Ecosystem Status Report: Gulf of Alaska 2023

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GOA 2023: Key Messages

1. 2023 Average productivity; Spatially variable; 4-year consistent environmental drivers

2. Variable pelagic prey base (zooplankton, forage fish); Reduced from 2022

3. Pacific cod & capelin show signs of increase (first since marine heatwave years)

4. Looking ahead to 2024 (El Niño): which groundfish are vulnerable & which might benefit?

GOA Full & Update Assessment Risk Tables: Environmental/ Ecosystem Considerations

Level 1

(No apparent environmental/ ecosystem concerns)

- Walleye pollock *(+ESP)*
- Pacific cod *(+ESP)*
- Sablefish (statewide) *(+ESP)*
- Pacific ocean perch
- Deepwater flatfish
- Rougheye/blackspotted rockfish
- Shortraker rockfish
- Other rockfish
- Skates

Environment: ocean temperatures cool to average

Prey:

- Pelagic: (Zooplankton & forage fish) reduced/variable
- Benthic & infauna: variable /unknown

Predation: relatively low (P. cod, P. halibut, arrowtooth flounder) except sablefish; no major changes in seabirds & marine mammal populations

Competition: potentially higher for zooplankton-eating groundfish due to pink salmon, P. ocean perch, pollock

2024: El Niño primarily impact larval survival & prey base for juveniles and zooplankton–eating adults

Physical Environment

- **Temperature**: cool to average (surface, depth, shelf edge) *[Lemagie, Worton, O'Leary, Siwicke, Fergusson, Danielson, Axler]*

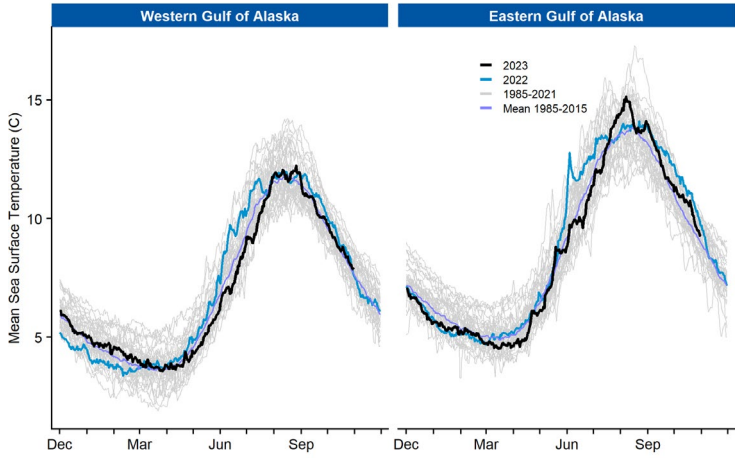
  → *2024 warmer surface*

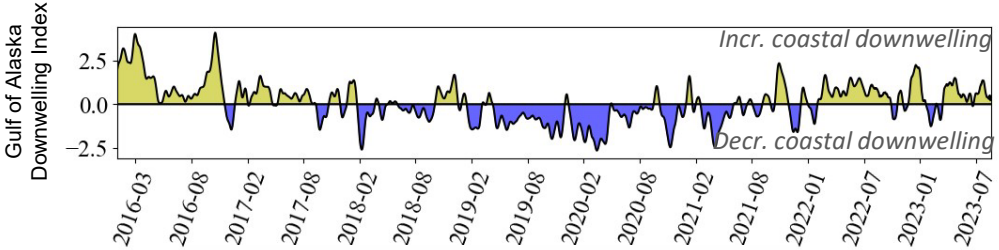
- **Winter/Spring Cross Shelf Transport**: average to below average (eddy kinetic energy, relaxed winter downwelling) [*Cheng, Bond, Stockhausen*]

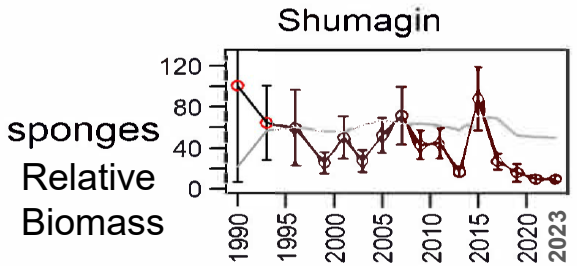
  → *2024 increase eddy strength & coastal downwelling*

