

Ecosystem Status Report: Aleutian Islands 2023

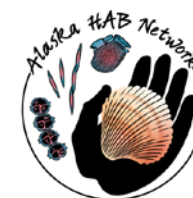
Ivonne Ortiz & Stephani Zador



Thank you!

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

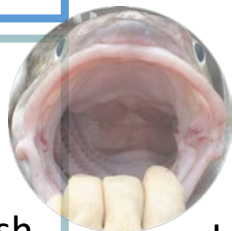
Level 1

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 $\mu\text{g}/100\text{ g}$ in blue mussels (1000 $\mu\text{g}/100\text{ g}$ 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
- zooplankton 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



- Persistent warm conditions,
- 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 due to lower availability of Atka.

Response to SSC comments (Dec. 2022)

" the SSC requests that authors for each section be encouraged to state the period over which "normal" (the mean, or median) is calculated, and the degree of departure from the mean or median needed to identify something as an anomaly."

ESR authors and contributors paid close attention to defining time series length, defining the average or median (authors are trying to move away from using "normal"), and articulating what constitutes an anomaly. Data sources are provided, where appropriate.

"The SSC suggests that it would be useful to consider that different species may react differently to a given temperature, regardless of location and time of year."

ESR authors believe the role of the ESR is to provide whole-ecosystem context. We work closely with ESP teams as those documents are developed and produced and believe ESPs are a more appropriate report for documenting species-specific thresholds.

For stock assessments that do not have ESPs, the ESR authors will work to review species-specific reference temperatures and/or phenology (spawning, egg development, hatching timing, location, growth curves) for discussion with the stock assessment authors for risk table determinations..

"... the SSC suggests that additional information indicating the abundance of key copepod species that are large and lipid-rich at later stages (C4 or C5) would be valuable."

ESR Editors communicated this recommendation to AFSC zooplankton expert, David Kimmel. Below is Dr. Kimmel's response:

"We agree with the SSC that additional information on key copepod species that are lipid rich and in the C4/C5 stage would be useful. We Will determine if our large copepod time-series correlates with key species, such as *Calanus glacialis*, later in the year. Identifying copepods at sea is simply not possible given the time and expertise necessary to carry out such a task across multiple ecosystem surveys..

"...the SSC recommends that the authors are consistent in providing headers but omit repetition of data..."

The ESR editors will be consistent in not including contributions that have not been updated since the previous year's ESR. Where appropriate, we will provide headers identifying contribution that were not updated but are expected to return when new data are available. While the ESR has been largely successful in working with our collaborators to include present year data, there are still some contributions that are 1 year lagged due to data analysis requirements or the delayed availability of survey data.

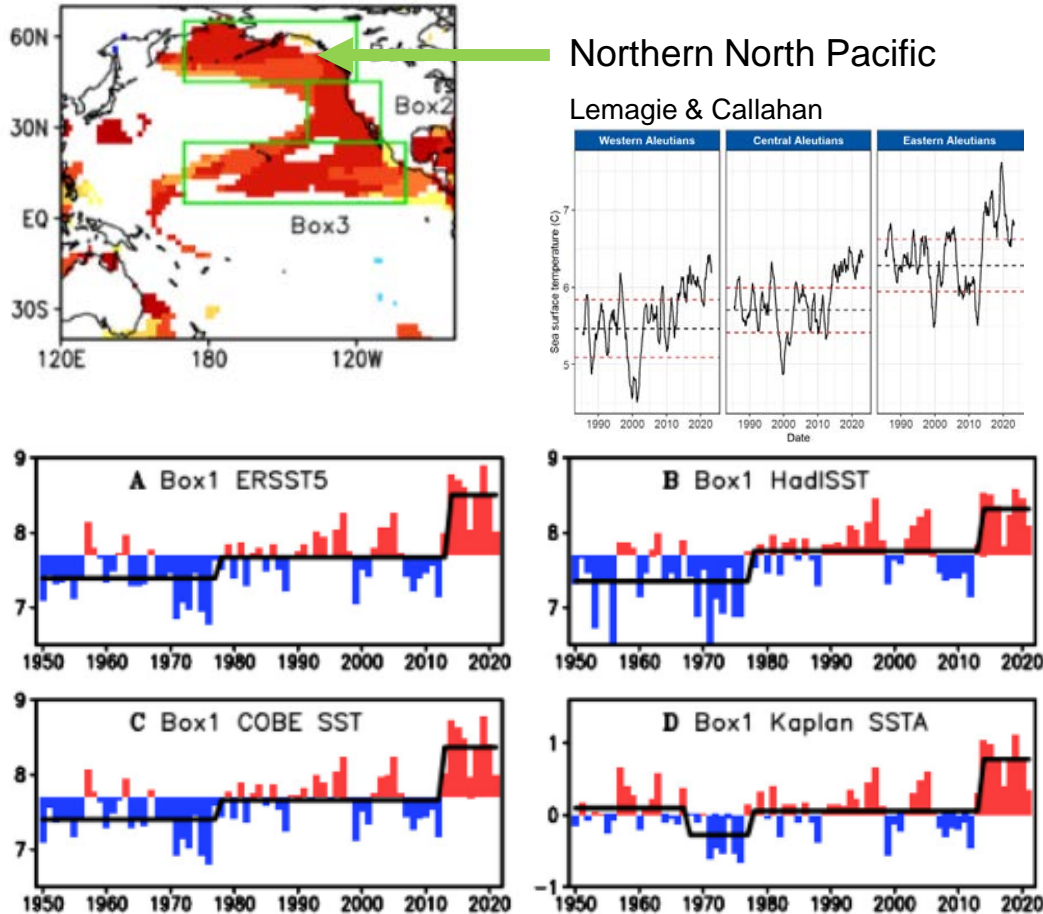
Sections with no updates provide the following text: \\

``There are no updates in this year's report. See the contribution archive for previous indicators at: [\url{https://apps-afsc.fisheries.noaa.gov/refm/reem/ecoweb/index.php}](https://apps-afsc.fisheries.noaa.gov/refm/reem/ecoweb/index.php)

Noteworthy

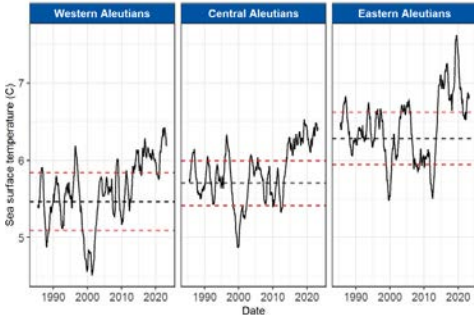
Changes in large scale sea surface temperature patterns

Temperature regime shift in North Pacific
annual mean sea surface temperature in 2013/14

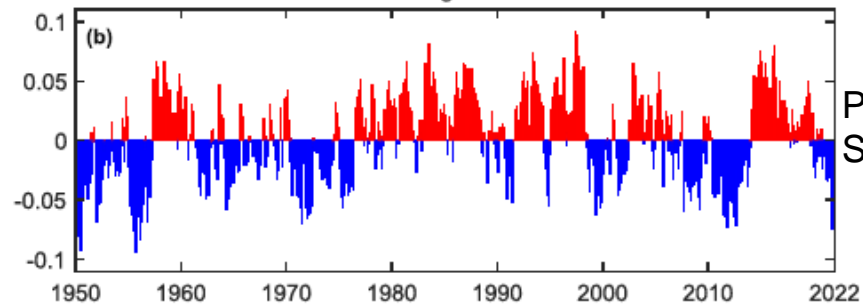


Northern North Pacific

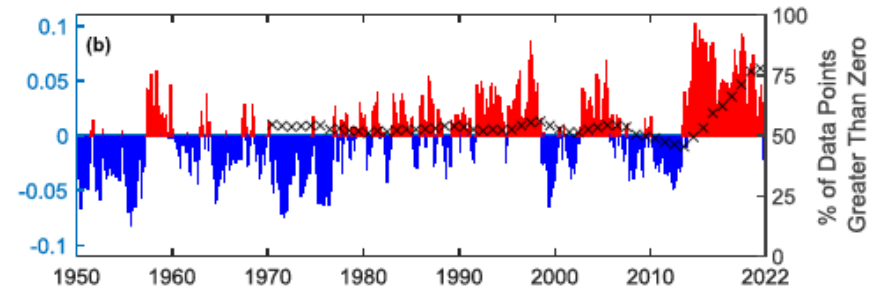
Lemagie & Callahan



- PDO indicator may not be as useful as it used to be
- First mode of variability of SST has changed
- Relationships with physical and ecological processes may vary as the climate continues to change



