Field trip: 8th Grade Ecological Relationships

Activity: Bioaccumulation use blank cards w/ skull + crossbones

Standards Covered:

- Roles and relationships among producers, consumers, and decomposers in the process of energy transfer in a food web.

Materials: 60 $1 bills, 20 of which are marked
Index cards or tokens or popsicle sticks: 12 green, 6 blue, 3 yellow, 1 red

Background Information:
*From the WILD Education programs by the Canadian Wildlife Federation

Bioaccumulation in food chains
Some toxic chemicals "bioaccumulate" in wildlife. Scientists discovered this phenomenon when they noticed that the levels of certain chemicals in some animals' bodies were significantly higher than those in the surrounding environment. These levels were highest at the top of food chains. The more links in a food chain, the higher the levels of toxic chemicals. Many types of chemicals are stored in fat tissues and eliminated by animals far more slowly than they are consumed. Over its lifetime, an animal will gather and store toxic chemicals at levels far above those in its environment. This bioaccumulation happens at each successive level of a food chain. Predators, such as polar bears, eagles, and people, are at the top of long food chains and sometimes accumulate concentrations of toxic chemicals in their bodies hundreds of times greater than those in the surrounding environment. Bioaccumulation can lead to serious health risks, including cancer.

Marine Pollution
Eighty per cent of marine pollution originates from human activities on land, coming mainly from individuals and communities, not industries. Pollutants make their way to the ocean through sewers, waterways, and atmospheric currents.
Untreated or partially treated sewage from domestic waste-water often ends up in waterways. Its main threat to humans is the bacterial and viral contamination of shellfish, which can turn seafood into a lethal meal and lead to the closure of economically important fisheries.

Persistent organic pollutants (POPs) are a class of chemicals that accumulate in food chains and cause tumours, deformities, loss of reproductive ability, and even death in plants and animals, including humans. Some examples are DDT, PCBs, and dioxins. POPs enter the environment through pesticides sprayed on lawns and crops and industrial chemicals that leak from landfills. They are transported long distances by waterways, ocean currents, and the atmosphere. POPs affect ocean wildlife, such as beluga whales, fish, seals, and even arctic species like polar bears.

Heavy metals, such as mercury and cadmium, cause problems similar to those caused by POPs. They enter the environment through mining and smelting operations, the burning of coal for electrical generation, and the pulp and paper industrial processes.

Methods:

- Tell students that we are going to use money to represent *food* moving up the food chain (instead of *energy* as in the Energy Transfer activity).

- Draw the following food pyramid on the board so everyone can follow along:
  Sun → Phytoplankton → Zooplankton → Herring → Osprey

- Randomly assign students to roles in the imaginary food chain by handing out the colored pieces. For 24 students:

12	Phytoplankton	green card
6	Zooplankton	blue card
3	Herring	yellow card
1	Osprey	red card
2	Recorders	at white board (It's nice if the Recorders can calculate an average)

- Phytoplankton each get $5 to start, representing the food that they made using the sun's energy. Point out that some of the bills are marked. The Phytoplankton should tell the recorders how many marked bills they each have. Recorders should write each student's number of marks under a Phytoplankton column (see example table below).

- Have the Zooplankton each eat 2 Phytoplankton by taking their bills. Each Zooplankton should get $10. Have the Zooplankton tell the Recorders how many marked bills they each receive.

- Have all the Herring each eat 2 Zooplankton and take their bills. Each Herring should now have $20. Record the number of marked bills that each Herring received.

- The Osprey eats the 3 Herring and takes their bills. The Osprey should have all $60. Record how many of the Osprey's bills are marked.

- The Recorders should now have a table that looks like the one below. If time, have students use a calculator to calculate the average number of marks per organism.

- Finally, inform the class that the marked bills represent pollution that was initially in the Phytoplankton's water. This could be a pesticide like DDT or another type of contaminant, such as PCBs or mercury. The pollution has worked its way up the food chain through **bioaccumulation.**

Sample Table:

	Phytoplankton	Zooplankton	Herring	Osprey
Number of individual marks	1 2 3 2 2 0 1 2 1 3 2 1	3 5 2 3 4 3	8 5 7	20
Average number of marks per organism	**1.66**	**3.33**	**6.66**	**20**

Topics for Discussion:

Have you heard of any toxins that accumulate in this way? DDT, mercury, PCBs?
Can you think of any predators besides ospreys that might be affected by bioaccumulation? tuna, shark, bears

DDT and Ospreys

DDT causes ospreys to lay eggs with thin shells that are easily crushed by the parents. Thanks to DDT, there were only 10 nesting pair of osprey in Massachusetts in 1972. DDT use was banned in the US in 1973, and now there are over 400 ospreys statewide.

Mercury and Fish

Why does the FDA have the following guidelines for eating fish?

1. Do not eat Shark, Swordfish, King Mackerel, or Tilefish because they contain high levels of mercury.
2. Eat up to 12 oz (2 average meals) a week of a variety of fish and shellfish that are lower in mercury.
    - Five of the most commonly eaten fish that are low in mercury are shrimp, canned light tuna, salmon, pollock, and catfish.
    - Another commonly eaten fish, albacore ("white") tuna has more mercury than canned light tuna. So only eat up to 6 ounces (one average meal) of albacore tuna per week.
3. Check local advisories about the safety of fish caught by family and friends in your local lakes, rivers, and coastal areas.

PCBs in New Bedford Harbor

See Abbey's write up on this topic.

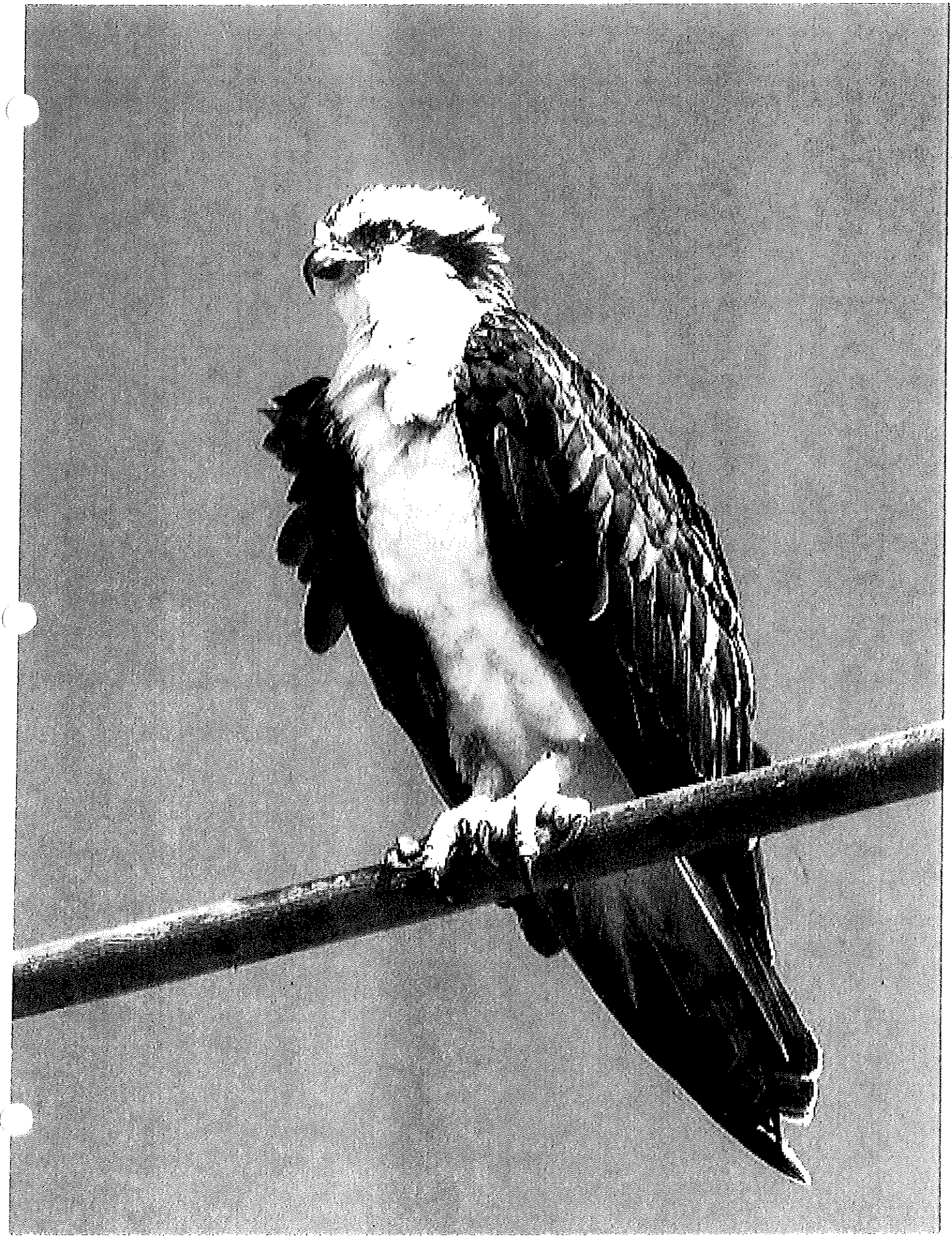
BIOACCUMULATION

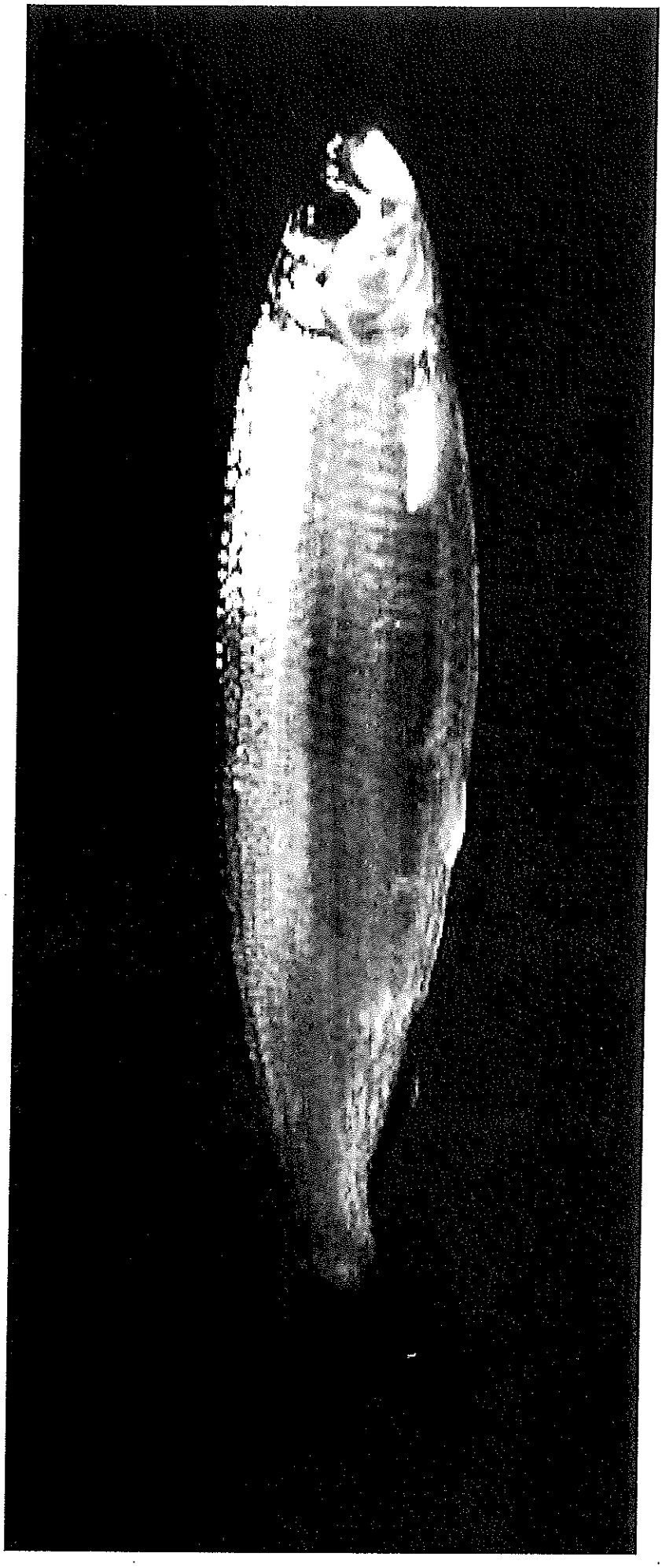
SAMPLE TABLE

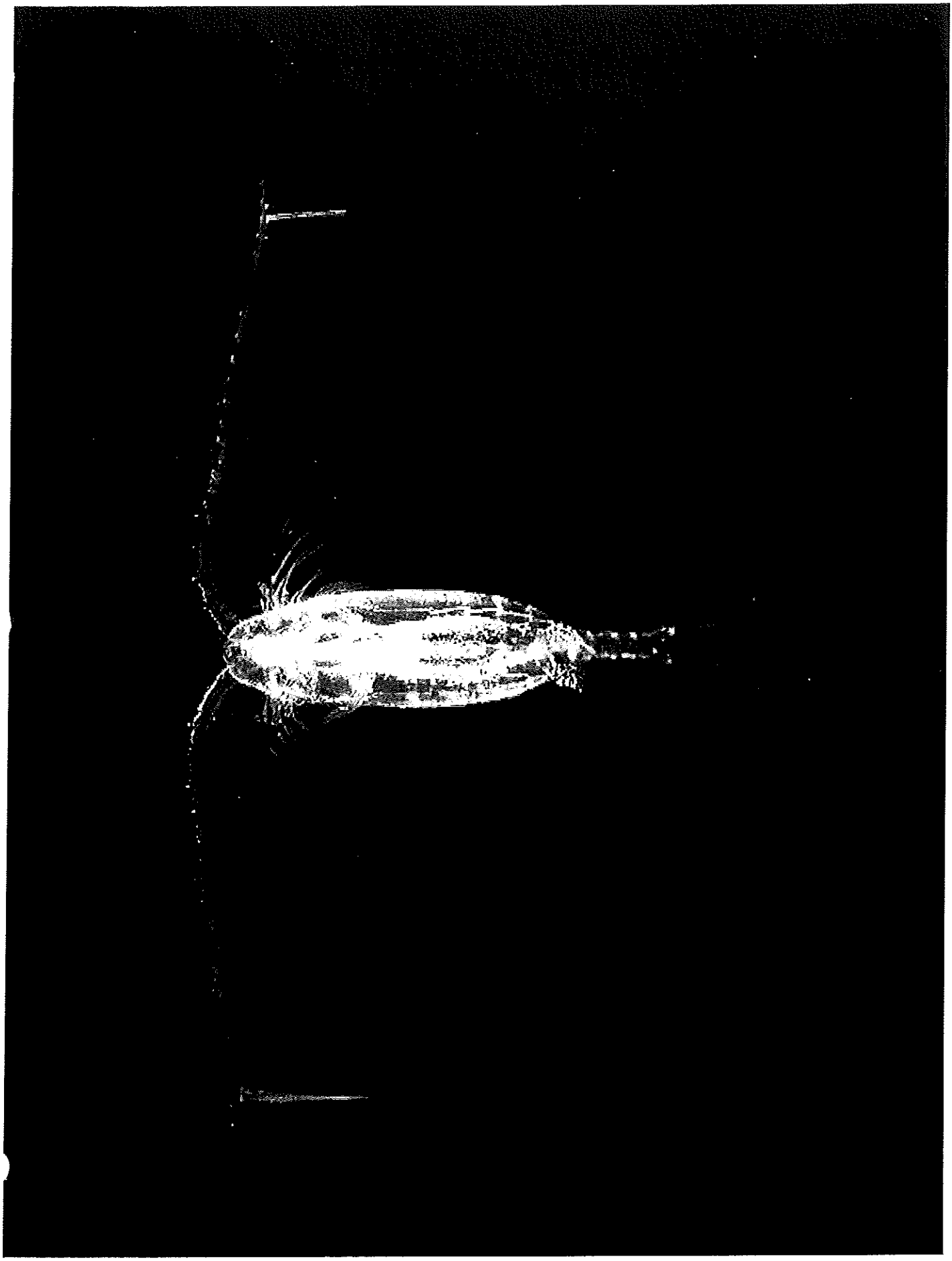
	Phytoplankton	Zooplankton	Herring	Osprey
Number of cards with toxins	1	3	8	20
	2	5	7	
	3	2	7	
	2	3		
	2	4		
	0	3		
	1			
	2			
	1			
	3			
	2			
	1			
Average number of marks per organism	**1.66**	**3.33**	**6.66**	**20**

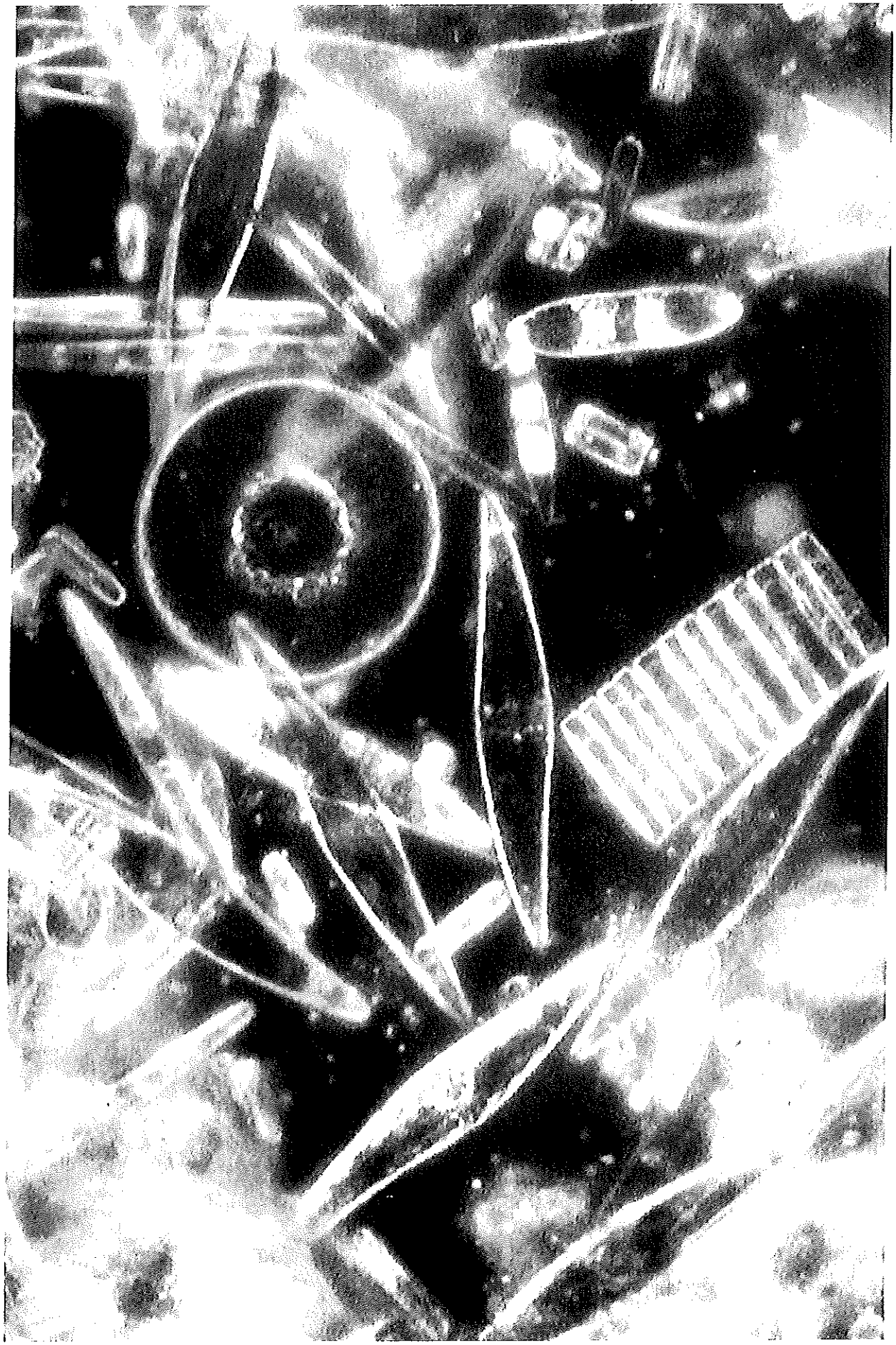
RECORD the number of cards with toxins (marks). Record the average number of marks per organism at the bottom of the column.

	Phytoplankton	Zooplankton	Herring	Osprey
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
Average				









BIOACCUMULATION

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	2			
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1				
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4				
5				
6				
7				
8				
9				
10				
11				
12				
Average				

Earth Systems
Standard IV, objective 2; Standard II, objective 2
8th Grade, Standard II objective 2

Title: Analyzing Arctic Marine Food Webs

Description: Working in teams, the students will use pictures to construct Arctic food webs and then compare and contrast their features. They will analyze the roles of producers, consumers, and decomposers, and then predict the effect that changes in the environment might have on the food webs.

Materials: For each group of students: picture cards of Arctic marine organisms, environmental factor cards, large sheet of butcher paper, markers, student sheet, overheads and overhead markers.

Time: 75 minutes

Procedure:

1) Hook: Have the students define the biological roles of producer, consumer, and decomposer, and ask them to give specific examples in a local ecosystem. What environmental changes could impact that ecosystem, and how might those changes affect the food webs that comprise it?
2) Divide students into groups. Instruct each group to arrange the set of picture cards into a food web on top of a large sheet of butcher paper. They should use the roles and clues given to them on the front of each picture.
3) Once the group agrees on how the food web is set up they need to use markers to draw in the lines connecting the parts of the food web. There will be a lot of lines going all over the paper.
4) Have each group of students draw an environmental factor card. Each group will create a presentation of the changes the environmental factor they drew will have on the food web on an overhead. Have each group present. As groups are presenting students should finish filling out their data tables. When all students have presented discuss the changes that are occurring and their causes and effects.

Expand/Adapt: This activity can be conducted in an open area with each student holding an organism card. Use different colors of string or yarn, held by students, to connect producers, consumers, and decomposers into the proper alignment. When any organism is eliminated from the food web as result of the impact of an environmental factor card, that student should release the string.

Scoring Guide:

1. Students participate in their group..... 4
2. Students create and present data..... 4
3. Students fill out data table and analysis..... 4

Answers to questions:

Suggestions for answers for Environmental factor cards.

1) **The sea ice in the Polar Regions is melting:**

- Ice algae, a food for many arctic animals will be reduced.
- More open water so other phytoplankton will produce more food by photosynthesis.
-Polar bears need ice for hunting and travel or they will die.
- Native Alaskan hunters need the ice for hunting.
-Walrus dive from the ice to the bottom so they can feed.
-Ringed seals rest, hunt, give birth, and nurse their young on the ice.

2) **The seawater is getting warmer:**

-Increases the recycling work of bacteria and produces more CO2
-Zooplankton will grow faster and eat more food, resulting in less food to reach the ocean bottom to feed benthic animals.
-As the water warms, some organisms will be forced to move further north to stay cool.
- Animals may loose their fur and blubber sooner.

3) **Increasing the amount of freshwater in the ocean (due to melting sea ice and glaciers).**

-Lowers the amount of salt on the oceans surface forcing some animals to migrate or adapt to deeper waters.
-Animal type on the surface will change
-Many phytoplankton would not survive in fresher water.
-High nutrient levels on the surface would be reduced, decreasing overall photosynthesis

4) **There is an increased amount of sunlight**

- With a reduction of sea ice cover, more light will penetrate into the water.
-This will increase photosynthesis.
- This means more food for many arctic animals.
- This may also mean increased temperatures, causing some animals to migrate or adapt.

5) **The amount of land is shrinking due to rising ocean levels.**

- Since land masses are shrinking it makes it even harder for polar bears to travel.
- Decreased habitats, which can cause a decrease in populations.

6) **The number of days of winter weather is declining, making the winter season shorter.**

- Organisms will have to adapt to longer spring months, less blubber and fur, maybe stay on land verses traveling to the oceans.
- Temperatures will increase forcing some animals to migrate.
-Increased plant grown will provide more food to the animals.

7) **Humans are drilling more for oil in these regions on land and in the ocean.**

-Destruction of habitat, forcing some animals to leave the area.
-Oil spills kill plants and animals.
-Chemicals in the metals contaminate fish and cause illnesses in animals that eat the fish.

8) **Humans are fishing more in these regions.**

- Decreases the number of crab, cod, etc.
- Decrease the amount of food available to their predators.
- Increases the organisms they would normally prey on.

9) **More people are touring the Polar Regions than ever before.**
- Destruction of habitat
- Animals eat human food and hunt less, causing an overpopulation of animals they would normally prey on.
-Increased air and water pollution destroys plant life.

Analysis Questions:

1. Yes, because even the ones that seem natural are caused by global warming. This can be traced back to humans.
2. Populations grow due to the increased availability of food at all levels.
3. It causes an increase in the organisms they eat. This causes a decrease in the population of producers.
4. They break down dead organisms to return the natural elements to the earth.