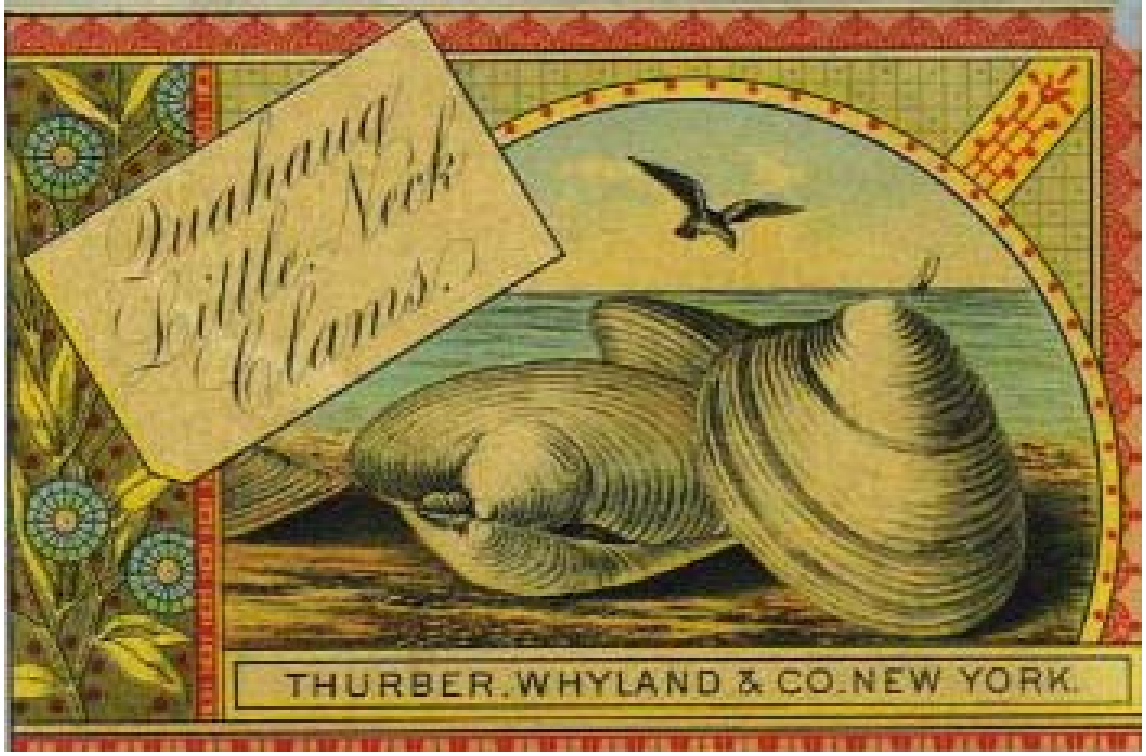

Shellfish and Aquaculture

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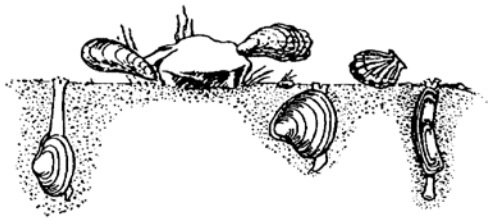
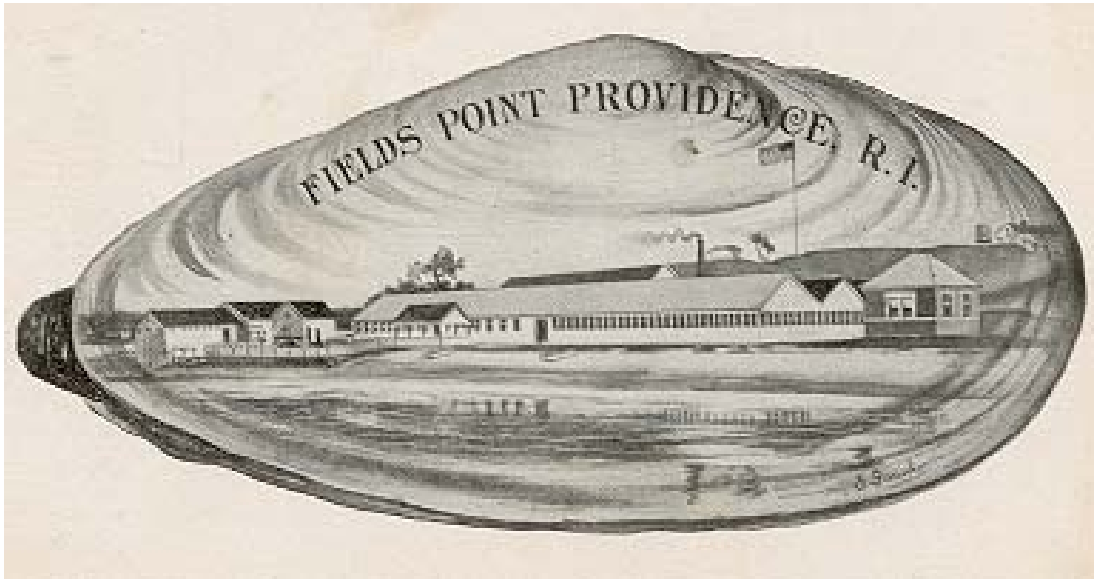
Dale Leavitt
Associate Professor - Marine Biology

OFFICIAL CLAM INSPECTOR

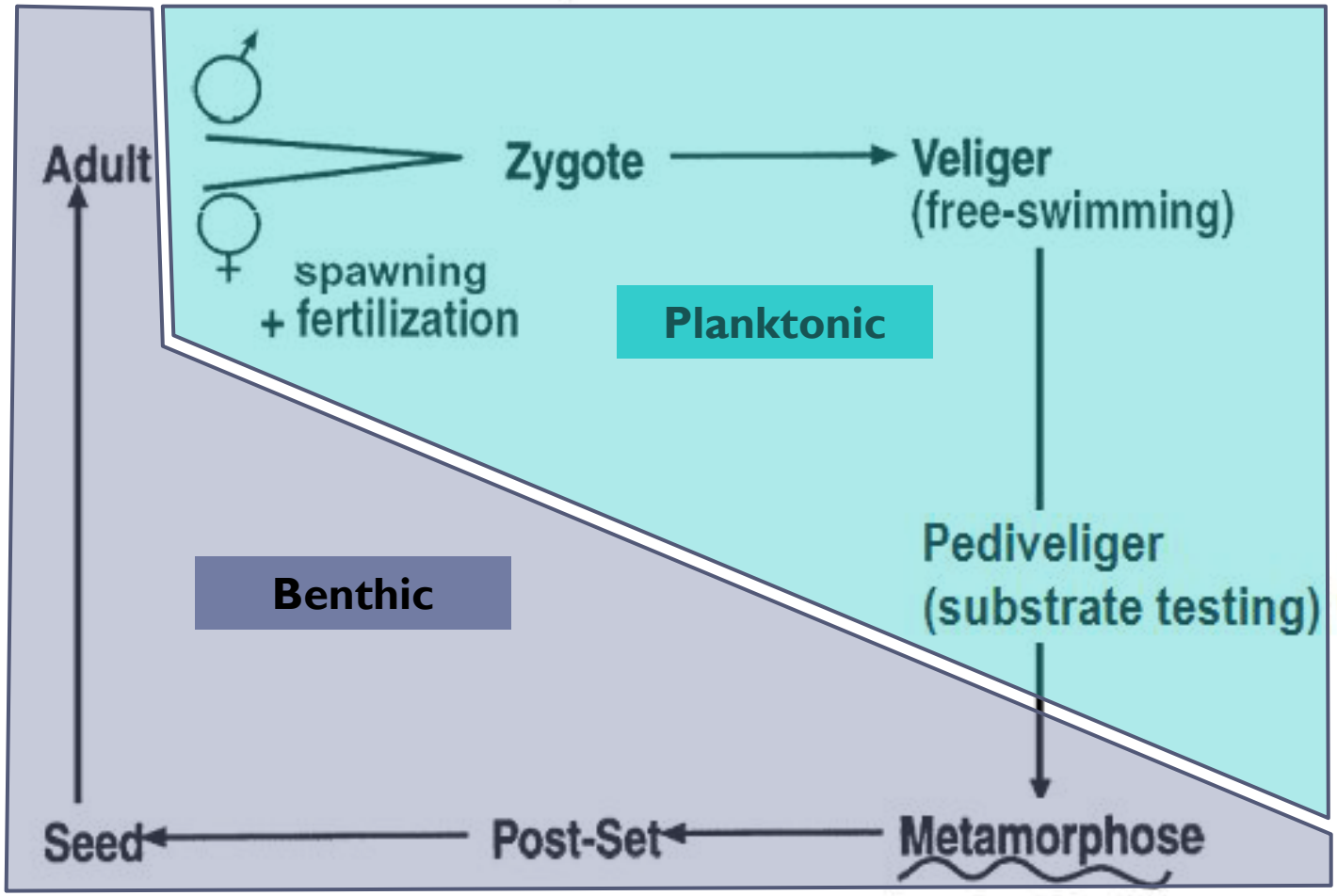


Today:

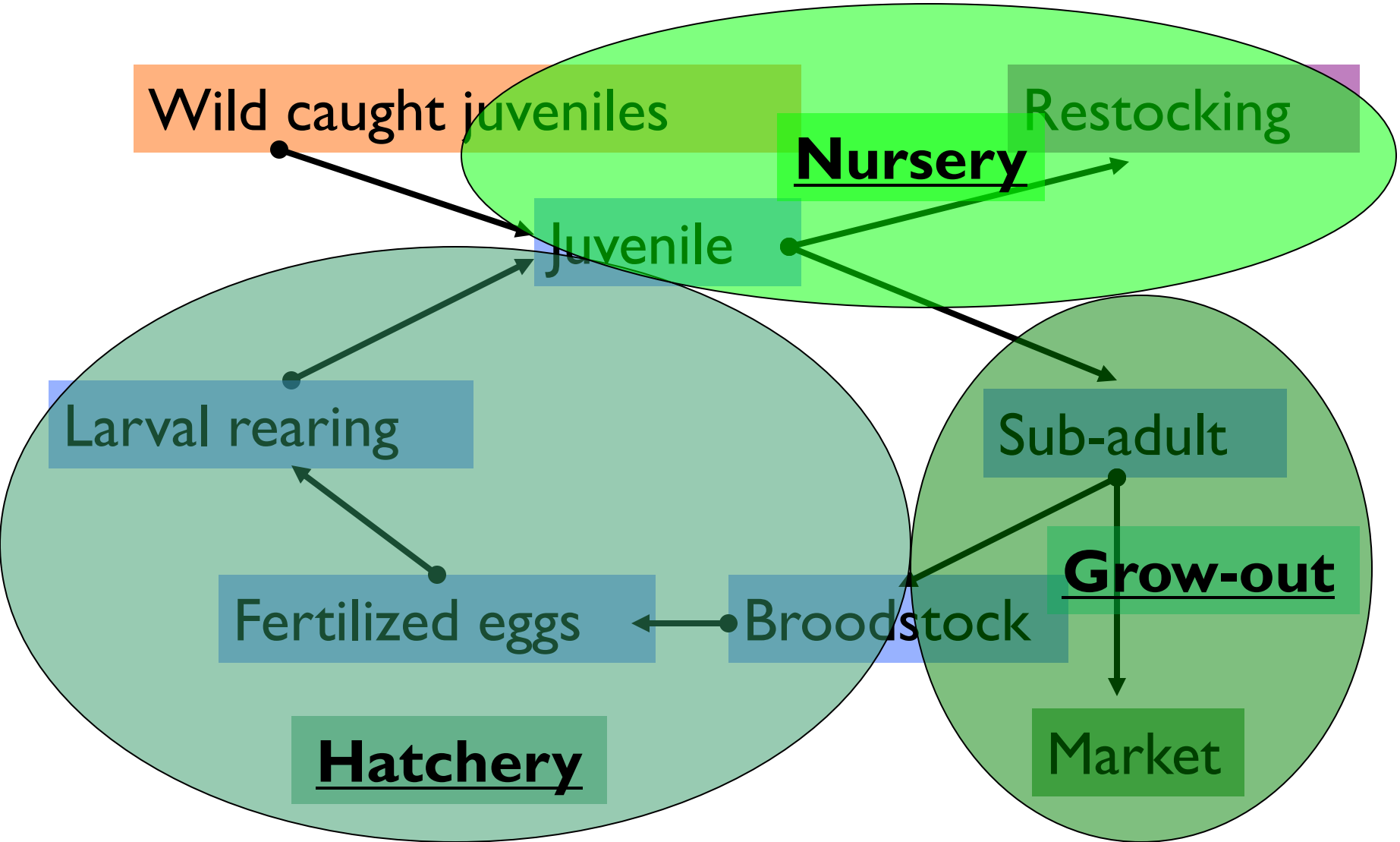
- Shellfish biology / Shellfish aquaculture
- Shellfish ecological services
- Shellfish & Subaqueous soils



