Tracking Genetically Modified Mosquitoes

hhmi | BioInteractive

Activity
Student Handout

INTRODUCTION

This activity accompanies the BioInteractive video *Genetically Modified Mosquitoes*. In this activity, you will provide questions and explore experiments to examine how releasing genetically modified (GM) mosquitoes impacts wild mosquitoes.

MATERIALS

- access to the video
- "Does Using GM Mosquitoes Work?" and "Data Tables" handouts
- calculator and/or spreadsheet software

PRE-ACTIVITY

1. Describe your knowledge of or experience with mosquitoes.

2. For what diseases, in humans or other organisms, do mosquitoes act as vectors (carriers)?

3. Watch the video *Genetically Modified Mosquitoes* and record any questions you have. Briefly discuss the video and your questions with a small group of other students.

PART 1: Research Questions

Imagine you and your family have recently moved to a small town on the islands known as Key West off the most southern tip of Florida. Life is good among the white sandy beaches.

Health officials in town are growing concerned, however. News reports from South America suggest that an unusually large number of infants are being born with abnormally small heads, a condition called microcephaly. Health officials have identified the mosquito species *Aedes aegypti* as a vector for the Zika virus that seems to be causing this outbreak. Mosquitoes of this same species have been found living in the Florida Keys. Alarmed city officials want to do everything they can to prevent Zika virus from spreading in Florida.

Some towns in Brazil have used genetically modified (GM) mosquitoes to reduce the size of local mosquito populations, as shown in the video Genetically Modified Mosquitoes. Now officials in Florida are considering releasing GM *Ae. aegypti* mosquitoes in your town. But first they want to know if the method works. Let's look at the evidence.

4. Work with your group to develop one or two research questions that would help determine whether releasing GM mosquitoes into the environment is an effective method for reducing wild mosquito populations in your area. For each research question you develop, fill out a table like the following.

Research question:
Data needed to answer the question:
Brief experimental design for collecting the data:
Predictions for your experiment: (what would the data show if GM mosquitoes are effective in reducing wild mosquito populations?)

5. Read through the handout "Does Using GM Mosquitoes Work?" Compare and contrast the question, experimental design, and the data described in the reading to your research ideas.

PART 2: Data Analysis

6. Scientists at the company Oxitec completed an experiment in Brazil similar to the one described in the "Does Using GM Mosquitoes Work?" reading. Some of their data are provided in the "Data Tables" handout. In this same handout, fill in the missing rows for the "Brazilian Data: *Untreated* Area" and "Brazilian Data: *Treated* Area" data tables. These rows should show the number of traps with eggs (*L*), the total number of traps (*T*), the total number of eggs in all traps (*E*), the ovitrap index (OI), and average density (AD).
7. On a separate piece of paper, create a line graph by plotting the months on the *x*-axis and AD on the *y*-axis for both untreated and treated areas. Place both untreated and treated data on the same graph.
8. Using the information in the *E* and *T* rows of the data tables, calculate the average AD, for the *untreated* and *treated* areas, both *before* and *after* the mosquitoes were released (U_b, T_b, U_a, and T_a). Then use these values to compute the relative change in mosquito density in the untreated versus treated areas.

   For example, the average AD for the *treated* areas *before* mosquitos were released is:
   T_b = (6 + 30 + 42 + 59) eggs/(10 + 9 + 10 + 8) traps = 3.70

   Use similar calculations, and the formula for relative change shown below, to complete the following table.

T_b	U_b	T_a	U_a	relative change = $\frac{\left(\frac{T_a}{U_a}\right)}{\left(\frac{T_b}{U_b}\right)} - 1$
3.70				

9. Use the data and evidence you gathered to make a claim about whether the GM mosquito program is effective in Brazil. Make sure to cite specific evidence to support your claim.

10. Although there may be a difference in the average density of mosquitoes between the untreated and treated areas, there may be alternative explanations for the difference other than the GM mosquito program. To further investigate the impact of the GM mosquito program, you will now calculate the fraction of female mosquitoes mating with GM males in the wild.
    a. Compute the mating fraction (*M*) for the missing months in the "Mating Fraction Data: Treated Area" table of the "Data Tables" handout.
    b. On a separate piece of paper, create a bar graph by plotting the month on the *x*-axis and the mating fraction on the *y*-axis for the treated area.
    c. Explain how the mating fraction evidence affects the claim you made in Step 9.

11. Write a short letter to city officials summarizing evidence (based on the Oxitec data) about whether releasing GM mosquitoes may work in your area. Be sure to emphasize the ultimate goal of the research and the GM mosquito technique. Also describe any further questions or concerns you have about the release.

PART 3: Additional Questions

12. Both the ovitrap index (OI) and the average density (AD) are measures of the population dynamics of *Ae. aegypti.* What ideas do you have for why the researchers use two different measures?

13. Why was it valuable for researchers to include an untreated area?

14. What additional data do you think the scientists might have or could have collected at each study site on factors that could influence the population dynamics of the mosquitoes?