Ecosystem & Socioeconomic Profile

Eastern Bering Sea Snow Crab

Erin Fedewa, Brian Garber-Yonts and Kalei Shotwell

September 2022

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NOAA FISHERIES

Overview

Sept 2022 Full ESP

- Intro: justification, data sources

- Metrics assessment: baseline, processes

- Indicators assessment: updates for current year indicators

- Recommendations; data gaps, future priorities

Appendix xx. Ecosystem and Socioeconomic Profile of the snow crab stock in the Eastern Bering Sea

Erin Fedewa, Brian Garber-Yonts, Kalei Shotwell, and Abby Tyrell

September 2022

FishWatch.gov
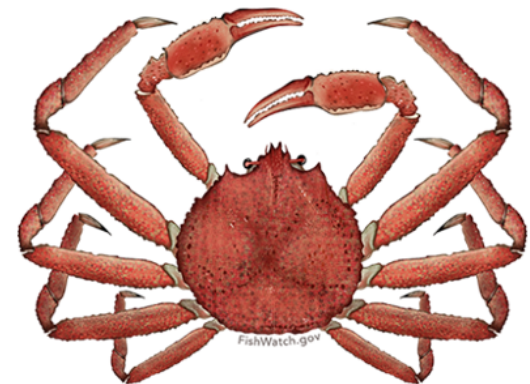
Responses to SSC Comments

"With regards to the Ecosystem and Socio-economic Profile (ESP) for snow crab, the SSC highlights previous requests to ESP analysts and Plan Teams to consider carefully the addition of social and community indicators in appropriate documents to meet requirements of National Standard 2. This is especially important for this stock in the context of upcoming rebuilding analyses and will be critical to track changes during rebuilding to account for the needs of affected communities and to ensure a fair and equitable distribution of rebuilding benefits and costs." (SSC, June 2022)

Moving forward, we plan to concentrate development of socioeconomic indicators in the ESP that are most directly associated with the condition or health of the stock and the conduct of the fishery, and therefore have the most direct bearing on the scope of stock assessment development and harvest specification decision processes that are the focus of ESP documents.

Effort has also been made to incorporate fishery-derived community indicators in this document that were developed from Alaska Bering Sea Crabber's Skipper Surveys distributed to the snow crab fleet following the 2020-2021 and 2021-2022 directed fisheries. We see the Skipper Survey as a means to extract local stakeholder knowledge through industry collaborations to potentially inform better decision making and improve socioeconomic outcomes for the snow crab fleet.

# Ecosystem and Socioeconomic Processes
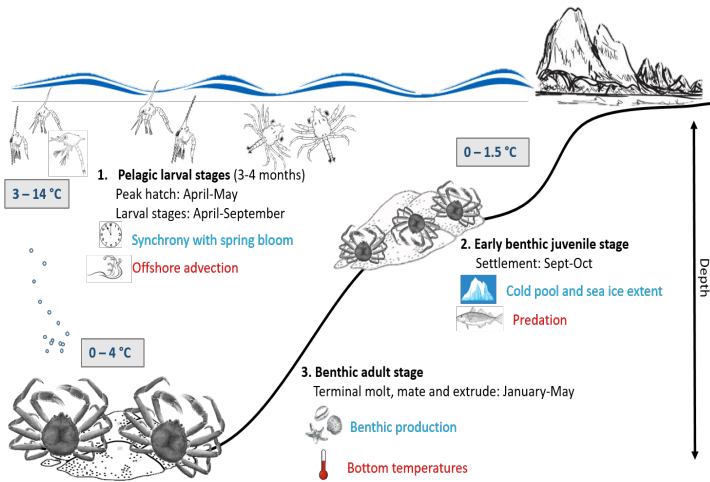
Stage	Habitat & Distribution	Phenology	Age, Length, Growth	Energetics
Egg	Clutch of embryos brooded under the female's abdomen until hatching	240 days at 6°C to 353 days at -1°C; cold temperatures trigger a 2-year reproductive cycle[1]	Egg diameter: 644.4-772.1 μm[2]	Optimal: 0°C – 3°C[3]
Larvae	Pelagic; concentrated in the upper 20m over the middle shelf[4]	April-June hatch	Mean carapace length: 1.25mm	Optimal: 6.9°C – 9.1°C[5]

- Ecosystem processes are evaluated across life history stage to highlight vulnerabilities and identify relevant indictors for monitoring

- Linkages between socioeconomic processes and stock health are hypothesized, but lack a working conceptual model