PDO based on EOF of SST from 1950-1993



Principal component for the first EOF of SST 1950-2021

Xs are % grid points > 0 in the first EOF from 1970 - 2021

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

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

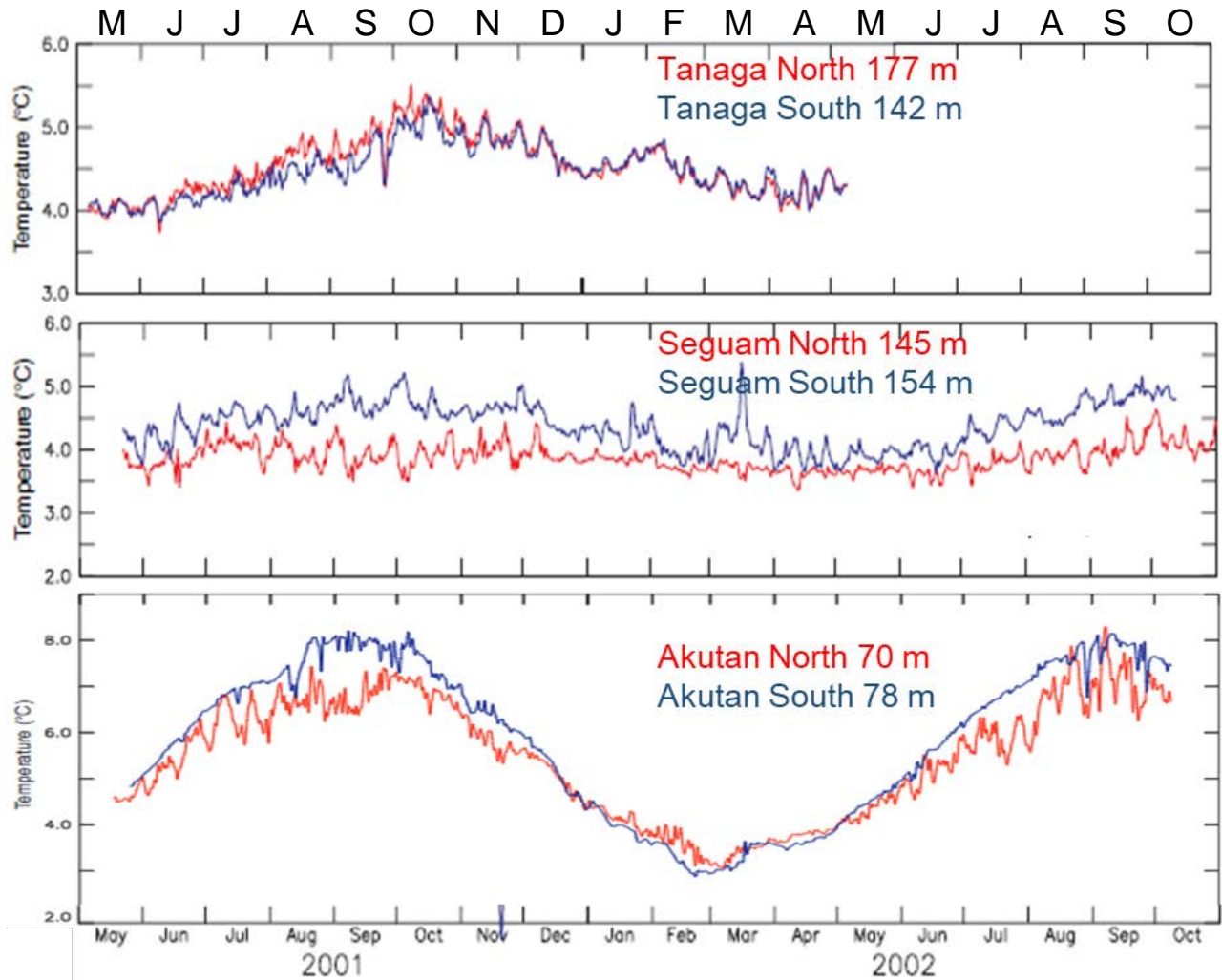
Noteworthy

Key temperature ranges for commercial species in the Aleutian Islands

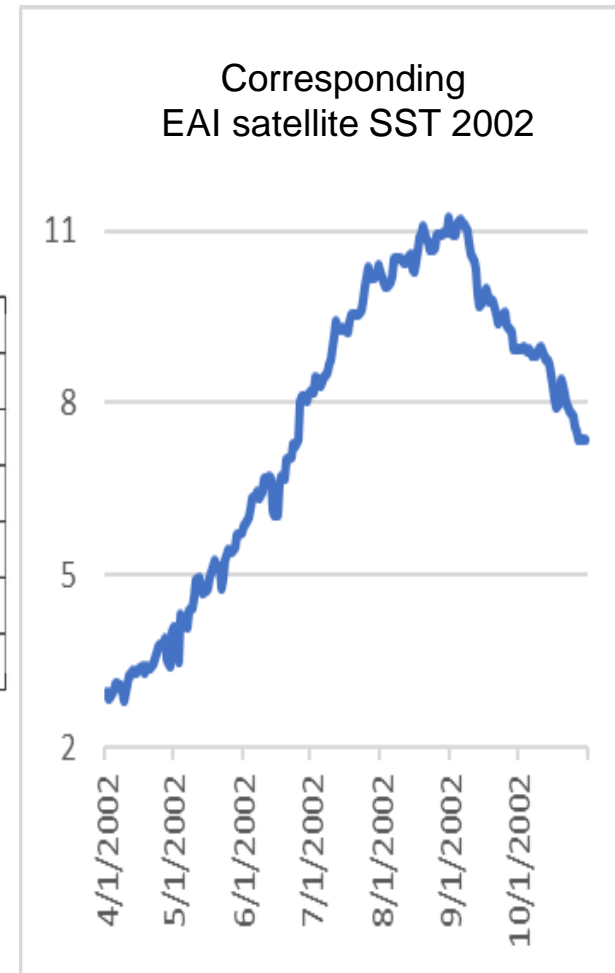
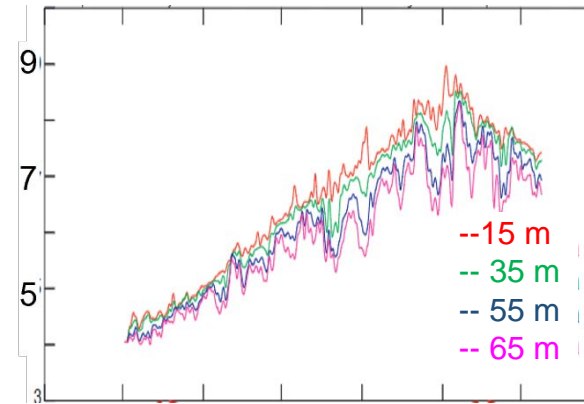
Atka mackerel nesting 3.7-10.7°C Jul-Oct

P. cod >20% hatch success 3 - 6°C Jan-May

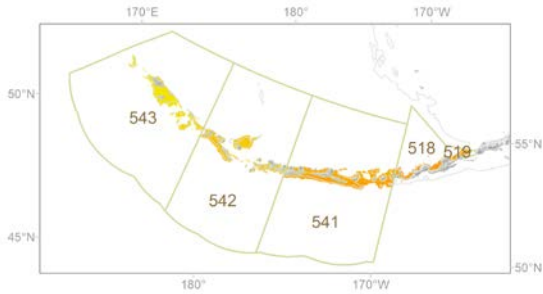
Pollock >20% hatch success -1 to 12°C Mar-Jun



Akutan Pass mooring 2002

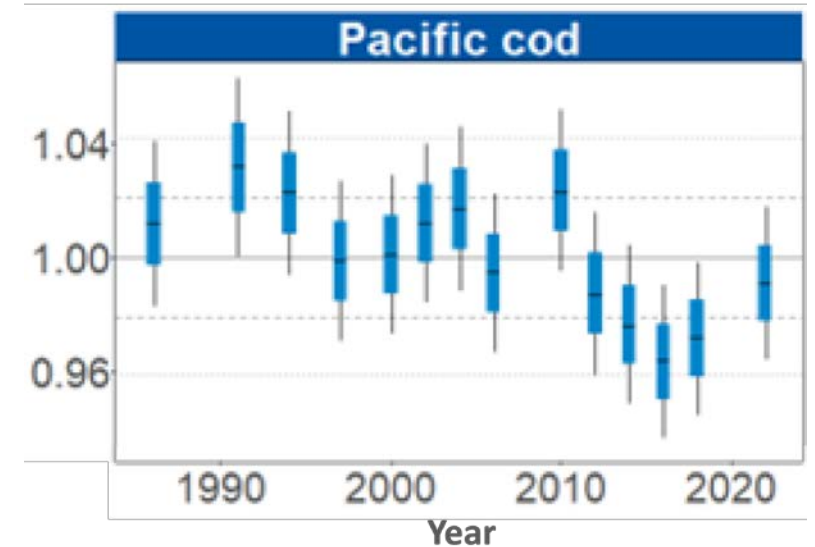
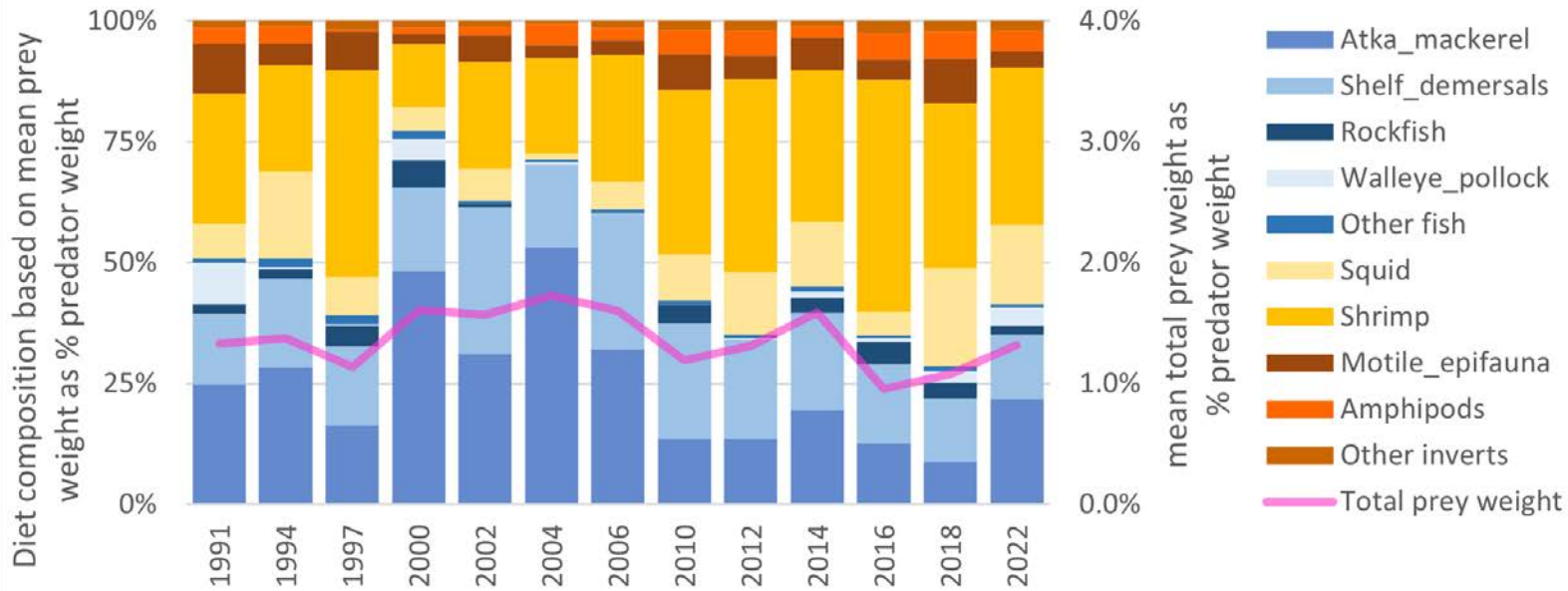


