TERRIBLE TOXINS

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QUESTION
How do toxins enter the marine ecosystem, what are the effects of toxic pollutants on marine life, and how do toxins become concentrated in the food web?

GRADE LEVEL: 3rd-6th **SEQUENCE**: prior understanding of predator/prey concept

UNDERLYING CONCEPT
Pollution comes from many sources, sewage outfalls and storm drain run-off are just a few examples. Whether it is from improperly disposing of motor oil down a storm drain, or allowing pollutants from industrial processes to enter the ocean, the effects of those actions extend into the marine environment on many levels and may impact coastal organisms for a long period of time.

METHOD: Use a Predator/Prey tag game to demonstrate food web relations, the concept of bioaccumulation, and human impact on the marine environment.

SKILLS
- Demonstrating
- Assessing
- Analyzing
- Interpreting

CALIFORNIA. SCIENCE STANDARDS
Grade 3: Life Science 3b, 3c, 3
Grade 4: Life Science 2b
Grade 6: Ecology 5a, 5b

OBJECTIVES Students will be able to:
- Demonstrate the build up and concentration of toxins in an organism
- Interpret how that buildup can affect animals in an ecosystem

TIME NEEDED
- One 55 minute class period

MATERIALS NEEDED
- Red or brightly colored candies such as sweet tarts, etc.
- Clear plastic bags
- Predator/prey Name Tags (included) - quantity determined by class numbers and predator/prey divisions. Print each food web level on different colored paper or students color them.
- Score sheets (optional) - students create them

VOCABULARY
Toxin: poisonous
Pollution: contamination of air, soil or water by the discharge of harmful substances
Industrial wastes: waste products produced by factories and other industries that often contain harmful chemicals
DDT (Dichloro Diphenyl Trichloroethane): a colorless insecticide, toxic to humans and animals when swallowed or absorbed through the skin
Bioaccumulation: toxins building up in each organism as they eat animals in the food web who have already eaten a toxin.
Trophic level: each of the steps in a food chain

BACKGROUND INFORMATION

Pollution comes from many sources. It is more difficult to control when it is in water because water itself is a common solvent for many things and transfers pollutants throughout the ecosystem. Southern California has many problems with pollution in the marine environment.

There are many types of pollution, some of the worst are DDT (Dichloro Diphenyl Trichloroethane) and PCBs (polychlorinated biphenyls--used as insulation in the 1970's). **Industrial wastes** pollute wetlands, bays, estuaries, and the ocean itself.

Pollutants enter the marine ecosystem in a variety of ways. Until the 1960's some chemicals were allowed to be disposed of offshore; we did not know then about their long-term toxic effects. Today urban street runoff, farm fields and industrial sites contribute to the **toxins** in the ocean. Some, such as mercury (spewed out by coal burning power plants) fall from the air.

Another important way pollutants enter the marine ecosystem is through sewage plants (outfall sites). They impact the environment through the effects at the outflow site (where the final treatment is deposited into the ocean). Soft, muddy sediments are like sponges that slowly soak up all of the chemicals and toxins. Small animals that live in the sediment pick up tiny particles of it and are then eaten by larger animals. Poisons are then spread throughout the food web. **Southern California's** Hyperian Sewage Plant is unfortunately a very good example. DDT has been found in the sludge from the Hyperian outfall site. It was thought that by depositing the sludge far out in the bay that the ocean would dilute and cleanse the outfall, but this did not happen.

Benthic (bottom dwelling) animals that live in the soft muddy sediment take the toxins and chemicals into their system, by eating the particles or through taking in the water with the dissolved contaminants. For example, on **Catalina Island** mussels have been found to contain arsenic. Small fish eat small animals and crustaceans in the sediment. Bigger fish such as the white croaker and California Halibut, eat these smaller fish as well as crustaceans who have already been contaminated. Essentially, fish that eat bottom-dwelling organisms become contaminated over time, as do the bigger fish that eat those fish.

Fish-eating birds and mammals also then become contaminated. Brown pelicans were nearly wiped out along the West Coast because they ate anchovies and other fish contaminated by **DDT** that flowed into waters off **Palos Verdes** from a pesticide plant. Scientist say that the DDT that destroyed the egg shells of the bald eagles and led to their extinction on Catalina Island, is related to the DDT in the **San Pedro Channel**. Years later after DDT had been outlawed, bald eagles were reintroduced to **Catalina Island** but once again they began to die out. It was discovered that the eagles were eating the seagulls (adult seagulls or chicks or eggs) that eat the fish, which have levels of DDT in them. So although DDT was no longer being put into the San Pedro channel it was still present in the food causing the new group of eagles to have problems in egg shell strength and hatching their young.

Dolphins in the San Pedro Channel have higher levels of toxins in them than dolphins found elsewhere. In general dolphins and seals off of Los Angeles County remain highly contaminated. They may grow tumors or lose their ability to fight off disease.

DDT (and other toxins that **bioaccumulate**) never leaves the system of an organism. Every time an animal is eaten by another animal the DDT or other toxin goes into the new animal and becomes even more concentrated, because the bigger the animal, the more contaminated food they will eat. It is important to note that people are not immune to this problem. People can get very sick from eating tainted fish or shellfish. These toxins can cause cancer or birth defects.

PROCEDURE:

DDT GAME

"INTO:"

1. What are ways that poisons could get into the ocean and wetlands? *(storm drain run off/urban streets, farmlands, industry , air pollution, sewage plants)*
2. How do the poisons get into an animal? *(they get into the food that it eats*; *Note: use direct instruction about sediments under the water absorbing chemicals*)
3. Who can tell me how the food web works? (*brief review; be sure predator/prey is understood*)
4. Do you think that the poisons stay in the body of the animal or do you think that they leave? (*stay there*)
5. What do you think happens to the poisons when the small animal is eaten by a bigger animal? (*they go into that animal too*)

Let's play a game to see how this works:

Before You Start

- Divide students into predator and prey group levels.
- For example: In a group of 35 students have at least 5 levels within the food web.
- Example:

  12 zooplankton/crustaceans/ clams/worms, etc
  9 small fish
  7 medium/large fish
  5 birds (sea gulls)
  2 bald eagles

To Play:

Students wear a colored name tag according to their animal group and play a simple walking tag game. Everyone starts off with 2 (or some set number of) candies each in their bags. Teacher explains that this is a "safe" or non-fatal amount of DDT or toxins for that animal's system.

1) Assign (or students choose) "roles" and tape the appropriate name tag to student's back.

2) Explain Animals can only "eat" the level below them. Be very clear who can "eat" whom. Students will wear colored predator/prey name name tags---each color represents a different predator/prey (trophic) level. The lowest level: plankton, tiny shrimp, crustaceans, etc. have 2 candies in their bags and these students are the "prey". The next higher up predator group (example, "small fish") are "its predators." Playing a walking tag game, predators must touch (tag) the prey below their "trophic" level. When they "get" the prey the predator "consumes" the prey's candies by adding those candies to the predator's bag. The prey that has been 'consumed' then moves out of the group and sits down.

3) Tagging continues until all the prey is caught.

4) When the game is over the eagles have all of the candies.

Discussion:

- Students discuss who has the most candies/DDT. Is it too much to live, or to have healthy baby eagles?
- What happens if there are no longer any healthy baby eagles being born? *(the eagle population will die out)*
- How did the animal get so much DDT? *(by eating the other animals)*
- Teacher explains the situation on Catalina Island.(using the background information provided)

Options:

A. With younger students *stagger the timing of bringing in the trophic levels*

1) *Start with levels 1 and 2. The small fish (Level 2) are the first to go find food (Level 1 organisms: copepods, clams, worms, crustaceans). The medium and large fish, sea gulls and eagles sit quietly on the sidelines watching the activity. The small fish have 30 seconds to 'eat' as many of the Level 1 organisms as they can. Any Level 1 organism caught by a small fish must give his or her bag of DDT to the Level 2 organism and then go sit on the sidelines. At the end of 30 seconds they must stop gathering.*
2) *The medium and large fish (Level 3) are now allowed to hunt the small fish and any remaining Level 1 organisms. Each medium or large fish should have time to catch at least one small fish. Give them between 15-60 seconds to hunt depending on the size of the area. Any organisms not "caught" continue to hunt and consume its own appropriate prey.*
3) *Then release the sea gulls to hunt the fish. The same time limit and rules apply. After 15-60 seconds release the Eagles to hunt the sea gulls. When an organism is caught he/she gives her bag of DDT to the predator.*
4) *At the end of the designated time ask all the players to come together in a circle and bring their food bags. Follow discussion described below.*

B) With older students

1) *All groups start the game at the same time. Discuss how many trophic (food web) levels the prey could realistically consume (for example, in addition to sea gulls, eagles might eat all levels of fish sizes but would not eat clams or worms found under water).*
2) *For some groups of students it works best to randomly assign predator/prey tags, simply be clear on who can eat whom, and directly start the tag game with everyone involved. The results of top predators 'winning' all the candies and realizing they have actually 'consumed a toxin such as DDT' leads directly into the review of bioaccumulation and the discussion.*

"Beyond"/extensions:

Students brainstorm ways to keep the toxins out of the system. *(laws, better testing procedures)*
Is there a way to help the eagles? *(maybe monitoring and studying them, testing the sea gulls)*