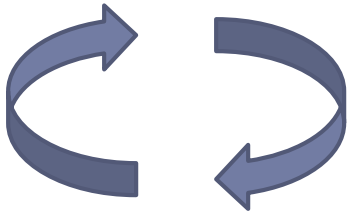
Shellfish Grow-out - Oyster

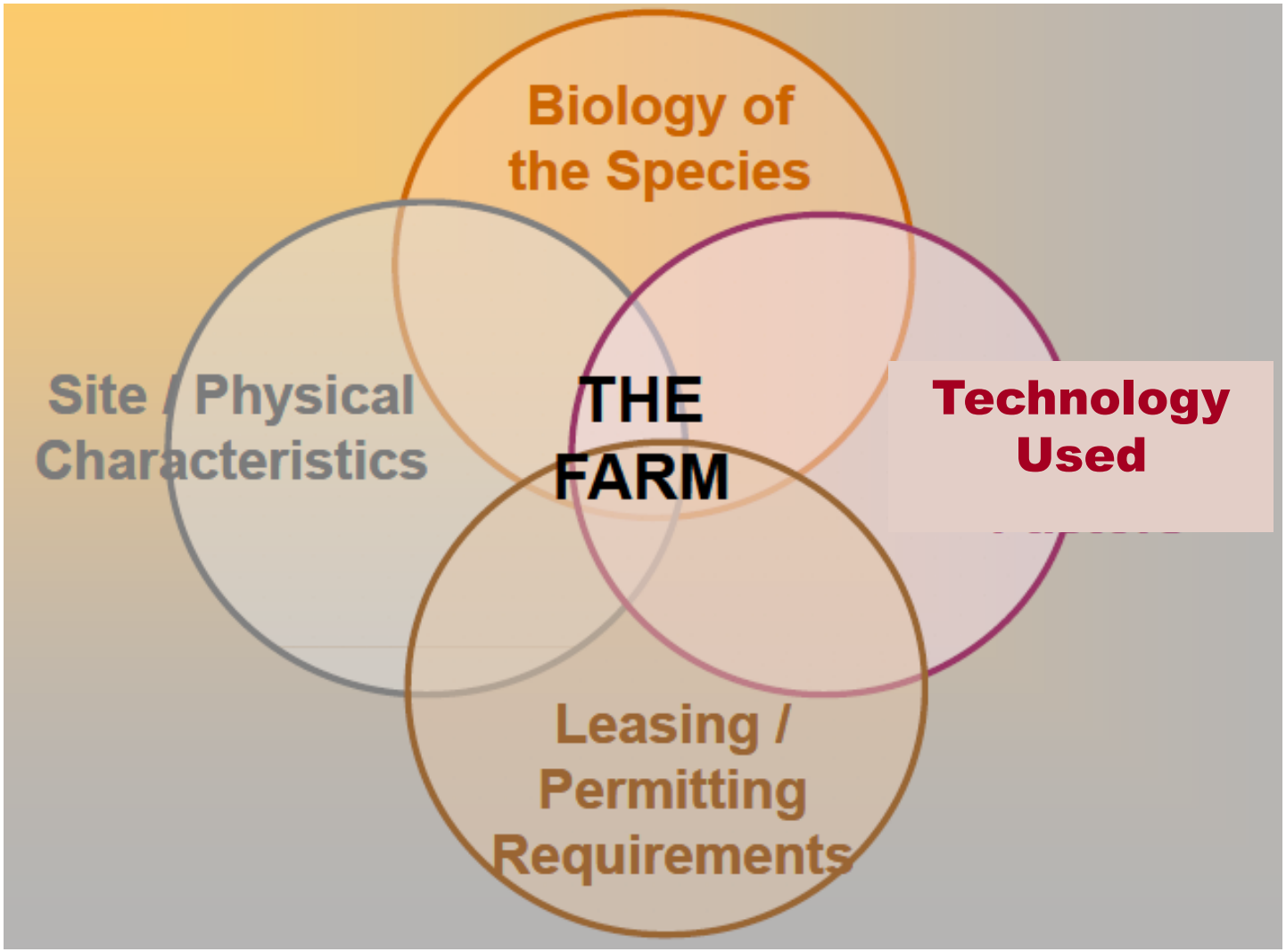
Roger Williams University

Dale Leavitt

Production Cycle (Northeast)

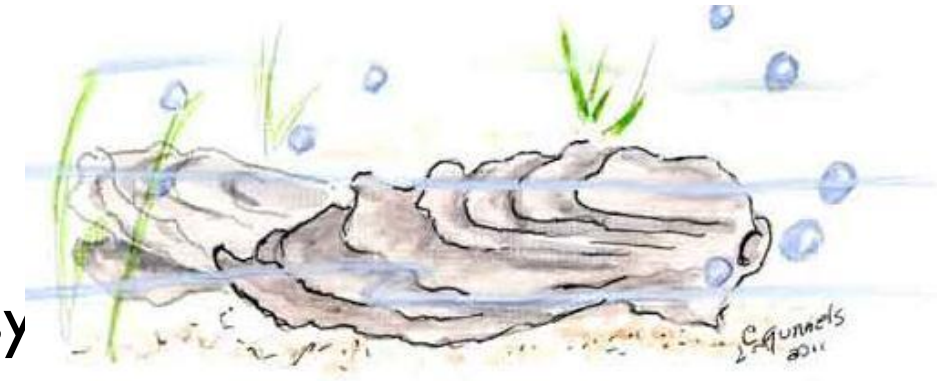
Begin: Receive seed from hatchery (1 - 4 mm)	First summer: Nursery culture (2 - 35 mm) June to October	Fall: Grow-out system (25 - 35 mm) August to November
Start again!		Overwinter (35 - 50 mm) November to May
Third Spring/Summer: Market of legal-sized oysters (75 mm)	Overwinter (50-60 mm) November to May	Second Summer: Grow-out system (35 - 75 mm) May to November Marketing of cocktail and legal-sized oysters

Getting it all right!

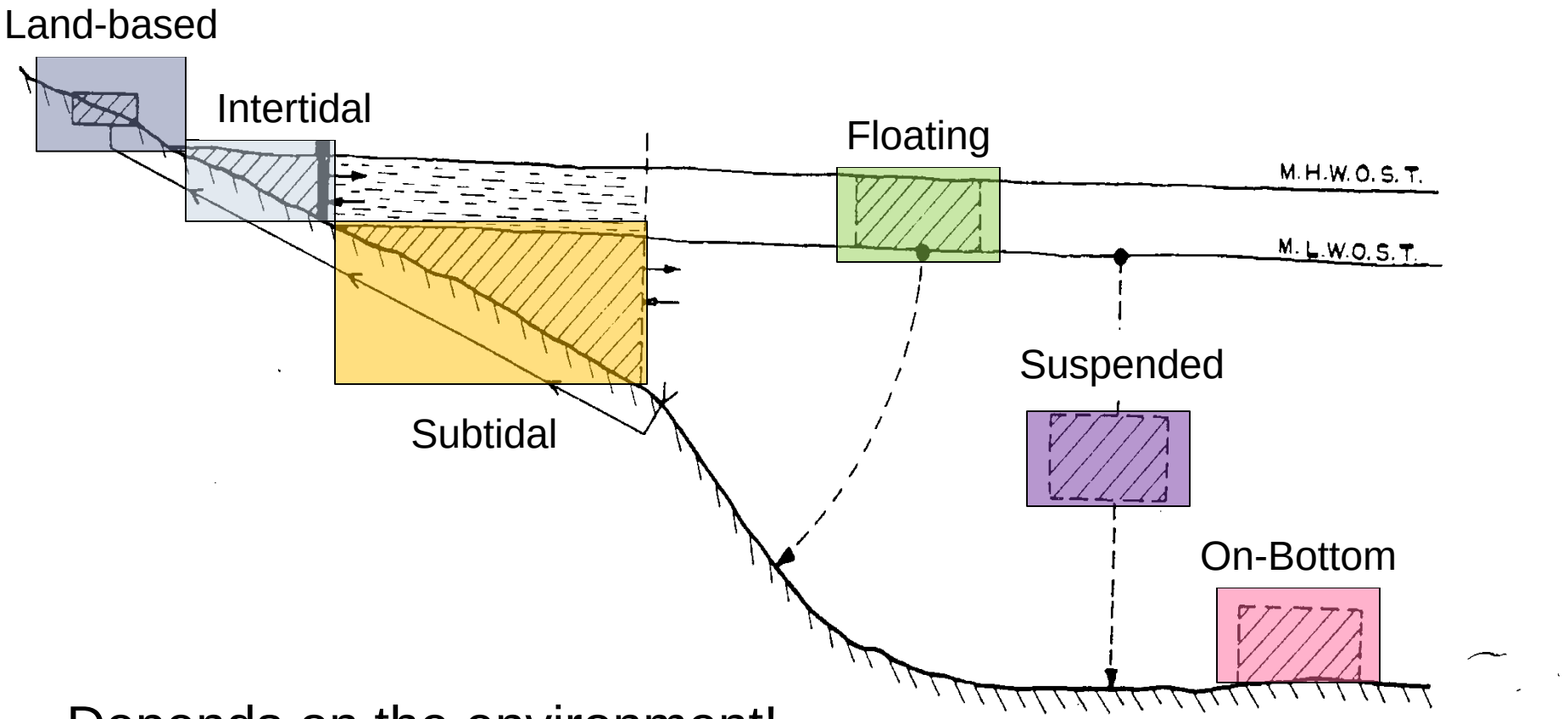


Let's start with the species

- American oyster
  - From hatchery or spat collected in wild
- Size to move into growout sy
  - Depends on technology
  - Can be anywhere between ¾" to 2"
- Start with as big seed as you can afford!
  - As you gain confidence, you can decrease the size of the seed you handle
- Don't invest more than you can afford to lose in the first year!



What technology options do I have?



Depends on the environment!

The Bottom Line!

- Be careful with your site selection
  - Physical factors can compromise growth and survival
  - Biological factors can also
  - Good to use this technology to make a first cut at determining your site characteristics
- Each site is a unique combination of factors
  - You can collect all the data that you want but it doesn't make up for time spent on-site
  - Experiment with species and technology to measure what works at your site and what doesn't
- Don't be afraid to change your direction once you have better information

Growout considerations

- Materials handling issue
  - Everything seems easy on a pilot scale, but can you handle hundreds of cages a day?
- Quality of end product is paramount issue
  - If it is easy to use, but gives a substandard product then you will not get a great price
- Simple is beautiful – cheaper is better
- Flow is critical
  - Any gear that ends up restricting flow is going to limit potential growth
  - Fouling will end up restricting flow so ease of cleaning is key

