Ecosystem Status Report Aleutian Islands 2023 – NPFMC AP Dec 2023

Thank you !

Ivonne Ortiz & Stephani Zador

With contributions from:

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photos: photolib.noaa.gov

2023 Ecosystem Status Report – Aleutian Islands

Risk Table Environmental/Ecosystem Considerations

Level 2

Multiple indicators showing consistent adverse signals a) across the same trophic level as the stock, and/or b) up or down trophic levels (i.e., predators and prey of the stock)

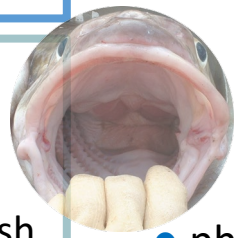
- AI Pacific cod

Level 1

No apparent environmental/ ecosystem concerns

- Northern Rockfish

Noteworthy



- Large scale changes SST patterns
- Key temperatures for AI groundfish
- Pcod eating less fish

Assessment 2023

- Sustained warmer temperature for 10 years
- Warmest winter on record
- Lowest heat and nutrients flux through passes, deeper mixed layer
- Seabirds reproductive success: above mean in EAI; mixed in WAI
- HABs increase EAI: 3,793 µg/100 g in blue mussels (1000 µg/100 g potentially fatal)

Multi-year since ~2013/14 –now linked to regime shift

- Sustained mid-depth & surface warmer temperatures, lower productivity
- Pinks impact: 3rd highest abundance, satellite chla
- Rockfish dominate pelagic foragers - energy banked in little preyed-on, long-lived rockfish (and pink salmon)

Implications for this year

- SST regime shift implies higher temperatures are the new norm
- sat SST 1-13.4°C, Bottom temperature max 6 - 6.6°C, but is warmer in Sep & <100 m depth
- fish &invertebrate prey availability expected in EAI, mixed availability in WAI
- HABs increased risk to human health in EAI

Cumulative effects

- higher bioenergetic costs
- lower productivity
- zoop, fish grow faster
- phenology might start to shift
- changes in prey field timing, composition and location
- rockfish & pink salmon main pathway of zooplankton into foodweb
- past indicators (e.g. PDO) may not be as useful in the future; their relationships with physical and ecological processes may vary as the climate continues to change

AI Pacific cod

Level 2

- Persistent warm conditions
- Narrow optimal thermal range for >20% egg hatch success
- Single-batch spawners
- Increased bioenergetic costs, increased consumption
- Lower amount of fish in diet since ~2010
- Lower prey quality resulting in reduced fish condition
- Decreased consumption of Atka as prey

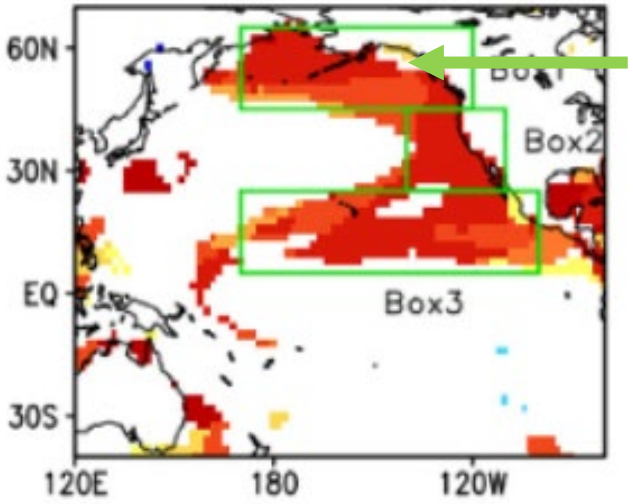
Northern Rockfish

Level 1

- Warm conditions and lower than average fish condition BUT
- Eggs hatch internally – live bearers, parturition April - June
- Long-lived species -each adult cohort's genetic composition is heavily influenced by the environmental conditions experienced during the first year at sea (Maselko et al 2020)
- Genetic portfolio includes the environmental conditions of every cohort's first year
- No apparent effects from Eastern Kamchatka Pink Salmon

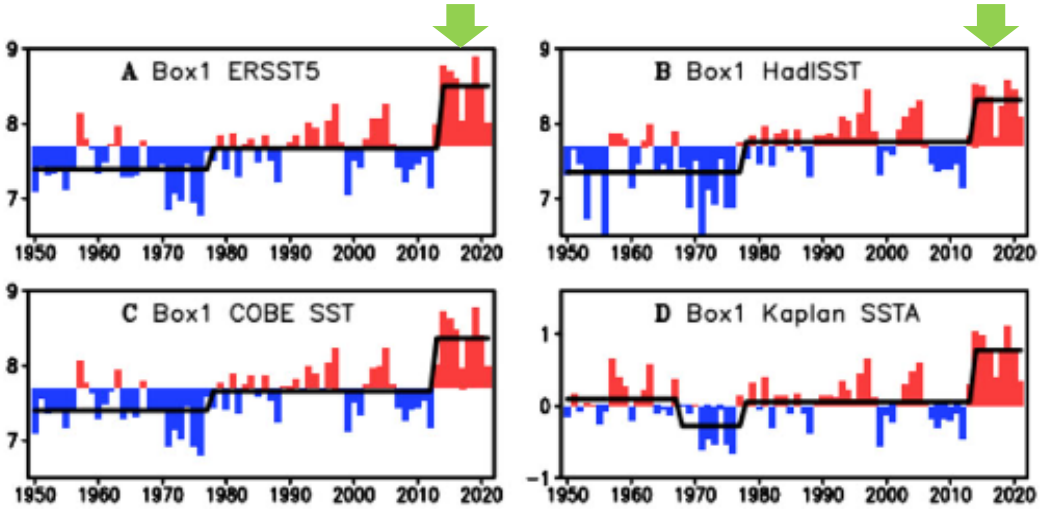
Noteworthy

Changes in large scale sea surface temperature patterns

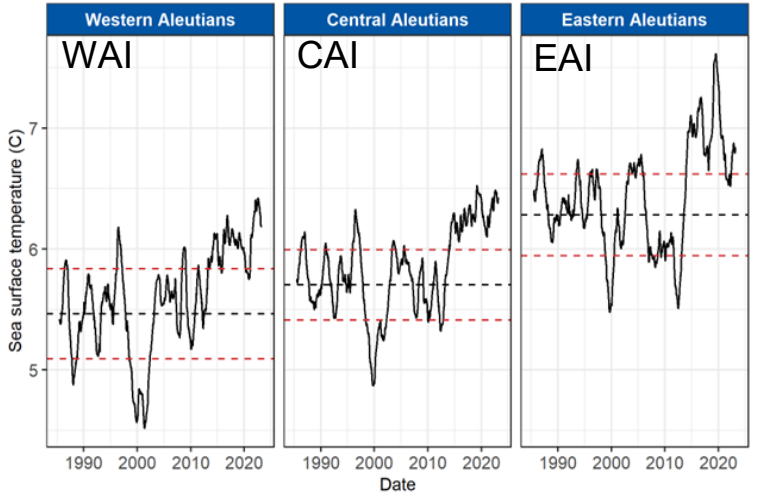


Northern North Pacific
Includes AI, EBS, GOA

- Decadal step change in North Pacific annual mean sea surface temperature in 2013/14
- Shifts in spatial patterns of sea surface temperature means that reference spatial patterns based on past years may not capture current conditions
- Pacific Decadal Oscillation is based on spatial pattern from 1950-1993, thus it may not be as useful as it used to be
- Relationships with physical and ecological processes may vary as the climate continues to change



Xiao and Ren, 2023. A regime shift in North Pacific annual mean sea surface temperature in 2013/14. Modified from Figures 1 and 2.



Lemagie & Callahan

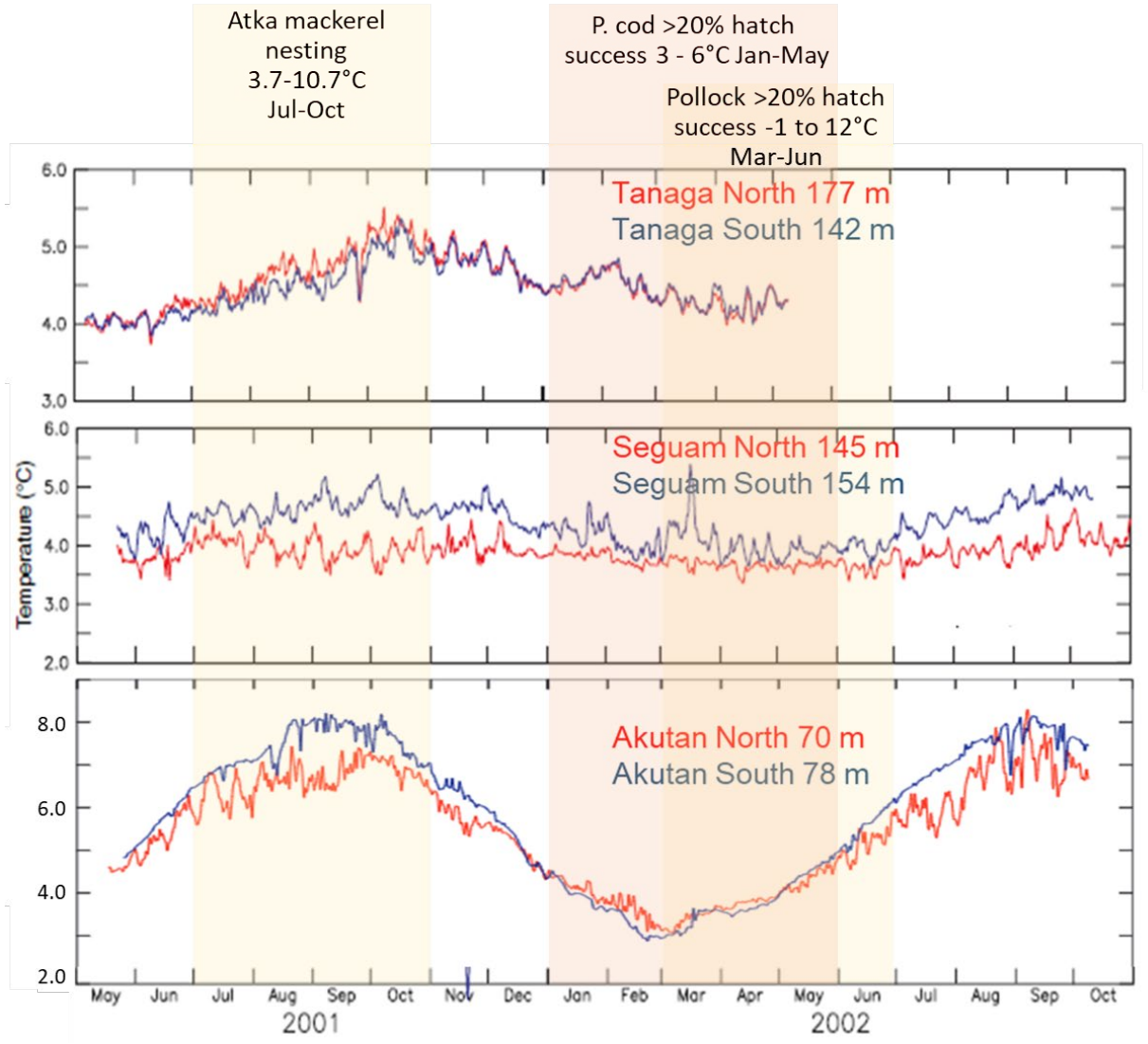
Werb and Rudnick, 2023. Remarkable changes in the dominant modes of North Pacific sea surface temperature. Modified from Figures 1b and 3b.

