Assessment of the Multi-Function Trawl Net System for Acoustic-Trawl Surveys of Coastal Pelagic Species in the California Current Ecosystem for the Integrated West Coast Pelagics Survey

Brad Erisman[1], Kelsey James[1], Alexander Jensen[1], Bryan Overcash[1], Josiah Renfree[1], Brittany Schwartzkopf[1], Kevin Stierhoff[1], and Juan Zwolinski[2,1]

[1]NOAA Fisheries, Southwest Fisheries Science Center, Fisheries Resources Division, La Jolla, California U.S.A.
[2]Institute of Marine Sciences, University of California Santa Cruz, Santa Cruz, California, U.S.A.

A presentation to the Pacific Fisheries Management Council methodology review

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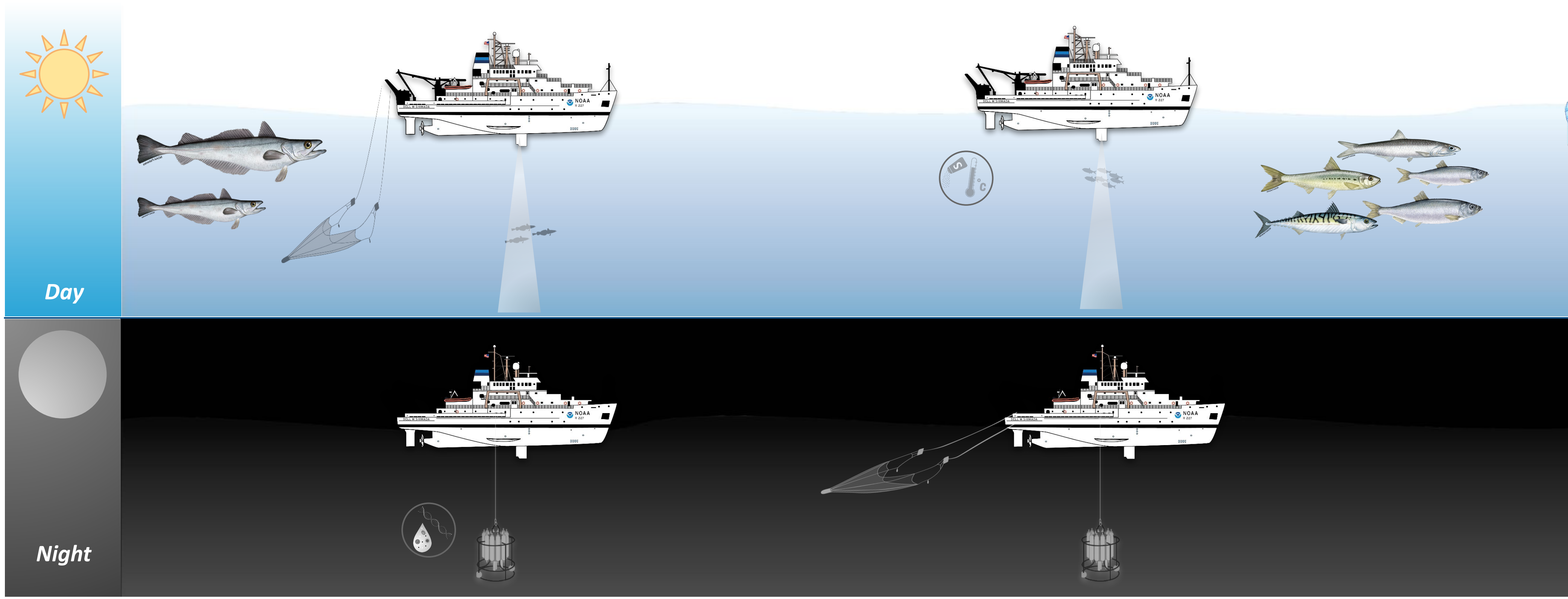
Background:
How We Got Here

Annie Yau

A Tale of Two Surveys

Joint U.S.-Canada Integrated Ecosystem and Pacific Hake Acoustic Trawl Survey

Coastal Pelagic Species (CPS) Survey



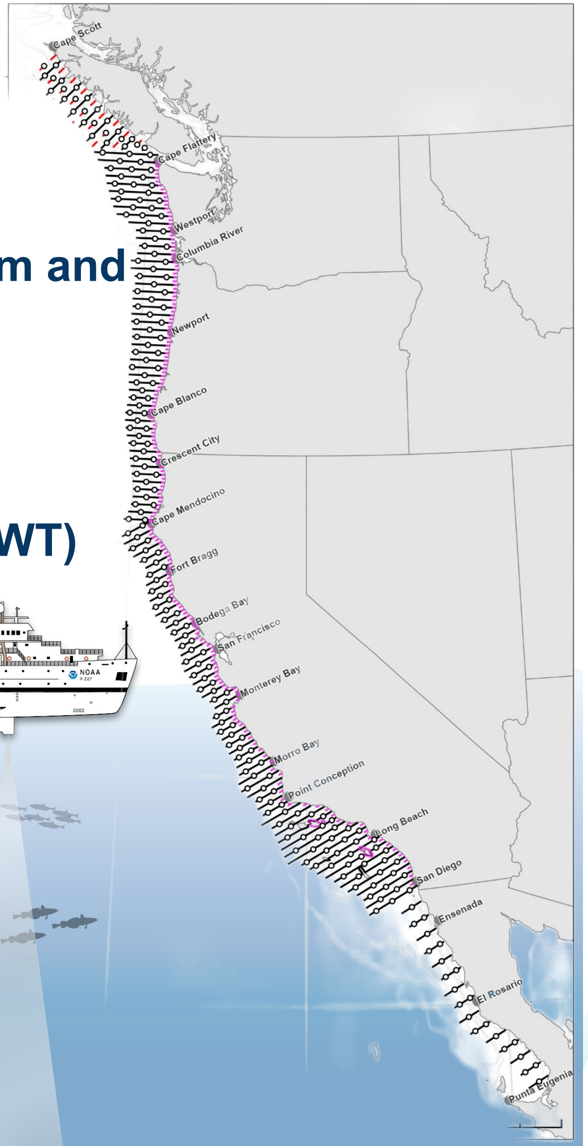
NWFSC and DFO Canada
1995-2023

SWFSC
2008-2024

A Tale of Two Surveys

California Current Ecosystem (CCE) Coastal Pelagic Species (CPS) Survey
Led by the SWFSC

Joint U.S.-Canada Integrated Ecosystem and Pacific Hake Acoustic Trawl Survey
Led by the NWFSC + DFO Canada

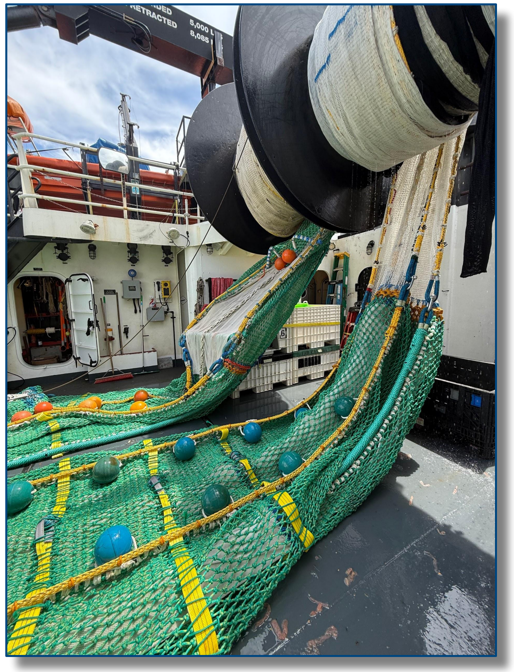


Nordic 264 Surface Trawl

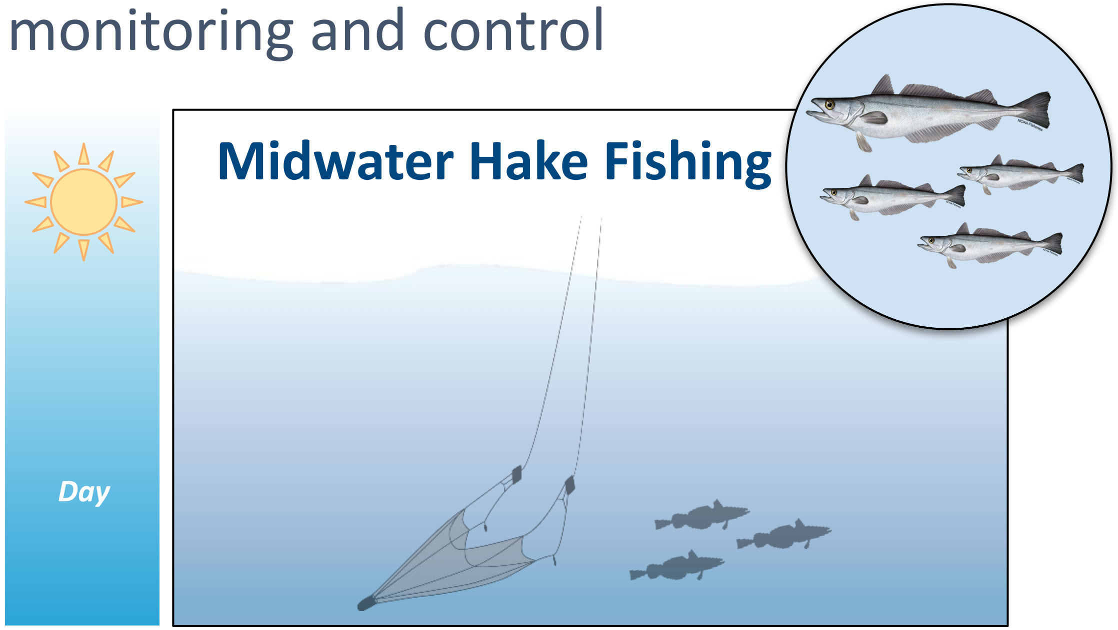
Aleutian Wing Trawl (AWT)

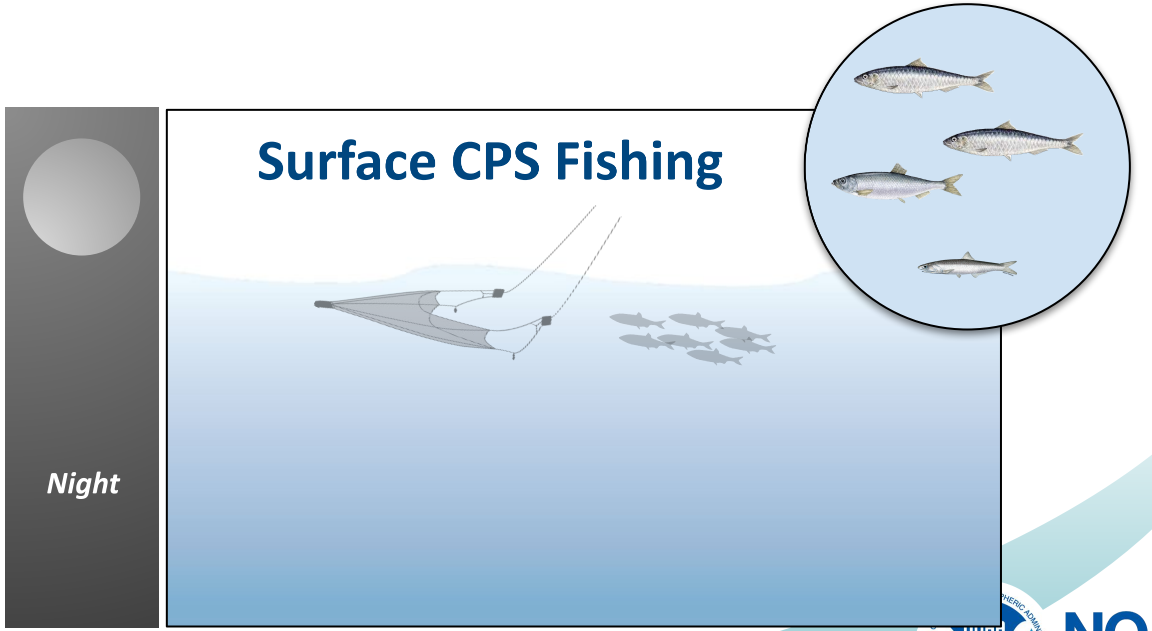
Integrated West Coast Pelagics Survey (IWCPS)
Led by the SWFSC, NWFSC, with Canada (DFO)

Multi-Function Trawl (MFT) Net System



- Designed and purpose-built by NMFS in collaboration with the fishing industry and net manufacturers
- Allows trawling at any depth (hake at midwater, CPS at surface)
- Increase safety and efficiency by eliminating need to change out nets & doors
- New net mensuration system allows real-time performance monitoring and control





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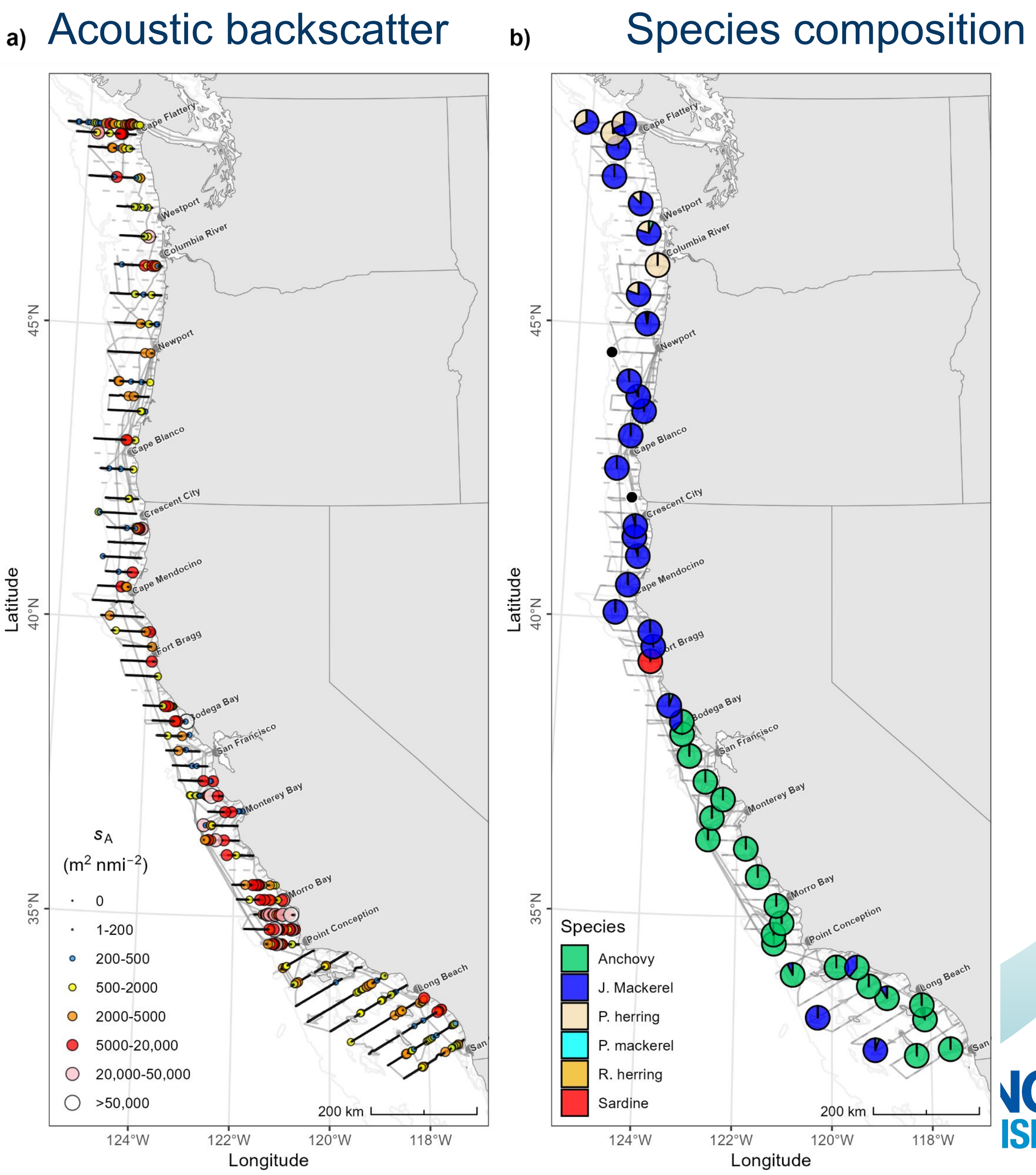
Background:
Acoustic-Trawl Method for the Integrated Survey

Kevin Stierhoff / Juan Zwolinski

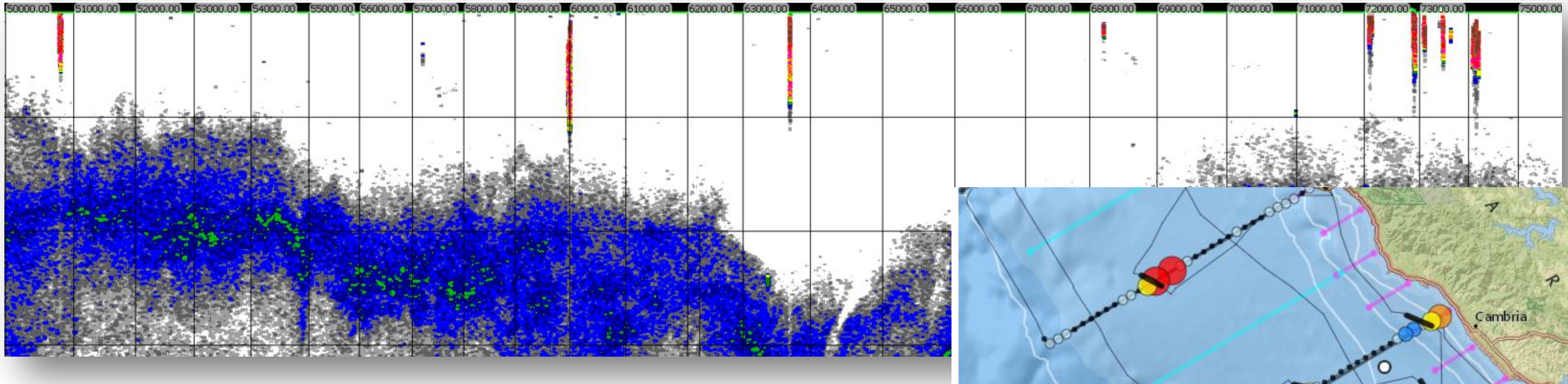
Acoustic-Trawl Method (ATM) Surveys

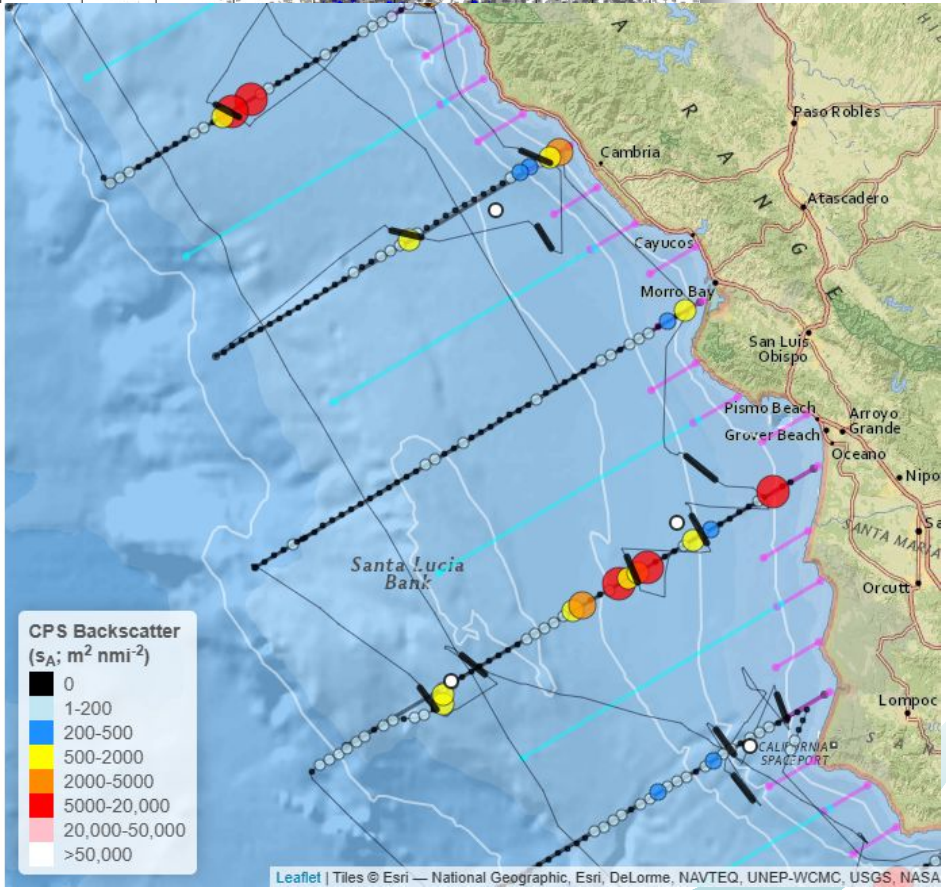
- In ATM surveys, acoustic backscatter provides the index of CPS abundance
- Trawl data provide relative estimates of species- and length-composition where backscatter are observed
- The SWFSC has been conducting ATM surveys of CPS in the CCE since ~2008
- The survey has evolved over time: methods improvements and operational disruptions
- Recent changes include a switch to the MFT in 2024 and the integration with the hake survey in 2025

Summer 2025



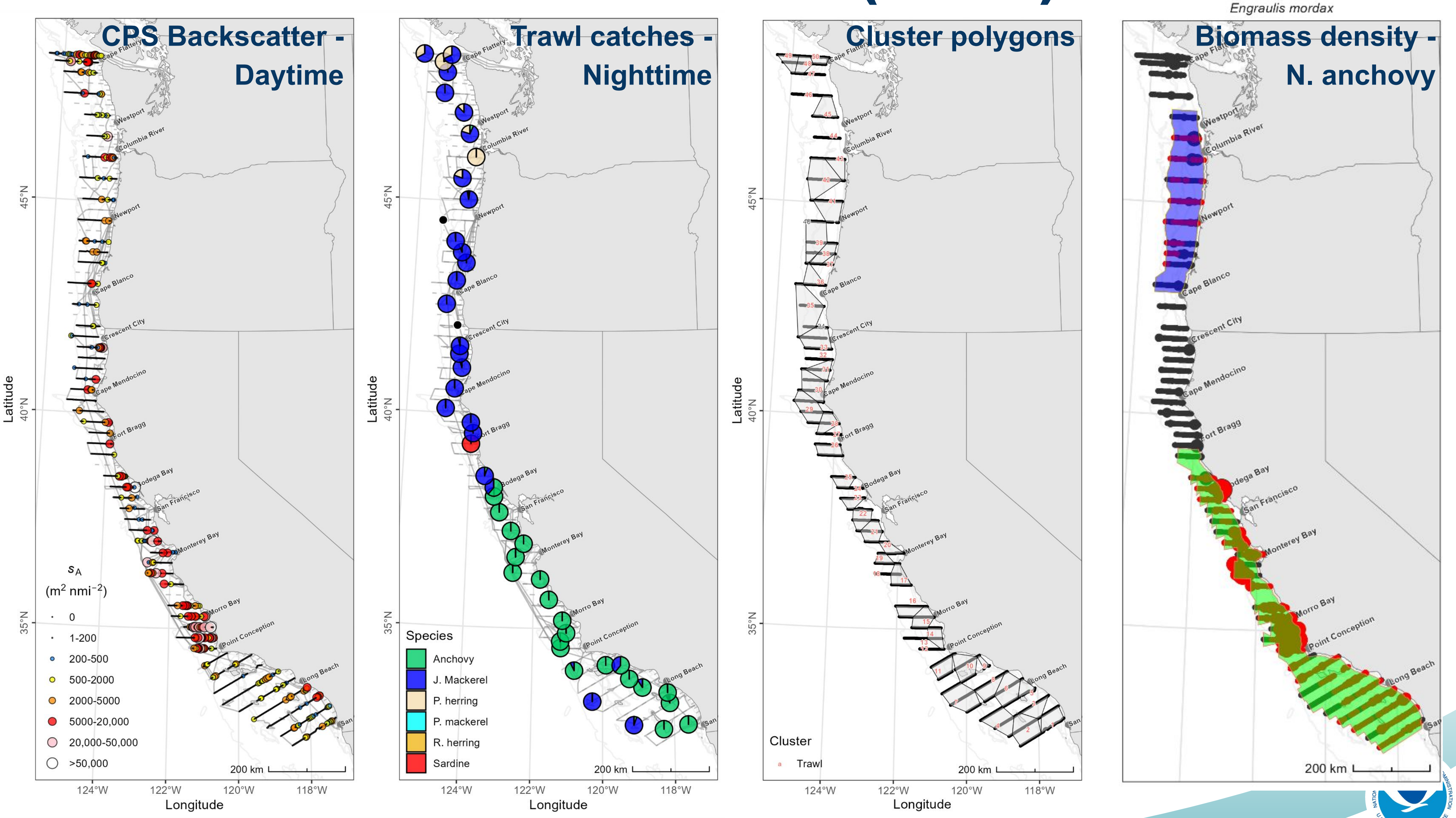
Acoustic-Trawl Method (ATM) Surveys





- During daytime, acoustic sampling is conducted along transects oriented perpendicular to the shore
- At night, surface trawling is conducted in areas where CPS backscatter was observed during the day
- Trawls conducted during a given night are combined into trawl clusters and provide species- and length-composition information for CPS nearby
- Backscatter in 100 m-long intervals is apportioned to species using the nearest nighttime trawl cluster

Acoustic-Trawl Method (ATM) Surveys



A. Rationale for switching from the Nordic 264 to the MFT without paired trawling

Brad Erisman

Terms

- **Catchability** (*q*): difference in abundance and size composition between the catch and the population that can be used to convert relative abundance estimates from surveys (CPUE) and establish biomass reference points; a function of fish availability and gear efficiency.

  $(q) = C/EB$ where C equals catch, E equals fishing effort, and B equals stock biomass

- **Availability**: accessibility of fish to a given gear; depends on horizontal and vertical distribution of fish in relation to the trawl.

- **Gear efficiency**: probability that fish in the path of a trawl will be caught and retained; determined by trawl design, deployment and performance of the gear and the size, morphology, behavior and other biological traits of fish.

- **Trawl representativeness** denotes that the trawl is representative of the echosigns observed in terms of species and length; affected by trawl duration.

Potential Effects of Trawl Net Changes

- Trawl design and sampling protocols can impact trawl performance such as the efficiency of capturing target species (a.k.a. trawl catchability or fishing power) and both the size- and species-selectivity of fish that enter and are retained in the trawl.

- Evaluations of trawl performance can allow for calculations of bias and uncertainty in abundance (biomass) estimates.

- Biases in fish lengths and species composition in trawl catches due to species- or size-specific differences in retention in the trawl can cause substantial errors in biomass estimates generated from net-based surveys, including ATM surveys.

- Changes in trawl design or sampling methodology can be evaluated to identify and correct for any differences in trawl performance when combining the data into a single survey time series.

Paired Trawl Experiments – When?

- When trawl data are used to generate the index of abundance:

  Swept-area method (distance trawled x area of net spread) used to estimate CPUE

  CPUE used to estimate absolute abundance of species and size composition within survey area

  Relationship between CPUE of two gears used to quantify/correct for changes in catchability, gear efficiency, selectivity and other aspects that directly affect abundance.

- When trawl sampling is used to directly validate the specific biological characteristics of specific schools targeted by acoustics (e.g., Hake Survey)

Why Paired Trawling was not Feasible

- **Effectiveness:** Paired trawl experiments are difficult, costly, and often limited in time and space; results may not encompass the entire extent or environmental conditions of the survey area.
- **Timing:** Insufficient time between contracting and obtaining new net, testing, and operational surveys.
- **Logistics:** No additional sea days available without impacting operational surveys.
- **Operations:** The 2024 vessel’s single net reel would have necessitated time consuming net switched and sequential trawling
- **Applicability:** (see next slide)

Trawl Data for CPS ATM Surveys

- Used to apportion the backscatter data to estimate biomass by species and length based on the relative abundance (% weight of catch) and length distributions of CPS in the catch.
- **NOT** designed to calculate swept area or CPUE; acoustic backscatter is the index of abundance, not catch and catch rate.
- In the ATM survey, catchability depends directly on: (1) the ability of acoustics to "see" all the fish in the water column; and 2) the coverage of the survey relative to the stock distribution (varies). Indirectly, and probably more difficult to quantify, differential species-selectivity by the trawl net in mixed-species environments affects acoustic catchability via the proportion of each species in the trawl cluster.
- Trawl sampling also used to generate age composition and weight-at-age for stock assessment.
- ***Conclusion:*** *Nets with similar design characteristics and performance should have similar selectivity and thus provide comparable biological data for estimating biomass*

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Encouraging Results from 2024

- Gear trials in summer 2024 indicated that the MFT was fishing in a similar manner as the Nordic 264 (depth range, spp. comps, CPS length comps).

- Crew completed 2-3 surface trawls/night when fishing duration reduced from 45 to 30 mins

- Scientific and industry experts comfortable using the MFT system for the 2024 summer CPS survey based on their knowledge of both Nordic 264 and MFT operations and catches

- Science team comfortable moving to the MFT based on trawls completed; set plan to compare selectivity and performance of net systems after 2025 Integrated Survey

Recommended Approach

Compare species and size compositions to determine whether there are differences in selectivity between net types and the potential influences on these variables associated with the conditions present during capture.

- Compare net specifications (e.g., mesh sizes, mesh size transitions) may help explain any observed changes in catch compositions and length distributions **(Section B)**

- Compare fishing performance (e.g., fishing depths, vertical and horizontal spread, trawl duration) to assess whether shifts in selectivity, availability, and representativeness occurred **(Section C)**

- Evaluate selectivity by comparing species proportions and proportions of fish across length bins for each target CPS **(Sections E & F)**

Summary and Conclusions

- Direct empirical comparisons between the catches of the two nets (paired trawls) would require considerable time and financial resources.

- A small number of paired trawls in 2024 or 2025 unlikely to provide enough information to detect meaningful differences.

- Maximum data generated through a complete net switch to compare results; also ensured a full survey for assessments.

- Collective optimism on MFT design, gear trial results, and 2024 survey results.

- **Approach**: compare available data from surveys using the Nordic 264 and the MFT to evaluate whether a change in the net type may have meaningful, detectable effects on species- and length-selectivity and survey-derived inputs for CPS stock assessments.

- **Focus** on understanding whether the MFT is sampling the same portion of the water column, same overall community, and the same length distributions of target species.

B. Specifications of both the Nordic 264 and MFT net systems, including dimensions of nets and doors, mesh sizes, and mesh-size transitions

Kevin Stierhoff / Bryan Overcash

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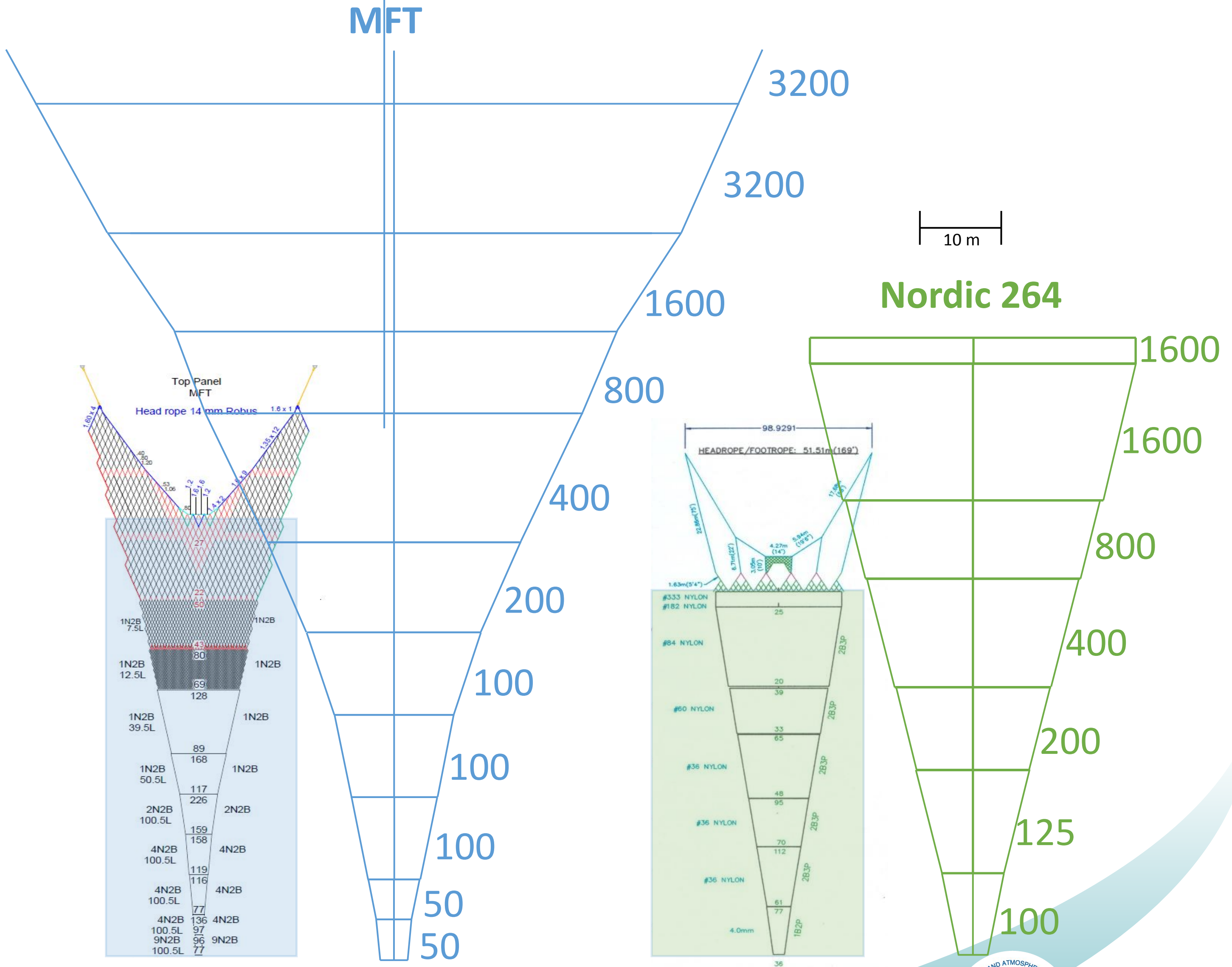
Comparing the Nordic 264 and MFT

Net characteristics

	Nordic 264	MFT
Height	15 m	18 m
Width	20 m	36 m
Opening area	~336 m^2	~648 m^2
Codend mesh	8 mm	8 mm
Doors	Nets XL Lite	Thyboron Type 22 VK 4m2

Numbers are the full mesh size (mm) of each panel

(note, only the highlighted area of each net is drawn)



Schematics courtesy of Sabrina Beyer (NWFSC)

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Comparing the Nordic 264 and MFT

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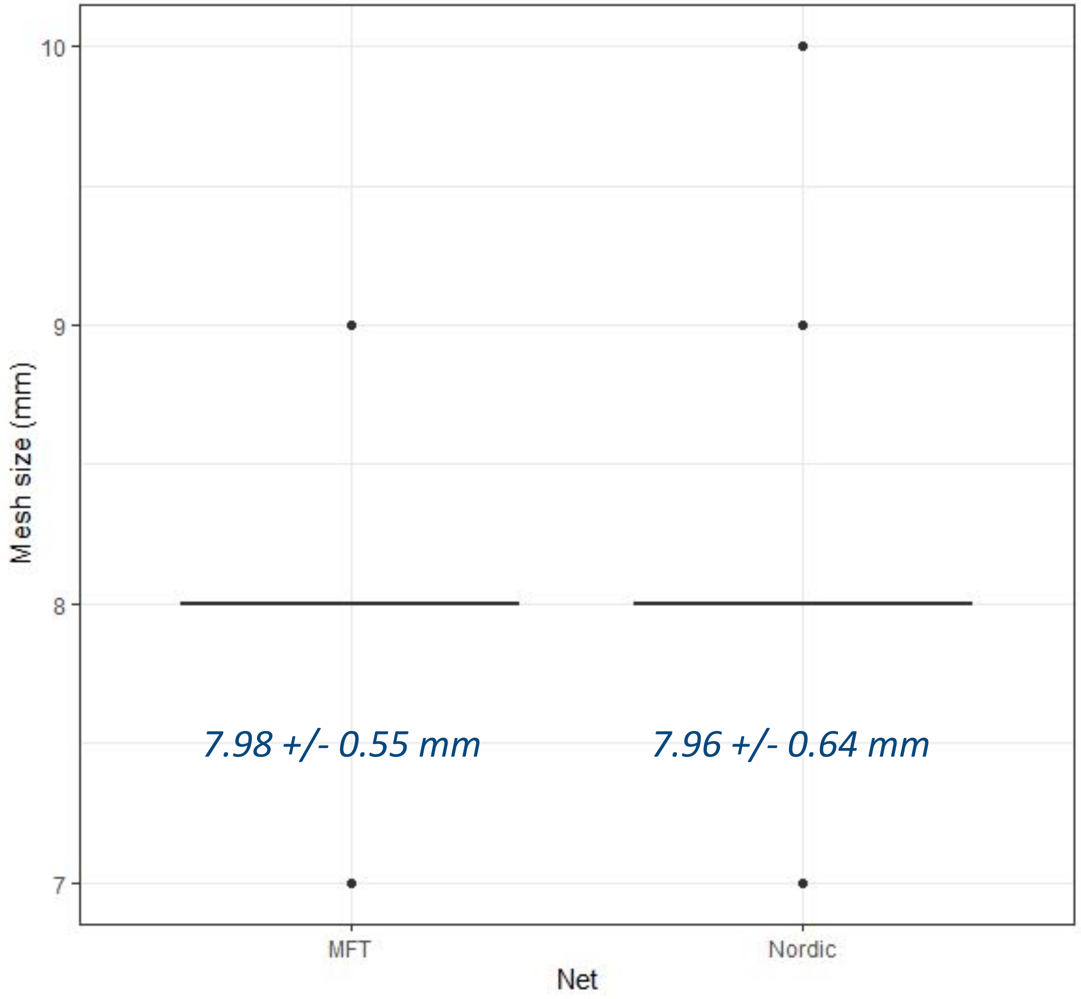
Measurements of 50 randomly selected cod end meshes



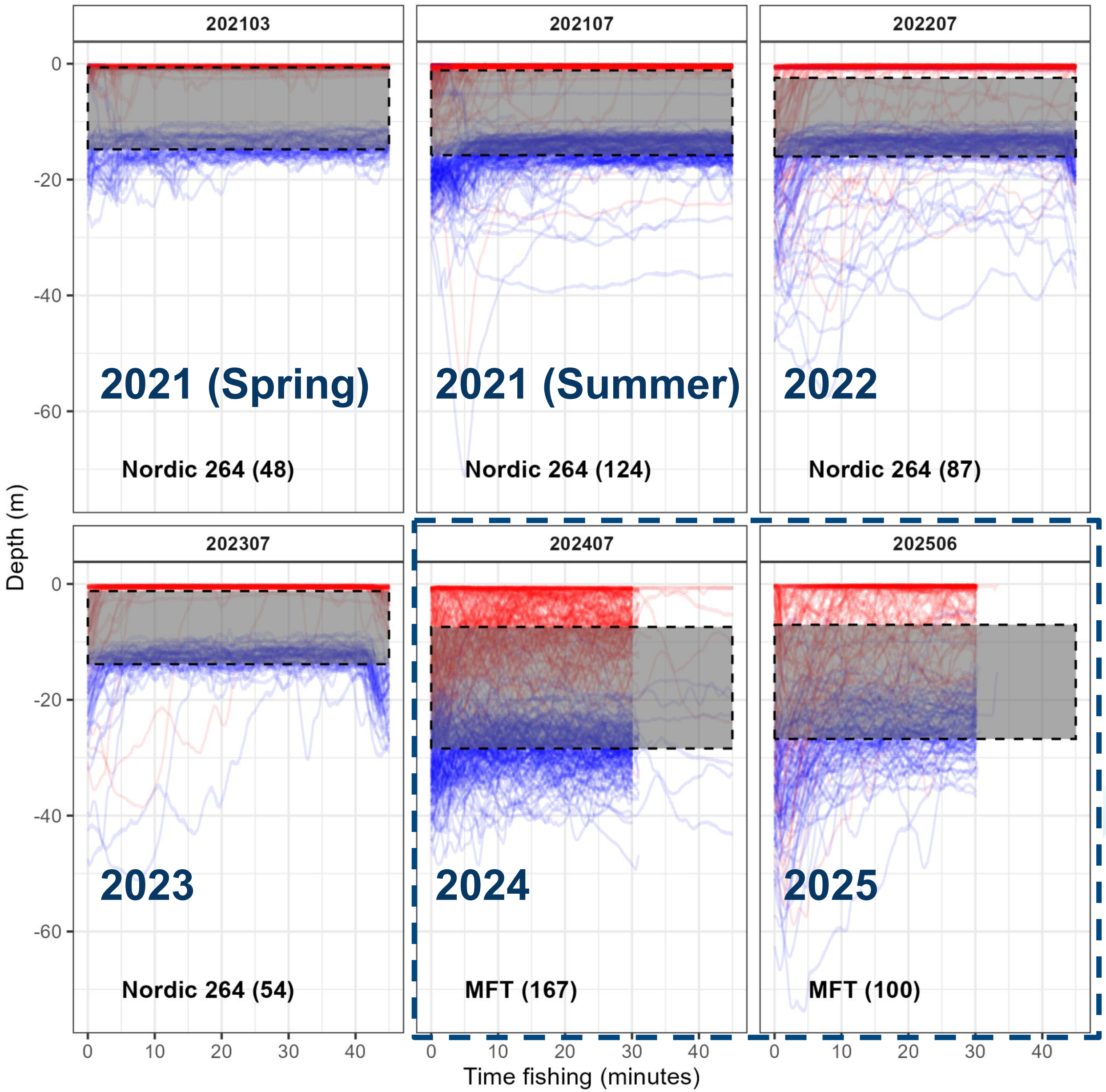
C. Performance of the Nordic 264 and MFT nets during fishing, including sampling depth and vertical and horizontal spread of the net mouth opening

Kevin Stierhoff / Bryan Overcash

Comparing the Nordic 264 and MFT

Net dynamics

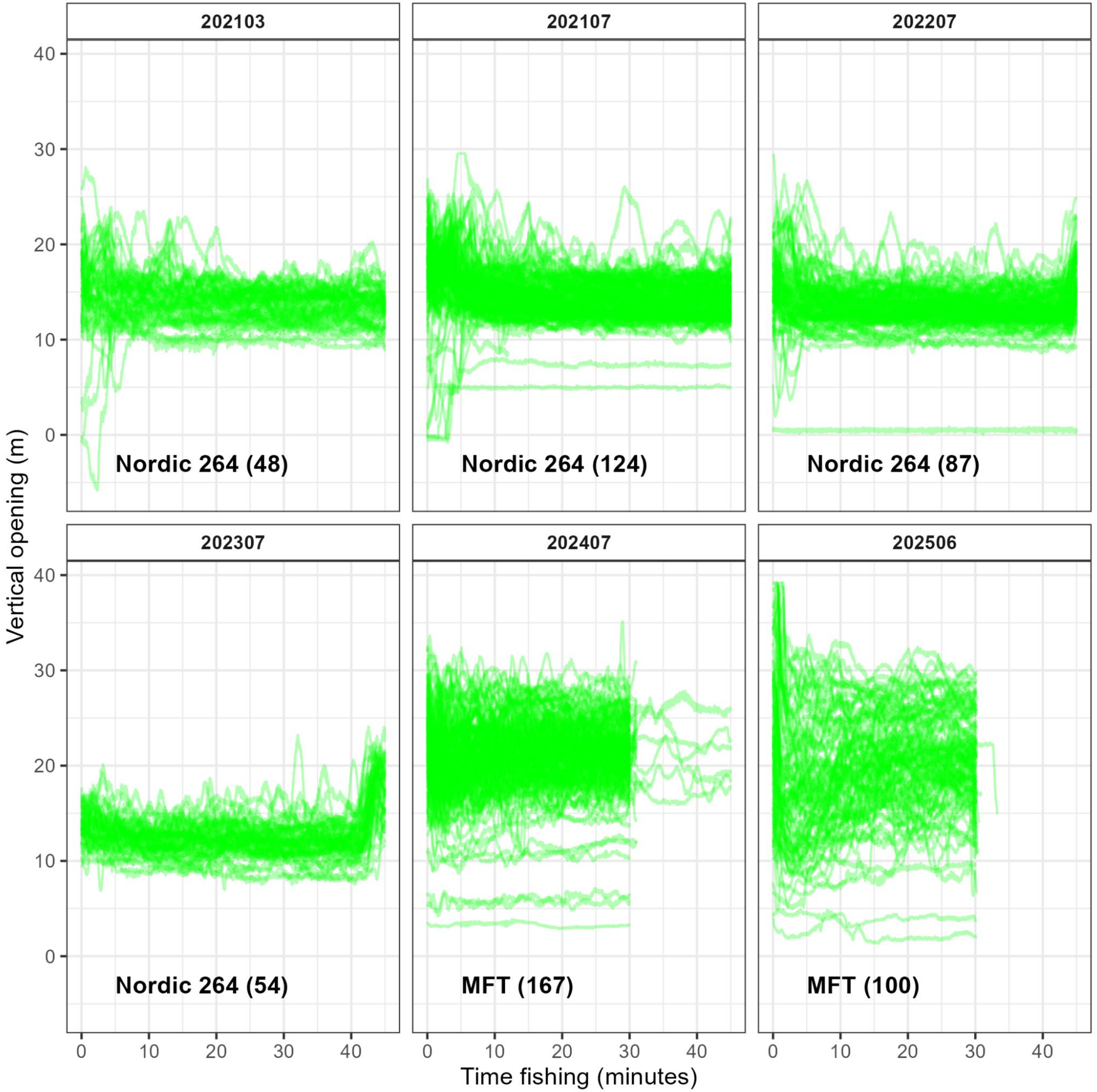
- Depth of **kite** and **footrope** TDRs, and **average fishing depths**
- **Subsurface fishing with the MFT, avoiding the propeller wash**



Comparing the Nordic 264 and MFT

Net dynamics

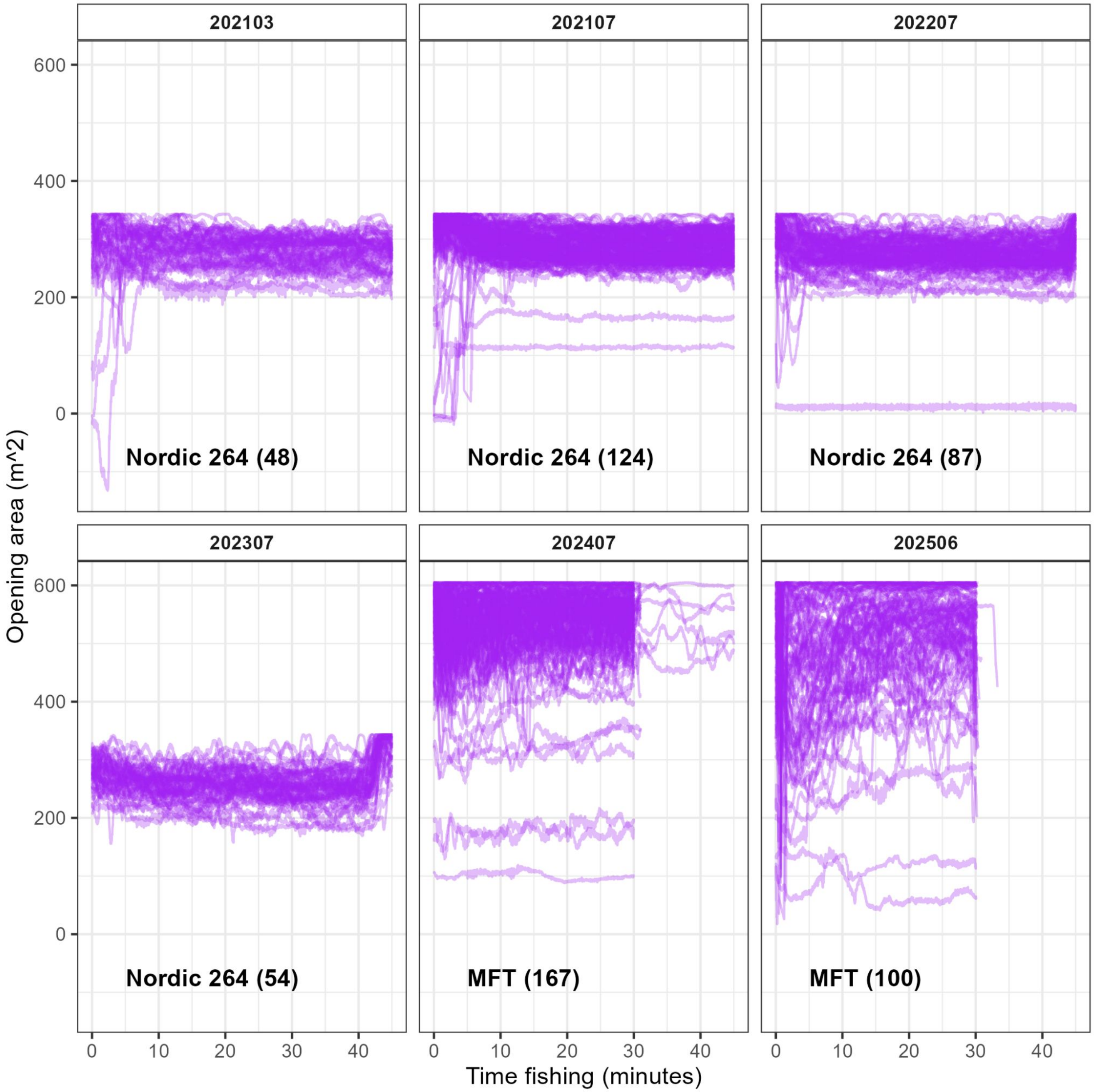
- Depth of **kite** and **footrope** TDRs, and **average fishing depths**
- **Vertical opening** from TDR depths



Comparing the Nordic 264 and MFT

Net dynamics

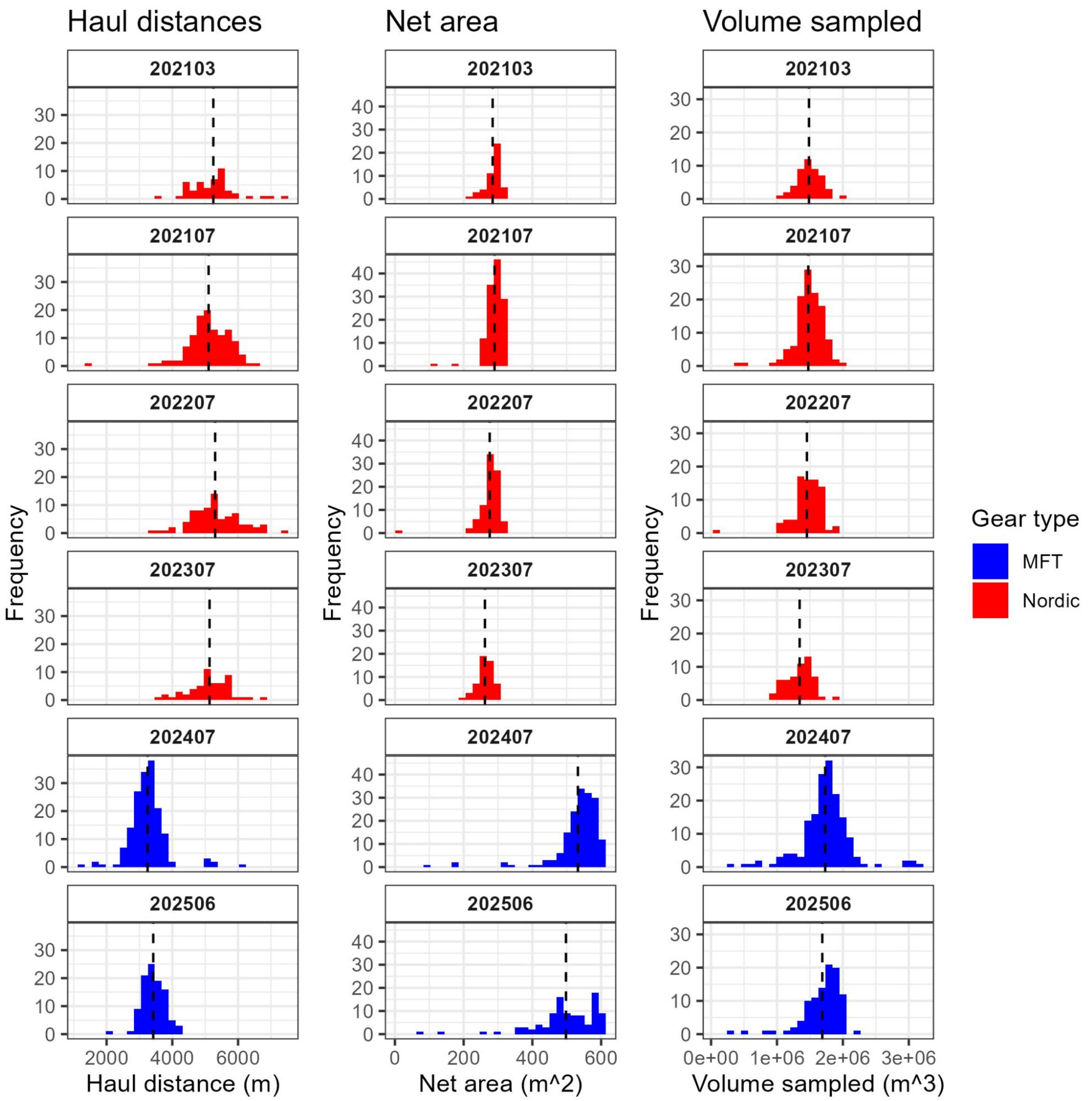
- Depth of **kite** and **footrope** TDRs, and **average fishing depths**
- **Vertical opening** from TDR depths
- **Opening area** approximated from the perimeter and opening height



Comparing the Nordic 264 and MFT

Net dynamics

- Depth of **kite** and **footrope** TDRs, and **average fishing depths**
- **Vertical opening** from TDR depths
- **Opening area** approximated from the perimeter and opening height
- Sampling volume computed from mouth area and distance over ground



Comparing the Nordic 264 and MFT

Net catches: Catch amount by weight

- MFT had higher proportions of medium and large catches (90%) than the Nordic 264 (52%)
- Nordic 264 had higher proportion of small or very small catches (48%) compared to the MFT (9%)

Gear type	Duration (min)	Years	Total tows (n)	# "Water tows" (< 10 kg)	# Small catches (10 - 30 kg)	# Medium catches (30 - 150 kg)	# Large catches (> 150 kg)
Nordic 264	45	2016 - 2023	798	25.1%	23.3%	30.5%	21.2%
MFT	30	2024 - 2025	267	1.5%	7.9%	36.0%	54.7%

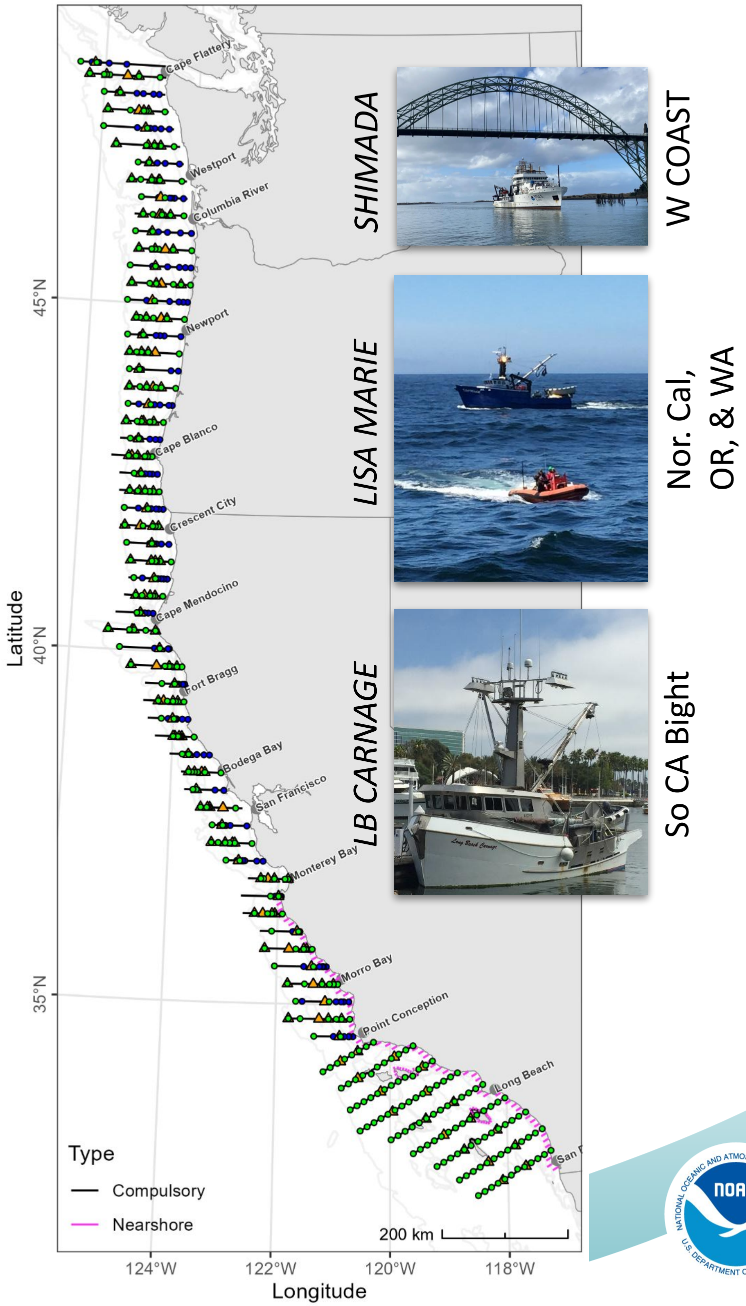
D. Methods and biomass estimation from the 2025 Integrated Survey

Kevin Stierhoff / Josiah Renfree / Juan Zwolinski

Survey Design, Plan, & Execution

Plan

- *Shimada* (**82 Days At Sea, DAS**)
  - 5 DAS transit, 13 DAS hake research (100 DAS)
  - San Diego - Cape Flattery
- *Long Beach Carnage* (**23 DAS**)
  - San Diego - Half Moon Bay
- *Lisa Marie* (**36 DAS**)
  - Half Moon Bay - Cape Flattery



 U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service

Survey Design, Plan, & Execution

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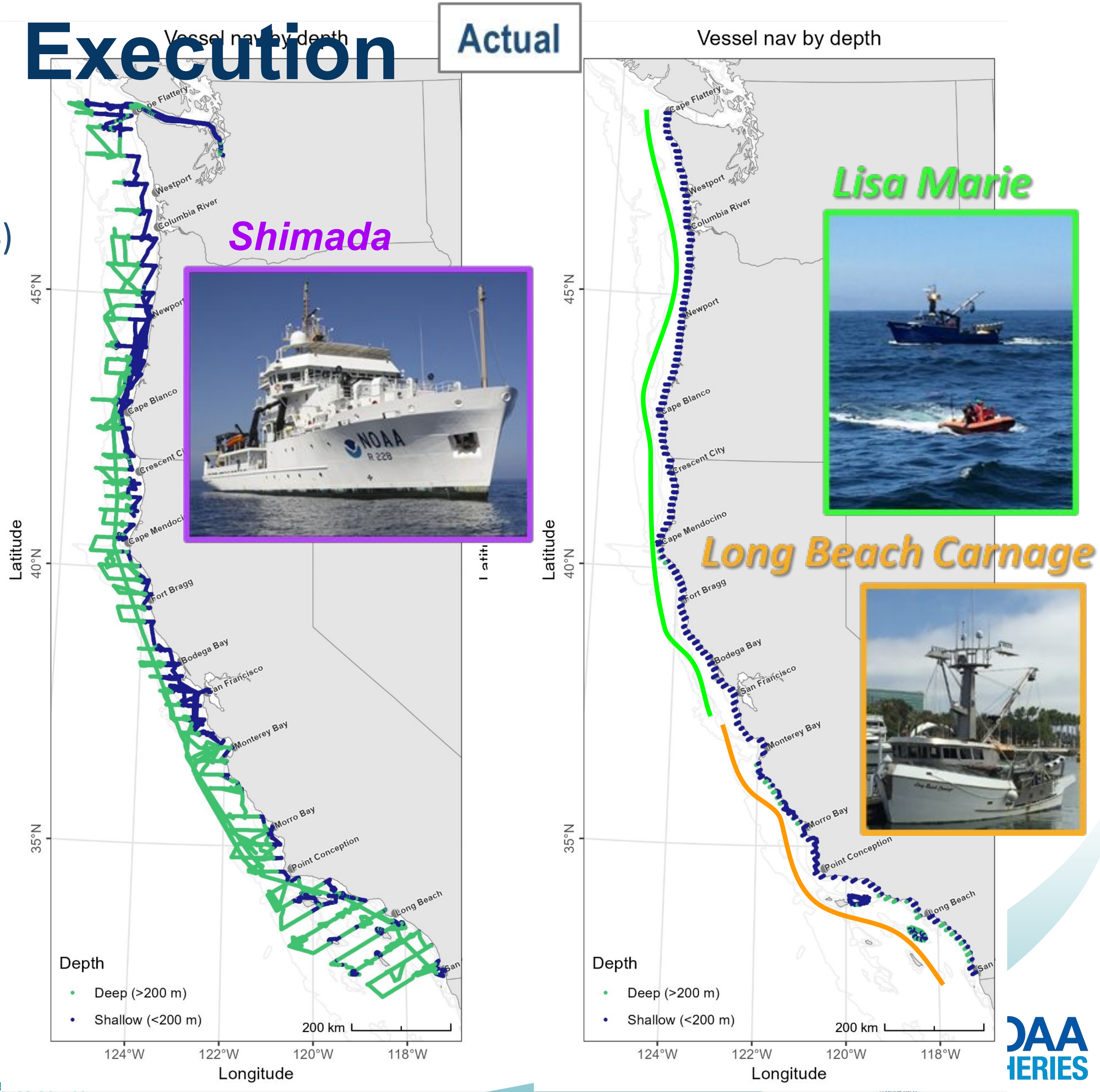
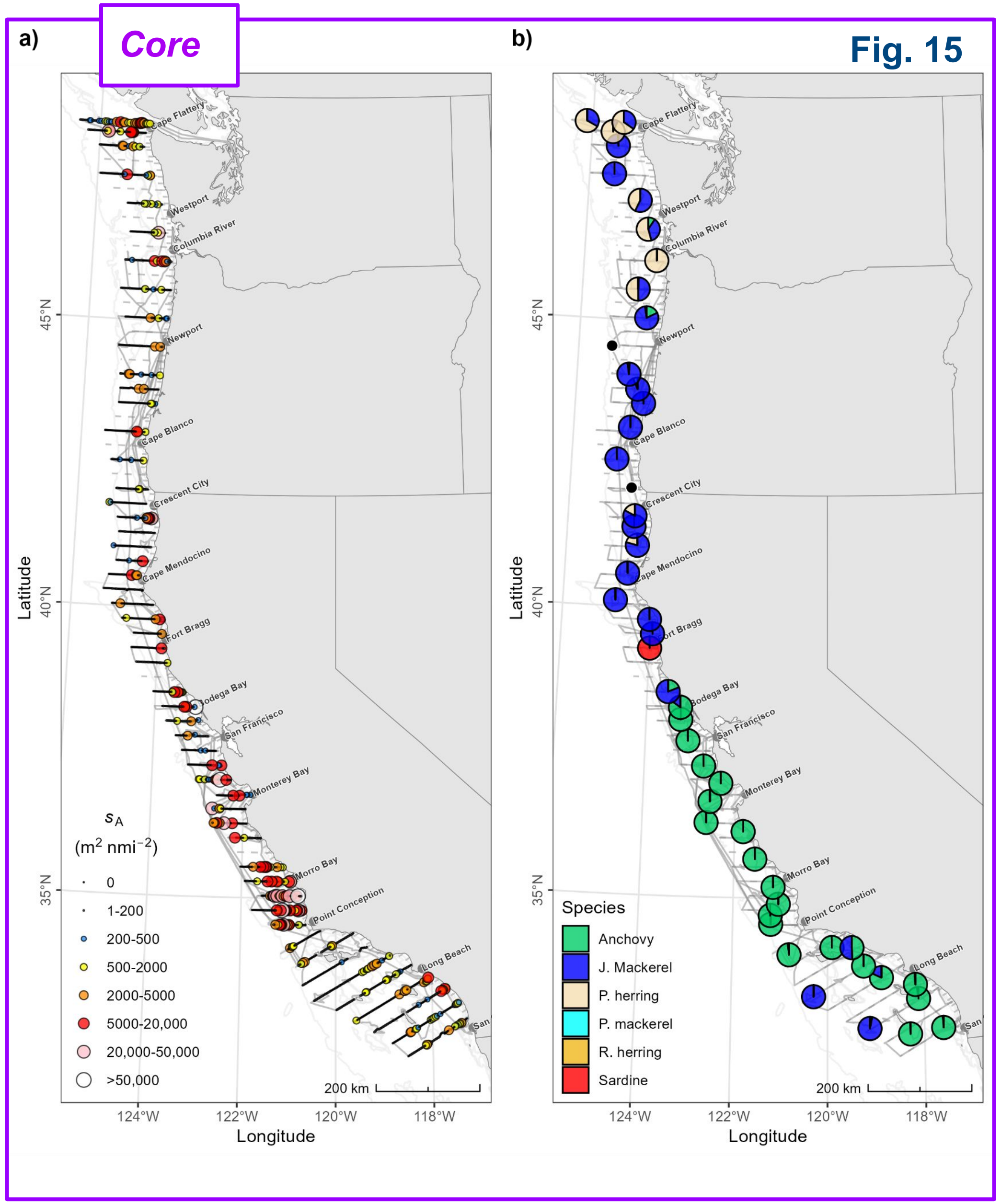
  - San Diego - Cape Flattery
- *Long Beach Carnage* (**23 DAS**)
  - San Diego - Half Moon Bay
- *Lisa Marie* (**36 DAS**)
  - Half Moon Bay - Cape Flattery

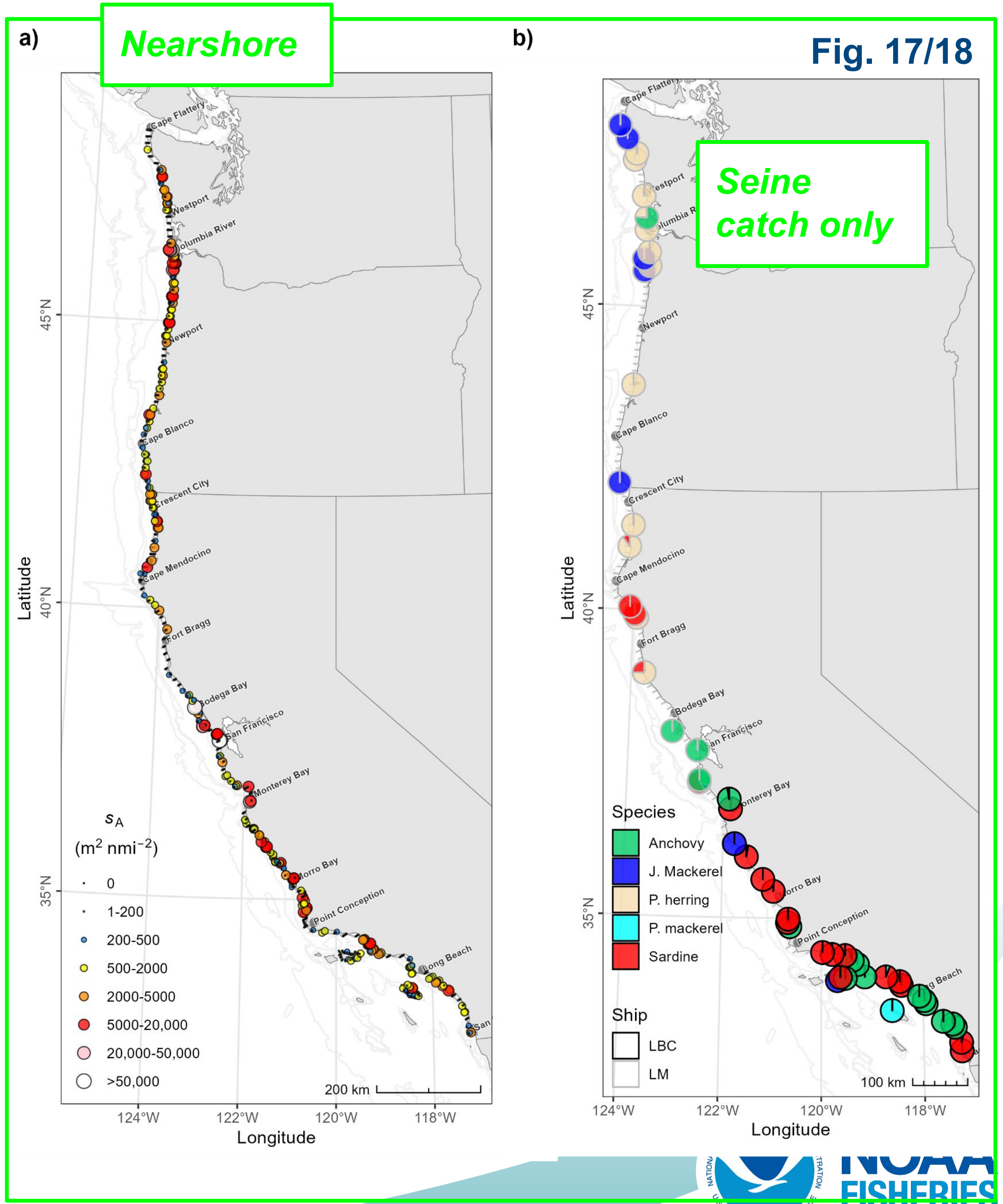
Actual

- *Shimada* (**70 DAS, ~54 <u>survey</u> days**)
  - San Diego - Cape Flattery
  - **<u>Loss of 16% of DAS, and 32% of effort</u>**
- *Long Beach Carnage* (**18 DAS**)
  - San Diego - Half Moon Bay
- *Lisa Marie* (**~35 DAS**)
  - Half Moon Bay - Cape Flattery



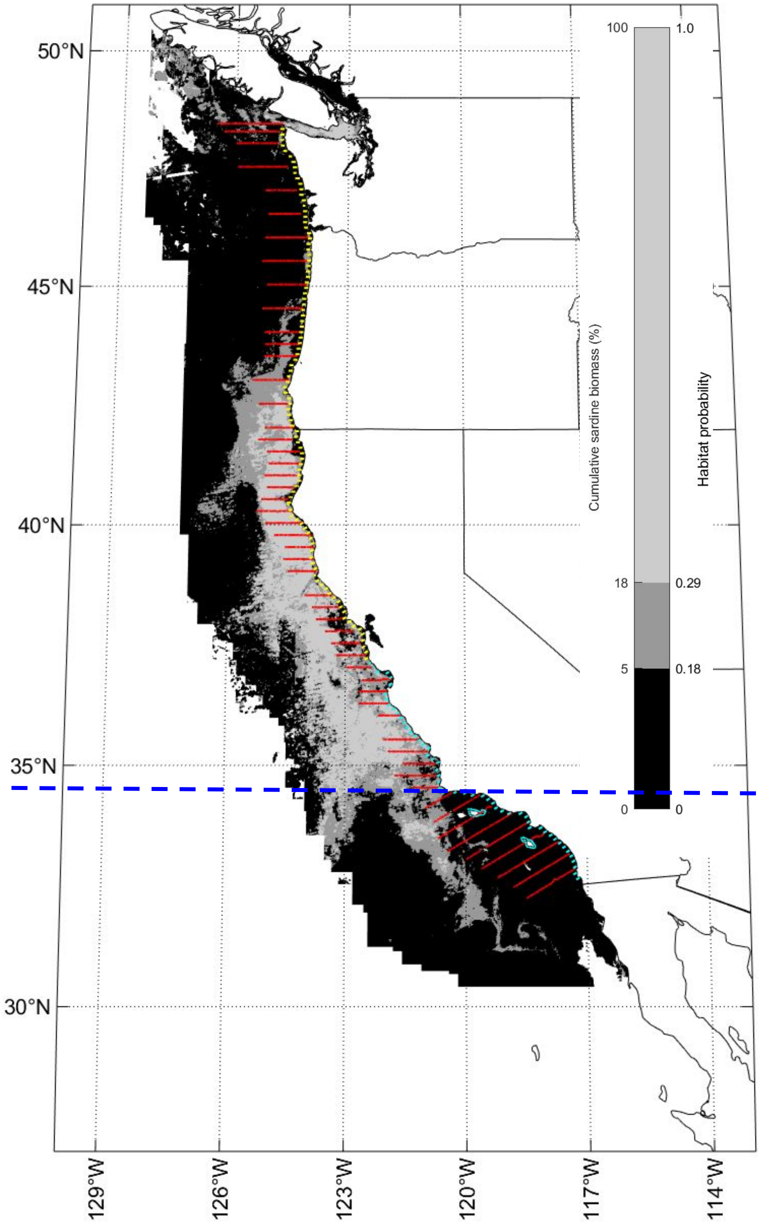
Backscatter and Catch Proportions

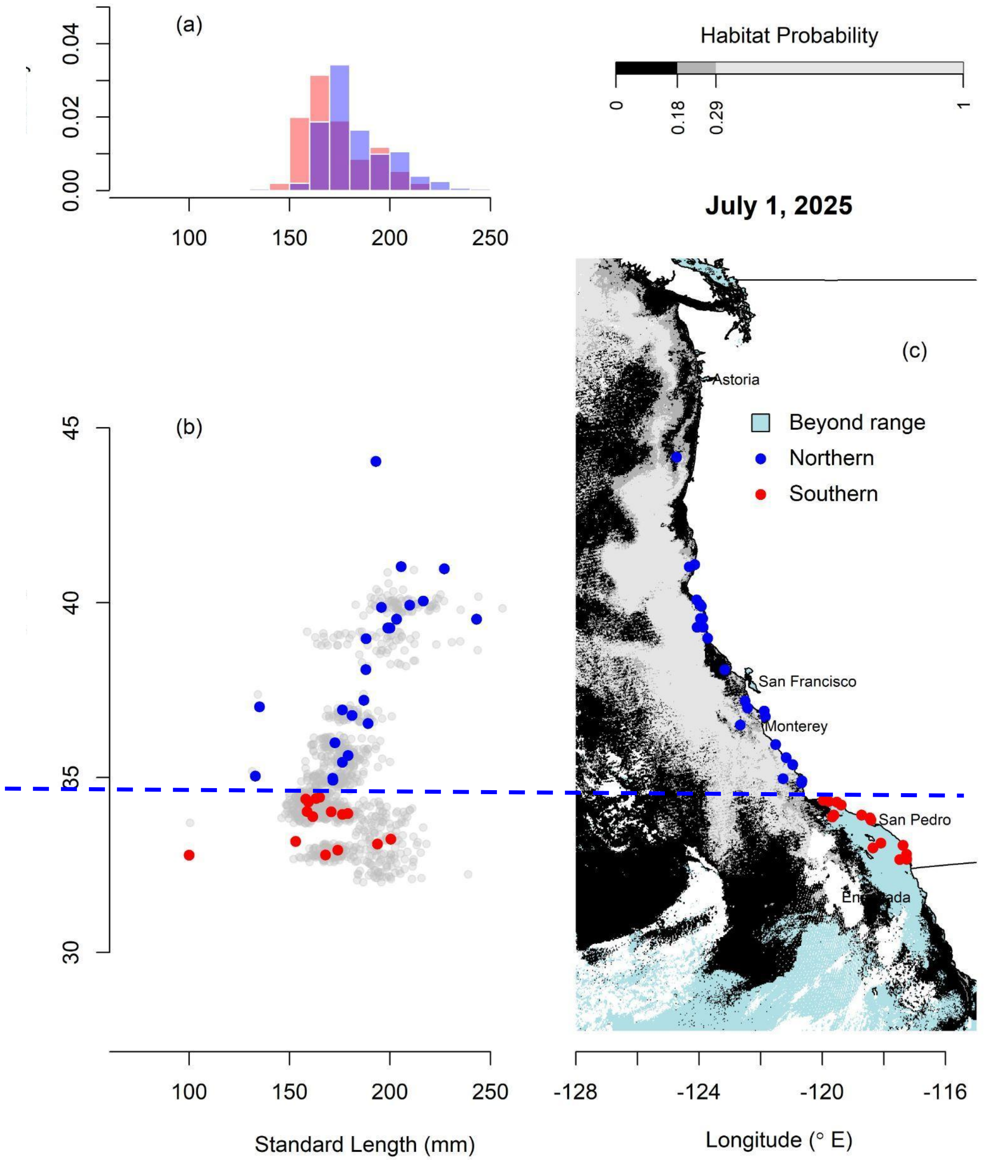




Assignment of P. Sardine Biomass to NSP

- *Revised habitat-model, averaged in areas ±2° latitude and longitude, centered around the daytime location of each vessel throughout*
- *Trawl clusters in areas with habitat probability < 0.18 assigned to southern subpopulation (SSP)*
- *In 2025, this habitat break corresponded with Pt. Conception*





P. Sardine | Northern Subpop. - Biomass

			Stratum			Trawl		Biomass			
Species	**Stock**	**Region**	**Area**	**Transects**	**Distance**	**Clusters**	**Individuals**	**Mean**	**CI (Lower)**	**CI (Upper)**	**CV**
Sardinops sagax	Northern	Core	19,688	29	1,119	8	80	45,867	339	130,483	80
		Nearshore	952	47	254	17	410	44,581	23,373	64,036	24
		All	**20,641**	**76**	**1,373**	**25**	**490**	**90,448**	**23,712**	**194,519**	**42**

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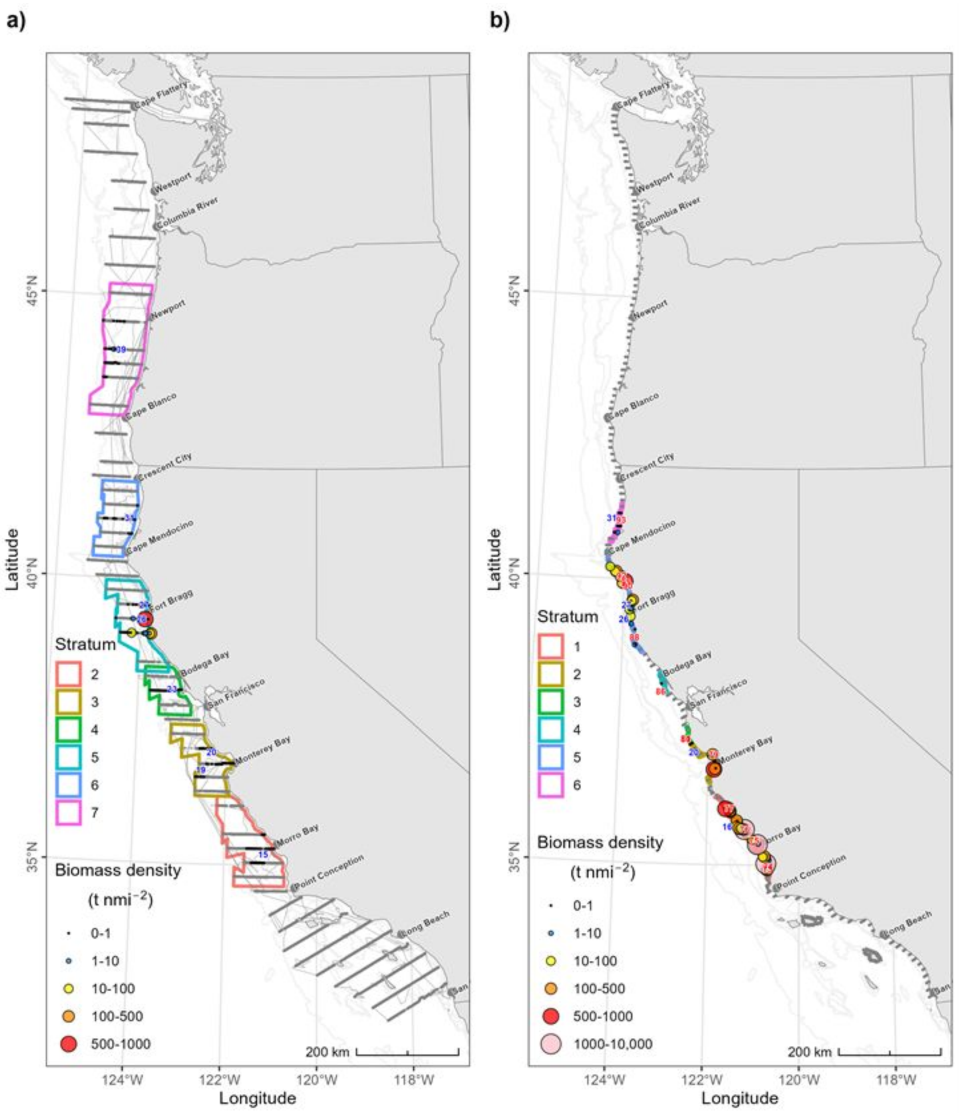
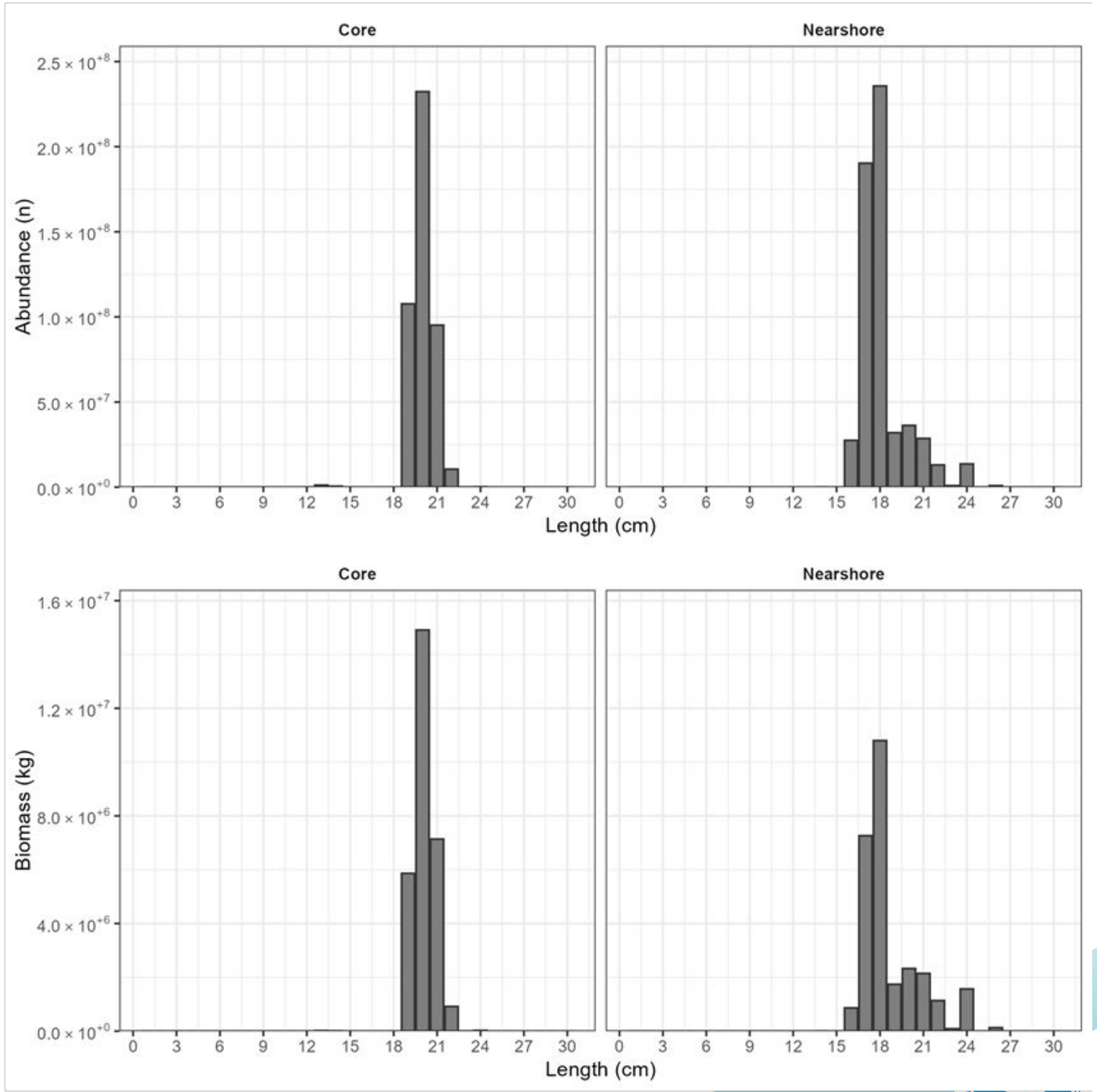
P. Sardine | Northern Subpop. - Biomass

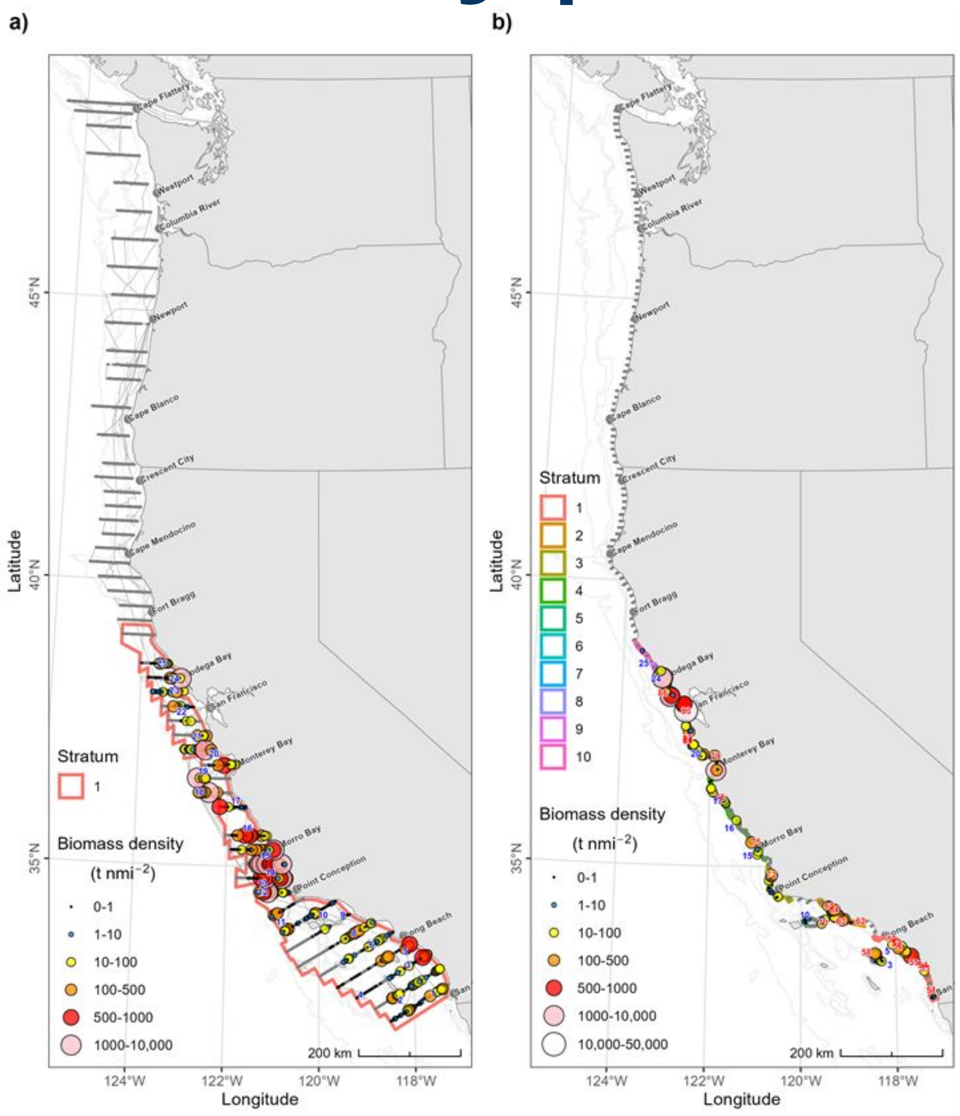


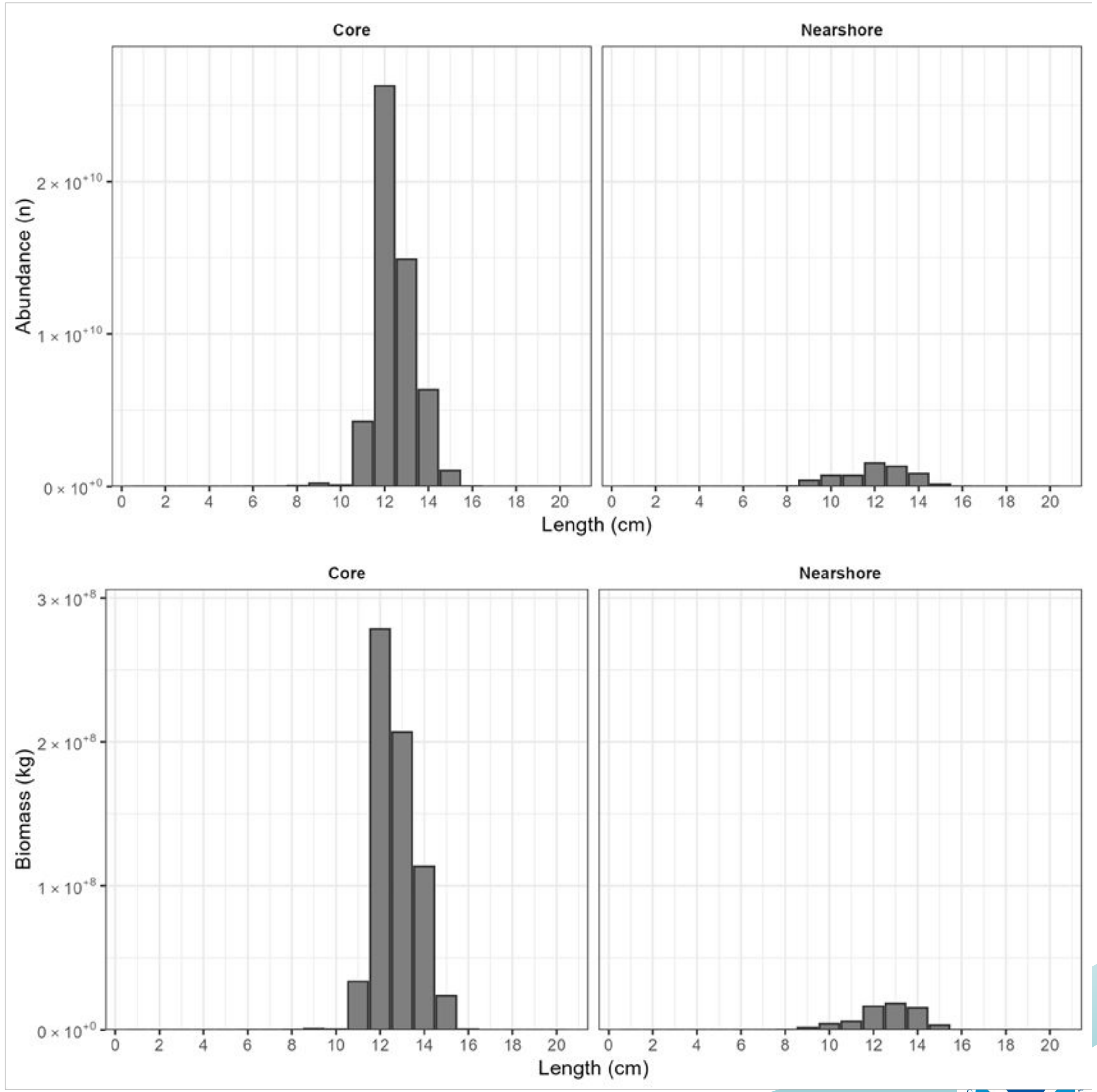


N. Anchovy | Central Subpop. - Biomass

			Stratum			Trawl		Biomass			
Species	**Stock**	**Region**	**Area**	**Transects**	**Distance**	**Clusters**	**Individuals**	**Mean**	**CI (Lower)**	**CI (Upper)**	**CV**
Engraulis mordax	Central	Core	23,719	26	1,322	24	783,764	1,124,464	428,068	1,532,631	26
		Nearshore	1,467	89	385	28	249,953	114,107	53,753	182,738	29
		All	**25,186**	**115**	**1,706**	**52**	**1,033,717**	**1,238,571**	**481,821**	**1,715,369**	**24**

N. Anchovy | Central Subpop. - Biomass

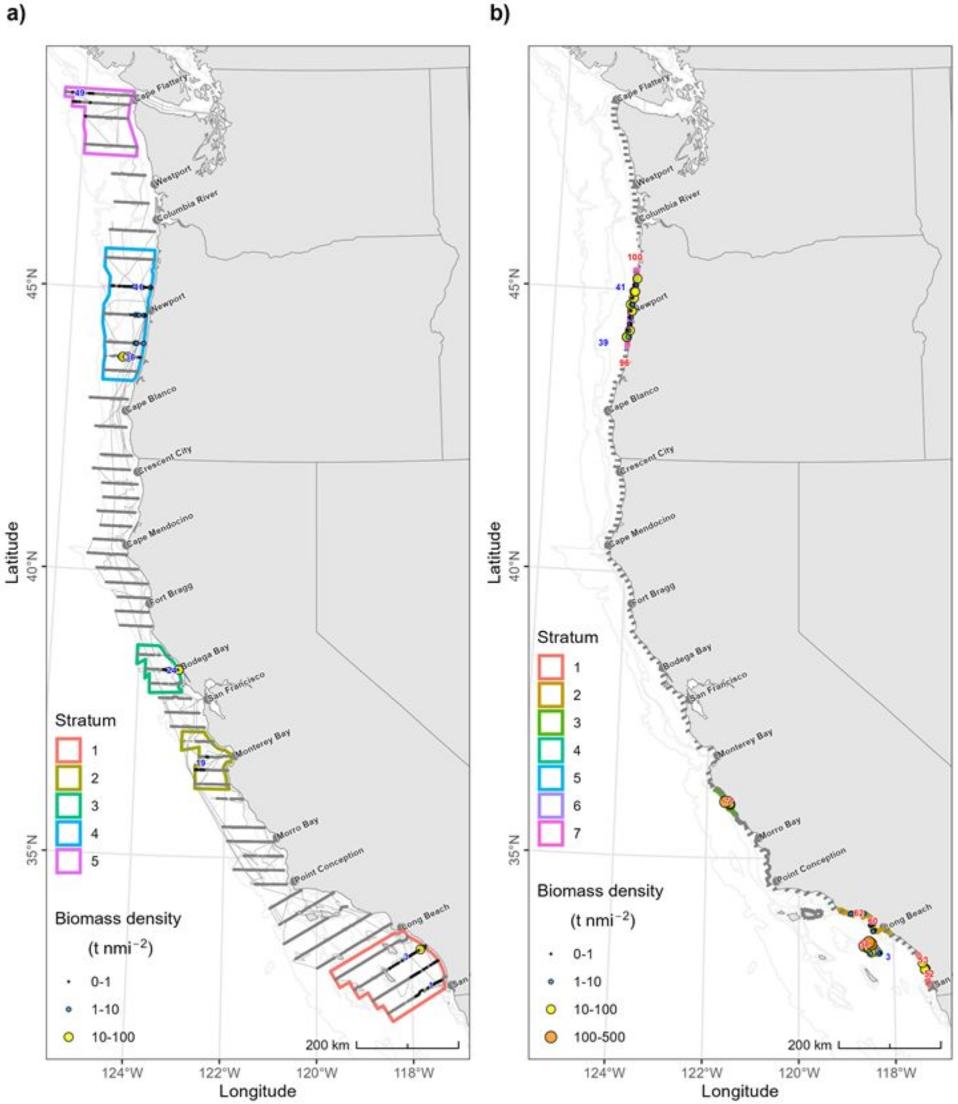


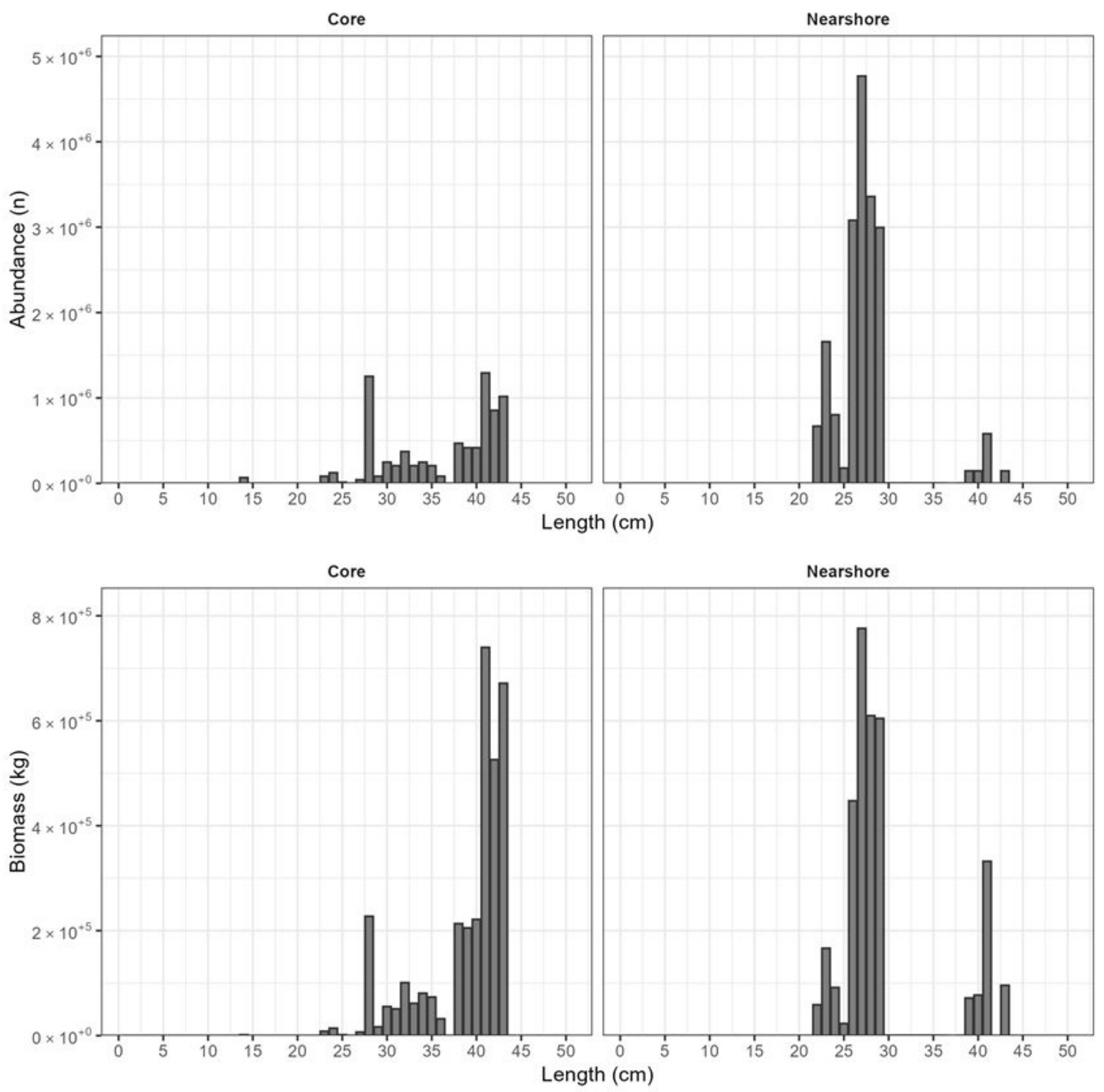


P. Mackerel - Biomass

			Stratum			Trawl		Biomass			
Species	**Stock**	**Region**	**Area**	**Transects**	**Distance**	**Clusters**	**Individuals**	**Mean**	**CI (Lower)**	**CI (Upper)**	**CV**
Scomber japonicus	All	Core	19,914	21	1,067	7	139	4,431	1,312	8,222	42
		Nearshore	649	43	147	8	210	4,830	2,573	6,547	22
		All	**20,563**	**64**	**1,214**	**15**	**349**	**9,261**	**3,885**	**14,769**	**23**

P. Mackerel - Biomass





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All CPS | Summary (Core + Nearshore)

			Stratum			Trawl		Biomass			
Species	Stock	Region	Area	Transects	Distance	Clusters	Individuals	Mean	CI (Lower)	CI (Upper)	CV
Clupea pallasii	All	All	22,943	94	1,277	31	36,608	**118,479**	47,345	231,391	**30**
Engraulis mordax	Central	All	25,186	115	1,706	52	1,033,717	**1,238,571**	481,821	1,715,369	**24**
	Northern	All	11,096	18	444	7	5,434	**4,164**	353	10,876	**67**
Etrumeus acuminatus	All	All	6,494	10	341	2	4	**8**	1	20	**58**
Sardinops sagax	Northern	All	20,641	76	1,373	25	490	**90,448**	23,712	194,519	**42**
	Southern	All	7,021	46	451	15	1,317	**17,519**	7,844	29,922	**28**
Scomber japonicus	All	All	20,563	64	1,214	15	349	**9,261**	3,885	14,769	**23**
Trachurus symmetricus	All	All	45,619	157	2,610	62	17,386	**867,960**	475,133	1,287,520	**22**

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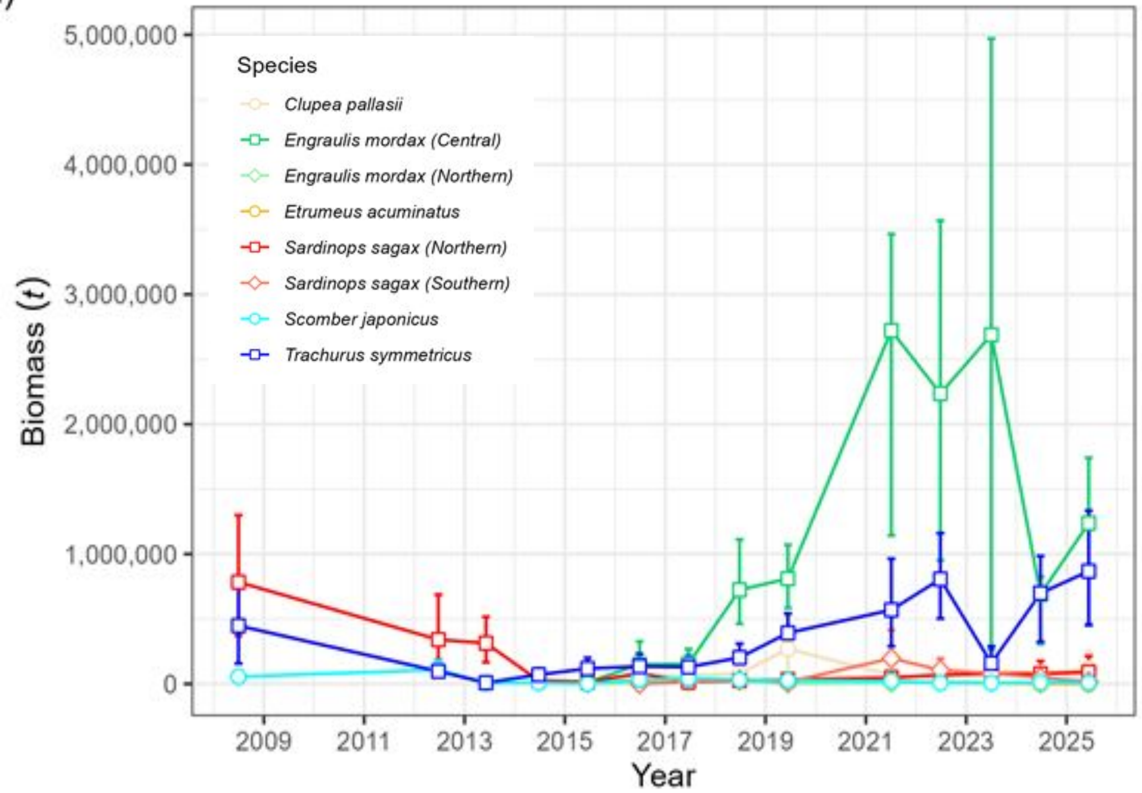
All CPS | Community Summary

- The biomass of the NSP of Pacific Sardine (90,488 t) increased slightly from the 77,703 t estimated in summer 2024 (Stierhoff et al., *In prep.*)
- In 2024, the biomass was observed almost entirely in the nearshore region near Pt. Conception and between Santa Cruz and San Francisco, whereas the biomass in 2025 was approximately equally distributed in the core and nearshore areas between Pt. Conception and Cape Mendocino
- The CPS community continues to be dominated by the central subpopulation of N. Anchovy and Jack Mackerel

a)



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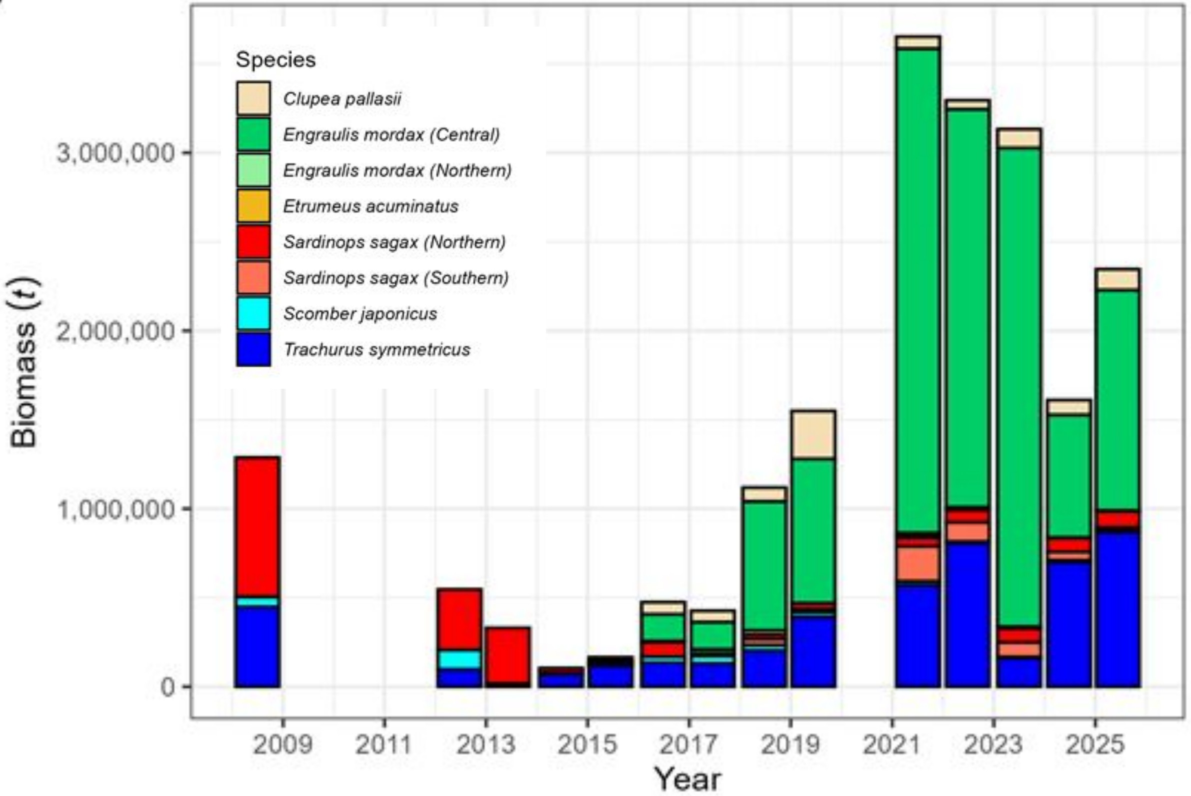
b)

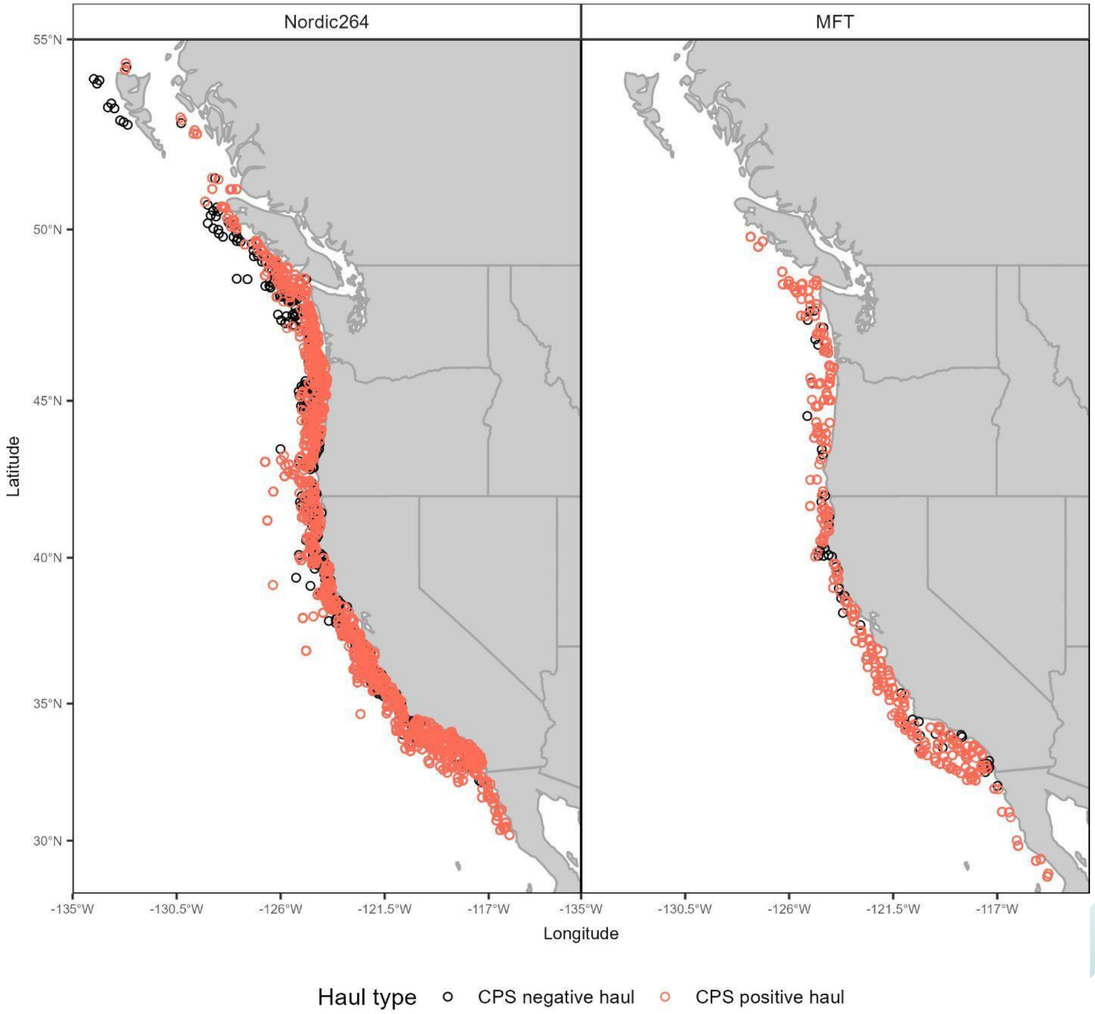


E. Species- and length-selectivity comparisons between the Nordic 264 and MFT nets

Alexander Jensen / Brittany Schwartzkopf / Kelsey James

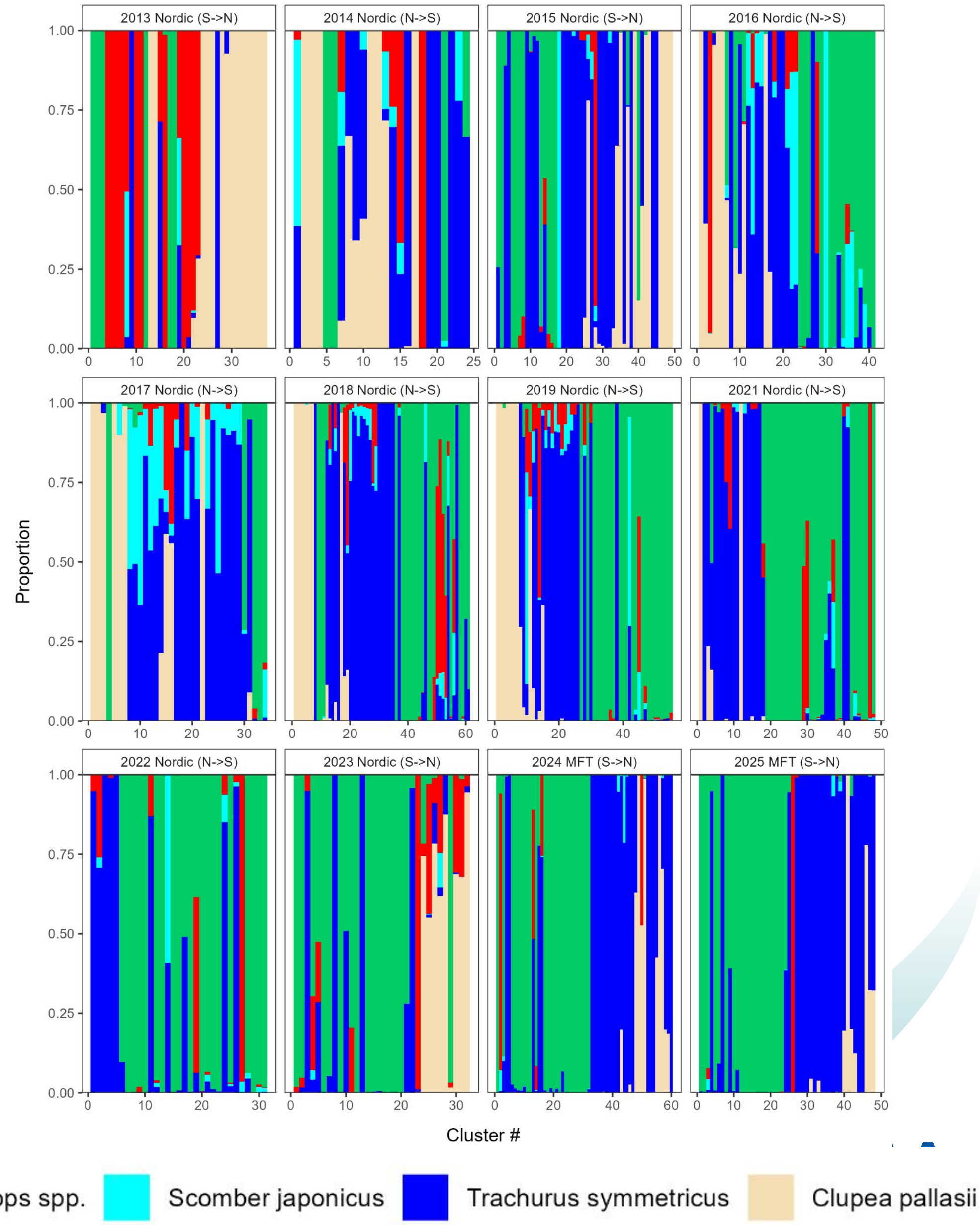
Defining the dataset

- Trawl data from 2013-2025
- Excluded spring surveys
- Data included catches of:
  - Northern anchovy (*Engraulis mordax*)
  - Pacific sardine (*Sardinops sagax*)
  - Pacific mackerel (*Scomber japonicus*)
  - Jack mackerel (*Trachurus symmetricus*)
  - Pacific herring (*Clupea pallasii*)
- Included Japanese and Pacific Sardine in an aggregate 'Sardine' species category



Species selectivities

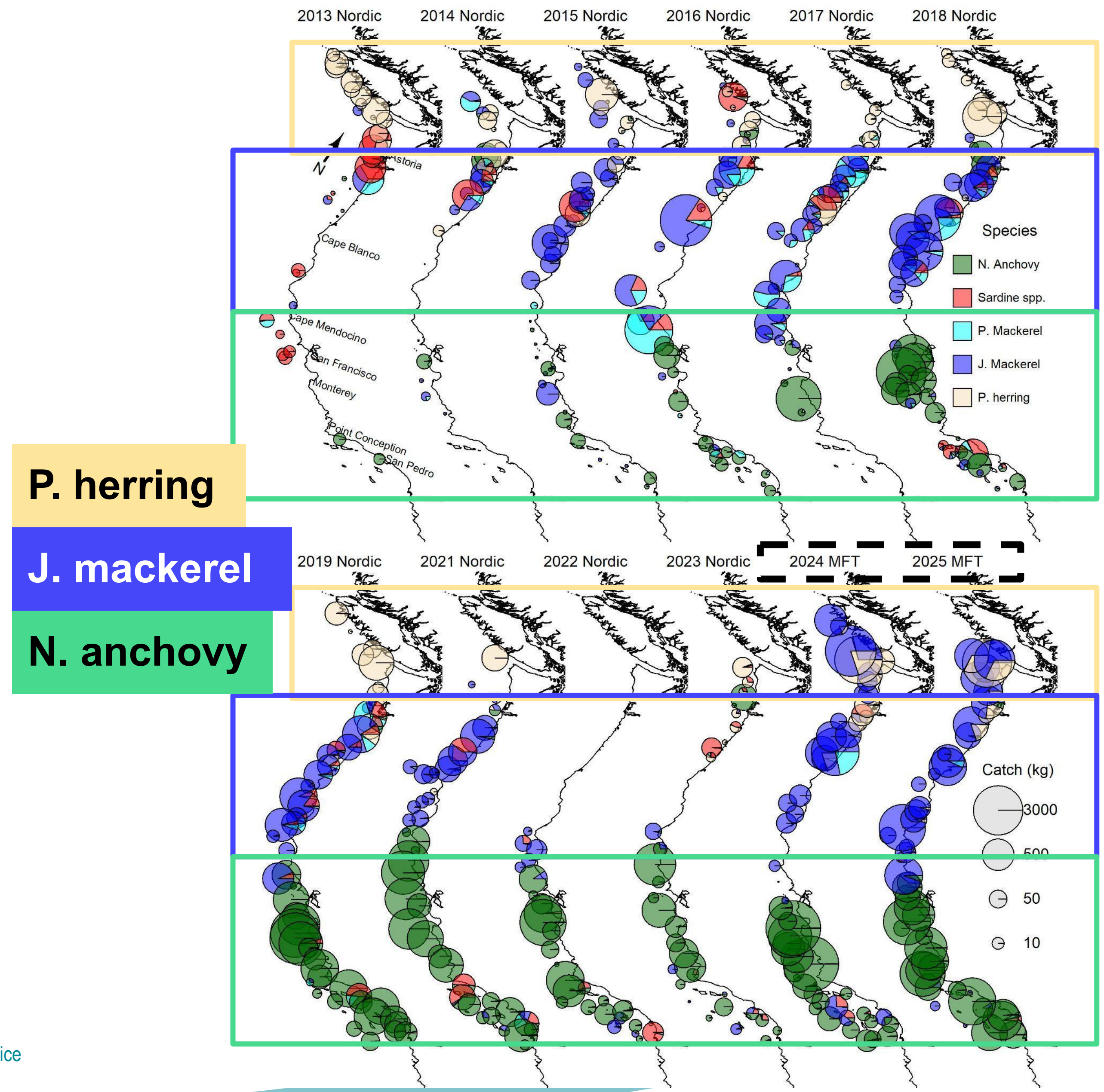
- Haul-level catches aggregated to trawl clusters
- Catch proportions for small pelagics varied widely among clusters and years
- Several overarching trends observed:
  - Greatest Sardine contributions in 2013, 2014
  - Greatest Pacific mackerel contributions in 2016-2018
  - Northern anchovy increasingly dominated catches across years



 U.S. Department of Commerce | National Oceanic and Atmospheric Administra

Species selectivities

- Catch proportions for small pelagics varied widely among sampling clusters, years, and *spatial regions*
  - Pacific herring=north
  - Jack mackerel=central
  - Northern anchovy=south
- Aside from more dominant anchovy and jack mackerel contributions in MFT years, proportions were broadly similar between nets



Species selectivities

Statistic	Overall	By net type	
		Nordic 264	MFT
$\overline{D_0}$	2.38	2.44	2.14
β_w	1.10	1.05	1.34
$\bar{J}$	0.31	0.32	0.24

- Calculated multiple metrics of species diversity sampled across survey years:
  - $\overline{D_0}$: Average species richness (i.e., species per cluster)
  - β_w: Beta diversity (i.e., number of unique communities)
  - $\bar{J}$: Evenness (relative dominance of one or two species)

Statistic	By year											
	2013	2014	2015	2016	2017	2018	2019	2021	2022	2023	2024	2025
$\overline{D_0}$	1.51	2.25	2.20	2.49	2.74	2.51	2.64	2.67	2.74	2.59	2.23	2.02
β_w	2.30	1.22	1.27	1.01	0.83	0.99	0.90	0.88	0.46	0.93	1.24	1.47
$\bar{J}$	0.33	0.43	0.26	0.44	0.48	0.33	0.28	0.25	0.22	0.35	0.23	0.25

Species selectivities

Statistic	Overall	By net type	
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β_w	1.10	1.05	1.34
$\bar{J}$	0.31	0.32	0.24

- Overall average species richness ($\overline{D_0}$) was lower and beta diversity (β_w) was higher for MFT survey years
    - Annual values for MFT years fell within the range of values observed for Nordic 264 survey years
- Species evenness ($\bar{J}$) was lowest for recent years
- All diversity metrics exhibited high interannual variability

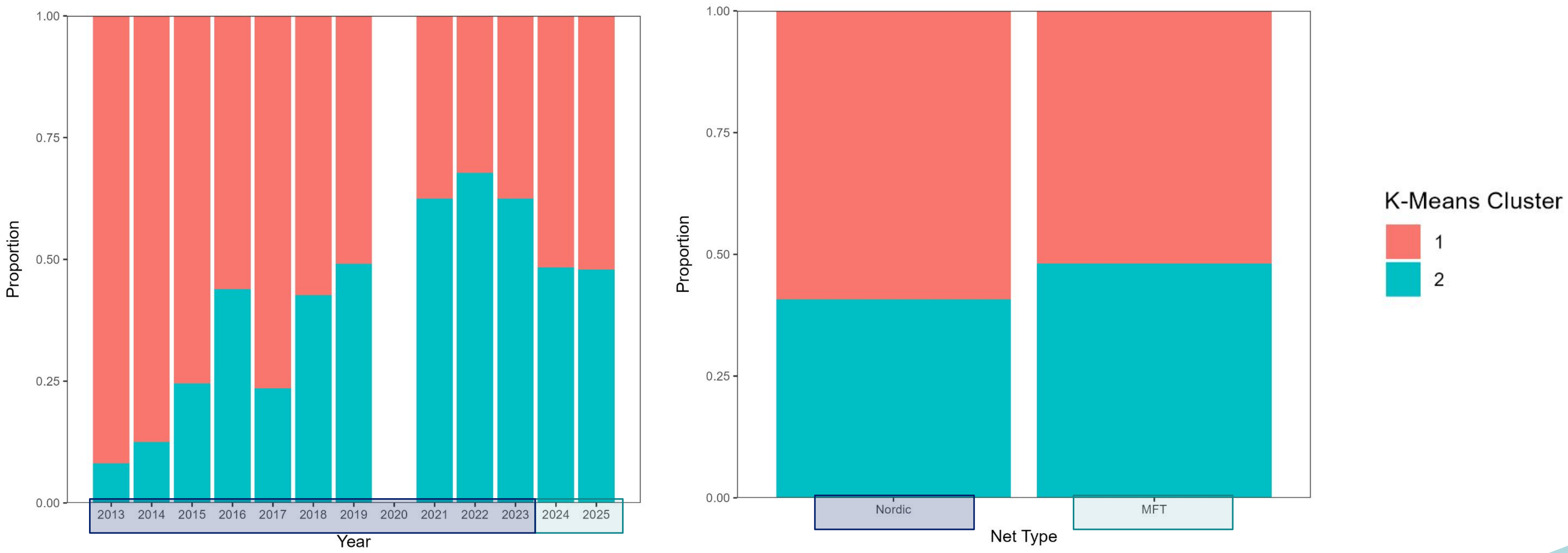
Statistic	By year											
	2013	2014	2015	2016	2017	2018	2019	2021	2022	2023	2024	2025
$\overline{D_0}$	1.51	2.25	2.20	2.49	2.74	2.51	2.64	2.67	2.74	2.59	2.23	2.02
β_w	2.30	1.22	1.27	1.01	0.83	0.99	0.90	0.88	0.46	0.93	1.24	1.47
$\bar{J}$	0.33	0.43	0.26	0.44	0.48	0.33	0.28	0.25	0.22	0.35	0.23	0.25

Species selectivities

- Following data transformation, conducted multivariate analyses
- K-means cluster analysis:
    - Identify best supported number of clusters (n=2)
    - Identify differences in assignments to K-means clusters among years and between net types
- Non-metric multidimensional scaling (NMDS):
    - Identify best supported dimensionality (n=2)
    - Identify differences in axis scores among years and between net types

