



Razor Clams in the Northeast

life history, fishery, research

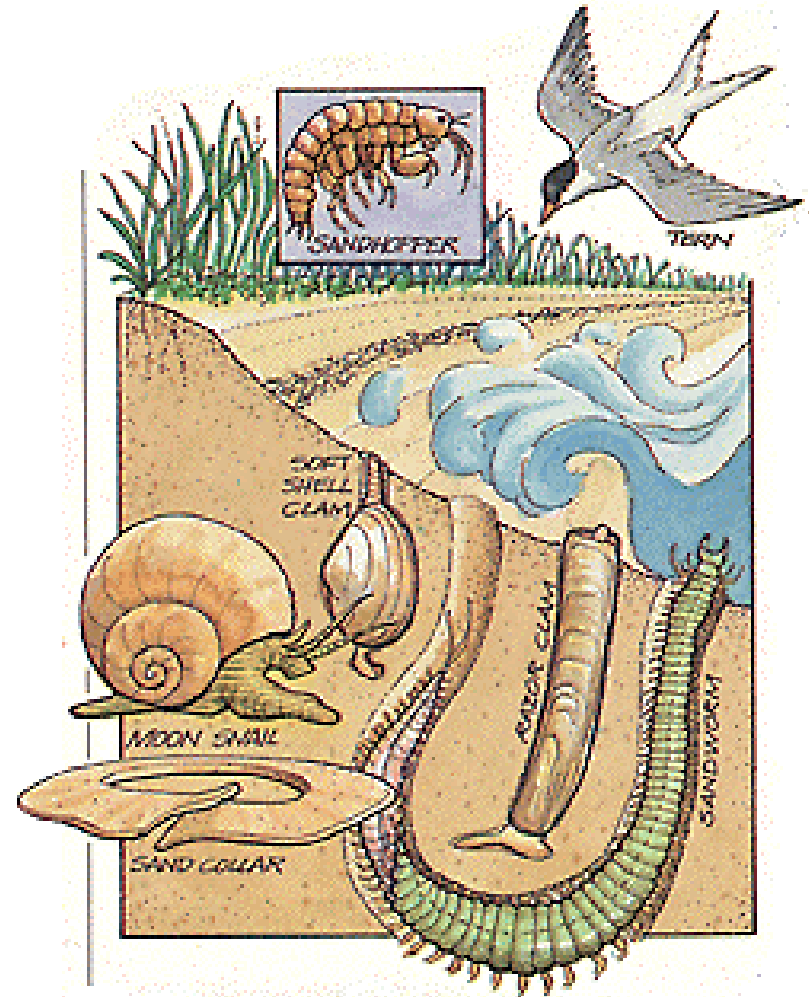
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Razor Clams

Life history and other considerations

- ▶ Species description
- ▶ Preferred habitat
- ▶ Population characteristics
- ▶ Food
- ▶ Growth
- ▶ Predation & Disease
- ▶ Behavior
- ▶ Fishery/Regs
- ▶ Research

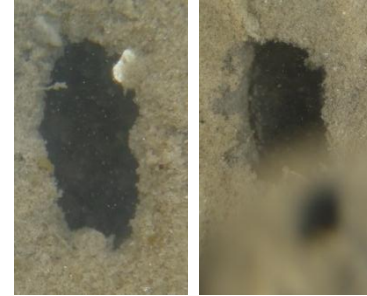


Species Description

- ▶ Most information on razor clams in NA published at turn of 20th of the century!
- ▶ Filter-feeding bivalve mollusk
- ▶ Occur naturally in the Western Atlantic (*Ensis directus*)
 - ▶ from Labrador through South Carolina
- ▶ Common names
 - ▶ straight razor clam
 - ▶ jackknife clam
- ▶ Size up to about 10" in length
 - ▶ usually about 6X longer than width
 - ▶ narrow, elongate shape resembles old-fashioned barber's straight edge razor
 - ▶ maximum size for the razor clams approaches 20cm (7.8") over a life span estimated at 7-8 years
- ▶ Shells glossy brown with a purple region near the curving edge
 - ▶ shells are covered with elastic cuticle (periostracum)
 - ▶ readily sheds sediment and overlaps the valve margins to protect the mantle



Species Description



- ▶ The short siphons are mostly round and separate
 - ▶ many sensory tentacles surrounding the area
 - ▶ siphons leave characteristic keyhole shape
- ▶ Most distinctive anatomical feature is the large muscular foot that extends from the anterior end of the clam
 - ▶ surrounded by a thick collar of mantle tissue
- ▶ Foot is capable of extending to approximately one-half of the total body length
 - ▶ combination of foot and mantle collar is responsible for the unique capabilities of the razor clam to dig, jump and swim



Species Description

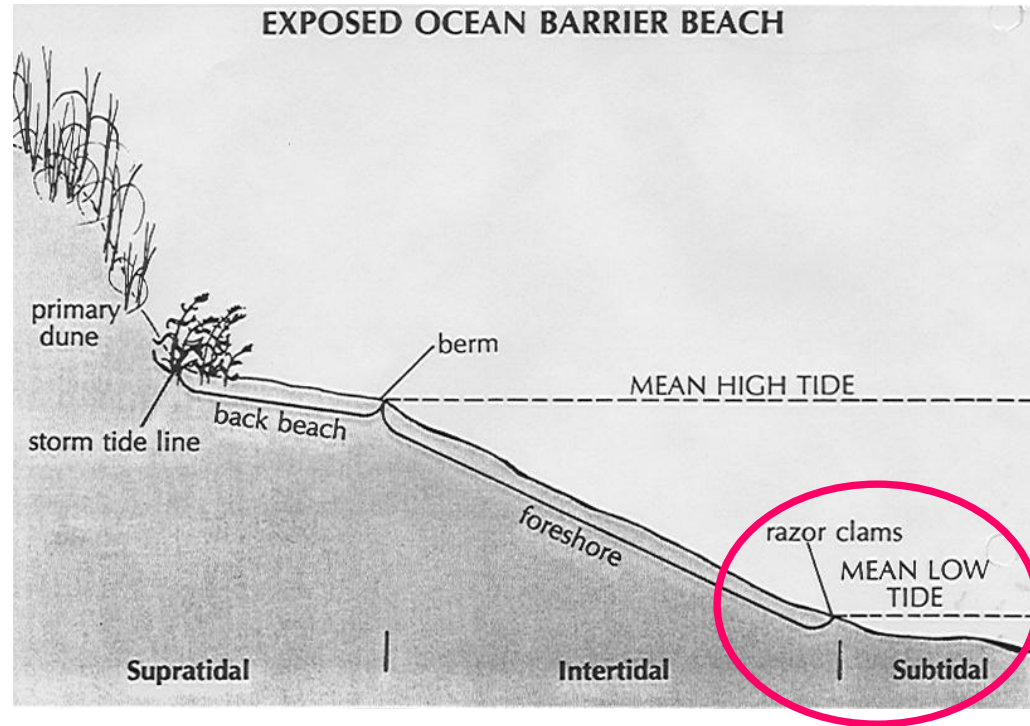
- ▶ Sexes are separate
 - ▶ gonadal tissue integrated into their visceral mass
 - ▶ eggs are fertilized externally during spawning, which is often in June
- ▶ Available data indicate fairly rapid growth in favorable conditions
 - ▶ quite rapid in the hatchery and nursery
 - ▶ from 0.5mm/day in the early stages
 - ▶ upwards of 0.3mm/day in growout cages
- ▶ Cold water species, *E. directus*, observed spawning in March-April in the North Sea, early June in Canada
- ▶ Following a large synchronized spring spawning, a continuous low level of larvae can be detected in the water column through much of the summer

Species Description

- ▶ Razor clam spawning and larval development follows normal molluscan stages
 - ▶ setting occurs between 10 days and 3 weeks, depending on ambient temperatures
- ▶ A unique behavior in post-set razor clams is their capacity to migrate following setting
 - ▶ juvenile razor clams, up to 10mm in length, have been observed swimming at the water surface in subtidal areas, suggesting that the small stage is highly mobile
- ▶ Small post-set razor clams have been observed larger-scale migrations through “byssal drifting”
 - ▶ by an attached byssal thread, small razor clams can move with the coastal water currents due to the drag on the byssal “sail”
 - ▶ behavior is thought to have led to the rapid expansion of the introduced American razor clam across northern Europe

Razor Clam habitat

- ▶ low intertidal to subtidal
 - ▶ primarily low subtidal areas (below mean low water) and in subtidal areas to about 20 m water depth
 - ▶ has been reported in depths to 100m
- ▶ prefer sandy substrates
 - ▶ fine to medium sand – can be muddy sand if without silt
 - ▶ can be found in mud & gravel
- ▶ can live in unstable sand and tolerate dynamic areas
- ▶ prefers areas with moderate water flow



Population characteristics

Stocking densities:

- ▶ Luczak *et al.* (1993) observed recruitment of 30,000 ind/m² that dropped to 10,000 within two weeks
- ▶ densities of juveniles recorded at 2,000/m² (~200/ft²) in Chesapeake Bay
 - ▶ low over-winter survival
- ▶ Final density of 4-6/m² (<1/ft²)

Food & Growth

- ▶ Suspension feeder and doesn't seem to feed on detritus
- ▶ Well-adapted for living in soft tidal substrates
 - ▶ short siphons – burrows just below the surface to feed
- ▶ Growth – data derived from studies in the North Sea

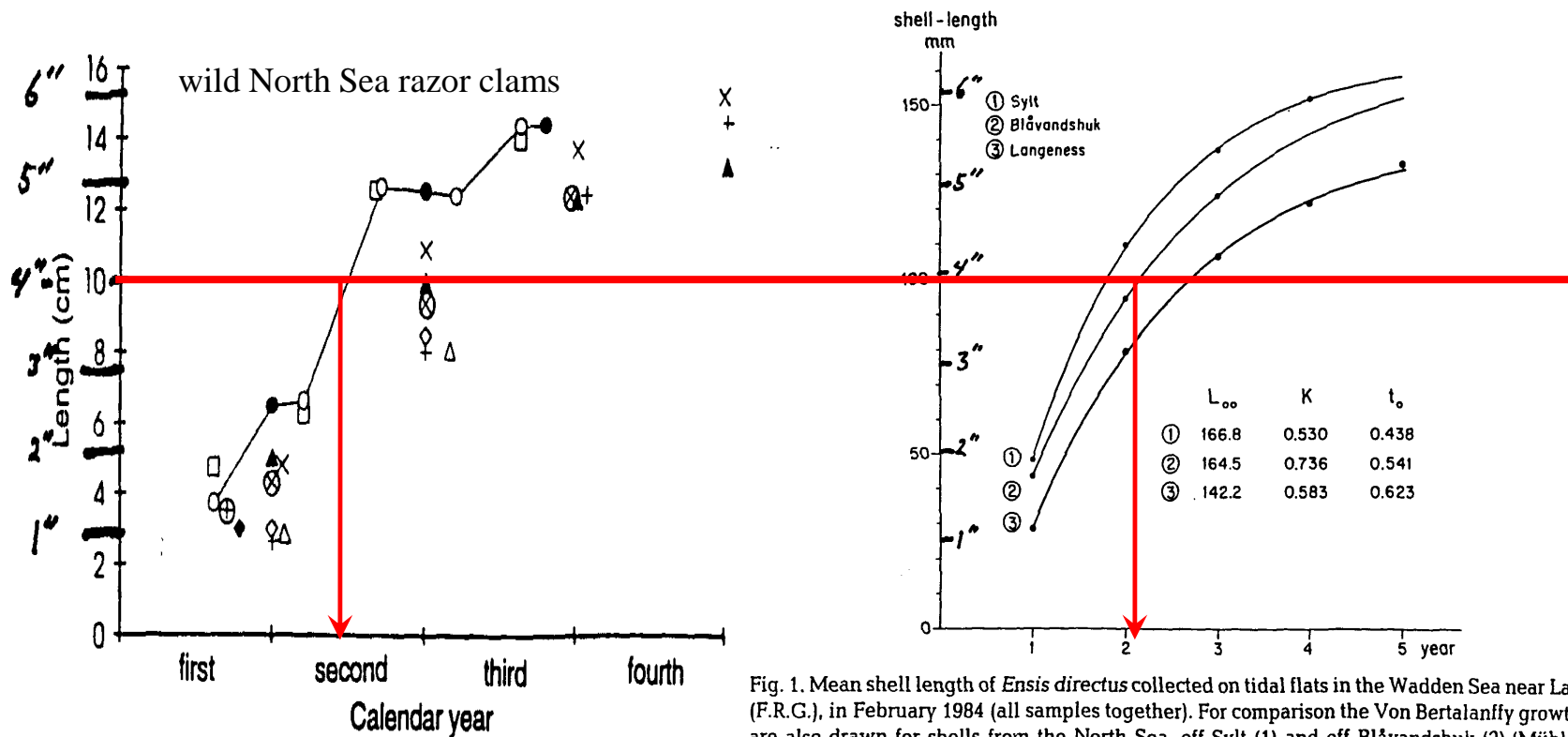


Fig. 1. Mean shell length of *Ensis directus* collected on tidal flats in the Wadden Sea near Langeland (F.R.G.), in February 1984 (all samples together). For comparison the Von Bertalanffy growth curves are also drawn for shells from the North Sea, off Sylt (1) and off Blåvandshuk (2) (Mühlenhardt-Siegel et al., 1983)

