Ecosystem & Socioeconomic Profile

Eastern Bering Sea Snow Crab Report Card

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September 2026

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Responses to CPT/SSC recommendations

May 2026 CPT Recommendations:

- *Look at correlation between DSEM survey recruitment response and estimated recruitment from snow crab assessment*
  This will be evaluated once a Tier 3 snow crab model is recommended by the CPT

- *Look at actual data input time series to evaluate if 0.1 observation error is justifiable*
  September 2026 DSEM models assume no observation error for all variables by treating them as fixed, but more informed estimates will be explored for the April 2027 ESP Update to CPT

- *Potentially consider rolling averages or multiple lags for drivers like cod consumption that influence multiple life history stages cumulatively*
  This will be prioritized for the April 2027 ESP Update to CPT

- *Back-transform causal effects for easier interpretation*
  This will be prioritized for the April 2027 ESP Update to CPT

- *Evaluate OOS predictive skill of DSEM models*
  This will be prioritized for the April 2027 ESP Update to CPT

Responses to CPT/SSC recommendations

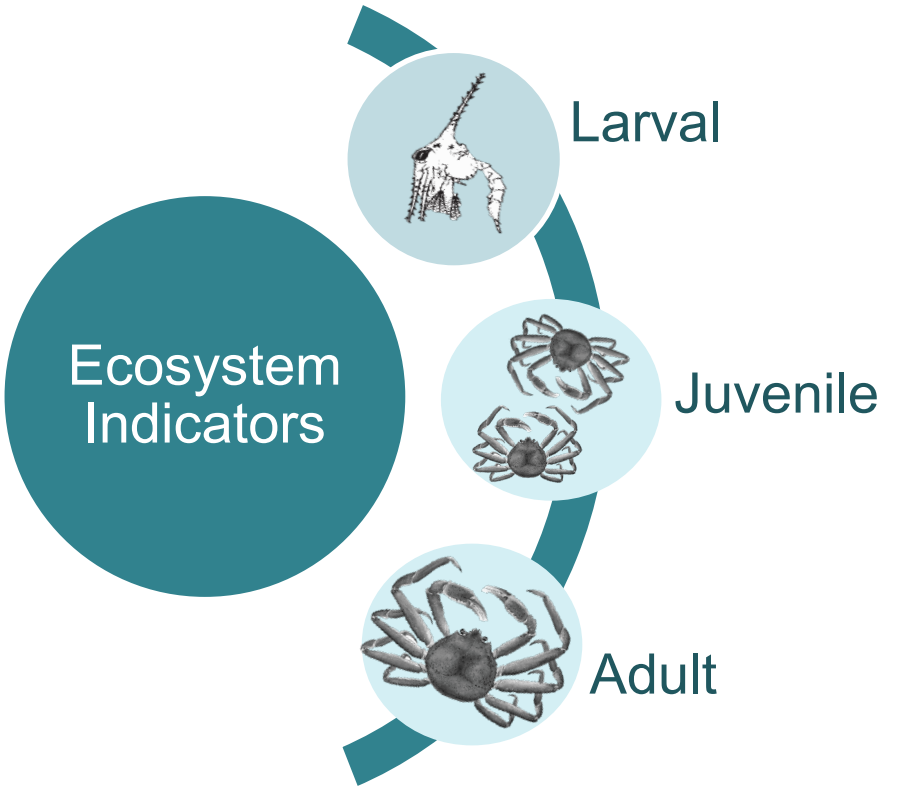
June 2026 SSC Recommendation:

Per the SSC, consideration should be taken to include short, influential timeseries whenever possible rather than defaulting the indicator to a contextual categorization:

"*The SSC recommends looking at multiple approaches to evaluate the biases or inconsistencies rather than defaulting to contextual use of those data*"

Energetic condition (n = 7 years) was classified as predictive in the 2026 Snow Crab ESP Report Card, but we note that the causal effect was largely driven by a single observation in 2019 and may not represent a generalizable relationship across the historical period. Additional diagnostics will be explored to evaluate the robustness of this causal pathway

