
Topics in Applied Mathematics: *Mathematical Modeling*

Math 396 Spring 2021

© 2021 Ron Buckmire

<https://zoom.us/j/83746366935> T 10:15am - 11:40am

<http://sites.oxy.edu/ron/math/396/21/>

Class 1: Tuesday January 19

TITLE Introduction to Mathematical Modeling

CURRENT READING Meerschaert, Sections 1.1, p. 3-9; Witelski, preface, p. vi-xii

SUMMARY

An introduction to Mathematical modeling.

DEFINITION: mathematical model

A mathematical model “is a mathematical construct designed to study a particular real-world system or phenomenon” (Giordano, Weir & Fox, page 54.)

A mathematical model is “a useful, practical description of a real-world problem, capable of providing systematic mathematical predictions of selected properties.” (Witelski & Bowen, page viii)

DEFINITION: mathematical modeling

Mathematical modeling is “a systematic mathematical approach to formulation, simplification and understanding of behaviours and trends in problems.” (Witelski & Bowen, page viii)

DEFINITION: The Five Step Method

1. Ask the question
2. Select the modeling approach
3. Formulate the model
4. Solve the model
5. Answer the question

Consider the *Mathematical Contest in Modeling*

Available here: *Mathematical Contest in Modeling*

The 2020 Problem A: <http://www.mathmodels.org/Problems/2020/MCM-A/index.html>

Problem

Global ocean temperatures affect the quality of habitats for certain ocean-dwelling species. When temperature changes are too great for their continued thriving, these species move to seek other habitats better suited to their present and future living and reproductive success. One example of this is seen in the lobster population of Maine, USA that is slowly migrating north to Canada where the lower ocean temperatures provide a more suitable habitat. This geographic population shift can significantly disrupt the livelihood of companies who depend on the stability of ocean-dwelling species.

Your team has been hired as consultants by a Scottish North Atlantic fishery management consortium. The consortium wants to gain a better understanding of issues related to the potential migration of Scottish herring and mackerel from their current habitats near Scotland if and when global ocean temperatures increase. These two fish species represent a significant economic contribution to the Scottish fishing industry. Changes in population locations of herring and mackerel could make it economically impractical for smaller Scotland-based fishing companies, who use fishing vessels without on-board refrigeration, to harvest and deliver fresh fish to markets in Scotland fishing ports.

Requirements

1. Build a mathematical model to identify the most likely locations for these two fish species over the next 50 years, assuming that water temperatures are going to change enough to cause the populations to move.
2. Based upon how rapidly the ocean water temperature change occurs, use your model to predict best case, worst case, and most likely elapsed time(s) until these populations will be too far away for small fishing companies to harvest if the small fishing companies continue to operate out of their current locations.
3. In light of your predictive analysis, should these small fishing companies make changes to their operations?
 - If yes, use your model to identify and assess practical and economically attractive strategies for small fishing companies. Your strategies should consider, but not be limited to, realistic options that include:
 - Relocating some or all of a fishing company's assets from a current location in a Scottish port to closer to where both fish populations are moving;
 - Using some proportion of small fishing vessels capable of operating without land-based support for a period of time while still ensuring the freshness and high quality of the catch.
 - Other options that your team may identify and model.
 - If your team rejects the need for any changes, justify reasons for your rejection based on your modeling results as they relate to the assumptions your team has made.
4. Use your model to address how your proposal is affected if some proportion of the fishery moves into the territorial waters (sea) of another country.