

LESSON 3: CHOOSING FISH

TEACHER GUIDE

LESSON OBJECTIVE

To determine which fish species will work best in your classroom aquaponics system, based on 5 criteria: water type, the fish's future, water temperature, eating habits, and oxygen needs.

LESSON MATERIALS

Handout – fish chart (last page of this section)

LECTURE WITH BACKGROUND INFORMATION

Different fish have different needs. Your challenge, in this section, is to figure out what fish species will do best in your aquaponics system. There are 5 factors to consider:

- Water Type: Salt or Fresh
- The Fish's Future: Pet or Plate
- Water Temperature: Cold or Warm
- Eating Habits: Carnivore or Omnivore
- Oxygen Needs: High or Low

WATER TYPE: SALT OR FRESH

There are two types of water that fish can live in: freshwater and saltwater. Vegetables and herbs, however, can live in only one type--fresh. Consequentially, we must choose freshwater fish.

Types of freshwater fish:

Tilapia – by far the most frequently used fish in aquaponics, because: it is easy to grow, likes warm water, has low oxygen needs, reaches harvest size in 9 – 12 months, and is delicious!

Goldfish - probably the second most popular fish because: they are hardy in a wide range of temperatures and conditions, will do a terrific job producing waste for your plants, and grow slowly so they live comfortably in tanks ranging from small aquariums to large tanks. This is generally the fish of choice for those who aren't interested in eating their fish, and is what we recommend for classroom aquaponic systems.

Others raise koi, catfish, trout, bass, shrimp, barramundi, pacu, perch, trout, oscars ...and yes, even fresh water lobster.

THE FISH'S FUTURE: PET OR PLATE

When selecting fish for your aquaponics system, the next decision to make is whether your fish are destined for the dinner plate (**edible**) or to be kept as pets (**ornamental**).

The truth is most fresh-water fish are edible. Whether you eat them or not is largely determined by where you live. For instance, cichlids and oscars, which are considered ornamental fish in the U.S., are actually treated as food in South America.

TEMPERATURE: COLD OR WARM

Fish are **cold-blooded animals**, meaning they take on the temperature of the water in which they live.

Different fish have different water temperature requirements depending on their natural climates. For example, tilapia originated in the lake waters of Africa and therefore evolved to thrive in warm water (above 70° F). Trout, on the other hand, originated in the streams of North America, Northern Asia and Europe and, as such, require cool to cold water (55° F and below). Goldfish can tolerate a wide range of temperatures, and readily survive ice-covered outdoor ponds in cold winter climates. So, the challenge is to select fish that will thrive in the water temperature you will be able to provide. (See chart below.)

	SALMON	BASS	TROUT	TILAPIA	GOLDFISH	KOI
Thriving Temp	55°-65°F	74°-80°F	55°-65°F	74°-80°F	65°-75°F	65°-75°
(Surviving Temp)	(38-68°F)	(40-90°F)	(38-68°F)	(60-95°F)	(45-90°F)	(45-90°F)

The temperature of the water in a tank set up in a classroom will be similar to its air temperature. That means if the heat is turned off in your classroom/school at night

during the winter and the air temperature drops greatly, then the water temperature will drop also. This can be bad for the fish and you may want to consider adding heaters to the tank for fish breeds that prefer warmer temperatures.

The biggest issue with temperature and fish are fast changes in temperature. Most fish can handle wide temperature changes over several hours and live, but big jumps in a few minutes can be fatal. If you experience wide temperature swings over short time periods, you should immediately stop feeding the fish. Most fish die from gut bacterial problems associated with temperature swings.

EATING HABITS: CARNIVORE OR OMNIVORE

Next consider what your fish will need to eat. Are the fish you are considering omnivores or carnivores?

Carnivores (trout, bass, perch and oscars) require a high-protein diet that is difficult to achieve without purchasing a high-quality commercial feed that is specifically formulated for carnivorous fish. Plus, carnivores are, well, carnivores. While almost all fish will show some proclivity towards nibbling on their neighbors, especially the young and the weak; other fish are the food of preference for carnivorous fish. This means that you cannot mix them with other species in your tank, and they should all be approximately the same size or they will snack on each other.

On the other hand, omnivorous fish (tilapia, catfish, pacu, koi, and goldfish) generally coexist well with their own species and with other omnivorous fish species.

	SALMON	BASS	TROUT	TILAPIA	GOLDFISH	KOI
Carnivore or Omnivore	C	C	C	O	O	O

OXYGEN NEEDS: HIGH OR LOW

All fish require oxygenated water, but some require more than others. Again, consider the native environment from where the fish originated. Tilapia and catfish hail from ponds, lakes and marshlands and so are used to relatively low amounts of oxygen and low water quality in general. Trout, on the other hand, evolved in streams and brooks sourced from clear mountain snow run-off. They are therefore happiest in highly oxygenated waters.

Instead of focusing on the exact oxygen requirements for the fish you are considering, think in terms of safety margins. If you have stocked with a low-oxygen fish species and something goes wrong with the aeration system in your fish tank for some period of time, you will have much more time to recover and be less likely to face disaster than if you stocked with fish requiring high levels of oxygen.

	SALMON	BASS	TROUT	TILAPIA	GOLDFISH	KOI
Oxygen needs	Medium	Low	High	Low	Low	Low

OUR RECOMMENDATION

Given that the school year only lasts 9 months, most edible fish take at least that much time to reach maturity, and the realities of harvesting (i.e. – killing) fish, we recommend that you adopt ornamental fish, like goldfish, and find them a new home in someone's pond or aquarium for the Summer.

OTHER FACTORS TO CONSIDER

FEEDING YOUR FISH

Fish tolerate a wide range of feeding schedules very well. They actually adjust their metabolism to match the availability of food. If you want your fish to grow quickly, or you have fewer than the recommended number and need to produce more food for your plants, go ahead and feed them often. Commercial aquaculture operations feed their fish as often as once an hour so as to feed their adult fish as much as 1% of their body weight in feed per day, and closer to 7% for juvenile fish. If, however, you are in an overstocked situation, or had an insect outbreak in one of your planting beds so you need to replant but only have small seedlings available, or for any number of other reasons, you need to “dial down” the amount of fertilizer your fish are producing, simply feed them less.

The best rule of thumb covering how much to feed your fish is only feed them as much as they will eat within five minutes. After five minutes, remove the remaining food from the tank with a fish net. Soon you will be able to judge just how much food to toss in, depending on your fish's behavior at that moment, and you will no longer need to wait five minutes to see how much they eat.

The time you spend observing your fish when you feed them is very valuable. Fish may stop eating for a wide variety of reasons including water temperature being outside of "thriving" range, pH being outside tolerable range, too much ammonia and/or nitrites (a fish may have died in the tank giving off excess ammonia), too little oxygen, stress or a disease. All of these are easily corrected if caught early, and potentially fatal if not.

CARE

When introducing new fish into your system:

- Be sure your system is fully cycled
- Match pH of water in fish tank with that in fish bag
- Match temperature of water in fish bag with that in the fish tank

Temperature: Typically, you will let them float in their unopened bag in your fish tank until the temperature of the water in the bag matches the temperature of the water in the fish tank (about 10 minutes). Then you can release the fish from the bag into the tank.

pH: If the difference between the pH of the water in the bag and that in the fish tank is greater than 0.2, then we recommend that you adjust pH before putting the fish in the tank. For example, if the fish bag is at 7.2 and tank is 7.0 don't bother making any adjustments. If the fish bag is 8 and tank is 7, then adjust pH in tank.

ASSESSMENT ANSWER KEY

1. Freshwater or saltwater, pet or plate (edible or ornamental), temperature range (prefers cold or warm temperature), carnivore or omnivore, high or low oxygen needs.
2. An ornamental fish is kept as a pet. An edible fish is for eating.
3. Goldfish or koi (or both). They are omnivores.

GO FISH!

	SALMON	BASS	TROUT	TILAPIA	GOLDFISH	KOI
Fresh or Salt	Salt	Fresh	Fresh	Fresh	Fresh	Fresh
Pet or Plate	Plate	Plate	Plate	Plate	Pet	Pet
Thriving Temp (Surviving Temp)	55°-65°F (38-68°F)	74°-80°F (40-90°F)	55°-65°F (38-68°F)	74°-80°F (60-95°F)	65°-75°F (45-90°F)	65°-75° (45-90°F)
Carnivore or Omnivore	C	C	C	O	O	O
Oxygen needs	High	Low	High	Low	Low	Low

STUDENT GUIDE – HOW DO WE CHOOSE THE BEST FISH FOR OUR AQUAPONIC SYSTEM?

VOCABULARY

Species – a group of organisms that look similar and are able to breed with one another

Edible – fish that you eat

Ornamental – fish that are kept as pets

Cold-blooded – when an animal’s body temperature changes with the temperature of its environment

Warm-blooded – when an animal’s self-regulates its body temperature to stay at a particular level

LECTURE AND DISCUSSION

Ask: Does anyone know what a “species” is?

- A *species* is a group of organisms that look similar and are able to breed with one another.

Ask: Can anyone name a species of fish?

- Great white shark, Rainbow trout, sting rays, goldfish, Atlantic salmon, large-mouth bass, bluegill, etc.

Today we are going fishing. Not with a hook and line, but rather a paper and pen. Why?

To figure out which fish species will grow best in our aquaponics system.

HANDOUT: "Go Fish!" Chart

	SALMON	BASS	TROUT	TILAPIA	GOLDFISH	KOI
Fresh or Salt	Salt	Fresh	Fresh	Fresh	Fresh	Fresh
Pet or Plate	Plate	Plate	Plate	Plate	Pet	Pet
Thriving Temp (Surviving Temp)	55°-65°F (38-68°F)	74°-80°F (40-90°F)	55°-65°F (38-68°F)	74°-80°F (60-95°F)	65°-75°F (45-90°F)	65°-75° (45-90°F)
Carnivore or Omnivore	C	C	C	O	O	O
Oxygen needs	Medium	Low	High	Low	Low	Low

As you can see, there are 6 species of fish listed across the top of the chart and 5 factors listed along the left side.

We are going to go through each factor and under each species cross off the conditions that DO NOT match those of our aquaponics system. So by the time we get to the bottom of the chart we will know exactly which species of fish we will purchase for our classroom. It will be the column(s) with nothing marked off.

Let's begin with water type: freshwater or saltwater.

FRESH OR SALT

There are 2 types of water that fish can live in: freshwater (that's the water you and I can drink) and saltwater (ocean water that we cannot drink). Plants, at least the type we are growing, can only live in one type: freshwater.

ACTION: So go to your chart and cross off the word "saltwater."

ASK: Which fish does it eliminate? Which fish are fresh water?

So, catfish, trout, tilapia, goldfish and koi are still in the running.

PET OR PLATE

Fish that are meant to be eaten are called **edible** fish, while those kept as pets are called **ornamental** fish.

Ask: What do we plan to do with the fish at the end of the school year: keep them as a pet or eat them?

We don't want to eat our pets so we are better off choosing an "ornamental" fish.

Action: Cross off all the spots that say "plate".

Ask: Now which fish species remain? (2 species: goldfish and koi.)

COLD OR WARM

Most fish are cold-blooded animals, meaning they take on the temperature of the environment (in this case the water) in which they live. Through evolution their bodies have become conditioned to handle a certain temperature range. Beyond this range, they may die.

Different fish can handle different temperature ranges, it all depends on the climates where the fish species originated. For example, tilapia come from the lake waters of Africa, so they like warm water (above 60°F). Trout, on the other hand, originated in streams of North America, Northern Asia and Europe. They prefer cold water (68°F and below).

The temperature of our water depends on the air temperature where we set it up our aquaponic system.

If we were to set it up outside, it would match the temperatures outside during the winter.

Ask: How cold does it get outside during the Winter? Would any of the fish like that temperature?

Ask: What's the temperature in the classroom (or other location you intend to set up your system) right now? (If there is no thermostat in the room, tell the kids the temperature or have them guess it.) Do you think the temperature changes at night or on the weekends?

(NOTE: Confirm evening and weekend temperatures during the late Summer and Winter with facilities management/janitorial staff. You may need to add heaters to your system during the winter.)

Ask: Based on this information, cross-off the temperatures that will not work in our classroom. Which fish species remain? (Goldfish and koi should still be in the running.)

CARNIVORE OR OMNIVORE

The next factor to consider is what will our fish eat.

Ask: Will they eat meat only, meaning they are carnivores, or plants and meat, also known as omnivores?

While almost all fish will nibble on their neighbors, especially the young and the weak, carnivorous fish will eat other fish. This means that you cannot mix them with other species in your tank, and they should all be approximately the same size or they will snack on each other.

Cross-off all the boxes that say carnivore.

HIGH OR LOW

All fish need oxygen in their water to live, but some need more than others. Once again, this depends on the climate in which the fish species evolved. Tilapia and catfish come from ponds, lakes and marshland—still water. So they can live in water with low oxygen levels. Trout, on the other hand, evolved in the churning waters of streams and brooks, which contain highly-oxygenated water.

To create highly-oxygenated water we need lots of bubbles and splashing water. Many air stones and lots of cascading water that splashes into the fish tank are 2 common ways to create highly-oxygenated water.

Ask: Does our system have that? (No)

Ask: Look at your chart. Put an “x” through the boxes that say “high”.

CONCLUSION

Ask: What species are the winners? (Goldfish and koi)

(NOTE: You can mix goldfish and koi, or use all goldfish or all koi.)

Review the chart. Make sure students understand why all 5 factors are important for choosing fish:

- 1) Fresh water – vegetables, herbs, & greens can't live in saltwater.
- 2) Pet (ornamental) or Plate (edible) – do you intend to eat the fish or keep it as a pet

- 3) Temperature – fish are cold-blooded animals. They need to live in water with temperatures that match their natural habitat
- 4) Omnivore or Carnivore – will the fish get along in their tank or will they try to eat one another
- 5) Oxygen Levels – some fish need more oxygen than others, based on their natural habitats

EXTENSIONS

Math – Now that you know which species of fish to purchase for your system, one question remains: how many fish should we get? Here's how to figure it out:

1 fish per 5 gallons of water

So, how many fish can we put in our 60 gallon tank (or whatever size your tank is)?
(ANSWER: 12 fish)

