



Investigation of Ark Clam Culture and Marketability

PROJECT TEAM INVESTIGATORS:

Leslie Sturmer, Jose Nunez, LeRoy Creswell, Shirley Baker
University of Florida, Institute of Food & Agricultural Sciences

Robert Degner, Kimberly Morgan
University of Florida, Agricultural Market Research Center

Alan Power, Randal Walker
University of Georgia, Marine Extension Service

John Baldwin
Florida Atlantic University, Dept. Biological Sciences

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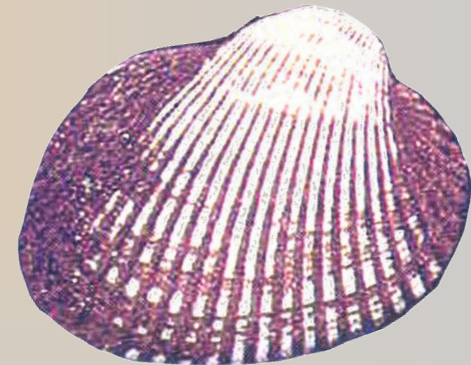


Rationale

- Shellfish aquaculture is a monoculture industry in Florida
- Need for diversification from a single species product
- Alternative species for aquaculture consideration
 - Native molluscan species
 - Cultured and marketed similar to hard clam, *Mercenaria mercenaria*



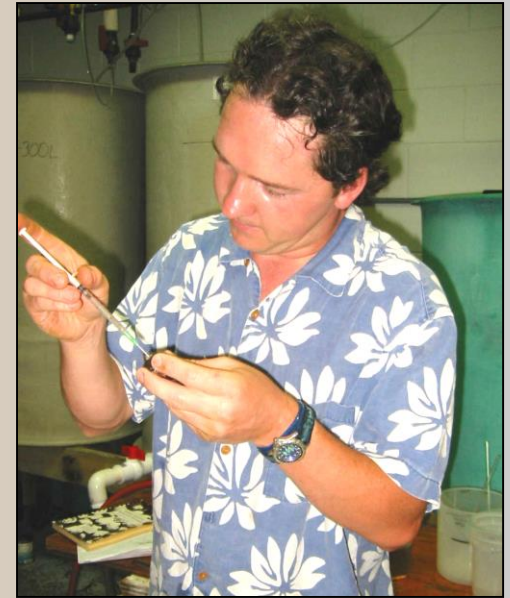
Ponderous ark
Noetia ponderosa



Blood ark
Anadara ovalis

Ark Clam Reproductive Patterns

- Determine gametogenic cycles of blood ark and ponderous ark off Florida's east and west coasts
 - Monthly gonadal index values
 - Peak spawning periods
 - Sex ratios



| Ark | Sexes | Sex Ratio (M/F) | Reproductive Pattern |
|-----------|-----------------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Blood | Separate, 2% hermaphrodites | 2.68 / 1 | Major peak during late spring-early summer months (45% ripe in May), no activity in summer, minor peak during winter (21% ripe in December) |
| Ponderous | Separate, no hermaphrodites | 1.19 / 1 | Peaks in summer and fall months, least activity in spring |

Ark Clam Reproductive Patterns

- Dribble spawning reproductive strategy for both ark clams
- Spawning prolonged over most of year with bimodal peaks
- Males and females represented in similar ratios

Journal of Shellfish Research, Vol. 23, No. 1, 173–178, 2004.

REPRODUCTIVE PATTERN OF THE BLOOD ARK, *ANADARA OVALIS* FROM THE NORTHEAST COAST OF FLORIDA

ALAN J. POWER,¹ JOSE NUNEZ,² MARCY MITCHELL,¹ RANDAL L. WALKER¹ AND LESLIE STURMER²
¹Shellfish Research Laboratory, University of Georgia Marine Extension Service, Savannah, Georgia 31411-1011; ²Whitney Laboratory, University of Florida, St. Augustine, Florida 32080

ABSTRACT In blood arks, the sexes are separate; however, a low incidence of hermaphrodites was observed in the current study (2.17%). Males occurred more frequently than females ($m/f = 2.68$). Ripe arks were present year round outside of the period from August to November 2002. A bimodal reproductive pattern was apparent with a peak in gonadal development during the late spring-early summer months (45% ripe in May), followed by a quiescent period in the late summer-fall, and followed in turn by a minor peak during the winter months (21% ripe in December). Spawning was apparent in all months with the exception of September, and individuals in this phase were most numerous in June (50%) and July (64.29%). Dribble spawning is likely used as a strategy to extend its spawning period and increase its reproductive success. A low incidence (3.33%) of parasitic infection by digenetic trematodes resulting in castration was also noted. The implications of these findings on the aquaculture potential of this species are discussed.

KEY WORDS: ark, gametogenesis, reproduction, sex ratio, spawning, *Anadara ovalis*

Journal of Shellfish Research, Vol. 24, No. 1, 69–73, 2005.

GAMETOGENIC CYCLE OF THE PONDEROUS ARK, *NOETIA PONDEROSA* (SAY, 1822), FROM CEDAR KEY, FLORIDA

ALAN J. POWER,^{1*} LESLIE STURMER,² CHERYL LUCAS,³ RANDAL L. WALKER^{1*} AND JUSTIN MANLEY³

¹Shellfish Research Laboratory University of Georgia, Marine Extension Service 20 Ocean Science Circle, Savannah, Georgia 31411; ²University of Florida, Cooperative Extension Service P.O. Box 89, Cedar Key, Florida 32625; ³Savannah State University 3219 College St., Savannah, Georgia 31404

ABSTRACT The gametogenic cycle of the ponderous ark, *Noetia ponderosa* (Say, 1822), was studied in a Cedar Key, Florida population between March 2001 and January 2003. Ponderous arks are dioecious, and no hermaphrodites were found in this study ($n = 592$). The sex ratio of females to males was 0.84:1.00, but was not significantly different from parity. On the Gulf coast of Florida, the ponderous ark dribble spawns over most of the year, peaking in the summer and fall months and with the least spawning activity occurring during the spring when gametes are maturing. A small percentage (5.2%) was found infested with an undescribed digenetic trematode. The Cedar Key area has an important commercial hard clam (*Mercenaria mercenaria*) aquaculture industry, and the implications of these findings on the potential for its diversification based on this species are discussed.

