

# Clam Stock Improvement

## *Results of Hybrid Clam Field Trials*

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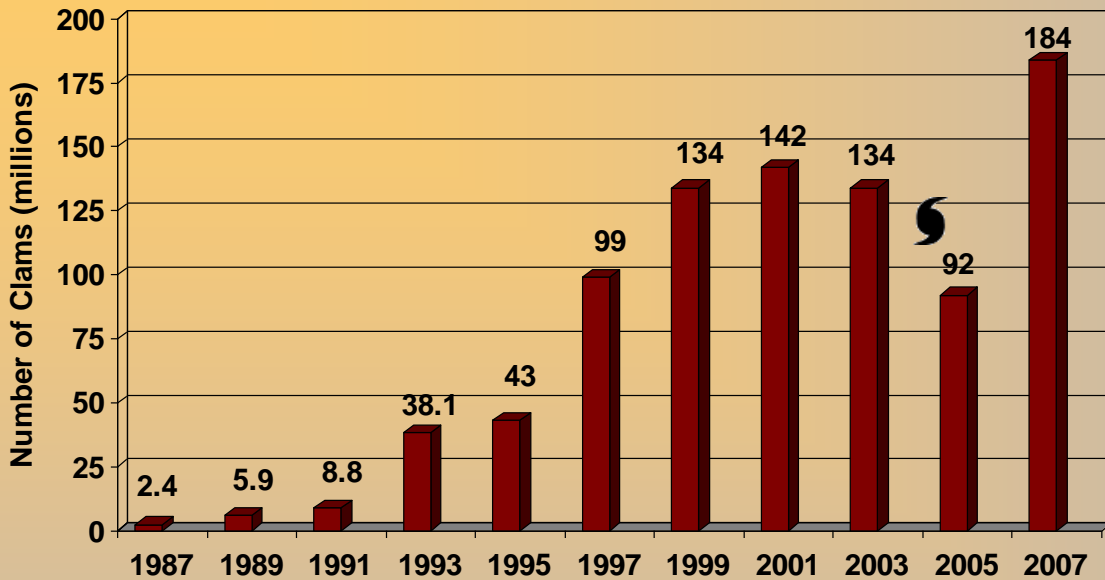


*Presented at 2009  
Clam Industry Workshop*

**HARBOR BRANCH**

FLORIDA ATLANTIC UNIVERSITY

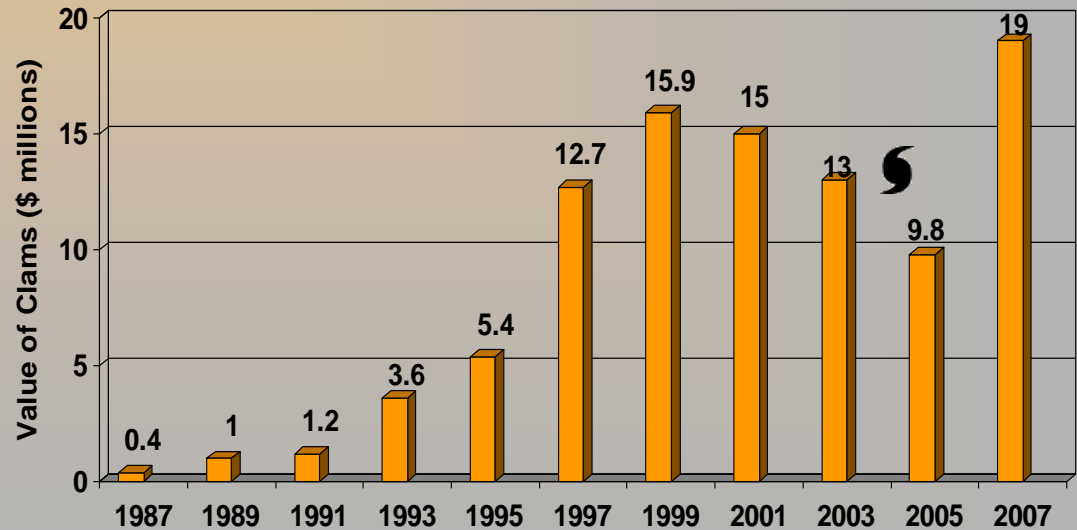
# Florida Clam Industry, 1987-2007



Production



Sales value



1987-2005 Compiled from Florida Agricultural Statistics Service's survey of aquaculturists


2007 Compiled from University of Florida survey of shellfish wholesalers

# Attributes

- Florida clams grow fast
  - 15-18 month growout from seed (6 mm) to littleneck size (1"SW, 2"SL) clam
  - One half to third of crop times of other states
    - Year-round growing conditions
    - Subtropical water temperatures
    - High natural productivity levels
- Florida clams are available year round
  - Plant and harvest continuously



# Why improve upon a good thing?

- 
- Concerns of loss of genetic diversity
  - Reduced seasonal growth
  - Increasing summer crop mortalities (>50%)
    - High water temperatures and other environmental stressors during prolonged summer months

# Industry-driven Applied Research Projects

- **Improvement of Cultured Hard Clam Stocks through Hybridization, 2006-9**
- **Assessment of F1 Hybrids Back Crossed with Hard Clams, 2009-11**
- **Evaluation of Thermally Selected Multi-Parental Crosses with Hard Clams and F1 Hybrids, 2010-2**

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Supported by the Cedar Key Aquaculture Association

