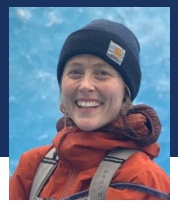
D1 BRISTOL BAY RED KING CRAB INFORMATION PAPER

SAM CUNNINGHAM & KELLY CATES, APRIL 2022



CONTEXT

- BBRKC survey abundance at low levels
- 2021/22 fishery not opened
- Survey finding red king crab in larger numbers north of the stock area
- Incomplete information on stock distribution and shell condition outside of the survey period

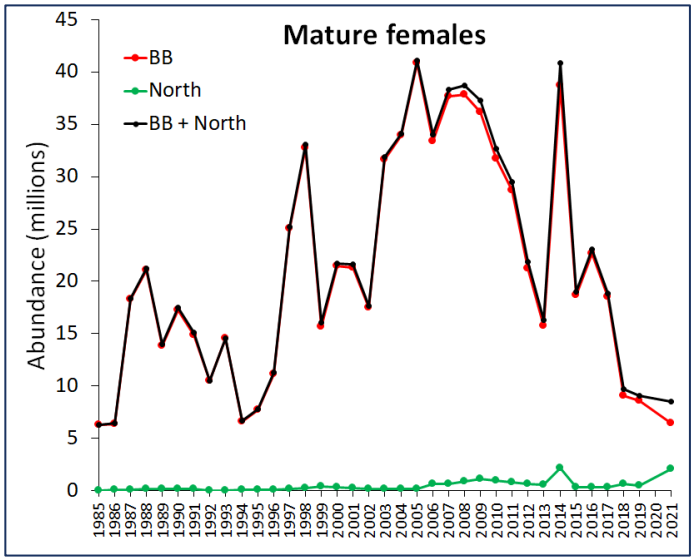
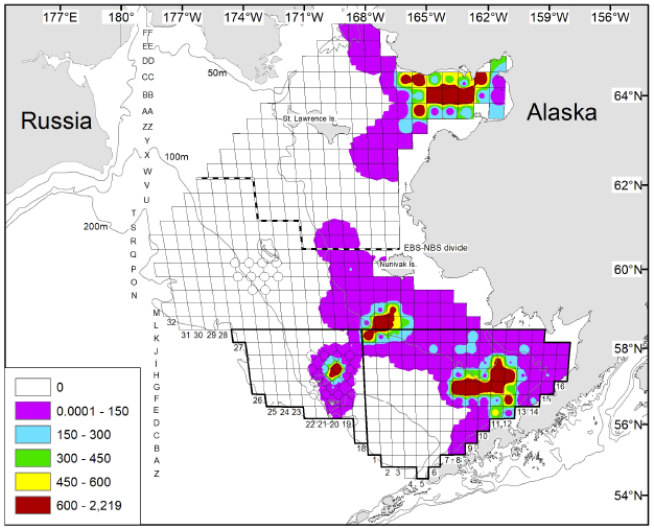


Figure 3-3

Mature female abundance



2021 Trawl Survey, Litzow et al.

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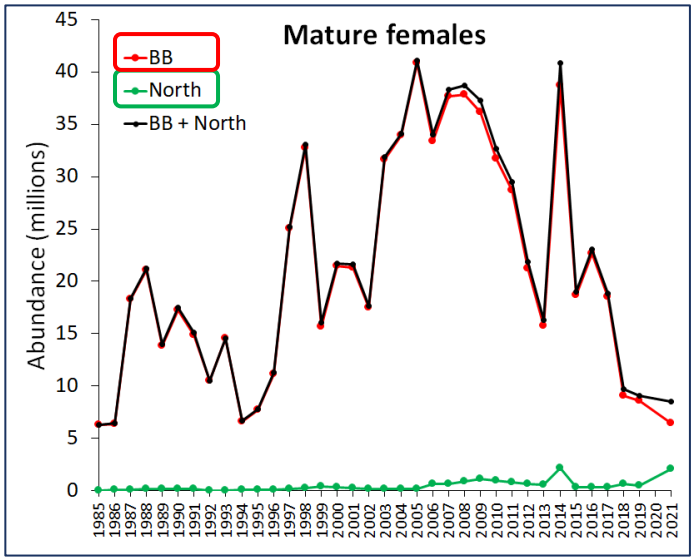

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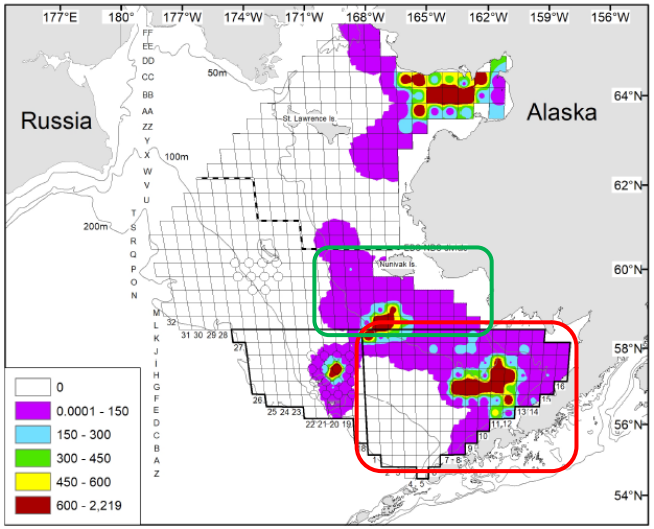
Mature female abundance



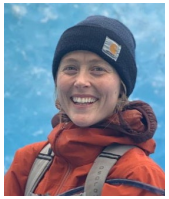
2021 Trawl Survey, Litzow et al.

COUNCIL REQUEST

1. Molt-mate cycle (and life-history)
2. Boundaries for trawl survey, BBRKC stock assessment, BBRKC fishery, trawl PSC limits (and others)
3. Bottom contact by pelagic trawl gear in the Bristol Bay region
4. Flexible spatial management measures

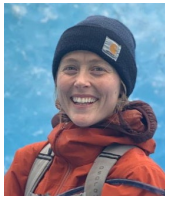
TOPIC 1: BBRKC MOLTING & MATING

Provide the best available information on Bristol Bay red king crab molting/mating annual cycle and how the seasonality of this overlaps with fisheries and the effects these interactions may have



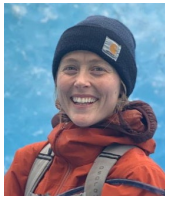
TOPIC 1: BBRKC MOLTING & MATING

- RKC molt multiple times per year through age-3 after which molting is annual
- At larger sizes, king crab (especially males), may skip molt as growth slows
- RKC shells begin to harden days to weeks after molt
  - Takes 74.2 days for the carapace to reach 90% of maximum hardness
- RKC are at increased risk of predation and harm from contact with fishing gear during molting



