

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



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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 Phlips, 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.



Mortality (%)

Locations and Stocks

- Negligible 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% FL – 32% LA
- No differences between genetic stocks

Oyster Bay

- Increased to 8-13% in SP3, doubled in next SP
- Cumulative (9.4 months):
 25% FL 40% LA
- Significant genetic stock
 differences

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* (mud worm)
- 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 interference protocols



Florida Oyster FARMS:

Farms for Aquaculture Research and Monitoring of Shellfish

Santa Rosa

- 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 seven counties on both coasts
- Provide tools to obtain experimental data from commercial farms
- Three components:







Triploid oysters (~700) reared by UF in Cedar Key distributed April-May

Average size: 75mm (3'') SH, 57 grams TWW quaculture Association www.thenaa.net 870.850.7900

15 12 17 11 11 11 11 11 18 19 50 51 25

Growers use their culture gear and provide routine maintenance

> Growers observe / report mortalities during late spring/summer months

1000

Water Quality





In-Situ Aquatroll 100 data loggers given to growers



emperature and salinity measured continuously inside culture bag



Growers download data on farm via mobile app and Bluetooth





Water quality data posted to dashboard and archived as monthly graphs



Health Assessment

Kits provided to growers to ship samples to John Roberts, UF College of Veterinary Medicine



Histology used to detect presence of major pathogens and pathological conditions

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

> > Values for normal tissues evaluated against pathological conditions by area quantification

Cedar Key – Baseline February 2023

- Fat cells in visceral body contain stored lipid (light tan) and undifferentiated gonads
- Mucus containing cells (blue) in gills, few hemocytes (dak blue), cells have differentiated
- Minimal hemocyte infiltration in mantle, fat cells contain stored lipid



Healthy GI Tract

H and E Healthy Visceral Body

Visceral Body Gl Tract Algorithym

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







Cedar Key, April-August 2023

- Salinity, ave=27 <u>+</u> 4 ppt
- Temperatures exceeding 80°F in April, reaching 90°F in June, maximum of 94°F in August, overall ave=83 <u>+</u> 6°F
- Minimal mortalities observed
 throughout culture period
- Oyster bags lost due to impacts of Hurricane Idalia (11'surge), August 30





Cedar Key – June 2023

- Heavy gill infiltration by hemocytes, but minimal evidence of gill atrophy
- Severe Perkinsus marinus infection in stomach and all sections of GI tract, associated fat cell degeneration, increased hemolymph fluid and hemocytes

Fat cell degeneration in visceral mass



Increased gill hemocytosis



Healthy stomach vs Perkinsus infection



Perkinsus (magenta) infected sections of GI mucus membrane, peri-intestinal sinus (yellow) packed with hemocytes (dark blue)





Indian River, April-August 2023

- Salinities high, ave=32 <u>+</u> 4 ppt
- Temperatures exceeding 80°F (26%) in April, reaching 90°F in May, overall ave=84 <u>+</u> 4°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%



Deployed April 5, 2023





Indian River – June 2023

- Significant gill atrophy and hemocytes
- Severe Perkinsus infection in GI tract
- Degeneration of fat cells, atrophy and compaction of gastric gland



Top: Dilated hemolymph (fluid) sinuses (light purple), degeneration of fat cells (grey), glands (green) severely shrunken with weakened cells (epithelium) (yellow). Bottom: Compaction and atrophy of gastric gland.

Healthy gill vs Gill atrophy and hemocytosis



Healthy rectum vs Perkinsus infection



Rectal mucus membrane thickened with protozoans, fat cells surrounding rectum degenerating (grey).



Mosquito Lagoon, April-August 2023



Deployed April 6, 2023

- Salinities high, ave=32.0 <u>+</u> 3.1 ppt
- Temperatures exceeding 80°F in April, reaching 90°F in July, overall ave=84.2 <u>+</u> 5.3°F
- Crop mortalities of market oysters on farm – do not have observations
- Mortality of sentinel oysters: May 26 minimal, August 13 - 31%





Mosquito Lagoon, June 2023

- Fairly healthy oysters
- Gills with hemocytosis (dark blue cells) and deposition of Leydig "fat" cells (light yellow)
- Some had visceral mass dilation with Leydig degeneration (gray areas)
- Gastric gland cells (green) are dilated and hemolymph, or fluid, in sinuses (blue)





