Changes in larval, juvenile, and adult Pacific sardines in the northern California Current

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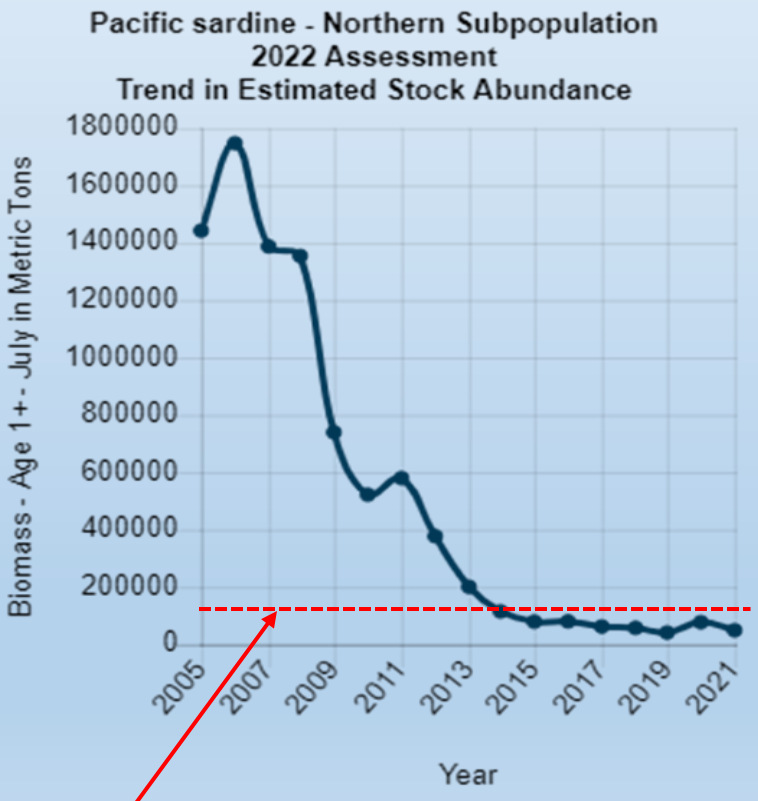
Portions of this presentation have unpublished data: do not cite

Pacific sardines are a coastal pelagic forage fish important to many trophic levels of the food web

The California current Pacific sardines fishery has been closed since 2015



Threshold required for commercial fishing

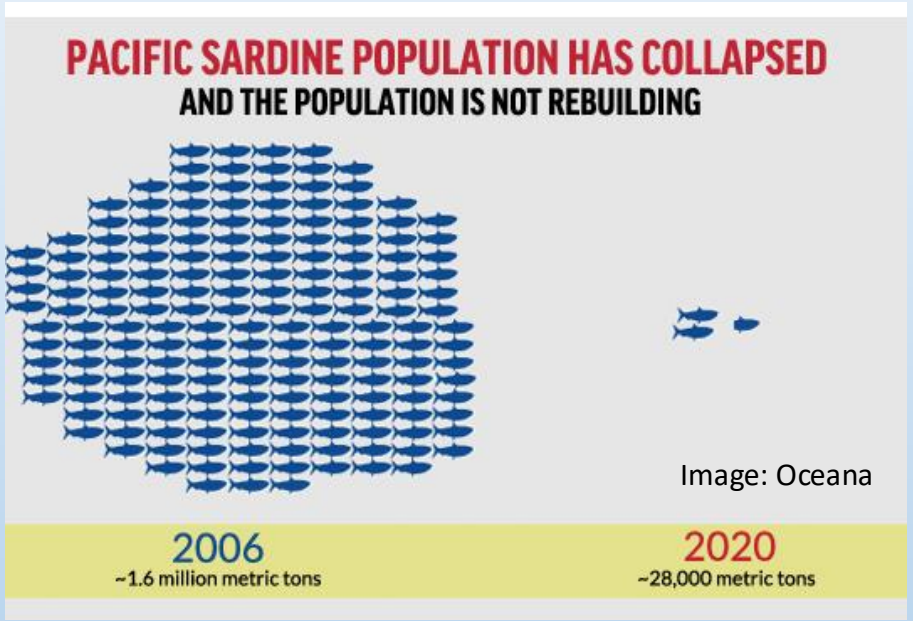


Image: Oceana

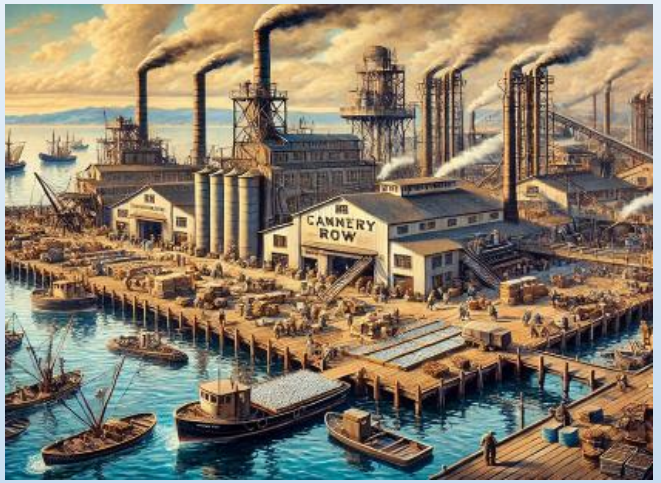
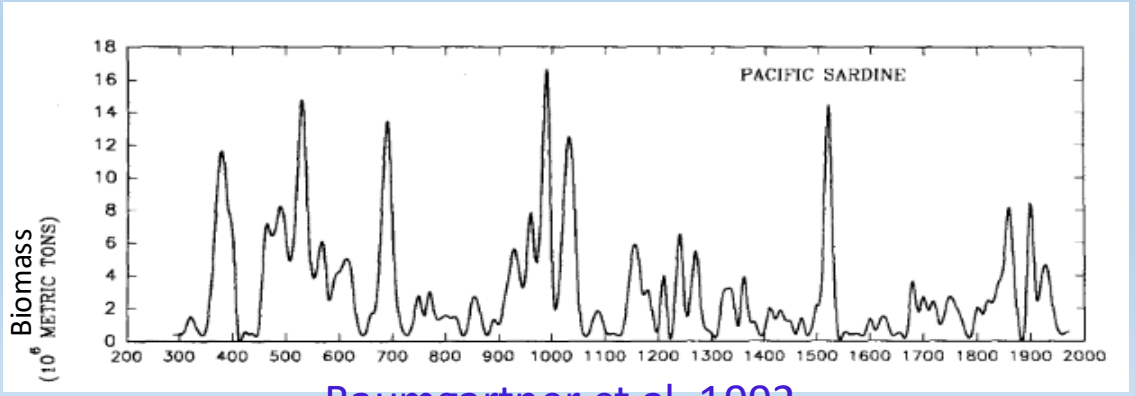
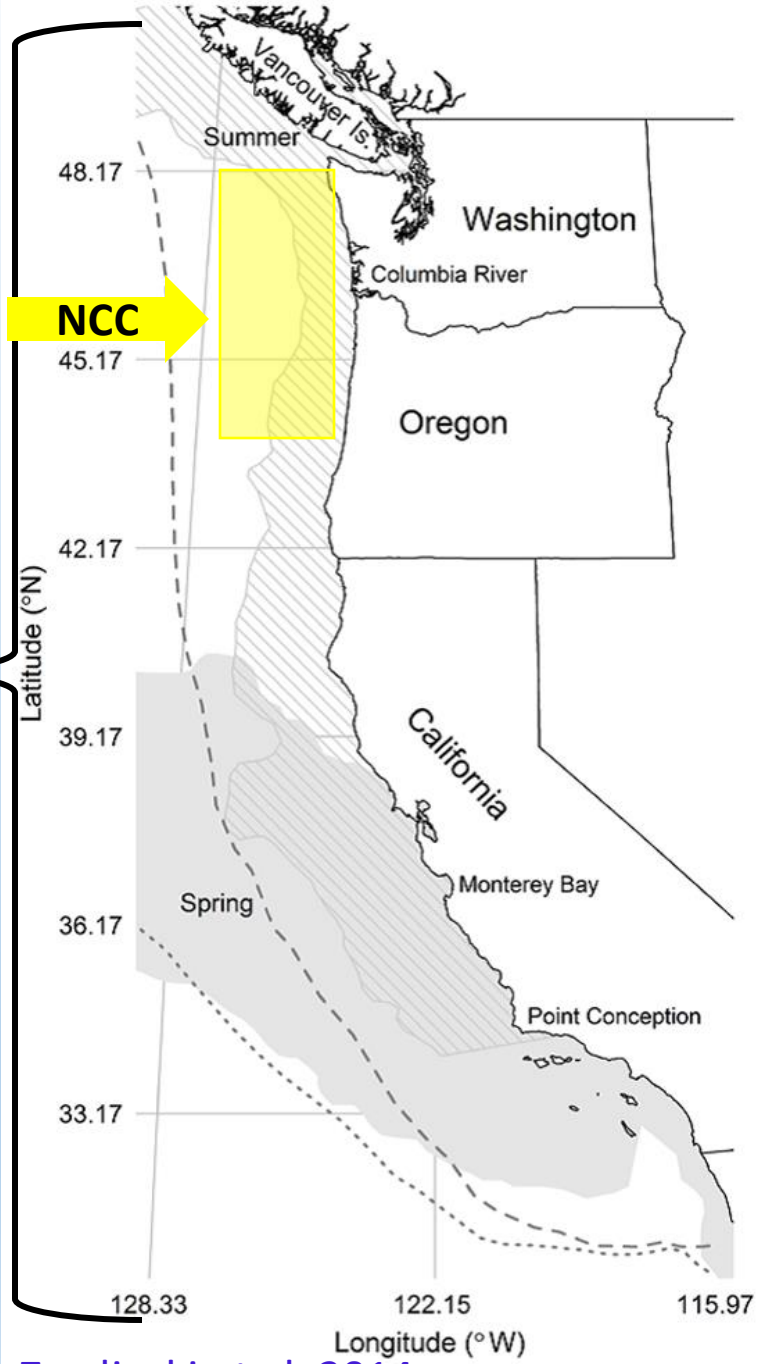


