# MSTP Science Lesson Template

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|---|---|---|
| **Teacher(s):** | | **Date:** |
| **Subject: Science/Living Environment** | **Grade(s): 8** | **Time to complete (in periods): 2 Lab periods** |
| **Unit: Ecology** | **Lesson Topic/Title: Estimating Populations** | |

**Student population:**
☐ Special Education ☐ LEP ☐ LD ☐ G&T ☐ Academically Average ☐ Low achieving ☐ Other

**<u>OBJECTIVES</u> of the lesson:**
[State the SPECIFIC <u>Science</u> and <u>Math</u> goals of this lesson. What will students know or be able to do by the completion of the lesson? Start each statement with "Students will understand…" or "Students will be able to…".]

Students will be able to:
1. Estimate population size by acquiring a sample from a sub region of the ecosystem.
2. Use the **mark-and-recapture** method to estimate the size of a population.
3. Describe factors that may affect population size.

**<u>BACKGROUND KNOWLEDGE</u> necessary for students before engaging in this lesson:**

STUDENTS SHOULD UNDERSTAND THAT A POPULATION IS ALL MEMBERS OF ONE SPECIES LIVING IN ONE AREA (ECOSYSTEM) AND THAT THERE ARE MANY BIOTIC AND ABIOTIC FACTORS THAT AFFECT THE SIZE OF A GIVEN POPOPULATION.

**<u>PRECONCEPTIONS</u> that may need to be addressed:**

Students may believe that the only way to determine a population's size is to capture and count each individual organism.

| **List 1 or 2 of the overarching NEW YORK STATE <u>SCIENCE</u> <u>STANDARDS</u> to be addressed in this lesson:** | **Write out CODES and <u>PERFORMANCE</u> <u>INDICATORS</u> for RELATED <u>SCIENTIFIC</u> <u>CONTENT</u> & <u>PROCESSES</u> addressed in this lesson:** |
|---|---|
| Key idea 6: Plants and animals depend on each other and their physical environment.<br><br>Appendix A: Living Environment – Laboratory Checklist. | 6.1: Explain factors that limit growth of individuals and populations.<br><br>6.1de: The number of organisms any habitat can support is limited by the available energy, water, oxygen, & minerals and by ability of ecosystems to recycle the residue of dead organisms through the activities of bacteria and fungi.<br><br>6.1f: Living organisms have the capacity to produce populations of unlimited size, but environments and resources are finite. This has profound effects on the interactions among organisms. |
| | |

# MSTP Science Lesson Template

| List 1 or 2 of the overarching NEW YORK STATE <u>MATHEMATICS</u> <u>STANDARDS</u> to be addressed in this lesson: | Write out CODES and <u>PERFORMANCE</u> <u>INDICATORS</u> for RELATED <u>MATHEMATICAL</u> <u>CONTENT</u> & <u>PROCESSES</u> addressed in this lesson: |
|---|---|
| Connections: Apply math to science ➔ | 8.CN.9 Recognize and apply mathematics to other disciplines, areas of interest, etc. |
| Algebra: Ratio & proportion, formulas ➔ | 8.PS.10 Use proportionality to model problems. |
| Statistics & Prob.: Predictions from Data ➔ | 7.S.8 Interpret data to provide the basis for predictions. |
| **MAJOR CONCEPTS addressed:** | **MAJOR SKILLS addressed:** |
| **Science: Population studies** | **Science:**<br>**Analyzes results from observations/expressed data.** |
| **Mathematics: Ratio & proportion; applications** | **Mathematics:**<br>**Setting up and solving proportions.** |

**How does understanding the listed math concepts INFORM Science knowledge? (Not just math that is simply *related* to the science, but math that helps students better *understand the science ideas*)**

By setting up a proportion and using algebra to calculate the population estimate of a species students will see that relationships exists between: the ratio of <u>the number of animals in a species that has been marked, compared to the entire population</u> and the ratio of <u>the number of recaptured in the species having marks, compared to the number recaptured</u>. This proportional relationship is frequently used by scientists to estimate the size of a population when it is not practical, or possible to physically count each member of a given population.

