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Canada

Pêches et Océans
Canada

State of the Physical, Biological and Selected Fishery Resources of Pacific Canadian Marine Ecosystems (SOPO)

Jackie King, Jennifer Boldt, Bronwyn MacDonald and Sue Grant

Canada

Co-authors from SOPO 2024

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Boldt, J.L., Joyce, E., Tucker, S., Gauthier, S., and Jackson, J. (Eds.). 2025. State of the physical, biological and selected fishery resources of Pacific Canadian marine ecosystems in 2024. Can. Tech. Rep. Fish. Aquat. Sci. 3687: viii + 337 p.



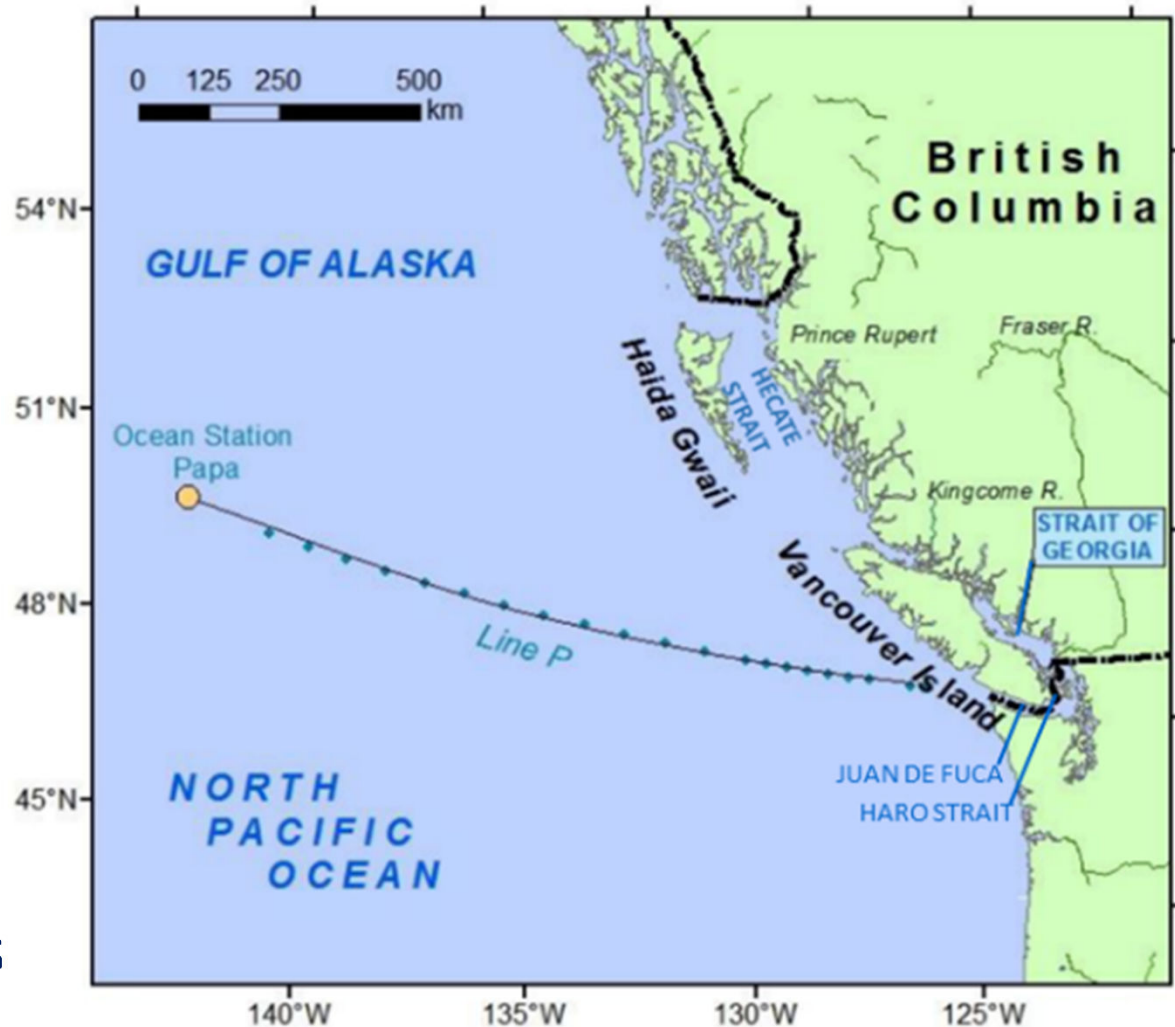


2026 Returns

	spawning & egg incubation	fry-stream	fry-lake	Juvenile-Ocean	spawning	
	2021	2022	2023	2024	2025	2026
Sockeye (5sub2)		lake				
Chinook (5sub2)		stream				
Sockeye (4sub2)			lake			
Chinook (4sub2)			stream			
Sockeye/Chum/Chinook (4sub1)						
Sockeye (3sub2: jacks)				lake		
Coho (3sub2)				stream		
Sockeye/Chum (3sub1)						
Pink (2sub1)						

Outline

- Freshwater habitat
 - Temperature
 - River flow
 - Spawner size
- Marine habitat
 - Physical environment
 - Prey
 - Predators
 - Juvenile salmon indices



- **Freshwater habitat**

- Temperature

- $\approx$ air temperature

- River flow

- snowpack, precipitation, drought

- Spawner size

- Fraser River sockeye

- 2021-2024



2026 Returns

spawning & egg incubation	fry-stream	fry-lake	Juvenile-Ocean	spawning
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2021	2022	2023	2024	2025	2026
	lake				
	stream				

Sockeye (5sub2)

Chinook (5sub2)

Sockeye (4sub2)

Chinook (4sub2)

Sockeye/Chum/Chinook (4sub1)

	lake			
	stream			

Sockeye (3sub2: jacks)

Coho (3sub2)

Sockeye/Chum (3sub1)

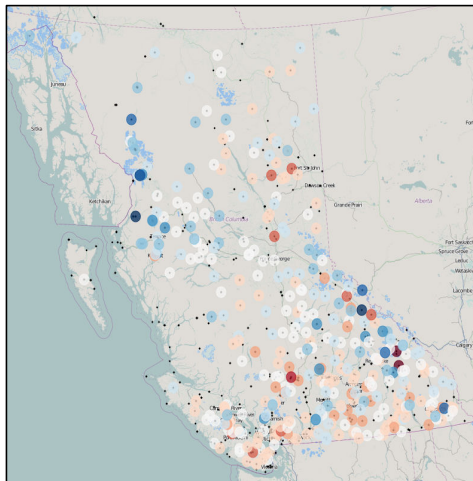
	lake		
	stream		

Pink (2sub1)

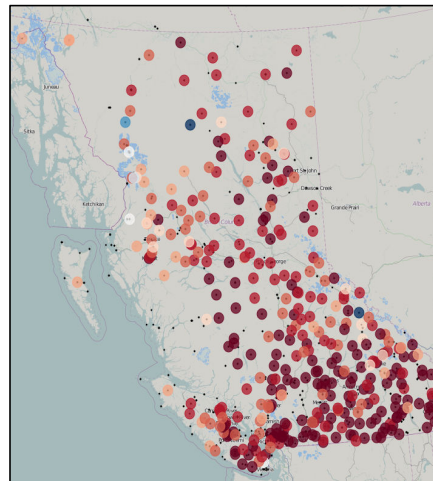
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2021 Heatdome; Fraser River exceeds 18-20°C

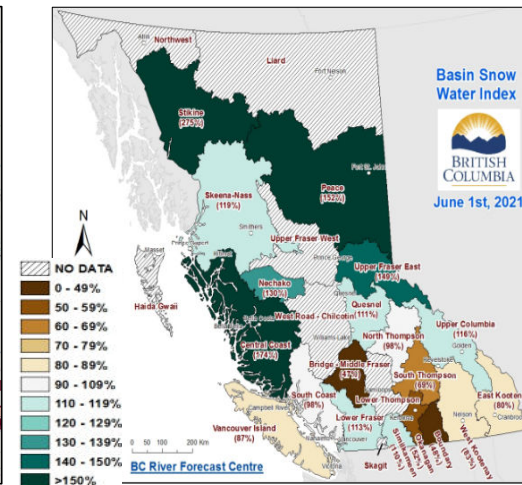
Tmax anomalies for May



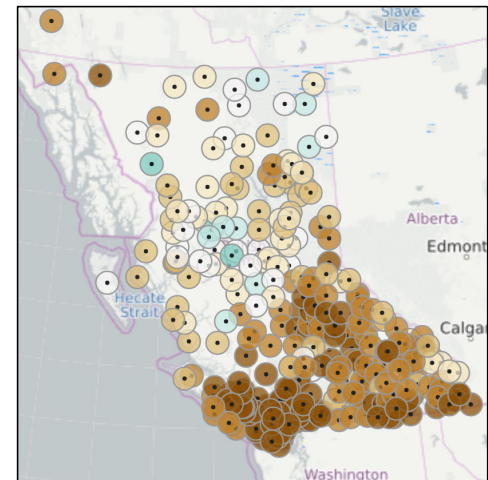
Tmax June



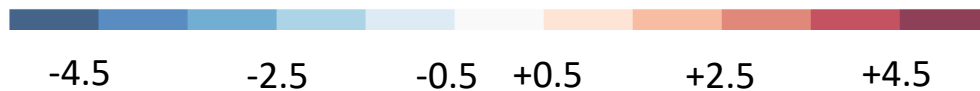
Snowpack June



Precipitation July



Tmax anomaly relative to 1971-2000 baseline (°C)



Precipitation Anomaly relative to 1971-2000 baseline (%)



Cold

Hot

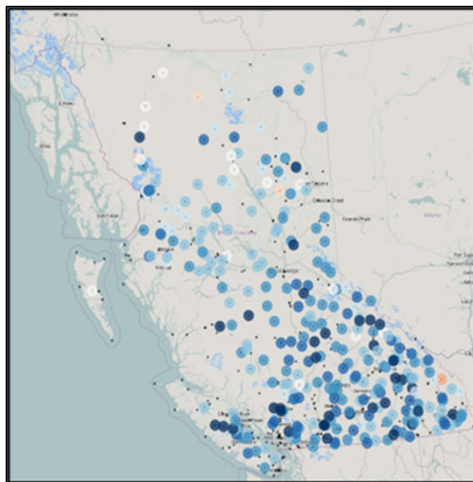
Dry

Wet

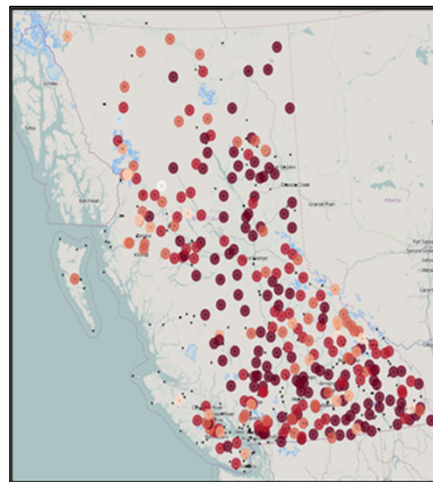
Updated from Curry, Lang and Dah, p. 20

2022 Summer conditions extended into late-October; Fraser River exceeds 18-20°C

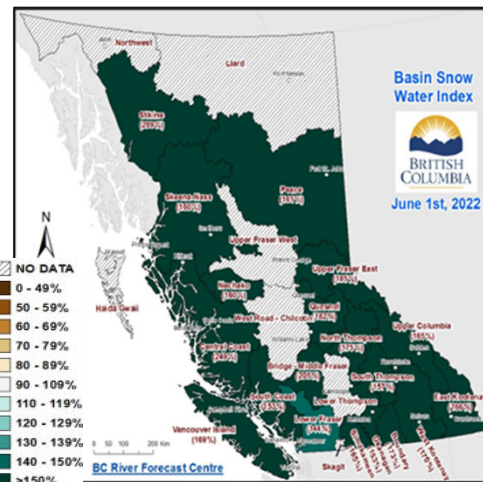
Tmax anomalies for May



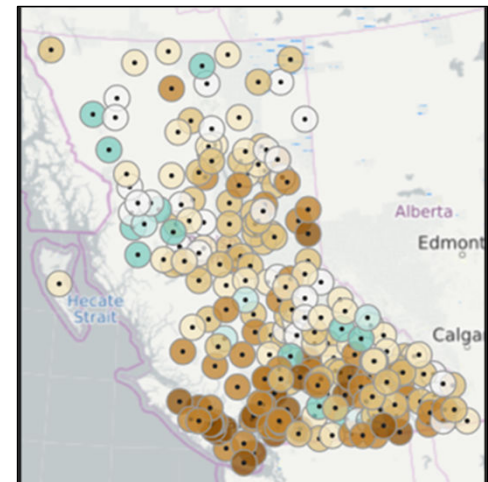
Tmax August



Snowpack June



Precipitation August



Tmax anomaly relative to 1971-2000 baseline (°C)



