Research plan

Creat a species-inclusive habitat

AR3A010
Architectural Engineering

Research tutor : Nico Tillie
Design tutor : Mo Smit
5550459-Yuxin Yang

1.Introduction

Plants and animals are companions that live in the city with humans. The city is a special and varied habitat for plants and animals, with many conveniences but not without many constraints.(*Jurgen Breuste,2018*).
As the city has grown, its territory has expanded. Nature is gradually folded into the cracks of the city. The more man-made landscapes there are, the less wild flora and fauna there are. Some animals leave the city because they are encroaching on their territory, others because the neat, manicured and managed natural spaces of the city do not provide them with sufficient food sources. At the same time, there are many species such as bats, crows and specific species of squirrel that are able to make their homes in the interstices of buildings, or obtain a steady source of food from human waste bins.


Figure1:Birds nesting on buildings

Figure2:Squirrel looking for food in bin

Firstly, the urban environment is now also not very friendly to animal species adapted to urban system. For example, glass façades are one of the biggest causes of unnatural bird mortality in cities, or the occurrence of young birds falling from height due to human activity. In addition to working to improve the living conditions of existing urban flora and fauna, secondly,I hope that some architectural strategies can be used to improve the natural environment of the city and attract more wildlife back to the city that has already returned to the fields.

Figure3:Biotope map of delft campus (image by Floris Beijer)

From the perspective of animal ecology, buildings are rocks (external spaces) and caves (internal spaces). Due to the lack of natural structures (such as trees), technical alternative structures are used as resting places and nesting sites.(*Breuste, 2021*) As our landscapes become increasingly urbanized over the next 50 years, it is more important than ever to provide services for wildlife in our built environment.

2.Existing design strategies

In recent years, developers and designers of the city have proposed strategies for integrating biodiversity in urban planning. In Gemeente Amsterdam's 'Twenty ideas for Integrating biodiversity in urban planning and development', for example, there are references to nesting brick and bat boxes attached to buildings, as well as installations in parks and forests such as rainwater pond and insect hotel. What they have in common is the creation of a man-made space to provide habitat for urban creatures such as insects, hedgehogs, squirrels, bats and birds, as well as the consideration of plant species to provide food sources.

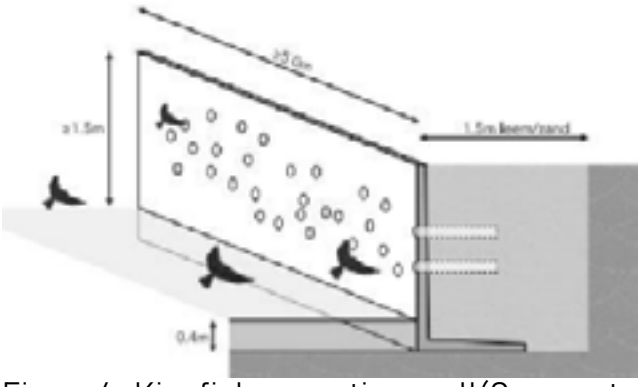


Figure4: Kingfisher nesting wall(Gemeente Amsterdam, 2019)

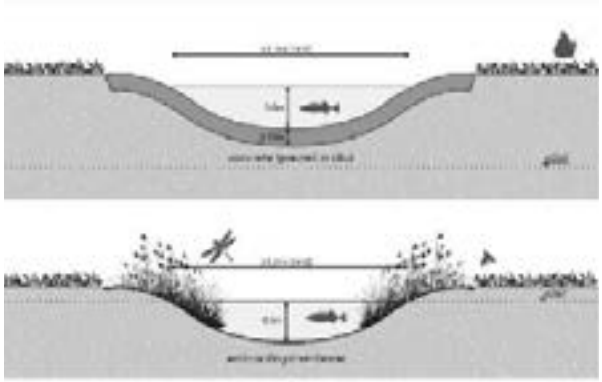


Figure5: Rainwater pond(Gemeente Amsterdam, 2019)

Hwang's installation featuring bat and bird habitat conditions above, and environments for terrestrial and amphibious species below. the project provides visitors ways to explore middle species sounds — particularly bat echolocation — by using ultrasonic detectors to regularly record bat calls and make the recordings accessible to visitors,both in person and online. (*Exhibit Columbus 2021*)

