Ecosystem Socioeconomic Profile (ESP)

GOA Pacific Cod

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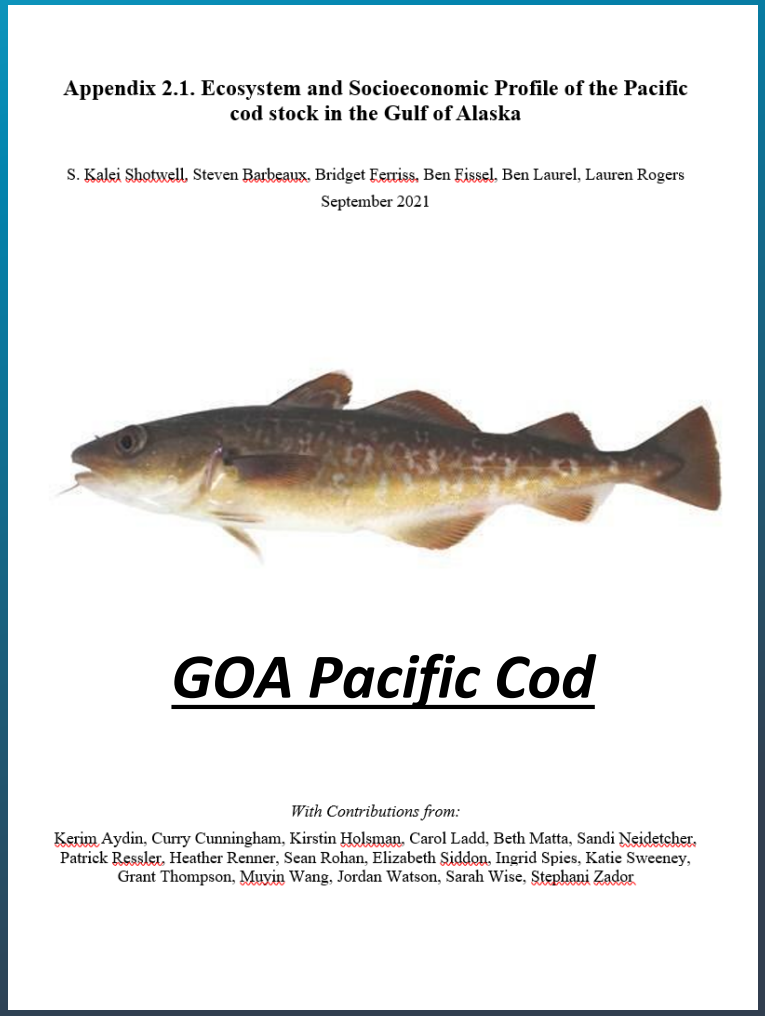
Overview

2021 GOA Pacific Cod ESP

- Recommended Dec 2019
- Team formed in Jan 2020
- Draft Full ESP in Nov 2020
- Final Full ESP Sep 2021
  - Allow for more team review
  - Updated comments, life history tables, literature cited
- 7 editors, 16 contributors



Appendix 2.1. Ecosystem and Socioeconomic Profile of the Pacific cod stock in the Gulf of Alaska

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September 2021

GOA Pacific Cod

With Contributions from:

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ESP Full Template

Stock/Complex:

Outline for Ecosystem and Socioeconomic Profile (ESP)

Executive Summary

- ❑ Short description of an ESP and summary of ecosystem and socioeconomic considerations from the recommendations section
- ❑ Response to Plan Team and SSC Recommendations
- ❑ Table of model performance where applicable

Introduction

Start with a short description of the ESP process with references

Justification & Data

- ❑ Stock-specific regional research priorities
- ❑ Scores in relevant national initiatives, stock assessment classification
- ❑ Brief description of data streams used, reference main SAFE
- ❑ Table of data sources, short description, references

Metrics Assessment

Identifies main processes, highlights mechanisms that lead to indicators

National Metrics

- ❑ Description and graph of relevant stock-specific measures collected in the national initiatives and associated stock vulnerabilities

Ecosystem Processes

- ❑ Summary of ecosystem processes that identify dominant pressures on the stock, evaluate by life history stage where possible with associated life history conceptual model and tables

Socioeconomic Processes

- ❑ Summary of socioeconomic processes that identify dominant pressures on the stock, evaluate by life history stage where possible with associated table of socioeconomic performance information

Indicators Assessment

Identifies the indicator suite and reviews the monitoring analyses

Indicator Suite

- ❑ Brief literature review on indicators previously explored for stock
- ❑ Description of indicator suite based on mechanisms identified in the metric assessment and literature review with time series graph

Indicator Monitoring Analysis

- ❑ Description of statistical tests for monitoring indicator suite (e.g., traffic light, importance methods, research ecosystem linked model)
- ❑ Supportive graphs and tables of statistical tests where relevant
- ❑ Table of model performance metrics (e.g. retrospective trends)

Recommendations

Summary of ecosystem and socioeconomic considerations for use in the main stock assessment

Ecosystem & Socioeconomic Considerations

- ❑ Summary conclusions from metric and indicator assessment

Data Gaps and Future Research Priorities

Description of metric or indicator data gaps, priorities for ecosystem and socioeconomic research that would support future versions of the ESP

Acknowledgements & Literature Cited

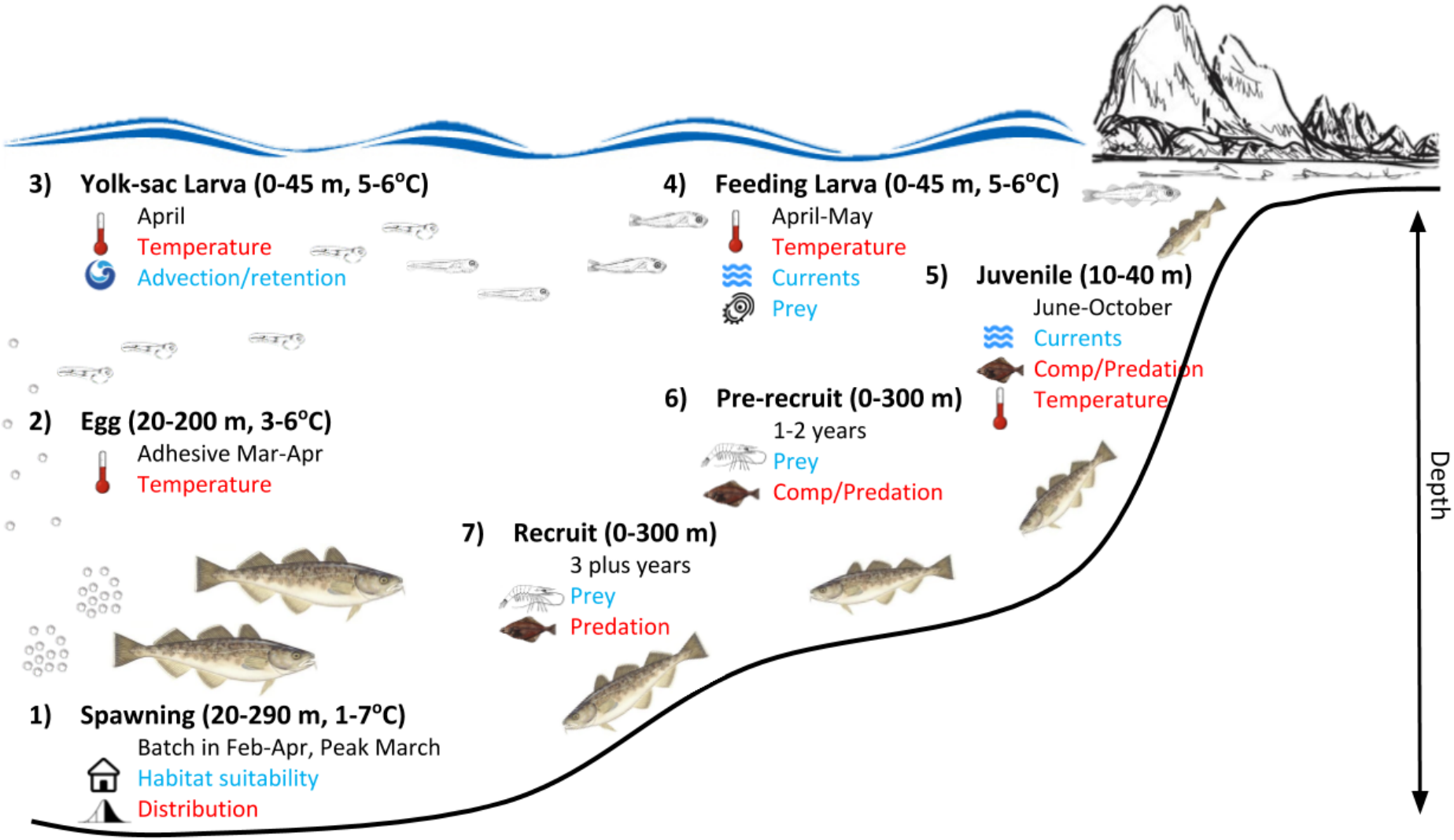
PT/SSC Comments

- Comments on ESPs in General
  - Develop method to aggregate indices into a score (SSC)
  - Do not rely on uninformed weighting, interpret indicators to be species-specific and not over-generalize, reevaluate 3-stage analysis as ESP process develops (PT,SSC)
  - Support ESP dashboard, suggest staged approach to data not thoroughly vetted and published (PT, SSC)
  - Recommend continued inclusion of community engagement and dependency indicators, potential to use as early indicators of large ecosystem changes (SSC)

PT/SSC Comments

- Comments Specific to this ESP
  - Prioritize development of ESP for GOA Pacific cod (SSC)
  - Suggestion to discuss expanding the spawning habitat suitability index (ROMS, wind) at ESP workshop, explore indicators to inform other parameters (M), encourage developing climate enhanced model 20.1 and discuss at ESP workshop (PT)
  - Support exploring additional indicators to describe trends in recruitment and recommends separating fishery engagement from dependency, exploring dependency in the next ESP, and consider how coastal communities can provide review of and feedback on the ESP (SSC)

Ecosystem Processes



Ecosystem Processes

Stage	Habitat & Distribution	Phenology	Age, Length, Growth	Energetics	Diet	Predators/Competitors
Recruit	Shore to Shelf (0-500 m), depth varies by age then size(24), sublittoral-bathyal zone, move w/in, between LMEs(24)	Recruit to survey and fishery age-1, length 20-27 cm(24)	Max: 25 yrs, 147♀/134♂ cm L_inf=94 cm, K= 0.2 (24,AFSC)		Opportunistic, small on inverts, large on fish(20, 21, 24, AFSC)	Halibut, Steller sea lions, whales, tufted puffins, fisheries(24); shelf groundfish(24)
Spawning	Shelf (40-290 m)(13-16,24), semi-demersal in shelf areas(13,15,16), seasonal migrations variable duration(26)	Winter-spring, peak mid-March, 13 wks (1,20,25)	1st mature: 2 yr, 26♀/36♂cm, 50%: 4-5yr, 45-65cm (24,AFSC)	Oviparous, high fecundity (250-2220·10^3) eggs (13,15), range 4-6 °C(14,16)	Opportunistic (20,21)	Halibut, Steller sea lions, whales, tufted puffins, fisheries(24); shelf groundfish(24)
Egg	Shelf (20-200 m), demersal, adhesive eggs(13,15-17,24)	Incubation is ~20 days, 6 wks(14,22)	Egg size: 0.98-1.08 mm (28)	Optimal incubation 3-6°C, 13-23 ppt, 2-3ppm dO_2 (27)	Yolk is dense and homogenous (AFSC)	
Yolk-sac Larvae	Epipelagic, nearshore shelf, coastal, upper 45 m, semi-demersal at hatching(13-15,18,24)	Spring, peak mid May, 14 wks(22,29)	3-4.5 mm NL at hatch (13-15,24,28)	Hatch temperature 4.5-5.8°C(2)	Endogenous	Share larval period with pollock(13)
Feeding Larvae	Epipelagic, nearshore shelf(13-15,24), 0-45 m (24)	Late spring, April – June, (22	25-35 mm SL at transformation (3,13-15,24)	1-2 weeks before onset of feeding(28,29)	Copepod eggs, nauplii, and early copepodite stages (Strasburger et al. 2014)	Share larval period with pollock(13)
Juvenile	Nearshore (2-110 m), 15-30 m peak density, inside bays, coastal, mixed, structural complexity (1-6,10,11,21)	Nearshore settlement in June, deeper water migrations in October(3,10,13-15)	YOY: 35-110 mm FL(2), age 1+: 130-480 mm FL(1,3,4,6,10); growth sensitive to temp	Energy density ↑ with length, lower in pelagic stage	Copepods, mysids, amphipods(2), small fish(10), crabs(19-21)	Pollock, halibut, arrowtooth flounder(19,20); macroalgae, eelgrass, structural inverts, king crab, skate egg case, juvenile pollock (1-5,7-9,11)
Pre-Recruit	Nearshore, shelf (10-216 m)(4), inside bays, coastal, mixed, mud, sand, gravel, rock pebble(1,2,4,6)	Age-2 may congregate more than age-1(25)	Begin to mature age 2-3, 480-490 mm FL (15)	Energy density and condition lower than in pelagic stage	Opportunistic, benthic invert, pollock, small fish, crabs(19-21)	Pacific cod, halibut, salmon, fur seal, sea lion, porpoise, whales, puffin(24); macroalgae, macroinvertebrate, king crab, skate egg case(4-5,7-9)

Ecosystem Processes

Stage	Processes Affecting Survival	Relationship to GOA Pacific cod
Recruit	1. Competition 2. Predation 3. Temperature	Increases in main predator of Pacific cod would be negative but minor predators may indicate Pacific cod biomass increase. Increases in overall prey biomass would be positive for Pacific cod but generalists.
Spawning	1. Spawning Habitat Suitability 2. Distribution	Temperatures outside the 3-6° C range contribute to poor hatching success and may impact physiological and behavioral aspects of spawning. Spring bottom temperatures outside this range are linked to observed pre-recruits and recruitment estimates(27)
Egg	1. Temperature(14,18,29,30)	Eggs are highly stenothermic(27)
Yolk-sac Larvae	1. Temperature(14,18,29,30) 2. Timing of spring bloom(13) 3. Onshore shelf transport(13,31,32)	Increases in temperature would increase metabolic rate and may result in rapid yolk-sac absorption that may lead to mismatch with prey. Current direction to preferred habitat would be positive for Pacific cod.
Feeding Larvae	1. Temperature(14,18,29,30) 2. Prey availability 3. Onshore shelf transport(13,31,32)	Increases in temperature would increase metabolic rate and may result in poor condition if feeding conditions are not optimal. Onshore transport to nursery habitat would be positive for Pacific cod while predation increases would be negative.
Juvenile	1. Competition(33) 2. Predation(33) 3. Temperature(34)	Evidence of density-dependent growth in coastal nurseries(33) would suggest that increases in competitors or predators would be negative for Pacific cod condition and therefore survival. Temperature increases may amplify risk of food availability and energy allocation(34)
Pre-Recruit	1. Competition(33) 2. Predation(33) 3. Temperature(34)	Evidence of density-dependent growth in coastal nurseries(33) would suggest that increases in competitors or predators would be negative for Pacific cod condition and therefore survival. Temperature increases may amplify risk of food availability and energy allocation(34)

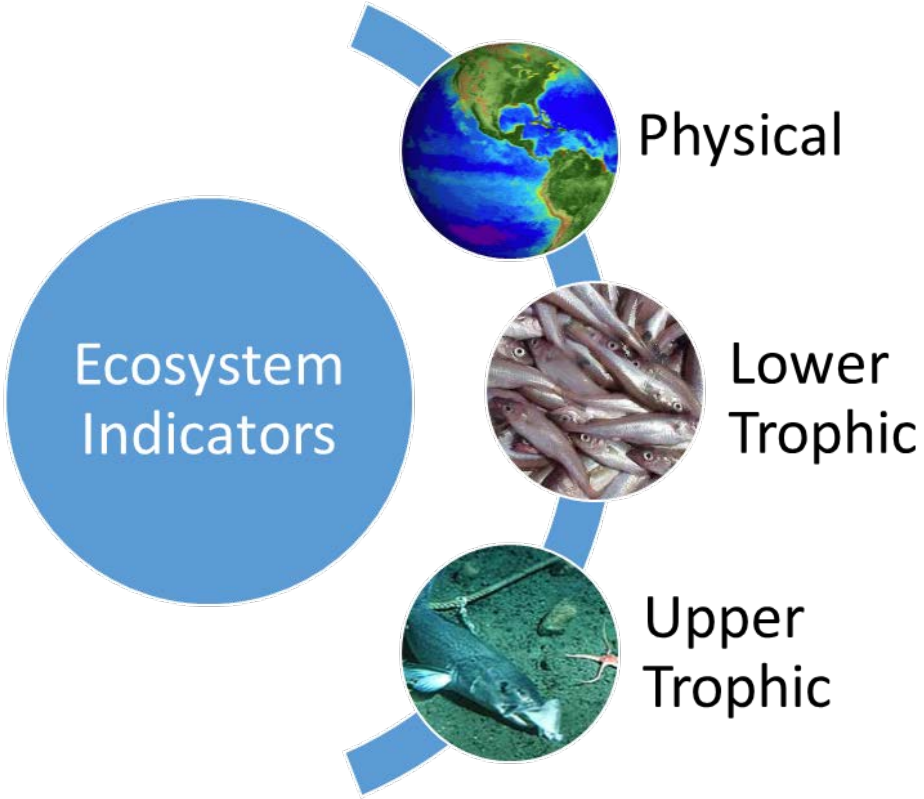
Socioeconomic Processes

- Economic & Community
  - Paired down version of EPR in assessment report
  - Stock-specific engagement from ACEPO report
- Future Streamlining
  - Focus on understanding stock health, fishery behavior
  - Not redundant with Econ SAFE or ACEPO

	Avg 10-14	2015	2016	2017	2018	2019
Total catch K mt	79.06	79.5	64.1	48.7	15.2	15.7
Retained catch K mt	75.7	77.5	63.1	48.0	14.4	14.5
Ex-vessel value M $	$50.8	$50.3	$41.0	$35.3	$14.5	$15.7
Ex-vessel price lb $	$0.304	$0.293	$0.294	$0.334	$0.452	$0.492
Hook & line share of catch	25%	21%	17%	18%	23%	23%
Pot gear share of catch	49%	52%	60%	55%	53%	52%
Central Gulf share of catch	61%	60%	53%	43%	47%	47%
Shoreside share of catch	90%	92%	92%	87%	88%	89%
Vessels #	421.4	386	360	246	154	176

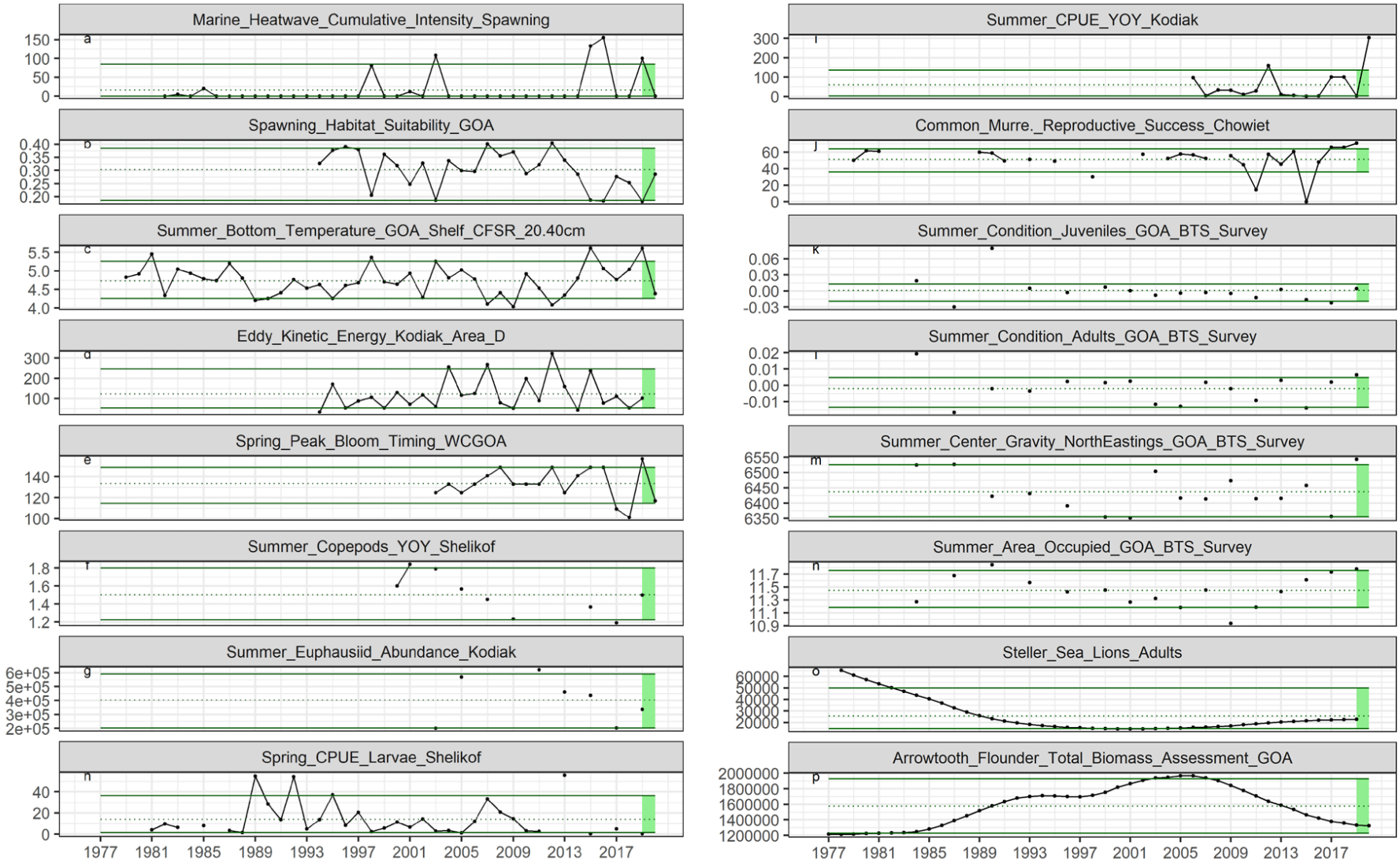
		Avg 10-14	2015	2016	2017	2018	2019
Global cod catch K mt		1,631	1,762	1,789	1,761	1,633	-
U.S. P. cod share of global catch		18.5%	18.0%	18.0%	16.9%	14.2%	-
Europe share of global catch		74.7%	74.8%	74.9%	75.9%	78.3%	-
Pacific cod share of U.S. catch		97.8%	99.3%	99.5%	99.5%	99.7%	-
U.S. cod consumption K mt (est.)		97	108	114	118	114	106
Share of U.S. cod not exported		29%	26%	29%	32%	36%	37%
Export volume K mt		103.8	113.2	105.3	92.8	73.1	65.1
Export value M US$		$325.2	$335.0	$312.0	$295.5	$253.4	$218.1
Export price lb US$		$1.421	$1.342	$1.344	$1.445	$1.571	$1.519
Frozen (H&G)	volume Share	81%	91%	94%	94%	91%	92%
	value share	81%	90%	92%	92%	90%	91%
Fillets	volume Share	7%	3%	3%	4%	5%	5%
	value share	9%	4%	4%	5%	6%	6%
China	volume Share	44%	53%	55%	52%	48%	41%
	value share	41%	51%	52%	50%	46%	40%
Japan	volume Share	17%	13%	14%	16%	15%	12%
	value share	17%	14%	15%	18%	17%	13%
Europe*	volume Share	27%	19%	17%	17%	16%	22%
	value share	29%	19%	18%	18%	18%	23%

Ecosystem Indicators



- 1. Marine heatwave index spawning
+ 2. Spawning habitat suitability
- 3. Bottom temperature shelf CFSR
+ 4. Eddy kinetic energy
+ 5. Spring bloom peak timing (satellite)
+ 6. Summer copepods (EcoFOCI)
+ 7. Euphausiids (acoustic backscatter)
+ 8. Spring Pacific cod larvae (EcoFOCI)
+ 9. Nearshore pollock CPUE (Kodiak)
+ 10. Common murre reproductive success
+ 11. Juvenile condition (BTS)
+ 12. Adult condition (BTS)
- 13. Center of gravity, northeast (VAST)
+ 14. Area occupied (VAST)
- 15. Adult Steller sea lion counts
- 16. Arrowtooth total biomass (SAFE)

Ecosystem Indicators



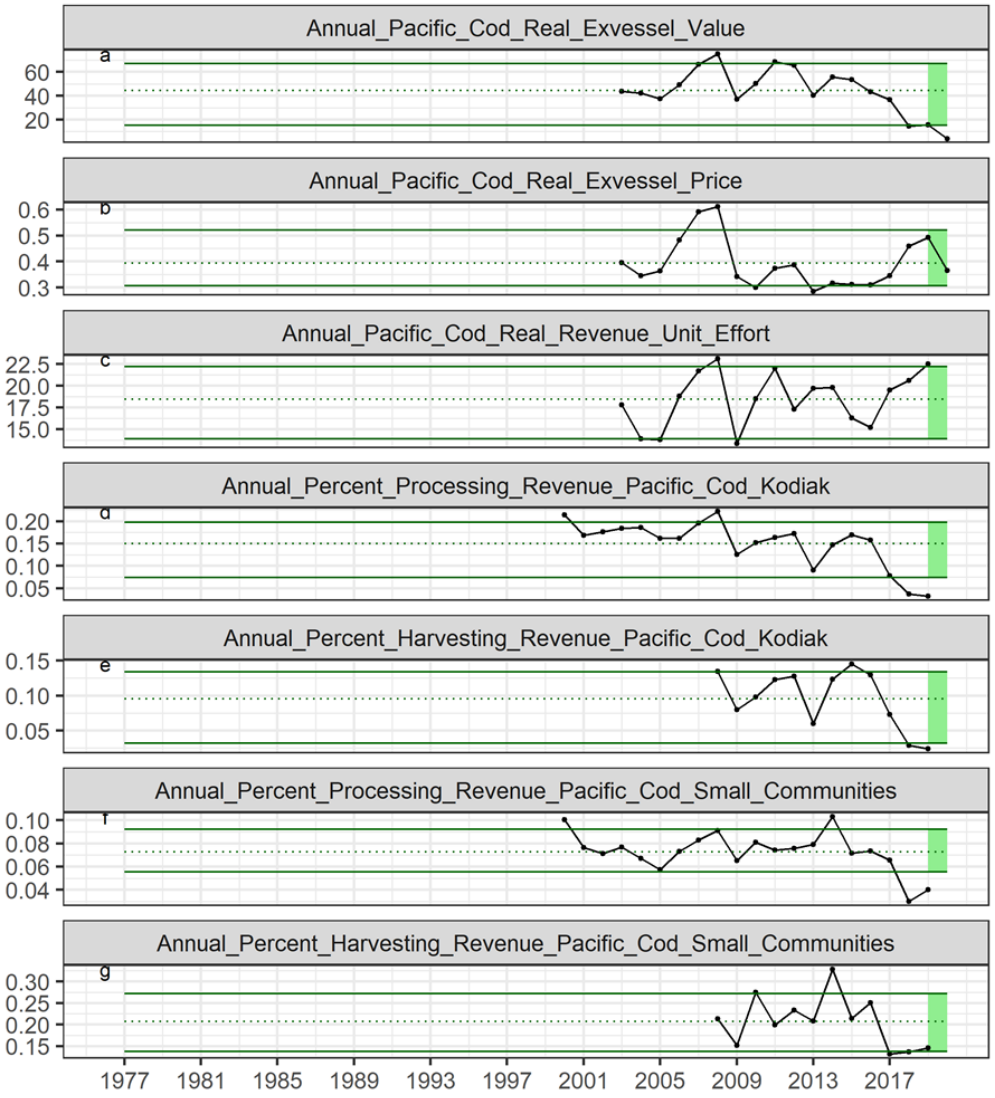
Socioeconomic Indicators

RQ = Regional Quotient

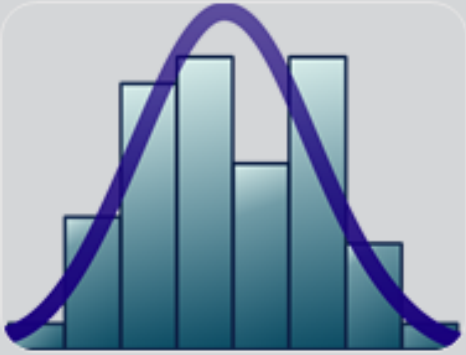
1. Ex-vessel value
2. Ex-vessel price per pound
3. Revenue per unit effort

4. Processing RQ for Kodiak
5. Harvesting RQ for Kodiak
6. Processing RQ for small comm.
7. Harvesting RQ for small comm.

Socioeconomic Indicators



Indicator Analysis Stages

Beginning Stage	Intermediate Stage	Advanced Stage
		
Traffic Light • Historical simple score (SSC) • Current year trends relative to mean of series • Evaluate whole suite utility	**Importance** • Regression R^2 • Direction, magnitude, uncertainty, inclusion weight • Prediction performance	**Ecosystem Model Run** • Comparison w/ operational • Retrospective • Prediction performance • Terminal SSB

Note: new this year for report card

Traffic Light Table

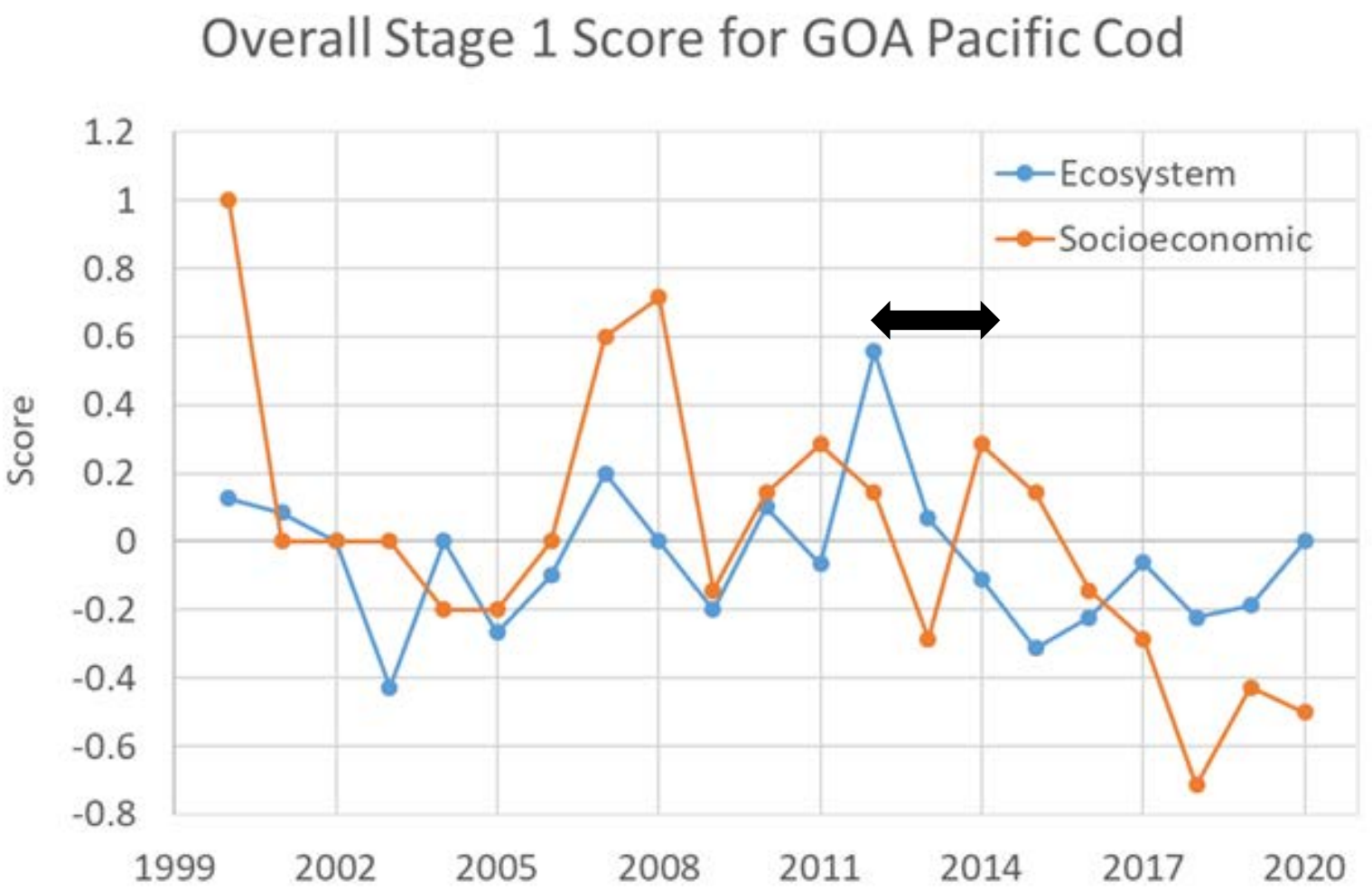
Indicator	2016 Status	2017 Status	2018 Status	2019 Status	2020 Status
Marine Heatwave Cumulative Intensity Spawning	high	neutral	neutral	high	neutral
Spawning Habitat Suitability GOA	low	neutral	neutral	low	neutral
Summer Bottom Temperature GOA Shelf CFSR 20.40cm	neutral	neutral	neutral	high	neutral
Eddy Kinetic Energy Kodiak Area D	neutral	neutral	neutral	neutral	NA
Spring Peak Bloom Timing WCGOA	high	low	low	high	low
Summer Copepods YOY Shelikof	NA	low	NA	neutral	NA
Summer Euphausiid Abundance Kodiak	NA	low	NA	neutral	NA
Spring CPUE Larvae Shelikof	NA	neutral	NA	neutral	NA
Summer CPUE YOY Kodiak	neutral	neutral	neutral	neutral	high
Common Murre. Reproductive Success Chowiet	neutral	neutral	neutral	high	NA
Summer Condition Juveniles GOA BTS Survey	NA	neutral	NA	neutral	NA
Summer Condition Adults GOA BTS Survey	NA	neutral	NA	neutral	NA
Summer Center Gravity NorthEastings GOA BTS Survey	NA	low	NA	high	NA
Summer Area Occupied GOA BTS Survey	NA	high	NA	high	NA
Steller Sea Lions Adults	neutral	neutral	neutral	neutral	NA
Arrowtooth Flounder Total Biomass Assessment GOA	neutral	neutral	neutral	neutral	neutral

Note: new this year for report card

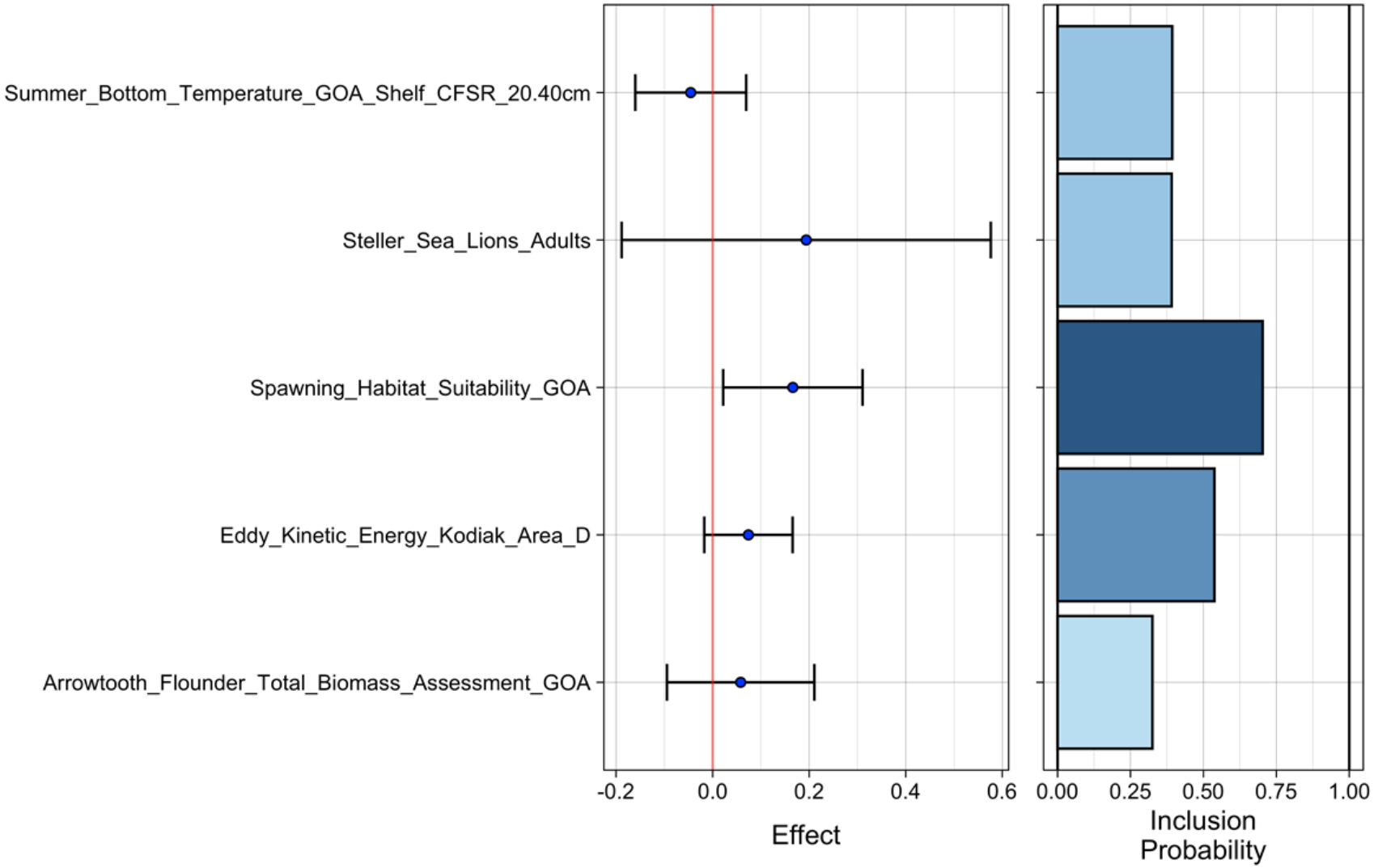
Traffic Light Table

Indicator	2016 Status	2017 Status	2018 Status	2019 Status	2020 Status
Annual Pacific Cod Real Exvessel Value	neutral	neutral	low	low	low
Annual Pacific Cod Real Exvessel Price	neutral	neutral	neutral	high	neutral
Annual Pacific Cod Real Revenue Unit Effort	low	neutral	neutral	high	NA
Annual Percent Processing Revenue Pacific Cod Kodiak	neutral	low	low	low	NA
Annual Percent Harvesting Revenue Pacific Cod Kodiak	neutral	neutral	low	low	NA
Annual Percent Processing Revenue Pacific Cod Small Communities	neutral	neutral	low	low	NA
Annual Percent Harvesting Revenue Pacific Cod Small Communities	neutral	low	low	low	NA

Traffic Light Score



Importance Statistics



Ecosystem Considerations

- Summary 2020
  - Hatch success temp dependent, impacts spawning habitat
  - Eddy kinetic energy recently high after low period 2016-2019
  - Area occupied of population has > over last decade
  - Condition varies by area, low for juv & adults in Shumagins
  - Comp/Pred of Pcod steadily < or stable, suggest limited prey
- 2021 Preliminary*
  - SST warm in winter/spring, high EKE in CGOA, larvae low
  - Age-0 Kodiak average, new competitors (sablefish)

**Special thanks to: Bridget Ferriss, Jordan Watson, Wei Cheng, Carol Ladd, Ellen Yasumiishi, Ben Laurel, Mike Litzow, Alisa Abookire, and Kevin Siwicke for presentations at GPT*

Socioeconomic Considerations

- Socioeconomic Summary
  - Ex-vessel value trending down while price/pound and revenue/effort trending upward from 2015-19
  - Projections for 2020 value and price were decreased
  - Small communities processing and harvesting RQ decreased after 2014, while Kodiak decrease after 2016
- 2020 Preliminary*
  - Actual ex-vessel value and price very close to projections
  - Socioeconomic information to be evaluated in RFI

**Special thanks to: Ben Fissel for his presentation at GPT and link to a new web page for data exploration*

Next Steps

- 2021 Report Card (November PT)
  - Includes current year ecosystem indicators
  - Socioeconomic indicators lagged, 2020 prelim
  - Update traffic light and hopefully importance
- 2022 Request for Indicators
  - Use ESP data gaps and research priorities
  - ESP team creates and submission in Jan
  - All indicators reviewed by teams in Feb
  - Unless partial initiated, report card in Nov

Questions?

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