Workshop on the Effects of Ocean Acidification on shellfish

Organismal Perspective

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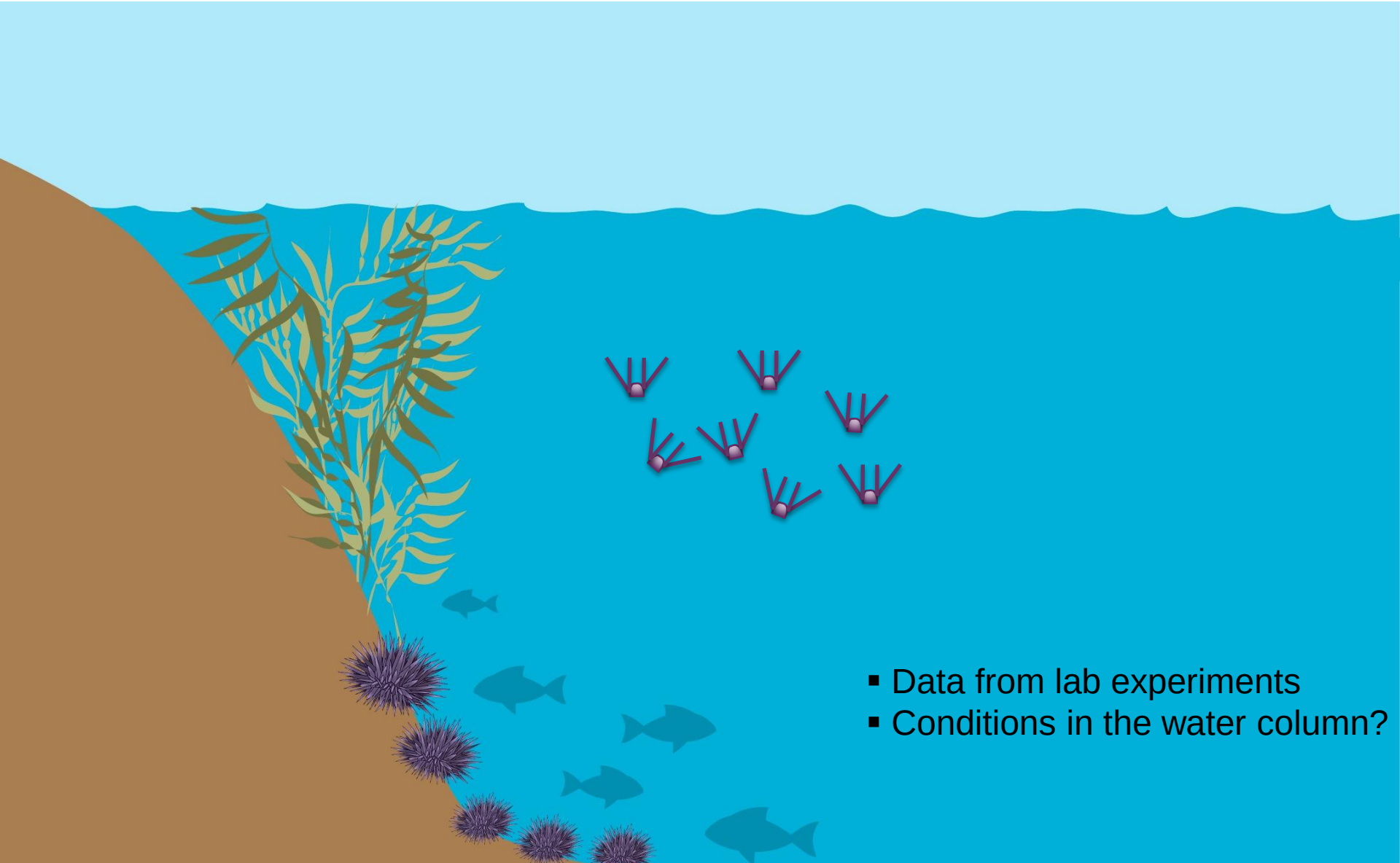
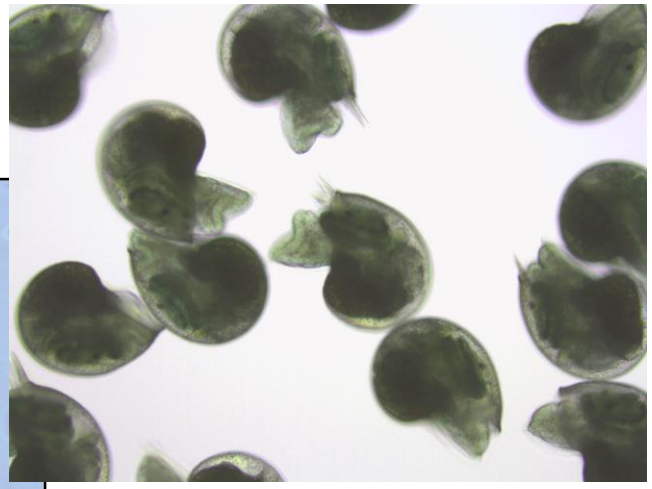
Outline of the Talk: Organismal Perspectives

1. A little bit about larval culturing & the lab set up
2. Data on research on invertebrate larvae
3. Update on some new directions & activities

Emphasis on early life history stages

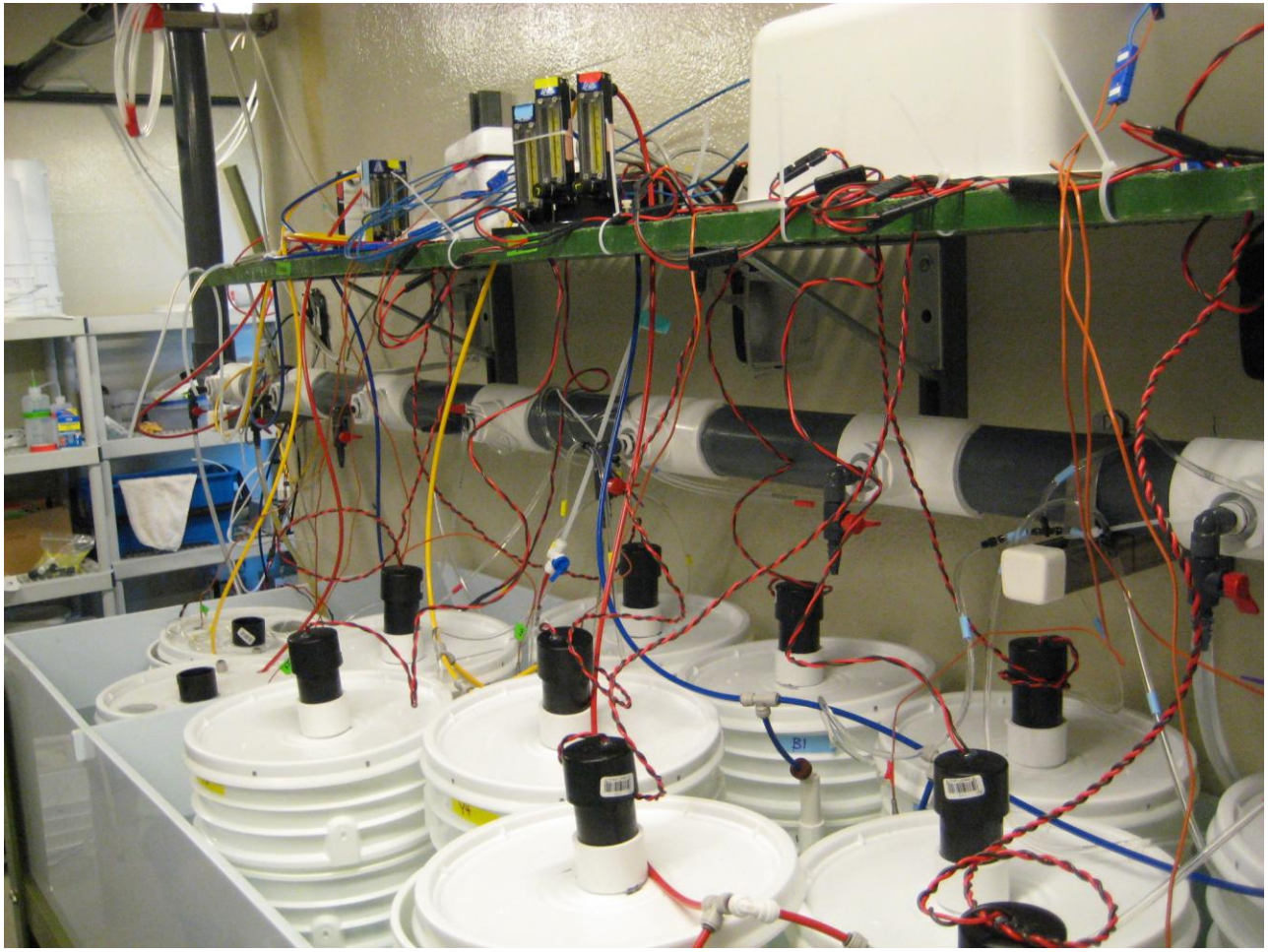


- Data from lab experiments
- Conditions in the water column?

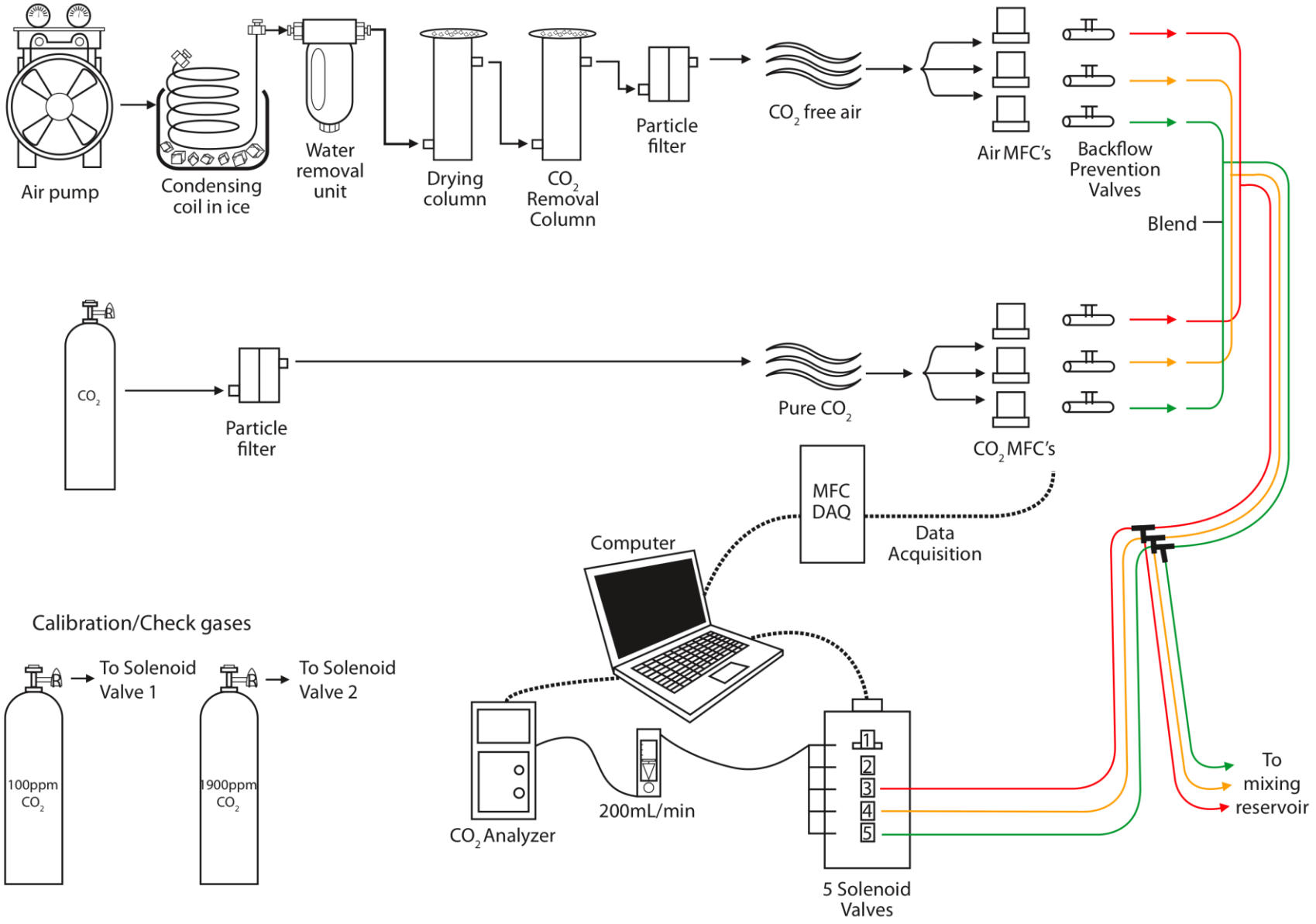


Vunerability of larval forms to variable pCO_2 waters?

Larval cultures raised in the lab @ UCSB

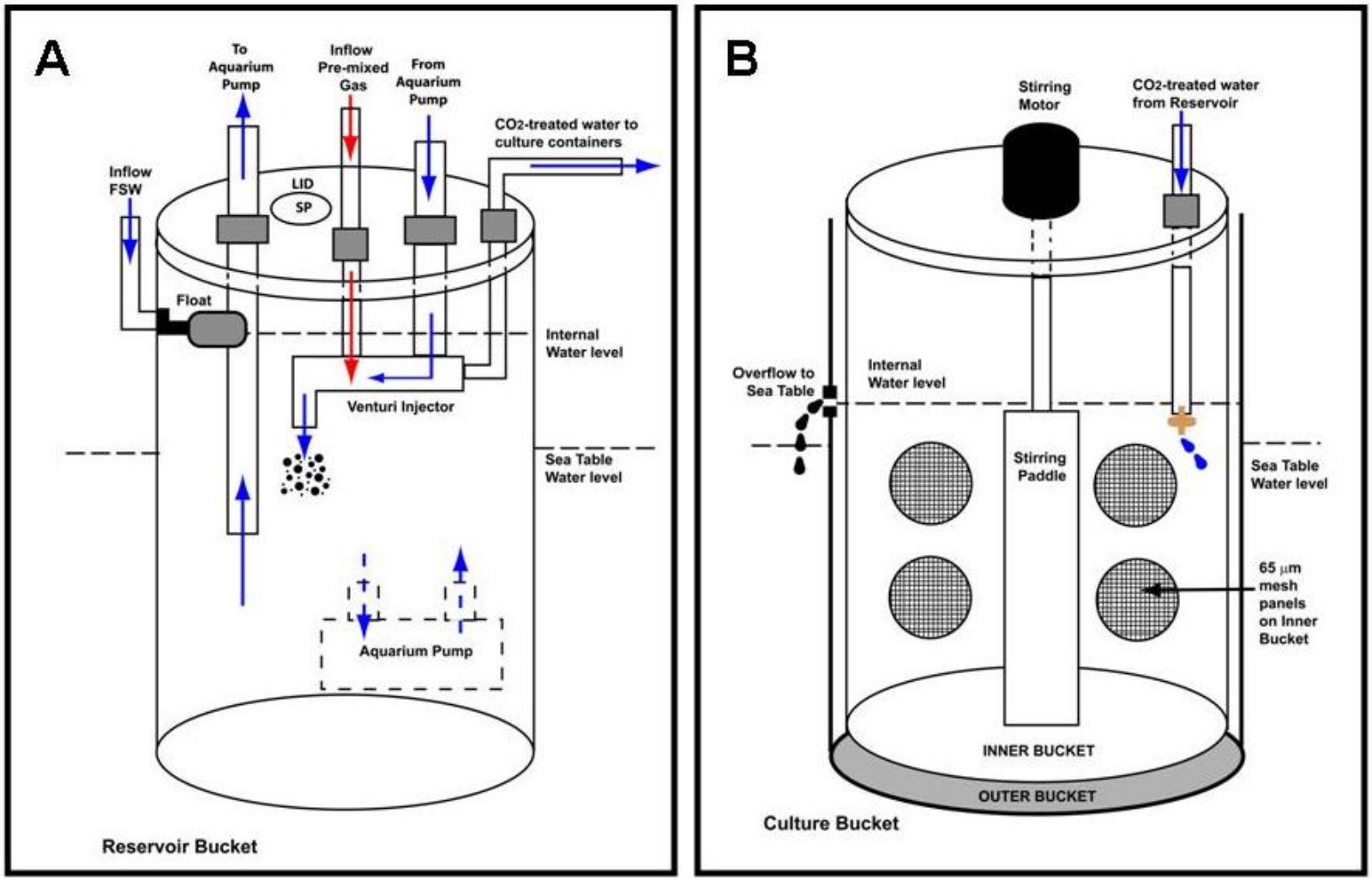


Design of CO_2 Mixing System



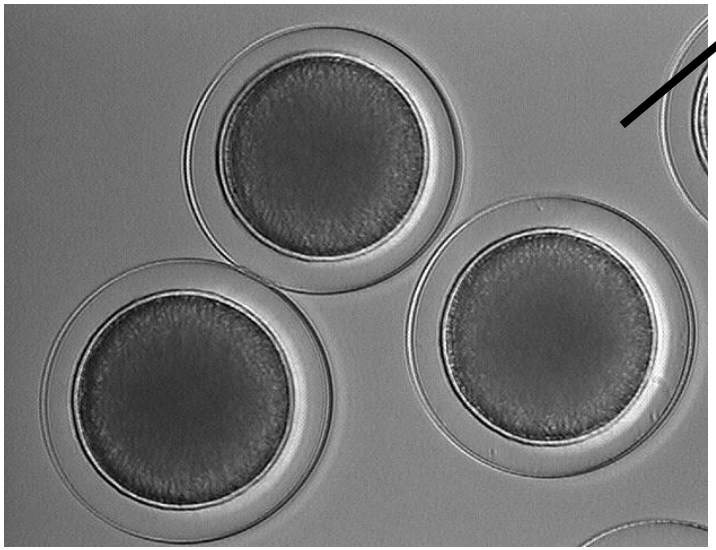
Fangue et al. (2010) *Limnol. Oceanogr.: Methods* (in press)

Design of Culture Buckets



Fangue et al. (2010) *Limnol. Oceanogr.: Methods* (in press)

Life cycle of a purple sea urchin



Control (380)	540 ppm	970 ppm

We go Old School

Morphometrics show **reduced** size of larval endoskeleton

Lytechinus pictus

O'Donnell et al (2010) *MEPS* 398: 157-171

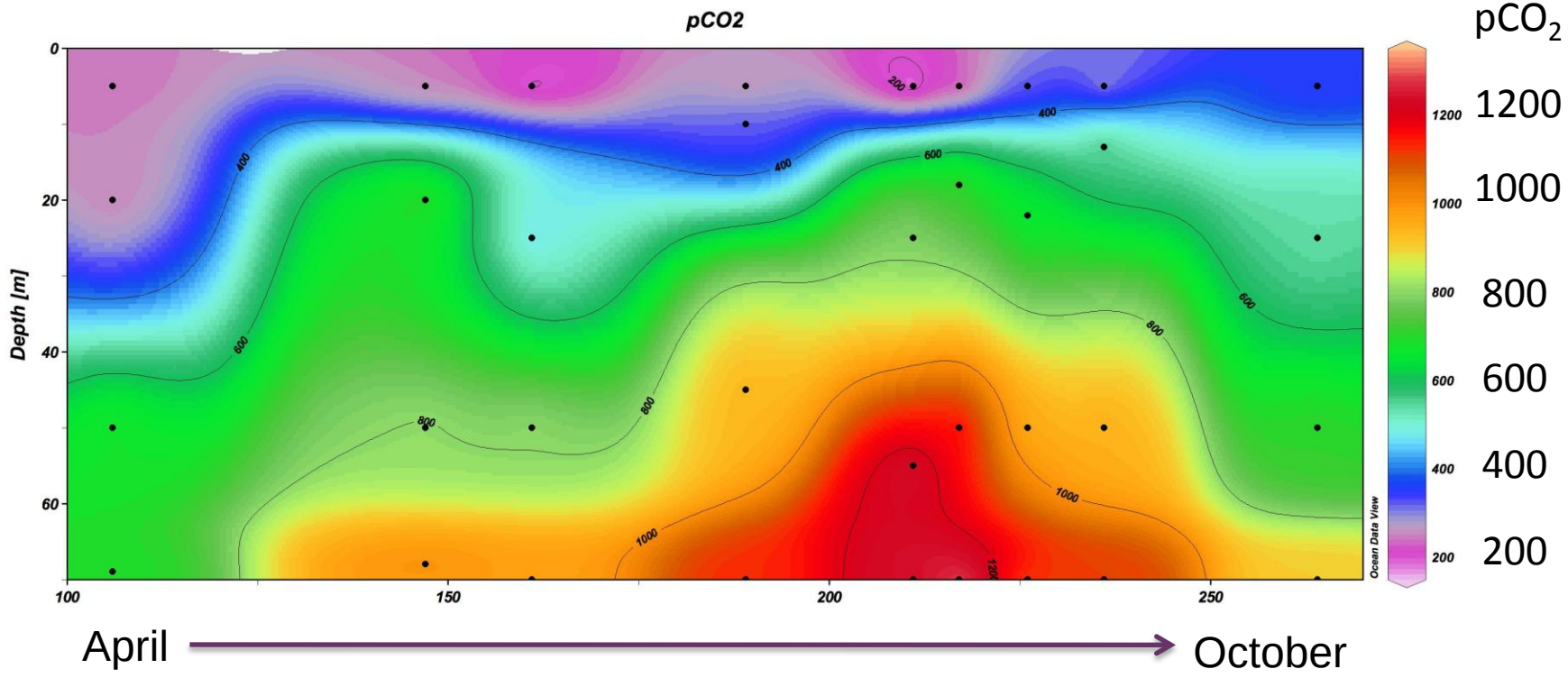
Total Skeleton after 48h of growth

380	540	970
	CO_2 (ppm)	

O'Donnell et al, (2010*) Mar. Ecol. Prog. Ser.* 398: 157-171

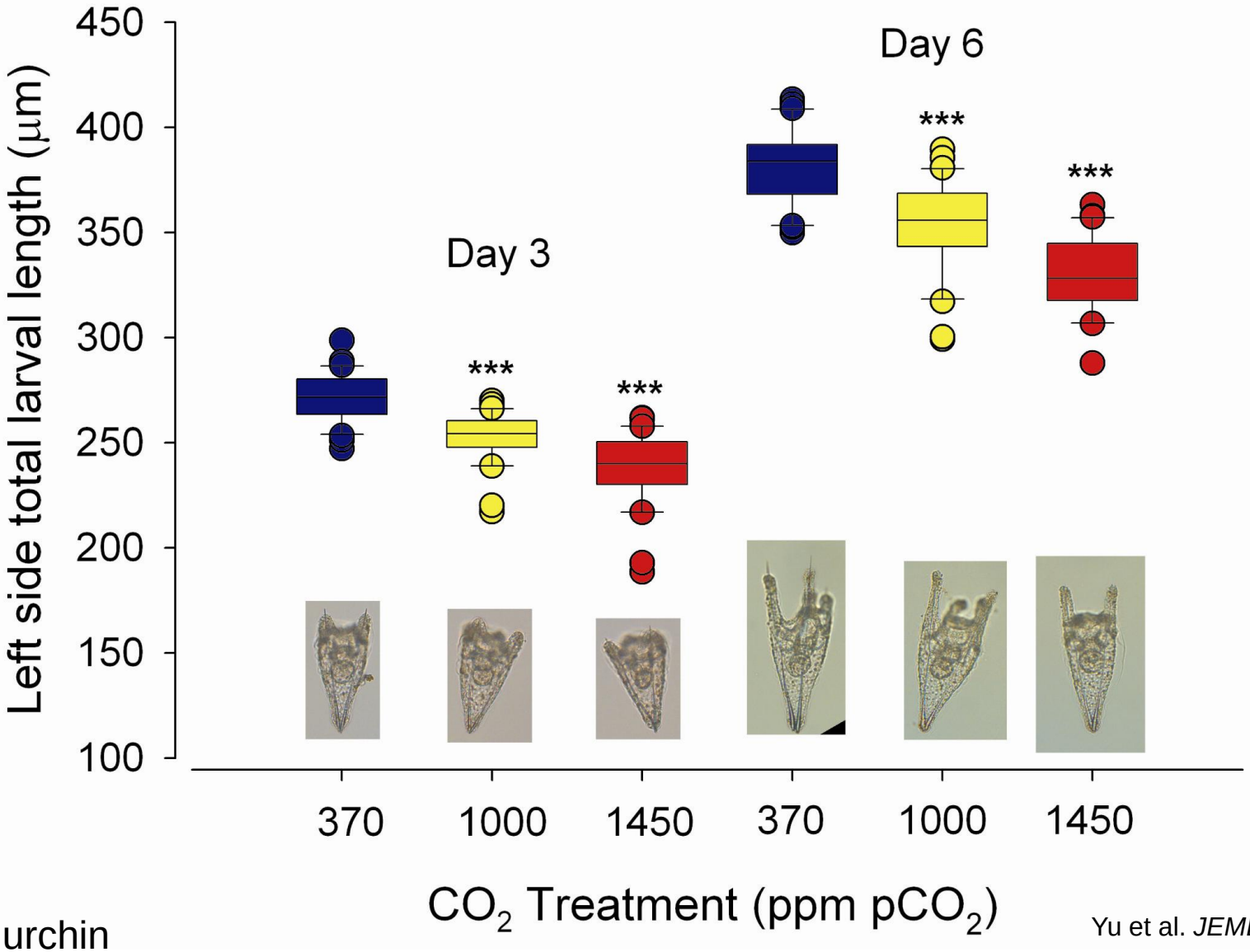
Environmental Conditions of Coastal Waters

- pCO_2 varies significantly



Data from the Oregon coast – courtesy of Drs. Francis Chan & Burke Hale

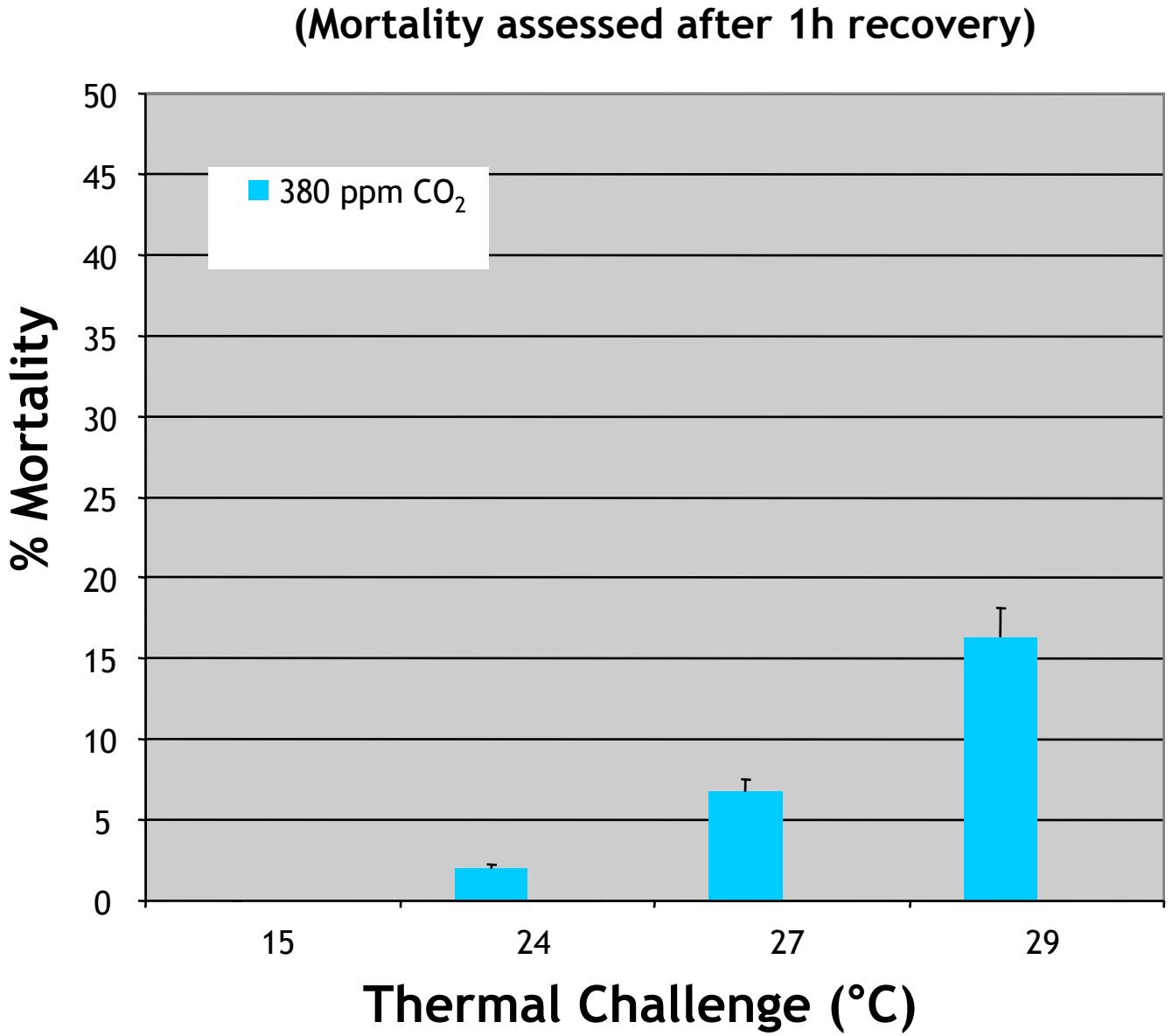
There is a maternal effect…



Purple urchin

Yu et al. *JEMBE (in prep)*

Thermal Challenge(1h) of 4-Arm Purple Urchins

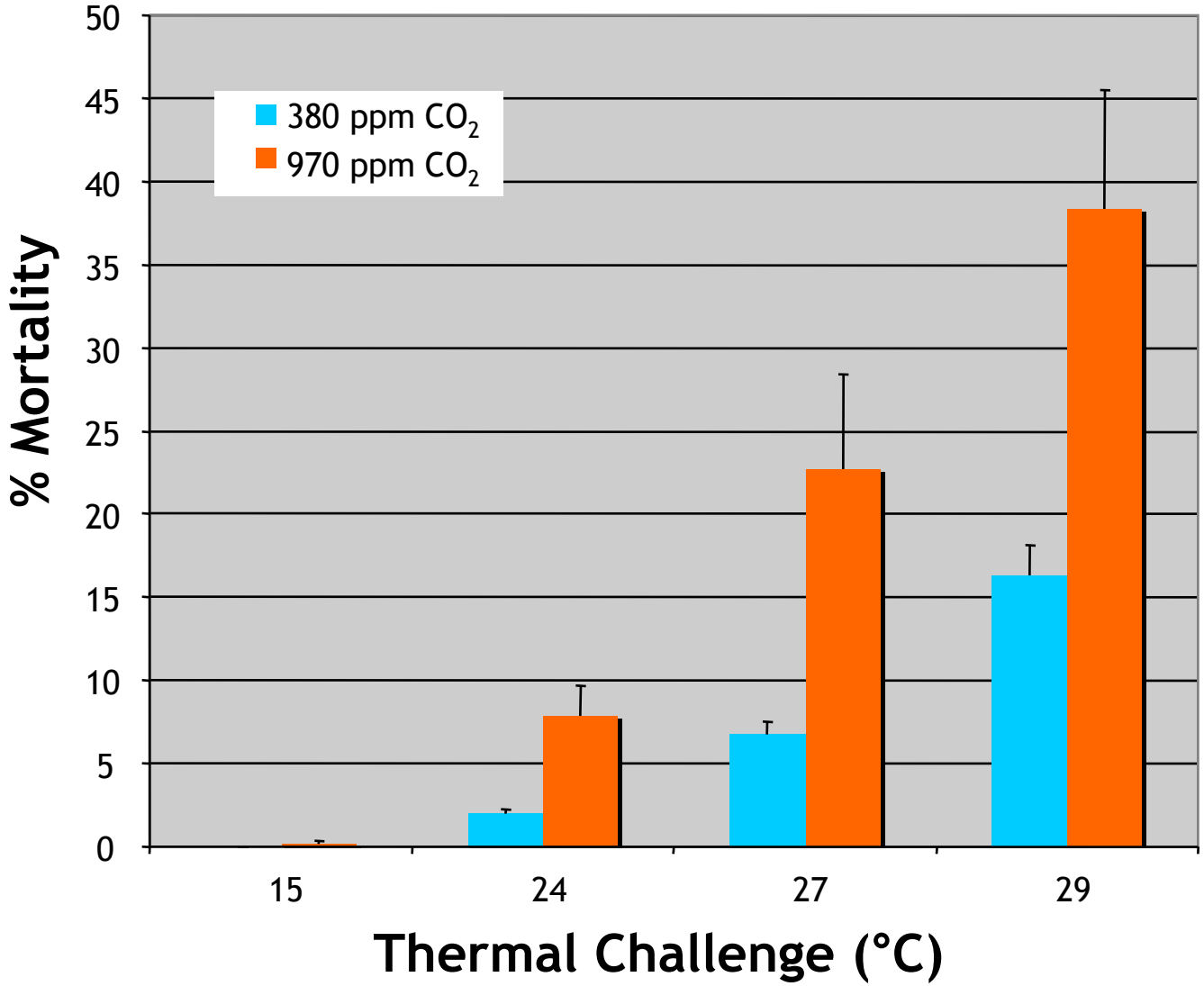


Dr. Nann Fangue
NSF Postdoc Fellow
Asst. Prof. UC Davis

Fangue & Todgham, unpubl. results

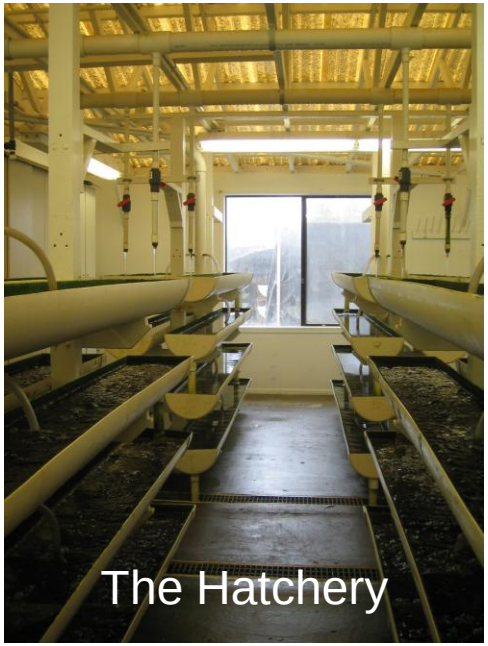
Thermal Challenge(1h) of 4-Arm Purple Urchins

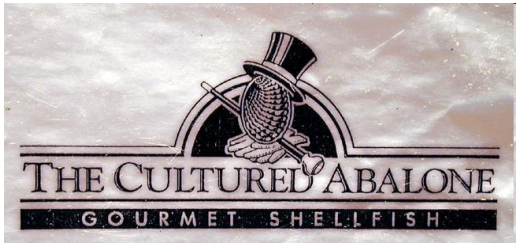
(Mortality assessed after 1h recovery)



Fangue & Todgham, unpubl. results

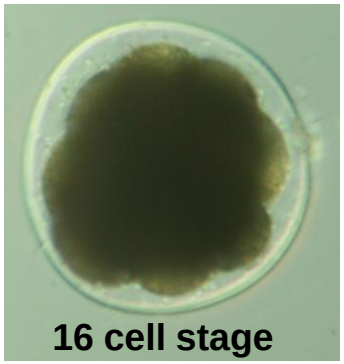
Abalone, Mackenzie & Ben



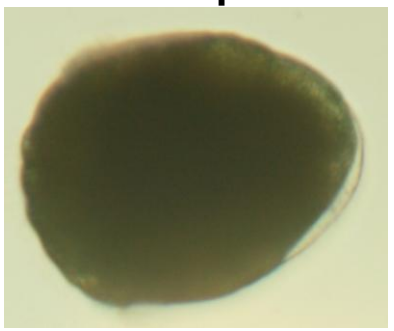


Abalone Life Cycle

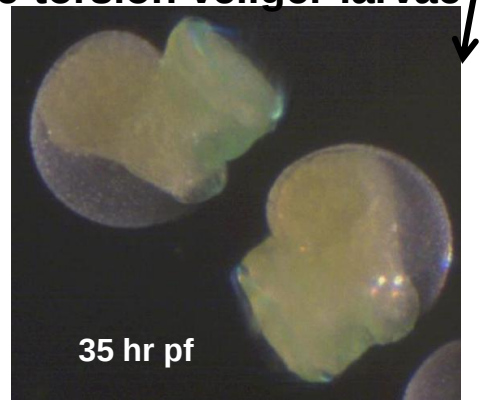
Red abalone - *Haliotis rufescens*



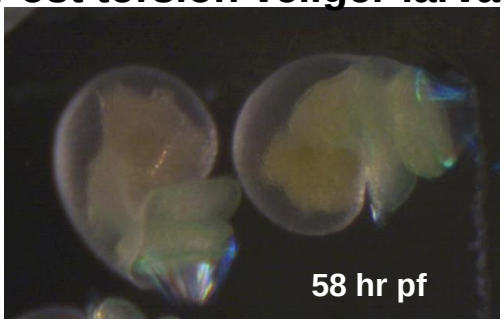
Trochophore



Pre-torsion veliger larvae

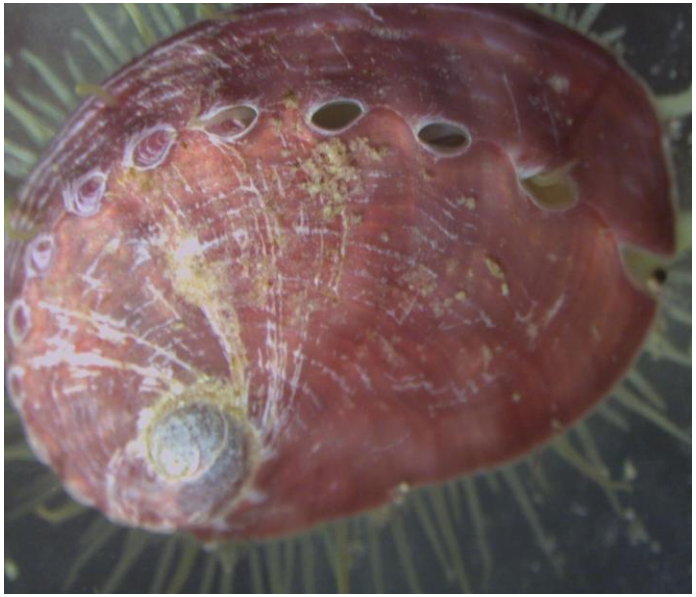


Post torsion veliger larvae



Pre metamorphic

Settled



Does CO_2 impact larval thermal tolerance?

Zippay & Hofmann (2010) *J. Shellfish Res.* 29:1-11

Methods

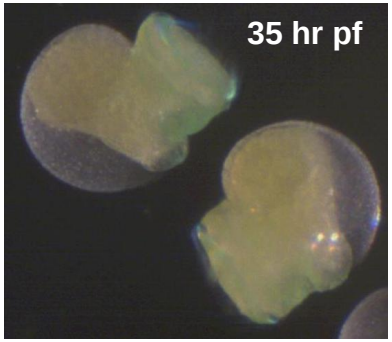
IPCC Scenarios (by 2100)

Present Day
380ppm
pH = 8.08

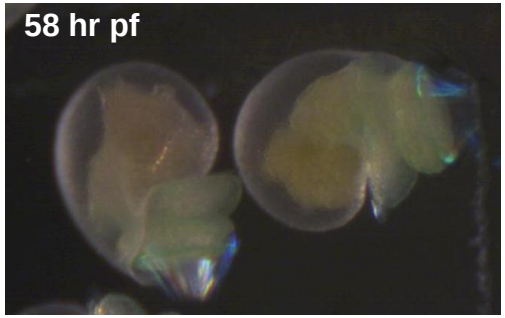
B1
570ppm
pH = 7.9

A1F1
990ppm
pH = 7.8

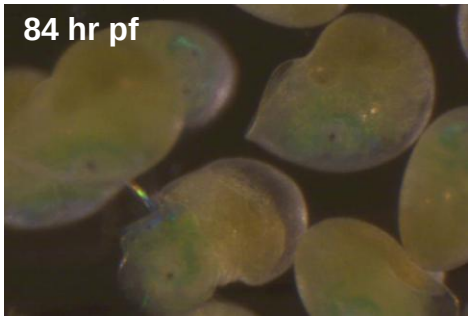
Sampling



Pre-torsion larvae

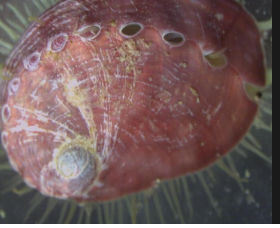


Post torsion larvae

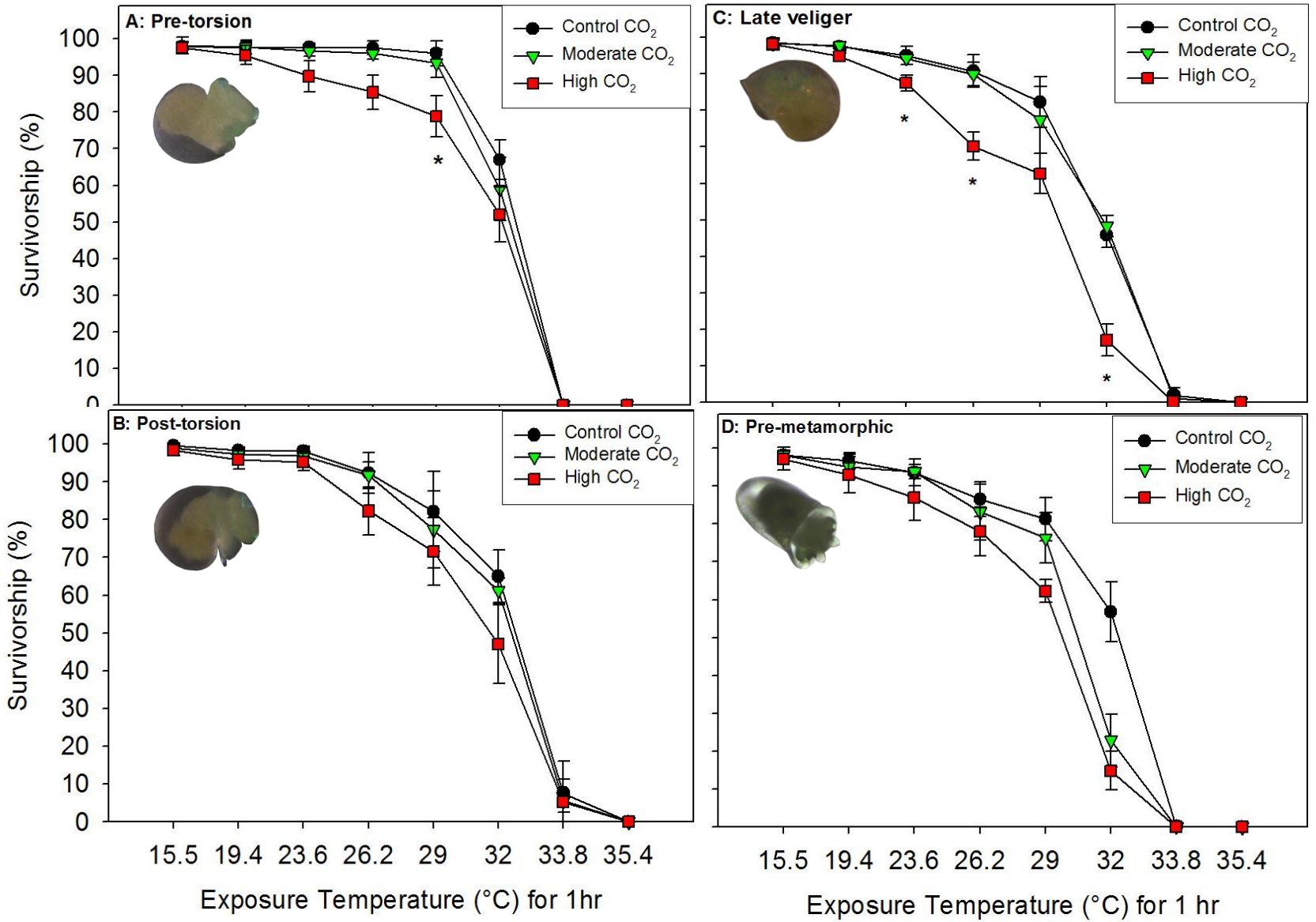


Late veliger larvae

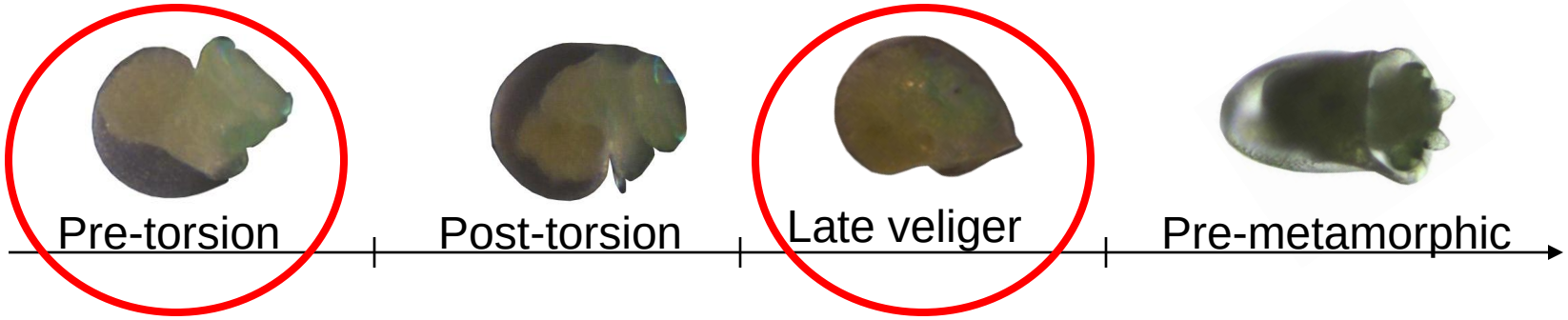
Pre metamorphic larvae



Survival Results



Summary of Survival Data



Two windows in development were sensitive

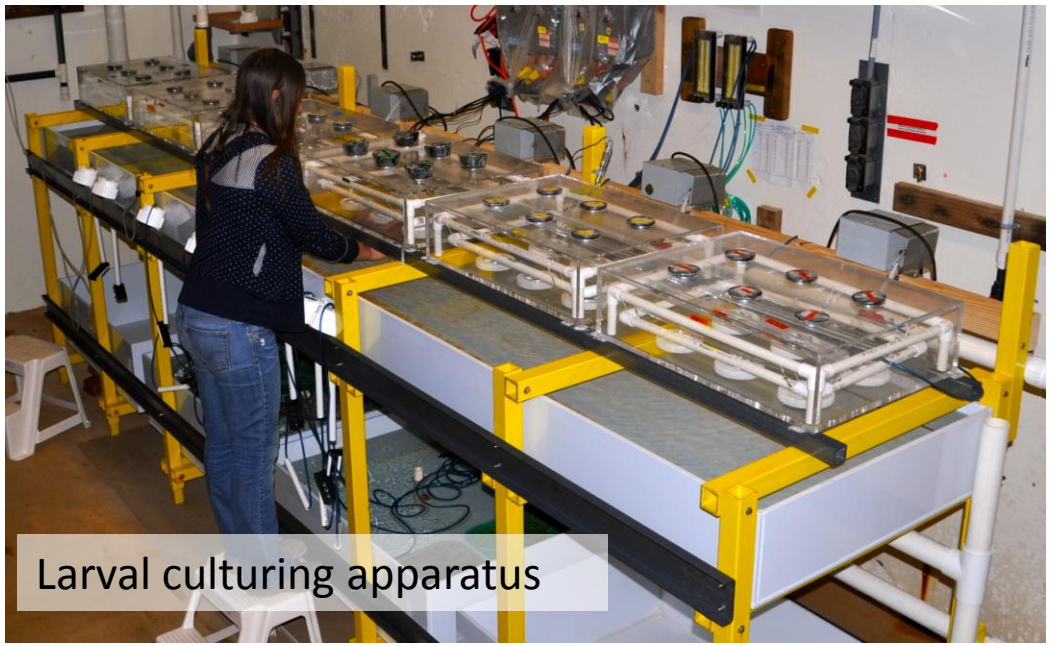
- **Stage specific differences in survival**
- **Within stages, CO_2 effect is not consistent**

Zippay & Hofmann (2010) *J. Shellfish Res.* 29:1-11

Adult oysters collected in Tomales Bay, CA

Adults held until larvae released (48hr)

Effects of elevated CO_2 on *Ostrea lurida* larvae and juveniles

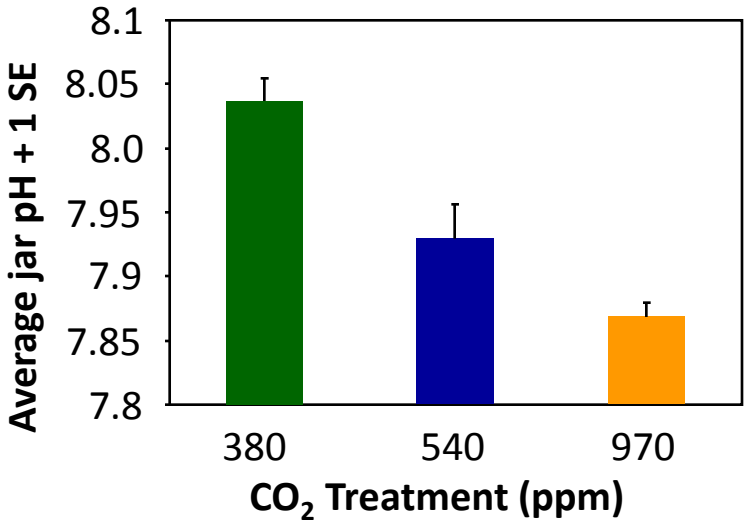

Larval culturing apparatus

pCO_2 levels

Control – 380 ppm

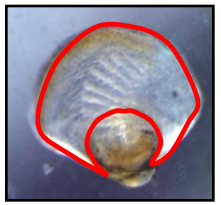
Elevated treatment 1 – 540 ppm

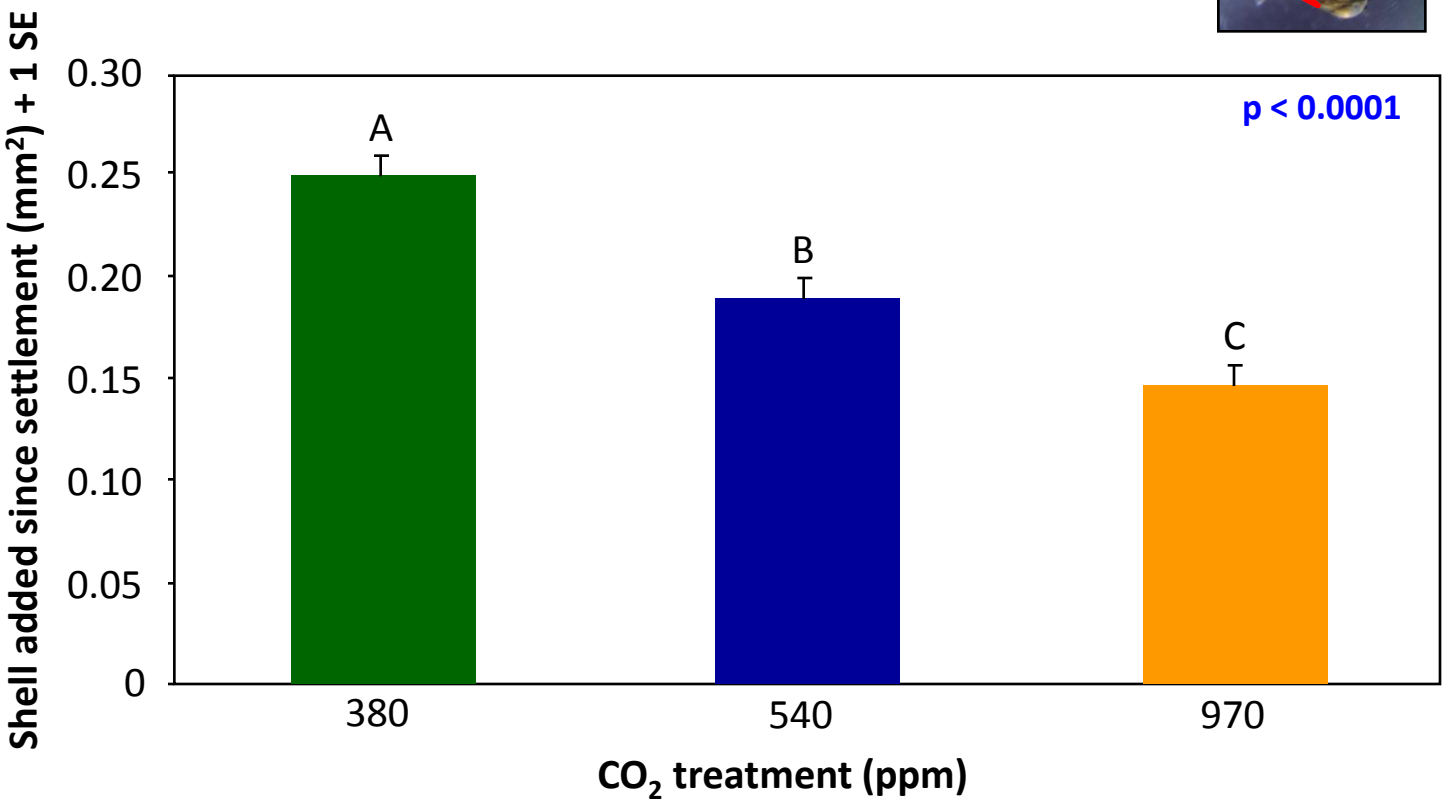
Elevated treatment 2 – 970 ppm



Effects of elevated CO_2 on *Ostrea lurida* juveniles

4-5 days later, juveniles had precipitated **42% less** shell area in 970 ppm relative to the control.





Data courtesy of Drs. Brian Gaylord, Eric Sanford, Tessa Hill

Thoughts & Future Directions

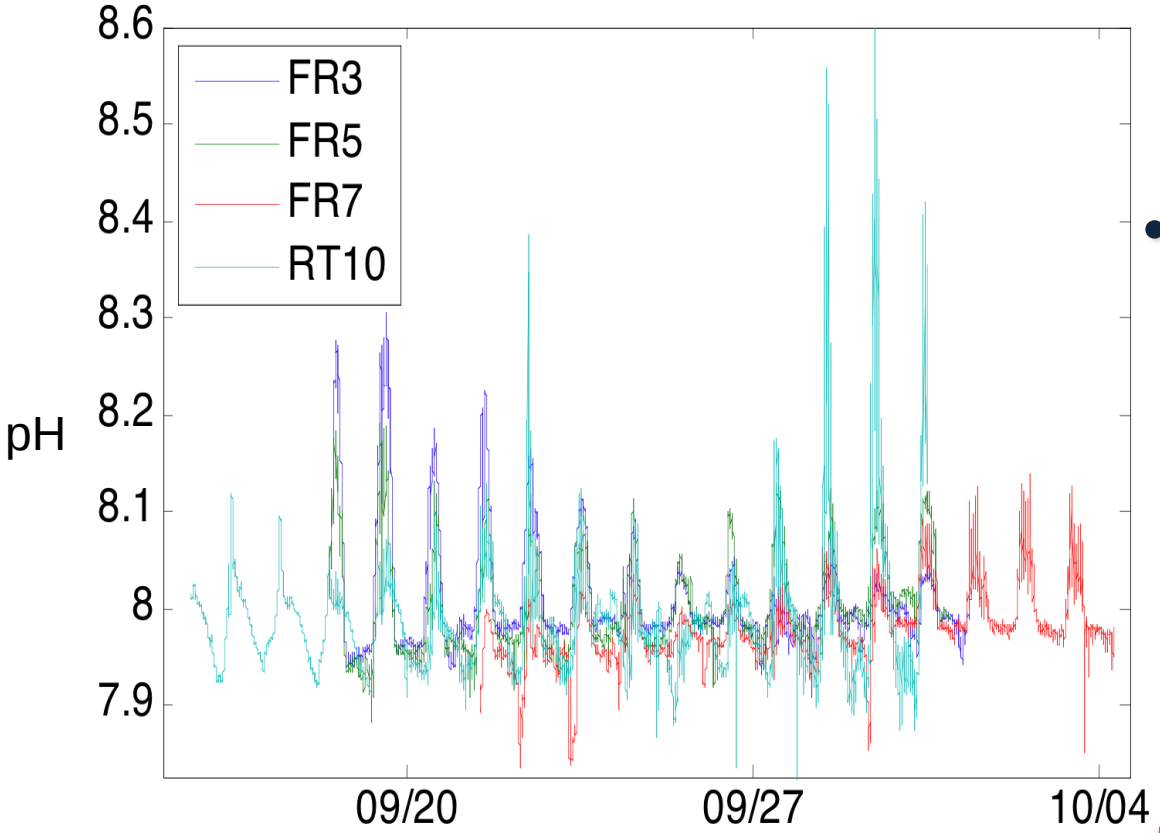
The Environment: Durafet™ loggers

Addressing local adaptation

Vulnerability, underpinnings of resilience/sensitivity

Todd Martz et al., 2010. *L & O: Methods*.

New technology: Durafet™ loggers



- **Natural variability of pH on a coral reef**
- **How will OA alter natural variability of pH?**

Data courtesy of Drs. Jennifer Smith & Todd Martz

Acknowledgments

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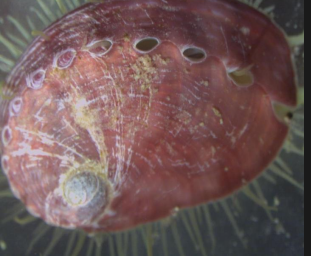

qPCR on *Biomin* genes

Gene Expression

No change in *engrailed* expression

↓ *ap24* expression with development

CO_2-acidified seawater did not influence the regulation of these two genes

Zippay & Hofmann (2010) *J. Shellfish Res.* 29:1-11