Apr 4th, 2:45 PM - 3:00 PM

Ocean acidification driven changes in pH exposure of zooplankton: projections from the Salish Sea model

Paul McElhany
Northwest Fisheries Science Ctr., United States, paul.mcelhany@noaa.gov

Vathsala DeSilva
Vicuna, Inc., United States, vaths@vicunainc.com

Tarang Khangaonkar
Pacific Northwest National Lab., United States, tarang.khangaonkar@pnnl.gov

Ocean Acidification Driven Changes in pH Exposure of Zooplankton: Projections from the Salish Sea Model

(But really, what about Dungeness crab…)

Paul McElhany[1], Vathsala DeSilva[2], Tarang Khangaonkar[3]

[1] NOAA Northwest Fisheries Science Center Mukilteo Field Station
[2] Vicuna Inc., Seattle, WA
[3] Pacific Northwest National Laboratory

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Simone Alin, Meliana Dyck, and Wen Long

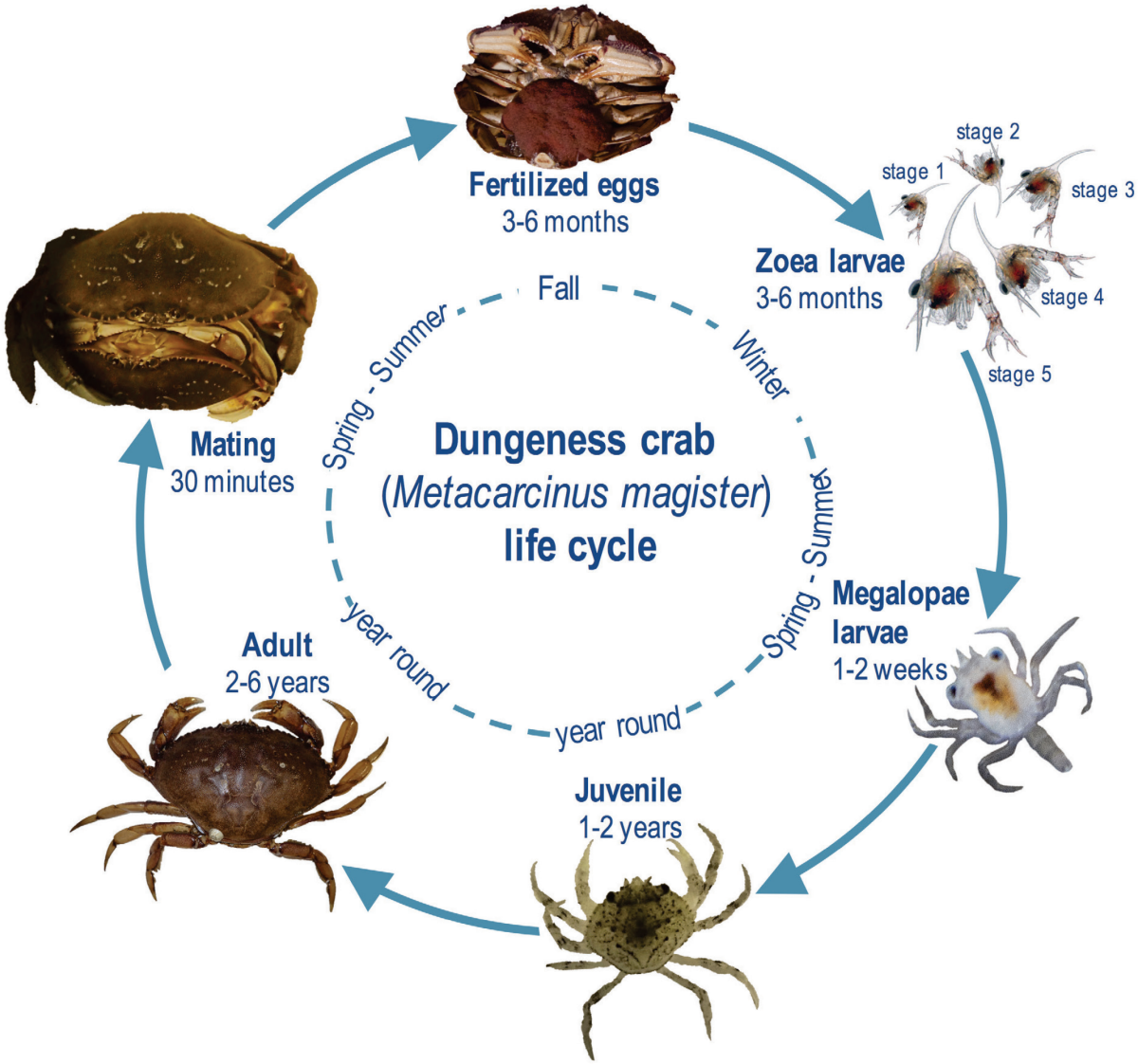
Salish Sea Ecosystem Conf.
April 4, 2018

Ocean Acidification

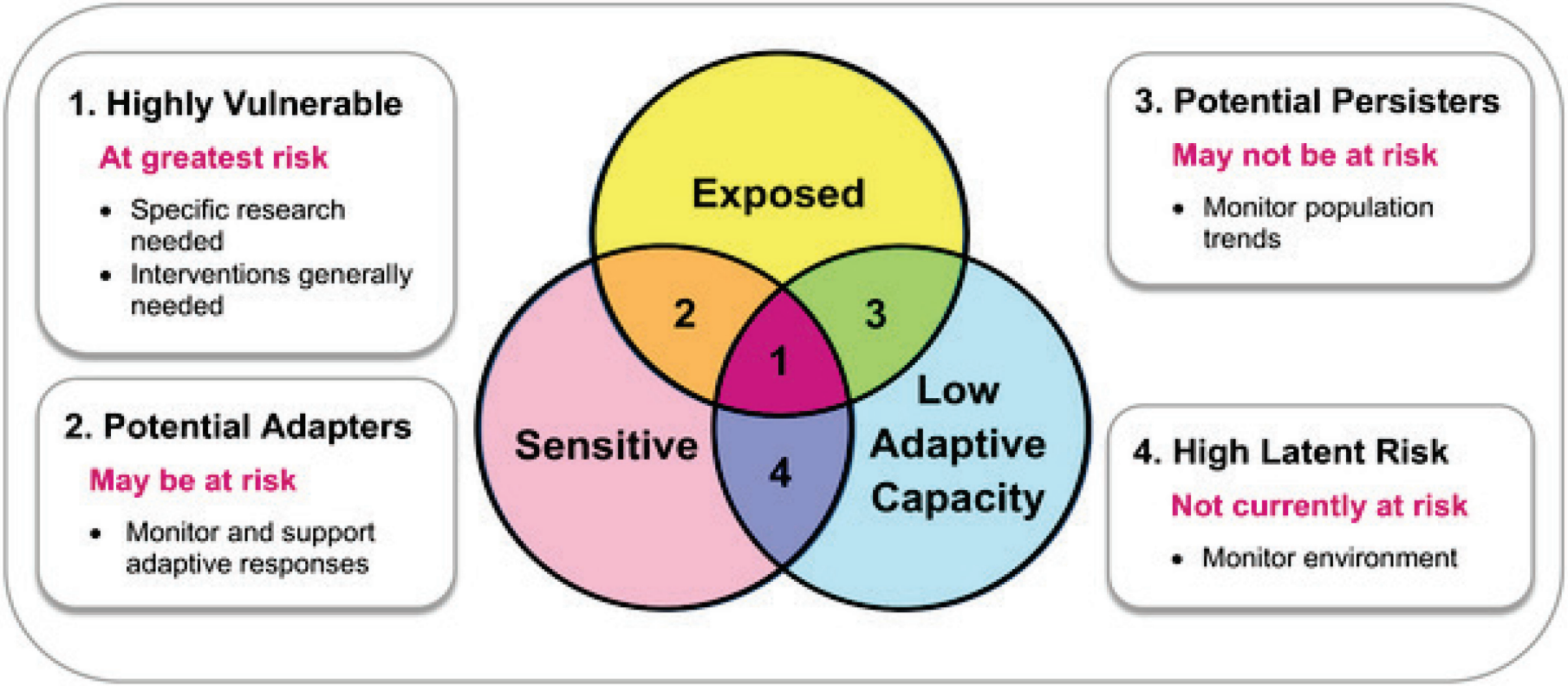
Carbon Dioxide

Acidification

Ocean Acidification and Dungeness Crab

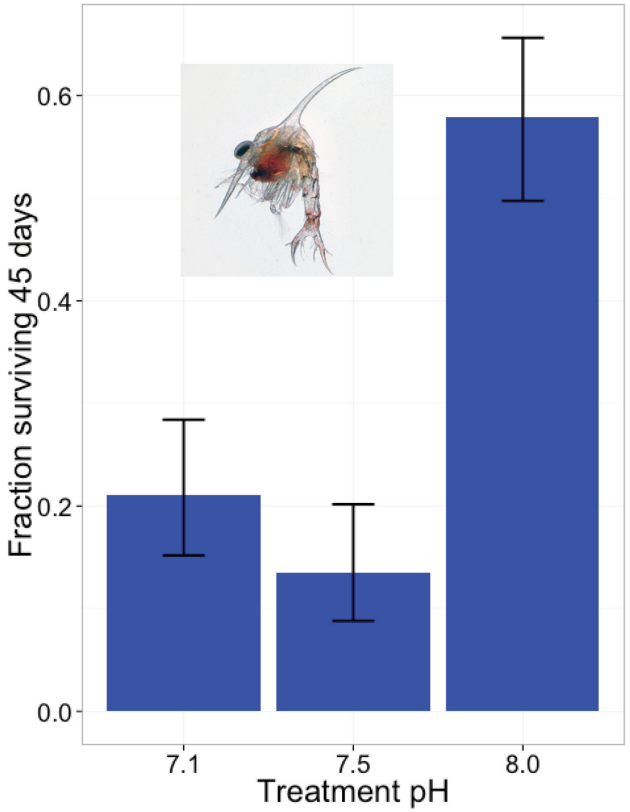


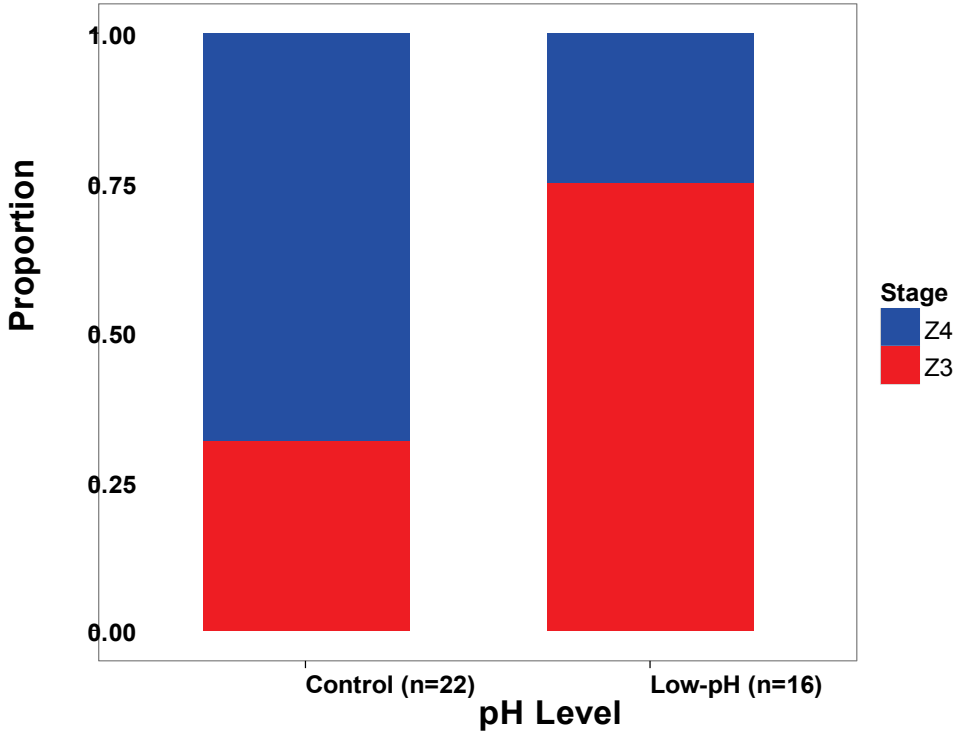
Vulnerability Framework



Ocean Time Machine

Dungeness crab survival and development





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Miller, Maher, Bohaboy, Friedman, and McElhany. 2016 (Marine Biology)

Relative pH Sensitivity:

Meta-analysis of ~400 OA Papers Relevant to California Current

Functional group

Benthic herbivorous grazers
Mesozooplankton
Bivalves
Pteropods
Coralline algae
Crabs
Shallow benthic filter feeders
Crangon shrimp
Dungeness crab
Carnivorous infauna
Deposit feeders
Humboldt squid
Small demersal sharks
Large zooplankton
Fish
Stony corals
Soft corals
Market squid
Pelagic bacteria
Sea stars moonsnail whelk
Nearshore sea urchins
Pandalid shrimp
Spiny dogfish
Coccolithophore
Meiobenthos
Large phytoplankton
Microphytobenthos
Small phytoplankton
Microzooplankton
Macroalgae
Benthic bacteria
Gelatinous zooplankton
Deep benthic filter feeders
Seagrass

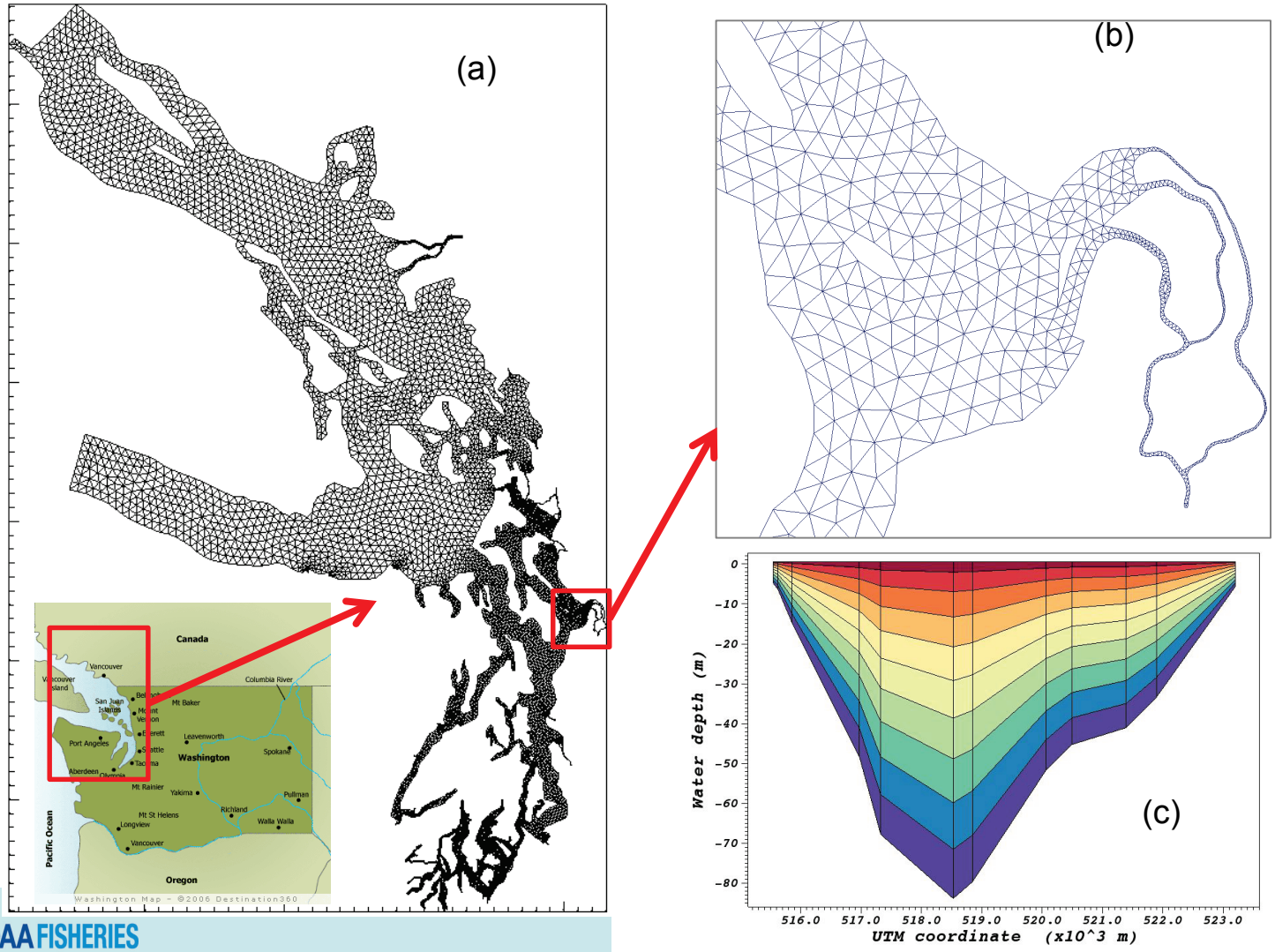
-0.5
0.0
0.5

pH sensitivity curve slope

NOAA FISHERIES

Busch and McElhany. 2016 (PLOS)

Pacific Northwest National Laboratory (PNNL) Circulation Model



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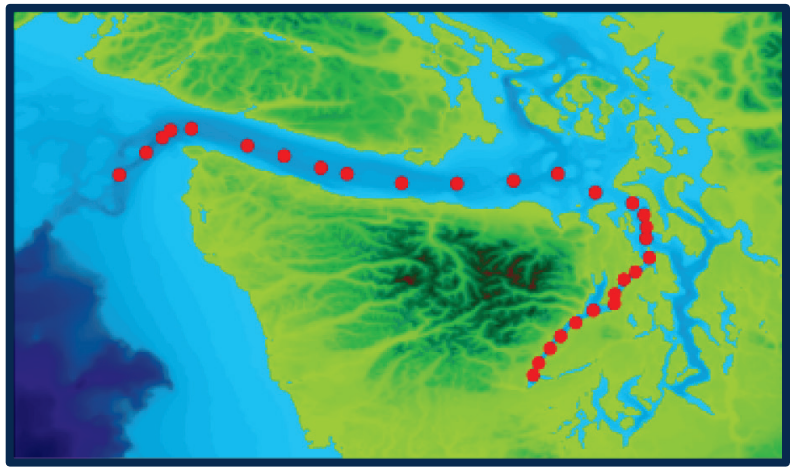
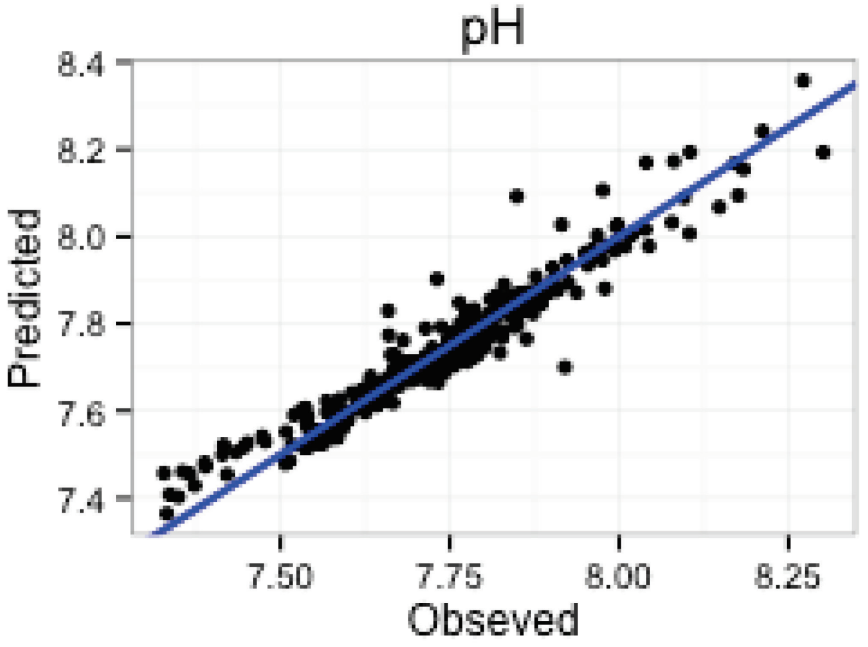
Carbonate Chemistry Proxies