Predation

- ▶ There are a number of common bivalve predators that will eat razor clams if given the opportunity, including:

Predators

► The usual cast of characters

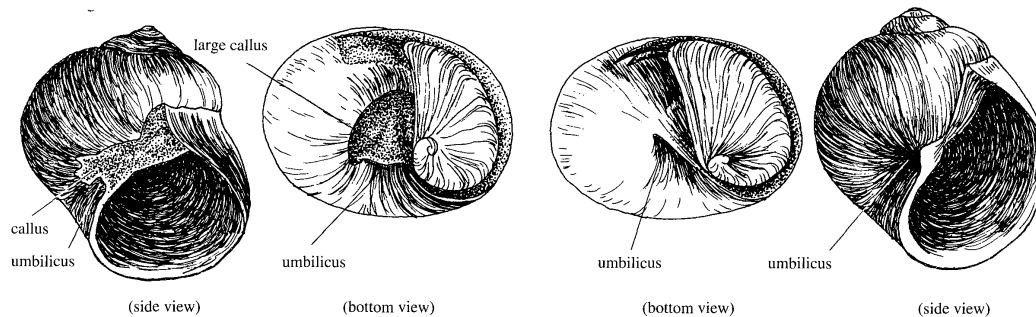
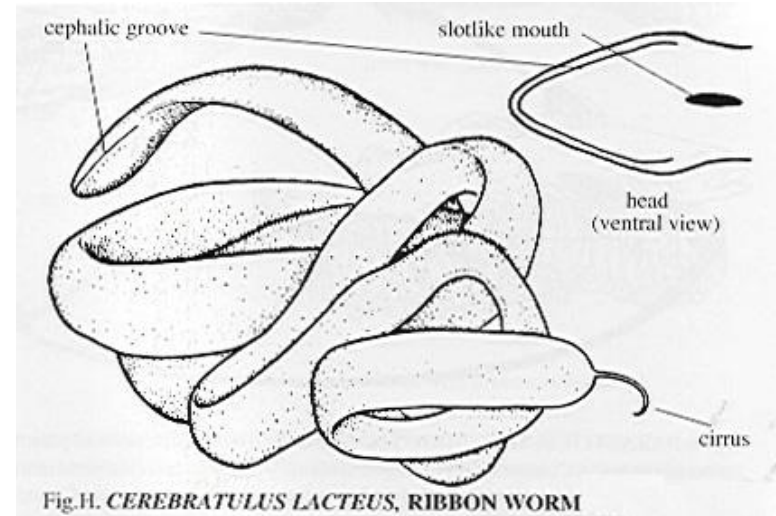
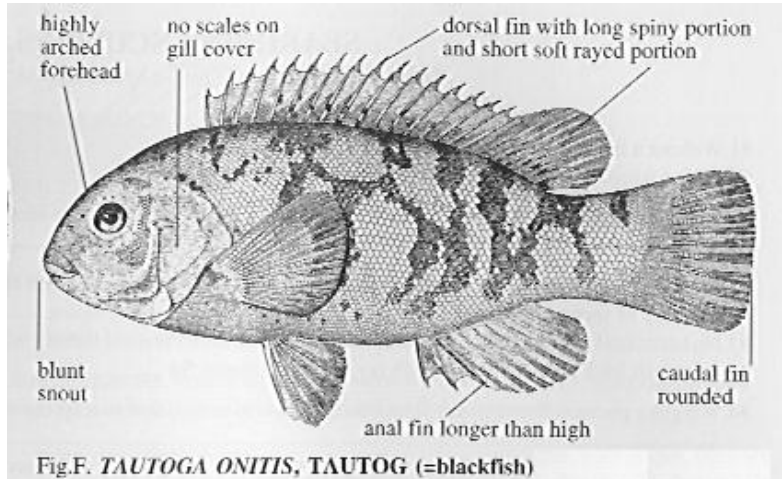


Fig.A. *NEVERITA DUPLICATA* (=Polinices d.), SHARK EYE

Fig.B. *EUSPIRA HEROS* (=Lunatia h., =Polinices h.), NORTHERN MOONSNAIL

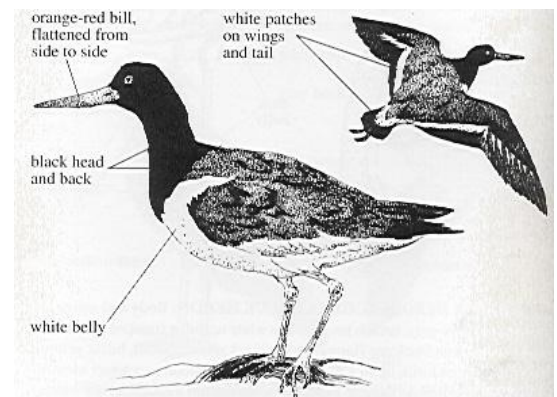


Fig.H. *HAEMATOPUS PALLIATUS*, AMERICAN OYSTERCATCHER

Disease

No observed diseases in western Atlantic,
but...

- ▶ West coast razor clam (*Siliqua spp.*) populations routinely devastated by NIX
 - ▶ Nuclear Inclusion X
 - ▶ rickettsia-like organism
 - ▶ primarily affects epithelial cells of the gills
- ▶ In Holland in 1994, researchers observed a large crash of the *Ensis* population without an explanation, no pathology done!

Behavior

Razor clams are **very** unique bivalves with respect to their mobility.

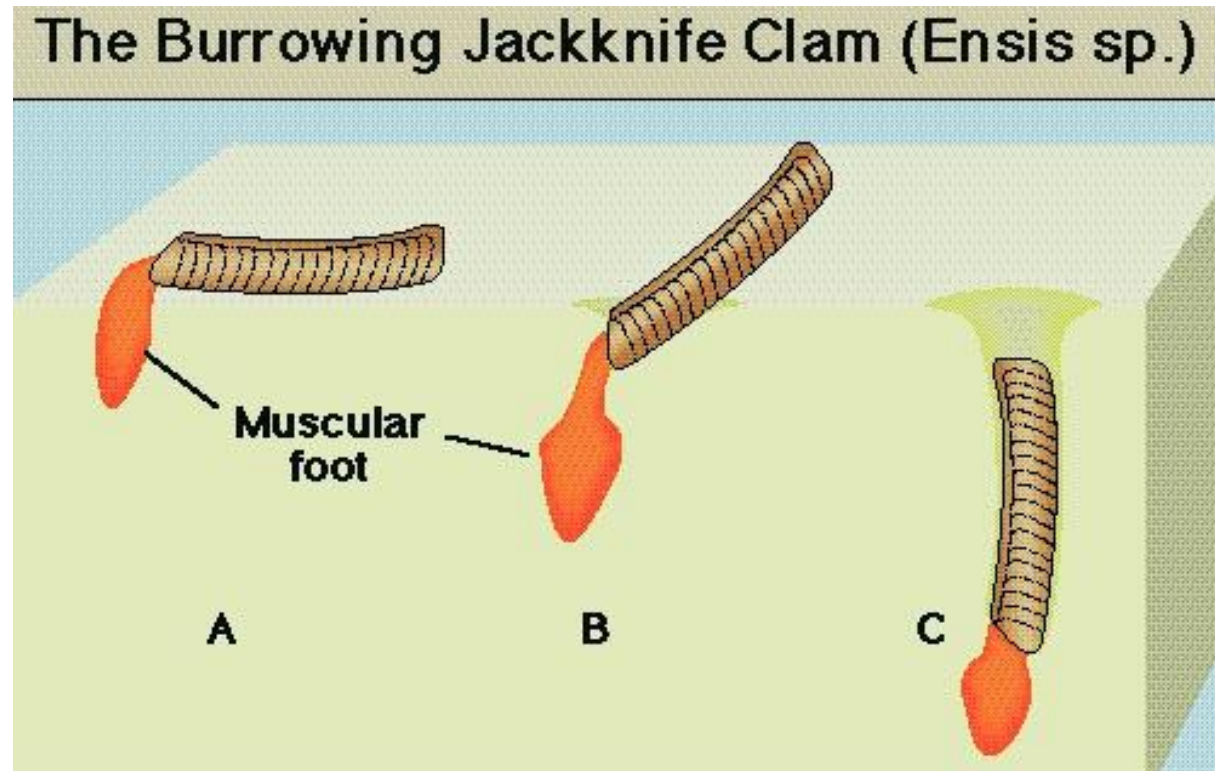
Often found sticking above sediment surface 25 to 50mm but can dig swiftly and relocate up to 1meter depth

Muscular foot & thickened mantle structure endows them with unique ability for movement

Behavior

Razor clams are very unique bivalves with respect to their mobility.

- ▶ They dig, swim & jump!
- ▶ Foot is larger and more agile than other clams
- ▶ Pushes narrow foot down deep into the substrate, then expands foot as an anchor and pulls the body and shell deeper into the sand
 - ▶ Extends tapered end of foot into sand and flare tip – serving as an anchor pulling the slim shaped clam deep below
 - ▶ As foot retracts water is forced out and fluidizes sand at the leading edge, easing its downward progress



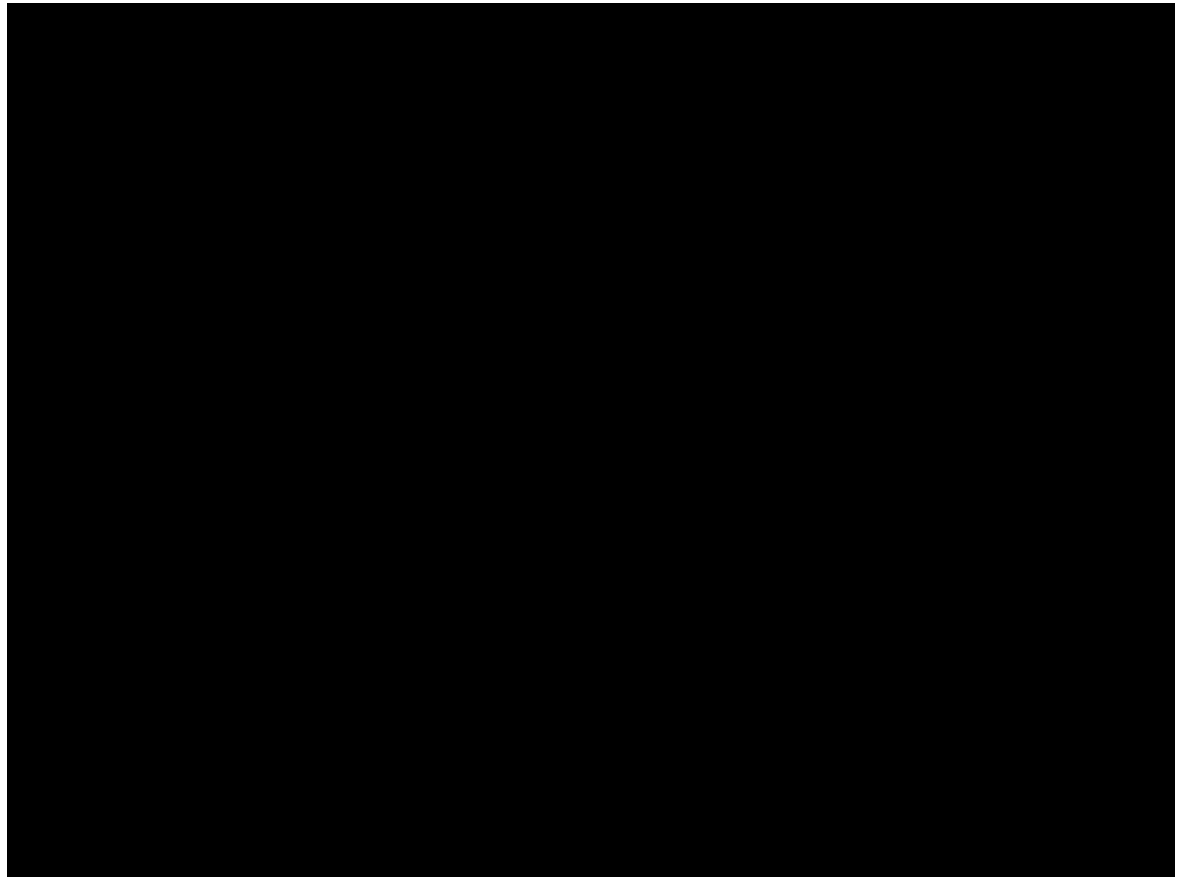
Digging in



Behavior

Razor clams are very unique bivalves with respect to their mobility.

