



United Nations  
Educational, Scientific and  
Cultural Organization



**MOUNT  
ARROWSMITH**  
BIOSPHERE REGION

# BIOSPHERE BOOKLETS

Lesson Plans & Activities

## KEYSTONE SPECIES

### SUMMARY/OVERVIEW

**Grades:**  
3-5

**Prep Time:**  
1 hour

**Learning  
Environment:**  
Outdoor & Indoor

**Total Lesson  
Length:**  
4 hours

#### DESCRIPTION:

This booklet introduces Keystone Species; including what they are, local examples, and their respective importance and impact on their ecosystems. Activities involve outdoor exploration as well as indoor worksheets and discussion topics. The booklet includes 4 hours of activities which can be delivered separately or on the same day.

#### CURRICULUM

##### EXPECTATIONS:

**Questioning and predicting:** Demonstrate curiosity and a sense of wonder about the world.

**Processing and analyzing data and information:** Compare results with predictions, suggesting possible reasons for findings.

#### BACKGROUND:

“Keystone Species” is a designation given to animals that play a unique and crucial role in the functioning of ecosystems. They have a disproportionately large effect on their environment relative to the number of individuals that live in that same ecosystem. Because of their role in maintaining biodiversity, efforts to manage and protect keystone species can help stabilize the entire ecological community.

*Source: EDI Environmental Dynamics YouTube Channel  
[https://www.youtube.com/watch?v=\\_IWw8Ruz8Uo](https://www.youtube.com/watch?v=_IWw8Ruz8Uo)*

### LESSON PLAN

#### TIME

1 hour  
30 min  
1.5 hour  
1 hour

#### ACTIVITY

1. Introduction – Keystone Species
2. Types of Keystone Species
3. Trophic Cascades
4. Conclusion

#### LOCATION

Outdoor  
Indoor  
Indoor  
Indoor

#### MATERIALS

Printed worksheets  
Printed worksheet  
Printed worksheet, scissors  
Notebook, ruler, pencil

TIME	ACTIVITY	LOCATION	MATERIALS
1 hour	1. Introduction: Keystone Species	Outdoor (E.g.: Dolphin beach or Beachcomber Regional Park)	Worksheet printout, clipboard, pen/pencil

# Introduction: Keystone Species

**GOAL:** Introduce the concepts of **FOOD WEBS** and **KEYSTONE SPECIES**. Explain that one organism's population has a direct effect on other populations of organisms and the entire ecosystem.

**PREPARATION:** Print worksheets and ID sheets, gather clipboards and pens/pencils.

**NOTE:** *If your class needs some practice working with food webs prior to this activity, please visit <https://www.mabr.ca/at-home-activities> for food web specific activities (View: Terrestrial Food Webs and/or Marine Food Webs and Resiliency).*

**LESSON PLAN:**

**Part 1: Beach Survey**

Survey an area of beach and compare its biodiversity with another area of the beach (with vs. without ochre sea stars = how many different species are found)? An intertidal identification sheet is available at <https://sierraclub.bc.ca/online-classroom/> under "Create an Intertidal Zone Poster".

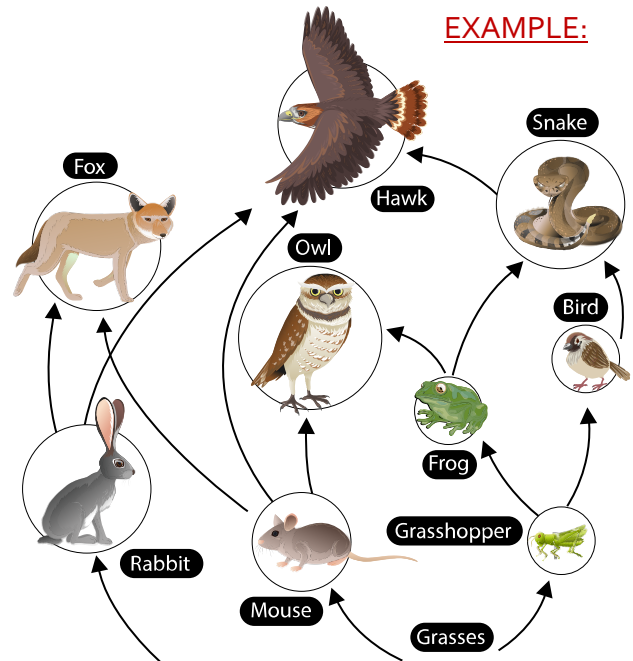
**Part 2: Complete the Food Web**

Ask students to create a small chart connecting the animals in the area to create their food web. Preferably focus on the animals seen at your chosen beach.