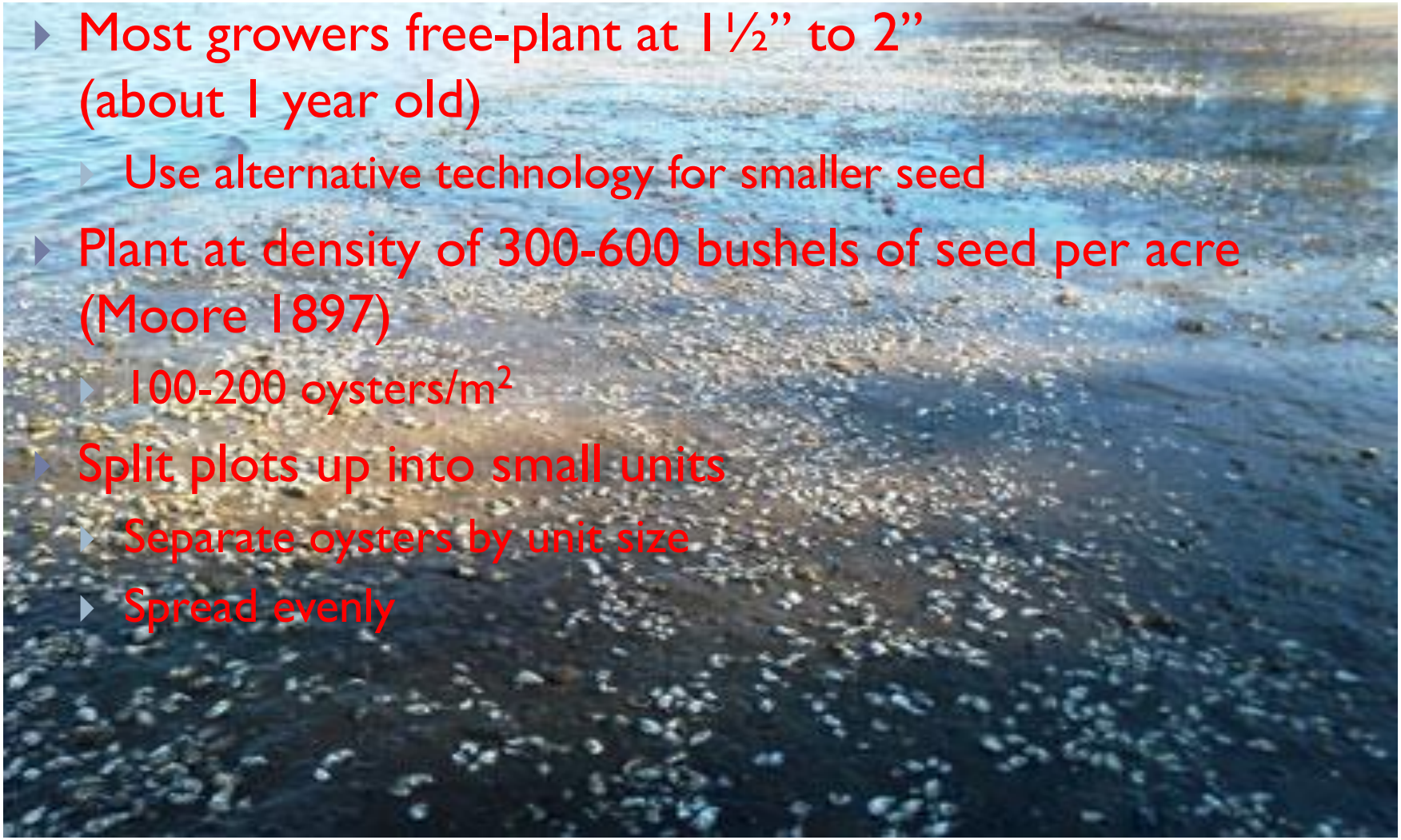
Other considerations

- If it is easy for me to work the gear is it too easy for someone to rip me off?
- Is the gear suitable for the site?
- Can I get permits
  - Is it unsightly? Navigation hazard?
    Perceived vs real conflicts
- Will it hold up to a storm?
- Will it tip over?
- Will it protect my seed from predators?
- Is it light and easy to store and transport?

Free Plant On Bottom

- The traditional way to farm oysters
  - In practice since 1800's
  - Still practiced in many regions (i.e. Connecticut)
- Generally move oysters from cultched seed beds to privately controlled growout beds

Sowing oyster seed for bottom planting



- Most growers free-plant at 1½" to 2" (about 1 year old)
  - Use alternative technology for smaller seed
- Plant at density of 300-600 bushels of seed per acre (Moore 1897)
  - 100-200 oysters/m^2
- Split plots up into small units
  - Separate oysters by unit size
  - Spread evenly

Free planting (CT)

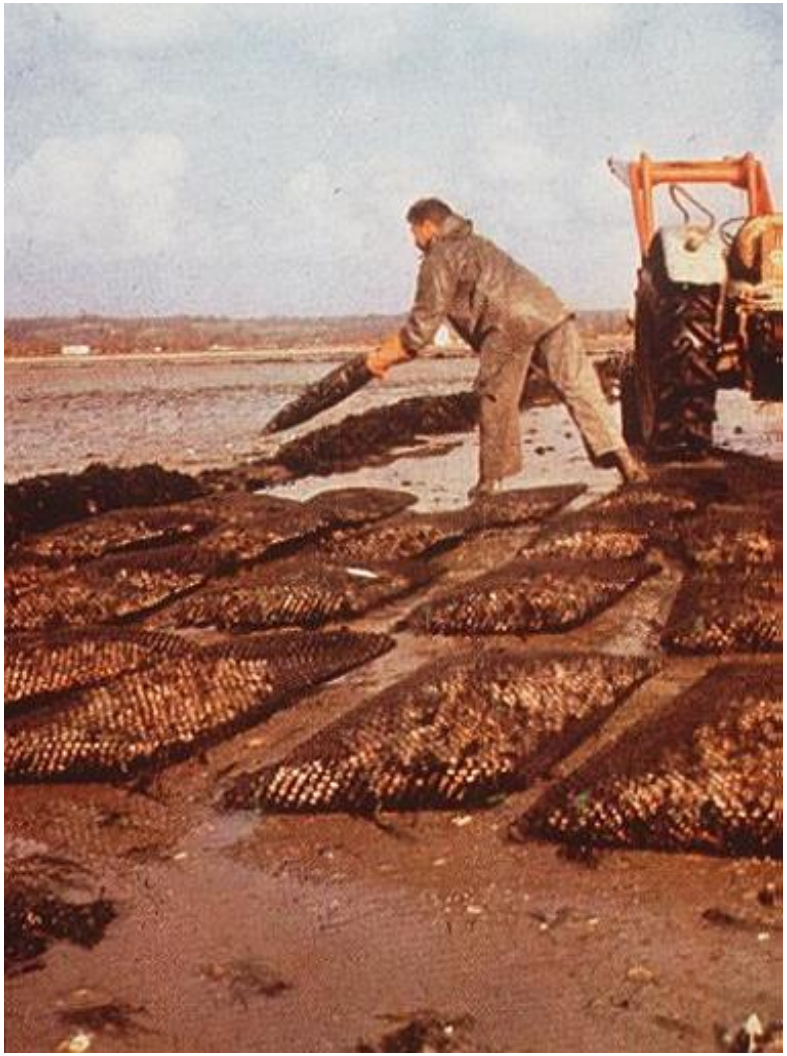
Predator Control - Starfish mopping

Harvesting bottom planted oysters (Cotuit, MA)

Some considerations with bottom culture

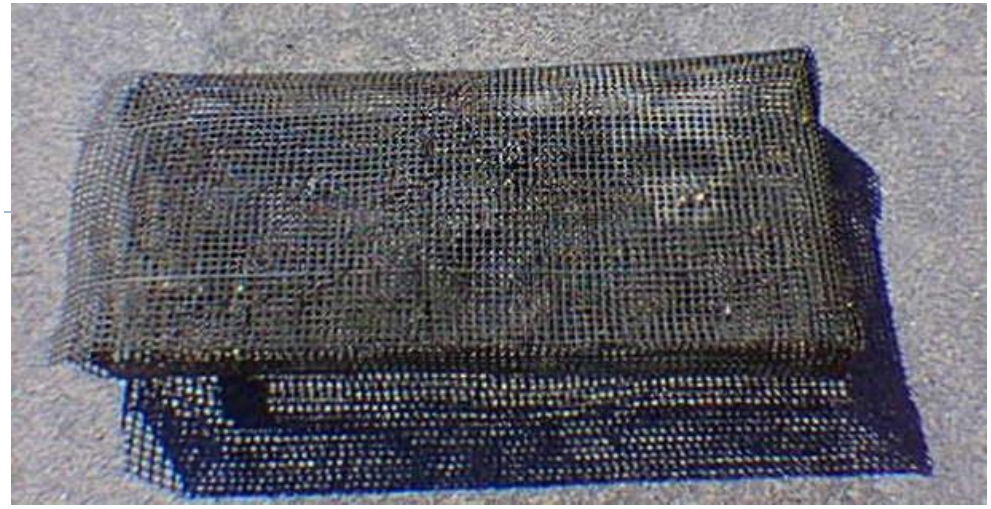
- Advantages
  - Less labor
  - Lower capital investment
  - Fewer permits needed
  - Lower visual impact
- Disadvantages
  - High mortality from predation
    - Resistance to predator control
  - Higher potential for silting over
  - If using spat-on-shell – lose spat on one side of shell

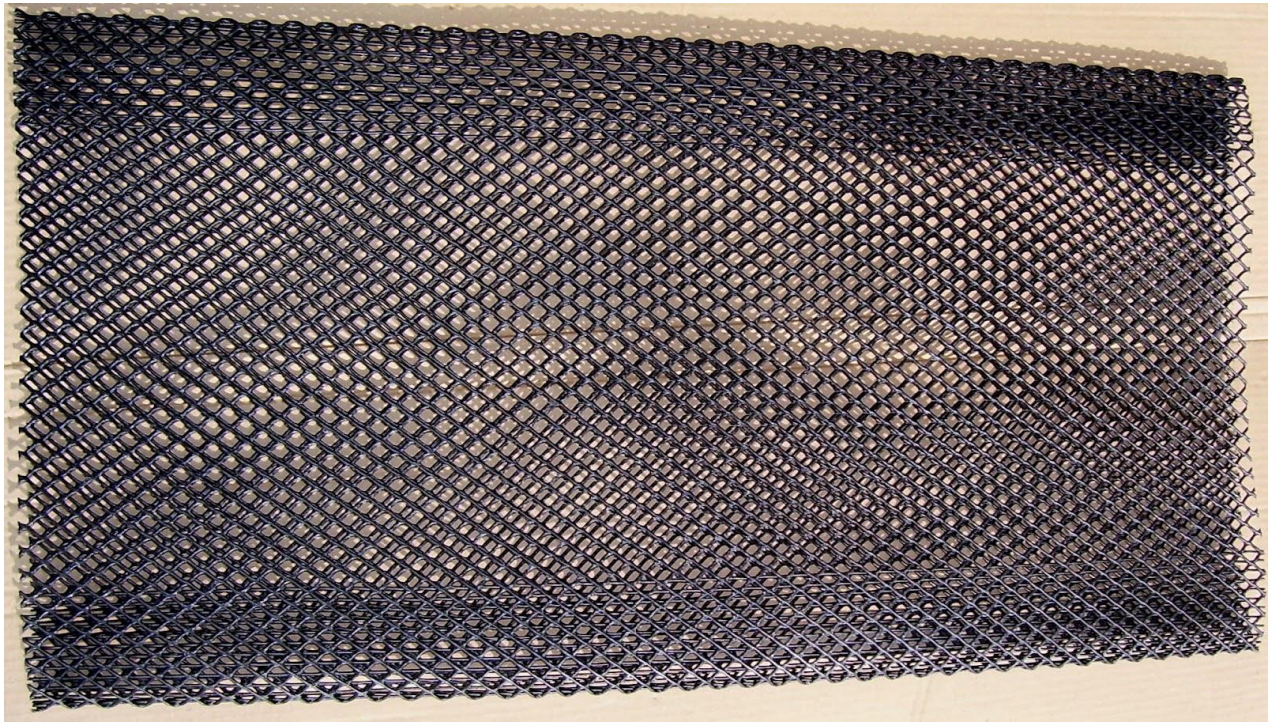
Also can place on bottom in bags



Often used for short-term holding of market-sized oysters.

Oyster Bags





Mesh size available (mm)

		1/16"	1/8"	3/16"	1/4"	3/8"	1/2"	3/4"	7/8"
Size (cms)	**Types**	**2mm**	**3mm**	**4mm**	**6mm**	**9mm**	**14mm**	**18mm**	**23mm**
100x40	R	*	*						
100x40	RS	*	*						
100x50	NR				*	*	*	*	
100x50	R			*	*	*	*	*	*
100x50	NRS				*	*	*	*	
100x50	RS			*	*	*	*	*	*
100x50	NR					*	*	*	
100x50	R			*		*	*	*	
100x50	NRS				*	*	*	*	
100x50	RS				*	*	*	*	*

Oyster bag description and characteristics

Types

R or NR = Reinforced and Not Reinforced open on both sides

RS or NRS-NM = Reinforced Sealed, and Not Reinforced Sealed Not Molded

RS or NRS-M = Reinforced Sealed, and Not Reinforced Sealed Molded

Standard with stock

Bag closures

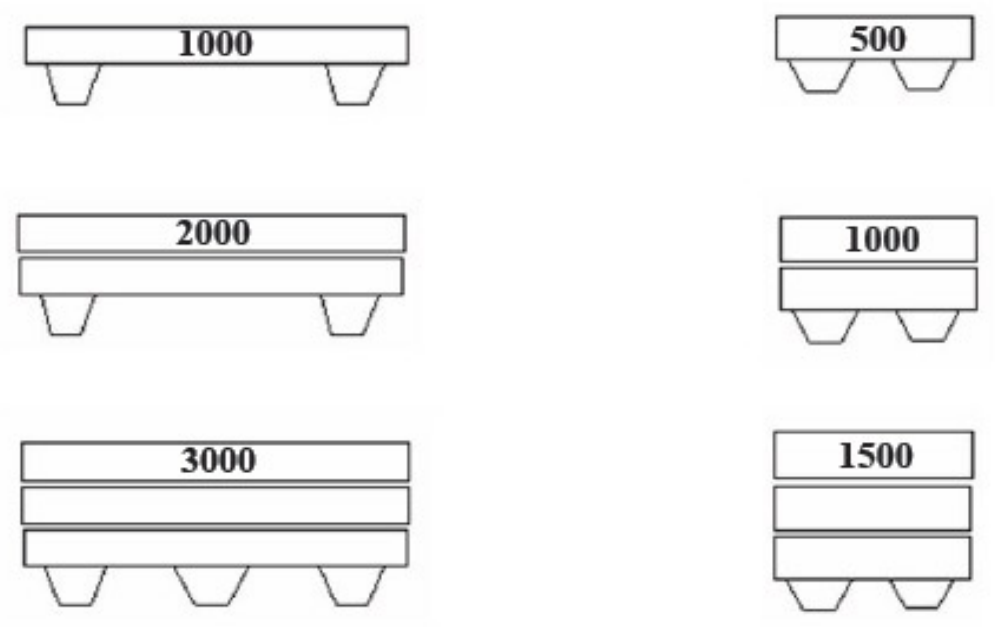
Off Bottom

Oysters in trays directly on bottom (Winnapaug Pond, RI)

Wire Mesh Oyster Tray configurations

OYSTER TRAYS

Trays can be used with or without grow-out bags and generally require some type of crane or hoist to lift them out of the water.

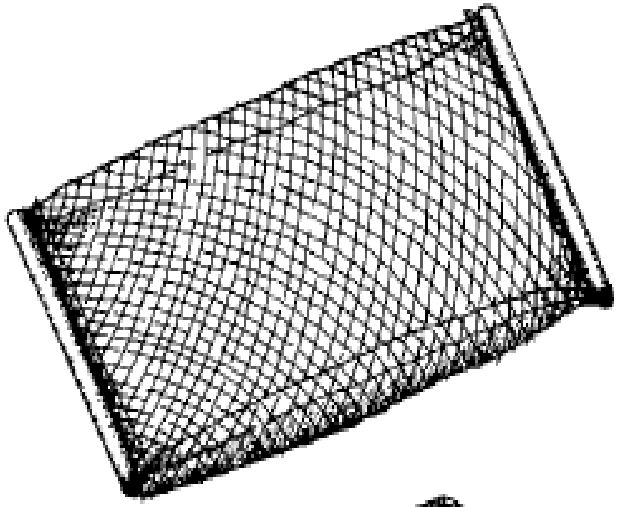


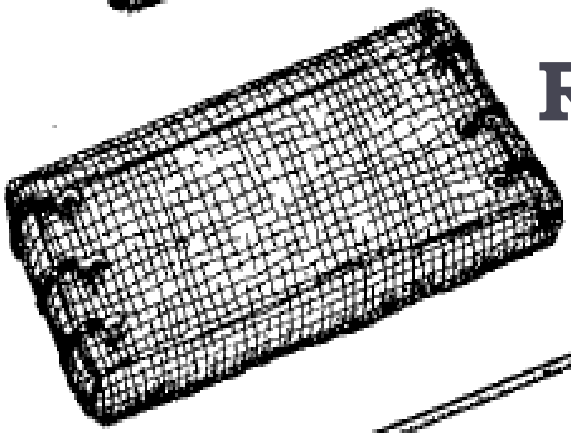
numbers are total oyster capacity

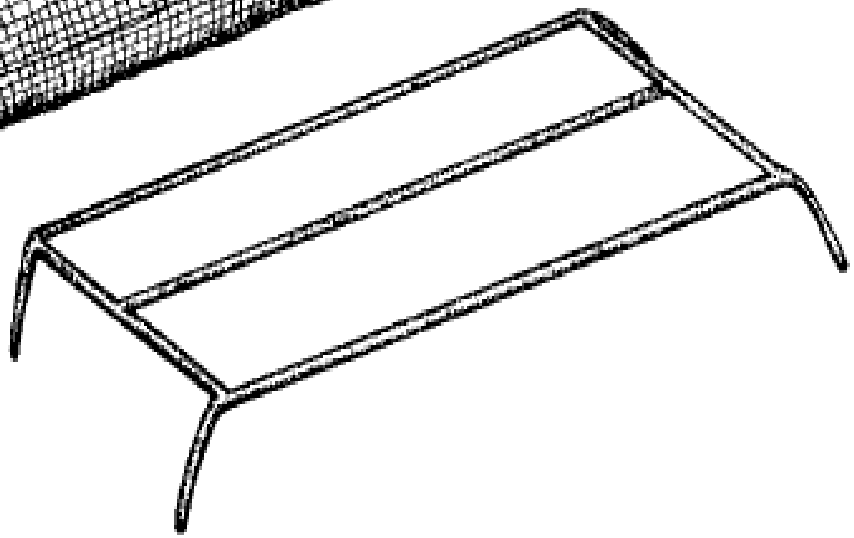
Aquatray

Another Aquatray system (Dennis, MA)

Rack & Bag

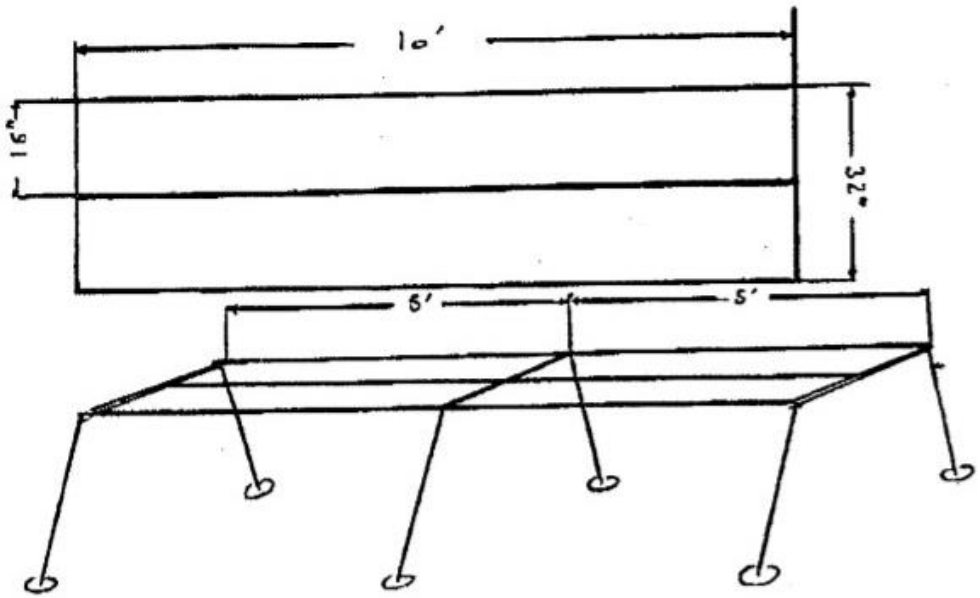




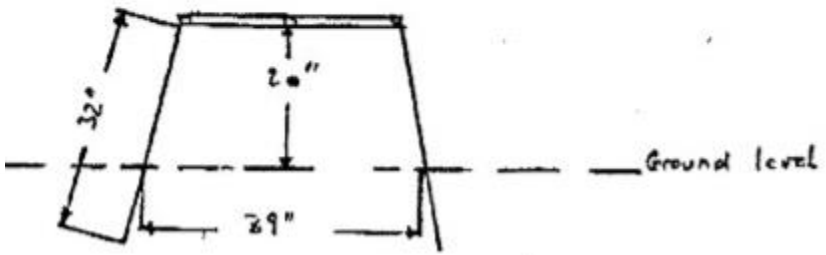


The rack

Plans for Racks



"U SHAPED LEG FRAMES

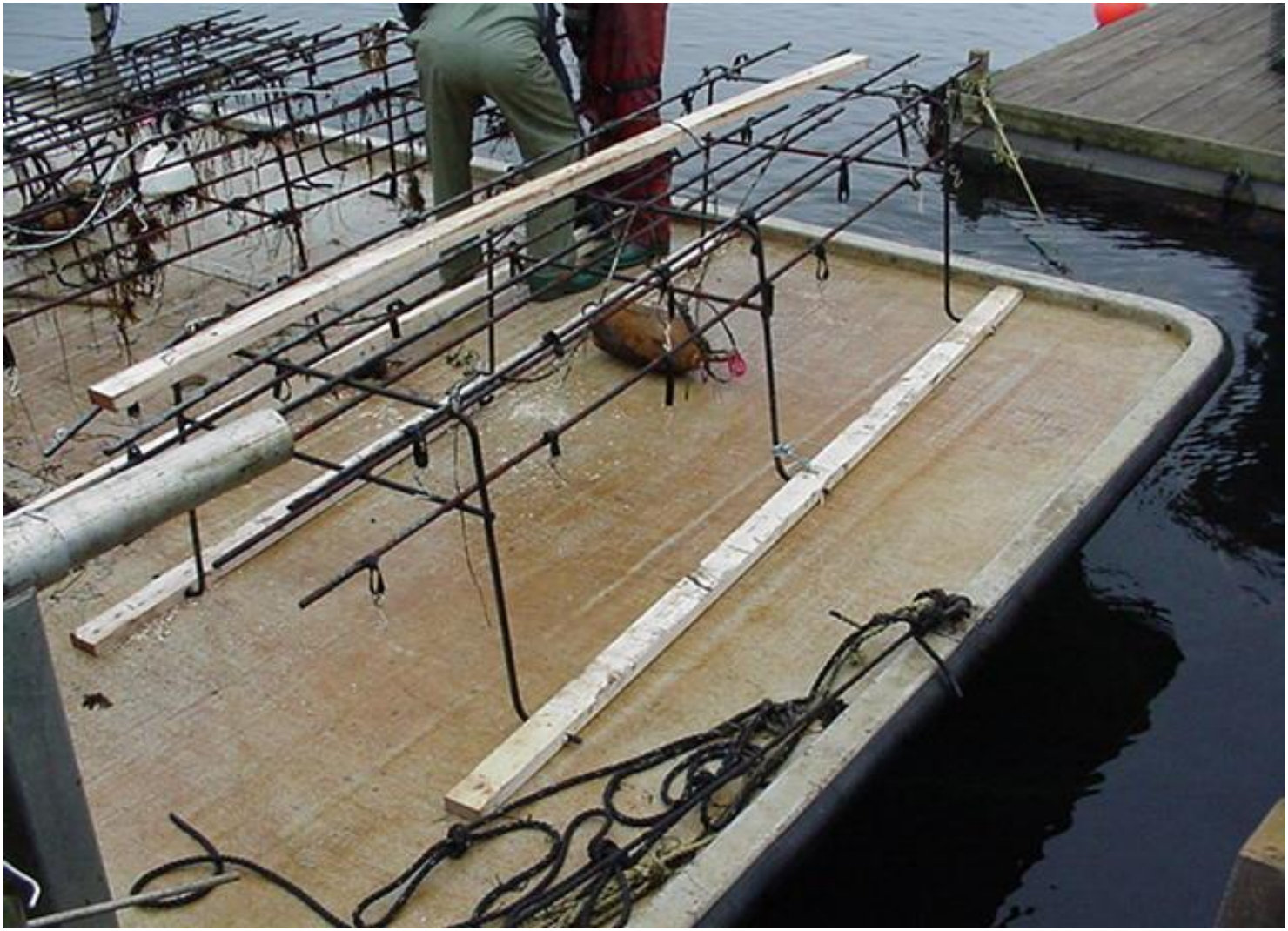


THE RACK IS MADE OF REBAR 5/8" THICK
6 CAGES CAN BE PLACED ON ONE RACK.