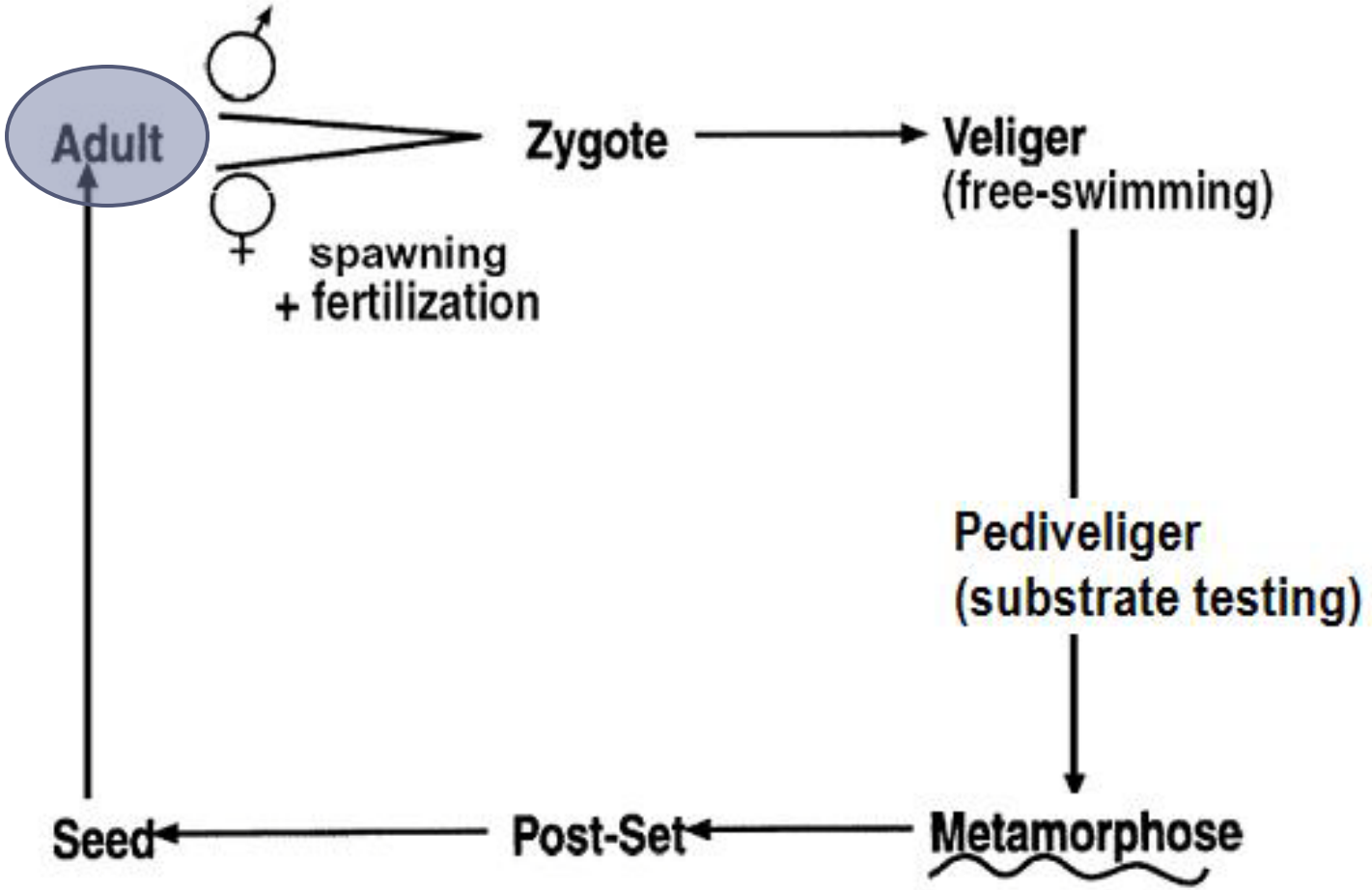
A typical bivalve's life cycle



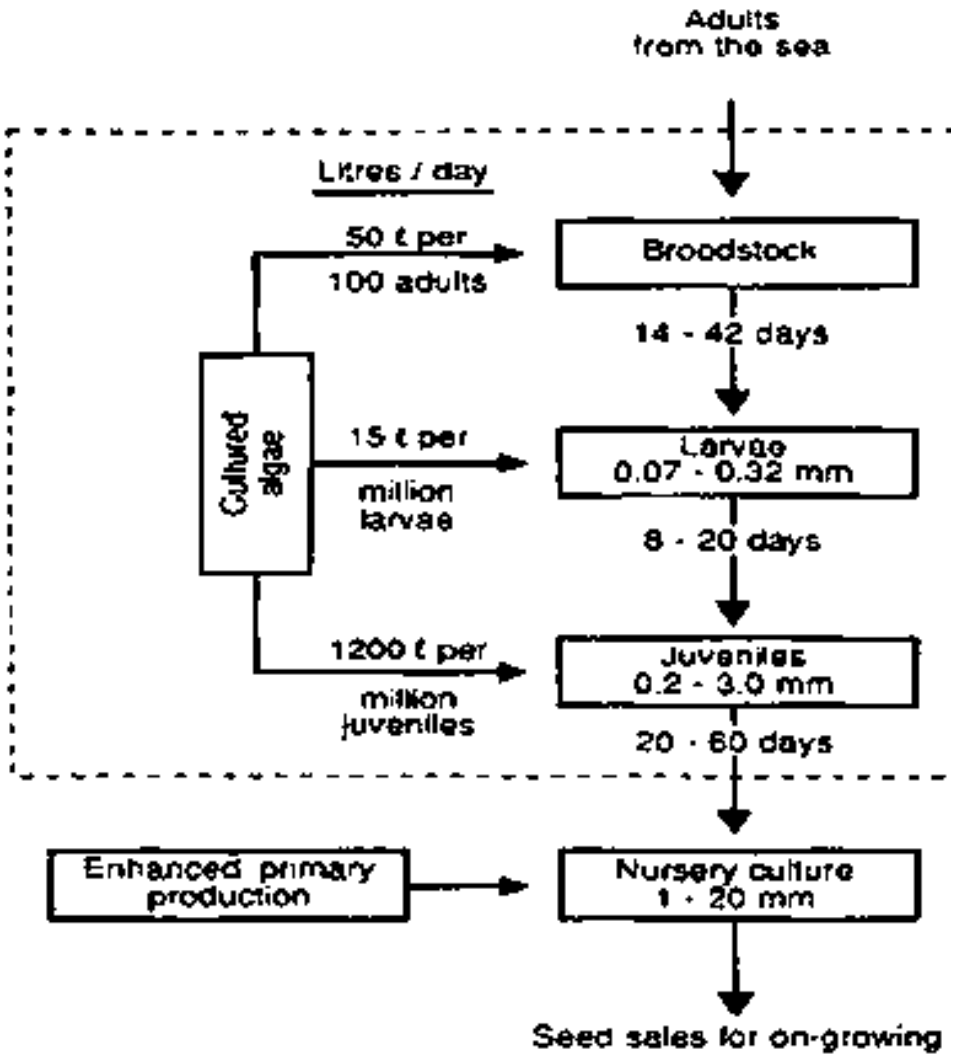
Overall culture schematic



The steps in culturing shellfish



Broodstock Conditioning



Broodstock Conditioning

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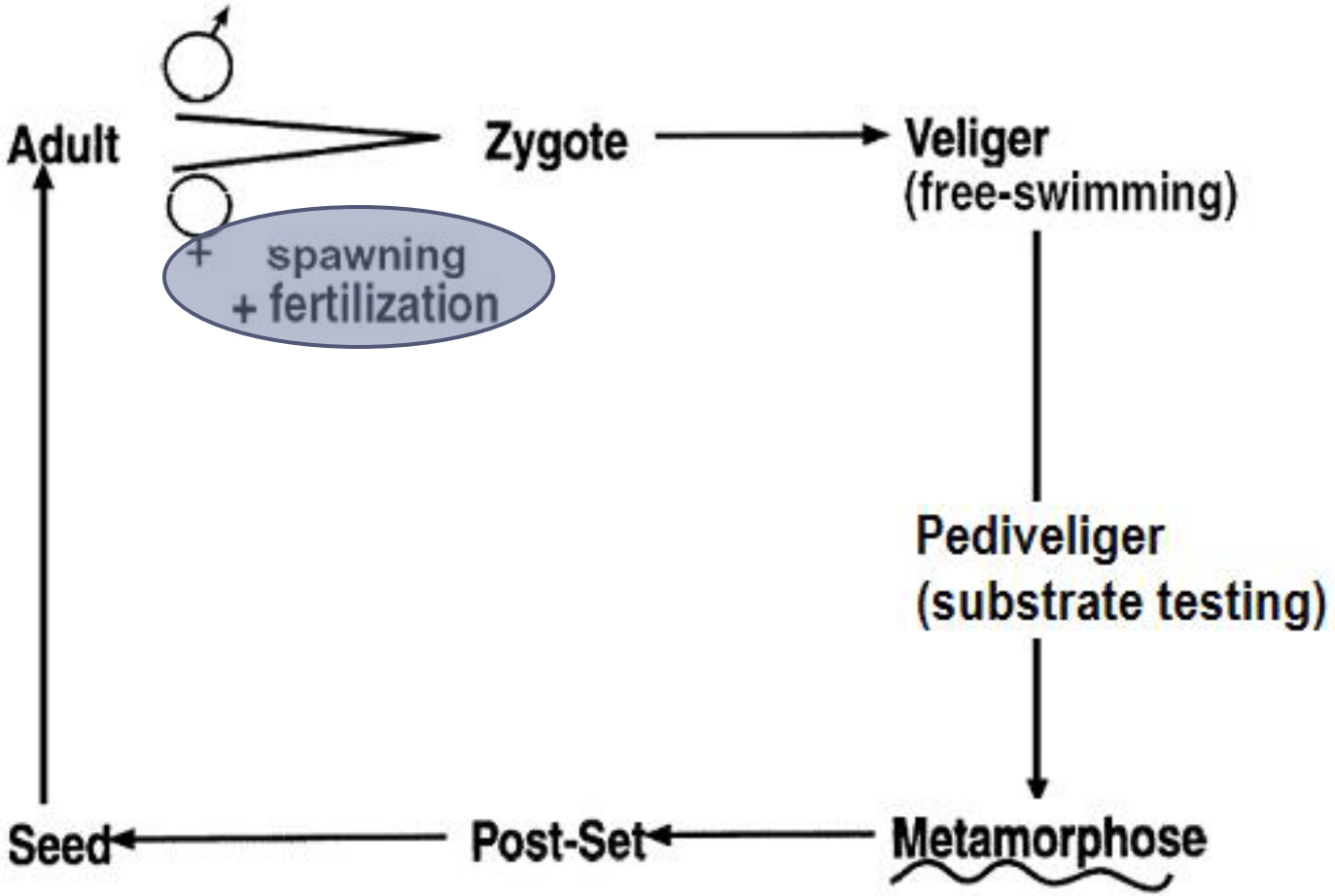
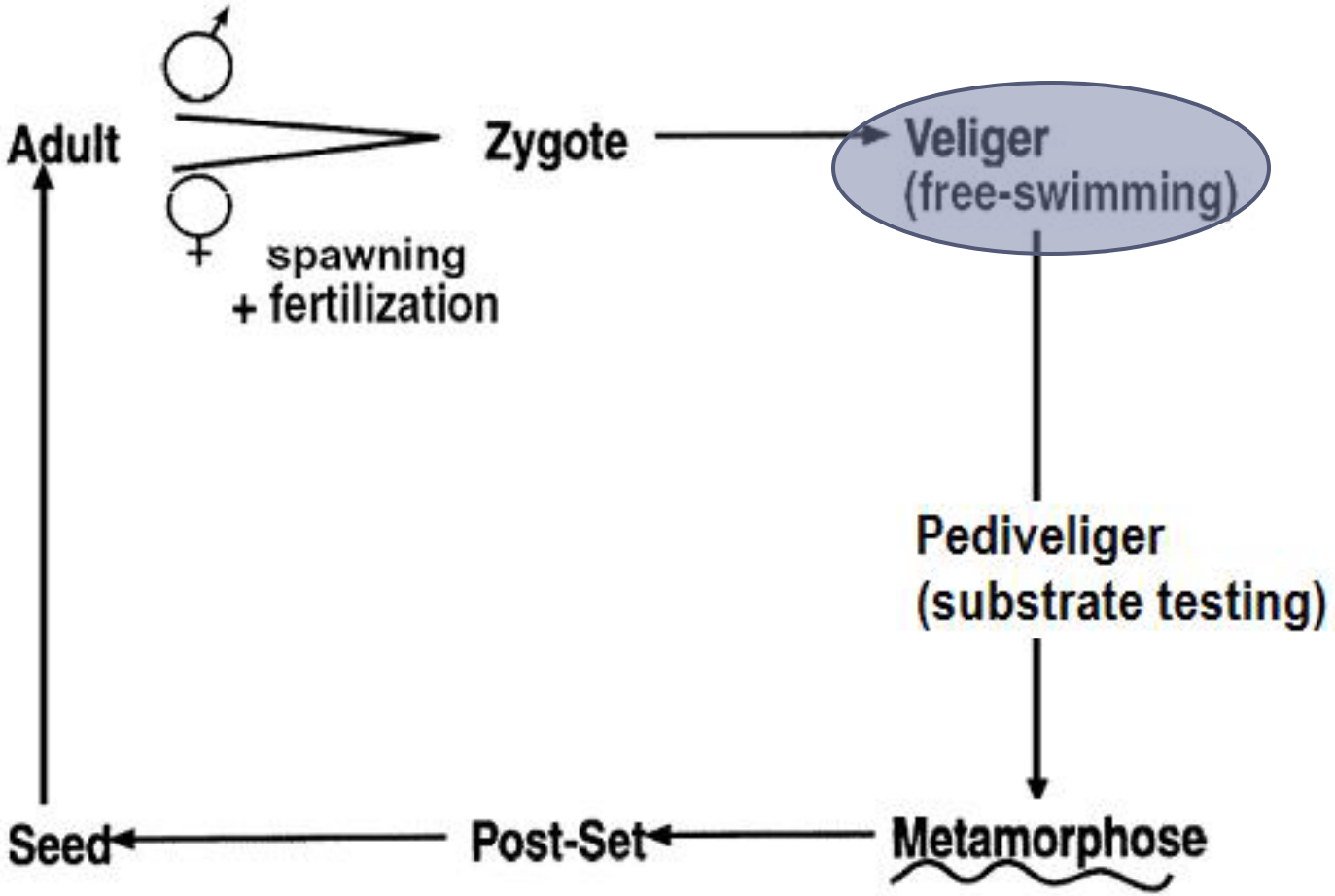
The steps in culturing shellfish