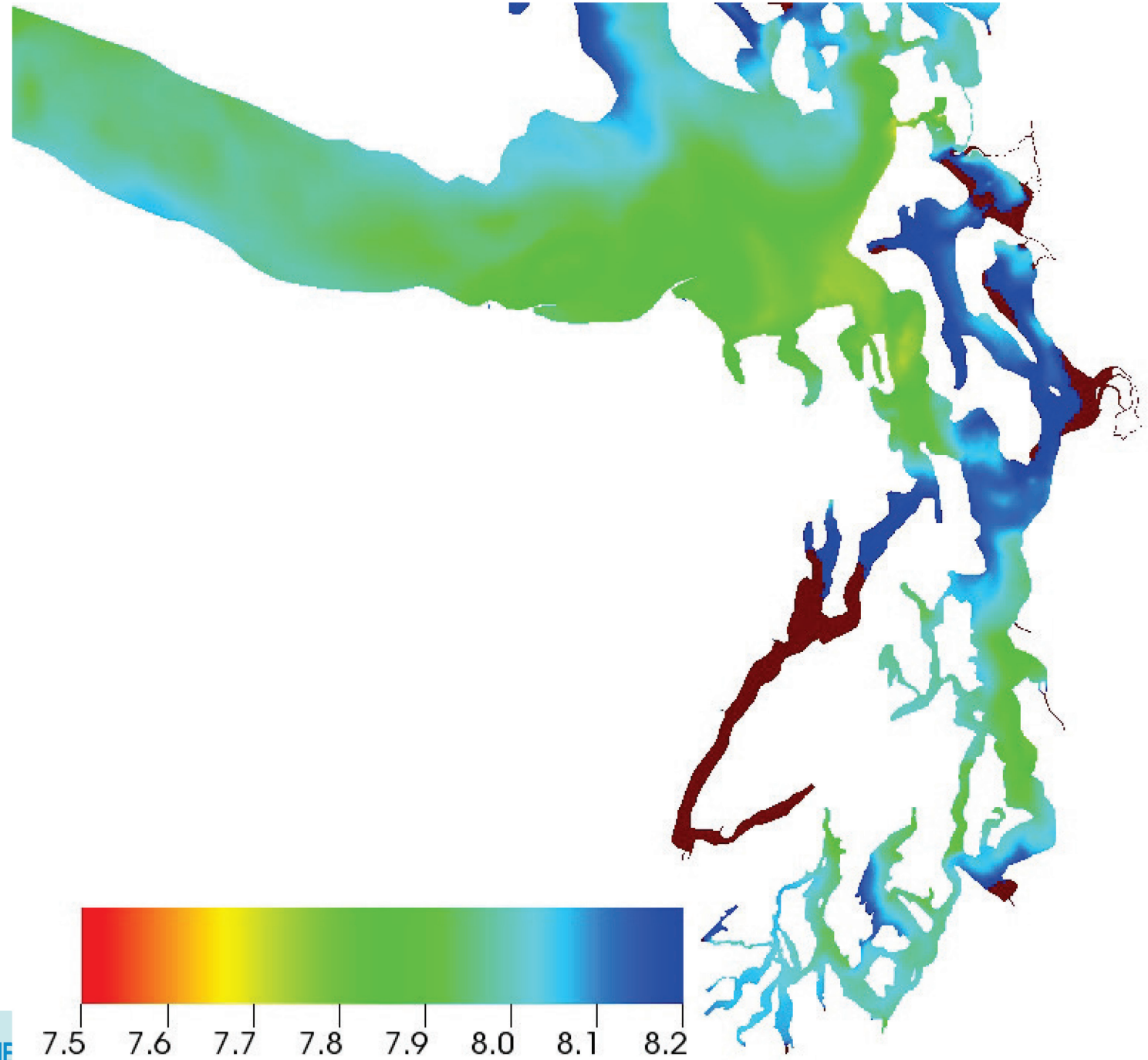
Carbonate Parameter = *f*(temperature, salinity, oxygen)

Puget Sound Carbonate Cruise
2008 (Feb and Aug)

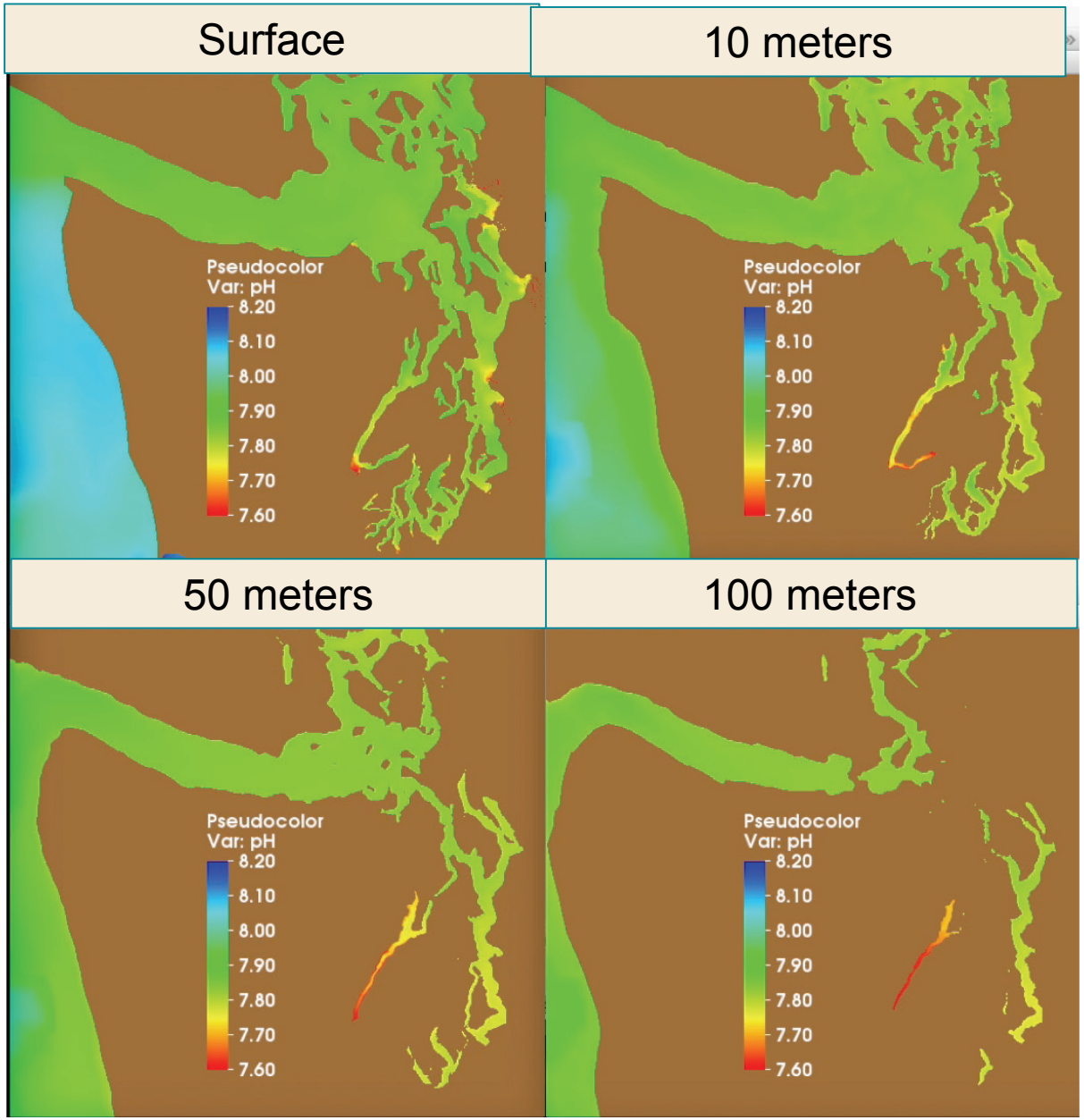


Feely et al. 2010




7.5
7.6
7.7
7.8
7.9
8.0
8.1
8.2

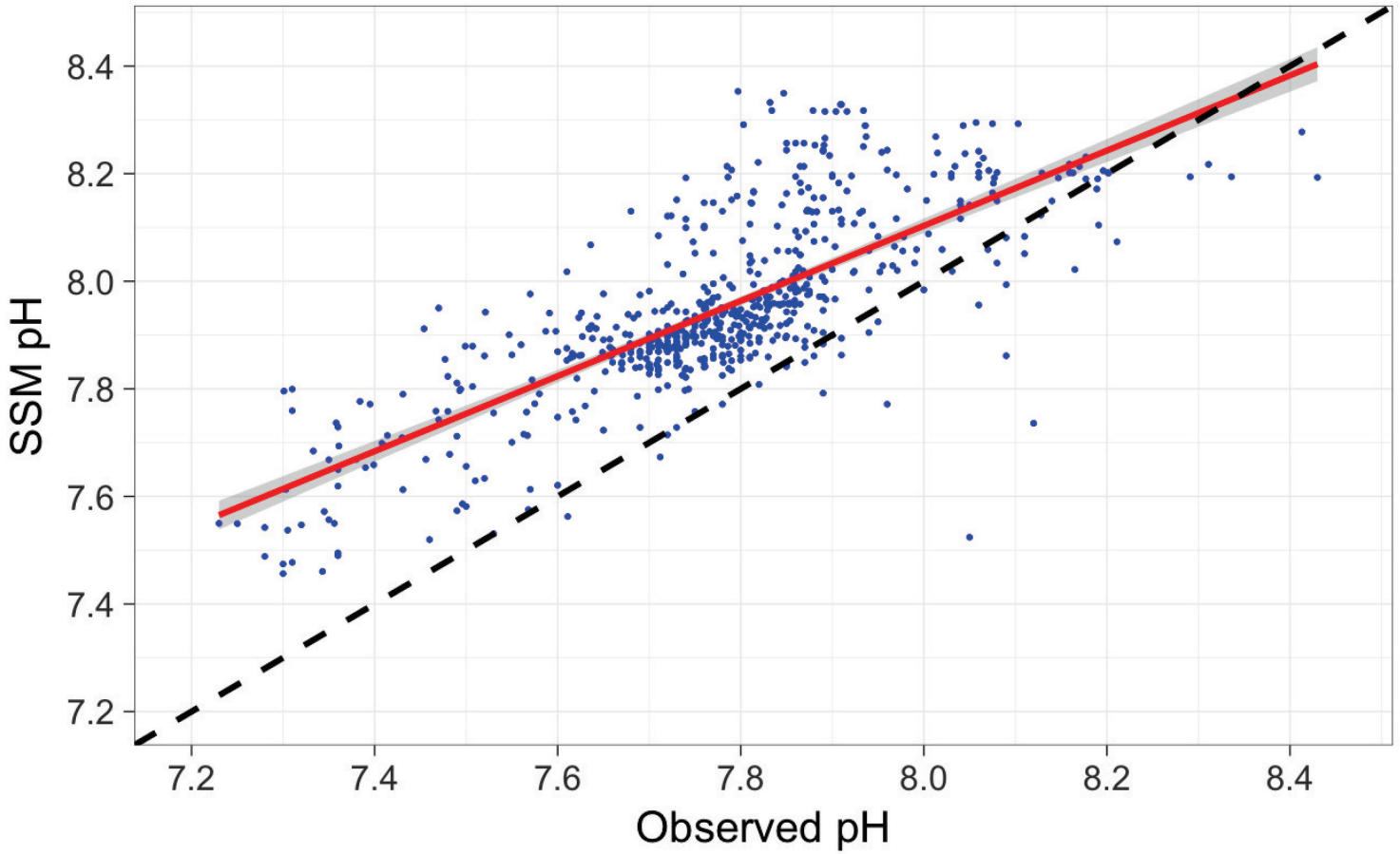
Explict Carbonate Chemistry



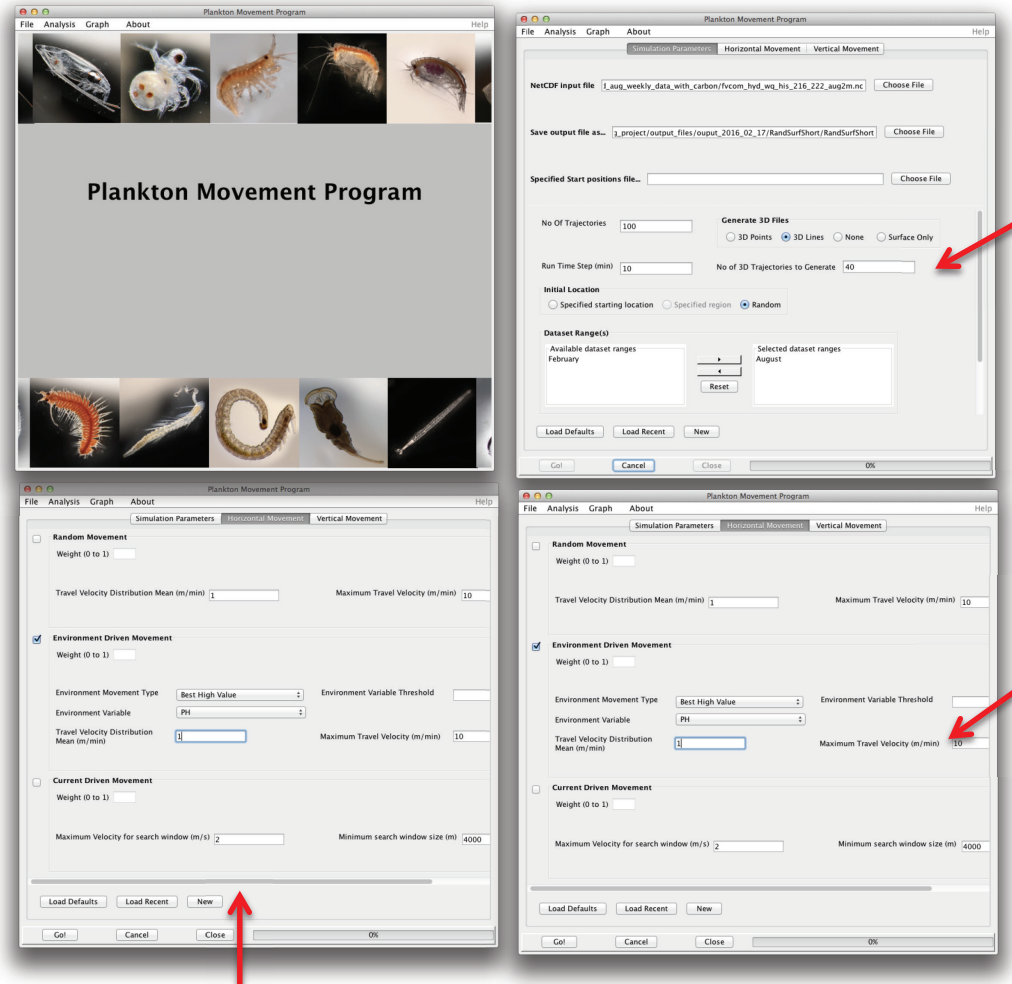
Puget Sound pH March to July 2014

Puget Sound Cruises 2014 (June-July) & (Sept.-Oct)

Model vs. Cruise pH - 2014



Data provided by Simone Alin, NOAA PMEL



Simulation Parameters

- Circulation model input
- Number of trajectories
- Starting locations

Vertical Movement

- Surface only
- Daily Vertical Migrations (DVM)
- Current-drive
- Environment-driven
- Combination

Horizontal Movement

- Stochastic
- Current-driven
- Environment-driven
- Combination

Plankton Movement Program (PMP)

Java program implements individually-based movement simulation

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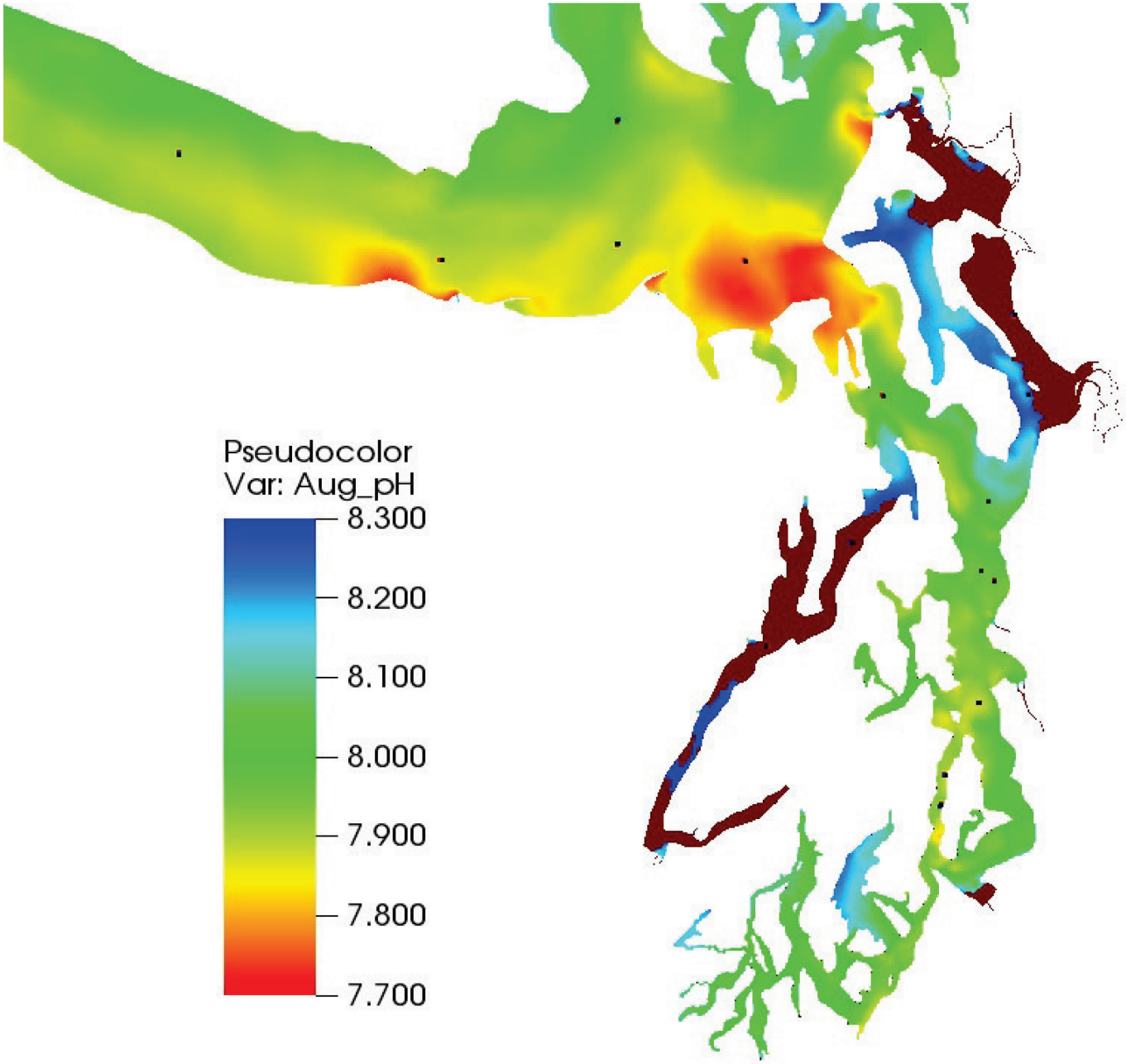
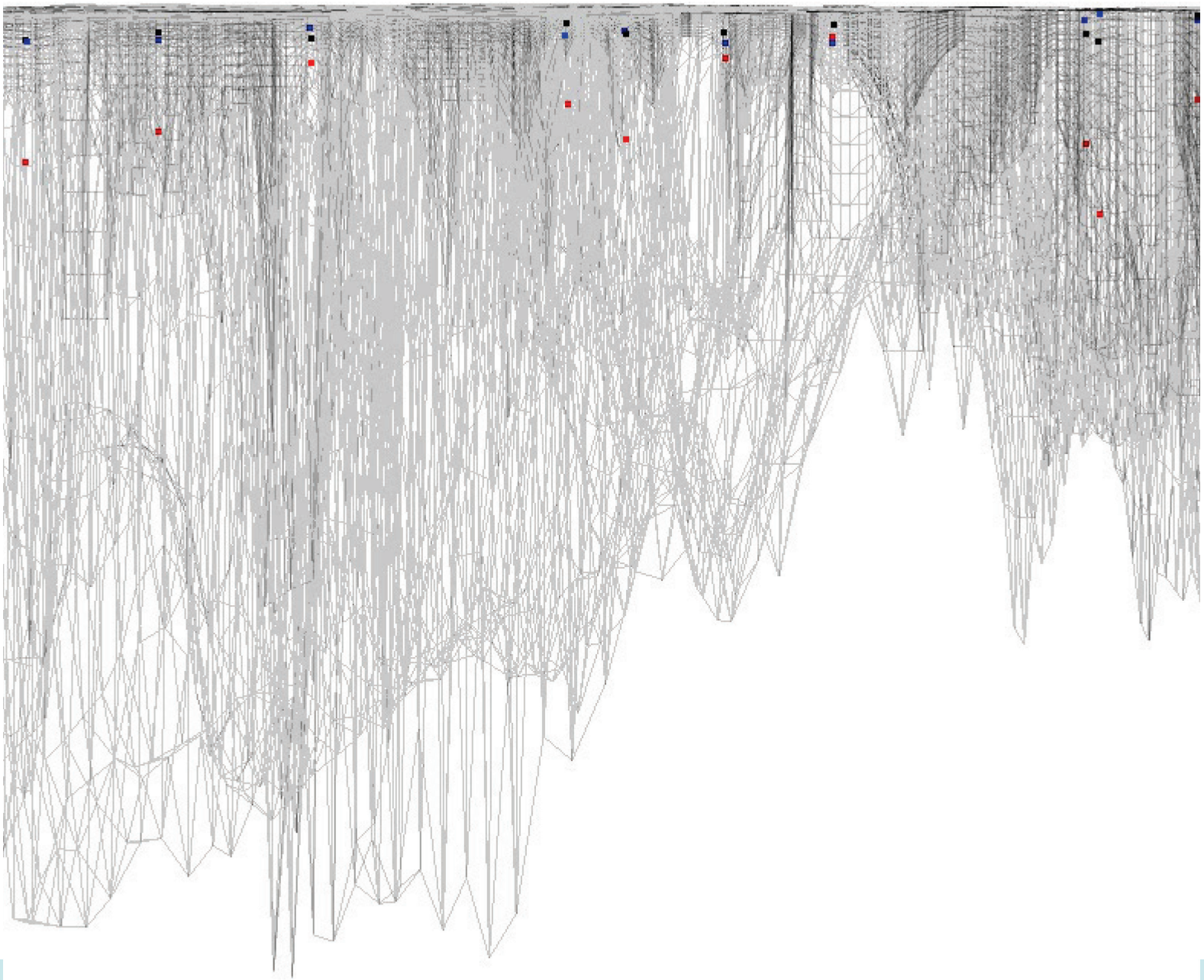
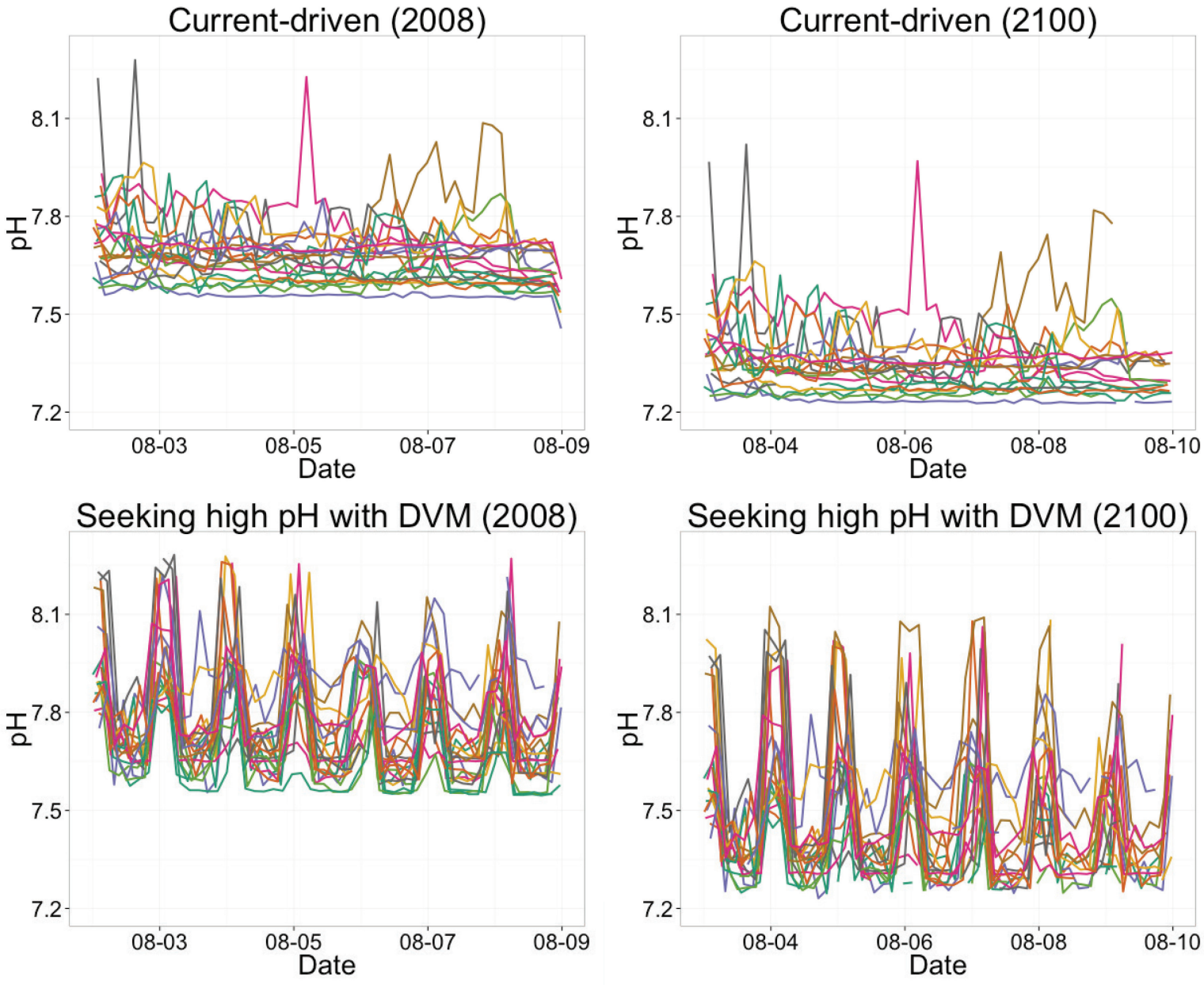
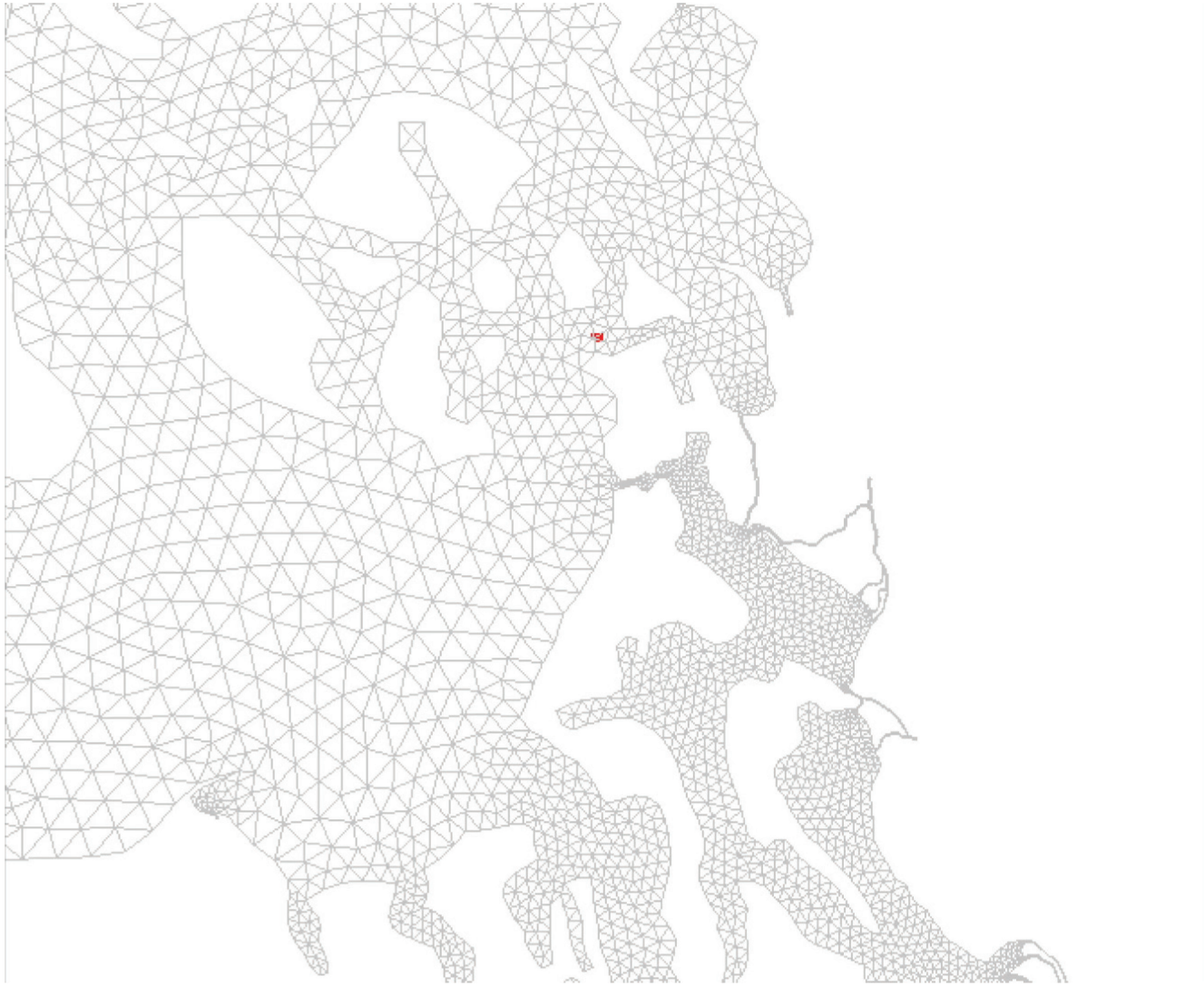

