Ecosystem & Socioeconomic Profile

General Update

May 2025 Crab Plan Team Meeting

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With helpful input from Shannon Hennessey, Kalei Shotwell and Mike Litzow
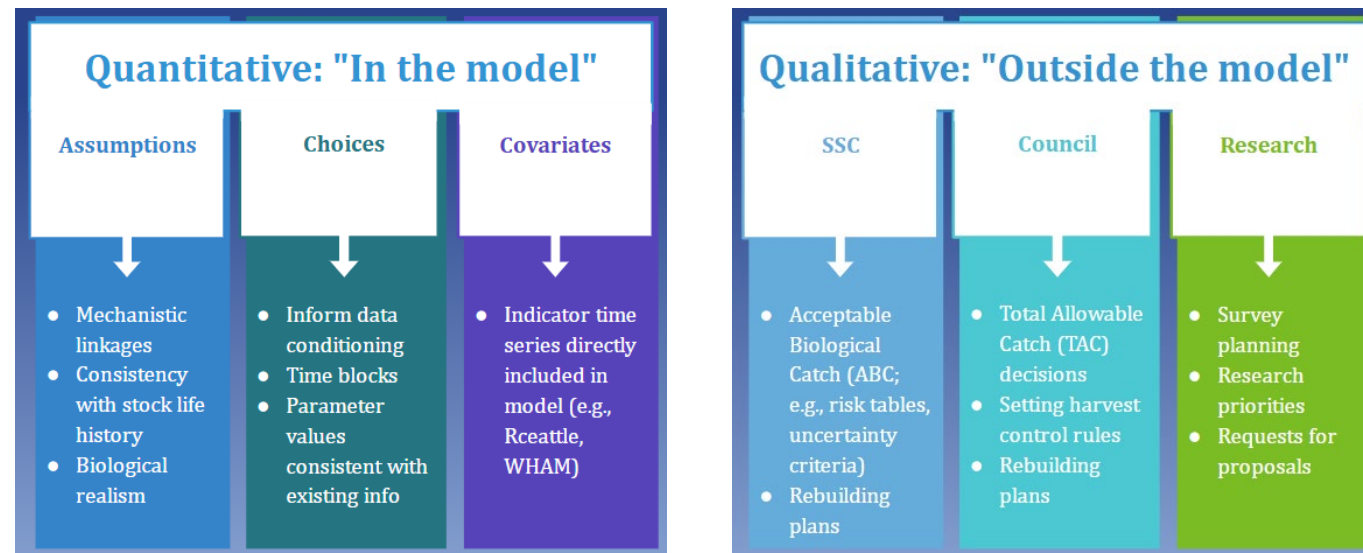
Ongoing ESP Challenges identified by CPT:

Decision points in the management process are informed by both qualitative/contextual information and quantitative/predictive information, but ESP indicators are not communicated to align with these intents

- Unclear which ESP indicators should be considered in qualitative management on-ramps like risk tables vs. quantitative on-ramps like research models

Many ecosystem indicators in crab ESPs haven't been quantitatively linked to population processes despite hypothesized mechanistic links

- CPT consensus that linkages should be clearly observed to permit use of indicator in management advice

Ongoing ESP Challenges identified by CPT:

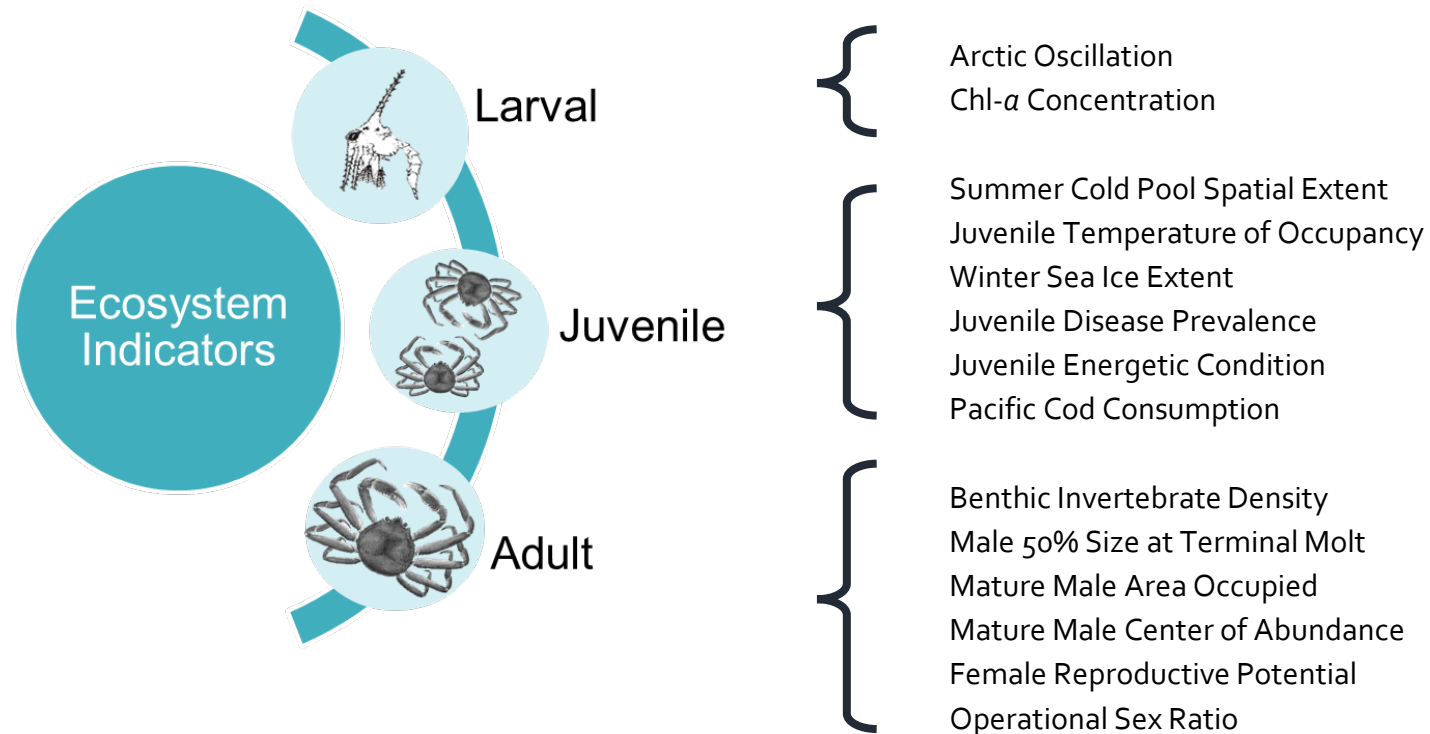Ecosystem indicator traffic light approach assumes directional relationship and stationarity

ESP has no mechanism for down-weighting indicators that don't quantitatively inform population processes

No precedence for dropping uninformative indicators in ESPs can lead to information overload

Indicator category	Indicator	2020 Status	2021 Status	2022 Status	2023 Status	2024 Status
Larval	Chlorophyll *a* Concentration	neutral	neutral	neutral	**low**	neutral
	Arctic Oscillation Index	**high**	neutral	neutral	neutral	neutral
Juvenile	Summer Cold Pool Extent	NA	**low**	neutral	neutral	neutral
	Juvenile Snow Crab Temperature of Occupancy	NA	**high**	neutral	neutral	neutral
	Winter Sea Ice Extent	neutral	neutral	neutral	neutral	neutral
	Juvenile Snow Crab Disease Prevalence	NA	neutral	neutral	neutral	neutral
	Juvenile Snow Crab Energetic Condition	NA	neutral	neutral	neutral	neutral
	Summer Pacific Cod Consumption	NA	neutral	neutral	neutral	NA
Adult	Summer Benthic Invertebrate Density	NA	neutral	neutral	neutral	neutral
	Male Snow Crab Size at Terminal Molt	NA	**low**	neutral	neutral	neutral
	Summer Male Snow Crab Area Occupied	NA	neutral	neutral	neutral	**low**
	Summer Male Snow Crab Center of Abundance	NA	*high*	*high*	*high*	neutral
	Female Snow Crab Reproductive Potential	NA	neutral	**low**	neutral	neutral
	Snow Crab Operational Sex Ratio	NA	neutral	neutral	neutral	neutral

Ongoing ESP Challenges identified by CPT:

Ecosystem indicators are currently categorized by life history stage in crab ESPs rather than weighting by importance to stock, so it is difficult to discern which indicators are most important


Larval
- Arctic Oscillation
- Chl-a Concentration

Juvenile
- Summer Cold Pool Spatial Extent
- Juvenile Temperature of Occupancy
- Winter Sea Ice Extent
- Juvenile Disease Prevalence
- Juvenile Energetic Condition
- Pacific Cod Consumption