- ▶ They dig
- ▶ They move on the surface
- ▶ They swim
 - ▶ Swimming similar to digging – rapidly retract foot while pressurized water escapes around base of the foot = propulsion
- ▶ They jump
 - ▶ curl foot under their body and rapidly retract causing ‘jumping’ movement



Razor clam fishery

▶ Harvesting methods

- ▶ Spearing
- ▶ Dry digging
- ▶ Pumping
- ▶ Method of choice for harvesting is “salting”



Razor Clam Harvest Regulations

Survey Responses:

Town	REGS	Size"	Comm/Day	Comm/Week	Rec/Day	Rec/Week	Family/Day	Family/Week
Barnstable	Yes	no size	40 QT			10 QT		10 QT
Bourne	No regs							
Chatham	Yes	4.5	N/A	N/A			12 QT	12 QT
Dennis	Yes	5	80 QT	480 QT	10 QT	10 QT	10 QT	10 QT
Edgartown	No regs							
Harwich	No regs							
Marion	No regs							
Mashpee	Yes	2	40 QT			10 QT		10 QT
Mattapoisett	No regs							
Newbury	Yes	5			10 QT	30 QT	10 QT	30 QT
Provincetown	No regs							
Tisbury	No regs							
Truro	No regs							
Wareham	No regs							
Westport	No regs							

Razor Clam Harvest Regulations

Town or State	Razor Clam Season	Harvest Methods Permitted
Chatham	N/A	Clam rakes Salting
NOTE:		
(A) The harvesting of razor clams and sea clams by salting (see 104. B. 25) is allowable provided there are no other species (such as soft-shelled clams or quahogs) within the inter-tidal zone of a given area. Areas of mixed species will be assessed and determined in the sole and unfettered discretion of the Shellfish Constable		
(B) The taking of any other shellfish by this method is prohibited.		
(C) Dry salting (salt not in a water solution) or broadcast salting (spreading dry salt over a tidal flat) is <u>prohibited</u> .		
Also: defines "salting as:		
Salting" means a saline solution derived solely from table salt and water used to harvest razor clams and sea clams.		
Newbury		
NOTE:		
(A) Commercial clambers limited to only 1 tide/day - their choice. 10-QT containers only - no bags.		
(B) Clam flats closed Sundays May 1 to Oct 1st.		
Mashpee		
NOTE:		
(A) Shellfish may be taken by hand, short-handled clam rake, hand trowel (garden variety), spade fork, plunger, dip net, scratcher or "potato rake", basket rake or bull rake, or scallop drags		
(B) None are harvested. There are only a few on sand flats just inside the bays.		
Barnstable	N/A	digging salting harvest method approved by Nat. Resources (salt should be safe, food grade)
	<i>Southside</i>	no dry digging, <i>Southside</i>
	11/1 - 5/31 Mon-Sat	hydraulic method, hand plunger, salting
	6/1 - 10/31 Mon-Fri	harvest method approved by Nat. Resources (salt should be safe, food grade)
	<i>Northside</i>	<u>No hydraulic, No hand plunger, Northside</u>
	year round	digging, salting
	Mon-Sat Northside	harvest method approved by Nat. Resources (salt should be safe, food grade)
Dennis	year round	RC harvest methods not in regulations
NH	no closed season	<u>hand or handheld tools only</u> residents only
NH	no closed season	dredge blade/knife/manifold max 48" licenses needed <u>monthly reporting required</u>

Why diversify local shellfish culture opportunities?

- ▶ Oyster and quahog are the big TWO in northeast
 - ▶ Private culture and municipal fisheries enhancement/propagation
- ▶ What happens to your business if you should lose a crop due to disease or some other uncontrollable environmental change?
- ▶ What other options do we have?
 - ▶ Soft shell clam
 - ▶ Bay scallop
 - ▶ Surf clam
 - ▶ European oyster

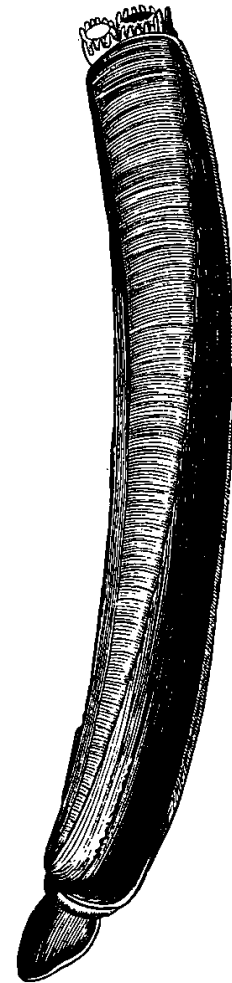
But....

- ▶ The more options developed – the more opportunities created
 - ▶ to sustain viable business locally
 - ▶ to expand the aquaculture industry in the northeast
 - ▶ expand fisheries enhancement efforts

What about farming them?

What do we know about Razor Clams?

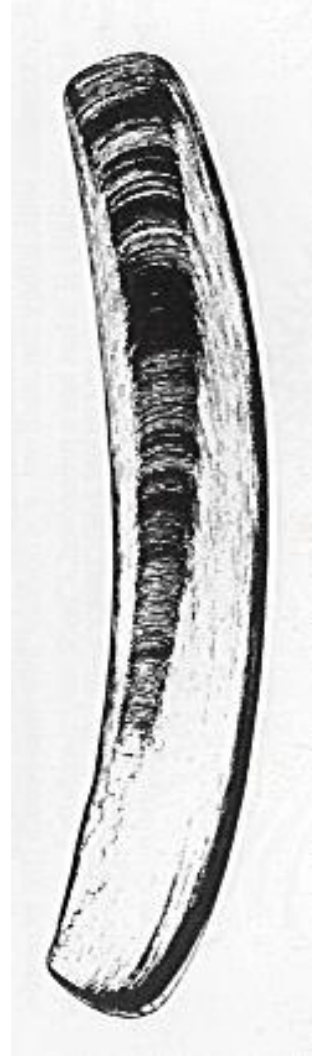
- ▶ **Biology**
 - ▶ Preferred habitat
 - ▶ Population characteristics
 - ▶ Food
 - ▶ Growth
 - ▶ Predation & Disease
 - ▶ Behavior
- ▶ **Market**



So....where do we stand?

Need to consider:

- ▶ **Lack of knowledge about species** – from basic biology to culture technology
- ▶ **Mobility** – have to contain clam from escaping via digging, crawling, and swimming
- ▶ **Predators/disease** – protection & prevention
- ▶ **Over-wintering mortality** – may be a function of tidal exposure
- ▶ **Poor shelf-life** – can they survive up to a week out of sediment?



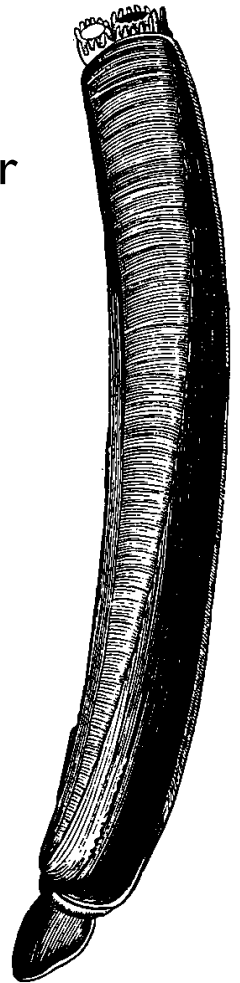
History of Razor Clam Research in NE

- ▶ **NRAC funded project (Burt & Leavitt) – Started in 2001**
 - ▶ **Goal**
 - ▶ to provide an opportunity for the current shellfish culture industry to investigate, develop, and optimize the growout technology for a cultured razor clam
 - ▶ **Specific objectives of the proposed work include:**
 - ▶ arrange with the participating commercial hatchery to spawn and raise larval/juvenile razor clams
 - ▶ solicit ideas for technology to achieve razor clam grow-out from an array of commercial shellfish growers
 - ▶ supply each of the six selected growers with razor clam seed and operating funds to construct and implement their concept of appropriate razor clam growout technology
 - ▶ identify sources and track economic data on razor clam markets within the region
 - ▶ analyze the data and project the overall benefits and limitations to the development of the razor clam as an alternate commercial aquaculture species in the northeast

Industry development of culture practices for the razor clam

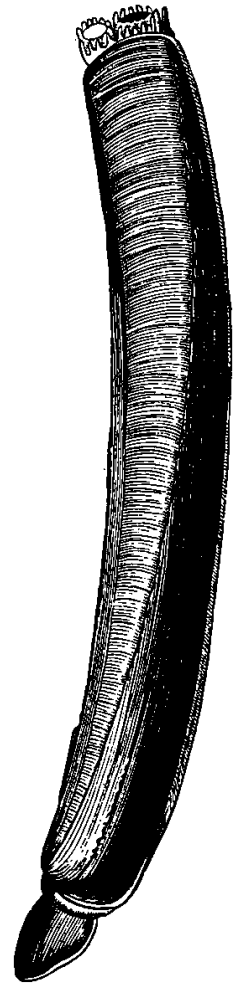
The objectives of the NRAC project were:

- ▶ Worked with a commercial hatchery to produce juvenile (5mm) razor clams
- ▶ Provide growers with seed razor clams to experimentally culture using their best technology
- ▶ Monitor success of growing razor clams on each farm
- ▶ The grow out component of this work has continued at a small scale through funding from the Southeast Massachusetts Aquaculture Center (SEMAC) in their experimental farm program – Research Farm Network (RFN)



Hatchery Production:

- ▶ Worked with a commercial hatchery to produce juvenile (5mm) razor clams
 - ▶ Aquaculture Research Corporation, Dennis, MA
 - ▶ Broodstock from Duxbury Harbor & Nauset Marsh.
 - ▶ Spawned 4 million razor clam larvae
 - ▶ Larval rearing was similar to other cold water species
 - ▶ Survival poor through setting and nursery
 - ▶ Received app. 150,000 1 cm seed for upwelling in Yr 1



Hatchery Production – Yr 2:

- ▶ Collected broodstock
- ▶ Spawned at numerous hatcheries and elsewhere



Hatchery Production – Yr 2:

- ▶ Hatchery attempts in Yr 2 (3 different hatcheries – 5 attempts)
 - ▶ Spawn in Dec 2001
 - ▶ Succumb to *Vibrio* infection post-set
 - ▶ Spawn in Jan 2002
 - ▶ Succumb to *Vorticella* infestation post-set
 - ▶ Spawn in Jan 2002
 - ▶ Succumb to neglect due to illness of manager
 - ▶ Spawn in Feb 2002
 - ▶ Succumb to unknown factors
 - ▶ Spawn in Mar 2002
 - ▶ Slowly lost due to unknown reasons during post-set
- ▶ Same problems were repeated in Yr 3
- ▶ Bottom Line
 - ▶ No razor clam seed for Yrs 2 & 3 due to hatchery failure
 - ▶ Primarily at the early post-set stage
 - ▶ Setting on screens a problem?

Nursery Production:

- ▶ Razor clam juveniles performed very well in an upweller
 - ▶ If you can get them through the early post-set stage in the hatchery.



Nursery Production – Yr 1:

- ▶ Provide selected growers with seed razor clams to culture
 - ▶ 10–15,000 seed distributed to growers in September
 - ▶ Mean length: 19.45mm (± 2.24)



Grow out

- ▶ Provide selected growers with funds to construct/develop their proposed culture technology

- ▶ A variety of techniques were tested

- Bottom netted raceways
- Boarded raceways
- Bottom tents
- Floating trays
- Bottom trays
- Bottom cages



Grow out – Yr 1:

► Evaluate survival and growth in the various nursery systems

► Survival

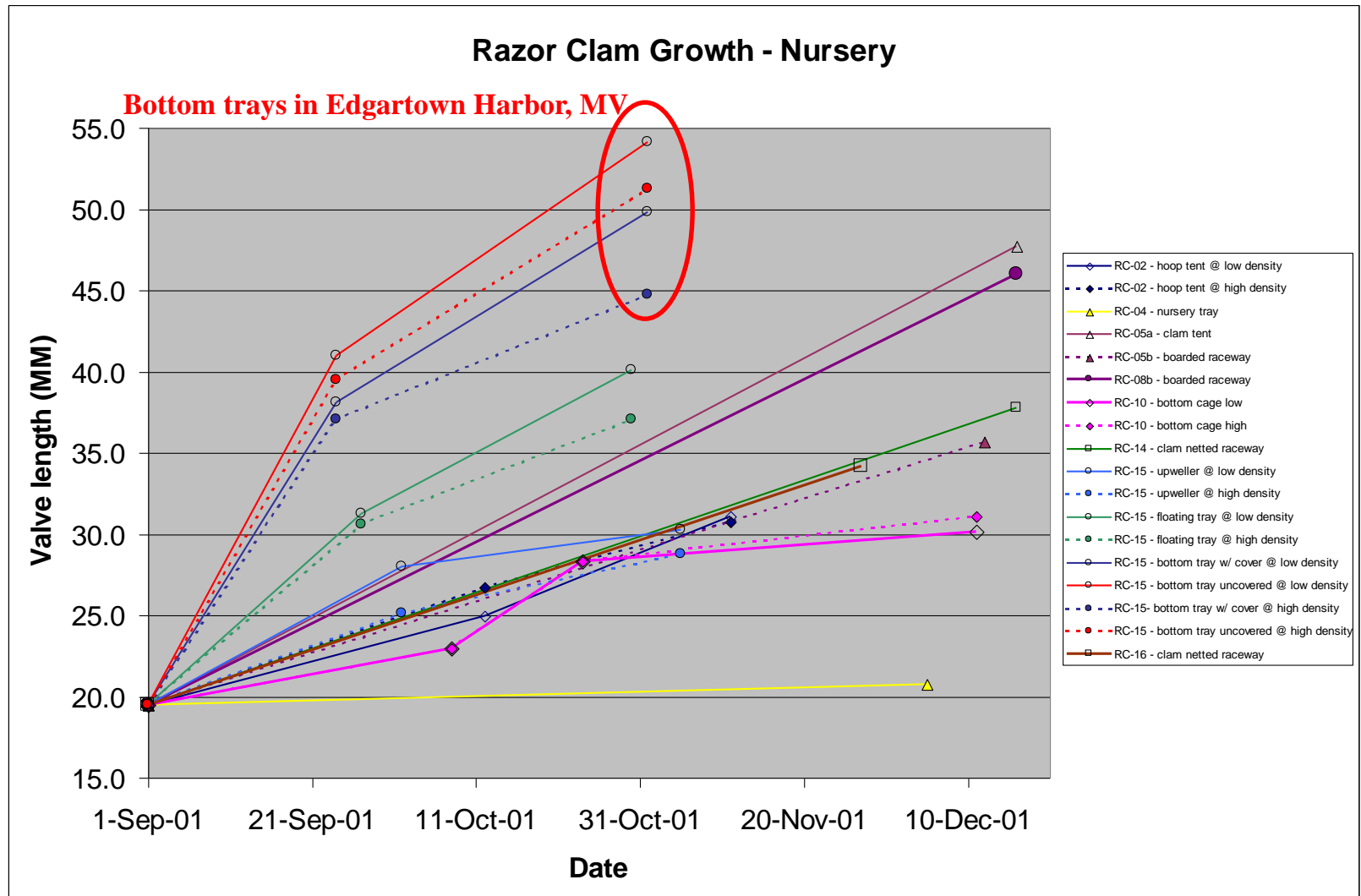
- Ranges from 0 to greater than 100%!

► Growth

- Growth interval of app. 3 months
- Grew from 20mm at beginning of September to 40-50mm by end of November
- An average daily gain of 0.25 (+0.16) mm/d



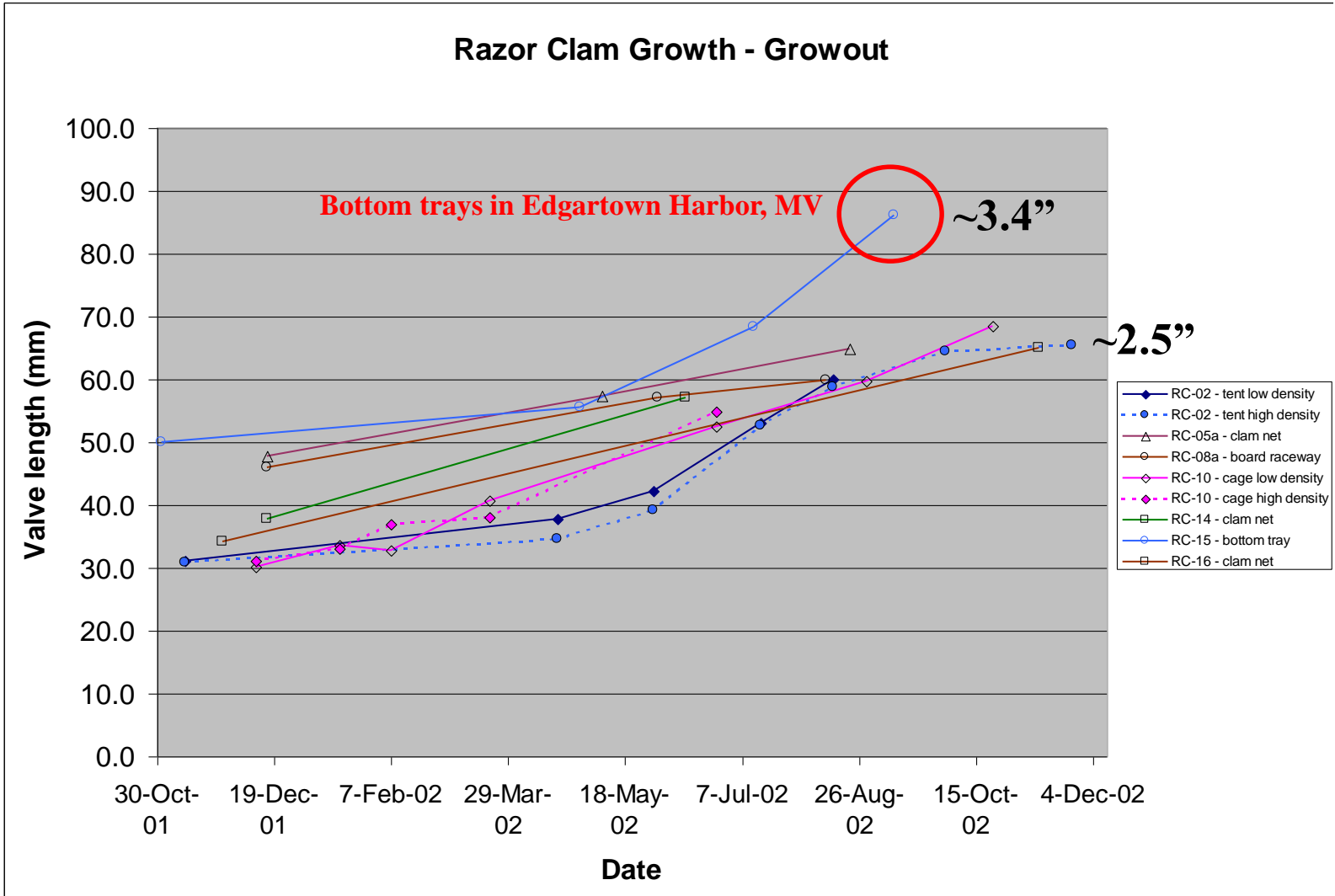
Grow out – Yr 1:



Grow out – Yr 2:

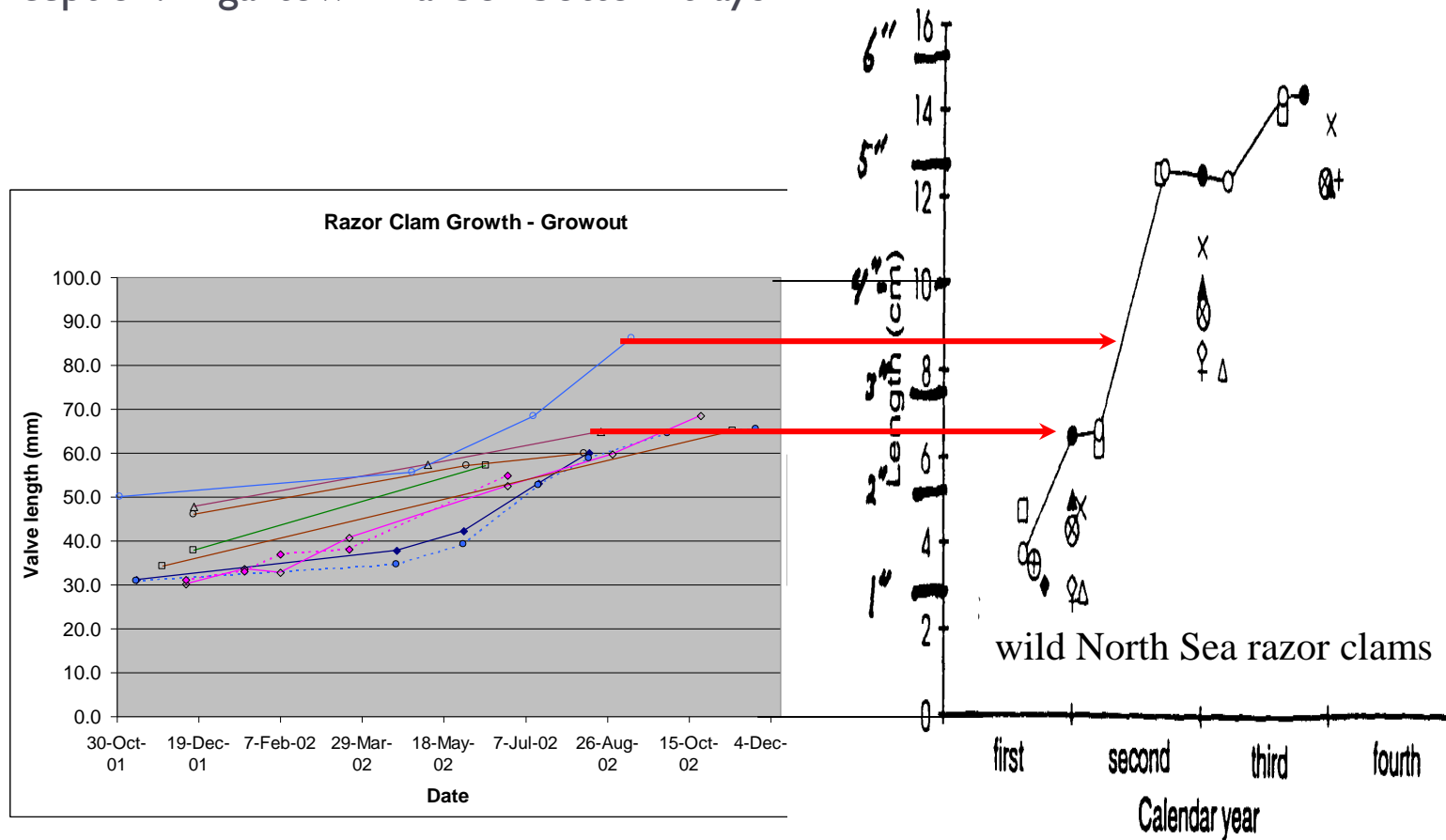
- ▶ Status of seed at the beginning of Yr 2
 - ▶ New Jersey (nursery box)
 - ▶ Seed arrived in poor condition and didn't survive through nursery
 - ▶ Connecticut (bottom cage)
 - ▶ Doing well – alive & growing
 - ▶ Rhode Island (bottom clam net)
 - ▶ Lost seed during first summer due to emigration problem
 - ▶ Massachusetts - Barnstable (bottom nets)
 - ▶ Lost most immediately after deployment = emigration?
 - ▶ Massachusetts - Wellfleet (boarded raceway)
 - ▶ High survival, little emigration & good growth
 - ▶ Lost all 2-3 inch razors in intertidal raceways in August
 - ▶ Overheated?
 - ▶ Massachusetts - Martha's Vineyard (upwellers, floating trays & bottom trays)
 - ▶ Alive and doing well

Grow out – Yr 2:



Comparative Razor Clam growth

- ▶ Most growth in Yr 2 comparable to Yr 1 wild razors
- ▶ Exception: Edgartown Harbor bottom trays



SEMAC Study



Recent SEMAC Study

- ▶ Conditions to investigate
 - ▶ Sediment types
 - ▶ Sediment type preferences?
 - effect of grain size?
 - ▶ Stocking/planting density
 - ▶ Optimal density?
 - ▶ Nursery containment systems
 - ▶ How to successfully contain a very mobile species?

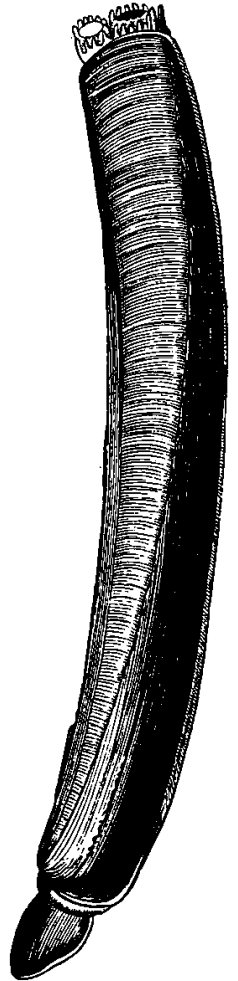
Industry development of culture practices for the razor clam

Objectives of the SEMAC project:

- ▶ Built on prior work to culture *E. directus*
 - ▶ Proposed alternative species for shellfish growers in New England region
 - ▶ Potential to *augment* farm profitability

IF

- ▶ Ability to produce meaningful AND reliable supply to marketplace was developed



Broodstock Collection



Collected from Barnstable Harbor 5/8/2012
Average length ~5.5", weight ~45g

Successful Hatchery Spawn - 2012



Broodstock

Collected 5/8/2012

Barnstable Harbor

Mean: ~5.5" and 45g



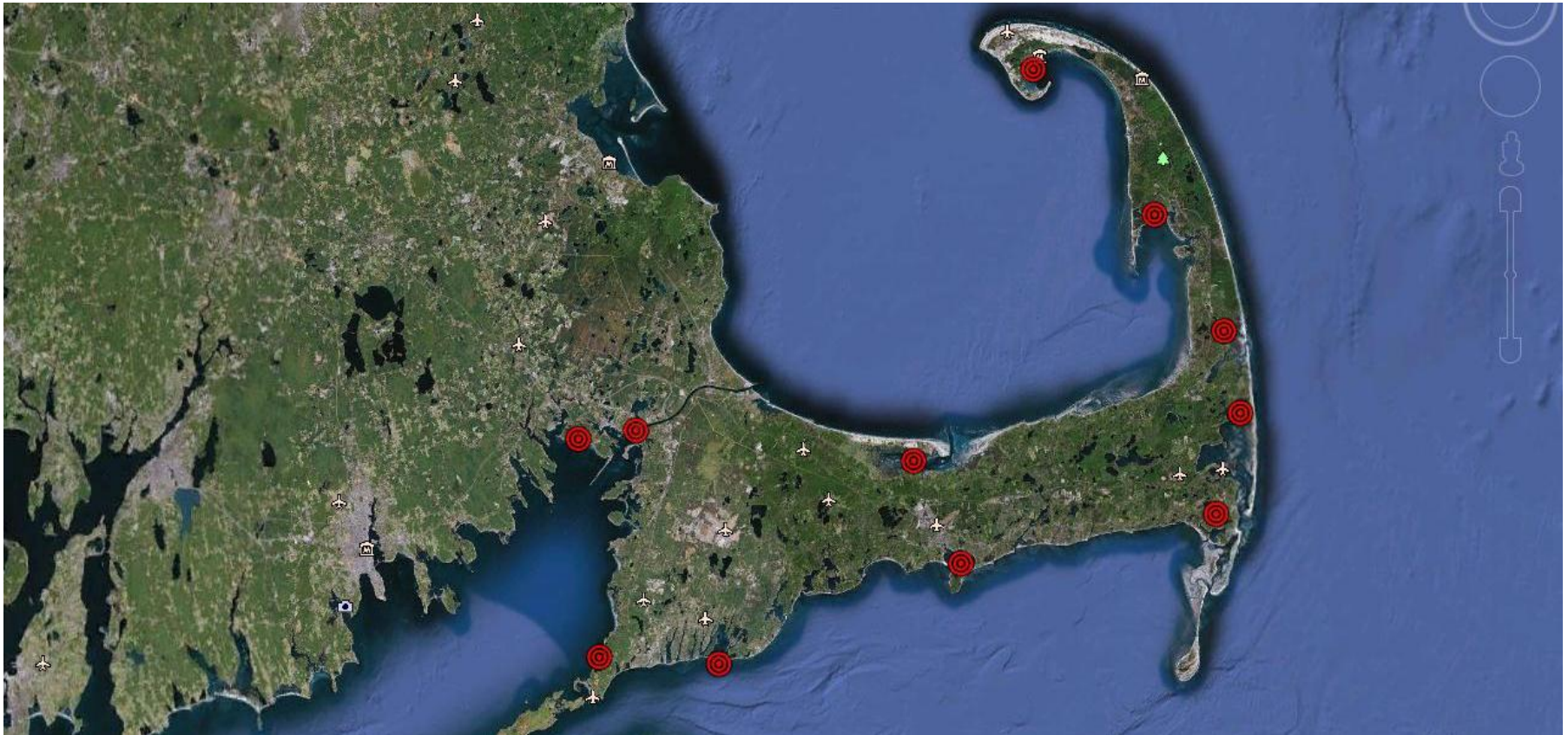
5 weeks old
Spawned 9 May 2012



2 Months old

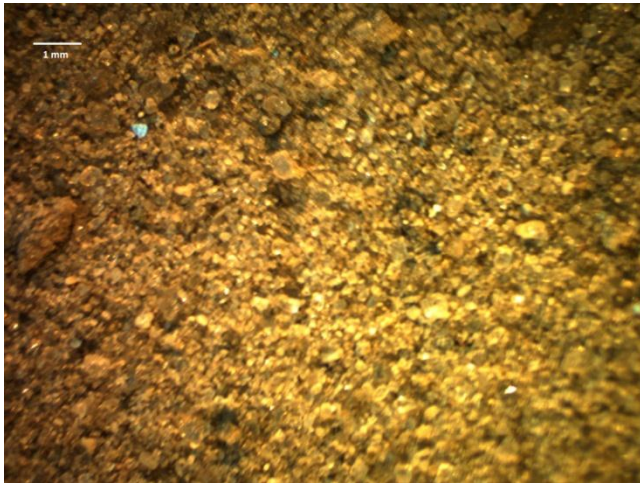
Distribution of Seed

- ▶ July 12/13 seed 65 days old (4 – 11 mm range, 7 mm avg)
 - ▶ Participants (11)
 - Wellfleet, Falmouth(2), Wareham, Provincetown, Orleans, Eastham, Barnstable, Yarmouth, Rhode Island, (Chatham earlier)

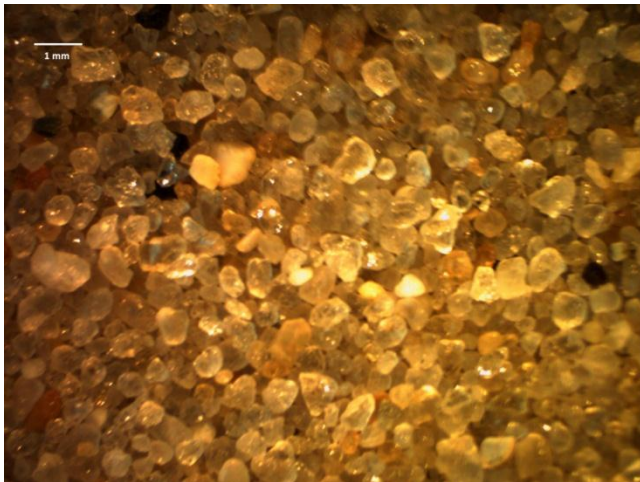


Sand Treatments

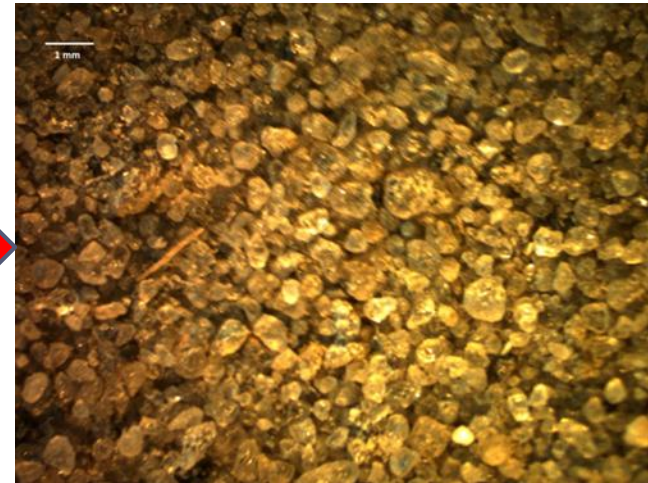
▶ Barnstable Harbor



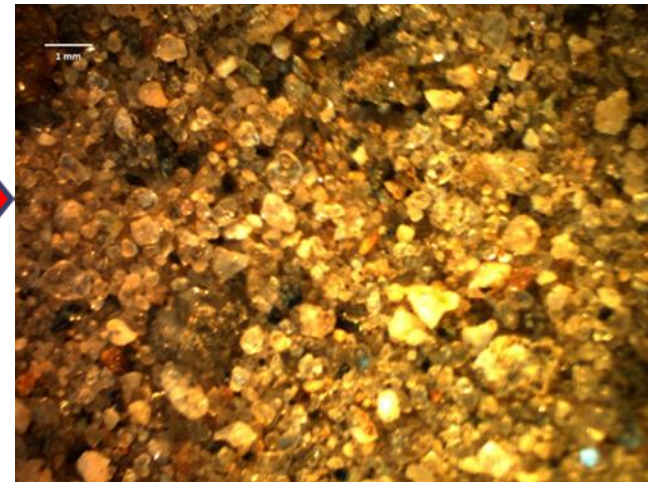
▶ Brewster – Cape Cod Bay



Play sand (Lowes)



▶ Nauset Marsh



Sand Treatments/Trays

Starting size of razors

	Length	Width	Ratio
Mean	6.54	1.69	3.87
St. Dev.	1.36	0.25	0.57
Min	4.05	1.10	2.47
Max	9.47	4.68	5.08

4 treatments/sand sources
- 3 treatments of each



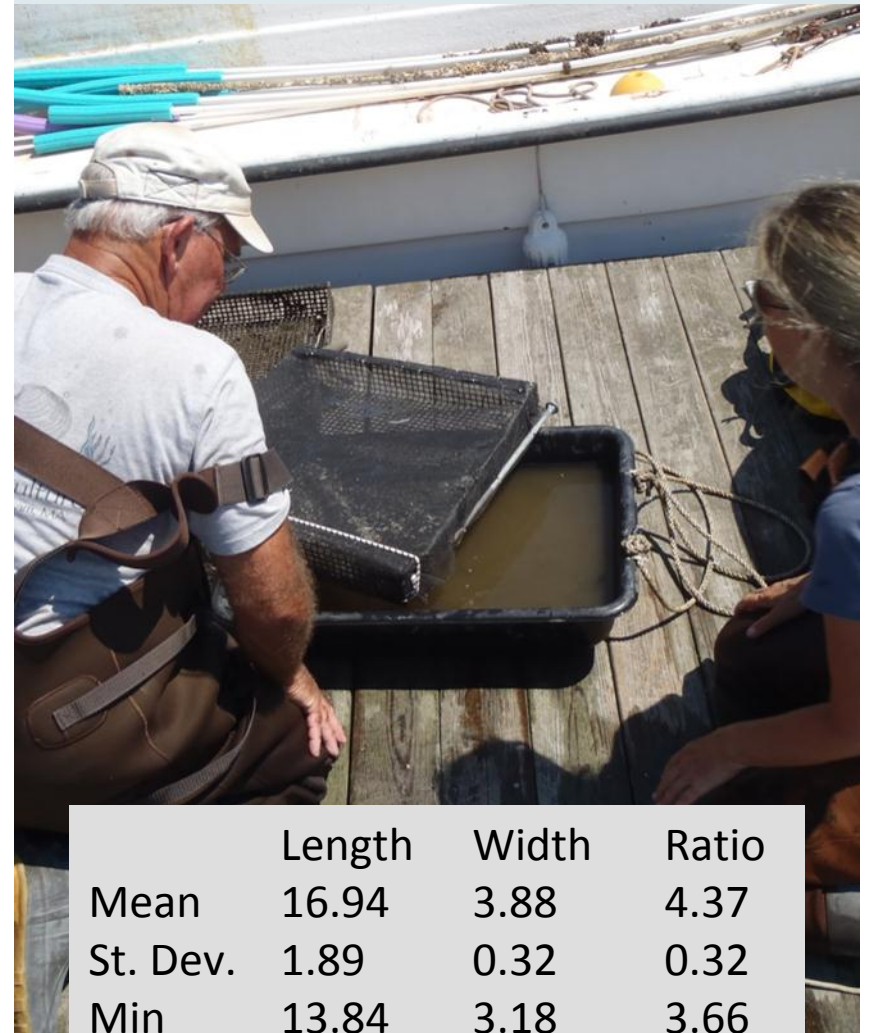
Other Sites – August 2012

Chatham – sand tray system



	Length	Width	Ratio
Mean	19.77	3.45	5.73
St. Dev.	2.52	0.34	0.37
Min	13.46	2.61	5.03
Max	24.71	4.17	6.33

Wareham – Floating Upweller



	Length	Width	Ratio
Mean	16.94	3.88	4.37
St. Dev.	1.89	0.32	0.32
Min	13.84	3.18	3.66
Max	20.77	4.57	5.12

Roger Williams University - August 2012



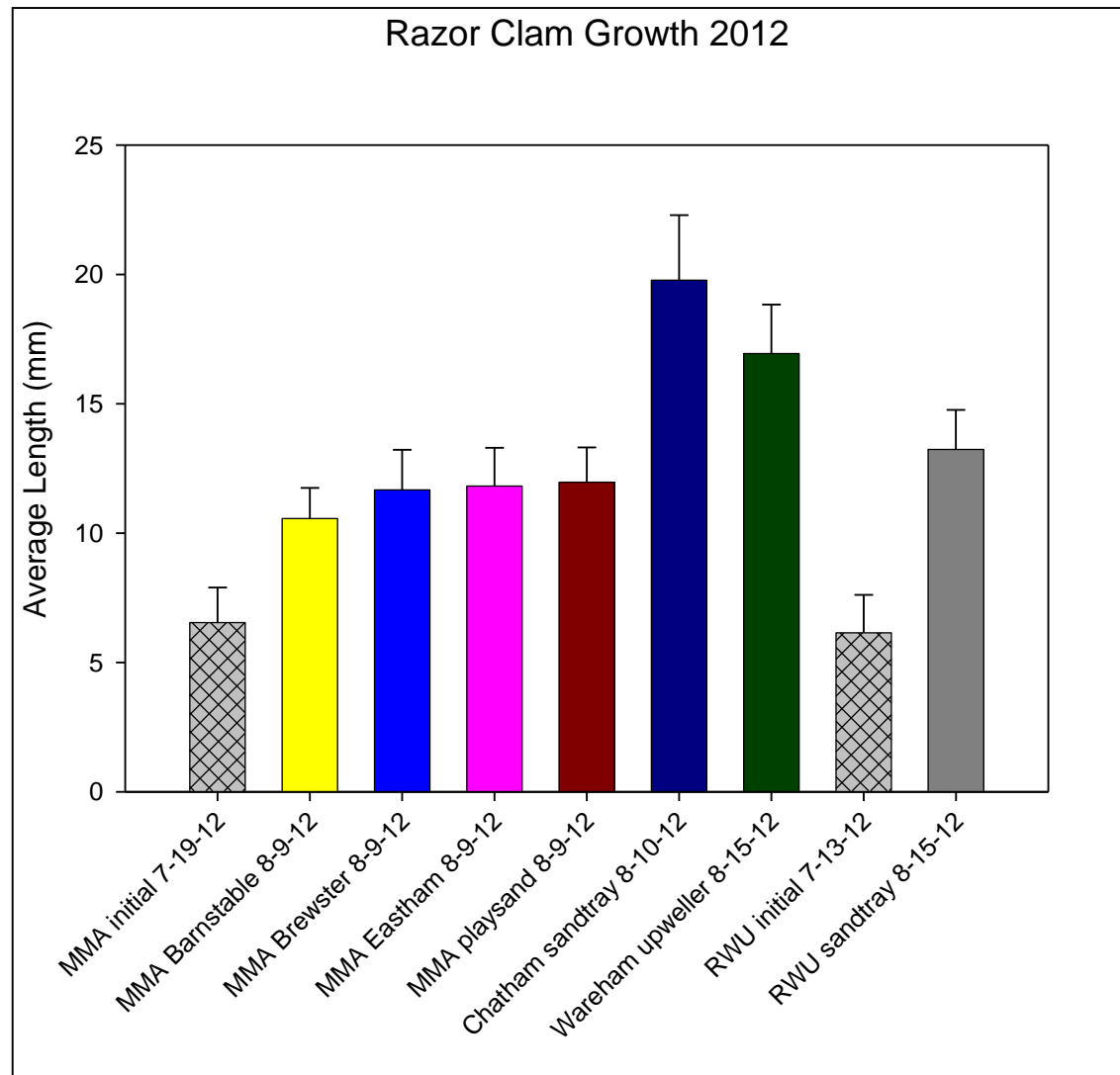
Sand tray system

		mean	stdev
7/13/2012	RWU	6.15	1.46
8/15/2012	RWU	13.23	1.53

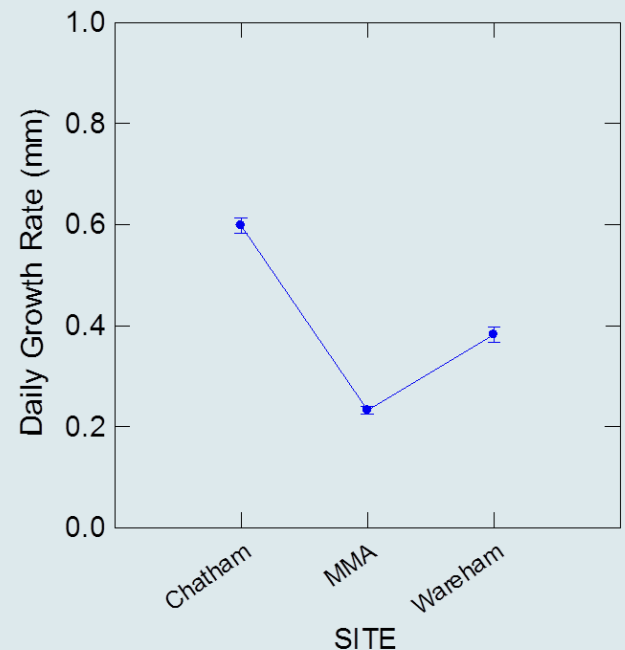
Growth – Length

After 1 month - from initial to mid-August 2012

- Significant effect of site on daily growth rate (DGR)
- Also different grow out methods
- Our site grew much slower



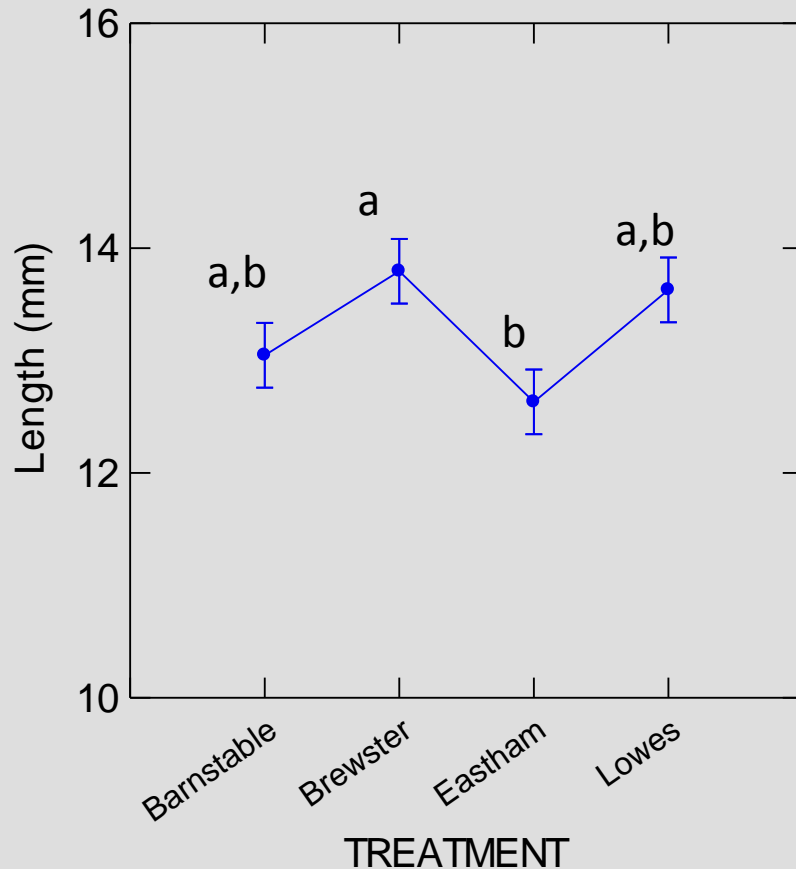
Daily Growth Rate



Sand Treatment Results

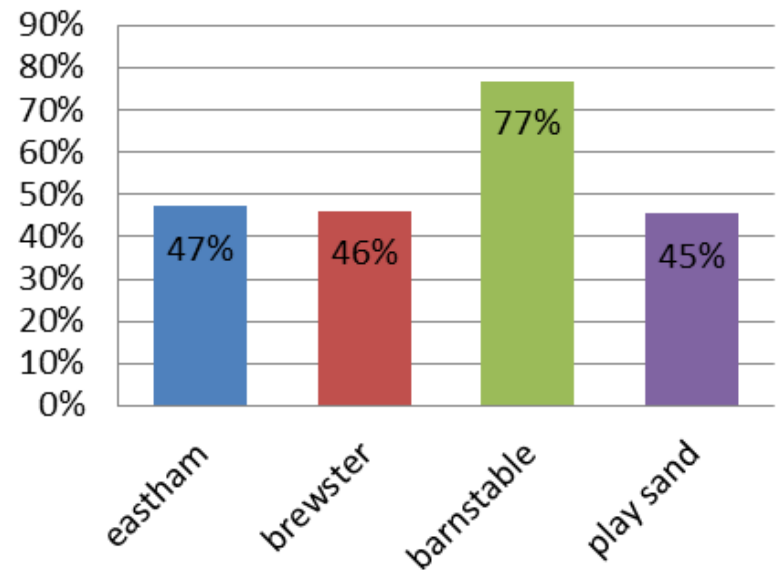
4 sand treatments - August

Least Squares Means

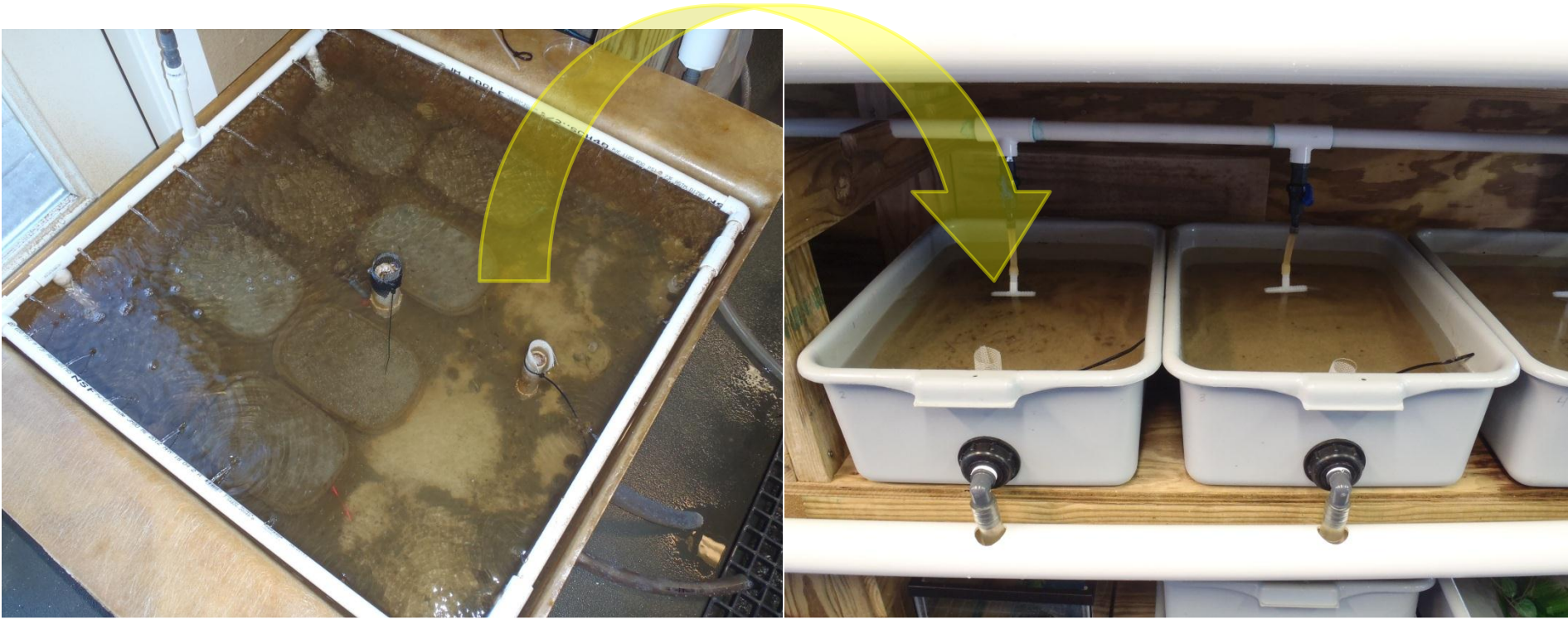


No significant effect of sand type on survival
- Barnstable better????

Percent Survival in Sand Treatments



Density Treatment



Transfer razors from 12 individual sand trays (4 treatments) in aerated tank to 4 sand trays all filled with Brewster beach sand.



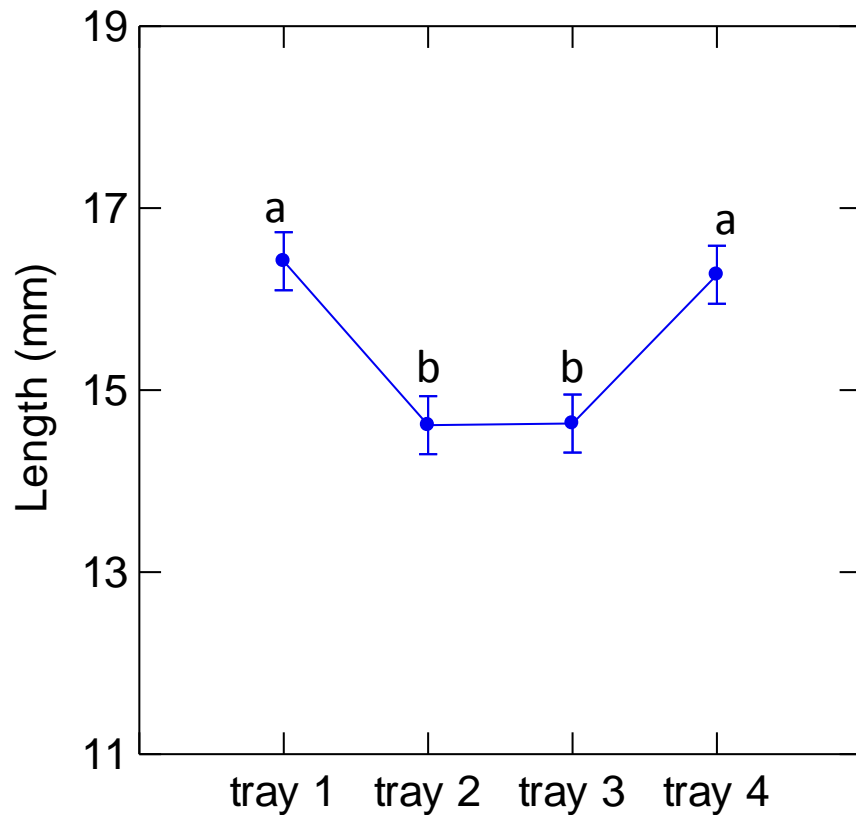
Density Treatment

- 4 density treatments – August, 2012
 - Tray 1 = 2160, about 1500/sq ft
 - Tray 2 = 1893, about 1315/sq ft
 - Tray 3 = 5340, about 3700/sq ft
 - Tray 4 = 3530, about 2450/ sq ft



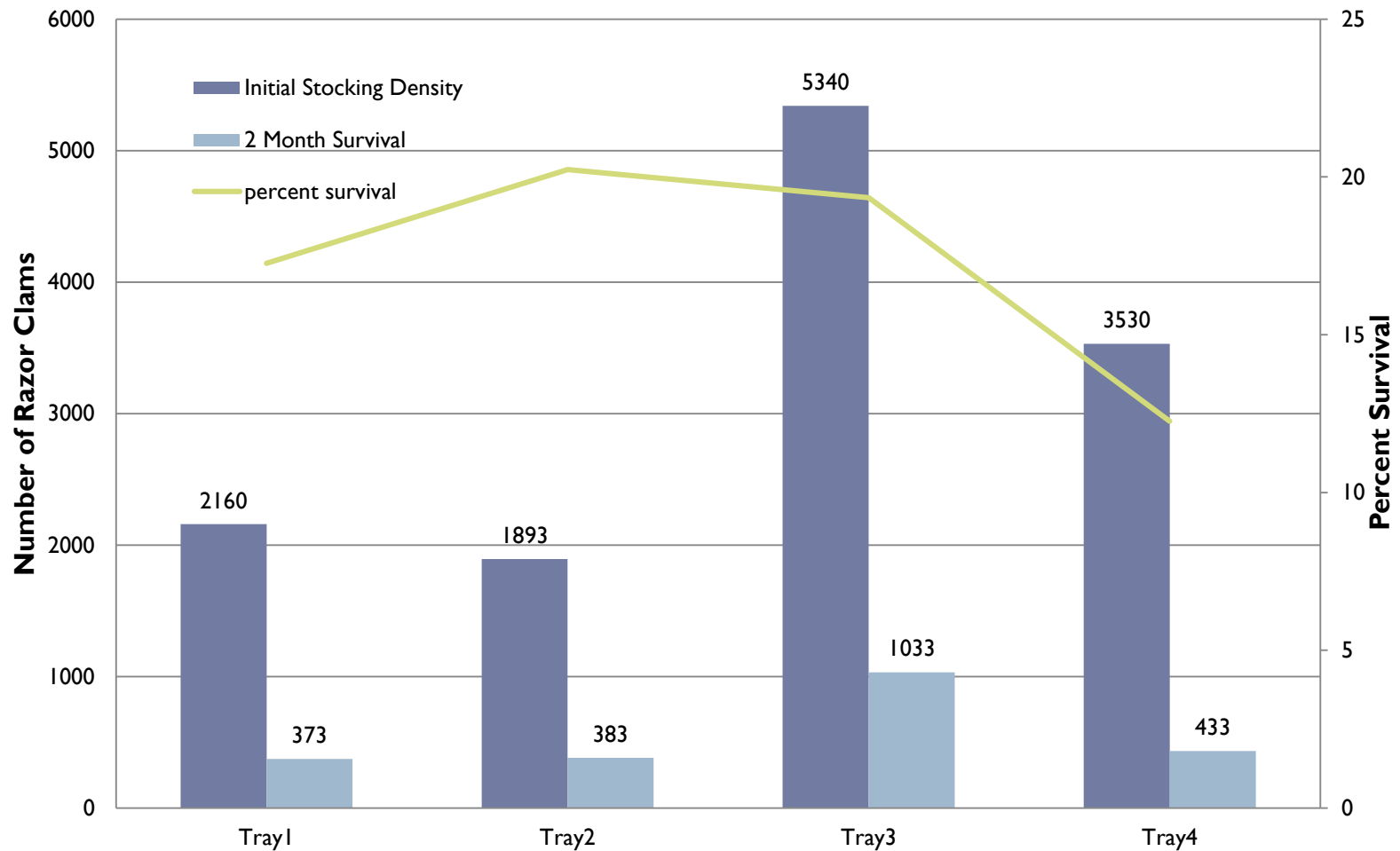
Density Treatment: Shell Length

Least Squares Means

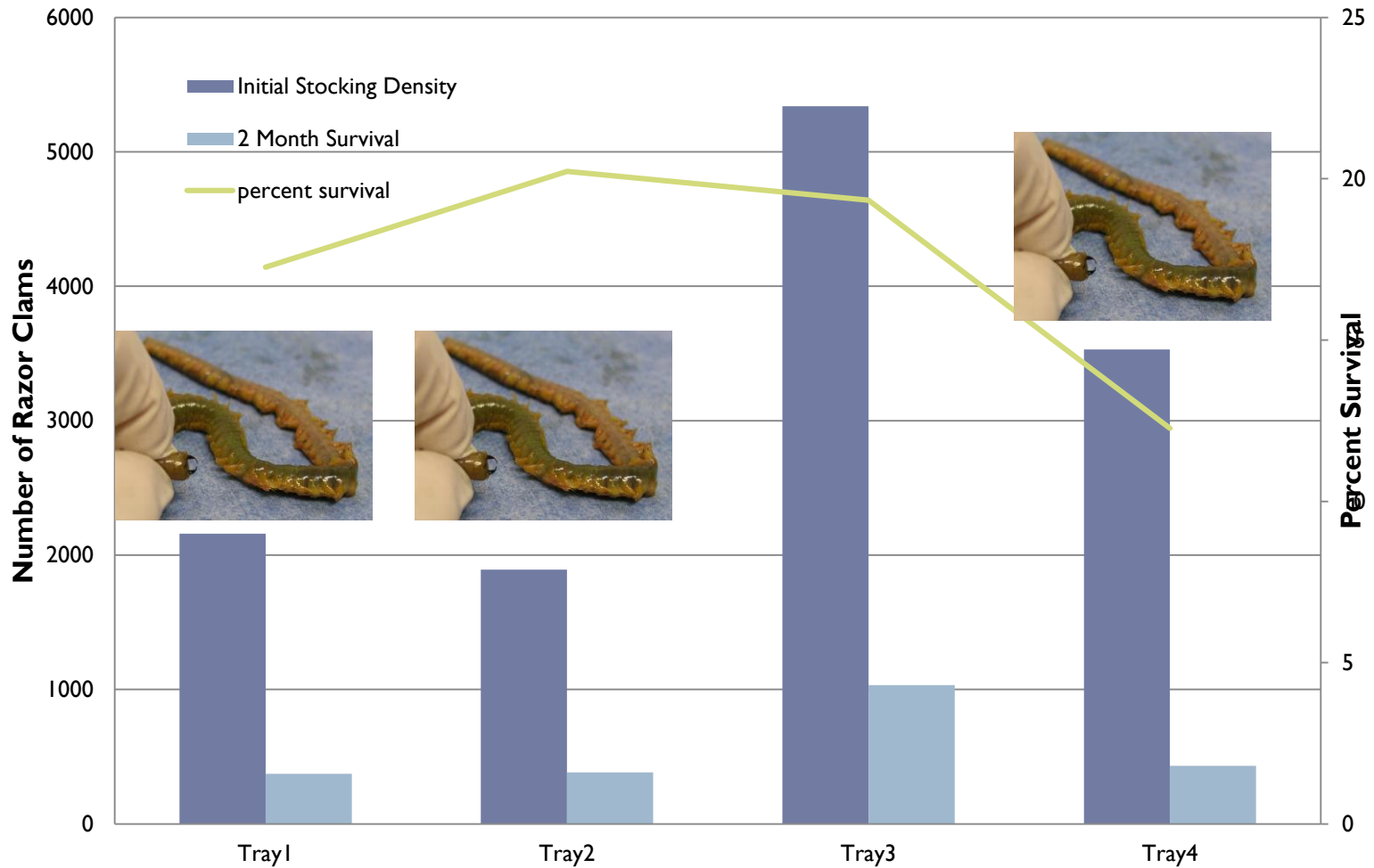


- Significant effect of tray ($p = 0.000$)
 - Lengths (mm) from November 2012
 - 110 days from initial deployment
 - 69 days post sand tray transfers

Density and Survival



Predation and Survival



Considerations

▶ Seed Fragility

- ▶ Shells can't close tightly
 - ▶ Vulnerable to external environment
 - NO fresh water
 - NO harsh handling/spraying

▶ Sediment

- ▶ Early placement optimal
- ▶ sediment type may be important (NO mason's sand/sharp sand)

▶ Temperature considerations

- ▶ vulnerable to high temps (intertidal exposure)

▶ Mobility

- ▶ Can and will swim/dig/escape if unhappy with current environment

Considerations

▶ Seed sources

▶ Availability of seed

▶ Not often commercially spawned

- Economic concerns for hatcheries

- Issues inherent with novel or alternative species...unknowns

▶ Marketing

▶ Identification of current or future markets

▶ Supply and demand

▶ Alternative species

▶ Unknowns

▶ Site characteristics may dictate relative success/failures

▶ No reliable template for success with new species

Recent Studies



Recent Razor Clam Project

- ▶ Proposal submitted by Rawson, Leavitt, Morse & Murphy in 2010 & funded by NRAC in 2011
 - ▶ Title: *Optimization of Hatchery & Culture Technology for Razor Clams*
- ▶ Goal:
 - ▶ Support the diversification of the shellfish culture industry in the NE
- ▶ Objectives:
 - ▶ Developing improved hatchery methods for the production of razor clam seed in order to provide commercial shellfish hatcheries with the means to produce a steady, reliable source of seed
 - ▶ Identifying improvements in grow-out technology for the culture of razor clams and increase the industry's interest in and acceptance of this alternative species.
 - ▶ Tracking the marketability of razor clams in regional and broader markets.
 - ▶ Communicating the progress and results of proposed work directly to industry partners and the industry at-large.

Chatham



Eastham – Nauset Marsh

► Site I



► Site II



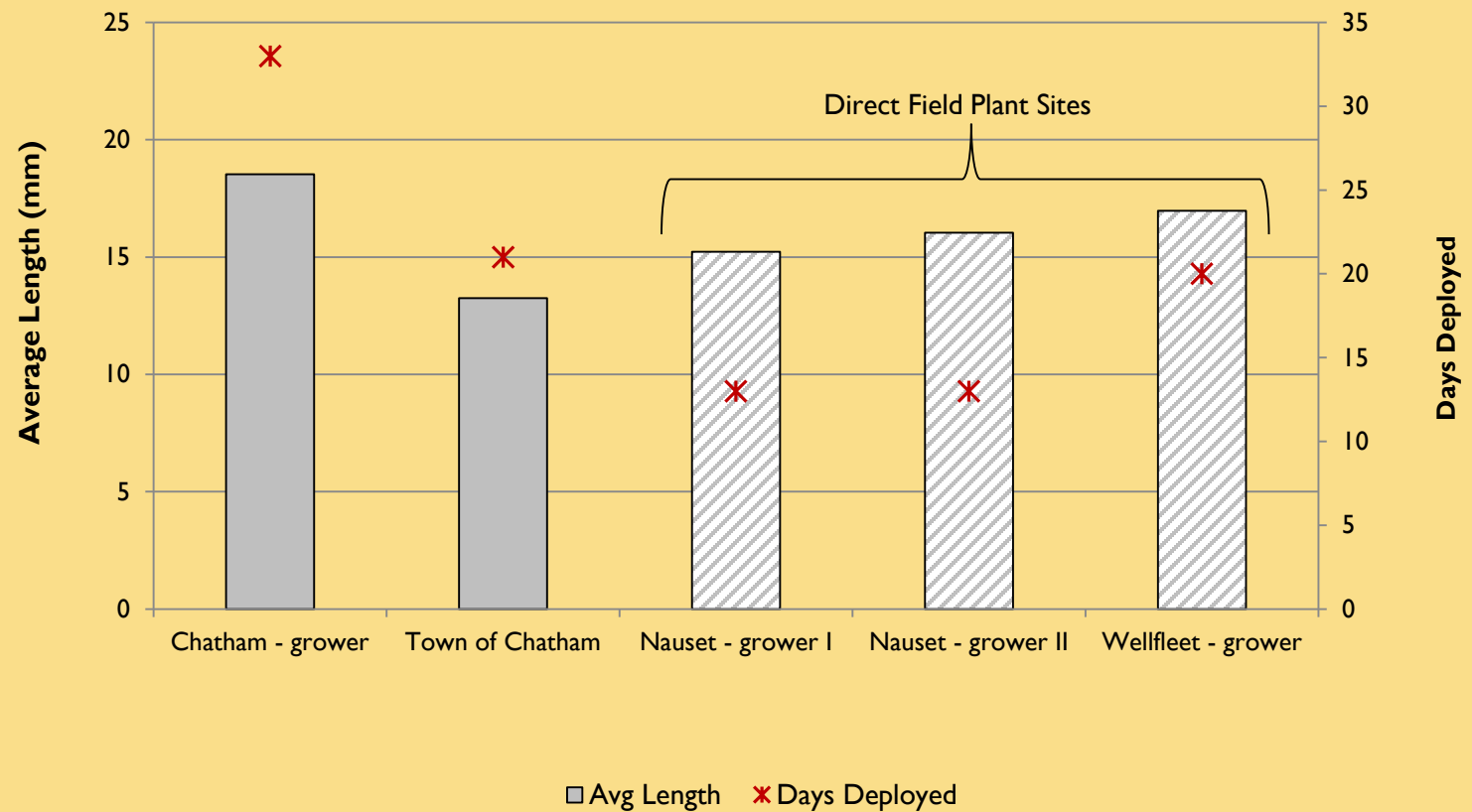
Wellfleet and Yarmouth



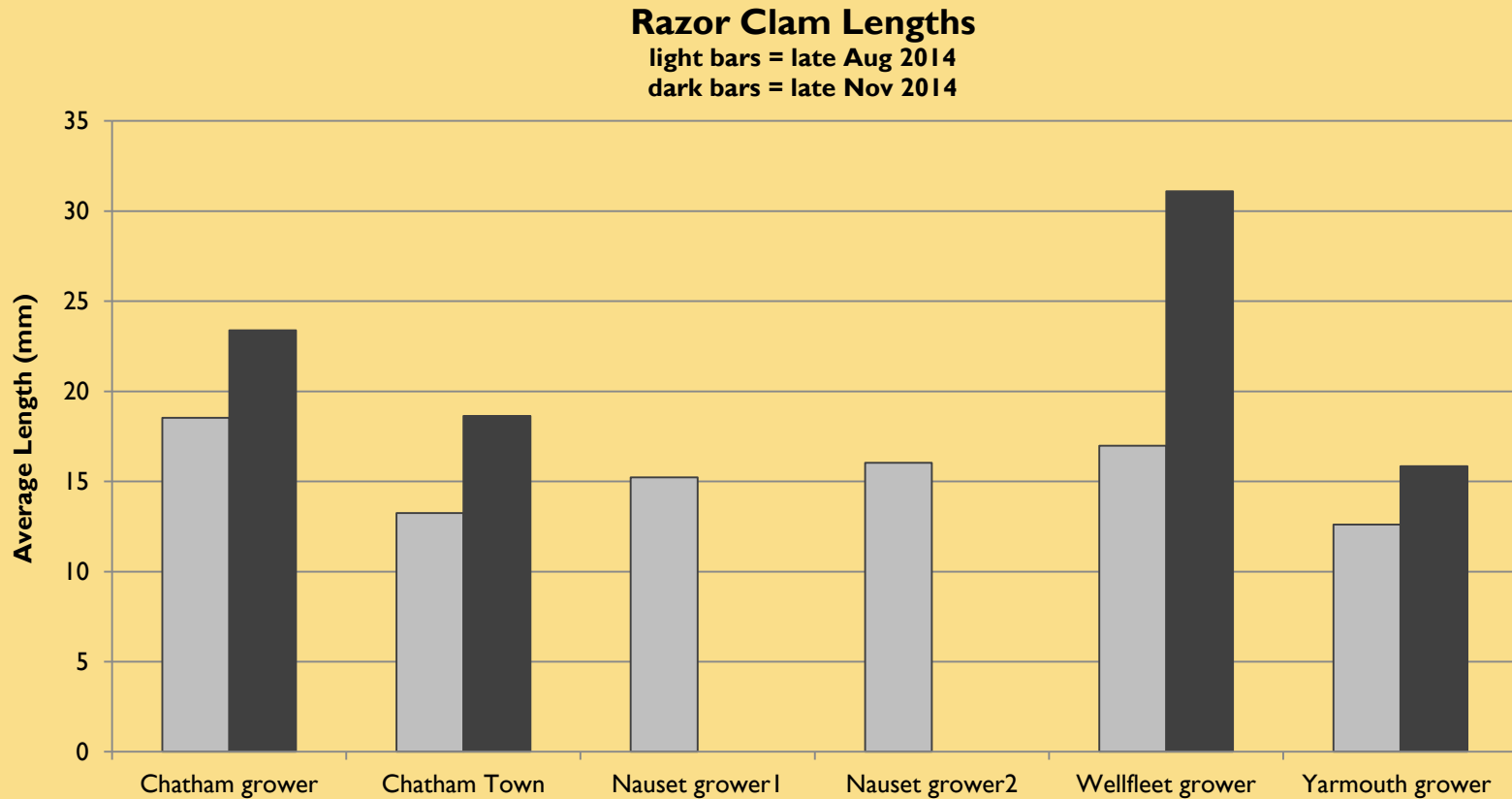
Site Differences



Razor Clam Lengths Late August 2014



Razor Clam Average Lengths (mm)



Our current state of knowledge

▶ Hatchery stage

- ▶ Razors can be held and handled in a similar manner to surf clams and other “cold-water bivalves”
- ▶ Spawning, larval culture and setting are straightforward and easy to accomplish

▶ Nursery stage

- ▶ They grow like weeds (ADG >0.25mm/day)!!
- ▶ Early post-set juveniles are highly susceptible to microbial problems when held in conventional downwellers
- ▶ Require high maintenance with excessively clean rearing conditions
- ▶ A quick and dirty experiment indicated that immediate planting in sediment may be a viable alternative to post-set downwelling (cannot be “sharp” sand).

Our current state of knowledge

▶ Growout stage

- ▶ The growth rate is on a par with (and potentially better than) the growth of wild razors in the North Sea (the only growth data I could find!)
- ▶ Preliminary data suggests that planting densities should be kept below 1,000/m² (~100/ft²)
- ▶ Razors will grow through the winter under some conditions
- ▶ Market size individuals (app. 4-inches) can be harvested in two growing seasons following “field-planting”
- ▶ Emigration and overheating of sediment (in intertidal) are two problems that need to be considered in selection of site and technology used
- ▶ Best technology includes effective containment to prevent emigration => bottom trays or boarded raceways
 - ▶ Needs to be stressed!!!
- ▶ Probably cannot grow in intertidal zone from Cape Cod to south

Concluding Thoughts

- ▶ Razor clams are a viable alternative species for shellfish farmers in the northeast
 - ▶ Good price/market
 - ▶ Encouraging growth rate
 - ▶ Relatively simple (and common) culture technology
- ▶ Still have some bugs to work out in
 - ▶ post-set nursery to achieve adequate seed supply for growers
 - ▶ growout methods
- ▶ Need to consider fishery management
 - ▶ Topic of discussion for towns

Thank – You!!

- ▶ Participating MA towns
- ▶ Grower partners
- ▶ ARC – Dick Kraus and ‘crew’!
- ▶ Dale Leavitt – RWU
- ▶ Funding assistance – NRAC, SEMAC, CCCE, WHSG, DAR



ARC 07-24-09



ARC 11-12-09