To Create Multifunctional Riverscapes

- The example of Älvkarleby in the Nedre Dalälven River, Sweden

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To Create Multifunctional Riverscapes – The example of Älvkarleby in the Nedre Dalälven River, Sweden

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Abstract

The natural environment and ecological services of rivers and the needs and expansion of human activities using rivers causes conflicting interests. Human survival is inseparable from the dependence on the natural environment, but at the same time, the continuous demand for natural resources has also caused an irreversible impact. Hydropower is regarded as sustainable and clean energy and is being developed and applied in increasing river basins, while it has also caused damage and pressure on the ecological environment of the rivers. The Nedre Dalälven river has long been considered as one of the important areas for wild salmon and sea trout in Sweden which are an important source of economy for local development in history, whereas they have been severely affected by the local hydropower development. At the same time it has also an important tourist river cultural value, especially sport fishing being one of the main reasons for visiting the Nedre Dalälven river. At present the different interests including hydropower production, rural construction, cultural recreation, and ecological restoration and protection intersect together, affecting the landscape of the Nedre Dalälven river. Landscape architecture can coordinate different stakeholder's interests in a visionary future illustration with ambitions to solve conflicting issues. This thesis analyzed the Nedre Dalälven river space flowing through the Älvkarleby area and the ecological landscape of the shorelines, especially the dilemma caused by the development of hydropower for local wild fish migration and development needs of local recreation activities. This thesis applies the Landscape Character Assessment method to carry out an inventory of the research river riparian landscape as the basis for a proposed ecological restoration and development of a municipal nature reserve divided in three functional zones, through observations, interviews and questionnaires including different stakeholders and interests. Strategy guidelines for ecological function restoration and human recreation needs are given for the three functional zones of the municipal nature reserve. Finally, an in-depth design work-Fish Nature Park, is proposed for the core protection area which is one of the functional zones. The thesis illustrated how landscape design-led research methods can be applied to address fish migration routes and habitat restoration, while also taking into account the needs of local cultural preservation and outdoor recreation. The thesis concludes that the task of applying environmental legislation to hydropower activity in rivers needs to include municipal comprehensive work and issues of additional protections and developments in order to be able to choose the best design solution and find the financing for that.

Keywords: River space, municipal nature reserve, ecological restoration, landscape planning, fish migration passage, human recreation

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Abbreviations

SLU	Swedish University of Agricultural Sciences
UGI	Uppsala Green Infrastructure network
LIV	Laxfisk i nedre Dalälven projekt (Salmonides in the Nedre Daläven project)
HÅVD	Hållbar vattenkraft i Dalälvenområdet Projektet (Sustainable Hydropower in the Daläven Area project)
LONA	The local Nature Conservation Initiative projects
VVO	Vattenfalls Värnområde för biologisk mångfald (Vattenfall's Protected Area for biological diversity).
LIS	Landsbygdsutveckling i strandnära lägen (Rural development in locations close to the beach).
NGO	Non Governmental Organization.
SCI	Site of Community Importance. It is a part of the Natura 2000 network and under the Habitats Directive Member States.
SPA	Special Protection Areas. It is a part of the Natura 2000 network and under the Birds Directive Member States.
NAP	Nationell plan för moderna miljövillkor för vattenkraften (National plan for modern evironmental conditons for hydropower)
SGU	Sveriges gelogiska undersökning (Swedish Geological Survey)
GIS	Geographic information system
UNESCO	The United Nations Educational, Scientific and Cultural Organization

1. Introduction

For a long time, development of human civilization has been inseparable from rivers and waters. River banks are interesting areas for establishing cities because people prefer to be close to the most important source for life which is water (Wagih & ElHalim 2020). Rivers and waters not only provide the necessary living conditions for the development of the region, such as clean water, food supply, air and lush vegetation and forests, but also provide the possibility of producing energy.

Swedish energy policy has decided that Sweden's electricity supply will be covered by 100 percent renewable energy types by 2040, and today domestic hydropower accounts for about 45 percent of electricity production in Sweden. Dalälven is a river in central Sweden that flows from the north of Dalarna and runs into the sea in northern Uppland, which is over 520 kilometers long, and is the second longest river in Sweden. It has 27 power plants producing over 4,000 GWh/year, which is about 8% of the country’s entire hydropower production (Wikipedia 2022). The Nedre Dalälven river is the lower part of the Dalälven river, from Avesta municipality and remaining 120 kilometers to the Baltic sea. It has seven hydroelectric power plants, and Älvkarleby hydropower station in the Nedre Dalälven river is the biggest plant which was built around the turn of the 20th century with a production capacity of 125MW/year (Vattenfall 2022).

However, hydropower as an energy source has many advantages in that it is renewable, also has disadvantages in the form of its impact on the riparian landscape and effects on biodiversity in the regulated watercourses. The Swedish Agency Marin and Water management indicates hydropower is the most extensive pressure on lake and river water bodies in Sweden based on the classification within the Water Framework Directive (Havs och Vatten myndigheten 2019).

Historically, the ecological environment of the Nedre Dalälven river is unique, it is where the biological borders of north and south of Sweden meet, Limes Norrlandicus, which has a lot of valuable habitats, on land and in the water. The Nedre Dalälven river has been an important source of fish, including salmon, sea trout and asp. They use the traversable part of the river for reproduction and rejuvenation. Commercial fishing once occupied an important economic position in Älvkarleby. However, since the construction of the hydropower plant, dams and currents, etc., have thus acted as barriers to wild fish migration, and these barriers have reduced the chances of fish populations reaching their natural breeding areas (Söderlund 2021). The strongest effect of these changes for sea-migrating salmonids is that most of the former spawning and rearing areas today are either dammed or drained. The regulation of the river has also strongly affected the remaining streams through both unnatural watercourses

and flooded streams with altered and / or destroyed habitats as a result. (Hagelin et al.2018). At the same time, urban and rural areas along the river are rapidly expanding causing the degradation of the river landscapes, and threatening their biodiversity (See u.å.). Fragmentation of wildlife habitats, soil erosion along river shorelines, and deforestation have become the main environmental problems in the local river region.

In recent years, most countries and regions have begun to pay more attention to protect and restore the ecological river environment. Ecological protection and restoration in rivers is a practice comprising a range of intentional human actions that seek to assist with 'the recovery of an ecosystem that has been degraded, damaged, or destroyed (SER 2004). In 2014, the Swedish Agency for Marine and Water Management and National Energy Agency suggested a national strategy to balance the need for improved ecological status and the need for hydropower (Swedish Agency Marine and Water Management 2019). Especially for the protection and restoration of the natural habitats and strengthening the resilience of the ecosystems on both shorelines of the river. Meanwhile, as social and environmental consciousness continues to rise, working with a long-term sustainable focus also strengthens the competitiveness of the local sights and attractions (Nedre Dalälven river landscape 2020). The protection and restoration of the riparian landscape is also crucial to the sustainable social development of the surrounding cities and villages.

The Swedish Sportfiskeförbundet was formed over a hundred years ago in Älvkarleby. Sportfiskarna is today a large national organization that takes an active part in work for biological diversity and care for natural river environments. With the creation of the local Sportfiskeområdet (Sport fishing area) in the 1960's Älvkarleby, sport fishing gradually flourished in Älvkarkeby and the surrounding region, and became one of the most valuable outdoor wildlife fishing areas in Europe (Cinclus 2015). There is also an increasing demand for recreational activities by the river, such as catering and hotel services, camping, and boating etc. These aspects besides hydropower energy production challenge the natural capacity of the river and the surrounding environment (Lifang et al. 2008).

The natural environment and ecological services of the Nedre Dalälven river and the needs and expansion of human activities using the river cause conflicting interests. This project will focus on working with the Nedre Dalälven river in Älvkarleby in Sweden to consider ecological environment for migrating species in relation to electricity production in hydropower plants and to develop rural living and tourist environments according to sustainable principles of the art of urban/rural design.

1.1 Purpose

The purpose of this thesis is to study how to achieve coordinated sustainable development of the Nedre Dalälven river space through the proposal to establish a municipal nature reserve. On the one hand, in the face of environmental issues brought by rural expansion and demands of hydropower production needed for the river resources, it seeks to explore the strategies for environmental protection and restoration, especially considering creating opportunities for the migratory routes for the wild fish. On the other hand, it is dedicated to finding feasible solutions to meet the increasing needs for local tourism and recreation development. In general, the purpose is to find the possibility of synergistic development for nature conservation and human needs, so that the local society, nature and economy can be developed in a sustainable way.

1.2 Research question

The research questions to be addressed in this thesis are to study coordinating different interests in a visionary future illustration with ambitions to solve conflicting issues of sustainable development of the Nedre Dalälven river space. This conflict of interest stems from the long-term and complex characteristics of river ecological restoration. It involves not only the intersection of multiple disciplines, but also involves the interests of different stakeholders, requiring multiple parties to communicate, negotiate and cooperate. In this thesis, the value forms of the Nedre Dalälven river ecological restoration mainly focus on the categories of "nature" and "human needs". Natural value refers to the enhancement of ecosystem services, especially fish, by the restoration of the natural environment of rivers and riparian landscapes. For human needs, this thesis pays more attention to the impact of local recreation and outdoor life development on rural sustainable development.
The questions is:

- How to create a multifunctional river spaces where conflicting interests like protection and restoration of ecology and ecosystem services, human recreational needs and development of water energy production can cope, through landscape planning and design?

1.3 Limitations

In this thesis, the river space of specific interest as an example could possibly zoom into the Älvkarleby village in the Nedre Dalälven river (see Fig 1). Älvkarleby Municipality is a small municipality with a population of 9457 located in the north side of Uppsala County. Skutskär is the largest village in the municipality. Älvkarleby village has approximately 2000 inhabitants. With the rapid development of railways and highways, Älvkarleby has formed a close cooperation network with its surrounding municipalities such as Tierp, Gävle and Uppsala.

The village of Älvkarleby, within Uppsala county, is located in the Nedre Dalälven river close to the Baltic sea, in a beautiful environment with high natural and cultural value. The study area includes part of the Nedre Dalälven river between Lanforsen hydropower station and the northern border of the sports fishing area at Sandören fish camp (see Fig 2). The surrounding shorelines with natural and cultural built structures are included in the thesis project area.

Fig 1. The Älvkarleby village and the research area in Älvkarleby Municipality.
Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan. Edited by Author.

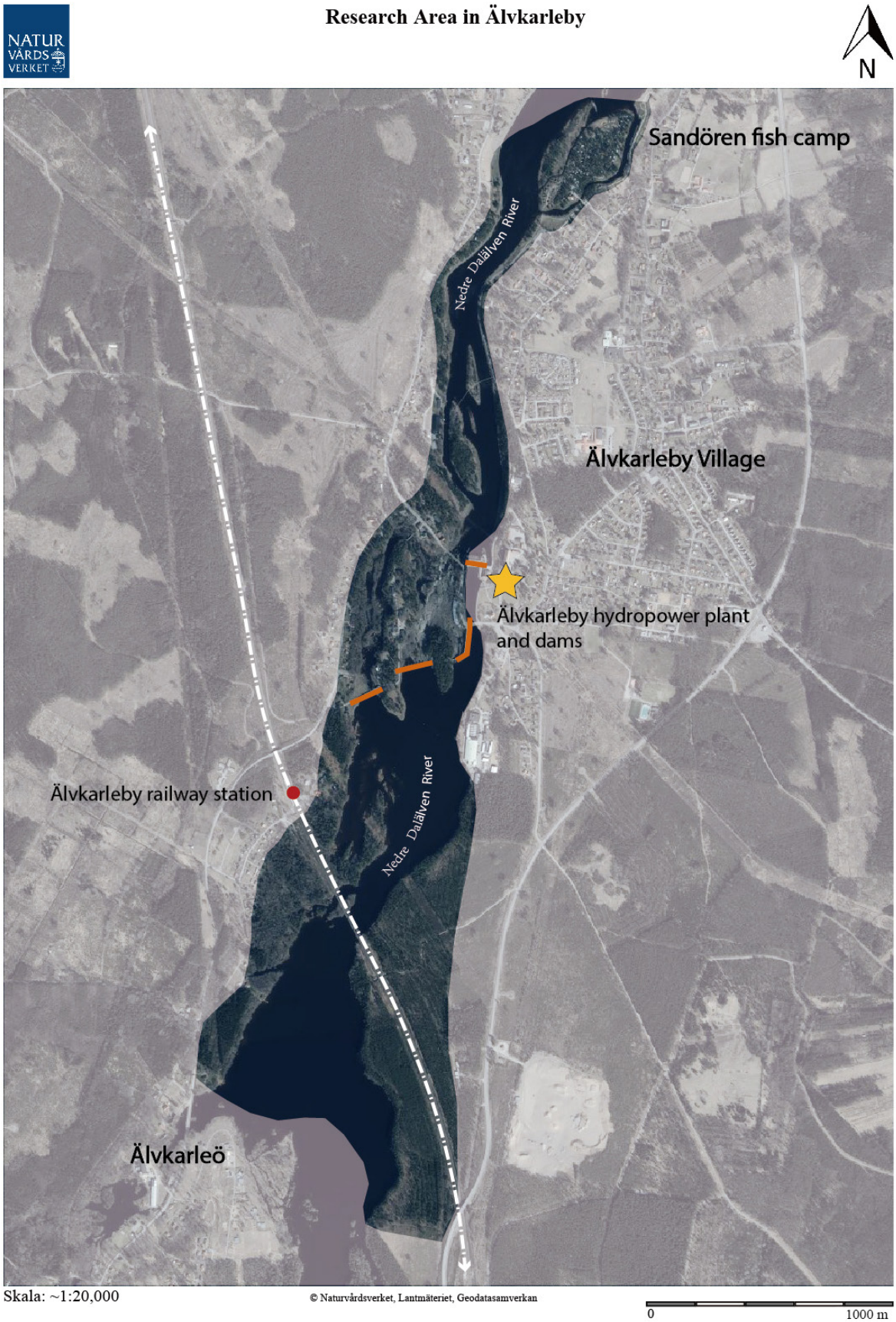


Fig 2. The scope of the research area in Älvkarleby village.
Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan. Edited by Author.

1.4 Procedure

Three main components lay the ground for the work process of this thesis: the background and methodology research, on-site field investigation and proposal planning work. A few different techniques have been used to gather information for the three phases (see Fig 3).

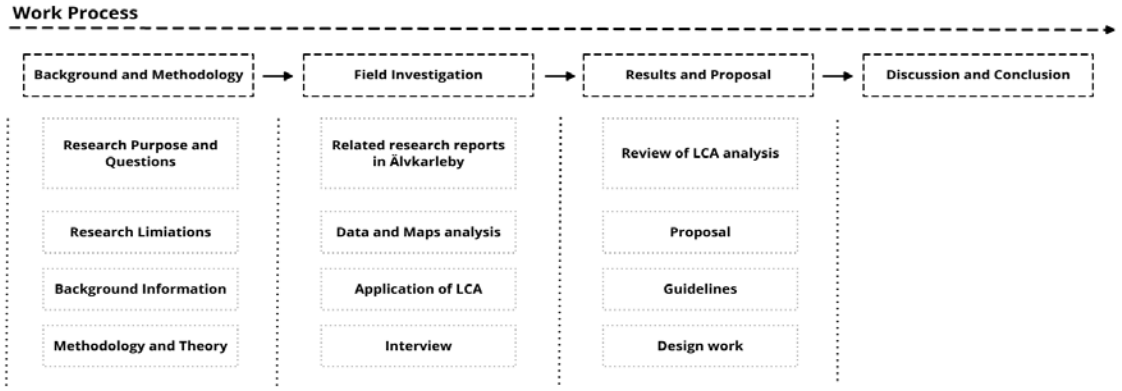


Fig 3. Work process

1.5 Structure

This thesis is divided into seven chapters. Chapter One is about the general introduction to the thesis, including the research purpose, research questions and the procedures for completing the thesis project. Chapter Two focuses on the background of the Nedre Dalälven river space in the study area, including the important natural and cultural resource in the local region and the contrasting changes in riparian landscape in history and present, meanwhile interpretation of the rural development according to the municipal comprehensive plan. Chapter Three introduces the specific research theories on the river's ecological restoration and methods. Chapter Four is Landscape Character Description, the investigation result of the research area, which will be the basis knowledge for the proposal. Chapter Five is the Vision divided into two parts. In the first proposal, the scope of the municipal nature reserve is given and divided into three zones according to different functions with the future development protection strategies. The second part is the detailed plan with the in-depth design based on the core protected zone which is one of the three functional zones in the proposal. Chapter Six and Seven are the discussion and conclusion. It is to put forward the reflection and the continued research in the future.

1.6 Concepts and glossary

Nature reserve

Nature reserve is an area set aside for the purpose of preserving certain animals, plants, or both. A nature reserve differs from a national park usually in being smaller and having as its sole purpose the protection of nature.

Ecological Restoration

Society for Ecological Restoration explains that Ecological protection and restoration in rivers is a practice comprising a range of intentional human actions that seek to assist with ‘the recovery of an ecosystem that has been degraded, damaged, or destroyed.

Fish passage

Fish passage is any device used to promote and regulate safe fish migration across hydroelectric facilities (see Fig 69 and 70).

Sustainable tourism

The United Nations World Tourism Organization (UNWTO) defines sustainable tourism as: Tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment, and host communities.

UNESCO's' Biosphere Reserve

Biosphere Reserve is about the interplay between humankind and the environment. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), a Biosphere Reserve has three main objectives: to develop society in a long-term sustainable way, to conserve biological and cultural diversity, ecosystems and landscapes, and to support demonstration projects, research and environmental monitoring.

Limes Norrlandicus

Limes Norrlandicus is called the Climatological border or Biological Norrland border that runs across Sweden between southern Värmland in the west and Gästrikland in the east and which also forms a significant vegetation border between the highlands, boreal zone and relatively poor northern nature, and the warmer, boreo nemoral and species-rich area to the south of the country.

2. Background Interpretation

2.1 The Nedre Dalälven River in Älvkarleby

The Nedre Dalälven River is the lower part of Sweden's second longest river, the Dalälven River, covering approximately 308,000 hectares and correlates with Limes Norrlandicus (the biological Norrland border). The region boasts high biodiversity, as the river forms a clear border zone between the northern and southern flora and fauna of Northern Europe. Due to the region's unique natural and cultural environment, it is part of the UNESCO's' Biosphere Reserve Programme of the United Nations agency. This makes the area very special, with a wealth of valuable habitats, good outdoor life conditions and a long-standing cultural landscape.

The Nedre Dalälven river landscape in Älvkarleby is known for its high natural and historic cultural value in the built structure at Älvkarleby waterfall which comprised the natural landscape characteristic and identity in history (see Fig 4). With the spread of the well reputation of the waterfall landscape in society and the railway construction, the local tourism and cultural recreation industries have gradually developed. The old railway park near the waterfall had provided a good place for local recreation.

Fig 4. The artwork of Älvkarleby waterfall landscape drawn by Elias Martin in the 1790s

Many existing historical and cultural heritages distributed near the hydropower station (the original location of the waterfall) show the outdoor life situations at that time.

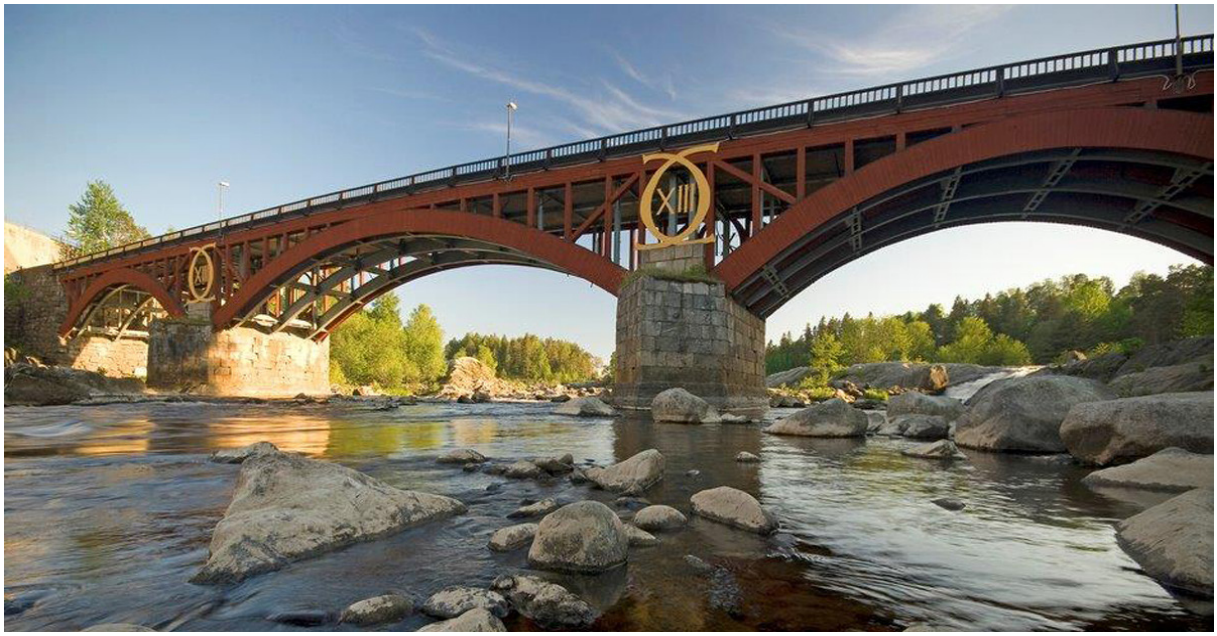


Fig 5. Carl XIII bridge (Nedre Dalälven 2021)

In addition, there are many areas with very high cultural value, combined with communication, power plant and military environment in combat rapids of the Dalälven with facilities from mainly the 19th century and the beginning of the 20th century. Expression of national interest: Carl XIII's reconstructed bridge from the 1810s with a bridge guard's cottage (see Fig 5), Svea engineering troops' camp on Laxön from the 1880s, tourist hotels from the 1890s and Älvkarleby power plant from the 1910s - the largest at the time - with associated staff housing, which will become important resources for outdoor leisure tourism in Älvkarleby (Swedish National Heritage Board 2018, page 19).

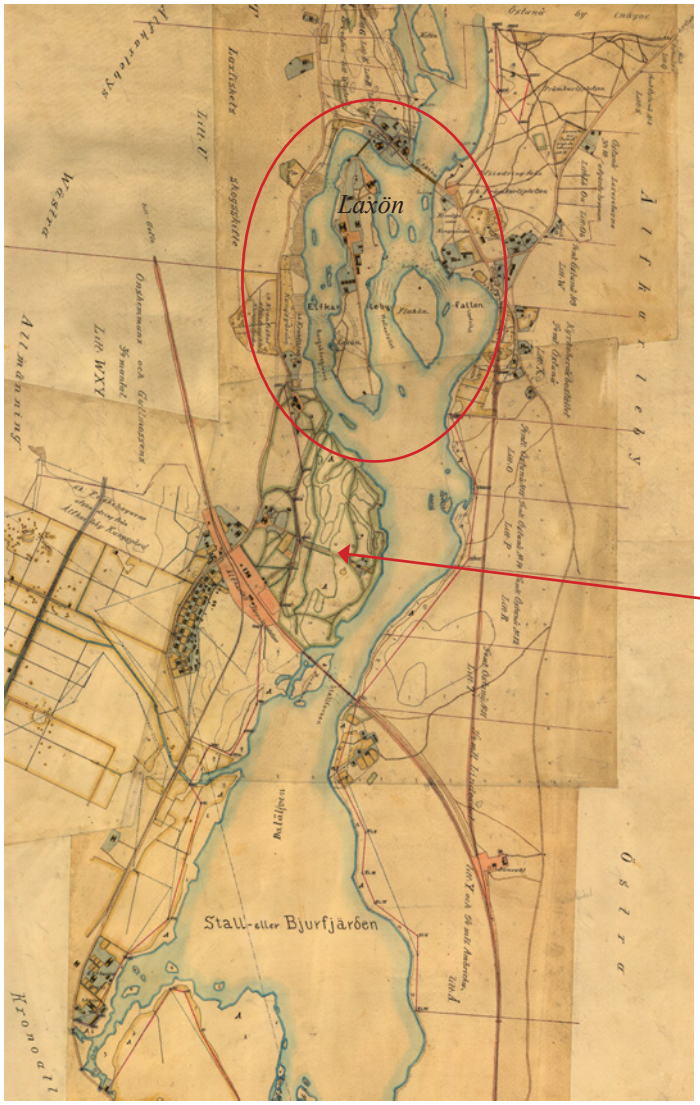


Fig 6. The map of the Nedre Dalälven river in 1911 with Kungsådran, Laxön and the old railway park. Data source/ Karta öfver trakten omkring Dalälfven vid Älfkarlebyfallen © Älfkarleby socken och Uppsala Läns Norra Domsaga. Edited by Carl Mohlin and JH Schönström.

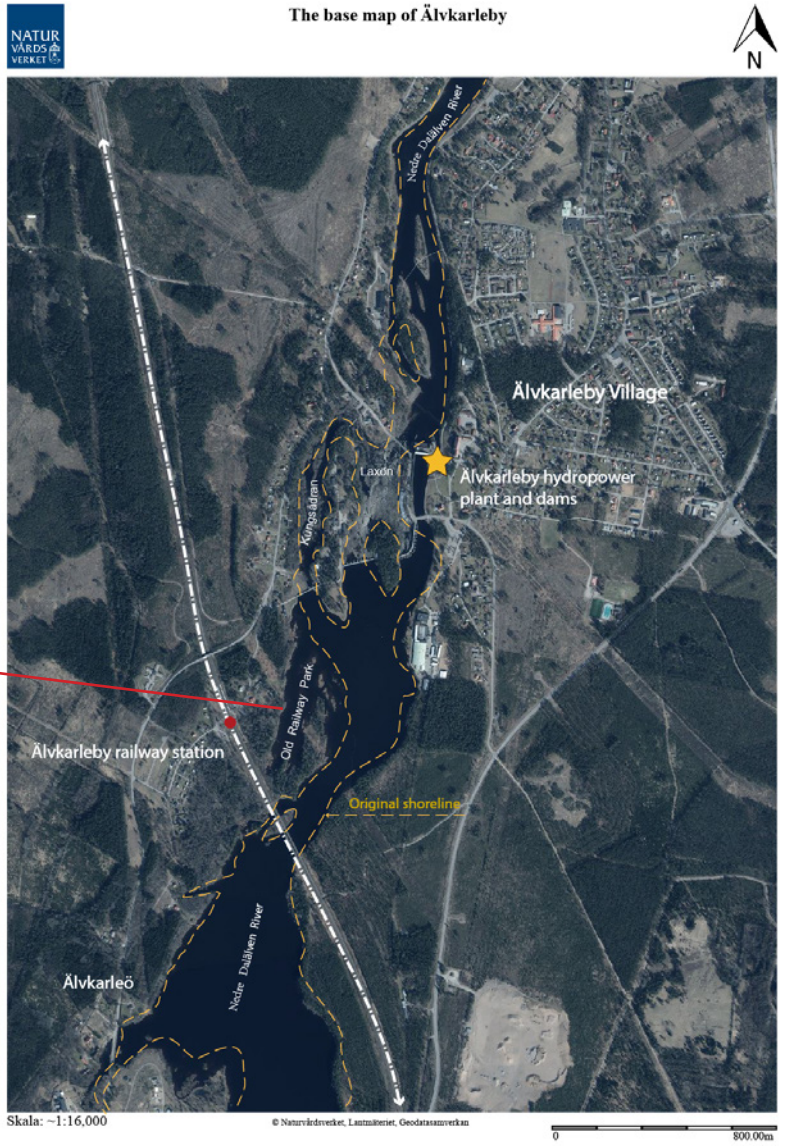


Fig 7. The base map of the Nedre Dalälven river in Älvkarleby shows the contrasting shorelines in the history and present. The yellow dot lines represent the original shoreline before the hydropower station and dams were established. The riparian landscape of the old railway park, Kungsådran and Laxön, changed a lot. Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan. Edited by Author.

