Re-live the River

Regenerating decaying blue ecosystems through Architecture

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Reading Instructions

Terminology

Ecosystem

An ecosystem is a geographical location where biotic (living organisms) and abiotic factors (Temperature, humidity, landscape etc.) work with weather to form a bubble of live. Ecosystems could be small as a pond or large as a country. Several connected ecosystems are known as biomes, sometimes stretching over continents and oceans. All ecosystems on the surface of earth are interconnected, influencing each other. (National Geographic, 2020)

Ecosystem Service

Ecosystem services are the benefits gained from a productive ecosystem. Such services are free and provides a range of benefits for humans and other organisms of the ecosystem. Ecosystem services could be: agricultural production through pollination, natural water purification, air purification, extreme weather mitigation and recreation for human well-being. (Naturvårdsverket, 2015)

Riparian Zone

A riparian zonr is the green ribbon joining the river aquatic zone and upland zone. A healthy riparian zone is critical to the health of the river and surrounding ecosystems as it controls flow of water , nutrients, sediment and organisms. (USU, 2020)

Abstract

Relive the River is a Thesis that investigates the potential of regenerating a severely modified natural water flow through architecture.

The aim with the report is to develop appropriate architectural methods to create multi-specie coexistence by the urban riverbank. The project will elaborate on possibilities to regenerate decaying aquatic eco-systems through design and find out how these interventions can benefit the Gothenburg region.

The project will analyze the most suitable locations in the urban periphery to intervene by using landscape and architecture as tools to find configurations best suited for the purpose.

The central program of the development will include habitat, recreation and education, serving every specie enjoying the aquatic and riparian zone. As catalyzing ecosystems has many bounded benefits the project will further investigate the potential of simultaneously working as a water rehabilitation provider, serving Göta Älv River and its tethered bio-diversity with natural water purification.

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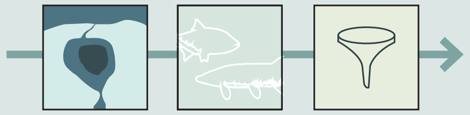
Introduction



Preface

Through over-exploitation of natural resources and unregulated miss-use of fossil fuels humans are facing an unprecedented environmental challenge. It is beyond any reasonable doubt that humans have unintentionally yet successfully disrupted the biophysical balance on the planet. As the human civilization is as much dependent on stabile planetary systems as any other living specie it is in everyone's best interest to prioritize protection, preservation and funding of the environmental sector in order to mitigate predicted changes induced by the IPCC as antropocene progresses. If the building sector neglects enforcing environmental measures it could mean that contemporary sustainable development efforts risks getting outdated sooner rather than later as ecosystems and environments are interconnected.

Developed cities around the world can only survive if they are able to provide its population with fresh water and sanitation - requiring functioning cities to be able to manage water pollution wisely. In OECD countries, cities are regarded as resilient against the hazardous risks water brings. Flooding, water pollution, droughts and storms are today relatively manageable due to reliable infrastructure, architecture, business models and institutional arrangements.(ISSUU, 2020) However, these frameworks of protection only constitute brief endurance of the human habitat in cities and don't sufficiently include a broader ecological coherence. If we as a society are to be truly resilient against the uncertain events of natural forces we need to scope the greater picture and readapt to nature. In the frequent event of environmental fragmentation as cities sprawl to the countryside we can observe a loosened fabric of ecological functions in the urban radius. Through additional rapid urban expansion eco-systems risk to vanish entirely through continuous division. This is a problem because naturally homogenous city park cannot replace the biodiversity of a lush pristine ecosystem.

Applying nature adaptation to building and development might have the potential to mitigate the brute force of climate change as well as repairing previous damage caused to ecosystems. It is evident that nature has astonishing capabilities to rehabilitate itself once given the chance to do so. Utilizing natures rehabilitating ability and adapting our built environment to nature could be an economically viable, widely applicable and effective tool in combating the environmental decline of urban waters.

The Essence of Life

Water is fundamental for the existence of life. It provides essential sustenance, sanitation and hygiene to almost every living species. Water makes up to about two thirds of the total weight of our bodies; it regulates our temperature, sanitizes our wastes, absorbs shocks and lubricates our joints among several other anatomic services. (Barker & Coutts, 2016) Humans can survive two days without water.

Not only has water kept us alive and functioning throughout the evolution on earth but it is also one of the oldest sources of energy production. Harnessing the kinetic energy from flowing water has been the main source of energy throughout the history of man. (Barker & Coutts, 2016) Today water cools power plants, combustion engines and buildings; it nourishes our agriculture and cleans our streets. There is no doubt that water has been a key-factor in the evolution of human civilization.

We are so dependent and interconnected with water and its cycles that it is often taken for granted as a natural resource. Today 40% of the worlds population live in coastal areas for the multiple benefits gained from living within close proximity to water sources (Barragan & de Andrés, 2015) Yet urban waters are often heavily polluted forcing cities to exhaust fossil water reserves.

As we are experiencing the Anthropocene era urbanization and city expansion are increasingly stressing the natural water cycle, impairing our most precious source of sustenance. Today, city waters risk heavy pollution from toxic seepage into rivers and groundwater from roads and industries. (Benivia, LCC, 2000-2020) Agricultural productions in the city periphery contribute to this pollution by eutrophication, raising the Ph-value of the water it enters and acidifies it. (EPA, 2019) In addition to the pollution the ongoing urbanization causes our cities to expand and densify, leaving less space for down prioritized ecosystems to function thus furthermore impairing natural water cycles.

As the imminent threat of climate change adds another level of complexity to these issues we risk losing native aquatic ecosystems that today provide us with important ecological services.

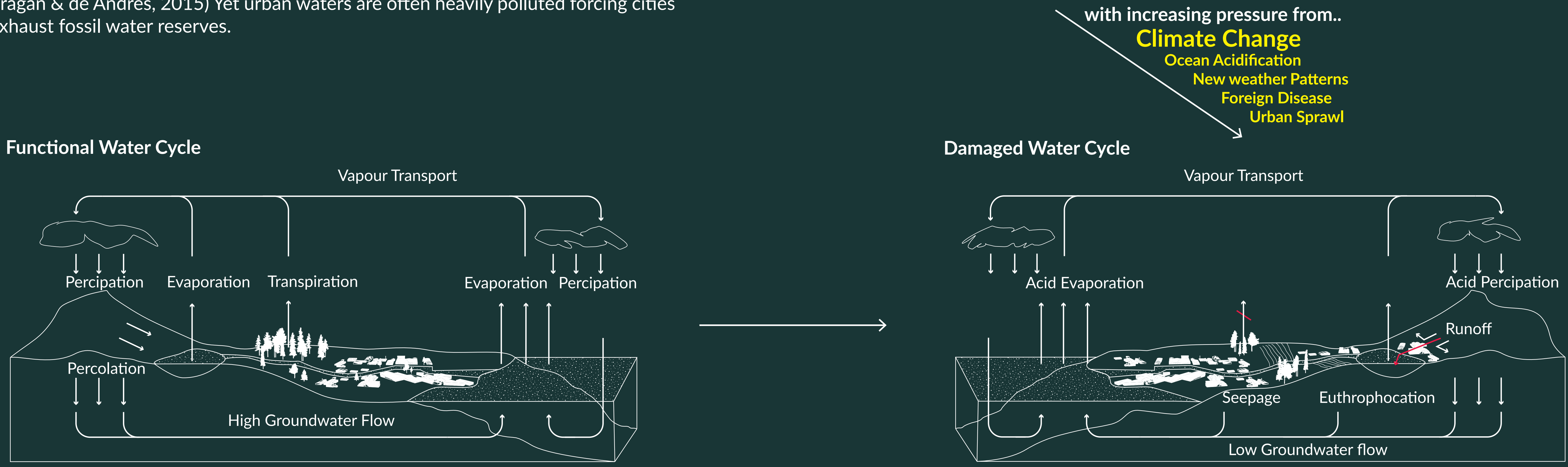


Figure 1: The changing water cycle

Under Pressure

Currently many blue ecosystems (Marine ecosystems) providing services for urban dwellers are either under threat to disappear or are heavily polluted—meaning that they cannot fulfill the performance which creates the expected services. (UN Habitat, 2012) Acknowledging the fragility of the ecosystem is of high interest to strategically find a location with the adequate surrounding qualities to regenerate rather than self-degenerate shortly after intervening. For example: Urban waters; Coastal areas, Rivers, Lakes, Wetlands or Artificial channels receive input from large amounts of pollution from a variety of sources, including industrial discharges, traffic such as cars, ships and trucks, residential/commercial wastewater, trash and polluted storm water runoff from urban surfaces. (EPA, 2015) Contaminated water is commonality rather than scarcity in many cities which raises a question if it is possible to make decayed/decaying riparian zones attractive to wildlife again. Should we restore the most devastated urban waters or find a place deemed more prominent for regenerative approaches to develop?

Although this thesis will not go into further detail about chemical or biological imbalances caused by pollution but rather examine the potential in restoring urban environments dealing with ecological loss. Those measures could mean relieving pressure from existing ecosystems through regenerative approaches or developing an ecosystem from scratch. In contrast to artificial development ecosystems materializes immensely more complex as every aspect of the system is organic. Ecosystems are dynamic and dependent on natural forces and situational conditions. If conditions are fraudulent the reaction of the eco-system will appear non-linearly, comparative with artificial systems which malfunctions usually appear linear, and therefore will be more challenging to maintain or repair if circumstances in the area changes. If maintained properly, urban waters can provide a wide range of positive impacts for a community: public spaces along rivers, offer residents opportunities for community gatherings, social cohesion, physical and mental recreation and environmental education. (Whelchel. et. al. 2018)

Research point to the ecological benefits and services gained by integrating Natural elements in architecture and urban planning. Social, ecological, aesthetic and economic values are to be found in this adoption probably in both smaller and larger scale. However, research concerning aquatic ecological benefits is scarcer, urging attention in times of global ocean stress, blue-ecosystem decay and fresh-water shortage.

This project is an exploration of the possibilities to inject eco-system based adaptation and ecological interventions into the design process to enforce the resilience of urban areas. Furthermore does the project pursue human recreation and the possibility to raise awareness about pristine aquatic environments by inviting nature back to the urban landscape. The Manifesto illustrates how aquatic inclusiveness could be achieved from properly designed riparian development, welcoming back species to the lost river habitat.

Method

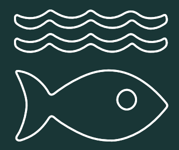
The project is developed through qualitative research, measuring values gained from some known ecological & conservation concepts followed by quantitative and qualitative analysis about the local pre-requisites in Gothenburg. Concepts and background are then funneled through the context related prerequisites to motivate the design.

Thesis Question

> *"Climate change can lead to land degradation, even with the implementation of measures intended to avoid, reduce or reverse land degradation (high confidence). Such limits to adaptation are dynamic, site specific and are determined through the interaction of biophysical changes with social and institutional conditions (very high confidence). In some situations, exceeding the limits of adaptation can trigger escalating losses or result inundesirable transformational changes (medium confidence), such as forced migration and conflicts.*
>
> *Examples of climate change induced land degradation that may exceed limits to adaptation include coastal erosion thus extreme soil erosion causing loss of productive capacity (medium confidence)." (IPCC, 2019)*

How can Architecture act to regenerate River Ecosystems in the Gothenburg Context?

6 Life below Water



By reintroducing natural water purification through flora and fauna and mitigating pollution through landscape buffert zones.

11 Life on Land

Regenerative development in the riparian zone attempt to unleash a biodiversity hotspot by providing habitat and suitable breeding grounds.

14 Sustainable Cities and Communities

Regenearative features could act to provides less polluted water among other services. Good quality water in Göta Älv is vital since it provides 700 000 people with fresh water.

Figure 2. Relation to United Nation Sustainable Development Goals

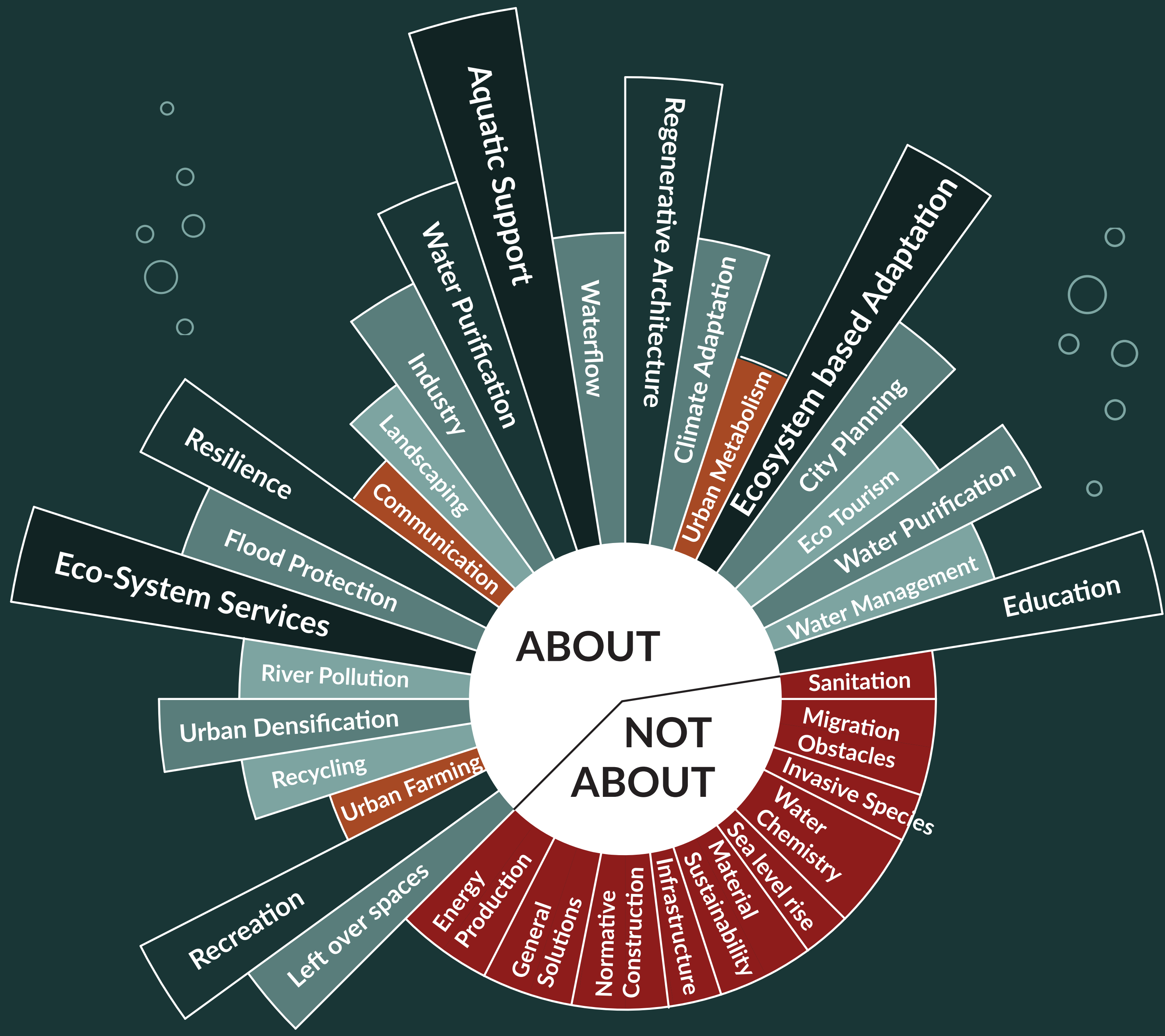


Figure 3. Delimitation Diagram

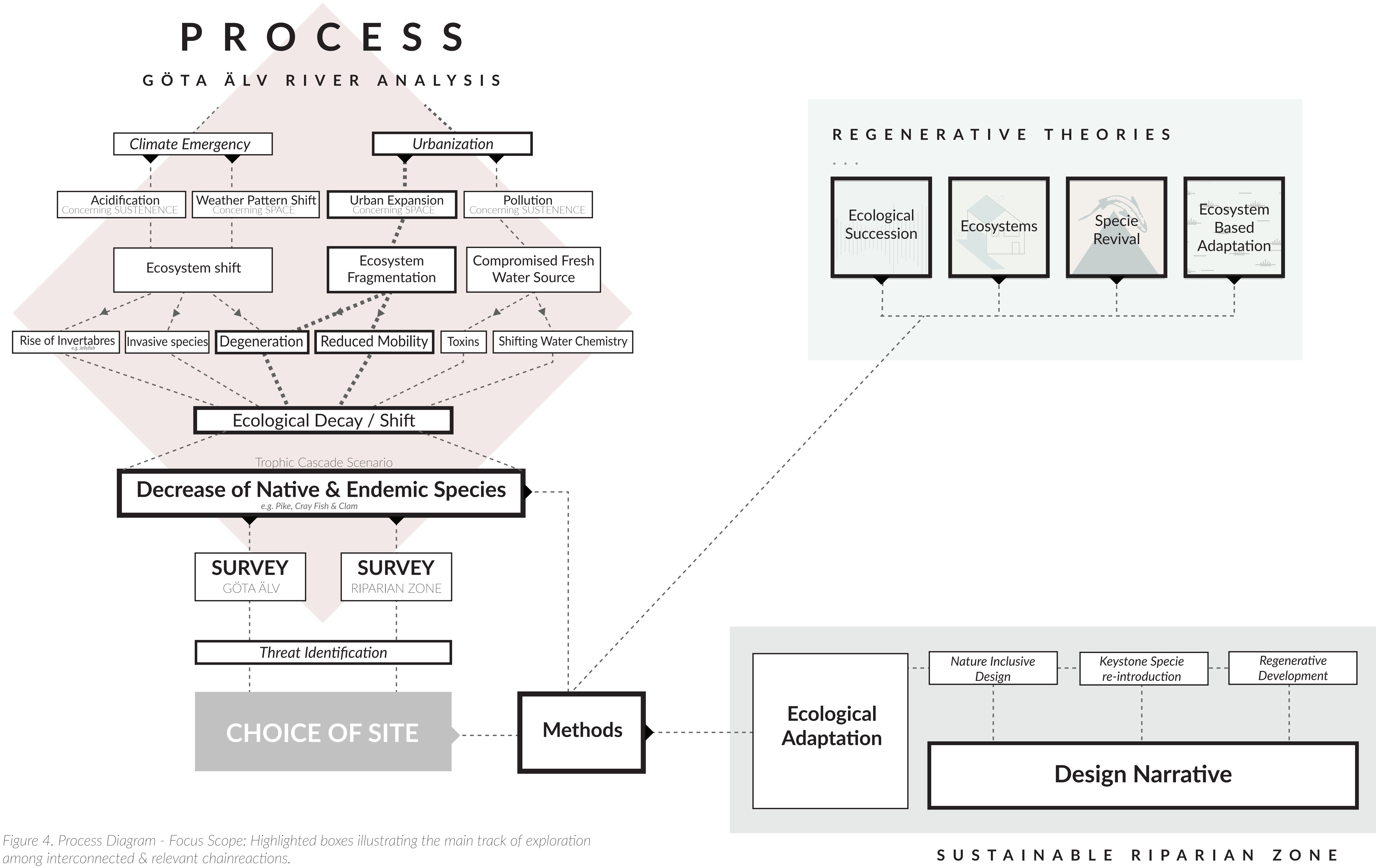
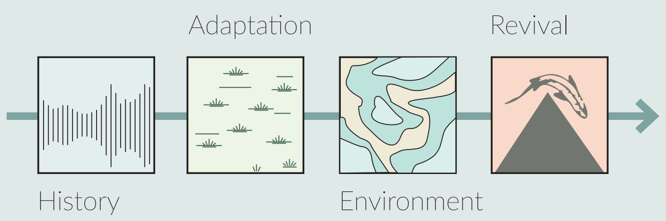


Figure 4. Process Diagram - Focus Scope: Highlighted boxes illustrating the main track of exploration among interconnected & relevant chainreactions.

Concepts



Ecological Succession

To fully understand how the project could be sustainably and robustfully implicated is to acknowledge the dynamic and constant process of the Hydrosere ecosystem. Ecological succession is the gradual process by which ecosystems change and develop over time. Under normal and undisturbed conditions nothing remains the same and habitats are constantly changing. (Offwell Woodland & Wildlife Trust. 2004) However, the timespan of larger eco-system changes are often immense and could vary from decades to thousands or millions of years. For instance a rocky landscape turning into a forest would under the right conditions take hundreds of years while the succession of cow dung would take about 3 months. Riparian zones and Hydrosere ecosystem in particular are usually transition phases which succeed rather quickly and have to be properly maintained in order to stay in its current and preferred conditions. (Offwell Woodland & Wildlife Trust. 2004)

One of the most significant characteristics of a natural riparian ecosystem is the shifting mosaic that fosters high biodiversity (Metz et al. 2016) As the project puts emphasis on catalysts of biodiversity in the riparian context it is therefore relevant to maintain these shifting properties in order to address the demands of threatened species. Using natural ecosystem succession as a tool could become practical in order to preserve the new biome reconstructions on the site since the succession sheds light over what direction the habitat would naturally develop.

Treating ecological succession as a tool could also serve the site with damage mitigation during hazardous events. Damages to riparian ecosystems could happen in various ways: Flooding remains a relevant challenge in Gothenburg as increasing rainfall and sea level rise through climate change is an increasing threat. In the event of flooding a reset of the ongoing succession could be a replenishing feature for the ecosystem and work in favor of the city and environment rather than being a means of destruction as such events would restore several properties of the wetland. Smaller flood discharges functions as sediment transportation and relieves a wetland from sediment congestion and basically cleanses the river bed. Larger floods creates more abrupt, dramatic changes and greatly changes the habitat distribution, but without changing the composition (Metz et al. 2016) Hazards of embankment or pollution could potentially cause general ecological decay which rends natural systems of several fruitful conditions resetting the ecological succession to an even earlier stage.

Key influences on the thesis project

- **Resilience** through long-term climate change adaptation
- **Biodiversity hot spots** in transitional zones and woodlands
- Developments here have **High Impact** as transition succession zones are rapidly changing and evolving
- Wetland are **Naturally re-enforcing** as time passes.

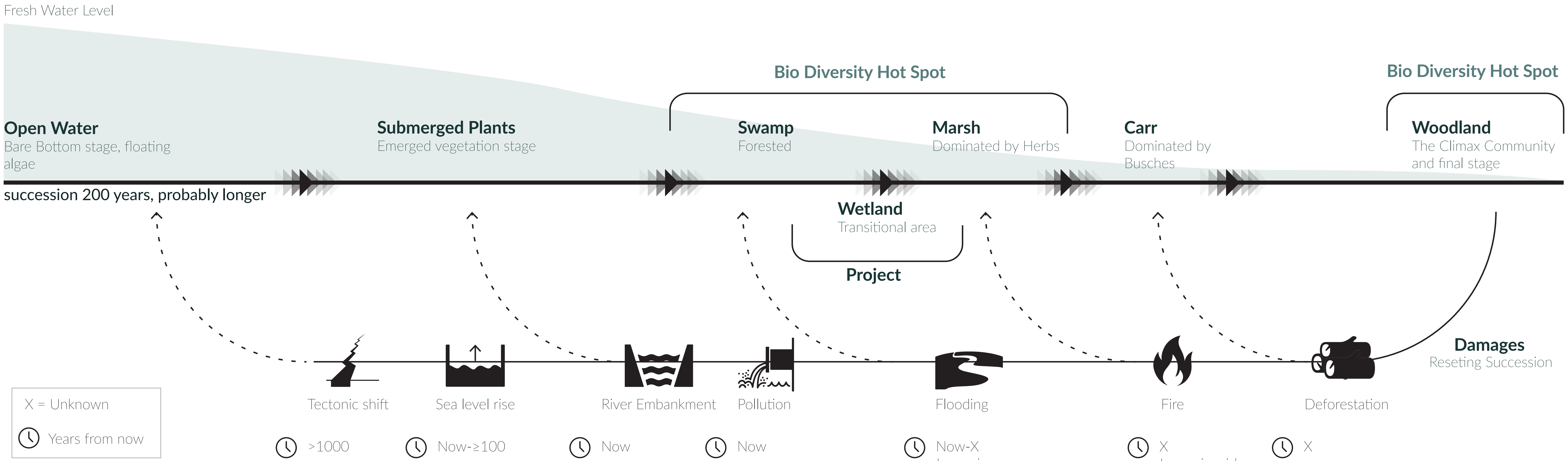


Figure 5. Timeline of Ecosystem Succession

Ecosystem-based Adaptation

Ecosystem based adaptations "EbA" describes a broad set of approaches to adapt to climate change. All of these approaches involve management of ecosystems and ecosystem services to reduce human community vulnerability from climate change impacts. (Scarano, 2017) EbA are often mentioned as alternative to hard protection measures against sea level rise. Other hard measures such as embankment or advancement along with EbA are some preparation strategies to approach climate change and climate induced changes of the coastal and riparian zone. EbA is multi-beneficial, bringing several co-benefits such as improving water quality and life on land and in water. Communities around the world are already implementing EbA responses at local scales, with emphasis on community participation, ownership and local priorities, needs and capacities. (IPCC, c4, 2019)

Risks
Major EbA efforts are today at greater risk of failure than hard physical measures since they are more complex to implement/design and require different and sometimes nonexistent maintenance strategies. (IPCC, c4, 2019) EbA, in contrast to these hard measures are dynamic and non-linear in the way they perform and react to forces. Also, expected services brought by the systems are not always very noticeable as a vast variety of human, environmental and climactic forces influences and change them, similar to an ecosystem.

