Managing Wildlife

High School Lesson Plan

Overview

QUEST Managing Wildlife explores our current understanding of wildlife populations in northern New England. Over the past century, as use of the landscape has changed, so have the wildlife species living there. This program investigates some of the animals that have disappeared and have been reintroduced, such as the turkey and the fisher. Through conversations with professionals in the field, the interactions between wildlife populations and human disturbance are also explored in this teaching unit. Research studies being conducted on nuisance species, fragmented habitat, and genetic diversity are also examined in an effort to depict the complexities of tracking, predicting, and managing wildlife populations.

Introduction

This lesson, for ninth through twelfth grades, focuses on teaching students about the factors that affect population size. The success of a species depends on its ability to reproduce and survive. This, in turn, is dependent on the stability of the ecosystem, the species' susceptibility to predation, and its reproduction strategy.

Time Allotment

This unit requires approximately ten 45-minute classes. Teachers with longer block scheduling may adapt the sessions to bests suit their circumstances.

Accessing Prior Knowledge

Before beginning this unit, students should have an understanding of the basic needs of animals for survival, food webs, and the interdependence of organisms and their environment. Students should also have been introduced to the concept of natural selection, understanding that for a particular environment some organisms will survive better than others because of characteristics they have.

Concepts to Clarify

Some preconceptions that students may bring to this study include the misconception that organisms can cause their own successful adaptation to their environment. Adaptation occurs through random genetic

Maine MATHEMATICS and SCIENCE Alliance

QUEST lessons are developed in partnership with Maine Mathematics and Science Alliance

Maine Public Broadcasting Network · New Hampshire Public Television · Vermont Public Television · PBS

Major funding for Quest is provided by the National Science Foundation. Additional funding is provided by the Maine Department of Inland Fisheries and Wildlife, Maine Forest Products Council, and Irving Woodlands LLC.

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mutations or behavioral changes which allow a species to survive; they are not brought about by the organism itself. It is because of the random change in the individual that it is able to survive or reproduce more effectively. Hence, individuals that inherit this trait will increase in number. If no change occurs in the environment, organisms with this trait may dominate the population; thus the species evolves.

Many high-school students understand what a population of an organism is. However, few clearly see the relationships among populations within a community, such as competition for resources. Even fewer relate the access to resources to the fact that this recycling of energy and matter has limiting effects on population size. It is difficult for students to see plants taking energy from the sun, creating food for their use, and then in turn supplying animals with the building blocks of molecules they need for energy and metabolism, or for cell construction and repair. Hence, the same molecules are separating and bonding into new compounds as they flow through the ecosystem. Concurrently, energy is being released, converted, and absorbed as it travels through the same system. Some students may misconstrue that matter is created and destroyed at each step, rather than each step being a part of a continuous cycle. Within any given system, there is a finite amount of matter, which limits the number of species that can be supported.

Students also tend to cling to the idea that the key factor affecting wildlife populations is the amount of food available to them. This is just one factor; others, such as reproductive success, predation, etc., are equally important. Students may also believe that species have the ability to modify their diets, allowing them to consume whatever is most plentiful in their environment. Conversely, other students may retain the image that species are parts of food chains, instead of food webs – thus, if the population of one species declines, and this species is the sole source of food for another species, it would have a devastating impact on its population. In fact, students should understand that organisms have a modest range of foods; rarely are they dependent on only one species. Students should be able to understand that a wider range of foods in an organism's diet often allows a species a higher degree of survivability in a given habitat.

CONNECTIONS TO THE STANDARDS

National Science Education Standards	Benchmarks for Science Literacy	Maine Learning Results	New Hampshire Curriculum Framework	Vermont Learning Standards
Content Standards (9-12) C. Life Sciences: The Interdependence of Organisms (p.186) -- Living organisms have the capacity to produce populations of infinite size, but	**Chapter 5: The Living Environment** 5D. Interdependence of Life (pp. 115-117) Benchmark 9-12, #1 (p. 117) -- Ecosystems can be reasonably stable over hundreds or thousands of years.	**Science and Technology** B. Ecology: #3 -- Analyze the factors that affect population size (i.e., reproduction and survival rates).	**Life Science** 3b. Demonstrate an increasing ability to understand how environmental factors affect all living things (i.e., individuals, community, biome, the biosphere) as well as species-to-species interactions.	**The Living World: Organisms, Evolution and Interdependence (9-12)** 7.13. Describe, model and explain the principles of the interdependence of all systems that support life (e.g., flow of energy, ecosystems, life

environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms. -- Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of populations' growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.	As any population or organism grows, it is held in check by one or more environmental factors: depletion of food or nesting sites, increased loss to increased numbers of predators, or parasites. If a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages that eventually result in a system similar to the original one. #3 -- Human beings are part of the earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.		End of Grade 10: Make predictions about changes in the size or growth rate of a population using mathematical models (e.g., from graphs and charts, students can determine relationships among the species within an ecosystem).	cycles, cooperation and competition, human populations' impact on the world ecological system), and apply them to local, regional, and global systems.
F. Science in Personal and Social Perspectives: Population Growth (p. 198) -- Populations grow or decline through the combined effects of births and death, and through emigration and immigration. Population can increase through linear or exponentia growth, with effects on resource use and environmental pollution. -- Populations can reach limits to growth. Carrying capacity is the maximum number of individuals that can be supported in a given environment…				

Materials Needed

- TV/VCR
- *QUEST Managing Wildlife* video
- Chart paper
- Markers
- Two varieties of beans of different colors
- Paper plates – 1 per student

Student Handout 1: Letter from Northern New England Wildlife Watchers
Student Handout 2: Species Life History Data Organizer
Student Handout 3: Summary Tables of Moose and Bear Population Growth
Student Handout 4: Quest at Home: Home Grown

1. Introducing the Concepts

Activity 1

This warmup activity offers an opportunity to address students' understanding of ecosystems. It will reinforce the concept that ecosystems are composed of a finite amount of energy and matter that flow through the biotic (living) and abiotic (nonliving) components in the system.

Step 1

Pose the following question to students: "Why are there more mosquitoes than black bears?" Give them some time to think individually about their answers and jot down some notes.

Step 2

Form small research teams of three students each. Have these teams brainstorm ideas about what affects species populations -- why in a given area the number of individuals in a population vary among different organisms.

Step 3

After students have had some time to form responses to the question, allow for a full class discussion. In a round-robin format, have each team suggest what affects population size. Create a master list on chart paper. (Keep this sheet posted throughout the lesson, and add to it as students' knowledge increases.) Assess students' current level of understanding by having them discuss what animals need for survival. If students are ready, begin to explore the concept of food webs as the mode of exchange of energy and matter. Discuss how a food web can translate into the carrying capacity of an area – the amount of resource (energy and mass) a habitat has to support life. Review different types of animals (e.g., mam-

mals, reptiles, birds, etc.) so that students can eventually generalize the concept. During class discussion, encourage students to articulate the following key concepts: Each species demands varying amounts of matter and energy from the environment. The less a species requires, the more of the species an environment can support. The actual interactions within the communities of an ecosystem obviously make this argument much more complex. However, to get this foundational idea across, a simple analogy may also be made: If you were baking and you had a finite amount of ingredients and cooking time, you could decide to bake bread or cookies. If you used up all of the ingredients and electricity, would you end up with more cookies or loaves of bread? Add complexity to this question by including the ability to go to the grocery store, varying the energy sources, or making a variety of items; the comparison should illustrate the complex web of factors that influence populations.

2. Exploring the Concepts

The following two activities will allow students to explore the topic of population change, particularly population growth and the factors affecting the increase of certain species.

Activity 2

Step 1

Tell students that they will be considering the following question: "How do populations increase?" Tell them that they will be watching a video to learn more about this.

Step 2

Play the section of the video on black bears, moose, and turkey.

Step 3

After viewing, brainstorm with the class a list of ideas responding to this question. Add this information to the master list on factors affecting wildlife populations from Activity 1. Also list on chart paper any new questions that may have been raised by students based on the video about bear, moose, and turkey population fluctuations in northern New England.

Step 4

Distribute copies of Student Handout 1, the letter from the Northern New England Wildlife Watchers (NNEWW). Suggest that students begin to compose their response to this challenge by preparing to review the video for information on factors that affect population increases in the three species presented: black bear, moose, and turkey. Also suggest that this information about other species will relate in some way to the status of the red fox. Ask each research team (formed during Activity 1) to choose one species. They are to collect as much data as they can to describe the life history of their species. They should gather as many specifics as possible (number of offspring, length of time with family unit, amount of food required per day, types of food consumed, age of reproductive maturity, life expectancy, etc.)

Step 5
Before reviewing the video, have each research team design a graphic organizer (table or concept map) that lists the types of information they should collect. (You may want to show them a copy of Student Handout 2 to serve as a model.) A few teams can share their ideas if this would be helpful. You may want to select one particular graphic organizer for all of the groups to use so that teams can compare their data. Or, they can design a comparative table after they finish collecting the data.