The two maps (Fig 6 and Fig 7) show the contrast changes in the local landscape before and after the construction of the hydropower station. Fig 6 is an inventory map of the Kungsådran area drawn in 1911. The rivers in the Laxön area (the red circle) were full of water at that time, and these areas were the most important areas for the survival and migration of salmon and sea trout. The old railway park (the red arrow) can also be seen in the map, which provides a good place for people's recreation in the region. However, after the construction of the hydroelectric power station, the upstream water level was raised and much of the old railway park was submerged below the surface (see Fig 7). Most of the park's buildings were also demolished. The migration routes of salmon have been severely affected.

2.2 The national interests in Älvkarleby

The municipality of Älvkarleby has rich resources with forests, rivers, wetlands, coasts and arable land. The municipality's natural values are high and up to half of its area is of national interest for nature conservation, outdoor life, cultural environmental values or as Natura 2000 areas (Älvkarleby Kommun 2020). In the early 1970s the Nedre Dalälven river landscape was designated as one of Sweden's 25 most important recreational areas and one of 11 objects of common Nordic conservation interest, therefore, attention to environmental protection issues related to natural and cultural values and the development of tourism have become one of the goals of sustainable development in the region (Miljöbalk (1998:808) 4 kap.2§).

In Älvkarleby municipality there are 14 Natura 2000 and nature reserves areas. The types of protected areas include nature reserve, Birds Directive (SPA) and Species and Habitats Directive (SCI) (see Fig 8). For all areas, there is a conservation plan approved by the County Administrative Board and many of them are protected as nature reserves or are planned to be protected as nature reserves. Within nature reserves, there are a large number of endangered and rare plant and animal species. They are concentrated in Marma, Dalälven and its surroundings as well as in Gårdskärskusten. Most species are linked to the natural environments of the forest landscape (Älvkarleby Kommun 2020).

The rich natural resources also create a various cultural and outdoor life in Älvkarleby. The most famous recreational activity in Älvkarleby is sport fishing(Länsstyrelserna i Dalarnas, Gävleborgs, Uppsala och Västmanlands, 2000). There is a very long fishing culture and a summer resort in the Nedre Dalälven river of Älvkarleby. Currently, it has developed into a sportfishing club and a sportfishing camp downstream of the Nedre Dalälven river.

Outdoor hiking is also very well developed in Älvkarleby. Currently, there are many long-distance hiking routes through the city, such as SlowTrips, Upplandsleden and Vikingaleden (see Fig 9). These hiking routes provide tourists a connection with the regions they visit and enable exchanges between cultures. It was also nominated for a "sustainable future, projects that help strengthen the long-term sustainable competitiveness of rural areas" (Nedre Dalälven river landscape 2021).

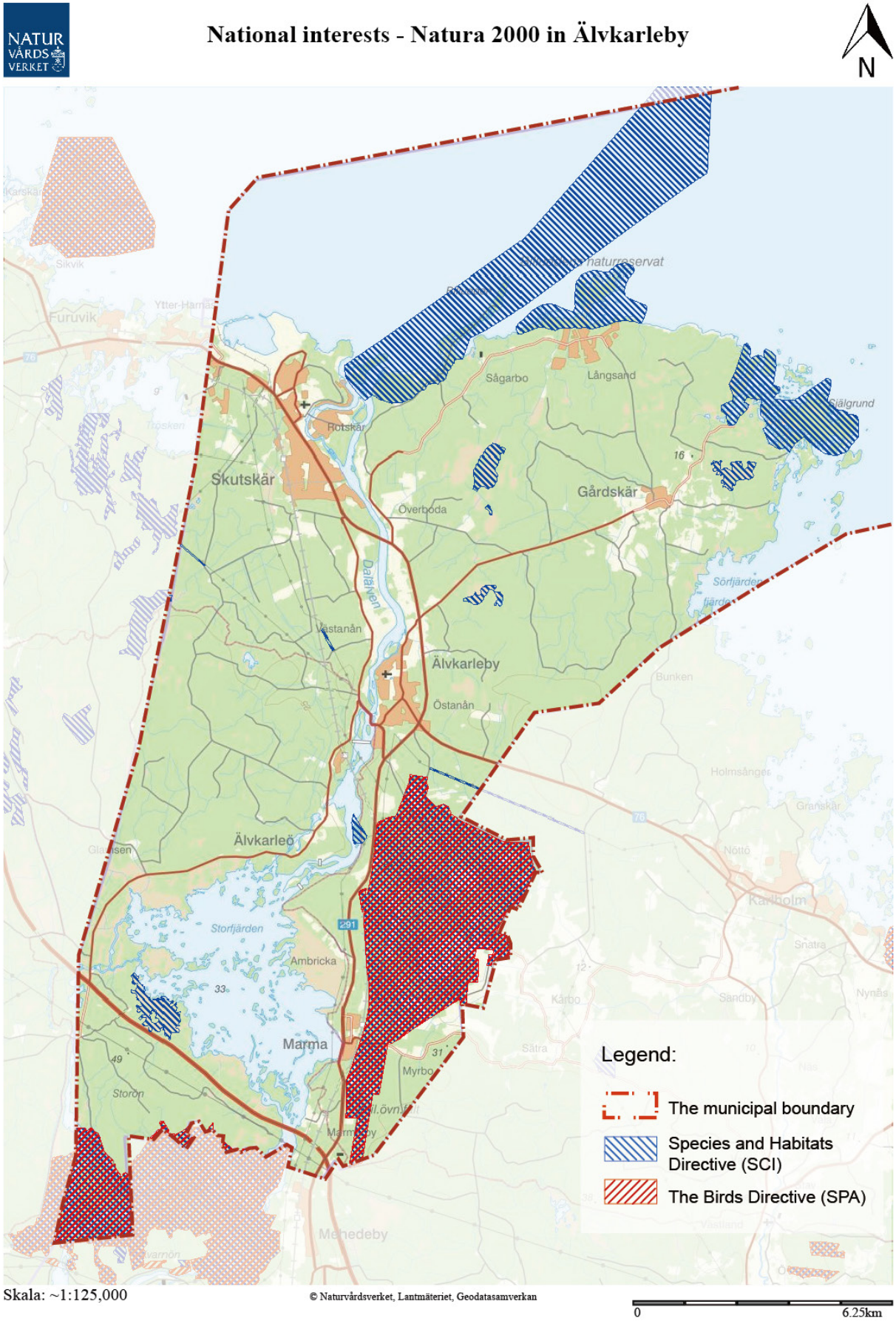


Fig 8. National interests - Natura 2000 areas in Älvkarleby municipality.
Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan

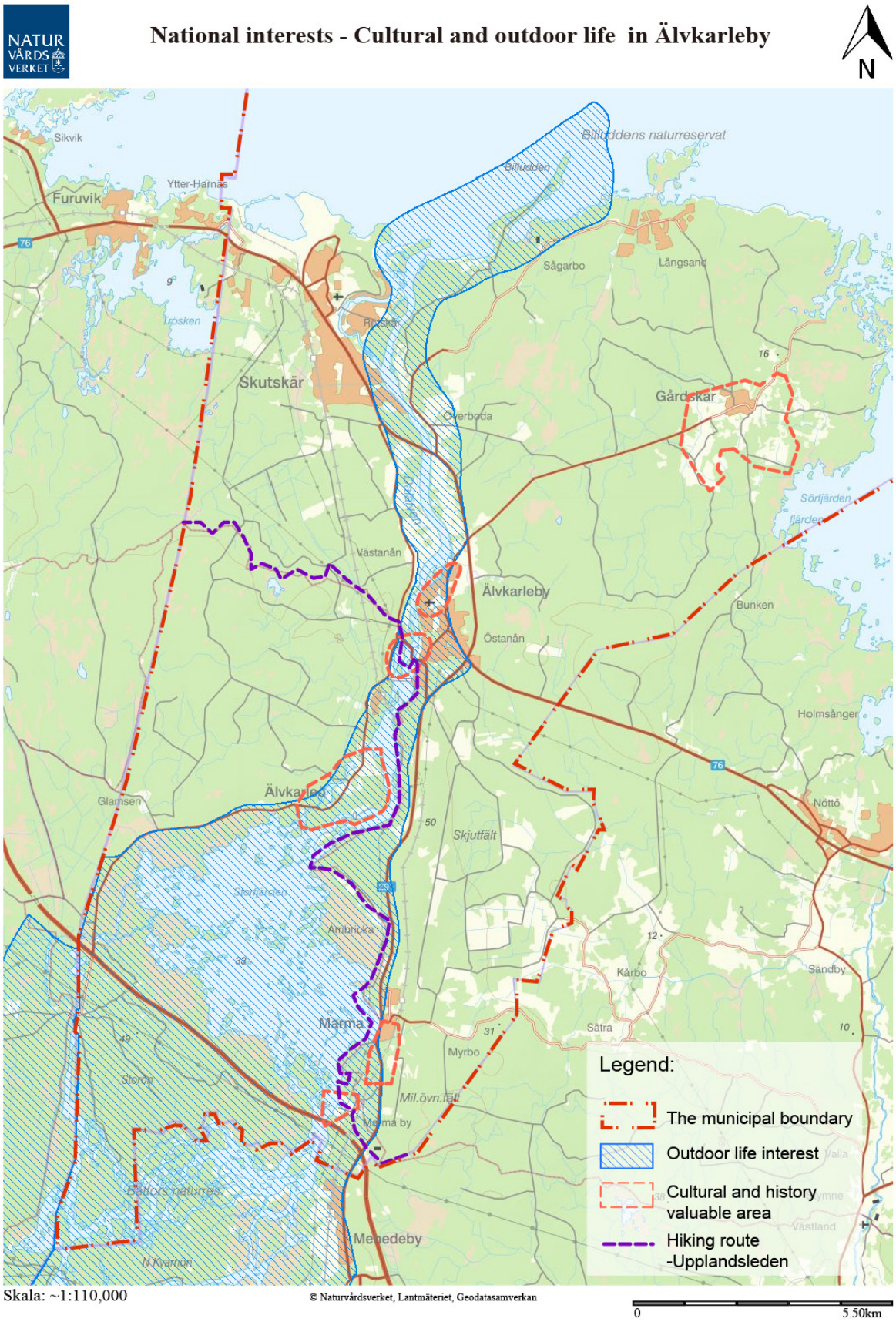


Fig 9. The cultural and outdoor life in Älvkarleby municipality map shows the Nedre Dalälven river shorelines and surrounding area are the outdoor life activities in national interests and three cultural and history valuable areas located near the Älvkarkeby hydropower plant (the original location of waterfall). Data source:© Älvkarleby Kommun, Naturvårdsverket, Lantmäteriet, Geodatasamverkan

2.3 Energy production and wild fish fauna

The development of Älvkarleby municipality relies heavily on resources on the Nedre Dalälven river, including forest logging, commercial fishing. Until the 20th century, forest logging and commercial fishing were forbidden by the government, whereas energy production developed instead. The Älvkarleby hydroelectric power station was built in the early 20th Century with the main purpose of supplying power to the railways and regional industries. Currently the plant has an annual power generation capacity of 125MW and supplies central Sweden with electricity. The Älvkarleby hydropower station belongs to the Vattenfall electric company, which has the biggest interests in local development. The expansion of the hydropower industry has promoted the development of Älvkarleby village, and Vattenfall owns a large amount of land on both shorelines of the Nedre Dalälven river.

The Nedre Dalälven river has a varied fish fauna, and is especially important for fish such as salmon, grayling, and trout which use the traversable part of the river for breeding and rejuvenation of the river. In addition to salmon and trout, these are grayling, eel, whitefish, aspen, river lamprey, pikeperch, id, stem and vimma (Hagelin et al. 2018). However, as human influence has increased, fish supplies have dwindled. In particular, the development of Älvlarleby hydropower energy directly leads to the degradation and fragmentation of the habitat of fish populations in the upstream. At present, marine migratory fish such as salmon and sea trout can only migrate up a few kilometers from the sea to Älvkarleby (Lundqvist et al., 2015; Lundvall 2016).

The first main reason is the connection between the upstream and downstream waterways is broken. Älvkarleby power plant is located eight kilometers from the point where the Dalälven river flows into the Baltic Sea. At present, the concrete dams of the hydropower station at Storfallet, Mellanfallet and Kungådran have formed a clear physical barrier for migratory fish fauna (Hagelin et al. 2018). Wild salmon and sea trout can only swim to Kungsådran and spawn, grow here and then migrate to the sea. Due to the limited water area of Kungsådran, the competition of fish for the environment has increased, which has greatly reduced the production of wild salmon. The other reason is the control of water flow. The Water Authority for the Bothnian Sea has developed measures that must meet current environmental quality standards regarding ecological status of natural water (connectivity, hydrological regime and morphological condition) for the water body up and downstream Älvkarleby power plant to achieve quality status Good ecological status (VISS, 2020). According to the report named with Biotope mapping and action plans for power lines in lower Dalälven in the LIV project, The current amount of water flows is not sufficient to create habitats for salmon and trout (Hagelin & Bruks 2018).

The research work of the wild fish passage in the Nedre Dalälven river started after the construction of the hydropower station. The departments currently in charge involve stakeholders with four counties along the Nedre Dalälven river, power companies, sportfiskarna, local environmental organizations and the Fisheries Research Station of SLU and so on. The related research projects include LIV, HÅV, LONA and NAP projects, etc,.

Some important research projects in Älvkarleby

From the first of January 2019, provisions in the Environmental Code apply, which means that "anyone who conducts a water activity subject to a permit for the production of hydropower electricity must ensure that the activity has modern environmental conditions." This means that the conditions and provisions of the permit for the activity must have been determined in accordance with the Environmental Code (1998:808) Chapter 11, Section 27. The Nedre Dalälven river's biodiversity conservation work is carried out primarily by the area's four county administrative boards, municipalities, as well as by hydropower companies and NGOs.

- In the *Sustainable Hydropower in the Dalälven Area project* (HÅVD project), the county administrative boards of Uppsala, Gävleborg, Västmankland and Dalarna have developed a comprehensive action plan for hydropower related environmental measures, in collaboration with the hydropower companies Fortum and Vattenfall.
- In the project *Salmonids in the Nedre Dalälven project* (LIV project), the county administrative boards have in cooperation with Fortum and Vattenfall investigated the possibility of restoring fish migration and reproduction potential for salmonids in order to regain self-reproducing wild salmon and sea trout in the Dalälven in the future.
- *The Local Nature Conservation Initiative* (LONA projects), is a grant project by the government which aims at long-term nature conservation in different aspects.
- *The National plan for modern evironmental conditons for hydropower* (NAP project, Nationell plan för moderna miljövillkor för vattenkraften), is cooperated by Uppsala Län and Vattenfall, and to find solutions that will lead to the greatest possible benefit for the aquatic environment.

About Fish fauna passage and habitat restoration

In the work with environmental adaptation of dam facilities and hydropower plants, a central question is whether a fish passage solution should be constructed upstream and downstream for fish and fauna. The Swedish Marine and Water Authority has started a special guidance work linked to this issue as it concerns several different guidance areas within the Swedish Marine and Water Authority, such as water management, protection of areas, restoration, and fish management. The Design of Passage Solutions is a guidance for designing and constructing a fish passage in the upstream and downstream (Havs och Vattenmyndigheten 2020). When fish and fauna passages are constructed past obstacles to migration, all migratory fish species and also other aquatic organisms should benefit from it.

2.4 Future development

The present comprehensive plan for Älvkarleby municipality is targeted to be completed by 2050. The objective is to develop Älvkarleby into an innovative area, a growing area and an area for everyone. The planning has high expectations in terms of ecological, social and economic sustainability. The content includes planning goals and specific strategies for regional land use, water use, national interest protection, and environmental standards. The plan has been released, and it has received extensive attention from the society.

2.4.1 The development of land use

In history, Älvkarleby's rural development is around the Nedre Dalälven river and waterfall. With the construction of the railway from Uppsala to Gälv, the relationship between Älvkarleby and the upstream-Älvkarleö has become close. In the comprehensive plan 2050, the railway station (the red circle) will be listed as one of the three primary development areas, thereby driving the supporting construction and improvement of the surrounding area, which is enough to illustrate the government's visions (see Fig 10 and 11).

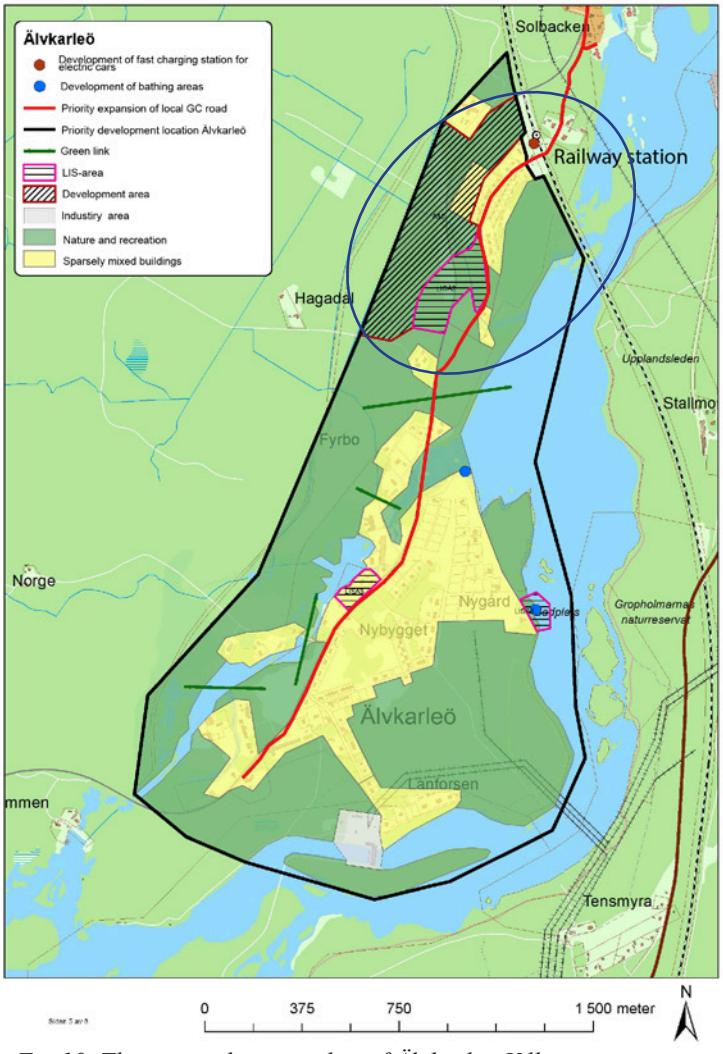


Fig.10. The comprehensive plan of Älvkarleö Villages. Data source:© Älvkarleby Kommun

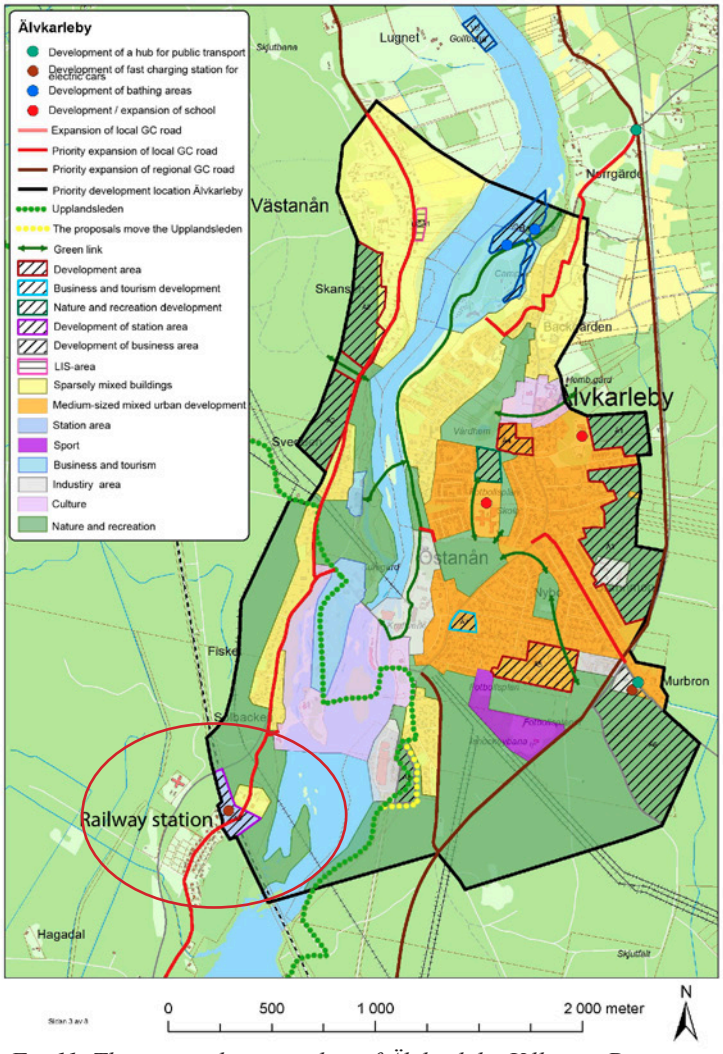


Fig.11. The comprehensive plan of Älvkarleby Villages. Data source:© Älvkarleby Kommun

The land use for Älvkarleby and Älvkarleö is primarily divided into residential areas (orange and yellow color), cultural and outdoor life areas (light pink color) and natural areas (green color) and the future development areas. The plan focuses on developing housing to accommodate future population growth. In sustainable development it is important to always work with fine grained mixed land uses. Housing areas should then rather be named neighborhoods that include both housing, work opportunities, service and recreation. It is important to do site analysis to create a sense of place and identity to the neighborhood.

Near the railway station, there will be planned a station development area, a residential development area and a LIS area (the blue circle). Laxön and Kungsådran (light pink color) are regarded as the most important cultural and outdoor life recreation areas.

2.4.2 The consideration about the natural and cultural environment

In the municipal comprehensive planning, it includes state-protected areas (nature reserves and Natura2000 areas), beach protection areas, municipally developed cultural landscape, groundwater reservoirs, water protection area, highest flows by the Dalälven river, landslide-erosion erosion by the Dalälven river, risk of flooding by the sea etc. Furthermore, there are maps that point out proposed nature reserves, core areas for the development of green structure and green link.

However, some descriptions leave a lot to be desired. According to the Swedish Society for Nature Conservation Älvkarleby's Consultation responding to the Overview plan for Älvkarleby municipality in 2018, the descriptions about the core areas for the development of green structure and green link do not meet the corresponding development goals. There is a lack of specific planning content for ecological restoration and habitat protection planning on both sides of the river (Naturskyddsföreningen 2018).

2.4.3 The watercourse and shore protection

All lakes, watercourses and seas in Sweden generally apply to shore protection. It is regulated in the Environmental Code (Miljöbalken 2 avd 13§). The purpose of protecting shoreline areas is to secure the public's opportunities for outdoor life and to preserve good living conditions for animal and plant life. The general beach protection covers both land and water 100 meters from the shoreline. In Älvkarleby municipality there are several valuable beach areas and there the beach protection has been extended to 300 meters, for instance Dalälven and its islands 300m on land and in water. In the comprehensive plan, there are some contradictions between the rural development area and the shore protection.

2.4.4 The connection systems

The development of physical connection systems in and out of the region is mainly focused on road planning, including roads, bicycle lanes, and sidewalks. In addition, preliminary plans are also given for the routes of outdoor leisure activities, such as canoe trails and Upplandsleden (see Fig 10 and 11). A new trail called Vikingaleden is a new opportunity for Älvkarleby to build its identity.

2.4.5 Green infrastruction in Uppsala County

Green infrastructure is a strategically planned network of natural and semi-natural areas designed to provide a wide range of ecosystem services (European Commission 2017). The work to develop green infrastructure in Uppsala County is based on a government mandate given to the County Executive Committee in 2015 to designate a regional action plan for green infrastructure (Boverket 2012). In accordance with government mandates, plans must identify the biomes, structures, elements, and natural areas of landscapes in terrestrial and aquatic environments, including those adjacent to urban areas, and report on appropriate conservation and restoration efforts.

Seven important categories are included in Uppsala Green Infrastructure (UGI), including coastal islands, lakes and streams, wetlands, agricultural landscapes, forests, built environments, and outdoor living (Länsstyrelsen Uppsala Län 2019). The village of Älvkarleby has high value in terms of lakes, wetlands, forests and outdoor living and is a priority part of UGI development (Ericson et al. 2010).

According to the comprehensive plan of Älvkarleby municipality, the development must be combined with the protection and development of green infrastructure, which means that there must be habitats and distribution routes for wildlife species in water and green spaces. At present, one of the priorities of UGI's work is to deepen the network construction, and carry out more perfect and detailed development guidelines from the regional to the local scale.

2.5 Summary

The village of Älvkarleby is very rich and unique in its natural and cultural resources. The Nedre Dalälven river is the most important development advantage of the local area. However, the natural carrying capacity of the river is also under unprecedented pressure and challenge with local development. The contradiction between environmental threats and rural development is not only a problem in Älvkarleby, but also plagues urban development around the world. There is no doubt that protecting and developing the excellent natural ecological environment of the Nedre Dalälven river will be a huge benefit, which is also the preferred way for sustainable development in Älvkarleby.

3. Theories and Methods

3.1 Theories of ecological restoration of rivers environment

What is ecological restoration?

Society for Ecological Restoration (SER) explains that Ecological protection and restoration in rivers is a practice comprising a range of intentional human actions that seek to assist with 'the recovery of an ecosystem that has been degraded, damaged, or destroyed. Restoration attempts to return an ecosystem to its historic trajectory. Historic conditions are therefore the ideal starting point for restoration design (SER 2004).

Ecological restoration of the river environment is a complex, long-lasting endeavor involving multiple disciplines of research, such as ecology, fish biology, water environmental engineering, hydropower engineering, and urban planning. The values that ecological restoration is based on can range considerably, where values are taken to mean the ascription of relative or absolute goodness or badness to certain things, actions, or relations (O'Neill et al. 2008). Given that ecological restoration involves the intentional manipulation of ecosystems in accordance with our values' (Higgs 2003), as such assistance is premised upon human intentionality, it is a choice based on values, and it is only one of many possible choices (Diamond 1987). At the same time, it also involves the interests of different stakeholders, requiring multiple parties to communicate, negotiate and cooperate. Restoration work is extremely challenging because of the numerous, intersecting features. For example, in the river restoration in California, (Kondolf et al. 2007) said that despite its substantial number of restoration projects, California does not have a comprehensive catalog of restoration efforts that is easily accessible by scientists, public agencies and community groups.

At present, many countries and localities are carrying out research on the theory and practice of river ecological restoration planning and implementation, and there are some discussions on the different values related to ecological restoration. For example, how the restoration concept for the Skerne River in the UK has allowed positive aesthetic values to underlie the restorer's design vision for the restoration of the river. In the restoration plan of rivers in California, the researchers need to understand the value assessment of ecological restoration work from the perspective of the values of different stakeholders (ibid). In a river restoration study of five rivers, including the Elbe river in Hamburg, Wagih discusses the relationship between rivers and landscapes, proposes the main characteristics to be considered in meeting the needs of urban development and rivers, and how to evaluate them (Wagih 2020).

The research on the Dalälven river, especially the research on ecological restoration, is largely based on the research on the ecological technology of fish habitat and reproduction, and a lot of research work has been carried out locally, which will be discussed in the next section. However, the significance and role of other values of the riparian landscape in the restoration project is a research gap in the region. This thesis attempts to study this gap.