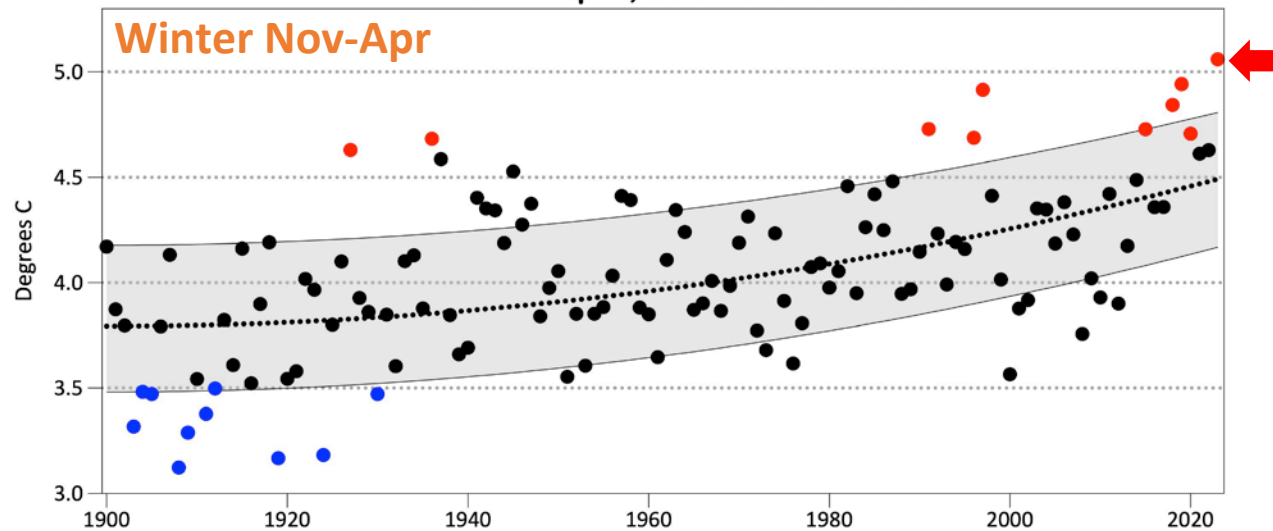
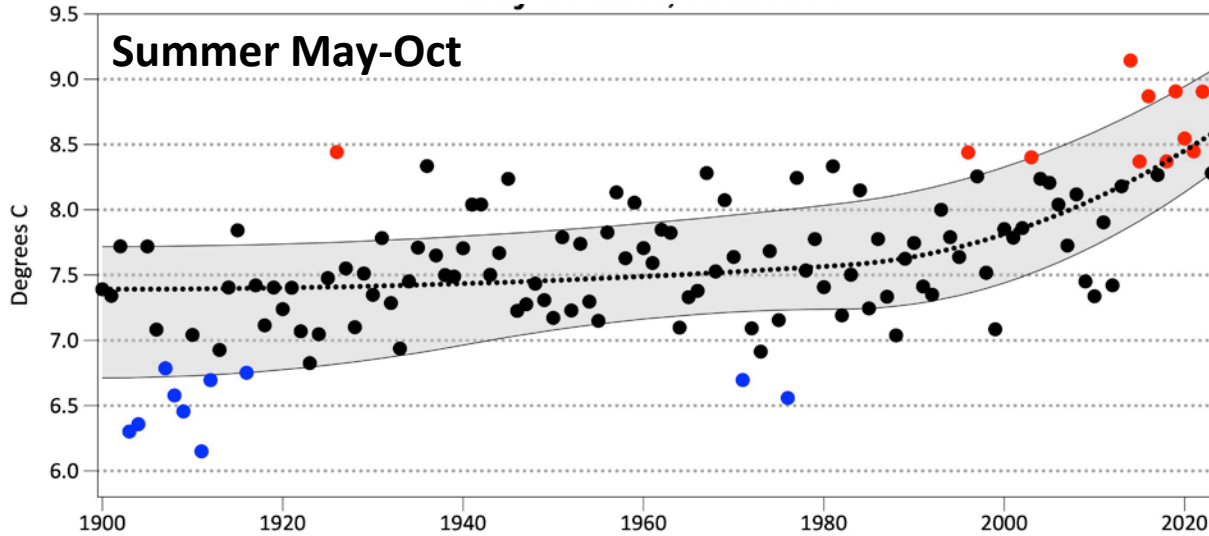
Noteworthy



- Less fish in diets
- Even when similar amount of prey was consumed, less fish results in low fish condition
- Lower fish condition due to lower prey quality + potentially higher bioenergetic costs