Step 6
Have the research teams choose a strategy for collecting the information from the video. (For example, each student on a team could try to collect all the information possible, or each team member could focus on just one aspect of the information.) Note: Not all of the facts about the life history of a species are in the video.

Step 7
Repeat the section of the video on black bears, moose, and turkey.

Step 8
Have the research teams report on the data they have collected They should then compare their data about the three species.

Activity 3

Note: This is an excellent activity to integrate with mathematics. You may want to contact a mathematics teacher to see if he or she could work with you in presenting the activity to students.

Step 1
Direct the research teams to look back at their life history data tables for black bear, moose, and turkey. Have teams choose either the black bear or the moose to study for this activity. Brainstorm with students where they might go to collect the remaining information they need on these species (Web resources, libraries, etc; see Resources section).

Step 2
Tell students that, at the end of their research, they should be able to do a demonstration using the materials provided (beans, charts, and tables) to show how a species population varies over time. If students are unfamiliar with modeling, you may first want to have them complete the activities described in Appendix 1A-1C (Population Growth Model Activity) before proceeding. Students may do these activities as a whole class, in teams, or as individuals..

Step 3
Once students have some experience with modeling, have them use Student Handout 3 (Summary Table) to examine the population growth of moose and bears. Each model includes rules that determine the number, sex, and rate of offspring. Review these rules with students.

To create a physical model of the populations, students can use beans to represent the two sexes. Have them make a chart with the years marked off as rows and the sexes as columns. The data represent a 10-year period for each species. Using Student Handout 3, have students total the number of each sex per year and place the appropriate number of beans on the chart. This will give them a visual representation of the exponential growth of these species populations. (**Note:** Be sure that students understand these are not data from a real study. This is conjecture based on the rules shown below the table. The rules, however, are not arbitrary; they have been derived from facts about the life history of these species.)

Step 4

Have students graph their data in histogram and scatter-plot formats. (Completed sample graphs can be found in the Answer Key.) If possible, have them determine the equation for each species' total population growth. Be sure to emphasize that these are figures based on models with specific rules. Clarify how the models may agree or disagree with real-life population growth.

Step 5

Once students have completed an analysis of each species population change, you may want to use the scenarios described below as discussion points to determine students' ability to use and adjust the models and understand the concepts. Discussions can be conducted as a whole class, in teams, in writing, or as written presentations. Each scenario can be modeled using the technique students have learned with their charts and beans.

Step 6

To relate their learning to the circumstances set forth by NNEWW, students should now conjecture some factors that might be important to track in order to determine for NNEWW how red fox populations increase. Again, discussion could be in either whole-class or team format.

Proficiency Guidelines

By the end of this concept-exploration activity, students should be able to explain that a population grows exponentially. They should be able to describe why this happens, identifying three factors that affect population growth rates: age of sexual maturity, rate of birth, and frequency of births.

Optional Assessment

To assess the depth of students' understanding of the concepts covered thus far in the lesson, consider having them respond in writing to the following question:

- If a species migrated into a favorable new habitat that was stable and of a given size, would its population continue to expand forever? Why or why not?

Population Growth Scenarios*

1. What would the impact be on the 10-year population if female bears were able to have cubs when they were 2 years old?

2. What would be the effect of doubling the number of times twins were born in the moose population? Determine the population for 5 years. How does it differ from your earlier calculations?

3. How did the number of newborns in a year vary across the 10 years in both species? In what year did the biggest change in the number of newborns occur?

4. If moose eat 45 pounds of vevetation per day when full grown, how would the demands on an ecosystem change over the 5- year time period?

5. If moose have a 2- to 4-square-mile home range, how has the demand for space increased from year 1 to year 5? If bear have a 20- to 175-square-mile range (depending on the richness of the habitat), how would the bears' needs change and how would they compare with those of the moose?

6. In year 9, it is decided that the herd is getting too large and a hunting season on female moose is opened. What will you base your recommendations on for the number of permits allowed for female moose?

7. What are the major fallacies in these two models, and how would you change them if you had a computer system to help you do it? Specifically, which factors are not being taken into consideration, and which are potentially incorrect.

* For use with Student Handout 3

3. Developing the Concepts

The following two activities will help students see how certain factors limit population growth.

Activity 4

Step 1

Tell students that they will be watching the rest of the video they began earlier. Suggest that they focus on the question, "What limits the growth of populations?" Then have students watch the remainder of the video.

Step 2

Using the same process that was used in Activity 2, students should create a master list of all the data they have collected from the film about factors limiting population growth and reproductive success. They should also list any new questions they may have about the populations of the species covered in the video.

