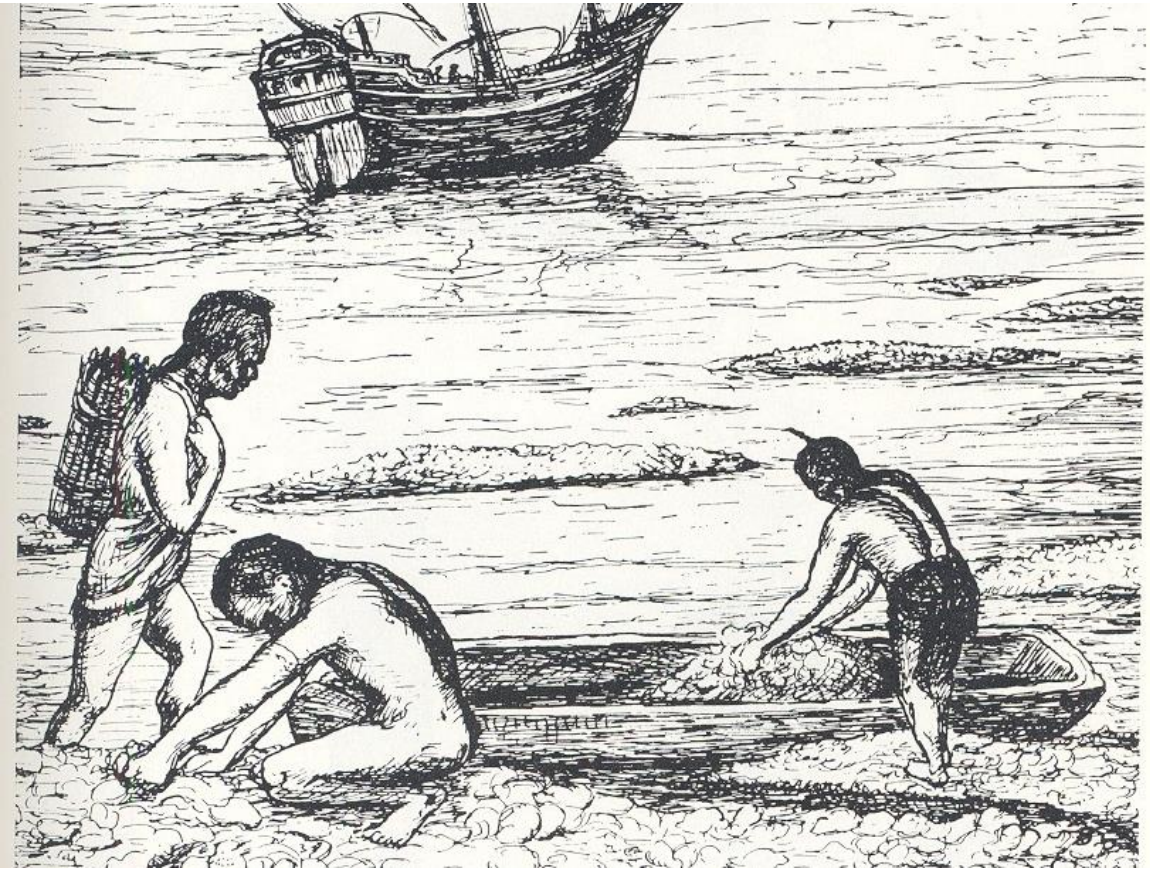
Oysters in Chesapeake Bay

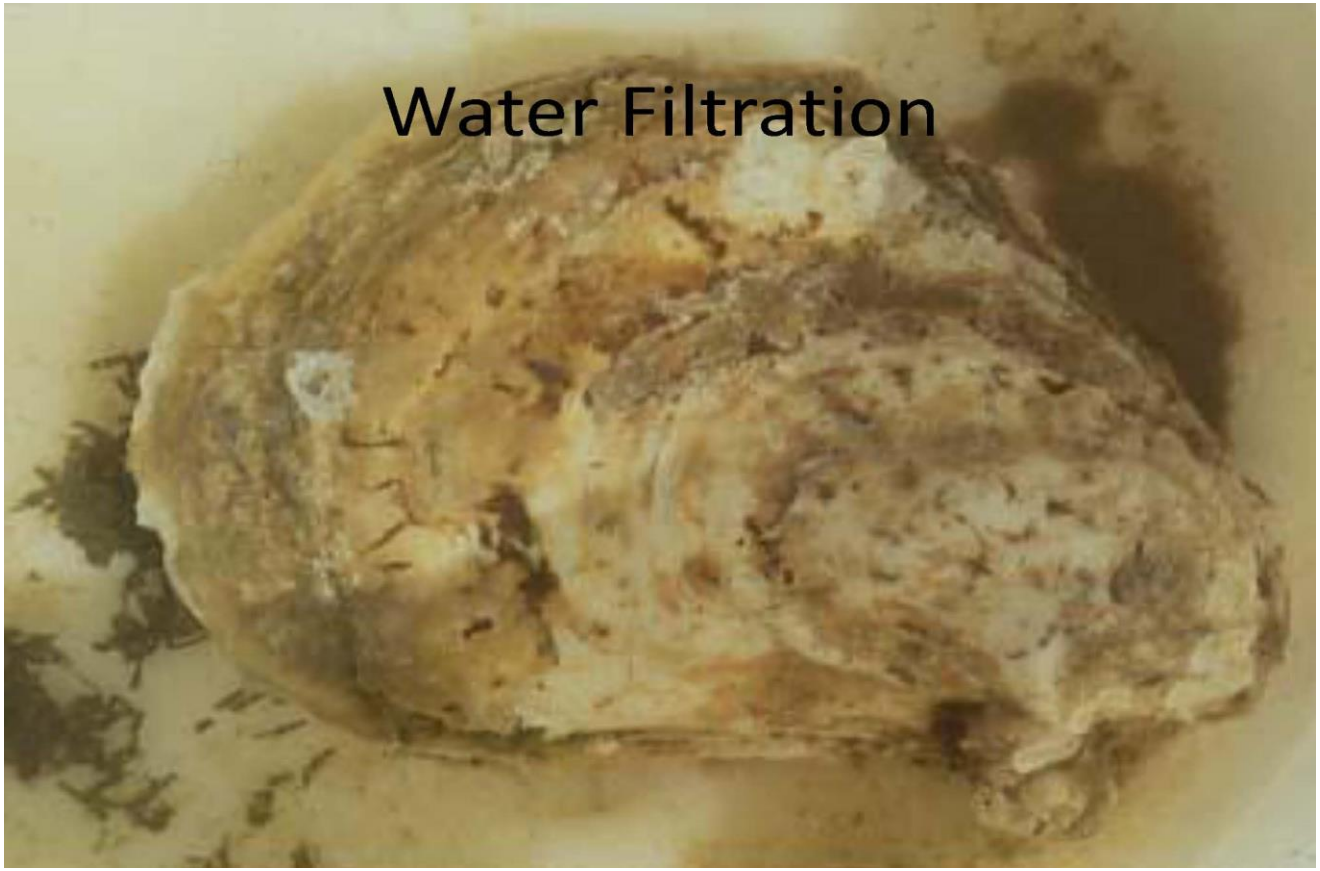
Skipjacks once dredged for oysters under sail.

Today they are curiosities and the oysters are mostly gone.



An early drawing

When Europeans first arrived, oyster reefs were navigational hazards for sailing ships. At high tide unwary pilots struck them, but at low tide large oysters could be harvested by hand.

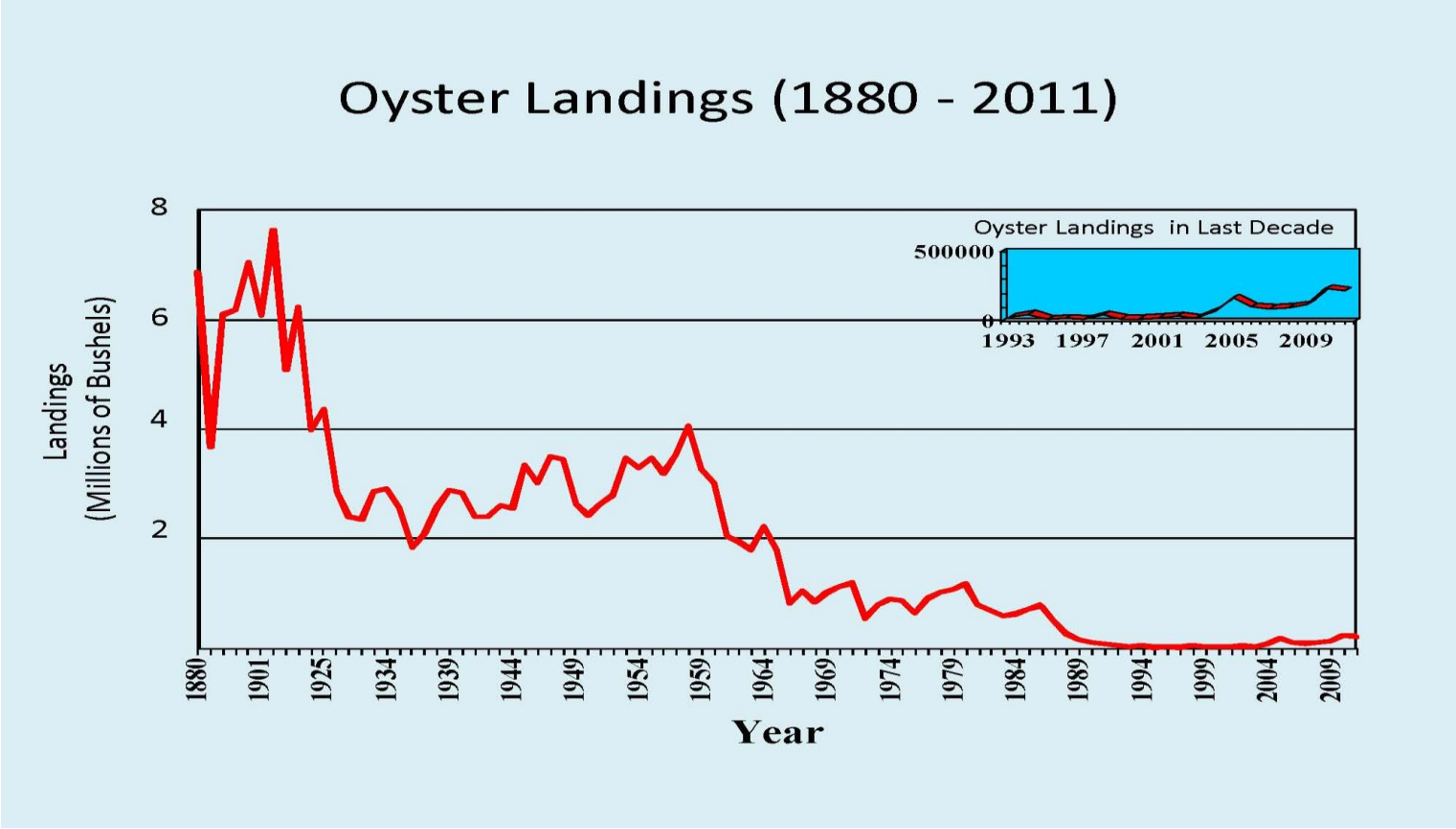


Oysters filter the water with their gills. Some of the sediment and algae is used for nutrition but most is discarded as pseudofeces. When Europeans arrived, oysters were so abundant they could filter a Chesapeake Bay-sized volume of water in a few days.

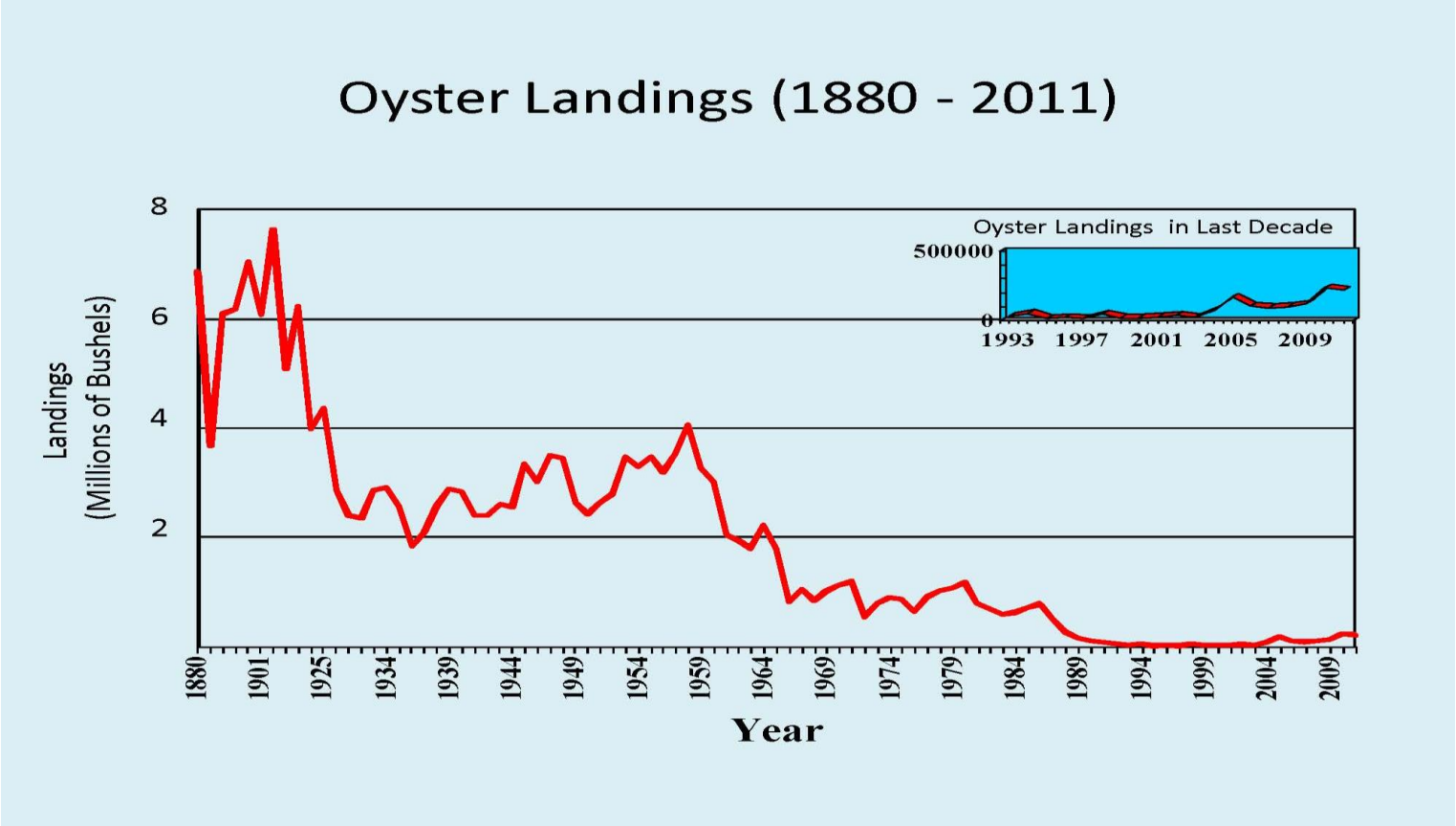
By about 1900, oysters were being harvested for road gravel and lime, first by using tongs, then by dredges. The shell was more valuable than the meat!

An oyster dredge

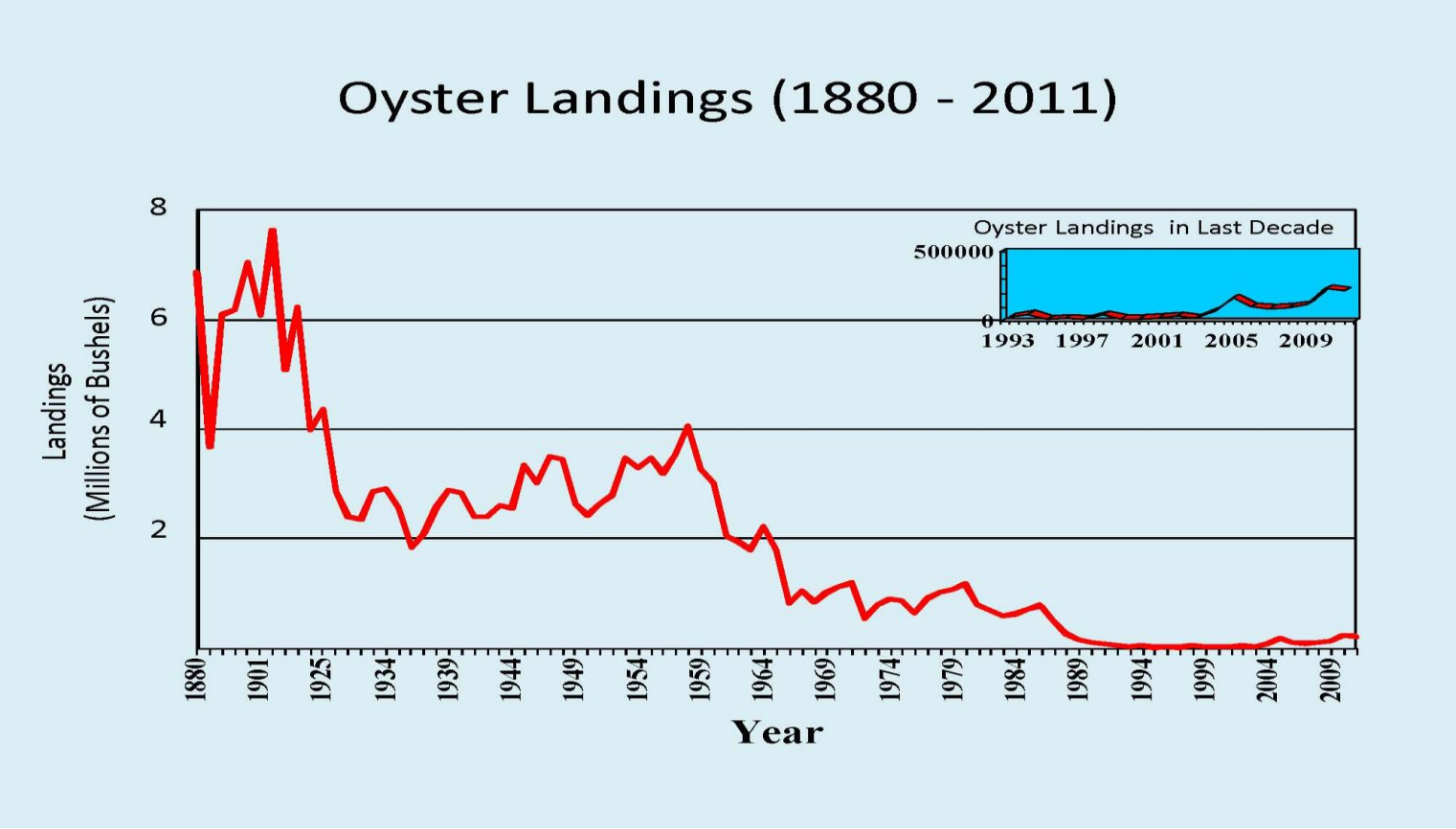
Dredges were introduced to Chesapeake Bay by watermen from New York when all their local oysters were gone. Dredges flatten reefs and scrape up everything, killing a lot of organisms, called bycatch.



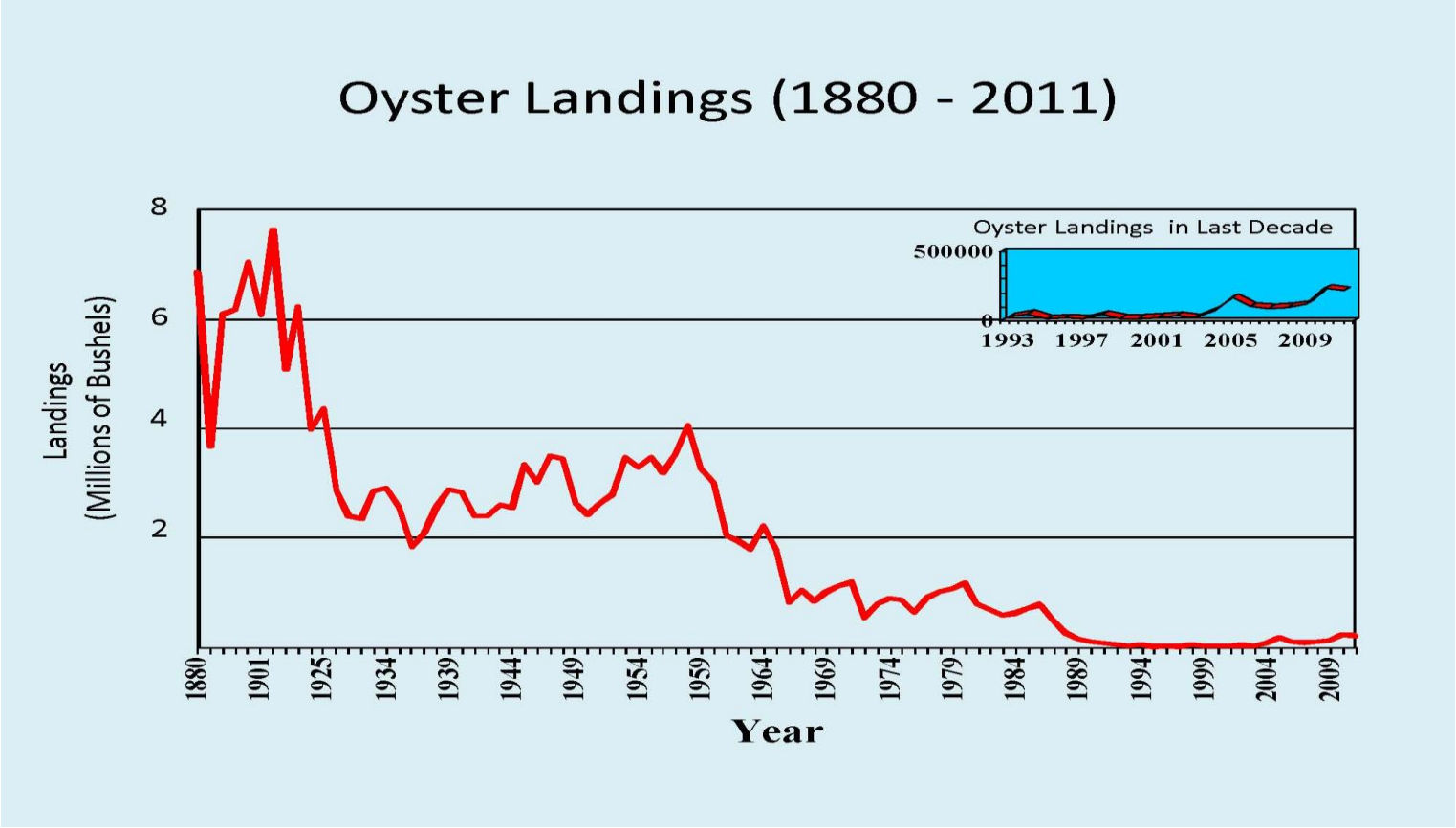
Oyster were overharvested and landings decreased until about 1935 because shell was used for road gravel and lime and not returned to the water to “set” or “strike” new oysters.



Harvests increased between 1935 and 1958 because shell was being returned to the water. Crushed stone for roads had become available by railway and truck from the Piedmont.



A disease called MSX was introduced in about 1960 when some well-meaning people imported oysters from the Pacific ocean in an attempt to improve oyster harvests. The native oyster, *Crassostria virginica*, had no resistance to the disease and MSX has devastated oyster populations in Chesapeake Bay.



Today, it would take about a year for oysters to filter a Chesapeake Bay-sized volume of water. Oyster populations are beginning to increase because of restoration efforts and aquaculture.

Oysters are just one part of the complex ecosystem found in Chesapeake Bay

Almost all living things need energy from the Sun

SUN

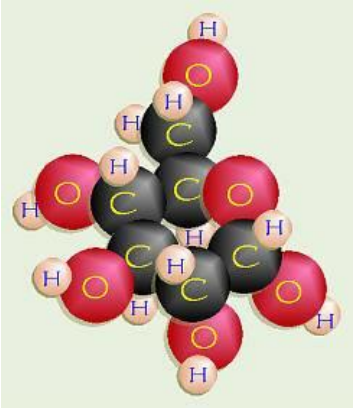
Carbon dioxide
CO_2

+
AND

Water
H_2O

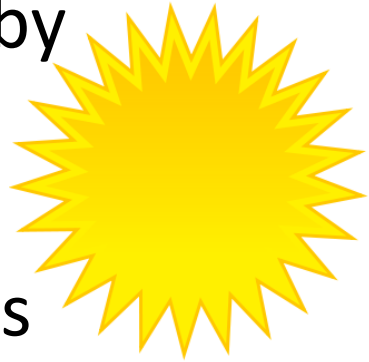
Yield

Glucose/Carbohydrates
$C_6H_{12}O_6$
AND
Oxygen gas or O_2



All living things need energy to live

- In marine environments, algae support all other forms of life. Plants do it on land.
- Algae (and plants) are autotrophs (means self-life), or <u>primary producers</u>.
- Algae (and plants) make their own food by photosynthesis, using energy in photons from the sun and a pigment, usually chlorophyll, and the inorganic substances carbon dioxide (CO_2) and water (H_2O).



PHOTOSYNTHESIS

6 CO_2 (CARBON DIOXIDE) + 6 H_2O (WATER)

forms

$C_6H_{12}O_6$ (GLUCOSE) + 6 O_2 (OXYGEN GAS)

In the presence of **CHLOROPHYLL**

and energy in

PHOTONS FROM THE SUN

RESPIRATION IS THE OPPOSITE OF PHOTOSYNTHESIS

ANIMALS GET ENERGY FROM THEIR FOOD, PRODUCED BY ALGAE OR PLANTS

$C_6H_{12}O_6$ (GLUCOSE) + 6 O_2 (OXYGEN GAS)

"BURNS" to form

6 CO_2 (CARBON DIOXIDE) + 6 H_2O (WATER)

and ENERGY

Cycle of Life

Inorganic carbon dioxide and water are combined in the presence of chlorophyll and the energy from sunlight by autotrophs like algae and plants to form organic matter.

Animals (heterotrophs, like oysters) consume the organic matter and release carbon dioxide and water back to the ecosystem, completing the cycle.

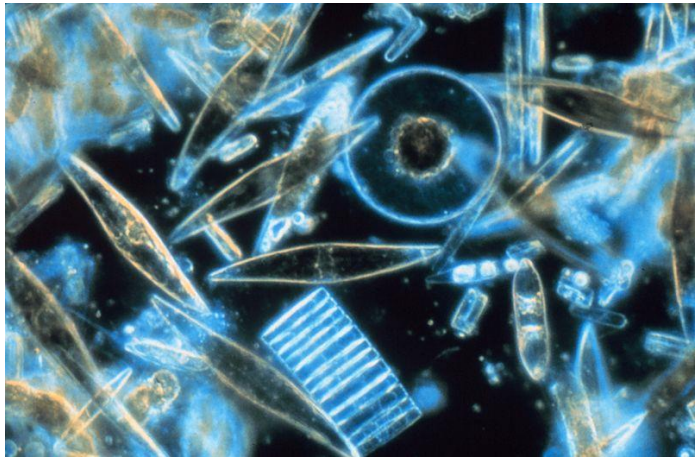
Nutrients

Many substances other than carbon dioxide and water are required for life. Two very important elements are Nitrogen (N) and Phosphorus (P).

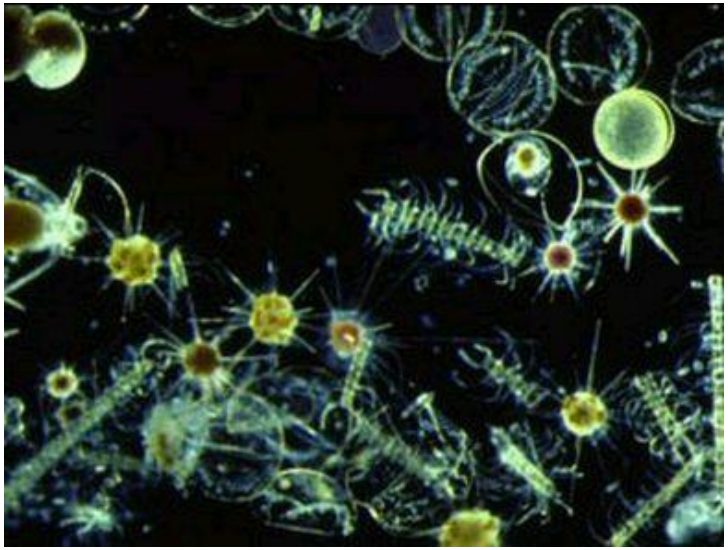
Just as fertilizer is needed to grow crops, N and P are needed by both primary producers (algae) and consumers (animals).

Phytoplankton

The microscopic, photosynthetic “plant” plankton that float at the mercy of currents in the sea. Primary producers or autotrophs.



