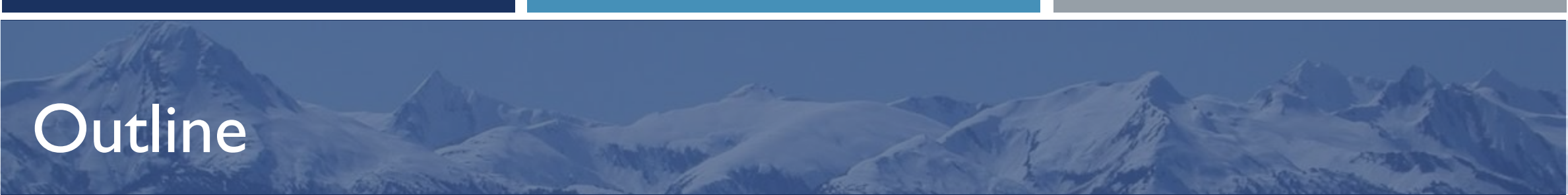


Ecosystem & Socioeconomic Profile (ESP) & Dynamic Structural Equation Model (DSEM) Workflow Update

Kalei Shotwell, Cole Monnahan



September 2026, Presentation to the Groundfish Plan Team



Outline

National ESPs

Coordination Team training at NSAW, guidelines and on-boarding tech memo, national R package

Alaska ESPs

ESP stock summary, PT/SSC recommendations, implemented ecosystem indicator categorization

ESP-DSEM Workflow

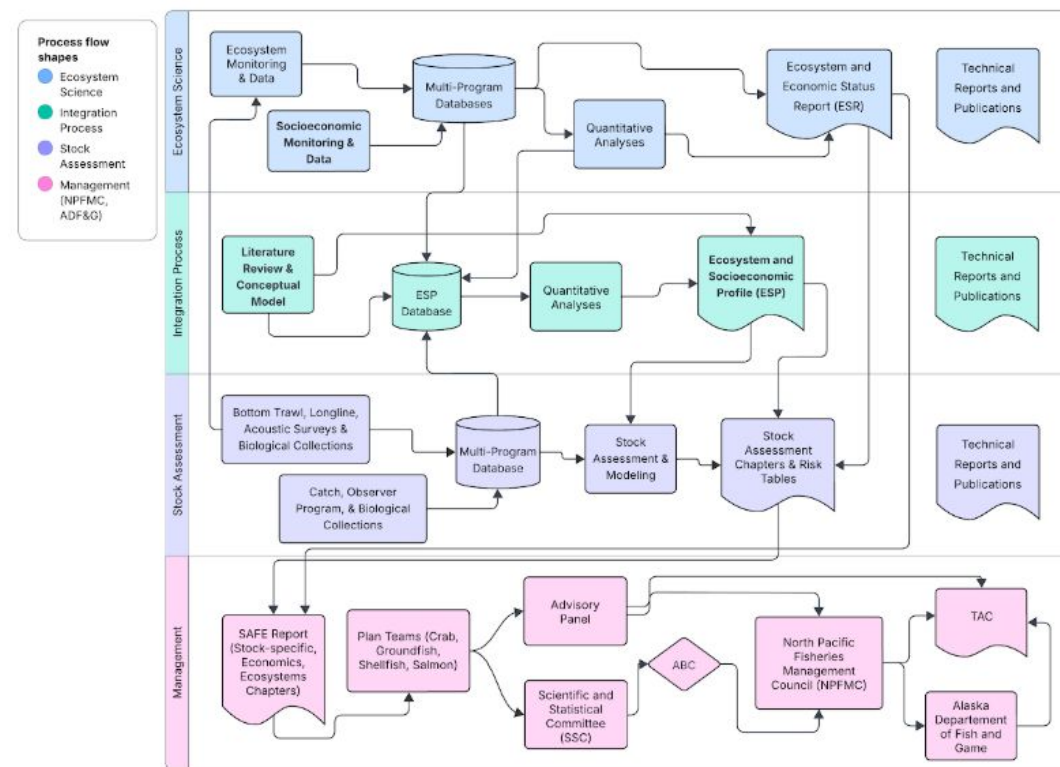
Overview of DSEM integration into ESP process, diagnostics, review of stocks exploring DSEM

Training ESP-DSEM Workflow

Pilot training completed in April 2026, NEFSC in two weeks, training plans for FY26/27

