# Addressing Oyster Mortality in Florida's Off-bottom Aquaculture Industry


UF IFAS
UNIVERSITY of FLORIDA

Leslie Sturmer, Extension
Andrew Kane, Emerging Pathogens Institute
Edward Phlips, SFFGS Fisheries
Erik Lovestrand, Florida Sea Grant Extension
Holden Harris, Nature Coast Biological Station

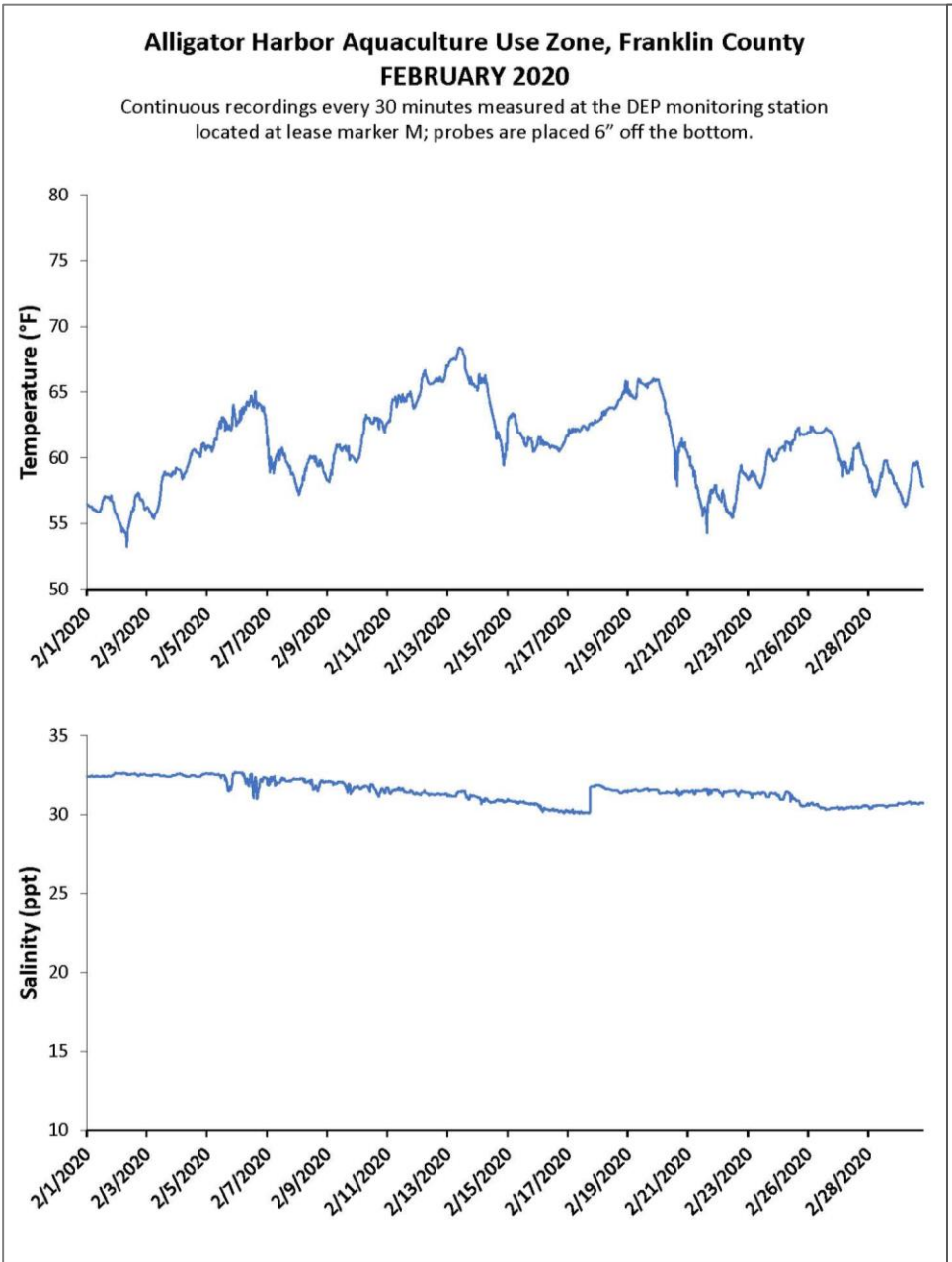
# Challenges of a new industry…

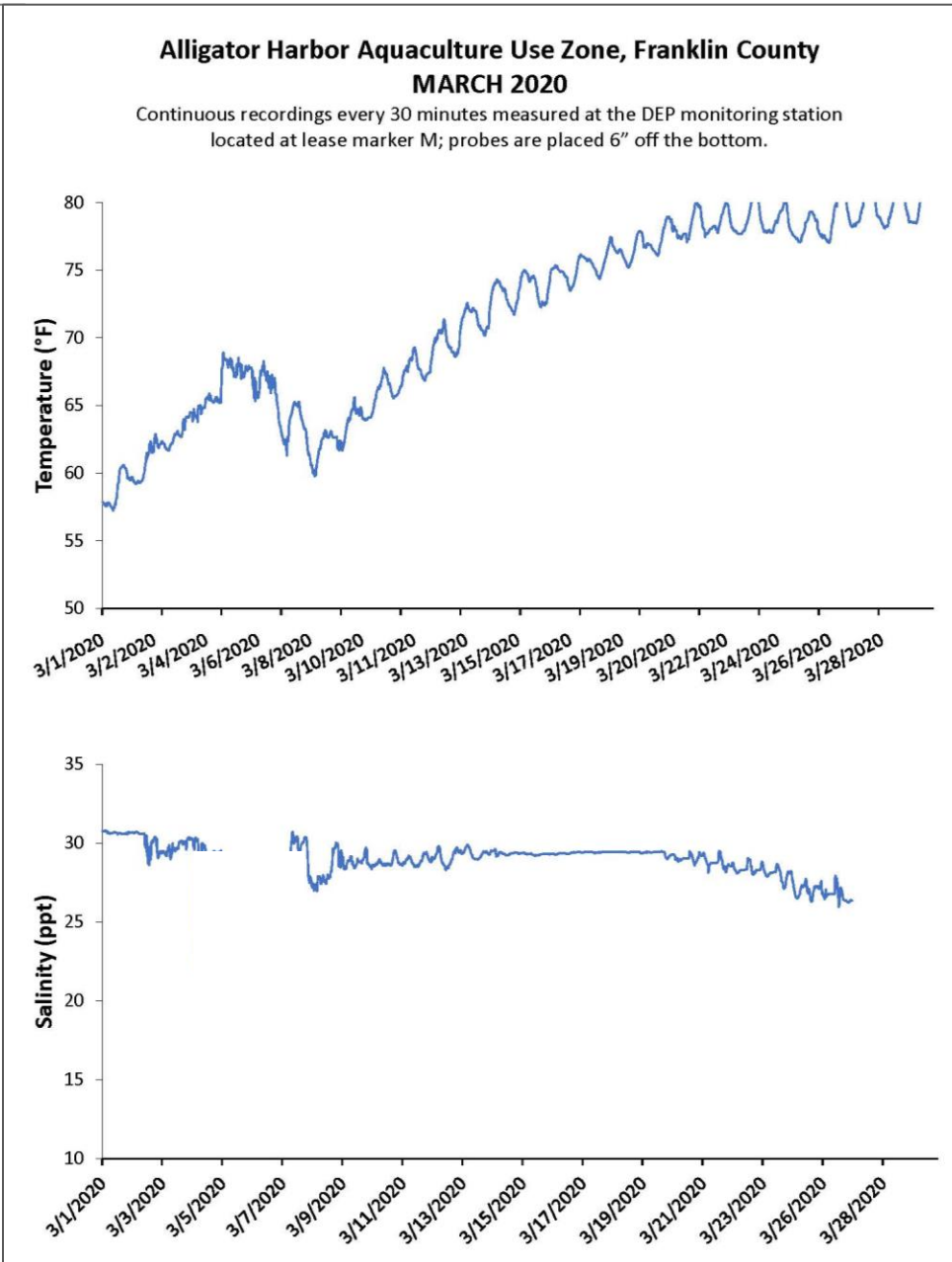
- Many: limited seed availability, year-round control of biofouling and oyster overset, risks (hurricanes, storms), economic feasibility
- **Recent unexplained oyster mortalities in late spring / early summer**
  - At some lease areas, 50-90% mortalities of triploid oysters reaching market size (2.5-3" SH)

