



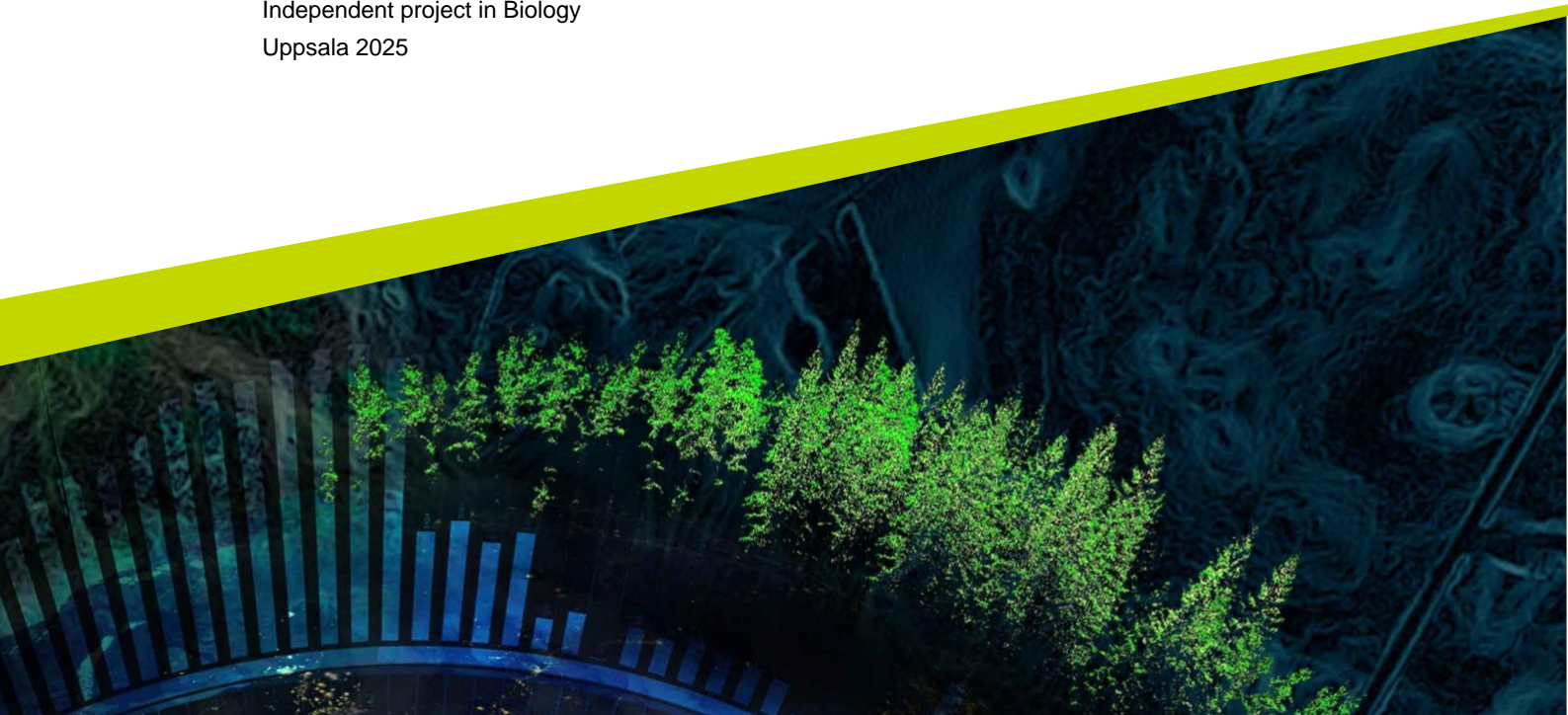
# Exploring cultural ecosystem services and fishing in Älvkarleby

Insights from fishers and stakeholders

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Dilara Cicek

Independent project • 30 credits  
Swedish University of Agricultural Sciences, SLU  
Department of Aquatic resources  
Independent project in Biology  
Uppsala 2025



# Exploring cultural ecosystem services and fishing in Älvkarleby: Insights from fishers and stakeholders

*Kulturella ekosystemtjänster och fiske i Älvkarleby: Insikter från fiskare och intressenter.*

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## Abstract

Fishing in Älvkarleby is deeply embedded in the local culture, economy and identity, offering diverse cultural ecosystem services. It is a rich fishing destination where Atlantic salmon (*Salmo salar*) and Sea trout (*Salmo trutta*) have shaped local traditions and tourism. However, challenges such as declining fishing stocks, hydroelectric dams and predation pressures threaten the sustainability of cultural ecosystem services, particularly recreational fishing. This study explores how fishers and stakeholders perceive cultural ecosystem services in Älvkarleby, the factors affecting them and potential management strategies to enhance their resilience.

A mixed-method approach was applied, combining a survey (N=99), participatory GIS mapping and stakeholder interviews. The survey captures perspectives on the cultural, recreational and ecological importance of fishing, while the GIS analysis identified spatial patterns of cultural ecosystem services and impact factors. Findings indicate that fishing and fishing areas remain highly valued, particularly for recreation, heritage and well-being. However, stakeholders expressed concerns about declining fish stocks, predation pressures and the conservation of wild fish populations. Mapping results highlight key areas where conservation, recreation and environmental pressures intersect, emphasizing the need for adaptive management.

The study underscores the value of integrating local knowledge and ecosystem-based management into fisheries governance. By prioritizing stakeholder participation, habitat restoration and sustainable fishing policies, Älvkarleby can preserve its fishing heritage while promoting long-term ecological and economic sustainability.

*Keywords: recreation, predation pressure, cormorants, fish stocking, participatory mapping, stakeholder survey, spatial analysis, sport fishing, recreational fishing, sustainable fisheries, ecosystem-based management, sea trout, salmon*

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# 1. Introduction

## *Cultural Ecosystem Services and Fishing*

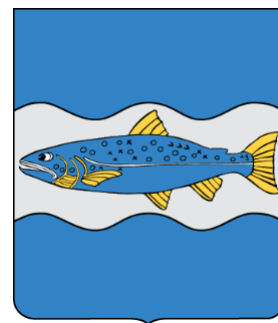
Fishing has long been a vital link between humans and nature, providing a range of benefits that sustain and enrich human lives. The benefits derived from ecosystems provide us with tangible resources, for example food and livelihoods as well as non-material contributions, such as recreation, aesthetic enjoyment and preservation of cultural heritage (Barbier 2017; Haines-Young & Potschin-Young 2018). Cultural ecosystem services are particularly significant in fishing communities, where interactions with the natural environment shape traditions, identities and connections to local natural areas (Vave et al. 2024).

Benefits from ecosystem services arise from the ways people use, experience and interact with ecosystems. Fishing communities draw cultural, recreational, and even spiritual value from their surrounding waters. These non-material benefits highlight the deep relationship between humans and nature, especially in fishing-dependent communities (Romanazzi et al. 2023). By exploring and mapping these services, using local knowledge from stakeholders, we can better appreciate their role in fostering both community cohesion and individual well-being (Pinheiro et al. 2021; Wikström et al. 2024)

## *Fishing in Älvkarleby*

In Älvkarleby municipality, fishing is the foundation of the local culture, history and economy. Geographically situated where Sweden's second-longest river, Dalälven, meets the Baltic Sea, the area has long been recognized as a fishing hub that has attracted both local and international fishing enthusiasts (Cooper 2025).

Sweden's first national organisation of anglers, “The Swedish Sports Fishermen's Association” was founded here in 1919 (Lindgren 2022), reflecting the area's longstanding influence on recreational fishing.



**Figure 1:** Älvkarleby municipality local coat of arms (featuring a salmon).

Atlantic salmon (*Salmo salar*) and Sea trout (*Salmo trutta*) (from now on referred to as salmon and trout), are central to Älvkarleby's fishing heritage, symbolized by the municipality's coat of arms (Fig. 1). However, the future of these species are threatened by migration barriers, such as hydroelectric dams, which restrict fish passage and hinder the natural reproduction of wild salmon and trout in Dalälven (Cooper 2025; Florin et al. 2024).

To sustain fish populations, the Fisheries Research Station in Älvkarleby,



managed by SLU Aqua, has released a large number (115 000) of salmon and trout smolt annually into Dalälven since the 1990s. The research station is responsible for 100% of the sea trout and approximately 30% of the salmon stocking (Florin et al. 2024). However, the station is planned for closure in 2025 due to lack of funding, raising concerns about the future impact on these fish populations and local tourism (Florin et al. 2024; Cooper 2025). Without continued compensatory stocking and free migration pathways (Florin et al. 2024; Hagelin et al. 2016) salmon and trout populations face decline, jeopardizing both ecological sustainability and cultural ecosystem services tied to fishing. This underscores the urgent need for alternate strategies to support fish populations.

### *Ecological and Economic Challenges*

Further complicating these issues are ecological and economic challenges. Hatchery farmed salmon and trout have lower survival rates during migration to the Baltic Sea compared to wild populations, with only 30% making it to the coast (Larsson et al. 2024). This raises concerns about the long-term sustainability of fish compensatory stocking. Predation also adds pressures to these stocks, particularly by piscivorous birds, mainly Great Cormorants (*Phalacrocorax carbo*) and Grey heron (*Ardea cinerea*) which heavily prey on farmed smolt, with trout smolt being especially vulnerable (Boström et al. 2009; Säterberg et al. 2023). Additionally, economic concerns are evident with a dramatic drop in fishing license sales, from 11,000 annually in the 1990s to fewer than 1,500 in recent years (Cooper, 2025), reflecting a decline in fishing tourism. While this decrease reduces fishing pressures, which can be beneficial for declining fish populations, it also threatens local businesses that depend on fishing tourism such as accommodation providers, fishing guides and equipment suppliers.

Efforts to protect wild salmon and trout populations include regulations requiring anglers to release captured wild fish and limiting the harvest of farmed fish (Olsson 2024; Älvkarleby Sportfiske 2025; Svenska Fiskeregler 2025). Engaging stakeholders such as anglers, tourism operators and environmental managers is essential for balancing conservation and economic interests. The municipality's reputation as a fishing hub and their fishing heritage depends on sustaining healthy fish populations, but declining fish stocks, predation and economic pressures add urgency to developing balanced and adaptive management strategies.

### *Global Challenges and Relevance*

Globally, aquatic ecosystems are under increasing pressures from e.g. climate change, habitat degradation and overfishing (Küpper & Kamenos 2018; Buonocore et al. 2021). Cultural ecosystem services, such as sportfishing and traditional practices tied to natural areas, are often overshadowed by material and

economic concerns (Ignatius et al. 2019), highlighting the need for balanced management strategies.

European directives like the EU Water Framework Directive and the Marine strategy Framework Directive aim to align fisheries management with sustainability goals, but implementation of these frameworks often requires balancing diverse stakeholder values (Hammer et al. 2003). These top-down frameworks can create challenges for local decision makers, who must balance broader conservation targets with realities of their communities, including economic development and cultural preservation. Navigating these policies requires addressing local concerns, such as maintaining fishing traditions and ensuring economic viability and diversely engaging local perspectives (Ignatius et al. 2019; Veidemane et al. 2024).

### *Knowledge gaps*

Despite this relevance, the integration of cultural ecosystem services into conservation and management strategies remains underexplored, particularly from the perspectives of fishers. Participatory and collaborative approaches that engage both local communities and experts can better capture the socio-ecological dimension of fisheries (Ignatius & Haapasaari 2018; Lähde et al. 2024). While some studies have advanced our understanding of ecological impacts and the spatial distribution of ecosystem services, there is a lack of research linking fishers' motivations and values with ecological impact factors. This leaves critical knowledge gaps in fishers management (Pinheiro et al. 2021; Prutzer et al. 2021), particularly along the Baltic Sea coastline.

Addressing these gaps is essential because anglers are not only users of the ecosystem but also possess key insights which can drive more effective conservation and management. Their knowledge is crucial for strategies that balance ecological sustainability, recreational use and tourism development. Stakeholder-driven processes, which integrate diverse perspectives, have proven effective in supporting adaptive management, which is vital in the Baltic Sea region where socio-ecological interactions are complex (Hammer et al. 2003; Veidemane et al. 2024). Integrating fishers' perspectives through surveys, participatory mapping and interviews provides a deeper understanding of the interplay between ecological, socio-economic and cultural factors (Pinheiro et al. 2021; Romanazzi et al. 2023).