National ESP Team Progress 2026

- January 2026 NSAW Training
 - ESP introduction: why, how, when?
 - Regional workflow overview and breakout session to create/adjust
- National guidelines and ESP onboarding tech memo in prep
- National landing page and GitHub repo, coordination with NEAP



Alaska ESP Summary



Update ESP



Full ESP

2025 ESPs
conducted

2026 ESPs
planned

2027 ESPs
planned

Alaska Sablefish		Cancelled		
Aleutian Islands Atka mackerel		Draft Full ESP	NA	Full ESP
Eastern Bering Sea Pacific cod		Cancelled		
Bering Sea Snow crab				
Bering Sea Tanner crab		Full ESP	NA*	
Bristol Bay red king crab				
Gulf of Alaska pollock		Cancelled		
Gulf of Alaska Pacific cod		**		
Gulf of Alaska arrowtooth flounder		Draft Full ESP	Full ESP	NA
BSAI Greenland turbot		Requested	Draft Full ESP	Full ESP
Eastern Bering Sea Pollock		Requested 2021	Draft Full ESP	Full ESP

Note:

* Staffing capacity
shortage

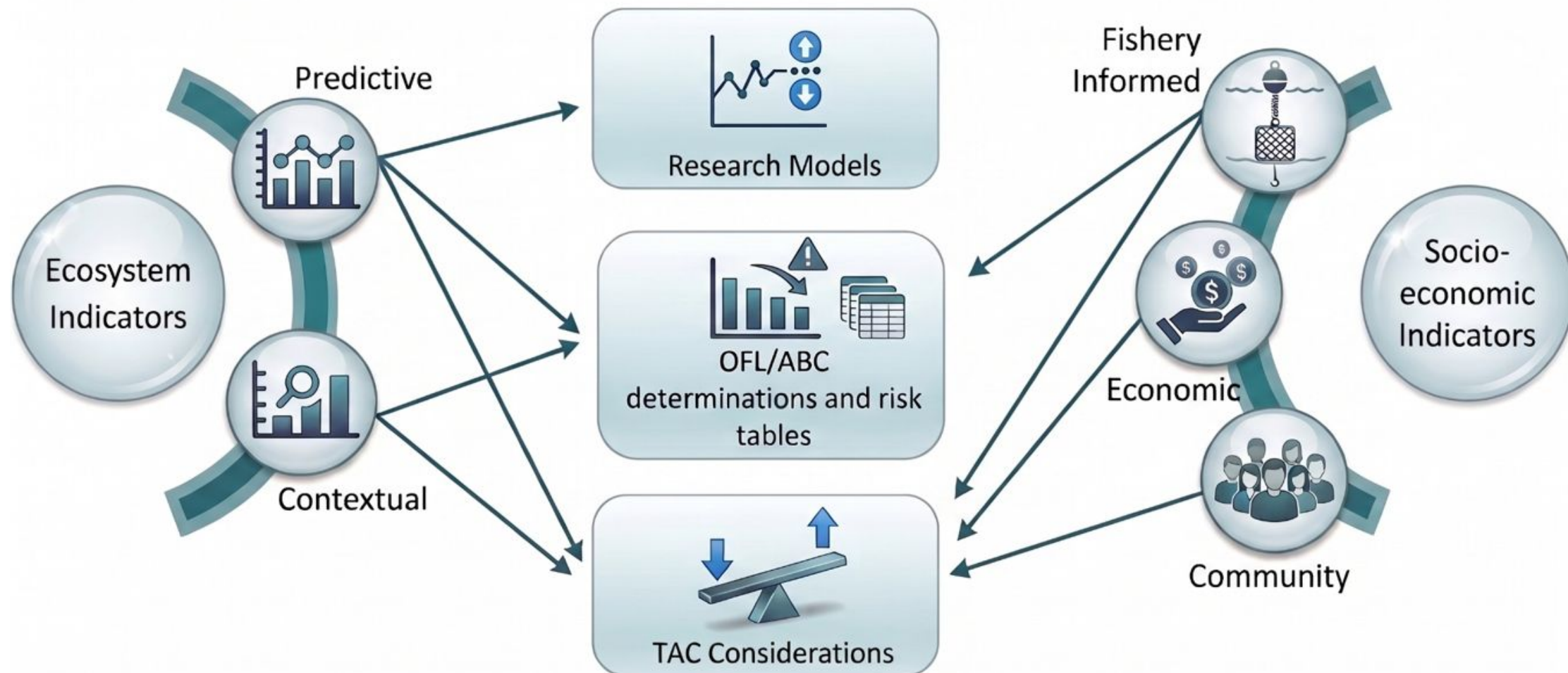
** Out-of-cycle
request



SSC/PT Recommendations - Summary

- Overall
 - PT: Recommended synthesizing contextual indicators by developing a multi-variate indicator to measure current year relative to historical conditions.
 - SSC: The SSC recognized progress with DSEM through RCEATTLE and encourages continued exploration of applications to additional stocks and supports efforts to create structured pathways for including environmental covariates in assessment models.
- Stock-specific
 - GOA arrowtooth: PT recommended the AFSC expert group develop proposed guidance for how to evaluate DSEM fits and how this effort can best be used in a management context. SSC supports ESP team categorizing indicators as predictive/contextual/monitoring.
 - Pacific cod: PT noted contents of the ESPs would be helpful in developing dynamic structural equation models (DSEMs) and causal diagrams in the future. SSC noted similar potential.

Ecosystem Indicator Categorization



ESP-DSEM Workflow

1

THEORY

– The Mechanism Table



Document expert hypotheses, expected causal impacts, and temporal lags.

2

MAPPING

– DAG Construction

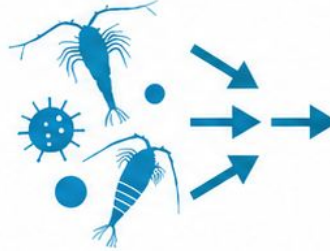


Build DAGs to define causal architecture and block bias.

3

FITTING

– Detached DSEM



Use Dynamic Structural Equation Modeling to validate trophic pathways.

4

VALIDATING

– Stock Dynamics



Link validated ecosystem drivers to recruitment and population trends.

5

SELECTING

– Management Advice



Translate results into risk tables and harvest specifications.

