

Aquaculture Potential of the Angelwing Clam: The Southern Geoduck?



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About the Angelwing Clam

- Pholadid bivalve mollusk
- Attractive white shell – valued by shell collectors
- Distribution – native to FL, entire Atlantic coast
- Grows to 10-20 cm
- Lives in individual burrows up to 2' deep
- Commercially harvested in Caribbean and Mexico

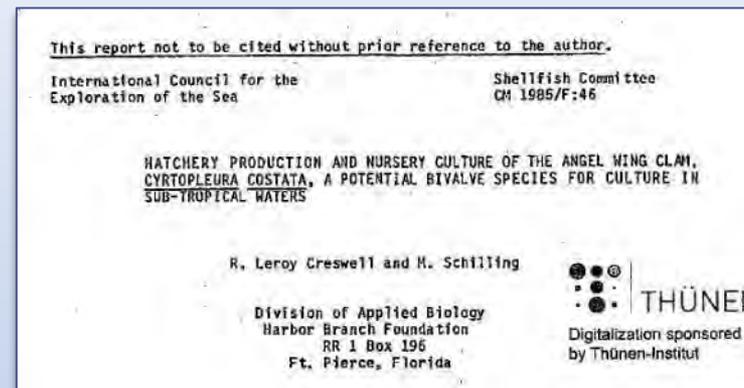


Cyrtopleura costata



Preliminary studies in 1980s

- Spawning technology developed
- Growout experiments indicated fast growth rate
- Market size (5-7 cm) reached in about 4-6 months
- Recommended further development of culture methods
- Major drawback of relatively short shelf life





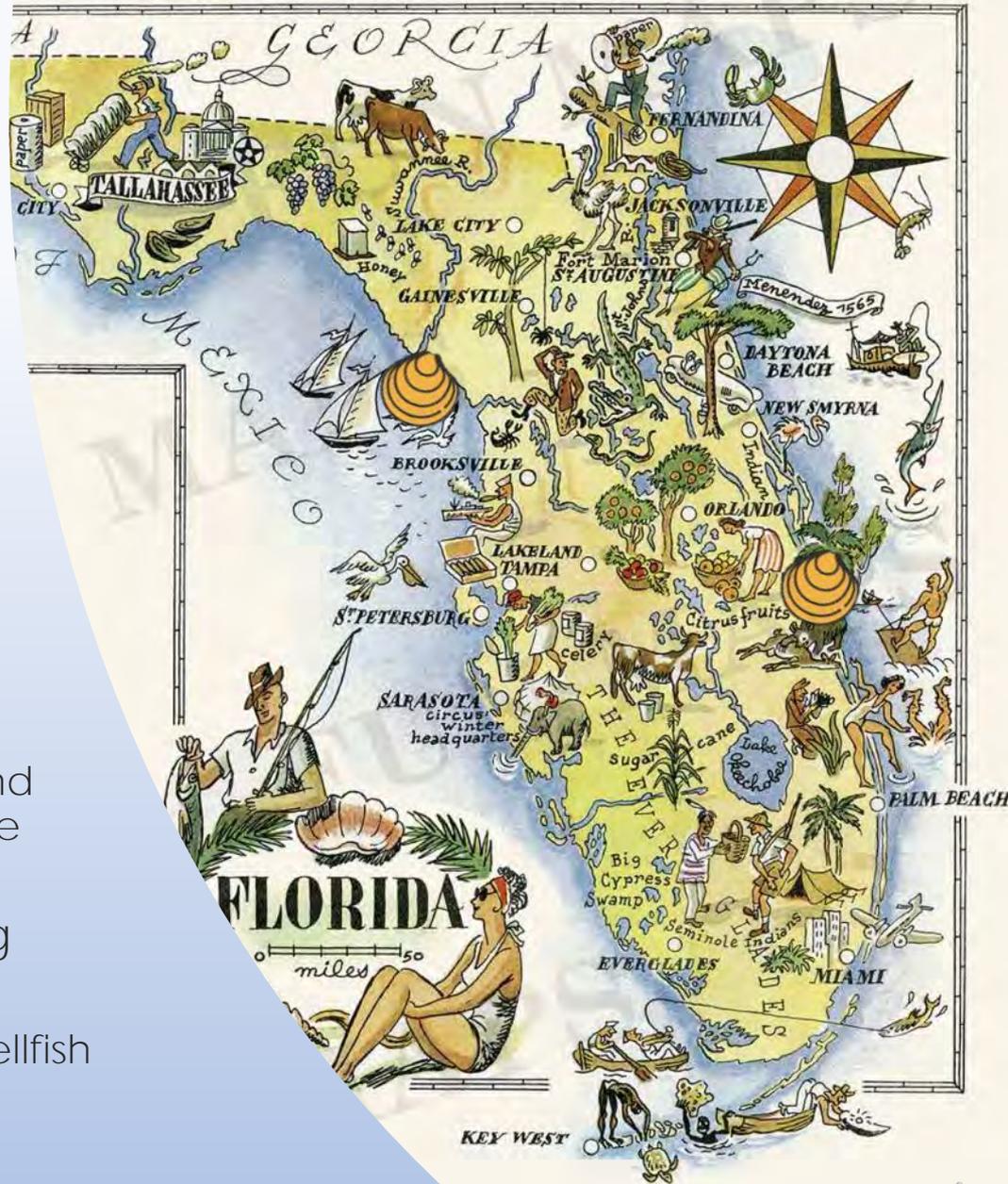
Why re-examine in 2020?

