. This has resulted in an almost continuous moderate marine heatwave throughout the AIs with periodic brief periods of strong or severe heatwaves. It should be noted that the SSTs in the eastern Aleutians are well above a level that would be considered a severe marine heatwave elsewhere in the Aleutians. The ecosystem implications of these sustained high temperatures are not known.

### **Trawl Survey Updates**

The SSC received an excellent presentation on the 2022 EBS and NBS bottom trawl surveys from Mike Litzow (NOAA-AFSC). There was no oral public testimony on the trawl survey specifically; however, testimony on other crab agenda items were related to the survey. In general, public testifiers questioned the ability of the bottom trawl survey to survey crab stocks adequately and noted the disconnect between the timing of the survey and the execution of some crab fisheries. Public testimony also mentioned the need for data from the NBS, which is very challenging to incorporate in the October specifications process due to the short time between the survey and the assessment deadlines. **The SSC commends AFSC survey staff for completing the bottom trawl surveys in 2022 under what continue to be challenging logistical conditions.** The SSC continues to be impressed with the rapid turnaround of the survey data and is pleased to hear that efforts are underway to modernize survey data processing, including efforts to develop Vector Autoregressive Spatio-Temporal (VAST) survey estimates for crab species. The SSC also commends the crab assessment authors for updating model runs and assessments in a very short time.

In general, the combined mature male biomass (MMB) of crab stocks increased relative to last year but remains very low overall. **The SSC continues to register substantial concern for the BSAI crab stocks as a result of these survey trends.** However, there were a few positive signs to note. MMB for most stocks increased relative to last year, though the clear exception was EBS snow crab. There may be some incoming recruitment for several stocks, including EBS snow, Tanner, and St. Matthew blue king crab (SMBKC). However, crab stocks in general continued to be in a depressed state.

The survey found that a proportion of female BBRKC had not completed their molt-mate cycle, which triggered discussions of whether re-towing should take place. After taking into consideration multiple factors, including the threshold analysis presented in May 2022, the low female biomass, and the broad distribution of females in Bristol Bay, AFSC staff made the decision not to undertake a survey re-tow. This decision was supported by the CPT. The SSC requests a re-evaluation of the consequences of re-towing for data quality, including the potential value in assessments (see request in BBRKC section below). Public testimony noted there may be benefits to re-towing when the fishery is closed. As recommended in October 2021, the SSC continues to encourage investigations into the drivers of temporal variability in the molt-mate cycle.

The SSC appreciated the presentation of more detailed survey results provided for EBS snow crab. The survey trends for EBS snow crab continue to be worrisome. Legal male snow crab biomass was down 44% from 2021, which had already declined by 69% from 2019. However, there were some positive signs of incoming recruitment, including an increased proportion of new shell crabs of both sexes and a large increase in immature female biomass. Immature male biomass continued to decline, however. Another stock of concern is Pribilof Island blue king crab, another overfished crab stock, for which mature male and female biomass decreased 44% and 72%, respectively, from last year. Mature Tanner crab male biomass west of 166° also declined but increased in the eastern area. Survey biomass of mature females had mixed results.

### **BSAI Crab Harvest Specifications and SAFEs**

Table 1 includes the stock status determination criteria, Table 2 includes the October 2022 SSC recommendations, and Table 3 details the maximum permissible ABCs and SSC-recommended ABCs. The SSC endorsed all of the OFL and ABC recommendations of the CPT (Table 2). St. Matthew blue king crab and Pribilof Islands blue king crab are overfished and under rebuilding plans. EBS snow crab are overfished and a rebuilding plan is being developed. None of the other crab stocks were overfished or approaching overfished status. None of the crab stocks were subject to overfishing.

Table 1. Stock status in relation to status determination criteria for 2021/22 as estimated in October 2022<sup>2,3</sup>. Hatched areas indicate parameters not applicable for that tier. Values are in thousands of metric tons (kt).

| Chapter | Stock   | Tier | MSST <sup>1</sup> | B <sub>MSY</sub> or<br>B <sub>MSY</sub> <sub>proxy</sub> | 2021/22 <sup>2</sup><br>MMB | 2021/22<br>MMB/<br>MMB <sub>MSY</sub> | 2021/22<br>OFL | 2021/22<br>Total<br>Catch | Rebuilding<br>Status |
|---------|---|------|-------------------|--|-----------------------------|---------------------------------------|----------------|---------------------------|----------------------|
| 1       | EBS snow crab                                     | 3    | 91.6              | 183.1  | 41.2                        | 0.23                                  | 7.5            | 3.6                       | <b>Overfished</b>    |
| 2       | BB red king crab                                  | 3    | 12.01             | 24.0   | 16.6                        | 0.69                                  | 2.2            | 0.10                      |                      |
| 3       | EBS Tanner crab                                   | 3    | 17.37             | 34.7   | 62.1                        | 1.79                                  | 27.2           | 0.78                      |                      |
| 4       | Pribilof Islands<br>red king crab                 | 4    | 0.86              | 1.71   | 3.88                        | 2.22                                  | 0.86           | 0.001                     |                      |
| 5       | Pribilof Islands<br>blue king crab                | 4    | 2.05              | 4.10   | 0.18                        | 0.04                                  | 0.00116        | 0.00                      | <b>Overfished</b>    |
| 6       | St. Matthew<br>Island blue king<br>crab           | 4    | 1.63              | 3.26   | 1.2                         | 0.37                                  | 0.05           | 0.001                     | <b>Overfished</b>    |
| 7       | Norton Sound red<br>king crab                     | 4    | 1.03              | 2.05   | 2.27                        | 1.10                                  | 0.29           | 0.003                     |                      |
| 8       | AI golden king<br>crab                            | 3    | 5.85              | 11.72  | 12.59                       | 1.07                                  | 4.81           | 2.72                      |                      |
| 9       | Pribilof Islands<br>golden king crab <sup>3</sup> | 5    |                   |  |                             |                                       | 0.093          | 0.021                     |                      |
| 10      | Western AI red<br>king crab                       | 5    |                   |  |                             |                                       | 0.056          | < 0.001                   |                      |

<sup>1</sup> As estimated in the 2022 assessment.

<sup>2</sup> For Norton Sound red king crab, MMB on 2/1/2022 is estimated using the current assessment in January 2022. Stock status for NSRKC is determined in February.

<sup>3</sup> PIGKC specifications are set on a calendar year basis.

Table 2. SSC recommendations for Eastern Bering Sea crab stocks. Stocks for which specifications are rolled over between assessments (Pribilof Islands blue king crab, Pribilof Islands golden king crab and Western Aleutian Islands red king crab) or were set in February (Norton Sound red king crab) or June 2022 (Aleutian Islands golden king crab) are also included. Biomass values are in thousand metric tons (kt). Tier designations in this table are based on the projected stock status in 2022/2023. Stocks for which the SSC recommended different harvest specifications from the CPT are bolded. Harvest specifications for SAFE Chapters 1 – 4 and 6 are set in October and Chapters 5 and 8 – 10 are set in June, in the year according to the assessment frequency cycle (see current SAFE Introduction for assessment cycle). Chapter 7 is set in February.

| SAFE Ch. | Stock                                      | Tier | F <sub>OFL</sub>         | B <sub>MSY</sub> or B <sub>MSY</sub> proxy | B <sub>MSY</sub> basis years <sup>1</sup> | 2022/23 <sup>2</sup> MMB | 2022/23 MMB / MMB <sub>MSY</sub> | $\gamma$ | Natural Mortality (M) | 2022/23 OFL        | 2022/23 ABC | ABC Buffer |
|----------|--|------|--------------------------|--|---|--------------------------|----------------------------------|----------|-----------------------|--------------------|-------------|------------|
| 1        | E. Bering Sea snow crab                    | 3b   | 0.32                     | 183.1                                      | 1982 – 2021                               | 55.0                     | 0.30                             |          | 0.28, 0.29            | 10.32              | 7.7         | 25%        |
| 2        | Bristol Bay red king crab                  | 3b   | 0.20                     | 24.0                                       | 1984- 2021                                | 17.0                     | 0.71                             |          | 0.18                  | 3.04               | 2.43        | 20%        |
| 3        | E. Bering Sea Tanner crab                  | 3a   | 1.17                     | 34.7                                       | 1982 - 2021                               | 47.58                    | 1.37                             |          | 0.23                  | 32.81              | 26.25       | 20%        |
| 4        | Pribilof Is. red king crab                 | 4a   | 0.21                     | 1.71                                       | 2000- 2021                                | 3.88                     | 2.27                             | 1        | 0.21                  | 0.685              | 0.51        | 25%        |
| 5        | Pribilof Is. blue king crab                | 4c   | 0                        | 4.10                                       | 1980/81-1984/85 & 1990/91-1997/98 [MMB]   | 0.18                     | 0.04                             | 1        | 0.18                  | 0.00116            | 0.00087     | 25%        |
| 6        | St. Matthew blue king crab                 | 4b   | 0.06                     | 3.26                                       | 1978 - 2021                               | 1.31                     | 0.40                             | 1        | 0.18                  | 0.066 <sup>3</sup> | 0.05        | 25%        |
| 7        | Norton Sound red king crab                 | 4a   | 0.18                     | 1.90                                       | 1980 – 2022 [MMB]                         | 2.42                     | 1.27                             | 1        | 0.18<br>(0.58 >124mm) | 0.30               | 0.18        | 40%        |
| 8        | Aleutian Is. golden king crab <sup>4</sup> | 3a   | 0.52 (EAG)<br>0.43 (WAG) | 11.72                                      | 1987 - 2017                               | 11.94                    | 1.02                             |          | 0.21                  | 3.76               | 2.82        | 25%        |
| 9        | Pribilof Is. golden king crab <sup>5</sup> | 5    | -                        | -  | See intro chapter                         | -                        | -                                |          | -                     | 0.093              | 0.070       | 25%        |
| 10       | W. Aleutian Is. red king crab              | 5    | -                        | -  | 1995/96-2007/08                           | -                        | -                                |          | -                     | 0.056              | 0.014       | 75%        |

<sup>1</sup> For Tiers 3, 4 where B<sub>MSY</sub> proxy is estimable, the years refer to the time period over which the estimate is made. For Tier 5 stocks it is the years from which the catch average for OFL is estimated.

<sup>2</sup> MMB is estimated on 2/1/2022 for Norton Sound red king crab and on 2/15/2022 for all other Tier 1-4 stocks, using the current assessments.

