Development of Site Specific Methods to Measure Oyster Denitrification Rates

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What Do Oysters Do For Water Quality

- Filter the water – algae used for nutrition
- Produce lots of "biodeposits" that when decomposed, a portion turns into benign N_2 gas
- When harvested, take nitrogen and phosphorus out of the bay

This Talk

- BMP Progress
- Oysters on Engineered Structures
- Faster, Better, Cheaper Denitrification Measurements

OYSTER BMP

- Panel has a complete draft, comments in 10 days ±
- Includes default rates for denitrification in restored oyster reefs. Developed from MD and VA data by Kellogg at VIMS.
- Includes N and P biomass increment in accreting reef
- Adds licensed harvest of harvest reefs – N and P in biomass

Oyster Castles –
Shoreline Protection

Reef Balls –
Fish Habitat

Reef

Reef Ball

Castle

Sediment

Harris 50 g dw m^{-2} d^{-1}

Harris 110 g dw m^{-2} d^{-1}

Bill Burton < 126 ind

Tilghman > 438 ind.

Tilghman < 12 ind.

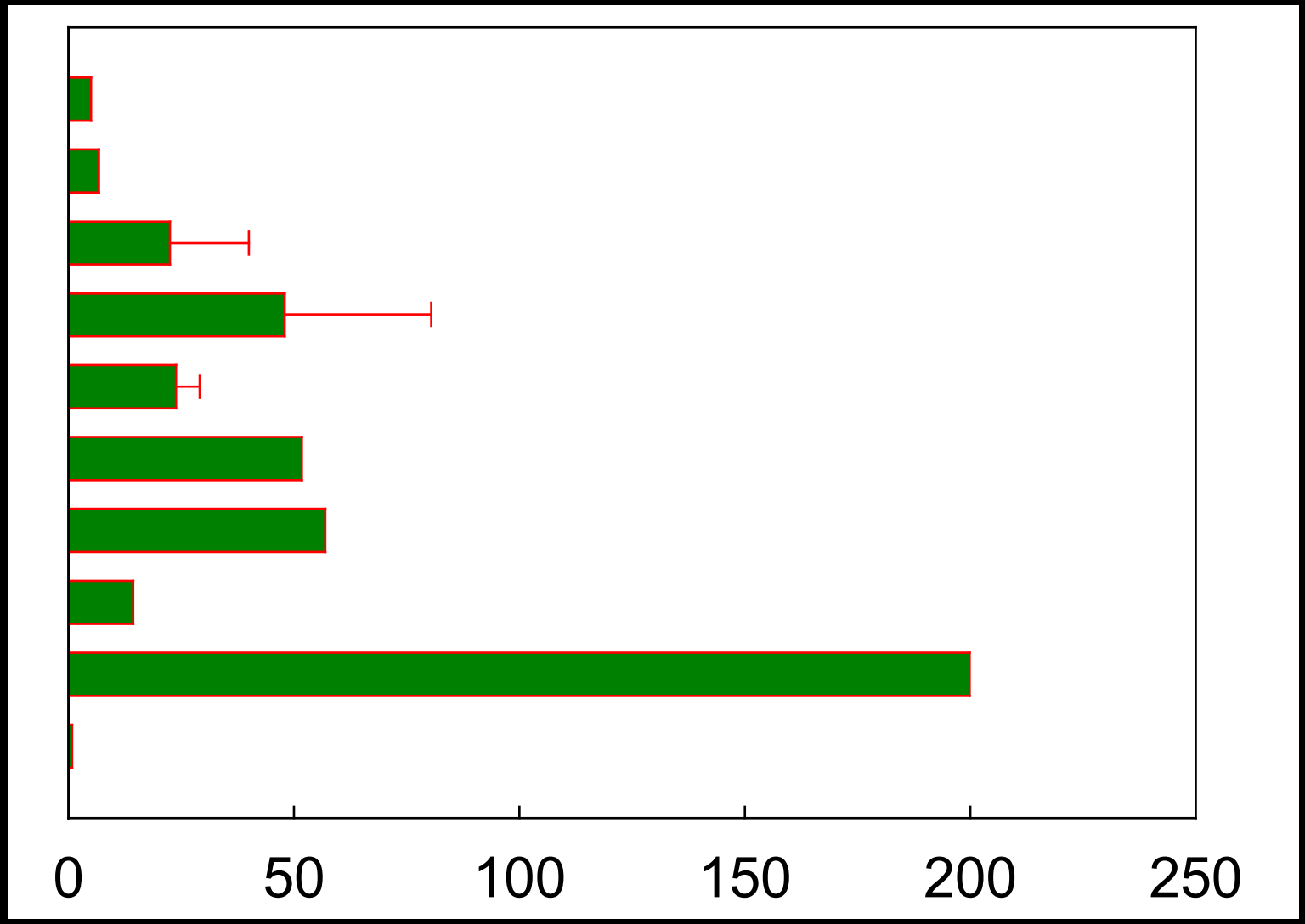
Cove Castle Oysters

Cove Castle No Oyster

Cove Castle No Oyster

Oyster Veneer

Sediment



Daily Denitrification Rate mmol m^{-2} d^{-1}

Our past approach (Kellogg et al. 2013)

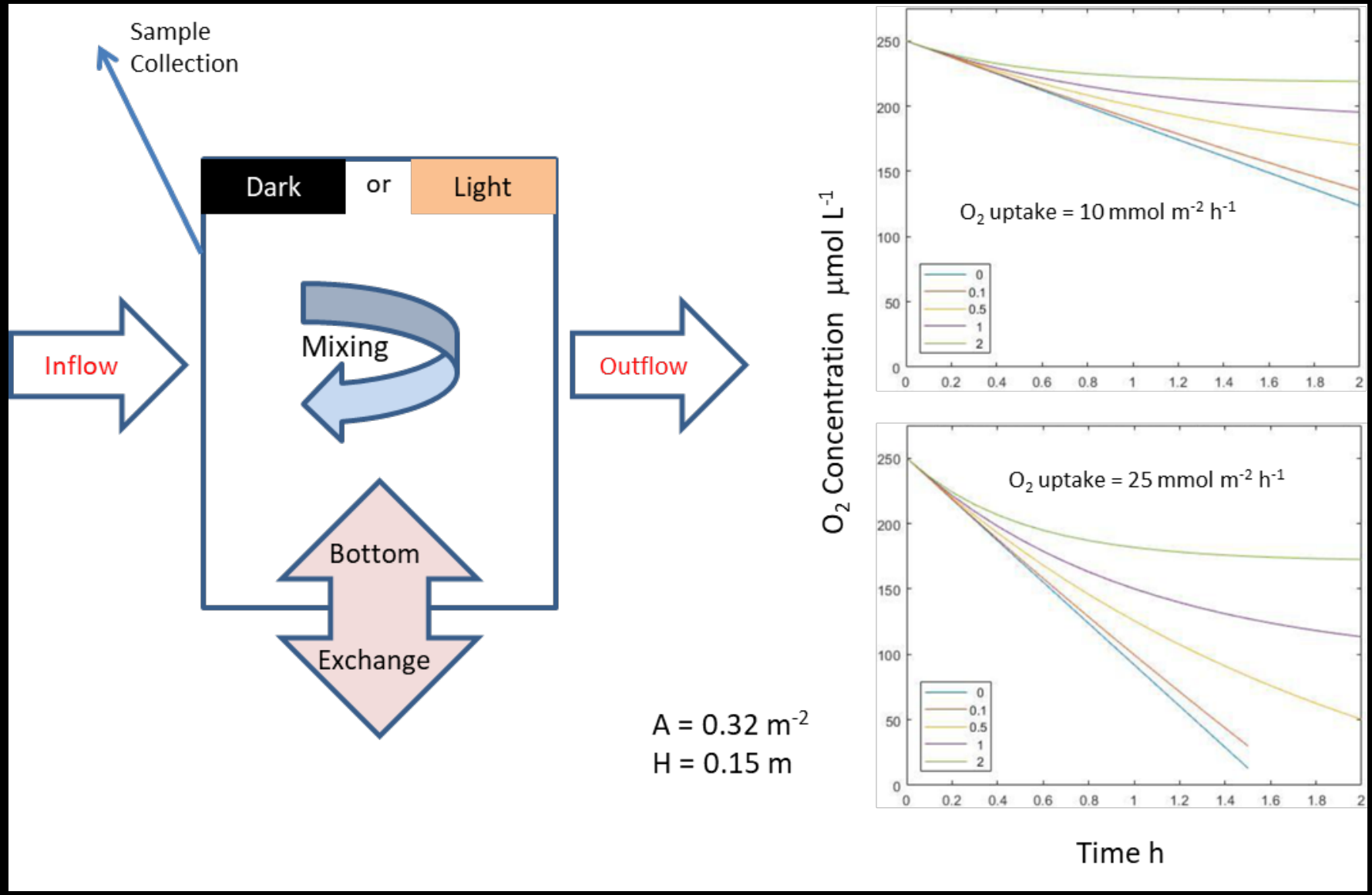
- *Ex-situ* incubations of community put in trays and equlibrated
- Time course incubations in stirred chambers in dark and light
- Uses divers for tray deployment, then later retrieval. ~2-3 days effort with logistics, 4 people. ~2 person days per tray
- 8 incubations at HPL per day, 4 scientists, 16 hour days, 2 many days per incubation
- Before chemical analysis, ~4 person days of effort per number

However, this really is the current state of the art and generates great data!!

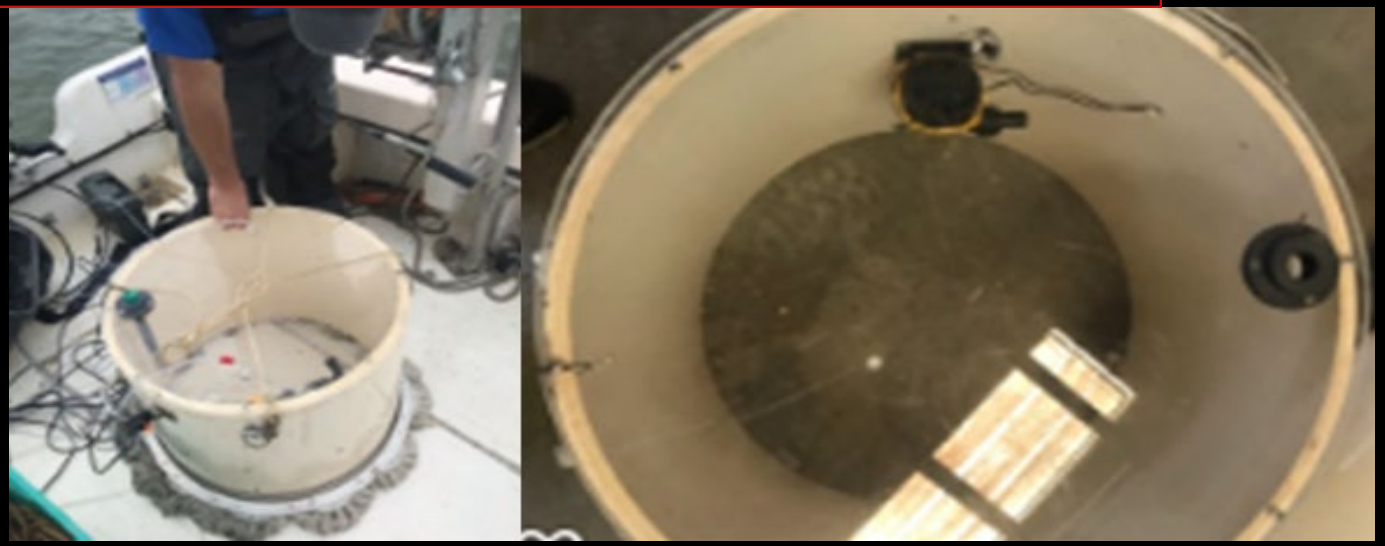
So Why Not Do This In the Field with a Chamber?

Because it will never seal!

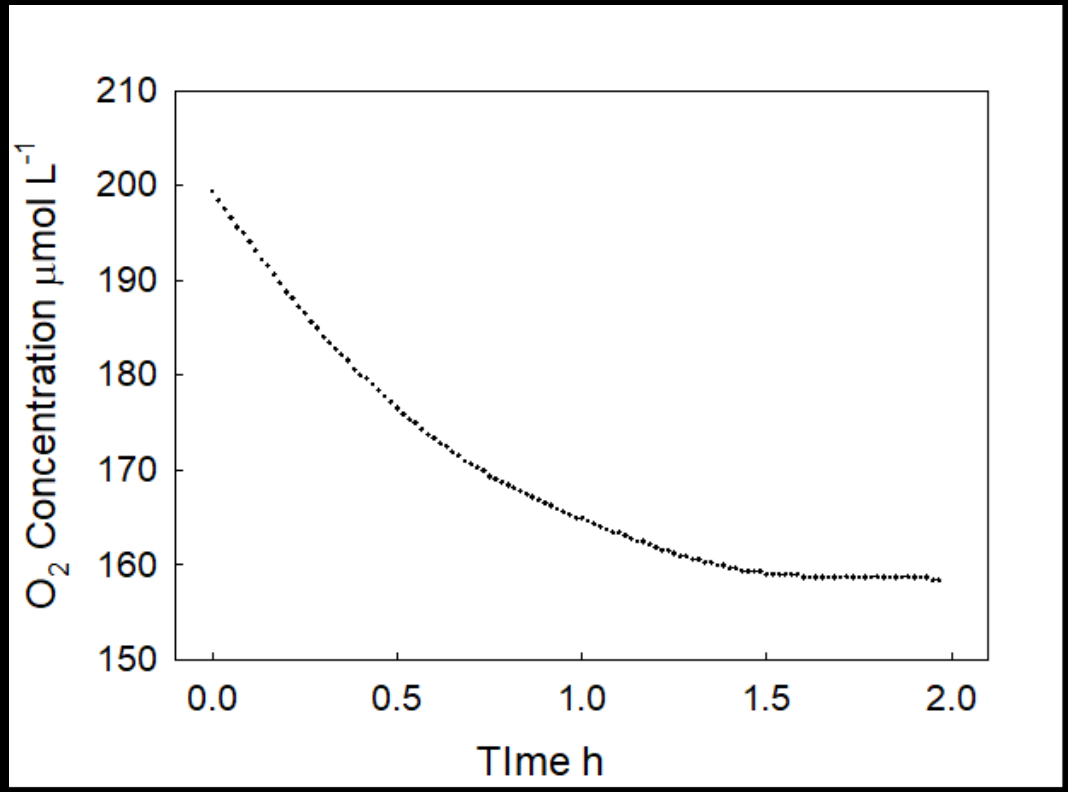
Have you even seen the surface of an oyster reef?

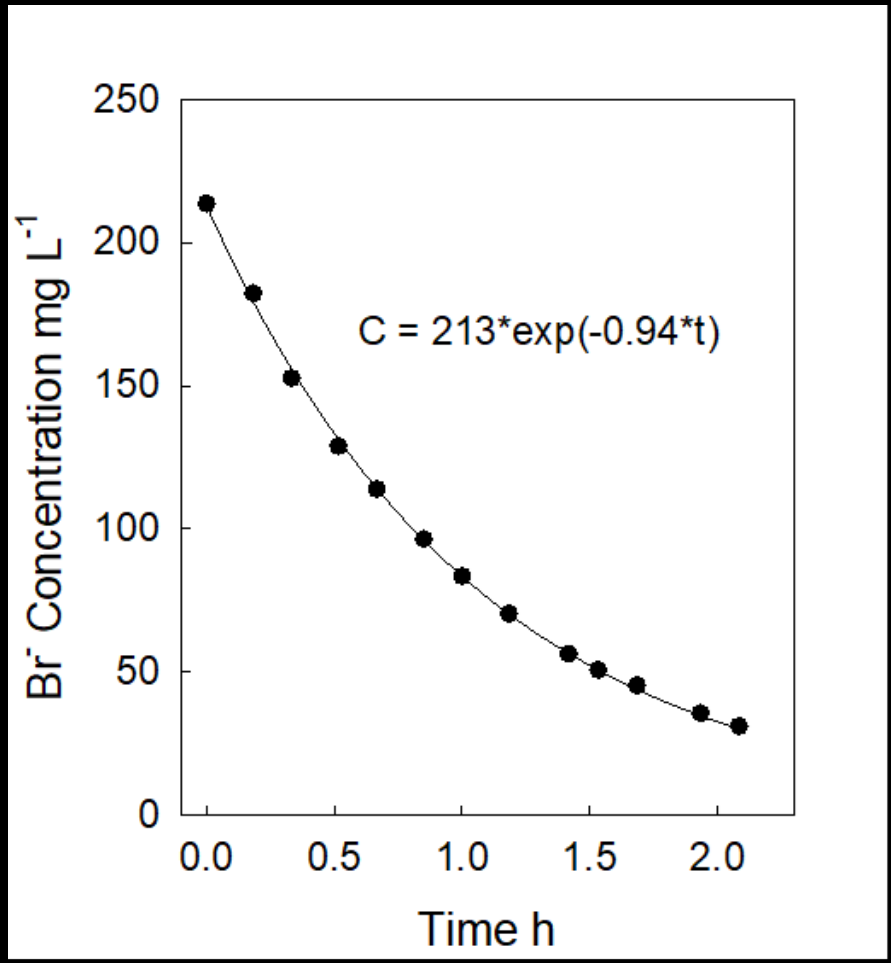


With leakage, non-linear changes in chemistry. However, if you know the leakage rate and can fit a differential equation (Larry Sanford), you could make an estimate

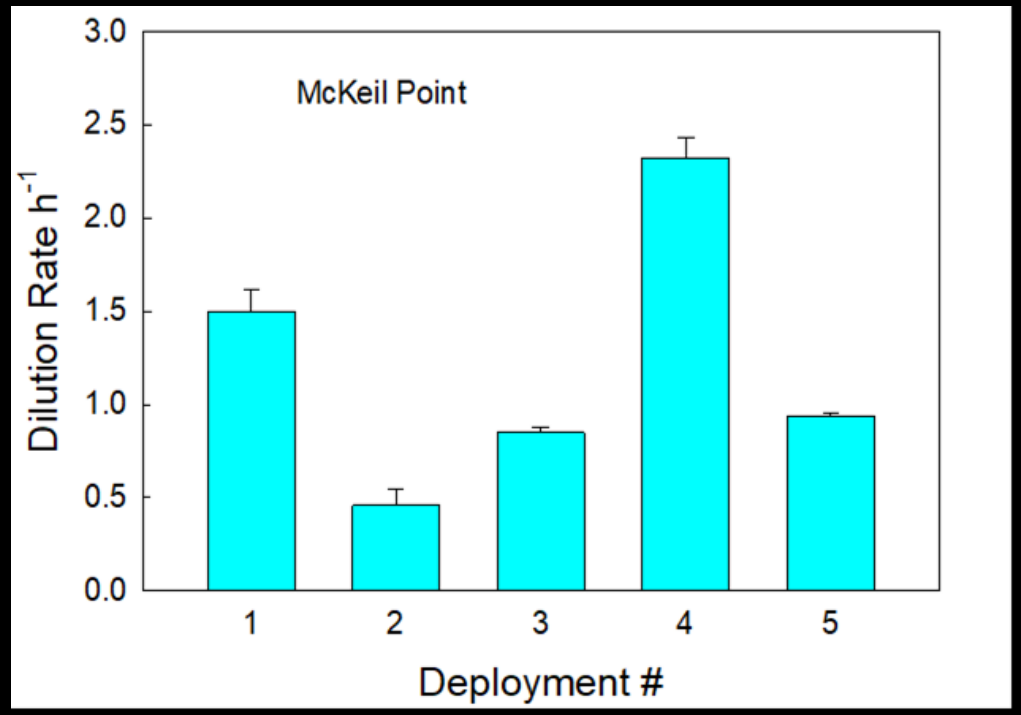


Best Estimate Oct 2021 - single deployable chamber		Unit cost	Sum	$7,225.23
CHAMBER CONSTRUCTION				
mop replacement head	Amazon spin micro fiber mop	$3.17	9	$28.53
bilge pump for water circulation	Amazon: Johnson pump 500 gph	$37.64	1	$37.64
24" White PVC Schedule 40 pipe	We bought 14' for $100 per foot from our hatchery. US plastics current cost is $205.64 per foot, 20' minimum.	$100.00	2	$200.00
Acrylic top				
Aluminum angle for oyster tub		$12.40	1	$12.40
battery for bilge pump circulator	Amazon: Dakota lithium 12v 18 ah	$179.99	1	$179.99
Luer bulkhead fitting		$1.00	2	$2.00
lifting rings, handles, rope		$100.00	1	$100.00
battery for circulation pump	Amazon, Dakota lithium	$179.99	1	$179.99
acrylic sheet for top	Material was on hand, costo fo 12 mm 24" x 24" US Plastics	$69.91	1	$69.91
low voltage wire		$10.00	1	$10.00
tubing		$0.27	40	$10.80
Total chamber Cost				$820.46
SAMPLING APPARATUS				
peristaltic sampling pump	Dyrabrest 0-140 mL	$119.00	1	$119.00
case for pump storage	Amazon: Sheffield 12626 field box	$14.99	1	$14.99
ammeter to determine if pump is worl	Amazon: Bediffer	$24.58	1	$24.58
battery pack for peristaltic sampling pı	Amazon: Progeny 350 w	$199.99	1	$199.99
Sampling gear cost				$358.56
Essential Water Quality Gear				
YSI Prosolo meter, ODO probe, case, sl	Xylem, university price. We have used 1, now will use 2 for outside measurements	$1,995.60	2	$3,991.20
BOAT GEAR				
davit with block		$400.00	1	$400.00
winch		$65.00	1	$65.00
anchors	for 3 point anchoring - 3 needed, 1 assumed with boat - 13 lb fluke anchor from Amazon	$99.99	2	$199.98
Boat gear total				$664.98
EXTRA GEAR (optional)				
Go Pro Black 7		$228.04	1	$228.04
Underwater light	Amazon, Suptig dive light 84 LED	$36.99	1	$36.99
Extras Total				$265.03
Labor				
		Per hour		
Machine Shop	Per hour, billing in progress, best estimate	$75.00	15	$1,125.00

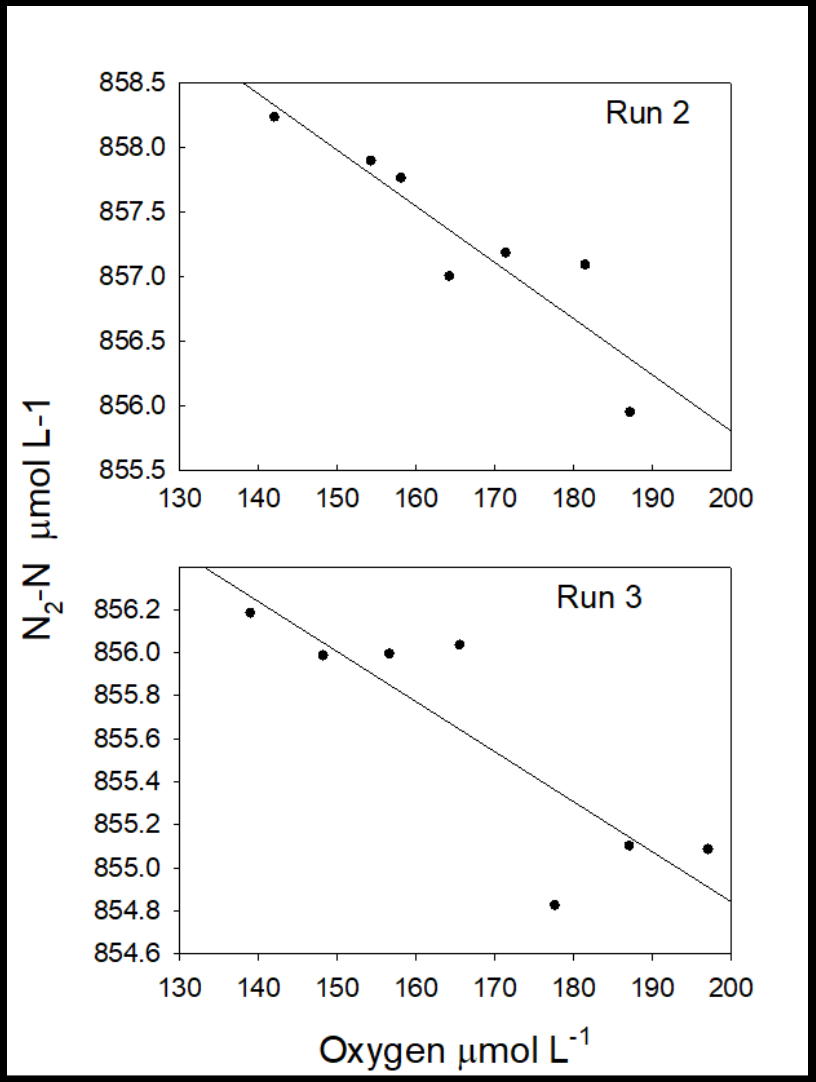

210
200
190
180
170
160
150
O_2 Concentration µmol L^{-1}
0.0
0.5
1.0
1.5
2.0
TIme h


250
200
150
100
50
0
Br^- Concentration mg L^{-1}
C = 213*exp(-0.94*t)
0.0
0.5
1.0
1.5
2.0
Time h

N_2-N Flux = $O_2Flux_{(YSI)}$ * $\Delta N_2/\Delta O_{2(mass\ spec)}$



As expected, each deployment can have a different seal to the bottom and a different leakage rate



Conclusions

- We can indeed make measurements despite the leakage
- Incubations are usually < 1 hour and after that the concentrations of O_2 and N_2 go asymtotic
- Per site person-power will be ~ 0.5 per incubation < 1/3 of current effort
- Less bottom disruption

- Data from Little Choptank same order as Harris Creek
- Approach could be used on on-bottom aquaculture
- Disadvantage – no simultaneous biomass estimation, will use ORP numbers
- Need good 3 point anchoring
- Possible to run 2 chambers at once, opposite sides of boat