- Large hard clam culture industry in Florida: over 250 growers, 1700 acres of submerged land leases
- Techniques developed for culturing geoducks in Pacific Northwest may be adaptable for angelwings
- Market and consumer acceptance for processed, packaged molluscan shellfish products



Project Objectives

- 1) Document procedures of producing post-set AWs
 - Conducted at commercial hatchery in Cedar Key
- 2) Evaluate AW culture methods
 - Conducted at UF land-based nursery facility in Cedar Key and open-water experimental lease in Gulf of Mexico
- 3) Assess post-harvest processing methods for market-size AWs
 - Conducted at commercial shellfish processing plant in Melbourne



Seed production: Spawning

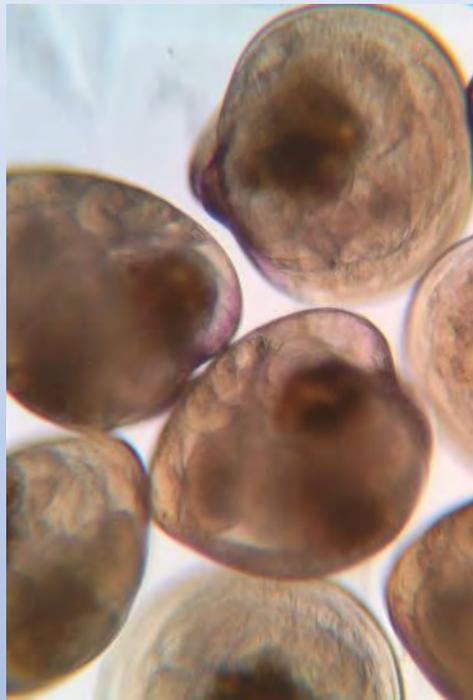
- Broodstock collection
 - Local assemblages
 - Monthly, March-May 2020
 - Adult sizes, 12-15 cm SL
 - April, some gonadal development
 - May, ripe males
- Spawning
 - Thermal cycling, 22-30°C
 - May 7th, 4x4 spawn
 - 22-24°C, 24-25 psu salinity