3.2 Landscape Character Assessment method

The thesis argues that using a landscape planning and design to analyze and discuss design solutions promote cooperation between involved stakeholders and the public. Therefore, the focus of the research work is divided into two parts: the investigation and analysis of the local riparian environment, and the planning and design of the proposal. In the investigation and analysis part, I used two methods including Landscape Character Assessment (LCA) method and interviews and questionnaires.

Landscape Character Assessment method (LCA) is the process of identifying and describing variation in the character of the landscape. In the European Landscape Convention definition "Landscape" combines natural components (including geology, soils and watercourses) and human influences (such as settlement and land use) with cultural perception (such as history, social associations and aesthetic value) (Tudor 2014).

The LCA method identifies and explains the combination of elements and features that make landscapes distinct from one another by mapping and describing Landscape Character Types and Areas. The LCA analyzes in detail the three main physical landscape components of landform, land cover and settlement. The LCA method is a useful tool for providing baseline information to guide the land management plans, decision on development proposals and landscape designation,etc.

The LCA method is divided into four steps. Step one is to define the purpose and scope of the assessment; Step two is desk study; Step three is field survey; Step four is landscape character description (see Fig 12).

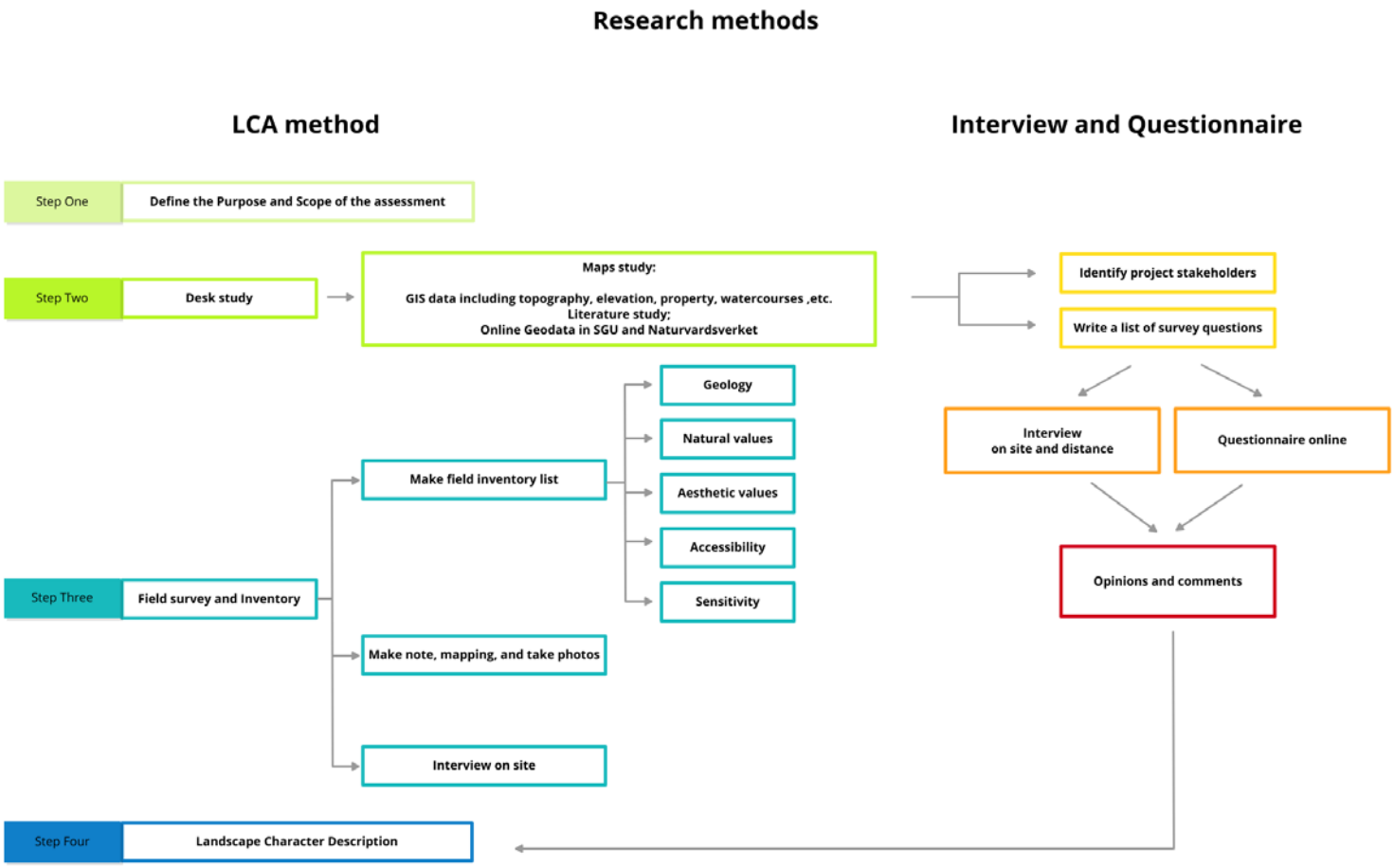


Fig 12. Flowchart for the LCA method applied in this thesis. Data source:by Author

Step 1- Define the purpose and scope of the assessment

According to the interpretation of the project background in Chapter 2 I have formed a preliminary understanding of the research area. When writing the main research purpose and question, I identified the research scope and area of the thesis, which provided a good basis for the field investigation work in the third step.

Step 2- Desk study

Desk study mainly refers to literature study and map research. The content of the literature study comes from research reports, books, journals, and graduation thesis on river landscapes from different regions and colleges. The content of the study comes from different data including municipal comprehensive planning digital maps, online geodata in Swedish Geological Survey (SGU), naturvardsverket. In addition, due to the large scope of the study area, GIS data is necessary. I obtained geographic data such as topography, elevation, property and watercourse through ZEUS.SLU, which helped me with later map analysis and drawing.

However, some data are difficult to obtain, such as natural habitats (including fish and fauna), vegetation inventories, and the investigation of specific ecological restoration areas. This information will be obtained by other means during the on-site investigation and interview phase. At the same time, I also started writing research questions that would be applied during interviews and questionnaires both on site and online.

Step 3- Field survey

In order to collect information more comprehensively, I conducted a total of three field surveys, which took place in different seasons. The information collected on site is recorded and maintained in a rigorous and methodical manner, for which I have developed a special standardized field survey form, see Table 1 in Appendix 1. The table content includes: Geology, Natural values, Aesthetic values, Accessible and Sensitivity five main items and 14 sub-items, these options are to objectively describe the landscape of the study area. The area for the survey includes six areas (see Fig 14). In the process of inventory, Some of this important additional information is recorded in the form of sketch areas for common features of attachments, draft landscape features, and draft descriptions. Field work is essential to capture the aesthetic, perceptual, and experiential qualities of the landscape. The Avenza map App (see Fig 14) is used in the field survey process to record survey paths, take site photos, archive zone numbers, etc.

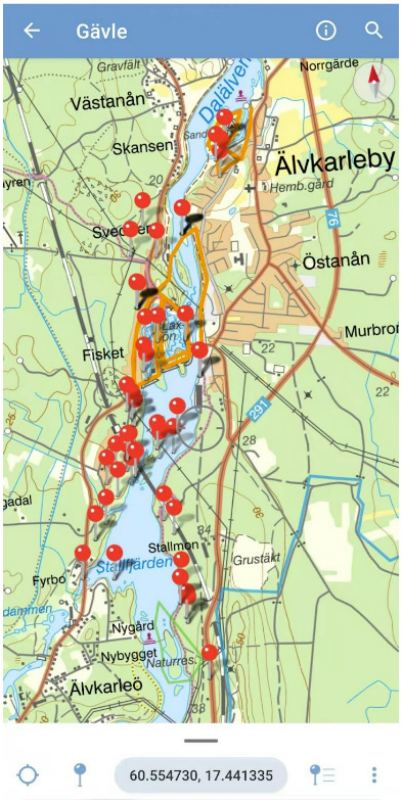


Fig 13. Avenza map used for the inventory process

Step 4- Landscape character description

The fourth stage is the classification and description of landscape features. The outputs of the characterisation process are further refined and finalized by classifying, mapping and describing landscape character areas and / or types. The character descriptions are informed by the desk study and field work which will, of course, include stakeholder engagement. Based on this foundational knowledge I selected Älvkarleby for my study area and divided it into six landscape feature areas (see Fig 14) and compiled a landscape feature description. The detailed content of the Landscape Character Description in Älvkarleby will be shown in chapter Four, meanwhile the description will be used as a basis for the proposal in this thesis.

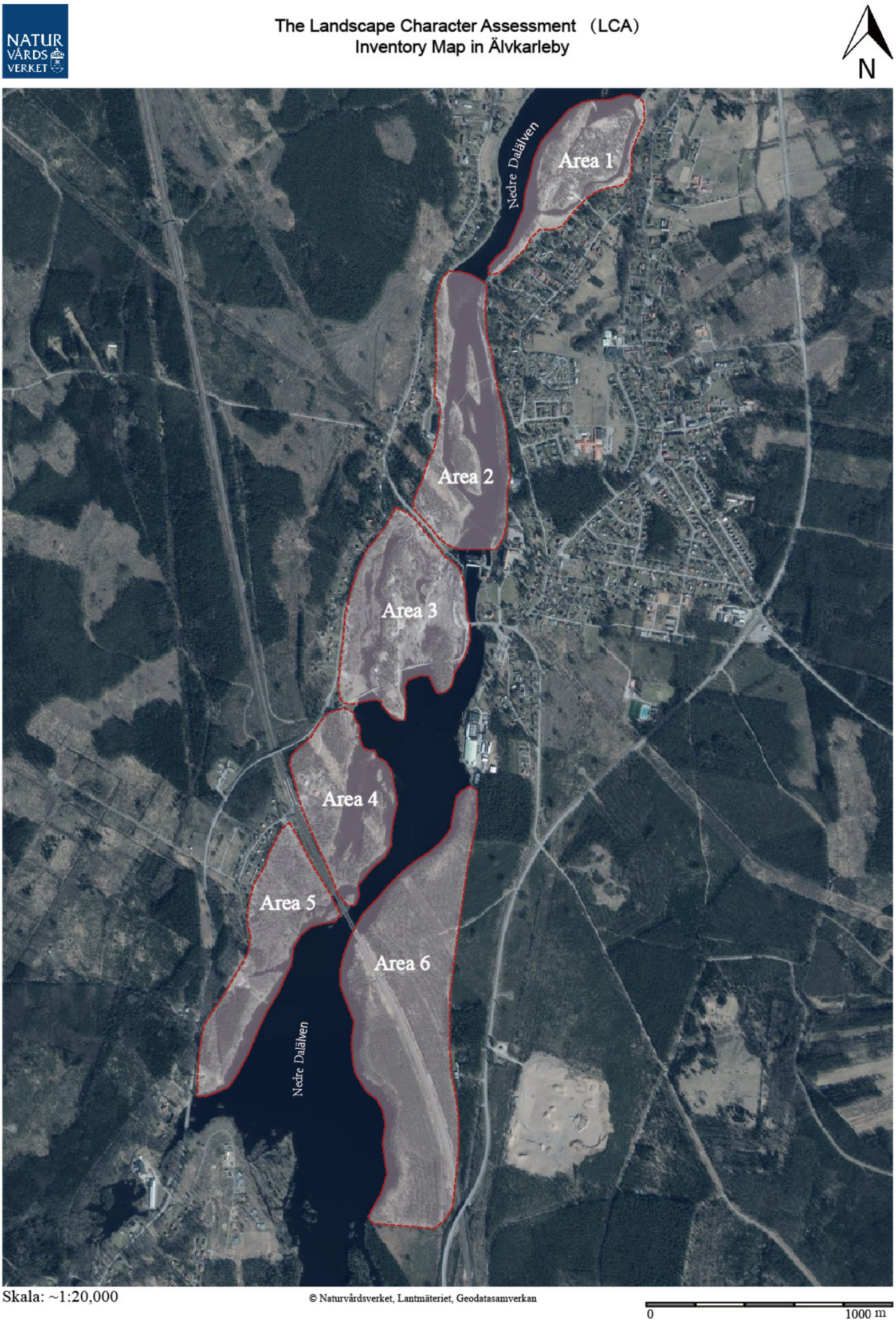


Fig 14. The six investigation areas in the LCA method. Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan. Edited by Author.

3.3 Interview and questionnaire

3.3.1 Research questions for interviews and questionnaires

The aim of the interviews and questionnaires is to get the opportunity to understand the description of the current dilemma of the region and the ideas for the future development of the region from many stakeholders. In parallel with the background study and literature research, some questions about the Älvkarleby arose. These questions include fish habitat, tourism, hydropower production and cultural environment, all of which have an impact on the future development of the river space. These questions are listed and summarized in two parts. The first part is a professional and technical question for a specific stakeholder interview (see Appendix 2). The second part, in the form of a questionnaire, was posted on the local Facebook group to collect inhabitants' opinions and demands on the development of Älvkarleby (see Appendix 4).

3.3.2 Stakeholders

The players in the Nedre Dalälven river environmental restoration and fish passage research fields are represented by the municipality, electricity company, various forestry companies, interest groups and local NGOs and inhabitants. Therefore, the stakeholders in the interview list are:

- The Counties - Uppsala and Gävleborg County;
- The local government - Älvkarleby municipality;
- The electricity company - Vattenfall AB;
- The local environmental organizations - Naturvårdsföreningen and Upplandsstiftelsen;
- The fish research institutes - The Fisheries Research Station of Aquatic resources, SLU in Älvkarleby;
- The fish - tourism and recreation businesses - Sportfiskarna;
- The local residents.

3.3.3 Process

After identifying the respondents and getting their contact information, I sent the document with questions to them. Some stakeholders responded to my questions via email. Other interviewees accepted the invitation to meet me on site. They answered my questions orally while we were visiting and observing in the research area. We also discussed the idea of the proposal. I recorded and summarized their comments, see Appendix 3. In parallel with the interviews, I also posted my questionnaire on the local Facebook group. I searched two local public groups and got 22 answers, the results are shown in Appendix 5.

3.4 Summary

Going back to the research question raised at the beginning of the thesis, it mainly focuses on the contradiction between river ecological restoration and rural recreation development. Through two investigation methods - LCA method and interviews, these environmental issues should be solved in this thesis are analyzed in a concrete, localized manner as below:

Primary ecological environmental issues are:

- Restore the possibility of fish migration routes
- Conservation of habitats in both upstream and downstream
- Strengthening the resilience of revetments.

Primary rural development needs are:

- Protect shoreline integrity and public access
- Develop sustainable outdoor life and tourism

Taking into account comprehensively, the restoration of the ecological environment will provide more ecological services, which cannot be measured by visible economic value growth, but are indeed necessary conditions for sustainable development. How to balance the conflict between the two aspects has been studied by many relevant departments in cooperation, and the research will continue. In chapter five, a proposal and corresponding strategy for this conflict will be presented.

4. Landscape Character Description

Generally, the LCA method analyzes in detail the three main physical landscape components of landform, land cover and settlement. Landform includes geographic features such as topography, soil type, watercourse and so on. Land cover has the forest type, vegetation and habitats sub-items. And the settlement is about the pattern of different settlements, like towns, villages or farmsteads, etc,.

In this case study, the study areas mainly focus on rivers and riparian landscapes. Therefore, the analysis requires a detailed classification of its rivers and surrounding riparian landscapes, based on geographic location (upstream and downstream relative to hydropower stations and dams), topographic features (height difference), revetment type and soil type, and habitat distribution, etc. Since the study area is located in rural areas, a reasonable classification cannot be obtained simply from the feature description of settlements. Instead, it will primarily consider the spatial aesthetics of the site, cultural and social functions and identities, which form the unique aesthetic value of the study areas. In addition, during desk research work, it was learned that the area has a high risk of soil erosion and fragmentation, which is critical to the restoration of the local ecosystem.Therefore, in the field investigation process, it is of great significance to pay attention to the sensitivity of the site and the human factors that threaten the sensitivity of the environment for the ecological restoration of the region.

The landscape character description of six classification areas includes geology, nature value, aesthetic value and sensitivity aspects. This knowledge comes not only from my observations of the site visiting, but also from information from literature study and interviews, so it will provide a comprehensive impression of the site.

4.1 Area One

Main characters

- Wide water-filled river
- Flat islands
- Outdoor life area

Fig 15. The background map of the LCA investigation Area One. Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan Edited by Author.

Fig 16. The photo from point 1A shows a swimming spot with a wide view of the nedre Dalälven river downstream.Photo by Author.

Fig 17. The photo from point 1B shows a sparse pine forest in Camping island. Photo by Author.

Fig 18. The photo from point 1C shows cabins in Camping island. Photo by Author.

Geology

Area One is an inwardly concave shoreline that contains two larger islands near the east shoreline of the river. The terrain of the island is flat (see Fig 16). The larger island is the Camping area and the smaller island is the fishing area. A small meandering creek separates the two islands. The islands are connected by a pedestrian bridge. There is also a creek split between Camping Island and the land, and a model bridge will connect to each other. On the creek between Camping Island and the land, there is a small jetty for the Älvkarleby boat club. The soil types of the islands are mainly swimming sediment, coarse silt-fine sand. The revetment is a gentle slope of sand or gravel. The bottom of the stream is stone, block and sand.

Natural value

These two islands are covered with sparse pine forests and a few deciduous trees (see Fig 17). Some bushes grow on the edge of the revetment. The fishing island is also covered with meadows on the edge of the island. In order to restore the spawning environment of salmon downstream of the hydroelectric plant, the stream between Camping island and the shoreline was carried out with the river restoration work by Upplansstiftelsen and Fortum in 2017. The measure is the addition of stones and blocks to the bottom of the river in order to create turbulent currents to attract fish. At present, the area is still considered as an ecologically valuable area for fish breeding.

Aesthetic value

The vegetation on the island grows sparsely, forming an open landscape. RVs, tents and cabins are scattered all over the Camping island, making the environment seem crowded (see Fig 18). At the northern end of the island there is an open small beach for swimming, which is a good viewing point overlooking the wide Dalälven river that flows northward. This area is an important outdoor life area and has been rated as the highest value group in the Nature Conservation Plan of the County Comprehensive Plan (Älvkarleby Kommun 2020).

Sensitivity

The revetments on islands and shoreline are mainly composed of coarse sand, fine sand, gravel and floating sediments, which are considered discreet areas prone to landslides and erosion. The large number of human activities on the island also tend to increase the risk of soil desertification. In addition, there is an outdoor bath and a small dock in the area. In the comprehensive plan, these outdoor life facilities will continue to develop, which will have an inevitable ecological impact on the water environment and fish species in the area if there is no protection.

4.2 Area Two

Main characters

- Wide rivers with steep slope
- Artificial island
- Sportfishing area

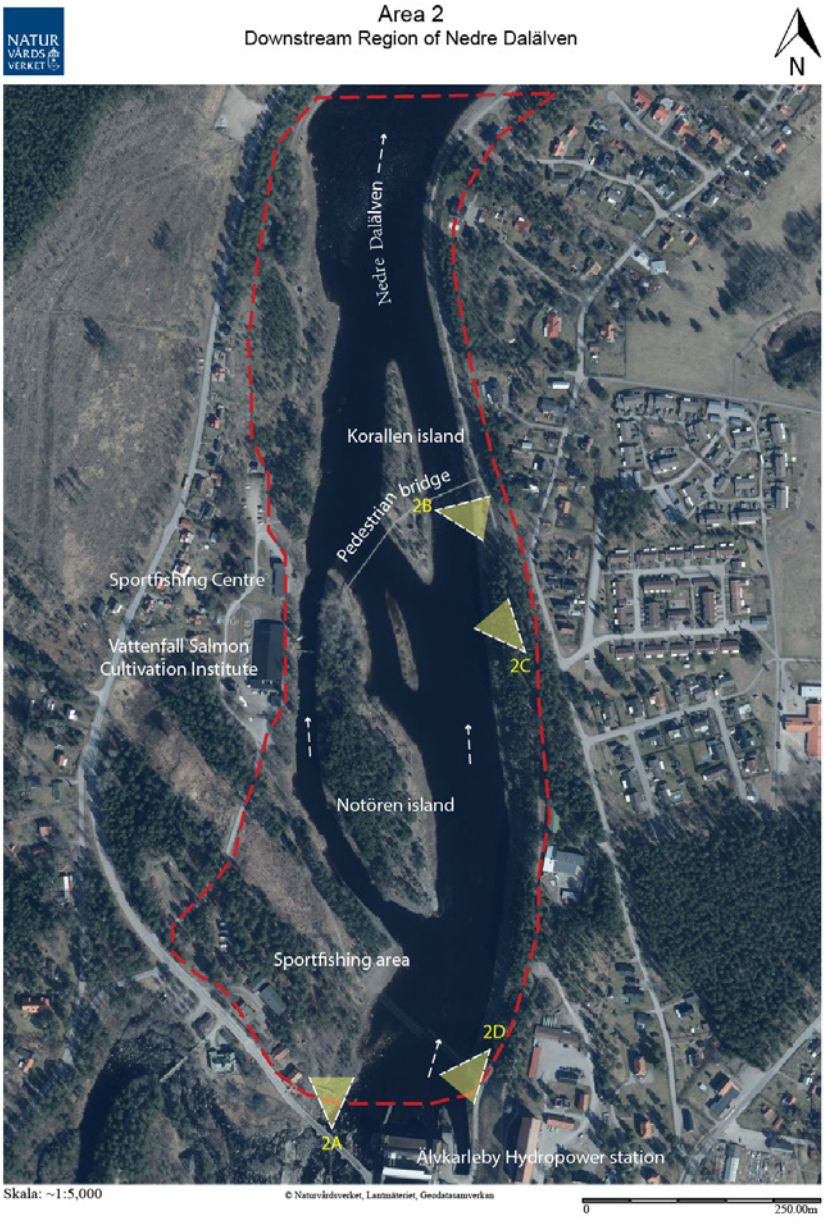


Fig 19. The background map of the LCA investigation Area Two. Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan Edited by Author.

Fig 20. The photo from point 2A shows a sport fishing area in the Nedre Dalälven river downstream. Photo by Author.

Fig 21. The photo from point 2B shows steep revetment in the erosion risk shoreline area. Photo by Author.

Fig 22. The photo from point 2C shows the bigger artificial island connected to the east shoreline with a pedestrian bridge. Photo by Author.

Fig 23. The photo from point 2D shows the Älvkarleby hydropower station. Photo by Author.

Geology

The topography of Area Two is complex. The terrain on the west side of the river is undulating, whereas near the bridge of Carl XIII the terrain becomes flat and open (Fig 20). Follow the riverside path to the old salmon farming college where the terrain rises and forms a steep slope. On the east side of the river, the terrain moves from high to low from south to north, forming a large vertical change (see Fig 22). There are two larger islands: Notören and Korallen, plus one slightly smaller island in the river, Rabben.The islands are pine forests covered with moraine hills and rocks, the Korallen and the smaller Rabben are islands created by excavated masses with plantations of willow and other shrub species. The soil type on both sides is mainly Ice river sediment sand. The soil at the western revetment consists of a partial block, sandy moraine and filling. In this area, the river is divided by three islands, forming water surfaces of different widths. On the west side, the river is narrow and the water flow is gentle, which is an area suitable for sportfishing. On the east side, the water surface is wider and the water flow is fast.

Natural value

The forest types in this area are trivial deciduous forest and coniferous forest. On the east bank of the river, meadow restoration work is underway to deal with the more serious soil erosion problems. The vegetation on the island is dominated by planted pine and birch trees, and the woodland takes a long time to grow into its natural island state. This area is an important area for salmon and sea trout migration as it is located downstream of the hydroelectric power station. In addition, it is home to many amphibians and birds, such as Gray Herons (*Ardea cinerea*), Goosander (*Mergus merganser*) and Mallards (*Anas platyrhynchos*).

Aesthetic value

Visually, the place is dominated by a wide river landscape. The steep east bank and artificial island stone revetment make it look neat and slightly unnatural (see Fig 21). Suspension bridges and hydroelectric power station buildings become important landmarks at the north and south ends. There are footpaths on both sides of the river. There is dense vegetation on both sides of the river bank, and only a few places have a wide view, where you can admire the ancient buildings of the hydropower station (see Fig 23). Standing on the suspension bridge, people can overlook the beautiful scenery on both sides of the river and listen to the murmur of the water.

Sensitivity

The beach presents a fragmented, clearly affected landscape. As this is an area of activity for sportfishing, human activities are connected to both sides of the river by means of suspension bridges. The expansion and development of villages also gradually reduced the space of the river. On the east shoreline, the trees were cut down in order to open up views to the water, which undoubtedly exacerbated the risk of soil erosion.

4.3 Area Three

Main characters

- Fast-flowing creeks and biodiversity protected area
- Drained rock valley and dam
- A place full of historical and cultural values

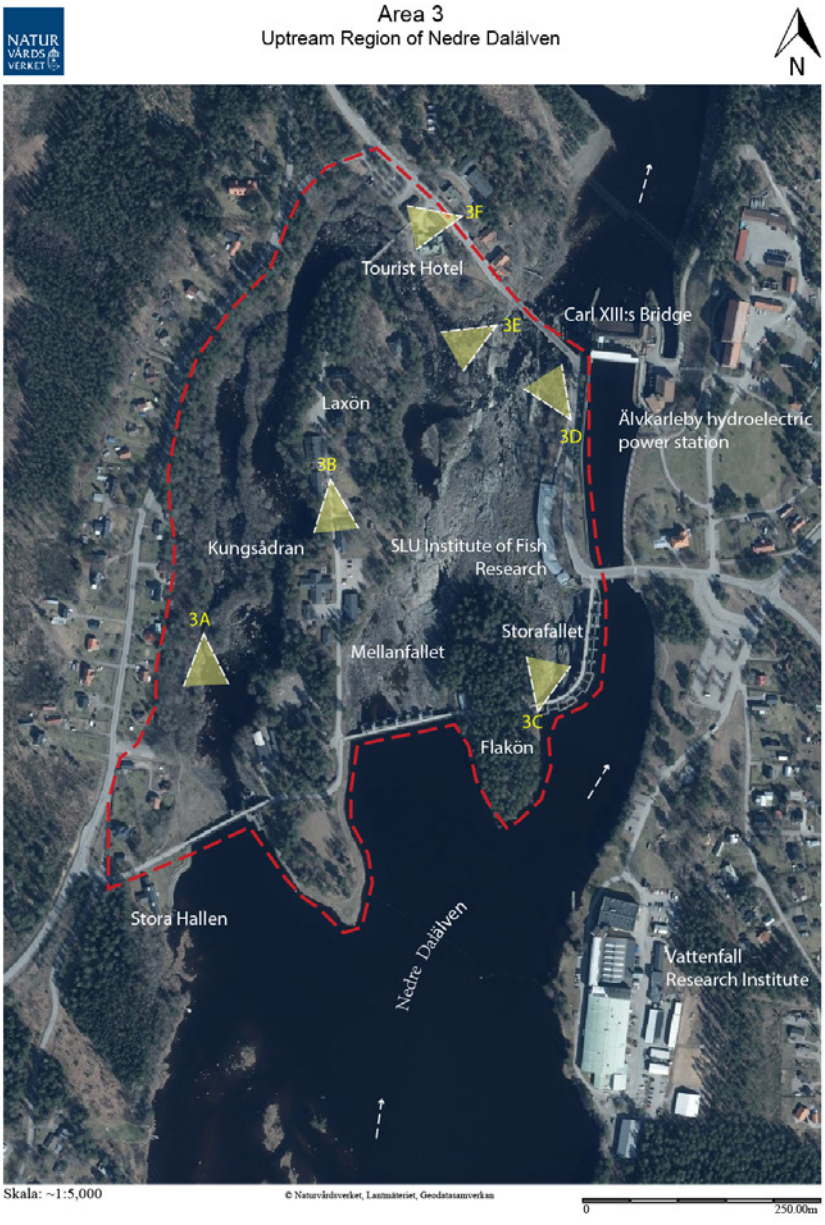


Fig 24. The background map of the LCA investigation Area Three. Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan Edited by Author.