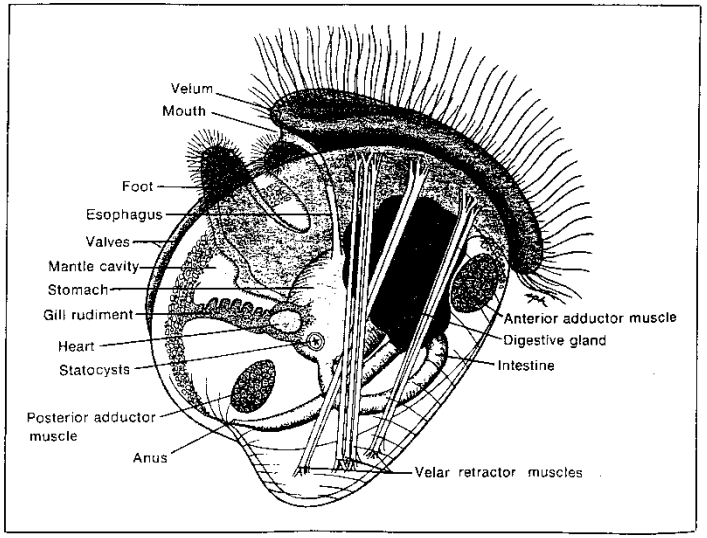


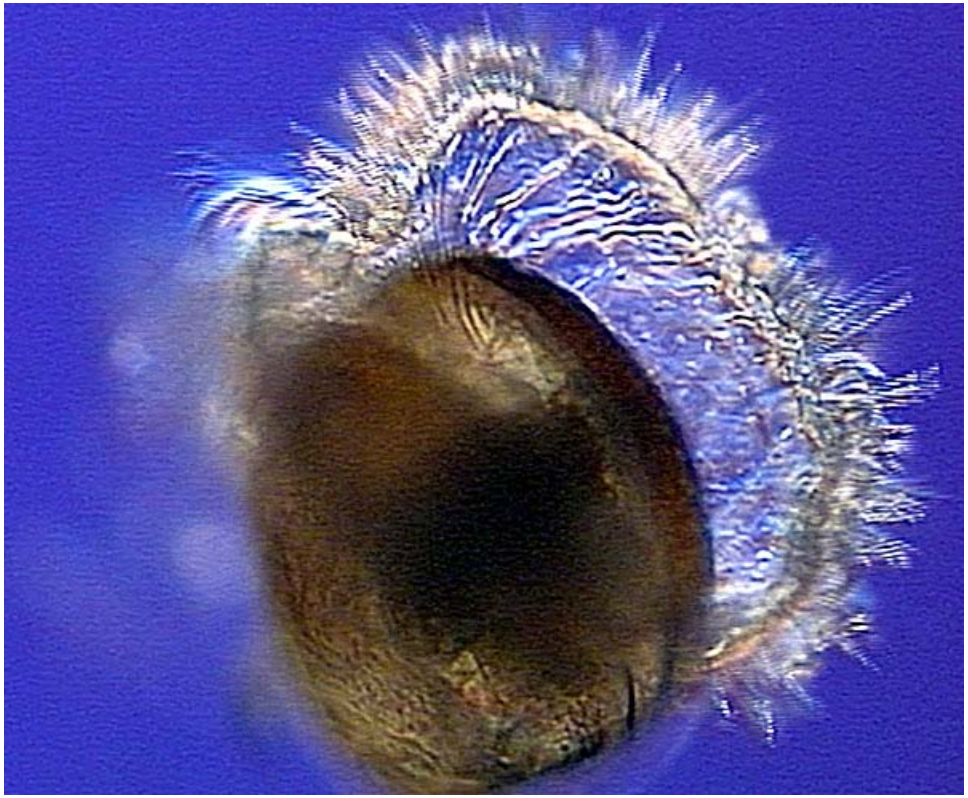
Spawning

The steps in culturing shellfish

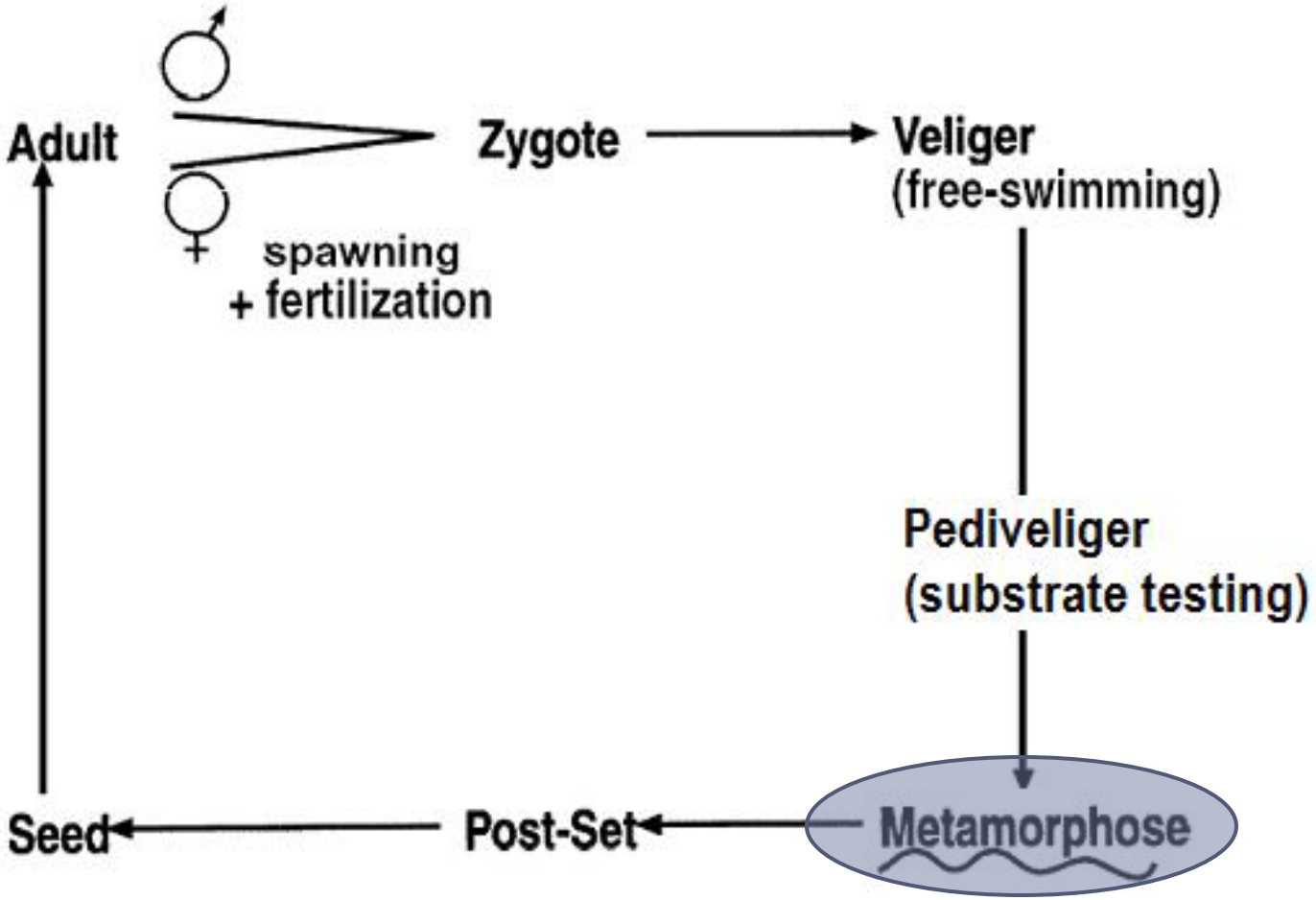


Veliger

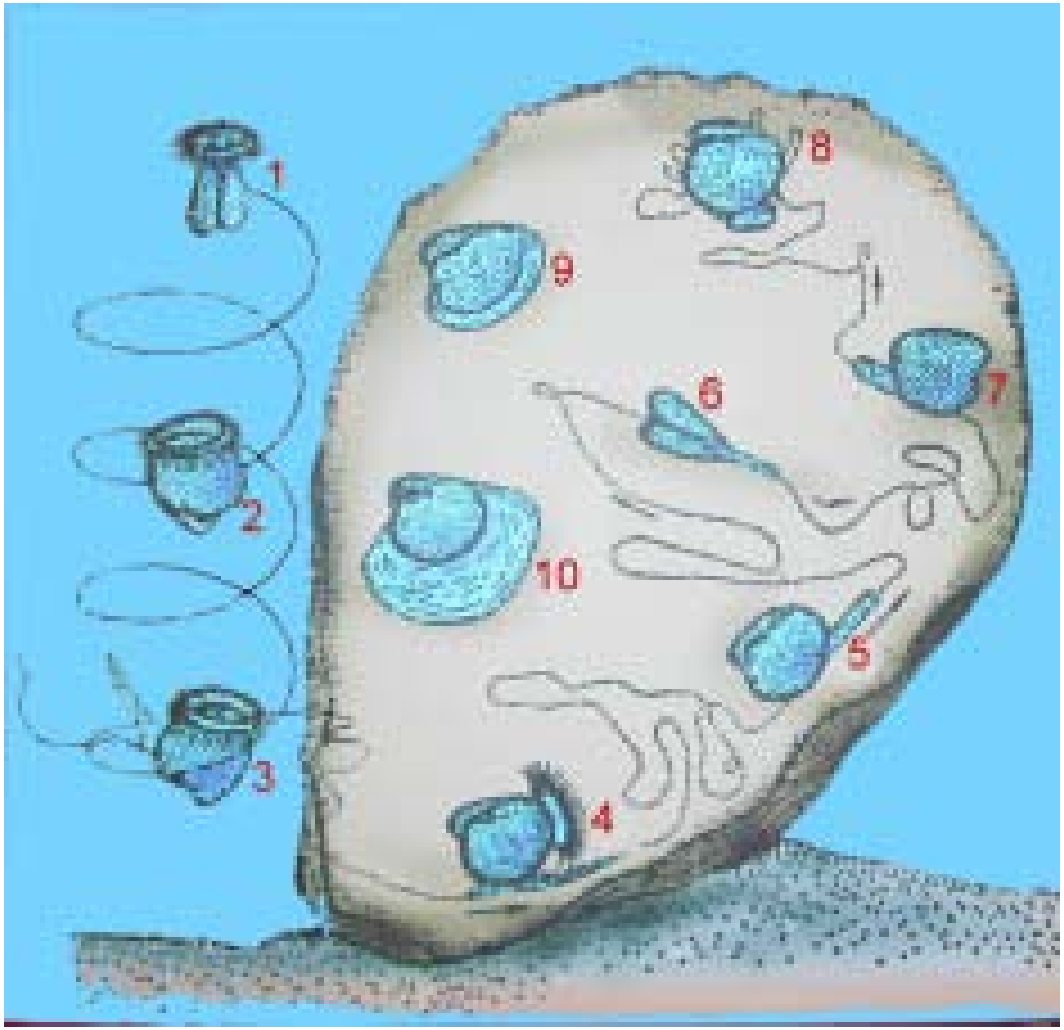