KEY WORDS: ark, gametogenesis, growth, reproduction, spawning, sex ratio

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Embryonic Development

Blood Ark



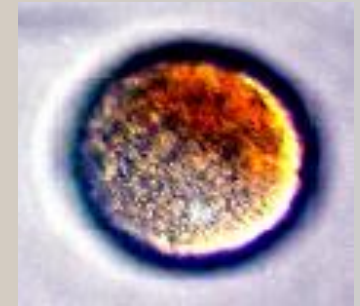
Fertilization
0 minutes



First cleavage
1 hour



Blastula
4-5 hours



Gastrula
7-8 hours

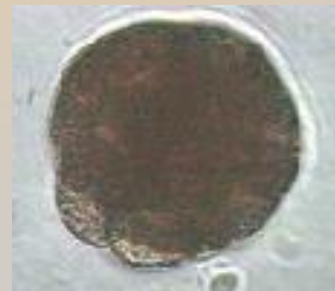
Ponderous Ark



Fertilization
0 minutes



First cleavage
1 hour



Blastula
5 hours



Gastrula
8-9 hours

Embryonic Development

Blood Ark



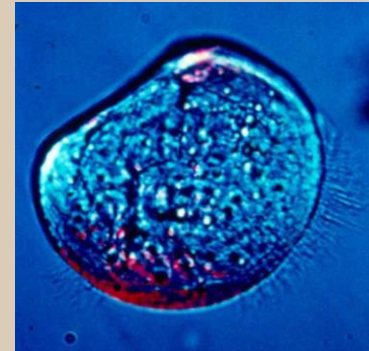
D-shape veliger,
19-21 hours

Ponderous Ark



D-shape veliger
21 hours

Hard Clam



D-shape veliger
24 hours

- Documented with light and fluorescence microscopy
- Differences in timing of development between ark clams were negligible
- Behavior and developmental timeline of ark clams similar to hard clam

Seed production

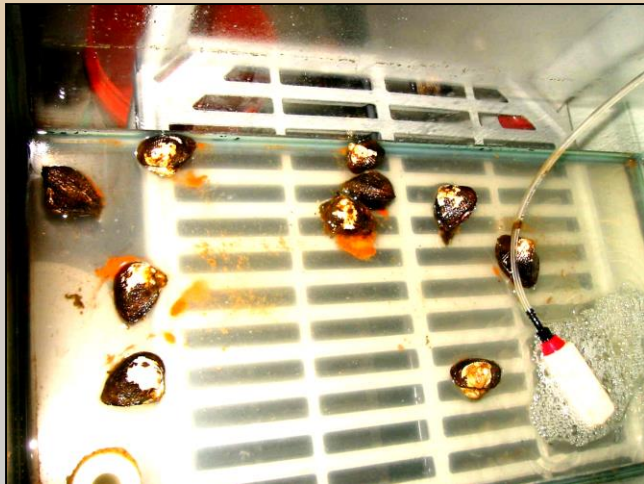
- Set-up experimental molluscan shellfish hatchery and nursery at UF Whitney Lab near Saint Augustine



- Conduct spawning, larval rearing and setting trials
- Develop reliable seed production techniques



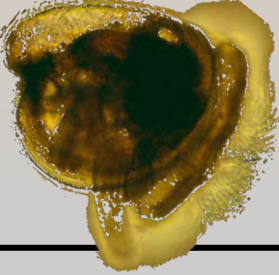
Spawning

- Reproductive wild ark clams were sourced from different locations
- Broodstock were condition at lab
- Spawning induced by temperature cycling from 68 to 86°C
- Serotonin injection not successful
- Spawning behavior like hard clam



- Egg color: orange to reddish
- Egg sizes: 55 μm - blood, 65 μm – ponderous
- Season: spring – blood, fall - ponderous

Larval Rearing

| Species | Day | Stage | Larval Size (μm) | Screen size (μm) | # per ml | Survival % |
|-----------------------------------------------------------------------------------------------------|-----|---------|-------------------------------|-------------------------------|----------|------------|
| Blood Ark  | 0 | Fert | 55 | | 7.8 | 100 |
| | 1 | D-shape | 80 x 65 | 34 | 4.3 | 55 |
| | 9 | Veliger | 115 x 110 | 54 | 0.5 | 6 |
| | 17 | Setting | 275 x 200 | 110 | 0.2 | 3 |
| Ponderous Ark  | 0 | Fert | 60 | | 3.0 | 100 |
| | 1 | D-shape | 90 x 70 | 34 | 2.4 | 80 |
| | 9 | Veliger | 130 x 100 | 54 | 1.7 | 57 |
| | 21 | Setting | 211 x 155 | 110 | 0.6 | 20 |
| Hard Clam  | 0 | Fert | 70 | | 7.2 | 100 |
| | 1 | D-shape | 105 x 90 | 34 | 6.9 | 96 |
| | 9 | Setting | 225 x 215 | 100 | 2.7 | 38 |

Setting and Post-set

- Setting was problematic
- No distinct pediveliger stage in both species
- Setting based on behavior
- Experiments conducted with different substrates and chemical cues to improve setting success
 - Benthic algae (<math><35\ \mu\text{m}</math>) promising
- Post-set rearing in downwellers
 - Tendency to crawl out of tanks
 - Attach to tanks and themselves with byssal threads
 - Sieving difficult