Figure6: Strata(Joyce Hwang, 2019)

A number of limitations can be seen in the extant design strategies. The first is that the nesting brick and bat box on the building are fixed and cannot cope with changes in the environment and cannot be subsequently changed in position to suit the animal's habits. The second is that nesting brick and bat box installations cannot be reused when buildings are demolished. The third is that when researchers consider urban animals inhabiting buildings, now is mainly focued on nest. The food,variation, connection, reproduction and safety of animals should also be considered. Therefore we can build the ecology system for animal in the building. The fourth is the neglect of the role of humans in the urban biological chain, for example by considering the reuse of grey water and organic waste in buildings.

3.Research question

In my research, I focused mainly on how to establish an ecological system at the building level, mainly by considering vertical greening, including green walls and green roofs, and therefore my research question was:

What does the modular vertical greening approach mean for urban ecology, from element to unit, building block and landscape?

Sub question:
1. What is local ecological system?
2. What is modular vertical greening?
3. What current plant filtration technology of the black water system are workable at vertical greening?
4. How to combine the needs of animal survival with modular vertical greening?

4.Theoretical Framework

Urban ecological system(with human influence): Ecology is the science of understanding the interactions of living things and their interrelationships with the abiotic environment. It was first introduced by Ernst Haeckel and was originally used to describe the laws of balance that create the natural world.*(Breuste, 2021)*
Urban ecosystems are ecosystems created by and strongly influenced by humans (*Sukopp und Wittig 1998, Endlicher2012*). Various authors have described the main effects of ecosystems and anthropogenic components under the influence of urban industries on natural biotic and abiotic geographic factors (*Leser 2008*). This shows a "man-made system" for strong material and energy input and exchange with the surrounding environment.

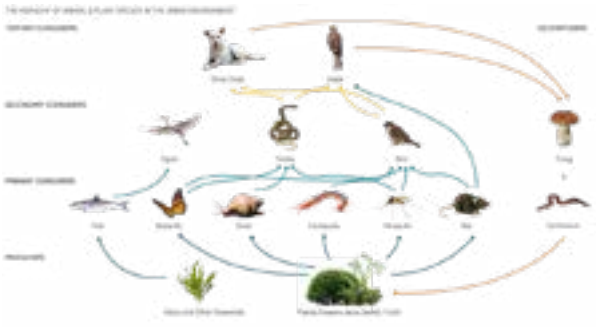


Figure7: Ecological system(https://arch4701fall2020.hku.hk/urban-ecology/)

Figure8: Ecological system((Zuñiga-Palacios et al., 2021))

Modular vertical greening: Modular, easily assembled and disassembled, above-grade vertical space greening with structural systems whose attachment bases include walls, roofs, slopes, etc.

Figure9: Modular green roofs(https://www.wallbarn.com/green-roofs/m-tray/)

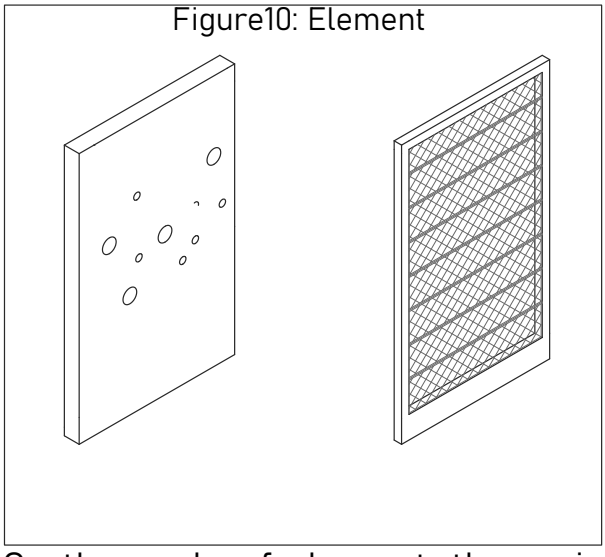
M-Tray® green roof system consists of specially-designed modular trays containing superior, engineered substrate and fully established flowering sedum. The system have specially-mixed substrate and100mm deep cavities and optimum drainage. (*https://www.wallbarn.com/green-roofs/m-tray/*)

Figure9: Modular living facade(James Parkes , 2022)

Buro Happold and Cookfox Architects have developed a prototype for a terracotta facade system that can house small wildlife, insects, birds and plants.
The modular system aims to provide wildlife including bees, birds and plants space to thrive on the facades of buildings in urban environments.(*James Parkes , 2022*)

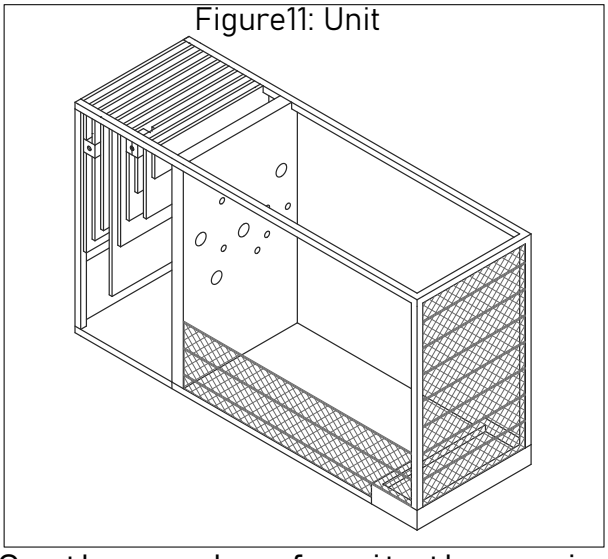
Scale of modular vertical greening system

Figure10: Element



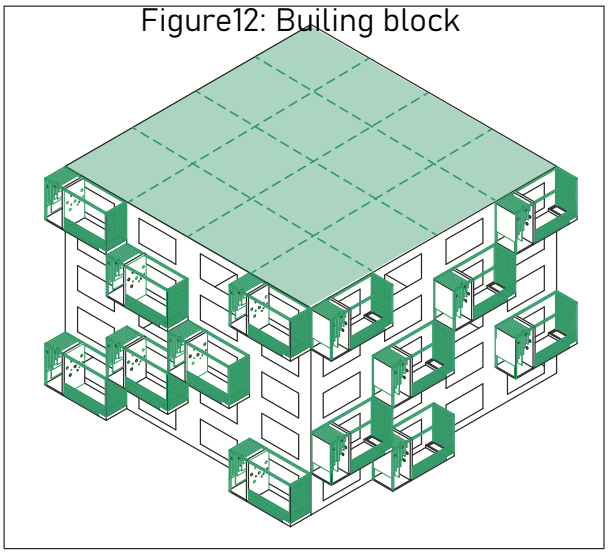
On the scale of element, the main consideration is vertical greening technique/structure,plants species/ soil and material

Figure11: Unit



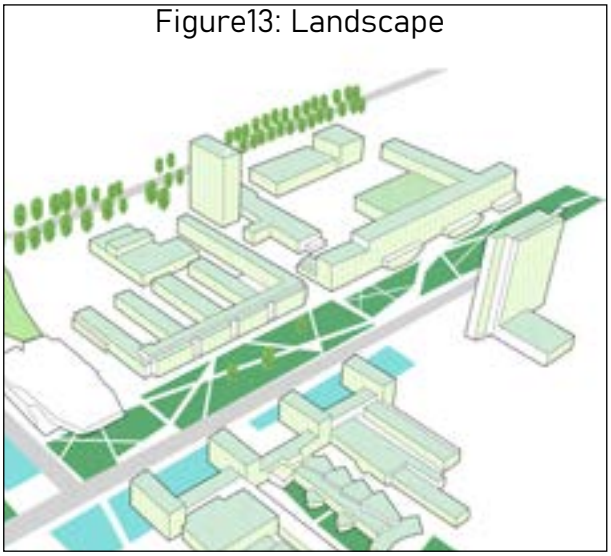
On the scale of unit, the main consideration is connection, proportion of plants to animals and black water recycling

Figure12: Builing block



On the scale of building block, the main consideration is the height/ orientation of animal nest and plants species.

Figure13: Landscape



On the scale of landscape, the main consideration is proportion of plants to animals to human

4.Method

1.Literature study and Data analysis

Read through books 'Design for biodiversity', 'Twenty ideas for Integrating biodiversity in urban planning and development' and 'First guide to nature inclusive design' to find information on: a. What are all the existing design strategies for integrating biodiversity, and what are the advantages and disadvantages

b. Which of these strategies are relevant to architecture

c. what wildlife is present in the delft campus

d. How do the different animals interact with each other

e. What are the survival needs of the animals and how do they correspond to the space

f. How different species interact with each other

g. How does urban life affect wildlife and what are the main differences with the wild environment

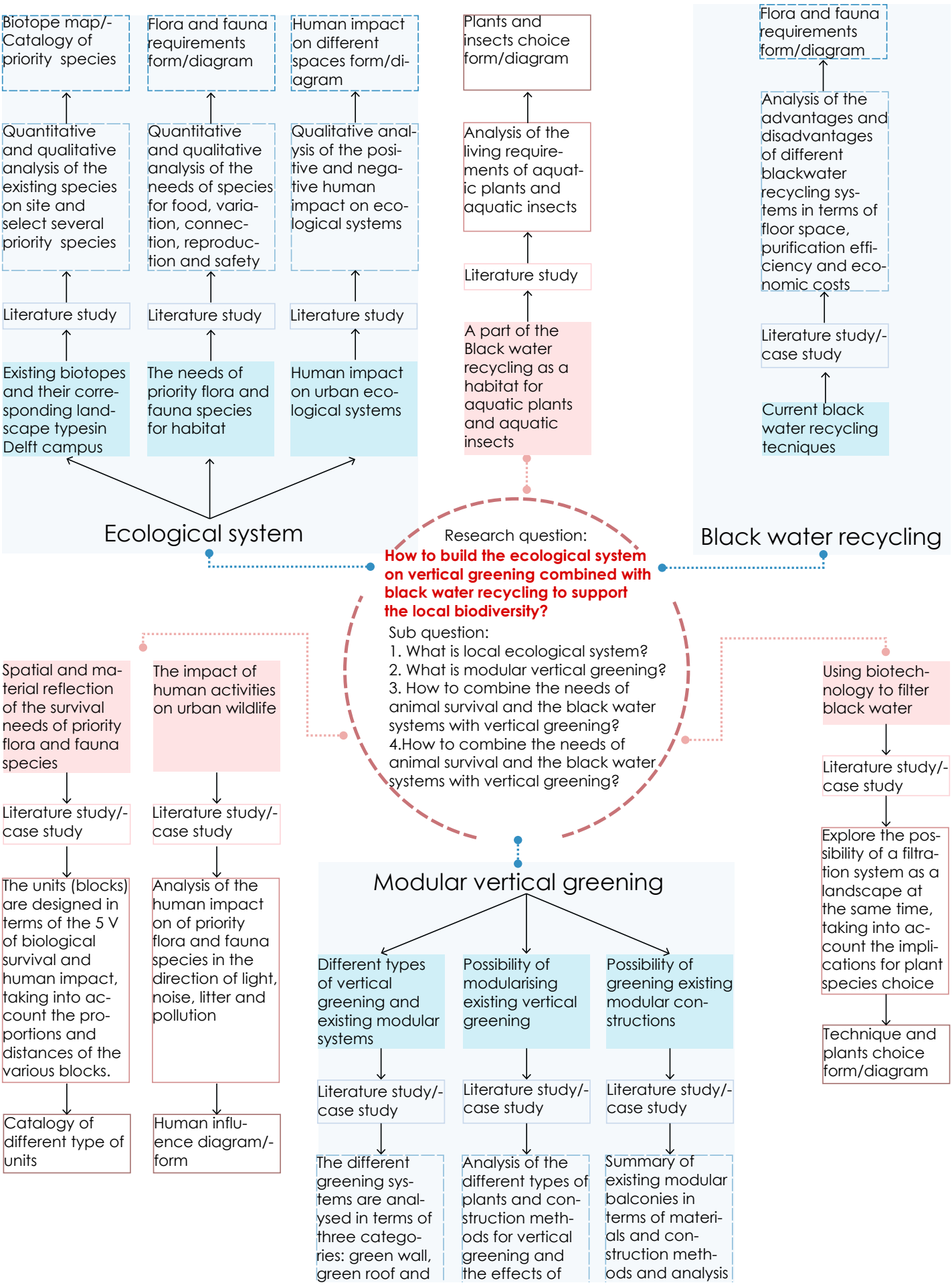
2.Case study

Study Joyce Hwang's research on animal habitats, such as animal habits and the possibility of different races living together (including the density of animals in the habitat)

Learn about the different types of vertical greening and explore the possibilities and innovations of modular vertical greening

3.Site visit

Compare the species of organisms in different cities in several of the available sites. Look for the possibility of a relationship between the ecosystem and the building's own water circulation system or waste system.


Biotope map/-Catalogy of priority species
Flora and fauna requirements form/diagram
Human impact on different spaces form/diagram
Quantitative and qualitative analysis of the existing species on site and select several priority species
Quantitative and qualitative analysis of the needs of species for food, variation, connection, reproduction and safety
Qualitative analysis of the positive and negative human impact on ecological systems
Literature study
Literature study
Literature study
Existing biotopes and their corresponding landscape typesin Delft campus
The needs of priority flora and fauna species for habitat
Human impact on urban ecological systems
Ecological system
Plants and insects choice form/diagram
Analysis of the living requirements of aquatic plants and aquatic insects
Literature study
A part of the Black water recycling as a habitat for aquatic plants and aquatic insects
Flora and fauna requirements form/diagram
Analysis of the advantages and disadvantages of different blackwater recycling systems in terms of floor space, purification efficiency and economic costs
Literature study/-case study
Current black water recycling tecniques
Black water recycling
Research question:
How to build the ecological system on vertical greening combined with black water recycling to support the local biodiversity?
Sub question:
1. What is local ecological system?
2. What is modular vertical greening?
3. How to combine the needs of animal survival and the black water systems with vertical greening?
4.How to combine the needs of animal survival and the black water systems with vertical greening?
Spatial and material reflection of the survival needs of priority flora and fauna species
The impact of human activities on urban wildlife
Literature study/-case study
Literature study/-case study
The units (blocks) are designed in terms of the 5 V of biological survival and human impact, taking into account the proportions and distances of the various blocks.
Analysis of the human impact on of priority flora and fauna species in the direction of light, noise, litter and pollution
Catalogy of different type of units
Human influence diagram/-form
Using biotechnology to filter black water
Literature study/-case study
Explore the possibility of a filtration system as a landscape at the same time, taking into account the implications for plant species choice
Technique and plants choice form/diagram
Modular vertical greening
Different types of vertical greening and existing modular systems
Possibility of modularising existing vertical greening
Possibility of greening existing modular constructions
Literature study/-case study
Literature study/-case study
Literature study/-case study
The different greening systems are analysed in terms of three categories: green wall, green roof and
Analysis of the different types of plants and construction methods for vertical greening and the effects of
Summary of existing modular balconies in terms of materials and construction methods and analysis

6.Preliminary design strategies and case study

Figure14: Modular vertical greening concept Diagram

The entire modular green balcony is divided into two parts, the space for human activities and the space for plant and animal activities without human intervention. There are direct interactions between humans and plants and animals (providing food and observation) and indirect interactions (fertilization and water filtration).

Figure15: Living Green Walls(Ebert, 2022)

Ehsan Baharlou and his team mixed seeds into earthen building materials that, once layered into walls, sprout lush plant life and evoke a Chia Pet aesthetic.It is to establish “an active ecological system that might store emitted carbon in 3D-printed soil structures through the process of photosynthesis.”

Figure15: Habitat Wall (Joyce Hwang, 2015)

Habitat Wall is a prototype wall structure that incorporates conditions for bat and bird inhabitation into its design, aiming to give a spatial and tactile presence to species-specific considerations. The prototype’s primary features include thin crevices of space. (Joyce Hwang, 2015)

5.Sources

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