Big Shark, Big Loss, Big Impact

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ACTIVITY DESCRIPTION:

Students are fascinated by the intoxicating combination of danger, beauty, and mystery of sharks, but may not realize the key role they play in marine ecosystems. Large predatory fish populations have plummeted over 90% in the last decade. This decline has the potential for serious and cascading effects on Canada's marine ecosystems.

This lesson plan contains two simulation games for students in grades four through seven that teach students why apex predators are necessary for functioning ocean ecosystems. In the first game, students simulate a food web (plankton < herring < pollock < shortfin mako shark) and see what happens when humans reduce the shark population. In the second game, students simulate the role that sharks play in changing the hunting behaviour of seals, the impact that has on fish populations (the seals' prey), and again what happens when humans reduce the shark population. Through collecting, analyzing, and graphing the data, students will explore the role of sharks and humans in maintaining ocean food webs.

ACTIVITY 1:
Site Needed: Large outdoor space
Group Size: 20-30
Materials Needed:

- 100 tokens to represent plankton (e.g., plastic poker chips)
- 5 arm bands in one colour
- 2 arm bands in a second colour
- 2 arm bands in a third colour
- Data tables for activity 1 (attached)

ACTIVITY 2:
Site Needed: Large outdoor space
Group Size: 20-30
Materials Needed:

- 200 tokens representing herring (e.g., plastic poker chips)
- 200 tokens representing pollock (e.g., plastic poker chips in a second colour)
- Long piece of rope
- 5 arm bands
- Data tables for activity 2 (attached)

BACKGROUND:

Canada's three oceans, Atlantic, Pacific and Arctic, are home to 41 species of sharks. Many sharks fill the role of "apex" or top predators in their ecosystems because of their large size and few natural predators. As apex predators, sharks feed on animals below them in the food web, and help regulate and maintain the balance of marine ecosystems. Most sharks have diverse diets and switch prey species when certain populations are low. By switching to more abundant prey, they allow low populations to rebound and prevent abundant species from monopolizing a limited resource. Apex predators also influence spatial distribution of prey species through intimidation and keep them from overgrazing certain habitats.

The unfortunate reality of course is that humans are the ocean's true apex predators, killing more than 100 million sharks each year. Sharks now represent the largest group of threatened marine species on the International Union for Conservation of Nature's (IUCN) Red List of threatened species, yet only three of the 350 shark species (Basking, Whale and White), are protected from the pressures of international trade.

Globally, between 26 and 73 million sharks are killed annually for their fins (caught both specifically and as bycatch). Once a delicacy and sign of prestige in Asian cultures, shark fin soup consumption is on the rise. A single bowl of soup can cost up to $100 making the fins the most commercially valuable part of a shark. Since the rest of the shark is less valuable and bulky, the fins are removed and the carcasses thrown overboard.

The overfishing of apex predators can lead to serious consequences for many other ocean species, in ripples called "cascades". Comparisons of areas with and without apex predators have shown that apex predators maintain greater biodiversity and higher densities of individuals, while areas without apex predators experience species absences. Without apex predators there is the potential for unchecked predation by lower predatory species and overgrazing of vegetation by herbivorous prey species.

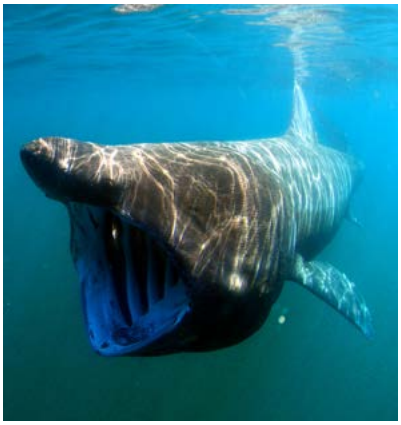
CURRICULUM CONNECTIONS:

Grade 4 – Understanding Life Systems: Habitats and Communities

- 1.2 identify reasons for the depletion/extinction of an animal species, evaluate the impacts on the rest of the natural community, and propose possible actions for preventing such depletions/extinctions from happening
- 2.2 build food chains consisting of different plants and animals, including humans

Grade 4 – Mathematics: Data Literacy

- D1.3 select from among a variety of graphs, the type of graph best suited to represent various sets of data; display the data in the graphs with proper sources, titles, and labels, and appropriate scales; and justify their choice of graphs



TEACHING PROCESS AND CLASS ACTIVITIES:

ACTIVITY 1: SHARKS ARE APEX PREDATORS

The following is a simplified Atlantic Ocean food web: Shortfin mako sharks are apex predators and eat pollock. Pollock are medium sized piscivores weighing as much as 18 kg. They eat smaller fish like Atlantic herring. Herring are small forage fish that eat plankton.

Reproductive rates vary widely between these different fish species. Shortfin mako sharks bear between 4 and 18 young once every 3 years. Pollock spawn once a year with females producing about one million eggs per year. Atlantic herring can spawn from April to November and a fully mature female can produce upwards of 260 000 eggs at a time.

HUMANS ARE ABSENT:

- **Before the game:** Discuss sharks as apex predators in marine ecosystems. The first simulation will represent an ecosystem where apex predators are present and human activities are absent.
- **Game instructions:** Scatter 100 plankton tokens on the ground in the designated play area. These plankton will be eaten by the herring.
- Select ~15 students to be herring. Record this number in the data table for round 1. Herring must collect plankton and avoid being eaten by pollock. If a herring is caught by a pollock, they give the pollock their plankton cards and go to a non-play area designated as the fish cemetery.
- Select ~5 students to be pollock and give each a matching armband. Record the number of pollock in the data table for round 1. Pollock hunt for herring by tagging herring and taking their plankton cards. Pollock must avoid being eaten shortfin mako sharks. If tagged they must give the sharks their plankton cards and go to the fish cemetery.
- Select ~2 students to be shortfin mako sharks and give each a matching armband. Record the number of sharks in the data table for round 1. Sharks hunt for pollock by tagging pollock and taking their plankton cards. As apex predators they have no predators.
- The simulation takes 45 seconds. Release the herring, followed by the pollock, followed by the sharks with 10 seconds between each group's release.
- After 45 seconds, have your students rejoin you (living and dead). Any fish that does not have a plankton card in its hands has died of starvation.
- If both sharks died of starvation, replace them with one new shark (a student from the fish cemetery) because a new shark moved into the area because there was no competition.

Grade 6 – Understanding Life Systems: Biodiversity

- 3.4 describe ways in which biodiversity within and among communities is important for maintaining the resilience of these communities
- 3.5 describe interrelationships within species, between species, and between species and their environment, and explain how these interrelationships sustain biodiversity

Grade 6 – Mathematics: Data Literacy

- D1.3 select from among a variety of graphs, the type of graph best suited to represent various sets of data; display the data in the graphs with proper sources, titles, and labels, and appropriate scales; and justify their choice of graphs

- The surviving herring and pollock now have the potential to reproduce. In this simulation, herring spawn twice a year and pollock spawn once a year. Alternating between two surviving herring and one surviving Pollock (i.e. two herring reproduce, one pollock reproduces, two herring reproduce, one Pollock reproduces), each living fish chooses one person from the fish cemetery to become a baby of the same species as the person who selected them.
- After all herring and Pollock have reproduced, any living sharks will reproduce by selecting a baby from the fish cemetery. There will probably not be enough students in the fish cemetery for everyone to reproduce; start by alternating herring and Pollock until you run out of students. Count the new population of living herring, pollock, and sharks and record the data in the data table for round 2.
- Play round two following the same rules as before. Collect the plankton cards from the students and scatter them on the ground again. Release the students and after 45 seconds of game play allow the survivors to reproduce and record the new populations on the data table. Play the game for at least three additional rounds, recording the population numbers on the data table.

HUMANS ARE PRESENT:

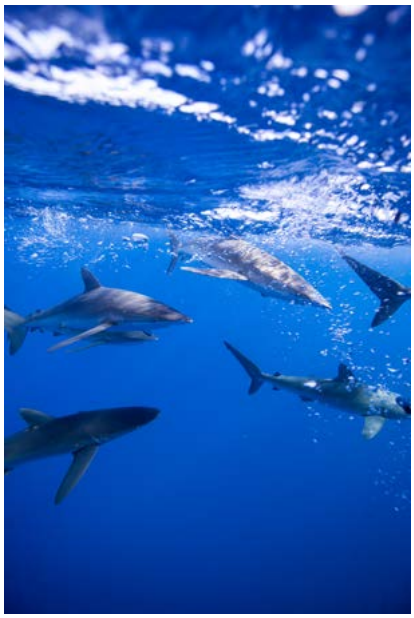
- Introduce two shark fishermen who wear the third coloured armbands and tag sharks. If any sharks die of starvation in this new environment, they will not be replaced because there are not enough sharks remaining in the ocean to move in and replace those that have been hunted. Using the same rules as before, play at least five rounds and record the number of survivors on the data table.
- **For discussion:** Gather the students and reflect on what happened. What happened to the food chain when the apex predators were removed? How would this impact other species in the ocean?
- **For assessment:** Students select the best way to display the data showing how prey populations changed in response to changes in predator populations.

Grade 7 – Understanding Life Systems: Interactions in the Environment

- 3.4 describe the transfer of energy in a food chain and explain the effects of the elimination of any part of the chain
- 3.5 describe how matter is cycled within the environment and explain how it promotes sustainability
- 3.7 describe ways in which human activities alter balances and interactions in the environment

Grade 7 – Mathematics: Data Literacy

- D1.3 select from among a variety of graphs, the type of graph best suited to represent various sets of data; display the data in the graphs with proper sources, titles, and labels, and appropriate scales; and justify their choice of graphs



ACTIVITY 2: SHARKS CHANGE PREY BEHAVIOUR

The following is a simplified Pacific Ocean food chain. The harbour seal has a wide diet which includes Pacific herring and Alaska pollock. Pacific herring congregate near the surface of the water, and are widely dispersed. Alaska pollock are found in deeper water, and have a more continuous distribution. Which fish species the seals prey upon depends on the presence or absence of sleeper sharks. Even though sleeper sharks consume few seals, their mere presence alters seal behaviour. Sleeper sharks prefer deep water and therefore when sharks are present, seals prefer to hunt in shallow water. This increases herring mortality and decreases pollock mortality.

When sharks are absent, seals increase their consumption of pollock and decrease their consumption of herring. As pollock populations drop and herring populations grow, other species connected to these fish through the food web (either as predators or prey) are affected by these changes leading to a cascade response.

HUMANS ARE ABSENT:

- **Before the game:** Explain the diet of the harbour seals and how they select their prey depending on whether sleeper sharks are present or absent.
- **Game instructions:** Use the rope to divide the designated playing area into two equal sections that represent surface water and deep water.
- Evenly distribute 50 pollock cards in the deep-water area.
- Unevenly distribute 50 herring cards in the surface-water area.
- Select 20 students to be harbour seals. They must collect fish tokens (herring and pollock) as food. Seals must avoid being eaten by sharks. If tagged, they give the shark their fish cards and go to an area designated as the seal cemetery.
- Select 5 students to be sleeper sharks and give them arm bands for identification. Sleeper sharks hunt seals by tagging the seals and collecting their fish cards. Because sharks prefer deeper water, four sharks will patrol the deep water and one will patrol the surface water.
- The simulation takes 30 seconds. Release the seals, and 5 seconds later, release the sharks.
- After round one, have your students rejoin you (living and dead).
- Each surviving fish now reproduces. Double the number of herring and pollock remaining and return them to their respective sections in the ocean playing field with the correct distribution. Record the number herring and pollock on the data table. Select 15 students to be seals and five students to be sharks (four deep water and one surface water). Because, in reality, the sharks rarely kill the seals, the number of seals will not change in our simulation.
- Play round two following the same rules as before. After 30 seconds record the number of fish survivor on the data table and allow the surviving fish to reproduce. Play the game for at least three more rounds, recording the number of fish on the data table.

HUMANS ARE PRESENT:

- Fishermen have reduced the number of sharks in the ocean. There are now only two sharks, one in the surface water and one in the deep water. The number of fish will return to previous levels of 50 herring and 50 pollock with the same distributions as before. The number of seals will remain at 15.
- Play at least five rounds with the reduced shark population and record the number of surviving fish on the data table.
- **For discussion:** What happened to the food chain when the shark numbers were lowered? How would this impact other species in the ocean?
- **For assessment:** Students select the best way to display the data showing how prey populations changed in response to changes in predator populations.

SUMMATIVE ASSESSMENT:

- Students select and research one reason why global shark populations are dropping (e.g., overhunting by humans, tangled in fishing nets, climate change). How have humans influenced this population decline and what can be done to reverse it? Have any conservation groups or countries worked to address this decline? Brainstorm different forms the report could be take: essay, poster, pamphlet, blog, comic book etc.

Data table: Activity 1: Sharks are apex predators

Humans are Absent

Round	# of Herring	# of Pollock	# of Shortfin Mako Sharks
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Humans are Present

Round	# of Herring	# of Pollock	# of Shortfin Mako Sharks
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Data table: Activity 2: Sharks change prey behaviour

Humans are Absent

Round	# of Herring	# of Pollock
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Humans are Present

Round	# of Herring	# of Pollock
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		