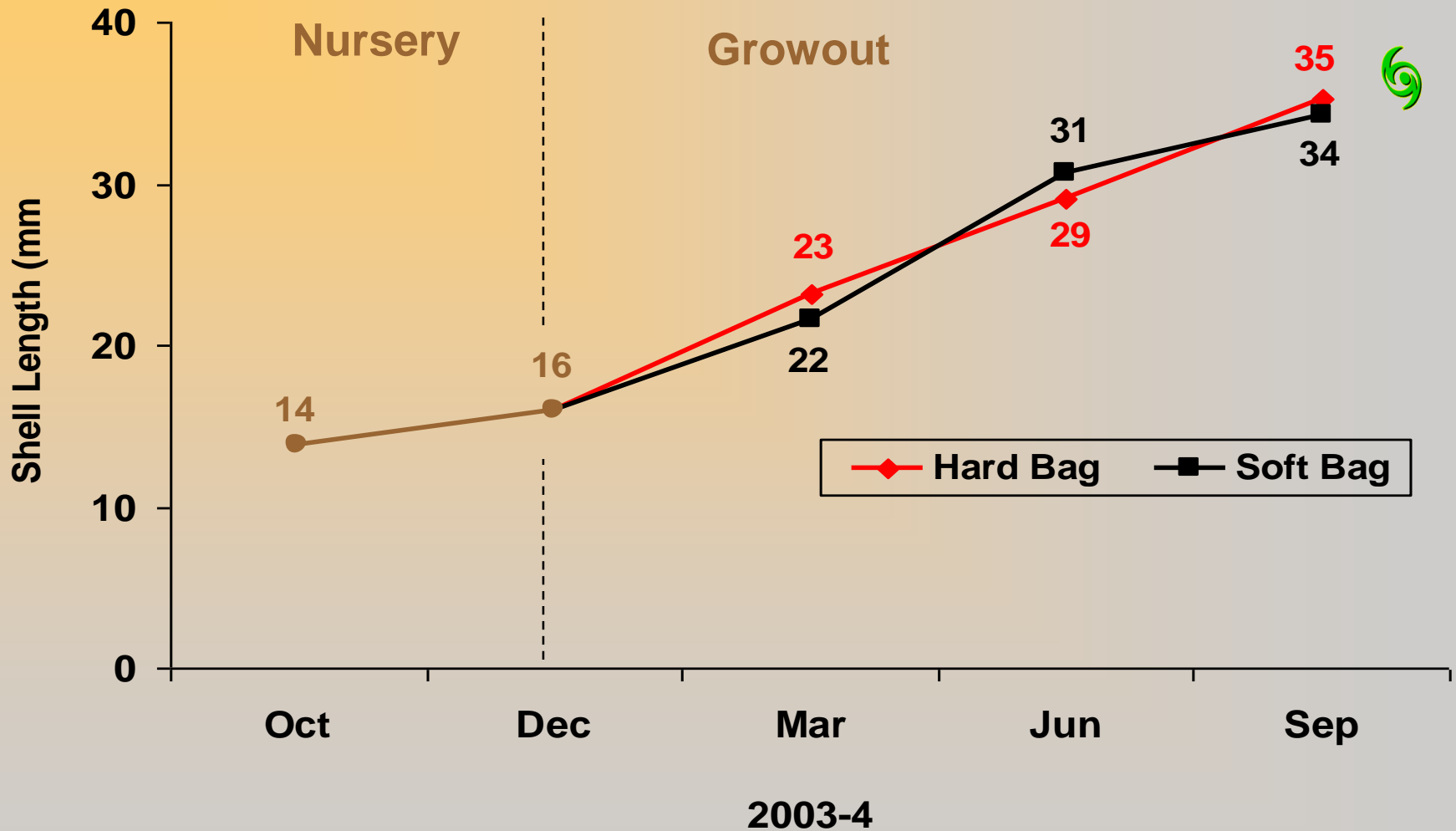


Ark Clam Culture

- Conduct nursery and growout rearing trials
 - Blood arks in St. Augustine
 - Ponderous arks in Cedar Key
- Document growth and survival of both arks in soft and hard culture bags

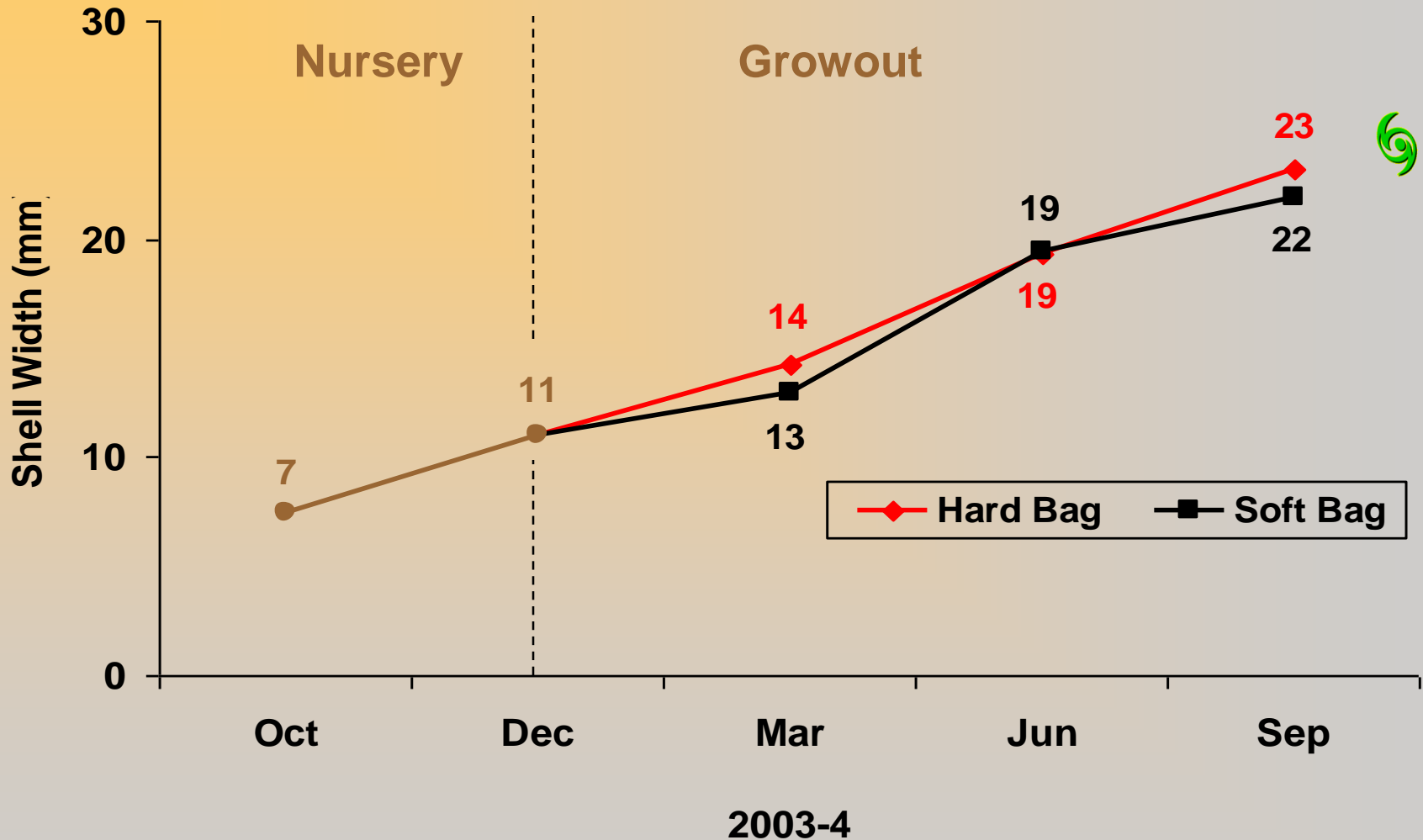


Blood Ark Nursery and Growout



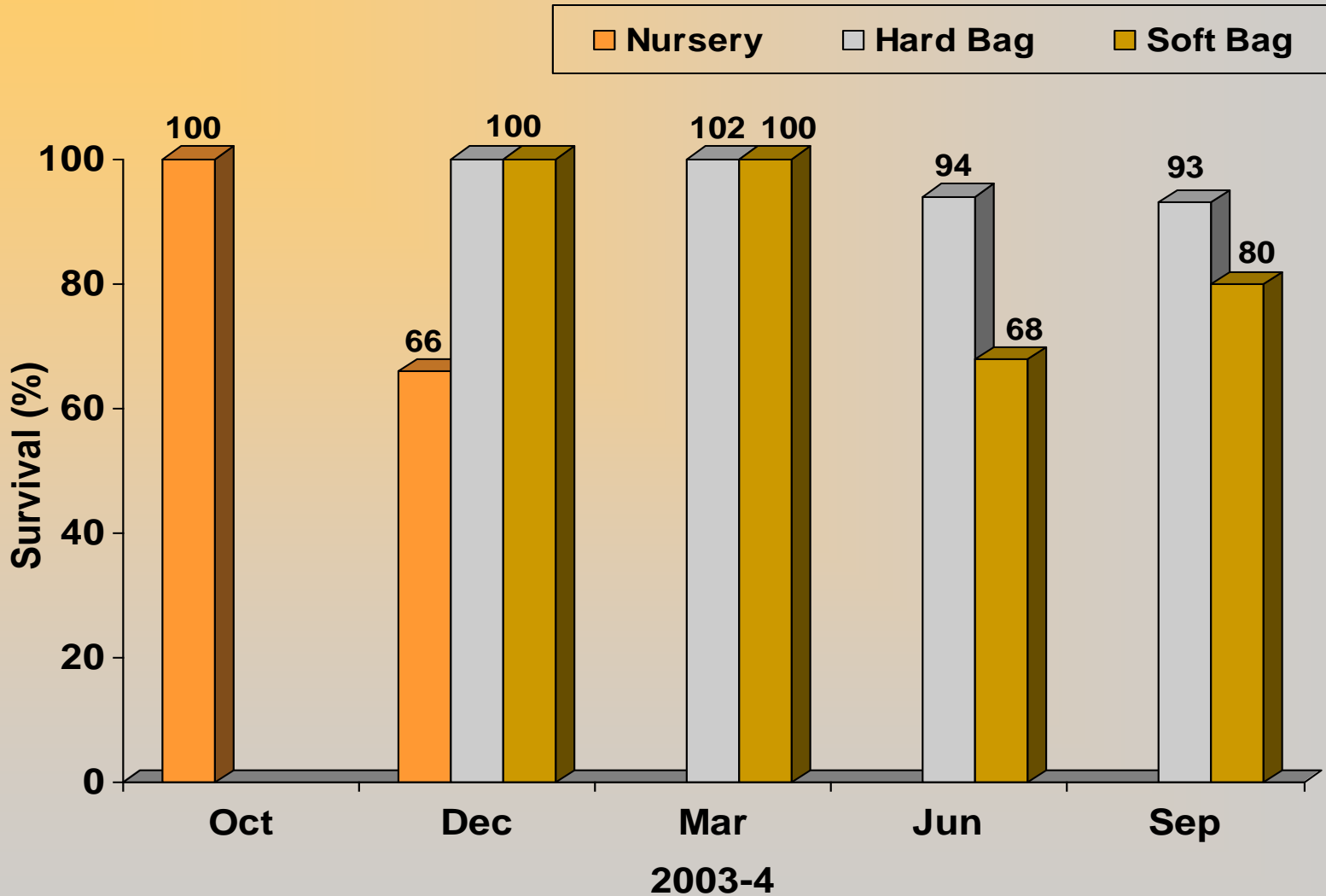
- From 14 mm to 35 mm (1.4") shell length in 12 months, No differences in bag types

Blood Ark Nursery and Growout



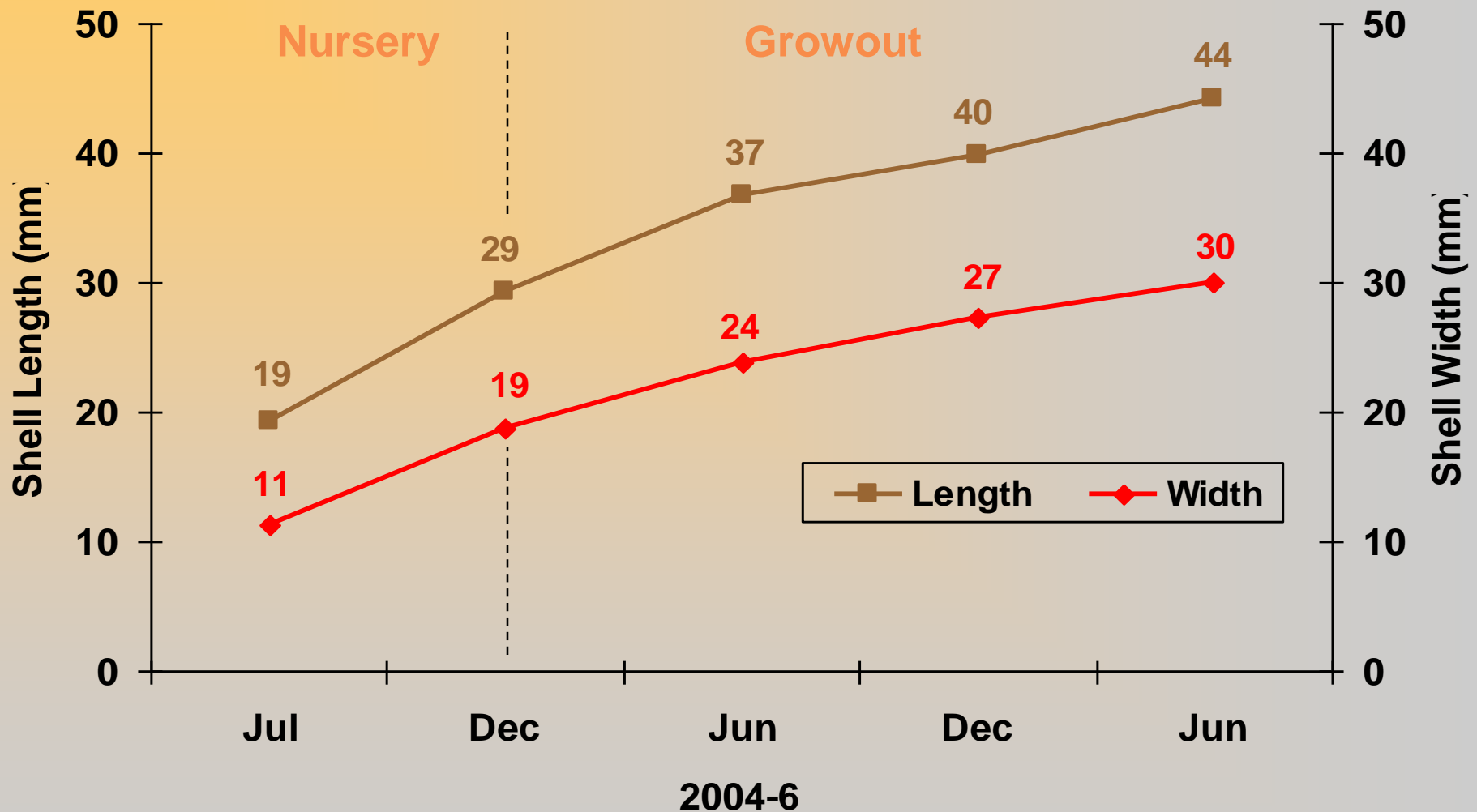
- From 7 mm to 22-23 mm (0.9") shell width in 12 months, No differences in bag type

