Considerations when Selecting Diploid and Triploid Oysters

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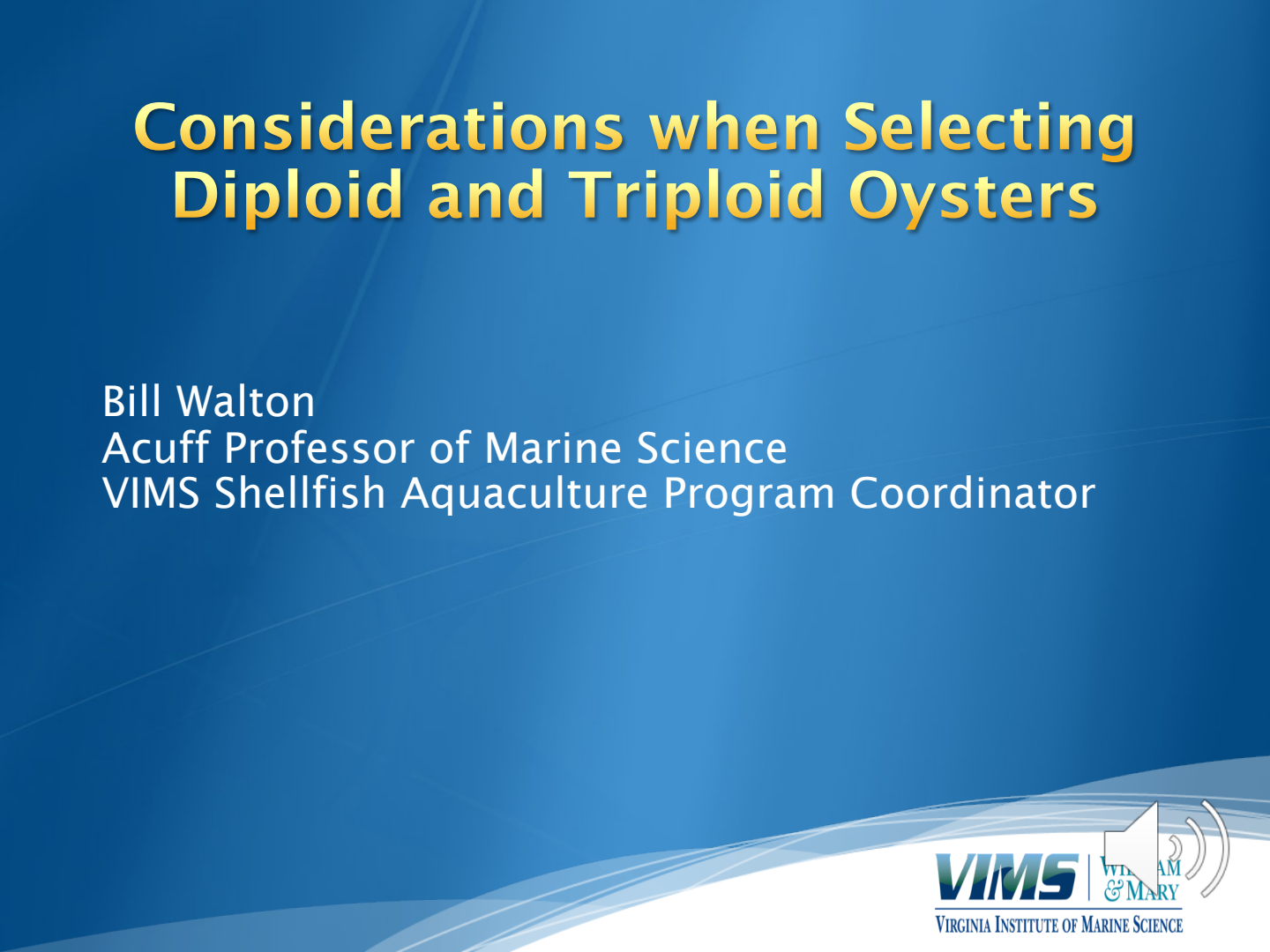


As a farmer, you may have a choice of diploid or triploid oysters

- Diploid oysters are what have been historically used.
- Triploids have been developed through a breeding program to be non-reproductive.
- No 'foreign' DNA.

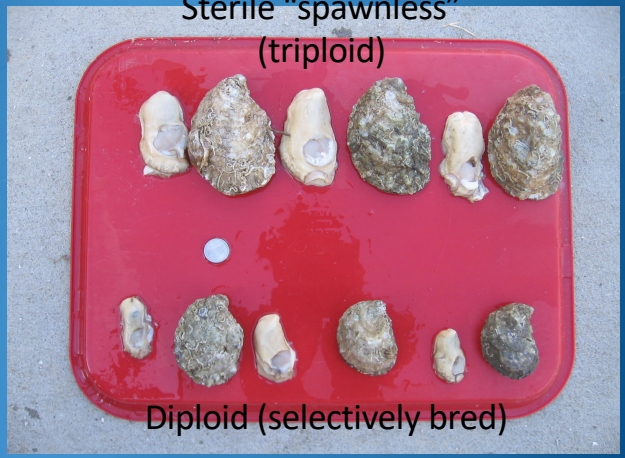
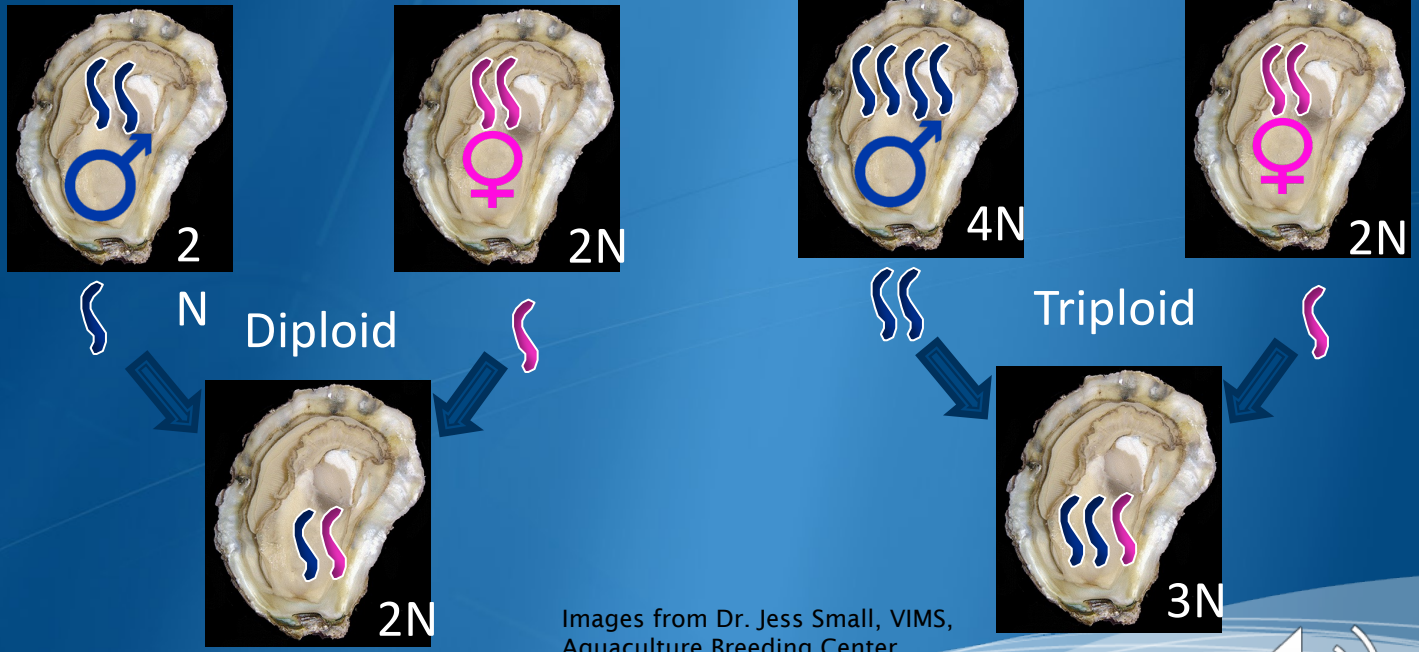


Image from Dr. Jess Small, VIMS, Aquaculture Breeding Center

Diploid and Triploid Production



Images from Dr. Jess Small, VIMS, Aquaculture Breeding Center

What is the Rationale for Triploids

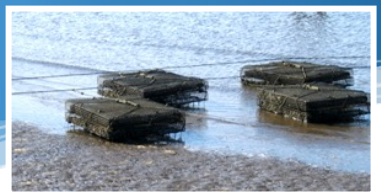
- Triploids commonly used in oyster aquaculture and agriculture
- Prior studies have shown that triploid oysters typically grow faster than diploids, particularly under favorable growing conditions, and produce fatter meats especially in the summer
- Do your research. Many published studies on survival and growth (especially research done in Virginia)

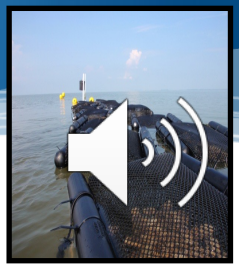
Photo: Julie Da

Side by Side Comparison in Grand Bay, Alabama

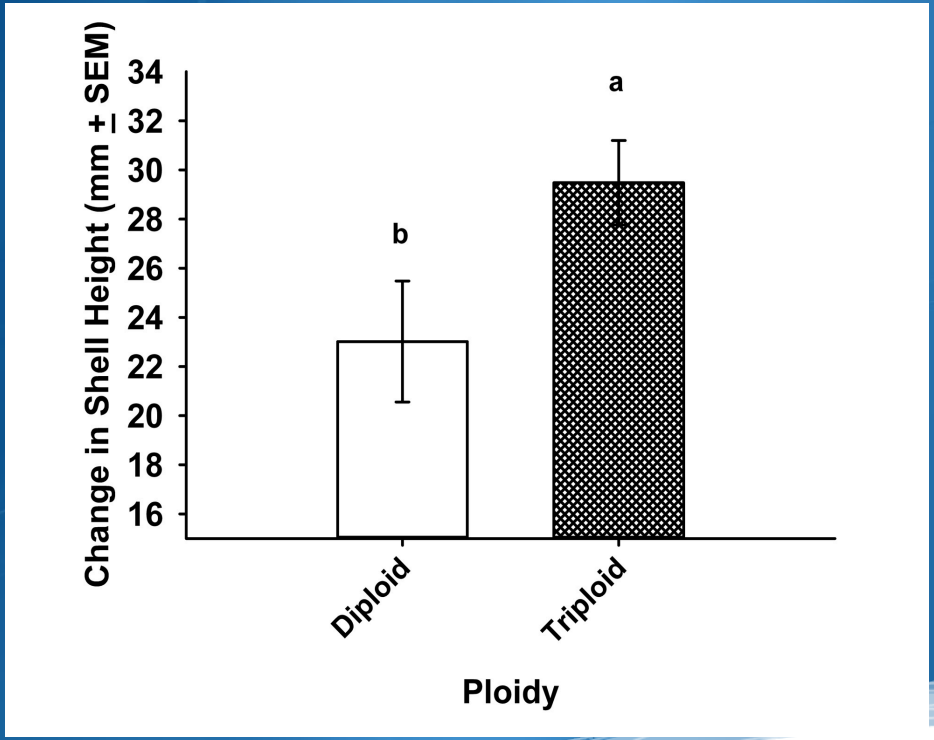
- Half sibling diploid and triploid oysters produced May 2010 at the Auburn University Shellfish Lab, Dauphin Island, AL
- Larvae and juveniles raised in identical systems until May 2011 (around 2”)
- Deployed into 4 commercial gear types (n ≥ 3) for 5 mo

Photos: Bill Walton, Courtney Coddington, & Julie Davis



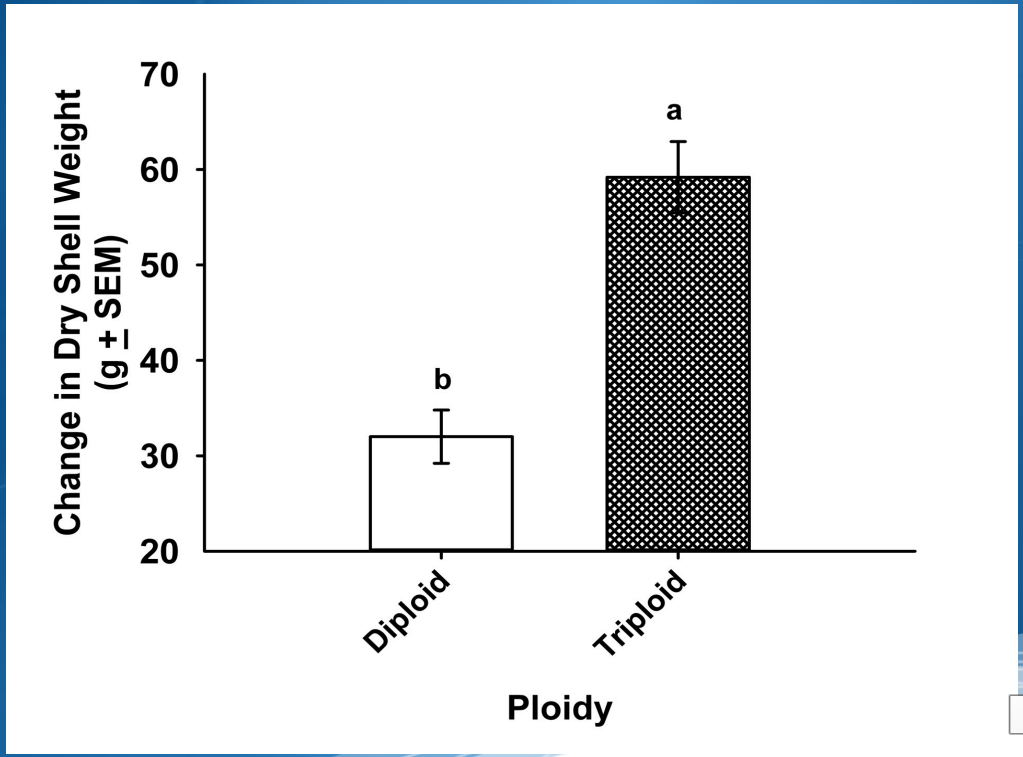


Effect of Ploidy on Change in Shell Height: Triploids Grew Faster

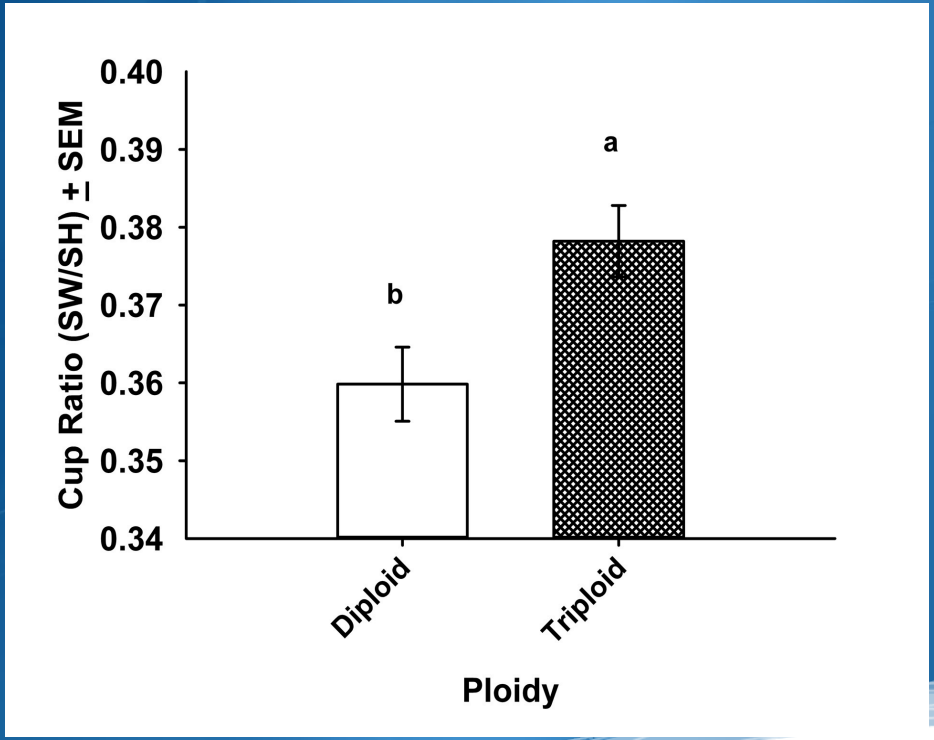


Walton, WC, FS Rikard, GI Chaplin, JE Davis, CR Arias & JE Supan. 2013. Effects of ploidy and gear on the performance of cultured oysters, Crassostrea virginica: Survival, growth, shape, condition index and vibrio abundances. Aquaculture 414:260-266.

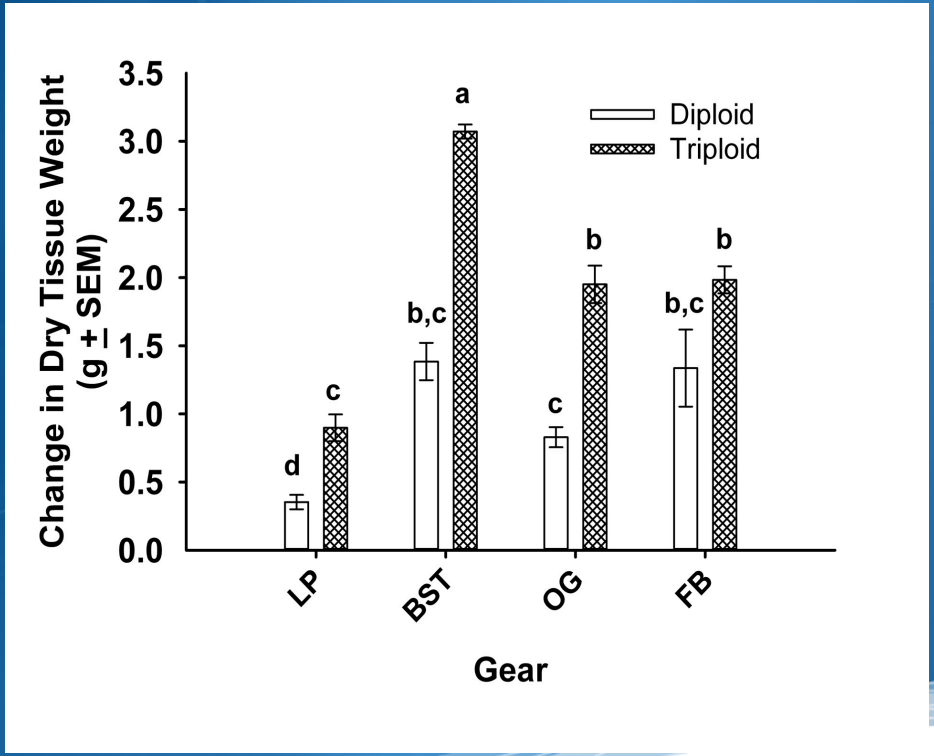
Effect of Ploidy on Change in Dry Shell Weight: Triploids Grew Heavier Shells



Effect of Ploidy on Cup Ratio: Triploids Had Deeper Cups



Change in Dry Tissue Weight: Effect of Ploidy Depended on Gear Type

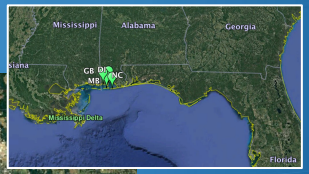


High Mortalities Reported: Summer 2016 in Alabama

- Die-offs reported by oyster growers in Alabama, in some cases very high mortalities
- Some association with triploids
- Similar observations in Virginia

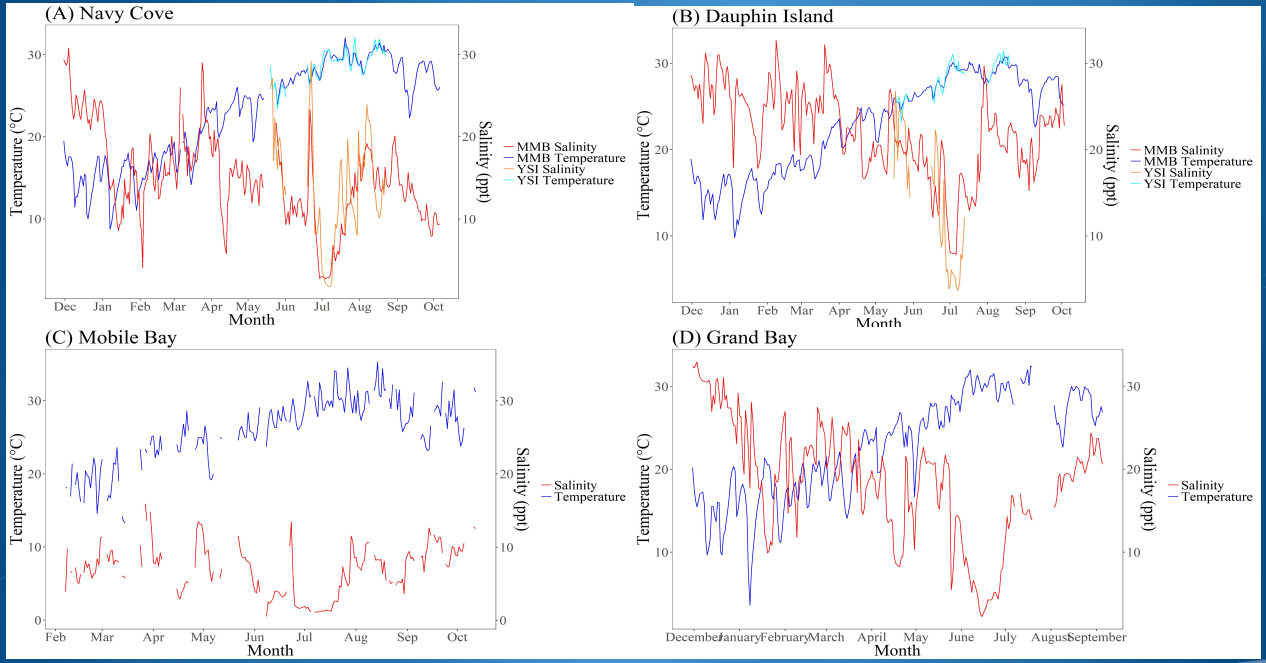
Conducted Side by Side Test at Four Commercial Farms in Alabama

- Diploids and triploids (spawned May/June 2016) raised in common area, deployed November/December 2016
- Four sites with commercial oyster farms
- 60 oysters per basket, deployed adjacent to the farms
- Four baskets of each ploidy followed at each site

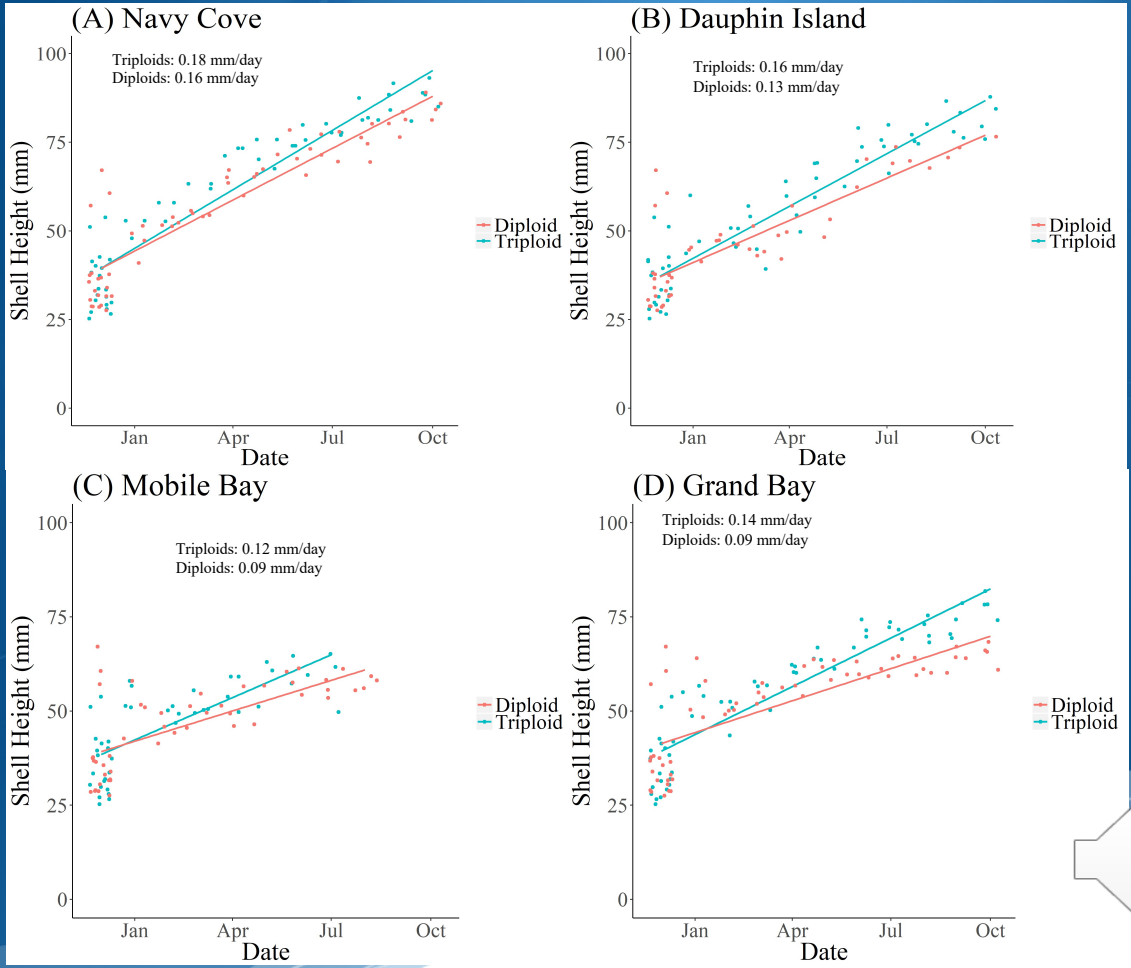


Wadsworth, P, S Casas, J La Peyre & WC Walton. 2019. Elevated mortalities of triploid eastern oysters cultured off-bottom in northern Gulf of Mexico. Aquaculture 505:363-373.

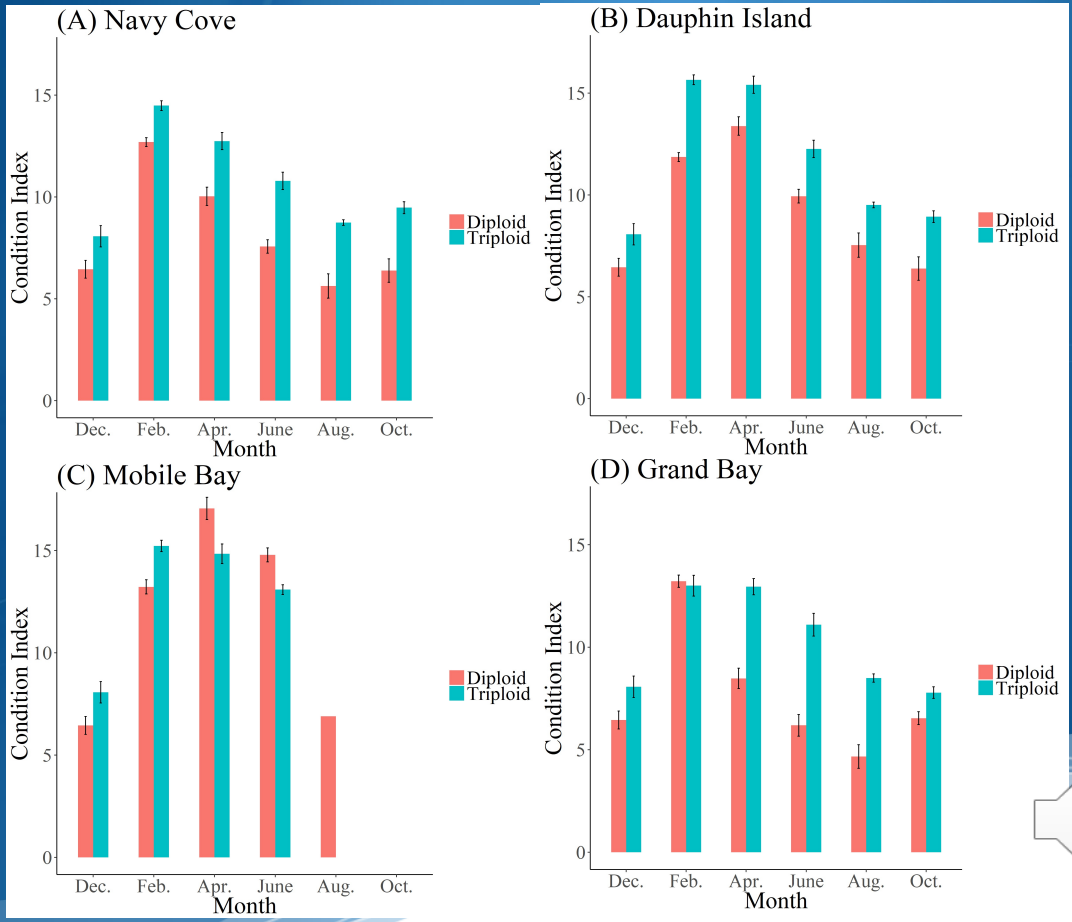
Sites Had Different Environmental Conditions



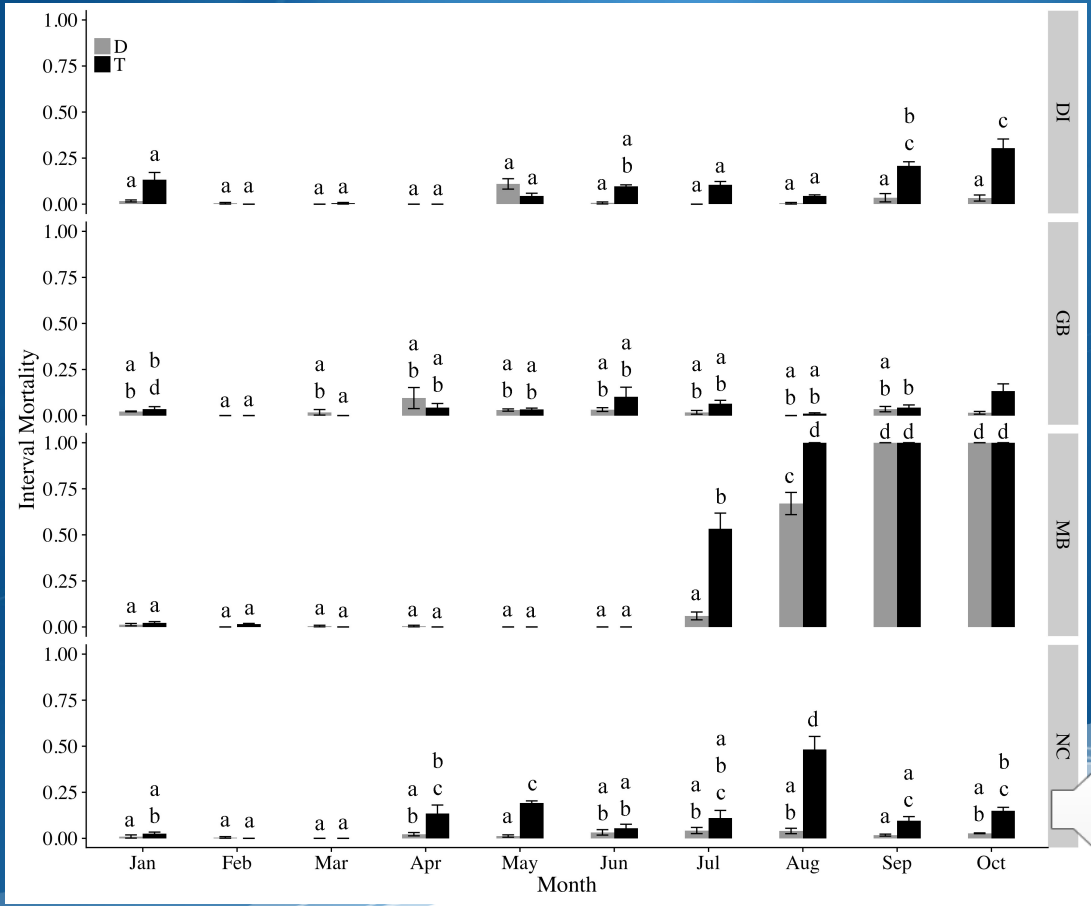
Triploids Grew Faster at All Sites



Condition Index

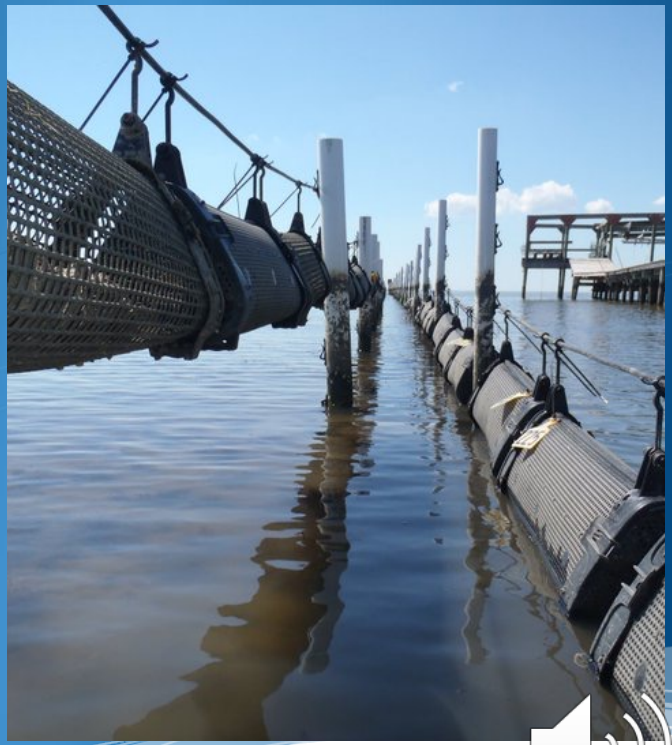


Interval Mortality Jan.- Oct. 2017



Conclusions from 2017 Study

- At some sites, triploid oysters had significantly higher mortality than diploid oysters at some times, suggesting a clear difference in vulnerability.
- Differences could not be attributed to a single factor (salinity, disease, etc.).



Given that Triploid Mortality Can Occur, Does a Farmer Affect That?

Oyster farmers routinely impose:

- Grading/tumbling (to sort by size and help shape and clean oysters), and;
- Desiccation to help control bio-fouling

Bodenstein, S, WC Walton & T Steury. 2021. The effect of farming practices on growth and mortality rates in triploid and diploid Eastern oysters, Crassostrea virginica. Aquaculture Environment Interactions 13: 33-40.

Farmer-Imposed 'Stress': Grading

Grading/tumbling is done periodically to sort oysters by size

Also potentially helps shape the oyster and clean bio-fouling

Farmer-Imposed Stress: Desiccation

Routine desiccation is a method used to control bio-fouling

AUSL recommends drying for 24-hours once per week under typical conditions

Experimental Design

Table 1. List of the control treatment and the 6 stressor treatments that oysters were subjected to in the experiment

	Stressor Treatment	Abbreviation
1	0 hrs desiccation, no tumbling	0/NT
2	18 hrs desiccation, no tumbling	18/NT
3	18 hrs desiccation, tumbling	18/T
4	24 hrs desiccation, no tumbling	24/NT
5	24 hrs desiccation, tumbling	24/T
6	48 hrs desiccation, no tumbling	48/NT
7	48 hrs desiccation, tumbling	48/T

7 OysterGro® cages per site

6 replicate bags per cage (all of the same treatment)

- 2n in 3 bags
- 3n in 3 bags

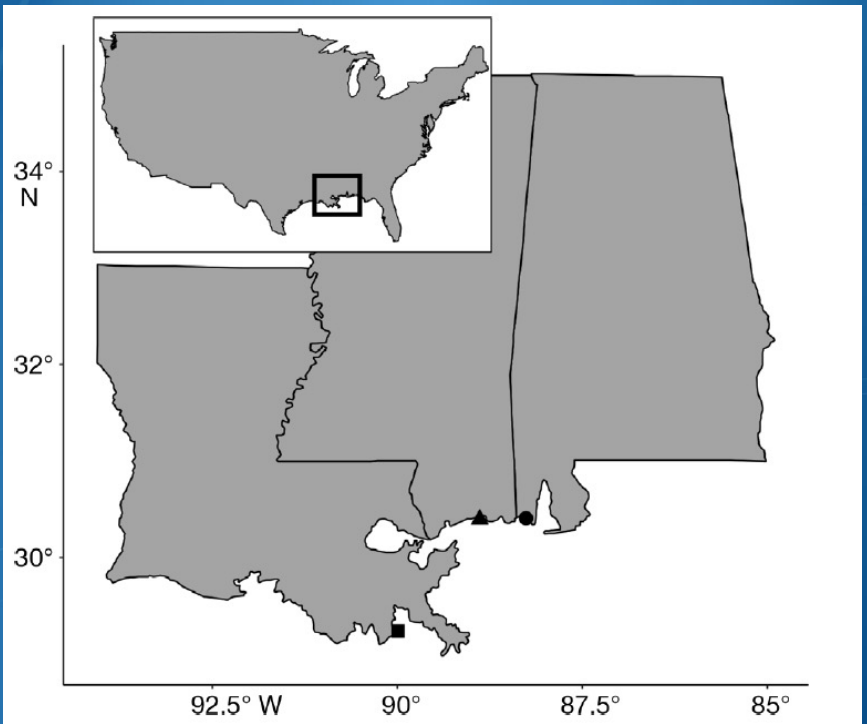
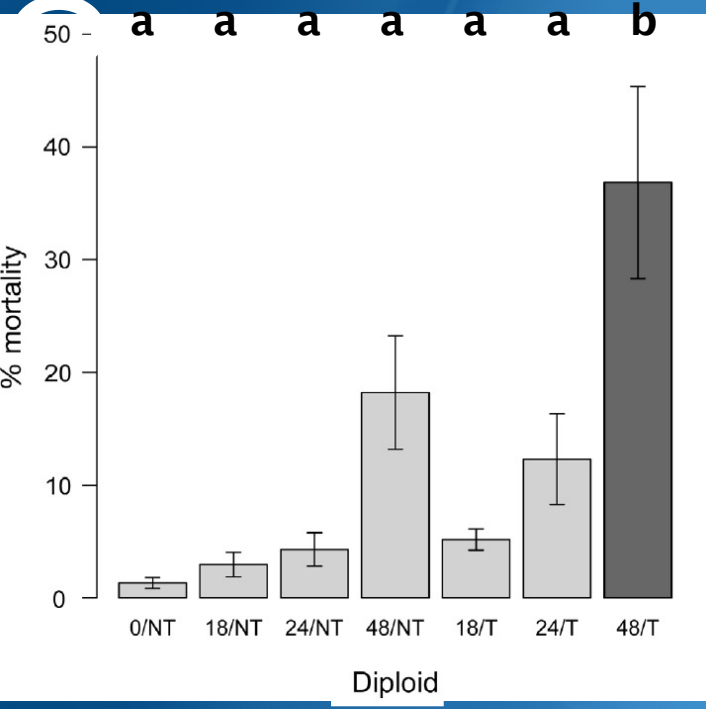
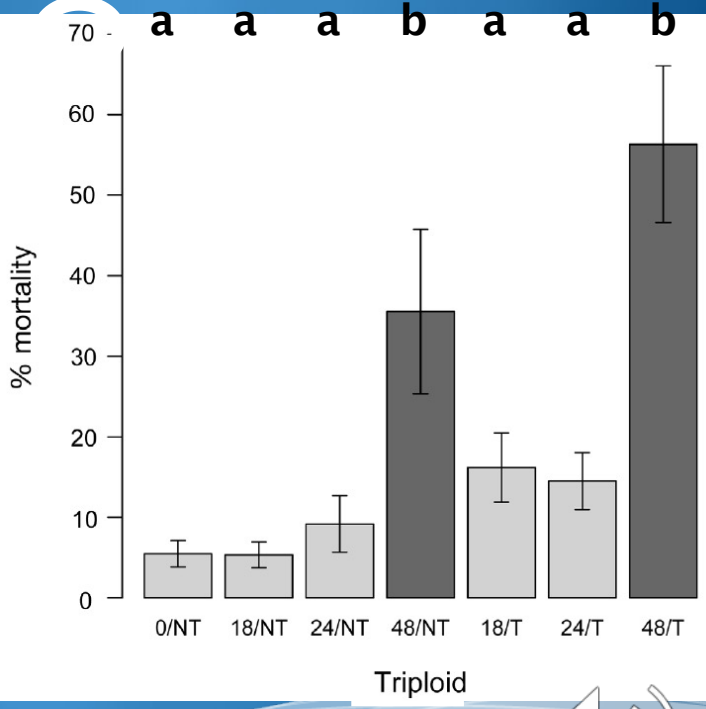


Fig. 1. The 3 farm sites used in this study: Grand Bay, AL (●), Deer Island, MS (▲), and Grand Isle, LA (■), USA


a a a a a a b
50
40
30
20
10
0
% mortality
0/NT
18/NT
24/NT
48/NT
18/T
24/T
48/T
Diploid


a a a b a a b
70
60
50
40
30
20
10
0
% mortality
0/NT
18/NT
24/NT
48/NT
18/T
24/T
48/T
Triploid

Conclusions

Ploidy Effects

- Growth: 3n > 2n
- Mortality: 3n > 2n

Ploidy × Stressor Effects

- 3n Mortality: 48/NT and 48/T > control (0/NT)
- 2n Mortality: Only 48/T > control (0/NT)
- Triploids more sensitive to stressor effects

Does Better Broodstock Increase Triploid Survival?

- Work led by MC Eastburn with Jerome LaPeyre
- Investigated whether maternal broodstock selection can increase triploid field performance
- In this study, testing low, mid and variable salinity

Methods: Broodstock Origin Study

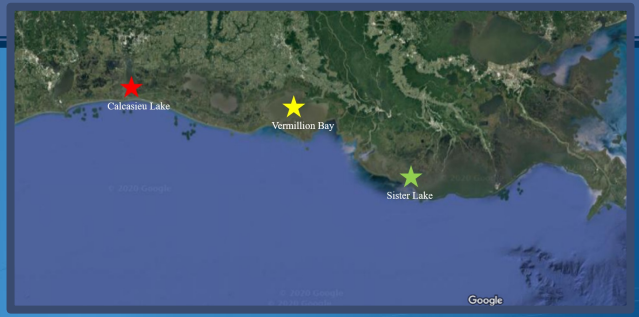
Wild Louisiana Broodstock Collected Early 2019

- Sister Lake
- Calcasieu Lake
- Vermillion Bay

6 groups of half siblings (3 broodstock x 2 ploidy)

Spawned: Mid/Late July 2019

Deployed: November 2019



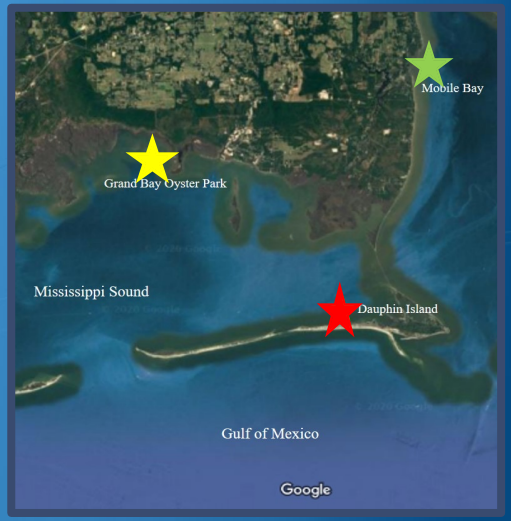
SITE	Salinity (ppt)	Temperature (℃)
Sister Lake	≤ 10	22.94
Calcasieu Lake	20	22.38
Vermillion Bay	≥ 10 ≤	22.25

Table 2: Average (mean) Salinity & Temperature for broodstock collection sites in Louisiana. Collected from USGS loggers.

Methods: Study Sites

3 Alabama Study Sites:

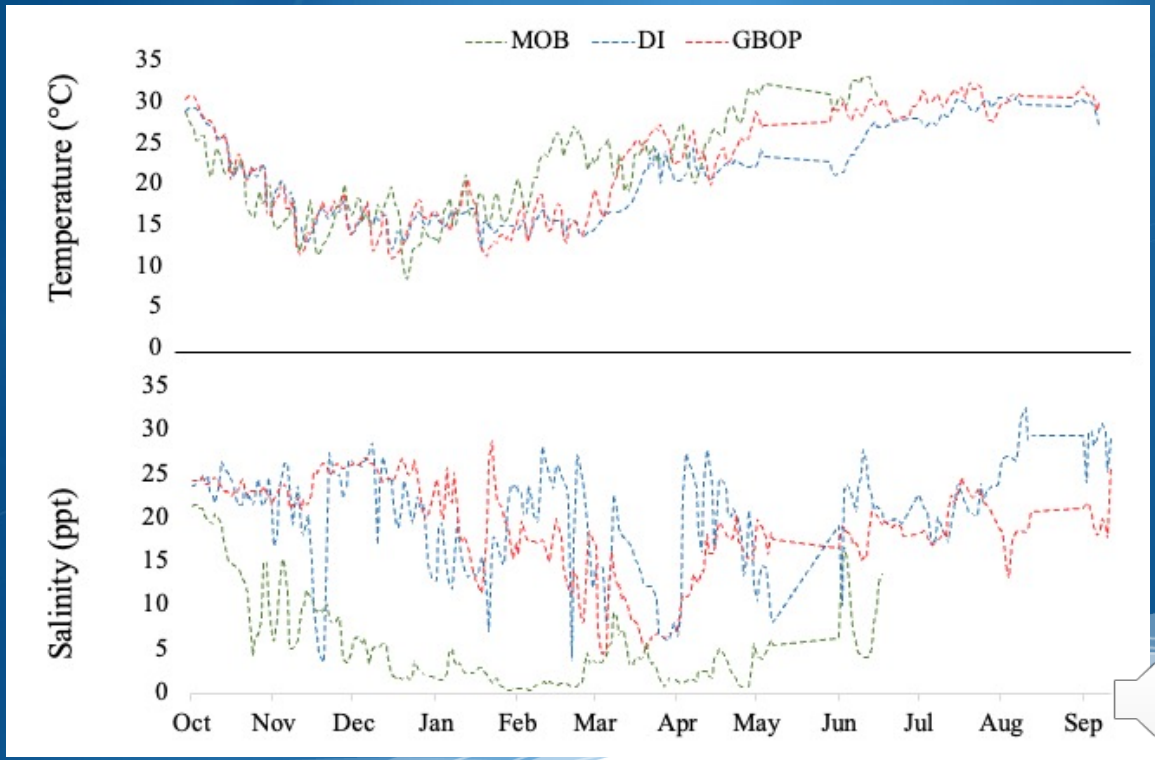
- Bama Bay Oyster Co. (Mon Louis Island, AL)
- Massacre Island Oyster Ranch (Dauphin Island, AL)
- Grand Bay Oyster Park (GBOP)



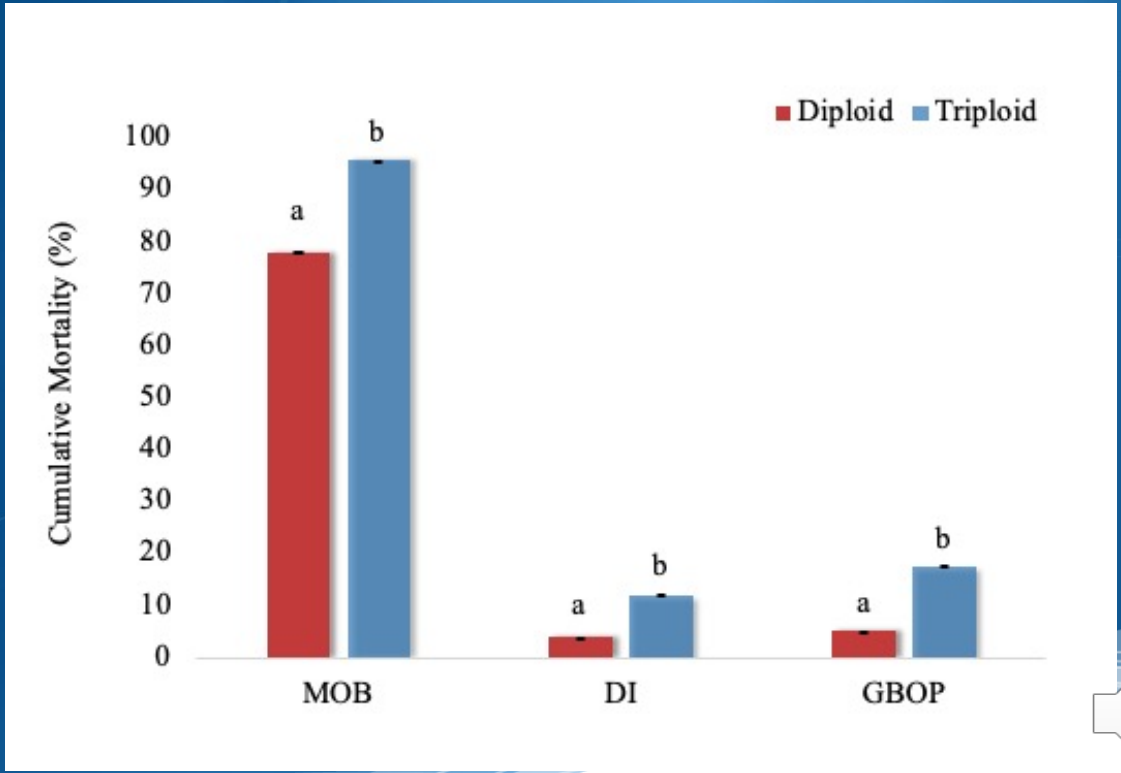
Site	Temperature (°C ± STD)	Daily Min (°C)	Daily Max (°C)	Salinity (ppt ± Std)	Daily Min (ppt)	Daily Max (ppt)
MOB	21.3 ± 5.75	8.43	33.2	5.62 ± 5.30	0.31	21.6
DI	21.3 ± 5.60	11.7	30.8	20.8 ± 5.77	3.40	32.6
GBOP	22.5 ± 6.56	10.9	32.6	19.2 ± 5.42	4.38	28.8

Table 3: Average (mean ± SD) salinity and temperature data collected daily from deployment to final collection at Mobile Bay, Dauphin Island, and Grand Bay.

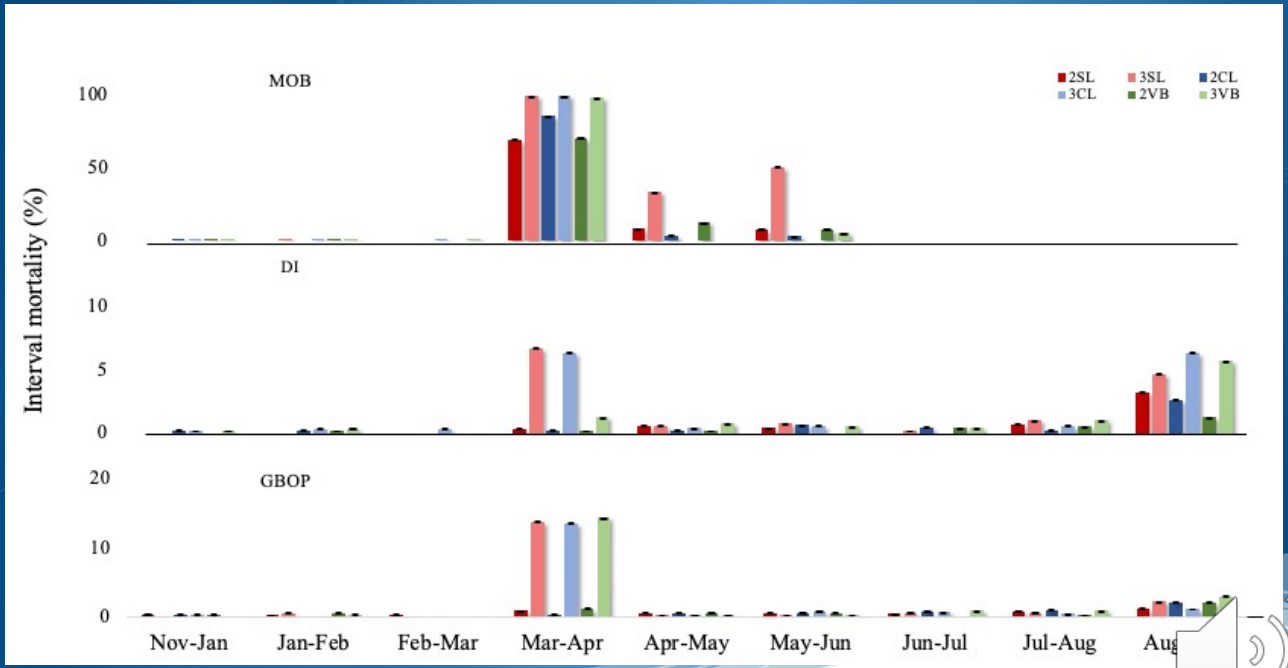
Results: Environmental Data



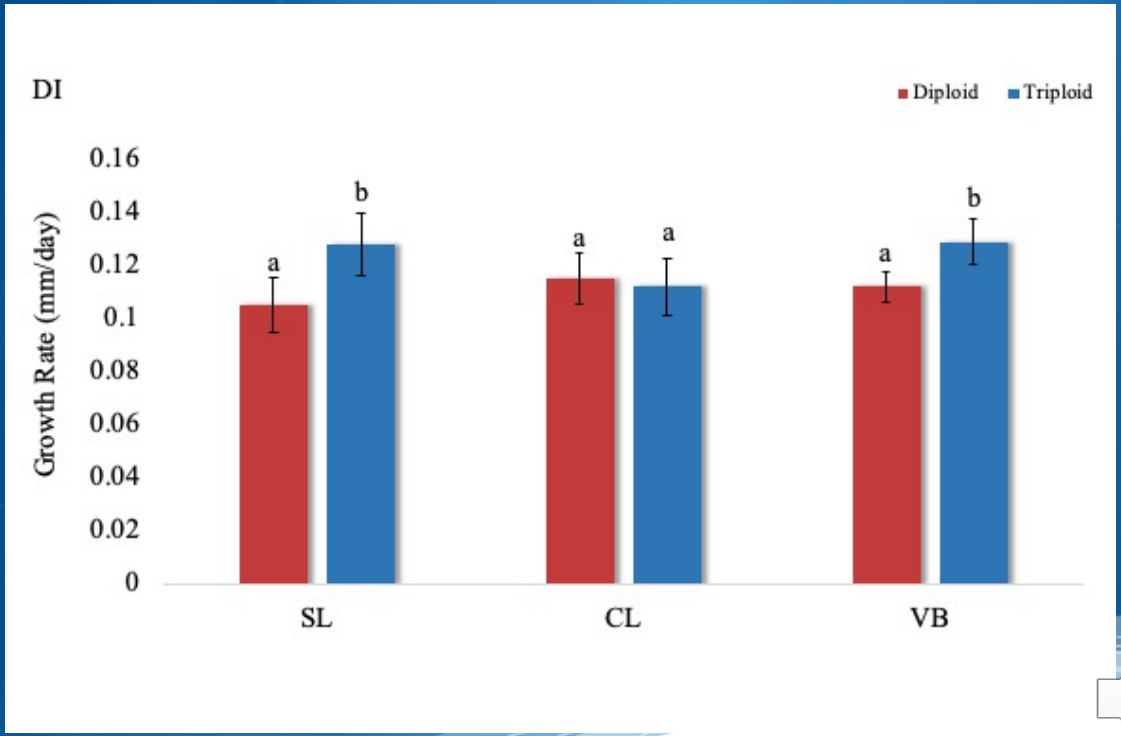
Results: Cumulative Mortality- Broodstock Origin & Ploidy



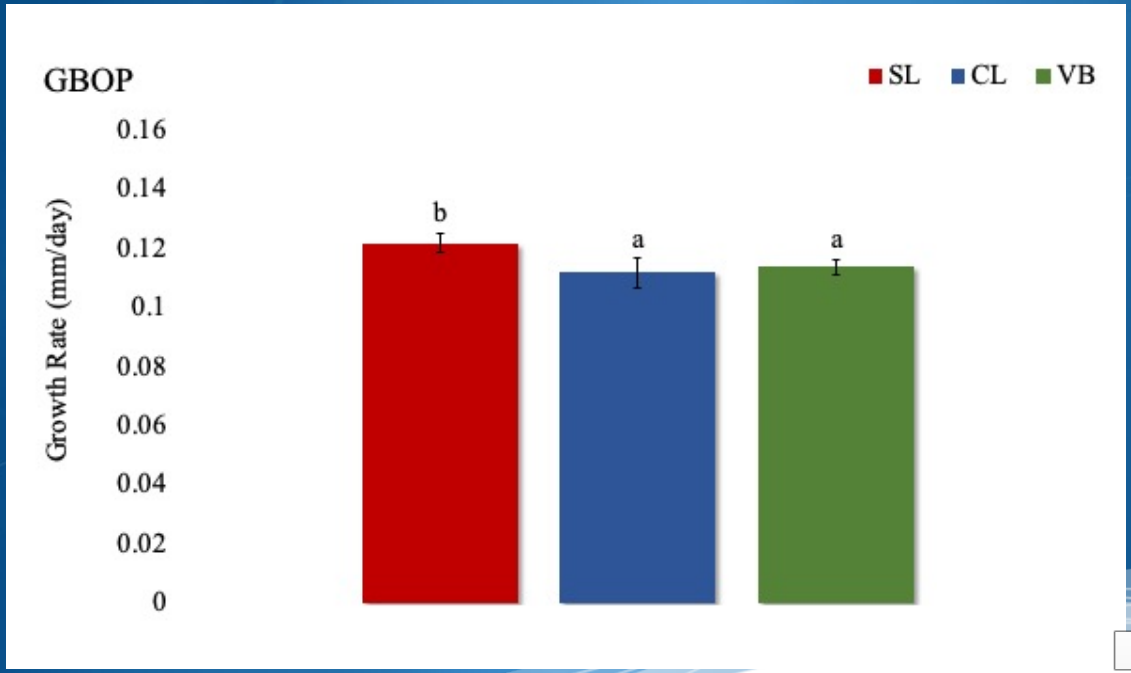
Results: Interval Mortality- Broodstock Origin & Ploidy



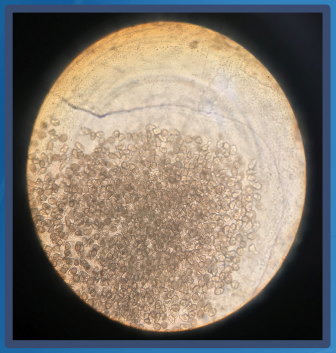
Results: Growth-Broodstock Origin & Ploidy

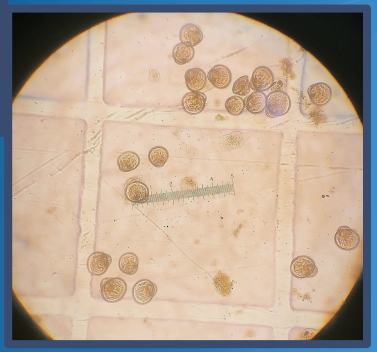


Results: Growth-Broodstock Origin & Ploidy



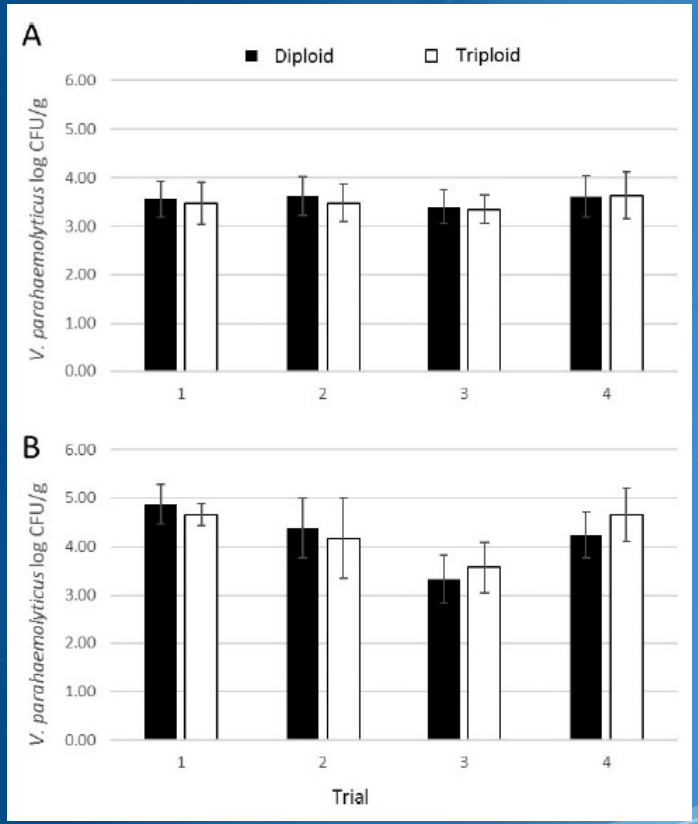
Conclusion: Broodstock x Ploidy

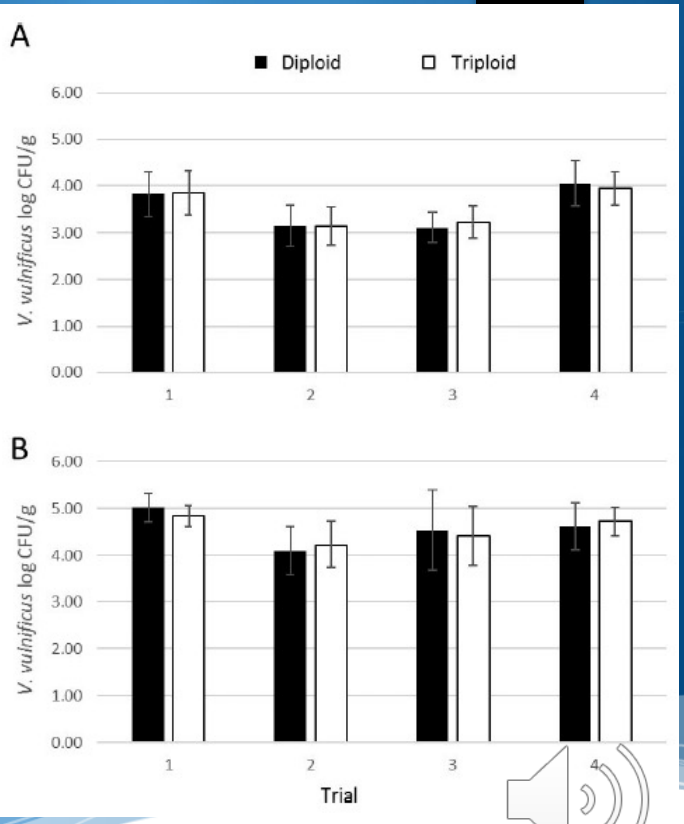




- Maternal Selection did not significantly affect mortality
- Triploids experienced higher mortality at all three sites regardless of broodstock origin
- Broodstock Origin can impact other performance aspects
- Site conditions can impact the severity of mortality
- Developing lines from local populations may help but is not always the solution

No Difference by Ploidy in *Vibrio parahaemolyticus* or *V. vulnificus*





Jones, JL, KA Lydon & **WC Walton**. 2020. Effect of ploidy on *Vibrio parahaemolyticus* and *Vibrio vulnificus* levels in cultured oysters. Journal of Food Protection 83(11).

Summary of Work to Date

- Triploids typically grow faster than diploids and often have a higher meat to shell ratio, especially in warmer months
    - Not always true, but never grew slower
- Triploids often have a higher mortality rate and appear more vulnerable to grower-imposed stress
- Maternal selection did not decrease mortality in Eastburn et al. study
- No difference in assessed Vibrio abundances between triploids and diploids (or in mudblister infestation in a separate study)
- As an aside, no observed evidence that diploids attract greater overset than triploids

Recommendations

- Consider mixed-ploidy strategy that spreads risk, while maximizing benefits of better meat condition
- Limit handling stress on oysters particularly during warmer month
- Stay up to date on latest research on selection, and other techniques that affect survival

Questions? Feel free to contact me.

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