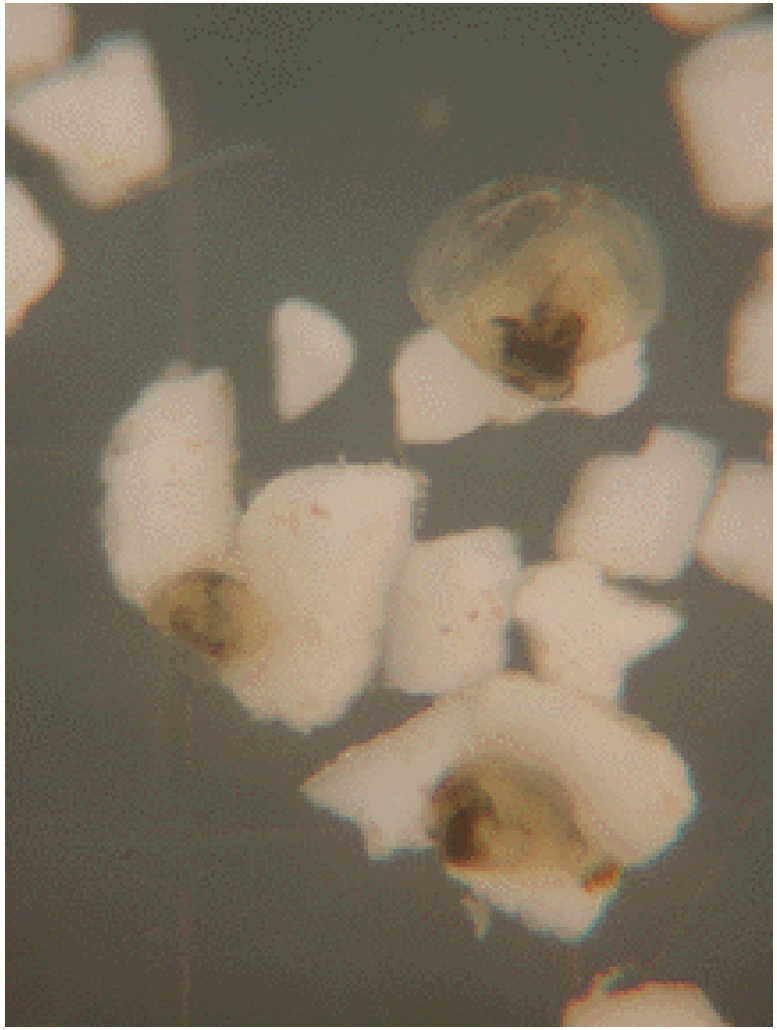


The steps in culturing shellfish

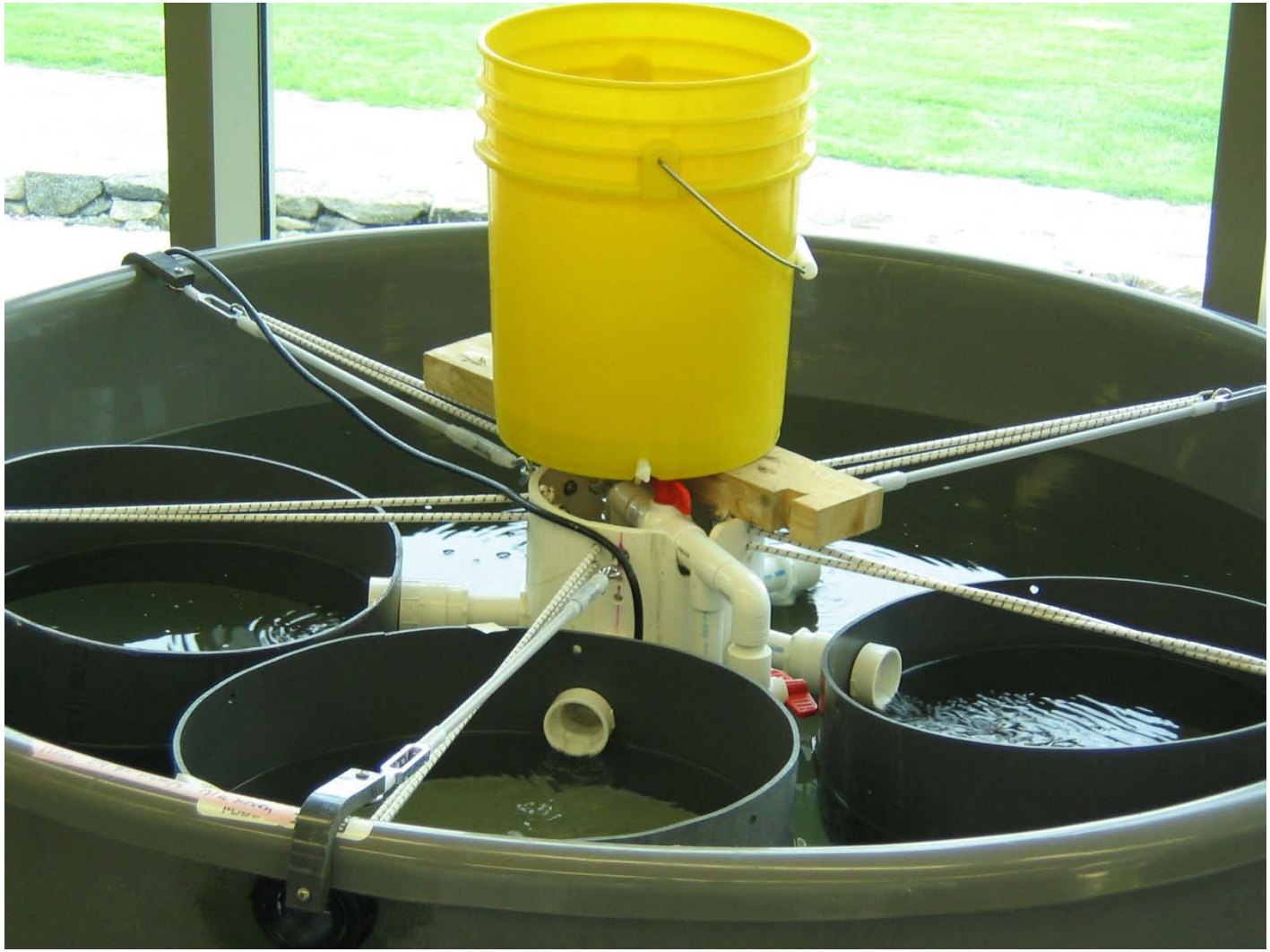


Metamorphosis





RWU Hatchery – Setting downweller



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RWU Hatchery – Remote set on cultch