Ortiz, Bond, Suryan

Noteworthy

Key temperature ranges for commercial groundfish species in the Aleutian Islands

Persistent warming conditions: The SSC suggested information on which species are most vulnerable to these persistent conditions would be helpful for understanding ecosystem impact

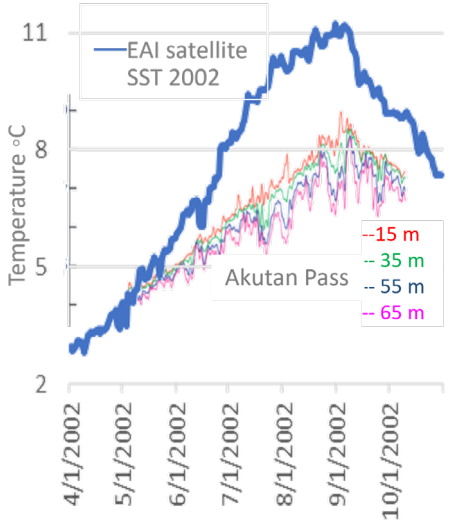


Most vulnerable: Pacific cod, narrow optimal temperature for >20% egg hatch success: 3-6°C January to May at 100-200 m. Eggs adhere to seafloor.
Maximum temperatures may have occasionally exceeded this threshold already.

From bottom trawl survey max bottom temperature: 6.6°C potentially same temperature in Jan-May in some areas. No. days ≥6°C since 2014:16. 11 times in 2016, depths 68-141m; 6 times at depths >100m, across AI.
September temperatures are higher than Jul-Aug survey temperatures.
Need winter bottom temperature indicator.

Second most vulnerable: Atka mackerel, wide nesting temperature 3.7-10.7°C in July to October, 15°C lethal for eggs, shallowest nests at 34 m depth.
Maximum temperatures believed to be close to but still under threshold

Atka mackerel: Bottom trawl survey max SST: 12.3; twice above 12°C max satellite SST 13.39. Satellite SST No. days ≥ 12°C since 2014: 79. In WAI & EAI.

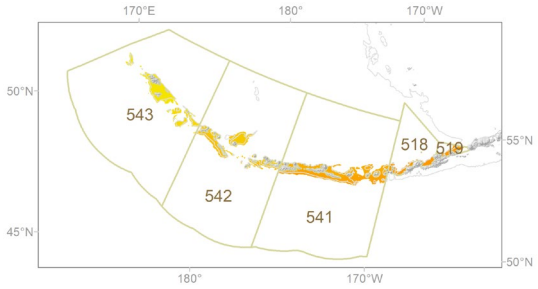


Mooring data: Staben et al 2005; satellite SST Lemagie & Callahan; bottom trawl temperature, O'Leary, .P. cod data: Neidetcher et al. 2014, Laurel, Rogers, Ortiz

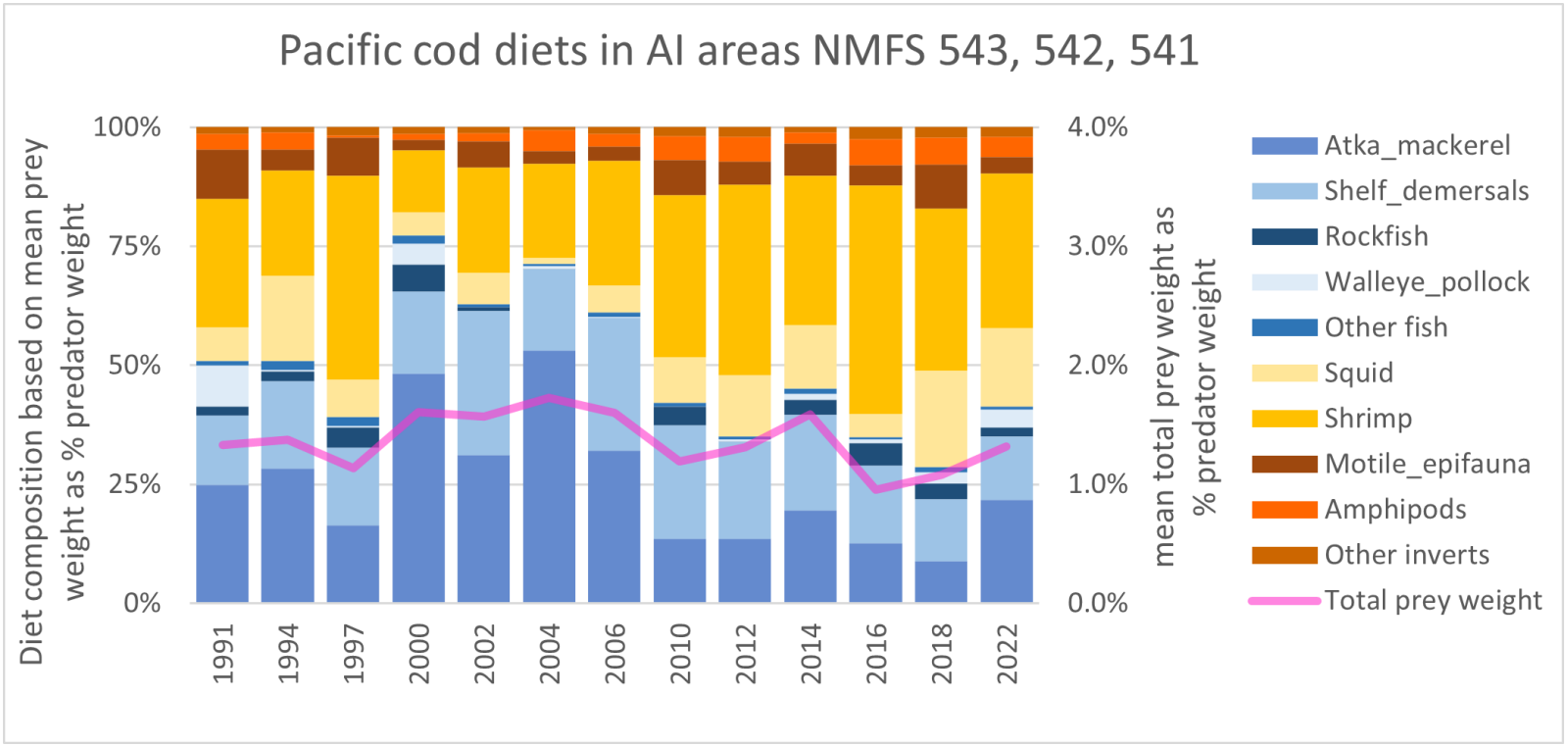
Noteworthy

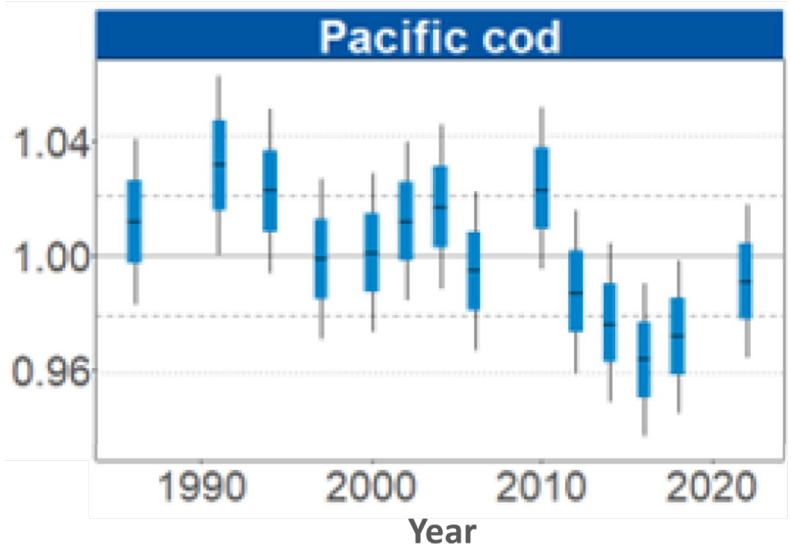
Changes in Pacific cod diets

Declines of non-commercial species in WAI: The SSC encourages efforts to explore mechanistic and food-web links for these observed trends, prioritizing diet data when samples are available



