

Project goals

- Practice modeling a real-world phenomenon that is not a routine homework exercise
- Become more comfortable with open-ended problems
- Practice communicating and explaining mathematical results clearly and professionally
- Practice working in a team on a mathematical problem

Project synopsis

The spruce budworm is one of the most destructive pests of conifers in North America. The natural life cycle of certain coniferous forests includes periodic outbreaks of such budworms, which can be devastating to the entire forest. Budworm populations and their interactions with host trees and predators have been extensively studied by biologists, ecologists, and applied mathematicians. In small numbers, the budworms are not a problem for the forest. In moderate numbers, they become an important source of prey for various bird species, and in these numbers can also have no lasting effect on the forest.



In larger numbers, the budworms are too numerous for predation by birds to effectively control, and their population can grow explosively. Your team is part of an effort coordinated by United States and Canadian forest management agencies to determine whether this is likely to happen and, if appropriate, to recommend countermeasures and estimate their cost. Other important information is available to your group via the *Conservation Algorithm Network of Vast Aquatic Significance*, known more commonly as C.A.N.V.A.S.

Useful facts and assumptions

- Forest service personnel have collected data on the budworm population during the first few weeks of the season.
- Faced with limited scientific information, your team has to construct a model for how the budworm population over the course of a single season (May 1 to October 31). Based on past studies, your group has decided to try to fit the data from the forest service on the rate of budworm growth to one of two models, using vector projection. Your choice of which model is best will be based on a comparison of residual vectors.
- If at any time during the season the budworm population exceeds the critical threshold, the forest will largely be destroyed. However, if pesticides can be applied before the population growth rate ever reaches 80% of its maximum, the budworms can be killed en masse and the forest will be saved.
- The pesticide is very effective, but it is expensive to apply. Human workers must spray the trees by hand. It cannot be dropped cheaply from the air. It is possible that the cost will be too great for the agencies to support a pesticide intervention, which your team should anticipate if appropriate.

Your team must now pull together all of its ideas to model the budworm population and determine whether a pesticide intervention will be required to save the forest, and if so, whether it will be cost-effective. Once you finish your calculations, your team should write a professional report restating the problem and summarizing your work and your findings. The crappie mission is critical and there's no room for mistakes. A rough report just won't do. Thus, your report must contain at least one meaningful, carefully labeled graph that adds something to the argument your team is making. You should report all answers with three significant digits.

Report guidelines

Preliminary check-in: Thursday/Friday, November 16–17, with your instructor at a scheduled time.

Final report due: Wednesday, November 29, at the beginning of class, in Canvas.

Group evaluations due: Wednesday, November 29, by 11:59pm, in Canvas.

Final interview: Thursday/Friday, November 30–December 1, with your instructor at a scheduled time.

Late papers/group evaluations: will not be accepted.

Preliminary check-in and final interview meetings

Your group turns in one report and everyone in the group gets the same grade for the Written Report section for this project. The Written Report accounts for 35% of your Project 1 grade. The rest of your score (65%) is earned during the Preliminary Check-in and Final Interview meetings with your instructor. In these meetings, you will answer a question regarding the development of the report's results to demonstrate your participation in the project. You are expected to participate in the project, understanding both the solution to the problem and the process by which it was obtained.

Written report

Use Microsoft Word or another suitable word processor. **Type all equations**, using (for example) the Microsoft Equation Editor built into Word and standard mathematical notation. Use RStudio to make all graphs. Graphs must include proper axis labels. Group members' names and class section (01, 02, or 03) must be clearly visible on the front page of your report. Margins will not exceed 1 inch and lines are to be no more than 1.5-spaced.

Reports will be self-contained, i.e., the reader will not need prior knowledge or understanding of the problem to understand your report. Your calculations and conclusions will be explained in detail, as befits a professional report. This report will be used by people of varying mathematical background, so do your best to keep your report at a level accessible to the widest possible audience (in other words, try to write for the general public whenever possible). Your explanation and presentation are as important as the mathematics, but of course your mathematical analysis must be clear, complete, and correct. It should go without saying that your grammar, punctuation, and spelling will be flawless.

Group evaluation

Every group member is required to submit to their instructor an informal group evaluation *the same day the reports are due*. The evaluation is at most a short paragraph about how well the group worked together. The evaluation *must* include your estimate of the share of the project work that you feel each group member did, expressed as a percentage (e.g. 33%/33%/33% or 40%/30%/30%, etc.). These percentages must add to 100%—or 99% is close enough. These evaluations will be held in confidence, and used at the end of the semester, if necessary, to adjust final grades.

A word to the wise

This project counts for 10% of your final grade. Please make sure that your report's qualities of clarity, completeness, and correctness reflect your best abilities. Please carefully read all the instructions and resources provided.