NOAA FISHERIES

Ecosystem & Socioeconomic Profile

Bristol Bay Red King Crab Report Card

Erin Fedewa, Kalei Shotwell and Brian Garber-Yonts

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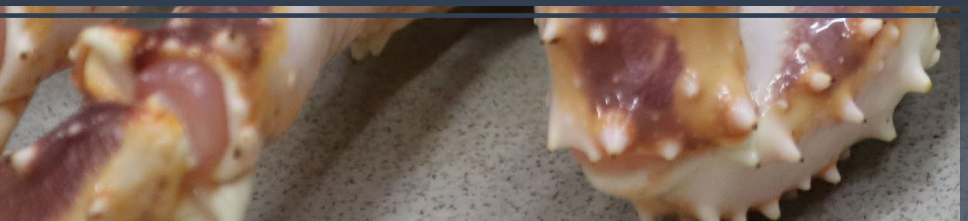
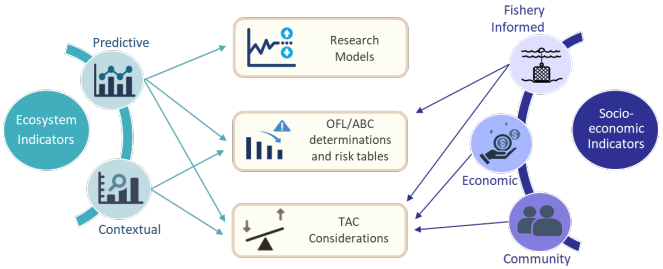
ESP Contributors: Matt Callahan, Curry Cunningham, Ben Daly, Shannon Hennessey, Jean Lee, Cory Lescher, Jens Nielsen, Katie Palof, Darren Pilcher, Dale Robinson, Emily Ryznar, Abigail Tyrell, and Leah Zacher

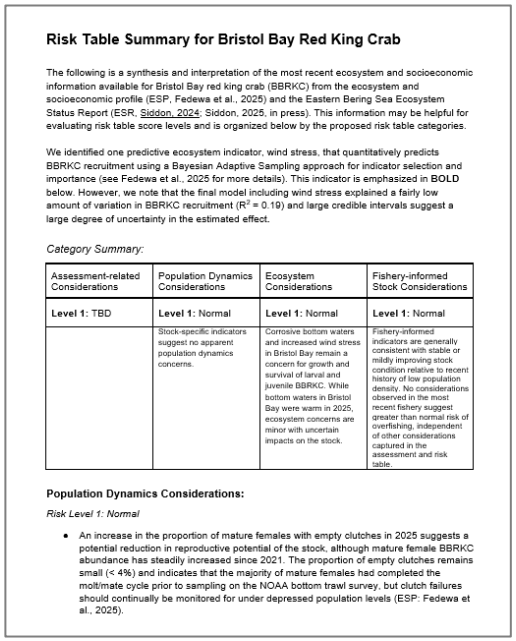


General Updates

- New indicator categorization framework
- New ESP templates for 2025:



ESP/ESR Risk Table Summaries



Risk Table Summary for Bristol Bay Red King Crab

The following is a synthesis and interpretation of the most recent ecosystem and socioeconomic information available for Bristol Bay red king crab (BBRKC) from the ecosystem and socioeconomic profile (ESP, Fedewa et al., 2025) and the Eastern Bering Sea Ecosystem Status Report (ESR, Siddon, 2024; Siddon, 2025, in press). This information may be helpful for evaluating risk table score levels and is organized below by the proposed risk table categories.

We identified one predictive ecosystem indicator, wind stress, that quantitatively predicts BBRKC recruitment using a Bayesian Adaptive Sampling approach for indicator selection and importance (see Fedewa et al., 2025 for more details). This indicator is emphasized in **BOLD** below. However, we note that the final model including wind stress explained a fairly low amount of variation in BBRKC recruitment (R^2 = 0.19) and large credible intervals suggest a large degree of uncertainty in the estimated effect.