Precipitation Anomaly relative to 1971-2000 baseline (%)



Cold

Hot

Dry

Wet

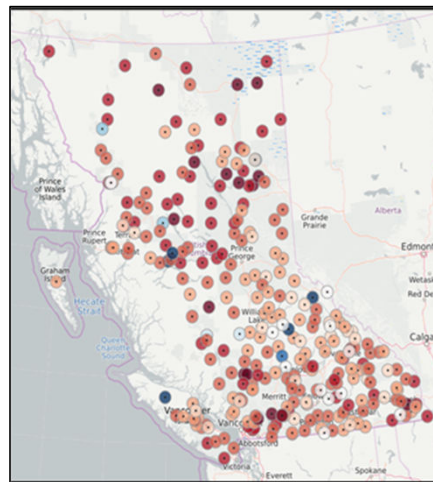
Updated from Curry, Lang and Dah, p. 20

2023 BC's warmest on record since 1940 & extreme drought; Fraser River exceeds 18-20°C

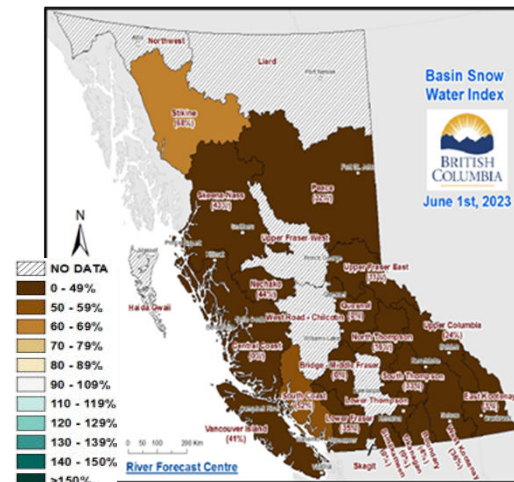
Tmax anomalies for May



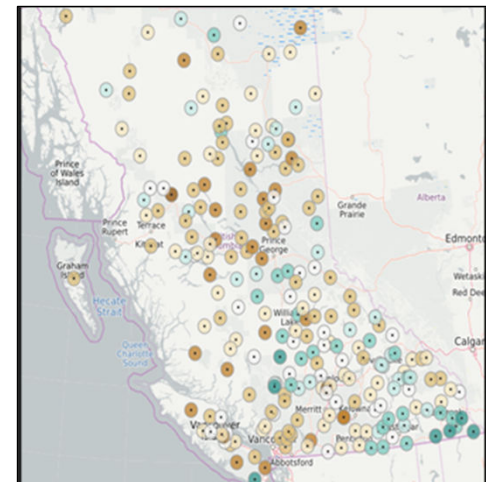
Tmax August



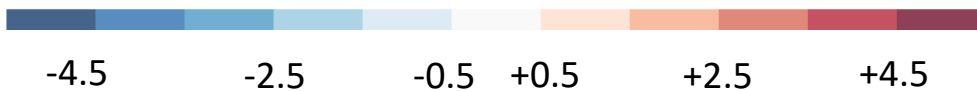
Snowpack June



Precipitation August



Tmax anomaly relative to 1971-2000 baseline (°C)



Cold

Hot

Dry

Wet

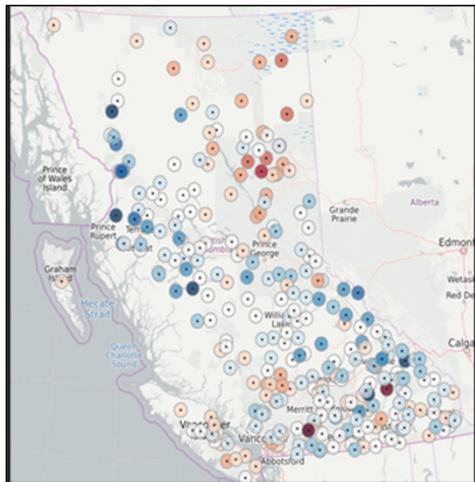
Precipitation Anomaly relative to 1971-2000 baseline (%)



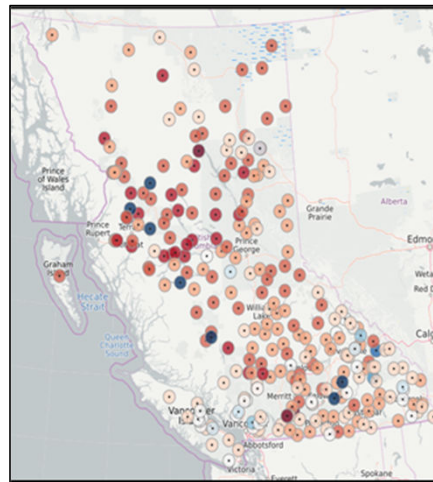
Updated from Curry, Lang and Dah, p. 20

2024 BC's second warmest on record since 1940 & drought persists; Fraser River exceeds 18-20°C

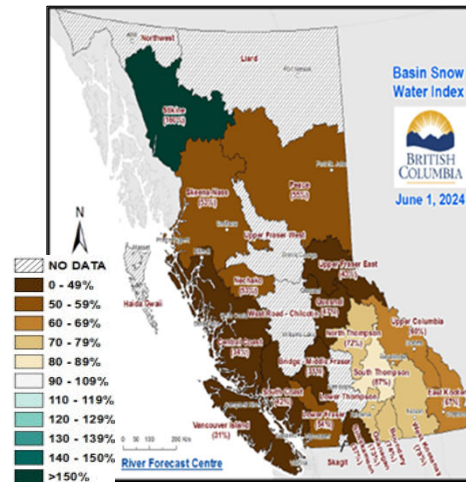
Tmax anomalies for May



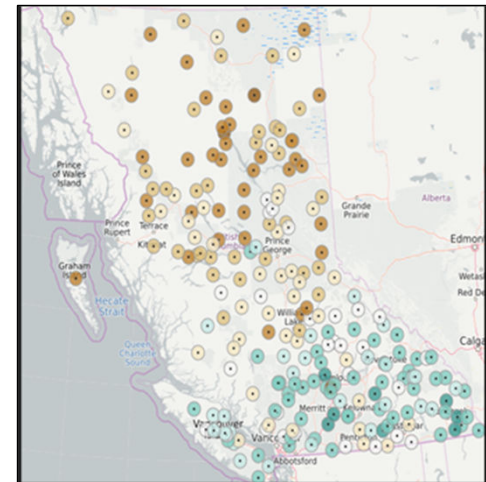
Tmax August



Snowpack June



Precipitation August



Tmax anomaly relative to 1971-2000 baseline (°C)



Precipitation Anomaly relative to 1971-2000 baseline (%)



Cold

Hot

Dry

Wet

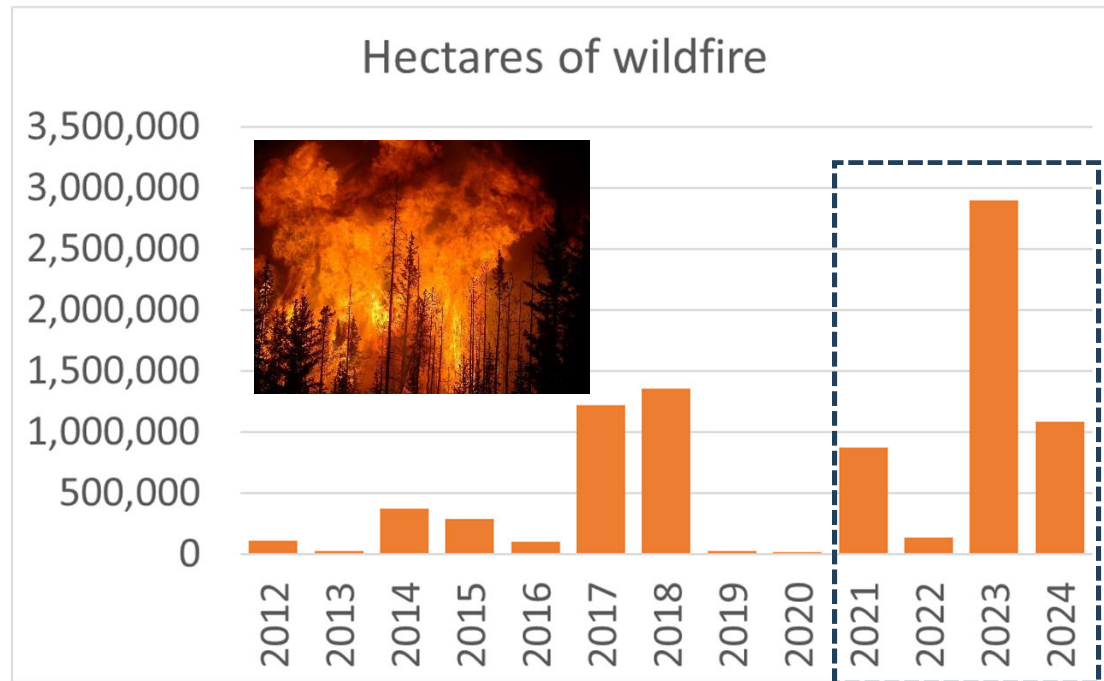
Updated from Curry, Lang and Dah, p. 20

[illegible][illegible]

Drought and Watershed Watch Maps

Changes to: river topography, sediment and trace element inputs, slope stability, scouring