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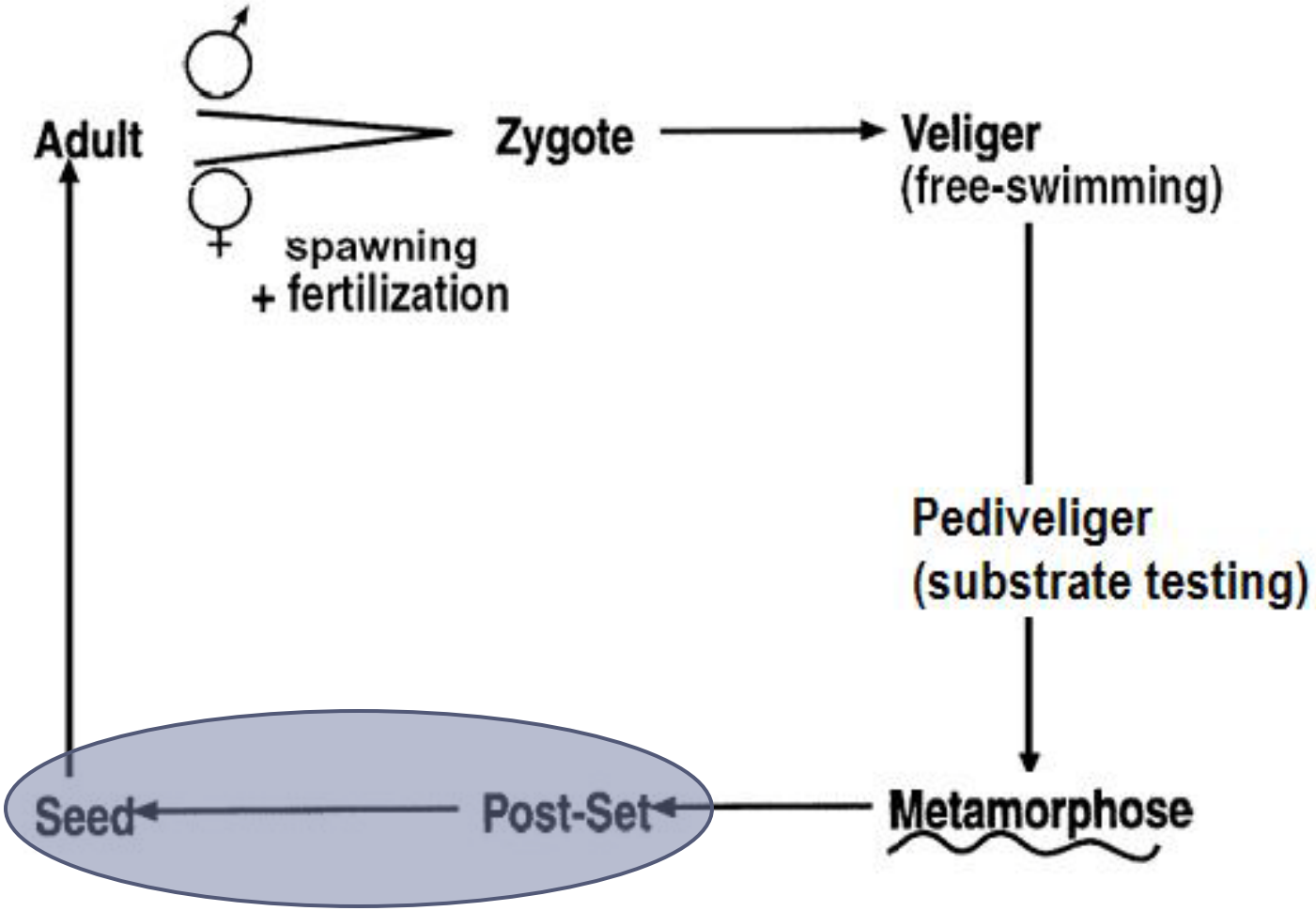
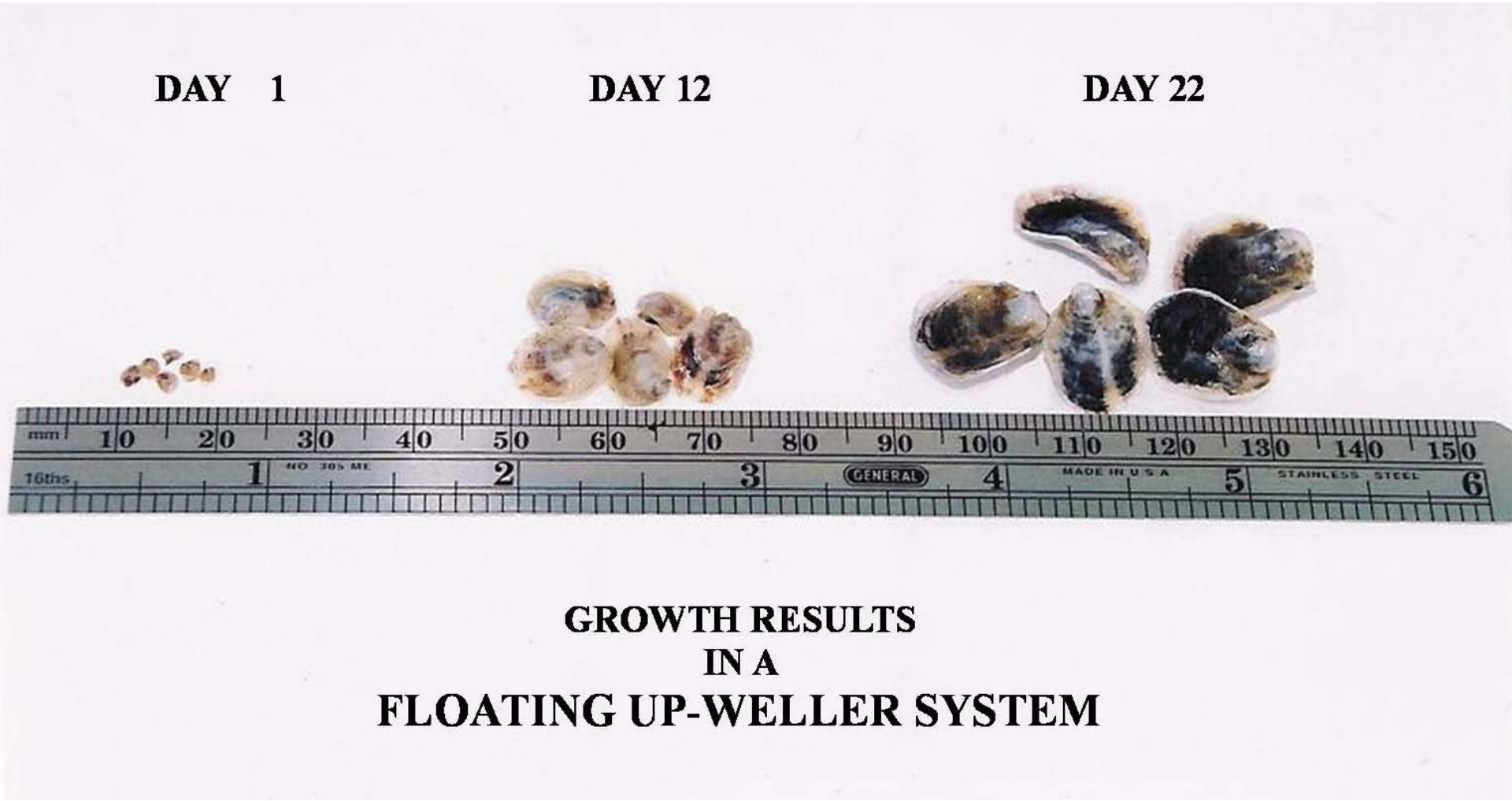
Setting Cues – Habitat related

- Oysters
  - Prefer a hard substrate with $CaCO_3$ (other oysters or shell)
  - Eggshell or bird grit (for single oysters)
  - Calcium carbonate cement slurry (Chinese hats)
- Bay Scallop
  - Like to settle on eelgrass blades
  - Netron and/or spat bags or old monofilament
- Quahogs, steamer clams, and razor clams
  - Like to settle on cobble/sand (We think!)
  - Nitex mesh screens
- Mussels
  - Somewhat indiscriminate with their setting
  - Fine thread or pieces of rope

The steps in culturing shellfish

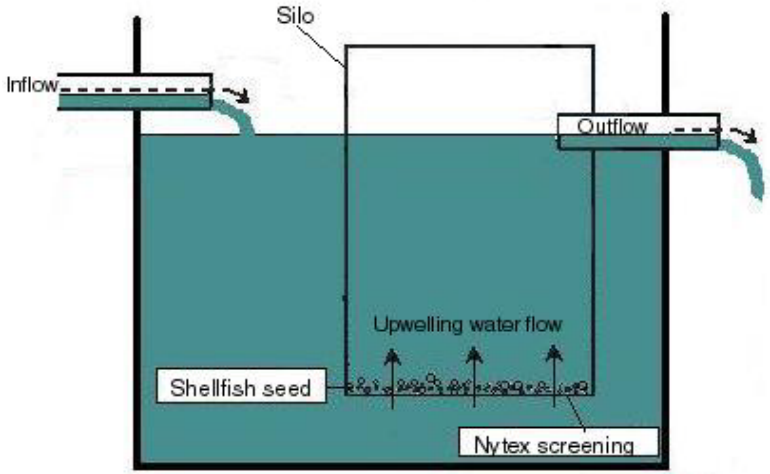


Post-set growth



GROWTH RESULTS
IN A
FLOATING UP-WELLER SYSTEM

Shellfish Nursery Systems



Upwellers

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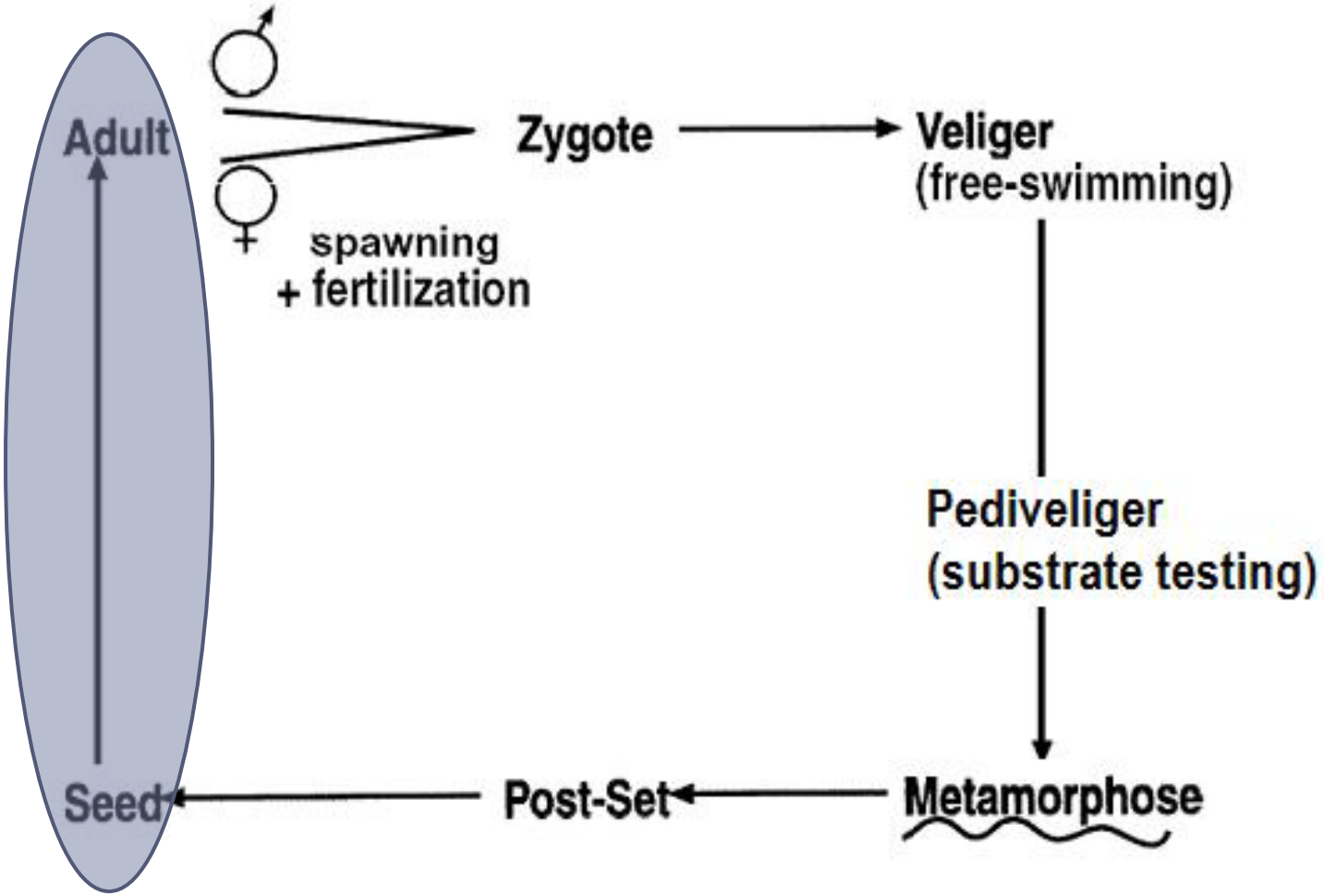
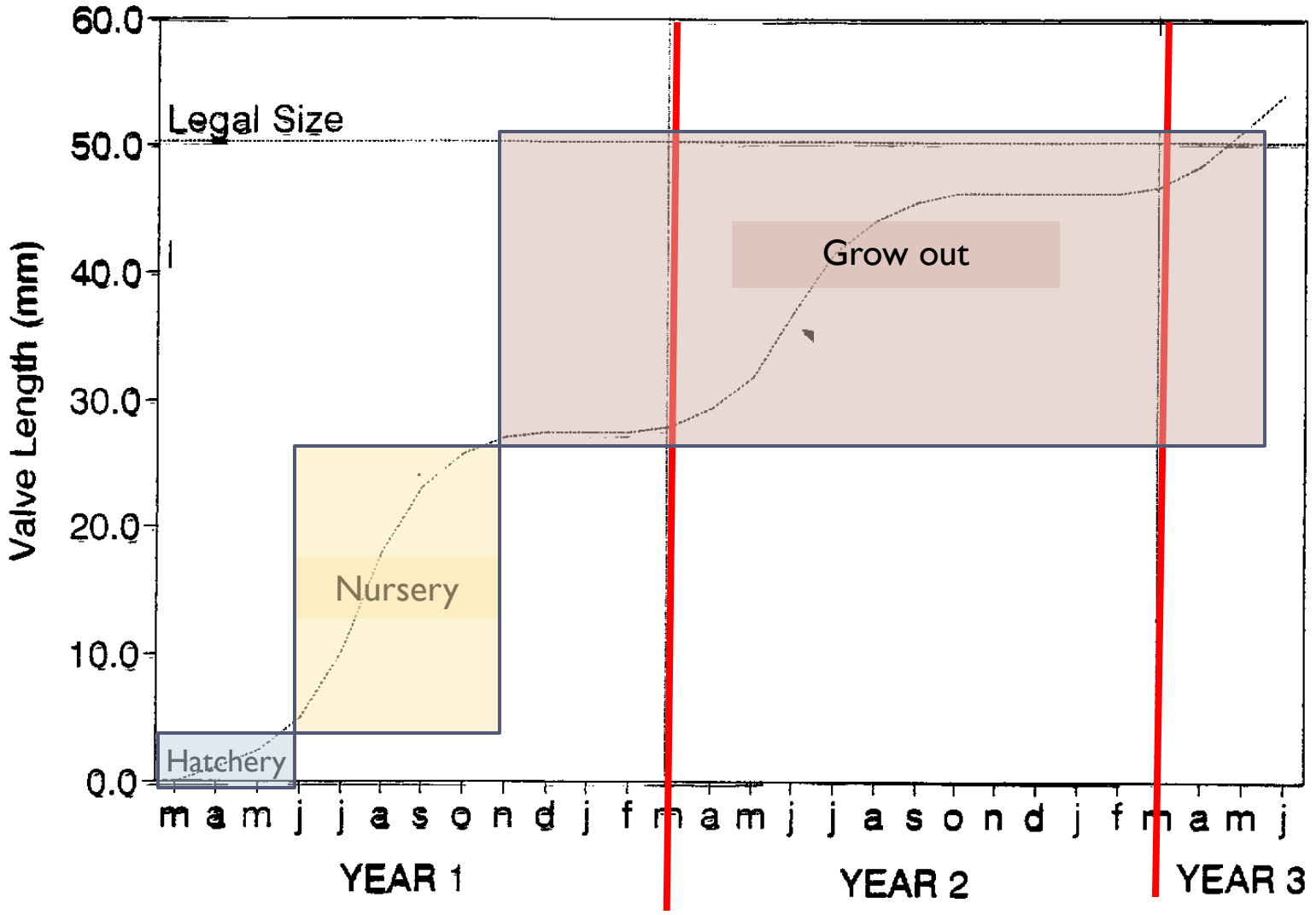
The steps in culturing shellfish



