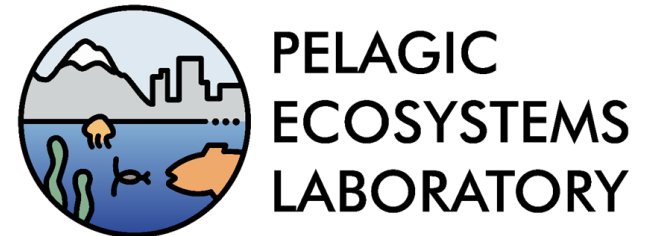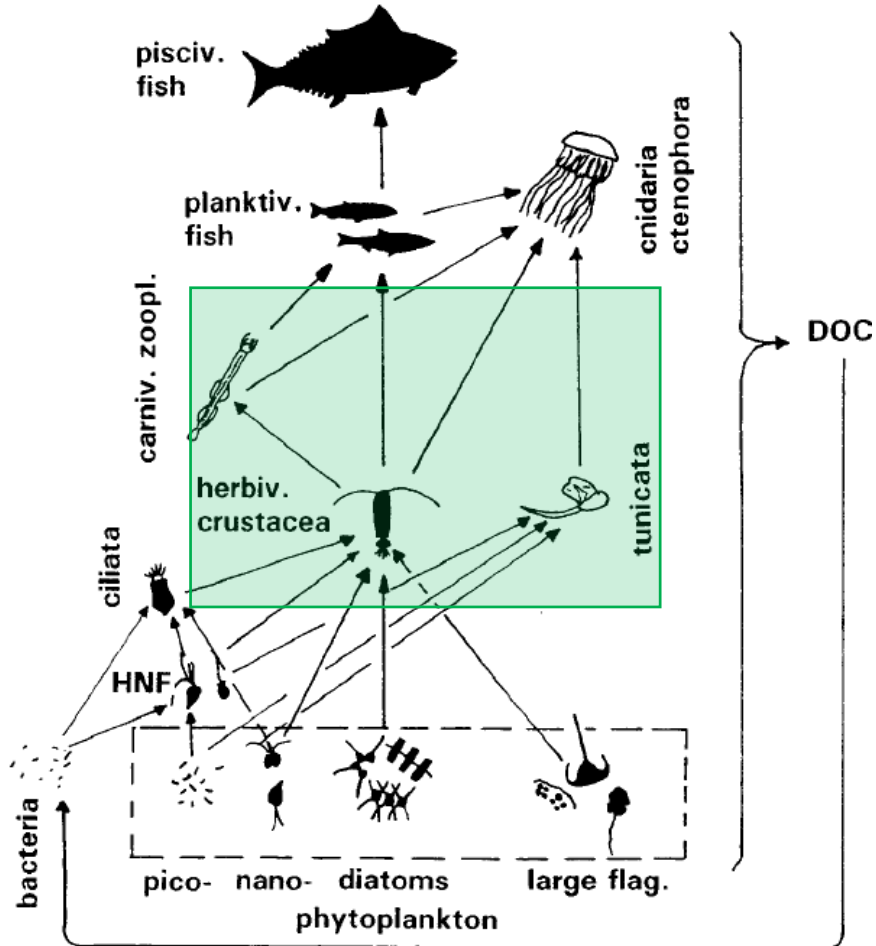# Community composition, functional traits, and trophic structure of zooplankton size fractions across an oligotrophic-eutrophic gradient

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PELAGIC ECOSYSTEMS LABORATORY

Food web implications of phytoplankton size structure

Zooplankton are the intermediaries between primary producers and tertiary consumers

Phytoplankton size structure determines trophic pathways, energy transfer and secondary production

Sommer et al Hydrobiologia 2002

Food web implications of phytoplankton size structure

Decima MEPS 2022
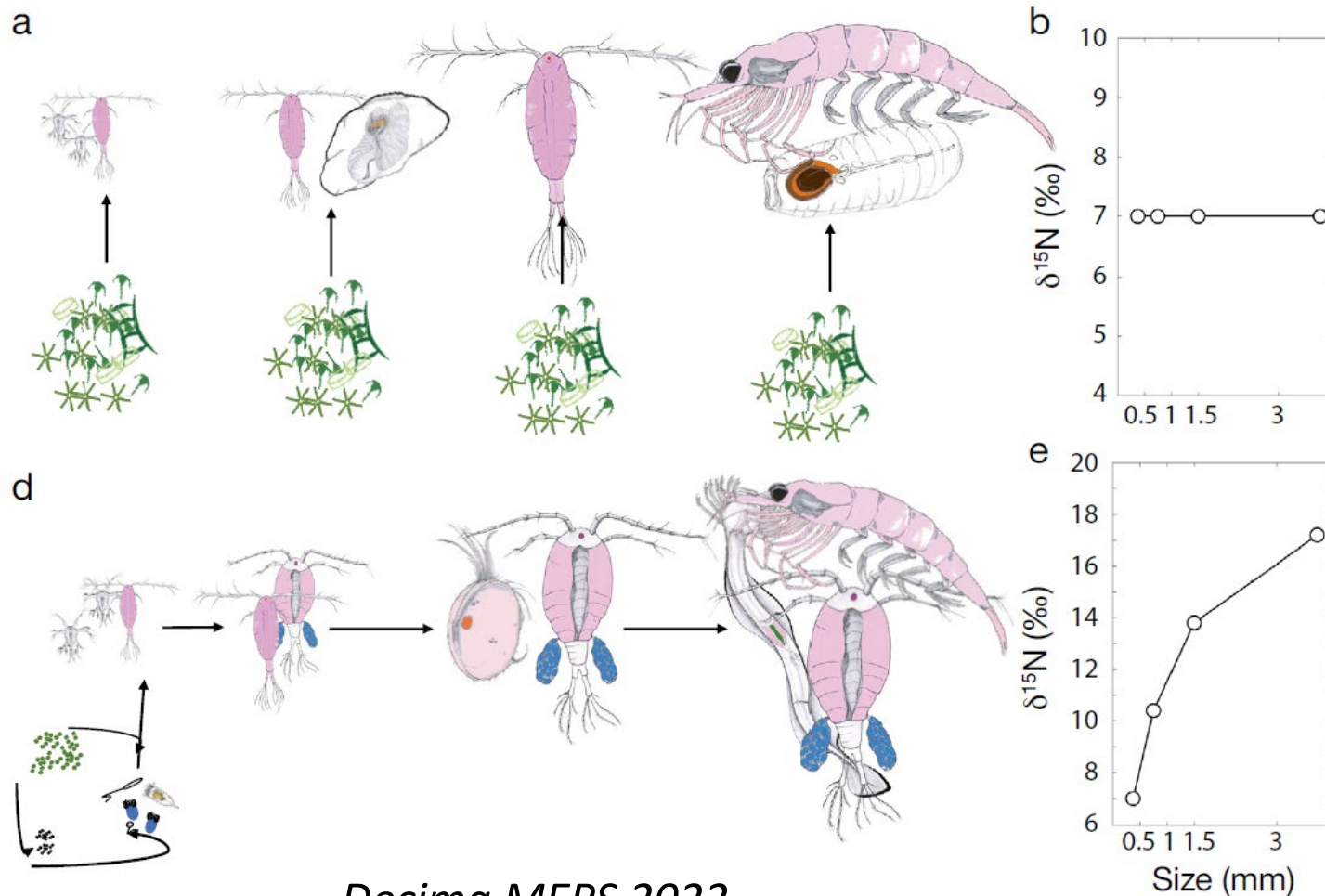
➤ Productive ecosystems & large phytoplankton favour grazing by multiple size classes

➤ Low production & small phytoplankton favour grazing by smallest size classes and increased carnivory

Project Aims

Empirically test zooplankton response to phytoplankton size across highly contrasting oligotrophic and eutrophic domains

Predictions:

1. Herbivory would extend into larger size fractions under eutrophic conditions;

2. Carnivory would extend into smaller size fractions under oligotrophic conditions;

3. Small particle grazers would be the dominant grazers in oligotrophic conditions and large crustaceans grazers in eutrophic conditions.
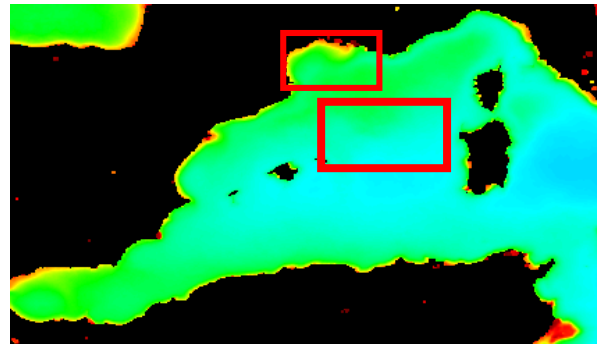
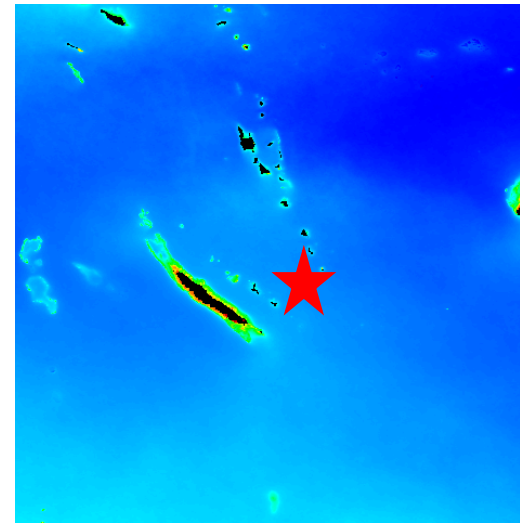SeaWiFs global chl (mg.m^{-3}); Sep 1997 - Dec 2010
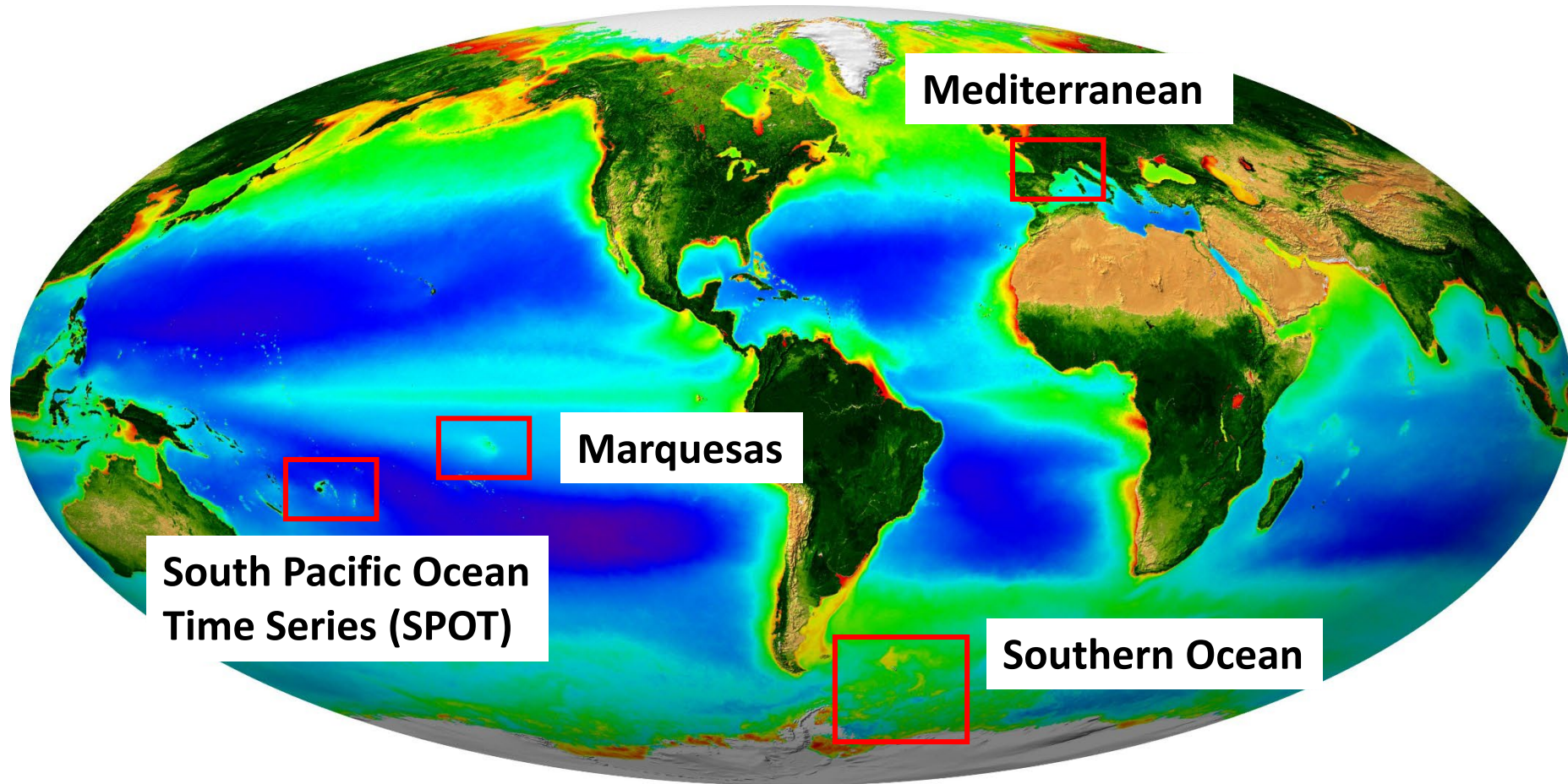
Regional phytoplankton production

Modis Chl-a 2002-2023

Mediterranean
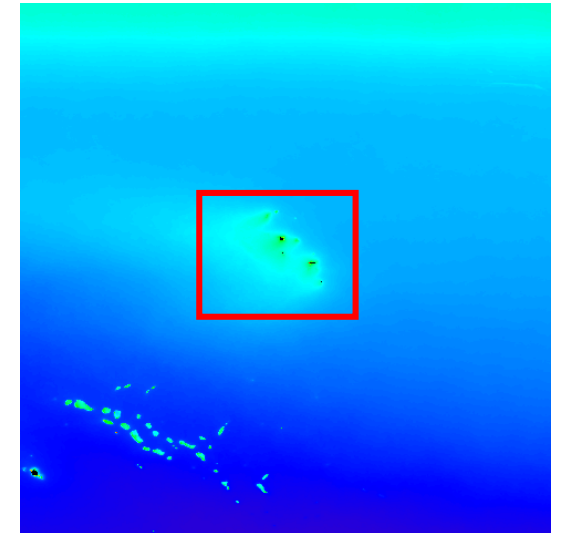Chl < 3 mg.m^{-3};
Nano > Micro > Pico >
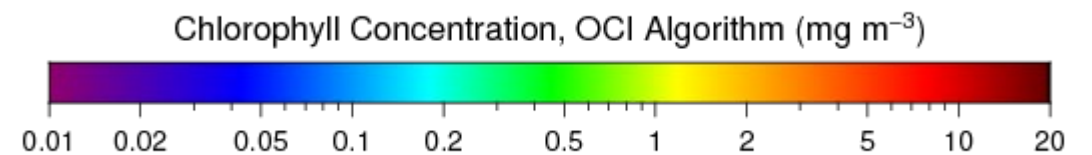
SPOT
Chl < 0.5 mg.m^{-3};
Pico > Nano

Marquesas
Chl < 3 mg.m^{-3};
Pico > Nano > Micro

Southern Ocean
Chl < 3 mg.m^{-3};
Micro > Nano > Pico

Chlorophyll Concentration, OCI Algorithm (mg m^{-3})

0.01 0.02 0.05 0.1 0.2 0.5 1 2 5 10 20
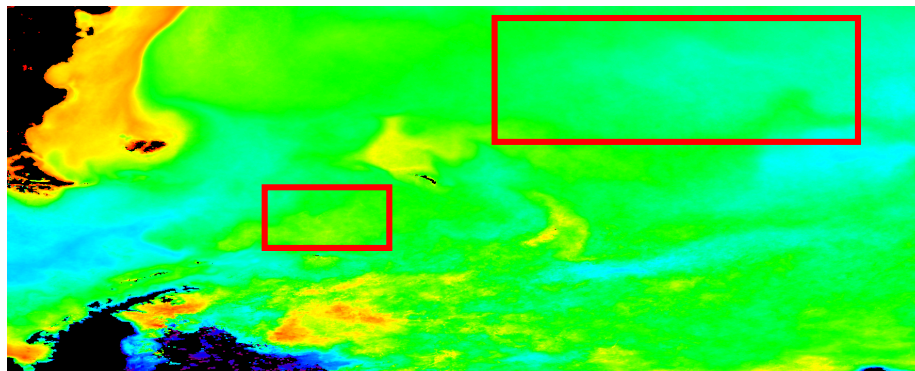
Methods

Region	Number of net tows (50cm ring net)	Mesh size
Gulf of Lion - Coast	11	64
Gulf of Lion - Oceanic	28	64
Marquesas	16	200
South Pacific Ocean Time Series	12	64
Southern Ocean	56	64

Size fractionated
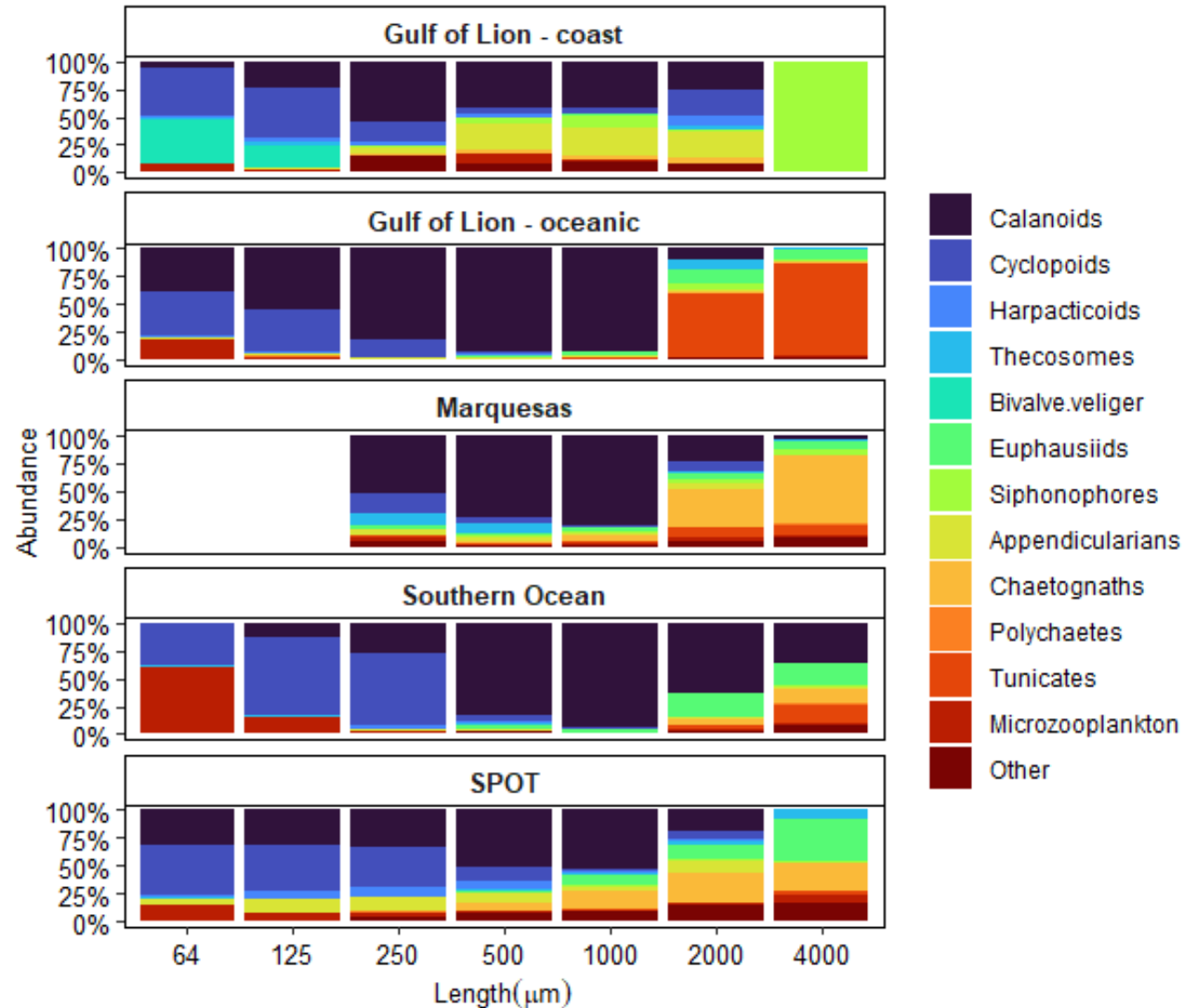[64, 125, 250, 500, 1000, 2000, 4000μm]

Stable N and C isotopes

Community composition
[Order level abundance]

Zooplankton community composition

- Meroplankton (64-125µm),
- Appendicularians (250-2000µm)
- Siphonophores (4000µm)

- Tunicates, Euphausiids (4000µm)

- Chaetognaths, Euphausiids (4000µm)

- Microzooplankton (64µm)
- Calanoids, Euphausiids, Tunicates (4000µm)

- Chaetognaths, Euphausiids (4000µm)

# Zooplankton community trophic traits
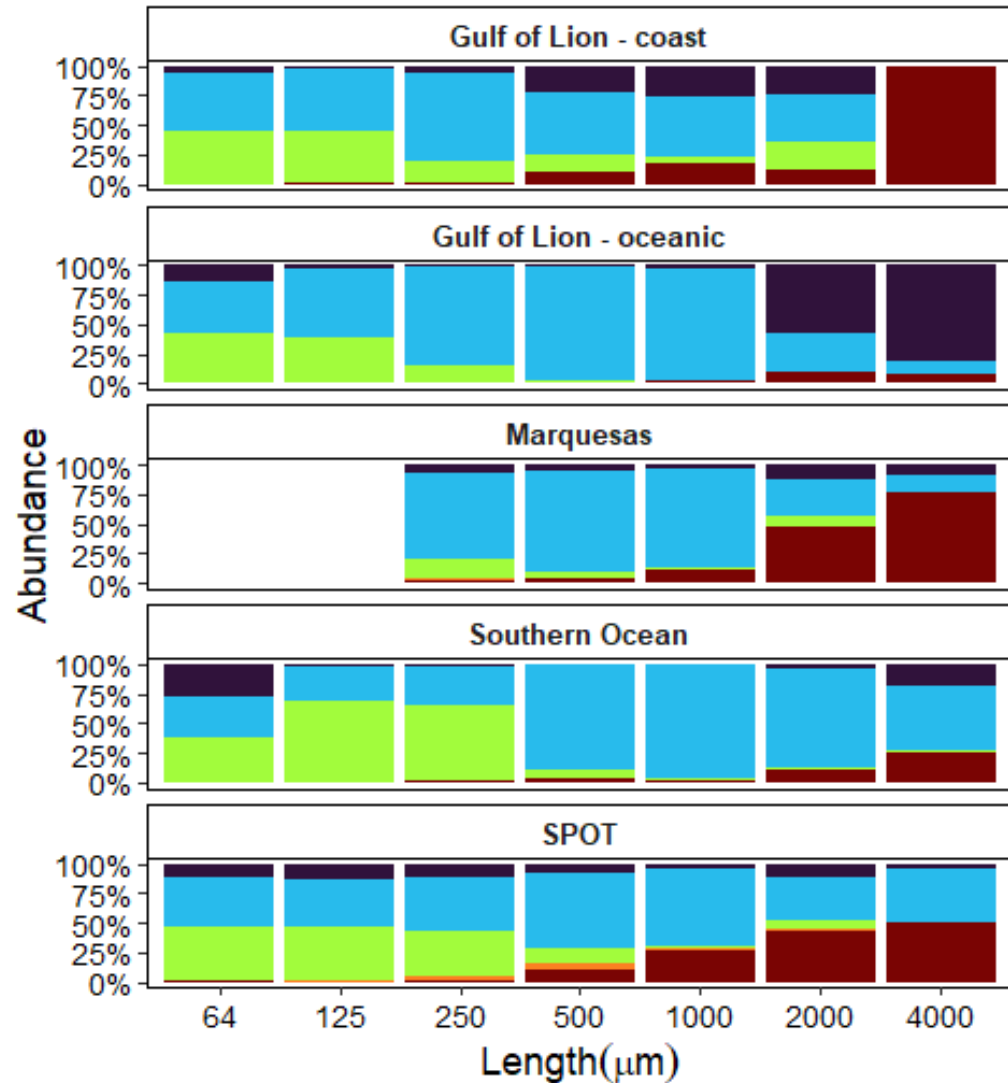
- ➢ Carnivores dominate 4000μm fraction
- ➢ High % Grazers in 500-1000μm fraction

- ➢ Grazers dominate 2-4000μm fraction

- ➢ Carnivores dominate 2-4000μm fraction
- ➢ Grazers present across 250-4000μm fraction

- ➢ Omnivorous grazers dominate 1-4000μm fraction

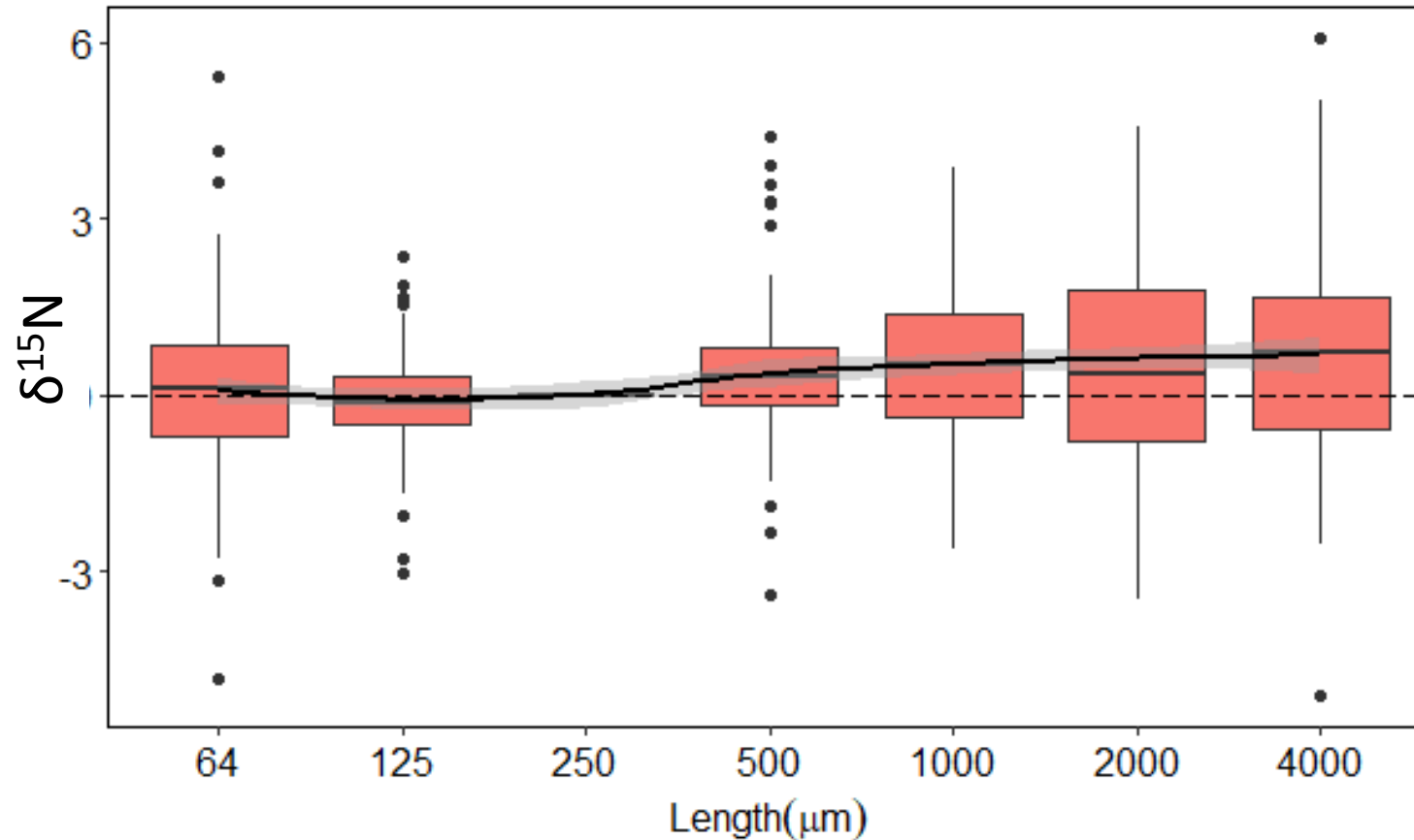- ➢ Carnivores & Omnivorous grazers ~ 50% each of 2000 and 4000μm fraction

Stable isotope distribution
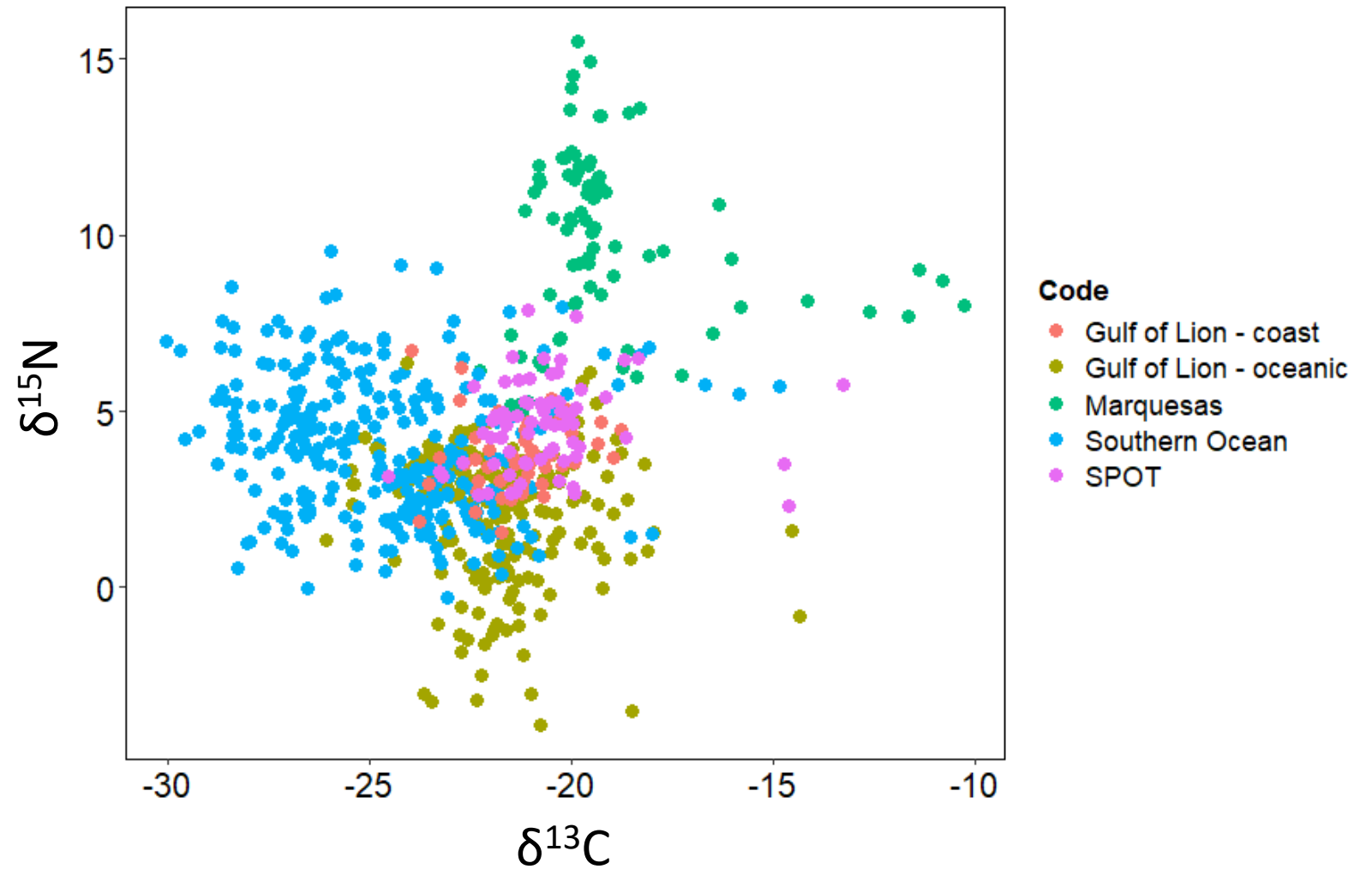
Zooplankton 'baseline' – 250µm fraction
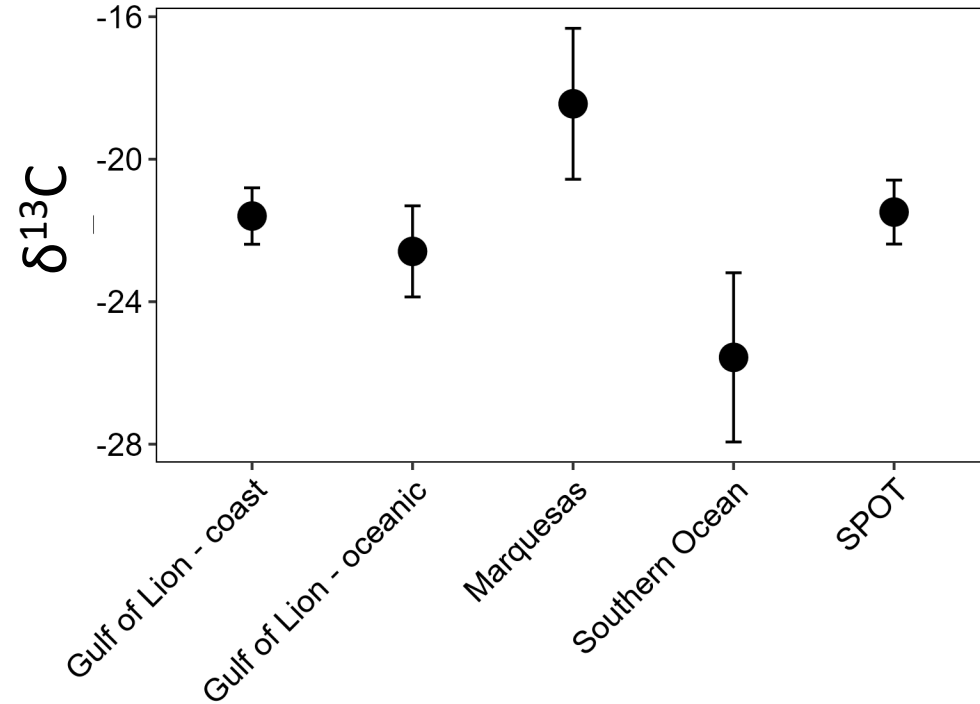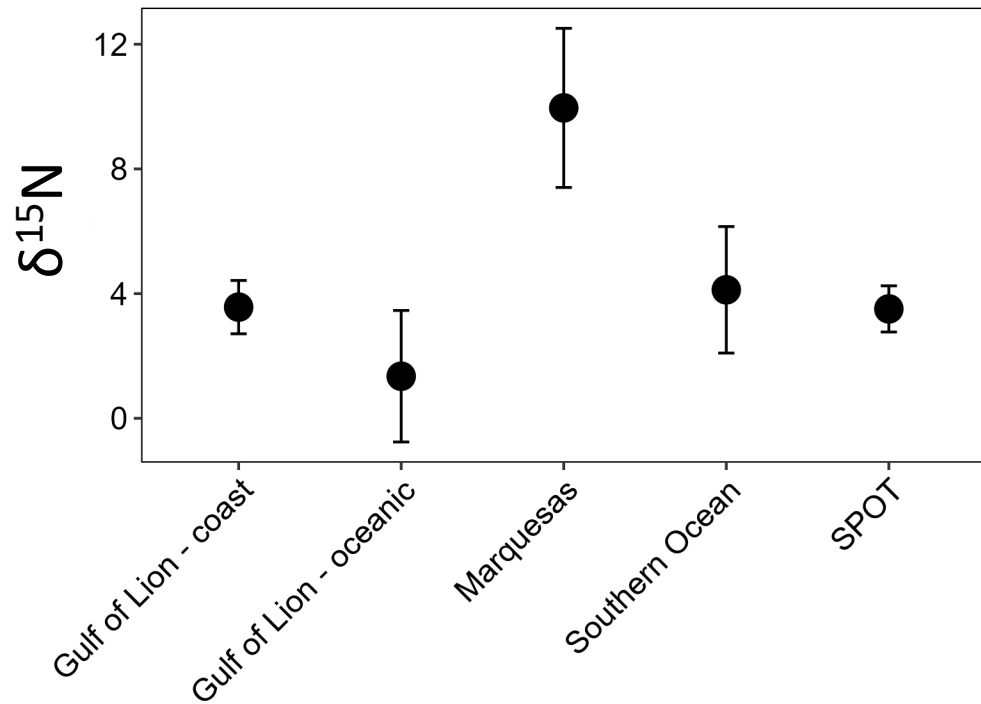
- Marquesas – high $\delta^{15}N$ due to denitrification
- GoL Oceanic – low $\delta^{15}N$ due to N fixation and / or ammonium recycling

Standardised $\delta^{15}N$ size class distribution

$\delta^{15}N$ at each station standardised to 0‰ for the 250μm size fraction

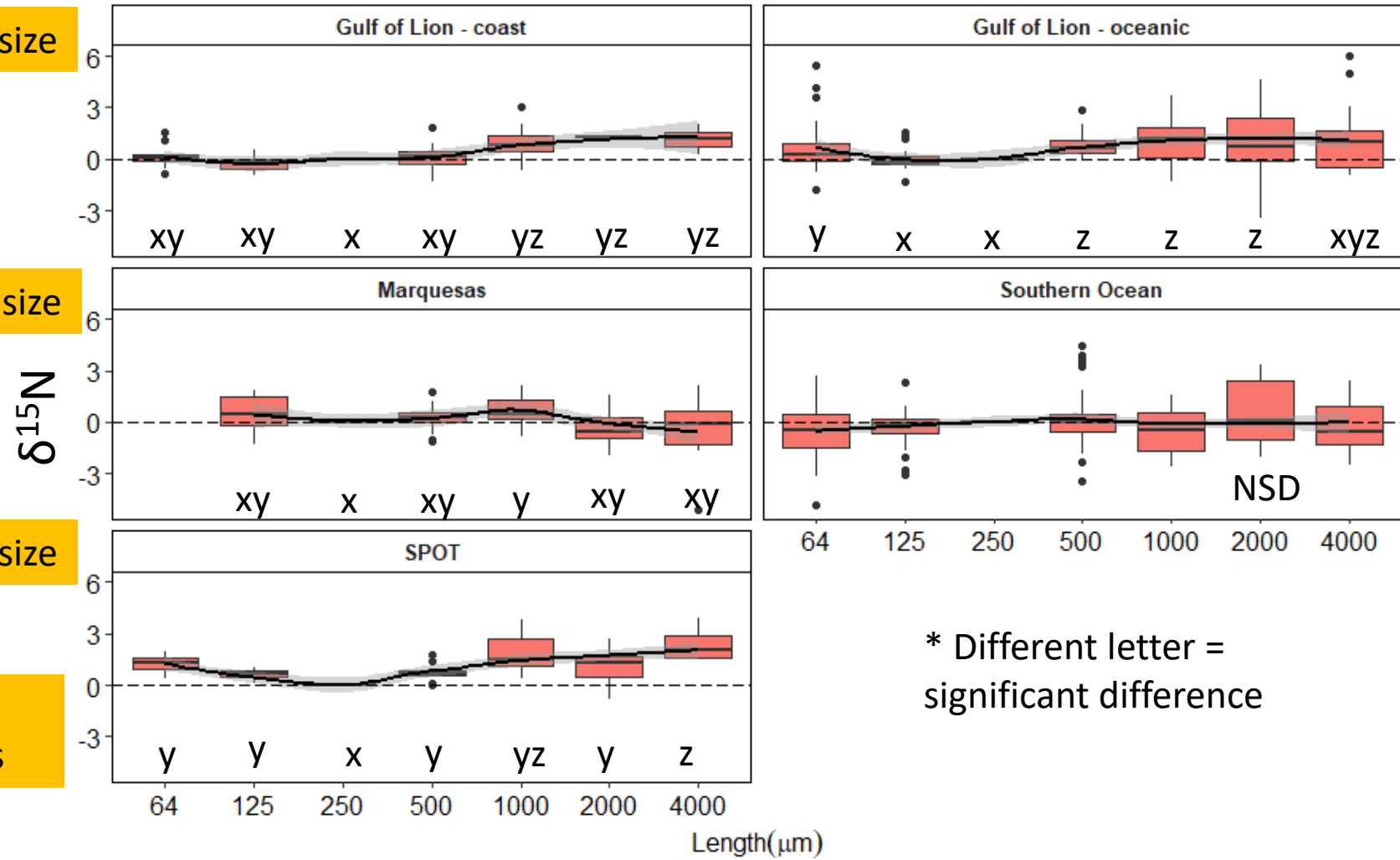# Standardised δ^{15}N regional size class distribution

↑ carnivores with size

↑ carnivores with size

↑ carnivores with size

High carnivory at smaller size classes

↑ grazers with size

↔ grazers

* Different letter = significant difference

Predictions

1. Herbivory would extend into larger size fractions under eutrophic conditions;

   ➢ In Southern Ocean (micro-phyto dominated) and Marquesas Islands (nano-phyto dominated)

2. Carnivory would extend into smaller size fractions under oligotrophic conditions;

   ➢ At SPOT (pico-phyto dominated), but also eutrophic GoL-coast (nano-phyto dominated)

3. Small particle grazers would play an important role in oligotrophic conditions and large crustacean grazers in eutrophic conditions.

   ➢ True for oligotrophic conditions but variable response in eutrophic conditions

Conclusions

Oligotrophic conditions - dominance of picophytoplankton favours longer food chains and increased carnivory amongst mesozooplankton.

Eutrophic conditions - response of zooplankton community appears dependent on dominant phytoplankton size class

- Microphytoplankton dominance favours large crustaceans omnivorous grazers
- Nanophytoplanton dominance can favour large tunicate grazers

Therefore important to take into account phytoplankton size structure in addition to biomass when predicting zooplankton response to changing ocean conditions.