



Bioaccumulation Tag

Objectives:

Students will understand that ingestion and toxic pollution are two major effects of marine debris. They will be able to describe the process of bioaccumulation as it relates to plastics and toxic pollutants attached to plastic.

Concept:

Marine debris has many effects on marine ecosystems. The three main effects are entanglement, ingestion, and toxic pollution. The effects of ingestion of plastic pieces and toxic pollution are magnified by the process of bioaccumulation, whereby top predators accumulate plastic or toxins when they consume prey that have ingested these plastics or toxins.

Materials:

- ⊙ Science notebooks
- ⊙ Pencils
- ⊙ Masking Tape
- ⊙ Markers
- ⊙ Fanny packs or grocery bags and twine
- ⊙ Poker chips, pieces of colored paper, or other game pieces
- ⊙ Sample of photodegraded plastic from gyre
- ⊙ Laptop/computer and projector or SmartBoard

Preparation:

Sort your game pieces. You will want approximately 100 or more of them. Of these, 80% should be one color, to represent plankton, and 20% should be another color, to represent plastic. If you'd like to make it even trickier, use more colors. Have all the colors except one represent plankton, with the final color being plastic. This way, students won't be able to guess which color they should avoid during the game.

You will need to create a "stomach baggie" for each student. This can be done using a fanny pack, or by stringing a grocery bag onto a length of twine that can be tied around the student's waist.

Introduction:

Ask each student to choose a marine organism that can be found in Alaska and identify the organism by writing the name on a piece of masking tape and wearing it like a nametag.

Ask the students to step forward if they are a type of phytoplankton. If no one steps forward, act surprised and explain that phytoplankton is the most important as these organisms produce their own food and are at the bottom of the food chain. Designate something green as phytoplankton. This is the producer.

Ask any organisms that eat phytoplankton to step forward. You may need to designate yourself as a type of zooplankton such as krill or copepods if no one steps forward. These are examples of a primary consumer.

Have students that eat primary consumers step forward (small fish, birds, and filter feeders such as baleen whales, clams, mussels, etc). These are your secondary consumers.

Finally, have the larger predators that eat the secondary consumers step forward (sea otters, seals & sea lions, walruses, toothed whales, large fish, sharks, octopus, etc.) as tertiary consumers.

Examine your food chain as a class. With just one little phytoplankton, will there be enough energy to travel through the food chain and support the large tertiary consumers? No!





Bioaccumulation Tag *Continued*

Discuss as a class what organisms need to be most abundant to keep a food chain like this healthy and strong.

Procedures & Activities:

Tell students you are going to play Food Web Tag. (This is a bit of misdirection, as this game is actually about bioaccumulation of plastic and toxins.) Pass out “stomach baggies” to everyone to put on.

Designate 2-3 tertiary consumers that can be orcas or humans.

Tell the rest of the students that they are secondary consumers, in this case fish.

Spread at least 100 game pieces across a wide area (80% of them should be one color for plankton, with 20% another for plastic).

Tell the fish that their goal is to collect as much “food” as possible and store it in their stomach baggies. Don’t mention that some of the chips aren’t zooplankton!

Explain that if the fish are tagged by a predator, they must give up their game pieces to the predator who will take the game pieces and put them in his or her own stomach baggie.

Begin the game. Allow fish to start collecting the food pieces.

Wait 30 seconds, and then allow the predators to go after the fish.

Once all the game pieces have been collected, stop play. Reveal that a certain color of game piece is actually plastic!

Have fish and predators count their game pieces and share how much food and plastic they have.

Discuss how primary and secondary consumers may not ingest enough plastic to affect them, but tertiary consumers accumulate the plastic from everything they eat.

Discuss how plastic that is ingested by one animal can make its way into that animal’s predator and so on up the food chain. This is called bioaccumulation, because the plastic – or other pollution – accumulates the farther you go up the food chain

Wrap-Up:

Explain that the issue of bioaccumulation goes beyond the plastic itself. As plastic floats through the ocean column, it begins to provide unnatural habitat for tiny microbes that are attracted to plastics because the rough surface of the plastic provides an excellent surface to cling to. As these plastics become home for microbes, a biofilm forms on them.

This microbe biofilm absorbs Persistent Organic Pollutants (POPs) from surrounding seawater. These POPs are trace insecticides, pesticides, industrial chemicals, and other toxic pollution in the water. When these plastics are ingested by animals, the microbes are digested and POPs subsequently absorbed into the animal’s fatty tissue. Then the animal’s predator eats its prey, digesting that fatty tissue and accumulating the POPs into the predator’s fatty tissue.

Records of bioaccumulation of POPs through eating plastics have been recorded in sea birds and top predator marine mammals such as Orcas.



Bioaccumulation Tag *Continued*

Some toxins, such as lead and phthalates, are purposefully added to plastics when they are manufactured to make them more flexible or heat-resistant. These toxins, just like the POPs, can bioaccumulate through both ingestion and leaching into the water.

Ask students to draw a simple marine food web in their science notebooks and identify how plastics or toxins might be transferred up each level. Have them answer the following questions in their science notebooks:

- What marine animals are most likely to be affected by bioaccumulation?
- How could people be affected by bioaccumulation?
- What can I do to help minimize the problem of bioaccumulation?

Extensions & Lesson Connections:

This lesson works well as a follow up or introduction to the "Effects of Marine Debris on Ecosystems" station rotations.

Evaluation:

Review the science notebook entries, including the food web and route of plastics drawing and reflection questions to assess synthesis and application of the materials learned.