Pacific cod diets in AI areas NMFS 543, 542, 541

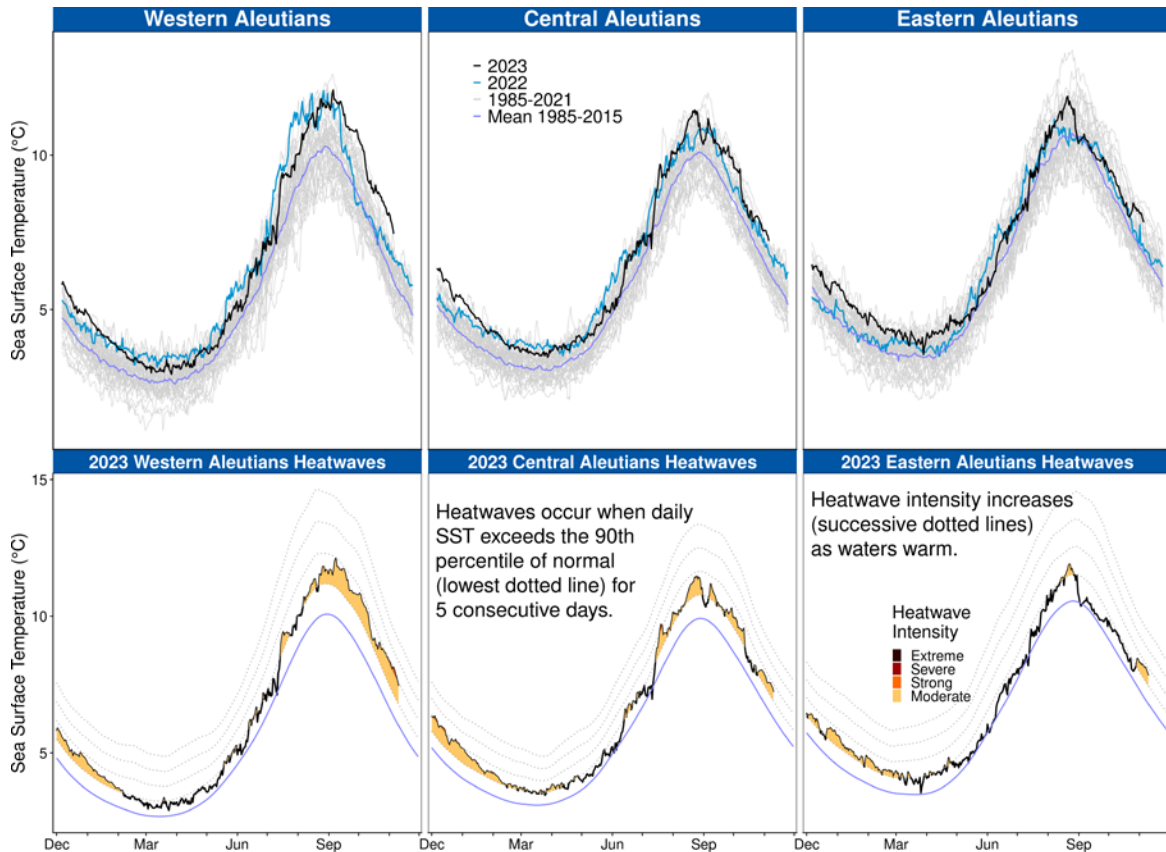




Long-term Sea Surface Temperature

- 2023 – Warmest winter in 124 years
- Warming trend winter and summer

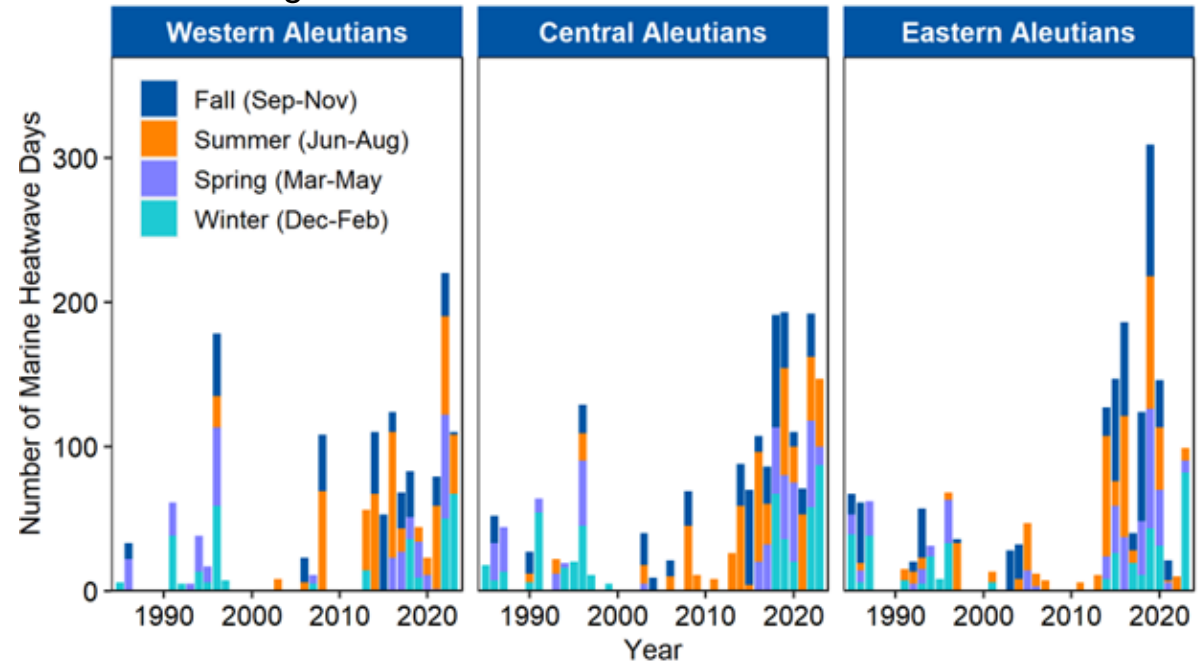
data through 11-12-2023



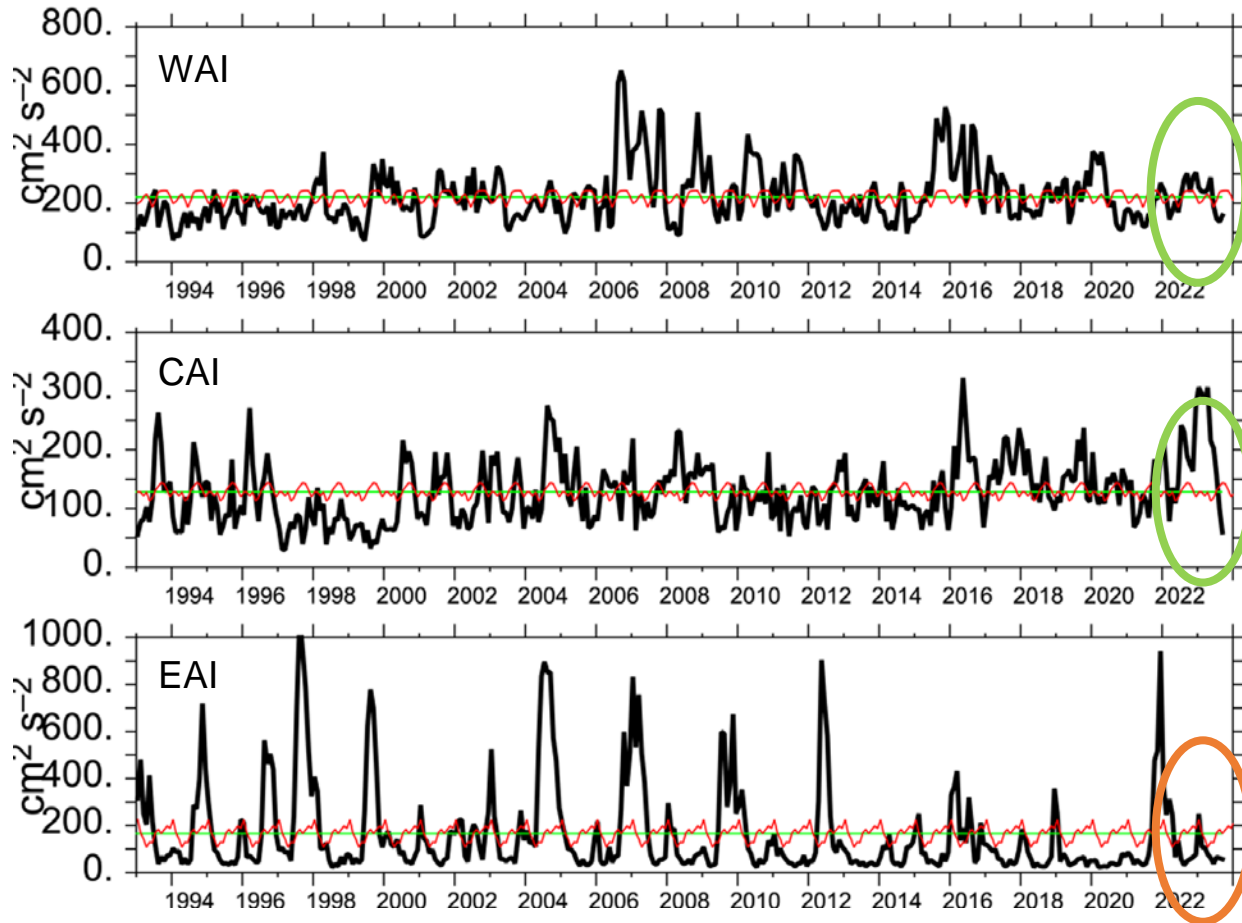
Satellite SST

- Warm winter throughout
- Cooler spring & summer but still above 1985-2021 mean
- Current Fall – warmest in WAI

data through 09-02-2023



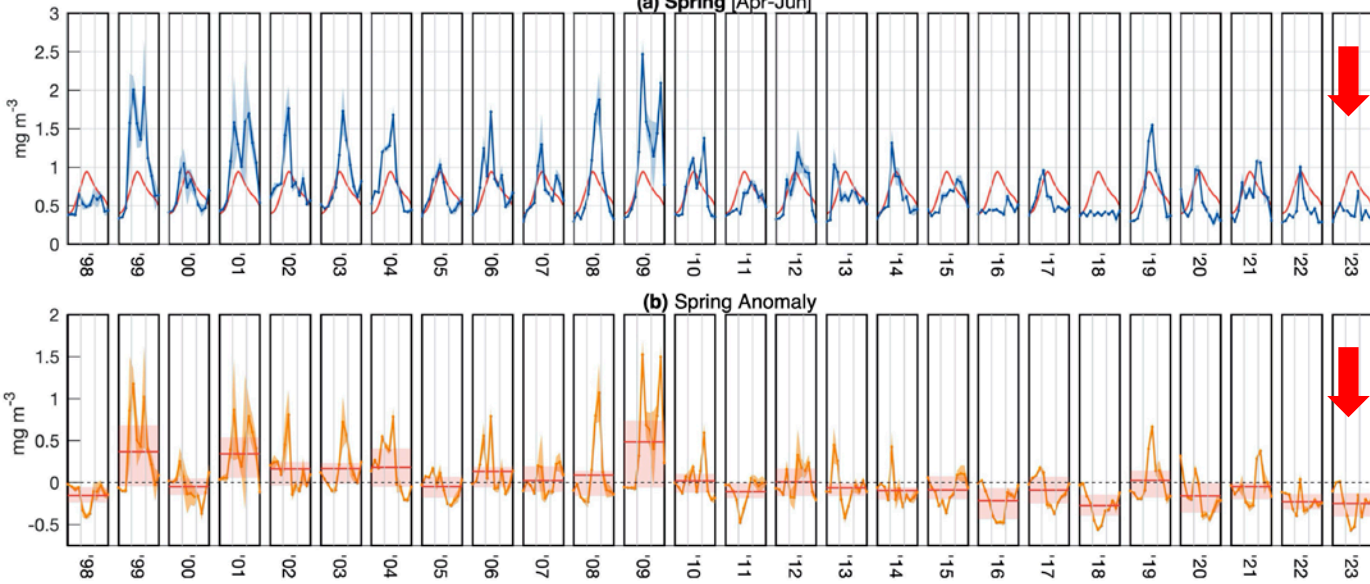
NOAA Coral Reef Watch data, courtesy National Environmental Satellite, Data, and Information Service (Updated: 11-10-2023)
 Data are modeled satellite products and periodic discrepancies or gaps may exist across sensors and products.
 Contact: matt.callahan@noaa.gov



Eddy Kinetic Energy

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

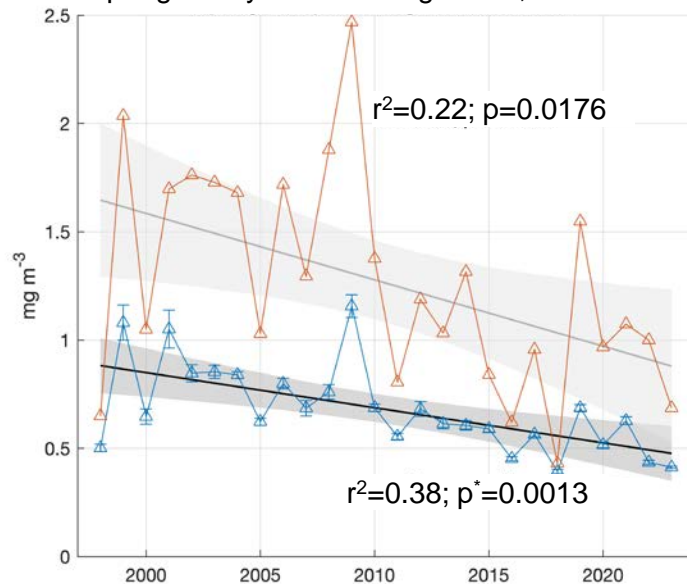
Spatial-Average Aleutian Islands GlobColour chl a



Satellite chl-a

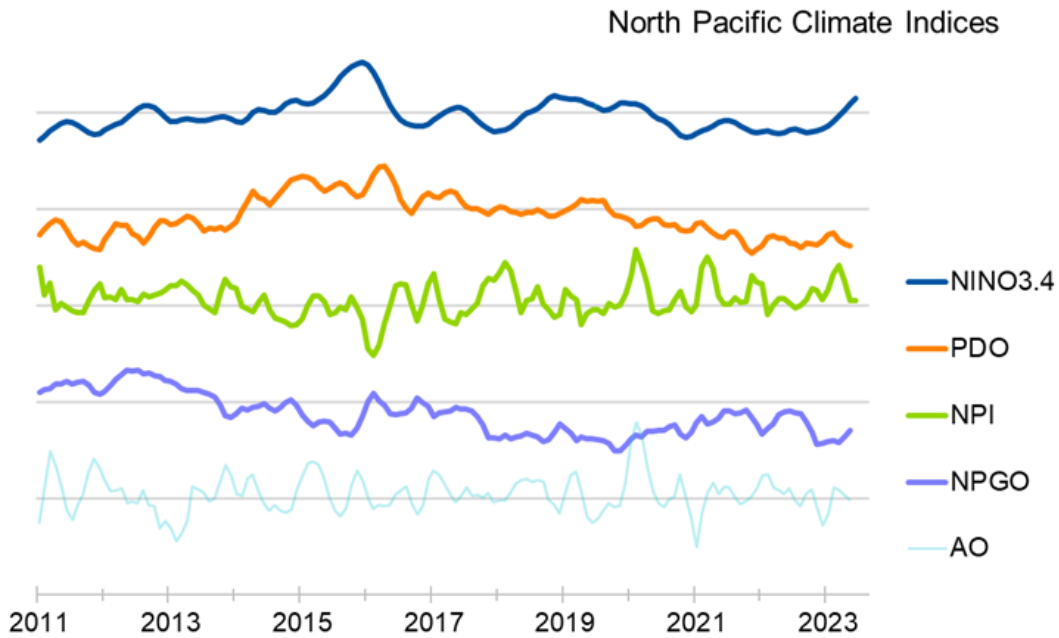
- Satellite chl-a, spring (Apr-Jun) phytoplankton biomass lower than 1998-2022 spring average
- Evidence for a negative trend in spring AI chl-a across the GlobColour time series
- low chl-a also in the adjacent off-shelf areas of EBS, shelf areas of GOA in recent years
- Note ratio of small to large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

Spring Ecosystem- Average Chla, GlobColour



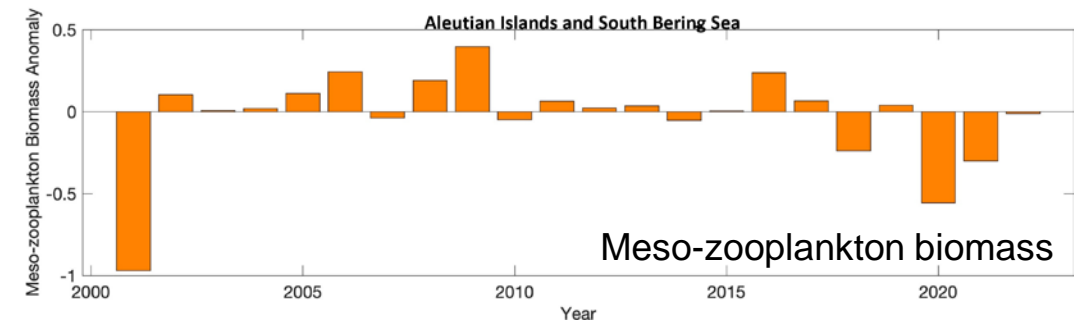
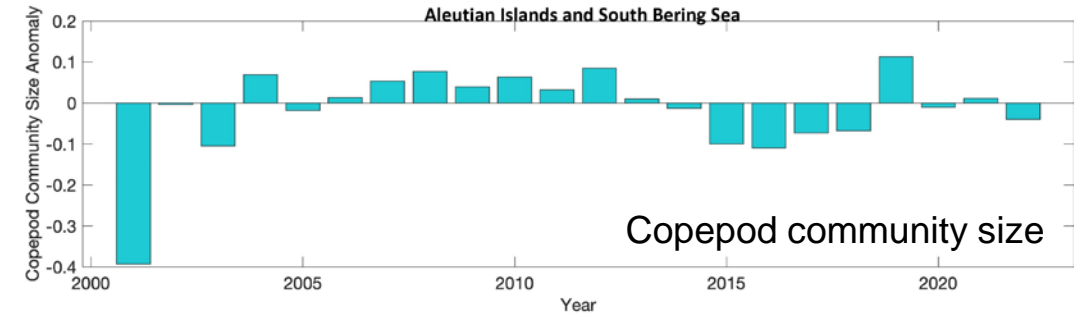
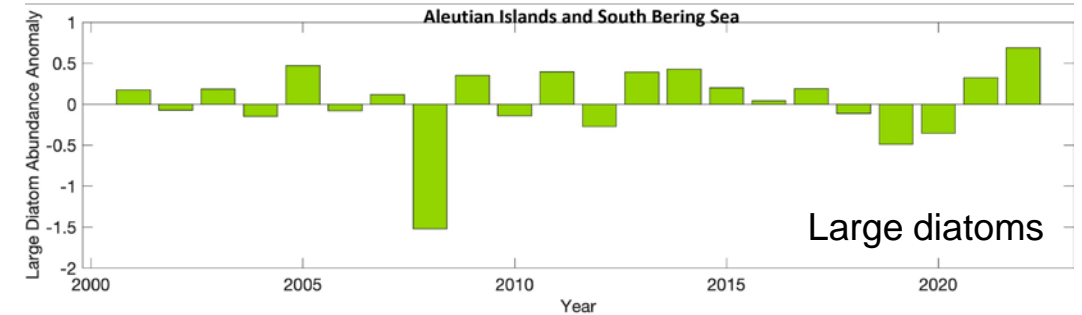
Climate Indices

- Negative PDO, Positive NPI, Negative NPGO jointly support increased zooplankton

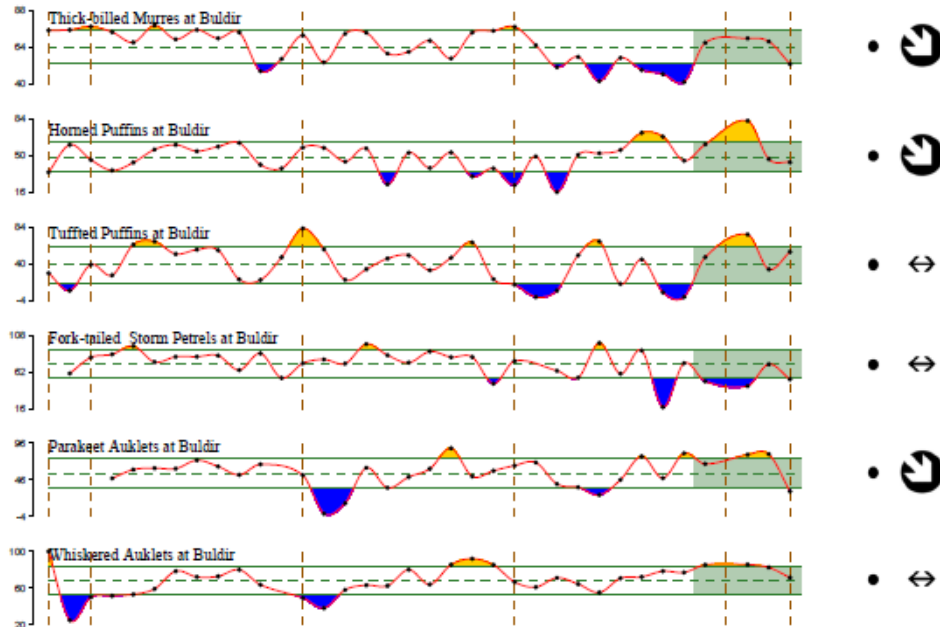


Continuous plankton recorder

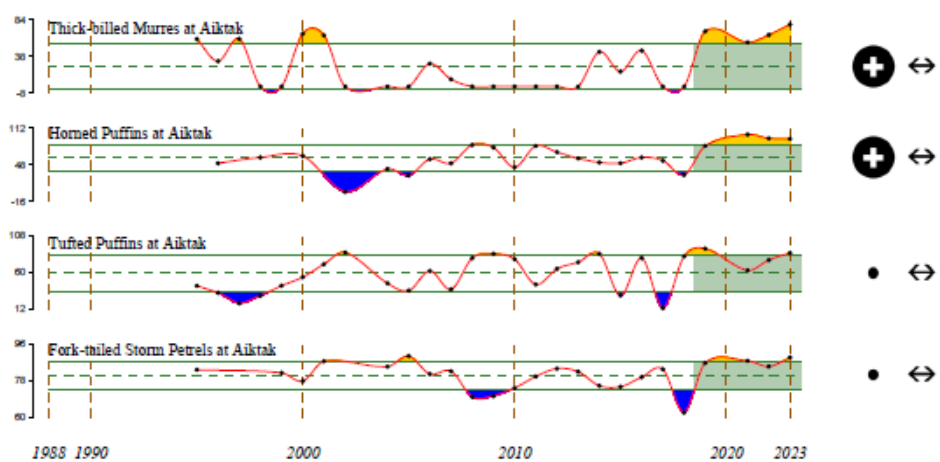
- Large diatom biomass in 2022: higher than 2000-2021 average
- Smaller size and lower meso-zooplankton biomass than 2000-2021 average in 2022



Western Aleutians



Eastern Aleutians



2019-2023 Mean
 + 1 s.d. above mean
 - 1 s.d. below mean
 • within 1 s.d. of mean

2019-2023 Trend
 + increase by 1 s.d. over time window
 - decrease by 1 s.d. over time window
 ↔ change < 1 s.d. over window

Seabird Reproductive Success

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

Site	Species													
	Primarily fish eaters						Primarily zooplankton eaters							
	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
Aiktak	😊	😊	😊	😊	😊	-	-	😊	😊	😊	-	-	-	-
Buldir	😊	-	😞	😊	😊	😞	😞	😞	😊	-	😞	😊	😊	😊

above 😊
 average 😞

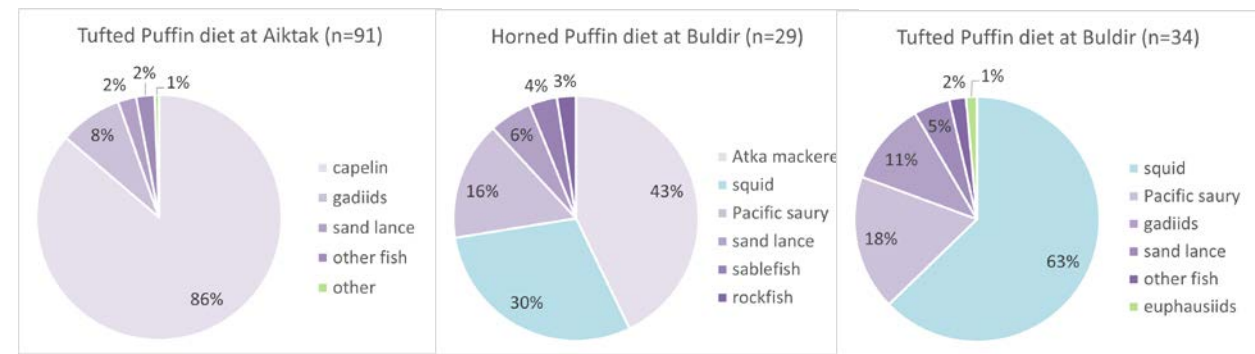
EAI
 WAI

Seabird Diets

Mostly capelin in the EAI

Fish and squid in WAI:

Atka mackerel 43% of diet of horned puffins, Pacific saury 18% in tufted puffin



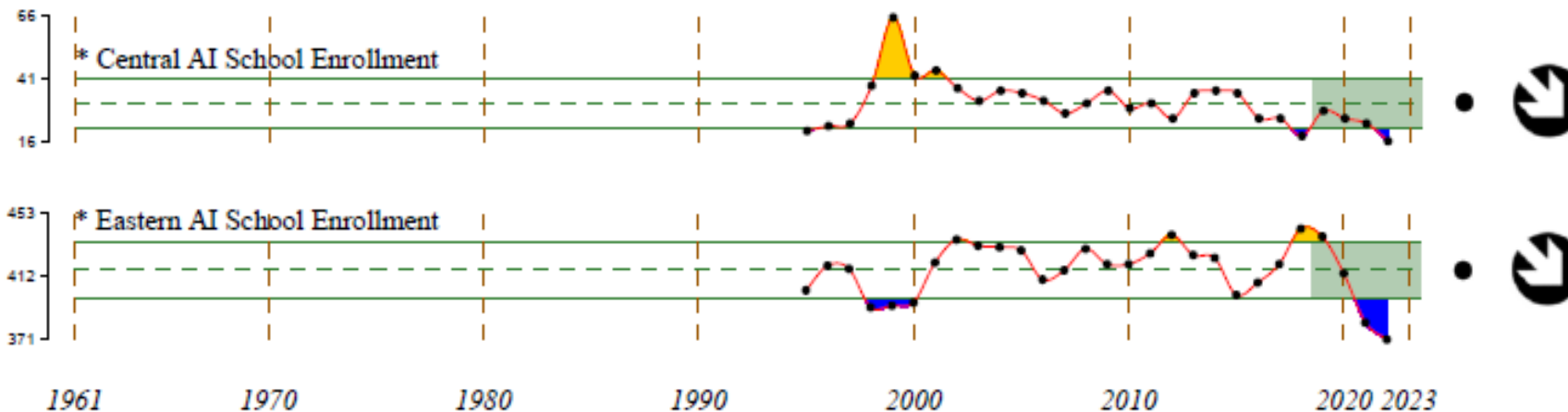


Harmful Algal Blooms

- 47x above the legal limit in blue mussels and 3.7x above the level considered as potentially fatal.
- Seabirds (shearwaters) planned to be tested for HABs after over 150 carcasses were reported in Akutan in mid-September; sample of 6 tested negative for Highly Pathogenic Avian Influenza

School enrollment

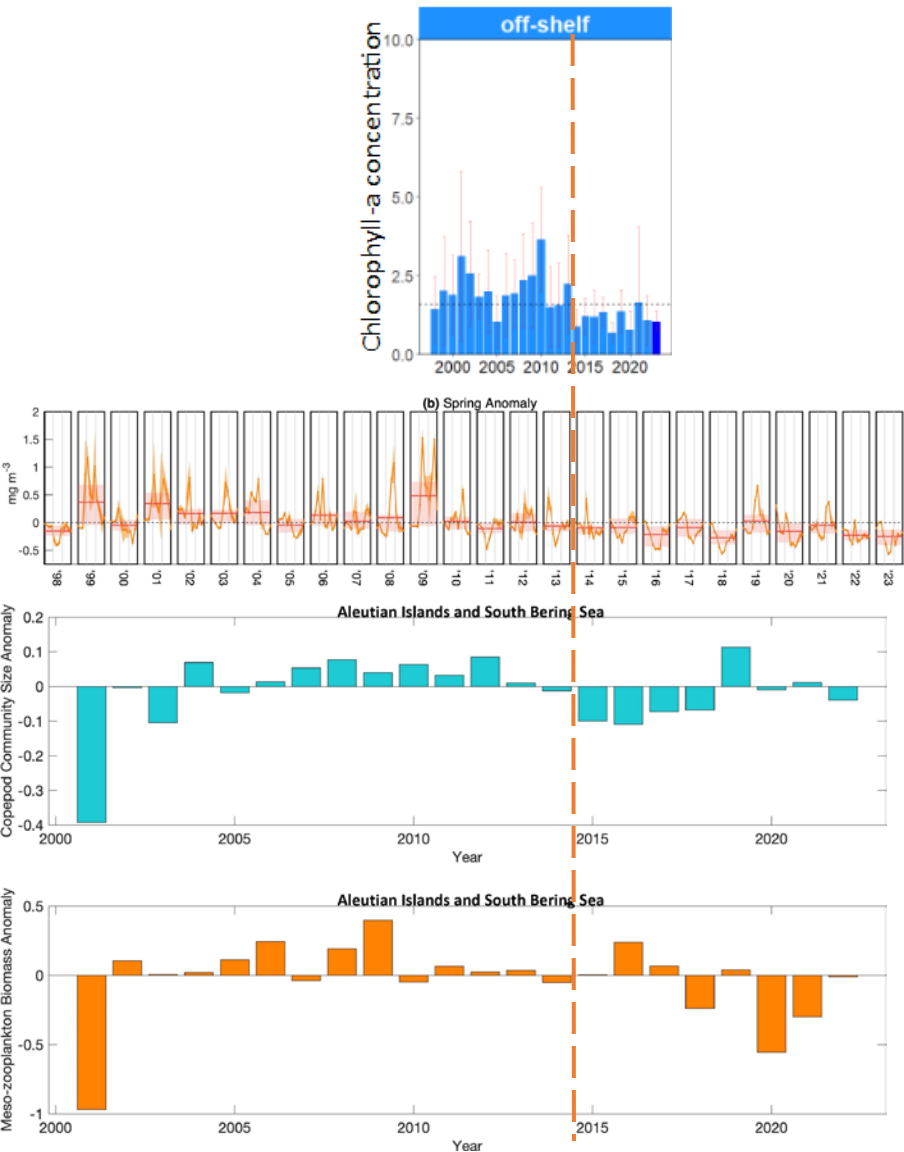
- Lower enrollment decreases the stability of the community.
- Enrollment bottomed out in AK in 2021-22 and **has not recovered in the Aleutians.**