- Less fish in diets; less amount of prey consumed
- Even when similar amount of prey was consumed, less fish results in low fish condition
- Lower fish condition potentially due to lower prey quality + potentially higher bioenergetic costs
- Decrease of fish in diet and mount of prey consumed most noticeable in western Aleutian Islands
- Trend not seen east of Samalga where prey consumption was highest in 2022 and condition was (+)

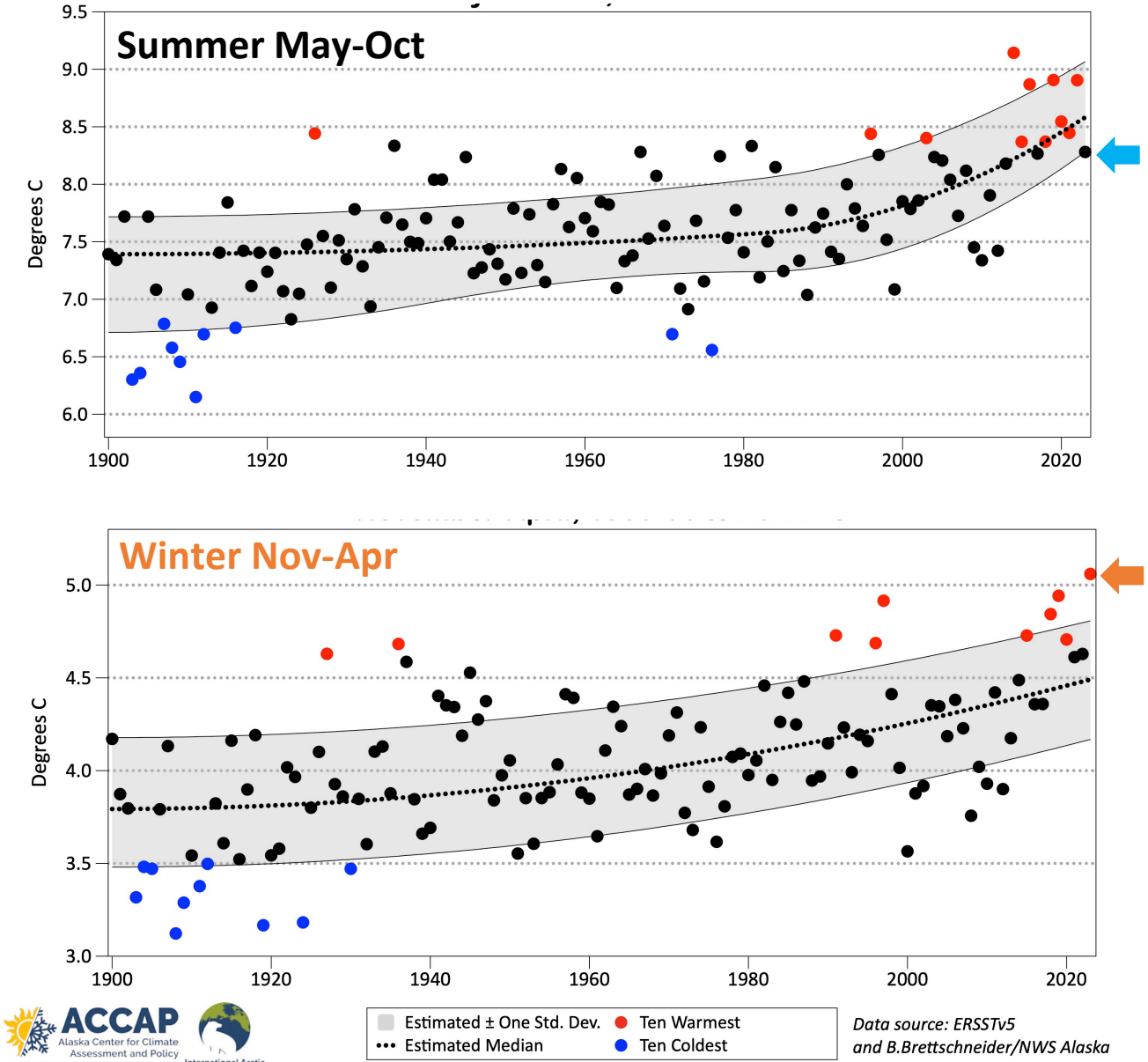




Ortiz, Aydin, Zador

Current Conditions 2023

Cooling in spring summer, warmest winter



ACCAP Alaska Center for Climate Assessment and Policy, a NOAA CAP/RISA Team

International Arctic Research Center

Long-term Sea Surface Temperature

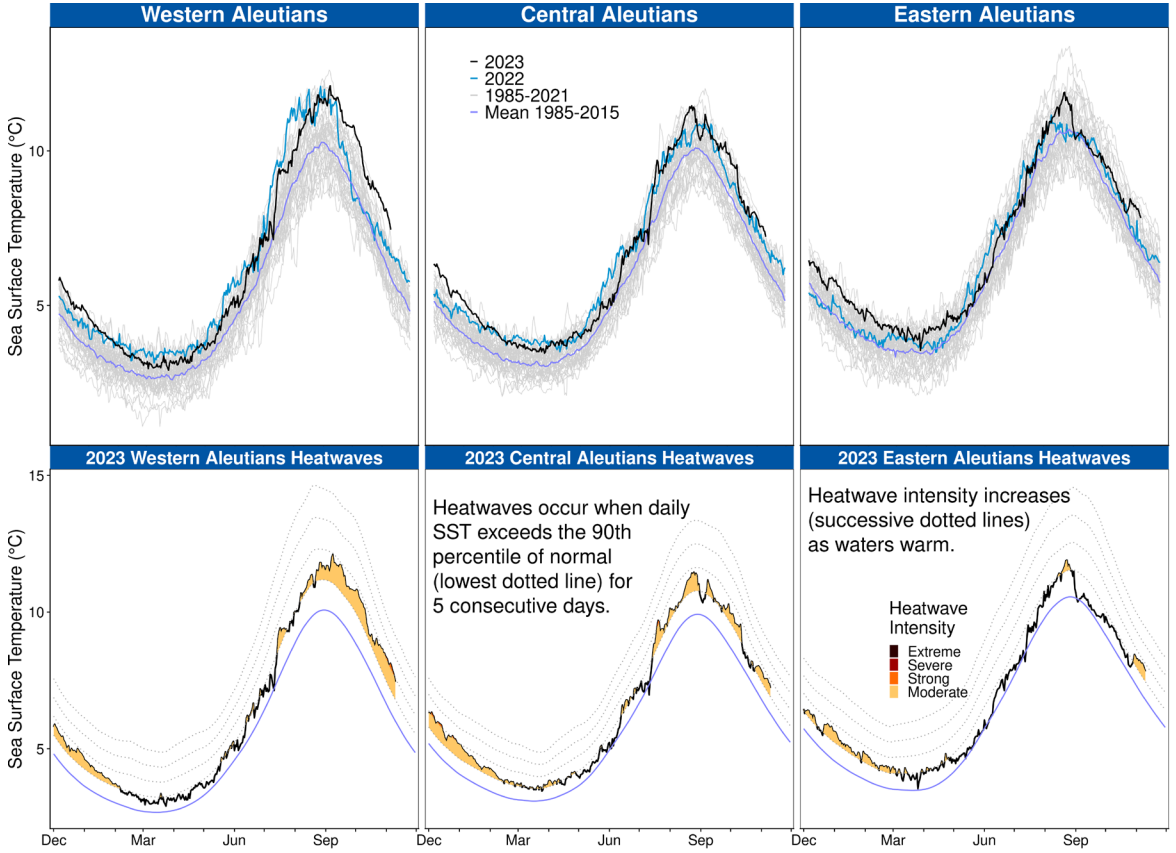
- 2023 – Cooling of spring and summer
- 2023 – Warmest winter in 124 years
- Warming trend winter and summer
- Data: Extended Reconstructed Sea Surface Temperature (ERSSTv5) global monthly sea surface temperature from moored buoys, surface drifters, ship observations, Argo floats above 5 meters, and Hadley Centre Ice-SST version 2 (HadISST2) ice concentration.