Adult
- Benthic Invertebrate Density
- Male 50% Size at Terminal Molt
- Mature Male Area Occupied
- Mature Male Center of Abundance
- Female Reproductive Potential
- Operational Sex Ratio

Ecosystem Indicators

Proposed Solution

**Ecosystem Indicators**

Predictive

Contextual

Proposing a new ESP ecosystem indicator workflow and communication pathway to:

- Develop criteria that categorize ecosystem indicators as predictive or contextual

- Improve communication of indicator importance and intent by highlighting indicators that demonstrate robust statistical relationships with stock
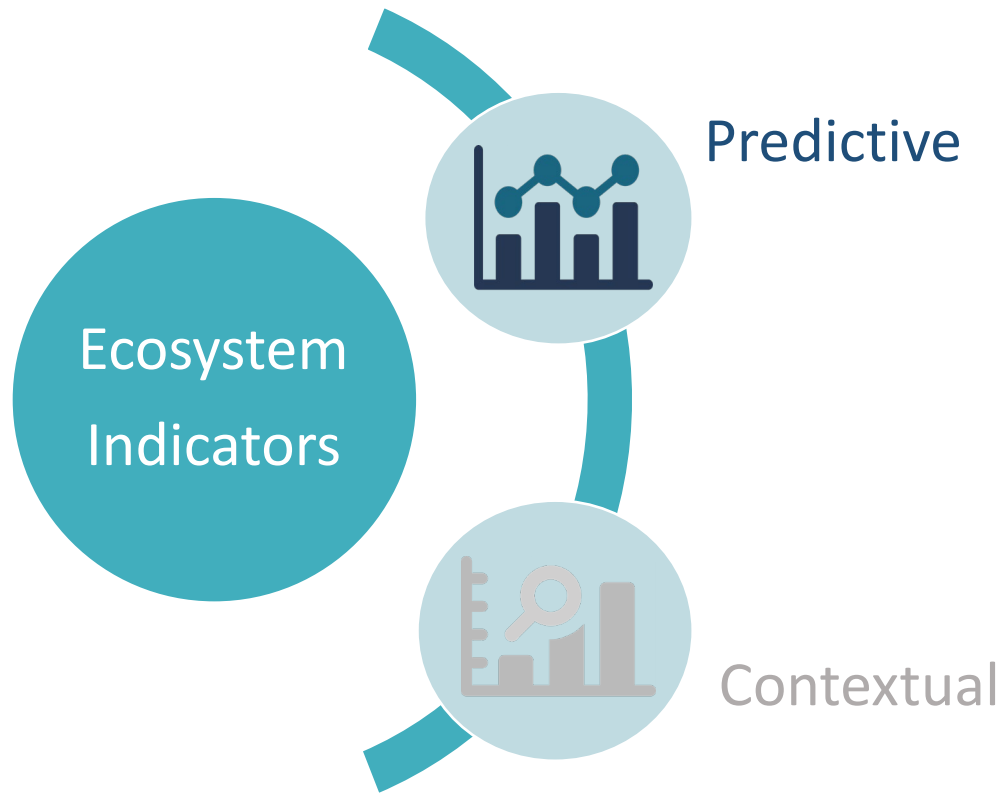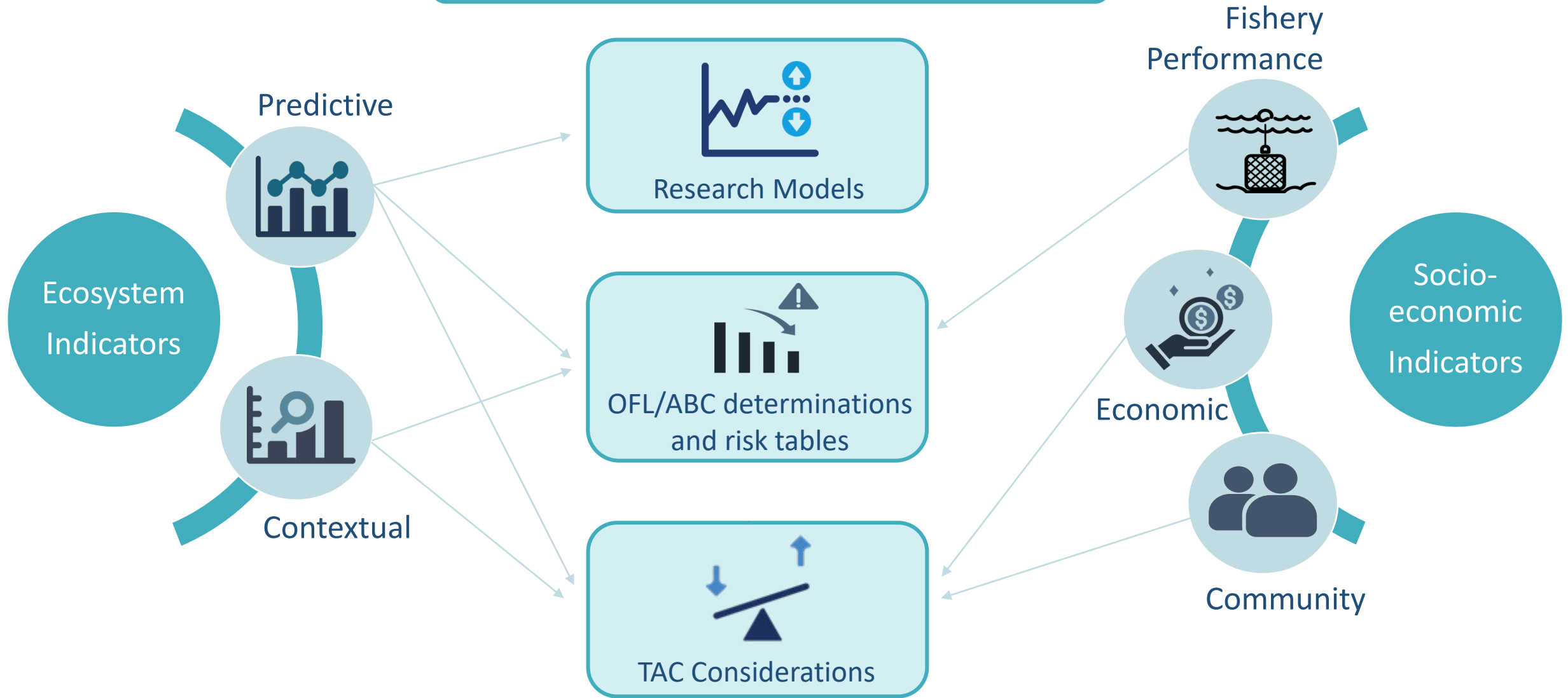
Predictive Indicator Evaluation Criteria