Fig 25. The photo from point 3A shows the stream in Kungsådran. Photo by Author.

Fig 26. The photo from point 3B shows the cultural buildings in Laxön. Photo by Author.

Fig 27. The photo from point 3C shows the rocky valley landscape in Storafallen dam. Photo by Author.

Fig 28. The photo from point 3D shows Carl XIII bridge. Photo by Author.

Geology

The topographical features of Area Three are obvious. Rocky to block-rich moraine dominates the drained valley, which constitutes a very special rocky landscape (see Fig 29). The river space is divided by Laxön and Flakön into three parts: Storfallet, Mellanfallet and Kungsådran. Kungsådran is an undulating water-filling valley (see Fig 25). The terrain in the valley is initially flat and rock-strewn, and becomes steeper downstream with turbulent currents. Mellanfallet and Storfallet are drained valleys with very large terrain height differences and full of boulders (see Fig 27). Storfallet is only open one day a year during the flood season, when the deep valleys are filled with water. The soil types of Kungsådran are mainly Ice age river sediment, sand and clay-silts. Mellanfallet and Storfallet have large stone blocks on the bedrock that have been formed by the strong waterfall flow.

Fig 29. The photo from point 3E shows the stream with blocks and stones under the Carl XIII bridge. Photo by Author.

Fig 30. The photo from point 3F shows the cultural heritage-tourist hotel. Photo by Author.

Natural value

The vegetation cover of the area includes pine forest, coniferous forest and deciduous forest, mainly Oak (*Quercus robur*), Ash (*Fraxinus ornus*), Alder (*Alnus serrulata*) and Hazel (*Corylus avellana*). Sly has in many places begun to colonize the drained riverbed. An evergreen plant called Horsetail (*Equisetum hyemale*) grows under the mixed forest.

Kungsådran is an important biodiversity reserve in the region, surrounded by rich vegetation with high natural values, especially as an important migratory breeding route for salmon and sea trout. Every year between spring and summer, fish migrate here to lay their eggs. Due to the physical obstruction of the dam, the fish cannot pass through the dam naturally and need artificial assistance to reproduce. At present, the local government and relevant departments are carrying out environmental research on the natural migration route of salmon, and have implemented many constructive measures in this area to restore the fish habitat environment. To increase the biodiversity of the area, local environmental groups have also carried out meadow restoration work at Läxons Rastplats. Here are red-listed vascular plants (*Lathraea squamaria*), an impressive bird life including Strömstare (*Cindus cindus*), Forsärla (*Motacilla cinerea*), Gråhäger (*Ardea cinerea*), Storskrake (*Mergus merganser*), Havsärn (*Haliaeetus albicilla*), and several mammal species such as Otter (*Lutra lutra*) and Beaver (*Castor fiber*).

Aesthetic value

Visually, Kungsådran is in sharp contrast to the other two areas. Meandering streams and lush vegetation on both sides make Kungsådran landscape look vivid, soft and natural with sounds of small water rapids. Mellanfallet and Storfallet are very quiet places. Gray-black concrete cliffs and boulders give a strong image of rigidity and insecurity. Only when the waterfall opens every year, will it attract countless people to appreciate the huge visual impact and sound brought by the large water flow with a height difference of more than 20 meters. The two islands of Laxön and Flakön are covered by thick coniferous forest although the forest is partly cut down on Laxön due to the many culturally valuable buildings from the period of the military camp. On the south side of Laxön, there are open green spaces. Due to the impoundment of the dam, the water level here is high and the shoreline is flat. The path along the water's edge offers a calming lake and expansive views, which contrasts with the rocky landscape on the north side.

The area also contains many cultural buildings and landmarks (see Fig 26). A chronological description of settlements starts with signs of manmade uses such as a well and facilities for old fashion fishing methods, Carl XIII bridge (see Fig 28) and an Inn with stables to change horses from 1816. Tourist hotel, the military camp approximately simultaneously 1875-1880, and the power station built 1911-1915. The military camp on Laxön is now used for cultural and tourist purposes, such as art galleries, restaurants, cafe and tourist hotel (see Fig 30), as well as officersmässen for festivities. The architectural style is the red and brown national romantic architecture style. The Falu red Carl XIII bridge with its ocher yellow emblem is the most important local landmark. In addition, the iron cross erected on the cliffs of Storfallet is one of the witnesses of the local historical illustration of conflicts over the salmon resources. The area has been identified as a cultural environment of national interest.

Sensitivity

The area is a complex sensitive area containing biological habitats, cultural heritage and leisure tourism as well as hydroelectric power plants. Model roads, humanoid roads, dams and bridges are interwoven into a network that makes the area accessible. The cultural tourism service industry also brings more human activities, which undoubtedly increases the sensitivity of the local ecological environment. The rocky ravine area between Mellanfallet and Storfallet is closed to the public. A small Vattenfall's protected area for biological diversity (VVO) has been formed on the west side of the Kungsådran stream, with access to the walk. However, there is currently a small amount of fishing in the area at certain times of the year, which will put potential pressure on local fish reproduction and has become one of the hotly discussed topics in the local area.

4.4 Area Four

Main characters

- Narrow river bay and islands
- Flat and inaccessible forest riparian landscape

Fig 31. The background map of the LCA investigation Area Four. Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan Edited by Author.

Fig 32. The photo from point 4A shows the narrow water upstream. Photo by Author.

Fig 33. The photo from point 4B shows the cultural buildings - Stora Hallen. Photo by Author.

Fig 34. The photo from point 4C shows the flat forests in the shoreline. Photo by Author.

Geology

Area Four is flat and low-lying land. As the dam raises the water level, the elevation difference between shoreline and water is low, and most of the riparian transitions smoothly to the river. Due to water storage, part of the original landscape (the old railway park) was submerged by water to form a peninsula only connected with the land under the railway bridge. Between the peninsula and the mainland is an inner river (see Fig 32). The soil types in this area have different proportions of moraine. The revetment is mainly composed of sand and clay-silts.

Natural value

The vegetation cover of the area includes pine forest, coniferous forest and deciduous forest (see Fig 34). The vegetation is dense and difficult to access the shoreline. Some rare flora is to be found in the area like Guckuskon (*Cypripedium calceolus*). The environment of the peninsula and inner river provides good habitat for wildlife. Wild animals such as Otter (*Lutra lutra*), Beaver (*Castor fiber*), Badger (*Meles meles*), and many birds live there. In future fish route planning in the LIV project, this area has great potential to become an important water area for prolonged spawning and breeding of fish.

Aesthetic value

Visually, the area is covered with dense forest forming a relatively closed area. Only in Stora Hallen, next to the Kungsåran dam, is the open sight place, where people can enjoy the whole lake view. The area used to be the old Älvkarleby railway park, but most of the buildings have now been demolished, except for Stora Hallen (see Fig 33), which was built in the late 1880s. The national romantic wooden structure of the auditorium building in red and light green reflects the typical architectural style prevailing in the turn of the 19th century, and has become an important cultural landmark for Älvkarleby.

Sensitivity

This area forms a relatively clear and complete natural area, due to the physical barriers on the southeast (the road and railway) and north sides (the dam and bridge). The main impact on the area comes from the railway and high-voltage line. The high-voltage line passes through the middle of the area, forming an open area of about 30 meters, which divides the forest, but also reduces the impact of human activities in the area. Only the railway station and the two houses along the village road. In the comprehensive plan, the development and construction of the railway station area will also have a certain impact on the ecological sensitivity of the area.

4.5 Area Five

Main characters

- Calm and wide river landscape
- Ecologically valuable forests

Fig 36. The photo from point 5A shows the riparian landscape under the railway bridge. Photo by Author.

Fig 37. The photo from point 5B shows the wildlife habitats in the shoreline. Photo by Author.

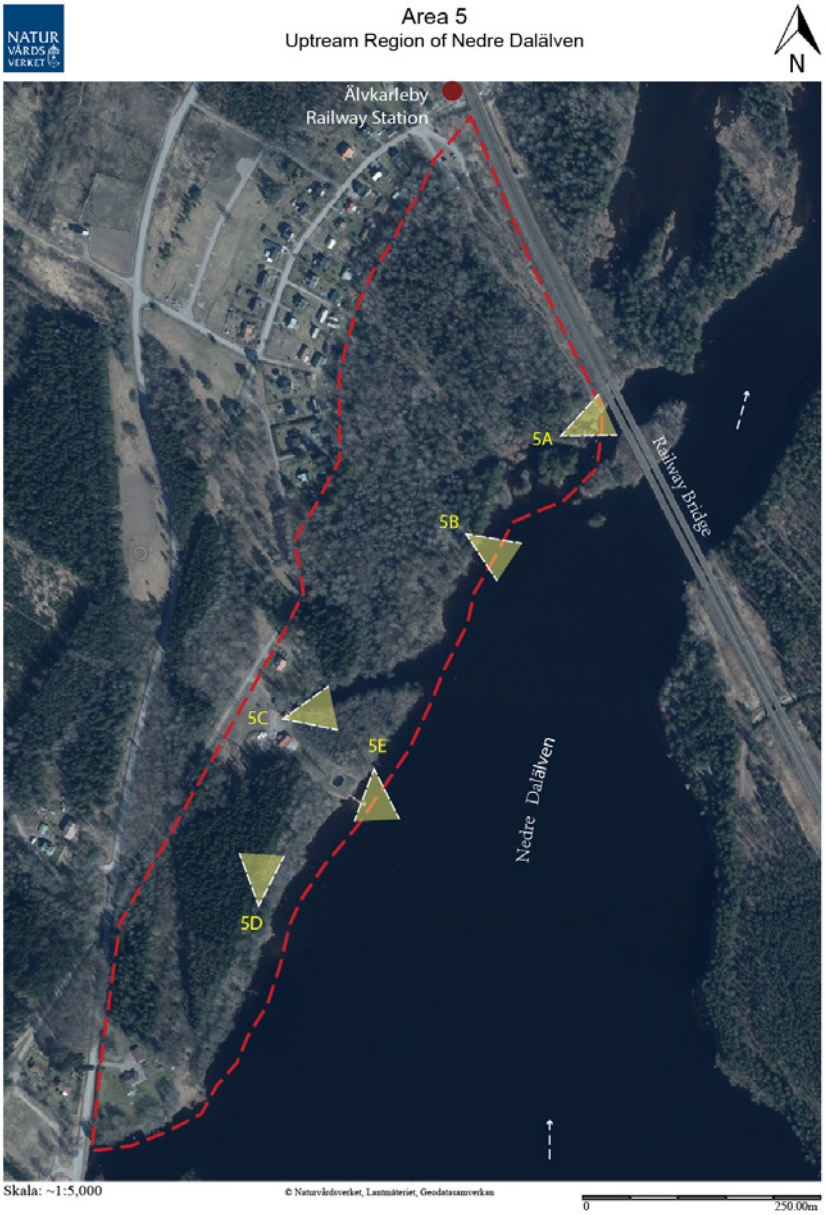


Fig 35. The background map of the LCA investigation Area Five. Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan Edited by Author.

Fig 38. The photo from point 5C shows the wedge estuary. Photo by Author.

Fig 39. The photo from point 5D shows the spur forest being cut down. Photo by Author.

Fig 40. The photo from point 5E shows the flat shoreline landscape. Photo by Author.

Geology

The terrain of Area Five is characterized by flat land. The height difference between the land and the water is very low, and the shoreline has neat edges and a smooth transition to the water. In the middle there is a wedge estuary that brings water into the land and is connected to the drainage channel of the catchment area (see Fig 36). Below the railway bridge on the south side of the area, the terrain undulates, forming some small depressions. The soil types in this area are mainly clay-silt and sandy moraine. The revetment is mainly composed of sand and clay-silts.

Natural value

This area is within the “nature conservation agreement area“ agreed upon by the local government and Skogsstyrelsen because of the high ecological value of the forest. Most of the area is covered by coniferous forest and deciduous forest. There is a high-value spur forest in the south which belongs to the company Stora Enso, currently it has been cut down (see Fig 39). The vegetation on the waterfront edge is deciduous forest and aquatic plants which are connected with small islands under the railway bridge, which provide a good habitat for wildlife (see Fig 37).

Aesthetic value

The area is covered with dense forest creating a relatively closed area. There is a path close to the waterside from the railway station to the south. There are several open sights, people can get close to the water to enjoy the calm wide view of the Nedre Dalälven river (see Fig 40). In the south-central part of the area there is a small open green space, a private building and some outdoor facilities such as seats and children's slides (see Fig 38).

Sensitivity

The flat, low-lying topography makes it vulnerable to flooding in Area Five. During the flood season, the water level rises and flood water enters the interior of the area to form water depressions and trickles. In addition, the regional ecological environment is also affected by human factors. For example, the high-value spruce forests in the middle of the region were all cut down. Private occupation of the public riparian space exacerbates disconnection and fragmentation of wildlife habitats. In Älvkarleby's urban comprehensive plan, near the railway station on the north side of the area, two more sites are planned as an urban development area and LIS area, which will increase the population density and influence in the area.

4.6 Area Six

Main characters

- Highlands by the river
- A narrow forest surrounded by railways, roads and river
- Curved shoreline and beautiful path-Upplandsleden

Fig 42. The photo from point 6A shows the riparian gently approaching the water on the north side of the railway. Photo by Author.

Fig 43. The photo from point 6B shows highland with six meter height different to the water in the south side of the railway. Photo by Author.

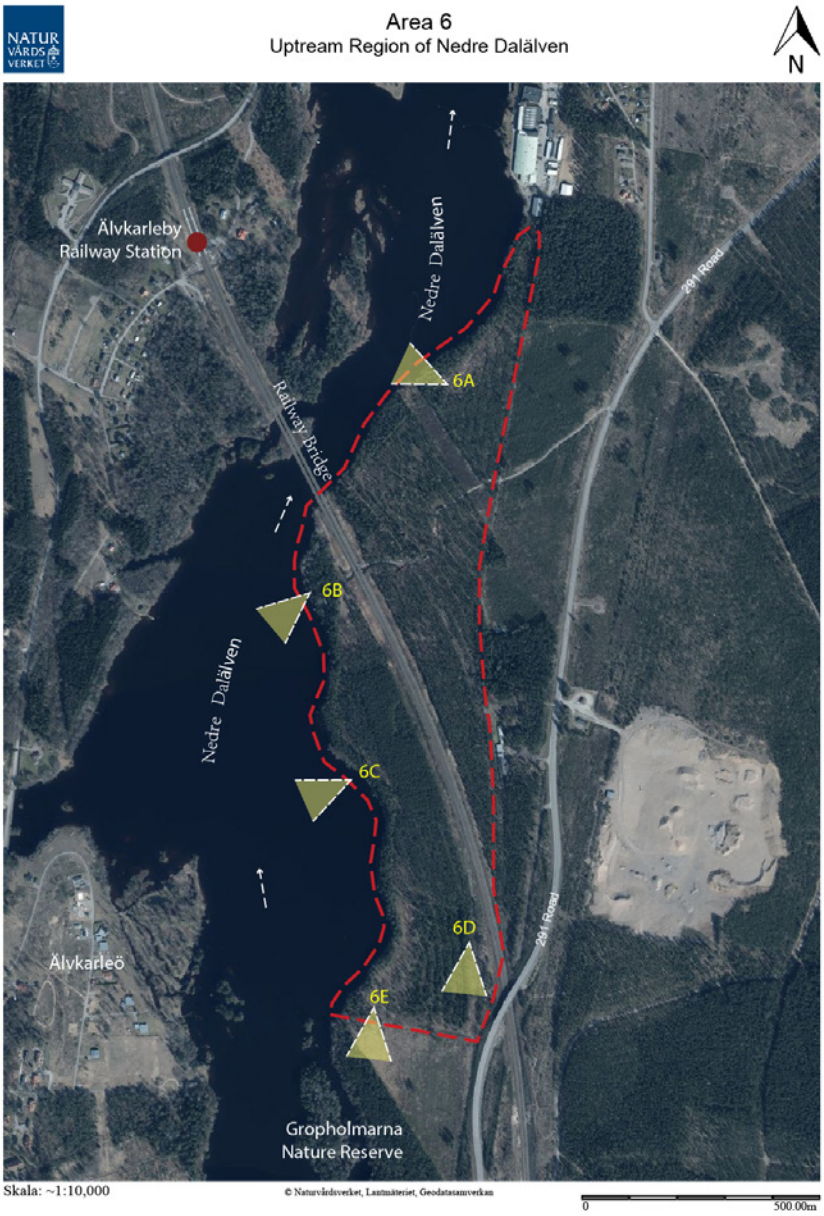


Fig 41. The background map of the LCA investigation Area Six. Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan Edited by Author.

Fig 44. The photo from point 6C shows a viewing point with rest facilities in Upplandsleden. Photo by Author.

Fig 45. The photo from point 6D shows the forest close to the motorway. Photo by Author.

Fig 46. The photo from point 6E shows the pedestrian outdoor life route - Upplandsleden. Photo by Author.

Geology

Area Six is a narrow landscape with the barriers of roads, railways and the Nedre Dalälven river (see Fig 45). The change in topography is a gradual decrease in elevation from south to north. On the north side of the railway, the height difference between the water surface and the mainland is low, and the shoreline is gentle (see Fig 42). The south side of the railway has the highest elevation, and the height difference between the water surface and the land is more than 6 meters, forming a steep slope (see Fig 43). The soil type in this area is mainly Ice river sediment sand. The revetment is mainly composed of rock, sand and clay-silt.

Natural value

Most of the forest in this area is covered by coniferous forest and deciduous forest. The vegetation on the waterfront edge is deciduous forest and aquatic plants. The southern part of the area has many vegetation of high ornamental value, such as deciduous trees Ash (*Fraxinus ornus*), Oak (*Quercus robur*), Linden (*Tilia tomentosa*) and Hazel (*Corylus avellana*), Horsetail (*Equisetum hyemale*) and Spring pea (*Lathyrus vernus*) are the most common ground cover plants. These plant species continue to the Gropholmarna nature reserve area on the south side. It is adjacent to the nature 2000 area (SPA and SCI) on the southeast side of this area.

Aesthetic value

Visually, Area Six is a quiet and natural place to view the Nedre Dalälven river. Upplandsleden on the shoreline offers a narrow hiking route. There are also several outdoor facilities along the path, including tables and benches, and a small sandy beach (see Fig 44). Another path starting from Marma, Vikingaleden, coincides with Upplandsleden in this area (see Fig 46), leading to Älvkarleby. There are no other buildings in the area except the Vattenfall building at the northern end.

Sensitivity

The integrity of the area is affected by several major urban infrastructures including railways, highways, high-voltage lines, etc., which fragment the regional landscape. Within a triangle of land that meets the Gropholmarna nature reserve area, the forest was cut down and a new deciduous forest was planted instead. These factors directly lead to the fragmentation of vegetation communities and bird habitats in this area. The further expansion of the power plant construction on the north side will also have a certain impact on the local ecological environment. In addition, this area is adjacent to water protection areas, so the ecological environment of the area is very important for the impact of groundwater quality.

5. Visions

In order to demonstrate the completeness and depth of the proposal, this chapter will describe hierarchically from two sections (see Fig 47), including the planning scope of the municipal nature reserve, protection purpose, and zoning strategies. Then it focuses on the planning scheme of the core protected area which is the most important zone in the proposal.

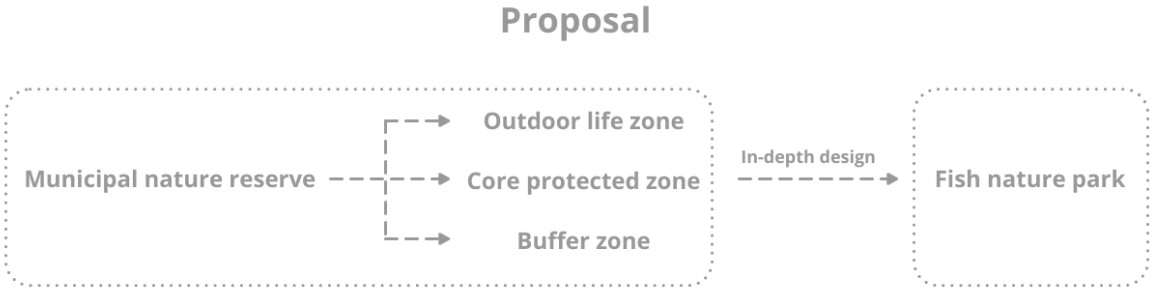


Fig 47. The illustration of two sections in the Vision chapter.

5.1 Proposal

Municipal nature reserve

In Sweden, establishing nature reserves is one of the most common ways of protecting valuable natural environments in the long term, and they are established by county administrative boards and municipalities, supported by the Environmental Code (Malena & Lisen 2017). The goals for establishing nature reserves are diverse. According to the Swedish Environmental Code, nature reserves can be used to preserve biodiversity; to conserve and preserve valuable, natural environments; to meet the needs for outdoor recreation areas; to protect, restore or recreate valuable, natural environments; to protect, restore or recreate the natural habitats for valuable, endangered species.

The proposal for this thesis is to plan an integrated municipal nature reserve along the shoreline of the Nedre Dalälven river, in order to meet the sustainable development of Älvkarleby village in the natural, cultural environment and outdoor living, with minimum environmental impact. The purpose of the municipal nature reserve area is to establish agreement on the inventory values of flora and fauna and agreement on maintenance. The purpose is also to seek a balanced development possibility between the contradiction between rural development (including human recreation and energy production) and the restoration of natural fish habitat. The area of the municipal nature reserve is approximately 2.8 square kilometers and the scope is extends from Sandören fish camping in the north to the Älvkarleö and Gropholmarna nature reserve in the south, including green areas, forests and islands on both shorelines of the river and the Laxön area. According to LCA's landscape characterization and landscape sensitivity survey and analysis, the municipal nature reserve is divided into three areas with different functions (see Fig 48).

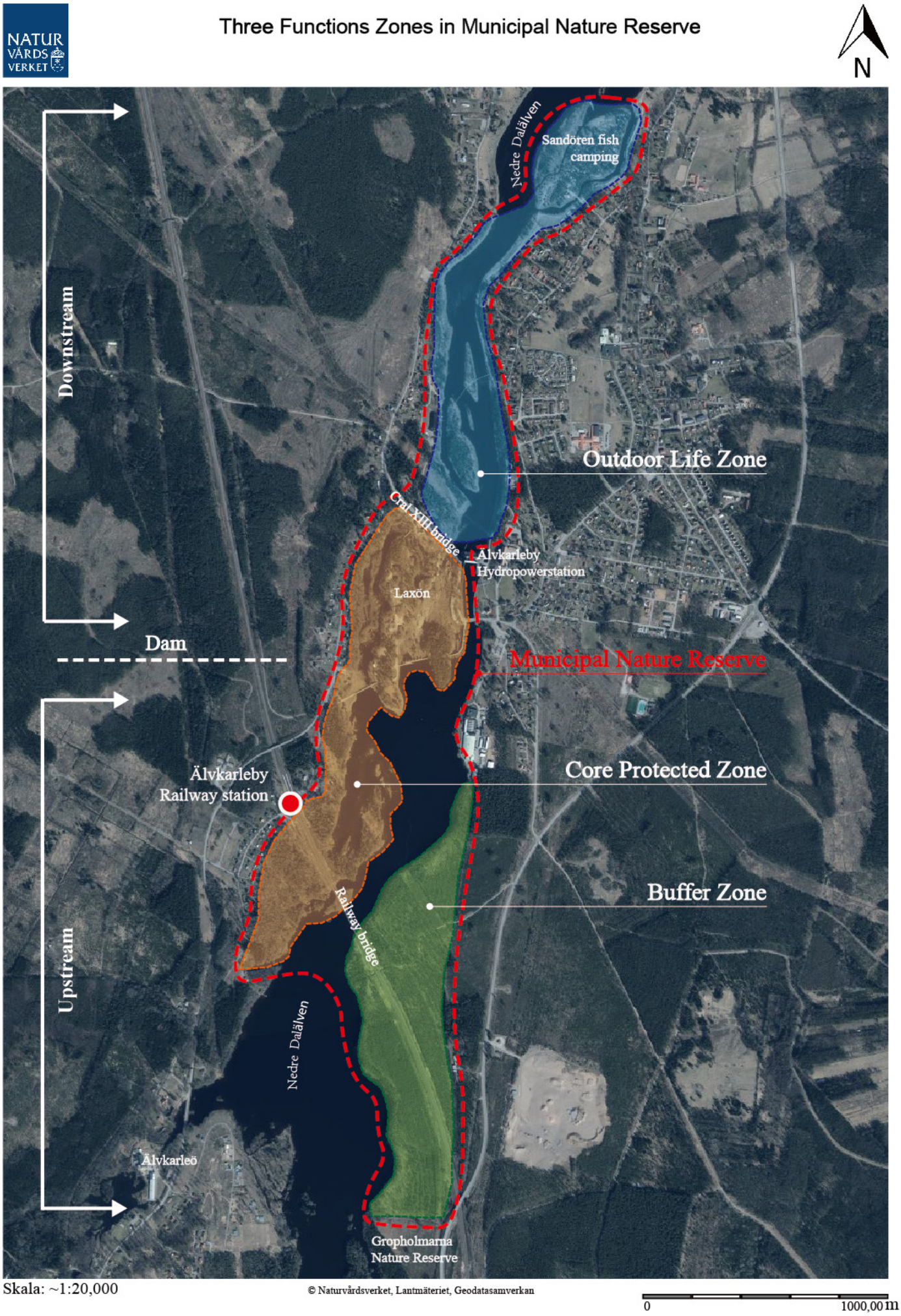


Fig 48. The illustration map of three function zones composed municipal nature reserve. Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan. Edited by Author.

5.1.1 Outdoor life zone

Outdoor life zone will be planned from the Älvkarleby hydropower station north to the Sandören fish camping islands. These areas are located downstream, where a large number of recreation facilities are concentrated, and will become an important outdoor life zone.

According to the Landscape Characters Description in Chapter Four, this zone is a highly valuable sport fishing area and is considered as potential wild fish habitats downstream. In order to restore the ecological environment of the stream, the local relevant departments Upplandsstiftelsen and Fortum carried out measures to add stone and block to the bottom of the stream in 2017. But the effect achieved so far is not obvious. The reason is that the added material is already compacted and cannot create turbulence to attract fish. In addition, the water area of the stream here is narrow and shallow, so it is easily affected by the regulation of water flow by the hydropower station, thus causing the stream to dry up.

In addition, Existing area recreational activities add pressure to fish habitat restoration efforts. In particular, in the municipality‘s master plan, the area will be expanded to build outdoor baths and yacht clubs. The development of the dock is bound to have a very negative impact on the habitat of fish.

The revetments on islands and shorelines have very serious erosion and soil desertification caused by a large number of human activities, such as construction, cutting down trees etc,. The meadow restoration work has already been carried out here, but the restoration area needs to continue to be expanded.

Environmental issues and Protection Purpose

- Minimize the negative impact of human activities on the natural environment;
- Restoring the habitat of fish downstream of the river;
- Improve the sandy revetment and increase the resilience of the revetment to face flood problems and soil erosion problems;
- Restore the integrity of the natural environment and reduce fragmentation.

