Florida Aquaculture Marine Bivalves

Produced by the Division of Aquaculture - 2017

Introduction

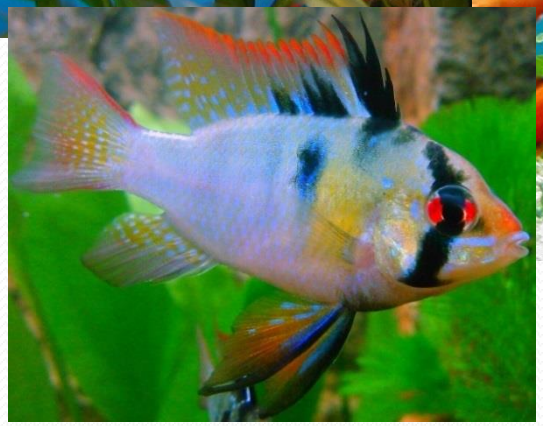
- This presentation will cover…..
  - The marine bivalve aquaculture economy
  - Florida's marine bivalve industry
  - Environmental benefits
  - Clam aquaculture methods
    - Hatchery
    - Nursery
    - Grow-out
    - Harvest and processing
  - Oyster aquaculture
  - Research priorities

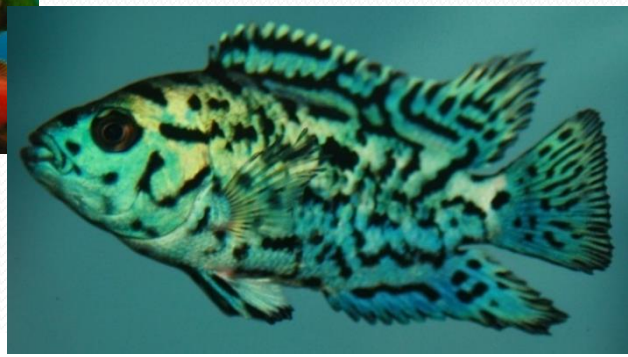
Did you know?

Clams rank #2 in Florida Aquaculture sales!

Which aquaculture product is #1?

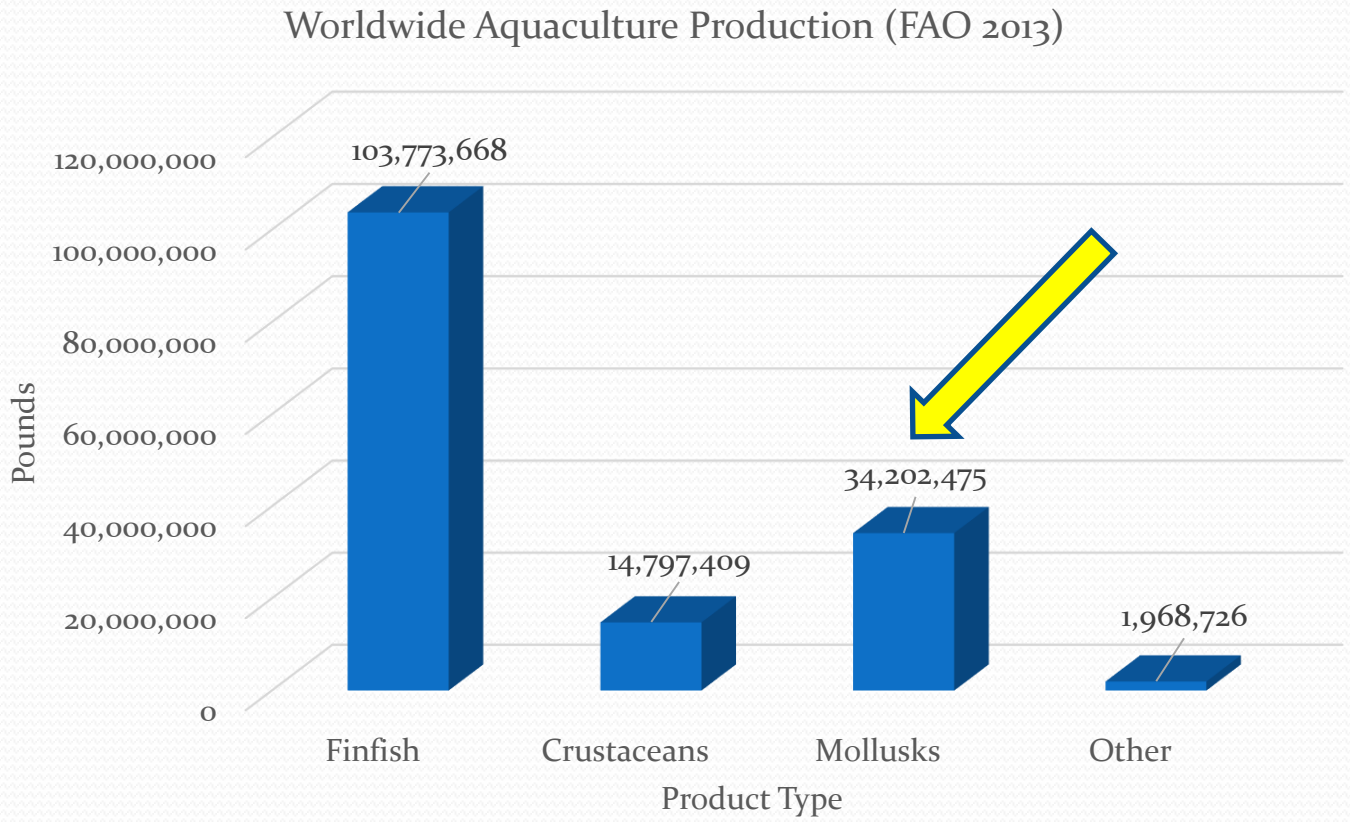
Ornamental Fish are #1





Valued at $27.3 million in 2012!

Marine Bivalve Aquaculture



In 2013, 34 million pounds of mollusks were grown globally!
Molluscs are the #1 Mariculture product in the world!

What is Mariculture?

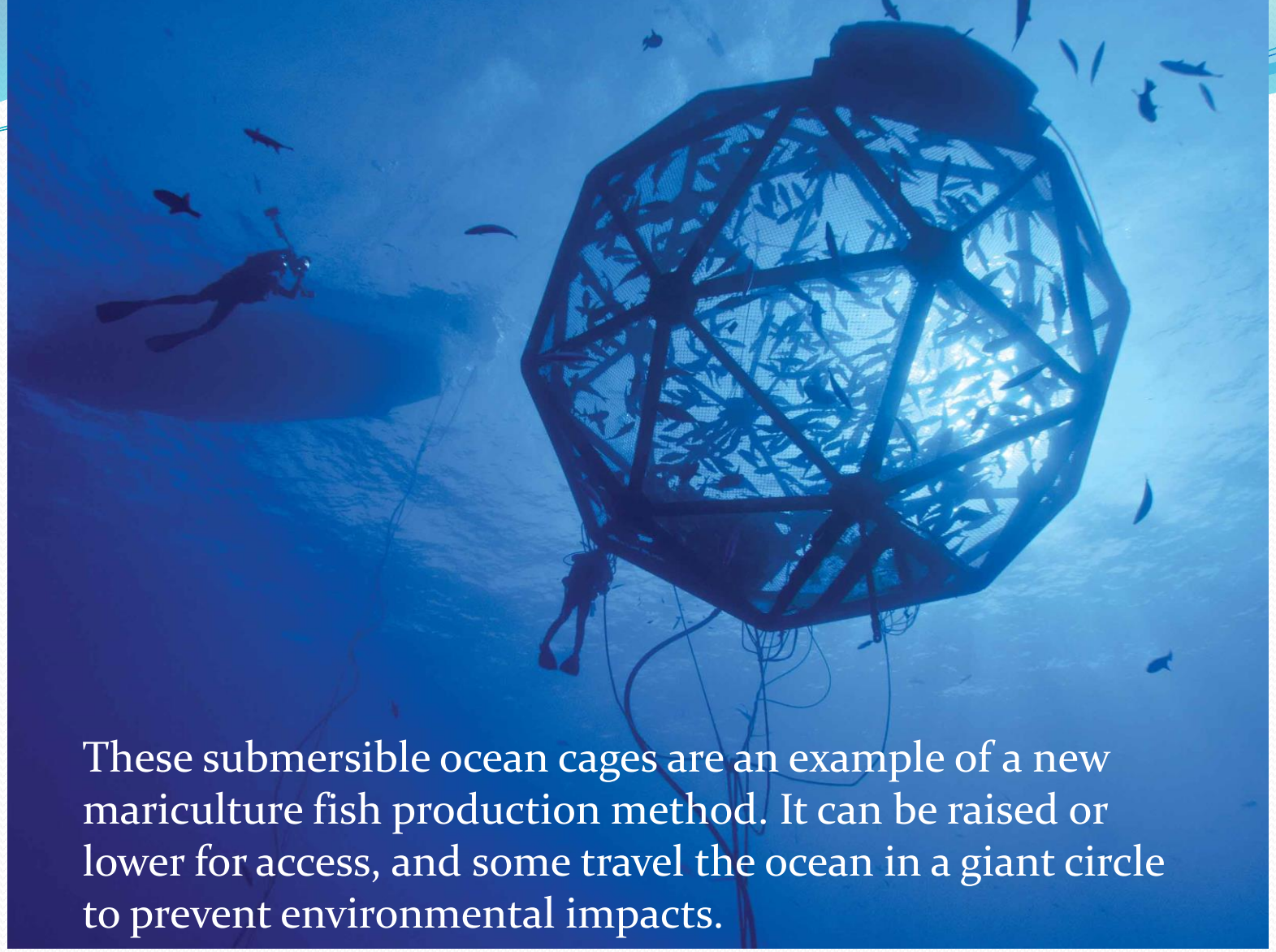
Mariculture is a specialized branch of aquaculture that produces aquatic products in the open ocean.

- Mariculture can be divided into 3 main categories
  1. Fish
  2. Molluscs
  3. Plants/Seaweed

Let's see some examples of Mariculture in the next slides.....