Ecosystem Indicators

Ecosystem Indicators
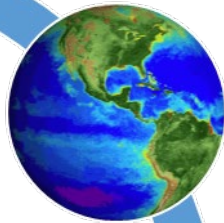
Physical
1. Arctic Oscillation (climate model)
2. Cold pool extent (BTS)
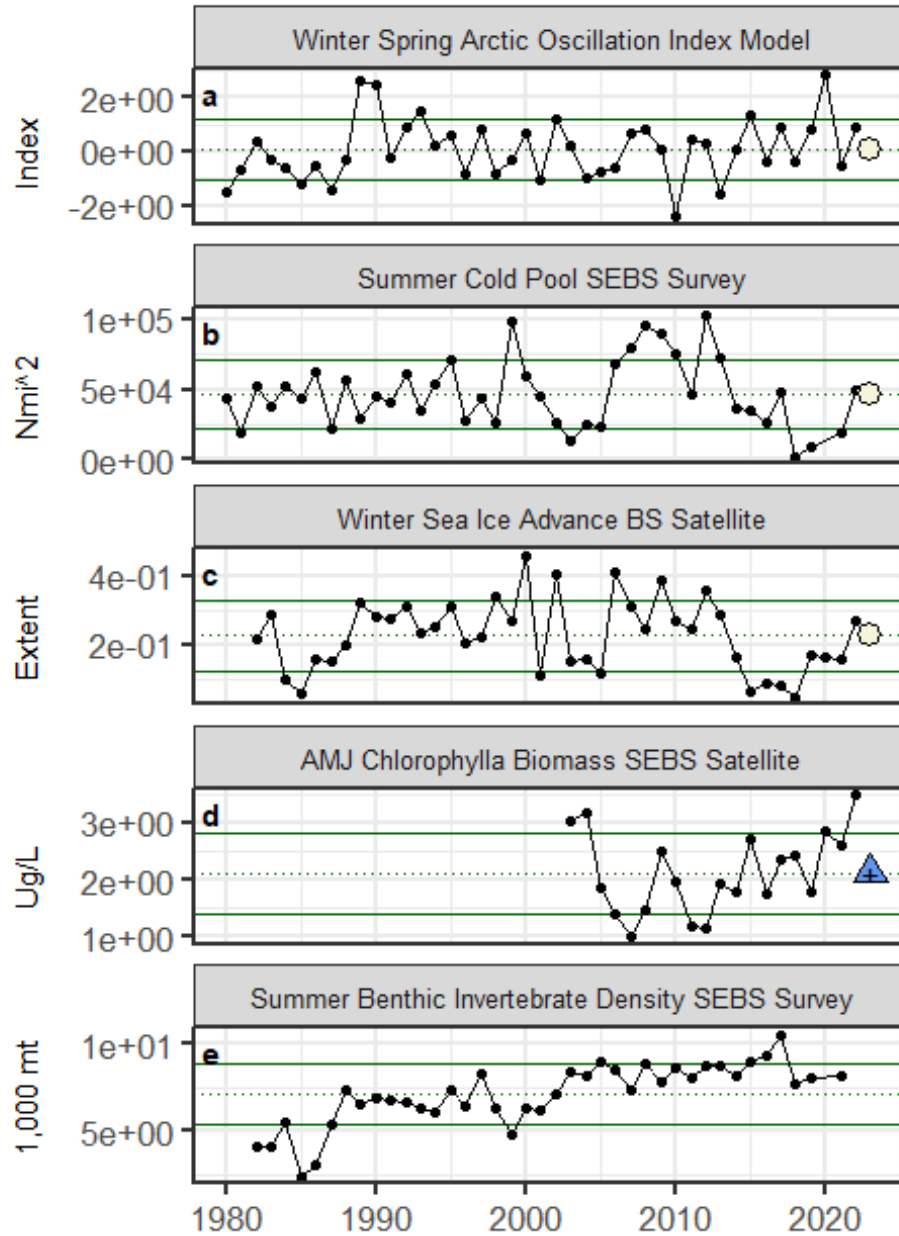3. Sea ice concentration (satellite)

Lower Trophic
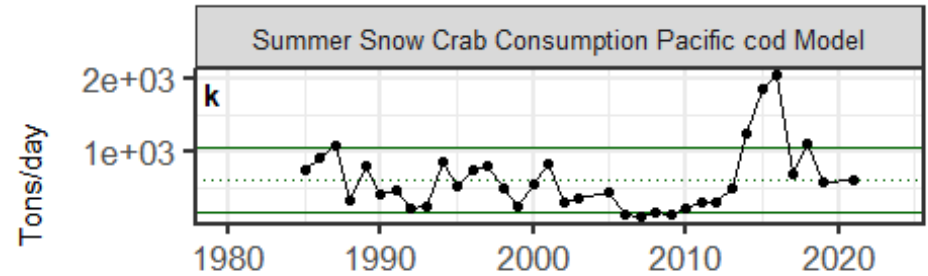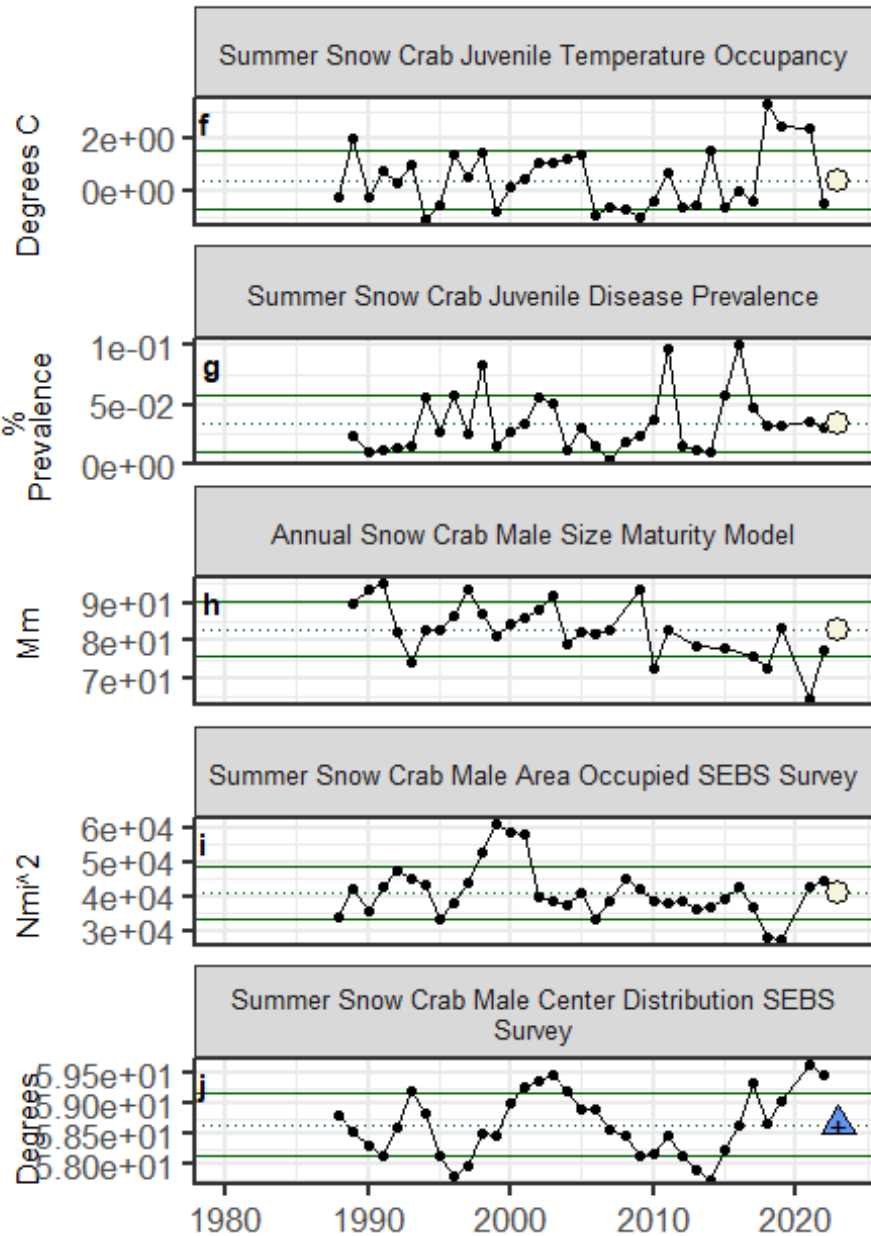4. Chl-a production (satellite)
5. Benthic invert density (BTS)