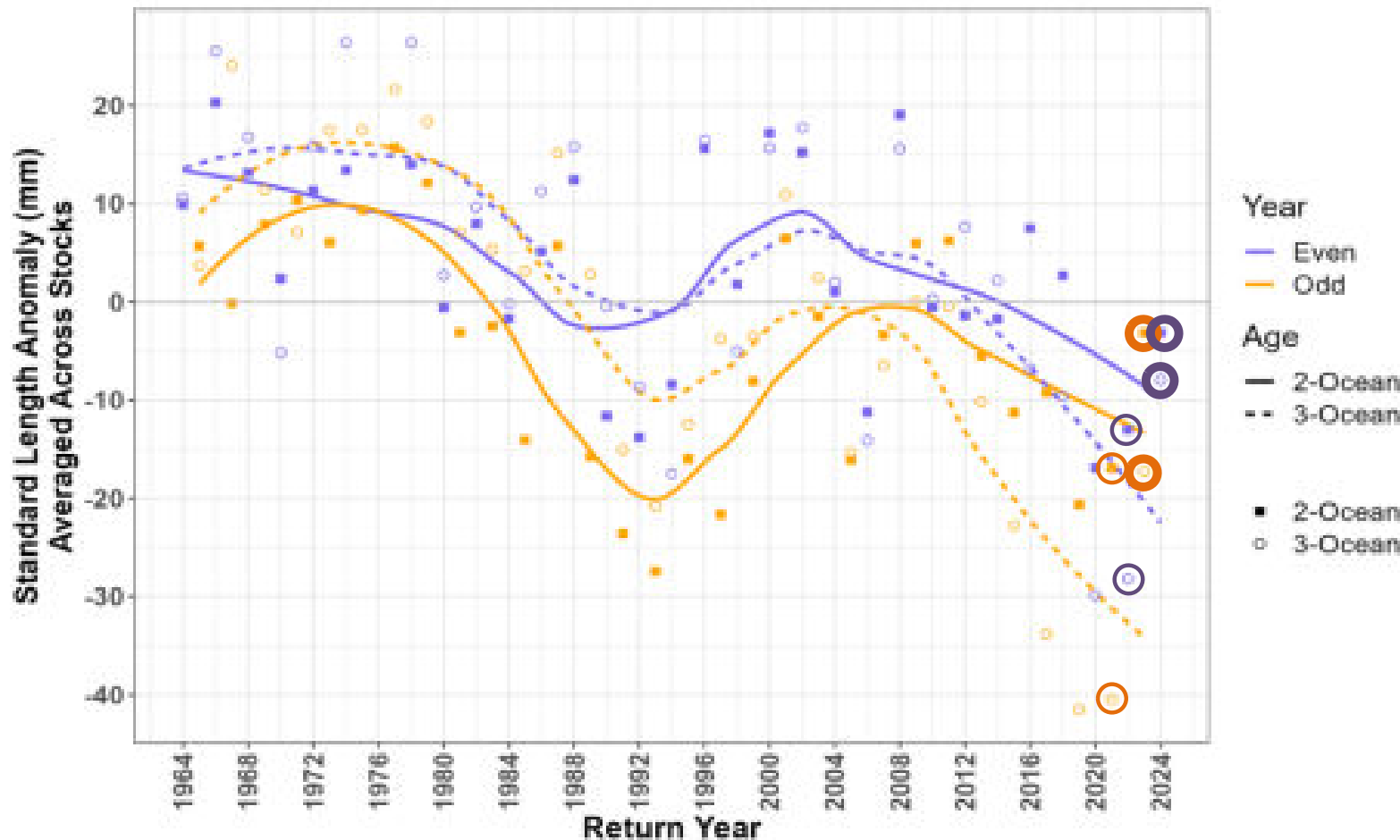
Fall 2021



Data from: B.C. Wildfire Service. <https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-statistics/wildfire-averages>

Photo credit: CBC News: Historic flooding in southern B.C., by the numbers. November 17, 2021

Fraser River Sockeye Spawning Size



- 2021-2022 Fraser River sockeye were small
- 2023-2024 increased size but still overall declining trend

- **Marine habitat**

- Physical environment

- sea surface temperature
 - upwelling
 - oxygen

- Prey

- zooplankton
 - herring

- Predators

- hake

- Juvenile salmon indices

2023-2024 (2025)



2026 Returns

spawning & egg incubation		fry-stream	fry-lake	Juvenile-Ocean	spawning
2021	2022	2023	2024	2025	2026
	lake				
	stream				
	lake				
	stream				
	lake				
	stream				

Sockeye (5sub2)

Chinook (5sub2)

Sockeye (4sub2)

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Sockeye/Chum/Chinook (4sub1)

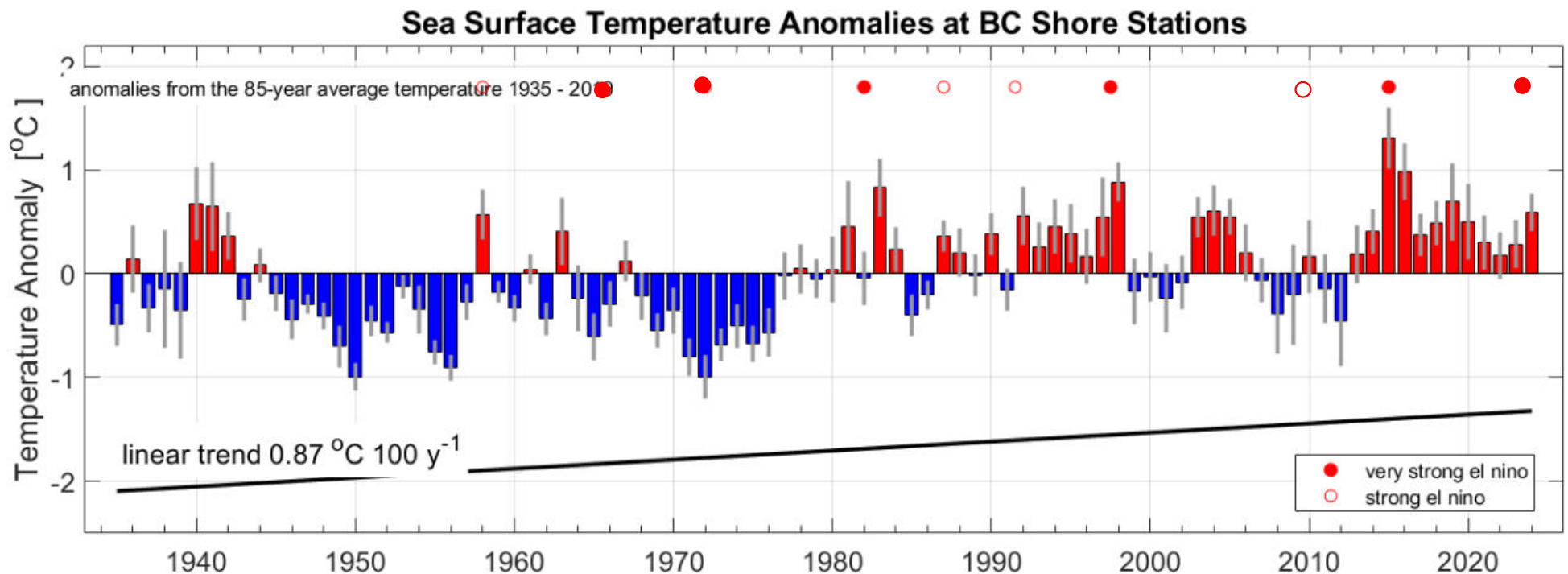
Sockeye (3sub2: jacks)

Coho (3sub2)

Sockeye/Chum (3sub1)

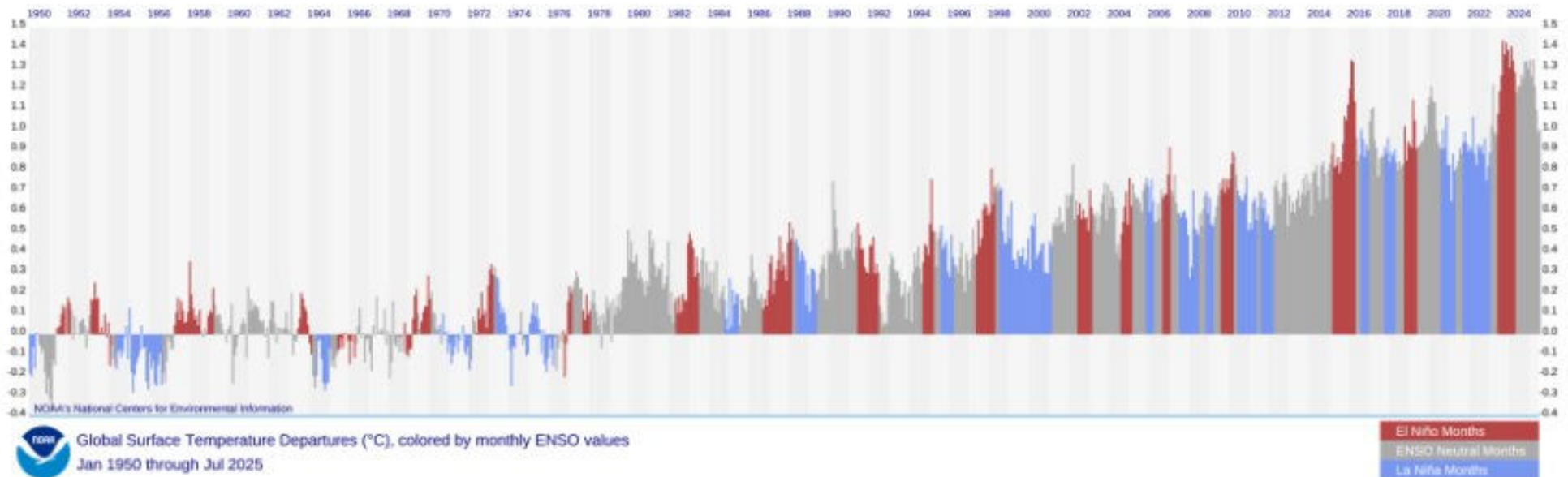
Pink (2sub1)

Long-term trend of increasing sea surface temperatures



- 2023 (a very strong El Nino): small positive SST anomaly, slight increase compared to 2022
- 2024 high warm anomaly
- Warming trend: positive trend of $0.85^{\circ}\text{C}/100 \text{ yr}$, up from $0.63^{\circ}\text{C}/100 \text{ yr}$ a decade ago

Global surface temperatures and ENSO events



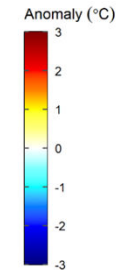
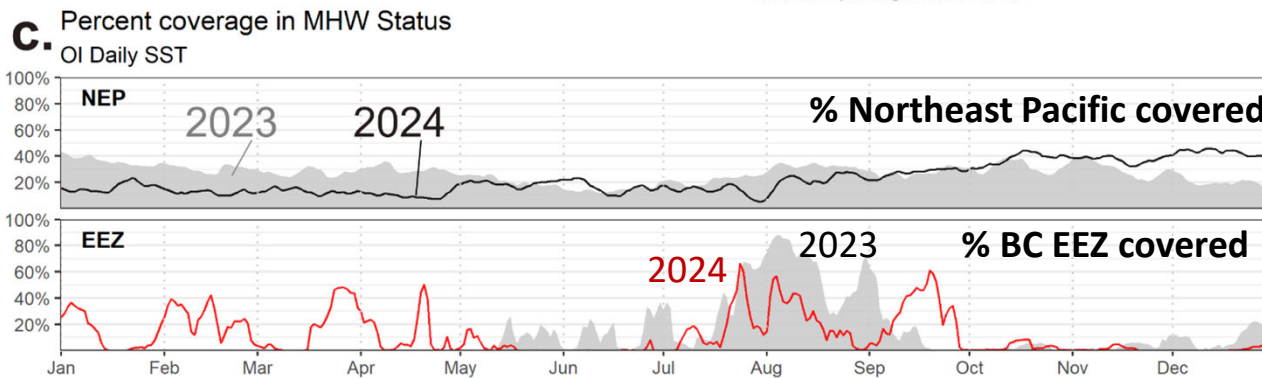
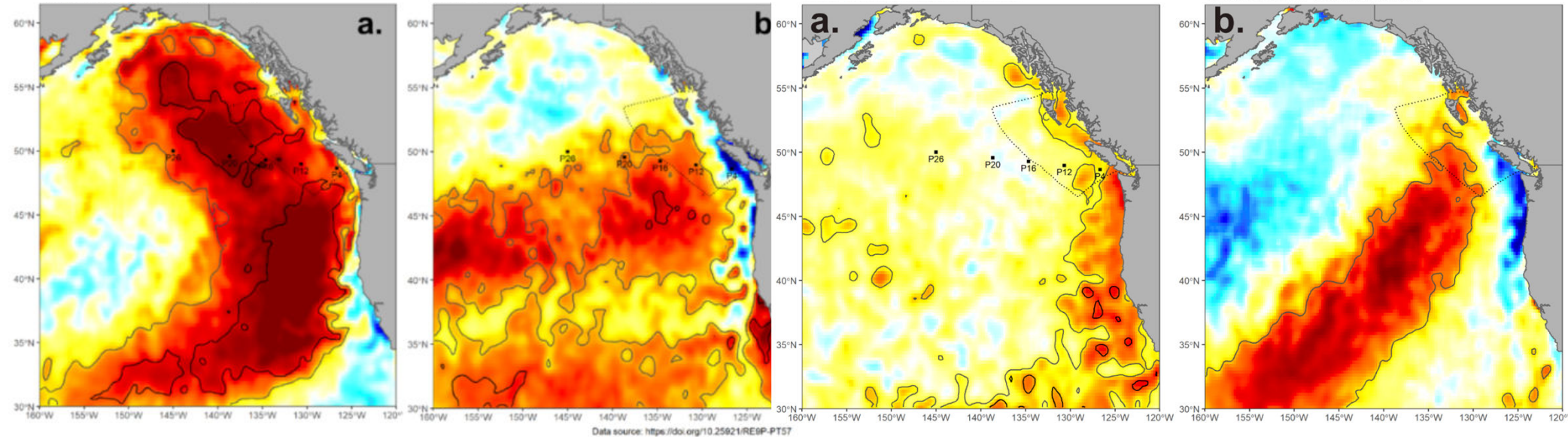
Marine heatwaves