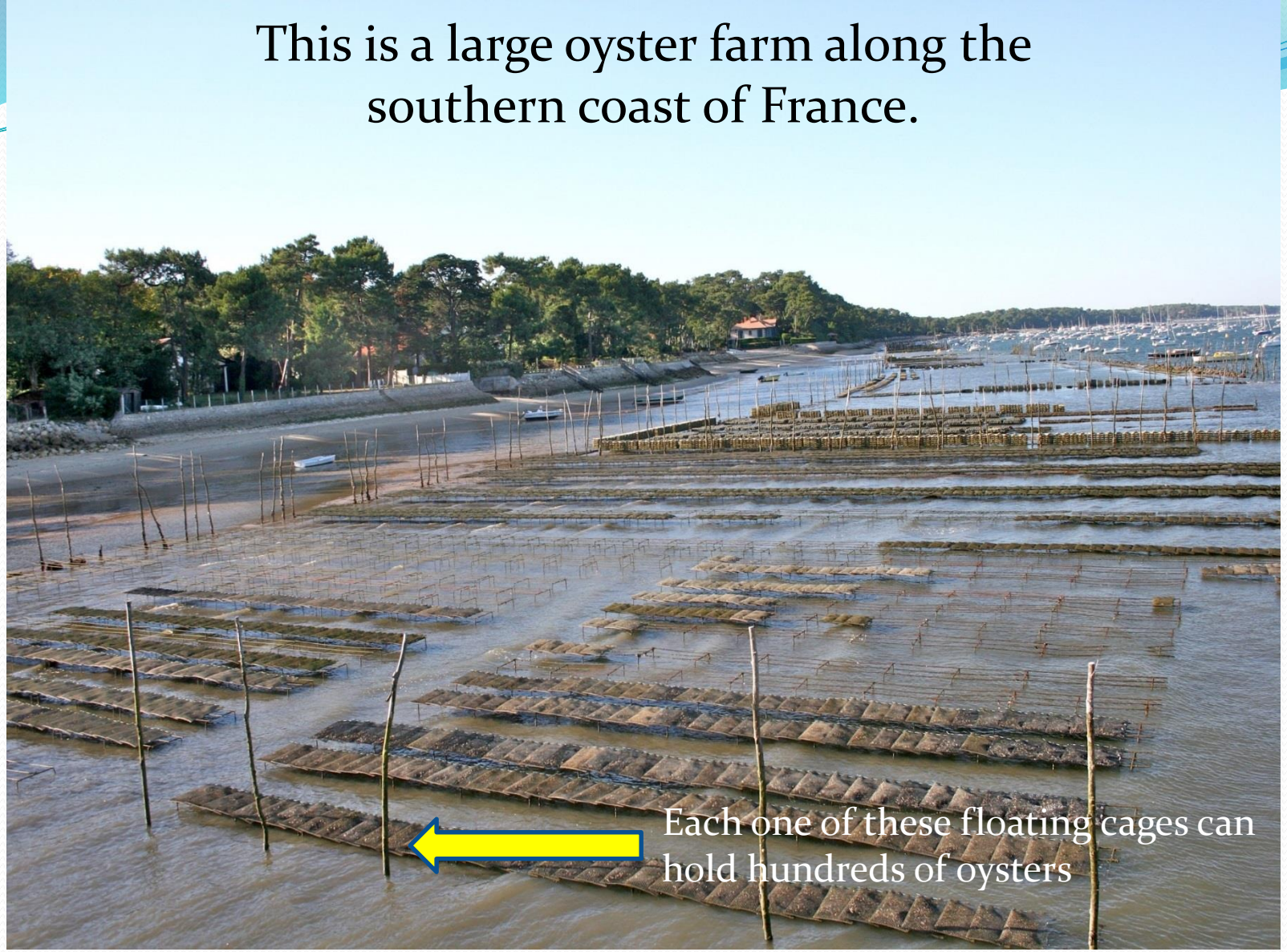
This is a typical net-pen salmon farm in Chile

A single net pen can be up to 105 ft wide, 33 ft deep and hold 90,000 salmon!



These submersible ocean cages are an example of a new mariculture fish production method. It can be raised or lower for access, and some travel the ocean in a giant circle to prevent environmental impacts.

This is a large oyster farm along the southern coast of France.



The “Floating city” in Luoyuan Bay, in southeastern China.

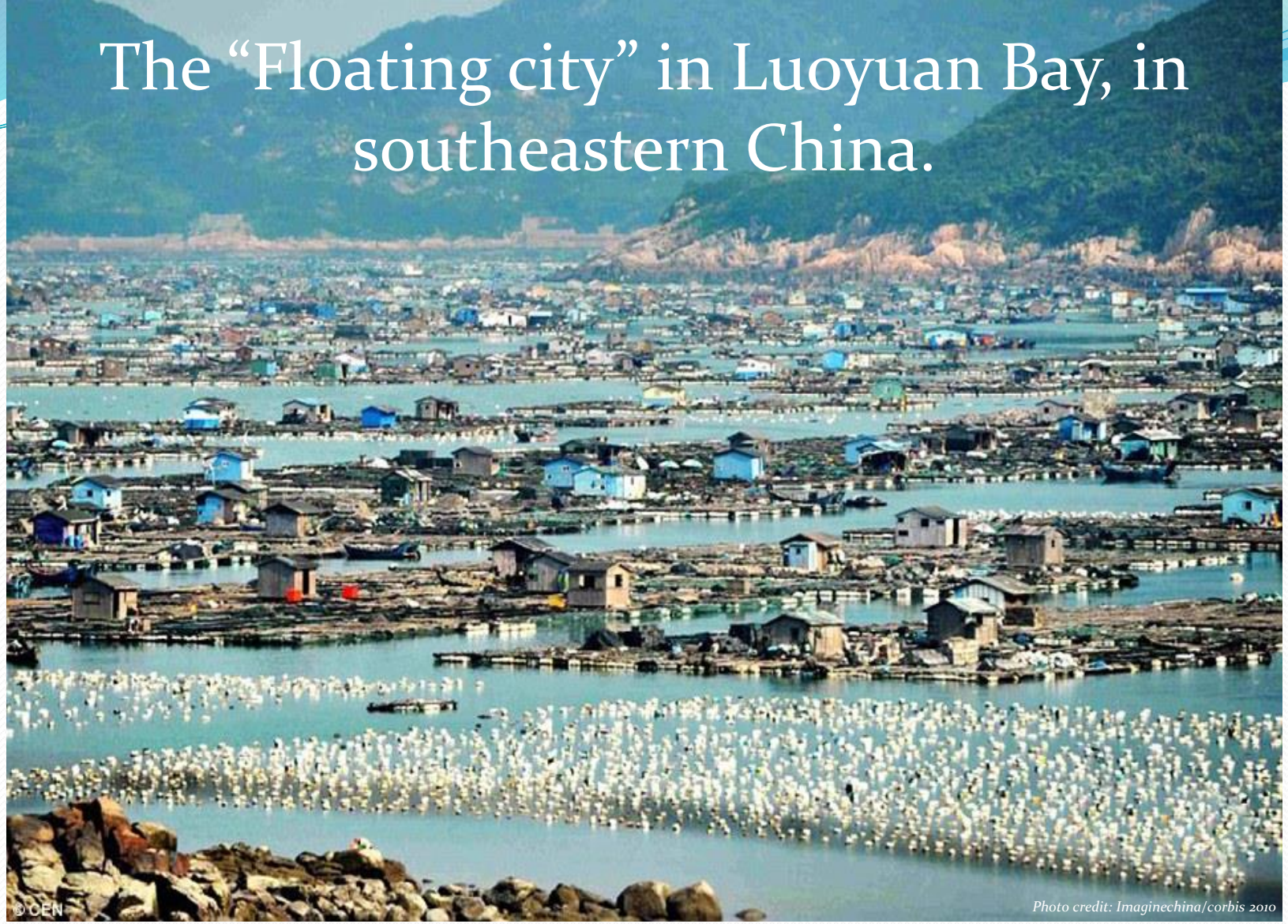
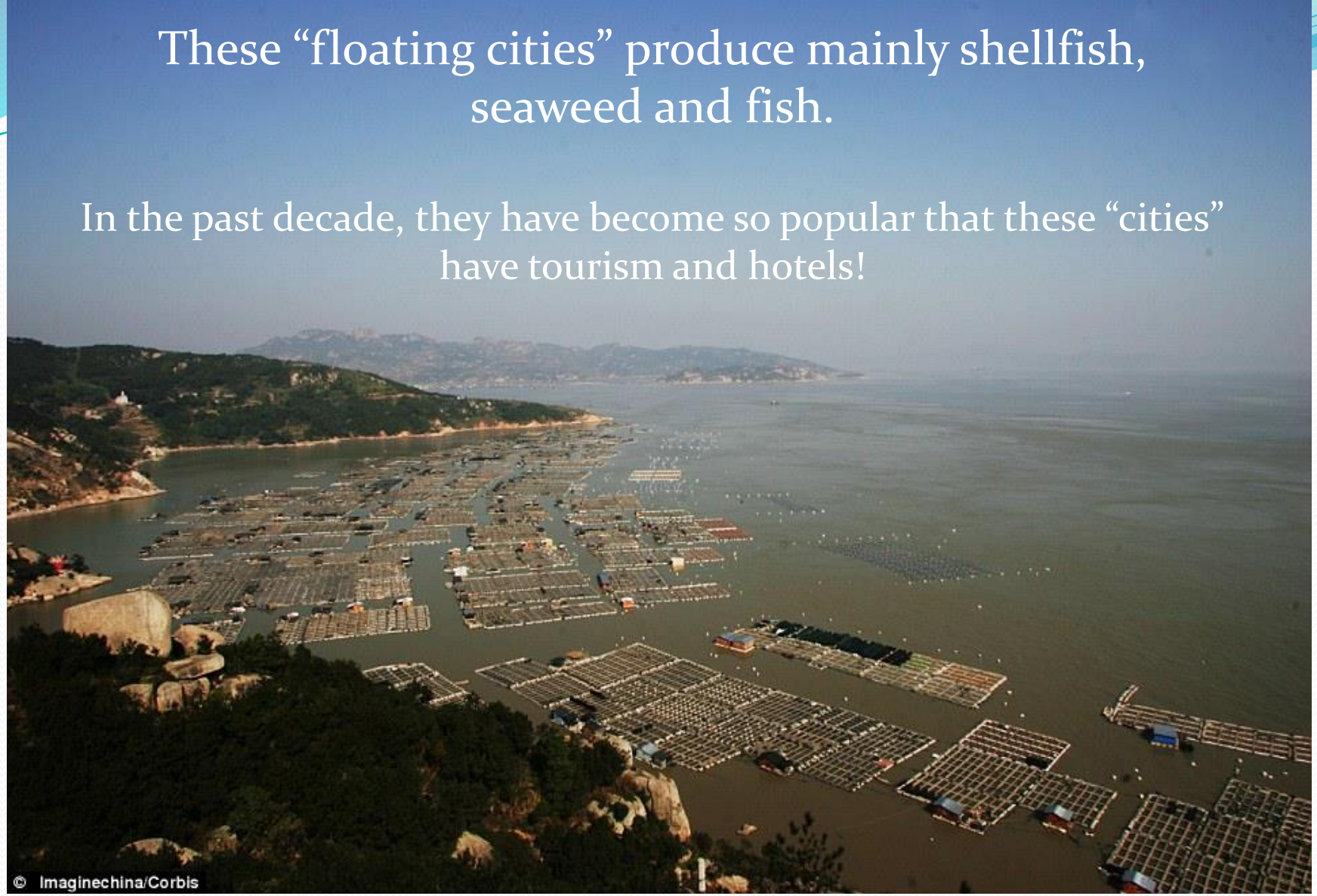


Photo credit: Imaginechina/corbis 2010

These high-density mariculture sites produce products from all 3 types of mariculture in this single area.