Upper Trophic
6. Snow crab area occupied (BTS)
7. Temperature of occupancy (BTS)
8. Snow crab center of abundance (BTS)
9. Pcod consumption of snow crab (BTS)
10. Male snow crab size at maturity (BTS)
11. Snow crab disease prevalence (BTS)

Ecosystem Indicators

Ecosystem Indicators

Ecosystem Indicator Traffic Light Table

Indicator category	Indicator	2018 Status	2019 Status	2020 Status	2021 Status	2022 Status
Physical	Winter Spring Arctic Oscillation Index- Model	neutral	neutral	**high**	neutral	neutral
	Summer Cold Pool- SEBS Survey	**low**	**low**	NA	**low**	neutral
	Winter Sea Ice Advance BS- Satellite	**low**	neutral	neutral	neutral	neutral
Lower Trophic	Chlorophyll-*a* Biomass SEBS- Satellite	neutral	neutral	*high*	neutral	*high*
	Summer Benthic Invertebrate Density- SEBS Survey	neutral	neutral	NA	neutral	NA

Ecosystem Indicator Traffic Light Table

Indicator category	Indicator	2018 Status	2019 Status	2020 Status	2021 Status	2022 Status
Upper Trophic	Summer Snow Crab Juvenile Temperature Occupancy	**high**	**high**	NA	**high**	neutral
	Summer Snow Crab Juvenile Disease Prevalence	neutral	neutral	NA	neutral	neutral
	Annual Snow Crab Male Size Maturity- Model	**low**	neutral	NA	**low**	neutral
	Summer Snow Crab Male Area Occupied- SEBS Survey	**low**	**low**	NA	neutral	neutral
	Summer Snow Crab Male Center Distribution- SEBS Survey	neutral	neutral	NA	*high*	*high*
	Summer Snow Crab Consumption Pacific Cod- Model	**high**	neutral	NA	neutral	NA

