Shellfish Upweller Nurseries

Dale Leavitt
Aquaculture Extension Specialist
Technique for growing juvenile shellfish

*Downweller Nursery*
RWU Downweller
Technique for growing juvenile shellfish

Raceway Culture Nursery
Raceway Culture System
Technique for growing juvenile shellfish

Field Nursery
Technique for growing juvenile shellfish

Upweller Nursery
Upweller Nursery
Technique for growing juvenile shellfish

*Upweller Nursery: advantages & disadvantages*

- **Advantages**
  - good water flow pattern
Technique for growing juvenile shellfish

Upweller Nursery: advantages & disadvantages

- **Advantages**
  - good water flow pattern
  - high food flux
  - high stocking density
  - predators excluded

- **Disadvantages**
  - requires access to water
  - relatively high start-up cost
  - high maintenance
Developing an shellfish nursery

*Upweller design strategies - four options*

- Onshore within a structure
- Onshore exposed to weather
- Floating with shore power
- Floating without shore power
Onshore within a structure

_Basically a building next to the water_

- Protected from the elements
- Reduces biofouling
- Utilities nearby
- User friendly
Onshore within a structure

*But....!*

- Limited availability
- VERY expensive!!!
- Hard to justify for seasonal use
- Need to lift water
Onshore exposed to the elements

*Land or dock space next to the water*

- Less expensive than a building
- Somewhat protected
- Utilities nearby
- User friendly
Onshore exposed to the elements

*But....!*

- Limited availability
- Moderately expensive
- Mother Nature
- Exposed to outside tampering
- Need to lift water
**Floating with shore power**

*On the water, frequently associated with a marina*

**FLUPSY - FLoating UPweller SYstem**

- At a water source
- Lower operating costs
- Utilities nearby
- User friendly
Floating with shore power

But…!

- Limited access
- Mother Nature!
- Exposed to outside interference
- Water quality
Floating with shore power
Floating without shore power

On the water, frequently at a mooring.

- At a water source
- Mobile
- Not dependent on shoreside utilities
- Minimal operating costs

Fig. 1 - Three-dimensional schematic of the Tidal-Powered Upwelling Nursery System.
Floating without shore power

But…!

- Limited access
- Not protected from disturbance (nature and human)
- Utilities not nearby
- Not user friendly
Developing a shellfish nursery

- Purchase/acquire seed from hatchery
  - Size & amount?

- Nursery System design
  - Downweller (175 to 500 μm).
  - Upweller (500 μm to 25 mm).
  - Raceway (3 mm to 25 mm).
  - Field nursery (>3 mm)
Developing a shellfish nursery

How does one develop a shellfish nursery system?

- Assess your needs
- Identify your location
- Decide on your general design strategy
- Obtain permits
- Purchase and install system
- Get seed
Developing a shellfish nursery

**Assessing your needs?**

- What shellfish are you growing?
- How many do you want to grow?
- What size seed will you acquire?
- How large do you want to grow them in the nursery?
- How much time can you spend maintaining the system?
- How much money do you have to invest in the system?
Developing a shellfish nursery

**Identifying your location?**

- What space do I have available?
- What are the water characteristics?
  - For shellfish to survive?
  - For shellfish to grow?
- What utilities do I have on-site?
- What is my primary means to access the site?
Design considerations

Various options when designing the upweller

- Tank design
- Discharge placement
- Silo shape
- Silo construction material
- Pump design and placement
- Size
Design considerations

**Tank design**

- Generally square tank or trough
Design considerations

Alternate tank designs

- No tank
Design considerations

**Drain placement**

- Central trough vs Outboard discharge
Design considerations

Silo shape

- Square vs Round
Design considerations

Silo Material

- Wood vs. Plastic vs. Fiberglass
Design considerations

**Materials for Silo Construction**

- Duct Pipe
Design considerations

**Materials for Silo Construction**

- Duct Pipe
- Sewer Pipe
Design considerations

Materials for Silo Construction

- Duct Pipe
- Sewer Pipe
- Plastic Barrels
Design considerations

**Materials for Silo Construction**

- Duct Pipe
- Sewer Pipe
- Plastic Barrels
- Plastic Buckets
Design considerations

Materials for Silo Construction

- Duct Pipe
- Sewer Pipe
- Plastic Barrels
- Plastic Buckets
- Sheet plastic
Design considerations

**Materials for Silo Construction**

- Duct Pipe
- Sewer Pipe
- Plastic Barrels
- Plastic Buckets
- Sheet plastic
- Fiberglass
Design considerations

Centrifugal Pumps

- Surface mount vs Submersible
Design considerations

Other Pumps
- Axial Flow Pump
  - upstream
Design considerations

**Other Pumps**
- Axial Flow Pump
  - upstream
  - downstream
Design considerations

**Other Pumps**
- Axial Flow Pump
- Paddlewheel
Design considerations

Other Pumps
- Axial Flow Pump
- Paddlewheel
- Airlift
Design considerations

Scale
- Small
Design considerations

**Scale**
- Small
- Not so small
Two questions seem to always come up!

- How much flow do I need to provide through the upweller?
- How many seed can I put in the upweller?
  or How big an upweller do I need for X million seed?
- Sometimes the answer to these two questions can be combined.
  - For example - a Rule of Thumb you may have heard
    - “100 gpm per 100,000 seed”
- However – we can do better than that!
- Need to think about
  - Flow
  - Stocking density
## Upweller Comparison Data - flow

### Upweller Data

<table>
<thead>
<tr>
<th>Literature values</th>
<th>flow (gpm / silo)</th>
<th>silo area (in²)</th>
<th>flow/area (gpm/in²)</th>
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<tbody>
<tr>
<td>* Malinowski 1986</td>
<td>5.0</td>
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<td>0.0325</td>
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<td>0.1365</td>
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<td>* Tidal raft Eastham</td>
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<tr>
<td>* FLUPSY - modified Leavitt</td>
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<td>* FLUPSY - solar Leavitt</td>
<td>79.4</td>
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</tbody>
</table>

Average = 0.08 gal/in²/min  
Best = 0.10 gal/in²/min
Calculating stocking density

_How much seed can you put in an upweller?_

- It is very site specific!
- Need to calculate a starting point.
- Adjust your stocking density as you learn your system and your waters.
# Silo Stocking Densities

(from Malinowski – 1986)

<table>
<thead>
<tr>
<th>Sieve Mesh Size</th>
<th>Approximate Clam Size Retained</th>
<th>Number of clams per ml</th>
<th>Optimal Stocking Volume</th>
<th>in Optimal Stocking Volume (approx.)</th>
<th>Weekly Volume Increase* (approx.)</th>
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<tbody>
<tr>
<td>Initial</td>
<td>0.75 mm</td>
<td>2,500</td>
<td>125 ml</td>
<td>312,000</td>
<td>100-300%</td>
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<tr>
<td>1.0 mm</td>
<td>1.50 mm</td>
<td>720</td>
<td>175 ml</td>
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<td>100-200%</td>
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<tr>
<td>1.4 mm</td>
<td>2.50 mm</td>
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<td>300 ml</td>
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<td>1,000 ml</td>
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<td>5.7 mm</td>
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<td>6</td>
<td>1,500 ml</td>
<td>9,000</td>
<td>35%</td>
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</table>

*Weekly increases in total volume of clams in a silo, as measured in a graduated cylinder
The following chart shows the number of individual upwell units required to produce seed of 6-8mm outplanting size, given a flow rate of 20 l/min/l seed.

<table>
<thead>
<tr>
<th>UPWELLER DIAMETER (inches)</th>
<th>10,000</th>
<th>20,000</th>
<th>50,000</th>
<th>100,000</th>
<th>500,000</th>
<th>1,000,000</th>
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<td>1</td>
<td>3</td>
<td>7</td>
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<td>8</td>
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<td>1</td>
<td>2</td>
<td>4</td>
<td>19</td>
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<td>1</td>
<td>2</td>
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<td>1</td>
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# Upweller Comparison Data - Density

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<th>flow</th>
<th>silo area</th>
<th>flow/area</th>
<th>clams/silo</th>
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<td>(gpm / silo)</td>
<td>(in²)</td>
<td>(gpm/in²)</td>
<td>(#)</td>
<td>(# / in²)</td>
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<td>* Manzi * et al. 1984</td>
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<td>2.1</td>
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Average = 13.7 #/gal/in²/min

Best = 4.8 #/gal/in²/min
Calculating approximate stocking density

- Surface area of 18 inch diameter round silo
  - $A = \pi r^2$
  - $A = 3.14 \times 9^2 = 254.3 \text{ in}^2$

- Flow rate is 75 gpm through each silo

- Target density is 5 clams/gpm-in$^2$ (@ 10 mm)

- Stocking density in a six silo system?
  - Stocking density per silo:
    - $254.3 \text{ in}^2 \times 75 \text{ gpm} \times 5 \text{ clams/gpm-in}^2 = 95,362 \text{ clams}$
  - Capacity of upweller system:
    - 6 silos @ 95,362 clams/silo = 572,175 clams
The final product

Whatever the nursery system set-up, the objective is to grow the largest and healthiest animals in the least amount of time at the least cost.