Category Summary:

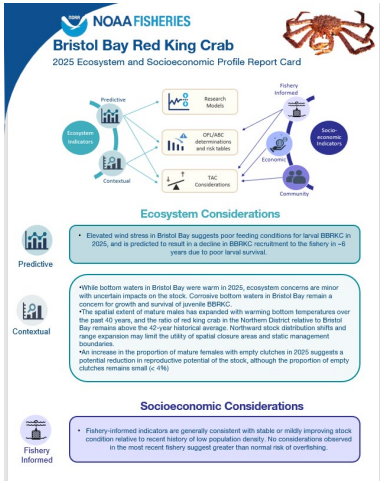
Assessment-related Considerations	Population Dynamics Considerations	Ecosystem Considerations	Fishery-informed Stock Considerations
Level 1: TBD	**Level 1**: Normal	**Level 1**: Normal	**Level 1**: Normal
	Stock-specific indicators suggest no apparent population dynamics concerns.	Corrosive bottom waters and increased wind stress in Bristol Bay remain a concern for growth and survival of larval and juvenile BBRKC. While bottom waters in Bristol Bay were warm in 2025, ecosystem concerns are minor with uncertain impacts on the stock.	Fishery-informed indicators are generally consistent with stable or mildly improving stock condition relative to recent history of low population density. No considerations observed in the most recent fishery suggest greater than normal risk of overfishing, independent of other considerations captured in the assessment and risk table.

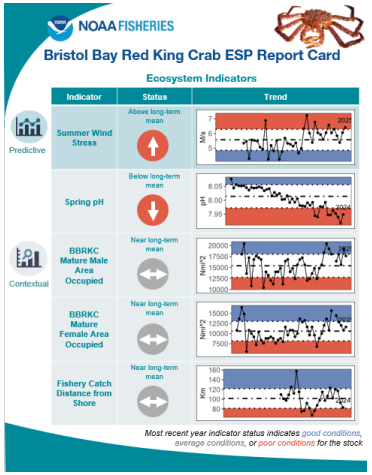
Population Dynamics Considerations:

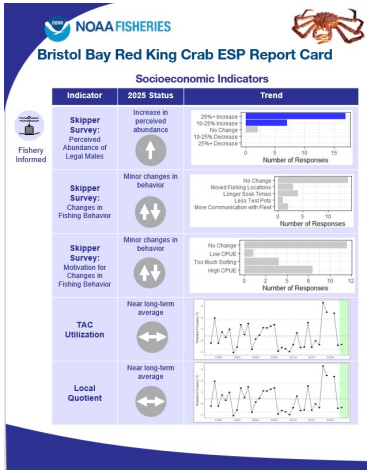
Risk Level 1: Normal

- An increase in the proportion of mature females with empty clutches in 2025 suggests a potential reduction in reproductive potential of the stock, although mature female BBRKC abundance has steadily increased since 2021. The proportion of empty clutches remains small (< 4%) and indicates that the majority of mature females had completed the molt/mate cycle prior to sampling on the NOAA bottom trawl survey, but clutch failures should continually be monitored for under depressed population levels (ESP: Fedewa et al., 2025).

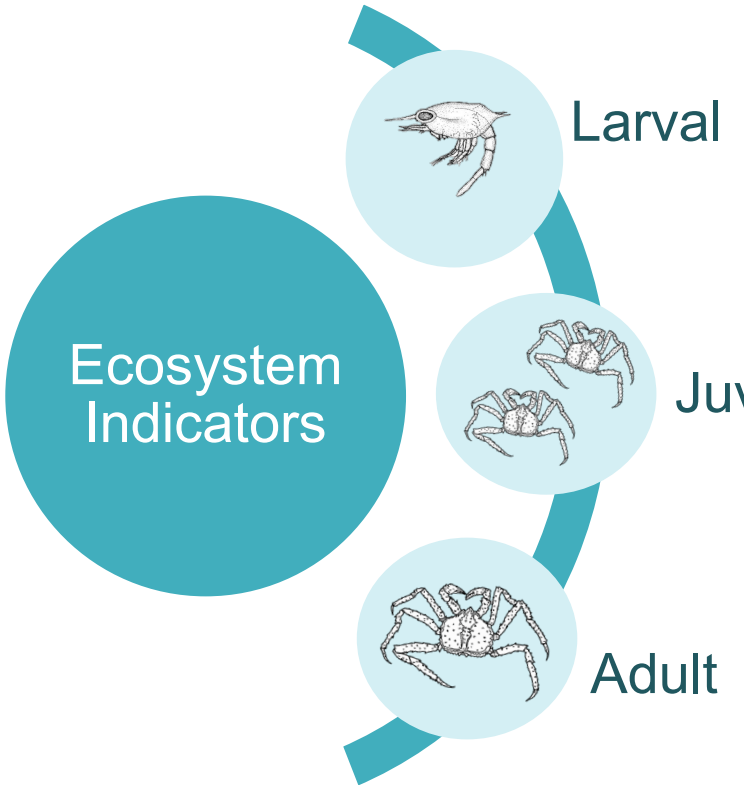
ESP Report Card and Reference Document







BBRKC Ecosystem Indicator Suite



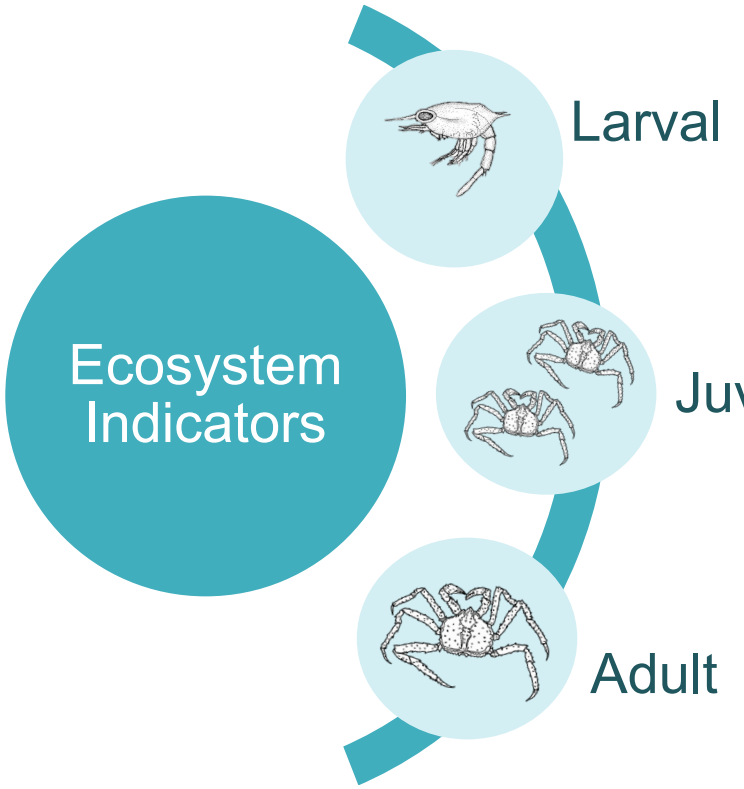
- Arctic Oscillation
- Summer Wind Stress
- Chl-*a* Concentration**
- Bristol Bay Sockeye Salmon Inshore Run Size

- Spring pH**
- Summer Bottom Temperature
- Pacific Cod Predator Density

- Benthic Prey Density
- Mature Male Area Occupied
- Mature Female Area Occupied
- Fishery Catch Distance from Shore
- Female Reproductive Failure
- Northern District/Bristol Bay Ratio
- Protected Area Proportion

** Modified indicators for 2025

Ecosystem indicator subsetting for importance analysis



Arctic Oscillation
Summer Wind Stress
Chl-*a* Concentration — *Limits model run start date*
Bristol Bay Sockeye Salmon Inshore Run Size

Spring pH
Summer Bottom Temperature
Pacific Cod Predator Density

Benthic Prey Density
Mature Male Area Occupied
Mature Female Area Occupied
Fishery Catch Distance from Shore
Female Reproductive Failure
Northern District/Bristol Bay Ratio
Protected Area Proportion

Not drivers of recruitment

Indicator Importance Testing:
Bayesian Adaptive Sampling

Indicator tested in BAS analysis	Lag Applied (years)	Rationale
Arctic Oscillation	6	Hypothesized to affect larval stages
Wind Stress	6	Hypothesized to affect feeding success of larval stages
Bristol Bay Sockeye Run Size	6	Predators of RKC larval stages
pH	4	Strongest effects on YOY RKC juveniles
Pacific Cod Density	1	Prior year most informative for survival
Bottom Temperature	2	Effects on survival of juvenile RKC
Benthic Prey Density	1	Prior year most informative for survival
% Empty Clutches	7	6 year larval lag + 12 months for embryo incubation

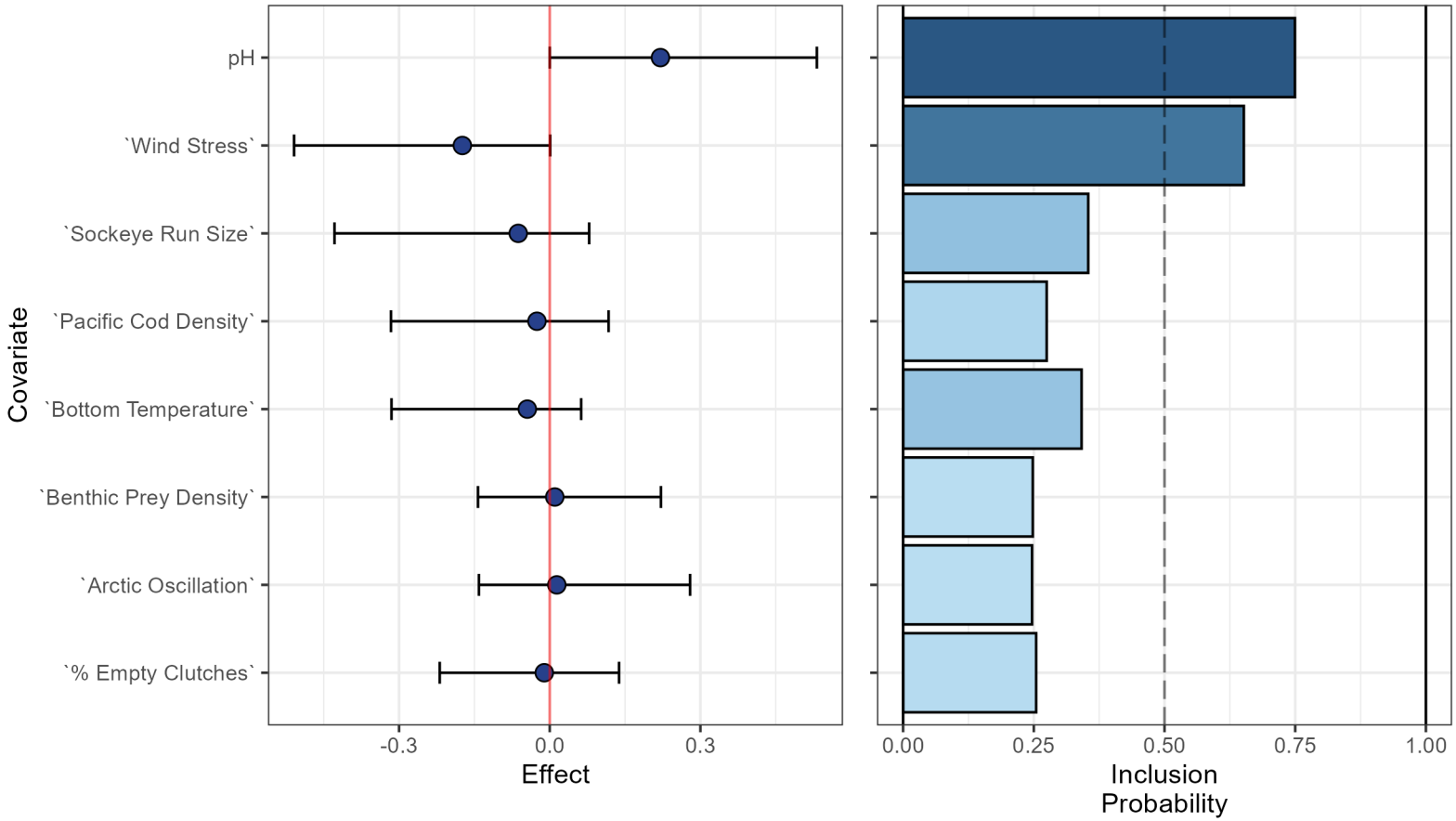
Larval indicator *Juvenile indicator* *Adult indicator*

Response Variable: Survey abundance of male BBRKC (95 – 120 mm CL)

Represents males ~ 6 - 7.9 years post-settlement, and 1 molt away from recruitment to the fishery

Indicator Importance Testing:

Bayesian Adaptive Sampling

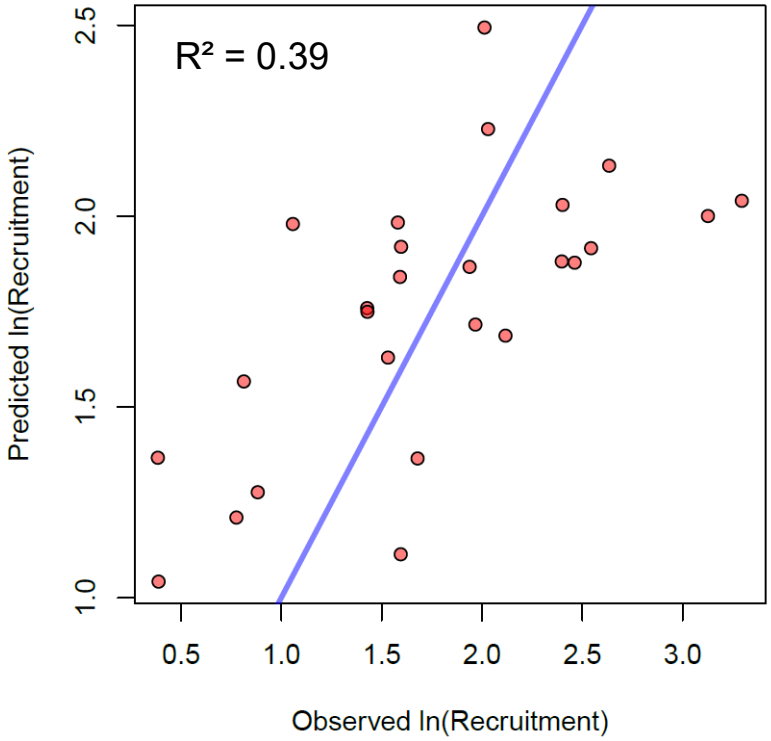


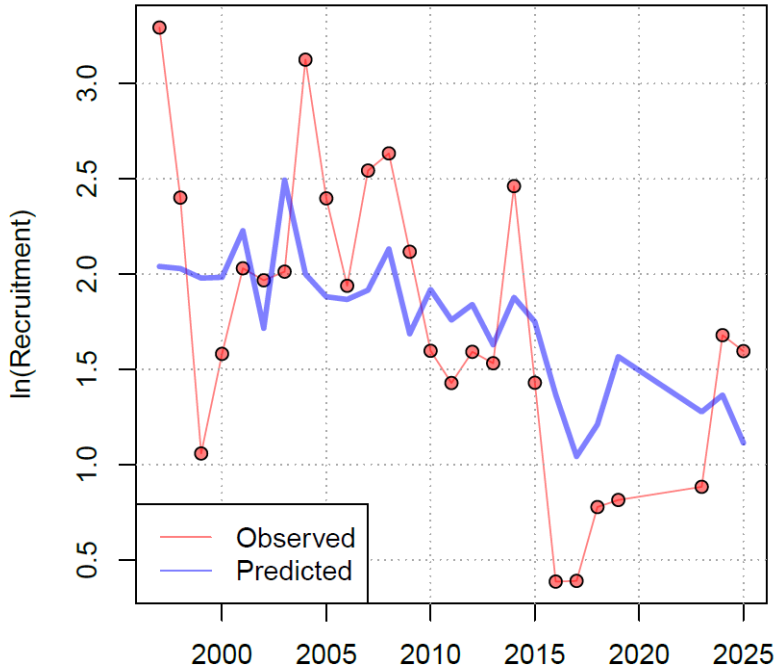
Two predictive indicators with inclusion probabilities > 0.5 and directional effects on recruitment were identified from the BAS analysis:

Wind stress and pH

Indicator Importance Testing:

Bayesian Adaptive Sampling





The final model selected using BAS explained a moderate amount of variation in BBRKC recruitment

Ecosystem Indicator Categorization

Predictive

- Summer Wind Stress
- Spring pH

Contextual

- Mature Male Area Occupied
- Mature Female Area Occupied
- Fishery Catch Distance from Shore
- Female Reproductive Failure
- Northern District/Bristol Bay Ratio
- Proportion of Mature Males in Closure Areas

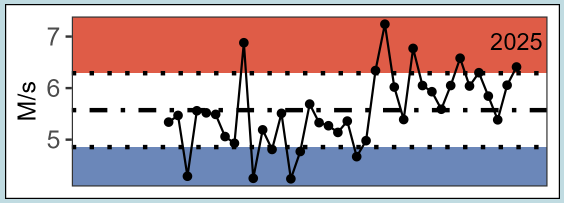
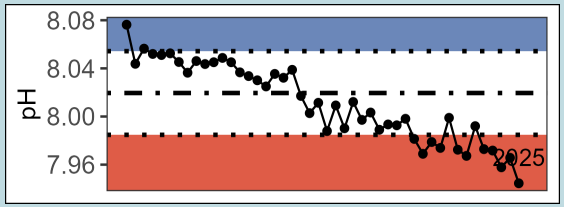
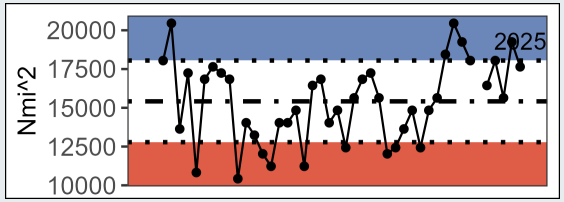
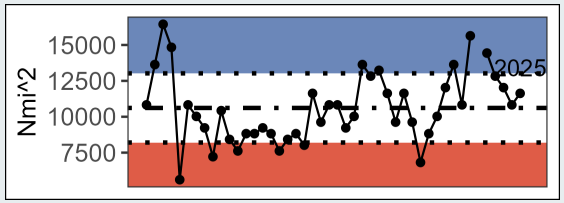
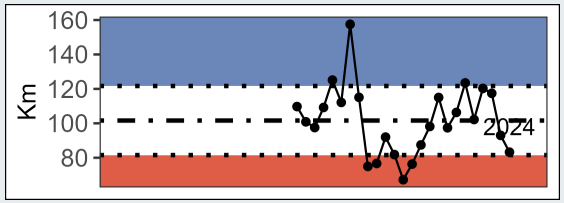
Monitoring

