



Oyster Bay
January

EFFECTS OF CO-CULTURE OF URCHINS, *LYTECHINUS VARIEGATUS*,
WITH EASTERN OYSTERS, *CRASSOSTREA VIRGINICA*

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OSS 2020

CAN URCHINS BE RAISED IN CULTURE WITH OYSTERS?

- Interest in culturing green sea urchin, *Lytechinus variegatus*, native to Gulf of Mexico, for roe (uni)
- Would co-culture have any significant effects on oysters
- One year of funding from Gulf States Marine Fisheries Commission, 2019-20



EXPERIMENTAL DESIGN: PILOT STUDY

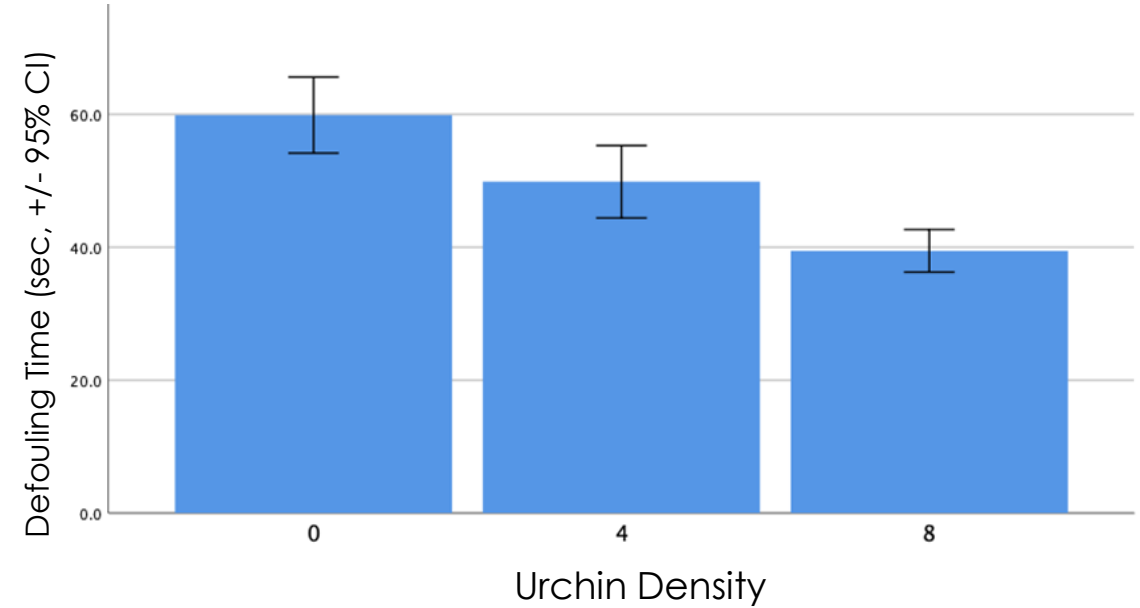
- Urchins (wild-collected adults) stocked at three densities (0, 4 and 8 urchins) with 40 subadult oysters (48 mm SH)
- Gear used: 9 mm bags and floating cages
- Two commercial oyster farms in Florida: Alligator Harbor (AH) and Oyster Bay (OB)
- Overwintered and harvested after 5 months



PILOT STUDY RESULTS, 2019-20

- Urchins had no effect on oyster survival or shell growth (SH, SW)
- Urchins reduced biofouling on oysters
- Oyster cleaning time decreased with increasing urchins (8>4>0)
- Urchins only reduced biofouling on bags at one farm site

NEXT STEPS?



Oyster Bay (OB)



Alligator Harbor (AH)

NEXT STEPS, 2022-23:
REEVALUATING CO-CULTURE OF EASTERN OYSTERS WITH
URCHINS USING HATCHERY-PRODUCED JUVENILES



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Funding from Gulf States Marine Fisheries Commission, Marine Aquaculture Pilot Project, 2022-23

POTENTIAL FOR COMMERCIAL DEVELOPMENT OF CULTURING HATCHERY-PRODUCED URCHINS WITH OYSTERS



Document hatchery production of green sea urchins juveniles

Determine performance of oysters with and without urchins

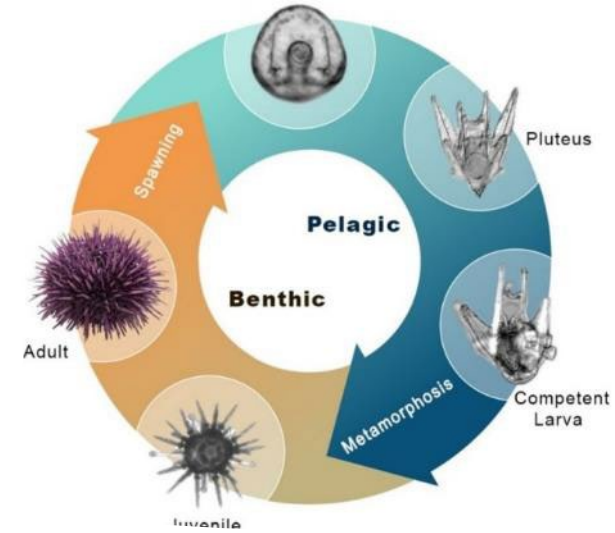
- Field nursery (2-3 months, 4 mm bags)
- Intermediate growout (3-4 months, 9 mm bags)
- Final growout (3-4 months, 14 mm bags)

