

# **Bristol Bay red king crab essential fish habitat and bycatch interactions with groundfish fisheries**

January 2013

## **1 Introduction**

During the Council's 5-year review of essential fish habitat (EFH) provisions in April 2010, a consideration was raised by the Crab Plan Team with respect to the analysis evaluating fishing effects on crab stocks. It was noted that to address EFH that considers the life history of crab the importance of spawning and larval distribution relative to oceanographic currents (pelagic habitat) for crab settlement should be considered. Also, the Crab Plan Team identified recent shifts in the red king crab population distribution such that the spawning population is now present in an area in southwestern Bristol Bay that is also a location of intensive trawl fishing. To respond to these issues, the Council initiated a discussion paper to further examine the Crab Plan Team's concerns.

This discussion paper was originally presented to the Council in April 2011, and a revised version presented again in February 2012. The focus of the papers included a discussion of the importance of southwestern Bristol Bay for red king crab populations, particularly an area southwest of Amak Island, and whether and how trawl fisheries in that area may be impacting the crab habitat. It was proposed that eggs released here have greater chance of survival through larval and juvenile life history stages due to oceanographic currents in this area and that the extent of the Bering Sea cold pool affects the distribution of ovigerous females and subsequently, the location of larval release. A more comprehensive revision to the methodology for assessing the effects of fishing on crab habitat for all crab stocks was proposed. In February 2012, the Council focused the discussion paper exclusively on red king crab issues, and deferred the revision to the methodology to the next 5 year EFH review, given that research is currently underway (but not yet complete) to more comprehensively address these issues.

Given the potential redistribution of crab in the area southwest of Amak Island due to temperature changes, the Council also requested that the discussion paper look at the efficacy of existing red king crab protection areas, such as the Red King Crab Savings Area and the Nearshore Bristol Bay Trawl Closure, to see whether these closed areas are still providing both habitat and bycatch protection to red king crab.

The objective of this document is to update on the status of analyses to address these two discrete red king crab issues. The first section below provides an update on the timing of research that has now been funded to address the importance of southwestern Bristol Bay as red king crab habitat, and its sensitivity to environmental variables. The second issue, regarding the efficacy of existing red king crab closure areas, is a much larger task than originally anticipated, and will involve considerable staff time by the Alaska Fisheries Science Center. A summary of the work to date is provided in the final section below, along with some discussion of possible objectives that may be achieved through this type of evaluation. Staff is requesting feedback from the Council as to the priority of the closure efficacy work.

## **2 Issue: Importance of southwestern Bristol Bay/Amak Island for larval release**

Research questions to address this issue were recommended for each red king crab life history stage, as a result of the Council's April 2011 discussion paper. Some of the research has already been completed, but other aspects will not have results until spring 2014, or potentially into 2015.

**Adult distribution:** To address adult red king crab distribution and aggregation during larval release, molting, and mating, assessment of the habitats and areas in which these occur was recommended. Alaska Fisheries Science Center scientists (Principal Investigator: Chris Long, Kodiak Laboratory) have been funded through the NOAA Fisheries Habitat and Stock Assessment Methods program to assess the spawning grounds of red king crab in the eastern Bering Sea. Pop-up satellite tags will be deployed on 60 ovigerous red king crabs during the 2013 AFSC bottom trawl survey of the EBS. Ovigerous females will be tracked during a 9-11 month period and larval release sites will be identified in the spring of 2014 when the tags come to the surface after the crab molts. The data collected from this study will provide the basis for understanding the importance of adult distribution, larval release location, pelagic habitat, and subsequent larval settlement habitat.

**Juvenile assessment:** To determine likely larval hatching locations, assessment of the juvenile crab distribution was also recommended. In 2010 and 2011, the nearshore waters of Bristol Bay were surveyed in a cooperative effort between the Bering Sea Research Foundation and the National Marine Fisheries Service biologists with a partial goal to assess the feasibility of a recruitment index of juvenile crab. In both years approximately 95 stations were towed along the Alaska Peninsula in southeastern Bristol Bay over an area approximately 5,700 nm<sup>2</sup>. In 2011, approximately 1,616 juvenile (19 to 28 mm carapace length) male and female red king crab were caught at two stations. In 2012, no tows had a high abundance of juvenile crab. Further survey work focused on specific juvenile nursery areas (different from areas towed in previous years) in inner Bristol Bay will continue in 2013.

