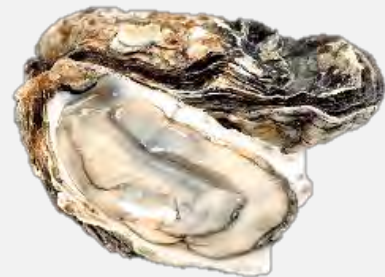




A FARMS Approach to Address Mortality in Florida's Off-bottom Oyster Aquaculture Industry



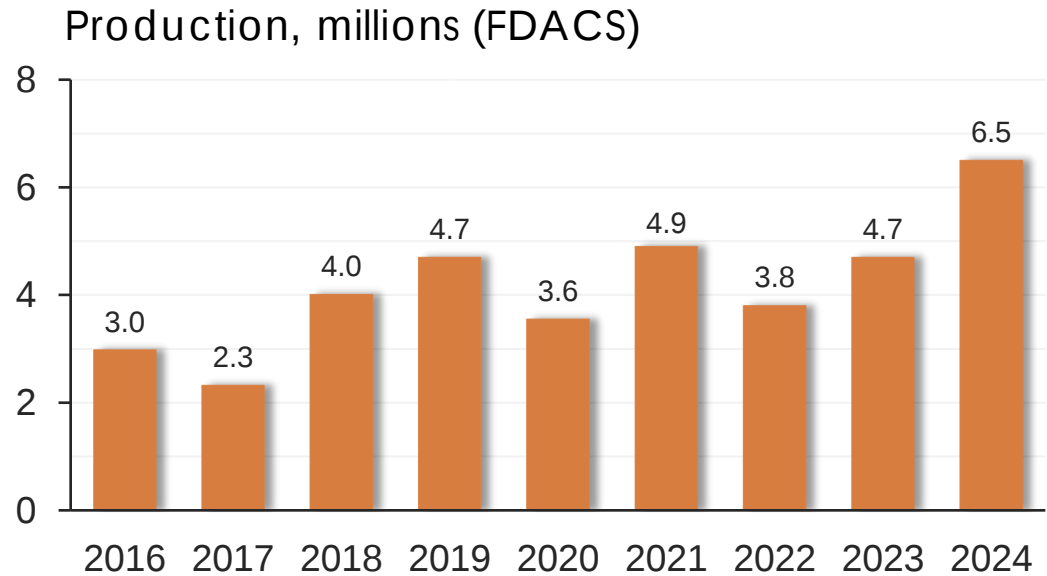
Leslie Sturmer
Shellfish Aquaculture Extension
John Roberts
College of Veterinary Medicine



Florida Off-bottom Oyster Culture: An Emergent Industry

By the numbers...

- Initiated in 2014
- >120 growers in 11 coastal counties
- \$10.5 million in sales value (USDA 2023)



Attributes

- Year-round growth
- Crop period of 8-10 months

Challenges

- Seed availability
- Storms / hurricanes
- Spring / summer unexplainable mortalities

Mortality Events at Alligator Harbor AUZ

- Spring-Summer 2017, Spring 2019, Spring 2020
 - Both diploids and triploids
- Pathology reports – Ryan Carnegie, VIMS and Susan Laramore, FAU-HBOI
 - No MSX, Dermo or pathogens of concern
 - Tissue erosion, edema, increased hemocytes
 - Gonadal development
- Fits model for “Spring/summer Unexplainable Mortality Syndrome” (SUMS)
 - Environmental stressors presenting acute challenge
 - Compounding stress of peak reproductive development



Addressing Oyster Mortality, 2020



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.



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 concerning mortality events with industry

- 1) Florida oyster growers' meeting, January 2020
 - Possible causes discussed
 - Consensus not reached
 - Agreed systematic approach needed to understand factors
- 2) Gulf oyster growers' workshop, May 2020
 - What is known and not known
 - Increase awareness of efforts
 - Seek industry input
 - Priorities for future work

<https://shellfish.ifas.ufl.edu/oyster-culture/unexplained-cultured-oyster-mortalities-gom/>

Addressing Oyster Mortality, 2020-21



Pilot study to evaluate relationships between production, health of cultured oysters, and environmental factors

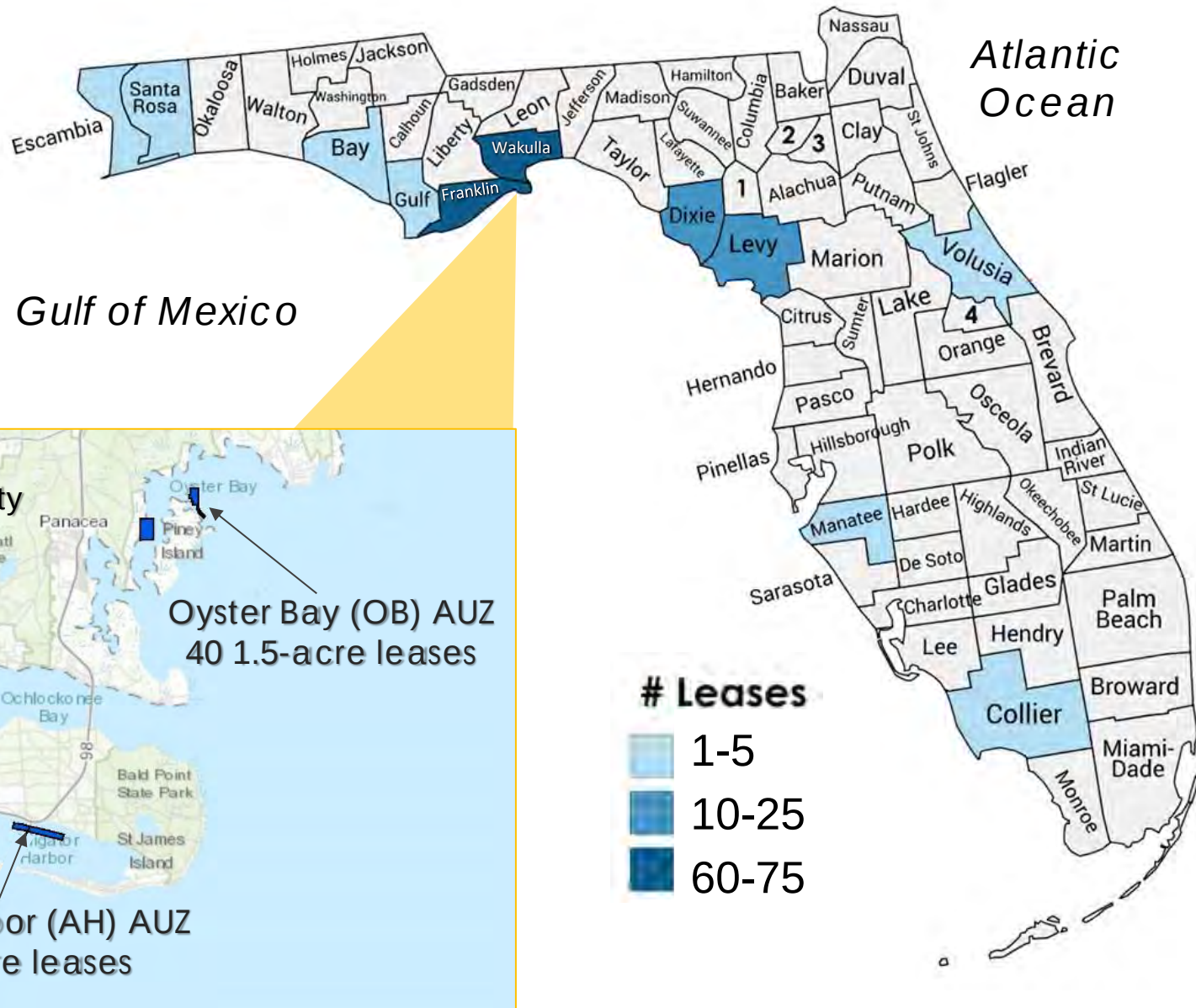
OBJECTIVES:

- 1) Monitor oyster growth and survival at two lease areas
- 2) Compare performance of FL versus LA triploids
- 3) Examine water quality and phytoplankton abundance
- 4) Assess shell parasitism and Dermo disease

UF/IFAS Team: Leslie Sturmer, Extension
Andrew Kane, Emerging Pathogens Institute
Edward Philips, SFFGS Fisheries
Holden Harris, Nature Coast Biological Station

