



Education Dept.
Georgia Aquarium
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DISCOVERY LABS

MATCHMAKING WITH MARINE ANIMALS

Teachers' Guide

Grades 9-12

Program Description: Using the science of genetics and animal management, students will learn the many ways marine populations are managed in zoological settings.

Enduring Understanding for Matchmaking with Marine Animals:

- ◆ Programs are in existence to manage and conserve select and typically threatened or endangered species populations.

Learning Objectives:

- ◆ Students will discover how biological traits are passed on to successive generations.
- ◆ Students will conclude that a goal of aquariums is to manage healthy populations of genetically diverse specimens.
- ◆ Students will examine why biological diversity is critical to maintain healthy, viable populations.

Georgia Performance Standards

SCSh3: Students will identify and investigate problems scientifically.

SCSh6: Students will communicate scientific investigations and information clearly.

SB2: Students will analyze how biological traits are passed on to successive generations.

SB5: Students will evaluate the role of natural selection in the development of the theory of evolution.

b. Explain the history of life in terms of biodiversity, ancestry, and the rates of evolution.

(***We will be focusing on the survivorship of animal species.)

Before coming to the aquarium, students should:

- ◆ Comprehend genetic terminology: dominant, recessive, alleles, homogeneous, heterogeneous, genotype, phenotype, biodiversity
- ◆ Understand the concepts of a Punnett Square
- ◆ Be able to construct a dihybrid cross

POST VISIT ACTIVITY:

Wildlife Management of Beluga Populations

(Adapted from “Checks and Balances” activity in the Project WILD Activity Guide)

Objectives:

Students will be able to:

1. Evaluate hypothetical wildlife management decisions.
2. Identify at least four factors that can affect the size of a wildlife population.

Duration: One or Two 45-minute periods

Materials:

- Paper, pencils, dice, and calculator
- Beluga Management Computation Worksheet
- Condition, reproduction and management cards (if working in small groups you will need a set per group)

Method:

Students become managers of a population of belugas in a paper-and-pencil and discussion-based game.

Background:

Wildlife managers attempt to maintain healthy populations of wild animals, while factors – both avoidable and unavoidable – affect the populations. Some of these factors are loss of habitat, weather conditions, pollution of food and water sources, development of other natural resources, poaching and recreation pressures. Many people are unaware of how such pressures can affect wildlife.

Belugas are listed on the IUCN List as “near threatened” due to their declining numbers. Certain populations, such as those in the Gulf of St. Lawrence, are near collapse. The Cook Inlet population in Alaska is critically endangered and is under protection of the US Endangered Species Act. Of the 7 Canadian beluga populations 2 are endangered, inhabiting the eastern Hudson Bay and the Ungava Bay.

Wildlife management is based on the best scientific and technical knowledge available. Such knowledge is growing. It is still limited and is continually affected by changes in the complex relationships between wildlife, human beings, and their shared environments.

In a sense, everyone shares responsibility for wildlife management. Although there are legally responsible agencies, their work requires the thoughtful and informed co-operation of citizens. There are frequently differences of opinion about the most appropriate policies and programs affecting wildlife. Individual citizens, private conservation groups, private industry, community groups and others all make important contributions to the overall conservation and protection of wildlife and their habitat.

Procedure:

The major purpose of this activity is for students to assume the role of wildlife managers for a population of beluga whales. Students will gain insight into some of the complex variables that influence responsible planning and management of the wildlife resource (beluga whale populations).

1. For this activity break students into small groups of 3 or 4 (or you can work collectively as a class as one beluga manager). Each group will need a set of the 3 decks of cards (totaling 36 cards). Each student within the group is the manager of a beluga population. The typical size of a beluga pod is ten animals. However, numerous pods of belugas do inhabit the same areas and often congregate in populations upwards of the thousands. These populations are sometimes referred to as stocks. The point of the activity is to end up with a viable population after nine rounds, representing nine years. If, at any time, the student's population of belugas reaches less than 10 or more than 200 individual animals, that student no longer has a viable stock population and observes the other students until the conclusion of the activity.