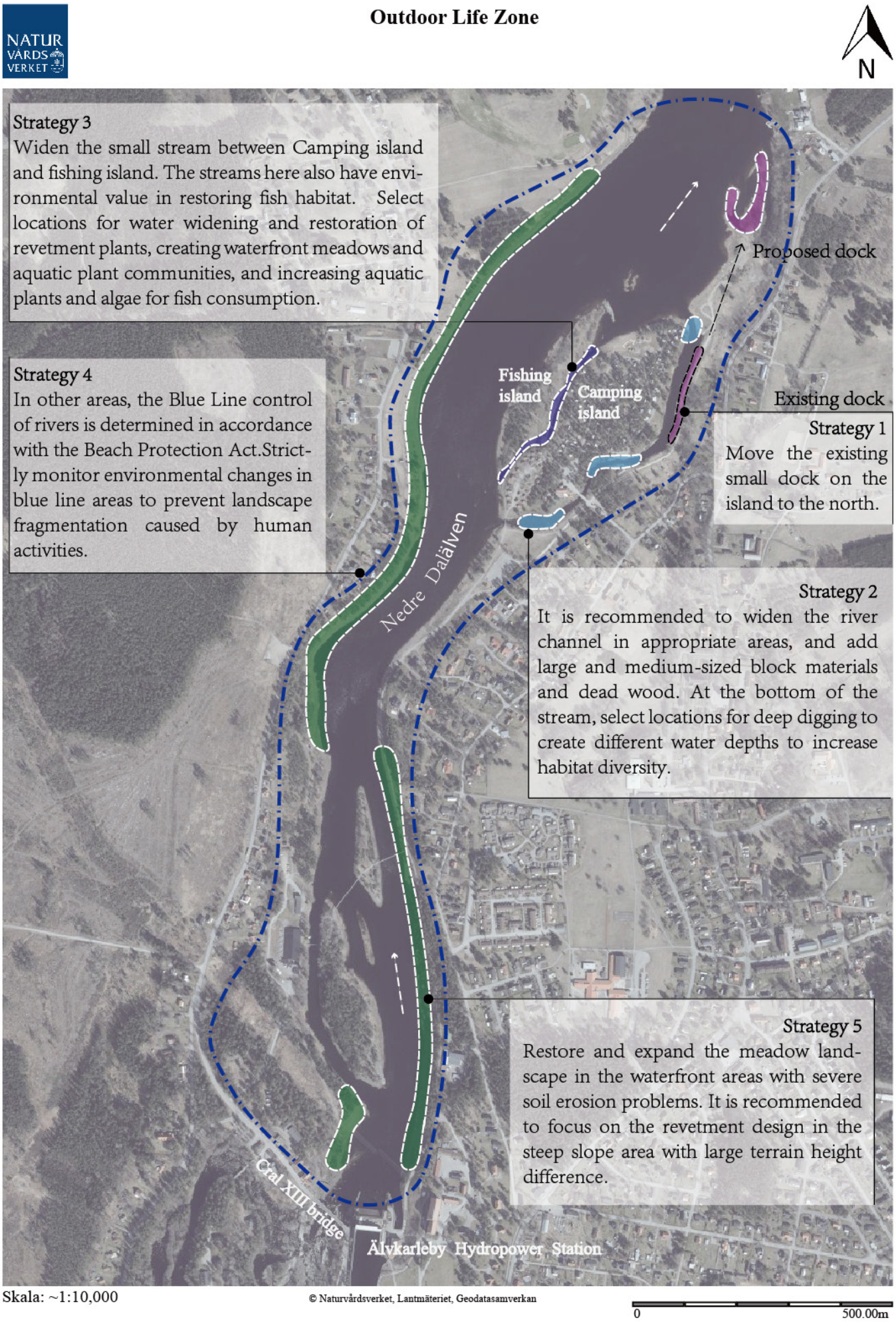
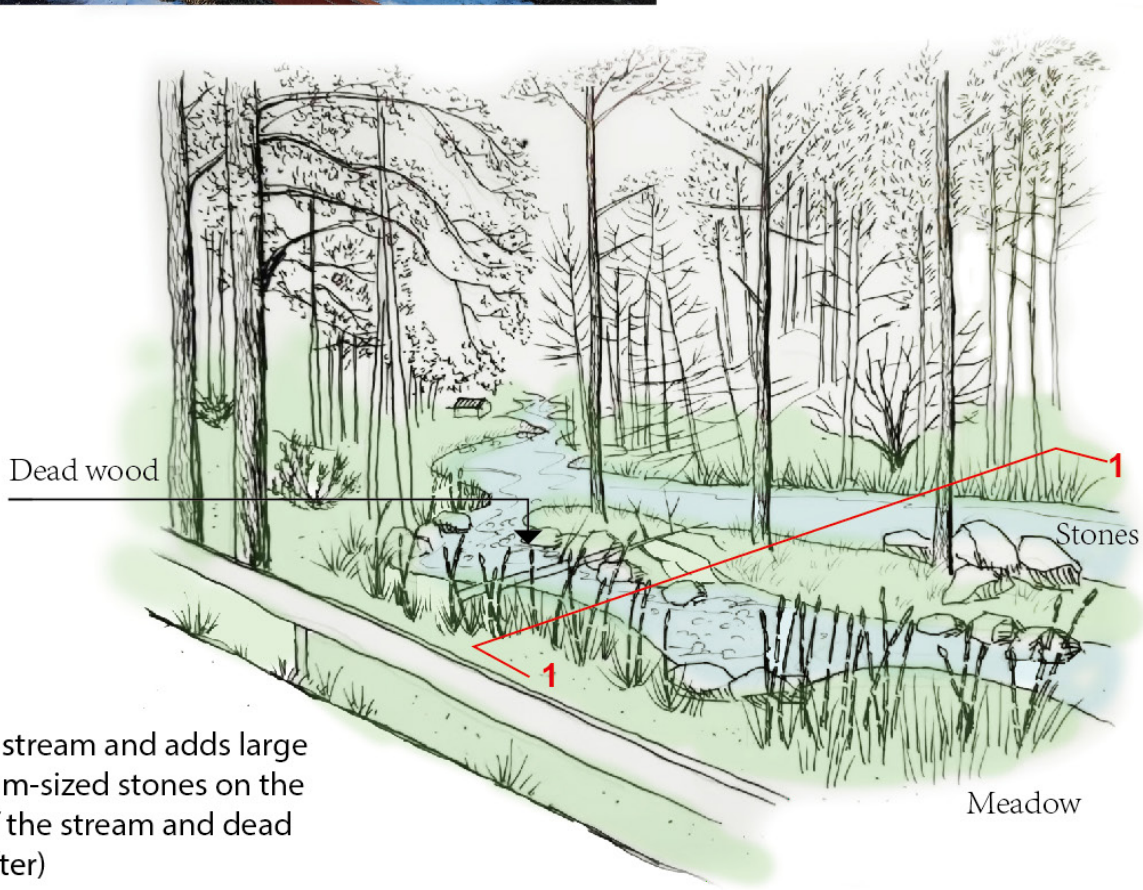


Fig 49. The strategies for outdoor life zone. Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan. Edited by Author.

The existing stream between the shoreline and Camping island. (Before)



Widen the stream and adds large and medium-sized stones on the bottom of the stream and dead wood. (After)

Section 1-1:
Shallow water with stone and dead wood could provide pore spaces for fish to spawn. Deep water will be good for fish playing and also could reduce the risk of drying out due to regulated water flow.

Fig 50. The illustration strategies of improvement of the existing stream for fish habitat in the Outdoor life zone.

5.1.2 Core protected zone

Core protected zone is centered on the Kungsådran dam, north to the Carl XIII bridge, south to the railway bridge, including Kungsådran, Laxön and the old railway park area, which is the place with the highest natural and cultural value rating. The planned development of this area is crucial to the municipal nature reserve and the development of the entire Älvkarleby. The thesis proposes this to be a fish nature park (see section 5.2) with high ecological quality and importance for human recreation.

Environmental issues and Protection Purpose

- Improve the protected area for biological diversity
- Protect wildlife habitat from being squeezed by urban construction and human activities
- Possibility to restore natural migration passage for the fish and fauna
- Maintain public open space on riparian and prevent privatization of waterfront space
- Develop local recreation facilities and sustainable tourism

In Kungsådran, there is an existing biodiversity protected area (VVO). It is a conservation area for local biodiversity planned and implemented by Vattenfall. There is a lot of precious vegetation and a small amount of wildlife habitat in the area. However, these species were extended to the surrounding area including the old railway park and the Laxön area, according to the LCA investigation. These fragmented habitats are cut off by physical barriers such as dams and railways, so that it cannot be formed as an intergrity ecological habitat envrionment.

In order to create the possibility of natural migration for fish, it proposes to build a fish passage at Kungsådredammen in the LIV report. Although the specific implementation plan and technology are still in the research stage, the feasibility of this proposal is very high. Therefore, there is a great need to improve the upstream water environment. And the restoration water area should be separated from the main river, for the safety of fish migration, which conclusion comes from the NAP project (see interview question1 in Appendix 2).

The cultural and recreation function of this area is gradually weakened since the water and riparian landscape changed caused by the establishment of the hydropower station. The cultural function of Laxön gradually diminishes, and only a few historic buildings remain there now. The Tourist hotel, which was a famous landmark in Laxon, is now closed. As the old railway park was abandoned. With the increasing needs of recreation and tourism, the public spaces will be recreated and the cultural characters and identity will be rebuilt.

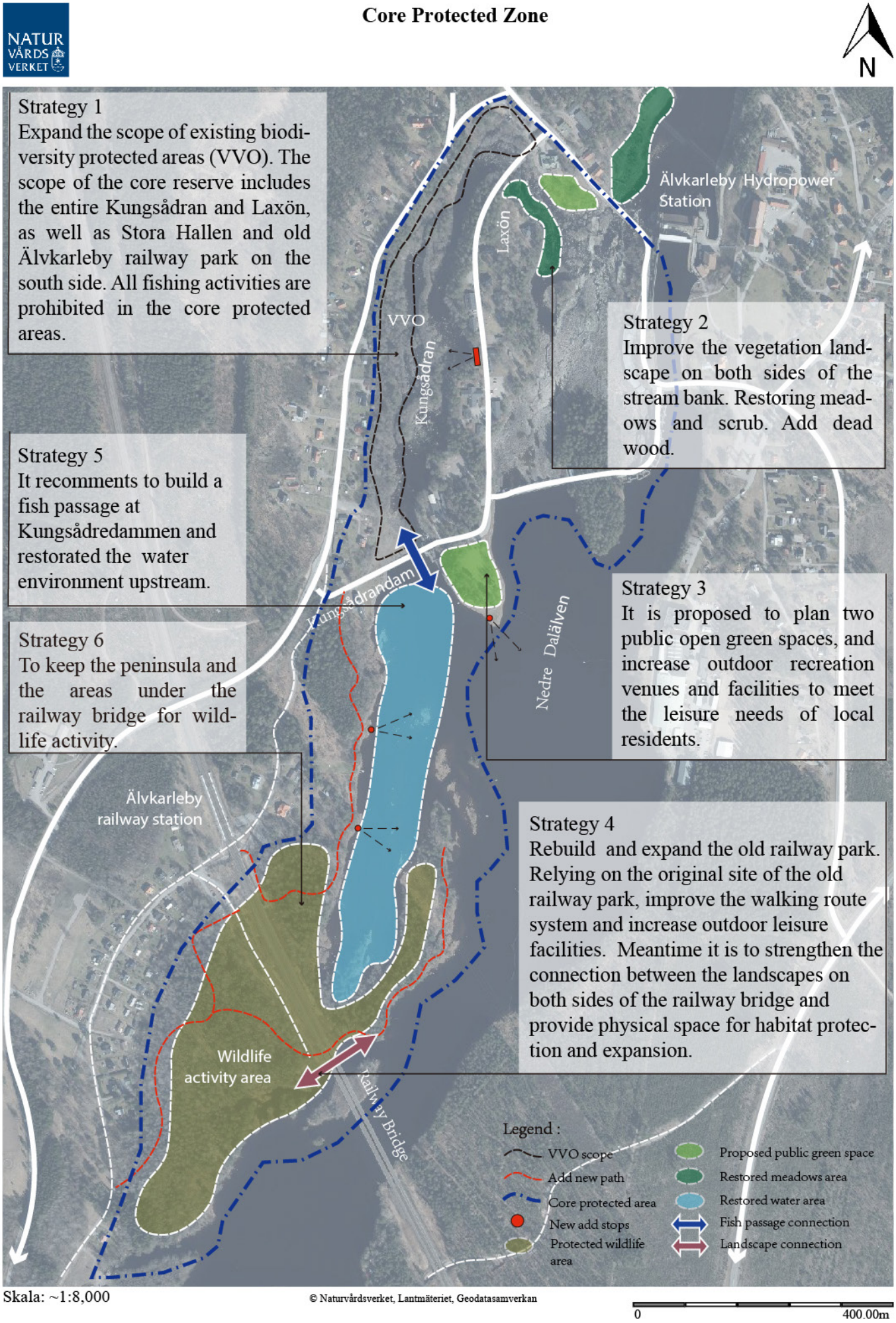
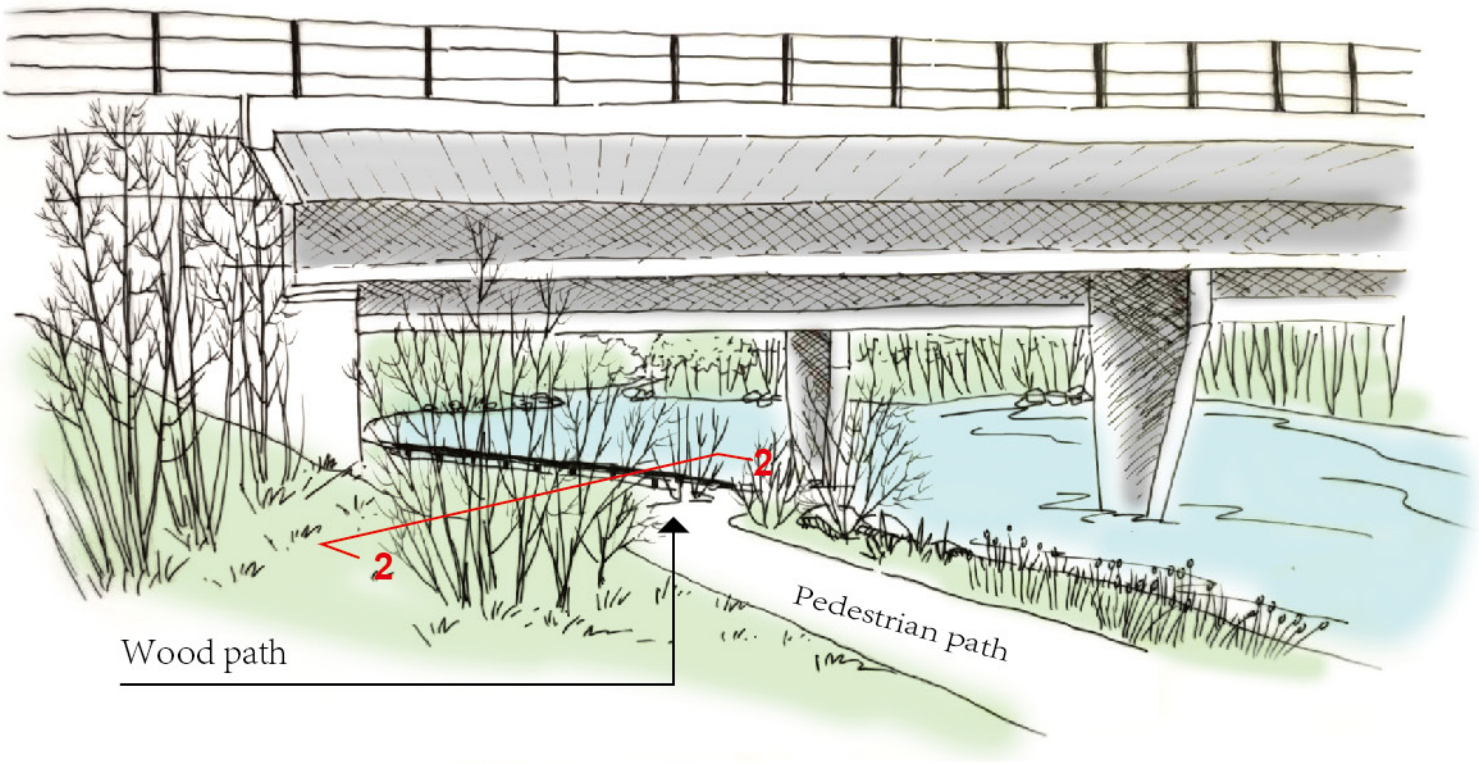
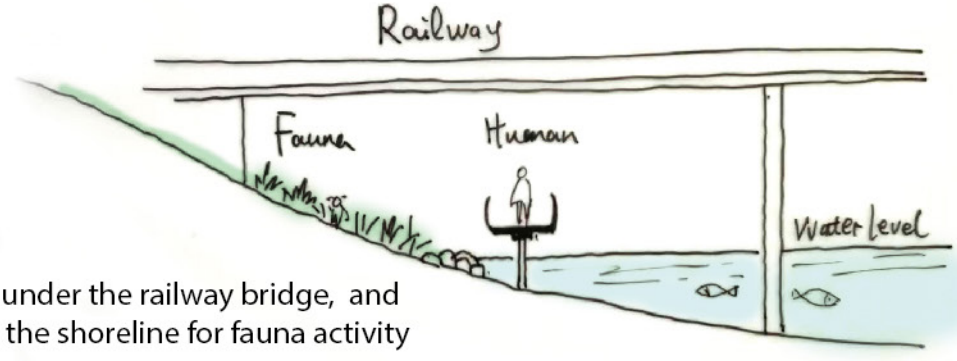


Fig 51. The strategies for Core protected zone. Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan. Edited by Author.

The existing shoreline under the railway bridge, which has no access to connect both sides of the landscape of the railway. (Before)



Creating connections for both fauna and human activities. (After)



Section 2-2:
Adding wood path under the railway bridge, and keeping away from the shoreline for fauna activity area.

Fig 52. The illustration strategies of creating the connections under the railway bridge in the Core protected zone.

5.1.3 Buffer zone

The areas upstream of the railway, including the riparian landscape on both sides of the Nedre Dalälven river, will be developed as a buffer zone. The scope is from the Älvkarleby railway bridge south to the Gropholmarna Nature Reserve and Älvkarleö. The role is to connect the core area with other natural corridors of Uppsala green infrastructure to form a network to deal with the environmental threats to the core area caused by urban expansion and infrastructure construction.

There are very obvious traces of land development and construction in the east bank forest. The ecological environment of this area is threatened by the expanding construction of Vattenfall Research Institute and the construction of arable land, as well as other reasons for deforestation. There is a need to establish a clear range of protected areas, inventory their forests, and implement strict monitoring.

This zone has a hiking trail- Upplandsleden, that offers a range of viewpoints appreciating the beautiful views of the Nedre Dalälven river along the way. At the same time, this trail is also an important outdoor life route in the Green Infrastructure networks in Uppsala County, and is a green corridor connecting the entire county. At present, the service facilities are intended to be available on the south side of the railway and lacking on the north side.

Environmental issues and Protection Purpose

- Maintain the integrity of the forest on the east shoreline of the Nedre Dalälven river and prevent fragmentation
- Develop local recreation facilities

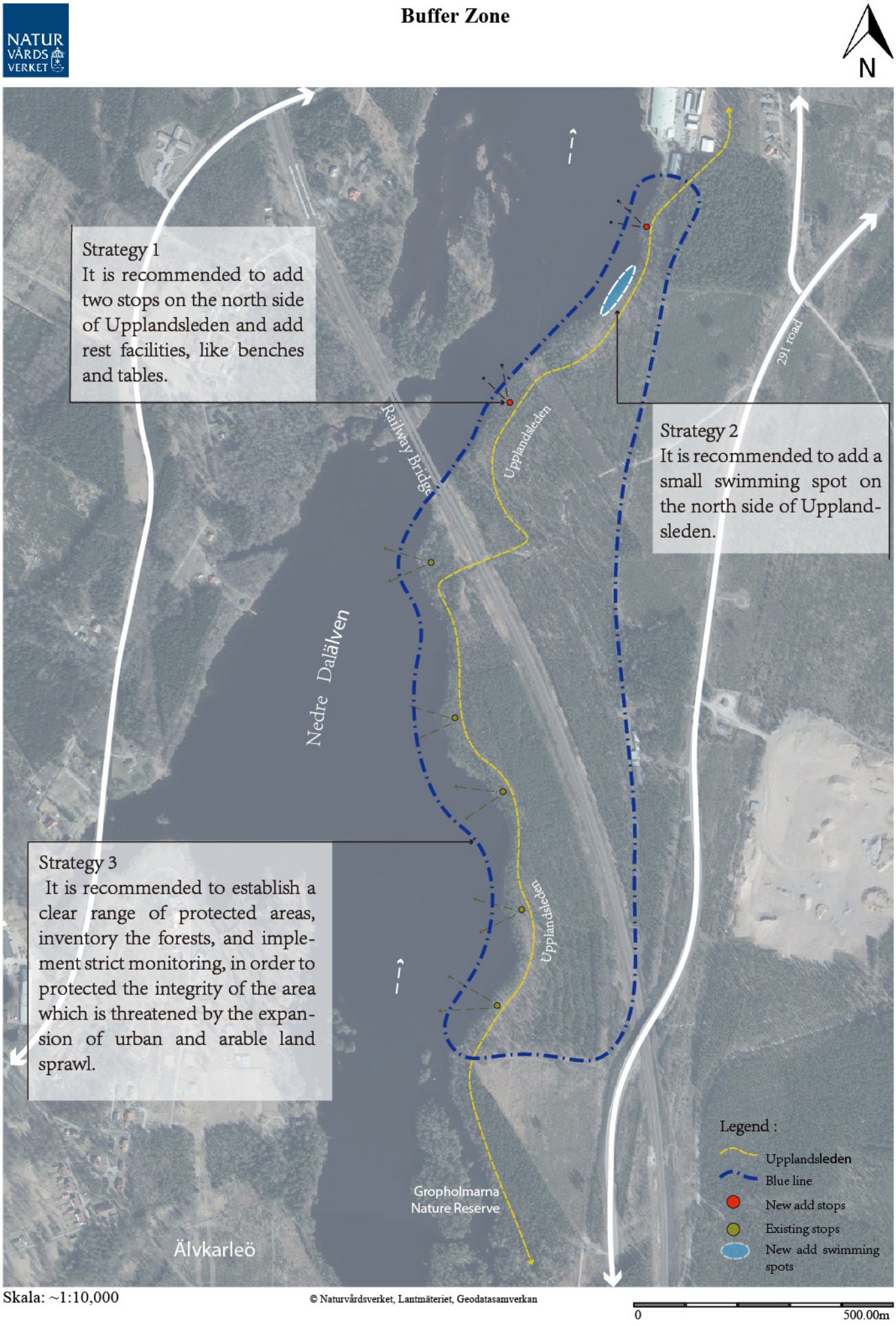
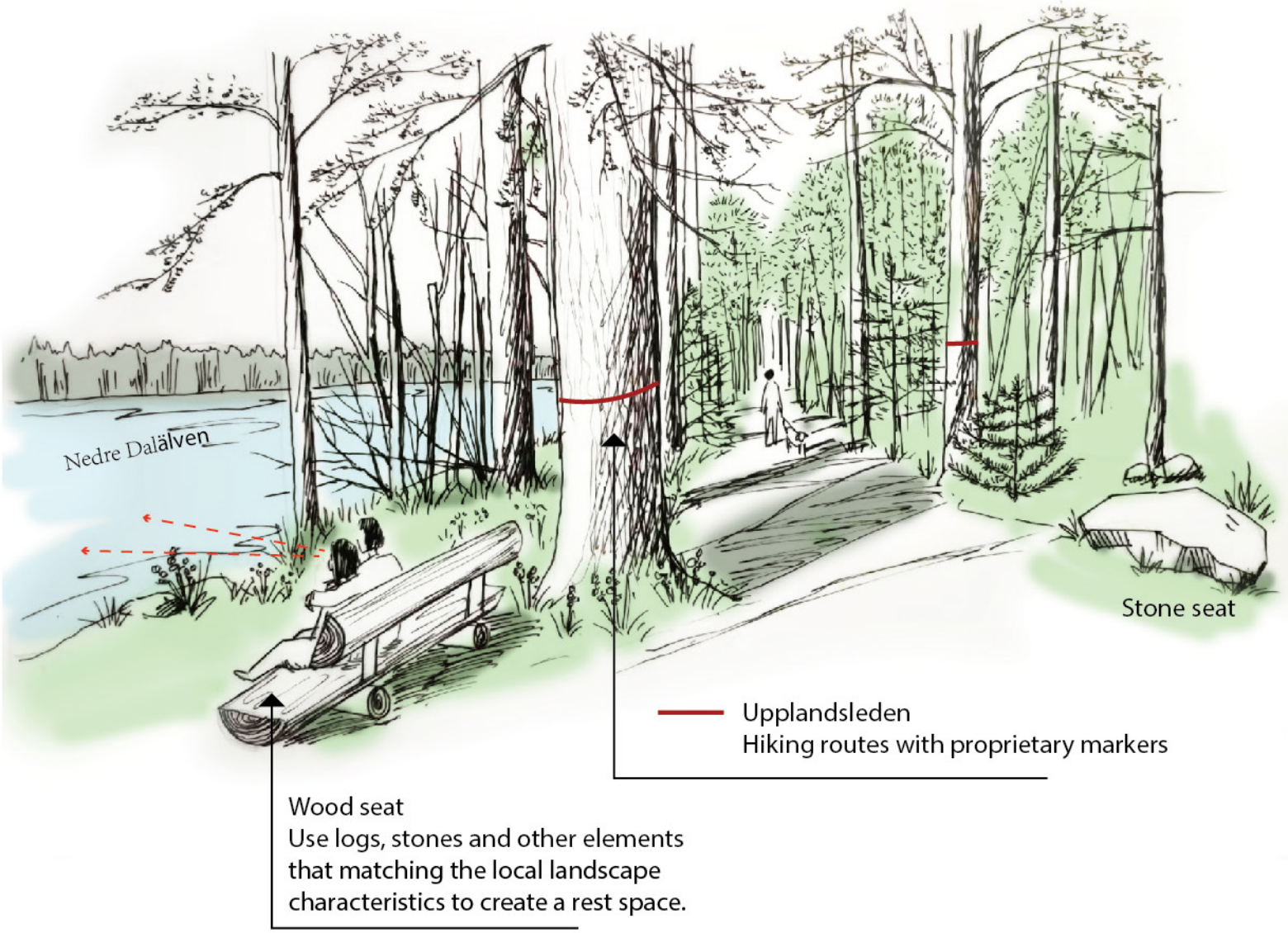


Fig 53. The strategies for the Buffer zone. Data sourvce:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan. Edited by Author.

Add two or three view points with rest facilities on the Upplandsleden path on the north of railway line. (After)



The existing hiking route - Upplandsleden on the east shoreline. (Before)

Fig 54. The illustration strategies of providing recreational facilities in the Buffer zone.

5.2 In-depth design

Fish nature park in core protected zone

In order to improve the research depth of the thesis and conduct in-depth research on feasible solutions to the research problems raised at the beginning, this section will focus on selecting the core protected zone for in-depth planning and design - Fish nature park. This area focuses on the multiple core issues of ecological restoration (especially wild fish migration), cultural protection and rural development. Therefore, the development of the fish nature park will play an important role in promoting the future development of the entire proposal of the municipal nature reserve.

5.2.1 Locations and background

The fish nature park is centered on the Älvkarleby railway station, extending north to Carl XIII bridge and south to the wedge estuary, including the forests, water and islands on the west riparian landscape of the Nedre Dalälven river (see Fig 55).

The fish nature park is an enlarged public river space based on the former site of the old railway park, existing Kungsådran and Laxön. The old railway park is located on the west side of the Nedre Dalälven river, in the forest area on the north side of the railway bridge. It is a place with a long history and cultural values. It used to be an important place connecting the two shorelines of the Nedre Dalälven river in history (see Fig 9 in section 2.6).

