Modelling diet shifts in a pelagic predator – albacore tuna – in relation to forage community composition and prey trait information from 2005–2019.

Project Team

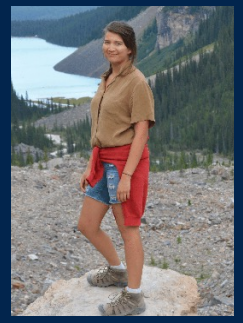
Stephanie Green

Natasha Hardy

Miram Gleiber

Larry Crowder

Cole Brookson



Caitlin Morganson

Cindy Matuch

Alana Krug-MacLeod

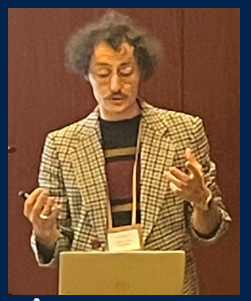
Zachary Roote

Iris George

NOAA Partners

Mike Jacox

Barb Muhling



Pierre-Yves Hernvann

Ric Brodeur

Steven Bograd

Elliott Hazen

Cat Nickels

Brian Wells

MEOPAR

LENFEST OCEAN PROGRAM

AQUATIC GLOBAL CHANGE ECOLOGY & CONSERVATION

UNIVERSITY OF ALBERTA

Stanford University

NOAA FISHERIES

Shifts in distributions projected for 15 highly migratory, top predators in the California Current System

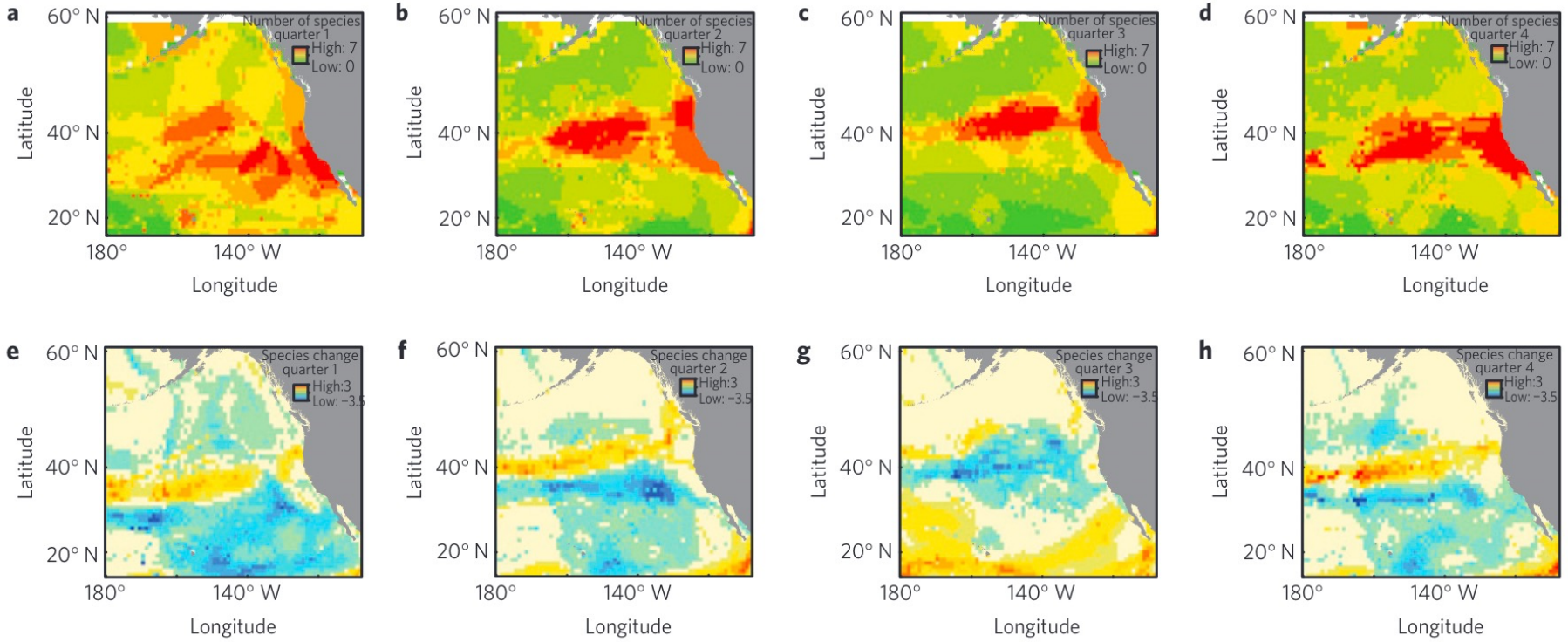
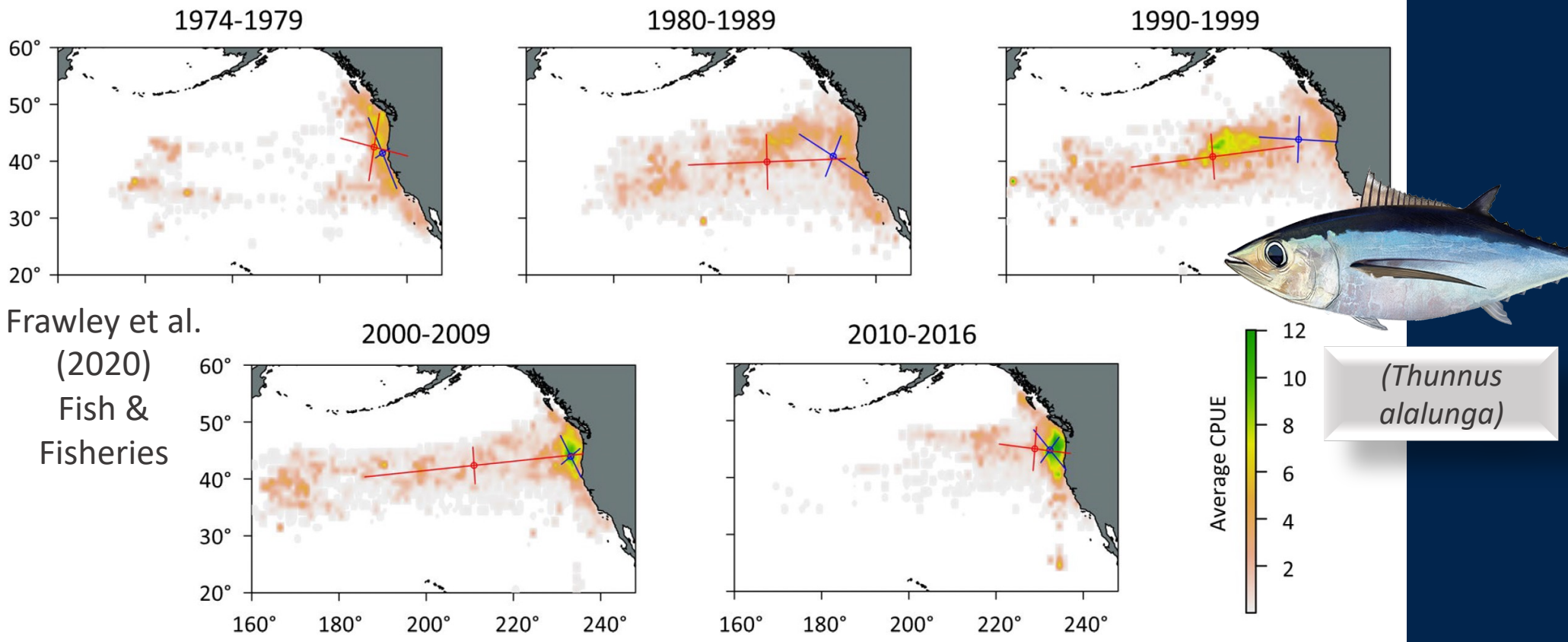


Figure 3 | Modelled species richness values and predicted changes. a–h, Quarterly modelled species richness for 2001–2010 from 15 top predator species (**a–d**) and predicted changes in species richness over the next century (2001–2020 compared with 2081–2100) (**e–h**).

Hazen et al. (2012) Nature Climate Change

Northward and offshore shift observed in fishing effort for albacore tuna

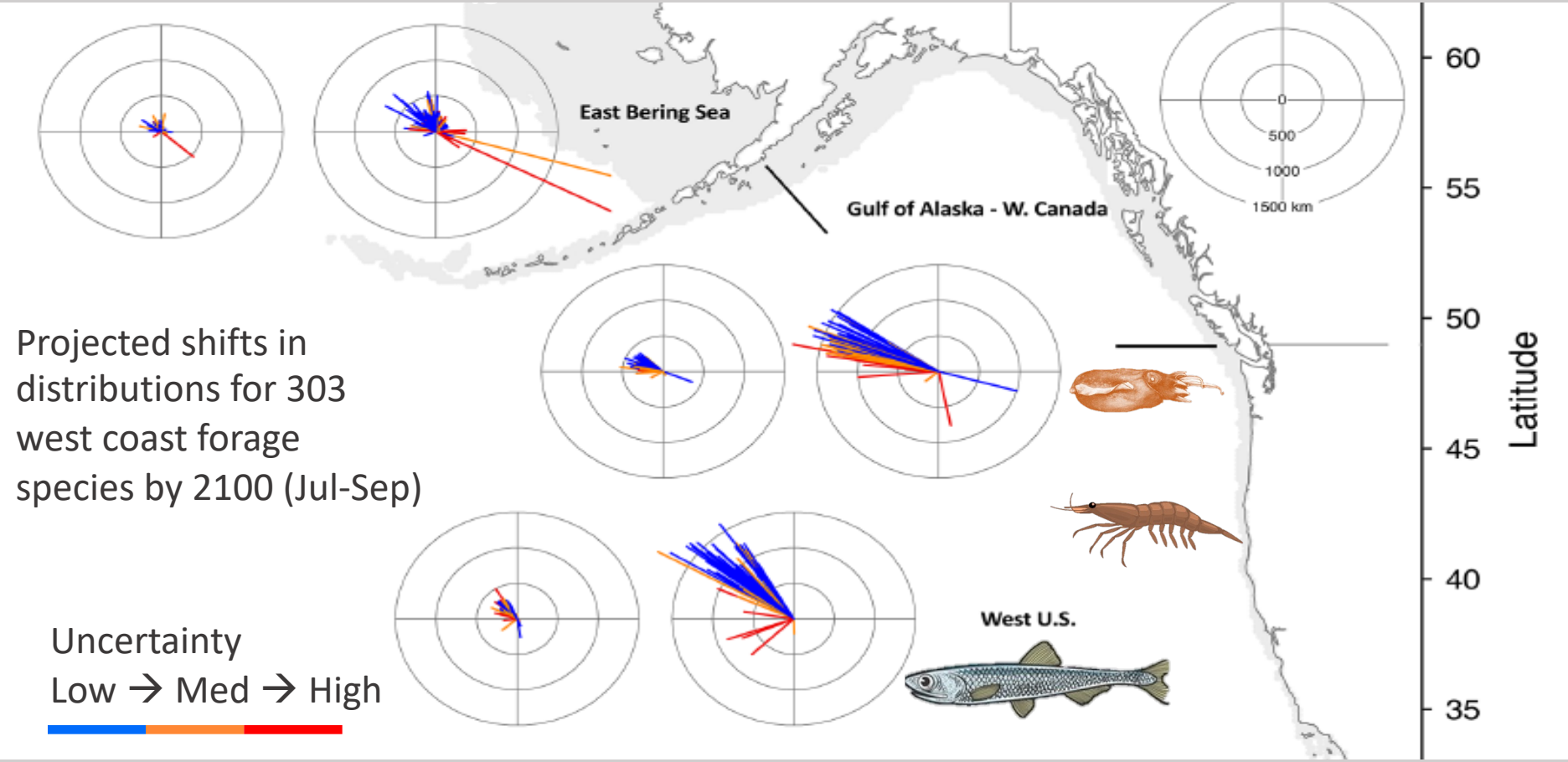


Frawley et al. (2020) Fish & Fisheries

(Thunnus alalunga)

FIGURE 1 North Pacific albacore catch per unit effort (total fish/total hours aggregated by 1° × 1° degree grid cells) averaged across each decade, as reported in US troll and pole-and-line albacore fleet logbooks. Centre of gravity and inertia of small (blue; <45 ft) and large (red; >60 ft) vessel fishing effort are shown for each decade. Figure appears in colour in the online version only

Shifts are projected in thermal habitat and distributions for over 303 west coast forage species

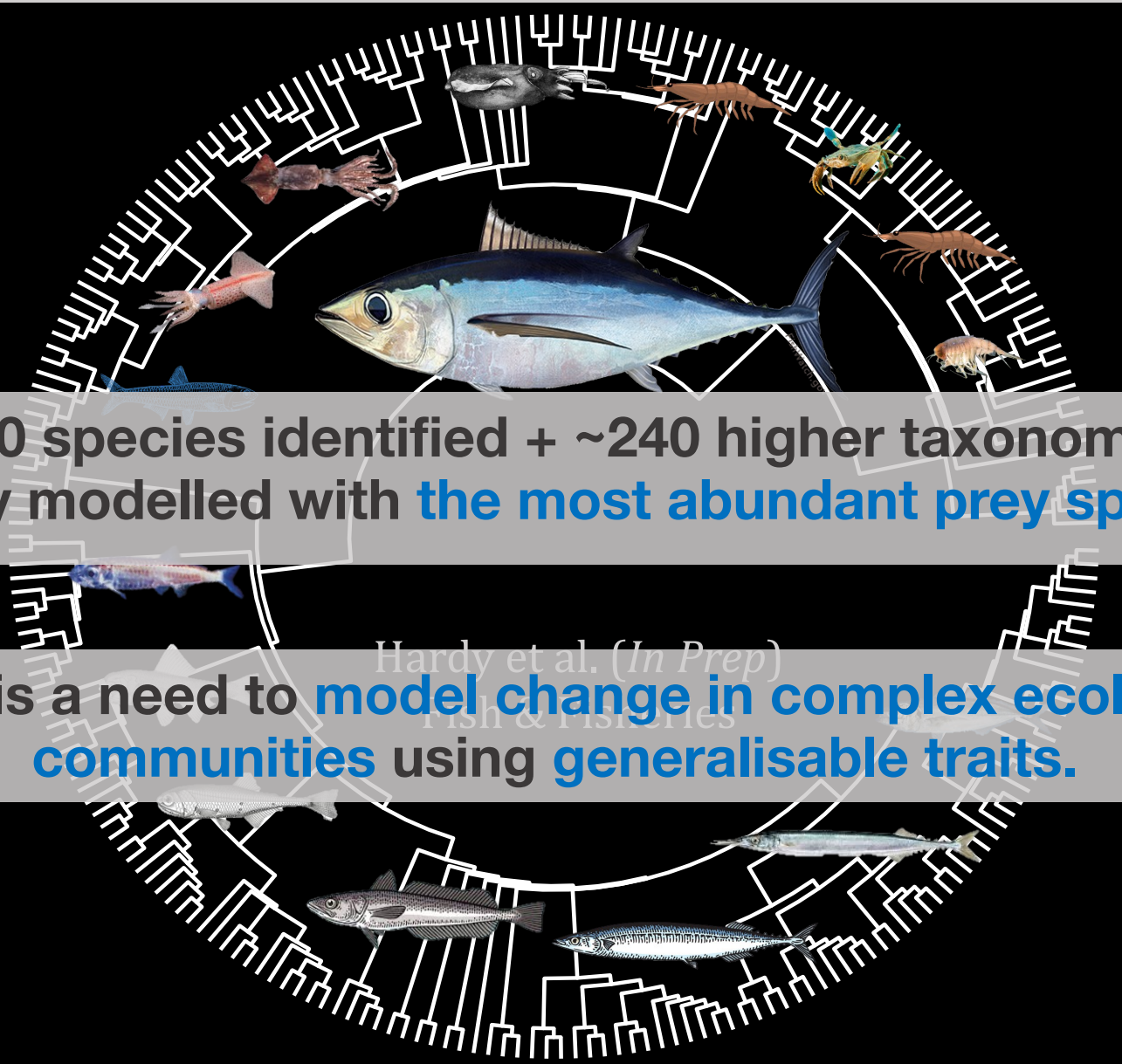


Projected shifts in distributions for 303 west coast forage species by 2100 (Jul-Sep)

Uncertainty
Low → Med → High

There is a knowledge gap in understanding how changing productivity and distribution of key forage taxa affects that of albacore tunas.

Large biodiversity of predator-prey interactions identified for albacore tuna



Over 300 species identified + ~240 higher taxonomic level
Typically modelled with **the most abundant prey species…**

There is a need to **model change in complex ecological communities** using **generalisable traits.**

Hardy et al. (*In Prep*)
Fish & Fisheries

Functional trait information mediate predation processes

Habitat position

Nutritional value

Aggregation behavior

Physical defenses

Encounter → **Attack** → **Capture** → **Consume**

Activity pattern (e.g. diel migration)

Coloration

Body shape

Body size

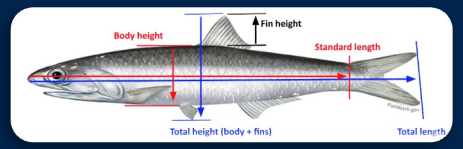
Lindardich, Brookson, Green (2021), Green et al. (2019), Green & Côté (2014)

Modelling predator-prey interactions with species functional trait information

Trait modules include 58 traits for > 500 species of SPF:

1. Habitat use, aggregation & predator avoidance behavior
2. Morphological metrics
3. Nutritional composition

Gleiber et al. (2022) Dataverse + (In Prep) Scientific Data



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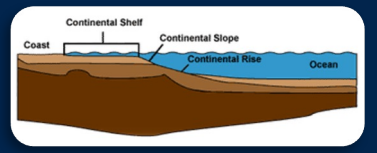

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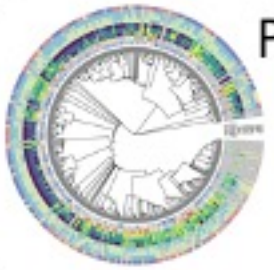


Pelagic Species Trait Database

doi:10.5683/SP3/0YFJED

UNIVERSITY OF ALBERTA

borealis

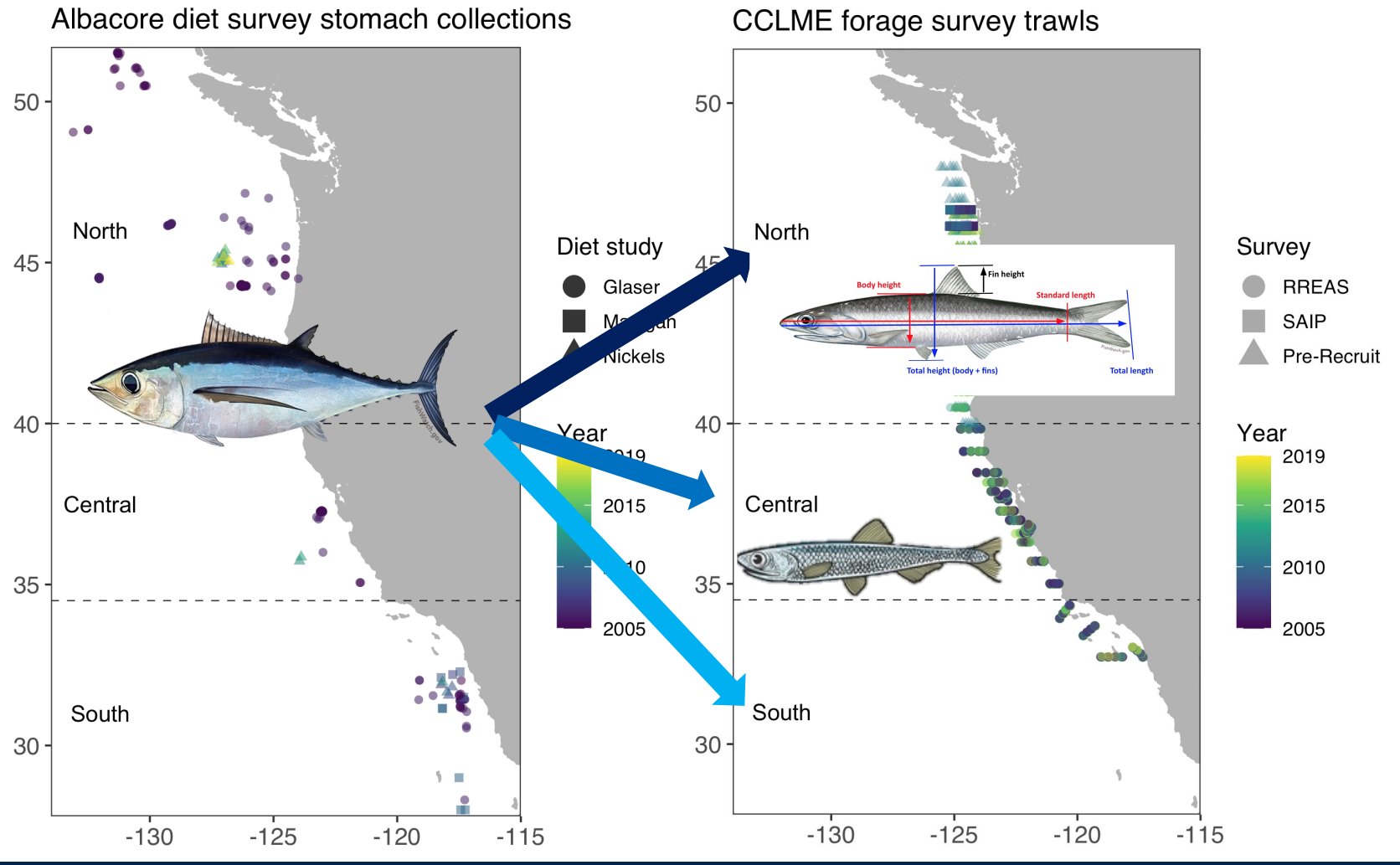
The Dataverse® Project

To simplify diverse predator-prey interactions and generalise across ecosystems

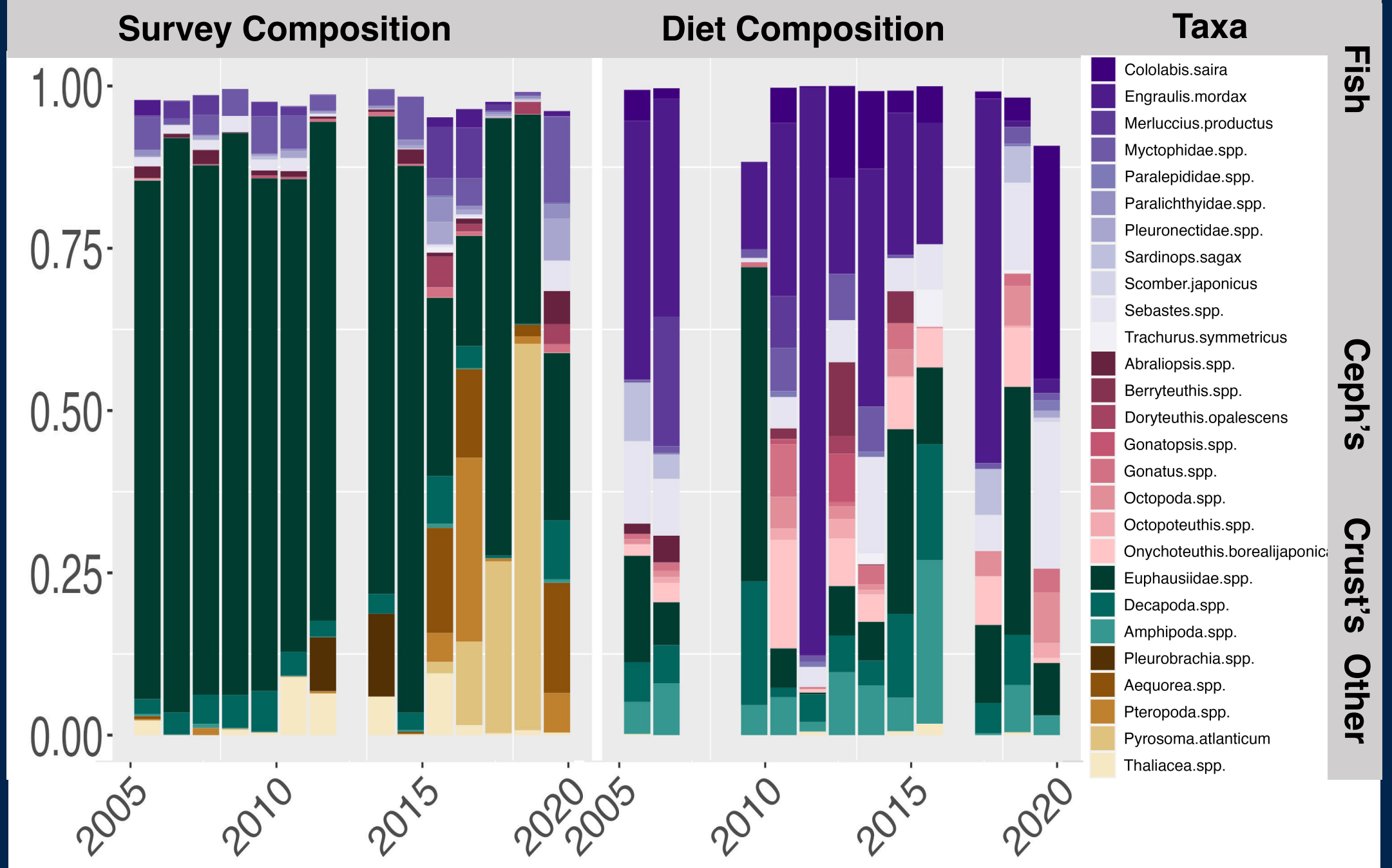
Research question

How does albacore diet composition shift ~

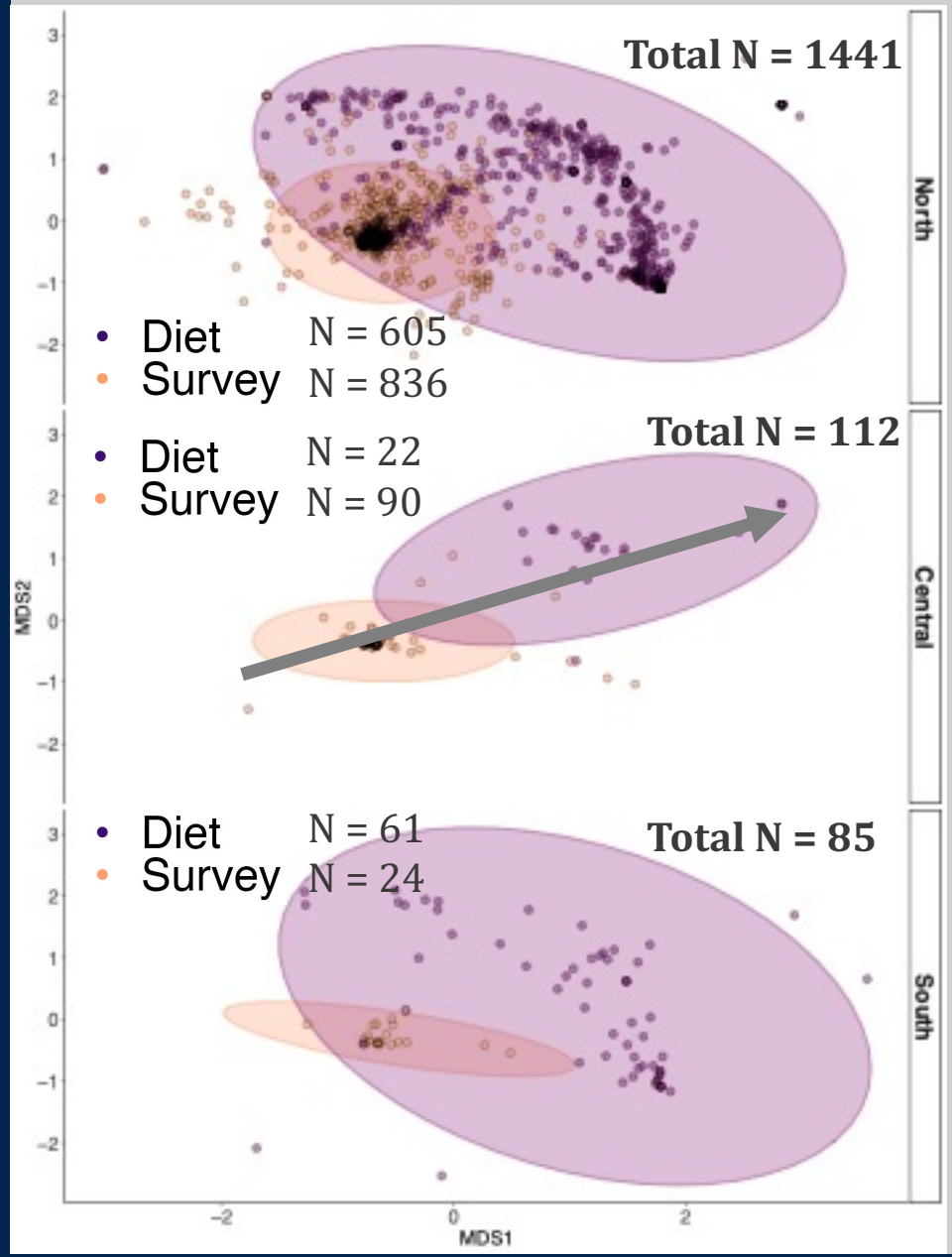
- **Forage community composition**
- **And prey trait information**
- **Regions of the CCLME and years sampled**



Diet and forage community composition across years



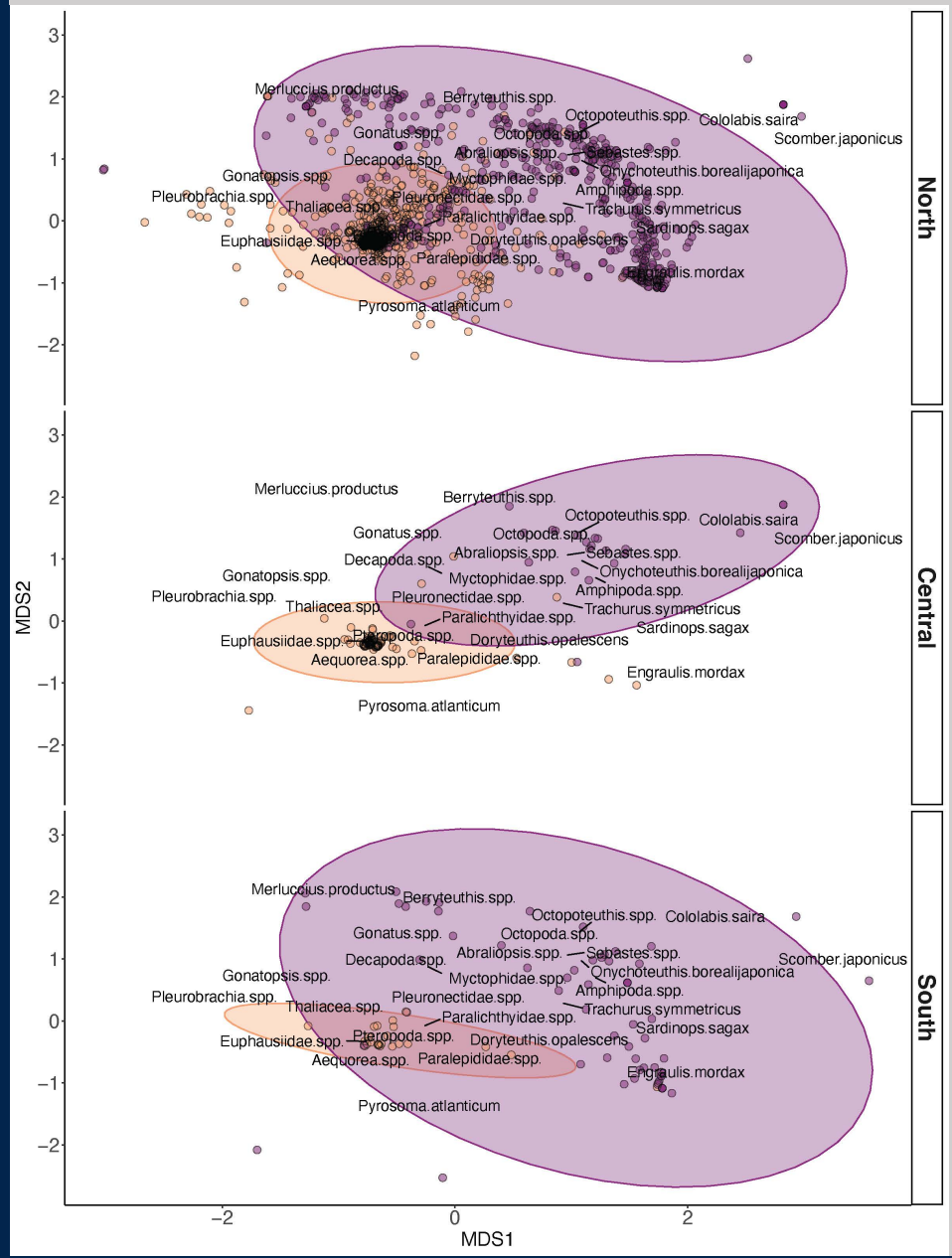
Diet and forage community composition differences and overlap

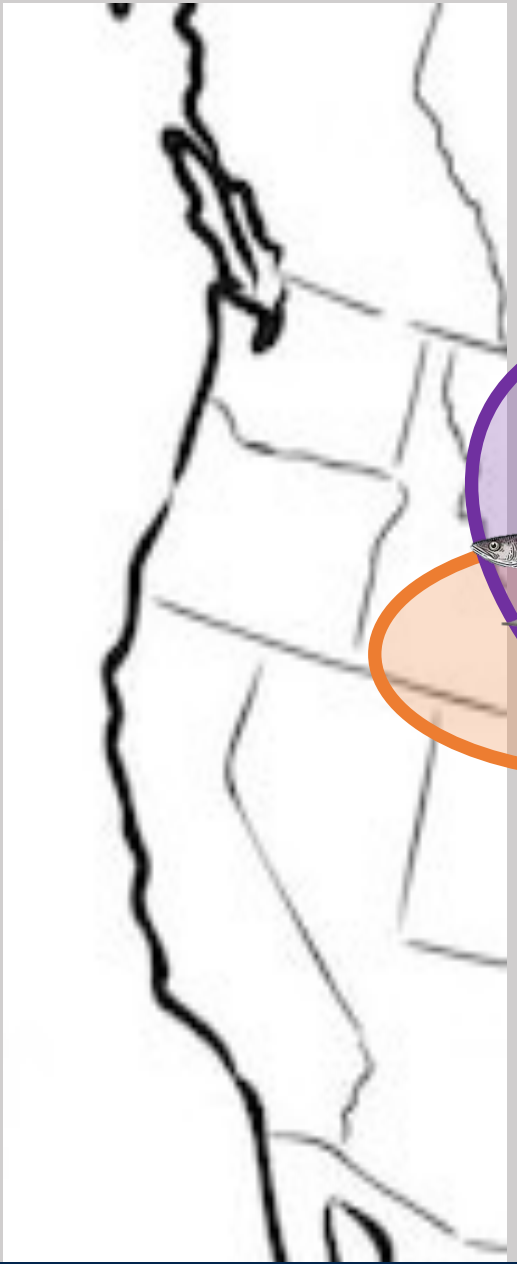


Results

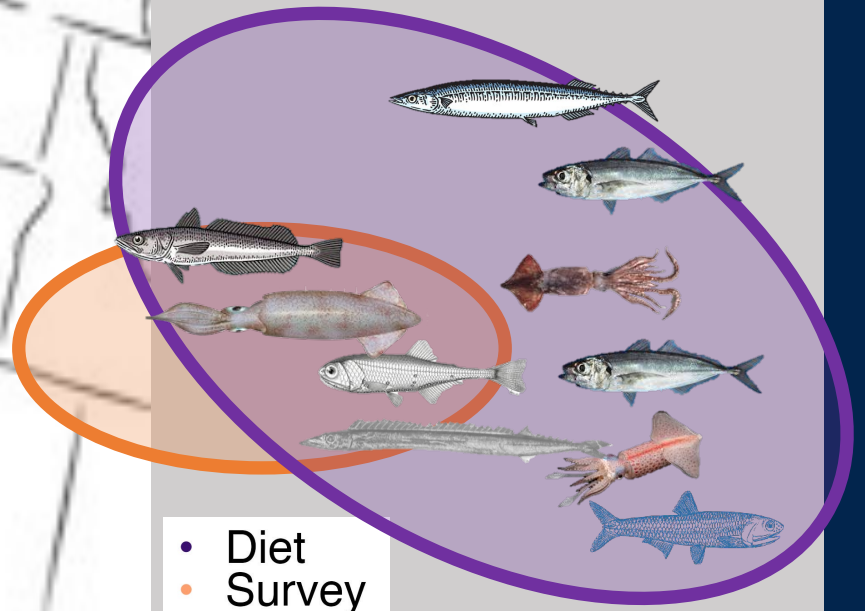
- Significant **difference in composition of samples from different resource users** – diet vs. survey.
- And to a lesser extent between regions of the CCLME.

Diet and forage community composition differences and overlap



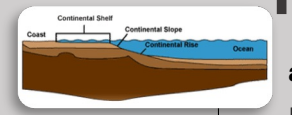


➢Broad albacore diet, with **areas of overlap** for some systematically **surveyed species**

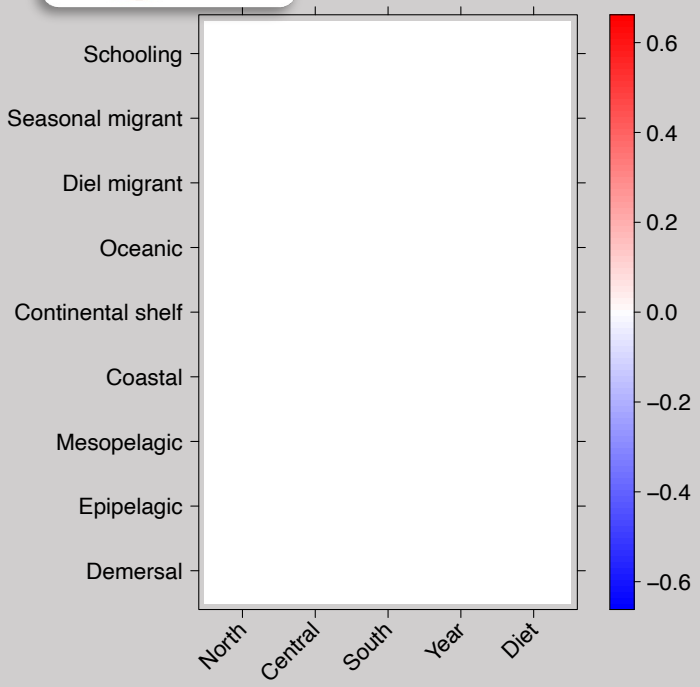


➢Explanatory species consistent.

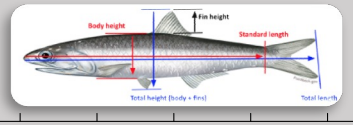
Trait-based relationships explain diet composition

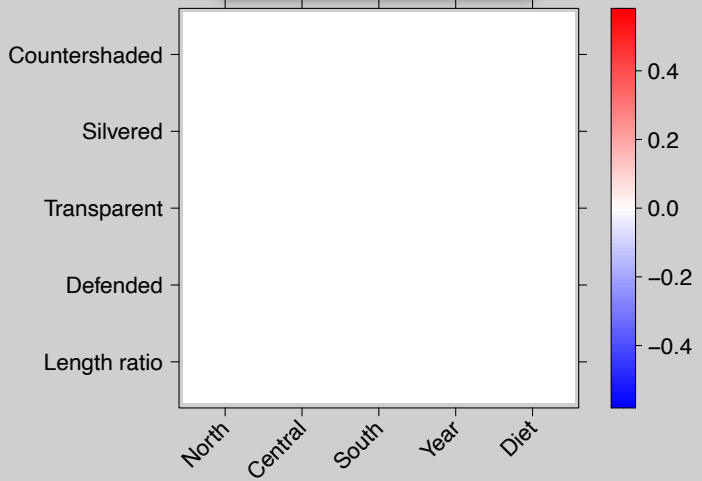


a) Habitat use

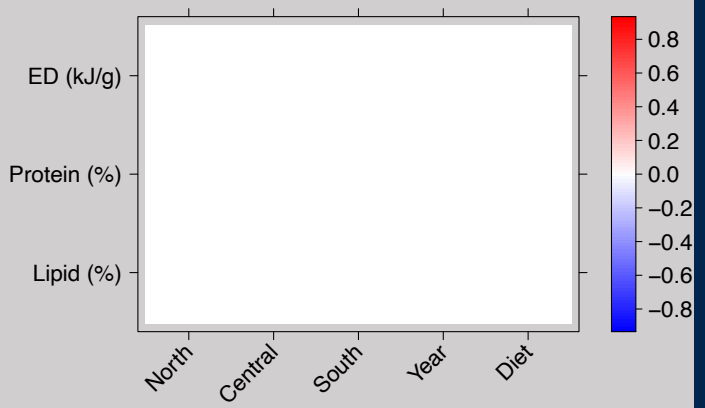


b) Morphological





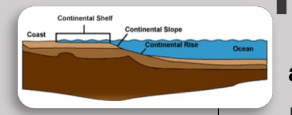
c) Nutritional Composition



Methods

➢ **Combined RLQ (ordination-based) and 4th corner (model-based) frameworks for community and multi-matrix modelling**

Trait-based relationships explain diet composition



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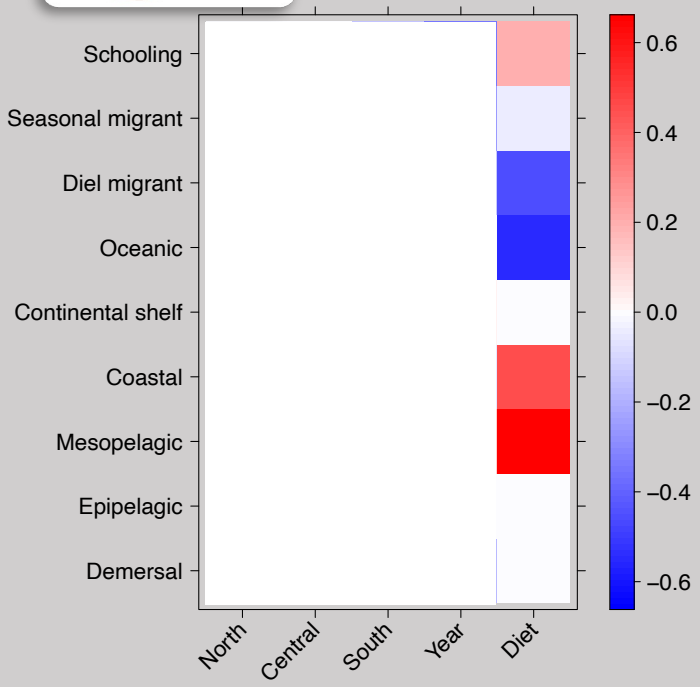

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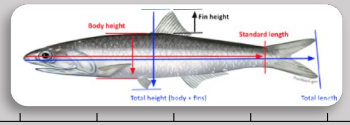
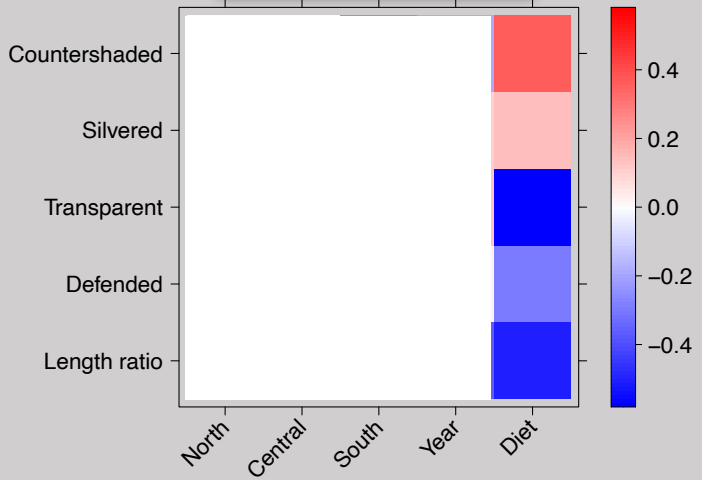
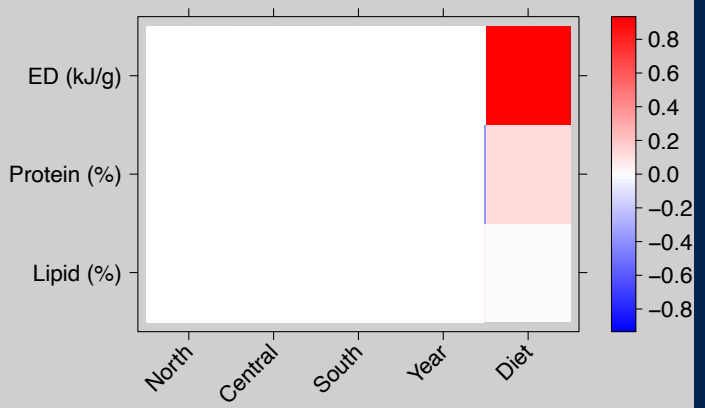




