Wolves, Deer, and Food Web Models

Summary

Students will physically model a 2-species and 3-species ecosystem, based on "Oh Deer!!" from the Project Wild activity book.
Students will perform their own simulations of the same system using a provided excel spreadsheet.

Time Frame

2 class periods of 90 minutes each

Group Size

Small Groups

Life Skills

Thinking & Reasoning, Social & Civic Responsibility, Systems Thinking

Background for Teachers

Predator-Prey Relationships
Predation is a mechanism in which species interact with each other. Predation is when a predator --(consumer that hunts and kills another consumer)- feeds on another living organism or organisms, known as prey --(species consumed by another species). Predator-prey relationships are essential to maintaining the balance of organisms in an ecosystem. .
Energy must constantly flow through an ecosystem for the system to remain stable. What exactly does this mean? Essentially, it means that organisms must eat other organisms. Food chains -(diagram that shows the flow of energy through one organism to the next) demonstrate the eating patterns in an ecosystem. Food energy flows from one organism to another.

Student Prior Knowledge

- Basic plotting.
- Basic spreadsheets.
- Introductory food web.
- The lesson "Chances with Wolves" may give some background info that would enrich the lesson, but is not necessary.

Intended Learning Outcomes

Make estimations and predications based on observations and current knowledge.
Identify variables and describe relationships between them.
Analyze data and draw warranted inferences.
Appreciate the challenges faced by scientists in the past and respect the contributions these men and women have made to advancing science and technology.
Understand natural and human-produced systems in science (appropriate to grade level): 1. Explain how the parts of a system are interconnected and function together as a unit. 2. Predict how changes in one part of a system will likely affect the rest of the system.
Understand that the goal of science is to produce a systematized body of knowledge consisting of concepts, theories, and generalizations that have explanatory and predictive power.

Instructional Procedures

Day 1: human simulation

Note: this may take one or two days. Safety can be a concern with the wolf-deer activity. Students may be required to hop, rather than run, for example, to reduce the risk of injury.

The teacher will explain to the class that they are going to perform a simulation. But instead of running the simulation on a computer, the students themselves will be the simulation.

Students will divide into two groups: deer and resources. A recorder (be it the teacher or a student) will record the number of deer and the number of resources.

The resources will stand on one end of the room.

The deer will begin at the other end, and each will try to be the first to tag a resource. A resource can be tagged once each round. A deer can tag one resource each round.

Once all the resources have been tagged, or all the deer have tagged one resource, the 'year' will be over. Deer that got to resources survive and will be deer again. Deer that didn't are resources for the next year. Resources that got tagged, or eaten, are deer the next year. Resources that did not get eaten remain resources for next year.

The recorder again records the new number of deer and the new number of resource.

A new year has begun. Students will move to the appropriate end of the room, and start over.

Students will repeat the procedure several times.

The following modification may be of interest: Each student will choose a blue, green, or red card. Blue deer need blue resources, green deer need green resources, and red deer need red resources. Red, green, or blue deer die to become red, green, or blue resources respectively, and red, green, or blue resources get eaten to become red, green, or blue deer. This isn't necessary, but it makes the resource hunt a bit more interesting, and it might help decrease the chances of having a complete deer extinction. If the cycles for different colors are out of phase, however, the violent population swings that would otherwise characterize the deer & resource populations may not happen, so make sure to start off with mostly 'resource' and few 'deer' for each color.

Students will return to their seats, record, and plot the numbers produced earlier by the recorder.

Students will then pair off to discuss the patterns in the plots.

(With several years of runs, you're likely to see a pattern. When the resources outnumber the deer, the deer population explodes. The next year, or two years later, they'll eat themselves nearly to extinction. If you have a round with ½ deer and ½ resources, the deer will become extinct.)

To see the effect of predation, students will perform the activity again, but with a couple of students being wolves. Each year, if a wolf eats a deer before the deer eats a resource, that deer becomes a wolf. If not, the wolf becomes a resource. Again, deer are safe once they tag a resource. (If using the red, green, and blue modification, there will likely not be enough students to have three different colors of wolves. Wolves can be colorless and pick up colors randomly, or students can just remember what color they were before they became a wolf.)

A recorder will record the number of wolves, deer, and resources each year.

Students will again return to their seats. Students will again plot each of the quantities in the simulation, and pair off to discuss the plots.

The teacher will lead a class discussion of the cycles seen in the simulation, and discuss possible effects of things such as predation, or hunting, etc., and preventing population explosions or swings.

Day 2: fast model and discussion

Note: this may take one or two days

Students will divide into small groups. The teacher will provide each group with a computer and a copy of the attached spreadsheet.

(The wolf_deer_model spreadsheet runs a simplified version of the game for a long time. Just enter the starting number wolves, deer, and resources, and whether or not to add randomization to the wolf-hunting-deer stage of the calculation, and run the model. Try different initial conditions. Some are more stable than others. You'll see quickly how wolves help stabilize populations. The 2nd sheet in

the excel file is where the calculations are made.)
Each group will formulate a hypothesis to be tested with the wolf_deer spreadsheet. Hypothesis may be simple or complex depending on the groups abilities. Examples may include: (a, simple) more wolves will create a more stable ecosystem, (b, intermediate) certain populations of each are stable, or (c, advanced, and would require a good deal of comfort with Excel) students may modify sheet two to add or subtract one level of complexity to the model.
Groups will the tinker with the spreadsheet to test their hypothesis. Groups will then present their results; perhaps via a report to the teacher, or a presentation to the class. Another option: run the simulation in front of the class as a demonstration with a chart that all students fill out showing the cause and effect of the amount of resources, predator, and prey.
The teacher will finish with a classroom discussion. Questions may include:

- How complex was this model? (extremely simple, although class members may feel otherwise)
- What are some unrealistic assumptions (simplifications) made?
- How could realism be increased?
- Another way to approach this may be to ask: What questions cannot be addressed with this model?
- An example is that this model says nothing about geography. This model could be run simultaneously for different areas. A certain number of wolves or deer could be randomly moved between adjacent areas each year. Thus the model wouldn't change much, but changes in populations over a geographical area could be studied. Of course the computational cost would be multiplied by the number of areas.
- What would be the advantage of increasing realism? (the model in its current form has very little predictive power)
- What would be some disadvantages? (the model in its current form is very understandable)

The teacher can then shift the discussion towards climate simulations. The same questions for the wolf model can be discussed for climate models. The teacher may refer to the attached slides.

Strategies for Diverse Learners

Some students may be more comfortable with the role of recorder than an active participant in the simulation. Students may need to be provided with hypotheses to test with the spreadsheet, rather than coming up with their own.

Extensions

See the discussion bullet points above.

Rubrics

Science Lab Report Rubric

Bibliography

Project Wild Activities and Curriculum Guide, "Oh Deer!!"

Authors

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