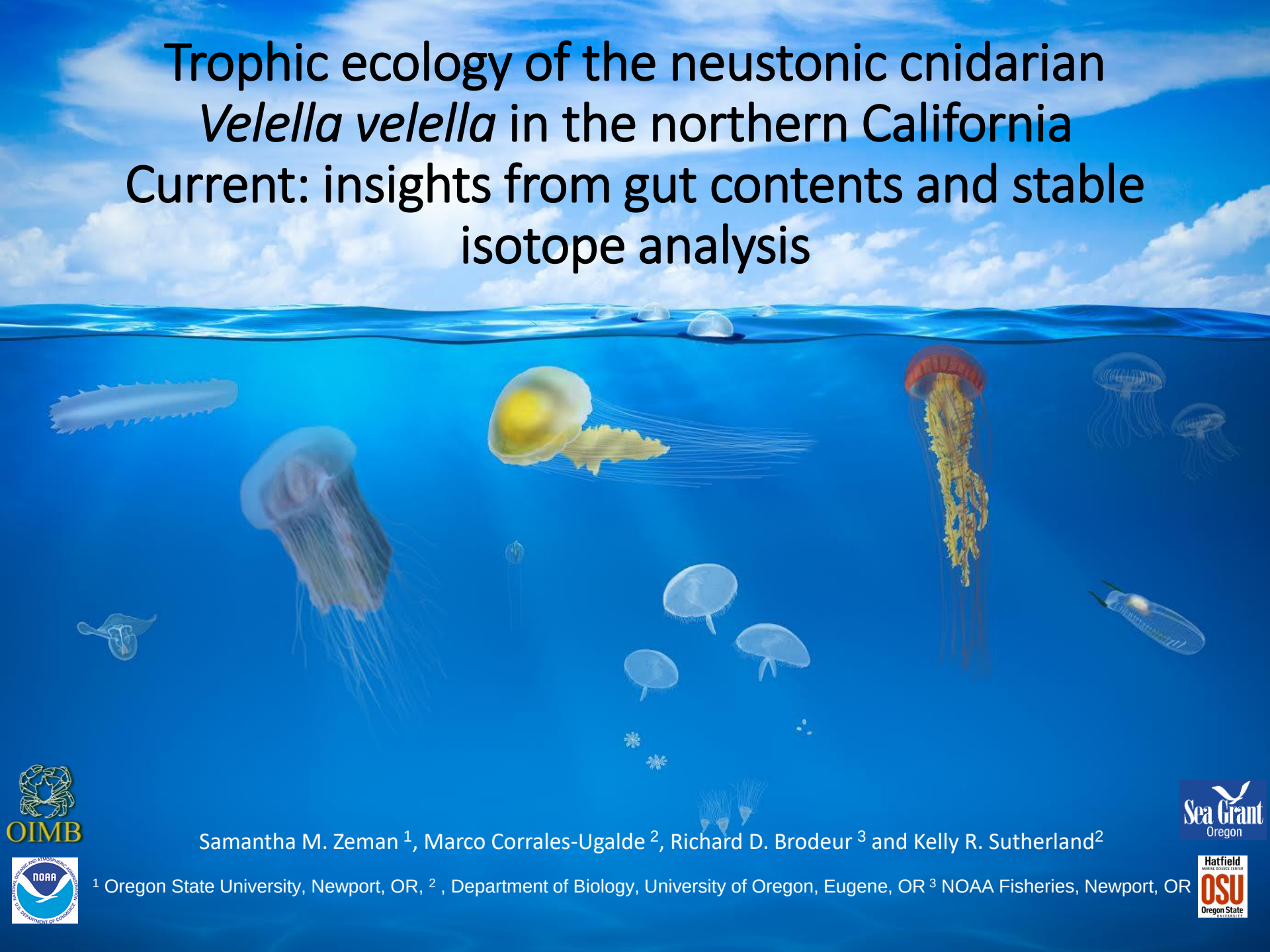
Trophic ecology of the neustonic cnidarian *Velella velella* in the northern California Current: insights from gut contents and stable isotope analysis



Samantha M. Zeman [1], Marco Corrales-Ugalde [2], Richard D. Brodeur [3] and Kelly R. Sutherland[2]

[1] Oregon State University, Newport, OR, [2] , Department of Biology, University of Oregon, Eugene, OR [3] NOAA Fisheries, Newport, OR

Velella velella is unique hydrozoan

- *Velella velella* are neustonic hydrozoan colonies with temperate and tropical distribution
- Found offshore, drift at surface with wind, currents, and tides
- Short tentacles catch prey below surface
- Tissues contain zooxanthellae

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V. velella in northern California Current (NCC)

- Widespread blooms (strandings and at-sea) occur in productive upwelling region during some years
- Prey mainly on fish eggs, euphausiid eggs, larvaceans
  - Predators or competitors of important fish species?
- Unknown contribution of symbiotic zooxanthellae to nutrition
- Depositing large amounts of organic material on land during strandings

Photo credit: Amanda Gladics

Despite regular notable bloom events in the productive California Current, almost nothing is known about *V.velella* trophic ecology.

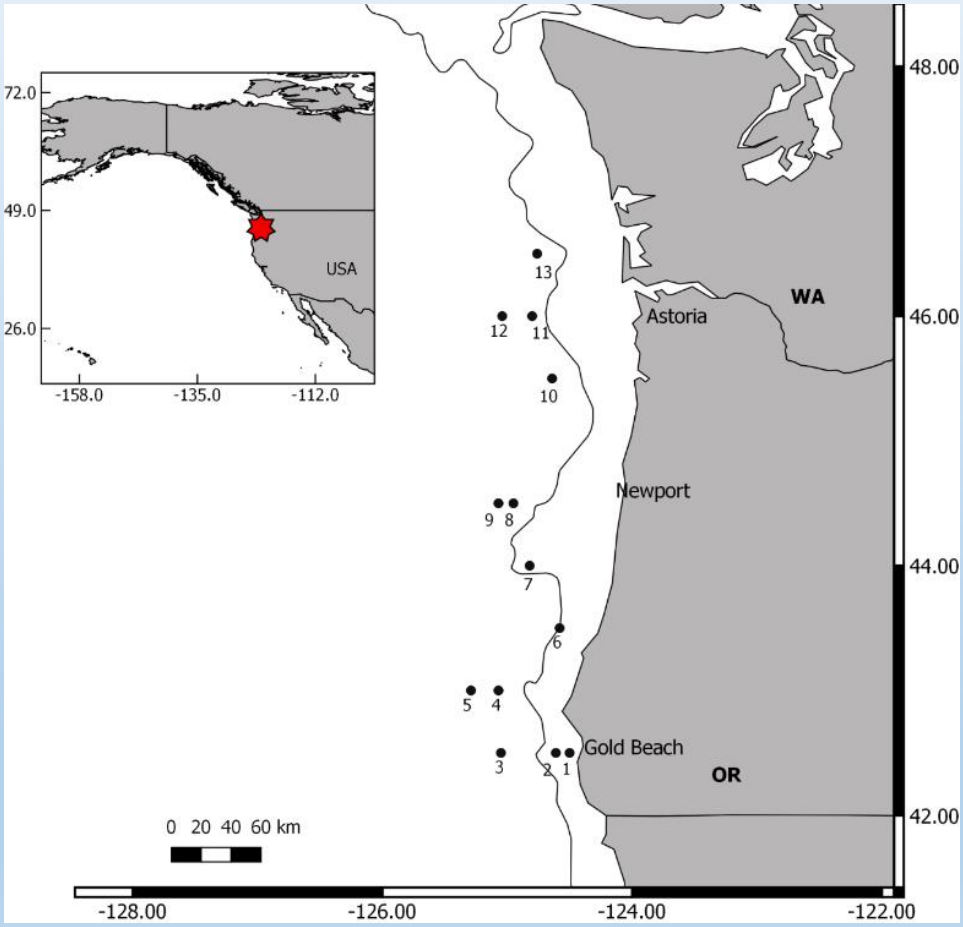
Using gut contents, we examined:

1) Prey items of *V. velella* colonies
2) Patterns to prey ingestion

Using Stable isotope analysis:

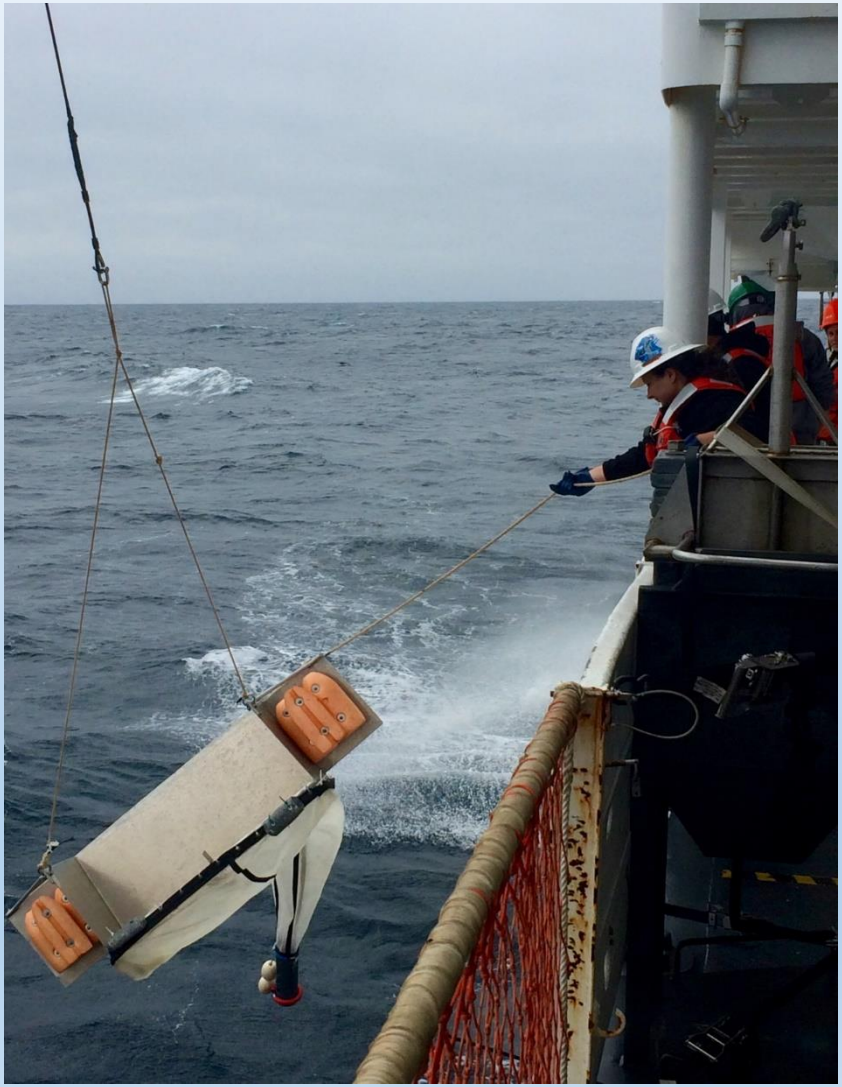
3) We quantified trophic niche and developed mixing models. And,
4) Examined importance of zooxanthellae

Sample collection for gut contents and stable isotopes



- NCC is an eastern boundary current with seasonal upwelling
- 87 *V. velella* colonies dip-netted Washington and Oregon, USA coastal waters in June and July 2015.
- Neuston samples were collected at each station to assess prey

Sample collection for gut contents and stable isotopes



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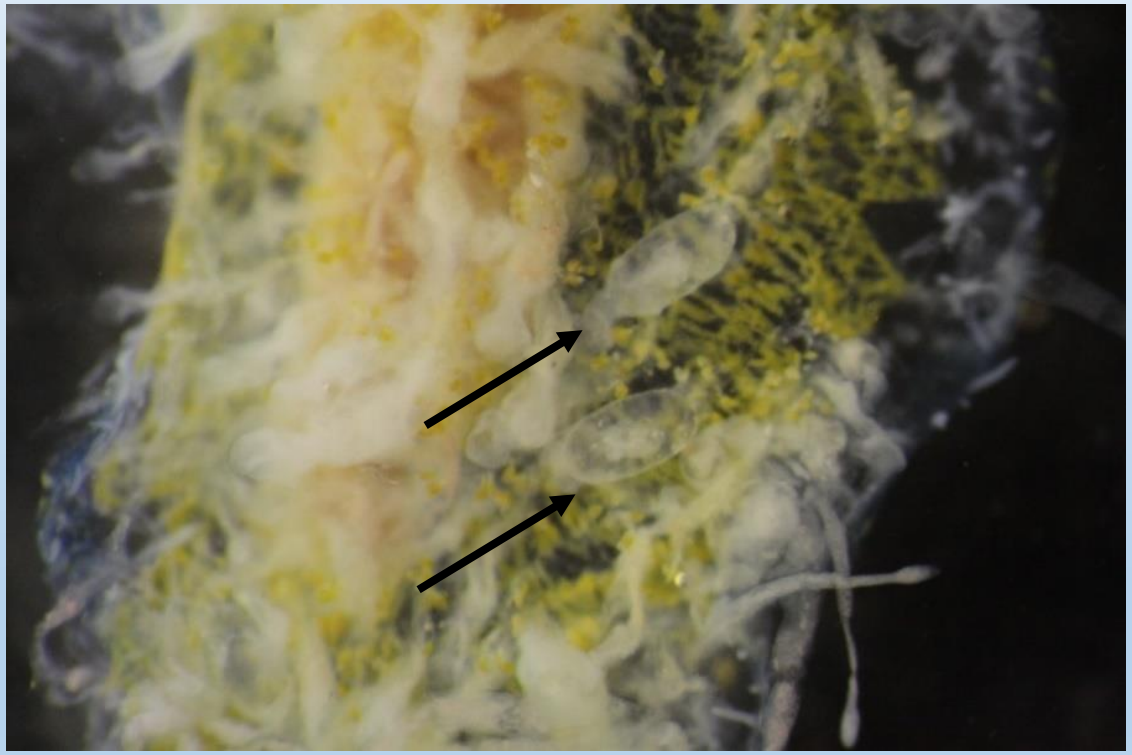
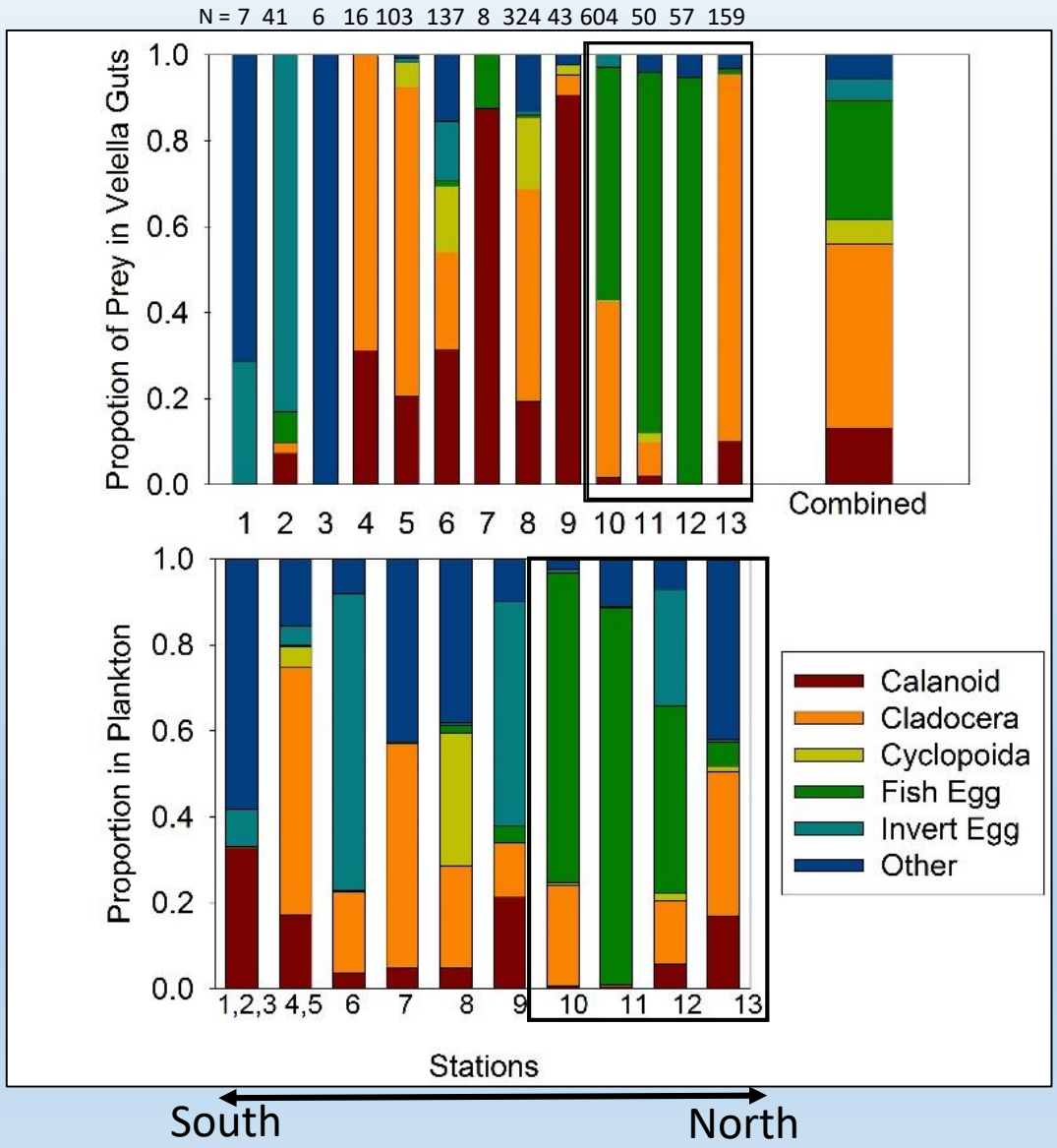
V. velella dissected to enumerate prey items

- Colonies dissected and captured prey were removed and identified from feeding zooids (gastrozooids and gastro-gonozooids)
- Prey identified to lowest possible taxonomic level

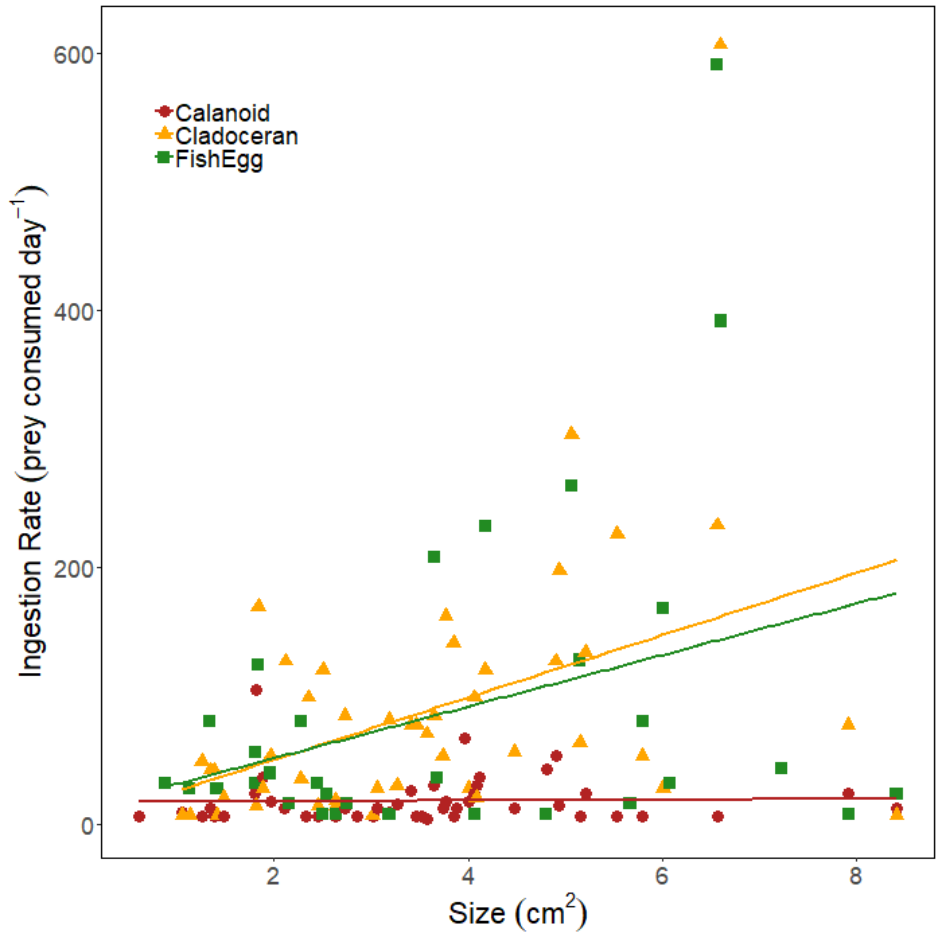


V. velella capturing variety of prey items

- Two predominant prey groups were cladocerans (43%) and fish eggs (23%)
- 97% of fish eggs were northern anchovy
- More northern stations (10-13) have fish eggs in both gut contents and plankton
- Different prey proportions in guts vs. plankton



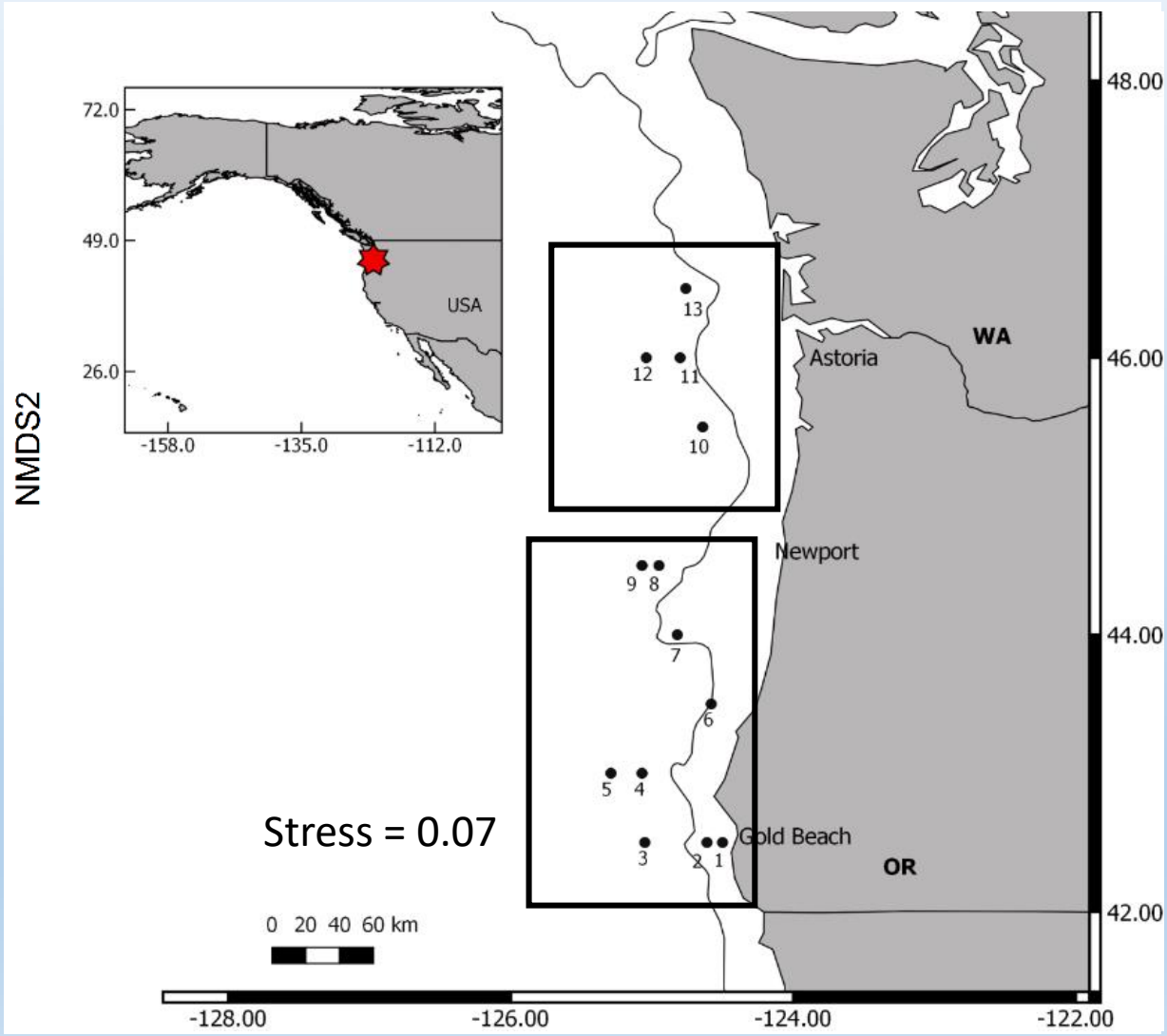
High ingestion rates for prey items



- High ingestion rates for cladocerans and fish eggs
- Size of colony has significant relationship with cladoceran and fish egg ingestion
- Ingestion rates amplified in large aggregations

Northern and southern stations have different prey consumption patterns

- NMDS to highlight prey consumption patterns
- Separation of prey categories
- Separation of transects
  - North (plume) vs south (nonplume)



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Using gut contents, we examined:

1) Gut contents of *V. velella* colonies
2) Patterns to prey ingestion

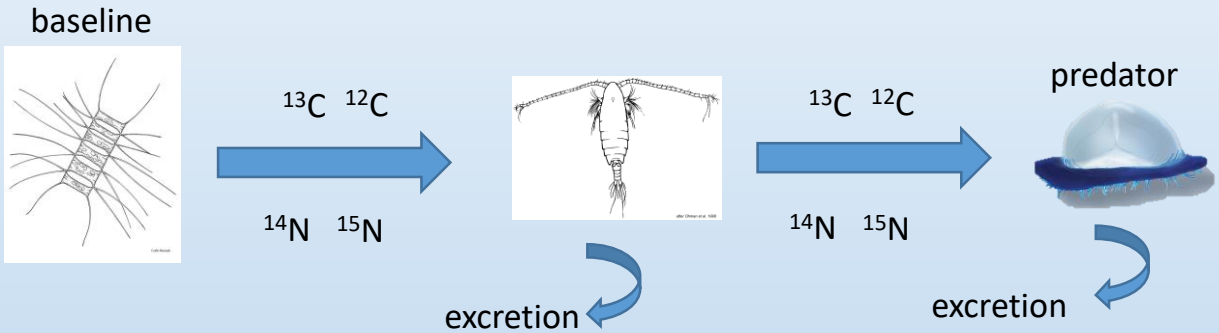
- High capture rates of anchovy eggs
- Alongshore patterns in feeding

Using Stable isotope analysis:

3) We quantified trophic niche and developed mixing models. And,

4) Examine importance of zooxanthellae

Carbon and nitrogen stable isotope ratios as tool to discover trophic relationships



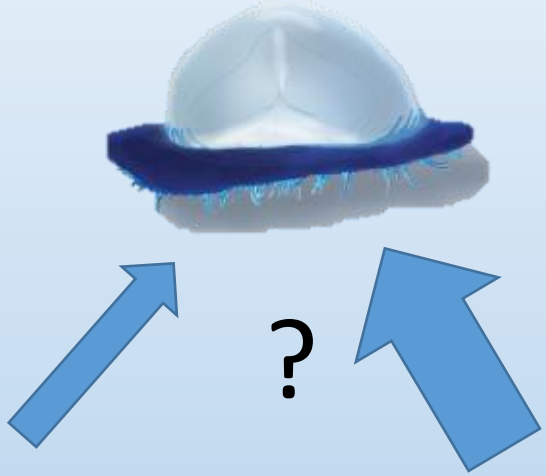
- $\delta^{13}C$ to trace prey sources in food webs
  - $\delta^{13}C$ increase by ~ 1‰ per trophic level
- $\delta^{15}N$ indicator of trophic level
  - $\delta^{15}N$ increases by approximately 3-4‰

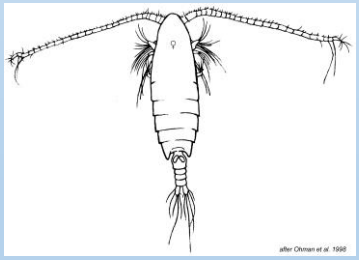
Use carbon and nitrogen ratio values to construct trophic niche and mixing models.

Represent assimilated dietary sources from longer time span

Stable isotope methodology

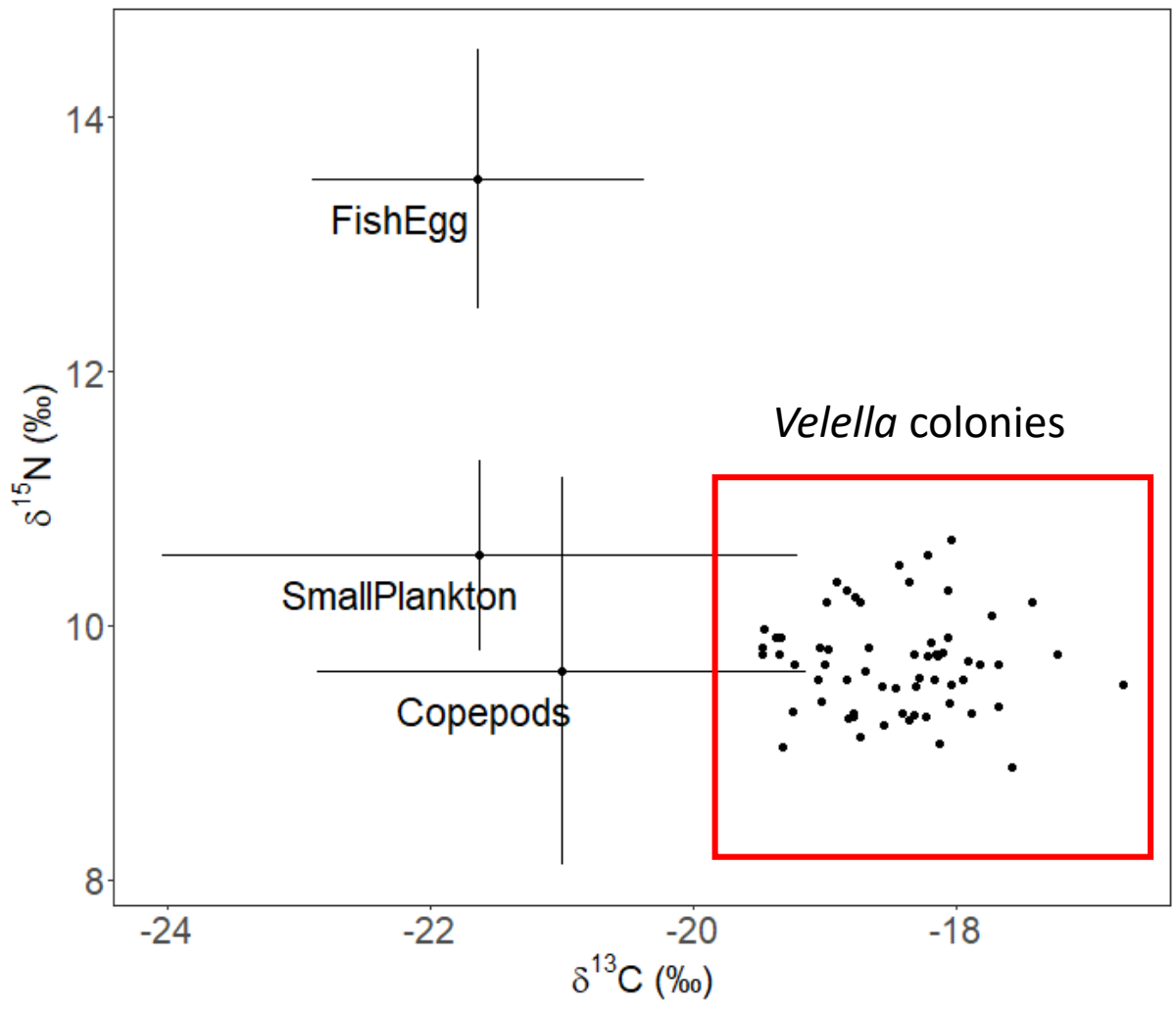
- 50 whole *V. velella* colonies were dried and homogenized
- Collected zooplankton material from key prey items determined by gut contents
- Use statistical packages, SIBER and MixSIAR, to reconstruct *V. velella* diet



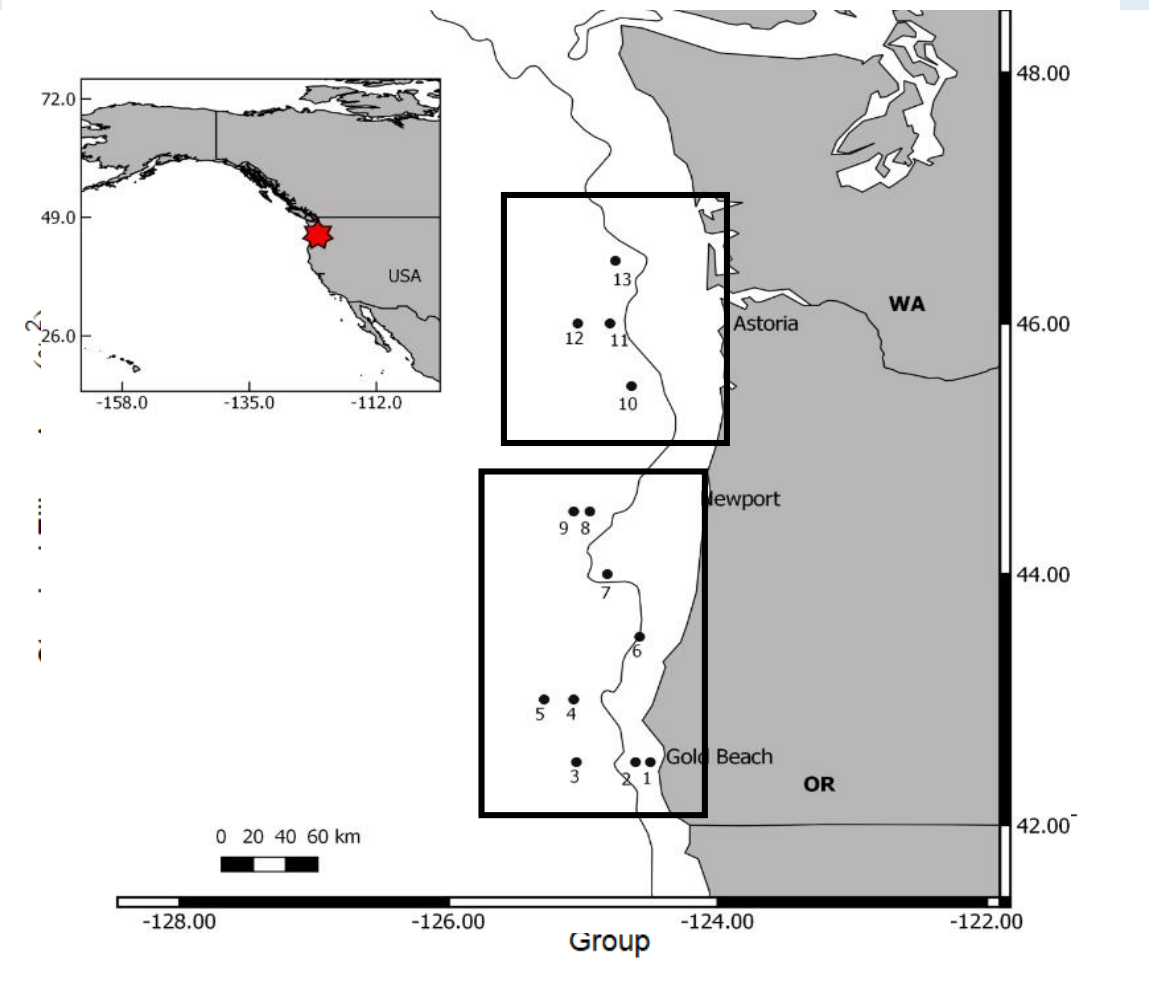


V. Velella colonies δ-space

- *V. velella* enriched (less negative) in $\delta^{13}C$ then most zooplankton prey categories
- $\delta^{15}N$ similar to copepods and other small plankton
- Fish eggs have highest $\delta^{15}N$

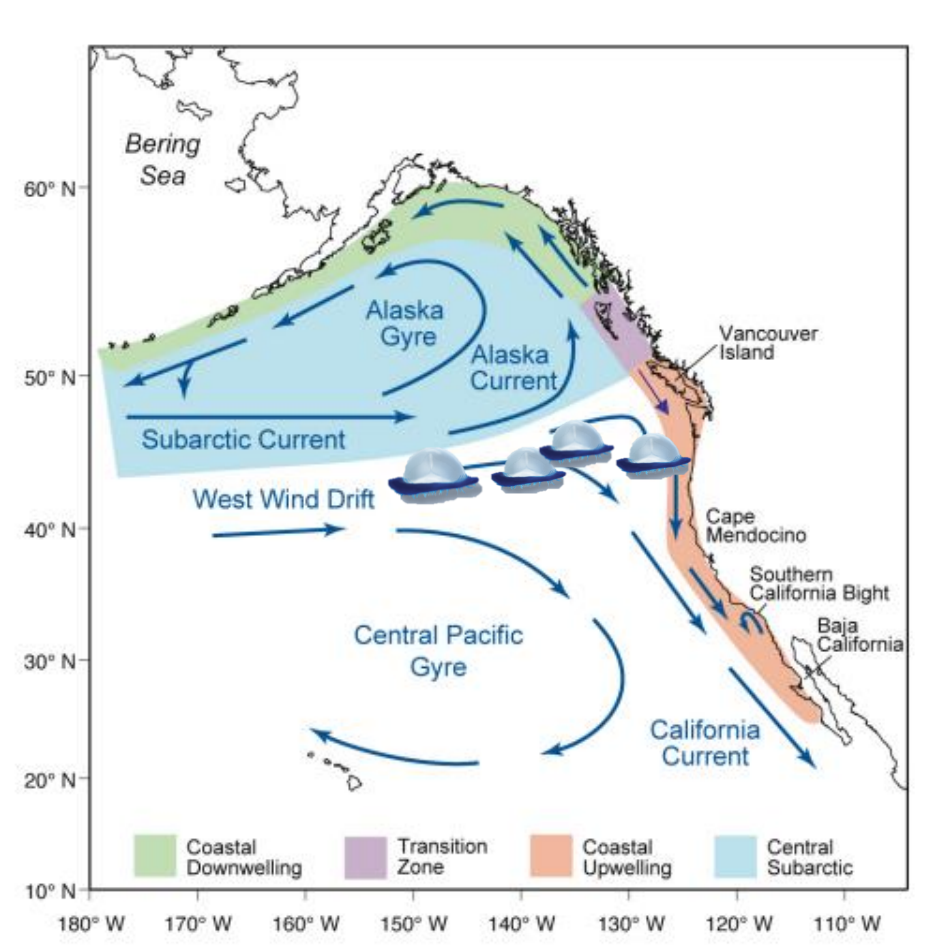


Sampling location of *V. velella* colonies impacts trophic niche



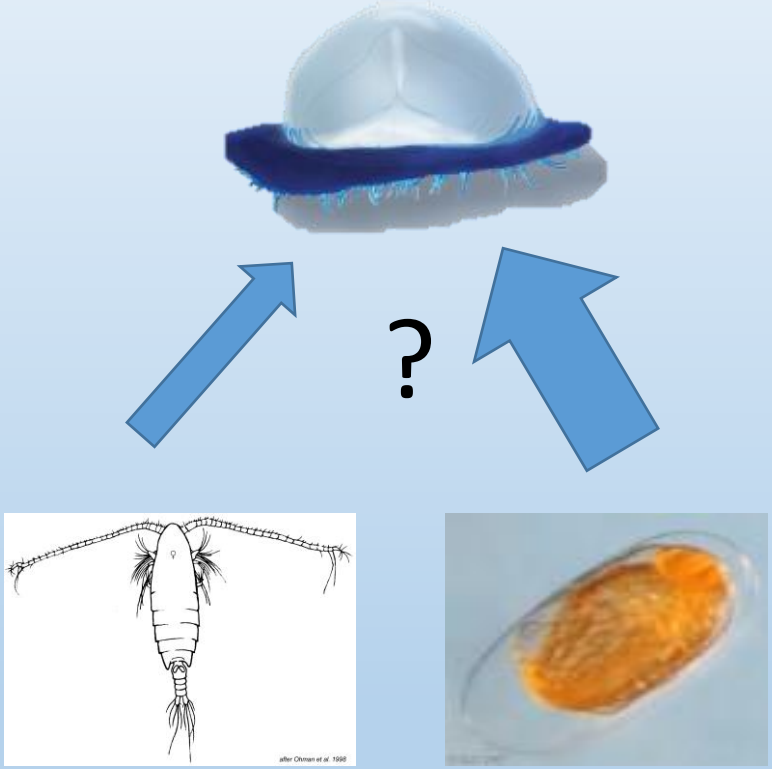
- Trophic niche as proxy for ecological niche
  - Standard Ellipse Area (SEA) with SIBER package used as metric
- Possible latitudinal differences in trophic niche?
  - No overlap between plume and nonplume stations
  - Nonplume stations had higher SEA

NE Pacific circulation and isotopic signatures of *V. velella* colonies

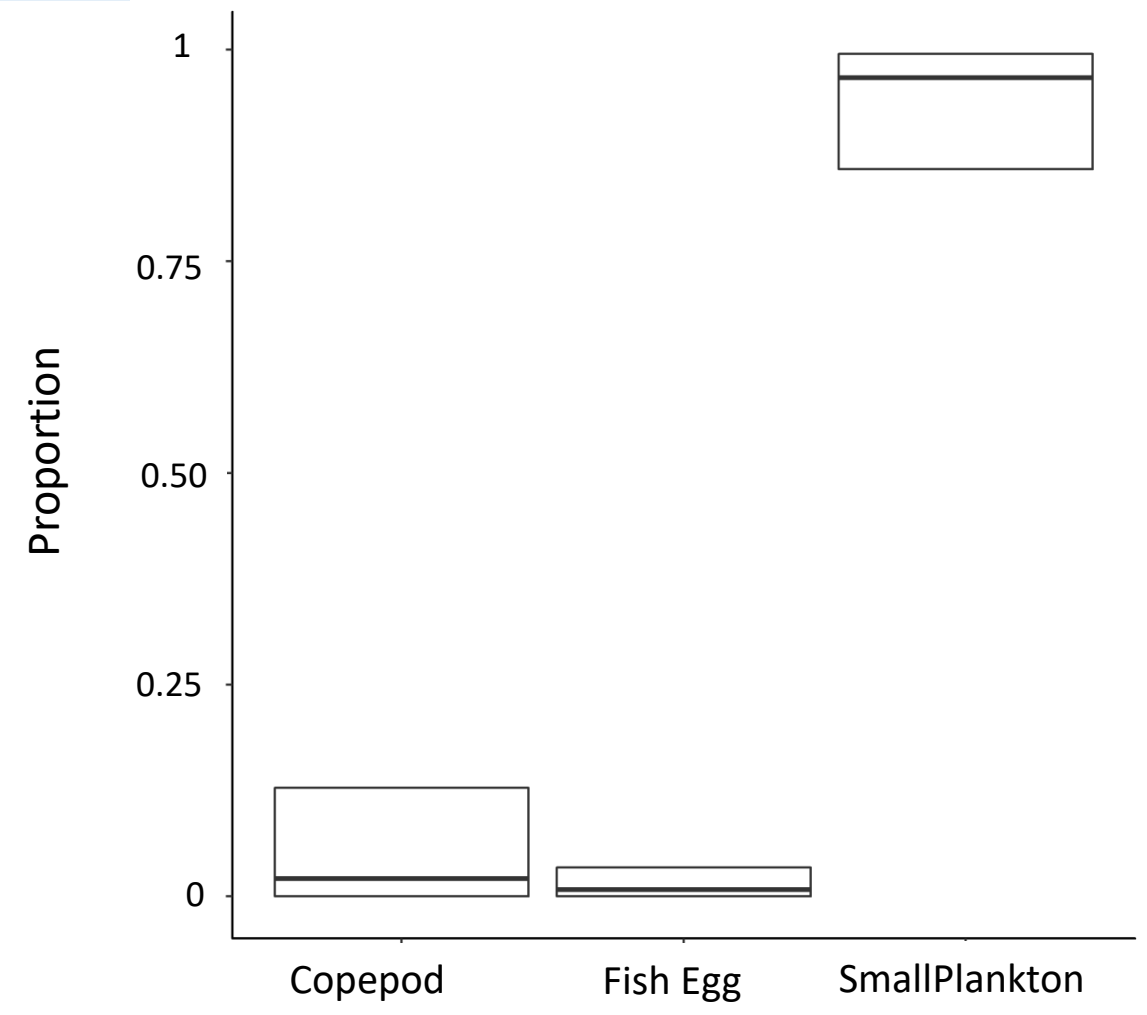


- Colonies passively accumulate in response to wind and current patterns
  - Aggregations as distinct events?
- Differences in isotopic values represent transient isotopic variability of baseline producers as they move across and down the NE Pacific

Stable isotope mixing models



Mixing models suggest small plankton are important component of *V. velella* diet

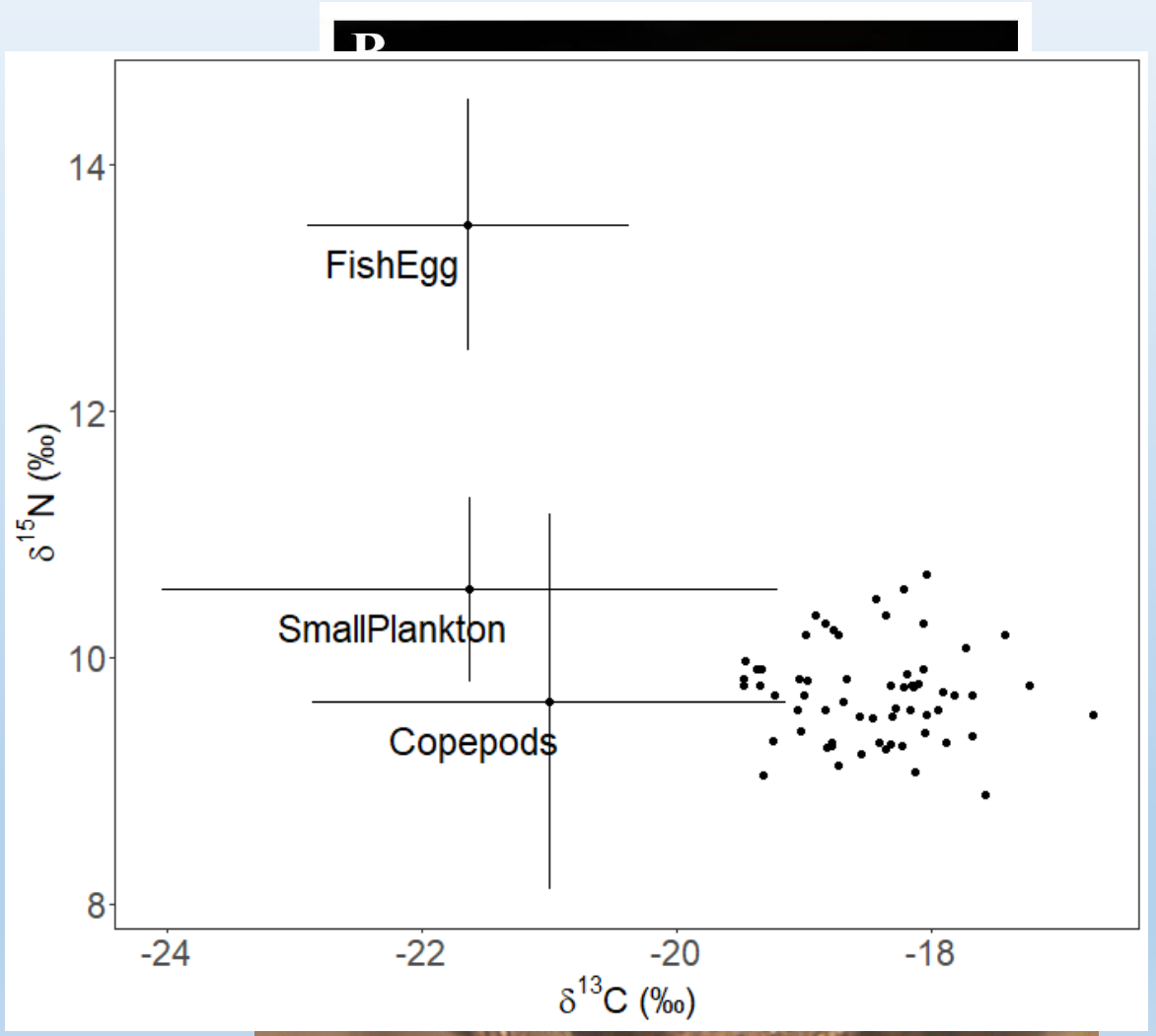


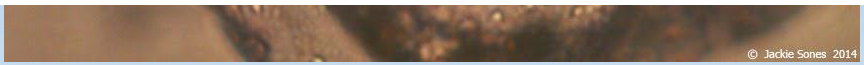
Boxplot: Median and 95% credibility intervals

- With consumer and prey isotopic values, use MixSIAR package to reconstruct *V.velella* diet
- *Velella* ingesting a greater proportion of small plankton
- Even with high amounts of fish eggs in gut, not a large component of diet
  - Not assimilating? Turn over rates?

Preliminary stable isotope results suggest the importance of symbiotic zooxanthellae

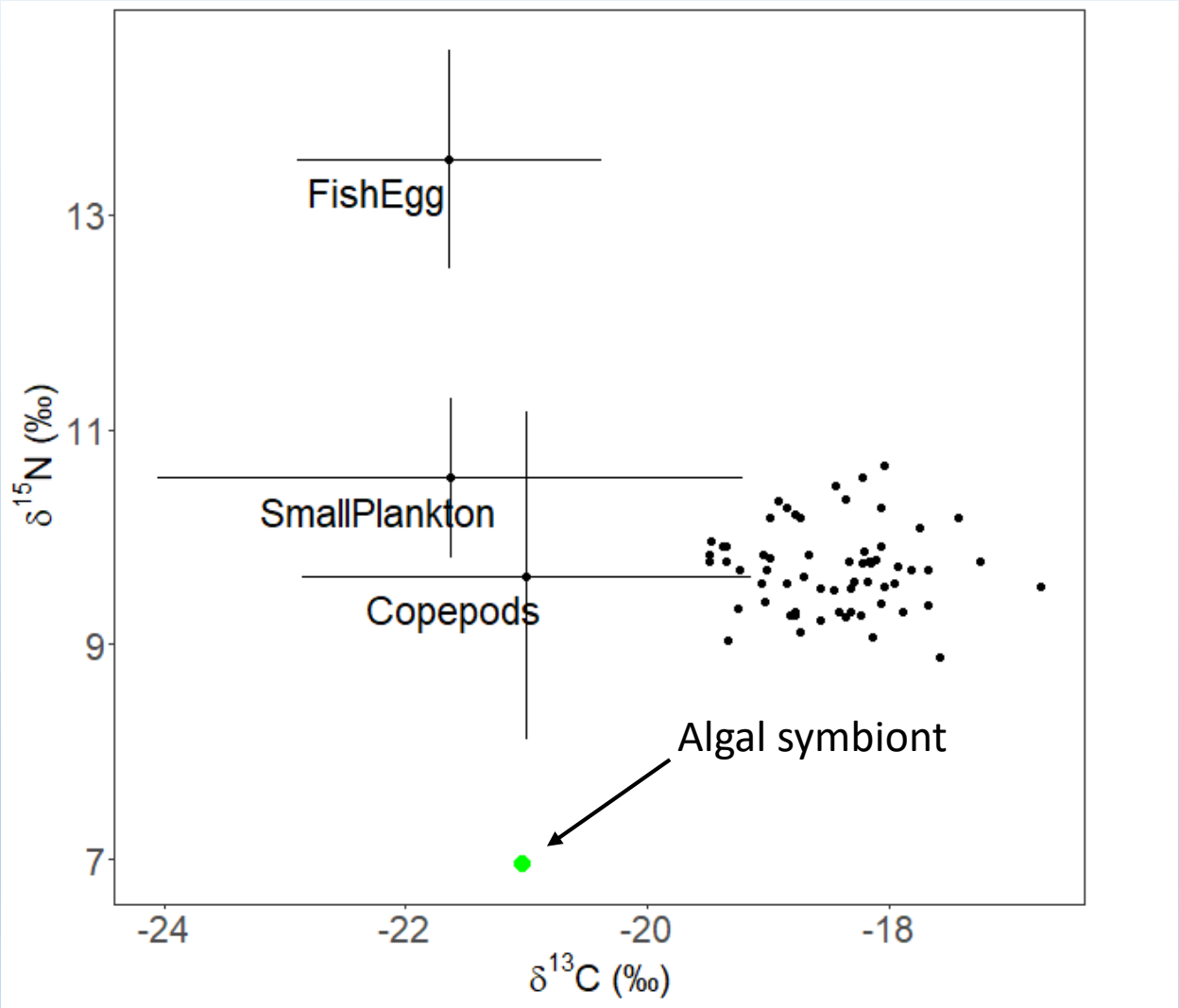
- Carbon and nitrogen signatures suggest looking deeper into zooxanthella contribution to *V. velella* nutrition
- Symbiotic dinoflagellate *Scrippsiella velellae* in tissue, including medusae



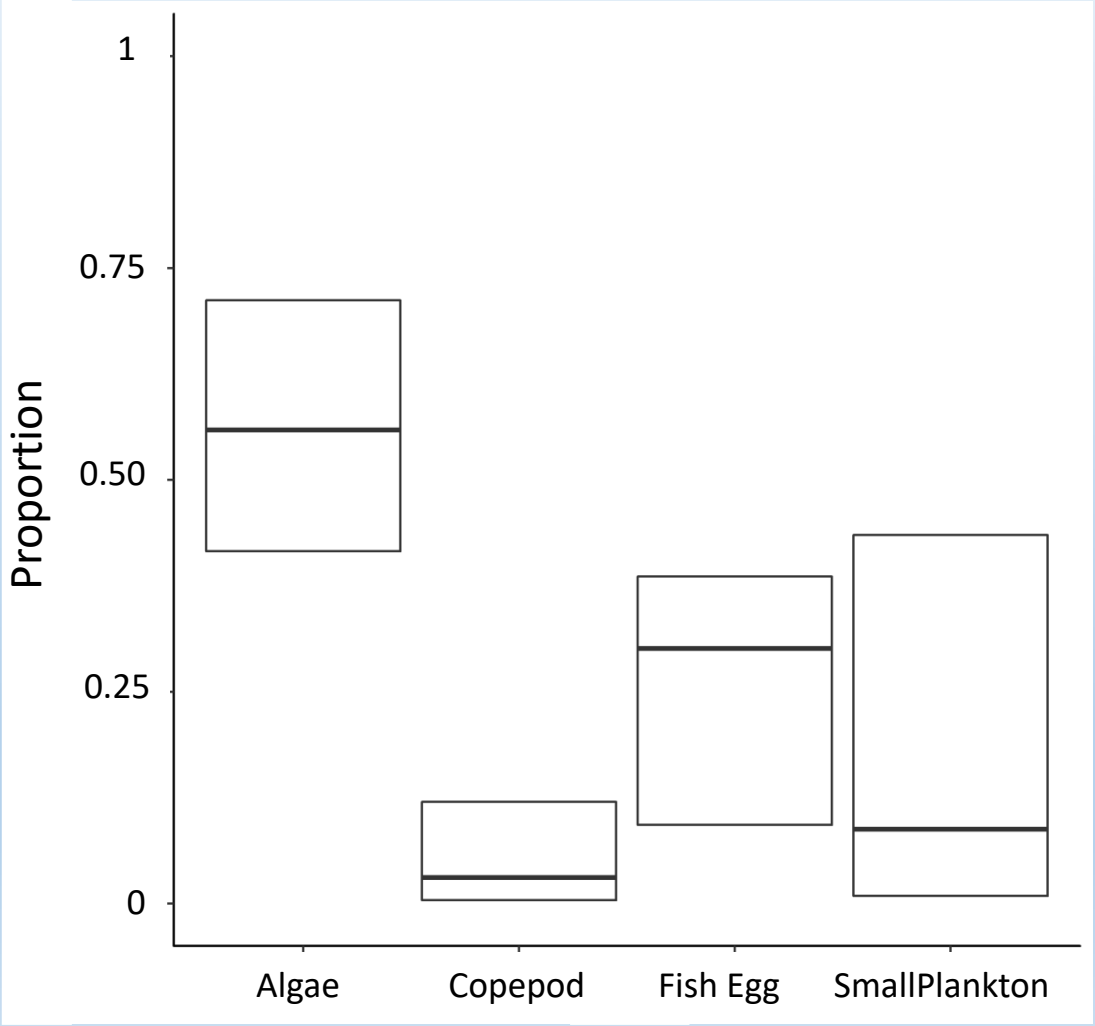


Isolating zooxanthelle

- By centrifuging whole colonies, isolated algal and host components
  - Colonies collected during the fall 2015
- Isolated single algal pellet, with lower $\delta^{15}N$ and more negative $\delta^{13}C$



Adding zooxanthellae to mixing model explores importance of symbiotic nutrition to *V. velella*



- Algae a greater proportion of diet than other prey categories
- Fish eggs more important proportion of diet
- Tantalizing evidence for more robust studies with zooxanthellae!

Need to consider limitations to stable isotopes before making conclusions

- Biochemical preparation
  - Freezing? Washing? Lipid-transformed?
- Trophic enrichment factors (TEFs)
  - Baseline isotopic values shifted from prey to consumer
- Prey sources
- No baseline carbon or nitrogen ratios
  - Particulate organic matter (POM) for primary production
- No isotopic turnover rates available for *V. velella* tissues

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Using gut contents, we examined:

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4) Examine importance of zooxanthellae

- Colony distribution and niche overlap
- Role of zooxanthellae

Now we know a little more about *V. velella* trophic ecology

- Fish eggs are predominant prey item in northern stations near Columbia River plume
  - Could be very significant in large aggregations
- First use of stable isotope analysis and gut contents to describe *V. velella* diet in the NCC
  - Even with uncertainties associated with SIA
- Use these results as a call to action!
  - Distribution patterns and importance of symbiotic algae

Acknowledgements

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Thank you
Any questions?