



**Friend or Foe:
What makes a species “invasive?”**

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Q-540: Teaching Environmental Education

Topic: Food chain dynamics

Big Idea: Invasive species in a lake ecosystem

Grade Level: 7th

Rationale:

Understanding the interdependence of species within an ecosystem is a fundamental aspect of the living environment. Before students can formulate their own questions regarding relationships among species it is crucial that they have first-hand experience with the delicate nature of food chains and ecosystems. This activity both introduces the concept of stability within an ecosystem and the underlying characteristics of an invasive species. By simulating a working food chain and collecting/graphing data across time, students will discover how inefficiently energy is converted as you move up the food chain. By simulating the introduction of a non-native species and sharing their results with the class, students will learn to assess when an introduced species is a problem and when it is not.

Background Information:

In order to fully understand how a species becomes invasive within certain ecosystems, it is imperative for both teacher and students to have working knowledge of the food chain. A food chain shows how each living thing gets its food. Some animals eat plants and some animals eat other animals. For example, a simple food chain links the trees & shrubs, the giraffes (that eat trees & shrubs), and the lions (that eat the giraffes). Each link in this chain is food for the next link. Animals that eat only plants are called *herbivores* while animals that eat other animals are called *carnivores*. Ecosystems are comprised of a variety of species across the food chain such that the majority of organisms are primary consumers, herbivores, and only a few are top predators. Because of the inefficiency of energy conversion, it is most often the case that herbivores and predators must consume much more food than is directly used to produce offspring. ***This means that it takes many individuals of prey to feed one predator and thus an ecosystem can typically support only a few top predators.***

The other important aspect of the food chain, which is especially relevant to the invasive species problem, is that ***the number of individuals of a species in an ecosystem is regulated by both how much food is available and how many predators there are.*** For example, if a predator is excluded from an ecosystem the prey may increase in numbers since they are no longer being eaten. On the other hand, if the number of prey in an ecosystem is reduced the predators no longer have as much food and are thus some are unable to survive or produce offspring.

It is clear that ecosystems are fragile and extremely sensitive to changes in composition due to extinction of species or introduction of non-native species. ***How a particular ecosystem will respond to changes is not always predictable, and there is certainly no formula for determining whether an introduced species will become an invasive pest.*** There are, however, certain questions that can be addressed in order to determine how problematic introduction of a species might be. For example, understanding how the “new” species fit into its own native ecosystem can give us a more clear understanding of what others species it might eat and which species might feed on it. The hard part, unfortunately, is determining how well species in the same level of the food chain will coexist with the introduced species. If the introduced species is better at foraging for food or escaping predators than those already in the ecosystem it

may replace native species and cause extinction. *By simulating how an ecosystem works and moving a particular species from one ecosystem to another it should become clear how a species can be classified as invasive in a novel ecosystem despite being a non-invasive in another.*

Goals and Objectives:

As a result of this lesson, students will be able to:

- Classify species in an ecosystem as herbivores, primary consumers, predators, or invasive species
- Predict and graph the effects of adding/removing species at various levels of the food chain on an ecosystem
- Communicate results of a simulation using charts, graphs, and written statements
- Formulate hypotheses regarding what makes a species invasive
- Collect and assess information from a variety of invasive species resources

NAAEE Guidelines for Learning (PreK-12) and Content Standards Correlation:

NAAEE Guidelines for the Eight Grade:

Strand 1: E, F, G	Questioning, Analysis, and Interpretation Skills
Strand 2.2: A, C, D	The Living Environment
Strand 3.1: A	Skills for Analyzing and Investigating Environmental Issues

IN State Science Standards:

7.2.7	Scientific Thinking: Communication Skills
7.4.2, 5	The Living Environment: Diversity of Life
7.4.9	The Living Environment: Interdependence of Life and Evolution
7.7.3	Common Themes: Constancy and Change

Lesson Plan/ 5 Es:

Lesson length: One to two class periods

- Materials:**
- Copies of food chain diagram (one per student)
 - Colored construction paper (four colors), cut into smaller squares
 - *(optional)* Masks or colored shirts for students to dress as their species

- Copies of ecosystem composition graph and prediction worksheet (one per student) and copies of game rules (one per group)
- Colored pencils or markers

Preparation: - Construction paper squares should be divided into baggies such that each baggy has about 20 pieces of the same color (more for green-algae). Four different colors should be used and one bag should be put together for each student such that there are equal numbers of each species.