- Arctic Oscillation Index
- Chlorophyll-a Concentration
- Bristol Bay Sockeye Inshore Run Size
- Bottom Temperature
- Pacific Cod Predator Density
- Benthic Prey Density

Bristol Bay Red King Crab ESP Report Card

Predictive

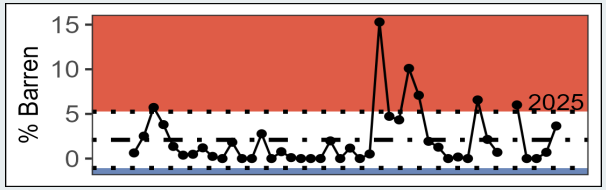
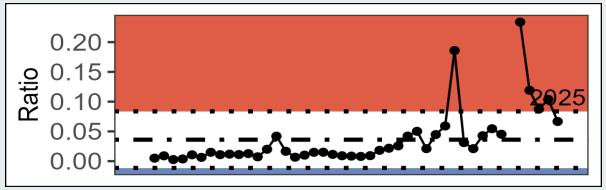
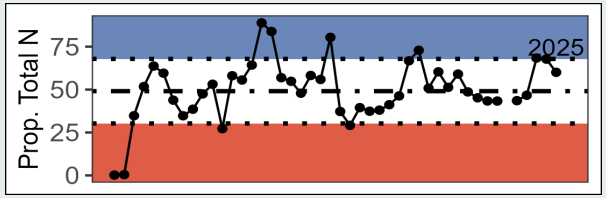
Contextual

Indicator	Status	Trend
Summer Wind Stress	Above long-term mean	
Spring pH	Below long-term mean	
BBRKC Mature Male Area Occupied	Near long-term mean	
BBRKC Mature Female Area Occupied	Near long-term mean	
Fishery Catch Distance from Shore	Near long-term mean	

Most recent year indicator status indicates good conditions, average conditions, or poor conditions for the stock

Bristol Bay Red King Crab ESP Report Card

Contextual

Indicator	Status	Trend
Female BBRKC Reproductive Failure	Near long-term mean	
Northern District: Bristol Bay RKC Ratio	Near long-term mean	
Proportion of Mature Males in Closure Areas	Near long-term mean	

Most recent year indicator status indicates good conditions, average conditions, or poor conditions for the stock

Ecosystem Considerations to Inform ABC and TAC Decisions

Predictive

- Elevated wind stress in Bristol Bay suggests **poor feeding conditions** for larval red king crab in 2025, and is predicted to result in a decline in recruitment to the fishery in ~6 to 8 years due to poor larval survival.
- Bristol Bay red king crab have experienced a steady decline in bottom water pH in the past two decades, and pH declined to 7.94 in 2025. Continued declines in pH are predicted to result in a decline in BBRKC recruitment due to **negative impacts on growth, shell hardening, and survival.**

Contextual

- While Bristol Bay was considerably warmer than the last four years, direct impacts on the stock are uncertain.
- The spatial extent of mature males has expanded with warming bottom temperatures over the past 40 years, and the ratio of red king crab in the Northern District relative to Bristol Bay remains above the 42-year historical average. **Northward stock distribution shifts and range expansion** may limit the utility of spatial closure areas and static management boundaries.
- An increase in the proportion of mature females with empty clutches in 2025 suggests a **potential reduction in reproductive potential** of the stock, although the proportion of empty clutches remains small (< 4%)

Next Steps

New Indicators in Development:

- Refined benthic invert prey indicator (Jonathan Reum)
- RKC-fishing gear spatial overlap (Sean Hardison)

Continuing to refine ESP report card documents, intermediate stage analysis and report card graphics. Any and all feedback welcome on new templates!

Questions?