Jul. 30- Aug. 5, 2023

Aug. 20-26, 2023

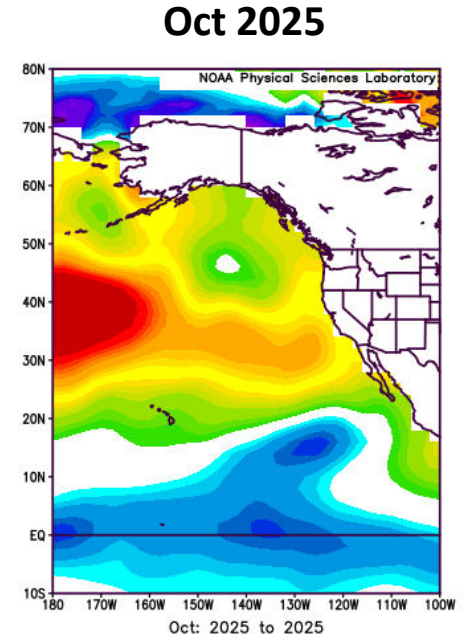
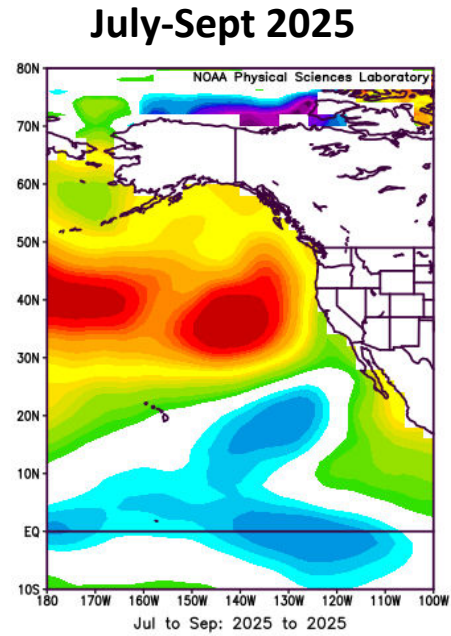
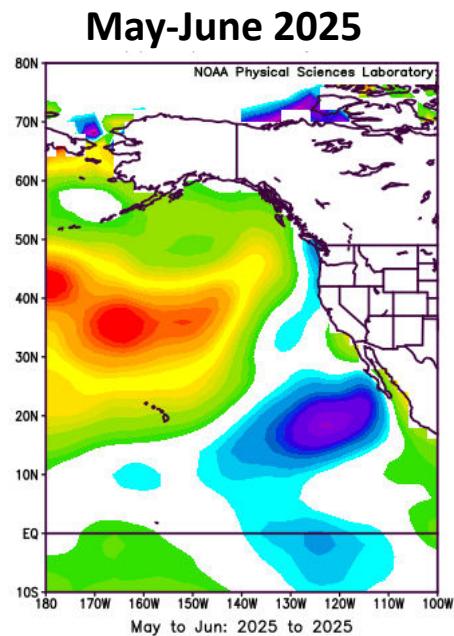
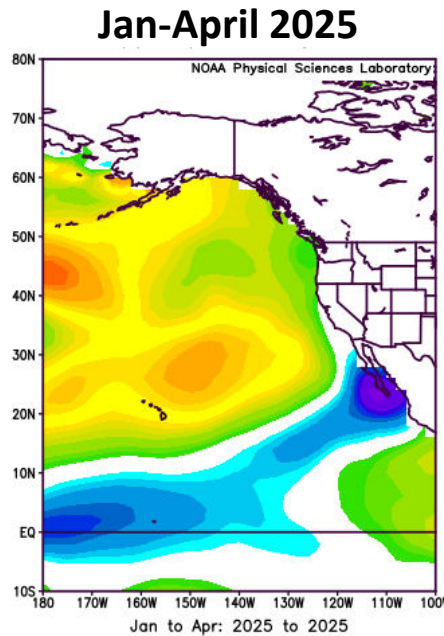
Jan. 28-Feb. 3, 2024

July 14- 20, 2024



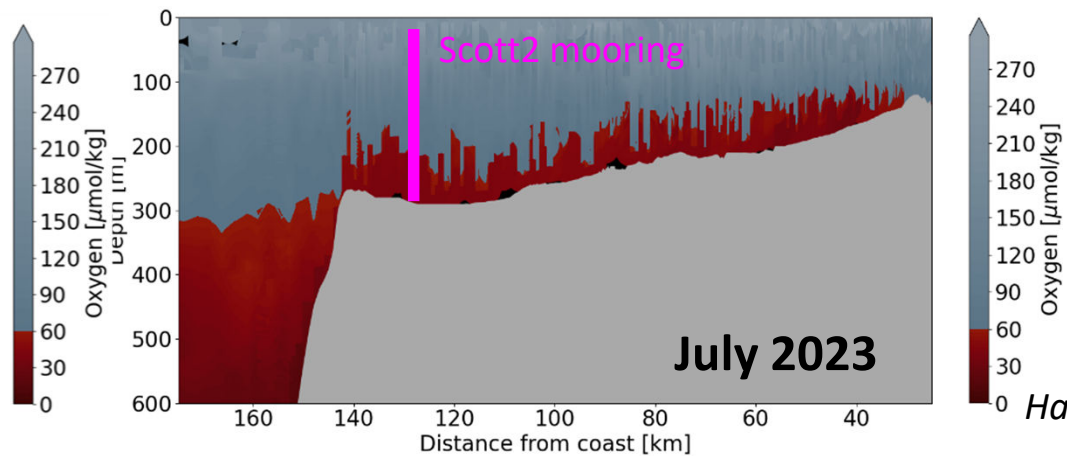
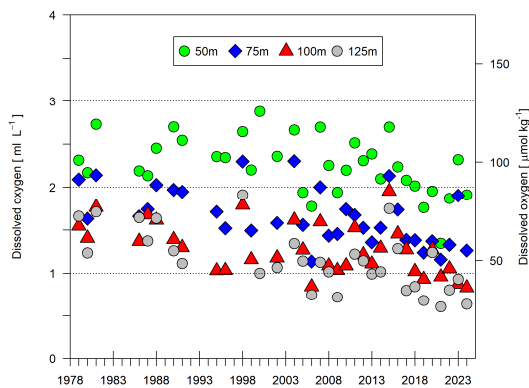
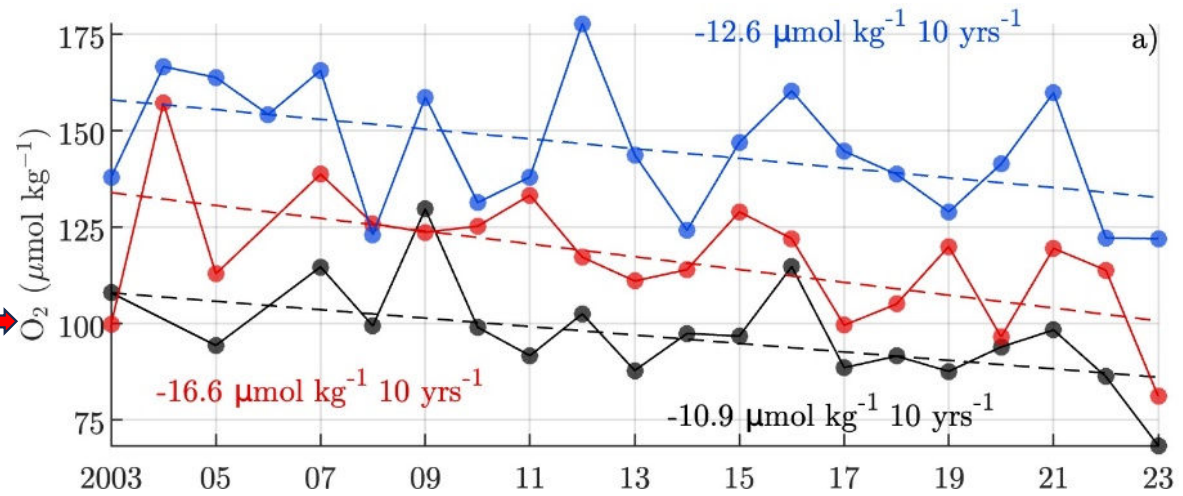
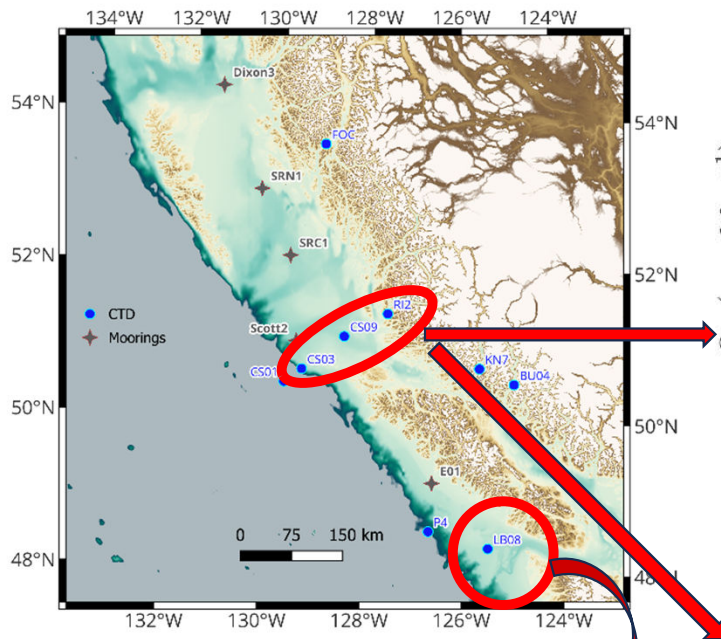
— 1.29 SD
— 2.33 SD
Hilborn, Clay, Guan and Hannah, p. 87