In the long-term, there is limited evidence and low agreement on how changes in temperature, fresh and ocean water acidification will influence aquatic and riparian ecosystems. (IPCC, c4, 2019) To achieve a robust and resilient EbA in the Swedish context, which yet barely experienced such changes it is relevant to prepare for probable hazardous scenarios brought by climate change. In the current state we have few documented large scale EbA development strategies in the world and even fewer research about performing examples.

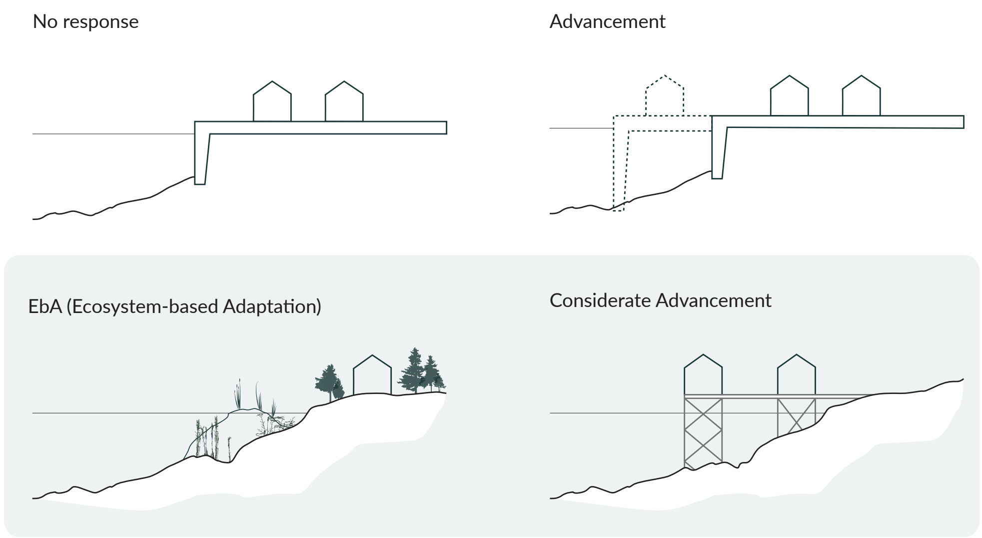


Figure 6: Common measures for riperian development

> *There is high confidence that ecosystem-based measures provide multiple co-benefits such as sequestering carbon, income from tourismm, enhancing coastal fishery productivity, improving water quality, providing raw material for food, medicine, fuel and construction, and a range of intangible and cultural benefits."*
>
> (IPCC, c4, 2019)

The Transitional Zone

As riparian ecosystems work in complex balances, receiving input from various external forces while simultaneously affecting bordering ecosystems it is only logical that it must be adapted to function in the specific context.

Wetlands, as a transitional zone characterized by its riparian ecosystems are multi-beneficial in the range of ecosystem services they provide. Wetlands can support wide biodiversity hosting a wide range of unique species unable to live in homogenous urban green areas. (CGIAR, 2020) Adding or restoring wetlands in the urban context could bring back lost native amphibic or aquatic species and relink the ecological chain. (Swanson, et. al. 2017) Another major service they convey is natural water purification from its dense flora mitigating the pollution in urban rivers and lakes. (Verhoeven & Meuleman, 1999)

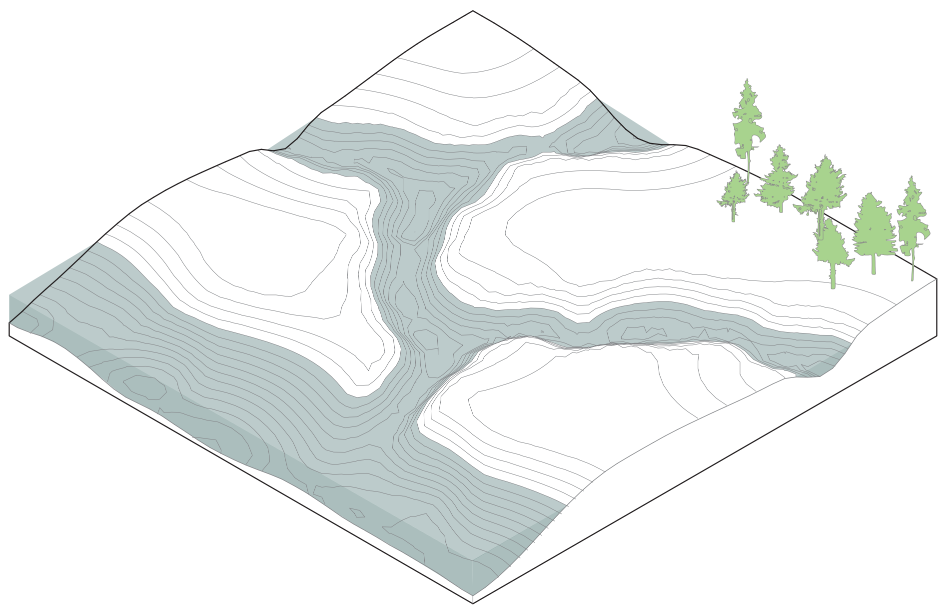


Figure 7: Possible Marshland landformation

Ecosystem promoting Environments
Positive and negative factors

Environmental enhancement is not necessarily achieved through natural preservation but could also be achieved through design. Examples below describe already existing ecosystem beneficial environments obtainable by both preservation and design.

Reefs
Natural reefs could be compared with terrainian rainforests. These living structures are home to several species allowing rich bio-diversity. Reefs are a highly efficient coastal defense against storms and surging water. However, as reefs are very sensitive to water chemistry changes reefs are receeding along urban riparian zones. (IPCC, c5, 2019)

Setback Leeve
Setback leeves are earthen embankments, located a distance from a river channel to allow the river to meander more naturally and to be able to occupy all or some of its natural floodplain during high water events. By adding design elements on such leeves brings opportunity to incorporate recreational activities to the floodplain as in simultaneously restores multi-specie habitats.

Floodplain
A floodplain is the natural inclination whichs frames the river and keeps the water from dispersing the landscape. A manipulated river often contain overbuilt floodplains with physical expansion all the way onto the riparian zone. Wide and naturally overgrown floodplains reduces the impact of flooding as it stores large amounts of water in the soil and biomass. Floodplains carry many natural features similar to wetlands and marshlands.

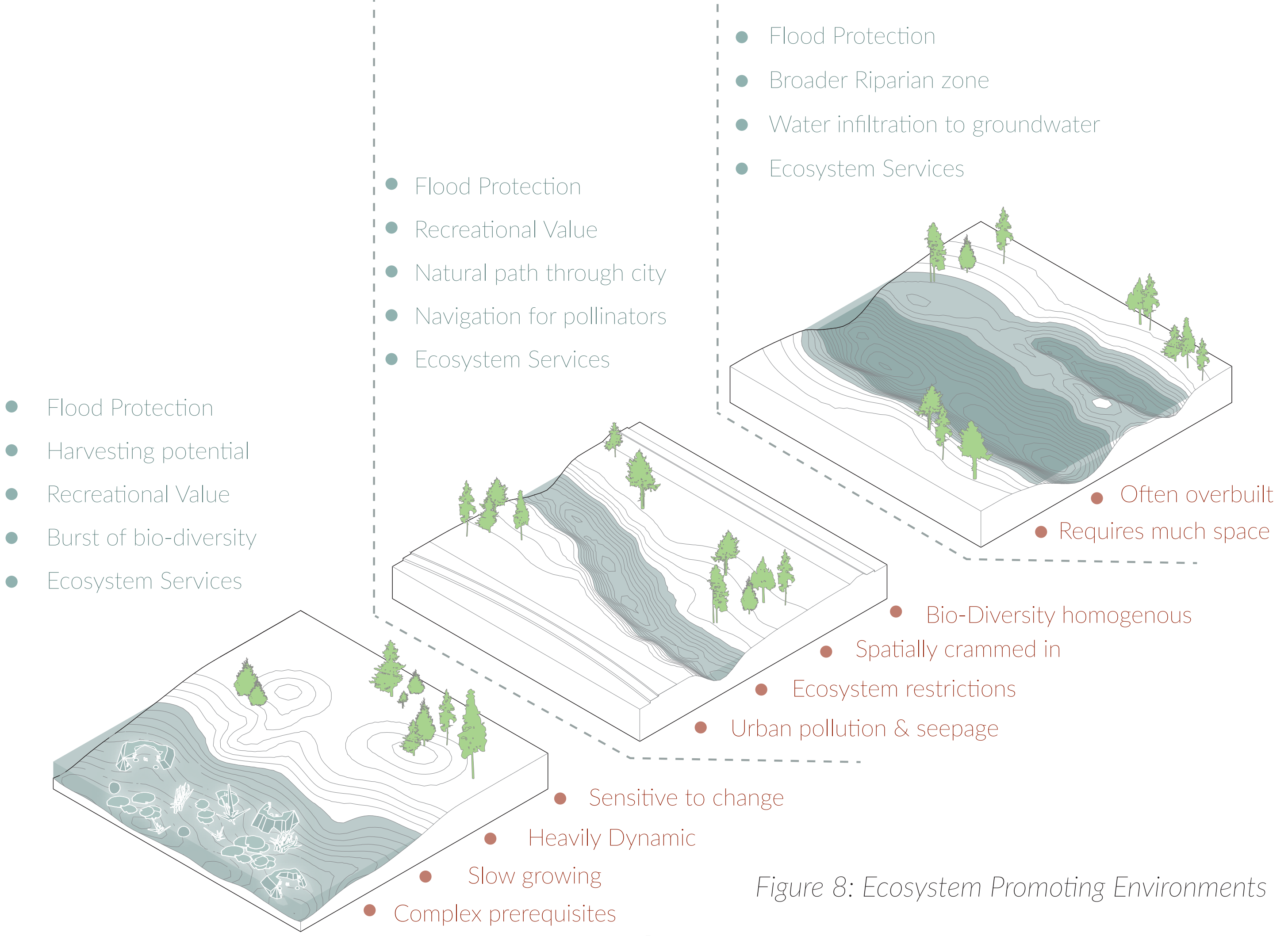


Figure 8: Ecosystem Promoting Environments

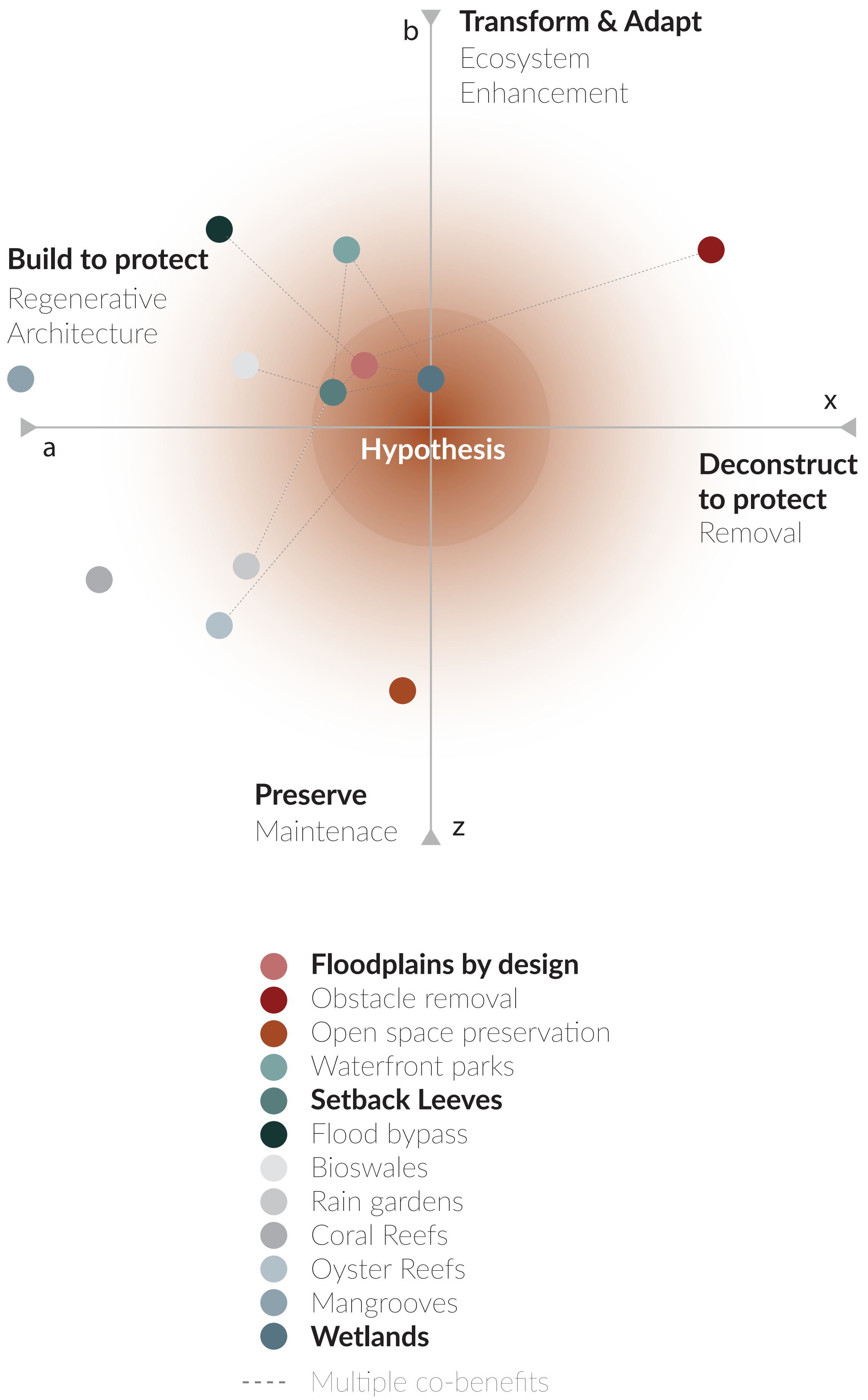


Figure 9: Project Relevance

Revival of the Key-Stone Specie

Keystone species is a conservation biology concept, alongside flagship and umbrella species, describing species in an ecosystem that has unproportunate impact on the system. The pike for example is the main native predator of Göta Älv (Jacobsen, 2020). The pike is an omnivore which means it consumes a great variety of prey further down the food chain preventing other species to reach unsustainable numbers. Keystone species have low functional redundancy, meaning that if the specie would disappear no other specie would be able to fill its function, forcing the entire ecosystem to change. This change will allow new and possibly invasive species to populate the habitat. (National Geographic, 2019) Key stone species are often but not always the predator of the habitat. Primary consumer species such as krill and down the food chain could have vital impact on the food web and could thus also be categorized as keystone specie.

The absence of the pike and other native organism in the Gothenburg branch of Göta Älv is today well documented. Many factors are to blame for this loss, however human activity have presumably had a major impact, meaning that human activities have considerate effect on our surrounding aquatic ecosystems. If our behavior, activities and physical development were adapted to respect or in best cases work symbiotic with ecosystems we might see cascading effects of river regeneration. A functioning aquatic zone including space for the native local keystone species have the potential to help balance out a decaying ecosystem

"Nothing supports the health and resilience of ecosystems better than the presence of keystone species in natural numbers."

European Rewilding Network, 2018

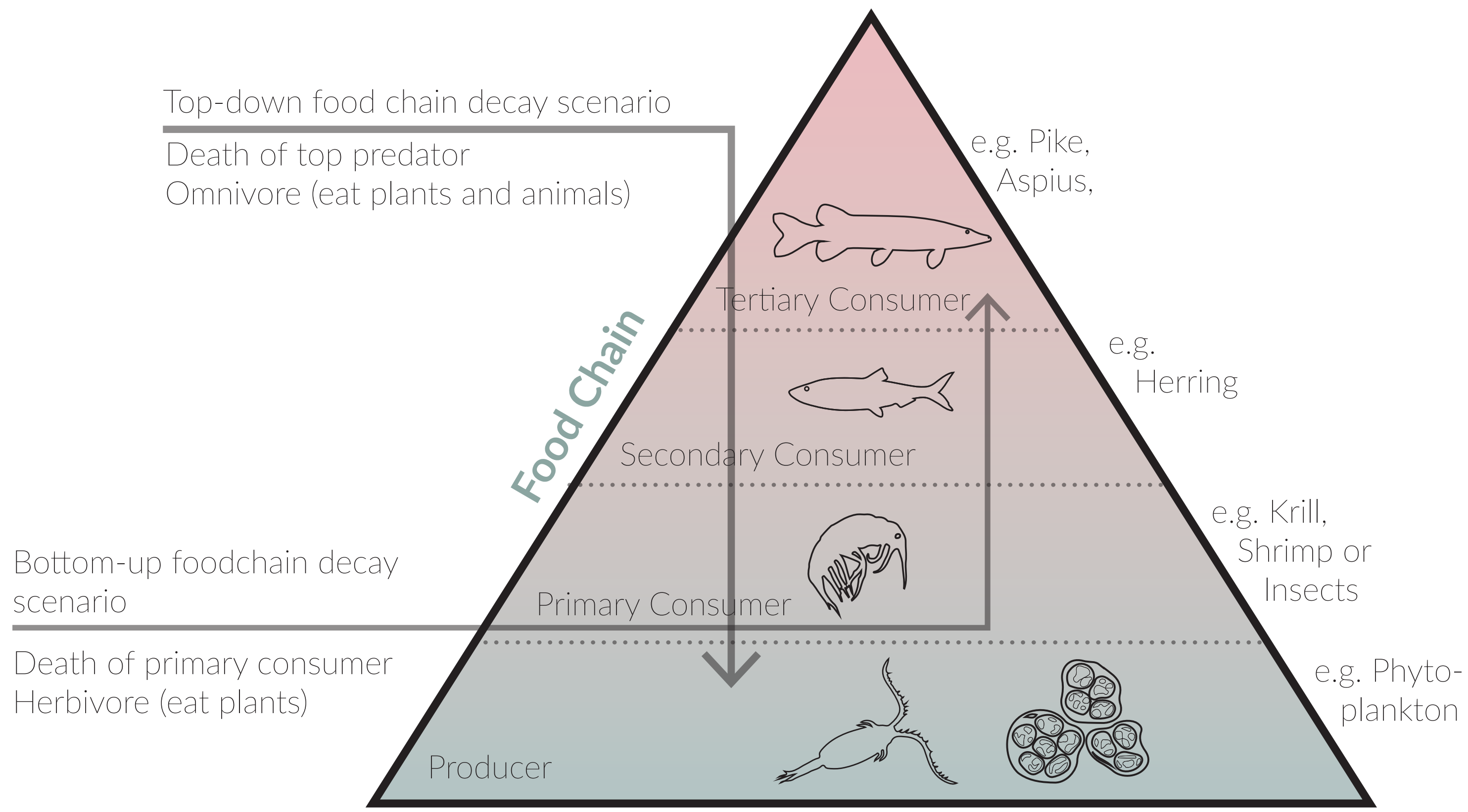
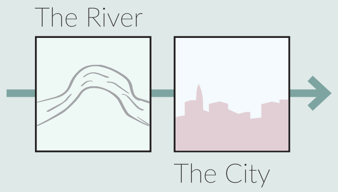


Figure 10. Diagram of Biodiversity loss through loss of keystone specie

ANALYSIS



CONTEXT

GÖTA ÄLV

Göta Älv is Sweden's largest river and flows from Vänern to the Kattegatt sea. The water flowing in the river is the most essential sustenance for life to flourish in the region, bringing water supply to wildlife and 700 000 people. The river is also important for agriculture, necessary for some industries and organizations while simultaneously functioning as a fairway for shipping. (Göta Älv Vattenvårdsförbund, 2015)

Besides all activities that are made possible through the reliant river flow the extensive Göta Älv water network provides vital sustenance and nutrients for some of the most bio-diverse riparian locations in Sweden. These zones are generally located in the pristine natural environments outside the larger cities in western Sweden. Göta Älv's diverse contributions to human activities and wildlife are numerous but steadily degrading as the river continues towards the ocean. Modifications in the shape of river locks, Water plants and embankments are weighing on the possibilities for the ecological cycle to function properly. (Göta Älv Vattenvårdsförbund, 2015) Re-Live the River is a project that focuses on the Gothenburg branch of Göta Älv River where the blue ecosystems are most severely compromised. The Gothenburg branch is the final outlet of the river which according to Jacobsen.P suffers from all previous river alterations in combination with the urban expansion. This part of the river hosts ecosystems that are decaying or entirely eliminated.