Ecosystem Indicator Suite



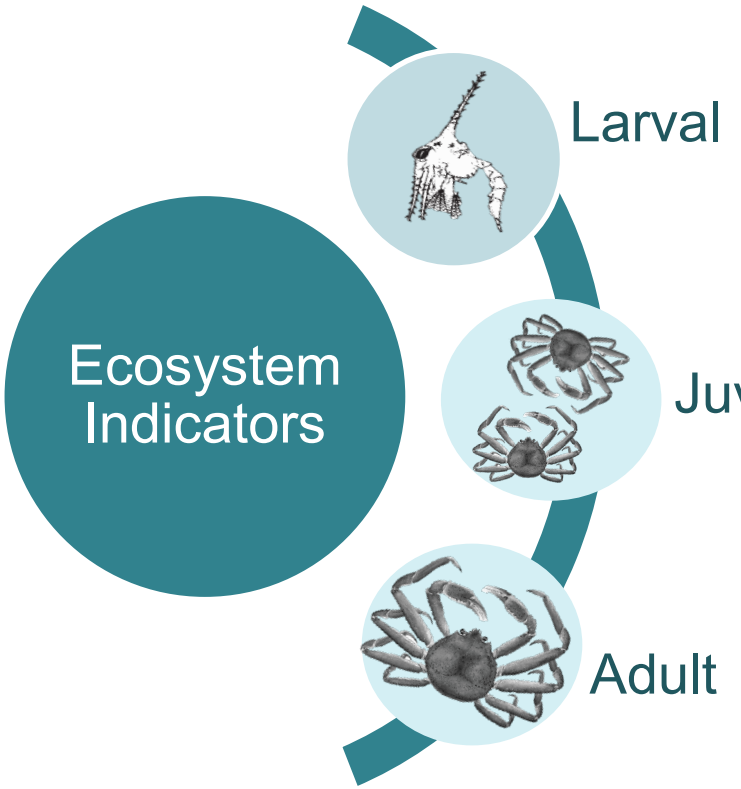
- Arctic Oscillation
- Chl-*a* Concentration

- Cold Pool Extent (< 0°C)
- Juvenile Temperature of Occupancy
- Winter Sea Ice Extent
- Juvenile Disease Prevalence
- Juvenile Energetic Condition
- Pacific Cod Consumption

- Benthic Prey Density
- Male Size at Maturity**
- Female Size at Maturity**
- Mature Male Area Occupied
- Mature Male Center of Abundance
- Female Reproductive Failure
- Operational Sex Ratio

** Modified indicators for 2026

Ecosystem indicator subsetting for importance analysis



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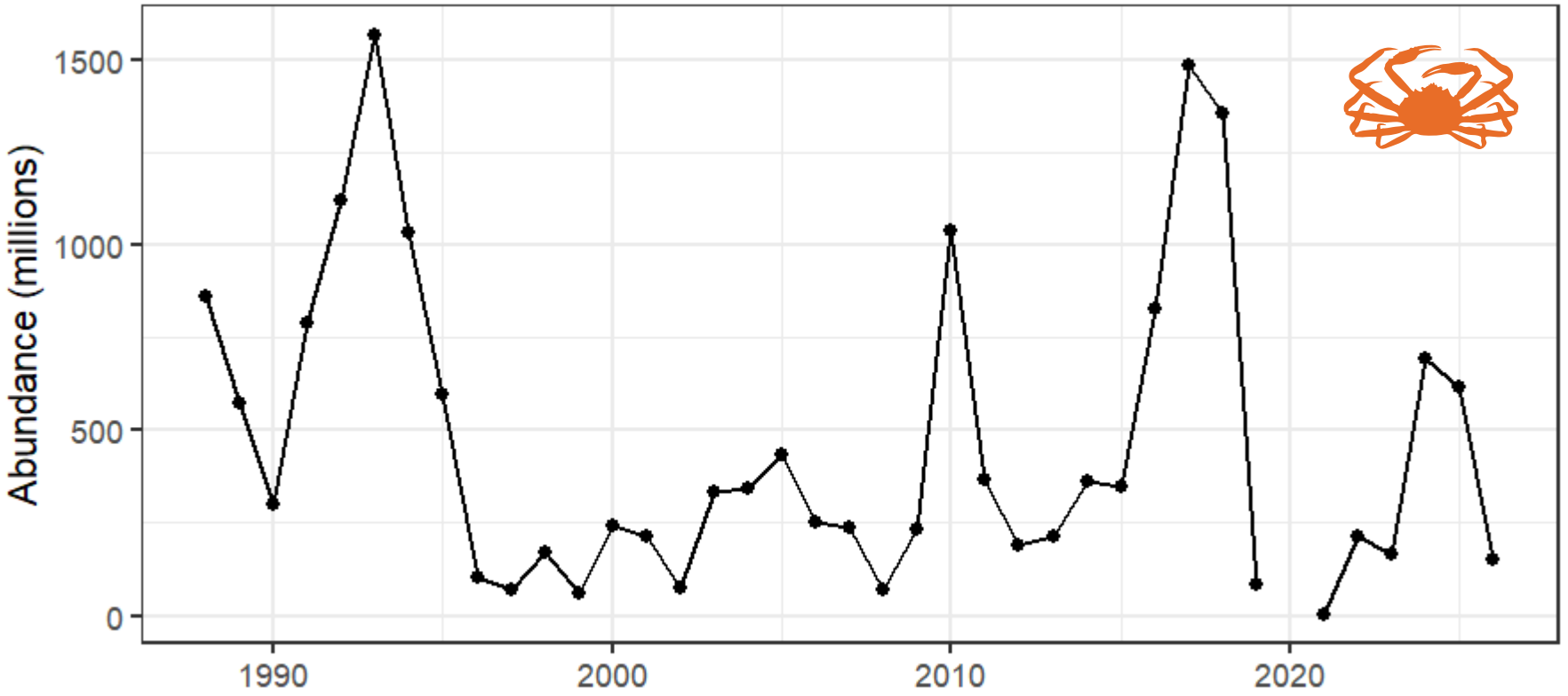
Not drivers of recruitment