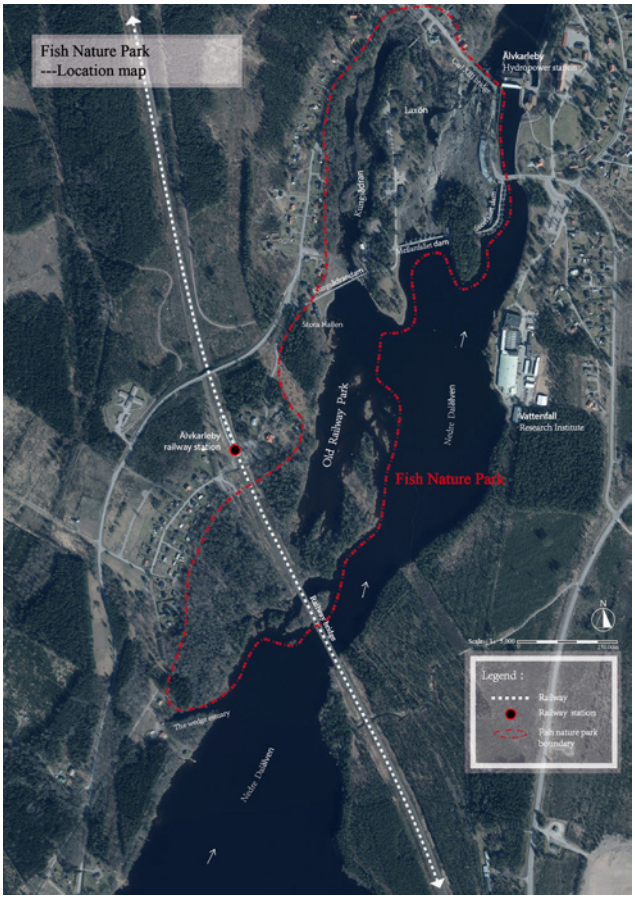


Fig 55. The location map of the fish nature park.

Due to the construction of the new railway, the landscape connection on both sides of the bridge has been cut off, and the pedestrian connection on both sides of the Nedre Dalälven river in this area has also become impossible. Many public buildings in the old railway park were demolished. At present, Stora Hallen is the only remaining building and has become an important historical and cultural landmark in Älvkarleby.

However, the pedestrian route is disconnected physically, which indirectly provides a larger living space for the wildlife in the area. According to the assessment results of LCA in Chapter Four, there are a large number of forests and their wildlife habitats with high ecological values. In particular, the river and islands upstream of Kungsådran dam, which are closely connected to the existing biodiversity protection area (VVO), are particularly important for the protection and restoration of wild migratory fish. The forest which is located to the south of the railway bridge is well preserved. The Nedre Dalälven river extends into the shoreline, forming a small scale wetland-like riparian landscape, which becomes a valuable habitat for wildlife.

5.2.2 SWOT analysis

STRENGTH

- Well preserved forest and an integrity wildlife habitat of high ecological value.
- High water quality environment, especially to provide a potential environment for the production environment of migratory fish.
- Near the existing biodiversity protection area (VVO) in Kungsådran.
- Beautiful and open view with a good sightline of the Nedre Dalälven river.
- Near the railway station, it is easy for visitors from other places to reach.
- Laxön is a cultural and historical valuable and recreation area. Including Stora Hallen, a famous historical landmark in Älvkarleby, which can provide a good foundation for cultural protection and public services.

WEAKNESS

- The physical connection to the riparian landscape is cut by the railway line.
- Dams block fish migration routes.
- Inaccessibility of riparian landscapes, lack of an accessible path to the water.

OPPORTUNITY

- Potential to develop into a migratory route environment for wild migratory fish.
- Provide ecological services to the surrounding area, including conservation of habitat, water opportunities, and outdoor recreation.
- Protect the publicity and integrity of river spaces.

THREAT

- The development of surrounding areas and the expansion of human activities will affect the natural protection of the area.
- The lack of monitoring of forests inside and outside the area.
- The deforestation of the outside forests will inevitably lead to changes in the ecological community, which will have a negative impact on the ecosystem of the entire area.
- Privately occupy public resources to fragment the riparian landscape

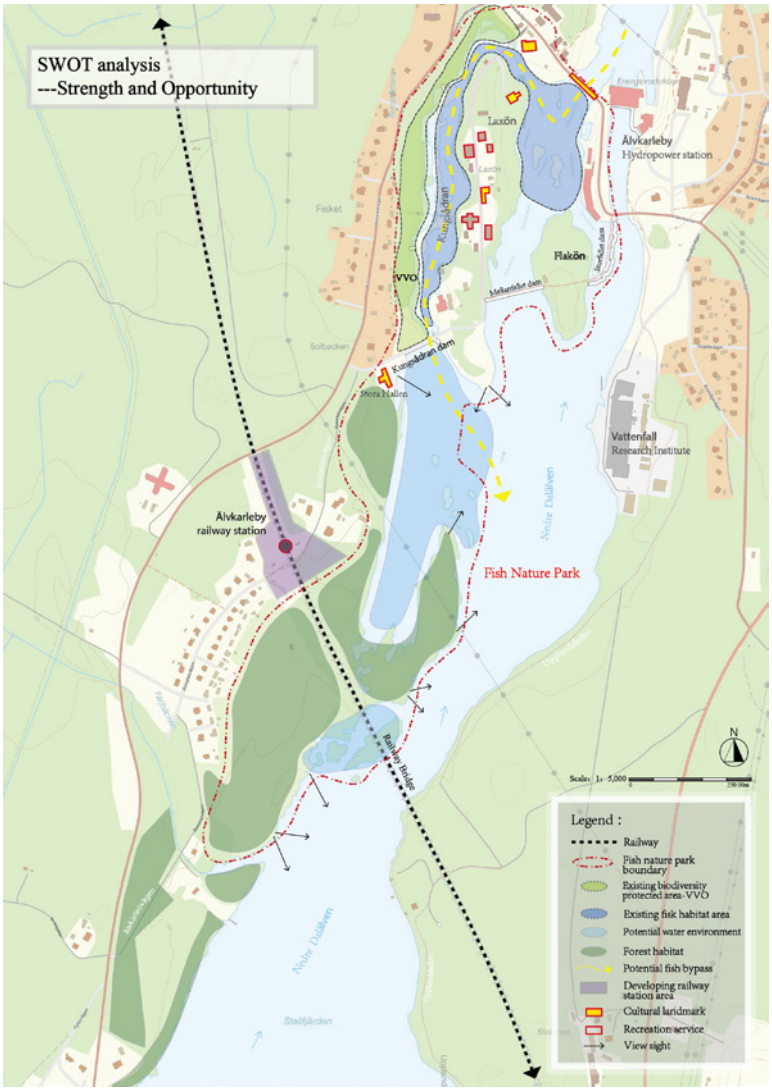


Fig 56. The Strength and Opportunity analysis of Fish nature park.

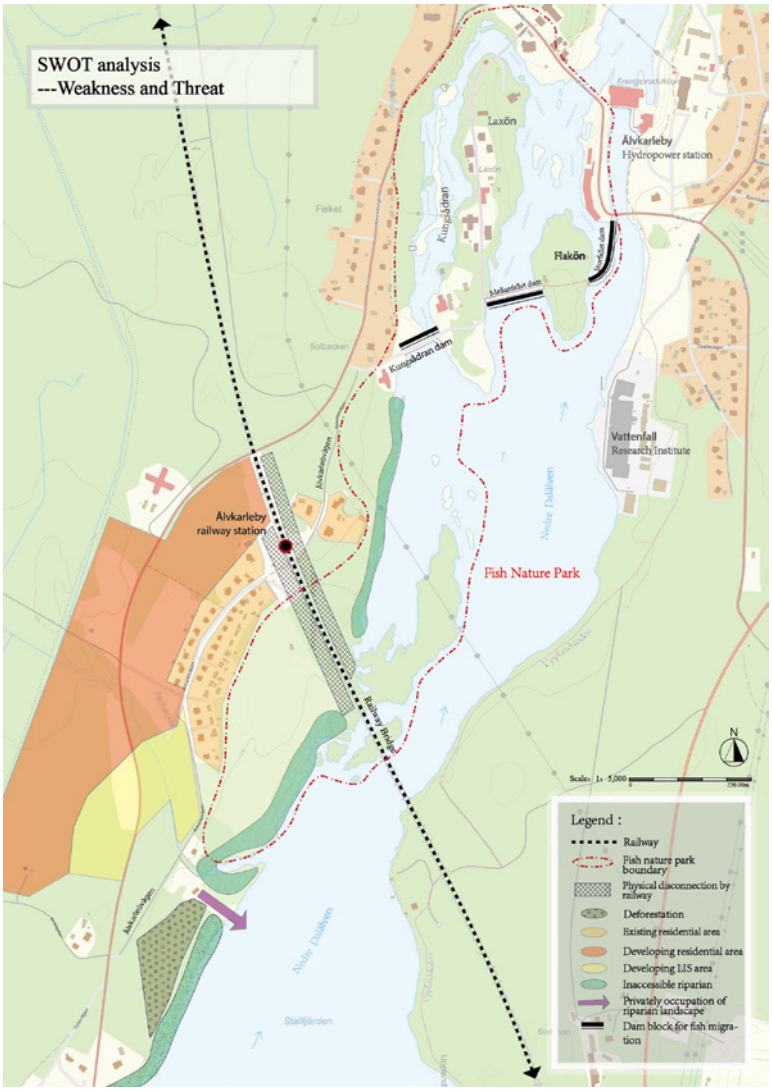


Fig 57. Weakness and Threat analysis of Fish nature park.

5.2.3 Master Plan

The planning of the new fish nature park follows three principles:

- First, it will create possibilities for the migration paths of wild migratory fish.
- Second, it will try to protect and restore the existing ecological habitat as much as possible, and avoid the shrinking of wildlife activity space caused by human factors.
- Third, it will provide recreation and outdoor life service facilities for human needs. These three principles also coincide with the guidelines of the core protected zone, and make it concrete.

Based on the above three main principles, the master planning of the new fish nature park embodies the design concept of "Restoring the natural environment using a nature-like approach". The use of a nature-like approach means that not only the use of restoration forms and materials tends to be natural, but also the aesthetic orientation of landscape design must be integrated with nature. It also means how positive aesthetic value served as the basis for the restorationists' design vision of the restored river (Prior 2016).

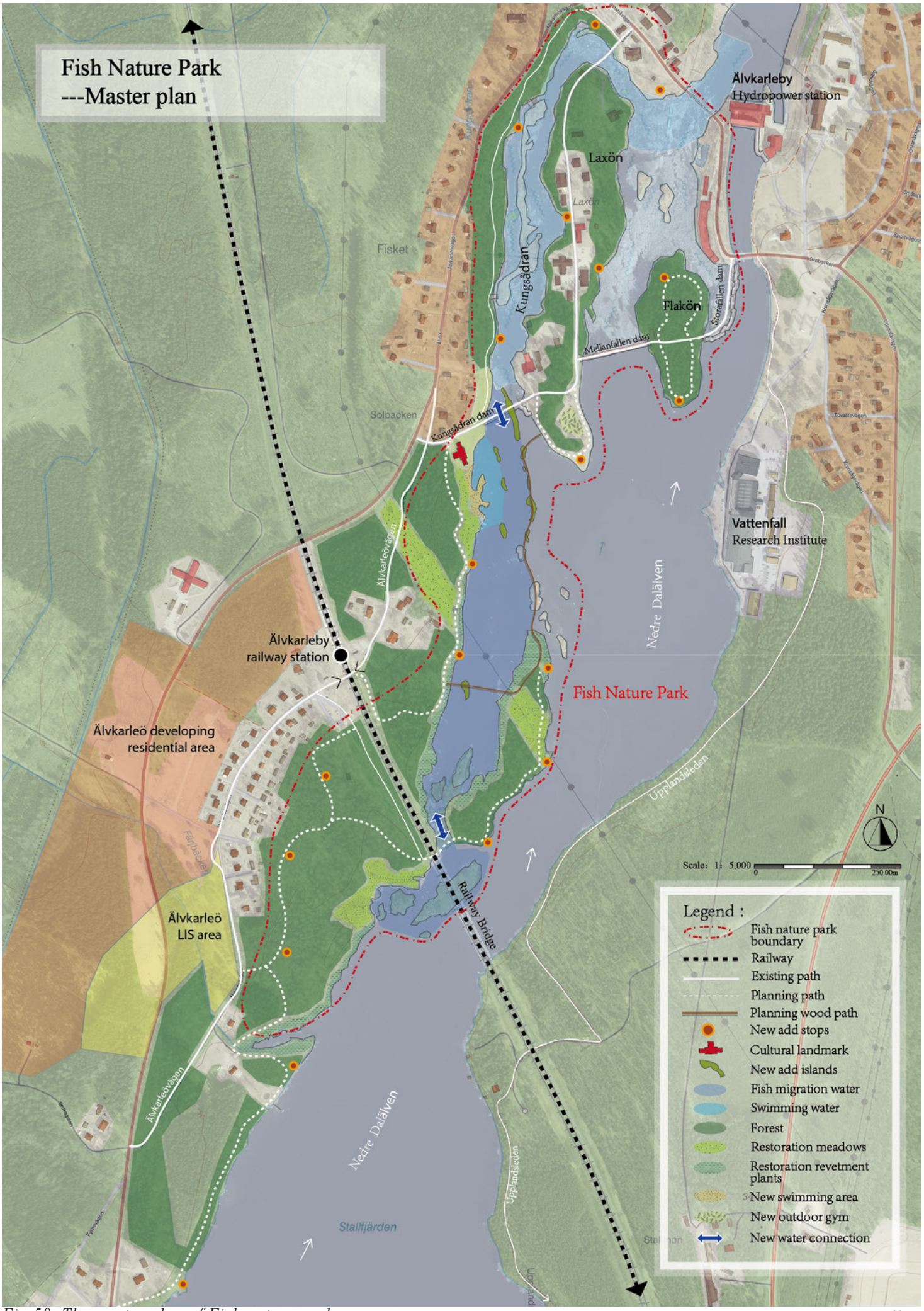


Fig 58. The master plan of Fish nature park.

- ***Restoration and improvement of the migratory environment of wild migratory fish***

In the report of Environmental adaptation of hydropower in Uppsala County National plan for modern environmental conditions for hydropower (NAP), the upstream waters of Kungsådran dam are seen as having great potential to restore the environment for fish playing and growing up (Calles & Emanuelsson 2018).

According to a large number of studies of fish migration routes and the discussion with interviewees, providing high-quality play and growth water environments for fish will provide ecological benefits for fish reproduction. At present, many projects are still in the research and testing stage, such as the control of water flow and the construction and location of the river bottom matrix, as well as the guidance of fish routes, which are included in the projects of LIV and HÅVD. From the perspective of landscape planning, a few measures are proposed to restore the water environment upstream of Kungsådran dam in a natural-like form.

First, it recommended creating the possibility of a water connection under the kungsådran dam bridge to form an open waterway (see Fig 59) and using landscape elements and approaches to recreate natural-lik fish paths. Due to the existing height difference of about 4 meters on both sides of the dam, when the waterway is opened, the bottom of the river should be treated into a slow slope to form a stepped stream, which is conducive to fish migration (see Fig 60 section A-a) .

Second, following the fifth protection strategy for the core protected zone, it is recommended adding small islands near Kungsådran and forming vertical natural waterway divisions within the existing islands. In order to attract fish away from the main waterway to swim to Kungsådran, the construction of the underwater network can use the foundation of the wood footpath, together with the linear distribution of islands to form the main channel for fish migration (see Fig 60).

Third, it is suggested to create a gap where the island and the mainland connected under the railway bridge, to introduce the water of the main river into the inner river of the park. The purpose is to connect the river bay to the Nedre Dalälven river, improve the water quality and flow here, and provide a safer route for fish migration (see Fig 62).

Lastly, restore and improve the vegetation of the riparian landscape in the new railway park, such as adding aquatic vegetation, shrubs and meadows to the riparian landscape, to provide benefits for fish foraging.

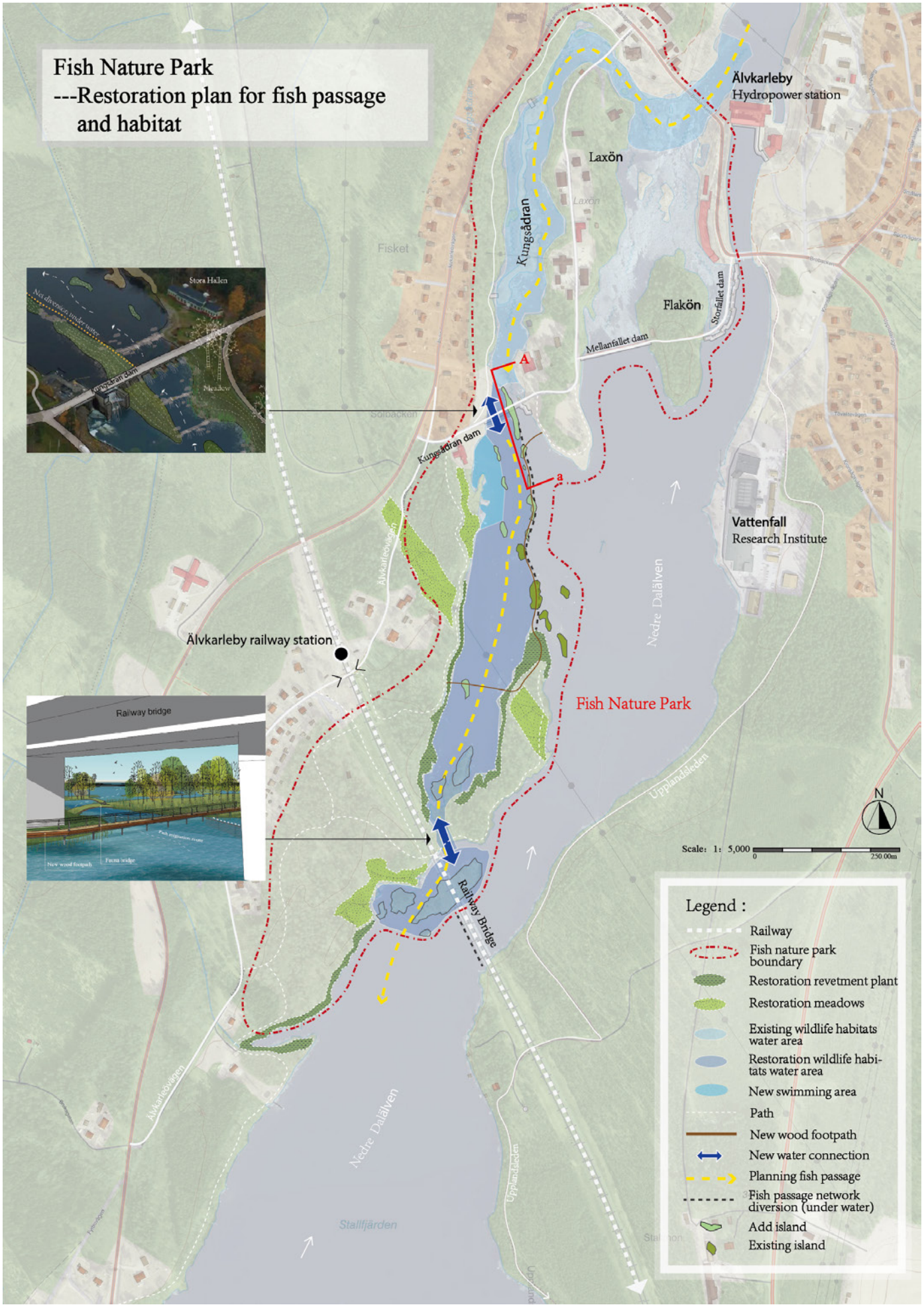


Fig 59. Restoration fish passage and habitat planning map shows the strategies for using existing inner bay waterways to restore fish habitats and create migratory routes. It recommended creating two connections in two places to make the inner bay water connected with the main water channel, and provide a circulating and freshwater environment for fish fauna.

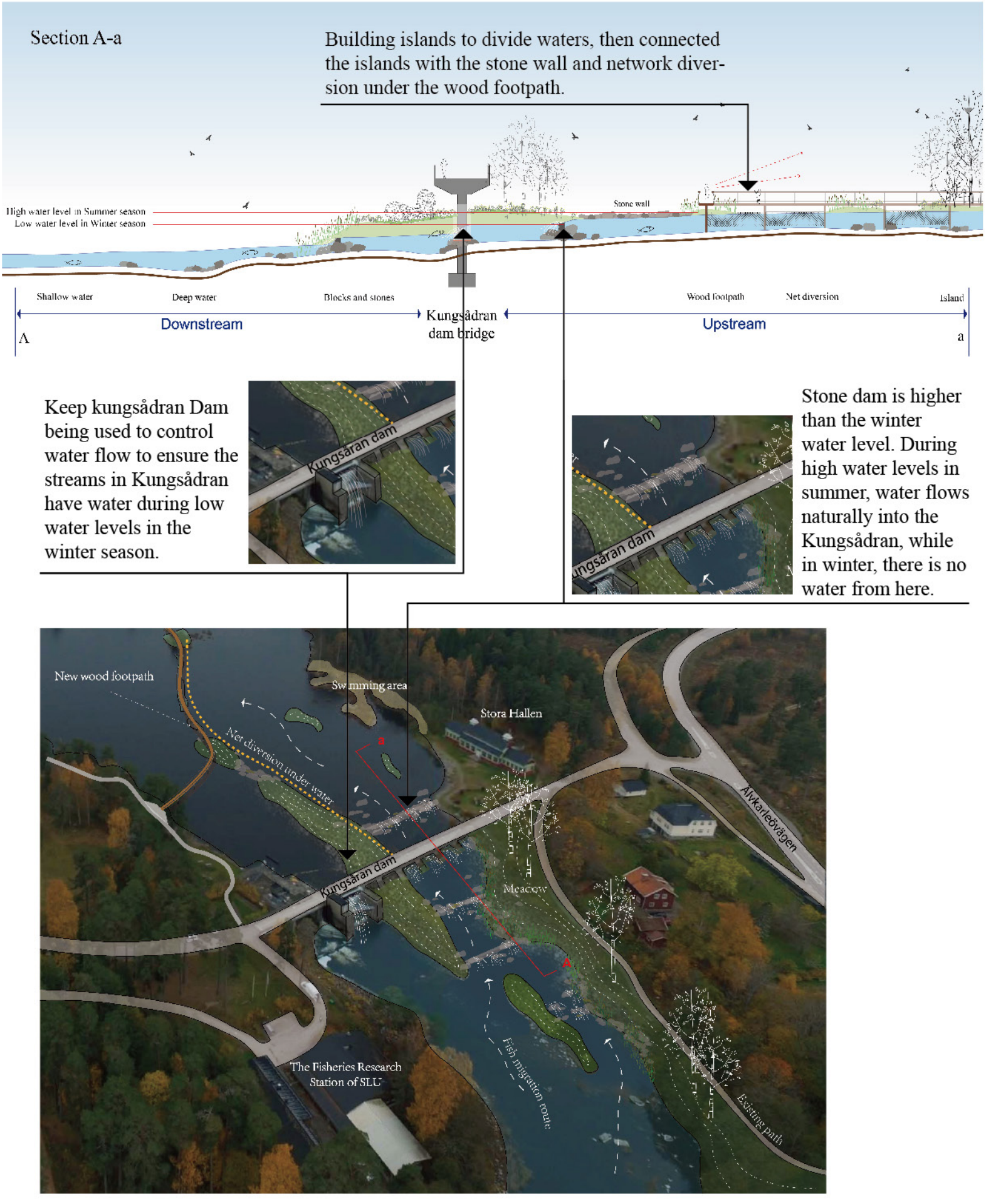


Fig 60. The illustration of water connection under the Kungsådran dam and rebuilding of fish migration passage. Section A-a shows the use of stepped gentle slopes to deal with the height difference between the two sides of the dam, and using the basic structure of a wood footpath to combine underwater network diversion. Keep Kungsådram Dam being used to control water flow to ensure that streams in Kungådran have water during low water levels in the winter season. And the stone dam could be used to control the water flow in summer season.