Step 3
In discussion, explore with students which factors limit the growth of populations. Examine in particular causes of mortality. New aspects of population ecology to explore based on this segment are predation between species (fisher and lynx), migration of species into an area and interbreeding of species (coyotes and wolves), specialized habitat (Bucknell's), and habitat loss (herps).

Discuss ecosystem stability with the class, identifying factors related to the rate of change in ecosystems (rapid clearing of woods for farms in the early twentieth century) and when that rate can push a species to extirpation or extinction.

Step 4
Suggest that students may want to review the video for additional details. In preparation for this review, explain to students that their reports to the NNEWW will be enhanced if they can give specific references supporting their reasons for species population increases or decreases based on current research. Tell them to gather as many specifics as possible about the causes of population decline (for example, what causes pressure on populations and increases mortality – weather, hunting, predator populations, disease, habitat loss, etc.).

Step 5
Review the second half of the video with the class.

Activity 5

Step 1
Have students compose lists of all of the species discussed in the video.

Step 2
Ask the research teams to identify what they remember from their earlier work on the trends in populations of the various species (increasing, decreasing, stable, etc.). You may want to refer them back to their graphs or give them copies of Answer Pages 1-3.

For those species with increasing populations, have teams predict whether they think the sides of the parabola depicting the growth of the population will be steep (for a rapid population increase, such as moose) or more gradual (for a slower increase, such as bear.) Ask them what a graph depicting a decline in species population would look like. What would one look like when the population is stabilized? Ask students to draft a graph for each population of species. (These graphs will show a relative trend for students to use to compare species; they are not intended to be numerically accurate due to a lack of statistical information.)

Step 3
After they have drafted their graphs, students should discuss their findings. Ask the research teams to

order their graphs from decreasing population to increasing population by degrees. See if they have any insights from doing this. Have teams identify a reason for each species population trend. (What is causing that population to increase, decrease, or remain stable?)

4. Synthesizing the Concepts

Activity 6

Step 1

Explain that as students examine the factors affecting mortality in wildlife populations, they will need to reflect on whether any of these factors might be causing the decrease in populations of the red fox observed by the Northern New England Wildlife Watchers instead of the hypothesis that it is the foxes' lack of success in reproduction. Have teams reflect on what they know and identify any further information they need to collect.

Step 2

Have each research team submit its hypothesis and supporting data for review. They should also include their strategies for any further research they need to conduct.

Proficiency Guidelines

Hypothesis Review: Teams should each present a theory about why the red fox population is decreasing, based on students' understanding of the factors influencing populations. Their theories should be substantiated with reasoning that is supported by evidence from their research and by correlations with other species. Suggestions for further research should be considered above and beyond proficiency.

5. Applying the Concepts

Activity 7

Step 1

The research teams are now ready to present their ideas to the NNEWW. Parents may be invited to attend the presentations. Other classes or members of the community can be asked to represent the NNEWW.

Step 2

A team should also be selected to assess each presentation. If the activity is kept within a class, research teams can serve as assessment teams. Each team will be given a maximum of 10 minutes to present their theory, reasoning, and justification.

Step 3

Members of the assessing team can then ask follow-up questions. Each session should last only 15 minutes. If time allows, other class members can ask questions.

Presentation Components:

Once the research teams' plans are approved, each team will then prepare for its presentation to the NNEWW.

Each project will have three components: (1) a written report, including a one-page summary to serve as a handout, (2) a visual and model, and (3) an oral presentation using the other two components.

Each team member is responsible for one component upon which he or she will be assessed.

Assessment Criteria:

Assessment requirements or standards should be established by the class. A clear description of proficient work for each piece should be readily available to every student. (See Proficiency Guidelines for Presentation to NNEWW below in the application activity that follows.)

It is best to have students do this project in class with materials supplied by the school. This will ensure that each student is actually doing the work and that they all have equal access to resources.

Proficiency Guidelines for Presentation to NNEWW

Students should demonstrate good teamwork skills. The one component of each presentation for which each individual team member is responsible should include the assessment criterion of how well this team member has related to the others. As a whole, the components should together present one coherent theory and supported argument. Each component should complement the others to form a persuasive argument.

(1) One-Page Summary and Written Report:

This should clearly explain the team's hypothesis. The one-page handout should have bulleted supportive reasoning and a depiction of one other species or example of a known population that has fluctuated based on the same proposed factor. The handout should be easily understood without technical language but should reflect a sound understanding of population dynamics. The graphic presentation should be neither too dense nor too large simply in order to fill space. It can include a minor visual for emphasis, but this should not be redundant of the visual presentation (described below). The written report should be comprehensive but limited to pertinent information. It should demonstrate a clear understanding of population dynamics. It can contain data tables and graphs with interpretation. Any recommendation of further studies or readings should be considered above and beyond proficiency.

(2) Visual and Model

This component should be relevant to the overall argument, presenting a visual representation of the data that clarifies and enriches the factual presentation of the oral report (see below) and the handout. All parts should be well labeled. Limited captions and other text may be used, but they should not repeat information given in the handout.

(3) Oral Presentation

This should present the research team's theory in a nutshell, enhancing the bulleted information in the handout and tying this to the visual images and data. The presenter should not read from either source but should refer to both. Facts should be presented and the theory explained with a clear understanding of the audience – people who are interested in the topic but do not have prior knowledge of the topic. Use of analogies and additional demonstrations can be seen as above and beyond proficiency.

6. Extending the Concepts

The following activity allows students to link classroom learning with home and the "real world," reinforcing their study of the factors affecting population growth. With this take-home activity sheet, they will be involving family members in documenting the growth of their family over three generations and summarizing this information in terms of population change.

Activity 8

Supply each student with a copy of the "take-home" activity called Home Grown. *(Student Handout 4)* Review the sheet together, and encourage students to involve their family members in completing the tables as fully as possible. Allow sufficient time for students to take the activity home and complete the tables -- two to three days should be adequate. In class, have students share their findings and look for common features.

Career Opportunities

Many organizations, such as regional wildlife preserves or nature centers, have summer programs suitable for high-school students to expose them to wildlife management issues and techniques. Individuals at these centers, state parks, and national parks frequently give presentations on their work. Students interested in wildlife biology, management, population biology, or ecology should explore opportunities to speak with – and possibly volunteer with -- individuals in the field.

Community Events

Many states have various programs in which citizens can collect data for scientists. In some states, Biodiversity Days are held, when volunteers go to designated areas and conduct inventories of the particular speciesfound in that area. Contact your state's Natural Heritage Program or Fish and Wildlife Department for further information.

For those who enjoy bird watching, an event called Christmas Bird Count occurs every December. Volunteer teams are given a route to follow to note the kinds and numbers of birds they see. These data are compiled and create an enormously beneficial database on the populations of all varieties of birds. Data from past years can be seen at The Christmas Bird Count Home Page, http://www.mbr-pwrc.usgs.gov/bbs/cbc.html For those who just want to watch their birds at home, the FeederWatch Program, sponsored by the Cornell Laboratory of Ornithology, offers an excellent opportunity: http://birds.cornell.edu/pfw/Overview/over_index.html

Some states also monitor their amphibian populations by having volunteers identify vernal pools, the breeding habitats of amphibians and reptiles. In Maine, for instance, there is the Calling Amphibian Survey, which is part of a nationwide program organized by the U.S. Geological Survey -- Biological Resource Division. Sixty-two roadside frog- and toad-monitoring routes have been randomly established across the state. Each spring, volunteers drive their routes three times, recording the diversity and intensity of calling frogs and toads. Those interested in participating in this citizen-science initiative should contact Maine Audubon's Susan Hitchcox at 207-781-2330, or at the Web site http://www.state.me.us/ifw/wildlife/01report/etss.htm

Maine also has workshops on vernal pools throughout the state for land managers, educators, land trusts, and land owners. A 1999, Maine *Citizen's Guide to Locating and Describing Vernal Pools* is available from MDIFW and the Maine Audubon Society.

Resources

The following Web sites can provide background information on the topics of population ecology, species life histories, and methods of surveying species populations.

New Hampshire Fish and Game Department http://www.wildlife.state.nh.us/
New Hampshire Natural Heritage Inventory http://www.nhdfl.com/formgt/nhiweb/
Maine Department of Inland Fisheries and Wildlife http://www.state.me.us/ifw/index.html
Maine Natural Areas Program http://www.state.me.us/doc/nrimc/mnap/home.htm
Vermont Department of Fish and Wildlife www.anr.state.vt.us/fw/fwhome/index.htm
The Vermont Nongame and Natural Heritage Program
http://www.anr.state.vt.us/fw/fwhome/nnhp/index.html
Precious Heritage: The Status of Biodiversity in the United States http://www.abi.org/pheritage-es.htm
NatureServe Explorer http://www.natureserve.org/explorer/

Northern New England Wildlife Watchers
P.O. Box 1000
Wetlands, N.H. 23335

Dear Students,

The New England Wildlife Watchers have been studying the populations of various species of wildlife throughout New England for the past fifty years. We have recently noticed some changes in the populations of some key species. We would like your assistance in helping us analyze the plight of these organisms. We hope you are willing to take the time to help us.

Our concern is for the red fox. We feel that its population is dwindling in New Hampshire and Vermont because it is not able to successfully reproduce. We think that the females must be having fewer pups. Some have suggested that this is because they are not well nourished enough, but we are not sure what factors may be causing the problem. We would like you to study the information on this species, see if you agree with our conclusions, and suggest how we might expand our research to get a better understanding of the predicament. Then we would like you to recommend to our wildlife agencies some actions that might be taken.

We look forward to hearing from you. We know your presentations will help inform us about this issue and help protect the red fox from further population declines.

Sincerely,

NNEWW Board of Directors

Species Life History Data Organizer

Species	Number of Young	Reproductive Rate	Sexual Maturity	Food	Special Needs	Life Expectancy
Black Bear						
Moose						
Turkey						

Summary Table of Model of MOOSE Population Growth*

Years	Offspring per Year M	Offspring per Year F	Total Population (includes original parents)	Total Female Offspring	Total Male Offspring
Year 1		1	3	1	
Year 2	1	1	5	2	1
Year 3	1	2	8	4	2
Year 4	2	3	13	7	4
Year 5	2	5	20	12	6
Year 6	4	7	31	19	10
Year 7	6	12	40	31	16
Year 8	11	20	80	51	27
Year 9	17	35	132	86	44
Year 10	28	63	223	149	72

Summary Table of Model of BEAR Population Growth*

Years	Offspring per Year M	Offspring per Year F	Total Population (includes original parents)	Total Female Offspring	Total Male Offspring
Year 1		1	3	1	
Year 2			3	1	
Year 3	1	1	5	2	1
Year 4		1	6	3	1
Year 5	1	1	8	4	2
Year 6	1	1	10	5	3
Year 7	1	2	13	7	4
Year 8	1	1	15	8	5
Year 9	2	3	20	11	7
Year 10	1	2	23	13	8

*** Model based on the following rules:**

Moose: Females are 1 when they have their first calf; the firstborn of each female is a female; gender then alternates each year; every fourth year there are twins.

Bear: Females are 3.5 years old when they have their first cubs; the firstborn of each female is a female; twins are born every 2 years; twins are 1 female, 1 male.

Home Grown

You're on a Quest!

Think about the various species populations that have increased in size in New England. Specifically, what is the increase of black bears? Moose? Wild turkeys? How does this affect the population growth of animals in your state? Think about the size of your own family as well as other species in your local area. This activity will help you analyze different factors that affect population growth.

Materials needed:
- *Computer with Internet access*
- *Pen and paper for notes*

Investigate with your family!

- What factors are creating a decrease in populations of various species? An increase?
- Is there a change in the types of migratory patterns of New England's birds? Moose? Black bears? Wild turkeys?
- What about your own family? Has your family size increased or decreased over the past few generations? Does your family live in the same town or state? Did various family members move over the past few years, migrating to another area?

Survey the growth of your family. Talk to family members and find out about your own family's population increase or decrease and migratory patterns over the past years.

Generation	Male	Female
Your great-grandparents' generation	For your great-grandfather, how many did he have? Uncles___ Aunts___ Sisters___ Brothers___	For your great-grandmother, how many did she have? Uncles___ Aunts___ Sisters___ Brothers___
	How many did they have together? Nieces___ Nephews___ Male cousins___ Female cousins___ Male children___ Female children___	
Your grandparents' generation	For your grandfather, how many did he have? Uncles___ Aunts___ Sisters___ Brothers___	For your grandmother, how many did she have? Uncles___ Aunts___ Sisters___ Brothers___
	How many did they have together? Nieces___ Nephews___ Male cousins___ Female cousins___ Male children___ Female children___	
Your parents' generation	For your father, how many did he have? Uncles___ Aunts___ Sisters___ Brothers___	For your mother, how many did she have? Uncles___ Aunts___ Sisters___ Brothers___
	How many did they have together? Nieces___ Nephews___ Male cousins___ Female cousins___ Male children___ Female children___	

Summarize some interesting facts about how your family has changed over the generations:

Electronic Quest!

Literature in the appendix or at the following Web sites can provide background information on the topics of population ecology, species life histories, and methods of surveying species populations. Dive into one of these Web sites and find out more!

