

# Introduction to Intensive Oyster Aquaculture

Overview of U.S. East Coast oyster culture operations  
and Florida's experiences



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PROGRAM



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# What is Aquaculture?



**DEFINITION:** “Aquaculture” means the cultivation of aquatic organisms.  
Chapter 597.0015, Florida Statutes

## EXTENSIVE AQUACULTURE:

- Advantages –
  - Limited inputs
  - Low overhead & production costs
  - Low stocking densities
  - Husbandry demands are reduced
  - Low labor costs
- Disadvantages –
  - Larger land requirements
  - Poor control of stock management
  - Low and non-reliable production



# What is Aquaculture?

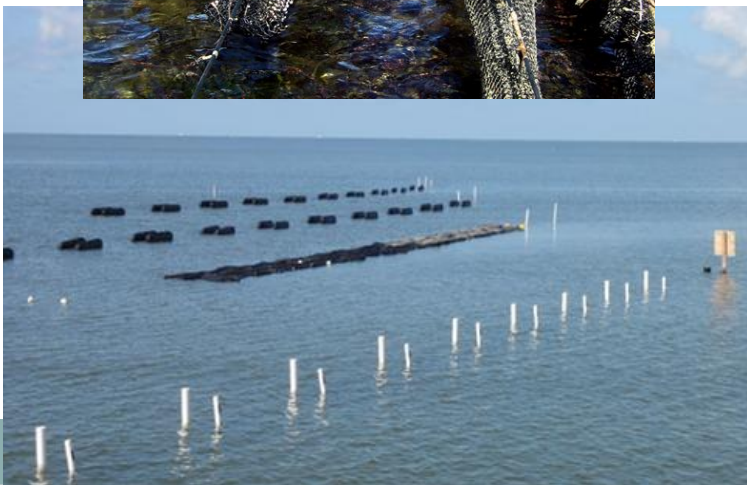


**DEFINITION:** “Aquaculture” means the cultivation of aquatic organisms.  
Chapter 597.0015, Florida Statutes



## INTENSIVE AQUACULTURE:

- Advantages –
  - Higher production
  - Better control of stocks
  - Less land requirements
- Disadvantages –
  - Higher inputs
  - High overhead & production costs
  - High stocking densities
  - Husbandry demands are increased
  - High labor costs



# Extensive Oyster Culture



- On-bottom culture is traditional method of farming oysters in United States
- Oyster seed comes from wild populations
- Planting of cultch (shell) to enhance bottom
- Commodity or shucked meat markets
- **In Louisiana –**
  - Leading oyster producing state
  - Over 400,000 acres of private leases
  - 80% of landings from leases (95% in 2012)
  - Seed oysters are harvested from public oyster reefs and/or cultch plantings
  - Return of 0.4-4.0 bushels of market oysters per 1 bushel of planted seed
  - \$28.5M sales from 135 leases (USDA 2005)
  - 11M lbs of meats (LDWF 2012)



Oyster “Lugger”

# Extensive Oyster Culture

- In Florida –

- Extensive methods have been promoted and tolerated in various forms and under changing laws for over 100 years
- In Franklin County, 8 shellfish leases (Chapter 370, F.S.), preempt 600 acres of state-owned sovereignty submerged lands
- Cultivation practices follow those methods used by FDACS to enhance public oyster resources (shell cultching)
- 25 leaseholders sold over 38,200 bushels, valued at \$1.2 million, at an average price of \$27 per bushel in 1995 (FASS survey)
- 5 leaseholders reported \$75.9 thousand in sales in 2012 (FASS survey)



# Intensive Oyster Culture in Florida



- Subtidal, on-bottom culture system developed by Harbor Branch Oceanographic Institution researchers during late 1980s
  - Limited tidal range in Florida
  - Lease statute limiting water column usage to six-inches above substrate
- Modular apparatus using rope and PVC pipe pieces to interconnect and support bags



- Growing bags—plastic ADPI
  - Mesh sizes: 1/8", 3/8", 5/8"
  - Stocking densities: 1500, 500, 200/bag

# Flexible Belt Culture System



- Adaptations to address siltation
  - Increased spacer height
- Tended by specialized worksiff
  - Featuring center well and floating ramps
  - Move along belt, raising/replacing onto bottom



# Multi-tier Oyster Rack



- In 1991, lease provision limiting use of more than six-inches of the water column in aquatic preserves removed from statute, Chapter 258.42, F.S.
- Multi-tiered, on-bottom system
- Welded rebar designed to support nine growing bags
  - 6, 12, and 18" off the bottom
- Racks linked together using long-lines
- Deployed and retrieved by work skiffs outfitted with boom and power winch