These “floating cities” produce mainly shellfish, seaweed and fish.

In the past decade, they have become so popular that these “cities” have tourism and hotels!



This is a large seaweed farm in Japan.

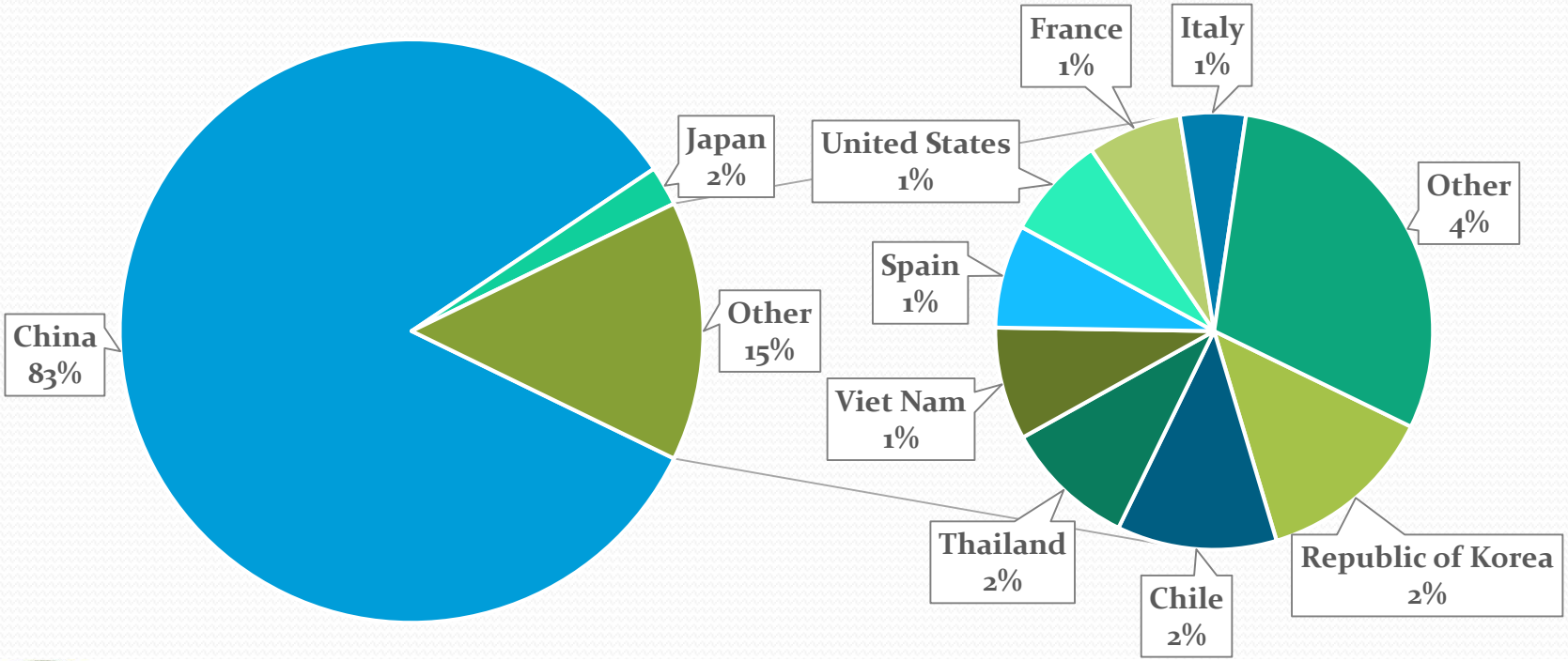
While not very popular in the U.S., nori or seaweed is a staple of east Asian cuisine.

~60 million pounds are produced annually worldwide.

Photo credit: George Steinmetz, NGM

Global Bivalve Aquaculture Industry

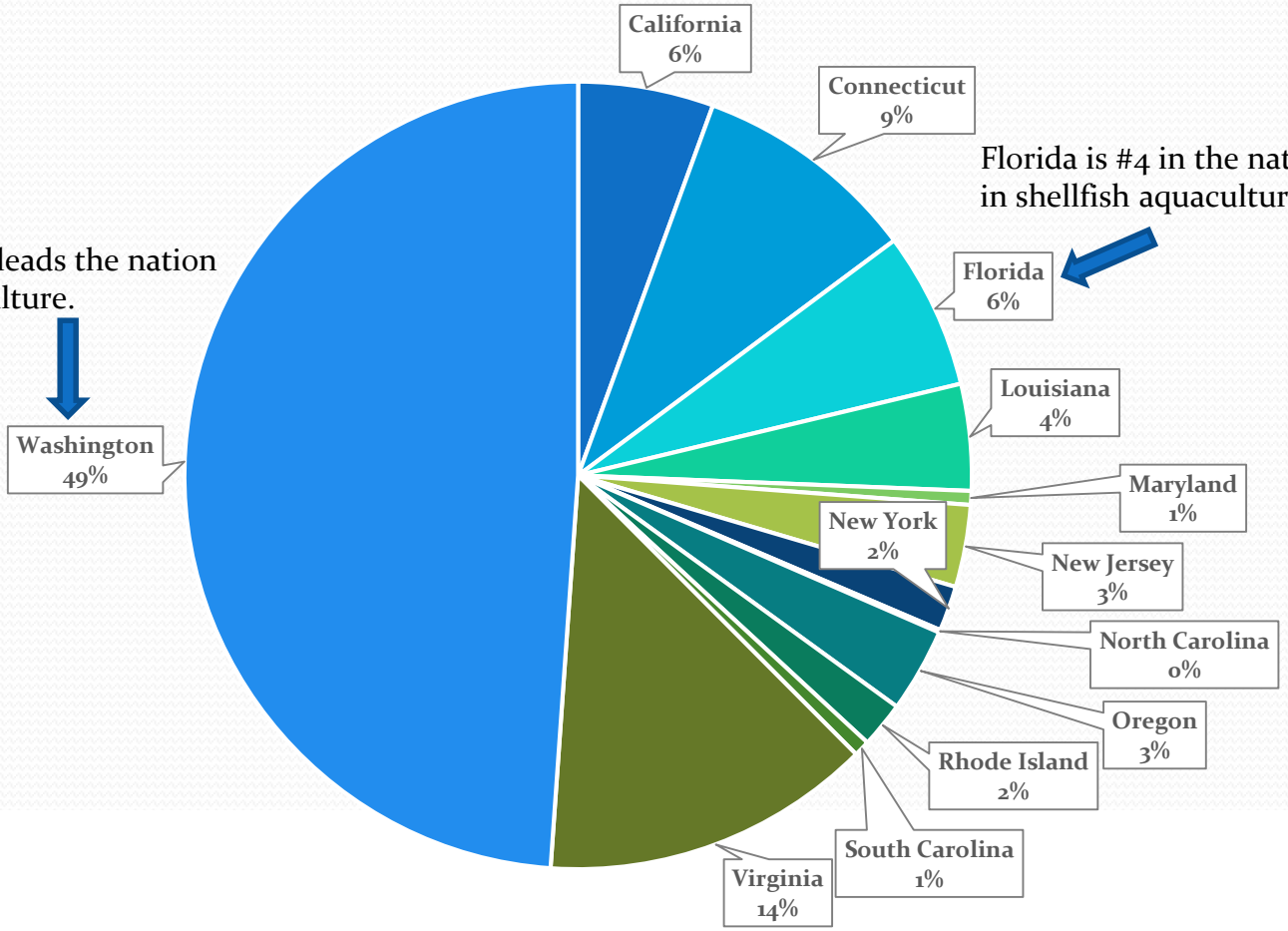
Mollusk Production by Nation



China produces a vast majority of the worlds mollusks.

U.S. Bivalve Aquaculture Industry

Annual Sales by State (% of national sales)

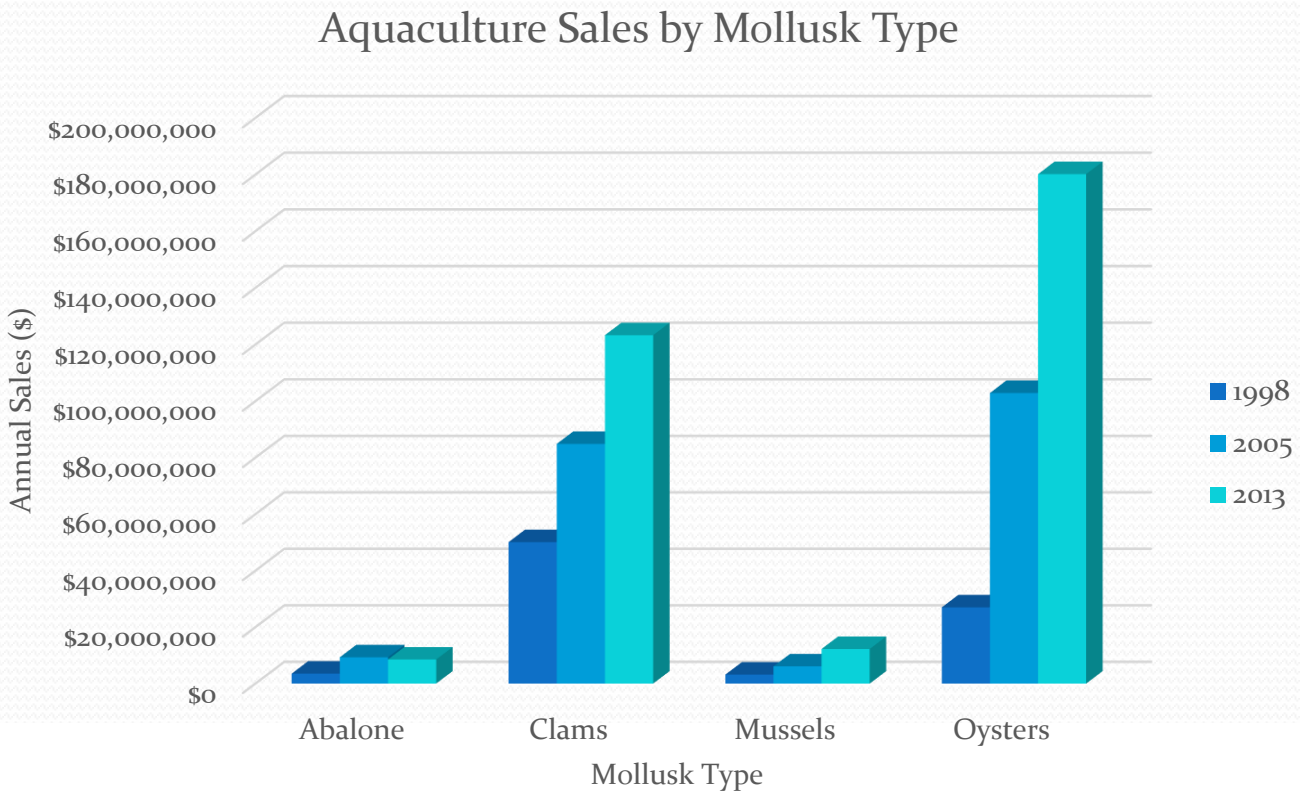


Florida is #4 in the nation in shellfish aquaculture!