Marine heatwaves



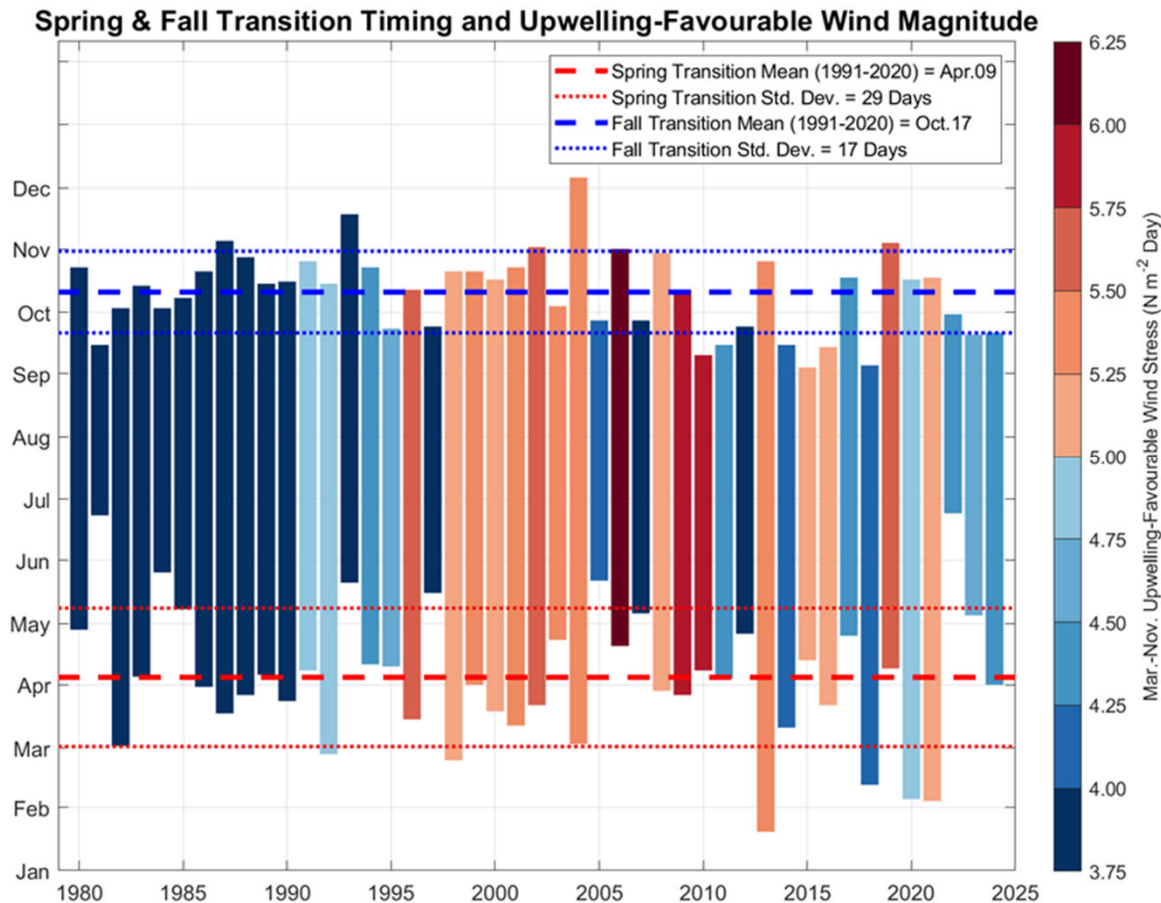
Updated from Hilborn, Clay, Guan and Hannah, p. 87

Increased, widespread hypoxia events



Spring Upwelling

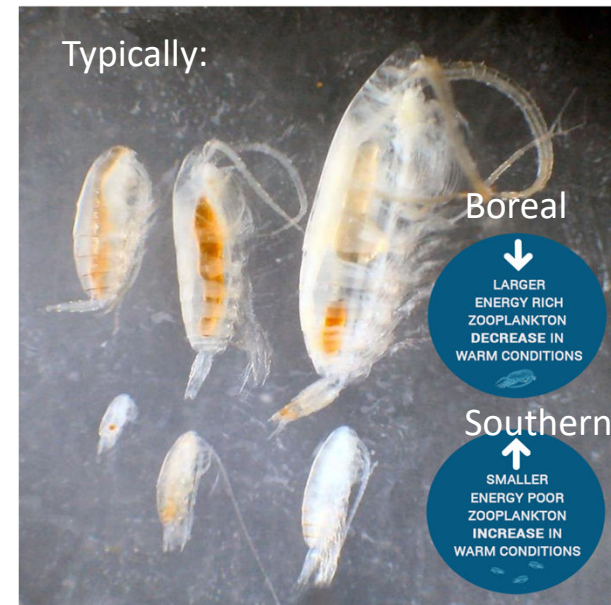
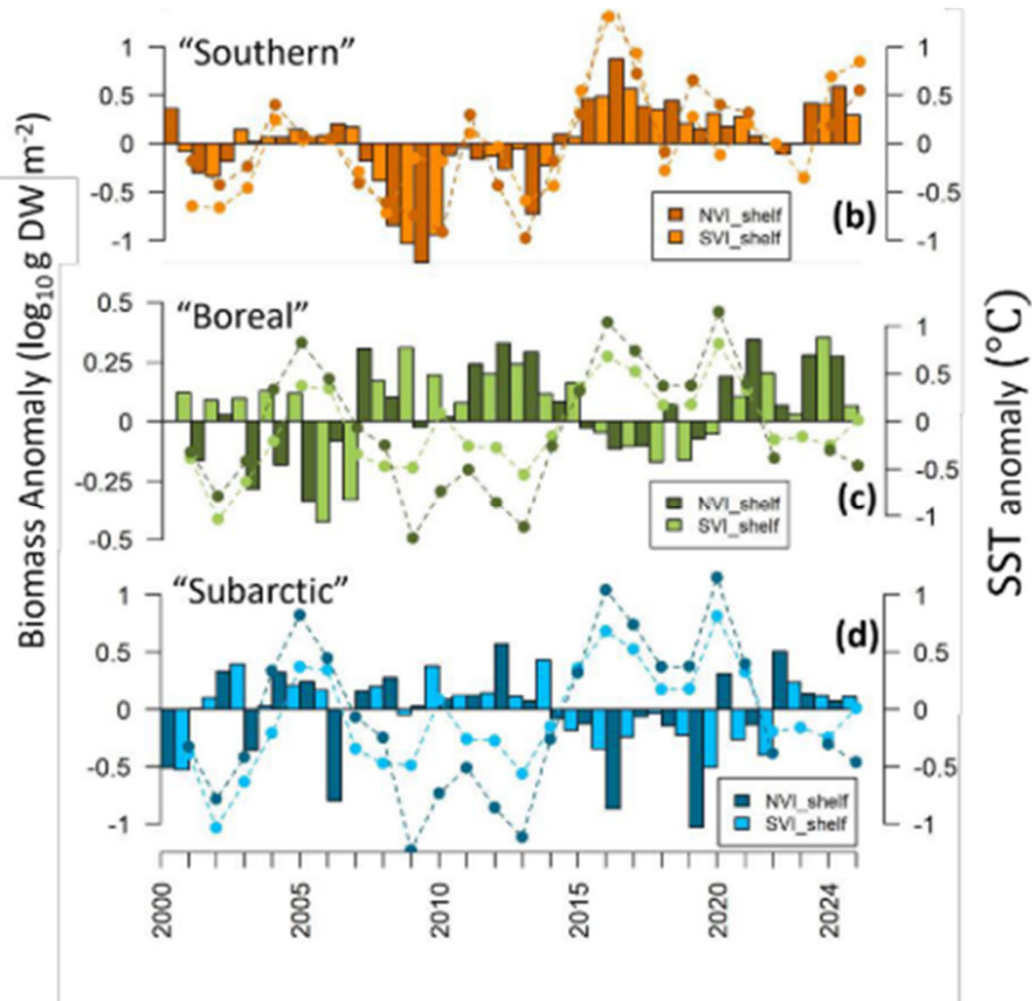
- 2023 late start, low magnitude
- 2024 average start, low magnitude



- the California Current system is driven by coastal upwelling
- stronger-than-average summer-time upwelling-favourable winds are generally associated with increased coastal productivity
- 2023 and 2024 low-average start and magnitude, should be associated with below average coastal productivity
- however this was not necessarily the case.....

Hourston and Thompson, p. 49

Zooplankton Community off Vancouver Island: Copepods

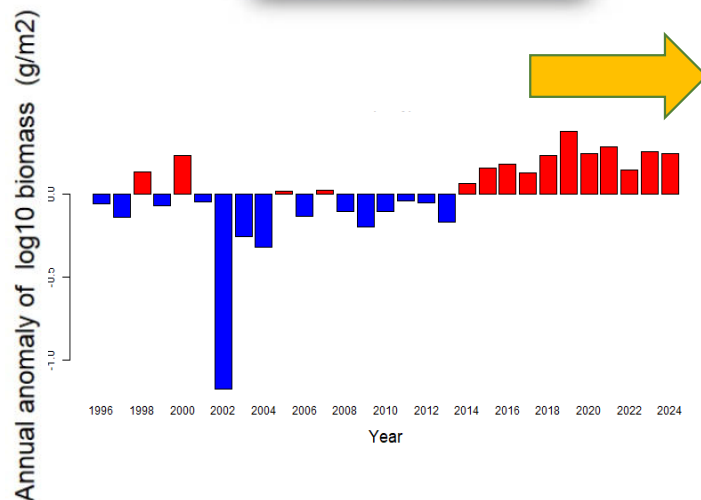


- from 2021-2024, southern and boreal copepods are both above average, unlike the previous 20 years
- copepods are prey items for very small juvenile salmon, and for salmon prey such as herring

