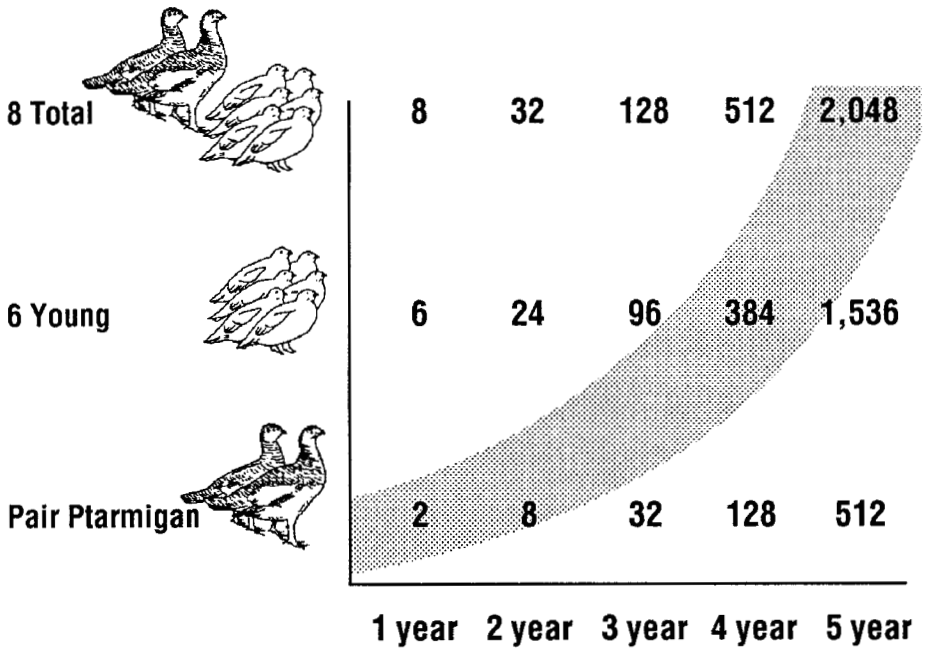
# Population Explosions
## 2 EXTENSIONS




*Section 2*
**WILDLIFE ACTIVITIES**

**Grade level:** 6-8

**State Standards:** M A-3, MA-4,MA-6

**Subjects:** Math,science

**Skills:** Addition, calculation, division, graphing, multiplication

**Duration:** 1period

**Group size:** 1-3

**Setting:** Indoors

**Vocabulary:** Axis, exponential, graphs, linear, potential,reproductive rates,rateofpopulation increase

### Objectives:
1. Students will describe the potential for exponential growth in populations.

2. Students will list two factors that determine the rate of population growth.

### Teaching Strategy:
Students discover the concept of exponential growth while calculating population sizes.

### Complementary Activities:
"Graphic Populations" *and* "How Many Bears Can Live in this Forest?" *in this section*. "Gone Forever" *in Section* 3.

### Materials:
F*or each student*: graph paper, pencils, copies of "Population Explosion Problems Worksheet" and "Population Explosion Discussion Worksheet" (*following*).
OPTIONAL: calculators.

### Background:
**See INSIGHTS *Section* 2, *Biodiversity and Populations – Alaska's Dynamic Wildlife*: "*Population Explosions*" and "*Carrying Capacity*" *Fact Sheets*.**

**NOTE: In this activity your students assume that no deaths occur so that they can witness the implications of exponential growth.** Other activities in this section illustrate the factors which slow or limit growth and stabilize or cause declines in populations.

### Procedure:
1. Hand out the "Population Explosion Problems Worksheets." Students can work individually or in groups with calculators.

2. Ask students to discover what would happen to the two wildlife populations if animals continued to be born, but no animals died.

3. Students calculate the number of animals in each population for several years (assuming that no animals die and half of the young born in each generation are females) and graph their results.

4. Write the following equations on the board:

Reproductive rate =
Number of young produced/female/year

Rate of population increase =
Number of animals in the population in Year X

Number of animals in the population in Year X- I

5. Students use these equations to determine and compare the reproductive rates and rates of population increase for each animal.
For example, a female vole produces six young three times a year, so the reproductive rate is 18 young/ female/ year. In Year 2, the rate of increase of the vole population will be 8,194 voles (number of voles at the end of Year 2) divided by 128 (number of voles after Year 1) for a 6,400 percent rate of increase.

6. Follow-up Discussion: The student groups should complete the "Population Explosion Discussion Questions" worksheet to prepare for a class discussion.

7. The class reviews the answers to the worksheets together.

## Evaluation:

1. Describe the shape of the curve on a graph that showed the potential growth of a wolf population (or of another species). (*All students should draw the "J-shaped" curve associated with exponential growth.*)

2. Describe three factors that affect the rate of population growth. (*Number of young born each year, how often female gives birth, age of female when she first gives birth.*)

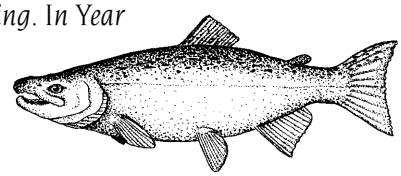
# EXTENSIONS:

A. **Research human population trends.** Students research human population growth and trends. Predict what will happen to the population in their community, in Alaska, the United States, the world. Create mathematical equations using the human population. Discuss how our growth affects wildlife.

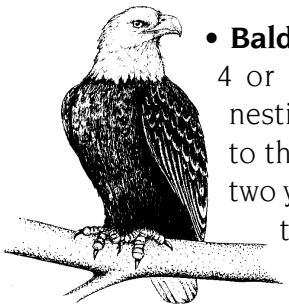
B. **Calculate and graph salmon, eagle, whale populations.** Students calculate the number of animals in the following populations (*answers are given in italics*). Graph the growth for each population. Be sure to label each graph. Compare the growth rate of these populations with the vole and ptarmigan populations.

• A female **silver salmon** can lay 2,400 - 4,500 eggs once in her lifetime. Silver salmon only lay eggs when they are 4 years old and die soon after they spawn. Assuming all eggs survive to adulthood, each female salmon laid 3,000 eggs, and half of the eggs are female, how many salmon would there be after 2, 3, 4, or 5 years if there was 1 pair in Year 1?

(*Because silver salmon don't spawn until they are 4 years old, there will be 3,000 salmon in Years 1,2 and 3. During Year 4, 1,500 females will produce 3,000 eggs each for a total of 4,500,000 eggs. The total salmon in Year 4 would be 4,500,000 since the original breeding adults die almost immediately after spawning. In Year five the total population of silver salmon is 4,500,000.*)



**Note:** The next two problems are more difficult because of the lag time before animals begin reproducing. You may want to work them out as a class, following each generation and its reproduction through several years or give them as extra-credit problems. The "Tables for Eagle and Whale Populations" (*following*) will help students keep track of the populations.



• **Bald eagles** first nest when they are 4 or 5 years old. Once they begin nesting, a pair of adults can raise up to three chicks each year, but one or two young is more common. Assume that eagles pair up and nest when they are 5 years old, after which they nest every year. Each pair of nesting birds produces two healthy eaglets. Starting with one pair of eagles which breed in Year 1, how many eagles would there be after 2, 4, 8, 12 years? Remember that only half of the young will be female.

(*The eagle population will be 6 at the end of Year 2, 10 at the end of Year 4, 30 after Year 8, and 90 after Year 12.*)

• **Humpback** whales can raise only one calf every two years. Young whales don't breed until they are 6 -12 years old. Assume they begin breeding when they are 9 years old. One pair of whales breeds in Year 1 and produces a female calf. Assuming only half the calves are females, how many whales would there be at the end of Year 2? Year 4 ? Years 6? Year 12? D*on't forget the lag time between birth and breeding - and that only females give birth to calves*. The first calf will be ready to breed in 9 years, however, it will have to wait for a second calf of the opposite sex, before it can breed**.**

(*The whale population will be* 3 *after Year* 2, 4 *after Year* 4, 6 *after Year* 8, 9 *after Year* 12. I*t would take* 12 *years to produce two calves old enough to breed; one would be* 9 *years old at the end of Year* 9 *and the second would be* 9 *years old at the end of Year* 11.)

## Credits:

Adapted from *Alaska Wildlife Week: Wildlife for the Future*, Alaska Department of Fish and Game, Anchorage, AK, 1985; and *Teach About Geese*. US Fish and Wildlife Service, Anchorage, AK, 1988.

## Curriculum Connections:

(See appendix for full citations)

*The Bald Eagle Returns* (Patent)

*Biodiversity* (Patent)

*Come Back Salmon* (Cone)

*Endangered Animals*: 140 *Species in Full Color* (Kest)

**Websites:**

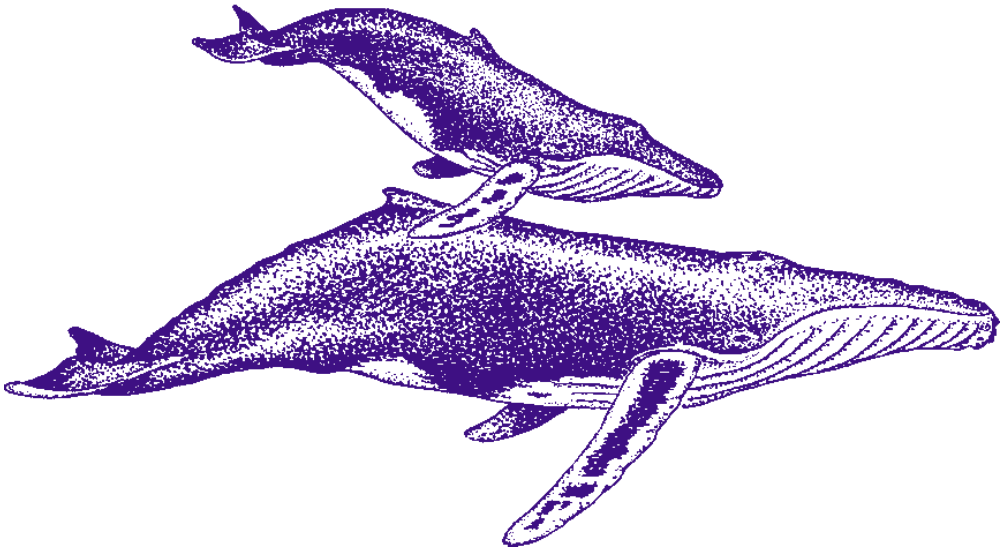
*Alaska Science Forum* <www.gi.alaska.edu/ScienceForum> Articles of particular interest: *Double Trouble* #838 and I*nnumerable Whales* #1178 and numerous articles on salmon populations.

*Animal Diversity Web*
**<**animaldiversity.ummz.umich.edu>

*World Population Awareness*
<www.overpopulation.org>

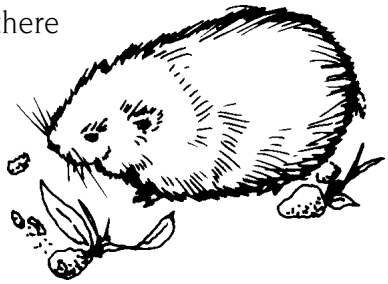
## Teacher Resources:

(See appendix)



# Population Explosion Problems Worksheet

1. What would happen to a population of **red-backed voles**? In Year 1, there are 2 voles, a male and female. Each female can produce 5-9 young each time she bears a litter and she can bear young 3-4 times each year. Young voles can breed at 3 weeks of age (so they are ready for the next breeding in this exercise). How many voles will there be at the end of year 1, 2, 3, 4 and 5? **(Assuming no voles died, each female had 6 young in each litter, and each vole alive at the beginning of the summer bred 3 times.)**



**YEAR 1:**

***lst breeding***

_____ (number of adults) ÷ 2 = _____ (number of females)
_____ (number of females) x 6= _____ (number of young)
_____ (number of young) + _____ (number of adults) = _____ (total adults)
_____ adults produced _____ young, total of _____

***2nd breeding***

_____ (number of adults) ÷ 2 = _____ (number of females)
_____ (number of females) x 6 = _____ (number of young)
_____ (number of young) + _____ (number of adults) = _____ (total adults)
_____ adults produced _____ young, total of _____

***3rd breeding***

_____ (number of adults) ÷ 2 = _____ (number of females)
_____ (number of females) x 6 = _____ (number of young)
_____ (number of young) + _____ (number of adults) = _____ (total adults)

**YEAR 2:**



***lst breeding***

_____ (number of adults) ÷ 2 = _____ (number of females)
_____ (number of females) x 6 = _____ (number of young)
_____ (number of young) + _____ (number of adults) = _____ (total adults)

***2nd breeding***

_____ (number of adults) ÷ 2 = _____ (number of females)
_____ (number of females) x 6 = _____ (number of young)
_____ (number of young) + _____ (number of adults) = _____ (total adults)

***3rd breeding***

_____ (number of adults) ÷ 2 = _____ (number of females)
_____ (number of females) x 6 = _____ (number of young)
_____ (number of young) + _____ (number of adults) = _____ (total adults at end of year 2)



***(repeat for Years 3, 4 and 5)***

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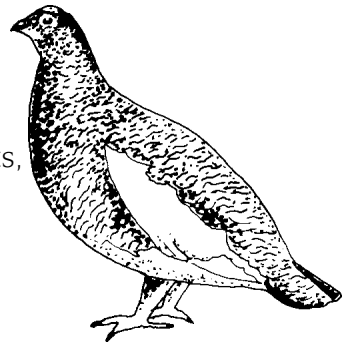
# Population Explosion Problems Worksheet

**VOLESCONTINUED**

**Year 3** - total adults at end of:
1st breeding _____ 2nd Breeding _____ 3rd breeding _____
**Year 4** - total adults at end of:
1st breeding _____ 2nd Breeding _____ 3rd breeding _____
**Year 5** - total adults at end of:
1st breeding _____ 2nd Breeding _____ 3rd breeding _____



2. What happens to this ptarmigan population? In Year 1 there are 2 adults, 1 male and 1 female. Ptarmigan can begin nesting when 1 year old, and each female lays 8 eggs. How many ptarmigan will there be at the end of Year 1_____, Year 2_____, Year 3_____, Year 4_____, Year 5_____?

**YEAR 1:**

_____ (number of adults) ÷ 2 = _____ (number of females)
_____ (number of females) x 8 = _____ (number of young)
_____ (number of young) + 2 (number of adults) = _____ (total adults)

**YEAR 2:**

_____ (number of adults) ÷ 2 = _____ (number of females)
_____ (number of females) x 8 = _____ (number of young)
_____ (number of young) + 2 (number of adults) = _____ (total adults)

**YEAR 3:**

_____ (number of adults) ÷ 2 = _____ (number of females)
_____ (number of females) x 8 = _____ (number of young)
_____ (number of young) + 2 (number of adults) = _____ (total adults)

**(repeat for Years 4 and 5)**
*Option: how many ptarmigan will there be after year* 10?

B. Graph the growth for each population. Be sure to label each graph.

How are the graphs similar?

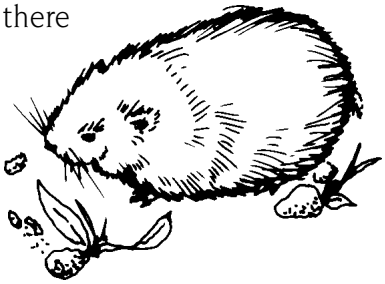
How are the graphs different?

Why are they different?

What factors determine the reproductive rate of a species?

# Population Explosion Answers

1. What would happen to a population of r**ed-backed voles**? In Year 1, there are 2 voles, a male and female. Each female can produce 5-9 young each time she bears a litter and she can bear young 3-4 times each year. Young voles can breed at 3 weeks of age (so they are ready for the next breeding in this exercise). How many voles will there be at the end of year 1, 2, 3, 4 and 5? **(Assuming no voles died, each female had 6 young in each litter, and each vole alive at the beginning of the summer bred 3 times.)**



**YEAR 1:**

***lst breeding***

**2** (number of adults) ÷ 2 = **1** (number of females)
**1** (number of females) x 6 = **6** (number of young)
**6** (number of young) + **2** (number of adults) = **8** (total adults)
**2** adults produced **6** young, total of **8**

***2nd breeding***

**8** (number of adults) ÷ 2 = **4** (number of females)
**4** (number of females) x 6 = **24** (number of young)
**24** (number of young) + **8** (number of adults) = **32** (total adults)
**8** adults produced **24** young, total of **32**

***3rd breeding***

**32** (number of adults) ÷ 2 = **16** (number of females)
**16** (number of females) x 6 = **96** (number of young)
**96** (number of young) + **32** (number of adults) = **128** (total adults)

**YEAR 2:**



***lst breeding***

**128** (number of adults) ÷ 2 = **64** (number of females)
**64** (number of females) x 6 = **384** (number of young)
**384** (number of young) + **128** (number of adults) = **512** (total adults)

***2nd breeding***

**512** (number of adults) ÷ 2 = **256** (number of females)
**256** (number of females) x 6 = **1,536** (number of young)
**1,536** (number of young) + **512** (number of adults) = **2,048** (total adults)

***3rd breeding***

**2,048** (number of adults) ÷ 2 = **1,024** (number of females)
**1,024** (number of females) x 6 = **6,144** (number of young)
**6,144** (number of young) + **2,048** (number of adults) = **8,194** (total adults at end of year 2)

**(*repeat for* Years 3, 4 *and* 5)**

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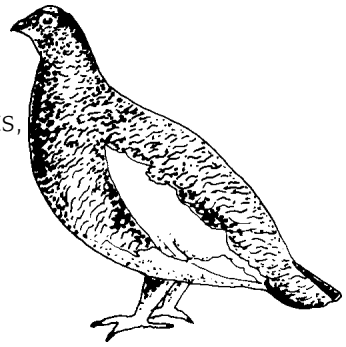
# Population Explosion Answers

## VOLES CONTINUED

**Year 3** - total adults at end of:
1st breeding **32,776** 2nd Breeding **131,104** 3rd breeding **524,416**
**Year 4** - total adults at end of:
1st breeding **2,097,664** 2nd Breeding **8,390,656** 3rd breeding **33,562,624**
**Year 5** - total adults at end of:
1st breeding **134,250,496** 2nd Breeding **537,001,984** 3rd breeding **2,148,007,936**



2. What happens to this ptarmigan population? In Year 1 there are 2 adults, 1 male and 1 female. Ptarmigan can begin nesting when 1 year old, and each female lays 8 eggs. How many ptarmigan will there be at the end of Year 1 **10**, Year 2 **50**, Year 3 **250**, Year 4 **1,250**, Year 5 **6,250**?

**YEAR 1:**

**2** (number of adults) ÷ 2 = **1** (number of females)
**1** (number of females) x 8 = **8** (number of young)
**8** (number of young) + 2 (number of adults) = **10** (total adults)

**YEAR 2:**

**10** (number of adults) ÷ 2 = **5** (number of females)
**5** (number of females) x 8 = **40** (number of young)
**40** (number of young) + **10** (number of adults) = **50** (total adults)

**YEAR 3:**

**50** (number of adults) ÷ 2 = **5** (number of females)
**25** (number of females) x 8 = **200** (number of young)
**200** (number of young) + **50** (number of adults) = **250** (total adults)

**(repeat for Years 4 and 5)**
*Option: how many ptarmigan will there be after year* 10? **19,531,250**

B. Graph the growth for each population. Be sure to label each graph.
How are the graphs similar? **(*Both show exponential growth.*)**

How are the graphs different? **(*The voles increase more rapidly than the ptarmigan.*)**

Why are they different? **(*The voles breed three times each year.*)**

What factors determine the reproductive rate of a species? **(*Number of breeding females, how often they breed each year, number of young born each time a female gives birth, the age at which a female first gives birth. Mortality (deaths) also determines the number of animals added in each generation*)**

# Population Explosion Discussion Questions

1. Compare the graphs and the annual rates of increase in each population. Describe the differences in the shape of the curves on the graphs. How does the rate of increase affect the shape of the curve?

2. What were the factors that affected the rate of population increase?

3. The results in the graphs assume that no animals died in any of the populations. How would you expect animal deaths to change the graphs?

4. If a catastrophe killed 90% of both the vole and ptarmigan populations, which population would recover more quickly? Why?

# Population Explosion Discussion Answers

1. Compare the graphs and the annual rates of increase in each population. Describe the differences in the shape of the curves on the graphs. How does the rate of increase affect the shape of the curve?

**(T*he curve is J-shaped for each animal, but the curve takes longer to appear when the rate of increase is lower.*)**



2. What were the factors that affected the rate of population increase?

**(1) *number of young animals produced by each female*, (2) *how often the females had young*, (3) *the age at which the females began producing young, and* (4) *the population size.***

3. The results in the graphs assume that no animals died in any of the populations. How would you expect animal deaths to change the graphs?

**(I*t depends on the rate at which animals die in relation to the rate at which they are born.* I*f more animals die than are added to the population each year, the curve will turn downward; if more are added than die, the curve will be upward, but not as steeply because the curve in the exercise assumes no deaths.*)**

4. If a catastrophe killed 90% of both the vole and ptarmigan populations, which population would recover more quickly? Why?

**(T*he vole population would recover more quickly because the rate of increase for voles is greater than the rate of increase for ptarmigan.* V*oles produce more young each year and begin reproducing at an earlier age.*)**

# Table for Eagle and Whale Populations

## Eagle Table

| Year | # of Adults - Female | # of Adults - Male | # of Juveniles | | | | | Total Population |
|---|---|---|---|---|---|---|---|---|
| | | | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |
| 11 | | | | | | | | |
| 12 | | | | | | | | |

## Whale Table

| Year | # of Adults - Female | # of Adults - Male | # of Juveniles | | | | | | | | Total Pop. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | |
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 8 | | | | | | | | | | | |
| 10 | | | | | | | | | | | |
| 12 | | | | | | | | | | | |