*Funded by: UF/IFAS Support for Emerging Enterprise
Development Integration Teams*

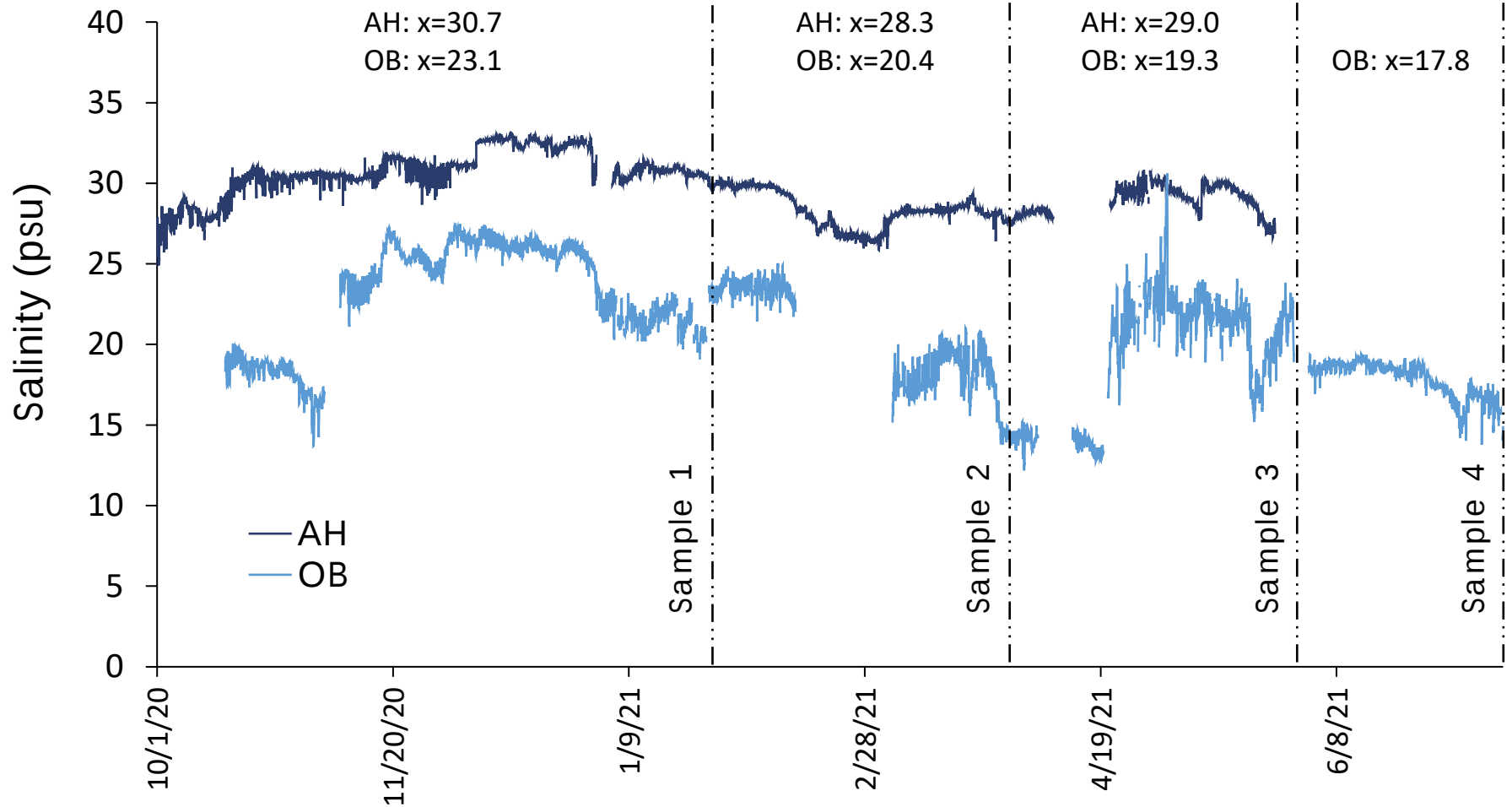
Oyster “sentinel” farms identified



Water Salinity

Alligator Harbor (AH): Oct 1, 2020 – May 25, 2021

Oyster Bay (OB): Oct 1, 2020 – July 13, 2021



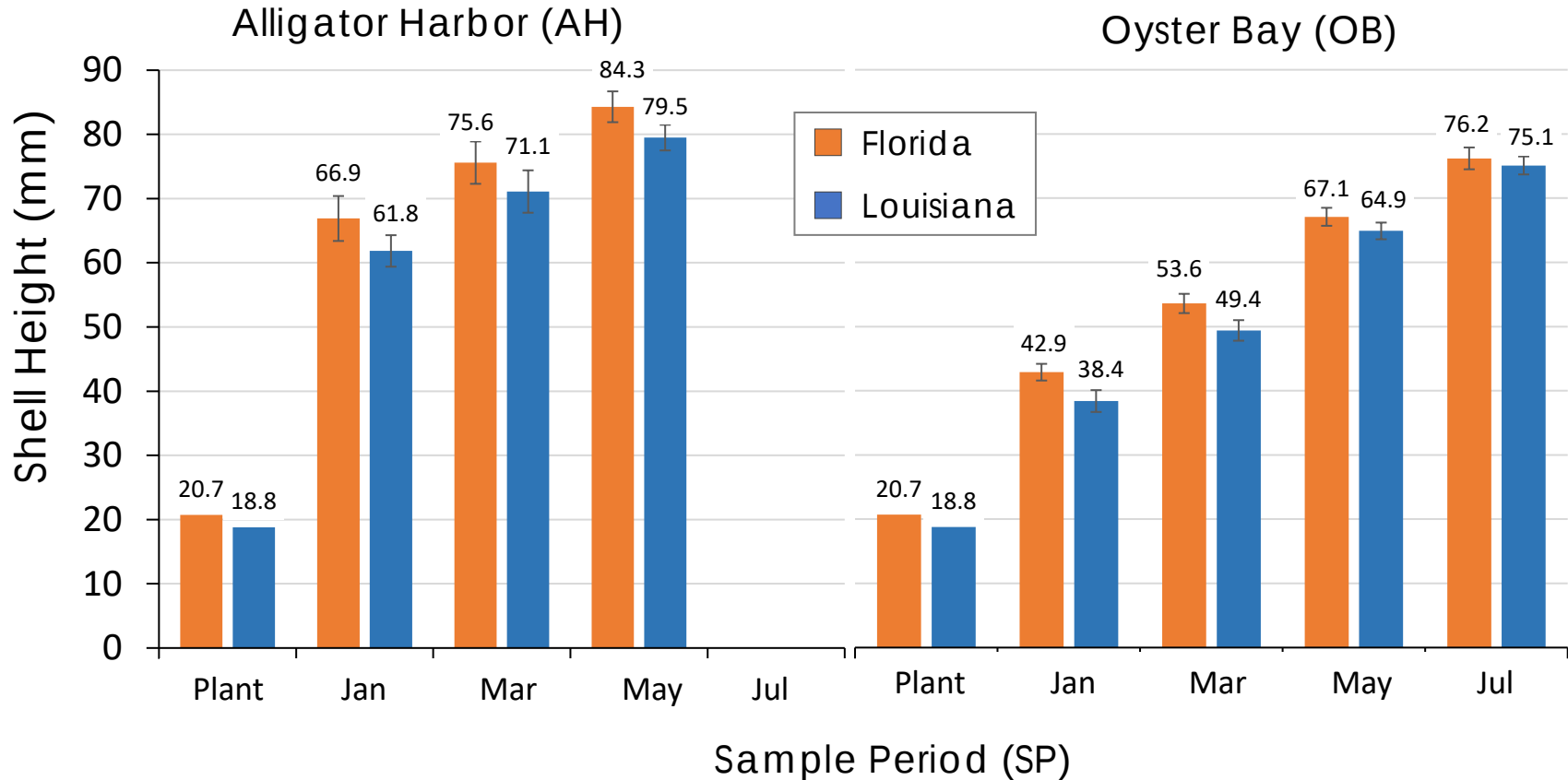
Salinities at AH high with little variation among seasons. OB is a lower salinity site with variations over culture period due to riverine influence, runoff and prevailing winds.