Hypothetical quahog growth curve



Shellfish Growout – Potential Sites

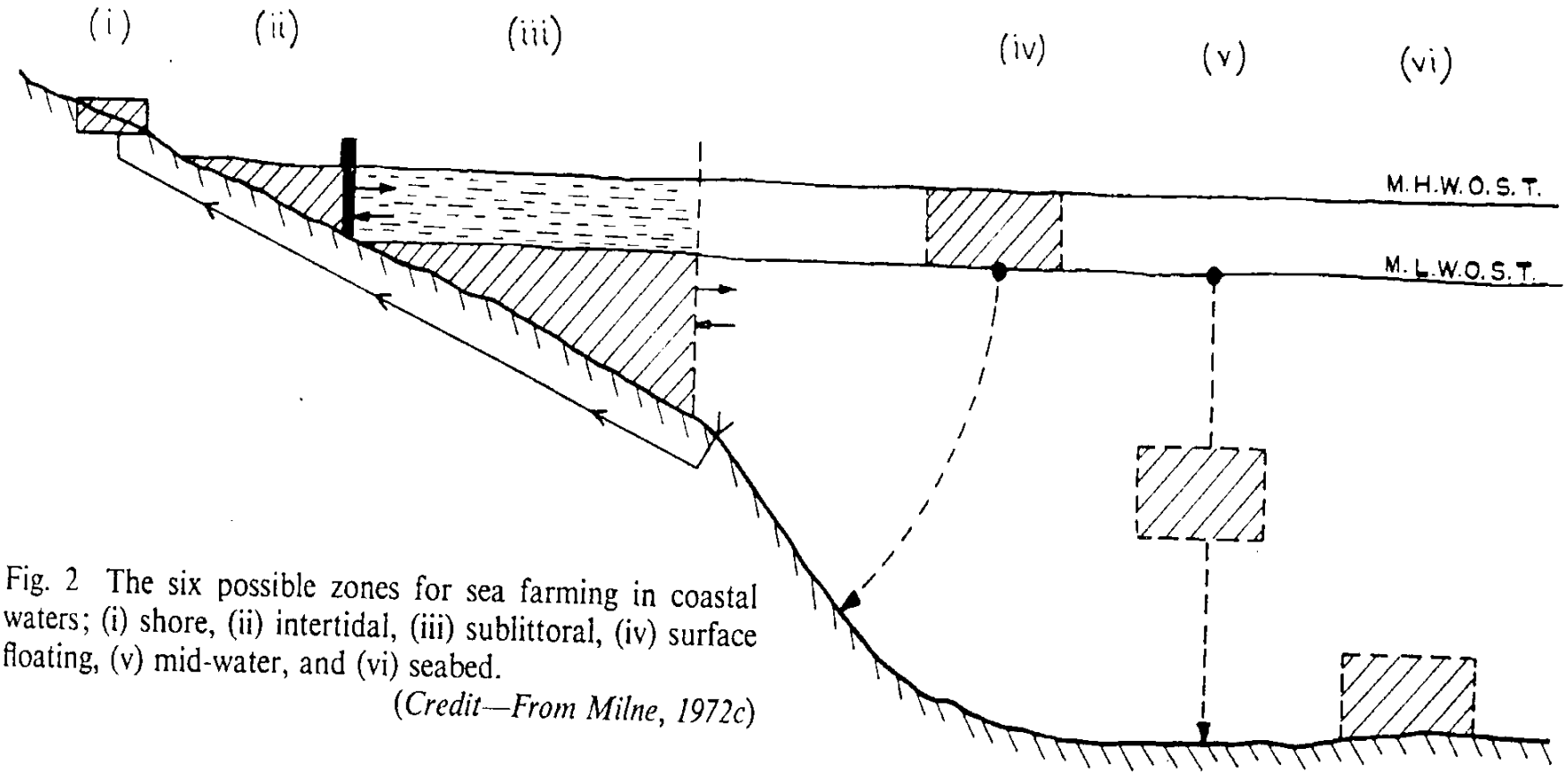


Fig. 2 The six possible zones for sea farming in coastal waters; (i) shore, (ii) intertidal, (iii) sublittoral, (iv) surface floating, (v) mid-water, and (vi) seabed.

(*Credit—From Milne, 1972c*)

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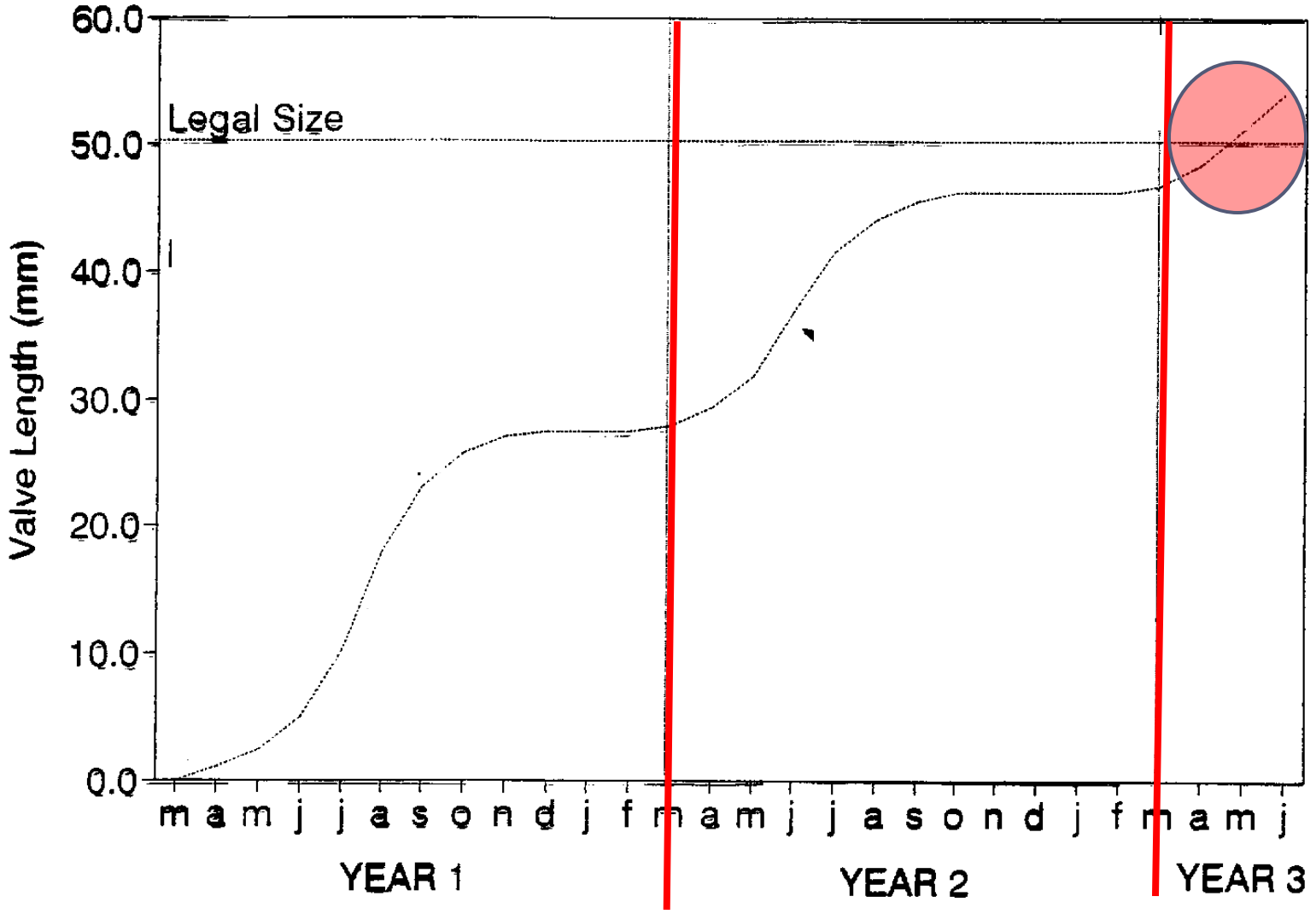

The fruits of your labor to market

Ecological Services

- There are many convincing reasons to consider managing for a strong shellfish population
- Shellfish as "Ecological Engineers"
  - Improving water clarity through daily filtering large volumes of water with a minimum particle retention size of 2-3 microns

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Ecological Services

- There are many convincing reasons to consider managing for a strong shellfish population
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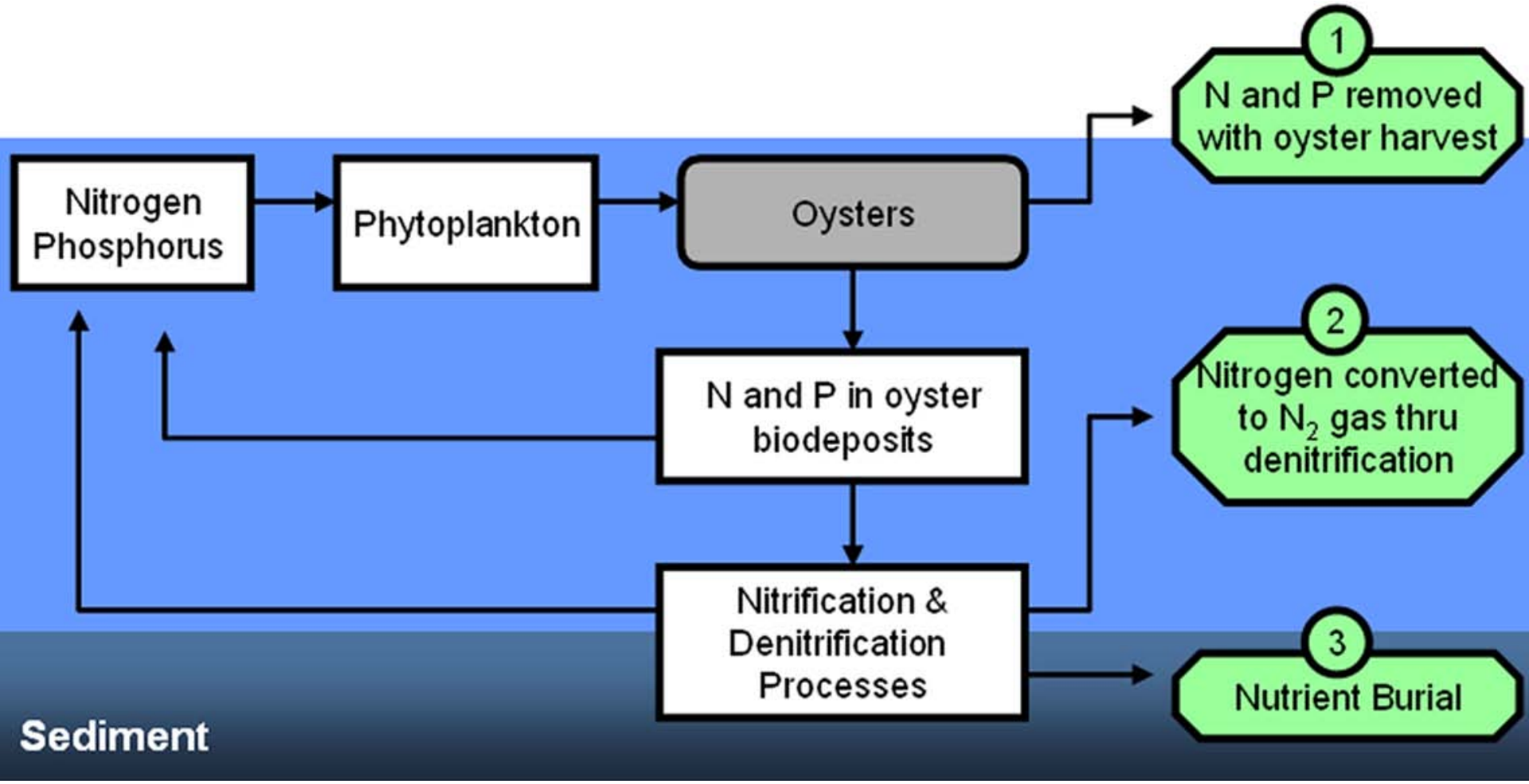
  - Improving water clarity through daily filtering large volumes of water with a minimum particle retention size of 2-3 microns
  - Removing nitrogen and other nutrients from coastal waters through the consumption of phytoplankton and suspended particulates and either assimilating them into bivalve tissue or transitioning them onto the sediment surface
  - Increasing the rate of nitrogen removal from the coastal ecosystem through promoting anaerobic denitrification in sediment below the oyster bed