**Larval assessment:** To address the essential fish habitat for larval red king crab, the April 2011 discussion paper recommended a larval assessment combined with a larval drift model to identify important hatching and settlement areas. Alaska Fisheries Science Center scientists (Principal Investigator: Ben Daly, Kodiak Laboratory) have proposed a study to assess the connectivity of red king crab larval release to settlement location in Bristol Bay. If funded, in 2014-2015, the study will build upon the study above to use individual based models to predict post-larval settlement locations, to determine the spatial distribution of newly settled red king crab, and to map benthic habitat associated with newly settled red king crab.

To better understand the expectations of female mating likelihood and female distributions during the time period when larvae are released into the water column, a time series analysis was completed by AFSC scientists (Chilton et al 2010)<sup>1</sup>. The results of this work suggest that colder seawater temperatures in Bristol Bay do affect the number of females mated and also move the location of larval release closer to shore.

### **3 Issue: Efficacy of existing groundfish closures, given changing distribution of red king crab**

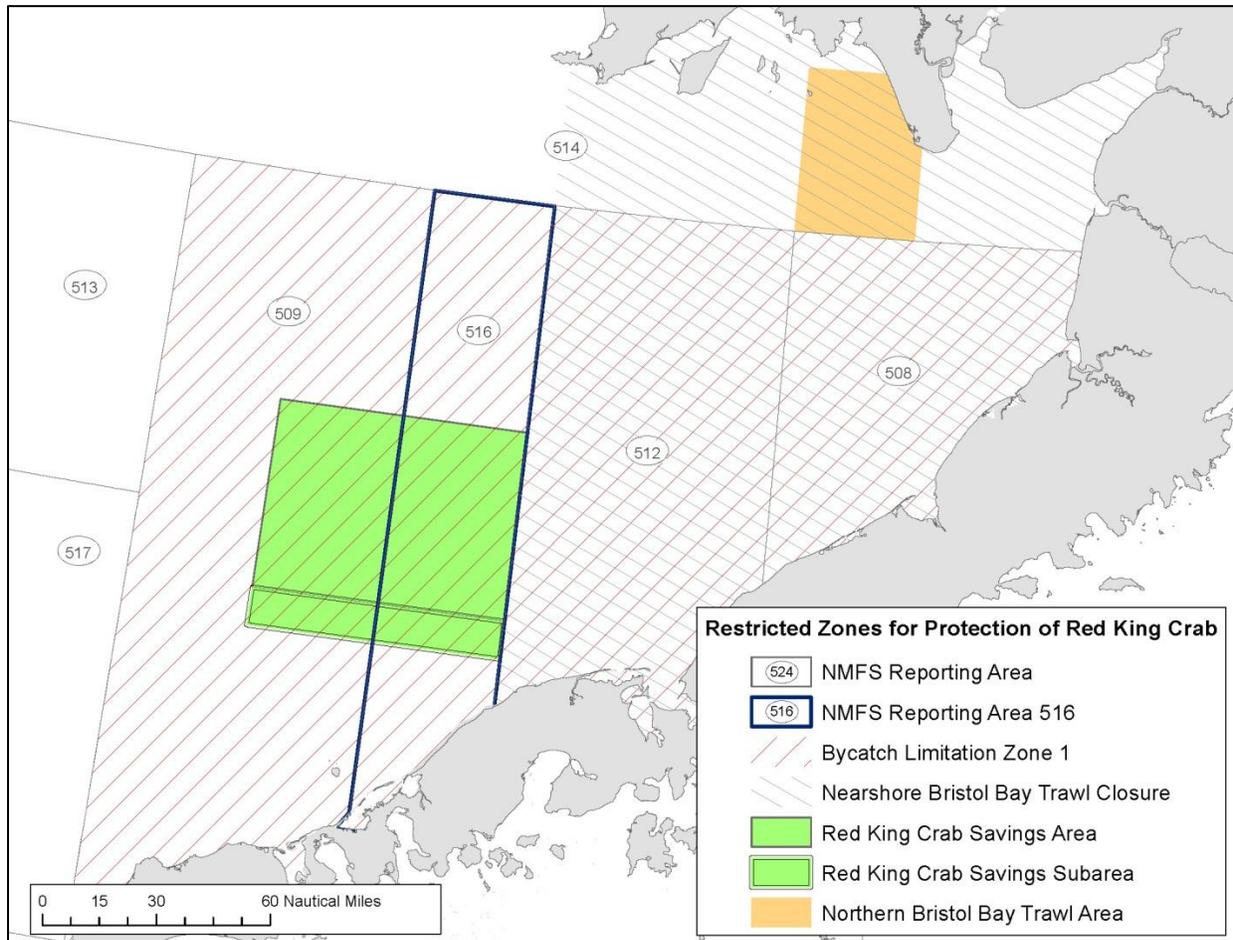
In previous iterations of this discussion paper, the changing distribution of the red king crab population in response to colder temperature regimes has been highlighted as a potential issue for evaluating the impacts of the groundfish fisheries on red king crab essential fish habitat. This also raised a question for the Council regarding existing red king crab protection areas, and whether they continue to be effective, given the changing distribution of the stock. The Council asked for an evaluation of this question, and that it not be limited only to the issue of protecting crab habitat, but also consider how effective the closures are at protecting against bycatch interactions with the groundfish fisheries which may adversely affect red king crab.