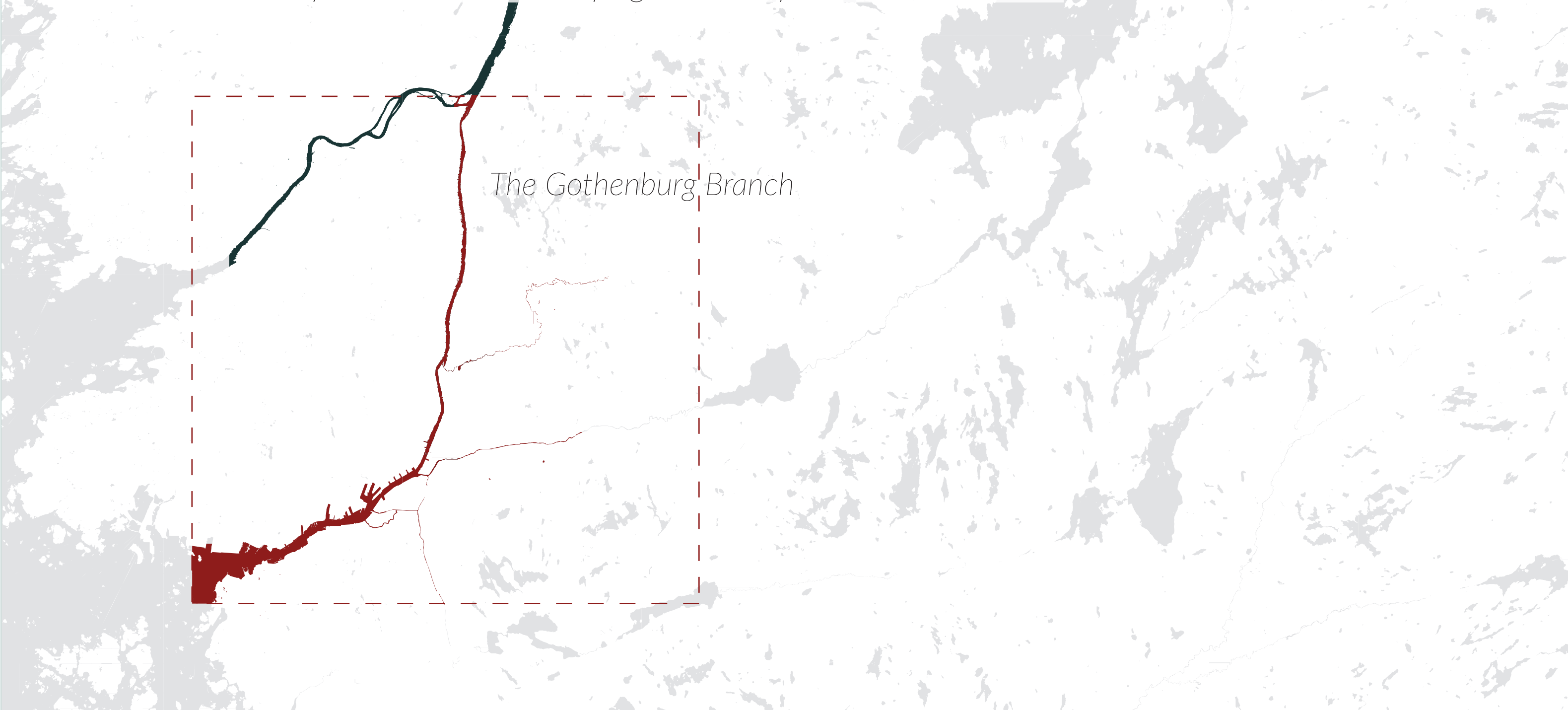


Figure 11. Göta Älv River

Heavily Modified Water

Since the Water directives were established in Sweden in the year 2000 all Swedish waters has been categorized into specific water bodies, giving each an individual status. This status is produced by the Swedish Sea and Water Authority and is an overall estimate of the ecological status and water quality of the measured water.

In the case of the Gothenburg branch of Göta Älv it is divided into 5 water bodies whom are all identified as "Heavily Modified Water". This means that the waters have gone through extensive physical changes in order to serve activities of social value. These modifications are so severe that there is no expectation that the river can go back to its original ecological position. (Göta Älvs Vattenvårdsförbund, 2015)

Water bodies that is categorized as HMW is graded through its ecological potential instead of its ecological status. The only way that Göta älv south of Nordre älv can achieve a higher potential and regain a good status is if very large changes are made, which would affect our community. Such changes has not yet been made. (Göta Älvs Vattenvårdsförbund, 2015)

River Locks

Regulates the waterflow and makes shipping transports possible in steeper terrain River Locks restrict the natural flow of sediment such as sand and prevents fish and other species to migrate if no alternative route is constructed.

Water Plant

Kinetic energy conversion from flowing water to electricity. River flow is altered by dams and riverlocks to produce energy by demand. Migratory aquatic species are heavily restricted and partly killed when crossing

River Embankment

Solidification of the floodplain for the purpose of socio-economic activities. Normally in the shape of solid piers or dock constructions in concrete or cement. Embankments harm aquatic ecosystems by forced claim of the riparian zone, causing riverbed pollution and loss of depth variation.

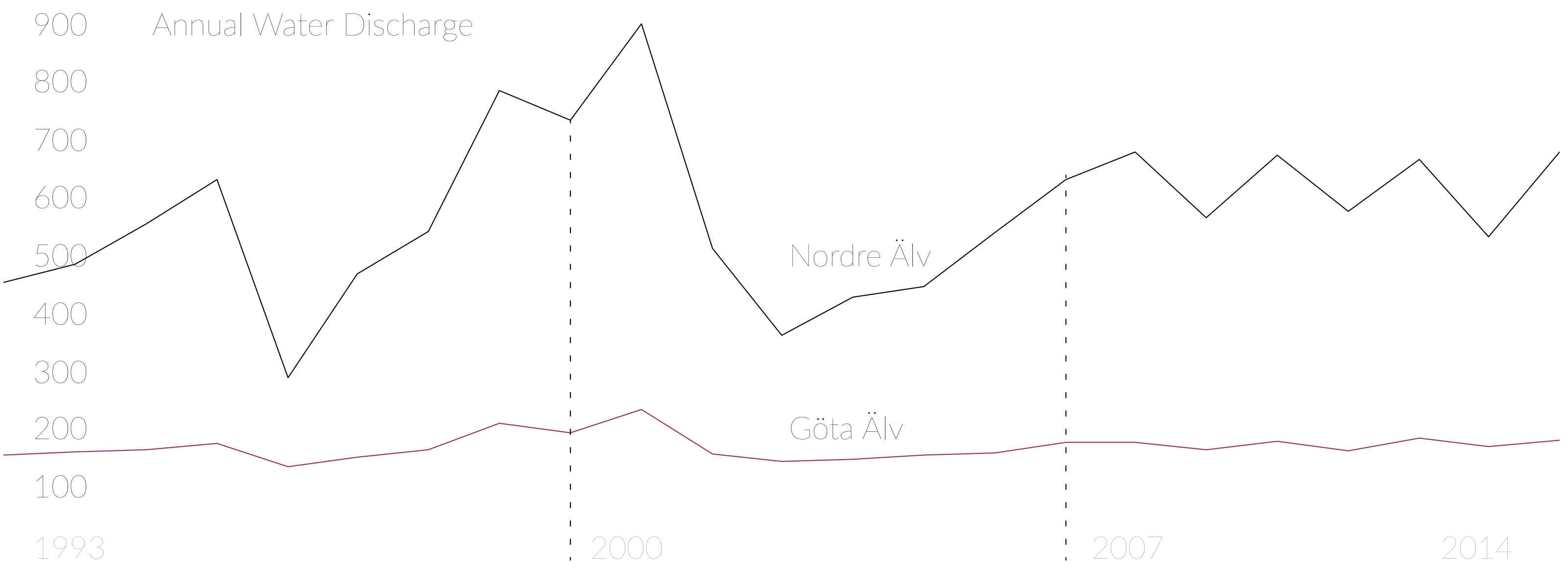


Figure 12: Annual Water Discharge in Göta Älv, 1993-2014

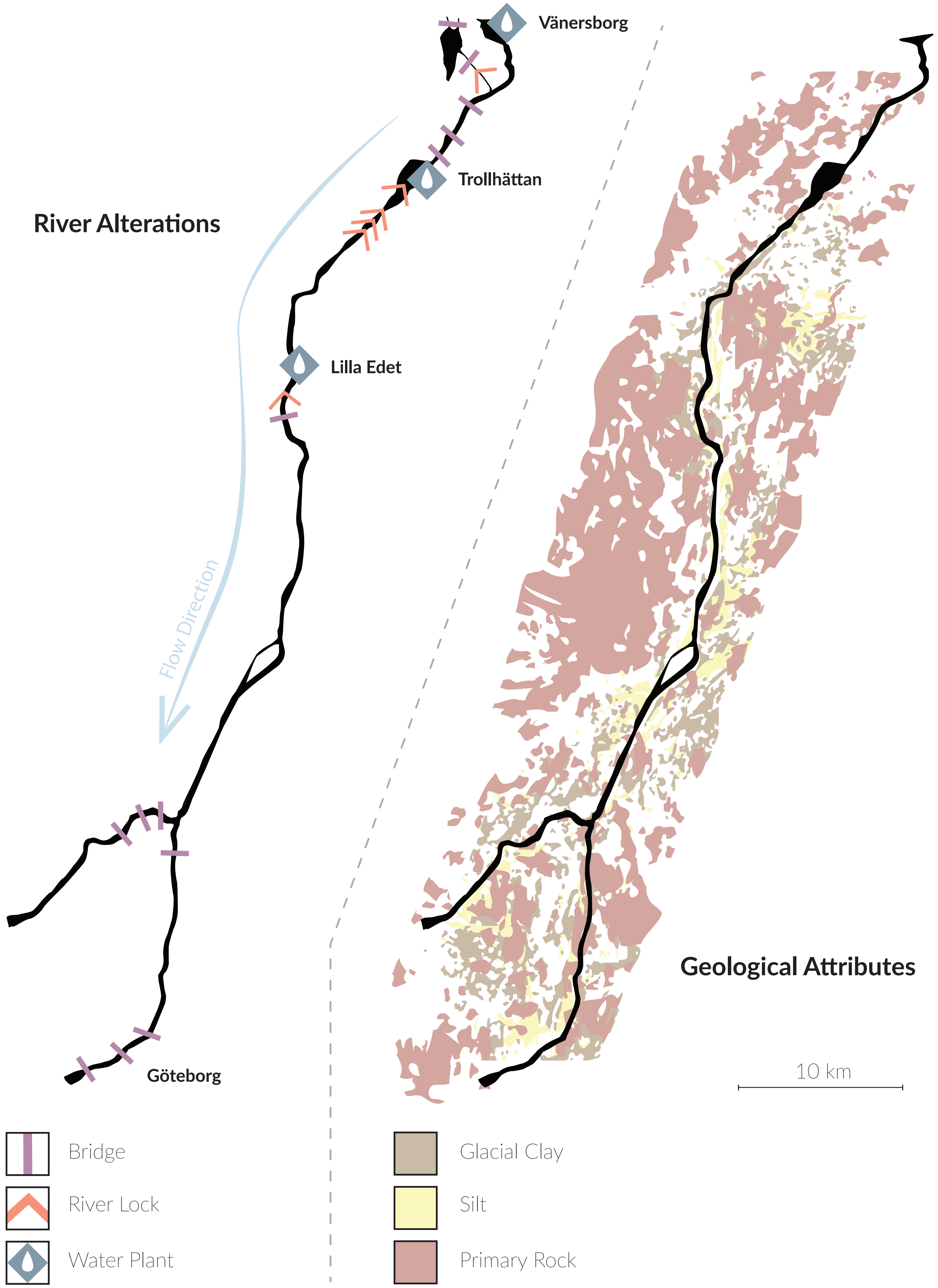
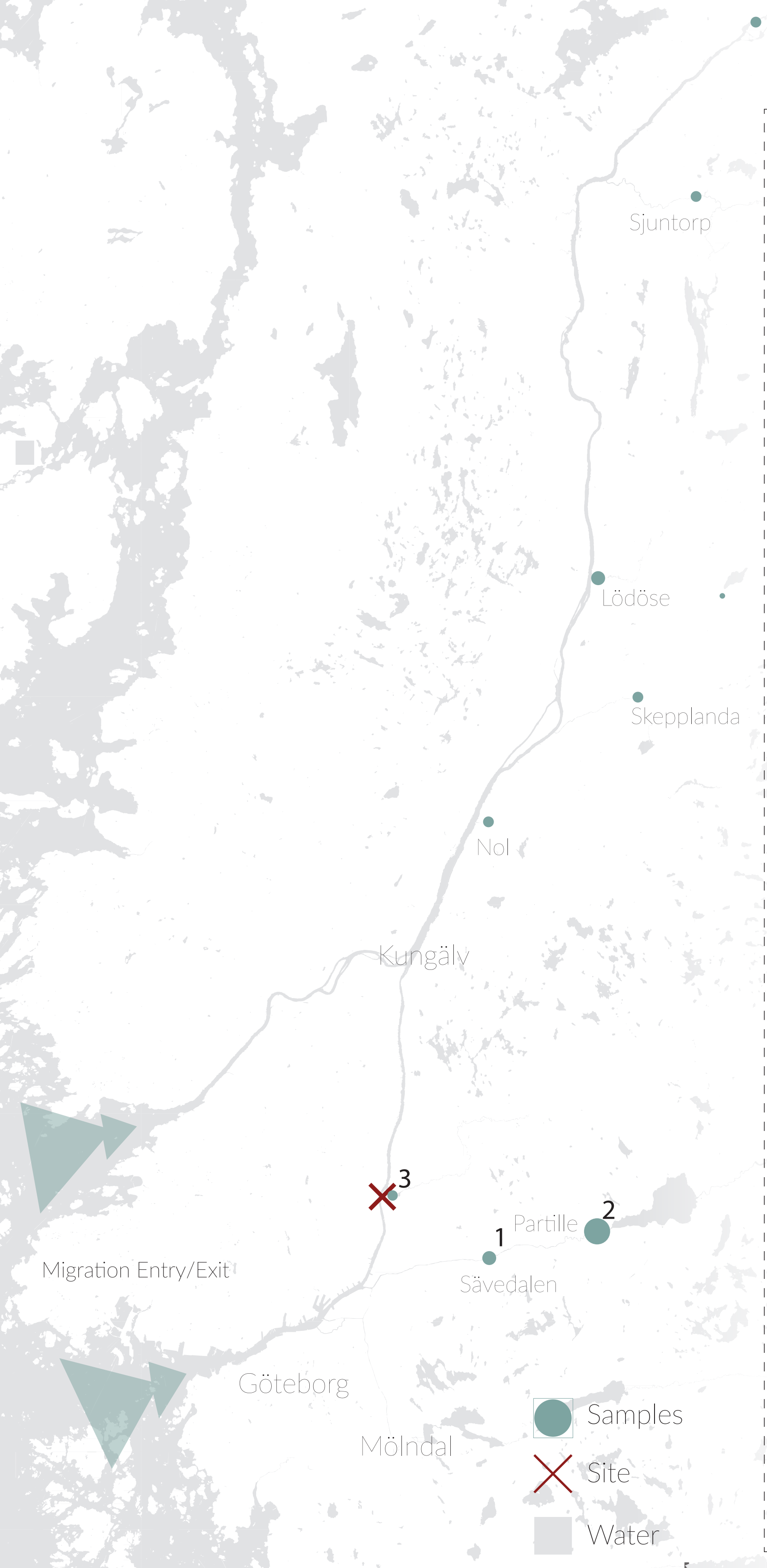


Figure 13. River Properties

Natural Habitat
Aquatic playzones in Göta Älv river network



1
Säveån - Kåhögs bridge

River bed substrate	Pebbles, Stones, Sand & Blocks
Areal	3450 m2
Length	200 m
Width average	23 m
Depth average	0.8 m

Moderately overgrown & water moss
Lively and flowing

Flat beaches with pasture on both sides of the river. The beaches upstream of the bridge are covered with deciduous trees.

2
Säveån - ugglumsbron

River bed substrate	Pebbles, Stones & Blocks
Areal	770 m2
Length	55 m
Width Average	14 m
Depth Average	150 cm/70 cm

Water vegetation barely overgrown with water moss.
Lively and flowing

Beaches and surroundings are dominated by filling material by the bridge fundaments. The northern side of the stretch is bordered by deciduous trees and bushes.

3
Lärjeån - Gamlestadsvägen

River bed substrate	Pebbles, Stones & Blocks
Areal	1750 m2
Length	155 m
Width average	7.5 m
Depth average	0.4 m

Barely overgrown with water moss & some flagellates
Lively, flowing and barely flowing

The beaches are rocky and overgrown with deciduous forest. The south side of the river is ravine-like and the north side is flat.

(Leklokaler för Asp, J.Berglund, 2005)

Imitating play Opportunities

To maximize the potential of ecosystem adaptation in Göta Älv a study of the local species could shed light on how to create a dynamic transition with the interventions. A diverse and complex space with sheltering islands could be credible to invite a range of various species during their migratory search for reproduction space. Keystone species and other species further down the food chain will then have a chance follow.

First of all the habitat/ecosystem would require as much space as possible, enabling physical development to adjust according to the best possible environment. Keystone species like the Pike prefers different environmental conditions so a mix of topography, shelter and refuge could be beneficial. Possible features: Varying water depth/topography, floral diversity, varying sediment layers/substrate layers, and shelter/refuge. Sampling specimens of some optimal keystone specie playzones in the region will serve to map how a more suitable nature-inclusive site could emerge, inviting wildlife back to the area.

Prefered hunting Depth

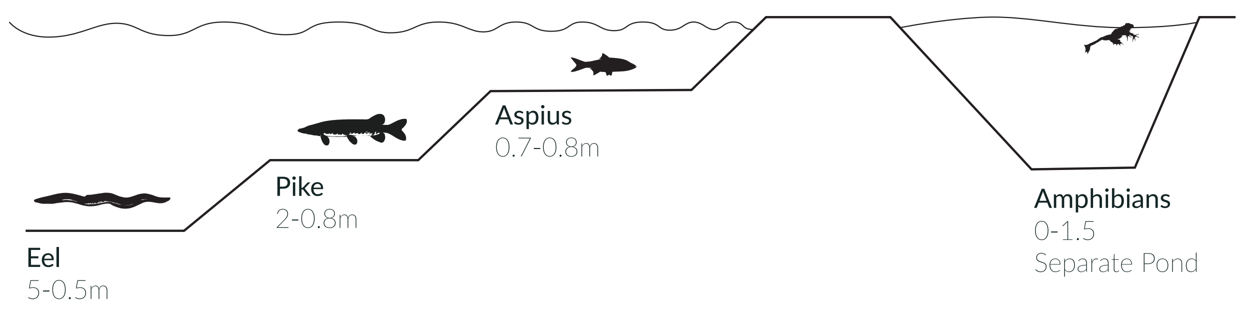


Figure 14. Hunting Depth

Essential Environmental Conditions

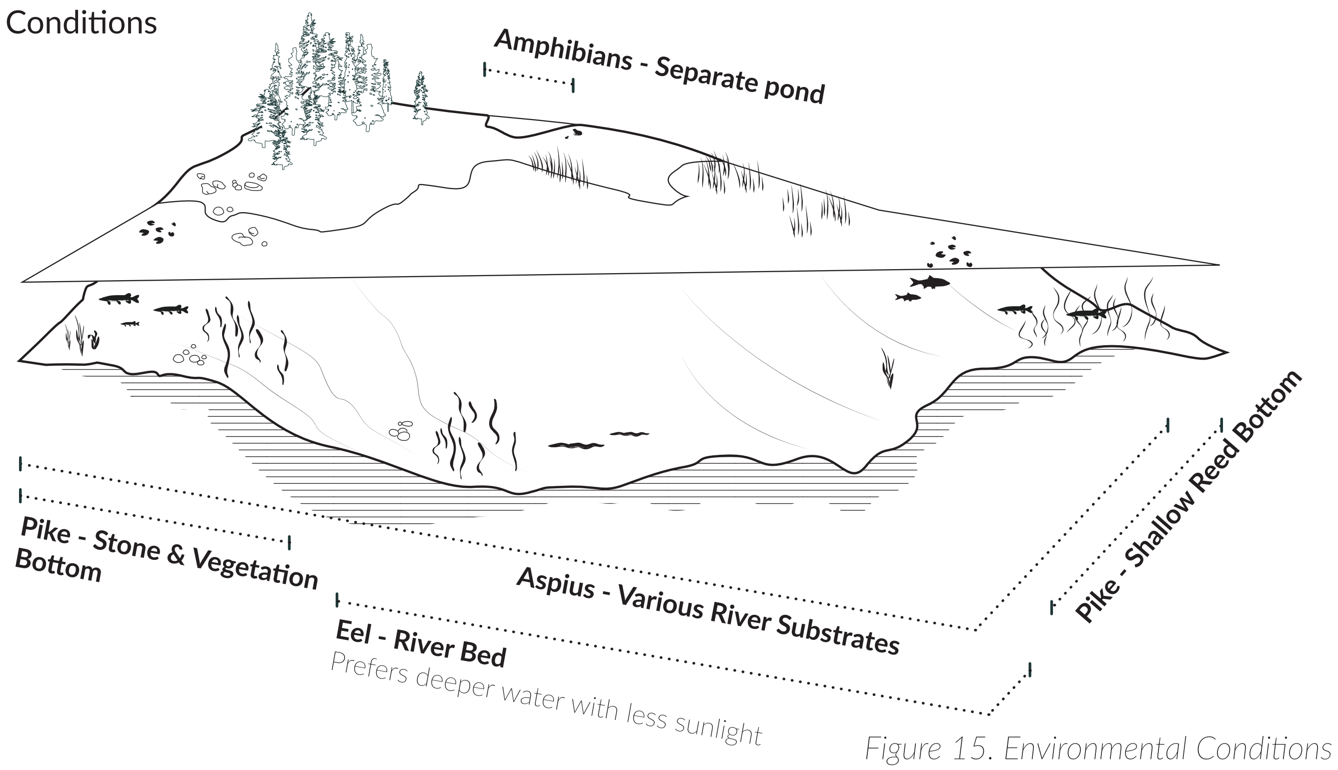
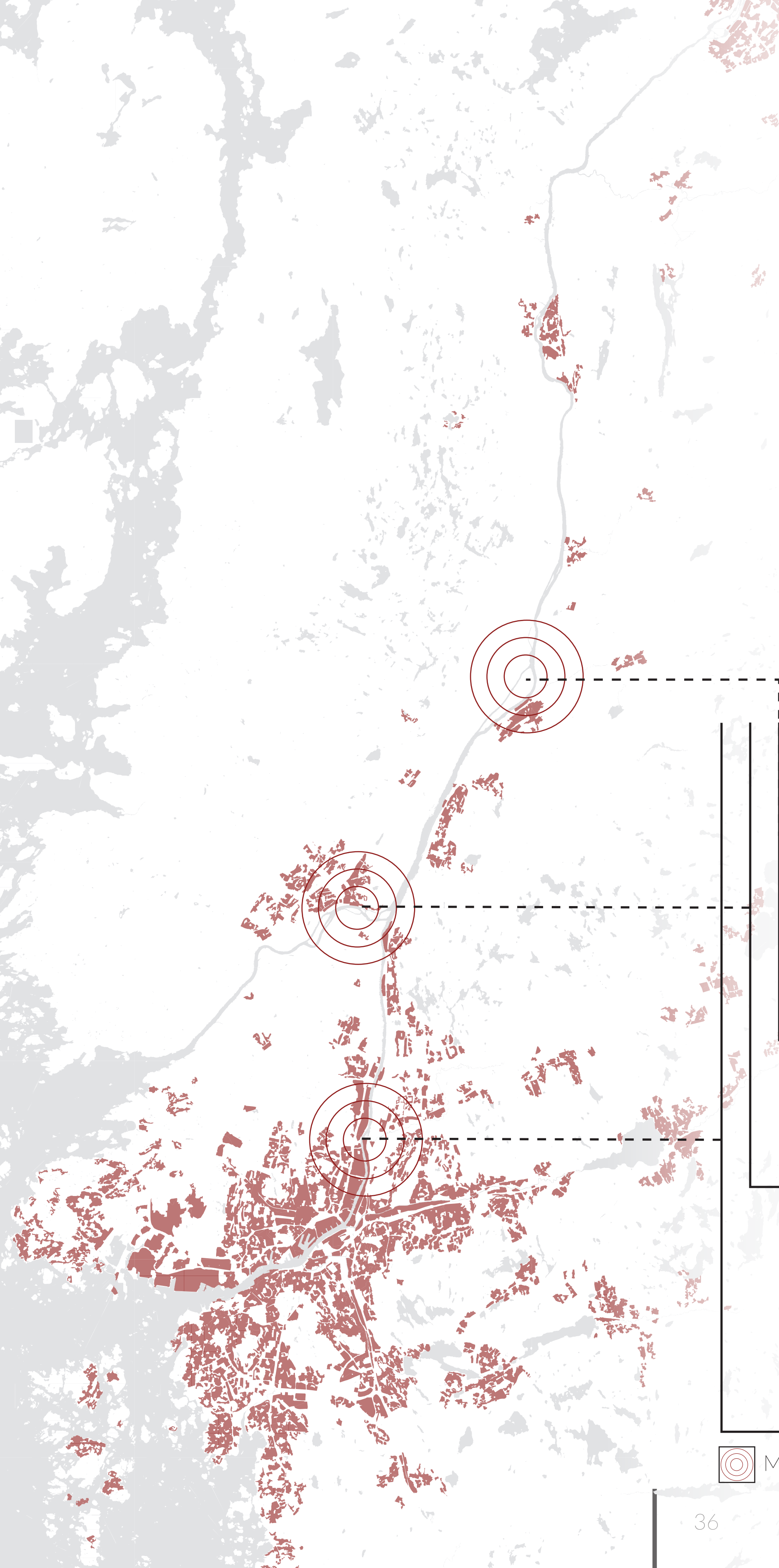


Figure 15. Environmental Conditions

Threats
Ecosystem Impairments



Threats to ecosystems appear in various forms but they are generally caused by human activities and climate change reactions. Such threats could cause trophic cascades of biodiversity and potentially cause decay of entire ecosystems. Threats below localizes Göta Älvs current unsustainable situation affecting already threatened native species.

