

# **TECHNICAL REPORT**

## **STAGED-STRUCTURED LEFKOVITCH MATRIX POPULATION MODELING OF TURTLE**

**MUHAMMAD RASHIEDY BIN MAHADZIR - 2019883282**

**NOORZAHIRAH BINTI ROZALI - 2019422808**

**NURUL RAMLAH BINTI MUZANI - 2019207038**

**(P46M22)**

**Report submitted in partial fulfillment of the requirement  
For the degree of  
Bachelor of Science (Hons.) (Mathematics)  
Faculty of Computer and Mathematical Sciences.**

**JULY 2022**

## **ACKNOWLEDGEMENTS**

IN THE NAME OF ALLAH, THE MOST GRACIOUS, THE MOST MERCIFUL

We are grateful to Allah S.W.T for giving us the strength to complete this project successfully. This project would not be possible without the help of our team member, supervisor, lecturer, friends and in essence, all sentient beings.

First and foremost, we wish to acknowledge the help provided by Mr Najir Tokachil, our supervisor who always gives encouragement, guidance and valuable feedback from initial to the final stage in order for us to develop a better understanding about this final year project and complete it successfully. His support came from different ways and one of that was by sharing his knowledge on this project. His invaluable suggestions and perspective have helped us to improve and complete this project.

On the other hand, we would like to express our gratitude to our lecturer, Dr Zati Aqmar binti Zaharudin, for always teaching and guiding us to learn more about the things we need to know in order to complete this project.

Next, we are also thankful to our classmates and friends who were always willing to assist with their ideas and suggestions, which resulted in the completion of this project. Finally, we would like to say thank you to our family members and friends for their moral support during the preparation of the report. We were able to complete this report on time because of all these factors. This report will not be completed without any support and commitments.

Thank you.

# TABLE OF CONTENTS

<b>ACKNOWLEDGEMENTS</b>	2
<b>TABLE OF CONTENTS</b>	3
<b>LIST OF TABLES</b>	5
<b>LIST OF FIGURES</b>	7
<b>ABSTRACT</b>	8
<b>CHAPTER 1</b>	9
<b>INTRODUCTION</b>	9
<b>1.1 Motivation</b>	9
1.2 Problem statement	12
1.3 Objectives	12
1.4 Significance of and Benefit of study	13
1.4.1 Significance of study	13
1.4.2 Benefit of study	13
1.5 Scope and Limitations of Study	13
1.6 Definition of terms	14
<b>CHAPTER 2</b>	15
<b>BACKGROUND THEORY AND LITERATURE REVIEW</b>	15
2.1 Background Theory	15
2.1.1 Mathematical Model of Animal Populations	15
2.2 Literature Review	16
2.2.1 Endangered Animal Population	16
2.2.2 Factors Lead to Animal Population Extinction	17
2.2.3 Leslie and Lefkovitch Matrix of Animal Population	18
<b>CHAPTER 3</b>	
<b>METHODOLOGY AND IMPLEMENTATION</b>	20
3.1 Methodology	20
3.2 Implementations	33
3.2.1 The Probability of Turtles Surviving and Remaining in the Same Stage ( $P_i$ )	34

3.2.2 The Proportion of Turtles that Survives and Grows into the next Stage (Gi)	39
3.2.3 The Calculation by Microsoft Excel	42
<b>CHAPTER 4</b>	48
<b>RESULTS AND DISCUSSION</b>	48
4.1 Results of Green Turtle population	48
4.2 Results of Hawksbill Turtle population	54
<b>CHAPTER 5</b>	62
<b>CONCLUSIONS AND RECOMMENDATIONS</b>	62
<b>REFERENCES</b>	64

## **ABSTRACT**

This research is mainly focused on two types of turtles discovered in the islands of Sabah, Malaysia: Green Turtles and Hawksbill Turtles. Selingan Island (PSL), Bakkungan Island (PBK), and Gulasaan Island (PGL) had been chosen as the three islands. At this time, these two species of turtles were threatened with extinction. In light of this circumstance, research was conducted to simulate the turtle population on these three islands. The stage-structure of the Green Turtle and Hawksbill Turtle was interpreted using the Lefkovitch matrix model and the Leslie matrix model, which include potential rates associated with the turtle's life cycle. Consequently, the future population size of turtles can be determined using the Lefkovitch matrix model and the Leslie matrix model. The highest future population for both of the turtles are in 2025 since the turtles have the highest number of forecasting eggs in the future. It can be related to determining how to maintain the turtle habitat in order to prevent the extinction of other turtles in the future, based on the future population results of turtles. The turtle habitat is threatened but still can be threatened in the future. The two matrix models are also used to predict the fecundity, growth rates, and survival rates of turtles and to identify the most vulnerable life stage that will require future protection. Based on the result, the prediction of the fecundity, growth rates, and survival rates for both of the turtles has been determined and the highest value is in 2025. The most vulnerable life stage of the turtles is in the class of eggs since the value of the annual survivorship is at the lowest. This study's findings were discussed in order to compare the life stages of both types of turtles and the turtle populations on the three islands. Thus, all the objectives in this research have been achieved by calculating the number of population turtles in the future using the Lefkovitch and Leslie matrix model.