Washington state leads the nation in shellfish aquaculture.

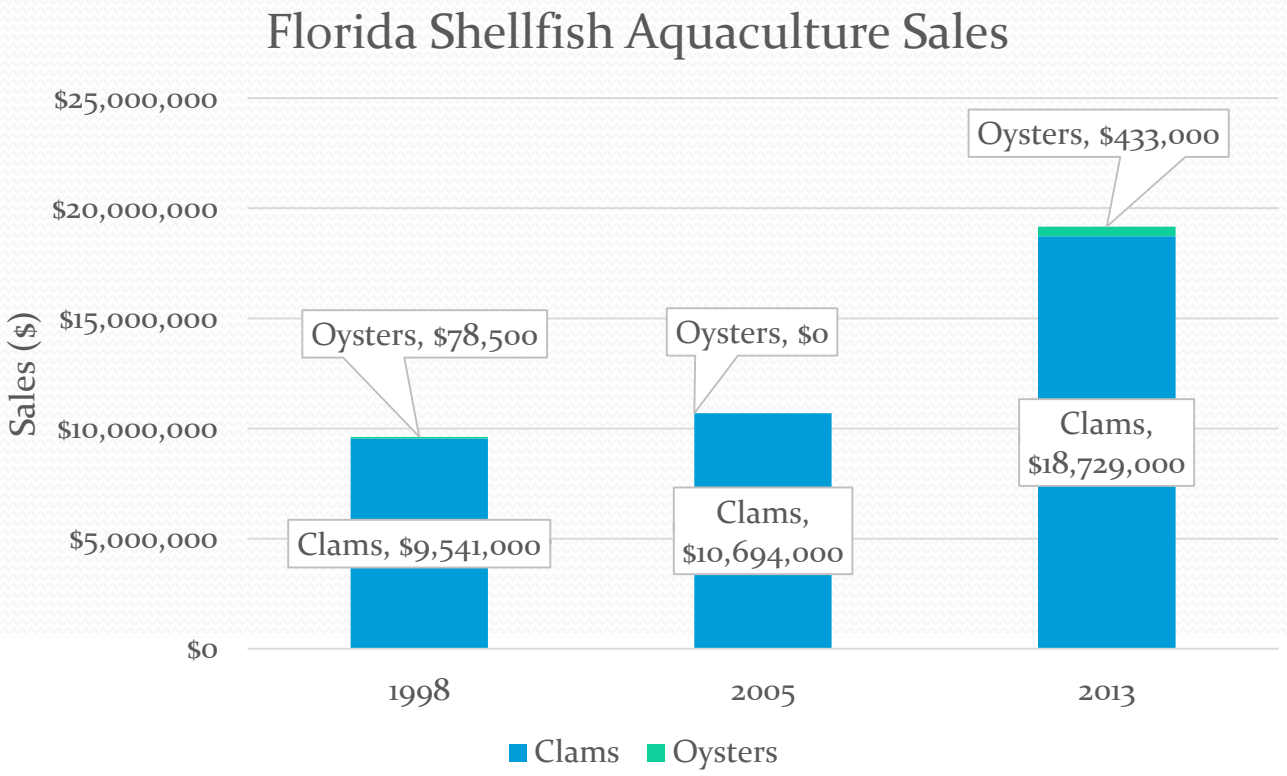
U.S. Mollusk Industry

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



Florida Shellfish Aquaculture Industry

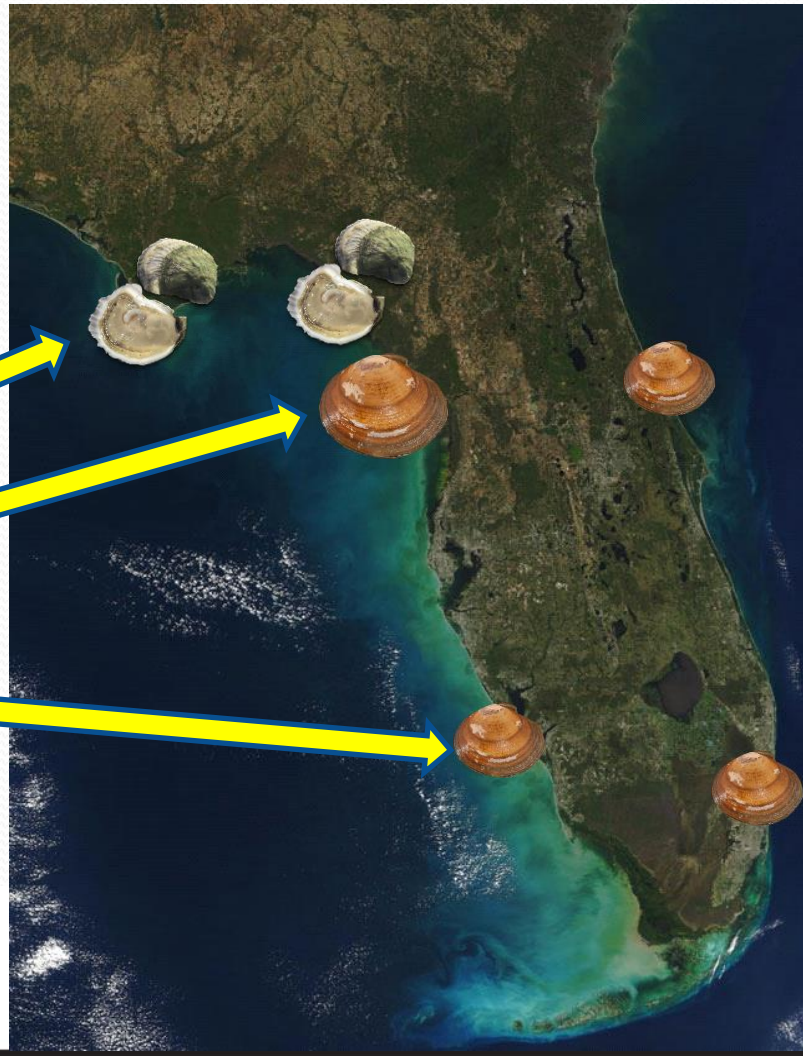
- Shellfish aquaculture in Florida is dominated by hard clams (98% of sales in 2013).
- Oyster aquaculture, in response to declining wild-stocks and advancing culture technologies, is increasing annually.



Florida Shellfish Aquaculture Industry

Where are shellfish cultured in Florida?

- The Big Bend region is a hotspot for oyster culture
- Cedar Key produces a vast majority of clams in the state.
- The SW and East coasts produce clams and oysters also.



Ecosystem Benefits of Shellfish Aquaculture

- Shellfish are living water filters
  - They feed by pumping water through their gills and remove particles that are edible.
  - Through filtering, shellfish clean the water and also remove harmful nitrogen, phosphorus and carbon from the environment.
    - ~550 million gallons of seawater are filtered each day in Florida by aquacultured clams alone!
    - In 2012, annual clam harvest removed 25,000 lb of nitrogen and 760,000 lb of carbon, a value of $99,680!

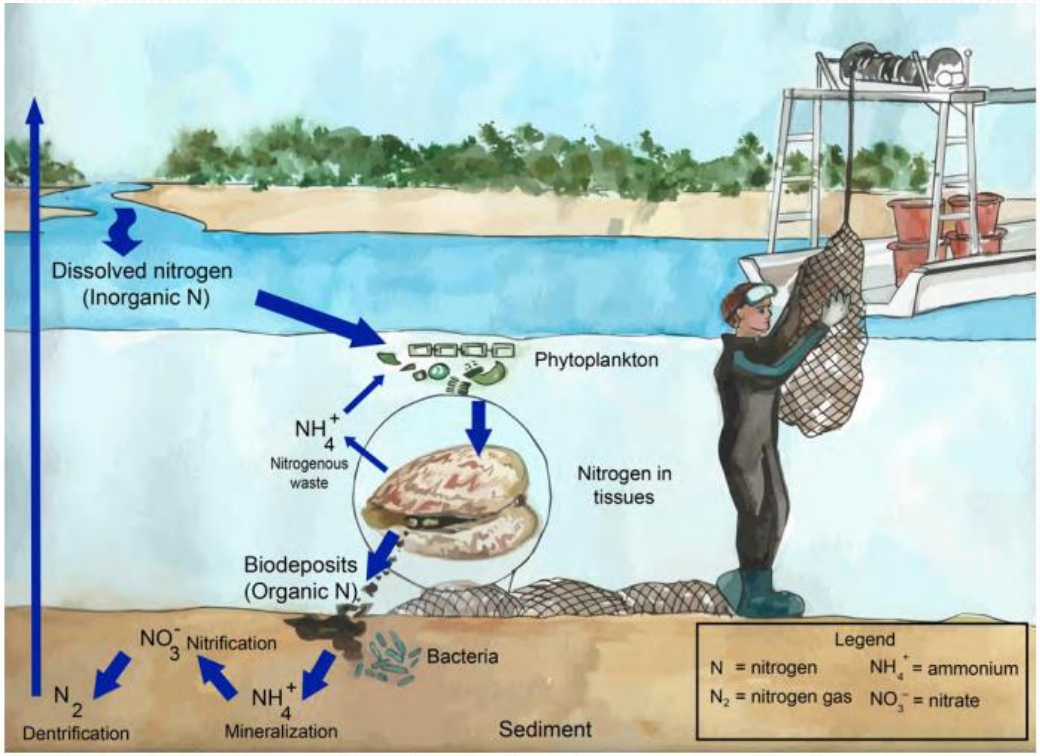
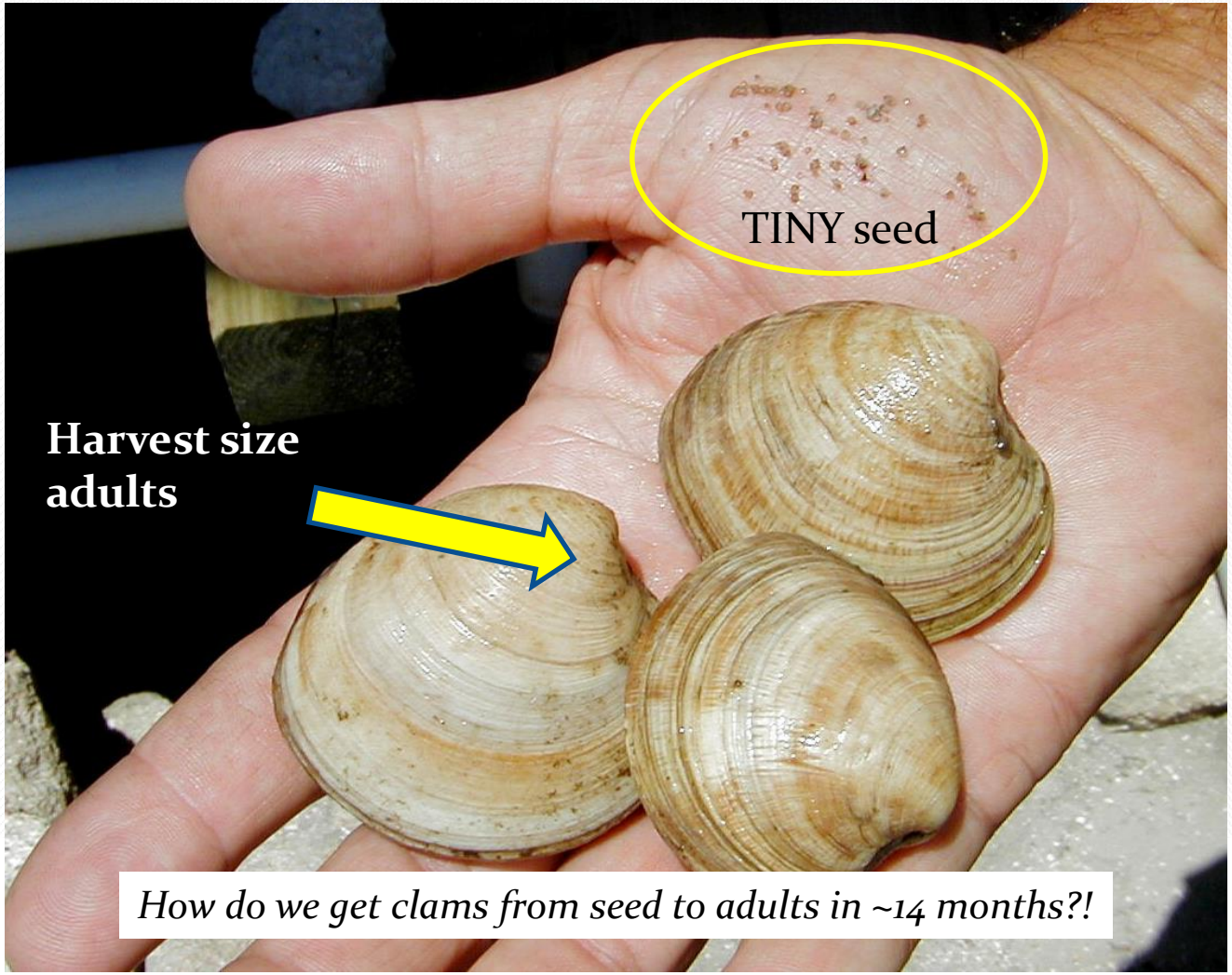