Evaluate at commercial farm sites on FL Gulf of Mexico coast

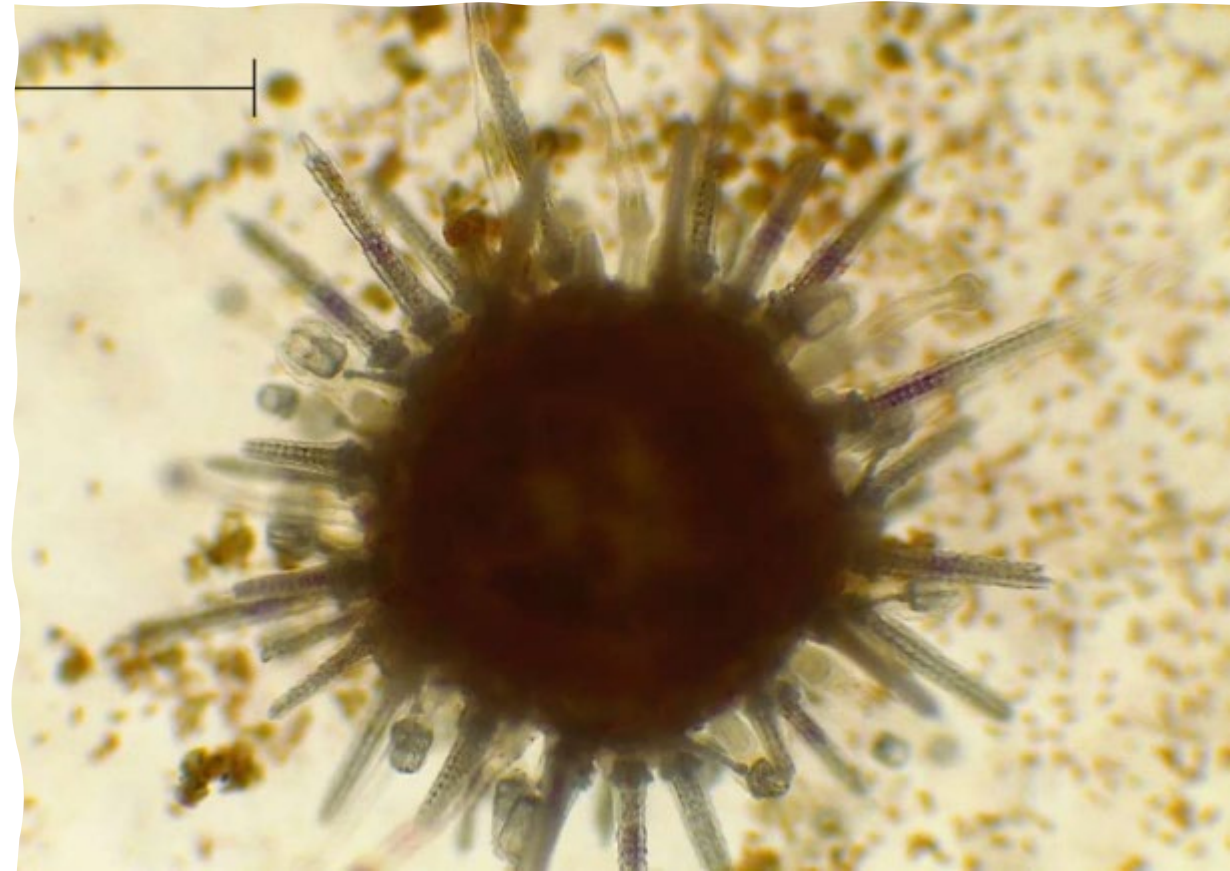
- Alligator Harbor, Franklin County (high salinity site)
- Oyster Bay and Skipper Bay, Wakulla County (variable salinity sites)
- Cedar Key, Levy County (medium salinity site)

Assess biofouling on oysters and bags with and without urchins

HATCHERY PRODUCTION OF GREEN SEA URCHINS



- Closed-system hatchery at University of Alabama-Birmingham
- Produce juveniles (7-9 mm test diameter)
- Broodstock collected from St. Joseph Bay, Florida
- Problems with water quality, bacteria, amphipods, food production



FIELD NURSERY CO-CULTURE

- Wild-collected sub-adult urchins: 29 mm
- 3n oysters: 16 mm shell height (R6 seed)
- 4 mm bags, cylindrical floats on sides
- Stock July 20-21, 2022
- Experimental design:
 - 3 treatments, 3 replicates, 3 sites
 - Growers flipped bags in control Trt B

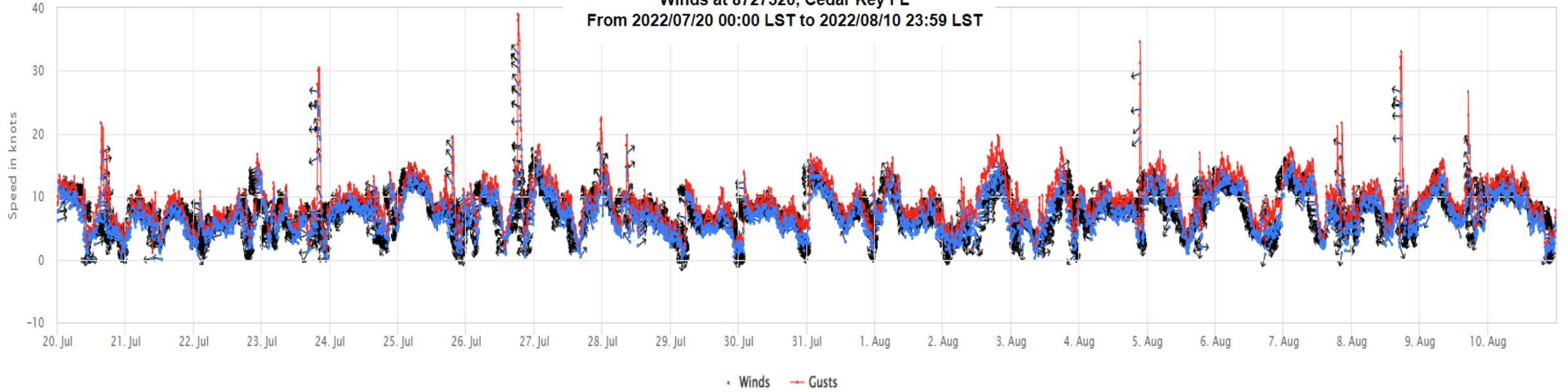
Treatment	Oysters (n)	Urchins (n)	Fouling Control
A	1200	12	None
B	1200	0	Flipping bags
C	0	12	None



NOAA/NOS/CO-OPS
Winds at 8727520, Cedar Key FL



NOAA/NOS/CO-OPS
Winds at 8727520, Cedar Key FL
From 2022/07/20 00:00 LST to 2022/08/10 23:59 LST



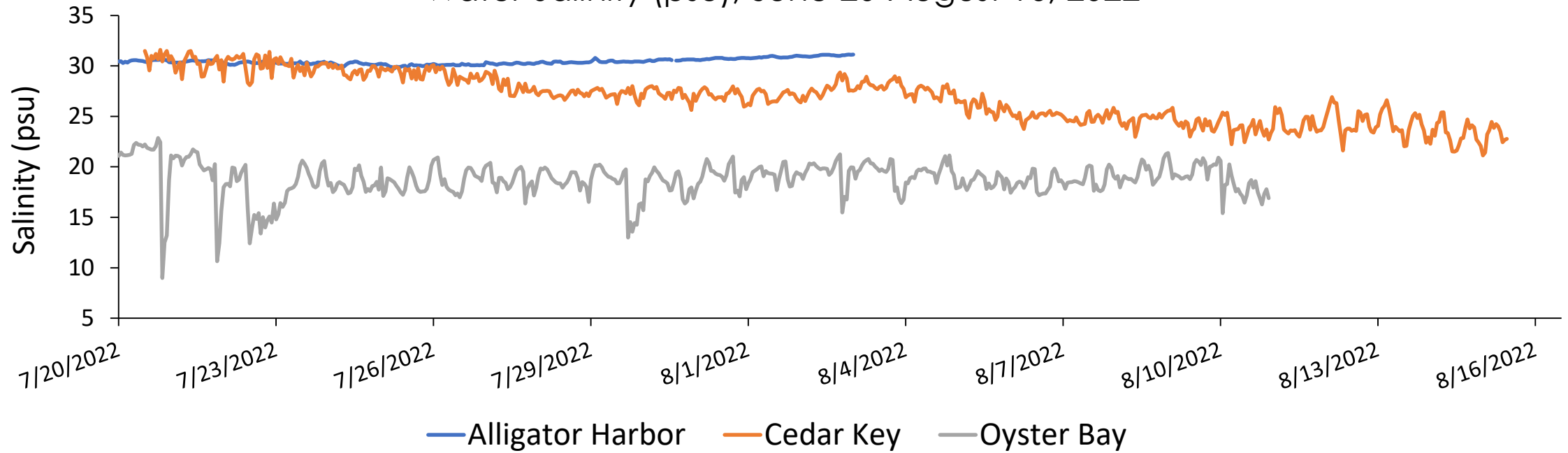
NOAA/NOS/Center for Operational Oceanographic Products and Services