- **Shelf-edge/Slope Habitat**: Reduced structural epifauna, long-term increasing acidification and decreasing oxygen (winter deep water intrusion on shelf) [*Laman, Whitehouse, Hauri, Pages*]

  → *2024 reduced deep water intrusion onto shelf*

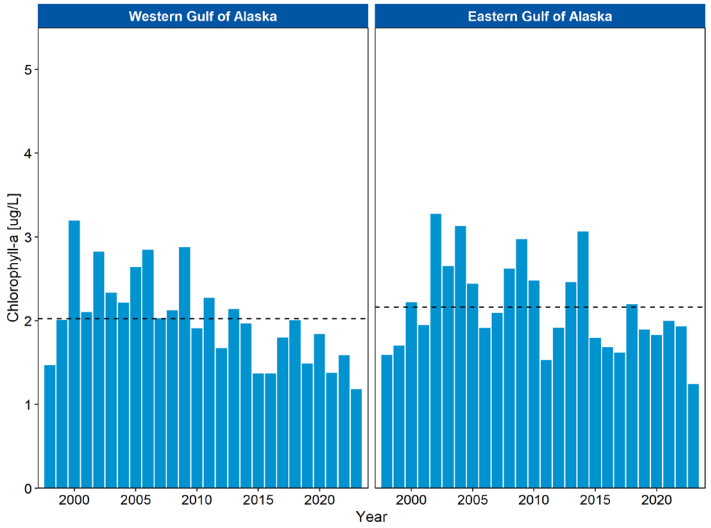


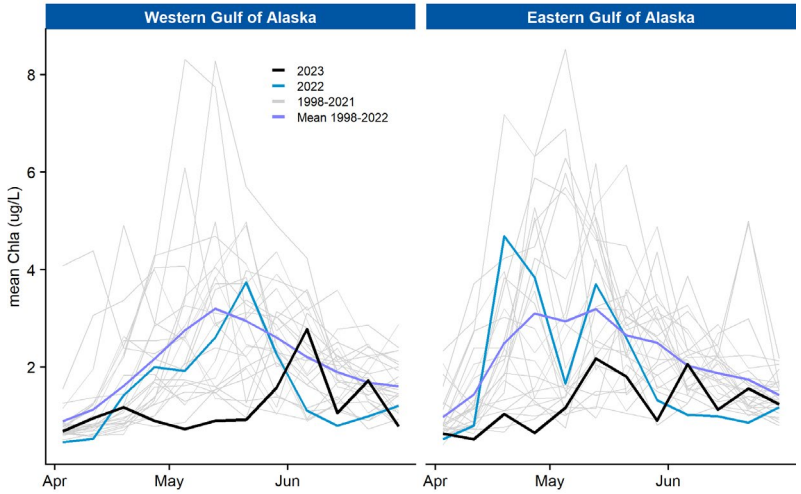




Reduced primary productivity

J. Gann, M. Callahan





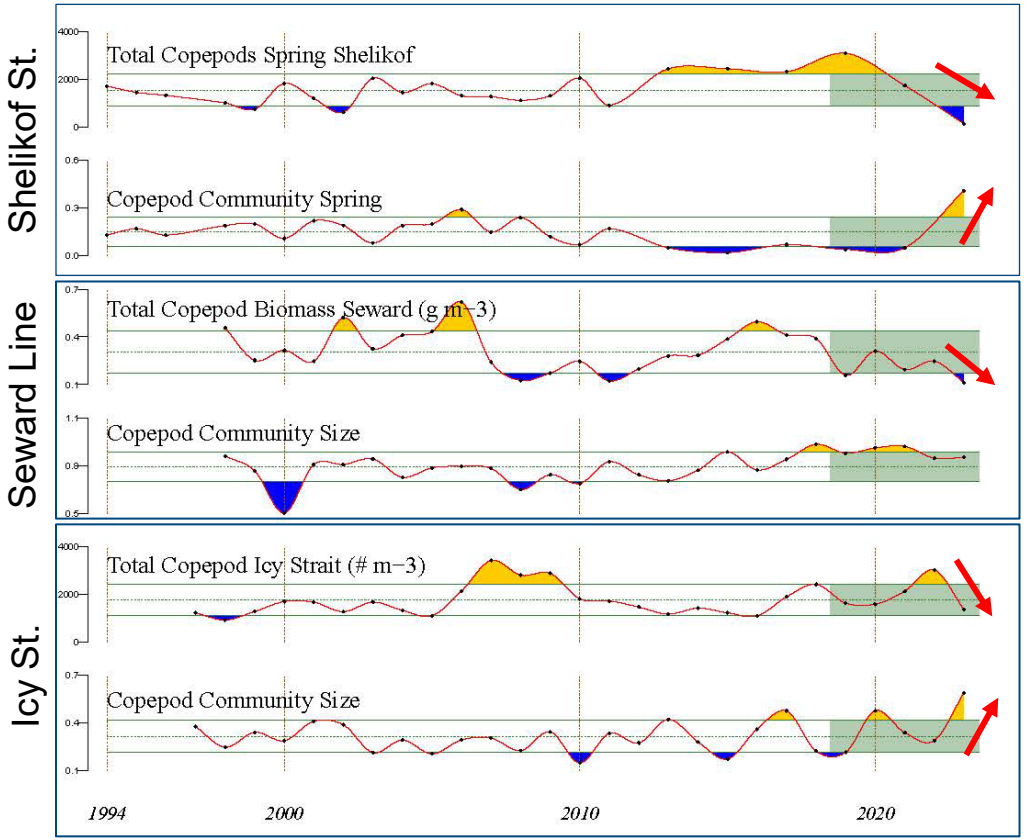
- Satellite-derived chl-a (1998-2023)
- Indicated low phytoplankton biomass
- Late timing of the chl-a spring bloom
- Unique in time series