2. Each student has a starting population of 100 animals.

- For this game, have the cards separated into three decks totaling 36 cards: a condition deck (18 cards), a reproduction deck (9 cards), and a management deck (9 cards). Shuffle the cards within each deck.

- Explain that cards will be drawn per person in the following sequence: **condition card, reproduction card, condition card, management card**. This sequence of drawing will be repeated--each repetition representing an annual cycle. (The students may think of each draw as representing a different season, e.g., autumn, winter, spring, summer.)

- As each card is drawn, it is read aloud to the entire group/class. Each student then rolls his or her die and follows the instructions on the card to determine his or her population's new size. Some computations may result in fractions or decimals and may be rounded to the nearest whole number.

- Students should use the Beluga Management Computation Worksheet to record their answers and keep track of their beluga population.

- Teachers may want to demonstrate how to use the Computation Worksheet with the class prior to beginning.

VARIABLES FOR FORMULAS

A = Starting Population	B = New Population	D = Decrease	I = Increase	N = Number to decrease/increase	R = Roll
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- Note: Students may object to the use of dice to determine the impact of decisions made for wildlife management purposes. Their concerns are appropriate; wildlife management is based on more than the chance elements reflected in the use of dice. However, chance has an impact on belugas as well, as in the case of weather conditions in a given year. Encourage the students to discuss and consider what is realistic and what is unrealistic about the impact of dice in this activity, and to recognize that wildlife management is far more complex than can be represented through this activity.

3. Wrap up the activity with a class discussion. Include topics such as:

- The apparent impacts of the condition, reproduction and management cards.

- The benefits and disadvantages of the management decisions made.

- Outcomes of the different management strategies used by different students. (Ask students to discuss how they might manage their populations differently given a second chance.)

- Realistic and unrealistic aspects of the activity.

- Examples of ways in which habitat can be improved in the short and long term.
- The necessity, benefits and disadvantages of human management of wildlife populations for both people and animals.

Variations:

1. Add a monetary aspect to the activity. For example, students allowing sight-seeing cruises might have more revenue available for projects like habitat enhancement based on income from sale of sight-seeing excursions. Expenses might include salaries of wildlife managers, funds for research, feeding animals in severe conditions, relocation, etc.
2. After using the given cards once, students may want to experiment with changing some of the parameters on the supplied cards or making additional cards. Students may also want to make additional complete sets of cards for use by small groups or individual students.

Extensions:

1. Have the students do a research project on the management of specific beluga populations, such as the Gulf of St. Lawrence, Cook Inlet, eastern Hudson Bay, or Ungava Bay.
2. Invite a wildlife manager from a local government to talk to the class about wildlife management.
3. Students may visit the GA Aquarium to observe beluga whales or participate in the Animal Encounters program to have a personal experience with beluga whales.

Evaluation:

Discuss with students:

1. Four factors that can affect the size of a wildlife population.
2. The idea that wildlife management may involve more management of people than of wildlife.

Reproduction cards

Reproduction card: Excellent Year

This has been an excellent reproduction year. Increase your population by five times your roll, if your population is over 50 individuals. If your population is between 50 and 10, increase your population by three times your roll. If your population is under 10, you may not reproduce.

Use Formula: $5 \times R = I$ $A + I = B$ OR $3 \times R = I$ $A + I = B$

(EX: you have a population size of 80 (which is more than 50) you roll a 4 so 5×4 gives you a population increase of 20)

(EX: you have a population size of 40 (which is between 50 and 10) you roll a 3 so 3×3 gives you a population increase of 9)

Reproduction card: Average Year

This has been an average reproduction year. Increase your population by three times your roll, if your current population is over 50 individuals. If your population is between 50 and 10, increase your population by two times your roll. If your population is under 10, you may not reproduce.

Use Formula: $3 \times R = I$ $A + I = B$ OR $2 \times R = I$ $A + I = B$

(EX: you have a population size of 80 (which is more than 50) you roll a 4 so 3×4 gives you a population increase of 12)

(EX: you have a population size of 40 (which is between 50 and 10) you roll a 5 so 2×5 gives you a population increase of 10)

Reproduction card: Average Year

This has been an average reproduction year. Increase your population by three times your roll, if your current population is over 50 individuals. If your population is between 50 and 10, increase your population by two times your roll. If your population is under 10, you may not reproduce.

Use Formula: $3 \times R = I$ $A + I = B$ OR $2 \times R = I$ $A + I = B$

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(EX: you have a population size of 40 (which is between 50 and 10) you roll a 5 so 2×5 gives you a population increase of 10)

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Use Formula: $5 \times R = I$ $A + I = B$ OR $3 \times R = I$ $A + I = B$

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(EX: you have a population size of 80 (which is more than 50) you roll a 4 so 5×4 gives you a population increase of 20)

(EX: you have a population size of 40 (which is between 50 and 10) you roll a 3 so 3×3 gives you a population increase of 9)

Condition cards

WEATHER CARD

A dry season where rivers and water levels have dropped causes difficulty with breeding and the ability to elude predators has had a serious negative impact on the survival of the population.

Decrease your population by the percentage equal to five times your roll.

$$\text{Use Formula: } 5 \times R = D \quad D\% \times A = N \quad A - N = B$$

(EX: You have a population of 124 belugas. You roll a 3 so $5 \times 3 = 15$. Decrease your population by 15%. 15% of 124 is 18.6 which rounds to 19 animals so $124 - 19$ leaves you with 105 belugas)

WEATHER CARD

An exceptionally cold winter has resulted in more ice which causes some animals to become trapped or easily preyed upon by predators (killer whales, polar bears, walruses) has had a negative impact on the survival of the population. Decrease your population by the percentage equal to five times your roll.

$$\text{Use Formula: } 5 \times R = D \quad D\% \times A = N \quad A - N = B$$

(EX: You have a population of 124 belugas. You roll a 3 so $5 \times 3 = 15$. Decrease your population by 15%. 15% of 124 is 18.6 which rounds to 19 animals so $124 - 19$ leaves you with 105 belugas)

WEATHER CARD

A mild winter with minimal amounts of ice buildup and easier traveling conditions has had a dramatic positive impact on the survival of the population. Increase your population by the percentage equal to five times your roll.

$$\text{Use Formula: } 5 \times R = I \quad I\% \times A = N \quad A + N = B$$

(EX: You have a population of 124 belugas. You roll a 3 so $5 \times 3 = 15$. Increase your population by 15%. 15% of 124 is 18.6 which rounds to 19 animals so $124 + 19$ leaves you with 143 belugas)

WEATHER CARD

Stricter fishing regulations has allowed for a larger food supply, and had a positive impact on the survival of the population. Increase your population by the percentage equal to five times your roll.

$$\text{Use Formula: } 5 \times R = I \quad I\% \times A = N \quad A + N = B$$

(EX: You have a population of 124 belugas. You roll a 3 so $5 \times 3 = 15$. Increase your population by 15%. 15% of 124 is 18.6 which rounds to 19 animals so $124 + 19$ leaves you with 143 belugas)

HABITAT LOSS CARD

The building of a new mining town has occurred, destroying critical habitat (this is actually occurring in the Bristol Bay population). Decrease population size by the number five times your roll.

$$\text{Use Formula: } 5 \times R = D \quad A - D = B$$

(EX: You have a population of 156 belugas. You roll a 2 so $5 \times 2 = 10$. Decrease your population by 10. $156 - 10$ leaves you with 146 belugas)

HABITAT LOSS CARD

Development of various industries has increased water pollution and has destroyed critical habitat. Decrease population size by the number five times your roll.

$$\text{Use Formula: } 5 \times R = D \quad A - D = B$$

(EX: You have a population of 156 belugas. You roll a 2 so $5 \times 2 = 10$. Decrease your population by 10. $156 - 10$ leaves you with 146 belugas)

HABITAT DEGRADATION CARD

An increase in shipping routes has occurred, damaging critical habitat. Decrease population by the number equal to three times your roll.

Use Formula: $3 \times R = D$ $A - D = B$

(EX: You have a population of 172 belugas. You roll a 4 so $3 \times 4 = 12$. Decrease your population by 12. $172 - 12$ leaves you with 160 belugas)

HABITAT DEGRADATION CARD

Aircraft have begun flying over causing sound interference making it harder for belugas to communicate with one another. Decrease population by the number equal to three times your roll.

