Florida Molluscan Shellfish Aquaculture Industry

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In collaboration with
In 2013, 34 million pounds of mollusks were grown globally! Molluscs are the #1 mariculture product in the world!
China produces a vast majority of the world's mollusks.
Washington state leads the nation in shellfish aquaculture

Florida is #4 in the nation in shellfish aquaculture!
U.S. Mollusk Aquaculture Industry

Molluscan aquaculture in the U.S. increased 368% from 1998-2013, and continues to expand today!

Aquaculture Sales by Mollusk Type
Florida Bivalve Aquaculture Industry

- Shellfish aquaculture in Florida is dominated by hard clams (98% of sales in 2013).
- Oyster aquaculture, in response to declining wild-stocks and advancing culture technologies, is increasing annually.

![Florida Shellfish Aquaculture Sales](chart)

Sales ($)

- **1998**:
  - Clams, $9,541,000
  - Oysters, $78,500

- **2005**:
  - Clams, $10,694,000
  - Oysters, $0

- **2013**:
  - Clams, $18,729,000
  - Oysters, $433,000

Clams  Oysters
Industry Development on West Coast

In the 1990s due to:

- Successful job retraining programs for former fishermen
- Excellent leasing program and regulatory framework
- Year-round growing conditions
Florida Shellfish Aquaculture Retraining Programs

- Infrastructure provided to expand employment opportunities for Florida fishermen affected by increasing regulatory restrictions
  - “Hands-on” training
  - Classroom curriculum
  - Development of business plans, lease applications
A Way of Life Ends

- Oyster fishery reclassifications and closures in Suwannee Sound (1990-1)
- Statewide ban on gill and entanglement nets (1994)
- Affected counties economically depressed
- Limited alternative employment
Retraining Programs in Cedar Key

Project OCEAN, 1991-3

- Served 4 coastal counties
- Culture technology transferred
- Over 200 former fishermen placed into small businesses
- 948 acres of aquaculture leases established off Levy and Dixie Counties

Project WAVE, 1995-7

Graduation, 1993
Current Status

- >300 certified clam growers in state
  - 150 in Cedar Key
- >2000 acres of submerged land leases in 12 coastal counties
- Profile dominated by small businesses
Certified Clam Farmers*

*FL Department of Agriculture and Consumer Services, 2014-15

Atlantic Ocean

St. John’s County, n=4

Volusia County, n=9

Brevard County, n=15

Indian River County, n=17

Levy County, n=150

Dixie County, n=15

Franklin County, n=30

Charlotte County, n=7

Manatee County, n=3

Lee County, n=33

Collier County, n=4

Gulf of Mexico
Supporting Infrastructure

- Seed suppliers
- Bag suppliers
- Other suppliers
- Equipment manufacturers

- Boat builders
- Wholesalers
Economic Impact

- Surveyed wholesalers to determine number and value of clams handled in 1999, 2007, and **2012**

- Used input-output methodology to estimate direct, indirect, & induced impacts

<table>
<thead>
<tr>
<th></th>
<th>Sales output</th>
<th>Value added</th>
<th>Labor income</th>
<th>Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>33.9</td>
<td>12.1</td>
<td>9.0</td>
<td>-</td>
</tr>
<tr>
<td>2007</td>
<td>52.9</td>
<td>31.5</td>
<td>25.3</td>
<td>606</td>
</tr>
<tr>
<td>2012</td>
<td>38.7</td>
<td>21.9</td>
<td>14.7</td>
<td>543</td>
</tr>
</tbody>
</table>
Clam Biology

• Northern hard clam or quahog naturally occurs along Atlantic coast from Nova Scotia to Florida
• Bivalve mollusk, poikilothermic
• Occupies intertidal and subtidal habitats in estuarine environment
• Infaunal, burrows into substrate to various depths (<8”)
• Filter feeders, remove food particles, usually small phytoplankton (algae) from water
• Sexes separate, but externally indistinguishable

Northern hard clam Mercenaria mercenaria, notata strain
Shellfish Aquaculture Methods

How do we get clams from seed to adults in 18 or more months?!
Three main phases of production

**Hatchery**
- Spawning
- Larviculture
- Setting & post-set rearing
- Grown to 1 mm

**Nursery**
- Shore-based raceways or upwellers
- Fed naturally occurring algae
- Grown to ~5-6mm

**Growout**
- Placed in open-water lease sites
- Grown to market size (~1")

Shellfish Aquaculture Methods
Hatchery Production of Seed

About 10-12 commercial hatcheries in Florida produce 0.5 billion seed annually.
Spawning and larval rearing

- Spawning of ripe adults or broodstock
- Rearing of microscopic larval stages under controlled conditions for 10-14 days
Algal production

- Production of several species of marine micro-algae to feed clam larvae
Post-set rearing

- Post-set rearing in downwellers at hatchery until 1-mm seed size
Land-based nurseries

- Serves as an intermediate step between hatchery and growout operation
- Creates a division of labor
- Provides small seed (1 mm) with adequate food supply and protection from predators until they reach a field plantable size (5-6 mm)
Land-based nurseries

- Systems (raceways, wellers) simple in design, operation, and maintenance
- Allows growers to purchase and rear inexpensive seed
- Provides for acclimation of seed to local growing conditions
- Many growers attracted to this option
- 75 of these facilities statewide
  - 35 in Cedar Key
The intake and flow-through of fresh seawater serves as a food source, allows for adequate oxygen, and removes waste.
Seed growth during the nursery phase

Small seed at start of nursery phase

Large seed at end of nursery phase
## Clam Seed Sizes

<table>
<thead>
<tr>
<th>Bag Mesh Size</th>
<th>Sieve Mesh Size (mm)</th>
<th>Seed Size (SL, mm)</th>
<th>Seed Count (number/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursery (3 mm)</td>
<td>3.3</td>
<td>5.0</td>
<td>15-20</td>
</tr>
<tr>
<td>Nursery (4 mm)</td>
<td>4.0</td>
<td>6.0</td>
<td>9-12</td>
</tr>
<tr>
<td>Growout (8-9 mm)</td>
<td>7.5</td>
<td>12.0</td>
<td>1-2</td>
</tr>
<tr>
<td>Growout (12 mm)</td>
<td>12.0</td>
<td>15.0</td>
<td>0.5-0.9</td>
</tr>
</tbody>
</table>
Clam Growout

- Open-water farming
- Lease state-owned submerged lands for farm sites
- Limited tidal range
- Subtidal cultivation
- Operating costs are low
- Food, oxygen and water exchange provided by environment
Leasing Program

- Established in state statute (Chapter 253, F.S.) in 1988
- Provides authority for leasing sovereign submerged lands
- Administered by FDACS Division of Aquaculture
- 10-year term, renewable and transferable
- Nominal application and annual rental fees
- Minimum effective cultivation requirement
Shellfish Leases

- Potential sites must undergo resource survey
- Located on nonproductive “bare” bottom substrate
- Waters must be approved for shellfish harvesting
- Can not impede navigation or conflict with other uses
- Usually grouped in block areas called Aquaculture Use Zones (AUZs)

Cedar Key Aquaculture Use Zones
Cedar Key Leases

Gulf Jackson
High Density Lease Area

Dog Island
High Density Lease Area

110 2-acre parcels

30 2-acre parcels

Photo courtesy of Pat Bonish
Hard Clam Leases

True or false?

You will get in trouble if you are not a leaseholder and you are caught in possession of cultured clams or harvesting clams from a specific lease site.

TRUE - It is against the law for anyone other than the leaseholder to harvest cultured clams from lease areas.
Growout Technology

- Soft bag - Polyester mesh material sewn in the shape of a bag
- Two-step process – field nursery (3-4 mm mesh) and growout (9-10 mm mesh) bags
- Secured to bottom with stakes
- Planted in rows (bags usually “belted”)
- Sediments serve as substrate
– Predator protection
– Harvesting device
– Inexpensive and durable
– Used for several crop cycles
## Clam Bag Stocking Info

<table>
<thead>
<tr>
<th>Bag Mesh Size</th>
<th>Stock Rate* (#/bag)</th>
<th>Stock Volume (ml/bag)</th>
<th>Stock Density (number/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursery (3 mm)</td>
<td>10-20,000</td>
<td>650-1500</td>
<td>625-1250</td>
</tr>
<tr>
<td>Nursery (4 mm)</td>
<td>10-20,000</td>
<td>1000-2000</td>
<td>625-1250</td>
</tr>
<tr>
<td>Growout (8-9 mm)</td>
<td>800-1200</td>
<td>400-1200</td>
<td>50-75</td>
</tr>
<tr>
<td>Growout (12 mm)</td>
<td>800-1200</td>
<td>800-2400</td>
<td>50-75</td>
</tr>
</tbody>
</table>

* Assuming bag is 4’ by 4’ in dimensions or 16 square feet
Florida hard clams grow fast and are available year-round!

- 15-18 month growout
- One half to a third of crop times of other states
- Year-round growing conditions
- Subtropical water temperatures
- High natural productivity
Clam crop survival

- Environmental conditions associated with clam mortalities
  - Low salinity events
  - High water temperatures (>95 °F)
  - Anaerobic conditions
- Susceptibility (tolerances) to these conditions related to
  - Size and age of animal
  - Physiological condition
  - Acclimation history
  - Other adverse conditions
- Other risks – storms, hurricanes

Unexplainable losses
Clam crop survival

• Biggest threat to clam production is predation
  – Crabs
  – Conchs and whelks
  – Rays
  – Drum
• Evidence of predation – shells, bag.
• Threats are dependent on clam size and seasons
Clam covering netting

• Need for additional predator protection
• Facilitates “belting” bags
• Helps manage fouling or encourages fouling
• Adds to cost of culture equipment
• Site specific in terms of which material to use

• Variety of materials used
  — Larger polyester mesh netting
  — Plastic “bird” netting
  — Chicken wire (1-2” hex mesh)
Clam bag net coatings

- Need for additional predator protection
  - Losses associated with rays
- May eliminate need for cover netting
- May encourage fouling
- Site specific in terms of which net dip to use
• Requires DACS approval
• See DACS Technical Bulletin #4: Shellfish Nets and Net Coatings

Clam bag net coatings

- Reviews pertinent regulations, food safety issues and approval process
- Provides recommendations on how to apply, handle, store and cure

- Products approved by DACS
  - Latex (water-based), alkyd
  - Acrylic polymer
Other clam culture considerations

Bottom net culture

- Developed for intertidal areas
- Primarily used in Northeast
- Method used initially on east coast of Florida
- Now being used in SW FL
- Consists of single layer of predator protection
- Clams allowed to bury deeper
- DACS now allows use of hand-held pump-driven harvesters
Clam Harvest

- Bags are pulled by hand using a winch or roller rig on the boat
Once clams are harvested from lease sites they are loaded onto boats and taken directly to certified shellfish wholesaler facilities under the seasonal time-temperature matrix where they are processed for sale.
The first step in processing is to clean or wash the clams using a tumbler. The tumbling action breaks open dead clams and thoroughly rinses off the shellstock.
After tumbling, clams are graded by their various sizes using an opposed roller sorter. Mesh bags catch clams as they fall out.
Clam Wholesalers

• About 50 certified clam wholesalers statewide
  – 21 firms in Levy County
• Clams sold as live shell stock
How to describe marketable clams?

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Number per Pound</th>
<th>Width / Hinge Size (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middleneck</td>
<td>7-9</td>
<td>1 1/4”</td>
</tr>
<tr>
<td>Littleneck</td>
<td>10-13</td>
<td>1”</td>
</tr>
<tr>
<td>7/8 inch</td>
<td>14-18</td>
<td>7/8”</td>
</tr>
<tr>
<td>Pasta</td>
<td>18-25</td>
<td>3/4”</td>
</tr>
</tbody>
</table>
Did you know?

Shellfish Aquaculture is GOOD for the Environment!

Shellfish Farming is Sustainable

- Shellfish seed are hatchery produced, not sourced from wild populations
- Shellfish feed low on food chain
- No feeds, fertilizers, herbicides, drugs, chemicals, or antibiotics are used in their production

Information provided by the East Coast Shellfish Growers Association
Florida is #4 in the nation for shellfish aquaculture!

The state’s shellfish industry has ~$ 20 million in sales annually!

Hard clams are the main product in Florida, over 180 million produced annually.

Oyster aquaculture farms are increasing in number each year.

Shellfish aquaculture is sustainable, benefiting Florida’s environment and the economy!