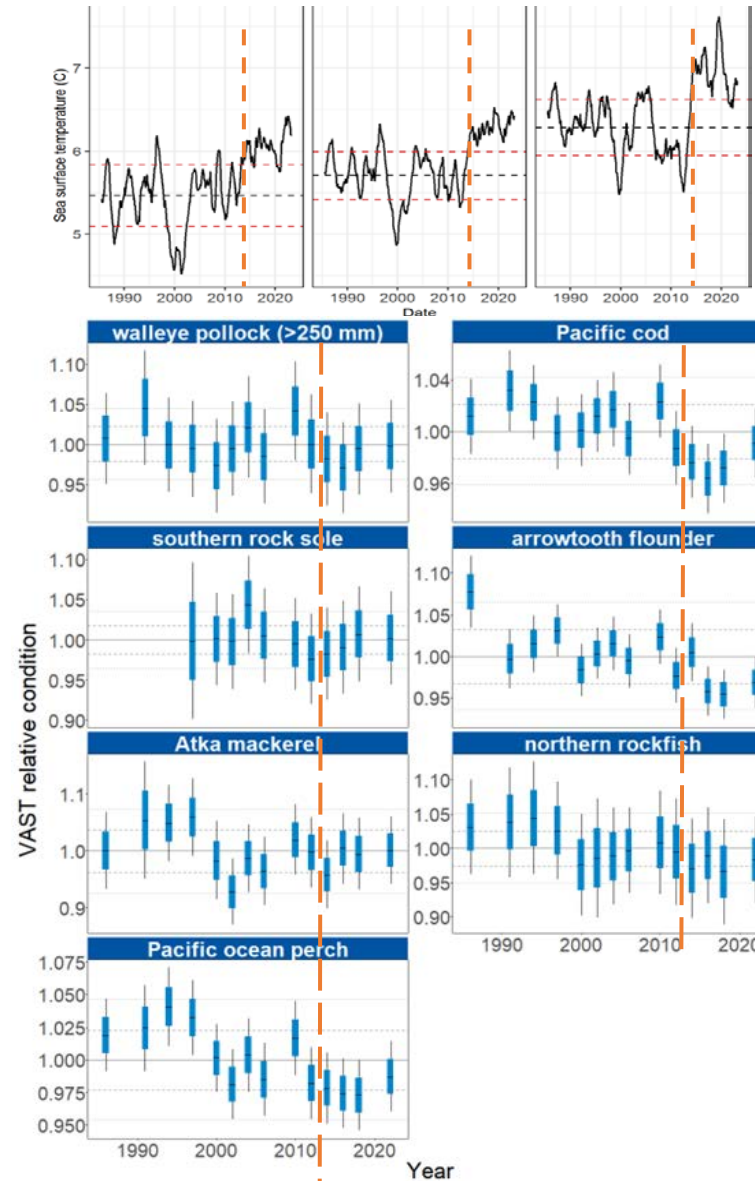
Persistent warm conditions

Multi-year patterns

Satellite chl-a & Copepods



Temperature and Fish Condition



Satellite chl-a, Diatoms & Copepods

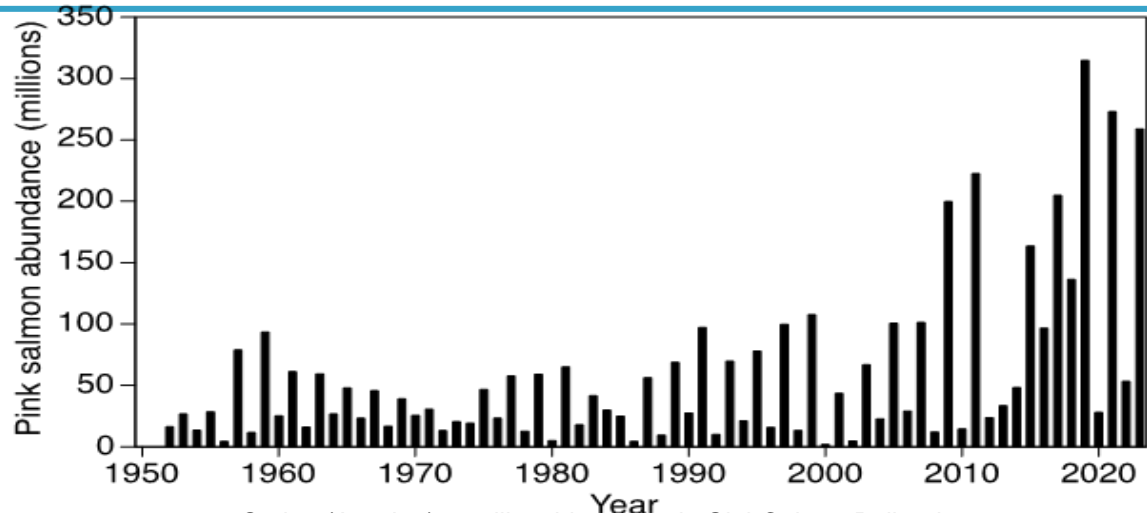
- Satellite-derived chl-a reverted to generally lower than average since 2014.
- Satellite chl-a in EBS off-shelf also decreasing since 2014
- Smaller copepods
- Lower meso-zooplankton biomass

Temperature and Fish Conditions

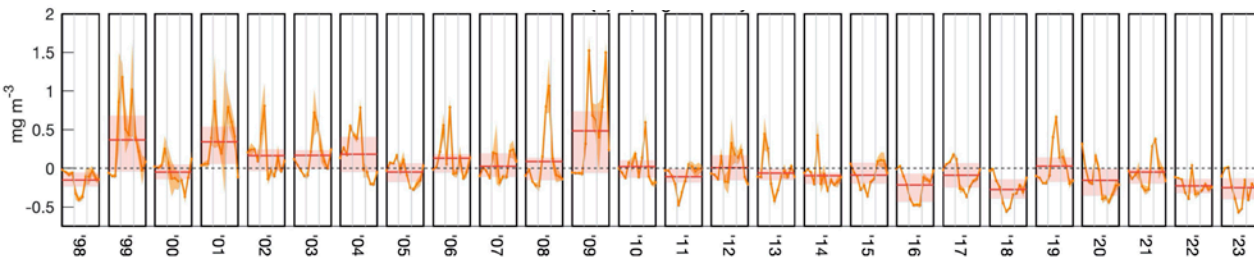
- Warmer temperatures
- Condition factor average or below average since 2014

Eastern Kamchatka pink salmon in odd years

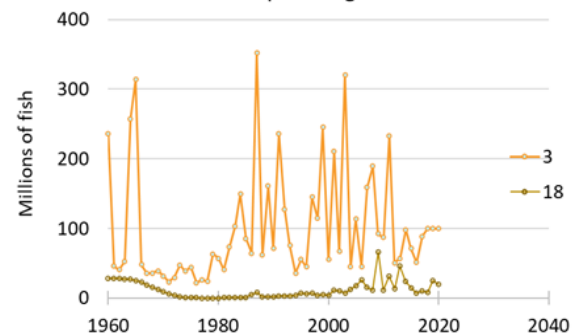
Multi-year patterns



Spring (Apr-Jun) satellite chl a anomaly GlobColour, Pelland



Pacific Ocean perch Age 3 and 18

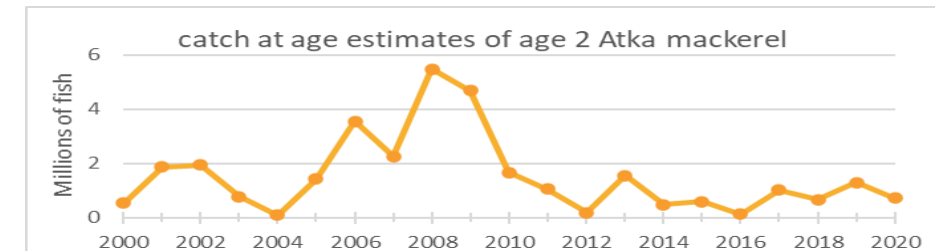
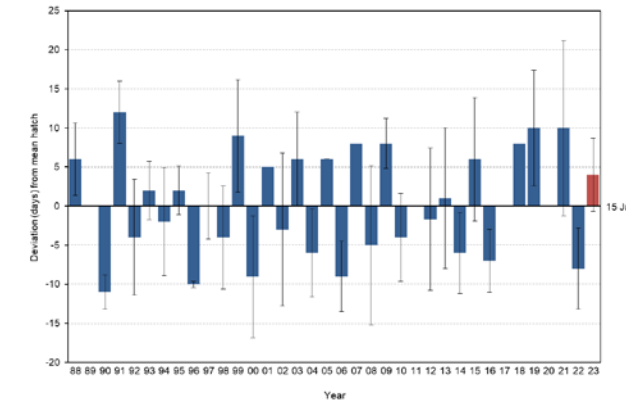


