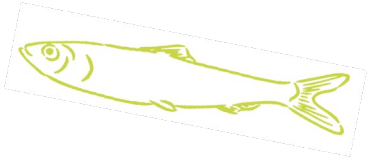
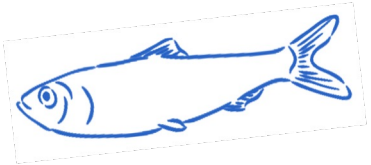
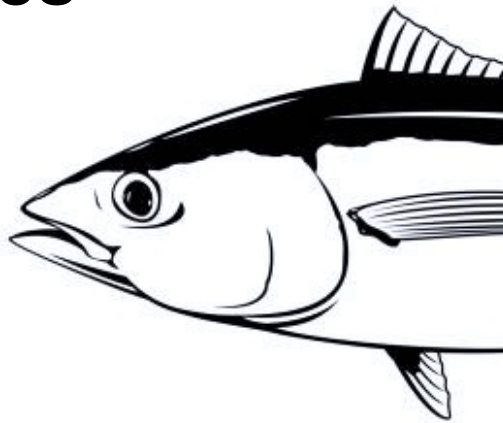
Effect of climate state on variation in nutritional value for small pelagic species

11/11/22







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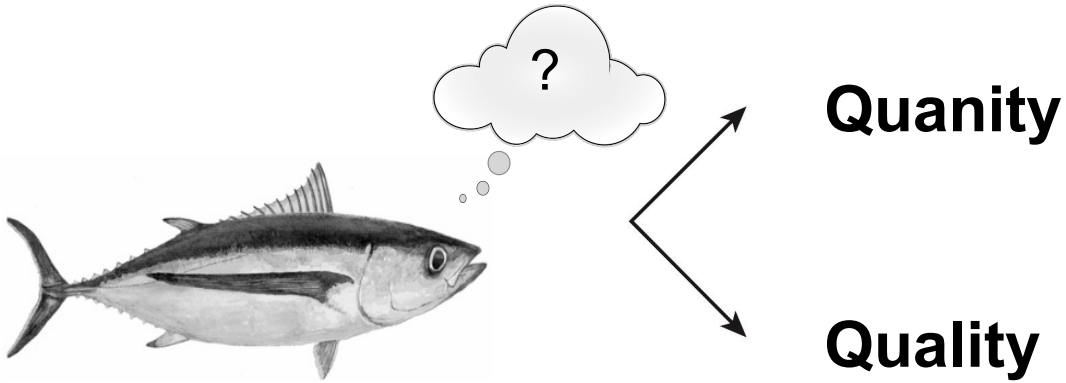
[1]University of Alberta, Edmonton, AB, Canada. [2]Stanford University, Stanford, CA, USA.



adapted from Machovsky-Capuska & Raubenheimer, 2020

OCEANFRESH MARKET

We price by % lipids, % protein, energy density!

- % Lipid, % Protein

  (+ dry matter & ash)

- Energy density

Nutritional quality is influenced by environment

Energy Density

- Year
  McKinstry et al. 2013

Between species

- Month
- Geographic location
  Anthony et al., 2000

Within species

Nutritional quality is influenced by environment

% Lipids

- Year
- Season
- Sea surface temp.
- Upwelling
- Geographic location

Deng et al., 1976; Fisher et al., 2020; Hellessey et al. 2018; Litz et al., 2010; McKinstry et al., 2013; Miller et al., 2017

Nutritional quality is influenced by environment

% Lipids

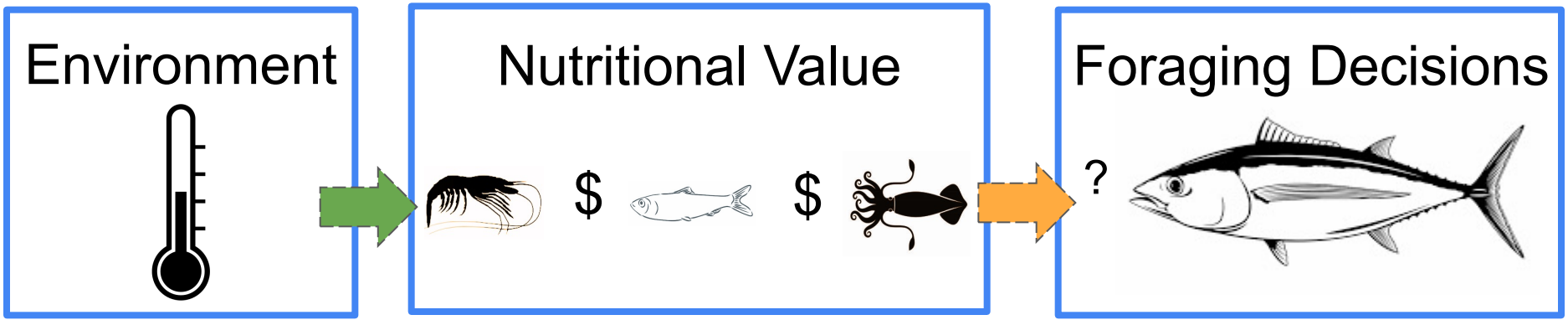
- Year
- Season
- Sea surface temp.
- Upwelling
- Geographic location

Deng et al., 1976; Fisher et al., 2020; Hellessey et al. 2018; Litz et al., 2010; McKinstry et al., 2013; Miller et al., 2017

… But detailed information on the response of body composition to climate variation is limited

Aim

to understand influence of environment and nutritional value on foraging decisions



Key Questions:

How does nutritional composition of albacore prey species vary?

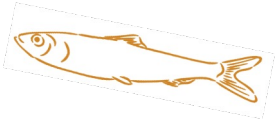
Key Questions:

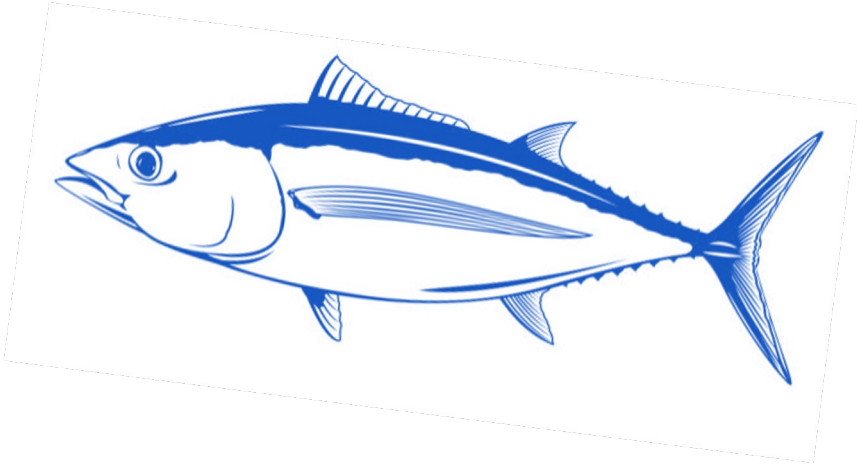
How does nutritional composition of albacore prey species vary?