ENGAGE (10-15 minutes):

(These activities should both assess what students already know about ecosystem, food chains, and invasive species and prepare them for the exploration activity)

The teacher should begin by handing out copies of the food chain worksheet and having students draw arrows between each species and others on which it feeds (e.g. sun → algae, algae → snails). After students have completed the diagram and written answers to the questions they should move into groups and compare their results with one another while discussing how they determined which species were linked. After short group discussion, the class will come back together and the teacher will lead a class discussion by asking questions such as:

- Is there any species that isn't eaten by any others? What happens to this species when it dies?
- Is there any species that survives without eating another species? How does this species survive?
- What would happen if you removed species X from the lake? Would the predator be able to survive? What would happen to the prey species once its predator was gone?
- Do all lakes have the same species in them? What about lakes from other states or countries?
- What would be the consequences of moving a species from its own ecosystem to another?

EXPLORE (20-30 minutes):

*(In this activity, students explore the concepts of food chains and invasive species by simulating an ecosystem through a hands-on experience in which each student acts as a different species within a lake ecosystem. Students receive little guidelines other than instructions for playing the game and on how to graph the results of their group's ecosystem simulation. Students must communicate with their group in order to obtain the results needed for their own graphs. **This activity can be run outside in order to increase excitement and encourage reflection about living organisms in the student's own environment.**)*

The teacher will divide students into groups of approximately 4 students each and hand out masks or other costumes (optional) as well as a bag of colored paper to each student such that each group has one student representing each of four species. **However, groups will not all consist of the same group of species!** Half of the groups will have one algae, one snail, one little fish, and one big fish while the other half will have one algae, one snail, one little fish, and one eagle. Each group will be given a copy of the game rules and the teacher will read these out loud and ensure that all groups understand the rules.

- Groups will stand in a circle around the room (or outside) and each student will start with the specified number of construction paper pieces. **Groups should be randomly scattered so that not all of the eagle groups are on one side and big fish groups on the other.** Step-by-step, the groups will follow the rules of the game. **The teacher should make sure all groups move step-by-step together, allowing students to ask questions along the way.**
- Students will record the number of pieces each member of the group has (of their own color) at steps 1 and 3 (including the repeat) in their chart. This will allow them to fill in the first three time points.
- After students have repeated steps 2 and 3 once, the “invasion” will occur where each little fish moves to the group next to it. **Make sure each group has one little fish after the move.**
- Students will start the game over according to the new rules based on which new little fish has moved in. Again, students should record the number of pieces each has after steps 1 and 3 (including the repeat). This will allow them to fill in time points 4-6.

EXPLAIN (10-15 minutes):

(After the activity has been run, students should be given an opportunity to reflect on their results and share their group’s findings with the class. Since the simulations of different groups should yield different results, the teacher will lead a discussion to help the students determine how and why these results were obtained.)

At this stage students return to desks and transform the data from their individual charts into the graph and answer the questions at the bottom of the sheet. After this has been completed the teacher will lead a discussion in which **the class explains what the first three time points look like and how a food chain works.** The teacher poses questions such as:

- Which species was most abundant? Which was least abundant? Why?
- What happened to the numbers of each species during the first three time points? How did they remain stable?
- Why was running a simulation helpful in determining how this ecosystem works? Is this something you could measure in the real world?

Students will then be asked to share their results from the invasion event. A volunteer from each group will be asked to draw their graph on the board and others will explain what happened once the new little fish species was introduced. ***The teacher will ask questions to help students understand why, in some cases, the top predator went extinct while in other cases nothing changed.*** In addition, the class will be asked to identify whether, in any of the scenarios, the introduced little fish would be categorized as an invasive species. In order to reach this answer, the teacher will ask questions such as:

- Did the introduced little fish cause the extinction of any other species?
- Did the introduced fish become more or less abundant than the native fish that had been there before?
- Why did simulations from different groups yield different results?

EXPAND (10-30 minutes):

(In order to expand the students' understanding of the concept and help them apply this knowledge to new problems, students will make a series of predictions about changes in food chain dynamics. This section should prepare the students for their independent projects in which they will analyze a local invasive species.)

As a class, and with the help of the teacher, students will address questions such as:

- What would happen if the algae went extinct? What if the snails went extinct? What about the little fish?

On the board or overhead projector, the teacher will list the students' predictions and have a volunteer graph what would happen to the ecosystem under each prediction. If time is available, students can again break up into groups and choose one prediction to test using the same simulation and rules. If this latter extension is used, the teacher should have students share their results and discuss whether or not their predictions were correct. If incorrect, students should address the possible reasons that the simulations would differ and whether this result would be applicable to real ecosystems.

EVALUATE:

(Assessment should occur at various stages of this activity, including the initial engage activity, throughout the class discussion, and based on the final worksheet and report. The teacher should observe students' participation throughout the discussions in order to assess student learning. Students will use the ecosystem composition worksheets as self-evaluations and as an aid for completing the final exercises.)