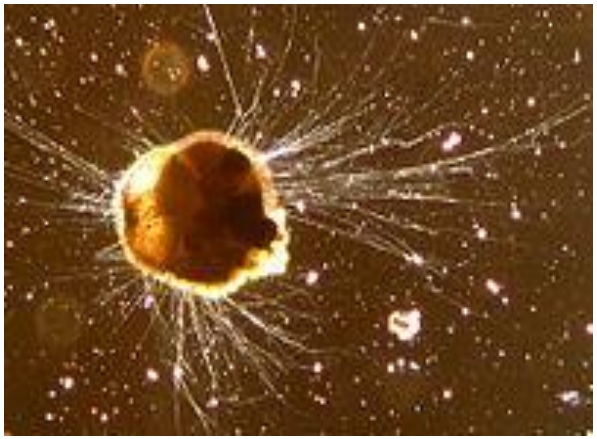
Diatoms



Zooplankton

The small heterotrophic floating animals in the sea. Small zooplankton feed on phytoplankton and are primary consumers.

Copepods look like tiny shrimp



Foraminifera are amoeba with shells

Nekton

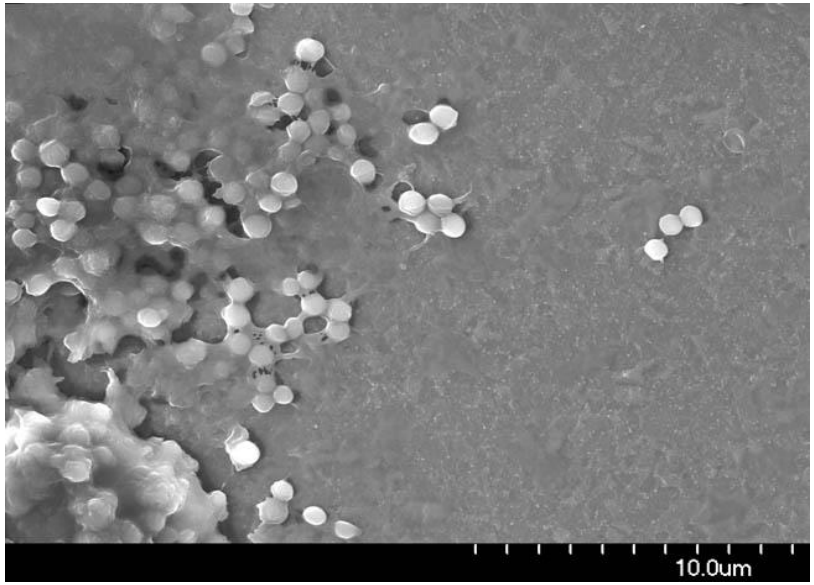
Nekton are the swimming animals of the sea that feed on phytoplankton, zooplankton or other nekton. Fish are nekton and can be small, like anchovies, or big, like rays.

Benthos

Benthic organisms live on or in the bottom sediment. They include organisms like worms, starfish and oysters that feed on phytoplankton and/or zooplankton or ingest the sediment because it is rich in organic matter (food).

Decomposers

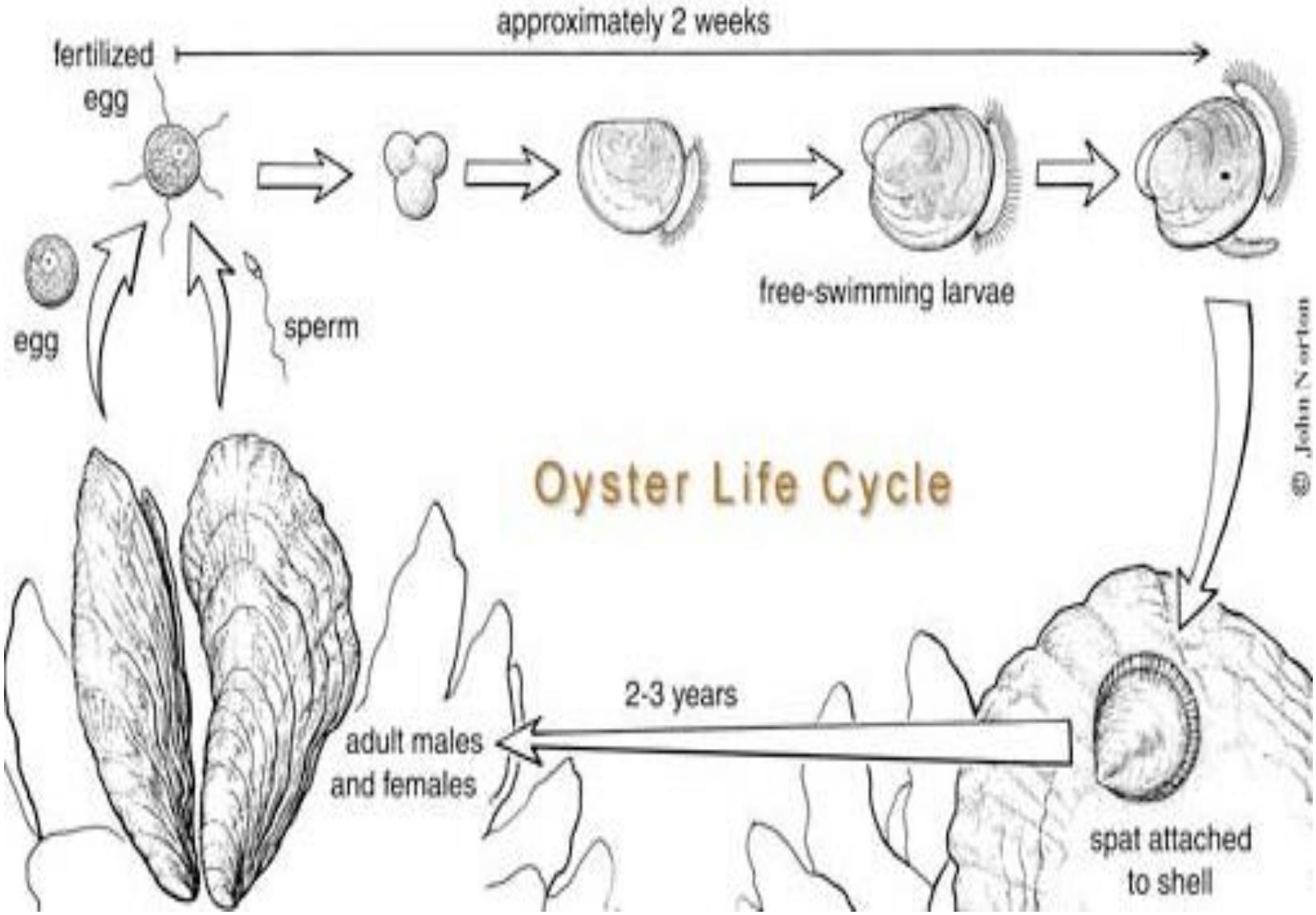
Microbes like bacteria respire organic material, especially in the sediment. They return carbon dioxide and water along with Nitrogen (N) and Phosphorus (P) “fertilizer” back to the ecosystem to promote more primary productivity.



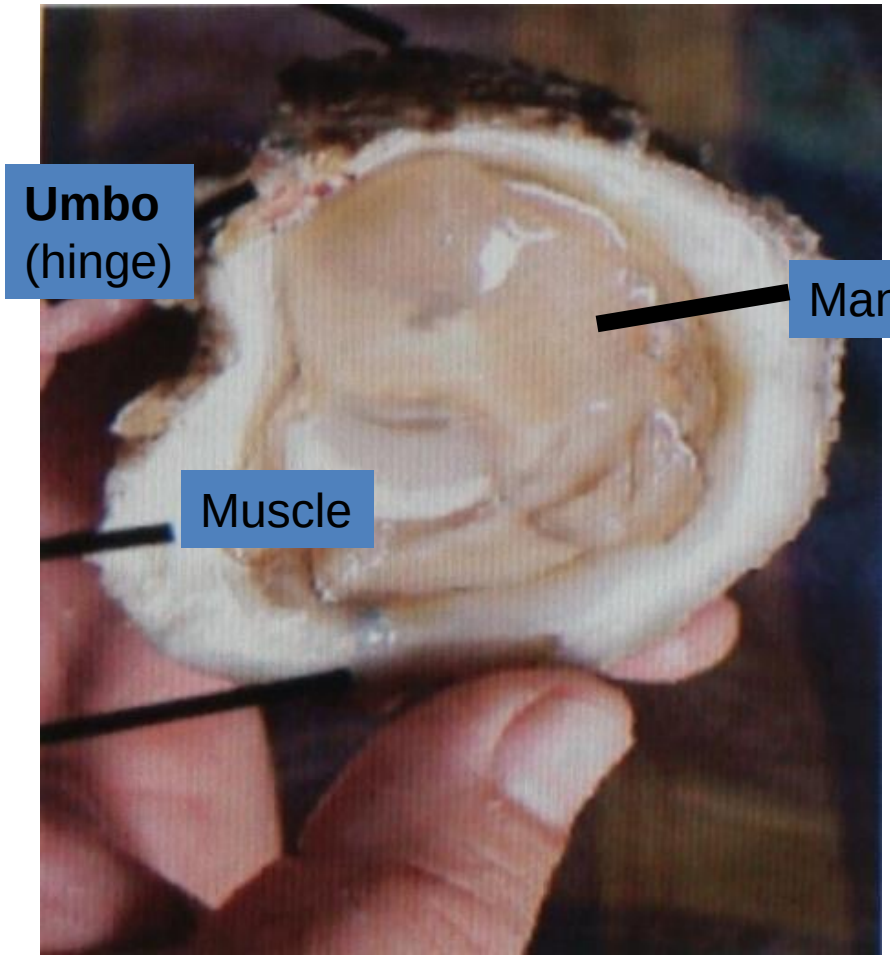
These bacteria are forming a biofilm.

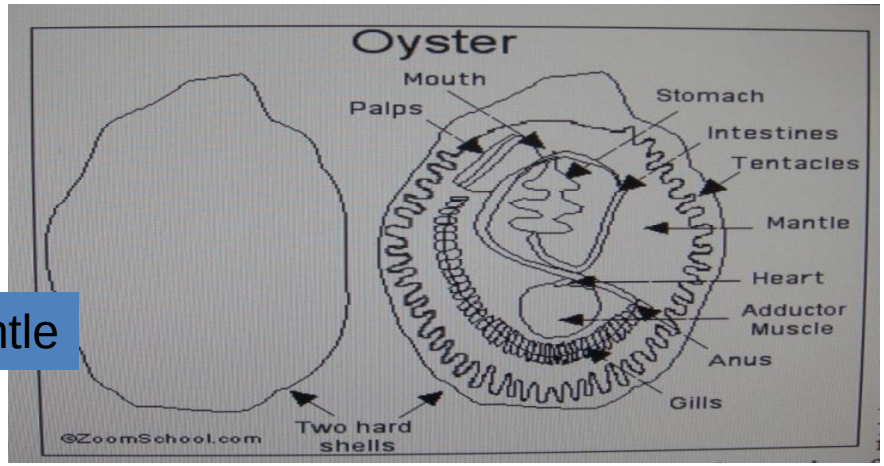
Red Tides

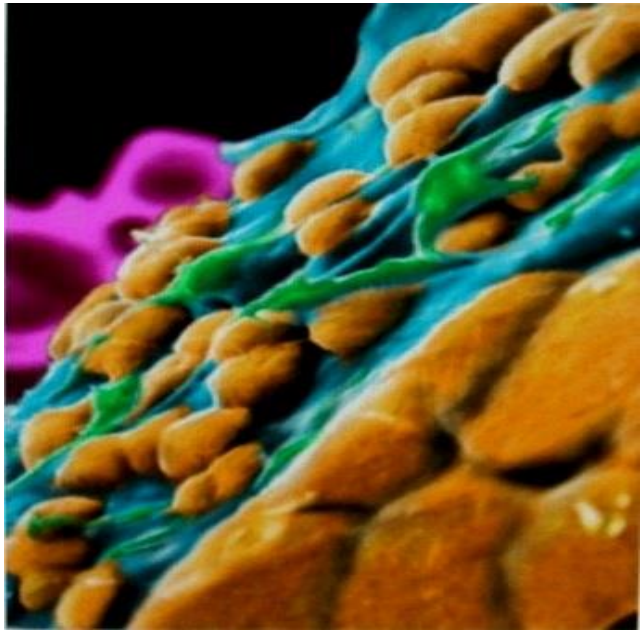
Sudden “blooms” of phytoplankton, some of which may be toxic to oysters and other animals, including humans. Many scientists believe red (or mahogany) tides are caused by too much fertilizer in the water.


approximately 2 weeks
fertilized egg
egg
sperm
free-swimming larvae
Oyster Life Cycle
© John Norton
2-3 years
adult males and females
spat attached to shell

How do oysters grow their shell?



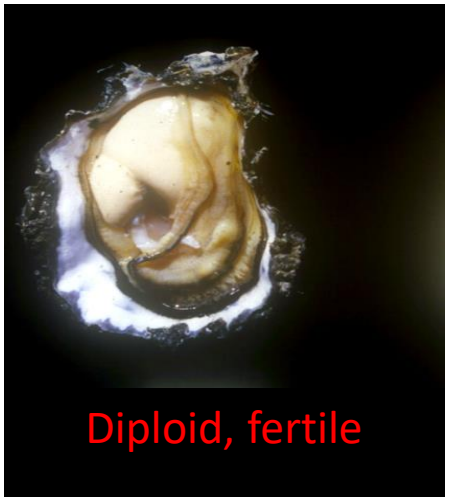




electron micrograph at site of shell formation

How to breed a sterile oyster

Diploid (fertile) males + Diploid (fertile) females + Tetraploid (sterile) males

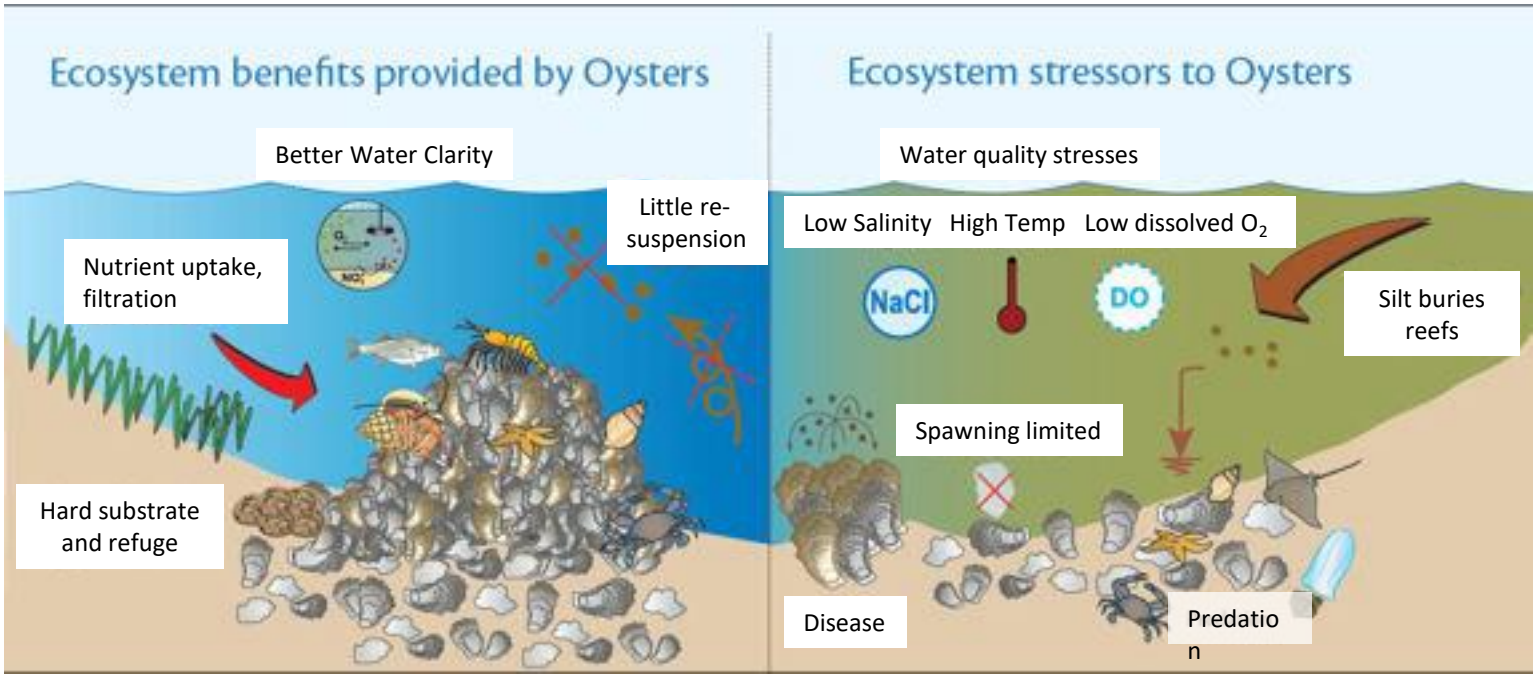


Two chromosomes

Three chromosomes

Oyster reefs as habitat

Oyster reefs grow upward as larvae “strike” or “set” on older shells. The reef provides sanctuary for many other organisms, including more filter feeders like barnacles and sponges.



Simultaneous spawning

Oysters, like this sponge, spawn simultaneously, triggered by “thermal shock” or by chemicals released by other oysters. Living close together on a reef favors fertilization.

Oysters Provide Ecological Services

Filter feeding clarifies the water and encourages the growth of sea grass (Submerged Aquatic Vegetation or SAV). Sea grass beds were once extensive, like oyster reefs, and provided nurseries for many organisms. Few sea grass beds remain today because of terrible water clarity.

Oyster reefs provide habitat for other organisms.

Oysters do not remove nutrients

Oysters filter particles out of the water and make the water more transparent, encouraging the growth of benthic sea grass.

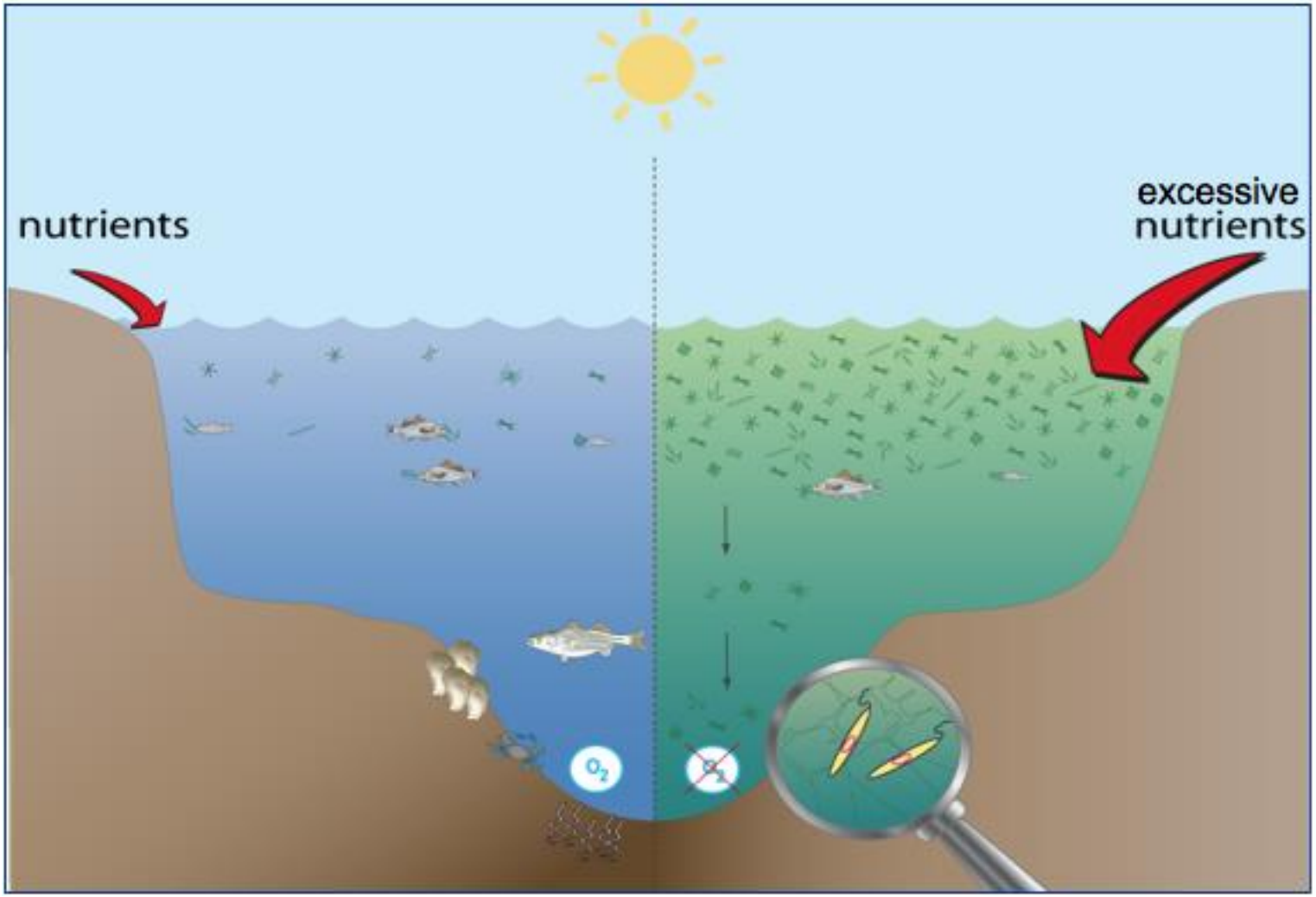
The particles (pseudofeces) settle rapidly to the bottom where the decomposers respire the organic material and return nutrients to the water for more phytoplankton growth.

Chesapeake Bay water quality is terrible!

The water in Chesapeake Bay is now very turbid. Sunlight cannot penetrate very far into the water to promote the growth of benthic plants (sea grass or SAV). The water is turbid because there are TOO MANY ALGAE IN THE WATER, CAUSED BY TOO MUCH FERTILIZER.

The deep axis of Chesapeake Bay contains no dissolved oxygen gas in summer and cannot support animal life. It is called a “dead zone.”

What is a Dead Zone?

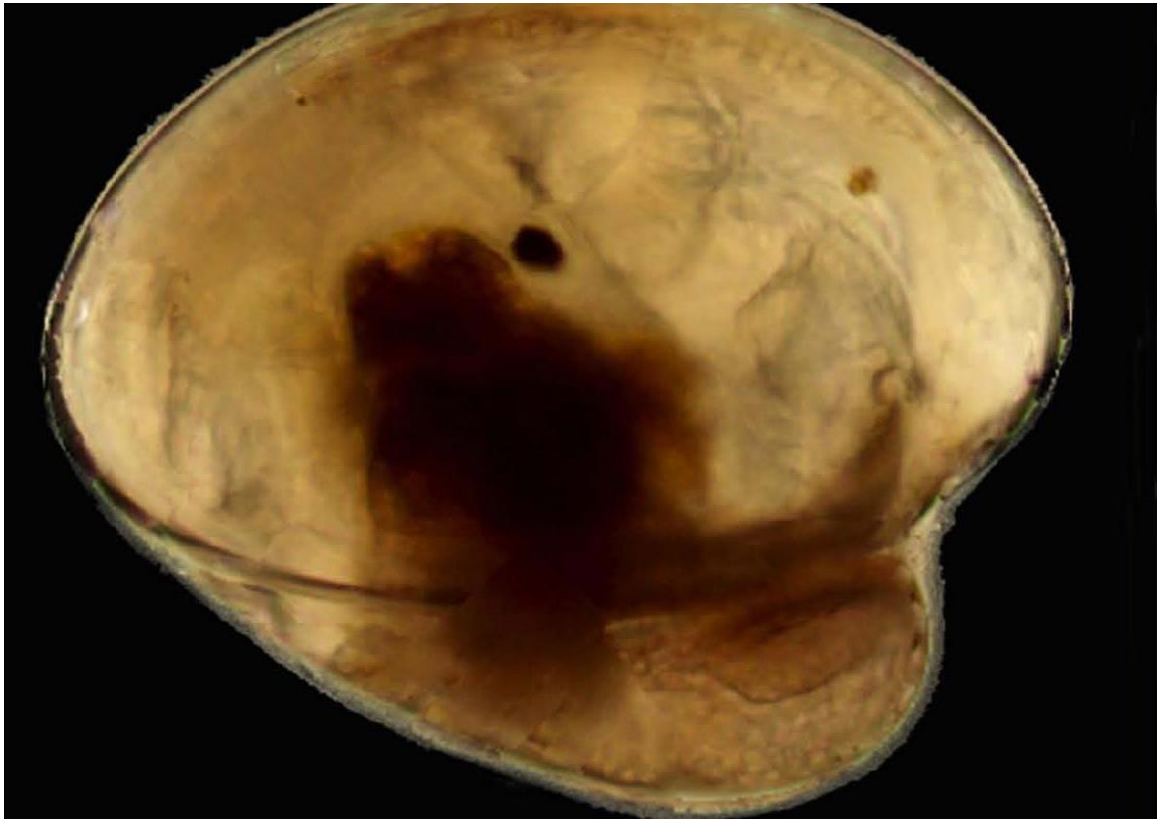


Nature needs our help to restore oysters

Oyster aquaculture is expanding rapidly using two strategies.

1) Grow single oysters, especially for the “half-shell” market, to be eaten raw, or

2) Grow “spat-on-shell” for conventional harvest.



A SINGLE EYED LARVA

Eyed larvae are produced in hatcheries from broodstock selected for good disease resistance or high growth rate. The larvae are “struck” or “set” onto either ground shell to produce single oysters, or onto whole shell to produce “spat-on-shell”.

Grow single oysters

Eyed larvae are placed in contact with ground oyster shell to “set” or “strike” and produce single oysters, called seed. Water is forced upward through silos with screens on the bottom to provide food and clean water. The oysters grow rapidly.

Grow single oysters

These seed oysters have grown to about ¼ inch in a few weeks in an upweller. There are about 300 in the person's hands.

Grow single oysters

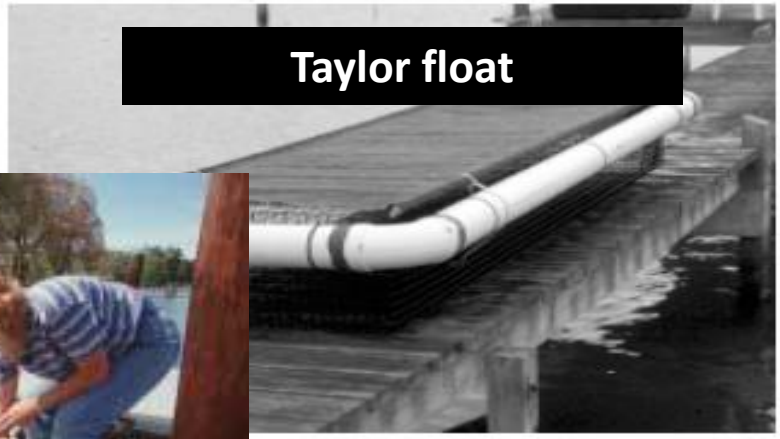
When the oysters grow to about ½ inch in size, they are moved to a larger, floating upweller called a FLUPSY.

Grow single oysters

When the oysters are bigger than about one inch they are placed in wire cages (so the rays can't eat them) on hard bottom so they don't sink in. In about one year they are ready for harvest. This cage weighs several hundred pounds and holds several bushels of oysters.

People can also garden oysters

Box 5. Side view of Taylor float.



Wire cage

Flip float

Spat on shell

Clean shell is loaded into coarse-mesh bags.

Spat on shell

Bags containing clean shell are placed in tanks with circulating water and eyed larvae are added. After a couple days the larvae have attached (“struck” or set”) on the shell and raw water is added to provide food.

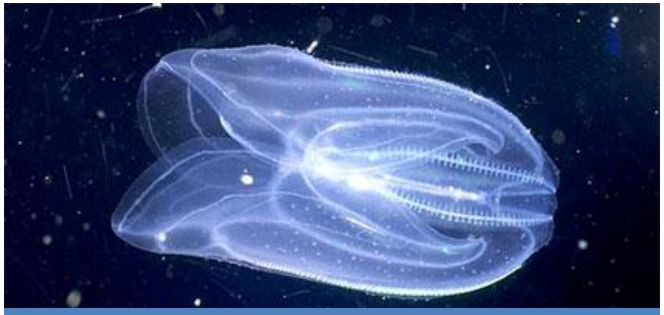
Spat on shell

After a couple weeks the oysters are big enough for the bags to be opened and emptied onto hard sand or shell bottom (an oyster ground) for harvesting by tonging or dredging in about a year.

Spat on shell

Spat attached to clean shell (bottom two shells) grow (middle two shells) and form clusters of oysters (top) for harvesting if the rays don’t eat them.

Oysters have predators



Comb jellies and many other organisms prey on oyster larvae, which are zooplankton

Blue crabs feed on small oysters

Oyster drills punch through the shells

Cow-nosed rays grind up oysters and have become more abundant because sharks, their major predator, are over-fished.

Source: Tidewater Oyster Gardeners Association

Biofilms (slime) develop rapidly and impede oyster strike

Two shells were added every 3 days. The bottom two shells have been in the water for 12 days. The top two shells have not been in the water. Oysters will not “strike” or “set” on slimy substrate. The biofilms form rapidly because abundant algae and organic matter in the water encourage the growth of microbes.

Reef restoration

Sanctuary reefs have been constructed at great cost. They do not increase oyster populations because diseases kill the oysters faster than new oysters can colonize the artificial reef. There are too few oysters to provide larvae and “slime” reduces strike.

What will happen in the future?

Can oyster populations rebound to provide more ecological services and jobs? Yes, but only if we improve Chesapeake Bay water quality by reducing pollution from fertilizer. Oyster aquaculture is expanding and we must continue to learn more about Chesapeake Bay's complex ecosystem.