<sup>3</sup> SMBKC OFL was erroneously rounded in earlier versions of this table

<sup>4</sup> AIGKC OFL and ABC are calculated by combining two separate assessment models for the EAG and WAG, as presented in the current assessment

<sup>5</sup> PIGKC specifications are set on a calendar year basis



Table 3. Maximum permissible ABCs (maxABC) for 2022/23 and SSC-recommended ABCs for stocks where the SSC recommendation is below the maximum permissible ABC, as defined by Amendment 38 to the Crab FMP. For those stocks where maxABC was not calculated, OFL was used as a proxy (maxABC=OFL). Stocks for which specifications are rolled over between assessments or were set in February or June 2022 are included. Values are in thousand metric tons (kt). Harvest specifications for SAFE Chapters 1 – 4 and 6 are set in October, and Chapters 5 and 8 – 10 are set in June, in the year according to the assessment frequency cycle (see current SAFE Introduction for assessment cycle). Chapter 7 is set in February. PIGKC specifications are set on a calendar year basis.

| SAFE Ch. | Stock                                     | Tier | 2022/23 Max. ABC | 2022/23 ABC |
|----------|---|------|------------------|-------------|
| 1        | EBS Snow Crab <sup>1</sup>                | 3    | 10.3             | 7.7         |
| 2        | Bristol Bay RKC <sup>1</sup>              | 3    | 3.04             | 2.43        |
| 3        | Tanner Crab <sup>2</sup>                  | 3    | 32.76            | 26.25       |
| 4        | Pribilof Islands RKC <sup>1</sup>         | 4    | 0.69             | 0.51        |
| 5        | Pribilof Islands BKC <sup>3</sup>         | 4    | 0.00104          | 0.00087     |
| 6        | Saint Matthew BKC <sup>1</sup>            | 4    | 0.07             | 0.05        |
| 7        | Norton Sound RKC <sup>4</sup>             | 4    | 0.30             | 0.18        |
| 8        | Aleutian Islands GKC <sup>4</sup>         | 3    | 3.74             | 2.82        |
| 9        | Pribilof Islands GKC <sup>3</sup>         | 5    | 0.092            | 0.07        |
| 10       | Western Aleutian Islands RKC <sup>3</sup> | 5    | 0.056            | 0.014       |

Basis for P\* calculation of maxABC:

<sup>1</sup> maxABC was not calculated for this stock therefore Max ABC = OFL as a proxy

<sup>2</sup>ADMB sd\_report

<sup>3</sup> Tier 5 (90% OFL)

<sup>4</sup> CV on OFL

### *EBS Snow Crab*

The SSC received extensive written and oral comments relevant to snow crab from the individuals and organizations listed in the General Crab Comments section.

Public testimony clearly expressed the interdependence of the industry across crab stocks, specifically including snow crab, BBRKC and Tanner crab. The SSC recognized public testimony made under each of these species in the context of the review for the snow crab assessment and rebuilding analysis. As highlighted by the extensive testimony, the SSC recognizes the socio-economic importance of the snow crab fishery to small businesses and communities with a strong reliance on crab fishing, processing or support services. The abrupt change in stock dynamics for snow crab – from an increasing biomass to overfished status - occurred in the absence of the bottom trawl survey in 2020. Public testimony reflected the importance of even a small fishery during rebuilding in order to maintain vessels and crews, and the need for flexible management options during the rebuilding process. **The SSC recognizes both the consequence of these large impacts and that these impacts will continue due to low abundance and fishery yield during rebuilding.**

The SSC thanks the stock assessment author and supporting analysts for their hard work and innovation in advancing both stock assessment methods and the understanding of the relationship between the EBS ecosystem and stock dynamics over the last two years. The detailed research to identify likely causes of mortality and to investigate other potential sources of change (distributional shifts or changes in survey catchability) have been crucial to support the estimation of elevated mortality in 2018–2019. The SSC notes that the timing of data availability for this assessment, in tandem with the need for a rebuilding analysis under the tight federal timeline, has precluded completing many of the previous recommendations from the SSC, and that a more thorough exploration of continued poor assessment model behavior might have been possible if more time were available between when survey data became available and assessment results were needed for review by the CPT in September.

The SSC appreciates the snow crab ESP, which has helped to provide additional context for the public testimony and the biological conditions facing the stock. The SSC offers no additional recommendations for the snow crab ESP at this time.

The SSC emphasizes that, despite missing survey data in 2020 and the complex population response to warming waters, a critical conclusion from this assessment is the continued low abundance of larger snow crab in the EBS based on both the available data and modeled dynamics. This supports the explanation of a large mortality event rather than a distributional shift or change in catchability.

The author and CPT presented a lengthy discussion regarding the evaluation of models that have reached a local minimum but not the maximum likelihood estimate (MLE). The SSC emphasizes that local likelihood minima are artifacts of fallible computational tools (there are no perfect tools). With perfect likelihood minimizing tools or search algorithms, results from any solution other than the MLE would never be considered. The SSC highlights that results from local minima should not be accepted as the basis for management; only model results from the best likelihood identified through minimization, jittering or any other convergence tests should be considered. If results corresponding to the MLE for a specific model are deemed implausible (e.g., due to extremely high estimated fishing mortalities; F), then alternative model structures should be explored. The SSC notes that this type of model instability often signals key issues with respect to model complexity or conflicting and/or uninformative data. In the context of snow crab, **the results presented as Model 22.1ab did not represent the MLE and should not be considered**, other than to indicate that the likelihood surface for that model structure was challenging and that some simplification of the model might be needed to ensure reliable convergence across a range of starting conditions.

The SSC considered three options for the 2022 assessment: 1) Model 22.1 - a slightly updated version of last year's GMACS model with this year's data, 2) Model 22.1a - a solution that was considered 'close' to the MLE based on the jittering analysis, and 3) rejecting this year's models and "rolling over" last year's OFL/ABC/stock status. Model 22.1 had poor fit due to overly restrictive initial conditions and implausibly high estimated historical fishing mortality, both of which were addressed with changes added for Model 22.1a. However, Model 22.1a, as noted by the author and CPT showed implausibly high Fs in 2020–2021, at least for the fully selected segment of the population. Further, it was not clear whether Model 22.1a was similar to the actual MLE with regard to all management quantities as was assumed by the CPT and author. The SSC would have strongly favored a model corresponding to the MLE generated during the jitter analysis. The SSC noted that these challenges did not appear to be a function of moving the assessment to GMACS, but rather related to the large number of estimated parameters and the challenge of modeling the complicated population dynamics for this species. However, the SSC highlights that the model instability observed in 2022 when the model was presented with new data is of great concern and underscores the need for continued model refinement.

After considerable discussion of the options for setting specifications, the SSC recognized the value of moving this assessment to GMACS, and of using one model for both the assessment and rebuilding analyses. **The SSC recommends basing the OFL, ABC and stock status on Model 22.1a as the best alternative available.** Based on concerns over convergence for Model 22.1a, the SSC discussed increasing the buffer recommended by the CPT (25%) by an additional 5%. After further consideration, the SSC noted that the buffer for snow crab was elevated from 20% to 25% for 2020 and 2021 due to the increased uncertainty in the population dynamics surrounding the mortality event resulting in part from the absence of a 2020 survey, which has been reduced due to an additional year of survey data in 2022. **Therefore, the SSC recommends a buffer of 25% (from the Tier 3b OFL to the ABC) reflecting the 20% value used prior to 2020 and an additional 5% accounting for the lack of results representing the MLE in 22.1a.** The SSC sees this as an interim choice and expects model results based on convergence to the MLE in the next assessment; finding ways to simplify this assessment may aid in this task.

**The SSC renewed its request from 2021 for a Tier 4 calculation, intended to provide a "fall back" in case a clearly acceptable Tier 3 model is not available (as has been the case in 2021 and 2022).** More broadly, **the SSC recommends a working group to explore the use of simpler models across crab stocks as noted in General Crab Comments.** For snow crab, a male-only model may also be worth exploring as part of this effort.

**The SSC strongly supports consideration of moving the snow crab assessment to December,** noting that the October timing remains problematic for crab assessments due to insufficient time to address unexpected problems and a lack of availability of NBS data for inclusion in the assessments. The SAFE report and author's presentation to the SSC repeatedly highlighted how the limited timeframe precluded a more thorough analysis of model instability issues in 2022. The SSC encourages consideration of ways to move more of the research and model development to the spring, so that fewer model changes are needed in the fall when the new year of data is added.

The SSC highlighted several recommendations from previous reviews and a few minor suggestions to the document:

- VAST modeling of trawl survey data including both the NBS and EBS should be prioritized. This could help understand some of the inconsistent recruitment/growth trends observed in recent years as well as prepare for potential changes in stock distribution or productivity under future warming of the Bering Sea.

- Explore ways to simplify the number of selectivity parameters, particularly the selectivities used for the BSFRF data, especially in reducing the number of estimated parameters while still informing the relative selectivity and catchability of the NMFS trawl survey.
- Continue to investigate an appropriate definition of maturity to describe the reproductive output of the stock. This issue highlights the unknown importance of the NBS, where a large proportion of the biomass (relative to the EBS) is composed of morphometrically mature males that are smaller than commercially preferred crab. Direct biological research is needed on this topic.
- Investigate whether there is information outside the assessment model (e.g., larval or post-settlement data) or in the model supporting estimated skewed sex-ratios at recruitment.
- Avoid connecting 2019 and 2021 when plotting survey time-series (e.g., Figure 14) as there were no data in 2020.
- Report the scale of standardized residuals where plotted (e.g., Figures 42 and 43).

### *Bristol Bay Red King Crab*

The SSC warmly welcomes Katie Palof (ADF&G) as the new lead author of BBRKC assessment and extends its appreciation for the concise and informative presentation. The responses in the document to the SSC and CPT were thorough and detailed.

Public testimony was received from Joshua Songstad, Jamie Goen (ABSC), Cory Lescher (ABSC), Oystein Lone, Lenny Herzog (Homer Crab Cooperative), Keith Colburn, Scott Goodman (BSFRF), and Siri Dammarell. Most significantly, the testimony highlighted the devastating social and economic impacts of the low crab stocks and closures and the need for flexibility to have small open fisheries if possible. The needs for continued improvements in data in response to climate change and transboundary movements were also highlighted.