Surveys have effectively been used to capture stakeholder perspectives on cultural ecosystem services, including exploring anglers' motivations and their role in sustaining fishing communities (Liu et al. 2019; Romanazzi et al. 2023; Vave et al. 2024). Socio-cultural governance studies also demonstrated how local values

shape management outcomes (Ignatius et al. 2019), emphasizing the importance of stakeholder collaboration. Similarly, participatory mapping and GIS-based spatial methods have been proven effective in identifying key areas of interest, including sites for recreation, conservation priorities and ecosystem stressors (Pinheiro et al. 2021; Wikström et al. 2024).

Despite these advantages, few studies combine these approaches with in-depth focus on fisher's values and lived experiences in fishing-dependent communities along the Baltic Sea coastline. Participatory methods, such as open GIS analysis, can help address this gap by mapping cultural ecosystem services and ecological impact factors (Lähde et al. 2024). This approach allows for a deeper understanding of human relationships with the ecosystem, and supports the development of tailored management strategies.

This study adopts a bottom-up approach by gathering local knowledge through a survey, participatory mapping and interviews. By engaging key stakeholders, such as sport fishers and local authorities, the research aims to develop tailored management strategies that align with local needs. This participatory approach will help identify areas for both recreational use and conservation in Älvkarleby, contributing to sustainable fisheries management and supporting locally adapted strategies for ecological sustainability and cultural heritage preservation of fishing in Älvkarleby.

#### *Aim of this Study*

The study will document and analyze cultural ecosystem services and impact factors related to fishing and fishing areas in Älvkarleby, by gathering local knowledge through a survey, participatory mapping and interviews. GIS-based analysis will identify key areas for conservation and recreational use. The aim is to contribute to locally adapted strategies that enhance ecological sustainability, preserve cultural heritage and ensure the long-term economic viability of fishing tourism and fish populations.

#### *Hypotheses*

##### **1. Cultural significance**

I hypothesize that fishing and fishing areas in Älvkarleby provide critical cultural ecosystem services contributing to local identity, recreation, local economy, and well-being. Survey data will assess the importance of these contributions and their broader social and cultural impacts, such as community cohesion and sense of place (Ignatius et al. 2019; Romanazzi et al. 2023).

## **2. Stakeholder perspectives**

I hypothesize that various stakeholder groups (locals, non-locals, frequent vs. occasional fishers and different age groups) will perceive the cultural, social and ecological importance of fishing and fishing areas differently:

- Locals will empathize cultural heritage, while non-locals will focus more on recreation, as residents are expected to be more attached to the area and its long-standing traditions, while visitors often view natural areas through a tourism perspective (Ignatius et al. 2019; Veidemane et al. 2024).
- Frequent fishers will prioritize conservation and notice ecological changes, while occasional fishers will value recreation more, as experienced fishers may be more attuned to ecological changes and conservation needs (Hammer et al. 2003; Liu et al. 2019).
- Younger fishers will focus on cost, while older fishers will emphasize cultural preservation, as younger individuals often make decisions based on financial considerations, while older ones have stronger ties to traditions (Ignatius & Haapasaari 2018; Romanazzi et al. 2023).

## **3. Farmed vs. Wild fish perception**

I hypothesize that all stakeholders will perceive wild fish populations as more important for conservation and cultural heritage, while farmed fish will be seen as vital for maintaining current fishing activities and tourism.

Statistical analysis of survey responses will identify key differences between groups, to understand how these perspectives can influence management preferences and priorities.

## 2. Methods

This study employed a mixed-method approach, combining survey data, interviews and GIS analysis to explore cultural ecosystem services related to fishing and fishing areas in Älvkarleby municipality. The Common International classification of Ecosystem Service (CICES) Version 5.1 (Haines-Young & Potschin-Young 2018) was used as a framework for categorizing cultural ecosystem services into three main categories:

- 1. Physical and experience-based interactions with nature:** Activities contributing to physical health, recreational and social interactions
- 2. Intellectual and representative interactions with nature:** Learning, research and artistic expression inspired by nature.
- 3. Spiritual, symbolic and other cultural interactions with nature:** Places and elements in nature that have symbolic, spiritual or cultural values.

### 2.1 Survey Design

The survey aimed to collect quantitative and qualitative data on participants' perspectives regarding cultural ecosystem services, fishing motivations, fishing practices and perceived ecological challenges in Älvkarleby municipality. It targeted both fishers and non-fishers who have personal or recreational ties to the area. The survey was designed using GIS Survey123, focusing on non-map-based questions and featured Likert-scale, multiple-choice, and open-ended free-text responses.

To reach a broad audience, a survey link, QR code and promotional flyers (Appendix 1) were distributed through several channels, including relevant facebook groups such as ‘Vad händer i Älvkarleby Kommun med Omnejd’ (2000 members), ‘Havsöring längs Gästrik - Upplandskusten!’ (1600 members) and ‘Friluftsförbundet Skutskär & Älvkarleby’ (500 members). It was also shared through Älvkarleby municipality official communication platforms including their website, facebook page, linkedin account and newsletter, and by Älvkarleby Sportfiske through their website and social media. The survey was made available for three weeks, allowing participants sufficient time to respond. A reminder to answer the survey was also sent out by the municipality and Älvkarleby Sportfiske.

The survey questions are detailed in the appendix (Appendix 2) covering several themes. These included participants' motivations for fishing and other outdoor activities, their views on accessibility and infrastructure of fishing areas, perception of cultural and ecological values tied to fishing and fishing areas, and

opinions on ecological impacts and suggestions for measures needed to address these challenges.

### 2.1.1 Survey Analysis

To structure the analysis and ensure meaningful comparison, respondents were grouped based on residency, fishing frequency and age (Appendix 3). These groupings ensured sufficient representation within each category while reflecting key aspects of the study.

#### **a) Residency**

Respondents were divided into two groups based on whether they live in Älvkarleby municipality or not, to explore potential differences in perspectives and values on cultural ecosystem service values between local residents and non-residents.

1. Local: Residents of Älvkarleby municipality
2. Non-local: Those residing elsewhere

#### **b) Fishing frequency**

To capture differences in fishing behaviour, respondents were divided into two groups based on how often they fish in Älvkarleby municipality:

1. Frequent fishers: Respondents who fish at least once a month
2. Occasional fishers or non-fishers: Respondents who fish a few times per year, rarely or never

Non-fishers were excluded from certain analyses as they received a reduced set of survey questions. Occasional fishers were therefore redefined to include only those who fish ‘rarely’ or ‘a few times a year’ for some questions. The decision to combine ‘a few times per year’, ‘rarely’ and ‘never’ into a single group was due to the small size of these subgroups. This grouping provided a balance between clarity and sample size, while capturing key differences in fishing behaviours and cultural ecosystem service values.

#### **c) Age**

Respondents were grouped into three categories to reflect different life stages, as age likely influenced perspectives on ecosystem services and fishing behaviours and to provide sufficient sample sizes.

1. Young adults (15-40)
2. Middle-aged participants (41-60)
3. Older participants (ages 61-80)

### 2.1.2 Data Processing and Statistical Testing

Survey data (Appendix 4) were processed and analysed in R version 4.3.1 (2023-06-16) with visualizing and statistical tests to assess survey responses (see Appendix 5 for an example R script). Given the variety of the question formats, the approach was tailored to each question type. Out of the total 30 survey questions (including questions about age, gender, etc.), a subset was selected for analysis based on relevance for the research objectives. These included Likert-scale questions and open-text responses relevant to the study.

The data were prepared for analysis, with Likert-scale response categories based on the frequency of agreement levels (Strongly agree, Agree, Neutral, Disagree, Strongly disagree). Visualization was conducted to illustrate response distribution, using general and grouped plots to compare responses across categories such as residency (local vs. non-local), fishing frequency (frequent vs. occasional fishers) and age (15-40, 41-60, 61-80).

Open-text responses were tokenized into individual words, and common non-informative words (e.g. (in Swedish) ‘att’, ‘och’)) were removed using custom stop words. Word frequency analysis was performed and visualized through bar plots and word clouds to highlight common terms.

Responses were then categorized into themes (i.e. ‘Trout and Salmon’, ‘Predation’) based on the most common words and context. Overlapping themes were captured using multi-level categorization (mentions of both trout or salmon and predation), and the total frequency of each theme was calculated as a percentage of total responses. These results were used to explore the relationships between ecological changes and social perceptions.

Fisher's Exact Test was used to assess statistical significance across groups (residency, fishing frequency and age (Chin & Lee 2008), using the `fisher.test()` function from R's base package. This test was selected for its robustness with small sample sizes and sparse data. P-values were calculated to identify significant differences between groups.

## 2.2 Interview and Mapping Design

Interviews were conducted to complement the survey by providing in depth qualitative insights and spatial data through participatory GIS mapping. This approach, referred to as an open GIS analysis (Wikström et al. 2024), aimed to gather and visualize local knowledge in an inclusive and transparent manner.

Participants were selected through a targeted approach, focusing on stakeholders such as municipality employees, tourism representatives and local fishing organizations. With assistance from the municipality, individuals were contacted and invited to participate. Due to time constraints, two interviews were conducted.

ArcGIS Pro and ArcGIS online were used to map and visualize the spatial distribution of cultural ecosystem services and impact factors. Two map layers were prepared in advance, one for cultural ecosystem services and one for impact factors. Each layer had its own attribute list, with predefined categories, subcategories, keywords and free-text fields. This was prepared in advance to ensure efficient data collection during the interview by allowing participants to efficiently mark points and enter attributes directly in the map. The lists were inspired by the CICES framework and a previous open GIS study on Sweden's west coast (Wikström et al. 2024) as well as survey responses regarding perceived changes and suggestions for improvements.

### 2.2.1 GIS Mapping Structure

The interviews were semi-structured focusing on water-related environments in Älvkarleby such as Dalälven and coastal areas. Participants were first introduced to the study objectives and provided with an explanation of cultural ecosystem services. This was followed by a technical demonstration of the GIS tools and map. During the interview, participants identified significant locations by identifying points directly in ArcGIS online. Corresponding attributes from predefined lists were selected. If their response did not match these predefined attributes, it was documented in the free-text field to capture their insight accurately.

The interview was designed to encourage participants to identify locations while sharing their experiences and thoughts about places, associated cultural ecosystem services and impact factors. To avoid influencing their responses, questions were open ended and designed to guide the conversation without directing it (Appendix 6). For example, instead of directly asking “Point out the most popular fishing spots”, participants were asked “Are there places in or near water where you or others participate in leisure activities?” After the interview, any missing data or unclear responses were reviewed using recordings and notes or clarified with participants to ensure data accuracy and completeness.

### 2.2.2 Interview Data Collection

Data were collected in two separate GIS map layers: one for cultural ecosystem services and another for impact factors.



### **Cultural Ecosystem Services**

Participants identified the type of cultural ecosystem services, categorized according to CICES definitions into three main categories with subcategories. They assessed the status of these services classifying them as good, moderate or poor, based on their personal judgment and perception, to estimate the current functionality. Free-text descriptions were also recorded to capture the additional context and used when predefined categories were insufficient. The criteria for status assessments were defined as:

**Good:** The service functions well and fulfils its purposes.

**Moderate:** The service functions partially but faces some problems.

**Poor:** The service is not functioning as it should or has major shortcomings.

### **Impact Factors**

Participants identified areas affected by human activity or natural disturbances, categorizing impact type using keywords and themes such as biological threats, infrastructure and habitat changes. They evaluated the level of impact as high, moderate and low, based on how strongly the areas were perceived to be affected. Free-text descriptions were used to document conflicts between different usages such as fishing and tourism, as well as to contextual details beyond the predefined categories, providing deeper insight into perspectives and concerns. The Impact levels were defined as:

**High:** Tangible and visible impact that greatly effects the area.

**Moderate:** Noticeable impact that is not overwhelming.

**Low:** Minimal impact with little noticeable effect.

### **2.2.3 GIS Analysis**

The analysis included visual inspection of spatial patterns, focusing on areas where cultural ecosystem services with poor status overlapped with high-impact factors. This helped identify critical areas for potential management attention. The results were summarized through map visualizations and frequency tables that are presented in the results section. Attribute data can be found in Appendix 7.