Figure 3. The role of hard clams in cycling and removing dissolved inorganic nitrogen from the marine environment.

Figure From: Barker et al. 2015; "Green Clams"

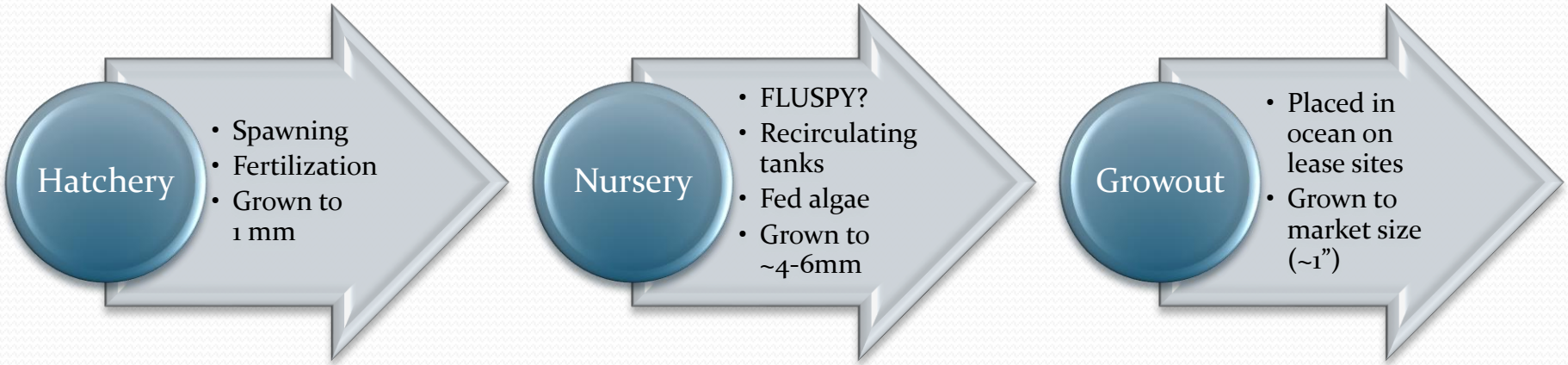
Shellfish Aquaculture Methods



Shellfish Aquaculture Methods

Three main phases of production

For this presentation, let's focus on hard clam production



We will talk about a FLUPSY in a few slides…

Hard Clam: Hatchery Phase

"Broodstock" are simply sexually mature, adult clams that are used for spawning.

At the beginning of the spawn, male and female broodstock clams are organized together in the same tray.

Hard Clam: Hatchery Phase

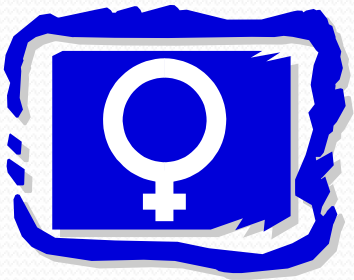
The water temperature is elevated above 79º F to induce the release of gametes (sperm of the males is released first which then triggers the release of eggs by the females).

Hard Clam: Hatchery Phase

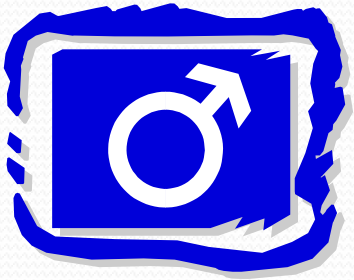
"Gametes" are either sperm for males or eggs for females.

As soon as the clams begin releasing their gametes they are removed from the tray and isolated in their own containers. Then it can be determined whether they are males or females.

How can we tell the difference between the gametes of the male and the female?



Female gametes are off-white, kind of yellowish in color and they have a grainy appearance.



Male gametes are white in color and they have a smooth, milky appearance.

Now let's see if YOU can tell the difference!!

Is this a male or female clam?

What about this clam?
Is it different than the one you just saw?

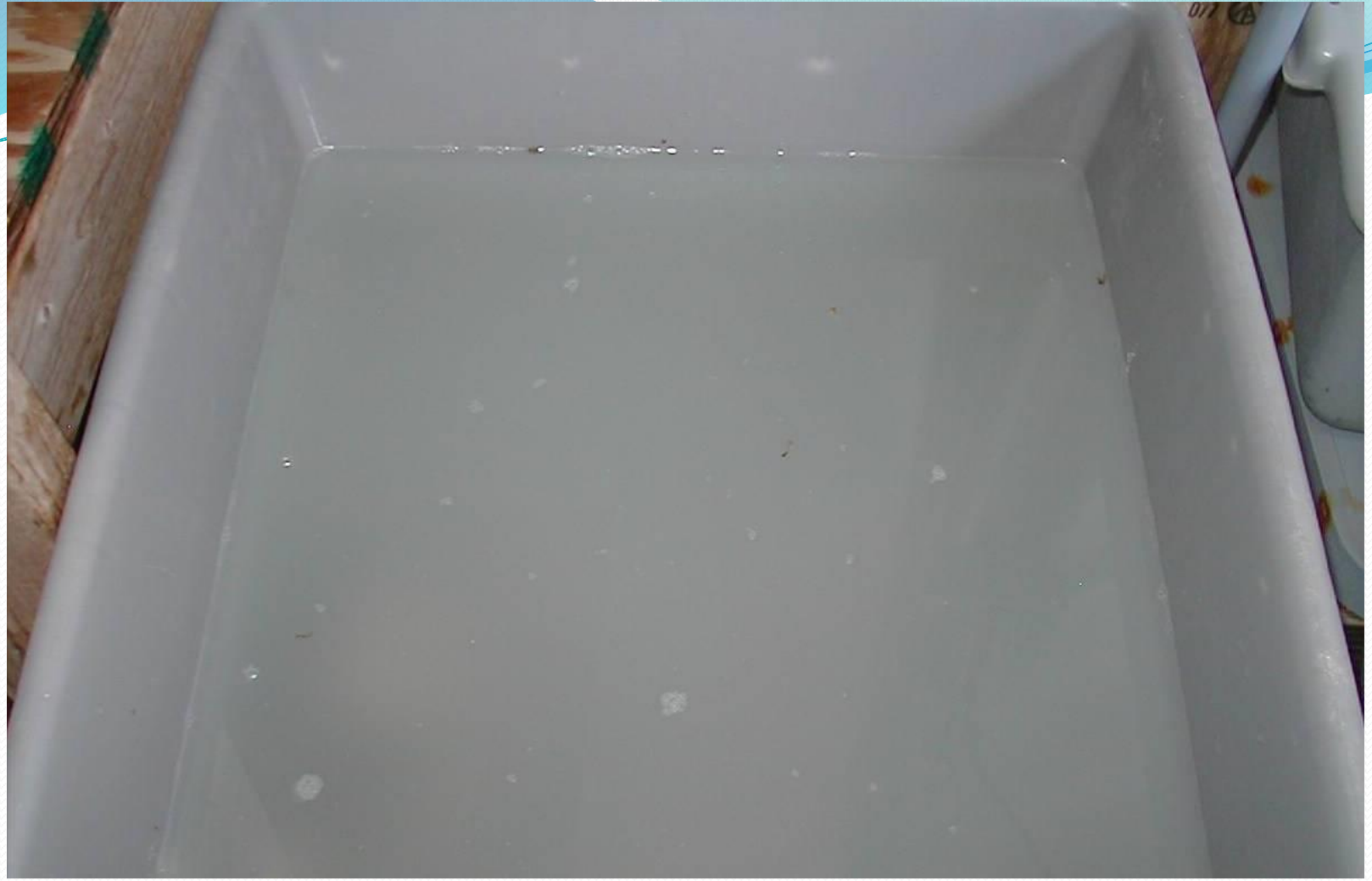
Notice the male sperm is cloudy and uniform.

While female eggs appear grainy and translucent.

If you said this is a male...
you are correct!!

If you said this is a female...
correct again!!

Once the males are determined they are removed from the tray and grouped in a separate container with all other males, where they continue releasing gametes into the water.



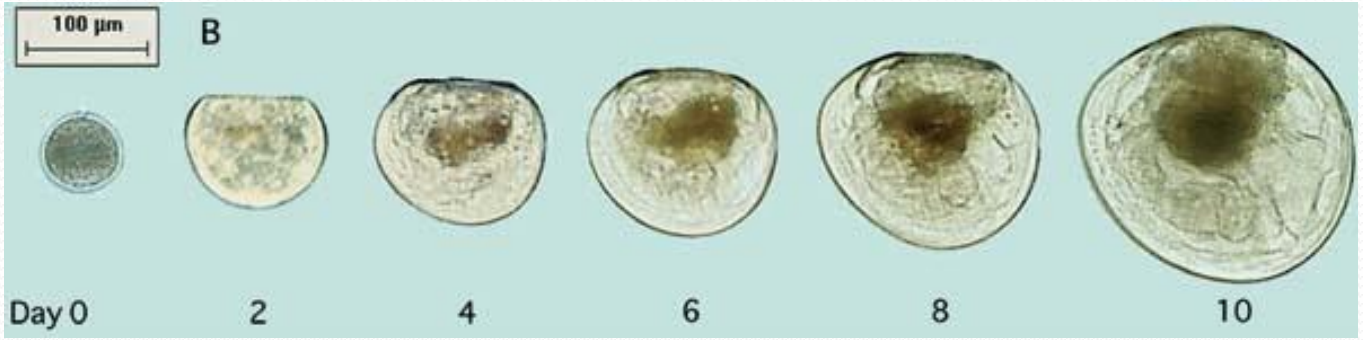
As the males continue to release their gametes the water takes on a cloudy, milky appearance.

With the male clams set aside, the eggs from every female are collected in a small container.

spawning

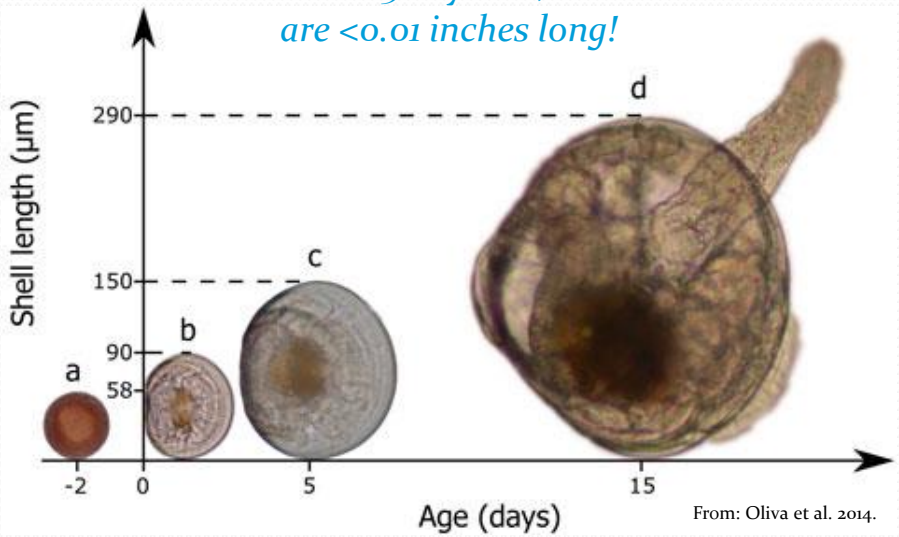
All eggs are then transferred to a large circular growing tank where the water is well aerated and moving.

The male gametes are then added to the water, where they will mix with the eggs, resulting in fertilization and the production of clam larvae.



From: FAO Tech. Paper #471.

Even at 15 days old, clams are <0.01 inches long!



From: Oliva et al. 2014.

Larval clams are difficult to see with the naked eye when they're only days old so it's best to view them under a microscope.

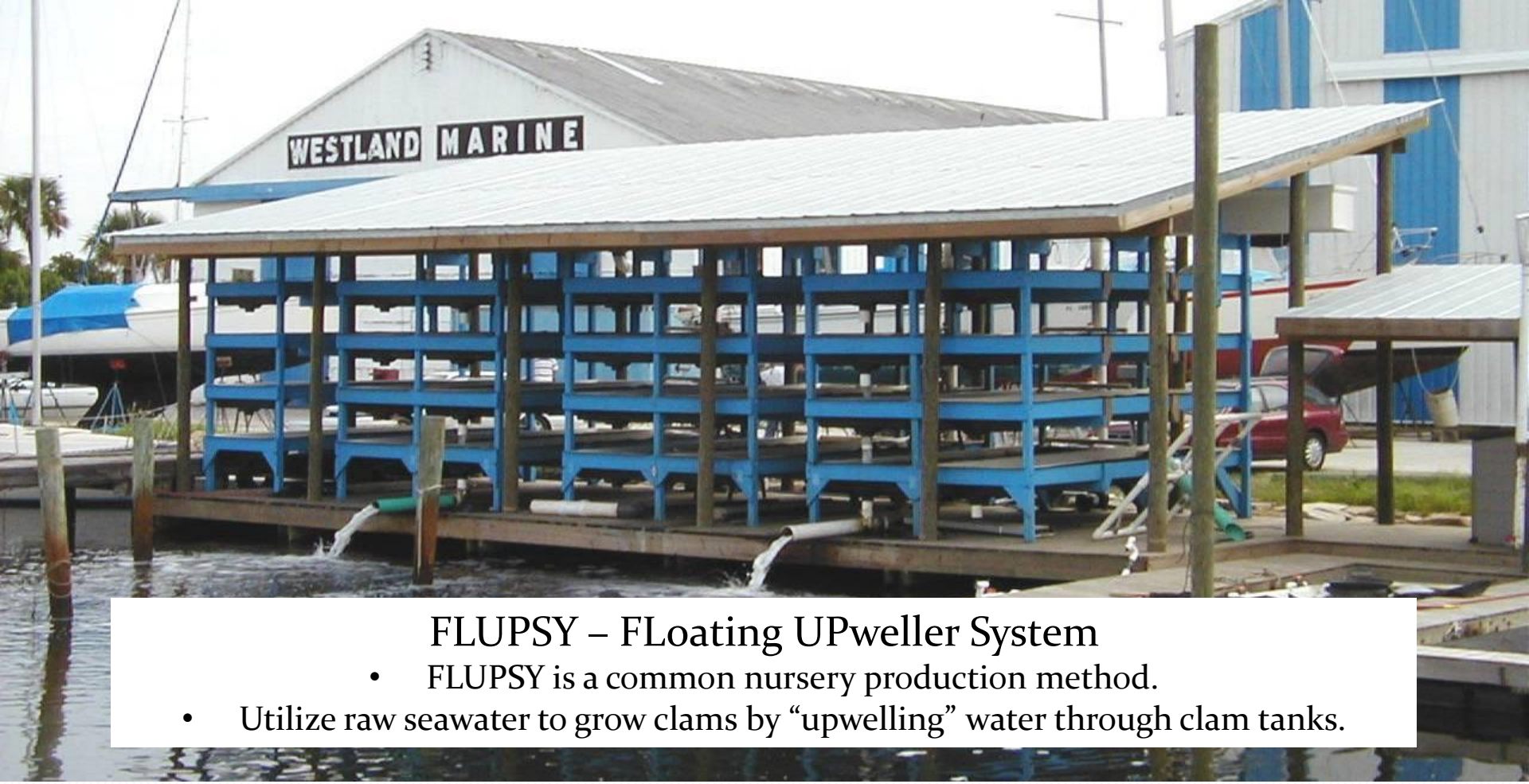
Photo credit: FAO Tech. Paper #471

Clam larvae are fed with algae…

…which is cultured on site in large tanks.

Hard Clam: Nursery Phase

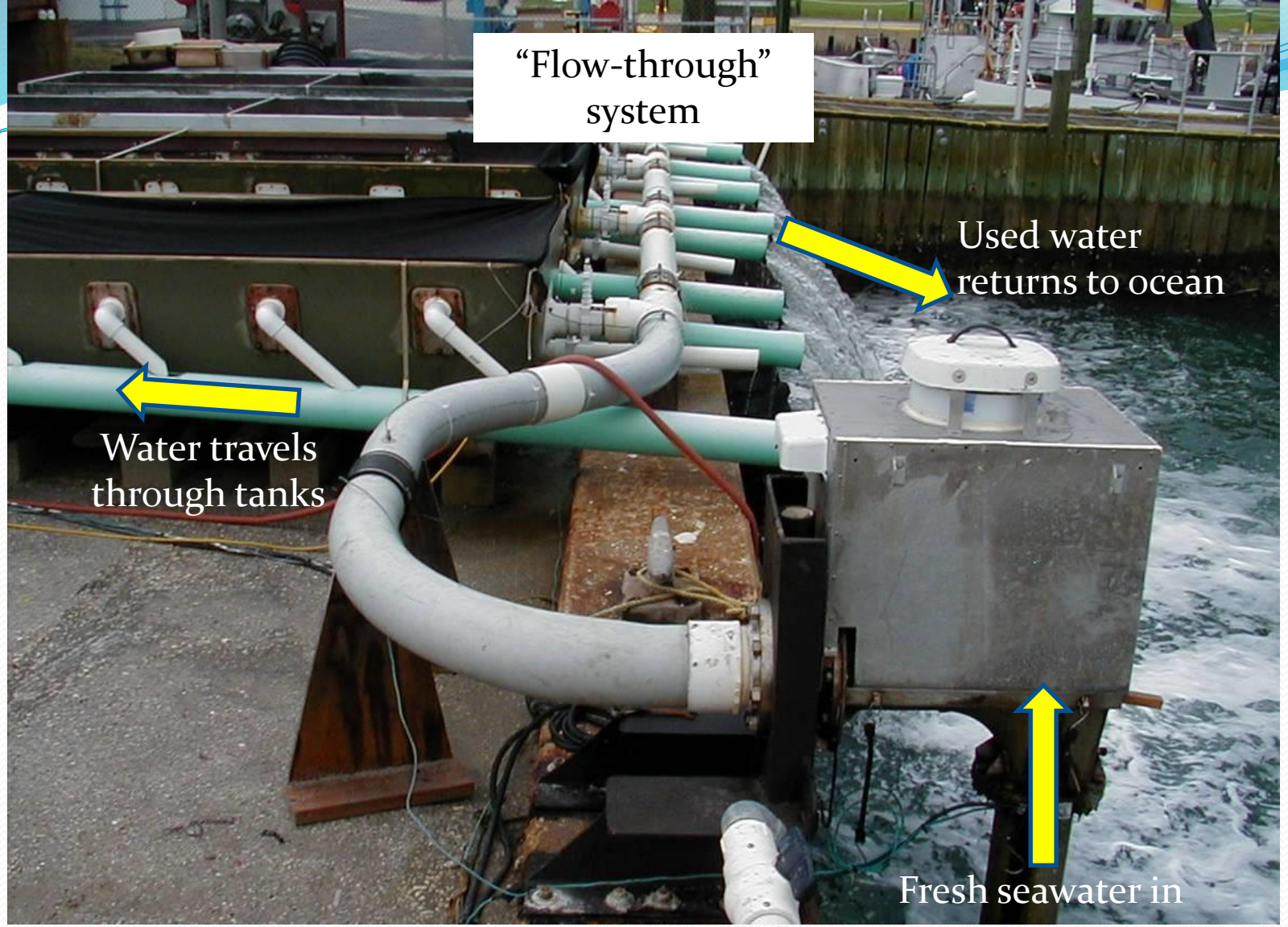
Instead of stocking larval clams straight onto lease sites, clams are grown to a larger size (~4-6mm) in controlled conditions to improve survival and growth.



FLUPSY – FLoating UPweller System

- FLUPSY is a common nursery production method.
- Utilize raw seawater to grow clams by “upwelling” water through clam tanks.

When larval (seed) clams reach ~1 mm in size they are moved to a flow through nursery setting where they can grow more rapidly.



The intake and flow-through of fresh seawater serves as a food source, allows for adequate oxygen and removes waste.

Depending on the size of the clams, the flow of water can either be pulled down (downwellers) or forced up (upwellers) through the clam seed.

- Downwellers are for small seed
- Upwellers are for larger seed

Which nursery system type is this?

Downweller

What about this system?

Upweller

Small seed at start of nursery phase

Large seed at end of nursery phase

Seed growth during the nursery phase

These two systems are flow through and utilize raw seawater

These two are recirculating and utilize filtered seawater

Land based nursery systems

- More costly to operate
- More control over water quality and feeding
- Improved survival and growth

Photo credits: Auburn University, Dolphin Island Shellfish Lab.

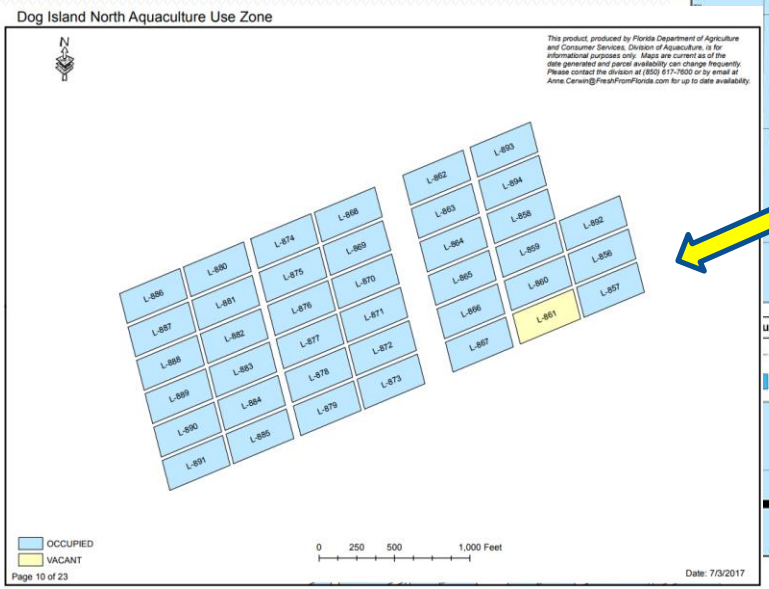
Hard Clam: Grow out

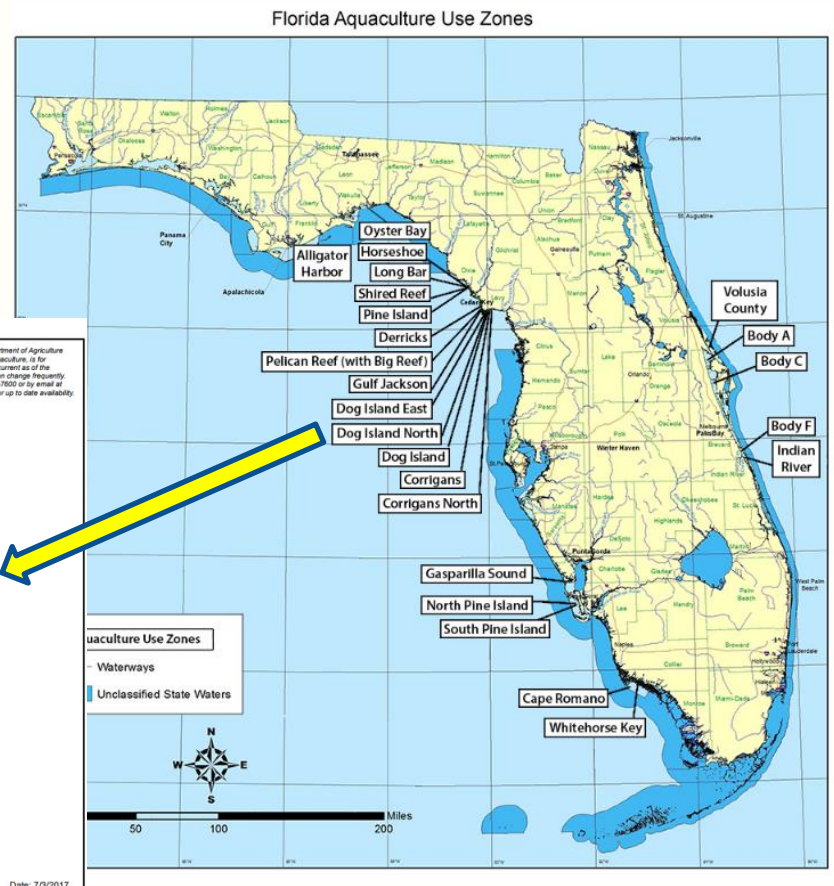
Once clams reach a certain size (~4-6 mm) they are placed in fine mesh bags and planted in areas called Submerged Land Leases.

Hard Clam: Grow out

Submerged land leases are lands owned by the State of Florida so aquaculturists must obtain permission from the State to farm their clams on a lease.

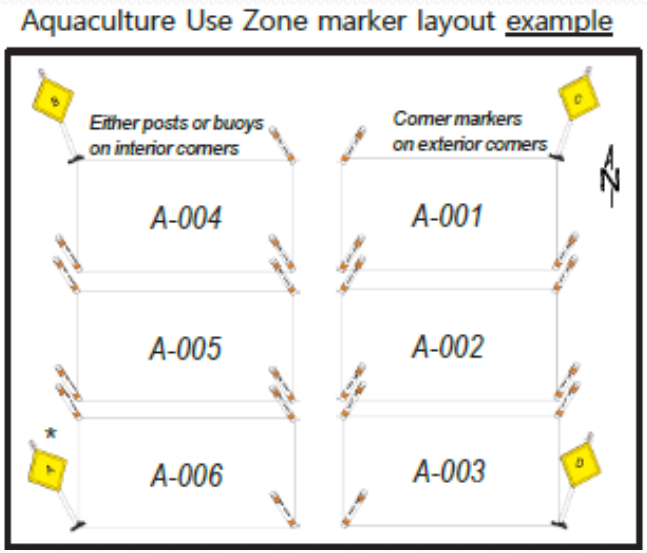
- Submerged land leases are public lands and available to anyone interested in applying.
- **Aquaculture use zones (AUZ)** are areas with predetermined lease sites grouped into a single area often containing dozens of parcels or lease sites

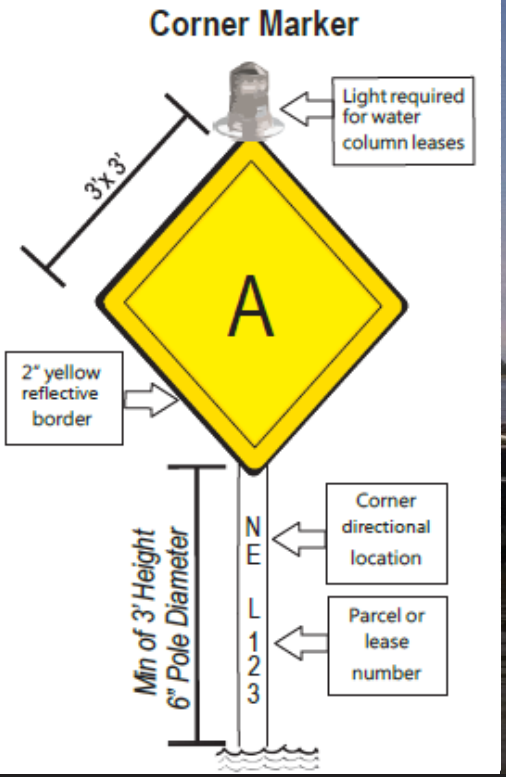




Hard Clam: Grow out

Lease holders must mark their leases to ensure navigational safety, provide area ID and deter the general public from entering the culture areas.





Hard Clam: Grow out

- Clams are placed in mesh bags on the bottom of lease sites to finish growing to harvest size (~1" shell length).
- Bags are aligned in rows and staked to the bottom.
- Clams prefer sandy bottoms with a continuous flow of nutrient rich water.
- To protect from predators, clams bags are covered with various net types.

Hard Clam: Grow out

True or false?

You will get in really big trouble if you are <u>not</u> a lease holder and you are caught in possession of cultured clams <u>or</u> harvesting clams from a specific lease site.

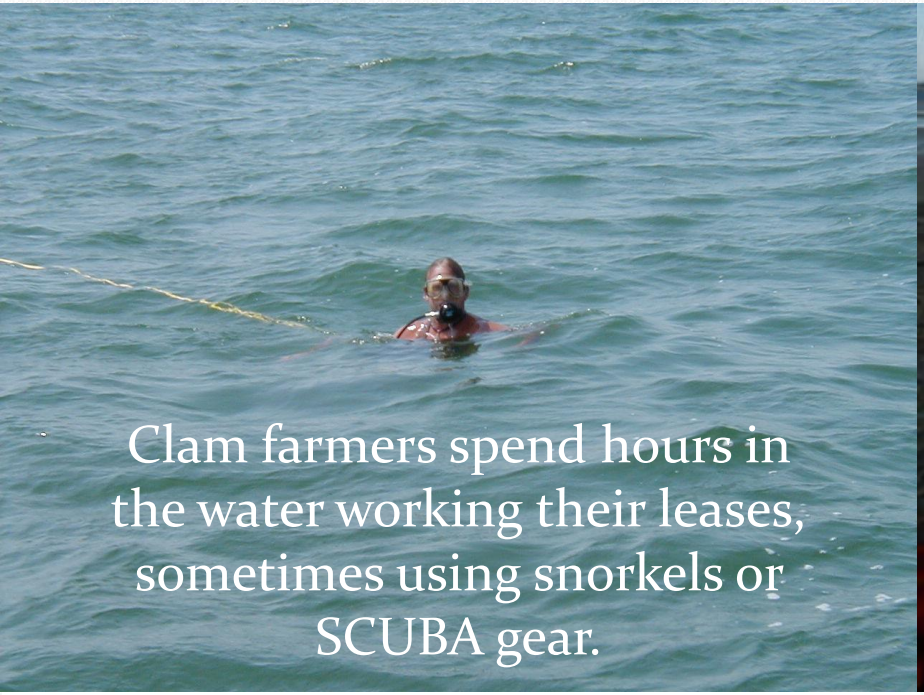
TRUE - It is against the law for anyone other than the lease holder to harvest cultured clams from lease areas.