Moderate marine heat wave in winter, cooler spring and summer but above long-term average

Daily Satellite SST

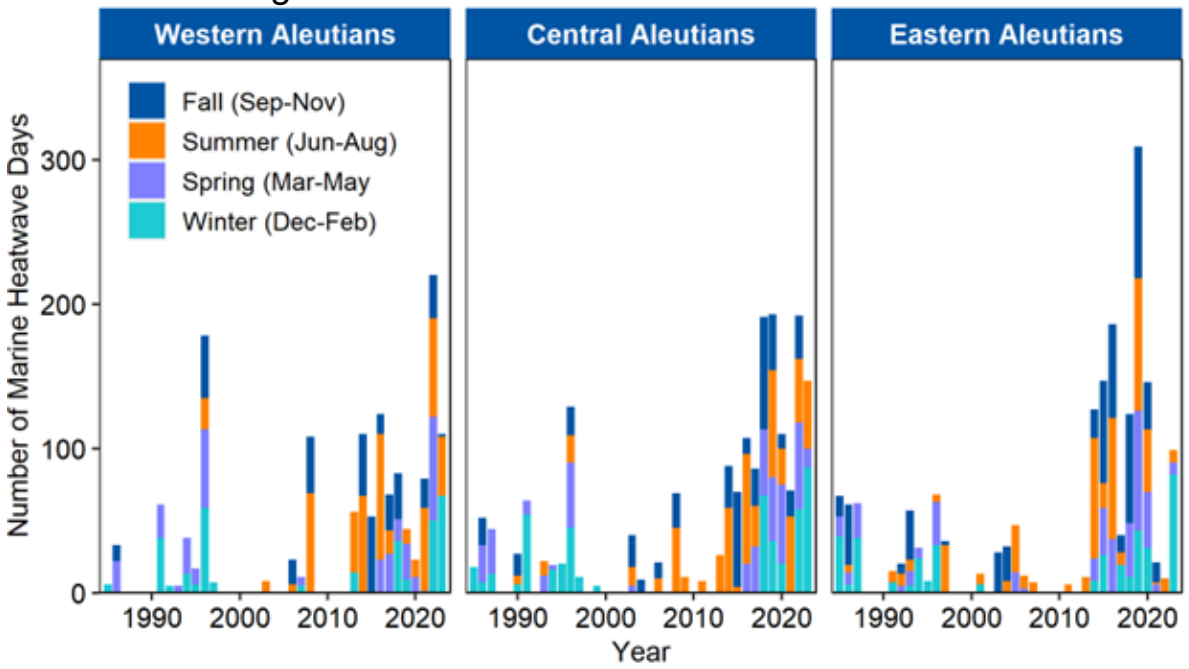
- Warm winter throughout
- Cooler spring & summer but still above 1985-2015 mean
- Current Fall – warmest in WAI

data through 11-12-2023



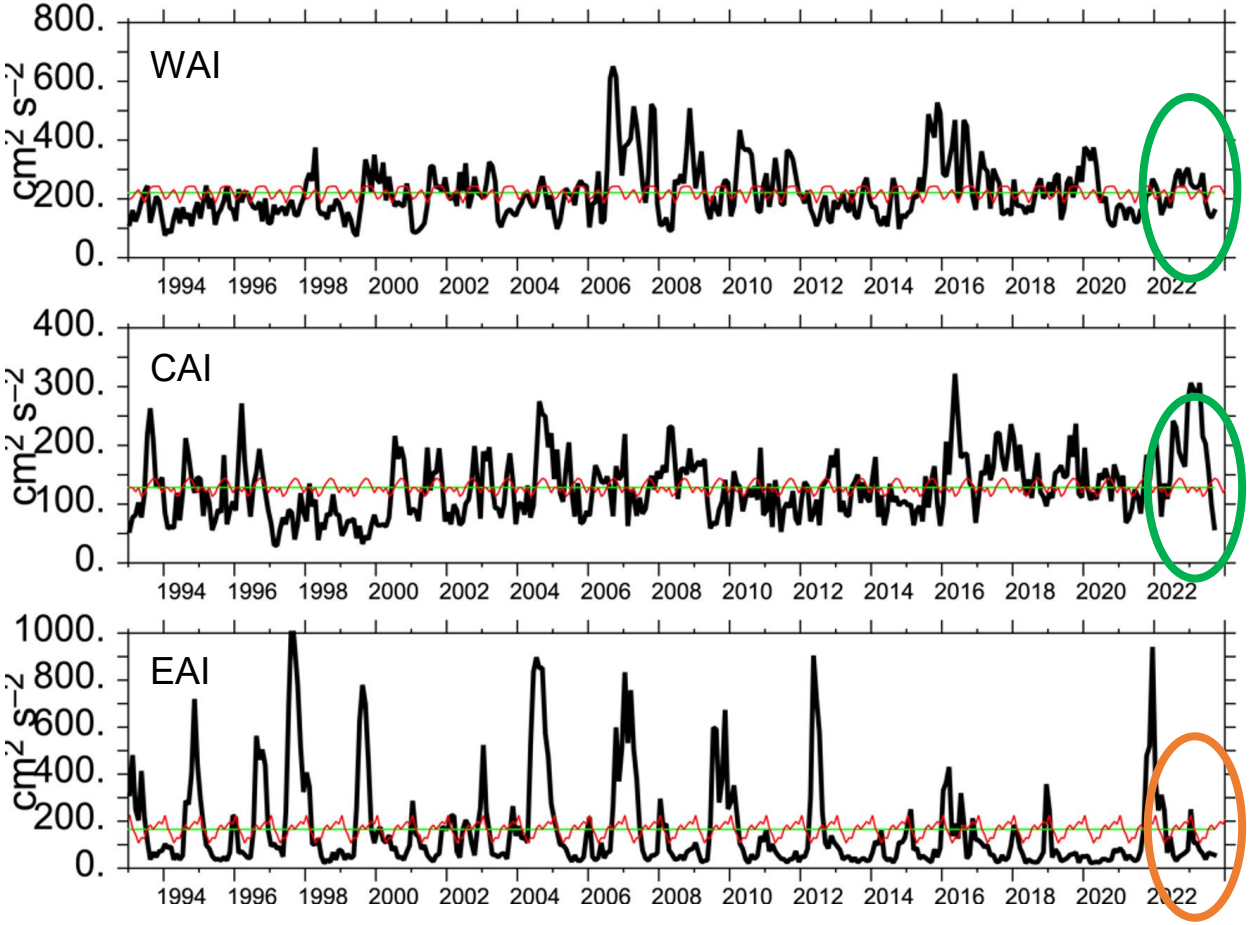
NOAA Coral Reef Watch data, courtesy National Environmental Satellite, Data, and Information Service (Updated: 11-10-2023)
Data are modeled satellite products and periodic discrepancies or gaps may exist across sensors and products.
Contact: matt.callahan@noaa.gov

data through 09-02-2023



Lemagie & Callahan

Lower transport of heat, salt and nutrients through passes across the chain



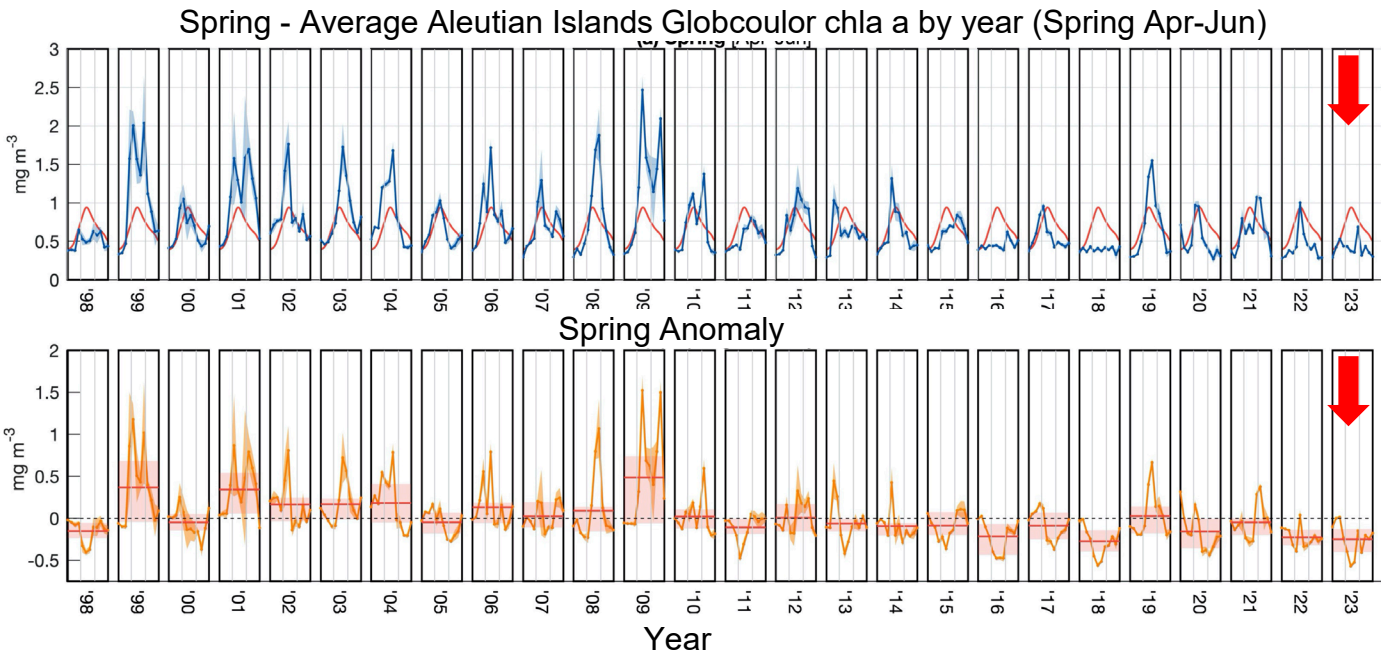
Eddy Kinetic Energy, monthly

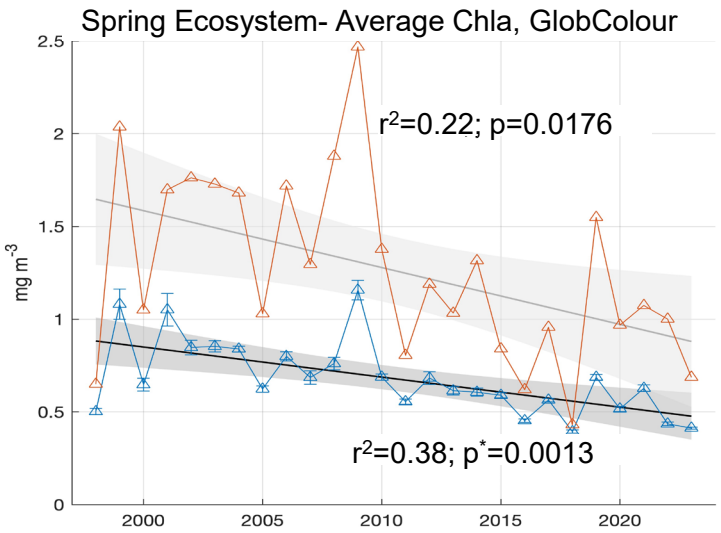
- Historical minima in EAI
- Currently below average in all three regions
- Lower transport of heat, salt and nutrients through passes

monthly average value 1993-2022
1993-2022 long term average

Cheng

Lower than average spring phytoplankton biomass, negative trend across time series