New Hampshire Fish and Game Department http://www.wildlife.state.nh.us/
New Hampshire Natural Heritage Inventory http://www.nhdfl.com/formgt/nhiweb/
Maine Department of Inland Fisheries and Wildlife http://www.state.me.us/ifw/index.html
Maine Natural Areas Program http://www.state.me.us/doc/nrimc/mnap/home.htm
Vermont Department of Fish and Wildlife http://www.anr.state.vt.us/fw/fwhome/index.htm
The Vermont Nongame and Natural Heritage Program http://www.anr.state.vt.us/fw/fwhome/nnhp/index.html
Precious Heritage: The Status of Biodiversity in the United States http://www.abi.org/pheritage-es.htm
NatureServe Explorer http://www.natureserve.org/explorer/

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Major funding for Quest is provided by the National Science Foundation. Additional funding is provided by the Maine Department of Inland Fisheries and Wildlife, Maine Forest Products Council, and Irving Woodlands LLC.

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Population Growth Model Activity

Many students are exposed to modeling in mathematics class. This activity may be an excellent opportunity for classes to integrate both their mathematics and science studies. Many standards-based mathematics curriculum have examples of activities in which students study exponential growth in populations and model these changes.

To have students create a simple population model, help them begin by marking paper plates into four quadrants. Have students crosshatch one quadrant on their individual plates. Give each student 5 beans of each type for a total of 10 beans. One bean type represents males and the other represents females. Show students how to shake their beans in their hands to mix them up, then drop them from about 5 inches above the center of their plates. Those falling into the crosshatched area are the successful offspring. Have students glue these beans into the first two boxes (Male and Female) for Year 1 on the Sample Population Growth Model chart (Appendix 1B). Then have them write the correct totals for all offspring and population in the third and fourth boxes for Year 1.

Students should repeat this process to determine the male and female offspring for Years 2 through 5. They should also find the total number of offspring and the total population for each year. When they have finished, they should fill in the Population Growth Model Activity Data Summary Sheet (Appendix 1C).

Have students summarize their thoughts about the data. Discuss how this activity both does and does not reflect the population growth of wildlife.

Have the students graph their data. Students should create both a histogram and a scatter plot using their data. What does each graph tell them? Is the growth linear or exponential (does it form a line or parabola)? Can they use the graphs to predict the population in two more years? If they are familiar with creating equations from the graphs using graphing calculators, have them identify an equation of best fit. Based on this model, how much will the population increase in 10 years?

Sample Population Growth Model

(Demonstration)

Years	Male	Female	Total Offspring in Year	Total Population
Year 1				
Year 2				
Year 3				
Year 4				
Year 5				

Place beans that land in the crosshatched area of the plate in the appropriate boxes, then total the number of male and female offspring per year.

Population Growth Model Activity

Data Summary Sheet

Years	Offspring Per Year M	Offspring Per Year F	Total Population (Includes original parents)	Total Female Offspring	Total Male Offspring
Year 1					
Year 2					
Year 3					
Year 4					
Year 5					

