GROUP MEMBERS: Bindu van Raak (611629)

Justin Mulder (563558)

Assem Abdellaoui (566456)

Justice Pandt (580014)

Joud Beniamin (617059)

Group 2 Project Report

Version 1.1

December 21, 2018

Table of Contents

[1. Introduction 2](#_Toc531023464)

[2. Context 3](#_Toc531023465)

[2.1 Situation in the Organisation 3](#_Toc531023466)

[2.2 Problem Statement 3](#_Toc531023467)

[3. Goals of the project 4](#_Toc531023468)

[3.1 Objectives 4](#_Toc531023469)

[3.2 Main Research Question and Sub questions 4](#_Toc531023470)

[Main Research Question 4](#_Toc531023471)

[Sub Questions 4](#_Toc531023472)

[4. Methodology 5](#_Toc531023473)

[4.1 Research Strategy 5](#_Toc531023474)

[4.2 Research Design 5](#_Toc531023475)

[5. Results and analysis 6](#_Toc531023476)

[6. Conclusion 7](#_Toc531023477)

[7. Discussion 8](#_Toc531023478)

[References 9](#_Toc531023479)

[Appendix A 10](#_Toc531023480)

# 1. Introduction

The purpose of this document is to provide a definition of the project, including this project’s goals and objectives. Additionally, this plan will serve as a contract between the group members.

The Project Report defines the following:

* Context of the situation
* Project goals and objectives
* Methodology of the project
* Results and analysis
* Conclusion
* Discussion

Chapter 2 will describe the context of the situation. There the needs of the client will be specified, and the problem will be stated. In chapter 3 the goals of the project will be outlined, describing the main objectives of the project. Also, the main research question and sub questions will be defined. In chapter 4 the methodology of the project will be explained. Here the research strategy and design will be further described. In chapter 5 the results will be outlined and analysed. In chapter 6 the main conclusions will be drawn and each question given a definitive answer. In chapter 7 the strengths, weakness and possible alternate interpretations of the results will be discussed. Lastly, the references and appendices will be stated.

# 2. Context

The Oostvaardersplassen is a closed nature reserve in the Netherlands. The area is home to many kinds of animals, the most prominent of which being large mammals. These large herbivores are supposed to have occurred in the Netherlands in the past and have helped shape the landscape. The general idea behind this nature reserve is to have the animals live as naturally as possible; for example, carcasses of dead animals will remain, and the animals are not fed in case of food shortages. However, this policy has led to animals starving and people seeing dead or suffering animals from the side of the road or train and feeling sorry for them. On the other hand, the general public protest when animals are shot to reduce the population and the strain on natural resources. There is no easy solution to this as every choice has its consequences.

## 2.1 Situation in the Organisation

Staatsbosbeheer, the organization owning the Oostavaardersplassen nature reserve, has asked Inholland University of Applied Sciences to develop an application which can predict the possible population given certain circumstances and thus give the best ethically acceptable solution to the problem. By building multiple mathematical models of real-life situations in order to make predictions, the application will be able to offer multiple options and conditions to calculate different theoretical solutions.

## 2.2 Problem Statement

In the Oostvaardersplassen nature reserve, three kinds of large herbivores are present: wild horses, wild cattle, and deer. Other major species are geese and birds of prey. As one can surmise from this, there are no major predators present. The ecological system in this nature reserve has been unbalanced from the beginning, partly due to the absence of a top predator and also due to the closed nature of the preserve, meaning the herbivores cannot migrate to new lands in search of food. This has caused overpopulation of these animals and this has led to animals starving, and the general public being very unhappy about this.

# 3. Goals of the project

## 3.1 Objectives

The objective of this project is to create an application which implements the necessary mathematical models which calculate the effects of certain conditions on the current situation and thus showing the best possible solution to the described problem.

## 3.2 Main Research Question and Sub questions

### Main Research Question

What is the best ethically acceptable measure which can be taken to improve the ecological balance in the Oostvaardersplassen?

### Sub Questions

The sub questions are as follows:

1. *What are the needs of the client?*
2. *What mathematical models are already available?*
3. *What variables should be taken into consideration when creating mathematical models?*
4. *Which models are simple enough to use with the data acquired?*
5. *How can the results of the models be displayed in an application?*

# 4. Methodology

## 4.1 Research Strategy

To finish this project, and approach will be taken that is more directed on a literature study. Most things which are needed to complete this project will be found in primary or secondary literature. However, there will be some descriptive research and some experiments undergone to help answer some of the sub questions. The depth of the research will be exploratory since it is setting out to discover the right solution to the described problem.

## 4.2 Research Design

In this section, we will go over each sub question and how we will answer them.

1. *What are the needs of the client?*

To answer this question, first a literature study will be carried out which focuses highly on the lessons of software engineering. During these lessons, the group will learn how to find the needs of a client and this knowledge will then be used to answer this question by means of a descriptive study. This will be qualitative research, as there will not be any numbers derived from it.

1. *What mathematical models are already available?*

This question will be answered by means of a literature study will be carried out on the provided books and previous projects. This will provide the group with the knowledge that previous project groups and/or researchers have already acquired which will in turn provide an answer to this question. This research will be quantitative as the existing mathematical models will merely be defined.