Socioeconomic Indicators

Socio-economic Indicators

Fishery Performance

1. Center of gravity (snow crab fishery)
2. Catch-per-unit-effort (snow crab fishery)
3. Total potlifts (snow crab fishery)
4. Number active vessels (snow crab fishery)
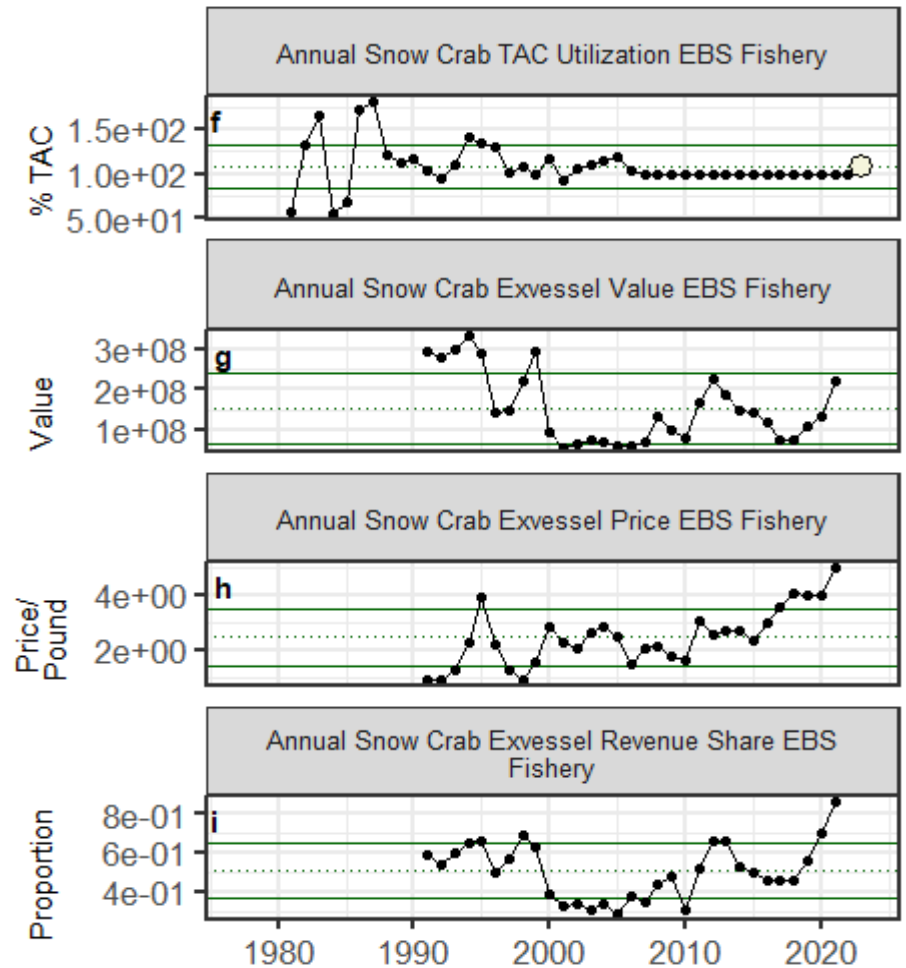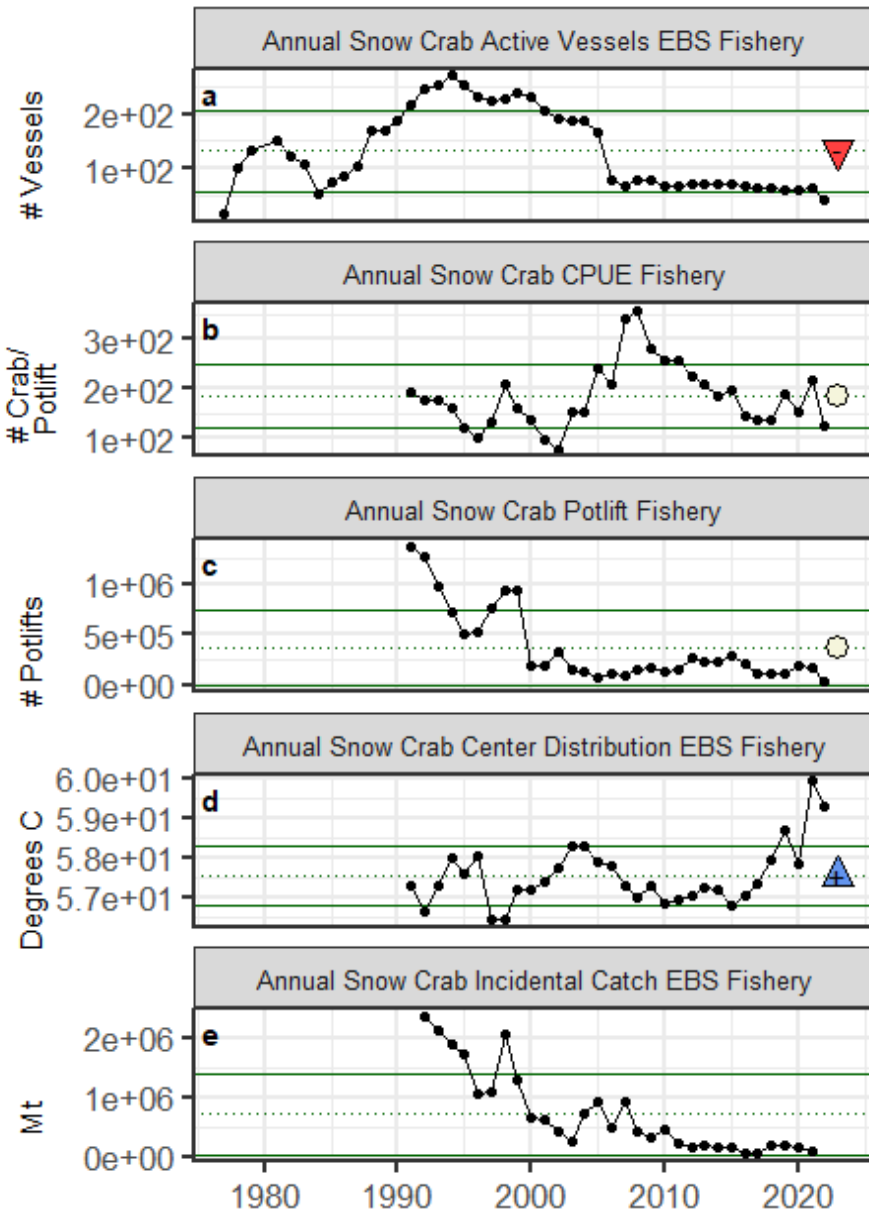5. Incidental catch of snow crab

Economic

6. Ex-vessel value (snow crab fishery)
7. Ex-vessel price/lb (snow crab fishery)
8. Ex-vessel revenue share (snow crab fishery)
9. TAC Utilization (snow crab fishery)