Students will utilize what they have learned from the simulation and class discussion to make and graph predictions about other changes to the food chain. The worksheet (p.11) can be given during class or as homework and should be turned in for assessment by teacher. The worksheet will be used to assess whether each student is

comfortable making predictions, both verbally and graphically, about food chain dynamics and to determine whether they have the ability to distinguish invasive species from non-invasive species.

In addition to the assessment above, the teacher may want to highlight the real world application of the topic by having students investigate a local invasive species using a variety of news and internet sources. This activity will act as a summative evaluation and students, either individually or as part of a group will write a report discussing how the species existed in its native habitat and why it has become an invasive pest in the new ecosystem. By comparing food chain dynamics of a species in its native ecosystem to dynamics in the local ecosystem, students will be able to explore why a species has become invasive. Students should determine what measures of control have been taken and suggest where efforts should be focused based on their new understanding of food chains and the characteristics of invasive species.

Resources:

The Food Chain Reaction Game:

http://ecokids.earthday.ca/pub/eco_info/topics/frogs/chain_reaction/assets/flash/chain_reaction.swf

On this website, students can learn about food chains and test their knowledge by building a food chain.

Invasive Species of Indiana:

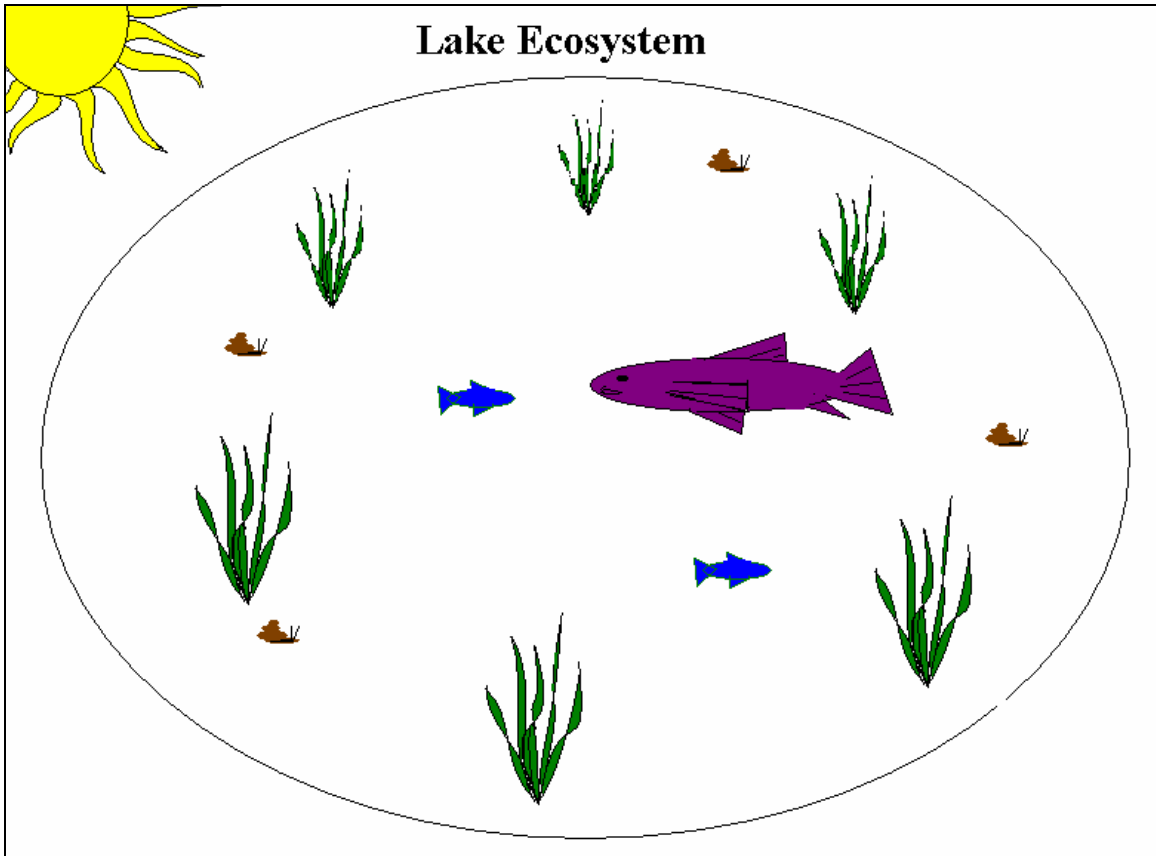
<http://www.in.gov/dnr/invasivespecies/>

This website is put together by the Indiana Department of Natural Resources and has descriptions and link to information about various invasive species in Indiana.

References:

1. IN State Science Standards
2. NAAEE Guidelines: *Excellence in Environmental Education- Guidelines for Learning (PreK-12)*
3. The SAGUARO Project (2001): <http://www.saguaro.geo.arizona.edu/5-Epdf.pdf>
4. Krasny, Marianne E. *Invasive Ecology*. Virginia: National Science Teachers, Association Press, 2003.

Name: _____



Food Chain: Draw arrows from each organism to its food/energy source.

Which species is the most abundant? _____

Which species is the least abundant? _____

Briefly explain why some species are more abundant than others: _____

Draw in any other organisms you think might be part of this food chain.

Since it doesn't get eaten by anything, what happens to the species at the top of the food chain? _____

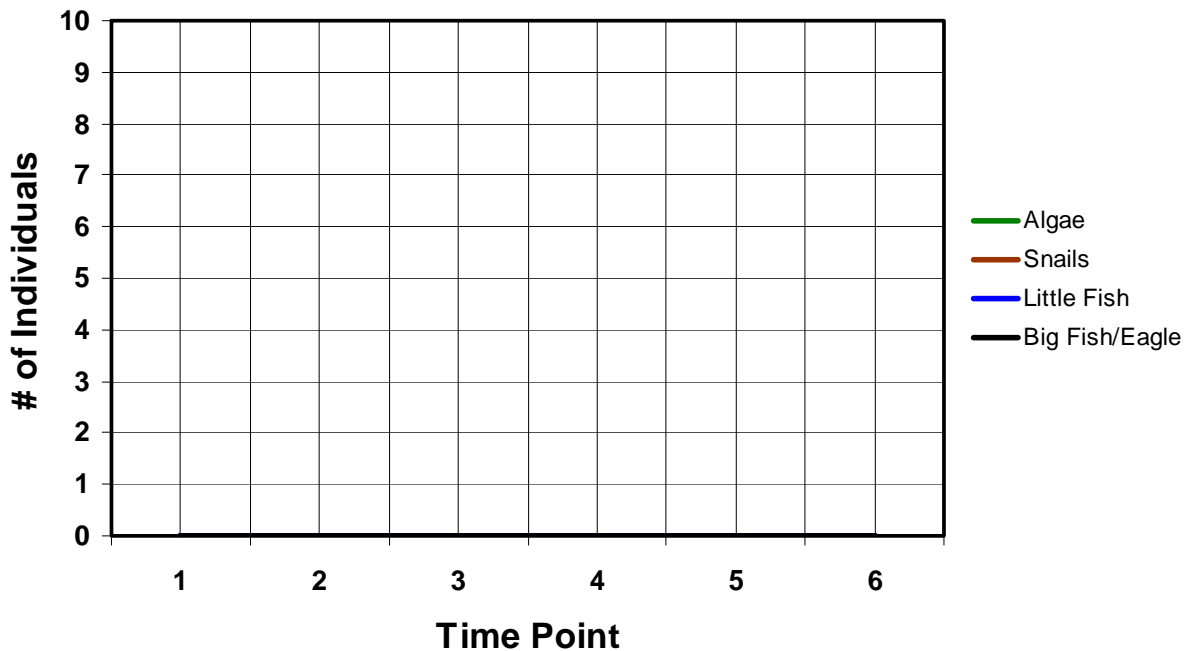
Rules of the “Friend or Foe” Game

- ALGAE:**
1. Start with ten algae (pieces of construction paper)
 2. Feed the snails in your ecosystem! Give them eight pieces of algae.
 3. Lucky you! The sun came out and you grew. Take out eight more pieces of algae.
 4. Repeat steps 2 and 3 one more time.
- SNAIL:**
1. Start with six snails (pieces of construction paper)
 2. Feed the little fish in your ecosystem! Give them four snails.
 3. Yum! After your algae snack you have the energy to raise more little snails, take out four more pieces.
 4. Repeat steps 2 and 3 one more time.
- LITTLE FISH:**
1. Start with four fish (pieces of construction paper)
 2. Feed the big fish or eagle in your ecosystem! Give them two little fish.
 3. Those snails were just what you needed to reproduce and have two baby little fish, take out two more pieces.
 4. Repeat steps 2 and 3 one more time.
- BIG FISH:**
1. Start with two fish (pieces of construction paper)
 2. You were hungry and ate the little fish!
 3. Since you ate those little fish, you now have the energy to reproduce! Take one more piece out of the bag for every two fish you ate.
 4. OLD AGE has taken your first two big fish! Return two pieces to the bag and then repeat steps 2 and 3 one more time.
- EAGLE:**
1. Start with two eagles (pieces of construction paper)
 2. You were hungry and ate the little fish!
 3. Since you ate those little fish, you now have the energy to reproduce! Take one more piece out of the bag for every two fish you ate.
 4. OLD AGE has taken your first two eagles! Return two pieces to the bag and then repeat steps 2 and 3 one more time.
5. Little fish should all move to the lake on the right of you! This time, follow these new rules depending on which lake you came from:
- Little fish from ecosystems with eagles- You guys are great at swimming away from eagle shadows but have never seen a big fish before. If you are in another ecosystem with an eagle, follow the same directions as above. If you are in an ecosystem with a big fish, give them three fish (or all of your fish, if you don't have three) when it's time to feed them.
 - Little fish from ecosystems with big fish- You guys are great at hiding under rocks from predators. If you are in another ecosystem with big fish, follow the same directions as above. If you are in an ecosystem with an eagle, you only have to feed them one little fish each time but all the other rules are the same (you can still take out two pieces every time).
5. All species: Start game over at step 1

ECOSYSTEM COMPOSITION CHARTS:

	Time Point					
Species	1	2	3	4	5	6
Algae						
Snails						
Little Fish						
Big Fish / Eagle						

Ecosystem Composition Graph



My ecosystem had:

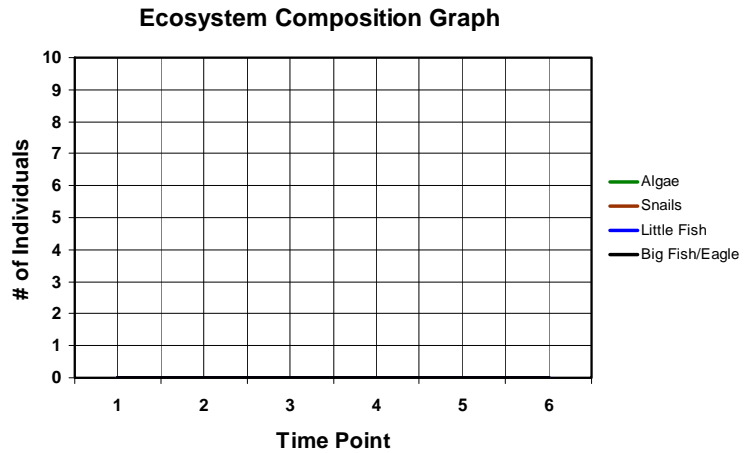
- An eagle
- A big fish

After time point 3, my ecosystem had a little fish from:

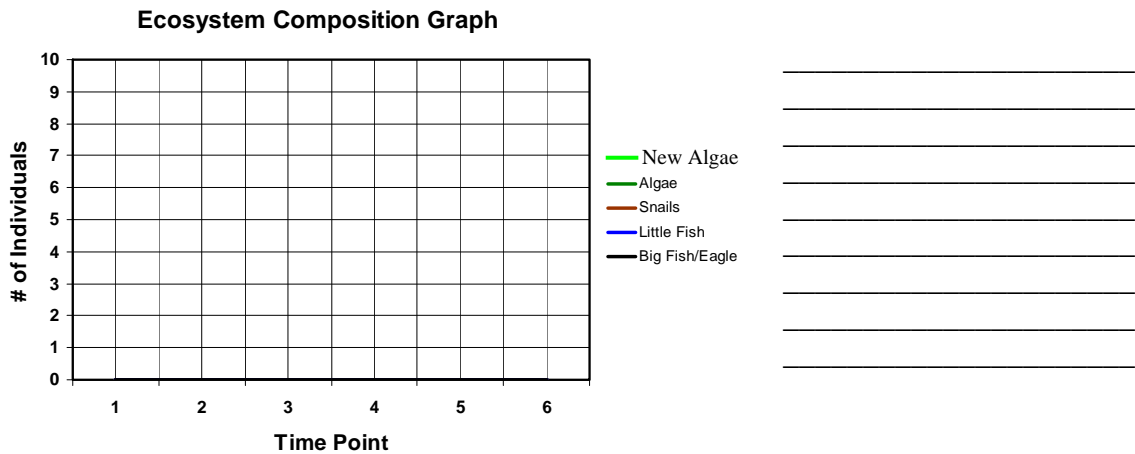
- An eagle lake
- A big fish lake

Name: _____

1. If the _____ species were to go extinct, I would predict:



2. If a new species of algae, that the snails can only eat half as much of because it's too tough, was introduced, I would predict:



3. If _____

_____, I would predict:

