Update on the presence of Japanese Sardine (*Sardinops melanosticta*) in the California Current Large Marine Ecosystem 2024

SSC Sardine Update Assessment Review 2/26/25

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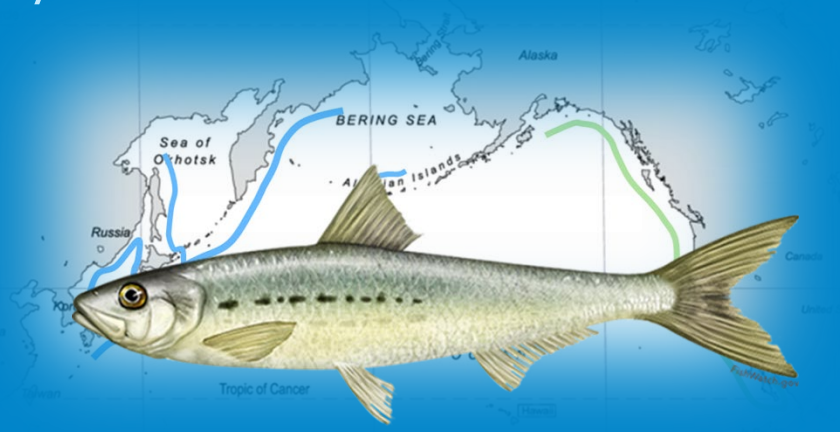
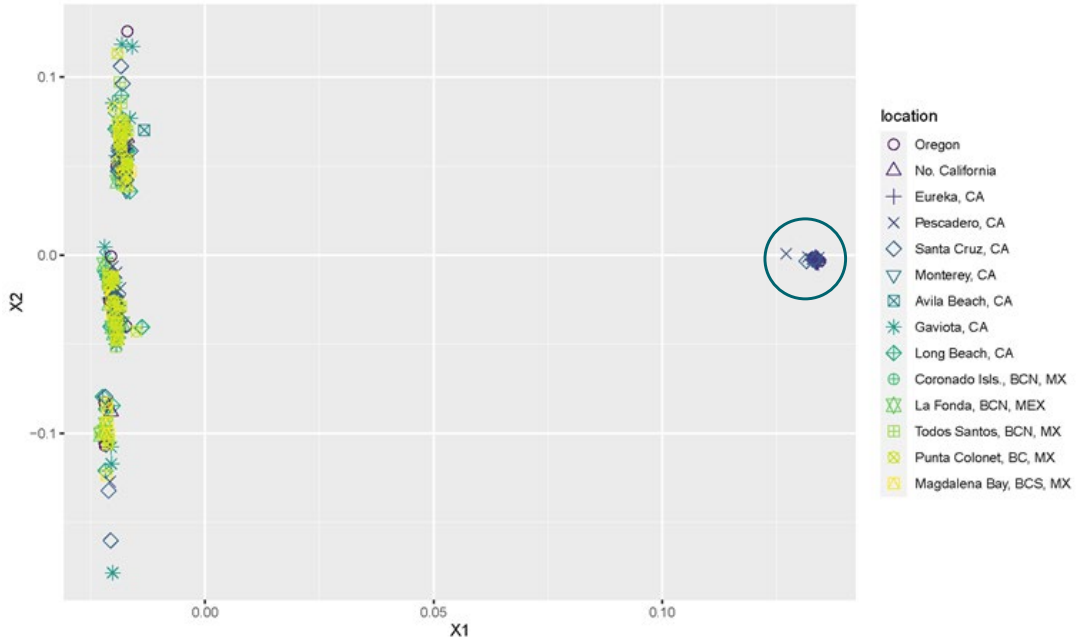
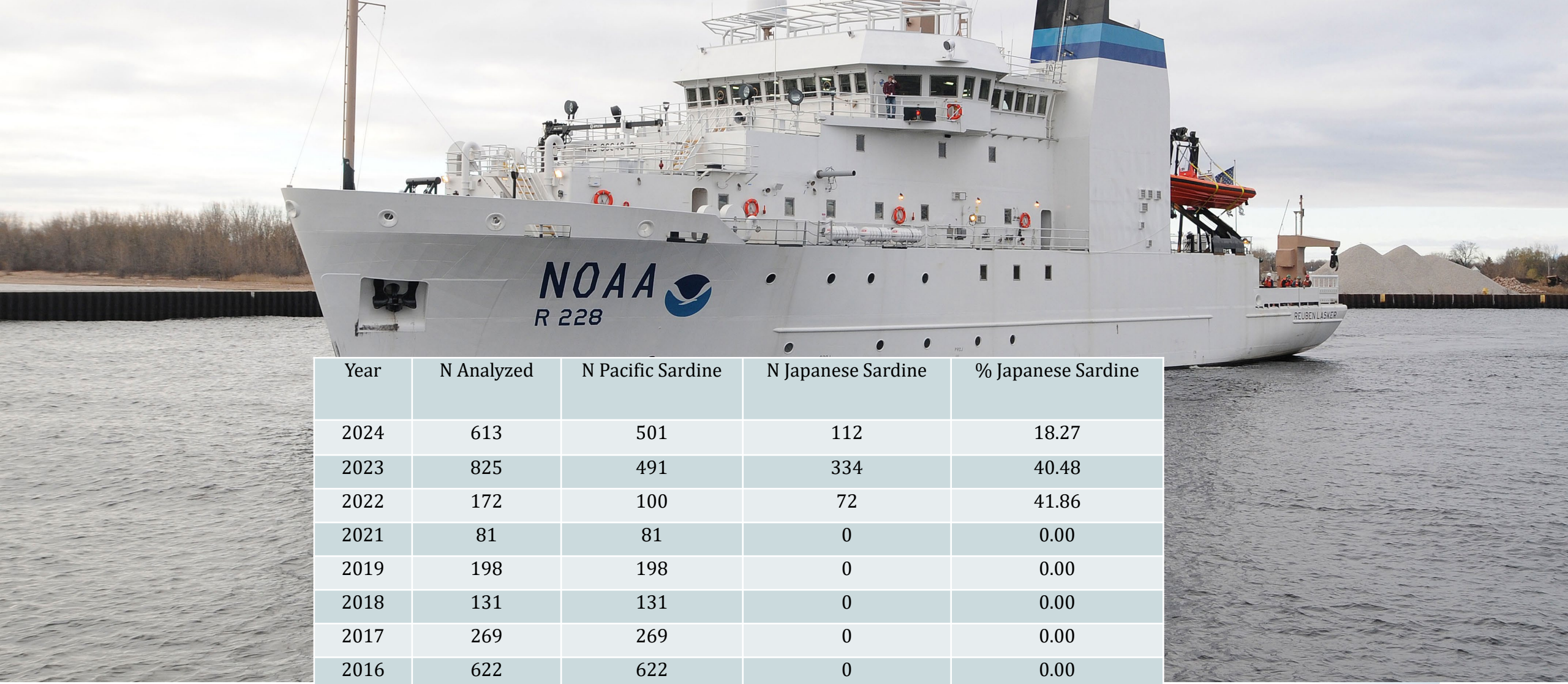


- In 2022 a highly unusual genetic cluster of sardine samples was noted when analyzing genetic data from the California Current system. Determined to be Japanese sardine, *Sardinops melanosticta*



Modified GTSeq technique

- Genotyping in Thousands by Sequencing
- Surveys have been archiving sardine tissue samples since the early 2000's
- Analyzed samples from 2013-2024
- Three mtDNA regions with fixed SNPs between Pacific and Japanese sardine
- Standard Illumina workflow
- MiSeq platform
- Our largest was 1800 samples in a single run



Year	N Analyzed	N Pacific Sardine	N Japanese Sardine	% Japanese Sardine
2024	613	501	112	18.27
2023	825	491	334	40.48
2022	172	100	72	41.86
2021	81	81	0	0.00
2019	198	198	0	0.00
2018	131	131	0	0.00
2017	269	269	0	0.00
2016	622	622	0	0.00
2015	175	175	0	0.00
2014	211	211	0	0.00
2013	892	892	0	0.00

Preliminary data, do not cite

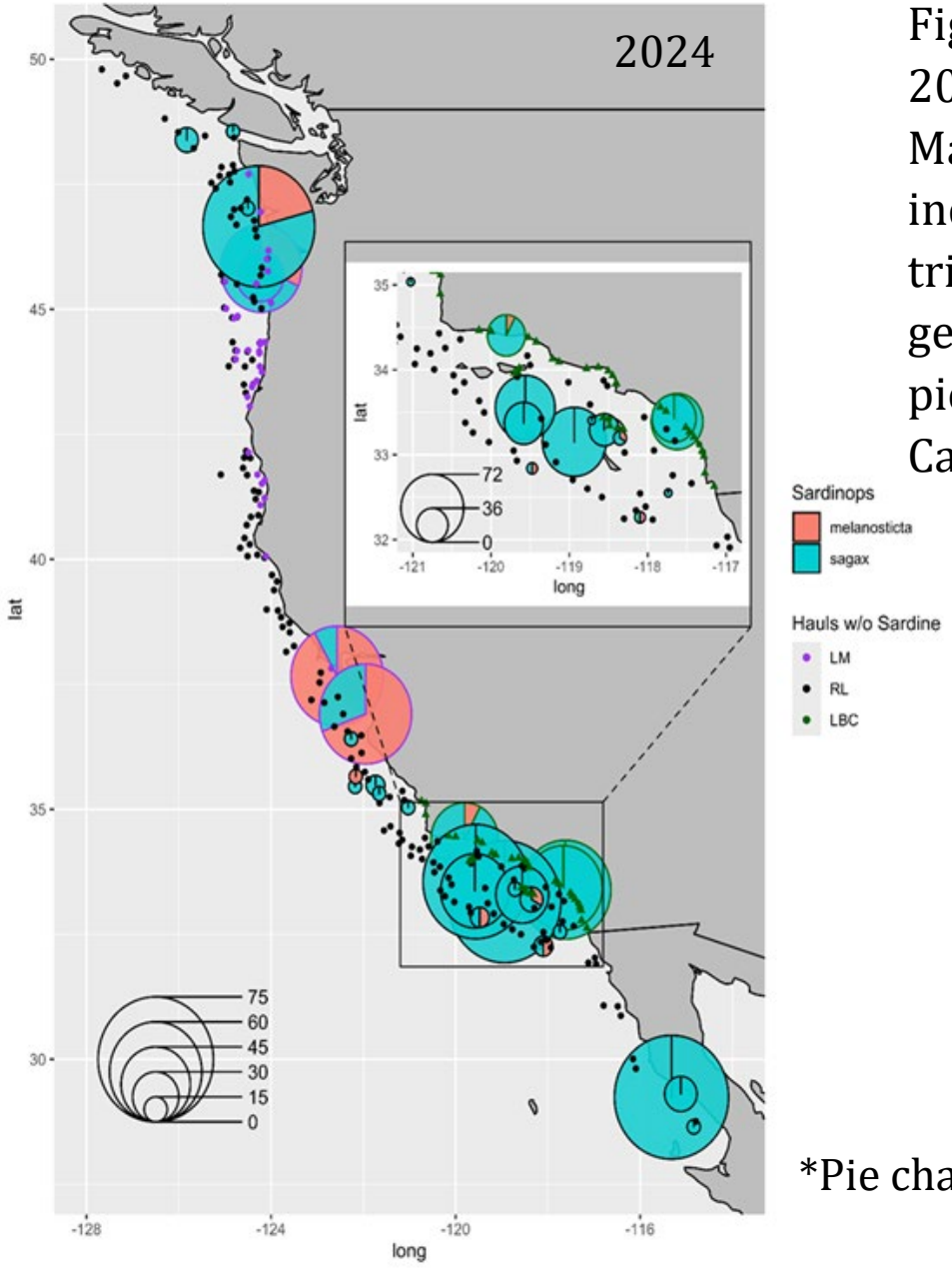
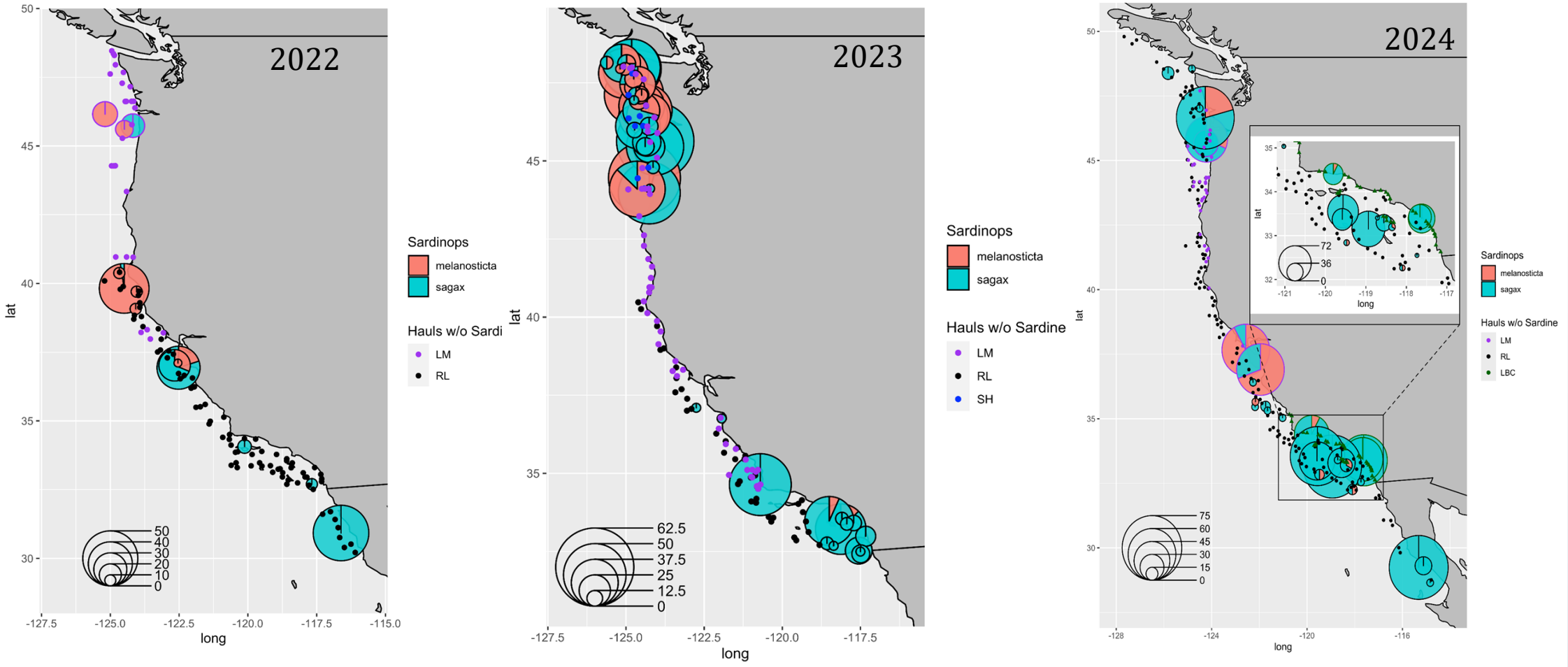


Figure 1. Trawl locations of Pacific and Japanese sardine taken during the 2024 CCES survey aboard the F/V Rueben Lasker (RL) = black, M/V Lisa Marie (LM) = purple, and F/V Long Beach Carnage (LBC = green). Dots indicate additional trawl locations where sardine were not collected, and triangles represent hauls with sardine collected that were not sampled for genetics. Pies represent the relative proportion of species per trawl. Size of pie is relative to number of individuals (rescaled in the inset of the Southern California Bight).

<u>Sampling notes:</u>

- Non-synoptic sampling for genetics
- FSV – all sardine sampled for biodata were also sampled for genetics (up to 75 fish per trawl)
- Inshore seiners – as many samples taken as practicable
  - Lisa Marie – all samples
  - Long Beach Carnage – 170/~1300

Pie charts are numbers of fish and not reflective of biomass



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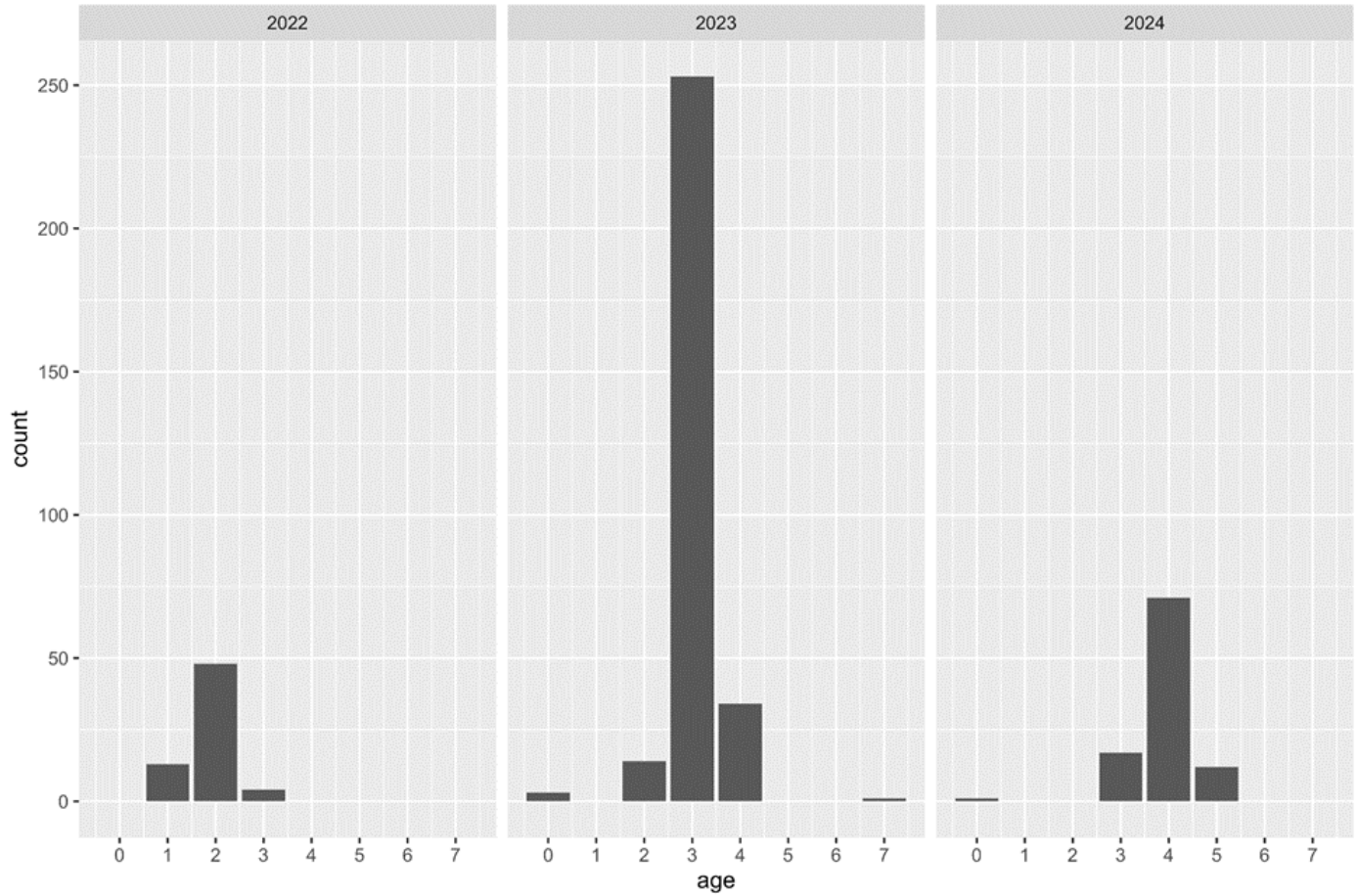

Figure 2. Ages of Japanese sardine collected in 2022, 2023, and 2024. Note that not all Japanese Sardine collected were aged.

Notable observations

- Single hauls with both species indicates the two species are likely schooling together
- Age-0 fish collected in 2023 and 2024 which suggests successful reproduction in the California Current system
- Age structure appears to show a cohort effect but non-synoptic sampling may obscure true signal

So Many Questions!

- How did they get here??
- Are there periodic pulses of Japanese sardine into the CCLME?
- Is there constant, low frequency movement of Japanese sardine into the CCLME?
- What is the dispersal mechanism and at what life stage does it happen?
- Is there hybridization and if so what are the implications?

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

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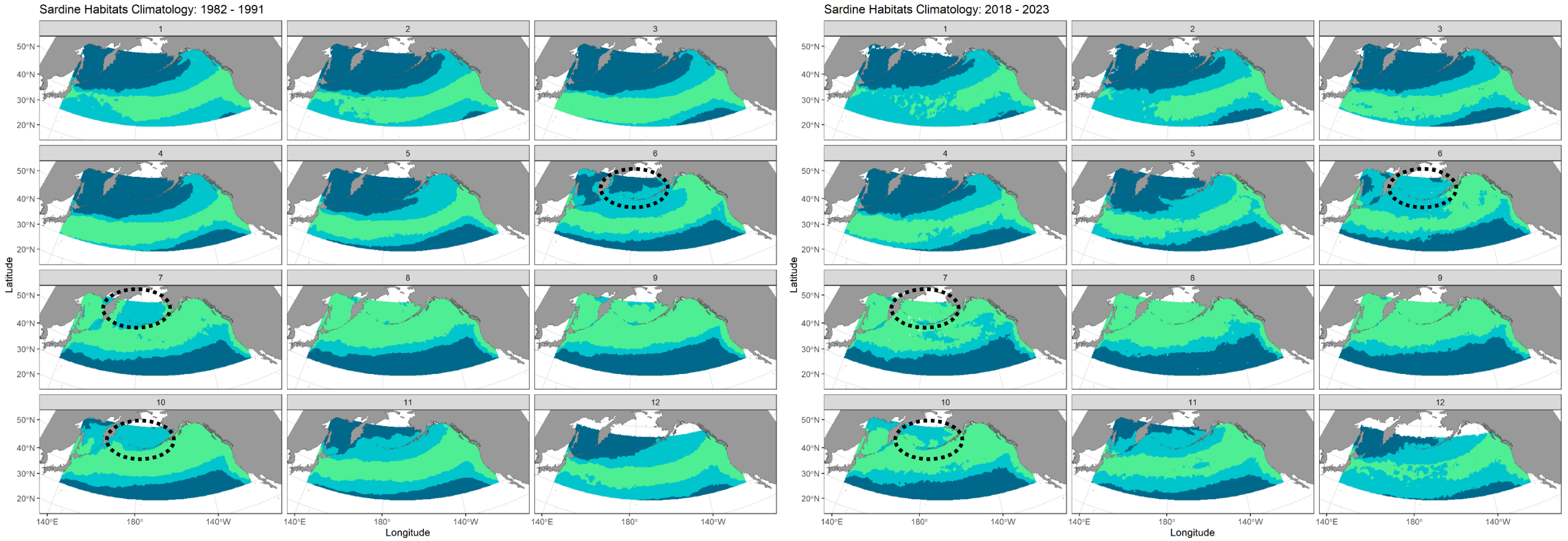
- With changes in temperature in the north Pacific ocean, new habitat opens up earlier and extends later in the year, particularly at coastal sites. (Coincidentally, AFSC observer program collected sardine outside of the Bering Sea [Kodiak Island] for the first time in September 2022 and proportion of Japanese sardine in Russian trawl surveys increased from ~50% in 2020 to ~75% in 2022)



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(Can't do the same analysis with chlorophyll, as record only starts in 19

