Lesson 2: Population Dynamics – Class Checkup Results

Background:

Now that you have completed Lesson 1 (*Checkup Time – Give Your Monarch a Physical!*), how does your butterfly compare with other monarchs? Is it larger or healthier than most monarchs? Are its wings torn and scratched, while other butterflies have wings that look brand new?

What are the characteristics of your class's population of monarchs? Are there more males or females? Have any of the females mated? Do any of the monarchs have OE parasites? What are the traits of an average butterfly in your population?

In this activity you will compile all of the monarch physical (Lesson 1) results for your class. You will determine the characteristics of a typical monarch for your population and compare it with your butterfly. You will also compare the class population of monarchs with other monarch populations. Lastly, if your monarch population is large enough, you may do further investigations and try to discover relationships between different monarch characteristics.

The Average Monarch Butterfly:

What does "average" mean?

When scientists study populations they often need to describe the general characteristics of a group. They want to know the traits of a typical or average member of a population. What does an average monarch butterfly look like? How long does the average monarch live? What is the average size of a monarch?

There are three different ways that scientists represent the average or typical value for any characteristic. The three concepts of "average" are mean, median, and mode.

Mean:

The mean is often called the average. When teachers discuss the class average, they are referring to the mean. The mean of a data set is the sum of the values divided by the number of values.

To calculate the mean, add all of the numbers in a data set. This sum is often called the "total." Then count the number of values in the data set. The number of values in the data set is often called "n." Now divide the "total" by "n" to get the mean. To help calculate the mean, the *MonarchHealth* data tables have a place to write the "total" and "n."

Example:
1) A data set includes the following numbers: 4, 2, 4, 9, and 6.
2) The total or sum for this data set is 25. (4 + 2 + 4 + 9 + 6 = 25)
3) There are five values in this set of numbers, so n = 5.
4) The mean is 5, because total (25) divided by n (5) is 5.

Median:

The median of a data set is the middle value when the numbers are written in increasing order. To determine the median, first arrange the values in the data set in numeric order. If the data set has an odd number of values, the middle value is the median. If there is an even number of values in the data set, the median is the average (or mean) of the two middle values.

Median (continued)**:**

       Example:
       1) A data set includes the following numbers: 4, 2, 4, 9, and 6.
       2) Arrange the values in the data set in increasing order.   [2, 4, 4, 6, 9]
       3) There is an odd number of values (n = 5) in the data set, so the median is the middle value.
       4) The median is 4, since the middle value in the data set is 4. (2, 4, <u>4</u>, 9, 6)

Mode:

       The mode is the most common value in a data set.

       Example:
       1) A data set includes the following numbers: 4, 2, 4, 9, and 6.
       2) There are two 4s in the data set. There is only one 2, 6, and 9 in the data set.
       3) The mode is 4, since it is the most common value.

How large is the "average" monarch?

Mass:

       Like other animals, the mass of any individual monarch does not stay the same. Water makes up a large portion of a monarch's mass. A butterfly can rapidly gain or lose water. On a warm day a butterfly will quickly dry out and can lose up to 20% of its mass. Imagine a 100 pound person losing 20 pounds in just one day!
       In addition to water, wing size can also affect the weight of a butterfly. The wings of a monarch are responsible for almost half of the butterfly's mass. A butterfly with large wings will frequently weigh more than a smaller butterfly.
       Even with many factors affecting mass, scientists have been able to determine the mean mass of a monarch. The mass of an average monarch is just over half a gram (0.5 g). How heavy is half of a gram? Half of a gram is quite light. In fact, it takes two monarchs to weigh as much as a paper clip!

Forewing Length:

       The length of a monarch's forewing can vary tremendously. Every year scientists from Altizer's lab head to Mexico to sample hundreds of monarchs for OE parasites. The tiniest monarch they have ever recorded had a forewing length of just 3.755 cm. The largest monarch was much bigger with a forewing length of 6.198 cm.
       In general, the average forewing is around 5 cm long. Over the past two years after sampling more than 1400 monarchs in Mexico and Georgia, scientists from the Altizer lab have calculated a mean forewing length of 5.194 cm. Male monarchs are often slightly larger than female monarchs. There also appears to be important size differences between monarchs in the three North American populations. Monarchs from the eastern population that migrate to Mexico appear to be much larger than monarchs in the South Florida resident population and the western migratory population.