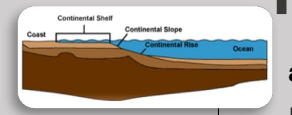
c) Nutritional Composition



Results

➢ **Traits mediate variance** in albacore diet and survey sample composition

Trait-based relationships explain diet composition



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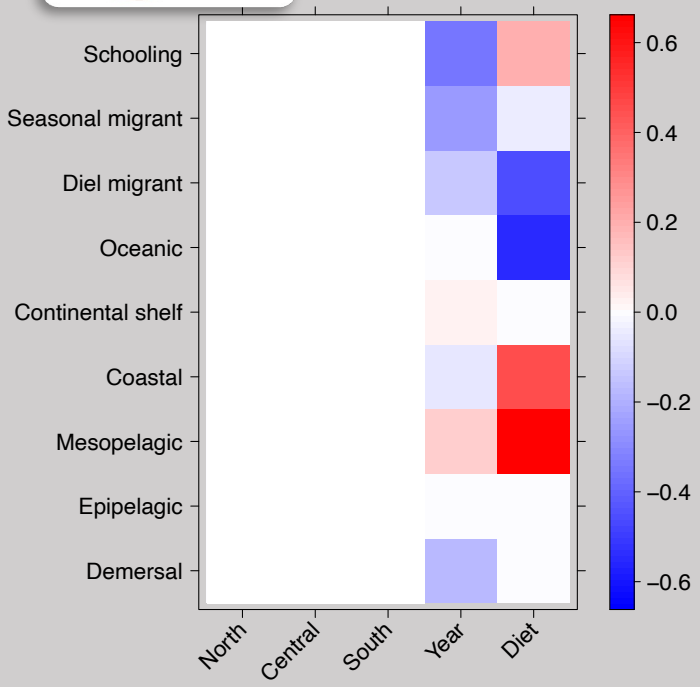

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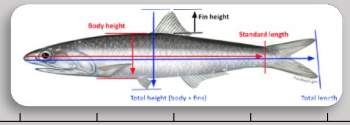
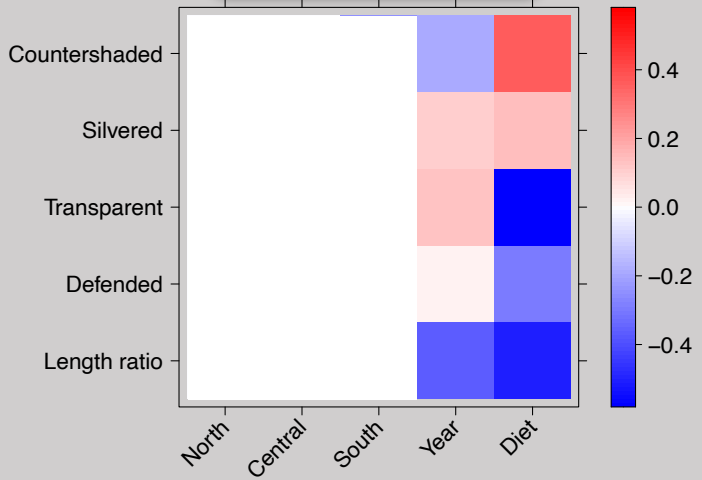
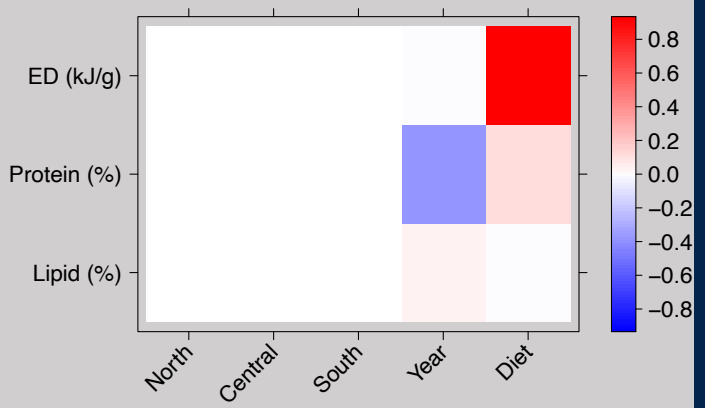




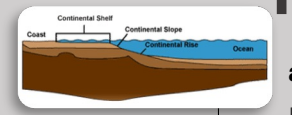
c) Nutritional Composition



Results

- **Traits mediate variance** in albacore diet and survey sample composition
- To a lesser extent **year**

Trait-based relationships explain diet composition



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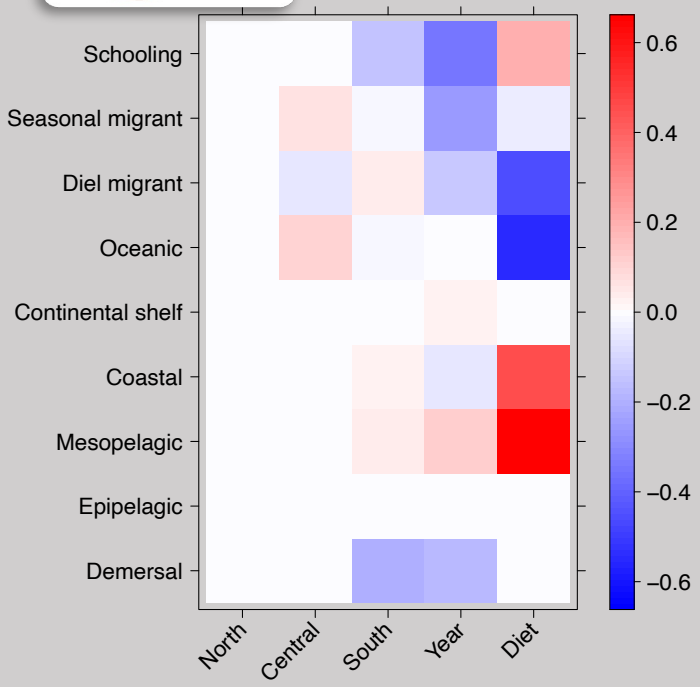

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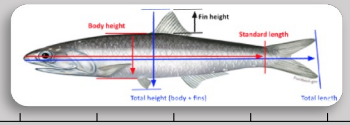
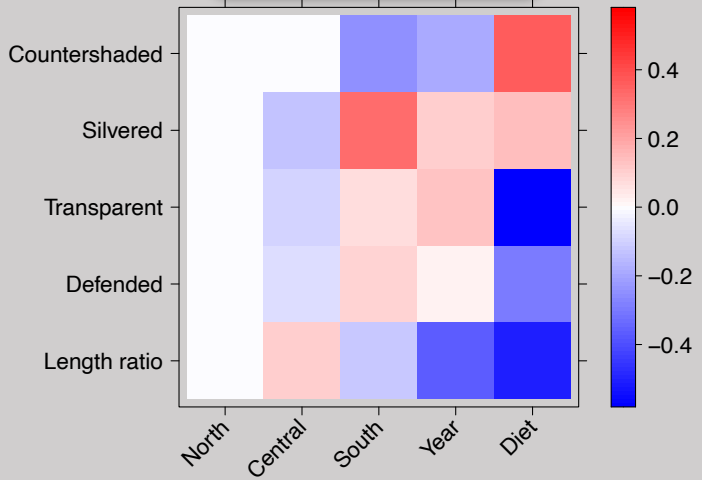
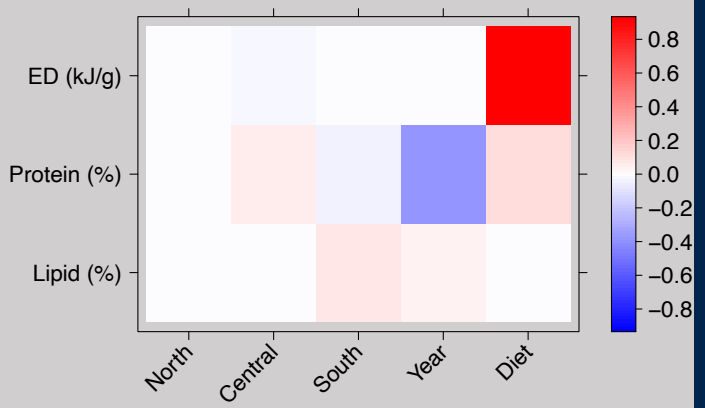




c) Nutritional Composition

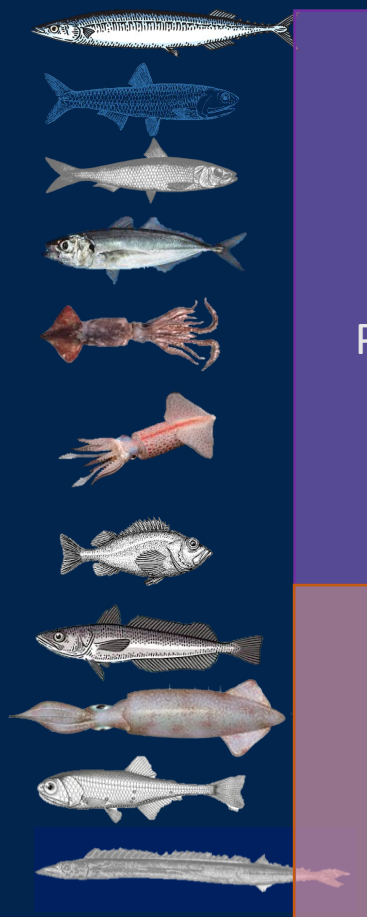


Results

- **Traits mediate variance** in albacore diet and survey sample composition
- To a lesser extent **year and region**

Indicator species and traits

Key Taxa

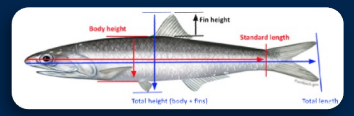


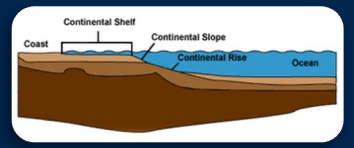
Saury
Anchovy
Sardine
Chub & jack mackerels
Boreal clubhook squid
Pelagic octopoteuthid &
Gonatid squids
Octopoda
Armhook squid (N)

Rockfishes
Hake
Market squid
Myctophids
Barracudinas

Key Traits

Albacore diet composition





Forage community composition

Energy density

Silvered &
Countershaded Colouration
Undefended

Coastal epipelagics
Offshore mesopelagics
Non-diel migrants

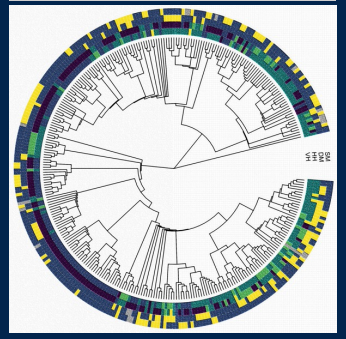
Shelf & demersal taxa
Epipelagics
Protein & lipid content

Next Steps

Albacore diet shifts

→

Species Key Traits



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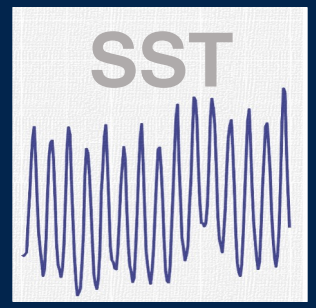
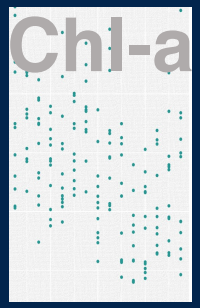
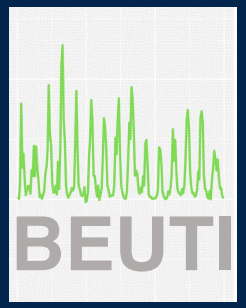
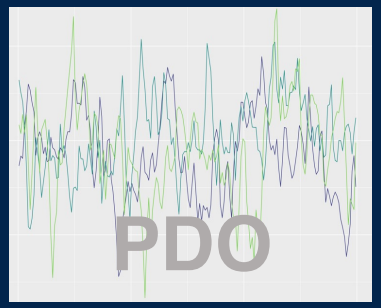
Environmental variables









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(1|year 2005–2019)

Modelling diet shifts using GAMM

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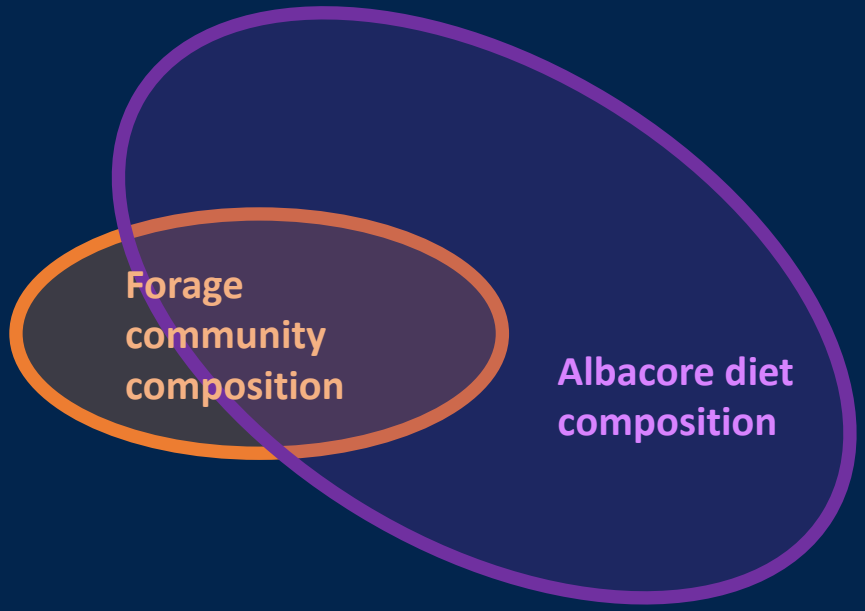
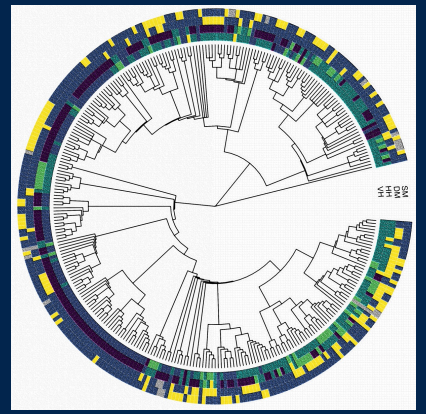
Region CCLME

Take Aways

- Broad sampling albacore compared to surveys
- Need to preserve these systematic surveys → insight on predator prey interactions.
- Also need systematic sampling of key traits, growth and maintenance of species trait information databases
- Importance of energy density





Session 4, Sala 1@ 12pm

Alana Krug-McLeod →

Effect of climate state on variation in nutritional value for small pelagic species

Lenfest Ocean Program Webinar →

Dec. 1, 11am PT, 7pm GMT

Thank you