Selection of endangered Species in the regional context

Species	Population
Sea Lamprey	Near Threatened
European Eel	Critically Endangered
Asp	Near Threatened
Freshwater Pearl Mussel	Endangered
Märlkräfta	Near Threatened

(Artdatabanken, 2019)

Fecal Pollution	Strong microbiological impact from E. coli, Viruses and Parasites.
PPCP	Storm water runoff, human wastes and drainage.
Weather Pattern Shift	Increased rainfall, meaning wider flushing radius in Vänern leading to more fecal impact.
Warming temperatures	Attracting forreign species who can establish in the river and its tributaries. Furthermore, changing temperatures changes the behaviour of native species whom could move or vanish from current territories, thus changing the entire eco-system.
Invasive Species	Woolhand Crab (Eriocheir sinensi), Salmon Parasite (Gyrodactylus salaris) and the aquatic plant species Water Plague (Elodea cirkanadensis) are commonly brought from abroad through the shipping and transport industry. These forreign species are expected to affect the eco-system negatively and could potentially wipe out entire native species.
Contaminated Land	Göta Älvs Industrial history has put a noticeable footprint of contamination in and around the river, making some areas costly and time consuming to decontaminate in order to withhold a good water quality in the river.
Noise Pollution	Neighboring Industries, Car traffic, Air traffic, Train traffic and Ship traffic.
Light pollution	Street lighting, fairway guidence lighting and city light.

(Göta Älvs Vattenvårdsförbund, 2015)

Measurement Sites

Reference Projects

Re-Build

#2 Pike Factory

Sportfiskarna
Gävle, Sweden
Completion year 2018

Järvsta Sjöäng is one of Sportfiskarnas many pike factory projects where an overgrown marshland is reconstructed to support the rich bio-diversity that once thrived in the area. Deep and shallow trenches are dug to host various aquatic species and small islands are built to strengthen birdlife. The area is relatively urban and is thought to become a recreational park featuring viewing towers, rest areas, hiking trails and educational information about the nature rehabilitation done at the site. To help kick start life in the pike factory staff from Sportfiskarna helped the newly arrived fish with sustenance by continuously releasing insects in the area. (Ljunggren, 2018)

The undeveloped land(Sportfiskarna, 2015)

Newly constructed soil Embankment (Söderman, 2018)

Re-Introduce

#1 XIXI Wetland Estate

David Chipperfield Architects
Landscape Architect: Belt & Collins
Hangzhou, China
Completion year 2015

The Xixi wetland estate is a 20 unit housing development located in the outskirts of the National Wetland Park in Hangzhou, China. The development rests on peat bedrock supported by plinths carrying the structures. This example of delicate integration of human residency in a natural environment shows how coexistence between humans and green / blue ecosystems could be realized. This could help to respectfully densify the overpopulated cities through coexistence rather than fragmenting and sprawling the landscape.

As shown in the pictures below, the monolithic and low-lying development symbolizes rising cliffs, not invading but a part of the landscape. The added islands of green structure supports biodiversity as it nourishes surrounding waters and brings shelter to aquatic species. Instead of dividing the construction lot into housing and natural zones the Xixi project fuses both systems into coexistence with blurred borders

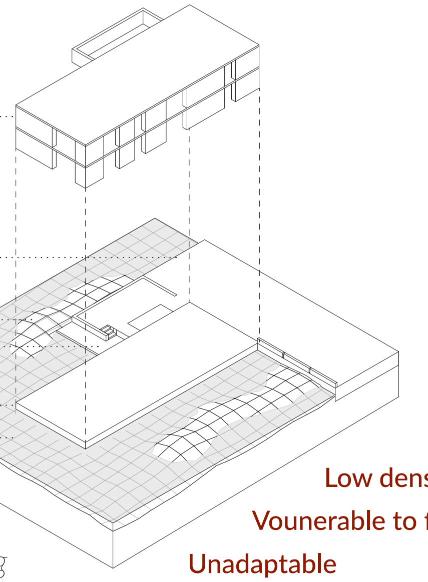
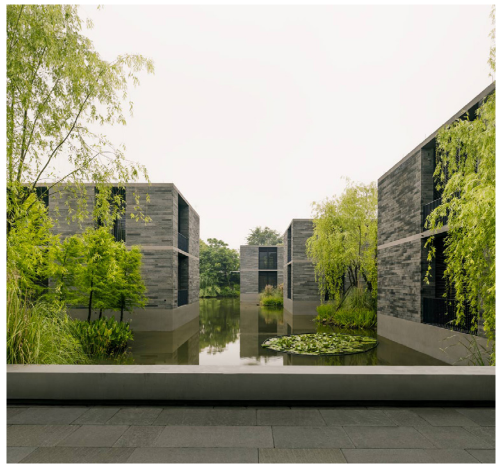


Figure 31: Axonometric - XIXI Wetland Estate Building



(Menges, 2015)

The Urban Possibilities
Gothenburg Context

Natural Urban Gaps
To justify Ecosystem based interventions in the urban context it is of interest to find a site that is adaptable with the natural parameters of an ecosystem. The site should be able to host natural space and simultaneously be able to adapt to the surrounding environment. Identifying 'left over spaces', discarded by local property owners, developers and regional governance could then be of interest. Natural and undeveloped gaps in the urban fabric are or could be a potential value for regenerative development and the city in general as they provide various ecological services. Services provided could be: Water sheds dedicated to storm water runoff, natural water flows protected by Natura 2000 water assets, sites of archaeological value, natural heritage sites or biotope protected areas. The In-between spaces such as these are more common to be found in the less densely developed parts of the city or in the 'in between city' as city space is prestigefully contested and natural features are often stripped away in the city expansion and densification process.

The In-between City
The Fringe, as a term for the urban periphery or the 'in-between city' mentioned in Sieverts Zwischenstadt is a dynamic place where development occurs differently than in the cities. The varying facilities here are often essential for the city, sustaining it with all its needs. City planning processes normally ends here, leaving a changing and heterogeneous landscape to digest. The In-between city can develop any diversity of settlement and built form as long as, as a whole, they are intelligible in their settlement network and, above all, remain embedded as an 'archipelago' in the 'sea' of an interconnected landscape. In this way landscape becomes the glue of the in-between city. (Sieverts, 2003) For the public, the in-between city is a relatively uncharted territory where land is less expensive, less structured and free from urban expectations. The qualities gained from the uniqueness of the fringe are in some cases gaining recognition from various groups of people, especially the city's younger citizens whom lust for new urban experiences.

As Cities expand due to increased urbanization the in-between city naturally gets influenced as it often defines and forms the city edge. This expansion inevitably puts pressure on already threatened remaining natural assets, emphasizing respectful integration of new physical development into the landscape. If new physical development were to recognize the values of these natural assets there is potential to create an interconnected living landscape where nature does not suffer from human activities. Such inclusive development could reconnect natural flows and migration paths, regenerating ecosystems and thus enabling a broad variation of ecosystem-services for the city and surrounding landscape.

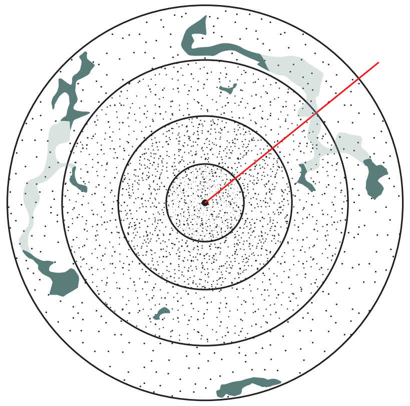
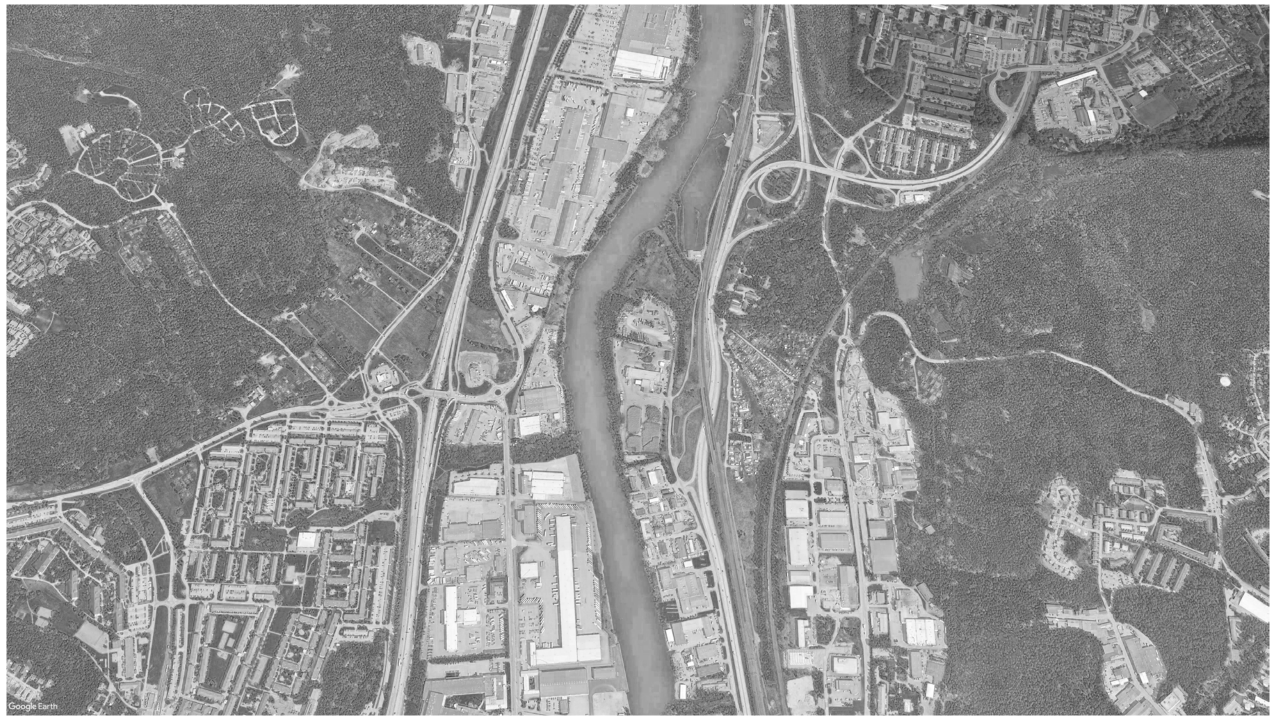


Figure 16: Regenerative development reconnecting pristine natural enironments in the city radius



Fringe ribboning Göta Älv River in Gothenburg

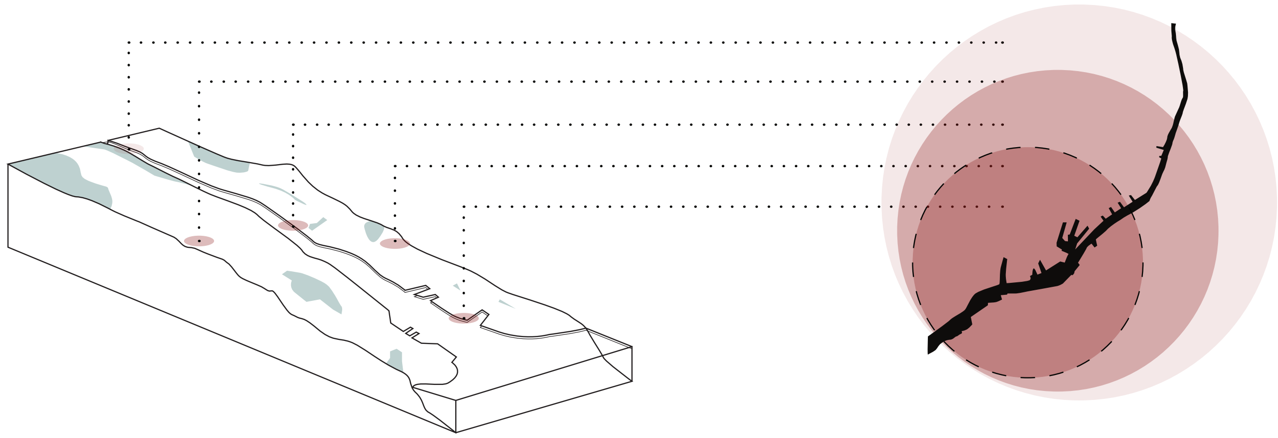
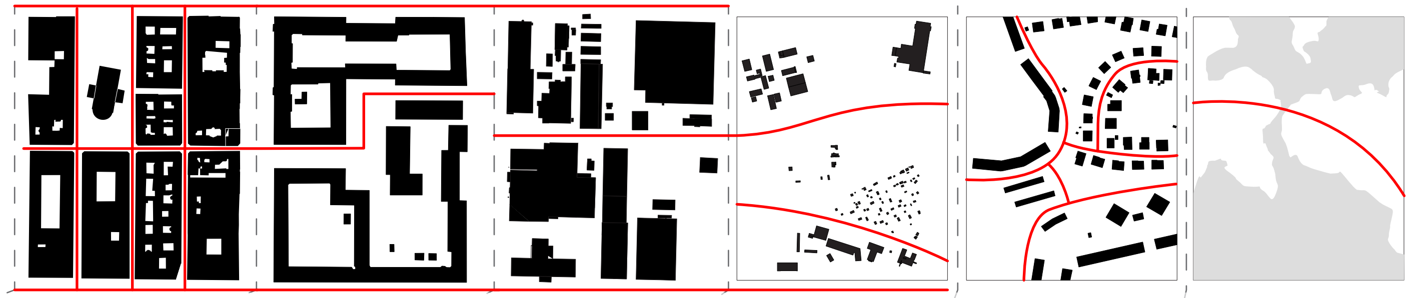


Figure 17: Urban Samples

Transect
The Urban Radius

To figure out the most suitable spot for an Ecosystem-based design narrative one must identify some location attributes that the city offers. The transect below shows existing typologies in a radius originating from the Gothenburg city core to the left, ending up in the natural zone at the city edge, to the right.

1 Urban Core | **2 Urban Centre** | **3 Urban Fringe** | **4 Rurban Fringe** | **5 Suburbia** | **6 Natural Zone**



1 Urban Core: The Urban Core is a dense and highly complex network of architecture and infrastructure with little room for pristine natural environments. The green areas that do exist are normally heavily programmed and bio-diversity poor. The road networks are logical and strict to support various flows of human traffic.

2 Urban Centre: The Urban Centre is relatively high in density with little green spaces. The road network is more assymetric and slightly less logical. Room for EbA are not found.

3 Urban Fringe: The urban fringe is dense with physical development but scarce with human population. Many socio-economic potential are to be found but the land is expensive and space damanding EbA are both spatially and economically inefficient this close to the urban core.

4 Rurban Fringe: In the periphery of the Urban fringe physical development is fragmented and scarce, yet relatively central. Patches of unprogrammed, left over pristine natural areas are to be found between industrial developments.

5 Suburbia: Gothenburg suburbs may look like they are lush with natural environment as fields of grass and trees surrounds housing units. Allthough suburban green spaces are most commonly homogenous in biodiversity and doesn't support a wider range of wildlife.

6 Natural Zone: The natural Zone is dense with bio-diversity as its functioning eco-systems has escaped human development. Such pristine areas are best left preserved in order to maintain the natural balance .

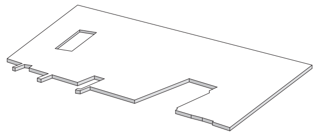
Figure 18: Urban transect of the Gothenburg context. From innercore on the left side to rural on the right.

The Urban Fringe

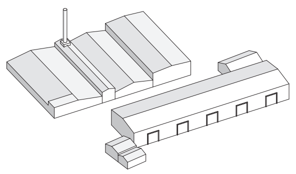
Positive & Negative Values

The Urban fringe is usually the most developed part of the urban periphery. This is a place where many stakeholders contest over cheap and relatively central land. As Riparian Fringes are often connected to shipping and industry there are immense infrastructural elements restricting ecosystems from flourishment. However, acupunctural interventions serving as green pitstops for migrating species might be a prominent solutions for these kinds of urban environments.

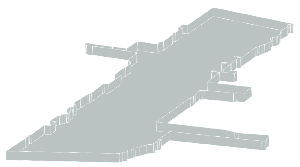
Components



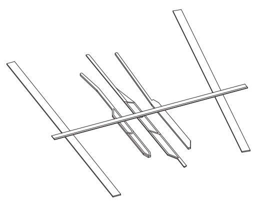
Landscape
Plain
Homogenous Terrain



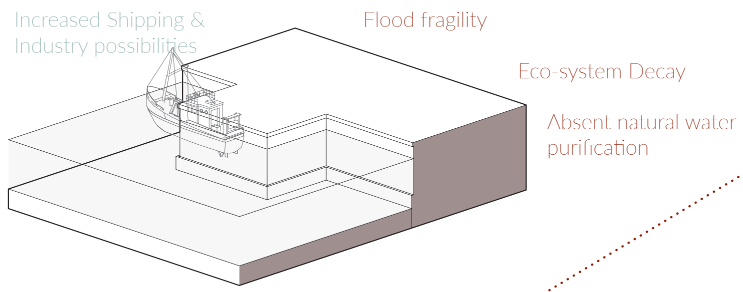
Built Environment
Industrial
Scale Variation
Elementary



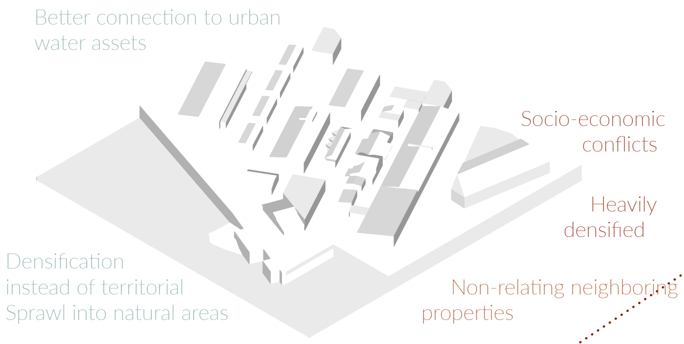
Aquatic Zone
Dredged River Bed
Heavily Modified



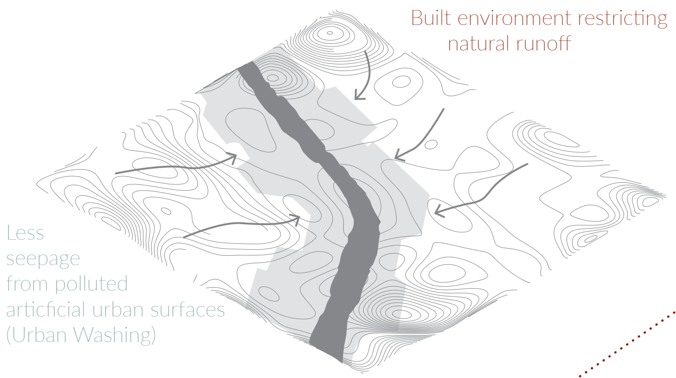
Infrastructure
Enclosing
Shaping
Fragmenting



Stark River Embankment



Dense Physical Development



Watershed Impairment

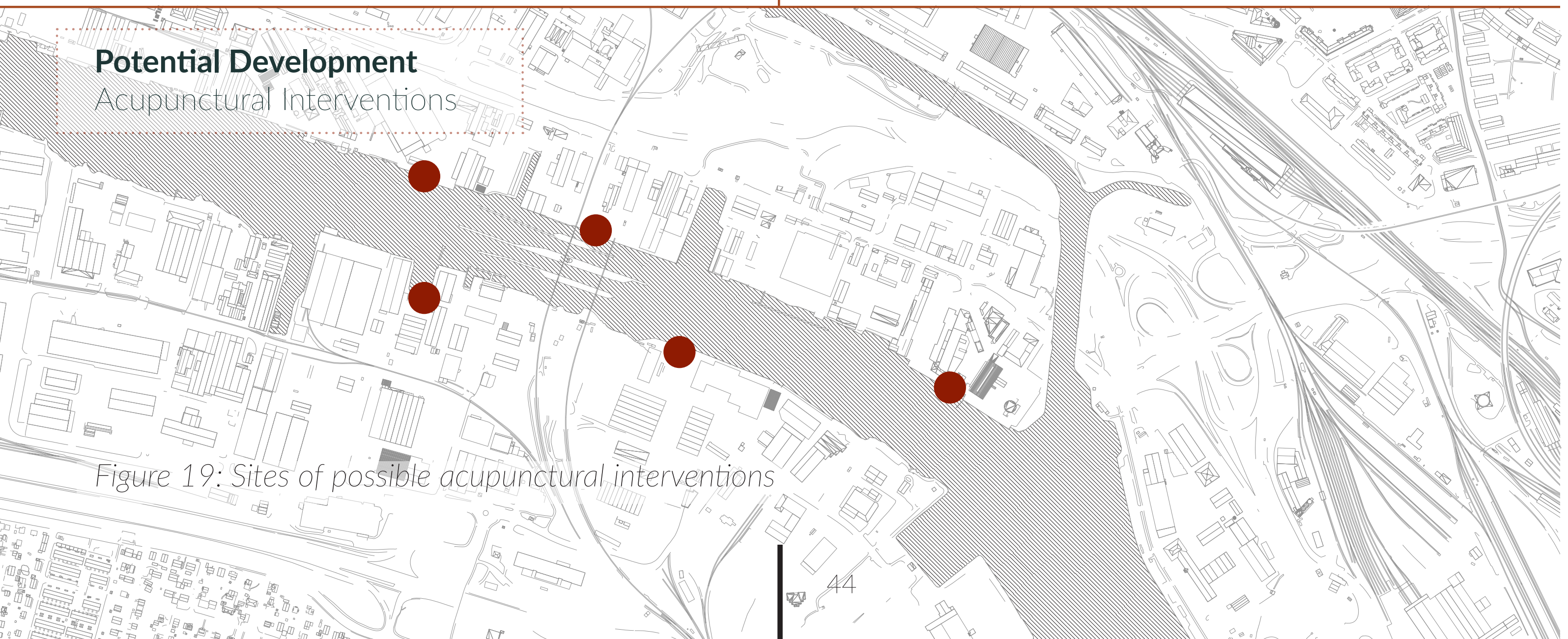


Figure 19: Sites of possible acupunctural interventions

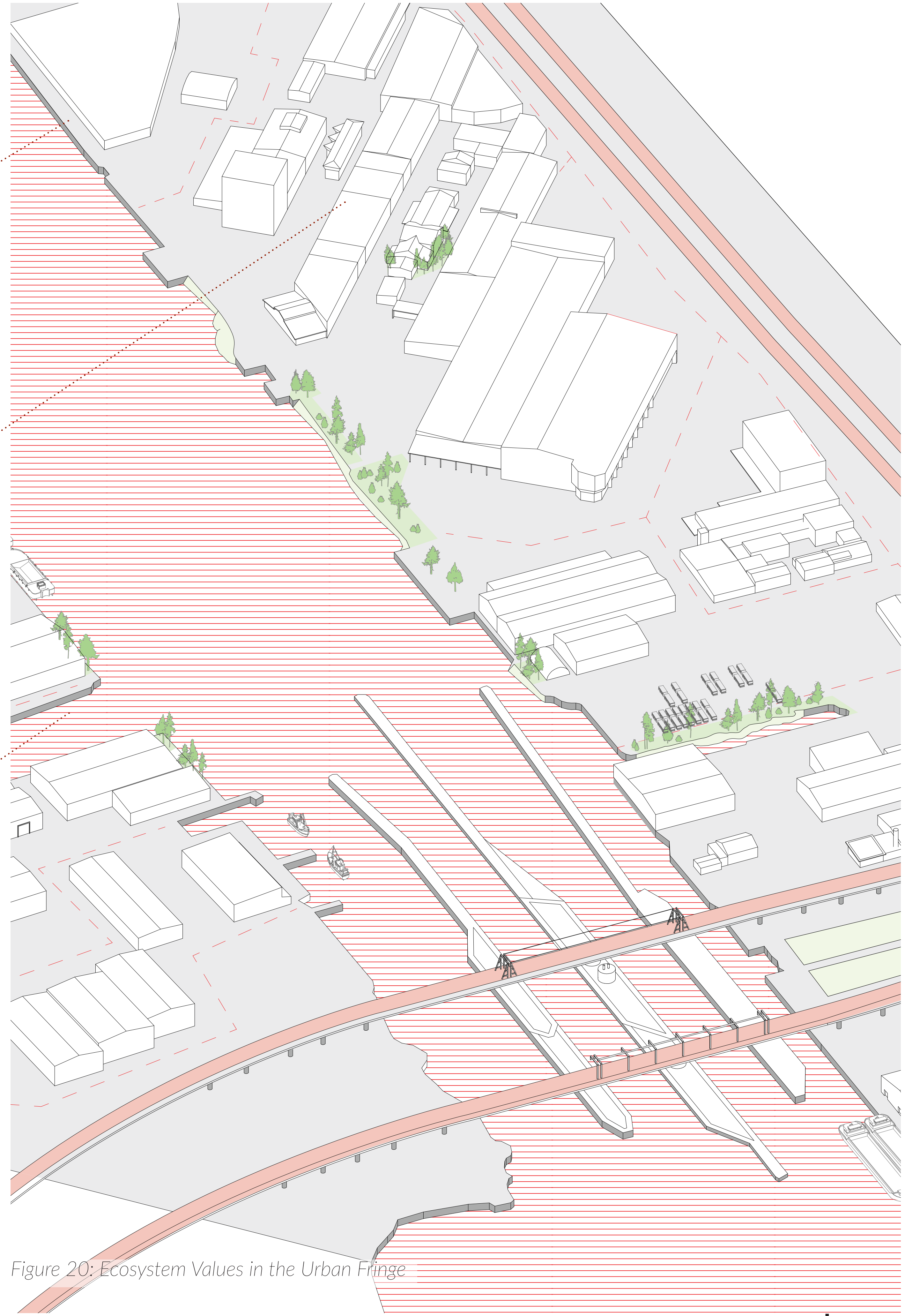


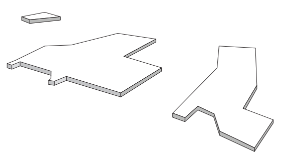
Figure 20: Ecosystem Values in the Urban Fringe

The Rurban Fringe

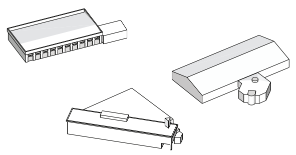
Positive & Negative Values

The Rurban fringe, as the urban and rural border, is a place that is more scarsely developed. This is where nature meets the city and architecture meets landscape. Here resides a mix of architectural typologies and organisations. The Rurban fringe hosts external markets, company complexes, city sustenence industries, Restaurants and transport terminals. The vast variety of functions on this land makes it a unique space for Aesthetic, ecological, Social and Economic possibilities.

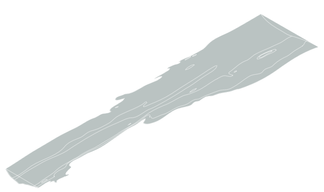
Components



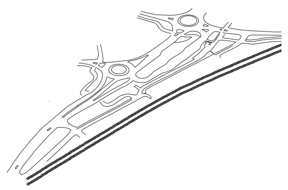
Landscape
Plain
Homogenous Terrain



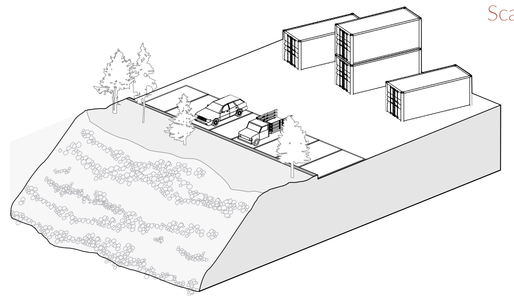
Built Environment
Industrial
Scale Variation
Elementary



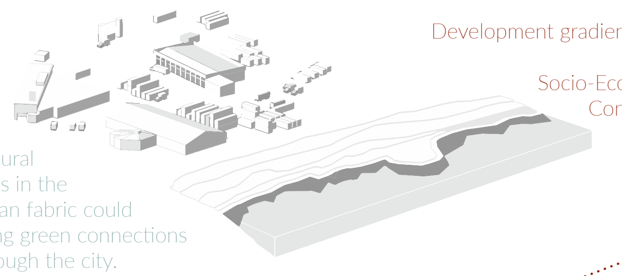
Aquatic Zone
Dredged River Bed
Partly Modified



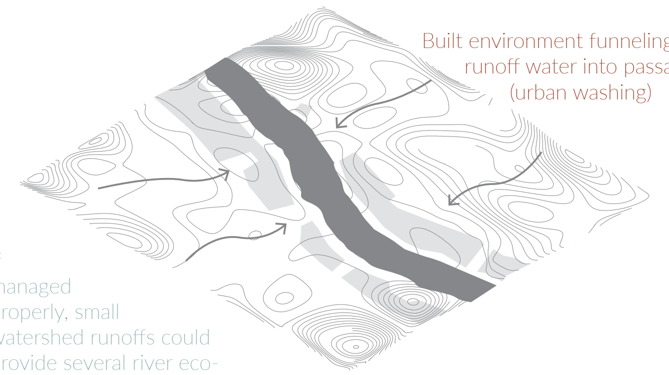
Infrastructure
Partly enclosing
Shaping
Patched



Modest River Embankment



Sprawled Physical Development



Watershed Impairment

Potential Development

Blurring the natural-artificial border

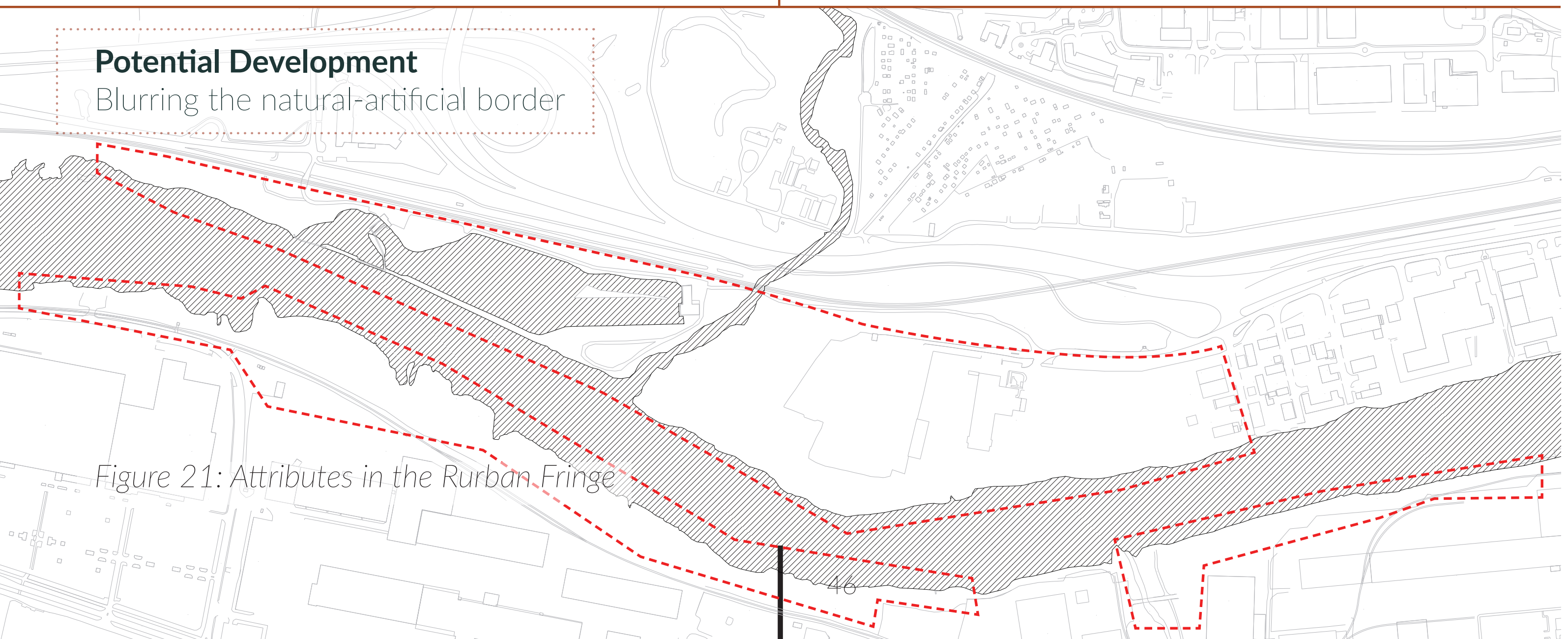


Figure 21: Attributes in the Rurban Fringe

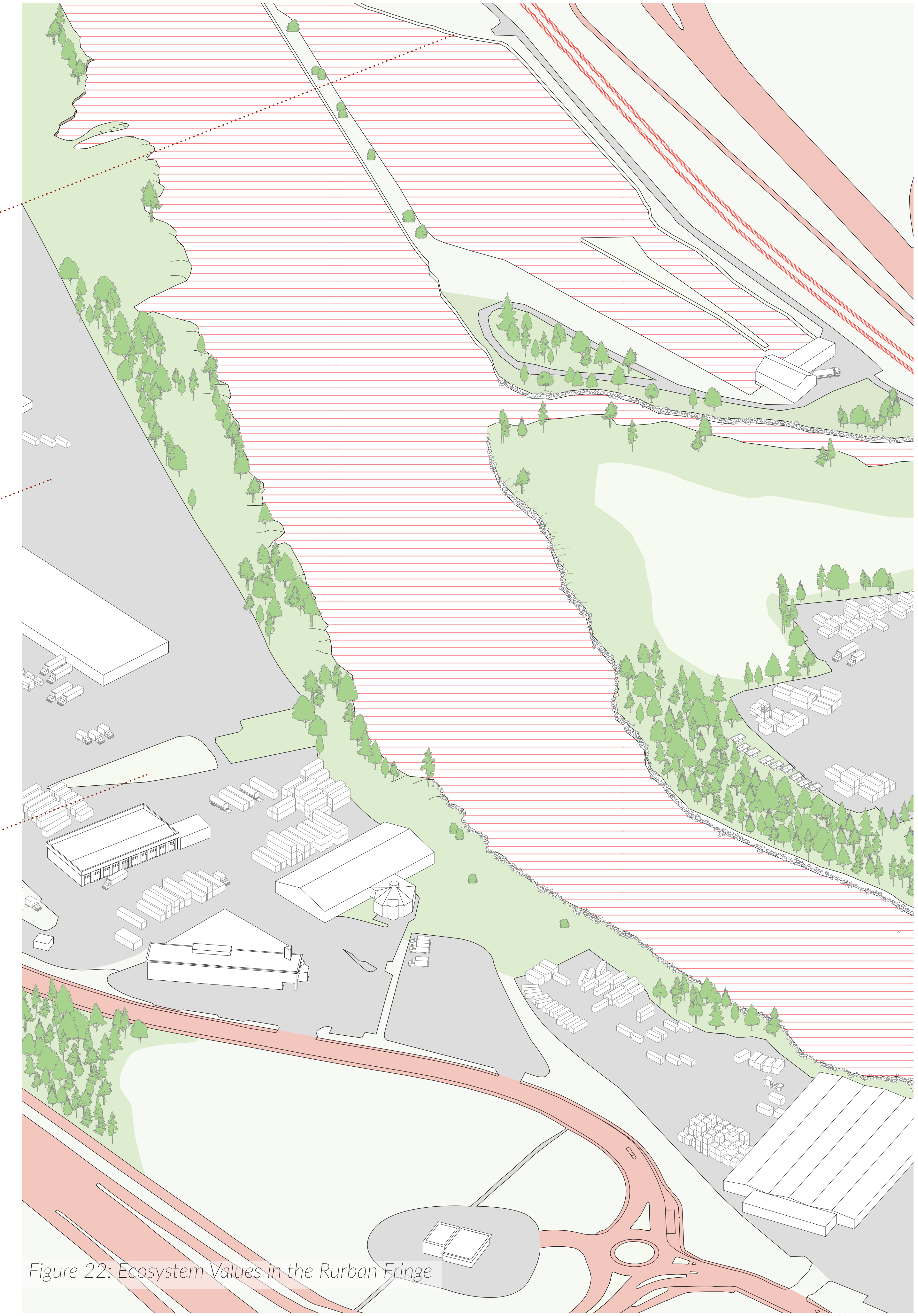


Figure 22: Ecosystem Values in the Rurban Fringe

Adaptation Design

Aquatic Support Modules

Submerged Habitats

Pristine submerged habitats such as reefs contain immense complex symbiotic relationships that is developed through time. By imitating the achievable positive features of these could support the revival of native mollusc and invertabrate species and in turn potentially serve decaying blue eco-systems and its keystone species with food suply, water purification and shelter.

Assembly Reef

Any depth

Laser/3D cut modules that are easy to assemble and possibly Added onto existing structures. The Structures could easily be printed in organic shapes, resembling pristine reefs and habitats.

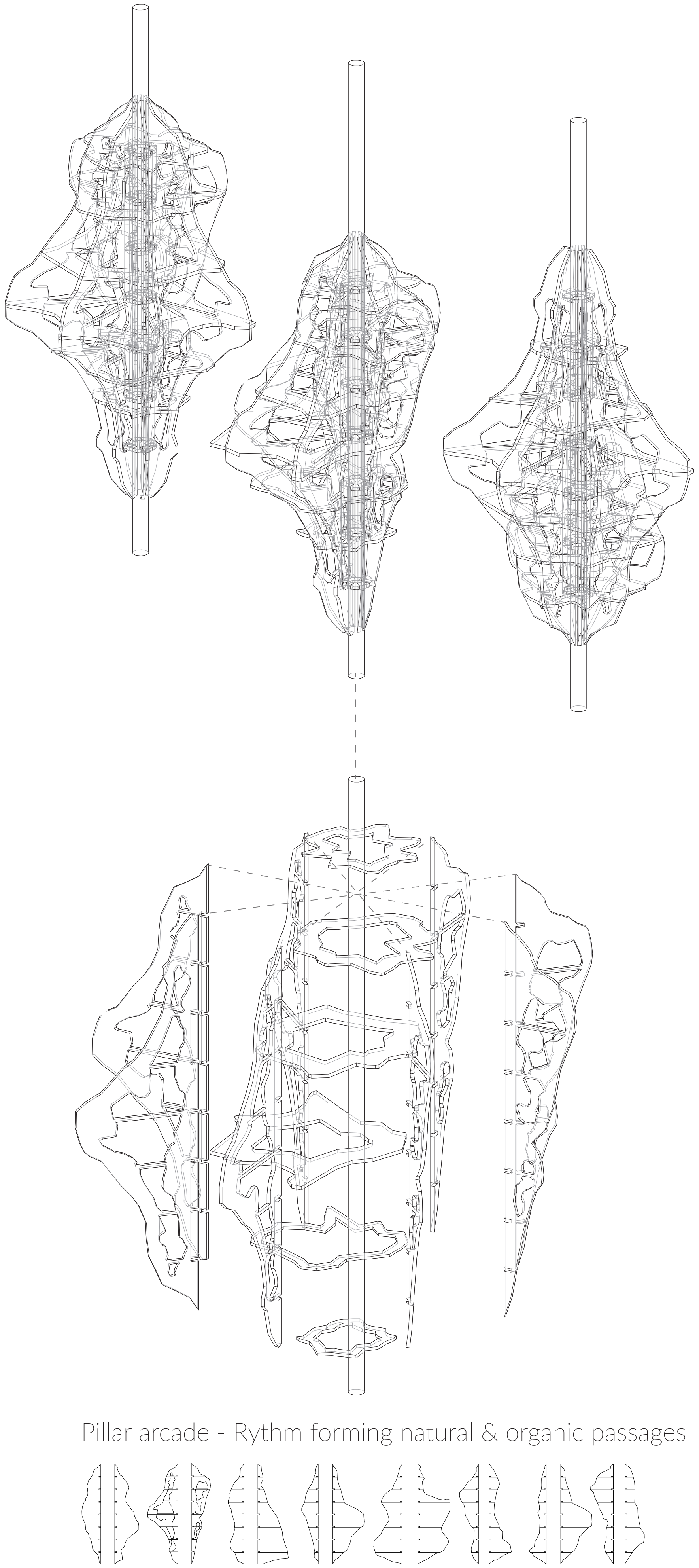
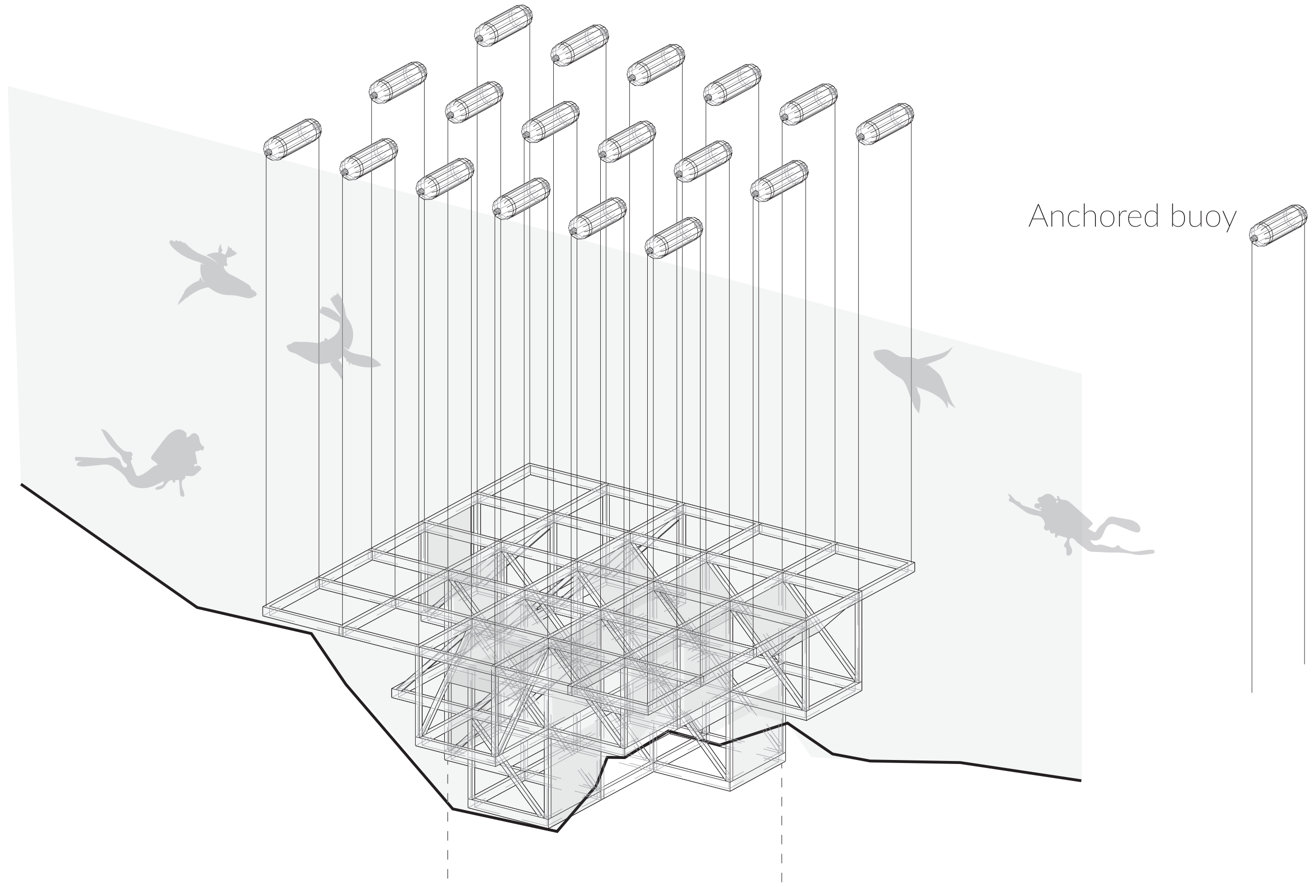


Figure 26: Axonometric - Assembly Cove Structure



Seaweed Reef

5-10m depth

Truss structures anchoring kelp wire.
The Seaweed Reef combines kelp forest possibilities with reefs to invite further bio-diversity.
The structure could be stationary or mobile.

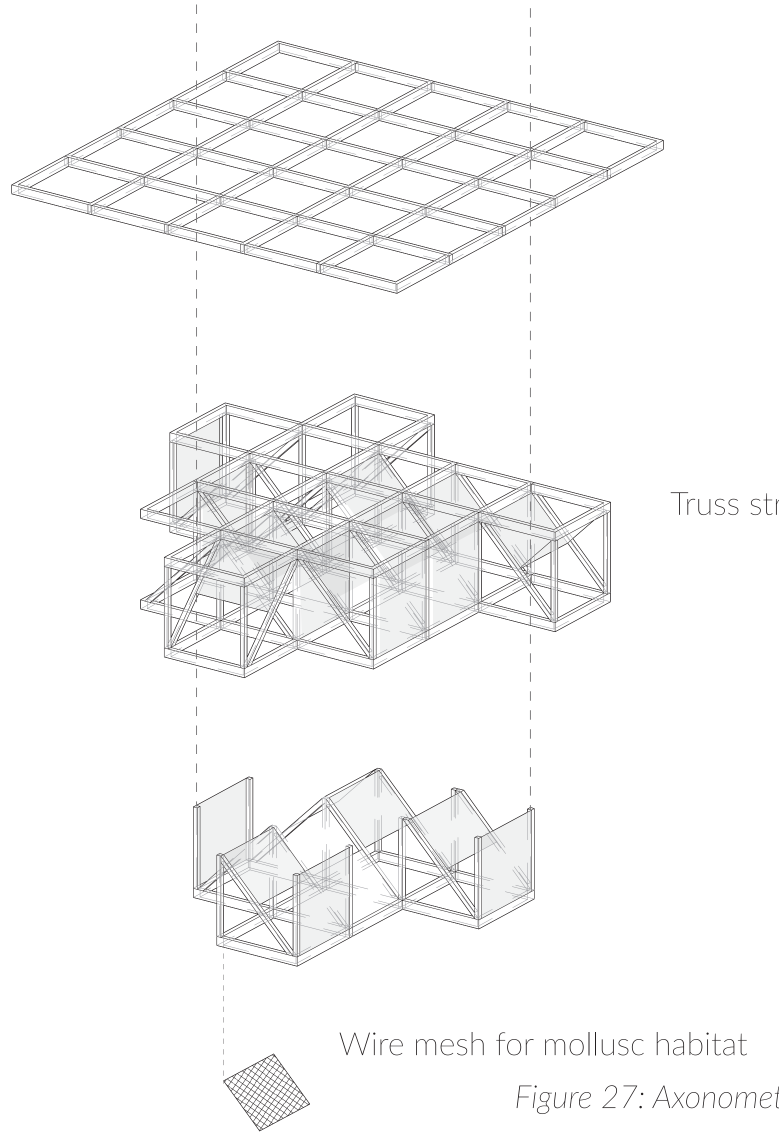


Figure 27: Axonometric - Seaweed Reef Structure

Oyster Nests
5-10m Depth
Wood/Steel + Wire
components are applied on
pillar beam structures
to host vertical oyster habitat.