STEP 1: BUILD THE RECTANGULAR FRAME 10' x 32" WITH A REINFORCEMENT IN THE MIDDLE.

STEP 2: ADD AND WELD THE 3 "U" SHAPED LEG FRAMES ON BOTH ENDS PLUS ONE IN THE MIDDLE OF THE LENGTHS. YOU MAY WANT TO WELD ROUND FEET ONTO THE LEGS.

Double Table with slippers (New Brunswick, Canada)



Rack & Bag (Wellfleet, MA)

A collapsible rack & bag system (Barnstable, MA)

Jiffy Pop Syndrome

June 28th

July 17th

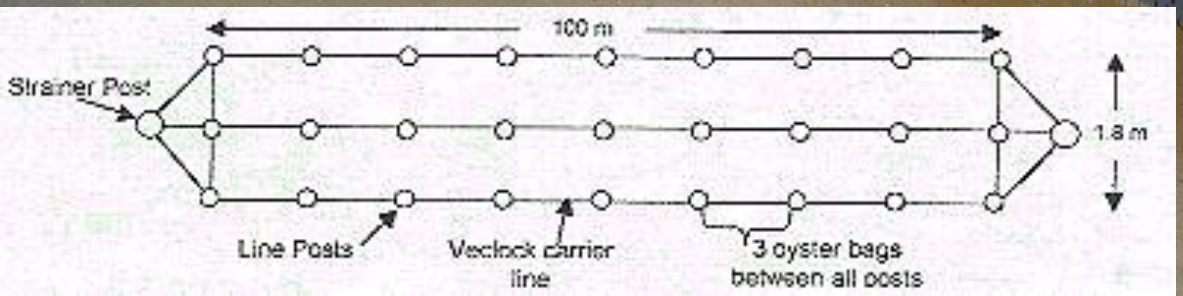
August 11th

November 10th

Oyster stocking density in bags

- Site specific - Rule of Thumb
- Generally put 1.5 – 2 gallons of biomass in a bag
  - If small oysters ½" (12.7mm) = ~16-20,000 oysters/bag
  - If 1 inch (25mm) = 2,700-3,700/bag
  - If 2 inch (50mm) = 450-625/bag
  - If markets (75mm) = 160-220/bag
- Jiffy Pop (Be Aware!!!!!)
  - If start with 50,000 oysters
  - Need ~2-3 bags at 10mm
  - Need ~100 bags at 1 inch
  - Need ~300 bags at market size

Australian Long-line System

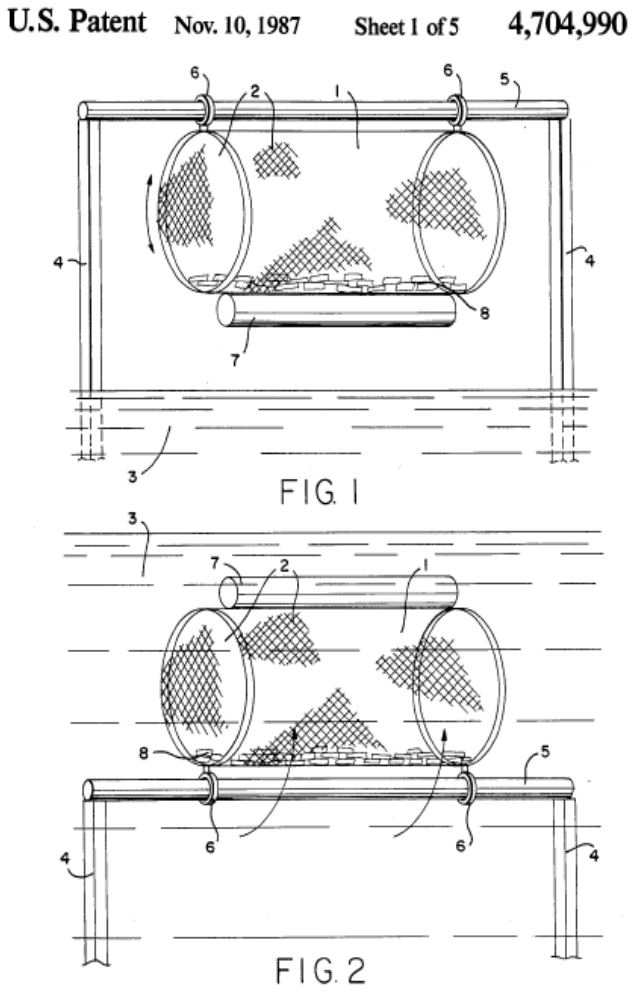



Seapa
Bags

Optimizing space use (Wellfleet, MA)

Rack and bag

- Advantages
  - Big enough to discourage theft
  - Good flow
  - Relatively easy to maintain and clean
  - Cheap per unit area
  - Allow dense deployment
  - Excellent product quality
- Disadvantages
  - Expensive – large capital cost
  - Subject to tipping or pulling over
  - Heavy
  - Requires a big boat with crane – if deep water
  - Still not storm proof
  - Anchoring and deploying can be tricky



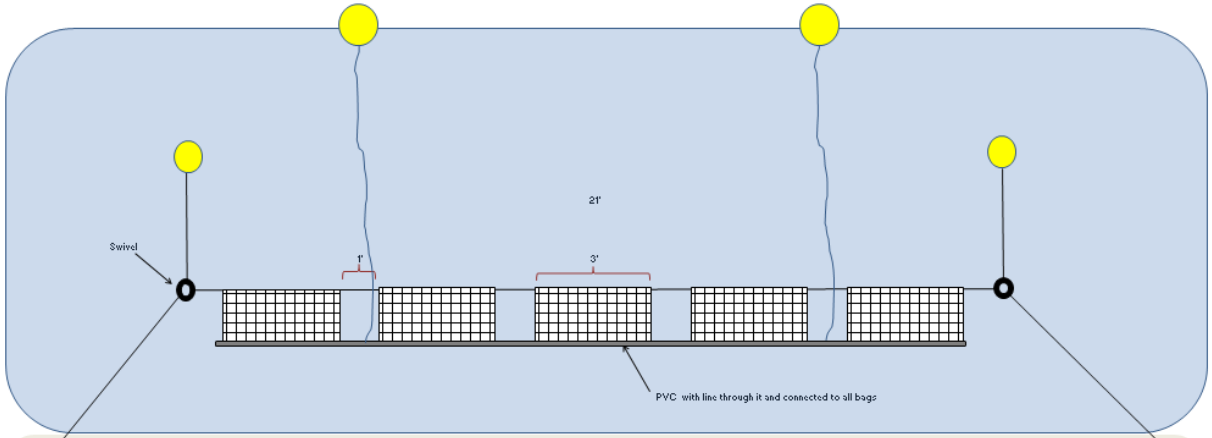
Another idea for growing oysters

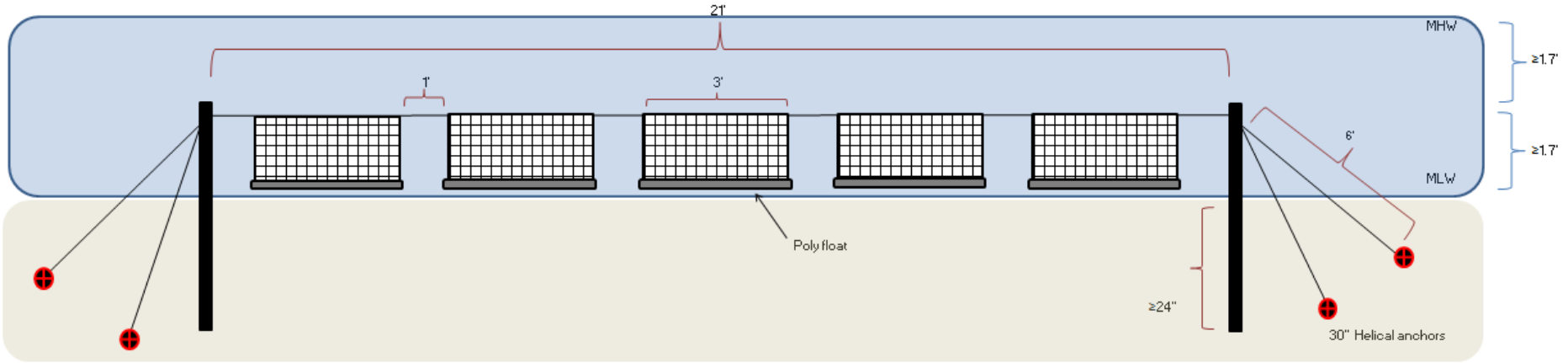
An Australian variation

“Flip-Bag” System

“Flip-Bag” System

Flip bag designs



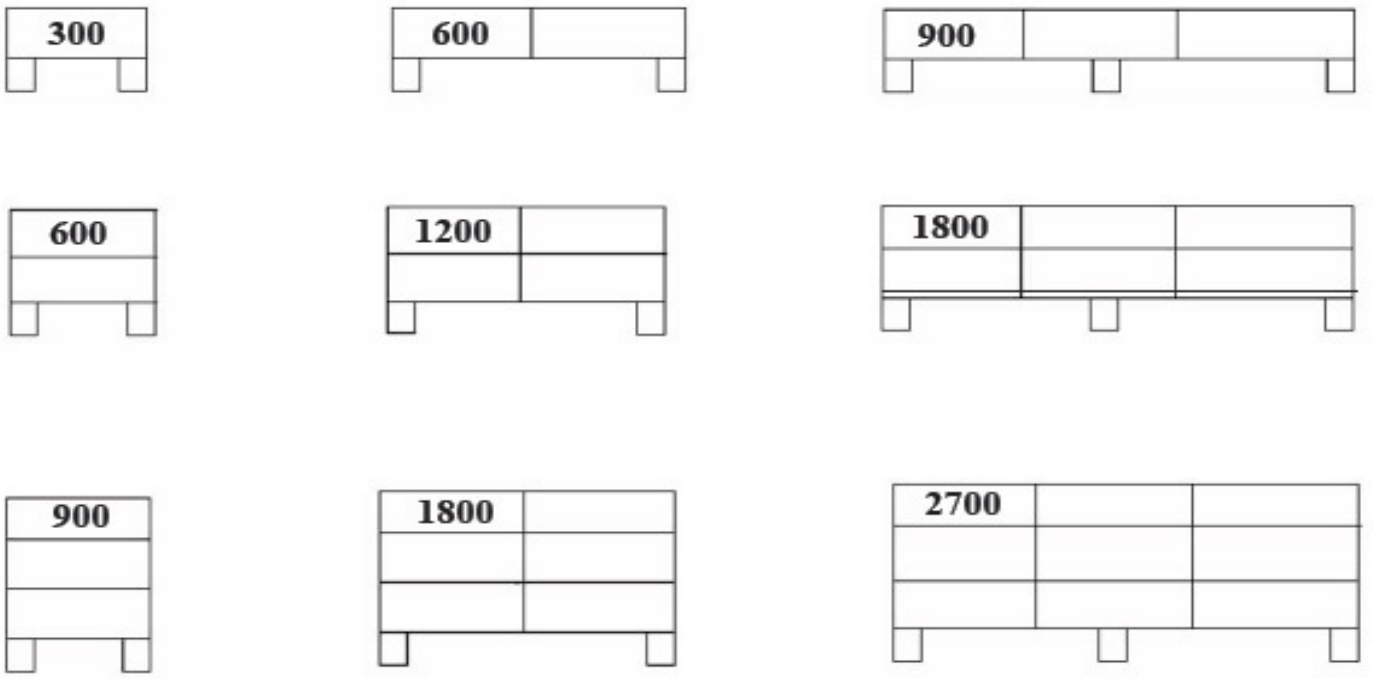


Bottom cages

Bottom Cage configurations

OYSTER CAGES

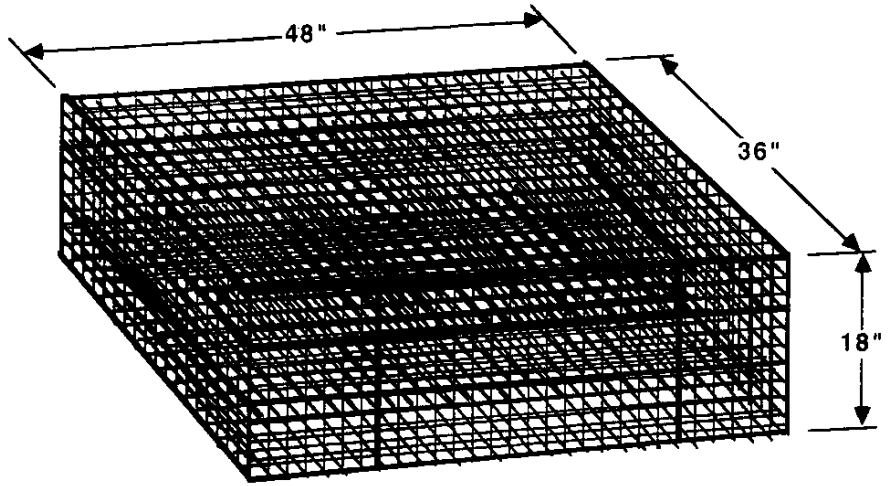
Cages require the use of a grow out bag which is accessed from the side of the cage.



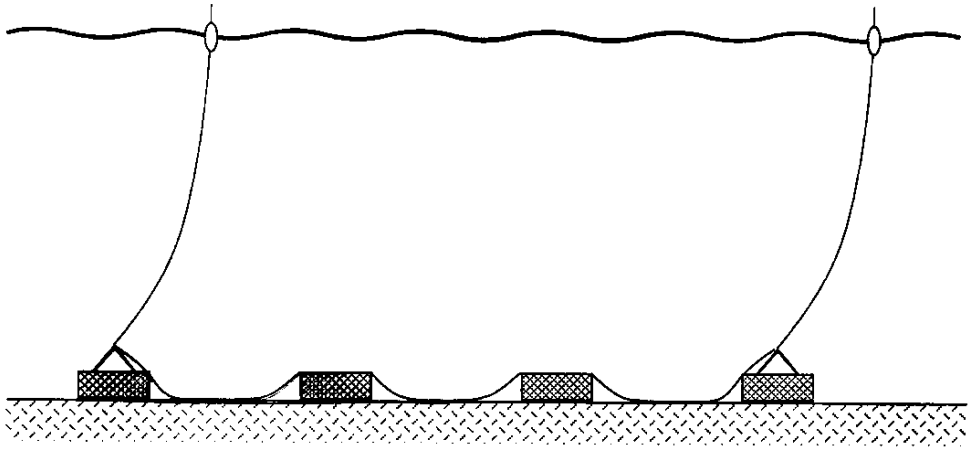
numbers are total oyster capacity

Another cage configuration (BayOyster, VA)

A heavy cage system (France)

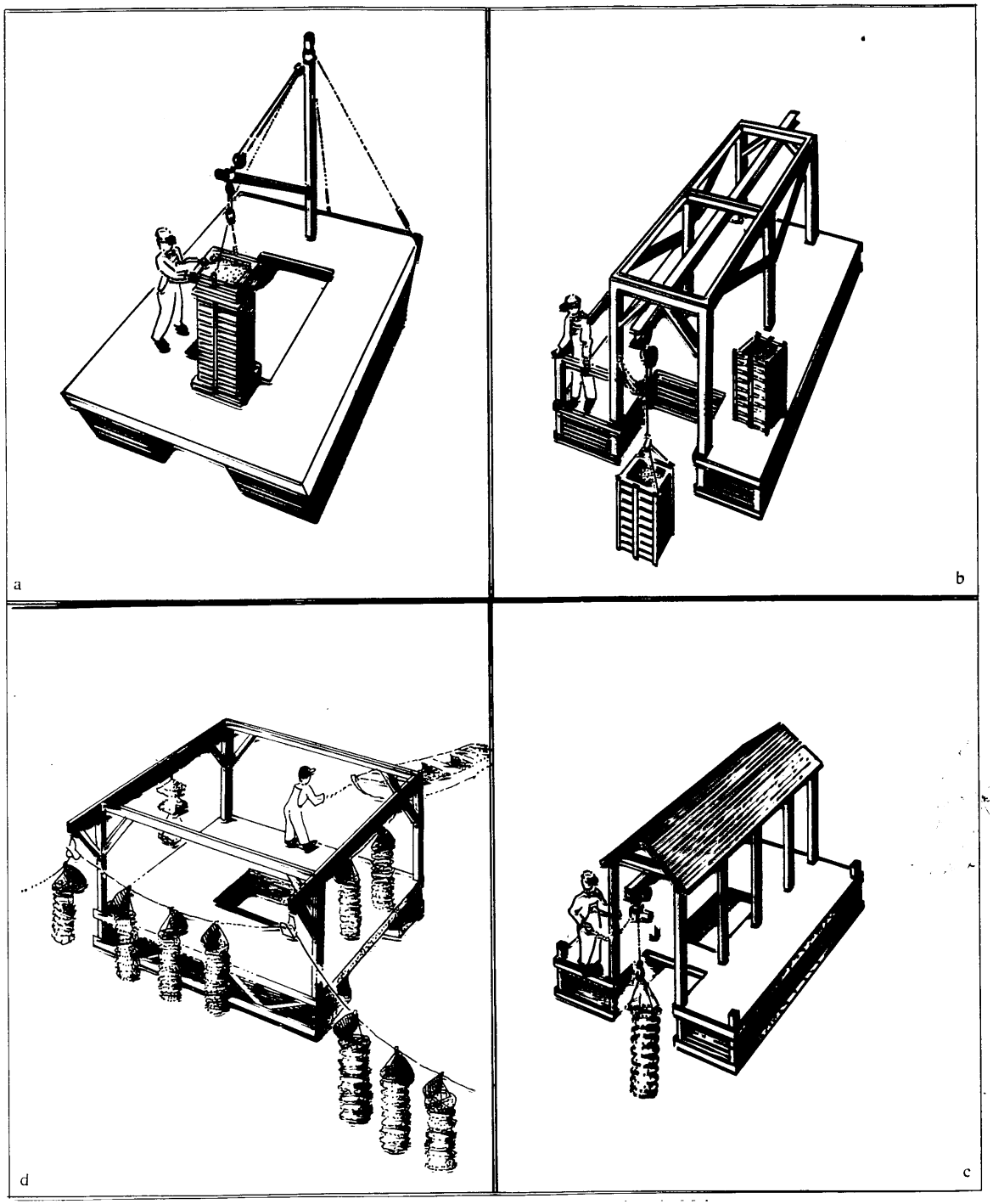


Sea scallop bottom grow-out cage.



Sea scallop grow-out cage trawl.

Handling



Work Platform

The size of a work platform varies according to the needs of the enterprise.

Off-bottom Culture

- Advantages
  - Avoid many predators and pests
  - Lower risk to siltation
  - Use 3-D aspect of water column
  - Easier to harvest
- Disadvantages
  - Capital costs are higher
  - Higher labor for set-up
  - Fouling may become severe
    - High maintenance requirements
  - More public concerns
    - Other recreational users

Some risks (New Brunswick, Canada)

Over-wintering oysters

Is your overwintering site secure?

You want to be certain that nobody besides you is going to make off with your crop.

- Is your overwintering location subject to disturbance, either accidental or deliberate?
- If you are using a bottom cage or other structure, is it in an actively fished location?
- Will you be in or near a navigational channel?

A "YES" answer to any of these questions might be cause to re-evaluate your overwintering site, and perhaps look for alternatives.

Is your overwintering site vulnerable to ice?

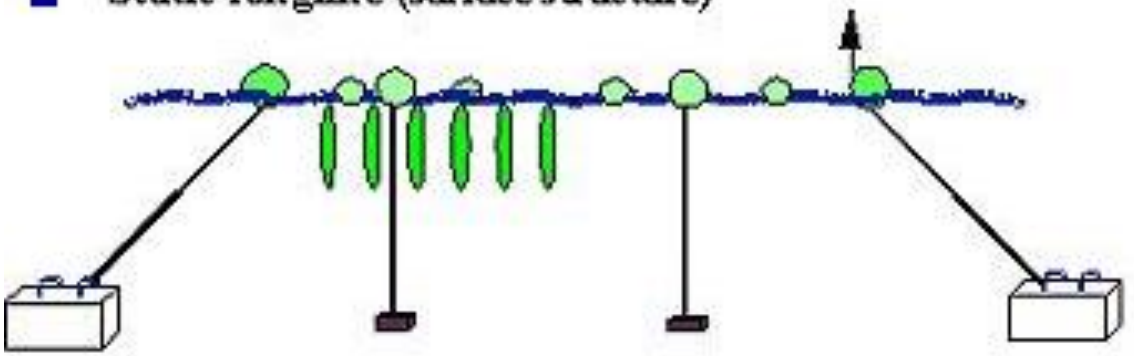
- Assess the potential for freezing on your site. Does it get lots of ice or just a little?
- How thick is the ice compared to the depth of your site—are your cages well below any ice that might form?
- Could large chunks of ice (which can devastate a farm site) float over your site during the spring thaw?
- If you are in an area with limited water exchange, will dissolved oxygen levels be affected?

One solution: Overwintering oysters

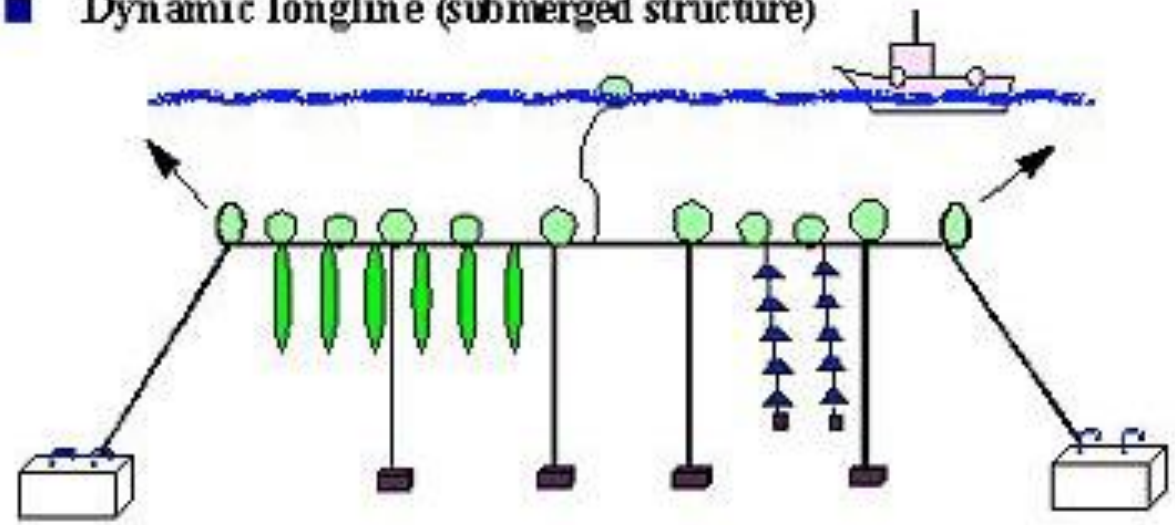

Suspended

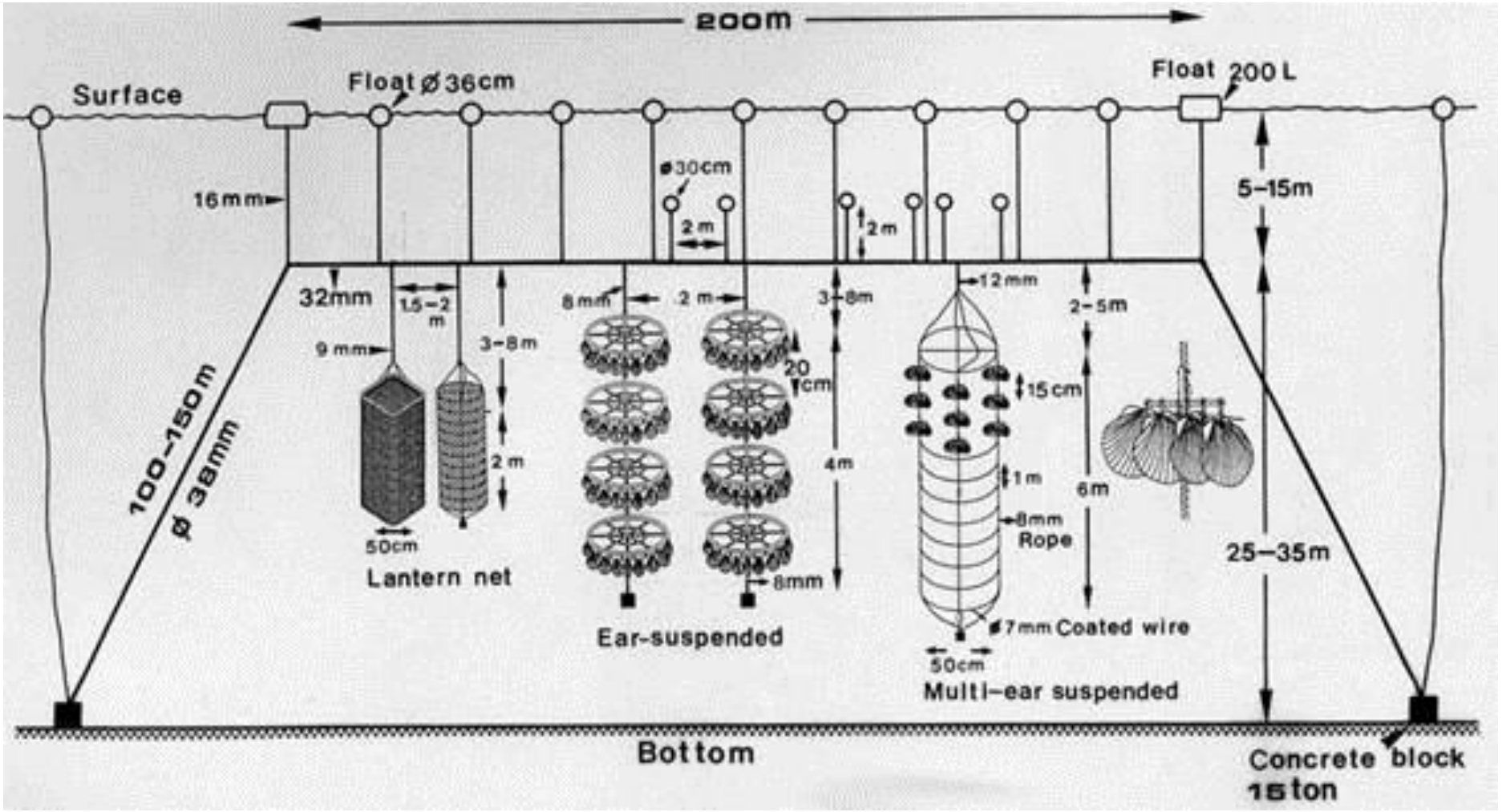
Longline suspension system

- Static longline (surface structure)



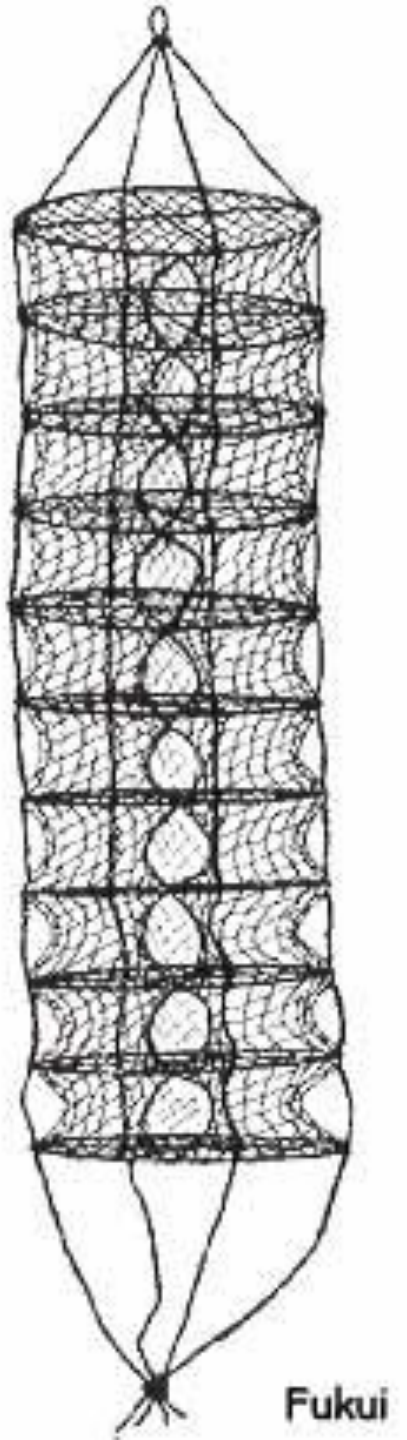
- Dynamic longline (submerged structure)




200m
Surface
Float ø36cm
Float 200 L
16mm
ø30cm
2m
2m
5–15m
32mm
1.5–2 m
8mm
2 m
3–8m
12mm
2–5m
9 mm
3–8m
20 cm
15cm
100–150m
ø 38mm
2 m
4m
1m
6m
8mm Rope
50cm
Lantern net
8mm
Ear-suspended
ø7mm Coated wire
50cm
Multi-ear suspended
25–35m
Bottom
Concrete block
15ton

Pearl nets

Lantern Net



Oysters in Lantern Net (Hood Canal, Washington)

Some thoughts on Pearl/Lantern nets

- Requires surface suspension
- Allows for midwater positioning
- Heavy
  - Ungainly
- Foul fast
- Sewing the side
  - a problem with emptying & filling
- Costly?

Hanging trays


RI Oyster Farm ~ Suspended Culture

Trays in Raft Culture

Nestier Tray

Aquatray

Italian tray system

A few other odd ways to grow oysters!

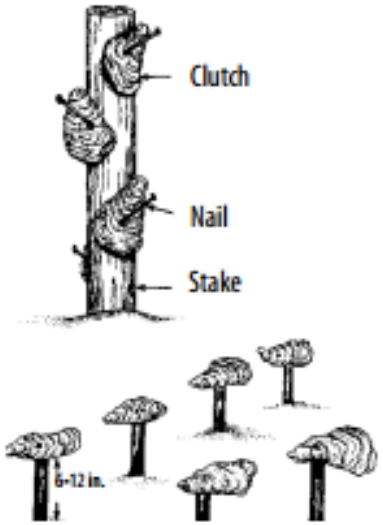


Figure 1. Stake culture
Smaller stakes extending 6 inches to 12 inches out of the bottom may also be used. In this case, one piece of cultch is attached to the top of the stake. Stakes should be installed about 2 feet apart in rows spaced to allow free movement during maintenance or harvesting.

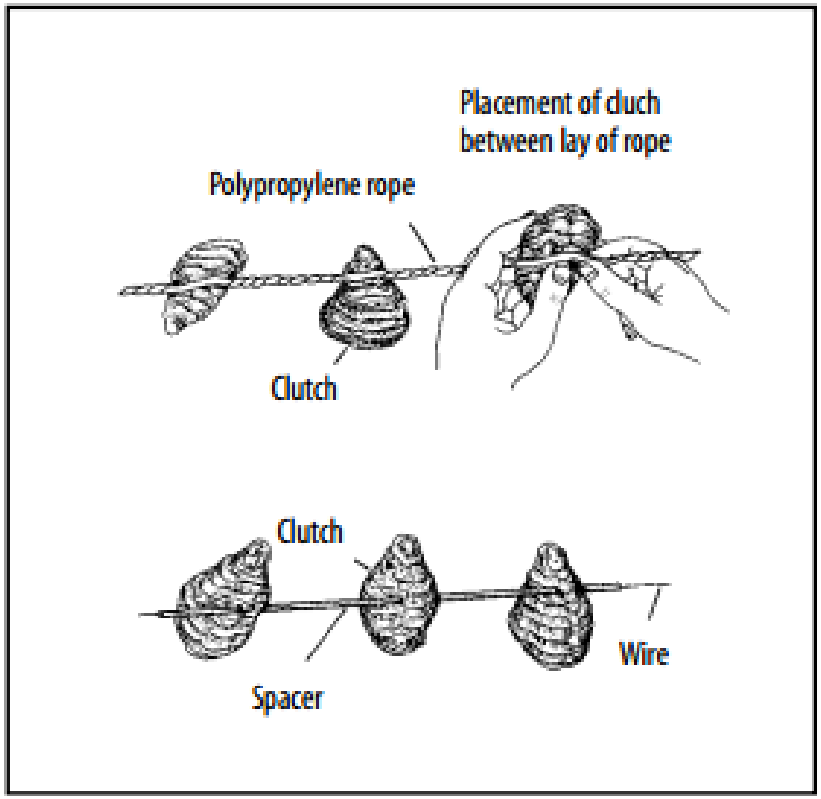
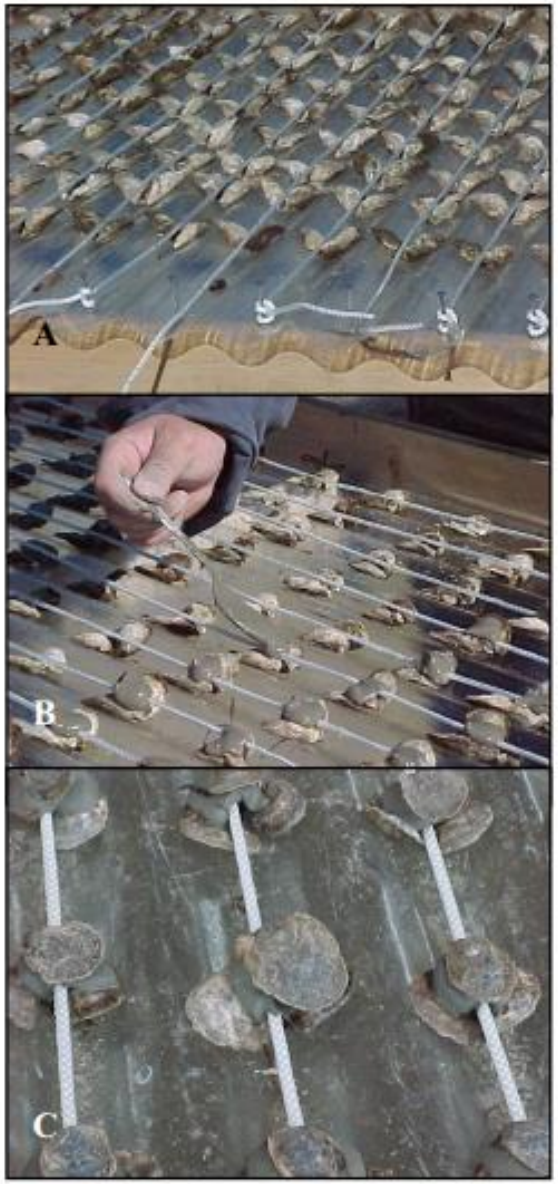


Figure 3. Basic Construction of Long lines



Cementing of oysters

Glued Oysters: Vertical Deployment

Glued Oysters: Horizontal Deployment

Glued oysters (from Andre Mallet):

- Benefits
  - Surprisingly good shape and growth (24 mo.)
  - Acceptable Cost of Production (10-12 cents/oyster)
- Drawbacks
  - Severe Fouling Problems at certain sites
  - Production Cycle has not been completed

Suspended from a raft

Figure 36 **Oysters on strings suspended from rafts**

The strings are about two metres long.

Oyster Grow-out Methods – cost comparison

Deployment Method	Up-Front Capital Cost	Loading Capacity	Up-Front Capital Cost Per Unit	Life Span	Amortized Cost Per Unit	Comments
ALS	4000/13.46	44,550	0.0897	8-10 years	0.0099	Least labor
Floating Bag System	1400/14.00	15,000	0.0933	8-10 years	0.0103	2nd least labor
Aquatech Trays (deployed in stacks of 7)	20.70	120	0.1725	10 years	0.0172	3rd least labor
Dark Sea Trays (deployed in stacks of 10)	21.69	80	0.2711	10 years	0.0271	4th least labor
Mexican Trays (deployed in stacks of 10)	12.69	80	0.1586	10 years	0.0158	4th least labor
French Rack & Bag	16.35	200	0.09675	Bags - 6-8 years Rack - 10 years	0.0138	Most labor intensive

Notes:

Numbers for Aquatech Trays, Dark Sea Trays, and Mexican Trays are based on raft culture; cost per raft is $3,000 with 64 stacks per raft. These trays can also be deployed by long line which costs less ($1,800) but is more labor-intensive.

French Rack & Bag System - Cost of one rack is $120 with a capacity of 8 bags.

Maintenance of oyster growout systems

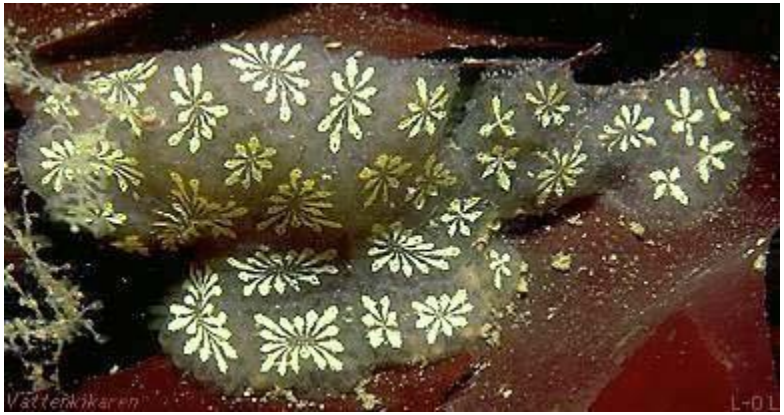
Management ~ fouling ~

Photo: Clair Carver

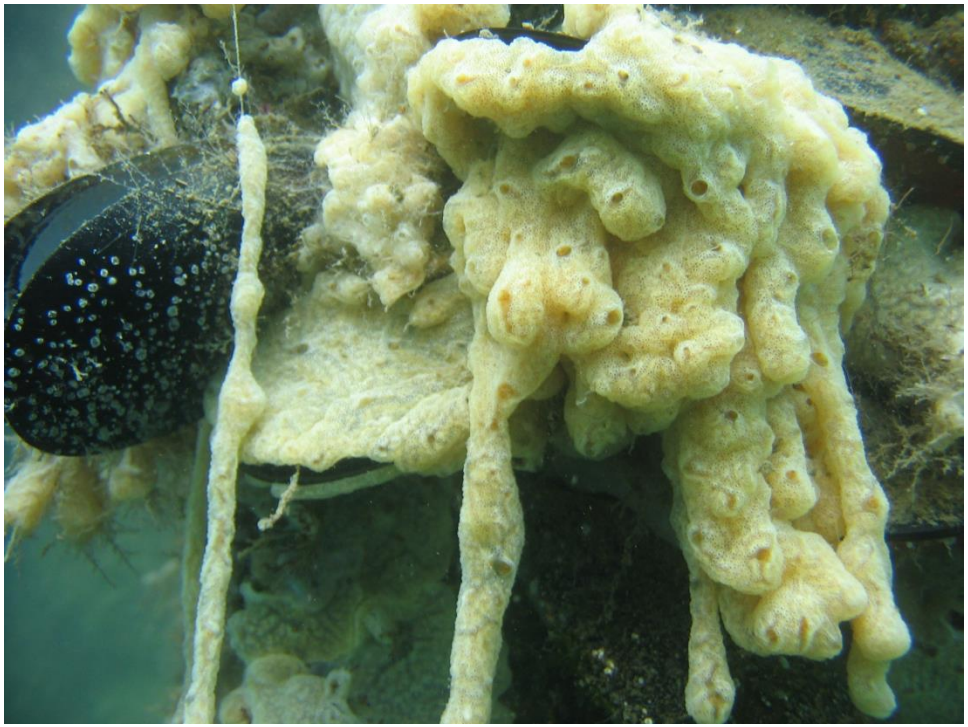
Solitary Tunicates *Stylela clava*

Solitary Tunicates *Molgula* sp.

Colonial tunicates (*Botryllus schlosseri* & *Botrylloides violaceus*)



Colonial tunicates *Didemnum* sp.



Boring Sponge
Cliona

Over-set


Overset

Spat collection

Chinese Hats

French tubes

French Tiles

en Brochette

Fouling control

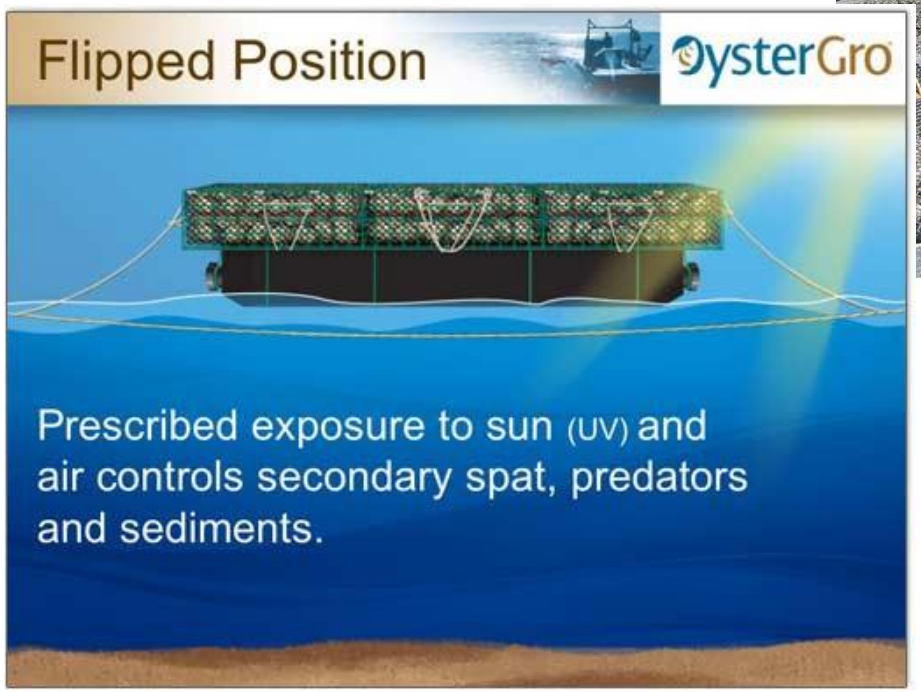
- Brushing or power washing
- Air drying
- Chemical control
  - ANTIFOULING MATERIALS
  - TOXIC AGENTS
    - BRINE DIP
    - ACETIC ACID
- Hot water dip
- Gear rotation

Fouling control

- Brushing or power washing

Fouling control

- Air drying



Fouling control

- Chemical control
  - ANTIFOULING MATERIALS

Fouling control

- Chemical control
  - TOXIC AGENTS
    - BRINE DIP
      - Saturated brine solution
      - Leave oysters out for 30-60 minutes to ensure closed
      - Dip for up to15 minute
      - Air dry for 2-4 hours
    - ACETIC ACID
      - 5% acetic acid (vinegar strength)
      - Spray with garden sprayer

Brine Dipping

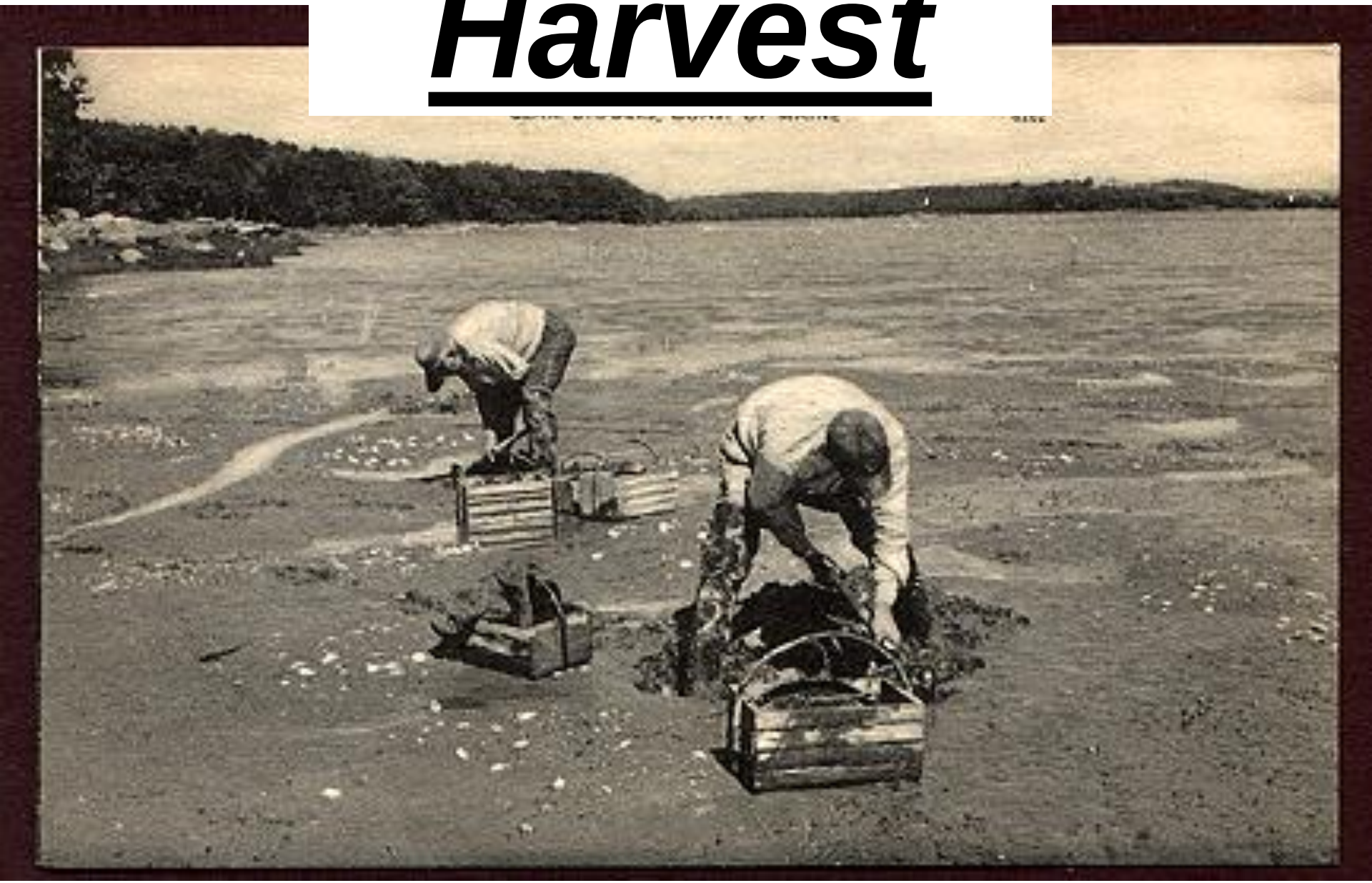
Fouling control

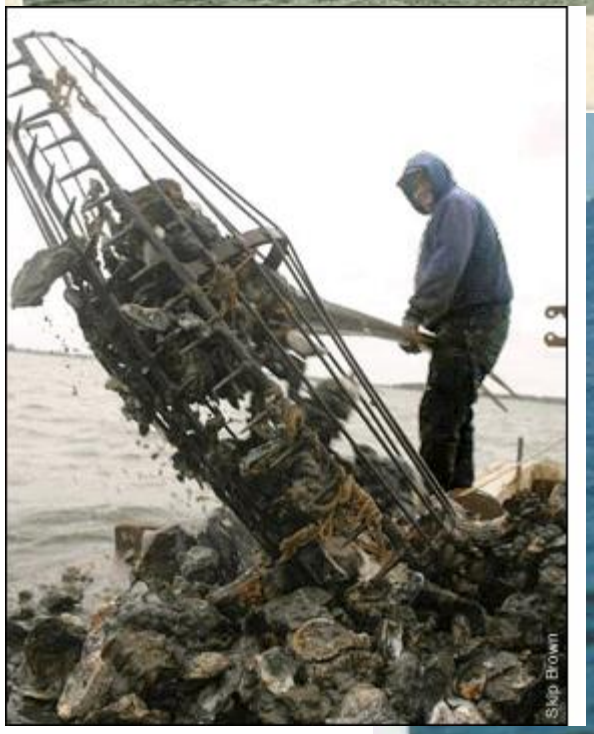
- Hot water dip
  - 82°C (182°F) dip for 3 seconds immediately followed with a cool water dip
- Korean: Hot water treatment
  - Heat up seawater to 55-60°C (130-140°F) in a great can or oven on a barge.
  - Soak the strings of oyster in the heated sea water for 10 to 15 seconds.
  - This method is effective in eradicating *Mytilus* spp., *Balanus* spp., and Ascidians

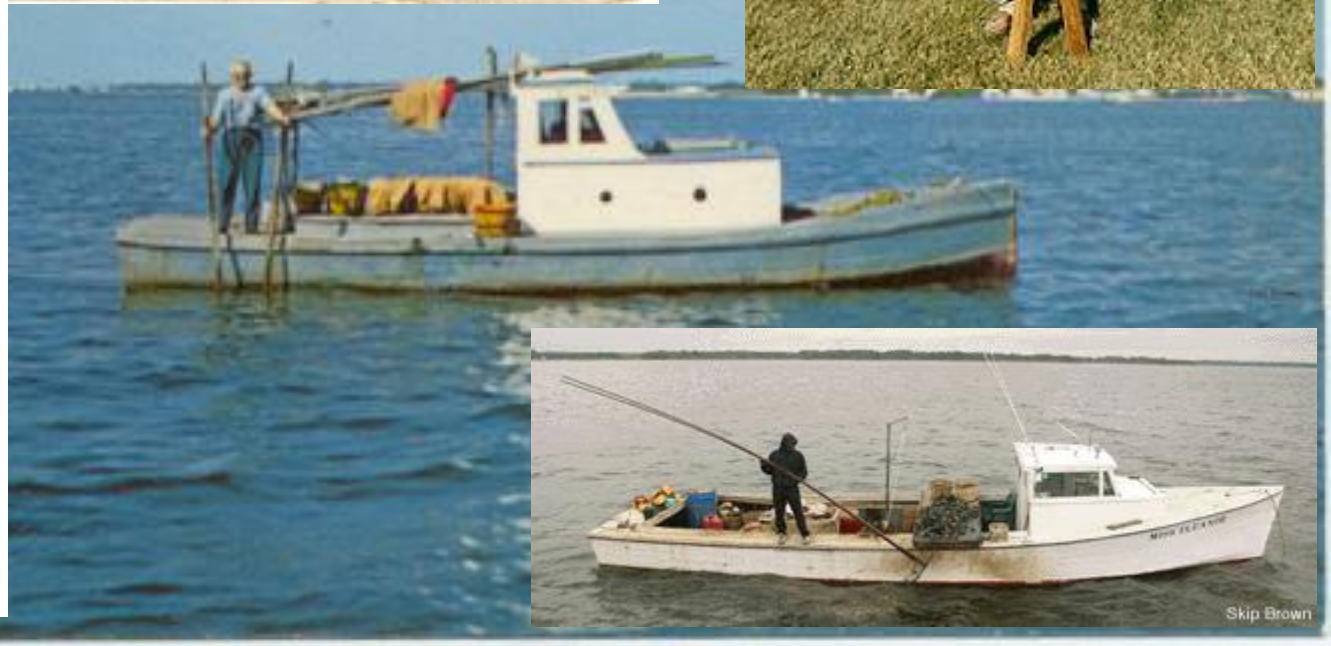
Fouling control

- Gear rotation
  - NRCS EQIP program
    - 25% redundancy in gear
    - Remove and replace
    - Clean fouled gear shoreside

Harvest




Skip Brown



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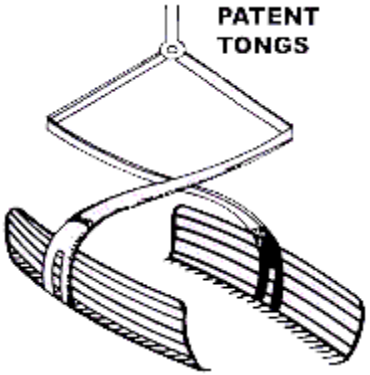
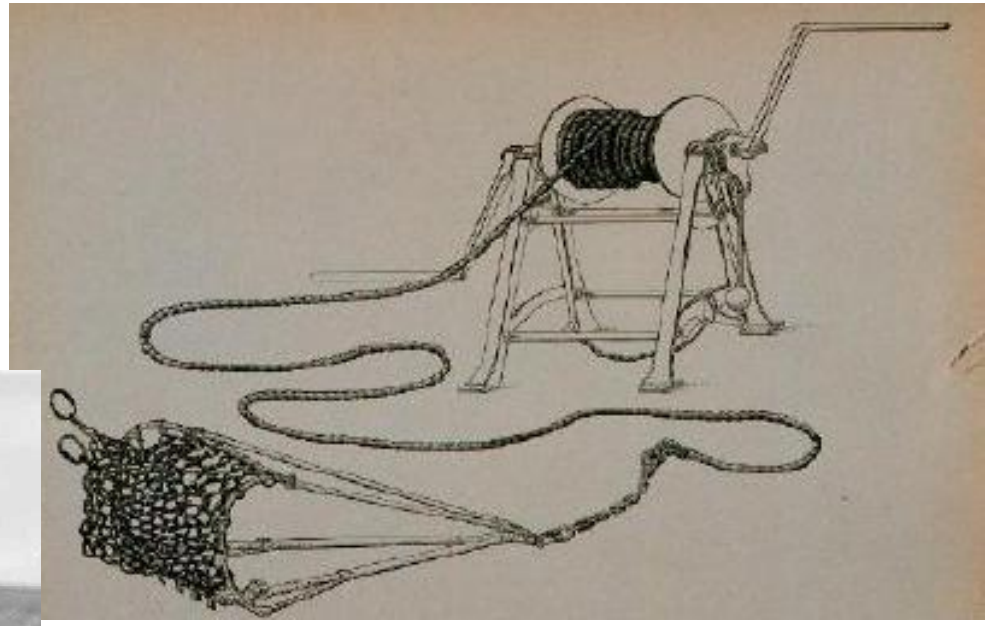
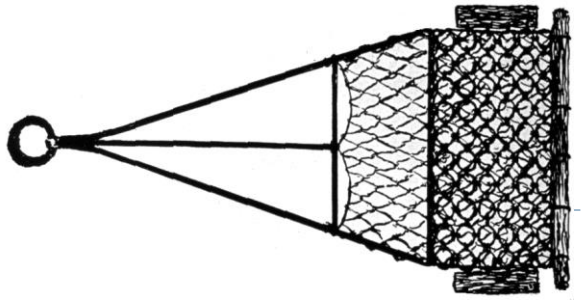

PATENT
TONGS





Dredging bottom planted oysters

Raking oysters

Grading

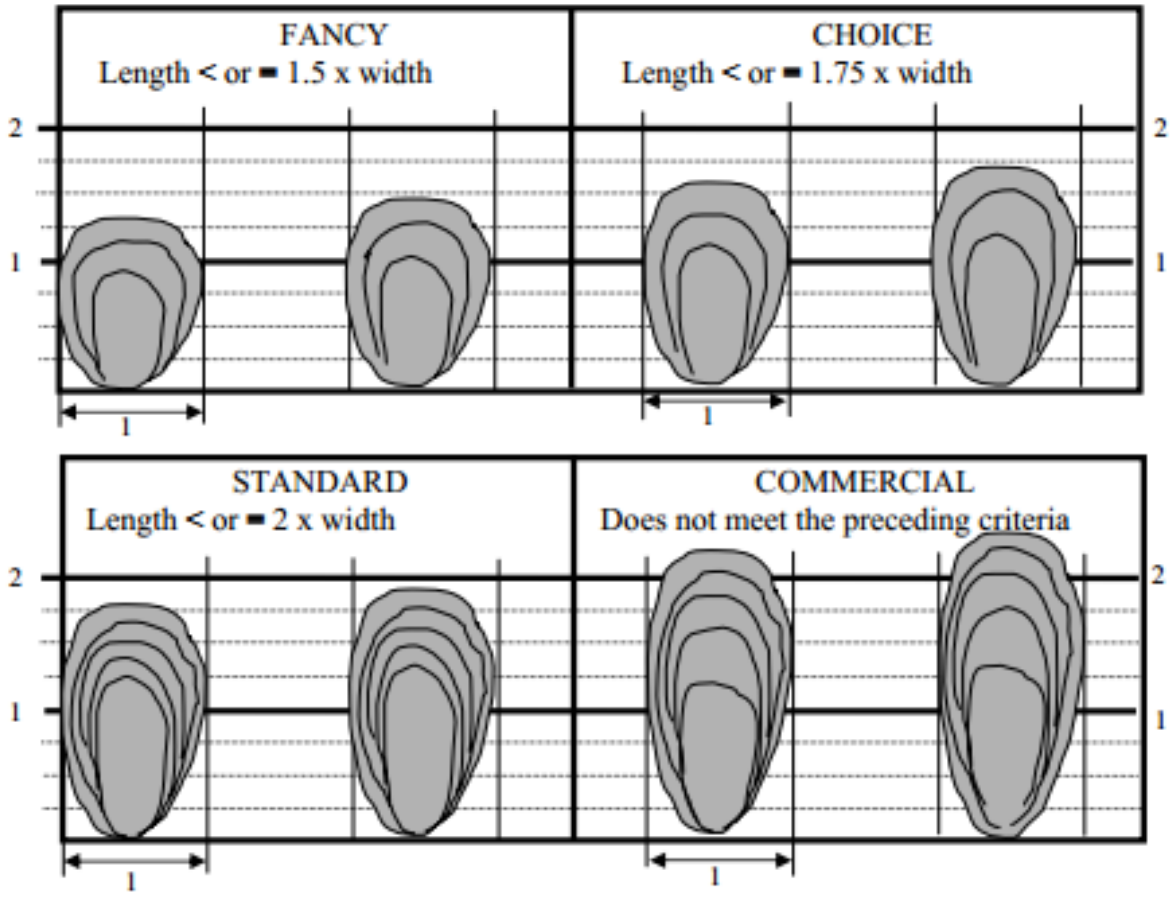


Figure 41 Grades of oysters

Grading & Culling

Grading Machinery

Oyster tumbler/grader

$ Total Operation Expense $ - Tumbler

		TOTAL $
- Tumbler Pipe (7' section)	112.00	
- V- Belt	65.00	
- Hydraulic Motor (Tumbler)		220.00
- Oil Flow Control		120.00
- Hydraulic Hose		68.00
- PVC pipe w/ fittings		14.00
- H2O Hose (1 ½ used fuel hose)		20.00
- Frame (wood) (2x4's)		47.00
- Wheels (8)		64.00
- Wire mesh panels (2)		22.00
- Wire Table		17.00
- Chute from tumbler to conveyor		50.00
- **TOTAL**		**$ 819.00**

Conveyor

		TOTAL $
- Conveyor Motor		220.00
- Conveyor Belt	75.00	
- Oil Flow Control		120.00
- 2"x2" Aluminum Angle Iron 80'	390.00	
- 4 bearings		160.00
- 2 Stainless Rollers		240.00
- Hydraulic Hose		68.00
- Nuts + Bolts		12.00
- Total $		$ 1,285.00
- Tumbler		$ 819.00
- TOTAL		$ 2,104.00

Production Number Comparison

At Maximum Production :

Cage : 1 Person

2400 oysters - 8 ½ hr harvesting

2 People

3700 oysters - 8 ½ hr harvesting

Dredge : (Tumbler + Conveyor)

1 Person

5100 oysters - 8 ½ hr harvesting

2 People

9200 oysters - 8 ½ hr harvesting