Name: Key Date: Block:

Standards: MM3A7a,b

AN OKEFENOKEE FOOD WEB

The Situation

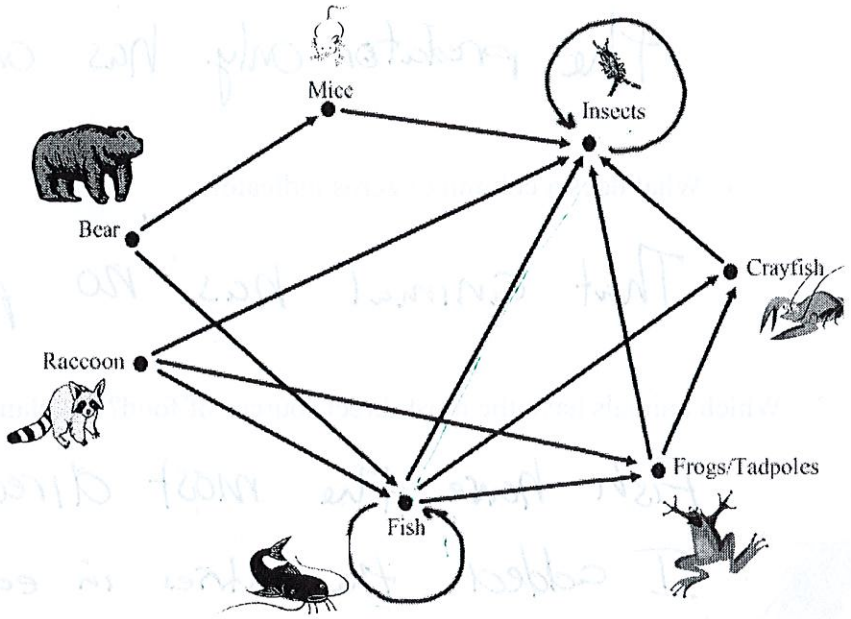
Recent weather conditions have caused a dramatic increase in the insect population of the Okefenokee Swamp area. The insects are annoying to people and animals and health officials are concerned there will be an increase in disease. Local authorities want to use an insecticide that would literally wipe out the entire insect population of the area.

Your Mission

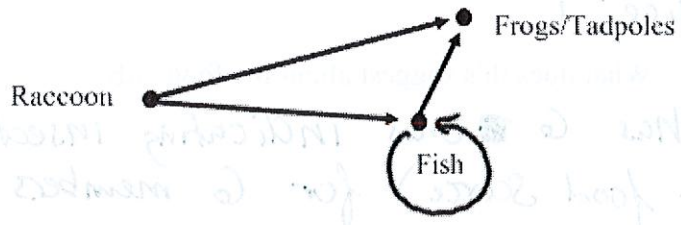
You, as an employee of the Environmental Protection Agency, must determine how detrimental this would be to the environment. Specifically, you are concerned on the effects on the food web of six animals known to populate the swamp.

Examine the digraph to the right of a food web for the six animals and the insects that are causing the problem in the Okefenokee Swamp.

A **digraph** is a directed vertex edge graph. Here each vertex represents an animal or insects. The direction of the edges indicates whether an animal preys on the linked animal. For example, raccoons eat fish. (Note: the food web shown is simplified. Initial producers of nutrients, plants, have not been included.)



Adjacency matrices can be used in conjunction with digraphs. If we consider just the relationships between raccoons, fish, and frogs in the food web shown, an adjacency matrix would look like the one below. In the matrix, rows represent the animal/insect eating the animal/insect in the columns. The columns represent he animal/insect being eaten.



$$\begin{array}{c} \\ R \\ FT \\ F \end{array} \begin{array}{c} \begin{array}{ccc} R & FT & F \end{array} \\ \begin{bmatrix} 0 & 1 & 1 \\ 0 & 0 & 0 \\ 0 & 1 & 1 \end{bmatrix} \end{array}$$

Source: "Okefenokee Food Web Learning Task," Unit 1, Mathematics III Frameworks, GADOE; Adapted by Amanda Merritt, Jordan Vocational High School, 2010

1a. Construct the associated matrix F to represent the larger food web.