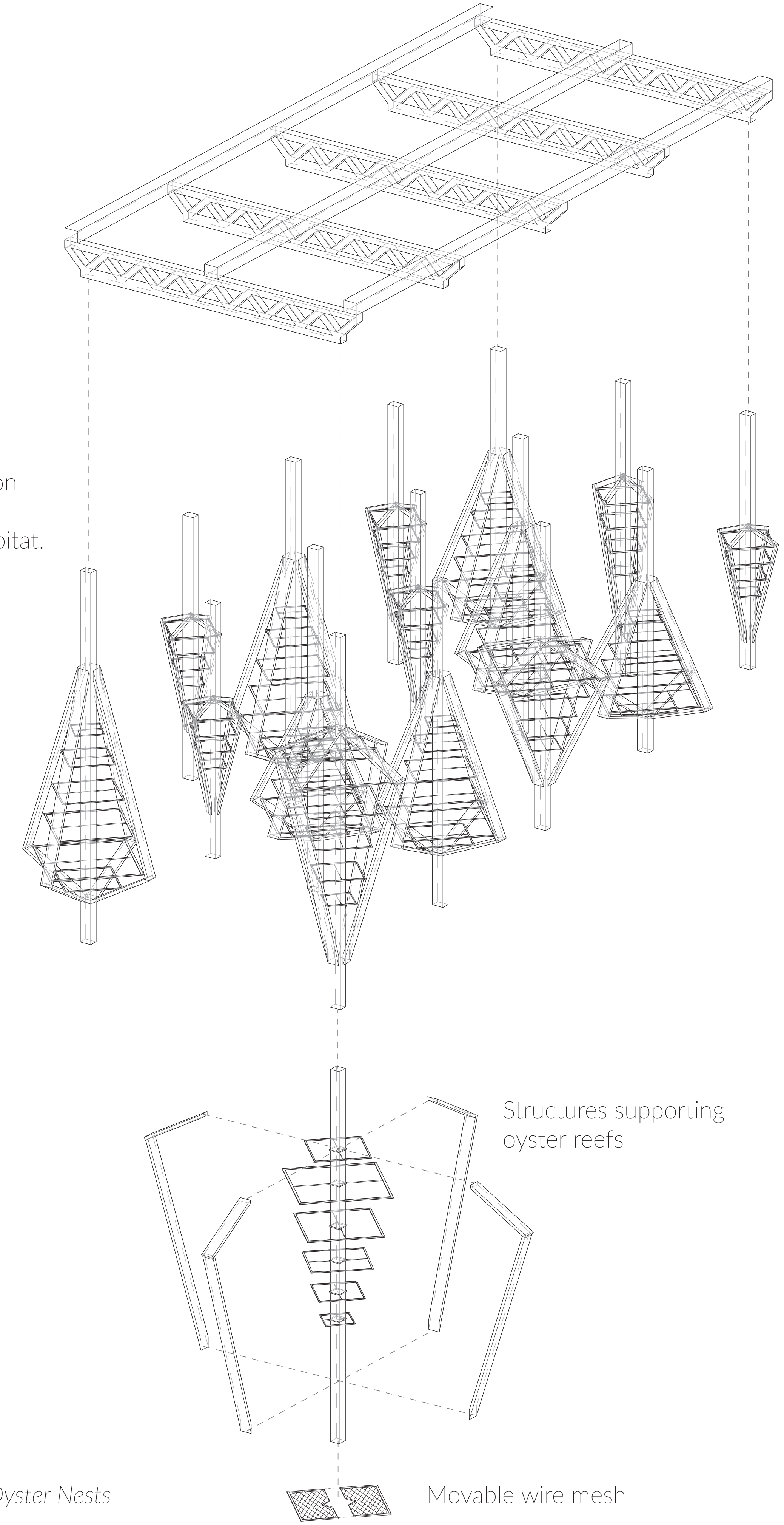


Figure 24: Axonometric - Oyster Nests

Building Structure
5-10m depth
Reinforced structure
to support submerged
habitats and recreational
activities

Lifetubes
1-Xm depth
40-100cm diameter
concrete tubes to carry
sediment for vegetation
and shelter within the
tube.

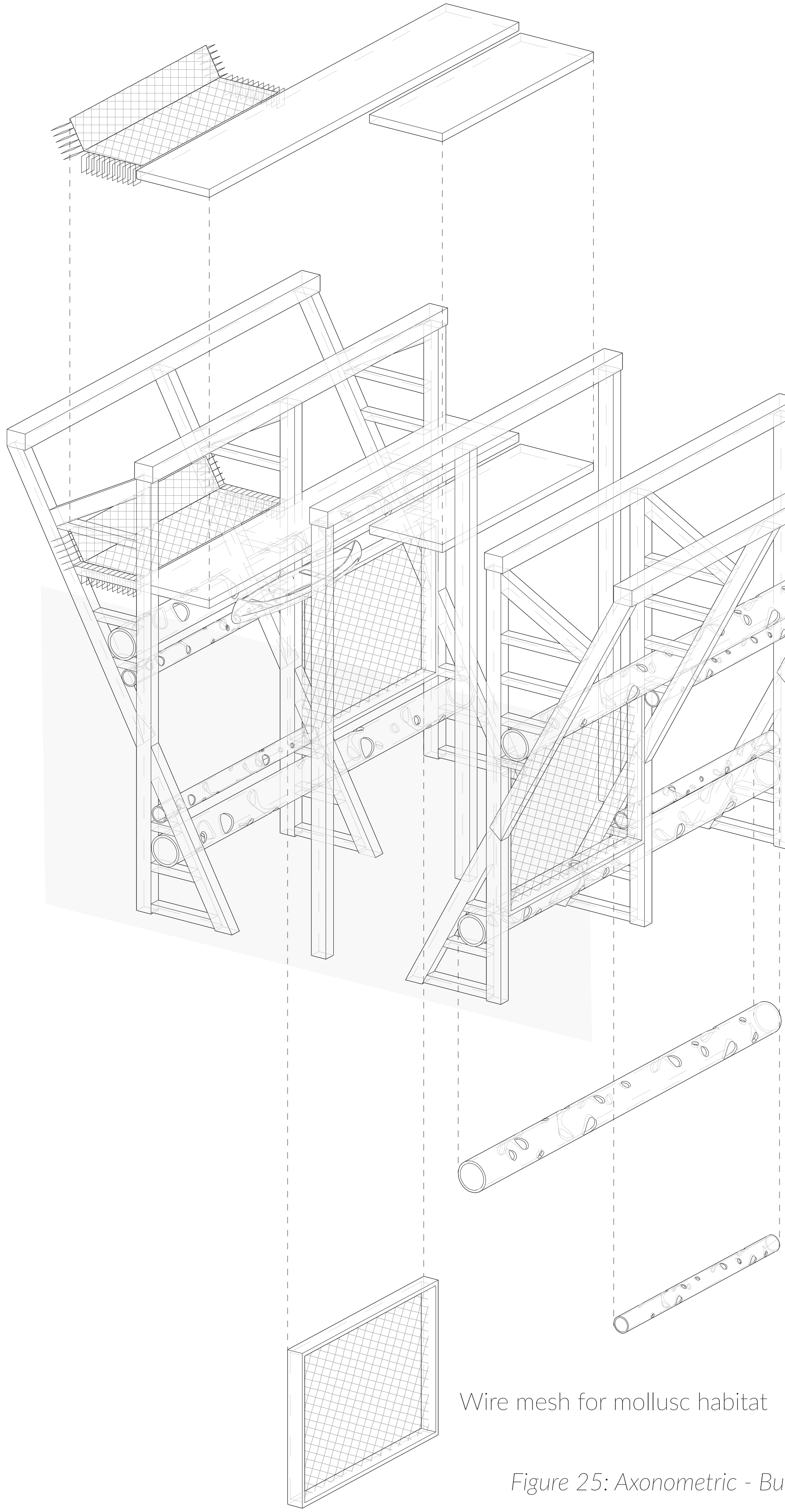
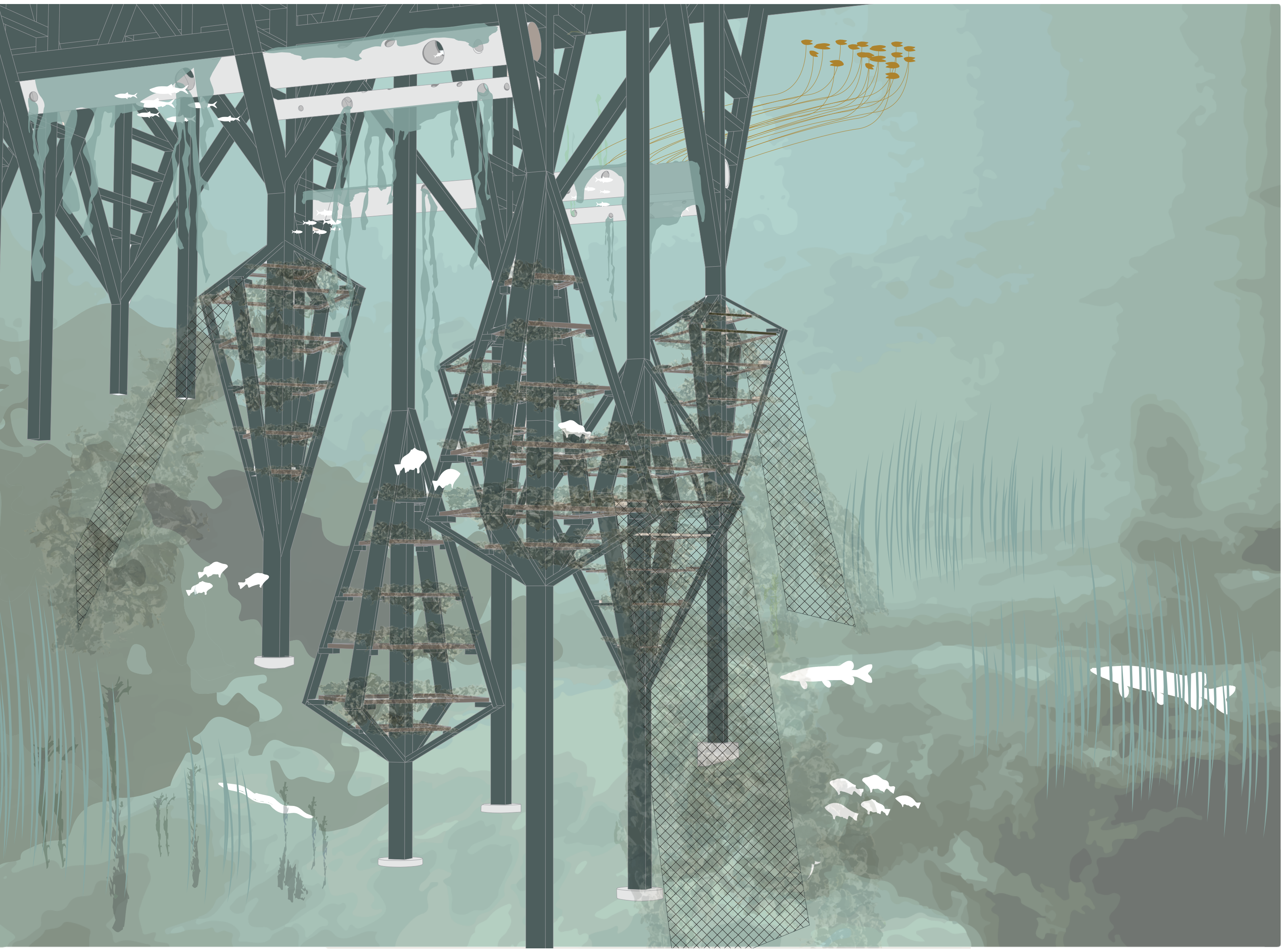


Figure 25: Axonometric - Building Structure with Additions



Composition of submerged habitats - 1 year estimated establishment

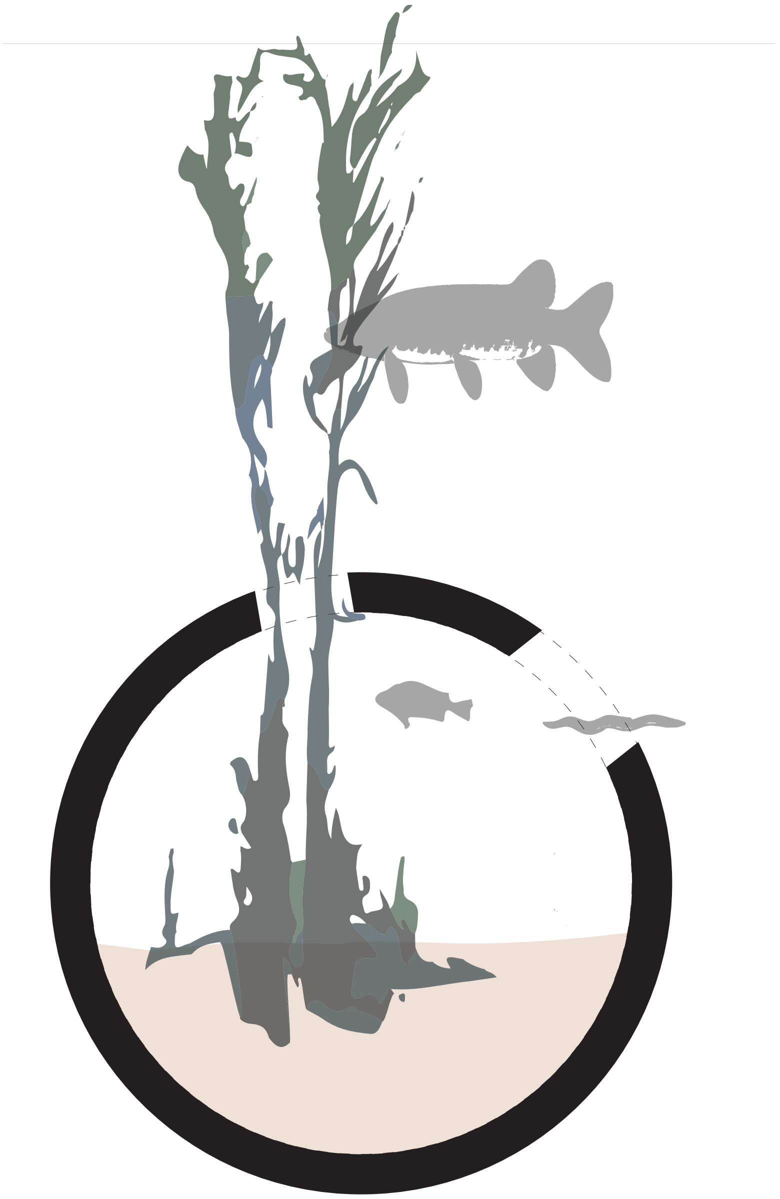


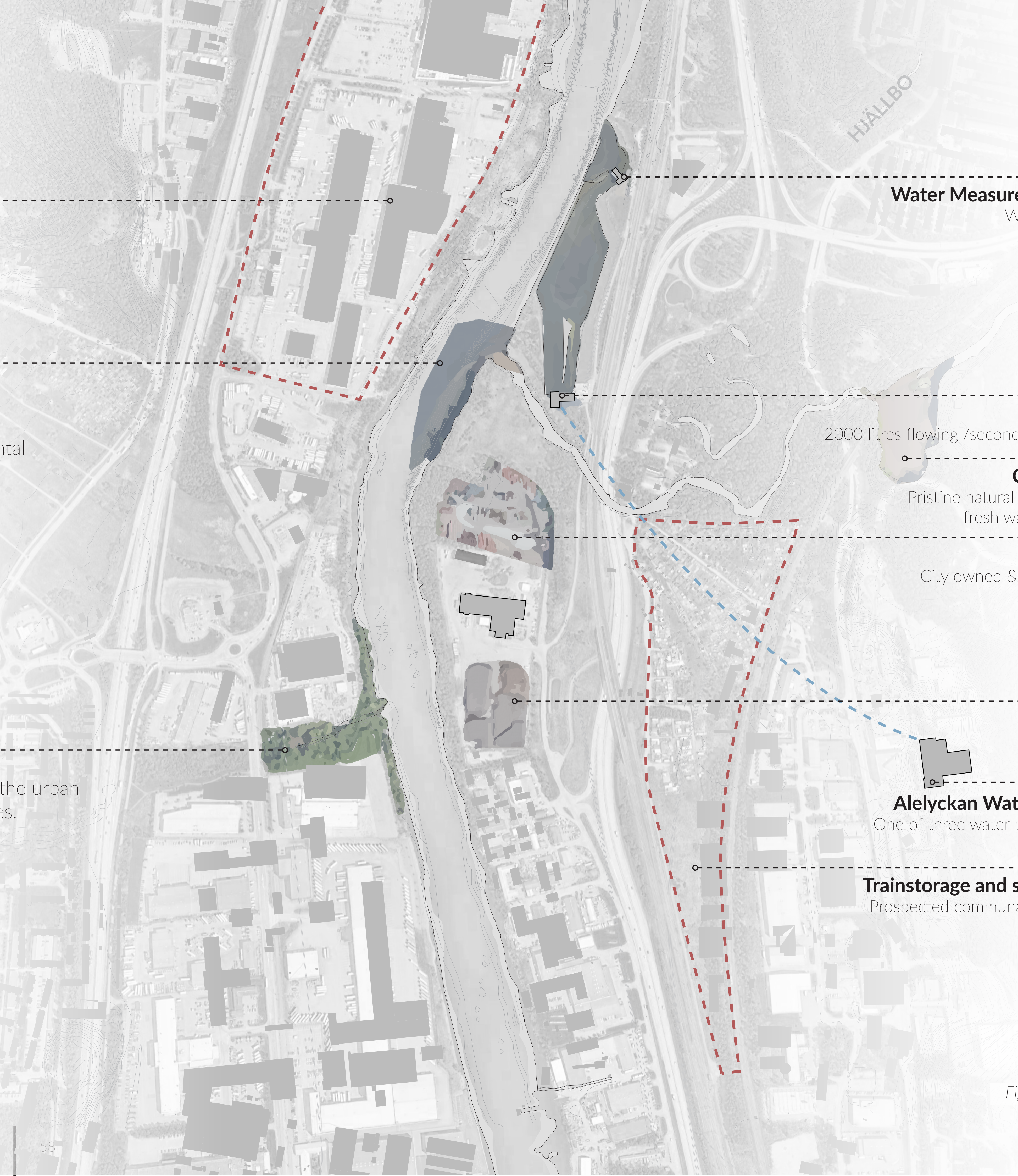
Figure 23: Section - Lifetube

Riparian Repair

Building with the Principles

In an attempt to move from theory to practice the adaptation design and concepts of conservation and ecology are taken into a specific context at the Göta Älv Riparian zone. The design proposal illustrates a digestation of these concepts and designs, funneled through the prerequisites and characteristics of the site.

Site Qualities
Unique properties



External shopping centre
Proximity to public activities

River Confluence
Browned water, rich with metals and humus, blends with Göta Älv nutrient poor water, creates unique environmental properties in the confluence zone.

Water Runoff
One of few preserved natural areas in the urban riparian zone, carries wetland properties.

Water Measurement & Filtration
Water treatment facility

Raw Water Inlet
2000 litres flowing /second <0.5% total river flow

City Water Reserve
Pristine natural environment providing fresh water buffert for the city

Container Storage
City owned & flexible container yard

Renova
Garden and natural waste landfill

Alelyckan Water Treatment Plant
One of three water purification stations for the Gothenburg region