## **2.3 Ethical Considerations**

The interview participants signed a consent form, informing them about the study and data handling. Survey responses were anonymized to protect privacy, and personal data handling followed the guidelines provided by SLU and relevant regulations.

## 3. Results

### 3.1 Survey Results

#### 3.1.1 Description of Survey Respondents

There was a total of 99 participants in the survey, however, one participant's age was missing. Therefore, these responses were removed, resulting in a total of 98 participants. The age distribution ranged from 15 to 80, with an average age of 53. Nearly half (48%) of the participants were between 41-60 years old. Regarding gender, 84% of the participants were male, and 16% were female. Of the 98 participants, 52% indicated that they do not live in Älvkarleby municipality, while 48% reported residing there. This distribution highlights a nearly equal representation of perspectives from both local residents and those living outside Älvkarleby. The majority of the survey participants were employed (60%), followed by retirees (19%), self-employed individuals (14%), students (3%) and unemployed (2%), with 2% of the participants specifying their employment status as 'Other'.

Approximately 29% of all the respondents reported that they fish every week, while 26% fished every month. Additionally, 31% of the respondents fish a few times per year, 8% fish rarely and 6% never fish. Among the 92 participants that do fish, the majority (68%) identified as sport fishers, indicating a strong emphasis on sportfishing in the area. Another notable group included those who engage in recreational fishing, accounting for 28% of the participants. Small-scale coastal fishing was reported by only 4% of the participants.

#### 3.1.2 Cultural Significance and Perceptions of Fishing and Fishing Areas

24% of the respondents had attended some type of fishing-related educational activities such as courses or lectures in Älvkarleby municipality. Examples of these included restoration projects and fly-fishing courses. Participation in fishing-related education varied significantly by residence, with local residents being more likely to engage in such activities compared to non-locals ( $P < 0.001$ ). Frequent fishers placed greater emphasis on teaching others about sustainable fishing compared to occasional fishers ( $p = 0.0029$ ). Overall, 96% of the respondents found it important or very important to teach others, such as children, youth and tourists, about sustainable fishing practices.

Fishing and fishing areas were regarded as culturally and economically valuable. The majority (94%) agreed or strongly agreed that fishing and fishing areas were important for the municipality's cultural heritage, and 91% believed that fishing is

important or very important for the local economy in the municipality. The importance of sustainable fishing practices was also emphasized, with older respondents (61-80) highlighting it more strongly than younger groups ( $p = 0.005$ ). In total, 97% found it important or very important to fish sustainably.

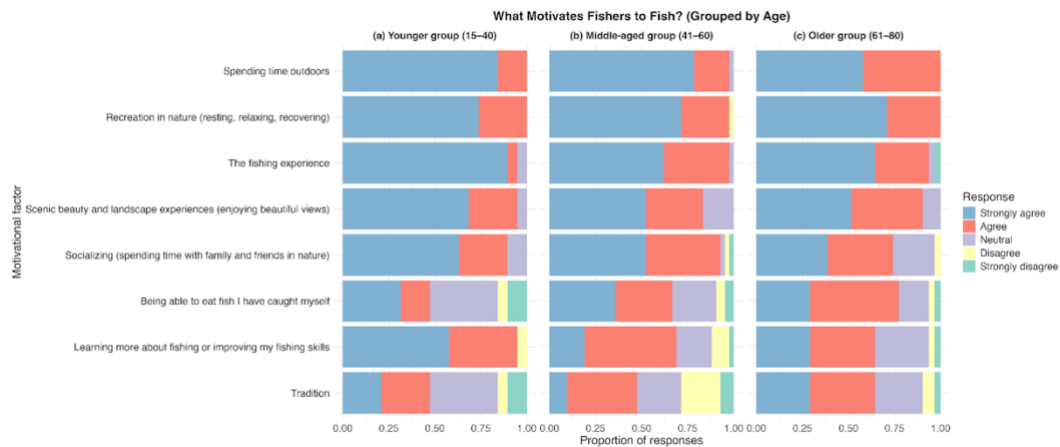
Participants also shared their presumptions and preferences related to fishing and fishing areas. About 74% felt that fishing and fishing areas in the municipality contributed to their personal cultural identity, and 92% stated that fishing and fishing areas in the municipality contributed to their sense of well-being or happiness. Middle-aged respondents (41-60) were more likely to agree that fishing areas enhance their happiness compared to younger (15-40) or older (61-80) groups. Additionally, 73% found fishing areas in the municipality aesthetically pleasing (beautiful).

Fishing traditions were widely recognized, with 81% identifying traditions tied to fishing, fish species or fishing areas in the municipality such as events like the day of the falls (in Swedish 'Fallens dag'), the salmon trophy (in Swedish 'Laxtrofén') and traditional fishing of lamprey (*Petromyzon marinas*) and salmon. 94% of respondents believed that fishing and fishing areas would remain culturally and economically important or very important in the future.

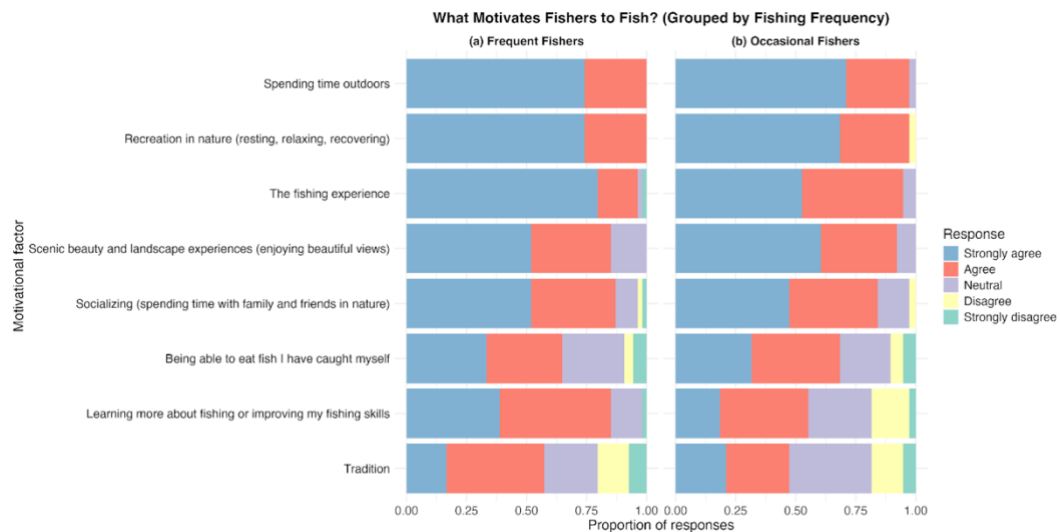
### 3.1.3 Analysis of Different Stakeholder Perspectives on Fishing

#### *Motivations for Fishing*

Spending time outdoors and recreational activities (e.g. to rest, relax, recover) in nature were the strongest motivations for fishing, highlighting the value of fishing as a relaxing outdoor activity (Appendix 8). The fishing experience and natural beauty and landscape experience (e.g. enjoy beautiful views) were also highly valued, emphasizing the aesthetic and experiential appeal of fishing. Other motivations such as learning fishing skills were more important to young adults (15-40) (Fig. 2) than middle-aged or older groups ( $p=0.034$ ). Additionally, frequent fishers reported a higher emphasis on skill development (Fig. 3) and the fishing experience compared to occasional fishers ( $p=0.003$  and  $p=0.009$ , respectively), indicating that programs emphasizing education and skill development could be effective in engaging younger and more frequent fishers. Fishing as a tradition was the least important motivation across age and fishing frequency groups.



**Figure 2:** What motivates fisher to fish? (grouped by age).  
 Stacked bar chart illustrating responses to the question ‘What motivates you to fish?’. Each chart shows the proportion of responses across different motivational factors, categorized by response type (strongly agree to strongly disagree). Subplots compare responses between (a) younger group (15-40), (b) middle-age group (41-60), and (c) older group (61-80). Non-fishers are excluded (N=92).

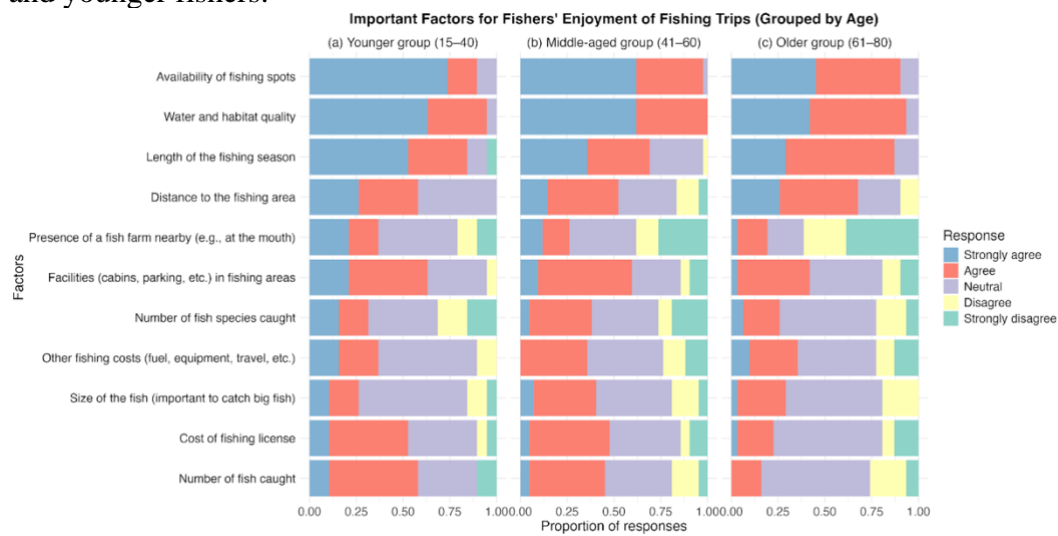


**Figure 3:** What motivates fisher to fish? (grouped by fishing frequency).  
 Stacked bar chart illustrating the responses to the question ‘What motivates you to fish?’. Each chart displays the proportion of responses across different motivational factors, categorized by response type (strongly agree to strongly disagree). Subplots compare responses between (a) frequent fishers and (b) occasional fishers. Non-fishers are excluded (N=92).

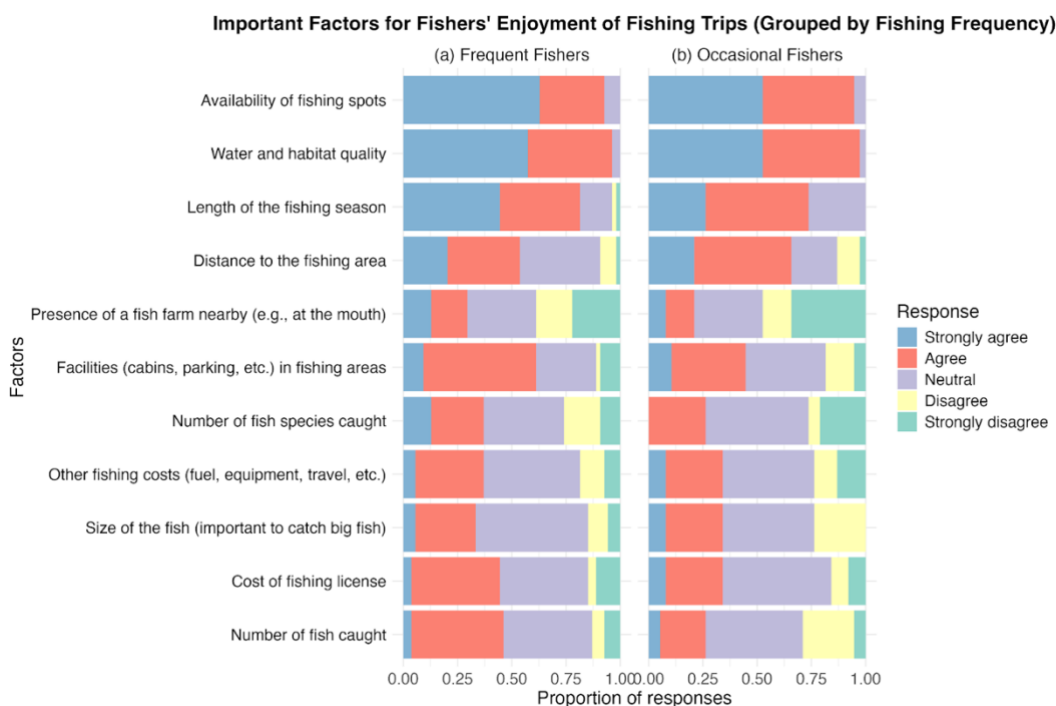
### *Factors for a positive fishing experience*

Water and habitat quality as well as access to fishing spots were identified as the most critical factors for a positive fishing experience, with 90% and 87% of agreement among responders (Appendix 9). This highlights the importance of environmental conditions and the availability of accessible fishing areas for fishers. In contrast, 40% of responses did not agree that the presence of fish farms nearby contributed to a positive fishing experience.