Blood Ark Nursery and Growout



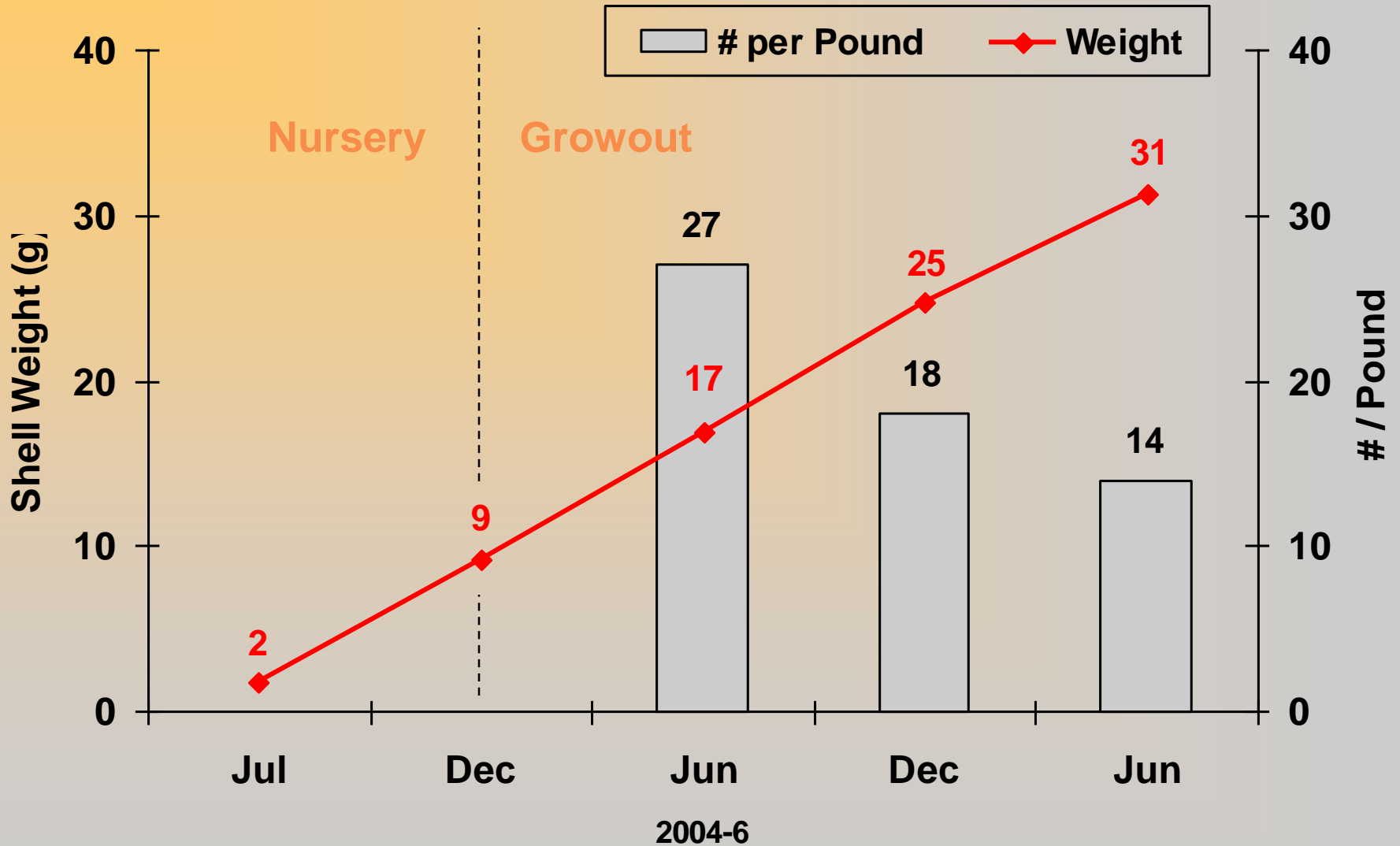
- 66% survival in nursery (2 months), 80-93% survival in growout (9 months)

Ponderous Ark Nursery and Growout



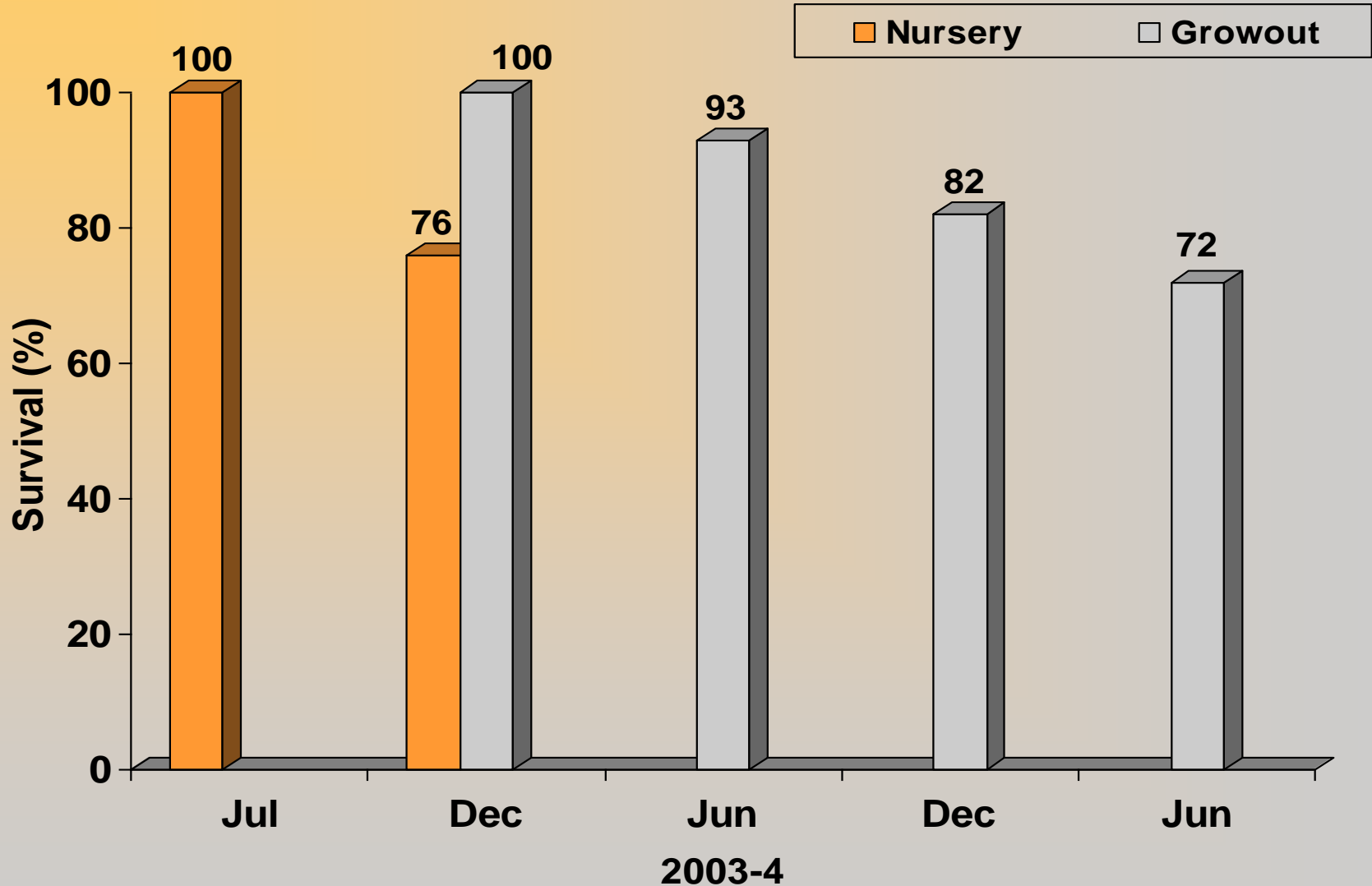
- From 19 mm to 44 mm (1 $\frac{3}{4}$ ") shell length and from 11 mm to 30 mm (1 $\frac{1}{4}$ ") shell width in 24 months