Data-Limited

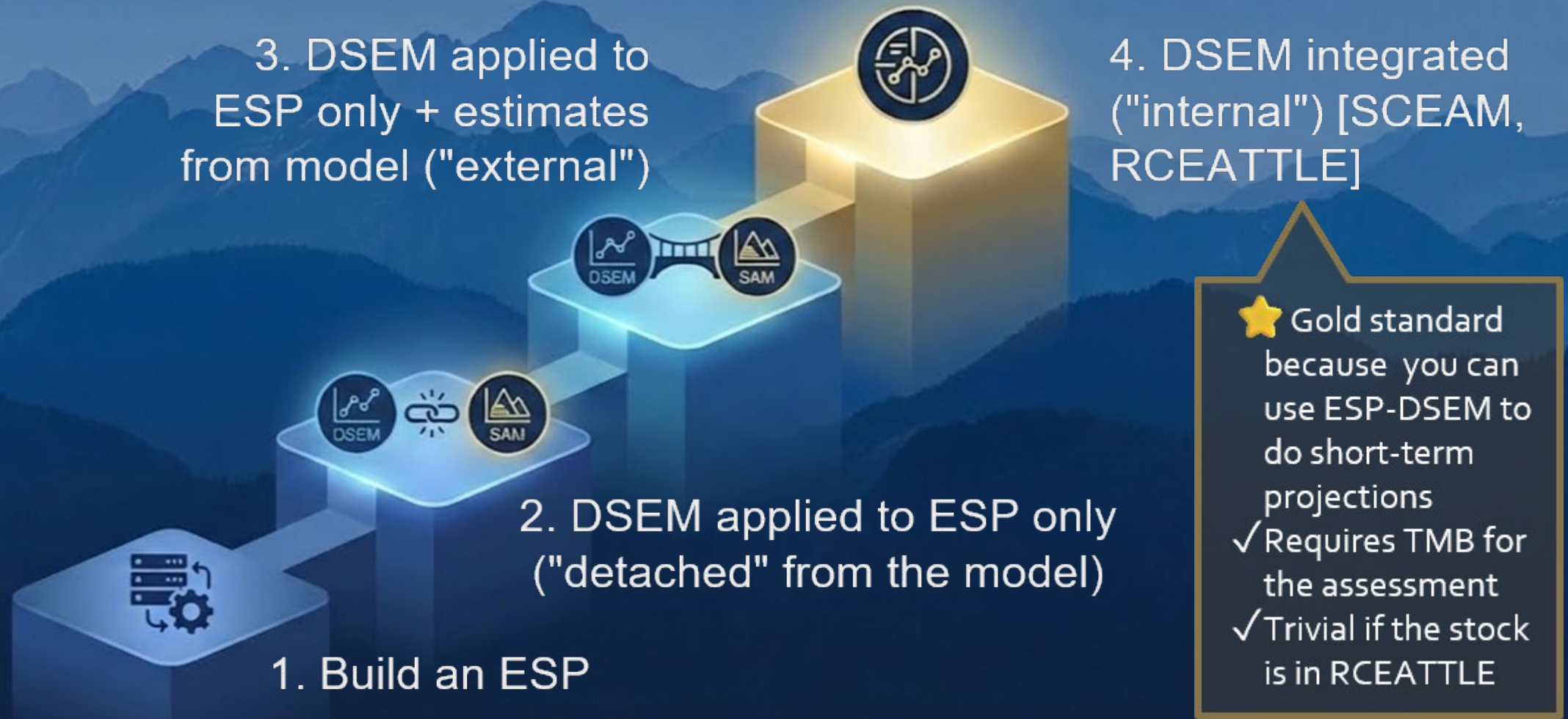
Data-Moderate

Data-Rich

ESP-DSEM Diagnostics

- Step 1: THEORY - Validates biological hypotheses based on expert consensus, explicit lag assumptions, and expected causal impacts.
- Step 2: MAPPING - Focuses on graphical structural checks of the Directed Acyclic Graph or DAG (such as acknowledging unobserved confounder bias).
- Step 3: FITTING - Establishes convergence gates for the detached subnetwork (invertible Hessian, low gradients) and checks goodness-of-fit via DHARMA randomized quantile residuals.
- Step 4: VALIDATING - Focuses on full model state-space diagnostics and checks to ensure estimated process variance has not collapsed to zero.
- Step 5: SELECTING - Lays out the hierarchical selection process (AIC, variance reduction, retrospective peels, and self-tests).

Levels of Analysis



External (Level 3) ESP-DSEM - GOA Arrowtooth



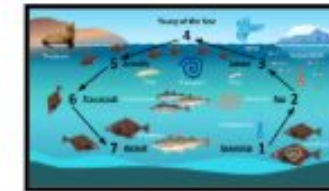
Plan Team Requests ESP

After the prototype sablefish ESP, the Plan Team recommended producing ESPs for the other focal species of the GOA-IERP

Indicator Category	Indicator	2019 Data	2024 Data	2025 Data	2026 Data
Stock	Age-0 recruitment (millions of fish)	100	100	100	100
	Age-1 recruitment (millions of fish)	100	100	100	100
	Age-2 recruitment (millions of fish)	100	100	100	100
	Age-3 recruitment (millions of fish)	100	100	100	100
Fishing	Age-0 fishing (millions of fish)	100	100	100	100
	Age-1 fishing (millions of fish)	100	100	100	100
	Age-2 fishing (millions of fish)	100	100	100	100
	Age-3 fishing (millions of fish)	100	100	100	100
Habitat	Age-0 habitat (millions of fish)	100	100	100	100
	Age-1 habitat (millions of fish)	100	100	100	100
	Age-2 habitat (millions of fish)	100	100	100	100
	Age-3 habitat (millions of fish)	100	100	100	100

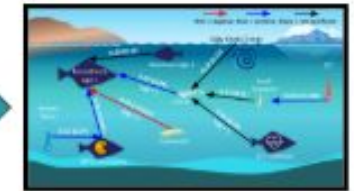
Arrowtooth ESP Mini

First draft of an ESP mini report with standard suite of indicators for the GOA arrowtooth prior to ESP team creation.



Draft Full ESP

Report and presentation to GOA Plan Team of draft full ESP and simplified external DSEM with preliminary results



DSEM Cookbook paper submitted and full ESP

Manuscript on DSEM applications submitted for review in Fish and Fisheries, includes GOA arrowtooth example. DSEM integrated RCEATTLE proposed as **research model** for future GOA arrowtooth assessments.

2016

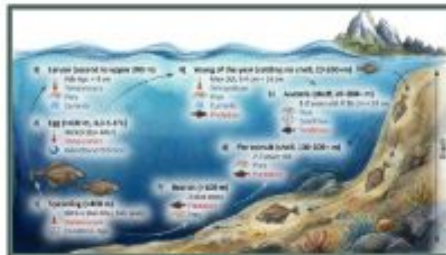
2019

2024

2025

Sept 2025

Sept 2026



PT/SSC Requests Recruitment and ESP

During the 2019 GOA arrowtooth SAFE, PT/SSC comments included investigating declining recruitment trends inclusive of generating an ESP.



Causal Model Development

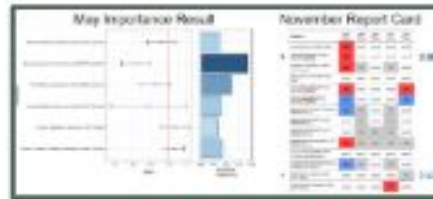
ESP Team and subject matter experts from AFSC and other agencies begin development of ESP, mechanism table, directed acyclic graphs or DAGs, and running dsem

Internal (Level 4) ESP-DSEM - GOA Pollock



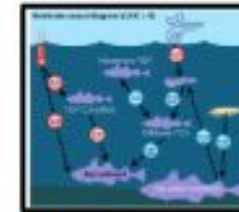
Plan Team Requests ESP

After the prototype sablefish ESP, the Plan Team recommended producing ESPs for the other focal species of the GOA-IERP



Pollock ESP Report Card

ESP report provided annually with Bayesian Adaptive Sampling method applied to analyze a small subset of indicators



SCEAM Manuscript Accepted

Series of DAGs for GOA pollock tested using a structural causal enhanced assessment model with DSEM finds **69% reduction** in recruitment variance

2016

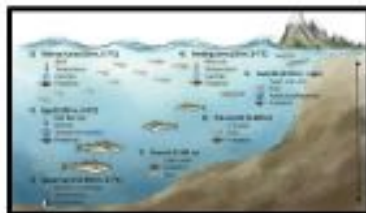
2019

2024

2026

2020-2023

2025



GOA Pollock ESP

ESP Team was developed during an AFSC ESP workshop in spring and completed the draft ESP report for Plan Team fall review



Causal Model Development

ESP Team and subject matter experts from AFSC and other agencies develop directed acyclic graphs or DAGs in workshops and results presented to GOA Plan Team

DSEM/RCEATTLE Operational

DSEM integrated RCEATTLE proposed as operational model for GOA pollock at Plan Team in fall



ESP-DSEM Integration Progress

DSEM Application Level

4 →
3 →
4 →
3 →
4 →



Update ESP



Full ESP

2025 ESPs
conducted

2026 ESPs
planned

2027 ESPs
planned

Alaska Sablefish



Cancelled

Aleutian Islands Atka mackerel



Draft Full ESP

Eastern Bering Sea Pacific cod



Cancelled

Bering Sea Snow crab



Bering Sea Tanner crab



Full ESP

Bristol Bay red king crab



Gulf of Alaska pollock



Cancelled

Gulf of Alaska Pacific cod



**

Gulf of Alaska arrowtooth flounder



Draft Full ESP

BSAI Greenland turbot



Requested

Eastern Bering Sea Pollock



Requested 2021



NA



Full ESP



NA*



Full ESP

Draft Full ESP

Full ESP

Draft Full ESP

Full ESP



ESP-DSEM Training (AFSC, NEFSC)

1. Morning Lectures

- a. Hybrid options
- b. Overview topics, deep dives and best practices

2. Afternoon Breakout

- a. In-person groups only
- b. PBJ flounder example

3. Regional Examples

- a. Troubleshooting
- b. Guidance for decisions

Welcome & Introduction
9 – 10am

Break, 10am

Overview Structural-
Causal Modeling
10:15am – 12pm

Lunch
12 – 1:30pm

Deep Dive on DAGs
1:30 – 2:30pm

Break, 2:30pm

Recap, Overflow, and
Prep for Day 2
2:45 – 4pm

Overview of DSEM
9 – 10am

Break, 10am

Model Creation and
Comparison
10:15am – 12pm

Lunch
12 – 1:30pm

Deep Dive on Snow Crab
1:30 – 2:30pm

Break, 2:30pm

Recap, Overflow, and
Prep for Day 3
2:45 – 4pm

Advanced Topics of DSEM
9 – 10am

Break, 10am

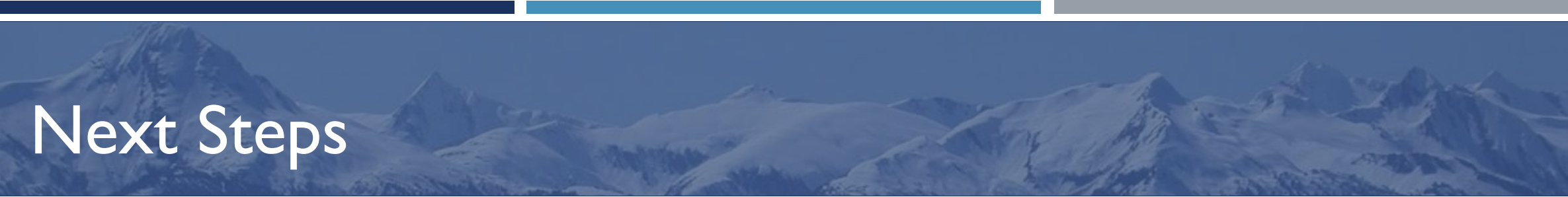
Best Practices of ESP-
DSEM Framework
10:15am – 12pm

Lunch
12 – 1:30pm

Bring Your Own DAGs
1:30 – 2:30pm

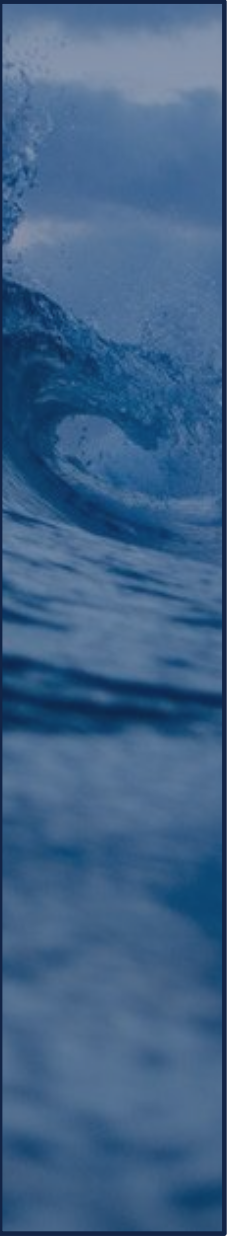
Break, 2:30pm

Sign-Up & Wrap-Up
2:45 – 4pm



Next Steps

- Adopted the new categorization for ecosystem indicators and the information is provided through coordinated risk table discussions
- Implementing the ESP-DSEM workflow through step-by-step guidance and associated diagnostics that are detailed in the ESP reports
- Next Steps:
 - Pending Plan Team and SSC feedback, begin applying ESP-DSEM workflow for all ESP stocks
 - Evaluate additional uses of ESP-DSEM output such as informing harvest projections for off-cycle assessments
 - Continue exploration and testing of model validation tools and good practices guide



Discussion

- 1) Can we adopt the ESP-DSEM workflow as a standard for the AFSC ESPs moving forward? Any concerns?
- 2) Do the listed diagnostics for the workflow cover what needs to be provided for evaluation of the ESP-DSEM? Are we missing anything?
- 3) Given the new workflow, do you still recommend the current list of stocks for ESPs? Are there any we should prioritize or that are missing?

Thank You!



Contact:

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Extra Slides Below

Alaska ESP Reports

Stock	Initiated	Full	Update*	Report card*
Sablefish	2017	2017 - <u>2019</u>	<u>2020</u>	<u>2021</u> , <u>2022</u> , <u>2023</u> , <u>2024</u>
Gulf of Alaska Pollock	2019	<u>2019</u>	<u>2020</u>	<u>2021</u> , <u>2022</u> , <u>2023</u> , <u>2024</u>
EBS Pacific Cod	2020	<u>2021</u>		<u>2021</u> , <u>2022</u> , <u>2023</u> , <u>2024</u>
GOA Pacific Cod	2020	<u>2021</u>	<u>2026</u>	<u>2021</u> , <u>2022</u> , <u>2023</u> , <u>2024</u> , <u>2026</u>
St Matthew Blue King Crab	2019	<u>2019</u>	<u>2020</u>	<u>2022</u>
Bristol Bay Red King Crab	2020	<u>2020</u>	<u>2025</u>	<u>2021</u> , <u>2022</u> , <u>2023</u> , <u>2024</u> , <u>2025</u>
Bering Sea Snow Crab	2021	<u>2022</u>	<u>2025</u>	<u>2023</u> , <u>2024</u> , <u>2025</u>
Bering Sea Tanner Crab	2024	<u>2025</u>		
GOA Arrowtooth Flounder	2024	2025 (<u>draft</u>)		
BSAI Atka Mackerel	<u>2025</u>			* 2025 new format