Growth: Shell Height (mm)

Plant: Oct 1, 2020

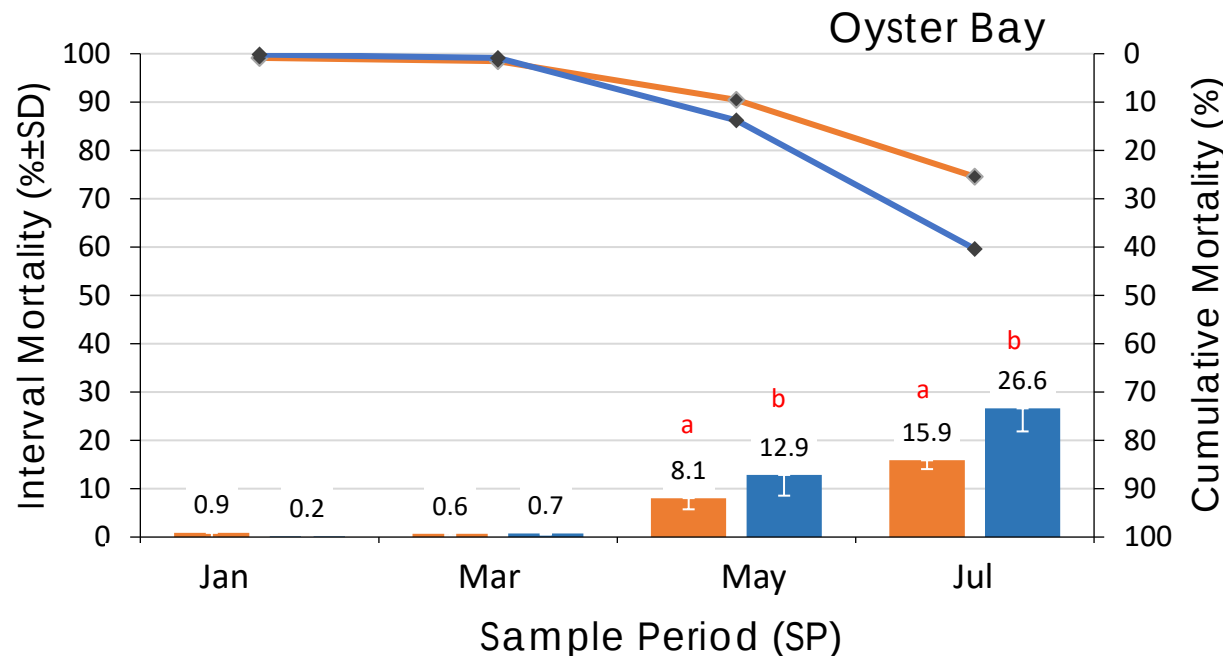
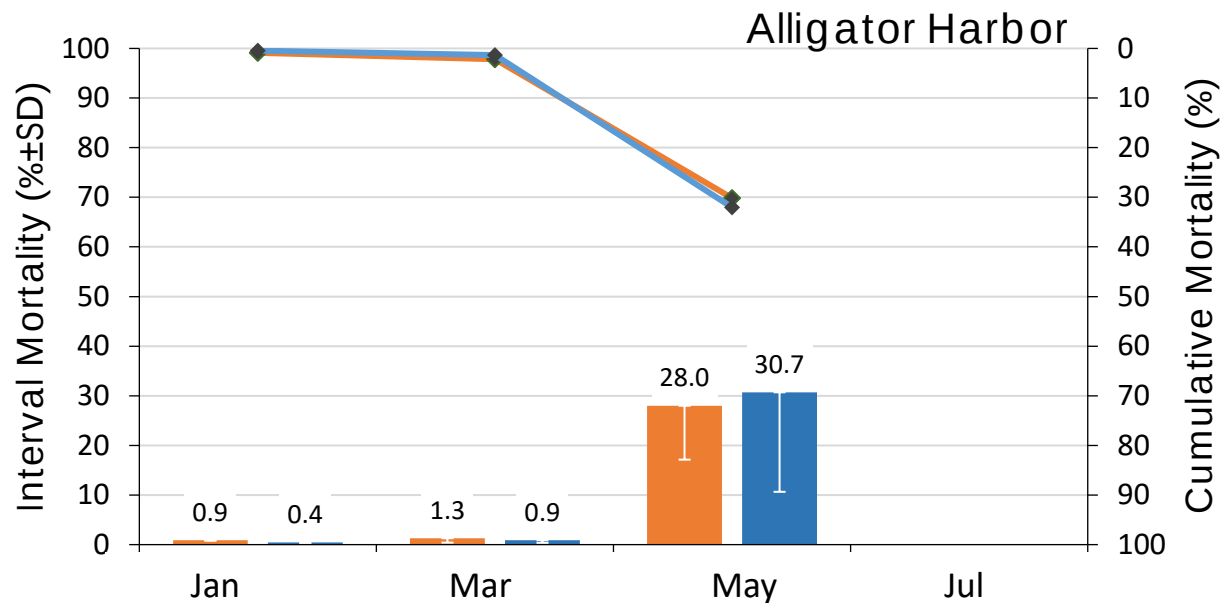
Harvest: May 25, 2021-AH / July 13, 2021-OB

Error Bars: 95% Confidence limits



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

Mortality (%)



■ FL Interval
 ■ LA Interval
 ◆ FL Cumulative
 ◆ LA Cumulative

Locations and Stocks

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

Alligator Harbor

- Increased to 28-31% in SP3
- Cumulative (7.8 months): 30.2% FL – 32.0% LA
- No differences between genetic stocks

Oyster Bay

- Increased to 8-13% in SP3, doubled in next SP
- Cumulative (9.4 months): 25.4% FL – 40.1% LA
- Significant genetic stock differences ($p < 0.05$)

SUMMARY:

Mortality Relationships*

- Mortality rates increased over time, SP strongest effect
- Lower mortality at OB compared to AH (SP2&3), significant interaction between location and SP
- Higher salinities and temperatures influenced mortality
- Dermo higher in SP4, did not demonstrate any pattern related to mortality, nor did Polydora
- Lower mortality in FL triploids than LA triploids
- Differences in genetic stocks indicate potential to bred higher resistance to environmental stressors

* 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 inference protocols

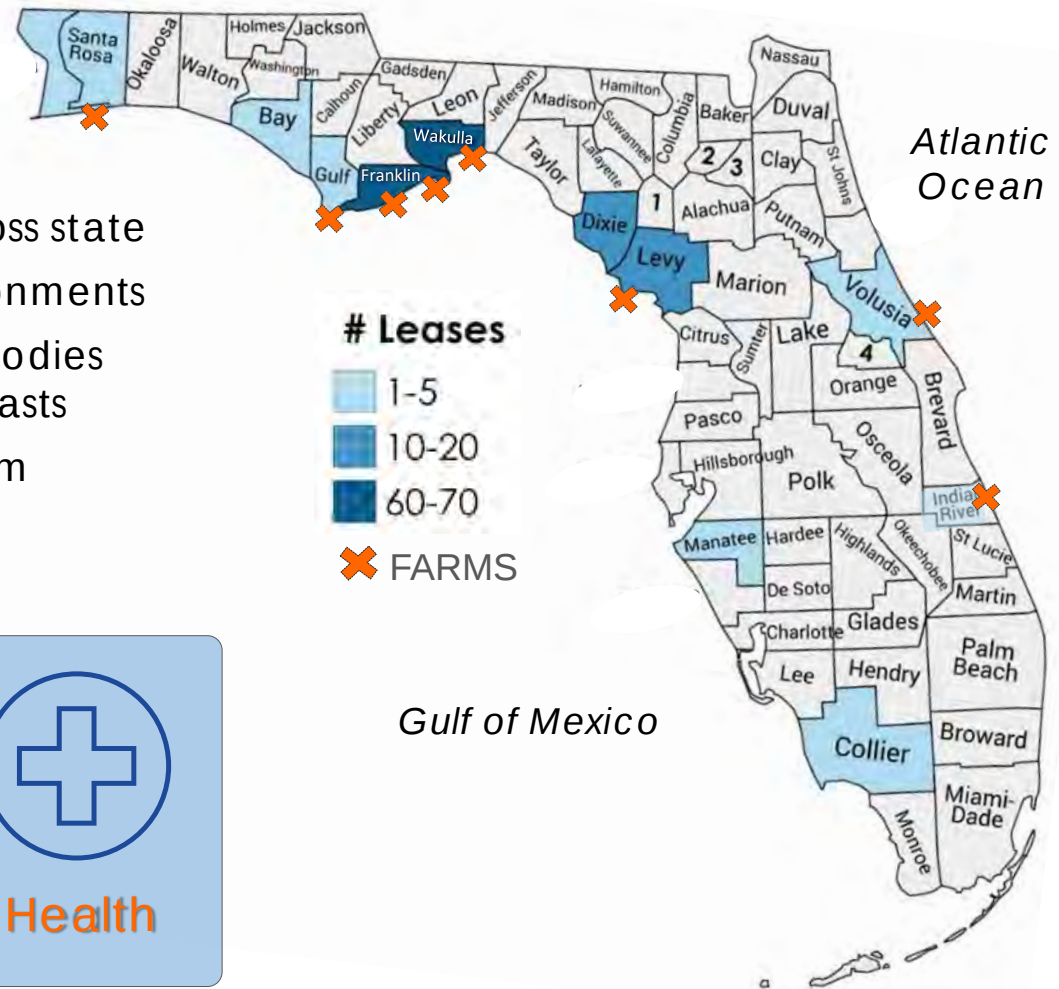
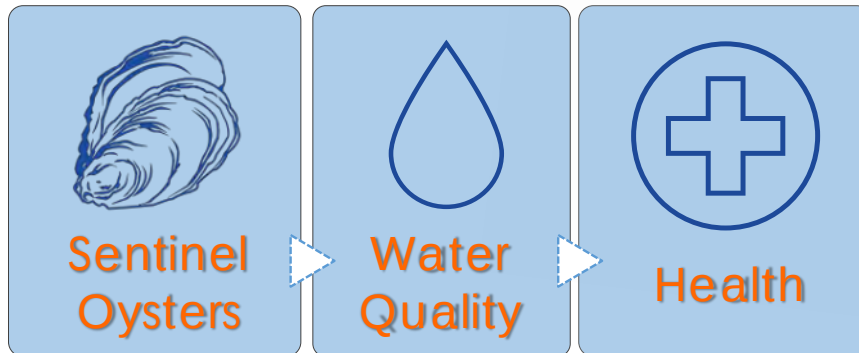


Florida Oyster FARMS:

Farms for Aquaculture Research and Monitoring of Shellfish

- In 2023, expand pilot study by increasing number of farms
- Provide greater replication across state
- Evaluate various growing environments
- Network of growers in 8 water bodies in 7 Florida counties on both coasts
- Provide tools to obtain data from commercial farms

Three components:





Sentinel Oysters

April 2023: Triploid oysters (~700,
3" SH) reared by UF in Cedar Key

Aug 2023: 10K 3N and 5K 2N (R12)

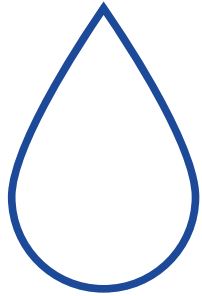
Aug 2024: 10K 3N (R6)

Growers use their culture gear
and provide routine maintenance

Growers observe / report mortalities
and harvest information (#s, dates)



Water Quality



In-Situ Aquatroll 100 data loggers
given to growers



Temperature and salinity measured
continuously inside culture bag



Growers download data on farm
via mobile app and Bluetooth



Cedar Key SHA, Dog Island, Levy County

2024
• Jan 2024
• Feb 2024

2023
• Mar 2023
• Apr 2023
• May 2023
• Jun 2023
• Jul 2023
• Aug 2023
• Sep 2023
• Oct 2023
• Nov 2023
• Dec 2023



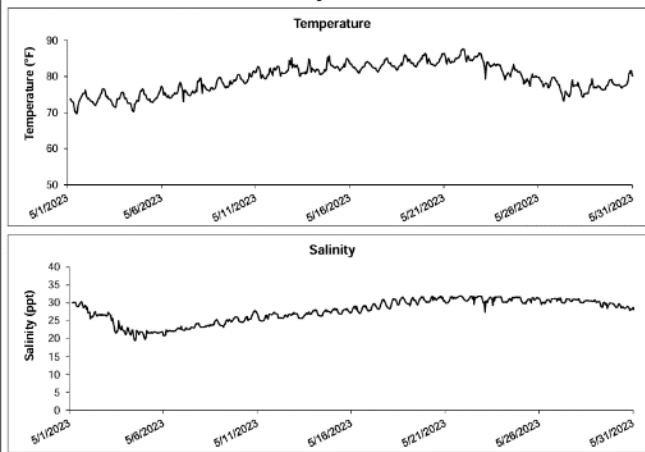
ARCHIVED

Water Quality Information

Alligator Harbor, Franklin County
Apalachicola Bay, Franklin County
Cedar Key, Levy County
Dog Island AIZ
Gulf Jackson AIZ
Horseshoe Beach, Dixie County
Indian River, Indian River County
Indian Pass Lagoon, Gulf County
Mosquito Lagoon, Volusia County
Oyster Bay, Wakulla County
Skupper Bay, Wakulla County
Pensacola Bay, Santa Rosa County

Cedar Key SHA, Dog Island North, Levy County

May, 2023



Scan to view WQ Data

Water quality data posted to dashboard and archived as monthly graphs

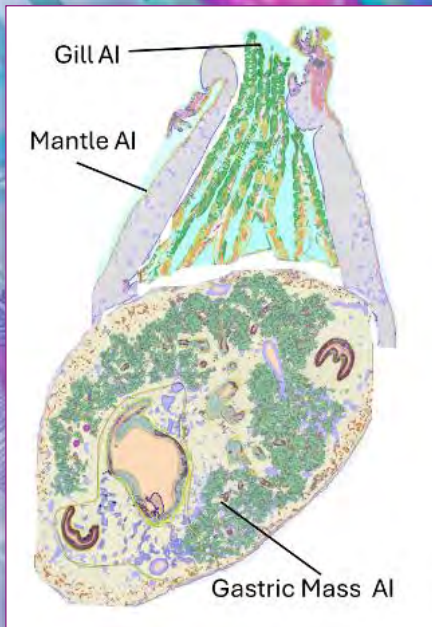
HydroVu



Health Assessment 2023



Kits provided to ship samples to UF
College of Vet Medicine in late June



Histology used to detect presence
of major pathogens and
pathological conditions

Stained slides scanned and
annotated using AI algorithms for
gills, mantle, gastric or visceral mass

Values for normal tissues evaluated
against pathological conditions by
area quantification





Cedar Key – Baseline February 2023

- GI tract/Visceral body - Fat cells (light tan) contain stored lipid, differentiated gonads
- Gills - Epithelium full, differentiation of cells, mucous containing cells (blue) and gland cells (pink)
- Mantle - Fat cells contain lipid, Minimal hemocyte infiltration (dark blue)

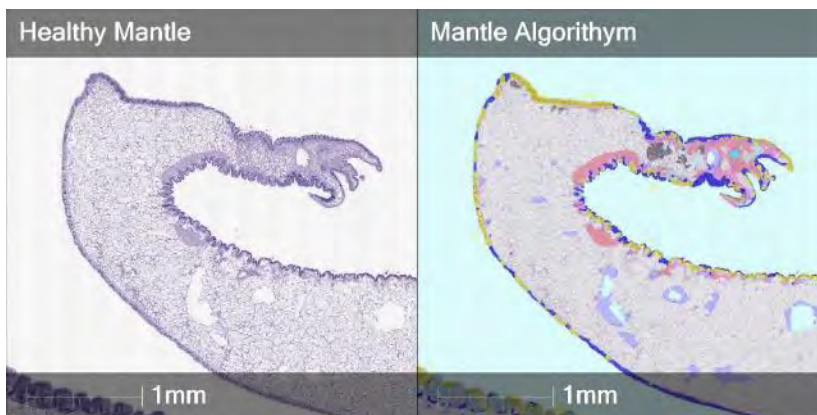
GI Tract Algorithm

	Oyster tissue
	Degenerate Leydig
	Connective Leydig
	Gastric gland
	Regressed repro
	Hemolymphatic
	PV Infiltration
	Stomach
	Intestine
	Intestine Perkinsus
	OOCYTE
	SPERM
	Hemocytes
	DG Fluid
	PIGMENT
	GI LUMEN
	GI mucosal parasite
	Smooth muscle