Ponderous Ark Nursery and Growout



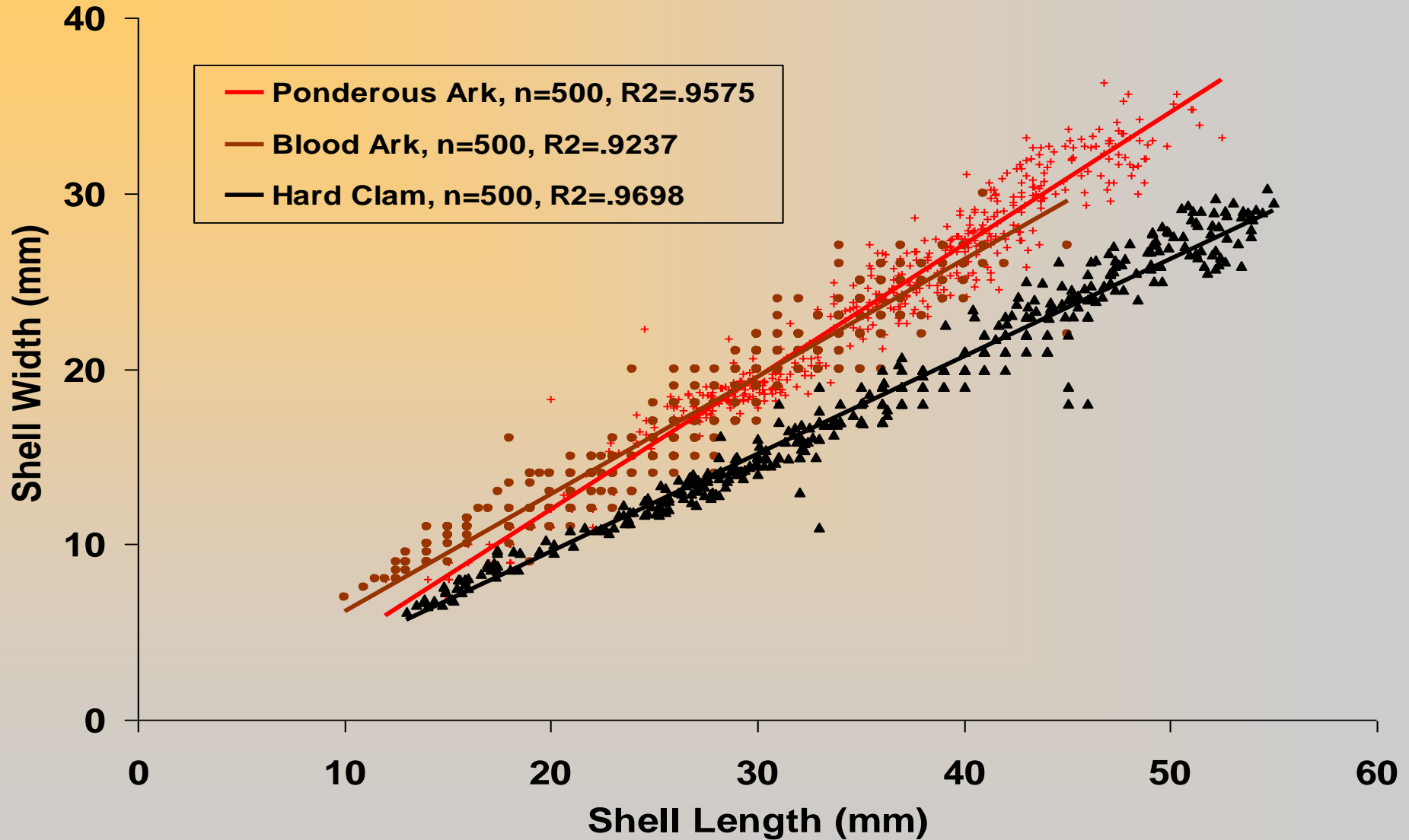
- From 2 grams to 31 grams whole weight (14 per pound) in 24 months

Ponderous Ark Nursery and Growout



- 76% survival in nursery (6 months), 72% survival in growout (18 months)

Ark versus Hard Clam Growth



■ Shell Length to Width Ratio: 1.5-Blood Ark, 1.4-Ponderous Ark, 1.9-Hard Clam



Ark Clam Marketability

- Assess magnitude of potential domestic market for ark clams, 2003
 - Over 2,100 shellfish wholesalers surveyed nationwide
 - 309 respondents, or 15%
- Survey results revealed limited trade awareness
 - Over 90% wholesalers unfamiliar with them
 - Only 1% reported selling ark clams in 2002
- Nearly one-third were willing to evaluate product samples of both species

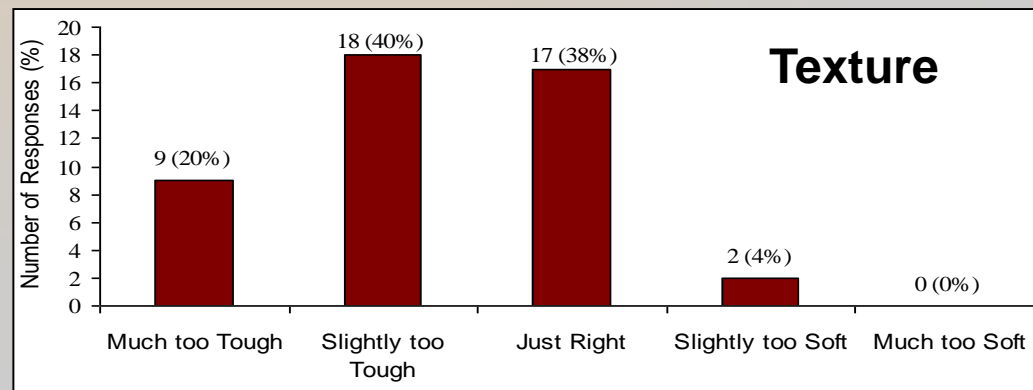
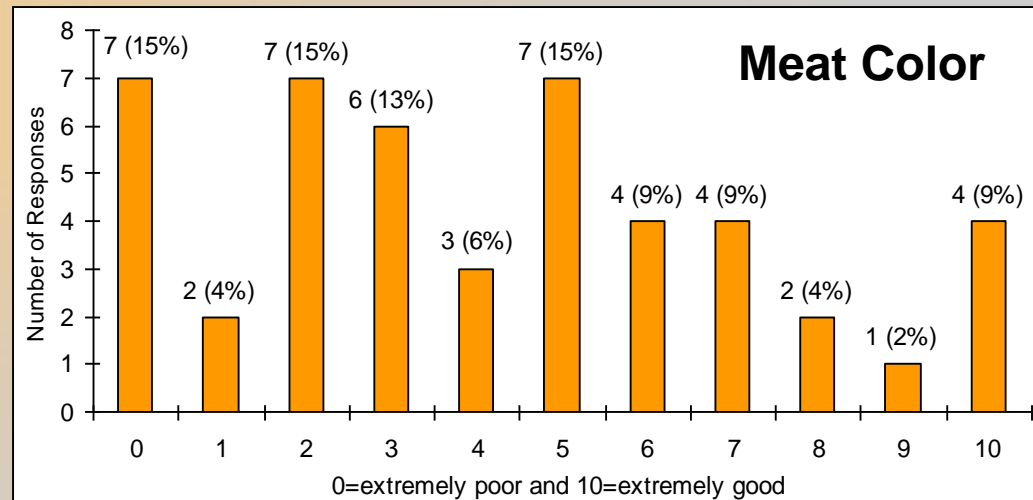
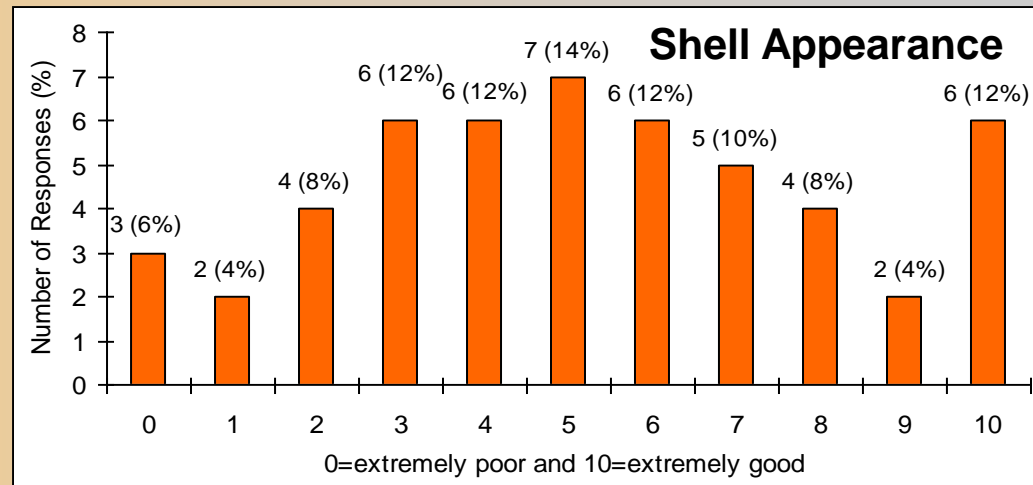
Ark Clam Marketability

- Determine desired product attributes and evaluate sensory attributes, 2003-4
 - 82 interested dealers received live samples and questionnaire
- Evaluate a number of basic product characteristics – appearance, taste, aroma, and textural properties
 - 52 provided useful evaluations, or 63%
- Estimate potential sales through respective firms



Marketability

- Mediocre evaluations for **Appearance**
 - Rating of 5 on 0 to 10 scale
 - Negative comments on black color, “fuzzy and “furry” shell
- **Meat Color** evaluations fared worse
 - 4.2 rating for blood
 - 3.6 rating for ponderous
 - Negative comments on bloody appearance
- **Texture** was “slightly” to “much too tough”
- Taste ratings were under 5 if eaten raw and about 5 is eaten cooked

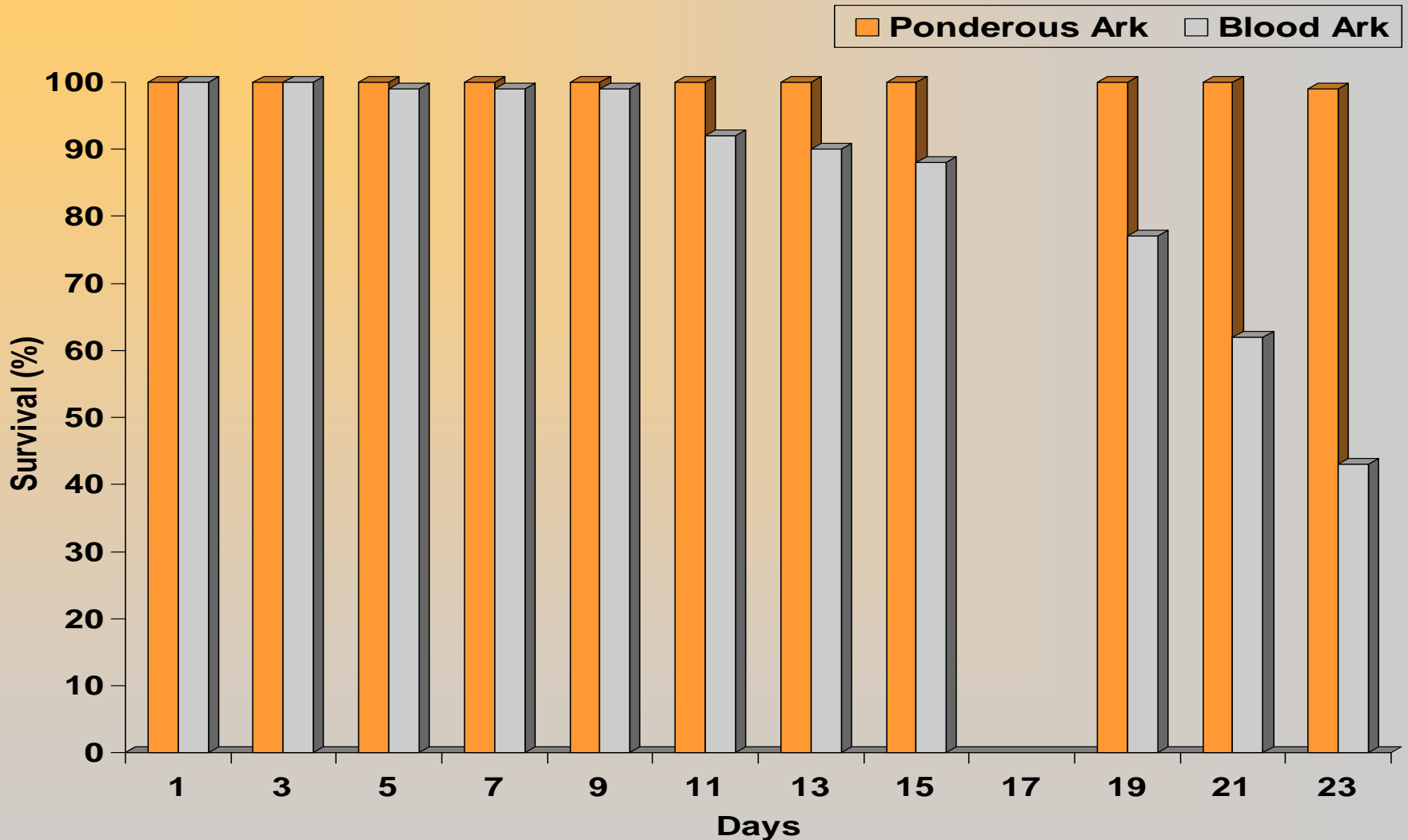


A large pile of dark, ribbed ark clams, likely the species mentioned in the text, is shown on the left side of the slide. The clams are dark brown to black with prominent ridges and are piled together, filling the left half of the frame.

Ark Clam Marketability

- Sales projections for arks
 - 50-60% of respondents could not sell
 - 11 firms, or 21%, estimated sales of 30 to 170,00 blood ark clams per week
 - 8 firms, or 14%, estimated sales of 30 to 120,000 ark clams per week
- Current market is limited
- Widespread lack of familiarity
- Unlikely to be a widespread, mainstream demand for ark clams
- Must recognize importance of ethnic markets in target locations on East and West coasts and Asian and Hispanic niche markets

Ark Clam Shelf Life



- Blood Ark – 99% survival in refrigerated storage after 9 days, 51% after 22 days
- Ponderous Ark – 99% survival in refrigerated storage after 23 days

Ark Clam Nutritional Composition

- Nutritional facts and labeling for cultured ark clams were determined for serving size of 100 grams of edible portion
 - Low in calories, fat, cholesterol
 - No carbohydrate
 - High in protein
 - High in sodium
 - High in iron (50-70% of daily value)

- In comparison, hard clams
 - Higher in calories
 - Similar in fats, cholesterol, and carbohydrate
 - Less sodium
 - ½ to 1/3 daily percent values for iron

| Nutrition Facts | | |
|------------------------------------------------------------------------------------------------------------------------------------|-------------------|---------------------|
| Serving Size (100g) | | |
| Servings Per Container | | |
| Amount Per Serving | | |
| Calories | 35 | Calories from Fat 5 |
| % Daily Value* | | |
| Total Fat | 0.5g | 1 % |
| Saturated Fat | 0g | 0 % |
| Cholesterol | 35mg | 12 % |
| Sodium | 740mg | 31 % |
| Total Carbohydrate | 0g | 0 % |
| Dietary Fiber | less than 1 gram | 4 % |
| Sugars | 3g | |
| Protein | 7g | |
| Vitamin A | 6% | • Vitamin C 2% |
| Calcium | 6% | • Iron 70% |
| *Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs: | | |
| | Calories: 2,000 | 2,500 |
| Total Fat | Less than 65g | 80g |
| Saturated Fat | Less than 20g | 25g |
| Cholesterol | Less than 300mg | 300mg |
| Sodium | Less than 2,400mg | 2,400mg |
| Total Carbohydrate | 300g | 375g |
| Dietary Fiber | 25g | 30g |
| Calories per gram: | | |
| Fat 9 • Carbohydrate 4 • Protein 4 | | |

Blood Ark

| Nutrition Facts | | |
|------------------------------------------------------------------------------------------------------------------------------------|-------------------|---------------------|
| Serving Size (100g) | | |
| Servings Per Container | | |
| Amount Per Serving | | |
| Calories | 50 | Calories from Fat 5 |
| % Daily Value* | | |
| Total Fat | 1g | 1 % |
| Saturated Fat | 0g | 0 % |
| Cholesterol | 55mg | 18 % |
| Sodium | 480mg | 20 % |
| Total Carbohydrate | 1g | 0 % |
| Dietary Fiber | less than 1 gram | 4 % |
| Sugars | 3g | |
| Protein | 11g | |
| Vitamin A | 6% | • Vitamin C 4% |
| Calcium | 10% | • Iron 50% |
| *Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs: | | |
| | Calories: 2,000 | 2,500 |
| Total Fat | Less than 65g | 80g |
| Saturated Fat | Less than 20g | 25g |
| Cholesterol | Less than 300mg | 300mg |
| Sodium | Less than 2,400mg | 2,400mg |
| Total Carbohydrate | 300g | 375g |
| Dietary Fiber | 25g | 30g |
| Calories per gram: | | |
| Fat 9 • Carbohydrate 4 • Protein 4 | | |

Ponderous Ark

Ark clam market information

Complete Market Report can be found on the UF/IFAS Florida Agricultural Market Research Center's website:

<http://www.agmarketing.ifas.ufl.edu>,

first click on "Publications," then click on "Marketing Research Publications 2000+"

Marketing Opportunities for Two Ark Clam Species:
Blood Ark Clams (*Anadara ovalis*)
And
Ponderous Ark Clams (*Noetia ponderosa*)

By

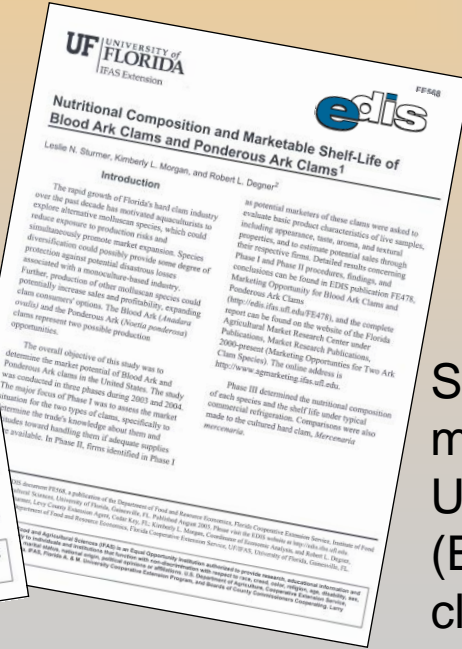
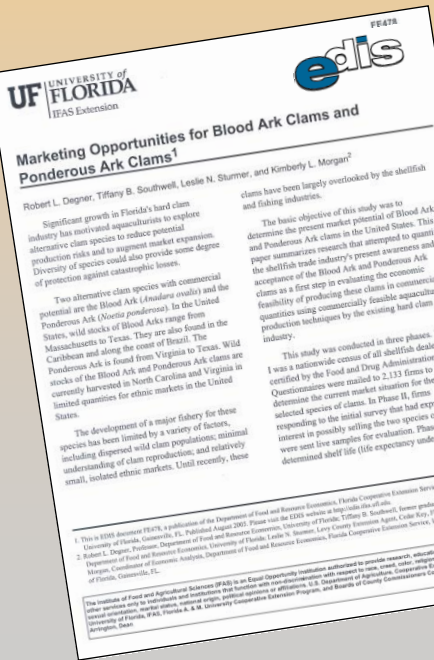
Robert L. Degner, Tiffany B. Southwell, Leslie N. Sturmer, and
Kimberly L. Morgan

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Cooperative Extension Service
and
Florida Agricultural Market Research Center
Food and Resource Economics Department
Institute of Food and Agricultural Sciences
University of Florida
Gainesville, Florida

Summaries of Phase I, II, III of the marketing assessment can be found at the UF/IFAS Electronic Data Information Source (EDIS) website: <http://edis.ifas.ufl.edu>, click on EDIS pub FE478 and FE568.



Report on hatchery and growout production for blood ark and ponderous ark clams due this spring