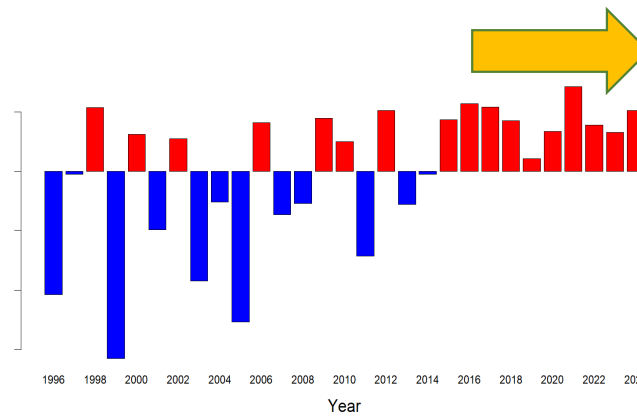
Sastri and Galbraith, p. 114

Zooplankton Community off Vancouver Island: Preferred prey

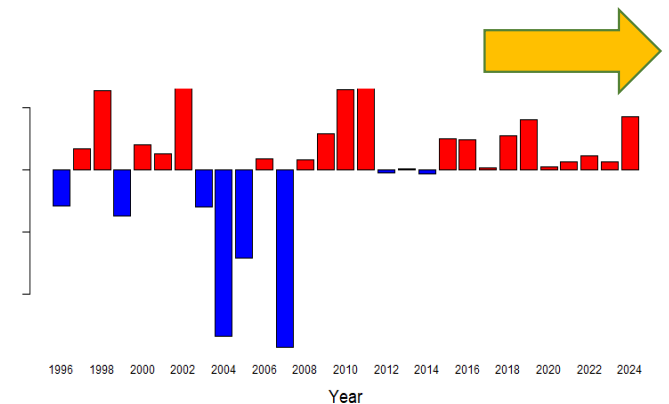
Baseline: 1996-2021



Amphipods



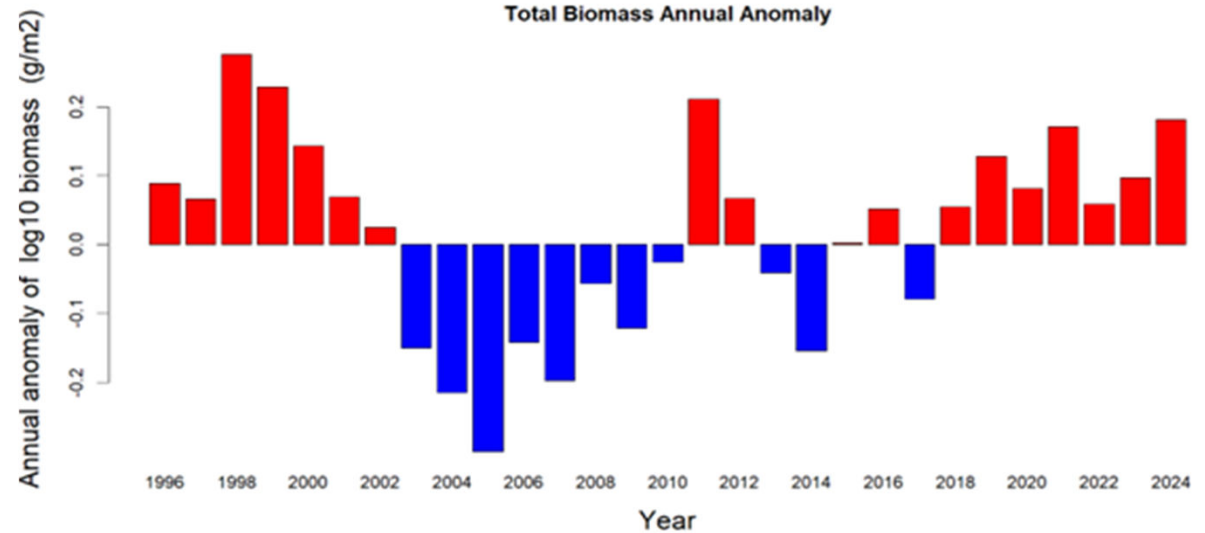
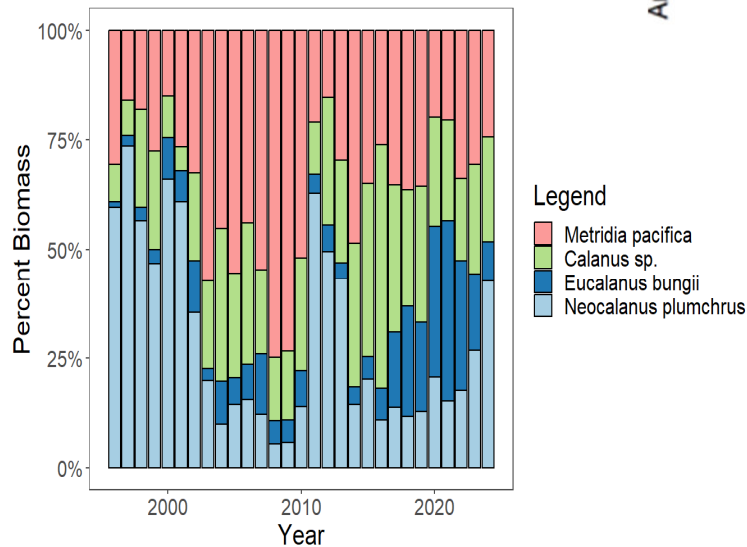
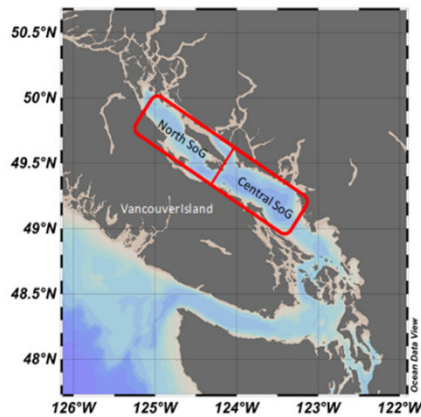
Decapods



Euphausiids

Sastri and Galbraith, p. 114

Strait of Georgia zooplankton biomass above average in recent years

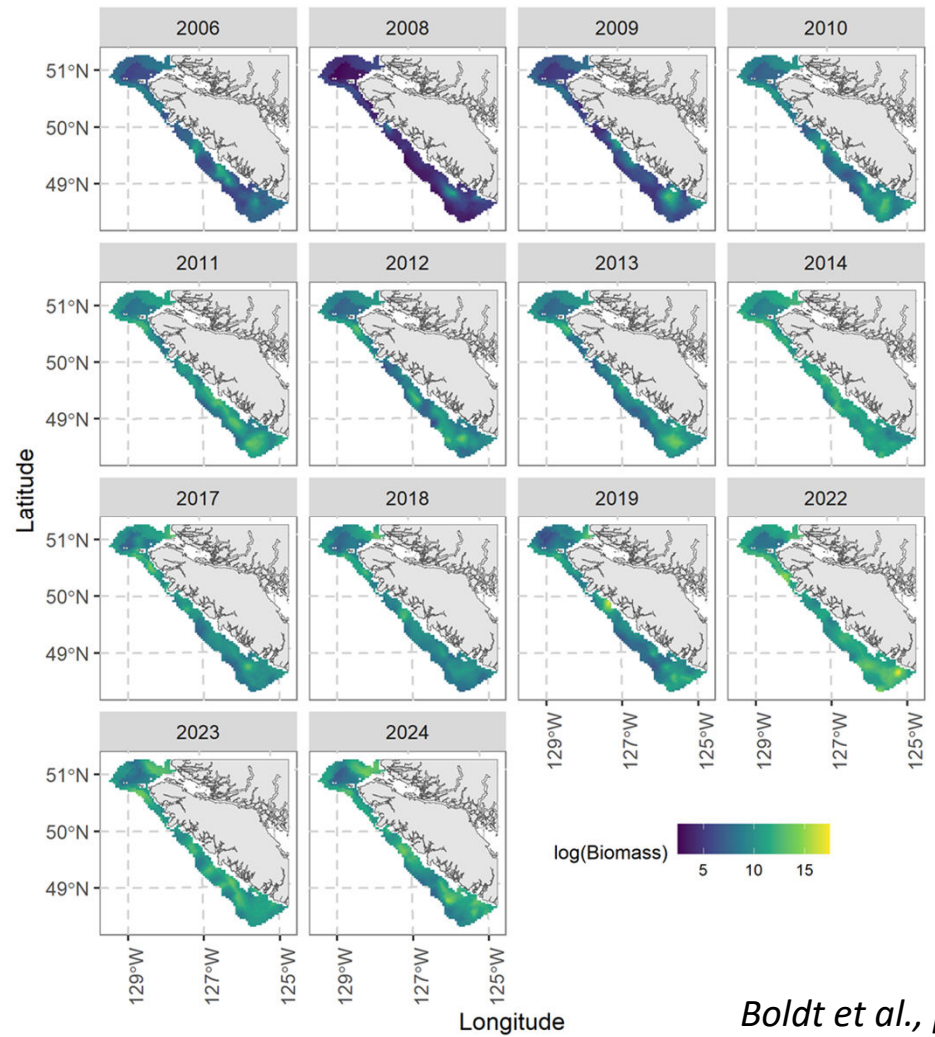
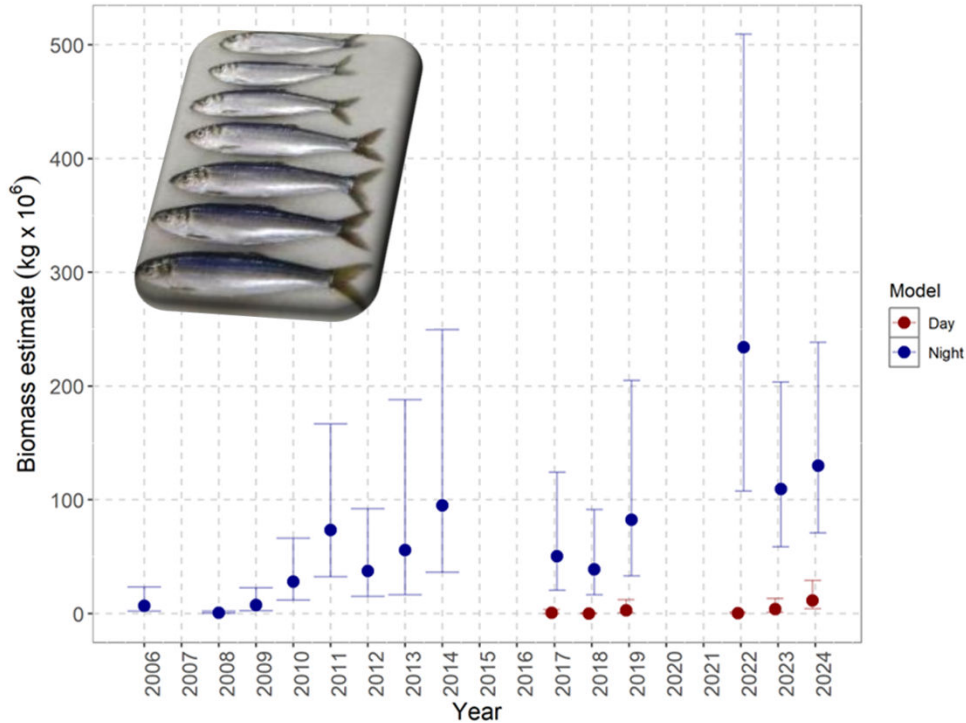


- medium-large copepods, euphausiids and amphipods had highest contribution to biomass
- the biomass of the large copepod, *Neocalanus plumchrus*, has increased

