Trophic Cascades and Human Impacts – MEED

Instructors: Joanna van Bommel and Erin Tattersall (both M.Sc. Students in Cole Burton's Wildlife
    Coexistence Lab, Forestry)
School: Norma Rose Point Elementary
Age: Grade 3
Proposed Date: February 5th and 8th

1. **Background**
    a. Learning Goals and Primary Learning Objectives
        i. Introduce concepts of species interactions, particularly trophic interactions
            (i.e.predation and herbivory)
        ii. Tie this into interactions with humans and impacts on animal communities
    b. Topics of module
        i. Species interactions
        ii. Trophic cascades
        iii. Human activities' impacts on natural communities
    c. Why is this module interesting?
This module is interesting because it allows students answering questions to come to their own
conclusions, test those conclusions, and decide for themselves if the theory makes sense.
    d. References
        i. Definition of trophic cascade:
            https://www.britannica.com/science/trophic-cascade
        ii. Journal article defining trophic cascades:
            http://www.cell.com/trends/ecology-evolution/fulltext/S0169-5347(16)30137-9
        iii. Example of a marine trophic cascade:
            http://science.sciencemag.org/content/282/5388/473

2. **Materials**
    a. Three colours of pinnys (there should be enough of one colour for half the students playing,
        there can be less of the other two) * *Optional*
        Any other identifier can be used instead
    b. Data sheet: columns for trial number, number of individuals (one column for each: predator,
        prey, plants), game-finish time, number of prey at end, number of plants at end, limiting factor
        (i.e. did the herbivores or the plants die out first), hypothesis

3. **Procedure**
    a. **Pre-Assessment**
        i. Single species questions:
            1. What does it mean to be a predator?

> *We are looking for answers that show the students understand predators hunt/eat meat*

   2. What is a word for animals that only eat meat?
      Carnivores, they are predators
   3. Can you give me some examples of predators/prey?
      Could be international, or specific to B.C. or a park near their school
   4. What is prey?
      We are looking for answers that show the students understand prey are hunted
   5. What is a word for animals that only eat plants?
      Herbivores. They are often prey to carnivores.
   6. Can you give me some examples of prey?
      Could be international, or specific to B.C. or a park near their school

   ii. <u>Species interaction questions</u>
      1. Can you tell me what a food chain is? *A chain of species linked by what they eat. Plants are at the bottom, herbivores eat plants, carnivores eat herbivores, those carnivores may be eaten by (usually) larger carnivores.*
      = Each of those levels (plants, herbivores, carnivores, larger carnivores) is called a TROPHIC level.

   iii. <u>Explain the concept of trophic cascade</u>
      1. Definition: when a change in the top predator species (behaviour, population size), affects more than two other trophic levels
      2. Example: Sea otters -> sea urchins -> kelp
         A decrease in sea otters will reduce predation on sea urchins. Therefore, the sea urchin population will increase. More sea urchins means they are eating more kelp. In the end less sea otters mean less kelp.

   b. **Participatory Learning: Trophic cascade game**
      i. Game objective: examine what happens to numbers of herbivores and plants when predator trophic levels change *(in this case, number of predators change)*
         1. 3 phases (can do more depending on time): intermediate numbers of predators, low predators, high predators
            a. *Exact numbers of predators will depend on number of students*
            b. *In scenarios where fewer predators are required, students that are sitting out may act as plants or herbivores in order to participate*
            c. Predicted outcomes
               i. Intermediate number of predators: plant and prey numbers should decrease at same rate (roughly same number at end)
                  (E.g. with 45 students: 5 wolves, 15 deer, 25 plants)
               ii. Low predators: more prey survive → eat more plants → plants die out first *(E.g. 1 wolves, 17 deer, 27 plants)*

iii. High predators: fewer prey survive → eat fewer plants → plant numbers are higher, prey die out first *(E.g. 10 wolves, 12 deer, 23 plants)*

ii. Ask students to choose a predator, an herbivore, and a plant (or just 'plant'). These animals should be in the same system, so that they would realistically interact with each other. * *Optional can also choose ahead of time*

    1. *Once the predator is chosen, the instructor can ask 'What type of herbivore does [carnivore] eat?' 'What type of plant does [herbivore] eat?'*

iii. Divide students into carnivore, herbivore, and plant, where carnivore<herbivore<plant (ex. 4 wolves, 7 deer, 10 plants).