# Mortality Events at Alligator Harbor AUZ

- Summer 2017, Spring 2019, Spring 2020
  - Both diploids and triploids
- Pathology reports – Ryan Carnegie, VIMS and Susan Laramore, HBOI-FAU
  - No MSX, Dermo or pathogens of concern
  - Gill and digestive epithelial tissue erosion
  - Increased hemocytes (defense cells)
  - Edema (excessive fluid) of connective tissue
  - Gonadal development, ripe males
- Oher observations
  - Mantle/gill abnormalities
  - Discoloration of shell caused by extensive deposits of conchiolin (organic protein matrix)
  - Associated with colonization of shell in which oyster is trying to ward off something
- Coincides with large blooms of amphipods and high siltation
- Fits model for "spring/summer" mortality

# Mortality Events at Alligator Harbor AUZ



# Addressing Oyster Mortality

**Trying to Explain Unexplained Cultured Oyster Mortalities in the Gulf of Mexico**

Wednesday, May 27 at 3 pm (EDT) / 2 pm (CDT)

A discussion on what we know about oyster mortalities in off-bottom farms along the Gulf Coast, effect of ploidy, current efforts to address mortality issues, what growers are observing and priorities for future work.

Sea Grant

Watch live via Zoom Meeting
Wednesday, May 27 at 3 pm EDT / 2pm CDT
https://auburn.zoom.us/j/97381854567

**OBJECTIVES**

1. Increase knowledge of oyster farmers about what is known about oyster mortalities along the Gulf Coast and the effect of ploidy
2. Increase awareness of current efforts to address mortality issues
3. Seek industry input about what is being observed and priorities for future work

**AGENDA**

**Welcome & Introductions: Leslie Sturmer,** *University of Florida*, **Bill Walton,** *Auburn University* **(5min)**

**What do we know about oyster mortalities? (40min)**

**Leslie Sturmer**: Florida studies comparing diploid and triploid oysters
**Bill Walton**: Alabama studies comparing diploid and triploid oysters, and studying effect of handling
**Jerome LaPeyre**, *Louisiana State University:* Current studies in Louisiana and Alabama testing effect of broodstock in different environments
**Joey Matt,** *Virginia Institute of Marine Science*: Research findings in Chesapeake Bay
**Ryan Carnegie,** *Virginia Institute of Marine Science*: Considerations beyond triploid mortality

**Q&A: Opportunity to ask questions, raise concerns, note observations (15 min)**

**Current efforts to address mortality issues (40min)**

**Tom Rossi,** *4Cs Breeding Technologies, Inc*: Development of new tetraploids
**Huiping Yang,** *University of Florida*: Development of Florida tetraploids and cryopreservation
**Scott Rikard,** *Auburn University*: Work at Auburn University Shellfish Lab
**Kelly Lucas,** *University of Southern Mississippi:* SALT Consortium efforts
**Brian Callam,** *Louisiana State University*: Current work in Louisiana
**Stan Allen,** *Virginia Institute of Marine Science*: VIMS Breeding program efforts
**Leslie Sturmer & Bill Walton**: Collaborative efforts to evaluate field performance of triploids from different broodstock

**Q&A: Opportunity to ask questions, raise concerns, note observations (15 min)**

**For more information contact:**

Bill Walton: wcw0003@auburn.edu
Leslie Sturmer: Lnst@ufl.edu
Visit: http://shellfish.ifas.ufl.edu/news/webinar-oyster-mortalities/

Began discussion with industry about unexplained cultured oyster mortalities

1) Florida oyster growers' meeting, January 2020
   - Possible causes discussed
   - Consensus not reached
   - Agreed systematic approach needed to understand factors

2) Gulf of Mexico oyster growers' workshop, May 2020
   - What is known and not known
   - Increase awareness of efforts
   - Seek industry input
   - Priorities for future work

Video and presentations available at
https://shellfish.ifas.ufl.edu/oyster-culture/unexplained-cultured-oyster-mortalities-gom/