- Quantitative, demonstrated relationship with population processes – i.e. recruitment & mortality
  - Evaluated via indicator importance scores, out-of-sample predictive skill etc.

- Predictive Indicator Examples:
  - Juvenile snow crab temperature occupied
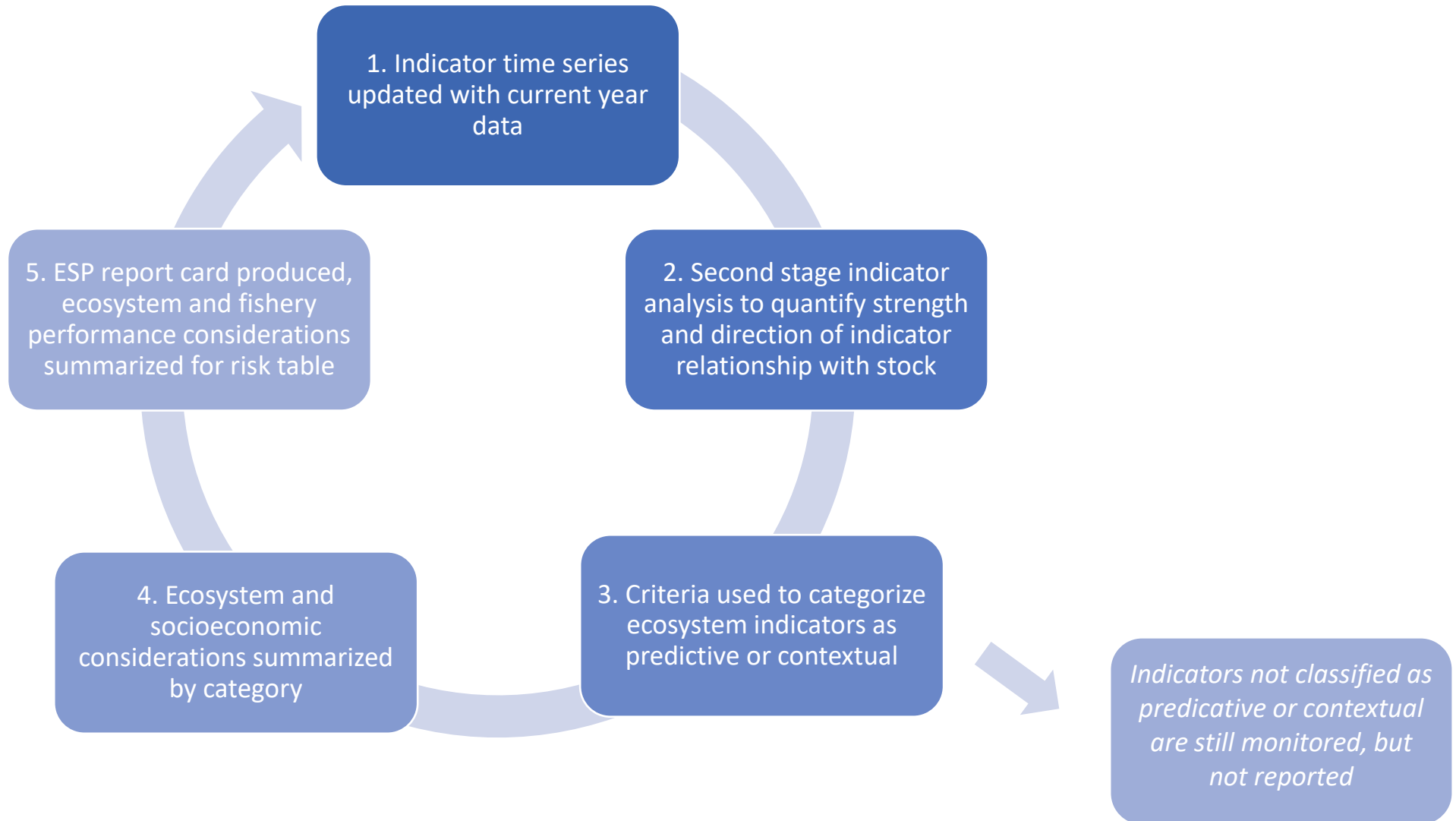 - Juvenile snow crab energetic condition