**Congresswoman Ginny Brown-Waite**

**Former Senator Mel Martinez**



# Improvement of Cultured Clam Stocks through Hybridization

- Hybridization is a common breeding technique
  - Used in commercial agriculture and finfish aquaculture
- Hybrids have superior traits to either parent species
  - For example, improved growth or environmental resistance
- The use of clam hybridization for “mariculture” potential was examined by Winston Menzel at Florida State University in the 1960-70s
  - Showed hybrids had improved growth, shelf life
  - Little data reported on merit of hybrids for improved survival
- This project allows for a rigorous examination of clam hybridization
  - To improve production
  - To assure product quality



# Clam Species

- The northern hard clam supports fisheries and aquaculture industries along Atlantic coast from MA to FL
- The southern quahog found from NC to Caribbean, recreationally fished in FL
  - May have production traits for resisting environmental stressors
  - Not cultured because of their tendency to gape in refrigerated storage
- *Mercenaria* species are normally separated by environmental tolerances, but readily hybridize where they do co-occur or under hatchery conditions



Northern hard clam  
*Mercenaria mercenaria*



Southern quahog  
*Mercenaria campechiensis*

# Hatchery Production

- Northern hard clams obtained from a Florida hatchery
- Southern quahogs obtained from the wild (Sarasota), where highly pure populations are known to exist
- Single parent crosses utilized
- Five spawns accomplished with different sets of parents, October-December, 2007
- Stock verification by allozyme method, FWRI





# Nursing Hybrid Seed

- Standard hard clam protocols used
- Land-based nursing
  - Downwellers
  - March-June 2008
  - Cedar Key
- Field nursing
  - Bottom bags, 4 mm
  - June–September 2008
  - Cedar Key



# Nursing Hybrid Seed

- Growth differences negligible
- Survival rates not statistical different
- About 600,000 seed from three families nursed for growout evaluation



<b>Stock</b>	<b>Survival (%)</b> Average $\pm$ SD
M x M	73 $\pm$ 8
M x C	82 $\pm$ 14
C x M	79 $\pm$ 9
C x C	74 $\pm$ 11



# Growout Trials

## Stock Comparison

- Replicated plants -  
Parental stocks and  
reciprocal crosses  
from 3 families
  - Cedar Key
  - Sept 2008-Sept 2009
- Standard planting  
procedures
  - Bottom bags, 9 mm
  - Net coated and  
covered with wire
  - Stocked at 1150/bag  
(72/ft<sup>2</sup>)



# Growout Trials

- Stocking Density Comparison
  - Parental stocks and reciprocal crosses from 1 family
    - Cedar Key
    - Sept 2008-Sept 2009
  - Bottom bags stocked
    - 960/bag (60/ft<sup>2</sup>)
    - 1150/bag (72/ft<sup>2</sup>)
    - 1360/bag (85/ft<sup>2</sup>)
- Site Comparison
  - 190K distributed to 8 growers in 3 counties
    - Cedar Key
    - SW Florida
    - Panhandle
- Gear Comparison
  - Bottom bag
  - Bottom plant



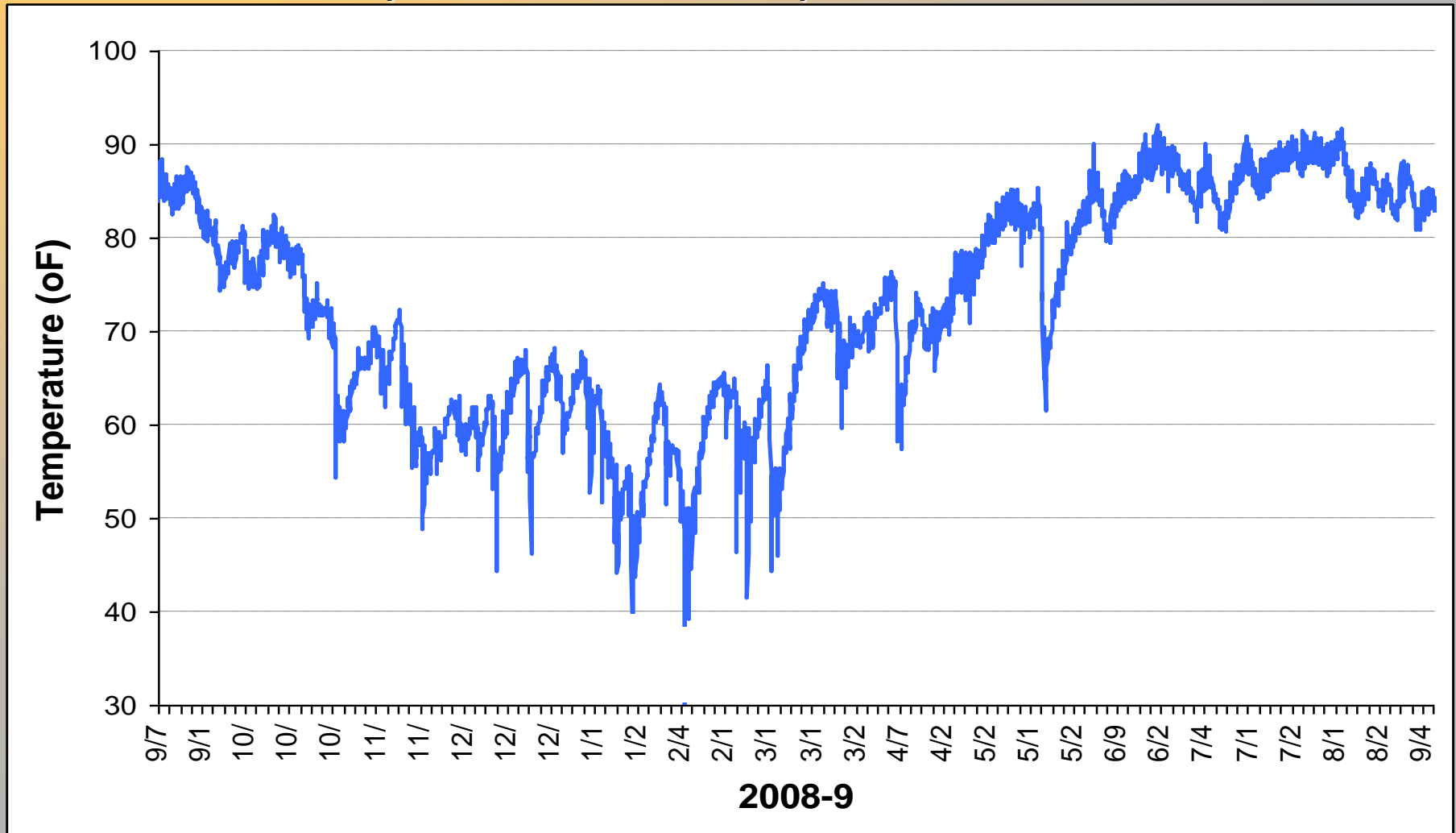
# Comparison of Production Characteristics