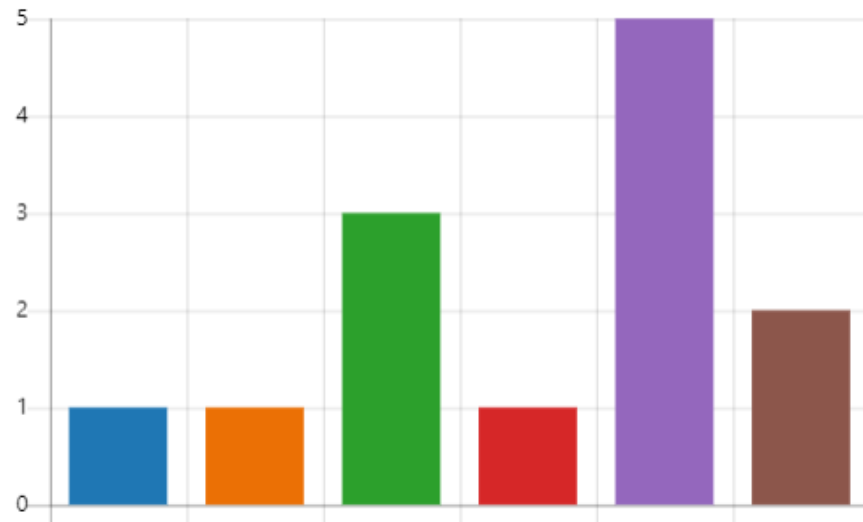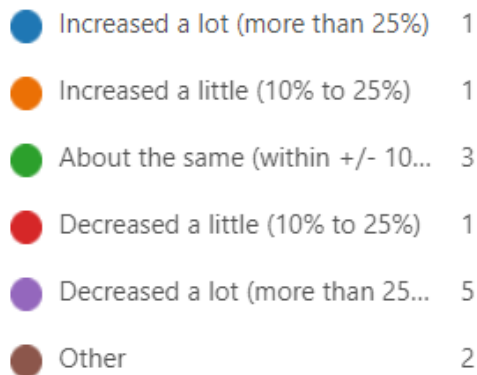**Community**

ABSC Skipper Survey Results

Socioeconomic Indicators

Development of future community indicators:
ABSC Skipper Survey

1. Based on your observations this snow crab season, how did the amount of industry preferred males that you encountered during the fishery change in comparison to the last snow crab season?

- Increased a lot (more than 25%)   1
- Increased a little (10% to 25%)   1
- About the same (within +/- 10...   3
- Decreased a little (10% to 25%)   1
- Decreased a lot (more than 25...   5
- Other   2

2021/2022 ABSC Skipper Survey Results

Comparing perceived abundances between years:
- 38% of skippers reported that commercial sized males had decreased more than 25%
- 31% of skippers reported that sub-commercial sized males had decreased more than 25%.

Fishing behavior:
- 23% of skippers noted that they fished deeper compared to the previous season
- Another 23% noted no significant changes in behavior and attributed their motivation to fish historic grounds to smaller quotas during the 2021/2022 season.

Sorting dirty/small crab:
- 38% of skippers replied that discarding decreased more than 25% from last season
- 70% of skippers noted an increase in Pacific cod in crab pots compared to the past season.

Socioeconomic Indicator Traffic Light Table

Indicator category	Indicator	2018 Status	2019 Status	2020 Status	2021 Status	2022 Status
Fishery Performance	Annual Snow Crab Active Vessels EBS Fishery	neutral	neutral	neutral	neutral	low
	Annual Snow Crab CPUE Fishery	neutral	neutral	neutral	neutral	neutral
	Annual Snow Crab Potlift Fishery	neutral	neutral	neutral	neutral	neutral
	Annual Snow Crab Center Distribution EBS Fishery	neutral	high	neutral	high	high
	Annual Snow Crab Incidental Catch EBS Fishery	neutral	neutral	neutral	neutral	NA
Economic	Annual Snow Crab TAC Utilization EBS Fishery	neutral	neutral	neutral	neutral	neutral
	Annual Snow Crab Exvessel Value EBS Fishery	neutral	neutral	neutral	neutral	NA
	Annual Snow Crab Exvessel Price EBS Fishery	high	high	high	high	NA
	Annual Snow Crab Exvessel Revenue Share EBS Fishery	neutral	neutral	high	high	NA

