Living Resource Considerations for Instantaneous Minimum Dissolved Oxygen Criteria for Chesapeake Bay

Denise Breitburg
Smithsonian Environmental Research Center

Smithsonian Institution

Sea Grant Maryland

NOAA

Center for Sponsored Coastal Ocean Research

You don’t recover from death

Goals of Instantaneous Minimum Criteria

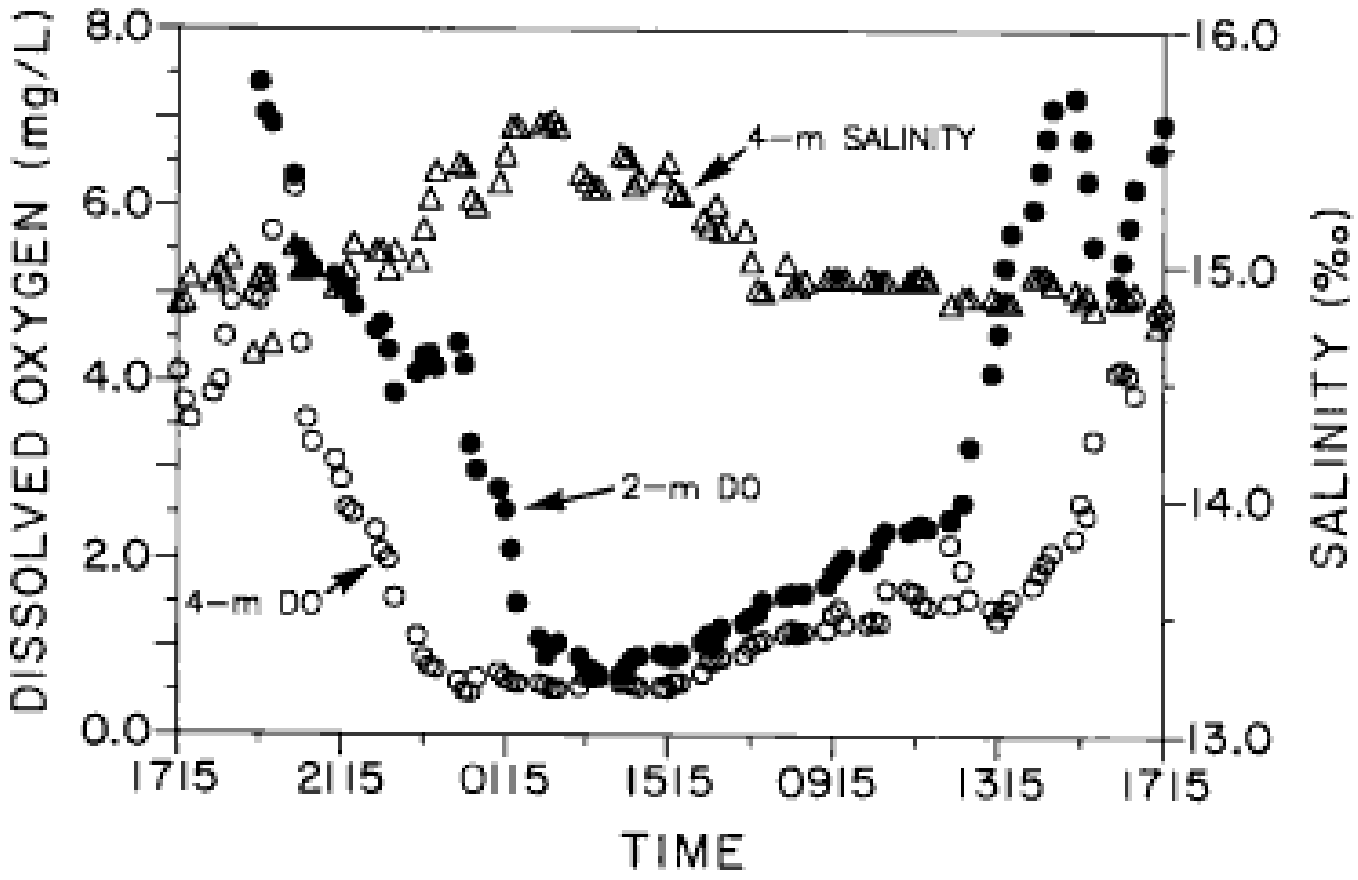
- acute mortality
- avoid averaging away real problems

You don’t recover from death

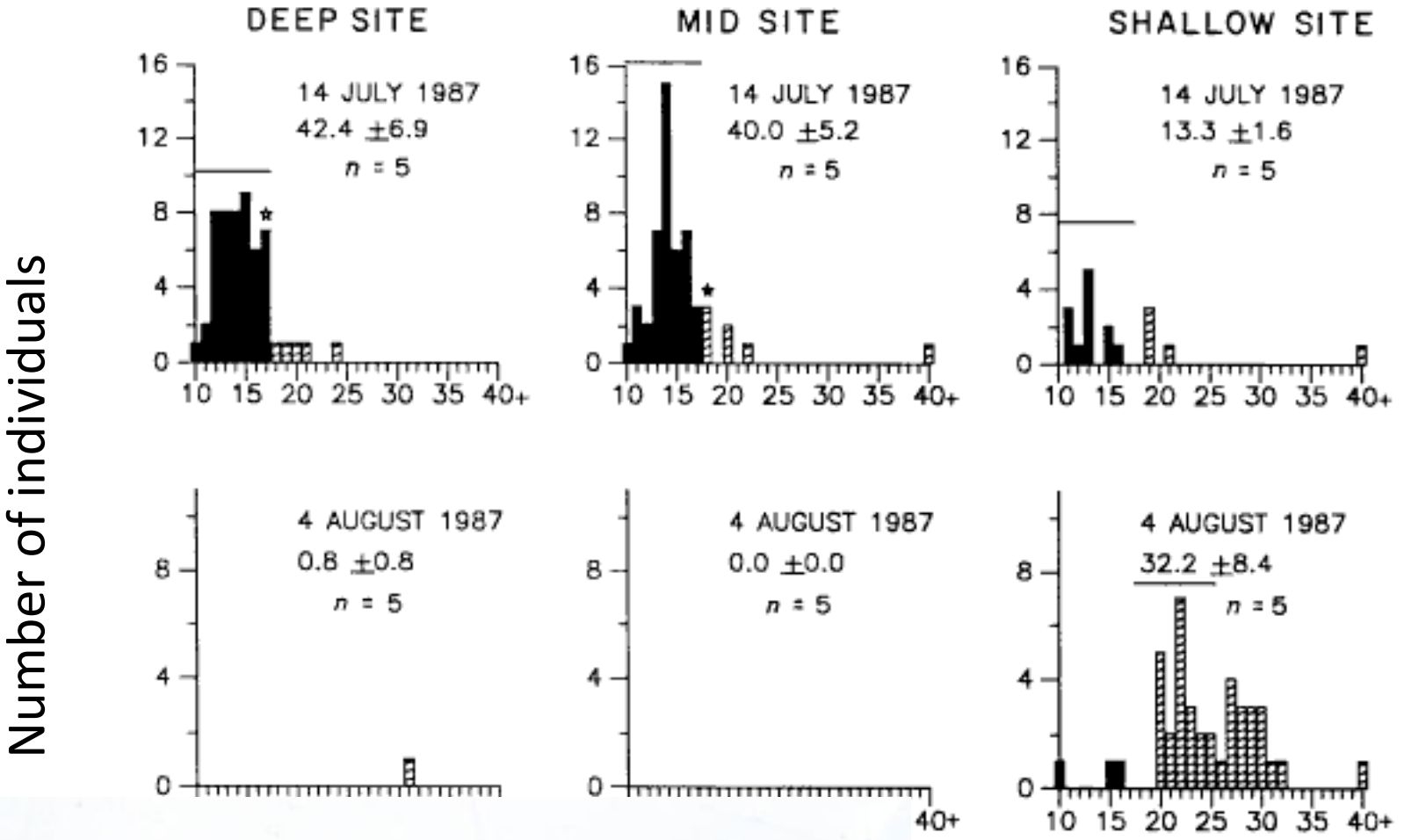
(Please humor me) – hold your breath

Short term exposure: (1) Wind/circulation-driven intrusions of deep water into shallow water habitat

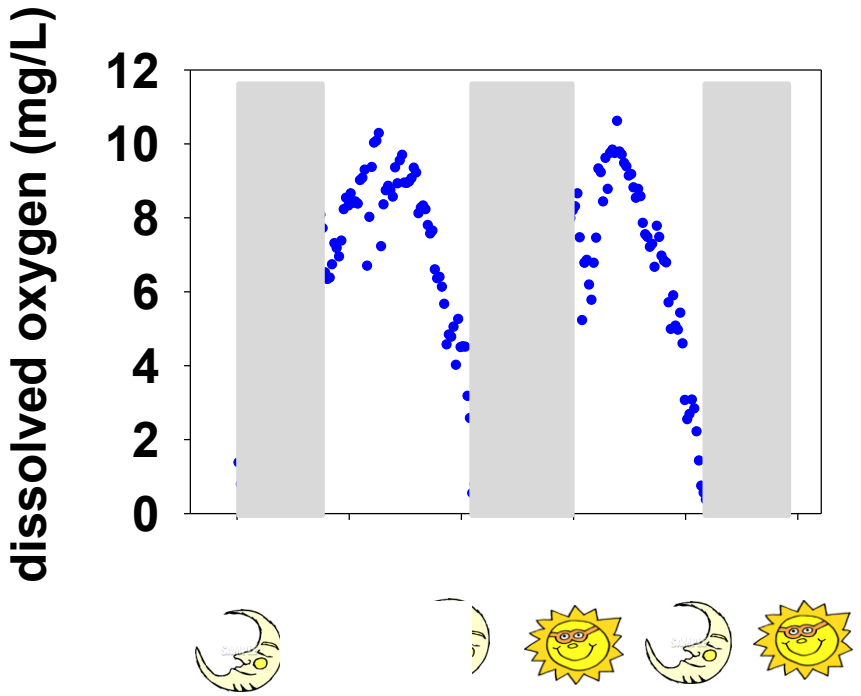
2 & 4 m dissolved oxygen near Calvert Cliffs



Breitburg 1992


DEEP SITE
MID SITE
SHALLOW SITE
Number of individuals
14 JULY 1987
42.4 ±6.9
n = 5
14 JULY 1987
40.0 ±5.2
n = 5
14 JULY 1987
13.3 ±1.6
n = 5
4 AUGUST 1987
0.8 ±0.8
n = 5
4 AUGUST 1987
0.0 ±0.0
n = 5
4 AUGUST 1987
32.2 ±8.4
n = 5
0
4
8
12
16
10 15 20 25 30 35 40+

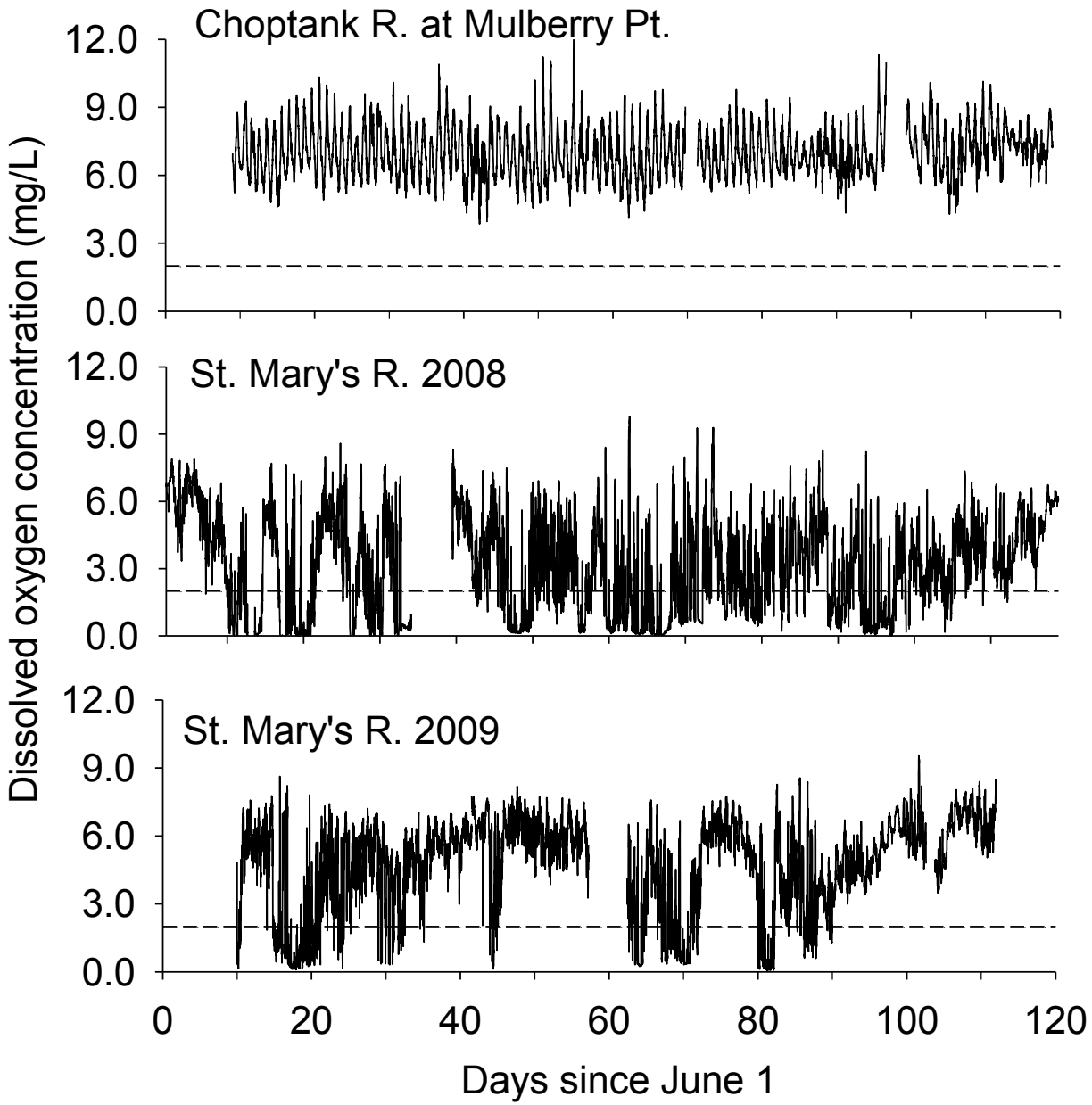
Short term exposure: (2) Diel-cycling hypoxia



Diel-cycling hypoxia

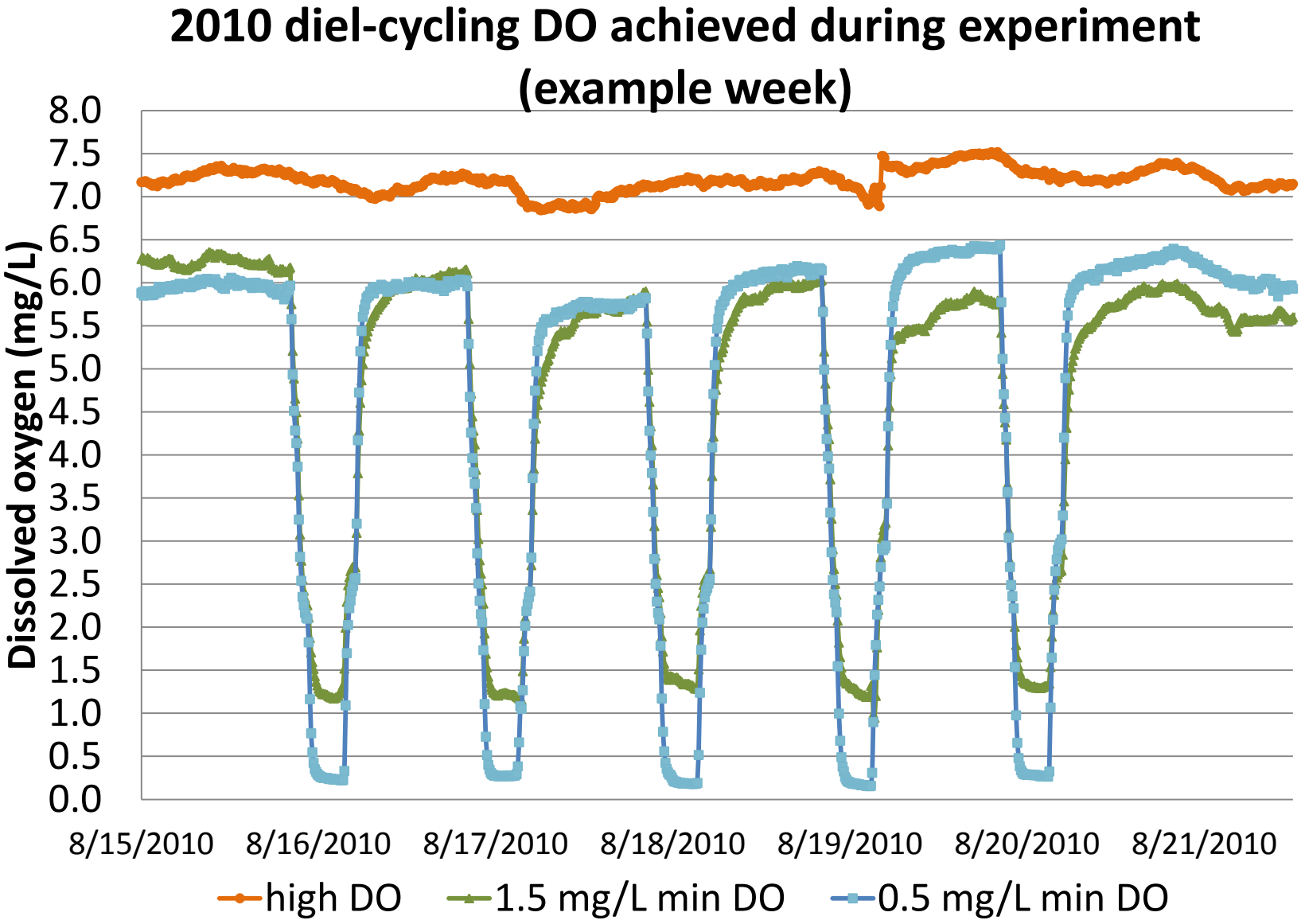
Fish kills

All 3 sites meet criteria based on averages

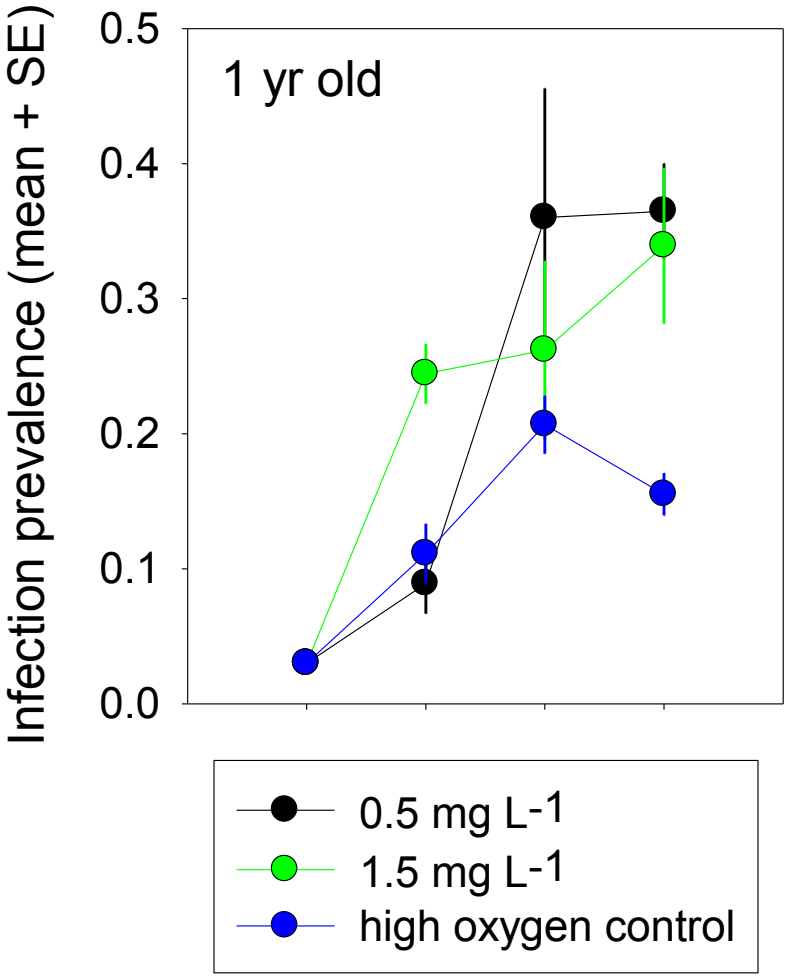


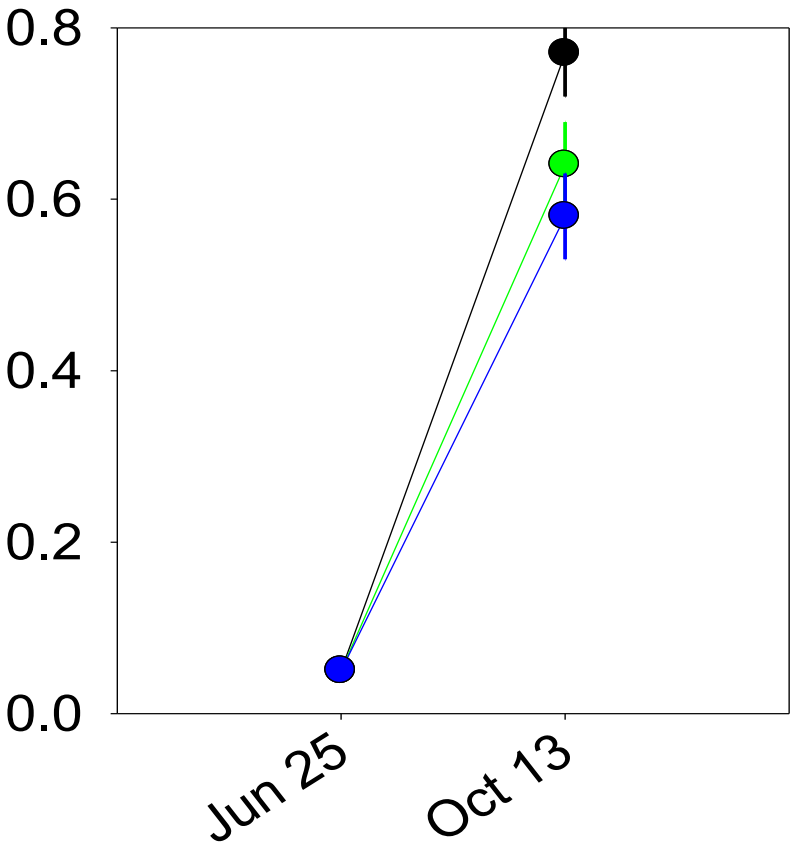
Diel-cycling hypoxia – repeated short term exposure can also lead to effects associated with chronic exposure to mild hypoxia

Perkinsus marinus (dermo) infections in oysters

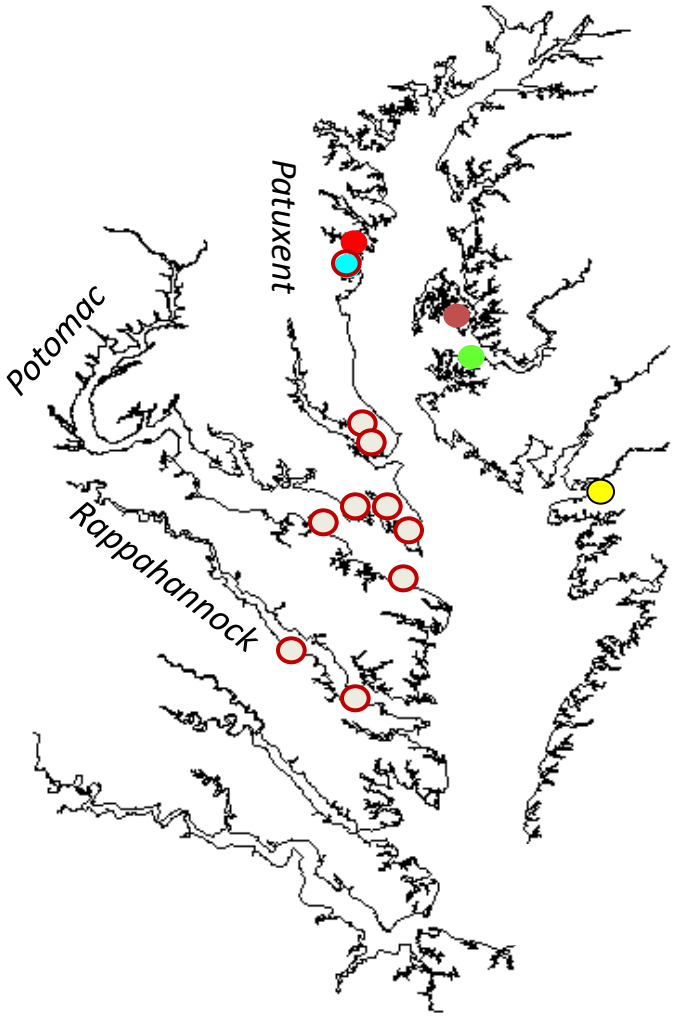

2010 diel-cycling DO achieved during experiment (example week)
Dissolved oxygen (mg/L)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
8/15/2010
8/16/2010
8/17/2010
8/18/2010
8/19/2010
8/20/2010
8/21/2010
high DO
1.5 mg/L min DO
0.5 mg/L min DO

Diel-cycling hypoxia increases acquisition of *P. marinus* infections in experimental oysters





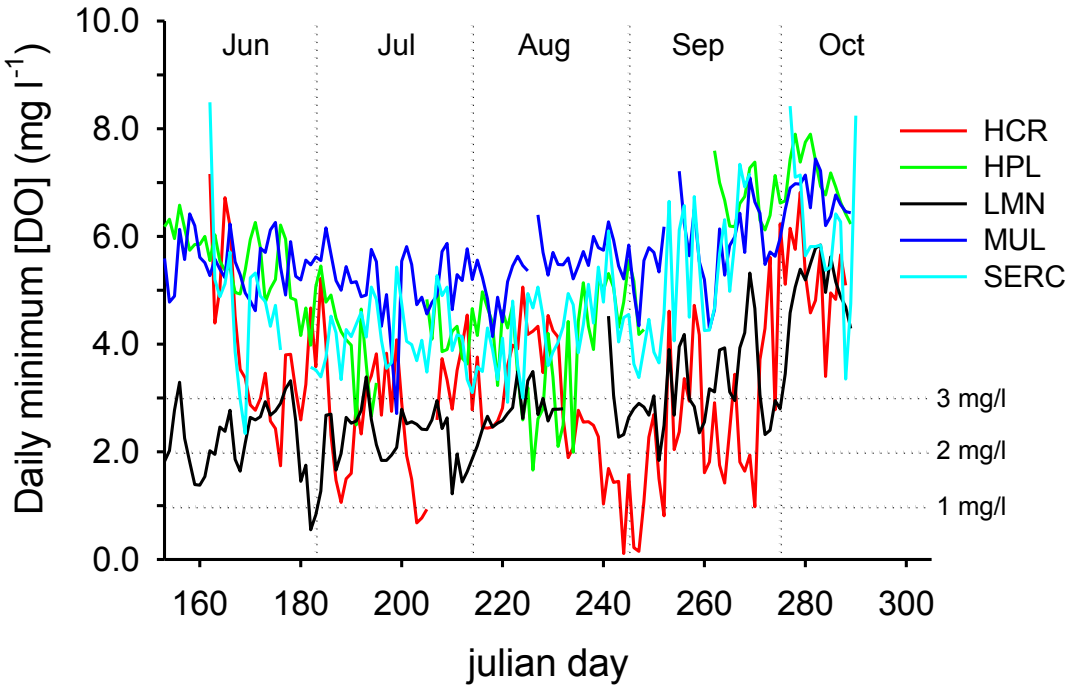
Field experiment (2008-09)



2008

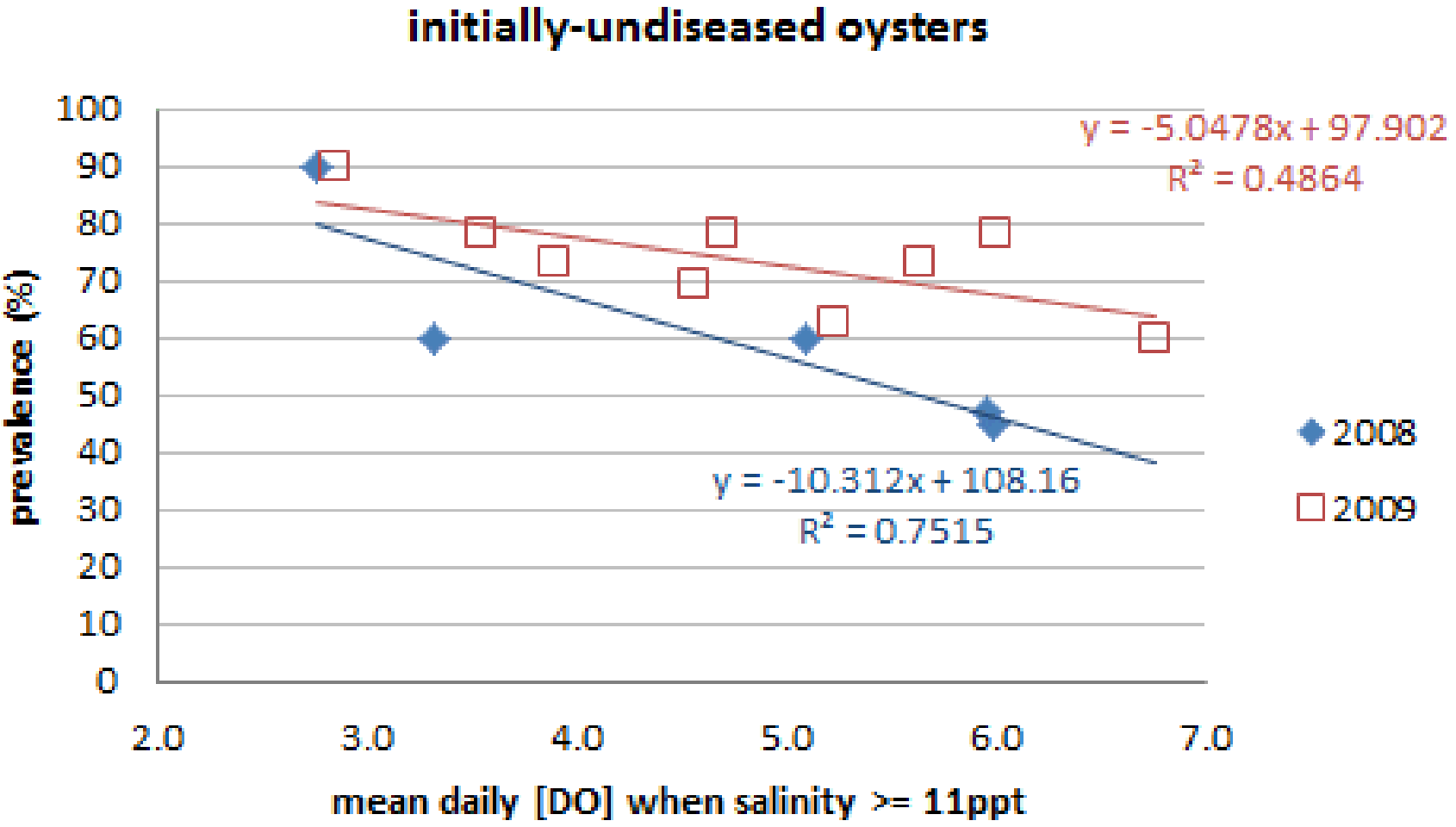
2009

Darryl Hodorp (USGS) , in prep

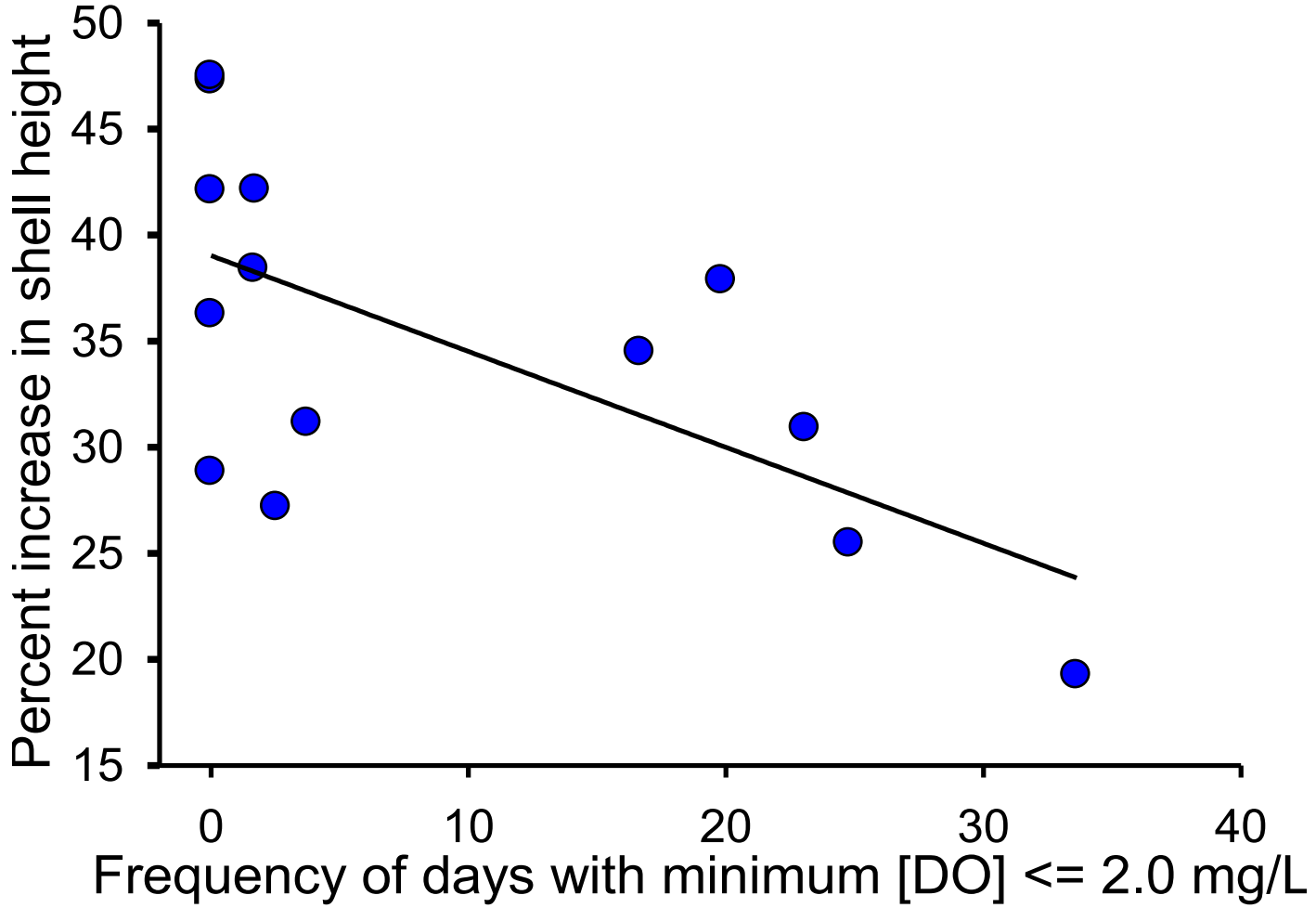


Increased disease Prevalence & intensity

	Prevalence	Intensity
1 yr olds:	P= 0.009 R^2 = 0.53	P= 0.02 R^2 = 0.44
2-3 yr olds:	ns	P= 0.014 R^2 = 0.51



Decreased growth



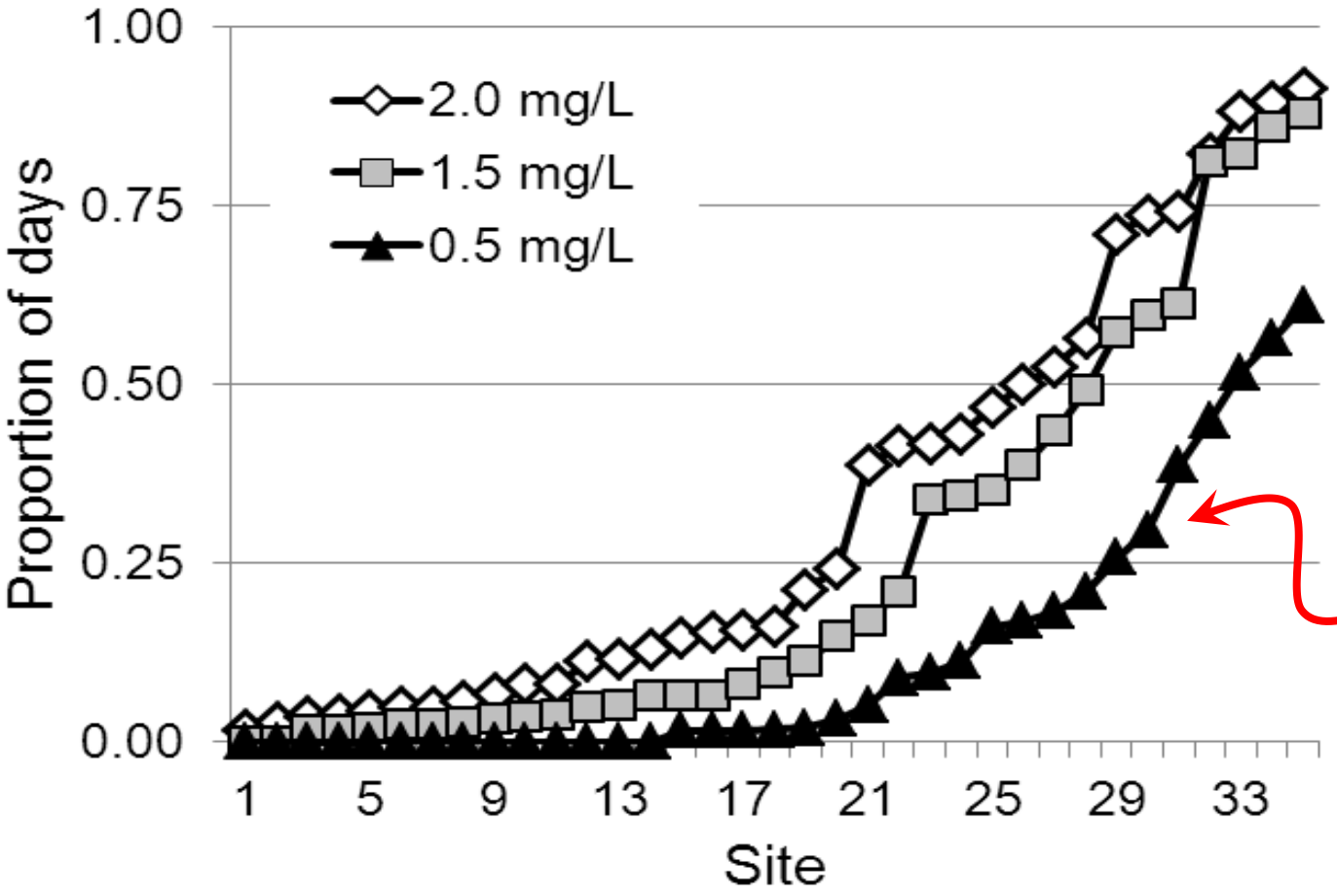
Effects	Lab	Field
New infections	X	X
Progression in 1 yr olds	X	X
Progression in older oysters		X
Growth		X

Exposure time vs hypoxia severity – Rainbow trout tested at 12-15oC

	>95% mortality	>95% survival
1 h	0.7	1.5
24h	1.6	3.5

Seager et al. 2000

Frequency of hypoxia near bottom in <2 m of water

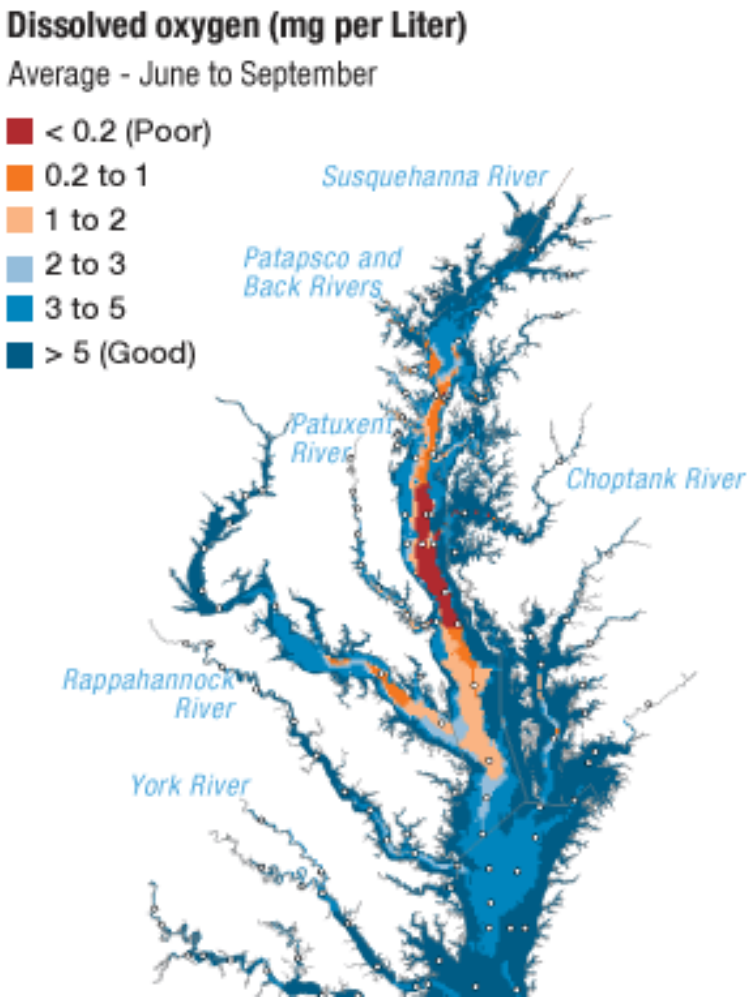


Lethal to most (all?) CB finfish

Breitburg et al. in prep – data from DNR shallow water monitoring program

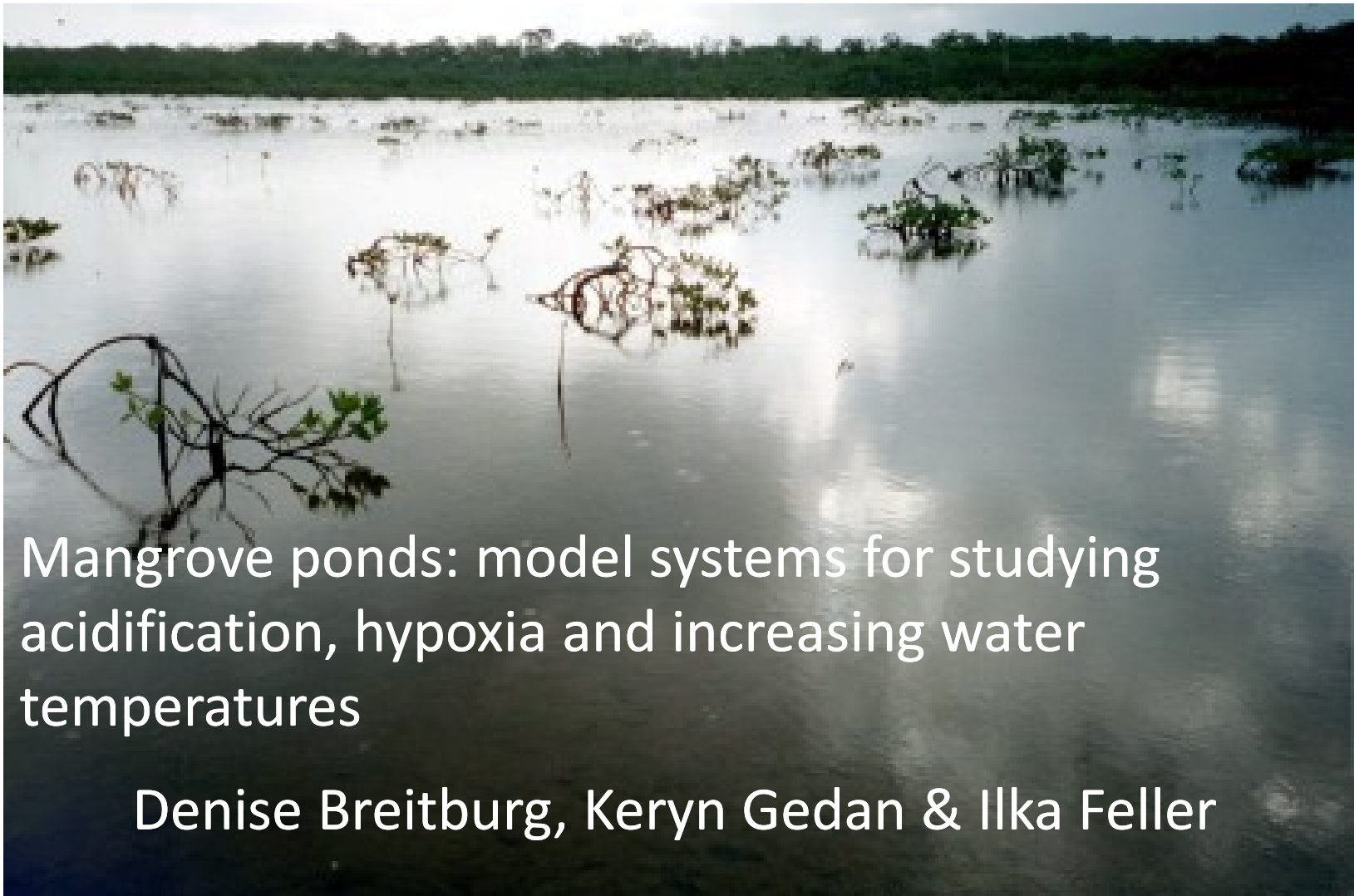
Problem – separating physics from anthropogenic effects

Winds & circulation cause ‘jubilees’; upwelled water will be low in oxygen unless deep-water criteria are changed



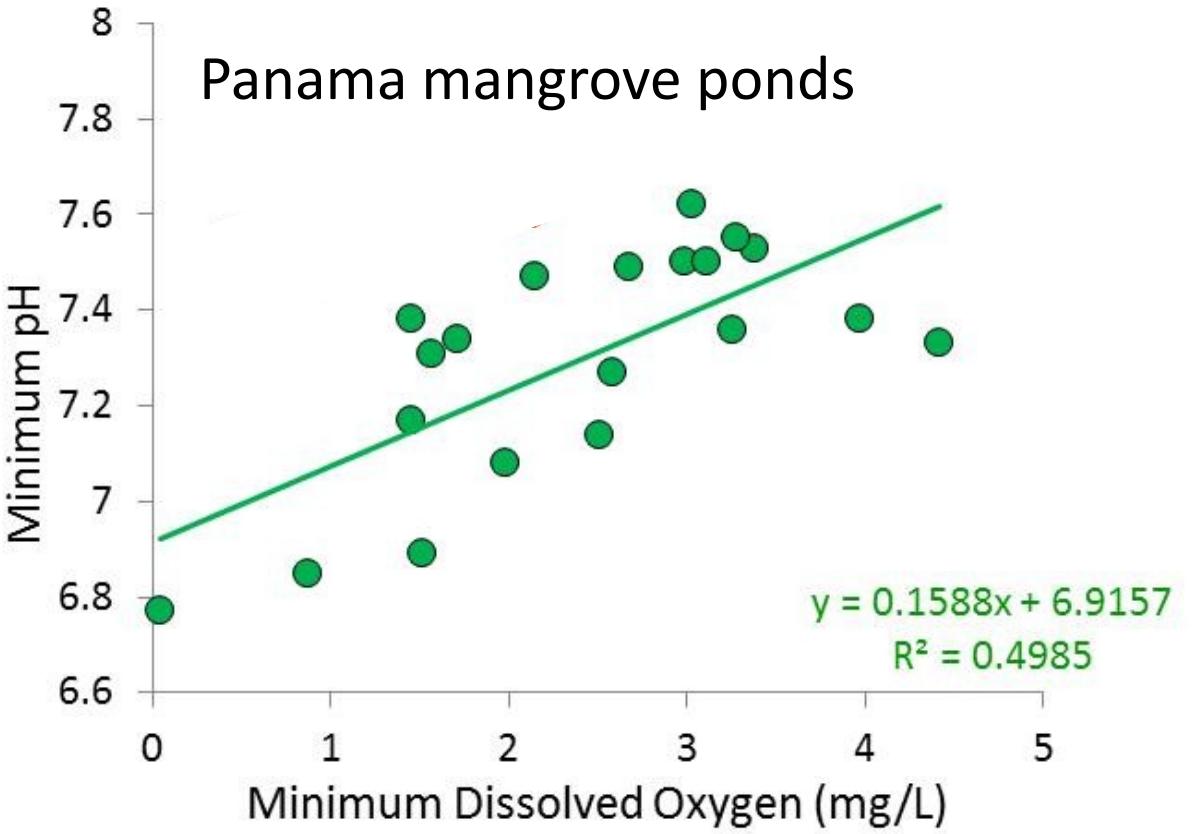
Problem – separating physics from anthropogenic effects

Diel-cycling hypoxia is a natural phenomenon exacerbated by anthropogenic nutrient loads



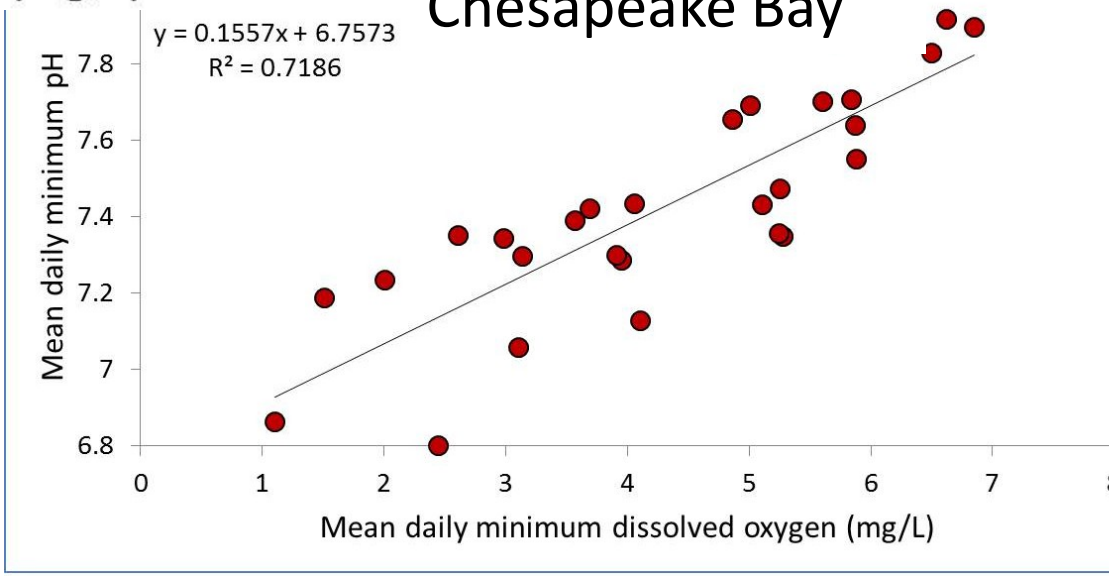

Rhizophora mangle
red mangrove
SharkHoleC
SharkHoleB
SharkHoleF
SharkHoleE
SharkHoleD
013 DigitalGlobe
Google earth

Panama mangrove ponds



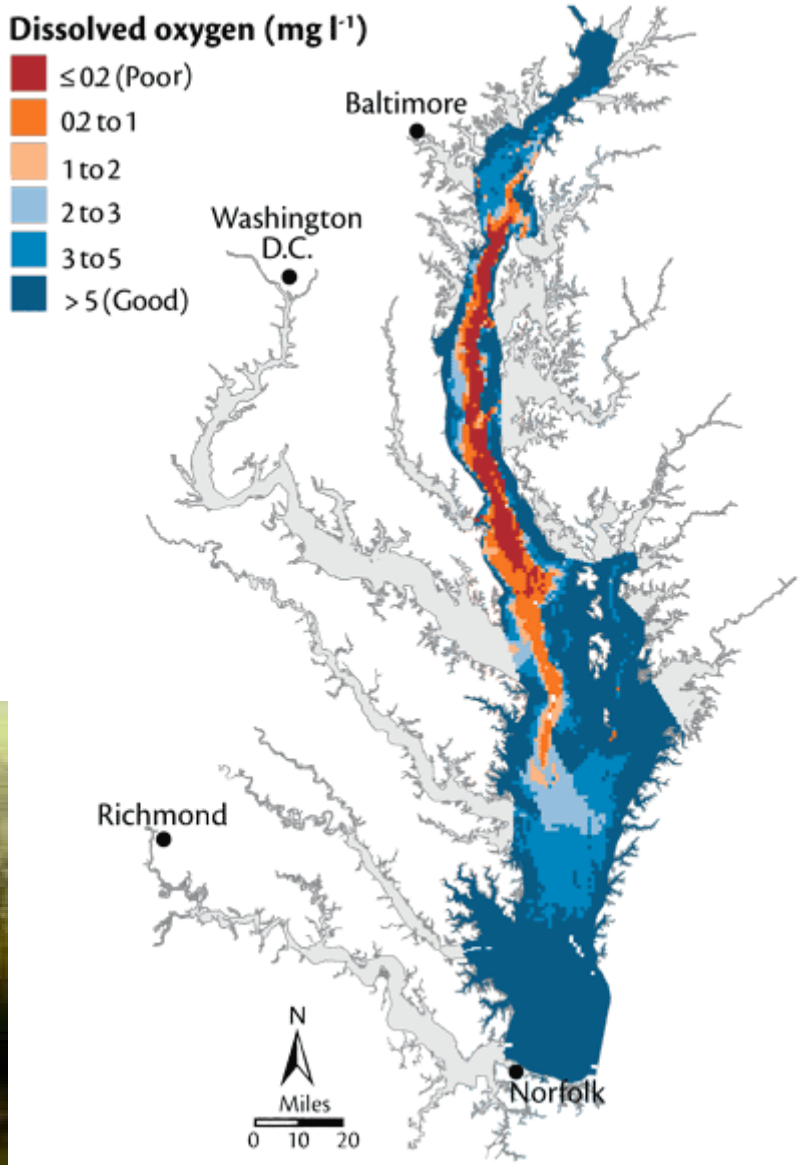
Slopes & intercepts almost identical

Chesapeake Bay



CB data from DNR shallow water monitoring program (sites _salinity ≥7)

Shallow water is a refuge from deep water hypoxia



show fish kill
show diel cycle

Diff from chronic (oyster compensation)

But short frequent exposure can also cause chronic problems
oyster disease

Commonness of diel cycle

Diff between minima & avg

Problems
intrusions = physics
diel – how much is anthropogenic
intermediate length patterns too (tidal, etc)

Shallow water as a refuge we could loose