Ecosystem Indicators

Predictive
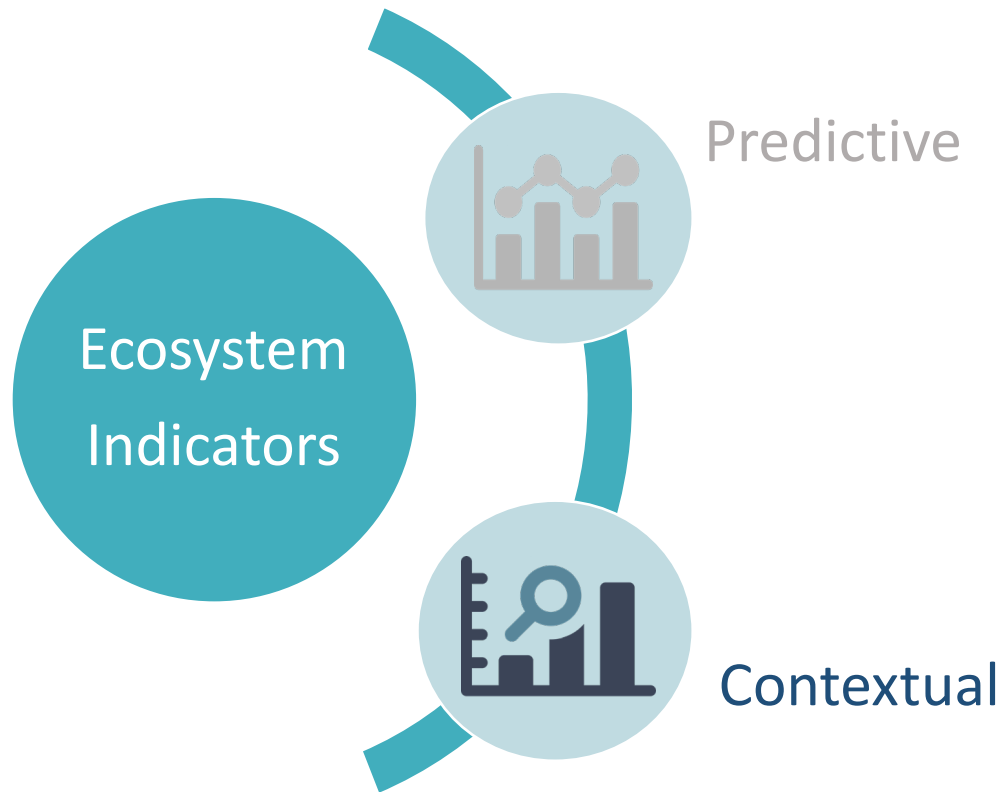
Contextual

Contextual Indicator Evaluation Criteria

- Highlights potential red flags related to the exploitable portion of the population (MMB), but is not a quantitative driver of recruitment
    - Examples: Mature male area occupied and center of abundance

- Provides anticipatory information or a direct measure of the status/health of large immature "pre-recruits" to the fishery or effective spawning biomass
    - Examples: Mature female clutch fullness, immature snow crab disease prevalence

- Provides contextual information to inform a management concern or risk table category
    - Example: BBRKC Northern District Ratio

Ecosystem and Socioeconomic Profile

Proposed annual workflow for ESP report cards

1. Indicator time series updated with current year data

2. Second stage indicator analysis to quantify strength and direction of indicator relationship with stock

3. Criteria used to categorize ecosystem indicators as predictive or contextual

4. Ecosystem and socioeconomic considerations summarized by category

5. ESP report card produced, ecosystem and fishery performance considerations summarized for risk table

Indicators not classified as predicative or contextual are still monitored, but not reported

Request for CPT Feedback

- Revisions/additions to indicator evaluation criteria?
- Overall thoughts on new categories and proposed attempt to improve communication/intent of ecosystem indicators?

Proposed Solution

Proposing a new ESP report card template to:

Improve communication of indicators for various ESP user groups

- Clear differentiation between predictive and contextual indicators
- Streamlining presentation of most noteworthy information only for rapid uptake under tight timelines

- Clarify the intent and management on-ramps for ecosystem and socioeconomic indicator categories
  - Which indicators feed into which management decisions?

PROPOSED REPORT CARD TEMPLATE

NOAA FISHERIES
Eastern Bering Sea Snow Crab

Ecosystem Considerations

Predictive

Juvenile snow crab occupied temperatures < 1°C are consistent with the return of cold water habitat required for rebuilding

Juvenile snow crab energetic condition remains high relative to the dramatic decline observed during the snow crab collapse

Contextual

A large proportion (90%) of mature females with full clutches suggests high reproductive potential despite depressed large male abundance and a heavily female-biased operational sex ratio

Socioeconomic Considerations

Fishery Performance

The Bering Sea snow crab fishery was closed for the 2022/23 and 2023/24 seasons, such that no data was generated

Economic

Unprecedented and ongoing economic and social pressures on the crab industry and stakeholder communities associated with the decline of BSAI crab fisheries

Community

Unprecedented and ongoing economic and social pressures on the crab industry and stakeholder communities associated with the decline of BSAI crab fisheries

Risk Tables   Research Model   TAC Considerations   **Management Utility or On-ramp**

NOAA FISHERIES
Eastern Bering Sea Snow Crab

Ecosystem Indicators

	Indicator	Current Status	Trend
Predictive	Juvenile Snow Crab Temperature of Occupancy	Below long-term mean (−)	
	Juvenile Snow Crab Energetic Condition	Above 5-year mean (+)	
Contextual	Juvenile Snow Crab Disease Prevalence	Near long-term average (~)	
	Male Snow Crab Size at Terminal Molt	Near long-term average (~)	
	Male Snow Crab Center of Abundance	Near long-term average (~)	

Link to ESP tech memo and ESP website with indicator data and full timeseries plots

Request for CPT Feedback

- Thoughts on report card format or suggestions for improvement? Any missing content?

- Formal ESP report card document still needed to detail indicator methodology and analyses?

Other ongoing ESP developments

- Continued coordination with AKFIN to automate socioeconomic indicators

- ESP report cards (BBRKC and Snow Crab) and full ESP (Tanner crab) to undergo AFSC internal review in fall

- Annual development of ESP tech memos

- Second stage indicator analysis methodology development
  - Response variables: recruitment and mortality
  - Sensitivity to lags and length of timeseries

- Dynamic Structural Equation Modeling Exploration