The SSC notes that, when there is a new assessment author, it is generally prudent to introduce minimal changes to the inherited model, as done here. The SSC supports the exploration of starting the model in 1985 (models 22.0 and 22.0a) instead of 1975 (Model 21.1b). This change eliminates the high M and high recruitment period that have high uncertainty and have been frequently questioned by the CPT and SSC. The later starting point resulted in negligible changes in the reference points or shared recruitment estimates, so this change seems pragmatic and parsimonious. In addition, 22.0a reduces the retrospective trend slightly and fits the data better than the other two model alternatives.

However, the SSC supports the author and CPT recommendation to evaluate the most appropriate starting date for survey data and time periods used for recruitment when calculating reference points at their January CPT workshop, as noted in the SSC's General Crab Comments, before accepting a new starting point for this assessment. **Therefore, SSC agrees with the CPT recommendation to use Model 21.1b for specifications with a 20% buffer between the OFL and ABC.** The SSC recommends that the series of low recruitments and low survey biomasses should not be used in the rationale for this buffer since their associated uncertainty is already included in the model. However, due to an increasing and substantial retrospective bias, the continued use of the 20% buffer is appropriate.

Given the current status of the fishery and the transition to a new lead author, the SSC encourages the authors to bring forward new explorations as they become more familiar with the data and model. Specifically, **the SSC recommends that a high priority be placed on trying to isolate factors that reduce the retrospective bias in mature male biomass.** The authors provided a likelihood profile for M showing that the maximum likelihood value for M appears substantially higher than the value used in the assessment and is similar for both males and females. Fixing male and female M at this value and running

a retrospective analysis would help determine if this is contributing to the bias. In addition, we encourage the authors to consider other possibilities such as the very tight prior on trawl survey catchability derived from Weinberg et al. (2004), and the value of estimating the sex ratio.

In addition, the SSC provides these comments and longer-term recommendations for BBRKC.

- The SSC looks forward to the stock structure template being applied to all EBS red king crab stocks.
- The SSC appreciates the MCMC outputs for examining the probability of going below reference points, but requests that some basic MCMC diagnostics such as autocorrelation plots and parameter chains be included.
- The SSC recommends investigation of the highly biased fits to the BSFRF index and suggests that the current approach of inflating the variance to account for lack of fit is inappropriate when obvious bias is present.
- The SSC supports cooperative research between the BSFRF, NMFS and ADF&G on tagging to examine hypotheses regarding spatial shifts in distribution.
- The SSC appreciates the BBRKC ESP and encourages further exploration of predation and community indicators for this stock.
- The SSC recommends that the authors consider the contributions of crab found to the north of the management area to this stock and consider the implications of including crab from this area for the assessment and sustainability of the stock.
- The accumulation of large males and particularly large females in the plus group indicates length bin groups may need to be re-evaluated.
- The SSC noted that the NMFS and the State determined that the survey re-tows would not be conducted in 2022, despite meeting the threshold to do so. The SSC requests an examination from the assessment author of the potential value of these re-tows, and whether re-tows provide a more or less accurate index of abundance.

### *Pribilof Island Red King Crab*

The SSC received a presentation of the 2022 Pribilof Island red king crab (PIRKC) stock assessment. There was no public testimony. This is a Tier 4 stock, and the assessment was moved to a triennial cycle in 2019. The assessment is implemented using GMACS and uses a  $B_{MSY}$  proxy defined as 35% of the average model-estimated mature male biomass (MMB) from 2000 to present. The directed fishery was closed in 1999.

Three assessment models were presented. The base model 22.1, which is the approved 2019 model (19.1) updated with new data; Model 22.1a, which adds bycatch size composition and estimated bycatch selectivity to Model 22.1; and Model 22.1b, which adds a constant estimated growth increment, consistent with other king crab stocks, to Model 22.1a.

The author's preferred model was 22.1b based on inclusion of bycatch size composition data, fits to the data sources and a more biologically realistic parameterization of the molt increment. The CPT endorsed the author's preferred model for specifications and recommended retaining the 25% ABC buffer used in the previous assessment (2019). This level of buffer is used with other low information king crab stocks (SMBKC, PIBKC). **The SSC concurs with the author- and CPT- recommended model and buffer to specify the OFL and ABC for PIRKC.**

The SSC notes the author's plan to work with other red king crab authors to complete a stock structure template for red king crab and looks forward to the outcomes. It is notable that, despite little change in

apparent PIRKC abundance, there has been an increase in the number of survey stations where PIRKC were present in recent years. This increasing trend in the area occupied is encouraging but should be interpreted with caution.

The SSC endorses the CPT recommendations that 1) the assessment author and other red king crab assessment authors (e.g., BBRKC) review the existing growth data and review potential additional sources of growth information, and 2) that the author examine whether the standard deviation around the growth increment is consistent with results from the tagging data for BBRKC.

In addition, the SSC encourages the author to consider the following avenues for further improvements to the model:

- Explore covariates (e.g., temperature) associated with historical BBRKC tagging growth increment data towards selecting records that best align with Pribilof Island regional conditions.
- Explore the use of a molt increment growth transition matrix.
- Explore analyses of molting at length for males towards specifying PIRKC molting probability in the assessment.
- Examine catchability and availability of PIRKC in the NMFS survey to shed some light on divergent changes in abundance in recent years. Data collected during the Bering Sea Fisheries Research Foundation (BSFRF) selectivity studies around the Pribilof Islands in 2017 and 2018 may support this effort.
- Examine retrospective patterns in future assessments.
- Consider the use of Bayesian methods with relatively uninformative priors for population processes to better account for uncertainties.

### *Tanner Crab*

The 2022 NMFS summer EBS trawl survey revealed an overall stable abundance of both mature male and legal male Tanner crab but showed an increase east of 166° and a decrease in the western area when compared with 2021 survey estimates.

No public testimony specific to Tanner crab was provided. However, there were multiple comments within other crab presentations on the importance and desire to execute a Tanner crab fishery as one of the major Bering Sea crab fisheries.

The Tanner crab stock has been assessed with a size-structured model since 2012, which is currently informed by abundance and size compositions from the NMFS EBS trawl survey, landings and discards from the directed fishery, and bycatch in the BBRKC, EBS snow crab, and groundfish fisheries. In recent years, this assessment has struggled with striking an optimal balance in model complexity, resulting in persistent issues with parameters estimated at or near bounds and retrospective patterns in recruitment. The stock assessment author has made marked improvements over the past years and the SSC commends their efforts and responsiveness to previous CPT and SSC comments.

Three models were presented by the assessment authors, including:

- **Model 22.01** – The model used in 2021 for assessing stock status with updated data from 2021/22.
- **Model 22.03** – An updated version of 22.01 that combined male and female bycatch fishery biomass data.
- **Model 22.07** – An updated version of 22.01 that started the model in 1982 (rather than 1948).

The SSC notes that all models successfully converged with few parameters hitting bounds, which has been a significant issue in the past. Model 22.07 was not endorsed by the CPT or SSC as it included 50 additional parameters. However, the SSC supports reconsideration of the model start date and notes that a standardized approach for changing start dates would be applicable to this stock (See General Crab Comments). Model 22.03 produced similar results to the base model, but also provided a better representation of the total catch mortality. However, the SSC notes that fits to MMB diverged markedly from the survey trends in the terminal years. **Nevertheless, the SSC supports the use of Model 22.03 for 2022/2023 harvest specification, in agreement with the CPT and assessment author.**

Based on Model 22.03, the 2022/23 mature male biomass is estimated at 137% of  $B_{MSY}$ , thus qualifying this stock under Tier 3a. Though the assessment author recommended an increase to the ABC buffer, the CPT recommended continuation of the 20% buffer between OFL and ABC for 2022/23 that was first adopted in 2020. **The SSC supports the CPT recommendation of a 20% buffer between OFL and ABC** as a reflection of continued uncertainty due to the lack of survey data for 2020, a severe decline in recruitment for 2019, the observation that recruitment pulses observed at small sizes in surveys have not subsequently resulted in large year classes in the modeled population, and the poor fits to the survey data for large crab.

A wide range of recommendations for future model development have been identified by the assessment author, the CPT, and the SSC since October 2020. While many of these are in the process of being addressed, the SSC highlights the following areas as highest priority for the Tanner crab assessment:

- Transition the Tanner assessment model to GMACS
- The investigation of model outputs that better inform State management, especially males of industry-preferred size to ensure proper scaling.
  - The SSC suggests fitting a range of simpler models or data limited approaches. This effort is fundamentally intended to support the use of Tier 3 size structured models, not replace them, but may help inform pathways toward greater model parsimony and stability.
  - The move to GMACS should give the authors an opportunity to start from a simpler base model and add features, rather than continuing to replicate legacy model complexities in GMACS, and provide for a more collaborative approach to assessing this stock.

Additionally, the SSC supports the development of methods and rationales for changing the start date of all crab models (including Tanner), as well as a working group to consider simpler models, as noted in the SSC General Crab Comments. The SSC also discussed the potential for the Tanner crab assessment to be considered for stock prioritization at a biennial or triennial assessment interval. This was suggested during the CPT meeting given that Tanner crab catches are consistently and markedly below ABC/OFL, which is one of the groundfish stock prioritization criteria for reducing assessment frequency. This would provide additional time for the author to implement recommended changes and pursue related research. **The SSC recommends that the CPT review the assessment frequency (see also Stock Prioritization section) for Tanner crab and provide the SSC their recommendation.**

### *St. Matthew Blue King Crab*

The SSC received a presentation from the CPT on the 2022 SMBKC stock assessment and an update on rebuilding progress. SMBKC is currently managed as a Tier 4 stock. The last full assessment was in 2020 as this stock was moved to a biennial cycle. A GMACS model (16.0-2022) was used, based on the last accepted model in 2020 with updated fishery data from 2020/21 and 2021/22 and the 2021 and 2022 surveys. The SMBKC fishery has remained closed to targeted fishing since 2015, and bycatch has been limited so no overfishing is occurring, but the stock remains overfished and under a rebuilding plan.

**For catch specifications, the SSC endorses the author's and CPT's recommended model and a 25% ABC buffer** due to continued uncertainty in the assessment as evidenced by a retrospective pattern in MMB, two diverging survey trends, and limited stock-specific life history information.

The SSC appreciates the author's work and encourages continued development of the assessment by following up on previous SSC recommendations as time allows, which include exploring:

- Data weighting (Francis and other approaches) and evaluation of models with and without the 1998 natural mortality spike;
- Causes of observed retrospective patterns;
- Potential explanations for the discrepancy in the time trends of the two types of survey data;
- Estimates of survey biomass based on VAST compared to design-based estimates, and estimates that combine the two surveys;
- Random walk on catchability;
- Assumed and estimated life history parameters (e.g., natural mortality, growth, and maturity) to ensure the best available science is being used to assess this stock.

### *Overfishing Status Updates*

PIBKC was last assessed in June 2021 as a Tier 4 stock and harvest specifications for 2021/2022 were set at that time. The CPT provided an update on the total catch, which was below the OFL, so overfishing did not occur. PIBKC continues to be overfished. This stock is assessed on a biennial schedule. The next full assessment will occur in 2023.

The SSC also received overfishing status updates for Aleutian Islands golden king crab (AIGKC), Pribilof Island golden king crab (PIGKC) and Western Aleutian Islands red king crab (WAIRKC). Catch for each of these three stocks was below the OFL, so overfishing did not occur in 2021 for PIGKC or in 2021/2022 for AIGKC and WAIRKC. AIGKC is assessed annually in June, but the harvest was not complete at the time specifications were adopted. PIGKC and WAIRKC are assessed on a triennial schedule, where the OFL and ABCs from their respective 2020 assessments will remain in effect until updated assessments are presented in 2023.

### **Norton Sound Red King Crab Model Runs**

The SSC received the CPT report on proposed Norton Sound red king crab (NSRKC) model runs for February 2023. The SSC thanks the authors for their responses to the SSC comments and suggestions. In addition to the base model (21.0), three new models were presented. Model 22.0 includes retention probabilities specific to shell condition, Models 22.1 and 22.2 are based on Models 21.0 and 22.0, respectively, but include individual M estimates for each of 8 length bins. The additional parameters resulted in negligible improvements in model fits and similar results to those from the more parsimonious base model. **Therefore, the SSC supports the CPT recommendations to bring forward Model 21.0 with updated data.**

The SSC requests that the methodology for calculating  $F_{OFL}$  based on a length-based M as requested by the CPT be clearly documented with supporting rationale.

The SSC further agrees with the CPT request for consideration of different methods for estimating discards to be brought forward in January 2023. It is acknowledged that data for a historical discard rate are limited to 2012–2019, so any bias should be clearly identified. Information from regional processors on increased



Pacific cod fishery effort in recent years should also be considered. The SSC notes that the potential catches are close to ABC depending on how total catches (with discards) are calculated and could have implications for Annual Catch Limit overages.

For February 2023, the SSC requests that the author provide an update on GMACS development for this stock, an update on potential movement of adult RKC to help explain perceived mortality in the model, and the details behind laboratory maturity studies that the author noted may result in a substantial decrease in size of functional maturity.

The survey selectivity parameter that is stuck on the bound forces survey selectivity to be 1 at all length bins. The SSC requests that the authors explore an inverse logistic (or other descending right limb pattern) selectivity to assess whether we may be missing larger crabs, due to either movement or gear selectivity. If this pattern were the case, it could have important implications for estimating higher natural mortality at the larger sizes. If this is not estimable, then it would make sense to fix selectivity at one for all size classes. Finally, the SSC requests a better explanation of the parameter  $r_1$  ('proportion of length composition 1') and what the implications are of  $r_1$  being on the boundary.

### **Snow Crab Rebuilding**

The SSC acknowledged the extensive work completed in preparation for the September CPT and October SSC meetings and in response to SSC comments. Specifically, the SSC noted that new methods to sample historical recruitment and natural mortality were developed and successfully applied to improve this rebuilding analysis.

Of the four time-periods for resampling recruitment and mortality requested by the SSC in June, two prioritized time series were included in the document: 1982-2017 and 2005-2019. Results were presented from Models 22.1a and 22.1ab; **the SSC did not consider results from 22.1ab for the rebuilding timeline due to the concerns raised during review of the assessment noted above.** The CPT recommended using the period 1982-2017 and Model 22.1a.

The SSC recognizes that the recent history of the stock includes both the largest recruitment and the mortality events estimated in the time-series, but that these events are not included in the author and CPT recommended resampling time-period. Further, temperature appears to be critically important to snow crab bioenergetics and mortality, and temperature is projected to be increasing over the species' distributional range. The 2005-2019 time-period approximately corresponds to the frequency of temperature anomalies projected during the next decade.

The SSC appreciated the detailed investigation by the author, identifying that the mortality event in 2018 appeared to result from the combination of high temperatures and extreme density-dependent mortality of large crab. Such high densities, and therefore another high mortality event, are unlikely to be observed over the duration of the rebuilding plan. **Therefore, the SSC supports the CPT recommendation to move forward with the rebuilding analysis using Model 22.1a with the recruitment and mortality resampling period set to 1982-2017. This would establish  $T_{MAX}$  at 10 years (2033), and therefore a rebuilding plan that provides for consideration of management alternatives that achieve rebuilding targets between  $T_{MIN}$  (2029) and  $T_{MAX}$  (2033).**

The SSC highlights that continued effects of climate change including increased frequency of reduced ice cover and reduced cold pool extent, as well as potential distributional shifts, suggest a challenging future for the EBS snow crab stock. Although not recommended as the basis for rebuilding reference points, the SSC suggests that retaining a figure illustrating the population projection relative to current reference points using the shorter time series (2005-2019) is appropriate to highlight the possibility that the rebuilding plan

may need to be revised depending on observed climate and population dynamics in the near- to medium-term.

The SSC notes that reported median times to rebuilding are sensitive to rounding to integer values. In particular, the preliminary result that the rebuilding time in the absence of bycatch is longer than that for the state harvest control rule plus bycatch (Table 2) was indicated, by the author, to be a rounding error. Similarly, the reported median rebuilding times using model 22.1a were identical for no fishing, bycatch only, and state harvest control rule plus bycatch, despite clear differences in the graphical results. **To reduce confusion, the SSC recommended that the rebuilding analysis identify differences in rebuilding times for management alternatives (potential  $T_{\text{target}}$  values) even when these values may round to the same year.**

To meet requirements of National Standard 2, the SSC highlights previous requests to SAFE authors, ESP analysts, and Plan Teams to carefully consider the addition of social and community indicators in appropriate SAFE-related documents. This is especially important for this stock in the context of upcoming rebuilding analyses and will be critical to track changes during rebuilding to account for the needs of affected communities and to allocate both overfishing restrictions and recovery benefits fairly and equitably as required under the Magnuson-Stevens Act (MSA).

**The SSC recommends, as noted in SSC General Crab Comments, that the assessment authors and CPT develop approaches for the estimation of unobserved crab mortality associated with interactions between crab and trawl gear (non-pelagic and pelagic).** This will be particularly important for informing rebuilding analyses for snow crab as the status quo assumption that unobserved mortality is zero is clearly biased and the magnitude of the true mortality is unknown. Noting that changes to the historical mortality estimates affect model scale and parameter estimates, this effort should begin with the stock assessments, rather than rebuilding analyses.

## C4 Greenland Turbot in Longline Pot Initial Review

The SSC received a presentation from analysts Sam Cunningham (NPFMC) and Kelly Cates (NOAA-AKRO). Oral public testimony was provided by Jim Armstrong (Freezer Longline Coalition; FLC).

The proposed amendment will allow longline pots for targeting Greenland turbot, to replace hook longlines that have recently experienced such extensive killer whale depredation that the fishery has not been viable. The SSC commends the analysts for a thorough analysis of the harvest, participation, community, and species interaction effects of this prospective gear change. **The SSC finds this analysis adequate to advance to final action, as it is sufficient to allow the Council to understand the fishery and policy impacts of the alternatives, subject to minor modifications.**

The SSC suggests the following modifications:

- Clarify the initial intent for the tunnel restriction, and why it is no longer necessary in this fishery.
- Ensure that the impacts of alternatives are presented with respect to a consistent baseline (two baselines are presented and discussions are not uniform about which is being used), where changes in both target and non-target catch is relative to an active HAL fishery or the more recent inactive fishery.
- Review the distinction between required and allowed retention, of halibut in particular, under different joint license or quota holding scenarios.

- Include some discussion of the likelihood that there is a high level of entry that could result in impacts to the season length for this or other fisheries (e.g., PIGKC), and the nature of any associated community impacts.
- Clarify, in qualitative terms, the community affiliations of the catcher vessels that have participated in the fishery.
- Qualitatively describe the general pattern of regional and, within Alaska, community distribution of noted FLC onshore employment.
- To the extent practicable, identify the Alaska ports where relevant activities described as generating municipal tax revenues and state shared fishery resource landing tax revenues have occurred.
- To the extent practicable, identify patterns of CDQ ownership of the vessels identified as potentially impacted by the proposed amendment.

## C5 BSAI/GOA Groundfish Specifications

The SSC received a series of presentations from Kalei Shotwell (NOAA-AFSC, BSAI GPT co-chair) and Jim Ianelli (NOAA-AFSC, GOA GPT co-chair) that included items from the September 2022 Joint Groundfish Plan Team (JGPT), BSAI Groundfish Plan Team (BSAI GPT), and GOA Groundfish Plan Team (GOA GPT) meetings. No public oral testimony was provided for BSAI/GOA groundfish specifications. Written comments were provided by Chad See (FLC).

### Joint Groundfish Plan Team Report

The SSC received a presentation from Jim Ianelli (NOAA-AFSC, GOA GPT co-chair) on the September 2022 JGPT meeting.

#### *Forage species*

**The SSC continues to support the JGPT organizing a public forage species workshop** (see the December 2021 SSC report, the January 2022 Ecosystem Committee Report, and the February 2022 Council motion). The SSC appreciates the information provided by the JGPT on the AFSC Forage Species Congress and **supports the JGPT-proposed timing of holding the Forage Fish workshop after the BSAI Forage Fish assessment in 2023**. The SSC notes that this will allow the new Forage Fish chapter author to complete both the GOA and BSAI chapters once before the workshop.

**The SSC supports the January 2022 Ecosystem Committee's recommendation that the workshop include participants from other research entities**; this aligns with the AFSC Forage Species Congress recommendation for increased collaboration with outside partners. **In addition to organizations whose research has already been reported on at the 2022 AFSC Forage Species Congress, and organizations suggested by the Ecosystem Committee for participation in the workshop, the SSC notes that ADF&G regularly monitors herring populations across the state and may be able to contribute to the stated workshop goals** (e.g., increased collaboration with outside partners, integrating existing data sources from surveys, expanding nearshore spawning surveys, information needed for management, and prioritizing improved monitoring of changes in abundance, distribution migration timing and conditions).