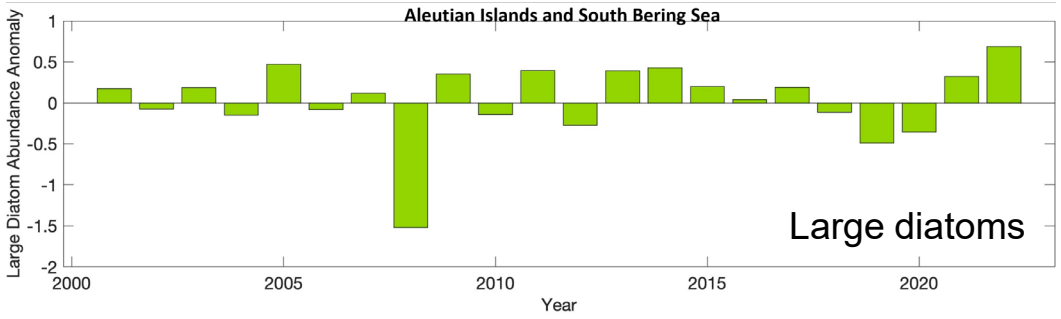


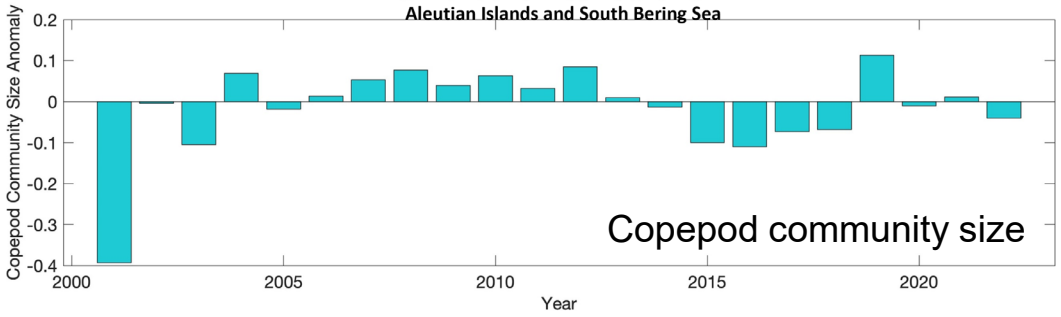
Satellite derived chl-a, proxy for phytoplankton biomass

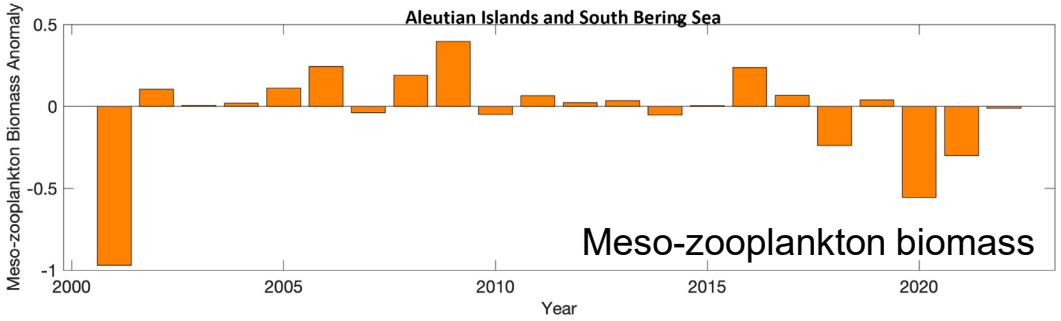
- Satellite chl-a, spring (Apr-Jun) phytoplankton biomass lower than 1998-2022 spring average
- Evidence for a negative trend in spring AI chl-a across the GlobColour time series
- Low chl-a also in the adjacent off-shelf areas of EBS, shelf areas of GOA in recent years
- Note ratio of small to large phytoplankton fluctuates (next slide)

Pelland

More species of smaller size copepods and lower meso-zooplankton biomass





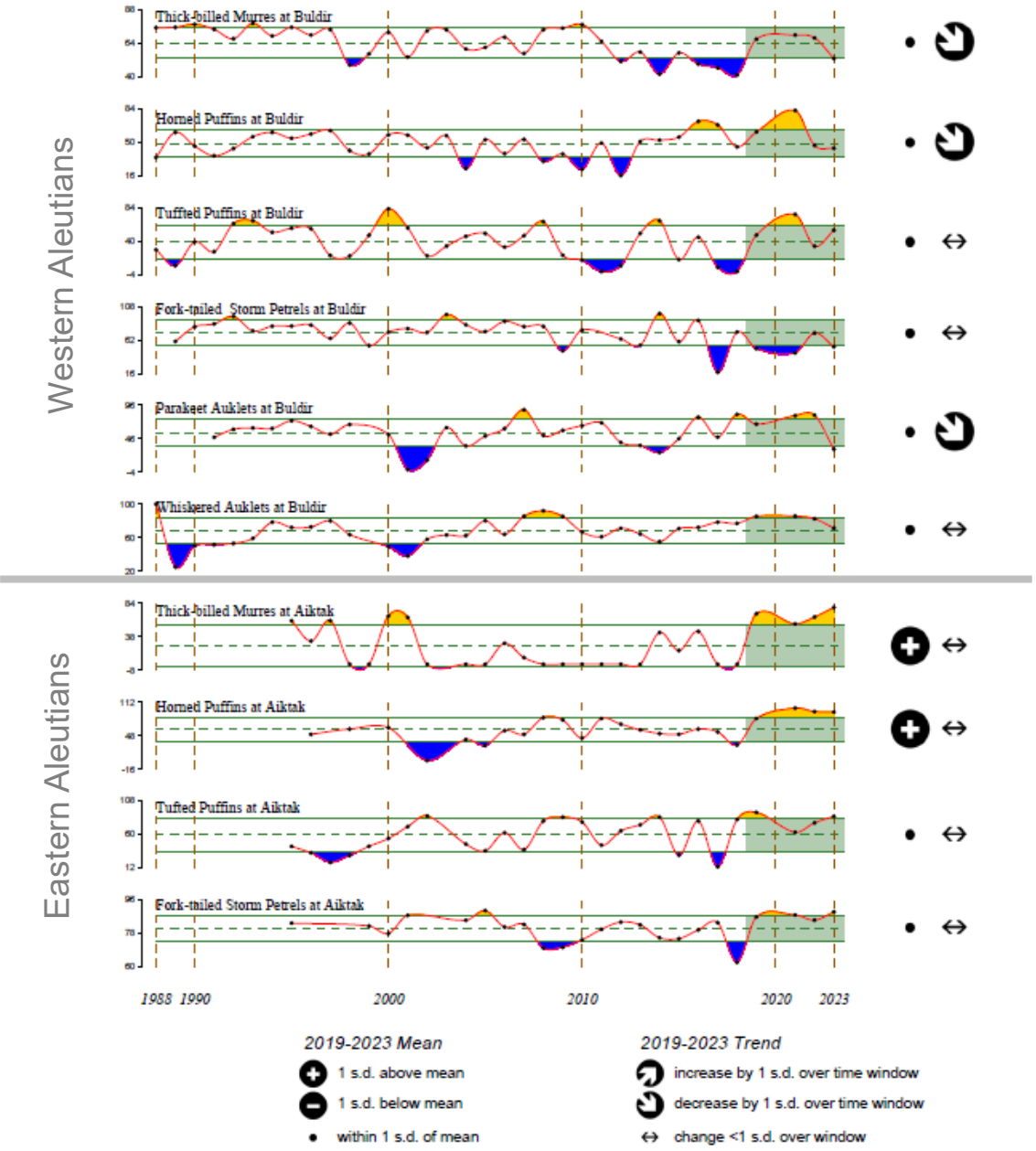


Continuous plankton recorder

- Large diatom biomass in 2022: higher than 2000-2021 average
- Sustained trend in copepod community size points to smaller size of copepods
- Lower meso-zooplankton biomass than 2000-2021 average in 2022

Ostle & Batten

Good foraging conditions in eastern Aleutians for all types of prey, mixed in western Aleutians