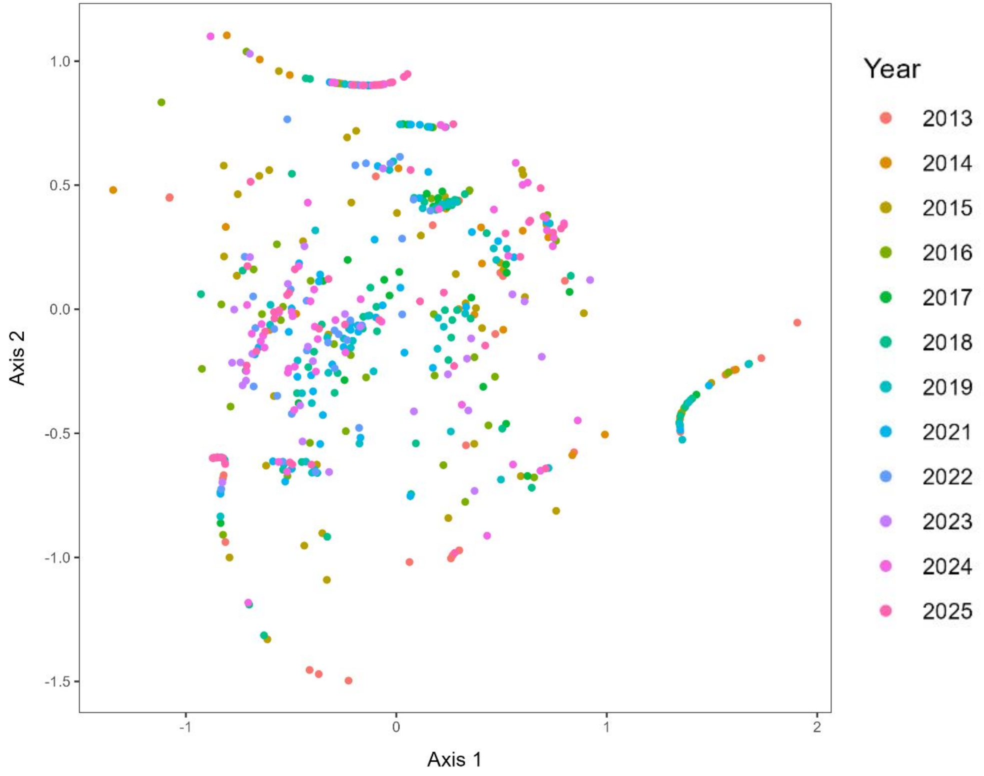
Species selectivities

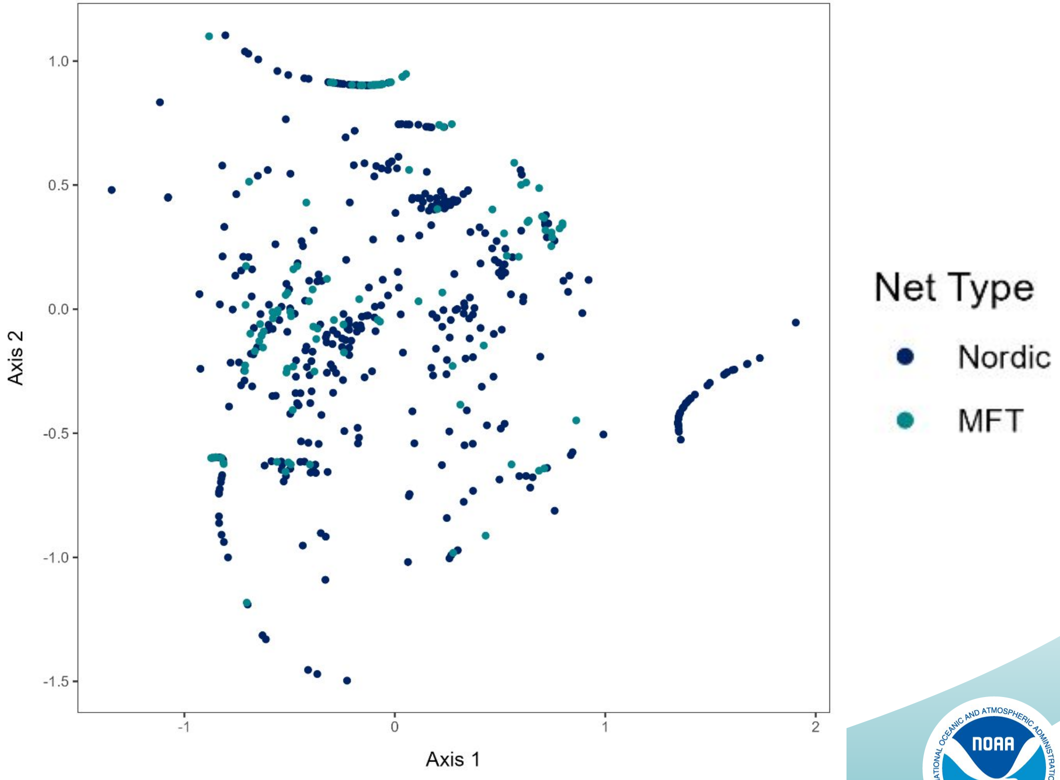
- K-means clustering showed high variability in sample assignments to K-means clusters among years and no clear difference between the Nordic 264 and MFT nets



Species selectivities

- NMDS illustrated the highly heterogeneous nature of the catch data, high variability in catch composition among years, and no clear differences in composition between the Nordic 264 and MFT nets

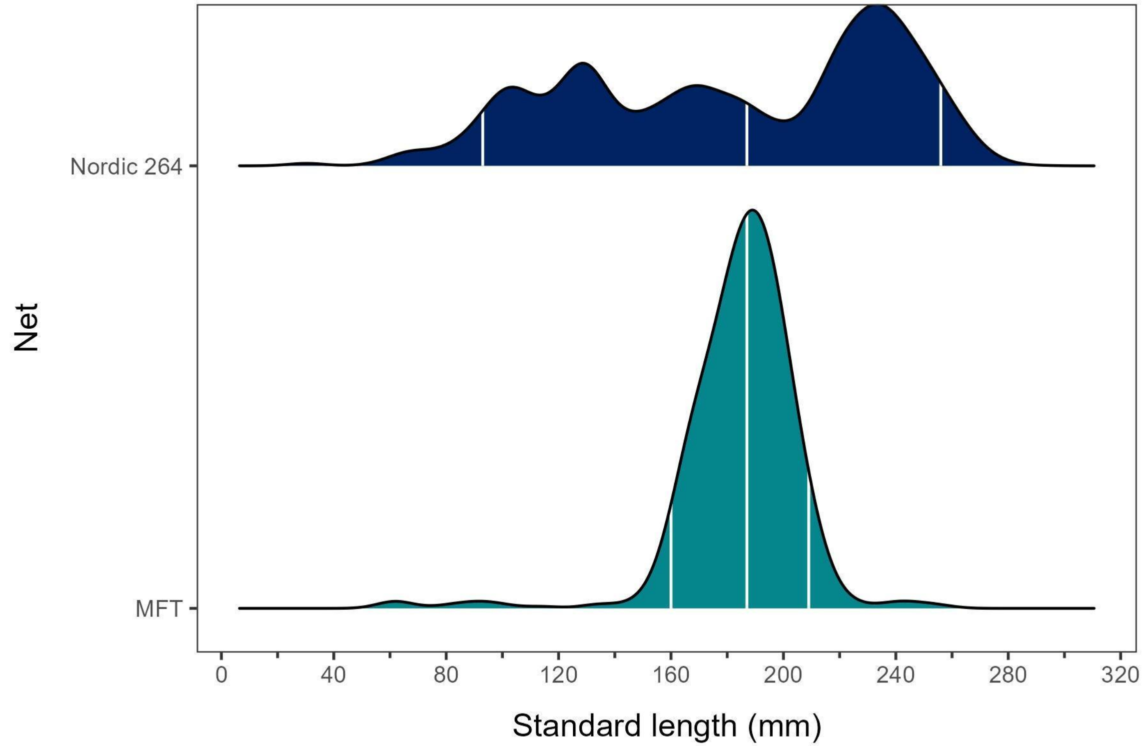


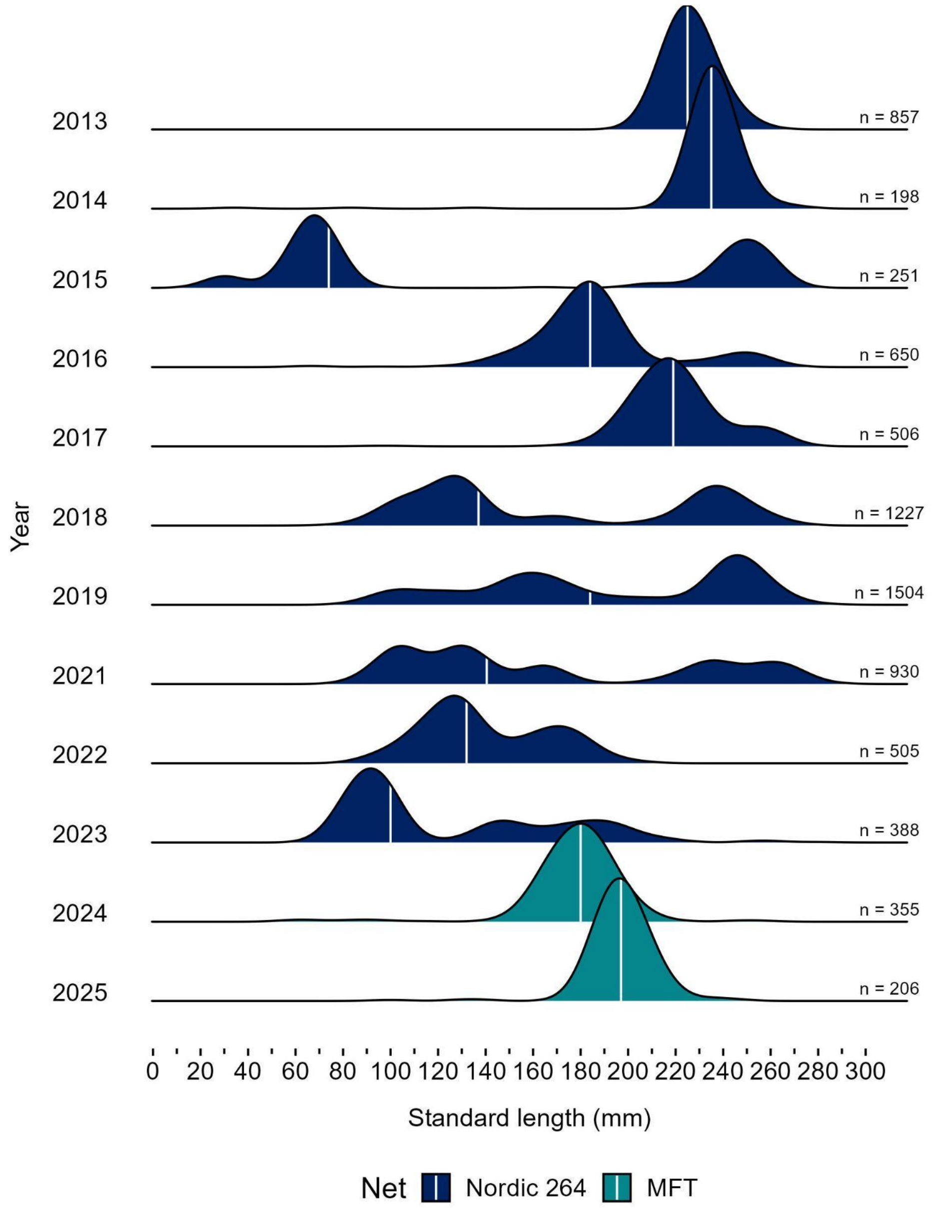


Species selectivities

- Takeaways:
  - Observed high interannual variability in species composition
  - Identified no meaningful differences in observed species compositions we could confidently attribute to differences in net type

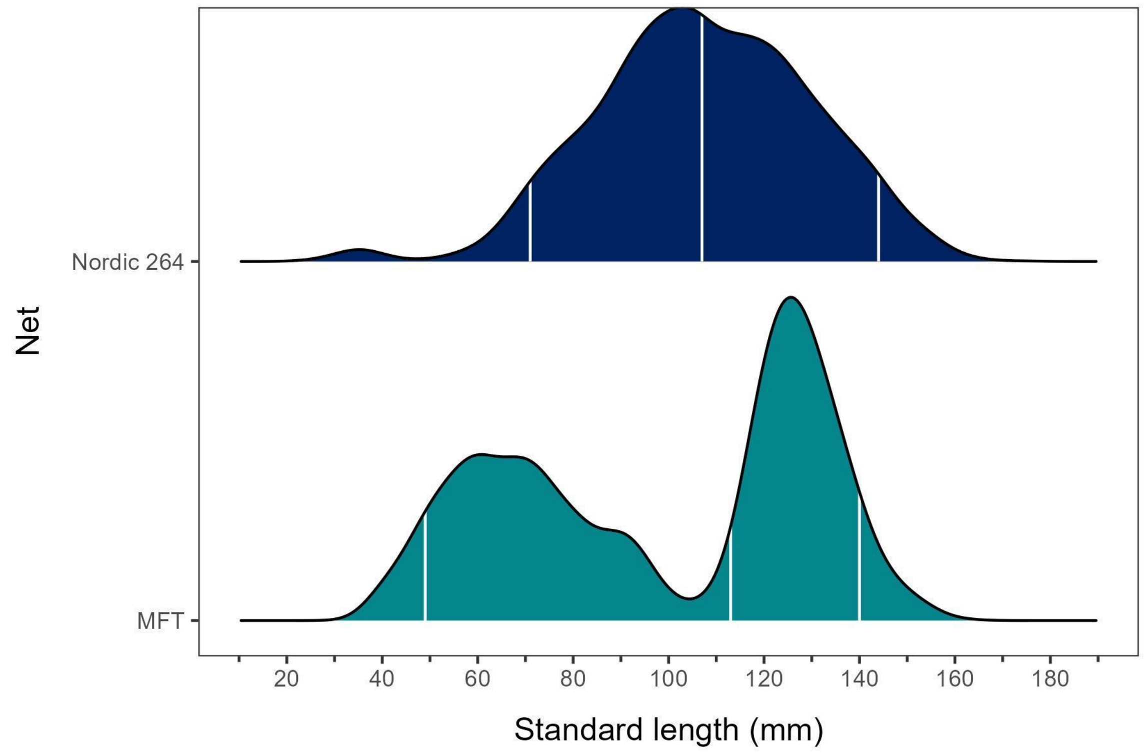
Length-selectivity Comparisons: Sardine

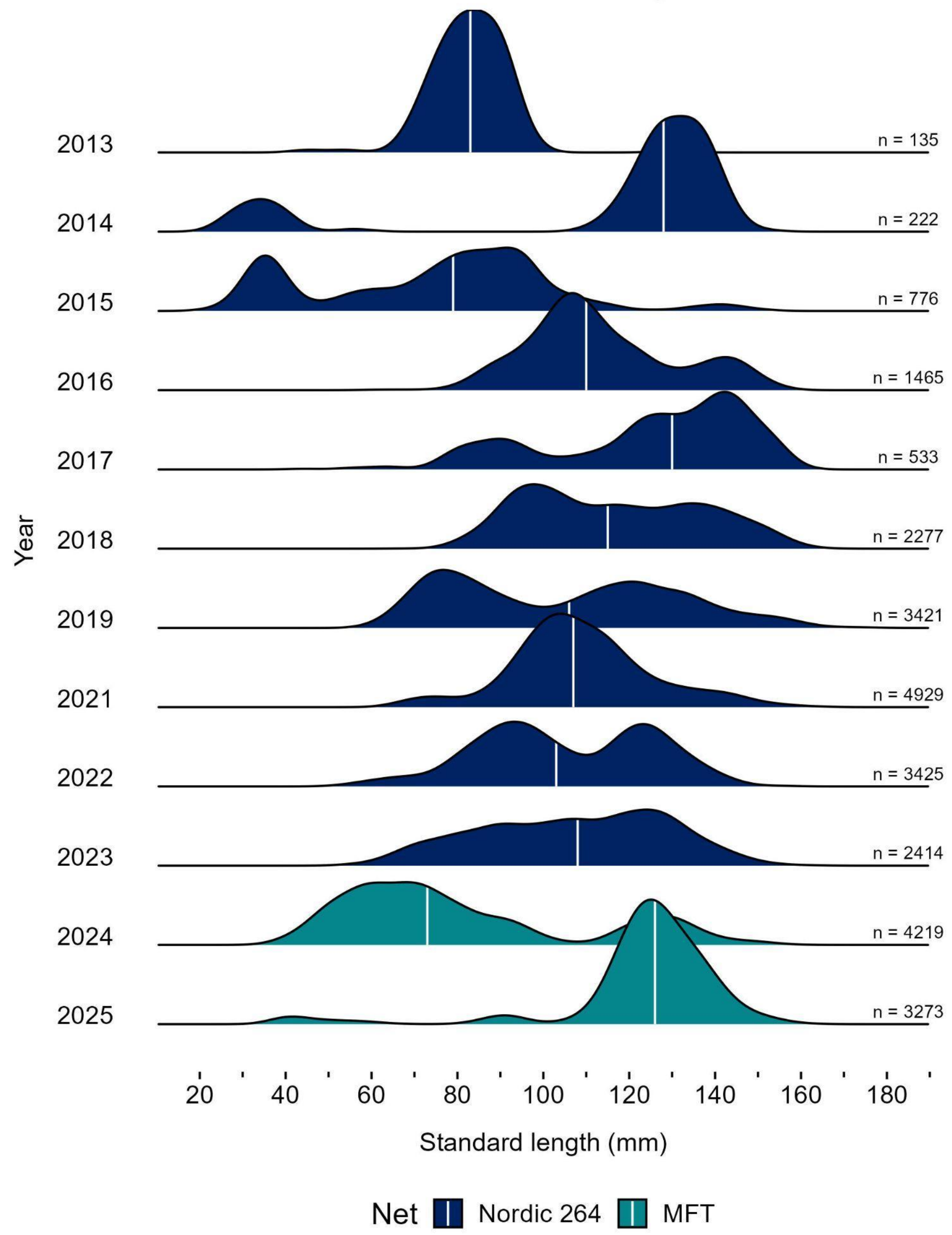




Net	Nordic 264			MFT		
Species	n	Min. Size	Max. Size	n	Min. Size	Max. Size
Sardine	7,016	25	292	561	60	256

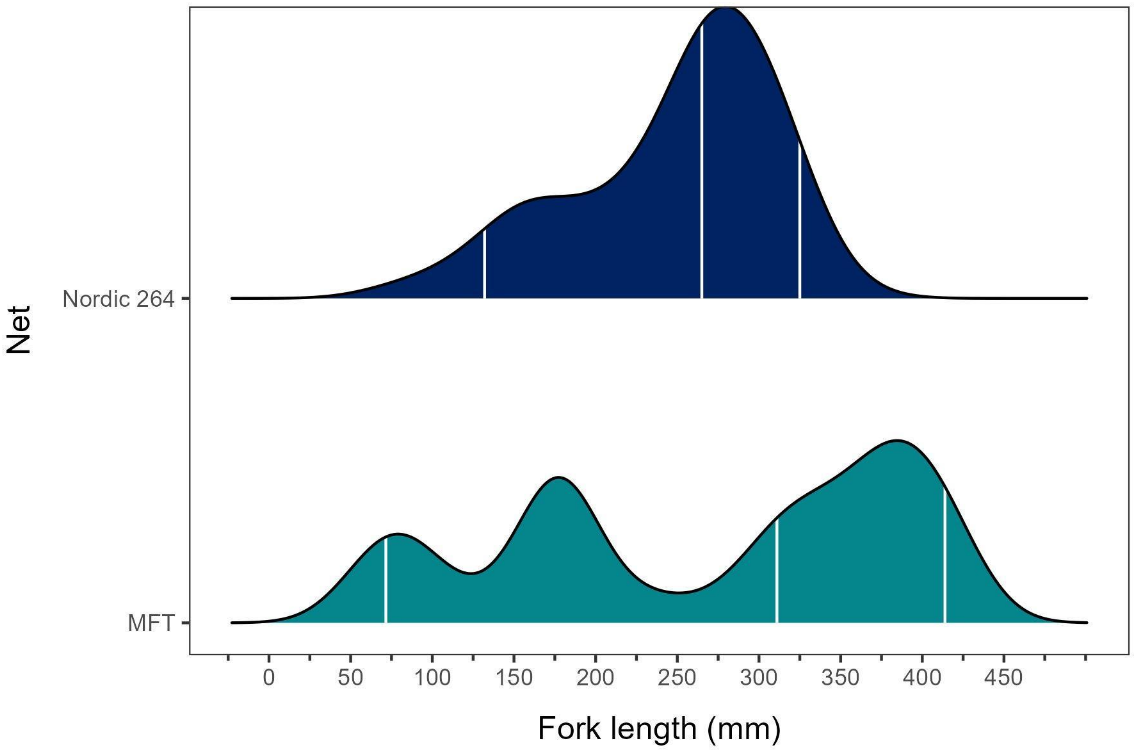
Length-selectivity Comparisons: Northern anchovy

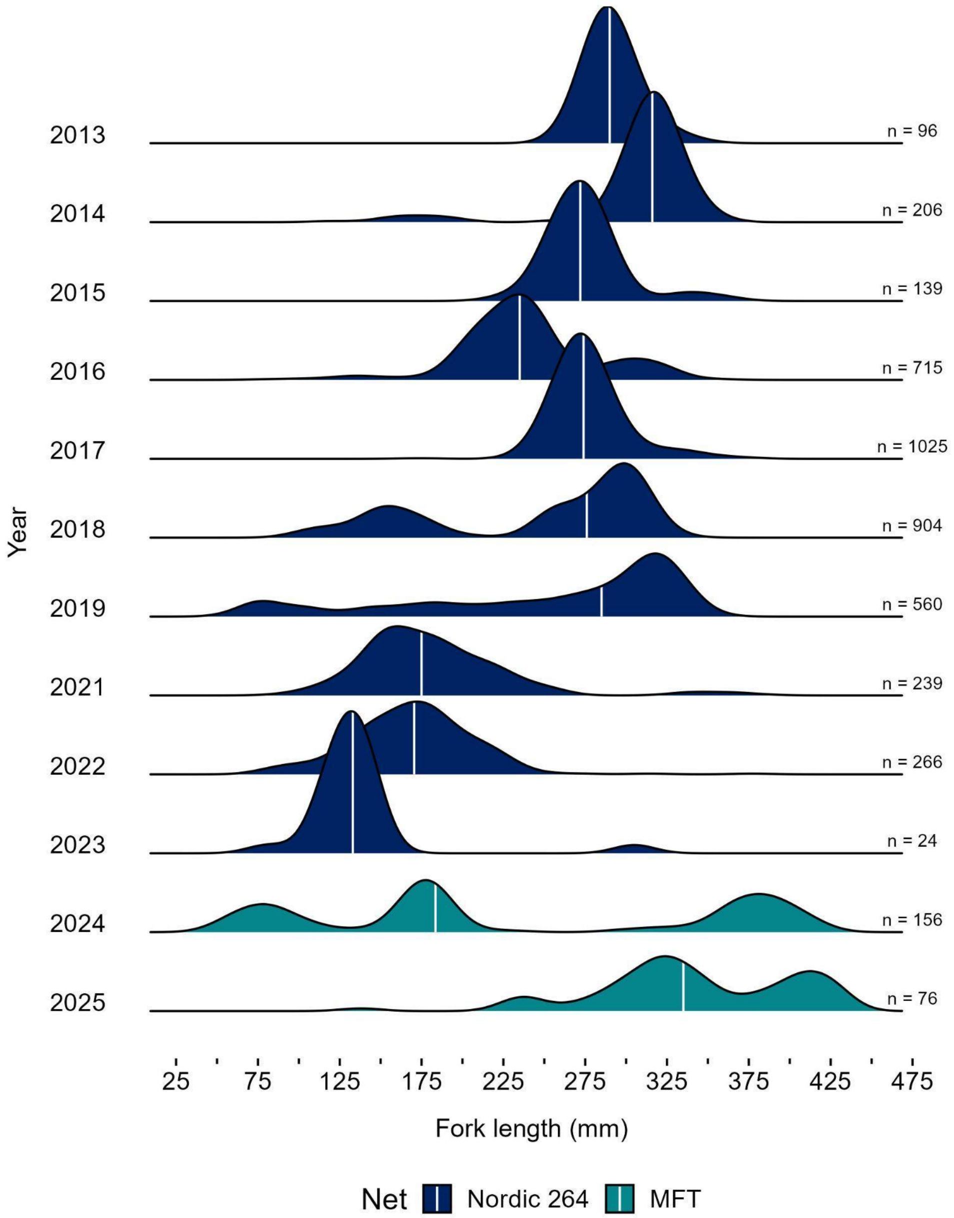




Net	Nordic 264			MFT		
Species	n	Min. Size	Max. Size	n	Min. Size	Max. Size
Northern Anchovy	19,597	22	178	7,492	35	163

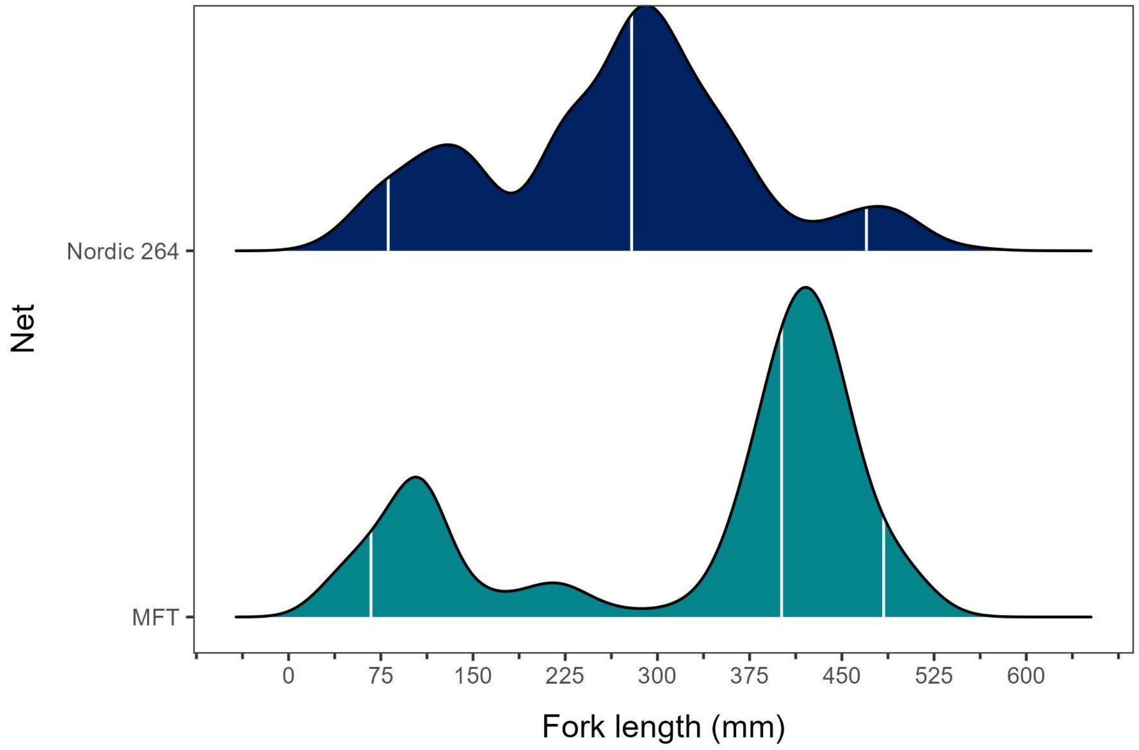
Length-selectivity Comparisons: Pacific mackerel

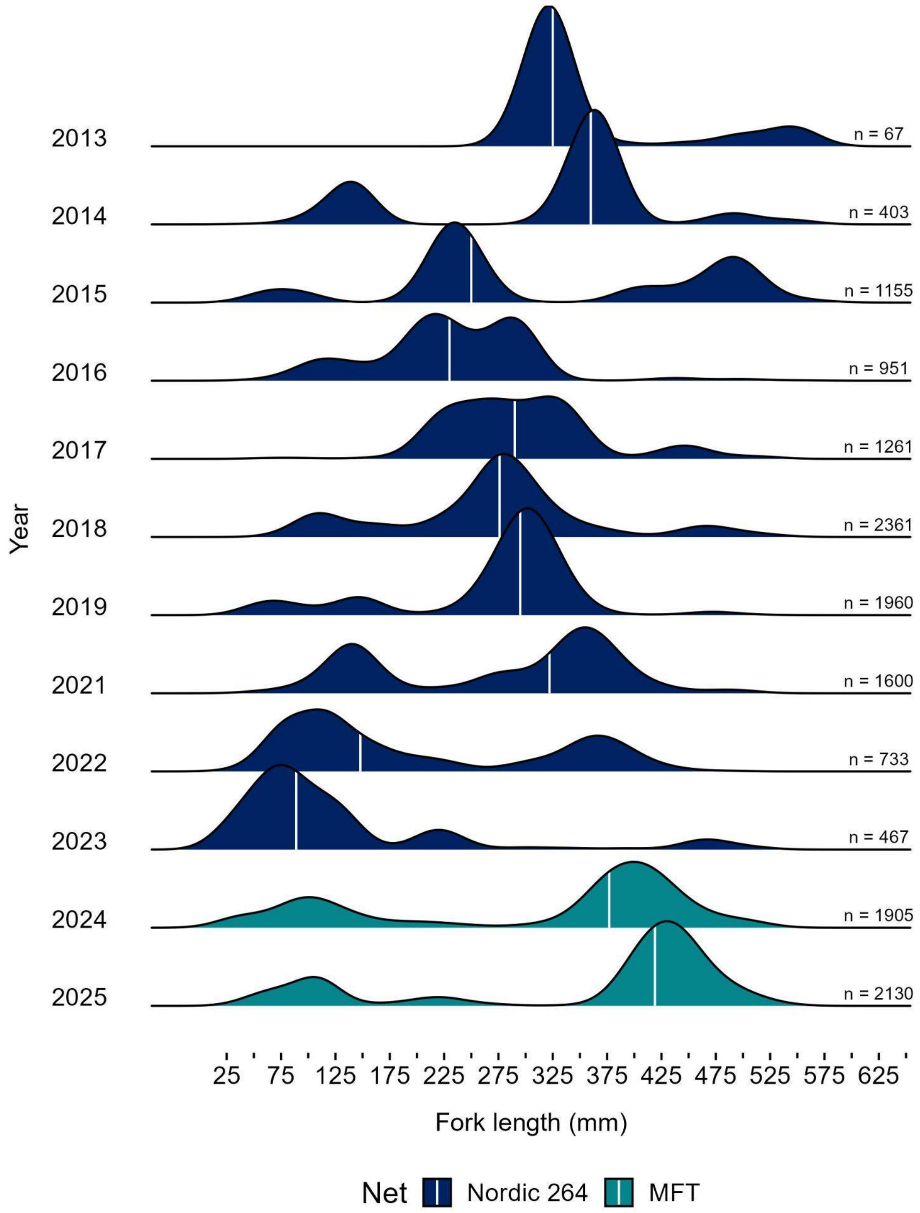




Net	Nordic 264			MFT		
Species	n	Min. Size	Max. Size	n	Min. Size	Max. Size
Pacific mackerel	4,174	53	382	232	47	431

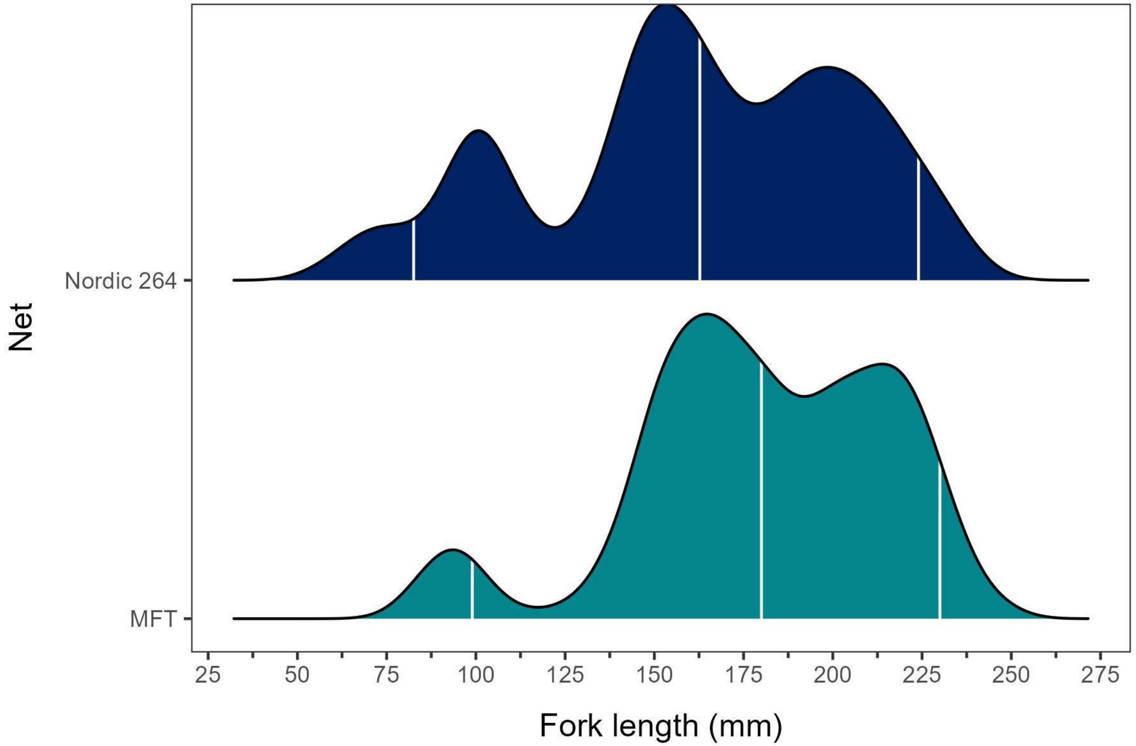
Length-selectivity Comparisons: Jack mackerel

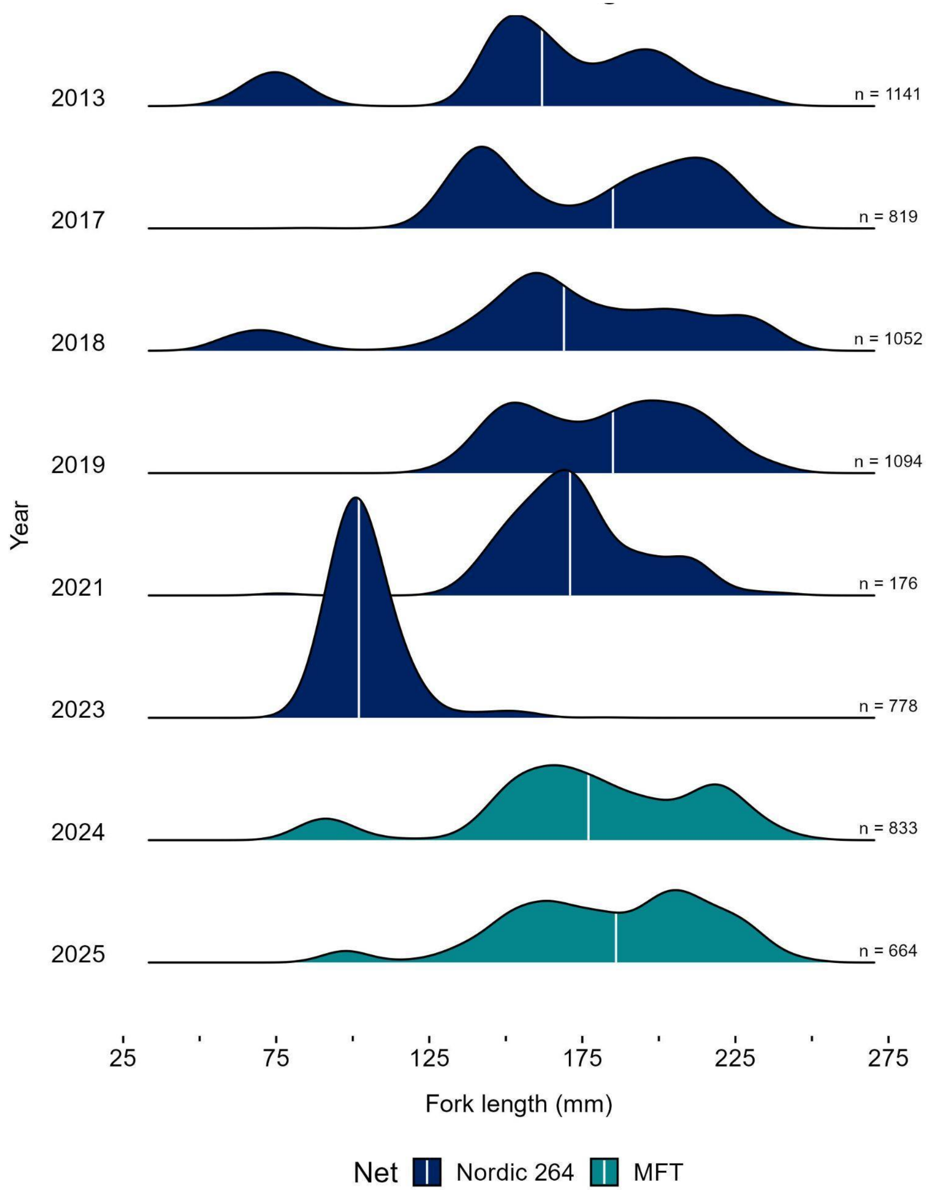




Net	Nordic 264			MFT		
Species	n	Min. Size	Max. Size	n	Min. Size	Max. Size
Jack mackerel	10,958	15	595	4,035	18	551

Length-selectivity Comparisons: Pacific herring





Net	Nordic 264			MFT		
Species	n	Min. Size	Max. Size	n	Min. Size	Max. Size
Pacific Herring	5,060	55	247	1,497	79	250

Length-selectivity Comparisons

- Takeaways:
  - Length ranges and distributions of specimen collected using the MFT fell within the ranges of those collected using the Nordic 264 for all target CPS
  - No meaningful differences in length selectivity for Northern Anchovy and Sardine
  - Some differences in maximum sizes (P. mackerel) and proportion of large fish (P. and jack mackerel)
  - High annual variability in length collected with just the Nordic 264
  - Unable to determine if the differences are the result of demographic changes in the small pelagic fish community over time, net differences, or other factors

F. Statistical comparisons of length-selectivity between the Nordic 264 and MFT nets for effects on survey-derived age composition and weight-at-age estimates

Alexander Jensen

Inputs to assessments

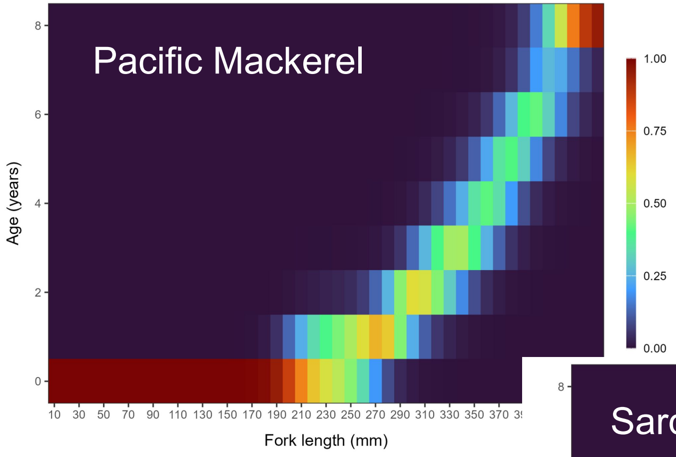
- Goal: Compare estimates of age composition and weight–at-age (WAA) for annual summer survey samples collected by the Nordic 264 and MFT nets for assessed CPS
  - Pacific Mackerel
  - Sardine (Japanese Sardine and Pacific Sardine, filtered by habitat model)
  - Northern Anchovy (central stock)
- Methods overview: Applied a simplified version of acoustic-trawl methodology (ATM) calculations for converting acoustics and trawl data to species-specific estimates of age composition and weight-at-age (WAA)

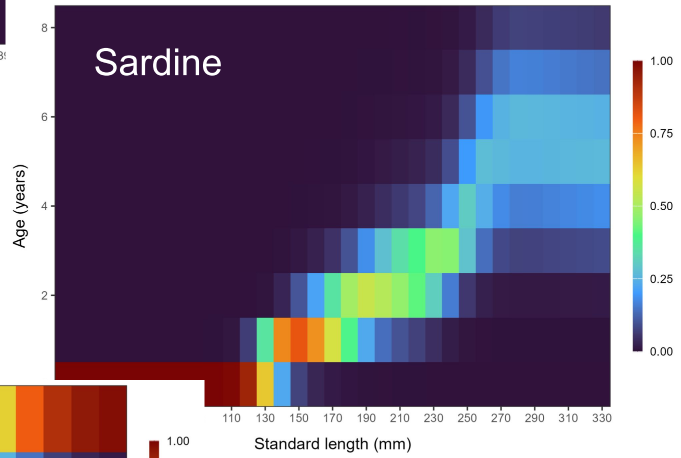
Inputs to assessments

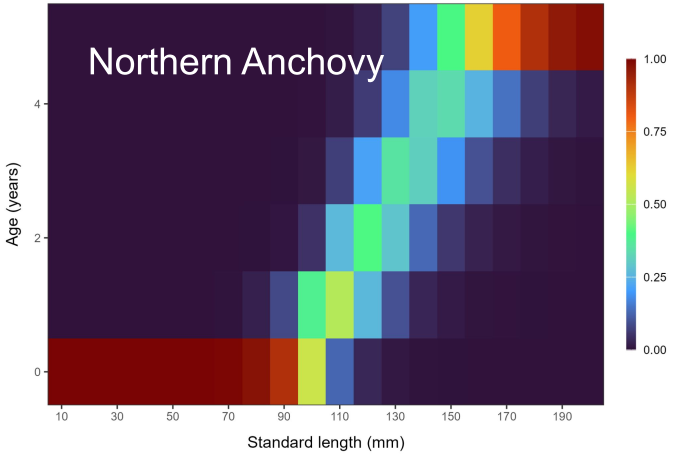
- Simplified workflow
  - Inputs: Annual species-specific lengths, weights (+scaling values)
    - Pooled age-length keys (ALKs) convert length-based estimates to age-based
  - Outputs: Estimate species-specific WAA, age composition
  - *Details/equations provided in the report and source publications* (Kuriyama et al. 2024; Stierhoff et al. In Prep)
- Implications of simplifications:
  - Limits confounding due to spatial structure of data among years
  - Avoids stochasticity stemming from annual ALKs
  - Did not attempt to account for differences in estimates of biomass

Inputs to assessments

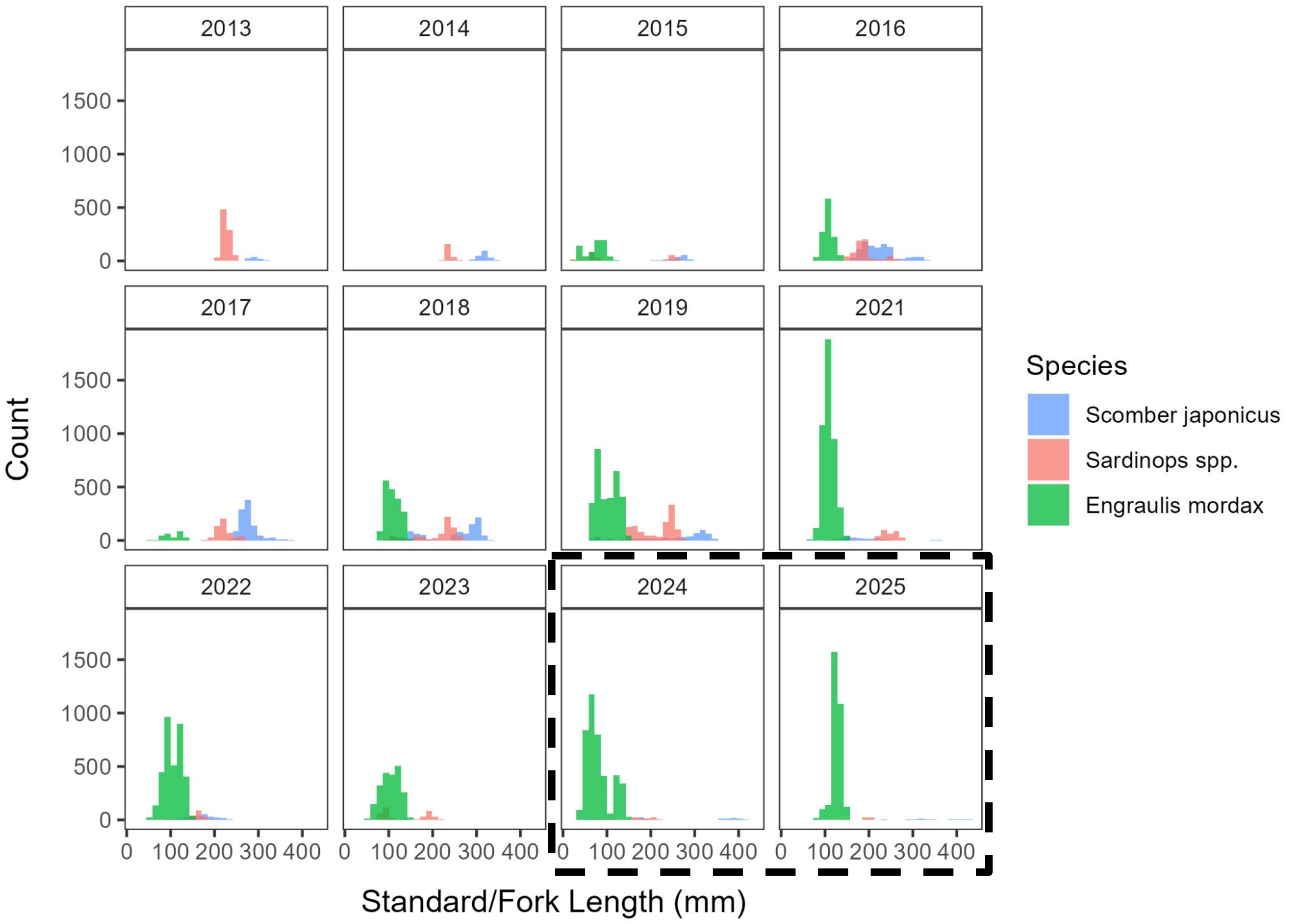
- Pooled ALKs were calculated for each species using ‘assessment-ready’ age and length data
  - Pacific mackerel: 2013-2019, 2021-2024
  - ‘Sardine’: 2013-2019, 2021-2024
  - Northern anchovy: 2015-2019, 2021-2024





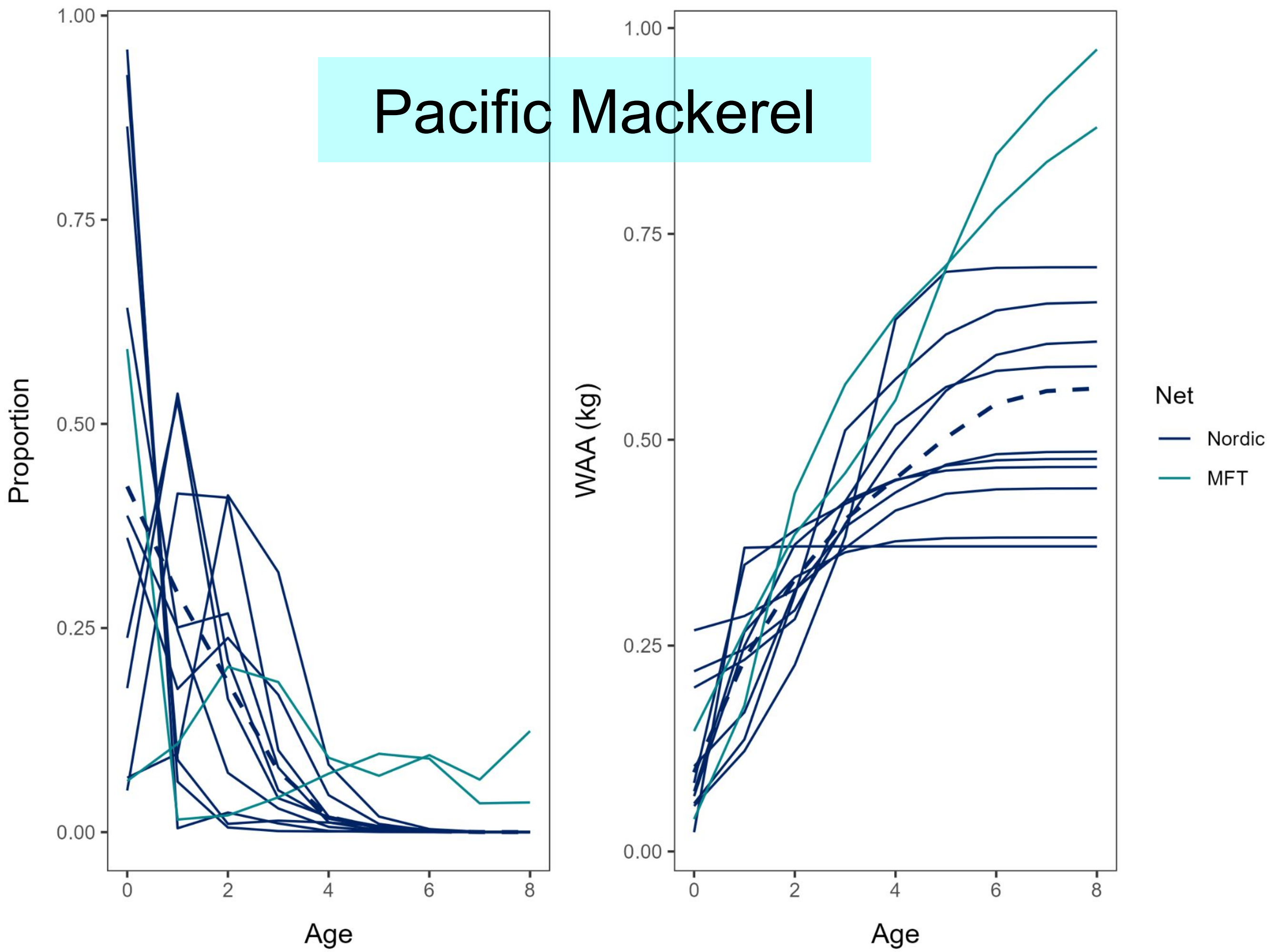


Inputs to assessments



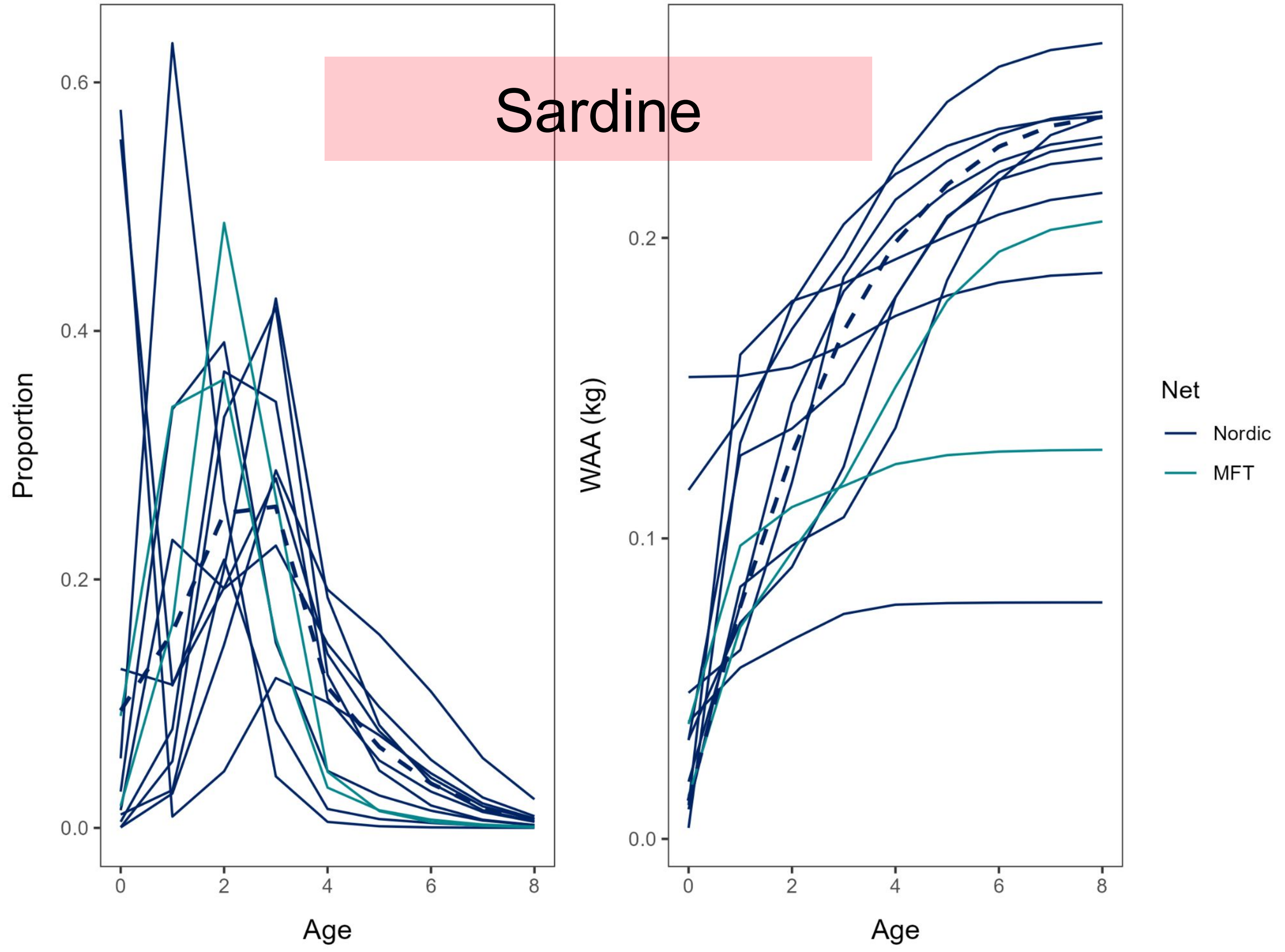
- Available length, weight data from the Nordic 264:
  - *Pacific Mackerel*: 2013-2019, 2021-2023
  - *Sardine*: 2013-2019, 2021-2023
  - *Northern Anchovy*: 2015-2019, 2021-2023
- Available data from the MFT:
  - *All*: 2024-2025

Inputs to assessments



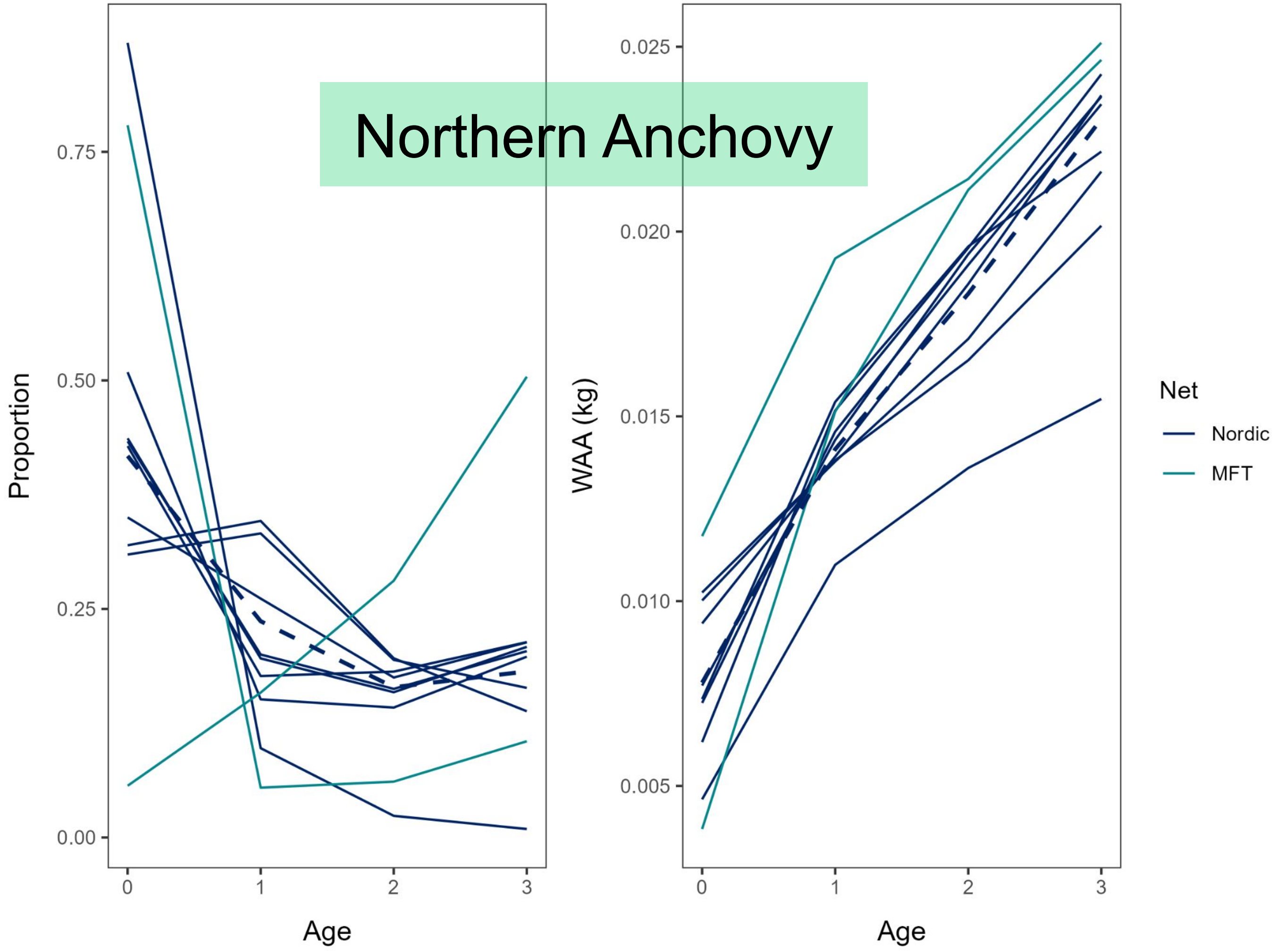
- Estimated greater proportional contributions *and* WAA of older age classes during MFT years relative to Nordic 264 years for *Pacific Mackerel*

Inputs to assessments



- Estimated age compositions and WAA for MFT survey years fell within the range of variability observed for Nordic 264 years for *Sardine*

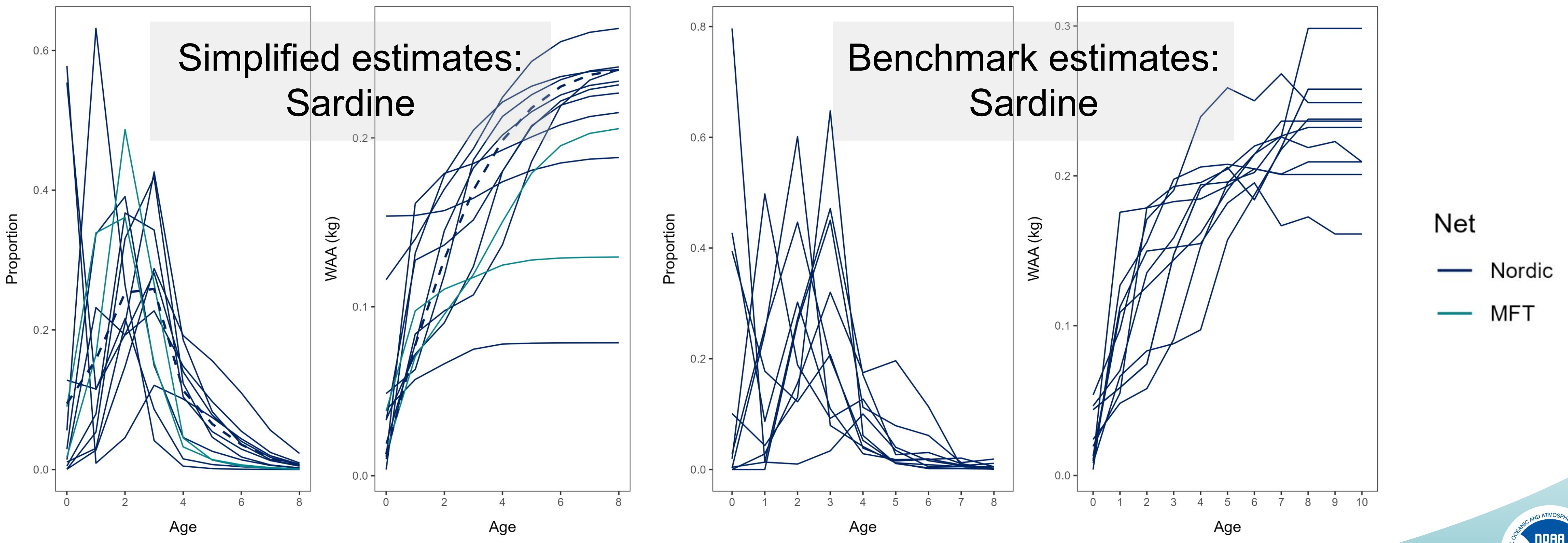
Inputs to assessments



- Estimated age compositions during MFT survey years exhibited more variability than observed during Nordic 264 years for *Northern Anchovy*
- Estimated WAA for older age classes was higher during MFT survey years

Inputs to assessments

- Validated performance of simplified calculations relative to estimates of age composition and WAA in recent benchmarks



Inputs to assessments

- Takeaways:
    - Greater sampled lengths and ages for *Pacific Mackerel* for MFT survey years translated to higher estimates of both WAA and the proportional contribution of ages-4+
    - There were no consistent differences in estimated age composition and WAA between nets for *Sardine*
    - For *Northern Anchovy*, MFT survey years produced the most variable estimates of age composition and highest estimates of WAA for ages-2+

G. Status update on trawl-related recommendations from the 2018 ATM survey review

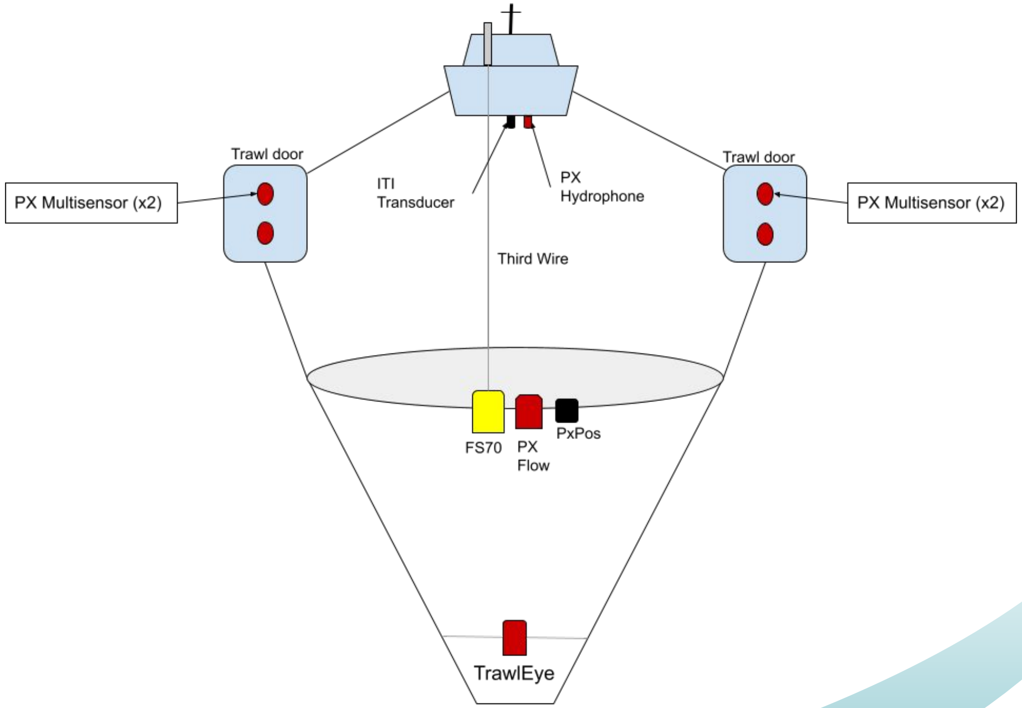
Josiah Renfree

HIGH PRIORITY

Use net monitoring devices to monitor the trawl during all hauls. The optimal instrumentation is trawl sonar, which monitors the variable geometry of the trawl opening, and the distribution of fish within and outside the trawl opening.

ADDRESSED

Net mensuration sensors are now regularly being utilized on MFT trawls for real-time monitoring of trawl performance. This includes sensors to measure door spread, height, and geometry; headrope and footrope depths; a miniature echosounder that can be positioned anywhere along the net; and a flow sensor. An FS70 trawl sonar has also been deployed during gear trials to verify net characteristics, but is not regularly used during the survey due to risk of complications and net entanglements during deployments.

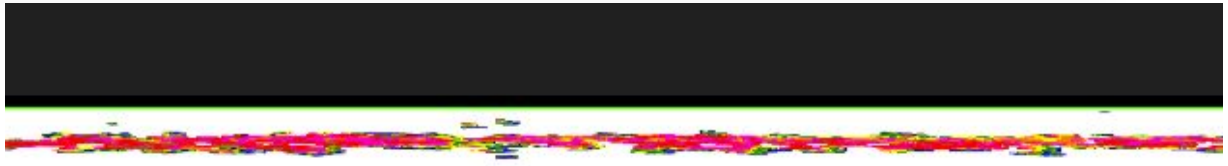


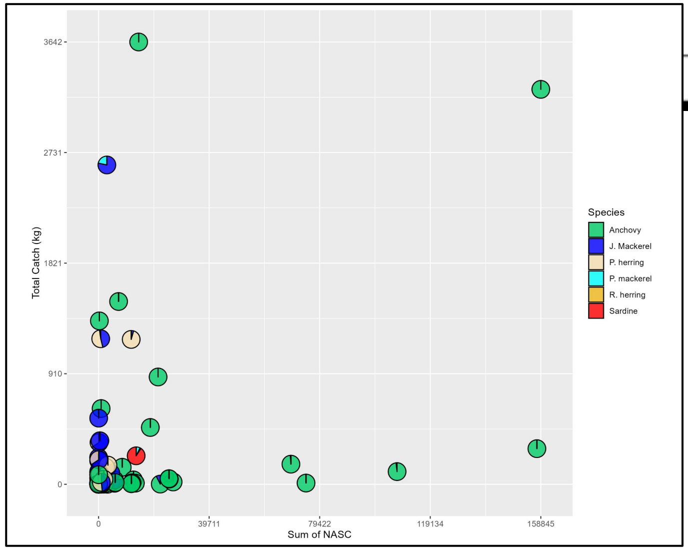
HIGH PRIORITY

Test efficiency (and suitability) of the existing trawl. This can be done either by comparing acoustic density measures with swept volume densities of the trawl or comparing swept volume densities with similar measures from larger trawls and other gear types.

PARTIALLY ADDRESSED

Preliminary analysis was done using data from the 2024 CPS Survey to compare nighttime CPS backscatter with the catch size of CPS in the concurrent MFT trawl, however no correlation was found (unpublished data). Additional analyses can be done to include more years and trawls or to utilize narrowband CW echosounder data as opposed to the wideband FM data used thus far.





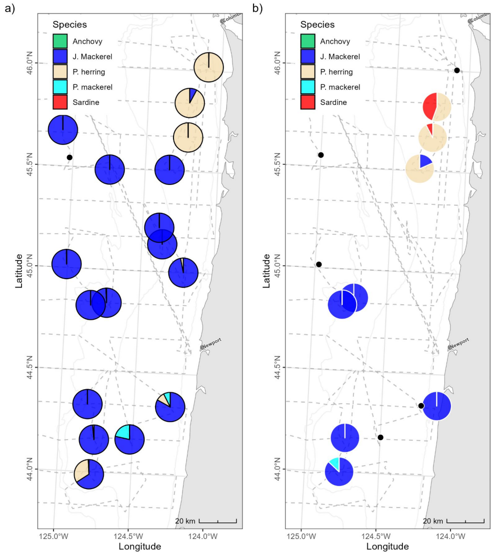
HIGH PRIORITY

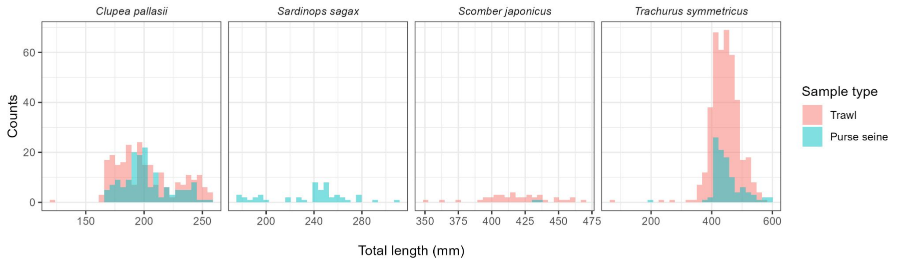
Develop methods to verify that daytime sound scatterers are the species and sizes caught in nighttime trawls; i.e. verify that efficient day time sampling of the acoustic record gives similar results as present night time sampling strategy. Such approaches could include alternative day-time sampling strategies (e.g. curved trawling trajectories) and/or different trawl gear, purse seining by day (either using research or industry vessels), or alternative sampling techniques such as drop cameras.

ADDRESSED

- Conducted curved tows in 2023 after discussions with skilled Icelandic fishermen. After observing no anecdotal advantages, resumed straight tows in 2024.

- In 2024, conducted 13 paired nighttime tows between *Lasker* (with MFT) and F/V *Lisa Marie* (purse seine), which in general showed comparable species and length compositions



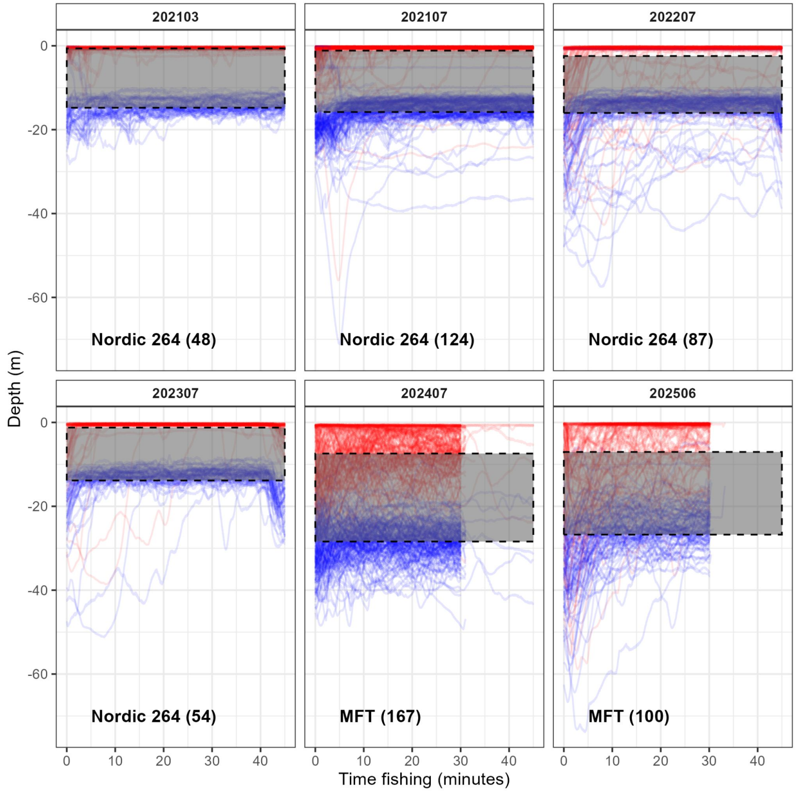


MEDIUM PRIORITY

Conduct night trawls at different depths in the same area, with the headrope at the surface, at 15 m, and at 30 m depth, for example to compare estimates of species and length composition.

PARTIALLY ADDRESSED OR ADDRESSED

During the 2024 and 2025 surveys, nighttime surface trawls with the MFT occurred at varying depths. These data could be analyzed to compare species and length compositions from trawls in similar areas and times but at different depths. These trawls, however, are never conducted in the exact same location, and the depths would not be substantially different given the door opening dimensions and operational fishing depths (~0-15-m variability). Finally, it would be difficult to fish the MFT at such specific depths given the observed variability in achieved depths.



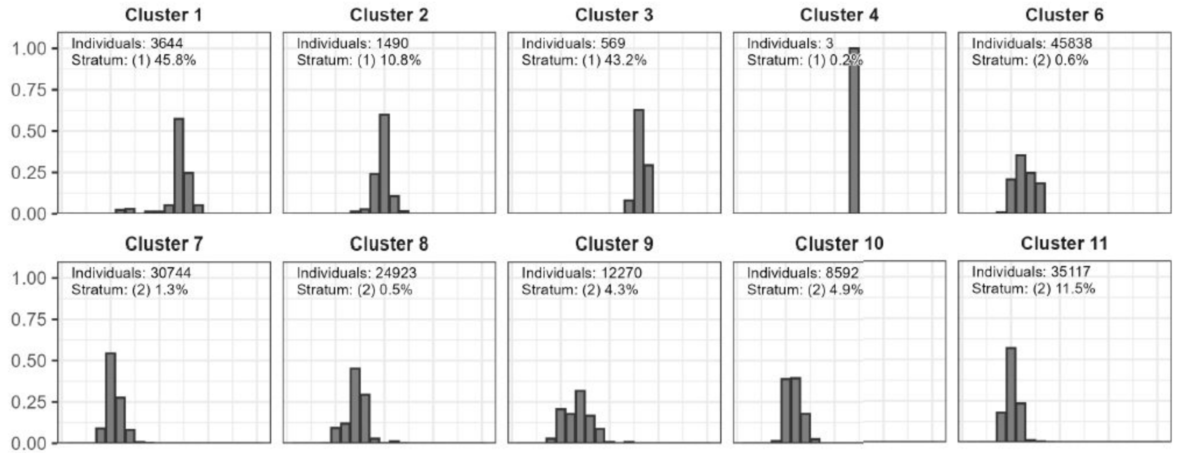
MEDIUM PRIORITY

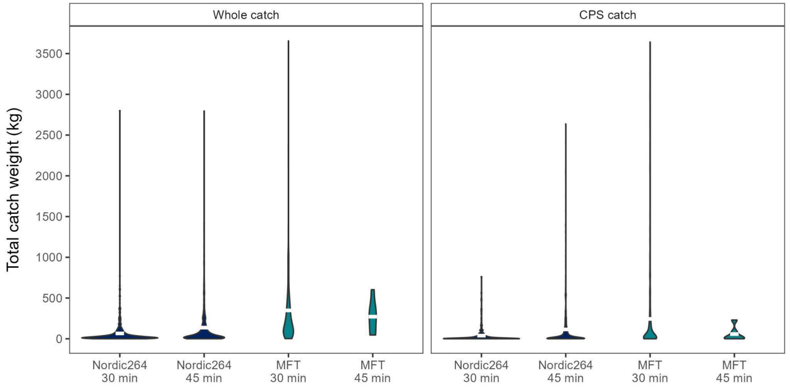
Compare the area (e.g. over several transects) and the current cluster approach to convert backscatter data to biomass when sample sizes for a particular species are insufficient.

ADDRESSED

- In the biomass reports, the length distribution of each species in each cluster is reported alongside the proportion of the abundance that it represents in each cluster. These plots allow for a descriptive analysis of the influence of each cluster in the biomass estimates.

- The lower percentage of small and “water” hauls since switching to the MFT in 2024 suggests that the occurrence of small sample sizes has been mitigated by the MFT net.





NOAA FISHERIES

LOWER PRIORITY

Study fish behavior in front of the codend and trawl opening and measure flow inside/outside the trawl using a high frequency Acoustic Doppler Current Profiler (ADCP). This will allow an evaluation of the frequency with which fish escape. Such work is needed because the codend is relatively short with a small mesh liner, and has probably insufficient filtering capacity at 4 knots. This might “block” the entrance of the codend and lead to an increased flow of water through the meshes in front of the codend where some fish will probably escape.

PARTIALLY ADDRESSED

- Compared to the Nordic 264, the MFT is longer and has a more gradual mesh taper throughout the net forward of the codend, which should improve water flow and minimize escapement via the “bucket effect.” This flow could be assessed with a sensor (Simrad PX Flow; Kongsberg) positioned at various points along the net.

- During development of the MFT, a net camera system was deployed near the Marine Mammal Excluder Device (MMED), allowing for observations of fish behavior and escapement. Changes to the MMED and MFT were applied based on these observations, with anecdotal improvements observed in video recordings.

CONCLUSIONS

Conclusions and future considerations

- Dynamics of the nets were similar, but the MFT can sample waters below the propeller wash which is more representative of what is sampled acoustically
- Species- compositions (i.e., selectivity) were similar, with any differences likely reflective of changes in the community structure of small pelagic fishes
- Little to no differences in length selectivity for Northern Anchovy and Sardine but stronger evidence for possible differences for Pacific Mackerel
- In summary, data collected using the MFT likely provides better biological information for apportioning backscatter and estimating biomass than the Nordic 264.

For more information about the Integrated West Coast Pelagics Survey

Integrated West Coast Pelagics Survey