**How does this lesson represent <u>BEST PRACTICE</u>?**

- ✓ Focuses on important (standards-based) ideas & skills and promotes conceptual understanding
- ✓ Uses a *variety* of instructional approaches to maintain student engagement (e.g., ☐ lecture **X** group work and team work ☐ demonstration ☐ field trips ☐ role play ☐ skits ☐ dramatization). **X** (others) modeling ☐ __________ *Please check.*
- ☐ Encourages guided discovery, inquiry, and design
- ☐ Engages students in peer and self assessment
- ✓ Includes key questions to elicit responses that reflect understanding of important content
- ✓ Promotes procedural fluency
- ☐ Addresses naïve conceptions
- ✓ Prompts discourse among students and with teacher
- ✓ Builds on prior student knowledge
- ✓ Aligns curriculum, instruction, and assessment
- ✓ Establishes cross-disciplinary connections
- ☐ Establishes real-world connections for students so that they generalize lesson concepts to MST applications
- ☐ Prompts higher order thinking (students analyze, compare and contrast, classify…)
- ☐ Prompts students to generate alternative ideas and strategies
- ☐ Adjusts instructional methods according to student population and understanding
- ☐ Procedure includes summary focused on key ideas
- ✓ Motivates learning during and beyond the lesson

**MSTP Science Lesson Template**

| **<u>MATERIALS AND RESOURCES</u> needed (including IT resources and other materials)** |
|---|
| **Estimating population size pre- and post-assessment<br>Counting turtles lab packet<br>Calculators<br>Model turtle populations (a package with an unknown number of “turtles”; one per 2 students)<br>Investigating populations report guidelines<br>Assortment of turtle reference books<br>Model of a report on an overhead transparency<br>List of turtle reference websites<br>Scoring rubric for lab reports<br>Environmental Science textbook for general populations estimating information** |

**<u>INSTRUCTIONAL PLANNING</u>: PROVIDE A <u>COMPLETE SEQUENCE</u> OF *<u>ALL</u>* TEACHING PROCESSESS AND STUDENT ACTIVITIES INVOLVED IN IMPLEMENTING THE LESSON.** **This should include *<u>ALL</u>* teacher explanations, examples, questions, and student activities associated with the delivery of the lesson. Nothing should be left to the imagination. *Other teachers should be able to reproduce this exact lesson using this lesson plan.* Indicate (with an asterisk) where embedded formative assessments will occur during the implementation of the lesson. Indicate instructional alternatives that may be employed for differentiating instruction for students with special needs. **BE SPECIFIC ABOUT HOW MATHEMATICAL CONCEPTS ARE INFUSED INTO THIS SCIENCE LESSON* Use additional pages if needed.***

# MSTP Science Lesson Template

**Day 1**

1.

Administer pre-assessment.

2. Facilitate a class discussion of estimating populations. "If scientists wanted to determine the size of a population, like crickets in a field or cliff swallows in a cliff colony, what techniques could they use?"
3.

- **Observation**
  - Direct: count them
  - What difficulties may arise when using this method?
    Anticipated answers: The population may be too large to count. The population may be spread out over too large a region of access. The conditions may not allow counting of the whole population.
- **Sampling**
  - Take a sample from a sub-region of the ecosystem.
  - For example, to estimate the number of tadpoles in a pond count all of the tadpoles in 1 cubic meter of the pond. Suppose you count 150 tadpoles. Use this information to estimate the number of tadpoles in the whole pond of 19,000 cubic meters.

    Estimated population = 150 * 19,000
    = 2,850,000 tadpoles
  - Ask: What sources of error may this method impose?
    Anticipated answers: The tadpoles may not be evenly distributed in the pond.
    A small sample may not be representative of the population.

- **Mark-and-Recapture**
  Suppose that a lake is stocked with catfish and we wish to estimate the total number of catfish in the lake. We will take a random sample of 40 catfish from the lake and mark them with tags. Then we will release these fish back into the lake. The next day we will revisit the same lake and take a sample of 80 fish from the lake. Suppose that 2 of these fish have tags. Estimate the "Total population size" of catfish in the lake.

  One method to use in this situation is ratio and proportion:

$$\frac{40}{\text{Total population}} = \frac{2}{80} \qquad \textbf{[Ratios of Part to Whole]}$$

$$2\,(\text{Total population}) = (40)(80)$$

$$\text{Total population} = \frac{3200}{2}$$

$$(\text{Estimated})\ \text{Total population} = \textbf{1600 catfish}$$

  However, we could set up the ratio and proportion another way and still arrive at the save answer:

$$\frac{\text{Total population}}{40} = \frac{80}{2} \qquad \textbf{[Ratios of Whole to Part]}$$

$$2\,(\text{Total population}) = (40)(80)$$

$$\text{Total population} = \frac{3200}{2}$$

(Estimated) Total population = **1600 catfish**

**Summary of the Mark-and-Recapture method:**

In general, an estimate of the population size using the mark-and-recapture method can be found by creating and solving a ratio and proportion problem. When two ratios are equal, we say they are "in proportion." Thus, we call the equation below "a proportion."