Seabird Reproductive Success

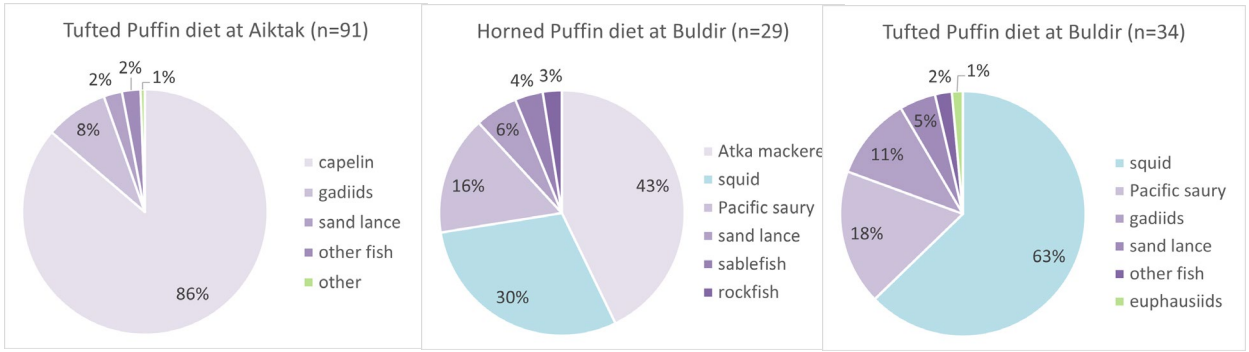
- Average or above for EAI seabirds: **good foraging conditions in summer for plankton and fish foragers in EAI; mixed in WAI**

above
average

Site	glaucous winged gull	common murre	thick billed murre	horned puffin	tufted puffin	red-legged kittiwake	black-legged kittiwake	fork-tailed storm-petrel	Leach's storm-petrel	ancient murrelet	parakeet auklet	least auklet	whiskered auklet	crested auklet	
	Primarily fish eaters ---------- Species ---------- Primarily zooplankton eaters														
Aiktak	above	above	above	above	above	-	-	above	average	above	-	-	-	-	EAI
Buldir	average	-	average	average	above	below	average	average	average	-	average	average	average	average	WAI

Seabird Diets

Mostly capelin in the EAI 86% in tufted puffin chick diets
Fish and squid in WAI: 63% squid in in tufted puffin chick diets
Atka mackerel 43% of diet of horned puffins



Rojek, Renner, Jones, Lindsay, Kaer, Kuletz, Ortiz, Zador,

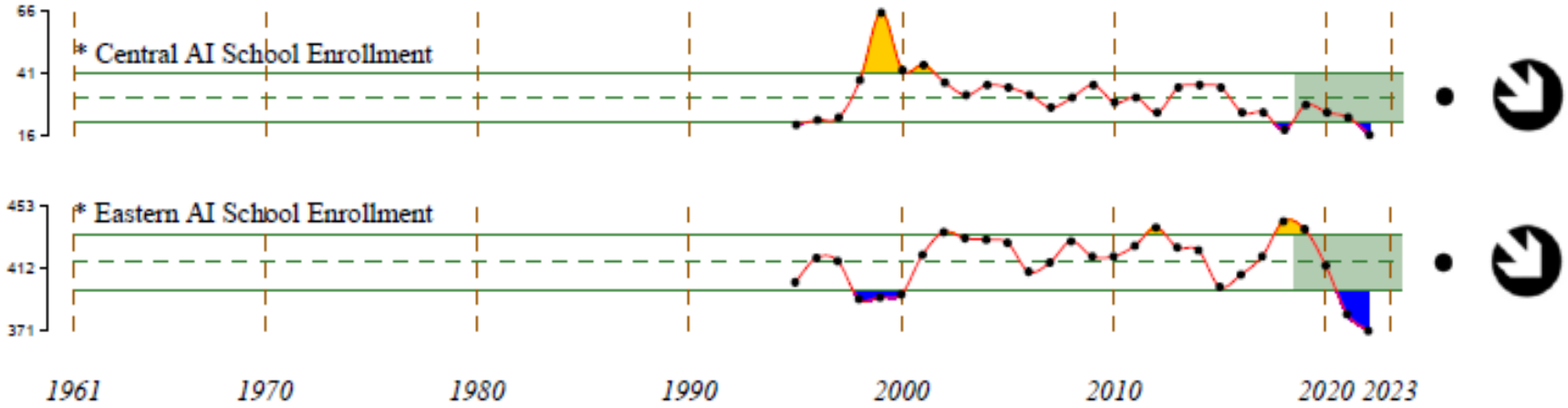
Harmful Algal Blooms

- Maximum PST recorded in June 15: 3.7x above level considered potentially fatal in humans; 47x above legal limit

- Seabirds (shearwaters) planned to be tested for HABs after over 150 carcasses were reported in Akutan in mid-September; 6 samples tested negative for Highly Pathogenic Avian Influenza

School enrollment

- Decreased school enrollment in 2022-23
  - Central Aleutians: decrease driven by Adak School
  - Eastern Aleutians: decrease driven by Unalaska elementary & high school
- Lower enrollment may decrease the stability of the community.
- Enrollment bottomed out in AK in 2021-22 and has not recovered in the Aleutians.

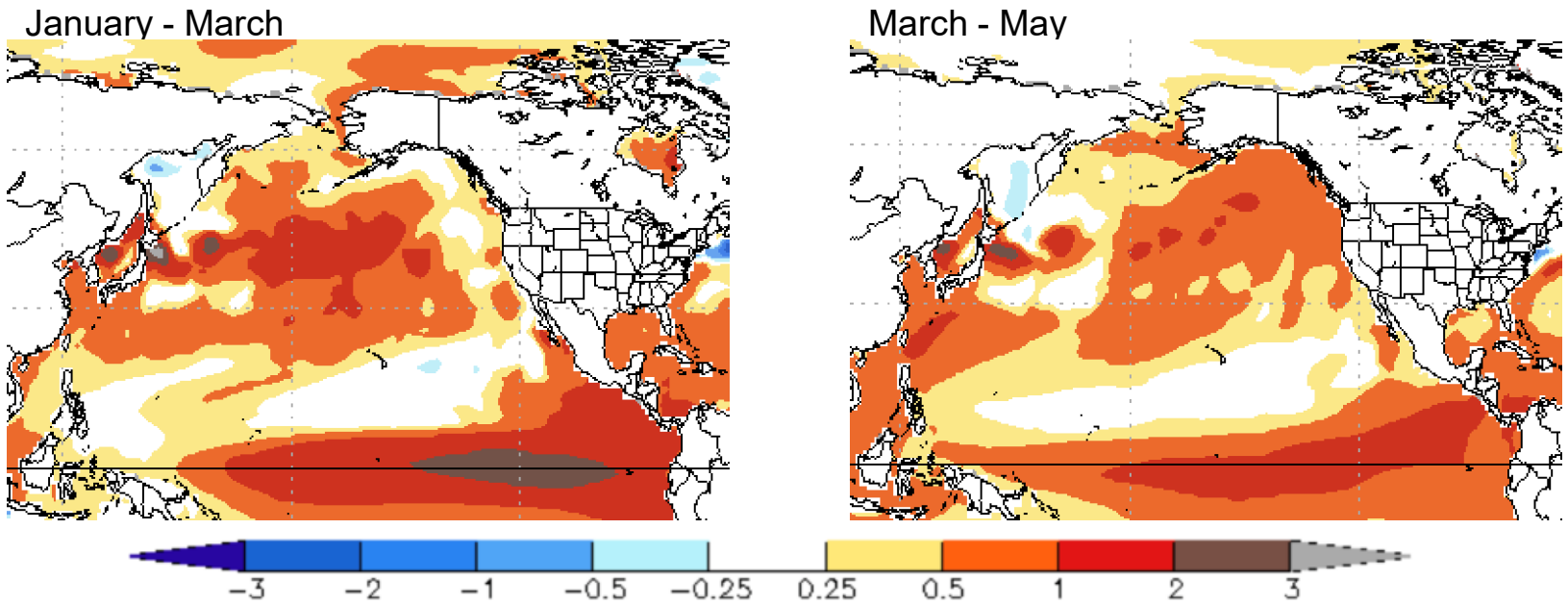


Farrugia et al., Ortiz

National Multi-Model Ensemble Forecast 2024

- **62% chance of El Niño** during April – June 2024,
- Climate prediction center, NOAA https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.shtml
- Warm conditions for western Aleutians (NMME, Bond) for January – March: potential issue for Pacifc cod.
- Ensemble indicates conditions should not be extreme relative to the past 20-30 years
- Sea ice should extend south of 60°N perhaps all the way to M2, and as far south as Bristol Bay along the coast

Sea surface anomalies from National Multi-Model Ensemble



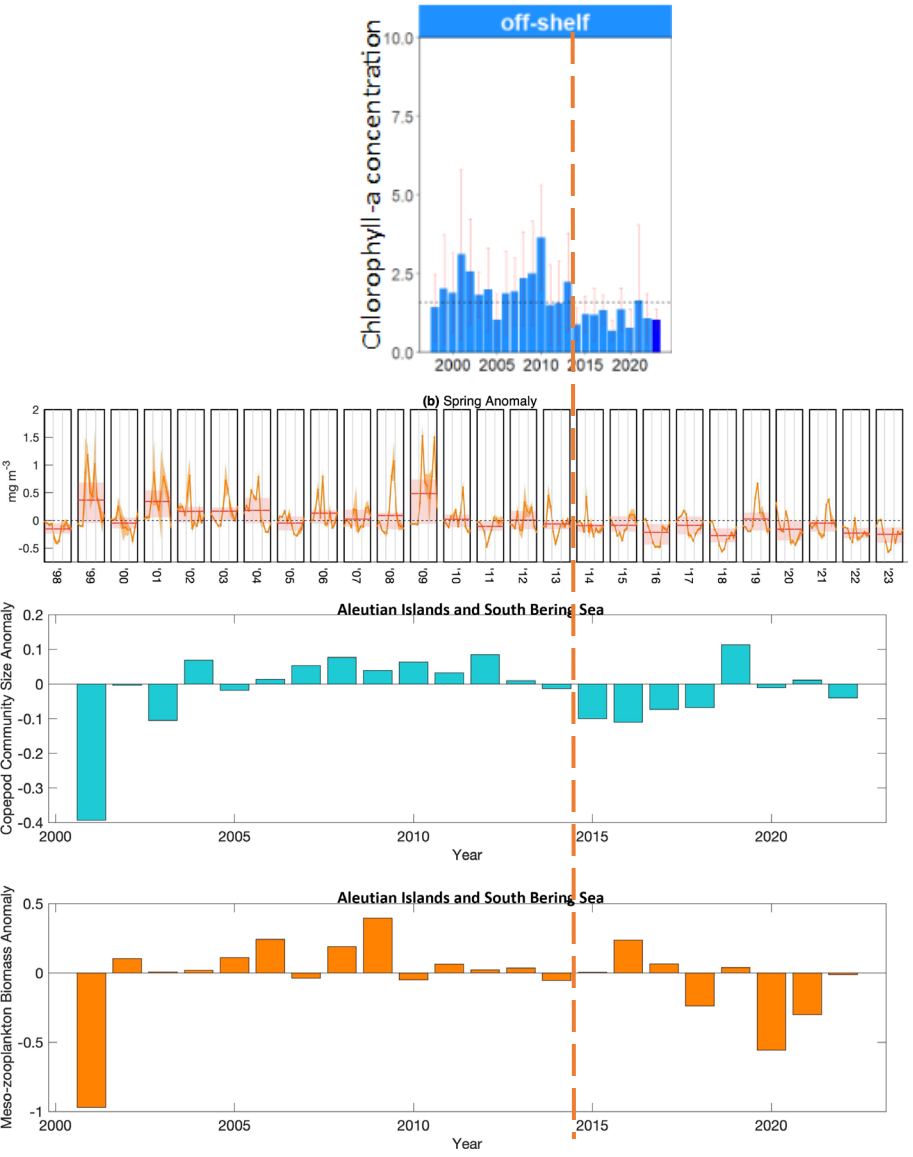
Anomalies are with respect to model hindcasts for the period of 1982-2010.