Image: Chatgpt



Baumgartner et al. 1992

California current



Zwolinski et al. 2014

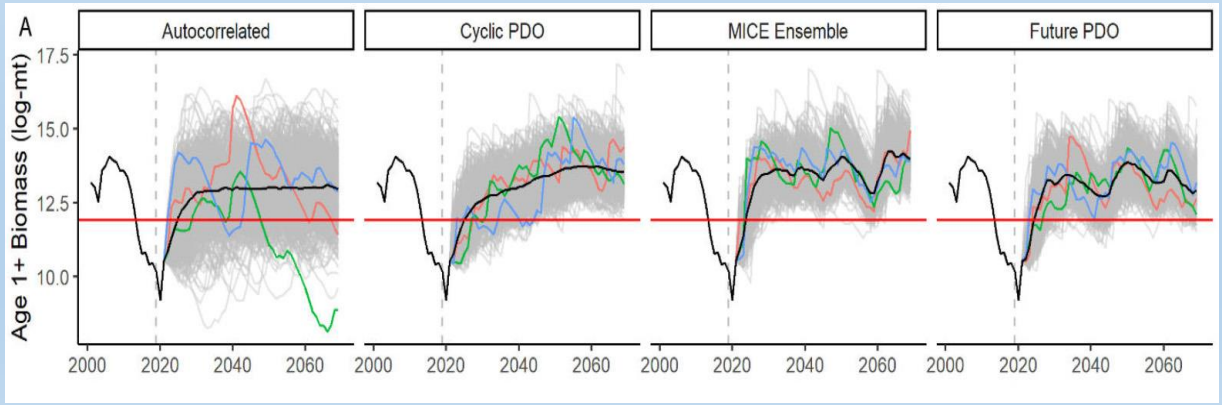
General biology of Pacific sardine in the California current:

- Pacific sardine adults can range the entire California current large marine ecosystem (CCLME)
- Adults spawn in spring in central to southern California pelagic waters (gray area)
- Larger fish can then migrate north (striped gray) in summer
- Some reproduction may occur as the fish migrate into the northern waters
- **The primary focus of this talk will be on the Pacific sardines in the Northern California current (NCC)**

Pacific sardine population predictions in the California current

- All recruitment scenarios show a rapid increase in the biomass of the population by the end of this decade

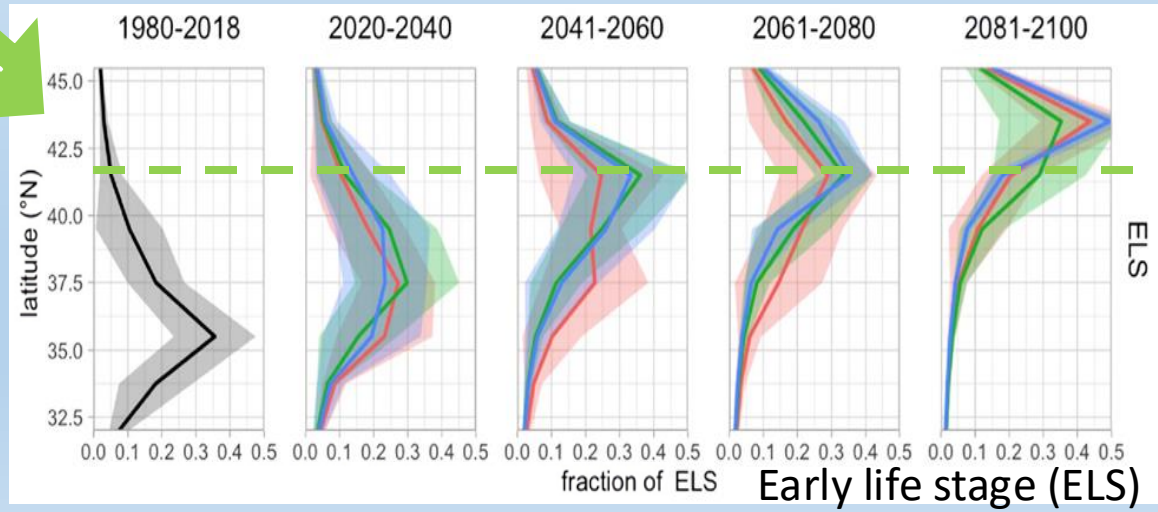
Wildermuth et al. 2024



Oregon border

- The spawning population is projected to move north in the next century in part driven by ocean warming

Koenigstein et al. 2022



Early life stage (ELS)

Research surveys in the Northern California current:

Larval Pacific sardines:

- Ichthyoplankton sampling (44.5°N) 1998-current bi-weekly year round

Juvenile Pacific sardines:

- 6-yr trawl survey in May (46-48°N) 2017-18, and 2021-2024
- Diets of albacore tuna July-October 2005-2007, 2009-2015, 2017-2023 (Oregon & Washington)

~~Adult Pacific sardines:~~

- ~~27-yr trawl survey in June (44.5-48°N)~~

(Hart 1943, Bentley et al. 1996; Emmett et al. 2005; Auth 2008; Lo et al. 2010, Auth et al. 2018)