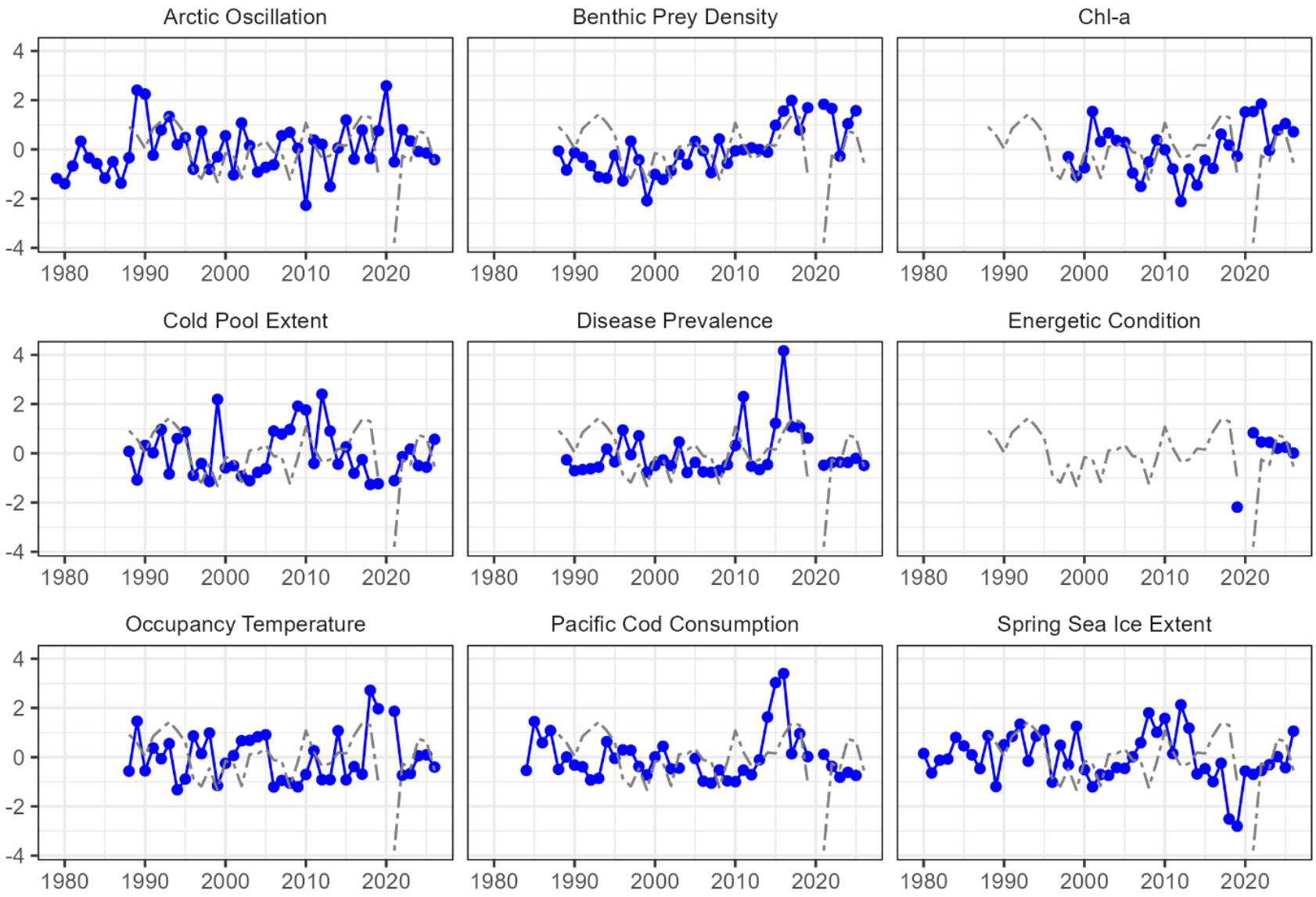
DSEM Response Variable: Snow Crab Recruitment

Abundance of 40-50mm immature male snow crab from EBS bottom trawl survey (1988-2026)

Lags informed by assumption that this size class is ~4.5-5.7 years post-settlement



DSEM Ecosystem Indicator Covariates



Methods for snow crab DSEM indicator analysis:

Step 1: Develop causal diagrams for drivers of snow crab recruitment and mortality

Step 2: Fit dynamic structural equation model models using dsem R package

- Scale all variables and model as AR1 process
- Use same background dataset in the model fitting process so that models are fit to same set of data and AIC can be used for comparison
- Assume linear relationships among variables
- Specify biologically-plausible lag for each causal pathway

Step 3: Model evaluation

- Estimate effect sizes for each link (betas), determine significance with two-sided Wald test
- Compare marginal AIC across models
- Compare reduction in unexplained recruitment variance, $\sigma^2_{R,unexplained^2}$

Base Recruitment Models:

Random recruitment variation (IID):
Snow crab recruitment (IID) + AR1 ESP indicators

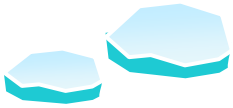
Autocorrelated recruitment variation (AR1):
Snow crab recruitment (AR1) + AR1 ESP indicators

Structural Causal Recruitment Models: Lagged causal pathways + AR1 ESP indicators

CLIMATE FORCING

Arctic Oscillation

Lag 0



Sea ice extent

Lag 1

Snow crab recruitment

LARVAL FOOD AVAILABILITY

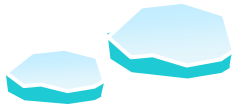
Lag 0

Chl-a concentration

Lag 4

Snow crab recruitment

JUVENILE FOOD AVAILABILITY



Sea ice extent

Lag 0

Juvenile energetic condition

Lag 0

Benthic prey density

Lag 1

Snow crab recruitment

COLD WATER HABITAT AVAILABILITY

Cold pool extent

Lag 0

Juvenile temperature occupied

Lag 1

Snow crab recruitment

DISEASE

Juvenile disease prevalence

Lag 0

Cold pool extent

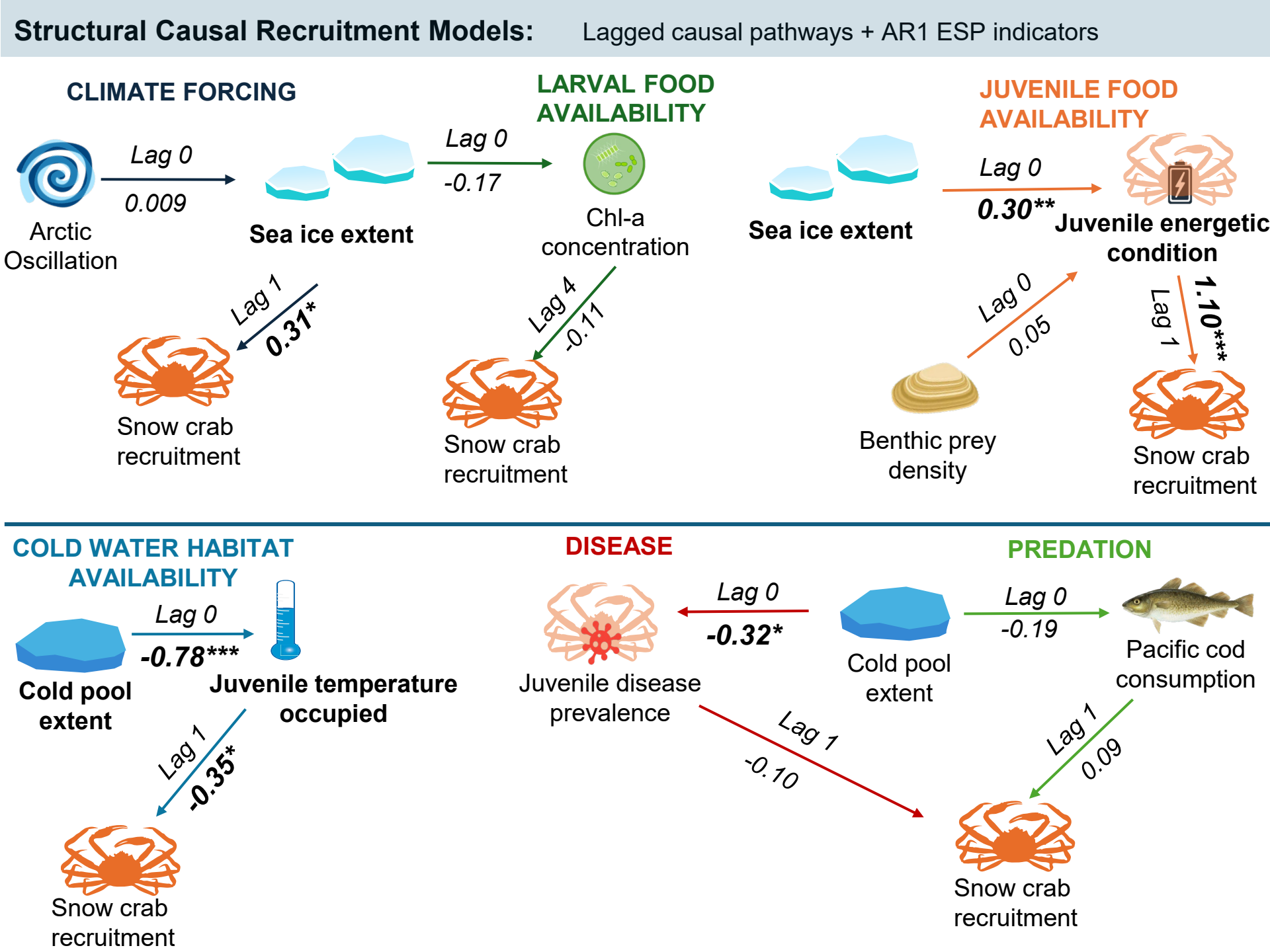
Lag 0

Pacific cod consumption

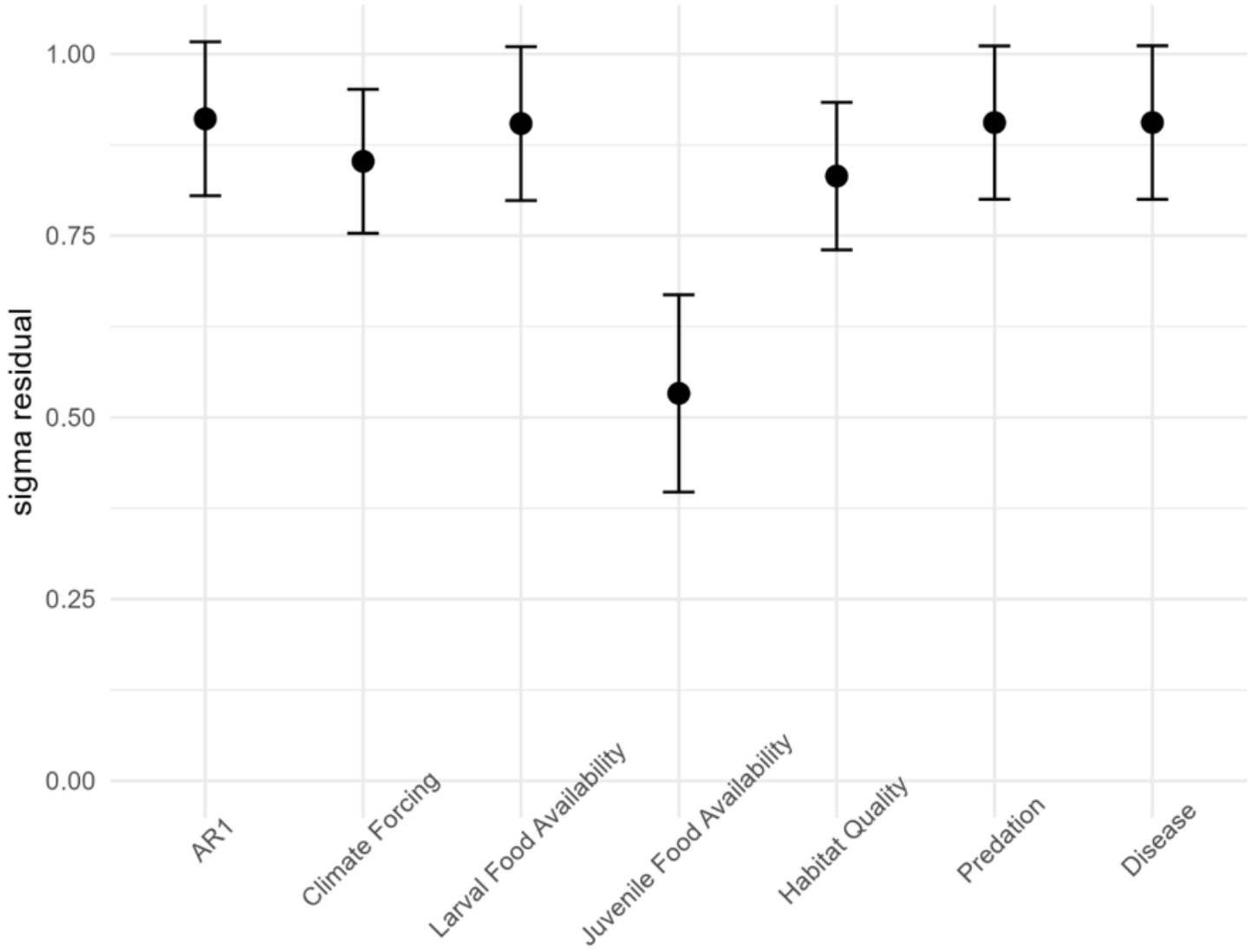
Lag 1

Lag 1

Snow crab recruitment


Structural Causal Recruitment Models:
Lagged causal pathways + AR1 ESP indicators
CLIMATE FORCING
Arctic Oscillation
Lag 0
0.009
Sea ice extent
Lag 1
0.31*
Snow crab recruitment
LARVAL FOOD AVAILABILITY
Lag 0
-0.17
Chl-a concentration
Lag 4
-0.11
Snow crab recruitment
Sea ice extent
JUVENILE FOOD AVAILABILITY
Lag 0
0.30**
Juvenile energetic condition
Lag 0
0.05
Benthic prey density
Lag 1
1.10***
Snow crab recruitment
COLD WATER HABITAT AVAILABILITY
Cold pool extent
Lag 0
-0.78***
Juvenile temperature occupied
Lag 1
-0.35*
Snow crab recruitment
DISEASE
Juvenile disease prevalence
Lag 0
-0.32*
Cold pool extent
Lag 1
-0.10
PREDATION
Lag 0
-0.19
Pacific cod consumption
Lag 1
0.09
Snow crab recruitment

Including sea ice and energetic condition causal pathways (Juvenile Food Availability Model) reduced estimated recruitment variance by 71% relative to the null IID model



Ecosystem Indicator Categorization

Predictive

- Sea Ice Extent
- Cold Pool Extent
- Juvenile Snow Crab Energetic Condition
- Juvenile Snow Crab Temperature of Occupancy

Contextual

- Juvenile Disease Prevalence
- Pacific Cod Consumption
- Male Size at Maturity
- Mature Male Area Occupied
- Mature Male Center of Abundance
- Female Reproductive Failure
- Operational Sex Ratio

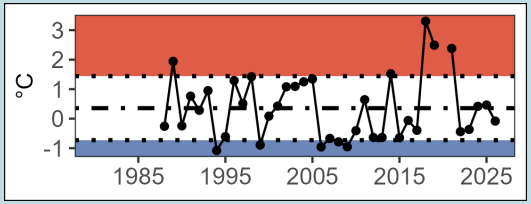
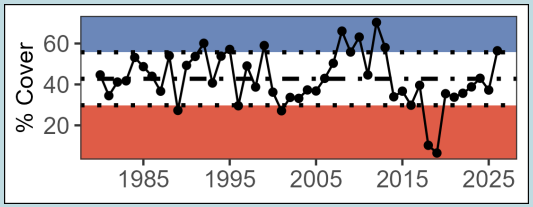
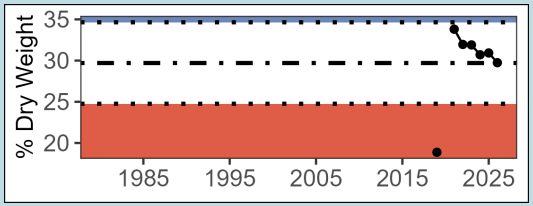
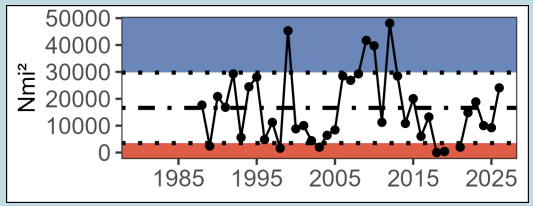
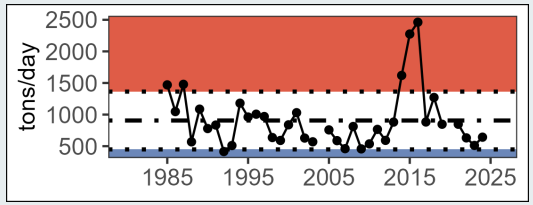
Monitoring

- Arctic Oscillation
- Benthic Prey Density
- Chl-*a* Concentration
- Female Size at Maturity

EBS Snow Crab ESP Report Card
Ecosystem Indicators

Predictive

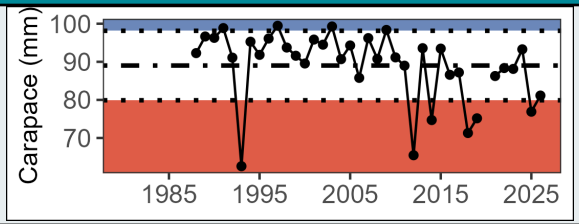
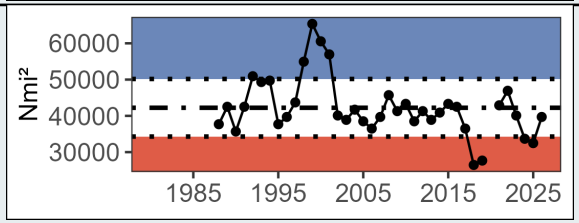
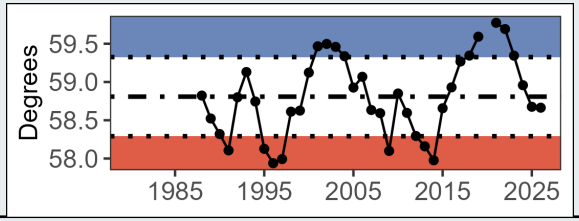
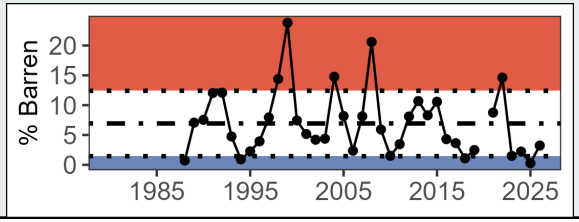
Contextual

Indicator	Status	Trend
Juvenile Snow Crab Temperature of Occupancy	Near long-term mean	
Spring Sea Ice Extent	Above long-term mean	
Juvenile Snow Crab Energetic Condition	Near long-term mean	
Cold Pool Extent (≤ 0°C)	Near long-term mean	
Pacific Cod Consumption	Near long-term mean	

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

EBS Snow Crab ESP Report Card
Ecosystem Indicators

Contextual

Indicator	Status	Trend
Male Snow Crab Size at Maturity	Near long-term mean	
Male Snow Crab Area Occupied	Near long-term mean	
Male Snow Crab Center of Abundance	Near long-term mean	
Female Snow Crab Reproductive Failure	Near long-term mean	

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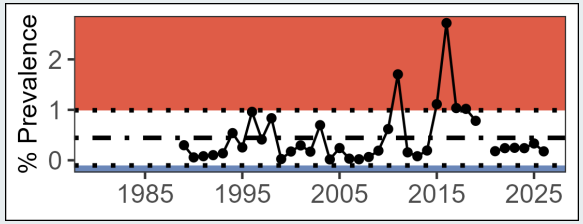
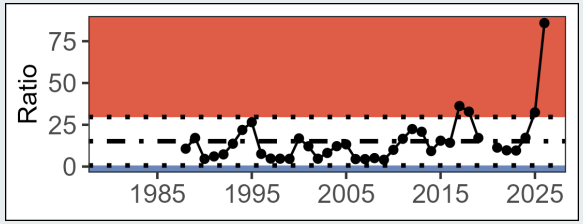
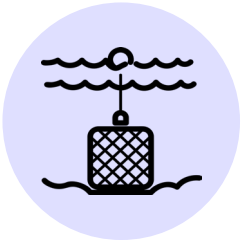
EBS Snow Crab ESP Report Card
Ecosystem Indicators

Contextual

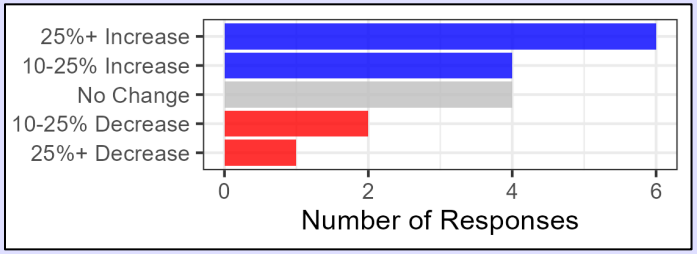
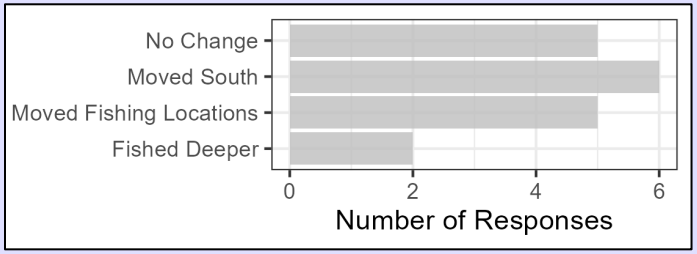
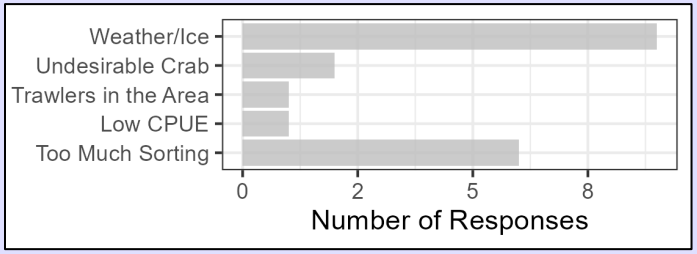
Indicator	Status	Trend
Juvenile Snow Crab Disease Prevalence	Near long-term mean	
Snow Crab Operational Sex Ratio	Above long-term mean	

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

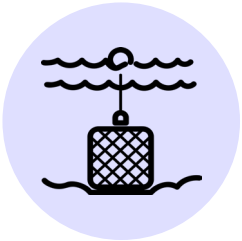
EBS Snow Crab ESP Report Card
Socioeconomic Indicators



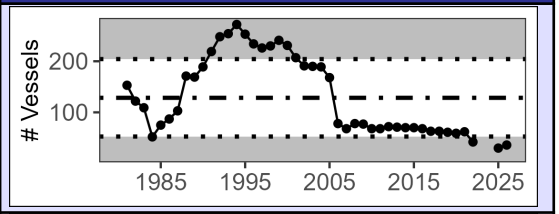
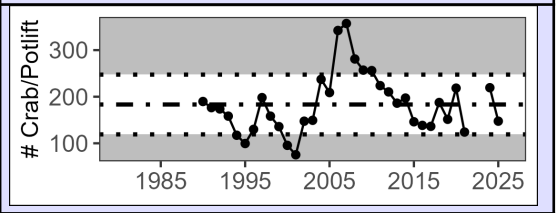
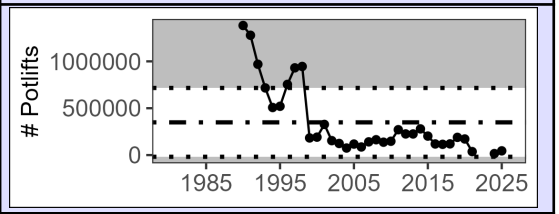
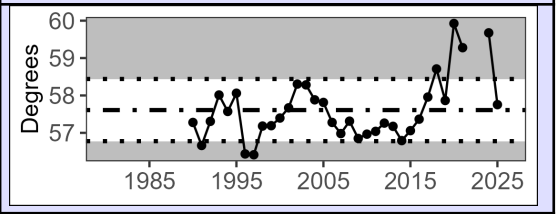
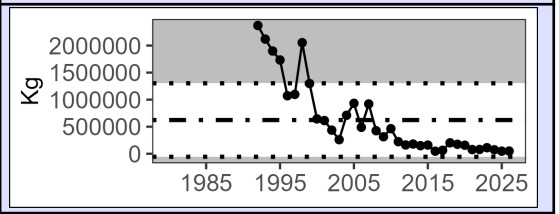
Fishery Informed

Indicator	Status	Trend
Skipper Survey: Perceived Abundance of Industry Preferred Males	Increase in perceived abundance	
Skipper Survey: Changes in Fishing Behavior	Change in area fished	
Skipper Survey: Motivation for Changes in Fishing Behavior	Weather challenges and more sorting	

EBS Snow Crab ESP Report Card
Socioeconomic Indicators



Fishery Informed

Indicator	Status	Trend
Number of Active Vessels	Below long-term average	
Fishery CPUE	Near long-term average	
Fishery Total Potlifts	Near long-term average	
Centroid of Fishery	Near long-term average	
Annual Incidental Catch	Near long-term average	

EBS Snow Crab ESP Report Card

Ecosystem Considerations for ABC and TAC

Predictive

- Juvenile snow crab **energetic condition** remains **elevated** in 2026, suggesting high survival due to elevated energetic stores.
- Juvenile snow crab **occupied temperatures** were **< 0°C** in 2026 and the **spatial extent of bottom waters ≤ 0°C** was **near average**, indicating conditions suitable for high survival, recruitment and stock recovery.
- Spring **sea ice extent increased substantially** in 2026 and is above the time series mean. High sea ice coverage promotes greater flux of primary production to the benthos and supports elevated energetic condition in juvenile snow crab.

Contextual

- Record-high mature female abundance in 2026 resulted in a **strongly female-skewed operational sex ratio** (85 mature females for every one >95mm large male), although only ~3% of mature females with empty clutches suggests **high reproductive potential**
- Bitter crab **disease** and **Pacific cod predation have** remained **below average** in recent years
- Mature male snow crab **center of abundance and area occupied** remain **near average** in 2026 despite relatively cold summer temperatures
- The **male size at 50% maturity** remains **near average** in 2026, although this indicator has been trending down for the past three decades.

EBS Snow Crab ESP Report Card

Socioeconomic Considerations for ABC and TAC

Fishery Informed

- Fishery **CPUE** and **total effort** in the fishery remain **below average**.
- Fishing during the 2025/26 season **shifted substantially to the southeast**, which is consistent with ~60% of skippers reporting that weather/sea ice, high sorting and fuel costs motivated this change in behavior.
- ~50% of skippers reported a **>10% increase in perceived abundance** of industry-preferred males relative to the previous open season, and 47% of skippers noted **slightly more to a lot more hybrid crab** than the previous season.


Questions?