Ecological services



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  - Increasing the rate of nitrogen removal from the coastal ecosystem through promoting anaerobic denitrification in sediment below the oyster bed
  - Increasing the three-dimensional complexity of the bottom of our coastal ponds/bays thereby providing increased habitat value for other important marine organisms

Why are oysters important to the bays?

- Habitat complexity
  - Hard substrate
  - Bottom roughness

Habitat

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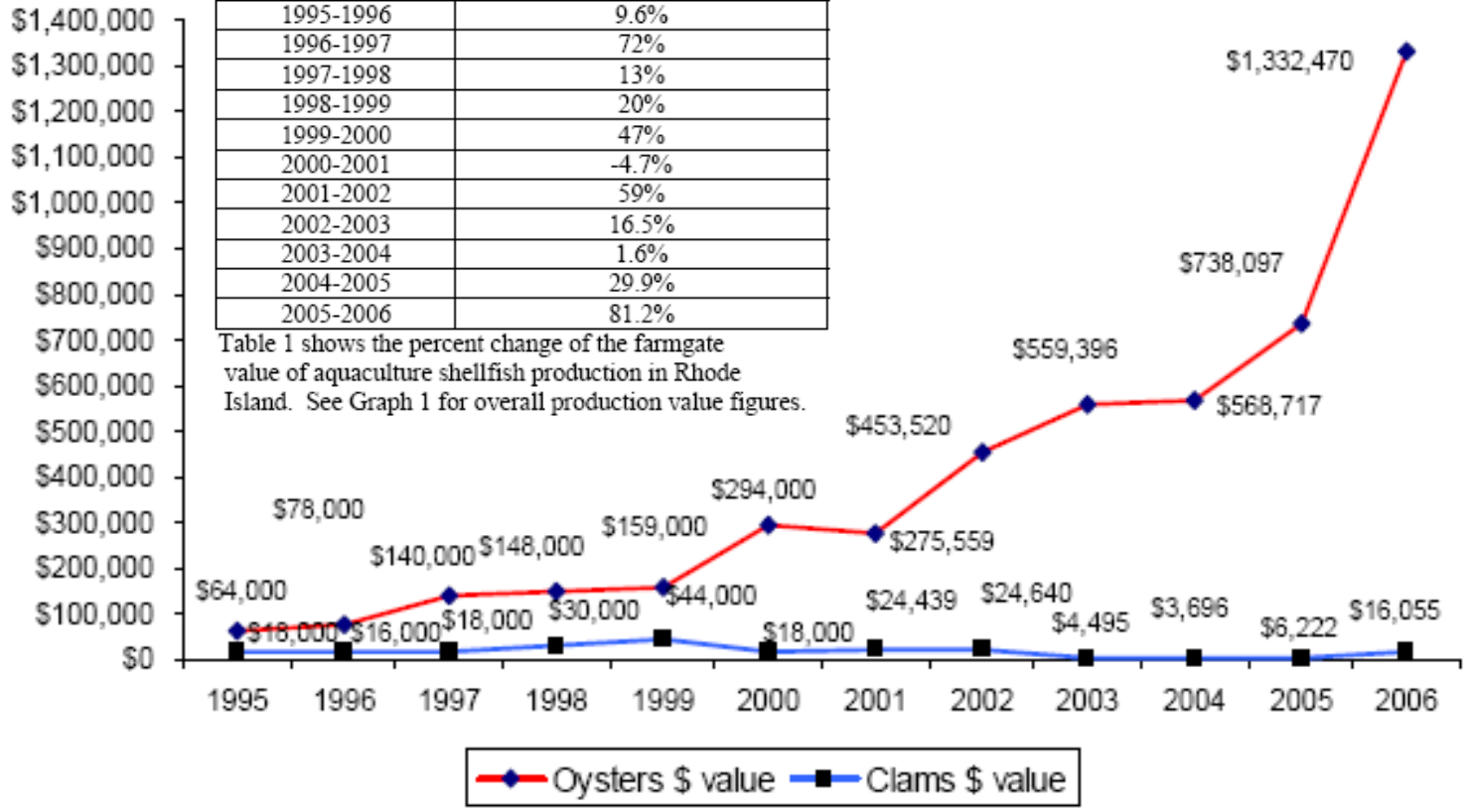
Shellfish as an economic benefit

Dollar Value of Shellfish by Species

Table 1

Year	Percent Change in Farmgate Value from Previous Year
1995-1996	9.6%
1996-1997	72%
1997-1998	13%
1998-1999	20%
1999-2000	47%
2000-2001	-4.7%
2001-2002	59%
2002-2003	16.5%
2003-2004	1.6%
2004-2005	29.9%
2005-2006	81.2%

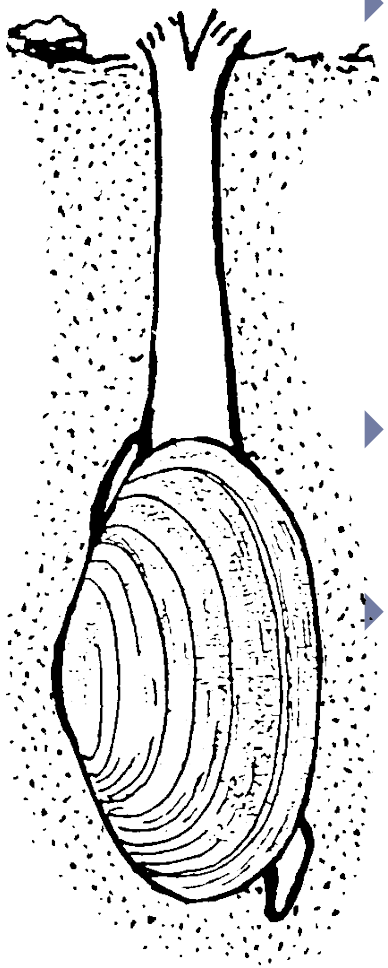
Table 1 shows the percent change of the farmgate value of aquaculture shellfish production in Rhode Island. See Graph 1 for overall production value figures.



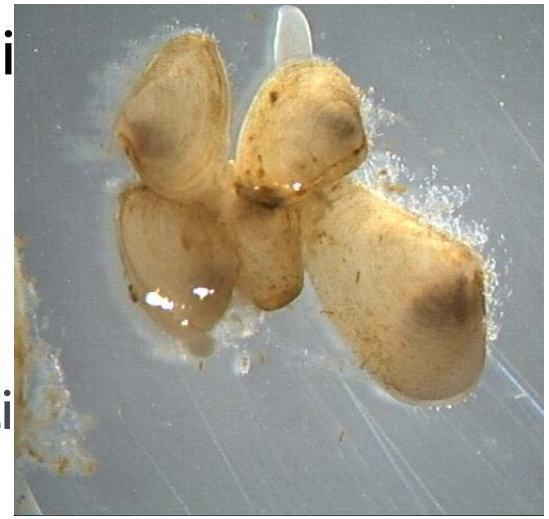
The role of sediment in shellfish production

- A volume of scientific literature available that relates shellfish production to subaqueous soil characteristics, including
  - Larval recruitment substrate selection
  - Post-metamorphic shellfish distribution
  - Shellfish growth and survival
- Two local examples of the interrelationship between shellfish production and sediment characteristics
  - Soft shell clam distribution
  - Oyster growth and survival

Soft shell clam (*Mya arenaria*)

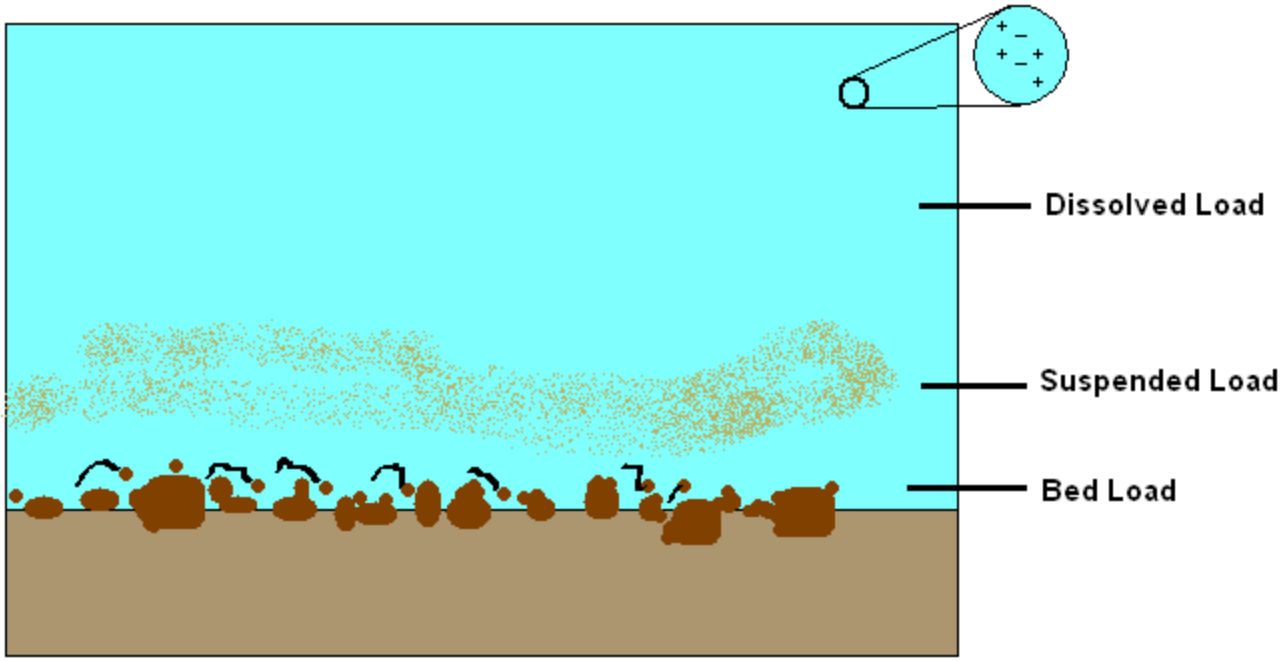


- An infaunal bivalve that is co
  to our local
  coastal embayments
  - Noted for its ability to exist deeply buried in the sediment
- Is an important commercial speci
  regionally
- It is becoming an important commercially cultured species
  - Partially dependent on wild collecti
    of seed

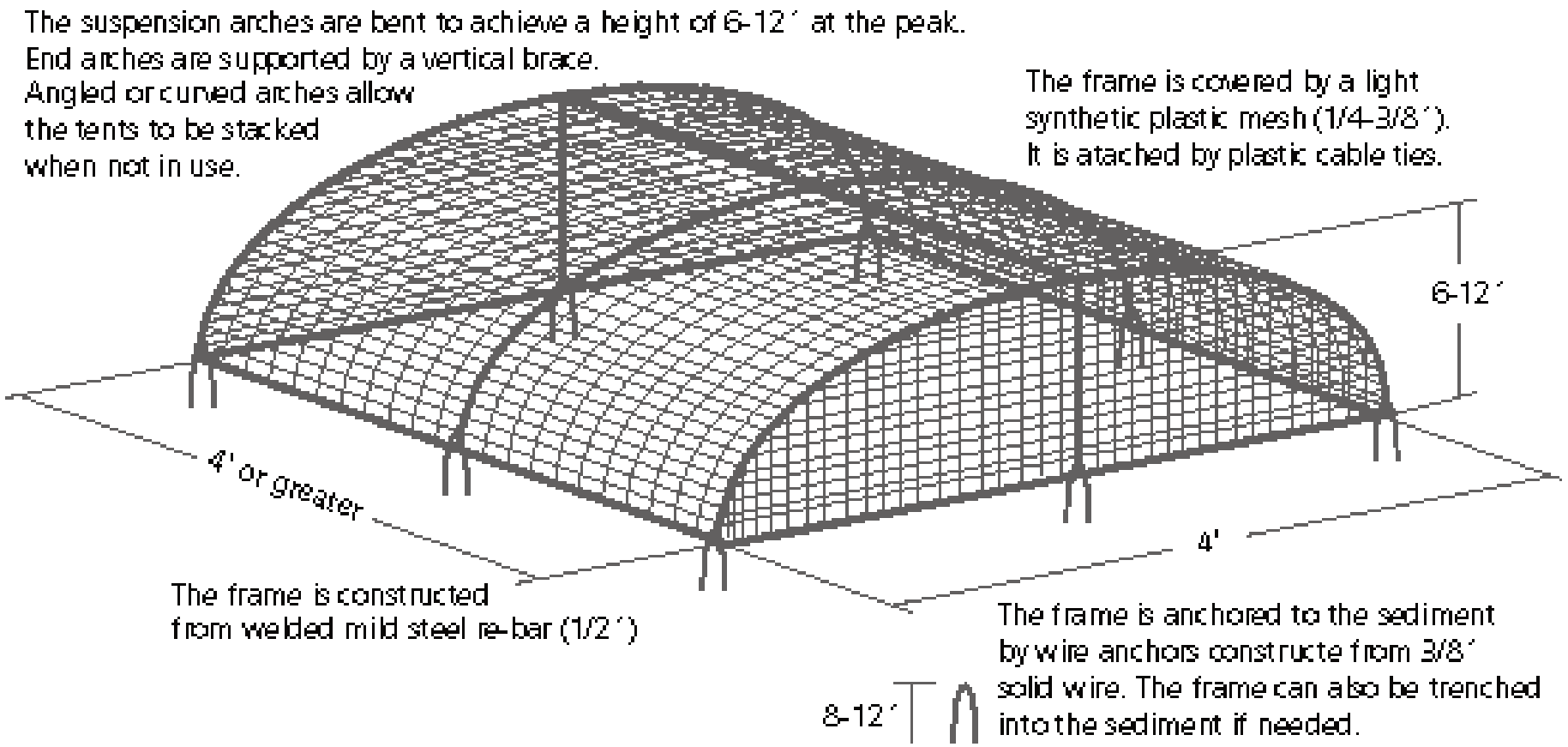


Soft shell clam distribution

- Long noted that in areas with soft shell clam seed – anything that disturbed water flow resulted in enhanced clam recruitment



Clam tents (intercepting sediment transport)



The connection between shellfish & substrate

- Alex Salisbury (URI Master's student of Mark Stolt)

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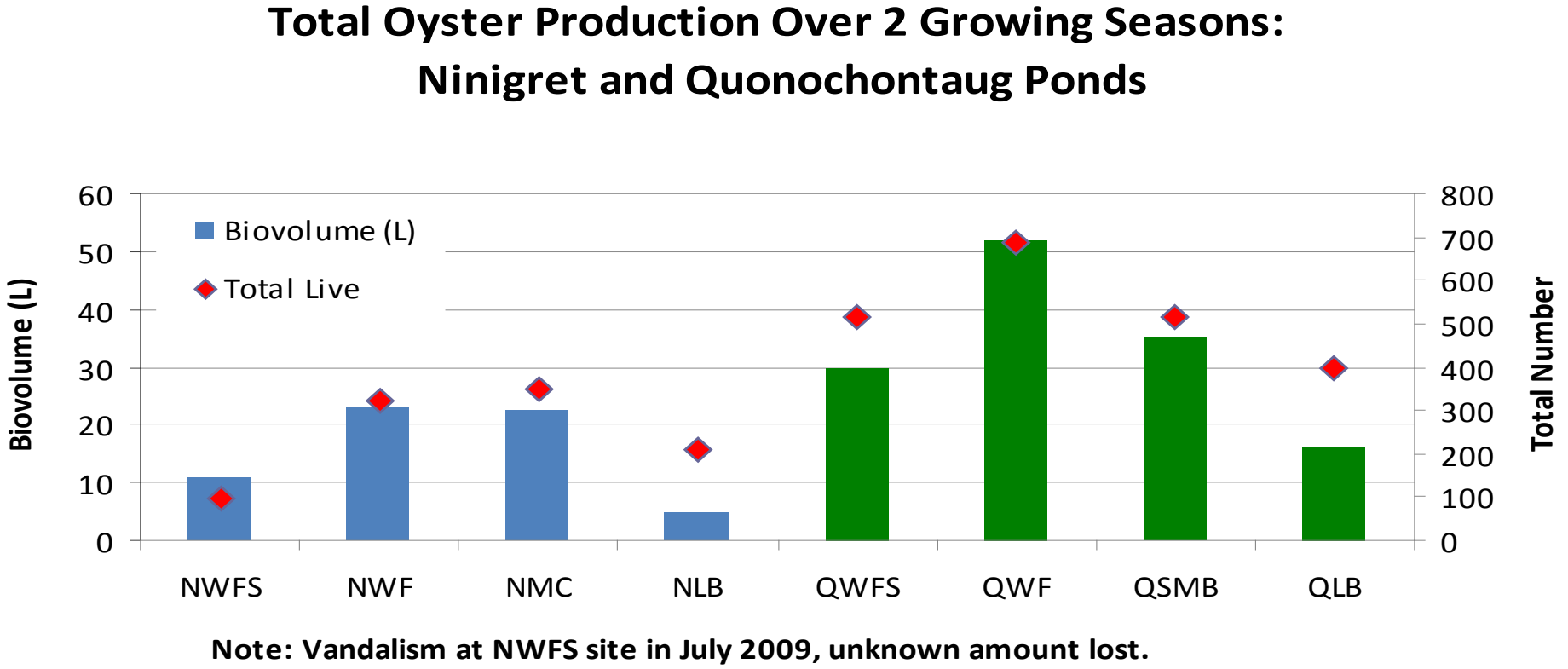
Measured shellfish growth in various soil types across two coastal ponds in RI



Total live oysters (#) and total biovolume (L) between oyster gear at study sites and subaqueous landscapes.

(WFS – washover fan slope; WF – washover fan flat; MC – mainland cove; MB – mainland beach; LB – lagoon bottom)

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The connection between shellfish & substrate

- Alex Salisbury (URI Master's student of Mark Stolt)
  - Oyster growth rates increased with increases in sand content of the surface horizon of the soil,
    - while soils having increases in silt-clay contents, showed a relative reduction in growth, as well as decreases in biovolume, and increased mortality.

Relationship of sand content to oyster growth

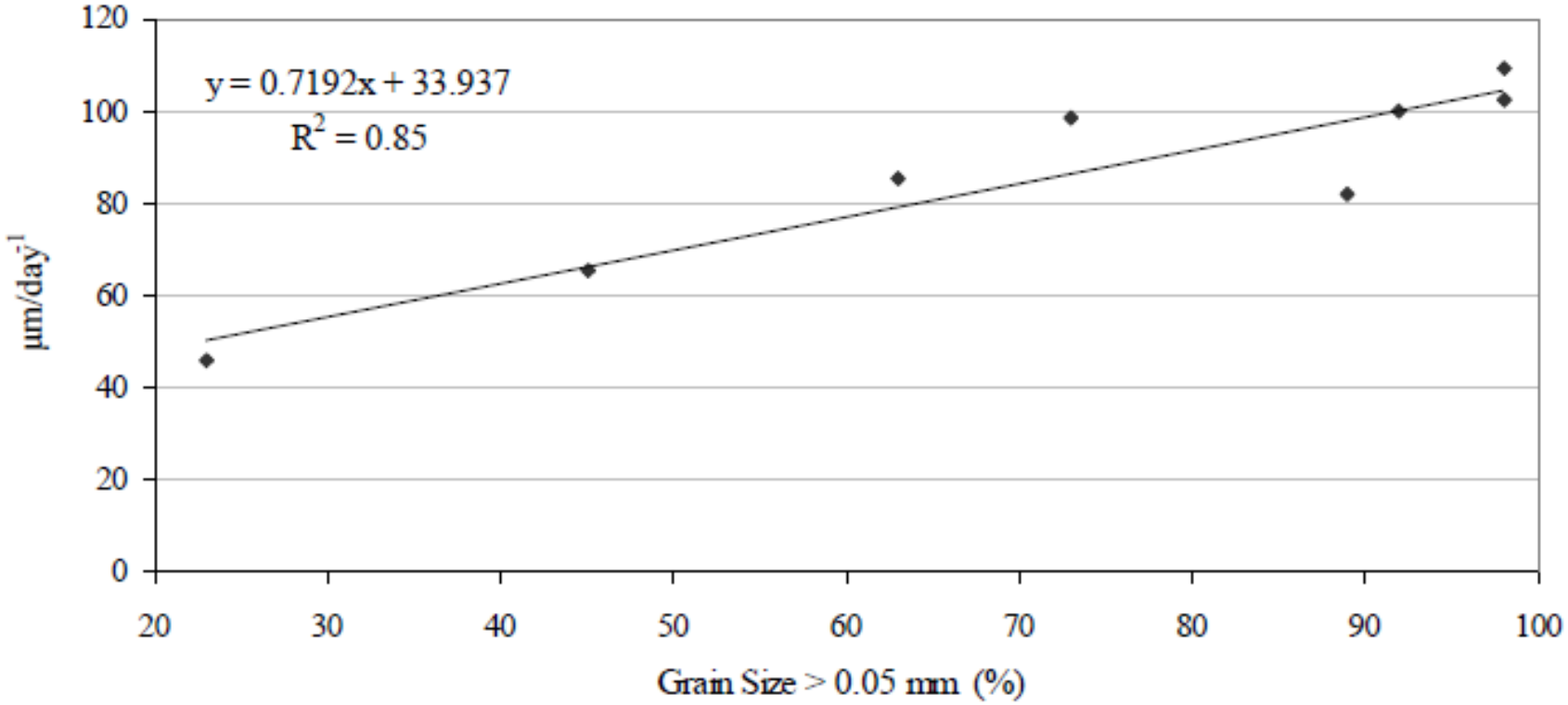

Figure 2.9. Regression analysis of soil particle size (Sand = <0.05 mm) predicting oyster growth on subaqueous landscape units (See Table 2.10). Note the positive slope of the regression.

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    - while soils having increases in silt-clay contents, showed a relative reduction in growth, as well as decreases in biovolume, and increased mortality.
  - Higher growth rates and decreased mortalities were observed on higher energy soil-landscape units than the fine textured Lagoon Bottom and Cove.
- Much more work needed to differentiate actual direct soil effects from indirect indicator effects
  - For example: is soil type an indirect indicator of current energy and thus food flux to the growing bivalve or does it have a direct impact on growth physiology?

In Conclusion: Shellfish aquaculture and soil characteristics

- Specific shellfish species have distinct likes and dislikes in terms of soil characteristics
  - Can impact their distribution and production performance
- Much more work is necessary to tease out the roles that various soil factors may play in shellfish production
  - e.g. the role of *in situ* pore water acidity on recruited spat survival
- Shellfish farmers can be very ingenious in adapting their species selection and culture technology to the prevailing soil characteristics at a specific site
  - Often don't have the luxury of optimizing their site selection based on soil characteristics