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<sup>1</sup> Chilton, E.A, R.J. Foy, and C.E. Armistead. 2010. Temperature effects on assessment of red king crab in Bristol Bay, Alaska. In: G.H. Kruse, G.L. Eckert, R.J. Foy, R.N. Lipcius, B. Sainte-Marie, D.L. Stram, and D. Woodby (eds.), *Biology and Management of Exploited Crab Populations under Climate Change*. Alaska Sea Grant, University of Alaska Fairbanks.

For reference, Figure 1 illustrates existing fishing closures for the protection of red king crab in the Bering Sea. The closures are described, by reporting area, in Table 1. There are two permanent closure areas in place: for all trawl in the Nearshore Bristol Bay Trawl Closure (NBBTC), and for non-pelagic trawl in the Red King Crab Savings Area (RKCSA). Zone 1 is a triggered closure that closes to select target trawl fisheries when applicable red king crab PSC limits are reached by those fisheries. A seasonal closure in reporting area 516, remnant of the Crab and Halibut Protection Zone that predated the NBBTC, also closes the area to all trawl gear from March 15 to June 15, annually.

**Figure 1 Restricted trawling areas for protection of red king crab in the eastern Bering Sea.**



**Table 1 Red king crab trawl closures, by NMFS reporting area**

Area	Effective date	Closure
508	1997	<ul style="list-style-type: none"> <li>• Closed to all trawl as part of Nearshore Bristol Bay Trawl Closure</li> <li>• Longline and pot vessels required to carry 100% observer coverage</li> </ul>
509	--	<ul style="list-style-type: none"> <li>• Open to trawling, except RKCSA (see below)</li> <li>• Closes, as part of Zone 1, to select target trawl fisheries when applicable red king crab PSC limits are reached by those fisheries</li> </ul>
512	March 1987	<ul style="list-style-type: none"> <li>• Closed to all trawl, first as the Crab and Halibut Protection Zone, and subsequently as part of Nearshore Bristol Bay Trawl Closure</li> <li>• Domestic Pacific cod trawl fishery allowed out to 25 fathoms, with 100% observer coverage, from 1987 to 1997</li> </ul>
Eastern part of 514 (east of 162° W)	1997	<ul style="list-style-type: none"> <li>• Closed to all trawl as part of Nearshore Bristol Bay Trawl Closure</li> <li>• Seasonal exemption for the Northern Bristol Bay Trawl Area, which is open to trawling from April 1 to June 15, annually<sup>1</sup></li> </ul>
516	1989	<ul style="list-style-type: none"> <li>• Closes to all trawl from March 15 to June 15, annually, originally as a seasonal extension of the Crab and Halibut Protection Zone</li> <li>• Closes, as part of Zone 1, to select target trawl fisheries when applicable red king crab PSC limits are reached by those fisheries</li> </ul>
Red King Crab Savings Area (RKCSA) (straddles 509 & 516)	1995	<ul style="list-style-type: none"> <li>• Closed by emergency rule from Jan 20-April 19, 1995, to non-pelagic trawl (note, 516 portion of RKCSA also closed March 15-June 15)</li> <li>• Closed by inseason action to all trawl from Jan 20-June 15, 1996</li> <li>• Closed by amendment to non-pelagic trawl beginning 1997</li> <li>• Exemption for trawling allowed in the Red King Crab Savings Subarea, when a commercial fishery for Bristol Bay red king crab was allowed the previous year</li> <li>• 100% observer coverage required for all pot and longline vessels fishing in the RKCSA, and all trawl vessels fishing in the subarea</li> </ul>

<sup>1</sup> Under a voluntary agreement between industry and members of the Togiak community, in place since 2009, the trawl fleet has agreed to cease fishing in the exempted Northern Bristol Bay Trawl Area by June 1, to avoid potential interactions with halibut.