→ *2024 early, larger phytoplankton spring bloom*

Zooplankton

D. Kimmel, R. Hopcroft, E. Fergusson

WGOA



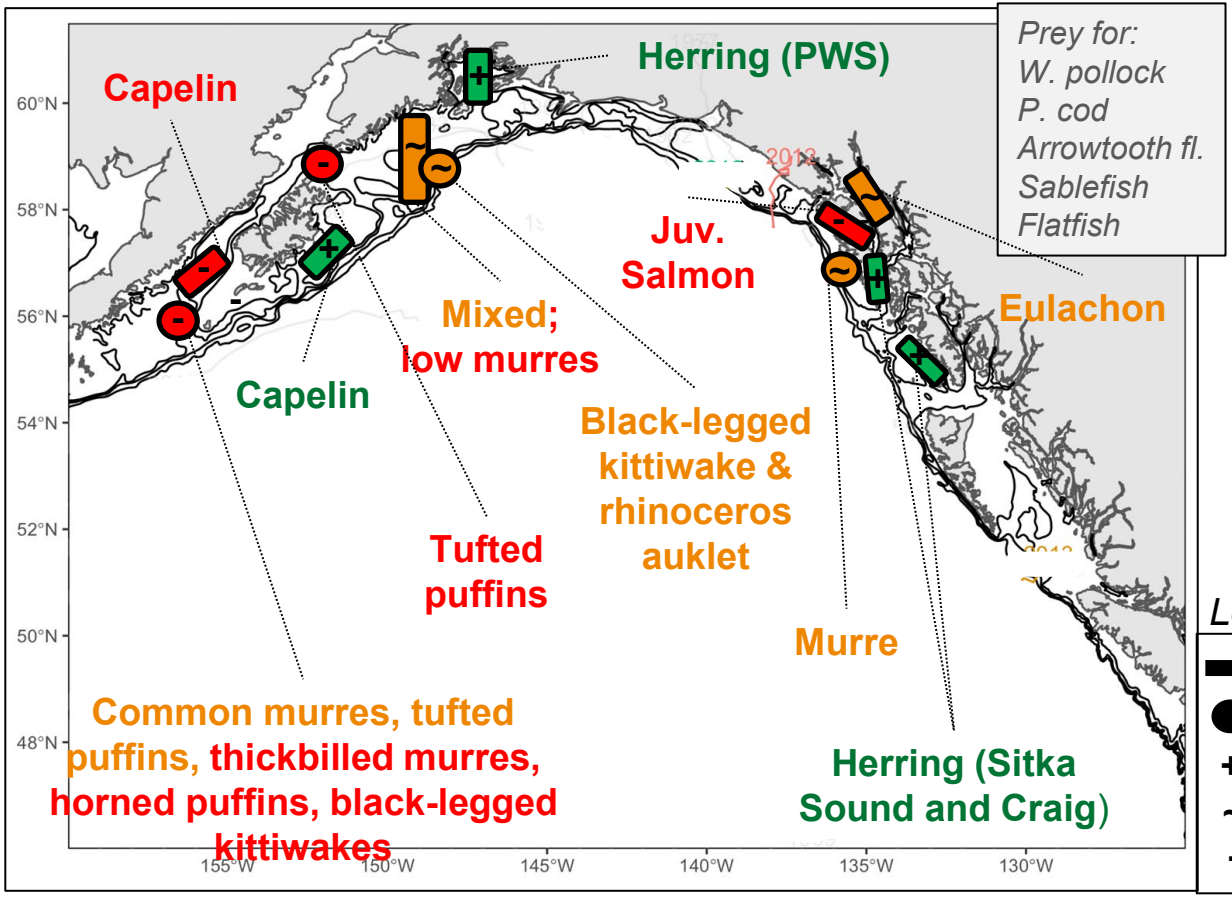
EGOA

- Surveys: EcoFOCI Shelikof spring, Seward Line spring, Icy Strait (SEAK) summer
- Lower total zooplankton biomass than 2022 (below average to average)
- Higher biomass of large copepods & euphausiids (Shelikof, Seward)
- Energy density (lipid content) above average in Icy St.

→ *2024 community shift to smaller copepods*

Forage Fish Prey Base: variable

B. Drummond, D. Cushing, S. Hatch, K. Hebert, S. Pegau, E. Pochardt, W. Strasburger, C. Worton



Prey for:
W. pollock
P. cod
Arrowtooth fl.
Sablefish
Flatfish

- Survey baselines from 1990's/early 2000's to present)
- Below to above average
- Incr: capelin, herring
- Decr.: sandlance, juv. salmon, age-0 pollock

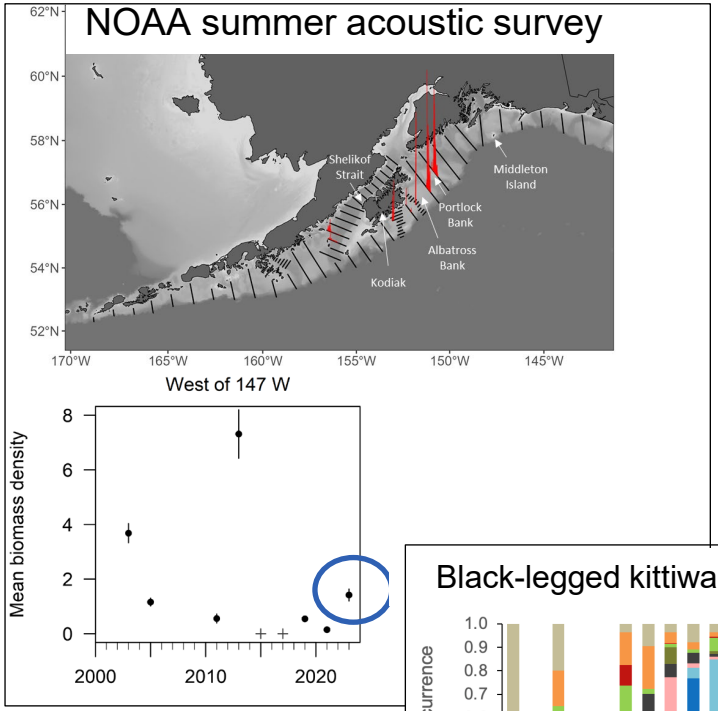
Legend

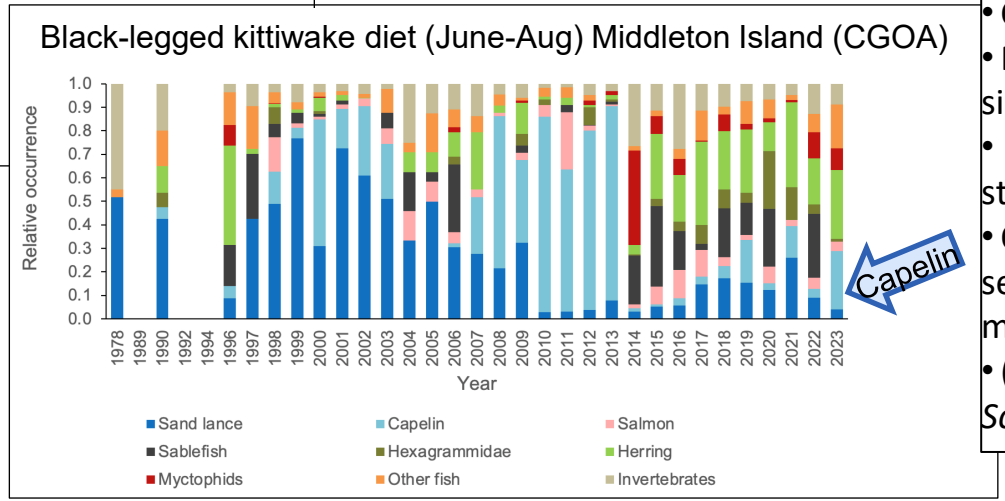
Surveys
Seabird Reproductive Success
\+ *Above Average*
~ *Average*
\- *Below Average*

Capelin returning in core habitat

S. Whelan, D. McGowan, L. Rogers, N. Laman, Skipper Science

- Capelin are rebounding in their core habitat (at least)
- Present around Kodiak, Middleton Isl., Chowiet Isl., Sitka
- Low biomass around AK peninsula (NOAA EcoFOCI summer survey) & eastern GOA (NOAA summer acoustic survey & Bottom trawl survey)

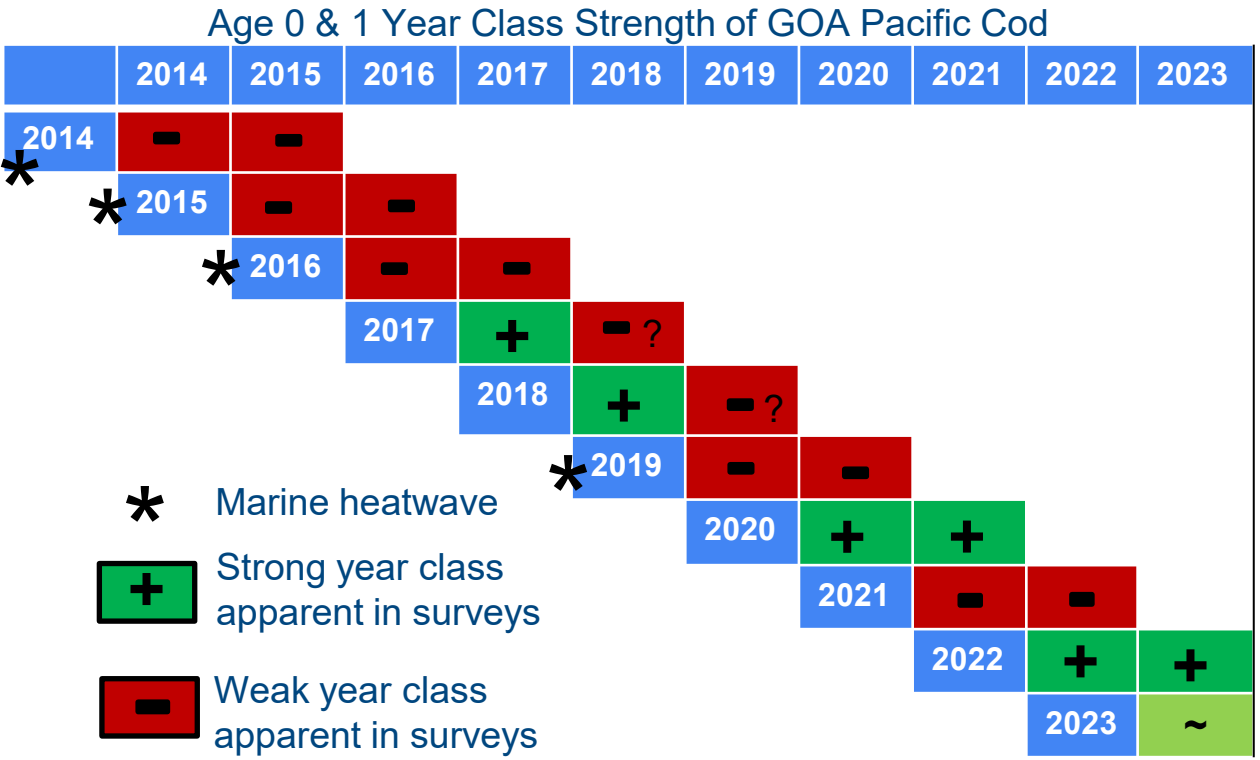




- Capelin observed around Sitka;
- Not uncommon but hadn't seen since heatwave years;
- Observed in chinook salmon stomachs in the area;
- Observed large groups of seabirds (rhinoceros auklets and murrelets) feeding in these areas
- (*synthesized from Skipper Science*)

GOA Pacific Cod age 0 & 1: 2017-2023

B. Laurel et al.



Fluctuations in year class strength

- Marine heatwave: warm SST & spawning habitat/ egg survival (2014-2016, 2019)
- Warm fall SST (2017, 2018)

Surveys: *NOAA beach seine Kodiak (since 2006) & AK peninsula (since 2018); NOAA EcoFOCI spring (odd years) and summer (2023, 2019)*

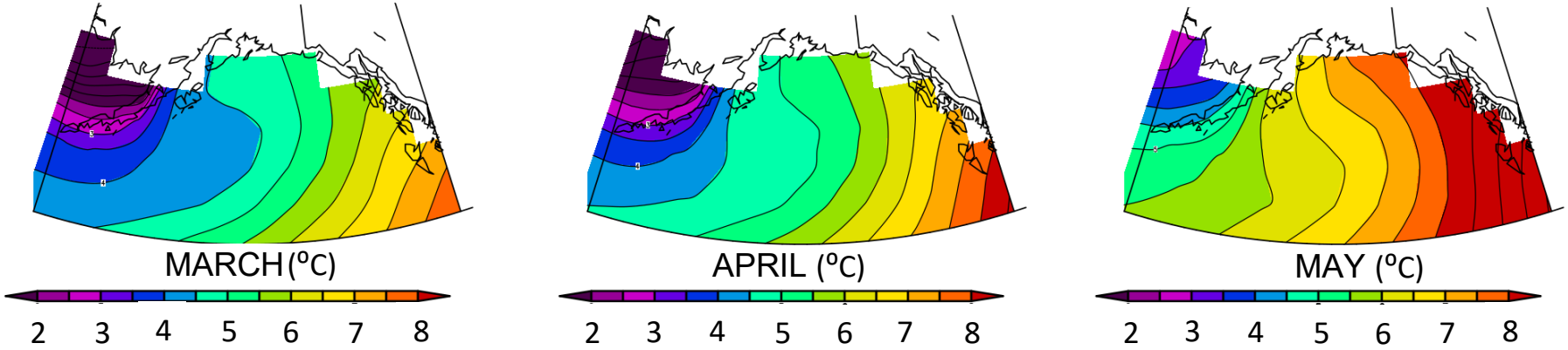
Looking ahead to 2024 (El Niño): warming SST

N. Bond

- National Multi-Model Ensemble predictions of sea surface temperatures in 2024 (baseline: 1991-2020)

VULNERABLE? (larvae favor cooler springs):
P. cod yolk-sac larvae & feeding larvae (5-6°C)
W. pollock yolk-sac larvae (3-7°C)
N. rock sole larvae

BENEFIT? (larvae favor warm springs):
Sablefish larvae & YOY (12-16°C)
S. rock sole larvae
P. ocean perch larvae
Rockfish larvae



Looking ahead to 2024 (El Niño)

VULNERABLE (?) 2024

SST (-)

Zoop (-)

P. cod: Larvae

W. pollock: Larvae, Adult

N. rock sole: Larvae, Adult

P. ocean perch: Adult

Dusky rockfish: Adult

BENEFIT (?) 2024

SST (+)

Zooplankton (-)

Transport (+)

S. rock sole: Larvae

P. ocean perch: Larvae

Rockfish: Larvae

Sablefish: Larvae

Arrowtooth flounder: Larvae

Rex sole: Larvae

P. halibut: Larvae

Looking ahead to 2024 (El Niño)

VULNERABLE (?) 2024

SST (-)

Zoop (-)

P. cod: Larvae

W. pollock: Larvae, Adult

N. rock sole: Larvae, Adult

P. ocean perch: Adult

Dusky rockfish: Adult

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Arrowtooth flounder: Larvae

Rex sole: Larvae

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Looking ahead to 2024 (El Niño)

VULNERABLE (?) 2024

SST (-)

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W. pollock: Larvae, Adult

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BENEFIT (?) 2024

SST (+)

Zooplankton (-)

Transport (+)

S. rock sole: Larvae

P. ocean perch: Larvae

Rockfish: Larvae

Sablefish: Larvae

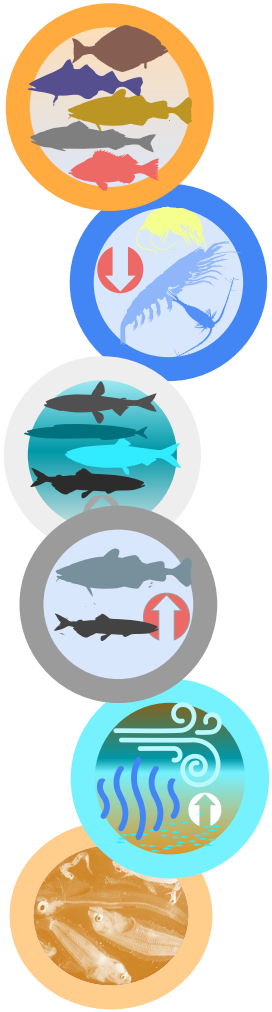
Arrowtooth flounder: Larvae

Rex sole: Larvae

P. halibut: Larvae

Questions:

- How would a low recruitment year in 2023 affect populations? 2 low recruitment years (‘23/’24)?
- If heat persists and mixes to depth (late 2024/2025?): which adult populations are vulnerable?
- Do populations have a buffer for unknown/indirect/cumulative ecological responses?



GOA 2023: Key Messages

1. 2023 Average productivity; Spatially variable; 4-year consistent environmental drivers

- Regional variability, average productivity, 3 La Niña's

2. Variable pelagic prey base; Reduced from 2022

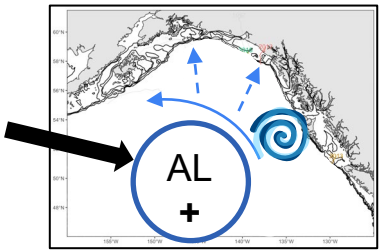
- Zooplankton: below average to average
- Forage fish: below average to above average

3. Pacific cod & capelin show signs of increase (first since marine heatwave years)

4. Looking ahead to 2024 (El Niño)*:*

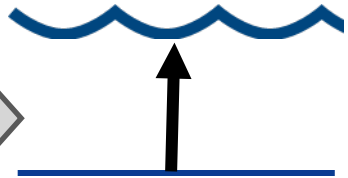
- Warm surface temperatures, potentially lower quality zooplankton prey, increased cross shelf transport
- Larval & juvenile groundfish most sensitive (some vulnerable, some benefit)
- Adult POP, pollock, dusky rockfish, n. rock sole are more vulnerable

Where are we headed (2024 +): El Niño

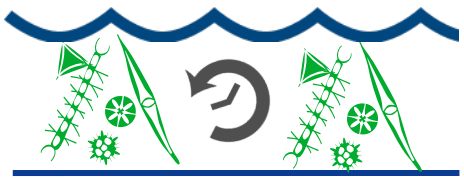


Aleutian Low: deeper and displaced SE

Warmer & wetter winter

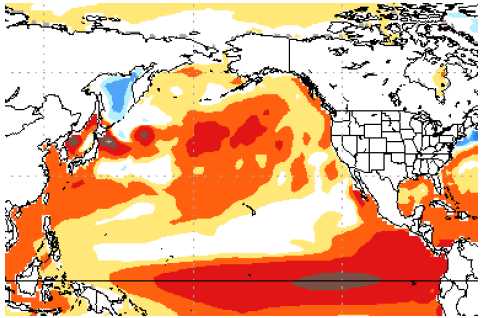


Shallower mixed layer depth (earlier stratification)



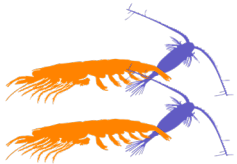
Earlier & more intense spring Bloom

?

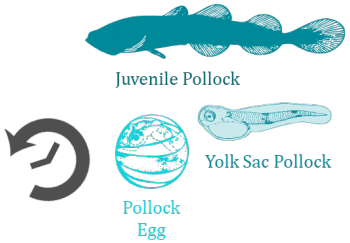


Jan, Feb Mar (2024)

Warmer sea surface temperature



Less lipid rich zooplankton community



Earlier phenology

Optimal thermal ranges for groundfish?