- ***Conservation of Wildlife Habitat***

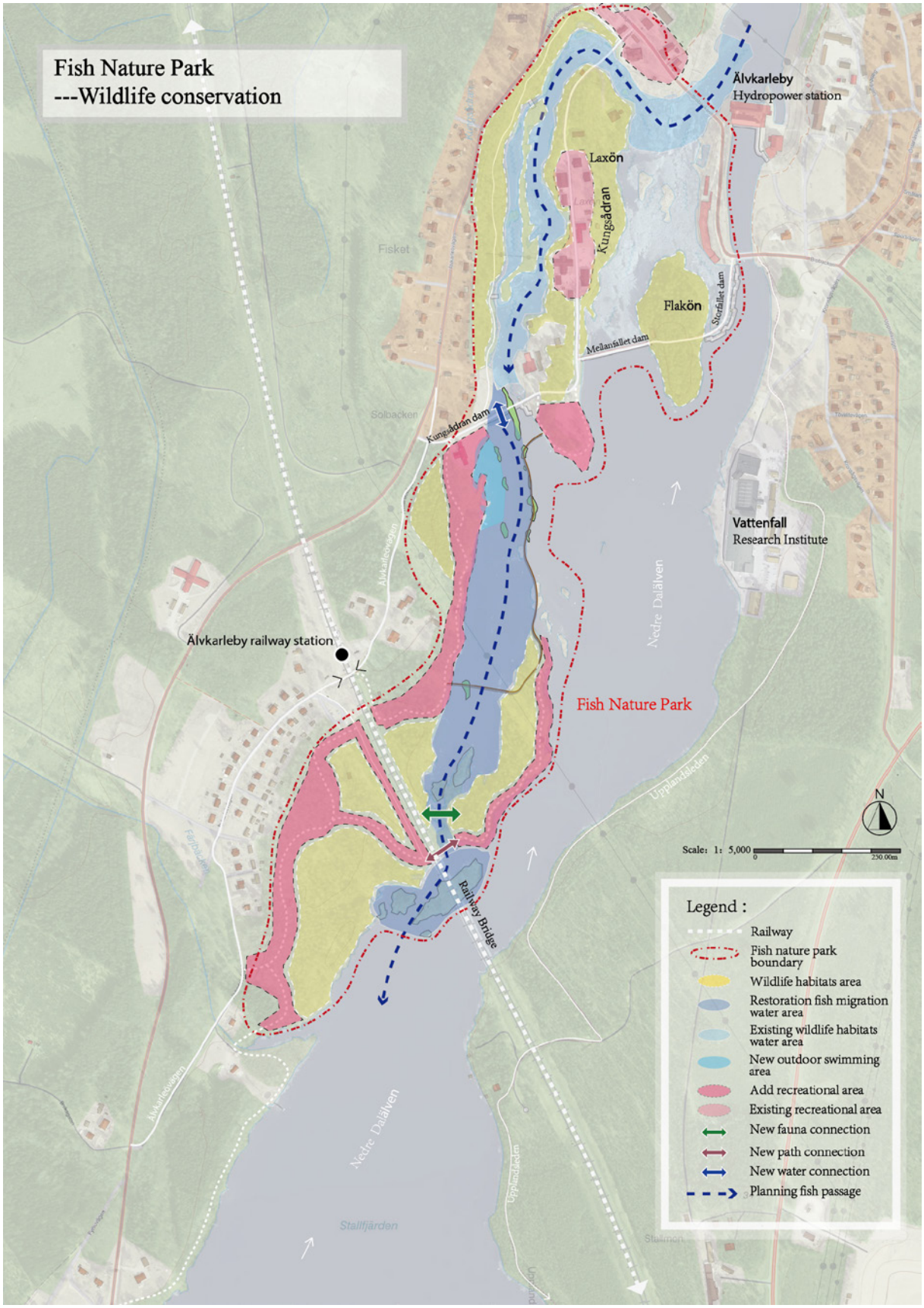
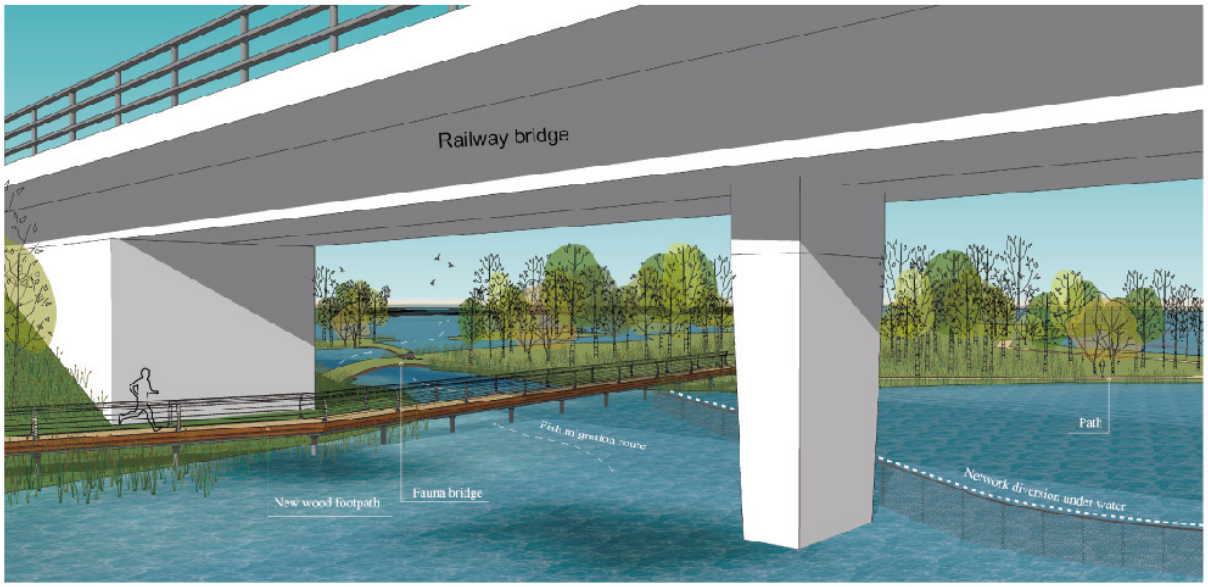
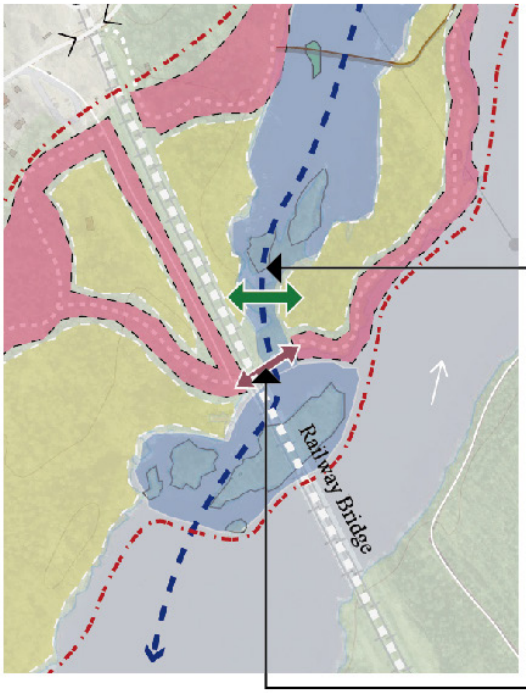


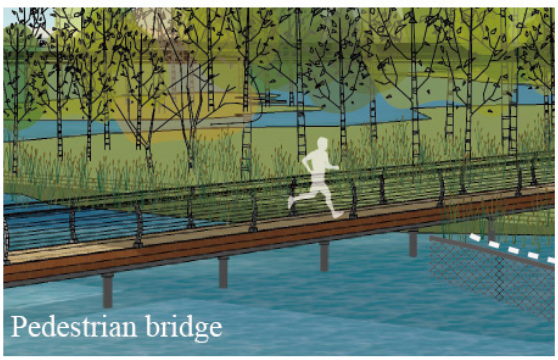
Fig 61. The wildlife conservation planning map shows the different functional areas for human and wildlife activities. The red colour represents the human activity areas, and the yellow colour shows the wildlife activity areas. Under the railway bridge and the Kungsådran dam bridge, it recommends creating the connections to provide opportunities for both human and wildlife to go through the barriers, with the aim to avoid fragmentation of the habitats caused by the rural development.

Based on further field investigations and interviews, the range of local wildlife habitats, including their range and nests, has been determined. Waters and forests important for wildlife survival will be planned as separate spaces to avoid human disturbance. From spatial planning, separate human activities from wild animals. In the planning of the tour route, the walking routes and viewing stops are arranged on the periphery of the wildlife habitat.In addition, opening a water channel between the island and the mainland under the railway bridge is proposed in the restoration proposal for the fish migration environment. This proposal would cut the connection to animal habitats. Therefore, it is recommended to design the fauna bridge as the connection between the water channel (see Fig 62).





For the wildlifes, it is recommended to design the fauna bridge as the connection between the gap, because of opening a water channel between the islands and mainland under the railway bridge in order to recreate the water connection for the fish.



In the planning of the tour route, the pedestrian bridge can provide the connections between the walking route on both sides of the railway in the new park. And the walking routes and viewing stops are arranged on the outside of the wildlife habitat.

Fig 62. The connections of wildlife and human activities under the railway bridge.

- ***Improvements to outdoor life***

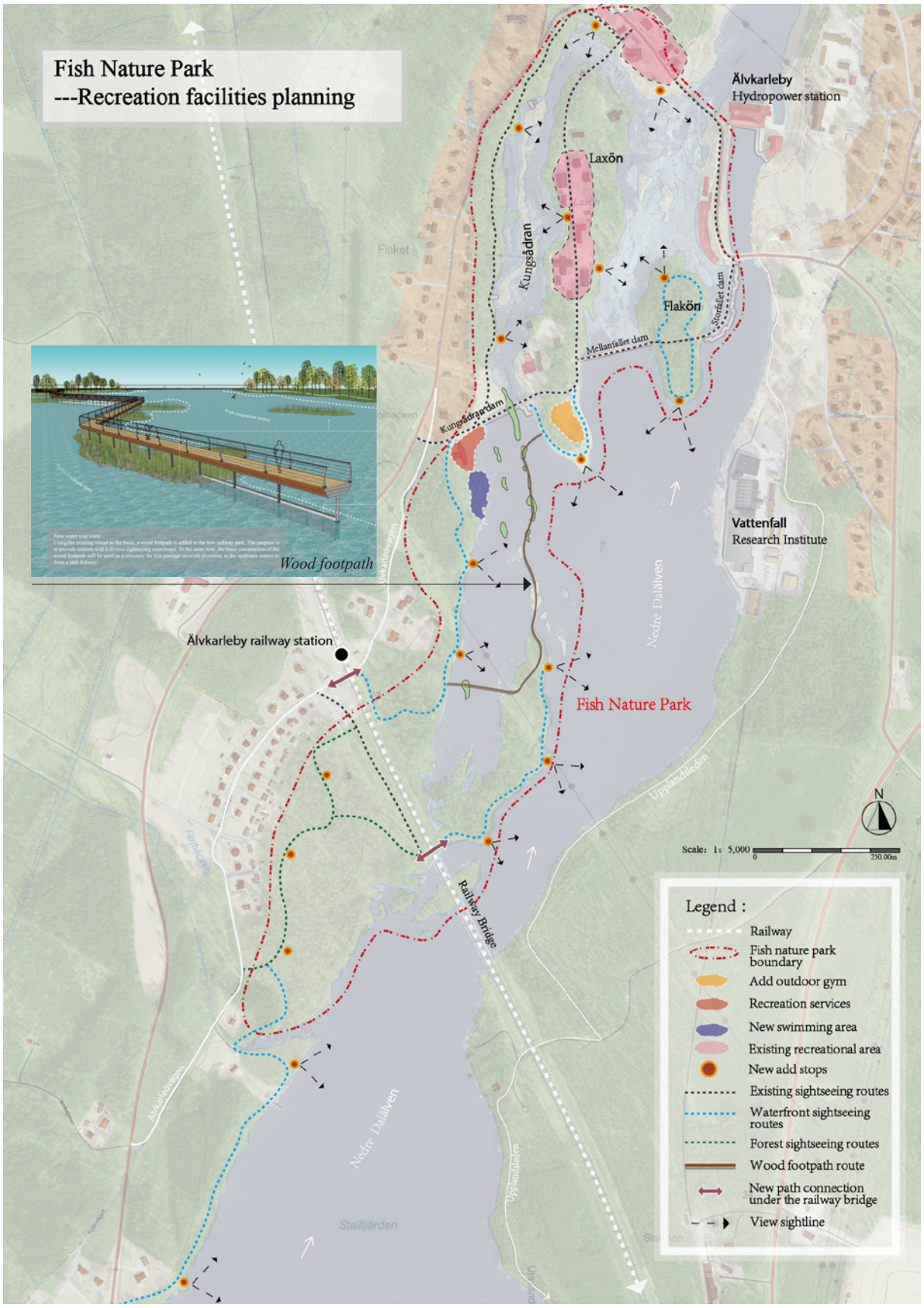


Fig 63. The recreational system planning map shows three kinds of pedestrian routes - blue lines represent the water sightseeing routes, the green lines represent the forest sightseeing routes, and the blown line represents the wood footpath on the water.

The park not only serves as an ecological medium for wildlife protection and fish habitat, but also provides more opportunities for human needs, such as recreation and outdoor life. In the planning of the pedestrian system, different types of water sightseeing routes (the blue lines) and forest sightseeing routes (the green lines) should be provided for residents. In some places with a wide field of view, there are additional stops and seats. Paths pass through the area under the railway bridge, making it possible to connect the landscape on both sides. In addition, a unique water route is planned to increase the richness of regional tours (the blown line). The foundation of the wood footpath can also be combined with underwater networks to become fishway protection boundaries.

For the outdoor living site, two main areas are planned. The first is at Stora hallen, which, combined with the existing cultural landmarks, can be developed into a local public activity area, including viewing areas, meadow areas and outdoor swimming areas. Swimming areas should include small sandy beaches and water areas suitable for different age groups, as well as jumping platforms. The other is on the peninsula to the east of the Kungsådran dam. This area will be planned as an outdoor gym and a rest area, because of the wide view here to appreciate the Nedre Dalälven river.

At the inner river of the new park, a water tour route will be proposed (see Fig 64). Using the existing islands as the basis, a wood footpath is added in the new railway park. The purpose is to provide tourists with a diverse sightseeing experience. At the same time, the basic construction of the wood footpath will be used as a structure for fish passage network diversion in the upstream water area to form a safe fishway.

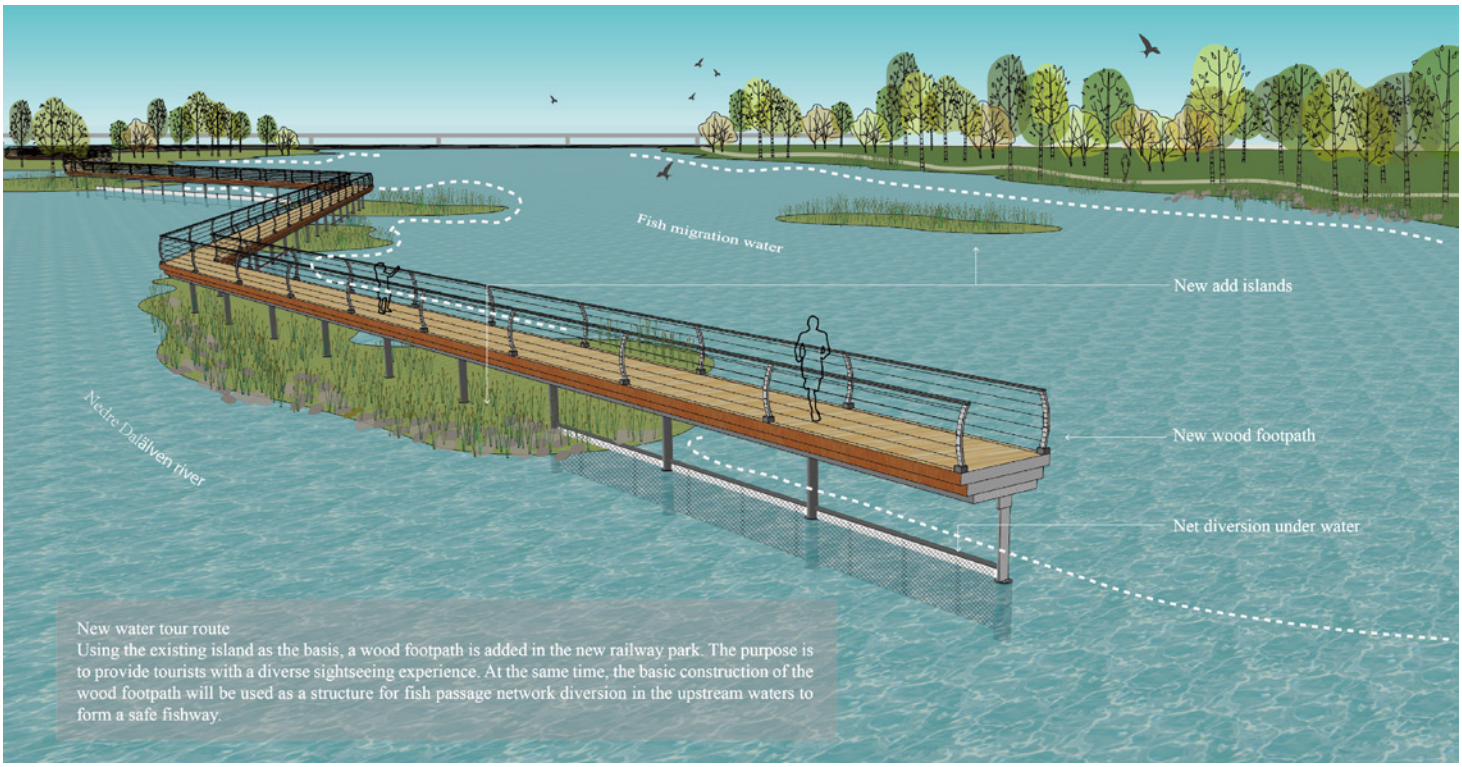


Fig 64. The illustration of the new wood footpath with net diversion in the fish nature park. Using the islands and the basic construction of the wood footpath to create a network barrier for fish migration.

6. Discussion

6.1 Discussion of goals and delimitation

The purpose of this thesis is to study how to address the conflicting interests in the Nedre Dalälven river riparian landscape through the proposal of establishing a municipal nature reserve by applying landscape planning methods. The prioritized goal is to restore the ecological riparian environment and to create possibilities for the migration routes of wild fish, meanwhile to provide more opportunities for local recreation and outdoor life.

In this thesis, the value forms of the Nedre Dalälven river ecological restoration mainly focus on the categories of "nature" and "rural development", and study the ways in which different stakeholders understand, explain and debate "ecological restoration" from the perspective of values. For example, the thesis may positively value assisted restoration of ecosystems, as it increases biodiversity or helps protect wild habitats from the negative impacts of anthropogenic factors. Or it actively provides green space by reintroducing cultural values. However, in the responses to the questionnaires, there are also views that too much ecological and environmental protection work also limits local economic development. It can be seen that it is still a long-term communication and compromise work in terms of establishing the proposal and scope of the municipal nature reserve.

The restoration and research work of the Nedre Dalälven river, especially for wild fish passage, started after the construction of the Älvkarleby hydropower station, and involved many stakeholders' engagement as I mentioned in Chapter three. These research efforts are substantial, ongoing, multidisciplinary and intersecting. This is consistent with the complexity and multidisciplinary nature of the landscape.

Landscape is the medium of the relationship between the environment and humans. In many cases of environmental restoration, the landscape is usually used as a coordinator to coordinate the research work of various disciplines. The proposal-the municipal nature reserve which presented in this thesis is not a vision of development that is generally adopted as the future, but rather an attempt at the first iteration. The purpose of establishing the municipal nature reserve area is not to simply enclose everything within the range, but to create a platform that provides an open and easy-to-communicate medium for research in multiple disciplinary fields, and provides a range of reasonable options for the intersection of multidisciplinary research.

6.2 Discussion of the research methods

The research method used in this thesis is the Landscape Character Assessment (LCA) method and interview and questionnaire. LCA is a good way to convey landscape experience and knowledge to people from different backgrounds, highlighting and describing important characteristics. This leads to an increased understanding of how decisions affect the surrounding landscape during different planning processes. In the chapter of landscape character description, it not only should describe objectively the geographical characteristics of the landscape in the research area, but also comprehensively consider the information obtained through questionnaires and interviews, like the aesthetics values and people's understanding and yearning for an ideal natural river. For example, people's perception and aesthetics of a space are affected by different values, which are subjective evaluations. But it is also an important part of the character of the local landscape, because it is the interaction between the landscape and people.

In addition, understanding the value of ecological restoration from the perspectives of different stakeholders is very important for the research of the thesis. But the work is challenging. Due to the research time limitation of the thesis, the selection of interviews with different stakeholders is not enough. Therefore, I think this limitation will shed light on the follow-up work of the thesis on how to better integrate watershed scales and prioritize the most valuable projects. This is also the update consideration for the first iteration mentioned above.

6.3 Discussion of the research results

Chapter five-Visions presents a proposal of a municipal nature reserve, carries out zoning planning and strategic analysis within a manageable range, and then selects core protected areas for in-depth design. The purpose of establishing a municipal nature reserve is to provide a comprehensive communication medium for addressing the complex conflicting interests in the Nedre Dalävlven river. All rivers in Sweden will in the next 20 years be revised according to the environmental legislations and there will be a great need for professional skills on water design for rivers and the surrounding urban and rural built areas. The current restoration work not only considers ecological aspects, but also other factors. Therefore, it is hoped that through this proposal, a new perspective will be inserted to the restoration work of the river and applying landscape as a medium which can play the role of coordinating the research of various disciplines.

The in-depth design proposed in this thesis - Fish nature park is seen as a comprehensive thinking on ecological restoration strategy and technology and sustainable development of the local environment. Based on the gradual and in-depth understanding of the research problem

and the information obtained from different interviews, I believe that the ecological restoration of the Nedre Dalälven river, especially the restoration of the fishway, will be a long-term and complex work. Each hydropower plant has its own different physical conditions and constraints, so restoration and planning efforts in the fish pass will vary. Taking Älvkarleby hydropower station as an example, the current research work is based on the basic condition that Kungsådran is the best route option. However, the specific implementation process in the future is still uncertain. The scheme proposed in this thesis is also a design work based on the assumption of this possibility. Its purpose is to integrate landscape planning perspectives and methods into restoration work, providing more diversified considerations for restoration work purely for fish, and adding a comprehensive functional strategy.

6.4 Discussion of future research

According to the above statement, the research of this thesis is an iterative cognitive process during the investigation and analysis phase, which poses considerable challenges to the planning and design of the proposal. However, this is one of the driving factors for the continuous change and improvement of the project. Therefore, the follow-up research of the project will focus on the following aspects:

First, keeping up with existing related research. It means keeping up with newer research findings, such as studies on water flow velocity and environmental assessments of fish pass structures. Second, the continuation of the inventory of study areas, such as forests and water resources, river biota, etc. The inventory work is complex, changing both in time and space. It is also prone to intersecting phenomena, especially with property rights, management and other aspects prone to problems. But this work is extremely important because it forms the basis for feedback loops between policies, landscape models and ecosystem policies. Third, making further in-depth research of restoration and protection plans in the Outdoor life zone and Buffer zone. Finally, better ways of incorporating stakeholder-driven and expert input into scenario design will aid in the ideation process. Therefore, it is important to present the proposal to residents of Älvlarleby and get feedback from the residents on their knowledge and experiences of the environment as well as advantages and disadvantages of the project proposals. It is important to use the municipal planning monopoly to have open meetings in comprehensive planning processes that by law take place every fourth year. The public and different professional experts need to meet in order for everyone to learn from each other.

7. Conclusion

I set out to study *How to create a multifunctional river spaces where conflicting interests like protection and restoration of ecology and ecosystem services, human recreational needs and development of water energy production can cope, through landscape planning and design?*

In the dimension of protecting and restoring ecosystem services, the establishment of a municipal nature reserve will provide a comprehensive platform for Älvkarleby. Although the research focus of this thesis is on the restoration of the migratory environment of wild fish, it plays a positive role in the protection of other ecological communities and habitats. This role is not only reflected in the promotion and improvement of protection policies and strategies, but also provides a medium for mutual intersection of research work in all aspects of the region.

For the dimension of balancing environmental protection with human needs and local development, the municipal nature reserve offers an alternative, which demonstrates the possibility of research by a landscape planning-led approach to address complex challenges. If implemented properly, it can result in valuable collaborations for financing and innovations, such as the concepts and technologies on display at the Fish nature park.

Finally, at the regional development dimension, the establishment of a municipal nature reserve will play a positive role in the coordinated development of Älvkarleby and its surrounding areas. This coordination will start with connection between the upstream and downstream areas of the Älvkarleby hydropower station and will later extend to the rural and urban areas in the Nedre Dalälven river.

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Popular science summary

The natural environment and ecological services of rivers and the needs and expansion of human activities using rivers causes conflicting interests. Human survival is inseparable from the dependence on the natural environment, but at the same time, the continuous demand for natural resources has also caused an irreversible impact. Hydropower is regarded as sustainable and clean energy and is being developed and applied in increasing river basins, while it has also caused damage and pressure on the ecological environment of the rivers. The Nedre Dalälven river has long been considered as one of the important areas for wild salmon and sea trout in Sweden which are an important source of economy for local development in history, whereas they have been severely affected by the local hydropower development. At the same time it has also an important tourist river cultural value, especially sport fishing being one of the main reasons for visiting the Nedre Dalälven river. Landscape architecture can coordinate different stakeholder's interests in a visionary future illustration with ambitions to solve conflicting issues. The purpose of this thesis is to study how to achieve coordinated sustainable development of the Nedre Dalälven river space through the proposal to establish a municipal nature reserve. This thesis analyzed the Nedre Dalälven river space flowing through the Älvkarleby area and the ecological landscape of the shorelines, especially the dilemma caused by the development of hydropower for local wild fish migration and development needs of local recreation activities. The research questions to be addressed in this thesis are to study coordinating different interests in a visionary future illustration with ambitions to solve conflicting issues of sustainable development of the Nedre Dalälven river space by applying landscape approaches. This conflict of interest stems from the long-term and complex characteristics of river ecological restoration. It involves not only the intersection of multiple disciplines, but also involves the interests of different stakeholders, requiring multiple parties to communicate, negotiate and cooperate. This thesis applies the Landscape Character Assessment method to carry out an inventory of the research river riparian landscape as the basis, and utilize the landscape design-led methods to propose a municipal nature reserve on the shoreline of the Nedre Dalälven river in Älvkarleby. The thesis concludes that the task of applying environmental legislation to hydropower activity in rivers needs to include municipal comprehensive work and issues of additional protections and developments in order to be able to choose the best design solution and find the financing for that.

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Appendix 1

Table 1: The Landscape Character Assessment inventory form of site visiting

Site scheme for landscape analysis								
Area No:	Location:							
Character of landscape type:		River space						
Time:2022.2.28								
Geology	Land form	Topography	flat	low land	deep ravine	vertical		
			undulating	rolling lowlands	wide valley	rocks		
			rolling	plateau	narrow valley	steep		
			water-filled valley	drained valley				
		Soil type	swimming sediment, coarse silt-fine sand	swimming sediment, clay-silt	Ice river sediment	block		
			river sediment, coarse silt-fine sand	river sediment, Gravel	Ice river sediment, sand	kalktuff		
			sandy moraine	sand	weathering soil	filling		
		Revetment	peat or mud	clay or silt	sand or gravel	grassy slope		
			moraine	stone block	filling			
		Hydrology	river	reservoir	dried furrow	drainage ditch		
			dam	lake	waterfall			
Natural value	Land cover	Forest	pine forest	spruce forest	coniferous forest			
			deciduous forest	trival deciduous forest	nobal deciduous forest			
		Vegetation	tree	scrub	meadow			
			emergent	floating	submergent			
		Habitat	fish	amphibian	bird			
			Insect and pollinator	other				
Aesthetic value	Visual	Spatial	open	semi-open	enclosed			
	Identity	Culture point	ancient monument	outdoor life	other			
	Landmark							
	Recreation							
Accessiable	Facility		bench	plantform	outdoor structure	others		
	Communications	accessibility	road	bike path	walkways	bridge		
		inaccessibility	railway					
Sensitivity								

Appendix 2

The investigation questions were posed during the interviews. These questions were produced in a document and sent to each interviewee by email. The list of interviewees can be found in section 3.3.2. The questions come from several reports of local research projects mentioned in the desk study (see 2.3). For each question, I first stated the research objects and the source of the content of them, and then asked the questions. Some pictures were used to illustrate my specific problem in the questions. The results of the interviews are stated in Appendix 3.

Below are the interview questions:

1 About recreating fish passages

I read some of the LIV project report, one document with the name is Förslag till fiskpassagelösningar i Nedre Dalälven from Länssyrelsen Gävleborg. In the report, there are four suggestions for establishing fishing routes, the primary suggestion is to create nature-like fishing routes with accessible flowing habitat, a choice of less ecological quality are nature-like fishing routes primarily for passage, the third option with less ecological qualities are technical fishing routes of the gutter type and other types of technical fishing routes.

Question:

- **What kind of fishing routes are considered to be used by the Älvkarleby hydropower plant?**
- **And what kind of environmental conditions need to be created in order to achieve this?**

Existing compensation measures in the context of Kungsådran and Kungsådredammen Vattenfall and Sportfiskarna carried out the work itself and laid out about 250 tonnes of spawning gravel at four locations in Kungsådran. The work was carried out by helicopter and the gravel that was placed was so-called spawning gravel where salmon and trout can bury their rum. The purpose of the measure is to strengthen the stocks.

Question:

- **Where are these four locations?**
- **Does this operation need to take place in more places?**
- **Does this spawning gravel impact the surrounding environment, especially to the reverments?**
- **Do you think these places have the potential to develop into habitat reserves?**
- **How does the protection of the original wild Daläven salmon species function in Kungsådran?**

About the water flow.

In the document named Biotopkarteringar och åtgärdsplaner för strömsträckor i neder Dalälven in LIV project, according to the description of water flow in Prerequisites section, to meet these environmental requirements requires a complex habitat with varying depths and flows. Normal values for spawning areas for trout and salmon are 0.1–0.7 m deep, 0.2–0.6 m / s water velocity.

Question:

- **What are the opinions of the current professional department on the planning of water flow?**

About the further planning

In the same report of the LIV project, they recommended building a large natural fish bypass in Kungsådran, which could attract the entire flow of water that makes up the new flow regime. Figure 2 shows that.

Question:

- **Is this plan feasible?**
- **If implemented, how can the new fauna passage be done in order to have an impact on the surrounding areas to be a holistic nature environment?**

Fig 65. The illustration from the LIV project - principle sketch of the proposed construction of a sheet pile and a new nature-like fishing road at Kungsådrans utskovsdamn.

About Network Diversion

From the report of Miljöanpassing av Vattenkraft i Uppsala Län-Nationell plan fär moderna miljövillkor för vattenkraften (NAP) project, it recommended to build network diversion in upstream area of Älvkarleby for protect the fish fauna.

Question:

- **How feasible is this measure?**
- **Is there an alternative? such as using existing islands as a physical diversion?**

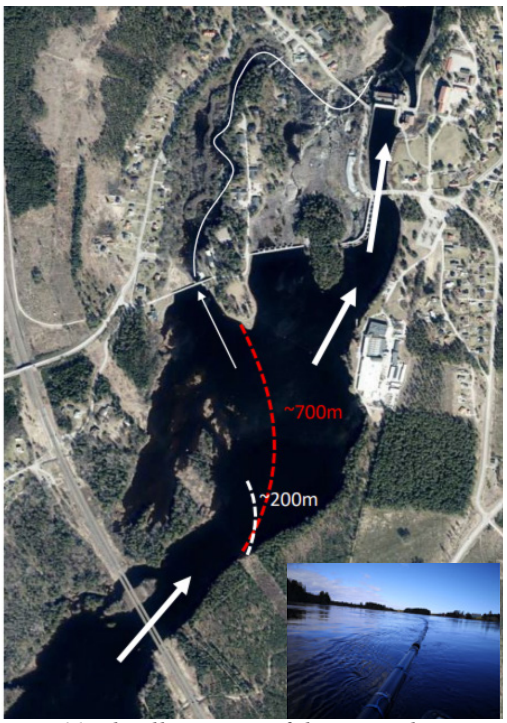


Fig 66. The illustration of the network diversion upstream from the Nap project.

2 About habitats downstream

Today there is a repaired stream at Älvkarleby camp where gravel and blocks have been added (Fig67 and 68). The measure was carried out by the Upplandsstiftelsen in collaboration with Fortum in 2017 (Loreth Remén et al., 2017) . This surface is to be considered a valuable habitat since it is downstream of all power plants.

In the report Biotopkarteringar och åtgärdsplaner för strömsträckor i nedre Dalälven from LIV project, the area is considered valuable for restoring salmon spawning, and the addition of large and medium-sized lumps is recommended in the report as a major ecological restoration measure. In the municipal comprehensive plan, the area will be built into an outdoor bath and a dock for boats.

Question:

- **Will these two contents conflict?**
- **Will the restoration of fish habitats be negatively impacted by the development of outdoor baths and marinas?**
- **Will the added stocks have a serious impact on sailing?**
- **What is your opinion?**
- **How does the regulation of the power stations according to the market demands of electricity that make water levels differ impact the new created habitat?**

Fig 67. The mapped area away from Älvkarleby hydropower station and the camping.

Fig 68. Fixed buck at Älvkarleby camping.

3 About environmental measures at Älvkarleby hydropower plant

I learned something about environmental measures to build fish passes. For upstream passage, nature-like fishing paths (circulation) are primarily recommended, followed by gutters, mainly to prioritize solutions that work for as many fish spec ies and life stages as possible.
For downstream passage it is recommended a low-sloping grille with an adjacent passage, escape gutter, but it has been observed that optimally placed shallow spillways in some cases had a good function. These techniques include Alpha galls (Alfagaller) and network barrier (Nätbarriär). The network barrier is an alternative to Alpha proposed by Vattenfall.

Question:

- **Are there any long-term plans for the application of these four technologies in Älvkarleby?**
- **If there are proposals, which technologies will be prioritized and where are they located?**
- **How do these technologies impact the surrounding environment and consider the requirements of the valuable natural environment?**

Fig 69. Nature-like fishing passage(circulation)

Fig 70. The fish ladder-technical fishing route

4 About fish habitat in Kungsådran

According to the description in the LIV report on salmon biome mapping, the salmon habitat class is divided into play area (lekområde), rearing area (uppväxtområde) and site area adult fish (ståndplatsområde vuxen fisk). In the report Biotopkarteringar och åtgärdsplaner för strömsträckor i nedre Dalälven from LIV project, there are two drawings showing the mapping and grading of play areas and growing areas in the surrounding area of Kungsådran.

Question:

- **Are there other ecological value areas with potential that can be developed into the above three fish reproduction functional areas?**

Fig 71.Map shows the play areas for fish in Kungsådran

Fig 72. Map shows the rearing areas for fish in Kungsådran

5 About water protection area

In Älvkarleby municipality, there are three public water sources that have different water protection areas for drinking water. Two of them are within the scope of this paper.

Question:

- **Are there any mutual impacts of the water protection areas and ecological solutions in the Älvkarleby waterfall area?**
- **What constraints do these three areas have on the development of surrounding areas?**

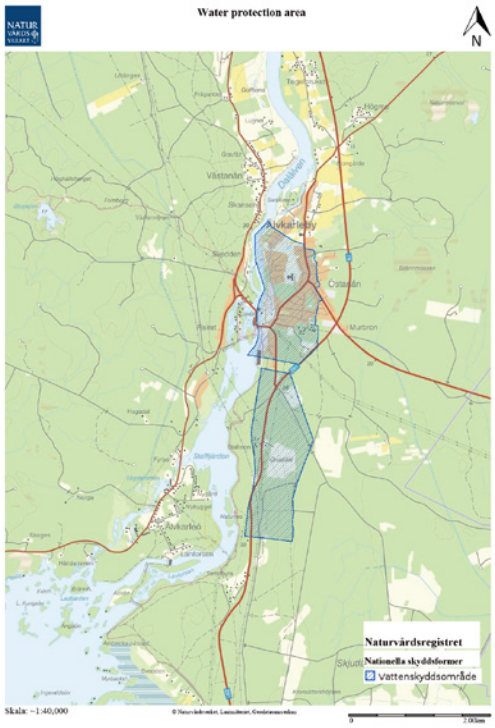


Fig 73. The water protection areas in Älvkarleby
Data source:© Naturvårdsverket, Lantmäteriet, Geodatasamverkan

6 About the LONA project

The LONA initiative means that government grants finance local nature conservation projects with up to 50%. The municipality and other actors in the project contribute with cash financing, with working hours or non-profit work.

Question:

- **Are there any nature conservation projects happening or about to happen in Älvkarleby?**
- **If not, does the local government intend to apply for the project in the future? and which area will be considered prioritized?**
- **Do you think that the research area of this paper will be considered as a priority area for environmental protection?**

7 About the riparian landscape

In the report Periodic Review in Nedre Daläven Landscape Biosphere Reserve 2011-2020, there are descriptions of developing open landscapes projects. One is LIFE Älväng, was to restore previously cultivated river meadows, which would help the wildlife habitats development. Source:

Question:

- **Do Älvkarleby have any plan for developing open landscapes and restoring the landscape and the meadows on the shorelines of the Nedre Daläven river?**
- **What information could you provide me for reference on the plants of the meadow landscape?**
- **Is there recent nature and vegetation inventory work done around the waterfall area in Älvkarleby?**

8 About the culture protection

The natural environment with the waterfall and salmon fishing, including highly valuable cultural heritage around the waterfall area in Älvkarleby, have a special identity and large potential for development of recreational purposes if protected.

Question:

- **Which areas do you think should be included in a nature reserve and thereby prioritized for protection? Why?**
- **What important value does it hold? What new functions for recreational uses do you see a need for in the area close to the railway station and the former nature park by Stora hallen, the waterfall area and the Tourist hotel and downstream in the Sports fishing area?**

Appendix 3

In the interview work, I selected a total of 5 stakeholders representing different departments, and the stakeholders list is placed in chapter three (see3.3.2). Two persons from Naturvårdsföreningen (the local environmental organizations) and The Fisheries Research Station of SLU in Älvkarleby (the fish research institutes) accepted my on-site interview, while persons from Vattenfall AB (the electricity company) and Länsstyrelse i Uppsala (the county administrative board in Uppsala) responded to my questions via email, and the answer from Sportfiskarna (the tourism business) has not been received so far.

The current ongoing research on fish passage and habitats mainly focuses on several aspects: The first is the possibility to make connections for fish passage under the Kungsådran dam. The second is the influence of the water environment and the composition of the channel matrix on the fish reproductive rate. The third is the diversion of the upstream waters, how to guide the fish to flow to Kungsådran, and away from the main river, so as to avoid dying from the turbine of the hydropower station. The last is the effect of water velocity on the attractiveness of fish. The flow and velocity of the water is both to increase the attractiveness of Kungsådran to the fish, and to minimize the loss of hydroelectric power generation.

The summary of interviews

According to LIV's research report, many experiments have been carried out on the restoration of fish game and growing environment in Kungsådran, and these tests have provided a lot of research data for improving its ecological habitat. The interviewees from The Fisheries Research Station of SLU in Älvkarleby and Länsstyrelsen i Uppsala indicated that the fishway connection proposal at kungsådran dam is highly feasible and there is good condition for the recovery potential in upstream waters. He said that he prefers to use a natural-like form to create the fish passage (see Fig 69). However, the person from Vattenfall indicated that the fish ladder (see Fig 70) could be considered primary.

About the vegetation on both shorelines of the Nedre Dalälven river, the interviewee from Naturvårdsföreningen was reminded that the riparian landscape downstream needs special protection due to the erosion. He explained that in order to solve the prominent problem of soil erosion in the downstream shoreline of the hydropower station, the restoration of the meadow is very important, whereas the area of the restoration so far is far from enough. In addition, he also represented habitats in Kungsådran, downstream and upstream areas, and it is important to connect them in further restoration work.

The interviewee from Vattenfall AB also expressed positive opinions about the water environment protection and restoration work on Camping Island, arguing that the development

of the boat stop there (proposed in the municipality's comprehensive plan) is bound to have a negative impact on the fish fauna in the area (see Fig 67). At the same time, he also said that there are many precious tree species in the forest in the east shoreline upstream (Buffer zone), but it seems that there is a lack of well monitoring and protection.

Opinions on underwater network diversion were obtained from interviewees from Länsstyrelse i Uppsala and The Fisheries Research Station of SLU in Älvkarleby. The former replied via email with two possible implementations of the network and provided a map with the location of the network implementation and an illustration of the network facilities (see Fig 66). The latter interviewee also believed that it was more feasible to use the existing islands to form divisions and guide the fish to pass through the waters in the old railway park and reach the upstream river.

At present, research on water velocity and flow is still ongoing, which mainly depends on the consideration of different stakeholders (such as how the economic and ecological benefits of hydropower production can be compromised). However, with the exception of those from the Vattenfall, all interviewees expressed a desire for more water flow into Kungsådran perennially.

Appendix 4

Below are the research questions for the questionnaire. It includes ten questions, and was posed on a Facebook group in Älvkarleby. A total of 22 responses were received from local residents. The results of the questionnaire are also stated in Appendix 5. Since the subjects of the survey were local people, the questionnaire was written in Swedish. Since the subjects of the survey were local people, the questionnaire was written in Swedish.
The link to the Questionnaire is:
https://docs.google.com/forms/d/1NAM5CzFNJjCbqFvLkUxAhSXD9hNr0CpTXHxzkVXuWCU/edit

Frågorformulär om Nedre Dalävens älvrum i Älvkarleby.

Denna enkät kommer från en studenternas examensarbete som i Master i Landskapsarkitektur för hållbar urbanisering vid Sveriges Lantbruksuniversitet. Avhandlingen kommer att undersöka hur skapandet av ett kommunalt naturreservat på platsen i Älvkarleby kan stärka ekologiska korridorer i Uppsala läns gröna infrastrukturnät.

Frågeformuläret innehåller totalt 10 frågor för att undersöka lokala invånares syn på landskapet i Daläven älven i Älvkarleby.

1. Är du... *

- Kvinna
- Man
- Annat alternative
- Vill ej svara

2. Hur gammal är du? *

- 7-16 år
- 17-24 år
- 25-35 år
- 35-45 år
- 45-55 år
- 55-65 år
- 65+

3. Vilken år din huvudsakliga sysselsättning just nu?

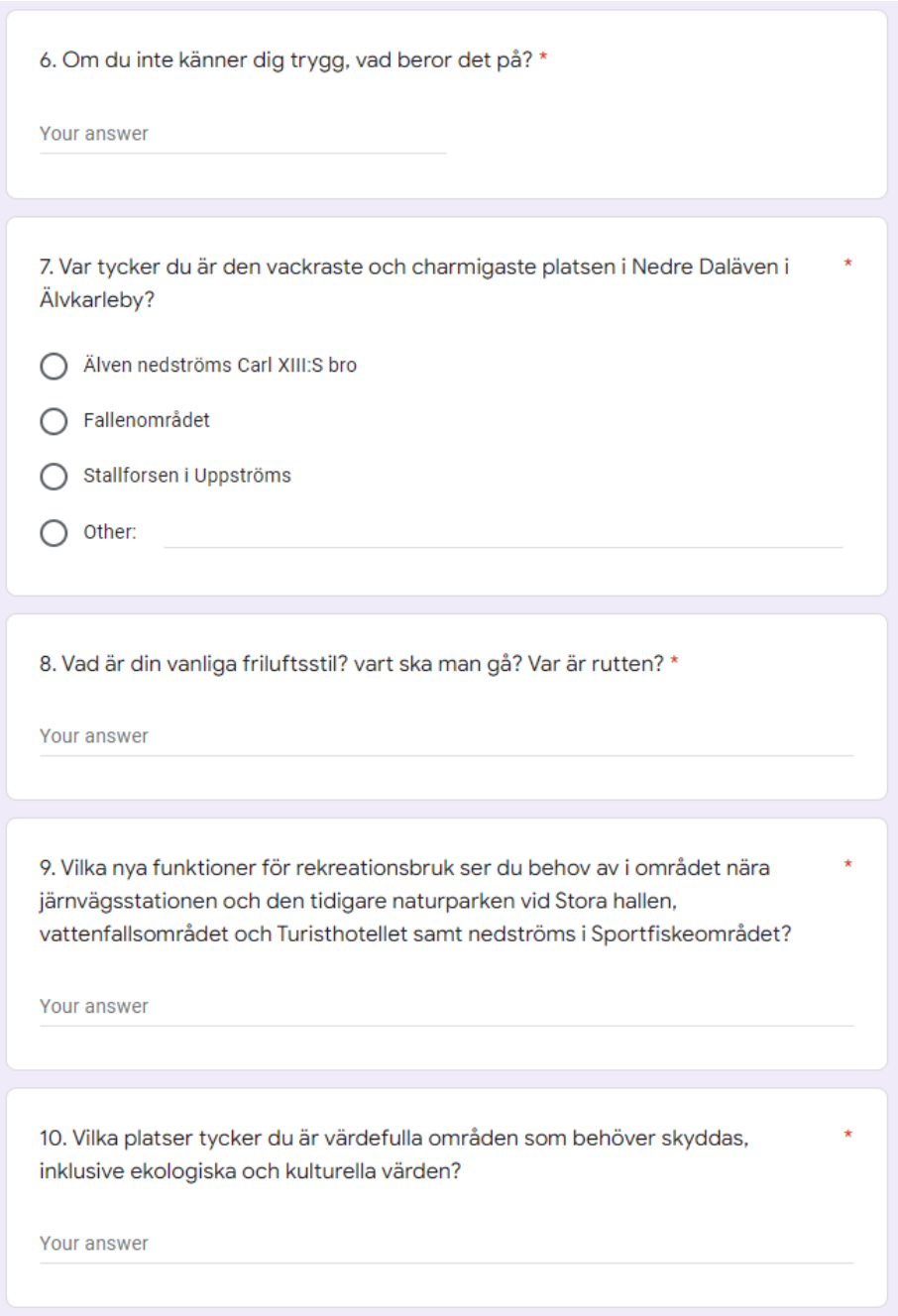
- Arbetar som anställd
- Egen företagare
- Studerande
- Pensionär (ålders-, sjuk- och föridspensionär)
- Arbetssökande
- Vill ej ange

4. Hur ofta besöker du idag Nedre Daläven älvrum i Älvkarleby? *

- Dagligen
- Flera gånger i veckan
- 1 gång i veckan
- 1 gång i månaden
- Mer sällan
- Aldrig

5. Känner du dig trygg vid älvrum? *

- Ja
- Nej
- Kanske



In English
Questions about Nedre Dalävens älvrum in Älvkarleby.

This questionnaire comes from a students' degree project as in the Master in Landscape Architecture for sustainable urbanization at the Swedish University of Agricultural Sciences. The dissertation will investigate how the creation of a municipal nature reserve on the site in Älvkarleby can strengthen ecological corridors in Uppsala County's green infrastructure network. The questionnaire contains a total of 10 questions to examine local residents' views of the landscape in the Dalälven river in Älvkarleby.

Q 1. Are you…
Options: Female, Male, Other alternative, Do not want to answer

Q 2. How old are you?
Options: 7-16 years, 17-24 years, 25-35 years, 35-45 years, 45-55 years, 55-65 years, 65+

Q 3. What is your main occupation right now?
Options: Works as an employee, Self-employed, Student, Pensioner (old-age, sickness and disability pensioner), Jobseeker, Do not want to enter

Nedre Dalävens älvrum in Älvkarleby
Here are some questions that are specifically about how you think the area around Daläven river room can be improved.

Q 4. How often do you visit Nedre Daläven älvrum today?
Options: Daily, Several times a week, 1 time a week, 1 time a month, Less often, Never

Q 5. Do you feel safe in the river room?
Options: Very safe, Fairly safe, Less safe, Not safe

Q 6. If you do not feel safe, what is the reason?

Q 7. Where do you think is the most beautiful and charming place in the area?
Options: The river downstream of Carl XIII's bridge, the Fallen area, Stallforsen in Uppströms, the west bank of the river, the east bank of the river, Other:

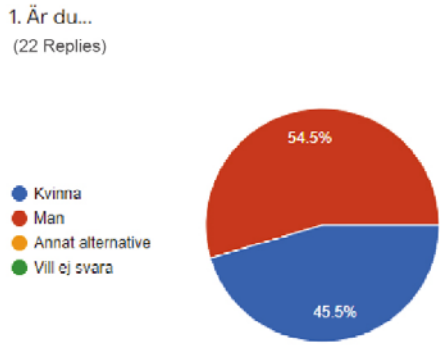
Q 8. What is your usual outdoor style? Where to go? Where is the route?
Answer in text.

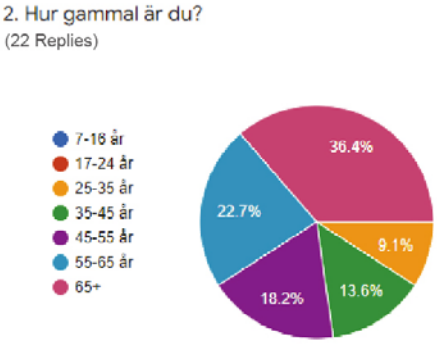
Q 9. What new functions for recreational use do you see a need for in the area near the railway station and the former nature park at Stora hallen, the waterfall area and the Tourist Hotel and downstream in the Sport Fishing area?
Answer in text.

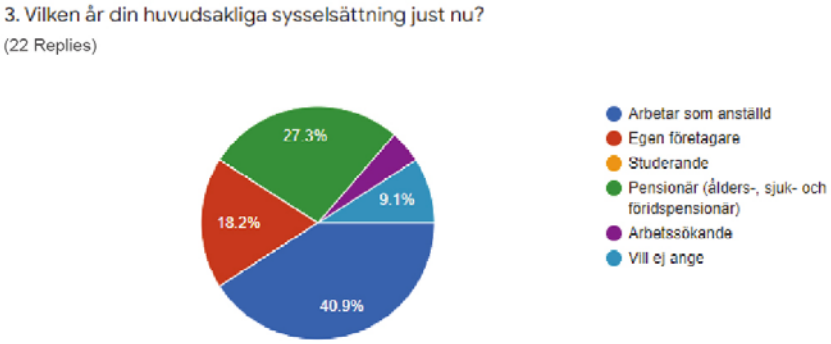
Q 10. Which places do you think are valuable areas that need to be protected, including ecological and cultural values?
Answer in text.

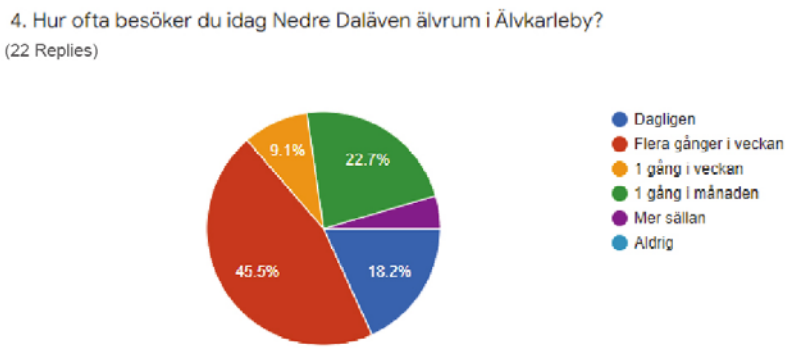
Appendix 5

There were 22 responses in this questionnaire. In the survey on ecological and environmental protection issues, 14 respondents said that the ecological landscape on both shorelines of the Nedre Dalälven river, especially the public space of forests and river riparian, should be protected. In particular, the monitoring and inventory work of forests has been lacking, and many red list plants lack special protection work. In the survey on outdoor life activities, 16 respondents said that their existing outdoor leisure routes are mainly concentrated downstream of the hydropower station, from Laxön to the camping island on both shorelines of the river. This is due to the lack of adequate recreational outdoor facilities and it is inaccessible upstream, so they have also made requests to increase waterside public recreational areas upstream, including walking routes, outdoor fitness, and swimming and boating.

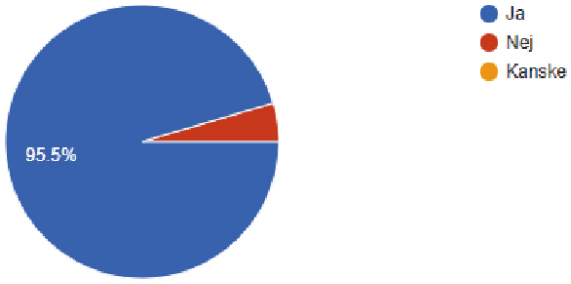




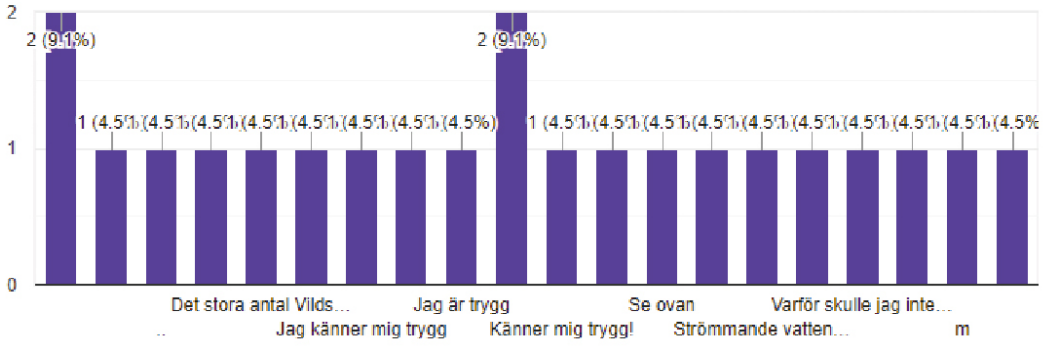




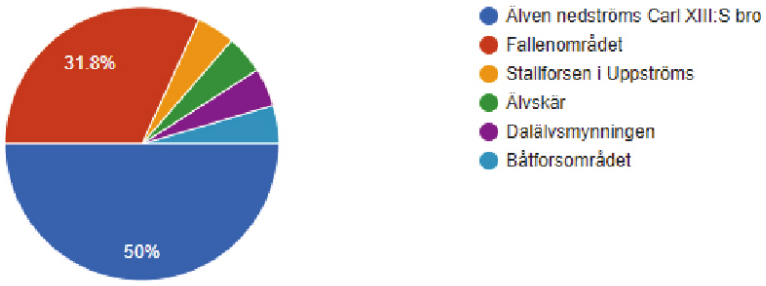
5. Känner du dig trygg vid älvrum?
(22 Replies)



6. Om du inte känner dig trygg, vad beror det på?
(22 Replies)



7. Var tycker du är den vackraste och charmigaste platsen i Nedre Daläven i Älvkarleby?
(22 Replies)



8. Vad är din vanliga friluftsstil? vart ska man gå? Var är rutten?

(22 Replies)

Vandring, från fallennoch nedströms. Eller Upplandsleden mot Marma

Urskog, svämlövskog

Älven runt via hängbroarna, laxön.

Upplandsleden längs älven

Promenera runt Häxön, ut på Billudden. Gå runt fallet Äby. Gå i skogen vid Lanforsen.

Runt fallen på små broarna o stigen vid kungsådran

Laxön runt

Runt broarna.

Längs kungsfåran

vid älven mitti emot campingen

Åka båt i Dalälven och vandra längs Dalälven

Över dammarna, fiskestigen, fiskekontoret över korallen, Carl den Vi es bro och tillbaka.

Från Laxön kring hängbroarna och upp till laxön igen

Hundpromenader

parkera bil vid turisten ta vägen upp mot Stora hallen, vägen över fallen ner mot fiskekampen och tillbaka över carl den 16:e,s bro och tillbaka till turisten.

Brukar vandra eller cykla längs älven.

Hålldammen till Lanet

Vandrar på olika ställen. I Älvkarleby runt fallenområdet men även ner till campingen och längs Lilllån.

Laxen över fallet

Cyklar ofta över broarna vid fiskecampen, den lilla stogen öster om Laxön, runt broarna vid fallen. Underbart!

Camping o fiske

Hundpromis i älvområdet

9. Vilka nya funktioner för rekreationsbruk ser du behov av i området nära järnvägsstationen och den tidigare naturparken vid Stora hallen, vattenfallsområdet och Turisthotellet samt nedströms i Sportfiskeområdet?

(22 Replies)

Vet ej

Paddling

Spara gammelskogen

Ett bra sätt att ta sig från tåget till vattebskidklubben. (man kan gå i tågbron) gjorde alltid vi när vi var yngre.

Låta det växa vild äng på fler ställen.

Har Inga bra förslag

Bra som det är

Uppstädning runt Turist hotellet.

Från turisten och nedströms på Västanåsidan

lekpark med gungor bl.a

Bättre farleder, gästbryggor och uppmärkning

Fallfåran håller på att växa igen det tar bort känslan av vattenfall även om växtligheten ökar den biologiska mångfalden

Utvecklad naturstig från fiskestigen. Öppna SLUs område mellan fiskestigen och Laxön. Otroligt fin stig att gå.

Fiske

viktigt med fler utomhus sittplatser för reflektion

Kanske en karta över området som skylt vid stationen som visar var man är och hur området ser ut.

Alla.

Att turisthotellet öppnar för tex lunch.

Bättre vandringsleder

Tycker att det redan är väldigt bra

Utomhus gym

10. Vilka platser tycker du är värdefulla områden som behöver skyddas, inklusive ekologiska och kulturella värden?

(22 Replies)

Hela området.

Turist hotellet

Allt vattennära

Alla stränder efter älven. Alla stora vackra lövträd, låta barrskogen vara kvar. Så marken och jordens mångfald behålls. Vi ska vara rädda om vår kalkrika jord som ger vackra blommor, marken runt grusgropen på västanån (kross gropen) nattvioler 😊.

Hela laxön. Biltrafiken borde dock förbjudas om man inte är handikappad

Det mesta är väl typ skyddat idag?

Laxön och området runt

Smolten, från skarvar, hägrar och sälar

Finns naturvårdsplan och förslag genom Upplandsstiftelsen

Hela dalälven strand. Sluta bygg efter dalälven. Bevara stränderna o allemansrätten.

Hela området, viktigt att det hålls tillgängligt och vårdat

Laxön området, begränsa inte för mycket med skyddsområden. Kommunen är redan hårt drabbad efter kustområdet vilket bekransar ekonomisk utveckling

All näring runt älven i Älvkarleby

Laxön. Runt Turisthotellet. Campingområdet inklusive badplatser.

Hela älvområdet

Man får komma ihåg att det är ett industriområde även om det är vackert

Laxön och turisthotellet har en lång historia bakom sig så den ska välbevaras.

Fallet

Kungsådran

Laxfisket o dess områden

Allt mellan Lanforsen och Untra

alla

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