

**An MCM Paper Made by Team 2417377 Based on
Summary**

As the.../Considering...(background)

For problem 1, we

For problem 2, we

For problem 3, we

Eventually,

Keywords: MATLAB, mathematics, \LaTeX .

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1 Introduction

1.1 Problem Background

A population that is necessarily dependent on reproduction for its development and continuation. Based on sexual reproduction, the birth rate (growth rate) of a population is greatly influenced by the sex ratio. Therefore, although many species exhibit a 1:1 sex ratio at birth, species tend to deviate from an even sex ratio in order to adapt to their environment and continue their populations. This is known as adaptive sex ratio variation.[1] The lamprey is one such typical species.

However, the role of the lamprey is complex. the seven-gill eel is complex. For some lake habitats, it is a parasite that is harmful to the ecosystem, and we want to reduce its reproduction; but at the same time, the seven-gill eel is a source of food in some parts of the world, and we want to promote its reproduction.[2] Therefore, we address these questions by studying the pros and cons of the ability to alter their sex ratio based on resource availability, modeling their relationship with growth rates, and studying their impact on other species in the ecosystem



Figure 1: a fish with lamprey

1.2 Restatement of the Problems

- Develop and examine a model to provide insights into the impact on the larger ecological system when the population of lampreys can alter its sex ratio
- Evaluate the advantages and disadvantages of the ability to change sex ratios for the population itself and for the external ecosystem under the same resource availability conditions, taking into account the modeling of question 1
-
-

1.3 Overview of Our work

We do such things ...

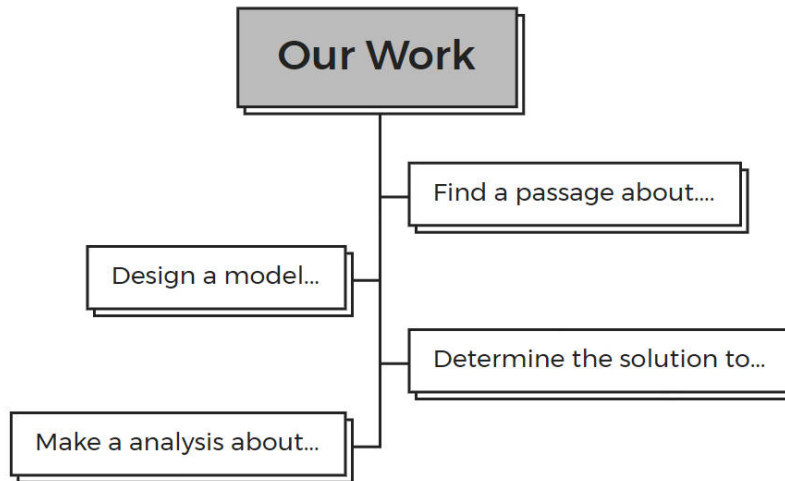


Figure 2: our work

- We do...
- We do...

2 Assumptions and Justification

To simplify the problem, we make the following basic assumptions, each of which is properly justified.

- **Assumption 1:**
 \hookrightarrow Justification:...[1]
- **Assumption 2:**
 \hookrightarrow Justification:...[2]
- **Assumption 3:**
 \hookrightarrow Justification:...[4]

3 Notations

The primary notations used in this paper are listed in Table ??.

Table 1: Notations

Symbol	Definition
W	the number of females
M	the number of males
RA	resource availability
α	the Proportion of male minnows
r	the birth rate relative to resources
β	the mortality rate relative to number
TNF	total number of fish

4 The Models and The solution

4.1 Model 1 and Solution

4.1.1 Details about Model 1

The detail can be described by equation (4-1):

$$\frac{\partial u}{\partial t} - a^2 \left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right) = f(x, y, z, t) \quad (4-1)$$

Table 2: The data of sea lamprey

Year	% Males	n	Males	Females
2007	53%	3,124	1,666	1,460
2008	57%	2,228	1,264	964
2009	54%	2,725	1,485	1,240
2010	58%	8,841	5,146	3,695
2011	60%	10,912	6,555	4,357
2012	60%	14,047	8,442	5,605
2013	61%	8,947	5,495	3,452
2014	59%	8,696	5,131	3,565

1. Sex ratio of sea lamprey in tributaries to Lakes Michigan and Huron[4]
2. the sum number of the Males is 59,522, for females the number is 59,522

4.2 Model 2 and Solution

4.2.1 Details about Model 2

4.2.2 Conclusion of Model 2

The results are shown in Figure 3, where t denotes the time in seconds, and c refers to the concentration of water in the boiler.

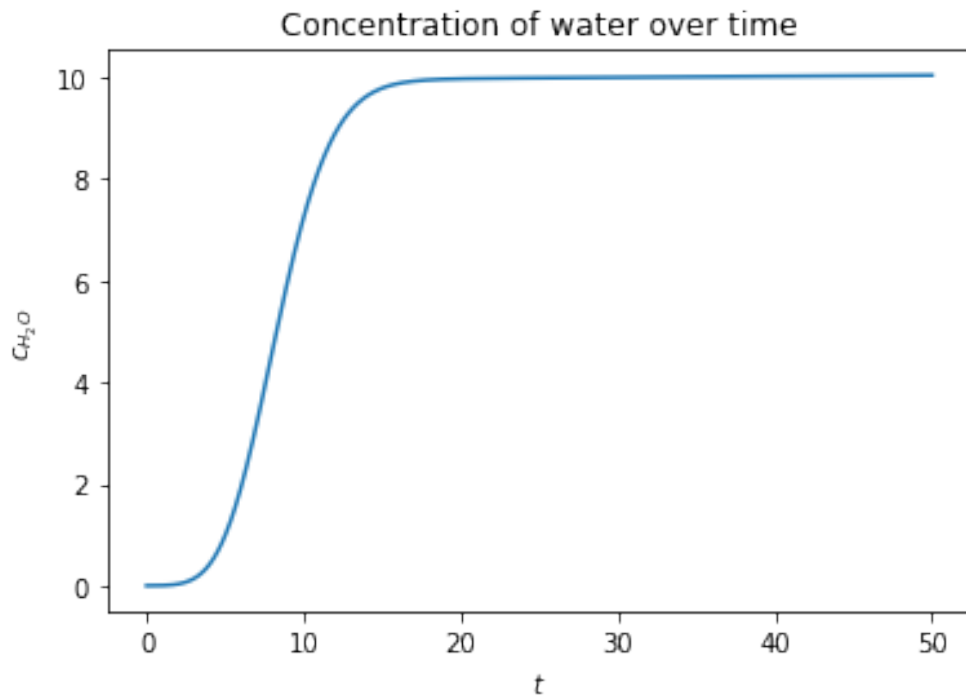


Figure 3: The result of Model 2

4.2.3 Commentary on Model 2

The instance of long and wide tables are shown in Table 3.

Table 3: Basic Information about Three Main Continents (scratched from Wikipedia)

Continent	Description	Information
Africa	Africa Continent is surrounded by the Mediterranean Sea to the north, the Isthmus of Suez and the Red Sea to the northeast, the Indian Ocean to the southeast and the Atlantic Ocean to the west.	At about 30.3 million km^2 including adjacent islands, it covers 6% of Earth's total surface area and 20% of its land area. With 1.3 billion people as of 2018, it accounts for about 16% of the world's human population.

Asia	Asia is Earth's largest and most populous continent which located primarily in the Eastern and Northern Hemispheres. It shares the continental landmass of Eurasia with the continent of Europe and the continental landmass of Afro-Eurasia with both Europe and Africa.	Asia covers an area of 44,579,000 square kilometres, about 30% of Earth's total land area and 8.7% of the Earth's total surface area. Its 4.5 billion people (as of June 2019) constitute roughly 60% of the world's population.
Europe	Europe is a continent located entirely in the Northern Hemisphere and mostly in the Eastern Hemisphere. It comprises the westernmost part of Eurasia and is bordered by the Arctic Ocean to the north, the Atlantic Ocean to the west, the Mediterranean Sea to the south, and Asia to the east.	Europe covers about 10,180,000 km ² , or 2% of the Earth's surface (6.8% of land area), making it the second smallest continent. Europe had a total population of about 741 million (about 11% of the world population) as of 2018.

Figure 4 gives an example of subfigures. Figure 4a is on the left, and Figure 4b is on the right.

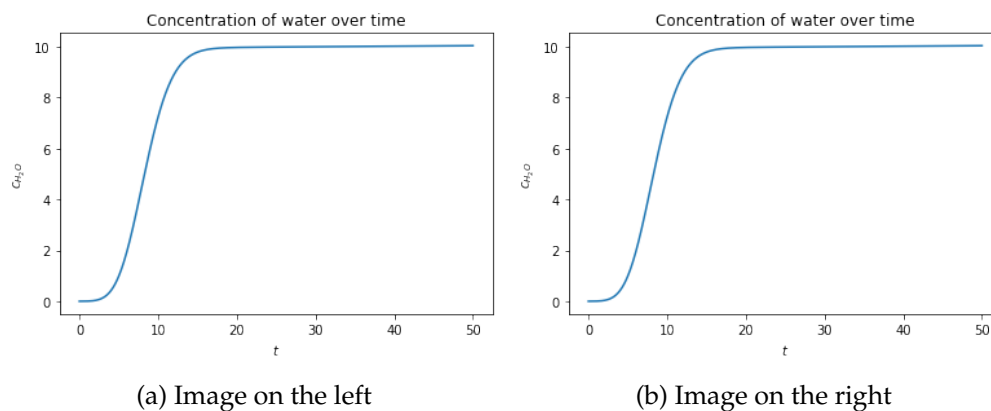


Figure 4: Two images

5 Test the Model

5.1 Sensitivity Analysis

5.2 Error Analysis

6 Model Evaluation and Further Discussion

6.1 Strengths

- First one...
- Second one ...

6.2 Weaknesses

- Only one ...

6.3 Further Discussion

6.3.1 Model Improvement

6.3.2 Model Extension

Memorandum

To: Heishan Yan

From: Team 1234567

Date: October 1st, 2019

Subject: A better choice than MS Word: L^AT_EX

In the memo, we want to introduce you an alternate typesetting program to the prevailing MS Word: L^AT_EX. In fact, the history of L^AT_EX is even longer than that of MS Word. In 1970s, the famous computer scientist Donald Knuth first came out with a typesetting program, which named T_EX...

Firstly, ...

Secondly, ...

Lastly, ...

According to all those mentioned above, it is really worth to have a try on L^AT_EX!

References

- [1] Karlin S, Lessard S. Theoretical studies on *sex ratio evolution*[J]. 1986.
- [2] Almeida P R, Arakawa H, Aronsuu K, et al. *Lamprey fisheries: History, trends and management*[J]. Journal of Great Lakes Research, 2021, 47: S159-S185.
- [3] *The National Center for Biotechnology Information: sea lamprey*, from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5378093/>
- [4]

Appendix: Program Codes

Here are the program codes we used in our research.

test.py

```
# Python code example
for i in range(10):
    print('Hello, world!')
```

test.m

```
% MATLAB code example
for i = 1:10
    disp("hello, world!");
end
```

test.cpp

```
// C++ code example
#include <iostream>
using namespace std;

int main() {
    for (int i = 0; i < 10; i++)
        cout << "hello, world" << endl;
    return 0;
}
```