**Examples include:**

- Plankton -> Clams -> Sea Stars -> Seagulls
- Plankton -> Fish -> Seals -> Orcas
- Fish, Shrimp or Crab -> Jellyfish -> Sea Turtle\*
- Clams -> Sea Stars -> Otters or Sea Snails

\*Leatherback Turtles have been sighted off of the coast of B.C. over 100 times since 1931!  
Source: <https://www.bcreptiles.ca>



**CONTENT:**

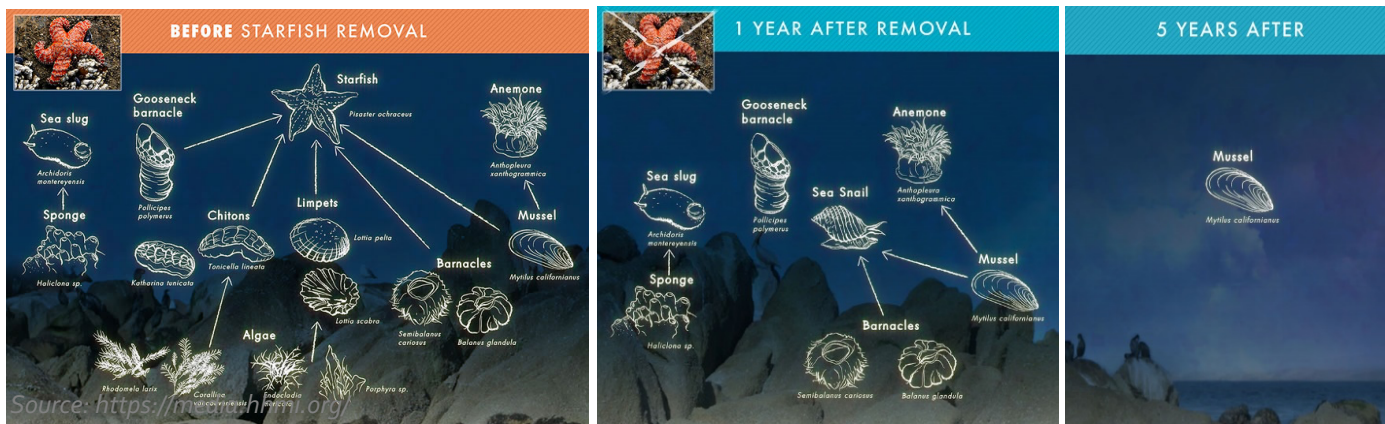
Ask students if they have heard the term "Food Web" before. If so, what is it? A Food Web refers to the interdependent connection of species that feed on one another. This is how energy (from food to molecules) is carried through the trophic levels.

Keystone Species - which can be animals, plants, or even bacteria and fungi - are the glue that hold a habitat together. Keystone Species are those whose presence and role in an ecosystem is crucial, to the point that they have an enormous or even disproportionate effect on other organisms within their habitat's system. If the Keystone Species is removed, the ecosystem falls out of balance.

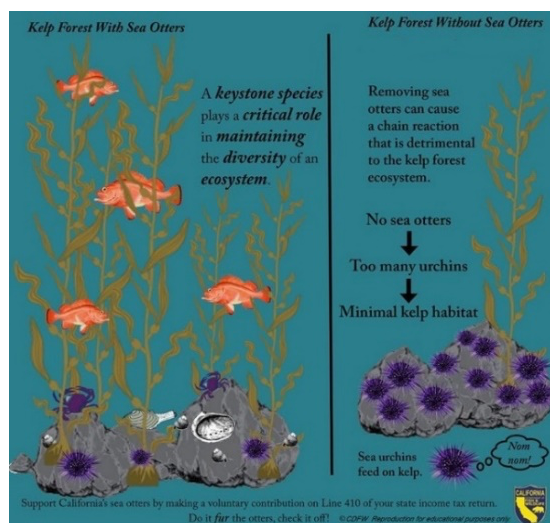
**Would you consider a sea star an important predator?**

They might not look like such at a first glance, but if we are patient to watch them, we might realize they are specialized coordinated bivalve/mollusk hunters, with their favourite being blue mussels. What do you think would happen if the sea stars were to disappear from an area? The mussel population would grow very fast. Mussel habitat includes rocks (attached through their byssal threads), so in a short period of time they will "cling" to the rocks and outcompete other animals that also make rocks their home, such as snails, sea anemones, barnacles, algae, etc. Therefore, the ochre sea star (*Pisaster ochraceus*) is a Keystone Species that keeps the intertidal zone healthy and diverse.

A Keystone Species is often, but not always, a **predator**



Great resource to suggest to students – meet the animal influencers that play an oversized, and often surprising, role in shaping our world: <https://media.hhmi.org/biointeractive/click/keystone/index.html>



Another example of species who can cause system imbalance are **sea urchins**. Sea urchins graze on kelp continuously, and the more sea urchins there are, the smaller the chance of there being a healthy kelp forest - leaving behind a barren and unproductive area. Why are kelp forests important anyway? They are home to dozens of other animals, serving as shelter, food, and nursery habitat, for example. What do you think happened to impact the sea urchin's population, causing them to "explode" in population? Their predator was not keeping them in check, due to the decrease in their numbers. Humans, sea birds, sea stars and some fish eat sea urchins, but sea otters are their main predator. When the numbers of sea otters are too low, sea urchins will dominate the area.

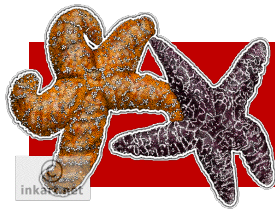
# Part 1: Beach Survey

At a local beach, compare one area that has **ochre sea stars** (*Pisaster ochraceus*), versus an area without them. Count the biodiversity (the amount/number of different species found) of the area **with ochre sea stars**, and compare those numbers with an area **without the sea stars**.

**SURVEY INFO:**

Date: \_\_\_/\_\_\_/\_\_\_      Time: \_\_\_\_\_      Location: \_\_\_\_\_

Surveyor's name: \_\_\_\_\_      School: \_\_\_\_\_



**Area WITH  
ochre sea stars**

**Area WITHOUT  
ochre sea stars**

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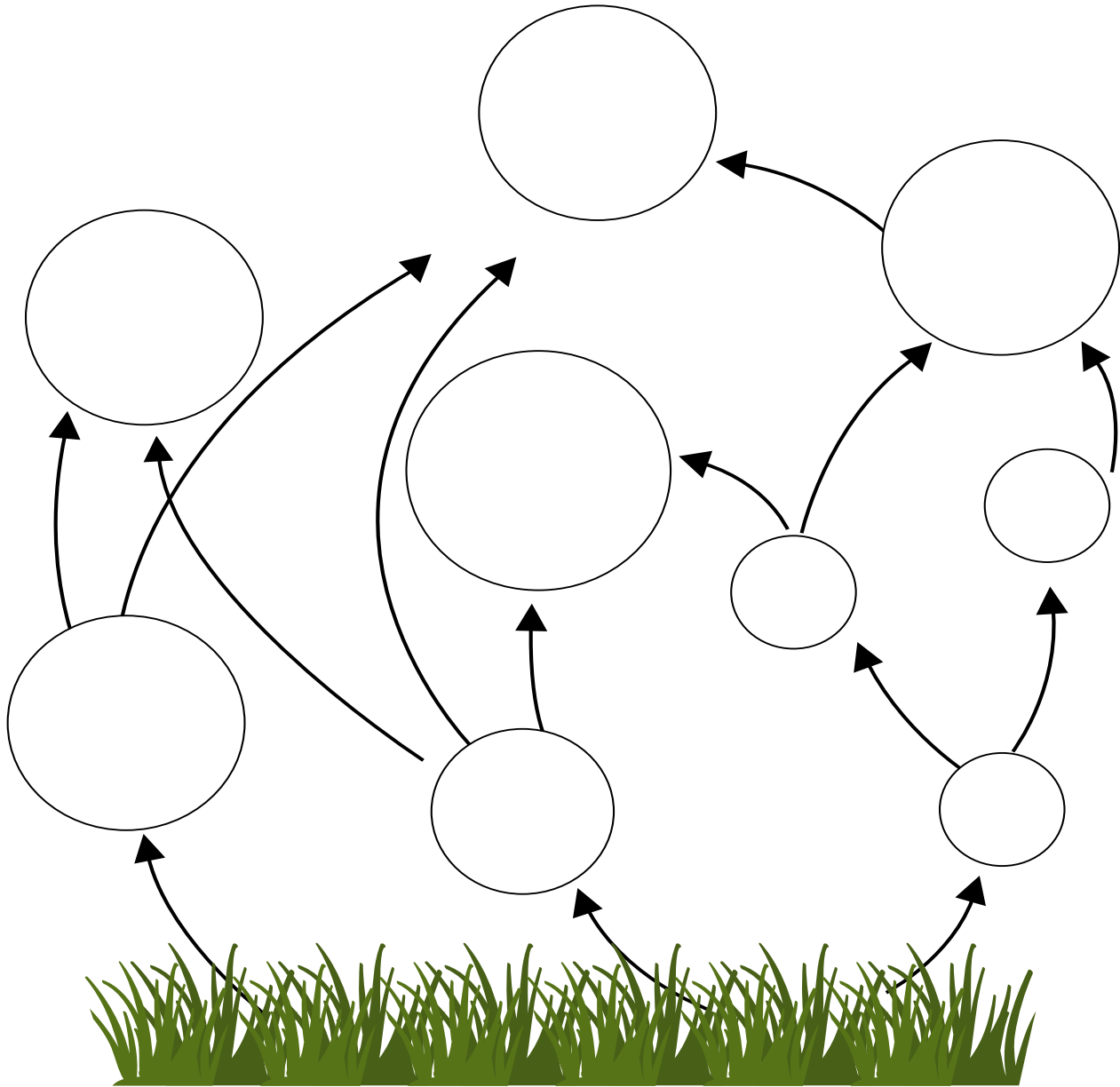
**Total number of species:**

**Total number of species:**

# Part 2: Complete the Food Web!

Fill in the blank circles within the food web below with the animals that are predators and the other organisms that are prey.

**Tips:** Arrows are showing the movement of energy from prey/primary producers to predators (example: the arrow (energy) would go from grass to a rabbit, or from a salmon to an eagle)



TIME	ACTIVITY	LOCATION	MATERIALS
30 mins	2. Types of Keystone Species	Indoor	Printed worksheet

# Types of Keystone Species

**GOAL:** Discuss how Keystone Species are different from each other. Different species will have different effects on their ecosystem and are classified as such.

**PREPARATION:** Print worksheet on page 7/8.

**LESSON PLAN:** Matching game. Ask students to match the description of the animal with the type of Keystone Species it is.

**Types of Keystone Species:** Keystone Mutualists, Keystone Modifiers/Engineers, Keystone Hosts, Keystone Preys.

**CONTENT:** We have learned that Keystone Species have a huge effect on their ecosystem - much bigger than the effects of other species. There are different types of "effects" that Keystone Species may exert. Compare one example of a Keystone Species with the other and ask the students if they both work the same way. Example: Gray wolves are categorized as apex **PREDATORS** that play crucial roles as Keystone Species. Other types of Keystone Species are:

ANSWER KEY:

**Garry Oak** trees are **HOST** Keystone Species

**Gray wolves** are a **PREDATOR** Keystone Species

**Elephants** are **MODIFIERS/ENGINEER** Keystone Species.

**Bees** are **MUTUALIST** Keystone Species

The **plateau pika** is a **PREY** Keystone Species (but also **HOSTS and MODIFIERS**)

MUTUALISTS

Hummingbirds are referred to as Keystone Mutualists because they influence the success of several plant species through pollination, resulting in **mutually beneficial** interactions.

PREY

Keystone prey are species that can maintain their numbers despite being **preyed upon**, therefore controlling the density of a predator.

MODIFIERS/ENGINEERS

On the other hand, Keystone Modifiers, such as the North American beaver, determine the prevalence and activities of many other species by **dramatically altering the environment**.

HOSTS

Species like the Saguaro cactus in desert environments and palm and fig trees in tropical forests are called Keystone Hosts because they **provide habitat** for a variety of other species.

Source: [www.nrdc.org](http://www.nrdc.org)

# Matching Game

Complete the matching game below by filling in the blanks with the type of Keystone Species based on the description. Does it describe a **PREDATOR**, **MUTUALIST**, **MODIFIER/ENGINEER**, **HOST** or **PREY** Keystone Species?

## MUTUALISTS


Hummingbirds are referred to as Keystone Mutualists because they influence the success of several plant species through pollination, resulting in **mutually beneficial** interactions.

## PREY

Keystone prey are species that can maintain their numbers despite being **preyed upon**, therefore controlling the density of a predator.

## PREDATOR

Gray wolves are categorized as apex **PREDATORS** that play crucial role as Keystone Species as they keep Elk populations controlled so the Elk don't overgraze.



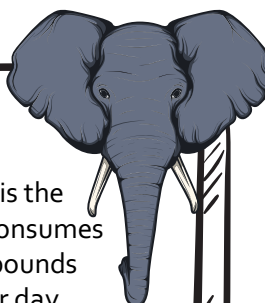
**Gray wolves'** presence has a ripple effect on the rest of its ecosystem. Studies show that wolves keep elk populations in check, preventing them from over-browsing on willow and aspen, which maintains healthy trees in the landscape.

## MODIFIERS/ENGINEERS

On the other hand, Keystone Modifiers, such as the North American beaver, determine the prevalence and activities of many other species by **dramatically altering the environment**.

## HOSTS

Species like the Saguaro cactus in desert environments and palm and fig trees in tropical forests are called Keystone Hosts because they **provide habitat** for a variety of other species.



A Keystone Species in the African savanna is the **elephant**, as it consumes as much as 300 pounds of vegetation per day, preserving sunny, open spaces where grasses can thrive.

## Did you know?



# Matching Game!

Fill in the blanks below with the type of Keystone Species, based on the description. Does it describe a **PREDATOR**, **MUTUALIST**, **MODIFIER/ENGINEER**, **HOST** or **PREY** Keystone Species?

Ecosystems containing many **Garry Oak** trees are considered "biodiversity hotspots", as they provide habitat to many organisms that do not thrive anywhere else.

\_\_\_\_\_

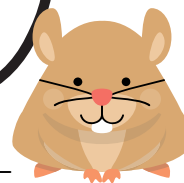


**Bees** support the reproduction of as much as 90% of the world's flowering plants. Not only do they pollinate fruits, vegetables, and other crops that provide humans with everything from food to clothing to fuel, but they also help produce the seeds, nuts, berries, and fruit that countless other species need in ecosystems around the world.

\_\_\_\_\_

The **plateau pika** play important roles in their ecosystem in Tibet. Not only do they make burrows that are the primary homes to a wide variety of small birds and lizards, but this rodent also serves as the principal food source for nearly all of the plateau's predator species.

\_\_\_\_\_



## Did you know?

8/12

Due to the successful reintroduction of sea otters, the kelp forests along the coast of B.C. are thriving again and are home to many other species!

Source: [www.dfo-mpo.gc.ca](http://www.dfo-mpo.gc.ca)





TIME	ACTIVITY	LOCATION	MATERIALS
1.5 hours	3. Trophic Cascades	Indoor	Round paper plates (2 per student), scissors, pencils, coloured pencils



# Trophic Cascade: What is it and why does it matter?

**GOAL:** Explain the concept of Trophic Cascades, where the absence of one species causes a “domino effect” in the community it lived in, with dire consequences that alter the quantity and diversity of animals living in an area. The harsh effect that community suffers from not having its Keystone Species is called a **Trophic Cascade**.

**PREPARATION:** Distribute paper plates (2 per student), scissors, pencils, and coloured pencils.

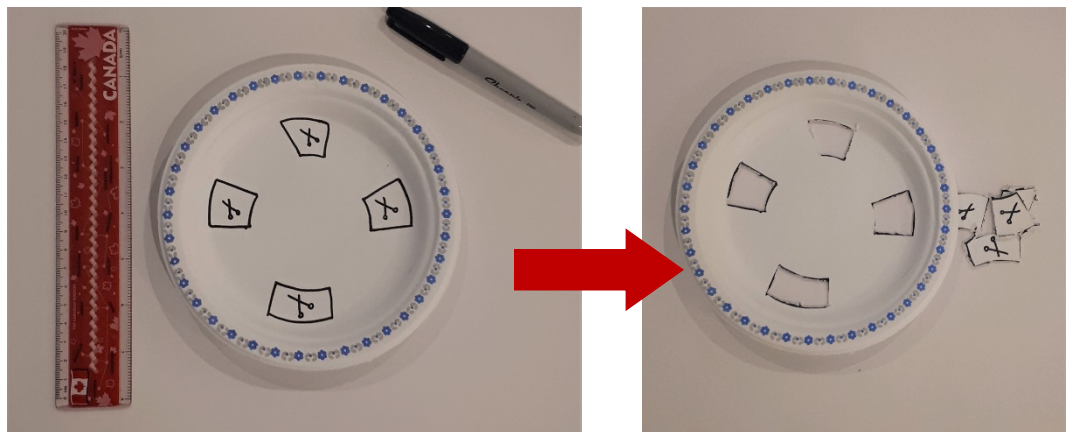
**LESSON PLAN:** After discussing the topic of Trophic Cascades, students are to create a wheel with 2 plates, one on top of the other. Create 4 “windows”/squares on one of them (the top plate). The plate below should have a Keystone Species (which will show through the cut-out window), and the other 3 cut outs show the animals directly kept in check by that Keystone Species. With a hole in the center and a paperclip, the wheel will spin and show the other drawn Keystone Species with their corresponding animals.

**CONTENT:** What keeps the population of animals in check? What makes sure that one species will not overpopulate the area? Predators and food! Without food an ecosystem will collapse, but without a predator, the community of animals may also collapse.

## INSTRUCTIONS:

### Step 1: top plate

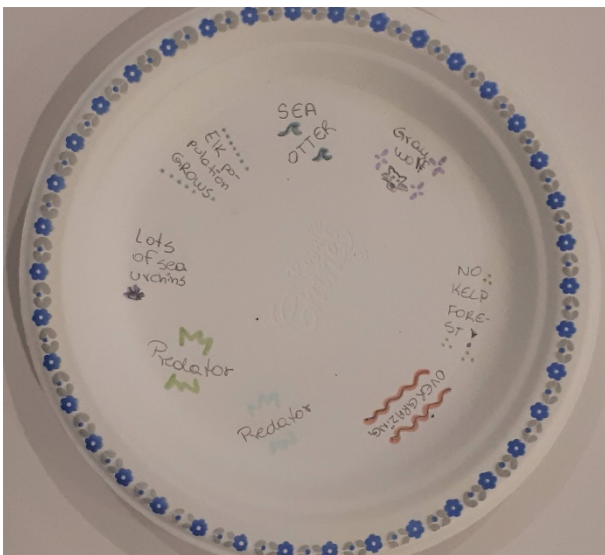
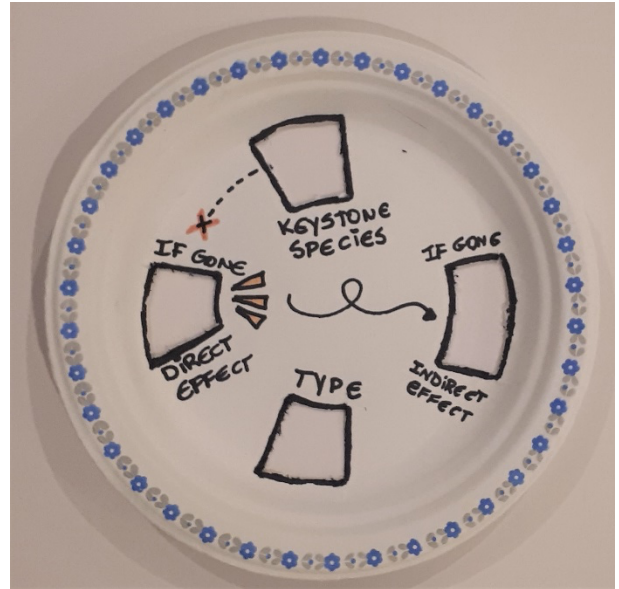
Ask the students to cut 4 “windows” (approx. 1” wide) in each of the extremities of the plate (see images).



**Step 2: top plate**

All 4 “windows” should be labeled:

- Top window should have the label “KEYSTONE SPECIES”.
- The bottom window (on the direct opposite side) should be labeled “TYPE”.
- The left window should be labeled “IF GONE” on top, and “DIRECT EFFECT” on the bottom.
- The right window should be labeled “IF GONE” on top, and “INDIRECT EFFECT” on the bottom.
- Additional arrows and decoration are a great asset!

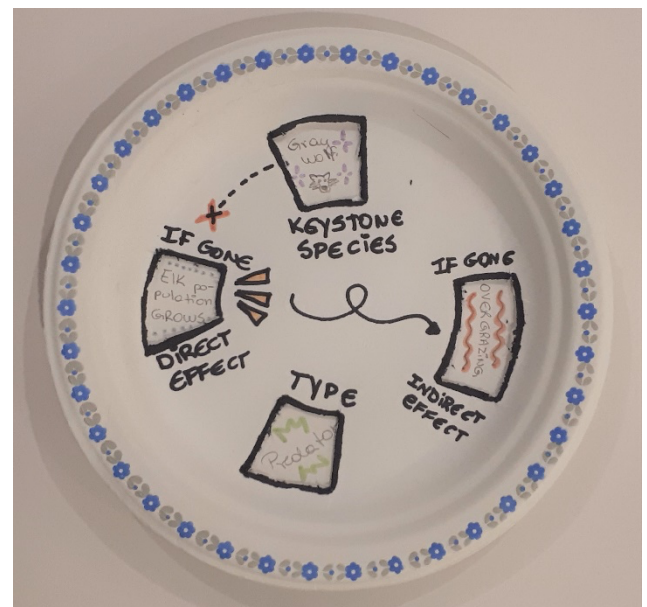


**Step 3: bottom plate**

Ask students to “fill” the windows of their bottom plate according to each label (see image to the left). There should be 3 in total, and as the top plate is rotated, different information appears on the windows (see image below).

**Last Step: line up the plates**

Ask the students to place one plate on top of the other, aligning the “windows” with the definitions below them. They should be able to rotate the plate and change the writings in it as they do so.



TIME	ACTIVITY	LOCATION	MATERIALS
1 hour	4. Conclusion	Indoor	Notebook

# Conclusion



**GOAL:** Connect information from all activities into one concept.

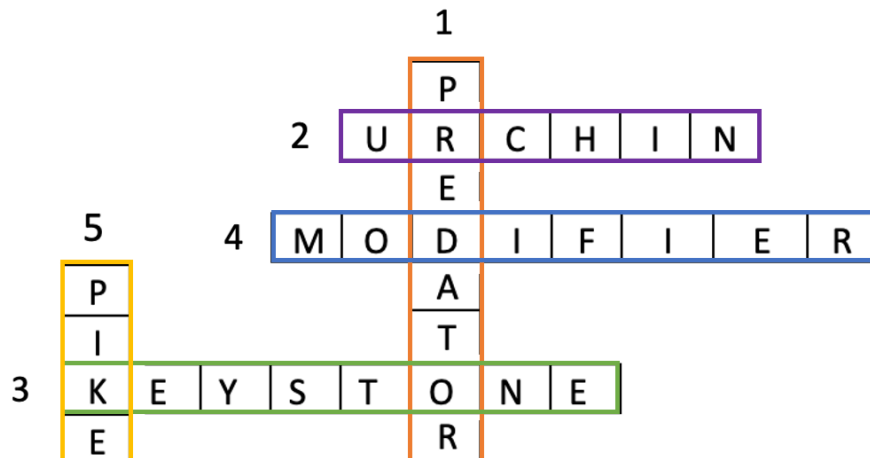
**PREPARATION:** Students will need their notebook, a ruler, a pencil and an eraser.

**LESSON PLAN:** Ask students to create their own crossword puzzle, with a minimum of 5 words (and their respective definitions). Once they have finished their puzzles, collect them all and distribute them at random for other students to solve the crossword.

**CONTENT:** A few follow up questions before starting the activity:

- What was one thing you learned today that surprised you, or that you didn't expect?
- What information did you already know or had heard of before today's class?
- What was the easiest concept to understand? What was the hardest?

- 1) The gray wolf is an apex \_\_\_\_\_
- 2) The ocean grazer that eats lots of kelp: sea \_\_\_\_\_
- 3) Species with crucial roles in their ecosystems
- 4) The Canadian beaver is an example of a \_\_\_\_\_ keystone species
- 5) Small rodent that lives in plateaus in Tibet



Show us your results! Snap a picture and share it with us on social media,  
or email it to the MABR Coordinator at  
[mandy.hobkirk@viu.ca](mailto:mandy.hobkirk@viu.ca)



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