Can variation be linked with environmental conditions?

Albacore as the lense

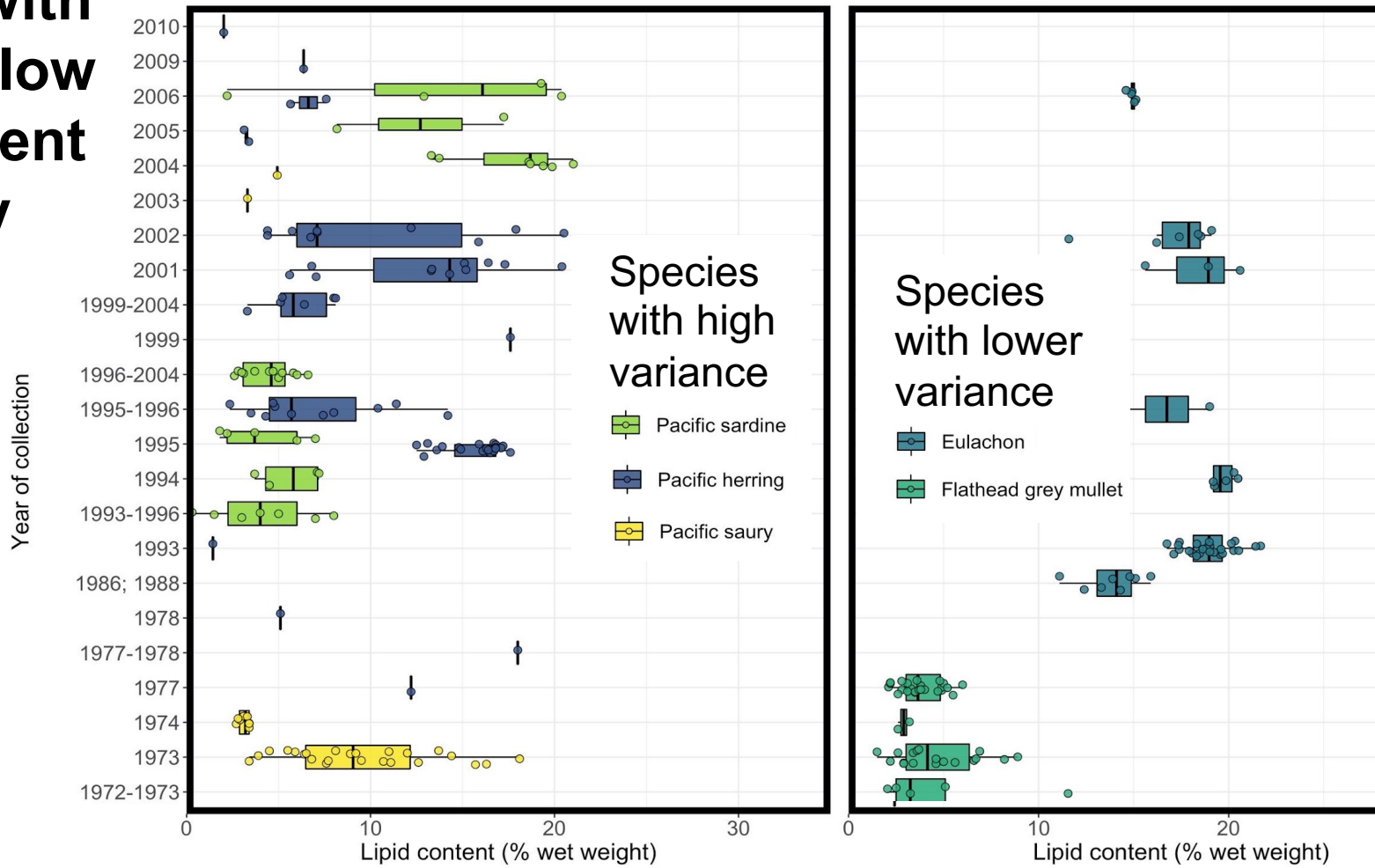
- commercially important
- pelagic
- apex predator





+ albacore prey
- diverse, range of niches

Species with high and low lipid content variability



Pelagic Species Trait Database
doi:10.5683/SP3/0YFJED
UNIVERSITY OF ALBERTA
borealis

Pacific Dataset→ few species with all metrics

LIPID		
Scientific Name	**Common Name**	**n**
Clupea pallasii	Pacific herring	69
Thaleichthys pacificus	Eulachon	57
Euphausia pacifica	North pacific krill	44
Cololabis saira	Pacific saury	35
Sardinops sagax	Pacific sardine	23
Atherinopsis californiensis	Jacksmelt	20
Cymatogaster aggregata	Shiner perch	19
Oncorhynchus keta	Chum salmon	18
Ammodytes hexapterus	Pacific sand lance	16
Diaphus theta	California headlightfish	12
Microgadus proximus	Pacific tomcod	12
Thysanoessa spinifera	Krill	10
Thetys vagina	Twin tailed salp	7

PROTEIN		
Scientific Name	**Common Name**	**n**
Thaleichthys pacificus	Eulachon	47
Clupea pallasii	Pacific herring	45
Euphausia pacifica	North pacific krill	10

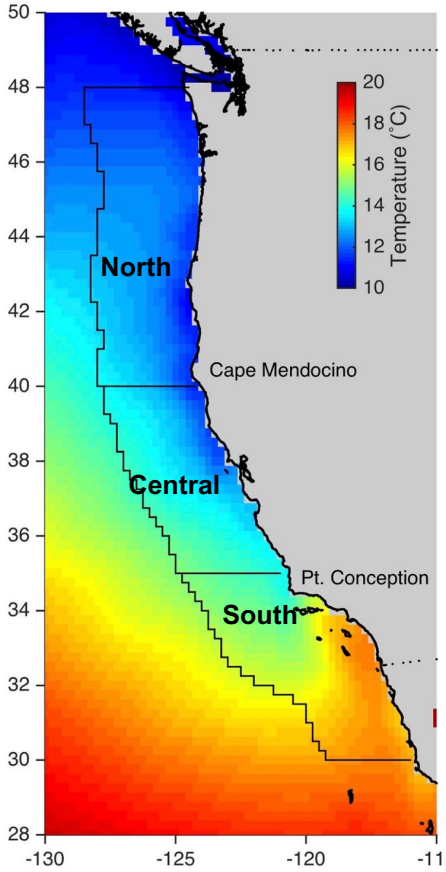
ENERGY DENSITY		
Scientific Name	**Common Name**	**n**
Clupea pallasii	Pacific herring	101
Thaleichthys pacificus	Eulachon	43
Anoplopoma fimbria	Sablefish	20
Sebastes spp.	Rockfish	12
Onychoteuthis borealijaponica	Boreal clubhook squid	11
Gonatopsis borealis	Boreopacific gonate squid	6

Makes it complicated to isolate drivers of variation

The California Current Large Marine Ecosystem

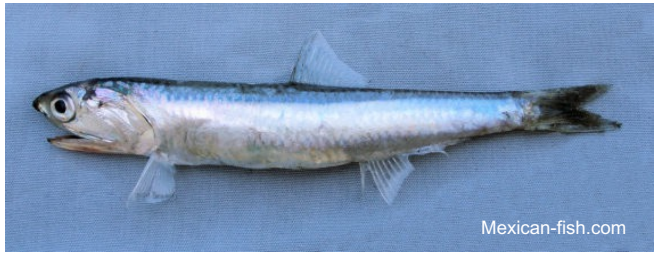
- a diverse and productive marine ecoregion
- has a natural environmental gradient
- experiencing strong climate change pressures

(Cannizzo, 2021; Poloczanska et al., 2016)



Adapted from Jacox et al., 2019

California Current Focus Species



• Doryteuthis opalescens • Onychoteuthis borealijaponica • Symbolophorus californiensis
• Engraulis mordax • Pyrosoma atlanticum

From the 2021 Summer CPS Survey

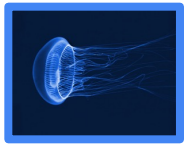
Market Squid
n North = 7
n South = 18

Pyrosome
n North = 2
n South = 3

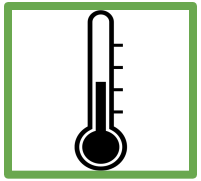
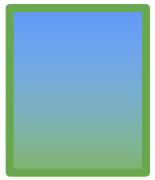
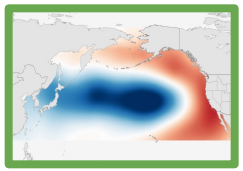
Anchovy
n North = 12
n South = 10

Bigfin Lanternfish
n North = 17
n South = 15

Boreal Clubhook Squid
n North = 7
n South = 16

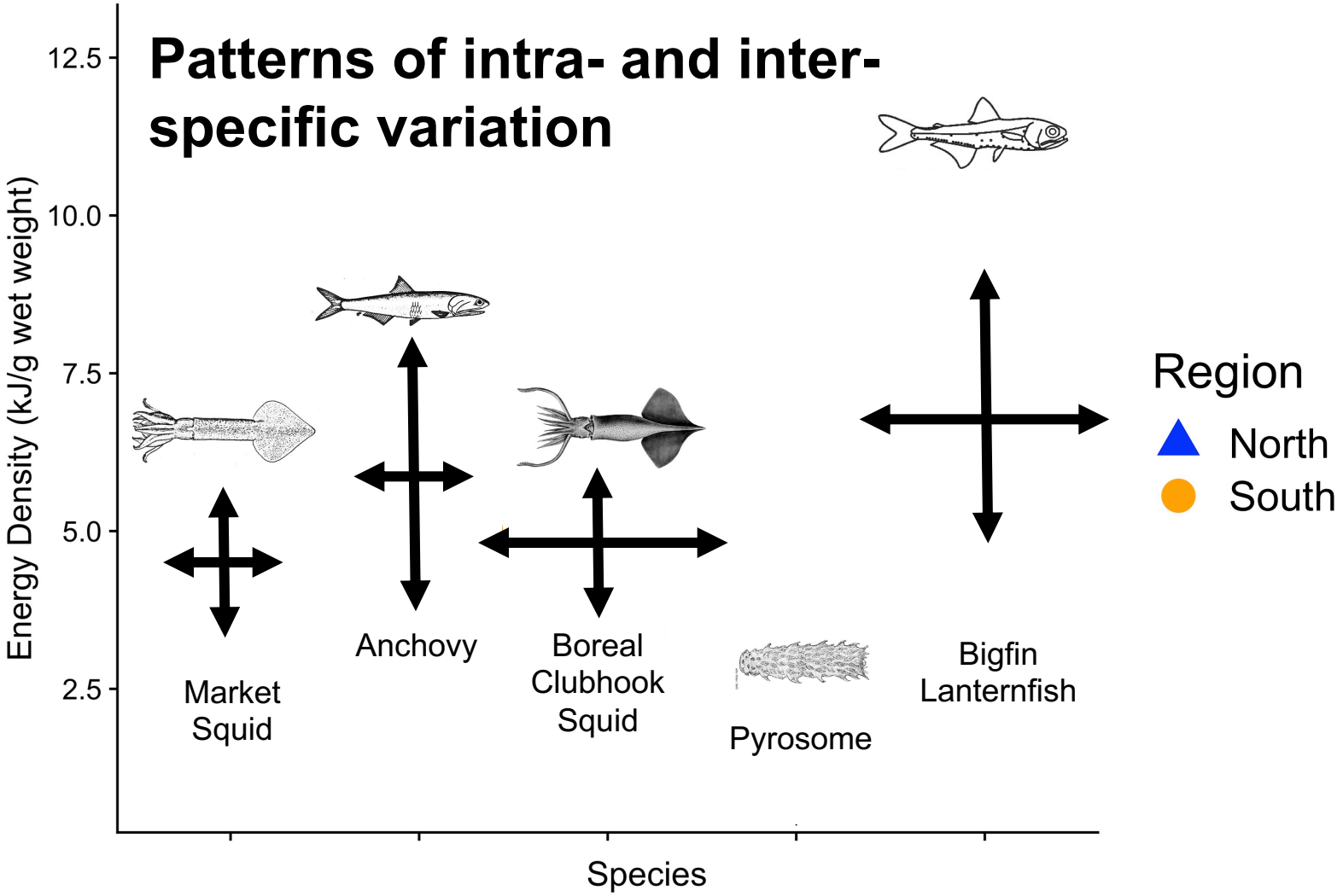



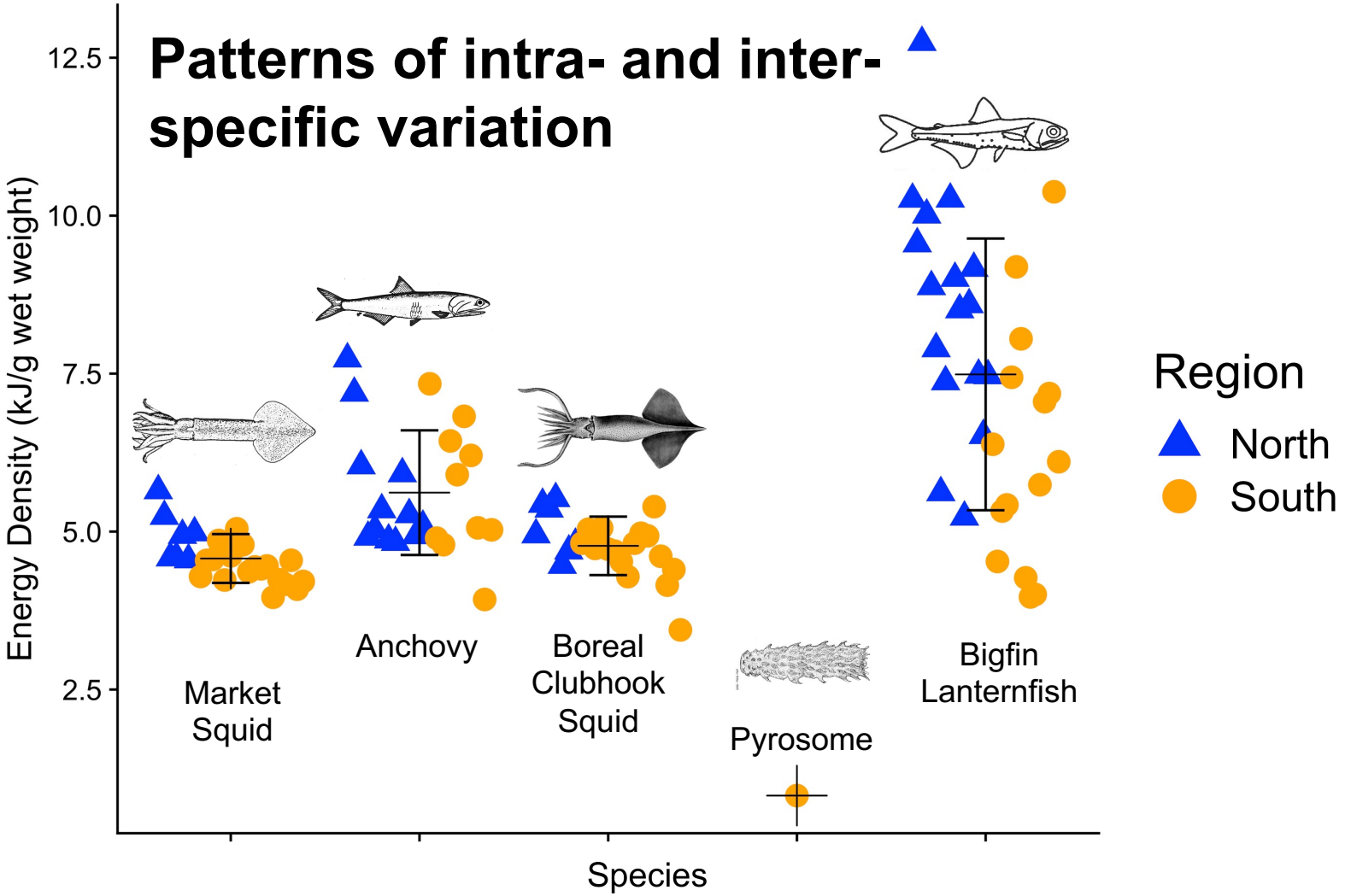

Paul Hillman/NOAA Fisheries, 2021

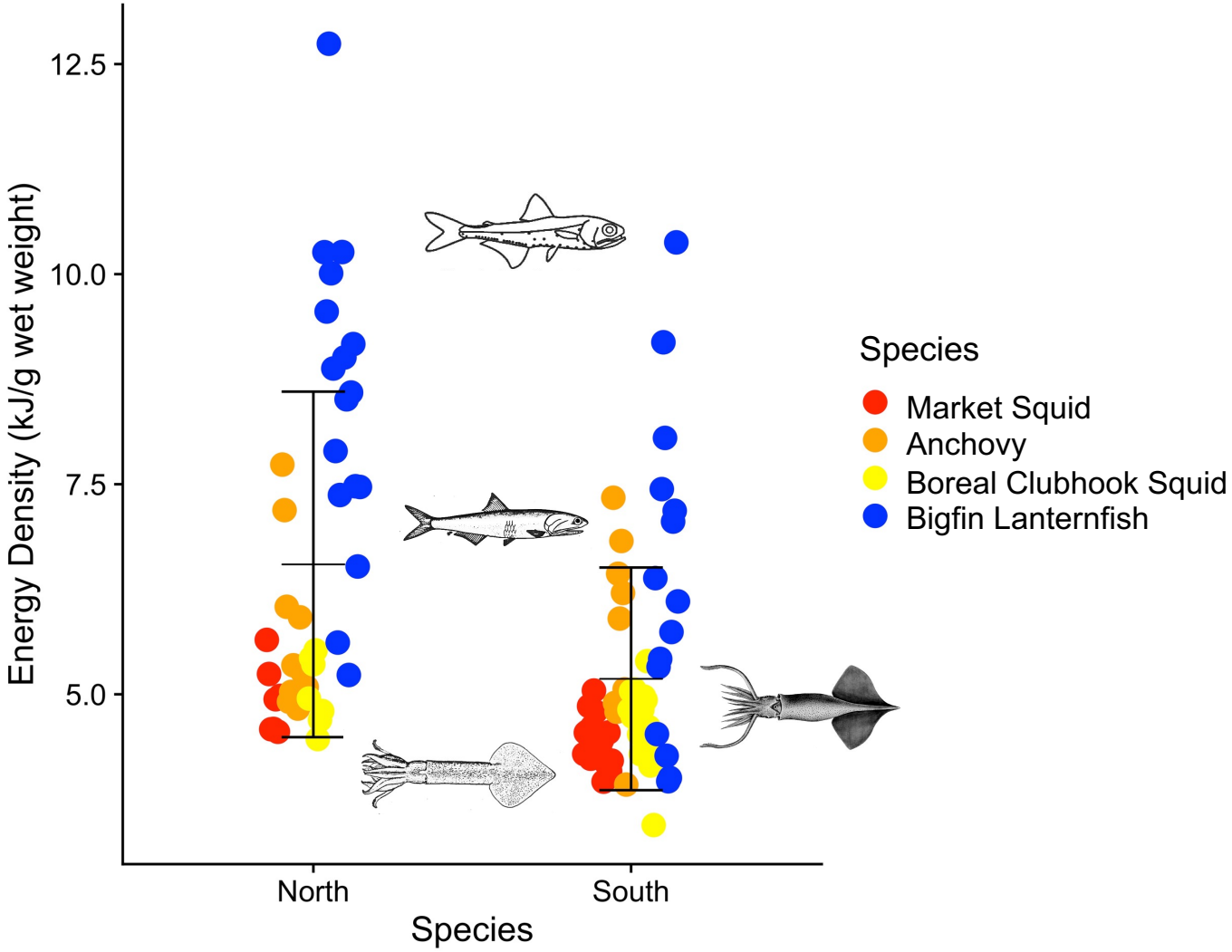

Measured % lipids, % protein, energy density

Patterns of intra- and inter-specific variation

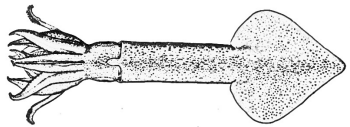



Patterns of intra- and inter-specific variation
Energy Density (kJ/g wet weight)
12.5
10.0
7.5
5.0
2.5
Market Squid
Anchovy
Boreal Clubhook Squid
Pyrosome
Bigfin Lanternfish
Species
Region
North
South

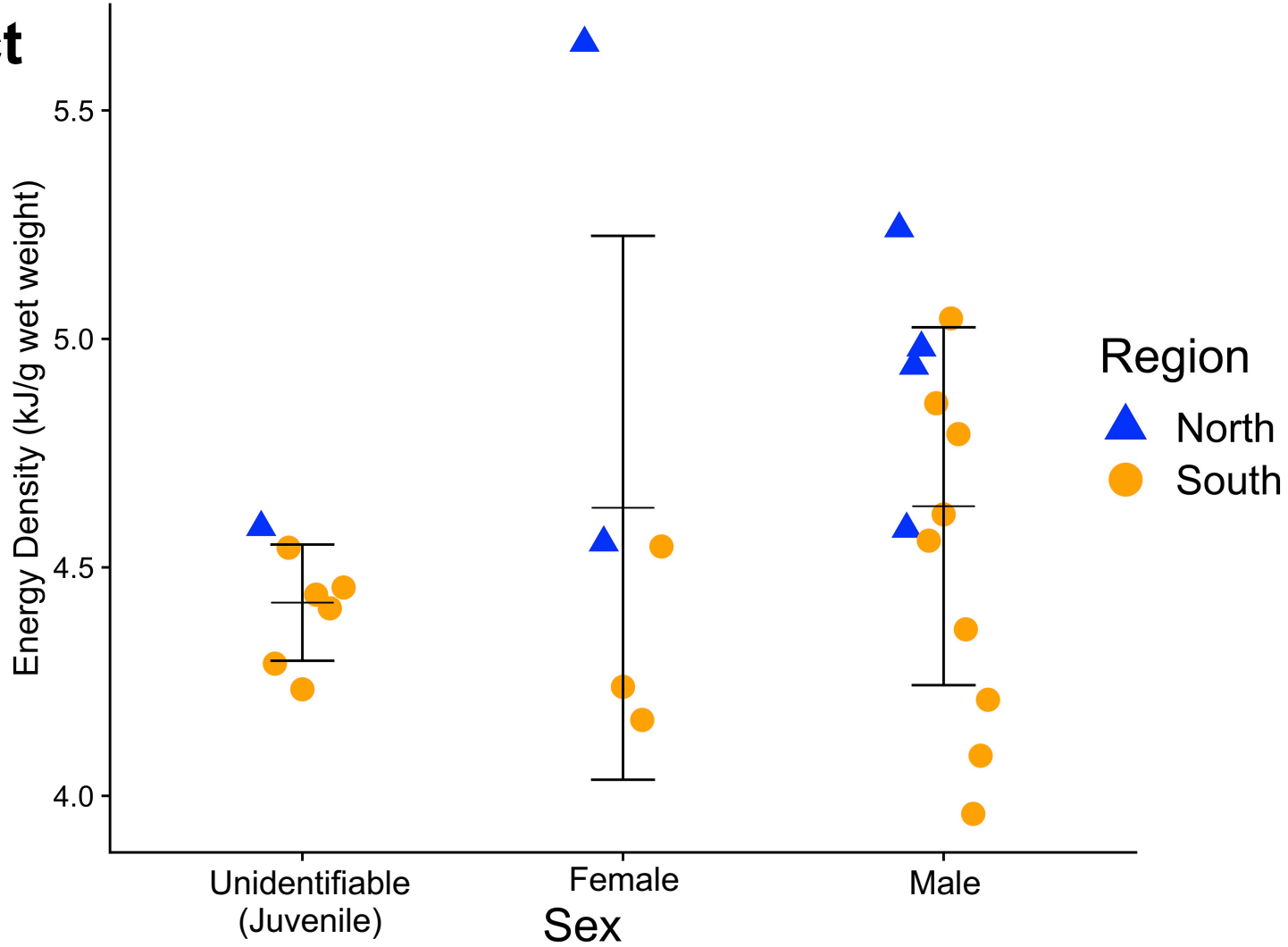
Regions are Similar



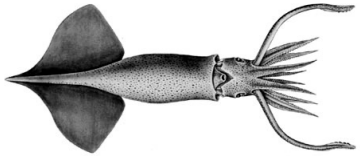
Minimal effect of sex on energy density



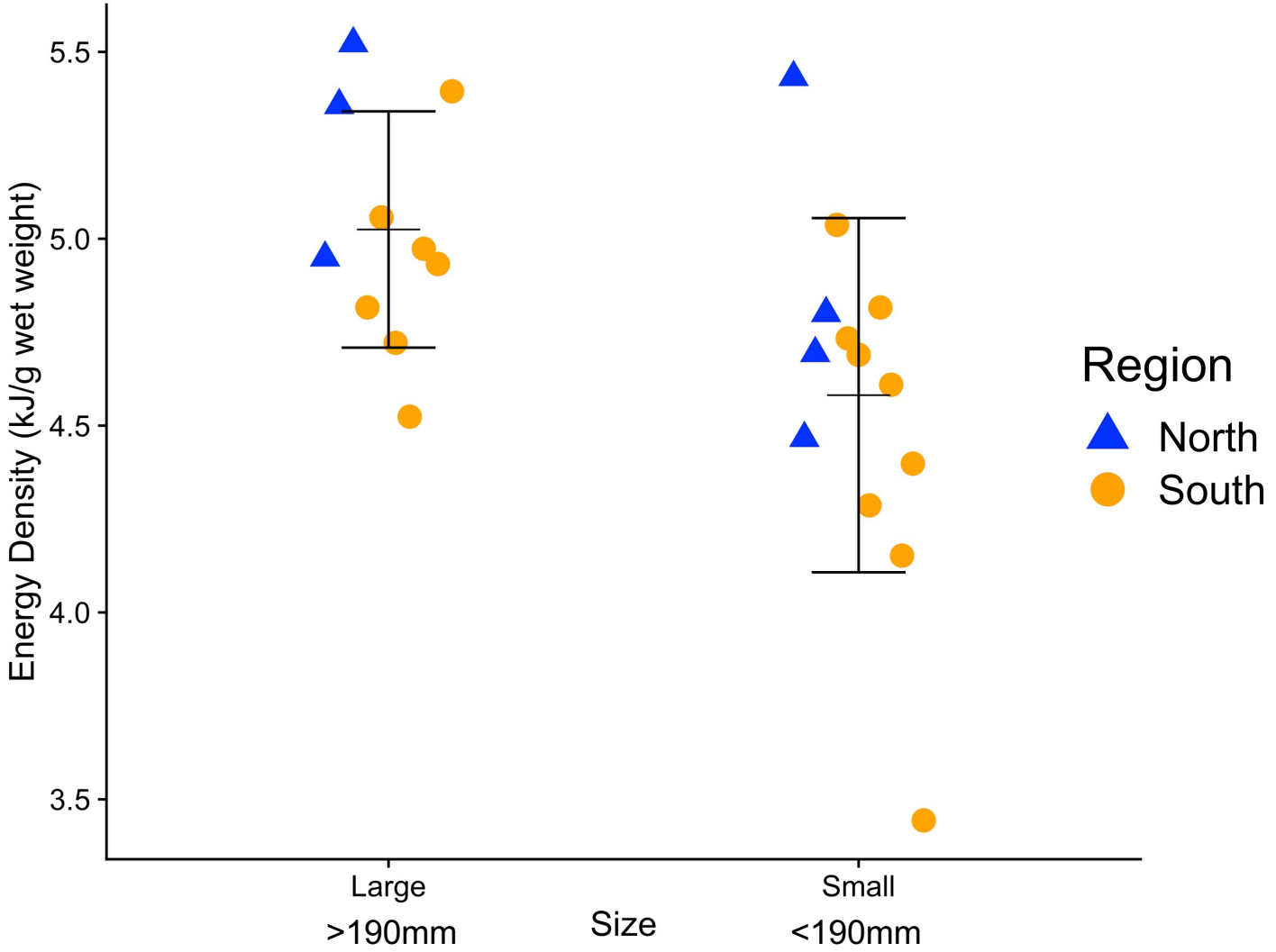
Market Squid

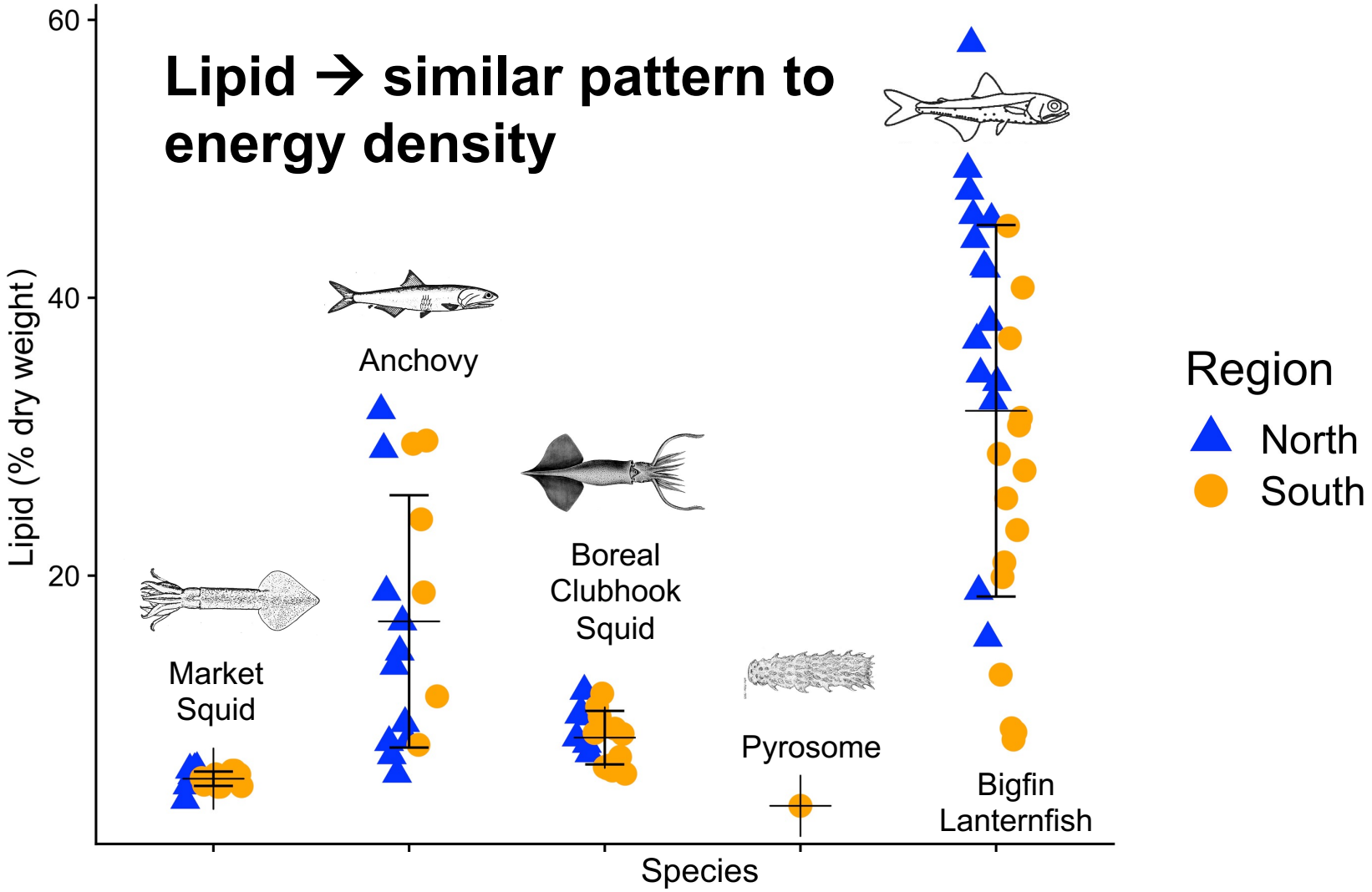


Size effect on energy density

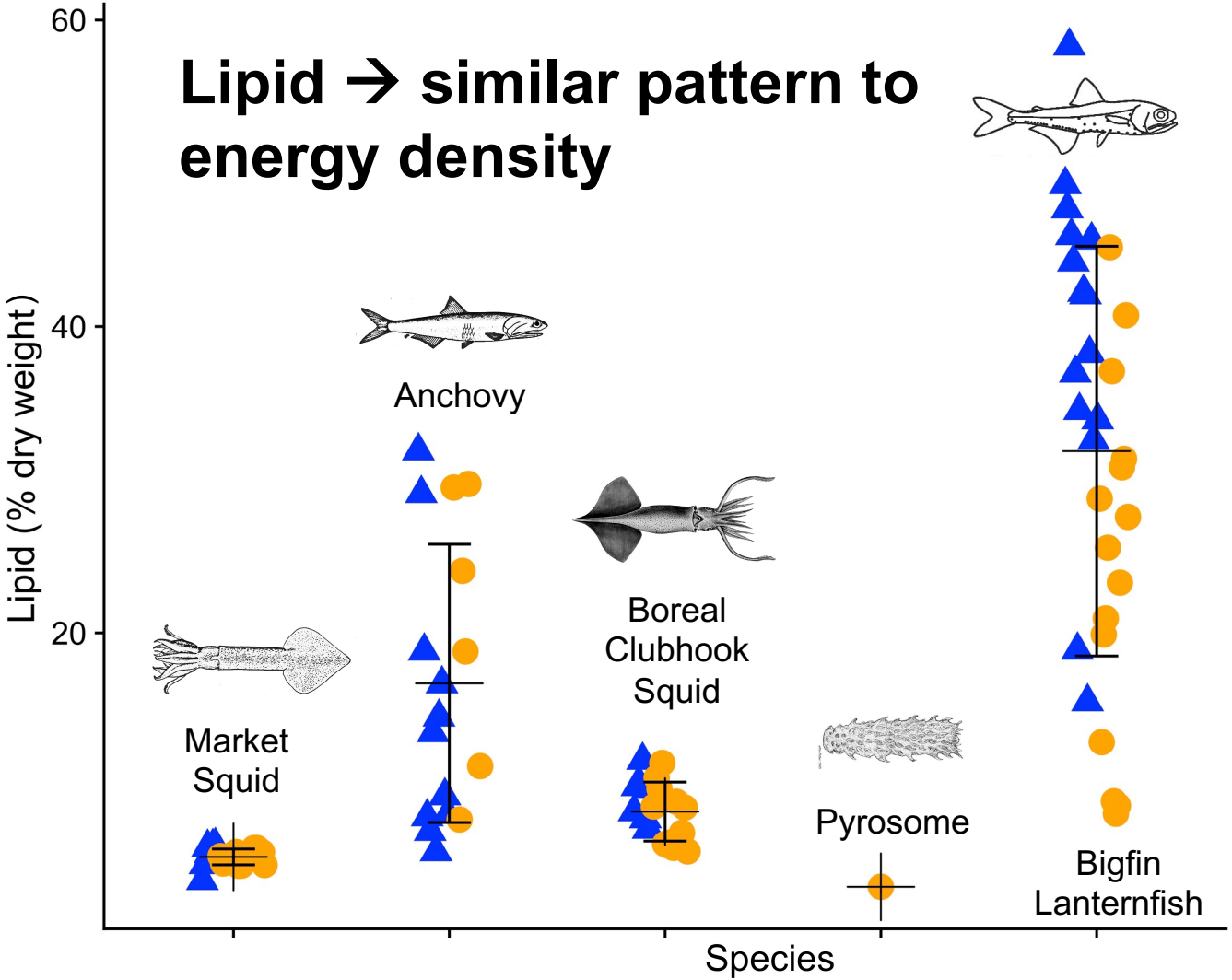


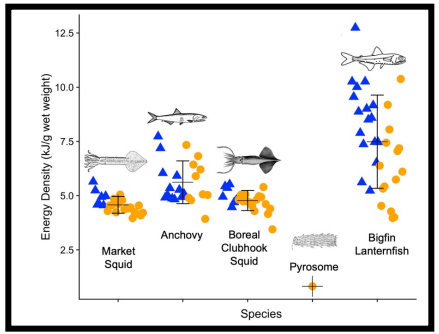
Boreal Clubhook Squid



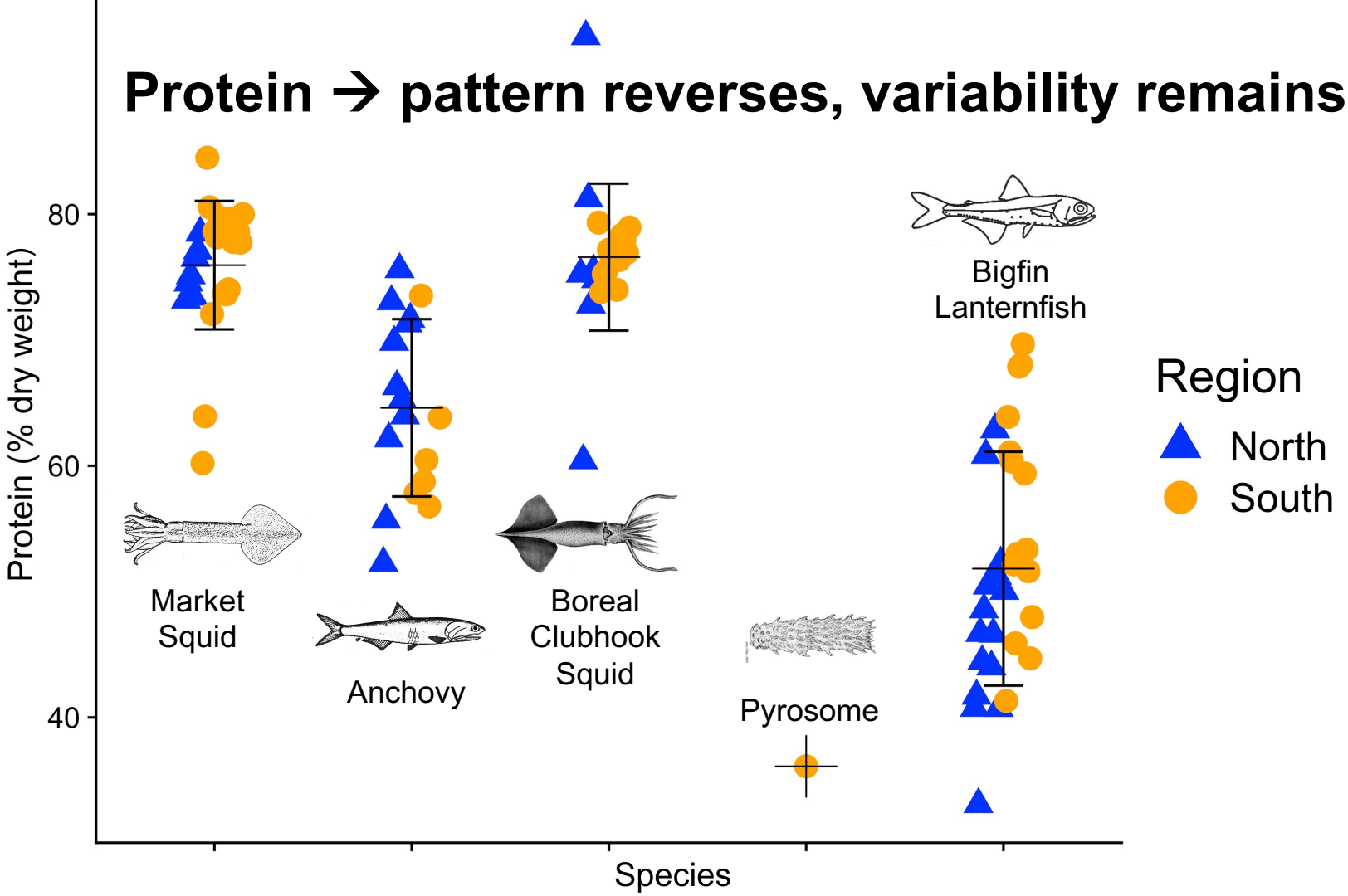

Lipid → similar pattern to energy density
60
40
20
Lipid (% dry weight)
Anchovy
Boreal Clubhook Squid
Market Squid
Pyrosome
Bigfin Lanternfish
Species
Region
North
South

Lipid → similar pattern to energy density

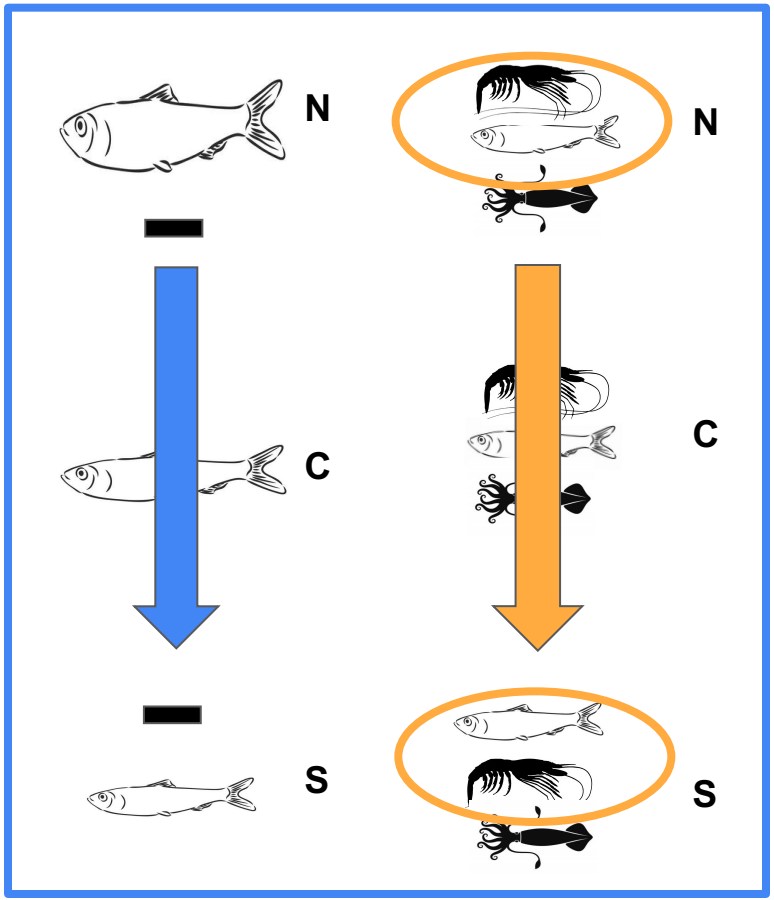




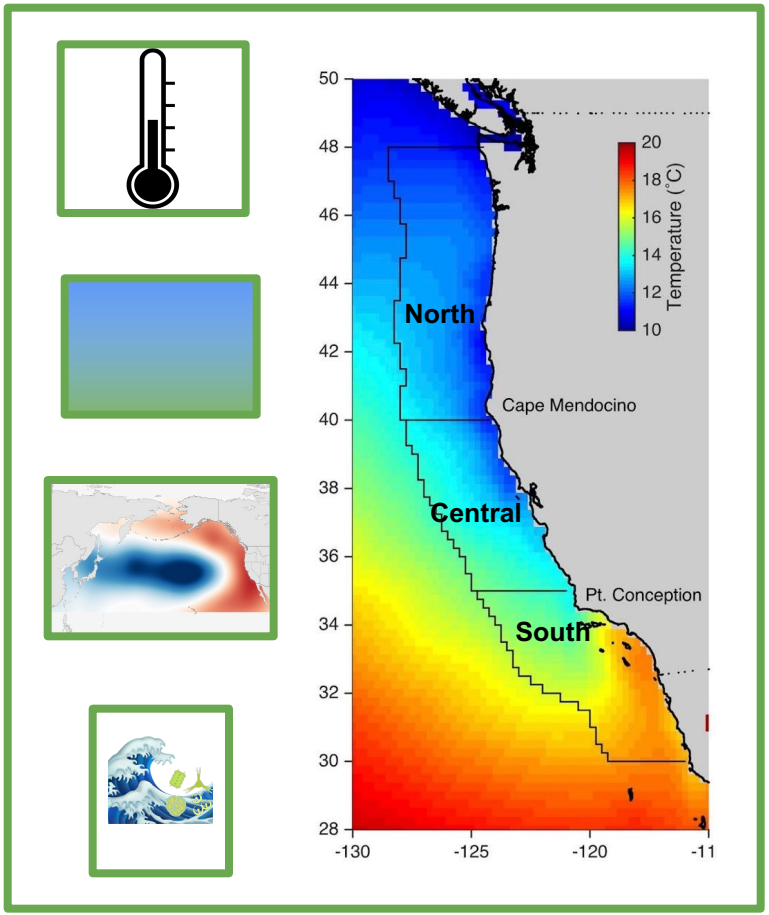
Protein → pattern reverses, variability remains



Next Steps

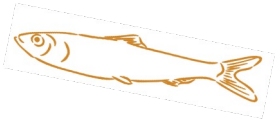

N
N
C
C
S
S

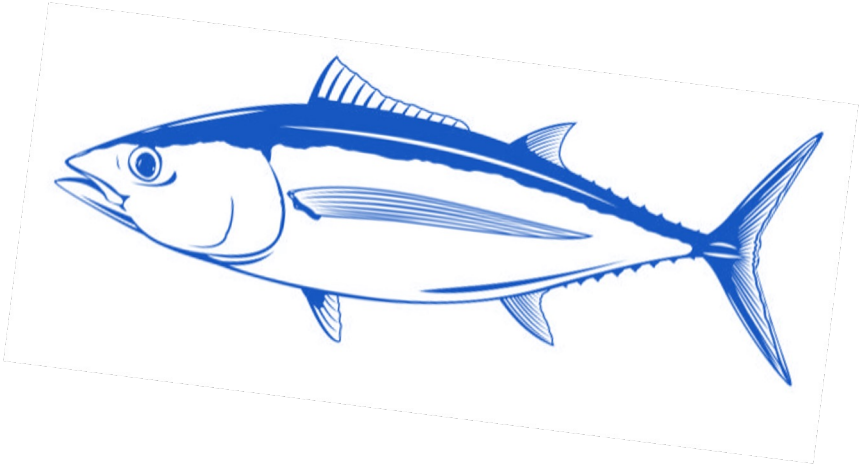
?


50
48
46
44
42
40
38
36
34
32
30
28
-130
-125
-120
-11
20
18
16
14
12
10
Temperature (°C)
North
Cape Mendocino
Central
Pt. Conception
South

Mixed Effects Modelling

- Nutritional metrics as response variables
- Control for species, size class, sex, maturity, haul
- Region and then specific environmental metrics as drivers





Acknowledgments to

- The Tuna Team

  Miram R. Gleiber[1], Natasha A. Hardy[1], Zachary Roote[1], Caitlin Morganson[1], Larry B. Crowder[2] and Stephanie J. Green[1]

  - [1]University of Alberta, Edmonton, AB, Canada. [2]Stanford University, Stanford, CA, USA.
- Bomb calorimetry

  Anela Choy and Elan Portner

  - The Choy Lab, Integrative Oceanography Division at the Scripps Institution of Oceanography at the University of California, San Diego
- Proximate composition

  Kelvin Lien

  - ALES Lab University of Alberta

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