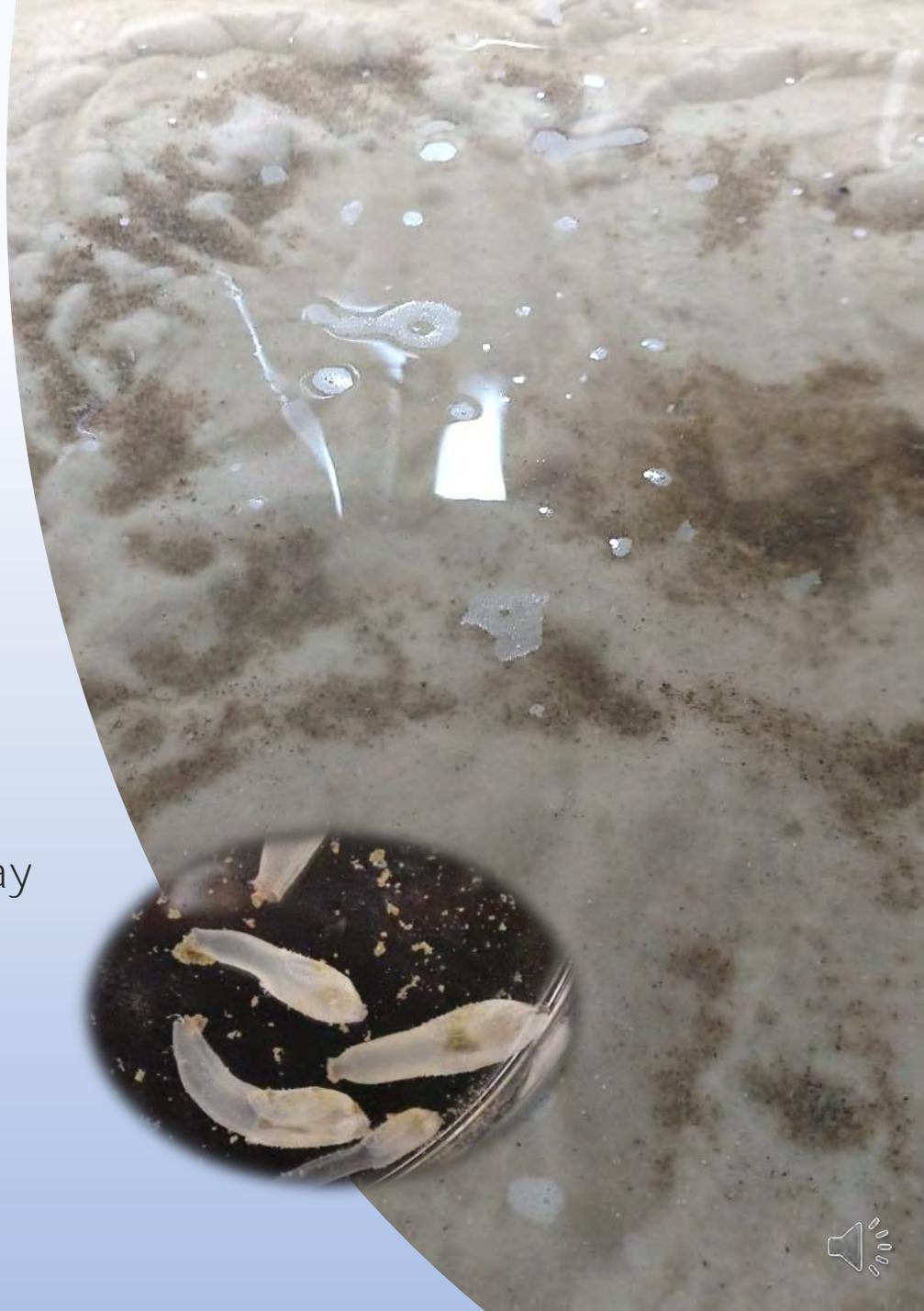
Seed production: Larval rearing

- D-stage larvae, 3M, stocked into 300-gal tank
- Provided *Nannochloris* sp. initially as larvae would not feed on *Isochrysis galbana*
- Every three days screen sizes increased – 35, 55, 75, 100 μ
- No mortalities or deformities found during larval period
- On May 27, 17 days from spawning, pediveligers observed
 - 10-14 days for hard clams
 - 16-21 days in prior research



Seed production: Setting

- Pediveligers (300 μ) placed in tank with graded sand added to half of the tank
- Setting occurred on bare tank bottom and sand surface
- Little mortalities observed
- Water exchanges every other day
- Increasing amounts of T-Iso fed
- On June 5th, post-set 2.3 mm SL
 - 10 days post-setting
 - 29 days after spawning





Seed production: Nursery rearing

- Transferred to UF facility
- Stocked ~ 7-9000 per tank
- Water initially filtered (100 μ)
- Flow-through, 2-10 gpm
- After 2-3 weeks, juveniles harvested
 - Size, 11.2 mm SL
 - Temperatures, 28.7 \pm 2.5 $^{\circ}$ C
 - Salinities, 22 \pm 4 psu
- Stock growout systems, June 24-July 8





Growout methods

- Bottom bags, 4'x4'
- 9 mm polyester net
- Internal PVC pipe (1", 2") frames
- Stocked at 450/bag, 28/ft²
- Cages, wire mesh with tops, n=4, 3'x3'x0.8'
- Lined with 9 mm netting
- Submerged into substrate
- Stocked at 450/cage, 50/ft²





PVC pipes, n-64,
4"-D, 6" length



PVC pipes, 3"Dx18",
stock in subtidal conditions



Netting, 8'x8'
polyester and plastic

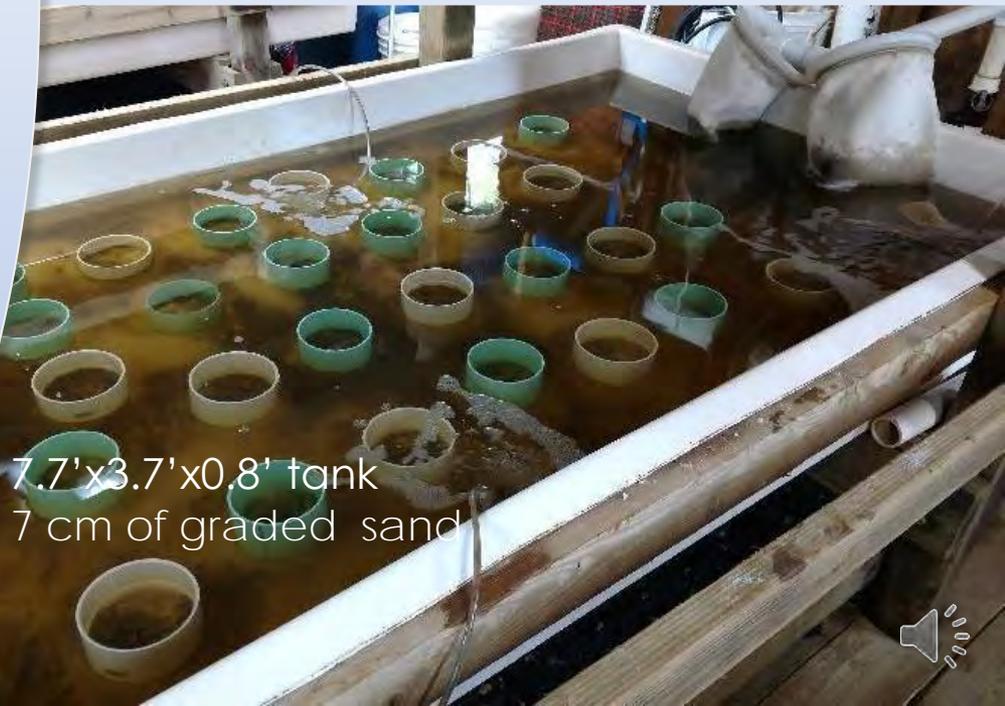
Growout methods

- Bottom Plant
- Pipes pushed into substrate at stocking
- Stocked 10-15/PVC pipe
- Secured netting with rebar around perimeter