1. *What variables should be taken into consideration when creating mathematical models?*

To answer this question, a literature study will be carried out on the previously collected data. Then the models will have to be studied to understand which variables are to be used.

1. *Which models are simple enough to use with the data acquired?*

To discover how the models can be simplified, a literature study will be carried out on the models already acquired, along with some experiments to define what or how the models can be simplified. This research will be qualitative.

1. *How can the results of the models be displayed in an application?*

To find out how the results can be displayed in an application a qualitative literature study will be carried out on the previous classes of Object Oriented Programming and the current classes of UML. This will define what is possible to do in the time of this project. Some exploratory research will also be carried out to find out the best and most effective way of displaying the results of the models in the application.

# 5. Results and analysis

In this chapter, the results of each data collection step in this project will be outlined. Once the results are stated they will be analysed and intermediate conclusions will be drawn.

The sub questions are as follows:

1. *What are the needs of the client?*

To answer this question, first a literature study was carried out on the current context outlined in Chapter 2: Context. In these chapters it was found that the client’s requirements were stated quite clearly. The client needs an application that can predict the possible populations of certain species in the nature preserve at a certain time given certain circumstances. The application should thus provide the best ethically acceptable solution to the problem. The application should be able to offer multiple options and conditions to calculate different theoretical solutions to the problem at hand.

From there, a list was made with all of the possible features that the application could have. However this list was quite extensive, and implementing all of the features in the application could not be done within the given time frame. Therefore, a small structured interview was carried out with the client where they were asked to prioritise each feature using the MoSCoW method. That method working as follows: Divide the features between Must-haves (20%), Should-haves (20%), Could-have (30%) and Would-like-to-haves (30%).

The feature list, with the client’s added priorities, is as follows:

1. *Predict future numbers of animals.* C
2. *Store and load the results of a prediction to and from a file.* W
3. *Switch between different mathematical models.* S
4. *Toggle natural factors that may affect the outcome.* C
5. *Alter initial data, capacity and starting amount of each animal.* S
6. *Project the predictions in a graph.* M
7. *Change type of graphs for projecting the results.* C
8. *Display results of different animals.* M
9. *Customise graph colours.* W
10. *Store time/date of the calculations made.* W
11. *What mathematical models are already available?*

After conducting research basically using relevant online scholarly articles and the recommended books, we have found lots of possible mathematical models that can be applied in the given context..

Such as the exponential and the logistic population growth. From which many formulas were deducted and that made it little vague and complicated to decide which ones to use. Referring to the situation and trying to understand it first, and starting from simple understandable models leaving out some variations and starting with assumptions was an urgent strategy to avoid being overwhelmed with a lot of formulas and equations.

1. *What variables should be taken into consideration when creating mathematical models?*

The **exponential** growth isn’t realistic since the resources are limited, which influences the birth and death rates, that’s why the **logistic** formula was used rather.

The interactions between the deer and the other species is only 30% and could be left out.

The effect of predators was also left out.

1. *Which models are simple enough to use with the data acquired?*

**Simple logistic growth equation with limited resources (food supply):**

We can apply this model to deer (Have relatively less interaction with other species)

The following assumptions were taken in consideration:

* Age, genetic and size factors were ignored.
* Fences are closed : no migration.

**Model with migration effect (Simple metapopulation growth rate)**

Where:

**Pi** is the probability of local colonisation

**f** is the fraction of patches in occupied territory

Some model variations were dropped and the following assumptions were taken in consideration:

* Pe and Pi are constant rates.
* No rescue effect or time lags.
* Homogeneity of patches.

1. *How can the results of the models be displayed in an application?*

# 6. Conclusion

This chapter will draw the final conclusions to each of the sub questions and give an answer to the main research questions.

1. *What are the needs of the client?*

While following the methodology for this sub question, the literature study and interviews were very successful in finding and defining the needs of the client. Looking at the results, it can be stated that the needs of the client and the answer to this sub question is as follows:

The needs of the client are an application which has the following features scaling from most important to least important:

1. *Project the predictions in a graph.*
2. *Display results of different animals.*
3. *Switch between different mathematical models.*
4. *Alter initial data, capacity and starting amount of each animal.*
5. *Predict future numbers of animals.*
6. *Toggle natural factors that may affect the outcome.*
7. *Change type of graphs for projecting the results.*
8. *Store and load the results of a prediction to and from a file.*
9. *Store time/date of the calculations made.*
10. *Customise graph colours.*

1. *What mathematical models are already available?*

Starting from simple models and pre-conducted researches has helped simplifying the research and reducing the amount of data and equations needed to few simple formulas but useful and manageable though. However the results found still have to be examined and applied to the real context and some influencing factors lead us to leave out some of them, especially if they turn to be not realistic and can not explain the whole situation with it’s variations and correlation between the subsystems and the interactions and dependency within the system.

1. *How can the results of the models be displayed in an application?*

***What is the best ethically acceptable measure which can be taken to improve the ecological balance in the Oostvaardersplassen?***

# 7. Discussion

In this chapter the strengths and weaknesses of the results will be discussed and other explanations covered.

# References

# Appendix A