**[Method 1: Proportion]**

$$\frac{\text{Number marked}}{\text{Total population}} = \frac{\text{Number marked in subsequent sample}}{\text{Number recaptured in subsequent sample}}$$ **[Ratios of Part to Whole]**

**OR**

**[Method 2: Proportion]**

$$\frac{\text{Total population}}{\text{Number marked}} = \frac{\text{Number recaptured in subsequent sample}}{\text{Number marked in subsequent sample}}$$ **[Ratios of Whole to Part]**

- Distribute worksheet for class work. (See attachment). The items not completed in class will be assigned for homework.

**Day 2**

1. Check homework and answer questions regarding the methods for estimating total population size discussed yesterday.

4. Explain that today we will be discussing ways to improve the accuracy of the mark-and-recapture method for estimating the total population size of a species.

4. For the technique of mark-and-recapture to be valid, scientists must collect samples randomly from the entire population. Explain that samples must be chosen to be representative of the whole region and the whole population. That is what we mean when we say that samples should be "randomly selected."

   For example, if we wanted to use a sample to determine the number of boys in a large room of 100 people, it would not be a random sample if we chose only from the table of 10 people seated near the front of the room. That would not be a "random sample." In fact, all girls may be seated at that particular table. The teacher should facilitate a discussion of ways we might select a more "random sample" of 10 people from that room.

5. To improve the accuracy of the mark-and-recapture method for estimating the size of a population, many samples should be taken. In general, the more samples taken, the more accurate the estimate of the population size.

   For example, suppose the New York Department of Agriculture wants to estimate the total number of

Mallard ducks in Suffolk County during the month of July. To do this, a random sample of 30 Mallard ducks was taken from various regions of Suffolk county and tagged. The ducks were then returned to the regions from which they were taken. For each of the next 5 days, 15 Mallard ducks were captured throughout the county and the number of tagged ducks in the sample was recorded in the chart below. The ducks were always returned to their habitat after they were captured.

| Trial number | # captured | # recaptured having a tag |
|---|---|---|
| 1 | 15 | 2 |
| 2 | 15 | 1 |
| 3 | 15 | 2 |
| 4 | 15 | 3 |
| 5 | 15 | 0 |
| Totals | **75** | **8** |

Notice that the total number of ducks captured in the 5 samples was 75 and the total number of recaptured ducks that had been tagged among the recaptured ducks was 8. An estimate of the total population size of Mallard ducks may be found by solving the following proportion. (An equivalent proportion would work as well):

$$\frac{\text{Number marked}}{\text{Total population}} = \frac{\text{Number marked in subsequent sample}}{\text{Number recaptured in subsequent sample}}$$ **[Ratios of Part to Whole]**

$$\frac{30}{\text{Total population}} = \frac{8}{75}$$

$$\text{Total population} * 8 = 30*75$$

$$\text{Total population} *8 = 2250$$

$$\text{Total population} = \frac{2250}{8}$$

$$\text{Total population} = 281.25$$

(Estimated)Total population **= 281 Mallard ducks**

6. Distribute lab packets and read the directions with students.
7. Arrange students into pairs.
8. Distribute model turtle populations.
9. Model how to select “turtles” randomly.
10. Invite students to collect data and complete the data table.
11. Remind them to show all work on separate paper, including proportions. Have calculators available for students.
12. While completing the lab packet, encourage students to take at least five samples before they analyze the data.
13. Instruct students to answer the lab questions.
14. Distribute the report guidelines and discuss.
15. Provide students with the following resources to complete their reports:

- Turtle resource books from the library.
- Environmental Science text books with population estimation information.
- List of general turtle information websites.

1. http://en.wikipedia.org/wiki/Turtle
2. http://42explore.com/turtle.htm
3. http://www.unc.edu/~dtkirkpa/stuff/maps.html
4. http://hsus.org/wildlife/a_closer_look_at_wildlife/turtles_and_tortoises/
5. http://www.hilozoo.com/animals/AR_p_turtle.htm
6. http://www.calm.wa.gov.au/science/turtles_general.html

- Grading rubric for the lab report. [See attachment]

**<u>ASSESSMENT Methodologies</u> [Embedded Diagnostic, Formative and Summative] planned to demonstrate the degree to which students have mastered the listed NYS Performance Indicators indicated on the prior page. *Attach COMPLETE EXAMPLES of all methods checked below***

✓ Selected Response: (Circle type(s): Paper/pencil tests; multiple choice; true/false; matching; short answer fill-ins)