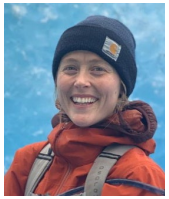
TOPIC 1: BBRKC MOLTING & MATING

- Mating occurs at the same time as molting for mature females
- The mating season primarily occurs from January to March for primiparous RKC females and from April to June for multiparous RKC females
- Mature males thought to molt once during the March to May period
  - Juveniles may molt several times per year
- Overall, the molting period for the entire population of BBRKC ranges from January to June



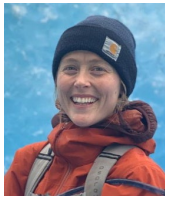
TOPIC 1: RECRUITMENT

- Larval dispersal is an important process for recruitment in benthic invertebrates
- Substantial transport distances may occur before reaching the settling stage
- Larval settlement locations vary with time spent in transport, oceanographic patterns and temperature
  - Shorter transport distance is associated with warmer conditions
- Current spatial distributions can supply larvae to nurseries along the Alaska Peninsula
- Larvae from SW Bristol Bay can reach the Pribilof Islands, but generally there is a disconnect between the Pribilof Islands and Bristol Bay RKC populations



TOPIC 1: RECRUITMENT

- Nearshore, SW Bristol Bay has historically (prior to 1980) been hypothesized as the most important spawning ground for BBRKC
- Recent studies suggest central Bristol Bay as important spawning grounds today
- Cold and warm years can affect both the recruitment success for BBRKC and the area to which they recruit
- Hatching generally occurs in April but embryo development can be delayed in cold years
- Mean age at recruitment into the directed fishery is 8-9 years
- Recruitment has been extremely low during the last 12 years



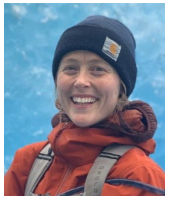
TOPIC 1: BBRKC MOLTING & MATING

General timeline of events around mating and molting of BBRKC*

(Dark blue represents core timing, light blue represents possible timing)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Multiparous Female Larval Hatch, Molt, Mating												
Primiparous Female Larval Hatch, Molt, Mating												
AFSC Trawl Survey												
Directed BBRKC Fishery												
Pelagic Trawl Pollock Fishery			A Season						B Season			

*This summary is intended as a general guide only and is non-binding



TOPIC 2: BOUNDARIES

Evaluate boundaries used for the BBRKC survey, stock assessment, PSC limits, and directed fishery

BOUNDARIES

Appendix I

ADFG Stat. Areas

Survey Stations

Crab Area T

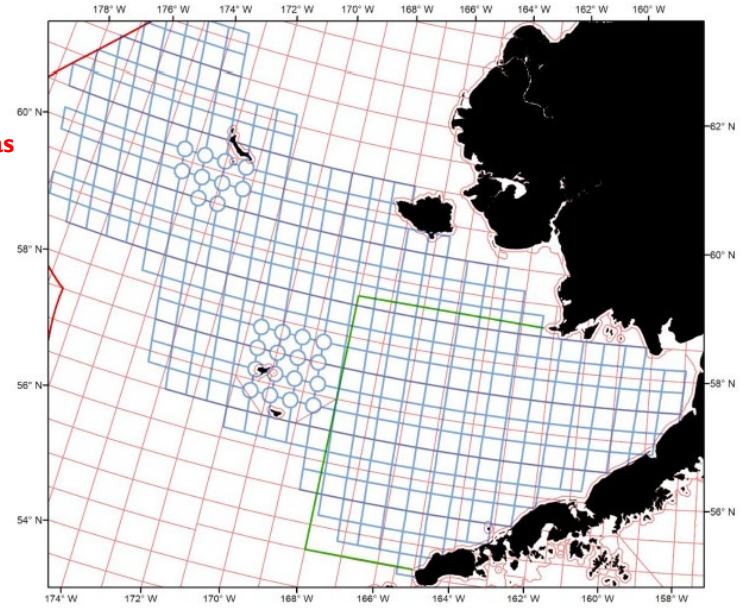
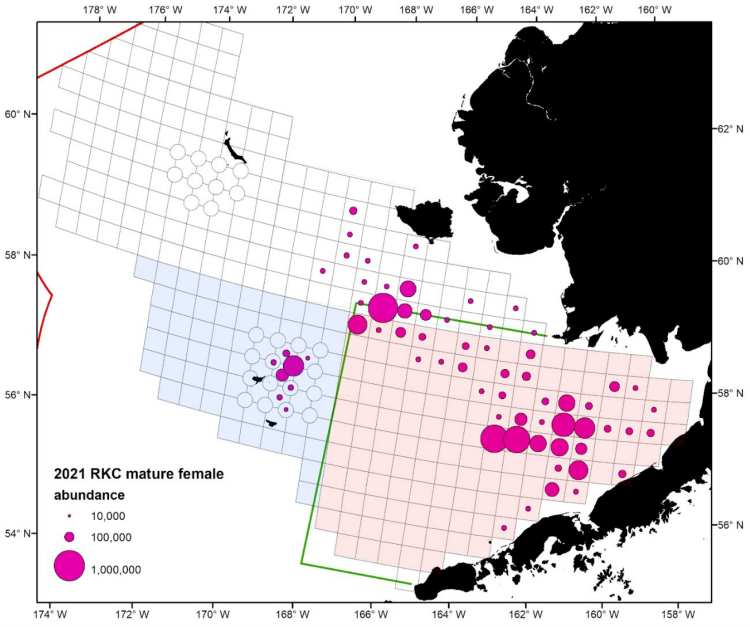


Figure 3-1

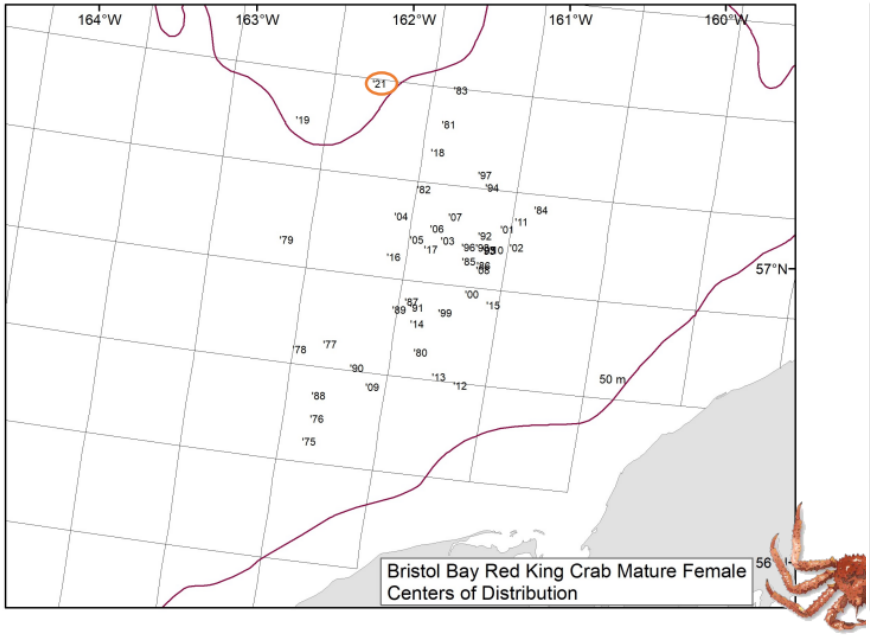
BBRKC Survey Stations

Crab Area T

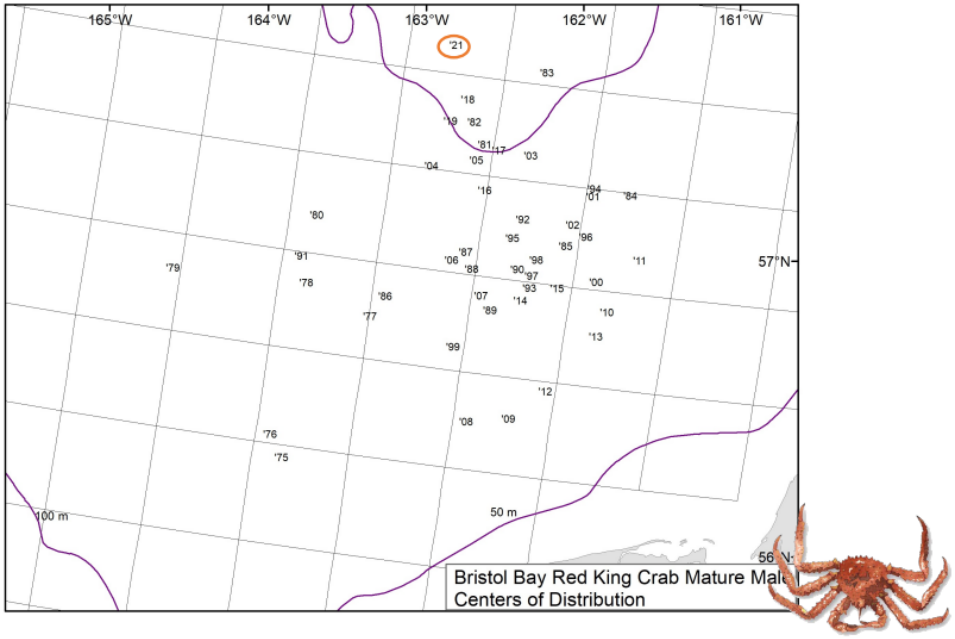


BOUNDARIES: CENTERS OF DISTRIBUTION

Mature Females



Mature Males



Source: Litzow et al. 2021

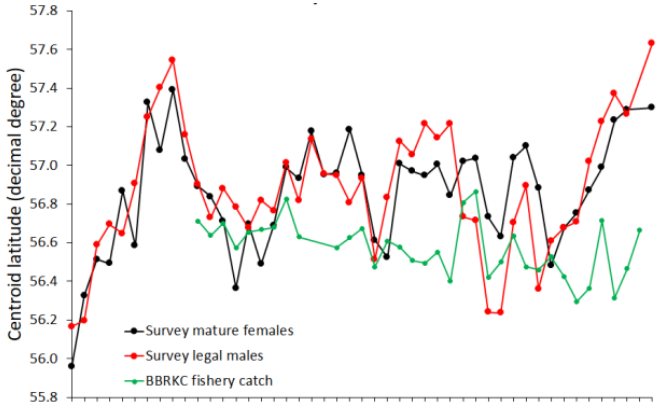
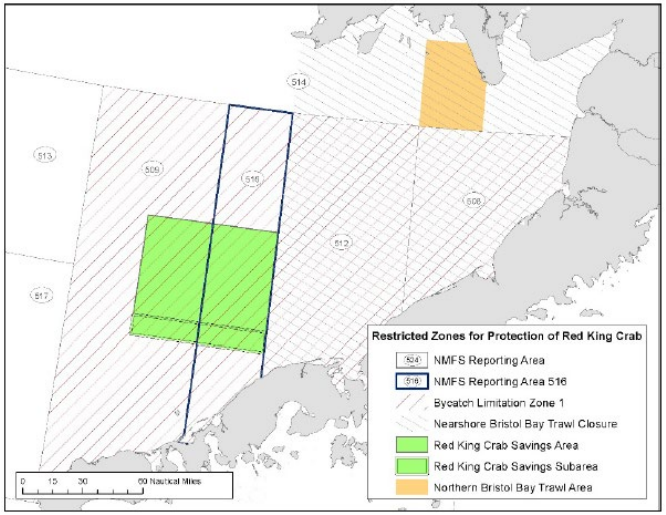
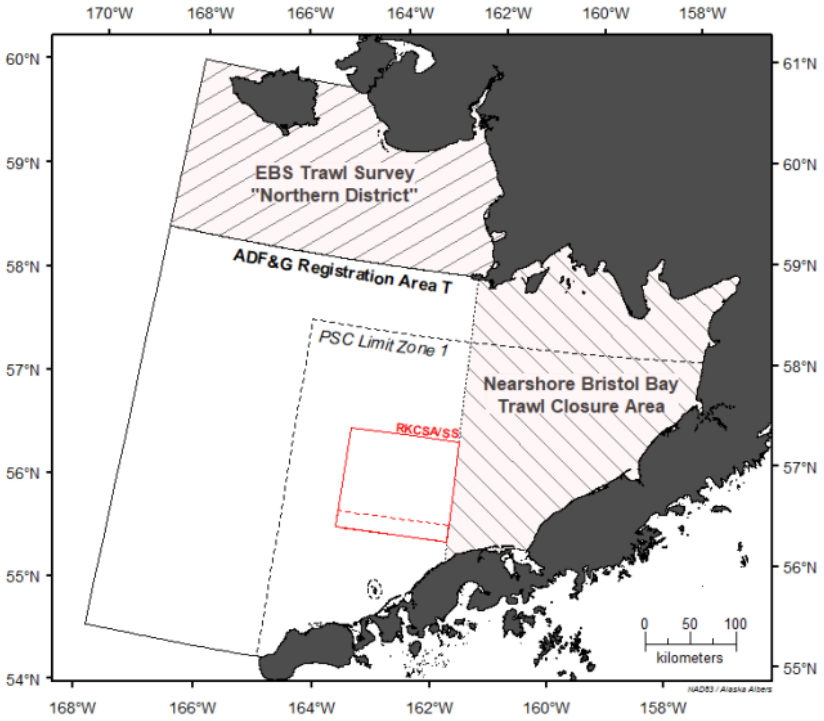


Figure 3-4

BOUNDARIES: TRAWL LIMITATIONS

Figure 3-7





BOUNDARIES: POLLOCK CATCH v RKC SURVEY

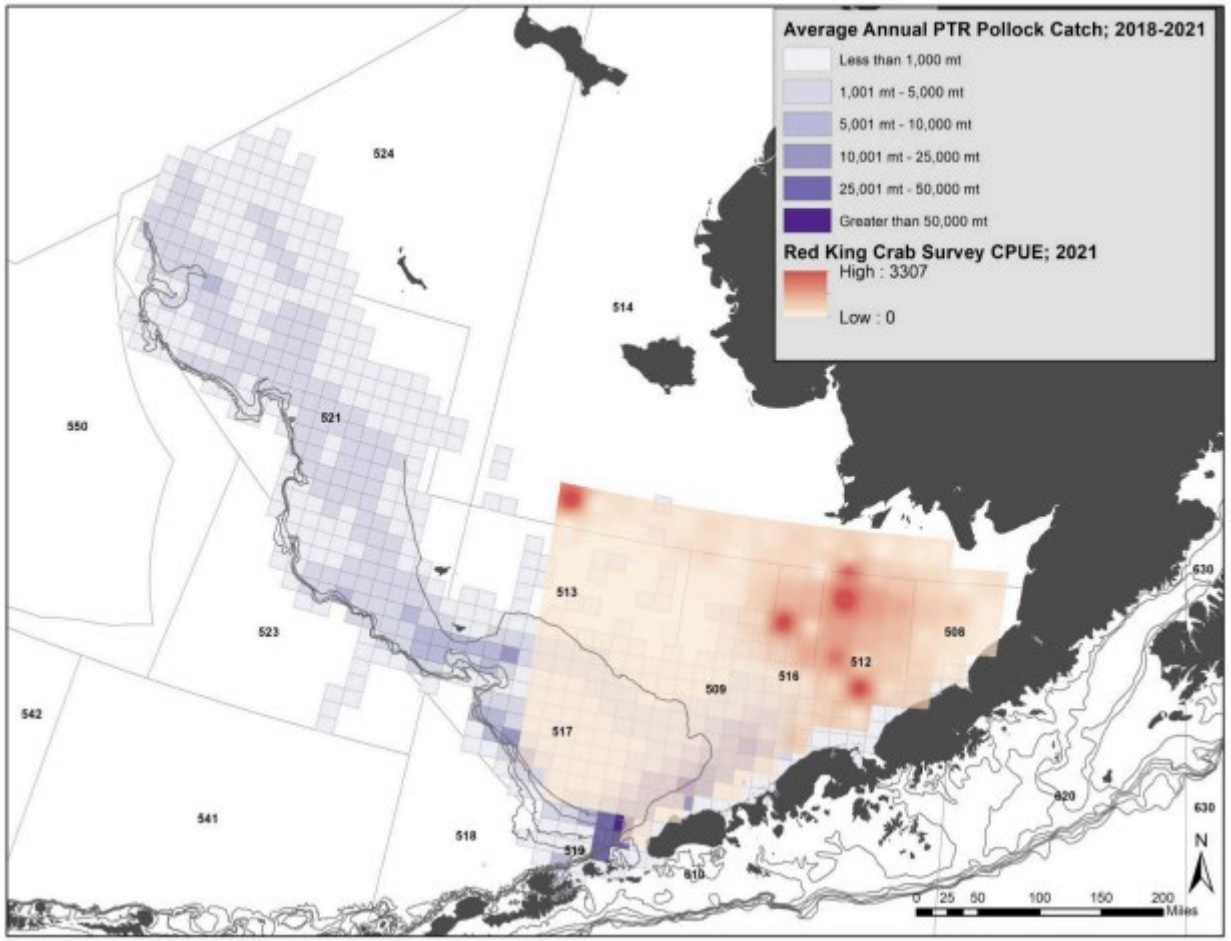


Figure 3-2

BOUNDARIES: 2021/2022 TAGGING (MALE)

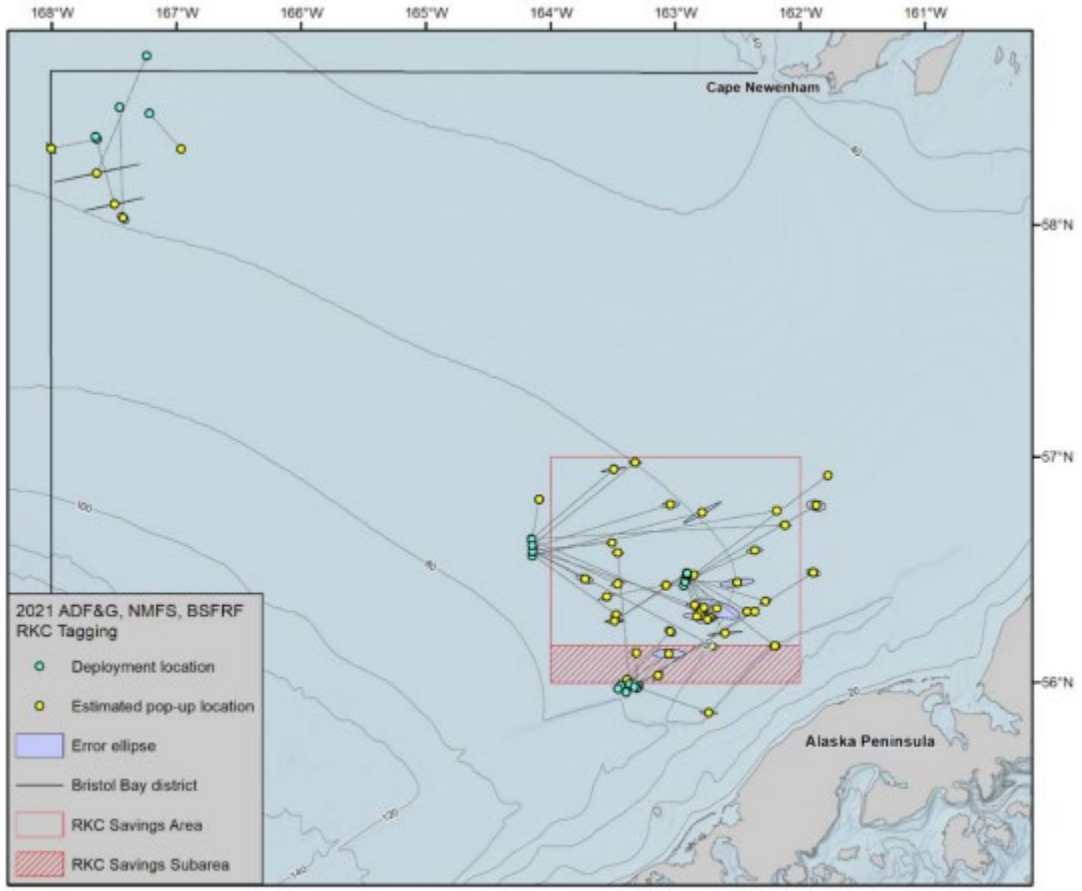


Figure 3-8 **Fall-to-winter 2021/22 male red king crab tagging results in Bristol Bay (Source: B. Daly, ADFG. March 2022. Pers. Comm.)**

BOUNDARIES: SURVEY & ASSESSMENT

- Mature female abundance and effective spawning biomass → stock assessment, Zone 1 PSC limit, and directed fishery status
- Stock assessment includes survey data as overlaps Area T, retained/discarded catch in directed fishery, and PSC
- PSC estimated in two ways:
  - For Zone 1 Limit (NMFS mgmt. areas; #animals)
  - For stock assessment (Area T; weight)
- BBRKC harvest limit (State) incorporates both raw survey area-swept abundance and model-based estimates (recruitment, growth, selectivity); Including new survey units affects both
- Cooperative action: If State/Federal areas do not align then rationalized BBRKC could not be retained in "northward expanded" areas

BOUNDARIES: RKC TRAWL PSC LIMITS

Year	A80 Limit	A80 Not Allocated	CDQ	TLAS Pollock/Atka/Other	TLAS Pacific Cod	TLAS Yellowfin	TLAS Total	Total
2010	98,920	23,204	21,079	400	6,000	47,397	53,797	197,000
2011	93,432	28,692	21,079	400	6,000	47,397	53,797	197,000
2012-2021	43,293	16,839	10,379	197	2,954	23,338	26,489	97,000
2022	14,282	5,555	3,424	65	975	7,700	8,739	32,000

Table 3-1

Year	A80	CDQ†	TLAS Pollock/Atka/Other	TLAS Pacific Cod	TLAS Yellowfin	TLAS Other Flatfish	Total
2010	54,479	779	22	0	0	0	55,280
2011	31,304	3,634	0	1,971	1,366	0	38,276
2012	24,164	2,605	3	0	102	123	26,996
2013	22,537	2,425	15	0	69	140	25,186
2014	26,586	1,457	0	85	92	0	28,220
2015	12,615	62	0	51	6	20	12,754
2016	21,442	430	6	547	842	58	23,325
2017	27,143	3,722	39	280	3,626	245	35,055
2018	9,799	1,936	14	199	778	12	12,739
2019	20,775	2,051	18	466	1,604	119	25,033
2020	32,474	6,301	9	175	3,034	762	42,755
2021	16,397	1,867	17	25	892	0	19,198

Table 3-2

BOUNDARIES: BBKRC RETAINED/DISCARDED

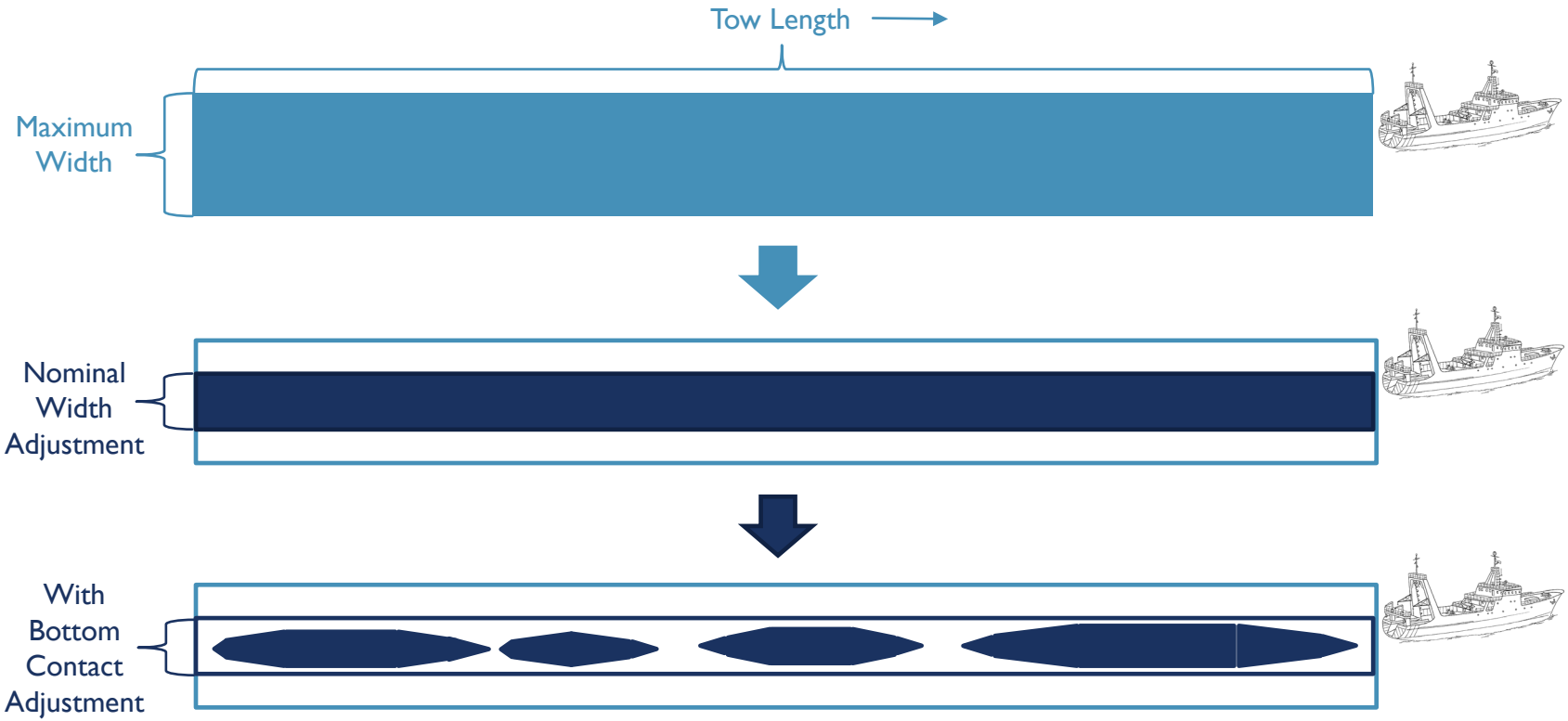
	Female discards	Male discards	Total discards	Discard mortality	Male catch (retained)
2005	1,682,031	3,181,024	4,863,056	**972,611**	2,763,147
2006	221,623	1,572,174	1,793,797	**358,759**	2,502,786
2007	731,651	3,498,460	4,230,111	**846,022**	3,162,287
2008	662,313	3,772,206	4,434,519	**886,904**	3,066,286
2009	350,730	3,118,571	3,469,302	**693,860**	2,556,645
2010	470,492	2,321,052	2,791,545	**558,309**	2,409,952
2011	118,511	1,338,976	1,457,486	**291,497**	1,298,023
2012	46,511	590,033	636,545	**127,309**	1,175,752
2013	409,457	908,106	1,317,563	**263,513**	1,272,273
2014	275,901	1,704,433	1,980,333	**396,067**	1,525,581
2015	801,260	1,107,517	1,908,777	**381,755**	1,526,974
2016	432,824	946,875	1,379,699	**275,940**	1,281,194
2017	233,063	730,783	963,846	**192,769**	997,214
2018	591,898	910,903	1,502,801	**300,560**	629,907
2019	151,967	813,686	965,653	**193,131**	548,516
2020	64,575	662,986	727,561	**145,512**	455,262
Average	452,800	1,698,612	2,151,412	430,282	1,698,237
Median	380,094	1,223,246	1,648,299	329,660	1,411,802

Table 3-3

TOPIC 3: PELAGIC TRAWL BOTTOM CONTACT

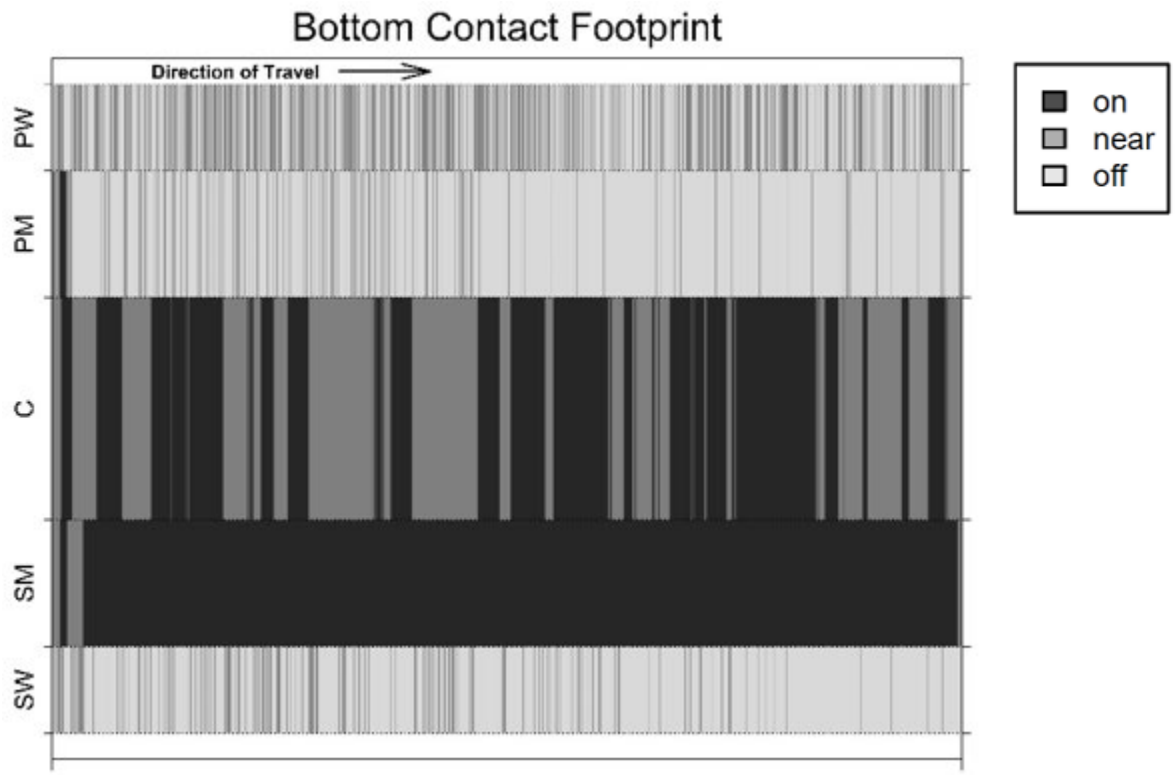
Provide the best available information on bottom contact by pelagic trawl gear and the impact it may have on BBRKC stocks

PELAGIC TRAWL BOTTOM CONTACT ESTIMATE



PELAGIC TRAWL BOTTOM CONTACT ESTIMATE

Example of an experimental CV tow – Objective to put trawl on-bottom



Source: B. King, unpublished. Courtesy APU FAST Lab, 2022

Figure 4-2
A Season

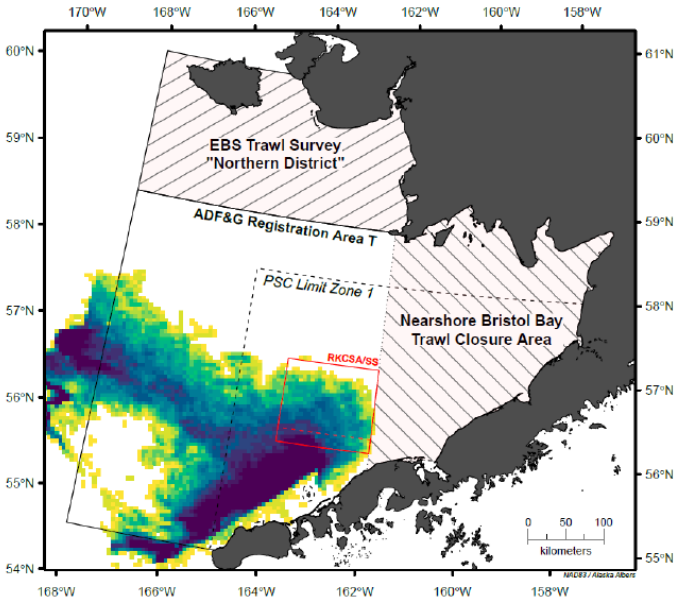
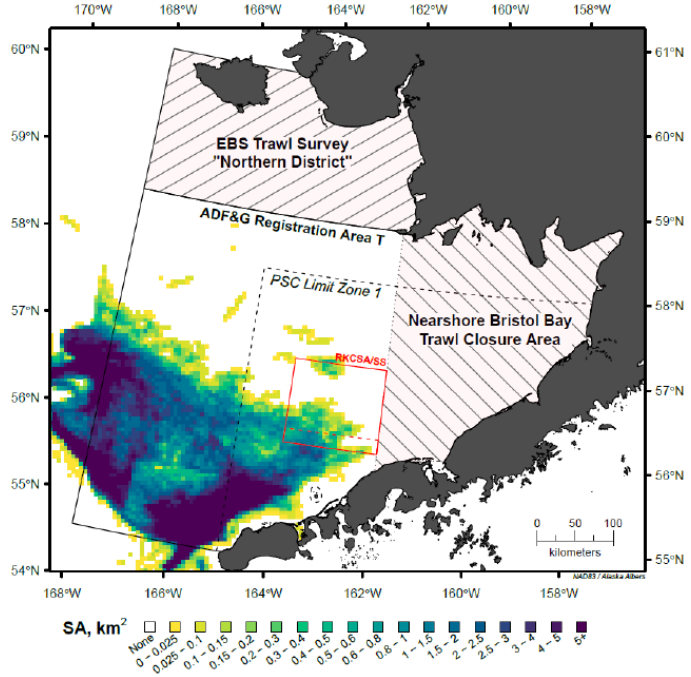


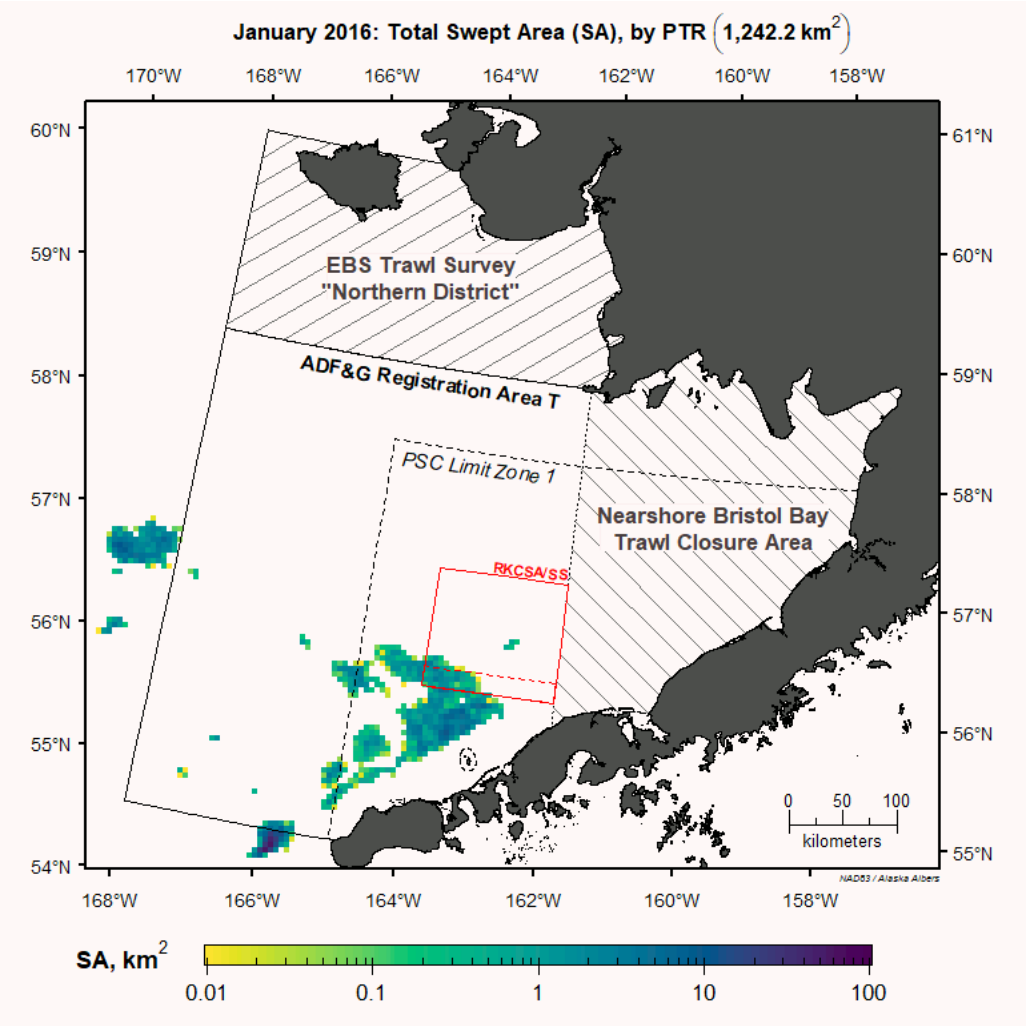
Figure 4-3
B Season



PTR BOTTOM CONTACT ESTIMATE:

SEASONAL AVERAGES 2003-2021

PELAGIC TRAWL BOTTOM CONTACT ESTIMATE



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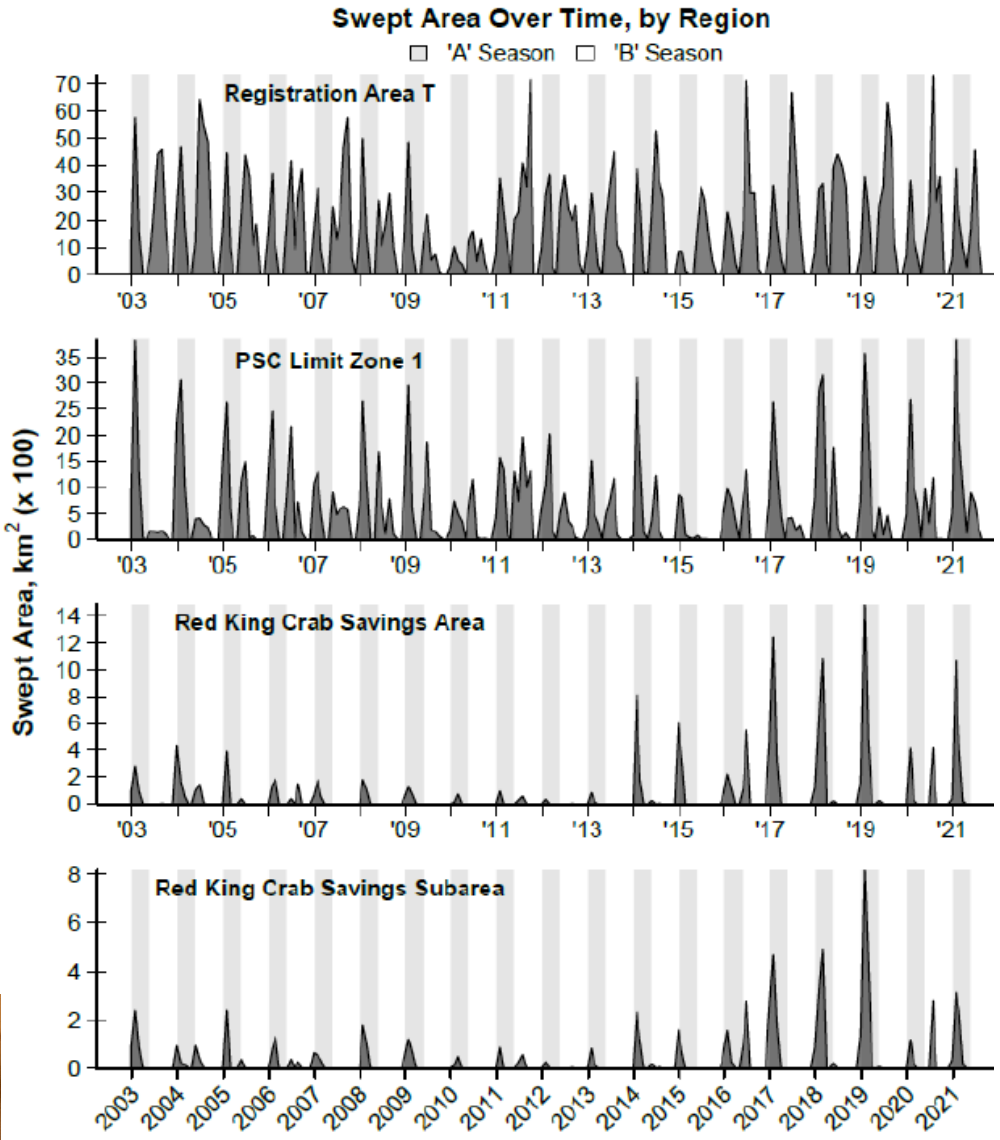


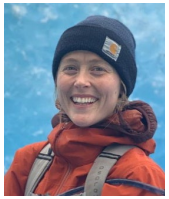
Figure 4-4

PELAGIC TRAWL BOTTOM CONTACT

- Research application: Ecosystem indicator
- Research recent/in-progress: Quantifying PTR bottom contact
- Unobserved mortality
- Bottom contact by other gear types

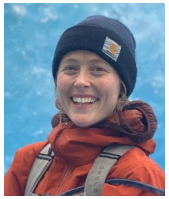
TOPIC 4: FLEXIBLE SPATIAL MANAGEMENT

Summarize mechanisms used in other council managed fisheries to create flexible, responsive spatial management measures for all gear types and how they might be applied to protect BBRKC



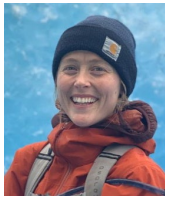
TOPIC 4: IN-SEASON MANAGEMENT

- For the groundfish fisheries in addition to PSC limit closures, NMFS has inseason adjustment authority for closures to prevent overfishing of any fish or shellfish, adjustments for an incorrectly specified PSC limit, and closures depending on PSC rates
- For crab PSC, these inseason adjustment authority actions have rarely, if ever, been necessary
- Crab PSC limits have rarely been exceeded and often the industry has more efficient and effective tools to avoid PSC:
  - Often the industry has information on the PSC rates sooner from vessel personnel
  - The industry can move out of or close an area with high PSC rates sooner than NMFS can issue an area closure
  - The industry can reopen an area sooner if PSC rates decrease



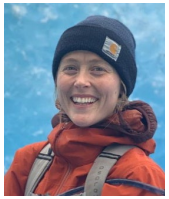
TOPIC 4: INCENTIVE APPROACHES

- Rolling Hot Spots (RHS)
  - The RHS works by monitoring bycatch rates of chum and Chinook salmon for AFA and CDQ participants and comparing them to a base rate
  - Fishing cooperatives may impose temporary area closures on their members
  - The efficacy of the program is reviewed annually by the Council
- Performance Incentives
  - Performance to a low level of bycatch in one year provides an insurance-like buffer in the following year
  - Chinook salmon PSC limit for some programs in the GOA



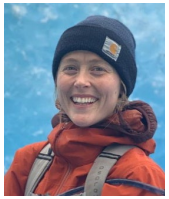
TOPIC 4: TIME AND AREA CLOSURES

- Permanent Area Closures
  - Same area closed every year to certain gear types
  - Example: RKCSA to non-pelagic trawling
  - Council may consider examining existing closure areas and deciding whether these areas should remain in the same location, should be moved, if new closure areas are warranted or if new gear type restrictions are necessary
- Seasonal Closures
  - Areas closed during specified times of the year to certain gear types
  - Example: Northern Bristol Bay Trawl Area (aka Togiak subarea)
  - Council may consider seasonal closures during important biological times for BBRKC
- Rotational Area Closures
  - Rotational closures are area closures that shift spatially dependent on input data or predetermined criteria
  - Closures target specific vulnerable species, generally for a specific demographic of the population
  - Example: Juvenile Atlantic Scallops
- Temperature Closures
  - Can go into effect when temperature thresholds are surpassed and conditions are unsafe for certain species
  - Examples: Texas cold snap, Yellowstone heat wave, TurtleWatch
  - Could be relevant for bycatch of BBRKC to avoid increase discard mortality rates



TOPIC 4: NON-SPATIAL MANAGEMENT

- Gear Modifications or Changes to Reduce Bycatch
  - Floating pots – Eliminates the opportunity for crab to enter pots
  - Slinky pots – Movement of pots may deter crab from entering pots
  - Modification of pots – Modify pots to deter RKC from entering
- Fisheries Executed in Tandem
  - Example: Halibut and Sablefish
  - Possibilities
    - Retention of multiple crab species during directed harvest
    - Pacific Cod and BBRKC



Questions?

Special Thanks

- Alaska Pacific University, FAST Lab: Felipe Restrepo, Bradley Harris
- NOAA HCD: John Olson
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- NMFS AKRO: Krista Milani, Mary Furuness, Josh Keaton
- Craig Rose, FishNext Research
- AFSC: Erin Fedewa, Leah Zacher
- Bering Sea Fisheries Research Foundation
- Alaska Bering Sea Crabbers
- Alaska Seafood Cooperative