Hard Clam: Harvest

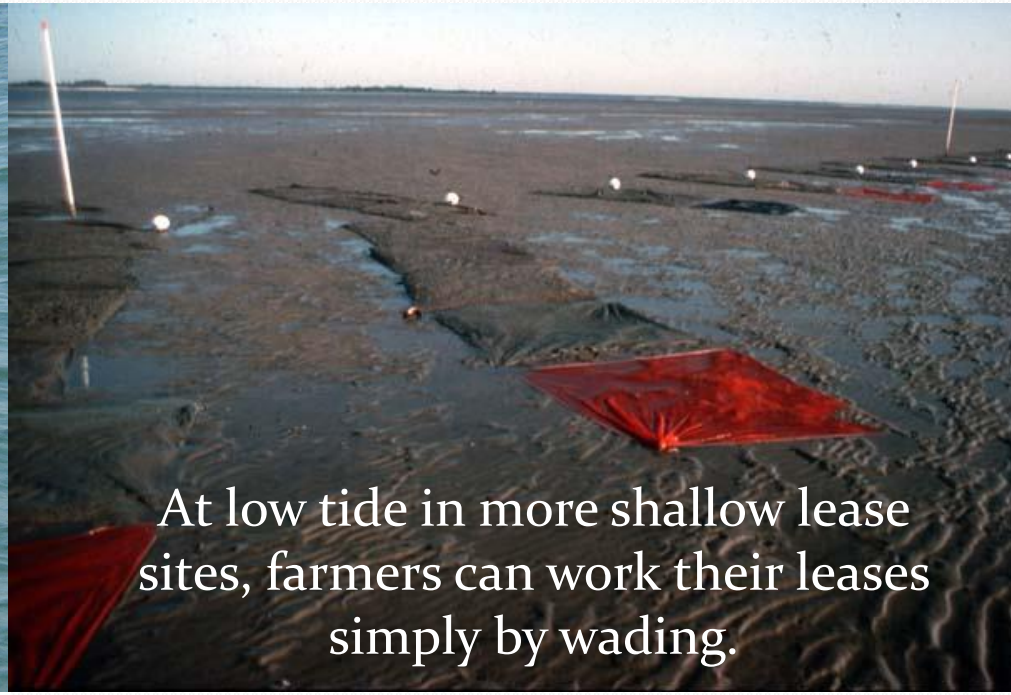
The final step of clam culture is harvest and processing for market.

Hard Clam: Harvest

Depending on the location of a lease area, the mean tide can range anywhere from 1 to 6 feet.



Clam farmers spend hours in the water working their leases, sometimes using snorkels or SCUBA gear.

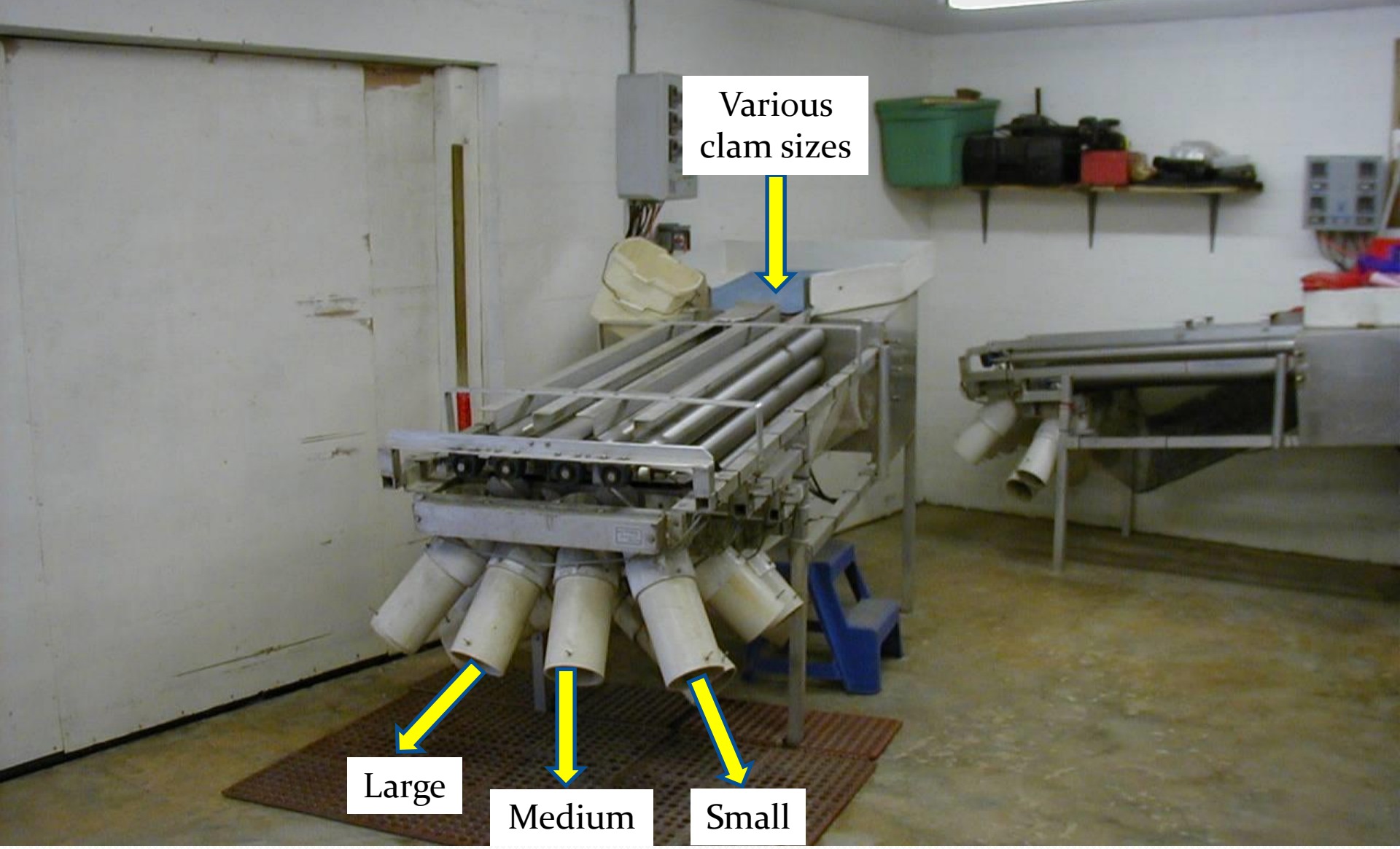


At low tide in more shallow lease sites, farmers can work their leases simply by wading.

Hard Clam: Harvest

Once clams are harvested from lease sites they are loaded onto boats and taken directly to special certified processing facilities where they are prepared for final sale.

The tumbling action is combined with a pressure washer to knock barnacles and other crusts off the shells, break open dead clams and thoroughly rinse 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.

Clams are named according to their size.
Littleneck clams are the most valuable of the various sizes of cultured clams available. Other size clams include middle neck, top neck, cherrystone, and pasta clams.

Oyster Aquaculture Methods

Similar to clams, oysters have a three phase production system. The key difference is in the grow-out phase.

- Clams are grown **on the bottom** in bags.
- Oysters are most-often grown in the **water-column** (at surface) in floating cages or baskets.
  - In Florida, 2 culture methods dominate the industry
    - Floating cages
    - Australian longline

Floating cages

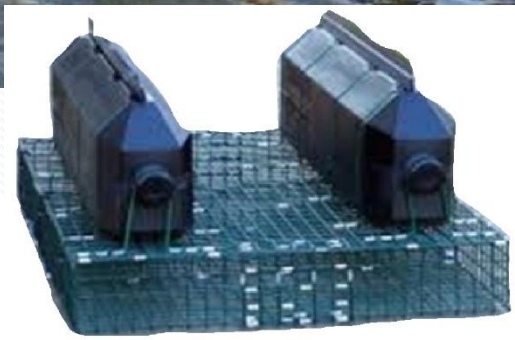
Photo credit: The Associated Press

Longline

Photo credit: Seapa Oyster Baskets Inc.

Floating Cage Method

Photo credit: Go Deep Shellfish Aqua Inc.



Floating cages are tied together end-to-end and attached between 2 pylons. Cages can be flipped to expose oyster to air for cleaning or water for growth.

Longline Method

Photo credit: Seapa Oyster Baskets Inc.

Similar to a clothes line, oyster baskets are hung along a cable that keeps the oyster near the surface of the water. The baskets can be raised above the water for cleaning or fully submerged for protection against storms.

Research Priorities

As a relatively new form of aquaculture in Florida, shellfish culture techniques are continuously being refined.

Current shellfish research is focused on:

1. Production of triploid oysters
   - Triploid oyster are sterile and cannot reproduce.
   - Because they do not reproduce, extra energy is put into growth.
   - Triploid oysters grow faster, produce more meat per oyster and are disease resistant!

Research Priorities

As a relatively new form of aquaculture in Florida, shellfish culture techniques are continuously being refined.

Current shellfish research is focused on:

2. Refining Sunray Venus spawning and nursery phases
    - The sunray venus is a native clam that is being developed for the aquaculture industry.
    - Shows a lot of promise along Florida's western and southern coasts.
    - Demand for seed currently surpasses hatchery supply.
    - Unique product to Florida with high market value!

Research Priorities

As a relatively new form of aquaculture in Florida, shellfish culture techniques are continuously being refined.

Current shellfish research is focused on:

3. Understanding the impact of harmful algal blooms on shellfish, and developing management strategies to minimize their impact of aquaculture operations.
   - During red tide events, shellfish accumulate toxins in their tissues which is dangerous to humans if consumed.
   - Red tide closes shellfish harvest areas annually along the southwestern coast of Florida.
   - Researchers are working on ways to rapidly detect this toxic, predict and monitor the toxins uptake by shellfish, and reduce red tide's economic impact in southwestern Florida.

Photo Credit: P. Schmidt, Charlotte Sun

Conclusions

- 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.
- Oyster aquaculture farms are increasing in number each year.
- Shellfish aquaculture is sustainable, benefiting Florida's environment and the economy!

Conclusion

For questions about this presentation or aquaculture in Florida please contact the Division at:

Tallahassee Office: (850) 617-7600
Bartow Office: (863) 578-1870
Email: aquaculture_web@FreshFromFlorida.com
Website: FreshFromFlorida.com