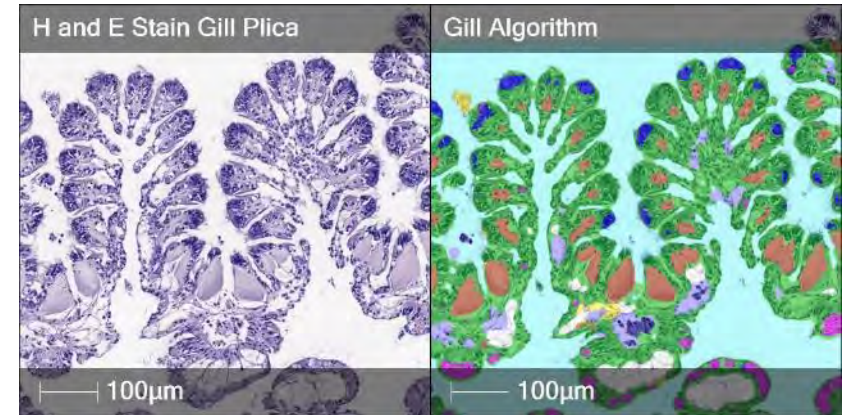
Healthy GI Tract



Healthy Mantle

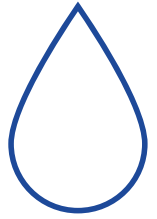


Healthy Gills

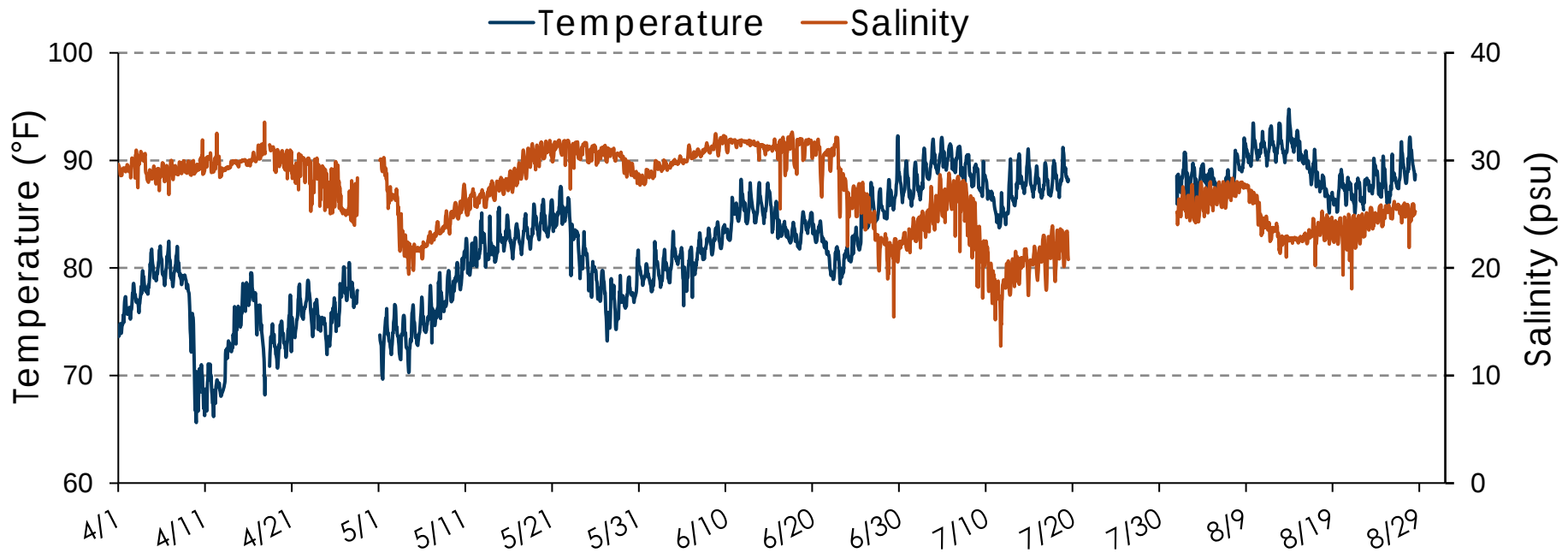




Cedar Key, April-August 2023



- Salinity, ave= 26 ± 4 psu
- Temperatures reaching 90°F in June, maximum of 94°F in August, overall ave= $83 \pm 6^\circ\text{F}$
- Minimal mortalities observed throughout culture period
- Bags lost due to impacts of Hurricane Idalia (11' surge), August 30

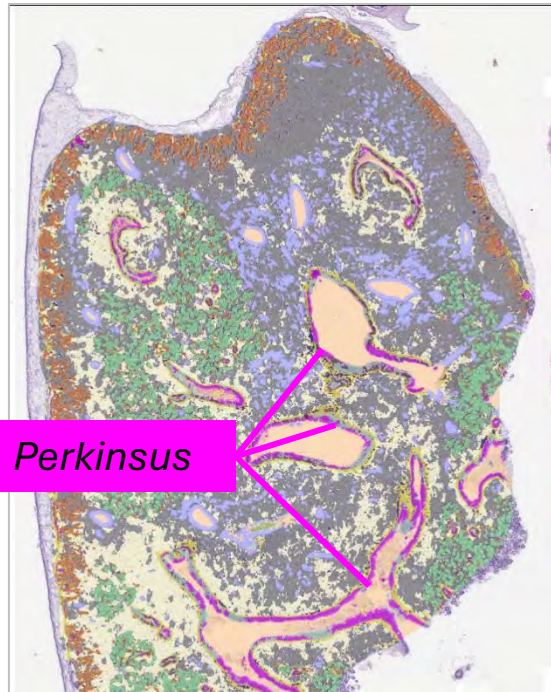


Cedar Key – June 2023

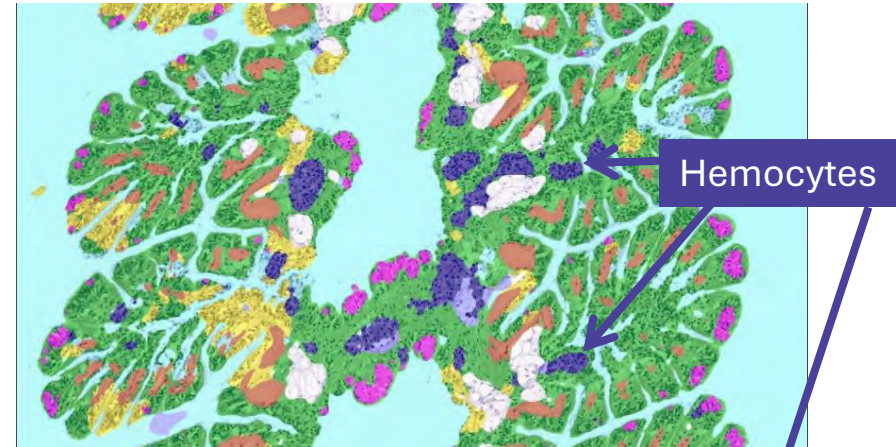


- Gills - Heavy infiltration by hemocytes (dark blue), but minimal evidence of gill atrophy
- Visceral Mass / GI Tract - *Perkinsus marinus* (magenta) infection in all sections, fat cell degeneration (grey), peri-intestinal sinus (yellow) packed with hemocytes (dark blue)