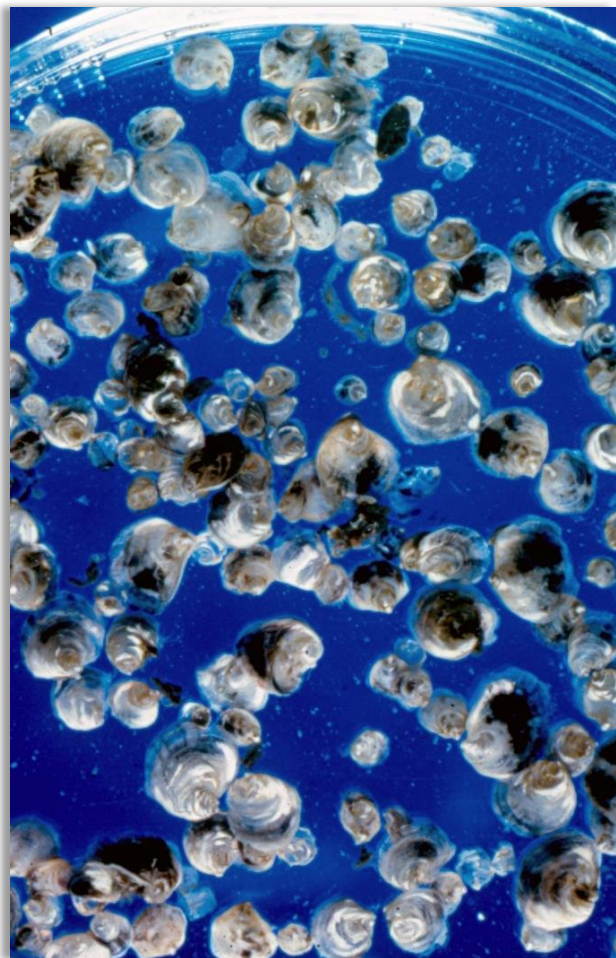
# Multi-tier Oyster Rack



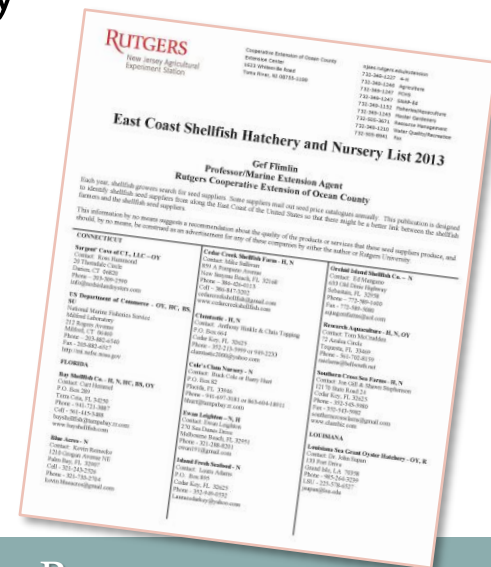
- Higher oyster growth rates and survival noted using rack system



# Single Oyster Seed



- Hatchery-produced seed
- Micro-cultch setting techniques used to create a single oyster spat
- 6 mm (1/4") shell height minimum size for field planting in bags
- Seed prices vary from \$10-25/1000 depending on quantity



For East Coast Shellfish Hatchery List, go to <http://ecsga.org>, click on Resources

# Apalachicola Bay Oyster Farming Project

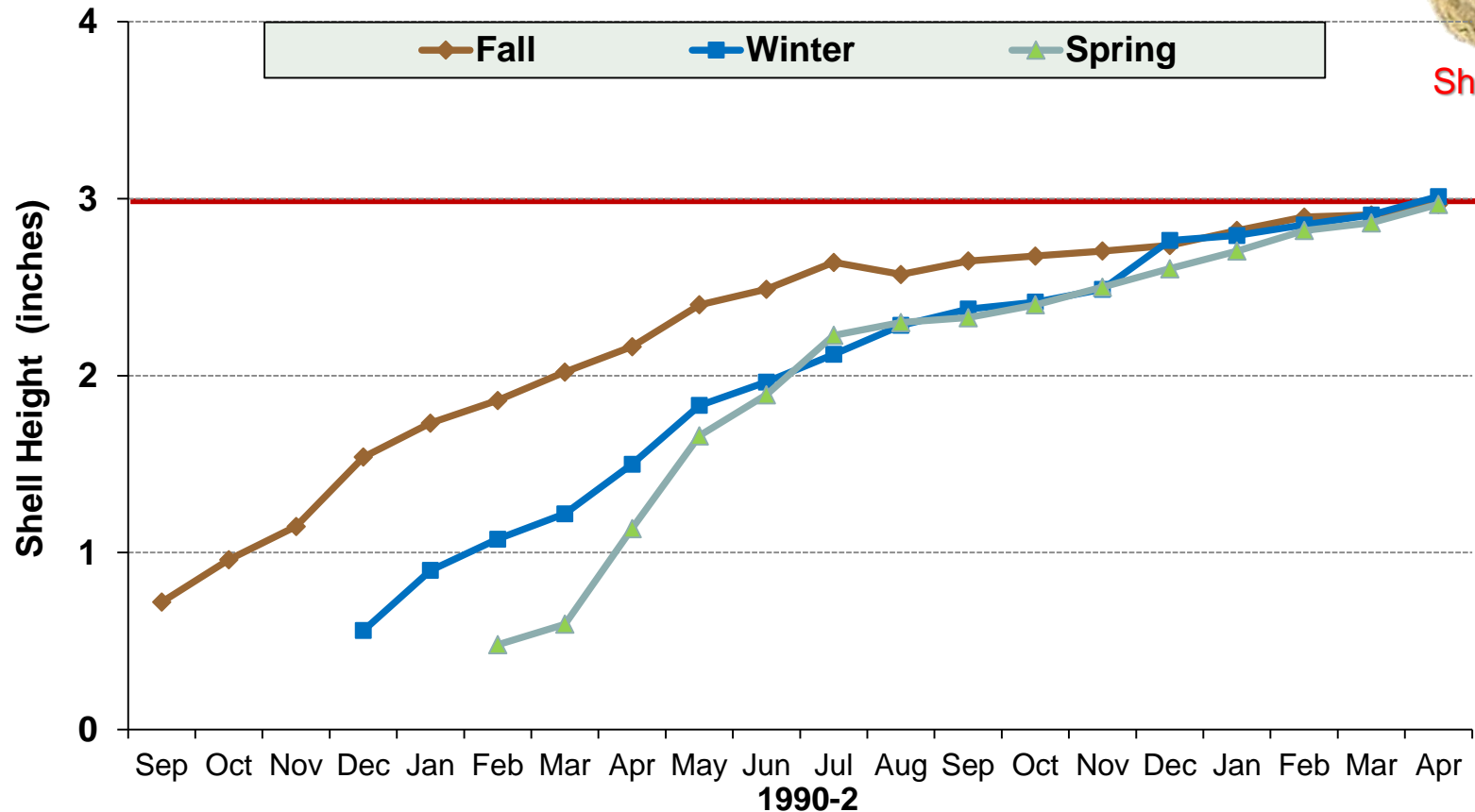
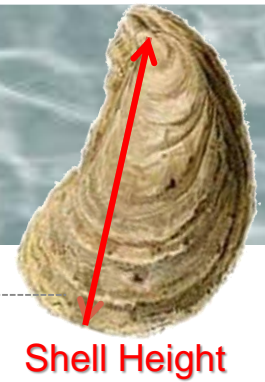