- Sampling every 4 months and at harvest (12 months)
- Growth – SL, SW, total and meat weight
- Survival
- Condition index – measure of degree of fattening or nutritive status
- Histology – determine gonadal stage and reproductive potential



# Water Temperature (°F)

Dog Island Lease Area, Cedar Key  
September 2008- September 2009



*Water temperature measured every hour with YSI 6600 data sonde*

# Growth & Survival (12 months) – Family A

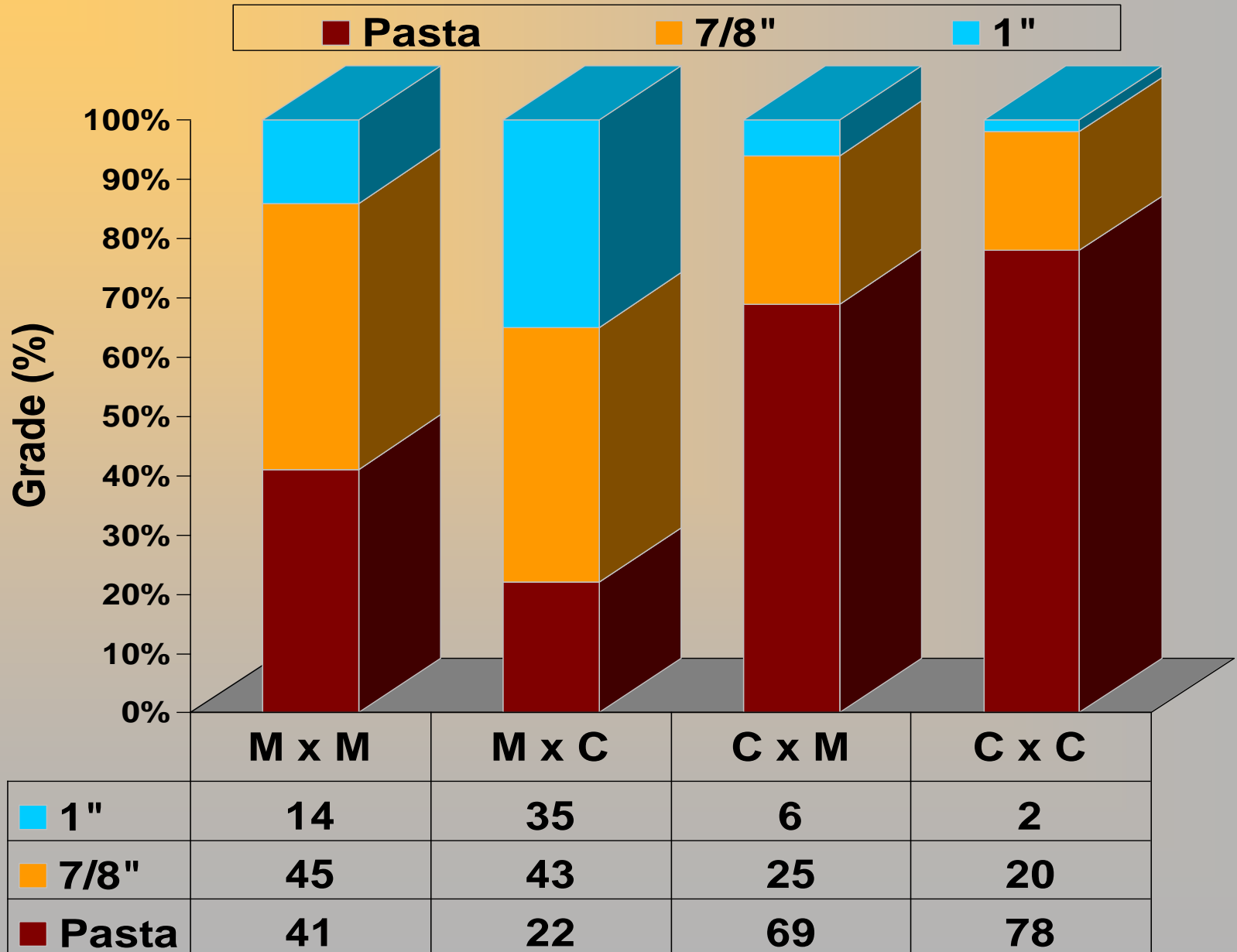
## Average $\pm$ Standard Deviation

Stock	Width (mm)	Length (mm)	Weight (g)	Survival (%)
M x M	23.2 $\pm$ 0.4	44.6 $\pm$ 1.6	27.4 $\pm$ 1.8	83.5 $\pm$ 0.7
M x C	24.9 $\pm$ 0.4	46.2 $\pm$ 1.2	32.1 $\pm$ 1.8	92.3 $\pm$ 5.7
C x M	21.9 $\pm$ 0.3	40.6 $\pm$ 0.8	21.8 $\pm$ 0.5	75.6 $\pm$ 3.8
C x C	21.7 $\pm$ 0.7	38.7 $\pm$ 0.04	20.2 $\pm$ 0.4	96.2 $\pm$ 5.3

Note: Littleneck –sized clam is about 25 mm (1”) in width, 50 mm (2”) in length, 30-38 grams in weight  
 7/8”-sized clam is about 22 mm (7/8”) in width, 44 mm (1 3/4”) in length, 23-30 grams in weight



# Grade (12 months) – Family A



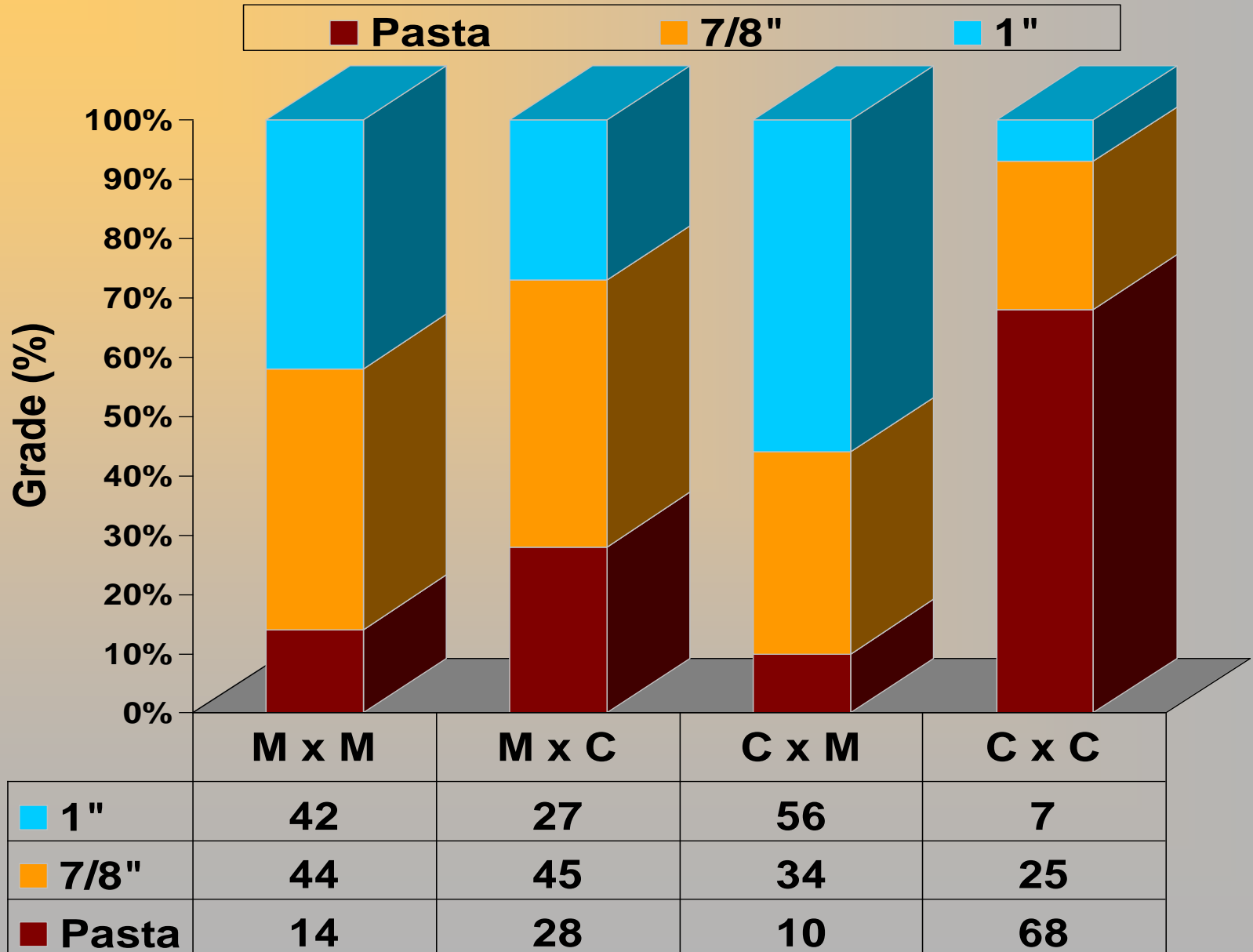
# Growth & Survival (12 months) – Family B