Hybridization and its Implications

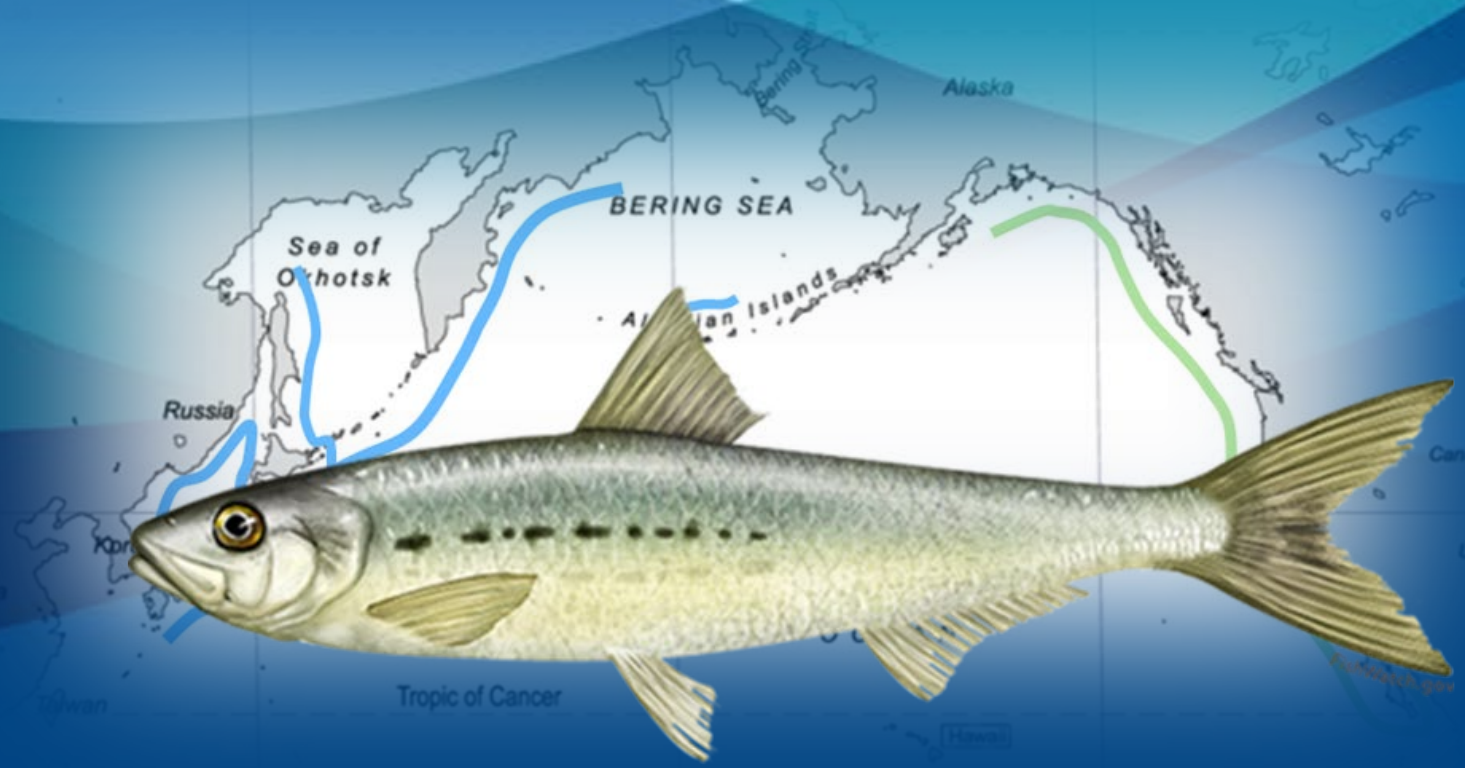
- Currently hybridization has not been detected but has not been examined in detail
- Actively developing genetic marker panel to detect hybrids

How might hybridization between Pacific and Japanese sardine impact abundance/biomass of the **total sardine resource (both species)?**

We don't know and it would take a good deal of work to find out

- Some possible hybrid fitness effects:
  - outbreeding depression - reduced fitness that may lead to lower productivity
  - minimal or no effects on fitness, neutral effect on productivity, could lead to homogenization of Japanese and Pacific sardine groups
  - Heterosis ("hybrid vigor") - increased fitness of hybrids could lead to increased productivity

Questions?



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