Young, Galbraith, Sastri and Perry, p. 237

Pacific Herring biomass increased

Prey for adult Chinook and Coho Salmon

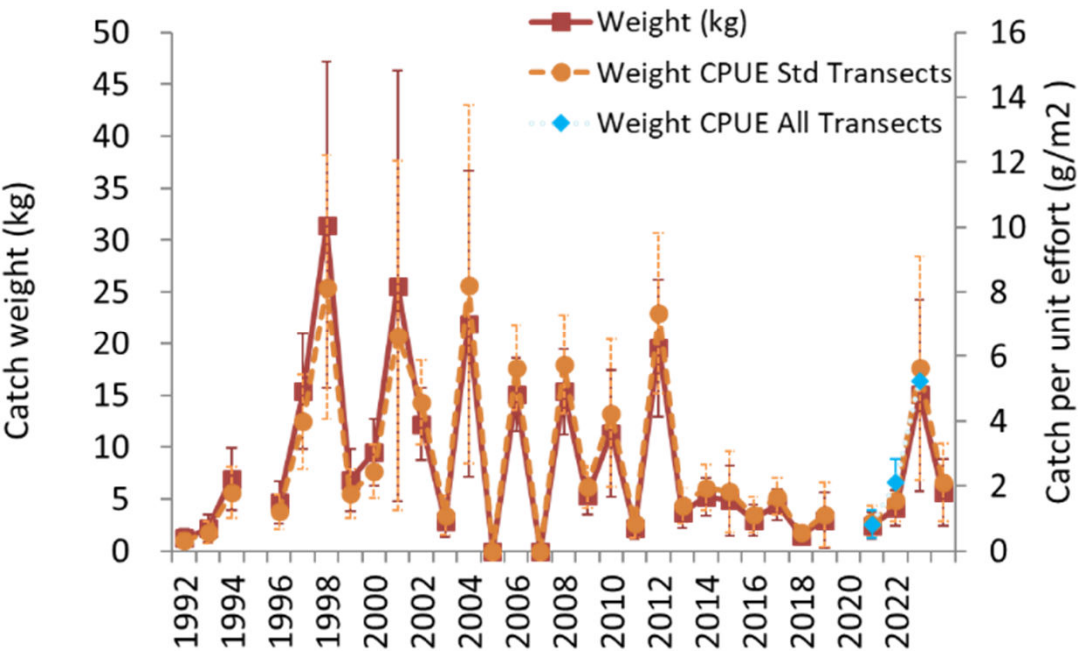


Boldt et al., p. 153

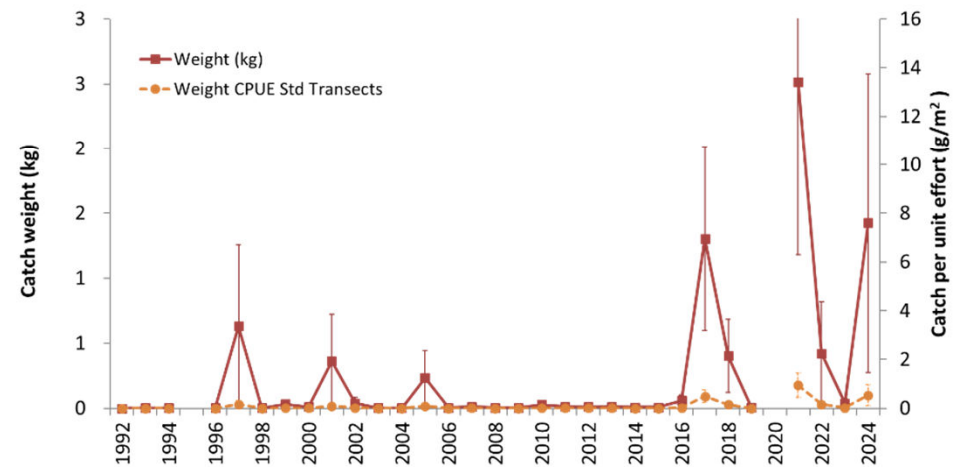
Strait of Georgia

Prey for juvenile Chinook and Coho Salmon

Age-0 Pacific Herring abundance above average

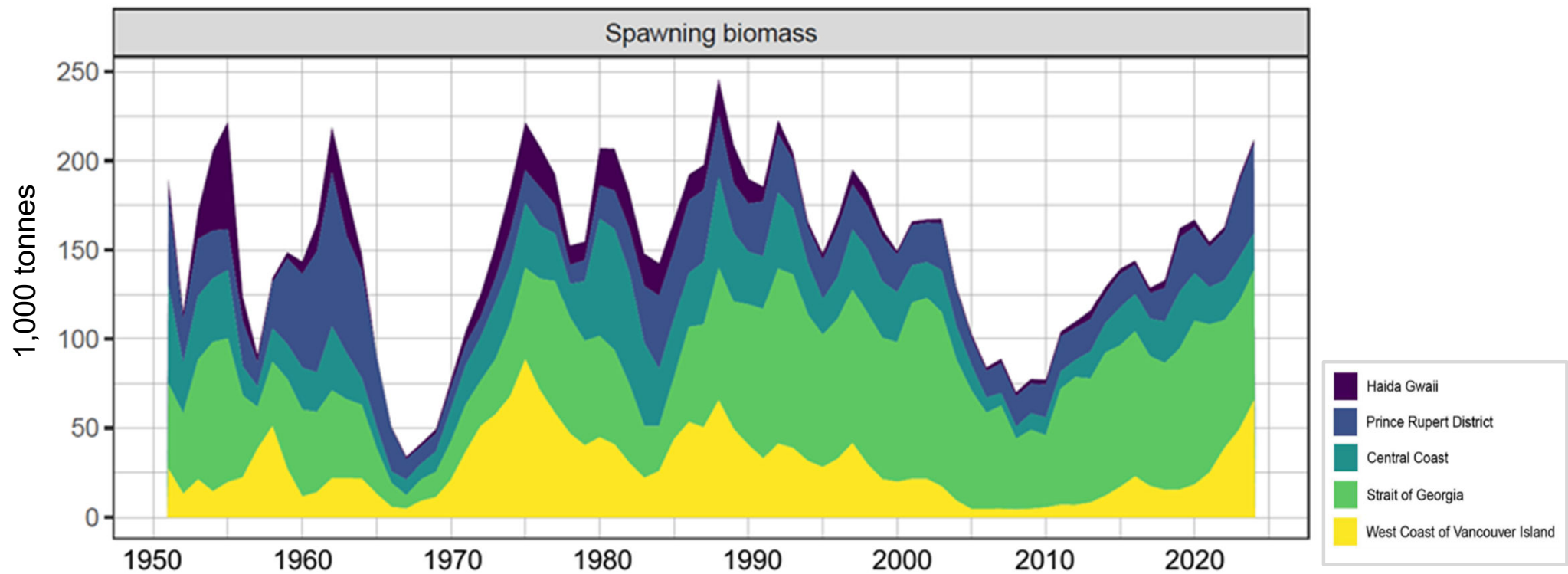


Elevated occurrence of Northern Anchovy



Pacific Herring – Coastwide Spawning Biomass

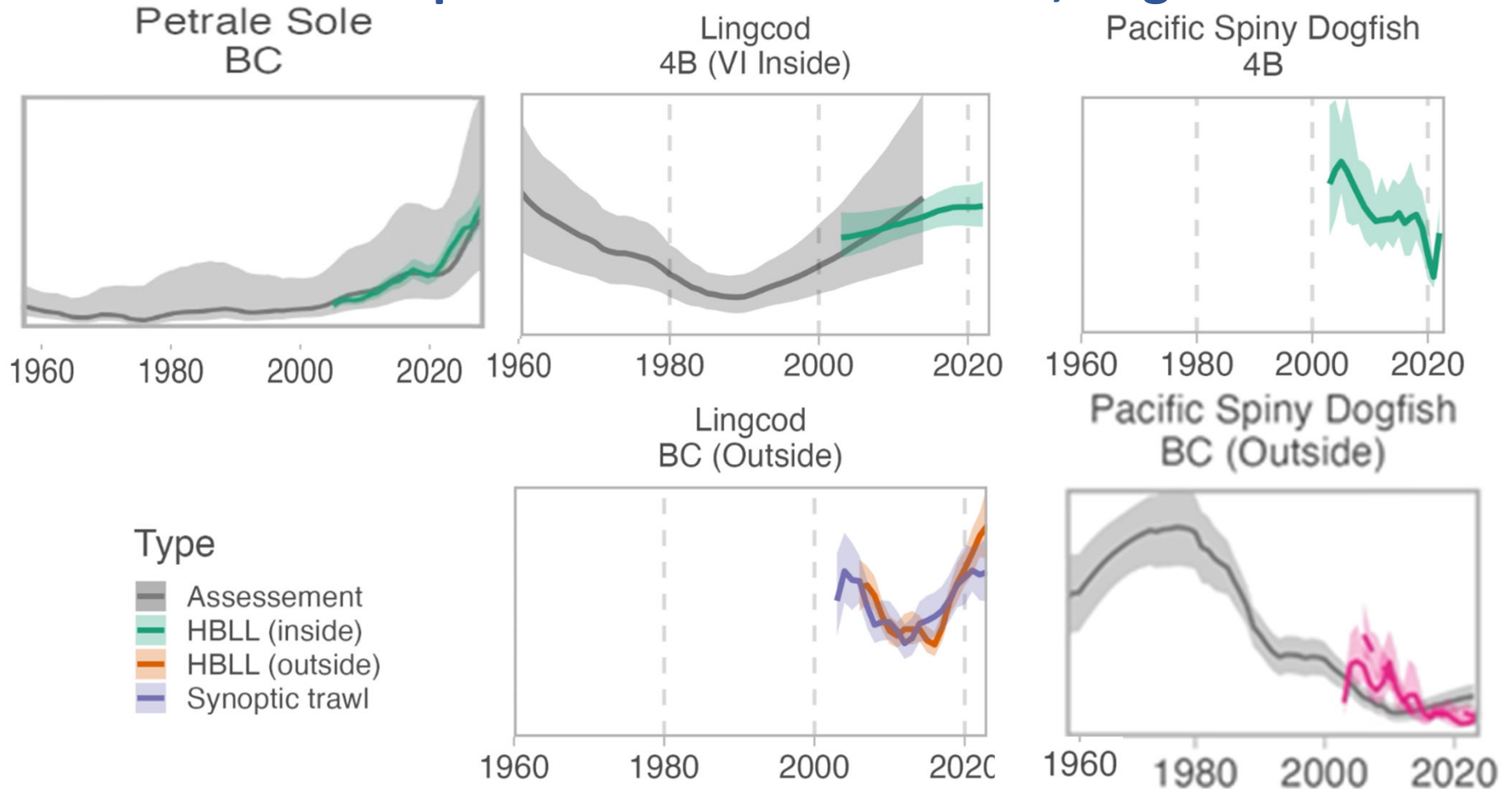
continued increasing trend in estimated spawning biomass since 2010