    1. *Use pinnys or other identifier to assign. Random draw for first round, then remove/add pinnys as needed. Once the correct number are in play, ask students to pass their pinny to the person on their right. Those without pinnys get one of the new added ones*

    2. One person will be the 'scientist'. They will be responsible for timing the exercise.
Can be student if they do not wish to participate, or can be instructor

iv. Explain each of the three scenarios to students, and ask what they think will happen
Easiest to ask what trophic level will die out first

v. Students will act out the species they have drawn. Carnivores will attempt to catch and 'eat' the herbivores (light touch), while herbivores will 'graze' on plants (light touch) and try to avoid being eaten. Carnivores and herbivores can move about freely (*adapt for mobility issues - plants, scientist, assistance, etc.*), while plants remain stationary.

    1. When and herbivore has been eaten, they are 'out' – students will sit/kneel where they are standing.

    2. Plants have to be eaten (touched) three times before they sit down. Start with two arms in the air, drop one after the first touch, drop the second after the second touch, sit down after the third touch.

    3. The game ends when either all of the plants or all of the herbivores have been eaten (if no end point is reached, cut off after two minutes) → time and finishing numbers are recorded by scientist

vi. IF TIME PERMITS: Add humans/human disturbance *(predator behaviour changes, new trophic level added)*

    1. Bonus 1: Roads
Same number of students in each category as intermediate level before, but now predator can RUN, and prey have to WALK *(give students a walking pace to follow)*
This simulates wolves using human linear structures like roads to move more quickly through an environment
- predicted outcome: similar to high predator scenario

    2. Bonus 2: Hunters
Add an additional category *(no pinnys or different colour)* to represent hunters who get to "eat" prey the same way as predators (light touch)
(E.g. 2 hunters, 5 wolves, 15 deer, 23 plants)
- predicted outcome: similar to high predator scenario

    3. Bonus 3: Farmers
Add an additional category *(no pinnys or different colour)* to represent farmers who get to kill predators (light touch)

(E.g. 2 farmers, 5 wolves, 15 deer, 23 plants)
This simulates predator conflict with humans, which often leads to predators being killed
- predicted outcome: similar to low predator scenario

c. Post-test
    i. Evaluate data sheet
        1. What happens to number of herbivores when there are x amount of predators? What happens to the number of plants? Why?
        2. What happens to the number of plants when predator numbers are increased/decreased? Why?
        3. Do predator numbers have an effect on plants?
        4. *Option for expansion: What else relies on the plants survival? Could that species be affected by changing the number of predators?*
    ii. Brainstorm examples of trophic cascades
        1. *Invite students to think of an animal in BC that they know of and explore what it eats, or what eats it. See how far they can go!!*
        2. Joanna and Erin can give examples from their study systems (with pictures!)

d. Summary
    i. This module is meant to get students to think beyond individual species and consider how they function together to make up a whole ecosystem. By exploring how changes in one population can lead to changes in another, students can begin to think about the nature of species interactions and their consequences for the ecological community. This should also encourage students to think about conservation and wildlife management: humans are also part of the ecosystem, and their activities (conservation-focused and otherwise) can have both direct and indirect effects on numerous species.

e. Make it your own
    i. Adjusting for older audiences
        1. High schoolers: thought exercises to expand the trophic cascade beyond three species.
        2. Expand the concept to bottom-up processes as well as top-down. Top-down processes describe those that begin at the top of the food chain (i.e. with predators) and work their way down, whereas bottom-up processes begin with primary producers (i.e. plants) and propagate up.
        3. Non-consumptive interactions between species can be introduced, such as apparent competition (interactions between competitors that are mediated by an intermediary species, ex. as deer populations increase, wolf populations increase, which decreases caribou populations).
        4. Discussing how life-history traits (such as generalist and specialist diets) affects the trophic cascade. Specialist species (those that only eat a narrow range of species) will have stronger effects on a trophic cascade because their survival depends more strongly on the survival of another single species.
    ii. Adjusting for younger audiences
        1. Focus on an interaction between 2 species; could be predator-prey, herbivore-plant, etc. Discuss what this interaction means for each animal's survival, then in

the exercise expand to population level by exploring what happens to the species b when species a increases/decreases.