☐ Essay: (Circle type(s): Extended written answers; Graphic organizers – KWL or TWK) (*indicate guiding questions, scoring criteria, and sample student responses*)

☐ Constructed Response: (Circle type(s): Multi-steps; Document-based questions) (*indicate guiding questions, scoring criteria, and sample student responses*)

✓ Performance Assessment: (Circle type(s): Individual; group; product-based; performance-based; artistic; authentic. (I*ndicate guiding questions, scoring criteria, and sample student responses.*)

✓ Classroom observation (Circle type: Formal; Informal) (*if formal, indicate guiding questions, scoring criteria, and sample student responses*)

✓ Whole class discussion (*indicate guiding questions, scoring criteria, and sample student responses*)

☐ Small group discussions (*indicate guiding question, scoring criteria, and sample student responses*)

☐ Individual student interviews (*indicate interview questions, scoring criteria and student responses*)

☐ Process or Reflective measures: (Circle type: Journals; Logs) (*indicate scoring method; explain development and use of rubrics; provide an example of a finished journal*)

☐ Portfolios (*indicate scoring method; explain development and use of rubrics; provide an example of a finished portfolio*)

✓ In-class worksheet/written assignment (*explain assignment and/or provide example of student work*)

☐ Quiz/Test/Exam (*indicate scoring method; provide an example*)

✓ Others (*describe*) **Student lab report, including calculations, and data tables.**

MSTP Science Lesson Template

| **<u>DESCRIPTION OF SUMMATIVE ASSESSMENT</u>: Indicate how students' learning of lesson objectives (stated earlier) was comprehensively assessed. ("Post" assessment.) Include description of assignment and sample items. *Attach scoring criteria (checklist or rubrics) used to evaluate the work, and three samples of student work (high, medium, and low).*** |
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| |

| **<u>*AFTER LESSON IMPLEMENTATION,* PROVIDE YOUR REFLECTIONS</u>: Tell the story of what happened in the classroom. Indicate what worked, what you would change for the next implementation, and students' reactions to the lesson. Use additional pages if needed.** |
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| |

***Attach to this lesson template: any and all WORKSHEETS and HANDOUTS, examples of ALL indicated ASSESSMENTS (embedded formative and summative), and SAMPLE STUDENT WORK.***

**MSTP Science Lesson Template**

Living Environment
Period ______________

Name_____________________

Date _____________________

**Estimating Populations Pre-Assessment**
**(and Post-Assessment)**

**1.** A scientist wants an accurate estimate of the number of crickets living in a large field. Describe one technique she could use.

**2**. A scientist uses a **sampling** technique to estimate the number of frogs living in a 1000 square meter marsh. The scientist carefully counts every frog living in one 10 square meter section of the marsh and then multiplies this count by 100 to estimate the total population.

Describe one source of error in this technique.

Describe one way to improve the accuracy of this technique.

**3.** A scientist does a **mark-and-recapture** study to estimate the total number of turtles living in a large pond. The scientist randomly catches and marks 20 turtles from the pond and then releases them. A week later, the scientist returns and randomly catches 40 turtles from the population. Four of the turtles have a mark. Estimate how many turtles live in the pond. Show all work.

**4**. What does "randomly" mean as it is used in problem 3 ?

**5**. Describe any possible sources of error you see in using the **mark-and-recapture** technique.

**Day 1** 

# Class Worksheet and Homework

1. A researcher uses a sampling technique to estimate the number of grasshoppers in a 1500 square meter field. She carefully counts all of the grasshoppers in a 5 square meter section of the field. Estimate the total number of grasshoppers in the field.

2. Suppose you wish to estimate the number of Monarch butterflies in Florida in the month of May using the mark-and-recapture method. On May 1, a random sample of 200 Monarch butterflies is caught and tagged. On May 20, another random sample of 300 Monarch butterflies is caught and 20 of these have tags. Set up a proportion problem and use it to estimate how many Monarch butterflies are in Florida in the month of May.

***Proportion*** ___________________________________________________________

Solve your proportion to estimate the total population size of Monarch butterflies in Florida in the month of May.

***Show your work.***

**[# 3 & 4 below are similar problems requiring solution by proportion.]**

3. Jenny's Gift Shop sells candles in a variety of packages. The cost per candle is the same in every package. A package of 8 candles costs $12.96. Write a proportion that can be used to determine the cost of a package of 3 candles.

***Proportion***___________________________________________________________

Solve your proportion to determine the cost of a package of 3 candles.

***Show your work.***

4. Mark made a skateboard ramp shaped like a triangle. It is 4.5 feet long and 3 feet high. He wants to make another ramp that is shaped like a triangle similar to the first ramp. The new ramp will be 4 feet high. Write a proportion that Mark can use to find the length, *x*, of the new ramp.

