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To: Erin Reinders, JR Pearson, Michelle Price, Mayor Tutikoff and City Council

From: Frank Kelty, Fisheries Consultant

Re: Fishery Activities and for the week ending 12-24-2021.

The past two weeks have been slow for Fishery activities which is usual for this time of year after the long North Pacific Council meeting. This past week on December 16-17th I attended a two Snow Crab (*Opilio Tanner*) Workshop via Zoom. The theme of the workshop was "2021 *Opilio* -What Happened?" The workshop was sponsored by the Bering Sea Fisheries Research Foundation (BSFRF). We had presentations from Alaska Department of Fish and Game (ADFG) and National Marine Fisheries Service (NMFS) Biologists and Fishery managers. I also attended a Bering Sea Fisheries Research Foundation (BSFRF) Board Meeting on December 21st, 2021.

Day One: December 16,2021

After Introductions and agenda discussions, we moved on to the first presentation was by Erin Fedewa, NOAA Fisheries Kodiak Alaska, she discussed ecosystem indicators to evaluate snow crab populations declines. She pointed out the other ecosystem declines in the Bering Sea other than crab stocks, such as salmon in western Alaska, seabird dieoffs, and decline on fur seals. Some of the theories discussed included warm water temperatures in the Bering Sea since 2014, reduced cold pool, predators such as Pacific Cod have been, and other fish have impacted smaller crab there has been evidence of this increasing for over 5 years. The observers working on groundfish surveys have opened many cod fish stomachs and have seen increases of crab in cod stomachs. She also presented some evidence of Bitter Crab Disease Syndrome this could also play a role in the decline.

The next presenters were Dr Cody Szuwalski, from the NOAA Alaska Fisheries Science Center in Seattle. Dr Szuwalski topic was What Happen to Snow Crab? from information on the studies have has been working on. He discussed NMFS surveys and to validate survey performance and relationships between trawl survey catches, and directed pot catch per unit efforts in the directed crab fishery. He discussed the movement of Snow Crab further to the Northwest including into Russia. He stated that the agency is trying to get some information from Russian Scientists to get information on what they are seeing on Snow Crab biomass that is on their side of the boundary. He

also stated that he is collaborating with other scientists at NOAA on other potential stressors, such as, bycatch, cannibalism, discard mortality disease, water temperature. A large unknown is unobserved trawling mortality is it much higher than assumed, especially when crab is in soft shell condition. He continues to work on the estimate of size -specific mortality over time, and he believes that water temperature may be the key factor as snow crab are now being observed at temperatures not previously seen. Dr. Szuwalski concluded that NMFS surveys and fishery CPUE shows similar trends, trawl bycatch mortality does not seem to be a larger factor; cod predation must consider crab abundance, cannibalism is worthy of additional analysis. Disease requires more analysis; recovery rates depend on the numbers of juvenile crab already in the Eastern Bering Sea.

Up next were the two presenters from ADFG Dr. Ben Daly and Mark Stichert, Alaska Western Region Commercial Fisheries Manager. They discussed the 2021 fishery and the expectations / coordination for this season fishery. Dr Daly, spoke about the decline of the Snow Crab the research directions the State of Alaska will be assisting with. He believes the same type of declines have happen between the east and western area of the Bering Sea. He noted that for the past two years much of the harvest happed by the international border, the current survey did not reveal any large abundance of crab near the shelf edge he noted that the survey pointed also out a large decline on the female crab as well. With the tread in warmer water, research is showing that substantial amounts of Snow Crab have moved into deeper water. Ben concluded that the collapse is due to several issues are likely to be the result of a collection of factors. He is excited about collaborative research. He advocated focusing on the questions to be answered and approaches to answer those questions. He suggested that an understanding of snow crab in Russia is important and advocated for a cooperative survey. Other areas for research include male size of maturity, closer look at pH and DO, crab movement, and a reevaluation of harvest control rules that may involve metrics other than mature male biomass, and spatial management.

Mark Stichert, of ADFG was next provided an overview of the three tiers of management measures used to manage the BSAI crab fisheries. There are three primary fishery data sources: observer (pot sampling) since 1998, retained catch (dockside samplers), and logbook and fish ticket data. For 2022, fishery management will maintain the status quo. Dockside sampling will occur as usual, but there is an observer shortage. Daily processor production rates may be lower owing to reduced staffing. Mark projects 20-30 boats this year, but this is highly uncertain. Given the small TAC, it is unlikely to run out of season before running out of TAC. It is expected that some boats will start their season far to the north where greatest catches were taken last year. Last year, 92% of the catch occurred north of 58°38". Previously, more than 90% was taken south of this line. However, we are entering a cold winter. How might this affect the fishery? Boats going north to where they finished fishing last year may be unable to access these grounds owing to ice. Also, survey data suggests the lowest snow crab stock abundance in the time series. Given these considerations, a prediction of season length is difficult. Potentially, 30-40 boats may result in a season of 3.7-5 days. Day one wrapped up with questions, concerns, and what day two would hold.

Day Two: December 17, 2021

Friday was as mainly a brainstorming session on various issues facing the Snow Crab fishery. The first morning session focused on the continuing research projects, the long-term proposals that we do now tagging projects, annual surveys and observer reports an observation. The shorter-term projects work on predation was needed especially work on understanding the feeding by cod are cod eating mostly soft-shelled molting Snow Crab and what time of year do cod feed on the majority of crab. Also checking cod from baited fisheries pot cod fishing against trawl cod is there a difference in the amount of crab in cod stomachs.

They discussed various crab growth impacts they discussed the work on lipid/fatty acid analyses that may be tied production in crab growth. They discussed the need to reexamine the work on in which crab temperature gradients, did the pattern hold during warm years if so, did these movements lead into areas on near the shelf break to areas of low oxygen or PH that led to a massive die offs of Snow crab.

If there was a massive die off, how can they verify it they discussed the use of a Clam sled that ADFG uses to tow over Scallop for survey work it can be used by a variety of vessels the expertise to use the sled may be a problem. They moved on to a discussion of examining snow crab on the Chukchi Sea shelf. Previous survey showed the high number of mature females in that area. There was also a discussion on molting and that larger males appear to be in larger number in colder water areas, this may be from skip molting events. They discussed climate, a scientist from Canada points out that in Eastern Canada snow crab fishery climate and water temperature are the major items face that stock of crab.

Erin replied that such sampling has occurred but remarked that many of the cod have empty stomachs or stomachs with bait only, it was agreed that fishermen could participate in several immediate research activities, including taking along biologists, small mesh pot deployments, video cameras and others. No one saw a problem allotting space and time for a vessel to deploy thirty-five tags on snow crab during fishing operations. UAF graduate student Connie Melovidov, will be leading this effort. Ben Daly of ADFG pointed out that the current satellite tags are a bit too large for snow crab. Nonetheless, deployment of existing tags may provide some useful information. Ben further pointed out that new micro-PAT tags are being developed, which should be more suitable for snow crab.

It is expected that these tags will become available in 6-12 months. Ben also hopes for the ability to do some beta testing of these small tags on Kodiak Tanner crab. Scott indicated the desire to tag crabs late to reduce likelihood of recapture during the fishery. He also indicated the desire to deploy crabs in more than one location. Leah advocates tagging crab where fishing is occurring this year and, assuming that some fishing is like last year, she would like to see some or all tagging off the slope.

Mike commented on the ability of NMFS to conduct surveys off the slope. He pointed out that such decisions would need to occur at a higher level within NMFS. He pointed out that one option for consideration may be to stop doing corner stations around the islands to free up some time to do other survey work. Ben expressed interest to cooperate with fishermen to do pot deployments in deeper water to explore the depth distribution of crabs. Scott indicated the desire to explore some marginal areas but realizes the tradeoffs with other survey priorities.

Edward likes the idea of a pot mesh size study. A mesh of 5 and 5/8 inches helps clean out many small crabs without much loss of 4" crab. Soak time needs to be considered along with mesh size. Edward is also interested to know if ADF&G has examined the size of crab by area. He pointed out a year when crab was larger going from the Pribilof Islands to the north. Does ADF&G have any of these data? Ben replied that size composition comes from the observer data, however he has not looked at those data. Lance Farr thinks that smaller crab is shallower than big crab. Chad Low has found the same patterns that Edward and Lance described. He also pointed out cleaner and larger crab to the north in the past 4 years.

Prior to lunch break, Scott indicated a desire to produce a higher-level plan for research, as well as a more immediate plan for work that could be done now. Mike feels that the Climate working group is a good venue to examine research priorities concerning climate forcing. This group could provide answers to specific questions that we may pose using modeling. Scott agrees but points out that there may be some longer-term research priorities that do not have climate components. Cody points out that the crab plan team provides one venue to share climate-related research. Scott feels that sharing of ongoing climate research is important.

There was further discussion about Bitter Crab Syndrome (BCS) it asked whether laboratory studies have been conducted it was pointed out work done by Ted Myers years ago in which transmission was established by injection. However, comprehensive laboratory studies have not been conducted. If the 2022 Snow Crab fishery performs well both Cody and Ben would be keen to see next year's survey results. Mark pointed out that interpreting CPUE is challenging. Mark pointed out that the snow crab collapse was very acute. He asked, is it now over and recovery can be expected to follow or is this the leading edge of a long-term regime shift? Scott appreciates this concern and points out that the situation may not become clearer until after this year's fishery and next year's summer survey. Mike suggests that we should leave long-term averages behind. He suggests that history is less and less informative going forward given climate changes. He also indicated that it is possible that we could enter a run of cold years. It was pointed out that concerns for other species in the Bering Sea, such as king and chum salmon, so snow crab is not an isolated case. Ben indicated that these broader changes have elevated the overall level of concern. Scott pointed out that this is not a fishery as usual nor is the planning as usual. The following activities were identified for importance to be looked at.

- Temperature-depth loggers on pots. Chris Siddon, has some available devices. These should be easy to deploy. Some may be available, but they are also relatively inexpensive. Mark and Scott suggested that financial resources could be brought to bear.
- Satellite tagging of snow crab. Tags will be delivered by January 14. First consideration should be given about where the crabs should be tagged. Mark suggested that they could be deployed in the traditional areas or that they could be deployed more to the north where they appear now. Cody suggests that this should be viewed as a pilot project to see
- if they work rather than answering specific questions. Ben points out that tagging may need to be confined to just one vessel owing to logistical considerations. Scott also pointed out the tradeoff between deploying tags in the location of the survey versus deploying tags late in the season to minimize the probability of recapture.
- Ben offered some data mining to examine mesh size and soak time effects. There may be information already available. Cory and ABSC may be good collaborators to collect new data on this project. Lenny pointed out that when catch rates are high, soak time is more difficult to control.
- Small mesh pot deployment will require some coordination. These pots may be owned by the Aleutian King Crab Research Foundation. Consideration should be given to what information will be gained. Cody indicates that recovery depends on the small crabs that are out there now. However, it will be difficult to evaluate without a baseline of similar data. Also, Gordon pointed out that the gear for AI GKC is quite different from those typically used in the snow crab fishery. Rather than repurpose AI GKC pots, it may be more prudent to re-web some pots used in the snow crab fishery.
- Live crab and tissue sampling – a vessel that returns to Kodiak will be involved in this work. They would hand off some of their snow crab to ADF&G or NMFS.
- Doug Wells asked whether it would be useful for vessels to sample cod stomachs. He noted cod caught west of St. Matthew Islands were full of mature females. He pointed out that all freezer-longliners have observers and that this could be a source of useful information. Erin was interested in this, but she was not sure about the observer protocol for collection of stomachs. Erin pointed out that the backlog of unanalyzed samples is an issue.
- Mark asked about sablefish predation on crab, and he raised the question about whether there may be more interactions between snow crab and the sablefish fishery. Erin was unsure about sablefish stomach collections and will ask about it. Lenny Herzog indicated that his vessels do not encounter many snow crab at three hundred fathoms depth, where his boats longline small conical pots. However, his vessels do not fish to the northwest in the Bering Sea.
- Doug asked is it possible to estimate the fraction of the snow crab stock that Pacific cod are consuming? Cody can estimate crab consumption at the time of the survey from stomach samples. However, this is a snapshot and results are hard to extrapolate over the However, this is a snapshot and results are hard to extrapolate over the full year.

The workshop concluded with participants thanking the speakers for their excellent work to investigate potential mechanisms and their participation in the workshop. Over 50 participants attended the two-day workshop.

On Tuesday, the December 21st I attended the Bering Sea Fisheries Research Foundation (BSFRF) board of directors meeting. Since was the Holiday season we had a short meeting. The financials still looked good even with no King Crab season revenue we still have \$1.9 million in reserves enough for two full budget years. We then discussed the December North Pacific Council meeting and the Executive Director Scott Goodman's, discussed his testimony to the Councils SSC panel on the need for assistance and support on additional crab research and support from the SSC and Council on upcoming research projects. He also discussed the tagging project that was just completed it went very well.

We then discussed planning issues such as additional funding, cap amounts on projects and limits, the board will also look at staff and research support amounts. The Board will form a committee to brainstorm additional funding opportunities for the foundation as well as partnerships on research projects.

Lastly, we discussed Bairdi Tanner crab on stock dynamics/ retention including on a lower size limit for Western Bairdi Tanner Crab from 5" to 4.5" to reduce sorting morality directed fishery and during the Snow crab fishery. BSFRF staff will continue to have discussions with ADFG and this issue. The Board will meet again in mid-January after the January NPFMC Crab Plan Team meeting in Anchorage.

Regards

Frank Kelty

Attachments:

1. Minutes from the BSFRF Snow Crab Workshop