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Alligator Harbor, April-August 2023

- Salinities high, ave=31.1 <u>+</u> 2.8 ppt
- Temperatures exceeding 80°F in April, reaching 90°F in August, overall ave=80.1 <u>+</u> 8.2°F
- Crop mortalities of market oysters on farm, both 3N and 2N, minimal in June
- Mortality of sentinel oysters: June 15 -<5%



Deployed April 26, 2023





Alligator Harbor, June 2023

- Overall healthy group
- Good immune response hemocytosis observed in gills
- Non-degenerated fat cells
- Mild Perkinsus infection



Healthy well conditioned oyster with abundant Leydig "fat" reserve in gills and palps



Rattlesnake Cove, April-August 2023

- Salinities, less than 20 in April, 20 to 30 remaining period, ave=22.0 <u>+</u> 5.5
- Temperatures wide ranging, less than 80°F in July, overall ave=82.2 <u>+</u> 6.2°F
- Do not have information regarding crop mortalities of market oysters on farm or sentinel oysters



Deployed March 16, 2023





Rattlesnake Cove, June 2023

- Fairly healthy oysters
- Gills have hemocytosis (dark blue) and deposition of Leydig "fat" cells (white)
- Perkinsus (magenta) found in visceral mass but no pathology







Indian Lagoon, April-August 2023



Deployed April 11, 2023

- Salinities low (<10) in April, increasing to >30 in June, ave=28.0 <u>+</u> 5.3 ppt
- Temperatures exceeding 80°F in April, reaching 90°F in July, overall ave=81.9
 <u>+</u> 6.4°F
- Crop mortalities of market oysters on farm, both 3N and 2N, minimal, June 20 <15%
- Mortality of sentinel oysters: June 20 -39%, August 13 - 28%



Indian Lagoon, June 2023

- Overall healthy
- Some individuals had severe Perkinsus infection
- Abundant Leydig ("fat") cell reserves in gills and visceral mass
- Mild atrophy and compaction of gastric gland

Severe Perkinsus "Dermo" infection in stomach



Gills appear healthy

Gastric gland appears healthy





Pensacola Bay, May-August 2023



Deployed May 3, 2023

- Salinities <10 psu Jun 27-Aug 2 (ave=9 ± 4 ppt), overall ave=16 ± 4 ppt
- Temperatures exceeding 80°F in May reaching 90°F in June, ave=84 ± 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

- Severe gill atrophy of soft tissue, average loss of 50%
- Moderate mantle hemocytes
- Moderate Perkinsus prevalence
 in some individuals
- Moderate fat cell degeneration



Outer hemolymph (water) sinuses (light blue) adjacent to mantel epithelium (cells) (yellow) are full of hemocytes (dark blue).



Gill filament size (orange) is unchanged but gill cells, gland cells, and mucus differentiation are lost

Healthy gill

Gill atrophy



Gills with atrophy blunted, pale, and have splits between gill filaments, do not extend to mantle fringe.

Florida Oyster FARMS, 2023-2024

- Network increased to include two more growers, one more county
- Seed distributed in Aug-Sept 2023
 - Triploid, FL F3,10,000, x=21 mm SH
 - $\circ~$ Half–sibling diploids, 5,000, x=19 mm SH
- Growers report management practices, harvest information (dates and #s)
- Shipping kits provided for health samples if mortality event occurs
- Plans to continue in 2024-25

What's next?

- Expand network to growers, researchers, extension agents in the South – VA to TX
- Funding awarded through NOAA grant, 2025-7



FARMS Implications

- Determining effects of environment and culture conditions on crops
- Creating awareness of stressful environmental conditions
- Better understanding of mortalities
- Developing baselines to compare performance at farm sites over time
- Documenting performance across farms using same seed stocks
- Sharing of information and ideas
- Strengthening connections within oyster community

Online Resource Guide for Florida Shellfish Aquaculture

UF IFAS

UNIVERSITY of FLORIDA



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 su begin to address these unexplainable mortalities, oyster growth, mortality, and health, along with basic but key water quality were monitored over a production cycle in 2020-21 at four farms in two lease areas. Results of this pilot study conducted by Shellfish Program can be found <u>here</u>.

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

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



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Acknowledgements