Bond

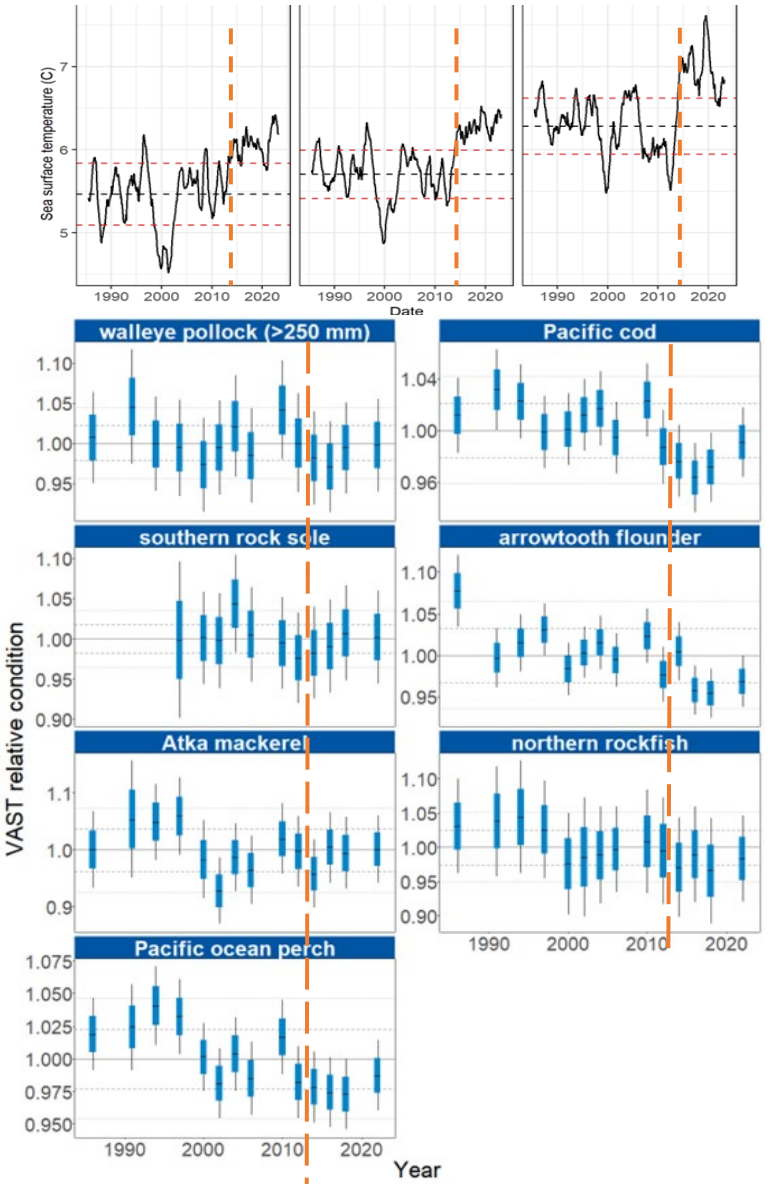
Persistent warm conditions: wide range of effects

Multi-year patterns

Satellite chl-a & Copepods



Temperature and Fish Condition



Satellite chl-a, Diatoms & Copepods

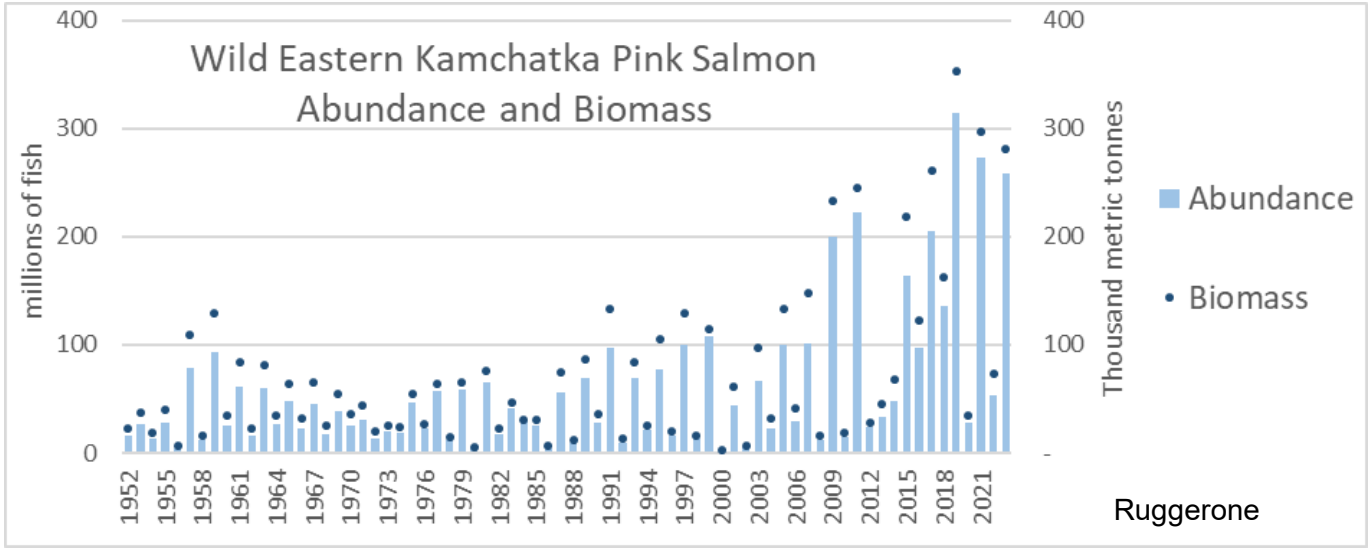
- Satellite-derived chl-a reverted to generally lower than average since 2014.
- Satellite chl-a in EBS off-shelf also decreasing since 2014
- Smaller copepods
- Lower meso-zooplankton biomass

Temperature and Fish Conditions

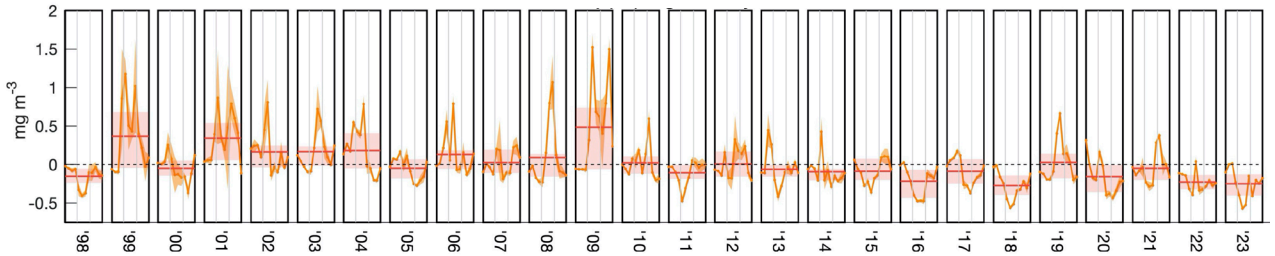
- Warmer temperatures
- Condition factor average or below average since 2014
- Higher energetic costs, increased food consumption

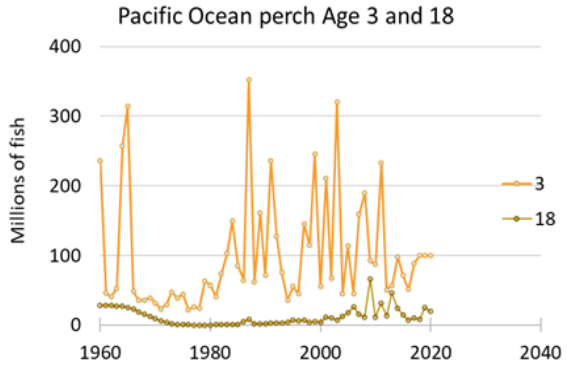
Wild Eastern Kamchatka pink salmon in odd years