#### *Whale depredation estimates*

**The SSC appreciates the responsiveness of analysts to the SSC's December 2021 request to update this analysis and looks forward to seeing models using these updated values in December 2022**. The SSC notes that there was a considerable decrease in total sablefish mortality due to whales in 2021, likely

due to an increase in pot gear use and a decrease in hook-and-line gear, and that the overall magnitude of whale depredation remains low relative to TAC (less than 1%). The SSC agrees that in the future, particularly if pot gear catch continues to increase, it may be worth exploring ways to provide stability and simplicity in how the depredation estimates are applied and possibly update these estimates less frequently.

### *Shark model updates and Pacific sleeper shark stock structure*

The SSC commends the authors on the extensive work done to bring forward data-limited assessment model options for components of the shark complexes in the GOA and BSAI and for updating the Pacific sleeper shark stock structure template for the GOA and BSAI (first developed in 2012). The SSC appreciates the responsiveness of the authors to both the GPT and SSC requests to explore data-limited models and updating the stock structure template.

**The SSC supports the JGPT and author recommendation to bring forward (1) the status quo assessment approach, (2) the ORCS catch model for sleeper sharks in GOA and BSAI, and (3) the alternative approach (90<sup>th</sup> percentile to account for extreme and rare catch events) for the other/unidentified sharks in the BSAI and GOA and for spiny dogfish in the BSAI. When bringing forward the ORCS catch model for sleeper sharks, the SSC asks for additional examination and recommendations from the author and GPTs regarding the following:**

- Whether the 75% ABC buffer is appropriate given the low productivity of the stock, the evaluation that sleeper sharks are considered “fully exploited” (based on an assessor evaluated score in Table 3), and the assumption that all stocks that are fully exploited are at or above  $B_{MSY}$ . In addition, the ORCS table of attributes (Table 1) which are evaluated for sleeper shark (Table 3) do not include any consideration of maturity of individuals caught (i.e., how best do you assess the exploitation status (underexploited, fully exploited, or overexploited) of a species when a majority of the individuals caught are immature?).
- Is it appropriate to include the “Discard rate” category for a species that is not retained?
- Should uncertainty be evaluated only within the ORCS model (percentile scalar is chosen to satisfy risk tolerance and is set based on confidence that the exploitation status is correctly identified) or also outside the model in the risk table, noting that the ORCS scoring criteria also address aspects of risk.

The SSC requests that a column is added to Table 3 to explain sources and/or reasons for scoring because the scoring might change over time.

The SSC suggests exploration of whether additional IPHC data may be available (particularly in the GOA) that could provide information on trends prior to the late 1990s.

**The SSC concurs with the following recommendations from the authors and JGPT regarding the stock structure template:**

- Combining the BSAI and GOA sharks into a single assessment document for Alaska sharks, while continuing to set separate OFLs and ABCs for each FMP. This provides efficiencies for both author and the review bodies, without loss of information.
- Developing fishery-dependent and -independent indices for use in stock assessment
- Retaining observer at-sea length measurements and expanding the list of shark species codes.

- The SSC supports the current efforts described by the JGPT to reach out to the observer program regarding potential change in protocols, using logbooks to record more information, and “a special project” to use machine learning to speciate sharks in the fixed-gear electronic monitoring strata.
- Continuing to expand biological studies of Pacific sleeper sharks to inform catch models

While the SSC recognizes the concerns identified in the stock structure template about potential stock status of sleeper shark and the need for improved monitoring, **the SSC did not support the authors’ and JGPT recommendation to separate the Pacific spiny dogfish ABC from the other shark species in the GOA at this time.** During questioning, it was made clear that the intent was to maintain the complex level ABC in the GOA, so it was unclear to the SSC how “separating the spiny dogfish ABC” was different than the calculation that is currently done, how it would help track catch better (end of the season catch is already tracked separately for different components of the complex and it was not clear how in-season tracking would change since the complex level ABC would remain in specifications), and how it would provide additional protections to sleeper sharks.

#### *State-space configurations*

The SSC appreciates the authors’ work on using the Woods Hole Assessment Model (WHAM) to incorporate length information and growth estimation into models. The JGPT indicated that the WHAM model would provide the ability to conduct climate-linked assessments rapidly and propagate errors correctly and easily. **The SSC supports the JGPT and author-recommended workshop on this modeling approach and its applications to be conducted in spring 2023.**

#### *Random Effects – Tier 4-5 considerations*

The SSC commends the authors on developing a consensus version of the random effects (RE) model (coded in Template Model Builder (TMB) and implemented as an R package called *rema*) for Tier 4/5 assessments and for apportionment. **The SSC supports the JGPT’s recommendation that stock assessment authors transition from the ADMB RE variants to the *rema* framework, which implements the same model variants in a single framework with several improvements.**

This work has provided a single framework for use across species (i.e., consensus version), corrected an error in some versions of the current ADMB RE model, provided a framework (R package) that can be used by authors that don’t have extensive knowledge of TMB, and provides additional features over the existing ADMB RE versions. There is also potential for future expansion and exploration. This single framework helps to avoid errors in application, facilitates review by other scientists, and expands the number of staff with varying levels of coding expertise that can conduct these assessments. This is a valuable example of work that agencies can do to develop efficiencies and maximize capabilities when challenged with limited staff and funding.

**The SSC suggests that assessment authors coordinate, to the degree possible, on how and when the features of this new software will be used, such that similar applications will be brought forward using consistent approaches.**

#### **BSAI Groundfish Plan Team Report**

The SSC received a presentation from Kalei Shotwell (NOAA-AFSC, BSAI GPT co-chair) on the September 2022 BSAI GPT meeting.

The SSC appreciates the extensive work done by the authors and the BSAI GPT to prepare and review the suite of models to be brought forward for the December SSC review. The BSAI GPT was very responsive to SSC recommendations to streamline their minutes and presentation to support a more focused and concise SSC review.

The BSAI GPT provided updates on the 2022 bottom trawl and EBS acoustic trawl surveys. The BSAI GPT recommended that bottom trawl survey staff produce a document detailing past changes in gear and survey configurations as well as species identification for authors to reference in future assessments. They also noted and appreciated extra efforts by survey teams to streamline products, collaborate and respond to requests by authors and conduct special project data collections. The SSC concurred with these recommendations and reiterated its appreciation for NMFS staff efforts to ensure continuity of surveys and transparency in sampling and data processing which are paramount to the stock assessment process. The SSC also recommended that staff explore tidal corrections for the bottom water temperature data in the Aleutian Island trawl survey (see Fig. 6 in [Stabeno et al. 2005](#)), especially if they are to be submitted as ecosystem indicators.

Assessment model updates and BSAI GPT recommendations were provided for EBS Pacific cod, AI Pacific cod, Pacific ocean perch, Other Rockfish, shortraker rockfish, Greenland turbot, yellowfin sole, and EBS pollock. All the updates were minor to moderate, and **the SSC concurred with the BSAI GPT recommended models to be brought forward for SSC review in December. Further, the SSC supported all the BSAI GPT's recommendations for data exploration and model refinement.** Several assessment updates noted potential impacts of the recent lack of the EBS slope survey on abundance and size/ age composition data. The SSC acknowledges that these challenges result from ongoing survey resource limitations and that the 2018 SSC Sub-Committee on Trawl Survey Options and Priorities ranked the slope survey as the lowest priority. **The SSC recommends that assessment authors continue to highlight instances where the lack of these data may degrade stock assessment performance.**

The SSC appreciated the responses to requests for additional information on blackspotted/rougeye rockfish assessment input data. The SSC concurs with the BSAI GPT's recommendations for no model changes at this time and for further examination of natural mortality values. The SSC acknowledged the changes in the IPHC longline survey sampling design in 2020 but noted that the survey was highly correlated with the bottom trawl survey prior to 2020. Given the retrospective bias in the current model and its difficulty in assessing the scale of the stock, the SSC recommends the author explore use of the pre-2020 data in the assessment with emphasis on sampling in untrawlable habitats. It may also be possible to continue use of the time series of IPHC data after 2019 if model-based estimates are used.

The SSC notes that survey staffing limitations and assessment author turnover continue to present challenges and appreciates concerted efforts by NMFS to improve efficiency and safeguard assessment quality under these difficult conditions. AFSC staff highlighted several specific initiatives including script/ software/ workflow standardization and documentation, team-based stock assessments, and cross-Team collaboration on broader issues like data weighting via the JGPT. The SSC supports this work and notes that more detail and information about other efforts are provided under Stock Prioritization (D1). The SSC highlighted the value of the development and documentation of the Random Effects (RE) Model R-software package (*rema*) and recommends that the BSAI GPT provide standardized reporting recommendations (e.g., depth stratification) for authors using the *rema* package.

The BSAI GPT requested SSC feedback on how to present assessment changes due to software platform updates (e.g., Stock Synthesis version updates). The SSC affirmed that the author need not present a status quo model run in an obsolete software version and that a presentation in the JGPT outlining the pertinent changes to the platform and its expected impacts on the assessment results, if any, would suffice.

The BSAI GPT also highlighted challenges associated with the computational resources required to run the VAST age compositions resulting in a bottleneck for producing stock assessment inputs. The SSC concurred with the BSAI GPT's support for efforts within the Groundfish Assessment Program to develop alternative methods for running model-based estimators using cloud computing or other high powered processing resources.

**The SSC recommends approval of the proposed 2023/2024 BSAI groundfish specifications as provided by the BSAI GPT. The SSC supports the BSAI GPT's recommendation to approve the Halibut DMR Working Group recommendation for proposed halibut DMRs for 2023/2024.**

### **GOA Groundfish Plan Team Report**

The SSC received a presentation from Jim Ianelli (NOAA-AFSC, GOA GPT co-chair) on the September 2022 GOA GPT meeting.

#### *Shelikof Survey*

The GOA GPT described concerns regarding staffing and vessel issues related to the NMFS Shelikof survey and indicated that the MACE survey team is talking with NOAA leadership about additional support for MACE survey operations. The SSC highlights the importance of data collected as part of MACE surveys for informing the assessment of GOA pollock among other species, and its support for consistency and continuity in survey operations and the availability of survey data products.

#### *GOA Pollock*

**The SSC supports continued research on environmental or maturity covariates that may help to inform Shelikof survey catchability within the stock assessment for GOA pollock.** The SSC continues to support exploration of methods that link covariates that reflect maturity or timing of spawning directly to catchability within the assessment model if possible.

#### *SEO Demersal Shelf Rockfish*

The SSC supports the GOA GPT recommendation to use the status quo and new *rema* package, with and without IPHC survey data, as the basis for the current assessment. In addition to this method, the GOA GPT reviewed a state-space surplus production model (SS-SPM) that has been developed for this species. **The SSC supports further research, at the discretion of the authors, in development of the SS-SPM as it provides a mechanistic basis for evaluating stock dynamics** and results in predictions that are quite similar to those produced by the *rema* package. However, the GOA GPT highlighted several concerns with the surplus production model including sensitivity to the prior on the intrinsic rate of growth and current definition of  $F_{MSY}$ . The SSC appreciates the efforts by the authors to advance this assessment and concurs with the GOA GPT recommendation for this model to remain on a research track for the current assessment cycle. The SSC supports the GOA GPT recommendation for a CIE-type review of stock assessment approaches for this species complex in the future.

#### *GOA Other Rockfish*

The SSC appreciates efforts by stock assessment authors to update natural mortality estimates for these species. The SSC is supportive of methods to develop a weighted average estimate of natural mortality and looks forward to reviewing the methodology and justification for the proposed weighting scheme.

#### *GOA Preliminary Groundfish Harvest Specifications*

**The SSC recommends approval of the proposed 2023/2024 GOA groundfish specifications as provided by the GOA GPT. The SSC supports the GOA GPT's recommendation to approve the Halibut DMR Working Group recommendation for proposed halibut DMRs for 2023/2024.**

## D1 Stock Prioritization

An overview and update of the AFSC stock prioritization process was provided by Chris Lunsford (NOAA-AFSC) and Diana Stram (NPFMC). John Gauvin (Alaska Seafood Cooperative) provided oral public testimony. There was no written public testimony. The presentation included context for stock assessment prioritization, including the evolution of AFSC stock assessments, current AFSC challenges given increased requests of staff, compressed schedules to produce assessments, and limited time for assessment review. The presentation provided a brief overview of the 2017 NPFMC stock assessment prioritization process and proposed future directions. The JGPT discussed a number of aspects of the stock prioritization process but did not have specific recommendations at this time.

The SSC recognizes the increasing time challenges that exist for the agency and review bodies, the increase in assessment complexity as well as in other research, and the need for efficiency while maintaining adequate protection for all species that fall under the Council's groundfish and crab FMPs. **The SSC commends the presenters on their summary of the wide range of challenges being faced, which provided valuable context for the 2022 review and update of the stock assessment prioritization effort.** The SSC notes that this re-evaluation of stock prioritization is timely given the Council is currently looking for similar efficiencies (staff paper on Council Process and Ideas for Change).

**The SSC endorses the reproducibility and streamlining processes.** The SSC supports the continued identification of other efficiencies (e.g., use of standardized reporting and cloud computing where relevant) and appreciates the creative thoughts being put forward towards promoting these efficiencies. The SSC also commends the use of best practices around reproducibility, transparency, and transferability.

Regarding the SAFE reports, while the main sections of the report should contain all the information needed to make sound and timely decisions, the SSC agrees that many pieces of information might be included in appendices for continued reference or automated updating. This might include stable items like mathematical descriptions of model structure or input data for which only the annually collected information needs to be appended.

For elements of the reporting process that can be automated, the SSC notes that easily accessible and standardized harvest specification tables would make the review process for the NPFMC more efficient. **The SSC encourages efforts in automating rote tasks to promote standardization and efficiency in communication,** especially in the construction of reports. In that regard, coordination with ongoing efforts by those working in economics and the social sciences on the SSC and PT is encouraged. These groups are also in the process of developing ESPs and ESRs. This is an opportunity to improve what the assessment teams and review bodies are doing in a way, and at a time, that could broadly help the joint gathering and dissemination of information. This could help to make a significant leap forward in cross-disciplinary decision making.

As it relates to reproducibility, the SSC notes that any existing documents on best practices and other guidelines for assessment authors should be updated to reflect a modernized workflow and to ensure consistency across stocks.

To facilitate further discussion on this topic at future meetings, **the SSC requests that the AFSC and JGPT develop definitions of partial, full, and benchmark assessments and specify what documentation and level of review are needed for each.** In addition, the SSC requests recommendations on whether partial, full, and benchmark assessments each occur on pre-defined schedules or whether the decision on conducting a full or benchmark assessment might be determined each year at the September GPT meetings. This could also include a discussion of trigger points for benchmark assessments.



## **Reevaluation of assessment frequency**

For the five-year re-evaluation of stock assessment prioritization, the SSC has been asked to review and provide feedback and recommendations to the AFSC on what analyses and metrics should be developed for determining how best to arrive at an appropriate frequency for conducting assessments. The AFSC proposed revisiting stock prioritization with the 2017 stock prioritization analysis as a starting point, considering metrics for comparing stocks before and after the reduced frequency in 2017 such as the ratio of catch to ABC, the average percent change in ABC by year, and the difference between projected and realized biomass. The AFSC also proposed a suite of additional stocks to be considered for reduced frequency in 2023.

**The SSC supports the approach presented by the AFSC for the re-evaluation of stock prioritization.** Specifically, for the stocks recommended for reduced frequency in 2017, (1) use the 2017 stock prioritization as a starting point, (2) calculate at least the two presented metrics (the ratio of catch to ABC and the average percent change in ABC by year) to compare before and after 2017 and, (3) for stocks with projected biomass, calculate the difference between projected and realized ABC since 2017 (e.g., as presented for yellowfin sole). **In addition, the SSC requests a short narrative of key considerations on a stock-by-stock basis for species that are being recommended for a change in assessment frequency.** This narrative should include an interpretation of results from the calculated metrics, reasoning for the recommended reduced frequency, as well as any additional considerations, concerns, or lack of concerns.

**The SSC requests that the CPT conduct a parallel process to re-evaluate stock prioritization for crab assessments.** The SSC acknowledges that there have been updates to the frequency of assessments for crab stocks since the 2017 stock prioritization effort (i.e., PIRKC from 2-yr to 3-yr, PIBKC from 3-yr to 2-yr, and SMBKC from 1-yr to 3-yr), but still recommends a re-evaluation. The SSC recommends that this first involve considering whether the prioritization criteria used in 2017 should be expanded (see recommendation in Tanner crab section to consider whether the frequency of Tanner crab assessments should remain annual given the low ratio of catch to ABC) and then evaluate whether assessment frequency should change.

## **Additional SSC comments**

The SSC recognizes that prioritization of stock assessments is part of a larger process that involves effective and efficient management of the human and financial resources dedicated to providing sound science advice. The re-evaluation of stock assessment prioritization needs to occur within the broad context of all analyses required for Council decision-informing products and other research required to advance the Council's goals for an ecosystem-based approach to management.

The SSC notes that several other regional Science Centers have also been working on developing processes for prioritizing work, streamlining how assessments are conducted and reviewed, and exploring mechanisms for improving efficiencies. Notably, the SSC is aware of such activities taking place at the NEFSC, the NWFSC and the SWFSC. As part of the re-evaluation process, AFSC staff may want to explore what progress and setbacks other regions have encountered, to benefit from those experiences. For example, other regional Science Centers have developed definitions of assessment status at different levels of maturation and complexity, especially in terms of the review process for new, revised, and innovative assessment models. Having clear definitions will help in evaluating the modeling and review workload, priority setting and timing. Other Science Centers have worked through these definitions with some success.

**Experience gathered from other regions may be useful in evaluating the optimal timing of assessments.** For instance, in the eastern U.S. management regions, this is accomplished via the Northeast Region Coordinating Council (NRCC). The NRCC is made up of several federal and regional entities. Its

purpose is to get broad consensus on prioritization and timing of assessments. For the eastern U.S. management regions, gathering and identifying the value of a review from a broad set of constituents has promoted not only efficiency but transparency. At the West coast centers (NWFSC and SWFSC), conducting assessments is entirely team-based and has resulted in increased efficiencies and facilitated transitions to new assessment authors. A team-based approach also supports sharing of best practices such as those related to optimization and computational efficiency. Finally, a team-based approach enables rapid mobilization of capacity to support additional analyses or to assist with trouble-shooting an ongoing analysis; both circumstances are likely to occur with increasing frequency under changing environmental conditions. **The SSC strongly supports AFSC moving to a more team-based approach and notes that the West coast centers' team-based framework may be a helpful example.**

While there is a need to conduct and communicate scientific analyses and outputs more efficiently, especially with regard to assessing stocks and conducting reviews, the SSC recognizes that scientists also need the time and latitude to develop novel approaches to dealing with emerging challenges. While gains in efficiency can be achieved through standardization and automation, scientific developments require time, diversity of thought, and perspective. The SSC supports continuing to provide assessment authors the flexibility and opportunity, to the degree possible, to pursue these developments as this should lead to a more robust assessment system over time.

The SSC encourages the AFSC to re-consider using a metric of stability to set priorities in the context of living in a highly non-stationary environment. Multiple heatwaves and other physical changes have affected marine ecosystems around Alaska since the 2017 evaluation. In particular, two stocks in the Alaska region underwent a sudden collapse with little warning. The possibility that other ecological surprises will occur needs to be considered when the assessment frequency is reduced. Identifying major disruptions early by further developing and making use of the efficient transfer of information from the fleet and from local communities may be helpful to consider. This could build on existing processes for gathering information about the status of the ecosystem such as the ESRs and ESPs and could provide an early warning system for assessment scientists and managers. In this context, it would be helpful to also establish criteria for when assessment frequency may need to be increased and to develop a formal approach to responding to early warnings. In addition to a metric of ecological stability, the criteria could include a metric(s) characterizing the potential impacts of a stock collapse on socioeconomic outcomes including sustained community participation.

**The SSC notes that the stream of information from surveys must be maintained and promoted even if assessment frequency for some species decreases.** Surveys can serve the purpose of providing more or less immediate indicators of ecosystem status, regardless of whether or not an assessment model is applied.

Finally, a concern was noted about the heavy time burden placed on the SSC in conducting in depth assessment reviews. While stock assessment prioritization can help reduce this burden, additional efficiencies in the Council's processes for reviewing stock assessments, other analyses, and research priorities are best addressed through the ongoing Council Processes and Ideas for Change evaluation.