## Average $\pm$ Standard Deviation

Stock	Width (mm)	Length (mm)	Weight (g)	Survival (%)
M x M	25.3 $\pm$ 0.9	46.3 $\pm$ 0.5	31.9 $\pm$ 0.4	90.9 $\pm$ 3.7
M x C	24.4 $\pm$ 0.2	44.9 $\pm$ 0.6	29.7 $\pm$ 0.3	99.1 $\pm$ 1.3
C x M	26.1 $\pm$ 1.1	46.1 $\pm$ 2.5	35.4 $\pm$ 4.5	100 $\pm$ 0
C x C	21.7 $\pm$ 1.4	38.2 $\pm$ 3.3	19.5 $\pm$ 5.0	85.1 $\pm$ 0.8

Note: Littleneck –sized clam is about 25 mm (1”) in width, 50 mm (2”) in length, 30-38 grams in weight  
 7/8”-sized clam is about 22 mm (7/8”) in width, 44 mm (1 3/4”) in length, 23-30 grams in weight

# Grade (12 months) – Family B



# Density Results: SURVIVAL – Family A

## Average $\pm$ Standard Deviation

Stock	Low Density	Medium Density	High Density
M x M	77.3 $\pm$ 11.7	87.7 $\pm$ 17.4	90.1 $\pm$ 6.8
M x C	92.4 $\pm$ 4.6	90.3 $\pm$ 6.6	88.0 $\pm$ 2.8
C x M	62.4 $\pm$ 0.6	62.4 $\pm$ 2.1	58.8 $\pm$ 1.2
C x C	58.6 $\pm$ 16.9	56.6 $\pm$ 30.6	79.3 $\pm$ 1.3

Low Density–960/bag (60/ft<sup>2</sup>) Medium Density–1150/bag (72/ft<sup>2</sup>) High Density–1360/bag (85/ft<sup>2</sup>)

# Density Results: LENGTH – Family A

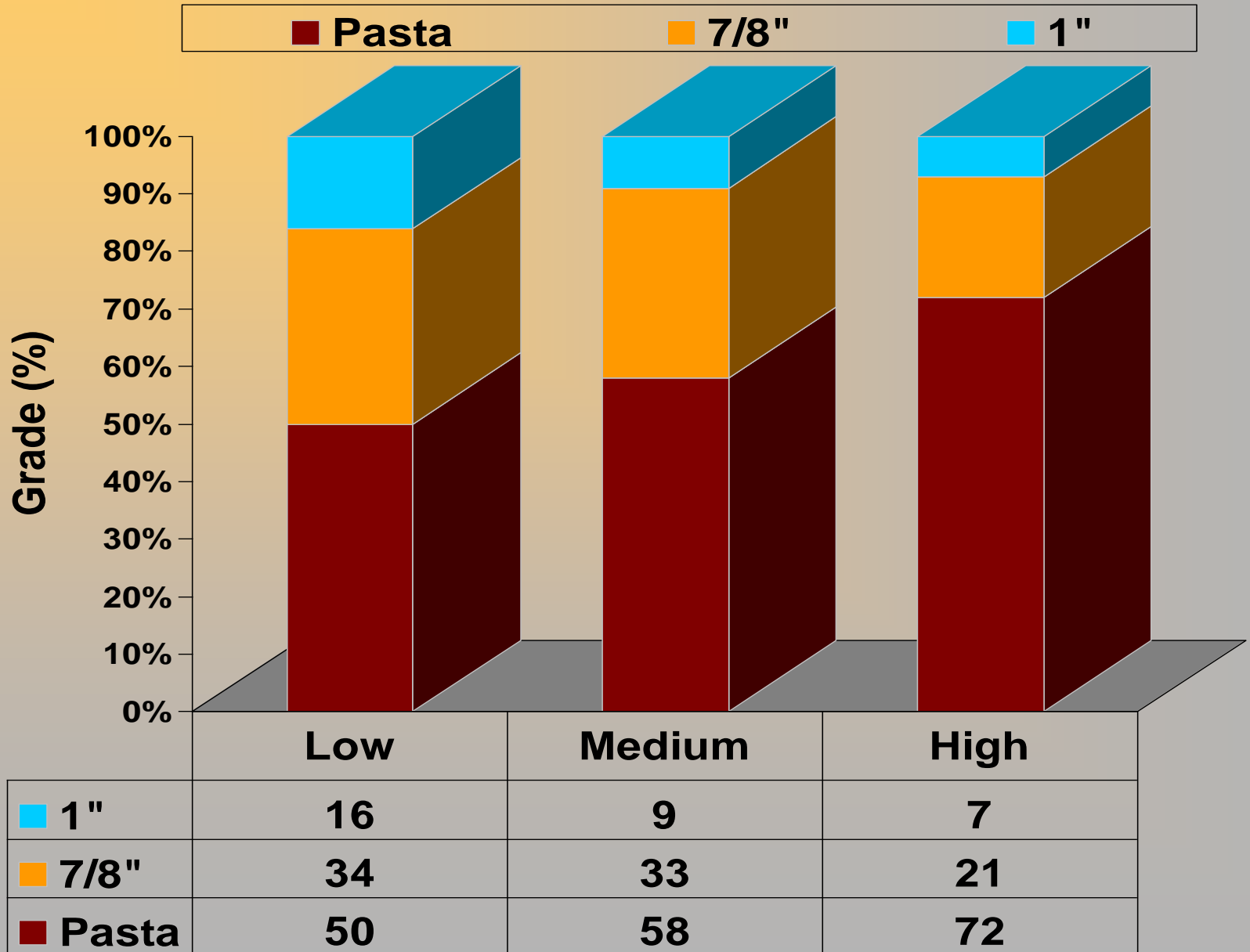
## Averages $\pm$ Standard Deviation

Stock	Low Density	Medium Density	High Density
M x M	41.4 $\pm$ 4.4	43.0 $\pm$ 4.3	39.7 $\pm$ 3.3
M x C	42.6 $\pm$ 2.6	45.0 $\pm$ 0.8	40.6 $\pm$ 0.2
C x M	35.4 $\pm$ 3.9	35.9 $\pm$ 1.2	35.3 $\pm$ 5.8
C x C	34.0 $\pm$ 2.2	35.0 $\pm$ 2.6	31.8 $\pm$ 1.9

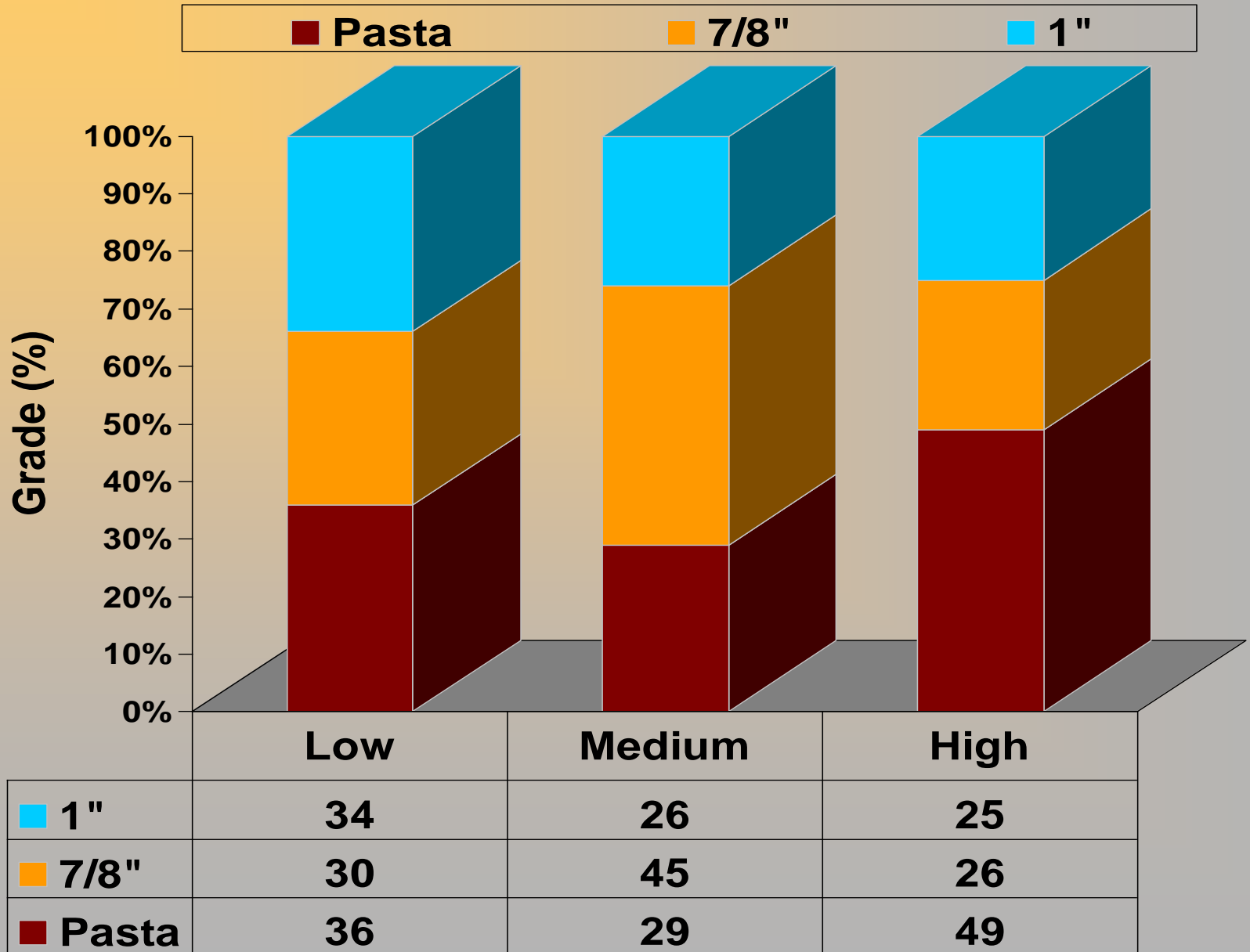
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Note: Littleneck–sized clam is about 25 mm (1”) in width, 50 mm (2”) in length

# Density Results: GRADE – M x M, Family A



# Density Results: GRADE – M x C, Family A



# Product Quality



- Consumer acceptance
- Sensory evaluation and profiling

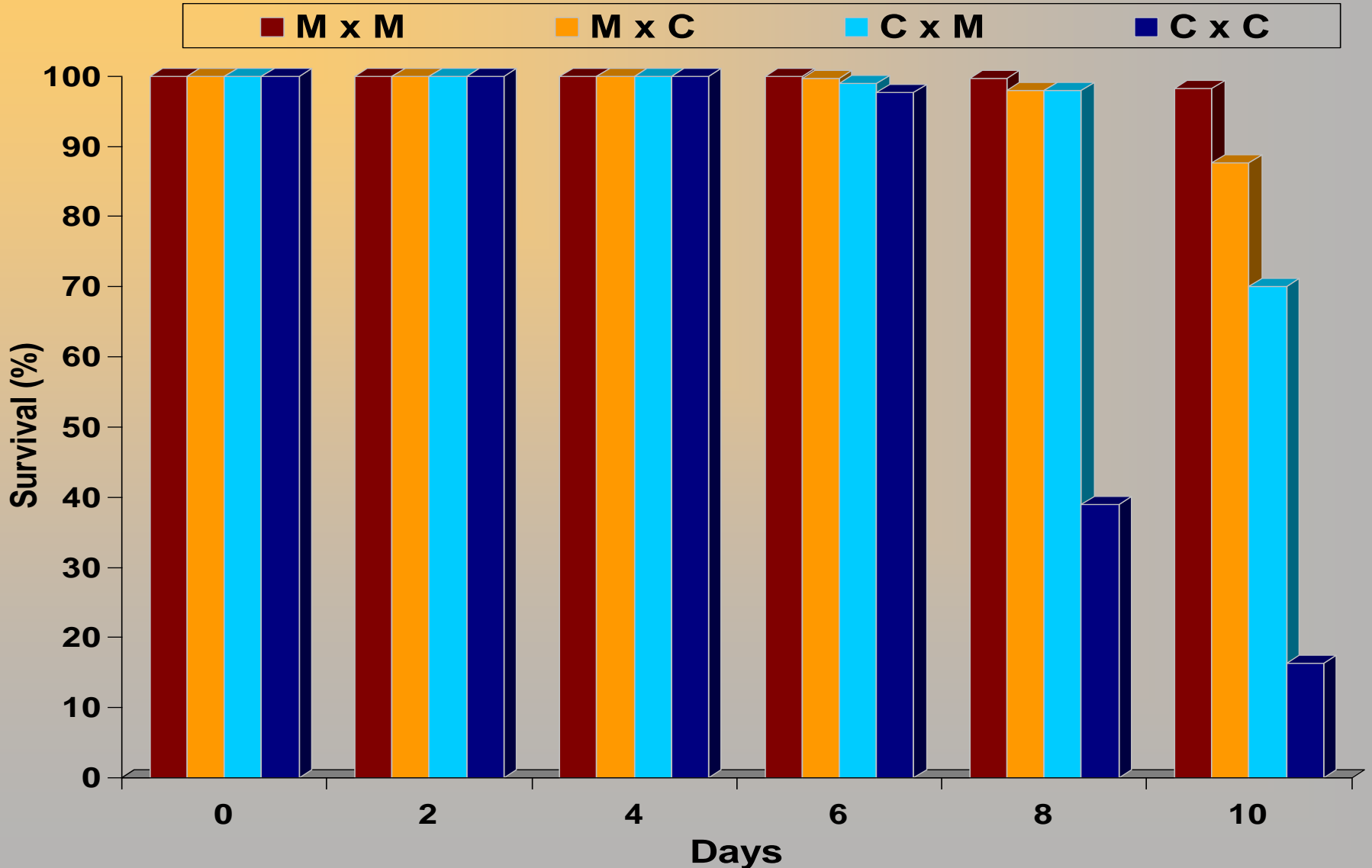
- Document shelf life
  - Survival in refrigerated storage (45°F)