$F =$

	Bear	Cr	Fi	Fro	Ins	Mi	Rac
Bear	0	0	1	0	0	1	0
Crayfish	0	0	0	0	1	0	0
Fish	0	1	1	1	1	0	0
Frogs	0	1	0	0	1	0	0
Insects	0	0	0	0	1	0	0
Mice	0	0	0	0	1	0	0
Raccoons	0	0	1	1	1	0	0

b. What does a row containing a single one indicate?

The predator only has one direct food source

c. What does a column of zeros indicate?

That animal has no predetors.

2a. Which animals have the most direct sources of food? Explain how you determined this from the matrix.

Fish have the most direct food sources.
I added the entries in each row.

b. Find the number of direct food sources for each animal.

Bear: 2
Crayfish: 1
Fish: 4
Frogs: 2
Insects: 1
Mice: 1
Raccoons: 3

3. The insect column has the most ones. What does this suggest about the food web?

The insect column has 6 ones indicating insects are pray (a direct food source) for 6 members of this food web. It suggests insects are very important to the ecosystem.

4. The matrix F^2 denotes indirect (through one intermediary) sources of food. For example, the fish relies on insects for food, and the bear relies on the fish for food, so the insect is an indirect source of food for the bear. Find F^2. Notice that insect column contains all nonzero numbers. What does this indicate?

$F^2 =$

	Bear	Cr	Fi	Fro	Ins	Mi	Rac
Bear	0	1	1	1	2	0	0
Crayfish	0	0	0	0	1	0	0
Fish	0	2	1	1	4	0	0
Frogs	0	0	0	0	2	0	0
Insects	0	0	0	0	1	0	0
mice	0	0	0	0	1	0	0
Raccoon	0	2	1	1	3	0	0

It indicates that insects are indirect sources of all food for all animals in the food web.

5a. Compute matrices F^3 and F^4 of the food web matrix to represent the number of direct and indirect sources of food for each creature.

$F^3 =$

	Bear	Cr	Fi	Fro	Ins	Mi	Rac
Bear	0	2	1	1	5	0	0
Crayfish	0	0	0	0	1	0	0
Fish	0	2	1	1	8	0	0
Frogs	0	0	0	0	2	0	0
Insects	0	0	0	0	1	0	0
mice	0	0	0	0	1	0	0
Raccoon	0	2	1	1	7	0	0

$F^4 =$

	Bear	Cr	Fi	Fro	Ins	Mi	Rac
Bear	0	2	1	1	9	0	0
Crayfish	0	0	0	0	1	0	0
Fish	0	2	1	1	12	0	0
Frogs	0	0	0	0	2	0	0
Insects	0	0	0	0	1	0	0
mice	0	0	0	0	1	0	0
Raccoon	0	2	1	1	11	0	0

b. Which creature has the most food sources?

Fish have the most food sources

c. Which creature is the biggest food source for the others?

Insects are the biggest food source for others

6. If an insecticide is introduced into the food web, it would kill the entire insect population.

a. Construct a new matrix G to represent the food web with no insects.

	Bear	*Cr*	*Fi*	*Fro*	*Mi*	*Rac*
Bear	0	0	1	0	1	0
Crayfish	0	0	0	0	0	0
Fish	0	1	1	1	0	0
Frogs	0	1	0	0	0	0
Mice	0	0	0	0	0	0
Raccoons	0	0	1	1	0	0

b. What effect does this have on the overall animal population?

It effects the number of direct food sources. Eliminating insects reduces the number of direct food sources for all animals.

c. What has happened to the row sums? Compare these with those of the original matrix.

The row sums have decreased

d. What does a row sum of zero indicate?

Mice and Crayfish have no direct food source.

7. Will all the animals be affected by the insecticide? Which animal(s) will be least affected?

Mice, crayfish and frogs have lost an important source of food. If these animals die off, and are taken out of the food web, then bears, fish and raccoons are only left with as a primary food source.

Your Findings

Organize and summarize your findings in two paragraphs (3-5 sentences each) to the health officials. Take and support a position on whether using an insecticide to destroy the insect population is harmful to the environment.

Using an insecticide to destroy the insect population would be harmful to the food web because it would eliminate primary and secondary food sources for a lot of animals. In turn this would also effect animals not included on this food tree. ~~It is~~ Even though insects are not liked by many humans, they are vital to the survival of many animals and it goes as far as human survival as well.