## **D2 Bristol Bay Red King Crab Discussion Paper**

The SSC received the Bristol Bay Red King Crab Expanded Information discussion paper for review, presented by Sam Cunningham (NPFMC) and Kelly Cates (NOAA-AKRO). Oral public testimony was received from Oystein Lone, Jaime Goen and Cory Lescher (ABSC), Scott Hansen, Heather McCarty and Mateo Paz-Soldan (CBSFA and City of St. Paul Island), Edward Poulsen, Lance Farr, John Gauvin (Alaska Seafood Cooperative), and Scott Goodman (BSFRF). Written public testimony was received from Marissa Wilson (Alaska Marine Conservation Council), Jaime Goen (ABSC) and Joshua Songstad (F/V Handler). **The SSC thanks Council staff for a very thorough document that pulls together data in response to**

**the Council request for information associated with potential management measures to protect BBRKC due to their continued lack of recruitment and low female abundance.**

This discussion paper broadly identifies the data available on sources of BBRKC mortality, seasonal and spatial fishery effort in the Bristol Bay region, and potential management options that could address that mortality. This document complements the April 2022 discussion paper that outlined crab life history overlap with fisheries, overview of management boundaries, assessment of potential impacts of pelagic trawl gear bottom contact, and other spatial management options. The current discussion paper focused on the following six topics to inform Council decisions:

1. Analysis of the impacts of annual or seasonal closures on pelagic trawl, groundfish pot, and longline gear in the Red King Crab Savings Area
2. Sources of BBRKC mortality across federal fisheries
3. Scientific information needed to create dynamic closed areas
4. Information needed for the A80 fleet to create a rolling hotspot closure system
5. Impact of groundfish predation on BBRKC
6. Impact analyses on hypothetical changes to the Pacific cod fishery

**The SSC notes the thoroughness of the information provided relative to these topics.** Notable exceptions were 1) the omission of available information on salmon and herring PSC, and 2) the potential degradation of CPUE in displaced rationalized fleets that may result in increased fishing time to achieve TACs. This would result in increased operating costs, habitat impacts, and increased trawl gear-crab interactions. **The SSC recommends that these considerations be included if relevant analyses are initiated.**

As the Council decides on the next step, the SSC notes that there are a suite of alternative tools for reducing BBRKC direct and incidental mortality including effort reductions, closures, and gear modifications. Given the complexity of the interactions and uses within this region, the SSC notes that clearly defined objectives, performance metrics, and performance monitoring would need to be established for any action. Following from these, the SSC suggests that a pre-specified process for adaptation of protective measures in response to performance metrics could also be established. Finally, the SSC notes that these tools have been implemented in other regions of the U.S. and the Council may benefit from lessons learned in those regions.

In addition to provision of the data, the discussion paper authors made a number of recommendations for research needed to further support decisions on these six topics. **The SSC highlighted a number of these recommendations as important for short-term or long-term support noting that these would augment the information already available to the Council.**

Short-term recommendations in response to author-suggested considerations were discussed by the SSC. **The SSC supported the need for a short-term research program to 1) assess the potential for pelagic trawl bottom contact based on the type/size of trawl nets being used and other factors based on fishing time/depth/location/target that may be correlated to actual bottom contact, and 2) consider using the Fishing Effects model currently used for EFH to identify potential pelagic fishing effort relative to closure areas.** The authors also highlighted the lower level of observed trips in the pot groundfish sectors relative to other gear types. **The SSC suggested that an analysis of the extrapolation process specific to the pot fishery in crab regions be considered to identify if any additional observer coverage is warranted.**

Longer-term recommendations in response to author-suggested considerations were also discussed by the SSC. The SSC agrees that understanding general crab distribution and movement timing will be important for understanding effects of a seasonal closure. However, the SSC notes that interannual variability in environmental conditions would preclude a timely detailed understanding even with multiple years of comprehensive surveys. **The SSC recommends that existing logbook data could be evaluated to bridge the gap between understanding of survey-based summer distributions and unknown winter distributions. The SSC suggests that data from the AFSC survey re-tows may provide enough information on relative interannual timing of molting and mating without a more comprehensive, multi-year survey.** The SSC discussed the value of understanding the timing of multiparous vs primiparous female mating, but cautioned that choosing one over the other would not be valuable in a consideration of closure areas. The SSC also cautioned that trying to identify specific mating timing between January and June to inform the Council on the efficacy of closure areas on an annual basis would be extremely difficult given environmental and behavioral variability. With respect to handling mortality of different crab species in different gear types, the SSC suggests that while most gear types have had research focused on handling mortality with various levels of certainty, crab handling mortality in hook and line fisheries is not well understood.

To establish dynamic closed areas, the authors identified extensive needs for information on general spatial distribution of BBRKC at different life-stages, distributions and seasonal shifts of all life stages intra-annually, and predictive variables to inform distribution in an upcoming season, which would trigger the opening/closing of certain areas. **The SSC notes that, while it would be valuable to have this level of detailed information, it is not currently available and the time and expense of addressing these topics would preclude having timely and accurate data to inform the Council on potential closure areas.** As such, any action that the Council decides to take will be a “blunt tool” because, while we have much information, there are many gaps in what is known about crab biology necessary to predict the efficacy of a closure area. **The SSC suggests that any future considerations of “dynamic” closures focus on annual or greater changes as opposed to any shorter time scale.** Seasonal movement data through tagging and surveys would be valuable in the future to inform the potential efficacy of dynamic closure areas.

### D3 Universal Data Collection Discussion Paper

The SSC received a presentation from Michael Fey (PSMFC) and Sarah Marrinan (NPFMC) considering key socioeconomic data components (‘data components’ from hereon in this summary) that can feasibly be collected uniformly across North Pacific federal fishing fleets to provide information useful to monitoring and evaluation of current and future Council programs and amendments. There was no public testimony.

The SSC notes that this effort fits among a number of existing discussion papers and analyses around Economic Data Reports (EDRs) and economic data collection. This analysis takes a *de novo* (i.e., starting anew) approach to identifying elements that could be effectively collected, but would benefit from a clearer identification of which analytical questions would be addressed. Specifically, the SSC suggests organizing the discussion of each data component around the following information, potentially summarizing it in tabular form:

- 1) **Where some version of each data component is currently used (e.g., Economic SAFE, program reviews), if at all** (the analysts also may find it helpful to draw on previous discussion papers that have examined how EDR data have been used);
- 2) **The extent to which the data component is responsive to current or potential future regulatory requirements** including:
  - a) Supporting the Council in science-based management in pursuit of the goals of National

Standards 1 and 8, and in compliance with National Standard 2 (e.g., community-level crew data would be responsive to National Standard 8 through tracking the sustained participation of fishing communities; observer costs could be inputs to an analysis of electronic monitoring programs);

- b) The potential to support the Council in program reviews (e.g., evaluating catch share outcomes against program goals where the EDR data are currently the best available scientific information); and
  - c) Executive Orders 13985 (Advancing Racial Equity and Support for Underserved Communities Through the Federal Government) and 14008 (Tackling the Climate Crisis at Home and Abroad) which point to analysis of the equitable distribution of resources and consideration of tribal affiliations.
- 3) If the data components were not collected through a uniform effort, which alternative, next-best source of information could meet the same analytical need(s), if any?
  - 4) If, and if so how, a data component could be a complement to existing data to create a richer source of information (e.g., the potential to leverage the ADF&G and Commercial Fisheries Entry Commission license database along with collected data to develop a fuller understanding of the contribution of crew to fishing communities).
    - a) For complementary existing data sources, address whether access to key elements is readily available, requires negotiation, or is not practicable.

Recognizing the approach the analyst took was to look within current EDRs for data components to consider, the SSC also encourages the analysts to consider whether there were any data gaps identified by the Social Science Planning Team (SSPT) that might be appropriate to consider within this paper. Additional data components that came up in the current discussion were the distinction between deck and processing crew aboard catcher/processors and the almost complete lack of shore-based processing crew information.

Additionally, while the SSC recommended the Council identify the needs for broad data collections across fisheries before discontinuing specific EDR data collections (SSC April 2021 Report), the SSC also expresses some concerns related to the feasibility and appropriateness of a single uniform data collection program for some data types. Specifically:

- Some data components are not “universal” in that it would not make sense to collect the information from all fleets (e.g., lease prices).
- Questions may need to be framed differently to understand the data components within different fleets. For example, crew compensation in catch share programs can be complicated as it is tied to quota ownership.
- There is a need to consider whether vessel EDRs are the best source of data to address an analytical need. For example, capturing vessel payments for quota can help monitor vessel net revenue and crew compensation, but vessel-level information may not provide an understanding of how people and communities are affected by catch share programs.
- Who would hold the data, how would data sovereignty issues be addressed, and are there confidentiality issues that would limit the utility of a given data set in addressing analytical needs?

**More generally, the SSC emphasizes the importance of socioeconomic data to documenting performance for monitoring, programmatic reviews, and as inputs for adaptive management in a dynamic market and natural environment.** The Council’s management measures are each designed with

a specific purpose and need, and it is imperative that those measures be supported by data programs that document performance relative to the stated goals. A shift from program-specific data collections to a uniform one increases the risk that necessary data for monitoring a program's idiosyncratic dynamics go unmonitored. To understand gaps that could emerge if there is a move to universal collection, the SSC recommends the analyst include a list of current EDR data that are not included in the uniform collection and a discussion of what components may be lost if EDR requirements are replaced or revised. This could include an analysis of these elements according to the rubric used for the data components as discussed above.

## D4 Amendment 80 Program Review Workplan

The SSC received a concise presentation from lead analyst Jon McCracken (NPFMC). There was no public testimony. The SSC appreciates the opportunity to contribute to the septennial review workplan. The workplan reflects experience with, and thought about, how to organize such reviews. The SSC supports drawing on the presentation formats of the recent Central GOA Rockfish Program Review and the BSAI Pacific Cod Sector Allocation Review as models.

The SSC finds the set of metrics chosen to track performance on each element of the Amendment 80 purpose and need to be informative, accessible, and appropriate. The SSC suggests deeper consideration of the following to the extent practicable:

- Capture ownership of the active vessels, with a specific focus on evolving ownership positions of CDQ groups.
- Describe the Alaska community engagement footprint of the fleet with respect to the location, nature, and magnitude of support service sector activity as informed, in part, by port call data.
- Estimate the share of community tax revenue attributable to the Amendment 80 fleet landings/product transfers.