Indicator Analysis Stage 1: Traffic Light Score
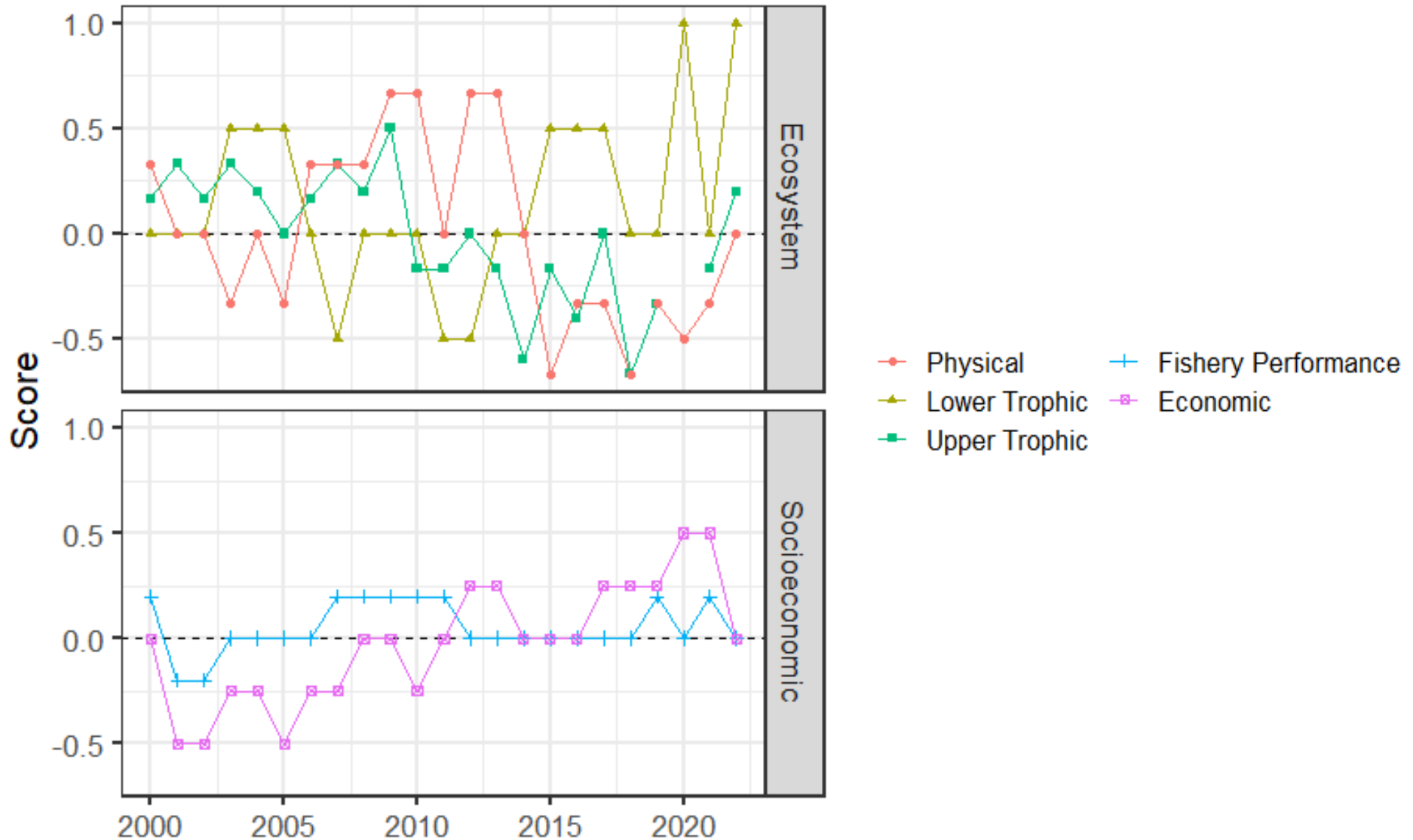
Indicator Analysis Stage 2: BAS Indicator Importance
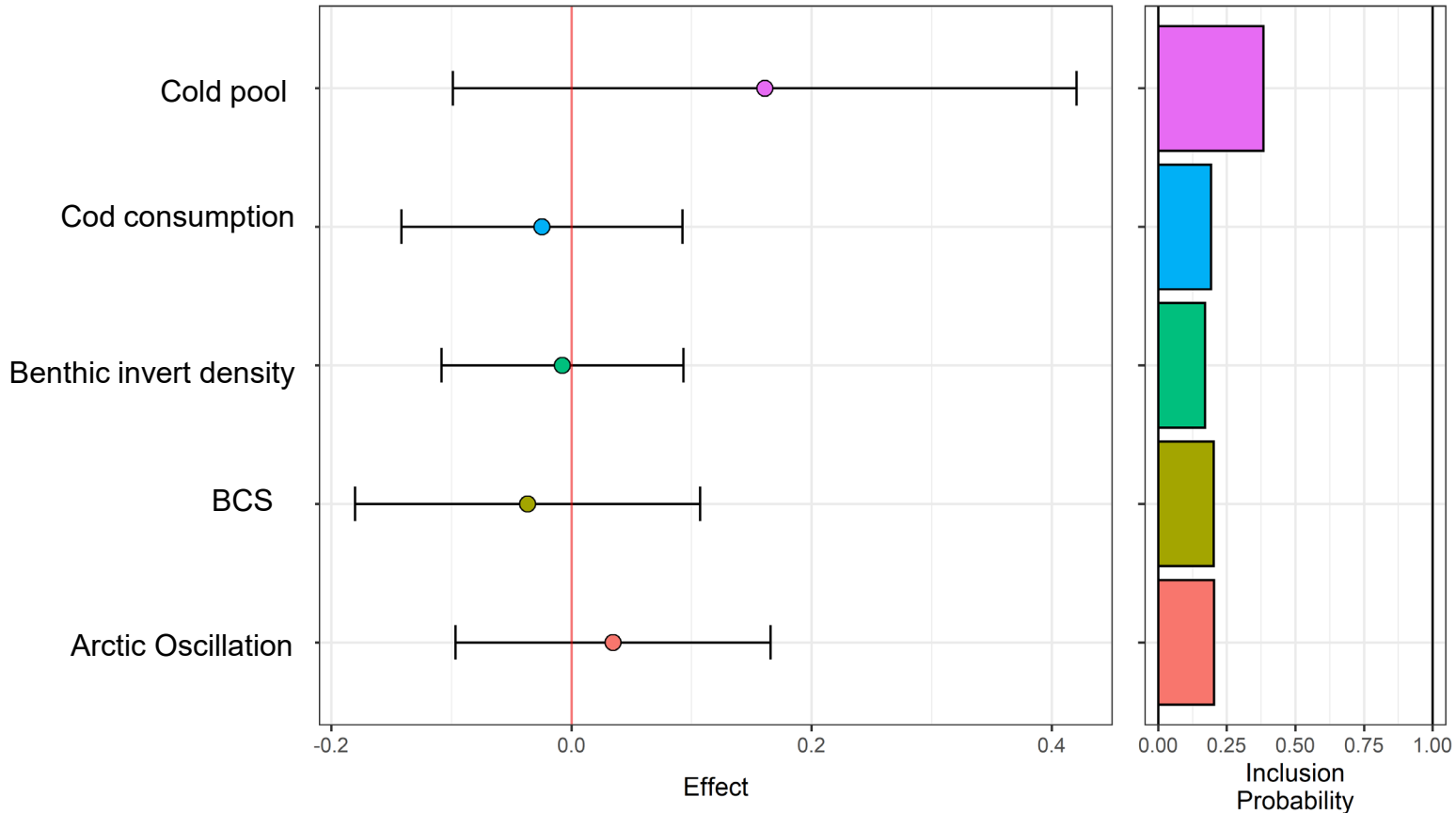
The highest ranked predictor was the cold pool extent, although effect sizes were relatively small (<0.2) and marginal inclusion probabilities were < 0.5 for all predictors

