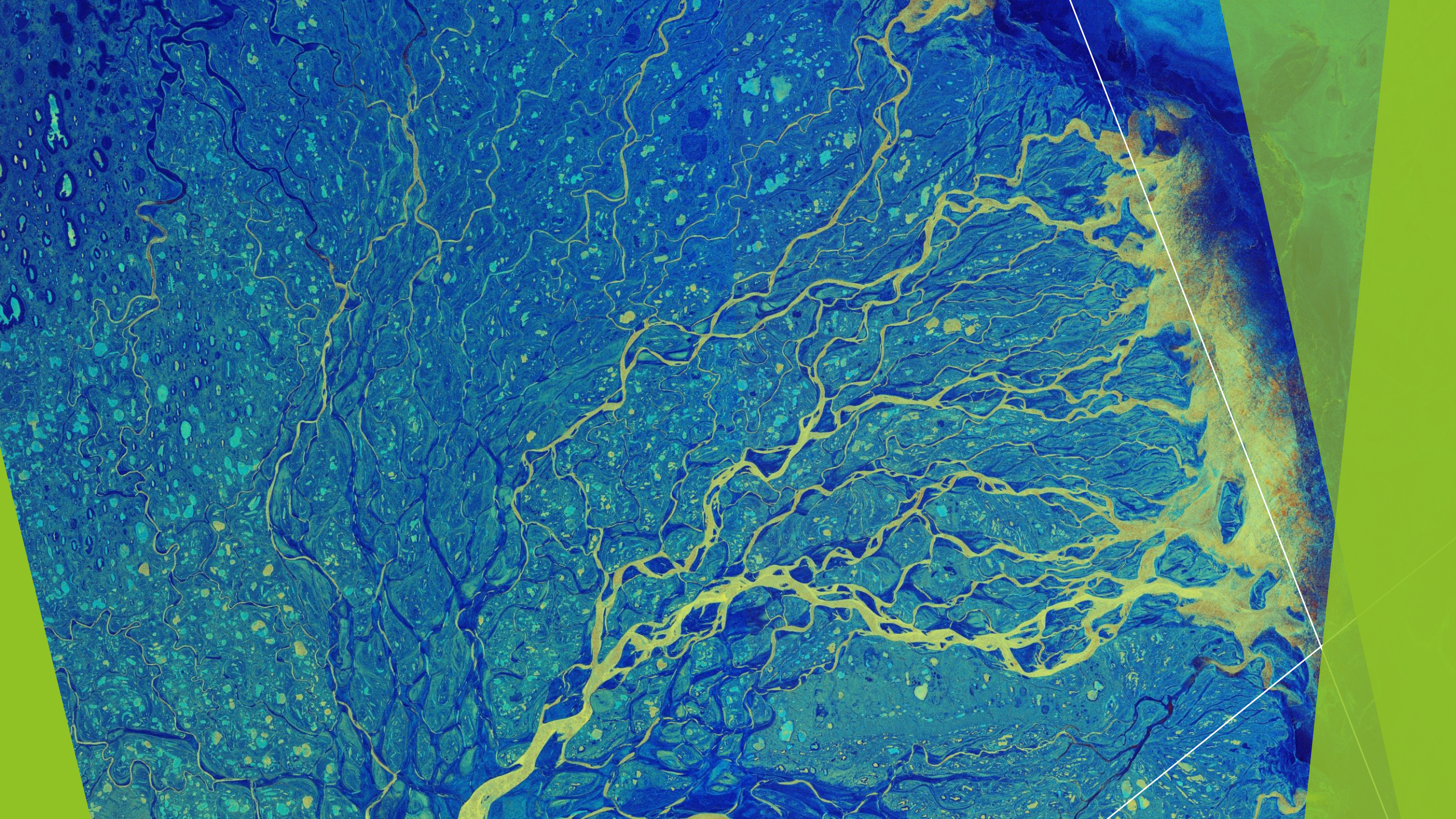
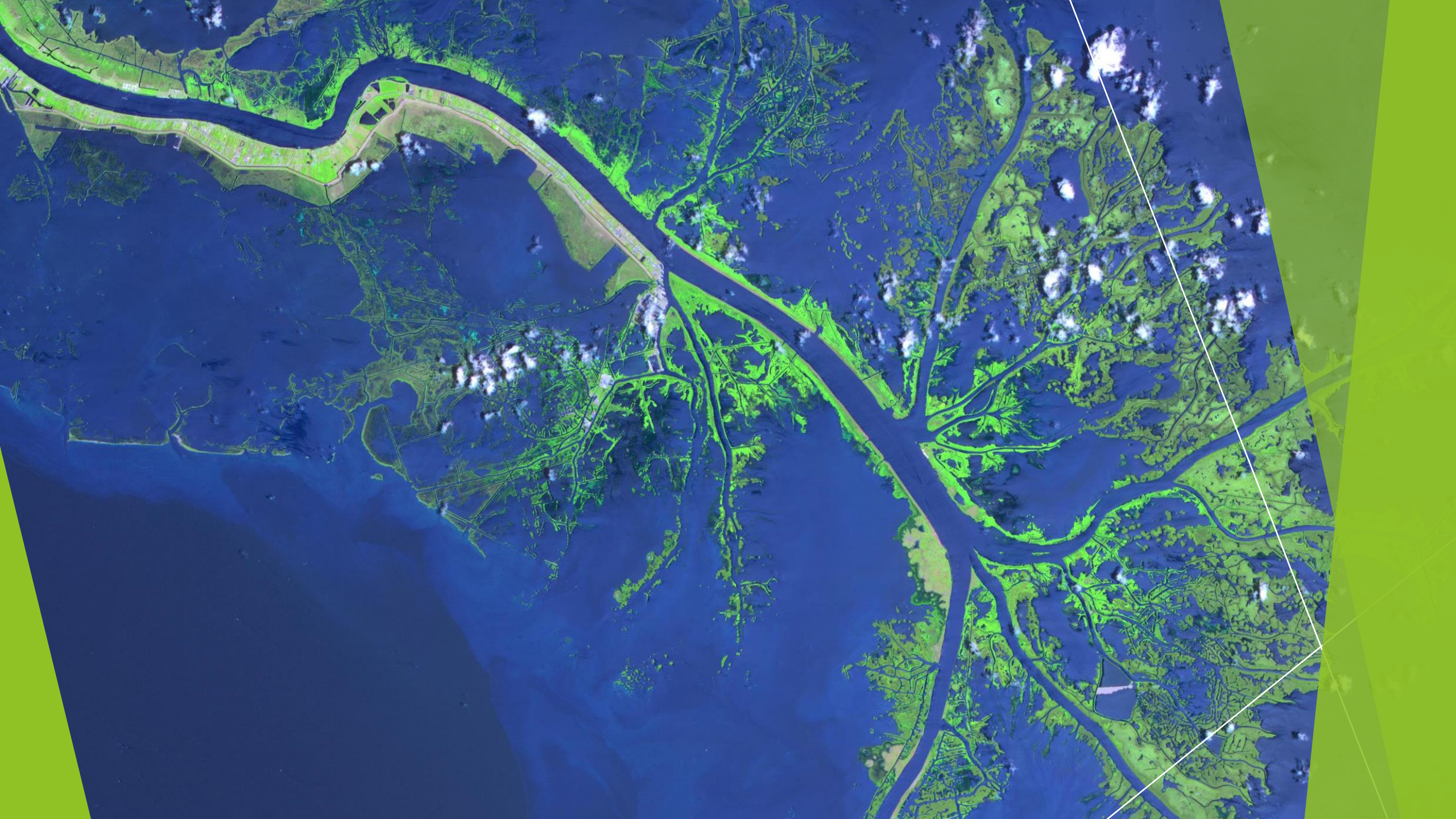
Integrated systems aquaculture and beyond

A permaculture approach

Bill Mollison

Of all existing systems, tropical rain forest and shallow water aquatic environments have the greatest natural yield. Mangrove swamps, marshes and estuaries produce sometimes prodigious biomass of great complexity.





THE MANGROVE ECOSYSTEM

Extreme Conditions and Extremely High Biodiversity

Mangrove forests are found on coastlines in tropical and subtropical areas. The mangrove tree looks a bit strange because its roots are partially above water, making the tree look like it's standing on many gnarly stilts. The roots are exposed to help the tree take in oxygen in a waterlogged environment. Fish, shrimp, crabs, and mollusks are among the organisms that take shelter within mangrove roots. This ecosystem is home to considerable biodiversity, but is unfortunately threatened by shrimp farming and rising sea levels. In some countries, shrimp farming clears large sections of mangroves to build holding tanks and processing facilities. The maps below show the changes to the mangrove ecosystem in Honduras from 1987 to 1999, where much of it has been removed to store shrimp brought in from the Gulf of Fonseca.

1987

1999

Mangrove forests are important nesting spots for shorebirds and migratory birds.

Great Egret
Ardea alba

Brown Pelican
Pelecanus occidentalis

Little Red Bat
Lasiurus minor

Great Blue Heron
Ardea herodias

Red Mangrove Tree
Rhizophora mangle

Coastal Protection

Mangrove forests are able to bear the brunt of storms that hit the coast. They reduce the impact of strong waves on anything that lives further inland, including humans. Mangrove trees also protect the coast from erosion by collecting sediments from rivers and ocean tides around their roots. These sediments build up and strengthen the shoreline.

Larvae

American Crocodile
Crocodylus acutus

Gray snapper
Lutjanus griseus

The Ocean's Nursery

Mangrove ecosystems host a lot of biodiversity, in part due to the mangrove tree's strange root system. The roots serve as a nursery for the larvae of many fish species, such as barracuda, tarpon, and snook. This is where fish can develop into adults before moving out to the big, unforgiving ocean. In fact, around one-third of all marine fish species are sheltered from predators in mangrove forests as juveniles.

Leaves and branches that have fallen into the water are called detritus, and are broken down by bacteria to return nutrients to the water.

Detritus

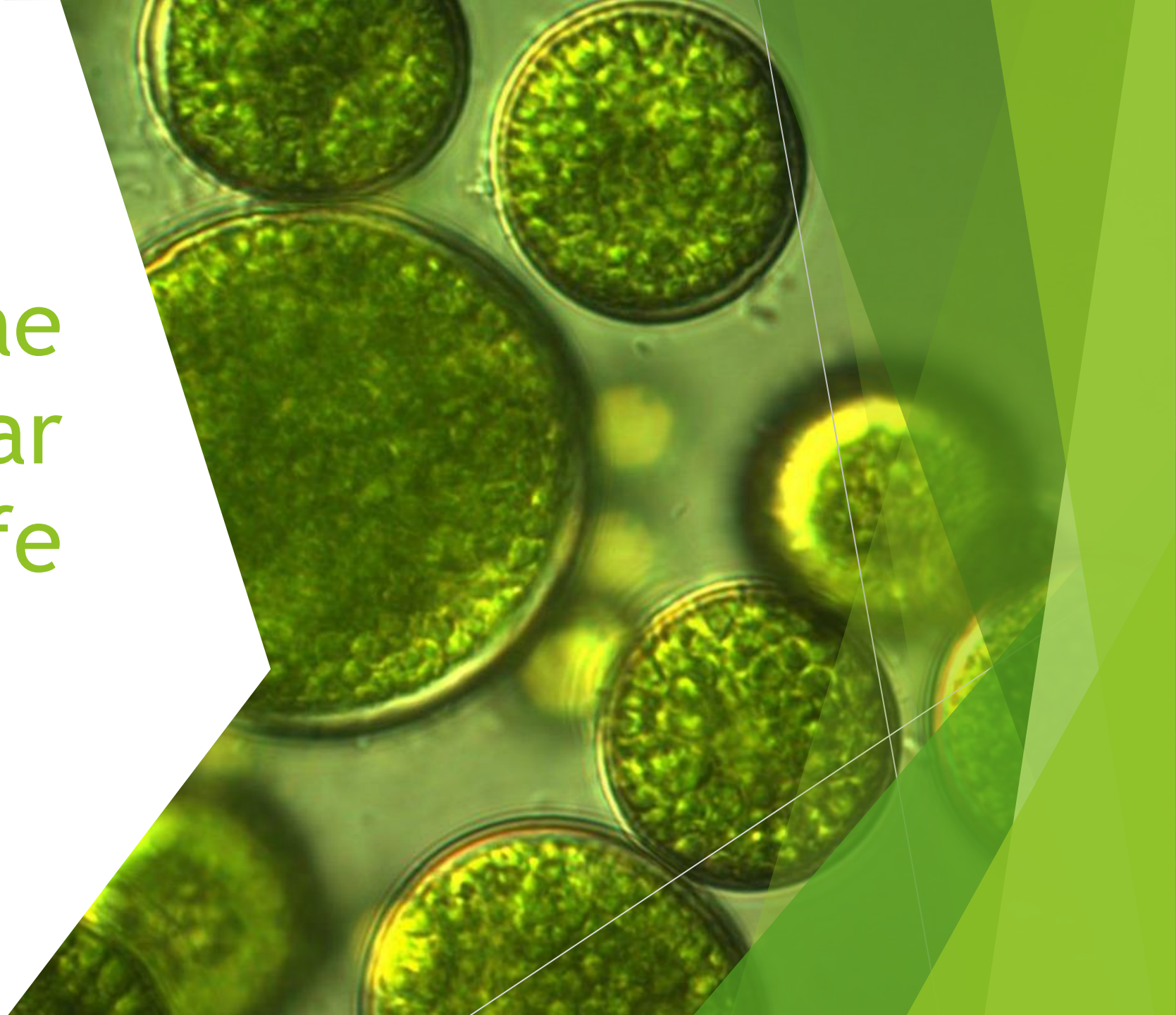
Pink Shrimp
Farfantepenaeus duorarum

Bocourt Swimming Crab
Callinectes bocourti

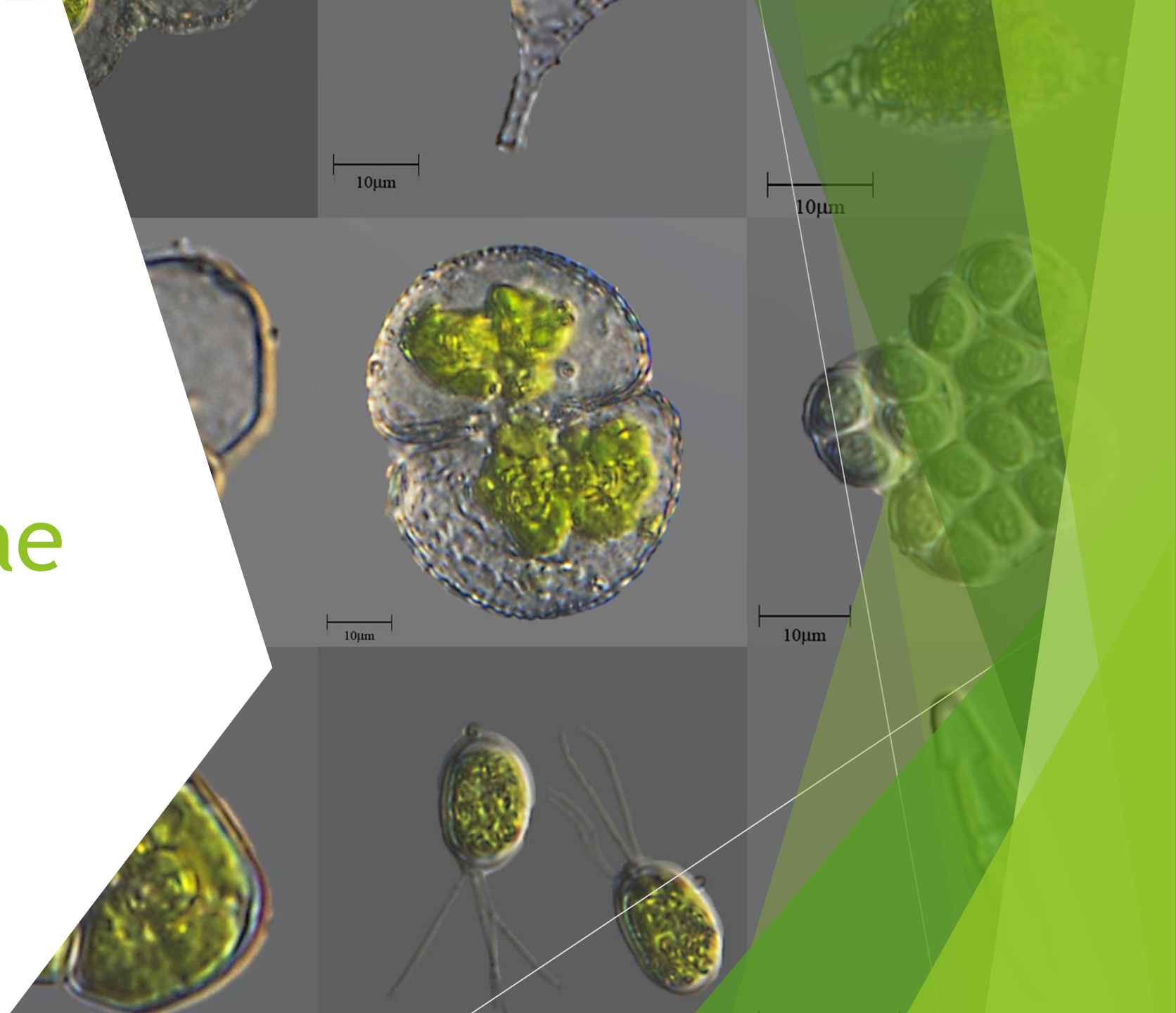
Hard clam
Mercenaria mercenaria

NATIONAL GEOGRAPHIC

Algae unicellular plant life

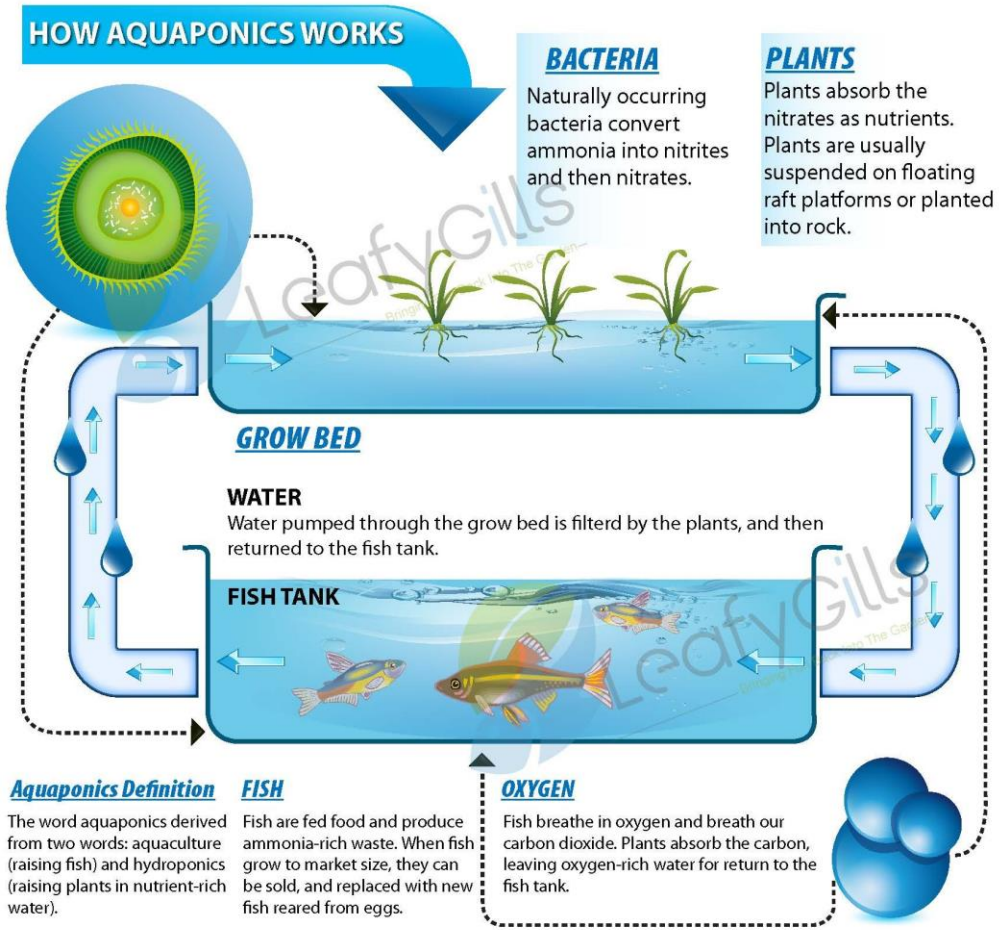


Algae

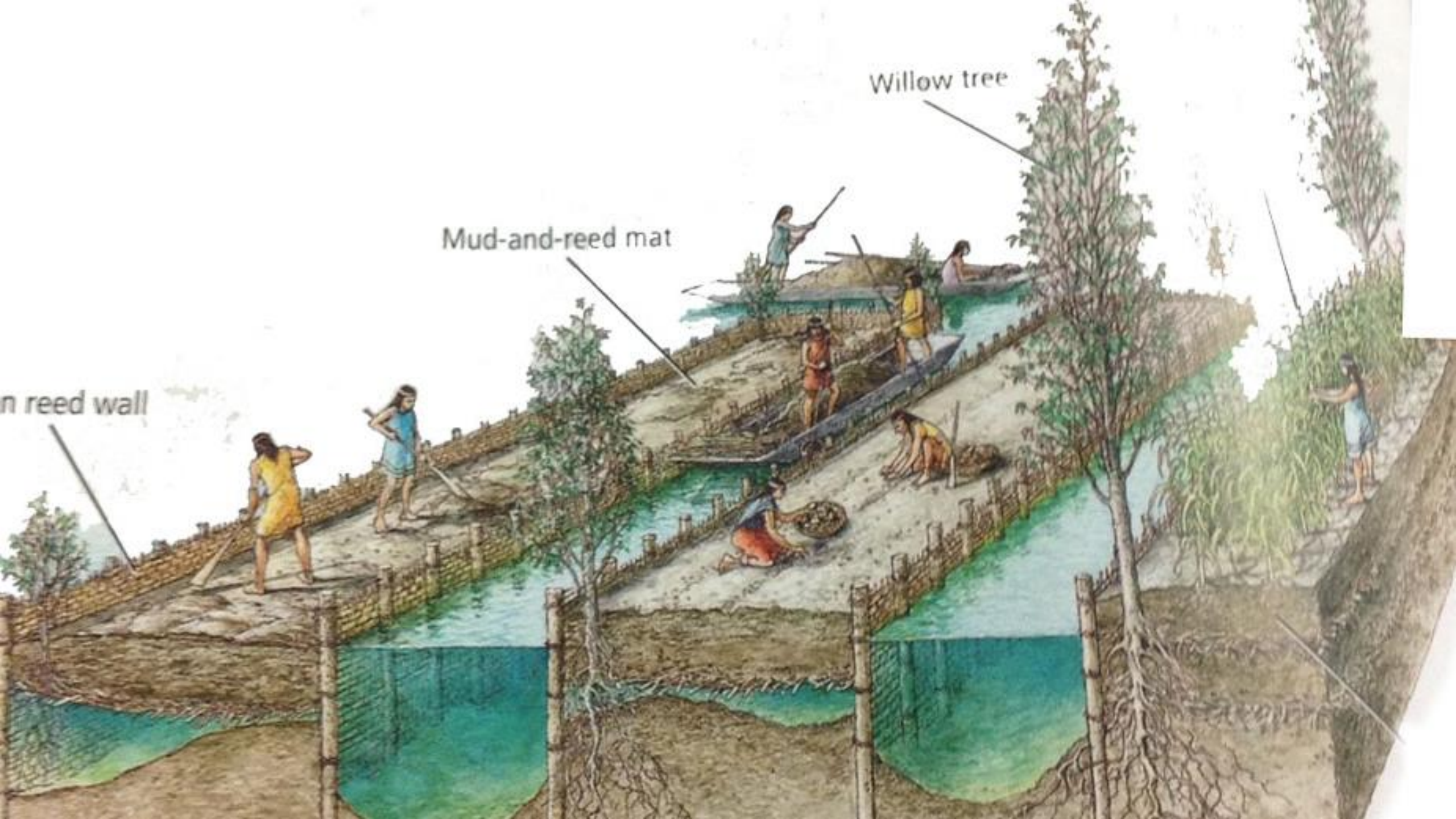


Aquaponics Definition

- Aquaponics is a food production system that couples aquaculture (raising aquatic animals such as fish, crayfish, snails or prawns in tanks) with hydroponics (cultivating plants in water) whereby the nutrient-rich aquaculture water is fed to hydroponically grown plants


HOW AQUAPONICS WORKS
BACTERIA
Naturally occurring bacteria convert ammonia into nitrites and then nitrates.
PLANTS
Plants absorb the nitrates as nutrients. Plants are usually suspended on floating raft platforms or planted into rock.
GROW BED
WATER
Water pumped through the grow bed is filterd by the plants, and then returned to the fish tank.
FISH TANK
Aquaponics Definition
The word aquaponics derived from two words: aquaculture (raising fish) and hydroponics (raising plants in nutrient-rich water).
FISH
Fish are fed food and produce ammonia-rich waste. When fish grow to market size, they can be sold, and replaced with new fish reared from eggs.
OXYGEN
Fish breathe in oxygen and breath our carbon dioxide. Plants absorb the carbon, leaving oxygen-rich water for return to the fish tank.

Aztec chinampas


Willow tree
Mud-and-reed mat
n reed wall

Tesfahun Fitamo

- Syntropic agro-forestry
- Integrated permaculture approach
- Ethiopia

Compost tea

Syntropic agroforestry

- Creating and integrated system
- Addition of biochar
- Donkey manure
- Compost tea
- compost.
- Chop and drop
- Mulching
- Complementary species