## D6 BS FEP Climate Change Taskforce – Climate Readiness Synthesis

The SSC received an informational presentation from Diana Stram (NPFMC) and Kirstin Holsman (NOAA-AFSC). Due to time limitations, this presentation was abbreviated, and the SSC intends to review a more extensive presentation at a future meeting. Public testimony was provided by Steve Marx (Pew Charitable Trust). The SSC commends the enormous amount of work that went into preparing the draft Climate Readiness Synthesis.

Recognizing the SSC will review the document in greater depth at a later meeting, three general points from the report were discussed. In Section 1: Management Overview, the SSC noted the value of Table 1-2 as an evolving assessment of current management measures and how each has, or does not have, climate adaptive attributes. Along with the proposed case studies, this table provides an innovative opportunity to evaluate the portfolio of current approaches and a natural structure to reassess and revisit management readiness over time.

The proposed ranking from one to five of management measures, based on readiness and not effectiveness, was at times counterintuitive. For example, two different static area closure measures, the Herring Savings Area and the Northern Bering Sea Research Area, were ranked differently with the latter being 'more climate ready' based on its initiation being driven by climate change. Whether climate change or variability were explicitly included in the development of the measure does not necessarily make it more or less climate ready. The SSC **encourages the authors to clarify how these rankings address and clearly reflect the definition provided** that a system's climate readiness "includes measures specifically aimed to be robust

to long-term climate change, absorb climate shocks, and facilitate equitable and timely responses to novel conditions and challenges that are unprecedented or outside of historical ranges.”

The SSC commended the effort to identify where climate change was incorporated in SAFE reports, and suggested that the authors may consider a deeper exploration of the extent to which (1) the current management system addresses community resilience with respect to climate change and (2) the extent to which quantitative measures of community resilience or a qualitative description of community resilience to climate change are incorporated in SAFEs or other documents with background socioeconomic information (e.g., ACEPO).

Finally, the SSC noted the excellent section on sources of knowledge and in particular the in-depth assessment of incorporating Indigenous knowledge. Highlighting the synergies with the Local Knowledge/Traditional Knowledge/Subsistence task force, and potentially the ways the Climate Readiness Synthesis can complement their efforts, would provide clarity as well as emphasize the overall team approach to addressing climate change in the Bering Sea. Finally, the SSC suggested this section could be strengthened with a brief discussion of how, when incorporating diverse sources of knowledge, the role of data sovereignty may be addressed.

## D8 Essential Fish Habitat Updates

The SSC received a presentation from Sarah Rheinsmith (NPFMC), Jodi Pirtle (NOAA-AKRO), Molly Zaleski (NMFS-AKRO), and Scott Smeltz (Alaska Pacific University) on the advances and findings from the 2022 Essential Fish Habitat (EFH) 5-year Review. Public oral testimony was provided by Jon Warrenchuk (Oceana) and Cory Lescher (ABSC). Written comments were provided by Jaime Goen (ABSC), Marine Wilson (Alaska Marine Conservation Council) and Jon Warrenchuk (Oceana). The question before the SSC was whether the combination of the EFH species distribution model (SDM) approach (Component 1) and the Fishing Effects (FE) model (Component 2) represent a reasonable scientific basis for evaluating whether the effects of fishing are more than minimal and not temporary. **The SSC recommends the current EFH methodology and FE estimates as a reasonable basis for the determination of fishing impacts, and that no species needs to be elevated for mitigation due to fishing impacts.** Based on the information provided, **the SSC finds that the 2022 FE evaluation supports the continued conclusion that the adverse effects of fishing activity on EFH are minimal and temporary in nature.**

The SSC notes that both the current SDM approach to defining EFH and the FE model represent substantial methodological advances since the 2017 EFH review process. EFH designation is now based on multiple habitat-based SDMs, an objective cross-validation approach is used to quantify performance, and a model ensemble has been implemented to generate combined predictions based on model performance. EFH designation has also been expanded to multiple life history stages using updated length-based criteria and the analysis incorporates additional sources of abundance and habitat information to inform EFH for early life stages. The SSC appreciates recent advances by the EFH team to correct an error in the treatment of area-swept effort and the plain-language summaries by stock authors describing the reliability of EFH designations with respect to survey data, and both seasonal and spatial representativeness. The SSC further highlights the utility of transparent and reproducible code for the EFH SDM analysis that is provided in the form of a publicly accessible GitHub repository. Likewise, analysts have made significant progress in improving the FE model during the current 5-year EFH review. Notably, an error transposing susceptibility between two gear types has been corrected, the defined set of gear categories has been expanded along with refinement of bottom contact adjustments based on the literature and public input, and, importantly, the FE analysis now includes data from both observed and unobserved fishing events. The SSC notes that an associated survey of assessment authors indicated no or low concern for 84% of SDM EFH maps and no or low concern for FE model evaluations of 70% of stocks. The SSC appreciates the substantial efforts by

EFH Component 1 and Component 2 teams in advancing the EFH analysis in this cycle and incorporation of feedback from stock assessment authors and the SSC throughout the process.

The SSC discussed the apparent mismatch between the multiple life stages for which EFH has been defined and the evaluation of fishing effects for only adult life stages. **The SSC suggests consideration during the next 5-year EFH review cycle of whether subsequent evaluations should consider other life stages for which EFH has been defined**, with explicit consideration of whether SDM-based EFH definitions for other life stages are sufficiently representative for FE evaluation given potential limitations in the data available to inform EFH definitions for earlier life stages.

Responding to author requests, the SSC considered available options for determining EFH and evaluating fishing effects in the next 5-year review in cases where data limit accurate SDM EFH definition for particular species or life stages. The SSC supports EFH and FE evaluation for species complexes or by combining data across species' life history stages as necessary to adequately determine EFH and evaluate fishing effects. The SSC encourages authors to consider whether alternative approaches for identifying core habitat areas might be utilized, incorporating knowledge from stock assessment authors, fishery participants, and other sources of Local Knowledge and Traditional Knowledge. While the SSC recognizes this represents a departure from the current SDM approach, this may be appropriate in specific cases for poorly indexed species or life stages.

While the SSC finds the current EFH evaluation methodology is appropriate for the current 5-year EFH review, it has several recommendations for research during the next review cycle. In prioritizing research during the next review cycle, the SSC encourages further consideration of what products or areas of research are necessary to satisfy EFH regulatory requirements as compared to what would benefit fishery management more generally, and whether a working group of EFH analysts and SSC members should be created to guide future research in this area.

**With respect to EFH research in the next 5-year review cycle the SSC has the following recommendations:**

- EFH SDM intercalibration of bottom trawl survey data with data from fixed gear surveys including the NMFS Longline Survey and IPHC Setline Survey. While the SSC appreciated the description of the overlap between current EFH definitions and NMFS Longline Survey locations, the SSC notes that with the current discontinuation of the EBS slope bottom trawl survey and reduction in sampling of deeper strata within the GOA bottom trawl survey, information on species' occurrence and abundance in deeper habitats will become more important in the future.
- Exploration of the extent to which fishery-dependent data can help inform future EFH SDM analyses, while highlighting the inherent problem of preferential sampling associated with fishery-dependent information.
- Expansion of EFH definitions to other life stages and seasons where appropriate, based on available data to inform occurrence, abundance, and habitat associations.
- Reporting of species-specific habitat disturbance from the FE model by major gear classes would be beneficial in considering habitat impacts in a strategic manner.

The SSC refers EFH authors to its comments from February 2022 for further recommendations regarding future EFH evaluation.

The SSC encourages continued consideration of long-lived benthic habitat features and the extent to which current definitions of depth distribution and recovery times within the FE model are appropriate, and whether they can be refined in the future given available data. Finally, the SSC notes that while presence-



absence and abundance data have been used successfully in the SDM analysis to define EFH, it may be appropriate in the future to consider whether there is additional information that may be used to highlight habitats that are asymmetrically important to population productivity including critical spawning or rearing habitats.

## **SSC Member Associations**

At the beginning of each meeting, members of the SSC publicly acknowledge any direct associations with SSC agenda items. If an SSC member has a financial conflict of interest (defined in the 2003 Policy of the National Academies and discussed in Section 3) with an SSC agenda item, the member should recuse themselves from participating in SSC discussions on that subject, and such recusal should be documented in the SSC report. In cases where an SSC member is an author or coauthor of a report considered by the SSC, that individual should recuse themselves from discussion about SSC recommendations on that agenda item. However, that SSC member may provide clarifications about the report to the SSC as necessary. If, on the other hand, a report is prepared by individuals under the immediate line of supervision by an SSC member, then that member should recuse themselves from leading the SSC recommendations for that agenda item, though they may otherwise participate fully in the SSC discussion after disclosing their associations with the authors. The SSC notes that there are no financial conflicts of interest between any SSC members and items on this meeting's agenda.

At this October 2022 meeting, a number of SSC members acknowledged associations with specific agenda items under SSC review. Chris Siddon noted that he supervises Katie Palof (CPT co-chair, BBRKC and SMBKC assessment author) and that he is married to Elizabeth Siddon (ESR co-author). Ian Stewart contributed to GOA ESR and to the Halibut DMR working group report (C5 Groundfish). Brad Harris contributed to the Fishing Effects model (D8 Essential Fish Habitat) and the Fishing Effects portion of the BBRKC discussion paper (D2). Robert Foy is the third or greater level supervisor for contributors to the following agenda items: all AFSC GPT nomination recommendations; Mike Litzow (C1 BSAI Crab co-chair, C1 BSAI Crab trawl survey updates), Cody Szuwalski (C1 BSAI Crab, snow crab assessment author); Jim Ianelli (C5 GOA GPT co-chair), Kalei Shotwell (C5 BSAI GPT co-chair), Steve Barbeaux (C5 BSAI GPT co-chair); Chris Lunsford (D1 stock prioritization); and Kirstin Holsman (D6 Climate Resilience). Finally, Dana Hanselman directly supervises Chris Lunsford (D1 Stock Prioritization) and contributed to the D1 agenda item and is the second or third level supervisor for multiple groundfish assessment authors and ESR author (Elizabeth Siddon). Dr. Hanselman is also married to Kalei Shotwell (C5 BSAI GPT co-chair, BSAI shortraker assessment author, and coauthor on multiple ESPs).