Cost of fishing permits and number of caught species had a mixed effect on fishing experiences, with many respondents expressing neutral opinions. Overall, environmental quality, accessibility and supporting facilities such as cabins, parking spaces, etc. were prioritized as key factors for a positive fishing experience. Younger (age 15-40) respondents placed higher importance on the number of caught fish (Fig. 4) ( $p=0.035$ ), while frequent fishers valued both the number ( $p=0.048$ ) and diversity of fish species ( $p=0.032$ ) more than occasional fishers (Fig. 5). These findings suggest that maintaining healthy fish stocks and diverse fishing environments is critical to meeting the expectations of frequent and younger fishers.



**Figure 4:** *Important factors for fishers' enjoyment of fishing trips (grouped by age).* Stacked bar chart illustrating the responses "What factors do you think are important for making a fishing trip a positive experience?". Each chart displays the proportion of responses across different factors, categorized by response type (strongly agree to strongly disagree). Subplots compare responses between (a) younger group (15-40), (b) middle-age group (41-60), and (c) older group (61-80). Non-fishers are excluded ( $N=92$ ).



**Figure 5:** Important factors for fishers' enjoyment of fishing trips (grouped by fishing frequency).

Stacked bar chart illustrating the responses "What factors do you think are important for making a fishing trip a positive experience?". Each chart displays the proportion of responses across different factors, categorized by response type (strongly agree to strongly disagree). Subplots compare responses between (a) frequent fishers and (b) occasional fishers. Non-fishers are excluded (N=92).

### 3.1.4 Analysis of Different Stakeholder Perspectives on Fishing Areas

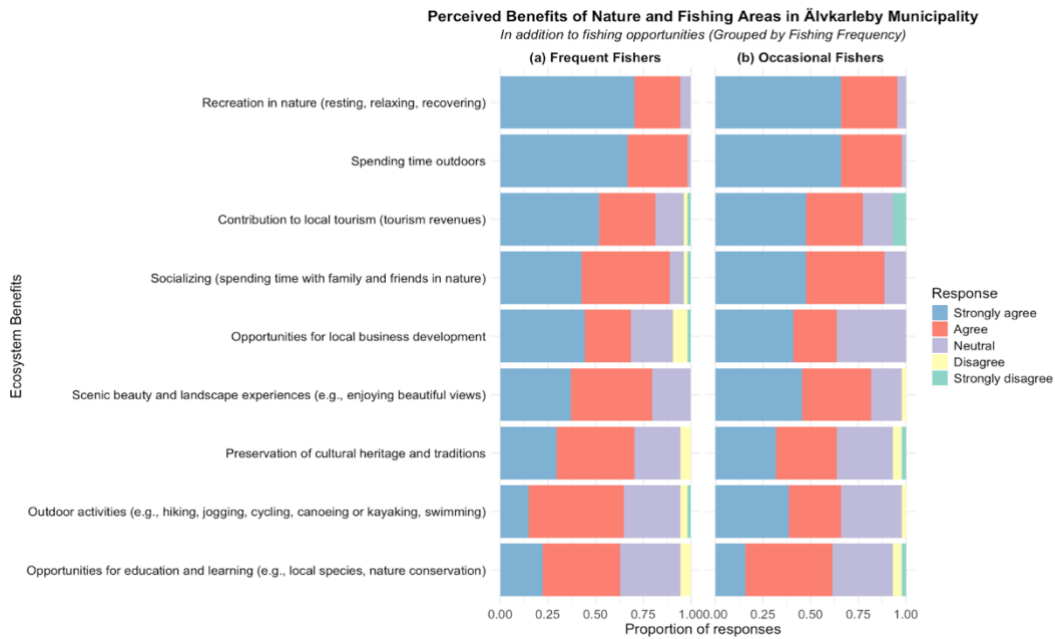
#### *Perceived Benefits of Natural Areas*

Recreation with the purpose of rest, relaxation or recovery in nature and spending time outdoors were the most important advantages or experiences in nature areas and fishing areas (in addition to fishing) in Älvkarleby municipality (Appendix 10). The perceived benefits of nature differed between residents/non-residents, age groups and frequency of fishing groups. Local respondents prioritized opportunities for local business development (Fig. 6) more than non-locals ( $p=0.0145$ ), with middle-aged (41-60) individuals placing the highest value on business opportunities ( $p=0.0263$ ). Local respondents also valued social interaction with family and friends significantly more than non-locals ( $p=0.0018$ ), suggesting that community-oriented initiatives promoting outdoor social activities could enhance local participation and well-being. Frequent fishers valued outdoor recreational activities such as hiking and swimming more than occasional fishers

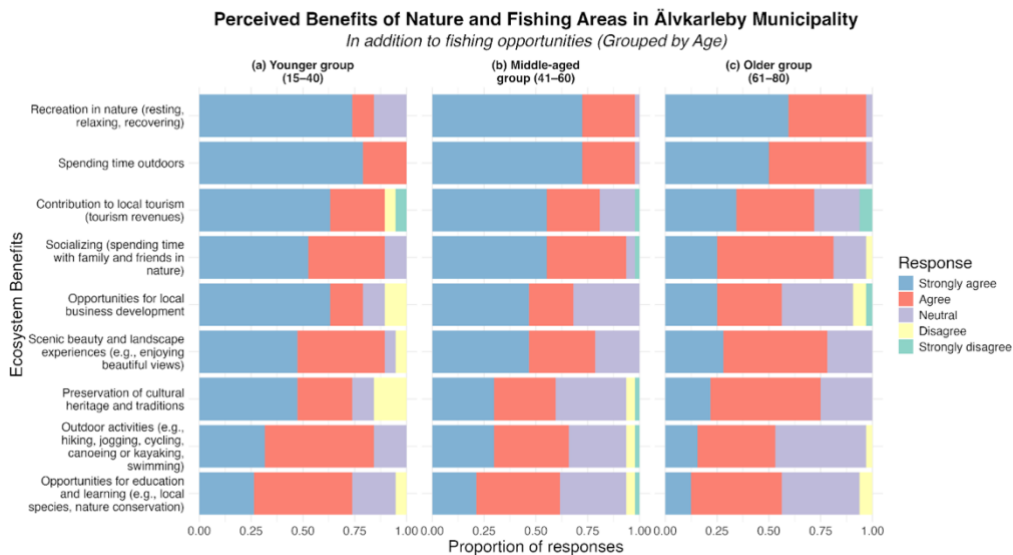
( $p=0.0267$ ) (Fig. 7), highlighting the importance of investing in recreational infrastructure to sustain their engagement. Additionally, older respondents (61-80) valued cultural heritage preservation more than younger groups ( $p=0.0371$ ) (Fig. 8), underscoring the need for policies that focus on maintaining cultural continuity through initiatives linked to natural environments.



**Figure 6:** Perceived benefit of nature and fishing areas (grouped by residence). Stacked bar chart illustrating the responses ‘‘What do you think are the most important advantages or experiences that nature areas and fishing areas in Älvkarleby municipality offer, in addition to the opportunity to fish?’’. Each chart displays the proportion of responses across different factors, categorized by response type (strongly agree to strongly disagree). Subplots compare responses (a) locals and (b) non-locals. All respondents ( $N=98$ ).



**Figure 7:** Perceived benefit of nature and fishing areas (grouped by fishing frequency). Stacked bar chart illustrating the responses ‘‘What do you think are the most important advantages or experiences that nature areas and fishing areas in Älvkarleby municipality offer, in addition to the opportunity to fish?’’. Each chart displays the proportion of responses across different factors, categorized by response type (strongly agree to strongly disagree). Subplots compare responses (a) frequent fishers and (b) occasional fishers. All respondents (N=98).



**Figure 8:** Perceived benefits of nature and fishing areas (grouped by age). Stacked bar chart illustrating the responses ‘‘What do you think are the most important advantages or experiences that nature areas and fishing areas in Älvkarleby municipality



offer, in addition to the opportunity to fish?'. Each chart displays the proportion of responses across different factors, categorized by response type (strongly agree to strongly disagree). Subplots compare younger group (15-40), (b) middle-age group (41-60), and (c) older group (61-80). All respondents (N=98).

### *Perceived Changes in Fishing Areas*

Out of the 98 respondents, the majority of respondents (83%) reported significant changes in the fishing area, particularly concerning water quality, fish stocks and fish species. A smaller proportion (3%) observed minor changes, while very few respondents (1%) stated that no changes had occurred. However, a notable number (13%) were uncertain, indicating gaps in awareness or information regarding the state of the fishing environment in Älvkarleby municipality. No significant differences concerning perceived changes in fishing areas were found across groups.

The analysis of open-text responses from 63 respondents provided insights into their perceptions of observed changes in fishing areas in Älvkarleby municipality. Common themes included concerns about declining fish populations, particularly trout and salmon, with many respondents highlighting the impact of predation by cormorants and grey seals (*Halichoerus grypus*). A significant number of respondents (59%) mentioned salmon or trout, with 60% referring to general fishing issues. Many noted worsening fishing conditions over the past 15-30 years, with a noticeable decline in fish numbers and a reduction in fish sizes. In addition to predation, some respondents also mentioned overfishing and changes in water flow as contributing factors to the decline in fish populations. As detailed in Table 1, 17% of responses highlighted predation as a key factor in the declining of fish stocks.

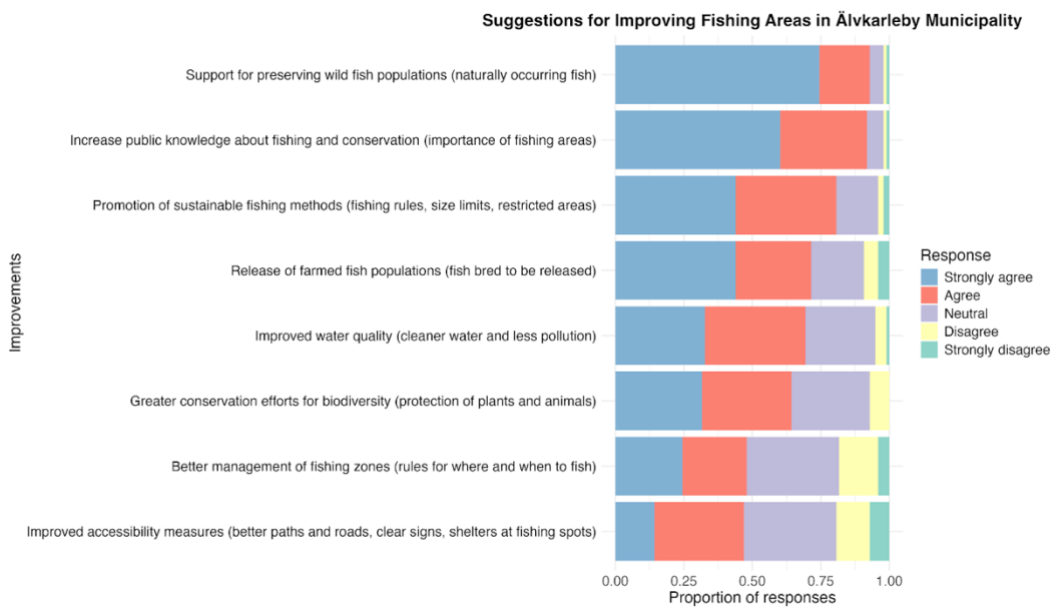
**Table 1:** Perceived changes in fishing areas, categorized by frequently mentioned words by 63 respondents.

| <b>Category</b>          | <b>Identified Words</b>        | <b>Total Count</b> | <b>Percentage</b> |
|--------------------------|--------------------------------|--------------------|-------------------|
| General Fish and Fishing | fish, fishes, fishing          | 38                 | 60%               |
| Trout and Salmon         | trout, sea trout, salmon       | 37                 | 59%               |
| Pike                     | pike, the pike                 | 4                  | 6%                |
| Other Fish Species       | herring, eel, lamprey          | 4                  | 6%                |
| Predation                | cormorant, the cormorant, seal | 11                 | 17%               |
| Decline                  | decreased, fewer, poor         | 37                 | 59%               |
| Temporal Context         | year, years, ago               | 15                 | 24%               |

A word cloud visualization of the most frequently mentioned words (trout, decreased, cormorant) highlights the key ecological concerns and the connection between fish decline and predator impacts (Appendix 11).

### 3.1.5 Suggestions for Improvement of Fishing Areas

Improving conservation of wild fish populations (naturally occurring fish) was the most strongly supported measure to improve fishing areas in Älvkarleby municipality, with the majority of respondents and all groups agreeing that conservation of natural fish populations is critical for sustainable fishing and the ecosystem (Fig. 9). Increasing public knowledge about fishing and conservation (the importance of fishing grounds) was also highly prioritized. Respondents emphasized the importance of ecological initiatives to raise awareness about sustainable fishing practices and the value of preserving fishing environments. Improving accessibility measures such as better paths and roads, clear signs, and shelters at fishing sites was considered less important compared to ecological and educational improvements.



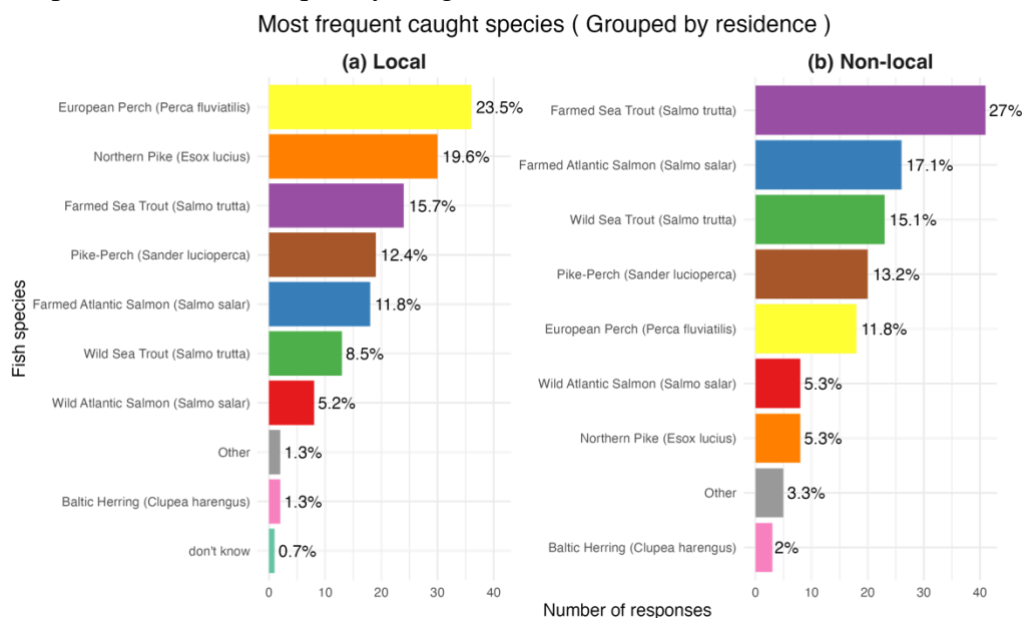
**Figure 9:** Suggestions for improving fishing areas in Älvkarleby municipality.

Stacked bar chart illustrating the responses ‘‘What do you think can improve the fishing areas in Älvkarleby municipality?’’. Each chart displays the proportion of responses across different factors, categorized by response type (strongly agree to strongly disagree). All respondents (N=98).

### 3.1.6 Farmed and Wild Fish Perceptions

#### *Most Frequently Caught species*

The most frequently caught fish species in Älvkarleby municipality were farmed trout (21%) and perch (*Perca fluviatilis*) (18%), followed by farmed salmon (14%). Wild salmon (5%) and herring (*Clupea harengus*) (2%) were caught less commonly. Less than 1% of respondents did not know which species they caught, indicating respondents are generally educated about and confident about the species they catch. Local fishers most often caught perch and pike (*Esox lucius*) (Fig. 10) ( $p < 0.001$ ). Locals caught farmed species of trout and salmon less frequently than non-locals. Non-local fishers most commonly caught farmed trout and farmed salmon. They also caught wild trout more often than locals, while pike and perch were less frequently caught.

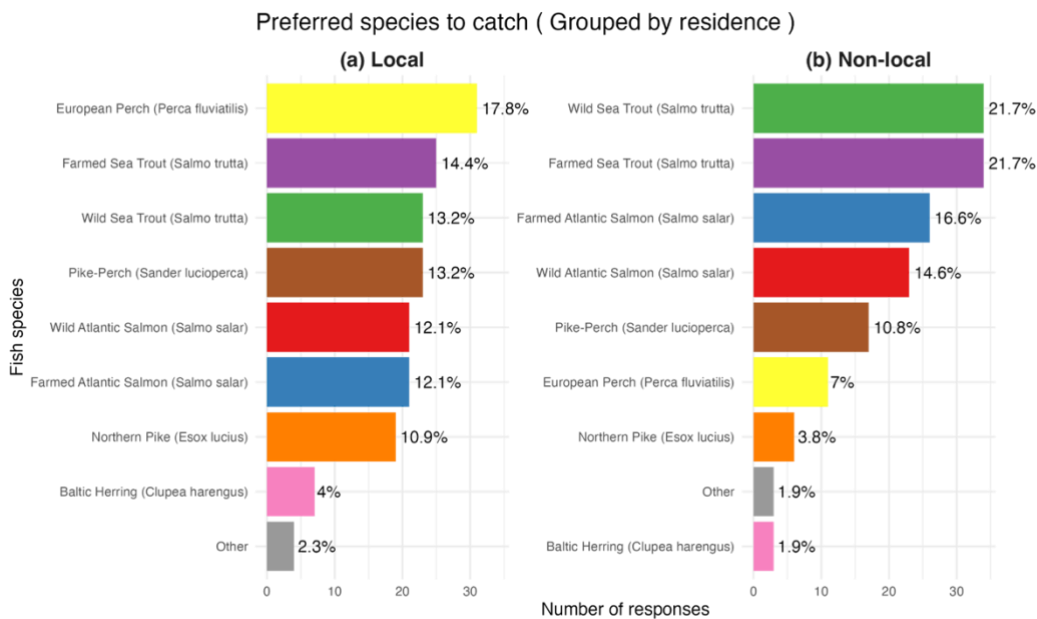


**Figure 10:** Most frequent caught species (grouped by residence).

Two plots comparing the most frequently caught fish species by (a) local and (b) non-local fishers. Non-fishers are excluded ( $N=92$ ).

#### *Preferred species*

The preferred species to catch were farmed trout (18%) and wild trout (17%), followed by farmed salmon (14%) and wild salmon (13%), indicating a high interest in trout and salmon fishing in Älvkarleby municipality. Herring (3%) and pike (8%) was least preferred. There were differences among local and non-local fishers, with local fishers preferring perch and farmed trout ( $p=0.0028$ ) (Fig. 11). While local fishers reported catching pike more frequently, they preferred to catching fewer pike than they currently do. Non-local fishers had a strong preference for farmed trout and wild trout.



**Figure 11:** Preferred species to catch (grouped by residence).

Two plots comparing the most preferred fish species to catch by (a) local and (b) non-local fishers. Non-fishers are excluded (N=92).

### Importance of Farmed and Wild Fish

The majority of the respondents (87%) rated wild fish as very important or important. Farmed fish were perceived as slightly less important than wild fish. Still, 78% of respondents considered farmed fish to be important or very important, reflecting their widespread recognition and connection to ecological and cultural values in Älvkarleby municipality. Frequent fishers considered farmed fish as more important ( $p=0.0073$ ) than occasional fishers.

## 3.2 GIS-analysis Results

The GIS mapping identified 54 cultural ecosystem service locations and 24 impact factor locations, focusing on water-related environments such as the river Dalälven and coastal areas within Älvkarleby municipality.

The cultural ecosystem services locations were categorized into three main categories, as shown in figure 12. The most frequently identified category was physical and experience-based interactions with nature (Table 2), reflecting activities such as tourism attractions, fishing spots and the appreciation for scenic landscapes. The second most common category was spiritual, symbolic, and other cultural interactions with nature (Table 2), which included traditional fishing areas and species or locations valued for their ties to cultural identity. The least represented category was intellectual and representative interactions with nature

(Table 2), representing research stations and natural areas that inspired cultural expression and art.

**Table 2:** *Different types of cultural ecosystem services identified.*

| <b>Type of Cultural ecosystem service</b>                        | <b>Number of points</b> | <b>Percentage</b> |
|--|-------------------------|-------------------|
| Physical and experiential interactions with nature               | 29                      | 54%               |
| Intellectual and representative interactions with nature         | 10                      | 18%               |
| Spiritual, symbolic, and other cultural interactions with nature | 15                      | 28%               |

Out of the 54 identified cultural ecosystem services, 33 locations were classified as having good status, while 8 were rated as moderate and 13 were rated as poor (Table 3). Several locations were associated with multiple categories of cultural ecosystem service, highlighting their multifunctional value. For example, some fishing spots were not only recreational areas but also held traditional and symbolic meaning (Fig. 12).

**Table 3:** *The status of cultural ecosystem services identified.*

| <b>Cultural ecosystem services status</b> | <b>Number of points</b> | <b>Percentage</b> |
|---|-------------------------|-------------------|
| Good status                               | 33                      | 61%               |
| Moderate status                           | 8                       | 15%               |
| Poor status                               | 13                      | 24%               |

The GIS mapping documented 24 locations representing impact factors affecting cultural ecosystem services, categorized by themes and severity of impact. Of these, 15 locations were classified as high impact, 8 points as moderate impact and only 1 was considered low impact (Table 4). The majority of high impact factors were concentrated in areas near hydropower infrastructure, tourism and fishing activities, and often overlapped with key cultural ecosystem service locations (Fig. 13). This was particularly the case in areas with poor or moderate ecosystem services status, such as dams and ecologically sensitive areas. This overlap highlights potential conflicts between conservation priorities and human activities, particularly where infrastructure or biological pressures negatively affect valued cultural services.