Multi-year patterns



Spring (Apr-Jun) satellite chla anomaly GlobColour, Pelland



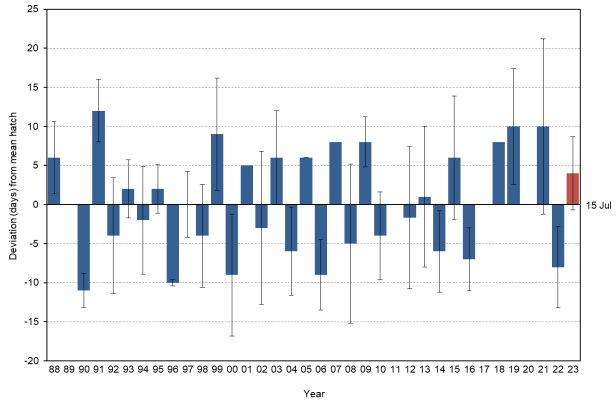


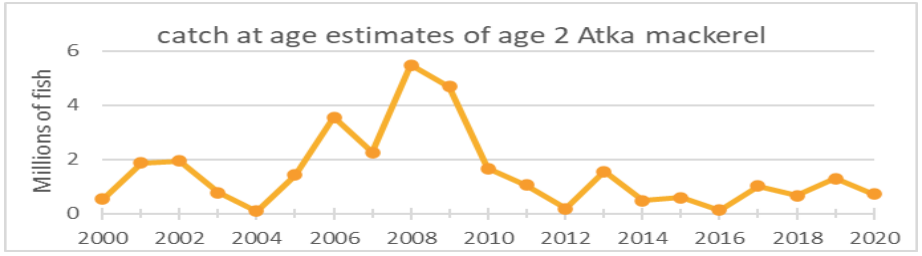
Spencer et al. 2020

Eastern Kamchatka pink salmon, third highest on record

- Based on catch + escapement
- Biennial pattern at several trophic levels from diverse sources
- No statistical analysis has been conducted
- Potential thresholds: 2009 for high abundance years
- No hatchery pinks in East Kamchatka

Tufted puffin hatch date anomaly at Buldir, Rokek et al.
no effect on reproductive success

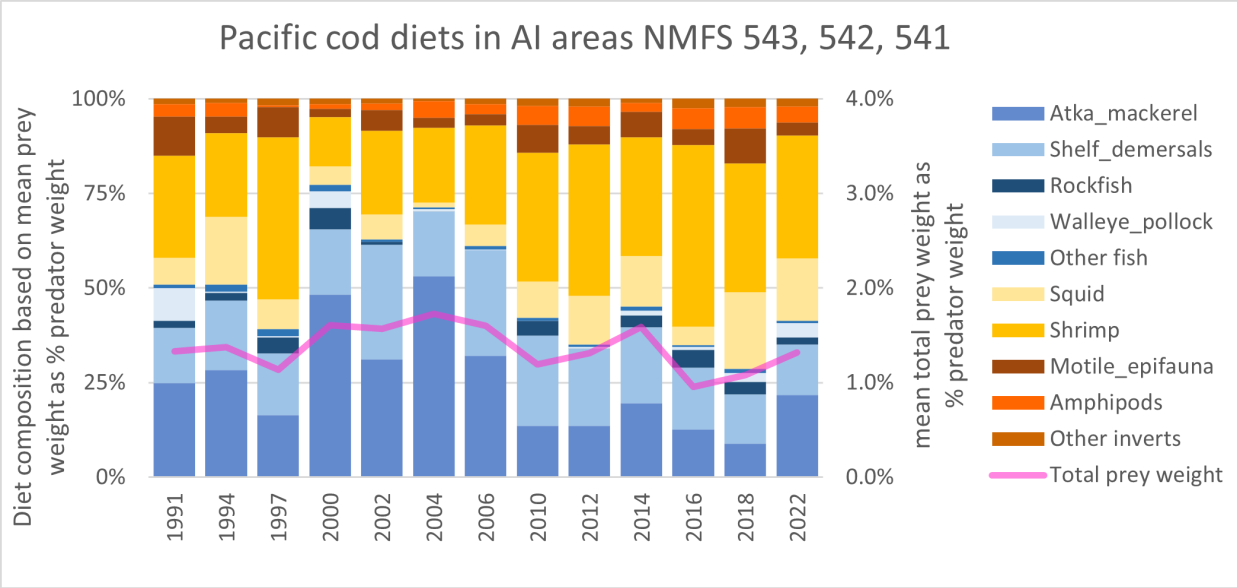




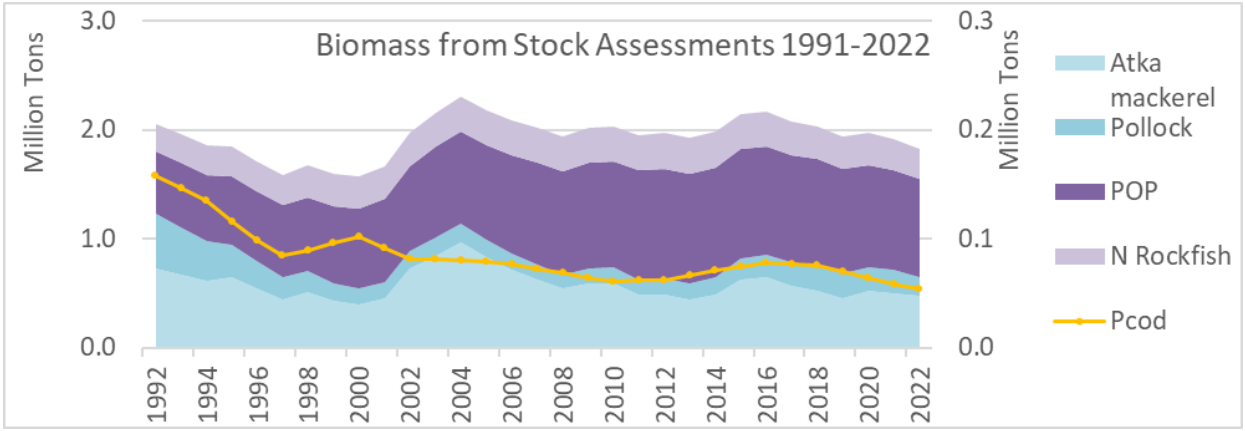
Lowe et al. 2021

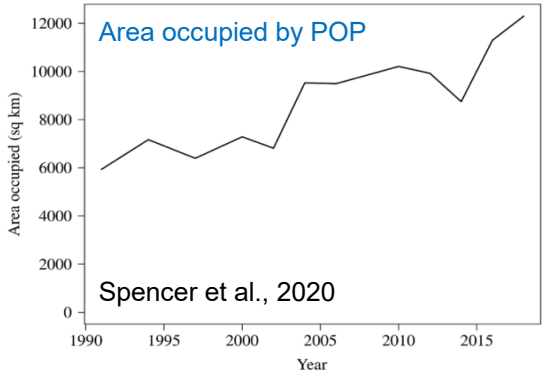
Pacific ocean perch and Northern Rockfish as main pelagic foragers

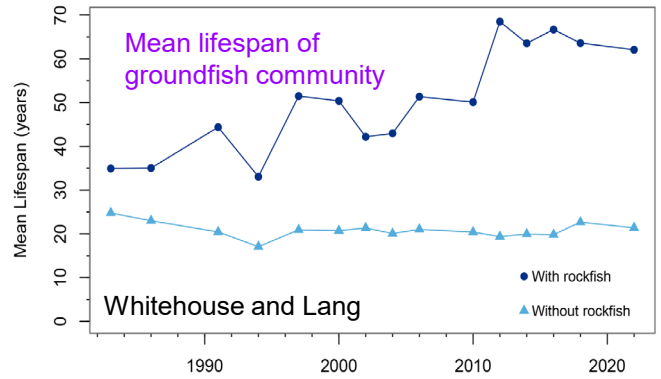
Multi-year patterns



- Increased competition with other fish feeding on zooplankton, changes in cod diet may be due to decreasing Atka mackerel
- POP expanding area occupied
- Longer mean lifespan of groundfish community (35 to 60 years) means a slower turnover rate & dampened effects of environmental variability (increased ecological stability)
- Spatial competition with Atka mackerel, pollock?







Summary and implications

Jan – Mar warmest winter on record, sustained warmer temperatures and large-scale changes in SST

Potential concern for higher bioenergetic costs, changes in phenology (timing and success of egg development, growth rates, and utility of past indicators (e.g. PDO may not be as useful in the future)

Lower than average phytoplankton biomass (sat chl-a) and small copepod size

Decreased primary production/ lower availability of large copepods as prey, despite favorable climatological conditions for zooplankton

Seabird reproductive success above average in EAI for plankton and fish-eating seabirds; mixed for WAI

Indicates potential availability of prey and good foraging conditions for both plankton and fish eating groundfish in EAI, but mixed availability in prey in WAI

HABs increased to 47x FDA limit in June

Indicates potential seasonal risk to human health and risk to predators in the ecosystem

Pacific cod diets

Decreased availability of fish in diets, available prey of lower quality and/ or increased bioenergetic costs and consumption.

Rockfish dominance of pelagic forage fish biomass

Potential for increased competition for zooplankton and decreasing availability of Atka mackerel and pollock as prey for fish and marine mammals. Rockfish are long-lived and are not a preferred prey item, but may increase resilience of ecosystem

Increasing Eastern Kamchatka pink salmon during both low abundance and high abundance years

Potential biennial pattern cascading to fish and combined with increased temperatures since 2014. Eastern Kamchatka pink salmon export energy from the system

The persistent warm conditions + rockfish dominance + increasing pink salmon abundance jointly might indicate

transition of the ecosystem to a state where rockfish and pink salmon are the main pathway of zooplankton into food web

Additional Information Available

Ecosystem Status Reports through 2022 are available here:

ESR Reports (1999-2022)