While staff attempted to proceed with an evaluation of this question, it has proven to be a much larger task than originally anticipated. There is not a simple index that can be used to determine whether the closures are effective. In order to assess the impacts of environmental variables, such as warm versus cold years, on the changing distribution of the stock, the analysis needs to take into account both the summer survey information as well as other year-round fishery data, which is often at a coarse resolution. It would be most helpful to have data from the cold years of the 1970s, however, prior to 1991, the available data from the fisheries is very limited and spatially unwieldy. This leaves only a very few years prior to the implementation of the RKCSA (in 1995) to evaluate a comparison of activity before and after the closure went into effect. Consequently, to evaluate the efficacy of the closure will require more complex analysis.

Nonetheless, staff have gathered data to address this question. For the commercial fisheries, fish ticket data from the commercial crab fishery has been collected from 1991 to 2012, as well as groundfish bycatch data, by gear type, for the same time period. For groundfish fisheries, the data have been mapped by month, in order to get a sense of the pattern of bycatch during the particularly vulnerable molting months. NMFS annual trawl survey information is available for a longer time period, showing both crab distribution for the summer months, and temperature data and the extent of the cold pool in Bristol Bay. The next step is to conduct statistical analysis of the data to see whether crab population and distribution of fishery catch and bycatch centroids are changing, and whether those correlate with warm versus cold years. It would also be important to talk with industry members, to evaluate other reasons for annual changes in groundfish fishing patterns that affect bycatch.

Another task is to determine an appropriate index for evaluating whether the closures are effective. This is also dependent on available data, and likely cannot be finalized until more of the statistical analysis of data has been accomplished. Some potentially simple indices have been rejected for various reasons. For example, using summer survey abundance of females is problematic because the distribution of crab

changes from summer to winter, and bycatch primarily occurs in the winter months. Another option could be to use catch in the commercial crab fishery to assess whether abundance increased before and after the respective closures, but again, there are limitations in the resolution of the available data which make this less than ideal as an index. The Council's original basis for establishing each of the closure areas, and determining their extent, has also been reviewed and synthesized, which may be of use.

Because evidence suggests that crab distribution varies considerably with warm versus cold years, the Council also asked for staff to consider how adaptive management measures might be used, keyed to an environmental variable. To link a regulatory measure (such as a closure) to, for example, a prediction of whether the coming year will be cold or warm, requires specific standards. While staff may have some ideas for how this might work, there are few examples elsewhere linking environmental variables with adaptive management in regulation, and more work will be required with a broader group of participants to develop something workable.

It is not our intent to suggest that this initiative is not worthy of Council attention. Indeed, the Council's groundfish FMP policy workplan specifically includes an objective to evaluate existing closures, such as the RKCSA, to see whether they are still achieving the purpose the Council intended. Additionally, the Council is currently considering setting crab PSC limits in the groundfish fisheries for all crab and all gear types, including those for red king crab. If the Council is reconsidering the red king crab PSC limits applicable to trawl vessels, it makes sense to evaluate how well existing protections are working. In fact, as part of the Council's motion on PSC limits, a reconsideration of the triggered closure for red king crab (Zone 1) is also included.

In summary, staff is looking for Council feedback on the priority of this evaluation. As described above, there does not appear to be a simple index that can be used to assess how effective the existing closures are. This evaluation requires expertise from the Alaska Fisheries Science Center crab biologists, and the scope of the task is beyond something that can be achieved in spare moments between existing priorities. Additionally, to evaluate this comprehensively, it would be advisable to pull in other experts as well, in the development of adaptive management triggers tied to environmental variables, and also industry input to evaluate changing groundfish fishing patterns. Given that this is still only a discussion paper, and has not been tasked as an analysis, it seems advisable to get further Council direction before soliciting additional input. The Council will likely also want to consider how this interrelates with its existing motion regarding PSC limits for red king crab in the groundfish fisheries.