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Salish Sea Ecosystem Conference

2014 Salish Sea Ecosystem Conference  
(Seattle, Wash.)

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Apr 30th, 3:30 PM - 5:00 PM

## Fish and Zooplankton Distributions in a Seasonally Hypoxic Fjord

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*University of Washington*

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*University of Washington*

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Sato, Mei; Horne, John K.; and Parker-Stetter, Sandra L., "Fish and Zooplankton Distributions in a Seasonally Hypoxic Fjord" (2014). *Salish Sea Ecosystem Conference*. 46.  
<https://cedar.wwu.edu/ssec/2014ssec/Day1/46>

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# **Fish and Zooplankton Distributions in a Seasonally Hypoxic Fjord**

A scenic landscape photograph of a fjord. The foreground shows a calm body of water reflecting the sky and mountains. The middle ground features a range of green, forested mountains. The sky is blue with scattered white clouds. The text is overlaid on the lower half of the image.

April 30 2014

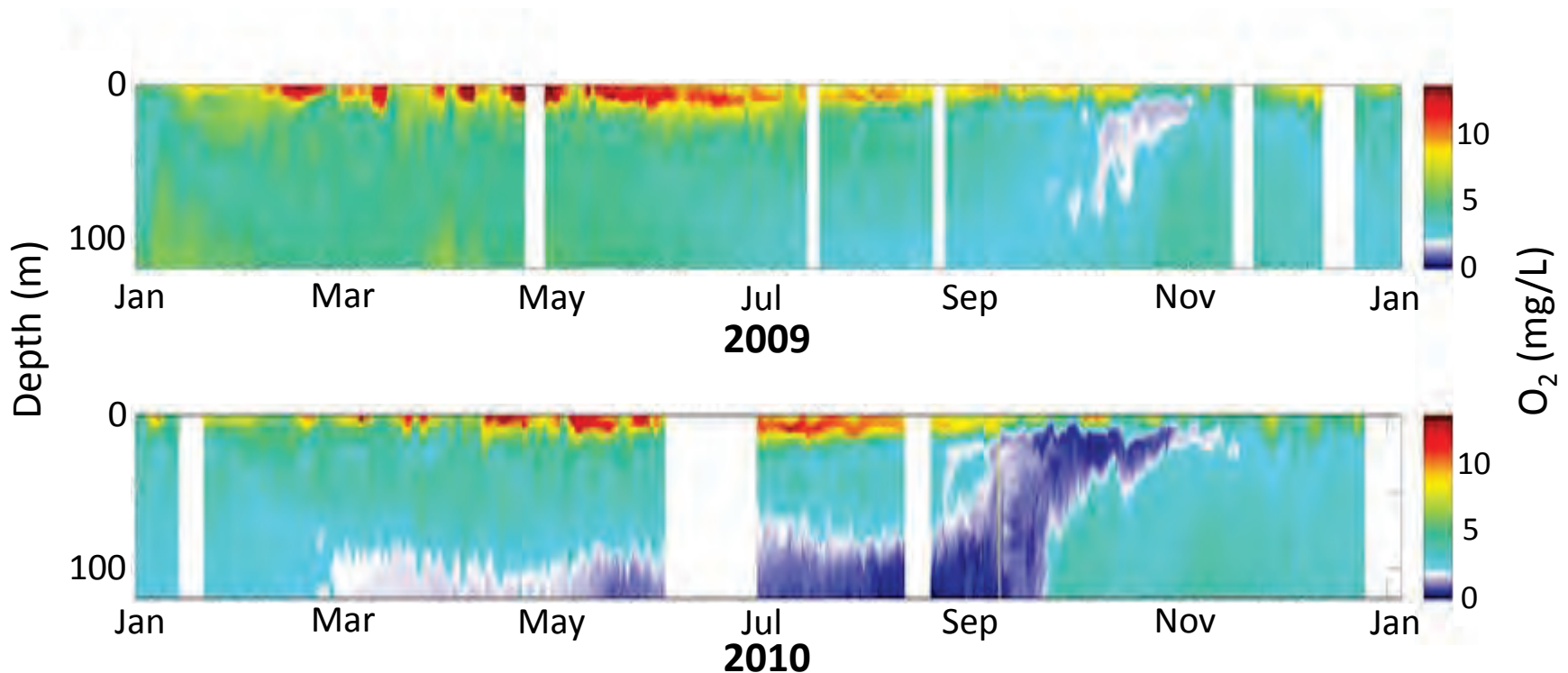
**Mei Sato, John Horne, Sandra Parker-Stetter**

School of Aquatic and Fishery Sciences

University of Washington

# Hypoxia Impacts on Ecosystems

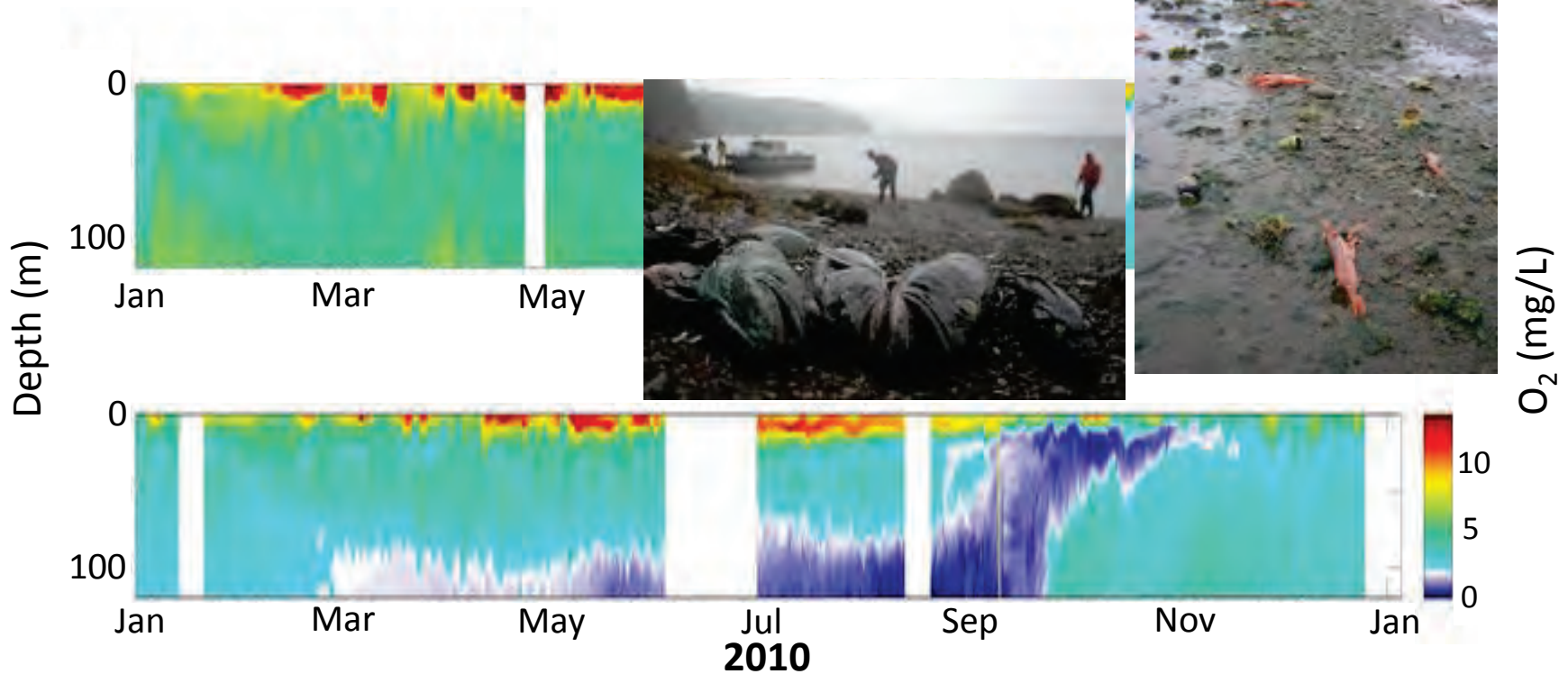
- Compress favorable habitat for predators and prey
- Shift in community composition
- Alter energy flow in food webs



(Newton & Devol 2012)

# Hypoxia Impacts on Ecosystems

- Compress favorable habitat for predators and prey
- Shift in community composition
- Alter energy flow in food webs



(Newton & Devol 2012)

(<http://seattletimes.nwsourc.com/ABPub/2006/09/20/2003268192.jpg>)  
([http://media.kitsapsun.com/media/img/photos/2010/09/21/0922\\_LOC\\_FishKill2\\_t160.jpg](http://media.kitsapsun.com/media/img/photos/2010/09/21/0922_LOC_FishKill2_t160.jpg))

## **Limitations in previous studies**

Lack of direct observation of how responses to hypoxia alter food-web coupling

## **Goal**

To understand how hypoxia affects

- distribution: predator/prey overlap,
- zooplankton community composition, and
- physiological/behavioral responses of fish.

If so, does hypoxia affect energy flow from zooplankton to fish?

## Limitations in previous studies

Lack of direct observation of how responses to hypoxia alter food-web coupling

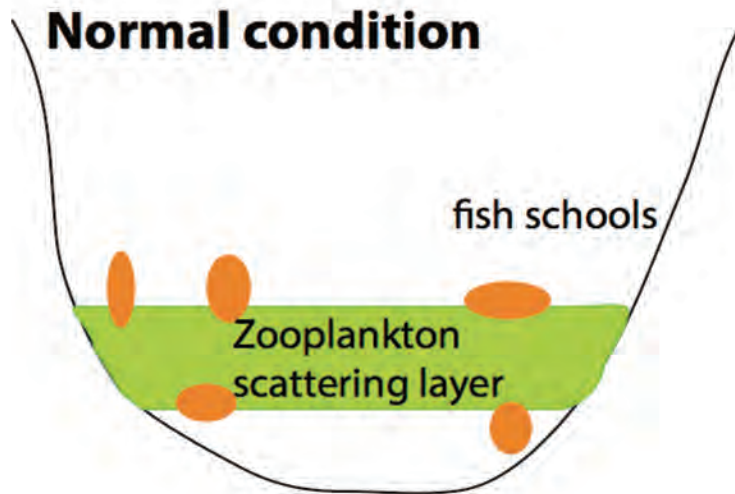
## Goal

To understand how hypoxia affects

- **distribution**: predators/prey overlap,
- zooplankton community composition, and
- physiological/behavioral responses of fish.

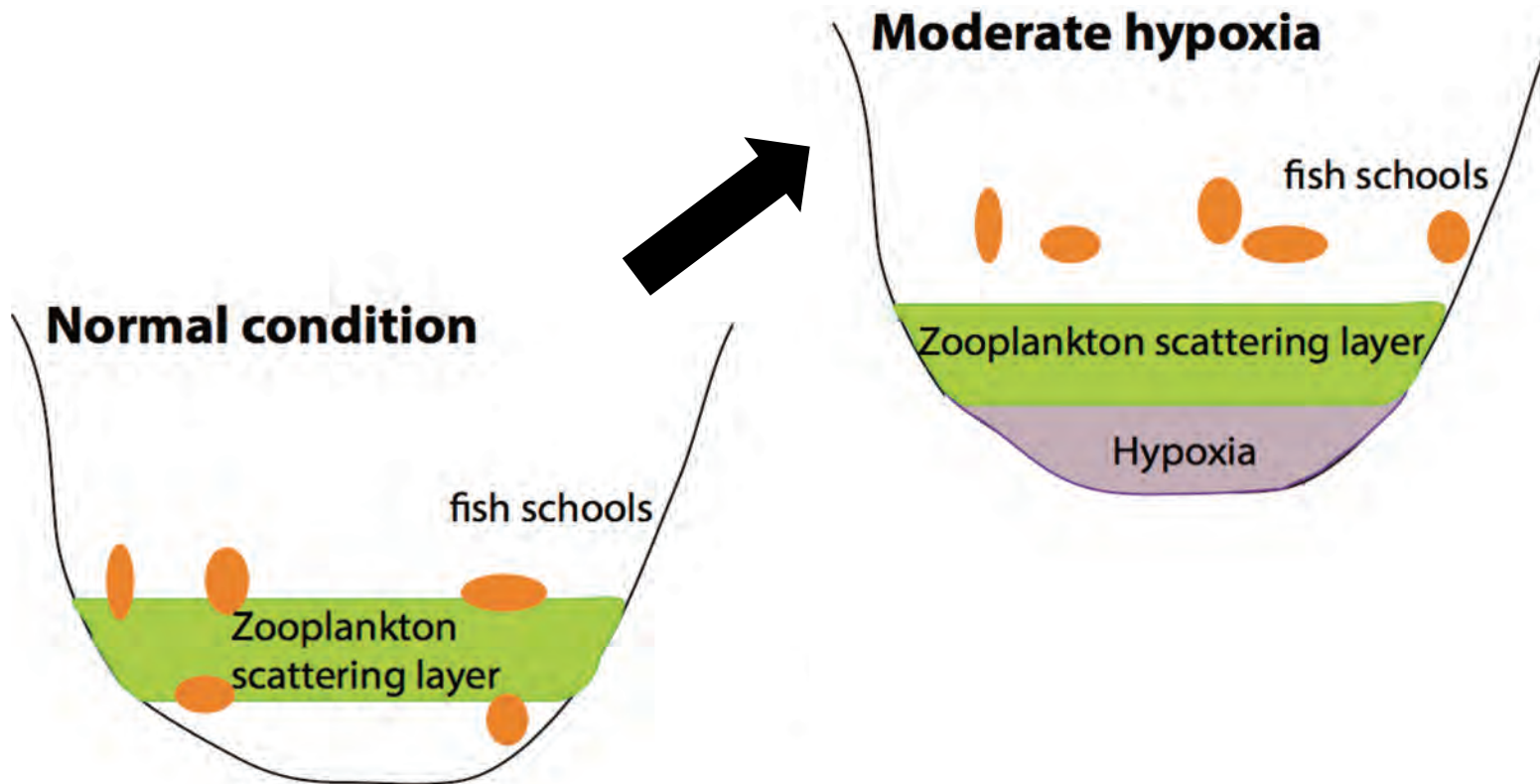
If so, does hypoxia affect energy flow from zooplankton to fish?

# Does hypoxia affect vertical distributions of predators and prey?



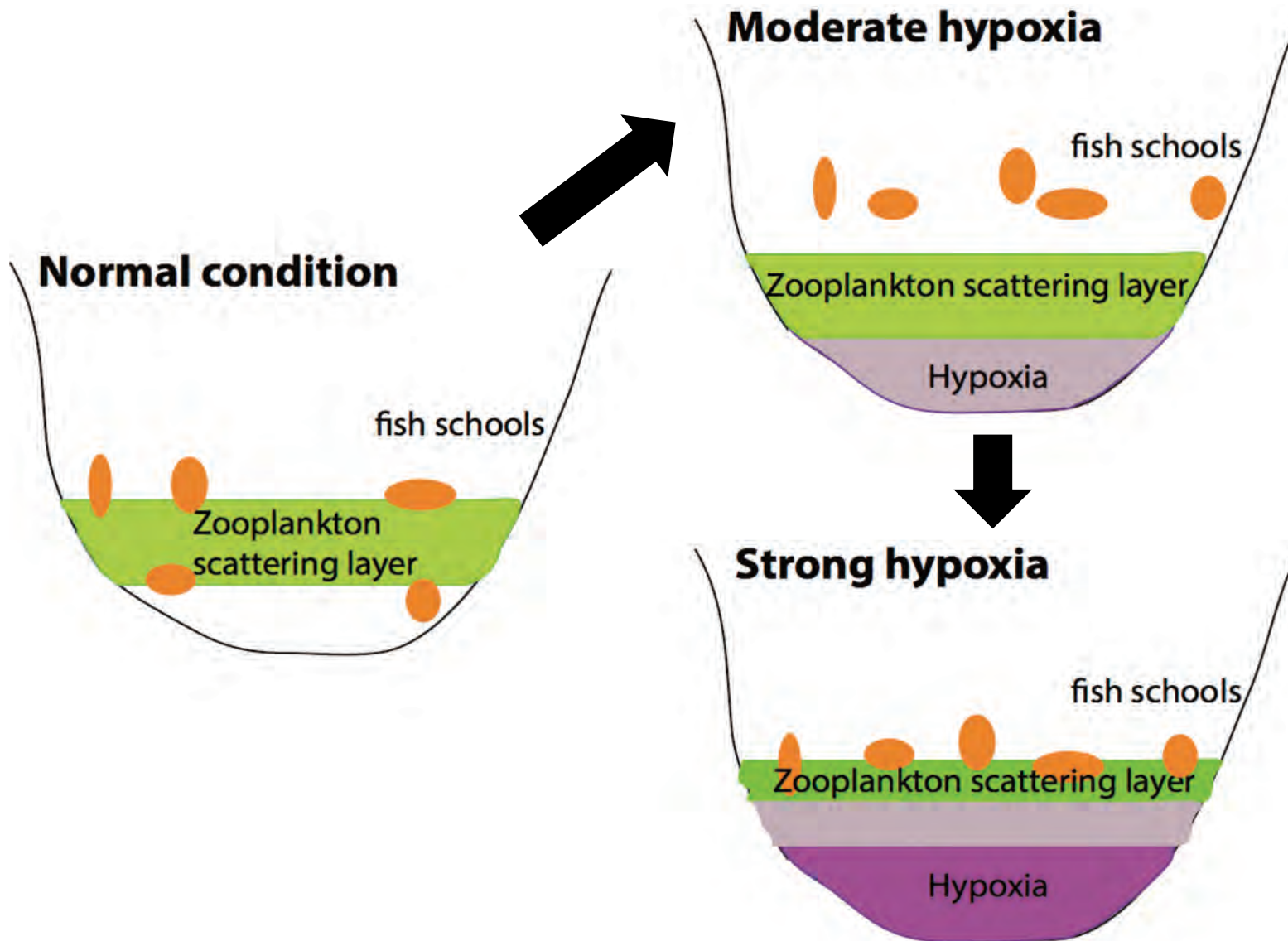


# Does hypoxia affect vertical distributions of predators and prey?

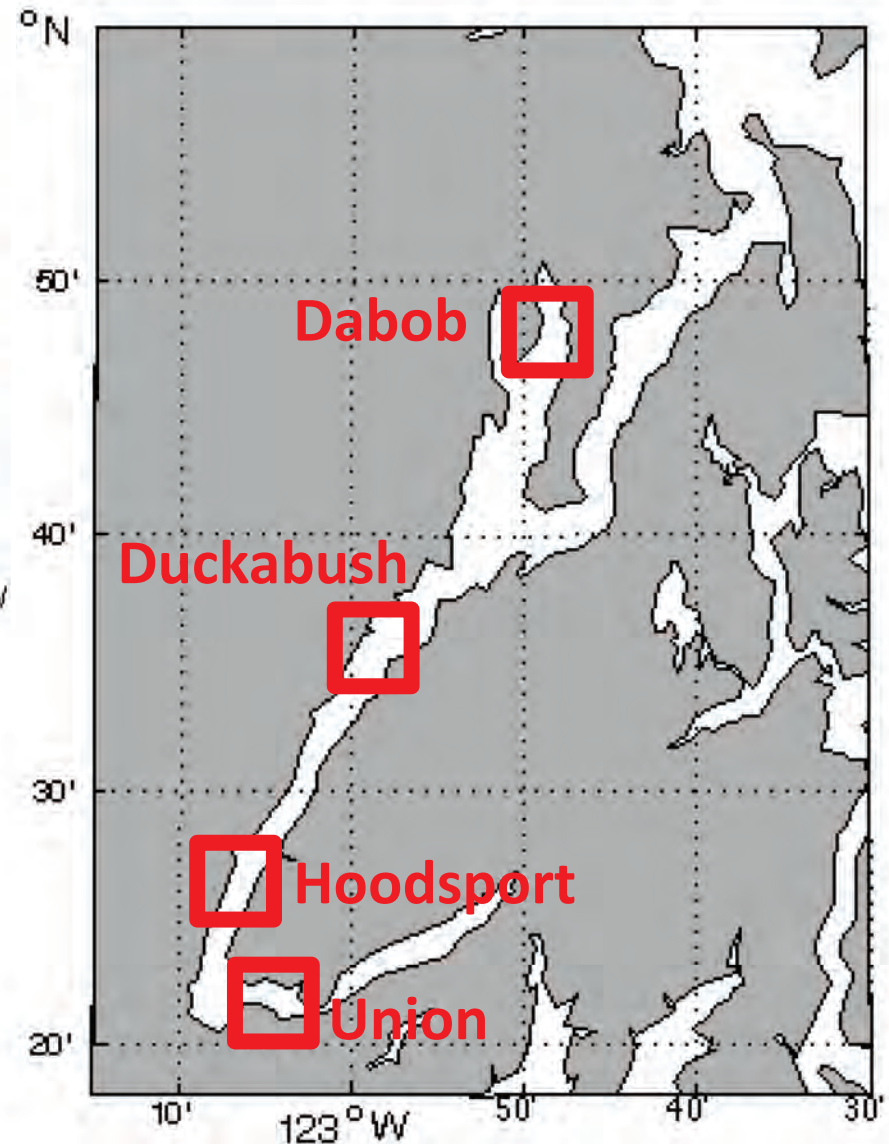
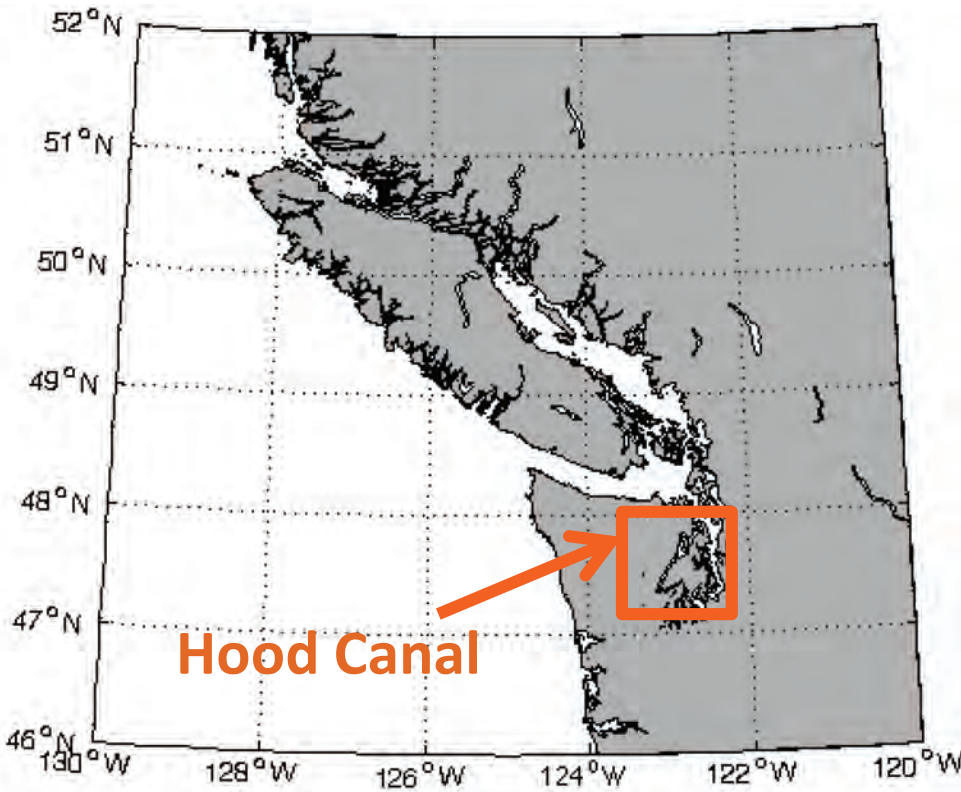




# Does hypoxia affect vertical distributions of predators and prey?



# Study site



Survey period

Jun – Oct in 2012 & 2013

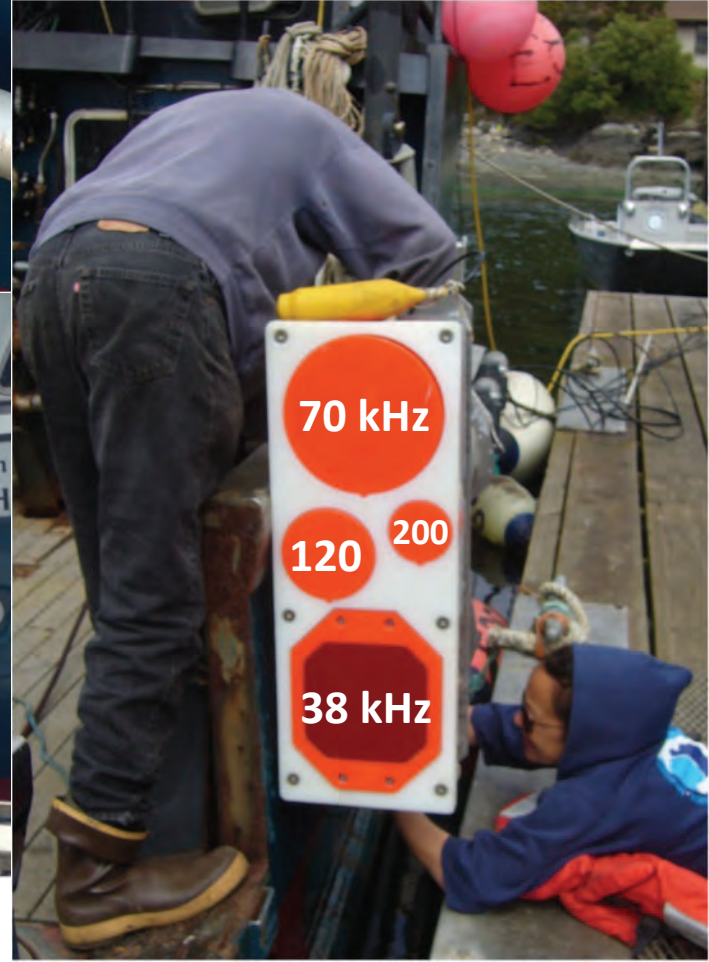


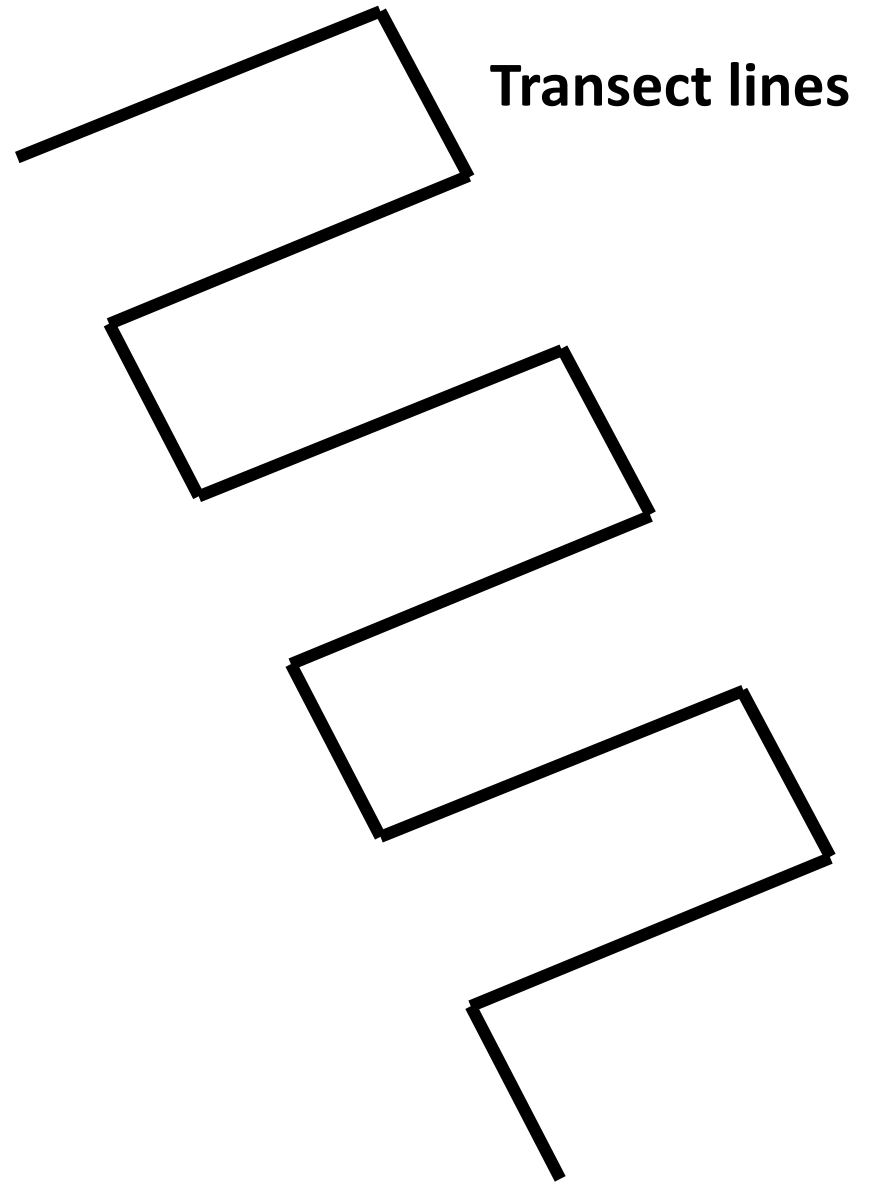
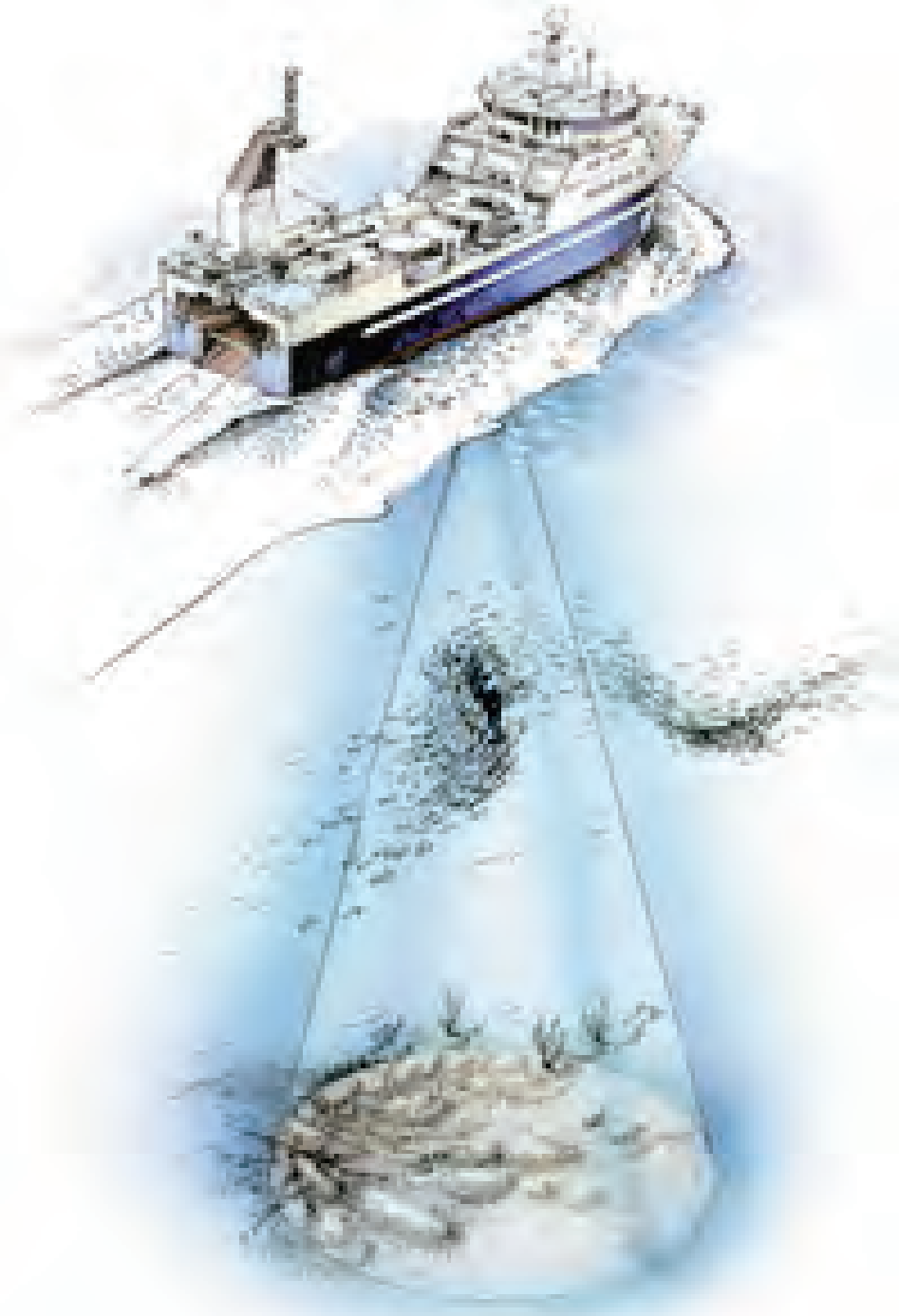
University of Washington  
MARINE RESEARCH

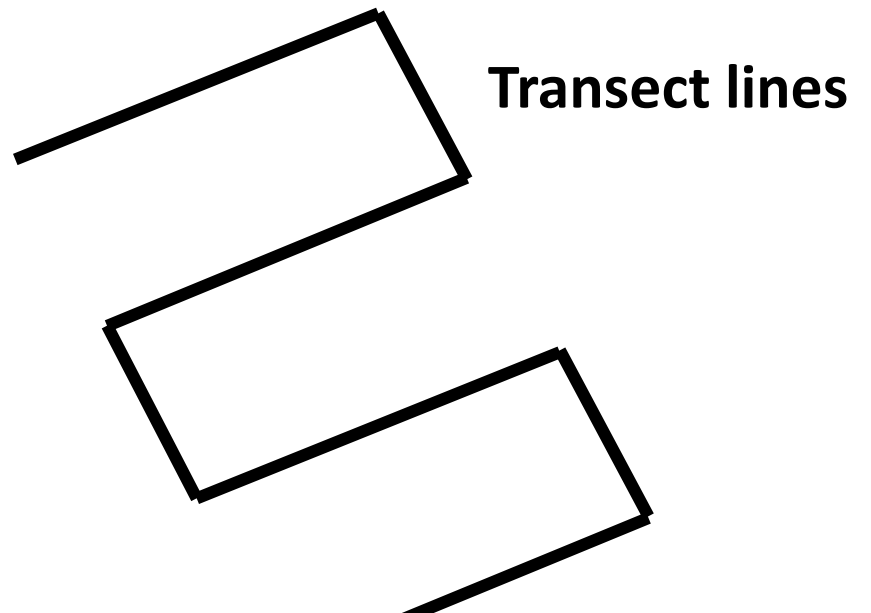
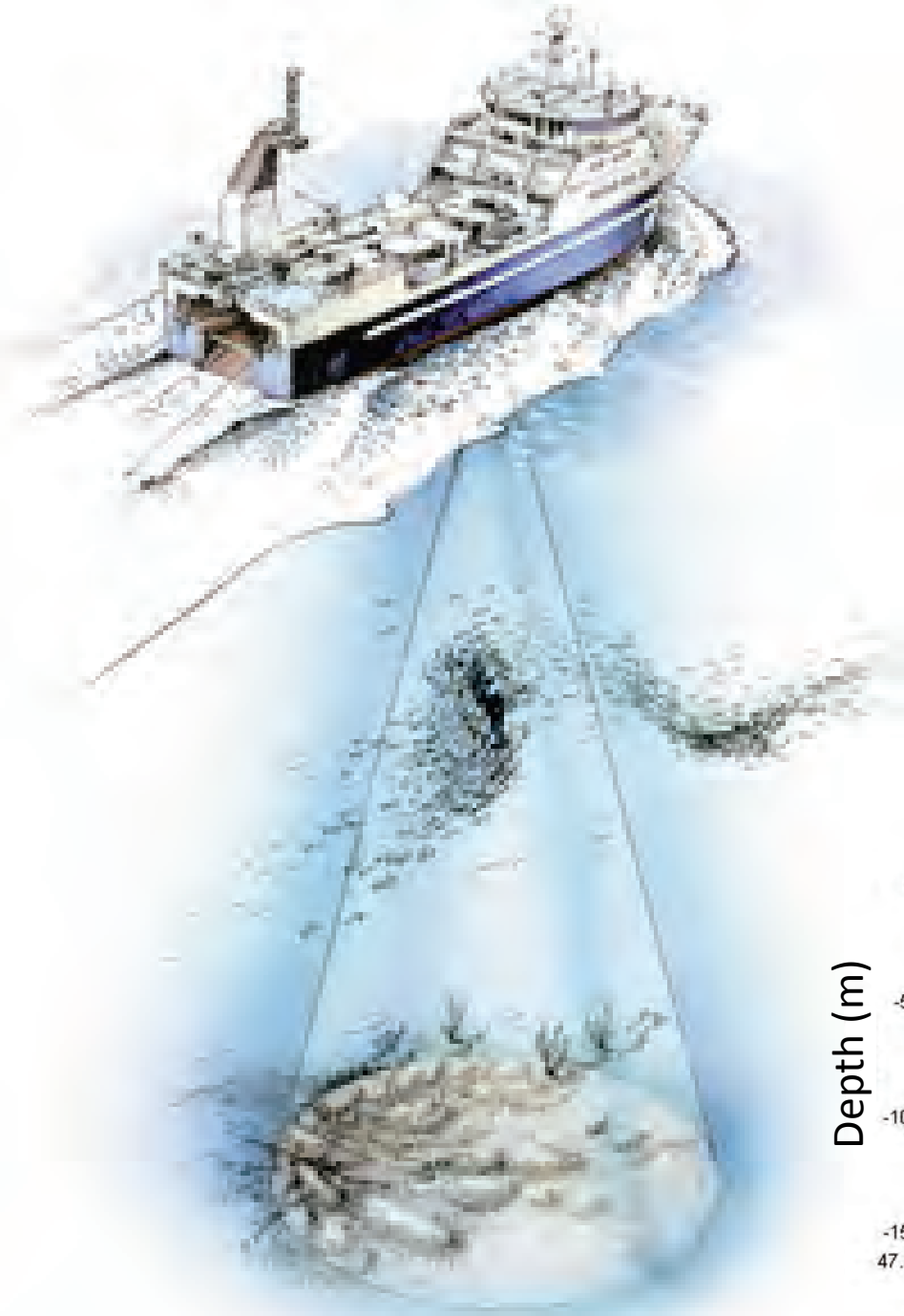
CENTENNIAL



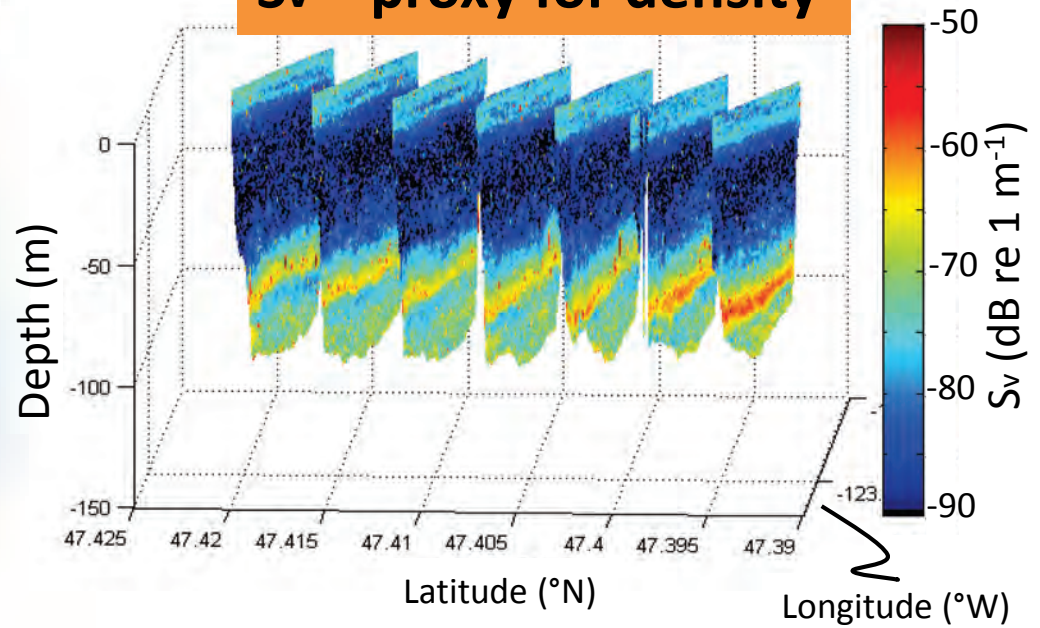
# Multi-frequency Echosounder



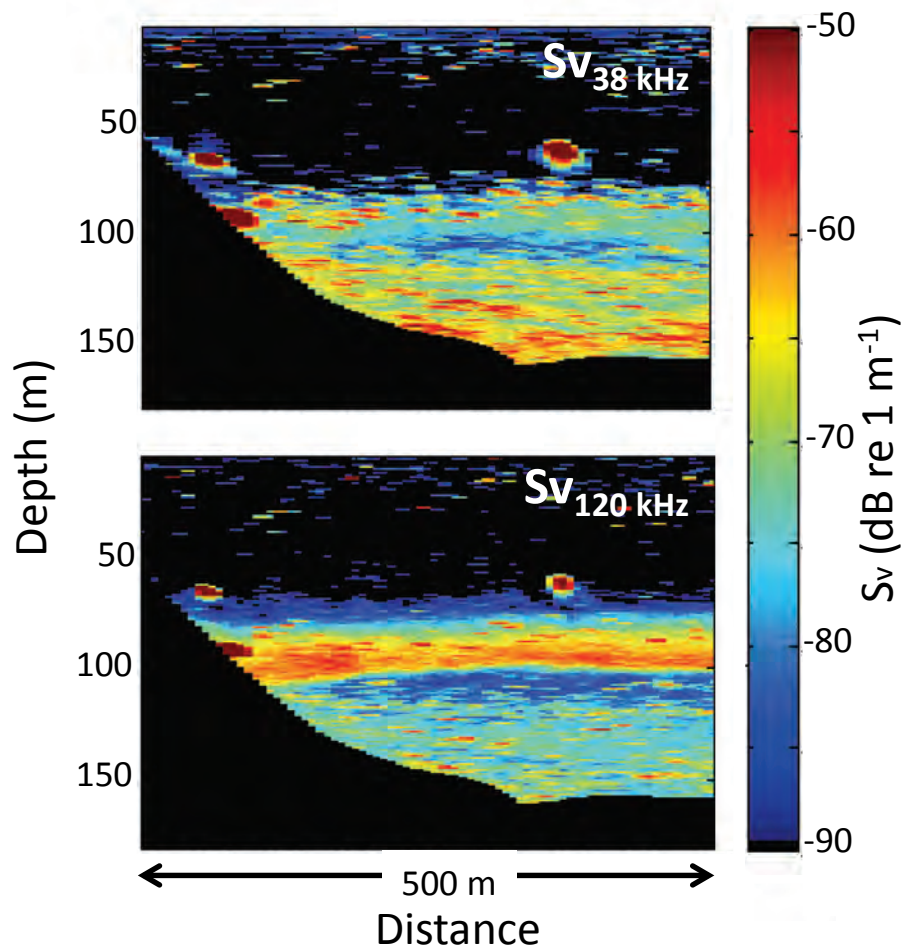




**$S_v$  = proxy for density**

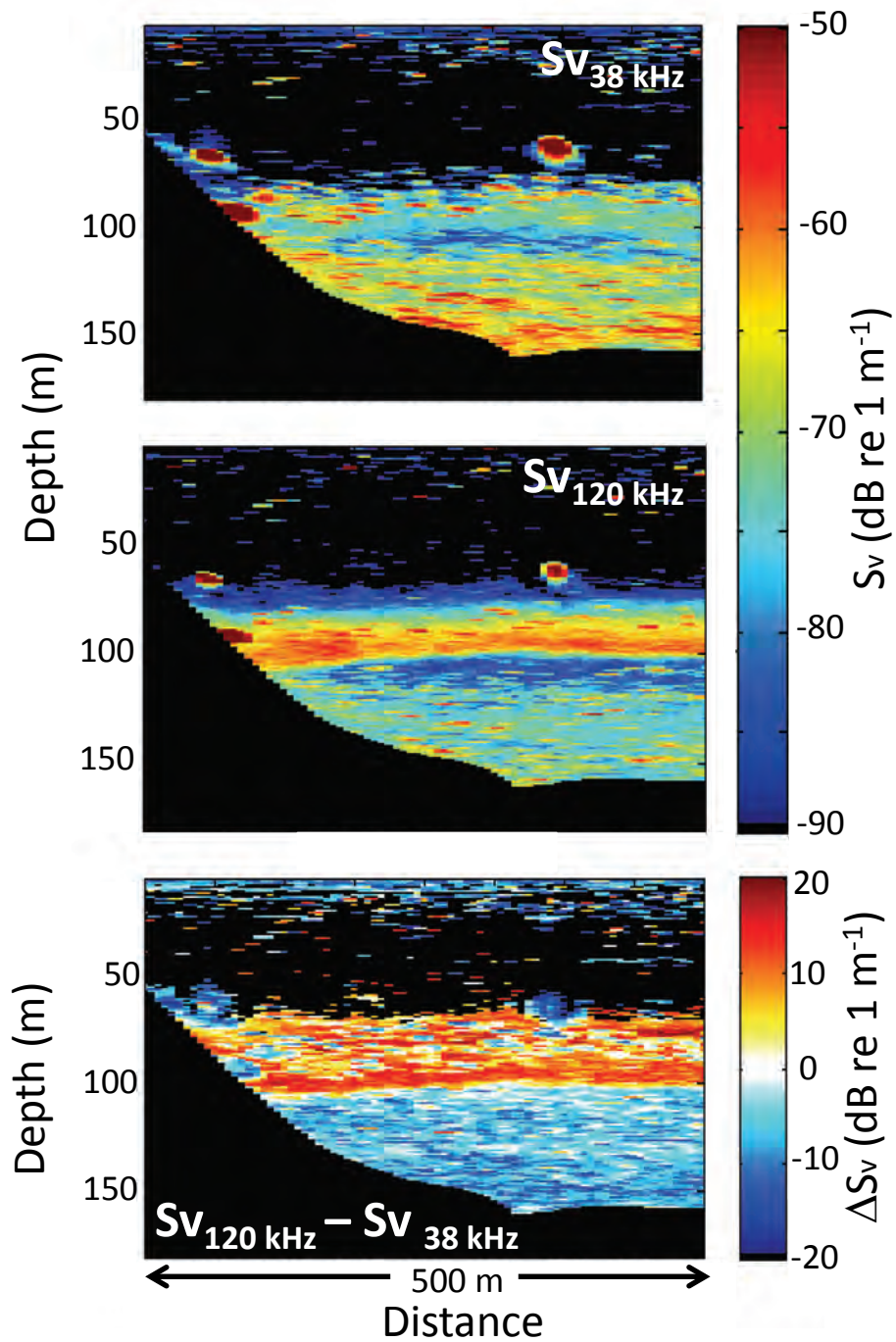




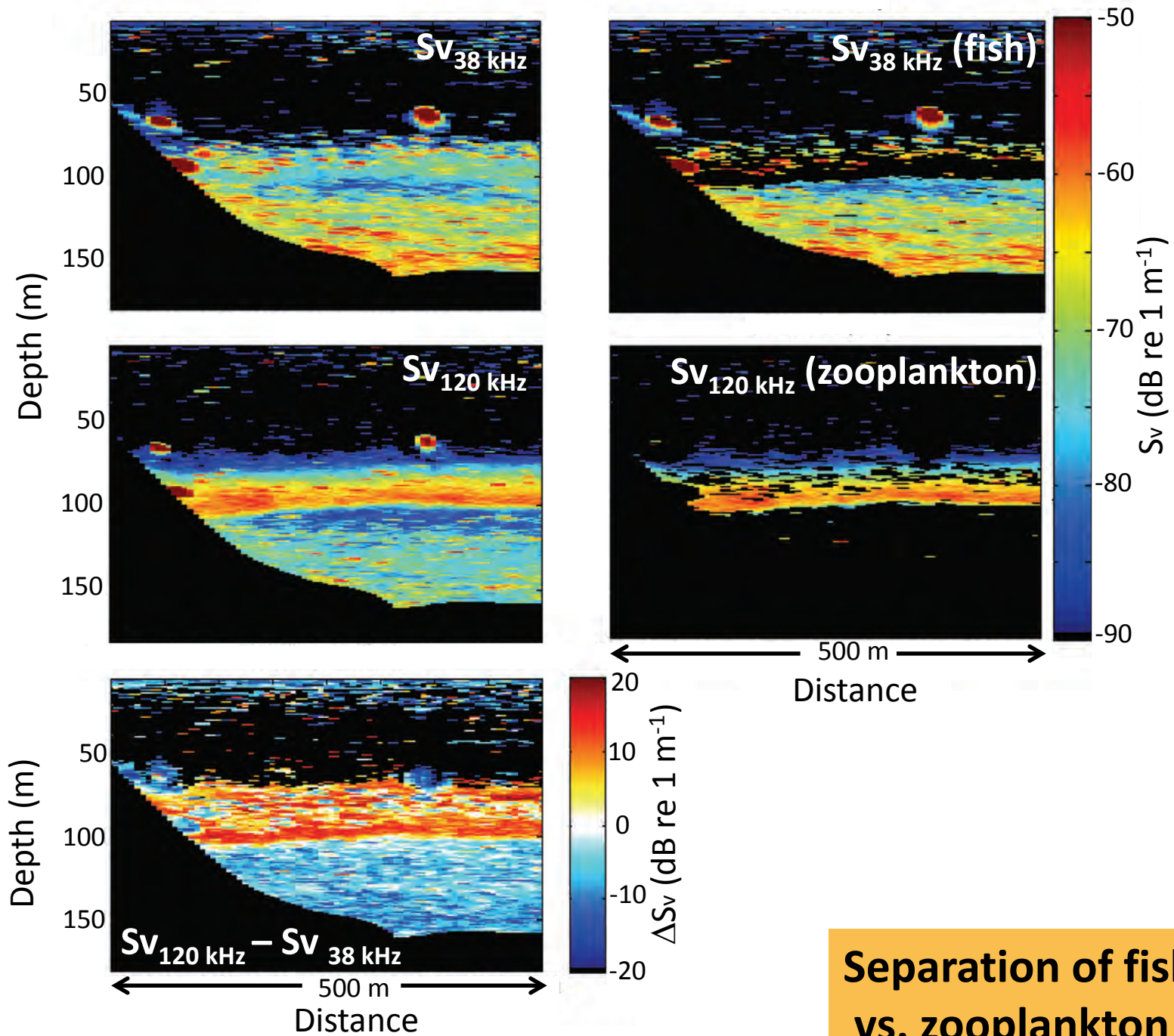


**Separation of fish  
vs. zooplankton**





**Separation of fish  
vs. zooplankton**



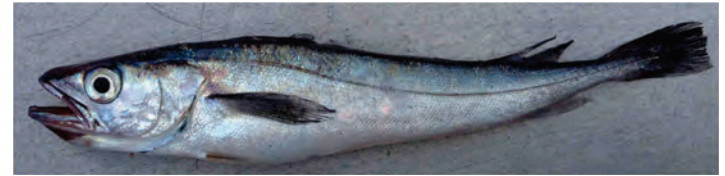
**Separation of fish vs. zooplankton**



# Net Samplings



Pacific herring



Pacific hake

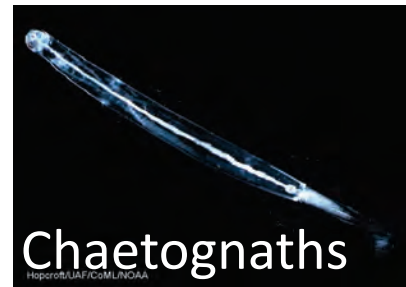
Euphausiids



Amphipods



Copepods

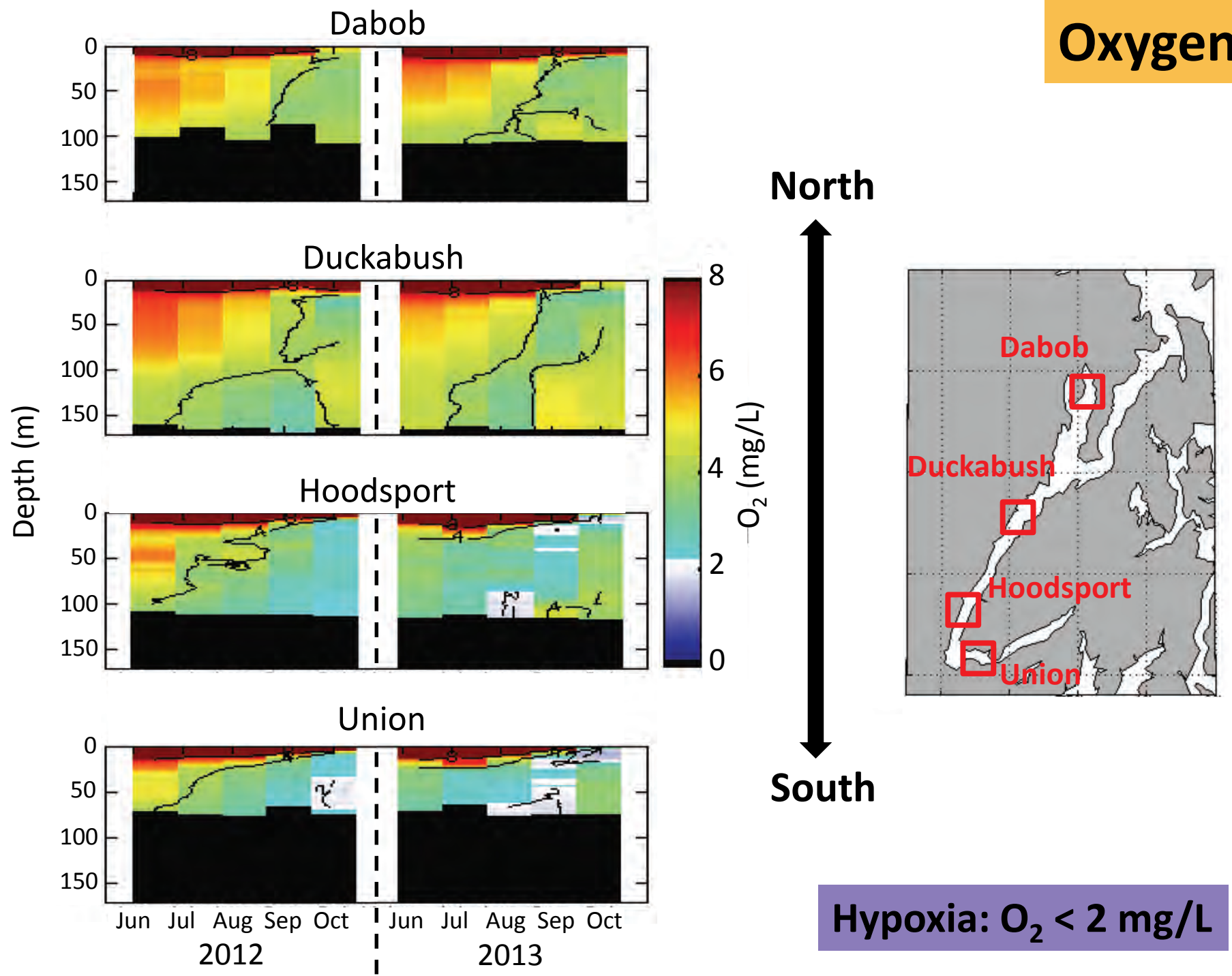


Chaetognaths



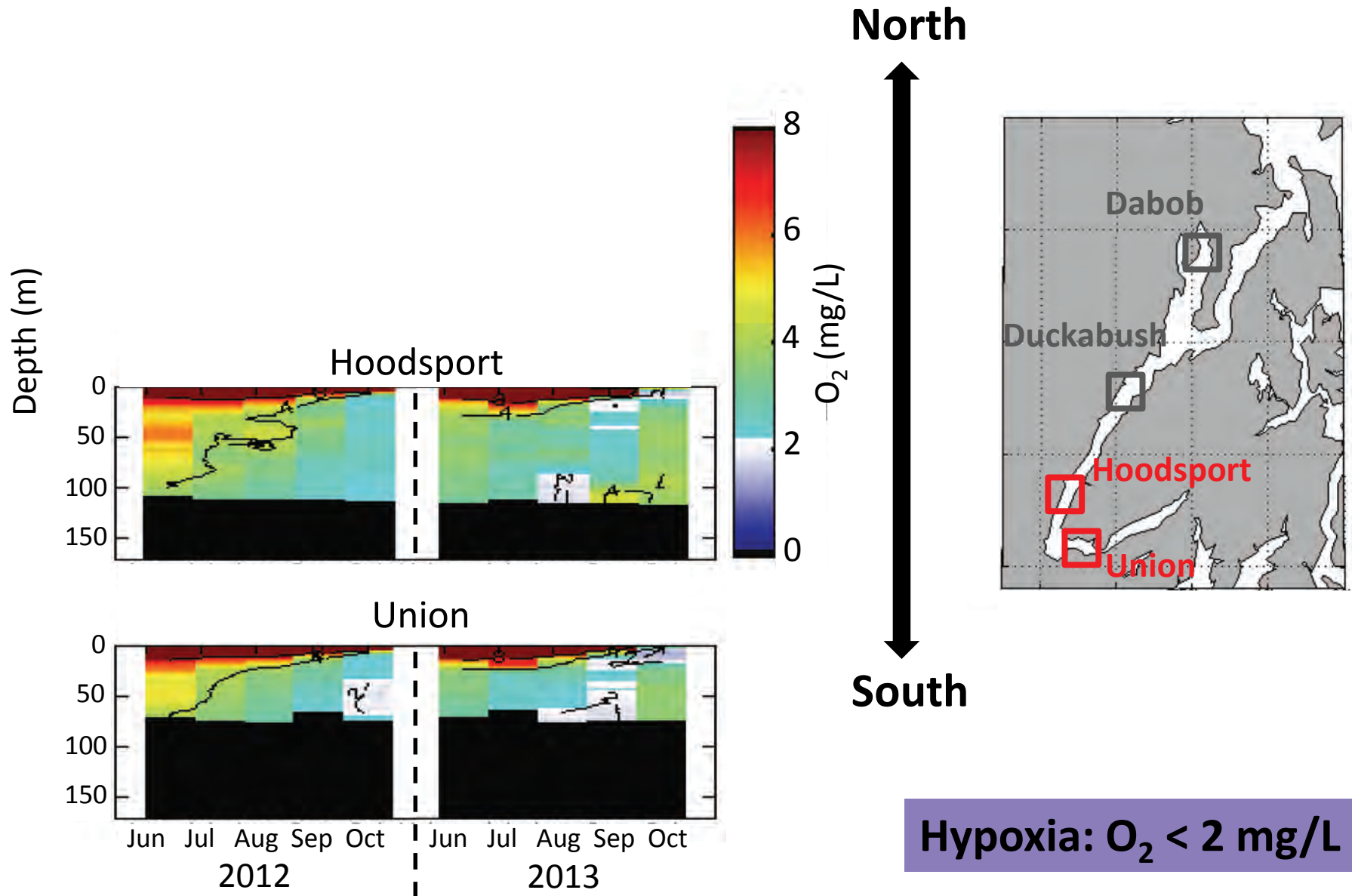
Jellyfish

# Oxygen

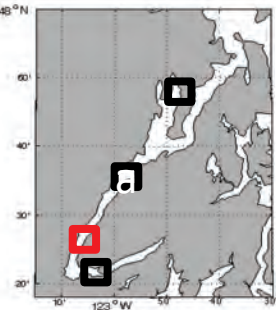




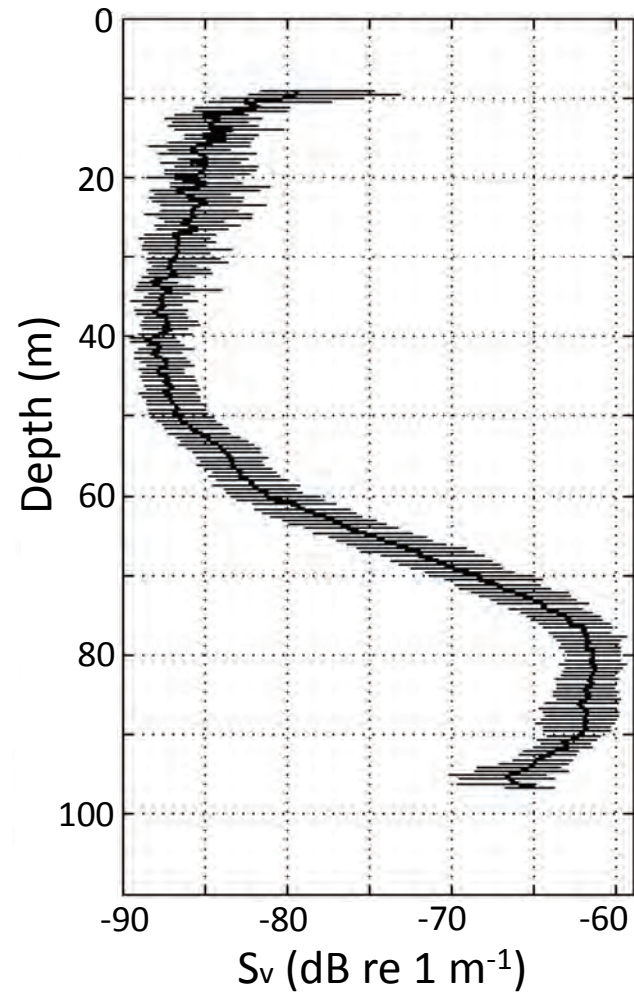
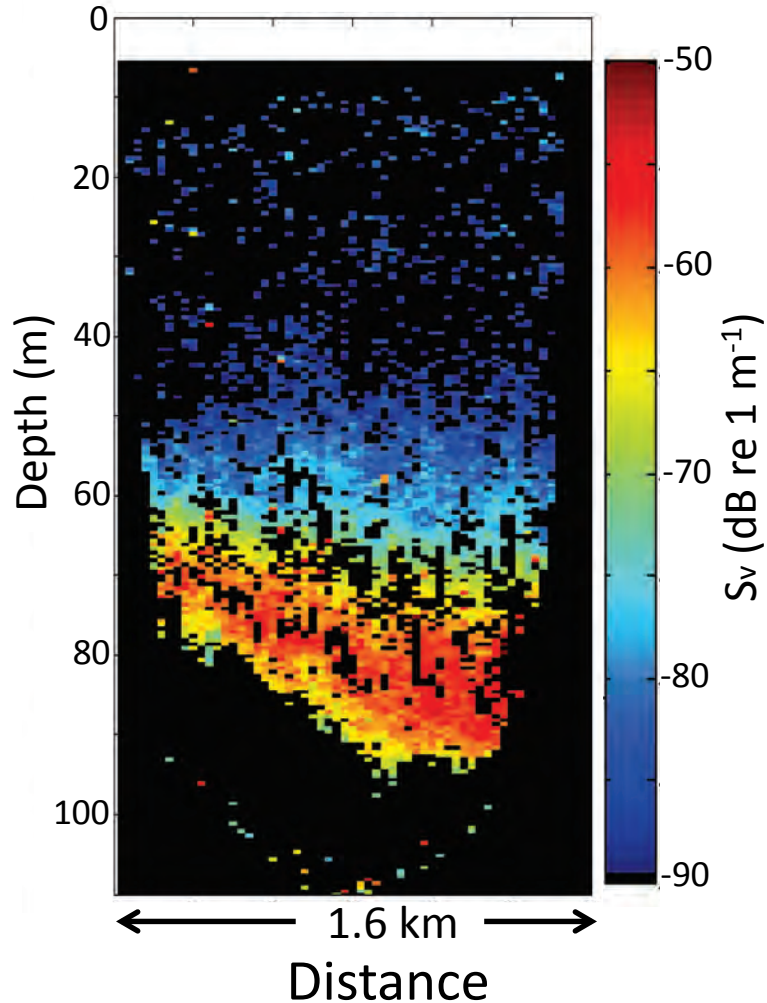
# Oxygen



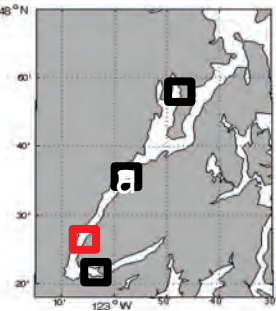
# Do zooplankton avoid hypoxic water?



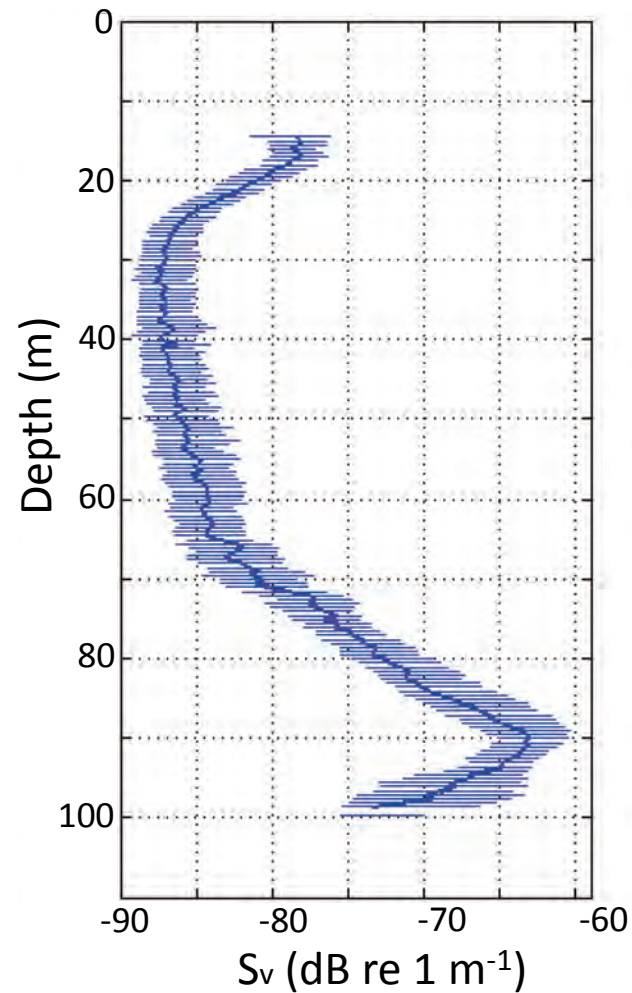
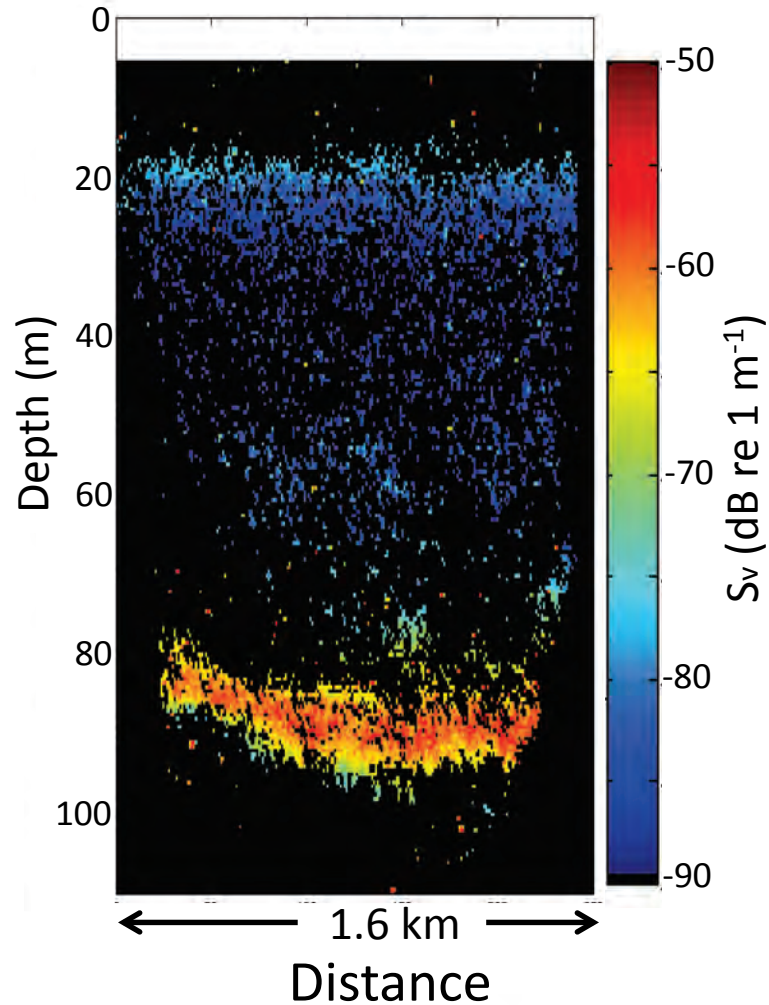
$Sv_{120\text{ kHz}}$  (zooplankton) : 2012 Aug



# Do zooplankton avoid hypoxic water?

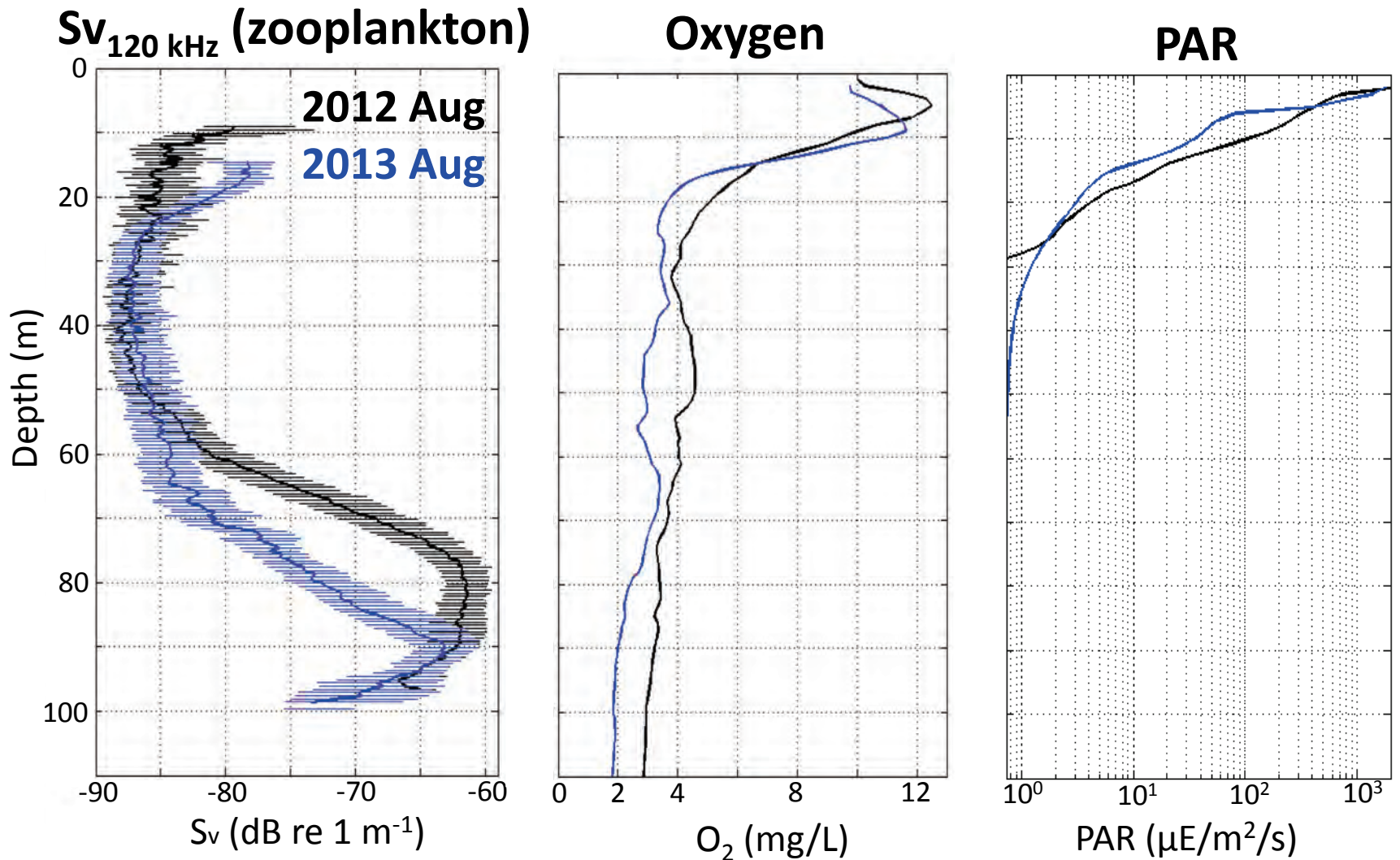
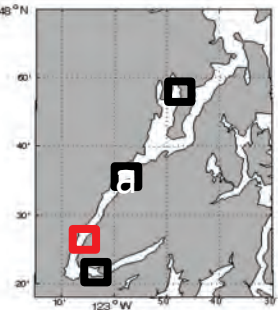


$Sv_{120\text{ kHz}}$  (zooplankton) : 2013 Aug

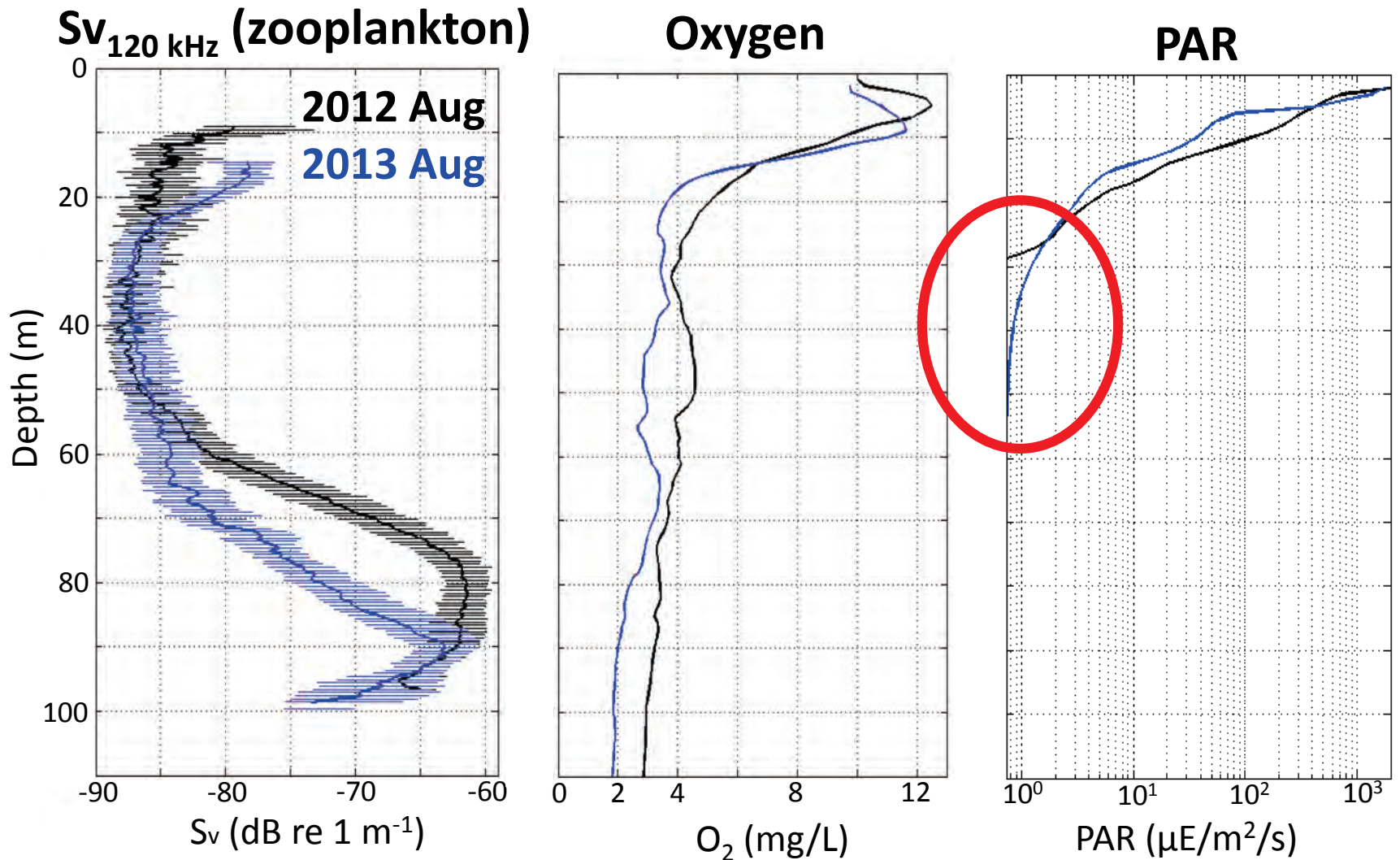
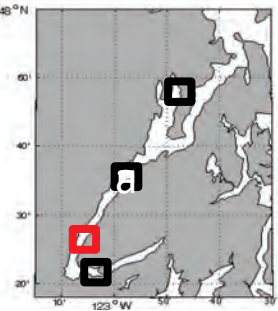




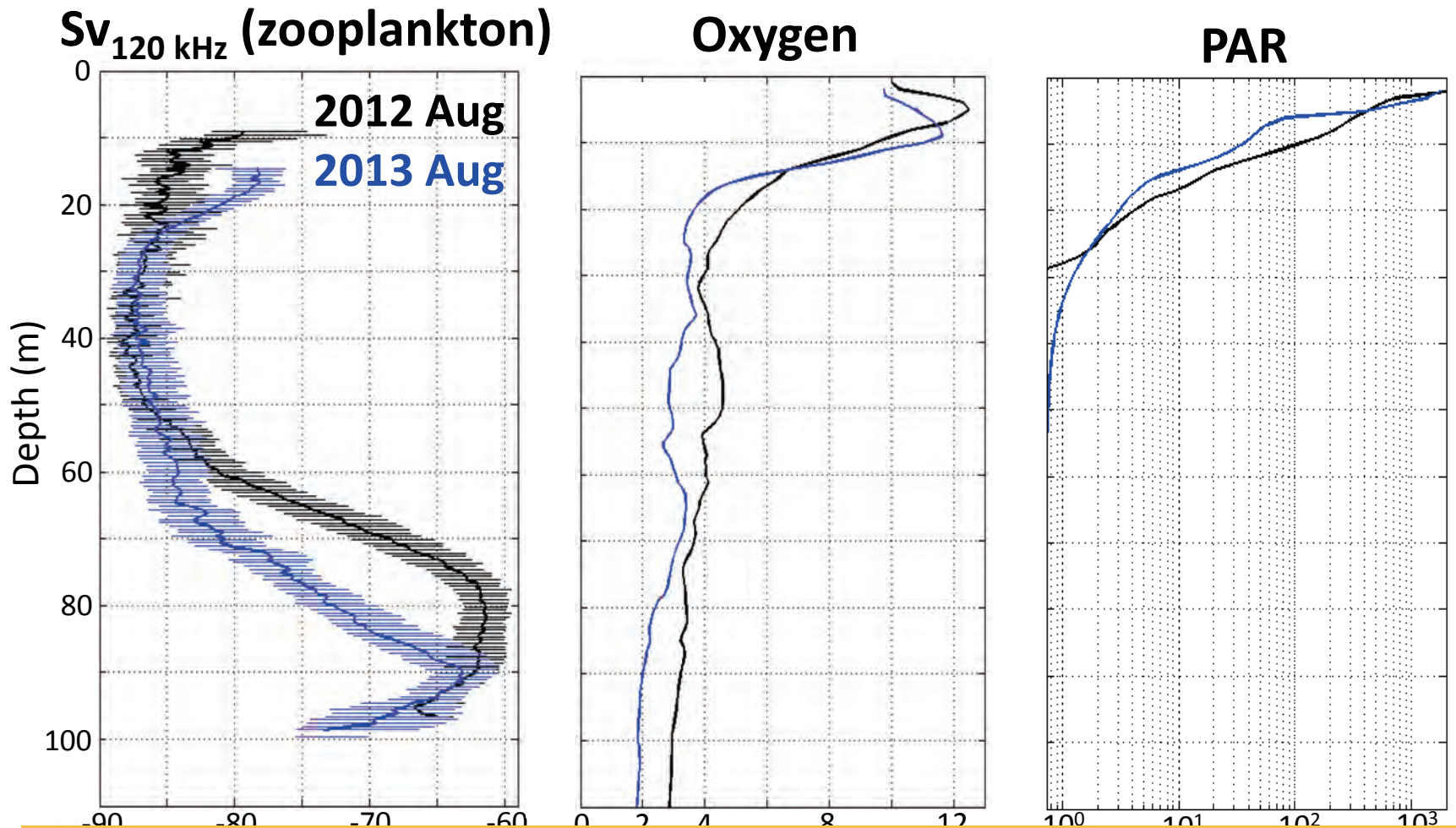
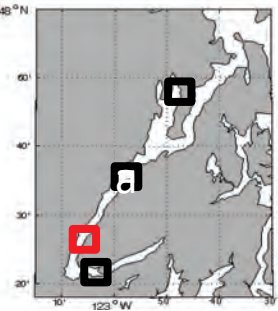
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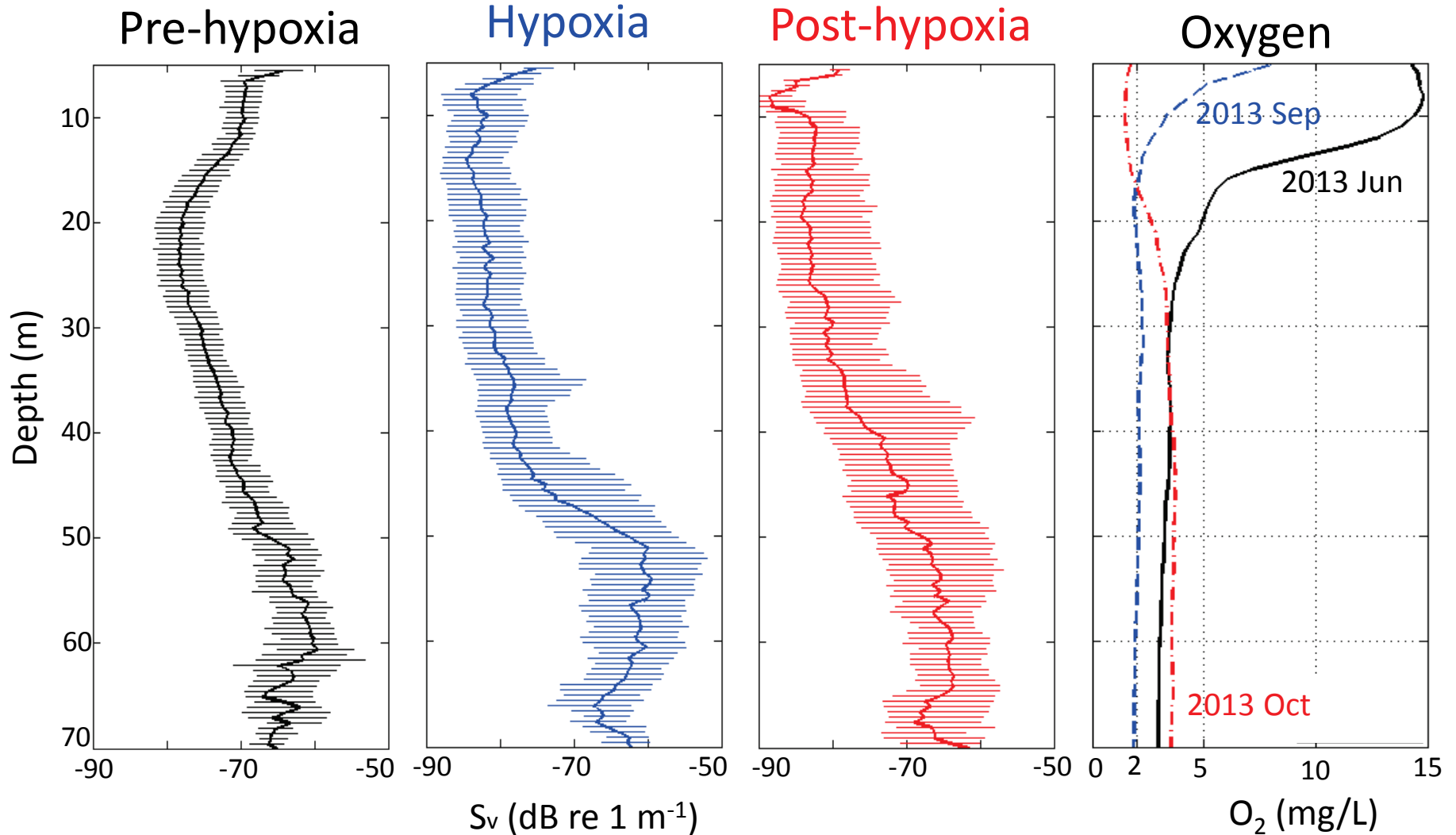
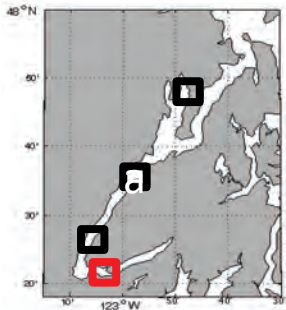
# Do zooplankton avoid hypoxic water?



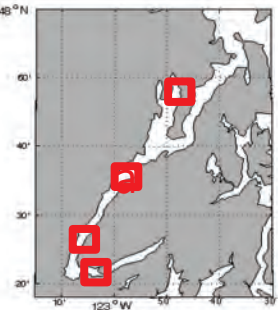
No upward movement of daytime scattering layer due to hypoxia



# Do fish avoid hypoxic water?



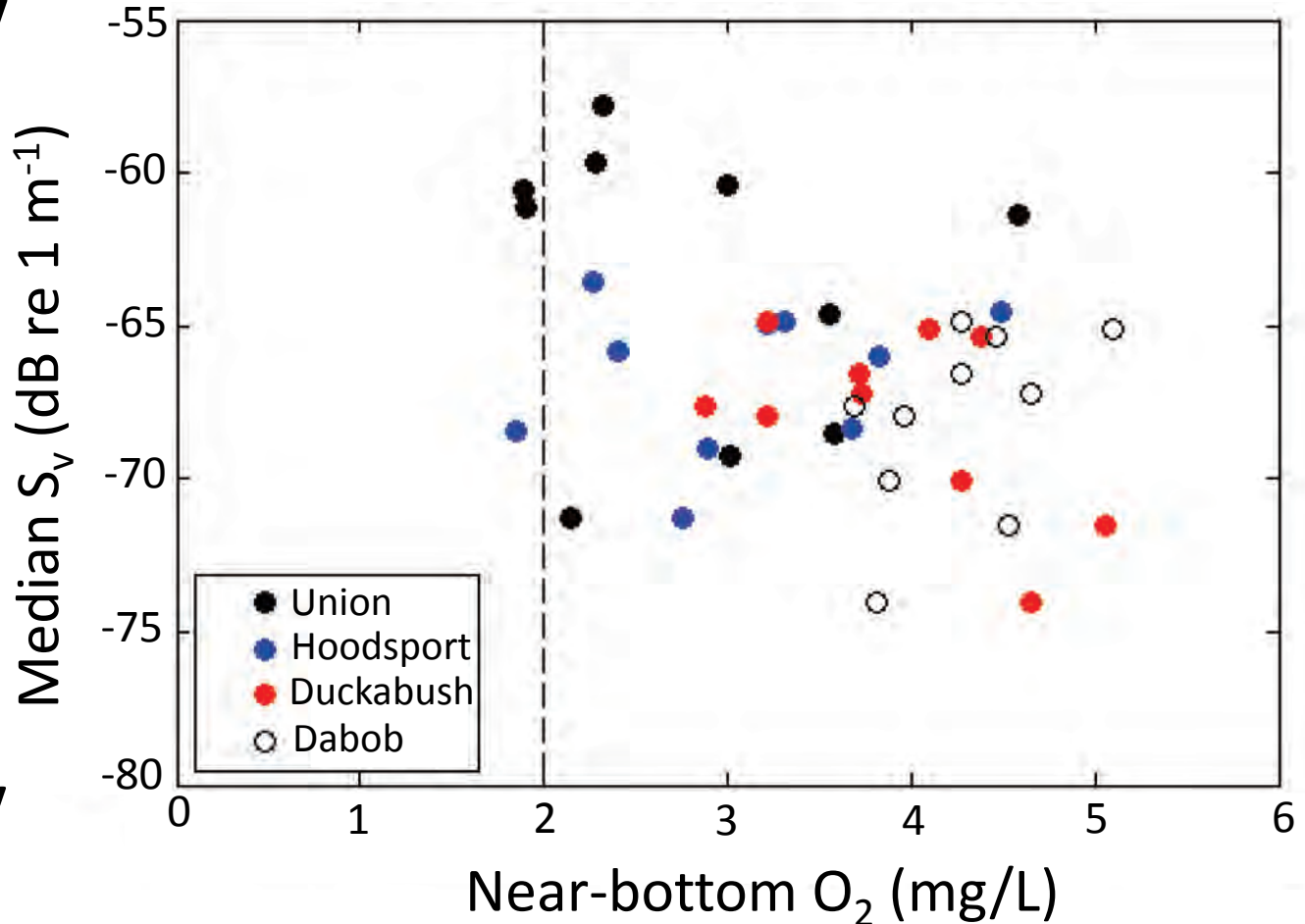
# Do fish avoid hypoxic water?

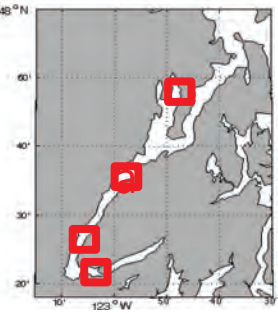


High density



Low density





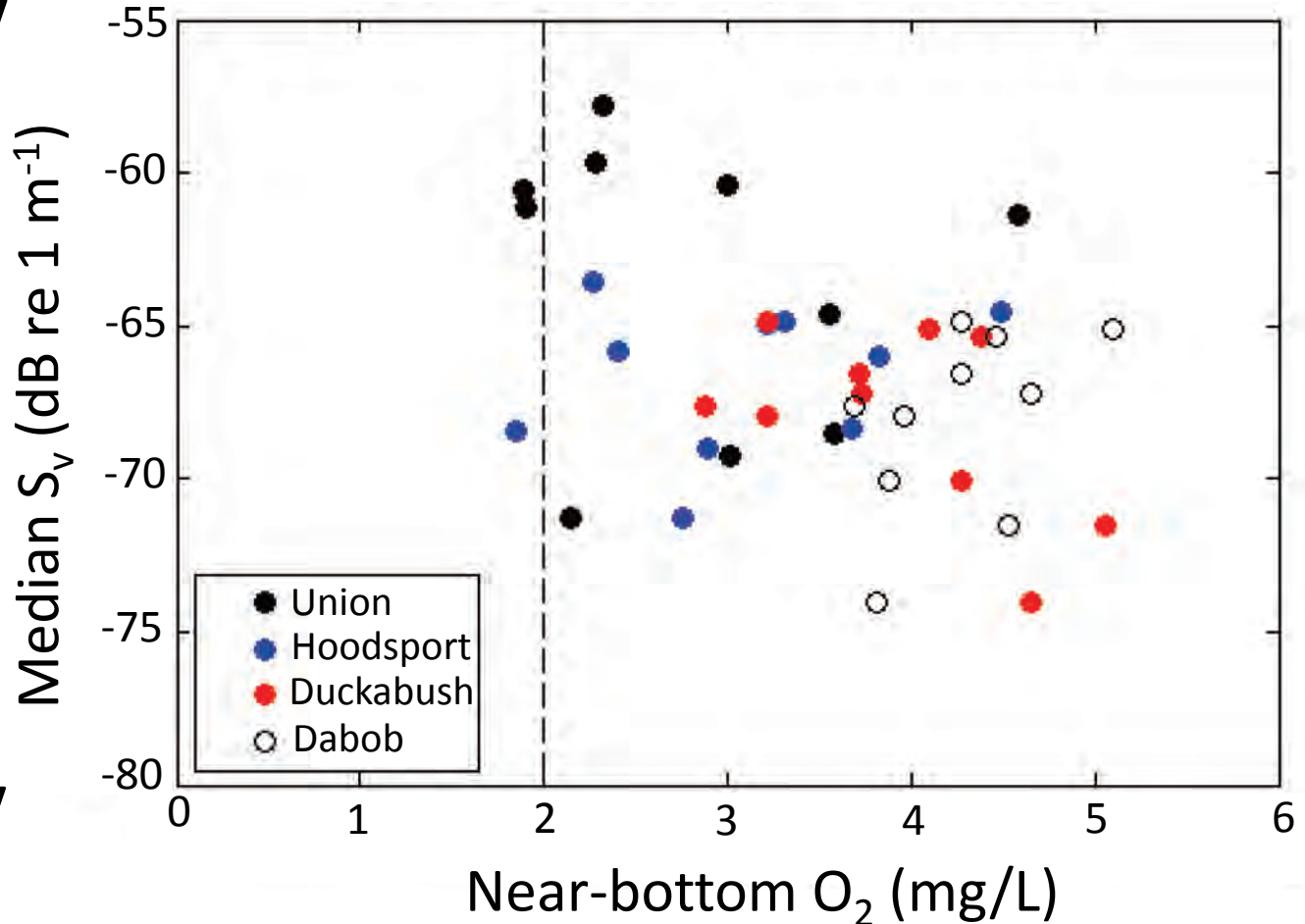
# Do fish avoid hypoxic water?

No avoidance of near-bottom hypoxic waters

High density



Low density

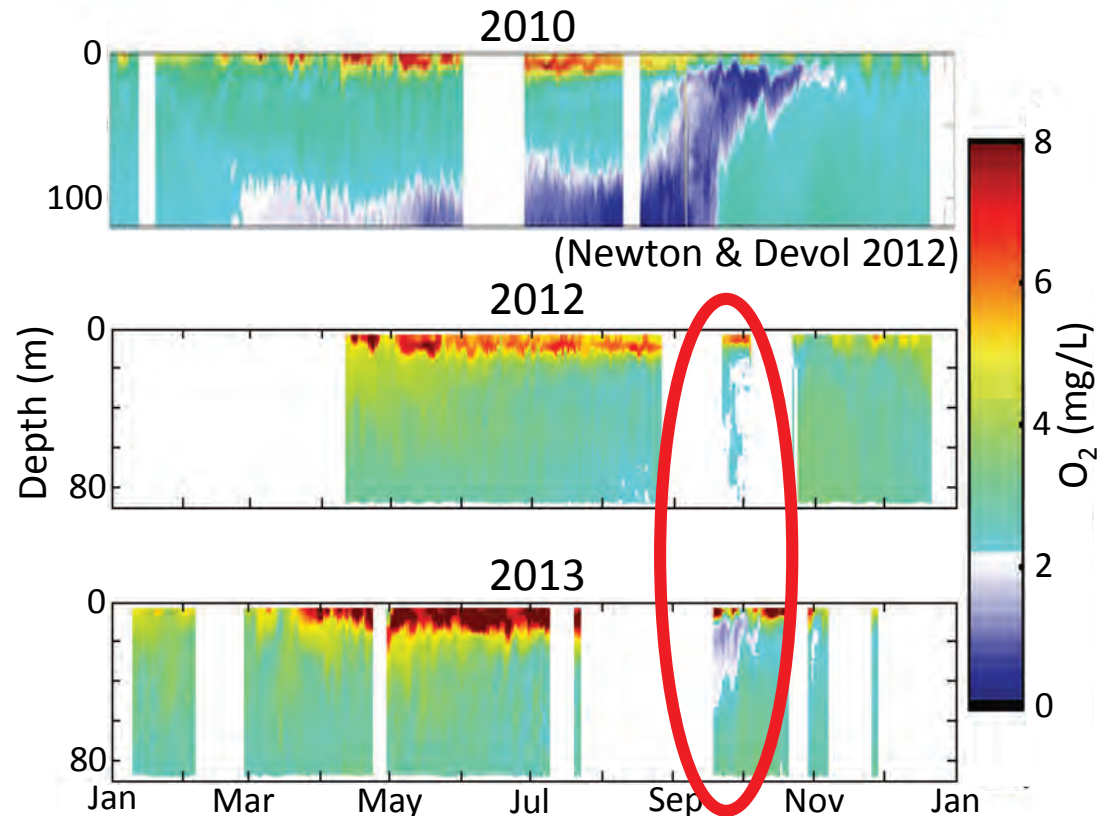


# Conclusions

- Hypoxia does not affect vertical distribution of fish and zooplankton

- survey period in 2012-2013 is moderately hypoxic ( $O_2 = \sim 2$  mg/L)

- Possibility of horizontal and vertical movements in distributions



(ORCA buoy data provided by Newton, Devol & Ruef)

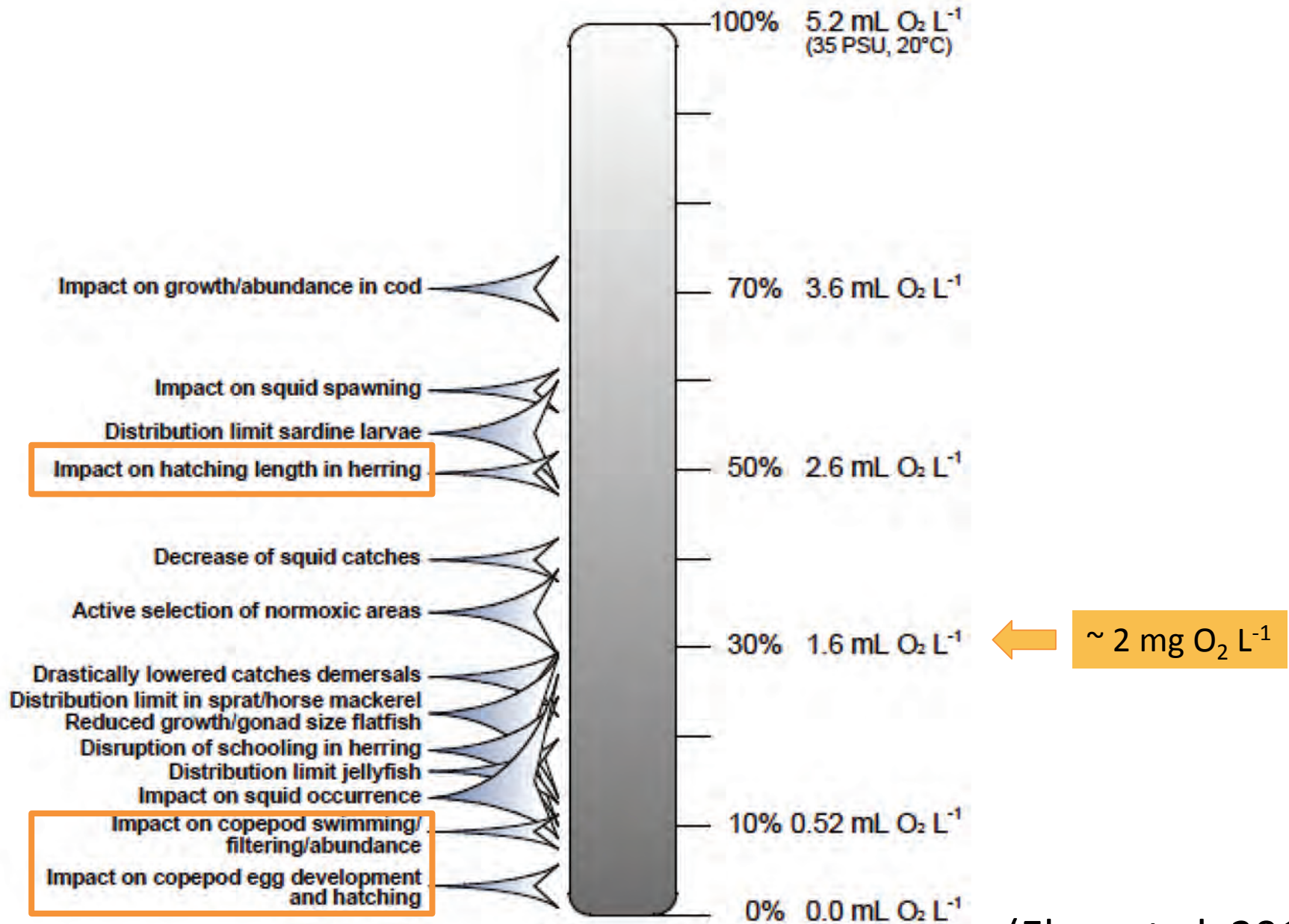


# Acknowledgements

Tim Essington, Julie Keister, Jen Nomura, Pamela Moriarty  
Amanda Winans, Shannon Hennessey, Hannah Linder,  
Halley Froehlich, Lillia Bannister, Sarra Tekola  
Capt. David Duggins, Scott Lindgren



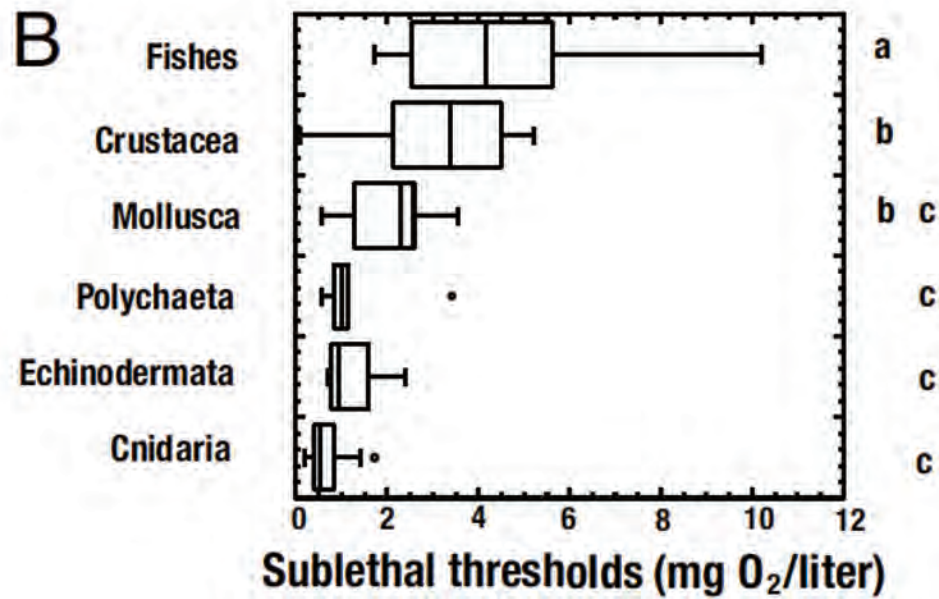
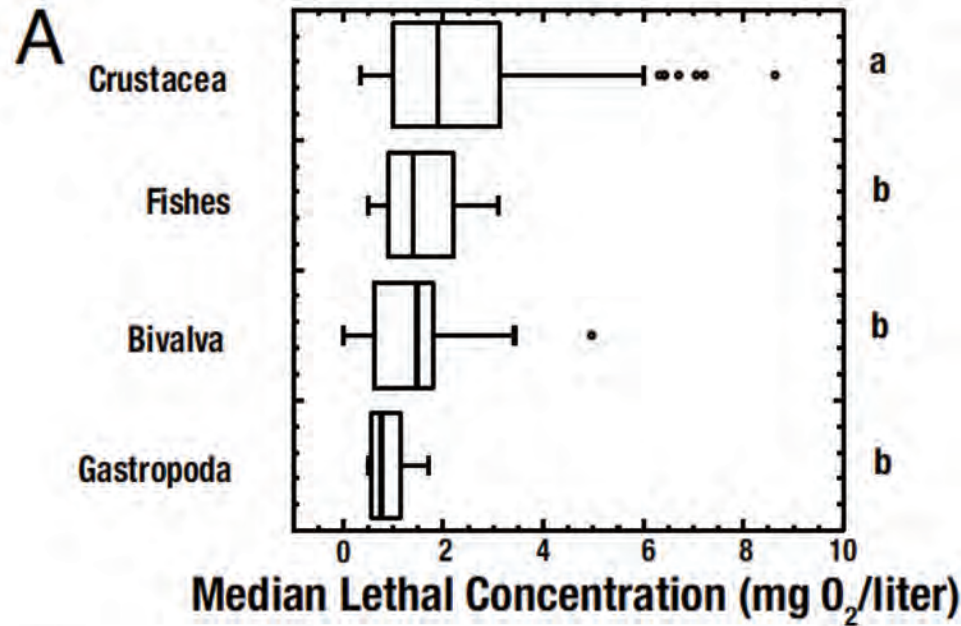
# Behavior and physiology responses



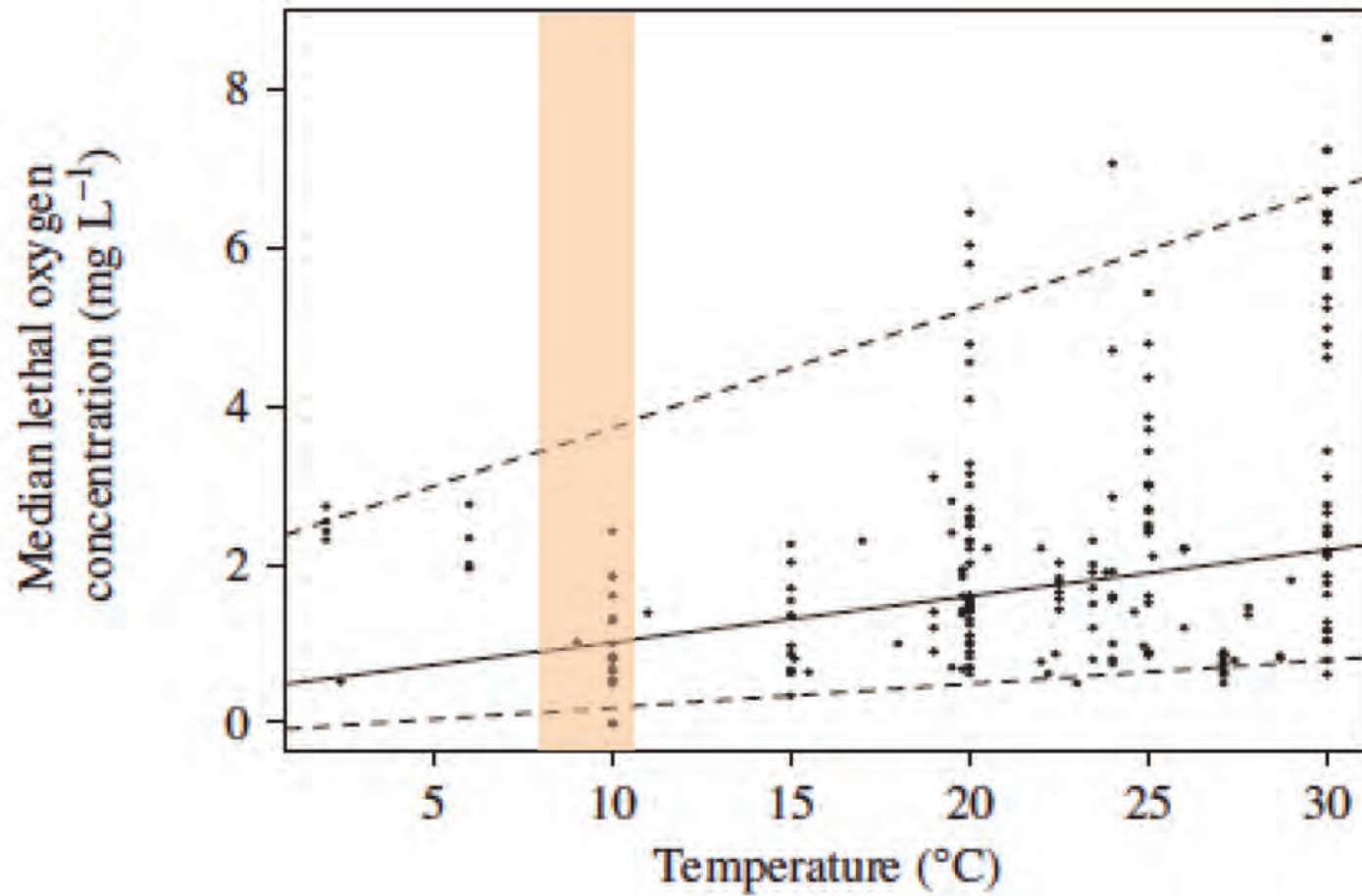
(Ekau et al. 2010)



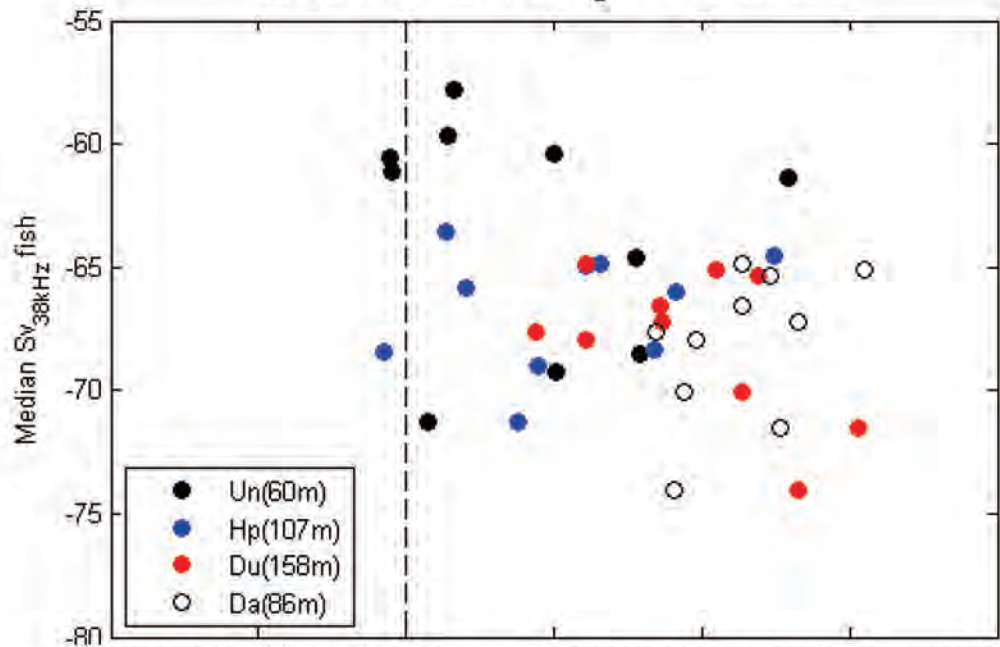
# Benthic metazoans species



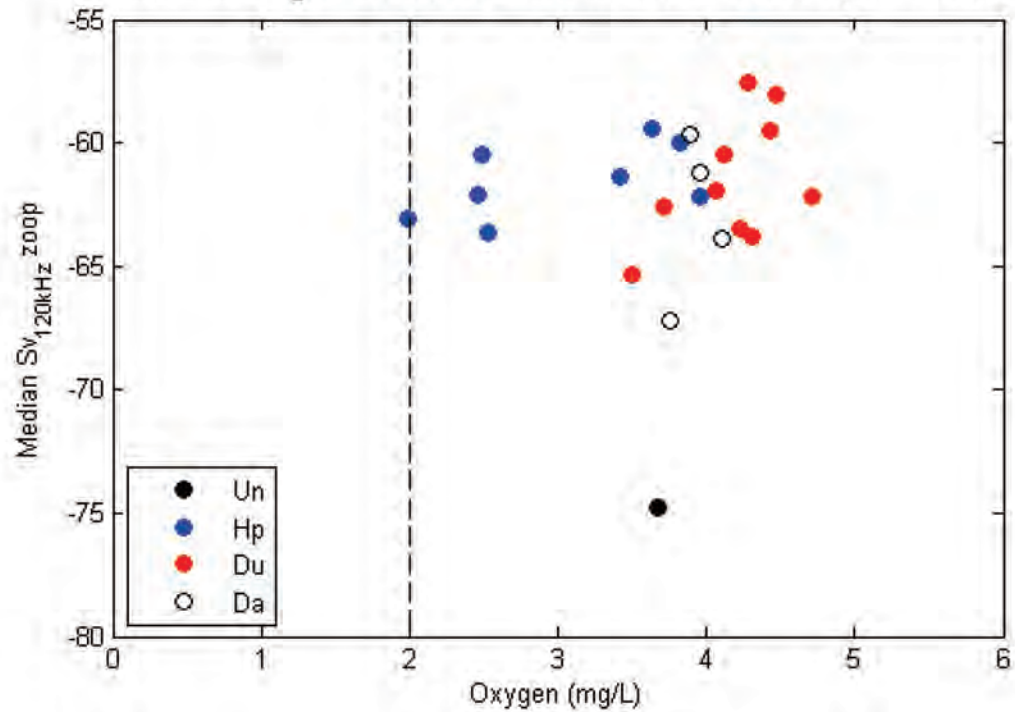
## Benthic macrofauna



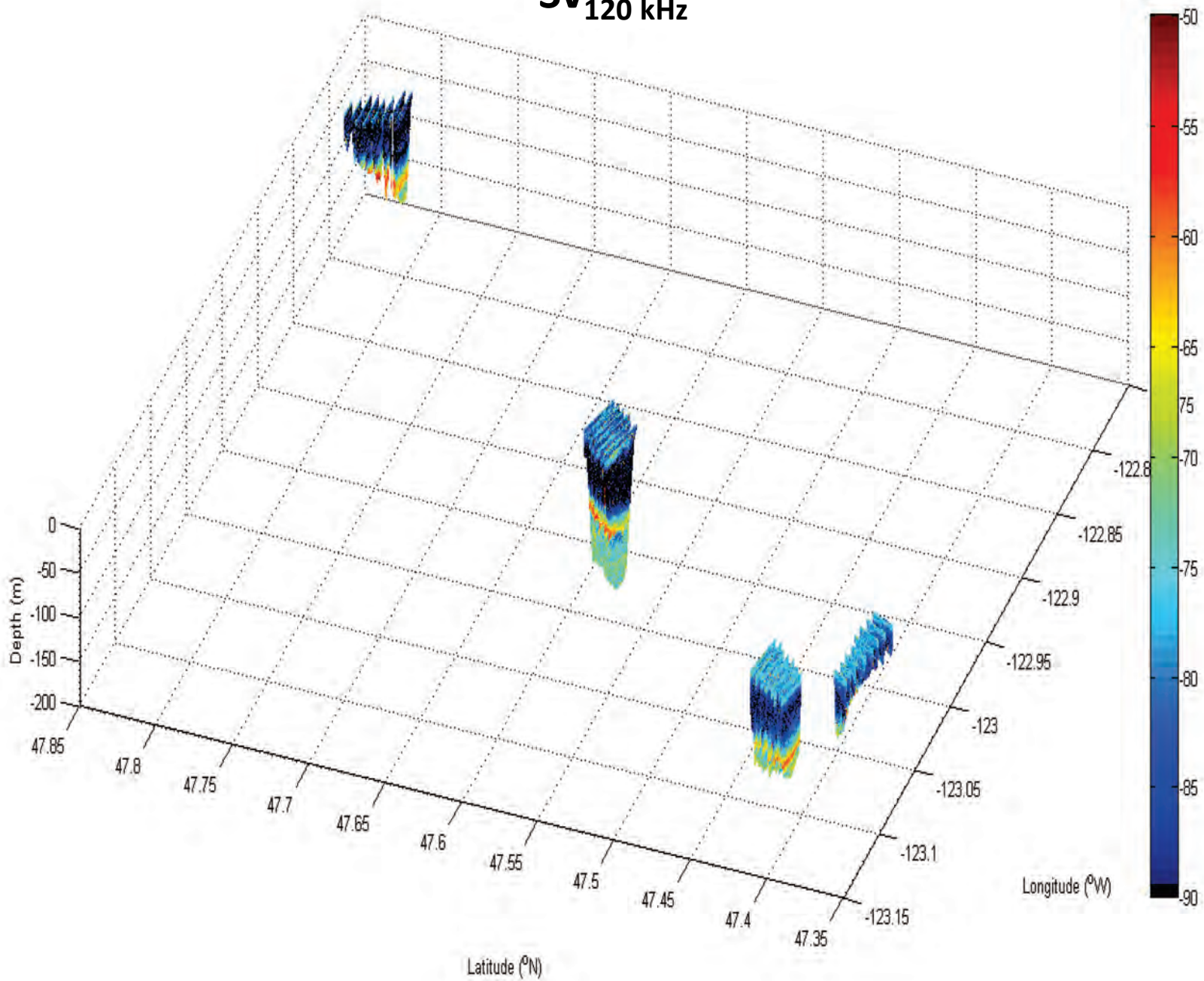
Comparison of near-bottom  $O_2$  vs. Sv fish at 38 kHz



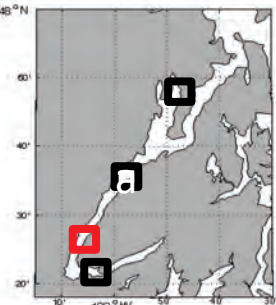
Comparison of  $O_2$  vs. Sv zoop at 120 kHz where peak of zoop layer is observed



# $Sv_{120\text{ kHz}}$







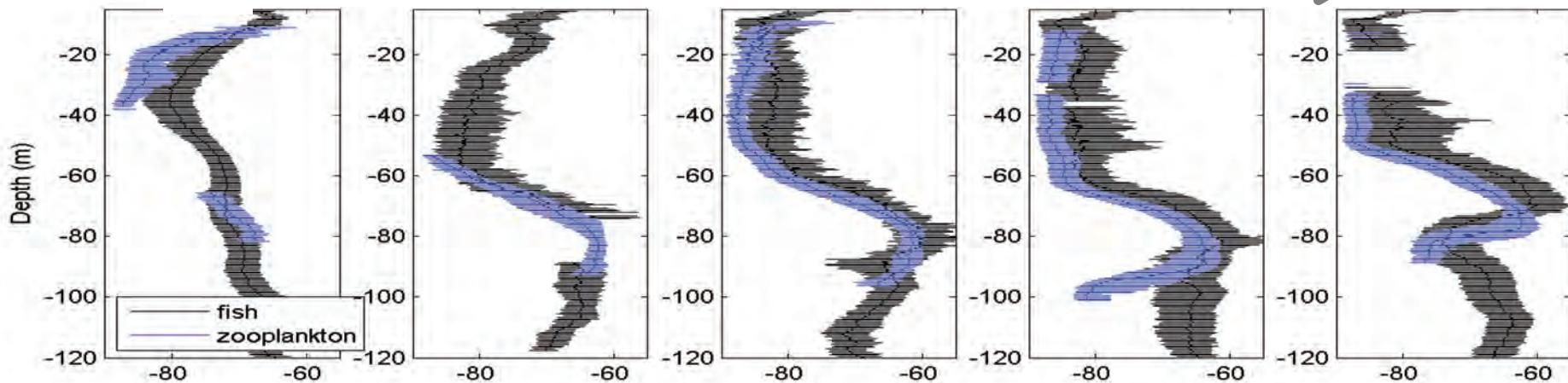
# Vertical Distributions

Fish  
Zooplankton

Jun

2012

Oct



Jun

2013

Oct

