



Foraging traits reveal climate-driven variability in albacore tuna prey quality

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Brian Wells, Toby Auth, Richard Brodeur, Jarrod Santora, John Field,
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NOAA
FISHERIES



UNIVERSITY OF
ALBERTA

Stanford
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LENFEST
OCEAN
PROGRAM

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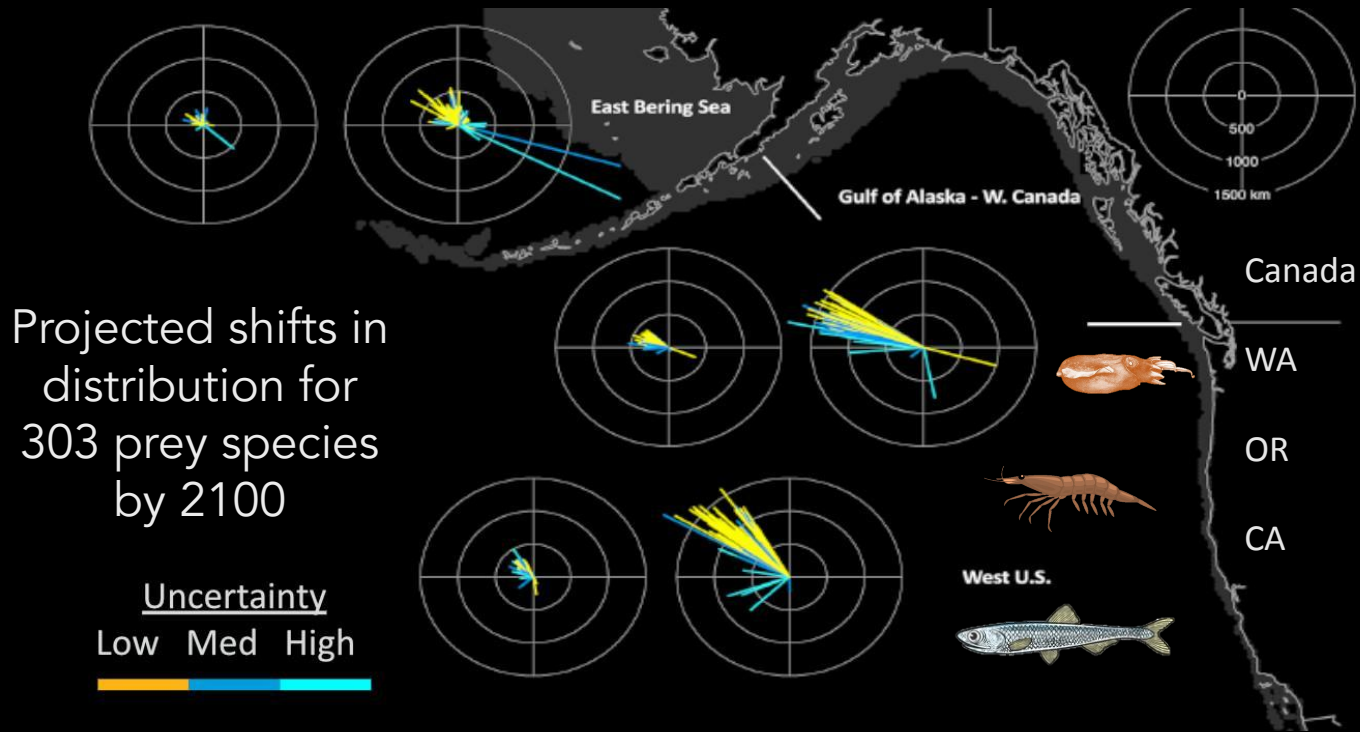
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Climate-driven shifts projected for Pacific species



Northward shifts for Albacore tuna



Albacore Research Foundation



F/V Foglifter



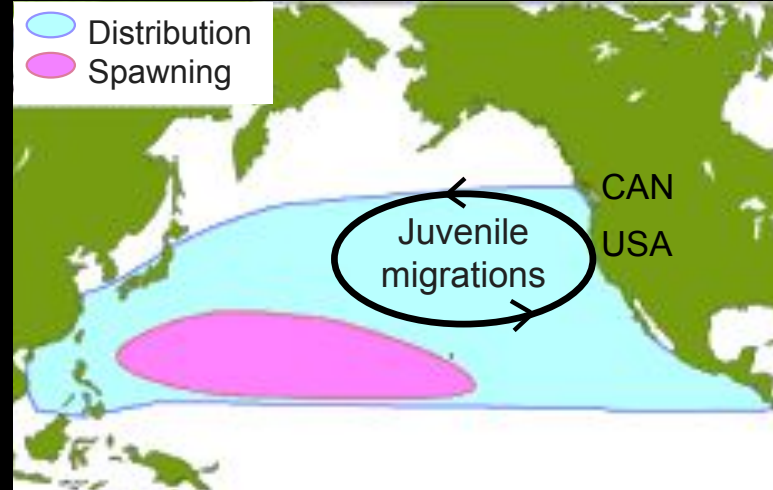
Frawley et al. (2021)
Fish and Fisheries

NE Pacific Albacore

- Highly migratory, temp sensitive
- Juveniles, July - October
- Transboundary shifts



F/V Foglifter



NE Pacific Albacore

- Sustainable, unique fishery
- low bycatch
- open access, flexible



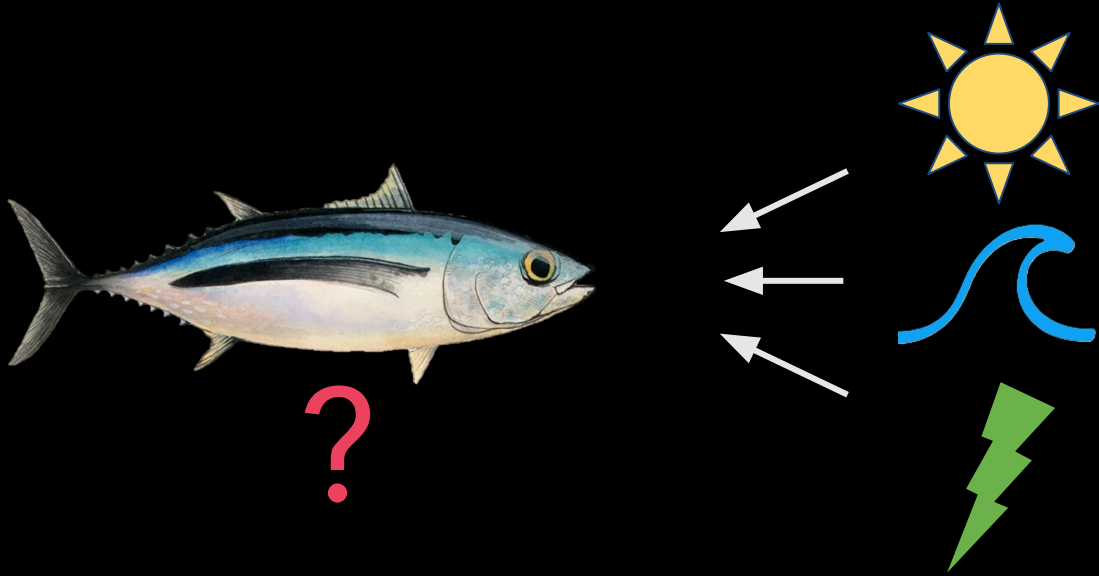
Oregon Albacore Commission



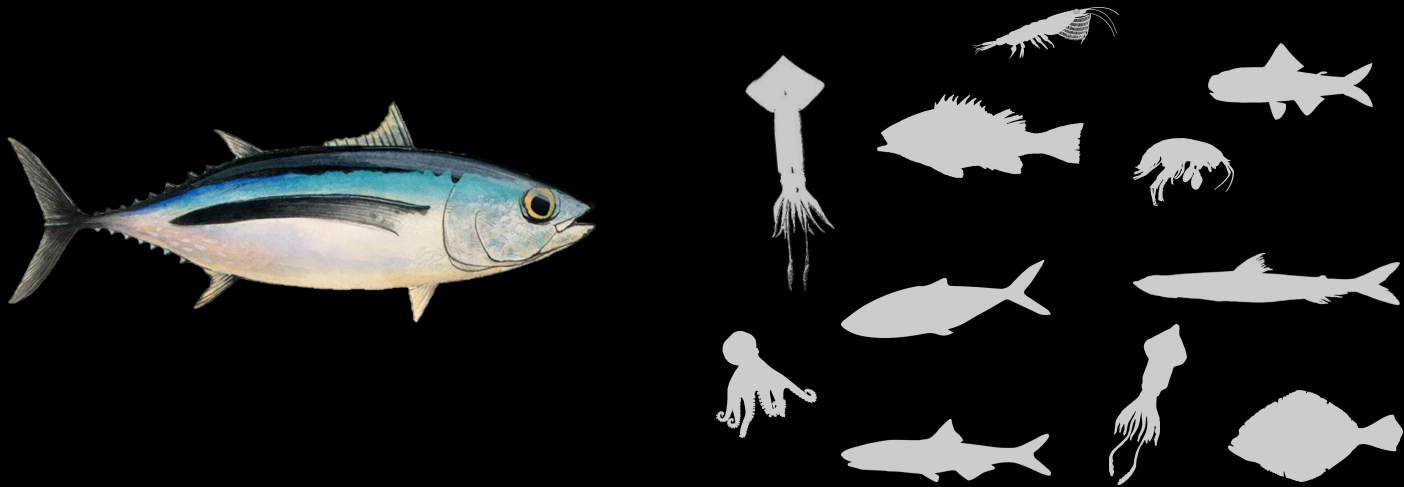
How will predator distributions
change into the future?



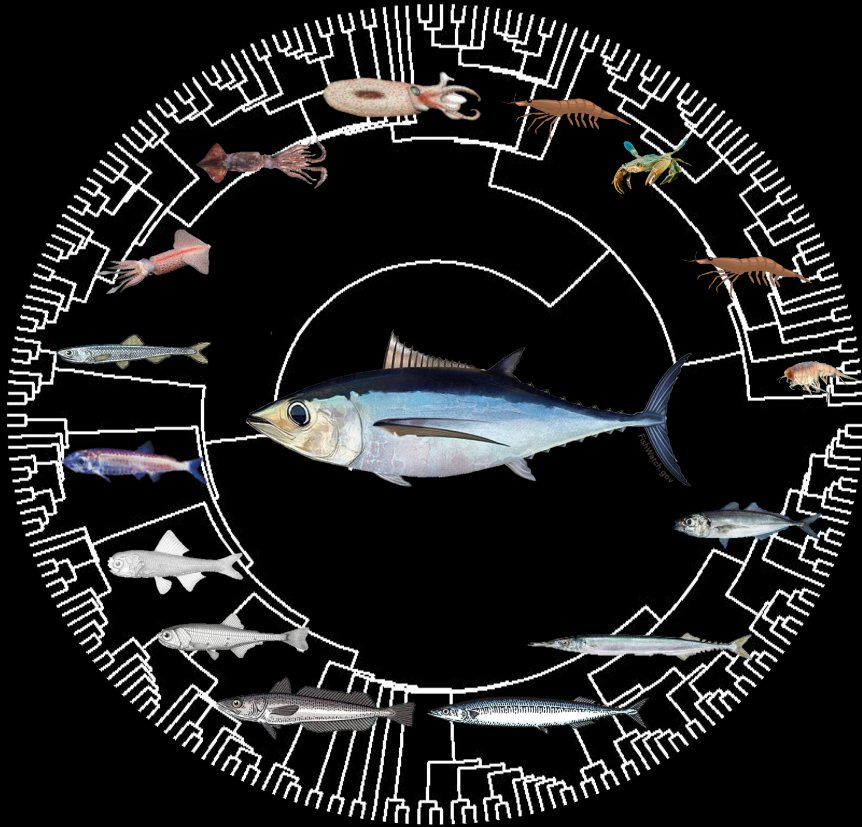
How will predator distributions
change into the future?



How will predator distributions
change into the future?



Predator-prey interactions complex for albacore tuna



Albacore consume:

- >300 sp. globally
- >120 sp. NE Pacific

Hardy et al. (2023)
Fish & Fisheries

Pelagic Species Trait Database

30+ traits



Habitat & behavior



Morphology



Nutrition

500+ species



NE Pacific, adult & juvenile

scientific **data**









Jan 12, 2024



OPEN

DATA DESCRIPTOR

The Pelagic Species Trait Database,
an open data resource to support
trait-based ocean research

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Stephanie
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Learn more about traits
and the database!

3:45pm - Session 4

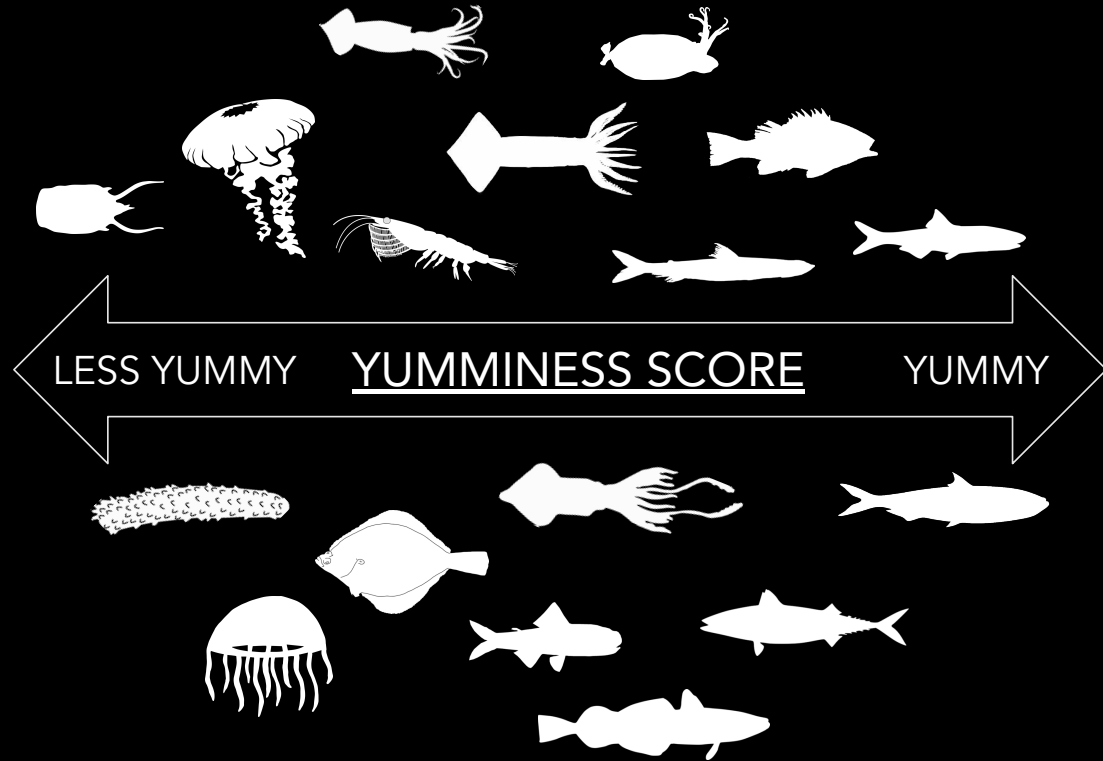
Albacore tuna select diverse prey, but similar traits

Habitat:	Coastal Epi/Mesopelagic
Behavior:	Schooling/shoaling Non-diel migrants
Morphology:	Silvered Countershaded Undefined
Nutrition:	Protein-rich Energy-rich Lipid-rich

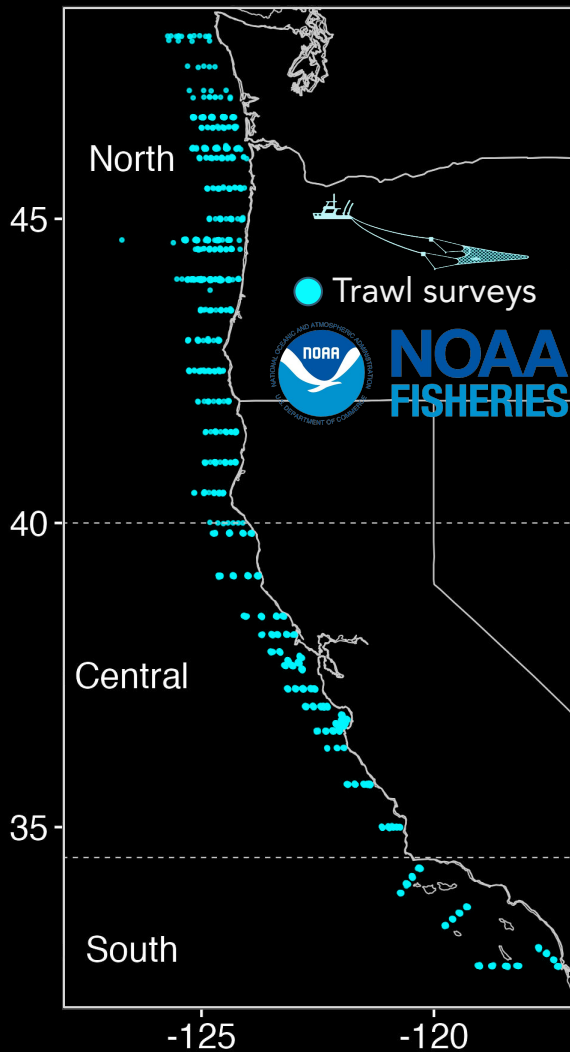
Gleiber et al. (2024)
Ecological Indicators

When & where are high quality prey?

Coastal
Epi/Mesopelagic
Schooling/shoaling
Non-diel migrants
Silvered
Countershaded
Undefended
Protein-rich
Energy-rich
Lipid-rich



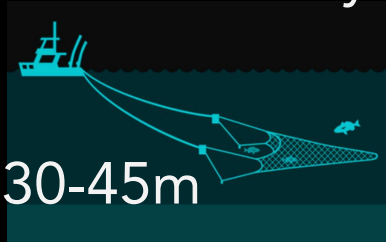
Pelagic forage community sampling



NOAA Trawl Surveys (May-June)

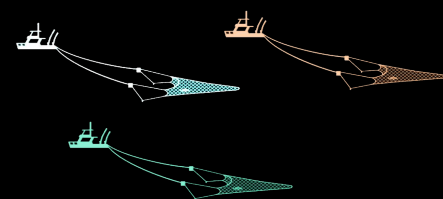
	Years
Rockfish Recruitment & Ecosystem Assessment	1990-present
Northern California Current	2011-present
Stock Assessment Improvement Program	2005-2011

Annual surveys



2005 - 2024

Standardize taxa IDs



Pelagic forage community traits

Yumminess Score



0

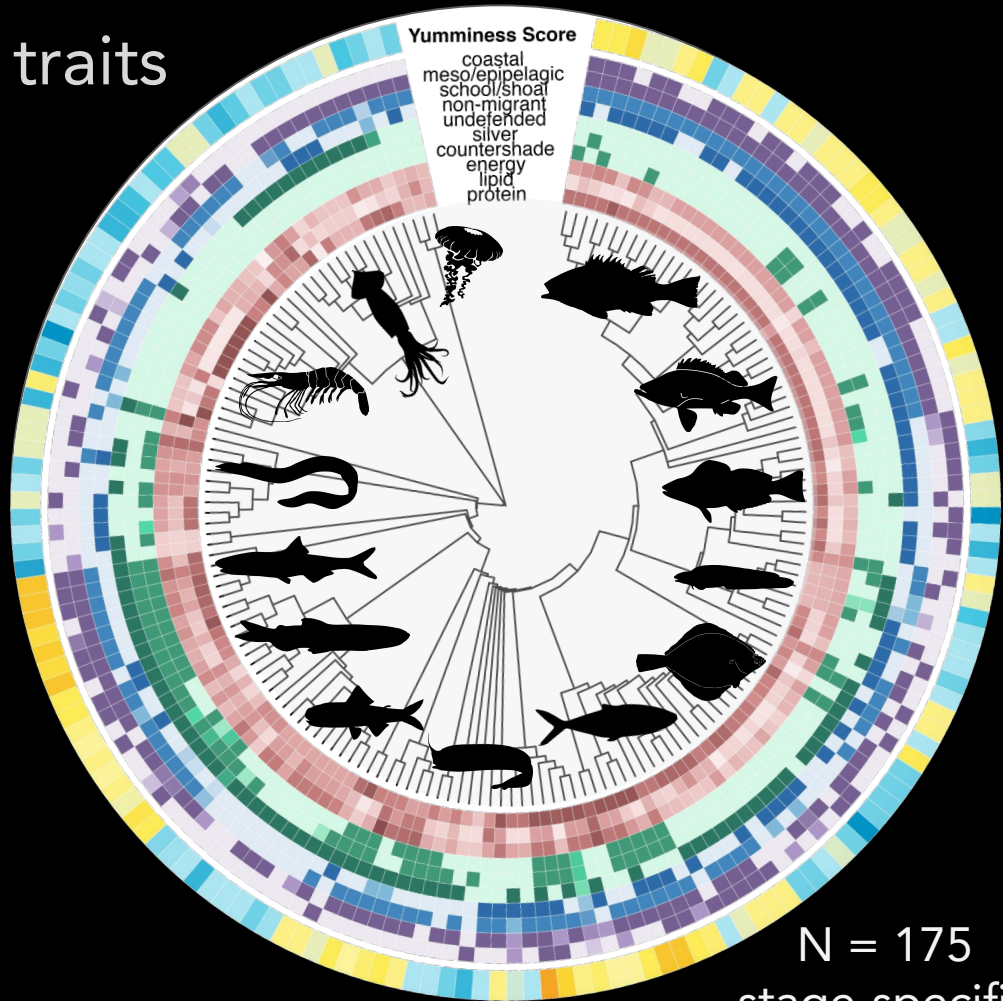
10

Trait



(-) selection (+)

Habitat
Behavior
Morphology
Nutrition



Pelagic forage community traits

Yumminess Score



0

10

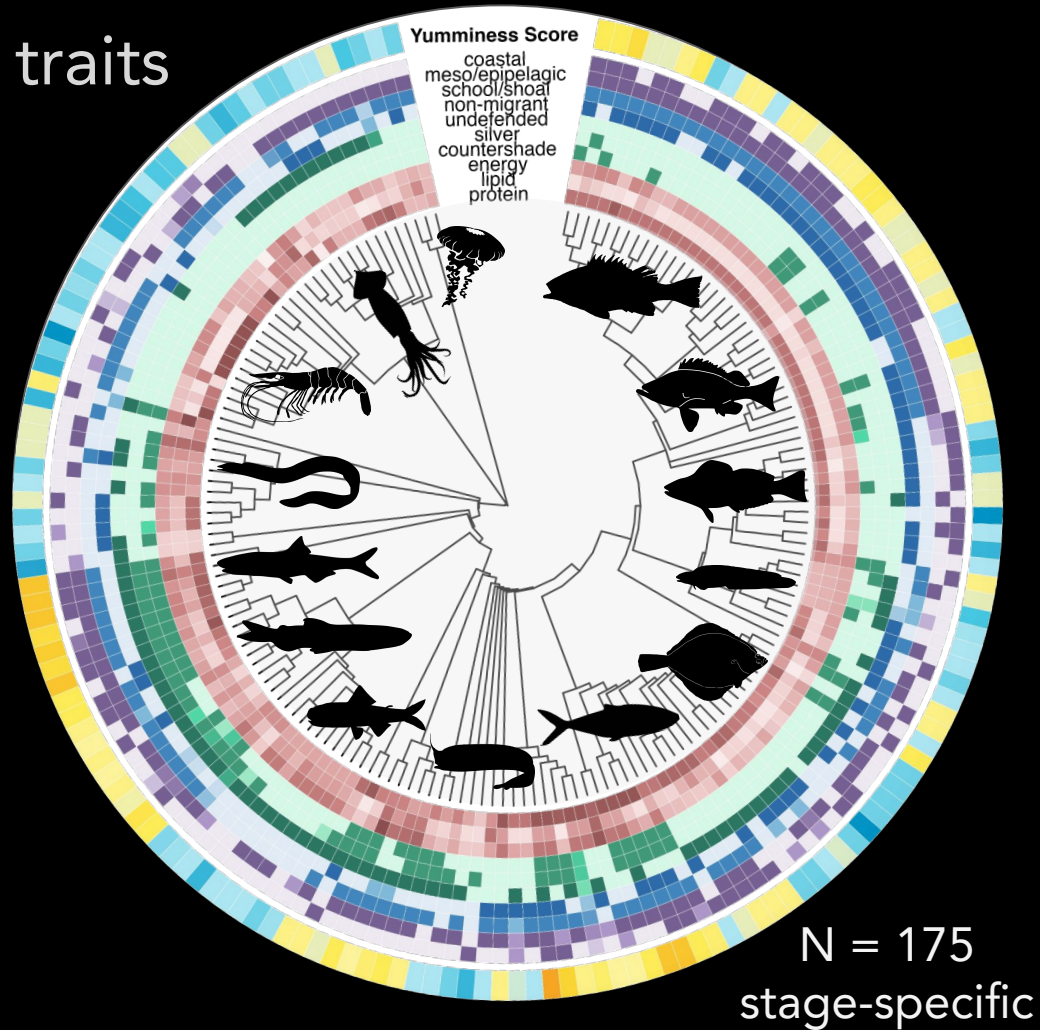
Trait

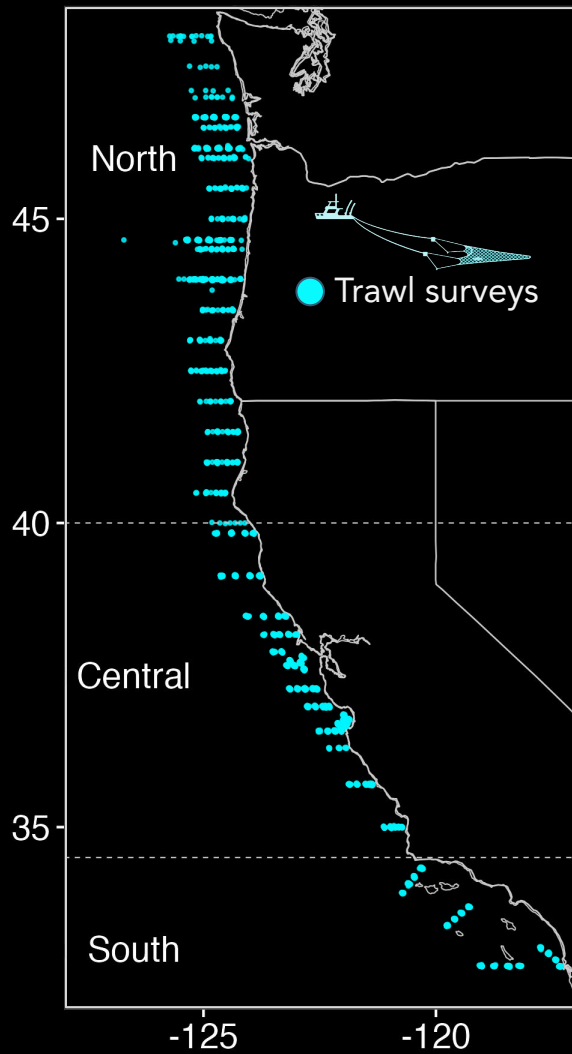


(-) selection (+)

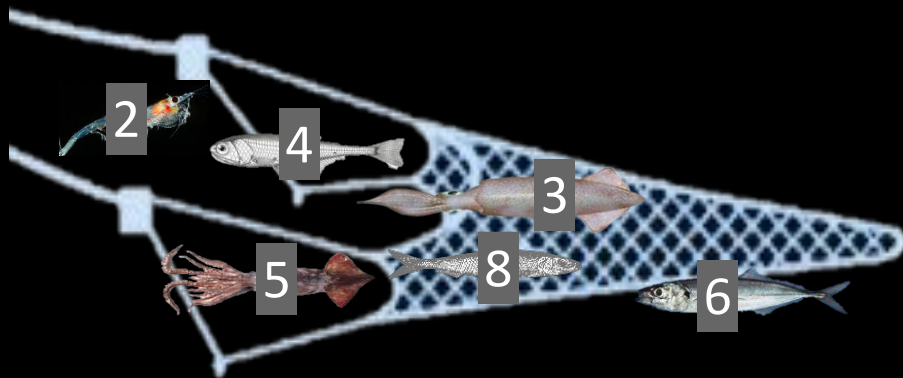
Habitat
Behavior
Morphology
Nutrition

90% in DB, 10% data gaps
(55-65% in data gaps)





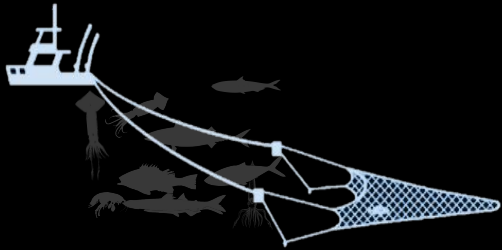
The prey community 'yummy' index



$$\sum (\text{yummy score} \times \text{abundance} [\%])$$

Is prey yumminess predictable with environment? (Boosted Regression Trees)

Trawl Yumminess Index
(n = 2,720)



~ Sea Surface Temperature

Surface Chl a

Upwelling Index (CUTI)

Habitat Compression Index (HCI)

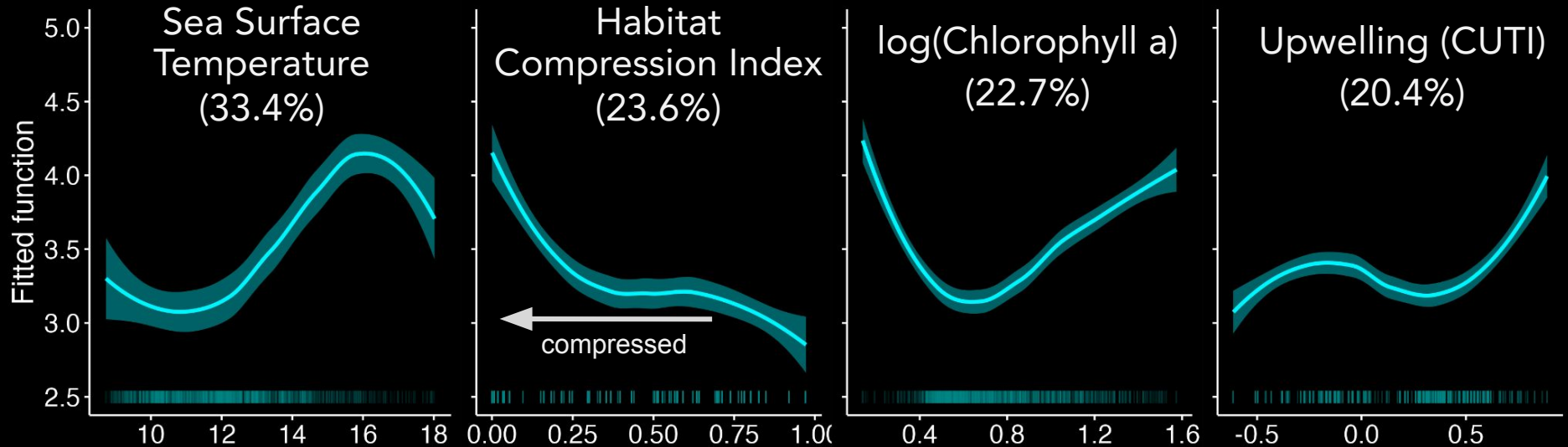
tested present & prior conditions



Nov-April mean

Yumminess Index \sim SST + HCI + $\log(\text{Chl a})$ + CUTI

Prior conditions: Nov-April mean

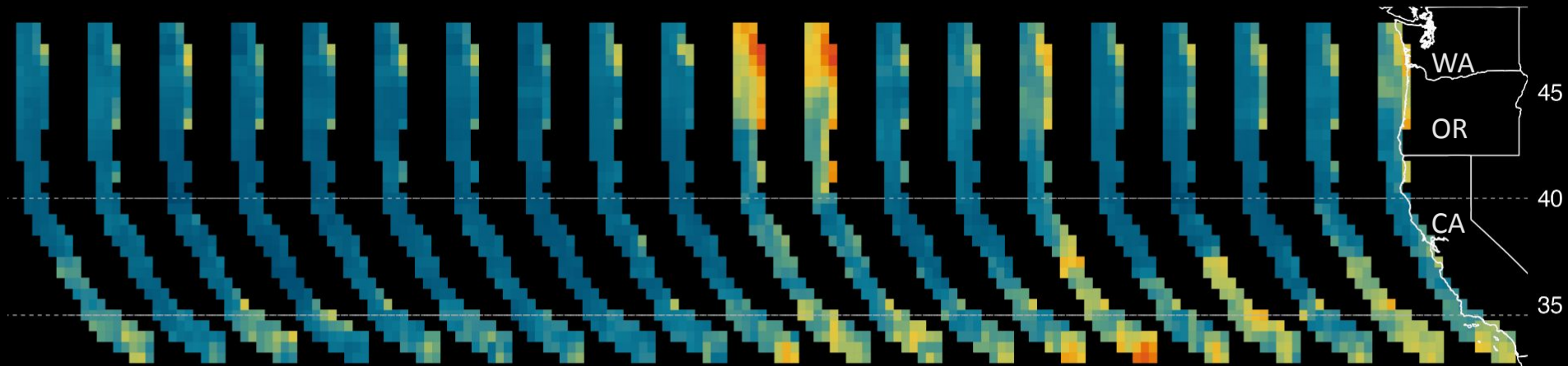


$\text{CV Dev}_{\text{test}} = 0.27, \text{rmse}_{\text{test}} = 1.3$

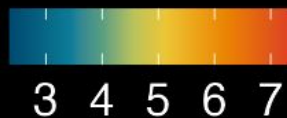
Train: 80%; Test: 20% withheld

Shifts in prey quality for top predators

2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024



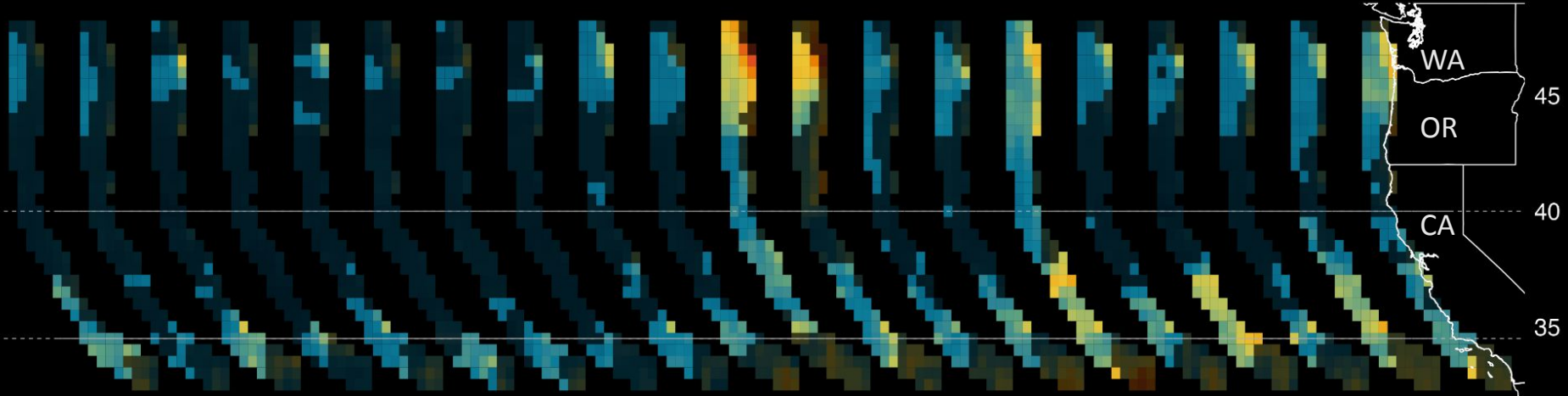
Predicted Yumminess Index



marine heatwaves

'Suitable habitat' = high quality prey & optimal SST

2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024



15-19°C

Predicted Yumminess Index

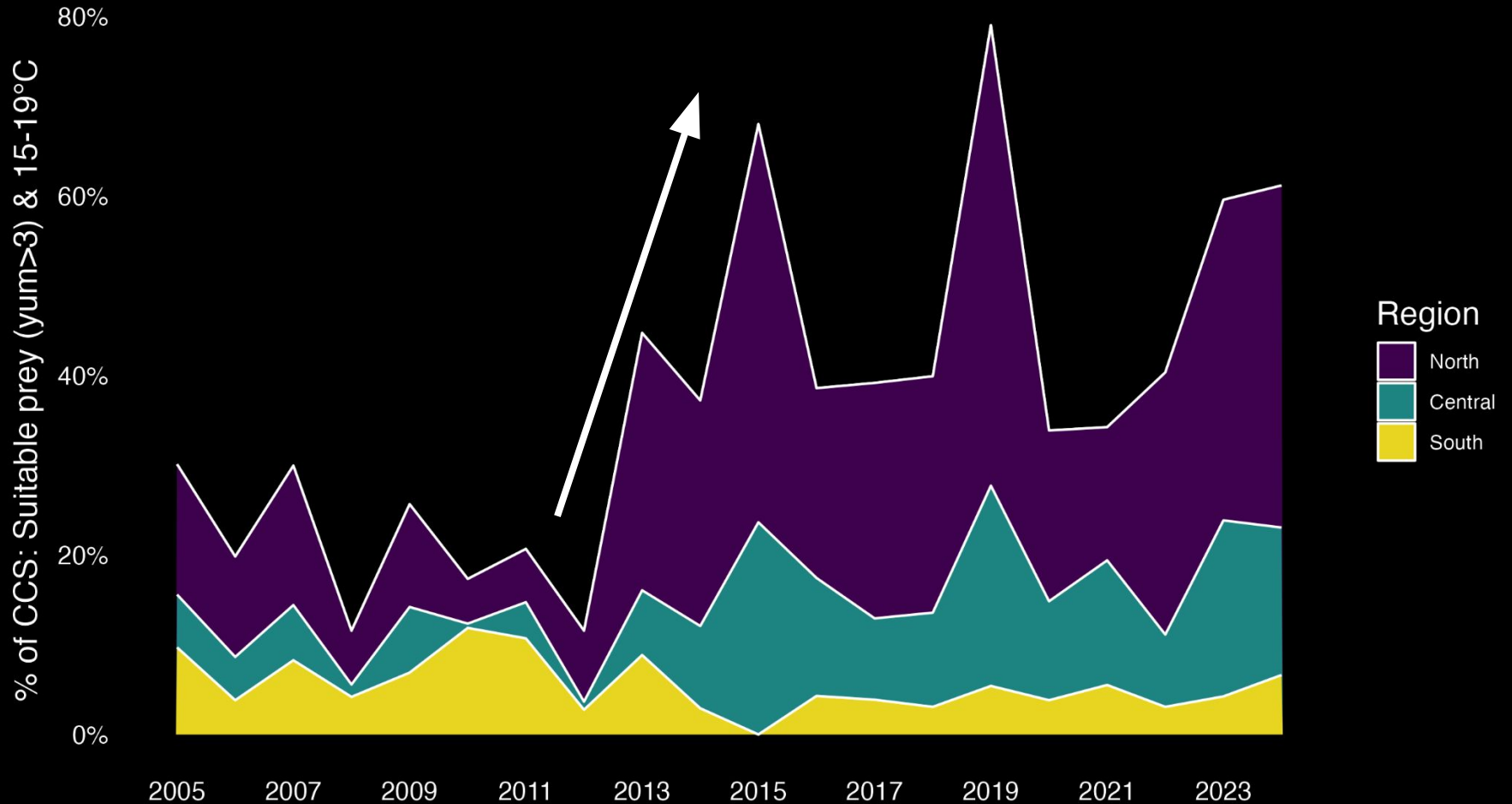


3 4 5 6 7

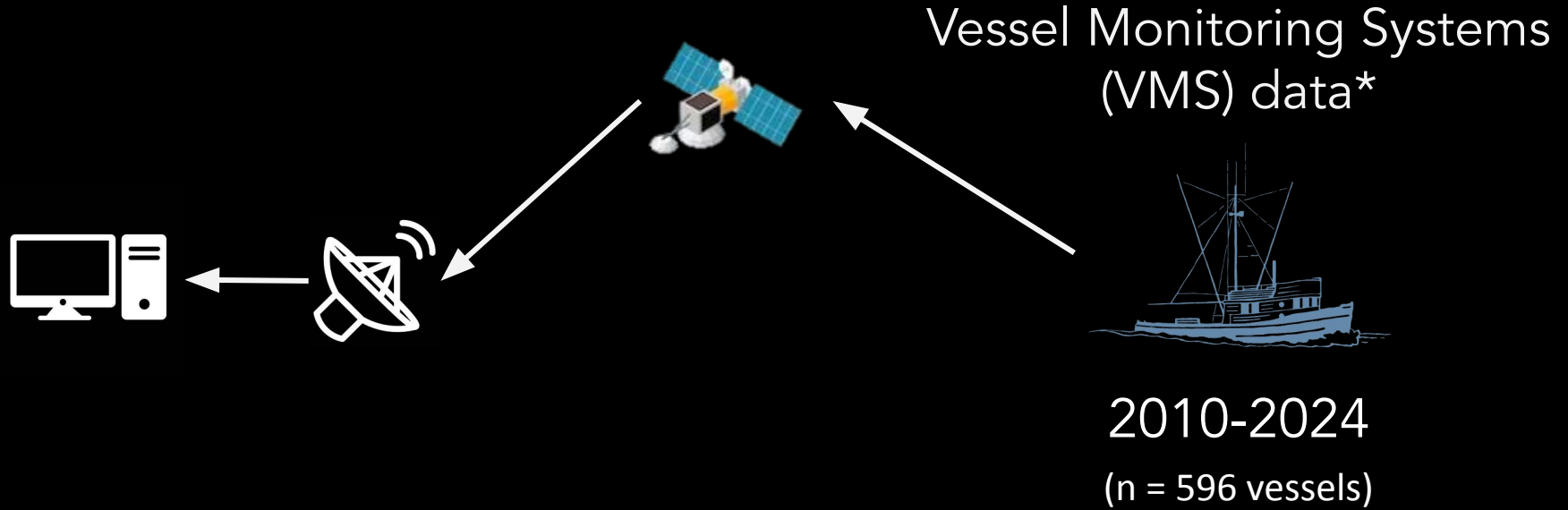
High quality prey



Expansion of 'suitable habitat'



Biological validation with fishery data

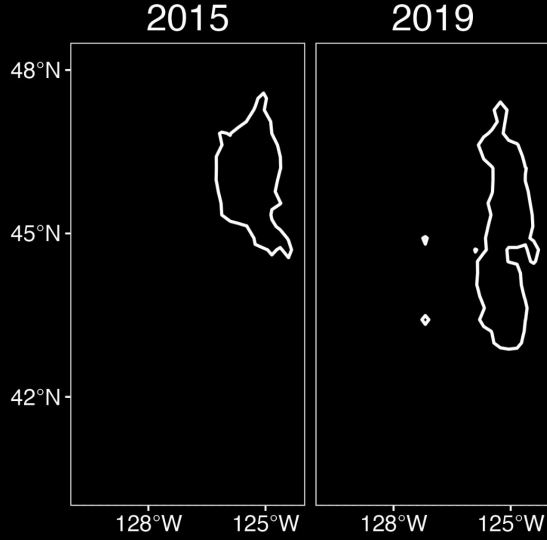


* Welch et al. (2025) *PNAS*

Biological validation with fishery data



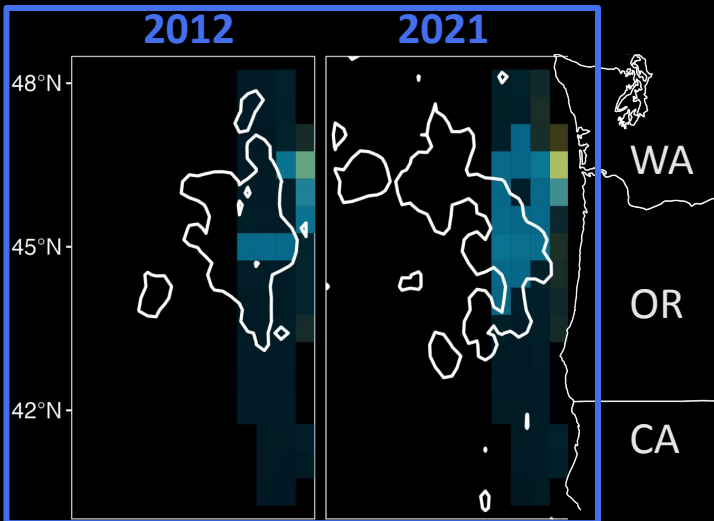
Vessel Monitoring Systems
(VMS) data*



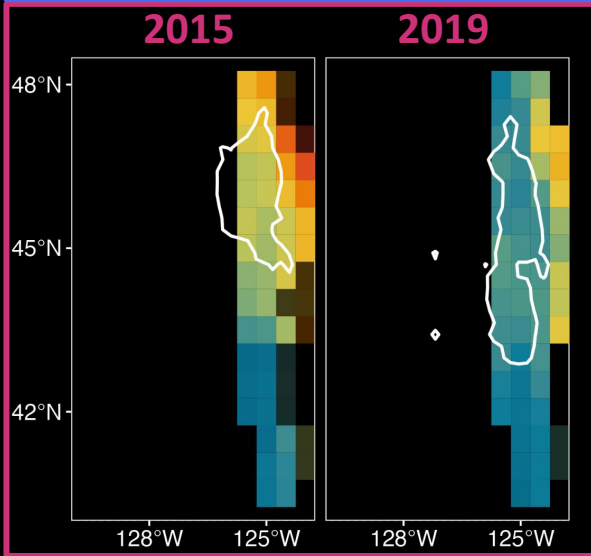
= >75% albacore fishing
vessel locations

* Welch et al. (2025) *PNAS*

Biological validation with fishery data



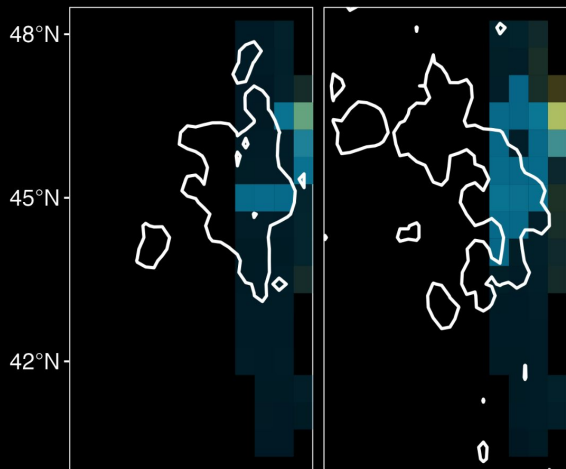
Yumminess Index



= >75% albacore fishing
vessel locations

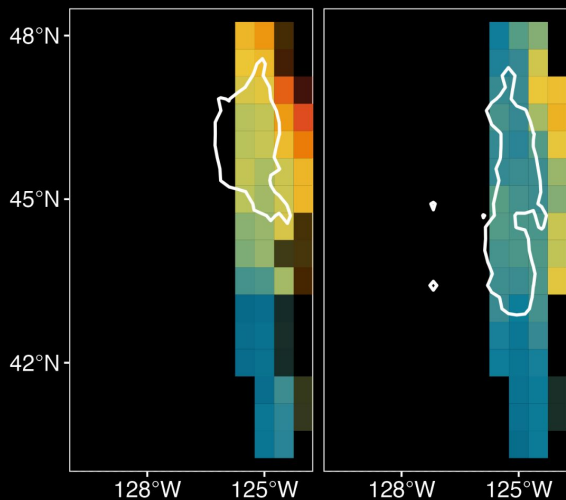
2012

2021

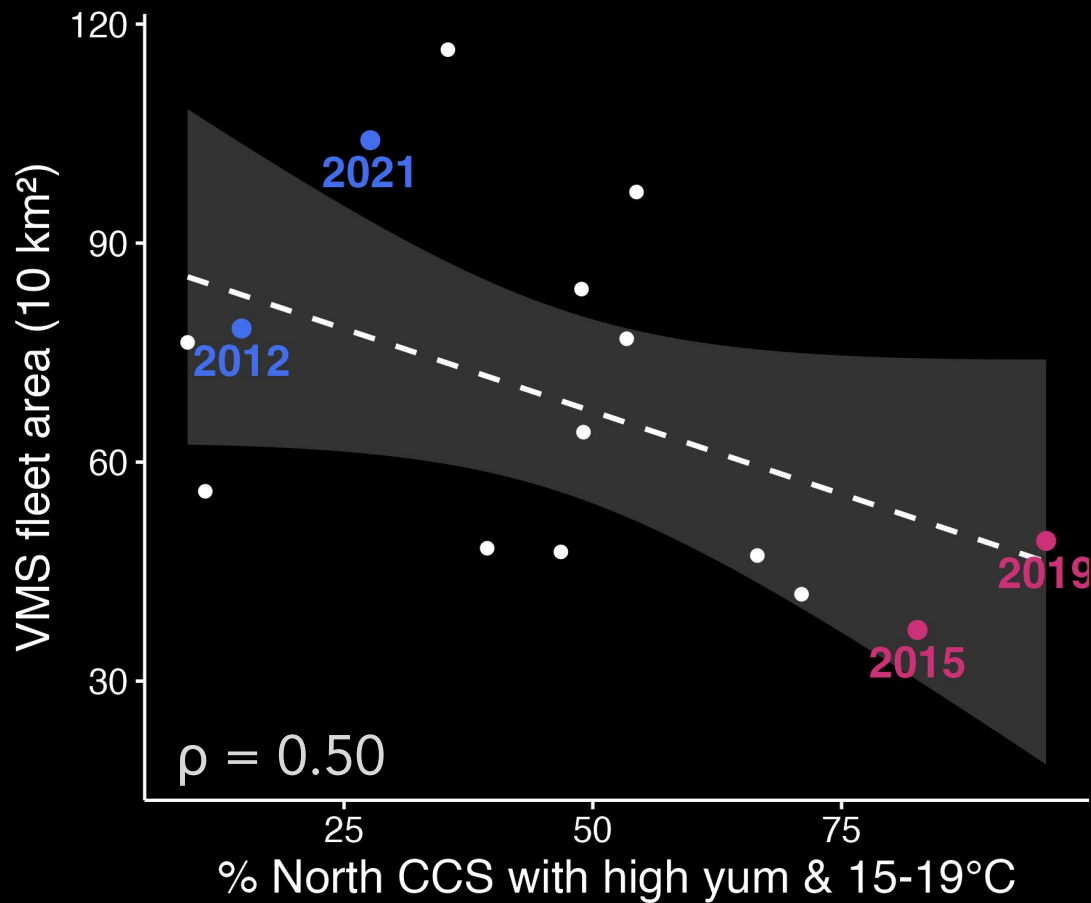


2015

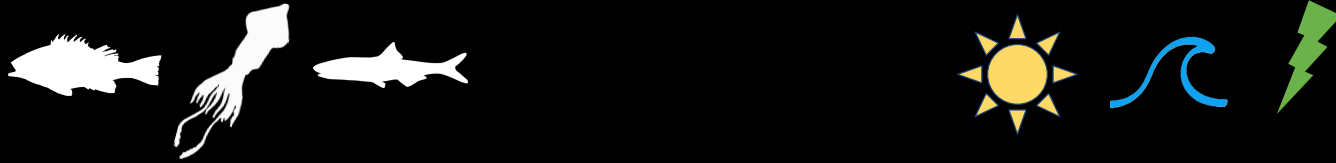
2019



Prey yumminess reflects fishing grounds



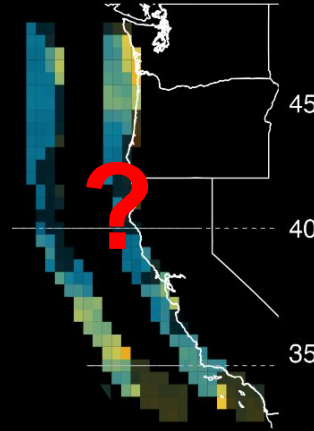
Albacore suitable habitat predictions: prey vs environment-only*



- Low correlations
- Variance: prey + sst > environment-only

Forecasting prey quality & distribution

*Where might albacore
be this year?*

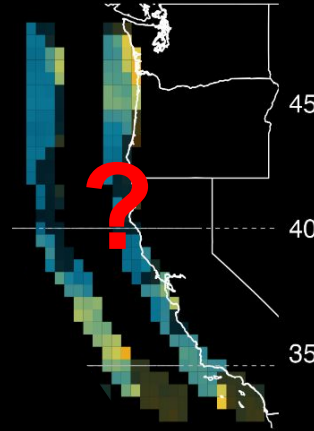


'Nowcast':

Annual albacore prey
from pre-season
conditions

Forecasting prey quality & distribution

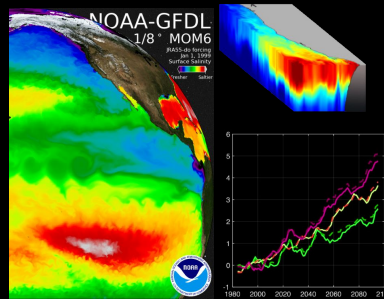
Where might albacore be this year?



'Nowcast':

Annual albacore prey from pre-season conditions

Where might albacore be in the future?



Long-term projections:

Decadal shifts in prey from climate projections

Thank you

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Stephanie Green

3:45pm

(this room!)

Pelagic Species Trait Database
& more!

Learn more about our
trait-based research