Ecosystem Considerations

- Near-normal cold pool extent and sea ice concentration indicate a **return to average environmental conditions** in the Bering Sea.

- Temperatures occupied by juvenile snow crab decreased by nearly 3°C from 2021 to 2022, suggesting **optimal cold-water habitat availability** for predator refuge.

- Above-average chl-a biomass and benthic invertebrate density may be indicative of **increased prey resources** for larval and benthic stages of snow crab

- Disease prevalence and Pacific cod consumption remain **near-average** in 2022

- The average **center of abundance** of mature male snow crab from 2021-2022 was the **most northerly in the 34-year time series**, indicative of a large-scale distribution shift from historic mid-shelf habitats.

Socioeconomic Considerations

- **Vessel participation** in the EBS snow crab fishery declined to 42 in 2022, the **lowest level since 1977** and approximately 68% of the average fleet size over the previous five years.

- Fishery performance indicators, including low CPUE during 2022 and the extreme northerly shift of the center of distribution of fishing activity observed in 2021 and 2022, combined with results of a survey of snow crab vessel captains, were indicative of **adverse fishing conditions during 2022**.

- Recent market trends combined with adverse fishery performance indicators reported for 2022 are evidence of **severe economic stresses** in the fishery and dependent stakeholders

Data gaps and future research directions

Ecosystem:
- Development of Essential Fish Habitat maps for snow crab by life history stage to provide spatial bounds to subset physical and lower trophic level datasets

- Development of indicators that quantify snow crab physiological and biological responses to rapidly changing ecosystem conditions in the Bering Sea
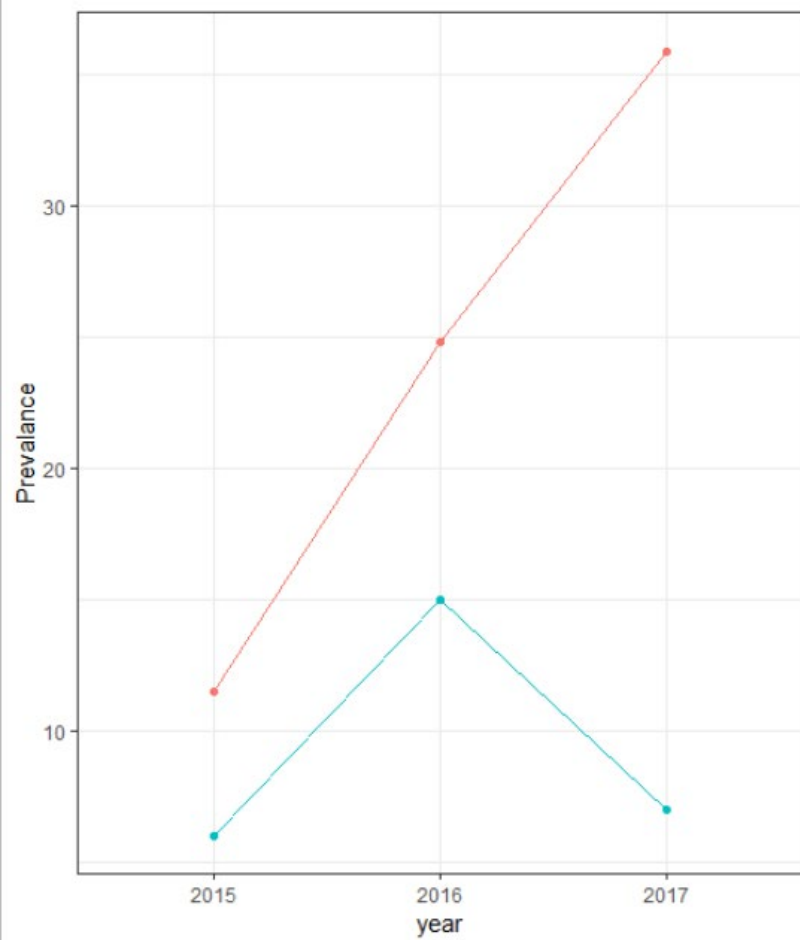
Socioeconomic:
- Research in spatial aspects of the EBS snow crab fishery with direct relation to the stock assessment to further develop relevant and informative socioeconomic indicators