Growout methods

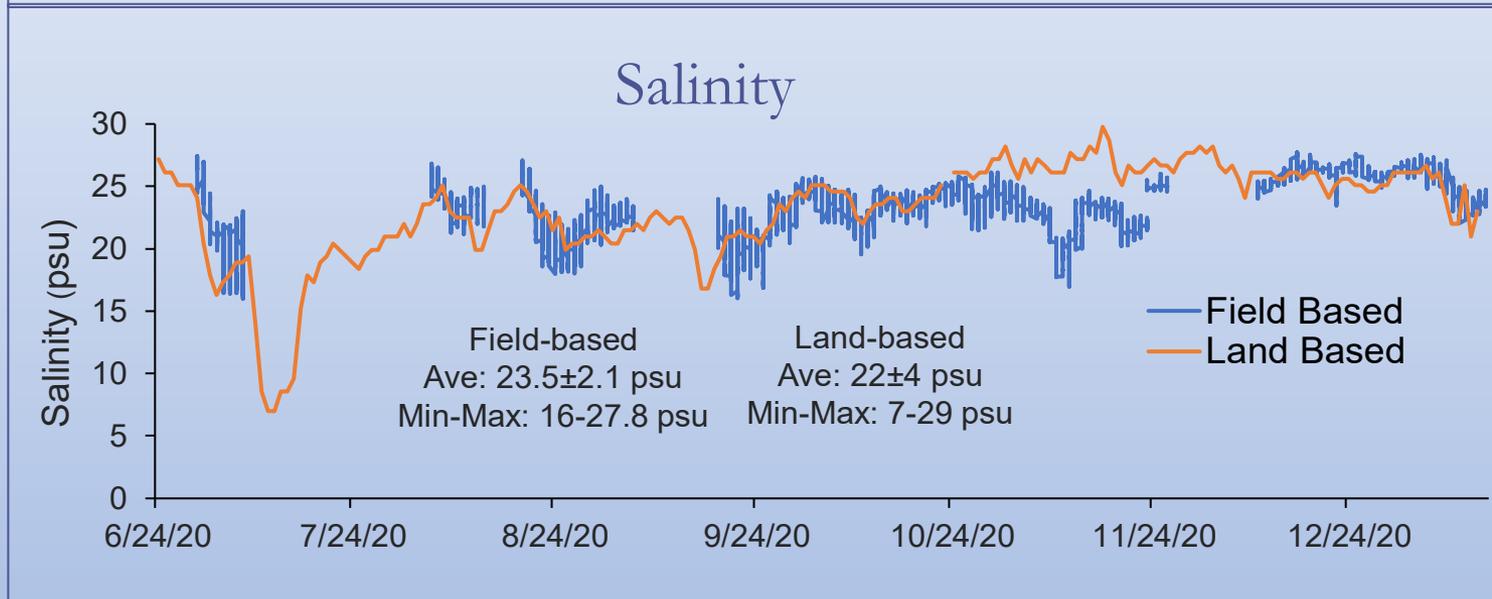
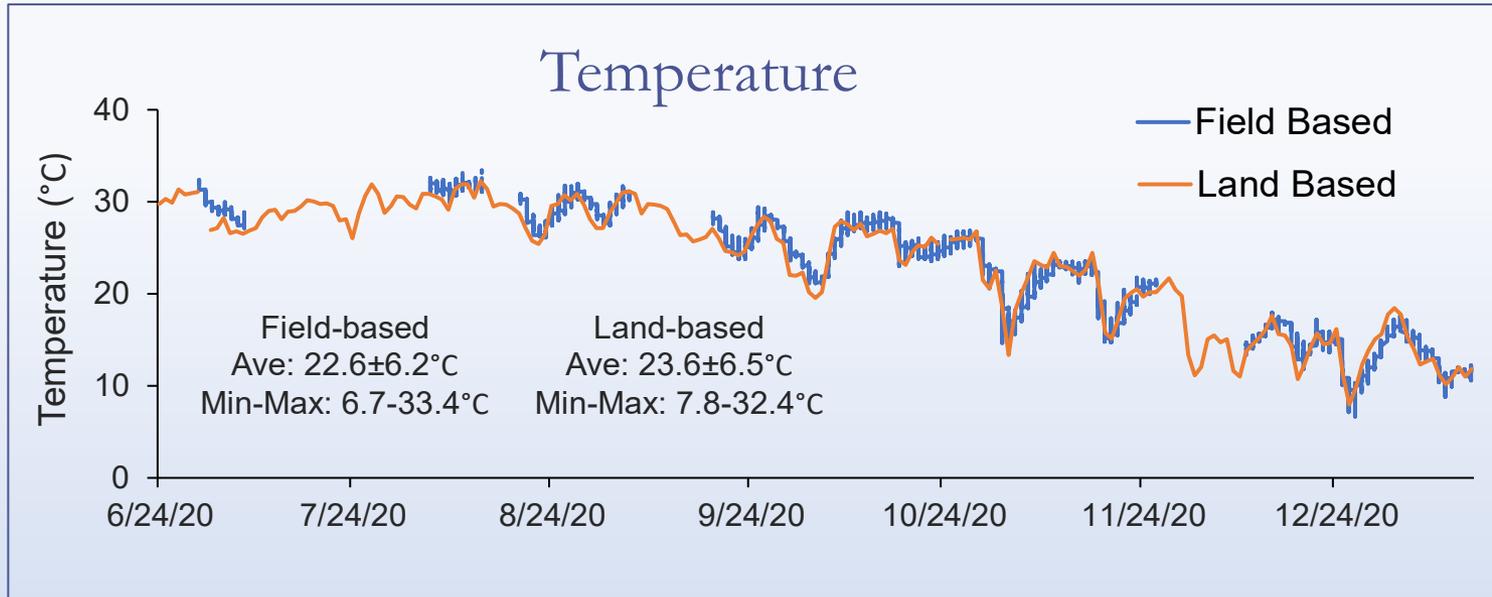
- Buckets, 3-gallon, n=9
- Filled with beach sand, 0.7'
- Lids used to snap netting (polyester and plastic) onto top
- Stocked 50-75/bucket
- Used to monitor growth and survival on a monthly basis
- Raceways tanks, n=2,
- Filled with graded sand, 7 cm
- Stocked 1200/tank, 40/ft²
- PVC pipes used to observe burymant at stocking
- Water flow, 15-28 gpm



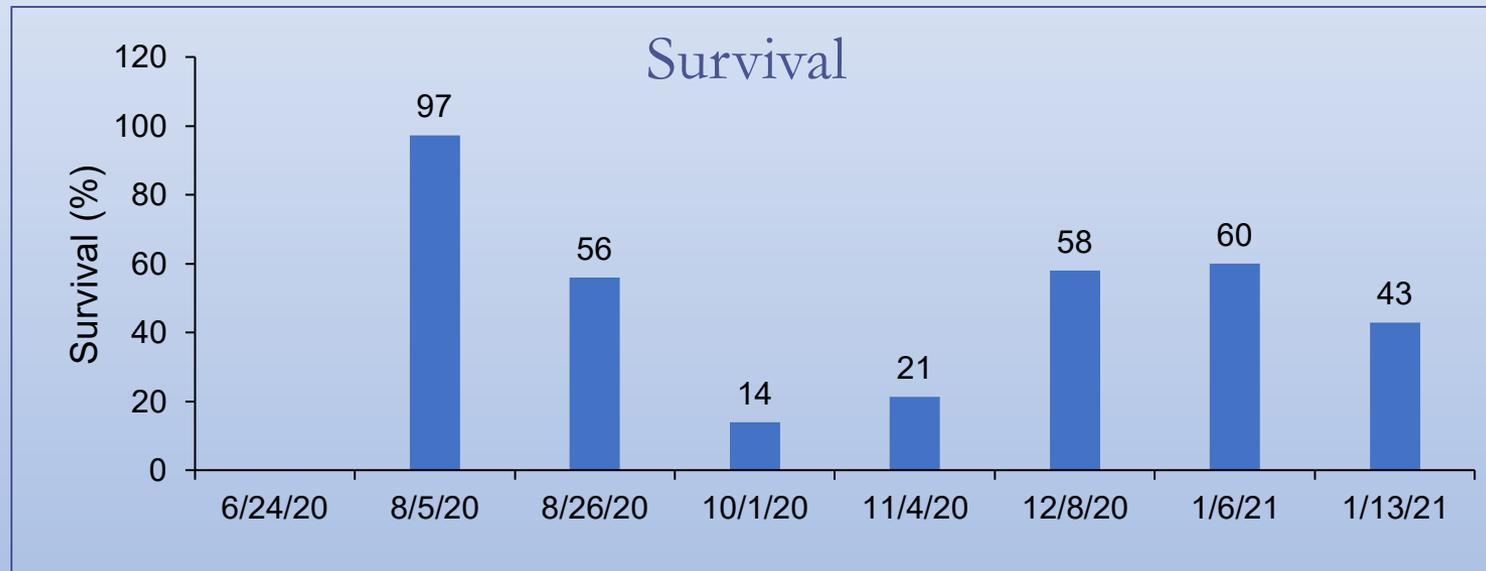
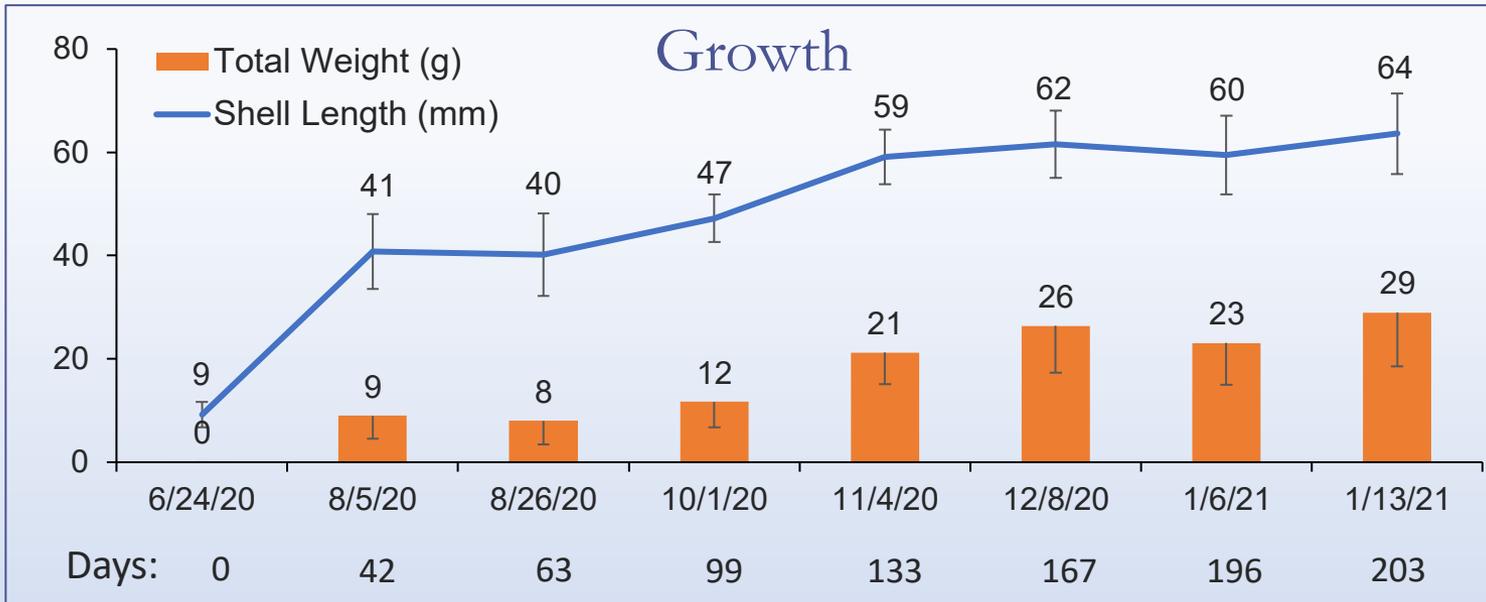
7.7'x3.7'x0.8' tank
7 cm of graded sand



Results:



Results: Buckets



Results: Bags and Cages



- Very little shell found
- No evidence of predation
- Assume juveniles did not bury in bags or cages
- Mortalities likely occurred after planting

Growout Method	Shell Length (mm)	Total Weight (grams)	Survival (%)
Bottom Bags	---	---	---
Cage #4	69.0 ± 5.0	36.0 ± 10.4	9.1



Results: Bottom Plant



Growout Method	Shell Length (mm)	Total Weight (grams)	Meat Weight (grams)	Dry Meat Weight (grams)	Condition Index	Survival (%)
Bottom Plant	61.6 ± 7.0	24.1 ± 7.4	6.5 ± 3.1	1.1 ± 0.5	7.2 ± 2.2	16.5

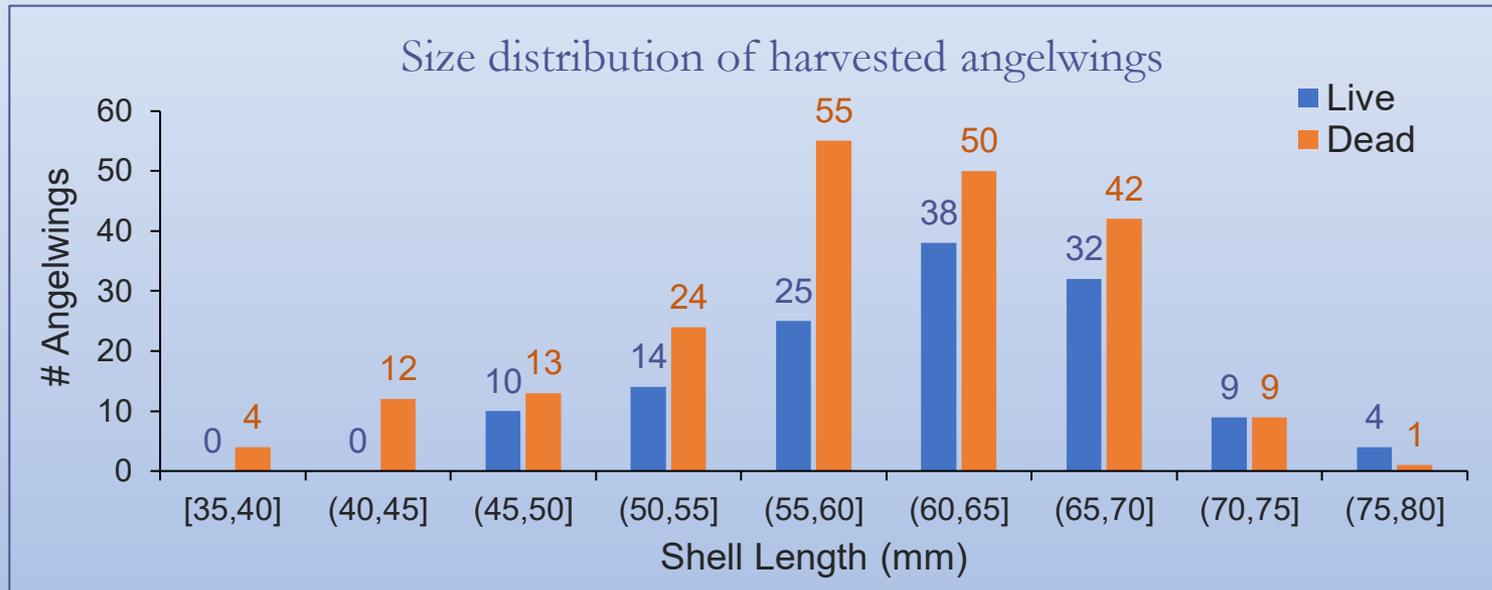
- Used 4" clam suction harvester
- No AWs recovered outside of pipes
- Shell breakage at harvest, <7%
- Growth rate, 0.28 mm/day



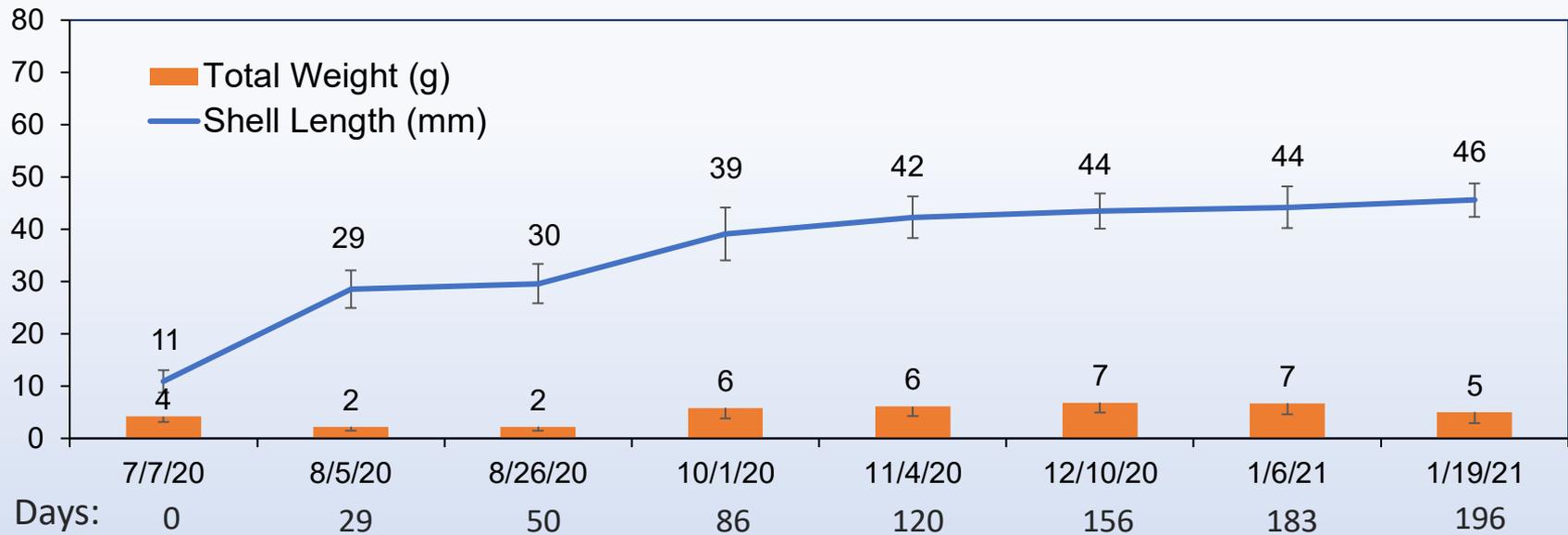
Results: Bottom Plant



- Harvested PVC tubes contained live AWs and intact shell
- Size distribution of shell and live AWs similar
- Mortalities possible related to winter storms and buryment
- If harvested 1-2 months earlier, survival >40%



Results: Raceways



Growout Method	Meat Wt (g)	Dry Meat Wt (g)	Condition Index	Survival (%)
Tanks	1.0 ± 0.3	0.1 ± 0.1	3.1 ± 2.2	35.8 ± 3.8

- Growth depressed, growth rate 0.18 mm/day
- Harvested AWs in poor condition
- Water flow did not provide adequate food supply
- Possibly overstocked and H₂S in sediments





**Southeastern
Seaproducts Inc**

Post- harvest methods

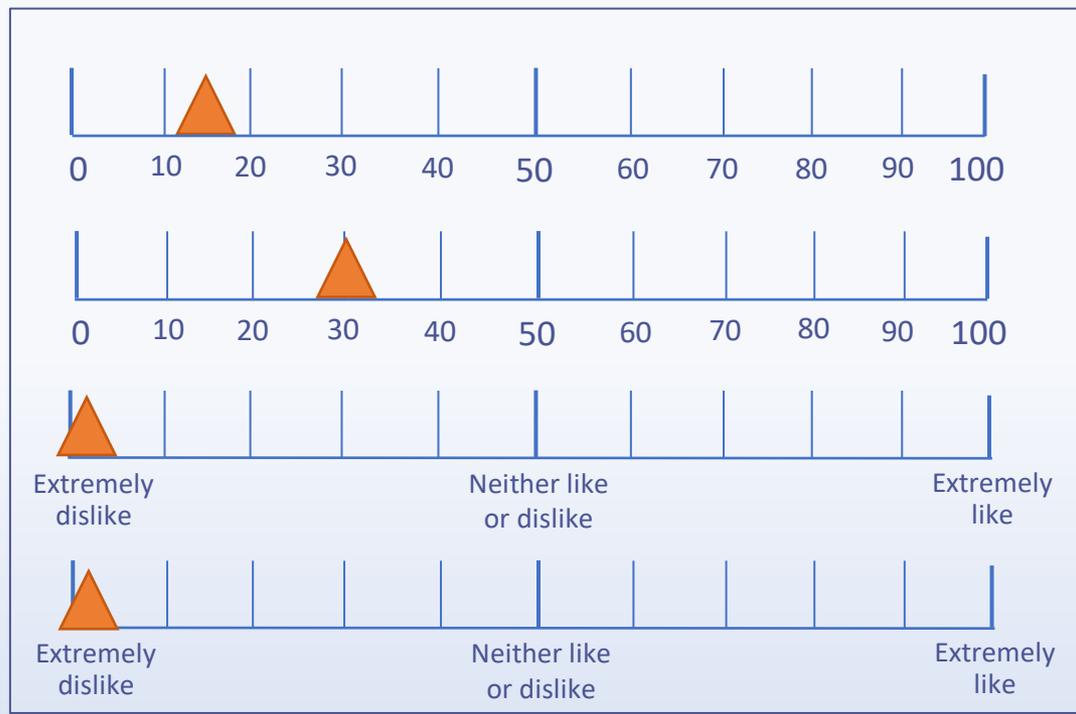
- AWs delivered in water
- Purged for 12 hours in chilled sea water
- Two treatments evaluated
 - Live packaging in modified atmosphere trays (MAP)
 - Partially cooked, flash frozen in vacuum bags
- Compared with live refrigerated storage (control)
- Assessed after 14 days



Results: Evaluation of attributes

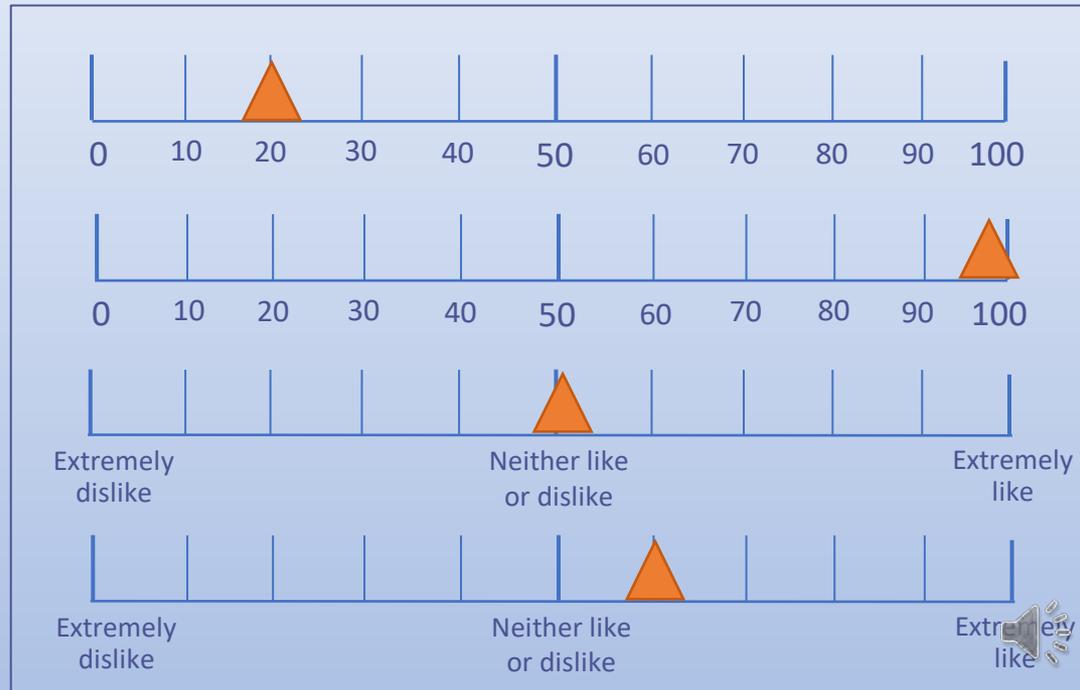
MAP

- Shell breakage (%)
- Shelf life-14 days (%)
- Appearance
- Taste



CF/VP

- Shell breakage (%)
- Shelf life-14 days (%)
- Appearance
- Taste



Results: Evaluation of attributes

- Shelf life on live shell stock product limited to 2 days in refrigerated storage
- Purge time adequate to completely remove grit

Marketability

- Live is preferred way to market, best shipped and held in seawater
- Post-harvest treatments for hard clams proved to be no benefit for angelwings



Summary:

Angelwings—an Aquaculture Candidate?

Factors to consider	Rating			
	Yes	Possibly	No	Uncertain
Spawning/larval rearing	✓			
Setting/post-set rearing	✓			
Juvenile production	✓			
Growout production		✓		
Culture at high densities		✓		
Low disease vulnerability		✓		
Water quality tolerance		✓		
Shelf life			✗	
Post-harvest methods			✗	
Product value/Marketability				?



Acknowledgements

- Clam Wranchos Hatchery
- Southeastern Seaproducts
- Funding:



*In Memory
LeRoy Creswell
1950-2020*