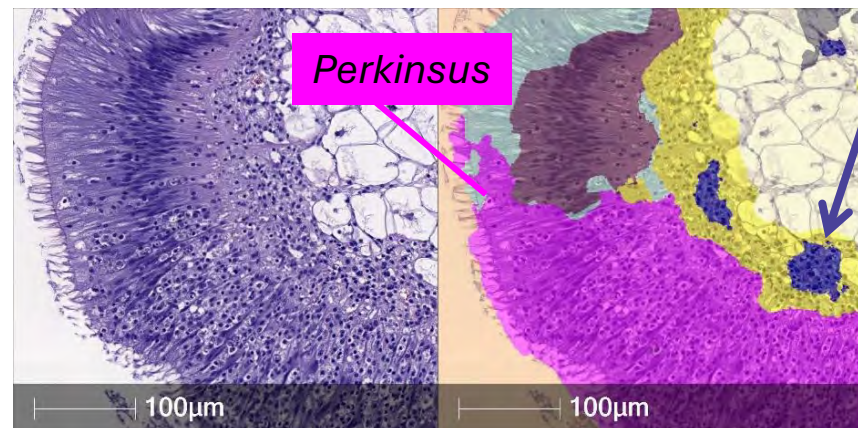
Visceral Mass



Increased gill hemocytosis



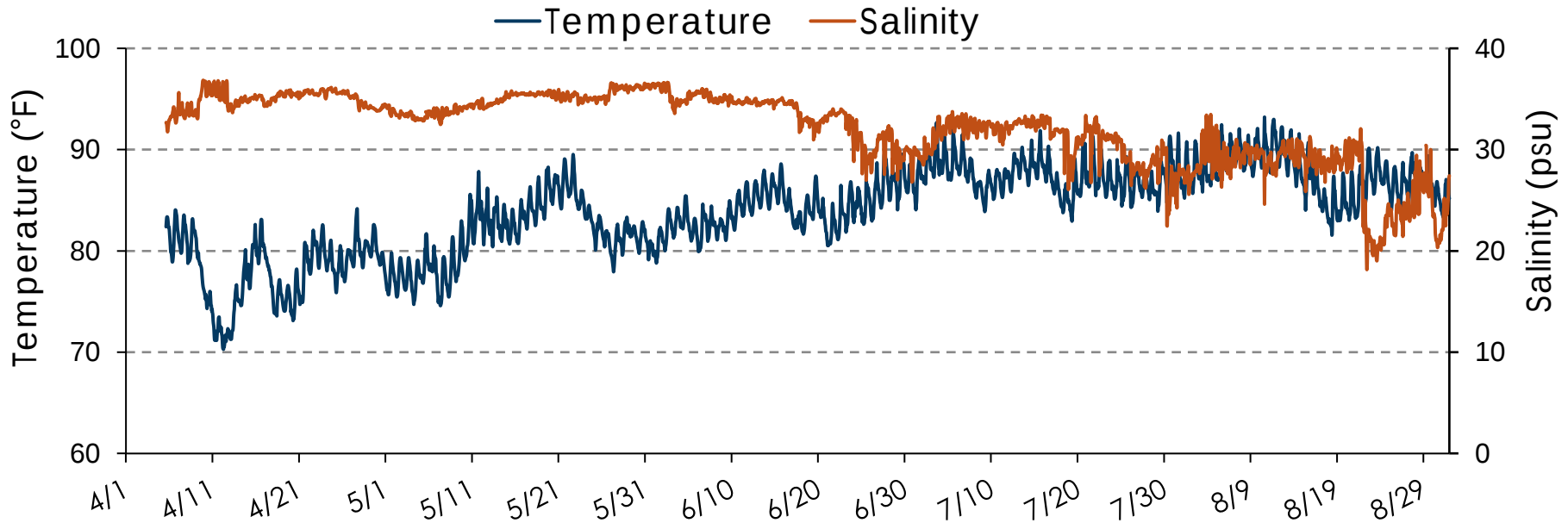
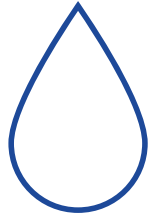
Healthy stomach vs *Perkinsus* infection





Indian River, April-August 2023

- Salinities high, $\text{ave}=32 \pm 4$ psu
- Temperatures exceeding 80°F in April, reaching 90°F in May, overall $\text{ave}=84 \pm 4^\circ\text{F}$
- Crop mortalities of market oysters on farm, both 3N and 2N, noted in April
- Mortality of sentinel oysters: June 1-30%, July 21-75%, overall >80%

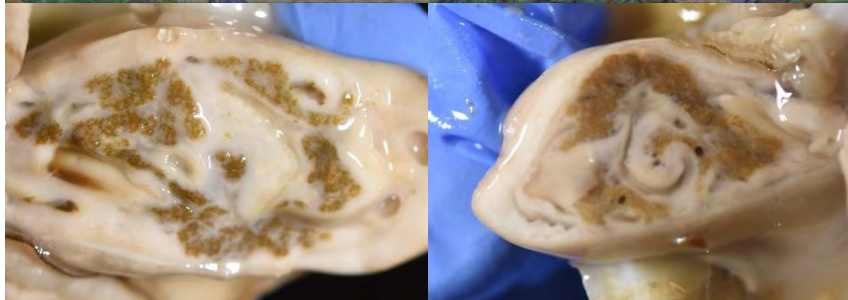
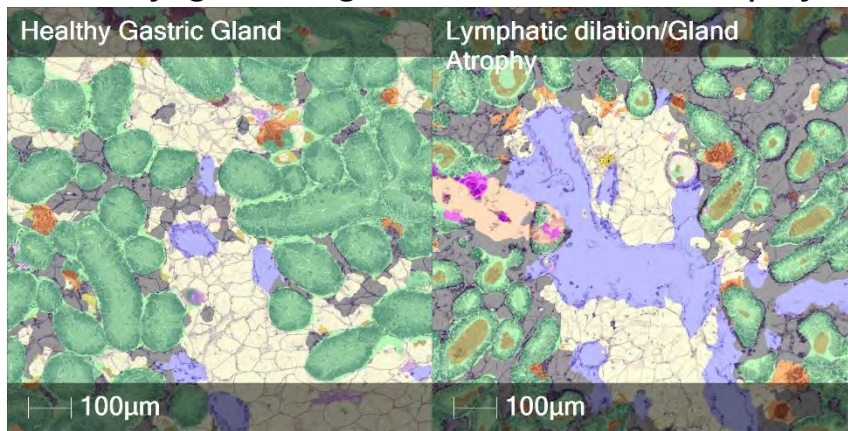




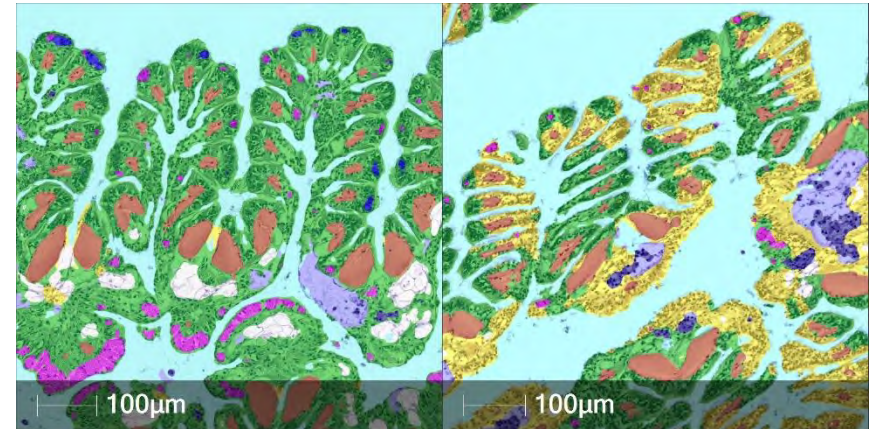
Indian River Lagoon – June 2023

- Gills - Significant atrophy, hemocytes (dark blue) in hemolymph sinuses (light blue)
- GI tract – Perkinsus (magenta) infection, fat cells degenerating (grey)
- Gastric gland – Top: Cells (green) shrunk, degeneration of fat cells (grey); Bottom: Compaction and atrophy

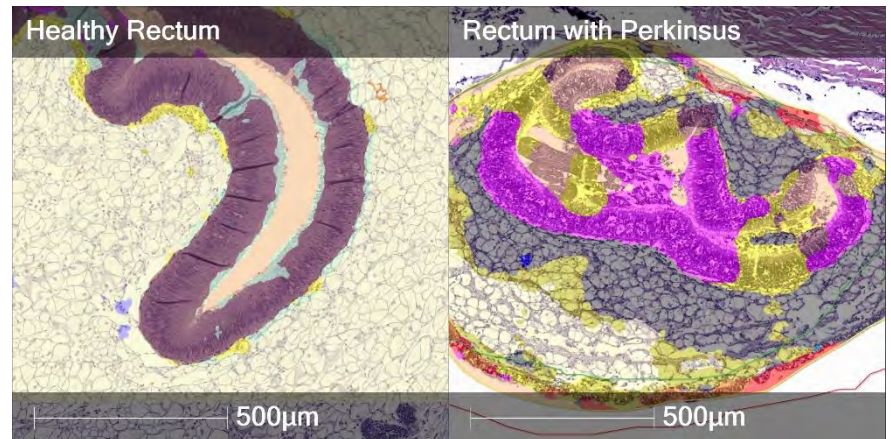
Healthy gastric gland vs Gland atrophy



Healthy gill vs Gill atrophy and hemocytosis



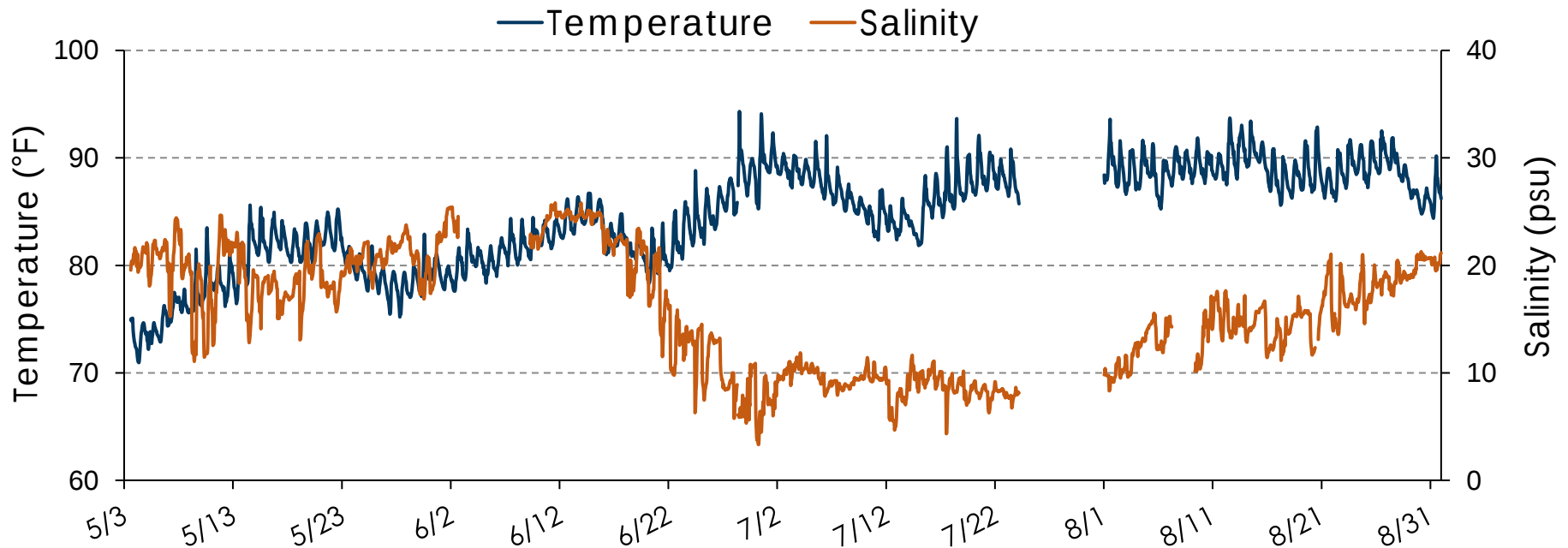
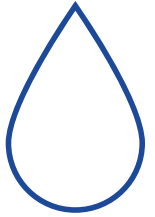
Healthy GI tract vs Perkinsus infection





Pensacola Bay, May-August 2023

- Salinities <10 psu Jun 27-Aug 2 (ave=9 $\pm$ 4 psu), overall ave=16 $\pm$ 4 psu
- Temperatures exceeding 80°F in May reaching 90°F in June, ave=84 $\pm$ 5°F
- Crop mortalities of market oysters on farm, both 3N and 2N, noted early June
- Mortality of sentinel oysters: June 28-16%, July 24-30%, August 22-48%, overall >70%

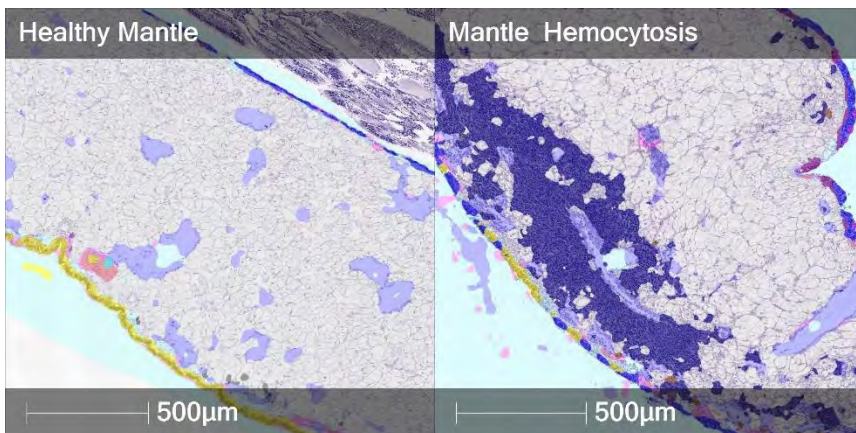




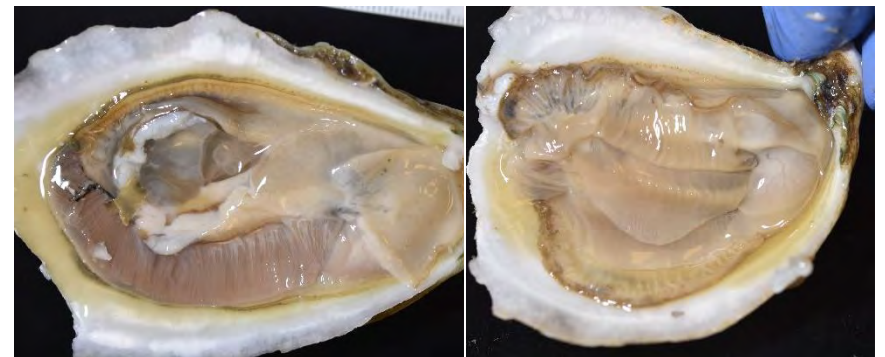
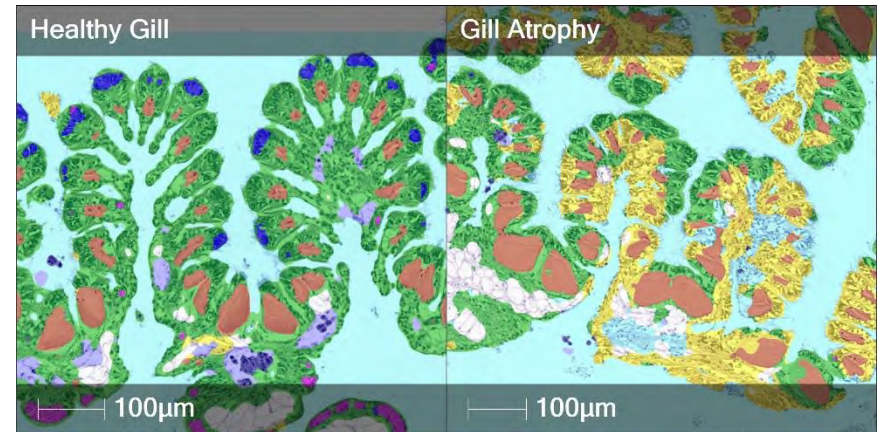
Pensacola Bay – June 2023

- Gills - Severe atrophy of soft tissue (50%); epithelium, mucus differentiation, and gland cells lost
- Mantle – Full of hemocytes (dark blue) in hemolymph sinuses (light blue) adjacent to mantle epithelium (yellow)
- Light *Perkinsus* prevalence and fat cell degradation in some individuals

Healthy mantle vs Mantle hemocytosis



Healthy gill vs Gill atrophy



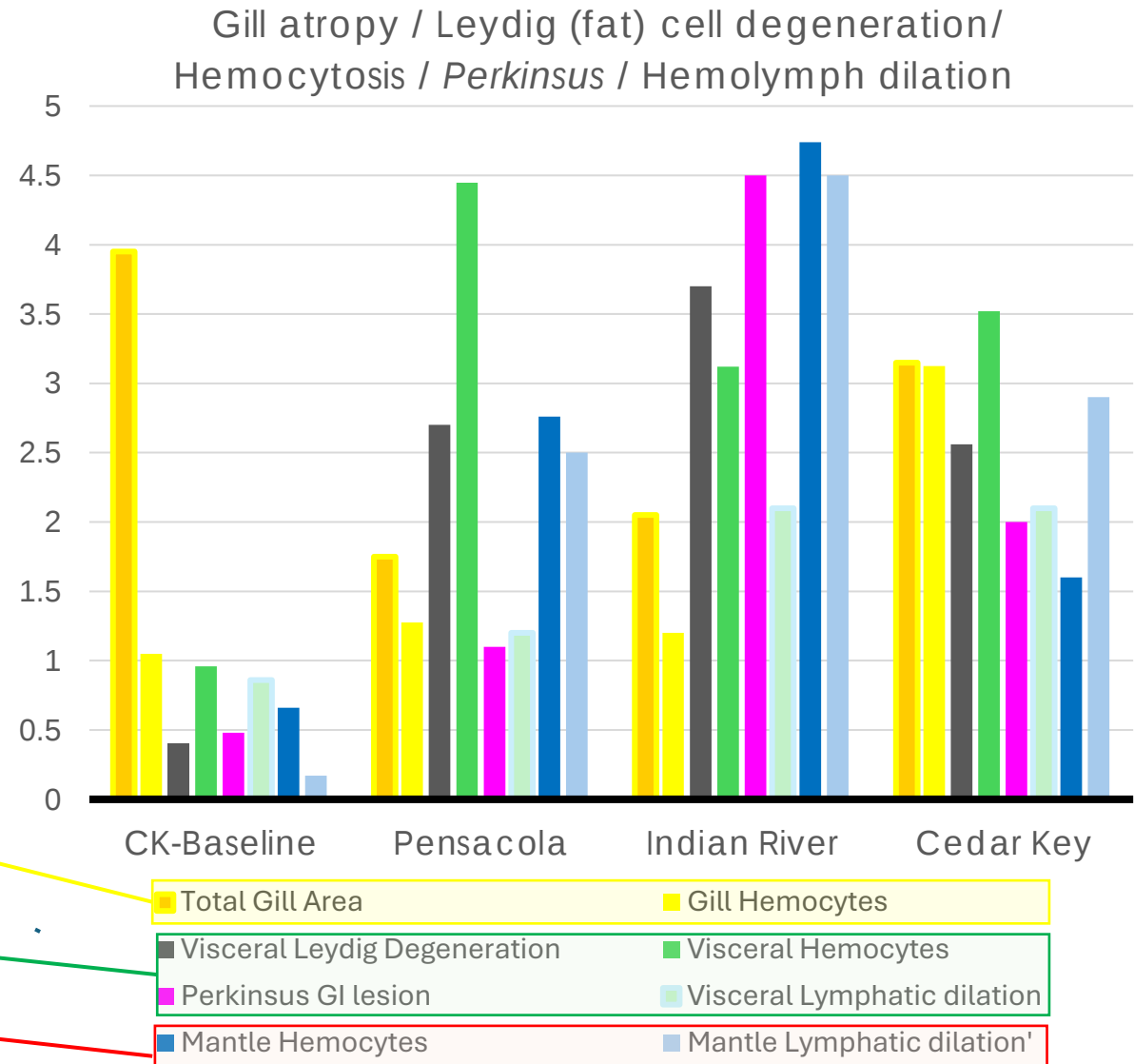
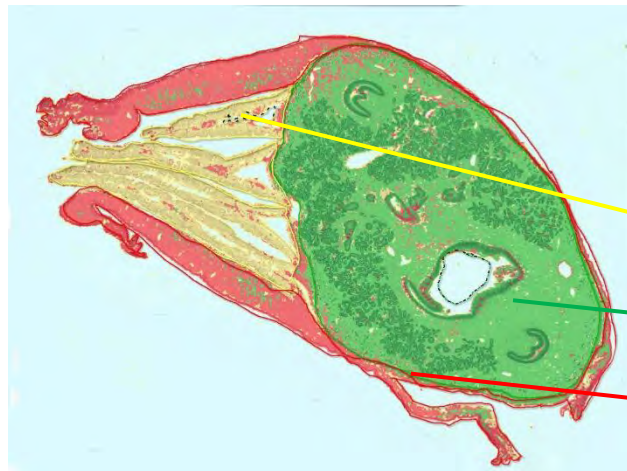
Bottom right: Gill atrophy - blunted, pale, splits between gill filaments, do not extend to mantle fringe



Oyster FARMS: Health

Relationships*:

- Increased gill atrophy with increased visceral hemocytosis and fat cell degeneration
- Increased *Perkinsus* GI infections also increased with fat cell degeneration and hemolymph sinus dilation
- Severe gill atrophy associated with mild *Perkinsus* infection



*Classified category ÷ total annotated tissue and standardized to a 0-5 scale



Oyster FARMS

Farms for Aquaculture Research & Monitoring of Shellfish

Mortalities of oysters reaching harvest size have been experienced by growers at some lease areas during late spring and summer. To begin to address these unexplainable mortalities, oyster growth, mortality, and health, along with basic but key water quality parameters were monitored over a production cycle in 2020-21 at four farms in two lease areas. Results of this pilot study conducted by the Shellfish Program can be found [here](#).

In 2023, a network of growers was formed across the state to increase the number of participating farms in a monitoring program, providing greater replication and environmental gradients. Growers receive equipment, sampling supplies, and guidance so that water quality, oyster performance, and health can be obtained from farms in ten water bodies.



Scan to visit website

<https://shellfish.ifas.ufl.edu/farms-2023>

What's next?

FARMS Approach across Southern US

- Project led by Oyster South
- Expand network to growers, researchers, extension agents in southern US
- January 2025 - December 2026
- Funded by NOAA Saltonstall-Kennedy

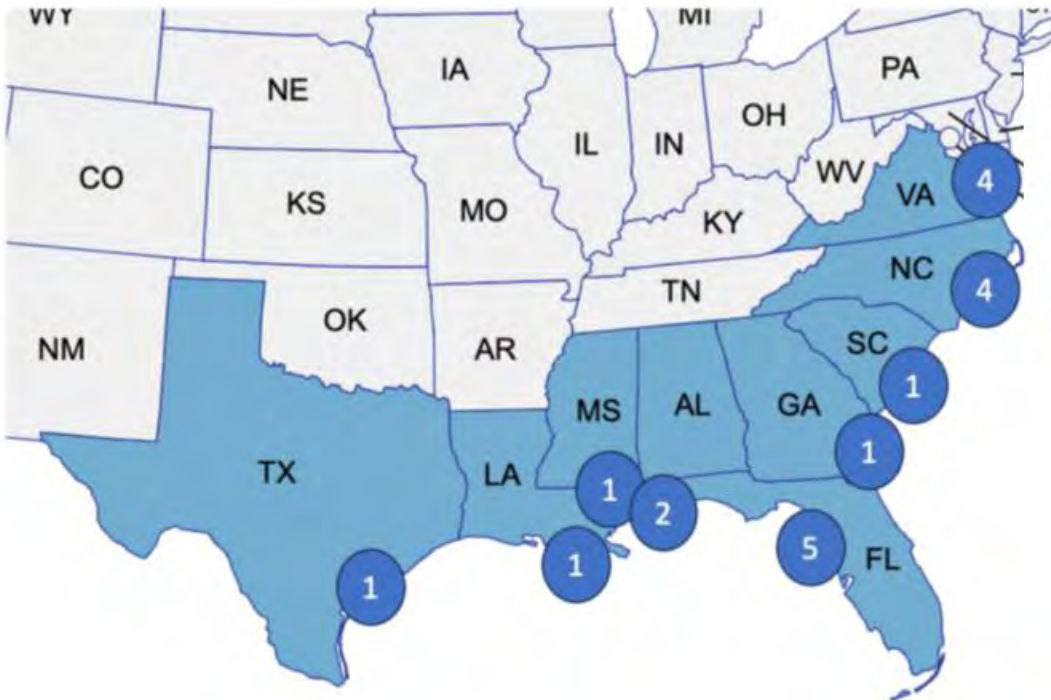


NOAA
FISHERIES



Common Experiment at 20 Oyster Farms

- Diploid and triploid seed (half-sibling) deployed in experiment at each site this summer
 - Following state regulations about seed supply



Monitoring through Summer 2026

- Environmental variables at each FARMS site over duration of experiment
 - Air and water temperatures
 - Salinity
 - Dissolved oxygen
- Assess each treatment for duration of experiment with increased sampling in second production year when mortality events are likeliest
 - Oyster health
 - Oyster survival and growth



FARMS Implications

- Identify factors common to mortality events
- Better understanding of mortalities – SUMS event or not?
- What can be learned from sites where there are no SUMS events
- Creating awareness of stressful environmental conditions
- Sharing of information and ideas
- Strengthening connections within oyster community

Photograph courtesy Steven Gray



Updates at the 2026 and 2027 Oyster South Symposiums

- Questions?
- Contact Bill Walton at walton@vims.edu



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