Spencer et al. 2020

Eastern Kamchatka pink salmon

- Continued high level for a low abundance year
- Biennial pattern at several trophic levels from diverse sources
- No statistical analysis has been conducted
- Potential thresholds: 2009 for high abundance years

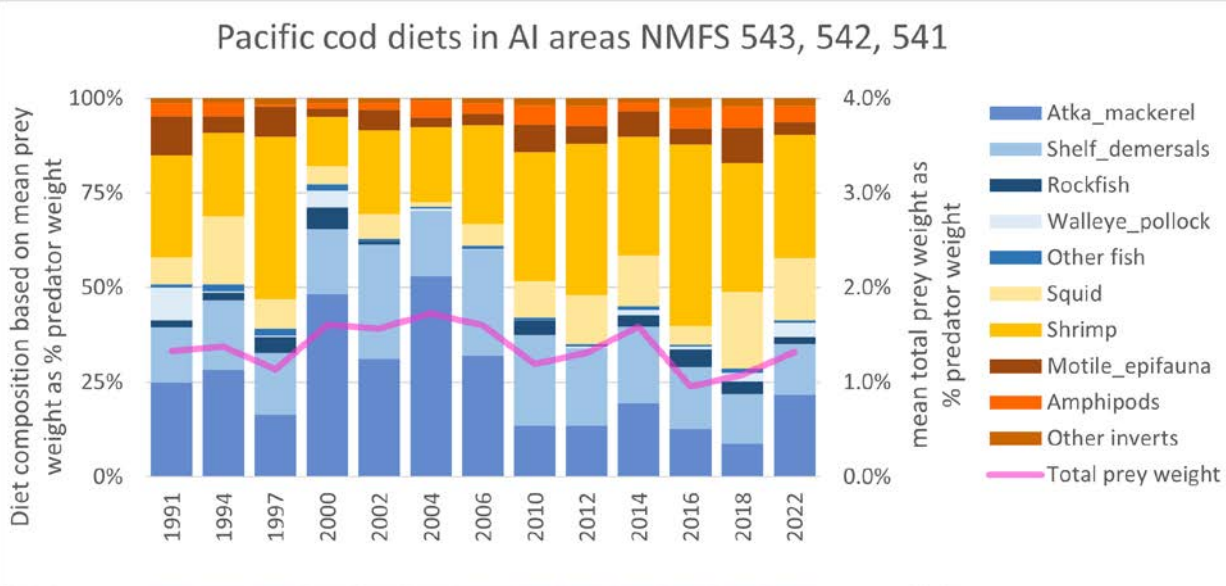
Tufted puffin hatch date anomaly at Buldir, Rokek et al.



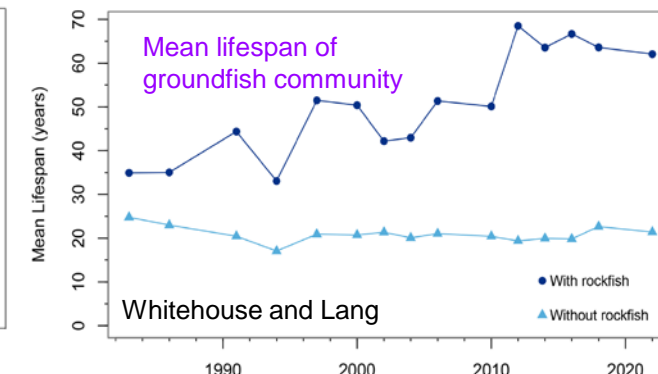
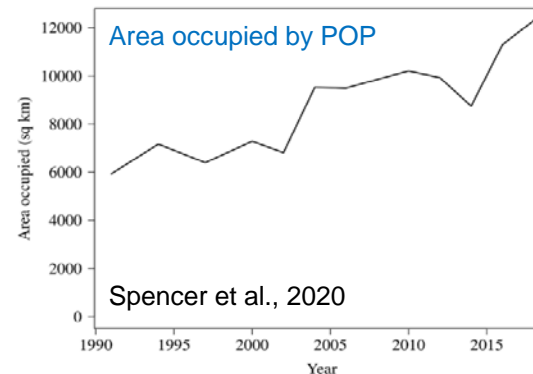
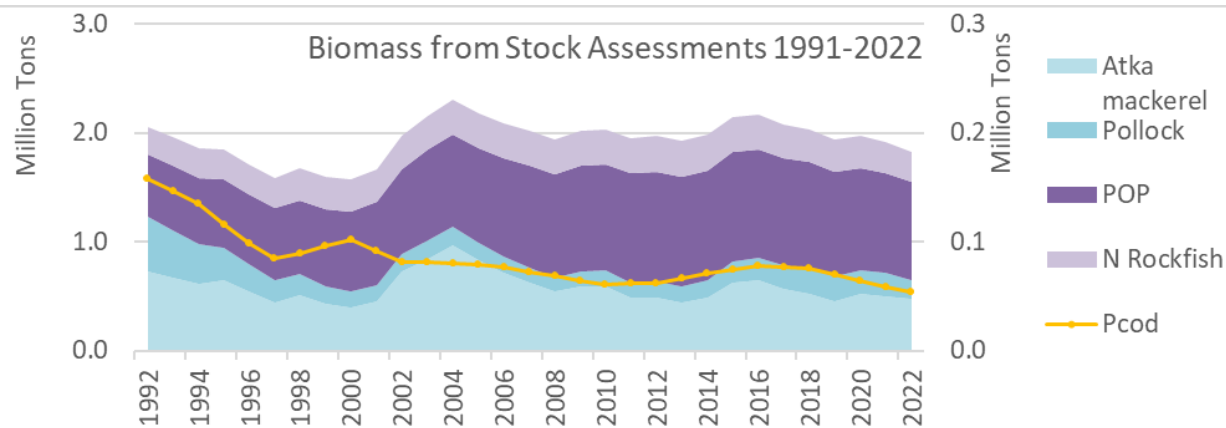
Lowé et al. 2021

Rockfish main pelagic foragers

Multi-year patterns

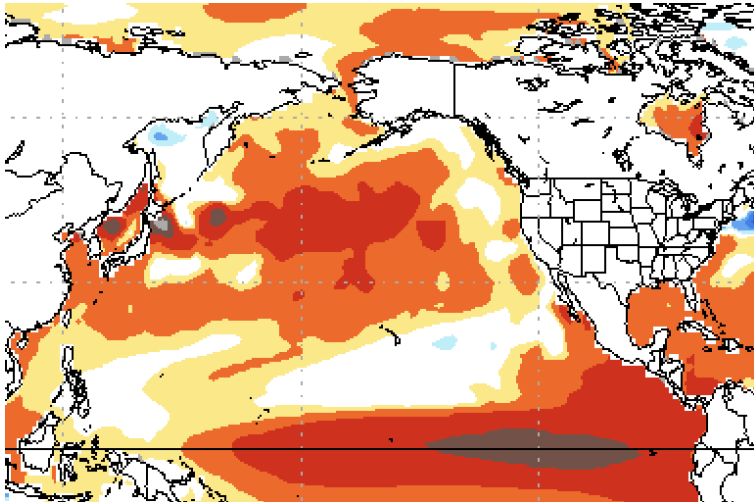


- Increased competition with other fish feeding on zooplankton, changes in cod diet due to decreasing Atka mackerel
- POP expanding area occupied
- Longer mean lifespan of groundfish community (35 to 60 years) means a slower turnover rate & dampened effects of environmental variability (increased ecological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

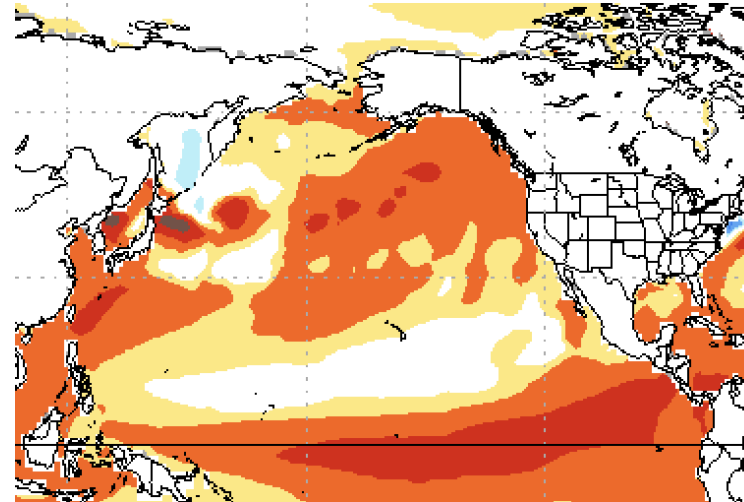


- **62% chance of El Niño** during April – June 2024,
 - Climate prediction center, NOAA https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.shtml
- **Warm** conditions for western Aleutians (NMME, Bond) for January - March
- Ensemble indicates conditions should not be extreme 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
January - March



March - May



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 of egg development, growth rates, and 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

Pacific cod diets



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



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

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

a 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)