CEDAR KEY

- Located in open waters
- Winds gusts ≥ 30 mph
- August 9, 2022 (20 days)
- Urchin survival: 0%



Water Salinity (psu), June 20-August 16, 2022



OYSTER BAY

- Salinities ≤ 20 ppt
- August 11, 2022 (22 days)
- Urchin survival: 0%



FIELD NURSERY: ALLIGATOR HARBOR

AFTER 2.5 MONTHS

- Urchin survival after 19 days: 100%-Trt A, 68%-Trt C
- Harvested October 5, 2022, delayed due to Hurricane Ian
- Blue crabs observed in bags resulting in predation on urchins



Treatment	Oysters (n)	Urchins (n)	Fouling Control	Urchin Survival (%)	Oyster SH (mm)	Oyster Survival (%)
A	1200	12	None	36 ± 29	59.0 ± 1.9	98.5 ± 1.7
B	1200	0	Flipping bags	--	55.9 ± 4.2	99.2 ± 0.6
C	0	12	None	0	--	--

No significant differences ($p > 0.05$) in oyster growth (SH, SL, SW, TWW) or survival

INTERMEDIATE GROWOUT CO-CULTURE: ALLIGATOR HARBOR

- Wild-collected sub-adult urchins, 29 mm
- 3N oysters, ave 56-59 mm SH, 400/bag
- 9 mm mesh bags with cylindrical floats
- Stock October 5, 2022
- Experimental design: 4 trts, 3 reps
 - Urchin density and placement of float on bags varied
 - Grower flipped bags in control TrtB
 - Oysters (51 mm) with barnacle set from Cedar Key used in Trt E



Treatment	Oysters (n)	Urchins (n)	Float Placement	Fouling Control	SH (mm)
A	400	10	Top	None	59
B	400	0	Side	Flipping bags	56
D	400	20	Side	None	59
E*	400	15	Top	None	51

URCHINS

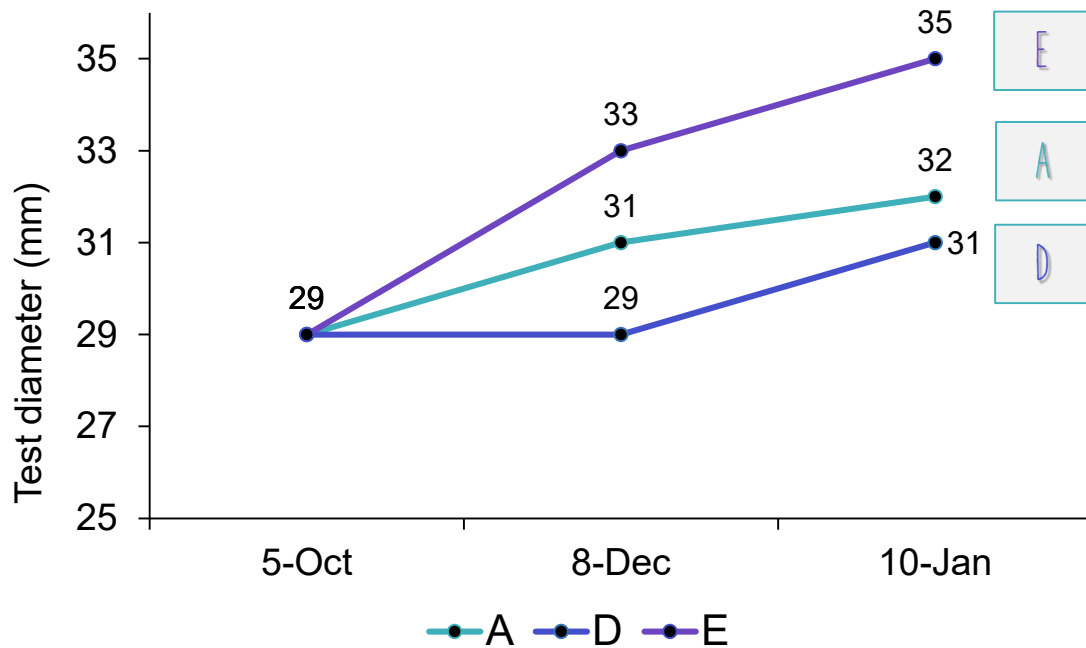
AFTER 3.5 MONTHS

Harvested January 10, 2023

Experimental Design				
Treatment	Oysters (n)	Urchins (n)	Float Placement	Fouling Control
A	400	10	Top	None
B	400	0	Side	Flipping bags
D	400	20	Side	None
E	400	15	Top	None

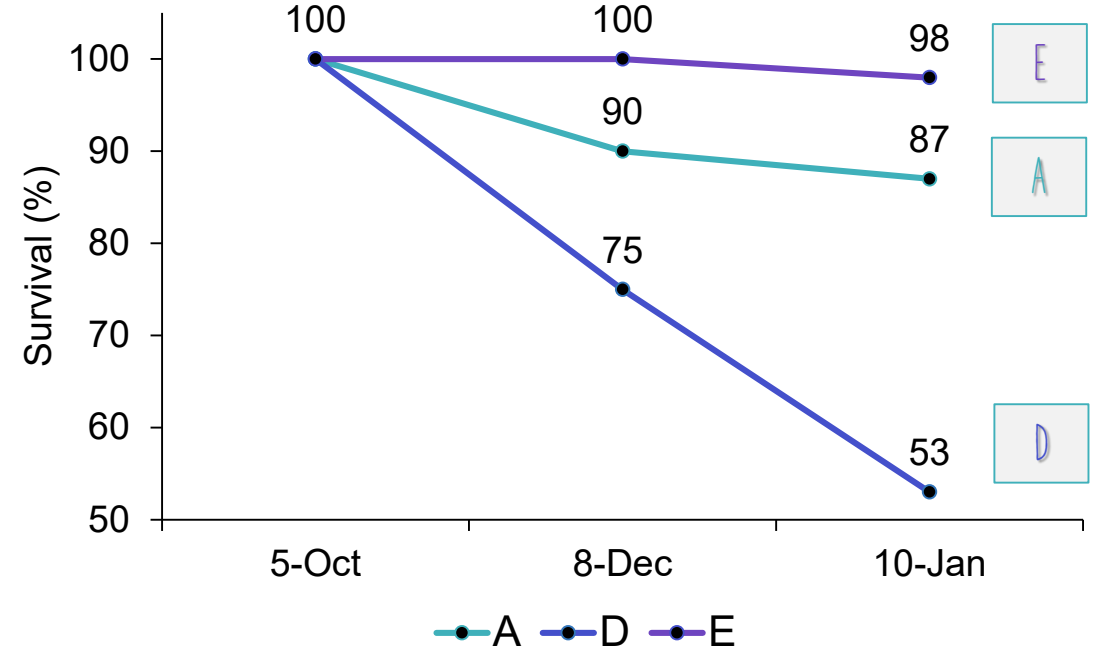


GROWTH



No differences ($p=0.07$) in length, but $E > A, D$ ($p=0.04$) in wet weight

SURVIVAL



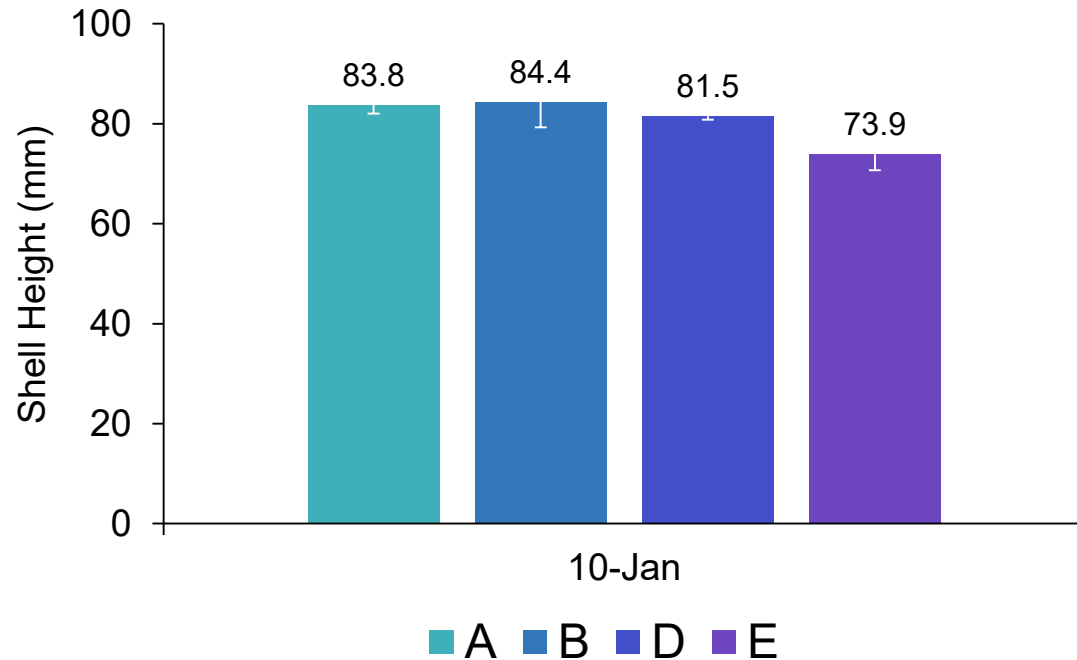
No statistical differences ($p=0.18$)

OYSTERS AFTER 3.5 MONTHS



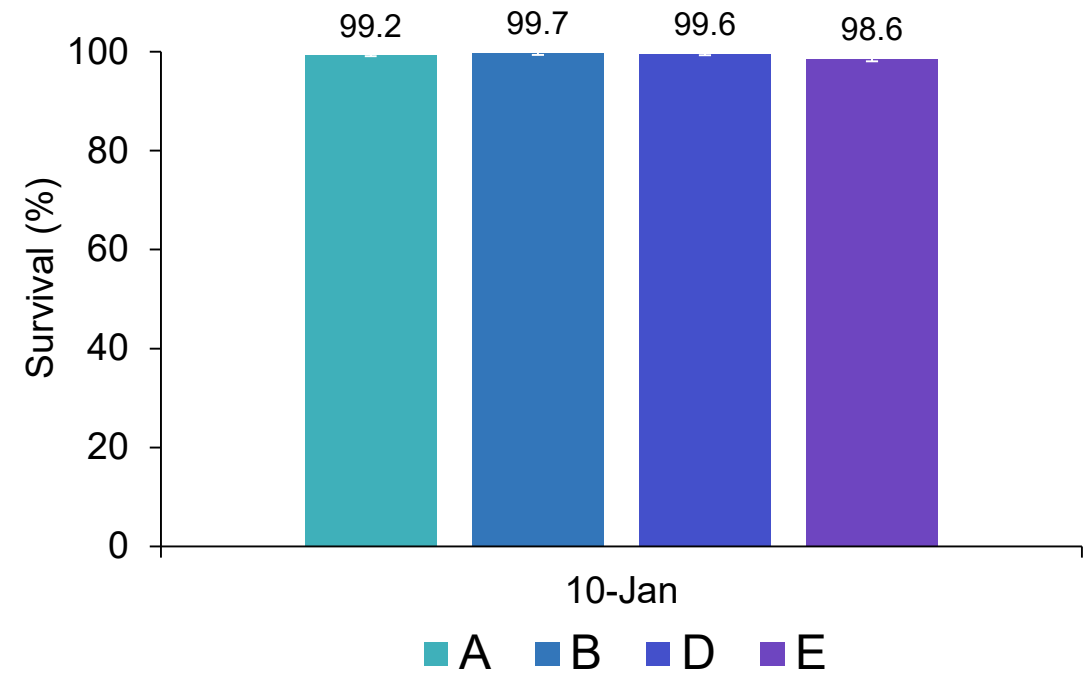
Experimental Design				
Treatment	Oysters (n)	Urchins (n)	Float Placement	Fouling Control
A	400	10	Top	None
B	400	0	Side	Flipping bags
D	400	20	Side	None
E	400	15	Top	None

GROWTH



No statistical differences ($p=0.86$) or in SL, SW, TWW

SURVIVAL



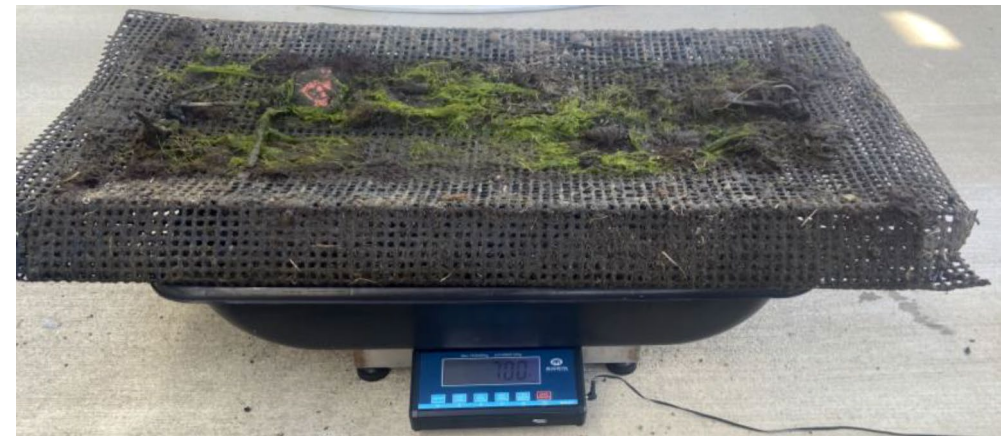
Statistical differences $B > A, D > E$ ($p=0.04$)

BIOFOULING

AFTER 3.5 MONTHS



Treatment	Experimental Design				Bag Fouling Results	
	Oysters (n)	Urchins (n)	Float Placement	Fouling Control	Weight (lbs)	Weight (%)
A	400	10	Top	None	4.1	62.5
B	400	0	Side	Bag flipping	1.5	40.7
D	400	20	Side	None	1.4	38.2
E	400	15	Top	None	2.5	53.5



- Treatment E (15 urchins): 64% reduction in barnacles, No amphipods
- Treatment B (no urchins): Matrix of gammarid tube-building amphipods with sediment/detritus

- Fouling weight quantified by weighing bags without floats and subtracting pre-deployment weight
- Weights significantly higher ($p=0.02$) in Trts A and E (floats on top) versus Trts B and D (floats on sides)
- No differences in weights with and without urchins (B&D)

FINAL GROWOUT CO-CULTURE: ALLIGATOR HARBOR

- Oysters, ave 73-84 mm SH, 150/bag
- 14 mm mesh bags with cylindrical floats
- Adult urchins (49 mm test) compared with sub-adults urchins (34 mm) from previous trial
- Stock January 10, 2023
- Experimental design: 4 treatments, 3 reps



Experimental Design				
Treatment	Oysters (n)	Urchins (n)	Float Placement	Fouling Control
B	150	0	Side	Bag Flipping
D	150	17 sub	Side	None
E	150	17 sub	Top	None
F	150	20 adult	Side	None



GROWTH AND SURVIVAL AFTER 3.5 MONTHS - ALLIGATOR HARBOR



- Harvested April 25, 2023

Experimental Design					Urchins		Oysters	
Treatment	Oysters (n)	Urchins (n)	Float Placement	Fouling Control	Test Diameter (mm)	Survival (%)	Shell Height (mm)	Survival (%)
B	150	0	Side	Bag Flipping	--	--	100.8 ± 5.6	93.1 ± 4.9
D	150	17	Side	None	36.5 ± 0.7	52.7 ± 36.3	96.2 ± 1.4	88.9 ± 14.8
E	150	17	Top	None	40.3 ± 1.5	96.1 ± 3.4	90.6 ± 1.0	85.8 ± 2.8
F	150	20	Side	None	50.7 ± 1.4	50.0 ± 26.5	96.1 ± 0.6	98.2 ± 1.5

- Higher growth rates ($p=0.05$) and weight gains ($p=0.03$) for subadults urchins (Trts D, E) versus adult urchins (Trt F)
- Survival higher ($p=0.065$) for urchins in bags with floats placed on top (Trt E, 96%) versus bags with floats on sides
- No differences in oyster growth rates ($p>0.05$) for SH, SL, TWW, WMW and survival

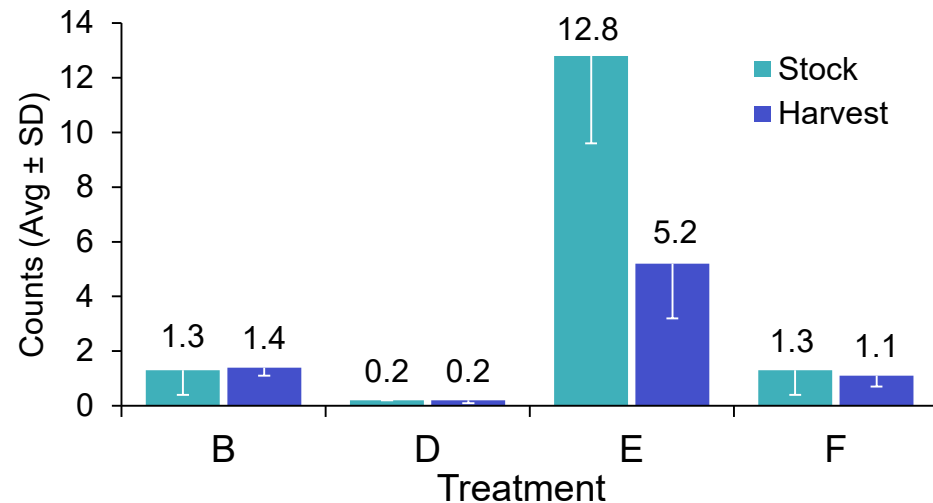
BIOFOULING

AFTER 3.5 MONTHS - ALLIGATOR HARBOR

- Increase (6%) in barnacles on oysters in Trt B, decrease (59%) in Trt E
- Bags with floats on top (Trt E) with highest fouling weight (6.3 lbs)
- Fouling on bags with side floats did not vary between Trt B (no urchins) and Trts D, F (urchins)
- Fouling on bags lowest ($p=0.004$) with adult urchins (Trt F) compared to subadult urchins (Trt D)

Experimental Design					Fouling Results	
Treatment	Oysters (n)	Urchins (n)	Float Placement	Fouling Control	Barnacle Reduction (%)	Bag Fouling Weight (lbs)
B	150	0	Side	Bag Flipping	6.4 ↑	3.9 ^{ab}
D	150	17	Side	None	13.3 ↓	5.9 ^a
E	150	17	Top	None	59.1 ↓	6.3 ^a
F	150	20	Side	None	15.4 ↓	2.6 ^b

BARNACLE FOULING ON OYSTERS



Oysters cultured with no urchins at harvest (Trt B)



Oysters cultured with urchins at harvest (Trt E)

CAN URCHINS POLISH PER-HARVEST OYSTERS?

GROWOUT CO-CULTURE: SKIPPER BAY

- Oysters reaching harvest size in 2-3 months
 - A - 72 mm SL, Heavy biofouling
 - B - 62 mm SL, Minimal biofouling
- Wild-collected adult urchins: 49 mm diameter
- 14 mm mesh bags, two-slot floating cages
- Stock January 11, 2023
- Exp design: 2 treatments, 2 reps, 1 control rep

Experimental Design

Treatment	Oysters (n)	Urchins (n)	Biofouling	Fouling Control
A-control	125	0	Heavy	Aerial Drying
A-test	125	20	Heavy	None
B-control	250	0	Minimal	Aerial Drying
B-test	250	20	Minimal	None



GROWOUT CO-CULTURE

AFTER 2.5 MONTHS - SKIPPER BAY



Oyster cultured without urchins (left)
Oyster cultured with adult urchins (right)

Experimental Design					Urchins	Oysters		
Treatment	Oysters (n)	Urchins (n)	Biofouling	Fouling Control	Test Diameter (mm)	Survival (%)	Shell Height (mm)	Survival (%)
A-control	125	0	Heavy	Cage Flipping	--	--	88.4	93.4
A-test	125	20	Heavy	None	45.0 ± 2.2	100	87.1 ± 1.3	92.8 ± 2.2
B-control	125	0	Minimal	Cage None	--	--	82.8	94.8
B-test	125	20	Minimal	None	45.2 ± 0.9	100	78.0 ± 4.0	97.0 ± 1.4

- No mortality observed for adult urchins placed inside bags within cages, also no growth
- Similar growth rates and survival for oysters in Treatments A and B and controls

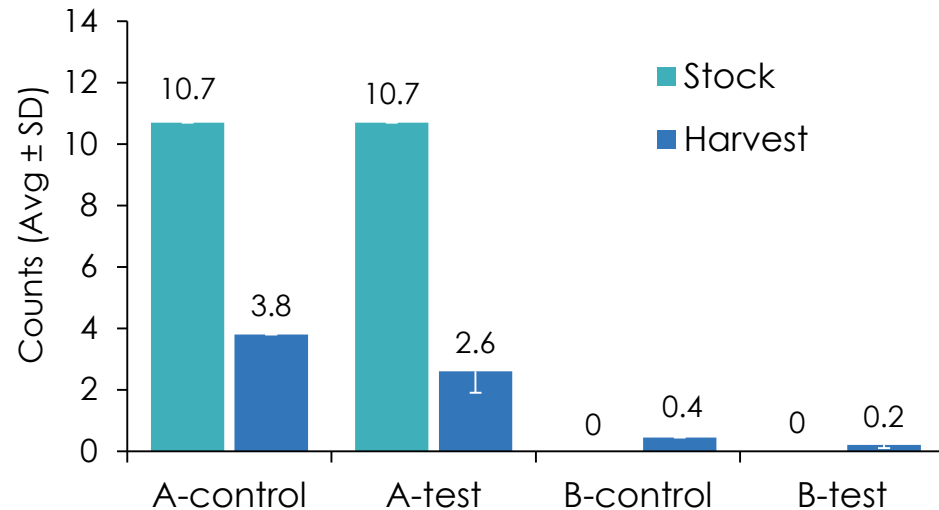
BIOFOULING

AFTER 2.5 MONTHS - SKIPPER BAY

- Similar decrease (Trt A) and increase (Trt B) of barnacles on oysters in treatments and controls
- Increase in soft-bodied fouling organisms (sea squirts) on oysters in control bags

Experimental Design					Fouling Results
Treatment	Oysters (n)	Urchins (n)	Biofouling	Fouling Control	Barnacle Reduction (%)
A-control	125	0	Heavy	Cage Flipping	64.5 ↓
A-test	125	20	Heavy	None	75.7 ↓
B-control	125	0	Minimal	Cage None	4 ↑
B-test	125	20	Minimal	None	2 ↑

BARNACLE FOULING ON OYSTERS



Oysters stocked without urchins (Trt B-control)



Oysters stocked with 20 adult urchins (Trt B-test)

SUMMARY

CO-CULTURE OF URCHINS AND OYSTERS

- Reliable hatchery production of urchins would be necessary for commercial development; reliance on wild sourced urchins is not realistic for aquaculture
- Use of urchins as a biofouling control method limited to lease areas with high, steady salinities (>25 psu)
- Site conditions may also restrict use of urchins to areas which provide protection from prevailing winds
- Gear type may be restricted to floating cages allowing urchins to sit deeper in the water than floating bags



SUMMARY

CO-CULTURE OF URCHINS AND OYSTERS

- Co-culturing organisms require conditions to be favorable for growth and survival of both species
- Results of field trials were not favorable for urchins nor potential for biofouling control of oysters clearly demonstrated
- Other practicalities of stocking urchins in oyster culture bags not addressed, such as tumbling
- Findings limit the potential of commercial development of urchin and oyster co-culture on Florida's Gulf coast

ACKNOWLEDGEMENTS

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- Johnny's Clams and Oysters
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- Southern Cross Seafarms

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