INTRODUCTION

Why does it matter if predator/prey relationships are out of balance?
Predators play a vital role in ecosystems. They keep prey populations in balance with the amount of available resources. Predators often take prey that is the easiest to catch, such as the sick, old, and the weak. This keeps disease low and the population healthy. Healthy prey populations are in turn vital for predator survival. Healthy prey and predator populations keep the entire ecosystem functioning and sustainable.

Depending on the environment, type of noise, and species, noise can affect a predator and prey species directly or indirectly. Noise can make it difficult for predators to find and catch their prey, or it can make it harder for prey to avoid predators. Sound upsets the balance between predator and prey. Noise can create a severe reaction: the prey species may leave an area. This can cause a food shortage for the predator. The predator must either change prey species, leave the habitat, or starve. Noise can also cause a predator to leave or avoid an area. The prey can then concentrate in this habitat (now devoid of their predator) and create what is known as a “predator haven.” The larger prey population can then deplete the resources, impacting the ecosystem and other species dependent upon the resource.

Consider this example:
Before 1995, Yellowstone National Park had been without wolves for 75 years. Without one of their key predators, the wolf, the elk population dramatically reduced the vegetation, which in turn negatively impacted important habitat for other species. The reintroduction of wolves in 1995 had a dramatic effect on biodiversity. Not only did wolves reduce the elk population, they changed the foraging behavior of elk in a way that hunting or culling by humans did not achieve. Elk no longer fed primarily in areas near the river. They moved more and fed in areas where there was more protection from wolves. As a result, the vegetation was allowed to grow and recover. The increase in vegetation provided habitat for birds, foxes, and grizzly bears, who benefited from an increase in berries. They changed coyote population dynamics and density in the park which also increased bird, fox, and other wildlife populations. Important tree species, such as willow and aspen, now thrived along the stream banks. Shading and stabilizing the stream bank improved water quality, thus improving trout habitat. The return of trees prompted the return of beavers to the park, changing the course of the river and creating habitat for other species.

You can view a great video clip (4 mins.) explaining the Yellowstone phenomenon at http://voices.nationalgeographic.com/2014/02/16/this-will-shatter-your-view-of-apex-predators-how-wolves-change-rivers/

Video Discussion Question: Why did the introduction of wolves increase the amount of vegetation? Can you list the animals that benefited from presence of wolves? Which populations increased? Which decreased?
INTRODUCTION - Cont.

Yellowstone is an example of a trophic cascade - top down control - where the presence of a predator suppresses the population of its prey, and relieves the next trophic level of pressure such as vegetation. In the above scenario, the return of wolves decreased the abundance of elk and changed their foraging behavior which allowed vegetation to thrive.

Another classic example of trophic cascade can be found in the kelp forests of the Pacific Northwest. Kelp forests provide important habitat for a variety of invertebrates, fish, and marine mammals. The kelp forest provides food and refuge for a variety of species. Sea urchin is one of the species which grazes on kelp from the sea floor. Then, sea otters feed on the urchins and keep urchins from overgrazing the kelp forest. Due to human activity such as hunting, sea otter populations have declined and in some areas completely disappeared. In other cases, killer whales needed to change their prey base to sea otters when sea lions left the area. Becoming the primary prey base for killer whales was not sustainable and sea otter populations declined. Without the otters to keep urchins in check, kelp forests become overgrazed, reducing the biodiversity and the health of the kelp forests. In areas where sea otter populations were restored, the kelp forest recovered and biodiversity returned.

Discussion Question
Without predation, what would happen to the population of the prey species?

Their numbers explode, and they would literally eat themselves out of house and home.

KEY DEFINITIONS

Ecosystem: all the living and nonliving things in an environment

Food Chain: the path that energy and nutrients follow in an ecosystem

Predation: the pursuit, capture, and killing of animals for food

Predator: an animal that hunts other animals for food

Prey: a living thing that is hunted for food

Trophic Cascade: an ecological phenomenon triggered by the addition or removal of top predators and involving reciprocal changes in the relative populations of predator and prey through a food chain, which often results in dramatic changes in ecosystem structure and nutrient cycling.

Trophic Level: step in a nutritive series, or food chain, of an ecosystem.
ACTIVITY INSTRUCTIONS

Space Needed: Inside or Outside
Materials: Role play cards on string necklaces
          Cones (for boundaries)
          Poker chips

Instructions - Round 1
Assign roles to students by handing out the role play cards. The students can wear them around their neck with string in order for them to know who is playing each role. For the first round, there should be...

- 1 killer whale
- 4 sea otters
- 16 urchins
- 25 kelp (poker chips)

To survive the round, each role must meet its needs:
- Killer whale needs to eat 1 sea otter (by tagging and taking the card). Killer whales do not eat urchins.
- Sea otters need to eat 2 sea urchins.
- Urchins need to eat 1 kelp. Have them hold onto the chip until next round.

Begin by spreading out kelp evenly in the “sea”. Have the sea otters and urchins come in from their respective sides first. After 30 seconds to a minute, send in the killer whale! Give students a time period or watch for when all or most of the roles are played out. At the end of this round, the system should be relatively balanced.

Have students record the results on their worksheet.
- How many killer whales, sea otters, urchin and kelp are left?
- At the end of this round, is the ecosystem in balance/is there enough of each group to have the populations continue?
- What do students predict for future life cycles?

Setting up for the next round:

- Untagged sea otters and urchins that were able to get their required food are able to reproduce, so students who were tagged out will change roles and now be an offspring of one surviving sea otter or urchin.

- If Predators got the required Prey, they stay in for the next round. If not, the Predator is out of the system and can play another role as urchin or sea otter offspring.

- Add one kelp for every kelp that is left.

VARIATION FOR YOUNGER KIDS or SMALL GROUPS
To make the game easier for younger kids or if you have a smaller number of kids, take out the killer whale, and change the numbers to where you have the double the amount the sea otter needs and double the number of kelp the urchin needs. For example, 1 sea otter means you need 4 urchin and 8 kelp.
ACTIVITY INSTRUCTIONS - Rounds 2 and 3

Round 2

Nearby were a population of stellar sea lions who are the main prey of the killer whales. A new shipping lane was added, increasing the number of ships in the area. Due to the added noise in the area, the sea lions were unable to echo-locate to find their food and use calls to find mates. They were forced to find new habitat and left the area. The killer whales are now forced to switch their prey base to the sea otter.

Questions for the group:
What does this mean for the killer whales who preyed upon sea lions? Will they need to eat more than one sea otter? Will more killer whales come to the area?

Add 1 killer whale.

Now the killer whales need to eat 2 sea otters each to meet their needs. Either use numbers from the first round or play the round with the original numbers with the extra killer whale. This time, have the killer whales go in at the same time as the sea otters and urchins.

Have students record the results on their worksheet.
- How many killer whales, sea otters, urchin and kelp are left?
- At the end of this round, is the ecosystem in balance/is there enough of each group to have the populations continue?
- What do you predict for future life cycles?

Setting up for the next round:
- Untagged sea otters and urchin that were able to get their required food are able to reproduce, so have one of the students that was tagged out be their one offspring.
- If Predators got the required Prey, they stay in for the next round. If not, the Predator is out of the system and can play another role as offspring.
- Add one kelp for every kelp that is left.

Round 3
The killer whales are still without the sea lions and have the same pressure on the sea otters. Have the students predict what will happen in this round.

The killer whales still need to eat 2 sea otters each to meet their needs.
Play the game as you did for Round 2.

Have students record the results on their worksheet.
- How many killer whales, sea otters, urchin and kelp are left?
- At the end of this round is the ecosystem in balance/is there enough of each group to have the populations continue?
- What do you predict for future life cycles?

Setting up for the next round:
- Untagged sea otters and urchin that were able to get their required food are able to reproduce, so have one of the students that was tagged be the one offspring.
- If Predators got the required Prey, they stay in for the next round. If not, the Predator is out of the system and can play another role as urchin or sea otter offspring.
- Add one kelp for every kelp that is left.
ACTIVITY INSTRUCTIONS - Round 4 and Optional Graphing

**Round 4**
The killer whales have left the area and 4 sea otters are reintroduced. Use the numbers from the last round without the killer whales.

- Is the system more in balance with the missing link of the otters?

**RESULTS - Optional Graphing**

Have students use the recorded results to create a line graph that illustrates population changes from Rounds 1 to 3 and Rounds 2 and 4.
List variables in the project (example: predator)

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__________________________________________________________________________

**Round 1**
Prediction/Hypothesis: (Example: Predator and Prey will have enough food to survive.)

__________________________________________________________________________

Starting numbers of Killer whale _________ Otter _________ Urchin__________ Kelp__________

Results

Ending numbers of Killer whale _________ Otter _________ Urchin__________ Kelp__________

At the end of Round 1, is the ecosystem in balance, meaning is there enough of each group to have the populations continue? What do you predict for future life cycles? Explain.

__________________________________________________________________________
__________________________________________________________________________

**Round 2**
Prediction/Hypothesis: (Example: Predator and Prey will have enough food to survive.)

__________________________________________________________________________

Starting numbers of Killer whale _________ Otter _________ Urchin__________ Kelp__________

Results

Ending numbers of Killer whale _________ Otter _________ Urchin__________ Kelp__________

At the end of Round 2, is the ecosystem in balance, meaning is there enough of each group to have the populations continue? What do you predict for future life cycles? Explain.

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Round 3  
Prediction/Hypothesis: (Example: Predator and Prey will have enough food to survive.)
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______________________________________________________________________________________
______________________________________________________________________________________
Starting numbers of Killer whale __________ Otter __________ Urchin__________ Kelp__________
Results
Ending numbers of Killer whale __________ Otter __________ Urchin__________ Kelp__________
At the end of Round 3, is the ecosystem in balance, meaning is there enough of each group to have the populations continue? What do you predict for future life cycles? Explain.
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______________________________________________________________________________________
______________________________________________________________________________________
Round 4  
Prediction/Hypothesis: (Example: Predator and Prey will have enough food to survive.)
______________________________________________________________________________________
______________________________________________________________________________________
______________________________________________________________________________________
Starting numbers of Killer whale __________ Otter __________ Urchin__________ Kelp__________
Results
Ending numbers of Killer whale __________ Otter __________ Urchin__________ Kelp__________
At the end of Round 4, is the ecosystem in balance, meaning is there enough of each group to have the populations continue? What do you predict for future life cycles? Explain.
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______________________________________________________________________________________
Review your hypothesis for Round 1. Was your hypothesis correct? _______________________________
Explain________________________________________________________________________________
______________________________________________________________________________________
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Review your hypothesis for Round 2. Was your hypothesis correct? _______________________________
Explain________________________________________________________________________________
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Review your hypothesis for Round 3. Was your hypothesis correct? _______________________________
Explain________________________________________________________________________________
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Review your hypothesis for Round 4. Was your hypothesis correct? _______________________________
Explain________________________________________________________________________________
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______________________________________________________________________________________
Why did the introduction of wolves increase the amount of vegetation?
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Which animals benefited from the presence of wolves?
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Which populations increased?
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Which populations decreased?
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