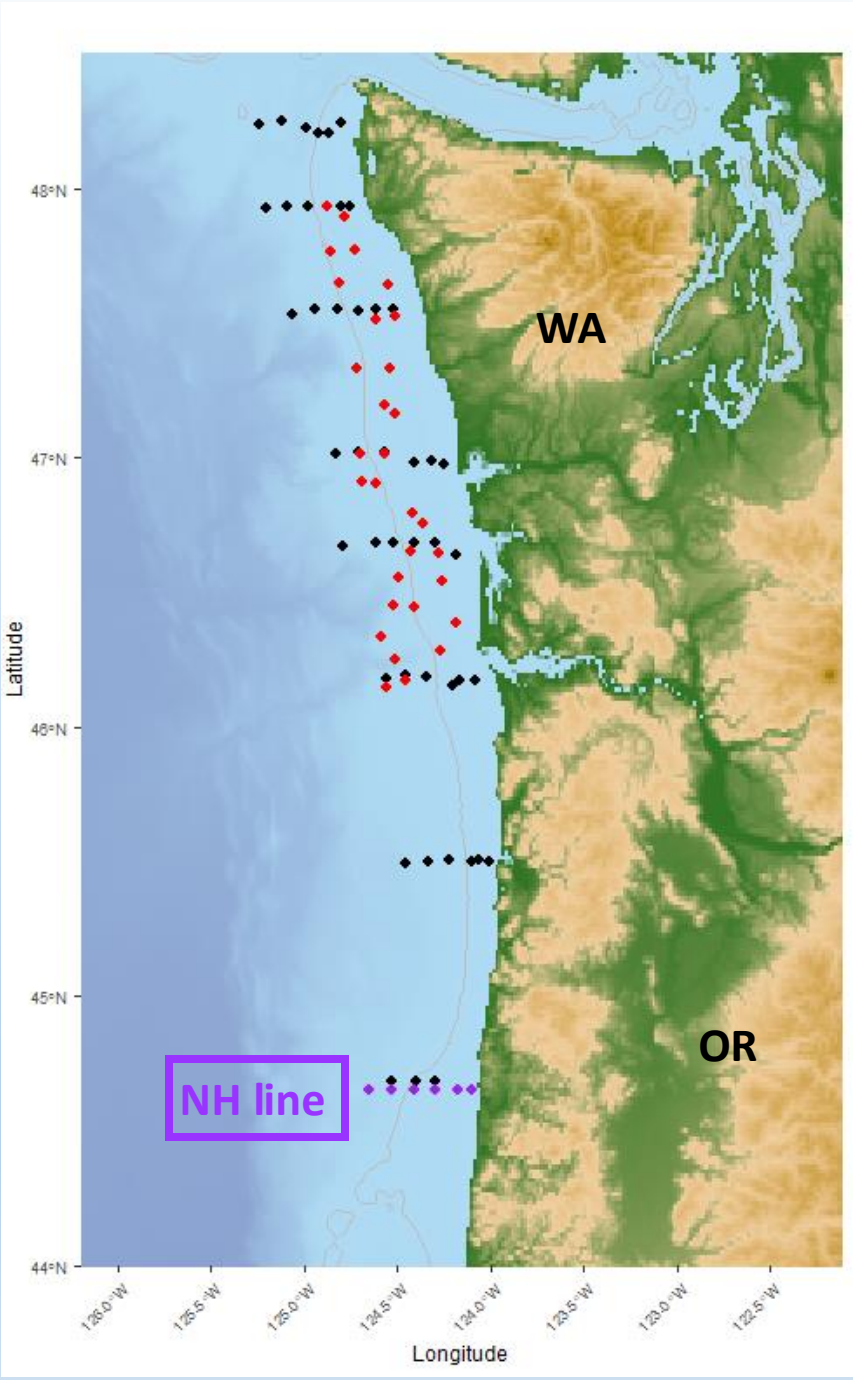


Image: Chatgpt

Yes, Japanese sardines have been identified in the Northern California current

No, we do not know if any of the larvae and juveniles we sampled are Japanese sardines- but we have preserved samples

Crossing the Pacific: Genomics Reveals the Presence of Japanese Sardine (*Sardinops melanosticta*) in the California Current Large Marine Ecosystem

Gary C. Longo, Jeremiah J. Minich, Nicholas Allsing, Kelsey James, Ella S. Adams-Herrmann, Wes Larson, Nolan Hartwick, Tiffany Duong, Barbara Muhling, Todd P. Michael, Matthew T. Craig

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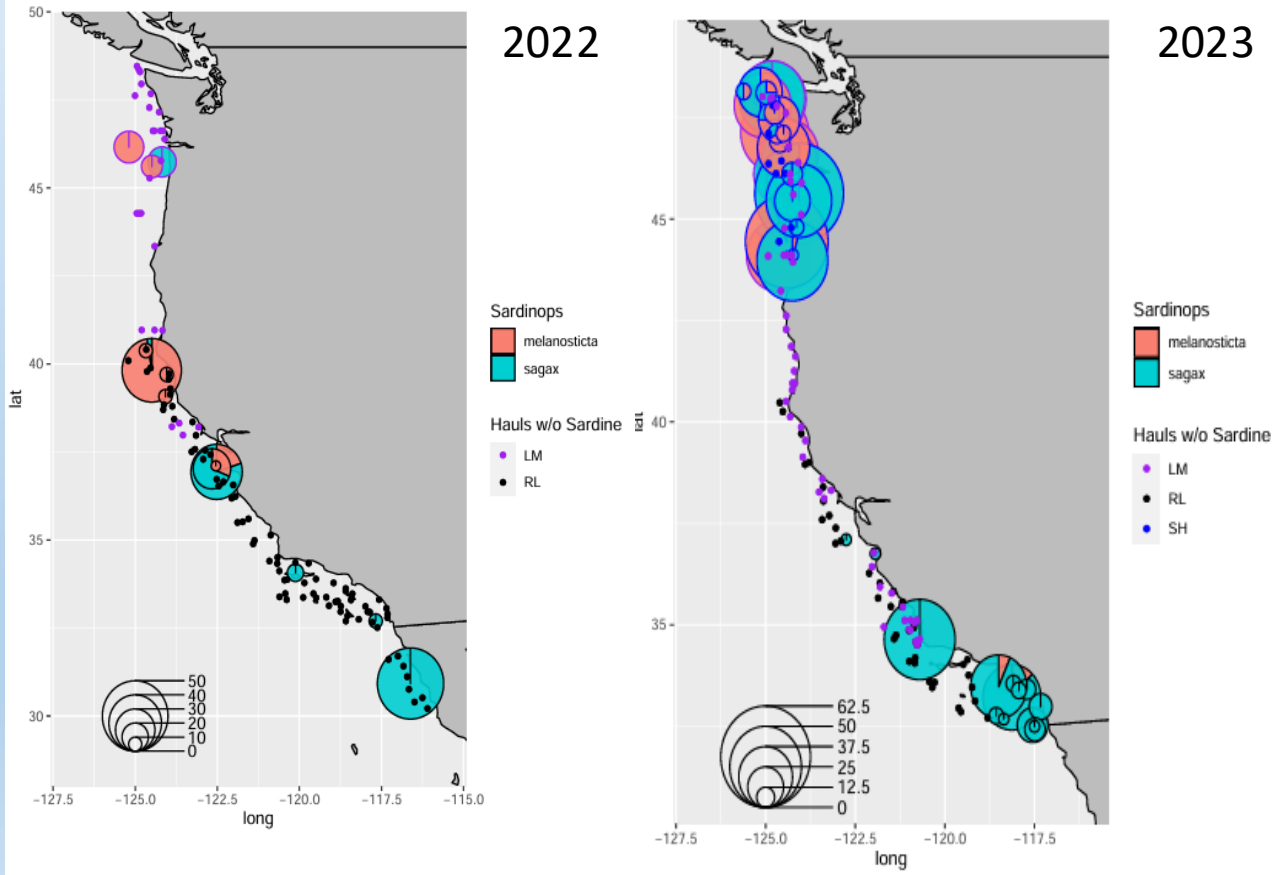
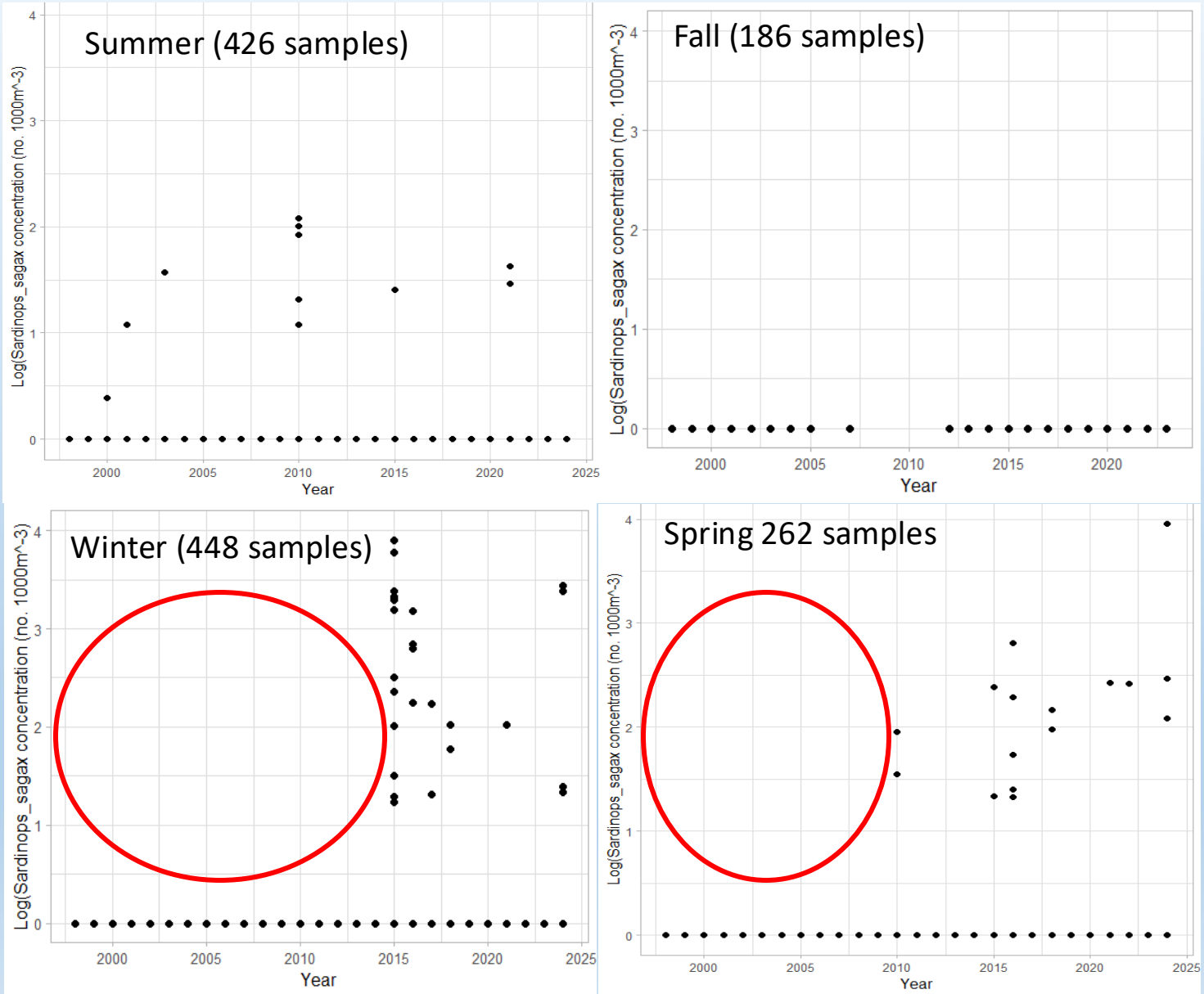


Recent increases in the abundance of larval Pacific sardine in central Oregon, nearshore-shelf, in winter and spring



Newport Hydrographic line 44.5 °N nm 1-25

- Summer and fall: no temporal trend
- Winter: zero occurrences first 17-yrs (1998-2014), then present most years since
- Spring: first present in spring 2010 (El Niño) and then present every year after 2014

Larval Pacific sardines catches were observed at the warmest stations in Jan-April

2015-2024
N= 270 stations
NH-01-25
Jan-April
Central Oregon

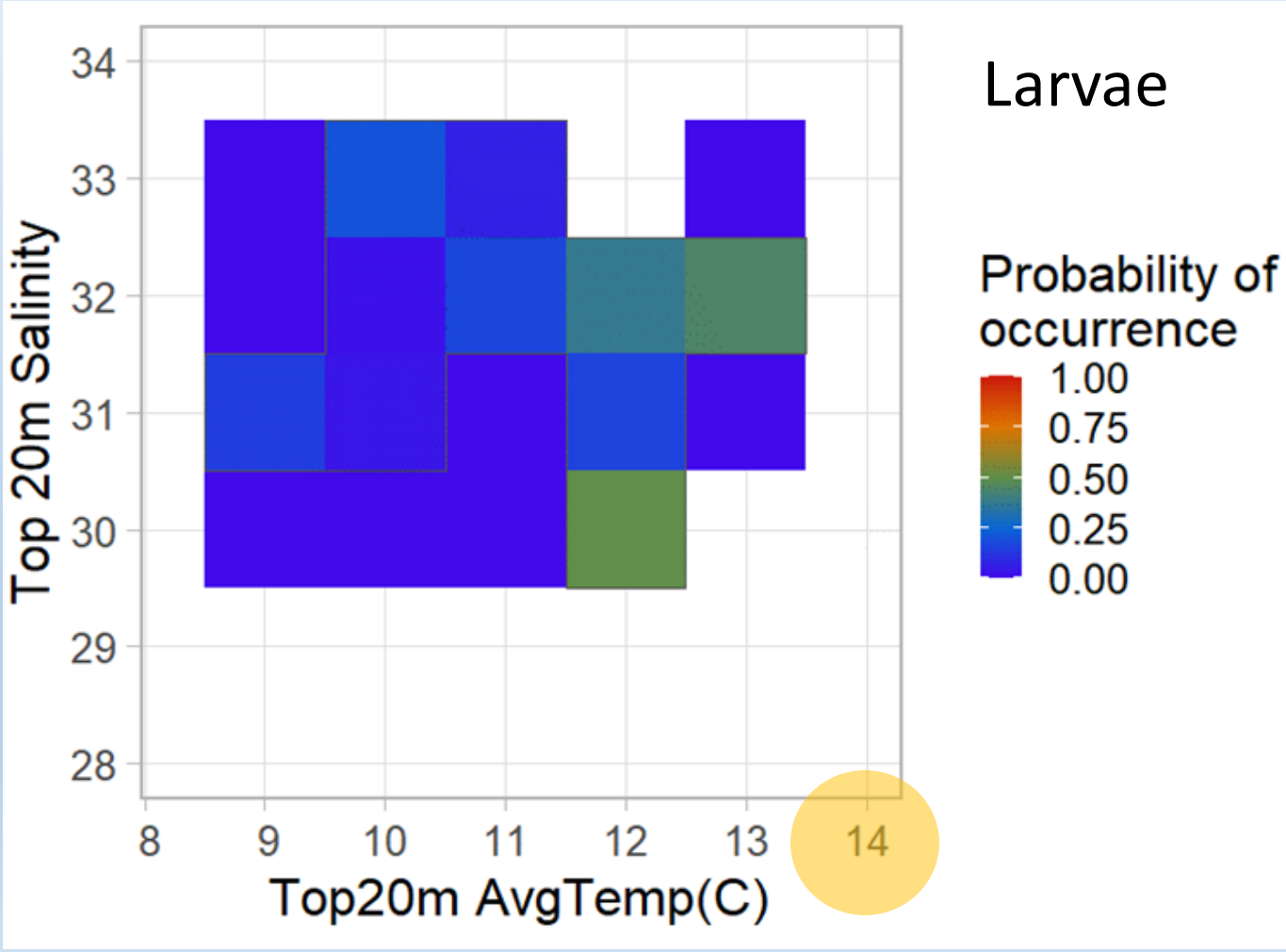


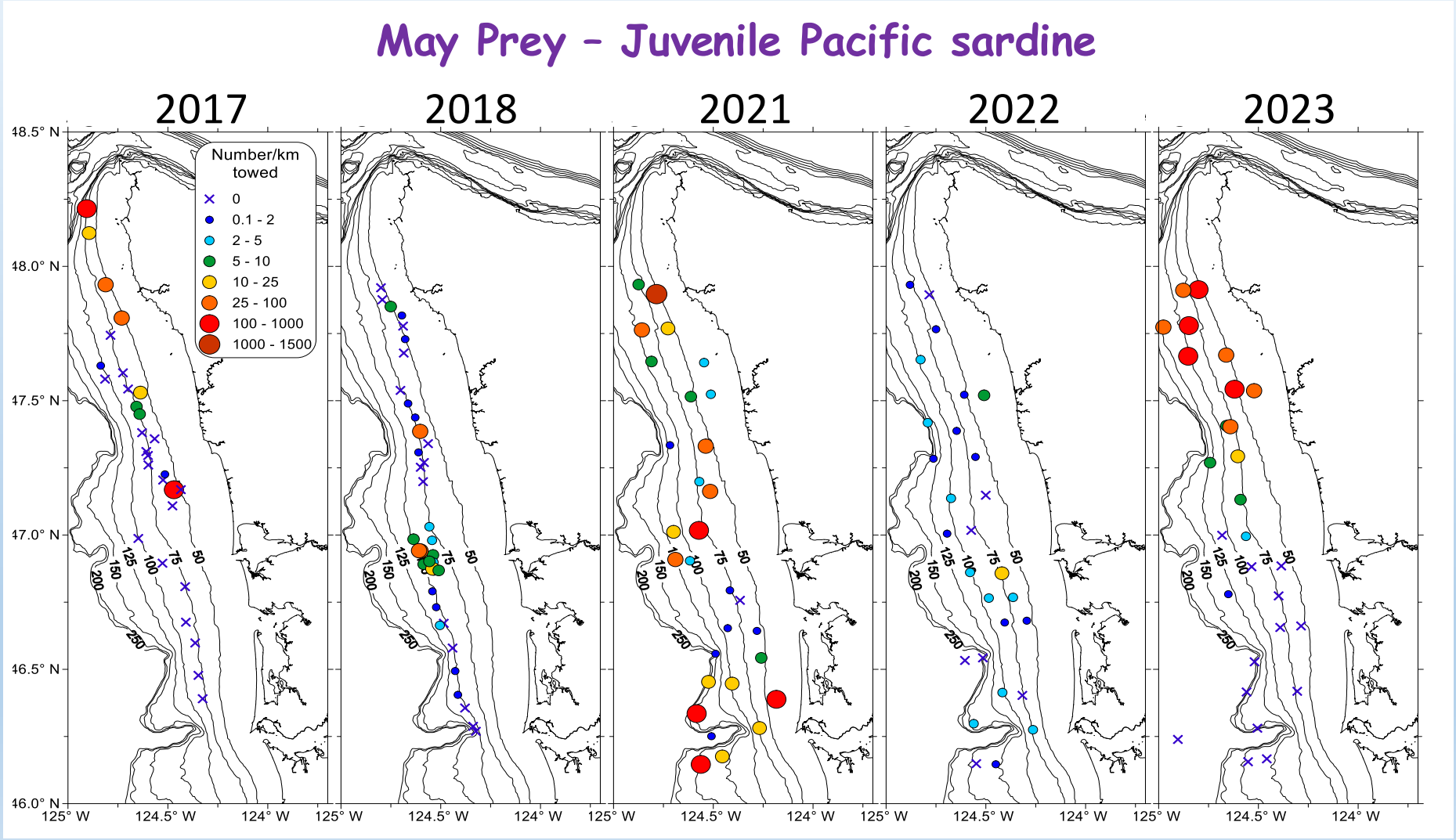
Image: Chatgpt

- Highest probability of occurrence of Pacific sardine larvae was where the average top 20 m temperature at the sampled site was 12-13° C

Catches of juvenile Pacific sardine in May Washington coastal waters

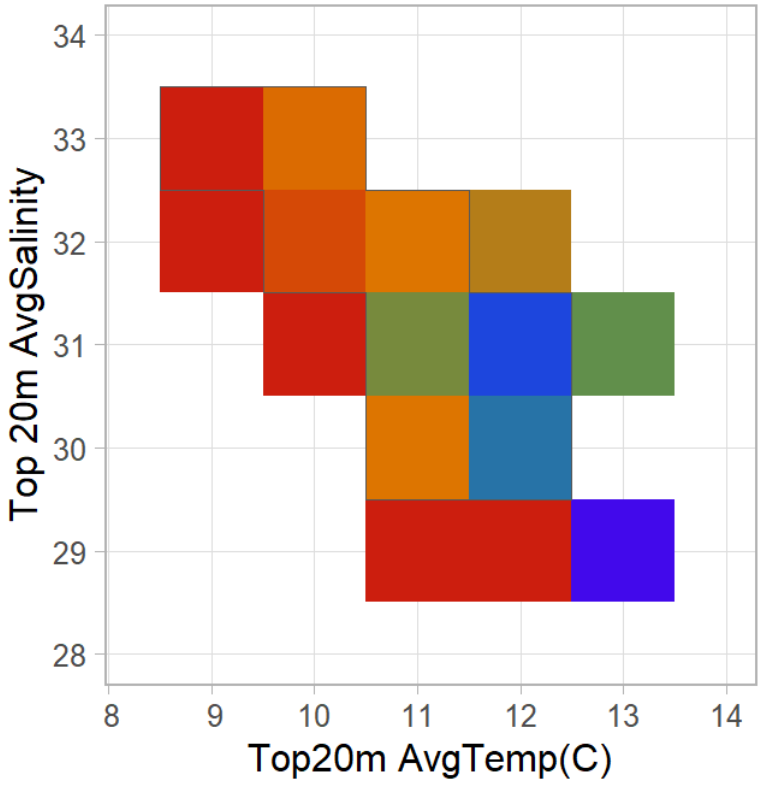
Average size 26.5 (±2.8) mm SL and are several months old (based on size)

*Were caught in low numbers in 2016 & 2019. No survey 2020

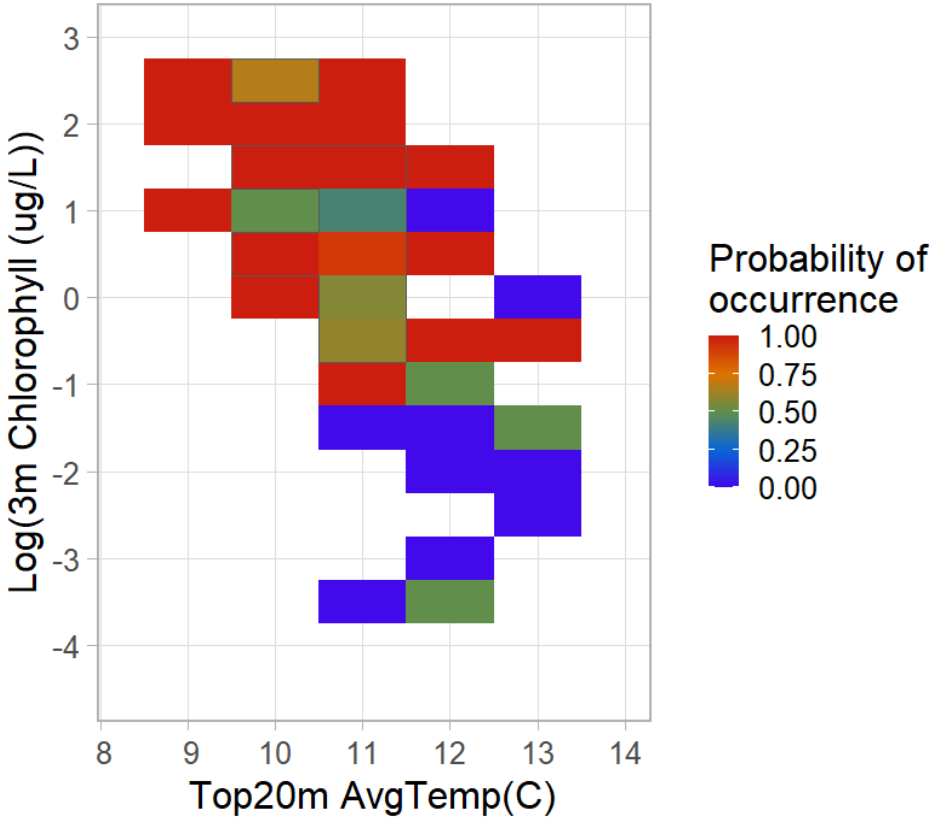


Sampled stations with the highest probability of occurrence of juvenile Pacific sardines were cold (9-12° C) and had elevated levels of chlorophyll

Salinity and Temperature



Chlorophyll and Temperature

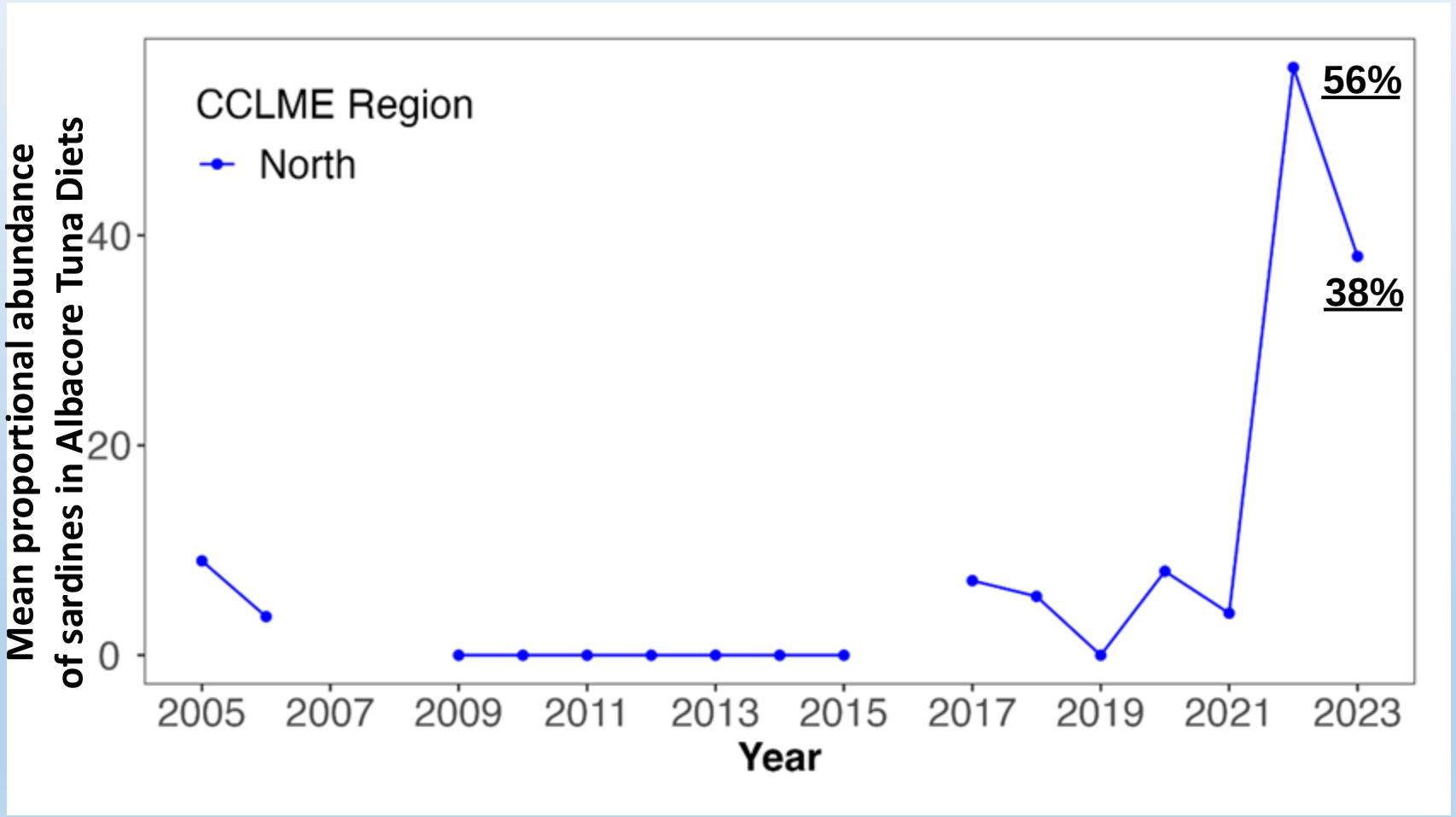


May 2017-18; 2021-23 N= 103 stations

Photo: Miram Gleiber

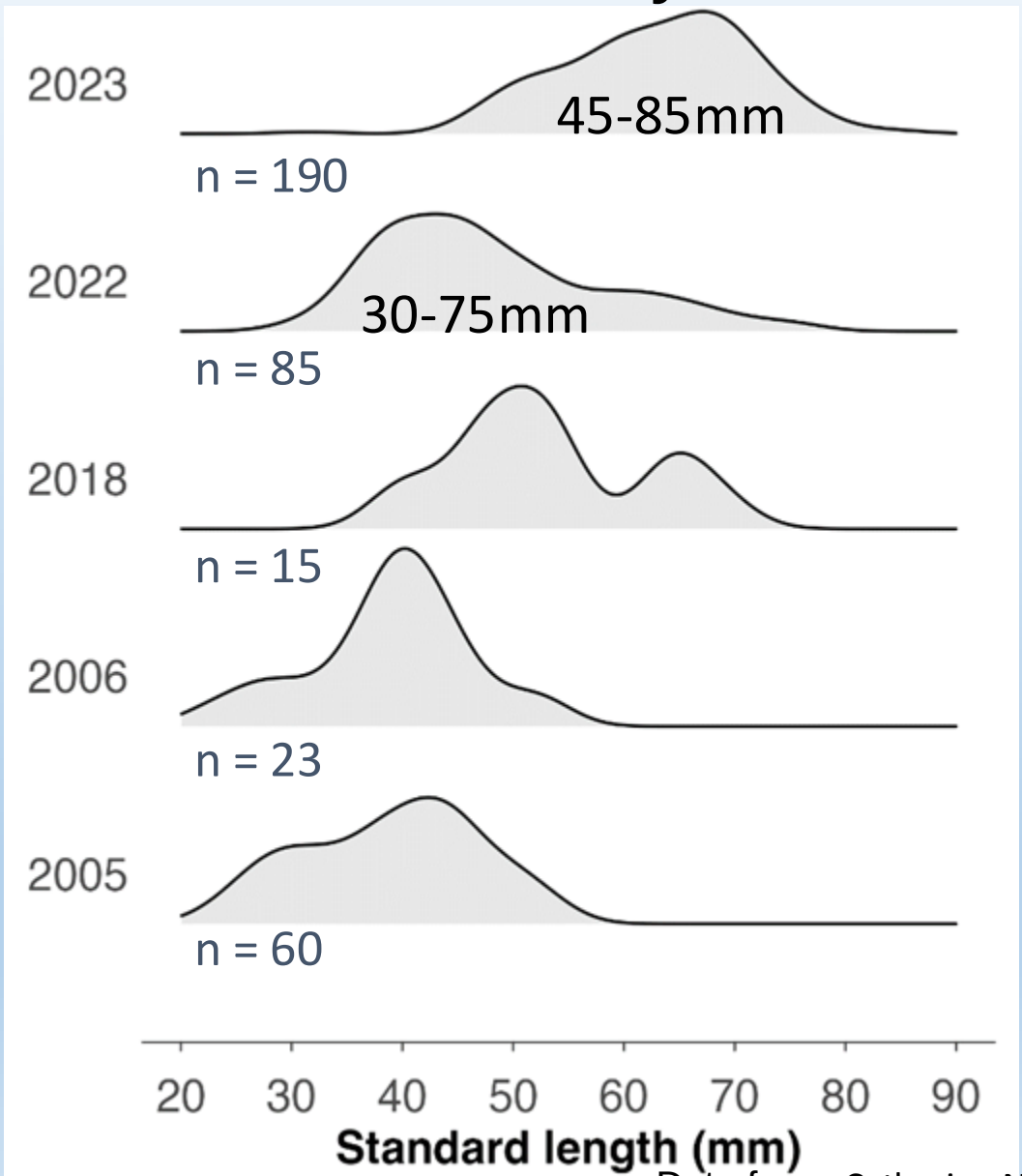
Juvenile Pacific sardines highly abundant in 2022 & 2023 in Northern California current Albacore tuna diets (July-October)

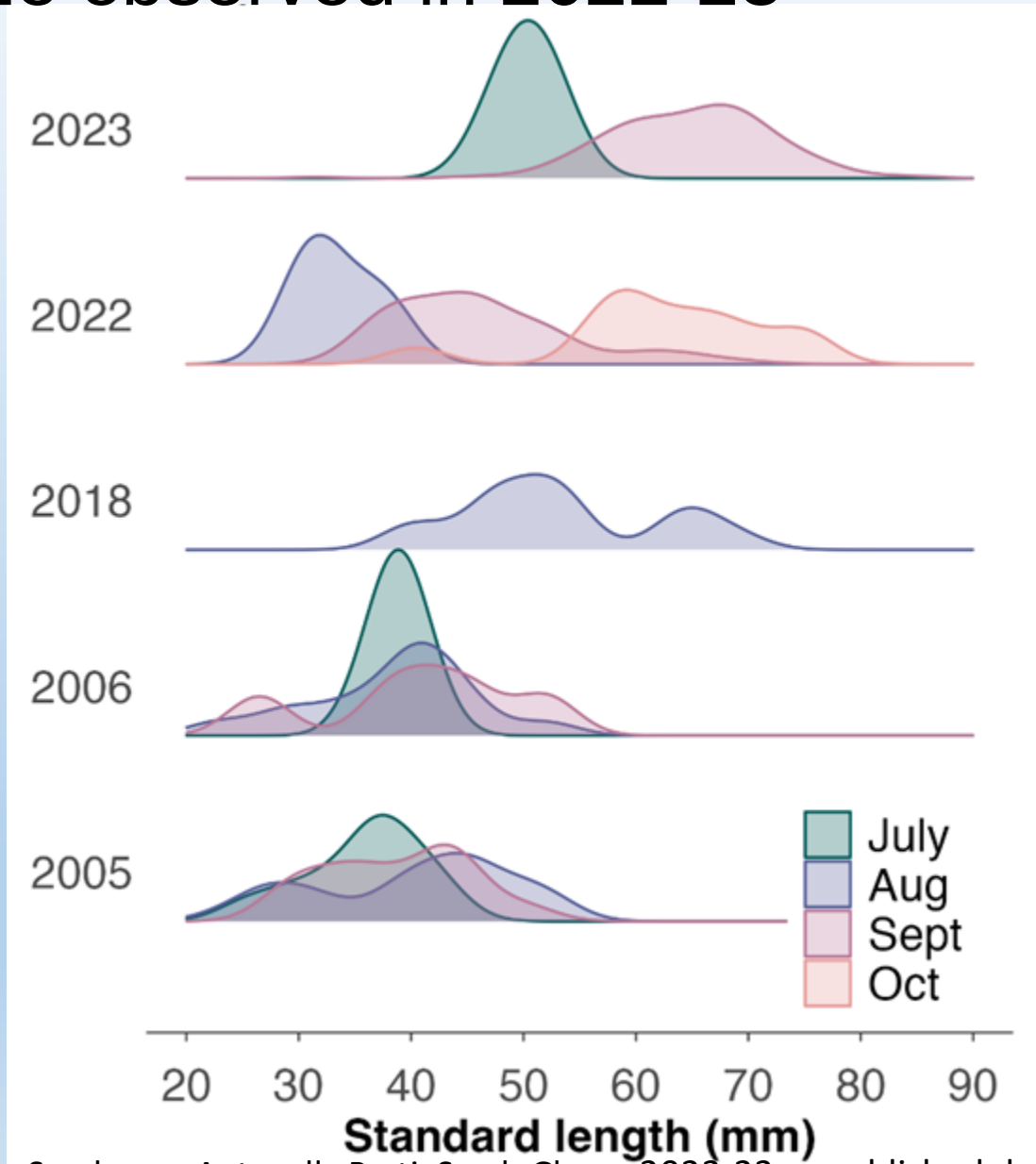
- Juvenile Albacore (500-1000 mm FL) in NCC July-Oct
- >20 km offshore
- Diverse diets of forage fish, squid, crustaceans
- Recently Pacific sardines anomalously abundant



Data contributors: Catherine Nickels, Owyn Snodgrass, Antonella Preti, Sarah Glaser. 2022-23 unpublished data

Pacific sardines being eaten were 30-85 mm juveniles with a monthly increase in size observed in 2022-23





Data from: Catherine Nickels, Owyn Snodgrass, Antonella Preti, Sarah Glaser, 2022-23 unpublished data

Change in size of larvae and juveniles through time

After approxim
days, the juven les
were around 25 m SL

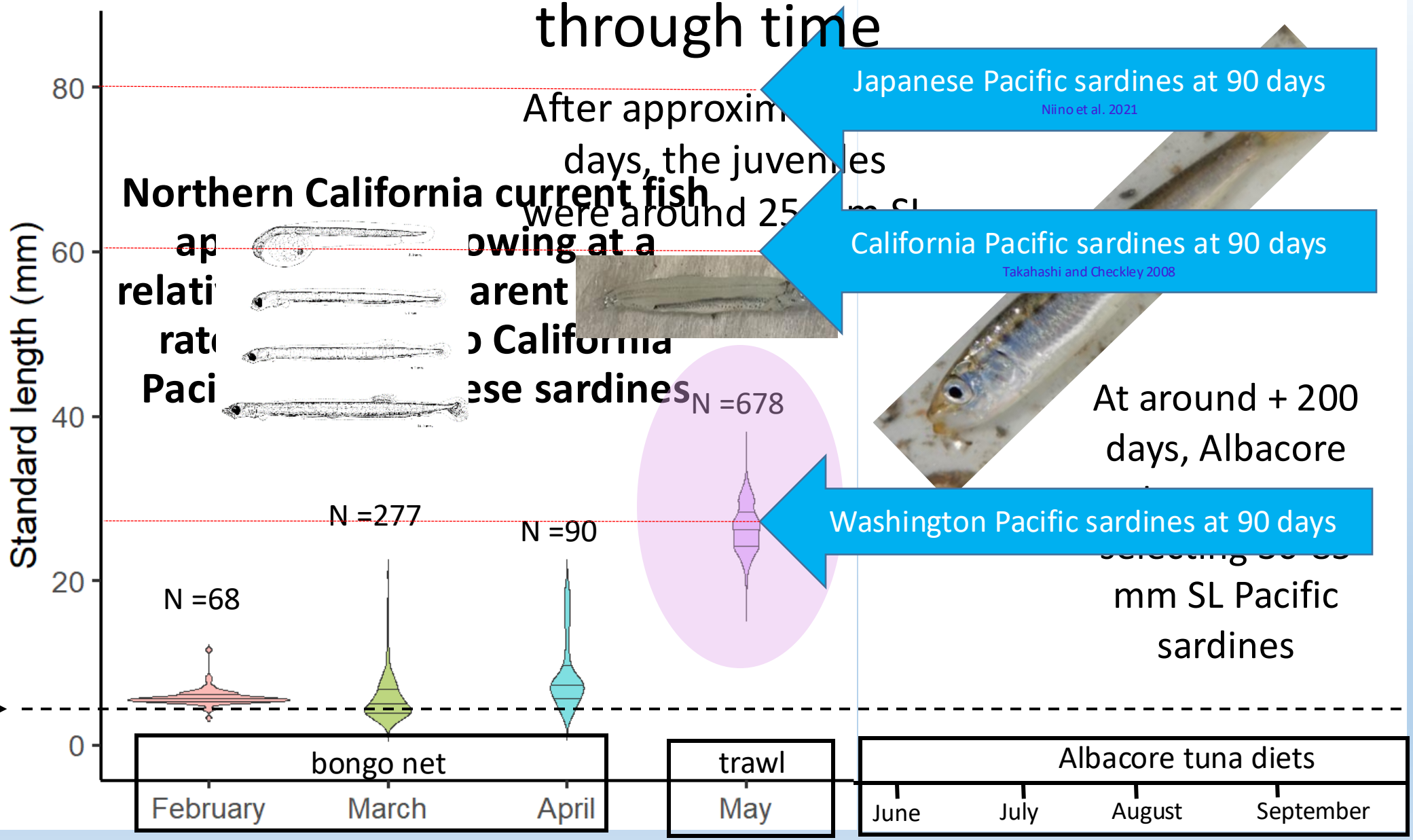
Northern California current fish ap owing at a relati arent rat o California Paci ese sardines

Japanese Pacific sardines at 90 days
Niino et al. 2021

California Pacific sardines at 90 days
Takahashi and Checkley 2008

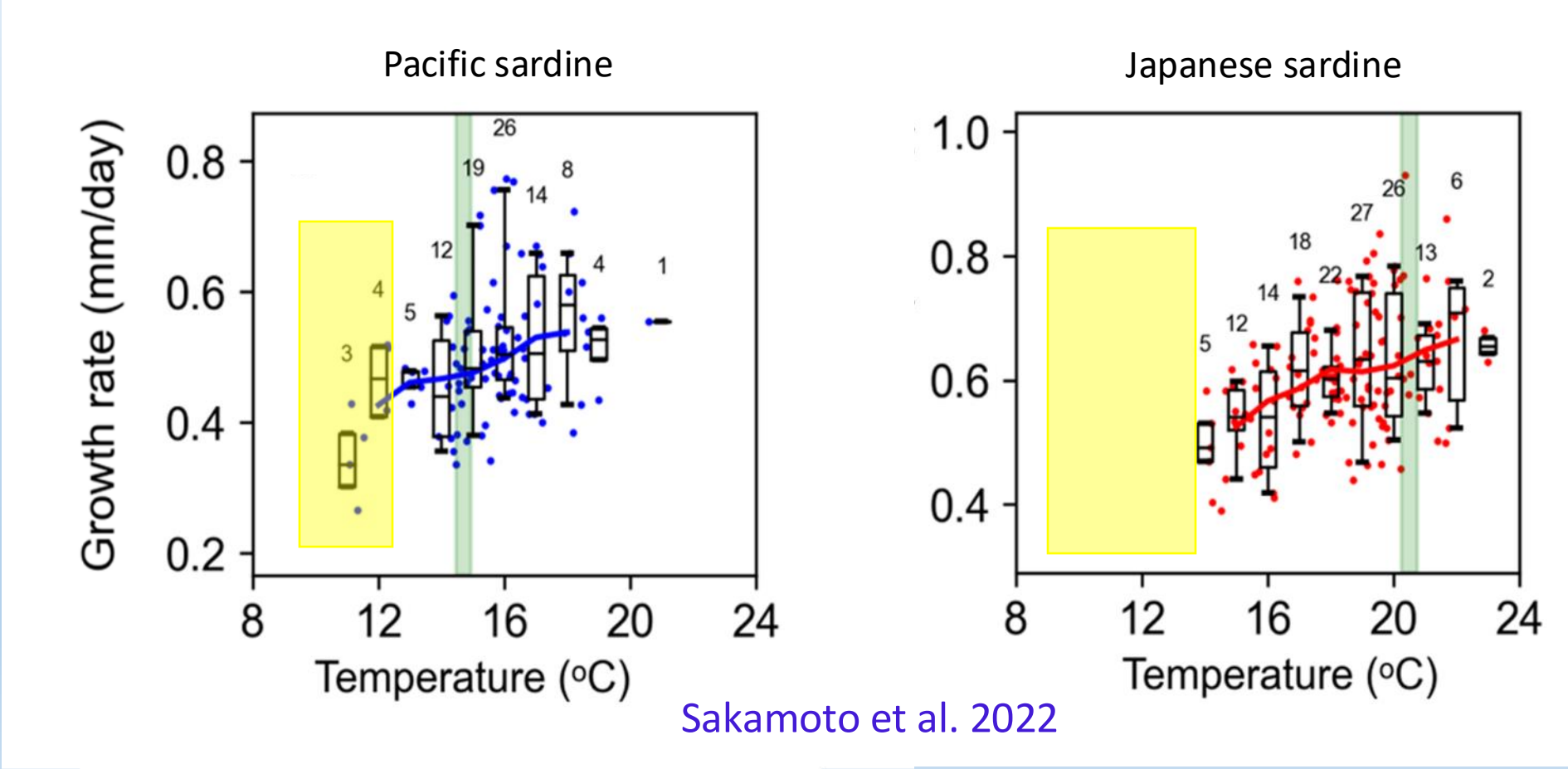
At around + 200 days, Albacore
mm SL Pacific sardines

Washington Pacific sardines at 90 days



Low growth rates that we are seeing may be due to cold temperatures in the Northern California current

Growth and temperature of California Pacific and Japanese sardines (35 - 60 mm)



Sakamoto et al. 2022

Green bar represents optimal temperature for field metabolic rate derived from carbon in otolith carbonate

Conclusions

- **Environmental conditions, timing, and location** of larval and juvenile Pacific sardines in the Northern California current have been unusual, with evidence of these early stages surviving and serving as forage for top predators.

- **Newly hatched larvae** have been found in waters ≤ 13°C, and juveniles were caught in cold temperatures (8.5-12°C) associated with higher chlorophyll levels.

- **Pacific sardines estimated to be 90 days old** in the Northern California Current were smaller compared to growth studies of California Pacific and Japanese sardines, potentially due to colder temperatures.

Acknowledgements

- Thanks to all the research scientists within Oregon State University and NOAA
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- Funding was provided by Bonneville Power Administration, and NOAA fisheries

Thanks! Any Questions?

Pacific sardine co-occurred with spawning Pacific herring in 2024 Yaquina Bay Oregon

- March 2024: Pacific sardines were taken by fishers while jigging for Pacific herring in Newport, OR (authors personal comm.)
- Co-occurrence of Pacific herring and sardine in Yaquina Bay could signal spatial overlap in winter and potential competition between these fishes

Photo: Wes Shum

Photo: Yak fish taco

Photo: John Files