SPATIAL DIFFERENCES IN JUVENILE SALMON FOOD QUALITY AND QUANTITY DURING THEIR EARLY MARINE RESIDENCE IN PUGET SOUND

MINNA HILTUNEN[1,2], URSULA STRANDBERG[2], JULIE E. KEISTER[3], AMANDA K. WINANS[3], DAVID BEAUCHAMP[4], MIIKA KOTILA[2], MICHAEL T. BRETT[5]

1 BIOLOGICAL AND ENVIRONMENTAL SCIENCE, UNIVERSITY OF JYVÄSKYLÄ, FINLAND
2 ENVIRONMENTAL AND BIOLOGICAL SCIENCES, UNIVERSITY OF EASTERN FINLAND, JOENSUU, FINLAND
3 SCHOOL OF OCEANOGRAPHY, UNIVERSITY OF WASHINGTON, SEATTLE, USA
4 WESTERN FISHERIES RESEARCH CENTER, U.S. GEOLOGICAL SURVEY, SEATTLE, USA
5 CIVIL AND ENVIRONMENTAL ENGINEERING, UNIVERSITY OF WASHINGTON, SEATTLE, USA

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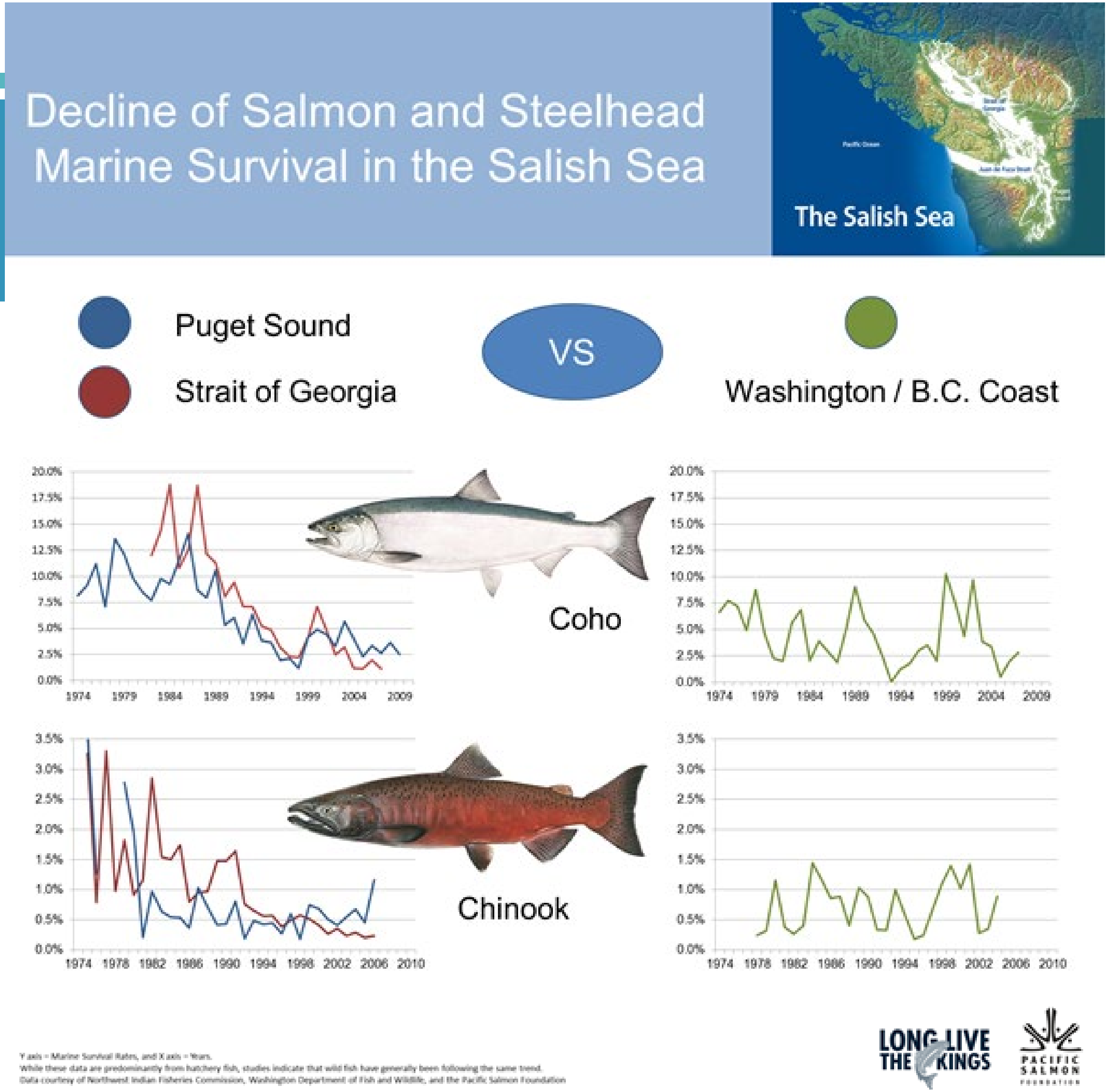
DECLINE IN SALMON STOCKS

- Many stocks of anadromous Pacific salmon (*Oncorhynchus* spp.) have declined on the west coast of the USA (Nehlsen et al. 1991)

- Recent recoveries on the Pacific coast, while some Salish Sea stocks have not recovered (Zimmerman et al. 2015)

- Declines in Chinook, and coho survival in the Salish Sea

- Puget Sound Chinook salmon marine survival currently <1%



THE CRUCIAL EARLY MARINE PERIOD OF SALMON JUVENILES

- Early marine growth of salmon juveniles is thought to determine their overall survival (Beamish & Mahnken 2001)

- Marine survival in Puget Sound Chinook was strongly related to offshore July weight of juveniles (Duffy & Beauchamp 2011)

SALISH SEA MARINE SURVIVAL –PROJECT

PACIFIC SALMON FOUNDATION

SALISH SEA MARINE SURVIVAL PROJECT

LONG LIVE THE KINGS

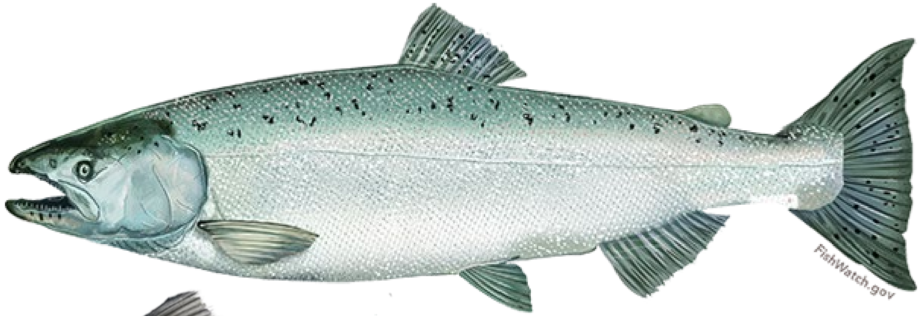
- Over 150 participating scientists from 60 organizations
- To better understand how salmon and steelhead survival are affected by bottom-up and top-down processes, climate, diseases, contaminants, etc.

OUR STUDY QUESTIONS

- Does the quality of salmon prey items vary?
- Are there spatial and temporal differences in the quality and quantity of prey in Puget Sound?

CHINOOK AND COHO SALMON

- Chinook salmon (*Oncorhynchus tshawytscha*)



- Coho salmon (*Oncorhynchus kisutch*)

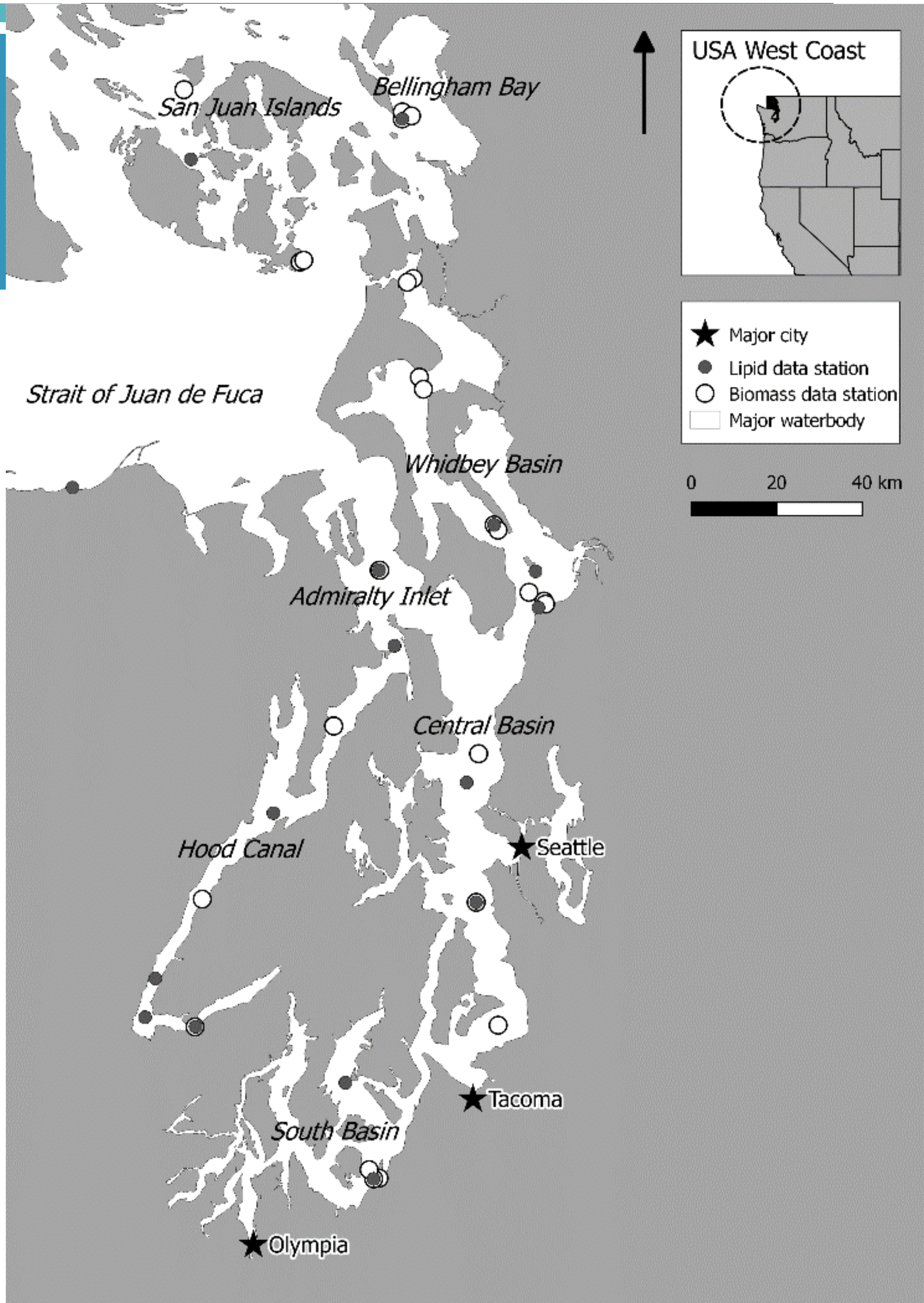
- Juvenile diet consist mostly of euphausiids, crab larvae, hyperiid and gammarid amphipods, and large copepods, with an increasing proportion of small fish as they grow

QUANTIFYING JUVENILE SALMON PREY QUALITY

- Dietary essential fatty acids (EFAs) are important for juvenile fish
  - EPA (Eicosapentaenoic acid, 20:5ω3)
  - DHA (Docosahexaenoic acid, 22:6ω3)
  - ARA (Arachidonic acid, 20:4ω6)
- They affect growth, reproduction, immune responses, and osmoregulation of fish
- Likely in high demand in rapidly growing juvenile salmonids that have recently entered the marine environment

METHODS: FIELD SAMPLING

- Zooplankton was collected in March-October 2017 with Bongo Net tows
  - ~20 offshore stations
  - Fatty acid composition
  - Biomass estimation
- Few additional samples taken for fatty acids in 2018



METHODS: FATTY ACID ANALYSIS

- Zooplankton sorted and identified to species/family (~60 taxa)
  - 13 broad taxonomic groups
- Freeze-dried samples were weighed and extracted for lipids
- Fatty acids derivatized to fatty acid methyl esters and ran with GC-FID
- Results expressed as μg FA / mg C

- Here, I am showing only the results on EPA+DHA and ARA

TECHNICAL REPORT WITH MORE FATTY ACID DATA!

Technical Report

Fatty acid composition of zooplankton prey for juvenile salmonids in Puget Sound

Minna Hiltunen[1]*, Ursula Strandberg[1], Julie Keister[2], David Beauchamp[3], and Michael T. Brett[4]

1 Department of Environmental and Biological Sciences, University of Eastern Finland, Joensuu, Finland

2 School of Oceanography, University of Washington, Seattle, USA

3 Western Fisheries Research Center, U.S. Geological Survey, Seattle, USA

4 Civil and Environmental Engineering, University of Washington, Seattle, USA

TECHNICAL REPORT WITH FATTY ACID DATA!

https://marinesurvivalproject.com/resources/

Fatty acid composition of zooplankton prey for juvenile salmonids in Puget Sound

minna.m.hiltunen@jyu.fi

Minna H… …ichael T. Brett[4]

ResearchGate

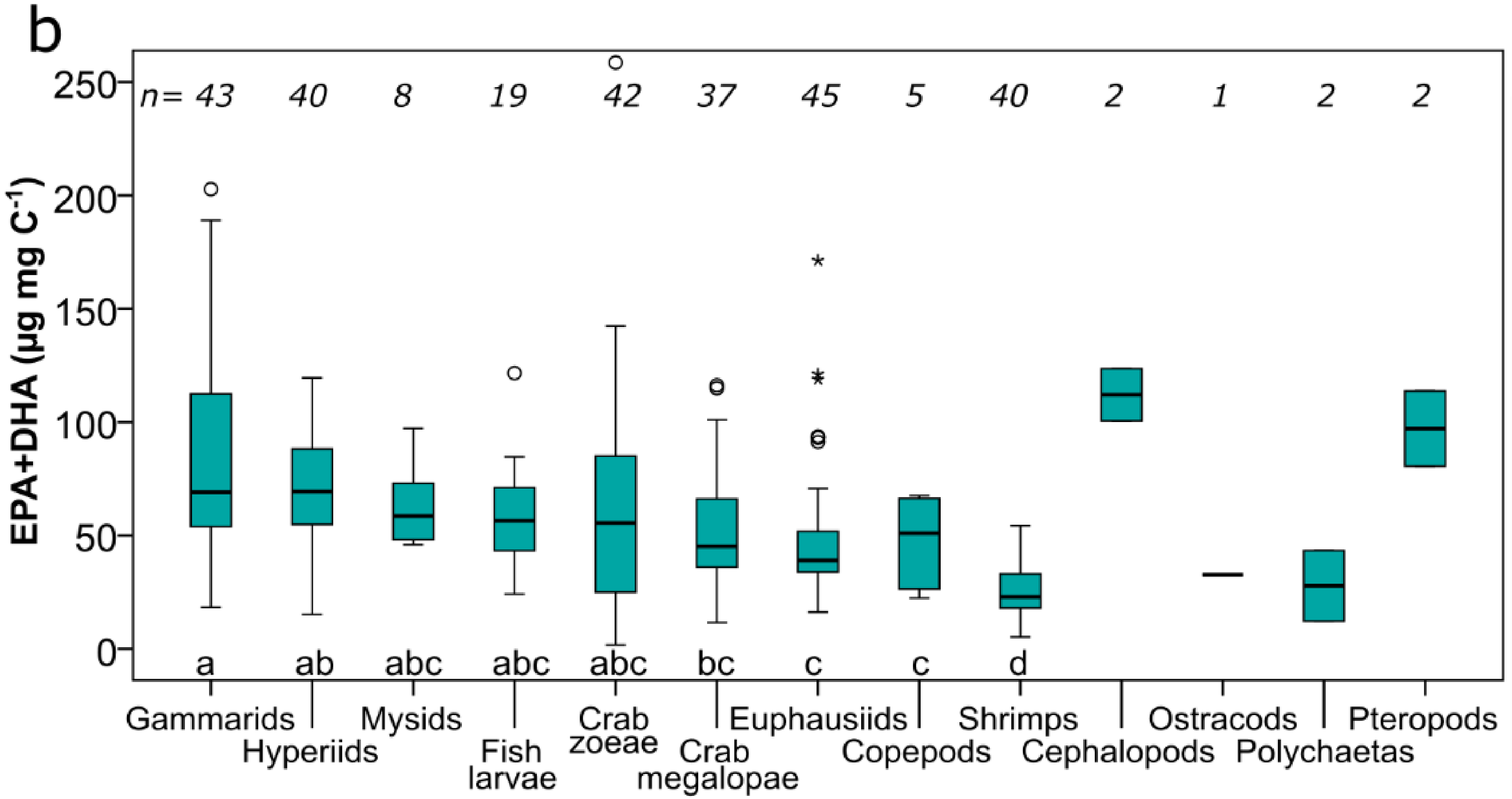
1 Departme… …land, Joensuu, Fi…

2 School of Oceanography, University of Washington, Seattle, USA

3 Western Fisheries Research Center, U.S. Geological Survey, Seattle, USA

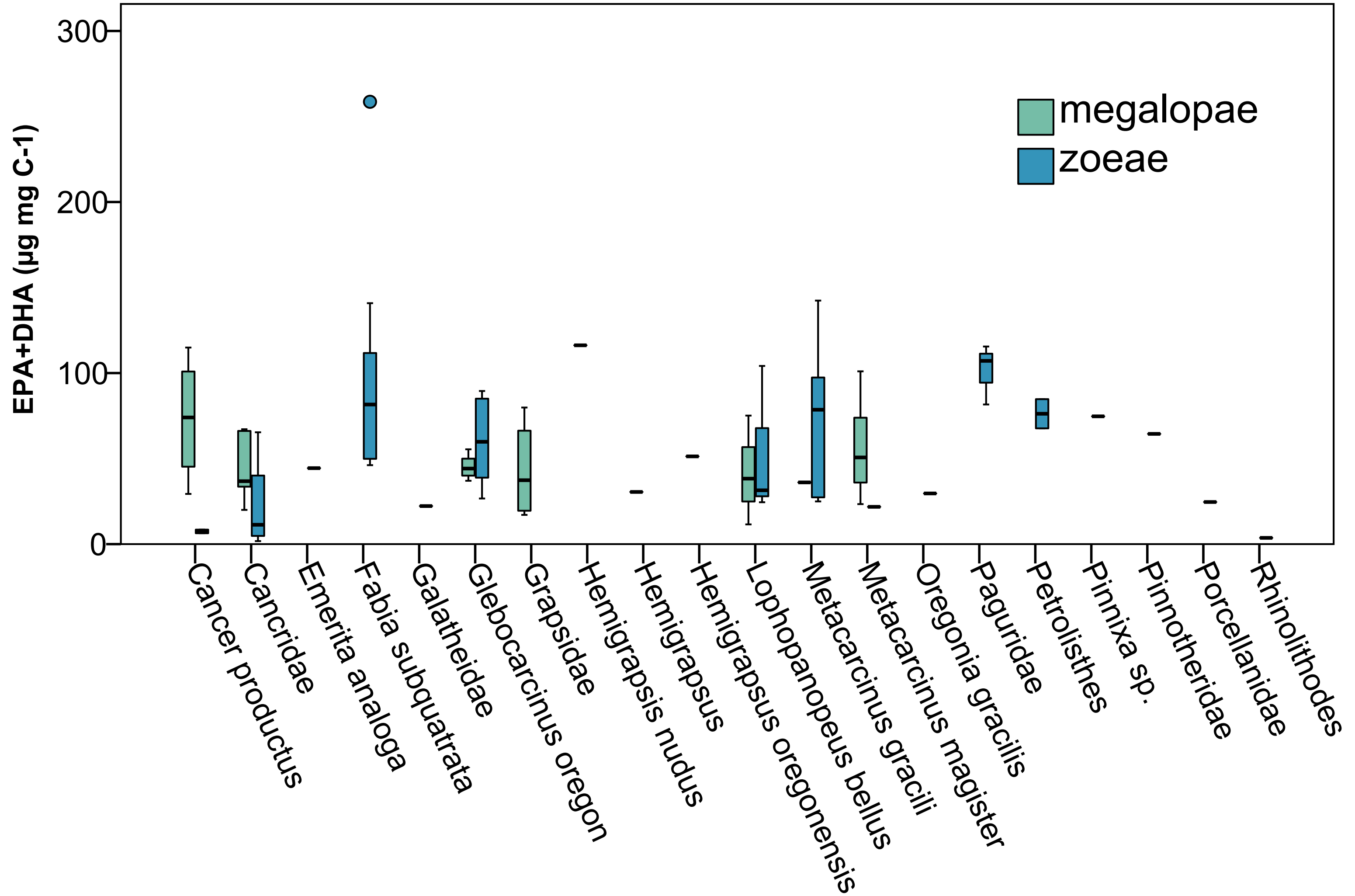
4 Civil and Environmental Engineering, University of Washington, Seattle, USA

RESULTS: EPA+DHA CONTENT OF PREY ITEMS

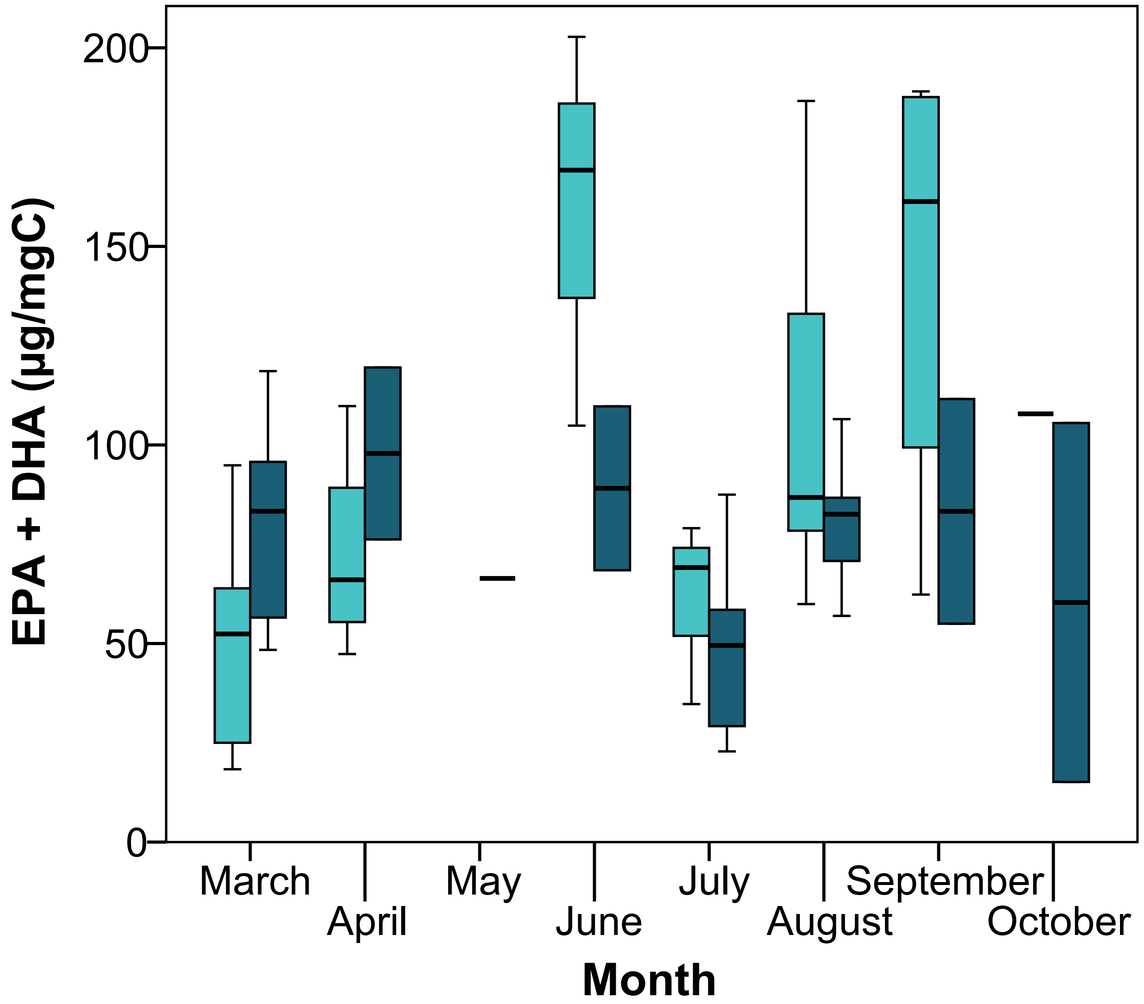


- Significant differences between taxa (Kruskal-Wallis, H = 80.419, p <0.001, n = 279)

CRAB LARVAE EPA+DHA CONTENT BY STAGE

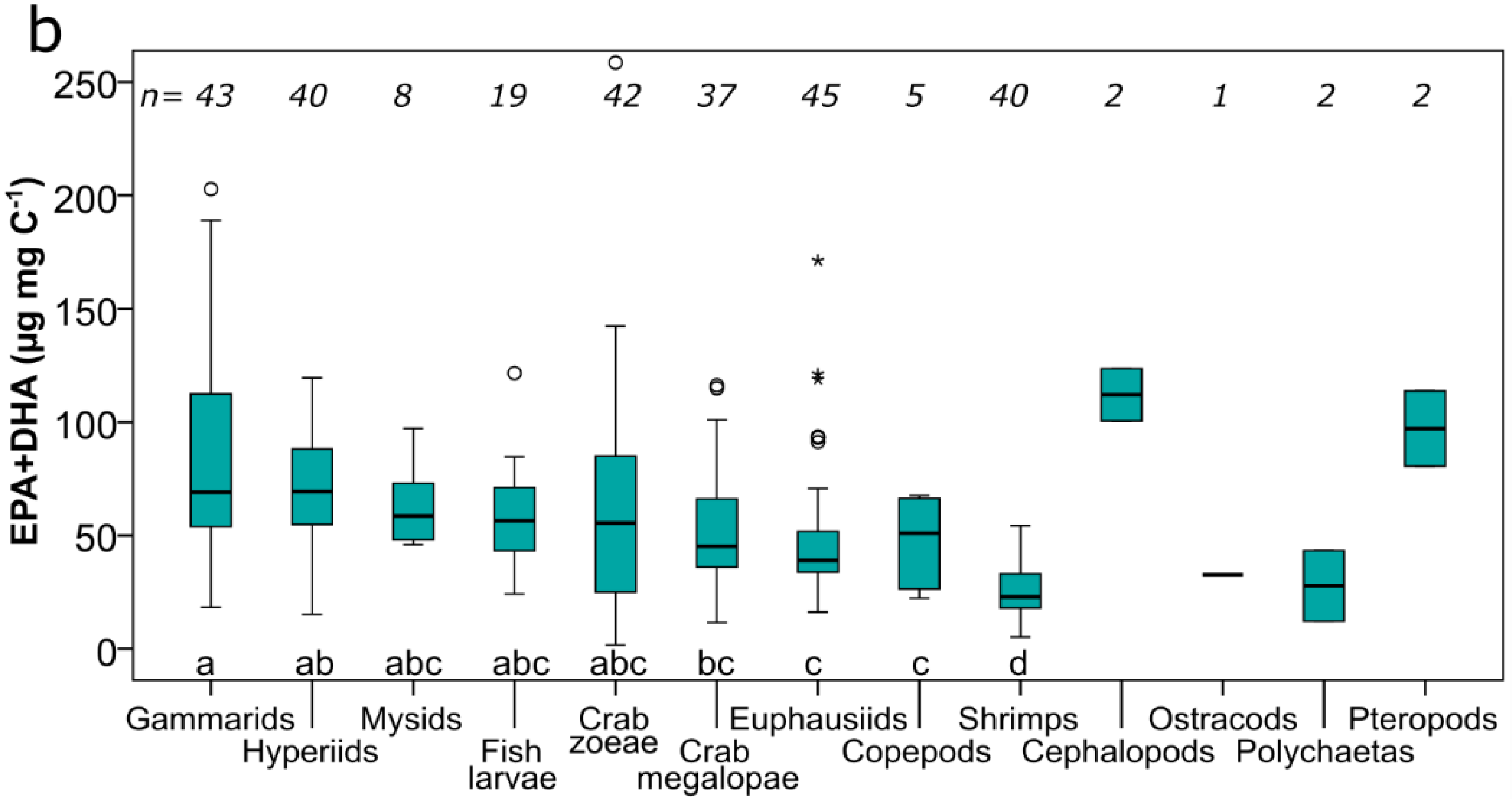


EPA+DHA CONTENT OF AMPHIPODS BY MONTH



Cyphocaris challengeri
Themisto pacifica

RESULTS: EPA+DHA CONTENT OF PREY ITEMS



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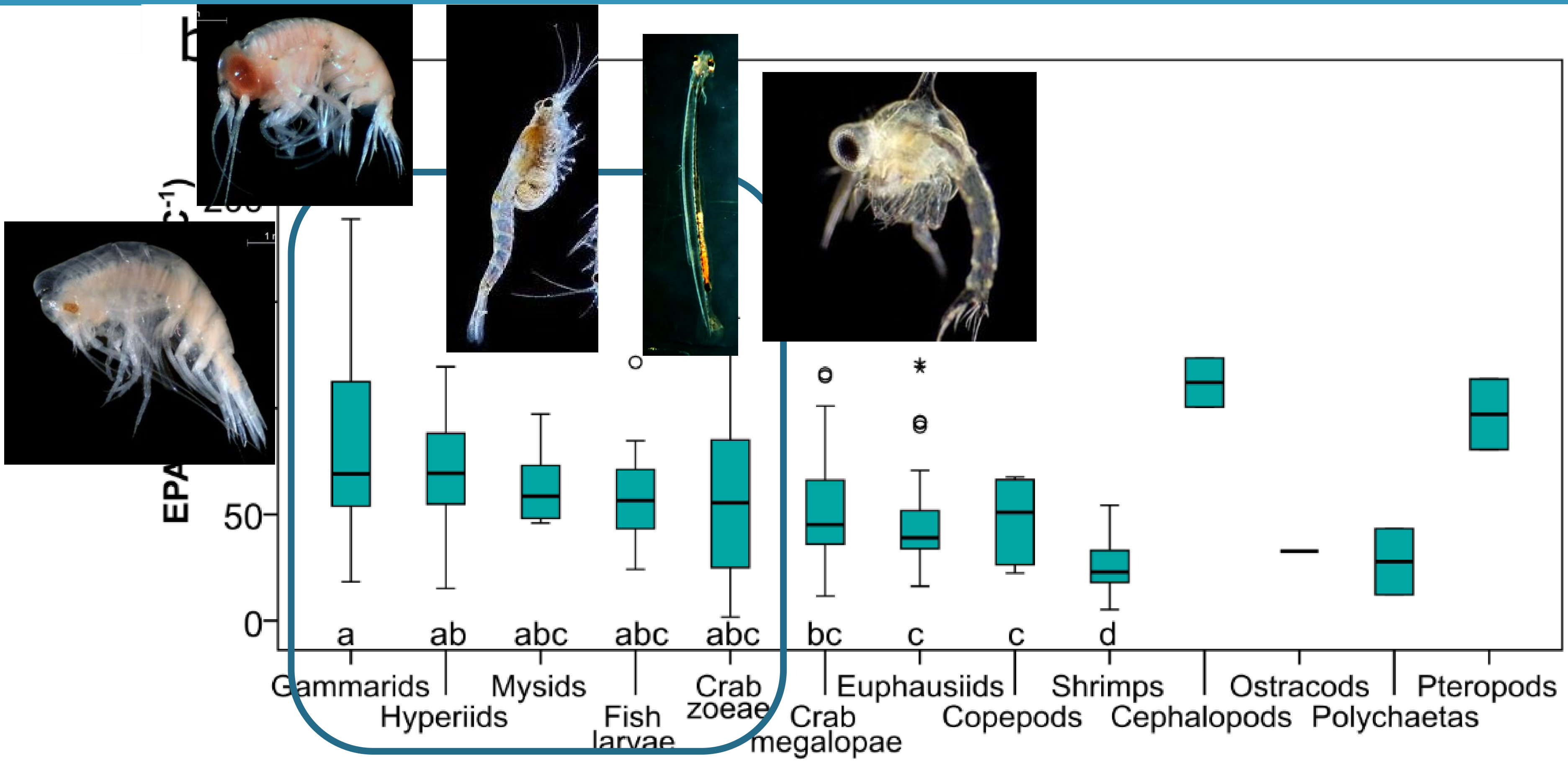

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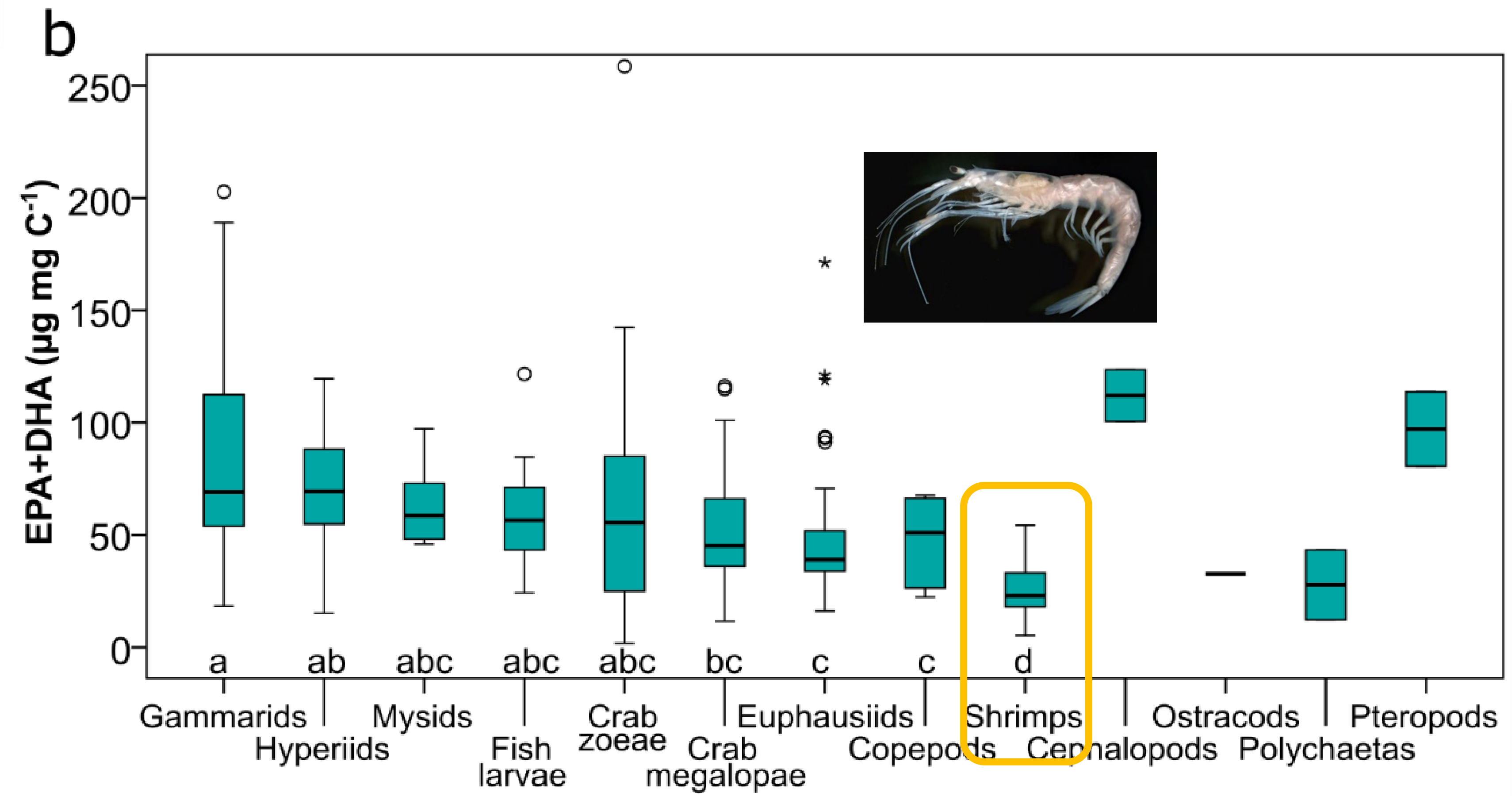
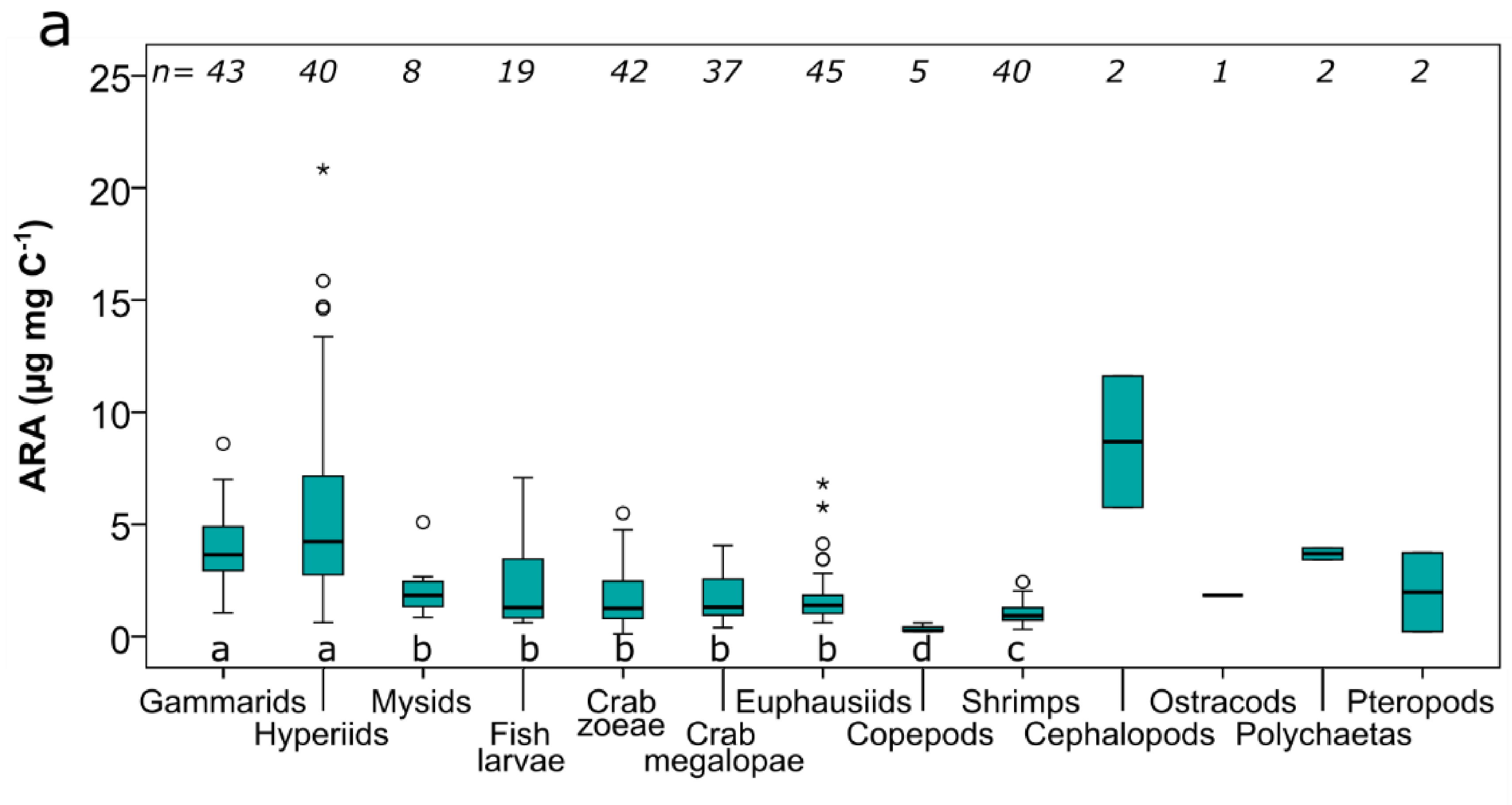


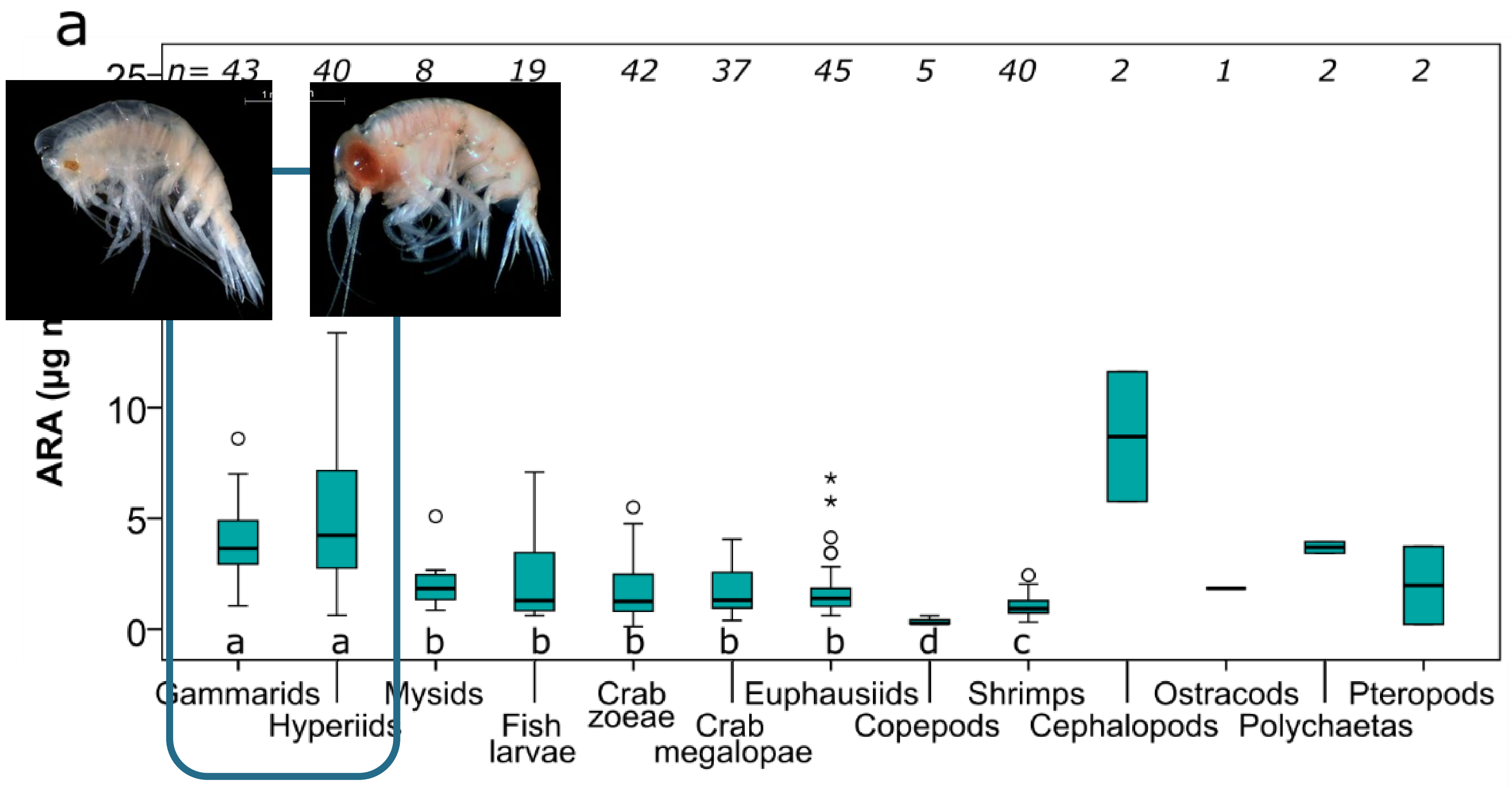
- Significant differences between taxa (Kruskal-Wallis, $H = 80.419$, $p < 0.001$, $n = 279$)

RESULTS: ARA CONTENT OF PREY ITEMS



- Significant differences between taxa (Kruskal-Wallis, H =125.499, p <0.001, n = 279)

RESULTS: ARA CONTENT OF PREY ITEMS



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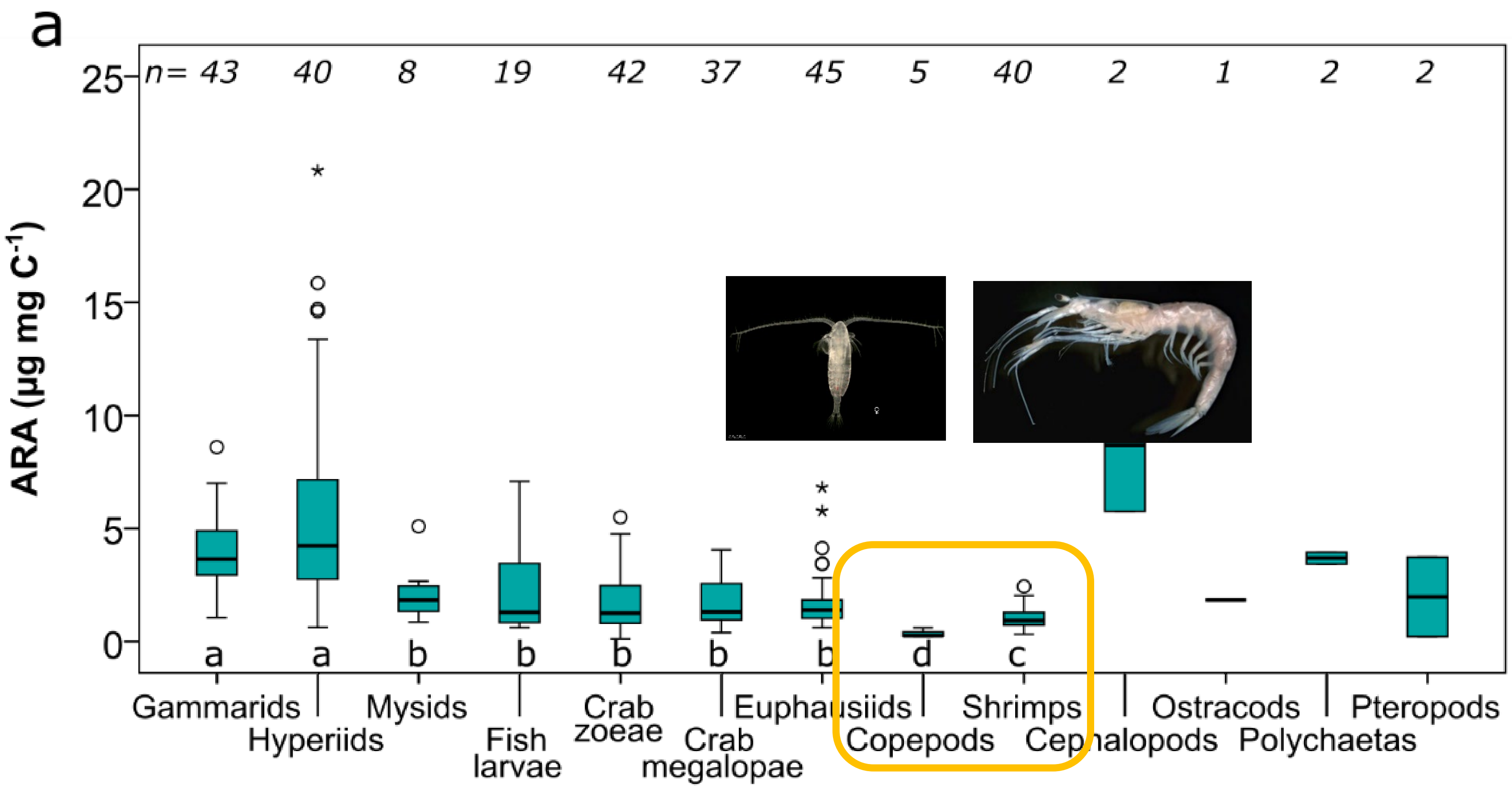


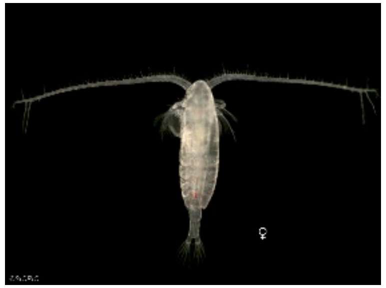
- Significant differences between taxa (Kruskal-Wallis, H =125.499, p <0.001, n = 279)

DISCUSSION: EFA CONTENT OF PREY

- Coho and Chinook salmon juveniles select large and pigmented prey items (Schabetsberger et al. 2003)
  - Also high in EFA





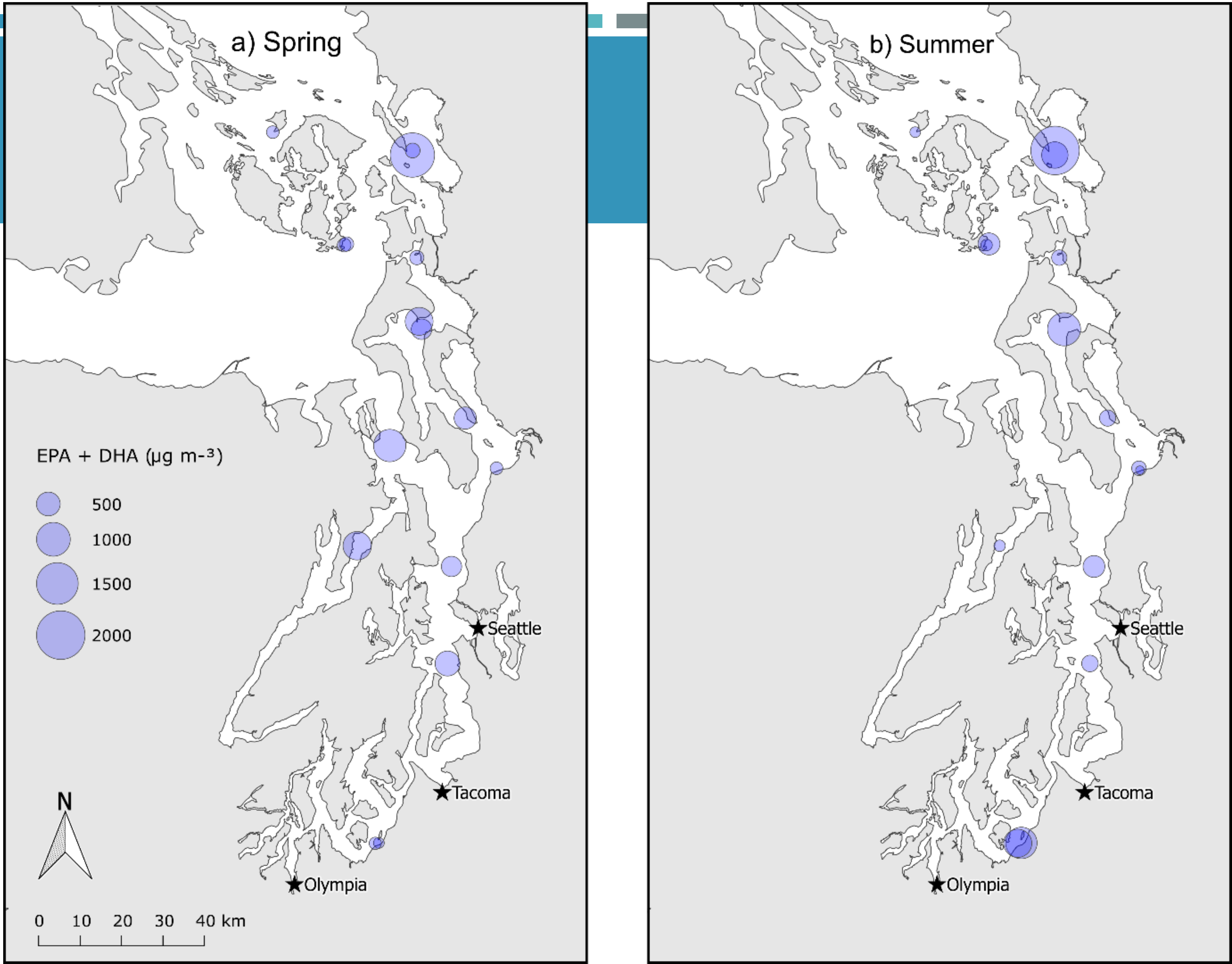

RESULTS: ESSENTIAL FATTY ACID AVAILABILITY IN PUGET SOUND

- We combined the taxon-specific EPA+DHA and ARA content with estimates of biomass to produce an integrated measure of food quantity and quality

- We were interested in EPA+DHA and ARA availability in spring (April-May) and early summer (June-July) corresponding to the critical early marine period for juvenile salmon

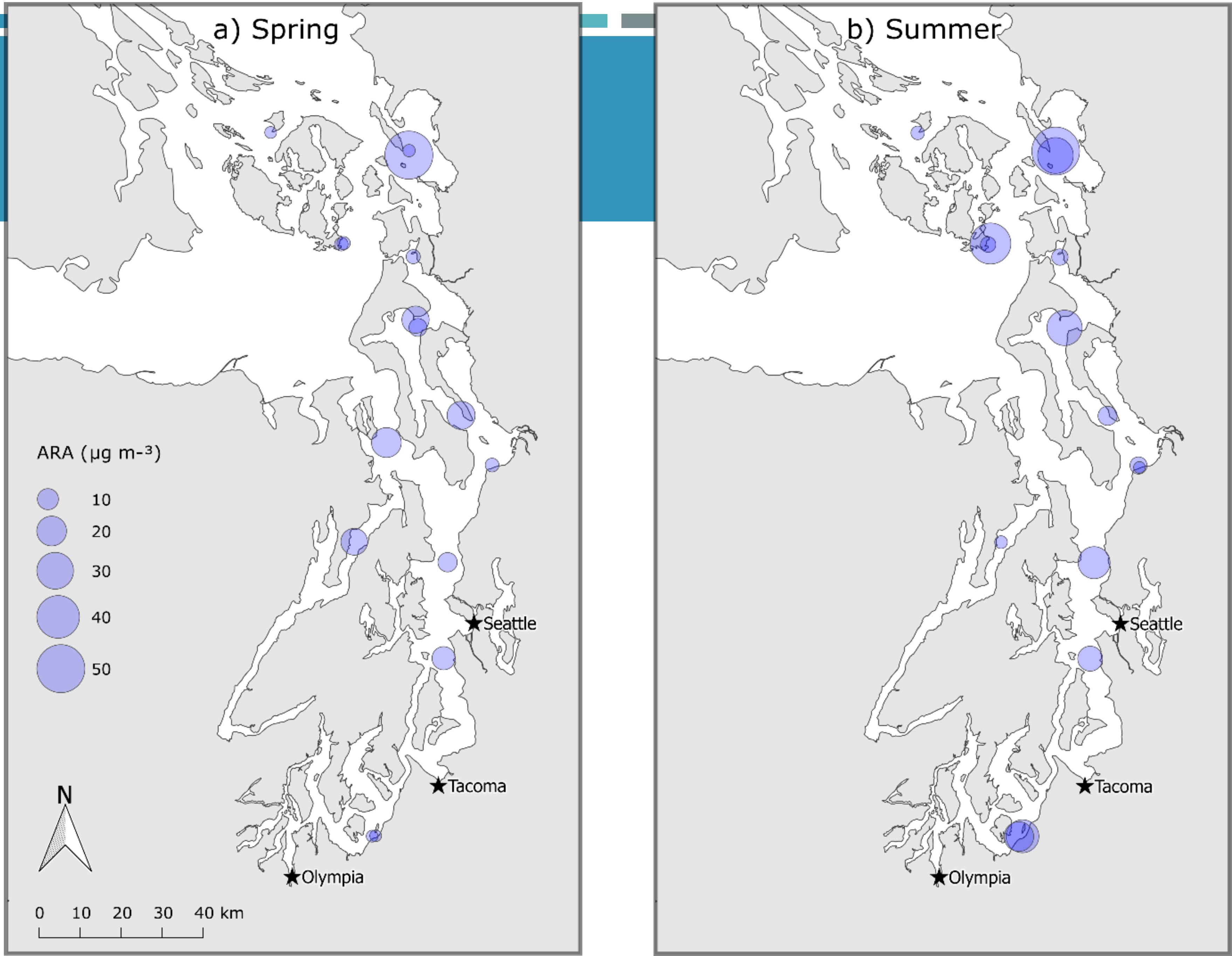
RESULTS: EPA+DHA AVAILABILITY

- High EPA+DHA availability in Bellingham Bay
  - Good feeding conditions
- In spring, very low availability in southern Puget Sound
  - Potential trophic mismatch

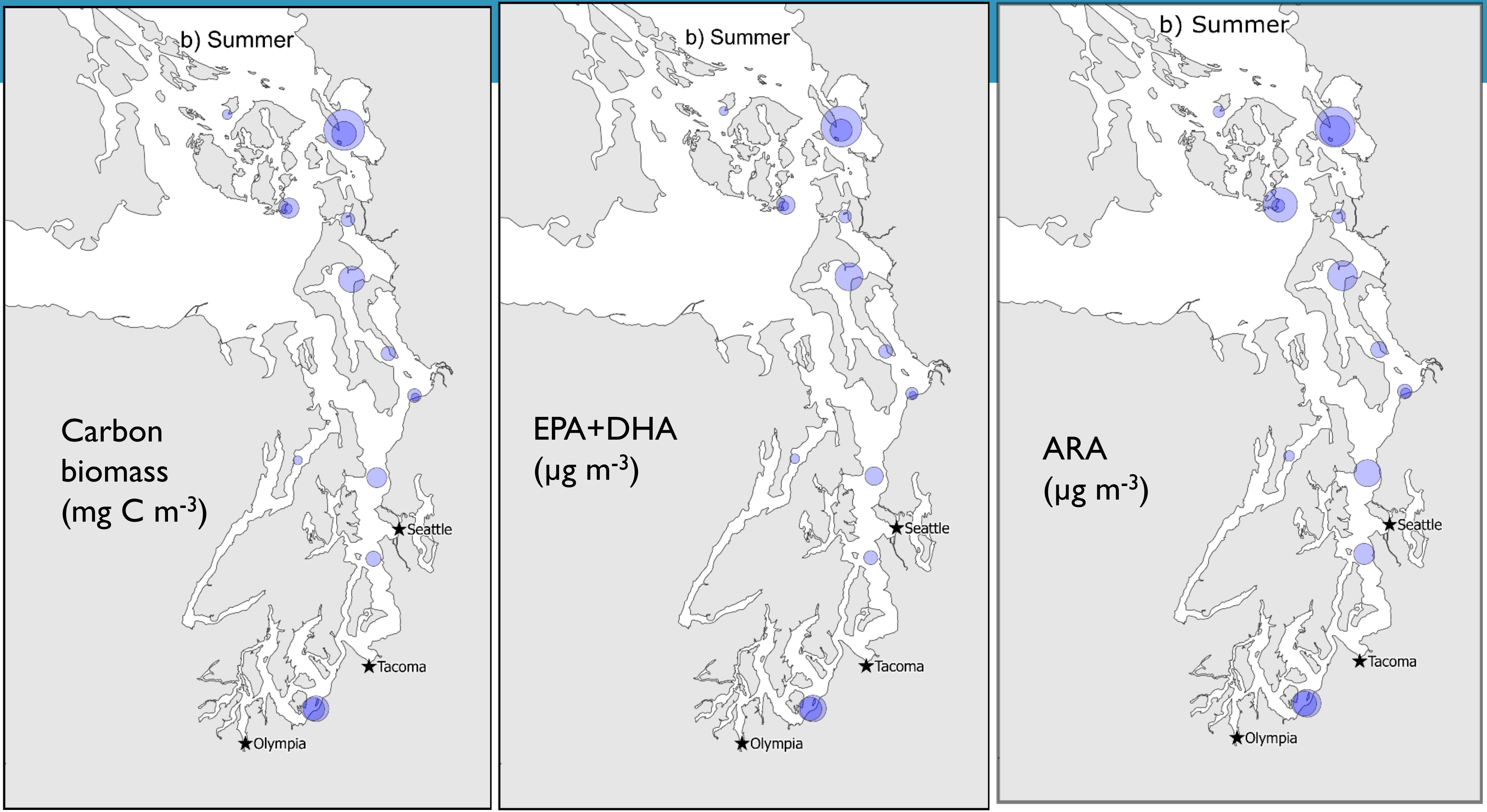


RESULTS: ARA AVAILABILITY

- Similar patterns to EPA+DHA



BIOMASS VS. EFA AVAILABILITY



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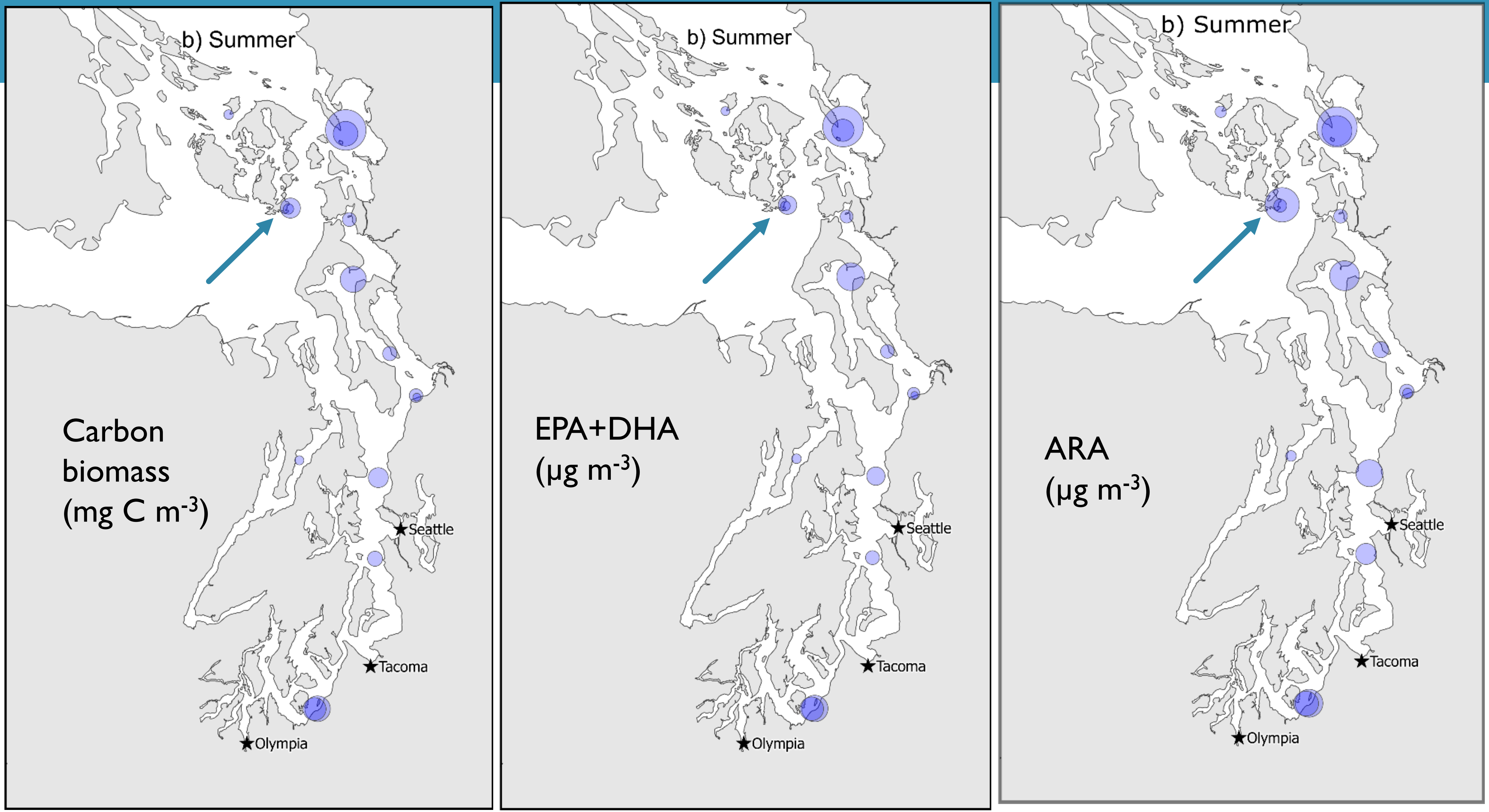

DISCUSSION: EFA AVAILABILITY

- Low EFA availability in southern Puget Sound when salmon juveniles enter in the spring → potential trophic mismatch
  - Chinook salmon had lower 1st year ocean growth in south compared to northern part during 1992-2008 (Clairborne et al. 2017)
  - South Sound had lower survival of coho salmon than other basins during 1992-2010 (Zimmerman et al. 2015)

CONCLUSIONS

- Clear differences in the quality of juvenile salmon prey
  - Salmon seem to target high quality prey
- Spatial and temporal differences in EFA availability in Puget Sound
  - Can these be linked to juvenile salmon fitness?
- Future studies will reveal the potential value of EFA availability as an integrated measure of food quantity and quality

THANKS!

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