**Table 4:** *Impact factor levels identified.*

| <b>Impact factor level</b> | <b>Number of points</b> | <b>Percentage</b> |
|----------------------------|-------------------------|-------------------|
| High impact level          | 15                      | 62%               |
| Moderate impact level      | 8                       | 33%               |
| Low impact level           | 1                       | 4%                |

The two most frequently identified impact factors were *biological threats and invasive species* and *ecosystem and habitat changes* (Table 5), each separately accounting for 29% of all impact factors. *Biological threats and invasive species*

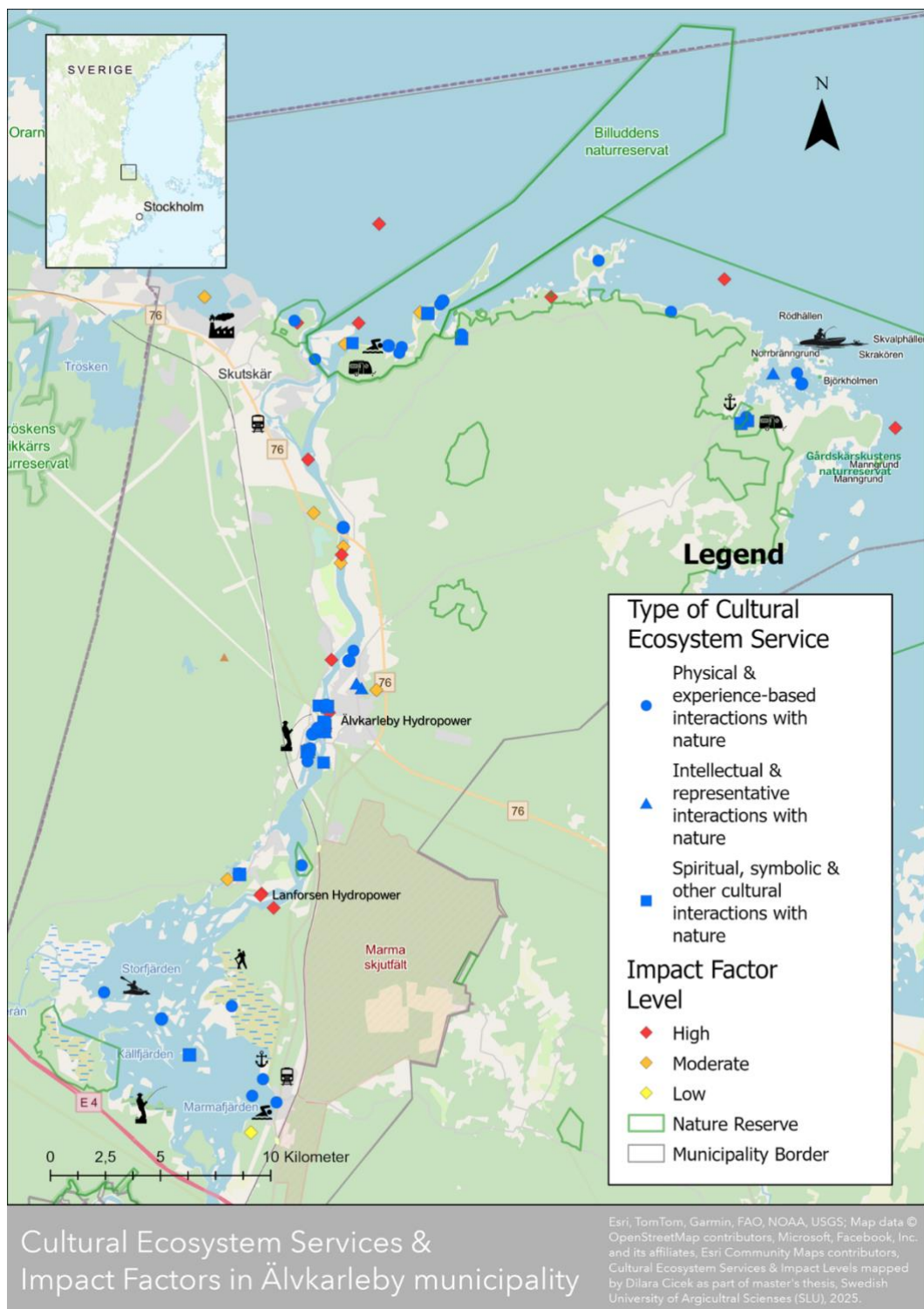
were primarily linked to cormorants, seals and herons, which prey on smolt. These pressures were noted in multiple locations, particularly near important fishing areas. Several high impact locations in Figure 13 align with areas where these predators are prevalent, reflecting concerns about their influence on both recreational and traditional fishing.

**Table 5:** *Type of Impact factor identified.*

| <b>Type of impact factor</b>             | <b>Number of points</b> | <b>Percentage</b> |
|--|-------------------------|-------------------|
| Biological threats and invasive species  | 7                       | 29%               |
| Ecosystem and habitat changes            | 7                       | 29%               |
| Infrastructure and human impact          | 5                       | 21%               |
| Climate impact and environmental changes | 2                       | 8%                |
| Fisheries-related impact                 | 1                       | 4%                |
| Water quality and pollution              | 1                       | 4%                |
| Conflicts and disruptive activities      | 1                       | 4%                |

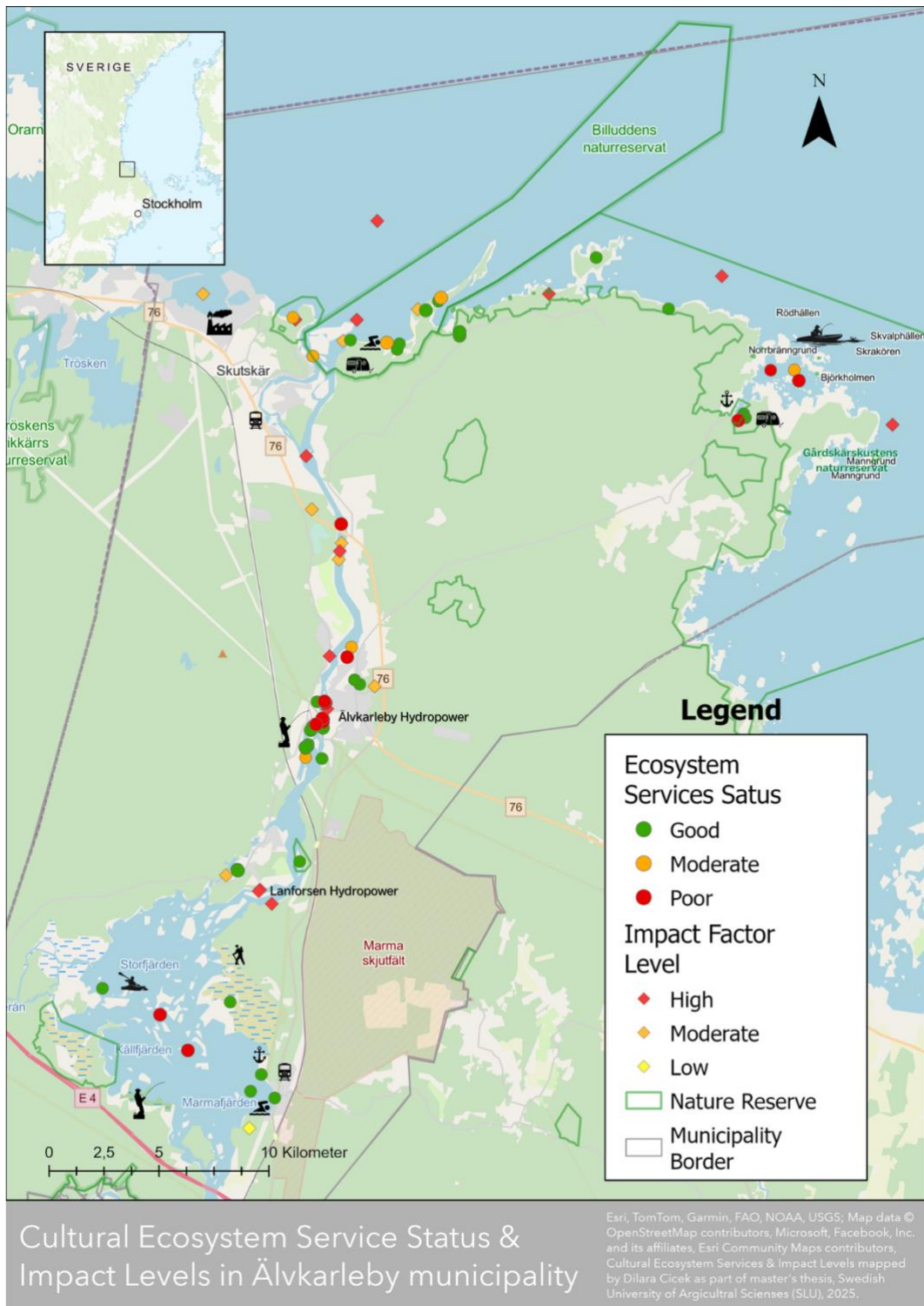
Equally significant were *Ecosystem and habitat changes* (Table 5), often related to hydropower operations and barriers to fish migration. Several identified locations highlighted migration barriers as critical issues affecting fish populations such as salmon and trout, with hydropower infrastructure altering water flow and limiting fish reproduction. These were major concerns for the sustainability of local fish populations, particularly in areas where natural fish migration is important for fish reproduction.

The third most common impact factor was *Infrastructure and human activities* (Table 5), which included water regulation, shoreline development and land use restrictions which were noted as affecting cultural ecosystem service and access to natural areas. In some cases, regulations in protected areas such as Gårdskärskust nature reserve, have been perceived as limiting local development and tourism opportunities, leading to conflicts between conservation goals and economic interests. Additionally, water level management was highlighted as a factor affecting the ecological character of fishing and recreational sites in Dalälven. It was noted that regulation of water flows in Dalälven has resulted in a sterile environment downstream, hindering vegetation growth and impacting fish populations due to areas regularly becoming dry and stagnated. Respondents emphasized the importance of dynamic, flowing water for both aesthetic and ecological value, suggesting that water regulations diminished the natural potential of the area.



**Figure 12:** Map of cultural ecosystem service types and impact levels.

*Spatial distribution of different cultural ecosystem service types (e.g., physical, intellectual, spiritual interactions with nature) represented by distinct shapes. Impact levels (high, moderate, low) represented by different colors.*



**Figure 13:** Map of cultural ecosystem service status and impact levels.

Spatial distribution of ecosystem service status (good, moderate, poor) and impact levels (high, moderate, low) in Älvkarleby municipality, represented by different shapes and colors.



## 4. Discussion

This study aimed to explore cultural ecosystem services related to fishing and fishing areas in Älvkarleby municipality, especially from the perspectives of fishers. By gathering local knowledge through survey, participatory mapping and interviews, the study identifies key areas for conservation and recreation, while contributing to strategies that balance ecological sustainability, cultural heritage and the long-term economic viability of fishing tourism and fish populations.

### *Fishing and Fishing areas as Cultural Ecosystem Services*

This study confirms that fishing and fishing areas in Älvkarleby provide significant cultural ecosystem services. Reinforcing its importance to local identity, well-being, recreation, cultural heritage and local economy. Furthermore, traditional events such as “The day of the falls” and “The salmon trophy” reinforce the cultural importance of fishing in the region. These findings align with previous research highlighting the role of fishing in identity, well-being and community cohesion (Romanazzi et al. 2023; Vave et al. 2024).

### *Stakeholder Perspectives on Fishing and Cultural Ecosystem Services*

Survey results indicate that different stakeholder groups value fishing and fishing areas in distinct ways, shaped by their background, experience and motivations. While differences between groups were expected, the results suggest that many of these values overlap across stakeholders, indicating shared priorities in both recreational and conservation aspects of fishing.

### *The Importance of Recreation*

Contrary to expectations, non-locals and occasional fishers did not emphasize recreation more than locals and frequent fishers. Instead, all groups highlighted spending time outdoors and recreation as primary motivations for fishing. This suggests that fishing is not just about catching fish but is deeply connected to nature and relaxation. When asked what makes a fishing trip enjoyable, all respondents emphasized access to fishing spots and the quality of water and habitat, underscoring the importance of maintaining good habitat conditions and ensuring accessibility to support fishers. These findings align with previous studies showing that time spent outdoors, recreation and the fishing experience itself are central to recreational fishing motivations (Wikström et al 2024; Liu et al. 2019).

Beyond fishing itself, respondents valued natural areas in Älvkarleby for recreation and spending time outdoors, reinforcing that these environments provide more than just fishing opportunities. This is consistent with research

showing how fishing regions often serve as multi-purpose spaces, benefiting both fishers and non-fishers through cultural and psychological connections to nature (Liu et al. 2019). Since recreational benefits are valued across all groups, management strategies should focus on maintaining the natural landscape and ensuring accessibility.

#### *Local Business Development and Cultural Preservation*

Contrary to expectations, locals did not prioritize cultural heritage more than non-locals. Rather, locals emphasized the importance of local business development and social interactions. Similarly, middle-aged (age 41-60) respondents also placed greater emphasis on opportunities for local business development. However, as expected, older respondents (61-80) placed greater importance on cultural heritage preservation.

These findings align with previous research indicating that socio-economic factors influence how communities interact with ecosystem services (Ignatius & Haapasaari 2018). This suggests that conservation and ecosystem service management should incorporate economic initiatives, such as promoting sustainable fishing tourism, guided fishing experience and local fishing events. By integrating social and economic benefits, these initiatives enhance participation, promote social interactions and well-being.

#### *Skill development*

Younger fishers were expected to prioritize the costs associated with fishing, but the hypothesis was not supported. Instead, younger participants and frequent fishers placed greater importance on skill development, reinforcing that fishing is an activity that requires learning and practice. A previous study similarly found that fishing skills and experience are highly valued among recreational fishers (Liu et al. 2019).

Furthermore, younger respondents also placed greater importance on the number of fish caught and frequent fishers valued both the quantity and diversity of fish species. Since younger and frequent fishers focus on skill development, they are more invested in catching a variety of fish and improving their fishing technique. This suggests that educational initiatives tailored to youth, experienced and new fishers could help sustain long-term engagement while promoting conservation ethics.

#### *Environmental Changes and Conservation awareness*

Another key hypothesis was that frequent fishers would prioritize conservation and notice ecological changes more than occasional fishers. However, the findings did not support this assumption. Instead, 83% of all respondents reported

significant environmental changes, with no difference between groups. The most mentioned change included declining salmon and trout populations over time, both in numbers and size and increased predation by cormorants. A few respondents also mentioned overfishing and changes in water flow as contributing factors to the decline in fish populations. These findings reinforce the need for conservation efforts to address shared ecological concerns. This shared priority aligns with a previous study which highlighted strong conservation values among fishers (Liu et al. 2019). The findings were also consistent with findings that bird predation on smolt is a major ecological pressure in Dalälven. (Säterberg et al. 2023).

Interestingly, 13% of respondents were unsure whether changes had occurred, indicating potential gaps in awareness or access to environmental information. This highlights the importance of engaging the public through for example citizen science activities, where fishers could contribute to data collections and environmental monitoring. Furthermore, a majority of respondents expressed that teaching others about sustainable fishing practices including children, youth and tourists was important. When asked if they think fishing sustainably is important, 97% of respondents agreed, further highlighting the need to integrate conservation education into fishing related activities. Workshops and informational campaigns could serve as effective approaches to embedding sustainable practices within the community.

#### *Suggestions for Improvements*

When asked about potential improvements for fishing areas in Älvkarleby, the most strongly supported measure across all groups was conserving wild fish populations. To maintain healthy fish stocks policies, aim to enhance habitat restoration efforts, such as ensuring free migration pathways. Additionally, respondents emphasized the importance of public education on fishing and conservation and promoting sustainable fishing practices. Reinforcing the need for ecological initiatives and raising awareness, these findings align with earlier results, emphasizing that sustainable management should incorporate both conservation and education initiatives.

#### *Species Caught and Preferences*

Locals primarily caught wild perch and pike, while non-locals caught more farmed trout and farmed salmon. These patterns indicate different fishing behaviours and possibly different fishing locations, locals might have a broader fishing area (possibly using boats along the coast or in inland waters), while visitors are drawn to well-known stocked fishing locations like Dalälven. When asked about their preferred species, non-locals favoured trout, reinforcing the

importance of this species. Interestingly, locals caught pike frequently but valued it less, while perch and trout were more preferred. This mismatch suggests that locals may see pike as abundant but less desirable, whereas they place more value on species like perch and trout. These patterns align with previous research showing that species preference is influenced by both cultural traditions and tourism demand (Liu et al. 2019). Trout and salmon being central to Älvkarleby fishing heritage, remain a key species for visitors, while locals engage in more diverse fishing practices.

#### *Farmed and Wild fish perceptions*

Respondents perceive both farmed and wild fish as important for fishing and fishing tourism in Älvkarleby. 87% of respondents rated wild fish as important, while farmed fish were slightly less valued, but still seen as important by 78%. Although the survey did not directly measure whether wild fish is more important for conservation and cultural heritage, the strong support for wild fish conservation as an improvement measure suggests that wild populations are viewed as ecologically significant. Meanwhile, the recognition of farmed fish as important for fishing tourism reinforces their role in sustaining fishing activities.

Management strategies should balance these needs including conservation efforts to protect wild salmon and trout populations, while maintaining sustainable fish stocking practices to support fishing tourism (Florin et al. 2024). Similarly, maintaining healthy pike and perch populations is important for supporting local fishers who depend on these accessible coastal species. These challenges reflect interconnected roles of cultural ecosystem services, conservation and fishing tourism, which requires a balanced approach in fisheries management (Lähde et al. 2024; Pinheiro et al. 2021).

#### *Interview and Mapping Insights*

GIS mapping pinpointed key areas where cultural and ecological pressures overlap, offering valuable insights for conservation and recreational planning. Several high impact factors were concentrated in areas with poor or moderate ecosystem service status (Fig. 12). Especially near hydroelectric dams, indicating targeted management actions are necessary to restore ecosystem health while balancing recreational and economic use. The ability to identify these overlaps will allow for better prioritization of restoration efforts.

One example is Gårdskärskusten nature reserve, established in 2023. While it aims to conserve biodiversity and natural habitats, interviews revealed concerns that coastal restrictions could limit local business opportunities. The decision to form the nature reserve has also been contested (Länsstyrelsen Uppsala län 2025).

However, the GIS mapping identified multiple cultural ecosystem service locations within the reserve, such as Gårdskärs Fiskehamn, an area valued for recreation, cultural heritage and local identity. Survey responses also emphasized that rest, recreation and spending time outdoors are among the most valued activities in Älvkarleby natural areas. These findings suggest that Gårdskärskusten has strong potential to serve as a hub for sustainable recreation and ecotourism. Particularly if conservation and recreational development efforts are carefully balanced.

Similarly, the southern part of Älvkarleby, including Marmafjärden and Storfjärden (Fig. 12) has strong tourism potential, with minimal ecological impact. The area supports well-functioning cultural ecosystem services, including a small marina, canoe trails, a swimming area and the Upplandsleden hiking trail. With easy train access, the area is well positioned for ecotourism and sportfishing. Despite these assets, interviews indicated untapped potential for branding pike and pike-perch fishing, which could attract international visitors while strengthening local identity.

Despite the area's low ecological impact, GIS mapping identified two major impact factors that threaten ecosystem sustainability in the broader region. The first is predation by cormorants, which reduces smolt survival rates during migration (Säterberg et al. 2023). Without measures to protect smolt, continued decline could threaten the fish populations and sustainability of fishing tourism. Rather than focusing on solely predator control, several non-lethal strategies can improve smolt survival, such as releasing smolt at night to reduce predation risk and enhancing smolt fitness before release through optimize feeding regimes (Larsson et al. 2024). Secondly, migration barriers prevent natural reproduction of salmon and trout, further stressing wild fish stocks. Restoring migration pathways is essential for supporting wild fish populations and preserving fishing related cultural ecosystem services. Without intervention, fish population decline could accelerate and cause a cascading effect on the food web and ecosystem (Florin et al. 2024).

GIS mapping highlights key areas where conservation and tourism efforts must be integrated, guiding decision making into targeted restoration, habitat protection and sustainable recreational development. By visualizing spatial patterns of ecological pressures and cultural ecosystem services, mapping enables planners to prioritize conservation actions while enhancing ecotourism opportunities. Protecting wild fish populations, mitigating ecological pressures and improving recreational infrastructure based on the mapping insights will strengthen Älvkarleby long term viability as a sportfishing and ecotourism hub.

### *Limitations of this Study*

This survey faced several limitations. First, the survey had low representation of young people and women, limiting the diversity of perspectives. Additionally, because the survey focused on fishing and fishing areas, responses were likely skewed toward sportfishing interests, reducing input from non-fishers. Despite these challenges, the survey achieved strong engagement with 99 responses (including one removed response) collected over three weeks. However, the low representation of non-fishers (6%) limits the ability to generalize findings to the broader community. Nonetheless, this study provides valuable insights into the perspectives of sport fishers and recreational fishers, who accounted for 94% of the respondents. Further research should target non-fishers, younger audiences and women to help capture a wider range of cultural and recreational values. While women are generally underrepresented in fishing compared to men, some sportfishing organizations cater to female anglers suggesting potential avenues for outreach.

Time constraints limited the stakeholder interviews to two, restricting insights from local experts. Future research could benefit from more interviews and use of online participatory mapping methods in surveys to collect spatial data from a broader audience. Expanding the scope of GIS analysis to cover a wider range of natural areas could also provide a more comprehensive understanding of cultural ecosystem services in the region.

## 4.1 Recommendations and Conclusions

Based on survey results, maps and stakeholder insights, the following recommendations are proposed:

- **Develop educational programs** to encourage and promote skill development and sustainable fishing practices, particularly for younger and frequent fishers.
- **Support local business initiatives** by integrating cultural ecosystem services into sustainable economic strategies, aligning with the priorities of locals and middle-aged respondents.
- **Restore migration pathways** to enhance the natural reproduction of key fish species.
- **Reduce smolt mortality** from predators by implementing non-lethal protection measures, such as nighttime releases and optimizing smolt fitness before release.
- **Promote low-impact fishing and recreation** zones to provide recreational opportunities and ensure sustainable resource use.
- **Enhance participatory decision-making** by actively involving stakeholders in fisheries management, fostering shared responsibility and long-term sustainability.

By implementing these strategies, Älvkarleby can strengthen its fishing heritage, ecological resilience, and economic opportunities, ensuring a sustainable future for both locals and visitors. Importantly, these findings align with Älvkarleby's vision for its fisheries strategy (Cooper 2025), which prioritizes sustainable fish stocks, stakeholder involvement, and economic development linked to recreational fishing. Furthermore, this study also highlights the value of participatory, bottom-up approaches in ecosystem-based fisheries management, demonstrating how collaborative strategies can address complex ecological and social challenges faced by fishing dependent communities. By actively involving stakeholders and integrating cultural ecosystem services into decision-making, Älvkarleby can serve as a model for balancing ecological sustainability with social and economic priorities.

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# Popular science summary

## **Fishing in Älvkarleby – A Tradition Under Pressure**

Fishing has long been an important part of Älvkarleby, shaping its cultural identity, economy, and traditions. Located where the Dalälven River meets the Baltic Sea, the area has been renowned for its thriving stocks of Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta*). However, these fish populations have declined significantly in recent decades, raising concerns about the future of Älvkarleby as a premier fishing destination.

This study explores how fishers and stakeholders perceive fishing in Älvkarleby and examines the challenges threatening its sustainability. By conducting a survey with 99 participants and mapping key fishing locations through stakeholder interviews, the study identifies important recreational areas, ecological pressures and potential solutions for sustaining both fish stocks and the fishing heritage of the region.

The results highlight widespread concerns over declining wild salmon and trout populations. Many fishers report lower catches, attributing this trend to increased predation from cormorants (*Phalacrocorax carbo*) and seals (*Halichoerus grypus*), which prey on juvenile fish, and hydroelectric barriers that obstruct migration routes, limiting natural reproduction. The Fisheries Research Station in Älvkarleby has attempted to mitigate these losses by releasing farmed salmon and trout smolt, but hatchery-reared fish have lower survival rates compared to wild populations, raising questions about the long-term effectiveness of stocking efforts.

Addressing these challenges requires a multi-faceted approach. Adaptive fisheries management strategies should balance conservation with fishing traditions, ensuring sustainable practices that protect wild fish populations. Improving fish migration pathways and restoring spawning areas are crucial steps toward rebuilding natural stocks. Engaging local stakeholders including fishers, scientists, and policymakers is also essential for developing effective, community-supported solutions. Public awareness and education programs can further promote responsible fishing practices and conservation efforts.

Fishing in Älvkarleby is more than just a pastime; it is deeply tied to the community's history, economy, and cultural identity. Without sustainable management, both the fish stocks and the traditions surrounding them risk being lost. This study underscores the importance of integrating local knowledge with ecological conservation to ensure the long-term viability of fishing in Älvkarleby. Finding a balance between ecological sustainability and fishing traditions is key to securing a future where both people and fish can thrive.

# Popular science summary in Swedish



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Läs mer om resultatdelen i min rapport – kontakta mig för mer information!

## En Rik Fiskehistoria

Älvkarleby är en av Sveriges mest kända fiskedestinationer, känt för lax (Salmo salar) och havsöring (Salmo trutta). Fisket har format regionens kultur, ekonomi och traditioner, och erbjuder inte bara mat utan även **rekreation och turism**. Men under de senaste decennierna har **fiskbestånden minskat kraftigt**.

Denna studie undersöker hur fiskare och intressenter **ser på fisket** och utforskar sätt att **bevara** både fiskpopulationer och Älvkarlebys fisketraditioner.

## Hur Genomfördes Studien?

För att förstå fiskarnas och intressenternas perspektiv och värderingar genomfördes en **enkät med 99 deltagare** som samlade in åsikter om fiskets betydelse och utmaningar. Dessutom genomfördes intervjuer med kartläggning, där **viktiga fiskeplatser, miljöpåverkande faktorer och områden för restaurering** identifierades.



## Fiskets framtid hänger på samarbete – kan vi hitta balansen?

Utforska den interaktiva kartan – skanna för att se fiskeplatser, ekosystemtjänster och miljöpåverkan.



## Vilka Är Utmaningarna?

Många fiskare är oroliga över **minskade fångster** och att bestånden av vild lax och öring minskar. **Predation från skarv** (*Phalarocorax carbo*) och säl (*Halichoerus grypus*) påverkar överlevnaden av unga fiskar, medan **vattenkraftverkens dammar** blockerar vandringsvägar och begränsar naturlig reproduktion.

## Vad Kan Göras?

**Flexibel Fiskeförvaltning** – Policy's bör balansera naturvård och fisketraditioner genom att främja hållbara fiskemetoder. **Återskapa Fiskvandring** – Förbättrade fiskvägar och restaurerade lekplatser kan hjälpa vilda fiskbestånd att återhämta sig. **Inkludera Intressenter** – Samarbete mellan fiskare, forskare och beslut fattare bidrar till en hållbar fiskeförvaltning, medan **utbildningsprogram** främjar ansvarsfullt fiske.

## Varför Är Detta Viktigt?

Fisket i Älvkarleby är mer än en hobby—det är en del av **samhällets kulturarv, ekonomi och identitet**. Utan hållbar förvaltning kan både fiskbestånd och fisketraditioner gå förlorade.

Genom att kombinera naturvårdsinsatser med lokala perspektiv kan vi **skydda både fisken och framtiden för fisket i Älvkarleby**.

# Appendix 1

## Dela din syn på fiske och fiskeområden i Älvkarleby kommun!

Hej! Jag heter Dilara och studerar biologi på vid Sveriges Lantbruksuniversitet. Just nu skriver jag mitt examensarbete om fiske och dess betydelse i Älvkarleby kommun, och behöver din hjälp!



Genom att svara på min enkät kan du dela dina tankar och erfarenheter kring fiske och hjälpa mig att kartlägga de kulturella värden och upplevelser som fisket och naturen bidrar med. Dina svar kan bidra till att förstå hur viktig fisket och fiskeområden är för framtidens natur- och kulturliv i Älvkarleby.

**Klicka på länken eller skanna QR-koden för att delta!**

Sista dagen att svara på enkäten: 22 November.

Din medverkan betyder mycket för mig och är ovärderlig för projektets framgång.



**Tack för ditt stöd och engagemang!**



## Appendix 2

Separate attachment file: Enkät\_Frågor\_Resultat.pdf.zip

## Appendix 3

Overview of all 98 respondents, number and percentage of response per groups.

| <b>Residence</b> | <b>Nr.</b> | <b>%</b> | <b>Fishing<br/>Frequency</b> | <b>Nr.</b> | <b>%</b> | <b>Age</b>                   | <b>Nr.</b> | <b>%</b> |
|------------------|------------|----------|------------------------------|------------|----------|------------------------------|------------|----------|
| Yes              | 47         | 48%      | Every week                   | 28         | 29%      | Younger group<br>(15–40)     | 19         | 19%      |
| No               | 51         | 52%      | Every month                  | 26         | 26%      | Middle-aged<br>group (41–60) | 47         | 48%      |
|                  |            |          | Few times a<br>year          | 30         | 31%      | Older group (61–<br>80)      | 32         | 33%      |
|                  |            |          | Rarely                       | 8          | 8%       |                              |            |          |
|                  |            |          | Never                        | 6          | 6%       |                              |            |          |

Overview of the 92 respondents who do fish (excluding non-fishers), number and percentage of response per groups.

| <b>Residence</b> | <b>Nr.</b> | <b>%</b> | <b>Fishing<br/>Frequency</b> | <b>Nr.</b> | <b>%</b> | <b>Age</b>                   | <b>Nr.</b> | <b>%</b> |
|------------------|------------|----------|------------------------------|------------|----------|------------------------------|------------|----------|
| Yes              | 43         | 47%      | Every week                   | 28         | 30%      | Younger group<br>(15–40)     | 19         | 21%      |
| No               | 49         | 53%      | Every month                  | 26         | 28%      | Middle-aged<br>group (41–60) | 42         | 45%      |
|                  |            |          | Few times a<br>year          | 30         | 33%      | Older group (61–<br>80)      | 31         | 34%      |
|                  |            |          | Rarely                       | 8          | 9%       |                              |            |          |

## Appendix 4

Separate attachment file: ALL\_DATA\_SURVEY.xlsx



# Appendix 5

Separate attachment file :R\_script\_exemple

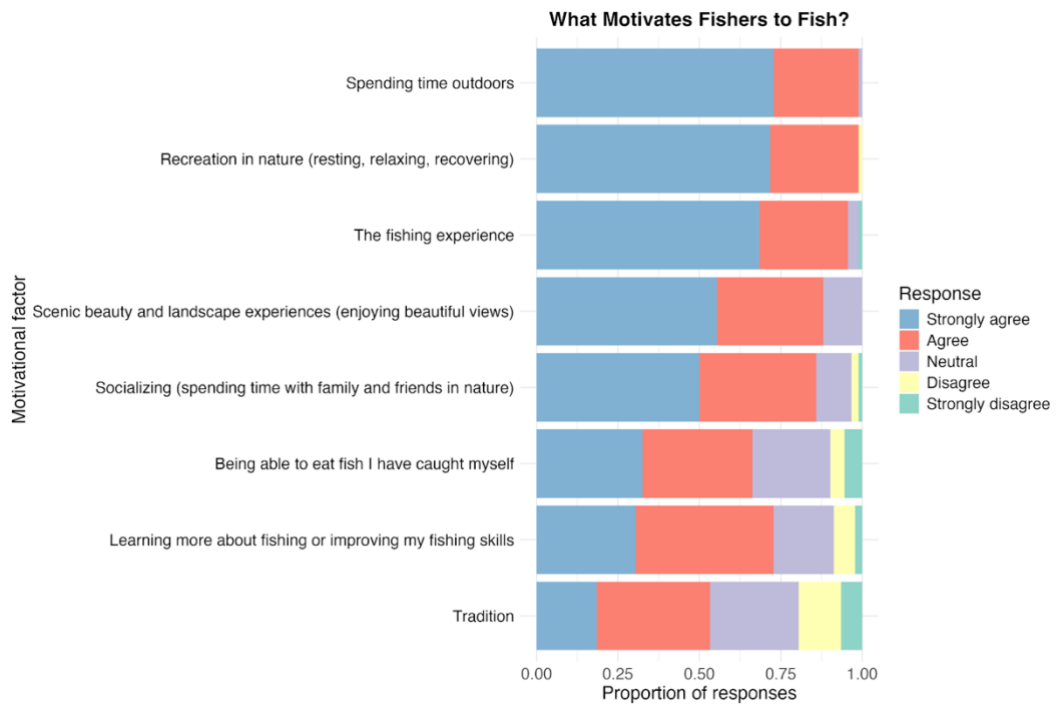
# Appendix 6

Separate attachment file: Intervju\_frågor.pdf

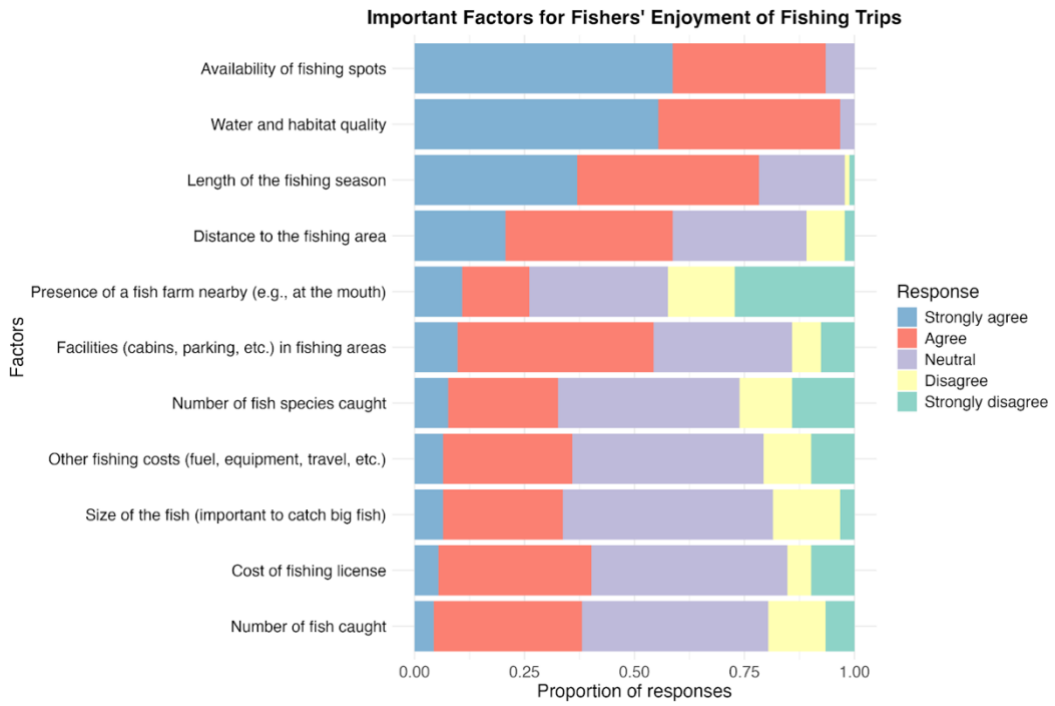
# Appendix 7

Separate attachment file: Attibute\_table.xlsx

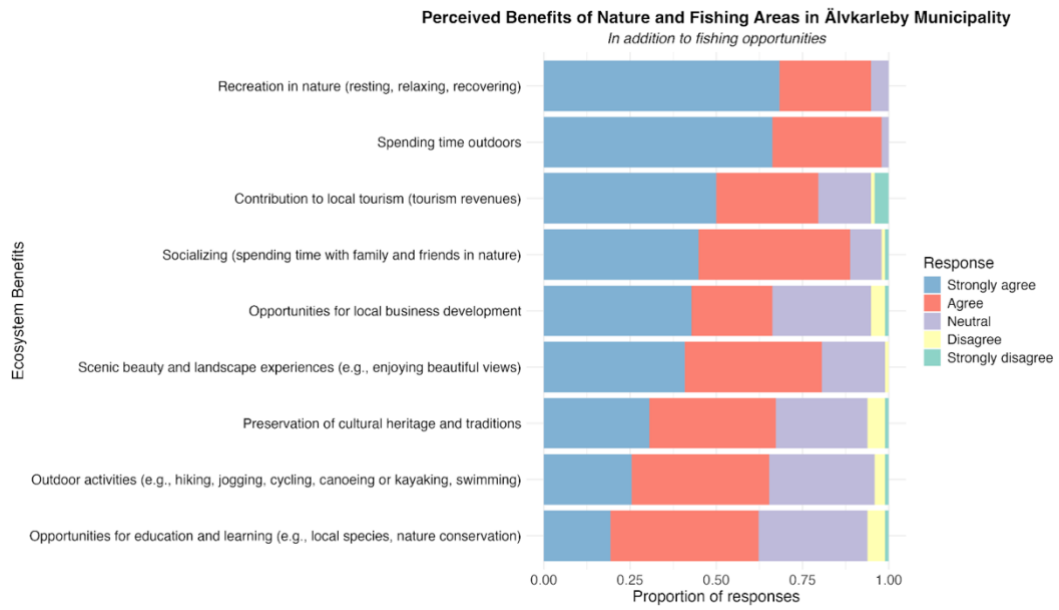
# Appendix 8



# Appendix 9



# Appendix 10



## Appendix 11



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