# Shelf Life: Survival in 45°F Storage

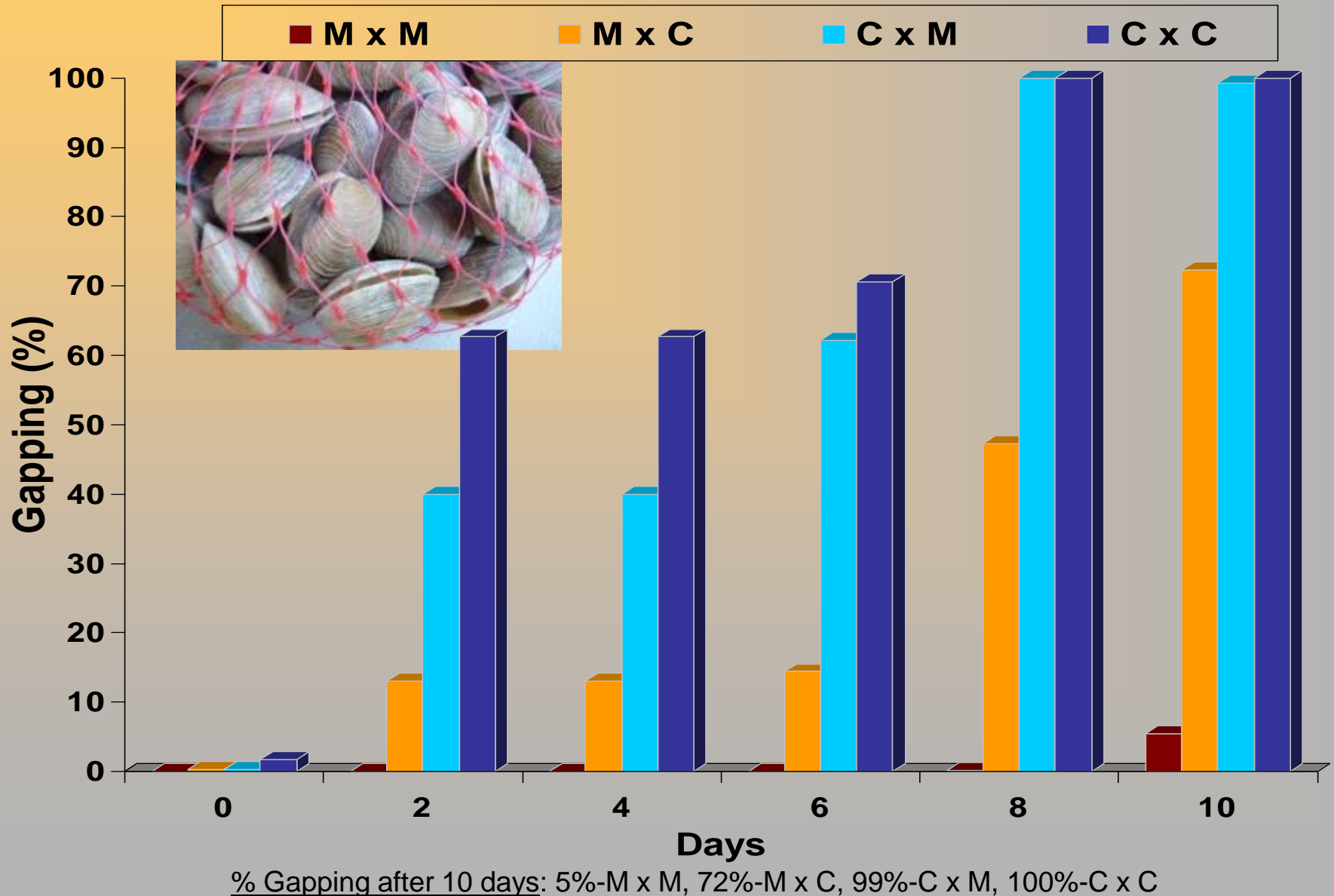
## Average of Families A, B, C



% Survival after 10 days: 98%-M x M, 88%-M x C, 70%-C x M, 16%-C x C

# Shelf Life: Gapping in 45°F Storage

## Average of Families A, B, C



# Consumer Acceptance Study

- Blind test of cooked clams
  - Acceptability
  - Flavor
  - Texture
- Rate according to scale of
  - 1 (dislike extremely) to 9 (like extremely)
- Rank in order of preference
  - 1, 2, 3, 4
- 90 responses compiled

Conducted on University of Florida campus by Dr. Charles Sims and Laura Garrido, UF Food Science and Human Nutrition



# Consumer Acceptance Results

<b>Stock</b>	<b>Acceptability*</b>	<b>Flavor*</b>	<b>Taste*</b>
M x M	5.8	5.6	5.4
M x C	6.0	5.8	5.7
C x M	5.6	5.6	5.4
C x C	5.8	5.6	5.4

\* No significant differences among clam stocks

<b>Stock</b>	<b>M x C**</b>	<b>C x C</b>	<b>M x M</b>	<b>C x M**</b>
<b>Ranking</b>	195	222	239	244
<b>Analysis</b>	b	ab	ab	a

\*\* Friedman Analysis of Rank and Tukey's HSD at 5% significance level

# Sensory Evaluation and Profile

- Blind tasting by UF trained panel using standards
- Characterization of raw clams
  - Appearance
  - Aroma
  - Basic Tastes
  - Flavor
  - Aftertaste
  - Texture, Meat
  - Mouth feel
- Scale of 1-10



Conducted by Dr. Steve Otwell and Laura Garrido,  
UF Aquatic Food Products Lab

# Results: Sensory Profile of Raw Clams

Ratings	Scale	M x M	M x C	C x M	C x C
Appearance	1-10				
Volume of Flesh	Not covered-Full	5.50	6.58	7.25	7.5
Plumpness	Flaccid-Plump	6	6.25	6.83	6.83
Aroma	1-10				
Briny	Not-Extremely	4.25	3.25	3.42	7.50
Metallic	Not-Extremely	3.25	1.5	1.50	6.83
Basic Tastes	1-10				
Salty	Not-Ext. (>10)	10.08	10.25	10.58	10.50
Umami	Not-Extremely	3.75	4	3.08	4.17
Flavor	1-10				
Seaweed	Not-Extremely	2.33	2.92	3	3.5
Chicken-Liver-Like	Not-Extremely	2.75	2.67	2.58	2.42
Earthy	Not-Extremely	1.83	1.83	2	2
Aftertaste	1-10				
Metallic	Not-Extremely	3.5	3	2.83	2.17
Astringent	Not-Extremely	2.08	1	1.75	2.08
Texture, Meat	1-10				
Firmness	Mushy-Ext.Firm	6.08	5.58	6.50	7
Chewiness	Not-Extremely	4.92	5.42	5.83	6.60
Mouthfeel	1-10				
Detect Grit	Not-Extremely	2.42	1.33	2.00	0.90



Sunshine Clam (M X C)



TropiClam (C X M)



# See you next year!

- Final report on hybrid project
- Initial report on backcrossing F1 hybrids with hard clams, 2009-10
  - Spawning, land-based and field nursing