Pseudocolor
Var: Aug_pH
8.300
8.200
8.100
8.000
7.900
7.800
7.700



Trajectories

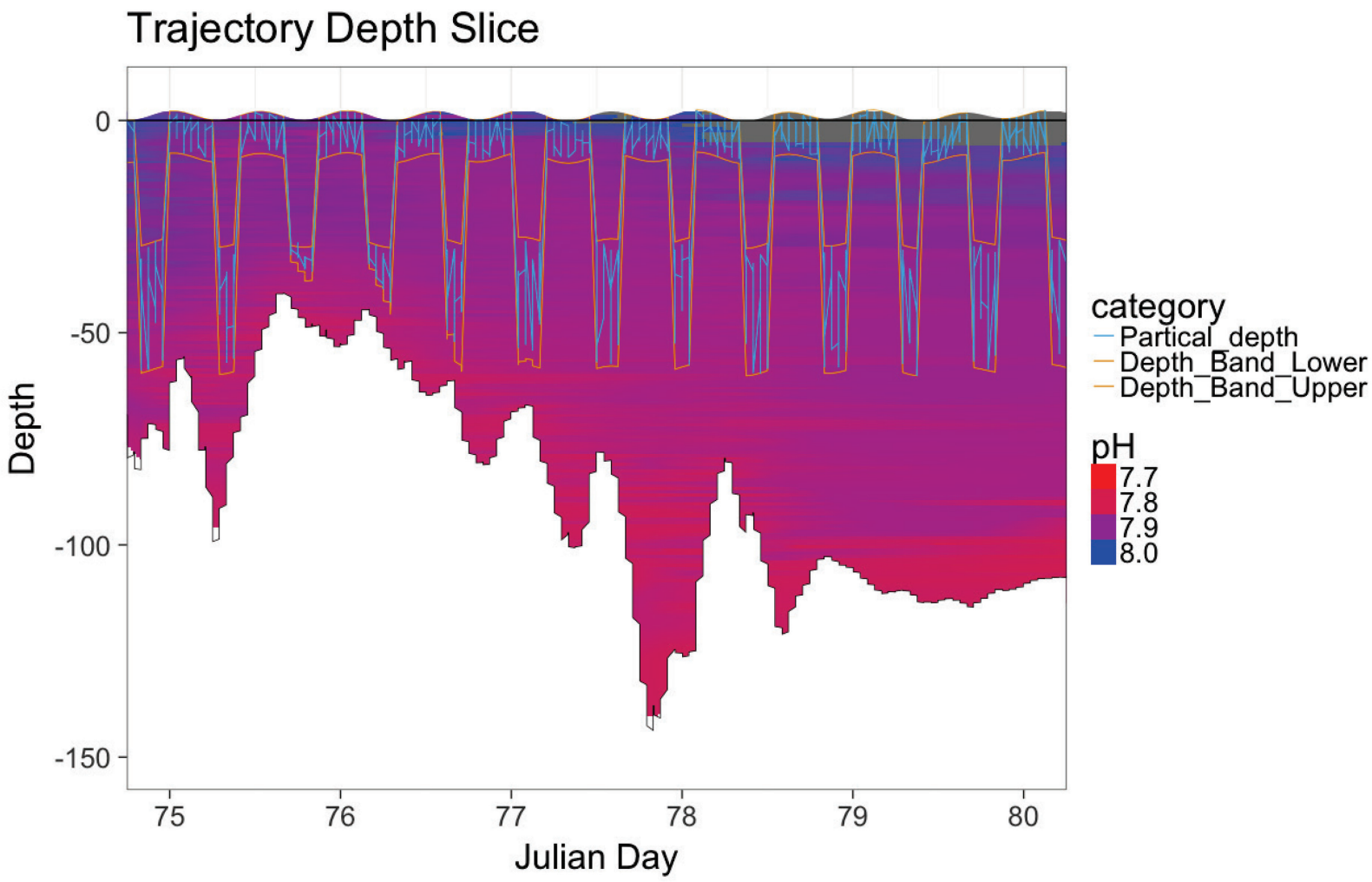


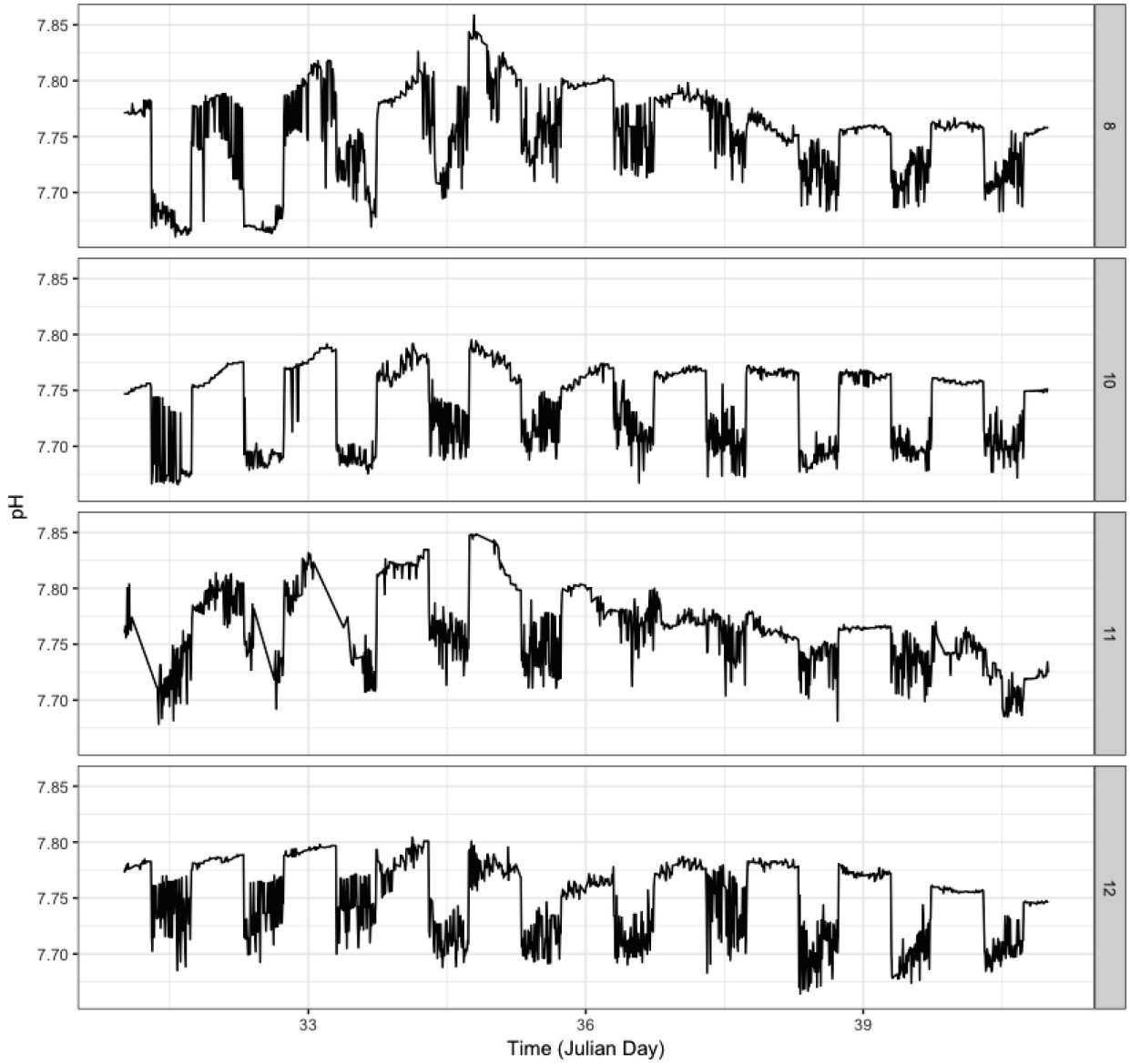
Dispersal from Ship Harbor



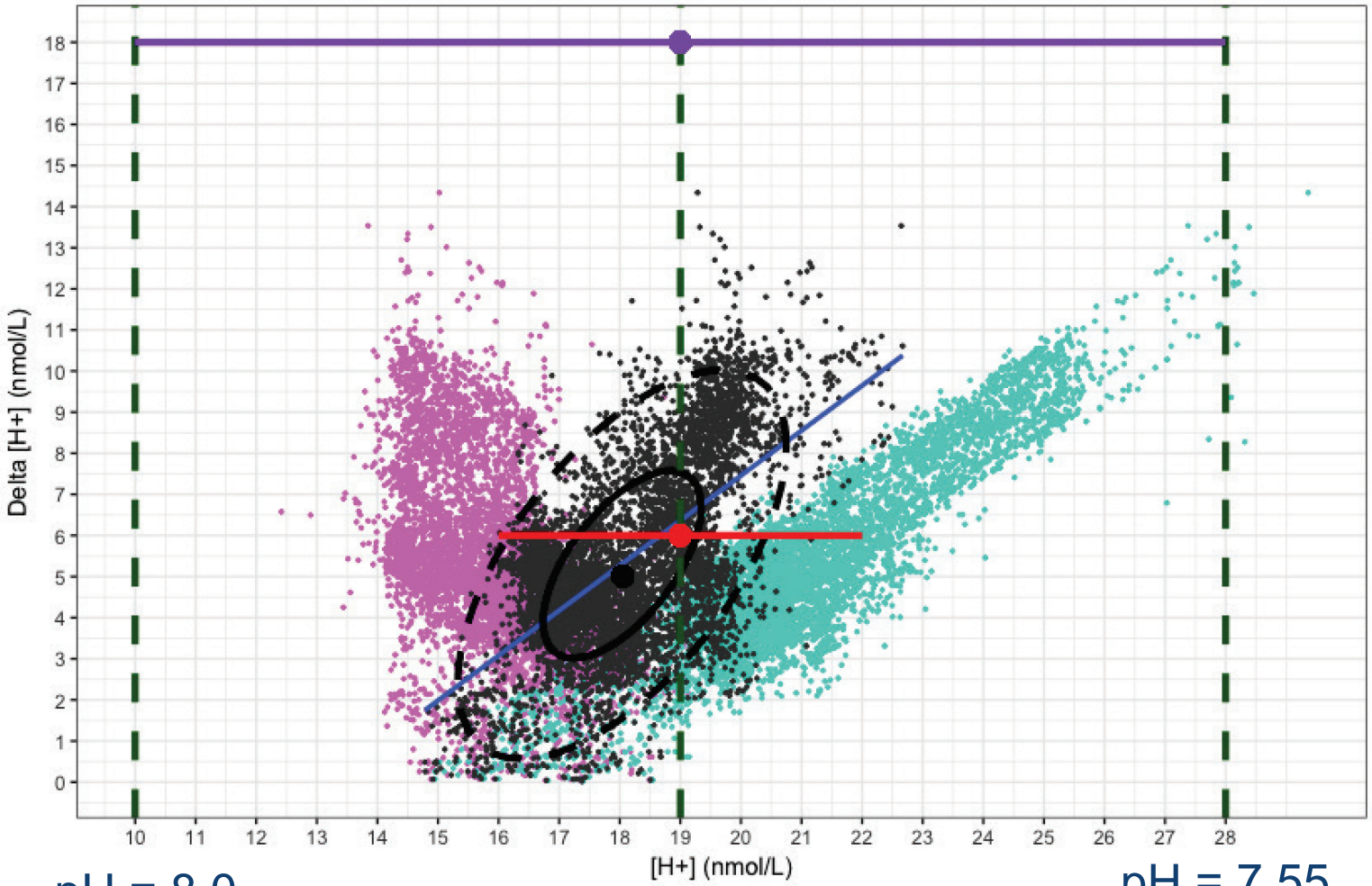
Crab Zoea on Edmunds Beach April 2017

Photo by Paul Briggs, City of Edmunds


Trajectory Depth Slice
0
-50
-100
-150
Depth
75
76
77
78
79
80
Julian Day
category
Partical_depth
Depth_Band_Lower
Depth_Band_Upper
pH
7.7
7.8
7.9
8.0


pH
7.85
7.80
7.75
7.70
8
10
11
12
33
36
39
Time (Julian Day)

Daily Range in [H+]



pH = 8.0

pH = 7.72

pH = 7.55

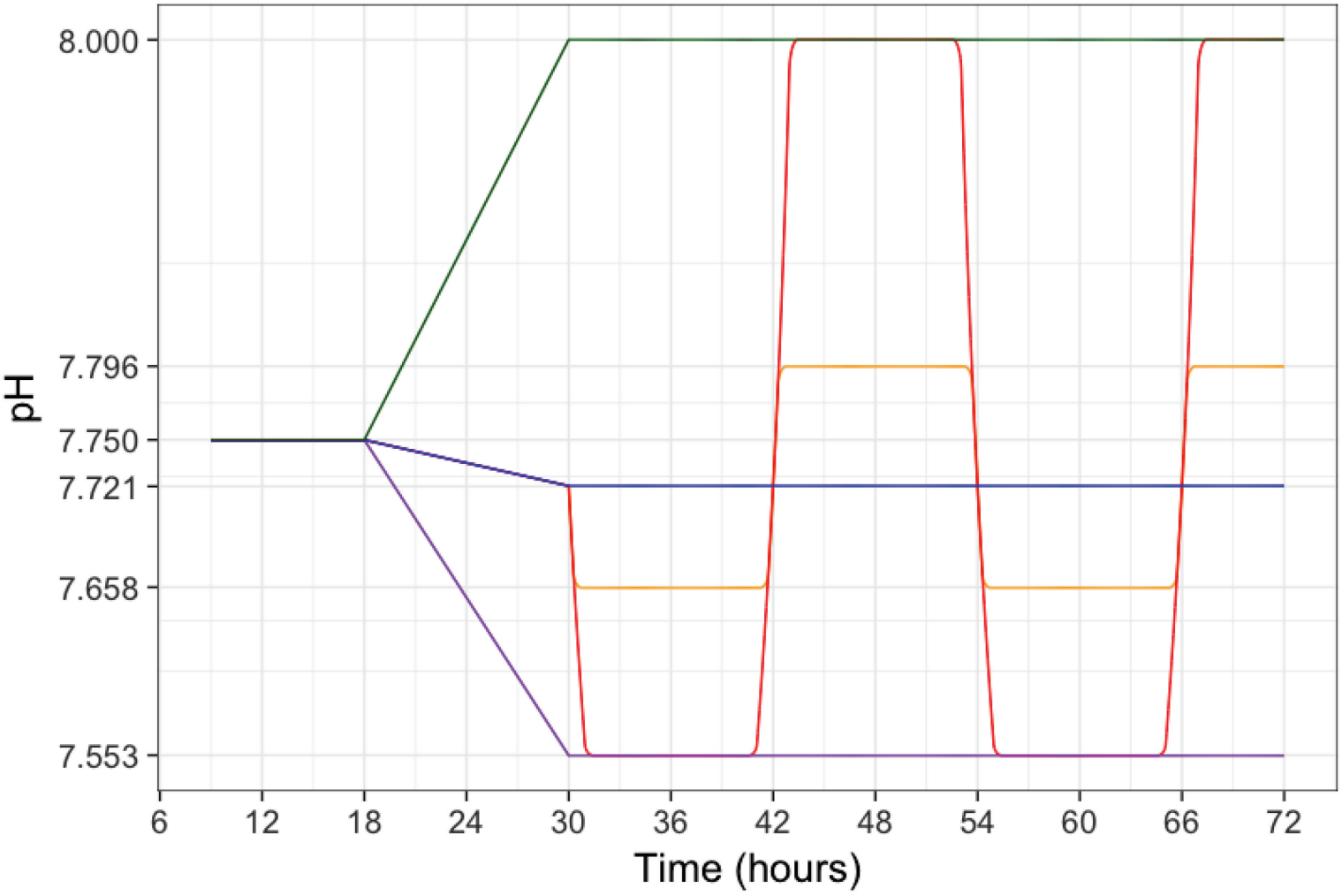
Hydrogen Ion Concentration

Pink = Daily Min

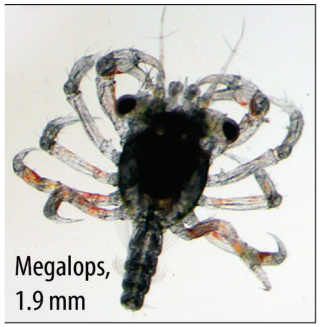
Pink = Daily Mean

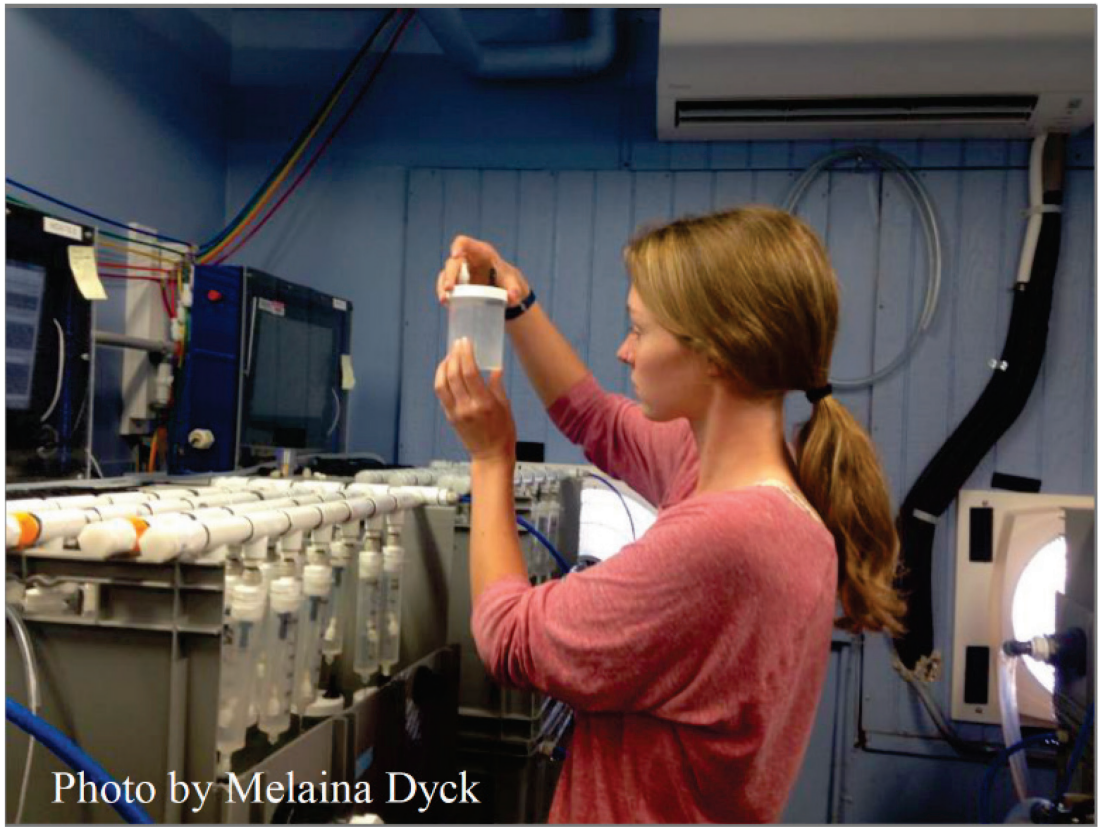
Pink = Daily Max

Experimental Fluctuating pH

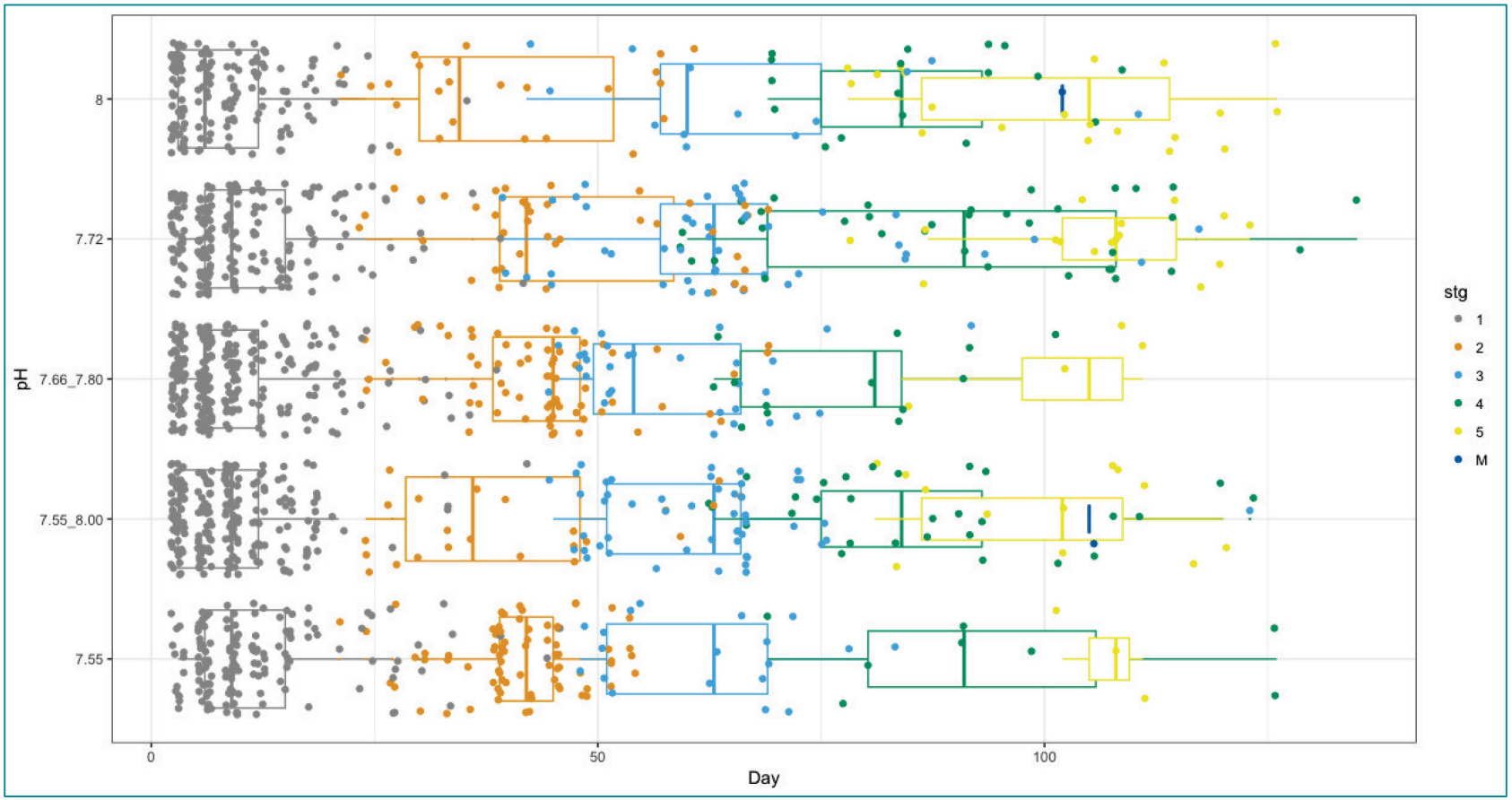


Fluctuating pH Experiment

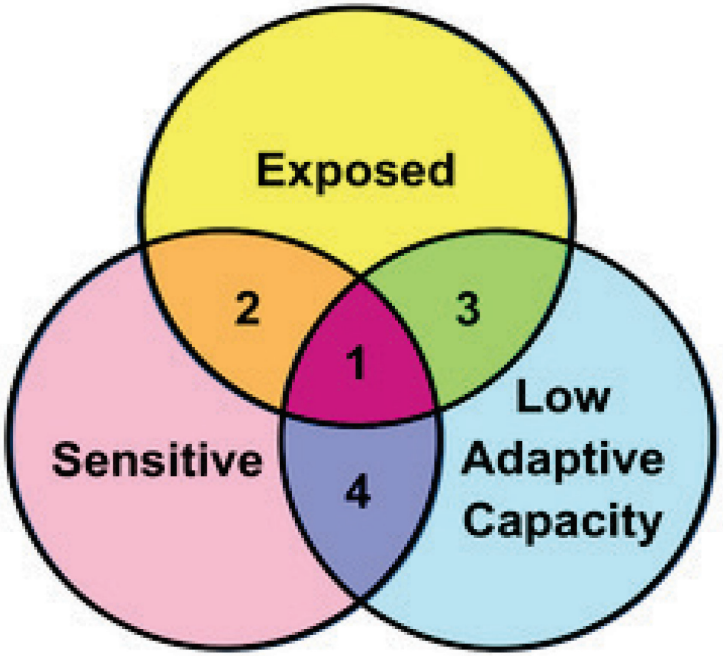


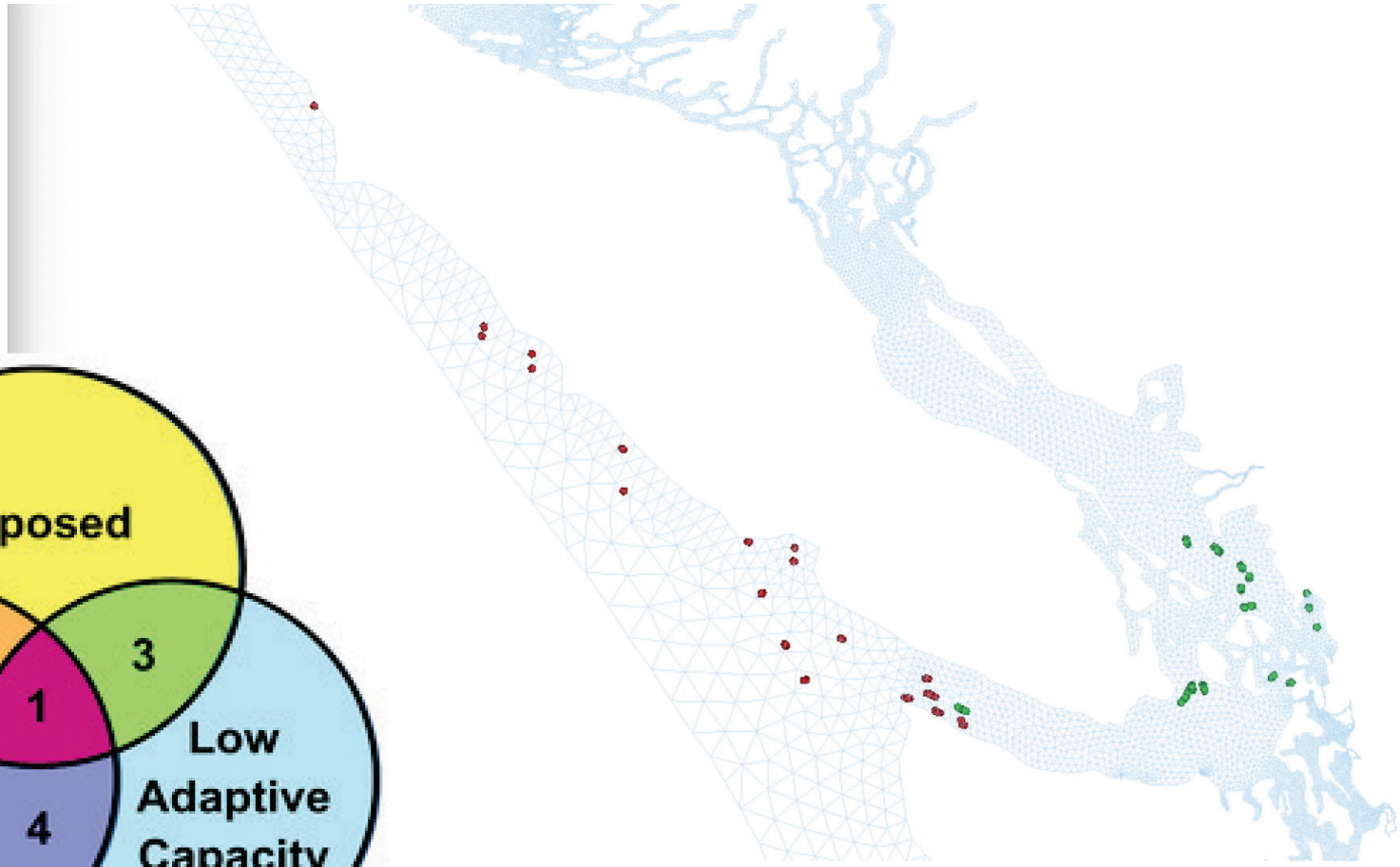


Zoea Development Stage in Fluctuating pH



SSM and Vulnerability Framework





Next Steps…

- Improved validation/tuning of carbonate chemistry
- Explicit forcing with future carbon
- Include more complex behavior (e.g. vertical decision making)
- User interface for plankton tracking