Trainstorage and skyfall water buffer
Prospected communal development project

Figure 29: Map - Site Qualities

GÖTA ÄLV RIVER

INPUT

PROCESSES

OUTPUT

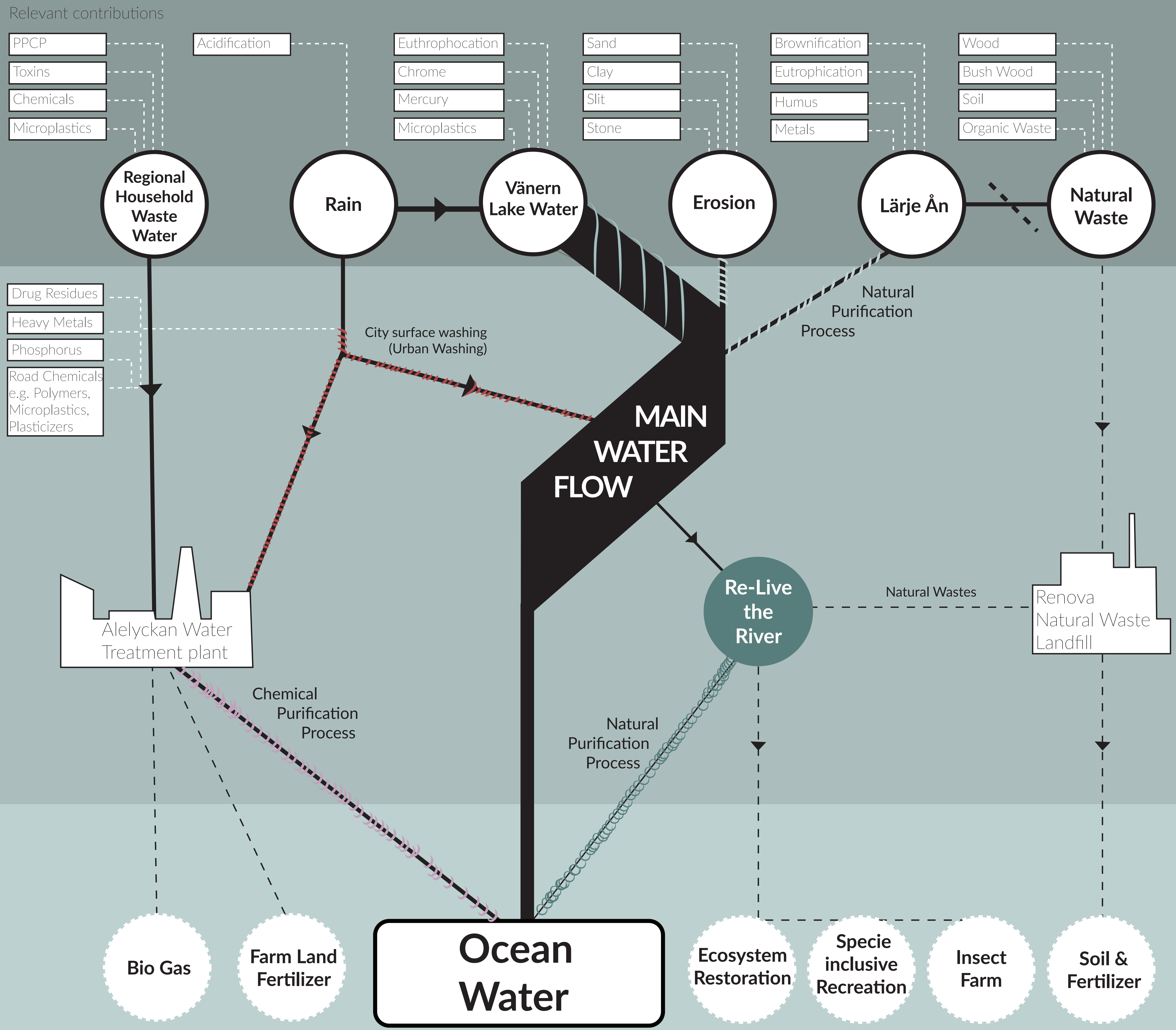


Figure 30. Potential ecosystem services on the developed site

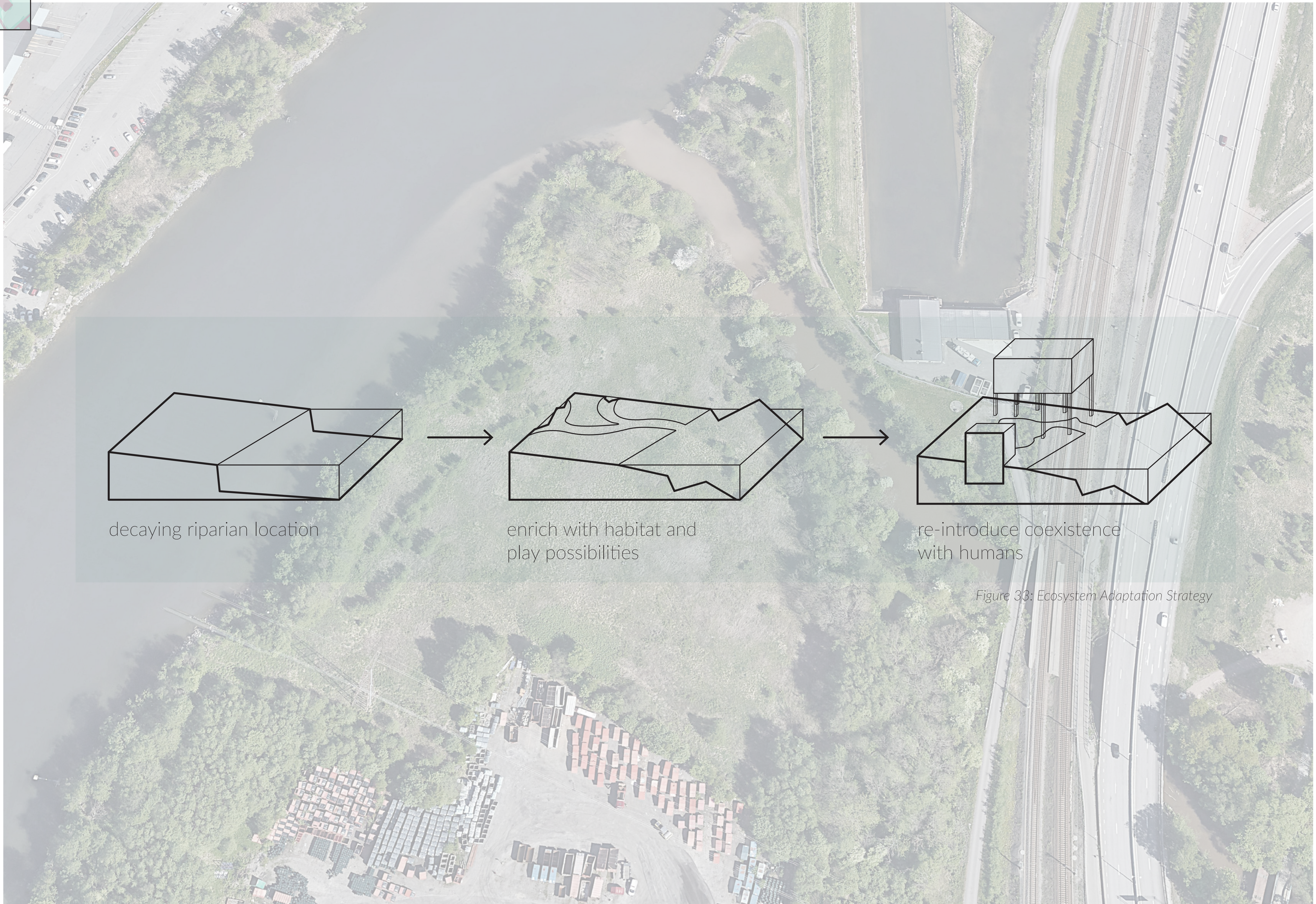
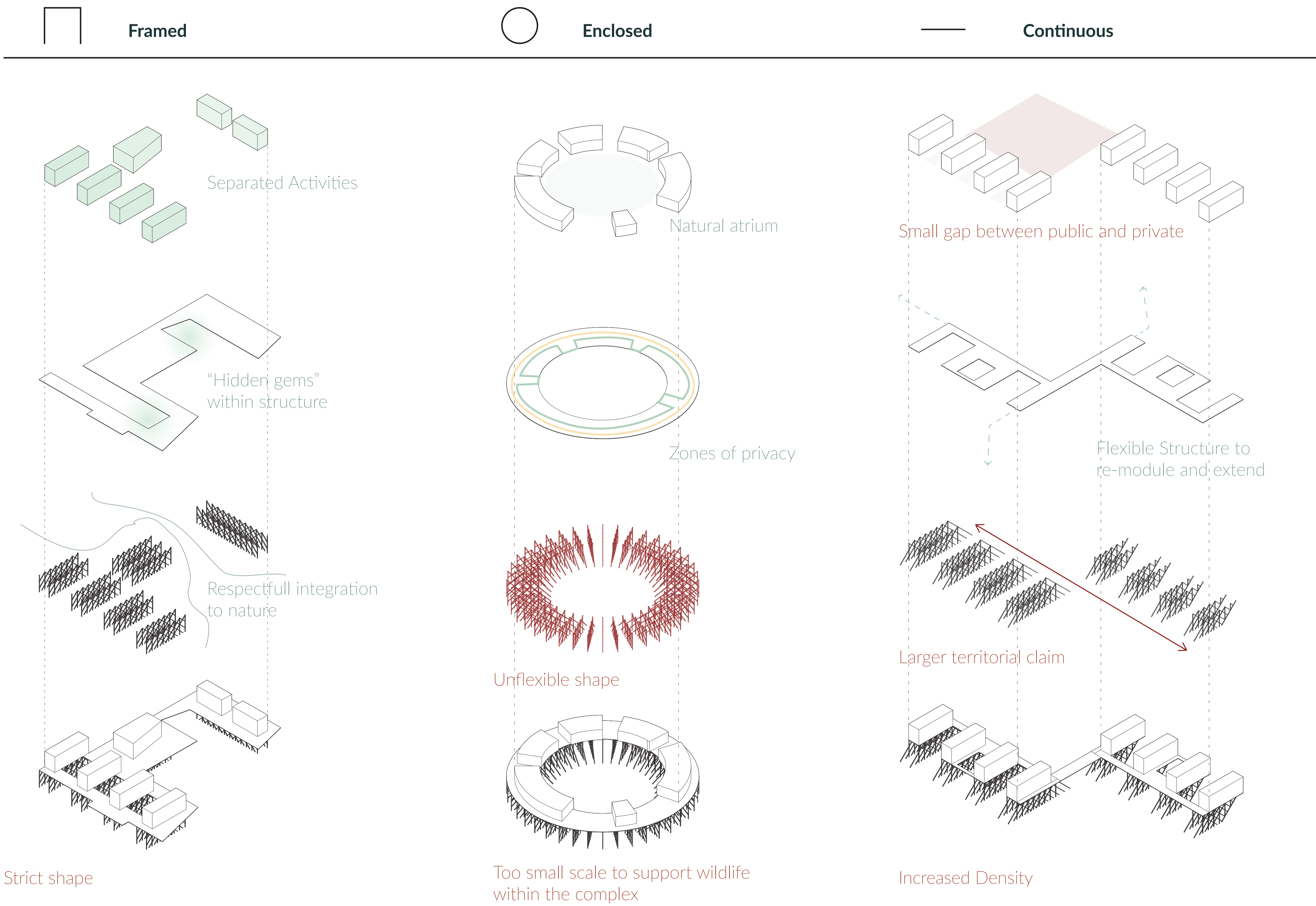


Figure 33: Ecosystem Adaptation Strategy

Landscape Composition



Creating a spatial relationship with nature

The shape and constellation of the built environment will greatly impact the natural landscape. Examples to the right shows what positive and negative potential the built form have when integrated with the landscape and ecosystem.

Figure 32: Axonometric - Building Compositions study on the developed lanscape

Introducing Coexistence

Figure 28: Axonometric - Landscape Footprint

Reestablishing the Wetland

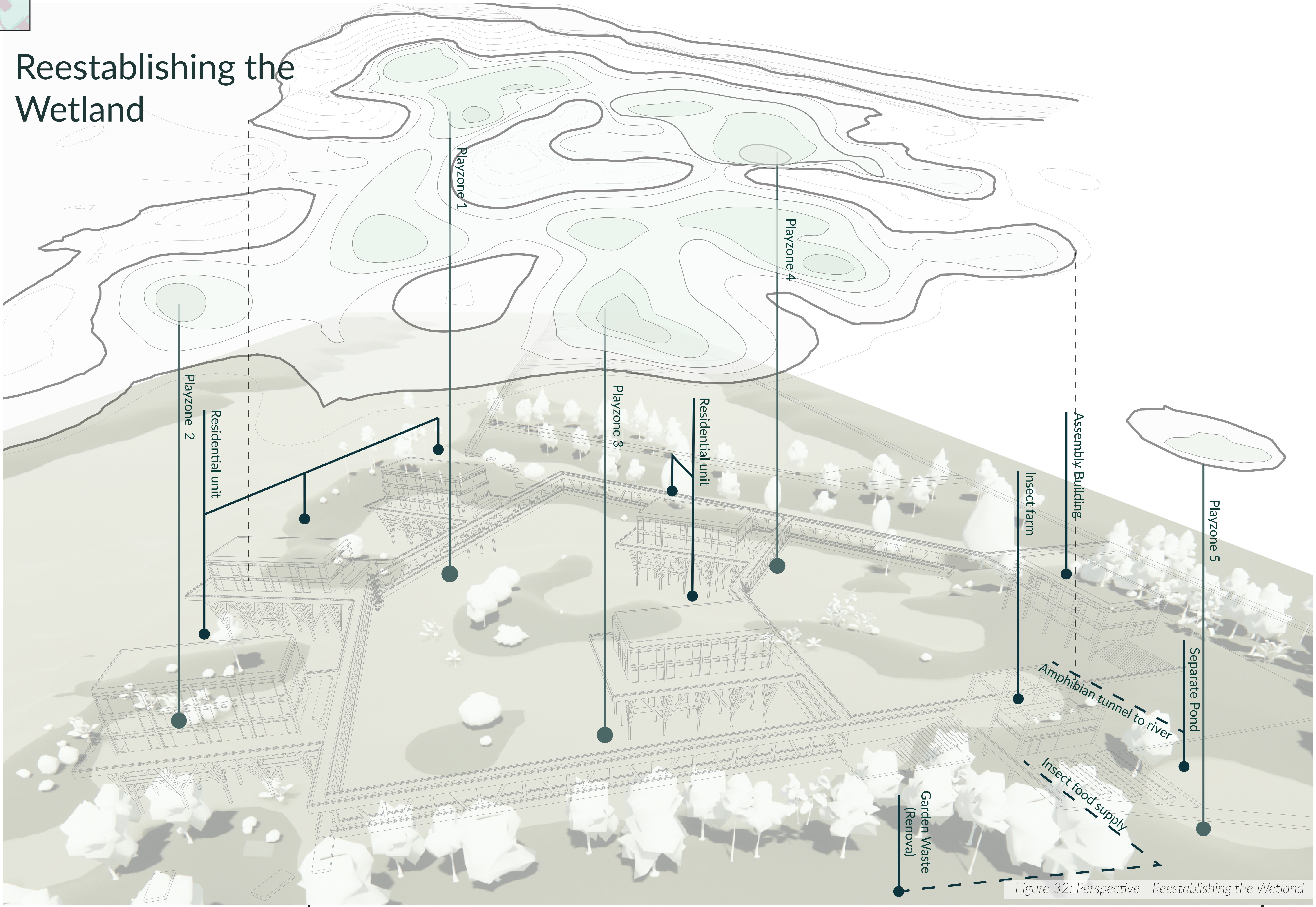


Figure 32: Perspective - Reestablishing the Wetland

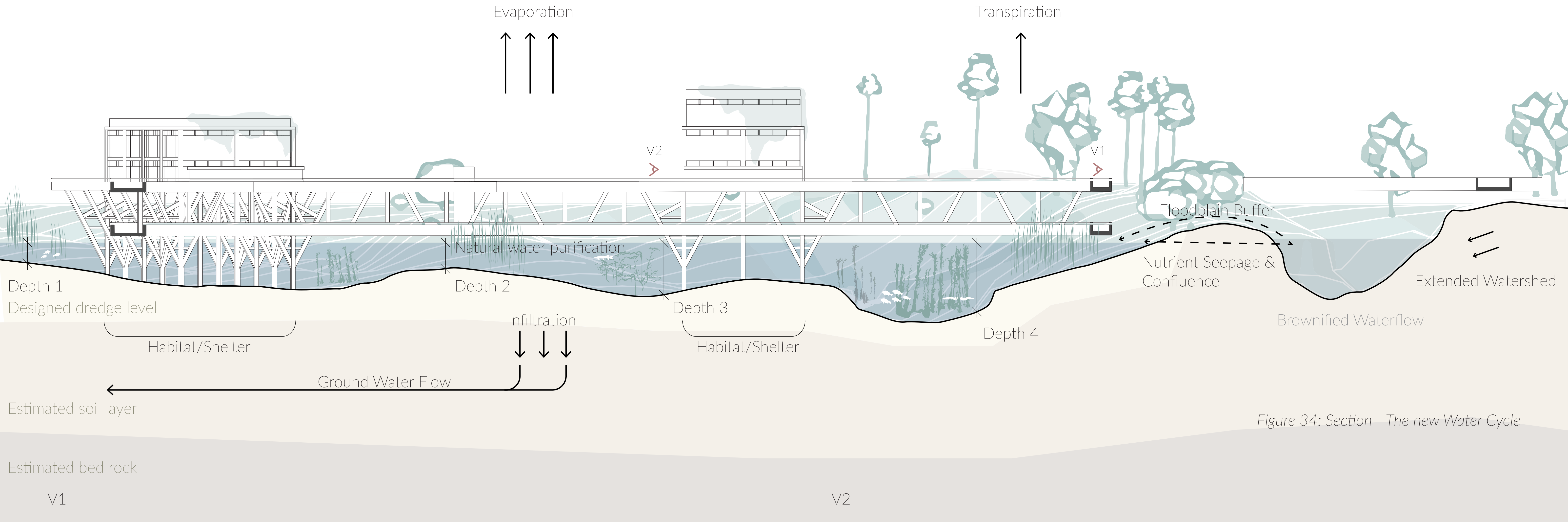


Figure 34: Section - The new Water Cycle

The Gantries

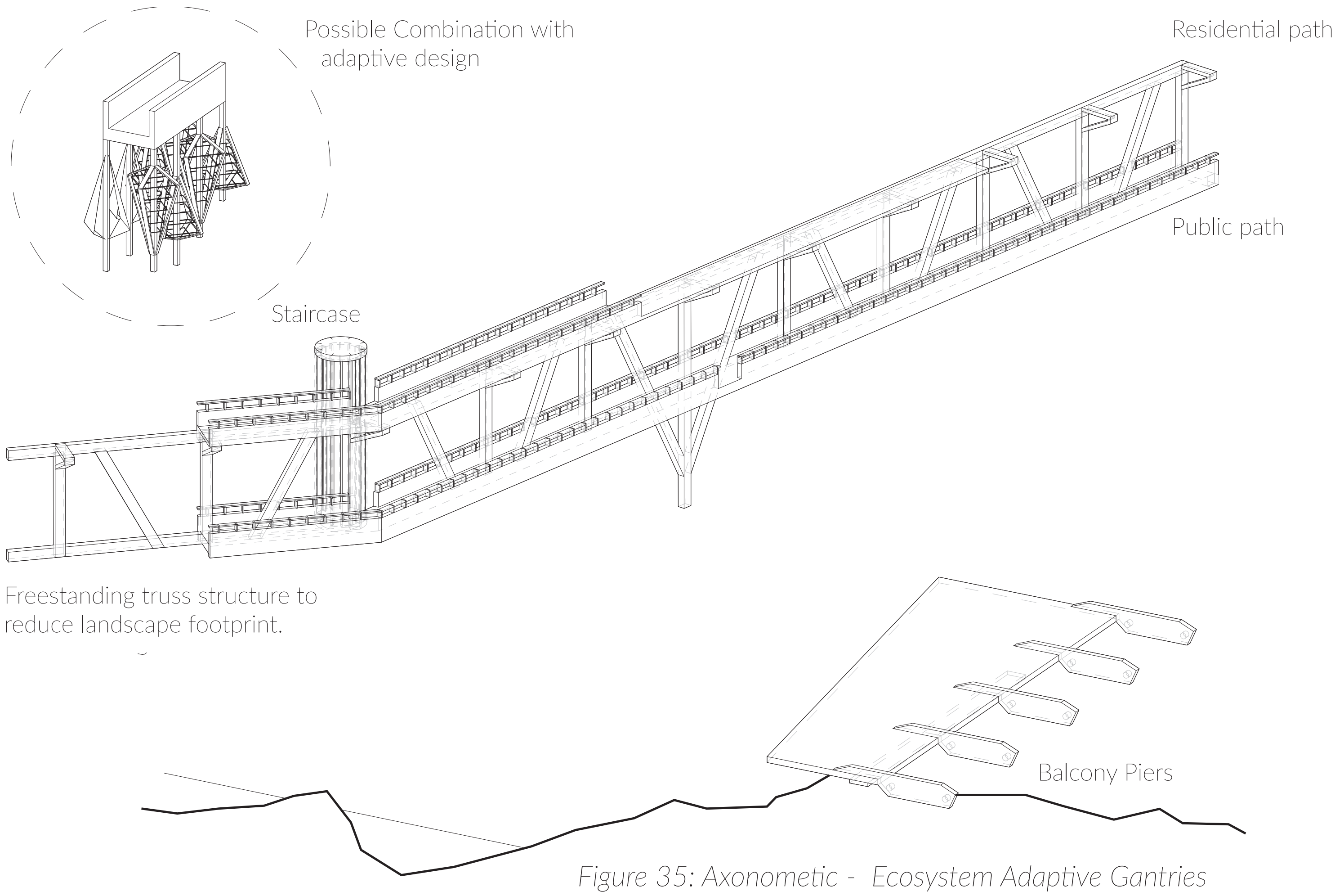
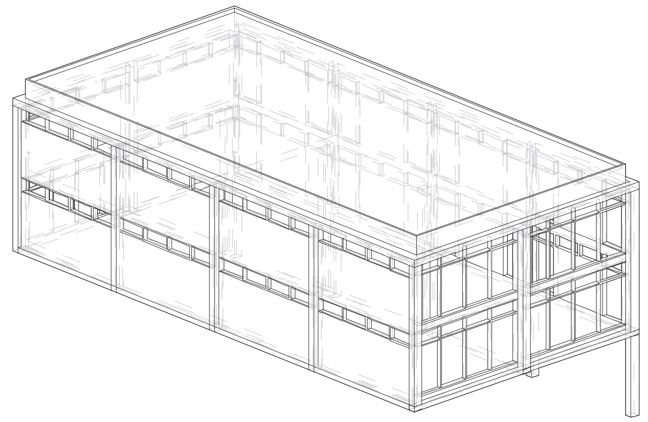


Figure 35: Axonometic - Ecosystem Adaptive Gantries

Assembly Building



Insect Farm

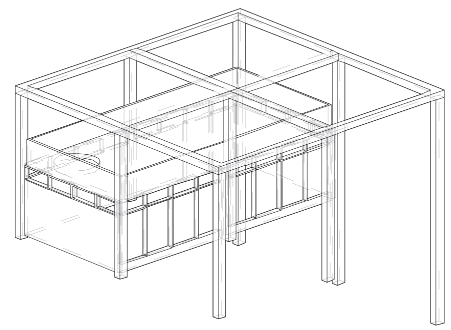
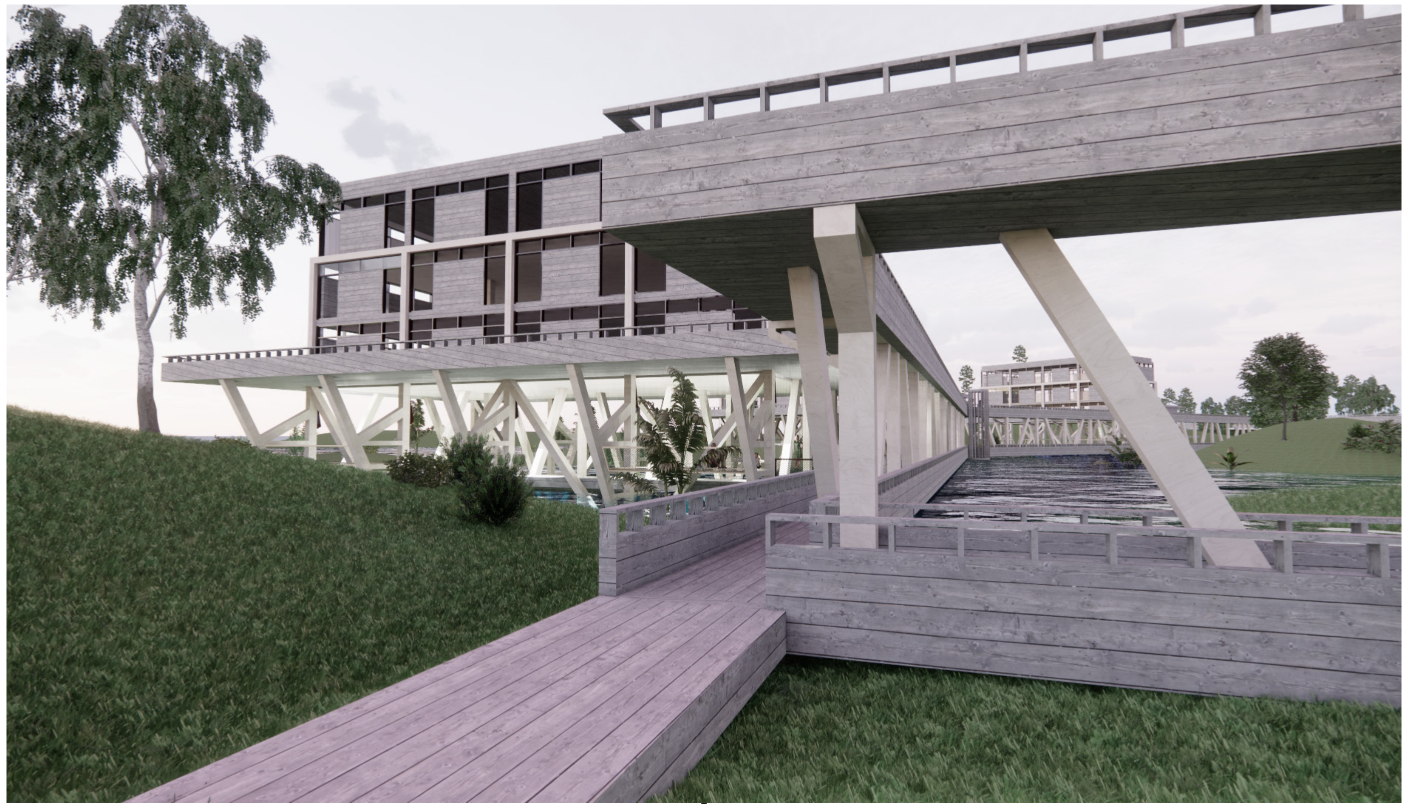
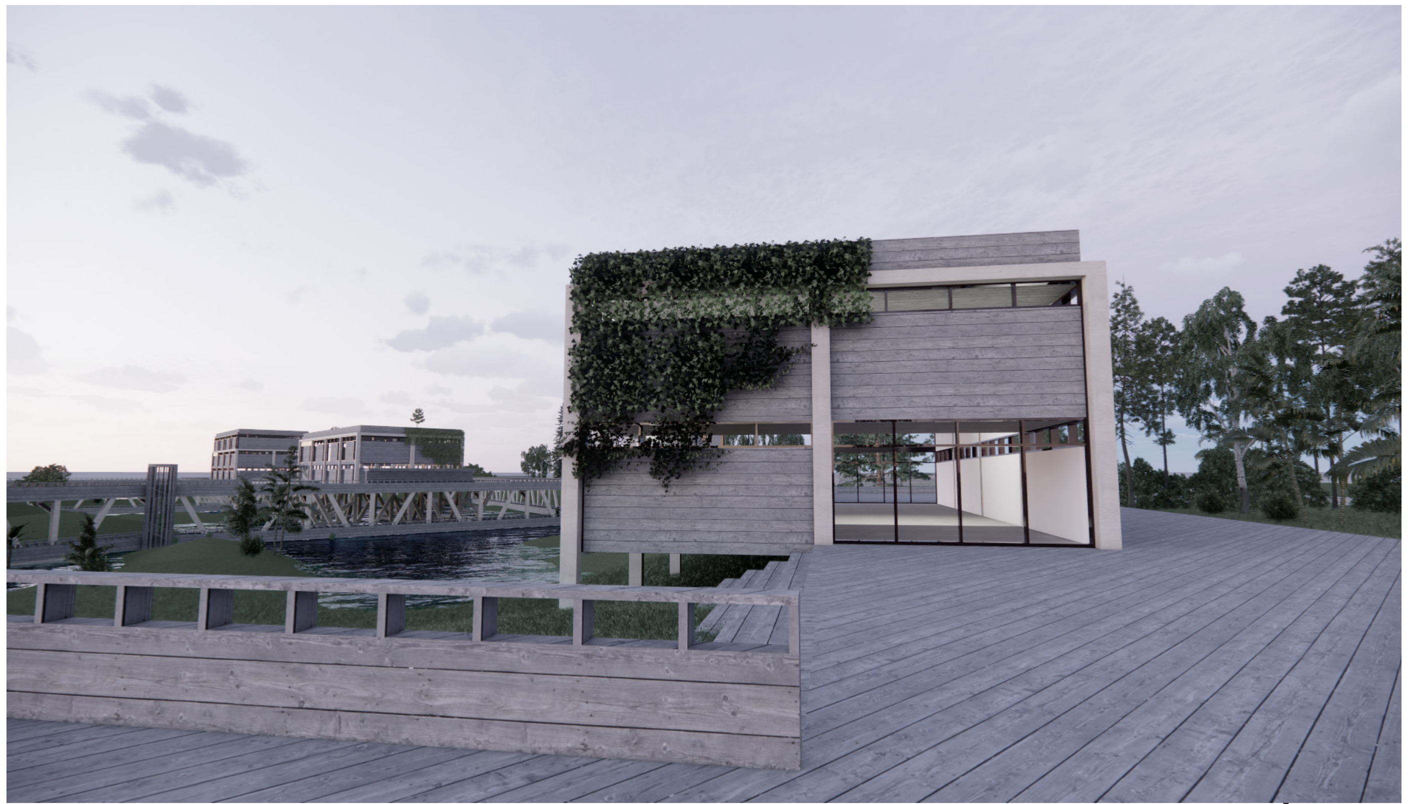


Figure 36: Axonometic - Shell Structures of the Creation house & Insect farm





The Mollusc

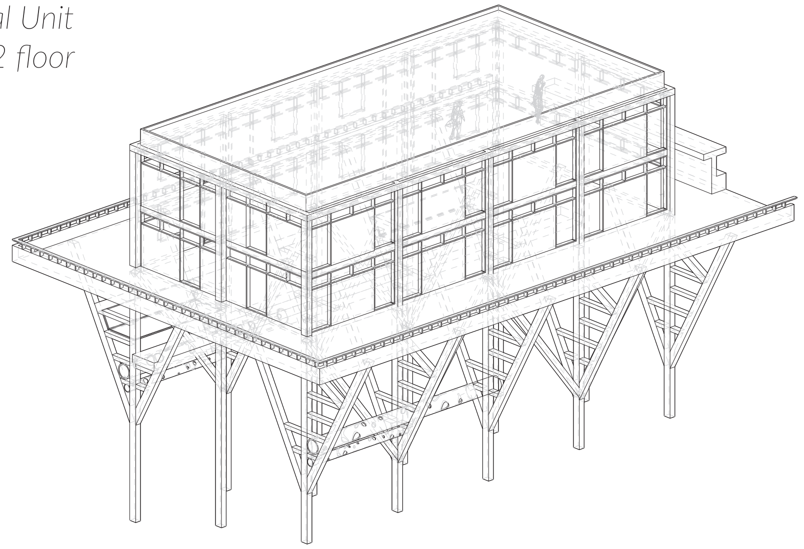


Figure 37: Axonometic - Shell Structure of the Mollusc with submerged habitats and recreational gantries

The Elder Mollusc

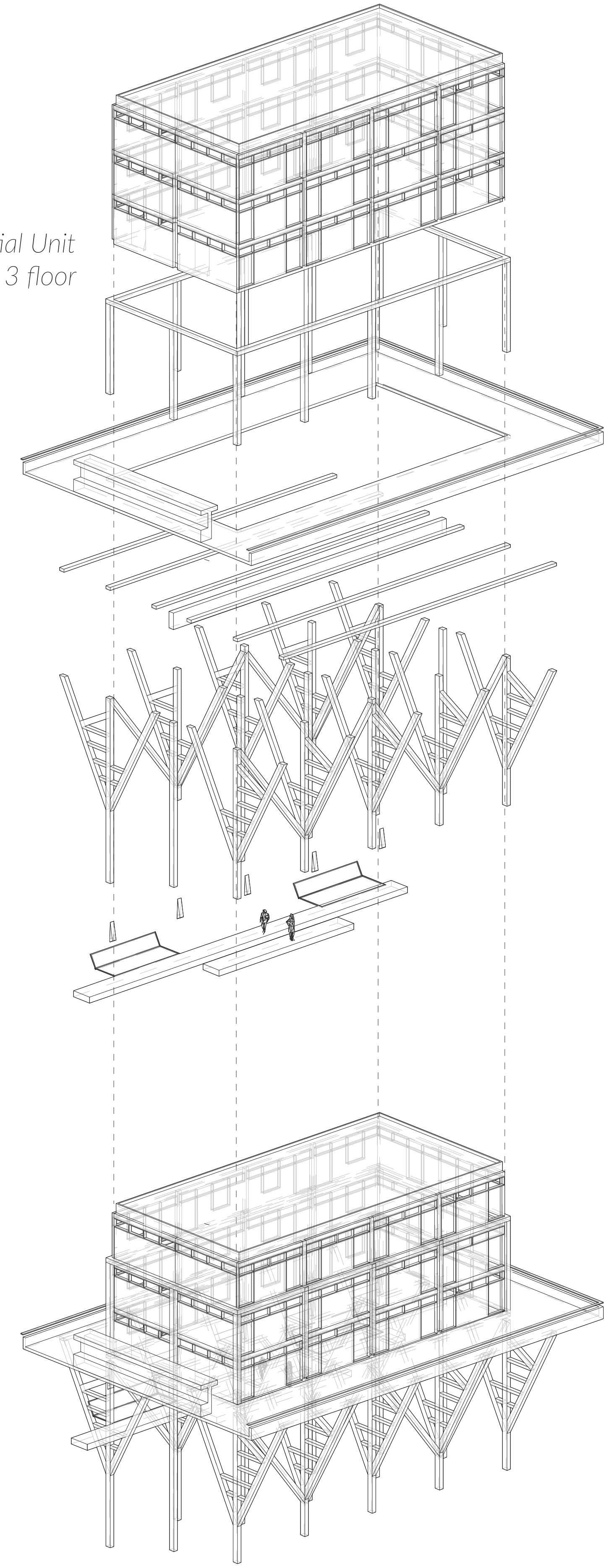


Figure 38: Axonometic - Shell Structure of the Elder Mollusc with submerged habitats and recreational gantries

Discussion

Confronting the challenges of interconnected urban, riparian and aquatic ecosystems from an architectural standpoint has been complicated since knowledge about ecosystems requires studies in other professional disciplines, such as biological science, conservation or ecology. Proper nature inclusiveness in architecture is complex as it is but integrating our human world could feel like a mission impossible. To robustfully and sustainably integrate physical development with the all parameters of nature we need analysis of spatial, biophysical, chemical values along with natural patterns which might be problematic to gain insight into within the boundaries of the architect toolbox. Using a set of recognized conservation concepts helped frame the threats and how to respond to them along with how to form the landscape for the purpose. I believe that if more architects were aware of such concepts there would be much more confidence in architects to build and simultaneously include ecosystems.

Concepts promoting pristine natural landscape were applied into the project discourse to more accurately pinpoint the reasonable response measures. However did none of these concepts bring forth any answers on how to act in a highly manipulated and polluted context which the project targets, meaning that in the worst case scenario measures of adaptation could become fraudulent, irrelevant or dysfunctional.
As the thesis attempts to recognize large scale threats such as increasing climate change impacts and water chemistry imbalances it became obvious that the interventions also risk becoming irrelevant because of unforeseen environmental reactions. However, working with these risks, visioning a future scenario where the Antopocen is not as radical as many times believed gave a sense of comfort and activistic courage to contribute to wildlife conservation through architecture.

Acknowledging architectures potential to strengthen ecosystem regeneration was utmost important as it recognizes nature inclusiveness as a long-term, multi-beneficial win-win situation for both the local context and the city as a whole.

Ecosystems are dynamic which brings the challenge of thorough local research before developing a site of ecological value. Reestablishing a wetland for example might require interdisciplinary competence for water management and connected issues, raising questions of economic viability. Other parameters of hesitance for companies could be fear of building another kind of typology with another focus.

To build with an environmentally regenerative mindset it is crucial that landscape architects in particular are included early on i process since they possess wider knowledge about nature and the benefits of preserving/creating natural zones.

Architecture seen from a holistic environmental view seems to have greater rather than lesser impact according to the analysis of the river and city. Obviously physical development has had great impact on native ecosystems once properly functioning within and surrounding Göta Älv and i believe that it is within the architects' power to mitigate or restore these impairments as architecture does not exclude technical nor static regenerative features in the design. Acknowledging aquatic and riparian environments better gives planning and designing a possibility to evolve into something more than normative building, bringing forth a more holistic way of creating architecture where multispecies coexistence could exist.

One research that could have been useful to examine further is the detail of design which could be beneficial in making the project more practical and feasible. Such research could entail greater analysis of construction logic, material choices and the impact of weather and water exposure the design needs to endure and evolve under during its lifespan. Such analysis would consider questions like: How will micro-organisms and invertebrate species interact with ecosystem inclusive architecture and its components?

Some attempts to use data from river discharges and analysis of habitable areas in the river were used to imitate natural complexity and to find a way to resemble pristine wetland environments through design. Such attempts proved to be difficult to implement as the availability to material shaping and acting organically would require much more research about material qualities and construction methods. Also did such interventions stroll further away from the principle of integrating the interventions with architecture and the focus became too technical.

Spatially and structurally complex structures seems to be the most logical habitat imitation strategy to shelter aquatic species and a study of scales and use/inclusion of these could be researched further to better motivate the interventions. Re-live the River is in many ways experimental and the interventions are not proven to function within the Göta Älv context. Many times does the question cross my mind if this set of interventions would be enough to restore this decaying part of the river and does the site contain sufficient potential to successfully regenerate its degraded ecological functions? Probably a project like this would require follow-up studies to examine if the physical impact and "positive" manipulation of the site would be sufficient to kick start the ecosystem and if initial assistance or further maintenance is crucial for the success of the river regeneration, similar to what Sportfiskarna are doing when they establish new wetlands in Sweden.

Somehow i do believe that we must dare to intervene now that many aquatic ecosystems are under stress, even though if the tools to do so are missing. Evidently bio-diversity decay in blue ecosystems impact surrounding green ecosystems which we as a society put much effort to sustain so it is in our best interest to act.
So how do we recognize or develop a sense of care for blue environments in the city?

Can we regenerate a decaying blue ecosystem in an urban context such as Gothenburg? As a citizen of Gothenburg I believe that we are too segregated from the river to understand that it is suffering in the first place. I believe that the barrier of physical development is the first issue to deal with so that people are able to expose themselves to city waters. In order to appreciate and gain knowledge about city water importance I believe that we must create recreational and educational accessibility inviting people to explore the riparian zone to create a better relationship between people and the river. How do we save something that we do not know is suffering?

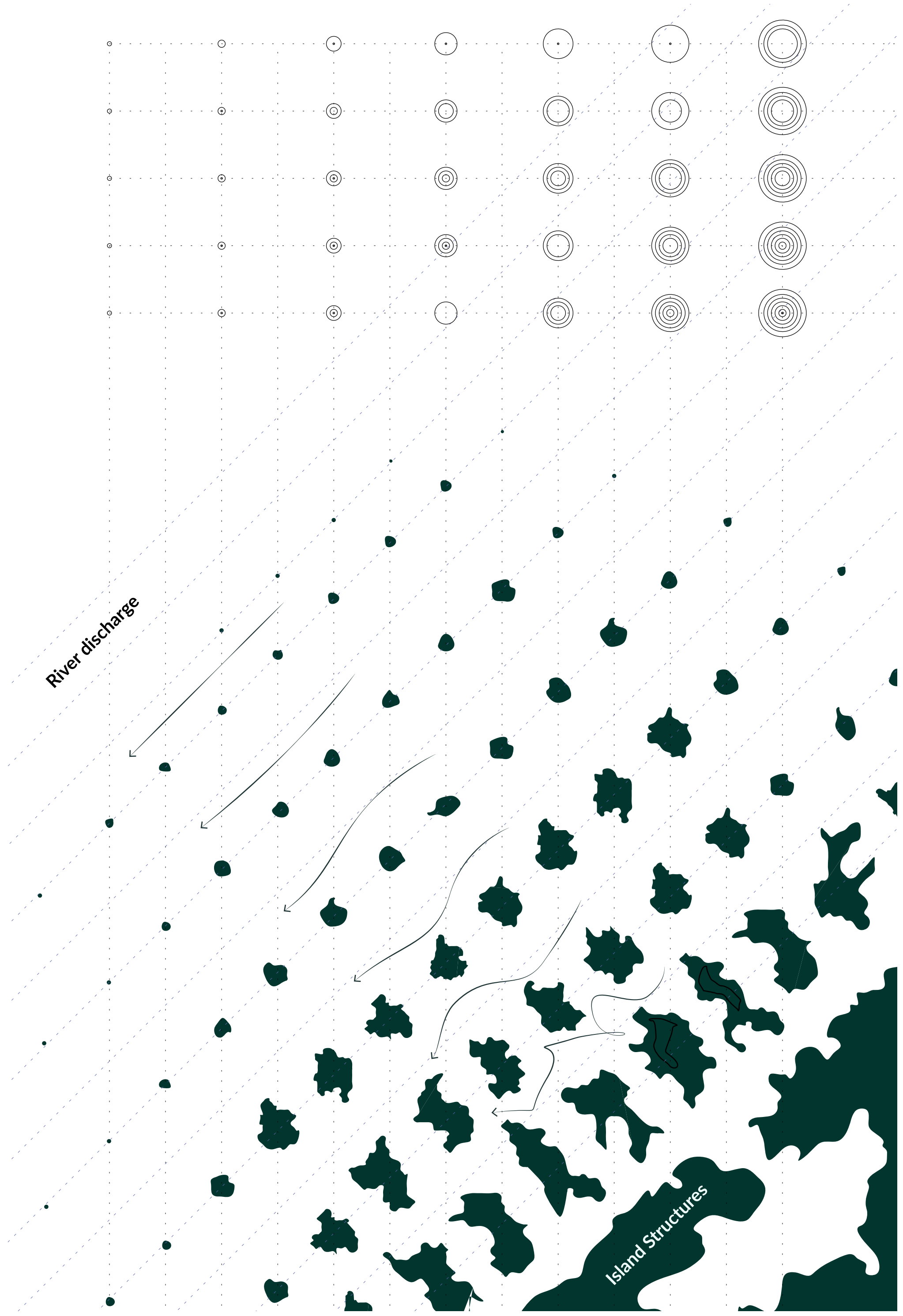


Figure 39: Adapting complexity of artificial river habitat to river discharge

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2 *Relation to United Nation Sustainable Development Goal* - Adapted from: *The Sustainable Development Agenda* (https://www.un.org/sustainabledevelopment/development-agenda/)
3 *Delimitation Diagram*
4 *Process Diagram - Focus Scope*
5 Timeline of Ecosystem Succession - Adapted from: *Hydrosere - A wetland Example of Succession in Action* (http://www.countrysideinfo.co.uk/successn/hydro.htm)
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9 *Project Relevance*
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14 *Hunting Depth* - Based on interview with: Persson, H. (2020) Wetland Construction Consulant, Länsstyrelsen Göteborg
15 Environmental Conditions
16 Regenerative development reconnecting pristine natural enironments in the city radius
17 Urban Samples
18 Urban transect of the gothenburg context. From innercore on the left side to rural on the right.
19 Sites of possible acupunctural interventions
20 Ecosystem Values in the Urban Fringe
21 Attributes in the Rurban Fringe
22 Ecosystem Values in the Rurban Fringe
23 Section - Lifetube

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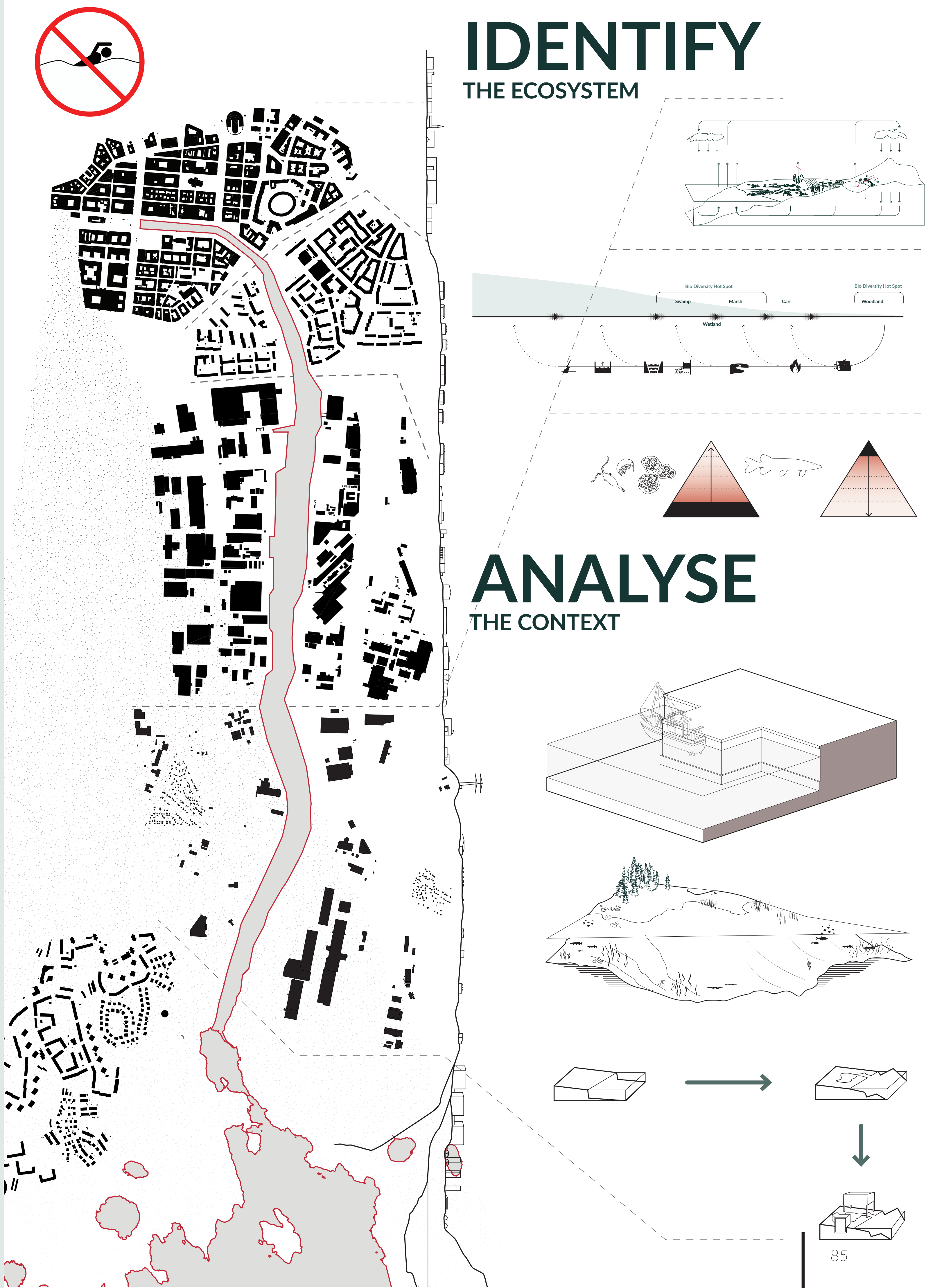
4 Interviews

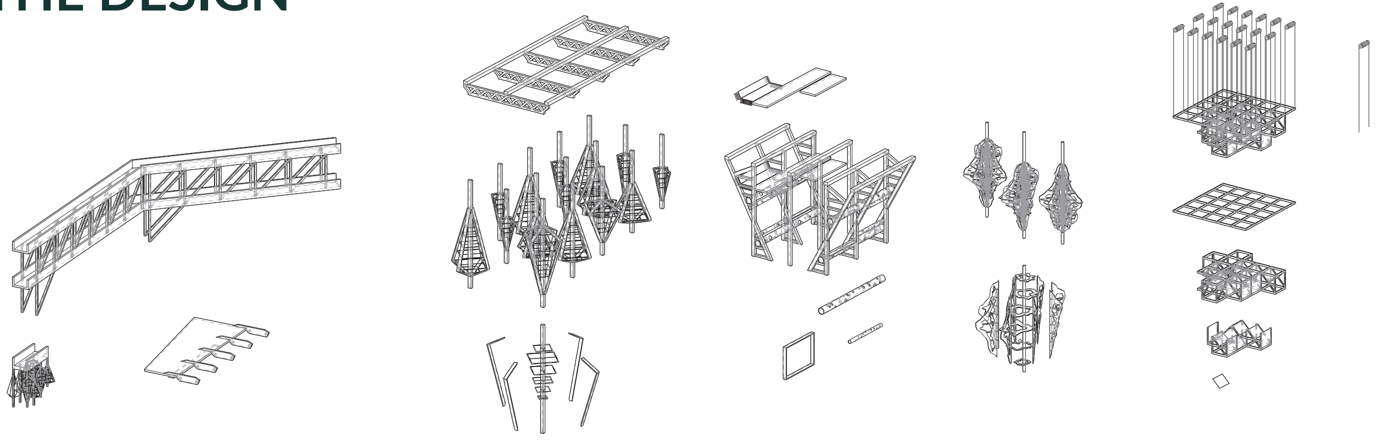
Jacobsen, P. (2020) Project Manager, Fishing Conservation at Sportfiskarna
Persson, H. (2020) Wetland Construction Consulant, Länsstyrelsen Göteborg

Appendix

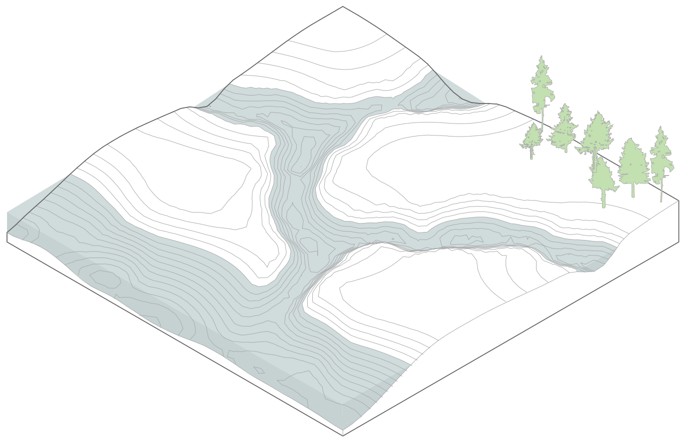
Composition posters



ADAPT
THE DESIGN



AND REGENERATE
A BIO DIVERSITY HOT SPOT



A project about integrating architecture to a local ecosystem