

# Bristol Bay Red King Crab PSC discussion paper

## January 2017<sup>1</sup>

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## 1 Introduction

In conjunction with a review of existing data and management measures in place for EBS snow crab bycatch in directed groundfish fisheries, the Council took the following motion for Bristol Bay red king crab (BBRKC) in February 2016:

*The Council initiated a discussion paper to outline the steps and information needed to consider the appropriateness of revising or implementing PSC limits or other management measures to minimize Bristol Bay Red King Crab PSC in directed groundfish fisheries*

This paper summarizes existing measures for BBRKC prohibited species catch (PSC) in groundfish fisheries as well as what data is available on PSC levels, accrual toward current PSC limits, observed data and current or planned research to evaluate efficacy of existing management measures.

## 2 Summary of previous discussion paper for BBRKC

Several discussion paper and related considerations have been taken up by the Council on BBRKC since 2010. Appendix 1 contains a brief summary by year of the various papers and discussions by the Council and SSC pertaining to BBRKC as well as motions adopted in relation to this and other BSAI crab PSC since 2010.

## 3 Stock status for Bristol Bay red king crab

Estimated mature biomass for BBRKC increased dramatically in the mid 1970s and decreased precipitously in the early 1980s. Estimated mature crab abundance increased from 1985-2009 with mature females being about three times more abundant in 2009 than in 1985 and mature males being about two times more abundant in 2009 than in 1985. Estimated mature abundance has steadily declined since 2009 (Figure 1). Recruitment for BBRKC was high during 1970s and early 1980s and has generally been low since 1985. During 1984-2016, only in 1984, 1986, 1995, 1999, 2002 and 2005 were estimated recruitments above

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the historical average for 1976-2016. Estimated recruitment was extremely low during the last nine years and while stock status remains close to the estimated  $B_{MSY}$  level the stock is projected to continue to decline in the near-future (Zheng and Siddeek, 2016).

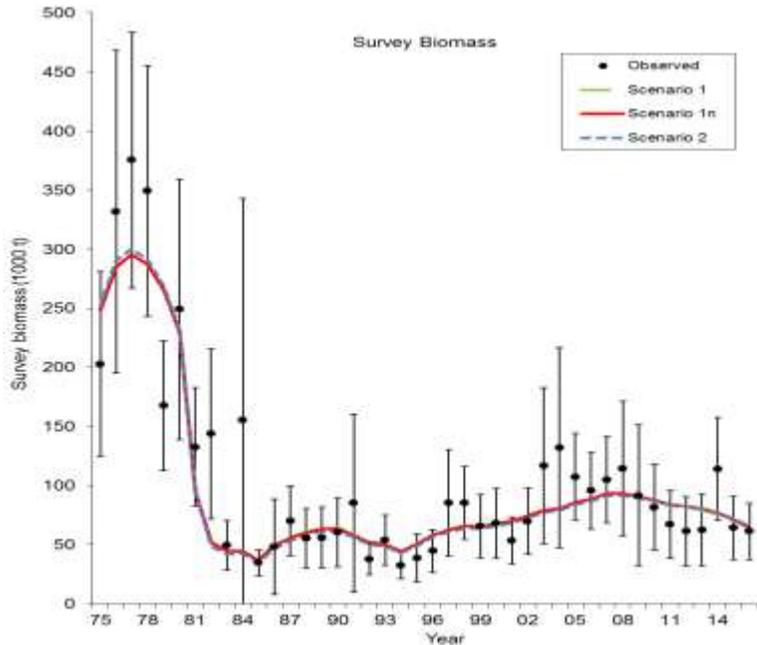


Figure 1 BBRKC model estimated survey biomass trends in conjunction with survey biomass data points and estimated variability. From Zheng and Siddeek, 2016

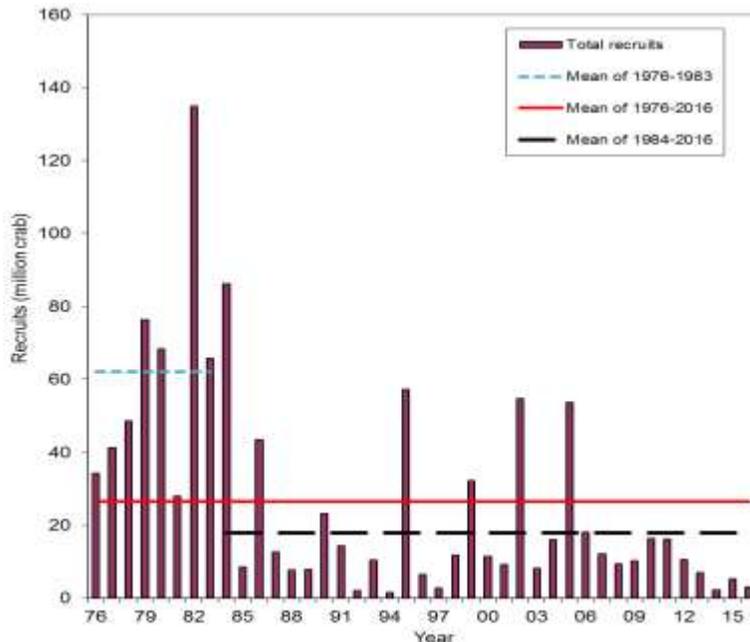


Figure 2 Model estimated recruitment for BBRKC. Also shown are three alternative mean estimates recruitments based on three time stanzas for evaluating  $B_{MSY}$  From Zheng and Siddeek, 2016

The distribution of BBRKC from the NMFS bottom trawl survey remains similar to previous years and concentrated inside of Bristol Bay with some inter-annual shift in the center is distribution of the mature male population (Figure 3)

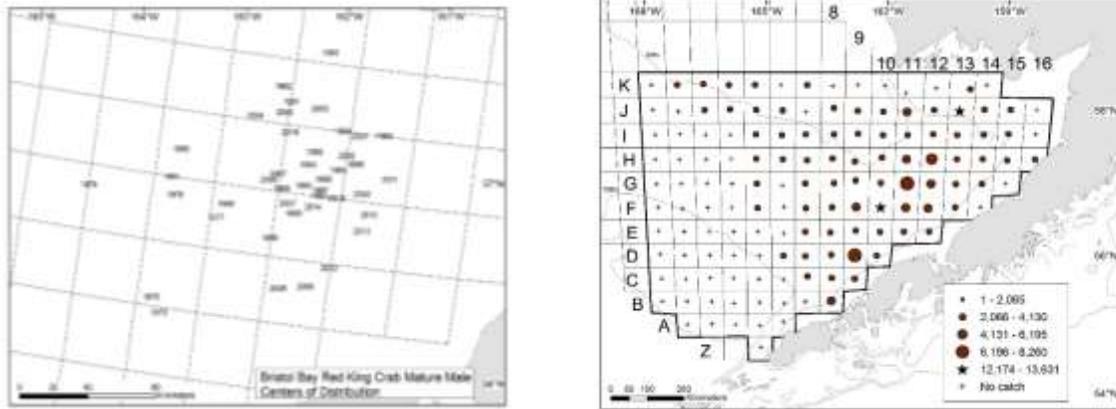


Figure 3 Center of survey population distribution for mature males (left panel) and abundance and survey location of total population from the NMFS bottom trawl survey (right panel) for 2016

#### 4 Status of BBRKC habitat and spawning/tagging research

The Alaska Fisheries Science Center (AFSC) has been conducting several research projects related to Bristol Bay red king crab. An NPRB project (began in 2014) is investigating how climate change may impact red king crab recruitment in Bristol Bay by refining a suite of hydrodynamic and individual-based models. Red king crab larvae spend months in the water column and have specific habitat requirements upon settlement, which implies that the location of larval release relative to oceanographic processes and suitable juvenile habitat may be important in determining recruitment success or failure in a given year. The nearshore region along the Alaska Peninsula is thought to be important for red king crab larval release and successful settlement of recruits in Bristol Bay, but mechanisms remain speculative. Further, changes in oceanographic conditions (temperature, currents, tides, etc.) and ovigerous female spatial distribution may impact larval advection in Bristol Bay. Our study couples a biophysical individual-based model (IBM) and a Regional Ocean Modeling System (ROMS) circulation model to estimate connectivity between the location of red king crab larval release and benthic settlement location in Bristol Bay. Model simulations test the overarching hypothesis that changing climatic conditions will drive complex changes in larval sources, growth, dispersal, settlement, and recruitment. Specifically:

1. Changes in climate will affect the extent of the cold pool (a body of subsurface water <math><2^{\circ}\text{C}</math> that occurs in the summer and varies with winter conditions) and distribution of adult female red king crabs, and hence shift larval source areas.
2. Changes in circulation patterns among warm and cold years will lead to differences in larval trajectories, and thus, in post-larval settlement areas. Under present average conditions, larvae released from southwest Bristol Bay will be transported to southeast Bristol Bay along the Alaska Peninsula, while larvae released from central Bristol Bay will be transported to northeast and northwest Bristol Bay (out of the Bay).
3. Changes in temperature will affect growth of larvae throughout their transport trajectories, which will impact when and where settlement occurs.

This project is currently in progress. ROMS model simulations are completed and we are now in the process of running IBM simulations and interpreting those results.

## 5 Management measures in groundfish fisheries for BBRKC stock

There are several management measures under the FMP to protect Bristol Bay red king crab stocks and habitat. These are fixed closures and a triggered time/area closure to trawl gear. No additional bycatch management measures are currently in place for fixed gear or bycatch outside of the designated areas. A description of the current measures are included below.

Figure 4 illustrates existing fishing closures for the protection of red king crab in the Bering Sea. The closures are described, by reporting area, in Figure 4. 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. For the BSAI trawl limited access sector the Zone 1 limits are by fishery category, but for Amendment 80 there is one limit to each cooperative that they can use for any target and are prohibited from exceeding. 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.

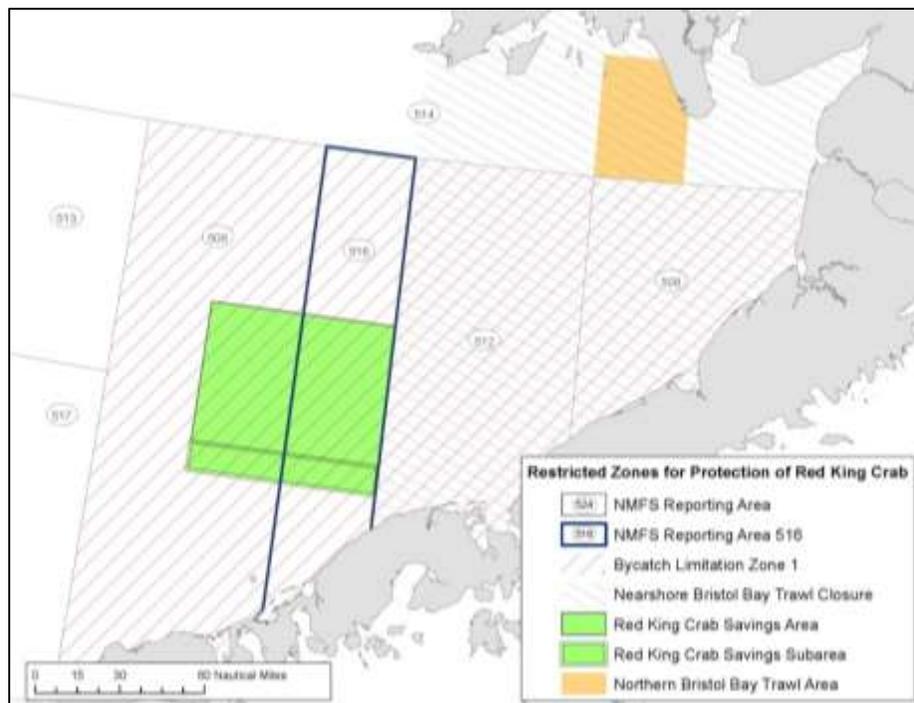


Figure 4 Restricted trawling areas for protection of red king crab in the eastern Bering Sea.

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.

Zones 1 and 2 are closed to directed fishing when the crab PSC limits (red king crab and EBS Tanner crab) are attained in specified trawl fisheries (Figure 5). Since Amendment 80 in 2008, cooperatives are prohibited from exceeding their Zone 1 and 2 limits. Zones 1 and 2 were established by Amendment 10 to the BSAI groundfish FMP, after being implemented by emergency rule by NMFS in 1986 (NPFMC 1986). These areas were initially based upon the trawl survey distribution of red king crab and Tanner crab stocks at that time. These areas have not been modified since however the PSC limits which are allocated by trawl fishery have been modified under subsequent amendments.

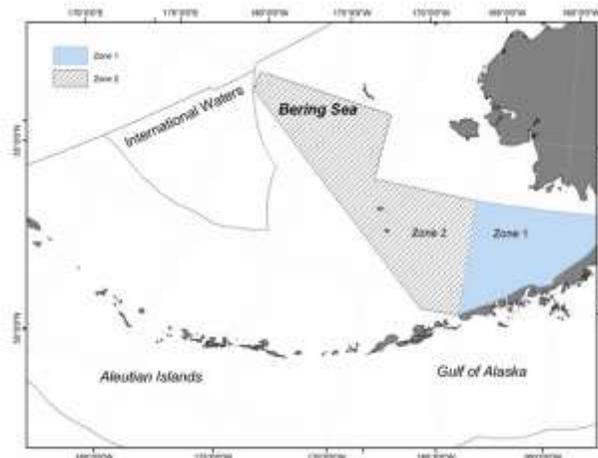


Figure 5. Zones 1 and 2 area for closures (Bristol Bay red king crab and EBS Tanner crab).

Table 2. PSC limits for red king crab.

<b>PSC limits for Zone 1 red king crab (No Zone 2 RKC)</b>	
<b>Abundance</b>	<b>PSC Limit</b>
Below threshold or 14.5 million lbs of effective spawning biomass (ESB)	33,000 crabs
Above threshold, but below 55 million lbs of ESB	97,000 crabs
Above 55 million lbs of ESB	197,000 crabs

The stair step procedure for determining PSC limits for red king crab taken in Zone 1 trawl fisheries is based on abundance of Bristol Bay red king crab (Table 2). Up to 25% of the red king crab PSC limit can be used in the Red king crab savings subarea, the area defined as the 56° - 56°10'N strip (10 nm strip), of the Red King Crab Savings Area. The red king crab PSC limit has generally been allocated among the pollock/Atka mackerel/other species, Pacific cod, rock sole, and yellowfin sole fisheries.

The PSC limit was initially developed in conjunction with observed bycatch in flatfish fisheries and thresholds consistent with the State harvest strategy for female effective spawning biomass. According to State regulations at 5 AAC 34.816, 'effective spawning biomass' is defined as the 'estimated number of mature female red king crab that the population of mature male crab could successfully mate with in a given year'. Mature female red king crab are defined as '3.5 inches (90mm) or more carapace length' while mature male red king crab are defined as '4.7 inches (120mm) or more carapace length' (5 AAC 34.816). The estimate of ESB is provided annually to Council staff and NMFS staff by the ADF&G assessment author for the BBRKC stock assessment for purposes of establishing the PSC limit.

Initially the three PSC levels of PSC limits were established under Amendment 37 (NPFMC, 1996). The lowest level of 35,000 crab was established consistent with observed bycatch in 1995 in the flatfish fisheries in Zone 1 (NPFMC, 1996). The middle level was set at 100,000 crab to reflect a 50% reduction from the PSC limit at that time. This 50% reduction was intended to be consistent with the BOF action to reduce directed BBRKC harvest rate by 50%. The highest level of 200,000 crab reflected the PSC limit at that time and was specified for use when the BBRKC stock was completely rebuilt (NPFMC, 1996). Since that time each limit was reduced by 3,000 crab to reflect current PSC limits reflected in Table 2

Nearly all BBRKC PSC is taken within Zone 1 however only trawl crab PSC accrues toward the PSC limit (Table 3). Trawl PSC has comprised between 10-100% of the total BBRKC PSC. The proportion of hook-and-line and pot gear proportion of PSC has ranged from 3-14% (hook-and-line) and <1-86% (pot gear) (Table 5).

This limit is further subdivided into sectors (e.g. Amendment 80, BSAI Trawl Limited Access), and then into cooperative-specific caps for the Amendment 80 sector. For the BSAI Trawl Limited Access sector seasonal allowances of RKC bycatch and other PSC in the groundfish fisheries are made by the NMFS Regional Office catch accounting. Amendment 80 regulations require two observers when fishing in the Bering Sea/Aleutian Islands. Within Amendment 80, the Alaska Seafood Cooperative allocates the Zone 1 red king crab and other PSC species bycatch to its member companies. These companies further subdivide these allowances to vessels they operate (Gauvin, 2016).

Table 3 BSAI Zone 1 PSC limits for trawl fishery categories and bycatch accruing towards those limits from 2012-2016

Value and fishery	2012	2013	2014	2015	2016
<b>PSC</b>					
Pcod TLAS	-	-	85	51	547
Pollock/Amack/Other TLAS	3	15	-	-	6
Rsole/Fsole/Oflat TLAS	123	140	-	20	65
Yellowfin Sole TLAS	102	69	92	6	835
A80	24,164	22,524	26,333	12,615	17,268
PSQ	2,605	2,425	1,457	62	430
Total Sum of PSC	26,996	25,173	27,967	12,754	19,152
<b>Limit</b>					
Pcod TLAS	2,954	2,954	2,954	2,954	2,954
Pollock/Amack/Other TLAS	197	197	197	197	197
Rsole/Fsole/Oflat TLAS	-	-	-	-	-
Yellowfin Sole TLAS	23,338	3,338	23,338	23,338	23,338
A80	43,293	63,293	43,293	43,293	43,293
PSQ	10,378	10,378	10,378	10,378	10,378
Total Sum of Limit	80,160	80,160	80,160	80,160	80,160
<b>Remaining (%)</b>					
Pcod TLAS	2,954 (100%)	2,954 (100%)	2,869 (97%)	2,903 (98%)	2,407 (81%)
Pollock/Amack/Other TLAS	194 (98%)	182 (92%)	197 (100%)	197 (100%)	191 (97%)
Rsole/Fsole/Oflat TLAS	-123	-140	-	-20	-65
Yellowfin Sole TLAS	23,236 (100%)	3,269 (98%)	23,246 (100%)	23,332 (100%)	22,503 (96%)
A80	19,129 (44%)	40,769 (64%)	16,960 (39%)	30,678 (71%)	26,025 (60%)
PSQ	7,773 (75%)	7,953 (77%)	8,921 (86%)	10,316 (99%)	9,948 (96%)
Total	53,164 (66%)	54,987 (69%)	52,193 (65%)	67,406 (84%)	61,008 (76%)

## 6 Data available for assessing BBRKC bycatch and crab samples observed in groundfish fisheries

### 6.1 BBRKC bycatch by gear, target, and area

Table 4 through Table 7 provide an overview of the BBRKC bycatch in numbers of crab taken by gear, area, and target in all BSAI groundfish fisheries as well as the proportion of total and Zone 1 bycatch taken by gear type. These estimates originate from the NMFS CAS and **do not include any discard mortality** as consistent with how PSC limits are managed by the NMFS Alaska Region (see section 6.1.1 for more information on how discard mortality is applied in assessments by gear type). These data are summarized here for characterizing relative trends and changes over time by gear, target, and area for PSC levels for purposes of informing any consideration of catch accruing towards the PSC limits currently and consideration of PSC limits for other gear types should the Council wish to consider changes to the current trawl-only PSC limit structure.

Table 4 Total BBRKC bycatch by gear and total in Zone 1 and total bycatch across the whole BBRKC stock area and within the RKCSA

Year	Hook and Line	Zone 1 Non-pelagic trawl	Pot	Pelagic trawl	Zone 1 total all gears	Total BBRKC stock area	RKCSA
2003	---	76,059	---	32	76,091	76,091	3,030
2004	12,545	77,582	181	16	90,323	90,481	8,199
2005	13,363	96,191	1,268		110,822	111,378	1,772
2006	6,720	74,392	2,029	25	83,167	84,298	5,628
2007	6,959	87,238	14,555	8	108,760	111,320	1
2008	5,576	85,541	14,028	40	105,185	107,324	4,706
2009	4,302	66,278	1,022	36	71,638	71,932	4
2010	1,531	55,093	804	21	57,449	57,863	
2011	2,680	37,970	11,046		51,696	52,975	
2012	3,456	26,993	5,188		35,638	36,361	
2013	5,739	25,173	65,244		96,156	102,247	
2014	7,105	27,965	80,896		115,966	119,950	
2015	3,515	12,754	101,956		118,224	128,210	

Table 5 Proportion of all PSC within Zone 1 overall and by gear type

Year	% of total catch within Zone 1	% of trawl catch within Zone 1 to total Zone 1	% of pot catch within Zone 1 to total Zone 1	% of hook and line catch within Zone 1 to total Zone 1
2003	100.00%	100.00%		
2004	99.83%	85.91%	0.20%	13.89%
2005	99.50%	86.80%	1.14%	12.06%
2006	98.66%	89.48%	2.44%	8.08%
2007	97.70%	80.22%	13.38%	6.40%
2008	98.01%	81.36%	13.34%	5.30%
2009	99.59%	92.57%	1.43%	6.00%
2010	99.29%	95.93%	1.40%	2.67%
2011	97.58%	73.45%	21.37%	5.18%
2012	98.01%	75.74%	14.56%	9.70%
2013	94.04%	26.18%	67.85%	5.97%
2014	96.68%	24.12%	69.76%	6.13%
2015	92.21%	10.79%	86.24%	2.97%

Table 6 Bycatch of BBRKC within the RKCSA by gear type and percentage of total bycatch over the BBRKC stock area. Blank cells indicate no bycatch in that year

Year	Non-pelagic trawl	Pot gear	Pelagic trawl	Total RKCSA	Percentage of BBRKC PSC
2003	3,026		5	3,030	3.98%
2004	8,199			8,199	9.06%
2005	1,772			1,772	1.59%
2006	5,628			5,628	6.68%
2007			1	1	0.00%
2008		4,705.84		4,705	4.38%
2010			4	4	0.01%

Table 7 BBRKC PSC by gear and target in numbers of crab. 2004-2015

Gear	Target	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Hook and line	Pacific Cod	12,543	13,079	5,649	6,950	4,787	2,759	1,492	2,661	3,340	5,749	7,170	3,558
	Sablefish							0	1				
Non-pelagic trawl	Flathead Sole	0	383	226	435	2,346							
	Other Flatfish		54										
	Pacific Cod	584	1,718	3,482	913	1,179	869	337	2,095	310	374	41	140
	Pollock - bottom					631		940					
	Rock Sole	44,875	45,525	55,629	72,886	44,768	47,258	36,185	29,531	22,427	17,307	24,151	8,628
Yellowfin Sole	31,731	47,033	13,568	11,385	36,011	16,905	17,071	5,480	4,111	6,947	2,913	3,366	
Pot	Pacific Cod	209	1,535	2,888	16,700	15,962	1,253	974	12,203	1,374	19,034	74,569	110,983
Pelagic trawl	Pollock -bottom			1		3	8	4					
	Pollock - midwater			3	8	30	25	15					

### 6.1.1 Discard mortality

This section described the discard mortality rates that are currently applied to groundfish bycatch by gear type **within the stock assessments for crab** to estimate overall mortality by groundfish fisheries in the assessment. These rates are not applied by NMFS to bycatch accruing towards PSC limits. As noted earlier all bycatch data provided in this paper is shown without discard mortality rates applied.

**Trawl bycatch rate:** The estimated mortality rate of red king crab and Tanner crab caught as bycatch in the trawl groundfish fisheries is 80%.

**Origin:** The Council has consistently used an estimated mortality rate of 80% for crab bycatch in trawl fisheries in Council analyses, since the early 1990s. This rate is an approximation based on a trawl research study conducted in 1987 in the BSAI joint venture fisheries (Stevens 1990). Species targeted were yellowfin sole, rock sole, and Pacific cod. The study found that 21% of the king crabs and 22% of the Tanner crabs captured incidentally in BSAI trawl fisheries survived at least two days following capture. A few earlier studies also looked at bycatch mortality in the trawl fisheries (Blackburn and Schmidt 1988, Owen 1988), which generally indicated that soft shell crab are much more vulnerable to impacts from trawling than hard shell crab, and that mortality appears to be directly correlated with time out of water. This latter finding was also apparent from the Stevens study, which noted that captivity time (which includes both towing time and deck sorting time) may have been longer in the study than it would be in a normal fishery, especially for king crab. There have been no recent studies of crab bycatch mortality in the Alaska trawl fisheries.

**Groundfish pot and longline rate:** The estimated mortality rate of red king crab and Tanner crab caught as bycatch in the fixed gear (pot and longline) groundfish fisheries is 50%.

**Origin:** Since the 1990s, various mortality rates have been used for crab bycatch in the fixed gear groundfish fisheries in the analysis of Council amendments. No direct research studies have been conducted on mortality of crab caught as bycatch in the longline or pot groundfish fisheries. A study was conducted through the observer program in 1990 which evaluated the condition of crab caught as bycatch in the groundfish fisheries. Combining these results with the Stevens (1990) research that looked at trawl mortality, a calculation was made for a 1993 Council analysis to scale the mortality results from the observer study for pot and longline crab bycatch upwards proportional to the difference between the observer study and Stevens' findings for trawl crab bycatch. Consequently, the Council's 1993 analysis used 30% pot and 45% longline mortality rates for Tanner crab bycatch, and 37% mortality rates for both gears for king crab bycatch<sup>2</sup>.

With the implementation, in 2008, of overfishing limits in the BSAI Crab SAFE, and assessments that accounted for total catch, the Crab Plan Team issued a directive that all assessments should use an 80% mortality rate for all bycatch in the groundfish fisheries, under the assumption that most of the bycatch originated from trawl vessels. Following a presentation to the Crab Plan Team in 2009 about the occurrence of crab bycatch in the pot and longline groundfish fisheries, the assessment authors now begun to distinguish among gear types in accounting for crab bycatch in the groundfish fisheries. A 50% mortality rate was applied to crab bycatch in the directed Tanner crab pot fisheries, consequently this rate is now also being applied to all crab bycatch in the fixed gear groundfish fisheries (where the assessment distinguishes bycatch among gear types).

## **6.2 Observed data on bycatch by gear type (sex and size composition)**

Observed data on samples taken by gear, sex, and length from 2008-2016 are shown in Figure 6 through Figure 8. Total number of samples increased in the fixed gear groundfish fisheries from 2013 to present which may be a result of observer restructuring and increased observer coverage on this fleet (Figure 6). The percentage female is consistently higher in the pot gear PSC (Figure 7). Generally all of the groundfish fishery samples represent larger sizes of crab in the PSC more consistent with mature crabs (Figure 8).

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<sup>2</sup> There were no results for longline red king crab bycatch in the observer study, consequently it is assumed that the pot mortality rate was simply cross-applied to longline gear.

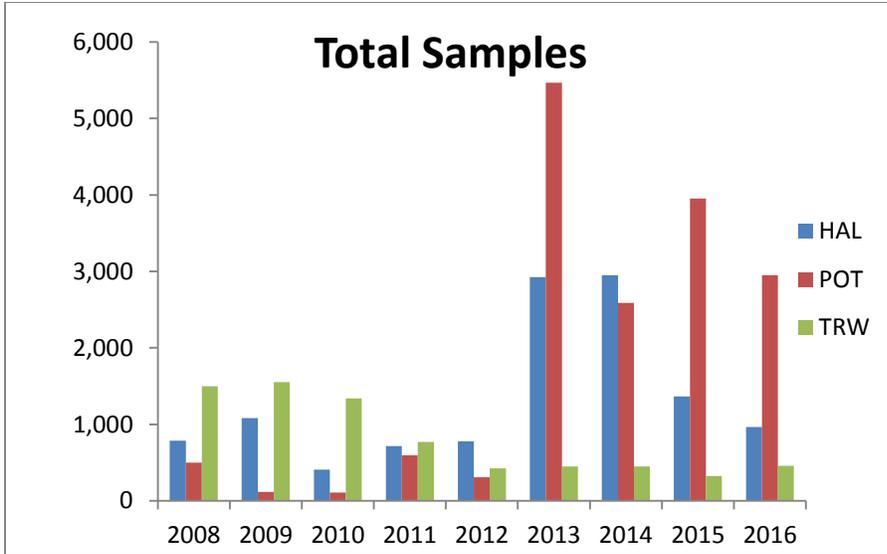


Figure 6 Total number of BBRKC samples obtained by year in groundfish fisheries 2008-2016 by gear type

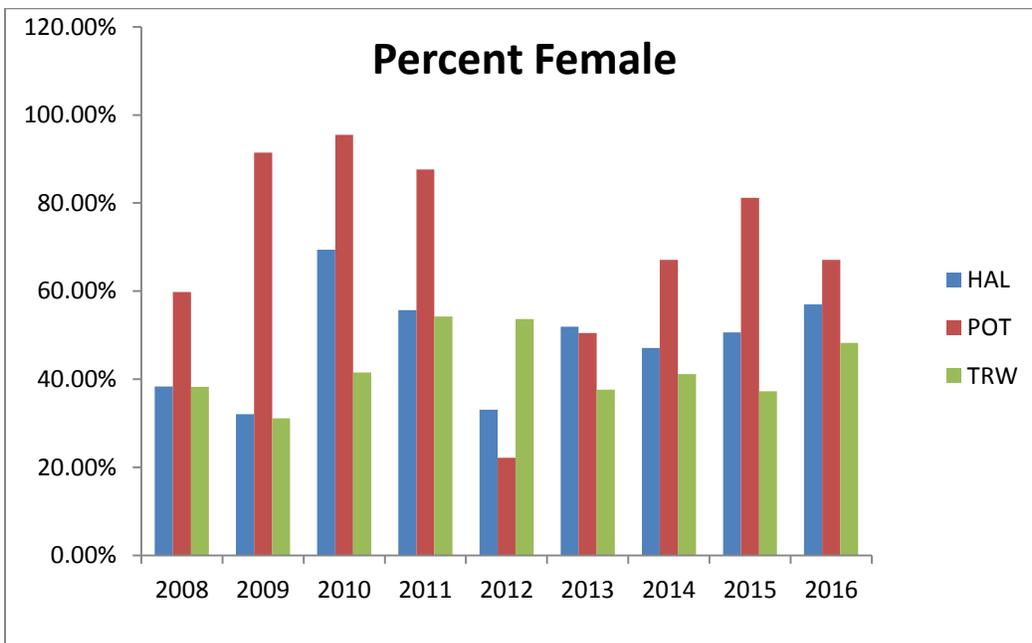


Figure 7 Percentage of female BBRKC obtained by observers in samples taken by year and gear type 2008-2016

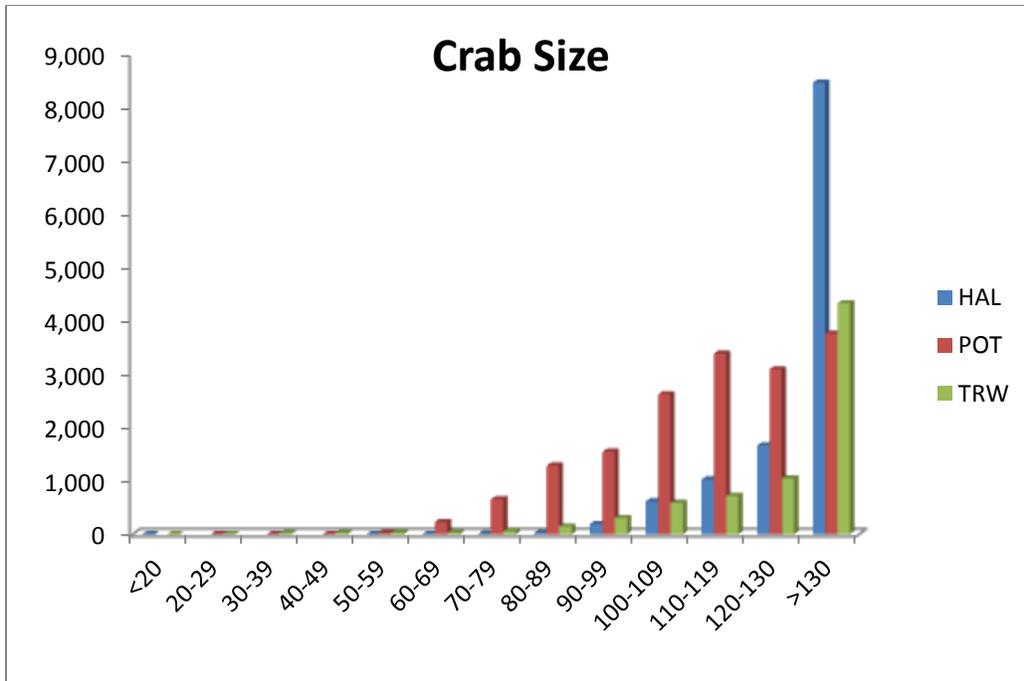


Figure 8 Length of BBRKC taken by gear type as PSC in groundfish fisheries based upon samples obtained from observers for all years 2008-2016

## 7 RKCSA and 10nm strip

### 7.1 Background on development of RKCSA (Amendment 37)

Low stock biomass levels in the early 1990s led to further consideration by the Council and NMFS to increase protection measures for this stock. The RKCSA was initially implemented by emergency rule from Jan 20-April 19, 1995 and was based on observed survey distribution of adult red king crab. Further analysis of bycatch and size and sex composition data as well as information available on molting and mating led to the selection of an extended year-round closure of the RKCSA under Amendment 37 (NPFMC, 1996). Data employed in that analysis indicated that about 40% of the mature males and 30% of all males occurred in the savings area. The western portion (163° to 164° W longitude) of the area was comprised almost entirely of males, with less than 1/2% of the females found there. The eastern portion (62° to 163° W longitude) of the savings area (contained in statistical area 516) was occupied by red king crab of both sexes. Approximately 19% of the mature males and 17% of the mature females were found in the eastern portion. These data led to the conclusion in the analysis for Amendment 37 that the Bristol Bay Red King Crab Savings Area covers substantial habitat for mature red king crab (NPFMC, 1996).

The 10nm strip from 56° to 56°10 N latitude or Red king crab savings subarea was specified separately from the rest of the RKCSA in order to provide access to productive rock sole fishing grounds in years when a GHL (and in later years a TAC) for BBRKC is established (NPFMC, 1996).

### 7.2 Data available to evaluate efficacy

There are limited data for use in comparing inside and outside of the RKCSA to evaluate the efficacy of the area. Some preliminary rate information within and outside of the 10 nm strip are provided in Table 8,

however data from within the RKCSA for non-pelagic trawl are not available, thus only fixed gear rates are shown for within the savings area.

This preliminary rate comparison analysis was completed using observer data that are current through December 16, 2016. Observer data were intersected on the RK Crab Savings Area, RK Crab Savings Area GHR (10 nm strip), and all of Reporting Area 509 so that data could be compared with different relevant spatial areas. Data were analyzed on an annual basis and were not subject to seasonal closures or restrictions. Data were queried by year, gear and target fishery. Included in Table 8 are the individual areas by gear. Data are grouped without year between 2008 and 2016.

Table 8 Comparison of rates inside 10 nm strip, RKCSA, and all of area 509. All years combined 2008-2016

	RATE IN WEIGHT			RATE IN NUMBERS		
	HAL	NPT	POT	HAL	NPT	POT
<b>AREA 509</b>	0.0015	0.0060	0.0116	0.0007	0.0030	0.0101
<b>10NM STRIP</b>	0.0015	0.0048	0.0229	0.0008	0.0030	0.0223
<b>RKCSA</b>	0.0016	-----	0.0240	0.0008	-----	0.0194

### 7.3 Steps needed to obtain additional data to evaluate efficacy

An EFP to allow access to the RKCSA to evaluate relative PSC rates inside and outside of the area and to collect size, sex, and molt condition on crabs caught as bycatch inside the savings area was not recommended by the SSC and the Council in December 2016. However some issues and concerns were noted by the SSC (see SSC minutes for December 2016) and it was not recommended for further implementation.

Some analysis of directed crab logbook data was presented in public comment in conjunction with that EFP (Sloan, 2016) and further development of this work may provide additional insight into movement patterns of crab during the winter fishery when survey data are not available. Additional survey data and comparisons between the Bering Sea Fishery Research Foundation (BSFRF) surveys and NMFS bottom trawl surveys may provide additional insight as to crab population densities within the RKCSA. The Crab Plan Team discussed some recommendations for additional available data to assist with any future evaluation of the efficacy of this closure. A dedicated survey has also been discussed (see SSC minutes December 2016) to provide these data comparisons within and outside of the savings area.

## 8 Next Steps/Council action

The Council requested this review and steps needed to revisit or implement additional management measures for BBRKC. Any revision to the areas, PSC limits or additional PSC limits to other gears would need to be initiated as an amendment to the BSAI groundfish FMP. If the Council wishes to consider modifications to the existing bycatch management measures for BBRKC, the Council should consider adopting a purpose and need for this evaluation and begin to develop alternatives for analysis. Appropriate PSC limits (either to modify the PSC limit for trawl fisheries or to develop PSC limits for other gear types) for analysis would need to be specified. As described in section 5, previous PSC limits were based upon average bycatch by trawl gear within Zone 1 for a period of several years. The data that are provided in Section 6.1 provides an overview of historical bycatch by gear type to inform this process should the Council initiate an amendment to modify PSC limits based on observed average bycatch numbers.

In order to move forward with any reconsideration of current BBRKC management measures the Council should consider the following:

- Does the Council wish to consider revising or otherwise evaluating the efficacy of the RKCSA?
  - It is important to recognize that the analysts ability to evaluate the efficacy of the RKCSA will be limited by the lack of available data on rates and winter biomass and molting/mating estimates within the RKCSA.
  - Should the Council move forward with any reconsideration of this (or other closures) in Bristol Bay, the SSC may provide guidance on additional means to evaluate the efficacy of this closure since its enactment in the 1990s to present.
- Does the Council wish to consider PSC limits for other gear types in Zone 1? As noted the bycatch numbers remain consistent however the trawl proportion is declining. Since 2013 trawl PSC in Zone 1 ranges from 10-24% of overall Zone 1 PSC while pot bycatch has increased from <2% in 2010 to >85% in 2015.

The Council may also choose not to modify management measures for BBRKC at this time.

## 9 References

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## **10 Appendix 1: Summary of Council actions and motions on BBRKC since 2010**

### **2010:**

Council reviewed crab bycatch discussion paper and initiated detailed motion to revise and/or set PSC limits and time/area closures for all 10 BSAI crab stocks.

In the 2010 5-year EFH review, Crab Plan Team identified issues with evaluating fishing effects on crab stocks, particularly with respect to recent shifts in the red king crab population distribution such that the spawning population may now be present in areas of intensive trawl fishing in southwestern Bristol Bay. Council initiated discussion paper to evaluate.

### **2013:**

- a) Council reviewed extensive discussion paper on bycatch by stock, fishery and area. No SSC review of broader bycatch discussion paper.
- b) Council reviewed BBRKC EFH discussion paper. SSC review of BBRKC EFH. Recommended research on Amak issues (fishery impacts on vulnerable life history stages) and interplay of trawl fisheries impact on BBRKC crab habitat and productivity as a priority. SSC supported a more general evaluation of efficacy of current closure areas as a lower priority.

Council motion combined these issues. Motion asked for expanded discussion paper to re-focus on only BBRKC, Tanner crab, Snow crab, and Saint Matthew blue king crab as those most challenging for the State in setting appropriate bycatch buffers between ABC and TAC.

### **2014:**

Council reviewed discussion paper on issues related to BBRKC, Tanner crab, Snow crab, and Saint Matthew blue king crab bycatch in groundfish fisheries. Resulting Council motion focused on assembling a template using snow crab to evaluate what information is available for crab stock to best

evaluate efficacy of current management measures and inform to what extent changes are warranted. No SSC review of this discussion paper.

**2016:**

Council reviewed snow crab discussion paper based upon the template requested in 2014. No SSC review of discussion paper. Council motion initiated analysis to modify the snow crab trigger PSC limit associated with COBLZ.

Council motion also tasked a discussion paper to outline the steps and information needed to consider the appropriateness of revising or implementing PSC limits or other management measures to minimize Bristol Bay Red King Crab PSC in directed groundfish fisheries.

## **D1 Snow Crab Bycatch**

### **Council Motion – February 6, 2016**

#### *Purpose and Need Statement*

Management measures in the Bering Sea-Aleutian Island groundfish FMP intended to protect Bering Sea snow crab (*C. opilio*) and their habitat have not been reviewed since they were specified in 1997. Since that time, our ability to model snow crab population dynamics and estimate incidental catch in the groundfish fisheries has improved. Management of the groundfish trawl fisheries has also changed; there is no longer a race-for-fish for some of the sectors that are subject to snow crab PSC limits. Therefore, it is appropriate due to these changes to review and analyze the limits in place and if changes are needed.

#### *Alternatives*

Alternative 1: No action

Alternative 2: Revise *C. opilio* PSC limits to be based on the stock assessment model estimate. Remove the minimum and maximum *C. opilio* PSC limit for trawl vessels in the COBLZ, and reduce the *C. opilio* PSC limit to (Option 1: 0.10 %; Option 2: 0.075%, or Option 3: 0.05 %) of the total abundance of *C. opilio*.

Alternative 3: Revise *C. opilio* PSC limits to be based on the stock assessment model estimate. Reduce the maximum and/or minimum *C. opilio* PSC limit for trawl vessels in the COBLZ by (Option 1: 10%; Option 2: 15%; or Option 3: 50%).

The Council initiated a discussion paper to outline the steps and information needed to consider the appropriateness of revising or implementing PSC limits or other management measures to minimize Bristol Bay Red King Crab PSC in directed groundfish fisheries.

**North Pacific Fishery Management Council**  
**C-6 BSAI Crab PSC limits**

**Motion 2-7-14**

The Council requests a revised discussion paper to outline the steps and information needed to consider the appropriateness of revising or implementing crab PSC limits or other management measures to minimize crab PSC in directed groundfish fisheries.

This paper should include:

1. A discussion of implementing future PSC limits in weights rather than numbers.
2. A template that could be used for any crab stock that outlines the necessary information. The paper should use the snow crab stock and (COBLZ) management area as an example to develop the template.

Information needed to evaluate current management measures could include:

- Figures depicting sample size, sex ratio and size frequency of crab bycatch in groundfish fisheries by gear.
- Graphs of size data including a reference to average size of crabs taken in directed crab fisheries.
- Maps that overlay existing closure area(s) with crab stock distribution at the time of survey (by sex and size category), the directed crab fishery(s), and groundfish bycatch by trawl, pot, and hook-and-line gear from 2008 – 2013.
- Tables showing PSC reported by groundfish fishing year; actual PSC limits for trawl gear by area/zone; total PSC and total PSC within the closure area(s) by gear type.

Information needed to develop future management measures could include:

- A description of the methodology that could be applied to set or revise abundance based PSC limits.
- A discussion of the application of mortality rates to the crab PSC that accrues to trigger limits, by gear type.

**Council motion on combined agenda items:**

**C-1(b) Discussion paper on Bristol Bay red king crab**

**C-2(a) Crab bycatch limits in BSAI groundfish fisheries**

February 7, 2013

The Council requests an expanded discussion paper to evaluate the existing fixed and triggered closure areas for Bristol Bay red king crab, Bering Sea Tanner, Bering Sea snow crab, and St. Matthew blue king crab, including information on recent stock distribution and the distribution and amount of PSC in the trawl and fixed gear groundfish fisheries.

Elements to include:

- Proportion of PSC by trawl and fixed gear fisheries inside and outside of the closure areas.
- A more detailed history of the closures to help identify the fraction of historical fisheries that occurred in these areas as well as their crab PSC.

With regard to ACLs and TAC setting, the Council recognizes that while the State of Alaska is primarily responsible for management of the crab fisheries, they do not manage the groundfish fisheries in the EEZ and have limited ability to project crab bycatch mortality in those fisheries. The Council recommends that the BSAI Groundfish Plan Team and the State work together, such that the BSAI Groundfish Plan Team would provide estimates of crab bycatch mortality in the groundfish fisheries, to help reduce the uncertainty in the estimates used by the State during TAC setting.

## **C-2(c) Crab bycatch in BSAI groundfish fisheries Council Motion-June 2010**

The Council moves the following problem statement and alternatives for analysis:

### **Problem Statement**

Total catch overfishing levels (OFLs) are specified annually for the ten crab stocks included in the Fishery Management Plan for Bering Sea/Aleutian Islands King and Tanner Crabs (FMP); these OFLs account for all sources of fishing mortality including directed crab fishery discards and bycatch mortality caused by groundfish, scallop, and Pacific halibut fisheries. Requirements to comply with Annual Catch Limits (ACLs), addressing uncertainty in OFL estimates, include Accountability Measures (AMs) that trigger a management action if an ACL is exceeded.

Crab bycatch in the directed crab and scallop fisheries is controlled by the State of Alaska, however current management structure does not link the crab and groundfish FMPs; if a crab ACL is exceeded due to bycatch mortality in a groundfish fishery the resulting AM would reduce directed crab fishery harvest the following year. Crab bycatch management measures were first adopted for BSAI groundfish trawl fisheries in 1986. These measures, established in the BSAI groundfish FMP, consist of triggered or fixed time and area closures and prohibited species catch (PSC) limits; PSC limits apply only to Bristol Bay red king, Bering Sea Tanner, and Bering Sea snow crab. There are no PSC limits for the remaining seven FMP crab stocks and the existing closure areas do not circumscribe the full distributional range of stocks they are intended to protect, thereby allowing bycatch mortality to occur without accrual towards PSC limits. Furthermore no bycatch management measures are imposed on the fixed gear groundfish or Pacific halibut sectors. In order to address crab bycatch in the BSAI groundfish fisheries the BSAI groundfish FMP must be amended.

### **Alternative 1 - No action**

Maintain existing crab PSC limits and closure areas.

### **Alternative 2 - Fixed PSC limits**

Crab PSC limits would be fixed in the BSAI groundfish FMP.

### **Alternative 3 - Variable PSC limits**

Crab PSC limits would be set annually based on crab abundance.

Note: Different alternatives may be chosen for each FMP crab stock.

Components with options that could be applied to alternatives 2 and 3:

Component 1: Closure areas

- a) Existing closure areas
  - b) Expand triggered closure areas to include full distribution of each crab stock
- Option: Triggered closure areas encompassing distribution of vulnerable size/sex components of crab stock

Component 2: Timing of closure areas

- a) Fixed
    - i. Year-round
    - ii. Seasonal
- Option: based on vulnerable life history or gear susceptibility
- b) Triggered
    - i. Full
    - ii. Stair-stepped (area closed expands as bycatch triggers are reached)

Component 3: Groundfish sectors/target fisheries included

- a) All trawl sectors

- b) All fixed gear sectors
- c) Halibut IFQ

Component 4: Overfished stocks

- a) Overfished/overfishing determination would trigger more restrictive PSC limits
- b) Overfished/overfishing determination would trigger more restrictive time and area closures

Component 5: Accountability measures

- a) Crab bycatch would accrue inseason towards groundfish sector PSC limit and an overage would trigger accountability measures during the subsequent season or year for that groundfish sector

Component 6: Catch accounting issues

- a) Account for PSC limit accrual against time/area closure thresholds on a crab fishing year (June-May)
- b) Account PSC limit accrual against time/area closure thresholds on a groundfish fishing year (January - December)

*Other considerations noted in Council discussion:*

Staff should consult with Crab Plan Team regarding further refinements to alternative framework noting that Council may further refine alternatives at preliminary review. Staff could consider further break-outs of sectors to fishery-levels as possible. Information in the analysis should include reporting bycatch both in numbers of crab as well as weight.