***Proportion*__________________________________________________**

What is the length, in feet, of the new ramp?

***Show your work.***

5. Ms. Lahti has an aquarium in her classroom. She has three types of fish: angelfish, goldfish, and guppies. These fish are distributed in the aquarium in a ratio of **4 : 6 : 10**, respectively. Determine the percent of each type of fish in the aquarium. [Hint: 4/20 is the ratio of angelfish to the total number of fish in the aquarium.]

***Set up three proportion problems and solve them to determine the three per cents requested. Show your work.***

***Proportion 1:* _________________________________________________________**

***Angelfish*** %____________________________

***Proportion 2:* _________________________________________________________**

***Goldfish*** %____________________________

***Proportion 3:* _________________________________________________________**

***Guppies*** %____________________________

# Investigating Populations
# Lab Report Guidelines

**Your lab report must include each of the following:**

1. **Coversheet—Activity title, your names, the date, and optional graphics.**
2. **Statement of the research question—How can the size of a population be estimated?**
3. **Statement of the hypothesis—If a system of marking and recapturing is used, then the size of a population of turtles in a pond can be estimated.**
4. **Introduction—A few paragraphs that give background information about turtles and the mark-and-recapture method of population sampling.**
5. **List of materials used.**
6. **Description of the procedures employed to answer the research question and to evaluate the hypothesis.**
7. **Results—Include the data collected in a table using the format below:**

| Trial number | # recaptured | # recaptured having a tag (marked) |
|---|---|---|
| 1 | ________ | ________ |
| 2 | ________ | ________ |
| 3 | ________ | ________ |
| 4 | ________ | ________ |
| 5 | ________ | ________ |
| Totals | ________ | ________ |

**Show the proportion and its complete solution for estimating the total population size.**

8. **Statement of the conclusion—Restate the hypothesis and use the data as evidence that supports the conclusion.**

# Procedures for Lab Activity

Biologists often use the mark-and-recapture technique to estimate the size of a population. In this activity, you will receive a container that represents a pond. The container will be filled with identical items that represent the total population of turtles in a pond. You will simulate the mark-and-recapture technique to estimate the total number of "turtles" in the pond.

Procedure:

- You and your partner will receive a bag of goldfish, a bowl, and a magic marker.
- Empty the entire bag of goldfish into the bowl. The bowl containing the goldfish represent the total population of "turtles" in a pond.
- Capture and mark an X on 20 of the goldfish. This represents 20 marked "turtles."
- Return the 20 marked "turtles" to the pond.
- Stir the pond to distribute the "turtles" throughout the pond.
- Close your eyes and recapture 15 of the "turtles." Open your eyes and count the number of marked turtles among the 15 that were captured. Record these numbers in the table below. Then, return the 15 turtles to the pond.

| Trial number | # recaptured | # recaptured having a tag (marked) |
|---|---|---|
| **1** | **15** | |
| **2** | **15** | |
| **3** | **15** | |
| **4** | **15** | |
| **5** | **15** | |
| **Totals** | | |

- Stir the pond and repeat the previous step four more times until the table is complete. Compute the totals.
- Set up a proportion using **20** as the ***number marked*** and the totals from the table for the ***number recaptured in a subsequent sample*** and the ***number marked in a subsequent sample***. Substitute these values into the proportion below (or an equivalent proportion):

$$\frac{\text{Number marked}}{\text{Total population}} = \frac{\text{Number marked in subsequent sample}}{\text{Number recaptured in subsequent sample}}$$

- Solve the proportion to estimate the total population size of turtles in the pond.
- Count the number of “turtles” in the bowl to determine the accuracy of your estimated population.
- Repeat the experiment, by adding five more trials to your table.
- Recalculate the totals in the expanded table.
- Set up a new proportion using the new totals and calculate a new population estimate.
- Is the new population estimate more closely related to the actual population size?
- What does this tell us about the number of trials that should be taken in the mark-and-recapture technique?

# Grading Rubric for Lab Report

| Item | Points Possible | Points Earned |
| --- | --- | --- |
| **Coversheet** | 6 | |
| **Research Question/Hypothesis** | 8 | |
| **Introduction/Background information on turtles** | 15 | |
| **Introduction/Sampling Methods** | 10 | |
| **Materials** | 6 | |
| **Procedure** | 10 | |
| **Results/Data Table** | 15 | |
| **Discussion** | 15 | |
| **Conclusion** | 15 | |
| **Total Points** | **100** | |

Comments: