CSI Chesapeake Bay:
What Killed the Copepods?

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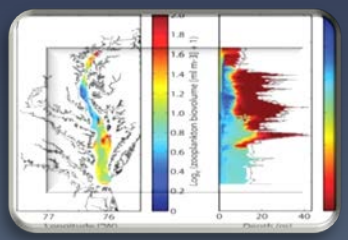
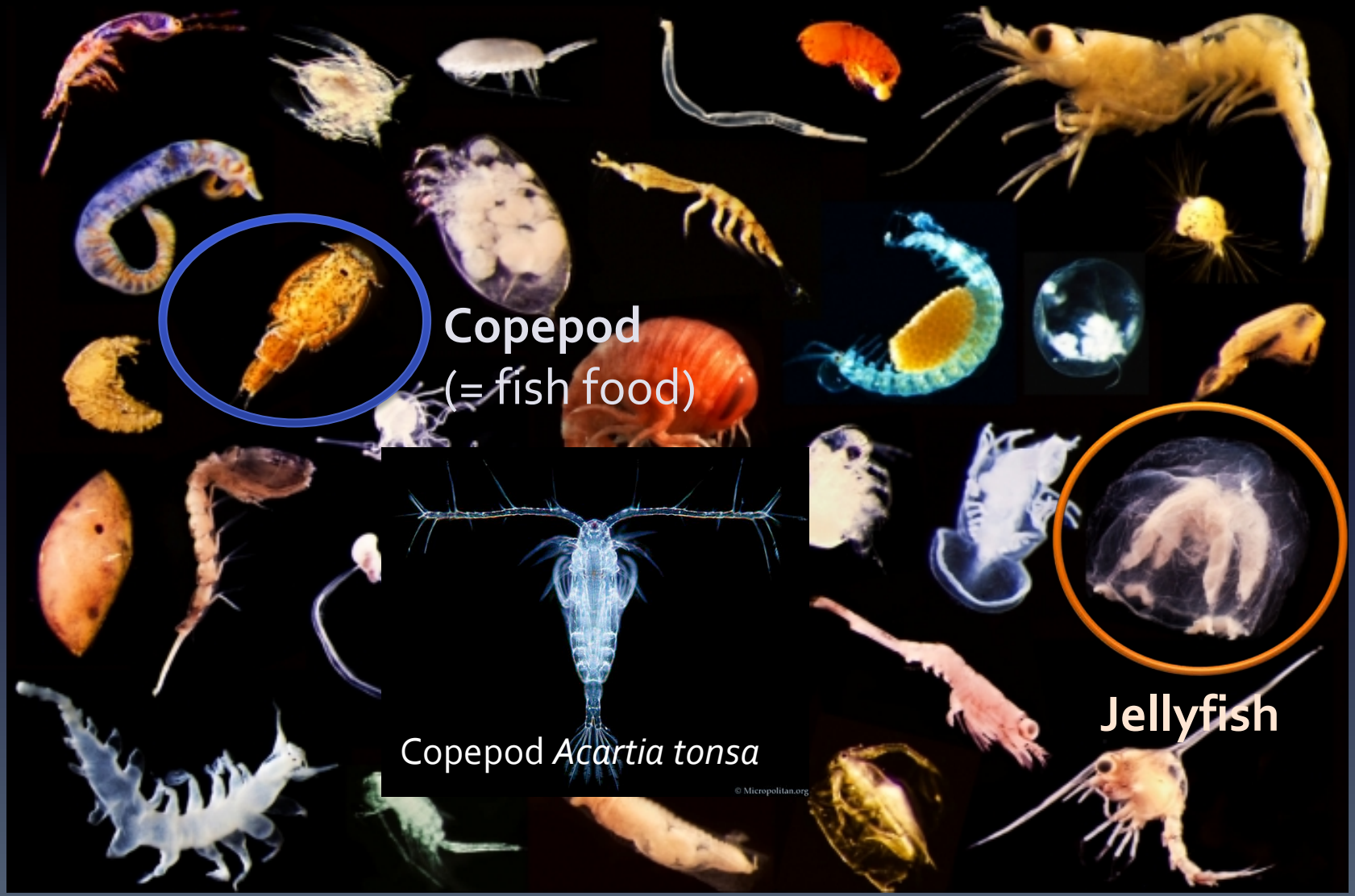



The life I thought I would have…

Zooplankton 101

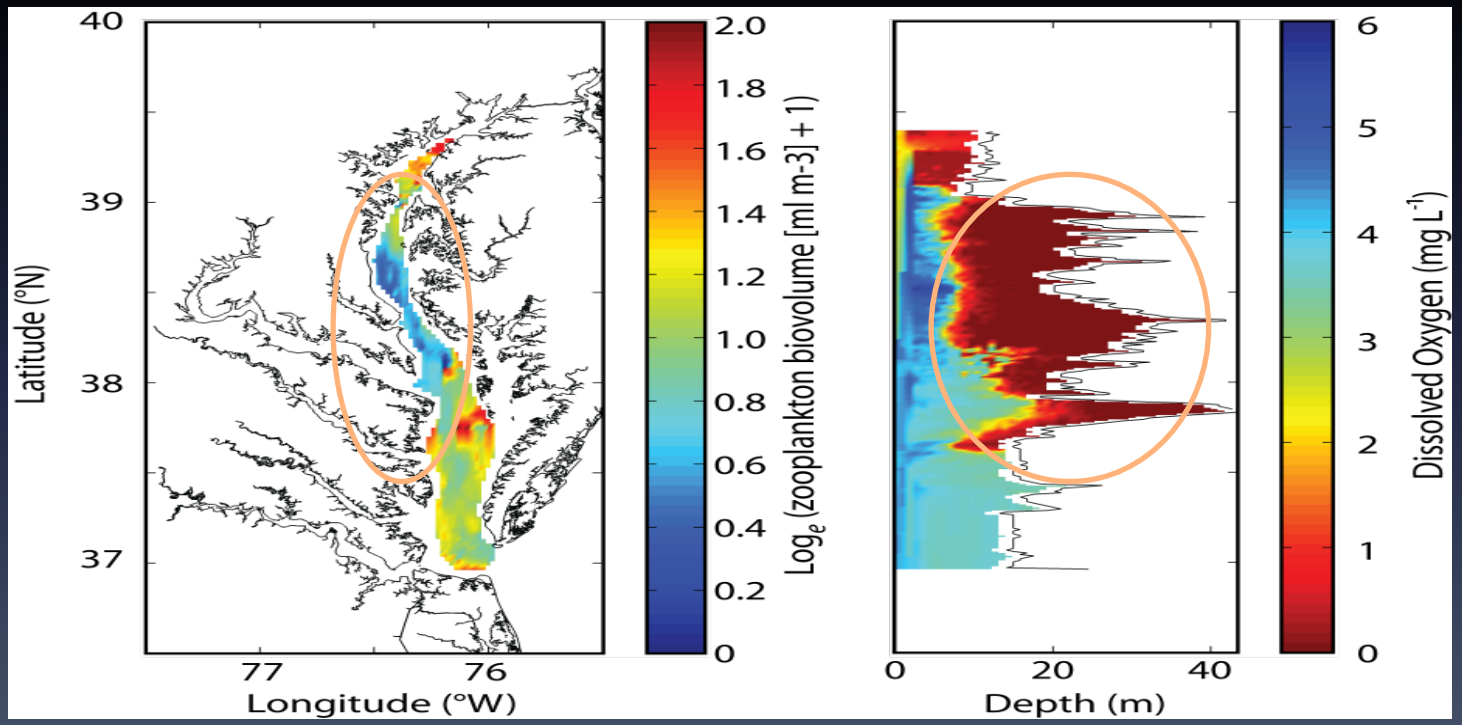
The drifters



The food web

The Story Began Here…

- Hypoxia (DO < 2mg/ L) correlated with low copepod abundance

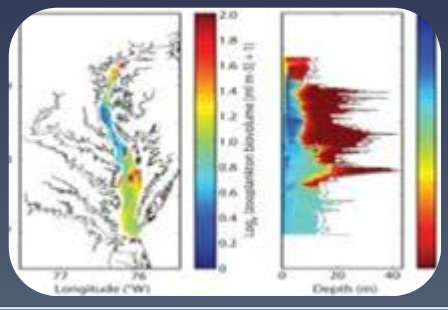


(Roman *et al* 2005)

Why?

Hypoxia

- Slower development rate
- Less egg production decrease and Lower egg hatching rate

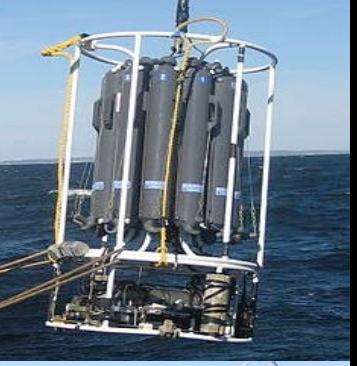


Jellyfish Predation

- Jellyfish bloom in summer
- The insatiable feeding feature
- Inverse correlation with zooplankton abundance

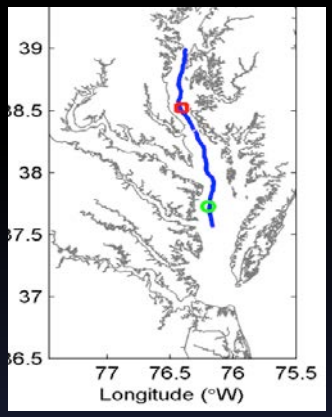
Fish Predation

- Anchovy is the most abundant planktivorous fish in the Bay
- Prey upon lots copepods
- Competition with jellyfish



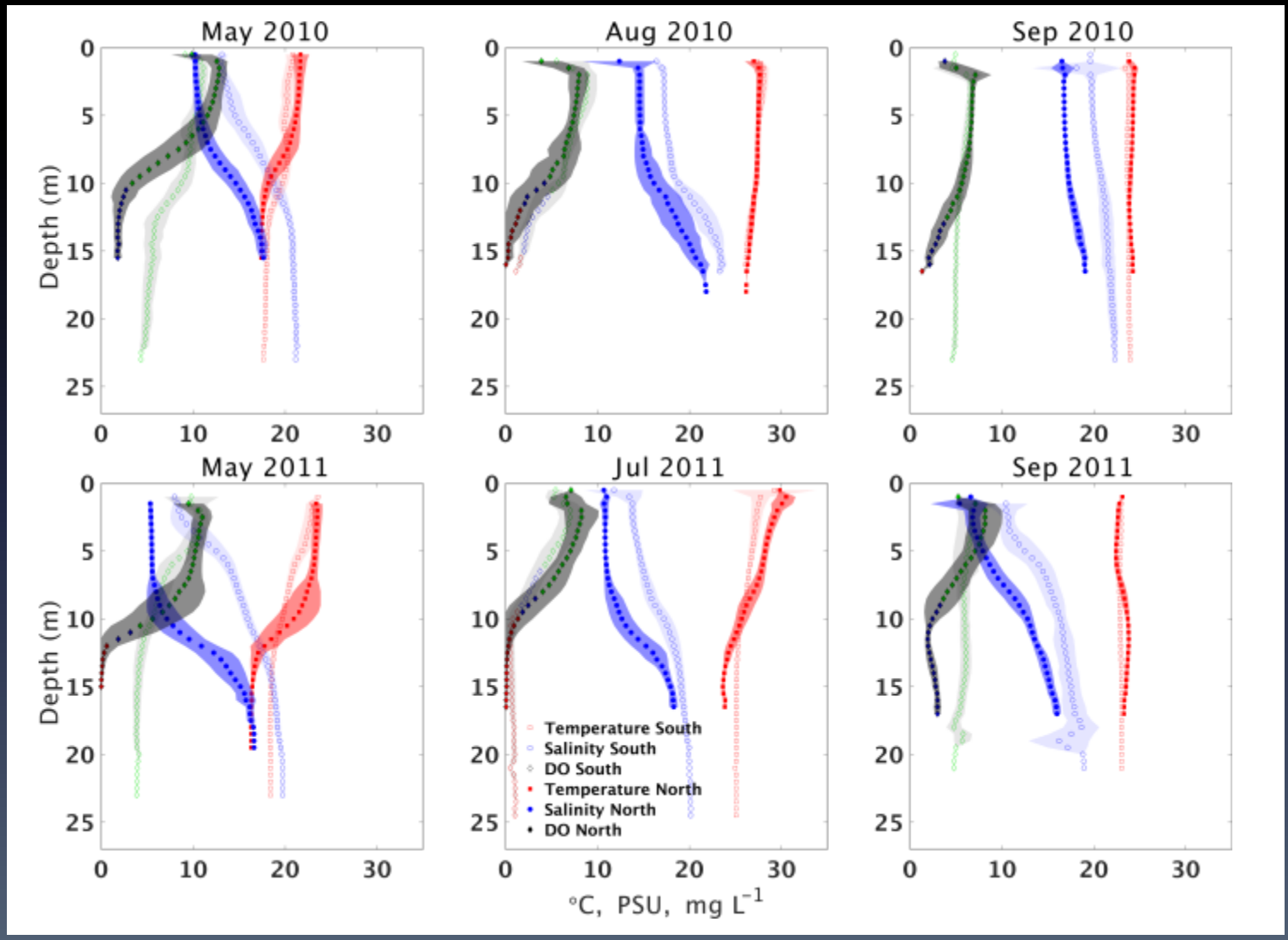
Investigation

Field Sampling

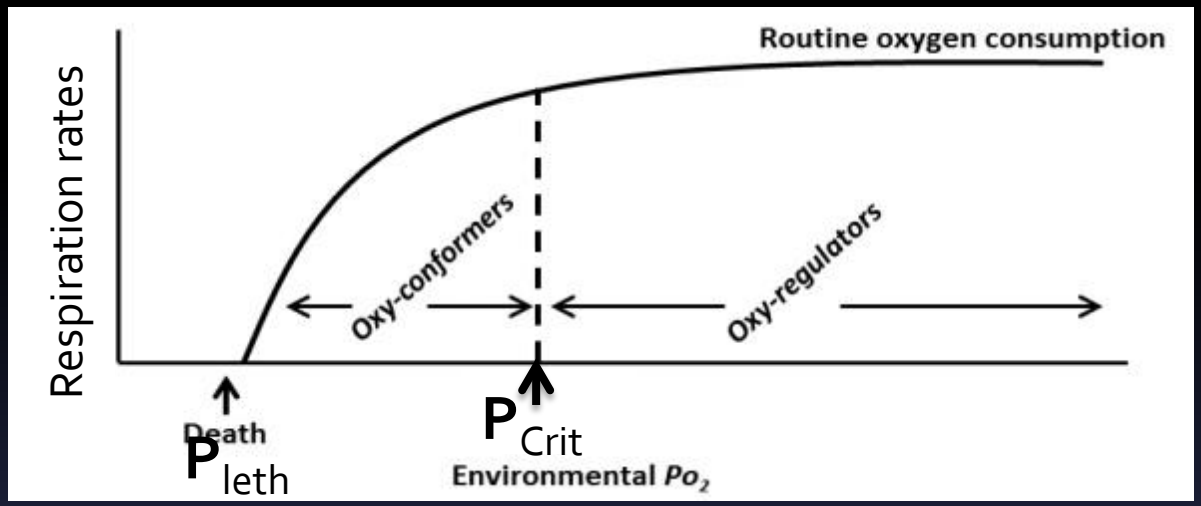


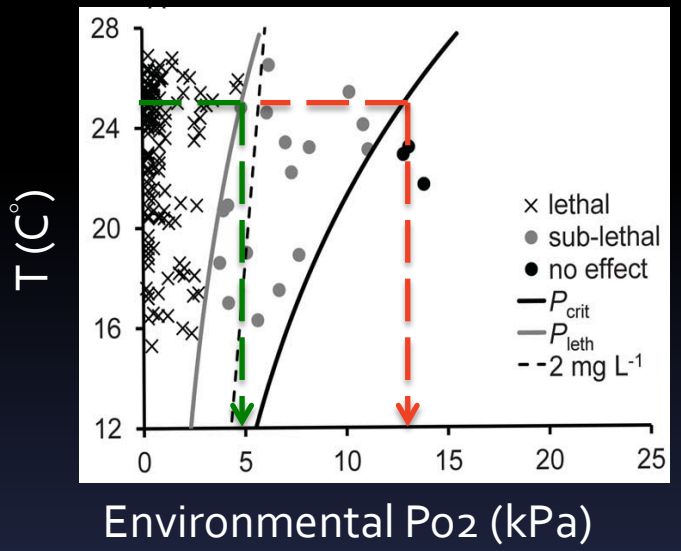
- **Cruises:** May Aug/Jul Sep, 2010 & 2011
- **Stations:**
  - North (38° 31.32’ N, 076° 24.48’ W)
  - South (37° 43.68’ N, 076° 12.0’ W)
- **Temperature, Salinity, DO, Fluorescence:** CTD
- **Copepod carcasses:** Niskin Bottles
- **Copepod & Larval Anchovy:** MOCNESS
- **Juvenile Anchovy abundance:** Mid-water Trawl
- **Jellyfish abundance:** Tucker Trawl
- **Jellyfish gut contents:** The Reeve net

Hypoxia was in the bottom water in summer



Not all hypoxia is the same





At 25°C , DO = 2 mg / L ≅ 5.5 kPa , yet the P_{crit} of

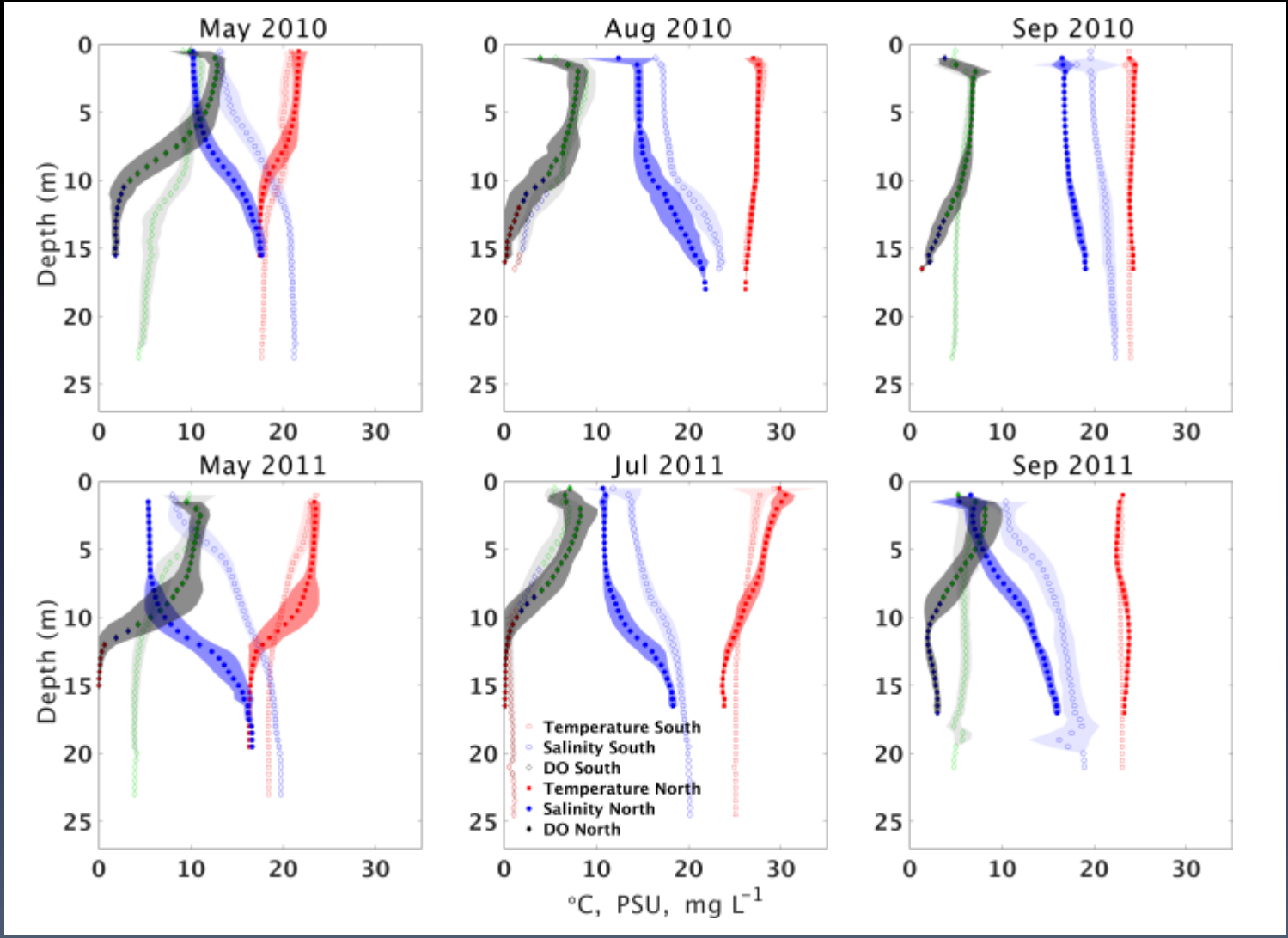
7 kPa <

12.3 kPa <

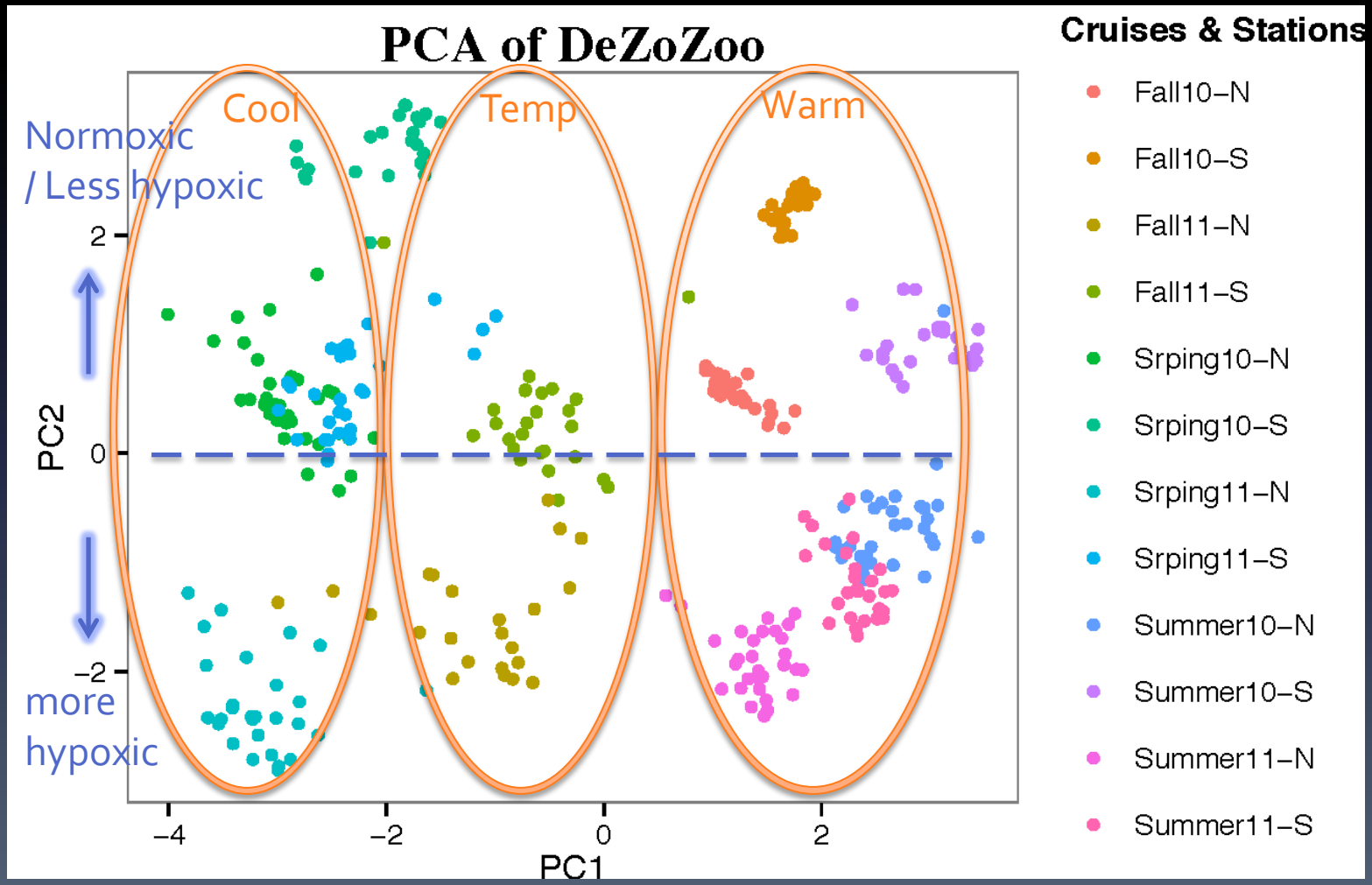
13 kPa

(Elliott, Pierson, & Roman, 2013; Thuesen, Rutherford, & Brommer, 2005; Thuesen et al., 2005)

Hypoxia could be underestimated with a fixed standard

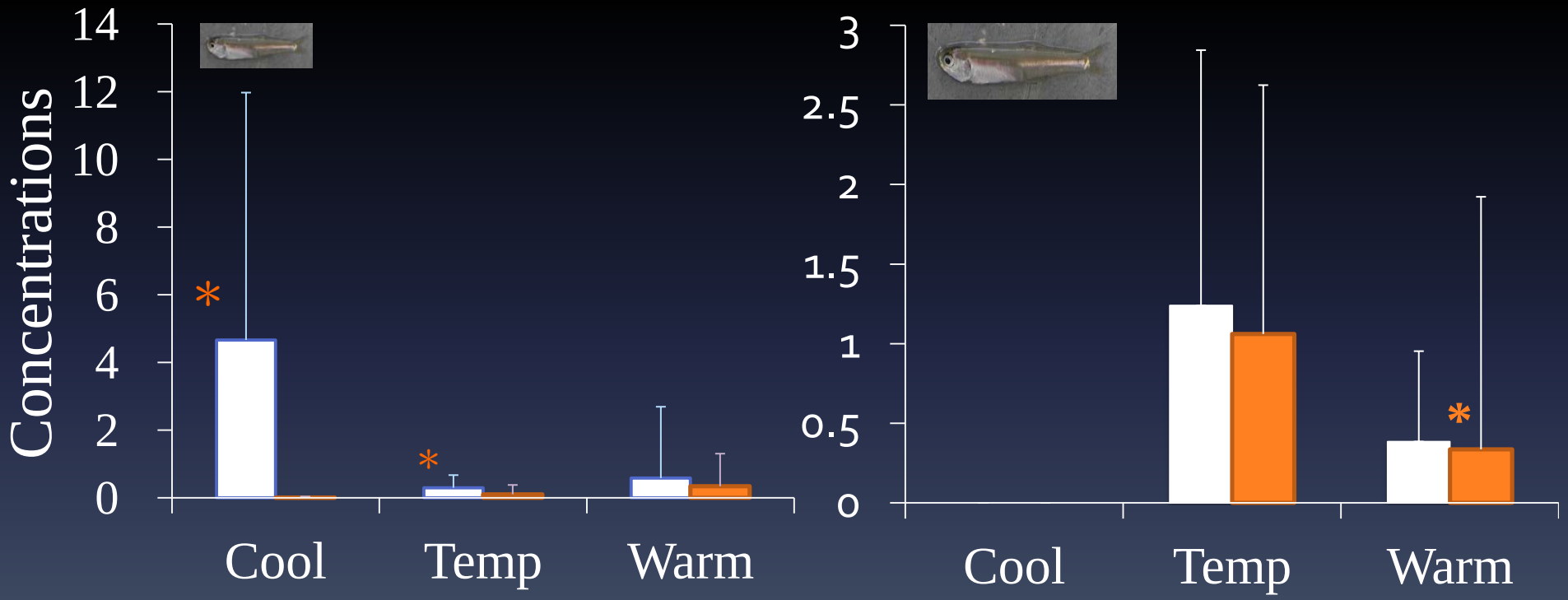


Grouping samples according to PCA results

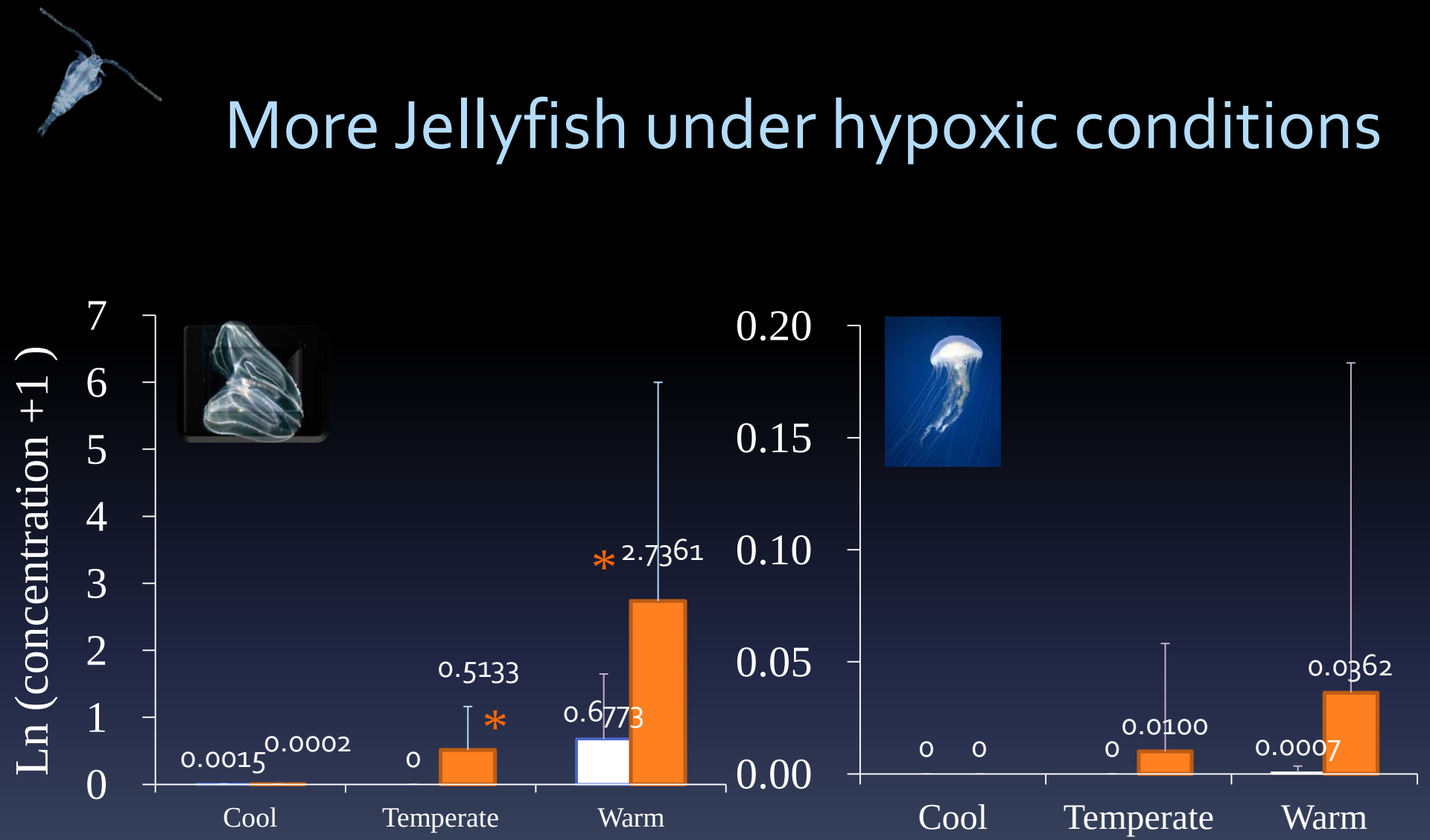


Less copepods under hypoxic conditions

Less Bay Anchovy under hypoxic conditions



More Jellyfish under hypoxic conditions



~Thank You~

- Dr. James Pierson & Lab
- Committee:
  - Dr. Michael Roman
  - Dr. Mary Beth Decker
  - Dr. Edward Houde
  - Dr. Elizabeth North
  - Dr. Denise Breitburg
- Dr. David Elliott
- Dr. Dong Liang
- Horn Point Lab

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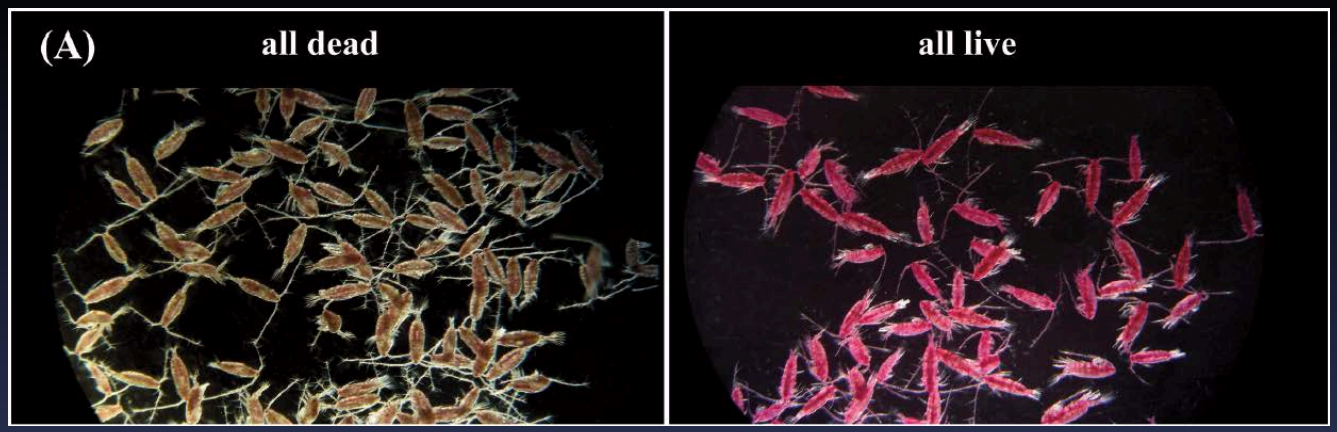
The dead do tell tales

- **Copepod non-predatory mortality** (Elliott et al 2009)

  M_{np} (% d^{-1}) = % dead ÷ carcass turn over time



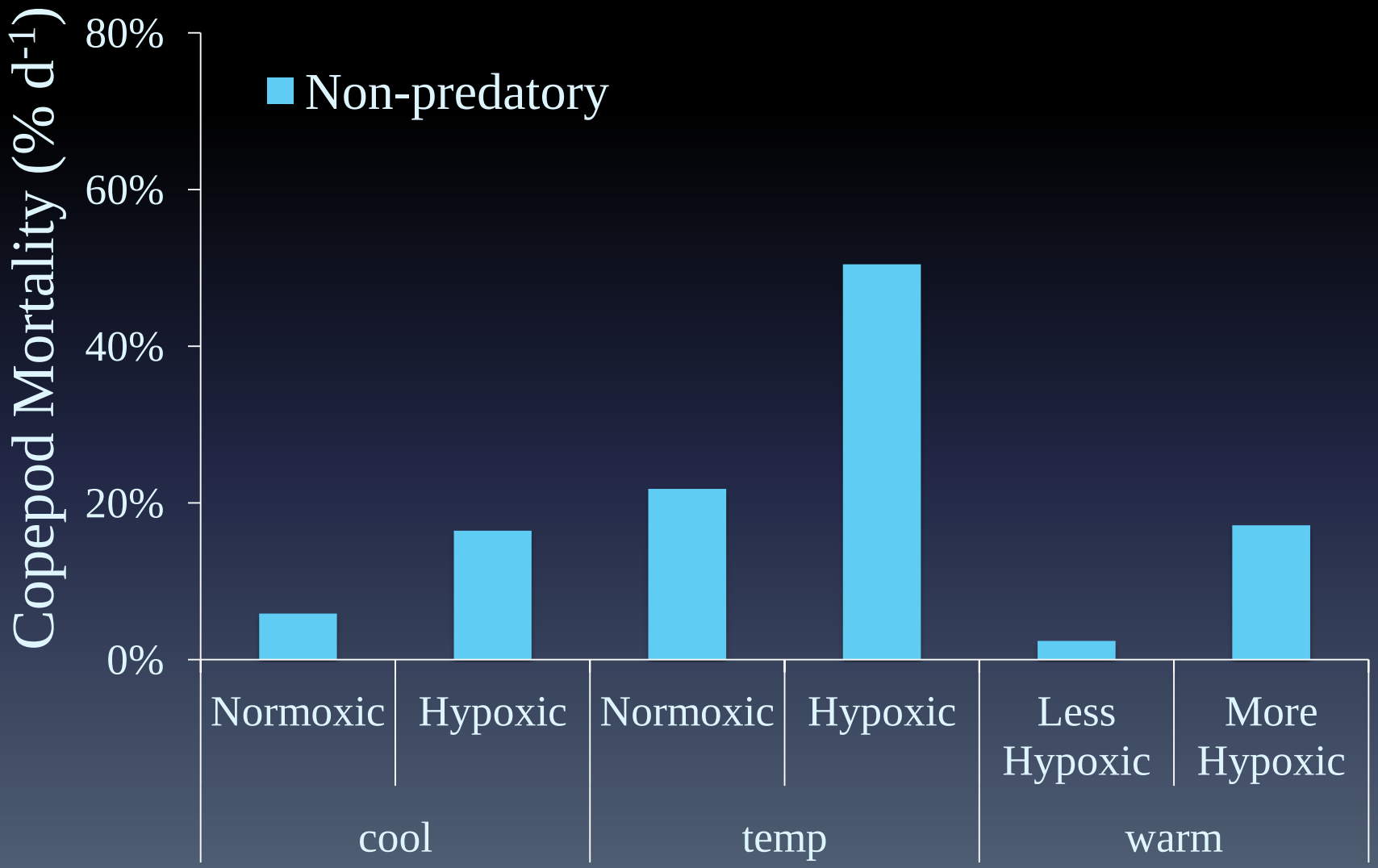
- **Copepod predatory mortality**

  Predator clearance rate (**F**, L ind^{-1} h^{-1})

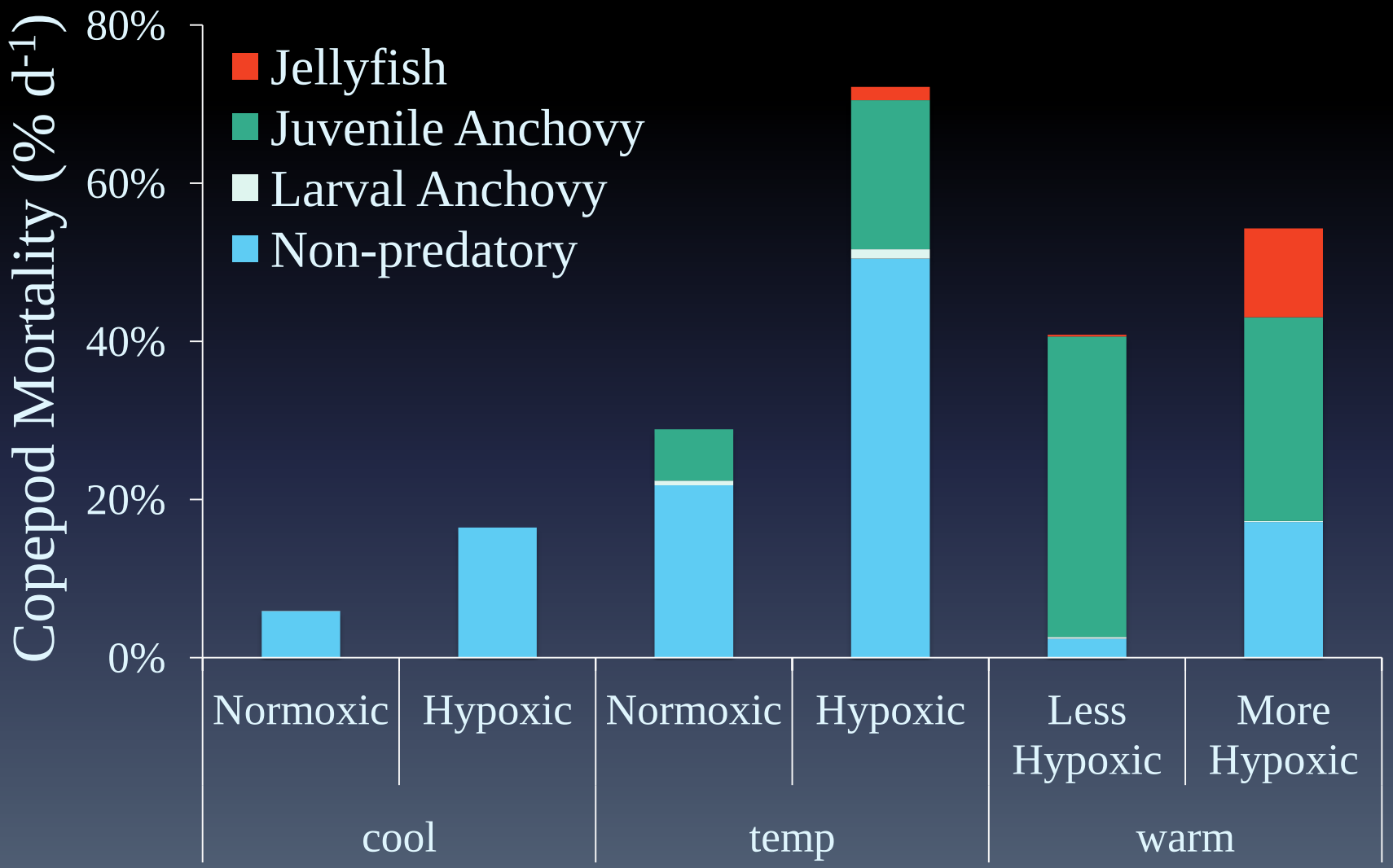
  =*Gut content ÷ (Digestion time x Prey Abundance)*

  M_p(% d^{-1}) = ***Ingestion x 24 x Predator ÷ Prey x 100%***

Higher non-predatory mortality rates under hypoxic conditions

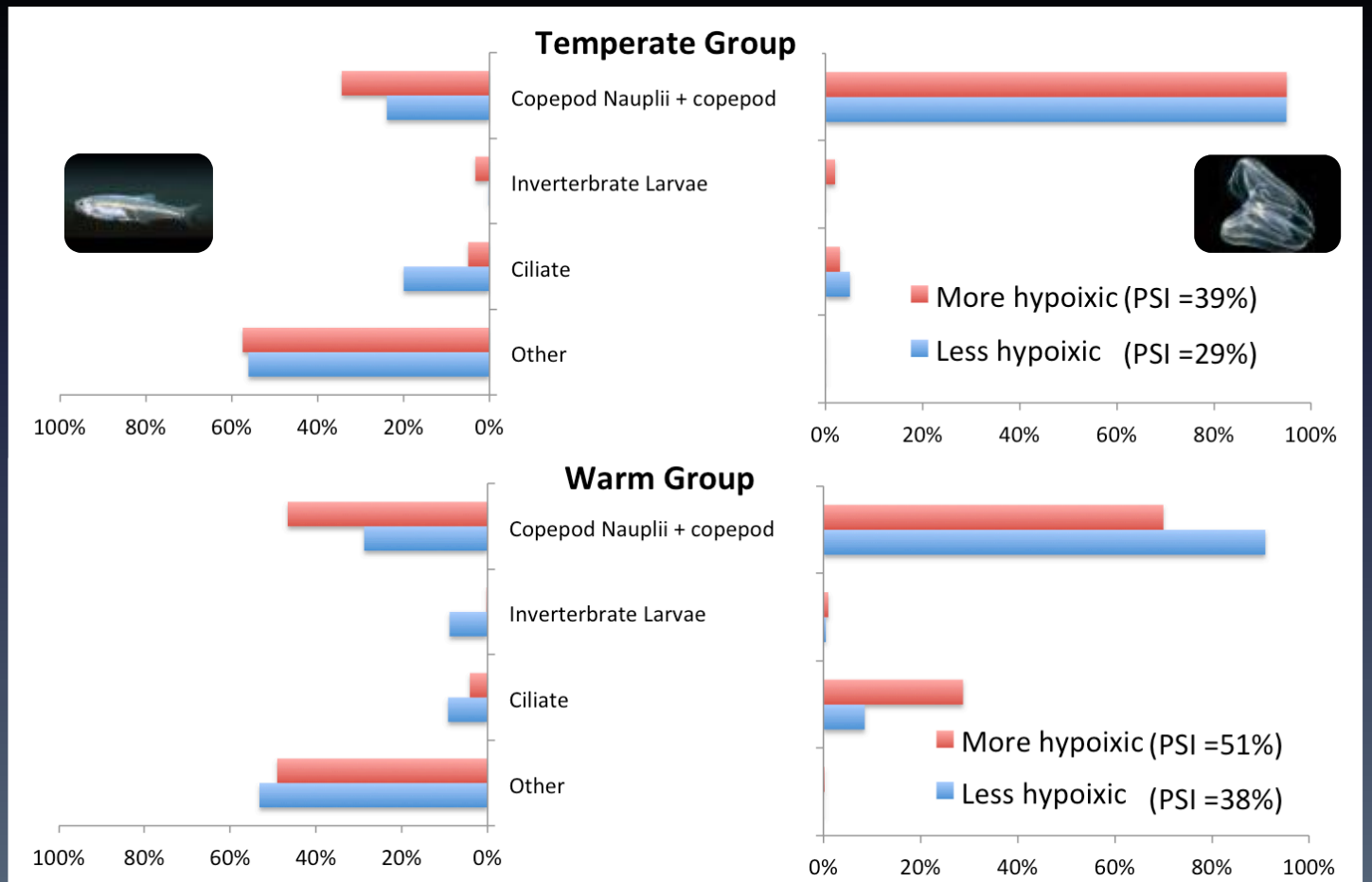


The importance of predatory effects increased with temperature



Competition between juvenile anchovy and jellyfish increased under hypoxic conditions

$$\text{Percent Similarity Index (PSI)} = \left(1 - 0.5 \sum_{i=1}^{n} |p_{jk} - p_{ak}|\right) \times 100\%$$



Take Home Messages

- Copepod mortality was higher under hypoxic conditions because of hypoxia and predation
- Future hypoxia study may consider the different responses among species and temperature
- Potential prey competition increased between jellyfish and juvenile anchovy under hypoxic conditions

sea walnut bloom in the Caspian Sea