- Improving the timeliness of socioeconomic indicators, including use of models for nowcast/forecast of time series
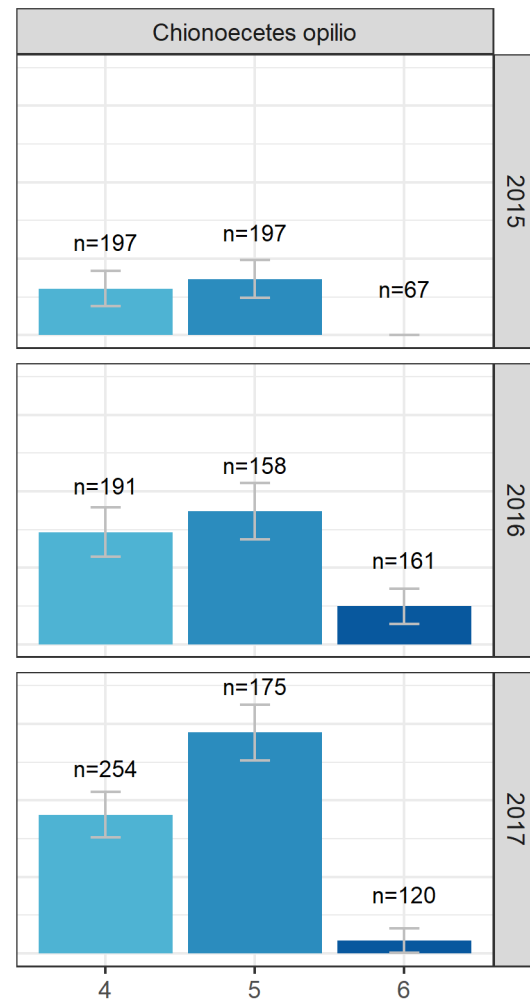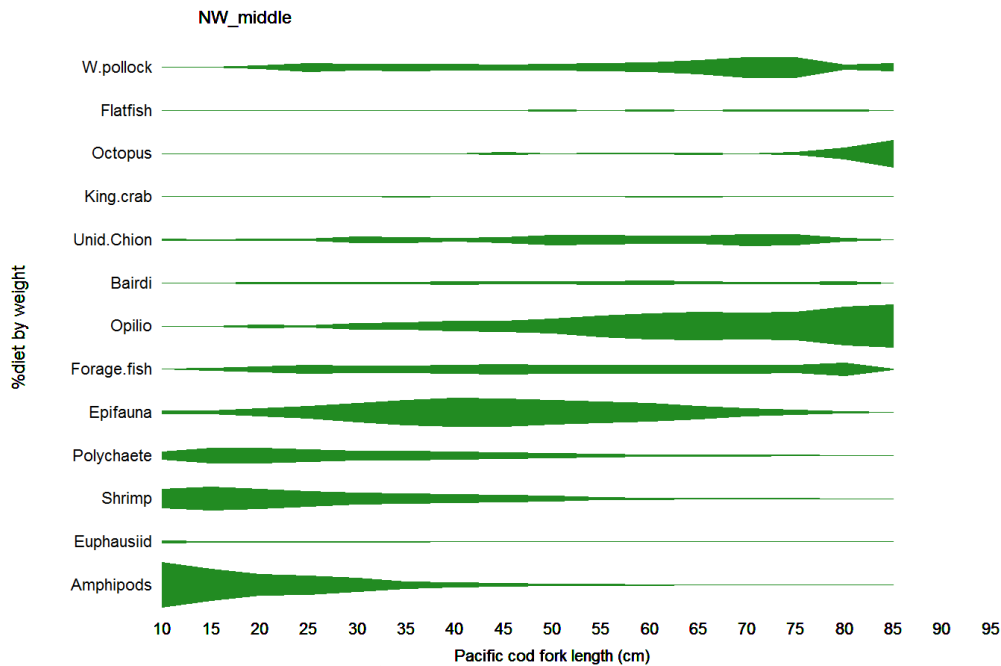
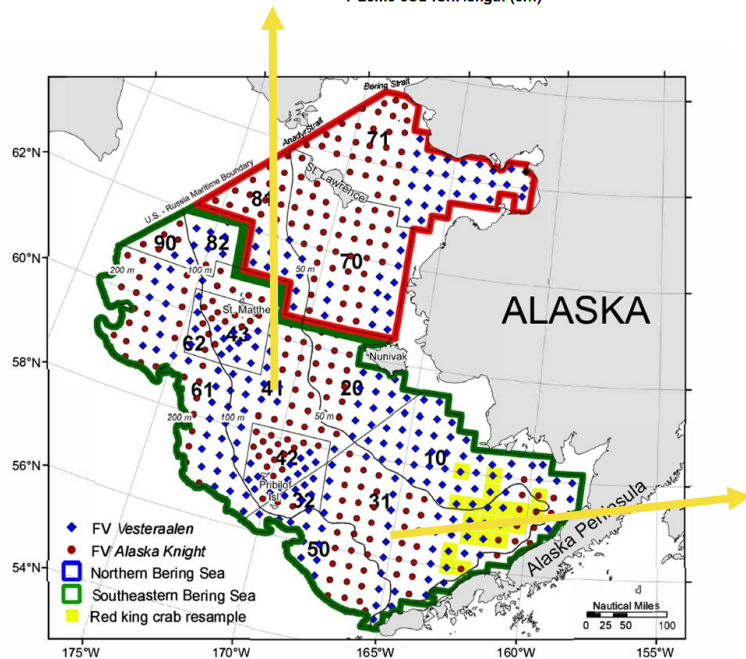Questions?

Location matters - N versus S middle domains

Figure 2. -- Sampled survey stations by vessel and the stratification scheme used for data analysis of the 2017 eastern and northern Bering Sea continental shelf bottom trawl surveys.