M = _____ bean

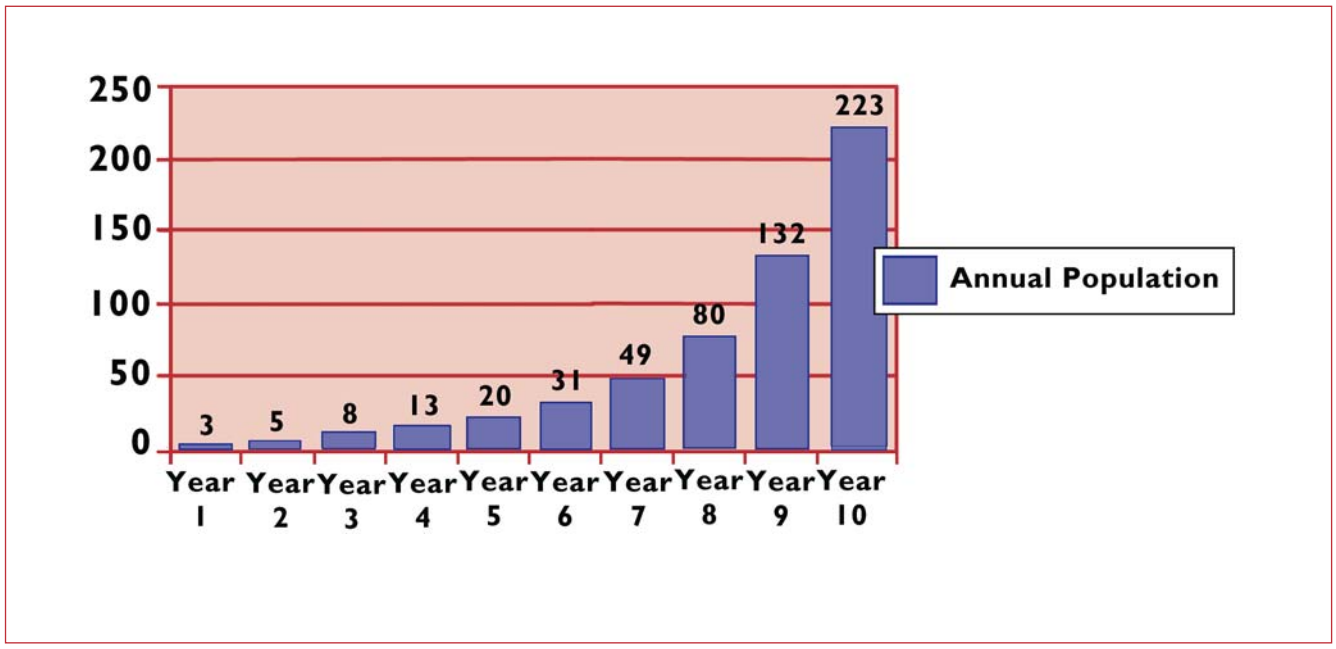
F = _____ bean

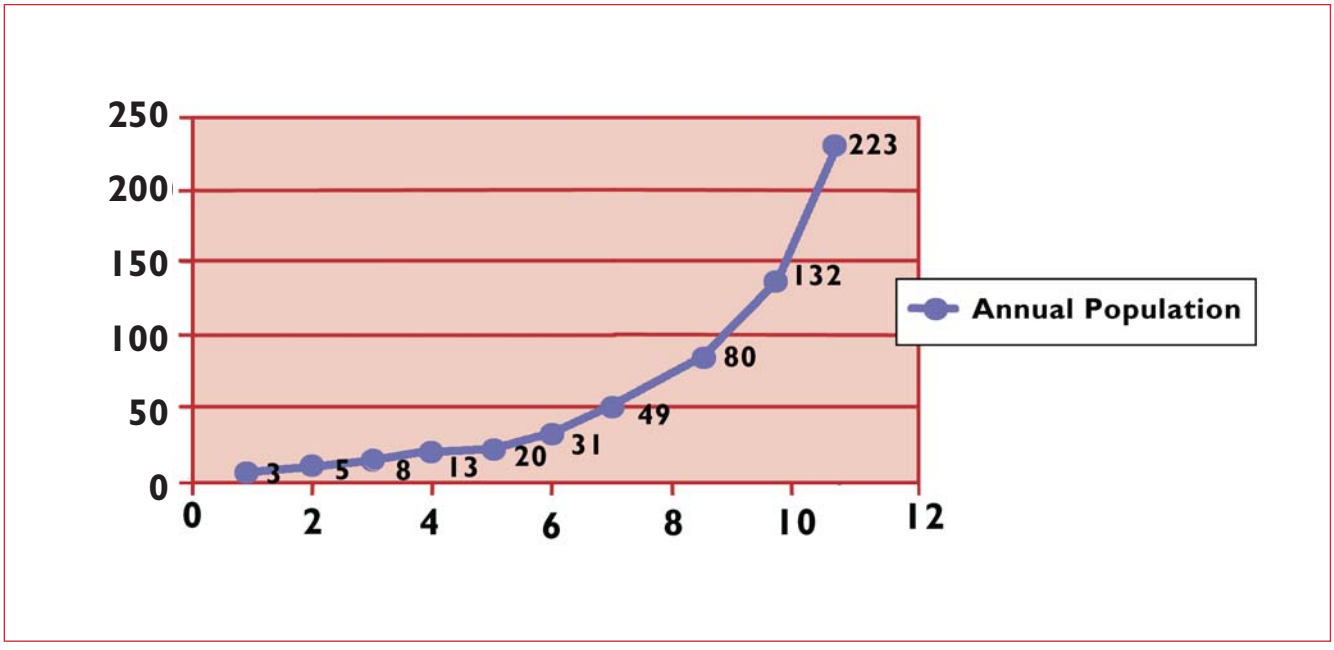
Rules:
Population mortality is random.
Every female reproduces annually.
Sex of offspring is random.

Species Life History Data Organizer

Species	Number of Young	Reproductive Rate	Sexual Maturity	Food	Special Needs	Life Expectancy	Range
Black Bear	1- 4 (usually 2)	every 2 years	3.5 years old	berries, insects, carrion, small mammals	dens for winter	12 - 15 years	20 - 175 miles
Moose	1- 2	every year	1 year old	grasses, aquatic, vegetation, shrubs & trees	wetlands	8 - 10 years	2 - 4 miles
Turkey	10 -12	every year	1 year old	acorns, seeds, berries, insects	open woods, roosting trees	10 years	3 - 5 miles

Graphs of Model of Moose Population Growth





Graphs of Model of Bear Population Growth