- Demonstrated technology to 189 participants
- Oyster growth and survival documented
- Concluded in 1991, no placement of project graduates onto leases
  - Leasing of bay bottom controversial
  - Presumed competition with natural resources

- Initiated in 1988
  - Decline in oyster landings
  - Governor Martinez requested federal funds (JTPA) for dislocated workers in Franklin County
- Intent
  - Assist underemployed oyster harvesters
  - Supplement natural oyster production though cultivation

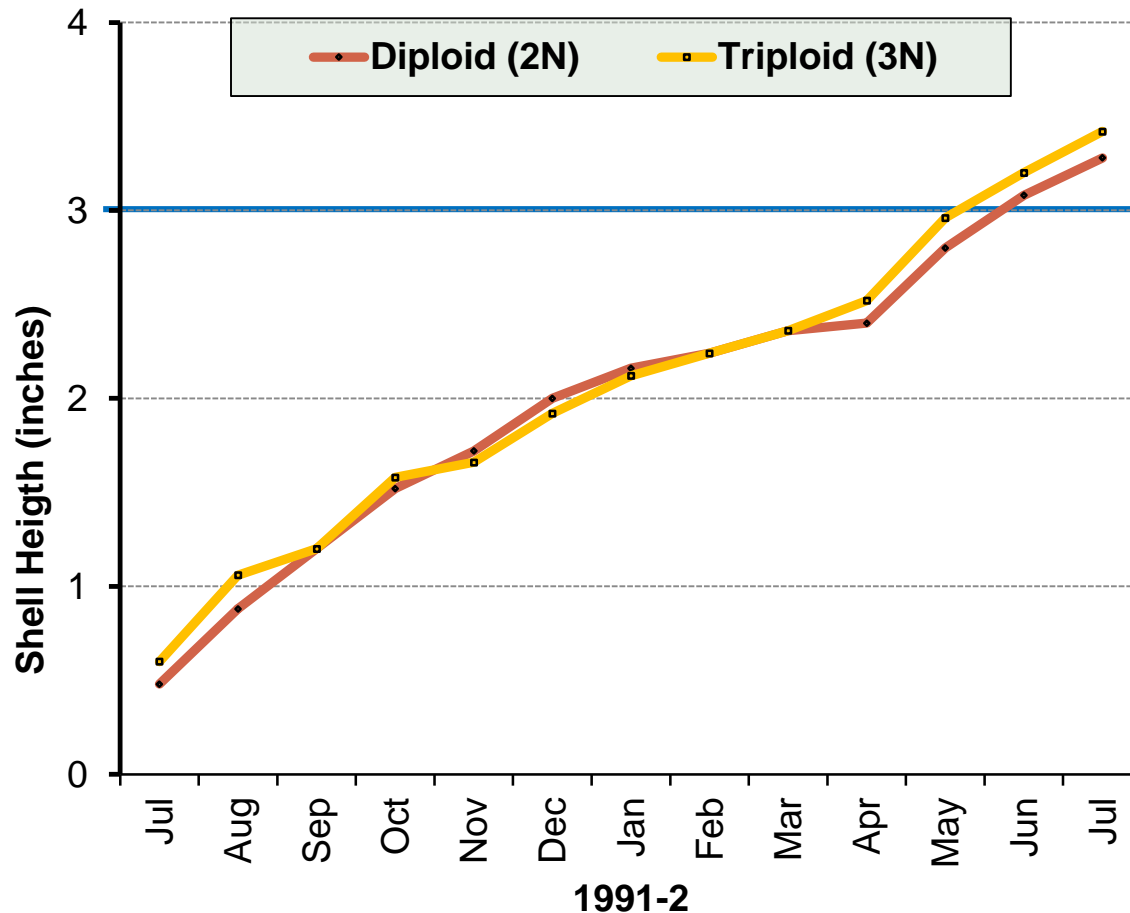


# Oyster Seasonal Growth Rates



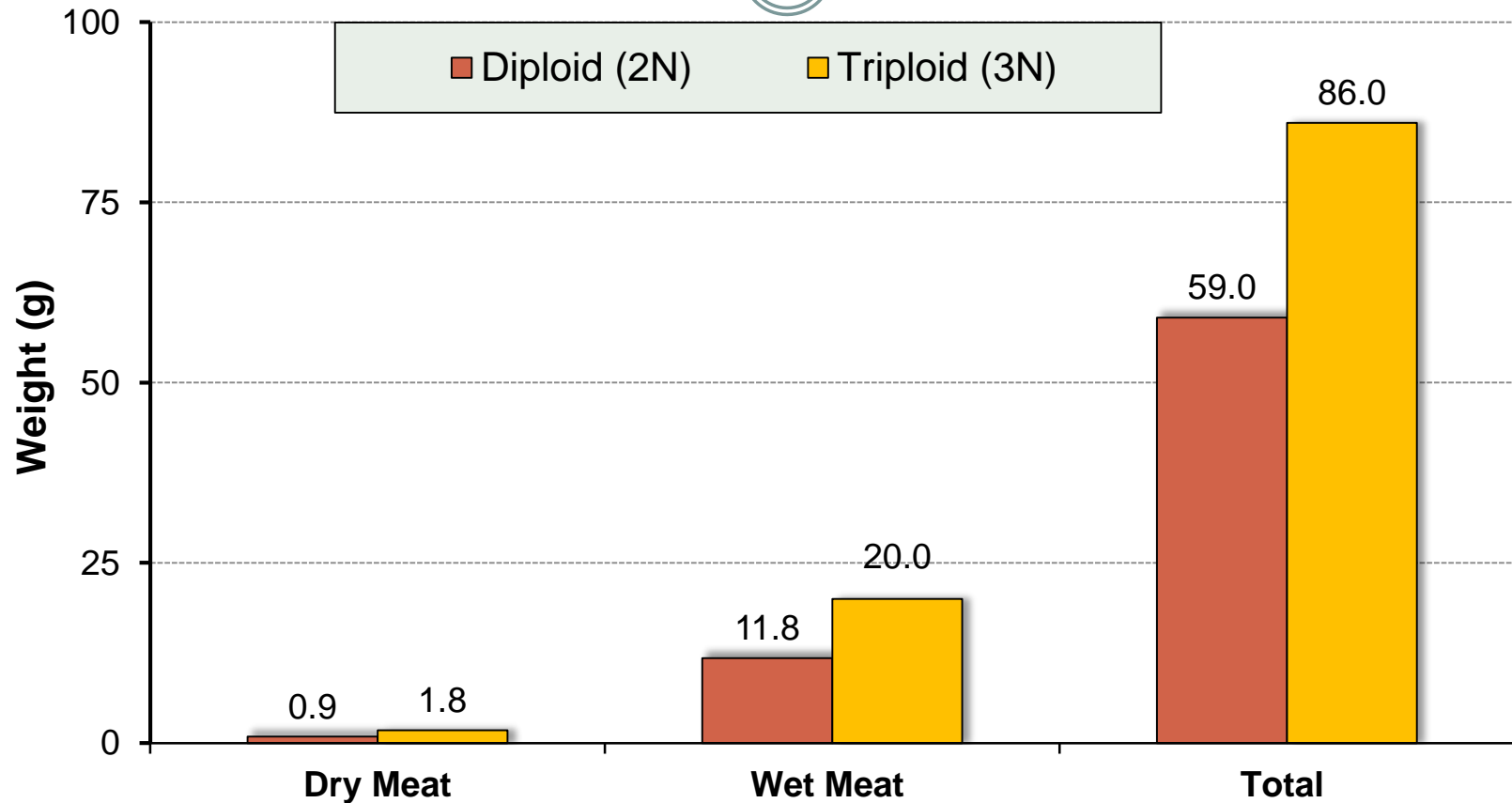
- Shell heights of 3" reached in 19 months—fall plant, 16 months—winter plant, and 14 months—spring plant
  - Growth rates of 3.0 mm/mo—fall plant, 3.9 mm/mo—winter plant, 4.6 mm/mo—spring plant
  - Survival rates did not differ among plants, ranging from 50 to 54%.

# Triploid Oyster Study



- Triploid oysters evaluated
- Artificially induced genetic manipulation resulting in reproductive sterility
  - Induced by chemical
  - 95% ploidy
- Cultured on racks
- July 1991 – July 1992
- Similar growth
  - 3.4" SH for 2N and 3N
- Reach 3" shell height in less than 12 months
  - Average growth rates of 5.3 mm /month
- Similar survival
  - 60% (2N) vs 62% (3N)

# Triploid Oyster Study - Weights



- Significant differences ( $p < 0.001$ ) in dry meat, wet meat, total weights between 2N and 3N
  - 98% increase in dry meat weight and 70% increase in wet meat weight

# Triploid Oyster Study - Results



- Condition indices were 4.8 for diploids (2N) versus 8.2 for triploids (3N)
- Increased glycogen in triploids resulted in better appearance and flavor
- Incidence of *Polydora* tubes and Dermo infection levels less prevalent in 3N oysters
- Triploids less susceptible to stress-related summer diseases

# Oyster Culture Economics in FL

*Preliminary Production Budgets for Oyster Aquaculture using a Flexible Belt System. 1990.*

*Eric Thunberg, Richard Weldon, and Chuck Adams, Staff Paper 271, University of Florida IFAS Food and Resource Economics Department.*



- Production Assumptions
  - ¼ acre plot
  - 4.5 flexible belts @ 144 bags/belt = 648 bags
  - 15-month growout
  - 65% overall survival
- Financial Assumptions
  - Bag costs - \$2.65 (\$4.73, 2013)
  - Seed costs - \$15/1,000 (\$30/1,000, 2013)
  - Oyster sales - \$0.18 apiece (\$0.32, 2013)
- Average net income to owner labor, risk and management of \$21,700 (\$37,540, 2013) over 5-year planning horizon

# Project OCEAN, Cedar Key

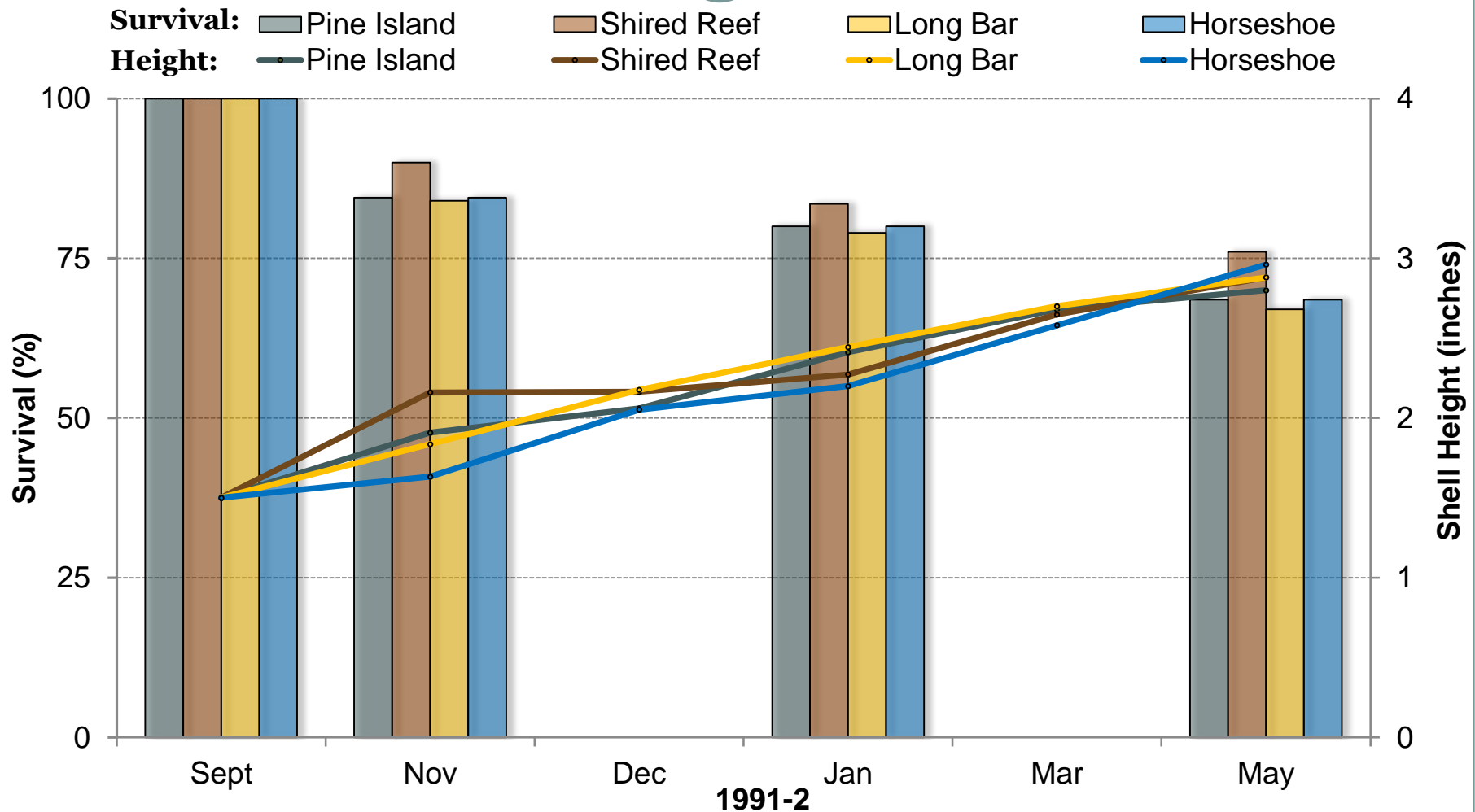


- Oyster and clam culture technology transferred
- 904 acres of state-owned submerged lands identified, permitted, surveyed and marked for leases in Levy and Dixie Counties
- 137 graduates placed onto leases in 1993

- Initiated in 1991
  - Community leaders lobbied state legislative delegation to acquire federal funding
- Intent
  - Assist underemployed oyster harvesters and seafood workers in Levy, Dixie, and Taylor Counties
  - 170 participants

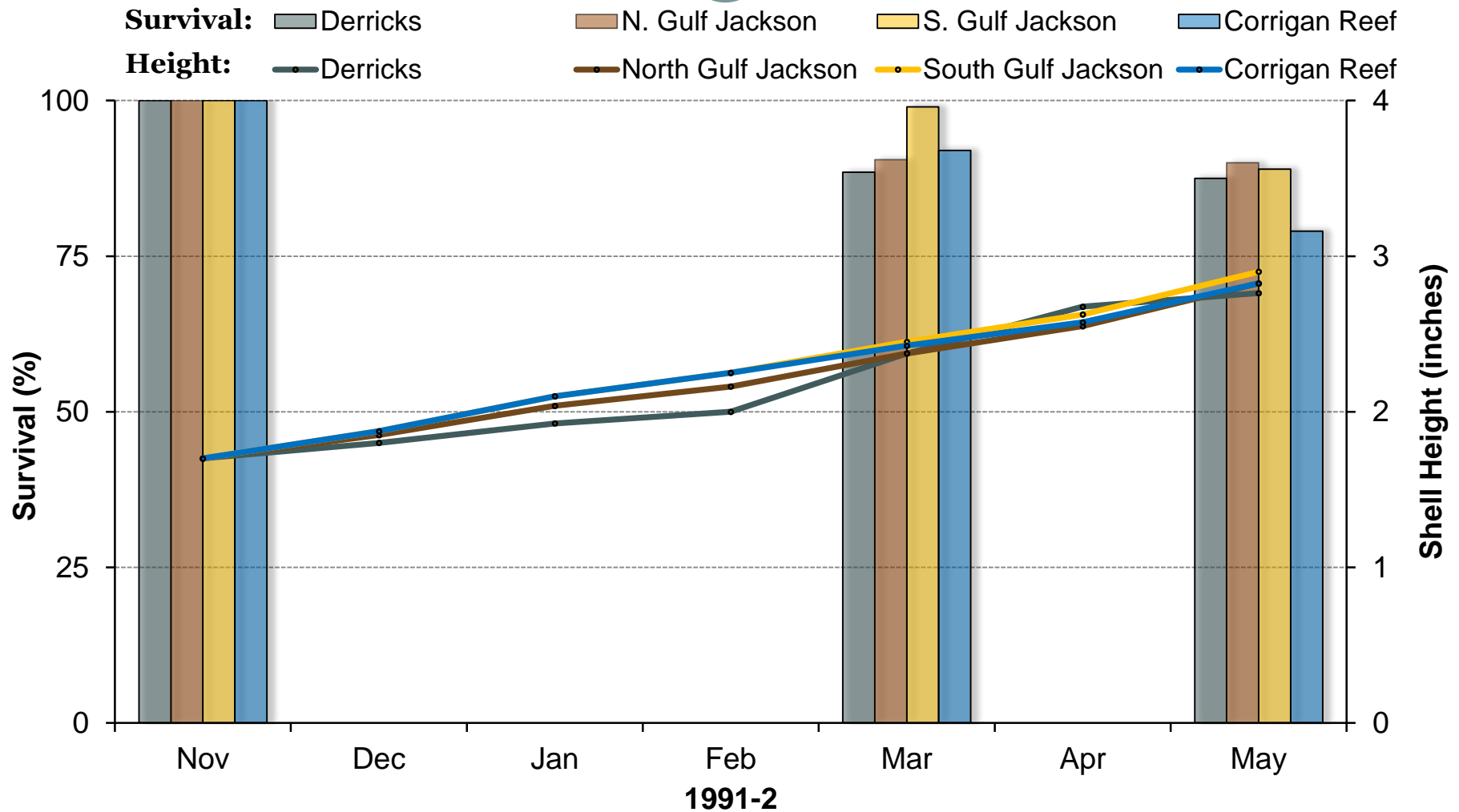
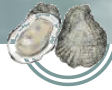


# Oyster Production at Dixie County Lease Sites



- Plant 1.5" SH seed, reach 2.8-2.9" SH in 8 months; survival ranging from 67-76%

# Oyster Production at Levy County Lease Sites



- Plant 1.7" SH seed, reach 2.8-2.9" SH in 6 months; survival ranging from 79-90%



# Oyster Culture in the NE

- Severe decline in oyster harvests due to diseases (e.g., MSX and Dermo)
- Reduction in natural populations, growers turned to use of hatcheries for seed supplies
- Hatchery technology developed for cultchless seed and stock improvement
- Technologies and gear developed over past 30-40 years to support intensive culture of single oysters
- High market demand in cosmopolitan areas
- High-value “boutique” oysters for half shell / raw bar markets, “brand” names and flavors reflecting local harvest areas
- Farm gate prices 38-47¢ apiece (USDA 2005)
- Economics work for small-scale operations



Charlestown, Rhode Island



Pemaquid Oyster Company



# Oyster Culture Gear in the NE



- Practiced intertidally where large tidal fluctuations create expansive flats
- Periodic air exposure allows for drying of soft-bodied fouling organisms and reduces overset of oysters
- Facilitates operational procedures, such as removal of culture bags for size-sorting or harvesting
- Most of the culture technology initially used was bag-on-rack, stacked racks, or modifications



Wellfleet, MA



Chesapeake Bay Oyster Company, MD

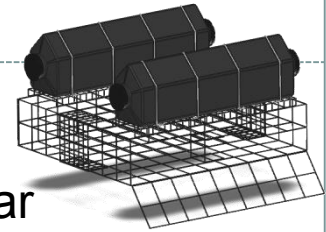
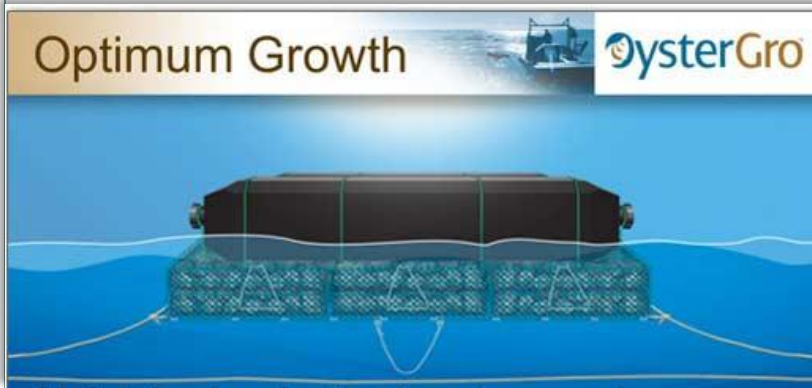


Delaware Bay, NJ



Matunuck Oyster Farm, RI

# New Intensive Oyster Culture Technology



- New “off-bottom” culture gear
- Culture bags are supported in upper water column rafts or long-lines
- Rapid oyster growth
- Oysters tend to “cup” due to tumbling action in bags
- Reduced physical labor associated with tending oysters as system design controls biofouling
- Both Louisiana State University and Auburn University shellfish researchers are currently evaluating these and other intensive oyster culture systems

# Oyster Culture Methods in NE\*

State	#Growers	Extensive Culture Methods (%)	Intensive Culture Methods (%)				
			Racks	Cages	Trays	Suspended / floating	Other
ME	40	0	X	X	X	X	bottom
MA	349	<5	30	10	35	15	bottom, 10
RI	50	0	48	30	2	20, mid-water hanging trays	0
CT	45	90	0	<10	0	<10	0
NY	40	75, on-bottom	2	23	0	0	0
NJ	16	30	64	18	0	18	raft, 9
MD	297 leases	80, spat-on-shell	0	15	0	5, Taylor floats	0
VA	542	60	<1	40	0	<1	0

\*Results of email survey of aquaculture extension specialists in the Northeast, August 2013



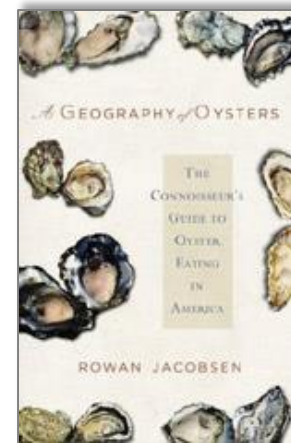
# Oyster Culture in the NE



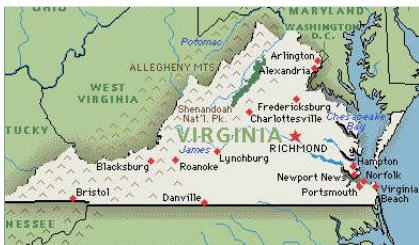
## Census of Aquaculture, Eastern Oysters, 2005\*

Geographic Area	# Farms	Sales (\$1,000)
<b>United States</b>	<b>264</b>	<b>13,281</b>
Connecticut	13	(D)
Maine	21	1,519
Maryland	8	(D)
Massachusetts	99	3,026
New Jersey	17	723
New York	13	3,934
Rhode Island	10	793
Virginia	18	(D)

\* Louisiana not included in totals, extensive methodology used  
(D) – Withheld to avoid disclosing data for individual farms



- 75% of Eastern oyster culture production associated with the Northeastern US



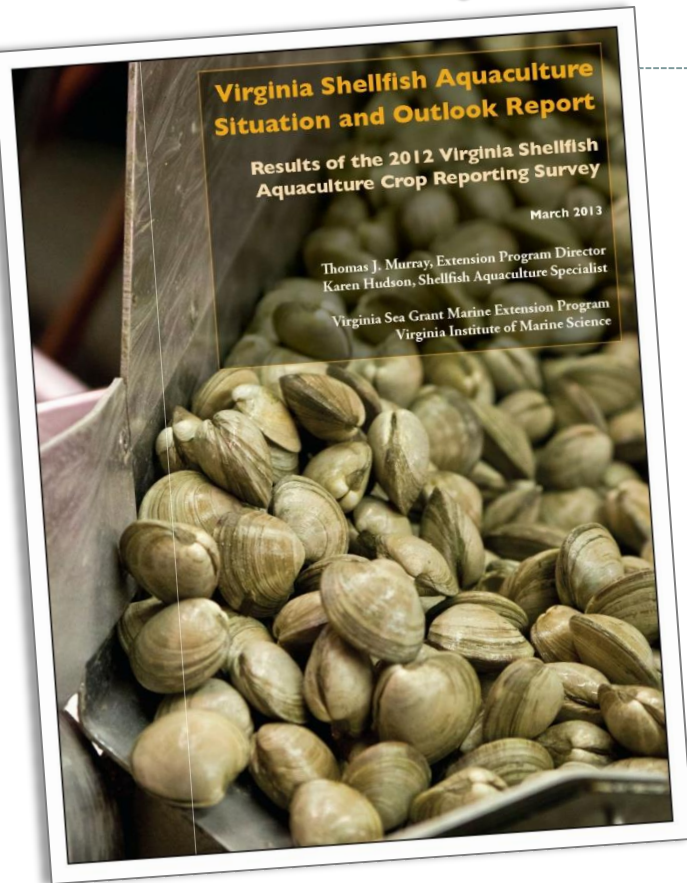
# Oyster Culture in Virginia



- Industry evolved from traditional extensive planting of “shell-on-bottom” using wild seed
- Current methods progressed to intensive, containerized forms—cages, racks, floats
- Single, “cultchless” seed from hatchery for harvest into the half-shell market
- Disease-tolerant strains of oyster seed developed by VIMS geneticists
  - Breeding program began in 1997 to address disease problems and decline in natural fisheries in Chesapeake Bay
  - Efforts led to the building blocks of oyster culture industry
- Majority of hatchery production is sterile triploid seed
- Existing infrastructure through clam culture

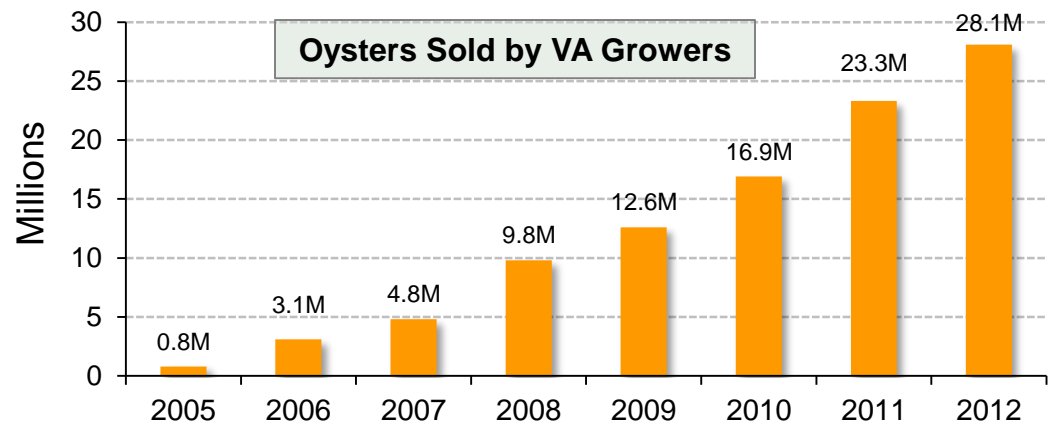


# Oyster Culture in Virginia



For full report, see  
<http://vaseagrant.vims.edu>  
For more info, go to  
<http://vashellfish.org>

- In 2012, 28.1M single oysters sold by VA growers with farm gate value of \$9.5M
  - 34-fold increase in production over 8 years
- Continued stability in average prices received by VA growers over same time period
  - 30¢ per oyster (range, 26¢-2009 to 34¢-2012)
- Extensive planting on bottom is resuming using “spat-on-shell” with eyed oyster larvae produced from hatcheries for sale as shucked meats



# Oyster Culture in Florida

## ATTRIBUTES



- Oyster growth is rapid and nearly continuous
- Proactive leasing program
- Proactive regulatory framework
  - Aquaculture certification and BMP programs
  - Certified aquaculturists exempt from season closures and limits
- Demand for half shell oysters
  - Particular demand for “boutique” oysters
  - Names/flavors reflect local harvest areas
- Market for IQF and pressure-treated oysters



# **Oyster Culture in Florida CONCERNS**

- Rapid growth results in poor shell quality
  - Labor associated with tumbling and handling would contribute to operating costs
- Prolonged spawning season results in poor meat quality and yields
- Subtidal, on-bottom cultivation methods present operational problems
- Biofouling, persistent problem
  - Labor for cleaning and removing fouling is major contribution to operating costs
- Alternate off-bottom methods may be limited to very specific sites
  - Problems with navigation
  - Multi-users conflicts
  - Risk of theft, Need for security

# Oyster Culture in Florida

## CONCERNS



- Predation in warm waters
  - Drills, conchs, finfish, crabs, worms
- Oyster-specific disease pathogen, *Perkinsus marinus*, or Dermo
- Risk of hurricanes and storms
- No genetic selection program for Florida oyster stocks
- Florida BMPs for genetic protection and disease prevention
  - Brood stocks must originate from Florida Gulf of Mexico (FL GoM) waters
  - Out-of-state hatcheries must utilize brood stock from FL GoM waters and be certified pathogen-free from MSX and Dermo
  - Sale of oyster stocks from Atlantic coast waters prohibited for use in FL GoM waters



# Oyster Culture in Florida CONCERNS

- Aquaculturists must adhere to *Vibrio vulnificus* control plan
  - Harvesting, shipping during Vv control months
  - Post-harvest processing
  - Temperature monitoring
- Market prices for a warm water, Gulf of Mexico-cultured oyster?
- No current financial feasibility analysis for an oyster culture operation located on Florida's Gulf of Mexico coast



For further information,  
contact Leslie Sturmer  
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or visit the website:  
**<http://shellfish.ifas.ufl.edu>**