Cleary et al., p. 147

Groundfish: salmon predators some increased, dogfish decreased

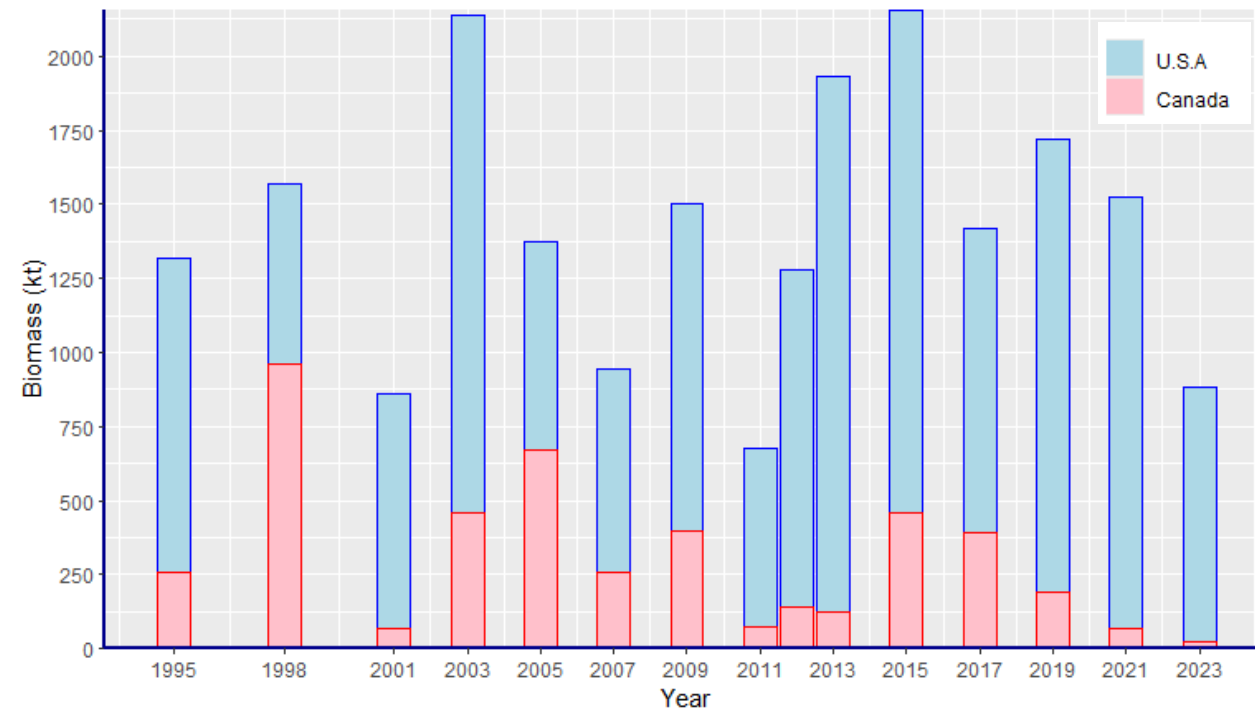
Relative biomass or abundance estimate



Dunic, English and Anderson, p. 163

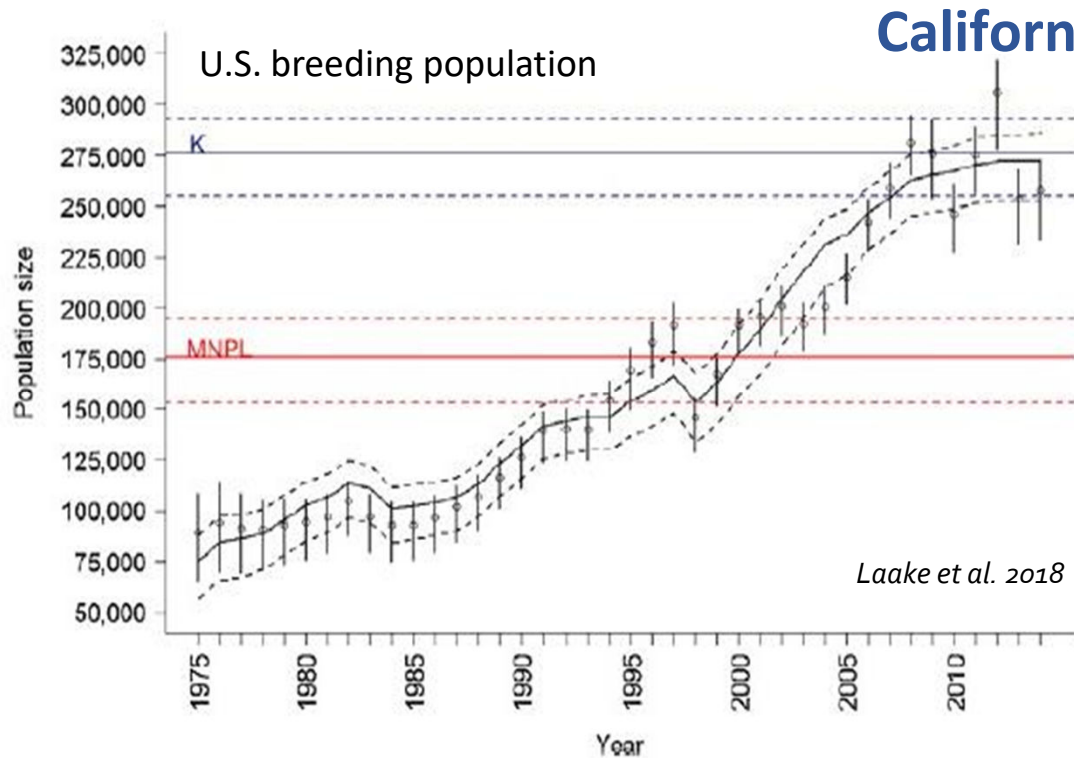
Pacific Hake 2023 survey

- 3rd lowest biomass recorded for North America
- Lowest proportion of stock in Canada; lowest biomass in Canada
- 2024 commercial fishery had is lowest landings in history

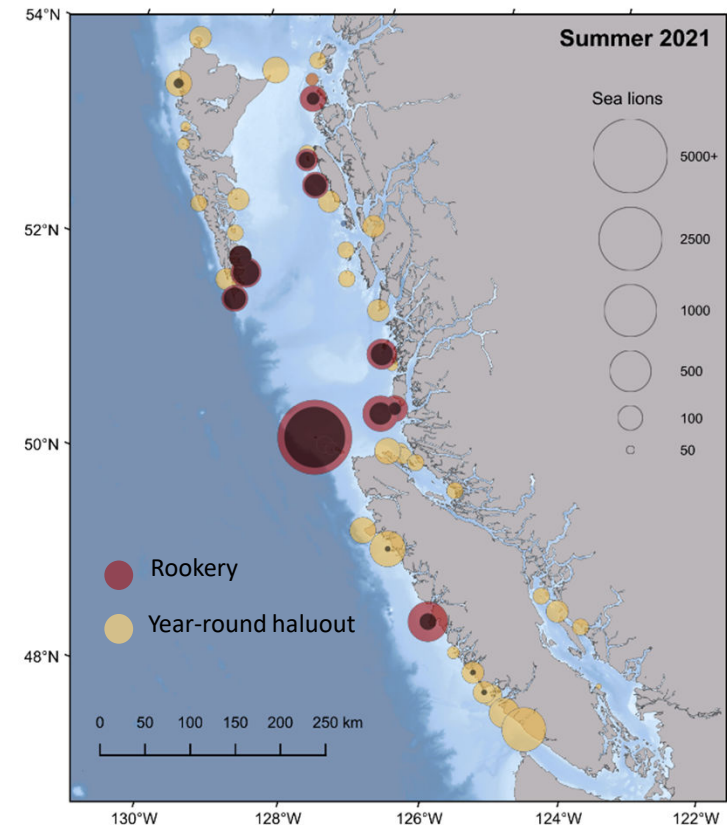


Gauthier and Stanley, p. 173

Harbour Seals abundance is stable/decreasing California Sea Lion abundance has stabilized

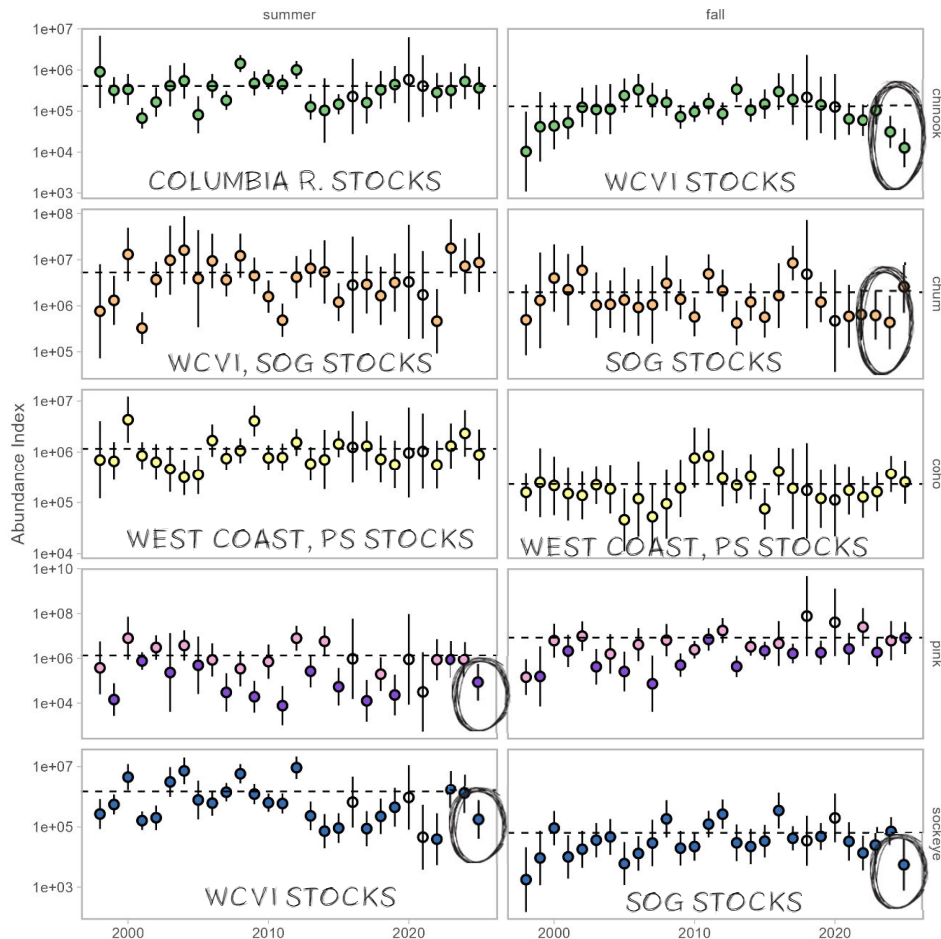


The 2014 US breeding season population was estimated at 257,606 (stabilized)



Tucker et al., p. 186

Juvenile salmon indices: Vancouver Island Continental Shelf



Chinook

2024 & 2025 BELOW AVERAGE IN FALL

Chum

2023 & 2024 BELOW AVERAGE IN FALL

Coho

AVERAGE

Pink

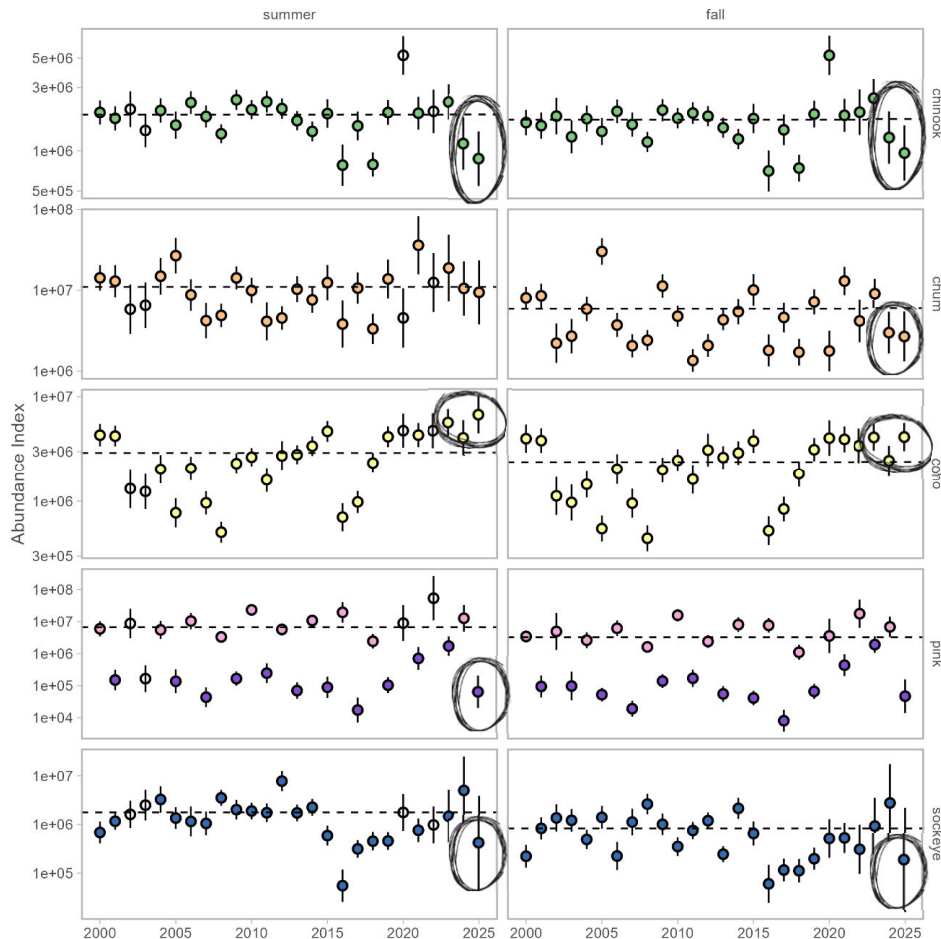
2025 BELOW AVERAGE IN FALL

Sockeye

2023 & 2024 AVERAGE, IMPROVEMENT FROM 2021
2025 BELOW AVERAGE IN SUMMER & FALL

Updated from King et al., p. 158

Juvenile salmon indices: Strait of Georgia



Chinook

2024 & 2025 BELOW AVERAGE IN SUMMER & FALL

Chum

2024 & 2025 BELOW AVERAGE IN FALL

Coho

2023 & 2025 ABOVE AVERAGE
2024 AVERAGE

Pink

2025 BELOW AVERAGE IN SUMMER & FALL

Sockeye

2023 & 2024 AVERAGE, IMPROVEMENT FROM 2021
2025 (BELOW AVERAGE) IN SUMMER & FALL

- **Freshwater habitat**

- some average conditions in some years
- but mainly lots of hot and dry years with some extreme flooding/fire events

- **Marine habitat**

- always warm
- MHW are frequent and persistent in the high seas; sometimes coastal cool waters
- nutritious copepods
- above average preferred prey biomass, including euphausiids in 2024
- high and stable abundance of predators
 - declining competitors

- If you can survive the freshwater habitat, the food web might help you with the difficult ocean conditions

- juvenile salmon indices for ocean entry years 2023, 2024, 2025 are average, except:
 - 2024 & 2025 WCVI chinook stocks below average
 - 2023-2025 SOG chum stocks below average
 - 2023 & 2025 SOG coho stocks above average
 - 2025 WCVI & SOG stocks below average



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SOPo 2025: March 4-5, 2026, Nanaimo, BC (Hybrid)
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Canada