Use Formula: $3 \times R = D$ $A - D = B$

(EX: You have a population of 172 belugas. You roll a 4 so $3 \times 4 = 12$. Decrease your population by 12. $172 - 12$ leaves you with 160 belugas)

HABITAT DEGRADATION CARD

Construction of a pipeline has occurred, damaging critical habitat. Decrease population by the number equal to three times your roll.

Use Formula: $3 \times R = D$ $A - D = B$

(EX: You have a population of 172 belugas. You roll a 4 so $3 \times 4 = 12$. Decrease your population by 12. $172 - 12$ leaves you with 160 belugas)

HABITAT DEGRADATION CARD

Increased fishing and crabbing operations have begun, damaging critical habitat. Decrease population by the number equal to three times your roll.

Use Formula: $3 \times R = D$ $A - D = B$

(EX: You have a population of 172 belugas. You roll a 4 so $3 \times 4 = 12$. Decrease your population by 12. $172 - 12$ leaves you with 160 belugas)

HABITAT LOSS CARD

An oil spill has resulted in a loss of critical habitat. Decrease population by the number equal to three times your roll.

Use Formula: $3 \times R = D$ $A - D = B$

(EX: You have a population of 172 belugas. You roll a 4 so $3 \times 4 = 12$. Decrease your population by 12. $172 - 12$ leaves you with 160 belugas)

HABITAT LOSS CARD

A hydroelectric power development has resulted in a loss of critical habitat. Decrease population by the number equal to three times your roll.

Use Formula: $3 \times R = D$ $A - D = B$

(EX: You have a population of 172 belugas. You roll a 4 so $3 \times 4 = 12$. Decrease your population by 12. $172 - 12$ leaves you with 160 belugas)

HABITAT LOSS CARD

Increased boat traffic along a traditional migration route has resulted in a loss of critical habitat. Decrease population by the number equal to three times your roll.

Use Formula: $3 \times R = D$ $A - D = B$

(EX: You have a population of 172 belugas. You roll a 4 so $3 \times 4 = 12$. Decrease your population by 12. $172 - 12$ leaves you with 160 belugas)

HABITAT LOSS CARD

Clear-cut logging and floating the logs downriver has resulted in a loss of critical habitat. Decrease population by the number equal to three times your roll.

$$\text{Use Formula: } 3 \times R = D \quad A - D = B$$

(EX: You have a population of 172 belugas. You roll a 4 so $3 \times 4 = 12$. Decrease your population by 12. $172 - 12$ leaves you with 160 belugas)

HABITAT LOSS CARD

Oil and gas exploration has occurred, resulting in a loss of critical habitat. Decrease population by the number equal to three times your roll.

$$\text{Use Formula: } 3 \times R = D \quad A - D = B$$

(EX: You have a population of 172 belugas. You roll a 4 so $3 \times 4 = 12$. Decrease your population by 12. $172 - 12$ leaves you with 160 belugas)

PREDATOR CARD

An increase in the walrus population has occurred, affecting the population size. Decrease population size by the percentage equal to your roll.

$$\text{Use Formula: } R\% \times A = N \quad A - N = B$$

(EX: You have a population of 124 belugas. You roll a 3 so decrease your population by 3%. 3% of 124 is 3.72 which rounds to 4 animals so $124 - 4$ leaves you with 120 belugas)

DISEASE CARD

Disease has struck the population. Decrease population by the percentage equal to your roll.

$$\text{Use Formula: } R\% \times A = N \quad A - N = B$$

(EX: You have a population of 124 belugas. You roll a 3 so decrease your population by 3%. 3% of 124 is 3.72 which rounds to 4 animals so $124 - 4$ leaves you with 120 belugas)

POACHING CARD

Poaching, the illegal killing of animals, has reduced the size of the population. Decrease population by the number equal to two times your roll.

$$\text{Use Formula: } 2 \times R = D \quad A - D = B$$

(EX: You have a population of 124 belugas. You roll a 3 so $2 \times 3 = 6$. Decrease your population by 6. $124 - 6$ leaves you with 118 belugas)

Management cards

HABITAT IMPROVEMENT CARD

Oil and gas exploration have been stopped in the population's calving grounds, improving critical habitat. Increase population by five times your roll.

$$\text{Use Formula: } 5 \times R = I \quad A + I = B$$

(EX: You have a population of 172 belugas. You roll a 4 so $5 \times 4 = 20$. Increase your population by 20. $172 + 20$ leaves you with 192 belugas)

HABITAT RESTORATION CARD

A national marine sanctuary has been created in the population's calving grounds. Increase population by the percentage equal to five times your roll.

$$\text{Use Formula: } 5 \times R = I \quad I\% \times A = N \quad A + N = B$$

(EX: You have a population of 127 belugas. You roll a 4 so $5 \times 4 = 20$. Increase your population by 20%. 20% of 127 is 25.4 which rounds to 25 animals. $127 + 25$ leaves you with 152 belugas)

HABITAT ALTERATION CARD

A small change in fishing practices has occurred, altering critical habitat. Increase or decrease population (students decide to increase or decrease before rolling the die) by the percentage equal to two times your roll.

Use Formula: $2 \times R = I$ $I\% \times A = N$ $A + N = B$ OR $2 \times R = D$ $D\% \times A = N$ $A - N = B$

(EX: **Increase:** You have a population of 127 belugas. You roll a 4 so $2 \times 4 = 8$. Increase your population by 8%. 8% of 127 = 10.16 which rounds to 10 belugas. $127 + 10$ leaves you with 137)

(EX: **Decrease:** You have a population of 127 belugas. You roll a 4 so $2 \times 4 = 8$. Decrease your population by 8%. 8% of 127 = 10.16 which rounds to 10 belugas. $127 - 10$ leaves you with 117)

RESEARCH CARD

A long-term study in water quality has been successfully accomplished. Increase or decrease population (students decide to increase or decrease before rolling the die) by two times your roll.

Use Formula: $2 \times R = I$ $A + I = B$ OR $2 \times R = D$ $A - D = B$

(EX: **Increase:** You have a population of 127 belugas. You roll a 4 so $2 \times 4 = 8$. Increase your population by 8%. $127 + 8$ leaves you with 135)

(EX: **Decrease:** You have a population of 127 belugas. You roll a 4 so $2 \times 4 = 8$. Decrease your population by 8%. $127 - 8$ leaves you with 119)

EDUCATION CARD

Project Wild, the GA Aquarium, and other education organizations have led to increased understanding of wildlife and habitat. Increase or decrease population (students decide to increase or decrease before rolling the die) by the percentage equal to two times your roll.

Use Formula: $2 \times R = I$ $I\% \times A = N$ $A + N = B$ OR $2 \times R = D$ $D\% \times A = N$ $A - N = B$

(EX: **Increase:** You have a population of 127 belugas. You roll a 4 so $2 \times 4 = 8$. Increase your population by 8%. 8% of 127 is 10.16 which rounds to 10 animals. $127 + 10$ leaves you with 137 belugas.)

(EX: **Decrease:** You have a population of 127 belugas. You roll a 4 so $2 \times 4 = 8$. Decrease your population by 8%. 8% of 127 is 10.16 which rounds to 10 animals. $127 - 10$ leaves you with 117 belugas.)

LAW ENFORCEMENT CARD

More conservation officers and law enforcement activities have protected the population against illegal actions like poaching. Increase population by the percentage equal to two times your roll.

Use Formula: $2 \times R = I$ $I\% \times A = N$ $A + N = B$

(EX: You have a population of 127 belugas. You roll a 4 so $2 \times 4 = 8$. Increase your population by 8%. 8% of 127 is 10.16 which rounds to 10 animals. $127 + 10$ leaves you with 137 belugas.)

HABITAT ACQUISITION CARD

Habitat acquisition has increased the area of protected and suitable habitat. Increase the population by five times your roll.

Use Formula: $5 \times R = I$ $A + I = B$

(EX: You have a population of 142 belugas. You roll a 4 so $5 \times 4 = 20$. Increase your population by 20%. $142 + 20$ leaves you with 162 belugas.)

SIGHT-SEEING CRUISES CARD

A request for sight-seeing cruises has been made. Do you wish to allow tourism in your area? If yes, decrease your population by the percentage equal to five times your roll. If no, record no change in the size of your population.

Use Formula: $5 \times R = D$ $D\% \times A = N$ $A - N = B$

(EX: You have a population of 132. You roll a 5. 5×5 is 25%. Decrease your population by 25%. 25% of 132 is 33. $132 - 33$ leaves you with 99 belugas.)

NATIVE HUNTING CONTROL

A native Alaskan village has requested permits to hunt belugas in their area. Do you wish to allow hunting permits for natives in your area? If yes, decrease your population by the percentage equal to five times your roll. If no, record no change in the size of your population.

Use Formula: $5 \times R = D$ $D\% \times A = N$ $A - N = B$

(EX: You have a population of 132. You roll a 5. 5×5 is 25%. Decrease your population by 25%. 25% of 132 = 33. $132 - 33$ leaves you with 99 belugas.)

Resources:

Project Wild: K-12 Curriculum & Activity Guide. Council for Environmental Education. 2001.

Project Caribou: An Educator's Guide to the Wild Caribou of North America.

Name: _____

Directions: Use the roll of the dice to determine the individual outcome of each card drawn. Use the appropriate formula to help determine your new beluga population number. This new number (represented as variable B) will then become variable A for the next card draw. The beluga population at the end of each round will be your starting beluga population number (variable A) for the next round. The point of the activity is to end up with a viable population after nine rounds, representing nine years. If, at any time, the student's population of belugas reaches less than 10 or more than 200 individual animals, that student no longer has a viable stock population and observes the other students until the conclusion of the activity.

VARIABLES FOR FORMULAS

A = Starting Population	B = New Population	D = Decrease	I = Increase	N = Number to decrease/increase	R = Roll
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POSSIBLE FORMULAS FOR CARD DRAWS

Condition			Reproduction		Condition			Management		
1) $5 \times R = D$	$D\% \times A = N$	$A - N = B$	1) $5 \times R = I$	$A + I = B$	1) $5 \times R = D$	$D\% \times A = N$	$A - N = B$	1) $5 \times R = I$	$A + I = B$	
2) $5 \times R = D$	$1\% \times A = N$	$A + N = B$	2) $3 \times R = I$	$A + I = B$	2) $5 \times R = D$	$1\% \times A = N$	$A + N = B$	2) $5 \times R = I$	$1\% \times A = N$	$A + N = B$
3) $5 \times R = D$	$A - D = B$				3) $5 \times R = D$	$A - D = B$		3) $2 \times R = I$	$1\% \times A = N$	$A + N = B$
4) $R\% \times A = N$	$A - N = B$				4) $R\% \times A = N$	$A - N = B$		4) $2 \times R = D$	$D\% \times A = N$	$A - N = B$
5) $2 \times R = D$	$A - D = B$				5) $2 \times R = D$	$A - D = B$		5) $5 \times R = D$	$D\% \times A = N$	$A - N = B$
6) $3 \times R = D$	$A - D = B$				6) $3 \times R = D$	$A - D = B$		6) $2 \times R = I$	$A + I = B$	
								7) $2 \times R = D$	$A - D = B$	

Round	Starting Beluga Population	Condition Card (Show the formula used and your work)			Reproduction Card (Show the formula used and your work)		Condition Card (Show the formula used and your work)			Management Card (Show the formula used and your work)		New Beluga Population
EX:	100	$5 \times R = D$ $5 \times 4 = 20$	$D\% \times A = N$ $20\% \times 100 = 20$	$A - N = B$ $100 - 20 = 80$	$5 \times R = I$ $5 \times 3 = 15$	$A + I = B$ $80 + 15 = 95$	$5 \times R = D$ $5 \times 4 = 20$	$D\% \times A = N$ $20\% \times 95 = 19$	$A - N = B$ $95 - 19 = 76$	$5 \times R = I$ $5 \times 3 = 15$	$A + I = B$ $76 + 15 = 91$	<u>91</u> (start # for next round)
1	100											
2												
3												
4												
5												
6												
7												
8												
9												

Name: