

LESSON 18: AQUACULTURE

TEACHER GUIDE

BACKGROUND INFORMATION

- Over-fishing the oceans has become an important problem.
 - We know we have lost at least 2,048 fish species due to overfishing.
 - In March 2009, the Food and Agriculture Organization of the United Nations reported that over 70% of fish species were currently endangered.
 - In a study at the National Centre of Ecological Analysis and Synthesis at the University of California, scientists projected that the oceans would, barring significant changes, become barren of fish by 2048.
- The depletion we are seeing is happening, in part, because we have become so efficient at harvesting at all fish-inhabited ocean depths. According to the movie “The End of the Line”, we now have the technology and fishing fleet capacity to catch four times the current supply of fish. We have enough long-line hooks to encircle the globe 550 times. You could fit 13 jumbo jets through the mouth of the largest trawling net.

- It's doubtful that we are going to eat less fish anytime soon. The health benefits of fish are just too compelling. Eating fish can provide an excellent source of Omega-3 fatty acids, vitamins and minerals that benefit one's overall health. The American Heart Association recommends at least two servings of fish per week to help prevent heart disease, lower blood pressure, and reduce the risk of heart attacks and strokes.
- Given that the demand vastly exceeds the supply, and the unlikelihood of changing habits, people have turned to aquaculture as a solution. Aquaculture means farming fish. There are two main types of aquaculture systems: "open pen" and "recirculating".
- The open pen form of aquaculture involves netting off a section of ocean off of a coast. This area is used as a pen for farmed fish. The main benefit of this system is that the fish can be raised in their natural habitat, the ocean. The main drawback of this system is that a large number of fish in a contained space produce a lot of waste. This waste cannot be effectively recycled since the fish are so segregated and packed. The waste therefore becomes a pollutant.
- The Recirculating Aquaculture Systems (RAS) farm the fish in tanks outside of the ocean. The main benefit of this method is that it can be done anywhere, including in land-locked areas and cities. This greatly reduces the need for

shipping the harvested fish. Unfortunately, waste management challenges plague this technique as well. An excellent filtration system is needed to keep the water free of ammonia.

- Aquaponics by its very definition, solves the waste management problem. Aquaponics takes the potentially toxic waste water from an aquaculture system and transforms it through a natural process into organic nutrients for a hydroponic system (hydroponics is growing plants in water, without dirt). The hydroponic plant growing system acts as a bio-filter for the aquaculture system and purifies the water that goes back to the fish.

LESSON OBJECTIVES

- To bring awareness to the plight of our oceans.
- To get the students thinking about supply and demand using fish as an example.
- To consider how people have gone about addressing current problems, and the pros and cons that accompany those solutions.
- To more fully understand how the aquaponics cycle works to benefit both the fish and the plants.
- To witness first-hand the effect of removing fish from an ecosystem can have.
- To practice the experimental write-up.

LESSON MATERIALS

- A fish tank with fish in it.
- A large, clean bucket. This bucket must breach the surface of the water. This means you should either float it in the tank water, or have a big enough bucket so it can sit on the bottom of the tank and still be above the surface.
- A net to catch a fish.
- Ammonia testing equipment. This is included with the AquaBundance system. Ammonia test kits can also be purchased at your local pet supply store.
- Materials for the students to do an experimental write-up such as paper and pencils.

ASSESSMENT ANSWER KEY

- Aquaculture is raising fish for food.
- The two main types of aquaculture systems are recirculating and open pen (A and D)
- The pro of recirculating aquaculture systems is that the fish can be raised in their natural habitat, the con is waste control. The pro of open pen aquaculture is that it can be located anywhere; the con is also waste control.
- The main con of aquaculture is waste control. Aquaponics uses the fish waste as food for the plants.

STUDENT GUIDE – WHAT IS GOING ON WITH THE FISH WE EAT?

VOCABULARY

- **Protein** – A type of food important to human health. Meat and beans both have protein.
- **Demand** – The amount of something that is needed to fulfill the want.
- **Extinct** – A species that no longer exists. All of the animals from that species have died.
- **Endangered** – A species in danger of becoming extinct. There are fewer animals still alive to fully support the species.
- **Aquaculture** – The farming of fish.
- **Pollute** – To make unclean.
- **Filtration** – Passing a liquid through a filter to remove harmful substances.
- **Insufficient** – Not enough.
- **Aerator** – A machine that puts air into the water.
- **Recirculating** – To move through a circular pattern.

LECTURE AND DISCUSSION

- Begin the lesson by asking the class: who eats fish?
- Fish is a very popular food in the United States as well as across the world. It is widely considered to be a healthy and tasty food. It provides a good source of protein without being too fatty.
-

- The problem is the demand for fish is greater than the amount available in the oceans. Humans want more fish than the oceans have. Plus, the number of people living on Earth keeps increasing so this problem is continuously getting worse.
- Humans pull a massive number of fish out of the oceans. Fishing in the oceans has already caused problems for the fish:
 - At least 2,048 fish species are now extinct from fishing in the oceans.
 - In 2009, 70% of fish species were endangered.
- Now, about half of the fish we eat comes from the ocean.
- The other half of the fish we eat comes from something called aquaculture.
- Ask the class to brainstorm the pros and cons of aquaculture: what is good about raising fish for food? What is bad about raising fish for food?
- Aquaculture exists in two main types:
 - The first type is “open pen”. This is where an area of water is netted off in a coastal region.
 - The main pro of open pen aquaculture is that it allows the fish to live in their natural habitat.
 - The main con of open pen aquaculture is that there are a large number of fish in a small space. These fish produce waste which pollutes the water around them.
 - The second type of aquaculture is “recirculating”. In recirculating systems, fish are raised in tanks outside of the oceans.
 - The main pro of recirculating aquaculture systems is that they can be located anywhere. This means there can be a ready supply of fish for places that are far from the oceans, like Colorado, Illinois and Kansas.
 - The main con of recirculating aquaculture systems is the same con

as for open pen aquaculture. The fish are contained in a small space and their waste has no place to go. Recirculating aquaculture systems require advanced filtration systems to deal with the fish waste. If the waste were not dealt with, the fish's environment would have too much ammonia.

- Aquaculture is a good solution to the problem of insufficient fish in the ocean. But, it still has some problems.
- Ask the class: which form of aquaculture is our aquaponics system more like – open pen or recirculating aquaculture systems?
- Aquaponics is more like recirculating aquaculture systems. The only difference is that we grow plants along with fish.
- Ask the class: how does our aquaponics system address the problems of aquaculture?
- The main problem with aquaculture is waste. Aquaponics systems use the waste from the fish and turn it into food for plants. The plants are our filter!
 - Not only do we not have the problem of waste, but we get healthy plants from it too!

ACTIVITY

- Ask the class: what is the problem with having fish waste in the tank?
- Fish waste produces ammonia, which at high levels, is poisonous to the fish.
- This is the problem in recirculating aquaculture systems. A good filtration system is required to remove the solid fish waste and ammonia from the water.
- The experiment we will do is designed to test how ammonia levels change if the fish water is not allowed to mix with the plants.
- We will catch a fish and put it in a bucket with an aerator and leave it overnight.

The water from the bucket will not be able to mix with the water going into the plant bed.

- Have each student begin an experimental write-up. At this point they should be able to write a title, purpose, hypothesis, materials and procedure.
- Catch, or have a couple students catch, one of your fish in a large bucket. The rim of the bucket should be above the water level in the fish tank so that the water in the bucket cannot circulate with the water in the rest of the tank. Put an aerator into the bucket so the fish has a supply of oxygen.
- Leave the bucket with the fish in the water to ensure that the temperature remains the same.
- Leave the bucket with the fish in it in the fish tank overnight.
- The following day, have one student test the ammonia level inside of the bucket. Have another student test the ammonia level of the water in the rest of the tank.
- Have each of the “tester” students report their results.
- Return the fish to the rest of the tank.
- At this point the students can complete their write-ups by adding the results and conclusion.

CONCLUSION

- Go over the results of the experiment.
 - If the experiment worked properly, the ammonia level in the bucket should have been higher than the level in the tank by the next day.
 - This should have happened because the fish waste produces ammonia, if it cannot be filtered by the plants, the ammonia will build up.
- Remind the class that there is a problem with over-fishing the oceans. People

want to eat more fish than the ocean has to give.

- The solution to this problem is aquaculture. Aquaculture is farming fish for food.
- Aquaculture has two main types: open pen and recirculating systems.
- Open pen is a netted off area along a coast in which fish are raised. With this system, fish are able to live in their natural habitat. The problem is, more waste is produced than can be dealt with and this waste becomes pollution.
- Recirculating aquaculture systems raise fish in tanks out of the ocean. These tanks can be placed anywhere, even in cities. Unfortunately, they still have a fish waste problem that must be dealt with using a good filter.
- Our aquaponics system deals with the waste problem by turning this waste into plant food that supplies our plants with all the nutrients they need.

EXTENSION

- Social Studies – this lesson provides a brief introduction to the social issue of overfishing. This provides a good lead to a more in depth discussion of this issue.
- Science – for more advanced students, this lesson could be taken further by learning the science behind how ammonia actually comes from fish waste.

Name _____

Date _____

ASSESSMENT 18 - AQUACULTURE

- 1) What does **aquaculture** mean? (In your own words)

- 2) What are the two main types of aquaculture? (Circle TWO)
 - A. Recirculating
 - B. Open water
 - C. Tank-raised
 - D. Open pen
 - E. Movable

- 3) Pick ONE of the types of aquaculture and write a pro and a con for the type. (In your own words)

- 4) How does our aquaponics system fix the problems aquaculture has? (In your own words)