Lesson 2: Population Dynamics – Class Checkup Results

Background for Further Investigations:

Sample Size and Relationships Between Variables:
      If your monarch population is large enough, you may do additional investigations to determine relationships between different characteristics or variables. It is always best to have a large sample size (or large number of test subjects) when conducting an experiment or analyzing a population to reduce the effect of individual differences. If the sample size is small, a few unusual or atypical individuals can have a great impact on the results. The influence of atypical individuals is less when the sample size is large. This is why scientists try to examine hundreds of monarchs instead of just a few. This is also one of the reasons why your participation in Project *MonarchHealth* is so important! Every sample you send to *MonarchHealth* increases the sample size for the project, making the results more significant.
      Scientists are constantly trying to interpret and understand their observations. Sometimes one factor influences another factor or variable. There are often relationships between variables. For instance, you may have noticed that boys in high school are usually taller than girls. The variable of height is affected by gender. A similar thing may be true for monarchs. Mass and forewing length may be affected by the sex of the butterfly. This is a relationship that you can study using *Tables IV* and *V*. Scientists at the Altizer lab are interested in the effect that OE parasites have on monarchs. If you have a large number of infected and uninfected butterflies, you could investigate the relationship between OE infections and butterfly size or fat reserves. *Tables VI* and *VII* are available for this purpose. There is also a blank data table that can be used to compare the mass, forewing length, and fat score of monarchs with other characteristics. Another option is to look at the relationship between mass and forewing length.
      If you are looking for ideas or would like more information about monarchs, OE parasites, and relationships to study, go to the research section of this website.
http://www.monarchparasites.org/

Lesson 2: Population Dynamics – Class Checkup Results

Materials:
- *Checkup Time – Give Your Monarch a Physical! – Patient Form*
    (Completed class set from Lesson 1)
- *Population Dynamics – Class Checkup Results*
    - *Table I – Class Results*
    - *Tables II & III – Summary of Class Results (Class Totals & Class Averages)*
    - *Discussion/Analysis*
- Calculators (recommended)
- Graph paper
- *Monarch Physical Rating Scales* (pages 1 and 2) (See Lesson 1)
    - *OE Infection Rating Scale*
    - *Wing Wear (Scale Loss) Rating Scale*
    - *Wing Damage Rating Scale*
    - *Sex Determination Table*
    - *Fat (Stored Energy) Rating Scale*

Procedures:

1) Use the results from Lesson 1 (Checkup Time – Give Your Monarch a Physical!) to complete *Table I – Class Results.*
    - Fill in the heading on *Table I – Class Results.*
    - Transfer the data from each completed *Patient Form* to *Table I – Class Results.*
2) Use information from *Table I* to complete *Table II – Class Totals.*
    - Fill in the heading on *Summary of Class Results (Tables II & III).*
    - Count the number of monarchs in *Table I*. Record this number under the "all monarchs" column, in the "total number" row, next to "n =." (Scientists often use "n" as a short way of referring to the total number of test subjects.)
    - Count the number of raised monarchs on *Table I*. Record this number on *Table II* in the "total number" row.
    - Continue to record the total number of different monarchs (wild, OE infected, not infected, male, female, mated female, and unmated female) on *Table II* by counting the data from *Table I.*
    - Calculate the "percent of total" for raised monarchs. Divide the number of raised monarchs by n. Convert this number from decimal form to a percentage. Record the percent of total monarchs that were raised.
    - Continue to calculate and record the "percent of total" for each of the remaining characteristics. (When doing the calculations for *Mating Status of Females*, remember to divide the number of mated and unmated females by the total number of females, not the total number of monarchs.)
3) Complete *Table III – Class Averages.*
    - Find the sum of the forewing lengths by adding all of the forewing lengths shown on *Table I.*
    - Record this sum on *Table III* in the "total" row under "forewing length."
    - Continue to use the data on *Table I* to find the sum for mass, wing wear, wing damage, and fat. Record the sums in the "total" row on *Table III*.
    - Determine the mean value for each characteristic on *Table III* by dividing the "total" by "n." (See Table I for the value of "n.")

- Record each mean value in the appropriate space on the "mean" row on *Table III*.
- Determine the median (middle value) for each characteristic and record in the appropriate space.
- Determine the mode (most common value) for each characteristic and record in the appropriate space.

4) Graphing – Refer to *Graphing Options* charts for additional support.
   a) Pie Charts
      - *Percent of Raised and Wild Monarchs* - Use data from *Table II* to make a circle graph showing the percent of monarchs that are raised and the percent of wild monarchs.
      - *Percent of Monarchs Infected and Not Infected with OE* - Make a circle graph showing the percent of monarchs that are infected with OE parasites and the percent that are not infected with OE. Use data from *Table II*.
      - *Percent of Male and Female Monarchs* - Make a circle graph showing the percent of monarchs that are male and the percent of monarchs that are female.
   b) Bar Graphs
      - *Percent of Monarchs with Different Characteristics* – Use data from *Table II* to make a bar graph showing the percent of total monarchs with various characteristics.
         - x axis – Characteristics (categories of raised, wild, infected with OE, not infected, males, and females)
         - y axis – Percent of Monarchs
      - Optional: Complete bar graphs for wing wear, wing damage, and fat scores based on instructions in the *Population Dynamics - Graphing Options* charts.

5) *Population Dynamics – Discussion/Analysis*
   - Fill in the heading on *Population Dynamics – Discussion/*Analysis.
   - Review the data in *Table II* and *Table III* before answering the questions on *Population Dynamics – Discussion/Analysis.*
   - Answer questions #1 - 9.
   - Use the *Monarch Physical Rating Scales* to answer the remaining questions. Take the numeric scores for wing wear, wing damage, etc. and convert those scores to written descriptions. Base the descriptions on the mean score rounded to the nearest whole number.

Further Investigations:

Additional Materials for Further Investigations:
- *Population Dynamics – Class Checkup Results*
   - *Table IV – Male Monarch – Size and Fat*
   - *Table V – Female Monarch – Size and Fat*
   - *Table VI – Monarchs Infected with OE – Size and Fat*
   - *Table VII – Monarchs Not Infected with OE – Size and Fat*
   - *Blank Table with Sample Numbers, Forewing Length, Mass, and Fat*

Procedures:
      The size and characteristics of your monarch population will affect what you may do beyond the basic activity. Are there questions that you have about the monarch population that could be answered with the data you already have? The *Background for Further Investigations* section may give you some ideas of relationships that could be studied. The *Graphing Options* section has many suggestions that may be helpful as well.

Population Dynamics – Class Checkup Results
Discussion/Analysis

Name _____**Class** _____ **Date** _____

Answer the following questions after completing Table II & III.

1. Are there more raised or wild monarchs in your population?

2. Are more of the monarchs infected or not infected with OE?

3. Are males or females more common?

4. Have more of the females mated or not mated?

5. What is the mean forewing length?

6. What is the mean mass?

7. What is the mean wing wear score?

8. What is the mean wing damage score?

9. What is the mean fat score?

10. Describe the average amount of scale loss based on the *rounded* wing wear score.

11. Describe the average amount of wing damage based on the *rounded* wing damage score.

12. Describe the average amount of fat (stored energy) based on the *rounded* fat score.

13. What are the characteristics of a typical or average member of your monarch population? Combine your answers from questions 1-12 and complete the following statement.

> An average monarch in our population is a   male / female   with a forewing length
> of _____ cm and a mass of _____ grams. It   is / is not
> infected with OE parasites, has _____ scale loss,
> and _____ wings are damaged. Its abdomen is _____
> _____.

14. Compare and contrast your monarch with a typical monarch in your population. How is your monarch similar to the average monarch? How is your monarch different from the average monarch?

15. The mean mass for a monarch is about 0.5 g and the mean forewing length is 5.194 cm. How does the average monarch in your population compare with average monarch in North America?

16. What questions do you still have about your monarch population?

17. What could you do to get answers to your questions?

Population Dynamics: Class Checkup Results
Table I – Class Results

Name _____Class _____ Date _____

Sample Number	Raised/ Wild	Date Sampled	Forewing Length (cm)	Mass (g)	OE Infection (yes/no)	Wing Wear Score	Wing Damage Score	Sex (Male/ Female)	Fat Score	Mating Status Female mated? (yes/no)

Population Dynamics: Class Checkup Results
Summary of Class Results (Tables II & III)

Name _____Class _____ Date _____

Table II – Class Totals

All Monarchs		Raised / Wild		OE Infection		Sex		Mating Status of Females	
		Raised	Wild	Infected	Not Infected	Males	Females	Mated	Not Mated
Total Number	n =								
Percent of Total	----								

Table III – Class Averages

	Forewing Length (cm)	Mass (g)	Wing Wear Score	Wing Damage Score	Fat Score
Total (Sum of all values)					
Mean (Mean = Total ÷ n)					
Median (Middle value)					
Mode (Most common value)					

Population Dynamics – Class Checkup Results
Table IV – Male Monarch – Size and Fat

Name _____Class _____ Date _____

Sample Number	Forewing Length (cm)	Mass (g)	Fat Score
Total (Sum of column values)			
Mean (Mean = Total ÷ n)			

n = Number of male butterflies   n = _____

Name _____Class _____ Date _____

Sample Number	Forewing Length (cm)	Mass (g)	Fat Score
Total (Sum of column values)			
Mean (Mean = Total ÷ n)			

n = Number of female butterflies   n = _____

Population Dynamics – Class Checkup Results
Table VI – Monarchs Infected with OE - Size and Fat

Name _____Class _____ Date _____

Sample Number	Forewing Length (cm)	Mass (g)	Fat Score
Total (Sum of column values)			
Mean (Mean = Total ÷ n)			

n = Number of monarchs with OE   n = _____

Population Dynamics – Class Checkup Results
Table VII – Monarchs Not Infected with OE - Size and Fat

Name _____Class _____ Date _____

Sample Number	Forewing Length (cm)	Mass (g)	Fat Score
Total (Sum of column values)			
Mean (Mean = Total ÷ n)			

n = Number of monarchs not infected with OE   n = _____

Population Dynamics – Class Checkup Results

Name _____Class _____ Date _____

Sample Number	Forewing Length (cm)	Mass (g)	Fat Score
Total (Sum of column values)			
Mean (Mean = Total ÷ n)			

n = Number of monarchs   n = _____