# Addressing Oyster Mortality

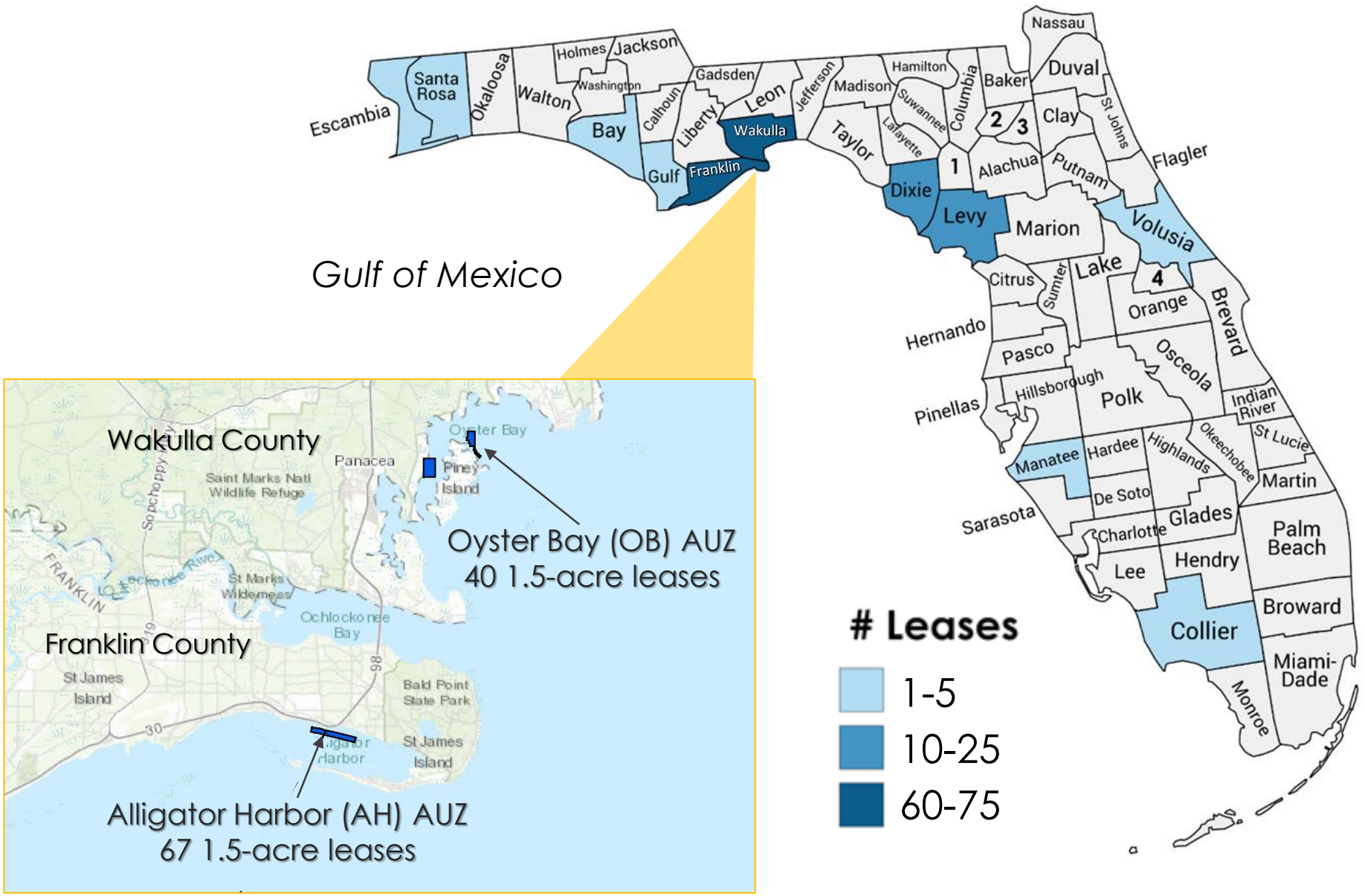
Study initiated to determine basic but key relationships between production and health of cultured oysters and environmental factors, 2020-21

OBJECTIVES:

1) Monitor oyster production at two commercial lease areas
2) Examine water quality parameters and phytoplankton abundance
3) Assess prevalence and severity of shell parasitism and Dermo disease

*Funded by: UF/IFAS Support for Emerging Enterprise Development Integration Teams (SEEDIT) program*

# Oyster "sentinel" farms established



# Seed Production

- Oysters spawned at Auburn University Shellfish Lab, May 2020
- Two triploid lines (stocks)
  - 2N ♀ x traditional LSU 4N ♂
  - 2N ♀ x new Florida 4N ♂
  - Half-siblings
- Allowed for evaluation of performance of two genetic lines

- Seed land-based nursed by UF in Cedar Key, June –September
- R12 (seed retained on 12 mm screen) target size

# Seed Distribution, Stocking and Gear

- Seed distributed: Sept 29, 2020
- 1,050 seed of each line per grower
- Average size:
  - FL: 20.7 mm SH, 1.4 grams WWW
  - LA: 18.8 mm SH, 1.4 grams WWW
- Deployed in 9mm Vexar bag
- Bags supported by floats
- Growers maintained oysters during culture period

# Sampling and Harvesting

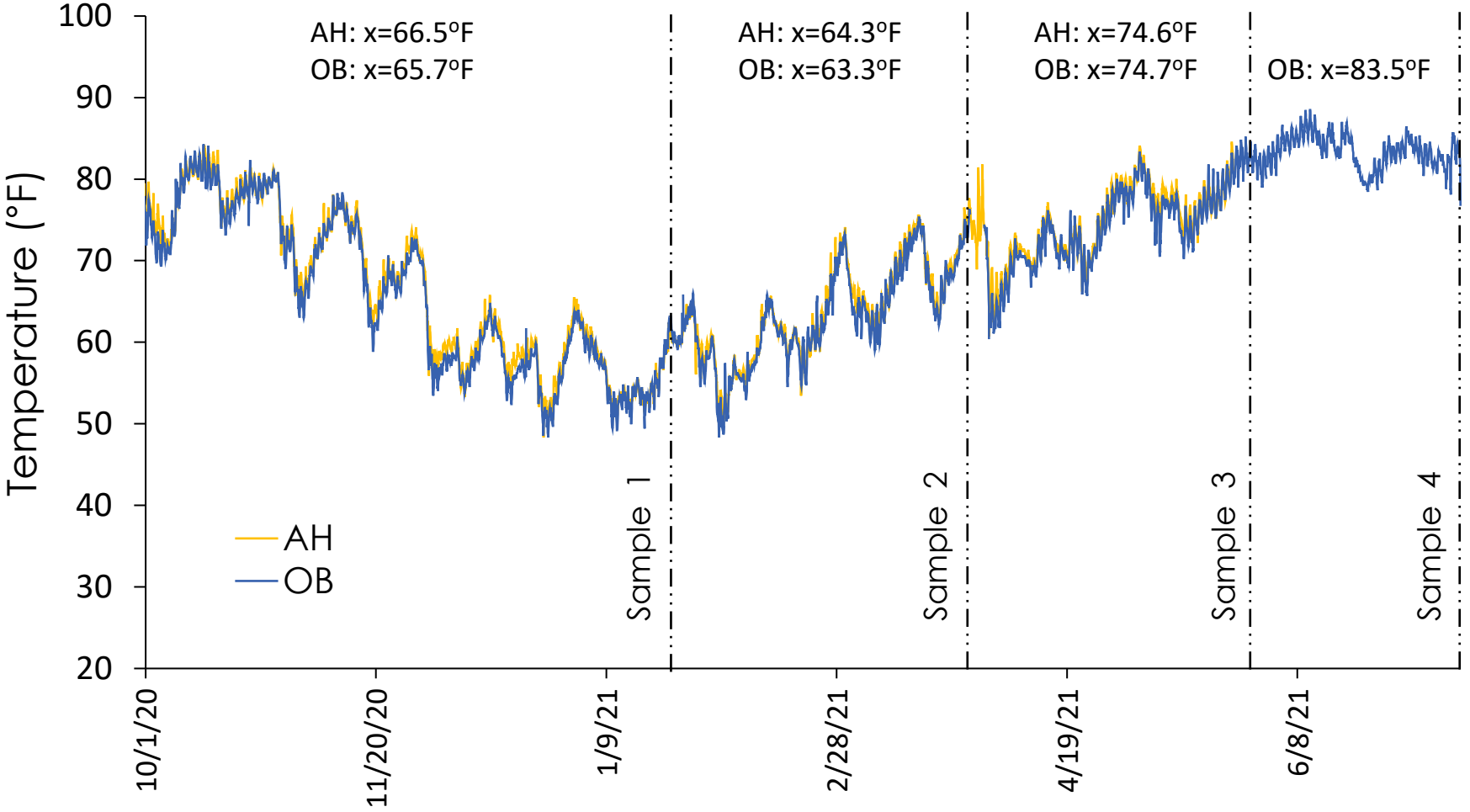
- Initiated sampling 4 months post-deployment
  - **Sample period 1**
    AH & OB: January 25-26
- Bimonthly until oysters reached market size (70-75 mm SH)
  - **Sample period 2**
    AH & OB: March 29-30
  - **Sample period 3**
    AH: May 25 - Harvest
    OB: June 1
  - **Sample period 4**
    OB: July 13 - Harvest

# Monitoring

- Water temperature and salinity
  - AH: YSI 6600 sonde maintained by DEP
  - OB: Onset HOBO temperature and conductivity loggers place in bag
- Growth and mortality
  - Measure shell height (SH), whole wet weight (WWW), n=15 per replicate bag
  - Count live and dead oysters, n=1-7 bags
  - Harvest: SL, SW, MW, DMW, CI, n=15-40
- Health
  - Oysters (n=12) per stock per grower collected each sampling period
  - Analyzed at UF Aquatic Pathobiology Lab
- Phytoplankton quality and quantity
  - Kits provided to grower per lease area
  - Water collected weekly, March-July
  - Two sets per month analyzed at UF Algal Lab


# Water Temperature (°F)

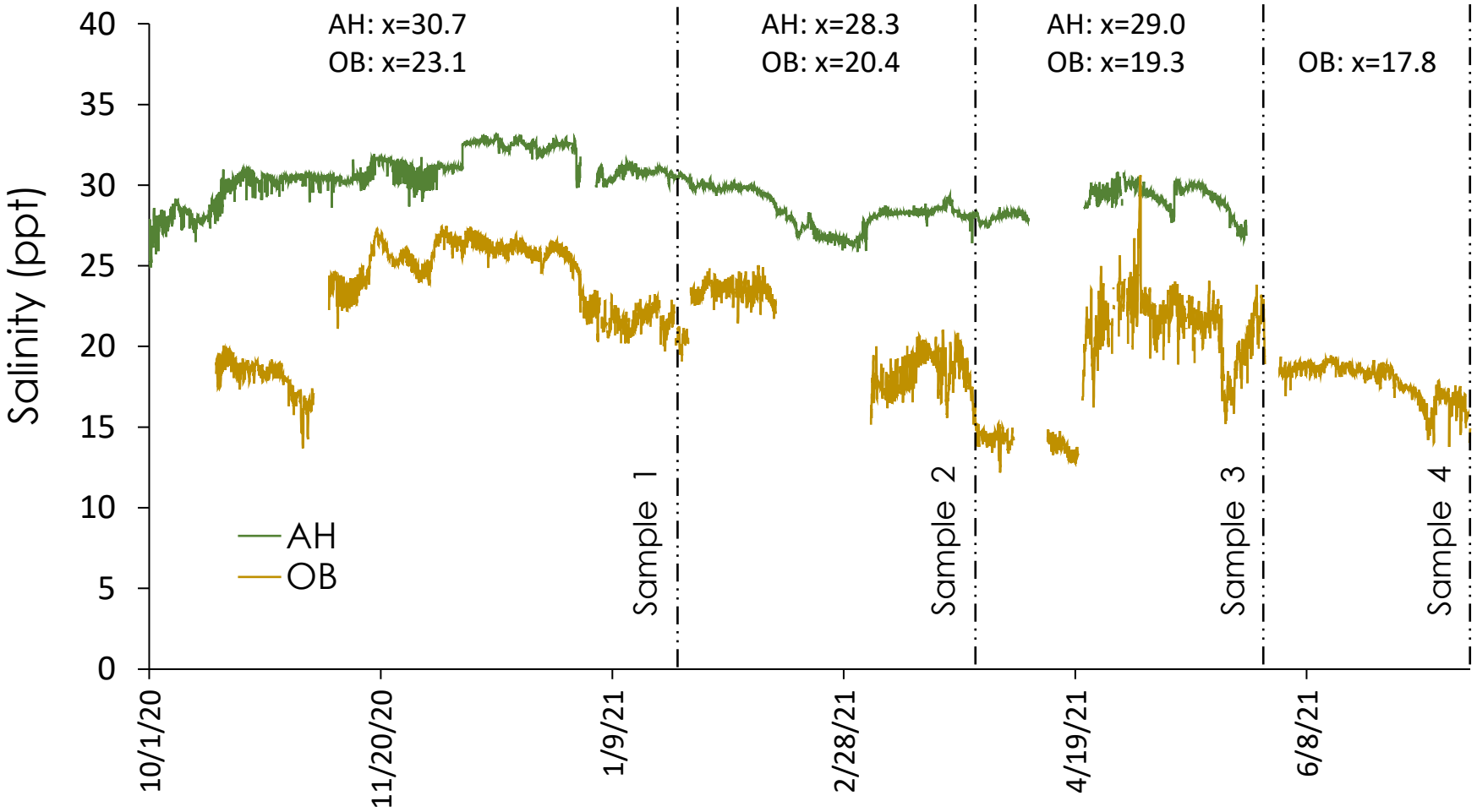
Alligator Harbor (AH): Oct 1, 2020 – May 25, 2021
Oyster Bay (OB): Oct 1, 2020 – July 13, 2021




Temperatures similar between lease areas - declining through sample period 1, increasing in sample periods 2, 3 &4, following expected seasonal patterns.

# Water Salinity

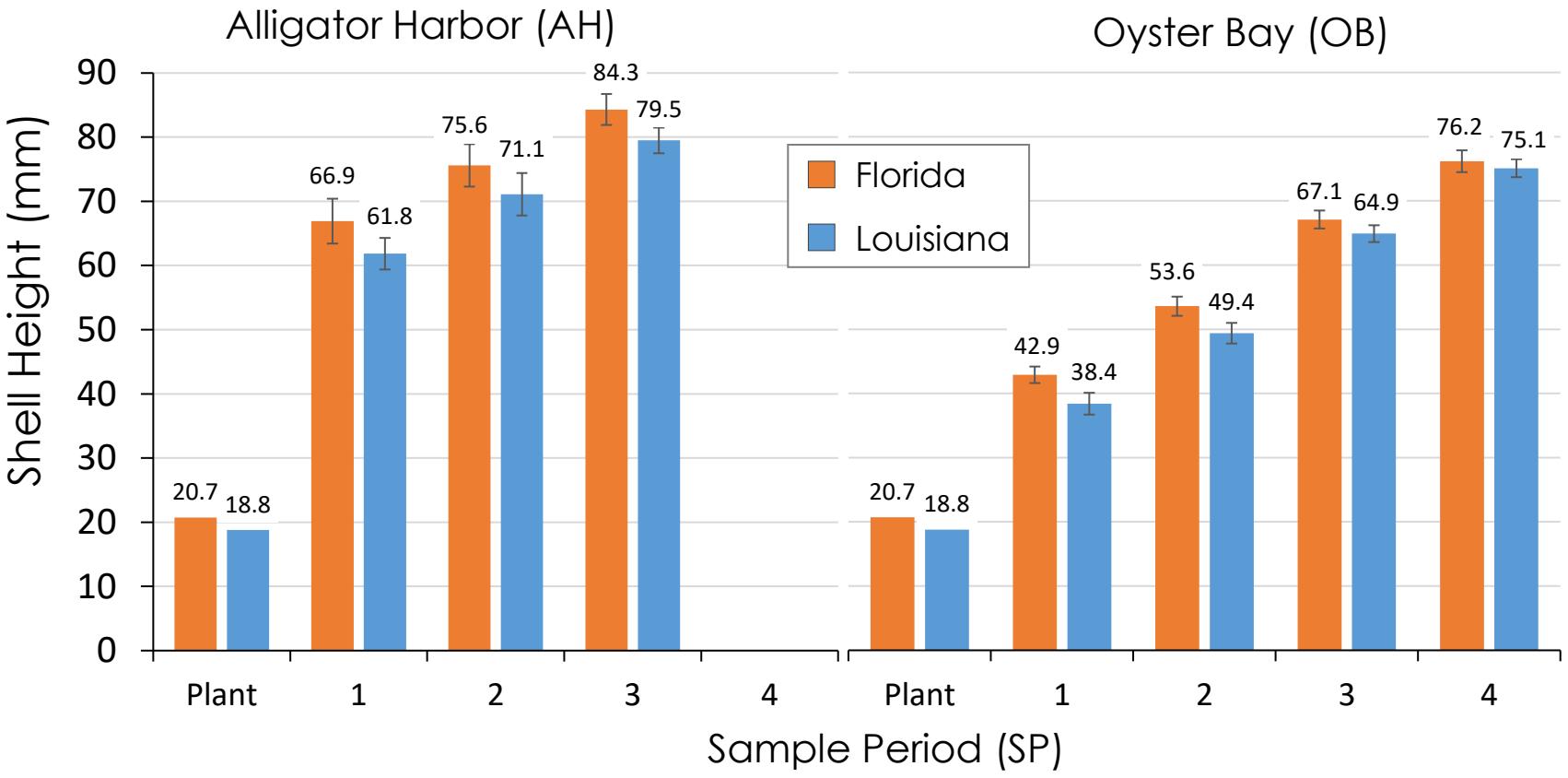
Alligator Harbor (AH): Oct 1, 2020 – May 25, 2021
Oyster Bay (OB): Oct 1, 2020 – July 13, 2021




Salinities at AH high with little variation among seasons. OB is a lower salinity site with variations over culture period due to riverine influence, runoff and prevailing winds.

# Growth: Shell Height (mm)

Plant: Sept 29, 2020
Harvest: May 25, 2021-AH / July 13, 2021-OB
Error Bars: 95% Confidence limits

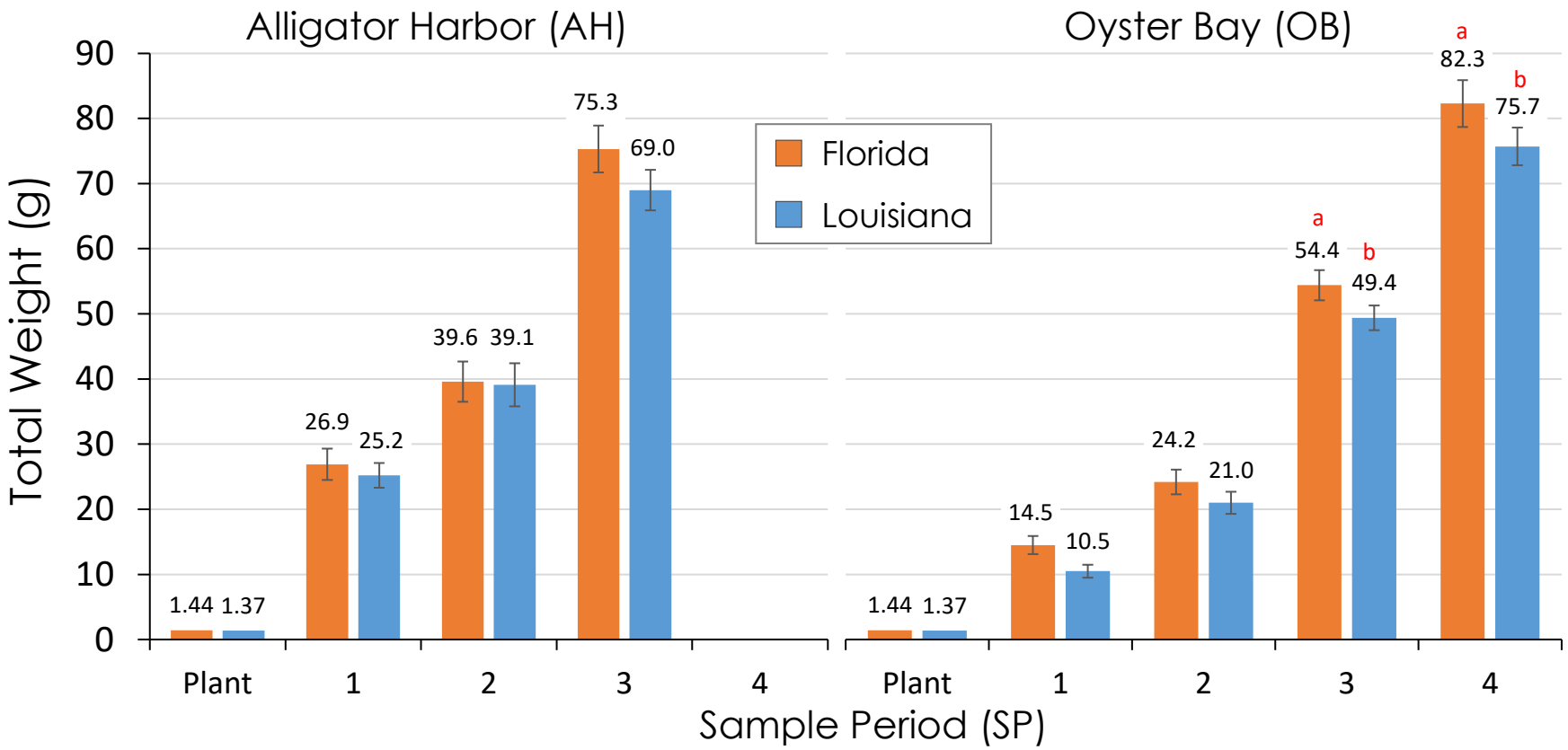



- Greatest growth: AH - 0.38 mm/day over SP1, OB - 0.23 mm/day over SP3
- Market size oysters (~75 mm SH): AH - 6 months in SP2, OB - 9.4 months in SP4
- No significant differences ($p$>0.05) between triploid stocks at both locations

# Growth: Whole Wet Weight (g)

Plant: Sept 29, 2020
Harvest: May 25, 2021 – AH / July 13, 2021 - OB

Error Bars: 95% confidence limits




- Greatest weight gain over last sample periods for each location:
  AH - 0.53 (LA) to 0.64 (FL) g/day) / OB - 0.63 (LA) to 0.66 (FL) g/day
- Significant differences ($p<0.05$) between triploid lines in SP3&4 at Oyster Bay

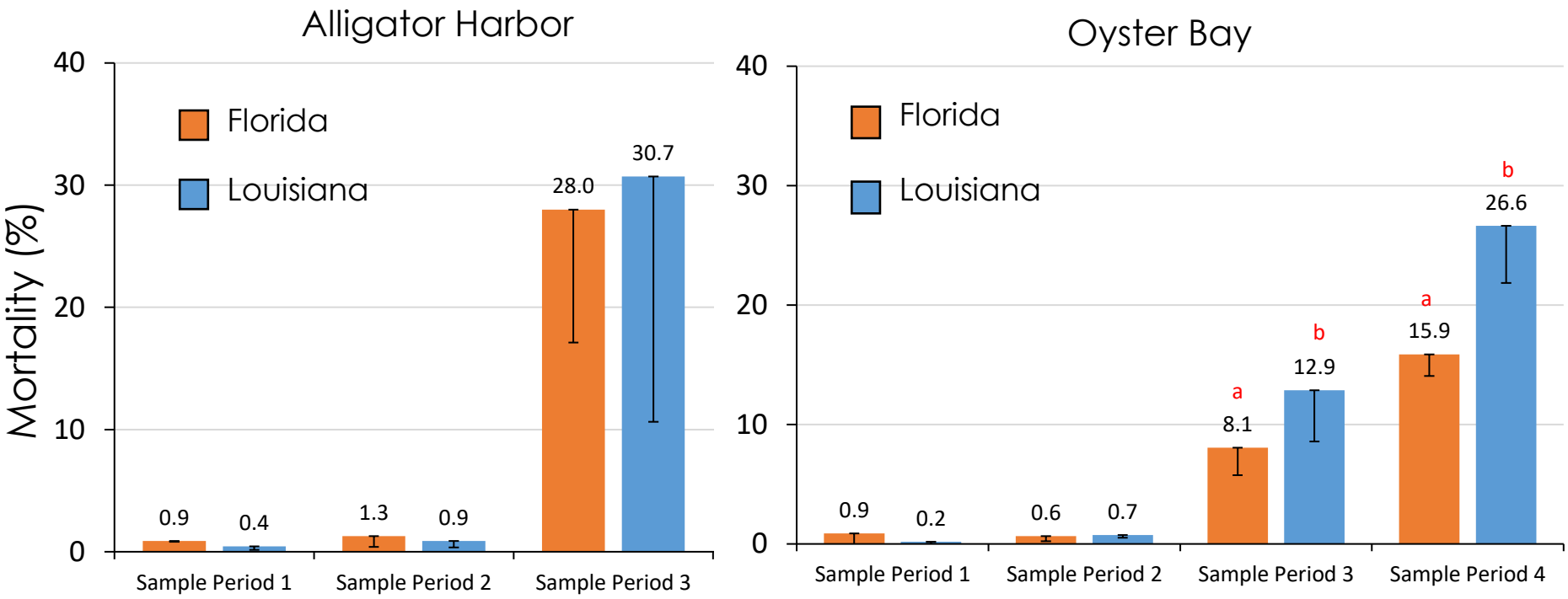
# Other Metrics at Harvest

Plant: Sept 29, 2020
Harvest: May 25, 2021-AH / July 13, 2021-OB

| Site | Alligator Harbor | | Oyster Bay | |
|---|---|---|---|---|
| Stock | Florida | Louisiana | Florida | Louisiana |
| Wet Meat Weight (g) | 7.7 | 6.4 | 9.6 | 8.8 |
| Fan Ratio | 0.64 | 0.69 | 0.75 | 0.75 |
| Cup Ratio | 0.31 | 0.29 | 0.38 | 0.36 |
| Condition Index | 9.3 | 8.6 | 8.7 | 8.4 |

Fan Ratio = SL/SH, preferred >0.66 / Cup Ration = SW/SH, preferred ratio >0.33


# Oyster Mortality (%)




Both Locations

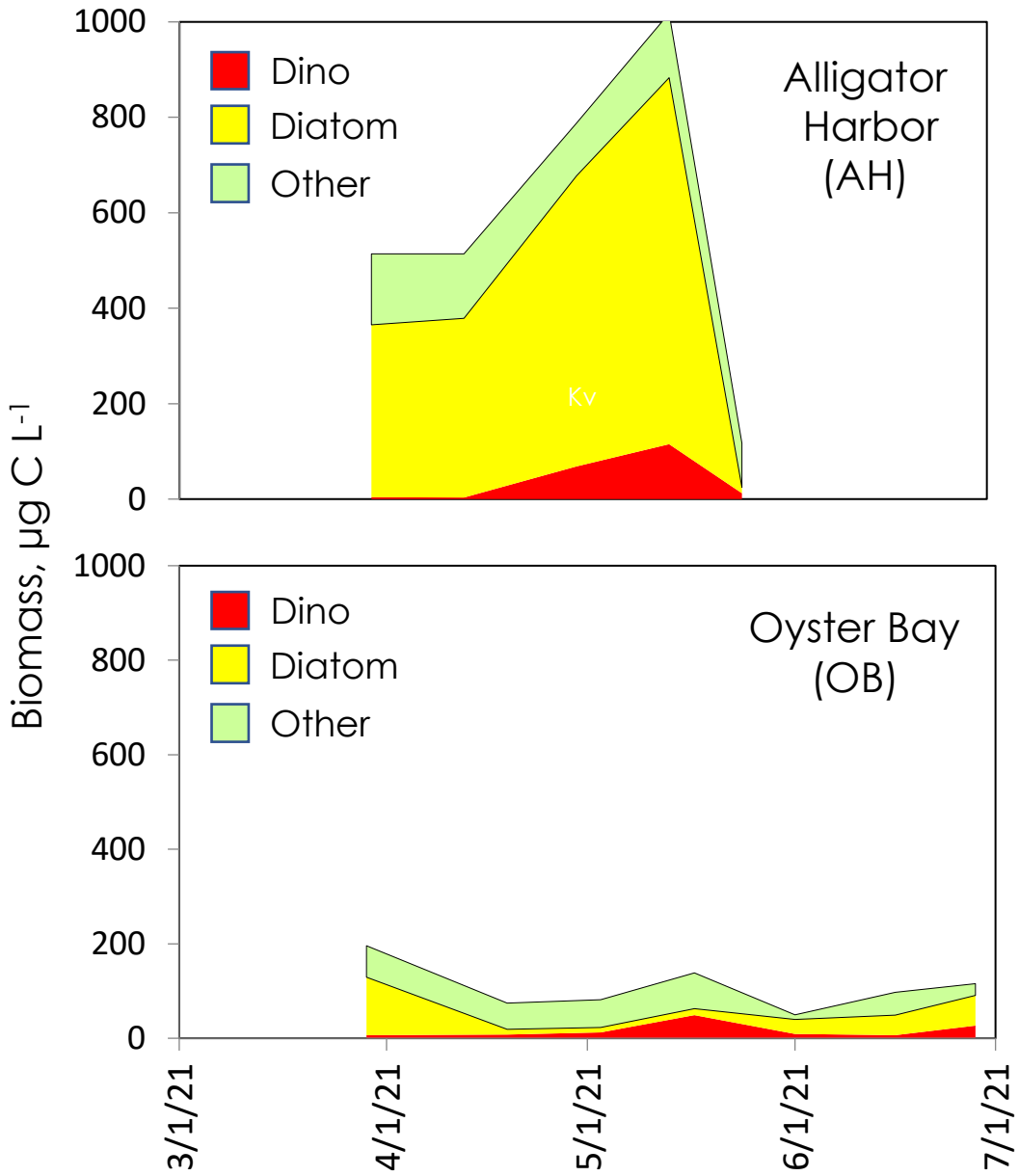
- Negligible (<2%) over first two sample periods / Highest interval mortality over last sample periods

Alligator Harbor

- Cumulative (7.8 months): 30.2% FL – 32.0% *LA* / No differences between genetic stocks

Oyster Bay

- Cumulative (9.4 months): 25.4% FL – 40.1% LA / Significant stock differences ($p<0.05$) at SP3&4




# Phytoplankton Biomass

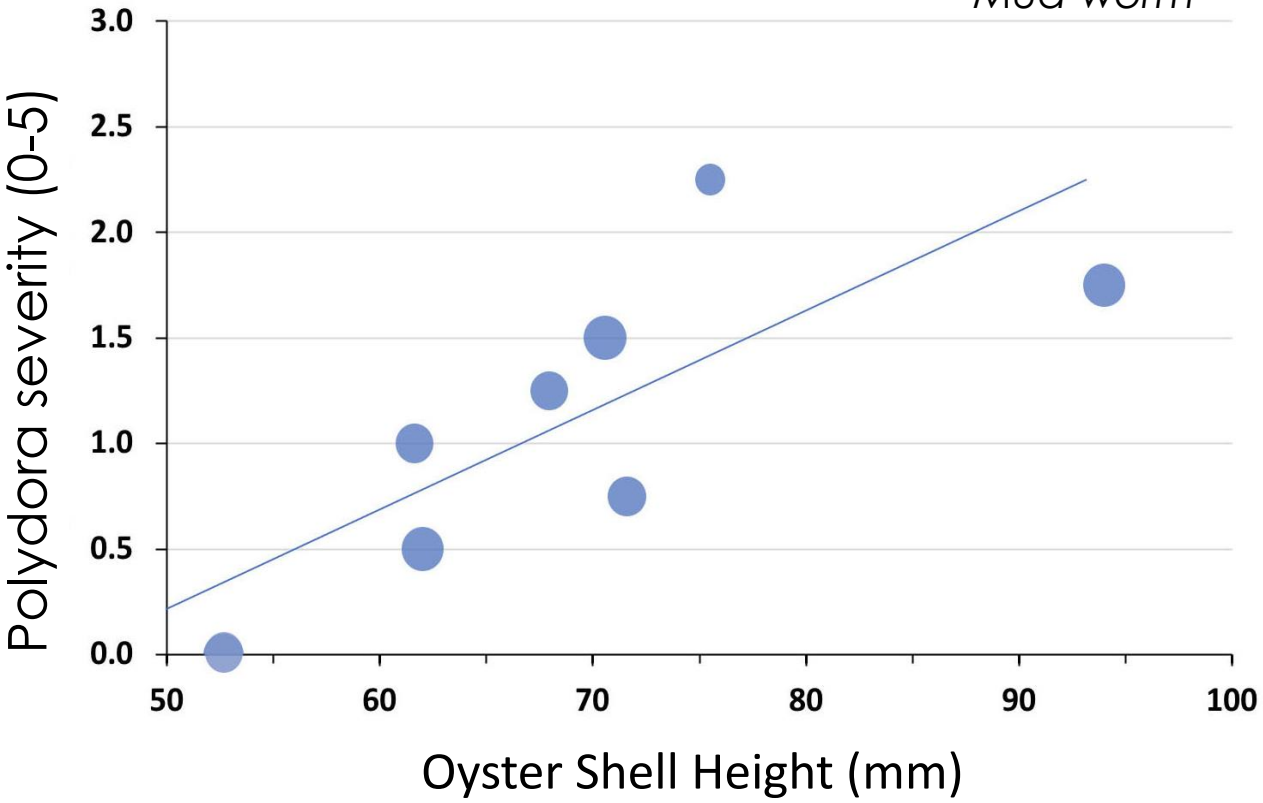
- Mean total values
  - AH: 590 µg carbon/L
  - OB: 108 µg carbon/L
  - Values 4.5 times higher at AH than OB
- Dinoflagellate biomass below that associated with HAB events
  - AH: 6.3% / OB: 15.7%
- Diatoms were major species, considered positive in food webs
  - AH: 61.3% / OB: 38.9%
- Other taxa dominated by nanoplanktonic species
  - AH: 32.4% / OB: 44.4%

# Health: Polydora shell parasitism

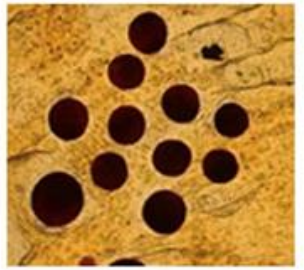
All locations and stocks –

- Prevalence increased from 57% (SP1) to 81% (SP4)
- Severity scores ranged from 0.44 (SP1) to 0.9 (SP4) out of 5, relatively mild
- Both increased with shell height

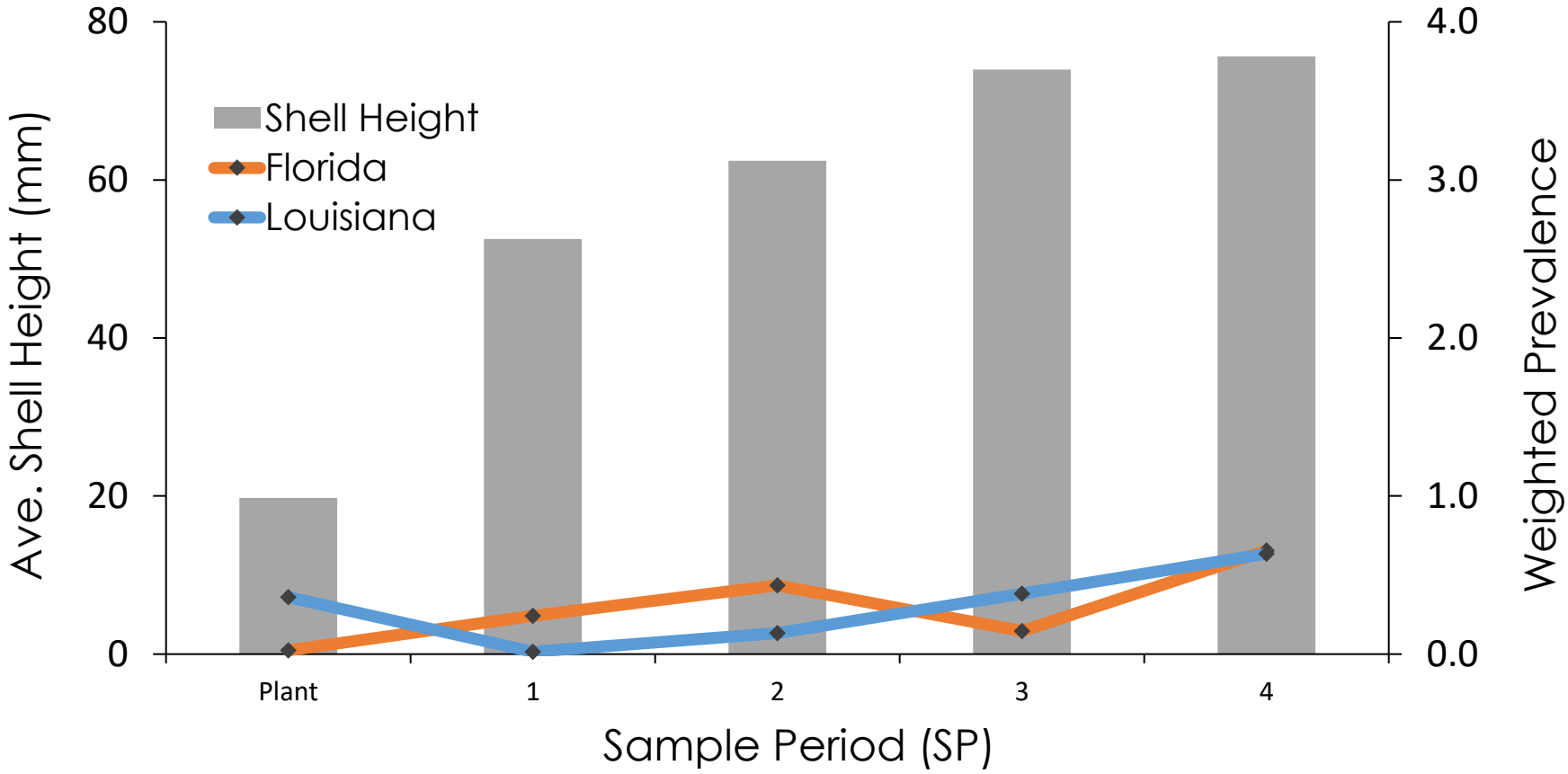
*Mud worm*



# Health: Dermo disease



Weighted Prevalence (prevalence * severity)




- WP <1.0 on a scale of 0-5 for all SPs and stocks, "mild" infection
- Differences in stocks varied by SP but not significantly ($p>0.05$)
- Prevalence and severity increased with SH across locations and stocks

# SUMMARY: Growth Relationships*

- A statistical framework used to examine how environmental, health and site factors affected oyster responses
- Shell growth (SH) rates were significantly affected by sample period (culture period), lease location, and their interaction
- At AH, rate in was higher (1.6 to 2.7 times) over first 4 months (Sept-Jan, SP1) than other periods and at OB
- During Feb-June (SP2&3), rates were higher at OB compared to AH
- Salinity influenced growth with no effect from temperature, health, or stocks

* Generalized linear model (GLM) used, regression models fit with normal error distributions using identity link, pairwise comparisons between significantly different means examined post-analyses with Tukey test

# SUMMARY: Growth Relationships*

- AH had higher weight (WWW) growth rates compared to OB
- Rates at both sites increased significantly over the culture period, effect was 3-5 times greater than differences between farm locations
- Higher temperatures and salinities affected weight gain
- No effects from health indices
- Ploidy stock influenced weight gain at OB with FL triploids having significantly higher rates** than LA triploids

* Generalized linear model (GLM) used, regression models fit with normal error distributions using identity link, pairwise comparisons between significantly different means examined post-analyses with Tukey test

** T-test used to determine effects of stocks (OB, SP2: $p$=0.033; SP3: $p$=0.047)

# SUMMARY: Mortality Relationships*

- Mortality rates increased over time, duration of culture period (SP) was strongest effect observed
- OB had lower mortality compared to AH (SP2&3) with a significant interaction between farm location and sample period
- Higher salinities and higher water temperatures influenced mortality
- Dermo significantly higher in last sample period, did not demonstrate any patterns related to mortality, no effects from *Polydora* on mortality
- Florida triploids demonstrated lower mortality than Louisiana triploids
- Differences between genetic stocks indicate potential to develop a line with higher resistance to environmental stressors and mortality events

* GLM used a logistic model with a logit link, significant fixed effects in models identified by simplifying from full models using backwards step-wise removal of least significant term to produce minimum adequate model, Laplace approximation used to estimate likelihood and test statistics based on GLM fitting and interference protocols

# Management Implications

- Awareness of stressful environmental conditions
- Harvest larger oysters prior to late spring / early summer
- Minimize handling stressors
- Reduce stocking densities
- Evaluate diploid and triploid stocks

## Thanks to the participating growers!

Photograph courtesy Steven Gray